INTERNATIONAL COMMISSION
for the
CONSERVATION of ATLANTIC TUNAS

R E P O R T
for biennial period, 2022-23
PART II (2023) - Vol. 2
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INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

CONTRACTING PARTIES

(at 31 December 2023)

Albania, Algeria, Angola, Barbados, Belize, Brazil, Cabo Verde, Canada, China (People's Rep.), Côte d'Ivoire, Curaçao, Egypt, El Salvador, Equatorial Guinea, European Union, France (St. Pierre & Miquelon), Gabon, Ghana, Grenada, Guatemala, Guinea (Rep.), Guinea Bissau, Honduras, Iceland, Japan, Korea (Rep.), Liberia, Libya, Mauritania, Mexico, Morocco, Namibia, Nicaragua, Nigeria, Norway, Panama, Philippines, Russia, São Tomé e Príncipe, Senegal, Sierra Leone, South Africa, St Vincent and the Grenadines, Syria, The Gambia, Trinidad & Tobago, Tunisia, Türkiye, United Kingdom of Great Britain and Northern Ireland, United States, Uruguay, Venezuela

COMMISSION OFFICERS

Commission Chairman	*First Vice Chair*	*Second Vice Chair*
E. PENAS LADO, EU (since 23 November 2021)	Z. DRIOUICH, MOROCCO (since 23 November 2021)	R. CHONG, CURAÇAO (since 23 November 2021)

Panel No.	*PANEL MEMBERSHIP*	*Chair*
-1- Tropical tunas	Angola, Barbados, Belize, Brazil, Cabo Verde, Canada, China (P.R.), Côte d'Ivoire, Curaçao, El Salvador, Equatorial Guinea, European Union, France, Gabon, The Gambia, Ghana, Guatemala, Guinea (Rep.), Guinea-Bissau, Honduras, Japan, Korea (Rep.), Liberia, Libya, Mauritania, Mexico, Morocco, Namibia, Nicaragua, Nigeria, Panama, Philippines, Russian Federation, São Tomé e Príncipe, Senegal, Sierra Leone, South Africa, St. Vincent and Grenadines, Trinidad & Tobago, United Kingdom of Great Britan and Northern Ireland, United States of America, Uruguay and Venezuela.	Ghana
-2- Temperate tunas, North	Albania, Algeria, Belize, Cabo Verde, Canada, China (P.R), Egypt, European Union, France (St. Pierre and Miquelon), Iceland, Japan, Korea (Rep.), Libya, Mauritania, Mexico, Morocco, Namibia, Norway, Panama, Russian Federation, Senegal, St. Vincent and the Grenadines, Syria, Tunisia, Türkiye, United Kingdom of Great Britain and Northern Ireland, United States, and Venezuela.	Japan
-3- Temperate tunas, South	Angola, Belize, Brazil, China (P.R.), Côte d'Ivoire, European Union, Japan, Korea (Rep.), Namibia, Panama, Philippines, South Africa, St Vincent and the Grenadines, United Kingdom of Great Britain and Northern Ireland, United States and Uruguay.	South Africa
-4- Other species	Algeria, Angola, Barbados, Belize, Brazil, Cabo Verde, Canada, China (People's Republic), Côte d'Ivoire, Egypt, Equatorial Guinea, European Union, France (St. Pierre & Miquelon), Gabon, The Gambia Guatemala, Guinea Bissau, Guinea (Rep.), Honduras, Japan, Korea (Rep.), Liberia, Libya, Mauritania, Mexico, Morocco, Namibia, Nigeria, Norway, Panama, São Tomé e Príncipe, Senegal, Sierra Leone, South Africa, St. Vincent and the Grenadines, Trinidad and Tobago, Tunisia, Türkiye, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, and Venezuela.	Algeria

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	Chair
STANDING COMMITTEE ON FINANCE & ADMINISTRATION (STACFAD)	D. WARNER-KRAMER, United States (since 23 November 2021)
STANDING COMMITTEE ON RESEARCH & STATISTICS (SCRS) Subcommittee on Statistics: Pedro Lino (European Union), Convener Subcommittee on Ecosystems and Bycatch: A. DOMINGO (Uruguay), A. HANKE (Canada), Conveners	C. BROWN, United States (since 30 September 2022)
CONSERVATION & MANAGEMENT MEASURES COMPLIANCE COMMITTEE (COC)	D. CAMPBELL, United States (since 25 November 2013)
PERMANENT WORKING GROUP FOR THE IMPROVEMENT OF ICCAT STATISTICS AND CONSERVATION MEASURES (PWG)	N. ANSELL, European Union (since 21 November 2017)
STANDING WORKING GROUP TO ENHANCE DIALOGUE BETWEEN FISHERIES SCIENTISTS AND MANAGERS (SWGSM)	E. PENAS LADO, European Union (since 23 November 2021)

ICCAT SECRETARIAT

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FOREWORD

The Chairman of the International Commission for the Conservation of Atlantic Tunas presents his compliments to the Contracting Parties of the International Convention for the Conservation of Atlantic Tunas (signed in Rio de Janeiro, May 14, 1966), as well as to the Delegates and Advisers that represent said Contracting Parties, and has the honor to transmit to them the ***"Report for the Biennial Period, 2022-2023, Part II (2023)"***, which describes the activities of the Commission during the second half of said biennial period.

This issue of the Biennial Report contains the Report of the 28th Regular Meeting of the Commission (Hybrid/New Cairo, Egypt, 13-20 November 2023) and the reports of all the meetings of the Panels, Standing Committees and Sub-Committees, as well as some of the Working Groups. It also includes a summary of the activities of the Secretariat and the Annual Reports of the Contracting Parties of the Commission and Observers, relative to their activities in tuna and tuna-like fisheries in the Convention area.

The Report is published in four volumes. ***Volume 1*** includes the Proceedings of the Commission Meetings and the reports of all the associated meetings (with the exception of the Report of the Standing Committee on Research and Statistics-SCRS). ***Volume 2*** contains the Report of the Standing Committee on Research and Statistics (SCRS) and its appendices. ***Volume 3*** includes the Annual Reports of the Contracting Parties of the Commission. ***Volume 4*** includes the Secretariat's Report on Statistics and Coordination of Research, the Secretariat's Administrative and Financial Reports, and the Secretariat's Reports to the ICCAT Conservation and Management Measures Compliance Committee (COC), and to the Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG). All Volumes of the Biennial Report are only published in electronic format.

This Report has been prepared, approved and distributed in accordance with Article III, paragraph 9, and Article IV, paragraph 2d, of the Convention, and Rule 15 of the Rules of Procedure of the Commission. The Report is available in the three official languages of the Commission: English, French and Spanish.

ERNESTO PENAS LADO
Commission Chairman

Report of the Standing Committee on Research and Statistics (SCRS)
(Hybrid / Madrid (Spain) – 25-29 September 2023)

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Appendices

Report of the Standing Committee on Research and Statistics (SCRS)
(Hybrid/ Madrid (Spain) – 25-29 September 2023)

1. General remarks by the SCRS Chair and the Executive Secretary

The 2023 Meeting of the Standing Committee on Research and Statistics (SCRS), held in a hybrid format, was opened on Monday, 25 September 2023 by Dr Craig Brown, Chair of the Committee. Dr Brown welcomed all the participants to the annual meeting, both online and in person.

General remarks by the SCRS Chair, Dr Craig Brown

The SCRS Chair welcomed all participants, both online and in person, and expressed his appreciation for the level of participation and looked forward to working with everyone during the week. The Chair reminded the Committee of the importance of the task before them, to review the enormous volume of scientific work carried out during the year and distill the consensus scientific advice that is critical for the Commission in carrying out its responsibilities for the management of ICCAT fisheries.

The Chair highlighted some of the accomplishments of the Committee during 2023, made possible through the capable support of the Secretariat, noting that five stocks were assessed, work was carried out toward the development of Candidate Management Procedures or Exceptional Circumstances criteria for eight stocks, and research in many areas was advanced. However, this level of effort overly strained the resources of both the Secretariat and the CPC scientists. Meeting the increasing needs of the Commission for scientific review and advice cannot be sustained at these levels, without additional resources provided to the Secretariat and increased science support from CPCs.

The Chair encouraged participants in their work, expressing his confidence in the successful outcomes of the meeting.

General remarks by the ICCAT Executive Secretary, Mr Camille Jean Pierre Manel

The ICCAT Executive Secretary, Mr Camille Jean Pierre Manel, addressed the meeting, welcomed all the participants and congratulated all the scientists and the Secretariat staff who contributed to the work of the SCRS throughout 2023 with significant progress.

Mr Manel also expressed condolences to the Kingdom of Morocco and Libya, for the recent tragic and catastrophic events, hoping that the resilience of their people will enable them to overcome these events very quickly. He also paid tribute to all the scientific delegates who have left ICCAT, in particular Dr Yukio Takeuchi, delegate from Japan (from 1995 to 2015), who passed away last July.

He noted in 2023, as in previous years, an increasing demand on the Secretariat, the main factor being the number of meetings of all kinds in which it is involved. Although, the SCRS decided to reduce the number of meetings in an effort to lighten the calendar, the overall scientific activity has increased, with a record number of meetings once again in 2023. Mr Manel noted that this steady and worrying increase in the number of meetings has reached a critical point. Without entering into complaints, he reiterated his sole concern of preserving the quality of the Secretariat's contribution with a fulfilled staff, and that the Secretariat believes that there is an urgent need to limit the number of meetings.

Finally, the ICCAT Executive Secretary highlighted the new context that will certainly impact ICCAT with the recent adoption of global instruments, namely the Kunming-Montreal Global Biodiversity Framework and the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement. Although the nature and extent of collaboration, consultation, cooperation and coordination with the relevant global, regional, sub-regional and sectoral bodies has yet to be clarified, RFMOs will potentially be called upon to play a role with regard to certain provisions concerning, in particular, area-based management tools and environmental impact assessment.

The full Executive Secretary speech is contained in **Appendix 1**.

2. Adoption of Agenda and arrangements for the meeting

The Agenda was slightly modified and is provided in **Appendix 2**. Full assessments were carried out this year on North Atlantic albacore (ALB-N), Atlantic sailfish (SAI), and blue shark (BSH). Additionally, intersessional meetings were held for the Subcommittee on Ecosystems and Bycatch, Working Group on Stock Assessment Methods (WGSAM) and the Small Tunas Species Group. Additionally, several meetings of the North Atlantic Swordfish Technical Sub-group on MSE and of Tropical Tunas Species Group (including MSE), as well as two Intersessional Meetings of Panel 1 on MSE and another three of Panel 4 on North Atlantic Swordfish MSE that involved a high number of SCRS delegates.

The following scientists served as rapporteurs of the various species sections (agenda item 9) of the 2023 SCRS Report.

YFT - Yellowfin tuna	S. Cass-Calay
BET - Bigeye tuna	D. Die
SKJ - Skipjack tuna	D. Angueko (East), R. Sant'Ana (West)
ALB - Albacore	H. Arrizabalaga (Atlantic), J. Ortiz de Urbina (Med.)
BFT - Bluefin tuna general	C. Brown (Coordinator), J. Walter (West), E. Rodríguez Marín (East)
BIL - Billfishes	F. Ngom Sow
SWO - Swordfish	K. Gillespie (Coord. and North), B. Mourato (South), G. Tserpes (Med.)
SMT - Small tunas	C. N'Guessan
SMA - Shortfin mako	R. Forselledo
BSH - Blue shark	R. Forselledo
POR - Porbeagle	R. Forselledo
SBF - Southern bluefin	

The Secretariat served as rapporteur for all Agenda items.

3. Introduction of Contracting Party delegations

The Executive Secretary introduced the 33 Contracting Parties present at the 2023 meeting both online and in person: Algeria, Belize, Brazil, Canada, China (P.R.), Côte d'Ivoire, El Salvador, European Union (EU), Gabon, The Gambia, Ghana, Guatemala, Equatorial Guinea, Guinea (Rep.), Japan, Korea (Rep.), Mexico, Morocco, Mauritania, Nicaragua, Nigeria, Norway, Panama, Russian Federation, São Tomé & Príncipe, Senegal, Saint Vicent and the Grenadines, Tunisia, Türkiye, United Kingdom, United States, Uruguay and Venezuela. The List of Participants at the Species Groups Meetings and the Plenary Sessions is attached as **Appendix 3**.

4. Introduction and admission of observers

Representatives from two Cooperating non-Contracting Parties, Entities, or Fishing Entities (Chinese Taipei and Costa Rica), two inter-governmental organizations (Agreement on the Conservation of Albatrosses and Petrels (ACAP), The Ministerial Conference on Fisheries Cooperation among African States bordering the Atlantic Ocean (ATLAFCO/COMHAFAT), two non-Contracting Parties (Colombia, Dominican Republic) and non-governmental organizations (EUROPÊCHE, Federation of European Aquaculture Producers (FEAP), Federation of Maltese Aquaculture Producers (FMAP), International Seafood Sustainability Foundation (ISSF), International Union for Conservation of Nature (IUCN), Marine Stewardship Council (MSC), Pew Charitable Trusts (PEW), Pro Wildlife, Sharkproject International, The Ocean Foundation, The Shark Trust and Worldwide Fund for Nature (WWF)) were admitted as observers and welcomed to the 2023 meeting of the SCRS (see **Appendix 3**).

5. Admission of scientific documents and presentations

As of 23 September 2023, a total of 153 scientific papers and 86 scientific presentations had been submitted at the different SCRS meetings. In 2015 a deadline of seven days before the beginning of the SCRS meetings was established for submitting the full documents and in 2019 it was agreed to also apply the same deadline for the submission of presentations, with the objective of facilitating the work of the rapporteurs in preparing the meeting. Taking into account the limited time that the Groups have to complete their work, adherence to deadlines greatly contributes to improving the work of the SCRS. The List of SCRS Papers and Presentations is attached as **Appendix 4**.

Besides the scientific documents and presentations, there are 13 reports of intersessional meetings and regular Species Groups meetings, 44 Annual Reports from the Contracting Parties, and non-Contracting Cooperating Parties, Entities and Fishing Entities, as well as various documents by the Secretariat.

6. Report of Secretariat activities in research and statistics

The Secretariat summarized its activities, data reported, publications, website updates, and other information contained in the 2023 Secretariat Report on Research and Statistics related to fisheries and biological data submitted for 2022, which included revisions to historical data. The activities and information included in this report refer to the period between 1 October 2022 and 6 September 2023 (the Reporting Period).

Regarding the activities conducted by the Secretariat in the most recent years, in addition to the normal activities on statistics, publications, data funds management and others, the Secretariat dedicated additional work to the preparation and attendance of SCRS meetings, as well as supporting the Commission and SCRS Officers in planning the meetings and managing all related correspondence work and documents. Moreover, it participated in stock assessment activities, and conducted extensive work related to coordination and management of external support for the SCRS data collection and research programmes and activities. The Secretariat's participation in these programmes mainly consisted in both administrative and scientific support, including the coordination of research proposals, calls for tenders, database management, fund administration, and oversight of auditory and accounting responsibilities, as well as IT support for the programmes. As in the past, during 2023 the Secretariat actively participated in all data collection and research programmes components. Finally, the Secretariat highlighted the effort being made in the development of the ICCAT Integrated Online Management System (IOMS), a system designed to manage online all the information associated with the ICCAT data requirements in the future. This is a long-term project intended to entirely replace the current ICCAT data management system.

A total of 57 ICCAT CPCs [52 Contracting Parties (CP), plus 5 Cooperating non-Contracting Parties/Entities/Fishing Entities (NCC)] have reporting obligations to ICCAT. For statistical purposes, this corresponds to a total of 75 flag related CPCs (50 CP + 1 CP [15 EU Member States] + 1 CP [5 UK flag States] + 5 NCC) who have reported information to ICCAT in recent years. The term "flag CPC" was adopted here to refer to those 75 flags. The SCRS report cards (2021 data), the SCRS catalogues (1992-2022), and the overall SCRS scorecards, were some of the instruments used to provide the SCRS with the current Flag CPC fisheries data during the Reporting Period. Various weaknesses in the information submitted were also identified and assistance was provided to CPCs to solve many of these. After five years of continuous improvements, the Secretariat observed in the last four years (2019 to 2022) a slight regression in data completion quality. More datasets have only passed the SCRS filtering criteria after the corrections had been made by the Secretariat (more than 90% of the errors linked to incomplete forms and invalid use of ICCAT codes). In addition, many CPC submissions made use of out of date ICCAT electronic forms. The Secretariat reiterated to the CPCs the Commission's requirement of using the most recent standard electronic forms for data submission and completing all the information requested.

Since the last provision of advice by the SCRS in September 2022, the Secretariat provided support to a total of 42 meetings (SCRS, 22; Commission, 15; Commission/SCRS, 5), in which the Staff was deeply engaged. In addition to these, the Secretariat also provided support to 7 additional workshops and meetings of the SCRS Technical Sub-groups.

The Secretariat has continued the series of periodic publications developed throughout the history of ICCAT, which includes: completed publication of volume 79 (completed issues 1 to 6) and has already published issues 1 to 8 of Volume 80 of the ICCAT Collective Volume of Scientific Papers; Part I of the Biennial Period 2022-2023, corresponding to Volume I (Commission meeting report), Volume II (SCRS Plenary meeting report), Volume III (Annual Reports) and Volume IV (Secretariat reports) were already published throughout 2022. Volume 48 of the Statistical Bulletin was published in an electronic version in

March 2023, which includes the catches and other statistics series for the period 1950 to 2021, and volume 49 will be available in early 2024. All documents presented to the SCRS are now published within the same year of their presentation in the ICCAT Collective Volume of Scientific Papers.

Following the 2019, 2020 and 2021 requests regarding the update and expansion of Chapter 2 of the ICCAT Manual, all new and updated chapters on small tunas and sharks reviewed by SCRS experts in 2022, went through final revisions and were published on the ICCAT website throughout 2023.

The ICCAT website, in the three official languages of the Commission, continues to be updated and new tools are being developed on a regular basis to provide better service to users. One of the major tasks associated with the ICCAT website is the automatic and dynamic use of data from the IOMS system using the IOMS public web services. This year, initial work has started, consisting of experimental development (testing of various techniques and technologies) of web modules for consulting and extracting data directly from the IOMS public application programming interfaces (APIs) for automatic, real-time publication on the ICCAT website.

In 2012, the SCRS approved a protocol to use the Data Fund and other ICCAT funds. This protocol defines a broad structure for use of the funds which includes improvement of statistics, training and support of SCRS work, including attendance to meetings. The protocol also includes the criteria to be followed for allocation of funds.

On the basis of this protocol, in 2023 the funds have been used as follows:

1. *Participation at SCRS meetings:* Financial assistance was provided to 46 delegates from developing CPs.
2. *Improvement of statistics:* With the support of the ICCAT/Japan Capacity-building Assistance Project (JCAP-2), one project was funded: i) Reinforcement of data collection, monitoring for tuna fisheries, and adaptation to the new catch documentation scheme of Statistic System in Belize.
3. *Enhancement of scientific capacity building:* JCAP-2 has also provided the financial support of a researcher from Namibia (Charmaine Jagger) to attend the Workshop on the Shark Research and Data Collection Programme (SRDCP).

To support the SCRS work, during its 2022 Annual Meeting the Commission approved a total amount of €416,635 for the 2023 Science Envelope. In addition, two contracts were signed with the European Union in June 2023 to finance 80% of the scientific activities of the Commission in 2023 (€900,000 + €648,420 for GBYP and other activities, respectively), within the framework of the Strategic Research Programme, that were not covered by the regular budget. In addition, the United States has confirmed its support to cover the costs of the: Enhanced Programme for Billfish Research Data Fund (EPBR), partially the costs of the Workshop of Western Africa Statistical Correspondents on Billfish Data Collection and Reporting held in Abidjan, Côte d'Ivoire, and the First Tropical Tunas Workshop on MSE for scientists (€193,679.00). Finally, Chinese Taipei has contributed €5,000 (€2,000 for EPBR and €3,000 for SRDCP).

The former Head of Administration and Finance, Mr Juan Antonio Moreno retired after 48 years of service at the ICCAT Secretariat. Consequently, Ms. Maria Bonacasa joined as Head of the Department of Administration and Finance in July 2023. Mr Cristóbal Garcia retired in December 2022 after 42 years of service at the Secretariat, and Ms. Ingrid Ferrer joined the Department of Administration and Finance in July 2023, as Administrative Assistant.

Finally, references were made to international cooperation promoted by the Secretariat with several international organization: UN Marine Biodiversity of Areas Beyond National Jurisdiction (BBNJ) process, FAO Committee of Fisheries (COFI), Regional Fishery Body Secretariats' Network (RSN) , FAO Coordinating Working Group on Fishery Statistics (CWP), Fisheries and Resources Monitoring System (FIRMS), Aquatic Sciences and Fisheries Abstracts (ASFA), Global Environment Fund (GEF), General Fisheries Commission for the Mediterranean (GFCM), Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), Tuna Compliance Network (TCN), International Council for the Exploration of the Sea (ICES), Western Central Atlantic Fishery Commission (WECAFC), Mediterranean Advisory Council (MEDAC), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), EU Regional Coordination Group Large Pelagics (RCG LP) and Regional Fishery Body Secretariats' Network (RSN).

Discussion

The Committee acknowledged and thanked the Secretariat for the extensive, efficient and hard work of the Secretariat to deliver the SCRS requests and keeping the usual standards under such an increasing heavy workload.

The Committee acknowledged that the steady and increasing the number of meetings has reached a critical point and agreed on the need to limit the number of meetings to a sustainable level, in line with the available human resources at the Secretariat and the CPCs capacity to engage national scientists in the Committee activities.

7. Review of national fisheries and research programmes

The Annual Reports made available electronically included the information as submitted by CPCs which could be reviewed and validated by the Secretariat by 27 September 2023. Further updates may be required for the Commission, as some information may be pending validation or correction.

Albania

Total catch of marine fisheries of Albania during the year 2022 was 5,502 metric tons and the amount of total bluefin tuna catch was 177.50 metric tons or 3.2% of total catch. The entire bluefin tuna quota was caught by two purse seiner and fishing operations were conducted in the western Mediterranean Sea (HSEA). Catching bluefin tuna started on 26 May 2022 and finished on 17 June 2022. Conservation and management measures regarding bluefin tuna fisheries are regulated by national legislation through laws, regulations and Ministerial Orders, implementing ICCAT related regulations.

Algeria

The national catches of tuna and tuna-like species recorded in 2022 are around 451.478 t for swordfish from a quota of 472.33 t; 1,649.691 t for bluefin tuna from a quota of 1,655 t, including 1,461 kg of dead individuals recorded during the live tuna fishing campaign by tuna purse seiners, and 5 t of bycatch; and 5,241.631 t for small tunas. Shark catch data have been collected in the context of monitoring shark species, for two shark species that are taken as bycatch and incidentally: around 4.767 t of blue shark (*Prionace glauca*) and 1.806 t of thresher shark (*Alopias vulpinus*). 29 Algerian-flagged tuna purse seiners, with a length of between 22 m and 40 m, have participated in the live bluefin tuna fishing campaign. This campaign was divided into five (5) joint fishing groups. As a result of this fishing, 1,649.691 t of bluefin tuna have been caught from the quota of 1,655 t that was allocated to Algeria. An amount of 1,461 kg of dead bluefin tuna have been recorded during the purse seine fishing operations, and an amount of 5 t of bycatch. The national programme for sampling on landing continues in national ports, which enables information on swordfish (*Xiphias gladius*) to be collected. It has been possible to carry out sampling for size and weight. 114 individual specimens were sampled. The size interval ranges from 90 cm to 239 cm.

Belize

As a member of three major RFMOs, ICCAT, IATTC and SPRMFO Belize continues to maintain a compliant fleet in all the areas where our vessels operate. Belize's fishing fleet which operated in the ICCAT area during 2022 comprised purse seiners and longliners which were licensed to target tuna and tuna-like species and their support vessels. Our fleet in previous years consisted predominantly of longliners which fluctuated over the years, followed by purse seine vessels. The total number of tuna longline vessels over the past five years averages 14 vessels while our purse seine fleet averages 8 vessels. Despite the fleet size and structure, the catches of tuna and tuna-like species and sharks have fluctuated over the past five years with catches ranging from 33,208 m/t in 2018, 31,383 m/t in 2019, 31,157 m/t in 2020, 27,772.28 m/t in 2021 to 40,859.80 m/t in 2022, inclusive of tunas, billfishes, and sharks. Skipjack has been the predominant catch for the past several years, amounting to 41% of our overall catches in the past five years. Blue shark, frigate tuna, wahoo, sailfish, dolphinfish continue to be the most commonly incidentally caught species in our overall fishery, inter alia. The compiled data including Task 1 and Task 2 for 2022 and the list of authorized vessels will be reported to the Secretariat on or before the deadline date.

Brazil

In 2022, the Brazilian fleet fishing for tunas and tuna-like fish consisted of 317 fishing boats, including about 240 artisanal and small-scale boats. The Brazilian catch of tunas and tuna-like fish, including marlins, sharks and other species (e.g. wahoo, dolphinfish, etc.) was 60,353 t (live weight), slightly higher than catches recorded in 2021, when 52,519 t were landed. Most of the catches were done by handline fishery (25,374 t; 42%), in associated schools, targeting tropical tunas, mainly YFT (11,982 t). The baitboat fishery accounted for the second largest catch in 2022, representing 32% (19,598 t) of the total tuna and tuna like-fish caught this year, with SKJ accounting for 80% of the fish landed, in weight (15,656 t). Longline catches reached 10,122 t, representing 17% of the total, being made up mainly of BSH (3,046 t), SWO (1,980 t), BET (2,096 t), and YFT (1,220 t). About 39% of all Brazilian catches of tunas and tuna-like fish came from artisanal and small-scale boats (10 to 20 m LOA), based predominantly in the Southeast and Northeast region and targeting YFT, BET, SKJ, DOL, plus a variety of small tuna species, with various fishing gears, including mainly handline, trolling and other surface gears. With the support provided by the Ministry of Fisheries and Aquaculture (MPA) to the Scientific Subcommittee of the Standing Committee for the Management of the Tuna Fisheries in Brazil, several scientific activities were continued in 2022, such as the collection of biological data, including size distribution of the fish caught and research on the bycatch of seabirds and sea turtles in the longline fishery, including the development of measures to avoid their catches.

Canada

Western Atlantic bluefin tuna, northern swordfish, and other tuna species (albacore, bigeye, and yellowfin) are harvested by Canada, primarily within Canada's Exclusive Economic Zone (EEZ). Canada has real time monitoring of catch and effort for all fishing trips targeting pelagic species. Upon completion of each fishing trip, independent and certified dockside monitors must be present for offloading to weigh out the landings, and verify log record data. In 2022, total landings for bluefin tuna, swordfish, and other tuna species were 613.3 t, 1341.5 t, and 555.6 t, respectively. Canada continues to actively support scientific research through: real time monitoring of catch and effort for all fishing trips; updating model indices; acoustic monitoring; tagging programs; and, biological sampling. Canada's leadership role extends to ecosystem related challenges and to the Standing Committee on Research and Statistics (SCRS) itself with assessment support for bluefin tuna, North Atlantic swordfish, and porbeagle shark. In 2022, Canada's bluefin tuna biological sampling program sampled tissue to address questions related to mixing, age-at-length and supports diet, lipid, histological, and genetic analyses of the catch. In 2022, Canada again coordinated the international biological sampling research program for swordfish in the Atlantic Ocean aiming to improve the knowledge of the stock distribution, age and sex of the catch, growth rate, age-at-maturity, maturation rate, spawning season/location, and diet. Canada also continued to coordinate an international sampling program for albacore tuna. For sharks, recent research focused on estimating reproductive characteristics or size-at-maturity for mako and porbeagle, evaluating distributions and population structuring for thresher and shortfin mako, developing data-poor stock assessment methods to contribute to the 2020 porbeagle assessment, quantifying post-release and natural mortality rates for porbeagle and shortfin mako, evaluating covariates with survival and recovery to contribute to bycatch mitigation, as well as continuation of our white shark research program.

China (P.R.)

The Bureau of Fisheries (BOF), Ministry of Agriculture and Rural Affairs of China is in charge of management of distant water fisheries including tuna fishing activities in ICCAT waters. And China Overseas Fisheries Association (COFA) assists BOF with coordination of tuna fisheries activities. China attaches great importance to the ICCAT tuna fishery and priorities were given to abide by the Recommendations and Resolutions adopted by ICCAT. China had set up a series of domestic MCS to implement ICCAT Recommendations by transferring those Recommendations into domestic regulation. China established a monitoring, control and surveillance system, like annual review of each fishing vessel performance, sanction scheme, fishing license system, VMS, logbook, monthly catch report (weekly report for BFT), national observer program, bycatch regulation, CDS and market-related measures, compliance training, setting a catch limit for each vessel on the target and bycatch stocks strictly in accordance with respective ICCAT Recommendations. Fishing vessels which violated management measures will be imposed severe sanctions, including fines, suspension or termination of fishing license, cancelation of qualification to conduct fishing activities and so on. In addition, China holds meetings at national level each year, in which all companies related to tuna fisheries shall participate. During the meeting, we will circulate new ICCAT Recommendations that come into force after translating them into Chinese. We also reiterate key compliance issues, such as catch limit, VMS, observer deployment, logbook, bycatch, transhipment and so on. Non-compliance behaviour for tuna fishing vessels will be punished.

El Salvador

The Republic of El Salvador is a developing country located in Central America, with more than 7 million inhabitants which, due to its social and economic challenges, is dependent on the agricultural production that it yields in its scarce territory of 21,041 km^2, as well as the fishing activity that is carried out in its territorial sea and on the high seas, which is processed on land, and in particular, the tuna canning industry. This fishing activity in the area of the International Commission for the Conservation of Atlantic Tunas (ICCAT) has been carried out since 2015, enabling economic development in this area of activity. The authority responsible for managing fishing activities and aquaculture is the Centre of Fisheries and Aquaculture Development (CENDEPESCA), which is a directorate attached to the Ministry of Agriculture and Livestock. El Salvador regulates the fisheries and aquaculture through implementation of the General Law on Management and Promotion of the Fisheries and Aquaculture. El Salvador's fisheries in the Atlantic use purse seine. In 2022, El Salvador complied with all the ICCAT management measures applicable to its fisheries, and in particular, as regards the fishing possibilities authorised under Recommendation 22-01 for tropical tunas.

Equatorial Guinea

The Republic of Equatorial Guinea has an exclusive economic zone (EEZ) of some 314,000 km2, with 644 km of coastline, and full sovereignty for exploitation of available fishery resources. The jurisdictional waters of the country are divided into two fishing areas: an island area and a continental area. Maritime fishing continues to be directed at catching the main available resources, such as: small coastal pelagics such as sardines, herrings, among others; large ocean pelagics: tuna and tuna-like species; coastal demersal species: snapper, seabream, rooster hind; and finally, deep water species, such as: meagre, shrimp, among others. As regards the two fishing methods employed, the coastal population carries out artisanal fishing as a long-standing tradition and has broad experience in this subsector, while industrial fishing has been undertaken to date by vessels of privately-held companies on the basis of agreements and/or contracts signed with the Ministry in charge. The industrial purse seine fishery is currently operated by Spanish vessel owners and a Senegalese vessel owner that hold tuna fishing licenses. Currently (for the period 2022-2023), issue of tuna licenses has been temporarily suspended by the government. As regards research, the Ministry of Fisheries and Water Resources continues to implement some components of the Project UTF/EQG/005/EQG on Assessment of Marine Fishery Resources in our Exclusive Economic Zone such as: census of artisanal fishers, vessels, etc. For conservation of the marine ecosystem and to ensure reproduction of biological species, the new Law No. 11/2017 of 20 November Regulating Fishing Activity in the Republic of Equatorial Guinea prohibits the use of trawl and purse seine nets, and longlines by the industrial fishery within the area of six (6) nautical miles, measured from the base line. In addition, section 40 of Law No. 7/2003, of 27 November, Regulating the Environment, refers to protection of species in relation to hunting and fishing. The government has also sanctioned a Decree that prohibits hunting of species in danger of extinction, such as sea turtles, large marine mammals (cetaceans). As regards statistics, Equatorial Guinea continues to have issues, since it does not have a national fishing fleet for tuna or the other species. For this purpose, two large projects are currently being implemented in the country: The Project on fishing and processing of tuna and tuna-like species on Annobón Island and the Project to support development of value chains in the Fisheries and Aquaculture Sector (PASPA) at national level, which has already commenced.

European Union

This report presents the fishing activities performed by the EU fleet in the ICCAT Convention area in 2022. The EU Member States with fleets actively fishing in the ICCAT Convention area in 2022 were the following: Croatia, Cyprus, France, Greece, Ireland, Italy, Malta, Portugal, and Spain. The EU fleet was composed of 3,219 commercial vessels with a great diversity in terms of vessel length and fishing gears involved in the different fisheries. Fishing gears include purse seine, longline, pole-and-line, handline, mid-water trawl, troll, baitboat, trap, harpoon, and sport and recreational fishing gears. The EU fleet operates in both the Atlantic and Mediterranean Sea. The main species and stocks regulated by ICCAT that are targeted or taken as bycatch by the EU vessels are: Atlantic and Mediterranean bluefin tuna, Atlantic swordfish, Mediterranean swordfish, tropical tunas (skipjack, yellowfin and bigeye tunas), Atlantic albacore, Mediterranean albacore, blue and white marlins, sharks and small tuna species (bullet tuna, Atlantic bonito, frigate tuna, little tunny and dolphinfish). As in 2022, the total reported EU catches for the main species regulated by ICCAT in the Atlantic Ocean and Mediterranean Sea amounted to 209,458 t, which represents an increase of 4.3% compared to 2021 (200,775 t). The EU fishing patterns remained relatively consistent compared to previous years, with 48.4% of the 2022 catches corresponding to tropical tunas (yellowfin, bigeye and skipjack), 18.3% to commercial sharks and 14% to albacore tuna. Skipjack, blue shark, albacore tuna, yellowfin tuna, bluefin tuna, swordfish and bigeye tuna continued to be the most important ICCAT fisheries resources exploited by the EU fishing fleet, in terms of volume. The EU continues to engage significant financial resources for the funding of studies and research activities in the context of the RFMOs to which it is a member, including in particular ICCAT. Research activities related to ICCAT fisheries are also carried out at national level by the EU Member States.

Gabon

Gabon does not have a tuna fleet. The existing fisheries interact incidentally with the tuna stocks. Moreover, for 2022, the fisheries administration issued licenses to foreign purse seiners for fishing tuna resources. These purse seiners have mainly targeted yellowfin (*Thunnus albacores*), bigeye (*Thunnus obesus*) and skipjack (*Katsuwonus pelamis*). For its part, the national fleet has taken bycatch of small tunas the information of which has been transmitted to the ICCAT Secretariat.

Ghana

The Ghanaian tuna industry exploits the tropical tuna species, namely, skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*). A total of 18 baitboats, and 17 purse seiners were authorized to operate within the EEZ of Ghanaian coastal waters and beyond exploit these tuna species amongst other minor tuna-like species such as the frigate mackerel (*Auxis thazard*) for the year under review. A total of 113,770.50 t of tuna was landed in 2022. The purse seine and baitboat fleets accounted for 91.5% and 8.5% of total catch, respectively. Skipjack was the most dominant (68%) followed by yellowfin (26%) and bigeye (3%). Other tuna-like species amounted to (3%) of the total catch. The reporting year observed an increase in fishing activities of the tuna fleet which can be attributed to the 39.71% increase in catches for year 2022 as against the previous year. More than 90% of the fishing of both fleets were on FADs. Moratorium on fishing on FADs was observed. Sampling of fish at the ports of Tema and Takoradi has improved in addition to more information from logbooks of all fleets. All these data have been incorporated in the 2022 AVDTH database submitted to ICCAT. Beach sampling of billfishes continued off the western coastline of Ghana from artisanal drift gill net operators with no catches of Atlantic sailfish and white marlin. Blue marlin and swordfish recorded a total 120.8 t and 16.4 t respectively for the recorded period. Sharks when caught by purse seiners during observer missions were released live; estimates of sharks from the artisanal fishery were obtained from the western shelf of Ghana. Drift nets are also used in capturing sharks which are consumed locally with no bycatch and discards in the fishery.

Guatemala

The State of Guatemala is a member the International Commission for the Conservation of Atlantic Tunas (ICCAT) and confirms its commitment to comply and participate in line with each of its responsibilities in the fishery. In Guatemala, fisheries management is carried out through the Directorate of Fisheries Regulations and Aquaculture, which is part of the Ministry of Agriculture, Livestock and Food. The main hydrobiological resource in international trade are the tuna fisheries. We have worked together with the industry, providing them with the necessary tools, which have been reviewed, reconciled and approved by the Commission. The work has been carried out with a regional approach, in conjunction with other countries that are Contracting Parties of the Commission. Guatemala has also made the necessary efforts so that the work is reflected in compliance with its obligations, actively participating in the meetings and providing information to the advisory scientific committee. Given the mandatory nature of the management measures for the tropical tunas and related species fisheries, in 2022, 2 purse seine vessels were registered to carry out fishing operations in the area of the Commission, taking a total catch of 11,931 t of tropical tunas, which break down as follows: 6,839 t of skipjack, 4,237 t of yellowfin, 855 t of bigeye.

Japan

Longline is the only tuna-fishing gear deployed by Japan at present in the Atlantic Ocean. 95% of logbook data from the Japanese longline fleet operating in the Atlantic in 2022 have been analyzed and included in this report (provisional). In 2022, the number of fishing days was 10,700 which was 76% of past ten years' average. The catch of tunas and tuna-like fishes (excluding sharks) in 2022 is estimated to be about 20,000 t, which is about 88 % of past ten years' average. In 2022, the most dominant species was bigeye tuna, representing 56% of the total tuna and tuna-like fish catch in weight. The second dominant species was yellowfin tuna occupying 21% and third one was bluefin tuna (18%). A total of 443 fishing days were monitored by observers in 2022 covering 4.2% of the entire operations.

Korea (Rep.)

In 2022, Korea has only longline fishery for tunas and tuna-like species in the Atlantic Ocean, and the coverage of data reporting was 100%. 9 Korean longline vessels engaged in fishing in the Atlantic Ocean, and fishing effort (No. of days fished) was 1,616 days, which is increased by 10% compared to 2021. Total catch was 3,067 t, which is also increased by 15% compared to 2021. The catches of Atlantic bluefin tuna, bigeye tuna and yellowfin tuna were 252 t (8%), 763 t (25%) and 481 t (16%), respectively. All Atlantic bluefin tuna were caught within 16°-28°W and 55°-60°N. Except for fishing operations targeting Atlantic and southern bluefin tunas, most of fishing efforts were focused on the areas of 10°E-40°W and 16°N-37°S. Three observers were deployed on board the Korean tuna longline vessels, and the observer coverage in Atlantic Ocean was 16% (No. of sets) in 2022.

Mauritania

In Mauritania, high seas tuna species were only targeted by foreign fleets operating under bilateral agreements and free licence arrangements. The fleets of these Contracting Parties which comprised in 2022 some 59 tuna vessels (52 purse seiners, 4 baitboats and 3 longliners) landed their products in foreign ports. Coastal tuna species were taken as bycatch by small pelagic high seas vessels. These statistics show that bycatch of high seas tuna taken by the high seas fishery in 2022 amounted to 18,836 t (i.e. an increase of 114% as compared with 2021*)* and essentially comprised *Sarda sarda* (58%), compared to Euthynnus sp (30%) and *Auxis thazard* (12%). Catches landed by the artisanal fishery and coastal fisheries have decreased -79% in 2022 compared to 2021. It should be noted that landings of tuna by purse seine in Mauritania are generally taken at night, and are not covered by the current monitoring system. A monitoring programme for these fisheries should be envisaged to strengthen data collection on small tunas and tropical tunas during the times not covered by the Artisanal and Coastal Fishery Monitoring System (SSPAC). Finally, several research programmes focussed on the study of some tuna species were launched by the IMROP in 2016 and 2017 with financial support from ICCAT; in particular, a programme to collect available data and information on the presence of bluefin tuna in the Mauritania area in 2016 and another programme to collect biological data in order to study the size structures and growth parameters and develop approaches to recover catches of these species from 2000 to 2016. Since 2018, the delegation of Mauritania to ICCAT has petitioned ICCAT regarding increased monitoring of the fisheries and bycatch of these tuna species.

Mexico

This report describes the characteristics of the longline yellowfin tuna (*Thunnus albacares*) fishery in the Gulf of Mexico as well as the species that make up the bycatch, while highlighting compliance with national regulations and/or implementation of the recommendations and resolutions adopted by the International Commission for the Conservation of Atlantic Tunas (ICCAT). It should be noted that fishing for yellowfin tuna in the Gulf of Mexico is carried out by midwater longline vessels. In addition to the target species, other species are also taken as bycatch such as: skipjack (*Katsuwonus pelamis*), bigeye tuna (*Thunnus obesus*), Atlantic bluefin tuna (*Thunnus thynnus*), shark and swordfish, among others. The regulatory framework that governs this fishery in Mexico includes the General Law on Sustainable Fishing and Aquaculture (LGPAS), and the Official Mexican Standard NOM-023-SAG/PESC-2014 that regulates exploitation of tuna species by longline vessels in waters of federal jurisdiction of the Gulf of Mexico and the Caribbean Sea, which is updated periodically to incorporate the regulations adopted by ICCAT. The Secretariat of Agriculture and Rural Development (SADER), through the National Aquaculture and Fisheries Commission (CONAPESCA), is the national authority in charge of implementing policies, programmes and regulations that facilitate competitive and sustainable development of Mexico's fisheries and aquaculture sector. For its part, the National Institute of Fisheries and Aquaculture (INAPESCA) is responsible for carrying out scientific research and collecting data on the longline tuna fishery in the Gulf of Mexico.

Morocco

The tuna and tuna-like species fishery attained a production of 24,255.58 t in 2022 compared to 19,519.96 t in 2021, which is a volume increase of 24.26%. The main species caught off the coasts of Morocco are bluefin tuna, swordfish, bigeye, yellowfin, skipjack, small tunas, and sharks. Collection of statistical data on fishing and effort is carried out virtually exhaustively through the fisheries administrative structures (Department of Maritime Fisheries and the National Fisheries Office), located along Morocco's Atlantic and Mediterranean coasts. A subsequent control is also carried out by the Exchange Office on exports of fishing products. As regards science, the National Institute of Fisheries Research (INRH), through its Regional Centres (6), which cover the entire Moroccan coastline, has strengthened collection of biological data on the major species (bluefin tuna and swordfish). The Regional Centre of the INRH in Tangier coordinates the collection and analysis of all these data. In recent years, monitoring has started of other species, in particular, the tropical species (bigeye tuna, among others), small tunas, and pelagic sharks especially in the areas to the South of Morocco. There has been significant progress in collection of statistical and biological data, as evidenced by the number of scientific papers, and the Task 2 data, submitted by Moroccan researchers to the different SCRS scientific meetings, for the purposes of tuna stock assessments.

Nicaragua

The Republic of Nicaragua has not carried out any positive fishing activity in the Convention area since the country does not yet operate national or chartered fishing fleets. Notwithstanding, Nicaragua complies with the obligation to provide data on zero catches and fishing inactivity.

Norway

Norway was allocated a quota of 300 tonnes of eastern bluefin tuna (*Thunnus thynnus*) for 2022. In addition to this, 5% of the unused quota from 2021 was carried over to 2022. Thus, the total Norwegian quota in 2022 was 315 tonnes. Due to bad weather conditions, the quota was not exhausted. Numerous observations of Atlantic bluefin tuna continued to be made, also in 2022, along the Norwegian coast and in offshore waters from late June to October, with the majority of observations made in August and September. Norway put a lot of effort into obtaining biological, ecological and genetic samples and data from Atlantic bluefin tuna caught in 2022. Norway continuously works on present and historical data on tuna and tuna-like species and aims to incorporate the data on these species into an ecosystem perspective. Norway participated at Management Strategy Evaluation (MSE) related meetings on bluefin tuna and at the SCRS annual science meeting also in 2022.

Panama

95% of small, medium and large-scale fishing activities are carried out in the waters of the Panamanian Pacific Ocean, within the Exclusive Economic Zone (EEZ). Therefore, only 5% of the fishing activities carried out in the Panamanian Caribbean, Atlantic Ocean, are artisanal; but an important fishery is also developed on the high seas by purse seine and longline vessels with international fishing licenses which have historically targeted tuna. The artisanal fishery operating in the Panamanian Caribbean, is sectorised towards the northern area of the country with a short continental shelf that enables development of fishing activities associated with rocky substrata, mainly the catching of lobster (*Panulirus argus*), and to a lesser extent, extraction of octopus and crab. As regards the international fisheries service, Panama maintains a register of vessels that engage in fishing and fishing related activities in the Atlantic Ocean, including the specifications and sizes, fishing gears, authorised species and fishing areas. Currently, the fleet with international fishing licenses comprises longline and purse seine vessels fishing mainly for yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonus pelamis*) and associated species.

Russian Federation

Fishery. In 2022 and 2023, a specialized (purse seine) tuna fishery fleet flying the Russian flag did not carry out any operations. In 2022, trawl vessels caught 366 t of 4 small tuna species and 6,969 t of Atlantic bonito as bycatch in the eastern central Atlantic.

In the first half of 2023, the trawl vessels caught 150.5 t of 3 small tuna species and 420.5 t of Atlantic bonito.

Research and statistics. In 2022, observers of the Atlantic branch of VNIRO (AtlantNIRO) sampled biological and fishery materials on tuna species aboard trawl vessels in the eastern central Atlantic (area BIL94B according to the ICCAT classification). Fish length, weight, sex and maturity stages of gonads as well as stomach fullness were measured. Species from the small tunas group occurred in trawls as bycatch, individually or up to several tons. 5803 specimens of material from frigate tuna, bullet tuna, oceanic skipjack and Atlantic bonito were collected for length measurement and 1,091 specimens for biological analyses.

Implementation of the ICCAT conservation and management measures. In course of the trawl fishery in the areas where tuna and tuna-like species occurred in the catches as bycatch, the ICCAT requirements and recommendations concerning compliance with restrictions on the tuna fishery and a ban on fishing for quota species were applied.

Senegal

In Senegal, tuna and tuna-like species are fished by the industrial and artisanal fleets. In 2022, the Senegalese industrial tuna fishing fleet comprised five (5) baitboat vessels and seven (7) purse seiners that exploited mainly Atlantic tropical tunas, in particular yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*) and skipjack (*Katsuwonus pelamis*). Some gears of the artisanal fishery also target or bycatch billfish (marlins and sailfish), large tunas, small tunas (Atlantic black skipjack, mackerel, bonito, Atlantic bonito, frigate tuna etc.) and shark. In 2022, total catches of tropical tunas taken by Senegalese baitboats and purse seiners amounted to around 55,181 t (42,467 t in 2021). The total catch of the five (5) Senegalese baitboats is estimated at 1,614 t for 2022 (1,845 t in 2021), with 802 t of skipjack, 721 t of yellowfin and 92 t of bigeye. The tropical tuna catches for 2022 of Senegalese purse seiners are estimated at 53,567 t (40,622 t in 2021), with 8,673 t of yellowfin, 38,928 t of skipjack, 645 t of bigeye and 5,321 t of small tunas (frigate tuna and Atlantic black skipjack). It should be noted that 86% (45,574 t) of catches are taken under floating objects (FOBs), 7,993 t on free schools. The fishing effort deployed in 2022 by the industrial tuna fleet was 870 days at sea and 700 fishing days for baitboats, and 1,694 fishing days and 1,738 days at sea for Senegalese purse seiners. The total catches of all species combined of the artisanal fishery for 2022 are estimated to have decreased 26% compared to 2021 (17,711 t).

St Vincent and the Grenadines

St Vincent and the Grenadines is a small island developing State which continues to explore all available sources of revenue in order to ensure food security for its people while meeting the challenges of sustainable utilization and a changing global environment. These efforts must be in compliance with acceptable international practices and standards and St Vincent and the Grenadines continues to develop, refine and implement the relevant legislative, management, monitoring, control and surveillance (MCS) mechanisms with regards to its fishing fleet. These measures are geared towards ensuring the activities of the fishing fleet are fully compliant with the conservation and management initiatives taken by ICCAT and other relevant organizations. During the 2022 reporting period, St Vincent and the Grenadines' fishing fleet operating in the ICCAT conservation area comprised longline fishing vessels that target tuna and tuna-like species on the high seas and smaller vessels operated by outboard engines that target tuna and tuna-like species within the exclusive economic zone. The vessels that fished on the high seas were foreign owned and registered with the St Vincent and the Grenadines Maritime Department. The total number of high seas longline tuna vessels that operated in the ICCAT Convention area during 2022 was four (4). The vessels started fishing with a St Vincent and the Grenadines fishing license in January 2022, which expired in May 2022. Hence, the data reported were for the period January to May 2022.

Tunisia

The tuna and tuna-like management and conservation plans are essentially governed by the provisions of Law No. 94-13 of 31 January 1994 and its implementing texts. In 2022, as for previous years, these plans were supported by implementation of all the control programmes (onboard observers programme) and the at-sea and in-port inspection programmes, in particular during the periods of prohibition on fishing for bluefin tuna and swordfish. In preparation for the 2022 bluefin tuna fishing campaign, Tunisia has adjusted its fishing capacity in accordance with the methodology adopted by ICCAT (Rec. 19-04). Based on this methodology, Tunisia established a fishing plan, allocating individual quotas to 48 vessels to fish for bluefin tuna in 2022. In this context and within the framework of improvement of collection of bluefin tuna catch statistics and monitoring of implementation of action taken to mitigate bycatch and discards in the tuna and swordfish fisheries, the relevant authority, in addition to catch documentation, has achieved a scientific observer coverage of its tuna fisheries of more than 10%. Allocation of quotas for bluefin tuna fishing and fine-tuning of gears targeting swordfish have greatly reduced bycatch; in 2022, no bycatch of sea turtles, sea birds, shark or sea mammals was reported by the national scientific observers programme. Total catches of bluefin tuna for 2022 amounted to 2,659.337 t, with 2,652.787 t taken by purse seine vessels authorised to fish for bluefin tuna. Regarding its contribution to the scientific research programme, Tunisia carries out different research activities on bluefin tuna, swordfish and small tunas. These activities are defined taking into account ICCAT recommendations and SCRS priorities.

Türkiye

Total marine fisheries production of Türkiye has been 335,003 t for the year 2022. The portion of tuna and tuna-like fish in the total catch was 16% corresponding to 53,889 t, including Mediterranean swordfish. In 2022, the catch amounts of bluefin tuna, swordfish, albacore, bullet tuna, Atlantic bonito and little tunny were 2,292 t, 378.7 t, 118 t, 808.9 t, 49,891.5 t and 410 t, respectively. Most of the bluefin tunas were caught by purse seiners, which have an overall length of 35-62 meters. The fishing operations were conducted intensively off Antalya Bay in southern Türkiye and in the central Mediterranean region in international waters off the coast of Malta. Bluefin tuna started to be caught on 15 May, finishing on 1 July. The conservation and management measures related to swordfish, the bluefin tuna fisheries and farming are regulated by national legislation through notifications, taking into account the related ICCAT regulations.

United Kingdom

The United Kingdom 2022 Annual Report provides information for both Metropolitan (Met) UK and the United Kingdom Overseas Territories (UKOTs) of Bermuda, British Virgin Islands, St Helena (including Ascension Island and Tristan da Cunha) and Turks and Caicos Islands. Met UK's only commercial/targeted ICCAT fishery is for albacore and uses midwater trawl gear. Catches from this fishery account for the majority of Met UK catches and totalled 120.8 metric tonnes (t) in 2022. The two vessels operating in the albacore fishery have Length overall (LOA) of 19.5m and 25m respectively. There are some incidences of bycatches of ICCAT species in fisheries utilising other gear types, predominantly gillnets and small purse seines which target non-ICCAT pelagic species. Bycatch accounts for 8% (10.7 t) of Met UK's total catch of ICCAT species. The fishing fleets of the UKOTs are small scale and deploy limited effort, mostly in close proximity to their shores. Offshore fishing, where conducted, is associated with seamounts within the UKOTs' respective maritime zones. The typical fishing gears utilised are rod-and-reel, trolling, pole-and-line, and handline. Use of these gears minimises the incidental capture of non-target species which are more typically taken as bycatch in fisheries using other, more industrial fishing methods. In addition, Bermuda continues to operate a single longline vessel, of <20 m LOA. The UK landed 317 t in total in 2022 (Met UK, 131 t; Bermuda, 98 t; British Virgin Islands, 11 t; St Helena, 77 t; Turks and Caicos Islands, 0 t). Total catches in 2022 decreased vs 2021, which is mainly due to the decrease in North Atlantic albacore catches by Met UK. UKOT activity remains diverse, ranging from no commercial activity by Turks and Caicos Islands (TCI) to reasonably consistent fisheries by Bermuda and St Helena. All UKOTs have ambitions to expand capacity to fish ICCAT species within their respective maritime zones. In 2022, Met UK and St Helena continued their tagging programmes, with Met UK tagging over 1,100 bluefin tuna and St Helena tagging 1,042 fish (yellowfin, skipjack and bigeye tuna).

United States

Total (preliminary) reported U.S. catch of main tunas (YFT, SKJ, BET, ALB, BFT) and swordfish for 2022 was 12,071 MT, an increase of about 59% from 7,562 MT in 2021. This total catch includes estimates of dead discards for tropical tunas, BFT, and SWO. Swordfish catches (including estimated dead discards) increased from 1,283 MT in 2021 to 1,339 MT in 2022, and provisional landings from the U.S. fishery for yellowfin tuna increased in 2022 to 7,749 MT from 3,960 MT in 2021. In 2022, U.S. vessels fishing in the Northwest Atlantic caught an estimated 1,362 MT of bluefin tuna, an increase of about 156 MT compared to 2021 (1,206 MT). Provisional skipjack tuna landings increased by about 38 MT to 103 MT from 2021 to 2022, bigeye tuna landings increased by 243 MT compared to 2021 to an estimated 1,208 MT in 2022, and albacore landings increased from 2021 to 2022 by 16 MT to 310 MT. The U.S. continues to monitor its pelagic longline fleet with its observer program with a target coverage of 8%. However, the achieved target has been over 10% in the past several years. Domestic management of ICCAT species includes the implementation of minimum size limits, time/area closures, and the mandatory use of circle hooks. The U.S. has also conducted extensive research, including tagging activities, on ICCAT species. Details of such research can be found in the main text of the report.

Uruguay

In 2022, the Uruguayan tuna fleet did not carry out any activity due to different factors. Moreover, it has not yet been possible to return to normal following the decrease in fishing activity and research at national level as a result of the COVID-19 pandemic, with many activities being suspended including some which were reflected in ICCAT related matters. Despite this, the analysis of historical catches and effort statistics of species of interest to the Commission was continued. Uruguay participated in and provided papers for several SCRS meetings, including the Intersessional Meeting of the Shark Species Group, the Atlantic Swordfish and Skipjack Data Preparatory and Stock Assessment Meetings, the Northeast Atlantic porbeagle assessment meetings, and the Meeting of the Subcommittee on Ecosystems and Bycatch. The work to control third party vessels in port continued, having started in 2009. Port inspections were carried out to determine which species had been landed, their origin and to control formal aspects of vessel documentation. All ICCAT Recommendations adopted at the 2022 Commission meeting have been implemented into Uruguayan law, and are currently in force through decree.

Venezuela

In 2022, the Venezuelan fleet directed at pelagic resources and operating in the Atlantic Ocean was made up of 89 industrial vessels: 84 longliners, 3 purse seiners and 2 baitboats. This year some 4,412.582 t of catches of tuna and tuna-like species were taken in the Atlantic Ocean. 78.42% of landings are tuna, yellowfin tuna (*Thunnus albacares*) being the most important (71.78 %), while skipjack tuna (*Katsuwonus pelamis*), bigeye tuna (*Thunnus obesus*), albacore (*Thunnus alalunga*), frigate tuna (*Auxis thazard*) and Atlantic blackfin tuna (*Thunnus atlanticus*) accounted for 4.82%, 0.88%, 0.72%, 0.12% and 0.078%, respectively. Bycatch of tuna-like species comprised billfish, including sailfish (*Istiophorus albicans*) (8.40%), and oceanic shark whose landings represent 0.24%, blue shark (*Prionace glauca*) being the most significant within this group (0.20%). 75.86% of landings were taken by the longline fishery, 20.13% by purse seine and 4.01% by baitboat. In 2022 research continued on the large pelagics fishery; these include tuna, billfish and shark.

Chinese Taipei

In 2022, the number of our authorized fishing vessels in ICCAT waters was 84, with 54 targeting bigeye tuna and 30 targeting albacore. The total catch of tuna and tuna-like species was about 22,599 t. Albacore was the most dominant species, which accounted for 52% of the total catch in weight, followed by bigeye tuna with catch accounting for 36% of the total catch. In general, Chinese Taipei fully implemented ICCAT conservation and management measures in 2022. All longline vessels operating in the ICCAT Convention area have been equipped with satellite tracking devices (Vessel Monitoring System, VMS) on board to automatically transmit a message of vessel position to our Fisheries Monitoring Center every 4 hours, and every hour since 30 January 2018. Captains of Chinese Taipei-flagged fishing vessels have been required to fully and accurately fill in the catch logbooks and electronic logbooks. In order to comply with the catch limits set by ICCAT, individual quota management has been conducted by the Fisheries Agency for Atlantic bigeye tuna, blue marlin and white marlin/roundscale spearfish, northern and southern Atlantic albacore and swordfish, and South Atlantic shortfin mako. The catches of those species were well below catch limits allocated by ICCAT for 2022. Regarding the requirements of ICCAT shark recommendations, Chinese Taipei has taken several measures, including enhancing data collection and prohibition of retaining, transshipping, landing, storing, or selling bigeye thresher shark, hammerhead sharks, oceanic whitetip shark, silky shark, and North Atlantic shortfin mako shark. We have carried out a scientific observer program in ICCAT waters since 2002. In 2022, 14 observers were deployed on fishing vessels operating in the Atlantic Ocean, and the observer coverage rate was 4.03% and 12.28% for albacore and bigeye tuna fleets, respectively. The research programs conducted by scientists in 2023 included research on bigeye tuna, albacore, yellowfin tuna, swordfish, and blue shark. The research results were presented at the intersessional working group meetings and regular meetings of the SCRS. As for the reporting obligation, the related statistical data and information required by ICCAT Recommendations were submitted to the ICCAT Secretariat within the required timeframe.

Costa Rica

In Costa Rica, the Costa Rican Institute of Fisheries and Aquaculture is the competent authority for implementation of fisheries development policies and technical management of the national fisheries. Costa Rica has a limited Exclusive Economic Zone in the Caribbean Sea of only 24,000 square kilometres, and due to its bathymetry and extension, very conservative development of artisanal fishing has taken place. There is ongoing research and analysis work based mainly on the catch and data analysis programmes, as well as control, monitoring and surveillance of compliance with management measures. In 2022, Costa Rica had a registered artisanal fleet of 216 vessels in the Caribbean Sea, of which 14 vessels target species within the Commission, using surface longline fishing gear. The remainder of the vessels are directed at more coastal fishing. Costa Rica initiated an Amendment Plan in 2021 with the objective of improving the collection of statistical data from the Caribbean Sea fishery, which were submitted as an attachment to the 2020 Annual Report. The aim is to improve management of the national fisheries in order to fully comply with ICCAT recommendations. A robust Vessel Monitoring System (VMS) is in place and implementation of a satellite vessel monitoring system (VMS) for the entire medium-scale commercial fleet started in 2022. Moreover, the forms for collecting data during fishing operations were modified in order to improve fishing information. In addition, biological sampling on landings was started in 2022 to obtain more information and a pilot onboard observers scheme (human and electronic) is currently being implemented, which would be the basis for the design of the onboard observer programme.

8. Reports of intersessional SCRS meetings

Below you will find information and quick access to all Detailed Reports of the intersessional meetings held in 2023. All reports are posted in the ICCAT Past meetings webpage and all information related to the Detailed Reports is included in the table below.

Detailed Report	***SCRS No.***
First Intersessional Meeting of the North Atlantic Swordfish MSE Technical Sub-group	SCRS/2023/001
Intersessional Meeting of the Tropical Tunas Species Group (including MSE)	SCRS/2023/002
North Atlantic Albacore Data Preparatory Meeting (including MSE)	SCRS/2023/003
Blue Shark Data Preparatory meeting	SCRS/2023/004
Meeting of the Subcommittee on Ecosystems and Bycatch	SCRS/2023/005
Intersessional Meeting of the Small Tunas Species Group	SCRS/2023/006
Meeting of the Working Group on Stock Assessment Methods (WGSAM)	SCRS/2023/007
Intersessional Meeting of the Swordfish Species Group (including MSE)	SCRS/2023/008
Sailfish Data Preparatory and Stock Assessment Meeting	SCRS/2023/009
Atlantic Albacore Stock Assessment Meeting (including MSE)	SCRS/2023/010
Climate Change Experts Meeting	
Blue Shark Stock Assessment meeting	SCRS/2023/011
Second Intersessional Meeting of the North Atlantic Swordfish MSE Technical Sub-group	SCRS/2023/012

The Committee discussed and agreed that the individual intersessional meeting summaries (previously contained within Section 8) would not be included in the 2023 annual SCRS report, nor would they be produced for future SCRS annual reports. If the Committee requires making specific notes about any particular intersessional meeting, they will add a footnote to the table contained in Section 8 where all intersessional meetings are listed with the associated links to the full meeting reports.

Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch

The Committee acknowledged and congratulated the Subcommittee on Ecosystems and Bycatch for all their work done and the progress achieved.

Pertaining to the ecosystem component

The Committee noted that while few SCRS exercises have focused on the consideration of Climate Change impacts, a lot of science literature exists that could inform on those exercises. It discussed how to compile and review this literature given the current capacity and obligations of the Subcommittee.

It was recognized by the Committee that the Ecosystem Report Card (EcoCard) appeared to require considerable effort to complete, and it is growing into a very large document. The Committee inquired about the possibility of preparing a reduced version of the EcoCard to present to the Commission. Such a reduced version could be continued to be updated over time to include more elements. It was clarified that a Sub-group of the Subcommittee would be reviewing the regular production of the EcoCard in connection with a scoping exercise to be conducted in the first quarter of 2024.

The Committee also inquired about the progress to develop the evergreen document which contains the ecosystem overviews and other aspects of the implementation of an Ecosystem Approach to Fisheries Management (EAFM) framework for ICCAT. It was noted that a review of the draft version of the document is scheduled to occur at the meeting of the Sub-group.

Finally, the Committee voiced concerns about the impact that offshore wind farms have on the ecosystem and fisheries. Given the rapid expansion of offshore wind development in areas of overlap with ICCAT species, fisheries and surveys, the Subcommittee was requested to develop a document that outlines the key scientific and management concerns related to offshore wind and ICCAT species. Individual CPC scientists were encouraged to monitor progress of offshore wind development and its potential impacts, as well as to participate in existing International Council on the Exploration of the Sea (ICES) working groups related to offshore wind.

Atlantic Albacore Stock Assessment Meeting (including MSE)

The Committee acknowledged the work carried out the stock assessment for ALB-N stock, currently under a Management Procedure (MP). It was noted that it is important the Executive Summary to clarify that the assessment results are used to characterize stock status, not for providing management advice. It was noted that the management advice is based on the application of the adopted MP and the confirmation that no exceptional circumstance (EC) was found that precludes its application for providing total allowable catch (TAC) advice for 2024-2025.

The Committee also inquired on the availability and number of indices of abundance used for evaluating the ALB-N ECs protocol. It was indicated that one index was not available this year, but that it was used as a combined index with other indices, as such their absence impact was minimized.

With regards to the ALB-MD, it was noted that the Commission has requested a stock assessment in 2024. However, the Committee indicated the relatively short time since the last full evaluation (2021). Moreover, it was indicated that the Committee should provide to the Commission some advice on the relevance and *importance of stock evaluations for 2024.*

Climate Change Experts Meeting

The Chair summarized the discussions on the Climate Change Experts Meeting, highlighting the active participation of SCRS scientists. The Committee indicated the need to have a wide and inclusive SCRS programme to address Climate Change matters, that should include all ICCAT Species Groups. It was also noted the importance of having a consolidation on current knowledge on this topic and its impact on ICCAT fisheries, as there are scientific works already undertaken that are not normally presented to the Committee.

It was also indicated that the draft ICCAT Plan of Action on Climate Change proposed by the Chair of the Climate Change Working Group is quite ambitious and will require substantial resources from both the SCRS and the Secretariat, which are not indicated in the plan provided. Finally, the Committee recommended that the SCRS be more proactive, by discussing and providing to the Commission the scientific advice on the proposed plan, instead of waiting for the Commission decisions on Climate Change in the framework of the ICCAT management of fisheries resources.

9. Executive Summaries on species

The Committee reiterated that in order to achieve a more rigorous understanding of these Executive Summaries from a scientific point of view, the previous Executive Summaries should be consulted, as well as the corresponding detailed reports which are published in the *Collective Volume of Scientific Papers.*

The Committee also pointed out that the texts and tables of these Summaries generally reflect the information available in ICCAT immediately prior to the SCRS plenary sessions, since they were prepared during the meetings of the Species Groups. Therefore, the catches reported to ICCAT during or after the SCRS meeting cannot be included in these Summaries.

The Committee decided to split the former Executive Summary of albacore into two Executive Summaries, one for Atlantic albacore and another one for Mediterranean albacore. In addition, three Executive Summaries are being provided for the shark species (shortfin mako, blue shark and porbeagle) instead of the usual single Executive Summary for major shark species.

9.1 YFT - Yellowfin

The most recent stock assessment for yellowfin tuna was conducted in 2019 using catch and effort data through 2018, although catch reports for 2018 were incomplete at the time of the stock assessment meeting, with 42% of the total catch being estimated using the average of the previous three years, by CPC and gear type. Species composition and catch at size from Ghanaian baitboats and purse seiners has been thoroughly reviewed during the past few years. This review led to new estimates of Task 1 and Task 2 catch/effort and size data for the period 1973-2013. Task 1 and 2 estimations for the period 2012 to 2018 (Ortiz and Palma, 2019) were updated for the 2019 ICCAT Yellowfin Tuna Stock Assessment Meeting (Anon., 2020a). The catch table presented in this Executive Summary (**YFT-Table 1**) has been updated to include these changes.

Readers interested in a more complete summary of the state of knowledge on yellowfin tuna stock status should consult the detailed report (Anon., 2020a). The Tropical Tunas Workplan (item 17.1.10) includes plans to address research and assessment needs for yellowfin tuna.

YFT-1. Biology

Yellowfin tuna is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three oceans. The exploited sizes typically range from 30 cm to 170 cm fork length (FL). Juvenile yellowfin tuna form mixed schools with skipjack and juvenile bigeye, and are mainly limited to surface waters, while larger fish form schools in surface and sub-surface waters. Spawning on the main fishing grounds, the equatorial zone of the Gulf of Guinea, occurs primarily from December to April. Spawning also takes place in the Gulf of Mexico, the southeastern Caribbean Sea and off Cabo Verde, although peak spawning can occur in different months in these regions. The relative importance of the various spawning grounds is unknown.

Although the distinct spawning areas might imply separate stocks, or substantial heterogeneity in the distribution of yellowfin tuna, a single stock for the entire Atlantic is currently assumed. This assumption is based upon information such as observed transatlantic movements indicated by conventional tagging and longline catch data that indicates yellowfin are distributed continuously throughout the tropical Atlantic Ocean. Movement rates and timing, migratory routes, and local residence times remain uncertain, but recent tagging activities (e.g., Atlantic Ocean Tropical tuna Tagging Programme (AOTTP)) offer insights (**YFT-Figure 1**). In addition, some electronic tagging studies in the Atlantic as well as in other oceans suggest that there may be some degree of extended local residence times and/or site fidelity.

The length at 50% maturity was estimated at 115.1 cm when vitellogenesis was used for the maturity threshold. Lacking additional information about the relationship between fecundity and age/length, the Committee agreed to retain a fecundity schedule based upon length - or weight-at-age at the peak of the spawning season.

A comprehensive set of direct ages was made available from yellowfin tuna sampled in the US Gulf of Mexico and the western Atlantic. Ages up to 18 years were observed using annual otolith increment counts validated using 14C bomb radiocarbon. Preliminary results of the AOTTP oxytetracycline (OTC) validation work also support the annual deposition of otolith increments. A second study of yellowfin tuna captured in the Ascension Islands also observed ages up to 18 years and confirmed that individuals as old as 18 occur outside of the US, and closer to the areas where fishing pressure is higher (e.g., Gulf of Guinea). This information supported a change in maximum age from 11 to 18 years (**YFT-Figure 2**).

Information concerning growth was also available from the AOTTP. The data suggest that the growth of yellowfin tuna is better estimated using a Richards function than a von Bertalanffy function. Therefore, the age-structured models used that functional shape (**YFT-Figure 3**). The AOTTP data also support the previous conclusion that growth rates are relatively slow initially, increasing at the time the fish leave the nursery grounds.

Tagging studies of yellowfin in the Pacific and Indian Oceans suggest that natural mortality is age-specific, and higher for juveniles than for adults. As was done in the previous assessments of yellowfin and bigeye, an age-specific natural mortality function (e.g., Lorenzen) was developed and applied to the 2019 assessment of yellowfin tuna. The implied natural mortality based on the t_{MAX} of 18 is 0.35 yr^{-1}, which is lower than the 2016 assessment assumption of 0.54 yr^{-1} based on a t_{MAX} of 11 years. (**YFT-Figure 4**). The most recent stock assessment does not consider sex-specific natural mortality or growth, yet there are disparities in average size by gender. Males are predominant in the catches of larger sized fish (over 145 cm), which could result if large females experience a higher natural mortality rate, perhaps as a consequence of spawning. In contrast, females are predominant in the catches of intermediate sizes (120 to 135 cm), which could result from differential growth (e.g., females having a lower asymptotic size than males). Recent results from studies in the Indian Ocean suggest a combination of the two hypotheses.

Younger age classes of yellowfin tuna (40-80 cm) exhibit a strong association with floating objects (FOBs: any type of object that can affect fish aggregation). The Committee noted that this association with FOBs, which increases the vulnerability of these smaller fish to surface fishing gears, may also have an impact on the biology and on the ecology of yellowfin due to changes in feeding and migratory behaviors. These uncertainties in stock structure, natural mortality, and growth could have important implications for the stock assessment. Data collected by AOTTP will continue to reduce these uncertainties.

YFT-2. Fishery indicators

Yellowfin tuna have been exploited by three major gears (longline, baitboat and purse seine fisheries) and by many countries throughout its range. Detailed data are available since the 1950s. Overall Atlantic catches declined by nearly half from the peak in 1990 (193,584 t) to 106,333 t estimated for 2013 but have since increased to an average of nearly 140,000 t during 2020-2022. A low catch was observed in 2021 (119,454 t), coincident with the COVID-19 pandemic and the imposition of the most recent moratorium. However, catches in 2022 rebounded to 148,211 t, well above the recommended TAC. The most recent catch distribution is given in **YFT-Figure 5**.

In the eastern Atlantic, purse seine catches declined between 1990 and 2007 (129,144 t to 50,306 t) but have subsequently increased to 97,643 t in 2022 (**YFT-Table 1; YFT-Figure 6**). Baitboat catches declined between 1990 (19,625 t) and 2022 (6,504 t). Longline catches, which were 10,253 t in 1990, declined to 5,328 t in 2022. In the western Atlantic, purse seine catches (predominantly from Venezuela) were as high as 23,151 t during the mid-1990s have since declined to 1,479 t in 2022. Baitboat catches also declined since a peak in 1994 (7,094 t), and for 2022 were estimated to be 2,067 t. Since 1990, longline catches have generally fluctuated between 10,000 t and 20,000 t.

It is difficult to discriminate fishing effort between free schools (composed of large yellowfin tunas) and FOB fishing (targeting skipjack) in the eastern Atlantic because the fishing strategies can change from one year to the next. In addition, the sea time devoted to activities on FOBs and the assistance provided by supply vessels are difficult to quantify. Nominal purse seine effort, expressed in terms of carrying capacity, decreased regularly from the mid-1990s until 2006. Since that time, several European Union purse seiners have transferred their effort to the eastern Atlantic due to piracy in the Indian Ocean, and a fleet of new purse seiners has started operating from Tema (Ghana), whose catches are probably underestimated. These factors have contributed to the growth in carrying capacity of the purse seiners, which is approaching the level observed in the early 1990s.

Numerous changes have occurred in the yellowfin fishery since the early 1990s (e.g., the progressive use of FOBs and the latitudinal expansion and the westward extension of the fishing area). Since 2011, significant catches of yellowfin tuna have been obtained by EU purse seiners South of 15°S off the coast of West Africa (in association with skipjack and bigeye on FOBs). There has also been a significant increase in catches of yellowfin and bigeye by a new Brazilian "vessel associated-school" handline fishery, where the vessel is used to aggregate fish, operating in the western Atlantic. These catches have increased seven-fold from 1,570 t in 2012 to 11,841 t in 2022. Finally, a new strategy of fishing on floating objects off Mauritania (north of 15°N) began in 2012. Catches on floating objects in this area tended to consist almost entirely of skipjack, therefore, effort directed in this manner may have a minimal impact on yellowfin tuna.

Four indices of abundance were used in various stock assessment model runs used to develop management advice (**YFT-Figure 7**). A major advancement in this assessment was the development of a joint longline index using high resolution catch and effort information from the main longline fleets operating in the Atlantic (Brazil, Korea (Rep.), Japan, United Stetes and Chinese Taipei). The indices were developed for 3 regions, but only two were used in the assessment: the North Atlantic (Region 1), and the tropical area (Region 2). A new echosounder-based buoy associated index (BAI) was developed and was assumed to represent the abundance of juvenile yellowfin tuna. An index of larger yellowfin tuna (>80 cm, 10 kg) in free schools for the EU purse seine fleet (EUPSFS index) was also used.

Longline indices from several individual nations were updated since the last assessment (**YFT-Figure 8**). The index trends suggest the biomass of yellowfin available to the various longline fleets has remained generally stable or increased since 2019. Cautious interpretation is warranted since individual longline indices were not used in the most recent assessment, and the joint longline index has not yet been updated.

The recent average weight in European purse seine catches, which represent the majority of the landings, had declined to about half of the average weight of 1990. This decline is at least in part due to changes in selectivity associated with fishing on floating objects beginning in the 1990s, which was observed in the increased catches of small yellowfin. A declining trend in average weight and a corresponding increase in the catch of small yellowfin is also evident in eastern tropical baitboat catches. Longline mean weights and catch at size have been more variable.

YFT-3. State of the stock

A full stock assessment was conducted for yellowfin tuna in 2019, applying two production models (Just Another Bayesian Biomass Assessment (JABBA), biomass production model (MPB)) and one age-structured model (Stock Synthesis (SS)) to the available catch data through 2018. The four SS model runs, were regarded as representing alternative recruitment, and steepness hypotheses. Likewise, the JABBA runs addressed different hypotheses about initial priors for *r*, and about which indices of abundance were representing the population. Finally, the base case selected for MPB estimated biomass and fishing mortality trends that varied somewhat from JABBA. The Group decided that, in order to capture this uncertainty in the population dynamics for developing the management advice, it was best to incorporate results from all of the accepted model runs.

The trend in the estimated biomass (relative to B_{MSY}) for all models shows a general continuous decline through time. SS runs suggest a few periods of large increases in spawning biomass associated with episodes of high recruitment. The model estimates that such very high recruitments have happened three times in the period 1960 to 2017. Production models show much less pronounced increases in total biomass at the equivalent times. Note, however, that for all models there are large uncertainties in the value of biomass at any point in the history, including 2018. Most model runs lead to biomasses at the end of 2018 above the level that produces maximum sustainable yield (MSY) (**YFT-Figure 9**).

Estimates of historical fishing mortality (relative to F_{MSY}) show similar trends for all models. For most model runs, fishing mortality increased progressively until the early 1980s, it varied in level until the mid-1990s, after which it declined gradually until the mid-2000s. Since the mid-2000s, the fishing mortality has had a generally increasing trend with fluctuations until 2018. Overall, the models estimate that the fishing mortality in 2018 was near the fishing mortality that would produce MSY. Again, for all models there are large uncertainties in the value of fishing mortality at any point in the history, including 2018 (**YFT-Figure 10**).

It is important to note that the SS model is the only one used that can provide estimates of recent recruitment (**YFT-Figure 11**). Recruitments were not estimated to vary from the stock-recruit relationship for 2018, due to the large uncertainty in terminal year recruitment estimates. The estimate of recruitment in 2017 is also more uncertain than for previous years, in part because there is no 2018 size frequency data to corroborate or contrast with it. SS models which use the buoy index suggest very high recruitment in 2017, whereas models that do not use the buoy index suggest that recruitment in 2017 was above average but not particularly high.

The Group gave equal weight to surplus production model and integrated assessment model results. Within surplus production models, JABBA and MPB were also given equal weight. Each run within a modeling platform (JABBA, and SS) were also given equal weight. For the combined results (MPB, JABBA, SS) used to develop management advice, the median estimate of B_{2018}/B_{MSY} is 1.17 - and the median estimate of F_{2018}/F_{MSY} is 0.96 **-**. The median FMS estimated is 121,298 t. Combining the results of all models provides a way to estimate the probability of the stock being in each quadrant of the Kobe plot in 2018 (**YFT-Figure 12**). The corresponding probabilities are 54% in the green quadrant (not overfished not subject to overfishing), 21% in the orange (subject to overfishing but not overfished) 2% in the yellow (overfished but not subject to overfishing) and 22% in the red (overfished and subject to overfishing). In summary, the results point to a stock status of not overfished (24% probability of overfished status), with no overfishing (43% probability of overfishing taking place).

The Group cautioned that the differences between the 2016 and 2019 assessment results are not due to stock recovery. In fact, the 2019 models indicate that the stock biomass declined between 2014 and 2018. Instead, the perceived improvement is more likely due to changes in key data inputs (natural mortality (M), growth, indices) and the suite of models applied (JABBA, MPB, SS).

The Group noted that catch reports for 2018 were incomplete, at the time when the assessment was conducted with 42% of the total catch being estimated using the average from the previous three years by CPC and gear type. Furthermore, no size data for 2018 were available at the time of the assessment. The 2018 estimated catch assumed for the stock assessment was 131,042 t. This has since been revised upwards to 136,530 t after additional reporting. It was not possible to re-run the stock assessment results with the new 2018 catch estimates, however a change of this magnitude was not expected to have substantial implications.

YFT-4. Outlook

Combined catch projections from 9 runs JABBA (Base Case, S2, S3, and S5), MPB, SS (runs 1, 2, 3 and 4) were provided at constant catches scenarios of 0 t and ranging from 60,000 to 150,000 t. The method used to combine the projection results is described in section 4.4 of the detailed report (Anon., 2020a). In the projection results from the SS and JABBA models, some iterations were predicted with exceptionally small biomass ratios and extremely high fishing mortality (F) ratios indicating the potential for stock collapse. Thus, probability of biomass being less than 20% of the biomass that supports MSY was calculated for each projection year and catch scenario (**YFT-Table 2**). The probability increased with higher catch levels and in later projected years. The probabilities more than 1% or 10% were observed with the constant catch more than 110,000 t or 140,000 t, respectively. The highest probability was 23.3% with 150,000 t constant catch in 2033. It should be noted that the reference chosen, 20% of biomass that supports MSY, was selected for informational purposes and has not been adopted formally by the SCRS for tropical tunas.

The combined projections show that 120,000 t constant catch will maintain more than 50% probability of being in green quadrant through 2033 (**YFT-Figure 13** and **YFT-Table 3**).

YFT-5. Effect of current regulations

Concern over the catch of small yellowfin tuna partially led to the establishment of spatial closures to surface fishing gear FAD sets in the Gulf of Guinea (Recs. 04-01, 08-01, 11-01, 14-01, 15-01) or entire Atlantic (Recs. 19-02, 21-01, and 22-01). In 2022, the Committee investigated the seasonal pattern of purse seine catch based on the data available at the Secretariat for the period 1991-2020 (Hordyk, 2023). The average proportion of the catch of yellowfin tuna (in weight) that was comprised of juveniles was 62.7% to 71% on FOBs, and was highest in the fourth quarter. The proportion of juveniles in the catches associated with free-school fishing was quite low, ranging from 1.6% to 4.9%.

Rec. 11-01 (reiterated in Rec. 22-01) also implemented a TAC of 110,000 t for 2012 and subsequent years. The catches have been above the TAC every year since 2013, averaging nearly 136,400 t. The implications for management are not known but are a cause for concern. The Committee strongly recommends a stock assessment of yellowfin tuna be conducted in 2024.

YFT-6. Management recommendations

The Group expressed strong concern that catches above 120,000 t are expected to further degrade the condition of the yellowfin stock if they continue. Furthermore, given that significant overages are frequent, existing conservation and management measures appear to be insufficient, and the Committee recommends that the Commission strengthen such measures.

The Commission should also be aware that increased harvests on small yellowfin tuna has had negative consequences to both long-term sustainable yield and stock status (**YFT-Figure 14**), and that continued increases in the harvest of small yellowfin tuna will continue to reduce the long-term sustainable yield the stock can produce. Should the Commission wish to increase long-term sustainable yield, the Committee continues to recommend that effective measures be found to reduce fishing mortality on small yellowfin tuna (e.g., FOB-related and other fishing mortality of small yellowfin tuna).

ATLANTIC YELLOWFIN TUNA SUMMARY

Estimates	Mean (90% confidence intervals)
Maximum Sustainable Yield (MSY)	121,298 t (90,428 - 267,350 t)[1]
2022 Yield	148,211 t
Relative Biomass[2]: B_{2018}/B_{MSY}	1.17 (0.75 - 1.62)
Relative Fishing Mortality: F_{2018}/F_{MSY}	0.96 (0.56 - 1.50)

2018 Total Biomass[3]		729,436 t
Stock Status (2018)	Overfished: No[4] Overfishing: No[5]	

(Rec. 17-01, Rec. 22-01)
- No fishing with natural or artificial floating objects from 1 January to 13 March 2023, throughout the Convention area. Prohibition of drifting FADs during a period of 15 days prior to the start of the closure period
- TAC of 110,000 t (since Rec. 11-01)
- Specific authorization to fish for tropical tunas for vessels 20 meters or greater
- Prohibition of discarding from purse seine
- Specific limits on FADs, non-entangling FADs required

[1] Minimum and maximum values of 90%LCI and 90%UCI among all runs by the SS, JABBA, and MPB
[2] SSB (Stock Synthesis) or exploited biomass (production models)
[3] Mean of the central estimates of the SS, JABBA and MPB models
[4] (24% probability of overfished status)
[5] (43% probability of overfishing taking place)

YFT-Table 1. Estimated catches (t) of yellowfin (*Thunnus albacares*) by area, gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL			163561	173185	154725	149206	137304	144561	134817	132453	153101	136461	123192	119573	105075	105892	102843	111874	117915	118280	113918	113686	106333	115024	130699	151385	137519	136530	136875	154547	119454	148211
	ATE		124725	124849	119431	116151	104363	113615	103601	96825	112772	106797	98205	88267	75559	77614	78667	93744	99135	97251	94678	91176	82445	89880	102473	114124	98841	102632	107952	124415	92260	114004
	ATW		38836	48336	35294	33056	32941	30946	31217	35628	40329	29665	24987	31305	29516	28278	24176	18130	18780	21029	19239	22510	23888	25144	28226	37262	38678	33898	28922	30131	27194	34207
Landings	ATE	Bait boat	18297	15496	13390	11250	12529	14080	16444	9830	13950	11398	9956	14511	9540	12492	12795	9457	8750	9305	12219	9029	6748	9352	9173	9862	7785	7274	6814	6354	5435	6499
		Longline	9079	14876	13935	14493	10740	13872	13063	11588	7576	5864	9183	11537	7206	7234	13437	8562	7443	5161	6298	5337	5657	4742	4343	4860	4583	5025	6132	4519	3962	5320
		Other surf.	1570	1817	1839	1839	1879	1752	1581	2437	2021	1714	2467	2886	2350	2988	2129	1595	1844	1752	1264	2040	3032	1702	1774	2651	2550	1803	3469	5886	3491	4530
	ATE	Purse seine	92332	89601	87759	87755	77720	82423	70730	70920	88838	87499	75294	57798	55409	54153	49471	73122	79675	79164	71875	72897	65676	72682	85146	94245	82477	86950	89919	105905	78541	96158
	ATW	Bait boat	6383	7094	5297	4560	4275	5511	5364	6753	5572	6009	3764	4868	3867	2695	2304	886	1331	1436	2311	1299	1602	520	810	1238	925	742	862	826	1028	2067
		Longline	13675	12626	11560	12605	11896	12426	14259	16168	15699	11926	10167	18166	18171	15469	16106	13780	14654	14888	11977	13005	10067	9059	10027	13129	11710	11236	11512	11591	9898	10935
		Other surf.	2606	5465	4907	5107	4459	3826	4900	4838	5107	3763	6445	5004	4826	5667	3418	1392	1417	1975	2686	4432	8181	12431	14293	16881	20493	17550	13288	14615	15238	19706
	ATW	Purse seine	16172	23151	13530	10784	12310	9184	6527	7870	13951	7966	4611	3266	2652	4442	2341	2067	1370	2722	2256	3768	4035	3131	3037	5948	5499	4331	3224	3053	1011	1479
Landings(FP)	ATE	Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
		Purse seine	3447	3059	2509	813	1495	1488	1781	2051	387	321	1305	1534	1054	747	836	1008	1423	1869	3021	1872	1332	1401	1901	2506	1384	1533	1596	1725	803	1459
	ATW	Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	63	49	35	32	28	0	
Discards	ATE	Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	5	7	10	7
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	137	0	63	40	17	20	19	25
	ATW	Longline	0	0	0	0	0	0	167	0	0	0	0	0	0	5	6	5	9	8	9	7	3	3	3	3	3	5	4	18	18	20
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATE CP	Angola	211	137	216	78	70	115	170	35	34	34	34	34	0	0	23	98	0	0	0	0	0	0	0	0	2	3	0	1	8	16
		Belize	0	0	1	0	3	963	0	326	406	0	0	0	0	0	0	0	405	1794	3172	5861	5207	7036	7132	3497	5811	8121	9152	8688	7571	9036
		Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	194
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Cape Verde	1612	1943	1908	1518	1783	1421	1663	1851	1684	1953	1868	3236	6019	5648	4568	7905	4638	5856	6002	4603	7513	4507	7823	6990	2756	5498	3699	6239	2043	952
		China PR	139	156	200	124	84	71	1535	1652	586	262	1033	1030	1112	1056	1000	365	214	169	220	170	130	20	78	286	346	188	163	81	32	140
		Curaçao	0	0	0	3183	6082	6110	4039	5646	4945	4619	6667	4747	24	1939	1368	7351	6293	5302	4413	6792	3727	5152	6140	7905	6535	7543	7751	8986	7700	3027
		Côte d'Ivoire	0	0	0	0	2	0	0	673	213	99	302	565	175	482	216	626	573	470	385	1481	2077	324	251	315	952	116	2649	4460	2117	3336
		EU-Denmark	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-España	40403	40612	38278	34879	24550	31337	19947	24681	31105	31469	24884	21414	11795	11606	13584	24409	32793	25560	21026	18854	11878	14225	21094	19266	12308	10669	14457	19418	9885	11207
		EU-Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-France	36087	34793	29594	33838	29351	30760	29900	29923	31861	34444	33035	23913	22662	18940	13733	16115	18927	20342	22037	18506	20258	22533	20451	26085	25831	24581	17745	15867	12454	16606
		EU-Ireland	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Latvia	16	0	55	151	223	97	25	36	72	334	334	334	334	334	0	0	0	200	143	15	0	0	23	0	0	0	0	0	0	**0**
		EU-Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**0**
		EU-Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Portugal	128	126	231	288	176	267	177	194	4	6	4	5	16	274	865	300	990	537	452	355	335	69	76	112	67	133	125	127	19	126
		El Salvador	0	0	0	0	0	0	0	0	933	0	0	0	0	0	0	0	0	0	0	0	0	0	2750	8252	6227	5553	3959	8694	6337	6175
		Gabon	12	88	218	225	225	295	225	162	270	245	44	6	2	44	0	1	0	0	0	0	0	0	0	1	3	0	0	0	0	**0**
		Gambia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
		Ghana	13283	9984	9268	8182	15087	13850	21450	12673	23845	18546	15839	15444	13019	14037	15570	16521	15858	20252	18501	15994	13552	18426	18896	19582	18969	21970	24099	24599	20111	29550
		Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	21	22	1	0	0	0	0	0	0	0	0	**0**
		Guatemala	0	0	0	0	0	0	0	0	0	0	2207	1588	2906	5265	3461	3736	2603	3124	2803	2949	4023	3754	5200	2703	3647	2499	2944	2581	1841	4228
		Guinea Ecuatorial	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	892	892	199	0	2	11	9	6	0	8	10	8	7	4
		Guinée Rep	0	0	208	1956	820	0	0	0	0	0	0	0	0	0	0	0	0	298	292	1559	1484	823	0	0	0	0	0	0	322	1327
		Honduras	0	0	4	3	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Japan	2627	4194	4770	4246	2733	4092	2101	2286	1550	1534	1999	5066	3088	4206	8496	5266	3563	3041	3348	3637	3843	3358	2857	2914	2708	2946	3395	2349	2727	3592
		Korea Rep	169	436	453	297	101	23	94	142	3	8	209	984	95	4	303	983	381	324	20	26	97	77	36	356	408	449	507	563	249	390
		Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	71	89	100	88	76	88	1	6	1731	10	0
		Libya	0	0	0	0	0	0	0	0	208	73	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Maroc	2396	3017	2290	3430	1947	2276	2307	2441	3000	2111	1675	814	1940	222	102	110	110	44	272	55	137	107	72	115	113	108	228	344	493	640
		Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Namibia	0	35	14	72	69	3	147	59	165	89	139	85	135	59	28	11	1	9	90	24	6	15	42	53	53	424	82	327	256	356
		Nigeria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	1	0	0	0	0	0	0	0	0	0	**0**
		Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Panama	10973	12066	13442	7713	4293	2111	1315	1322	626	1112	0	1887	6170	8557	9363	6175	5982	5048	4358	5004	3899	4587	3202	4305	5073	4071	5863	8187	8346	10835
		Philippines	0	0	0	0	0	126	173	86	0	50	9	68	13	30	88	53	152	89	134	5	56	0	0	0	0	0	0	0	0	**0**
		Russian Federation	2160	1503	2936	2696	4275	4931	4359	737	0	0	0	0	4	42	211	42	33	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		S Tomé e Príncipe	181	125	135	120	109	124	114	122	122	122	122	134	145	137	144	160	165	169	173	177	182	186	301	301	266	3	17	13	15	24
		Senegal	15	1	94	77	152	248	663	194	279	558	253	589	1106	1347	1071	720	1146	939	1235	1875	1081	603	1883	6850	3988	5029	8161	8177	8228	9407

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			South Africa	266	486	199	157	116	261	320	191	342	152	298	402	1156	1187	1063	351	303	235	673	174	440	1512	925	706	387	389	551	700	398	1018
			St Vincent and Grenadines	5391	2476	2142	2981	3146	3355	2170	2113	3715	189	56	14	0	101	209	83	74	28	0	0	0	0	0	0	71	0	0	0	0	**0**
			UK-Sta Helena	171	150	181	151	109	181	116	136	72	90	158	226	240	344	177	97	104	65	163	149	53	152	178	181	221	199	310	87	79	67
			USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Uruguay	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	0	0	0	0	0	0	0	0	0	3612	245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	1301	3851	2681	3985	2993	3643	3389	4014	2787	3363	4946	4145	2327	860	1707	807	1180	537	1463	818	1023	902	927	761	563	550	464	437	180	253
		NCO	Benin	1	1	1	1	3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cambodia	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cayman Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Congo	17	14	13	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	541	238	212	257	269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Faroe Islands	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Georgia	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	388	477	1847	0	148	0	0	0	1510	1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	1157	2524	2975	3588	3368	5464	5182	3072	2019	43	466	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	6	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Ukraine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Vanuatu	1624	2357	2357	1130	576	0	228	0	0	0	0	0	24	145	483	450	331	23	10	124	21	0	0	0	0	0	0	0	0	
	ATW	CP	Barbados	161	156	255	160	149	150	155	155	142	115	178	211	292	197	154	156	79	129	131	195	188	218	262	324	270	248	121	173	212	202
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	143	1164	1160	940	264	42	41	38	33	0	2163	359	623	955	653	625	1082
			Brazil	5131	4169	4021	2767	2705	2514	4127	6145	6239	6172	3503	6985	7223	3790	5468	2749	3313	3677	3615	4639	7277	11645	13643	16682	18362	16381	12907	13183	13664	15522
			Canada	71	52	174	155	100	57	22	105	125	70	73	304	240	293	276	168	53	166	50	93	74	34	59	19	193	15	108	75	110	198
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	81	86	0	21	0	**0**
			China PR	0	0	0	0	0	628	655	22	470	435	17	275	74	29	124	284	248	258	126	94	81	73	91	182	232	172	158	380	108	388
			Curaçao	170	155	140	130	130	130	130	130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	127	107	126	72	22	96	28	95
			EU-España	989	7	4	36	34	46	30	171	0	0	0	0	0	1	84	81	69	27	33	32	138	155	105	360	357	239	299	200	317	156
			EU-France	91	121	20	0	600	27	4	0	9	0	4	49	18	0	0	0	122	456	712	412	389	690	641	403	346	488	864	1222	808	634
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	151	60	88	179	260	115	127	92	4	2	0	15	70	505	131	3	3	8
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	381	91	21	18	119	0	64
			FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	476	369	513	763	636	1429	2376	2144	1836	0	**0**
			Grenada	858	385	410	523	302	484	430	403	759	593	749	460	492	502	633	756	630	673	0	0	0	0	1167	1607	1257	1391	818	784	287	630
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	71	40	13	14	15	9
			Japan	469	589	457	1004	806	1081	1304	1775	1141	571	755	1194	1159	437	541	986	1431	1539	1106	1024	734	465	612	462	415	147	655	306	684	582
			Korea Rep	11	0	0	84	156	0	0	0	0	0	0	0	580	279	270	10	52	56	470	472	115	39	11	12	3	6	0	16	123	91
			Mexico	855	1093	1126	771	826	788	1283	1390	1084	1133	1313	1208	1050	938	890	956	1211	916	1174	1414	1004	1045	968	1279	1241	1028	760	817	881	606
			Panama	0	0	0	0	0	0	5	0	20	28	0	0	0	2804	227	153	119	2134	1126	1630	1995	902	1580	1863	1620	2104	2382	2189	1304	1125
			Philippines	0	0	0	0	0	36	106	78	12	79	145	299	230	234	151	167	0	0	0	30	72	76	0	0	0	0	0	0	0	**0**
			St Vincent and Grenadines	65	16	43	37	35	48	687	1989	1365	1165	568	4251	3430	2680	2989	2547	2274	854	963	551	352	505	153	434	701	373	105	226	3	106
			Trinidad and Tobago	4	120	79	183	223	213	163	112	122	125	186	224	295	459	615	520	629	788	799	931	1128	1141	1179	1057	890	1214	982	973	1244	1080
			UK-Bermuda	58	44	44	67	55	53	59	31	37	48	47	82	61	31	30	15	41	37	100	66	36	12	10	9	25	32	50	52	74	61
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	3	10	5	0	0	0	0	0	6	5
			UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	2	0	0	0	0	0	0	0	**0**
			USA	6283	8298	8131	7745	7674	5621	7567	7051	6703	5710	7695	6516	5568	7091	5529	2473	2788	2679	3315	4777	4177	3184	2798	4104	4444	2720	2625	3648	3948	7732
			Uruguay	20	59	53	171	53	88	45	45	91	91	95	204	644	218	35	66	76	122	24	6	7	0	0	0	0	0	0	0	0	**0**
			Venezuela	16663	24789	9714	13772	14671	13995	11187	11663	18687	11421	7411	5792	5097	6514	3911	3272	3198	4783	4419	4837	5050	3772	3127	4204	5059	2743	2029	1931	1973	3167
		NCC	Chinese Taipei	2895	2809	2017	2668	1473	1685	1022	1647	2018	1296	1540	1679	1269	400	240	315	211	287	305	252	236	139	293	181	213	395	272	433	288	416
			Costa Rica	0	0	0	0	0	0	6	5	4	0	1	1	0	7	9	7	4	6	14	15	32	120	117	139	183	114	74	117	150	54
			Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	183	181	3	43	116	164	**0**
		NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	327	327	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	
			Colombia	2404	3418	7172	238	46	46	46	46	46	46	46	46	46	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	1	14	54	40	40	15	15	0	0	65	65	65	65	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	30	31	9	0	0	0	80	78	120	169	119	81	119	65	103	124	102	110	132	119	120	256	194	179	145	110	179	307	0	
			Dominican Republic	0	0	0	0	0	89	220	226	226	226	226	226	226	226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Jamaica	0	0	0	21	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	1514	1880	1227	2374	2732	2875	1578	2197	765	14	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	29	13	0	6	0	
			Seychelles	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	92	130	144	110	110	276	123	134	145	94	139	147	172	103	82	106	97	223	114	98	136	93	175	191	232	199	172	190	156	174
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	681	689	661	555	873	816	720	330	207	124	17	0	0	0	0	0	0	0	
Landings(FP)	ATE	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	50	71	27	109	35	0	0	0	0	0	0	0	**0**
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	77	28	39	40	103	152	58	35	82	256	267	174	50	66	60	67	0	**0**

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	15	25	22	16	176	95	89	114	86	78	0	0	0	0	0	0	67	**0**
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	267	116	24	0	0	0	0	0	0	0	**0**
			EU-España	1149	910	559	87	384	494	733	714	0	0	335	368	142	154	67	270	279	352	358	140	146	353	511	547	418	276	342	269	260	312
			EU-France	1554	1461	1074	472	658	703	832	914	344	309	672	597	244	128	33	52	203	181	344	347	129	115	332	349	158	293	290	291	388	990
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	57	35	17	32	9	34	8	12	13	19	0	0	0	0	0	0	27	26
			Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	72	0	66	20	67	95	389	876	487	461	0	0	0	0	0	0	0	**0**
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	155	125	177	114	99	54	101	54	163	59	0	0	0	0	0	0	62	53
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Mixed flags (EU tropical)	744	688	876	254	452	291	216	423	42	13	298	570	292	251	416	464	467	857	1601	0	0	0	791	1436	757	898	903	1098	0	
	ATW	CP	Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	7	0	3	0	**0**
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	24	21	9	24	7	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	3	0	0	**0**
		NCO	Mixed flags (EU tropical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	32	19	15	6	18	0	
Discards	ATE	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	137	0	63	40	17	20	19	25
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5	7	10	7
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Sta Helena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0**
	ATW	CP	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	5	9	8	9	7	3	3	3	3	3	5	3	4	5	3
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	13	17
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

YFT-Table 2. Estimated probabilities of biomass the Atlantic YFT stock levels < 20% of B_{MSY} in the combined projections of JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4) in a given year for a given catch level (0, 60,000 – 150,000 t). This result was used to develop the management advice of Atlantic YFT stock.

TAC	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
60000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
70000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
80000	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
90000	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%
100000	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%	0.4%	0.4%	0.5%	0.5%	0.6%	0.6%
110000	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	0.7%	0.8%	0.9%	1.0%	1.2%	1.4%	1.5%
120000	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	1.0%	1.2%	1.5%	1.8%	2.1%	2.4%	2.6%	2.9%
130000	0.0%	0.1%	0.2%	0.5%	0.8%	1.2%	1.6%	2.1%	2.6%	3.0%	3.5%	3.9%	4.3%	4.7%
140000	0.0%	0.1%	0.3%	0.7%	1.2%	1.8%	2.6%	3.2%	4.0%	4.8%	10.4%	12.2%	12.9%	13.4%
150000	0.0%	0.1%	0.3%	1.0%	1.7%	2.7%	3.7%	4.8%	11.9%	12.7%	15.9%	21.3%	22.1%	23.3%

YFT-Table 3. Estimated probabilities of the Atlantic YFT stock (a) being below F_{MSY} (overfishing not occurring), (b) above B_{MSY} (not overfished) and (c) above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level (0, 60,000 – 150,000 t), based upon the combined projections of JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4). This result was used to develop the management advice of Atlantic YFT stock.

a) Probability that $F \leq F_{MSY}$.

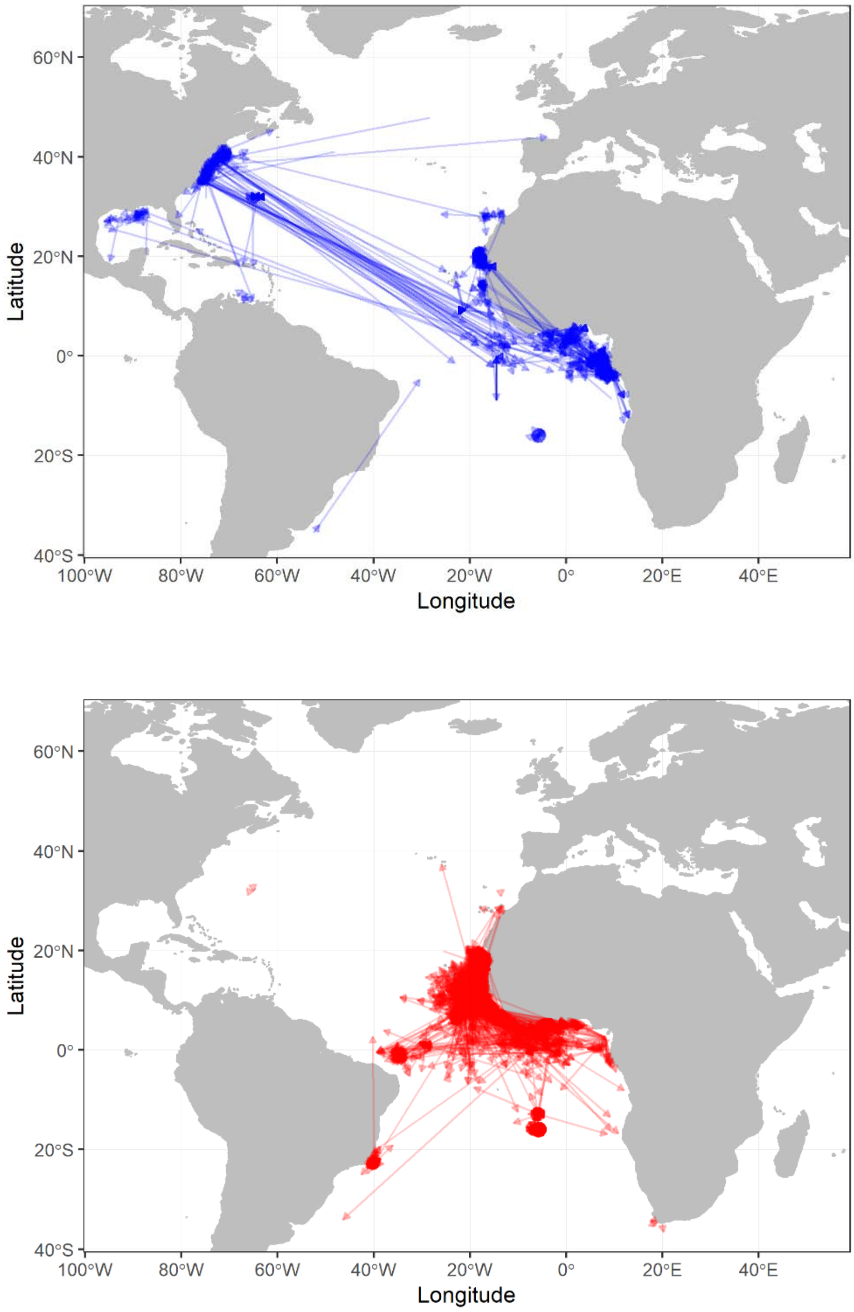
TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
60000	99	99	100	100	100	100	100	100	100	100	100	100	100	100
70000	98	99	99	99	100	100	100	100	100	100	100	100	100	100
80000	96	97	98	98	99	99	99	99	99	100	100	100	100	100
90000	93	95	96	97	97	98	98	98	98	99	99	99	99	99
100000	88	90	92	93	94	95	95	95	96	96	97	97	97	97
110000	81	84	85	86	87	87	88	88	89	90	90	90	90	90
120000	71	72	72	73	73	74	74	74	74	74	70	70	70	70
130000	60	59	58	56	55	53	50	49	47	46	46	45	39	39
140000	48	46	43	39	36	32	30	26	24	23	22	21	21	19
150000	39	35	30	25	22	17	15	13	13	12	11	10	10	8

b) Probability that $B \geq B_{MSY}$.

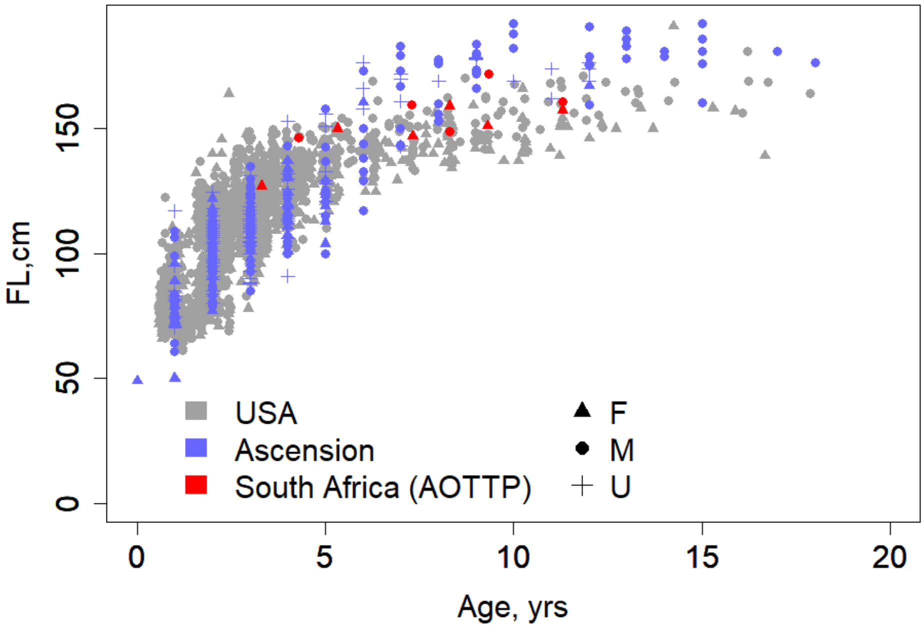
TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	64	84	95	99	100	100	100	100	100	100	100	100	100	100
60000	64	75	85	92	96	97	98	99	99	99	100	100	100	100
70000	64	74	83	90	94	96	97	98	98	99	99	99	100	100
80000	64	72	79	86	91	94	96	97	97	98	98	99	99	99
90000	64	70	77	82	87	90	92	94	95	96	97	97	98	98
100000	64	68	73	78	82	85	87	89	91	92	93	94	94	95
110000	64	67	69	72	75	77	79	81	83	84	85	86	86	87
120000	64	65	65	67	68	68	69	70	71	71	68	69	69	69
130000	65	63	62	61	60	59	56	56	55	53	52	51	46	45
140000	64	61	59	56	54	49	46	40	37	34	31	29	27	25
150000	64	60	55	50	45	37	32	27	23	20	18	13	12	8

c) Probability that $F \leq F_{MSY}$ and $B \geq B_{MSY}$.

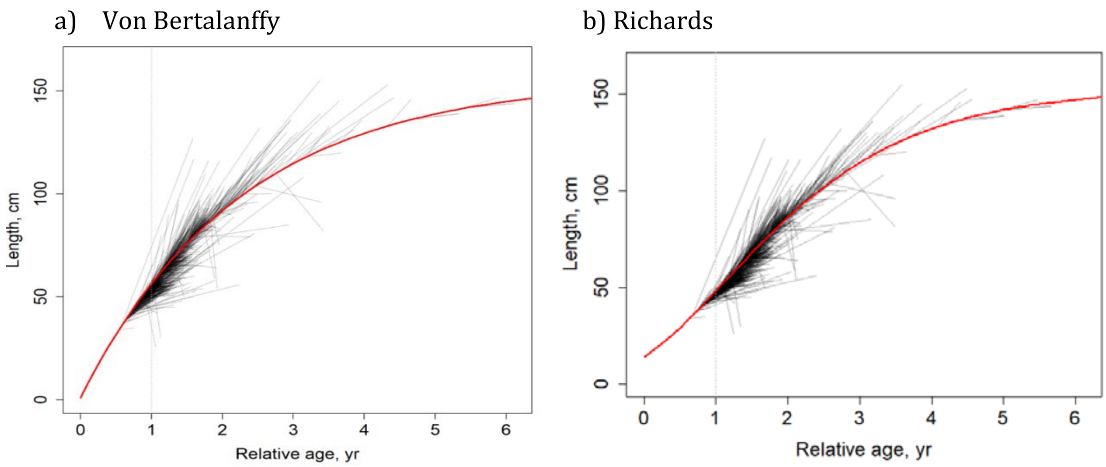
TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	64	84	95	99	100	100	100	100	100	100	100	100	100	100
60000	64	75	85	92	96	97	98	99	99	99	100	100	100	100
70000	64	74	83	90	94	96	97	98	98	99	99	99	100	100
80000	64	72	79	86	91	94	96	97	97	98	98	99	99	99
90000	64	70	77	82	87	90	92	94	95	96	97	97	98	98
100000	64	68	73	77	82	85	87	89	90	92	93	94	94	95
110000	64	66	69	72	75	77	79	81	82	83	84	85	86	86
120000	63	63	64	65	65	66	66	67	67	68	65	65	66	66
130000	58	57	56	54	52	50	47	46	45	44	43	42	38	38
140000	48	45	42	38	35	31	29	26	24	22	21	20	20	19
150000	39	34	30	25	21	17	15	13	12	12	11	10	9	7



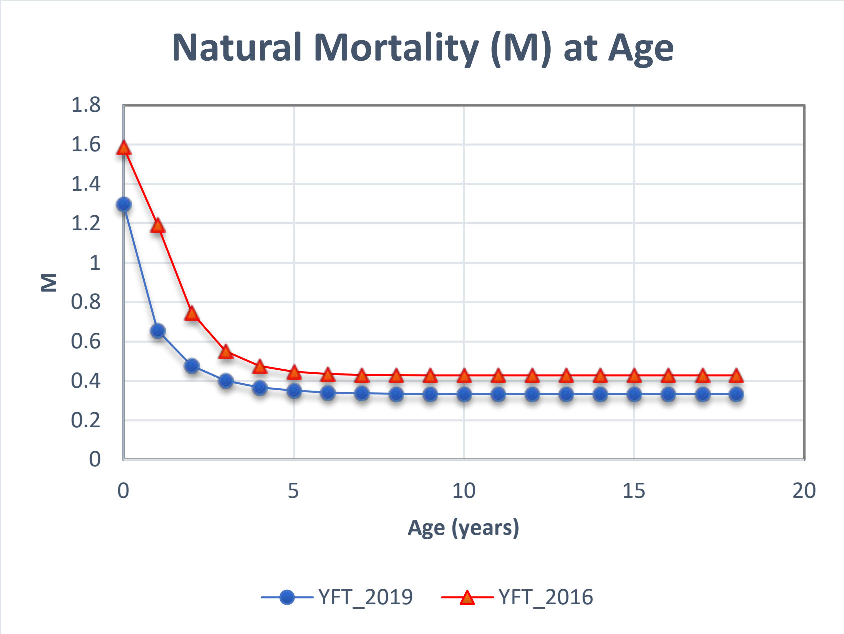
YFT-Figure 1. Apparent movements (straight line distance between the tagging location and that of recovery) calculated from conventional tagging from the historical ICCAT tagging database (top panel) and the current AOTTP activities (bottom panel).



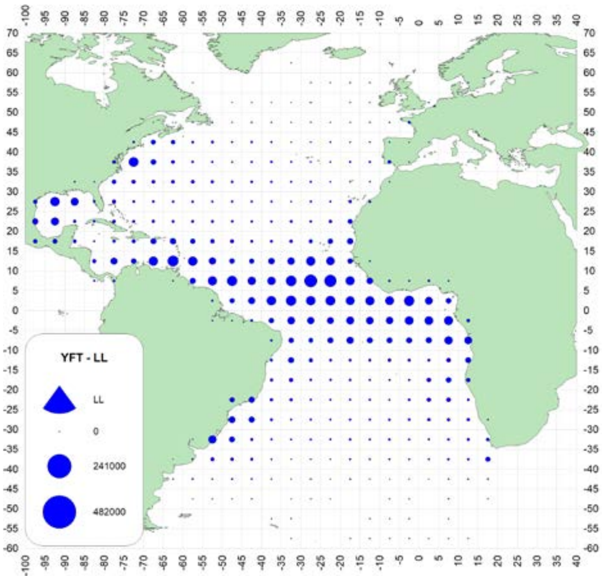
YFT-Figure 2. The size at age of YFT fish sampled off Ascension Island, the USA and South Africa (AOTTP), by gender. Ages of USA and AOTTP samples were assigned based on assumed birthday. No adjustment was made to annulus count for Ascension data.



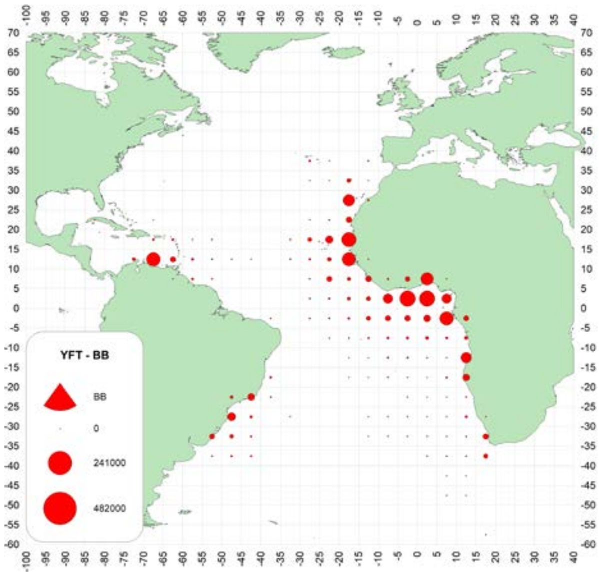
YFT-Figure 3. Vector plot of the growth increments of AOTTP fish measured upon recovery. The relative age of each fish at the time of tagging is estimated from the length at tagging by inverting the von Bertalanffy (left panel) and Richards (right panel) growth equations using parameters estimated by SS. The age at recapture is then taken to be the age at tagging plus the time at liberty. Each growth trajectory (shown in grey) starts on the fitted curve (shown in red).



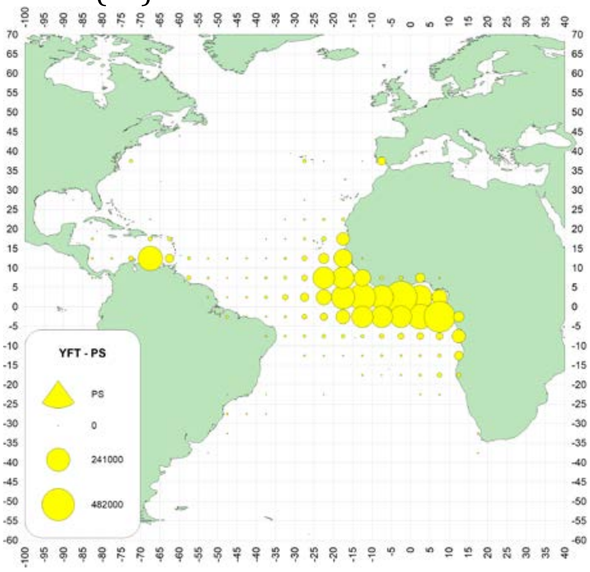
YFT-Figure 4. New information on age and growth supported a Richards growth function, and a change in maximum age from 11 to 18 years which had implications for the estimated (Lorenzen) natural mortality at age which depends on both. The implied 2019 natural mortality based on the t_{MAX} of 18 is 0.35 yr^{-1}, which is lower than the 2016 assessment assumption of 0.54 yr^{-1} based on a t_{MAX} of 11 years.



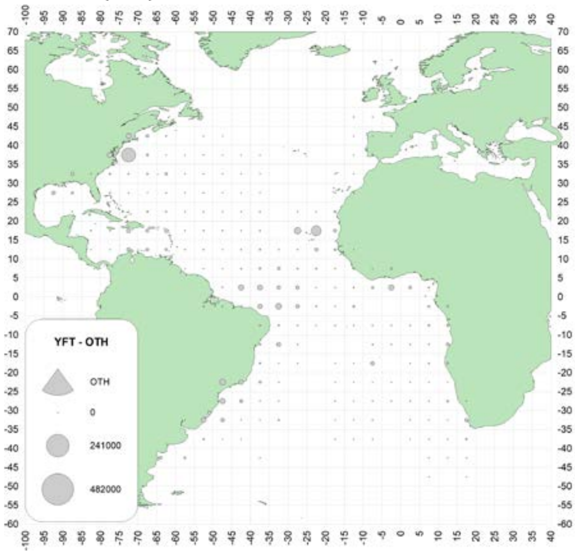
a. YFT (LL)



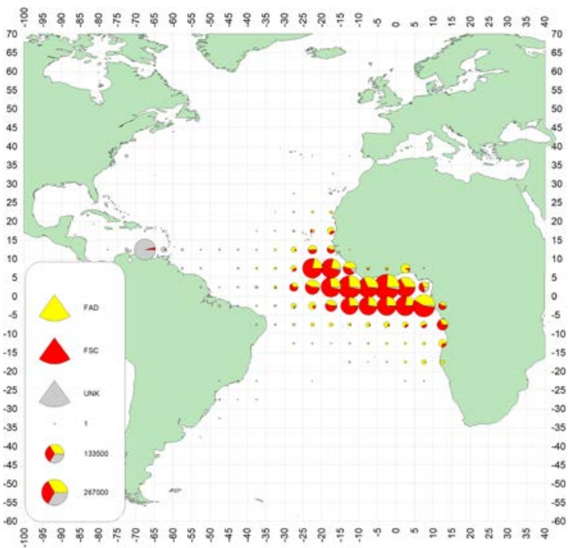
b. YFT (BB)



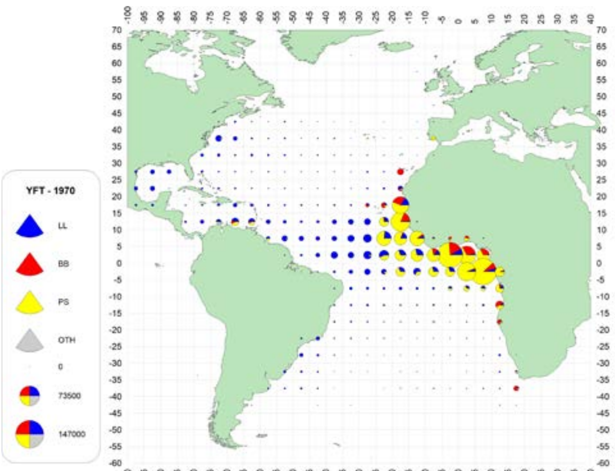
c. YFT (PS)



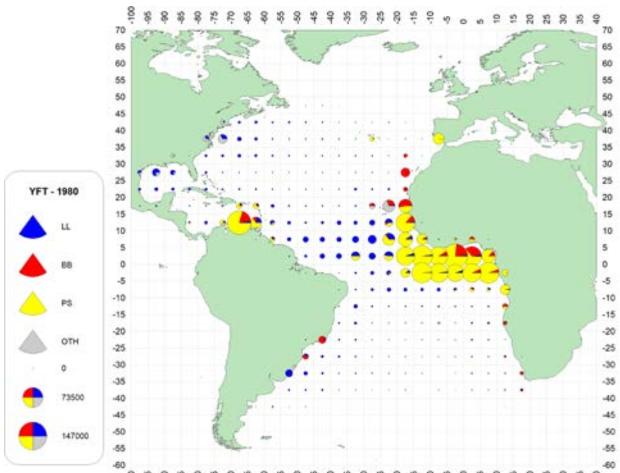
d. YFT (oth)



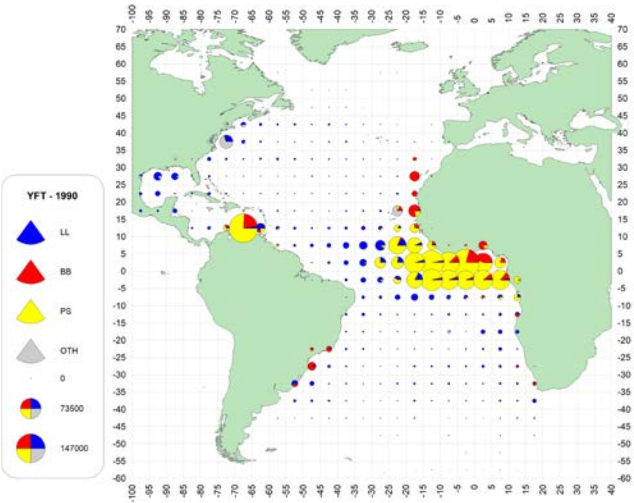
e. YFT (FAD/FREE 1991-2021)



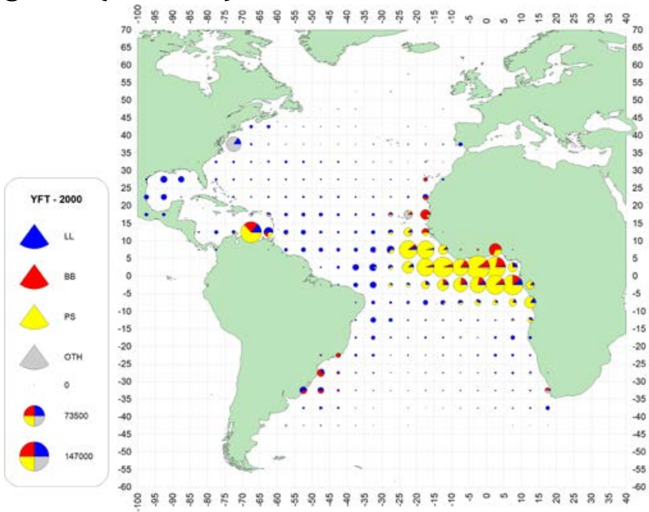
f. YFT (1970-79)



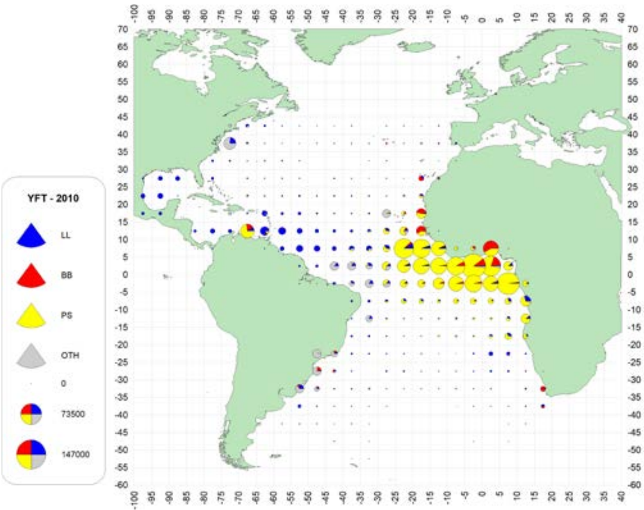
g. YFT (1980-89)



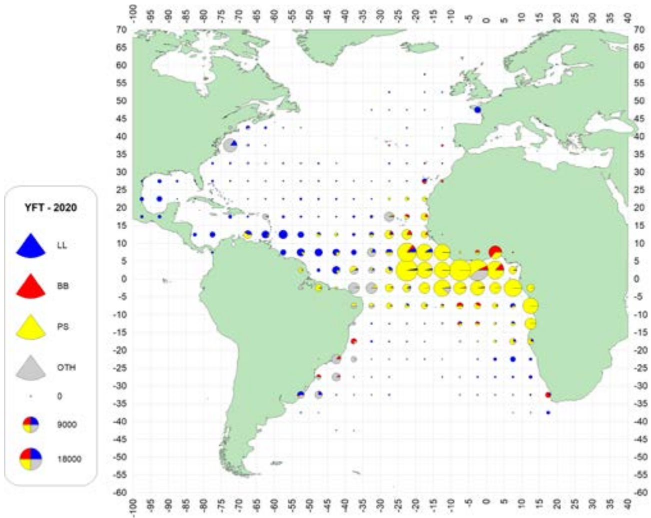
h. YFT (1990-99)



i. YFT (2000-09)

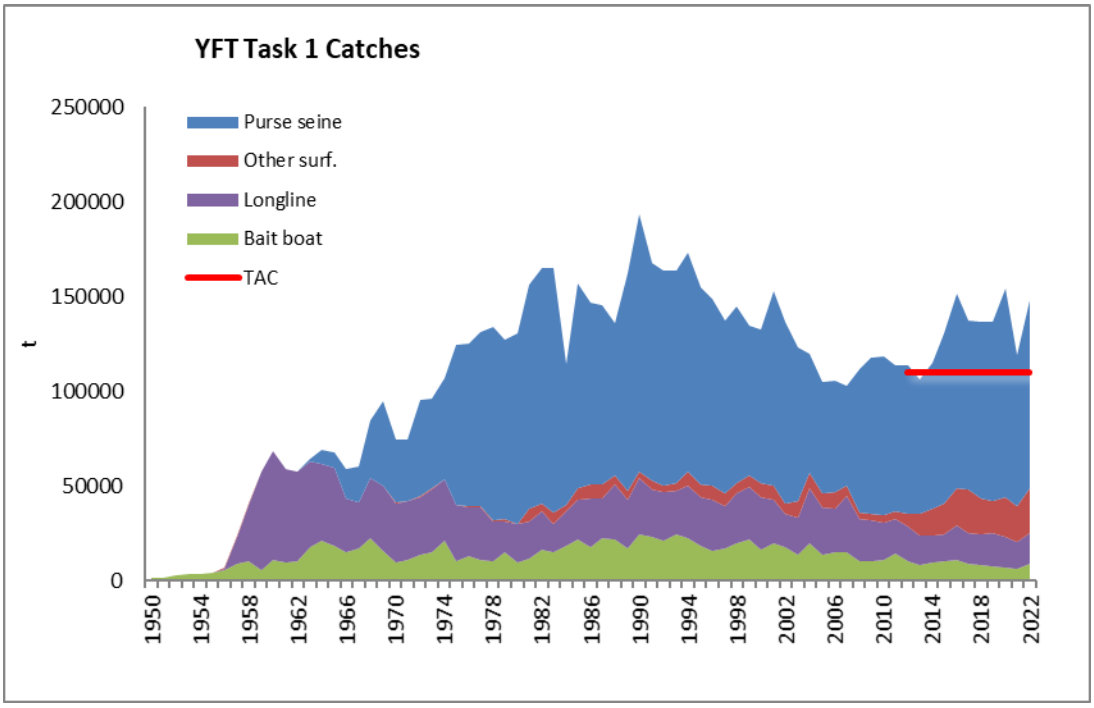


j. YFT (2010-19)

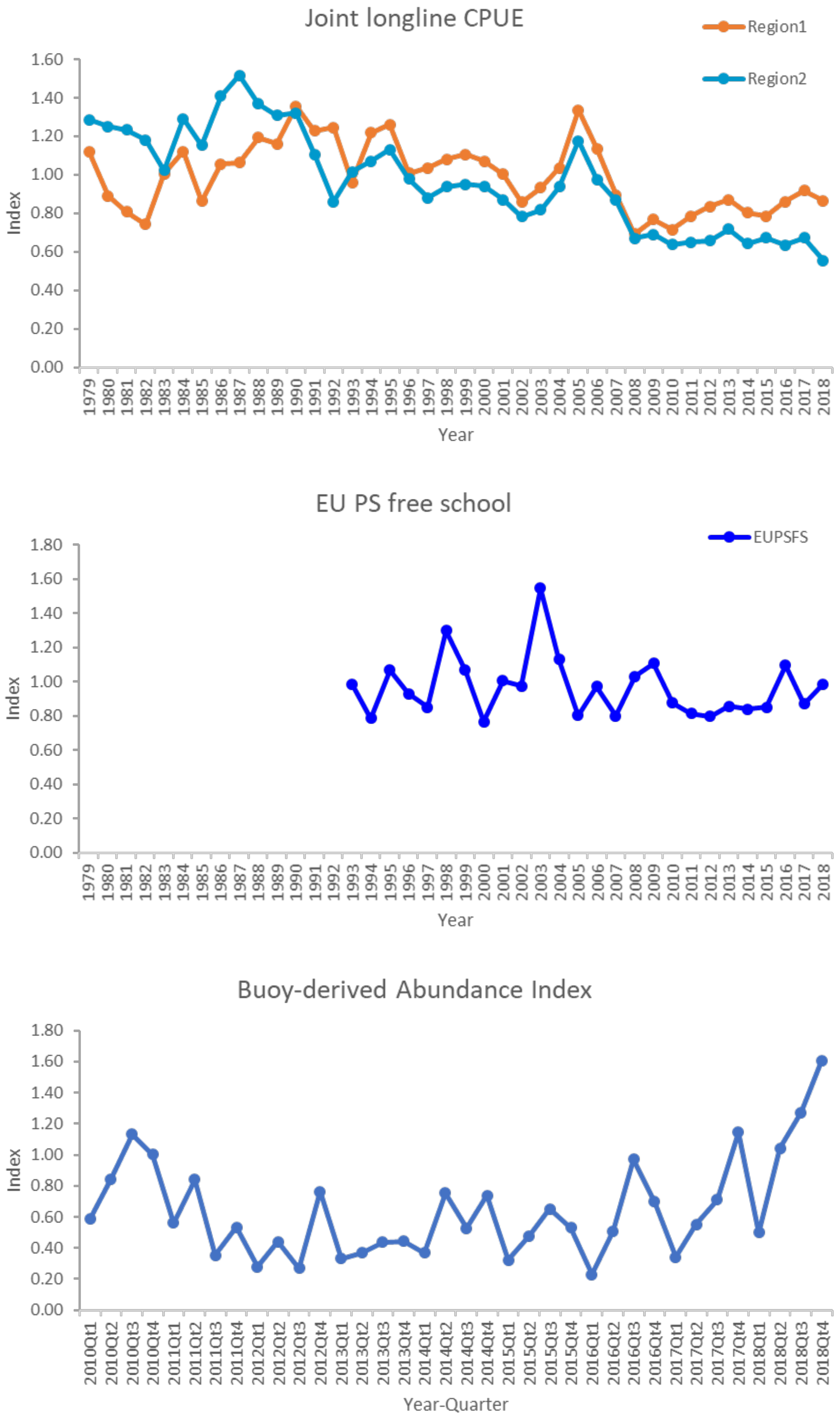


k. YFT (2020-21)

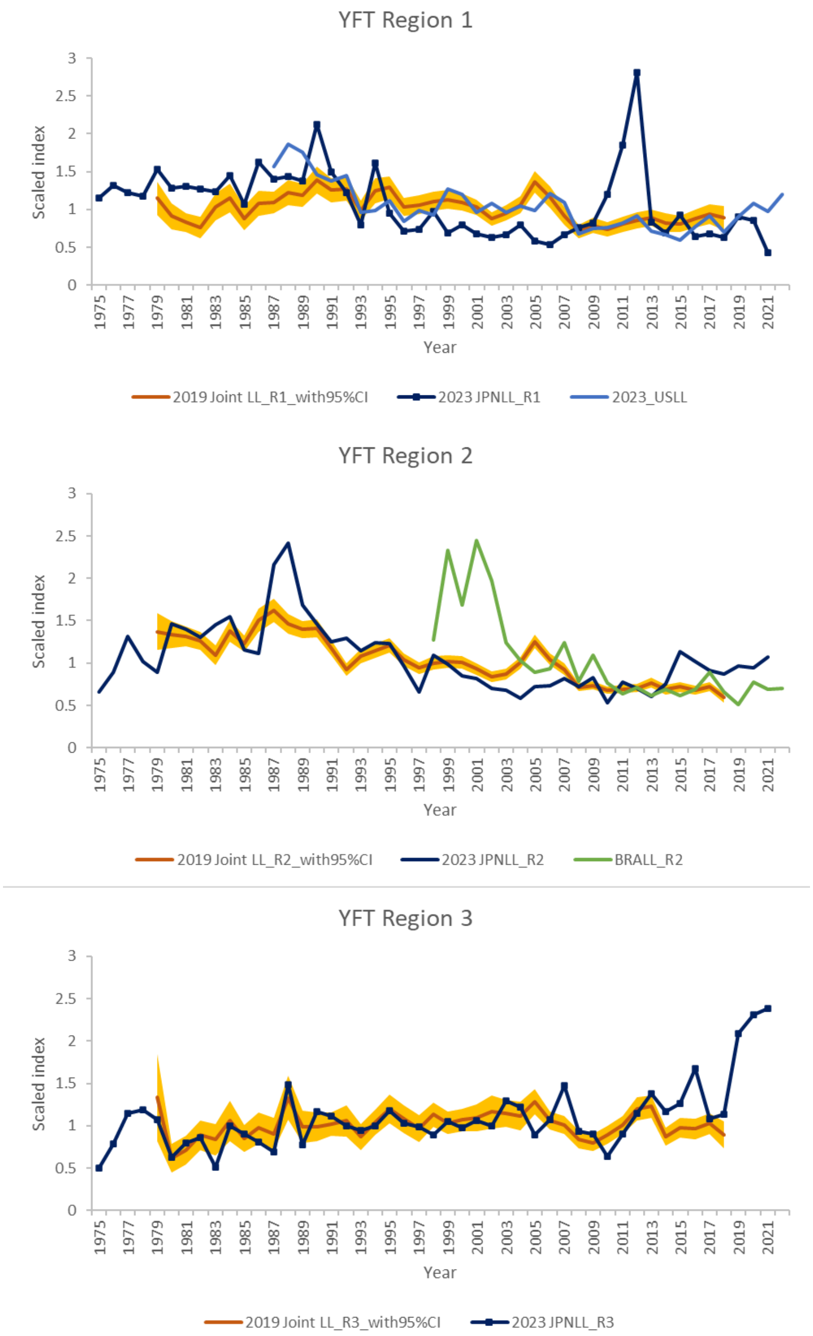
YFT-Figure 5. Geographical distribution of yellowfin tuna total catches by major gears [a-e] and by decade [f-k]. The maps are scaled to the maximum catch observed during 1970-2021. Note: the last panel (k) shows only 2 years of information. Thus, apparent changes in the size of the pie charts (in k) should not be interpreted as a reduction in catch during 2020-2021.



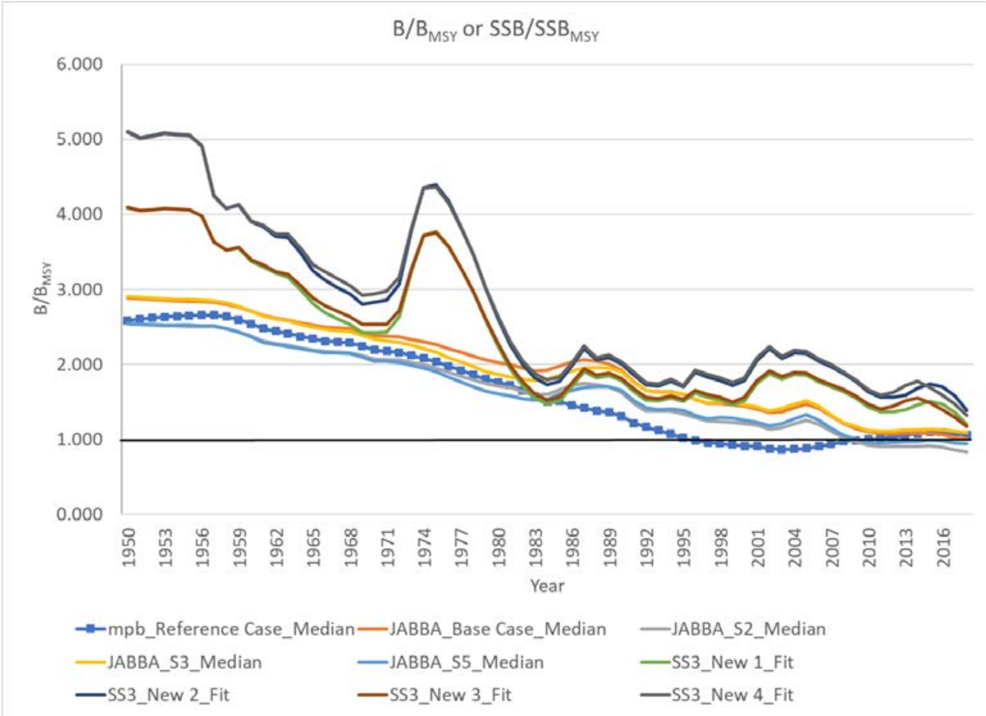
YFT-Figure 6. Yellowfin tuna total catch 1950 – 2022 by main fishing gear group.



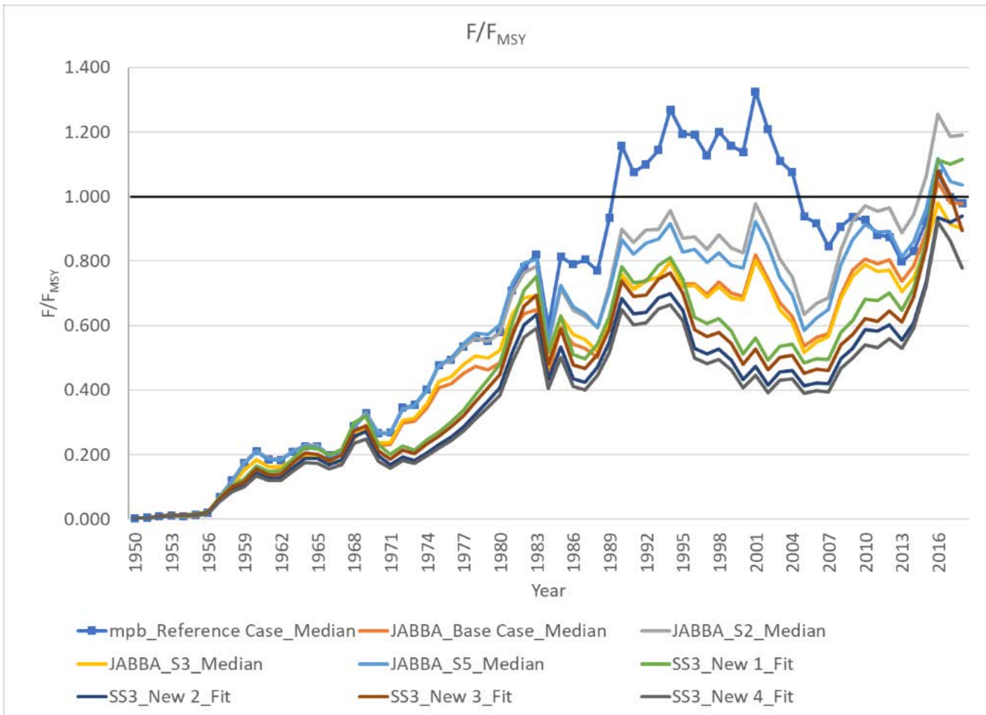
YFT-Figure 7. Annual abundance indices used for the Atlantic yellowfin tuna stock assessment reference cases. Regions 1 and 2 for joint longline mean the area of index that are northern and tropical areas, respectively. Buoy-derived abundance index was used only in Stock Synthesis and joint longline index in region 1 only for JABBA.



YFT-Figure 8. Comparisons of abundance indices updated in 2023, and the joint longline index used in the2019 stock assessment of Atlantic yellowfin tuna, by region. The Brazilian longline index includes information for both regions 2 and 3.

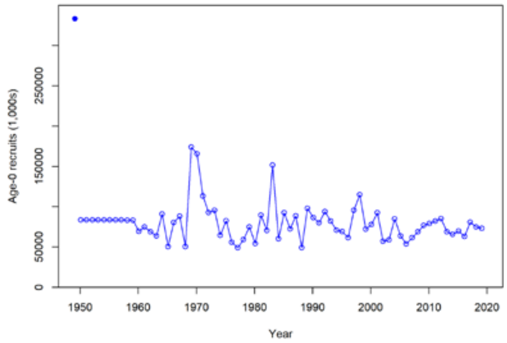


YFT-Figure 9. Estimates of relative biomass (B/B_{MSY}) obtained for all model runs used to develop the management advice.

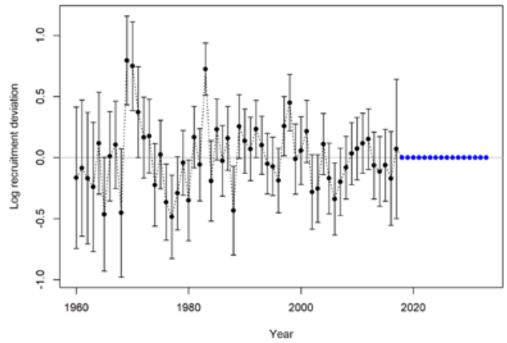


YFT-Figure 10. Estimates of relative fishing mortality (F/F_{MSY}) obtained for all model runs used to develop the management advice.

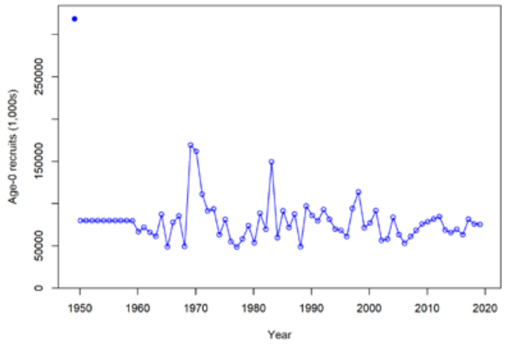
a) SS Run 1: Age 0 recruits



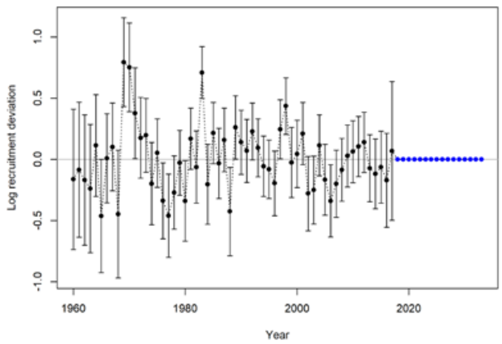
b) SS Run 1: Recruitment Deviations



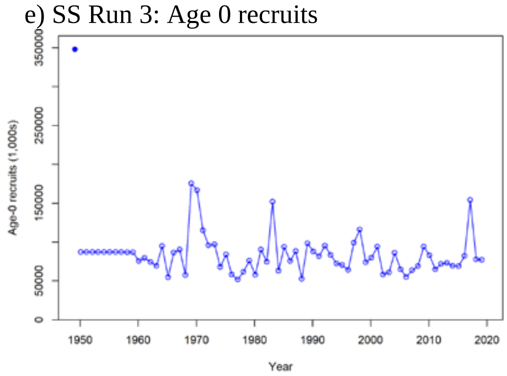
c) SS Run 2: Age 0 recruits



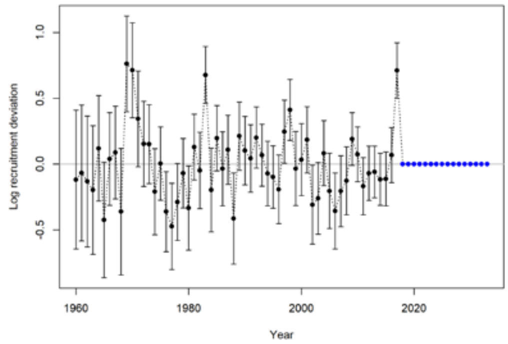
d) SS Run 2: Recruitment Deviations



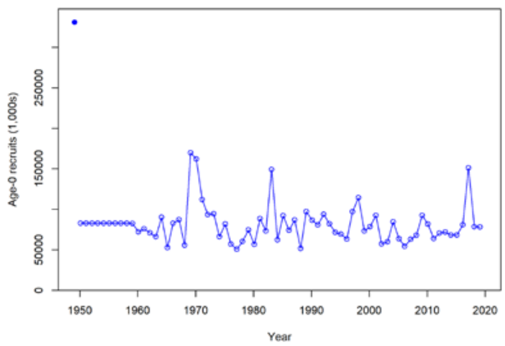
e) SS Run 3: Age 0 recruits



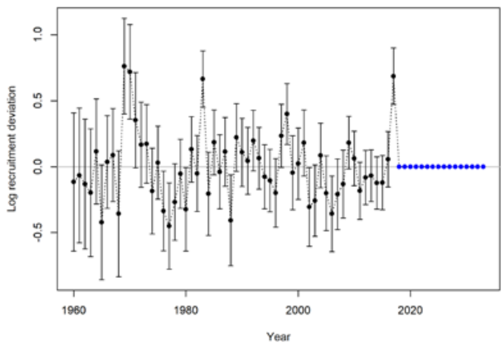
f) SS Run 3: Recruitment Deviations



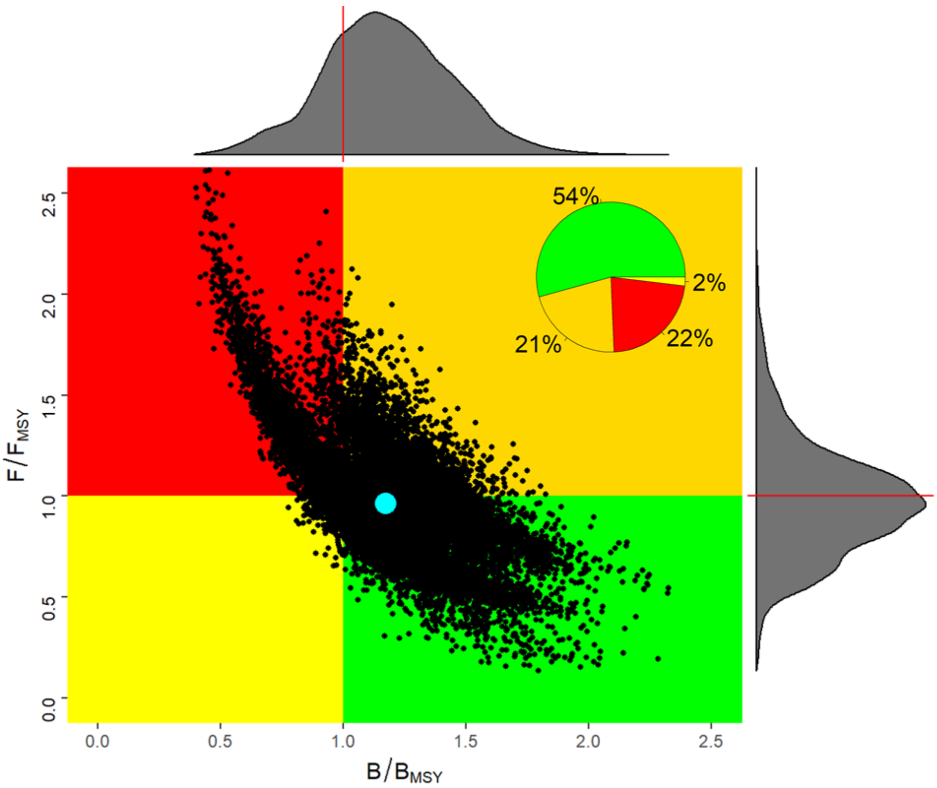
g) SS Run 4: Age 0 recruits



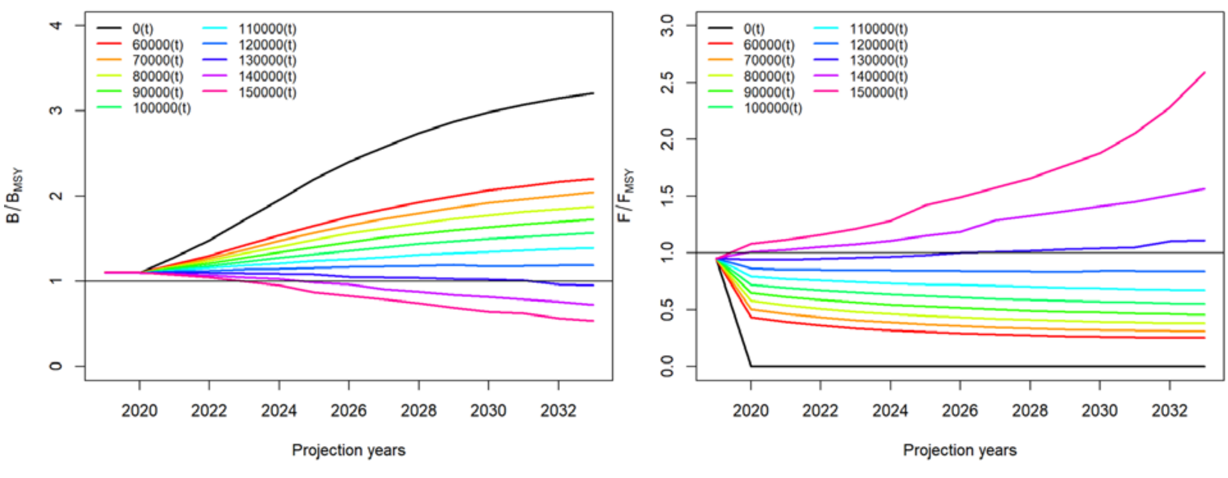
h) SS Run 4: Recruitment Deviations



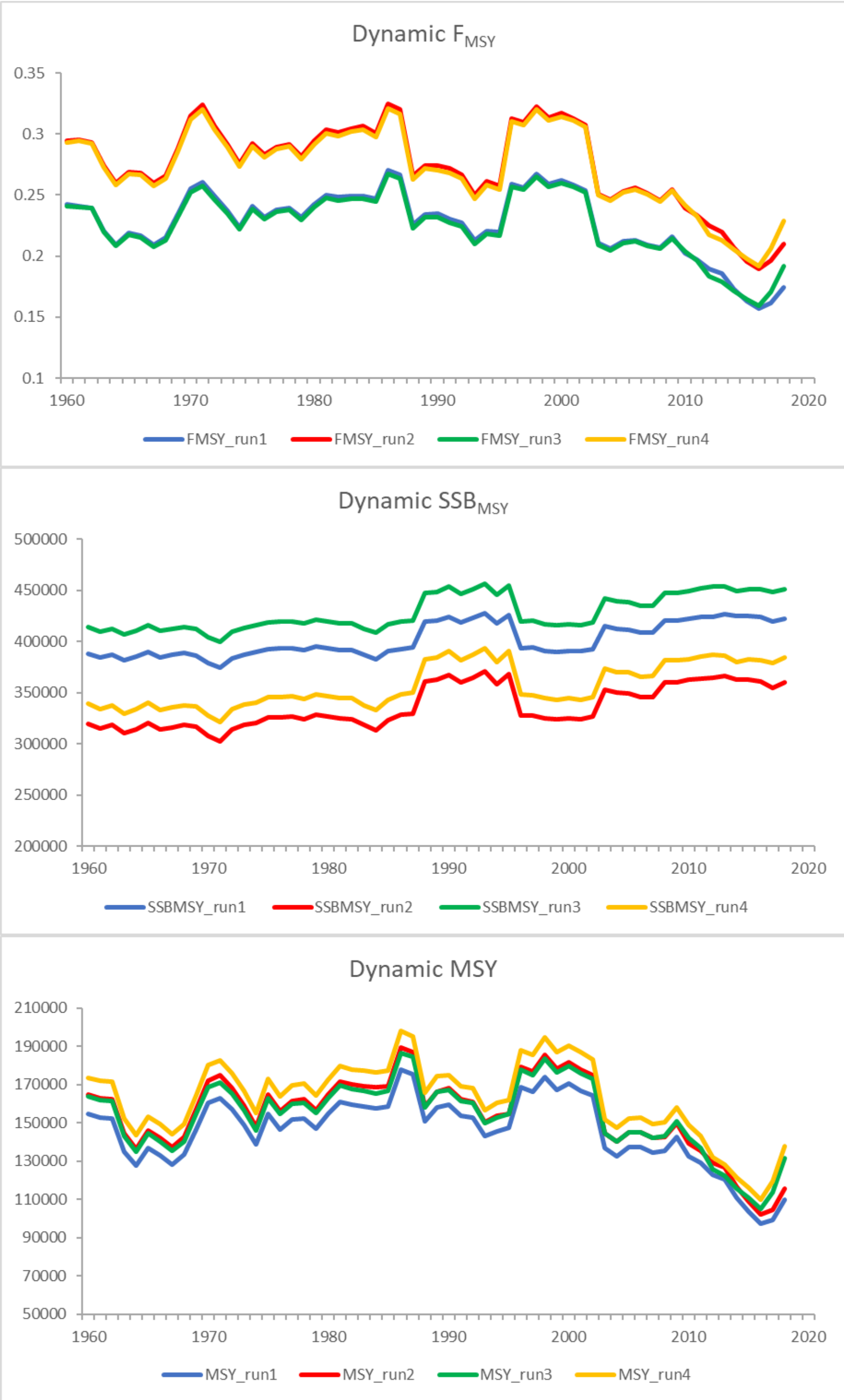
YFT-Figure 11. Annual estimates of Age-0 recruits (left panels) and recruitment deviations with 95% confidence intervals (right panels) for Stock Synthesis model runs. Models which used the buoy index suggest very high recruitment in 2017, whereas models that do not use the buoy index suggest that recruitment in 2017 was not particularly high. Note: Production models (JABBA, MPB) do not produce estimates of recruitment.



YFT-Figure 12. Kobe plot estimated from the combination of Stock Synthesis, JABBA and MPB model runs chosen to develop the management advice. The trajectory of individual runs are shown in the detailed report, and in **Figures 9 and 10** above.



YFT-Figure 13. Trends of projected relative biomass (left panel, B/B_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic yellowfin stock under different TAC scenarios (0, 60000 – 150000 t) from JABBA, MPB, and SS3 using 9 runs (JABBA (Base Case, S2, S3, and S5), MPB, Stock Synthesis (runs 1-4)). Each line represents the median of 20000 iterations by projected year. In 2019, the catch was assumed to be 131,042 t, equal to the 2018 estimated landings, which have since been revised upwards to 136,530 t after additional reporting.



YFT-Figure 14. Effect of changes in overall fisheries selectivity on estimate of MSY and reference points used for the determination of stock status (Dynamic SSB_{MSY}, F_{MSY} and MSY for the Stock Synthesis runs). For each year, reference points are calculated with the selectivity of each gear for that year, and relative yearly catch of each fleet.

9.2 BET - Bigeye

A stock assessment for bigeye tuna was conducted in 2021 through a process that included a data preparatory meeting in April and an assessment meeting in July. The stock assessment used fishery data from the period 1950-2019 and indices of relative abundance used in the assessment were calculated through 2019. The complete description of the stock assessment process and the development of management advice is found in the Report of the 2021 Bigeye Tuna Data Preparatory Meeting (Anon., 2021a) and the Report of the 2021 Bigeye Tuna Stock Assessment Meeting (Anon., 2021b).

BET-1. Biology

Bigeye tunas are distributed throughout the Atlantic Ocean between 50ºN and 45ºS, but not in the Mediterranean Sea. This species swims at deeper depths than other tropical tuna species and exhibits extensive vertical movements. Similar to the results obtained in other oceans, pop-up tagging and archival acoustic tracking studies conducted on adult fish in the Atlantic have revealed that they exhibit clear diurnal patterns: they are found much deeper during the daytime than at night. In the eastern tropical Pacific, this diurnal pattern is exhibited equally by juveniles and adults. In the western Pacific these daily patterns have been associated with feeding and are synchronized with depth changes in the deep scattering layer. Spawning takes place in tropical waters when the environment is favorable. From nursery areas in tropical waters, juvenile fish tend to diffuse into temperate waters as they grow. Catch information from surface gears indicate that the Gulf of Guinea is a major nursery ground for this species. Dietary habits of bigeye tuna are varied and prey organisms like fish, mollusks, and crustaceans are found in their stomach contents. Bigeye tuna exhibit relatively fast growth: about 110 cm fork length at age three, 145 cm at age five and 163 cm at age seven. Recently, however, reports from other oceans suggest that growth rates of juvenile bigeye are lower than those estimated in the Atlantic. Based on Indian Ocean tagging data, growth rates of bigeye tuna differ between sexes, males reaching around 10 cm larger L_{INF} than females. Bigeye tuna become mature around 100 cm at around 3 years old. Young fish form schools mixed with other tunas such as skipjack and young yellowfin tuna. These schools are often associated with drifting objects, whale sharks and sea mounts. This association weakens as bigeye tuna grow.

Extensive growth information obtained during the Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP) has confirmed previous assumptions about growth rates and the Richards curve published by Hallier *et al*. (2005) continues to be used in the BET assessment. It is assumed that natural mortality (M) is larger for young fish than for old fish. Age-specific M assumptions were modified significantly from the 2018 assessment. Modifications were based on new information recently obtained by ageing otoliths of Atlantic BET showing that fish reach 17 years of age (in contrast to previous estimates of 15 years) and by the decision to use a better procedure to derive natural mortality from maximum age. Various pieces of evidence, such as a lack of identified genetic heterogeneity, the time-area distribution of fish and movements of tagged fish, as confirmed by the recent data obtained from the AOTTP programme (**BET-Figure 1**), suggest an Atlantic-wide single stock for this species. However, the possibility of other more complex scenarios of stock structure should not be disregarded. Knowledge about the relationship between recruitment and spawning stock remains limited, so assumptions about the steepness of this relationship for small spawning stock sizes and the interannual variation in recruitment remain the same as the assumptions of the 2018 assessment. These uncertainties in stock structure, natural mortality, and the relationship between spawning stock and recruitment have important implications for the stock assessment as described in the Report of the 2021 Bigeye Tuna Stock Assessment Meeting (Anon., 2021b).

BET-2. Fisheries indicators

The stock has been exploited by three major gears (longline, baitboat and purse seine fisheries) and by many countries throughout its range. ICCAT has detailed data on the fishery for this stock since the 1950s. Scientific sampling at landing ports for purse seine vessels from the EU and other fleets has been conducted since 1980 to estimate bigeye tuna catches (**BET-Figure 2, BET-Table 1**). The size of fish caught varies among fisheries: medium to large fish for the longline fishery and purse seine free school sets, small to large for subtropical baitboat fishery, and small for tropical baitboat, western handline and purse seine floating object (FOB) / fish aggregating device (FAD) fisheries.

The major historical baitboat fisheries are located in Ghana, Senegal, the Canary Islands, Madeira and the Azores. Since 2012, a "vessel associated-school" fishing method using handline, where the vessels acts as a fish aggregating device developed in the western equatorial area, with bigeye catches increasing from 555 t in 2012 to an average of 4,670 t in 2015-2019. The tropical purse seine fleets operate in the Gulf of Guinea in the eastern Atlantic and across the tropical equatorial area. The longline fleets operate across a broader geographic range, covering tropical and temperate regions (**BET-Figure 2**). While bigeye tuna is a primary target species for most of the longline and some baitboat fisheries, this species has always been of secondary importance for the other surface fisheries. In the purse seine fishery, unlike yellowfin tuna, bigeye tunas are mostly caught while fishing on floating objects such as logs or manmade fish aggregating devices (FOB/FADs). The estimated total numbers of FADs released yearly has increased since the beginning of the FAD fishery, especially in recent years. During 2018-2022, bigeye landings in weight caught by longline fleets represent 47%, purse seine fleets 34%, baitboat 11% and other surface fleets 8% of the total landings (**BET-Table 1**).

The total annual Task 1 catch (**BET-Table 1**, **BET-Figure 3**) increased continuously up to the mid-1970s reaching 60,000 t and fluctuated over the next 15 years. In 1992, catch reached about 100,000 t and continued to increase, reaching a historic high of about 135,000 t in 1994. Since then, reported and estimated catch continuously declined and fell to 59,192 t by 2006. From the low level of 2006, catches increased again and reached 80,000 t in 2015. Catches averaged close to 73,000 t in the period 2016-2020. Catches of all tropical tunas declined considerably in 2021, and the reported catch of bigeye tuna was only 47,568 t. The preliminary catch reported for 2022 was 62,513 t, slightly above the TAC of 62,000 t.

After the historic high catch in 1994, all major fisheries exhibited a decline in catch while the relative share of each fishery in total catch remained relatively constant until 2008. These reductions in catch were related to declines in fishing fleet size (longline) as well as decline in catch per unit effort (CPUE) (longline and baitboat). Although the general trend of decreasing catches continued for longline and baitboat, the purse seiner catches increased, as did the relative contribution of purse seine in the total catches for the period 2010-2019. Other surface fisheries, from CPCs with no specific catch limits under Rec. 16-01, also increased the catches from around 500 t in 2011 to around 4,500 t in 2016-2020, mainly due to the development of a handline vessel associated-school fishery in the equatorial western Atlantic.

Nominal purse seine effort, expressed in terms of carrying capacity, has decreased regularly since the mid-1990s up to 2006. However, after that year, several European Union purse seiners have transferred their effort to the eastern Atlantic, due to piracy in the Indian Ocean, and a fleet of new purse seiners have started operating from Tema (Ghana). All this has contributed to the growth in carrying capacity of the purse seiners, which is gradually nearing the level observed in the early 1990s. More detailed information on carrying capacity is included in item 21.10 of the *Report for Biennial Period, 2020-21 Part II (2021), Vol. 2*.

Small bigeye tuna continues to be diverted to local West African markets, predominantly in Abidjan, and sold as *faux poissons* in ways that make their monitoring and official reporting challenging. Monitoring of such catches has recently progressed through a coordinated approach that allows ICCAT to properly account for these catches and thus increase the quality of the basic catch and size data available for assessments. Currently those catches are included with those from the main purse seine fleet in the ICCAT Task 1 data used for the assessments. The 2020-22 catch for *faux poissons* was estimated by the Group to be 4% of the total purse seine BET catch.

In the 2018 assessment mean average weight of bigeye tuna was reviewed. It showed mean weight decreased prior to 2004 but has remained relatively stable at around 10 kg for the last decade. Average weight, however, is quite different for the different fishing gears. In 2017 it was around 55 kg for longliners, 10 kg for baitboats, and 6 kg for purse seiners. Since 2000, several longline fleets have shown increases in the mean weight of bigeye tuna caught, with the average longline-caught fish increasing from 40 kg to 60 kg between 2000 and 2008. The average weight of bigeye tuna caught in free schools is more than double the average weight of those caught around FOB/FADs. Since 1991, when tuna catches were identified separately for FADs for EU and other CPCs purse seine fleets, the majority of bigeye tuna are caught in sets associated with FADs; particularly since the mid-2000s (60%-80%). Similarly, baitboat-caught bigeye tuna weighed between 6 and 10 kg up to 2011, but with greater inter-annual variability in average weight compared to longline or purse seine caught fish.

During the 2018 assessment a Joint Longline standardized abundance index (Hoyle *et al*., 2019) was used instead of each individual CPC's standardized CPUE indices used in the 2015 assessment. The joint longline standardized index for 1959-2017 was constructed using detailed operational data (including set by set and vessel identifiers) from major longline fleets, (Japan, Korea (Rep.), United States and Chinese Taipei). The index was broken down into two periods, 1959-1978 ("early") and 1979-2017 ("late") because of changes in the level of information available on fishing operations.

The development of this joint standardized CPUE index was motivated to reduce data conflicts that arise when CPUE trends differ for different fleets in the same period. This can occur when available data are sparse, when the fishery occurs at the extremes of the spatial distribution of the stock and/or does not represent a meaningful proportion of the stock biomass, or when the index references only a small portion of the age or size distribution. This can also occur when there are important changes in fisheries operations (e.g., targeting, regulations, spatial distribution) that cannot be addressed in the standardization process.

The 2018 joint longline indices were an improvement over fleet-specific indices and, for the "late" period, was able to account for differences in fishing efficiency of longline vessels. The "early" joint longline index developed in 2018 for the period 1959-1978 was included in the assessment of 2021 (**BET-Figure 4**).

A new joint longline index was produced in 2021 for the "late" period 1979-2019 (**BET-Figure 4**). Unfortunately, it was not possible to update this index by using the same level of detailed data and same set of fleet-specific longline data sets as it was done during the 2018 assessment due to restrictions on analyses caused by the COVID-19 pandemic. The 2021 "late" joint longline index used data aggregated to monthly catches by fleet and 1x1 latitude longitude. This index was developed without set-by-set data.

A new quarterly acoustic echosounder buoy index associated with FADs covering the period 2010-2019 is now available for all three species of tropical tunas and helped the assessment account for changes in abundance of juvenile BET (**BET-Figure 5**). This new index is a significant improvement in the available information set for the stock assessment given the challenges faced up until now to develop an index from the purse seine fisheries of tropical tunas. The index is developed from tuna biomass estimates obtained from the acoustic buoys placed in FADs. Observations of tropical tuna species composition from purse seine FAD catch sets conducted in similar places and times to the acoustic observations are used to develop a buoy index for each species of tropical tuna.

In the assessment, the joint longline index was assumed to have a selectivity for older fish, equivalent to the Japan longline fleet in the tropical Atlantic. As the acoustic buoy index represents BET abundance associated with FADs it was assumed that it represents the same range of sizes and ages of BET as those caught in the purse seine FAD fishery.

BET-3. State of the stock

The 2021 stock assessment was conducted using similar assessment models to those used in 2018, updating the data until 2019, but with some significant changes in natural mortality assumptions, derived from new information and new assumptions on maximum age, the relative abundance indices used and the fleet structure of the model used for providing management advice. As in 2018, stock status evaluations for Atlantic bigeye tuna used in 2021 several modeling approaches, ranging from non-equilibrium (MPB) and Bayesian state-space (JABBA) production models to integrated statistical assessment models (Stock Synthesis). Different model formulations considered to be plausible representations of the stock dynamics were used to characterize stock status and the uncertainties in stock status evaluations.

The Stock Synthesis integrated statistical assessment model allows the incorporation of more detailed information, both for the biology of the species as well as fishery data, including the size data and selectivity by different fleet and gear components. As Stock Synthesis allows modelling of the changes in selectivity of different fleets as well as to investigate the effect of the length/age structure of the catches of different fisheries in the population dynamic, productivity and fishing mortality, it was the agreed model to be used for the management advice. The Stock Synthesis uncertainty grid includes 27 model configurations, all of which were given equal weight, that were investigated to ensure that major sources of structural uncertainty were incorporated and represented in the assessment results (**BET-Table 2**). Although the results of two production models, non-equilibrium and Bayesian state-space, are not used for management advice they provide comparative perception of stock status. The median relative biomass (B/B_{MSY}) and relative fishing mortality (F/F_{MSY}) trajectories from production models and the Stock Synthesis models depicted similar patterns. The set of 27 Stock Synthesis models has wide uncertainty bounds for these trajectories, and the biomass trajectories from all the production models are within these bounds.

Results of the uncertainty grid of Stock Synthesis runs show a long-term decline in spawning stock biomass (SSB) from the beginning of the fishery, accelerating from 1970 to 2000 and a relative stable SSB in the last 20 years. Relative fishing mortality increased from the beginning of the fishery until 1999, rapidly declined from 1999 to 2008 and has been relatively stable since. Recruitment estimates for the recent period of 2015-2019 show an increasing trend (**BET-Figure 6**), in spite of the relative stability of recent SSB (**BET-Figure 7**).

The stock synthesis uncertainty grid shows 1950-2019 trajectories of increasing F and decreasing biomass (B) towards the red area of the Kobe plot ($F> F_{MSY}$ and $SSB<SSB_{MSY}$) (**BET-Figure 7 and 8**). Overfishing starts in around 1993 and the stock becomes overfished around 1997, therefore reaching the red quadrant of the Kobe plot and mostly remained in the red quadrant until 2019 when overfishing ceased (**BET-Figure 8**). The results of the assessment, based on the median of the entire uncertainty grid shows that in 2019 the Atlantic bigeye tuna stock was overfished (median SSB_{2019}/SSB_{MSY} = 0.94 and 80% confidence interval (CI) of 0.71 and 1.37) and was not undergoing overfishing (median F_{2019}/F_{MSY}=1.00 and 80% CI of 0.63 and 1.35). The average of MSY was estimated as 86,833 t with (80% CI of 72,210 t and 106,440 t) from the uncertainty grid deterministic runs.

Calculations of the time-varying benchmarks from the stock synthesis uncertainty grid show a long-term increase in SSB_{MSY} and a general long-term decrease in MSY. This change in benchmarks is the result of the change in overall selectivity caused by the shift to catch greater proportions of smaller fish. The current estimate of MSY is below what was achieved in past decades because of this shift. Other potential sources of changes in stock productivity have not been accounted in the assessment as no evidence for such changes has been presented to the Committee (**BET-Figure 9**).

Current estimates of stock status in 2019 are more optimistic than the 2017 stock status estimated at the 2018 assessment. Sensitivity analyses demonstrated that such changes in stock status partially result from replacing the 2018 "late" joint longline index with the new "late" joint longline index and incorporating new mortality at age vectors (**BET-Figure 10**).

The effect of natural mortality, steepness, and Sigma R (variability on the log of recruitment) on the uncertainty around current stock status are shown in **BET-Figure 11**. Of the three axes of uncertainty, natural mortality contributes the most to changing the perception of stock status. Assumptions about natural mortality are the greatest contributors to this uncertainty (**BET-Figure 11a**).

Uncertainty regarding the change in the longline index methodology was not incorporated into the uncertainty grid because it was not clear to the Committee on an appropriate way to do so. The scale of the impact of such change in methodology can be seen in **BET-Figure 10.** Therefore, the current stock status (**BET-Figure 8**) is more uncertain than the SCRS has been able to quantify with the uncertainty grid.

BET-4. Outlook

During the 2021 assessment projections were conducted for the uncertainty grid Stock Synthesis for a range of fixed catches from 35,000 to 90,000 t for 15 years (which corresponds to 2 generation times of bigeye) from 2020-2034. Projections results are driven by all the assumptions made for the projection period: by the catch estimate for 2020, by the assumption that removals equal the TAC from 2021 onwards, by the assumption that the relative contribution of different fleets to catches from 2020 onwards are the same as the contributions for 2017-2019 and that future recruitment is determined by spawning stock. The 2020 catch in the projections is 22% lower than the average catches of the period 2015-2019, and, for the first time since 2015, this catch did not exceed the TAC.

Under the projections of 2021 the assumed catch for 2020, and 2021 were 59,919 t and 61,500 t, respectively. As of September 2023, the reported catch of 2020 was 57,971 t, smaller than the catch used in the projections made in 2021. The 2021 catches reported of 47,568 t were lower in comparison, but the 2022 preliminary catches of 62,513 t were slightly higher than the TAC of 62,000 t. Therefore, projections conducted in 2021 have to be interpreted with caution as none of the projection tables were calculated with catches for 2020-2022 that match the current reported catches for such period.

For some of the projections, the modelled stock could not sustain some of the constant high TACs in the long term, as SSB was predicted to decline below a safe threshold (**BET-Table 3**). This safe threshold is an indicator of very low SSBs that may compromise the rebuilding ability of a stock when such low levels of biomass are reached. The value of 20% SSB at MSY is used by the Committee for both YFT and BET. The results of projections of the Stock Synthesis are provided in the form of Kobe II Strategic Matrices including with probabilities that overfishing is not occurring ($F<=F_{MSY}$), stock is not overfished ($SSB>=SSB_{MSY}$) and the joint probability of being in the green quadrant of the Kobe plot (i.e., $F<=F_{MSY}$ and $SSB>=SSB_{MSY}$) (**BET-Table 4**).

The rapid change in probabilities of overfishing and overfished during 2020 and 2021 (**BET-Figure 12**). are the result of the fact that estimated stock status in 2019 is close to the center point of the Kobe plot. When a stock is at such center point decreases in fishing mortality initially lead to large changes in these probabilities as can be seen from the marginal histograms (**BET-Figure 8**).

The more optimistic outlook presented in the 2021 assessment compared to the one obtained in 2018, is the result of a combination of factors: updates to the data and biological parameters, changes in the methodology and data used for the joint longline index, use of the buoy index, changes to the fleet structure in the stock synthesis models, and the assumed catches of BET for 2020 and 2021 which were low in comparison to catches for 2015-2019. There was some disagreement among Committee members on whether all these changes represent improvements to the information used to provide the determination of stock status and the outlook for the stock. Therefore, the Kobe II matrix should be interpreted with caution.

BET-5. Effect of current regulations

During the period 2005-2008 an overall TAC was set at 90,000 t. The TAC was later lowered (Rec. 09-01 and later modified by Rec. 14-01) to 85,000 t. Estimates of reported catch for 2009-2015 (**BET-Table 1**) have been always lower than 85,000 t. The TAC was again reduced to 65,000 t in Rec. 15-01 which entered into force in 2016 and Rec. 18-01, and in Rec. 19-02 to 62,500 t and 61,500 t for 2020 and 2021, respectively. TACs for 2022 and 2023 were set to 62,000 t in Rec. 21-01 and Rec. 22-01, respectively. Catches exceeded the TAC by more than 20% every year from 2016-2019 except 2018 when catches were 12% higher than the TAC. Note that because TACs do not limit catches of all countries and fleets that can catch bigeye tuna, the total catch removed from the stock can exceed the TAC. Rec. 19-02 included new catch limits for CPCs not previously under catch limits that took effect in 2020. Such limits were somewhat modified in subsequent recommendations. Current limits are described in Rec. 22-01. Such limits may have contributed to the declines in reported catch for 2020 and 2021 which were lower than the TAC, although such decline may have also been partly due to the effects of COVID-19 in fishing operations. Preliminary reported catches for 2022, however, overpassed the TAC by about 500 t.

Concern over the catch of small bigeye tuna partially led to the establishment of spatial closures to surface fishing gear in the Gulf of Guinea (Recs. 04-01, 08-01, 11-01, 14-01, 15-01 and 19-02). The Committee examined trends on average bigeye tuna catches by areas as a broad indicator of the effects of such closures as well as changes in juvenile bigeye and yellowfin catches due to the moratorium. The efficacy of the area-time closure agreed in Rec. 15-01 was evaluated by examining fine-scale (1ºx1º) skipjack, yellowfin, and bigeye catch by month distributions. After reviewing this information, the Committee concluded that the moratorium has not been effective at reducing the mortality of juvenile bigeye tuna, and any reduction in bigeye tuna mortality was minimal, largely due to the redistribution of effort into areas adjacent to the moratorium area and increase in number of fishing vessels. The FAD fishing closure in Rec. 19-02 was implemented in 2020 and 2021, however its effects cannot yet be evaluated. Although such closure may have contributed to the lower catches of BET estimated for 2020 and 2021, it was maintained during 2022 when catches have again slightly exceeded the TAC.

BET-6. Management recommendations

The Atlantic bigeye tuna stock in 2019 was estimated to be overfished but not undergoing overfishing. According to the Kobe II Strategy Matrix (K2SM), a future constant catch of 61,500 t, which is the TAC established in Rec. 19-02, will have a high probability (97%) of maintaining the stock in the green quadrant of the Kobe plot by 2034. This would leave the stock in a state consistent with the Convention objectives and the recovery plan in Rec. 19-02 (**BET-Table 4**). The K2SM, incorporates some of the known main sources of uncertainty, however, some other sources of relevant uncertainties were not been included in the development of the K2SM, including the appropriateness of the range of natural mortalities used in the uncertainty grid and the change in methodology used to develop the Joint Longline index. Therefore, current stock status and the outlook for the stock are more uncertain than portrayed in the summary table and the K2SM. Projection probabilities should be interpreted with caution. Until such additional sources of uncertainty can be properly incorporated in the estimation of stock status and the K2SM, the Commission should consider adopting a TAC that would shift the stock status of BET towards the green zone of the Kobe plot with a high probability.

The Commission should be aware that increased harvests on small fishes could have had negative consequences for the productivity of bigeye tuna fisheries (e.g., reduced yield at MSY and increased SSB required to produce MSY) (**BET-Figure 9**). Rec. 19-02 contains measures adopted by the Commission aimed at increasing long-term sustainable yield by reducing the catch of juveniles of tropical tunas. It is too early to know the extent by which these measures have reduced mortality of juvenile BET.

ATLANTIC BIGEYE TUNA SUMMARY	
Maximum Sustainable Yield	86,833 t with (72,210 -106,440 t)[1]
Current (2022) Yield	62,513 t[2]
Relative Spawning Biomass (SSB_{2019}/SSB_{MSY})	0.94 (0.71-1.37)[1]
Relative Fishing Mortality (F_{2019}/F_{MSY})	1.00 (0.63-1.35)[1]
Stock Status (2019)	Overfished: Yes[3] Overfishing: No[3]
Conservation & management measures in effect:	Rec. 16-02, Rec. 17-01 and Rec. 22-01 – Total allowable catch (TAC) for 2022 and 2023 was set to 62,000 t for Contracting Parties and Cooperating non-Contracting Parties, Entities or Fishing Entities. – No fishing with natural or artificial floating objects from 1 January to 13 March in 2023, throughout the Convention area. – No more than 300 FADs active at any time by vessel. – Use of non-entangling FADs. – Prohibition of discarding from purse seine.

[1] Combined result of stock synthesis 27 uncertainty grid runs. Median and 10 and 90% percentile in brackets.
[2] Reports for 2022 reflect the most recent data but should be considered provisional.
[3] Probability of overfished 58%, probability of overfishing 50%.

BET-Table 1. Estimated catches (t) of bigeye tuna (*Thunnus obesus*) by area, gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL	A+M		113790	134932	128047	120767	110255	107954	121425	103434	91636	75802	87596	90043	67954	59192	69895	63172	76427	76074	76749	71317	66977	75308	80000	79897	78665	73077	75384	57971	47568	62513
Landings		Bait boat	16466	20352	25687	18342	21277	19173	22197	12141	14430	8460	11233	20238	13104	10605	10561	6307	11548	7842	12659	10459	9195	8715	7970	6710	8366	7932	7341	6811	6141	6855
		Longline	62891	78908	74872	74930	68312	71857	77227	72011	56123	47351	55356	49400	37961	34182	46231	41063	43533	42516	37899	34930	32245	36770	40379	36345	35190	32065	33890	27288	21649	32620
		Other surf.	628	973	561	363	546	445	678	459	723	226	451	293	733	552	449	220	258	487	1146	1012	2783	4960	6002	6472	7217	4616	6054	5461	5339	5167
		Purse seine	31515	32667	25260	26592	19127	15490	20139	17460	20103	19552	19689	19094	15129	13310	11962	14810	20007	24235	23767	24080	22122	24253	24418	28624	26838	27284	26929	17026	13762	16793
Landings(FP)		Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
		Purse seine	2290	2032	1667	540	993	989	1184	1363	257	214	867	1019	1026	542	692	772	1081	994	1277	823	632	609	1193	1744	1015	1151	1145	1355	646	1028
Discards		Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	2	0	0	26	15	27	29	41
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	38	2	10	3	1	2
Landings	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
		Barbados	0	0	0	0	24	17	18	18	6	11	16	19	27	18	14	14	7	12	7	15	11	26	30	19	16	29	14	20	25	24
		Belize	0	0	10	0	5	195	0	134	96	0	0	0	0	4	60	70	234	249	1218	1242	1336	1502	1877	1764	1961	2135	2307	991	600	1002
		Brazil	1256	601	1935	1707	1237	776	2024	2768	2659	2582	2455	1496	1081	1479	1593	958	1189	1173	1841	2120	3623	6456	7750	7660	7258	5096	6249	6284	6499	7341
		Canada	124	111	148	144	166	120	263	327	241	279	182	143	187	196	144	130	111	103	137	166	197	218	257	171	214	237	193	104	253	330
		Cape Verde	319	385	271	299	228	140	9	2	0	1	1	1	1077	1406	1247	444	545	554	1037	713	1333	2271	2764	1680	1107	1418	880	576	171	2
		China PR	70	428	476	520	427	1503	7347	6564	7210	5840	7890	6555	6200	7200	7399	5686	4973	5489	3720	3231	2371	2232	4942	5852	5514	4823	5718	3614	1638	3249
		Curaçao	0	0	0	1893	2890	2919	4016	3098	3757	2221	3203	3526	27	416	252	1721	2348	2688	3441	2890	1964	2315	2573	3598	2844	3530	2787	1519	1701	824
		Côte d'Ivoire	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	790	576	47	507	635	441	12	544	1239	384	2334	141	59	386
		EU-España	16782	22096	17849	15393	12513	7110	13739	11250	10133	10572	11120	8365	7618	7454	6675	7494	11966	11272	13100	10914	10082	10736	10058	11469	11544	8400	9117	5997	6598	6424
		EU-France	12648	12262	8262	9135	5955	5583	5413	5873	5533	4437	4048	2989	2814	2984	1525	1130	2313	3355	3507	3756	3222	3837	2801	4772	4039	4055	5118	2104	1809	3678
		EU-Ireland	0	0	0	0	4	0	0	0	10	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EU-Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	7	0	0
		EU-Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EU-Portugal	5616	3099	9662	5810	5437	6334	3314	1498	1605	2590	1655	3204	4146	5071	5505	3422	5605	3682	6920	6128	5345	3869	3135	2187	3146	4405	3146	3069	3106	3123
		El Salvador	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	992	1450	1826	2634	2464	1518	1492	1479
		FR-St Pierre et Mi	0	0	0	0	0	0	0	0	90	21	0	28	6	0	2	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0
		Gabon	1	87	10	0	0	0	184	150	121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Gambia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Ghana	3577	4738	5517	4751	10174	10647	11704	5632	9864	6480	9061	17888	8860	2307	2559	3372	4515	6253	3541	4468	2963	4175	5918	5194	3838	3636	2917	3160	1925	3672
		Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0
		Grenada	20	10	10	0	1	0	0	0	0	0	0	0	0	0	10	31	0	0	0	0	0	0	18	23	33	27	19	11	0	10
		Guatemala	0	0	0	0	0	0	0	0	0	0	736	831	998	949	836	998	913	1011	282	262	163	993	340	1103	1602	1488	1623	906	768	855
		Guinea Ecuatorial	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	50	0	58	0	3	10	17	4	11	7	8	6	6	5
		Guinée Rep	0	0	334	2394	885	0	0	0	0	0	0	0	0	0	0	0	0	328	322	1516	1429	902	0	0	0	0	0	0	0	5
		Honduras	0	0	61	28	59	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Iceland	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Japan	35053	38503	35477	33171	26490	24330	21833	24605	18087	15306	19572	18509	14026	15735	17993	16684	16395	15205	12306	15390	13397	13603	12390	10365	10994	9854	9327	8973	9332	12132
		Korea Rep	377	386	423	1250	796	163	124	43	1	87	143	629	770	2067	2136	2599	2134	2646	2762	1908	1151	1039	675	562	432	623	540	587	674	763
		Liberia	65	53	57	57	57	57	57	57	57	57	57	0	0	0	0	0	0	0	0	0	0	0	0	27	98	1	3	222	29	0
		Libya	1085	500	400	400	400	400	400	400	31	593	593	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Maroc	774	977	553	654	255	336	1444	1160	1181	1154	1399	1145	786	929	700	802	795	276	300	300	308	300	309	350	410	500	850	1033	1239	1363
		Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Mexico	1	4	0	2	6	8	6	2	2	7	4	5	4	3	3	1	1	3	1	1	2	1	2	2	3	3	3	3	3	4
		Namibia	0	715	29	7	46	16	423	589	640	274	215	177	307	283	41	146	108	181	289	376	135	240	465	359	141	109	79	568	1185	2070
		Nigeria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
		Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Panama	10138	13234	9927	4777	2098	1252	580	952	562	211	0	1521	2310	2415	2922	2263	2405	3047	3462	1694	2774	2315	1289	2337	1664	2067	3052	1648	1107	1328
		Philippines	0	0	0	0	0	1154	2113	975	377	837	855	1854	1743	1816	2368	1874	1880	1399	1267	532	1323	1964	0	0	0	0	0	0	0	0
		Russian Federatioı	0	0	0	13	38	4	8	91	0	0	0	0	1	1	26	73	43	0	0	0	0	0	0	0	0	0	0	0	0	0
		S Tomé e Príncipe	4	3	6	4	5	6	5	4	4	4	4	11	6	4	0	92	94	97	100	103	107	110	633	421	393	2	81	46	90	149
		Senegal	8	123	357	190	272	789	1372	915	1159	497	322	490	770	1318	1293	734	1144	969	479	436	606	369	1031	1500	2978	2870	2272	2772	856	746
		Sierra Leone	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		South Africa	88	79	27	7	10	53	55	249	239	341	113	270	221	84	171	226	159	145	153	47	435	332	193	121	257	282	432	357	380	464
		St Vincent and Gr	1740	812	519	596	545	1937	2940	1921	1143	130	103	18	0	114	567	171	293	396	38	25	16	30	496	622	889	428	504	220	136	568
		Trinidad and Toba	3	29	27	37	36	24	19	5	11	30	6	5	9	12	27	69	56	40	33	33	37	59	77	37	25	17	13	10	9	10
		UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
		UK-Sta Helena	6	6	10	10	12	17	6	8	5	5	4	6	18	25	18	28	17	11	190	51	19	17	44	77	70	45	4	0	0	1
		UK-Turks and Cai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0
		USA	1090	1402	1209	882	1138	929	1263	574	1085	601	482	416	484	991	527	508	515	578	866	727	903	892	1082	568	836	921	829	801	968	1203
		USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Uruguay	48	37	80	124	69	59	28	25	51	67	59	40	62	83	22	27	201	23	15	2	30	0	0	0	0	0	0	0	0	0
		Venezuela	809	457	457	189	274	222	140	221	708	1241	847	1060	243	261	318	122	229	85	264	98	94	169	132	156	318	165	28	79	129	39

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	NCC	Chinese Taipei	13426	19680	18023	21850	19242	16314	16837	16795	16429	18483	21563	17717	11984	2965	12116	10418	13252	13189	13732	10805	10316	13272	16453	13115	11845	11630	11288	9226	4093	8181
		Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	4	4	1	0	6	1
		Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	25	34	53	2	4	1	**0**
	NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Benin	8	9	9	9	30	13	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cambodia	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Congo	14	9	9	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cuba	36	7	7	5	0	0	0	0	0	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Dominica	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Faroe Islands	0	0	0	0	0	0	11	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (ETRO)	42	356	915	0	7	0	0	0	362	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NEI (Flag related)	4378	8964	10697	11862	16565	23484	22190	15092	7907	383	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Saint Kitts and Ne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	1	0	
		Seychelles	0	0	0	0	0	0	0	58	0	162	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Sta Lucia	0	0	0	0	0	0	0	0	1	2	2	0	2	0	0	0	0	0	0	0	0	0	6	10	24	13	13	9	3	3
		Togo	86	23	6	33	33	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Vanuatu	1807	2713	2610	2016	828	0	314	0	0	0	0	104	109	52	132	91	34	42	39	23	9	4	0	0	0	0	0	0	0	
Landings(FP)	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	46	42	16	41	23	0	0	0	0	0	0	0	**0**
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	75	28	37	38	61	102	40	22	45	97	165	121	38	53	42	54	0	**0**
		Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	13	25	20	13	117	59	46	60	34	42	0	0	0	0	0	0	57	**0**
		Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	95	45	0	0	0	0	0	0	0	0	**0**
		EU-España	764	605	371	58	255	328	487	474	0	0	223	244	143	88	49	190	250	211	216	98	80	143	334	398	323	216	265	200	224	299
		EU-France	1032	970	713	314	437	467	553	607	229	205	446	397	222	79	26	51	150	122	394	192	56	54	191	233	108	213	201	233	289	689
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	56	28	15	26	9	18	6	11	5	15	0	0	0	0	0	0	23	13
		Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	72	0	60	20	22	74	203	288	245	209	0	0	0	0	0	0	0	**0**
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	151	106	135	97	85	38	70	41	80	27	0	0	0	0	0	0	53	12
	NCO	Mixed flags (EU t	494	457	582	169	301	193	143	281	28	8	198	378	294	189	348	337	375	324	257	0	0	0	503	993	546	669	637	868	0	
Discards	CP	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	38	2	10	3	1	2
		EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	15	18	19	35
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**0**
		Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	6	5
	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	**0**

BET-Table 2. Details of the specifications for the 27 Stock Synthesis models of the uncertainty grid for the Atlantic bigeye tuna. The 27 models are constructed as a fully crossed design of the 3 uncertainty parameters below (3x3x3=27). Max age represents the assumption of lifespan used to estimate age specific natural mortality. Sigma R represents the variability of recruitment not explained by the spawning stock recruitment relationship and Steepness represents the shape of the SSB vs recruitment relationship. The bold values represent the model combination that the Committee defined as 'reference' case. This reference case model was defined solely for the purpose of constructing the initial runs of the assessment and for comparison with sensitivity runs. The reference case model was given the same weight than any of the other models of the uncertainty grid in the estimation of stock status and development of forecasts.

Parameter	Value1	Value2	Value3
Max_Age	17	20	25
Steepness	0.7	0.8	0.9
Sigma R	0.2	0.4	0.6

BET-Table 3. Percent of the model runs that resulted in SSB levels <= 20% of SSB_{MSY} during the projection period for a given catch level (in 1000 t) for Atlantic bigeye tuna.

TAC (1000s mt)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
35	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
37.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
40	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
42.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
45	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
47.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
50	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
52.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
55	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
57.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
60	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
61.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
62.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
65	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
67.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
70	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
72.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
75	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
77.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
80	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
82.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
85	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	2%	8%
87.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	13%	27%
90	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	14%	28%	32%

BET-Table 4. Estimated probabilities of the Atlantic bigeye tuna stock being below F_{MSY} (overfishing not occurring), above B_{MSY} (not overfished) and above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level ('000 t), based upon Stock Synthesis 2021 assessment outcomes.

a) Probability of Overfishing Not Occurring (F <= F_{MSY}).

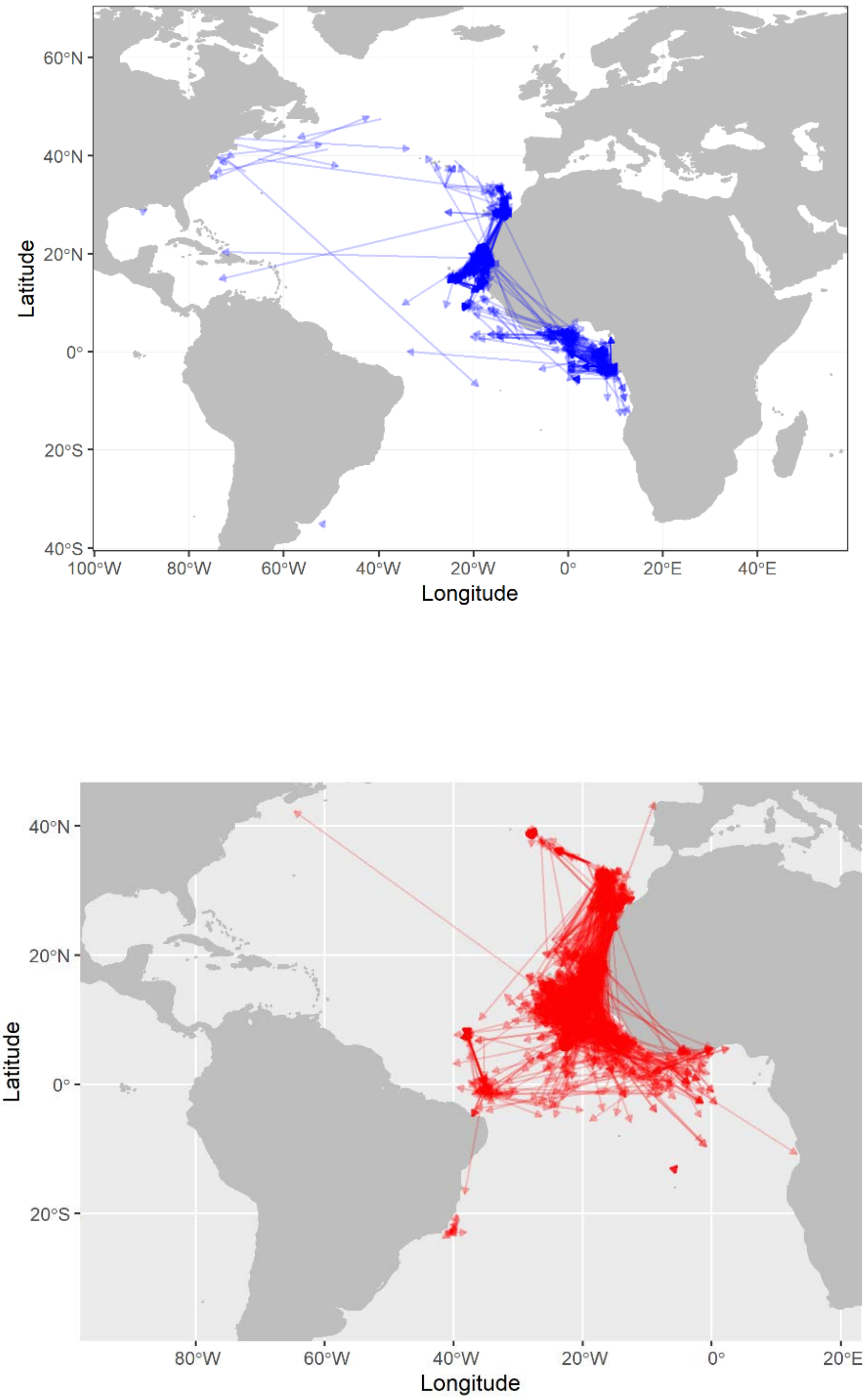
TAC (1000s mt)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
35	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
37.5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
40	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
42.5	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
45	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
47.5	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
50	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
52.5	98%	99%	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
55	97%	98%	98%	99%	99%	100%	100%	100%	100%	100%	100%	100%	100%
57.5	96%	97%	98%	98%	99%	99%	99%	99%	100%	100%	100%	100%	100%
60	94%	96%	96%	97%	98%	98%	99%	99%	99%	99%	99%	99%	99%
61.5	93%	95%	95%	96%	97%	97%	98%	98%	98%	98%	98%	98%	99%
62.5	92%	94%	95%	96%	96%	97%	97%	98%	98%	98%	98%	98%	98%
65	90%	92%	92%	93%	94%	95%	95%	95%	96%	95%	95%	95%	95%
67.5	88%	89%	90%	91%	92%	92%	93%	93%	92%	92%	92%	92%	91%
70	85%	86%	87%	87%	88%	88%	89%	89%	88%	87%	87%	86%	85%
72.5	82%	83%	83%	83%	84%	84%	83%	83%	82%	81%	80%	79%	78%
75	78%	80%	79%	79%	79%	78%	77%	76%	75%	74%	73%	71%	69%
77.5	75%	76%	75%	74%	73%	72%	70%	69%	67%	66%	65%	63%	61%
80	71%	72%	70%	69%	67%	65%	62%	60%	58%	56%	55%	53%	52%
82.5	67%	67%	65%	64%	60%	57%	55%	52%	50%	47%	46%	44%	43%
85	63%	63%	60%	58%	53%	50%	47%	44%	41%	39%	38%	37%	36%
87.5	59%	59%	55%	53%	47%	43%	40%	36%	34%	32%	31%	31%	31%
90	55%	54%	50%	48%	41%	37%	33%	30%	28%	27%	26%	27%	26%

b) Probability of Not Overfished (SSB >= SSB_{MSY}).

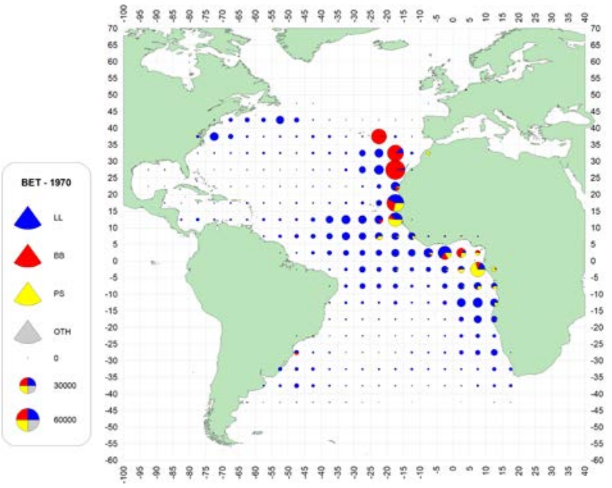
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
35	85%	91%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
37.5	85%	91%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
40	84%	90%	95%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
42.5	84%	90%	94%	97%	99%	99%	100%	100%	100%	100%	100%	100%	100%
45	84%	89%	94%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%
47.5	83%	89%	93%	96%	97%	99%	99%	100%	100%	100%	100%	100%	100%
50	83%	88%	92%	95%	97%	98%	99%	99%	100%	100%	100%	100%	100%
52.5	83%	87%	91%	94%	96%	97%	98%	99%	99%	100%	100%	100%	100%
55	82%	87%	91%	93%	95%	96%	97%	98%	99%	99%	100%	100%	100%
57.5	82%	86%	90%	92%	93%	95%	96%	97%	98%	98%	99%	99%	99%
60	82%	86%	89%	90%	92%	93%	94%	95%	96%	97%	98%	98%	98%
61.5	81%	85%	88%	89%	91%	92%	93%	94%	95%	96%	97%	97%	98%
62.5	81%	85%	87%	89%	90%	91%	91%	93%	94%	95%	96%	96%	97%
65	81%	84%	86%	87%	88%	88%	89%	90%	91%	91%	92%	93%	93%
67.5	80%	84%	85%	85%	85%	85%	85%	85%	86%	87%	88%	87%	88%
70	80%	83%	83%	83%	82%	82%	81%	80%	81%	81%	81%	81%	82%
72.5	80%	82%	82%	81%	79%	77%	75%	74%	74%	74%	74%	73%	73%
75	79%	81%	80%	78%	76%	73%	70%	68%	68%	66%	66%	65%	64%
77.5	79%	81%	79%	75%	72%	68%	64%	62%	60%	58%	57%	55%	54%
80	78%	80%	77%	72%	68%	63%	58%	56%	52%	50%	48%	47%	46%
82.5	78%	79%	75%	69%	64%	58%	53%	47%	45%	42%	41%	40%	39%
85	77%	78%	73%	66%	59%	52%	47%	41%	38%	36%	35%	34%	35%
87.5	77%	77%	71%	63%	55%	47%	40%	35%	32%	31%	30%	31%	31%
90	76%	76%	69%	60%	50%	43%	35%	30%	27%	26%	28%	28%	27%

c) Probability of Not Overfished (SSB >= SSB_{MSY}) and Overfishing not occurring (F <= F_{MSY}).

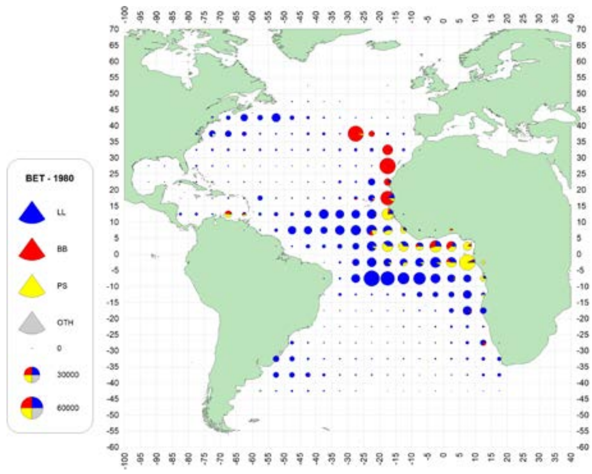
TAC (1000s mt)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
35	85%	91%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
37.5	85%	91%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
40	85%	90%	95%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
42.5	84%	90%	94%	97%	99%	99%	100%	100%	100%	100%	100%	100%	100%
45	84%	89%	94%	96%	98%	99%	100%	100%	100%	100%	100%	100%	100%
47.5	83%	89%	93%	96%	97%	99%	99%	100%	100%	100%	100%	100%	100%
50	83%	88%	92%	95%	97%	98%	99%	99%	100%	100%	100%	100%	100%
52.5	83%	88%	92%	94%	96%	97%	98%	99%	99%	100%	100%	100%	100%
55	82%	87%	91%	93%	95%	96%	97%	98%	99%	99%	100%	100%	100%
57.5	82%	86%	90%	92%	93%	95%	96%	97%	98%	98%	99%	99%	99%
60	81%	86%	89%	90%	92%	93%	94%	95%	96%	97%	98%	98%	98%
61.5	81%	85%	88%	89%	91%	92%	93%	94%	95%	96%	97%	97%	97%
62.5	81%	85%	87%	89%	90%	91%	92%	93%	94%	95%	96%	96%	97%
65	81%	84%	86%	87%	87%	88%	89%	90%	90%	92%	92%	93%	93%
67.5	80%	83%	84%	85%	85%	85%	85%	85%	86%	87%	87%	87%	88%
70	79%	82%	83%	82%	82%	81%	81%	80%	81%	81%	80%	81%	82%
72.5	78%	80%	80%	79%	79%	77%	75%	74%	74%	74%	74%	73%	73%
75	76%	78%	77%	76%	74%	72%	70%	68%	68%	66%	65%	65%	64%
77.5	73%	74%	74%	72%	70%	67%	64%	62%	59%	58%	57%	56%	54%
80	70%	71%	70%	68%	64%	61%	57%	55%	52%	50%	48%	47%	46%
82.5	67%	67%	65%	63%	59%	55%	52%	47%	44%	42%	41%	40%	39%
85	63%	63%	60%	58%	53%	48%	45%	40%	37%	36%	34%	34%	34%
87.5	59%	58%	55%	53%	47%	42%	38%	34%	31%	30%	29%	29%	30%
90	55%	54%	50%	48%	41%	37%	32%	28%	26%	25%	25%	26%	25%



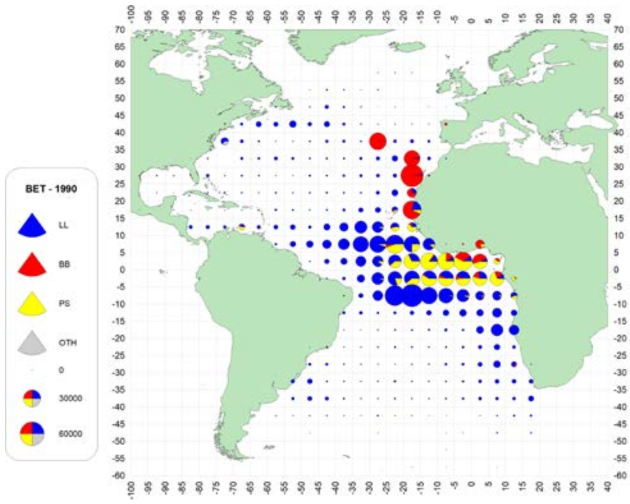
BET-Figure 1. Apparent movements (straight line distance between the tagging location and that of recovery) calculated from conventional tagging of Atlantic bigeye tuna from the historical ICCAT tagging database (top panel) and the current AOTTP activities (bottom panel).



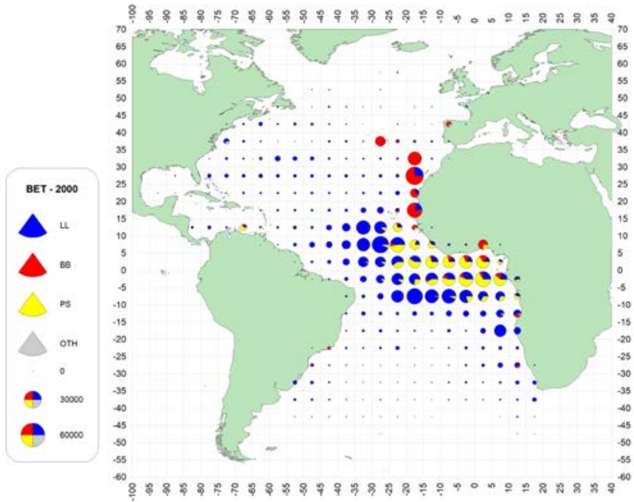
a. BET (1970-79)



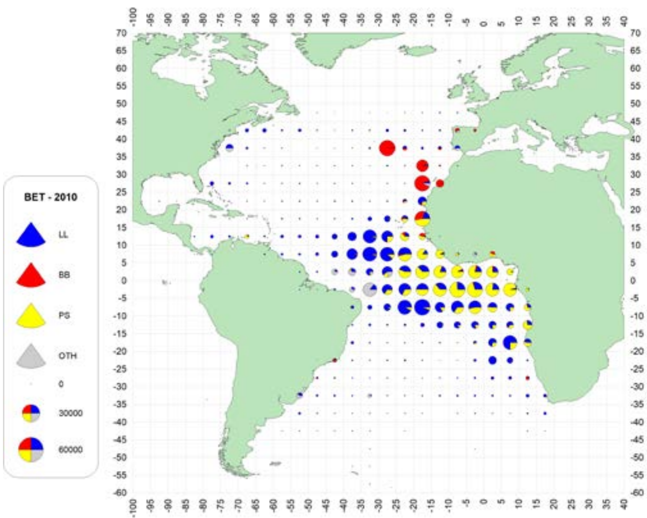
b. BET (1980-89)



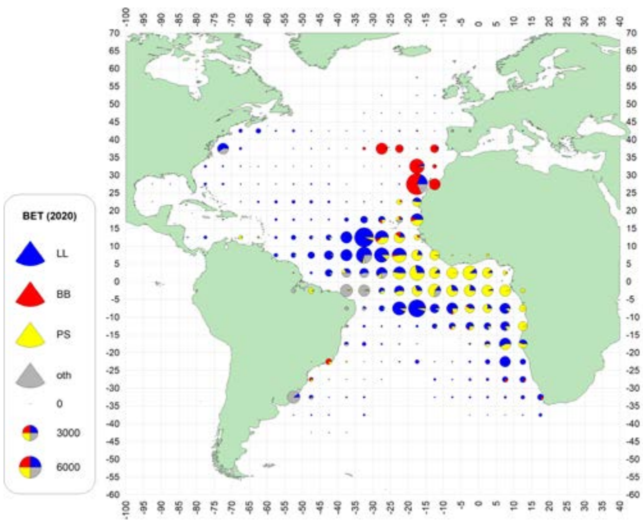
c. BET (1990-99)



d. BET (2000-09)

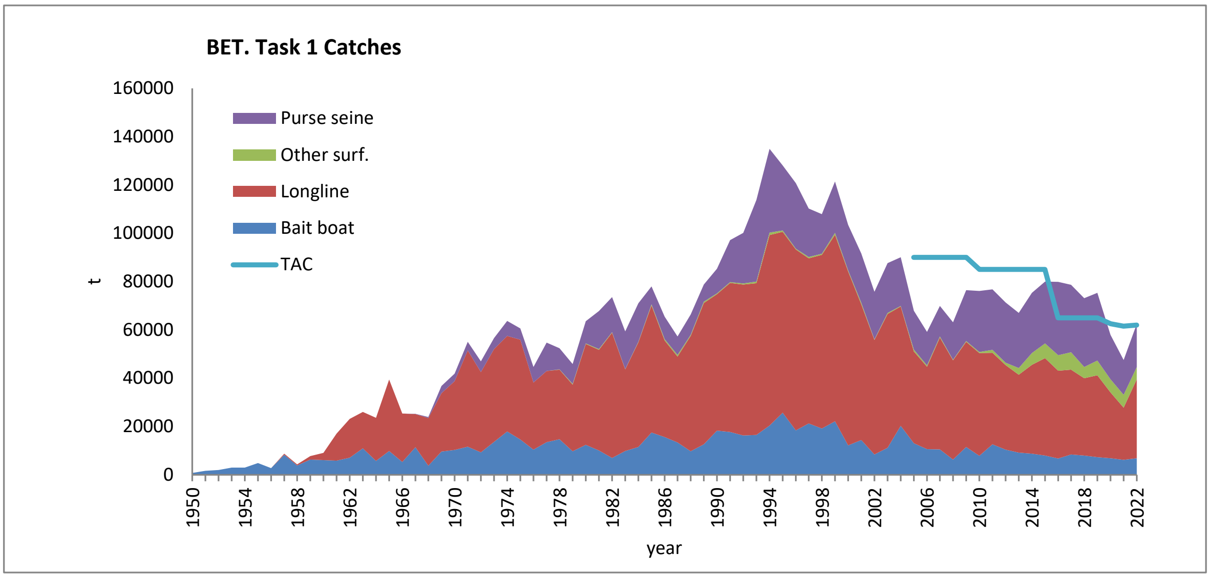


e. BET (2010-19)

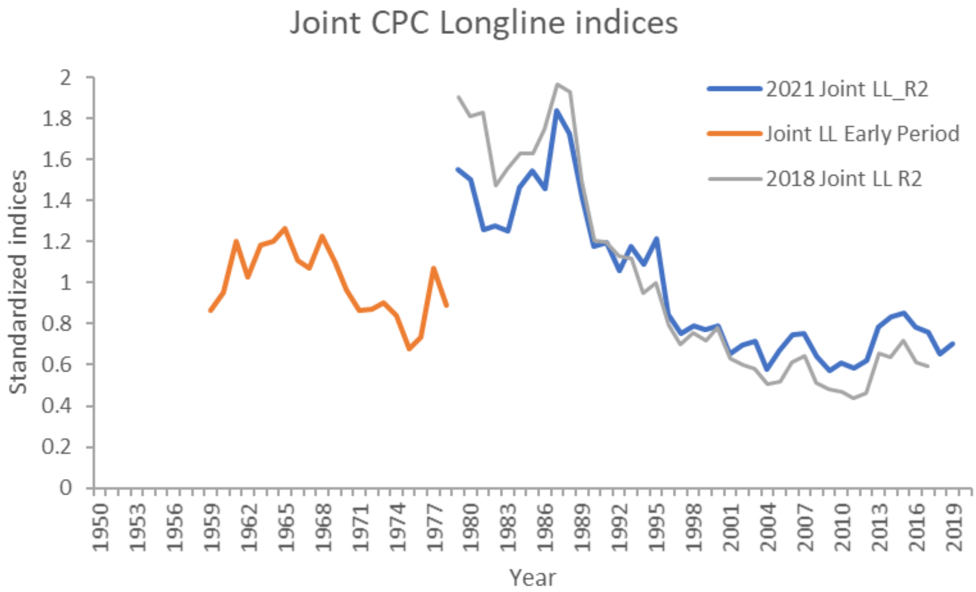


f. BET (2020-21)

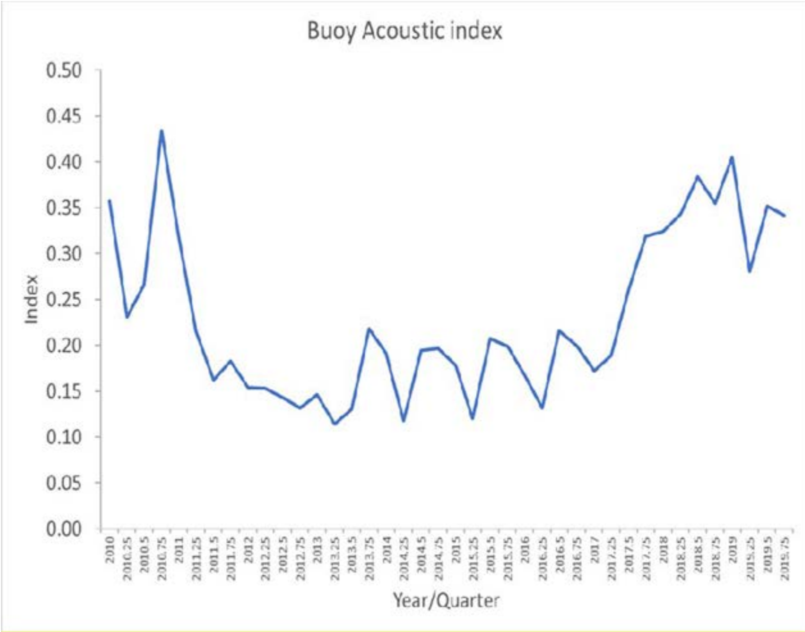
BET-Figure 2 [a-f]. Geographical distribution of the bigeye tuna catch by major gears and decade. The maps are scaled to the maximum catch observed during 1970-2021 (the last decade only covers 2 years).



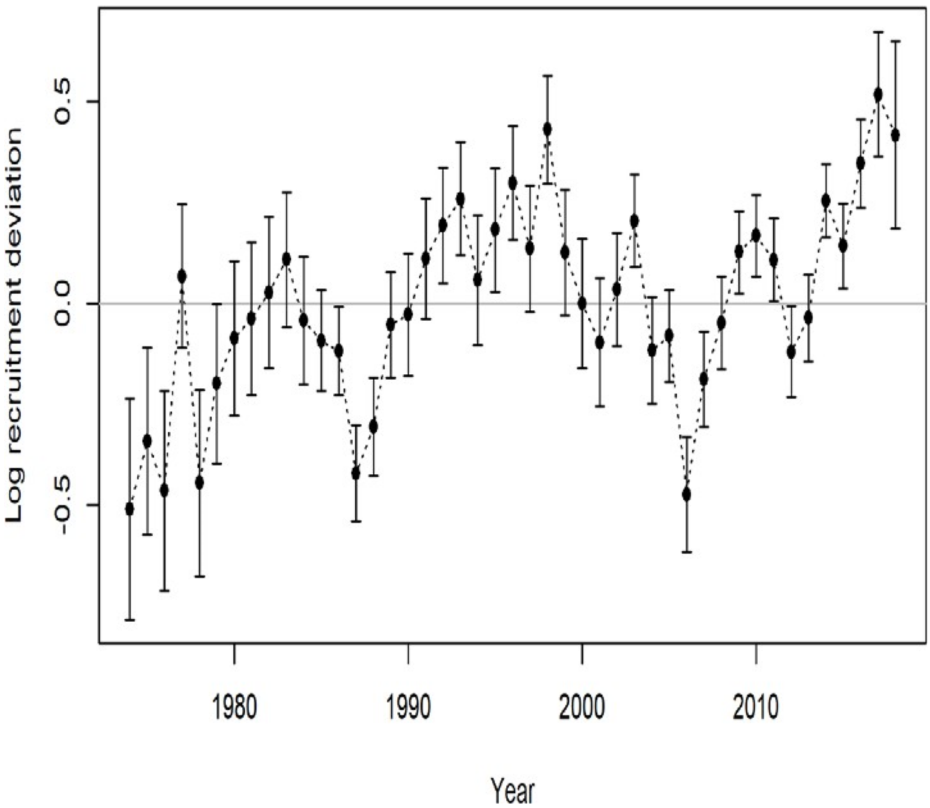
BET-Figure 3. Bigeye tuna estimated and reported catches for all the Atlantic stock (t).



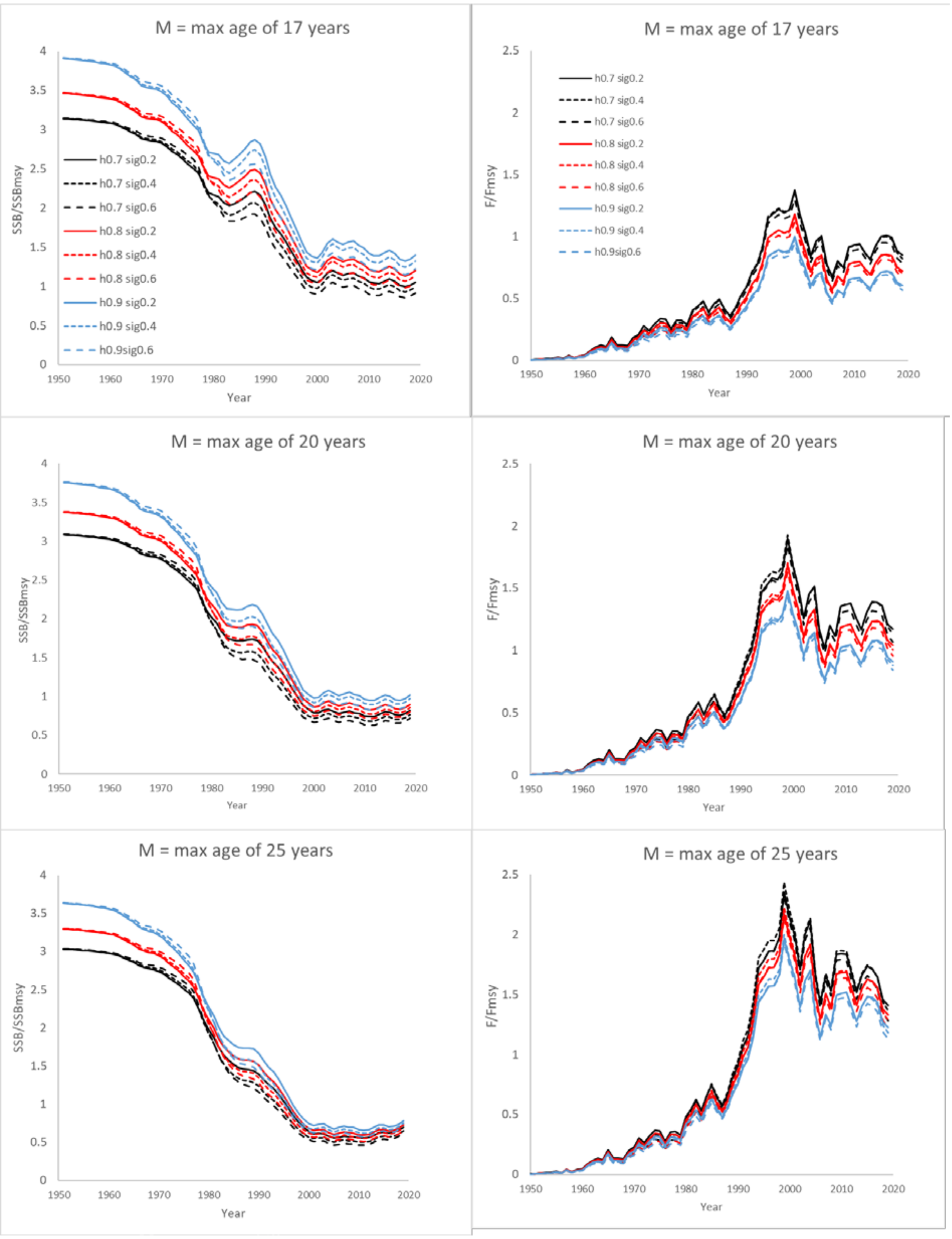
BET-Figure 4. Annual joint longline index for 1959 to 2019 that include two series Early period (1959-1978, Joint LL Early Period) and the late period (1979-2019, 2021 joint LL_R2) used in the 2021 stock assessment. For comparison the 2018 joint index late period (1979-2017) is presented (2018 Joint LL R2) which was used for sensitivity runs. Indices are split in 1979 because of the lack of vessel ID data prior to that year. 2018 index for the late period was developed with set by set and vessel data, but 2021 index for the late period was not.



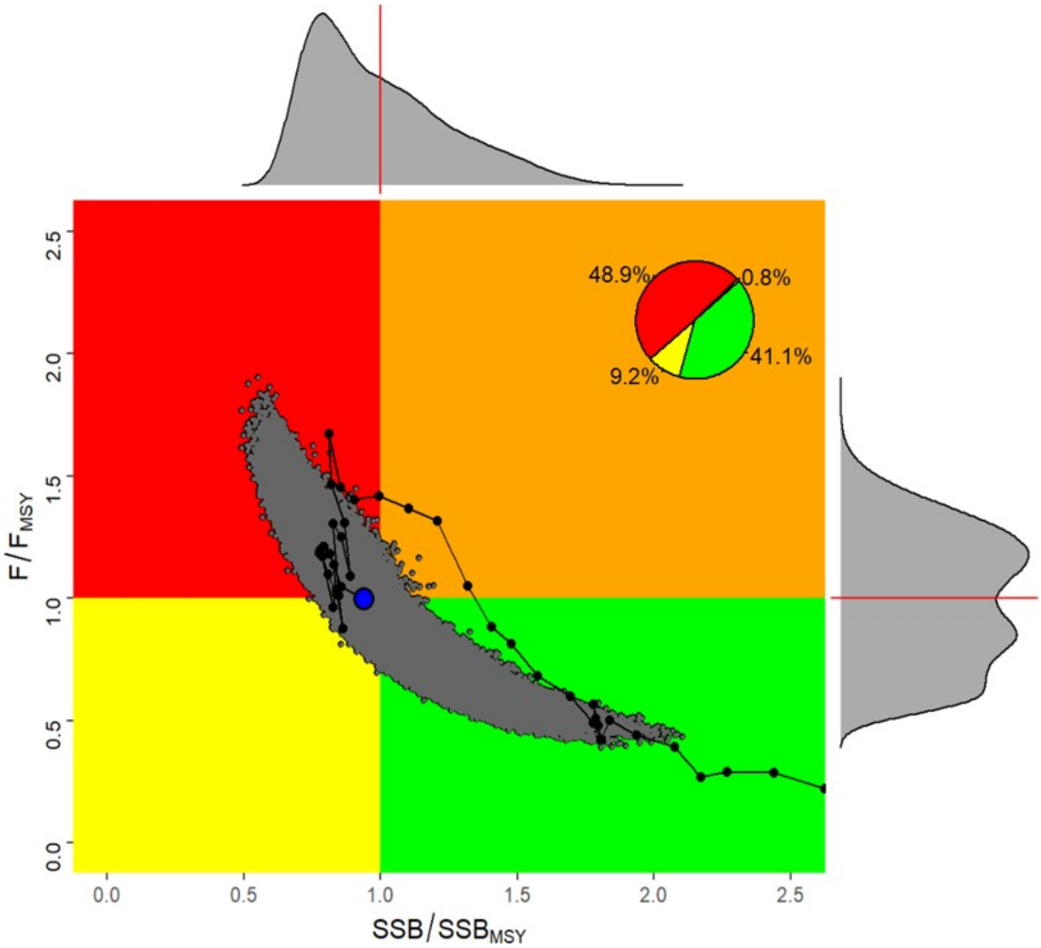
BET-Figure 5. Quarterly abundance index from acoustic buoys used in the FAD fishery for 2010 to 2019.



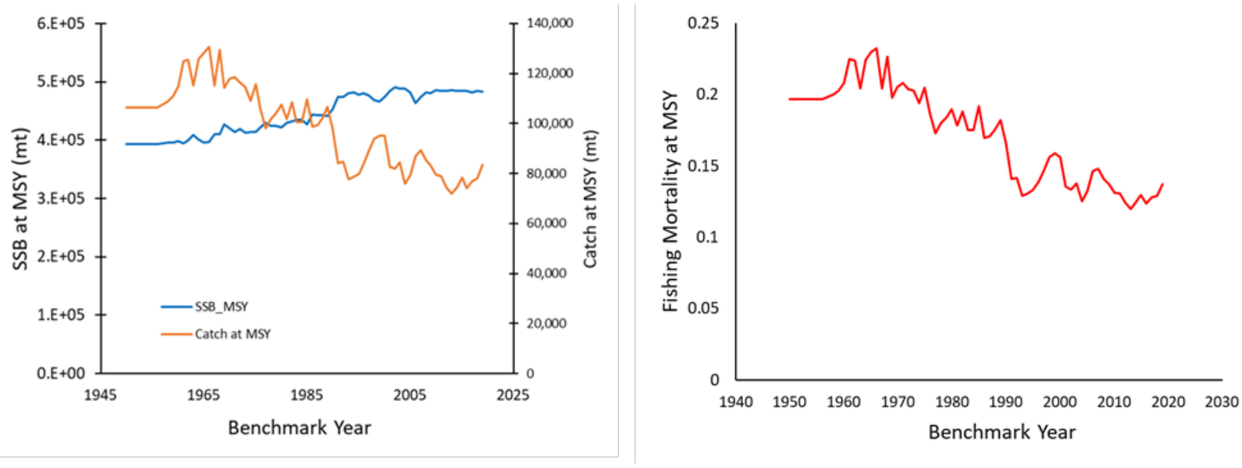
BET-Figure 6. Estimated recruitment deviations for the period 1974-2018 for Stock Synthesis reference case (see **BET-Table 2** for definition). The zero line represents the expected recruitment resulting from the previous year spawning stock biomass. Positive values represent better than expected recruitments, negative values, worse than expected recruitment.



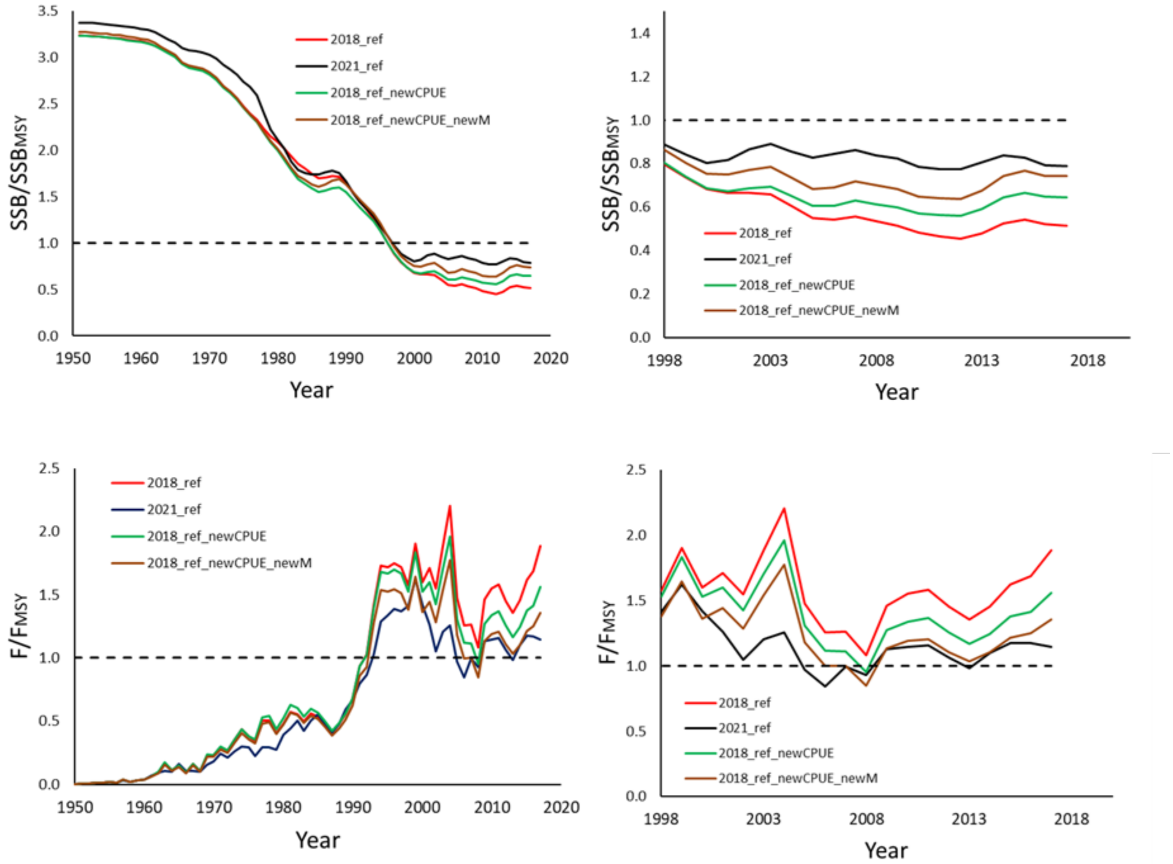
BET-Figure 7. Time series of stock status trends across the 27 Stock Synthesis models of the uncertainty grid. Panels in each row represent the different assumptions of maximum age and thus natural mortality. Left panels represent SSB/SSB_{MSY} trends and right panels F/F_{MSY} trends. Individual lines represent different combinations of steepness and Sigma R.



BET-Figure 8. Stock Synthesis: Kobe plot of SSB/SSB_{MSY} and F/F_{MSY} for stock status of Atlantic bigeye tuna in 2019 based on the log multivariate normal approximation across the 27 uncertainty grid model runs of Stock Synthesis with an insert pie chart showing the probability of being in the red quadrant (48.9%), green quadrant (41.1 %), orange (0.8%) and in yellow (9.2 %). Blue circle is the median and marginal histograms represent distribution of either SSB/SSB_{MSY} or F/F_{MSY}.

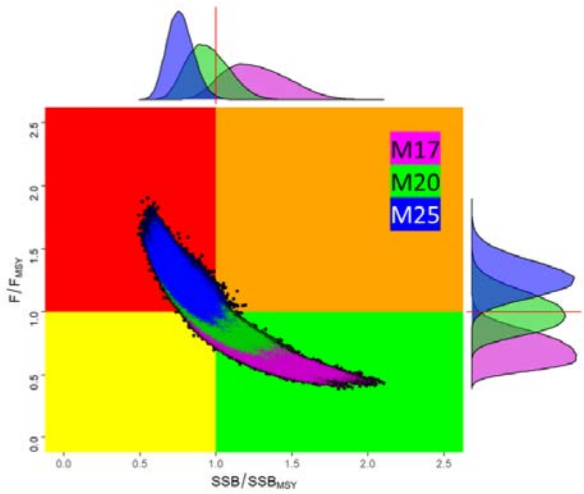


BET-Figure 9. Dynamic estimated SSB at MSY (mt) and Catch at MSY (left panel) and estimated of fishing mortality at MSY (right panel) benchmarks by year, demonstrating the effects of changes in selectivity for bigeye tuna using the Stock Synthesis 2021 reference case.

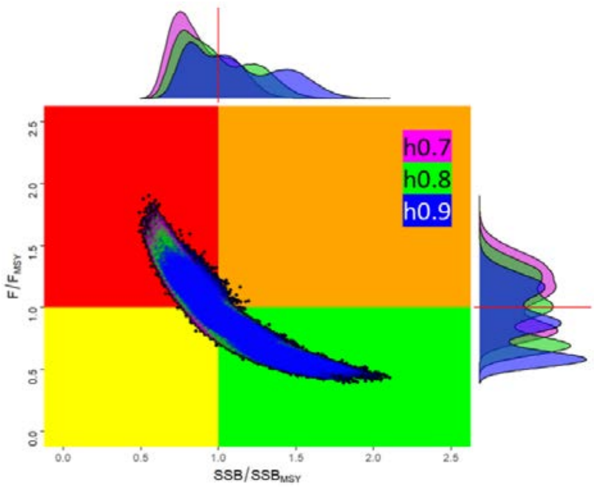


BET-Figure 10. Sensitivity runs showing time series of stock status trends (left panels 1950-2017, right panels 1998-2017, upper panels SSB/SSB_{MSY} and lower panels F/F_{MSY}) demonstrating the effects of changes in stock status resulting from the incorporation of the 2021 joint longline index and the new assumptions about natural mortality. Lines represent the 2018 (2018_ref) and 2021 (2021_ref) reference cases, the 2018 reference case replacing the 2018 joint longline index with the 2021 joint longline index (2018_ref_new_CPUE) and this last case with the replacement of the 2018 natural mortality with the 2021 natural mortality (2018_ref_new_CPUE_new_M). The natural mortality of the 2021 reference case corresponds to the maximum age of 20.

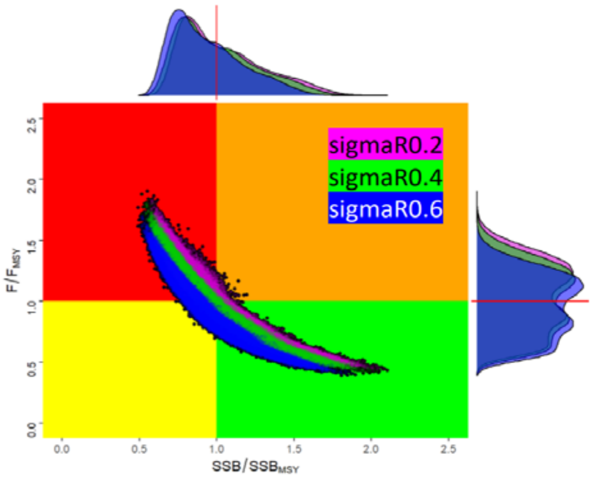
(a) effect of Maximum age(M)



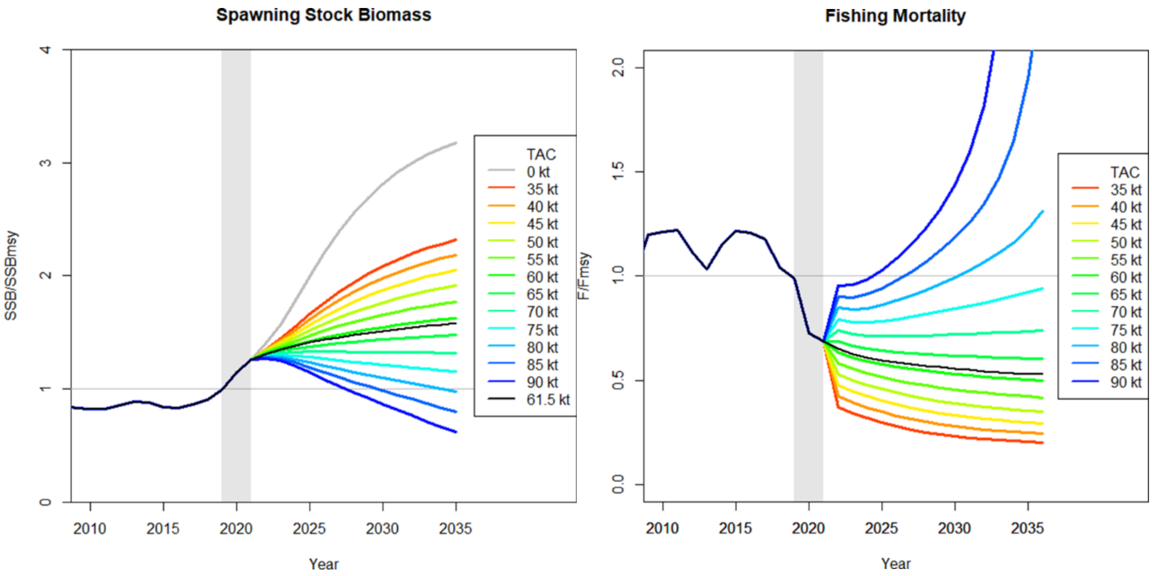
(b) effect of steepness (h)



(c) effect of sigma R



BET-Figure 11. Effects of the main axes of uncertainty parameters (a: Natural mortality associated with maximum age assumption, b: Steepness, c: Sigma R) on Kobe phase plot for the 27 Stock Synthesis uncertainty grid for Atlantic bigeye tuna. In each plot the cloud of points and the marginal histograms colors match the level in each uncertainty parameter.



BET-Figure 12. Deterministic projections of SSB/SSB_{MSY} (left panel) and fishing mortality (right panel) for the 27 Stock Synthesis uncertainty grid runs at 35,000-90,000 t constant catch for Atlantic bigeye tuna. The lines are the mean of 27 deterministic runs and the black line is for the current TAC (61,500 t). The grey bar represents the period when catches for 2020 and 2021 are fixed to 59,919 t and 61,500 t respectively.

9.3 SKJ - Skipjack

The last stock assessment for eastern and western Atlantic skipjack were conducted in 2022 through a process that included a data preparatory meeting, held online from 21-25 February 2022 (Anon., 2022a), and a stock assessment meeting, held online from 23-27 May 2022 (Anon., 2022b). Additionally, informal intersessional meetings of the Group were held in April and July (Anon., 2022c) to prepare and finalize the stock assessment results. This report covers the most recent information on the status of the eastern and western skipjack stocks. The 2022 assessment was able to provide quantitative estimates of management reference points and projections of stock status for both skipjack stocks, something that was never achieved before by the Committee.

These new assessments for the eastern and western Atlantic skipjack stocks used fishery data from 1950-2020 and 1952-2020, respectively, and indices of relative abundance used in the assessments were calculated through 2020. In both cases, Surplus Production models and Statistically Integrated models were used.

For a complete and detailed description of the assessment and the state of knowledge and status of the eastern and western Atlantic skipjack tuna stocks, readers should consult the Report of the 2022 Skipjack Tuna Data Preparatory Meeting (Anon., 2022a) and the Report of the 2022 Skipjack Stock Assessment Meeting (Anon., 2022b).

SKJ-1. Biology

Skipjack tuna is a cosmopolitan species found in schools distributed mainly in tropical and subtropical waters of the three oceans. This tropical tuna is the predominant species aggregated around FOBs (including FADs) where it is caught, commonly associated with juveniles of yellowfin tuna, bigeye tuna and with other species of epipelagic fauna. This species exploited sizes range from 30 cm to 62 cm FL for SKJ-W (**SKJ-Table 2**) and 30 cm to 80 cm FL for SKJ-W (**SKJ-Table 3**).

Skipjack tuna breed opportunistically throughout the year over broad areas of the Atlantic Ocean. Both stocks show synchronized spawning behavior when in a school. Moreover, the skipjack's reproductive potential is considered high because it reaches sexual maturity around one year of age and spawns in warm waters above 25º C which represents a large ocean area. More specifically, the eastern skipjack stock, spawns over a wide area on either side of the equator, from the Gulf of Guinea to 20º-30º W. There are two known spawning areas for the western skipjack stock, one off the Brazil margin delimited by the parallel of 20º S and the southern limit of the Brazil current, and another area in the North of the Atlantic Ocean, located in the Gulf of Mexico and Caribbean.

Movement patterns based on AOTTP tagging data demonstrated some connectivity between the Azores and Gulf of Guinea areas for the eastern stock, which had not been observed in the ICCAT historical tagging data. Although in general, the AOTTP tagging data shows minimal exchange between the eastern and western skipjack stocks, the separation between the two stocks is less clear for those tags released by the AOTTP close to the boundaries of the stock (5º S; 35º W) (**SKJ-Figure 2**). This pattern sparked concerns in the current way catches are assigned to a stock when fleets are fishing near and/or across this boundary area. More studies on the potential migration across stock boundaries are needed. These include analysis of returned AOTTP skipjack tags, or potential future releases of conventional tagged fish in places where movement details remain unknown (e.g., Venezuela to the Equator and northern migrations of the western stock). Such studies could improve our understanding of these movements and of potential levels of mixing across the current stock boundaries.

Length at 50% maturity remains estimated at 42 cm, approximately 9.5 months old, and the size of full maturity at 55 cm. Both reproduction parameters remain the same as those used in the last stock assessment.

Considerable uncertainty remains around the growth parameters for the skipjack tuna. To deal with this uncertainty, a distribution of potential growth curves was developed considering available estimated growth parameters compiled from scientific literature, and the resulting growth parameters are shown in the Report of the 2022 Skipjack Stock Assessment Meeting (Anon., 2022b). Natural mortality at age was estimated assuming the Lorenzen function and maximum age of 6 years.

All these uncertainties reported on growth, natural mortality, and stock structure could have important implications for the stock assessment of the eastern and western skipjack stocks. Research should aim to continue to reduce these uncertainties.

SKJ-2. Fishery indicators

Skipjack tuna stocks have been historically exploited by two major gears (purse seine on the eastern stock and baitboat on the western stock) and by many countries throughout their range. Longline fisheries remove a comparatively small portion of the total removals (**SKJ-Figures 1, 5 and 6**).

The numerous changes that have occurred in the skipjack fisheries, mainly since the early 1990s (e.g., the progressive use of FOBs and the geographical expansion of the fishing areas by surface fleets), have brought about an increase in skipjack catchability and the proportion of biomass exploited. The nominal catches for the eastern stock had shown a generally increasing trend since the 1960s (**SKJ-Figure 4**). The total catches increase from 1,171 metric tons in 1960 to about 283,000 metric tons in 2018. Since 2018 the total catches decreased to 206,953 t in 2021. The preliminary catch reported for 2022 have increased by 31% (271,371 t) (**SKJ-Table 1**). This recent increase is observed for most of gears, in particular eastern Atlantic purse seine.

The Group estimated the current fishing capacity of all large-scale purse seiners (defined as vessels with ≥ 335 m^3 of fish hold-volume) targeting tropical tunas in the Atlantic, using a combination of data sources including the ICCAT authorized vessel records, ISSF records on purse seiners, and AIS data. The Group estimated that at least 67 - and possibly 72 - large-scale purse seiners were operating in the Convention area as of the first half of 2022. The 2022 capacity estimate (67-72) for large-scale purse seiner was similar to the estimate of capacity made by the SCRS in 2020 (68-72 vessels) and lower than the capacity estimate in 2021 (74-80), indicating that at least some vessels moved out of the ICCAT area during the last year. The Committee was informed by national scientists of the reductions in the operations of the baitboat fleet in recent years (since 2020), in part due to the implementation of a Marine Protected Area (Decree No. 2020-1133 on the creation of the Marine Protected Areas of Kaalolaal Blouffogny and Gorée (Senegal)) limiting access to live bait for the fishery.

The western skipjack landings have shown a slight decrease since 1982, and this has intensified in the most recent period of the time series (2013-2020) (**SKJ-W Figure 6**). The maximum total catch for this stock was observed in 1985 (40,272 t), and the lowest catch since 1985 was reached in 2020 (18,903 t). This trend can be explained by the reductions in the baitboat catches, which decreased from 26,941 t on average for the period 2011 – 2015 to less than 15,400 t (on average) in the most recent period of the time series (2016-2021). On the contrary, handline catches have increased in recent years, reaching more than an annual average of 2,960 t in the period between 2016-2021, a significant increase over the 301 t average for the period 2011-2015 (**SKJ-Table 1**). Data provided in Task 1 Fleet showed a reduction in the number of vessels operating within the Brazilian baitboat fleet (from 54 baitboat vessels operating in 2015 to 30 vessels in 2020). This reductions in the number of baitboat vessels may be driving much of the decrease in catches of this stock observed in the recent period, as the Brazilian fleet catches the majority of skipjack in the West side of the Atlantic. Finally, preliminary catches reported for 2022 show an increase of 1,335 t (from 20,048 t in 2021 to 21,383 t in 2022). This increase concerns catch of the others surface gears, with the exception of PS and BB (**SKJ-Figure 6**).

Estimates of "faux poisson" catches for the purse seine fleets targeting tropical tunas in the eastern Atlantic were provided by the majority of the CPCs as indicated in **SKJ-Table 1**. For the 2022 stock assessment, the Group estimated "faux poisson" catches based on a methodology presented and adopted by the Group at the data preparatory meeting and were included under the "NEI_mixed flags" code for the stock assessment.

As indicated before, another important fishery indicator was the westward expansion of the eastern purse seine FOB fisheries with an increase in catches in the equatorial area. In the last decade surface fleet fisheries have reported catches on both sides of the skopjack stock boundary of the equatorial area (**SKJ-Figures 1 and 3**). Recent research has shown some similarities between the skipjack size ranges among the catches reported by the EU and Ghana PS-FOB when they are operating on either side of the boundary (40-50 cm SFL, **SKJ-Figure 7** and **SKJ-Figure 8**). Such fish caught by these two fleets tend to be smaller than those caught by purse seiners in the West stock area, mainly by Venezuela PS non-FOB fisheries (45-60 cm). It is possible that the stock boundary area is a mixed area including individuals of both stocks. Any increases in effort of purse seine vessels fishing on FOBs in this area could increase removals from the western skipjack stock.

Mean weight time-series by major fishery for both eastern and western skipjack stocks were estimated using the most recent information available on T1NC, T2SZ and T2CS (Task 2 catch-at-size estimated/reported by ICCAT CPCs). For the eastern and western skipjack stocks, the estimated mean weights have oscillated throughout the time series (1969-2020), **SKJ-Figure 9, SKJ-Figure 10**. The estimated mean weight of eastern skipjack is about 2.1 kg for 1969-2020. The western skipjack average weight is 3.4 kg, indicating that fish caught on eastern stock are smaller than the ones in the western stock.

Three relative indices of abundance were included in the stock assessment of the eastern skipjack, the Canary historical baitboat index (1980-2013), the EU PS FAD index (2010-2020), and the EU Echosounder buoy (2010-2020) index. The EU PS FAD index is new for this stock, derived from sets made by vessels fishing on FADs with operational buoys not owned by the vessel making the set. The Canary baitboat index showed a generally stable trend. For the recent period, the EU PS FAD index showed a slight decreasing trend over the time series, while the EU echosounder buoy index showed a sharp decline at the beginning of the series and a sharp increase at the end of the series (**SKJ-Figure 11**). For the western skipjack, five relative abundance indices were included in the stock assessment model: Brazilian baitboat historical (1981-1999) and recent (2000-2020), Brazilian handline (2010-2016), US-longline (1993-2020), and Venezuelan purse seiner (1987-2020) indices. The indices for recent years showed a slight decrease trend since the mid-2010s (**SKJ-Figure 12**).

SKJ-3. State of the stocks

The 2022 Skipjack Stock Assessment Meeting (Anon., 2022b) was conducted using similar assessment models/methods to those used in the assessments of other tropical tuna species, including yellowfin and bigeye tuna. Stock status evaluations for both stocks of Atlantic skipjack tuna used in 2022 included several modelling approaches, ranging from non-equilibrium (MPB) and Bayesian state-space (JABBA) production models to integrated statistical assessment models (Stock Synthesis). Different model formulations considering plausible representations of the dynamics of the skipjack stocks were used to characterize the stock status and the uncertainties in stock status evaluations.

Eastern skipjack stock

A full stock assessment was conducted for the eastern skipjack tuna stock in 2022, applying production models (JABBA) and one integrated statistical assessment model (Stock Synthesis) to the available catch data through 2020. The Group decided to combine the results of JABBA and Stock Synthesis, with equal weighting, to estimate stock status and develop management advice to capture all major uncertainties in the population dynamics. The uncertainty grids were comprised of combinations of CPUE selection ((i) Canary BB index + EU PS FADs index, and; (ii) Canary BB index + Echosounder buoy index), steepness *h* (0.7, 0.8, or 0.9), and growth (25, 50 or 75th regression quantiles) for both Stock Synthesis and JABBA.

SKJ-Figure 13 shows the historic trends of the relative fishing mortality (F/F_{MSY}) and relative biomass (B/B_{MSY}) from the different assessment model runs for eastern skipjack. The combined results of the assessment, based on the median of the entire uncertainty grid, show that in 2020 the East Atlantic skipjack tuna stock was not overfished (median B_{2020}/B_{MSY} = 1.60) and was not undergoing overfishing (median F_{2020}/F_{MSY} = 0.63). The median MSY was estimated as 216,617 t from the uncertainty grid of the deterministic runs. Probabilities of the stock being in each quadrant of the Kobe plot (**SKJ-Figure 14**) are 78% in the green (not overfished, not subject to overfishing), 4% in the orange (subject to overfishing but not overfished), 1% in the yellow (overfished but not subject to overfishing) and 16% in the red (overfished and subject to overfishing). In summary, the results indicated a stock status of not overfished (83% probability), with no overfishing (80% probability).

Noteworthy, the estimated stock biomass of the combined results as shown in the Kobe plot (**SKJ-Figure 14**) and summary table, there is large uncertainty in biomass estimates reflected in the long tails of the biomass distribution relative to B_{MSY} (95% confidence interval of 0.5 to 5.79 B/B_{MSY}). This large range of uncertainty in stock status estimates has implications on the estimated probabilities for each constant catch scenario in the projections that have been used to develop management advice (**SKJ-Tables 4 and 5**).

In the projection results from the Stock Synthesis and JABBA models, some iterations of high catches were predicted with exceptionally small biomass, which results in extremely high fishing mortality. Especially Stock Synthesis and JABBA runs with the Acoustic Buoy index removed projected low biomass within 3-4 years once the stock is harvested at high constant catches. **SKJ-Table 5** and **SKJ-Figure 15** show the joint stochastic projections for both quantities (B/B_{MSY} and F/F_{MSY}). The probability of biomass being less than 10% or 20% of the biomass that supports MSY was calculated for each projection year and catch scenario (**SKJ-Table 4**). Assuming a constant catch at MSY level, the probability of the stock being below 20% of the B_{MSY} at 2028 was about 17% and the probability of being below 10% of the B_{MSY} was about 14%.

Western skipjack stock

The assessment of the western skipjack stock was conducted using a Bayesian state-space production model (JABBA) and an integrated statistical assessment model (Stock Synthesis). Given that the stock status estimated from the JABBA model agreed with the estimated stock status using Stock Synthesis, the Group decided to use the results of the surplus production model as a comparative perception of the western skipjack stock status, but not for the development of management advice. Therefore, the final stock status and management advice presented in this Executive Summary are based on the combined results from the 9 distinct Stock Synthesis runs derived from the uncertainty grid proposed for the western skipjack stock. A more detailed description of the assessment can be seen in the Report of the 2022 Skipjack Stock Assessment Meeting (Anon., 2022b).

SKJ-Figure 16 shows the historical trends of the relative fishing mortality (F/F_{MSY}) and relative biomass (B/B_{MSY}) from the different assessment model platforms for the western skipjack. Based on the combined results used to the develop management advice (9 Stock Synthesis deterministic runs), the median estimate of SSB_{2020}/SSB_{MSY} is 1.60, and the median estimated for F_{2020}/F_{MSY} is 0.41. The combined results of all runs indicates that the western skipjack stock is estimated to be in healthy condition with 91% probability of being in the green quadrant, and that the stock is not overfished nor undergoing overfishing (**SKJ-Figure 17**). There was a relatively low estimated probability that the stock is either overfished (yellow quadrant; 6.2%) or both overfished and undergoing overfishing (red quadrant; 2.9%).

The catch advice is provided in the form of Kobe 2 Strategy Matrices including probabilities that overfishing is not occurring ($F \le F_{MSY}$), stock is not overfished ($SSB \ge SSB_{MSY}$) and the joint probability of being in the green quadrant of the Kobe plot (i.e., $F \le F_{MSY}$ and $SSB \ge SSB_{MSY}$) (**SKJ-Table 7**). Future constant catches of 20,000 t, close to the current catch (19,951 t in 2021) are expected to maintain the stock in the green quadrant. The median MSY across the 9 grid runs was 35,277 t. Future constant catches of this level are expected to maintain the stock in the green quadrant ($F \le F_{MSY}$ and $SSB \ge SSB_{MSY}$) with about 70% probability by 2028. Probabilities of the stock biomass being below 20% and 10% of B_{MSY} are presented in **SKJ-Table 6.** The probability of the stock biomass being below 20% or 10% of B_{MSY} was less than 1% until 2028 assuming a future constant catch at the level of MSY. The projections for both quantities (F/F_{MSY} and SSB/SSB_{MSY}) are presented in **SKJ-Table 7** and **SKJ-Figure 18.**

SKJ-4. Effect of current regulations

The current regulations for tropical tunas, in Rec. 22-01, only entered into force in June 2023, and the impacts on the SKJ stock and fisheries are not yet evident in the available scientific data. However, the previous Recommendation, Rec. 21-01, included several measures that impacted fishing for the eastern stock, including the first Atlantic-wide, temporal closure on fishing for schools associated with FADs, limits to the number of FADs that can be actively managed by individual purse seiners, changes in FAD design, and others. In addition, taking into consideration the multi-species nature of tropical tuna fisheries, the TAC and catch limits adopted for other tropical tuna stocks, mainly bigeye tuna, may also explain the drop in skipjack catches in recent years. Before this closure, the Commission had adopted various FAD spatio-temporal closures (Rec. 98-01, Rec. 99-01, Rec. 14-01, and Rec. 16-01).

The effect of the temporal FAD closure was evaluated by examining catch of each tropical tuna species, by month and by fleet, in 2020 with comparison to a reference period in the 1990s, to account for years in which no closure was in place. There is preliminary evidence that tropical tuna catch was lower during the closure than during the same months in the reference period, and the annual 2020 catch was lower than in 2019. Preliminary catch estimates for skipjack in 2021 are also lower than the catches recorded in 2020. After reviewing this information, the Committee concluded that Atlantic-wide, temporal closures on fishing on FAD-associated schools may lead to reduced catch of eastern skipjack. This conclusion is further discussed in section 19 (Responses to the Commission) of this report.

Although the measures in Rec. 19-02 also applied to the western stock, no fleets were targeting western skipjack using FADs, so the impact of Rec. 19-02 on the western stock and fisheries was likely to be minimal.

SKJ-5. Management recommendations

Eastern skipjack stock

The stock status of eastern Atlantic skipjack tuna in 2020 was estimated with a high probability (78%) to be in a sustainable condition (green quadrant), with that stock not overfished or subjected to overfishing. According to the Kobe 2 Strategy Matrix (K2SM), a future constant catch using the median MSY of 216,617 t will have about 55% probability of maintaining the stock in the green quadrant of the Kobe plot through 2028. Assuming a constant catch at MSY[1], the probability of the stock biomass being below 20% of B_{MSY} in 2028 was about 17%, and the probability of stock biomass being below 10% in 2028 was about 14%. Moreover, provisional catches for 2022 are substantially higher than the MSY estimated in the last stock assessment.

The Commission should also be aware that fishing effort for skipjack also impacts other species that are caught in combination with skipjack particularly in the purse seine FOB fisheries (particularly juveniles of yellowfin and bigeye tuna).

Western skipjack stock

The status of the western Atlantic skipjack stock in 2020 was estimated with a high probability (91%) to be in healthy condition and is not overfished nor undergoing overfishing. According to the Kobe II Strategy Matrix (K2SM), a future constant catch using the median MSY of 35,277 t will have about 70% probability of maintaining the stock in the green quadrant of the Kobe plot by 2028. Assuming a constant catch at MSY, the probabilities of the stock biomass being below 20% or 10% of the B_{MSY} until 2028 are less than 1%.

The SCRS will present results of the candidate management procedures (CMPs) of the western Atlantic skipjack tuna management strategy evaluation (MSE) to the Commission for their consideration for MP adoption in line with the MSE Road Map, which is contained in item 19.36.

[1] Projections are conducted with the MSY estimated for each model of the uncertainty grid.

ATLANTIC SKIPJACK SUMMARY		
	Eastern Atlantic	***Western Atlantic***
Maximum Sustainable Yield (MSY)[1]	216,617 t (172,735 – 284,658 t)	35,277 t (28,444 – 46,340 t)
Yield for 2020 at the Stock Assessment	217,874 t	18,183 t
Current yield for 2022	271,371 t	21,383 t
Relative Biomass (B_{2020}/B_{MSY})[2]	1.60 (0.50 – 5.79)	1.60 (0.90 – 2.87)
Relative Fishing Mortality (F_{2020}/F_{MSY})[2]	0.63 (0.18 – 2.35)	0.41 (0.19 – 0.89)
Stock Status (2020)		
Overfished:	No	No
Overfishing:	No	No

[1] Median and 95% confidence interval estimated from the joint uncertainty grid.
[2] Median and 95% confidence interval based on 90,000 iterations of the multivariate lognormal (MVLN) approximation for Stock Synthesis and 90,000 Markov chain Monte Carlo (MCMC) iterations for JABBA.

SKJ-Table 1. Estimated catches (t) of skipjack tuna (*Katsuwonus pelamis*) by area; gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL			209776	191405	174844	157152	148941	161412	182296	155487	163360	122185	154941	181467	172499	138376	145662	145104	163604	189933	219484	251498	258603	232672	242142	259762	266002	306442	275439	241133	227002	292754
	ATE		176555	161456	152984	129590	117229	132325	154940	126294	131909	100585	130192	154006	143982	111923	120223	123091	137829	164026	187096	218431	224007	205316	221076	237395	241957	283169	255318	222230	206953	271371
	ATW		33221	29949	21860	27562	31712	29087	27356	29193	31451	21600	24749	27461	28517	26453	25440	22013	25774	25907	32388	33067	34596	27356	21066	22367	24045	23273	20121	18903	20048	21383
Landings	ATE	Bait boat	31670	37767	33840	35861	36993	46506	44901	33705	56493	31167	34428	54194	48279	44700	44316	31863	35105	38607	38085	44814	30670	25682	23843	28875	25776	33437	24415	15677	16664	16194
		Longline	2	10	3	7	47	85	42	48	53	59	83	67	83	204	428	199	59	46	35	58	79	54	21	540	498	113	350	366	97	289
		Other surf.	1013	366	423	409	425	1228	301	2399	867	597	562	1324	2672	5270	3436	3803	5137	5098	5885	6769	7206	2184	2527	2623	4698	5087	5432	5784	9814	10038
		Purse seine	125997	107452	105709	89096	72015	76790	100459	79507	72492	67097	88350	90464	87660	58570	66817	81431	89059	112070	133696	159881	179759	170477	183342	190130	202265	233353	215150	189772	175056	236892
	ATW	Bait boat	19902	22855	17744	23741	27045	24727	23881	25641	25719	18737	21990	24082	26028	23766	23898	20702	23518	22803	29468	30693	32187	24817	17538	16810	14648	14926	15410	14593	15573	11687
		Longline	21	16	36	21	7	21	58	22	60	334	95	206	207	286	52	49	20	854	352	62	642	464	209	806	292	322	416	193	420	1217
		Other surf.	504	1367	2021	450	313	513	481	467	374	413	367	404	316	355	280	361	202	306	708	498	792	837	728	1534	5702	4797	2395	2432	2515	7242
		Purse seine	12794	5712	2059	3349	4347	3826	2936	3063	5297	2116	2296	2769	1967	2045	1209	901	2035	1943	1859	1814	975	1238	2524	3110	3347	3182	1881	1649	1537	1237
Landings(FP)	ATE	Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39
		Purse seine	17873	15860	13010	4217	7749	7716	9237	10634	2004	1666	6769	7956	5288	3181	5226	5796	8471	8205	9395	6909	6293	6918	10712	15227	8626	11123	9762	10610	5283	7811
	ATW	Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	107	55	45	19	35	0	
Discards	ATE	Bait boat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	631	0	94	56	208	22	35	106
	ATW	Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Landings	ATE CP	Algerie	0	0	0	0	0	171	43	89	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Angola	13	7	3	15	52	2	32	14	14	14	14	10	0	0	0	0	50	636	44	91	514	0	1	1	1	3	0	10	14	**0**
		Belize	0	0	0	0	0	720	0	229	278	0	0	0	0	0	0	0	1373	2714	7429	15554	6218	10779	12599	7730	9958	20748	17063	19180	18044	29134
		Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1008	4948
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Cape Verde	1138	1176	1585	581	858	1245	1040	789	794	398	343	1097	7157	4754	5453	4682	4909	5155	7883	5535	16016	15254	17600	10925	7823	7852	5785	6068	1281	1250
		China PR	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Curaçao	0	0	0	7096	8444	8553	10045	11056	15450	7246	12084	10225	101	3042	1587	6436	9143	9179	11939	12779	17792	18086	19621	22180	20660	24539	17360	10841	12398	3953
		Côte d'Ivoire	0	0	0	0	0	0	0	1173	259	292	143	559	1259	1565	1817	2328	2840	2840	5968	10923	8063	2365	254	675	1534	22	3241	990	1311	2266
		EU-Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
		EU-España	63660	50538	51594	38538	38513	36008	44520	37226	30954	25466	44837	38751	28178	22292	23723	35124	36722	41235	56908	67040	66911	51628	46085	52110	57458	52912	48378	31804	37865	33569
		EU-Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-France	33691	32798	25239	23068	17035	18323	21800	18149	16320	16180	19336	21326	14850	7033	6196	4439	7790	14900	13067	13139	16173	17674	20960	19342	16574	23112	20438	12800	16178	21217
		EU-Germany	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	**0**
		EU-Greece	0	0	0	0	0	0	0	0	0	0	102	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Ireland	0	0	0	0	0	0	0	0	0	0	0	14	14	14	0	0	8	6	0	0	0	0	0	0	7	0	0	0	0	**0**
		EU-Italy	0	0	0	0	0	0	0	0	0	4	29	34	17	0	0	0	0	0	0	0	0	0	0	47	57	91	131	402	69	3483
		EU-Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	0	0	6	0	0	0	0	**0**
		EU-Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	6	5
		EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9	0	0	23	0	0	0	0	0	5	1	0	0	0	0
		EU-Portugal	5651	7528	4996	8297	4399	4544	1810	1302	2167	2958	4315	8504	4735	11158	8995	6057	1084	12974	4143	2794	4049	1712	1347	708	1785	7480	2799	1033	6640	4026
		EU-Rumania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6970	16949	14577	17045	16729	14806	9374	10633
		Gabon	1	11	51	26	0	59	76	21	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
		Gambia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	
		Ghana	20225	21258	18607	24205	26380	43612	54088	36517	57540	40194	34435	47746	54209	31934	35419	38648	43922	45505	44169	54032	48064	49986	61849	54723	57496	68147	62855	63223	44489	76751
		Guatemala	0	0	0	0	0	0	0	0	0	0	2120	4808	6389	4959	5546	6319	4036	2951	2829	3631	4907	5811	7078	7386	9800	8648	7626	6503	5873	6839
		Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1224	1224	1010	0	1	1	3	1	0	1	1	1	1	1
		Guinée Rep	0	0	975	6432	2408	0	0	0	0	0	0	0	0	0	0	0	0	1500	1473	7942	7363	5484	0	0	0	0	0	0	888	5133
		Japan	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	4	5	2	4	1	1	3	5	2	3	3
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1
		Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	61	80	49	98	21	19	29	21	6770	489	0
		Maroc	3652	3672	6886	2859	5532	4741	4176	4091	1737	1303	3403	3843	4666	4032	1592	1309	2580	2343	2151	2267	2045	1068	576	258	750	3585	1258	3171	5503	4189
		Namibia	0	2	15	0	1	0	0	0	8	0	0	0	0	0	0	0	71	2	2	15	1	0	0	1	1	0	0	1	11	19
		Nigeria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	12	4	0	0	0	6	2	0	0	0	0	**0**
		Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Panama	13027	12978	14853	5855	1300	572	1308	1559	281	342	0	7126	11490	13468	18821	8253	8518	9590	12509	10927	14558	14165	8372	11510	8815	9089	10926	10626	10554	13192
		Russian Federation	540	1471	1450	381	1146	2086	1426	374	0	0	0	0	0	392	1130	313	260	0	20	0	0	2	1	1	110	178	25	6	0	**0**
		S Tomé e Príncipe	212	190	180	187	178	169	181	179	179	179	179	117	166	143	0	229	235	241	247	254	260	266	360	380	346	15	36	40	87	120
		Senegal	108	64	282	238	429	1983	1784	1357	1284	1178	639	1456	5033	3858	4552	3045	4566	2743	5441	4477	4659	3931	5943	17082	25431	28476	30633	23286	29537	42671
		South Africa	6	4	4	1	6	2	1	7	1	1	2	2	1	0	0	4	4	2	6	8	2	5	2	2	1	2	2	1	1	2
		St Vincent and Grenadines	5731	2184	1847	1501	1191	1441	2127	1422	1435	524	42	0	0	1	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	**0**
		Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	36	0	0	0	15	17	0	0	0	0	0	0	0	0	**0**
		UK-Sta Helena	65	55	115	86	294	298	13	64	205	63	178	317	321	88	110	45	15	25	371	29	7	26	6	127	9	7	28	1	2	1
		USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Venezuela	0	0	0	0	0	0	0	0	35	2407	1197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		NCC	Chinese Taipei	2	10	3	5	47	73	39	41	24	23	26	16	10	9	14	19	6	11	15	2	12	9	4	2	2	3	4	4	4	3
		NCO	Benin	2	2	2	2	7	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cayman Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Congo	10	7	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	133	744	2803	0	27	0	0	0	760	148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Vanuatu	10808	10896	8477	5992	1233	0	1192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATW	CP	Barbados	6	6	6	5	5	10	3	3	0	0	0	0	0	0	0	0	0	0	1	2	0	1	1	1	2	1	1	0	0	1
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	164	0	0	0	0	0	**0**
			Brazil	17771	20588	16560	22528	26564	23789	23188	25164	24146	18338	20416	23037	26388	23270	24191	20846	23307	23456	30571	30863	32438	25195	18133	18231	20068	19687	17925	17432	18788	20544
			Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	0	88	0	**0**
			China PR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42
			Curaçao	45	40	35	30	30	30	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	100	123	157	35	30	0	151
			EU-España	397	0	0	0	0	0	1	1	0	0	0	0	0	0	5	11	0	0	0	0	0	0	0	641	223	109	192	124	78	147
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	10	0	0	0	0	25	224	282	23	2	210	10
			EU-Portugal	0	0	0	0	0	0	0	4	1	0	3	3	5	21	11	0	6	0	8	0	0	0	0	0	0	0	0	0	0	**0**
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85	35	135	27	0	70	0	37
			Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	232	67	160	265	160	411	1234	700	283	0	**0**
			Grenada	25	11	12	11	15	23	23	23	15	14	16	21	22	15	26	20	0	0	0	0	0	0	22	17	17	18	30	10	13	18
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	86	54	44	7	91	**0**
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Mexico	1	1	0	2	3	6	51	13	54	71	75	9	7	10	7	8	9	7	9	8	5	5	7	10	6	6	4	4	3	3
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	543	410	161	185	0	0	22	40	0	31
			St Vincent and Grenadines	66	56	53	37	42	57	37	68	97	357	92	251	251	355	90	83	54	46	50	0	36	39	47	0	78	36	35	29	0	**0**
			Trinidad and Tobago	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			USA	367	99	82	85	84	106	152	44	70	88	79	103	30	61	66	67	119	95	107	99	326	183	94	179	199	78	46	68	65	103
			Venezuela	11172	6697	2387	3574	3834	4114	2981	2890	6870	2554	3247	3270	1093	2008	921	757	2250	2119	1473	1742	1002	1179	2019	2317	2222	1276	927	614	694	213
		NCC	Chinese Taipei	9	7	2	10	1	2	1	0	1	16	14	27	28	29	2	8	0	2	1	11	1	2	21	17	34	32	27	19	19	8
		NCO	Argentina	50	1	0	1	0	2	0	1	0	0	0	30	0	0	0	0	3	12	0	0	0	0	0	0	0	0	0	0	0	
			Colombia	2074	789	1583	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	1017	1268	886	1000	1000	651	651	651	0	0	624	545	514	536	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	24	43	33	33	33	33	85	86	45	55	51	30	20	28	32	45	25	0	13	0	4	41	16	27	21	11	10	4	0	
			Dominican Republic	143	257	146	146	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Jamaica	0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	
			Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
			Sta Lucia	53	86	72	38	100	263	153	216	151	106	132	137	159	120	89	168	0	153	143	109	171	139	87	138	142	122	78	44	83	73
Landings(FP)	ATE	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114	395	368	179	636	301	0	0	0	0	0	0	0	**0**
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	419	131	162	276	603	726	411	230	428	1362	1485	1046	327	512	355	410	0	**0**
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	88	171	116	105	917	415	441	545	520	351	0	0	0	0	0	0	447	**0**
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	562	544	202	0	0	0	0	0	0	0	**0**
			EU-España	5959	4719	2899	453	1990	2562	3802	3700	0	0	1738	1907	713	437	366	1158	1994	1394	1842	983	998	1623	3028	3658	2788	1943	2396	1809	2035	2163
			EU-France	8055	7573	5568	2447	3414	3647	4316	4740	1786	1601	3484	3096	918	346	206	287	1120	743	1480	1646	463	440	1716	1920	893	2169	1616	1681	2206	3355
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1223
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	260	69	66	162	59	136	51	102	72	93	0	0	0	0	0	0	180	496
			Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	387	0	330	118	359	614	1778	2379	1670	2146	0	0	0	0	0	0	0	**0**
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	796	548	977	693	680	354	609	284	962	400	0	0	0	0	0	0	415	613
		NCO	Mixed flags (EU tropical)	3858	3568	4543	1316	2345	1508	1119	2194	218	65	1547	2953	1708	1478	3003	2998	2624	3427	2372	0	0	0	4484	8603	4618	6499	5396	6710	0	
	ATW	CP	Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	9	0	9	0	**0**
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	67	35	7	13	9	0	**0**
		NCO	Mixed flags (EU tropical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	37	21	29	6	17	0	
Discards	ATE	CP	Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	631	0	94	56	208	22	35	106
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	ATW	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	**0**
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

SKJ-Table 2. CAS (catch-at-size) matrix estimated for SKJ-E (eastern stock) in thousands of fish caught, by year and 2 cm size classes.

Li (2cm)	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
20	0	0	1	0	0	0	0	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1	6	0	0	0	0	2	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
24	0	6	34	4	0	0	0	0	0	1	0	14	0	0	0	0	0	0	1	1	1	1	2	1	2
26	1	13	45	4	0	0	0	0	0	3	0	7	37	1	1	1	1	0	5	5	5	6	16	13	19
28	2	20	98	40	1	14	1	2	0	4	3	10	207	28	8	4	4	2	29	28	31	35	92	78	109
30	3	18	25	4	6	40	11	59	7	49	30	69	195	82	63	30	22	13	139	145	154	186	462	379	549
32	3	16	28	18	10	63	15	73	67	58	211	221	315	180	175	90	53	40	436	463	492	587	1430	1189	1645
34	31	57	88	93	131	279	54	169	200	197	314	543	664	489	460	262	206	145	935	975	1064	1188	2765	2283	3192
36	73	112	161	167	358	744	246	386	493	632	895	1950	1008	1194	1037	652	603	573	1475	1638	1634	1860	4149	3373	4643
38	240	377	707	904	1013	2078	644	1318	1345	1514	1718	3110	2914	2512	2115	1264	1301	1183	1788	2595	2452	2874	5454	4087	5796
40	466	834	1771	1850	2584	5500	1396	3105	2984	3467	2818	4613	5792	5083	4161	2828	3003	1923	2873	4772	3890	4250	7835	6102	8632
42	870	1685	3268	3123	4836	8551	2181	4038	4286	5124	3817	6139	8555	7530	7647	5279	5163	3688	5155	8087	5912	6321	12267	9322	12041
44	1555	3301	5077	4843	7418	9364	2744	4676	5359	6572	5133	6514	9817	9390	9033	6635	5633	6784	6801	11022	7190	8355	15072	11687	14621
46	1299	3188	4128	3953	5969	8204	2764	3994	6284	7182	6053	6165	8229	11027	9690	6104	4738	8674	7537	10436	7591	9682	15780	12262	16248
48	1070	2590	3555	3821	3685	6076	2129	3357	6648	5961	4708	5337	5538	7235	6943	5245	3954	7097	5951	7628	5988	8055	12395	8430	11789
50	981	1776	3289	3385	2159	4020	1977	2823	5797	4095	3339	3774	3842	4527	3898	4579	3110	4439	4213	4525	4220	5286	8042	4824	5781
52	1150	1783	3229	3129	1952	2564	1798	1836	3838	2692	2055	2821	2725	3131	2459	3467	2431	2847	3113	2746	2605	3173	4461	2687	2954
54	1138	1627	2775	2693	1915	1760	1470	1529	2528	2046	1420	1875	1767	2110	1420	2119	1756	1617	1648	1592	1396	1965	2516	1507	1815
56	797	1122	1681	1702	1343	1086	1168	1073	1697	1616	967	1110	1005	1648	771	1056	1145	898	943	976	777	1081	1388	887	1132
58	498	606	927	853	770	651	579	635	1130	1169	632	639	595	942	445	469	740	468	521	600	411	569	868	595	700
60	275	317	458	354	294	611	535	385	760	613	565	532	375	516	319	232	494	219	394	401	271	404	469	472	501
62	115	135	198	194	165	303	236	177	393	445	491	370	315	217	192	199	347	137	248	269	205	288	308	388	336
64	29	63	111	89	80	105	205	93	238	203	343	223	144	114	135	160	203	74	149	144	117	223	189	330	157
66	8	24	37	42	52	127	222	45	122	149	201	153	111	91	61	122	104	37	91	51	41	142	137	251	96
68	8	8	24	19	36	41	106	21	93	107	177	121	66	35	32	75	56	10	30	16	19	78	81	166	95
70	1	0	0	6	8	27	71	22	37	75	61	69	35	21	7	35	22	2	8	4	32	25	35	99	38
72	1	0	0	1	1	3	34	6	5	34	29	34	28	9	12	8	7	1	3	4	27	10	13	26	9
74	4	7	10	12	8	3	23	3	2	9	12	4	8	5	1	6	3	0	1	6	10	1	1	13	7
76	0	0	0	0	0	2	7	0	6	2	1	2	2	1	0	1	0	0	1	7	1	0	0	4	3
78	0	0	0	0	0	5	2	1	11	5	0	0	1	1	1	1	0	0	1	9	1	0	0	3	0
80	0	0	0	0	0	0	7	1	5	0	0	1	0	1	0	1	0	0	1	3	0	0	0	0	0
82	0	0	0	0	0	0	0	0	9	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	0
84	0	0	0	0	0	0	0	0	3	4	13	0	0	0	0	0	0	0	2	1	0	0	0	0	0
86	0	0	0	0	0	0	0	0	6	9	26	0	0	0	0	0	0	0	1	0	0	0	0	0	0
88	0	1	0	0	0	0	0	0	9	9	26	0	0	0	0	0	0	0	1	0	0	0	0	0	0
90	0	1	0	0	0	232	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	10619	19687	31734	31305	34796	52451	20627	29895	44370	44045	36061	46425	54290	58121	51087	40924	35098	40871	44495	59151	46536	56644	96228	71456	92910

Li (2cm)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	1	0	0	0	0	4145	0	0	1	0
22	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	3	0	1	15	3	0	5
24	2	1	0	1	1	1	2	0	0	1	6	1	3	1	7	10	21	1	0	0	8	6	13	24	11	5	4
26	17	17	4	8	8	11	11	7	2	7	10	11	6	8	41	25	55	5	5	4	20	20	30	27	57	30	28
28	97	81	27	61	63	60	70	33	26	41	67	35	34	48	95	67	118	22	55	29	80	60	117	134	123	89	116
30	471	390	145	330	311	342	366	138	142	293	523	230	183	288	382	269	324	252	383	246	349	455	811	779	719	516	515
32	1521	1261	520	1028	920	1118	1168	483	378	1005	1791	706	584	1081	1045	1054	1046	1108	1326	843	1009	1451	2568	2318	2392	1796	1976
34	3004	2456	1316	2085	1716	2414	2336	953	811	2030	3453	1973	1172	2523	2423	2818	3055	3499	4131	2045	2472	3529	5516	5277	5913	4051	4521
36	4385	3768	2731	3422	2592	3665	3723	2160	1633	3284	4677	3304	1866	4639	3792	5386	5557	7082	7362	3363	4997	5964	7583	9332	10659	7674	7431
38	5489	5337	3556	4249	3244	4565	4638	3721	2716	4526	5178	4478	2954	6275	4740	6189	7031	9873	9477	4466	6209	5823	9489	14112	15679	10985	10105
40	6798	8127	5582	5415	4409	7059	6654	6391	4148	6205	6422	6544	4683	8124	5773	6455	9679	11951	11654	6108	8236	8495	14280	19006	22065	17171	15242
42	10183	12771	9548	7912	6743	10726	8182	9074	5832	8788	8143	9041	6848	8711	7685	7242	10924	13469	12299	7297	9701	13151	16993	20404	25817	19362	16646
44	13058	14890	11521	8926	9530	13306	8473	10222	7138	10306	9769	10159	8166	8429	8521	8344	11115	13559	12459	9324	11775	16208	16143	19485	24687	19420	15613
46	14204	13457	12145	10178	11360	12818	8123	9029	7592	9235	10458	9695	7986	7391	7671	8264	10545	11421	13222	10319	12328	13482	12622	16231	20569	17256	13770
48	11042	9206	8467	7895	9350	8939	6779	7583	6667	7057	9988	7959	6498	5397	6207	6472	9279	8567	10897	9866	10236	9728	10546	11076	13409	12417	9867
50	5622	4329	3815	4210	5722	6353	4950	5544	4486	4954	6982	6023	4470	3551	4249	4631	6480	5888	7511	7909	6708	6814	7857	6535	7502	7507	5843
52	3549	2251	2247	2642	3894	3452	2971	3504	2709	2865	4050	3681	2958	2531	3143	3226	4293	4268	5302	6903	5023	5597	5315	3923	4229	4857	4062
54	1647	1053	1365	1129	1829	2042	2243	2052	1574	1675	2209	2202	2008	1774	2117	2476	2347	2925	3574	6114	3868	3969	3880	2328	2500	3042	2598
56	1009	681	948	691	1014	1060	1304	1104	938	1091	1433	1552	1408	1148	1388	1750	1525	1942	2645	4544	2919	2828	2601	1664	1534	2528	1996
58	626	583	645	489	701	652	900	797	609	776	826	955	800	779	908	1393	918	1373	1866	3474	2147	2038	1943	1070	1154	1785	1547
60	441	474	468	345	441	403	563	552	398	576	580	642	435	637	696	924	556	780	1583	2560	1681	1398	1291	866	926	1559	1253
62	267	359	305	246	239	220	335	346	227	364	405	460	267	418	412	644	373	504	1144	1969	1233	956	826	621	565	946	811
64	194	220	176	129	150	171	152	216	116	224	280	297	137	187	335	472	181	262	637	1322	875	571	584	400	275	614	542
66	129	133	111	47	75	107	79	112	54	184	134	155	79	103	126	145	68	134	300	706	584	474	348	169	96	334	362
68	98	78	75	38	24	40	38	77	31	91	68	99	61	33	46	75	47	53	139	239	329	378	220	99	48	158	154
70	39	37	30	12	20	19	52	20	16	46	28	24	28	17	17	35	9	29	18	85	170	337	104	39	22	44	38
72	25	23	5	5	8	11	20	7	12	27	14	15	11	18	11	37	9	9	19	31	50	161	84	33	2	11	7
74	8	7	1	0	2	1	3	2	10	12	7	7	5	20	16	11	0	4	4	10	5	88	33	13	1	4	1
76	1	1	0	3	2	3	3	2	4	2	3	5	9	12	8	1	1	3	1	2	1	4	8	4	0	0	0
78	0	0	0	0	0	0	1	3	3	4	1	3	4	3	1	1	1	3	0	0	1	1	0	2	0	1	0
80	0	0	0	0	1	1	0	0	1	2	0	1	3	2	2	0	1	1	0	0	0	0	1	1	0	1	0
82	0	0	0	3	1	0	0	0	1	1	18	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
88	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
90	1	0	0	4	2	0	0	1	0	1	1	2	5	0	0	0	1	2	1	0	2	0	1	0	0	0	0
TOTAL	83925	81992	65756	61508	64371	79561	64138	64134	48273	65674	77527	70263	53671	64151	61860	68417	85562	98989	108017	89778	93021	103985	125952	135986	160957	134165	115056

SKJ-Table 3. CAS (catch-at-size) matrix estimated for SKJ-W (western stock) in thousands of fish caught, by year and 2 cm size classes.

Li (2cm)	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	1	1	1	1	1	0	0	0	1	0	2	0	0
26	1	1	1	1	1	1	1	1	1	1	0	1	0	0
28	1	2	2	2	2	2	1	1	1	1	0	1	0	0
30	2	3	2	2	2	3	2	2	1	4	1	8	1	2
32	5	7	6	6	6	7	7	8	7	10	5	14	1	1
34	5	7	6	6	6	7	26	30	27	16	11	18	2	1
36	7	10	9	8	9	13	39	45	40	23	22	23	4	3
38	23	34	30	30	30	46	66	70	64	44	49	44	8	6
40	25	38	34	36	35	78	107	117	106	83	84	91	30	34
42	33	50	45	49	47	116	110	110	104	113	95	186	119	342
44	50	75	67	75	73	161	161	147	140	160	127	273	211	556
46	59	87	78	81	89	175	159	149	140	210	153	266	231	253
48	55	82	72	72	89	166	152	154	148	219	154	274	300	289
50	54	79	69	68	93	129	127	130	123	198	188	241	461	436
52	43	56	48	52	63	84	107	120	95	165	131	192	792	847
54	30	39	32	34	43	61	83	87	69	139	106	197	710	1025
56	29	36	27	27	31	41	64	72	58	116	119	215	684	932
58	31	34	22	25	27	30	41	56	49	98	123	278	467	676
60	37	41	27	31	37	33	43	62	52	76	113	289	496	550
62	21	25	16	16	27	19	19	26	25	55	85	241	400	580
64	21	24	17	18	25	21	16	23	20	51	73	187	313	461
66	11	10	6	9	10	7	12	22	18	49	46	136	253	420
68	8	11	7	7	10	9	5	6	7	38	34	89	121	280
70	16	23	21	19	24	27	8	5	5	26	21	64	83	211
72	10	15	14	12	17	17	5	3	3	13	12	25	50	79
74	2	4	4	3	6	6	4	2	2	7	7	16	36	26
76	0	1	1	1	2	1	1	0	0	4	4	12	24	18
78	0	0	0	0	1	1	0	0	0	6	7	3	10	6
80	0	0	0	0	1	0	0	0	0	4	8	0	0	1
82	0	0	0	0	0	0	0	0	0	9	4	0	0	1
84	0	0	0	0	1	0	0	0	0	6	4	0	0	0
86	0	0	0	0	0	0	0	0	0	1	4	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	578	796	665	693	808	1263	1369	1449	1303	1944	1792	3385	5808	8036

Li (2cm)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
20	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	1	1	0	0	0	1	0	0	0	0	0
24	0	0	0	0	0	0	1	1	0	0	2	0	0
26	1	0	0	0	1	0	1	0	1	0	0	1	1
28	1	0	0	0	2	1	2	1	3	0	1	5	1
30	1	1	12	15	3	1	2	1	4	0	17	10	2
32	1	2	15	33	4	4	4	2	13	1	56	31	4
34	3	10	14	24	5	5	6	3	30	22	127	35	11
36	17	29	74	62	16	15	35	33	49	77	305	58	32
38	27	57	59	121	75	36	76	48	129	68	512	148	79
40	56	166	694	305	105	63	86	67	202	121	586	281	114
42	385	706	1047	383	93	108	121	101	393	221	687	326	146
44	600	1016	1100	407	311	229	235	147	518	357	894	512	204
46	373	547	945	551	385	389	419	357	764	530	855	716	283
48	380	475	1041	710	648	647	583	756	1070	707	793	837	434
50	588	582	1637	922	729	919	958	1258	1204	741	833	981	531
52	877	986	1448	1111	701	929	1183	1473	1291	821	885	1020	621
54	933	1122	1437	1288	795	778	1129	1437	1214	863	1213	914	607
56	811	824	1300	1323	854	743	952	1067	1093	851	991	899	566
58	643	638	1054	1003	792	682	830	565	855	790	898	798	626
60	529	527	681	691	528	509	424	287	588	595	553	647	538
62	491	592	390	369	251	326	265	187	373	399	362	420	436
64	359	422	184	168	155	189	121	68	182	282	271	219	256
66	354	419	95	86	103	97	83	49	119	159	97	86	114
68	269	255	54	42	90	40	51	19	49	127	41	43	64
70	229	238	33	34	51	19	56	9	19	81	66	35	57
72	102	79	30	21	53	16	14	5	31	85	18	28	49
74	48	22	11	10	29	19	14	13	15	39	21	27	26
76	41	12	2	4	10	7	5	5	15	34	30	13	12
78	16	7	2	2	3	15	11	11	13	38	8	10	16
80	4	5	1	1	1	1	0	0	5	3	4	1	3
82	2	11	0	1	1	0	11	7	16	11	2	1	1
84	0	2	1	0	0	0	0	0	1	6	2	7	0
86	0	1	0	0	1	1	0	0	0	0	0	2	3
88	0	0	0	1	0	0	0	0	0	0	1	2	0
90	0	0	0	0	1	0	0	0	0	28	1	1	1
TOTAL	8141	9750	13363	9691	6797	6786	7677	7979	10258	8057	11131	9116	5838

Li (2cm)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
20	0	0	0	0	0	0	0	0	0	0	0	0	1
22	0	0	0	0	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	1	0
28	0	0	0	0	0	0	0	0	1	3	0	1	0
30	1	2	0	2	0	4	0	2	10	6	3	2	1
32	2	3	1	3	8	11	2	4	16	9	0	9	1
34	8	11	5	11	29	52	8	10	34	16	0	23	3
36	27	34	10	27	32	86	16	12	24	34	2	39	12
38	65	75	48	75	92	144	29	30	47	45	9	78	13
40	152	174	119	147	144	294	45	84	67	102	30	94	25
42	173	167	140	125	150	350	74	175	128	247	105	133	190
44	208	187	177	132	201	425	103	319	382	458	338	223	362
46	320	302	296	185	187	413	188	473	901	634	477	316	442
48	510	466	400	344	312	577	329	567	1228	909	899	411	908
50	579	732	522	517	519	801	526	614	1316	1337	1207	696	979
52	690	1000	826	697	735	935	689	675	904	1486	1306	775	704
54	739	1180	963	821	895	1013	725	740	809	1426	1327	587	501
56	775	1206	935	898	959	952	714	745	726	1091	955	478	391
58	850	1063	1004	985	1066	817	620	684	568	543	723	418	388
60	743	782	880	861	916	551	407	457	471	334	356	404	302
62	584	509	569	556	602	449	321	371	372	175	188	368	217
64	340	292	297	291	321	327	230	256	265	107	102	405	113
66	157	193	194	190	208	268	196	214	109	39	49	322	123
68	85	99	103	104	104	197	136	149	37	19	11	270	136
70	73	41	47	46	41	57	48	47	17	21	0	146	117
72	54	13	10	12	10	50	40	41	14	19	0	75	56
74	26	11	9	9	7	31	25	26	7	8	6	50	70
76	8	4	5	2	3	25	16	16	8	4	9	31	41
78	13	8	5	5	5	2	2	2	6	5	7	5	27
80	5	0	0	0	0	4	3	6	5	3	6	6	22
82	2	0	1	0	0	2	2	2	0	0	0	3	7
84	0	0	0	0	0	0	0	0	0	3	0	0	0
86	4	0	0	0	0	0	0	0	0	0	0	0	7
88	0	0	0	0	0	0	0	0	2	0	0	0	0
90	0	0	1	0	0	0	8	1	3	0	0	1	0
TOTAL	7193	8555	7567	7046	7548	8837	5500	6722	8478	9085	8116	6369	6161

Li (2cm)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
20	0	0	0	1	18	0	0	0	0	0	0	0
22	0	1	0	0	0	0	0	1	0	0	0	0
24	1	7	0	0	0	0	0	1	0	0	0	0
26	0	6	0	0	0	0	0	1	0	3	0	0
28	1	0	0	0	14	33	0	4	2	2	1	2
30	2	1	1	1	36	0	1	16	10	8	4	4
32	10	5	2	0	12	1	4	39	24	59	30	11
34	23	13	6	0	15	33	29	109	87	62	48	48
36	40	28	21	11	8	1	14	300	271	242	214	207
38	69	47	30	12	10	136	74	453	435	398	378	350
40	76	70	35	26	187	75	141	244	335	248	160	149
42	160	278	242	309	93	150	185	265	571	295	226	165
44	288	479	475	596	295	61	512	396	843	439	350	277
46	615	634	735	742	524	994	571	636	988	769	592	489
48	847	850	1035	996	507	1622	842	894	1096	1097	894	694
50	963	900	1163	995	2050	2410	486	1004	1061	1140	975	816
52	1053	807	1154	981	3063	1783	494	972	980	1025	918	783
54	898	686	1026	919	1536	807	439	616	632	834	711	486
56	758	570	841	784	667	420	429	758	689	599	616	562
58	611	484	692	701	843	341	550	663	661	603	601	562
60	493	396	547	584	526	107	389	218	205	200	184	256
62	322	277	375	416	287	203	446	116	100	79	70	108
64	147	123	170	190	20	68	215	64	46	67	37	48
66	113	129	145	168	2	69	156	35	11	9	5	35
68	78	150	151	186	1	38	96	19	9	9	3	12
70	47	128	121	157	0	2	22	14	5	5	1	27
72	27	72	61	76	1	0	22	12	3	3	3	24
74	10	76	65	91	19	5	24	4	3	3	1	0
76	10	46	38	52	1	1	3	4	2	5	1	22
78	1	29	24	34	20	0	12	1	1	54	28	0
80	5	24	19	26	0	0	0	0	1	10	13	21
82	1	7	6	9	2	0	6	0	1	6	5	21
84	1	0	0	0	0	6	0	0	1	1	0	0
86	1	7	6	9	0	6	3	0	4	0	0	21
88	0	1	0	0	0	0	0	7	1	0	0	0
90	0	1	0	0	24	11	0	14	6	0	1	0
TOTAL	7670	7332	9187	9072	10781	9382	6165	7881	9085	8272	7072	6201

SKJ-Table 4. SKJ-E. The probability of stock biomass being below 10% or 20% of B_{MSY} during the projection period for a given catch level and is based on 180,000 iterations of the MVLN and MCMC statistical analyses developed from the Stock Synthesis and JABBA model runs (2 model platforms x 3 steepness options x 3 growth/M options x 2 index combinations).

Probability of B<10%*B_{MSY}

TAC (kt)	2023	2024	2025	2026	2027	2028
100	5%	6%	6%	6%	6%	6%
110	5%	6%	6%	6%	6%	7%
120	5%	6%	6%	7%	7%	7%
130	5%	6%	7%	7%	7%	7%
140	5%	6%	7%	7%	7%	7%
150	5%	6%	7%	7%	8%	8%
160	5%	7%	7%	8%	8%	8%
170	5%	7%	7%	8%	8%	9%
180	5%	7%	8%	8%	9%	9%
190	5%	7%	8%	9%	9%	10%
200	5%	7%	8%	9%	10%	10%
210	5%	7%	9%	10%	11%	12%
220	5%	7%	9%	10%	12%	14%
230	5%	7%	9%	11%	14%	15%
240	5%	8%	10%	13%	15%	17%
250	5%	8%	10%	14%	17%	20%
260	5%	8%	11%	15%	19%	23%
270	5%	8%	13%	17%	21%	31%
280	5%	9%	14%	18%	27%	48%
290	5%	9%	15%	21%	41%	51%
300	5%	10%	16%	27%	49%	54%

Probability of B<20%*B_{MSY}

TAC (kt)	2023	2024	2025	2026	2027	2028
100	6%	6%	6%	6%	6%	6%
110	6%	6%	6%	7%	7%	7%
120	6%	6%	7%	7%	7%	7%
130	6%	7%	7%	7%	7%	7%
140	6%	7%	7%	7%	7%	7%
150	6%	7%	7%	8%	8%	8%
160	6%	7%	7%	8%	8%	8%
170	6%	7%	8%	8%	8%	9%
180	6%	7%	8%	9%	9%	9%
190	6%	7%	8%	9%	10%	10%
200	6%	7%	9%	9%	10%	11%
210	6%	8%	9%	10%	11%	14%
220	6%	8%	9%	11%	14%	17%
230	6%	8%	10%	13%	17%	20%
240	6%	8%	11%	16%	19%	22%
250	6%	9%	13%	18%	22%	26%
260	6%	9%	15%	20%	25%	32%
270	6%	10%	17%	22%	29%	43%
280	6%	11%	18%	25%	38%	61%
290	6%	12%	20%	30%	54%	64%
300	6%	13%	22%	38%	61%	67%

SKJ-Table 5. SKJ-E. Joint probabilities of the eastern Atlantic skipjack stock being below F_{MSY} (overfishing not occurring), above B_{MSY} (not overfished) and above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level (thousand t), based on 90,000 iterations of the MVLN approximation for Stock Synthesis and 90,000 MCMC iterations for JABBA.

Probaility $F<=F_{MSY}$

TAC (kt)	2023	2024	2025	2026	2027	2028
100	91%	92%	93%	93%	93%	94%
110	90%	92%	92%	93%	93%	93%
120	89%	91%	92%	92%	93%	93%
130	88%	90%	91%	92%	92%	92%
140	87%	89%	90%	91%	91%	92%
150	85%	87%	88%	89%	90%	90%
160	84%	85%	86%	87%	88%	88%
170	82%	84%	84%	85%	85%	86%
180	81%	81%	82%	82%	82%	82%
190	79%	79%	79%	78%	77%	76%
200	77%	76%	75%	73%	71%	70%
210	75%	73%	71%	68%	65%	63%
220	73%	70%	67%	63%	59%	57%
230	71%	67%	62%	57%	53%	50%
240	69%	63%	57%	51%	46%	42%
250	67%	60%	52%	45%	39%	35%
260	65%	56%	47%	38%	32%	27%
270	63%	52%	42%	33%	26%	20%
280	60%	48%	36%	27%	20%	14%
290	58%	44%	31%	21%	14%	10%
300	56%	40%	26%	16%	10%	7%

Probability $SSB>=SSB_{MSY}$ or $B>=B_{MSY}$

TAC (kt)	2023	2024	2025	2026	2027	2028
100	82%	88%	91%	92%	93%	93%
110	82%	88%	90%	92%	92%	93%
120	82%	87%	90%	91%	92%	92%
130	82%	87%	89%	91%	92%	92%
140	81%	86%	88%	90%	91%	91%
150	81%	85%	87%	89%	90%	90%
160	81%	84%	86%	87%	88%	89%
170	80%	83%	84%	85%	86%	87%
180	80%	81%	82%	82%	82%	83%
190	79%	80%	80%	79%	78%	77%
200	79%	78%	77%	74%	72%	70%
210	78%	76%	73%	70%	66%	63%
220	77%	74%	69%	64%	60%	58%
230	77%	72%	65%	59%	55%	52%
240	76%	69%	61%	54%	49%	45%
250	75%	66%	57%	49%	43%	37%
260	74%	63%	53%	44%	36%	29%
270	73%	61%	48%	38%	29%	19%
280	72%	57%	44%	32%	20%	12%
290	71%	54%	39%	24%	12%	9%
300	70%	51%	34%	17%	9%	7%

Probability $F<=F_{MSY}$ and $SSB>=SSB_{MSY}$ or $B>=B_{MSY}$

TAC (kt)	2023	2024	2025	2026	2027	2028
100	82%	88%	91%	92%	93%	93%
110	82%	88%	90%	92%	92%	93%
120	81%	87%	90%	91%	92%	92%
130	81%	86%	89%	90%	91%	92%
140	81%	85%	88%	89%	90%	91%
150	80%	84%	86%	88%	89%	90%
160	79%	83%	84%	86%	87%	88%
170	79%	81%	83%	84%	84%	85%
180	78%	79%	80%	80%	81%	81%
190	77%	77%	77%	77%	76%	75%
200	76%	75%	74%	72%	70%	68%
210	75%	72%	70%	67%	63%	61%
220	73%	70%	65%	61%	57%	55%
230	71%	66%	60%	55%	51%	48%
240	69%	63%	55%	49%	45%	41%
250	67%	59%	50%	43%	38%	33%
260	65%	54%	45%	37%	31%	25%
270	62%	50%	40%	32%	24%	17%
280	60%	46%	34%	26%	17%	10%
290	58%	41%	30%	19%	10%	8%
300	55%	38%	25%	13%	7%	6%

SKJ-Table 6. SKJ-W. The probability of stock biomass being below 10% or 20% of B_{MSY} during the projection period for a given catch level and is based on 200,000 iterations of the MVLN approximation for the Stock Synthesis.

Probability of B<10%*B_{MSY}

TAC (1000s mt)	2023	2024	2025	2026	2027	2028
16	0%	0%	0%	0%	0%	0%
18	0%	0%	0%	0%	0%	0%
20	0%	0%	0%	0%	0%	0%
22	0%	0%	0%	0%	0%	0%
24	0%	0%	0%	0%	0%	0%
26	0%	0%	0%	0%	0%	0%
28	0%	0%	0%	0%	0%	0%
30	0%	0%	0%	0%	0%	0%
32	0%	0%	0%	0%	0%	0%
33	0%	0%	0%	0%	0%	0%
34	0%	0%	0%	0%	0%	0%
35	0%	0%	0%	0%	0%	0%
36	0%	0%	0%	0%	0%	0%
38	0%	0%	0%	0%	0%	0%
40	0%	0%	0%	0%	0%	0%

Probability of B<20%*B_{MSY}

TAC (1000s mt)	2023	2024	2025	2026	2027	2028
16	0%	0%	0%	0%	0%	0%
18	0%	0%	0%	0%	0%	0%
20	0%	0%	0%	0%	0%	0%
22	0%	0%	0%	0%	0%	0%
24	0%	0%	0%	0%	0%	0%
26	0%	0%	0%	0%	0%	0%
28	0%	0%	0%	0%	0%	0%
30	0%	0%	0%	0%	0%	0%
32	0%	0%	0%	0%	0%	0%
33	0%	0%	0%	0%	0%	0%
34	0%	0%	0%	0%	0%	0%
35	0%	0%	0%	0%	0%	0%
36	0%	0%	0%	0%	0%	0%
38	0%	0%	0%	0%	0%	1%
40	0%	0%	0%	0%	1%	3%

SKJ-Table 7. SKJ-W. Estimated probabilities of the western Atlantic skipjack stock being below F_{MSY} (overfishing not occurring), above B_{MSY} (not overfished) and above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level (thousand t), based on 200,000 iterations of the MVLN approximation.

Probaility $F<=F_{MSY}$

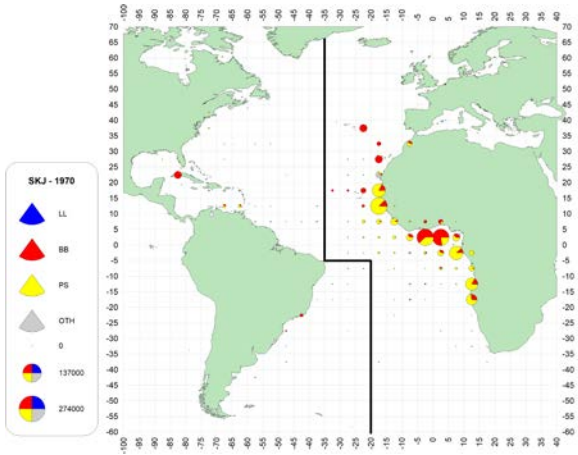
TAC (1000s mt)	2023	2024	2025	2026	2027	2028
16	100%	100%	100%	100%	100%	100%
18	100%	100%	100%	100%	100%	100%
20	100%	100%	100%	100%	100%	100%
22	99%	100%	100%	100%	100%	100%
24	99%	99%	99%	100%	100%	100%
26	98%	98%	98%	99%	99%	99%
28	97%	97%	97%	97%	97%	97%
30	96%	95%	94%	93%	93%	92%
32	94%	92%	91%	89%	87%	85%
33	93%	91%	88%	86%	83%	80%
34	92%	89%	86%	82%	79%	75%
35	91%	87%	83%	78%	74%	70%
36	90%	85%	80%	75%	70%	65%
38	88%	81%	74%	67%	61%	56%
40	85%	76%	67%	59%	53%	48%

Probability $SSB>=SSB_{MSY}$

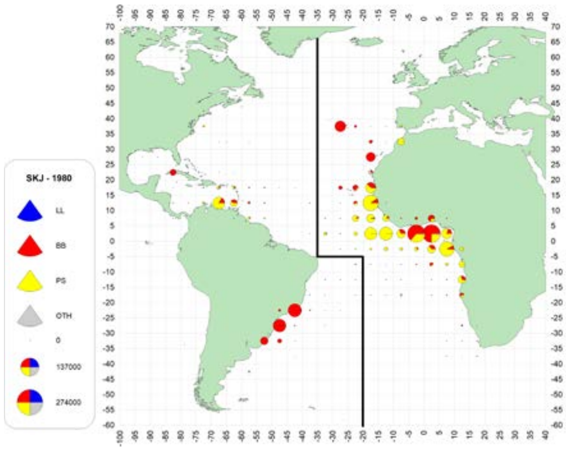
TAC (1000s mt)	2023	2024	2025	2026	2027	2028
16	99%	100%	100%	100%	100%	100%
18	99%	100%	100%	100%	100%	100%
20	99%	100%	100%	100%	100%	100%
22	99%	99%	100%	100%	100%	100%
24	99%	99%	99%	100%	100%	100%
26	98%	99%	99%	99%	99%	99%
28	98%	98%	98%	98%	98%	98%
30	98%	97%	96%	96%	95%	94%
32	97%	96%	94%	92%	90%	88%
33	97%	95%	93%	90%	87%	84%
34	96%	94%	91%	87%	83%	79%
35	96%	93%	89%	84%	79%	74%
36	96%	92%	87%	81%	75%	69%
38	95%	89%	82%	73%	66%	60%
40	94%	86%	76%	66%	59%	53%

Probability $F<=F_{MSY}$ and $SSB>=SSB_{MSY}$

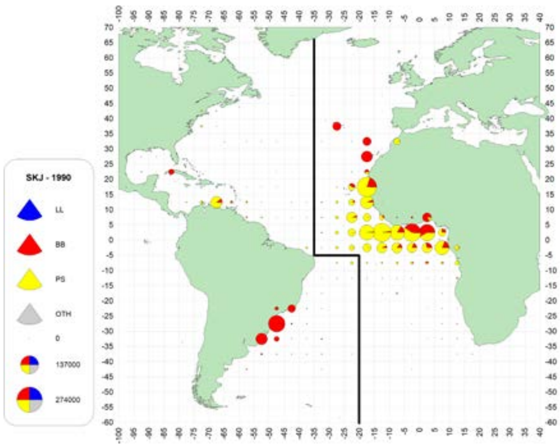
TAC (1000s mt)	2023	2024	2025	2026	2027	2028
16	99%	100%	100%	100%	100%	100%
18	99%	100%	100%	100%	100%	100%
20	99%	100%	100%	100%	100%	100%
22	99%	99%	100%	100%	100%	100%
24	99%	99%	99%	99%	100%	100%
26	98%	98%	98%	99%	99%	99%
28	97%	97%	97%	97%	97%	97%
30	96%	95%	94%	93%	93%	92%
32	94%	92%	91%	89%	87%	85%
33	93%	91%	88%	86%	83%	80%
34	92%	89%	86%	82%	79%	75%
35	91%	87%	83%	78%	74%	70%
36	90%	85%	80%	75%	70%	65%
38	88%	81%	74%	67%	61%	56%
40	85%	76%	67%	59%	53%	48%



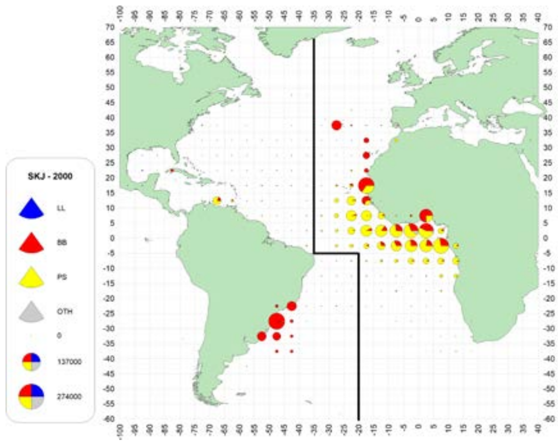
a. SKJ (1970-79)



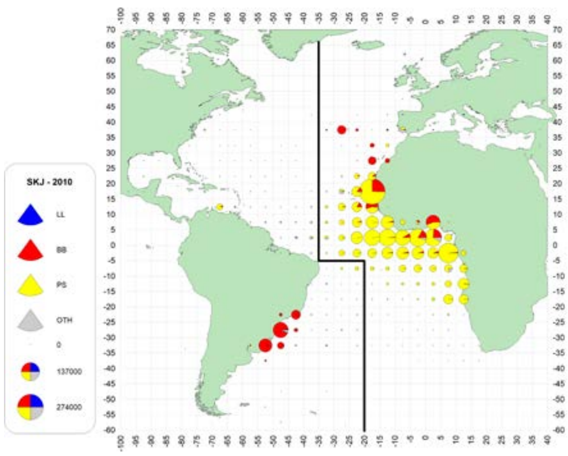
b. SKJ (1980-89)



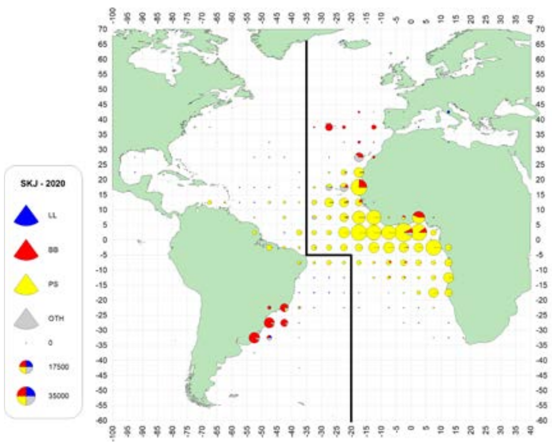
c. SKJ (1990-99)



d. SKJ (2000-09)

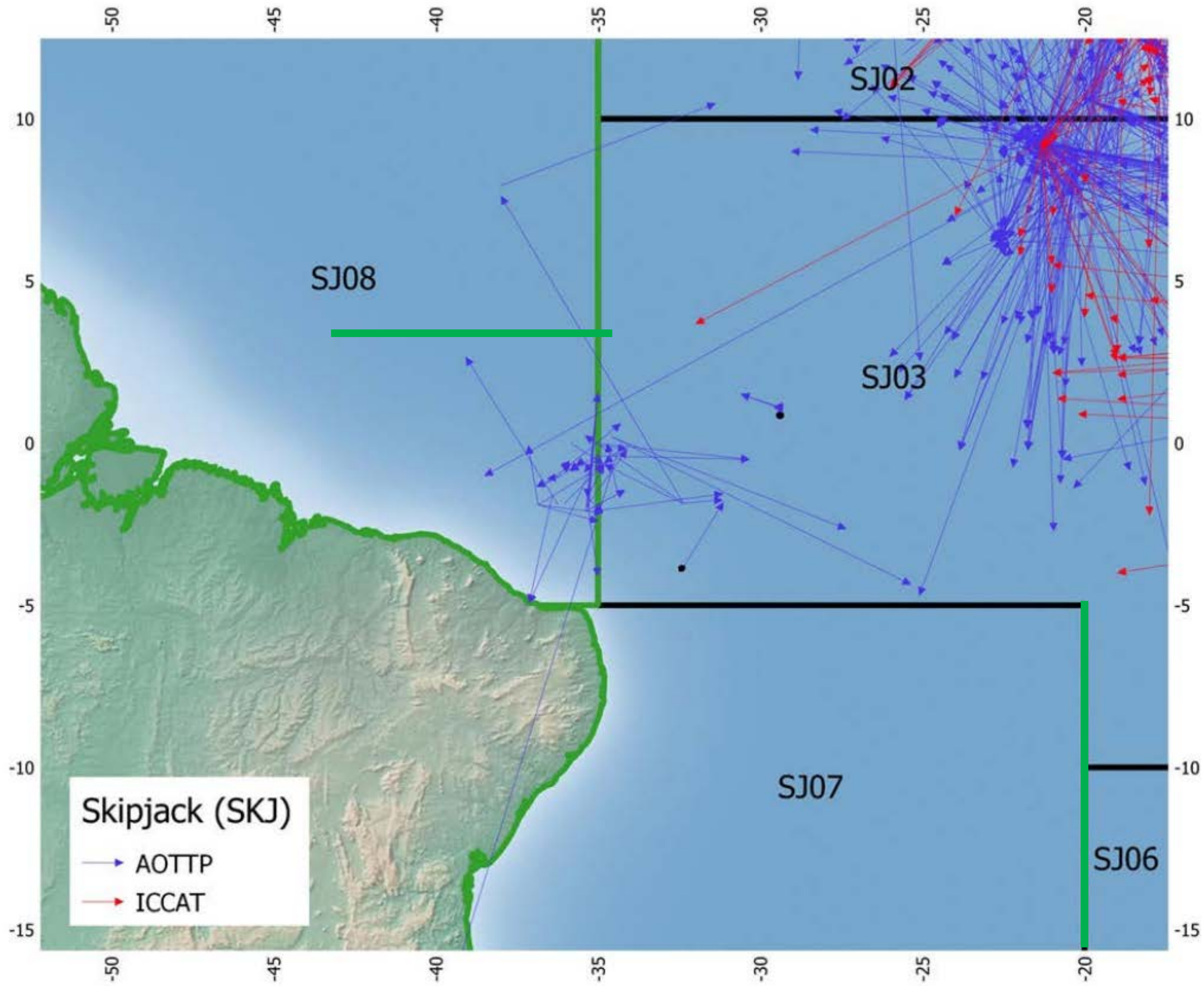


e. SKJ (2010-19)

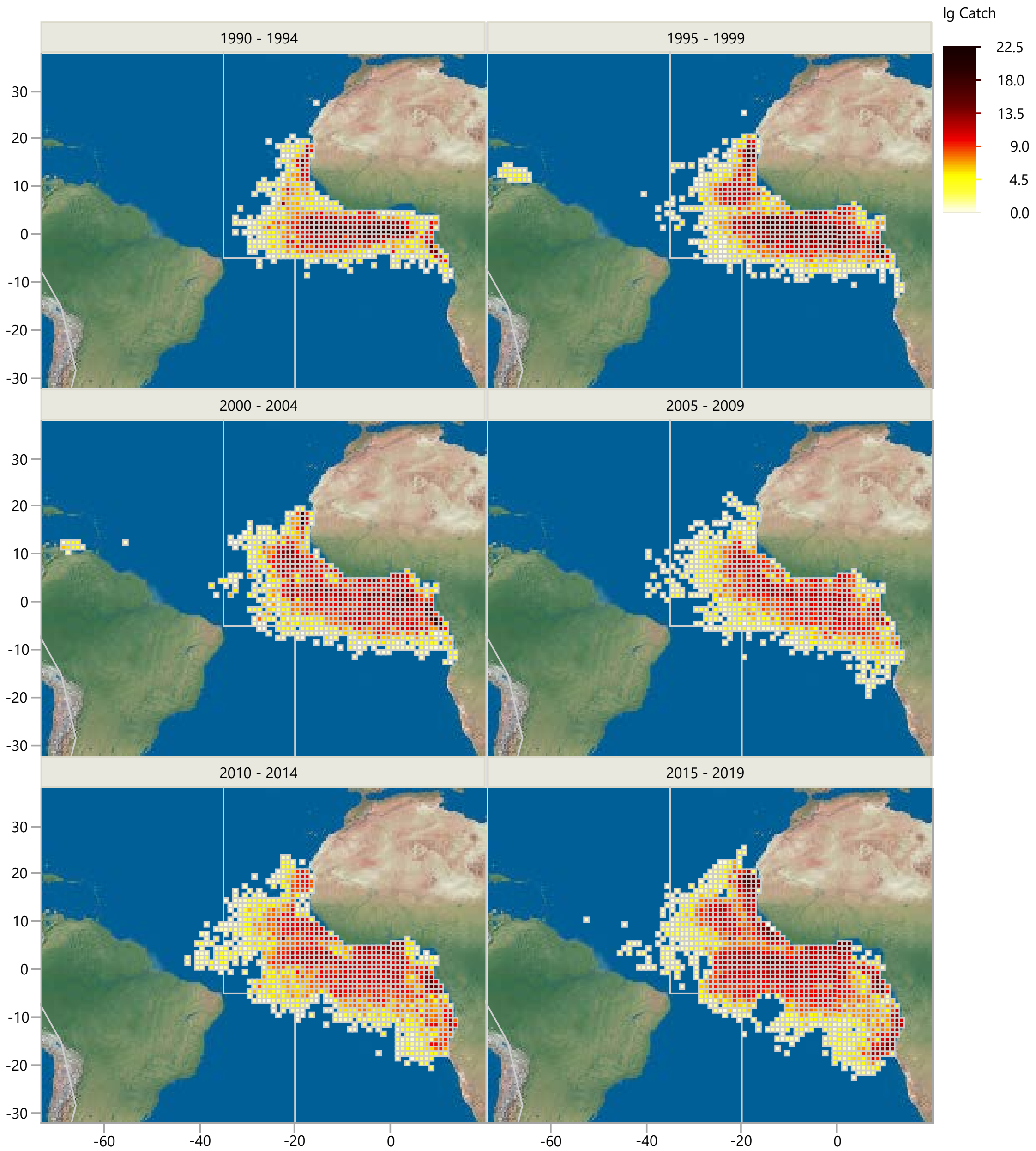


f. SKJ (2020-21)

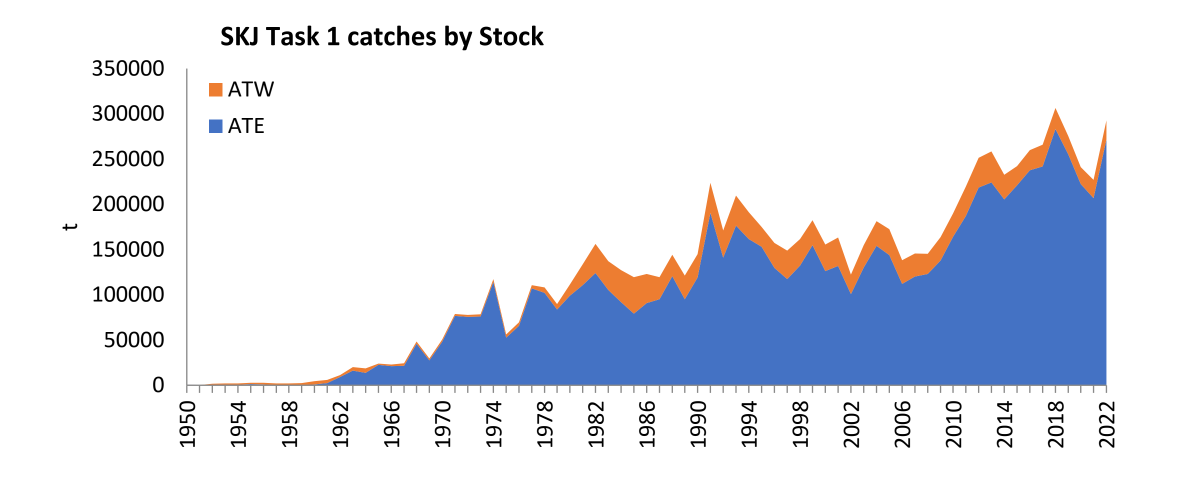
SKJ-Figure 1. [a-f]. Geographical distribution of the skipjack catch by major gears and decade. The maps are scaled to the maximum catch observed during 1970-2021 (last decade only covers 2 years).



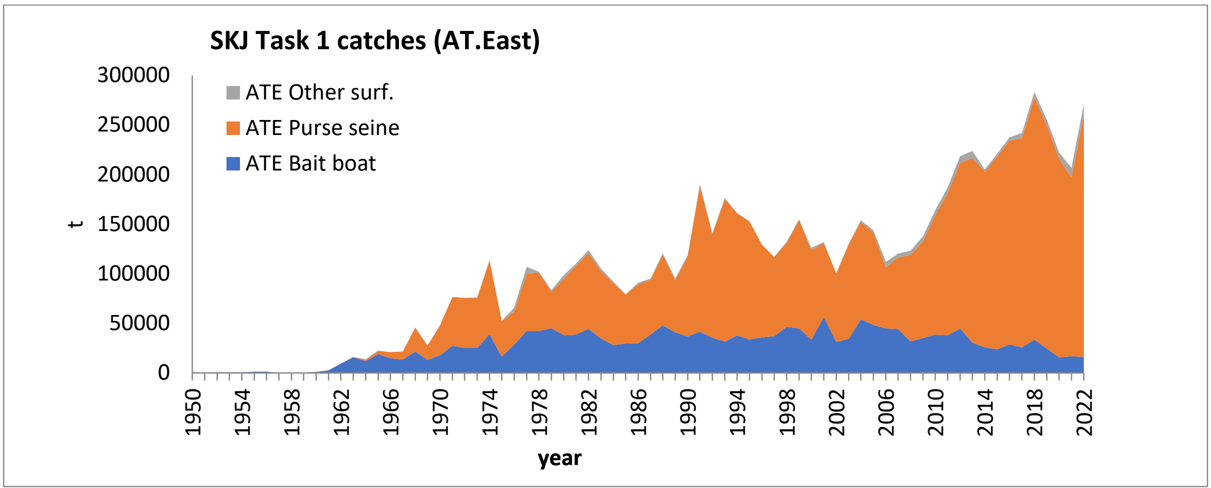
SKJ-Figure 2. A map of the AOTTP (blue lines) and ICCAT (red lines) tagged returns demonstrating the movement of fish in proximity to the eastern-western stock boundary. Area codes correspond to SKJ sample areas. Green line represents the East-West stock boundary.



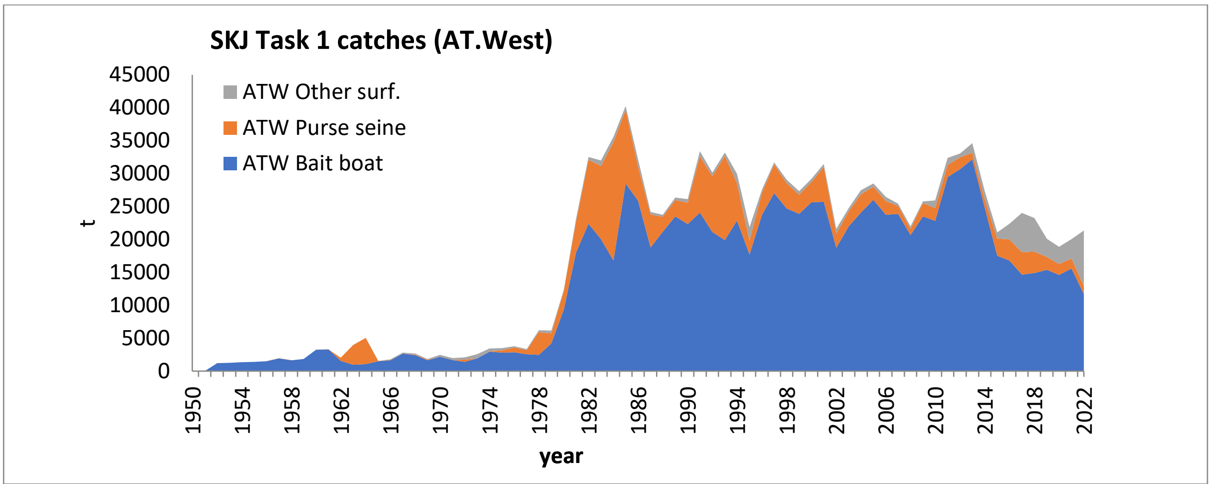
SKJ-Figure 3. Spatial distribution of the total SKJ catch (lg scale) from all PS-FAD fisheries by 1º x 1º of latitude - longitude and by lustrum (each box) 1990 – 2019. Line denotes the SKJ stocks boundary.



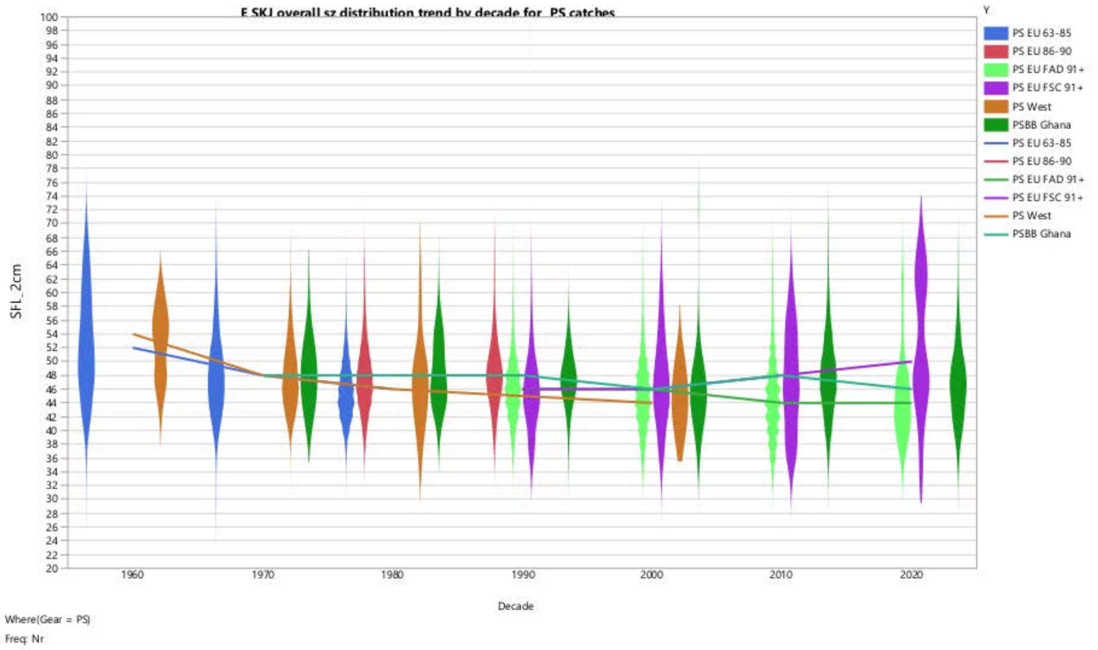
SKJ-Figure 4. Total skipjack catches (t) in the Atlantic and by stock (East and West) between 1950 and 2022. The 2022 figure is still preliminary.



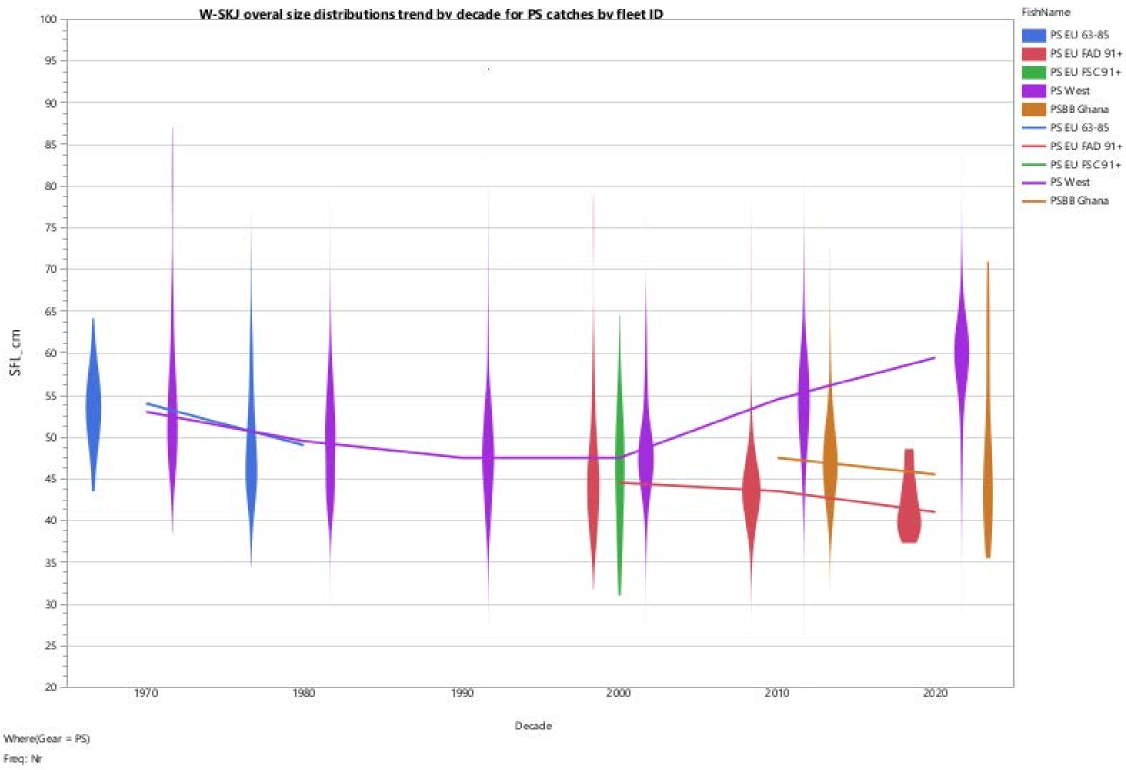
SKJ-Figure 5. Skipjack catches in the eastern Atlantic, by gear (1950-2022). The values for 2022 are preliminary.



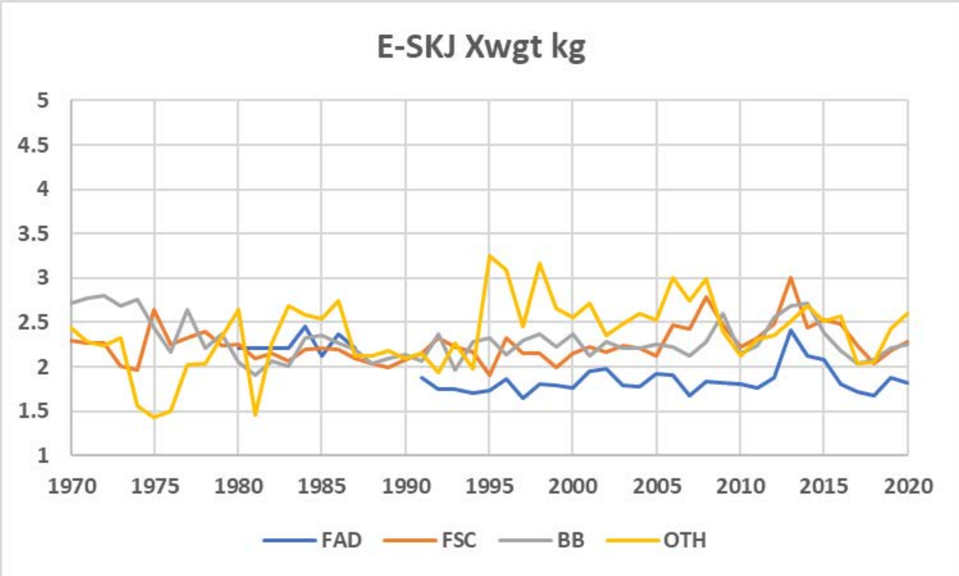
SKJ-Figure 6. Skipjack catches in the western Atlantic, by gear (1950-2022). The values for 2022 are preliminary.



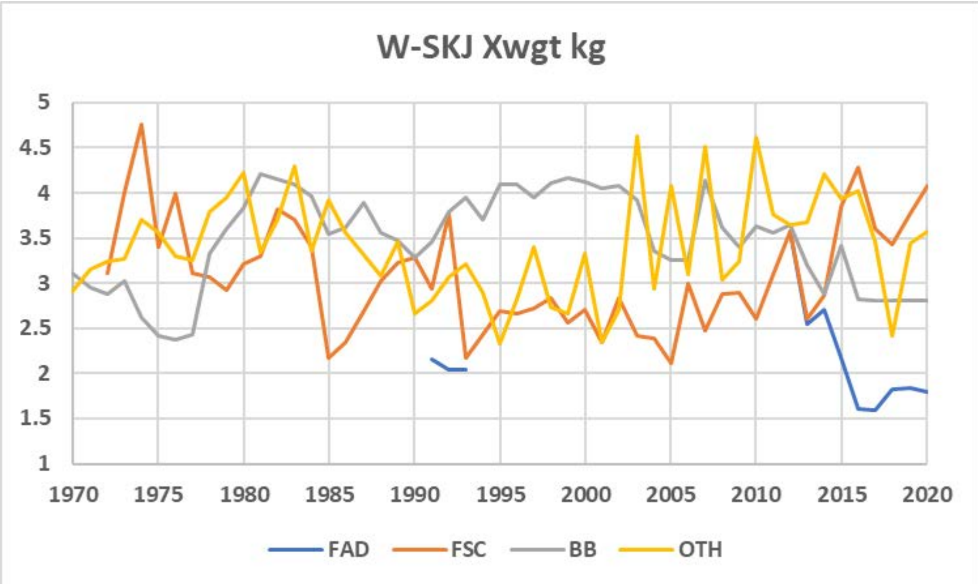
SKJ-Figure 7. SKJ-E. Overall size distribution of catch by decade for the PS fisheries by fleet ID, lines indicate the median of the distribution.



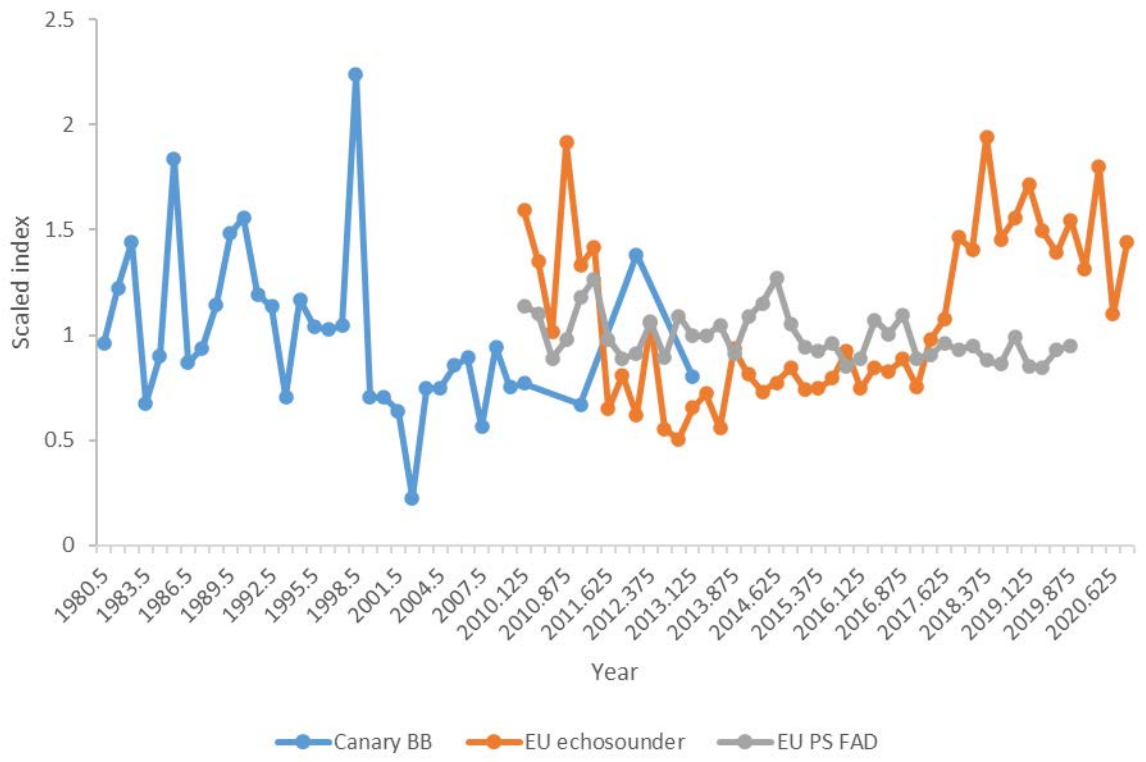
SKJ-Figure 8. SKJ-W. Size distributions by fleet ID from the PS fisheries, lines indicate the median of the distributions.



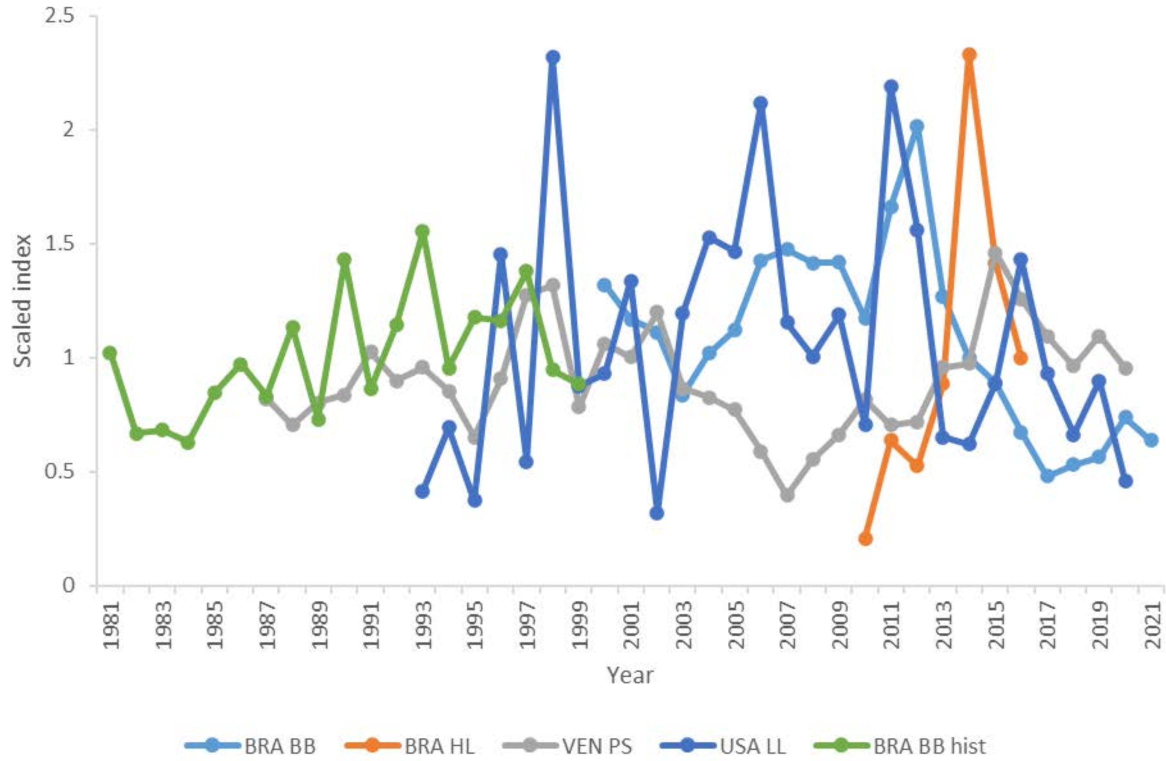
SKJ-Figure 9. SKJ-E. Mean weights (kg) estimated from the overall CAS estimations updated by Secretariat including Fishing mode free-schools (FSC), FOB (FAD), baitboat (BB), and other gears (OTH).



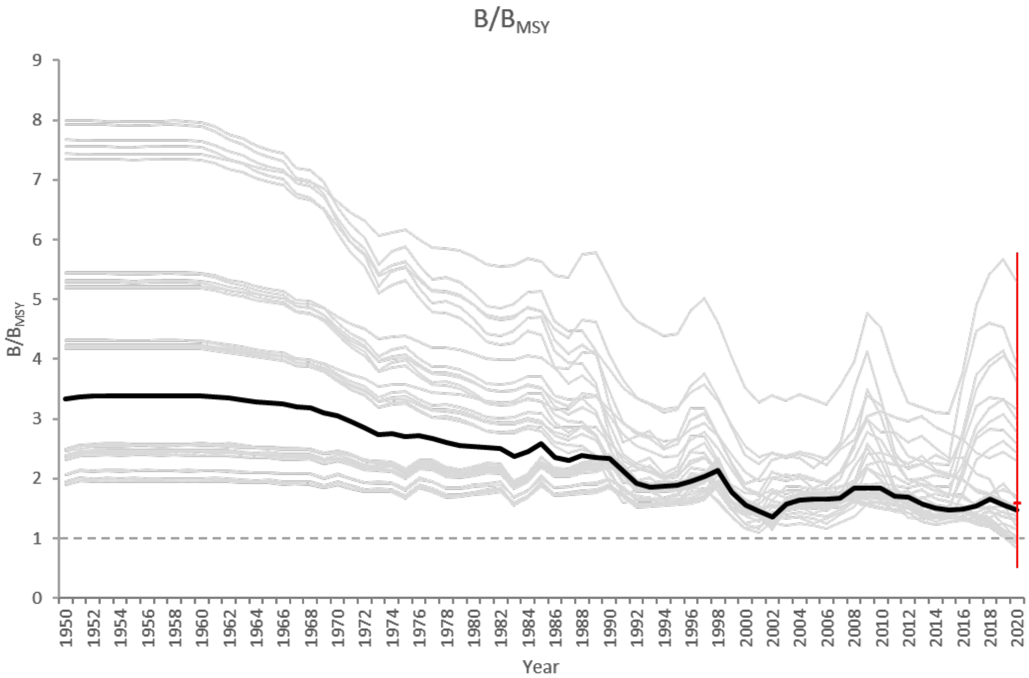
SKJ-Figure 10. SKJ-W. Mean weights (kg) estimated from the overall CAS estimations updated by Secretariat including Fishing mode free-schools (FSC), FOB (FAD), baitboat (BB), and other gears (OTH).

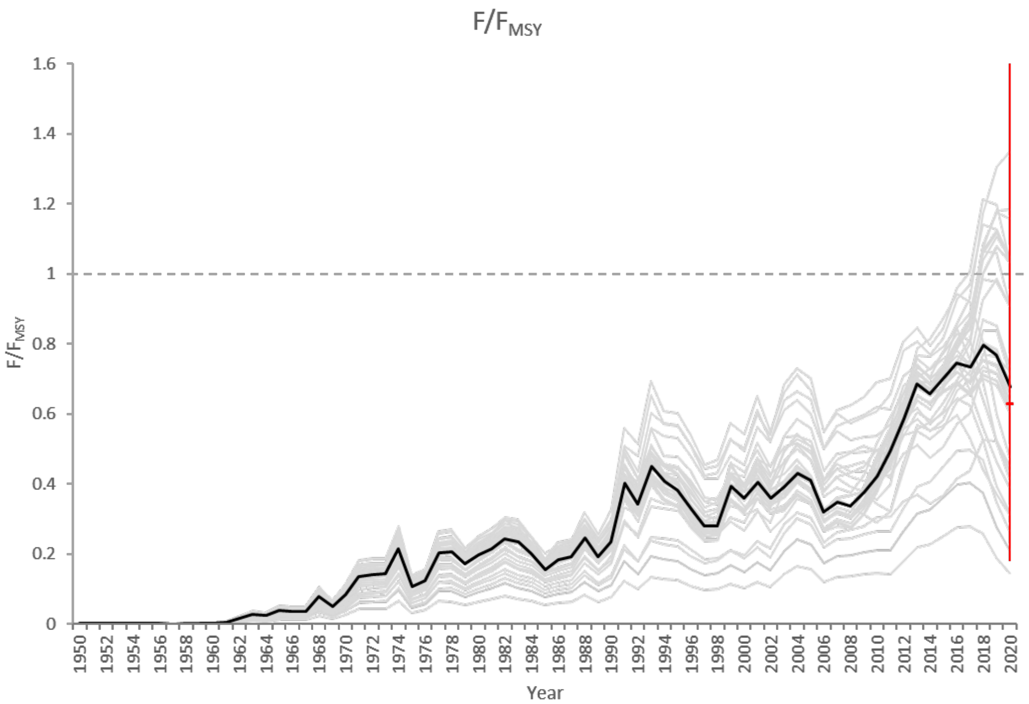


SKJ-Figure 11. SKJ-E. Relative abundance indices included in the final stock assessment models, Stock Synthesis and JABBA, for the eastern skipjack stock. Years in the x axis are non-integers because the model runs at quarterly time steps.

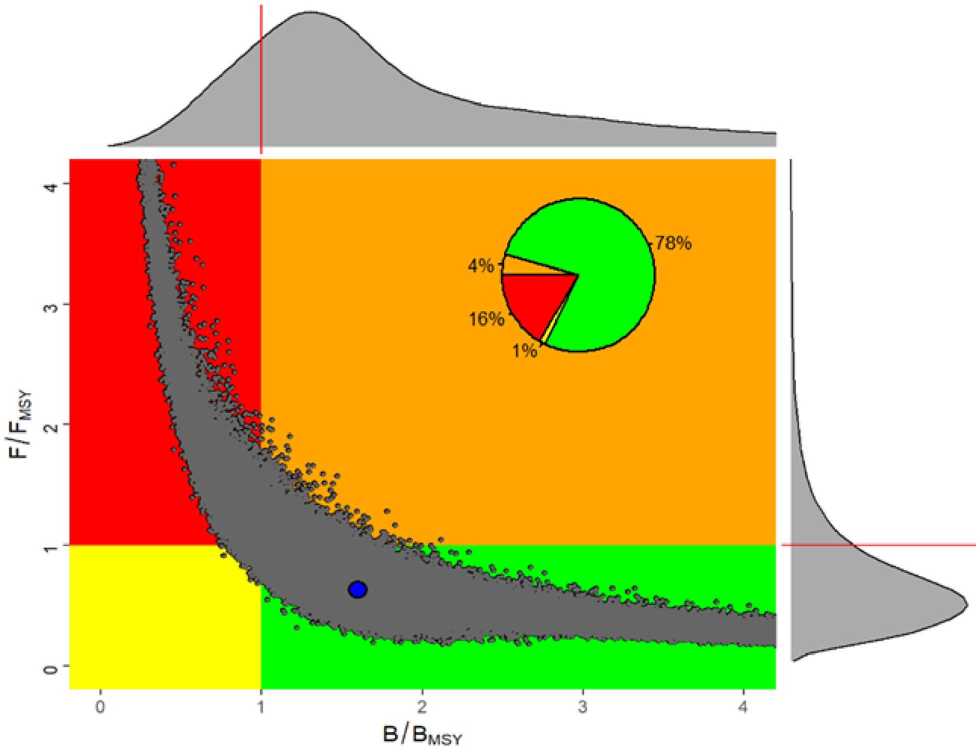


SKJ-Figure 12. SKJ-W. Relative abundance indices included in the final stock assessment model, Stock Synthesis, for the western skipjack stock.

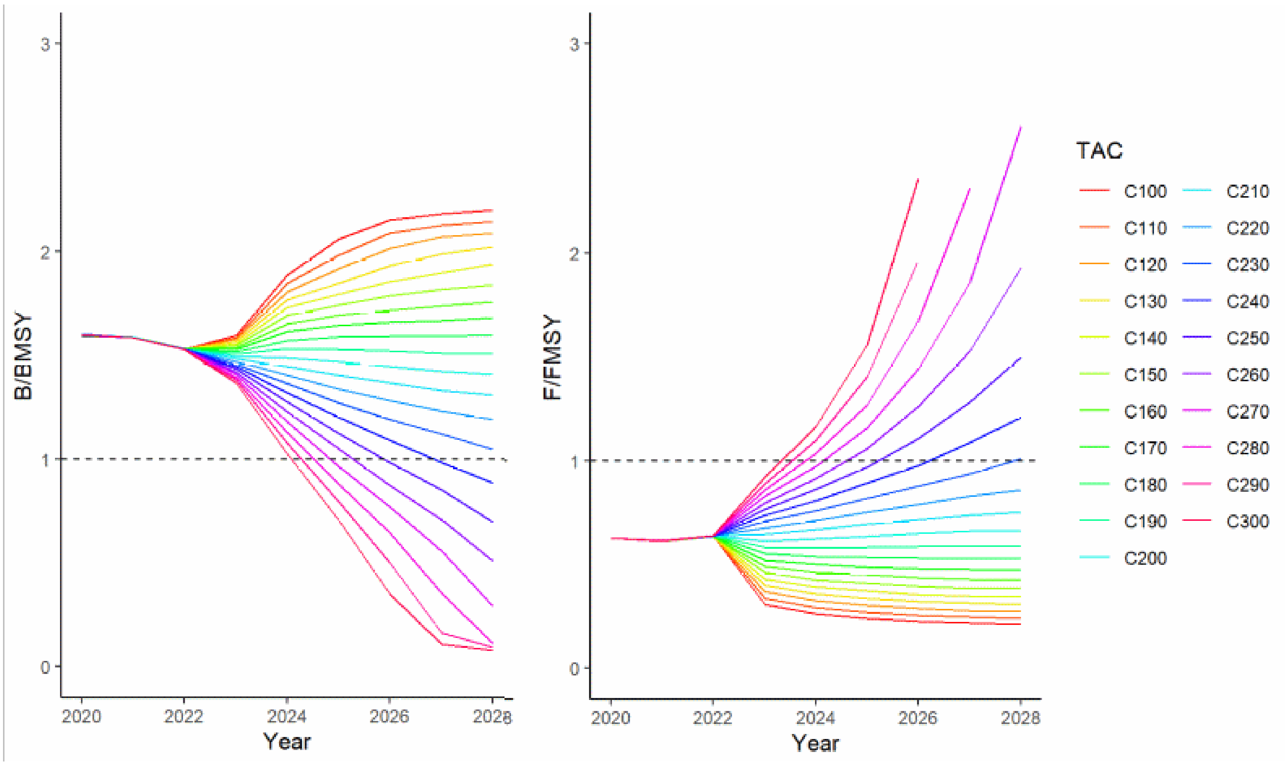




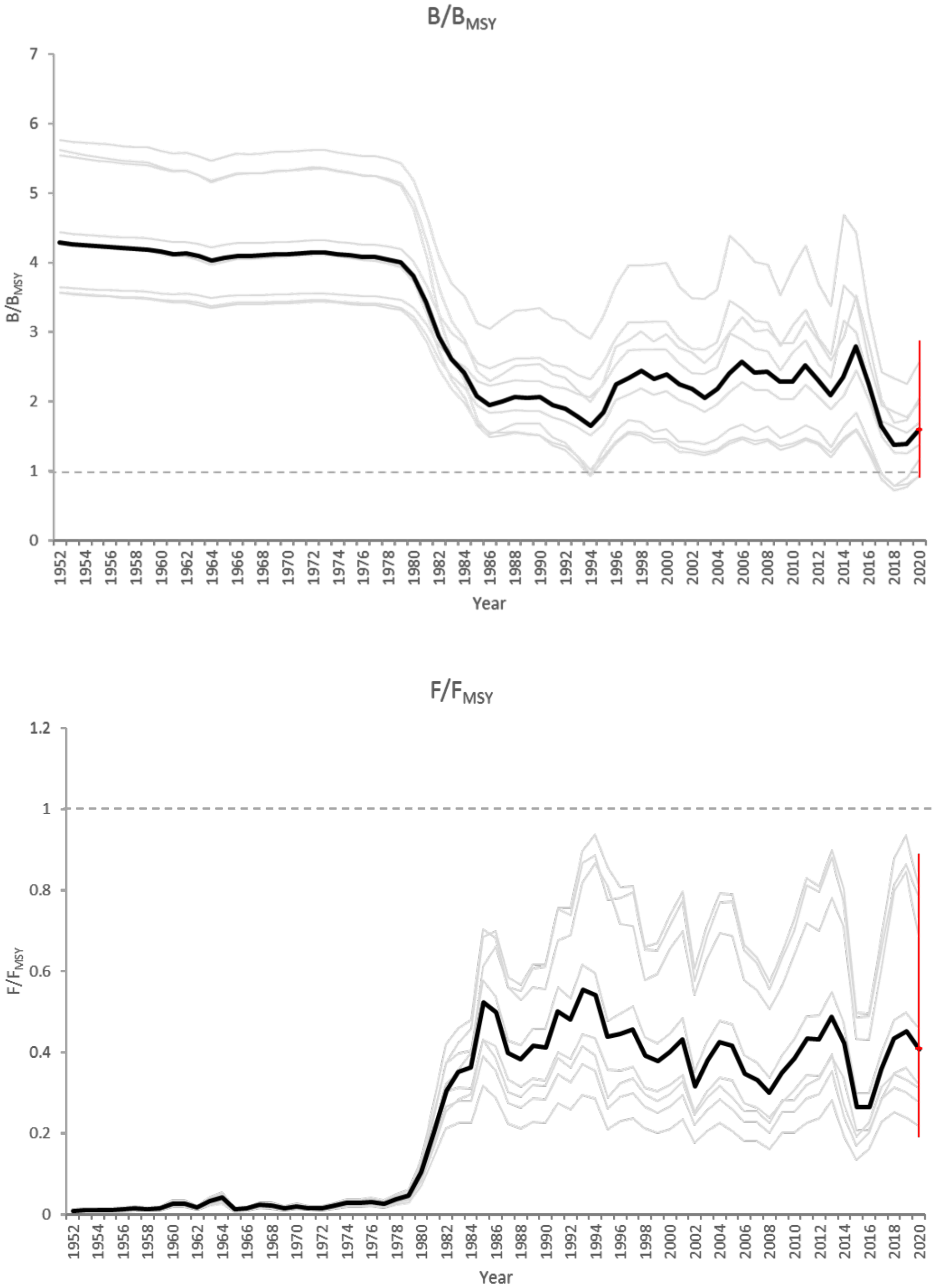
SKJ-Figure 13. SKJ-E. Relative abundance (B/B_{MSY}) (top) and fishing mortality (F/F_{MSY}) (bottom) historic median trends for the eastern skipjack stock estimated by each model from the uncertainty grid, solid line represent the median of the trends plotted, and the vertical red line in 2020, the 95% confidence bound of the stochastic combined results.



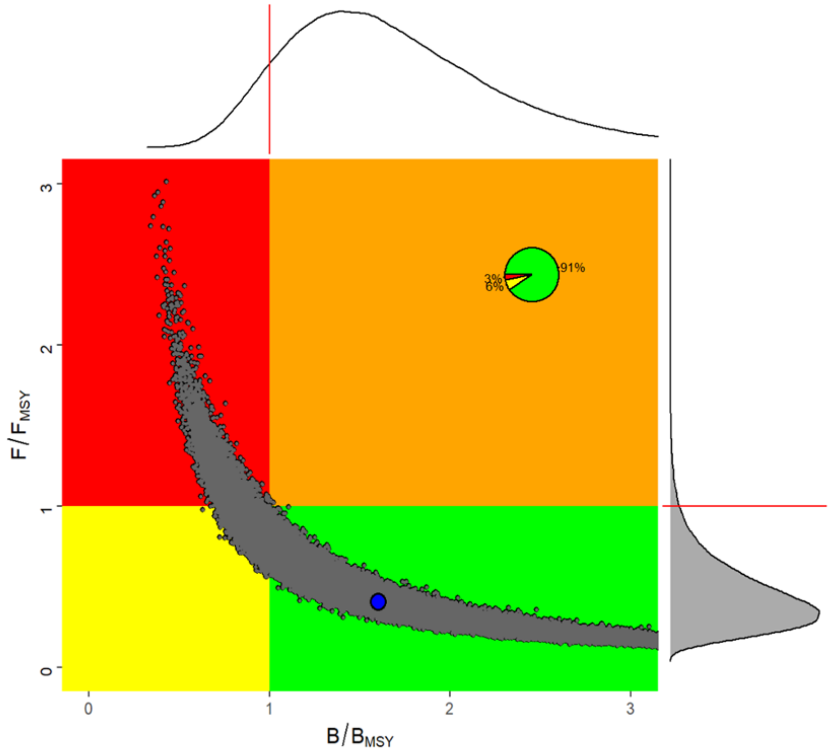
SKJ-Figure 14. SKJ-E. Joint Kobe phase plot for the 18 Stock Synthesis uncertainty grid runs and 18 JABBA uncertainty grid runs for the eastern Atlantic skipjack stock. For each run the benchmarks are calculated from the year-specific selectivity and fleet allocations, and based on 90,000 MVLN iterations for Stock Synthesis and 90,000 MCMC iterations for JABBA. The blue point shows the median of 180,000 iterations for SSB_{2020}/SSB_{MSY} or B_{2020}/B_{MSY} and F_{2020}/F_{MSY} for the entire set of runs in the grid. Grey points represent the 2020 estimates of relative fishing mortality and relative spawning stock biomass for 2020 for each of the 180,000 iterations. The upper graph represents the smoothed frequency distribution of SSB_{2020}/SSB_{MSY} or B_{2020}/B_{MSY} estimates for 2020. The right graph represents the smoothed frequency distribution of F_{2020}/F_{MSY} estimates for 2020. The inserted pie graph represents the percentage of each 2020 estimate that fall in each quadrant of the Kobe plot. All SSB for Stock Synthesis showed the values at the end of years.



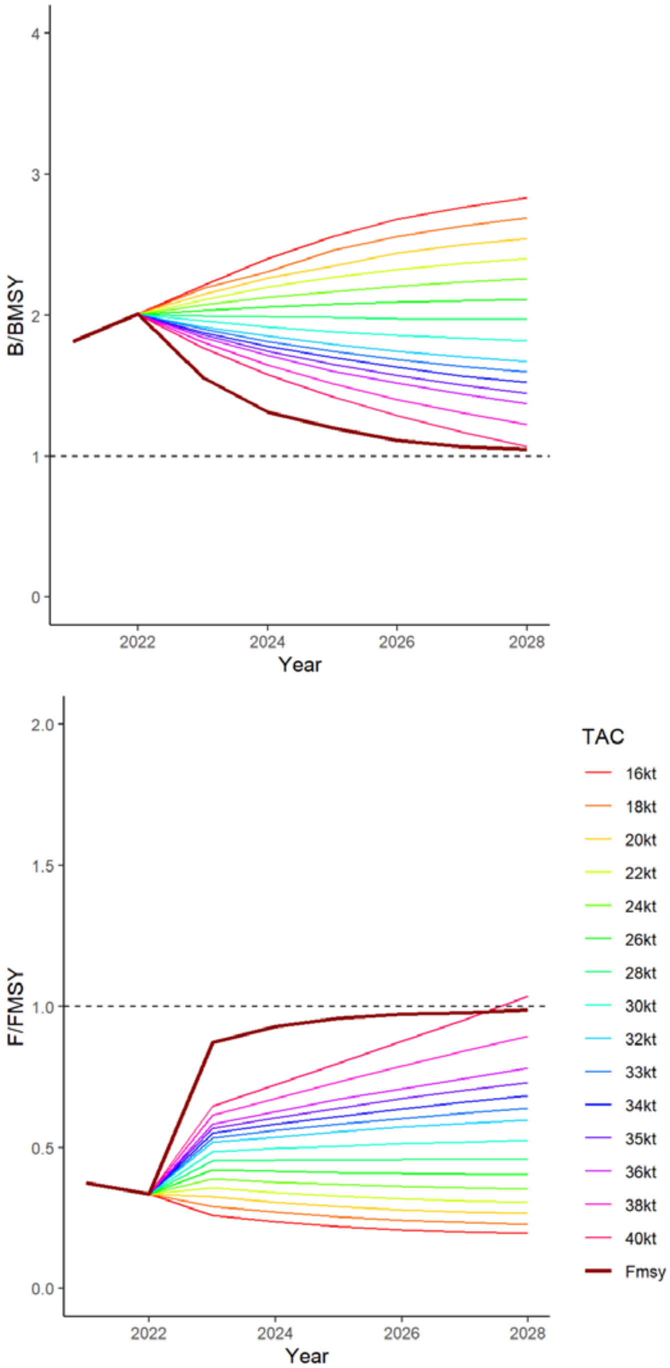
SKJ-Figure 15. SKJ-E. Joint stochastic projections of B/B_{MSY} and F/F_{MSY} for the 18 Stock Synthesis and the 18 JABBA uncertainty grid runs at 100-300 thousand t constant TACs for the eastern Atlantic skipjack stocks. The lines are the median of 180,000 iterations.



SKJ-Figure 16. SKJ-W. Relative abundance (B/B_{MSY}) (top) and fishing mortality (F/F_{MSY}) (bottom) historical median trends for the western skipjack stock estimated by each model from the uncertainty grid, solid line represents the median of the trends plotted, and the vertical red line in 2020, the 95% confidence bound of the stochastic combined results.



SKJ-Figure 17. SKJ-W. Kobe phase plot for the 9 Stock Synthesis uncertainty grid runs for the western Atlantic skipjack stock. For each run the benchmarks are calculated from the year-specific selectivity and fleet allocations and based on 200,000 MVLN iterations. The blue point shows the median of 200,000 iterations for SSB_{2020}/SSB_{MSY} and F_{2020}/F_{MSY} for the entire set of runs in the grid. Black line with black symbols represents the historical evolution of the median of all runs. Grey points represent the 2020 estimates of relative fishing mortality and relative spawning stock biomass for 2020 for each of the 200,000 iterations. The upper graph represents the smoothed frequency distribution of SSB/SSB_{MSY} estimates for 2020. The right graph represents the smoothed frequency distribution of F/F_{MSY} estimates for 2020. The inserted pie graph represents the percentage of each 2020 estimate that fall in each quadrant of the Kobe plot. All SSB showed the values at the end of years.



SKJ-Figure 18. SKJ-W. Stochastic MVLN projections of SSB/SSB_{MSY} and F/F_{MSY} for the 9 Stock Synthesis uncertainty grid runs at 16-40 thousand t constant TACs and constant F_{MSY} for the western Atlantic skipjack stocks. The lines are the median of 200,000 iterations.

9.4 ALB-AT - Atlantic albacore

The status of the North Atlantic albacore stock is based on the analyses conducted in June 2023 with available data up to 2021. Complete information on the assessment can be found in the Report of the 2023 Atlantic Albacore Stock Assessment Meeting (including MSE) (Anon., 2023a).

The status of the South Atlantic albacore stock is based on the analyses conducted in July 2020 with available data up to 2018. Complete information on the assessment can be found in the Report of the 2020 Atlantic Albacore Stock Assessment Meeting (Anon., 2020b).

ALB-AT-1. Biology

Albacore is a temperate tuna widely distributed throughout the Atlantic Ocean and Mediterranean Sea. On the basis of the biological information available for assessment purposes, the existence of three stocks is assumed: northern and southern Atlantic stocks (separated at 5°N) and a Mediterranean stock (**ALB-AT-Figure 1**). However, some studies support the hypothesis that various sub populations of albacore exist in the North Atlantic and Mediterranean. Likewise, there is likely intermingling of Indian Ocean and South Atlantic immature albacore which needs further research.

Scientific studies on albacore stocks, in the North Atlantic, North Pacific and the Mediterranean, suggest that environmental variability may have a serious potential impact on albacore stocks, affecting fisheries by changing the fishing grounds, as well as productivity levels and potential MSY of the stocks. Those yet sufficiently unexplored aspects might explain recently observed changes in fisheries, such as the lack of availability of the resource in the Bay of Biscay in some years, which are demanding focussed research.

The expected life-span for albacore is around 15 years. While albacore is a temperate species, spawning in the Atlantic occurs in tropical waters. Present available knowledge on habitat, distribution, spawning areas and maturity of Atlantic albacore is based on limited studies, mostly from past decades. In 2023 a new age specific natural mortality vector was adopted by the Committee.

More information on albacore biology and ecology is published in the *ICCAT Manual*.

ALB-AT-2. Description of fisheries or fishery indicators

North Atlantic

The northern stock is exploited by surface fisheries targeting mainly immature and sub-adult fish (50 cm to 90 cm FL) and longline fisheries targeting immature and adult albacore (60 cm to 130 cm FL). The main surface fisheries are carried out by EU fleets (Ireland, France, Portugal and Spain) in the Bay of Biscay, in the adjacent waters of the Northeast Atlantic, including the Azores Islands in summer and autumn, and in the vicinity of the Canary Islands year around. The main longline fleet is the Chinese Taipei fleet which operates in the central and western North Atlantic year around. However, Chinese Taipei fishing effort decreased in the late 1980s due to a shift towards targeting tropical tunas, and then continued at this lower level to the present. Over time, the relative contribution of different fleets to the total catch of North Atlantic albacore has changed, which resulted in differential effects on the age structure of the stock. Since the 1980s, a reduction of the area fished for albacore was observed for both longline and surface fisheries.

Total reported landings, steadily increased since 1930 to peak above 60,000 t in the early 1960s, declining afterwards, largely due to a reduction of fishing effort by the traditional surface (troll and baitboat) and longline fisheries (**ALB-AT-Table 1**; **ALB-AT-Figure 2**). Some stabilization was observed in the 1990s and early 2000s, mainly due to increased effort and catch by new surface fisheries (driftnet and mid-water pair pelagic trawl). The lowest catch level of the whole time series was observed in 2009 with 15,391 t, but catches have substantially increased since then, and have fluctuated around the TAC in the last few years.

The preliminary total reported catch in 2022 was 31,654 t (below the TAC of 37,801 t), and the catch in the last five years has remained slightly above 30,000 t. During the last years, the surface fisheries (mainly by EU-Spain, EU-Ireland and EU-France) contributed to approximately 84% of the total catch (**ALB-AT-Table 1**). Longline catch contributed to approximately 16% of the total catch during the last five years. During the last decades, both Chinese Taipei and Japan have reduced their fishing effort directed to albacore. In the case of Japan, albacore was taken mainly as by-catch.

South Atlantic

During the last decades, the total annual South Atlantic albacore landings were largely attributed to five fisheries, namely the surface baitboat fleets of South Africa and Namibia, and the longline fleets of Chinese Taipei, Brazil and Japan (**ALB-AT-Table 1**; **ALB-AT-Figure 2**). The surface fleets are albacore directed and mainly catch sub-adult fish (70 cm to 90 cm FL). These surface fisheries operate seasonally, from October to May, when albacore is available in coastal waters. The longline Chinese Taipei fleet operates over a larger area and throughout the year, consisting of vessels that target albacore and vessels that take albacore as bycatch, in bigeye directed fishing operations. On average, the longline vessels catch larger albacore (60 cm to 120 cm FL) than the surface fleets.

Albacore landings increased sharply since the mid-1950s to reach values oscillating around 25,000 t between the mid-1960s and the 1980s, 35,000 t until the last decade when they oscillated around 20,000 t. However, total reported albacore landings for 2017 decreased to 13,825 t, which is among the lowest values in the time series. The preliminary total reported catch in 2022 was 23,544 t, mostly by longlines and baitboats. The Chinese Taipei catch in the last years has decreased compared to historical catches, mainly due to a decrease in fishing effort targeting albacore. During the last decades, Japan took albacore as bycatch using longline gear, but recently Japan is again targeting albacore and increased the fishing effort in waters off South Africa and Namibia (20°-40°S). Thus, catches during the last decade have substantially increased compared to those in the last few decades.

ALB-AT-3. State of stocks

North Atlantic

In 2023 a thorough revision of North Atlantic Task 1, size and age data was conducted, and catch rates were updated with new information for the northern albacore fisheries up to and including data to 2021. In the stock assessment two model formulations with different degrees of complexity were used. In addition to the surplus production model that is part of the adopted Management Procedure, a Stock Synthesis model was also used. The more complex stock synthesis model allowed to incorporate more detailed data and alternative hypotheses, compared to the surplus production model. Both models provided similar results and the Committee agreed to use the Stock synthesis model to characterize stock status, as well as to verify that catch projections are consistent with the catch advice provided by the Management Procedure (MP).

The five CPUE indices (four longline and one baitboat) specified in the MP were used in the production model (**ALB-AT-Figure 3**). These indices were further split into different areas for the Stock synthesis model. Despite their variable pattern, these indices showed an overall increasing trend during the last decades.

The Stock Synthesis model results suggest a biomass drop between 1930 and the 1990s and a recovery since then, while fishing mortality decreases. Relative to MSY benchmarks, the base case scenario estimates that the stock remained slightly overfished with B below B_{MSY} between the late 1970s and the 2000s, but has now recovered to levels well above B_{MSY} (**ALB-AT-Figure 4**). Peak relative fishing mortality levels in the order of 1.66 times F_{MSY} were observed in the early 1980s but overfishing stopped in the early 2000s, with the current F_{2021}/F_{MSY} ratio being 0.45. There is large uncertainty around the current stock status estimated by the model. The probability of the stock currently being in the green area of the Kobe plot (not overfished and not undergoing overfishing, $F<F_{MSY}$ and $B>B_{MSY}$) is 99.6% while the probability of being in the yellow area (overfished, $B<B_{MSY}$) is 0.4%. The probability of being in the red area (overfished and undergoing overfishing, $F>F_{MSY}$ and $B<B_{MSY}$) is 0% (**ALB-AT-Figure 4**).

South Atlantic

In 2020, a stock assessment of South Atlantic albacore was conducted including catch and effort data up until 2018, and considering similar methods as in the previous assessment.

For the South Atlantic stock, the standardized CPUE indices are mainly based on longline fisheries, which catch mostly adult albacore. The same three longline CPUEs that were used in 2016 were also selected to update the 2020 stock assessment results. The longest time series of Chinese Taipei showed a strong declining trend in the early part of the time series followed by a less steep decline over the next three decades (similar to the Japanese longline index), and an increasing trend since the early 2000s. The Uruguayan longline CPUE series showed a decrease since the 1980s (**ALB-AT-Figure 5**). The Chinese Taipei CPUE was the only index that informed stock trends in recent years. In addition, standardized CPUE series from the Brazilian longline (2002-2018) and the South African baitboat fishery were made available, which were used for sensitivity analyses.

In the 2020 assessment the Committee selected a base case to best represent the population dynamics of albacore and uncertainty around stock status as well as impact of alternative fishing scenarios. Base case model results suggest that biomass increased since fishing mortality started to decrease in the early 2000s, and currently there is a 99.4% probability that the South Atlantic albacore stock is neither overfished nor subject to overfishing, with only 0.6% probability for the stock to be overfished. The median MSY value was 27,264 t (ranging between 23,734 t and 31,567 t), the median estimate of current B_{2018}/B_{MSY} was 1.58 (ranging between 1.14 and 2.05) and the median estimate of current F_{2018}/F_{MSY} was 0.40 (ranging between 0.28 and 0.59). The wide confidence intervals reflect the large uncertainty around the estimates of stock status (**ALB-AT-Figure 6**).

ALB-AT-4. Outlook

North Atlantic

In 2021, the Commission adopted a MP that uses a production model and a Harvest Control Rule (HCR) to set TACs every three years (Rec. 21-04). MSE tests showed that this MP would meet the management objectives for this stock, i.e., to be in the green quadrant of the Kobe plot with a probability higher than 60%. Variants to this MP have also been tested (see item 19.6 of this report)

The current management procedure results in a TAC of 47,251 t for 2024-2026. This represents a 25% increase with respect to the previous one and is in line with the positive stock status estimated in the 2023 assessment. If the Commission would select any of the variants requested in Rec. 21-04 (F_{TAR} between 0.8 and 1 and B_{THRESH} between 0.8 and 1.2), the resulting TAC would be the same because the maximum TAC increase of 25% would apply in all cases. It is noted that this TAC for 2024-2026 is above the MSY estimate for this stock (41,995 t); this is because the current biomass is well above B_{MSY} (B_{2021}/B_{MSY} = 2.19), and therefore this level of catch can be sustained in the near term. Projections conducted by the stock Synthesis model also supported that level of catch in the short term.

South Atlantic

The Kobe matrix indicates that catches around the MSY level of 27,000 t will maintain biomass levels above B_{MSY} and fishing mortality below F_{MSY} with a high probability of 90% over the projection horizon through 2033 (**ALB-AT-Table 2**). In fact, due to the current high stock biomass, catches of up to 30,000 t are expected to maintain stock levels above B_{MSY} until 2033 with a probability higher than 60%. However, it is important to note that these catch levels would exceed MSY and it would require a reduction in TAC after 2033 to prevent overfishing (**ALB-AT-Table 2**).

ALB-AT-5. Effect of current regulations

North Atlantic

In 2021, the Commission adopted a model-based management procedure including the HCR described in **ALB-AT-Figure 7**, with a maximum TAC of 50,000 t and a maximum change of +25% -20% when B_{CUR}>B_{THR}. Its application established a TAC of 37,801 t for 2022-2023 (Rec. 21-04) and the possibility to carry over some unused portions of the quotas to be caught later in time remained. The Committee noted that, since the establishment of the TAC in the year 2001, catch remained substantially below the TAC in all but four years (**ALB-AT-Figure 2**), which might have accelerated rebuilding over the last decades. The bulk of the catch is caught by traditional surface fisheries operating in the Bay of Biscay and surrounding waters. Thus, it is likely that the fluctuations in catches reflect the fluctuations in the availability of the resource to those local regional fisheries, and the carry-over allows to compensate the fleets for the years when the stock was less available.

Furthermore, Rec. 98-08 that limits fishing capacity to the average of 1993-1995, remains in force. The effect of this Recommendation has not been evaluated but a general decrease of fishing mortality has been observed since its implementation.

South Atlantic

In 2022 the Commission established a new TAC of 28,000 t for 2023-2026 (Rec. 22-06). The Committee noted that reported catches remained below 28,000 t since 2004 (**ALB-AT-Table 1**). The Committee did not test for the effect of perfect implementation of the TAC since 2004.

ALB-AT-6. Management recommendations

North Atlantic

Recommendation 21-04 sets the management procedure to achieve the management objective of maintaining the stock in the green area of the Kobe plot with at least 60% probability while maximizing long-term yield.

In the 2023 assessment, the Committee noted that the relative abundance of North Atlantic albacore has continued to increase over the last two decades and the stock is estimated to be in the green area of the Kobe plot with > 99% probability. Considering that no exceptional circumstances have been detected that preclude the application of the MP, the Committee recommends applying the MP to the current biomass estimate (B_{2021} in the Summary Table below) to set the next TAC for the 2024-2026 period. The recommended TAC obtained by applying the MP is 47,251 t, which represents a 25% increase with respect to the previous one.

South Atlantic

Results indicate that, most probably, the South Atlantic albacore stock is not overfished and that overfishing is not occurring. Projections at a level consistent with the MSY (27,264 t) showed that probabilities of being in the green quadrant of the Kobe plot would remain very high (90%) by 2033. In fact, due to the current high stock biomass, catches of up to 30,000 t are expected to maintain stock levels above B_{MSY} until 2033 with a probability higher than 60%. However, it is important to note that these catch levels exceed MSY and it would require a reduction in TAC after 2033 to prevent overfishing (**ALB-AT-Table 2**).

ATLANTIC ALBACORE SUMMARY		
	North Atlantic[1]	**South Atlantic**
Maximum Sustainable Yield	41,995 t (38,860 - 45,130)[2]	27,264 t (23,734 - 31,567)[2]
Current (2022) Yield	31,654 t	23,544 t
$Yield_{current}$ in last year of assessment [3]	31,393 t	17,098 t
SSB_{MSY}	93,202 t (51,136 - 135,269) [2]	124,453 t (79,611 - 223,424) [2]
F_{MSY}	0.115 (0.092 - 0.141)[3]	0.219 (0.116 - 0.356) [2]
B_{2021}	519,799 t (462,465 - 608,819) [3]	
SSB_{2021}/SSB_{MSY}	2.19 (1.21 - 4.01) [2]	
B_{2018}/B_{MSY}		1.58 (1.14 - 2.05) [2]
$F_{current}/F_{MSY}$ [4]	0.45 (0.29 - 0.71)	0.40 (0.28 - 0.59)
Stock Status	Overfished: NO Overfishing: NO	Overfished: NO Overfishing: NO
Management measures in effect:	Rec. 98-08: Limit number of vessels to 1993-1995 average. Rec. 21-04: TAC of 37,801 t for 2022-2023, according to MP. Management objective is to keep the stock in (or rebuild it to) the green area of the Kobe plot with at least 60% probability, while maximizing catch and reducing variability of TAC.	Rec. 22-06: TAC of 28,000 t for 2023-2026
Recommended TAC for the period 2024-2026 as estimated following the MP adopted in Rec. 21-04[5]	47,251 t	

[1] All values from the Stock Synthesis model, except for B_{2021} and F_{MSY}, which are used for TAC calculation, where values from the production model are shown.
[2] Mean (North Atlantic) or median (South Atlantic) and 95% CI for the reference/base case.
[3] Median and 95% CI for the production model used for the MP iteration (Rec. 21-04).
[4] Current year (the last year in the assessment) is 2021 for North Atlantic and 2018 for South Atlantic.
[5] The recommended TAC is capped by the maximum allowed increase of 25%, since the TAC obtained when applying the MP equation resulted in a higher value ($F_{TAR}*B_{CUR}$ = 47,673.9 t).

ALB-AT-Table 1. Estimated catches (t) of albacore (*Thunnus alalunga*) by area, gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				70949	70464	65931	57229	57045	56341	62206	64511	65048	54462	53571	48501	54199	61416	42274	39350	37640	38636	44115	50704	44095	40361	40835	44783	42299	46831	50400	49358	56452	55198
	ATN			38135	35163	38377	28803	29023	25746	34549	33123	26252	22716	25567	25957	35318	36963	21991	20483	15391	19411	19989	25432	24671	26638	25635	30400	28475	29786	34922	31274	31391	31654
	ATS			32814	35301	27554	28426	28022	30595	27656	31388	38795	31746	28005	22545	18882	24453	20283	18867	22248	19225	24126	25272	19424	13723	15201	14383	13825	17045	15478	18084	25061	23544
Landings	ATN		Bait boat	15646	11967	16411	11338	9821	7562	8780	11072	6123	6638	7840	8128	10458	14273	8496	7931	4994	6026	5530	8816	4975	7341	9265	14455	12196	11330	12662	11855	11696	11069
			Longline	7093	7309	4859	4641	4051	4035	6710	7320	7372	6235	7826	7037	6911	5223	3237	2647	2619	3913	3666	3510	6298	3076	4541	5448	5025	4567	4758	5714	4870	4422
			Other surf.	7279	7506	3555	3337	4378	6846	6817	5971	2808	365	470	577	624	625	525	274	427	231	359	344	816	163	136	95	139	62	179	116	115	288
			Purse seine	229	292	278	263	26	91	55	191	263	93	211	344	99	162	198	70	101	70	3	176	40	35	116	50	38	39	65	21	30	3
			Trawl	1779	2131	3049	2571	2877	1318	5343	3547	5374	5376	3846	2369	7001	6385	3429	4321	2811	2026	6852	6678	6558	9184	5771	6299	6611	8820	10816	7577	8309	9713
			Troll	6109	5959	10226	6652	7870	5894	6845	5023	4312	4009	5373	7501	10224	10296	6105	5239	4440	7146	3578	5909	5891	6660	5597	3753	4165	4807	6292	5938	6250	6134
	ATS		Bait boat	7341	9334	7009	6913	8092	10352	6708	6815	10343	9710	6973	7475	5084	5876	3375	4350	7926	3748	5938	6931	5211	4765	4965	2949	1846	3228	2852	4297	4434	7014
			Longline	23950	24806	20040	21000	19547	19799	20640	24399	28039	21671	20626	14735	12977	17740	15087	13218	12113	13471	16445	17846	13888	8907	10104	11243	11674	13715	12473	13747	20601	16289
			Other surf.	74	96	92	256	145	1	74	116	389	325	85	300	323	395	1762	1219	2066	1651	1538	66	266	7	0	108	114	84	113	17	0	196
			Purse seine	1450	1065	413	258	118	434	183	58	25	39	308	16	499	442	58	81	144	355	205	428	58	44	131	83	190	19	3	11	21	34
			Trawl	0	0	0	0	120	9	52	0	0	0	12	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	ATN		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	179	209	300	302	160	151	53	121	0
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Trawl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
			Troll	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATS		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	37	11	5	10
			Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATN	CP	Barbados	0	0	0	0	1	1	1	0	2	5	8	10	13	9	7	7	4	6	4	20	22	13	16	38	32	15	7	10	12	12
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	26	39	416	351	155	230	79	1	399	448	385	216	326	201	214
			Brazil	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	148	83	14	**0**
			Canada	9	32	12	24	31	23	38	122	51	113	56	27	52	27	25	33	11	14	28	34	32	47	32	20	17	26	31	12	40	27
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	**0**
			China PR	0	14	8	20	0	0	21	16	57	196	155	32	112	202	59	24	27	142	101	21	81	35	21	103	124	124	129	208	291	240
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	**0**
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	53	39	146	0	0	0	151	549	0	76	14	30	1
			EU-España	18380	16998	20197	16324	17295	13285	15363	16000	9177	8952	12530	15379	20447	24538	14582	12725	9617	12961	8357	13719	10502	11607	14126	17077	13964	15691	16536	16205	17408	16870
			EU-France	6293	5934	5304	4694	4618	3711	6887	5718	6005	4320	3456	2444	7266	6559	3179	3009	1139	1293	3352	3370	4625	6716	3441	4229	4191	5824	7881	4753	5397	6362
			EU-Ireland	1946	2534	918	874	1913	3750	4858	3464	2093	1100	755	175	306	521	596	1517	1997	788	3597	3575	2231	2485	2390	2337	2492	3102	3213	2938	2879	3374
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	3385	974	6470	1634	395	91	324	278	1175	1953	553	513	556	119	184	614	108	202	1046	1231	567	2609	929	1111	2527	498	2493	1596	501	281
			FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	4	0	7	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Great Britain	499	613	196	49	33	117	343	15	0	0	0	0	6	19	30	50	67	118	57	50	133	136	31	0	0	0	0	77	165	121
			Grenada	0	0	2	1	6	7	6	12	21	23	46	25	29	19	20	15	18	18	18	0	0	0	79	50	62	37	23	22	6	
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	**0**
			Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Japan	485	505	386	466	414	446	425	688	1126	711	680	893	1336	781	288	402	288	525	336	400	1745	267	276	297	366	196	334	260	261	301
			Korea Rep	8	0	2	2	1	0	0	0	0	0	0	0	59	45	12	59	82	110	60	200	184	64	5	13	8	27	48	116	115	124
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	90	3	0	0	0	0
			Maroc	0	0	0	0	0	0	0	0	0	55	81	120	178	98	96	99	130	0	0	0	0	0	0	20	20	20	25	29	40	60
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	7	0	1	1	0
			Panama	60	117	73	11	5	0	0	0	0	0	0	0	0	96	298	113	45	154	103	0	246	108	103	200	0	196	185	176	183	181
			Philippines	0	0	0	0	0	151	4	0	0	0	0	0	9	0	8	19	54	0	0	83	0	0	0	0	0	0	0	0	0	**0**
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	**0**
			Sierra Leone	0	0	0	0	0	0	0	0	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			St Vincent and Grenadines	2	0	0	0	0	0	1	704	1370	300	1555	89	802	76	263	130	135	177	329	305	286	328	305	291	297	173	180	252	202	**0**
			Trinidad and Tobago	0	0	0	0	2	1	1	2	11	9	12	12	9	12	18	32	17	17	23	47	67	71	95	71	48	33	22	16	27	22
			UK-Bermuda	0	0	0	0	1	0	2	2	2	0	0	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0	1	2	4	5
			UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	**0**
			USA	509	741	545	472	577	829	315	406	322	480	444	646	488	400	532	257	189	221	369	409	819	458	354	250	238	103	221	328	296	311
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	246	282	279	315	75	107	91	299	348	162	346	457	175	321	375	222	398	288	247	312	181	285	351	287	301	165	221	246	299	317
		NCC	Chinese Taipei	6300	6409	3977	3905	3330	3098	5785	5299	4399	4330	4557	4278	2540	2357	1297	1107	863	1587	1367	1180	2394	947	2857	3134	2385	2926	2770	3549	2896	2806
			Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	5	11	5	1	1	2	1
			Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	**0**
		NCO	Cuba	0	0	0	0	0	0	0	0	0	1	322	435	424	527	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	1	0	2	0	0	
			Dominican Republic	0	0	0	0	323	121	73	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	13	10	8	11	3	8	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	1	0	1	1	0	0	0	1	3	2	10	0	2	2	2	2	0	130	2	3	2	0	0	2	1	0	1	0	0	0
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	414	507	235	95	20	140	187	196	172	228	195	0	0	0	0	0	0	0	
	ATS	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168	0	5	0	0	0	0	0	0	0	**0**
			Belize	0	0	2	0	0	0	8	2	0	0	0	0	0	54	32	31	213	303	365	171	87	98	0	123	219	311	158	162	31	13

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Brazil	3613	1227	923	819	652	3418	1872	4412	6862	3228	2647	522	556	361	535	487	202	271	1269	2077	2016	462	490	658	497	343	854	534	502	543
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	8	46	24	0	5	0	5	0	0	0	0	0	0	0	0	0	0	**0**
			China PR	0	0	0	0	0	0	39	89	26	30	26	112	95	100	35	25	89	97	80	61	65	34	120	94	185	116	132	184	10	31
			Curaçao	0	0	0	0	9	192	0	2	0	0	0	0	0	0	0	0	21	4	4	24	0	0	1	14	10	0	0	0	0	18
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	43	45	50	0	0	0	0	0	6	19	45	47	19
			EU-España	783	831	457	184	256	193	1027	288	573	836	376	81	285	367	758	933	1061	294	314	351	369	259	418	195	347	303	186	30	37	32
			EU-France	565	130	83	191	39	40	13	23	11	18	63	16	443	347	12	50	43	109	50	151	40	41	54	64	78	16	3	10	21	16
			EU-Portugal	483	1185	655	494	256	124	232	486	41	433	415	9	43	8	13	49	254	84	44	11	1	3	1	9	9	11	3	2	3	3
			Ghana	0	0	0	0	0	0	0	0	0	0	53	0	0	0	5	10	14	25	0	0	0	0	0	0	0	0	0	0	0	**0**
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	56	0	0	15	0	1	3	1	0	0	0	0	**0**
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	**0**
			Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	74	0	0	0	0	0	0	0	0	0	**0**
			Honduras	0	0	2	0	7	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	467	651	389	435	424	418	601	554	341	231	322	509	312	316	238	1370	921	973	1194	2903	3106	1131	1752	1096	1189	2985	1506	900	1737	1871
			Korea Rep	20	3	3	18	4	7	14	18	1	0	5	37	42	66	56	88	374	130	70	89	33	2	4	48	86	167	170	131	131	153
			Maroc	68	24	24	0	5	4	0	0	0	14	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Namibia	0	1111	950	982	1199	1429	1162	2418	3419	2962	3152	3328	2344	5100	1196	1958	4936	1320	3791	2420	848	1057	1062	994	214	888	260	2166	8165	6319
			Panama	318	458	228	380	53	60	14	0	0	0	0	0	17	0	87	5	6	1	0	12	3	18	6	5	13	1	13	31	17	12
			Philippines	0	0	0	0	0	5	4	0	0	0	0	0	52	0	13	79	45	95	96	203	415	18	0	0	0	0	0	0	0	**0**
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	24	0	0	**0**
			South Africa	6881	6931	5214	5634	6708	8412	5101	3610	7236	6507	3469	4502	3198	3735	3797	3468	5043	4147	3380	3553	3510	3719	4030	2065	1785	2572	2455	4026	3823	5587
			St Vincent and Grenadines	0	29	30	41	0	23	0	2116	4303	44	0	0	0	65	160	71	51	31	94	92	97	110	100	107	101	98	31	0	14	23
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Sta Helena	38	5	82	47	18	1	1	58	12	2	3	1	35	62	46	94	81	3	120	2	2	0	0	0	0	0	0	0	0	**0**
			USA	0	0	0	1	5	1	1	1	2	8	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Uruguay	28	16	49	75	56	110	90	90	135	111	108	120	32	93	34	53	97	24	37	12	209	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	19400	22573	18351	18956	18165	16106	17377	17221	15833	17321	17351	13288	10730	12293	13146	9966	8678	10975	13032	12812	8519	6675	7157	8907	9090	9227	9626	9851	10519	8894
		NCO	Argentina	0	2	0	0	120	9	52	0	0	0	12	18	0	0	0	0	0	130	43	0	0	0	0	0	0	0	0	0	0	
			Cambodia	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	0	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	146	123	102	169	47	42	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	684	1400	96	131	64	104	85	35	83	91	0	0	0	0	0	0	0	
Discards	ATN	CP	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	179	209	300	302	160	151	52	121	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	ATS	CP	Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	11	5	10
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0**

ALB-AT-Table 2. South Atlantic albacore estimated probabilities (in %) based on Bayesian surplus production model that the stock fishing mortality is below F_{MSY} (a), biomass is above B_{MSY} (b) and both (c). Projections for constant catch levels (16,000 t to 34,000 t) are shown.

(a) Probability $F<F_{MSY}$.

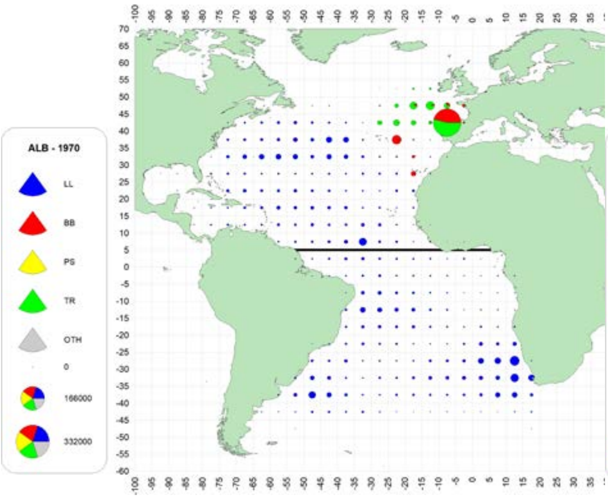
TAC | Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
16000	100	100	100	100	100	100	100	100	100	100	100	100	100
18000	100	100	100	100	100	100	100	100	100	100	100	100	100
20000	100	100	100	100	100	100	100	100	100	100	100	100	100
21000	100	100	100	100	100	100	100	100	100	100	100	100	100
22000	100	100	100	100	100	100	100	100	100	100	99	99	99
23000	100	100	100	100	100	100	99	99	99	99	99	99	99
24000	100	100	100	99	99	99	99	99	99	99	99	98	98
25000	100	100	99	99	99	99	98	98	98	98	98	97	97
26000	99	99	99	99	98	98	98	97	97	96	95	95	94
27000	99	99	98	98	97	97	96	95	94	93	92	91	90
28000	99	98	98	97	96	95	93	92	91	89	87	86	84
29000	99	98	97	96	94	93	90	88	85	82	80	77	74
30000	98	97	96	94	91	89	85	81	78	73	70	65	62
32000	97	95	92	88	82	76	69	62	56	49	44	39	35
34000	95	91	85	77	67	57	48	40	32	27	22	19	16

(b) Probability $B>B_{MSY}$.

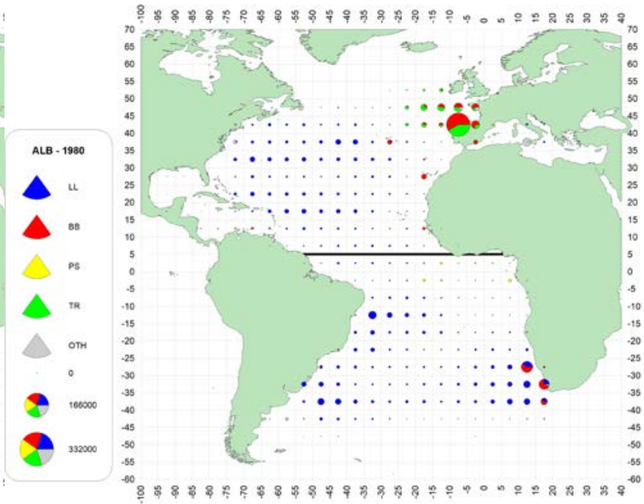
TAC | Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
16000	100	100	100	100	100	100	100	100	100	100	100	100	100
18000	100	100	100	100	100	100	100	100	100	100	100	100	100
20000	100	100	100	100	100	100	100	100	100	100	100	100	100
21000	100	100	100	99	99	99	99	99	99	99	99	99	99
22000	100	100	100	99	99	99	99	99	99	99	99	99	99
23000	100	100	100	99	99	99	99	99	99	99	99	99	98
24000	100	99	99	99	99	99	99	99	98	98	98	98	98
25000	100	100	99	99	99	99	98	98	98	98	97	97	97
26000	100	99	99	99	99	99	98	98	97	97	96	95	95
27000	100	99	99	99	98	98	97	97	96	95	94	93	92
28000	100	99	99	99	98	97	96	95	94	93	91	90	88
29000	100	99	99	98	98	97	96	94	92	90	88	85	83
30000	100	99	99	98	97	96	94	92	89	86	83	79	76
32000	100	99	99	98	96	93	89	85	80	74	68	62	56
34000	100	99	98	96	93	89	82	75	66	58	49	42	36

(c) Probability of green status ($B>B_{MSY}$ and $F<F_{MSY}$).

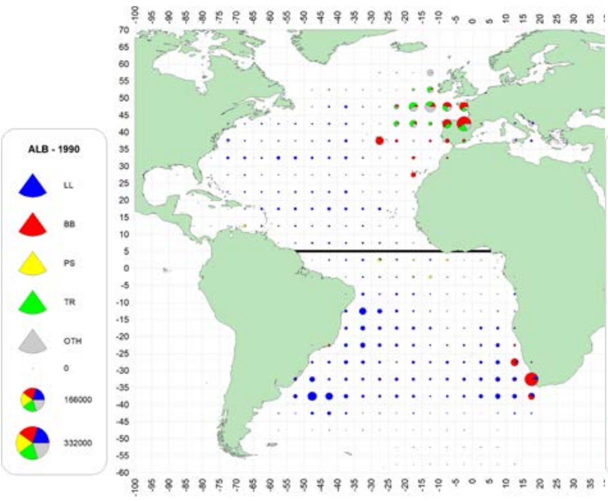
TAC | Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
16000	100	100	100	100	100	100	100	100	100	100	100	100	100
18000	100	100	100	100	100	100	100	100	100	100	100	100	100
20000	100	100	100	100	100	100	100	100	100	100	100	100	100
21000	100	100	100	99	99	99	99	99	99	99	99	99	99
22000	100	100	100	99	99	99	99	99	99	99	99	99	99
23000	100	100	99	99	99	99	99	99	99	99	99	98	98
24000	100	99	99	99	99	99	99	98	98	98	98	98	98
25000	100	99	99	99	99	98	98	98	98	97	97	97	96
26000	99	99	99	98	98	98	97	97	96	96	95	94	94
27000	99	99	98	98	97	97	96	95	94	93	92	91	90
28000	99	98	98	97	96	95	93	92	90	89	87	85	83
29000	99	98	97	96	94	93	90	88	85	82	79	77	74
30000	98	97	96	94	91	89	85	81	78	73	69	65	61
32000	97	95	92	88	82	76	69	62	56	49	44	39	35
34000	95	91	85	77	67	57	48	40	32	27	22	19	16



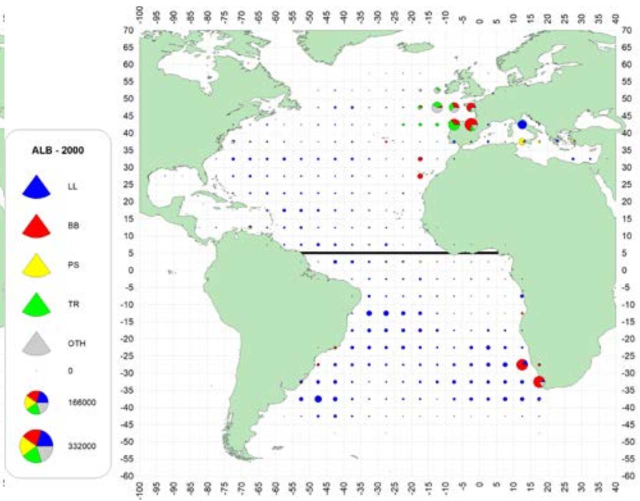
a. ALB (1970-79)



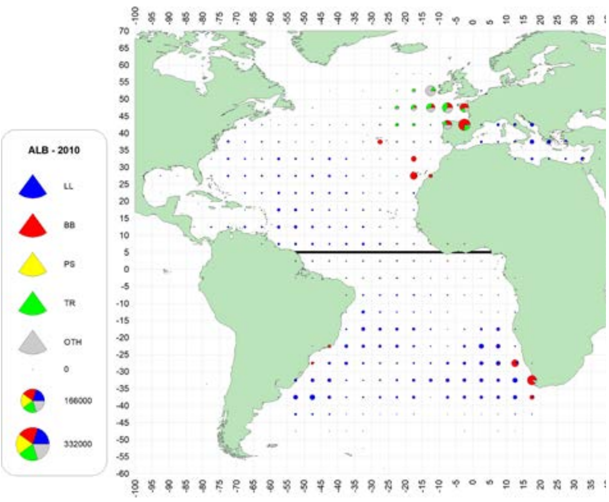
b. ALB (1980-89)



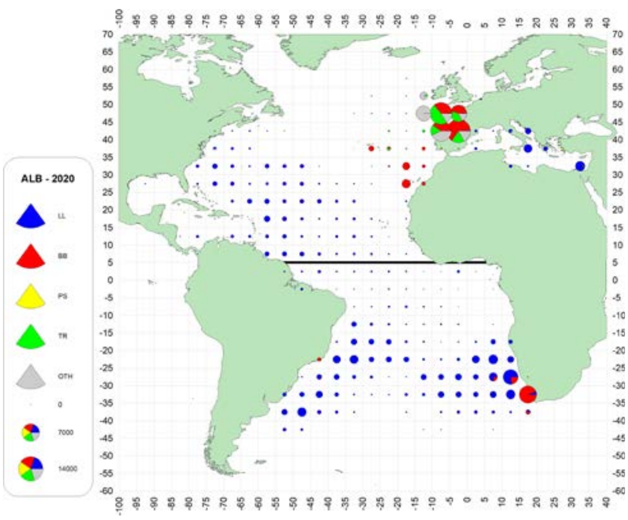
c. ALB (1990-99)



d. ALB (2000-09)

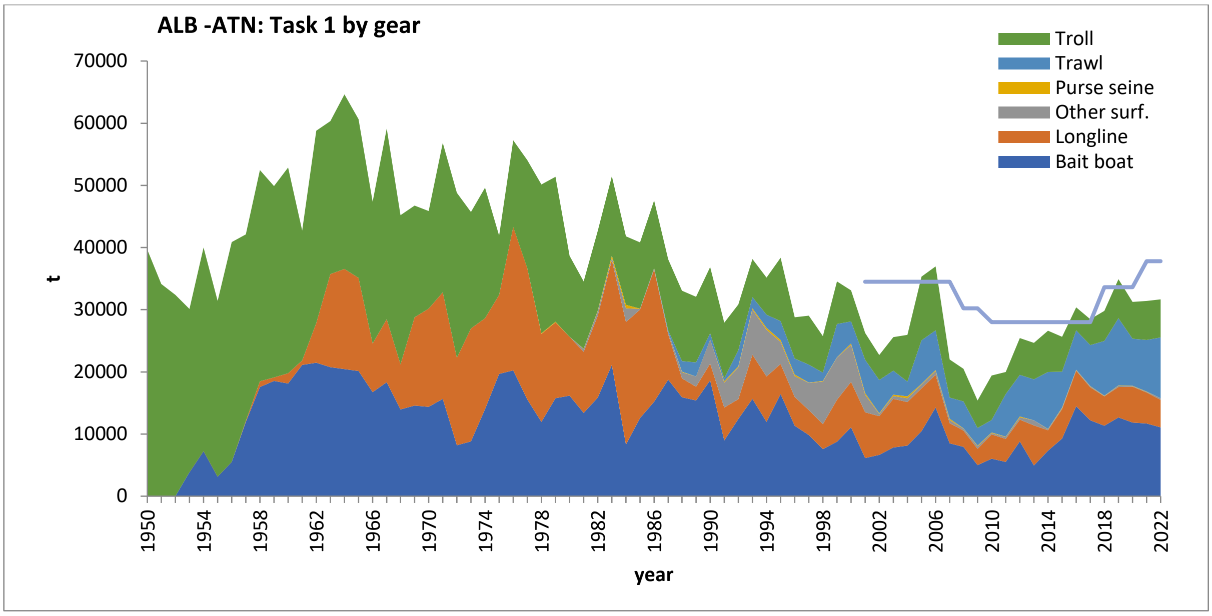


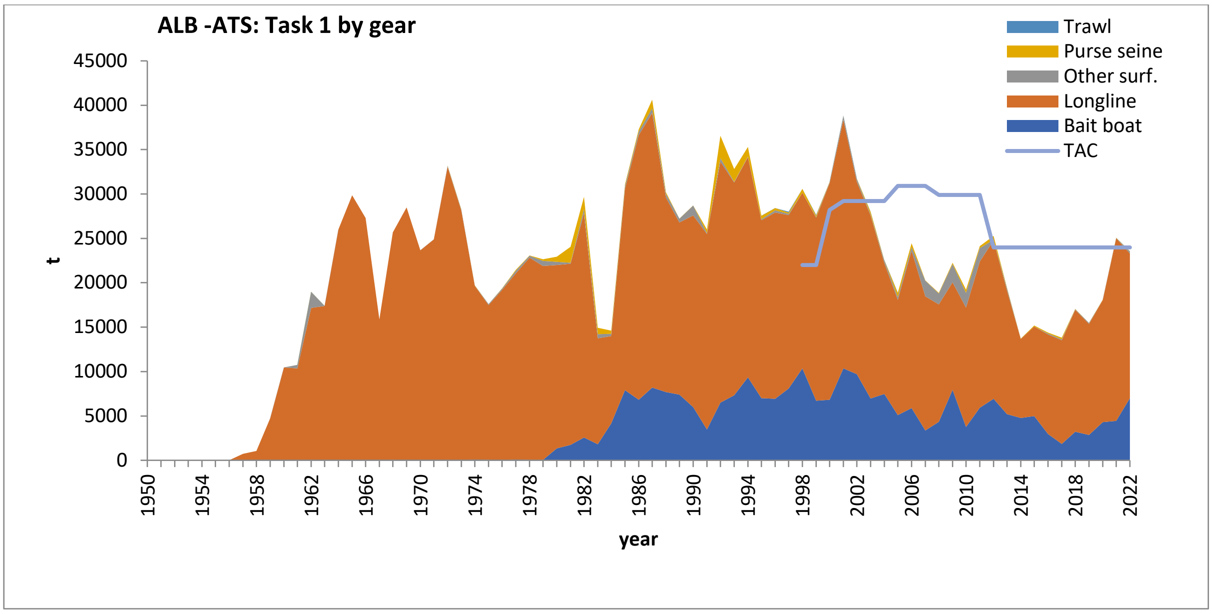
e. ALB (2010-19)



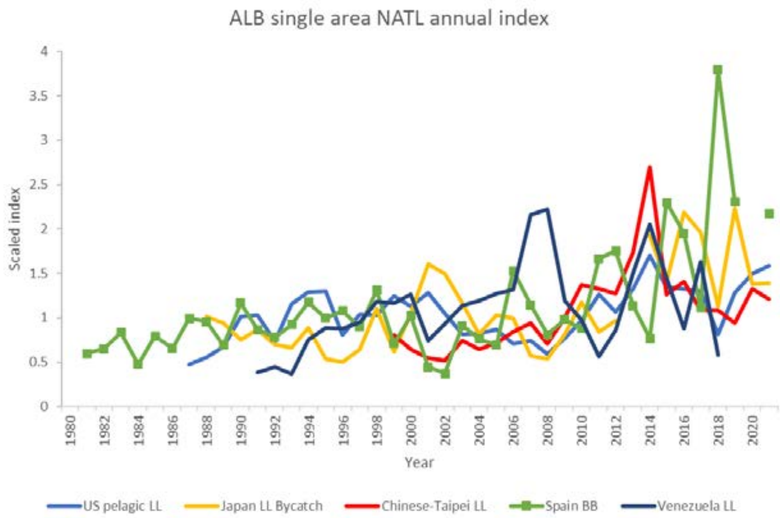
f. ALB (2020-21)

ALB-AT-Figure 1. Geographic distribution of albacore accumulated catch by major gears and decade (1970-2021). Baitboat and troll catches prior to the 1990s, these catches were assigned to only one 5ºx5º stratum in the Bay of Biscay. Plots are scaled to the maximum catch observed from 1970 to 2021 (last decade only covers 2 years).

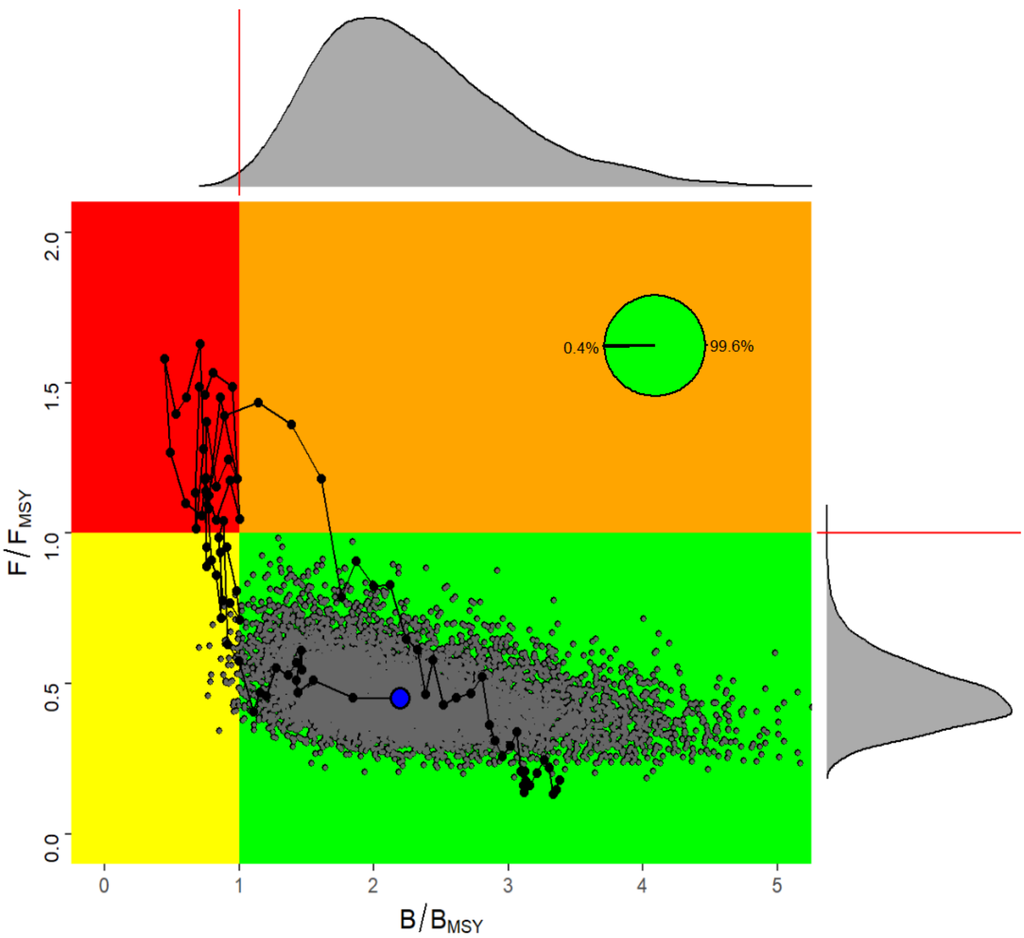




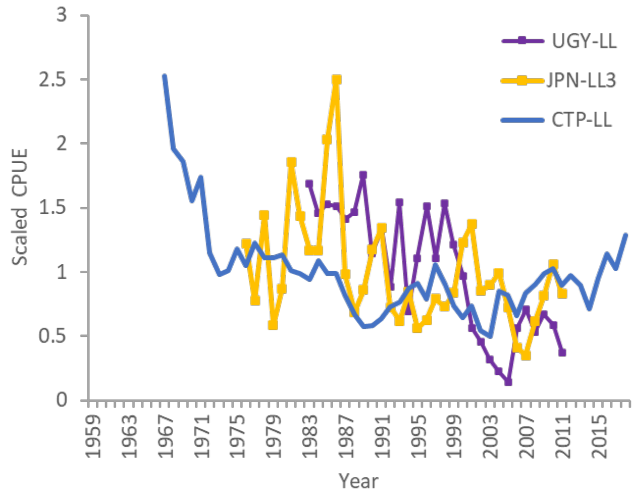
ALB-AT-Figure 2. Total albacore catches reported to ICCAT (Task 1) by gear for the northern (top) and southern (bottom) Atlantic stocks including TAC.



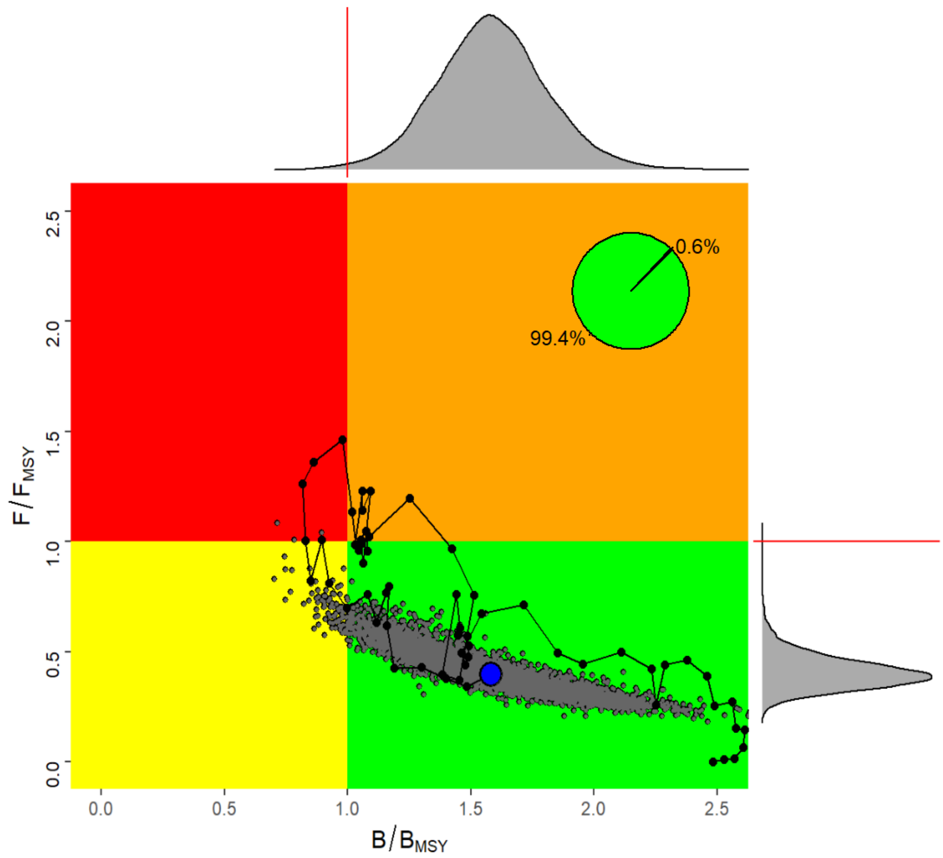
ALB-AT-Figure 3. North Atlantic albacore. Standardized catch rate indices used in the 2023 stock assessment from the surface fishery (baitboat) which take mostly juvenile fish, and from the longline fisheries which take mostly adult fish.



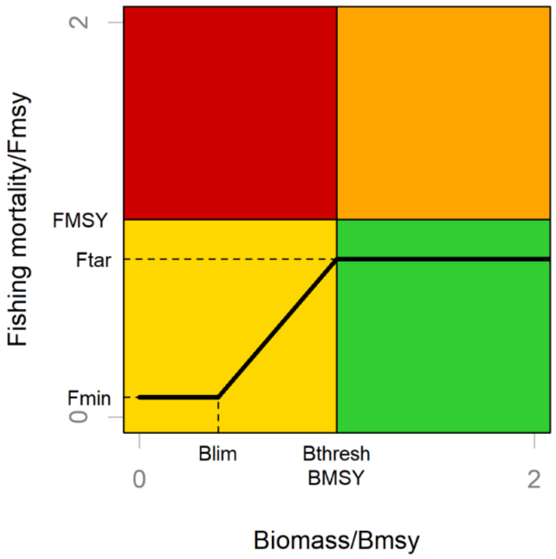
ALB-AT-Figure 4. North Atlantic albacore (Kobe plot). Stock status trajectories of B/B_{MSY} and F/F_{MSY} over time (1930-2021), as well as uncertainty (grey dots) around the current (F_{2021}/F_{MSY}, B_{2021}/B_{MSY}) estimate (blue point) based on Stock Synthesis model with probability of being overfished and overfishing (red, 0%), of being neither overfished nor overfishing (green, 99.6%), and of being overfished (yellow, 0.4%).



ALB-AT-Figure 5. South Atlantic albacore. Standardized catch rates used for the base case of the 2020 Stock Assessment (Anon., 2020b).



ALB-AT-Figure 6. South Atlantic albacore (Kobe plot). Stock status trajectories of B/B_{MSY} and F/F_{MSY} over time (1956-2018), as well as uncertainty (grey dots) around the current (2018) estimate (blue point) based on Bayesian surplus production model with probability of being overfished and overfishing (red, 0%), of being neither overfished nor overfishing (green, 99.4%), and of being overfished (yellow, 0.6%).



ALB-AT-Figure 7. Graphic form of the HCR adopted in Rec. 17-04. B_{LIM} (set at $0.4B_{MSY}$) is the limit biomass reference point, B_{THRESH} (set at B_{MSY}) is the point below which fishing mortality decreases linearly, F_{TAR} (set at $0.8F_{MSY}$) is the target fishing mortality rate to be applied to achieve the management objectives, and F_{MIN} (set at $0.1F_{MSY}$) is the fishing mortality to be applied when $B<B_{LIM}$.

9.5 ALB-MD - Mediterranean albacore

The status of the Mediterranean albacore stock is based on the 2021 assessment using 2019 as the terminal year for catch data. Complete information is found in the Report of the Intersessional Meeting of the Albacore Species Group including the Mediterranean Albacore Stock Assessment (Anon., 2021c).

ALB-MD-1. Biology

Albacore is a temperate tuna widely distributed throughout the Atlantic Ocean and Mediterranean Sea. On the basis of the biological information available for assessment purposes, the existence of three stocks is assumed: North and South Atlantic stocks (separated at 5°N) and a Mediterranean stock (**ALB-MD Figure 1**). However, some studies support the hypothesis that various sub populations of albacore exist in the North Atlantic and Mediterranean.

Scientific studies on albacore stocks, in the North Atlantic, North Pacific and the Mediterranean, suggest that environmental variability may have a substantial impact on albacore stocks, affecting fisheries due to a shift in species distribution, as well as productivity and potential MSY of the stocks.

The expected lifespan for Mediterranean albacore is around 15 years. In the Mediterranean, there is a need to integrate different available studies so as to better characterize growth of Mediterranean albacore. Besides some additional recent studies on maturity, in general, there is poor knowledge about Mediterranean albacore biology and ecology in some areas.

More information on Mediterranean albacore biology and ecology is published in the *ICCAT Manual*.

ALB-MD-2. Description of fisheries or fishery indicators

During the assessment, the catch series were revised and approved by the Group. It is known that the catch series of some ICCAT CPCs are still incomplete, and efforts are being made to recover those catches to complete Task 1 estimations. In 2021 and 2022, the reported landings were 2,895 t and 2,295 t, respectively, below those in the last decade (**ALB-MD-Table 1** and **ALB-MD-Figure 2**). The majority of the catch came from longline fisheries. EU-Italy is the main harvester of Mediterranean albacore, with around 43% of the catch during the last 10 years. In 2022 the Italian catch remained similar to the average over the last five years.

ALB-MD-3. State of stocks

In 2021, the stock assessment for Mediterranean albacore was conducted using catch and CPUE data up to 2019. A Bayesian state space surplus production model (JABBA) was used for assessment purposes.

Eight indices were used: Spanish, Italian, Ionian, Ligurian, Med-South, and historical Italian longline indices, western Mediterranean larval index (providing information on the trends of the spawning biomass), and the Spanish Tournament index (new). These indices (expressed in fish number or weight) showed a general decreasing trend over time. Comparatively, the larval survey suggests the largest decrease in biomass during the 2000s and early 2010s, and the Italian longline index suggests the greatest increase during the most recent years (**ALB-MD-Figure 3**).

Overall, the data inputs to the model remain uncertain, including: possible under-reporting of the catch; limitations both in spatial and temporal coverage of available indices of abundance; the fact that most indices are limited to the most recent years of the fisheries; and, conflicting trends among these indices. In fact, the conflict between the trends of the Italian longline and western Mediterranean larval index proved crucial when characterizing the current state of the stock.

The Committee reiterates that the ability of the available catch per unit effort (CPUE) series to monitor stock trends is limited.

The results indicate that current fishing mortality levels (2019) are above F_{MSY} (1.2; 0.62-2.18, median and 95% Confidence Interval (CI)), and the current biomass is below the B_{MSY} level (0.57; 0.32-1.00, median and 95% CI) (**ALB-MD-Figure 4**). The probability of being in the red, yellow, orange and green quadrants of the Kobe plot is 73.8%, 23.6%, 0.1% and 2.5%, respectively (**ALB-MD-Figure 4**).

ALB-MD-4. Outlook

The best available model was projected into the future under alternative catch scenarios. The Kobe matrix indicates that catches of the order of 2,700 t, close to the average of the last three years (2017-2019) of the assessment would allow the stock to recover to the green quadrant of the Kobe plot with a greater than 50% probability within a time frame of eleven years, which is approximately twice the estimated generation time for this stock. Reducing the catch level to around 2,000 t would allow the stock to recover to the green quadrant of the Kobe plot with a greater than 60% probability within a time frame of eight years (2029). Larger decreases would allow for faster recoveries and/or higher probabilities to be in the green quadrant (**ALB-MD-Table 2**).

ALB-MD-5. Effect of current regulations

In 2017 the Commission adopted Rec. 17-05, according to which no increase in catch and fishing effort is allowed until more accurate scientific advice was available from the SCRS. Albacore catches in the Mediterranean have been relatively constant between 2016 and 2019 with only a slight decrease from 2018 to 2019. Moreover, a time closure of two months (1 October - 30 November), originally aimed at protecting juvenile Mediterranean swordfish, applies to the longline fleet targeting albacore in the Mediterranean from 2018 onwards. Furthermore, according to the same Recommendation, the number of vessels for each CPC is limited to the number of vessels that were authorized to target Mediterranean albacore in 2017 under paragraph 28 of Rec. 16-05.

From 2012 onwards, the seasonal closure aimed at the protection of swordfish in the Mediterranean (Rec. 16-05, Rec. 13-04, and Rec. 11-03) contemplates an additional 45 day closure of the swordfish fishery (between 15 February and 31 March), that also affects the albacore fisheries in the Mediterranean.

ALB-MD-6. Management recommendations

As noted previously under the State of the Stocks section, the limitations and uncertainty in data inputs contribute to uncertainties in the characterization of stock status, in particular for fishing mortality, as noted by the wide confidence intervals on F/F_{MSY}.

Based on the best available data and models, the projections of current (2019) stock status show that catches on the order of those observed in the first decade of the 2000s (5,000 t) are not sustainable and catches exceeding 4,000 t would lead to a high probability of driving the stock to extremely low levels, risking stock collapse (**ALB-MD-Figure 5**). By comparison, catches on the order of 2,700 t, close to the average of the last three years (2017-2019) would allow the stock to recover to the green quadrant of the Kobe plot with a greater than 50% probability by 2032 (**ALB-MD-Table 2**; 11 years is approximately twice the estimated generation time for this stock), however this level of fishing also has a 17% probability of reducing B/B_{MSY} below 0.2 in 2032, a level below which there is an increased risk of stock collapse. Catches higher than 2,700 t will delay the recovery of the stock and have a greater than 17% probability for B below $0.2{*}B_{MSY}$ (**ALB-MD-Table 3**). Decreasing catches below 2,700 t would allow for faster recoveries and/or higher probabilities of being in the green quadrant.

MEDITERRANEAN ALBACORE SUMMARY	
Maximum Sustainable Yield	3,653.9 t (2,446 - 5,090 t)[1]
Current (2022) Yield	2,295 t
Yield in last year of assessment (2019)	2,484 t
B_{MSY}	19,703.1 t (11,676 - 36,833 t)[1]
F_{MSY}	0.184 (0.091 - 0.335)[1]
B_{2019}/B_{MSY}	0.570 (0.322 - 1.004)[1]
F_{2019}/F_{MSY}	1.213 (0.618 - 2.175 t)[1]
Stock Status	Overfished: YES Overfishing: YES
Management measures in effect:	Rec. 22-05: 15-year Rebuilding plan (2022-2036); TAC for years 2022, 2023 and 2024: 2,500 t Limited number of vessels (reference year 2017 or 2018); Census of authorized sport & recreational vessels (maximum three albacore specimens/vessel/day); Time closure: 01/10-30/11 + 1 month between 15/02-31/03; alternatively, 01/01-31/03.

[1] Median and 95% credibility intervals for the Bayesian surplus production model.

ALB-MD-Table 1. Estimated catches (t) of albacore (*Thunnus alalunga*) by area, gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL	MED		2138	1349	1587	3150	2541	2698	4856	5577	4870	5608	7898	4874	3529	5965	6520	2970	4024	2124	4628	2047	1503	2400	3800	4396	3176	2863	2762	2675	2895	2295
Landings		Bait boat	231	81	163	205	0	33	96	88	77	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Longline	410	350	87	391	348	194	416	2796	2597	3704	4248	2335	1997	3026	4101	2694	2160	1719	2327	1959	1392	2343	3235	4333	3087	2378	2656	2497	2798	2112
		Other surf.	879	766	1031	2435	1991	2426	4271	2693	2196	1757	46	87	169	134	182	246	634	404	1408	8	18	27	5	4	2	2	8	29	1	34
		Purse seine	559	23	0	0	0	0	0	0	0	1	3557	2452	1362	2803	2237	24	1230	0	869	68	86	15	543	34	82	481	30	66	72	110
		Trawl	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	5	0	0	0	0	0	5	7	9	3	2	2	5	13	1
		Troll	59	129	306	119	202	45	73	0	0	117	0	0	0	1	0	1	0	1	0	6	0	3	0	0	2	1	67	62	5	0
Discards		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	6	7	8	10	16	0	0	0	16	5	39
Landings	CP	EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	12	20	30	11	7	2	2	1	1	0	0
		EU-Cyprus	0	0	0	0	0	0	0	6	0	12	30	255	425	507	712	209	223	206	222	315	350	377	495	542	568	624	714	632	513	448
		EU-España	298	218	475	429	380	126	284	152	200	209	1	138	189	382	516	238	204	277	343	389	244	283	53	51	206	71	68	67	133	98
		EU-France	64	23	3	0	5	5	0	0	0	1	0	0	0	0	2	1	0	1	2	0	0	1	1	0	0	0	15	15	24	36
		EU-Greece	1	1	0	952	741	1152	2005	1786	1840	1352	950	773	623	402	448	191	116	125	126	126	165	287	541	1332	608	522	297	158	182	145
		EU-Italy	1275	1107	1109	1769	1414	1414	2561	3630	2826	4032	6913	3671	2248	4584	3970	2104	2727	1109	2501	1117	615	1353	1602	1490	1348	1044	1287	1423	1192	1154
		EU-Malta	0	0	0	0	1	1	6	4	4	2	5	10	15	18	1	5	1	2	5	19	29	62	37	56	4	104	77	13	137	50
		EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	246	77	396	429	278	316	622	177
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	750	800	0	30	21	19	17	20
		Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	10	10
		Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	14	0	0	0	1	1	0	0	0	0	0	0	0	0	**0**
		Türkiye	0	0	0	0	0	0	0	0	0	0	0	27	30	73	852	208	631	402	1396	62	71	0	53	25	44	38	4	16	58	118
	NCO	NEI (MED)	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Yugoslavia Fed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	CP	EU-Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	6	7	8	10	16	0	0	0	16	5	37
		EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

ALB-MD-Table 2. Mediterranean albacore estimated probabilities (in %) based on Bayesian surplus production model that the stock fishing mortality is below F_{MSY} (a), biomass is above B_{MSY} (b) and both (c). Projections for constant catch levels (0 t to 4,000 t, MSY 3,600 t, average catch 2017-19, 2,700 t) are shown. Assumed catches for 2020 and 2021 were 2,700 t (average of the 2017-2019 period).

(a) Probability $F<F_{MSY}$.

TAC | Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
500	99	100	100	100	100	100	100	100	100	100	100	100	100	100
1000	94	96	97	98	98	98	99	99	99	99	99	99	99	99
1500	81	85	88	89	91	92	93	94	95	95	95	96	96	96
2000	64	69	73	76	78	80	81	82	84	84	85	86	87	87
2500	47	52	55	58	61	63	65	66	68	69	70	70	71	72
2600	44	48	52	55	57	59	61	63	64	65	66	67	68	68
2700	41	46	49	52	54	56	58	60	61	62	63	64	64	64
2800	39	43	46	48	50	52	54	55	57	58	58	59	60	60
2900	36	40	43	45	47	49	51	52	53	54	55	55	56	57
3000	34	37	40	42	45	46	47	48	50	51	51	52	52	53
3600	22	24	25	26	27	28	28	28	29	29	29	29	29	30
4000	16	17	18	19	19	19	19	19	19	19	19	19	19	19

(b) Probability $B>B_{MSY}$.

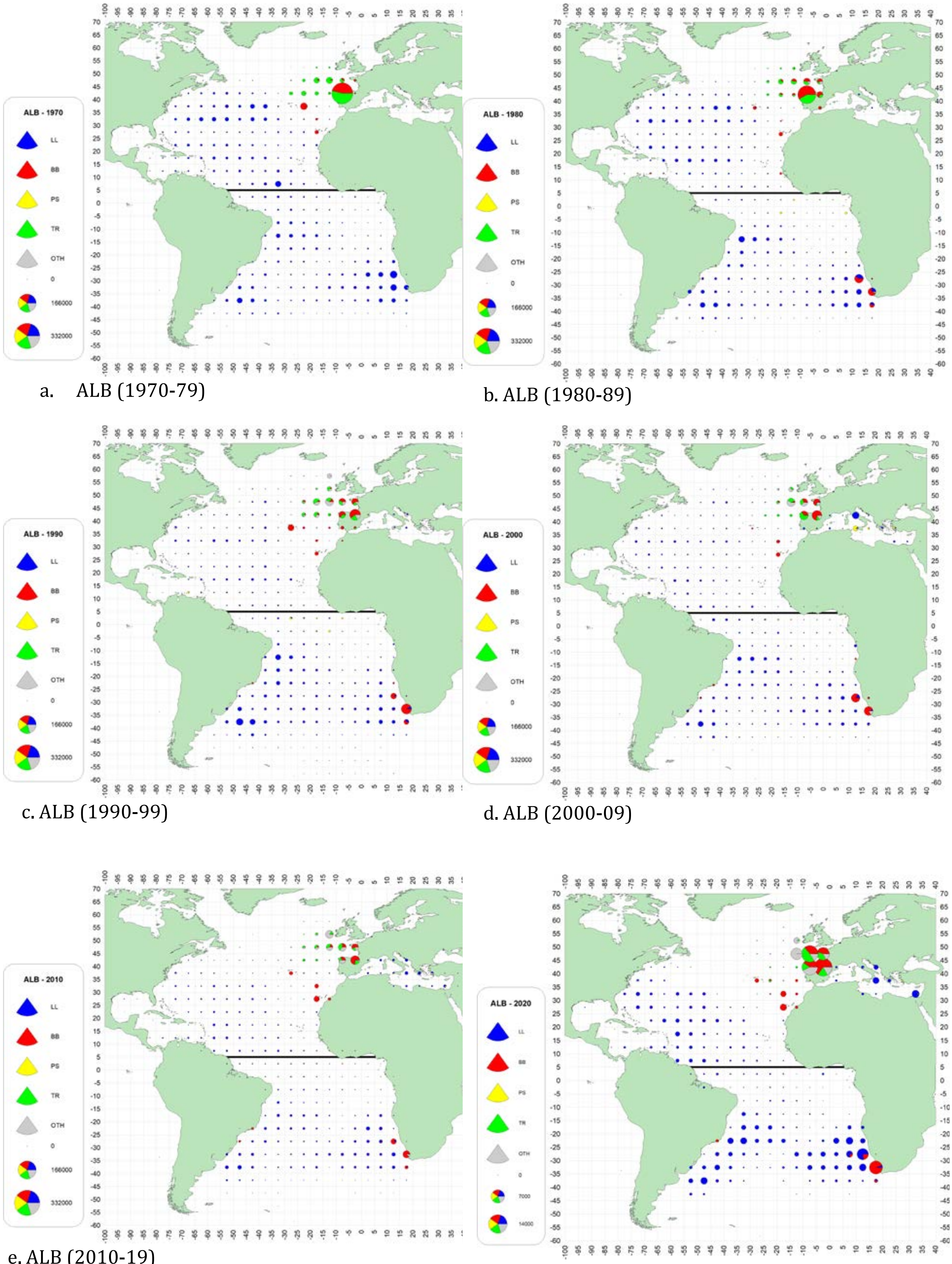
TAC | Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
0	18	35	52	66	76	83	88	91	94	95	97	97	98	98
500	18	32	47	60	71	78	83	87	90	92	94	95	96	97
1000	18	30	42	54	63	70	76	80	84	87	89	90	92	93
1500	18	28	38	48	55	61	67	71	75	78	81	83	84	86
2000	18	27	35	41	48	53	57	61	65	67	70	72	73	75
2500	18	24	30	35	39	43	47	50	52	55	57	58	60	61
2600	18	24	29	34	38	41	44	47	50	52	54	56	57	58
2700	18	23	28	32	36	40	42	45	48	49	51	53	54	55
2800	18	23	28	31	35	38	41	43	45	46	48	49	50	52
2900	18	23	26	30	33	36	39	41	42	44	45	47	48	49
3000	18	22	26	30	32	34	37	39	40	41	43	44	45	45
3600	18	20	21	23	24	25	25	25	26	26	27	27	27	27
4000	18	18	19	20	20	20	20	19	19	19	19	19	19	19

(c) Probability of green status ($B>B_{MSY}$ and $F<F_{MSY}$).

TAC | Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
0	18	35	52	66	76	83	88	91	94	95	97	97	98	98
500	18	32	47	60	71	78	83	87	90	92	94	95	96	97
1000	18	30	42	54	63	70	76	80	84	87	89	90	92	93
1500	18	28	38	48	55	61	67	71	75	78	81	83	84	86
2000	18	27	34	41	48	53	57	61	65	67	70	72	73	75
2500	18	24	30	35	39	43	47	50	52	54	57	58	60	61
2600	18	24	29	34	37	41	44	47	50	52	54	56	57	58
2700	18	23	28	32	36	40	42	45	48	49	51	53	54	55
2800	18	23	28	31	34	38	41	42	44	46	48	49	50	51
2900	17	22	26	30	33	36	38	41	42	44	45	46	47	48
3000	18	22	26	29	32	34	36	39	40	41	43	44	44	45
3600	16	18	20	21	22	23	24	24	25	25	26	26	26	27
4000	13	14	16	16	17	17	18	18	18	18	18	18	18	17

ALB-MD-Table 3. Mediterranean albacore estimated probabilities (in %) based on Bayesian surplus production model that the stock biomass is below 20% B_{MSY}. Projections for constant catch levels (0 t to 4,000 t, MSY 3,600 t, average catch 2017-19, 2,700 t) are shown. Assumed catches for 2020 and 2021 were 2,700 t (average of the 2017-2019 period).

TAC	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*	*2029*	*2030*	*2031*	*2032*	*2033*	*2034*	*2035*
0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
500	1	1	0	0	0	0	0	0	0	0	0	0	0	0
1000	1	1	1	1	1	0	0	0	0	0	0	0	0	0
1500	1	1	1	1	1	1	1	1	1	1	2	2	2	2
2000	1	2	2	3	3	4	4	4	5	5	5	6	6	6
2500	1	2	3	5	6	8	9	10	11	12	13	13	14	15
2600	1	2	4	6	7	9	10	11	13	14	15	15	16	17
2700	1	3	4	6	8	10	12	13	14	16	17	18	19	19
2800	1	3	5	7	9	11	13	15	16	18	19	21	22	23
2900	1	3	5	8	10	13	15	17	19	20	22	23	25	26
3000	1	3	6	8	11	14	17	19	21	23	24	26	27	28
3600	1	4	9	14	19	24	29	33	37	39	42	45	47	49
4000	1	5	11	19	26	33	38	43	48	51	54	57	59	61



a. ALB (1970-79)

b. ALB (1980-89)

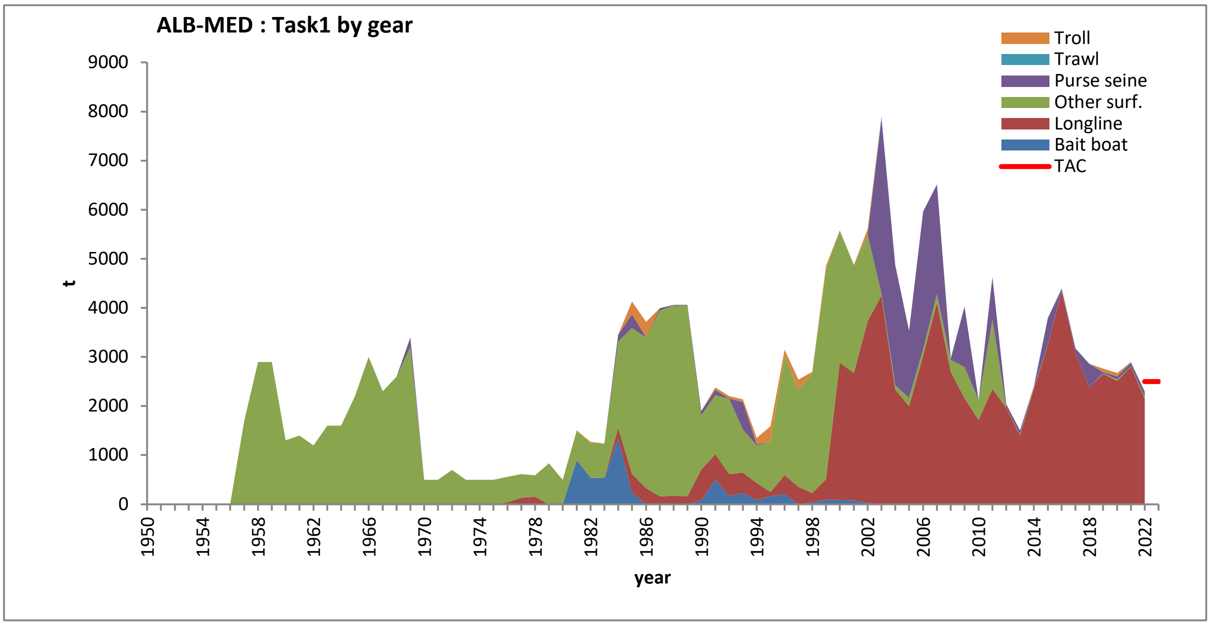
c. ALB (1990-99)

d. ALB (2000-09)

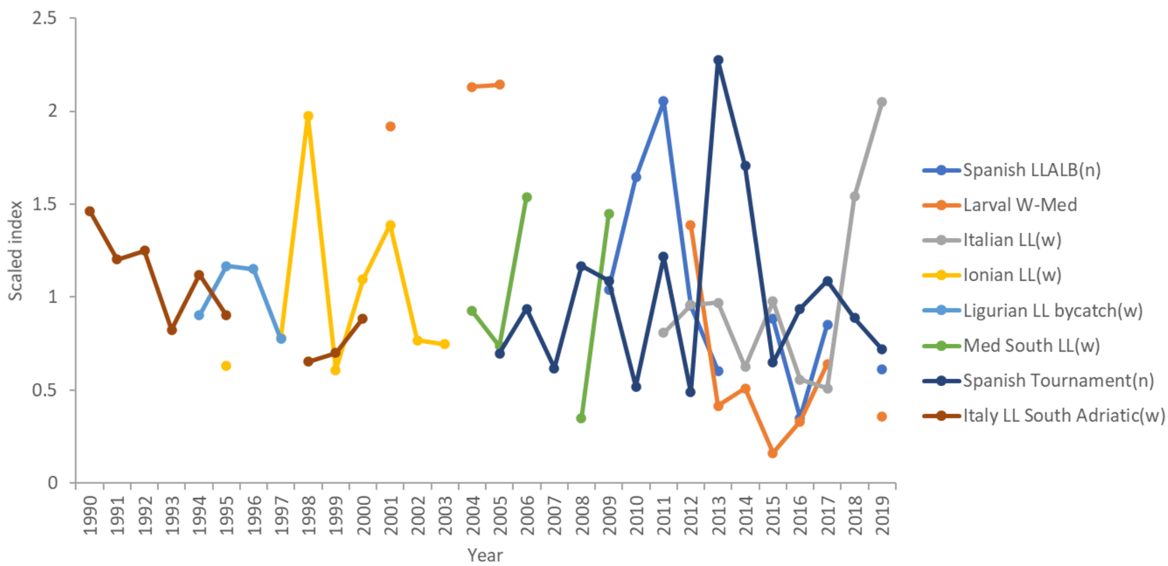
e. ALB (2010-19)

f. ALB (2020-21)

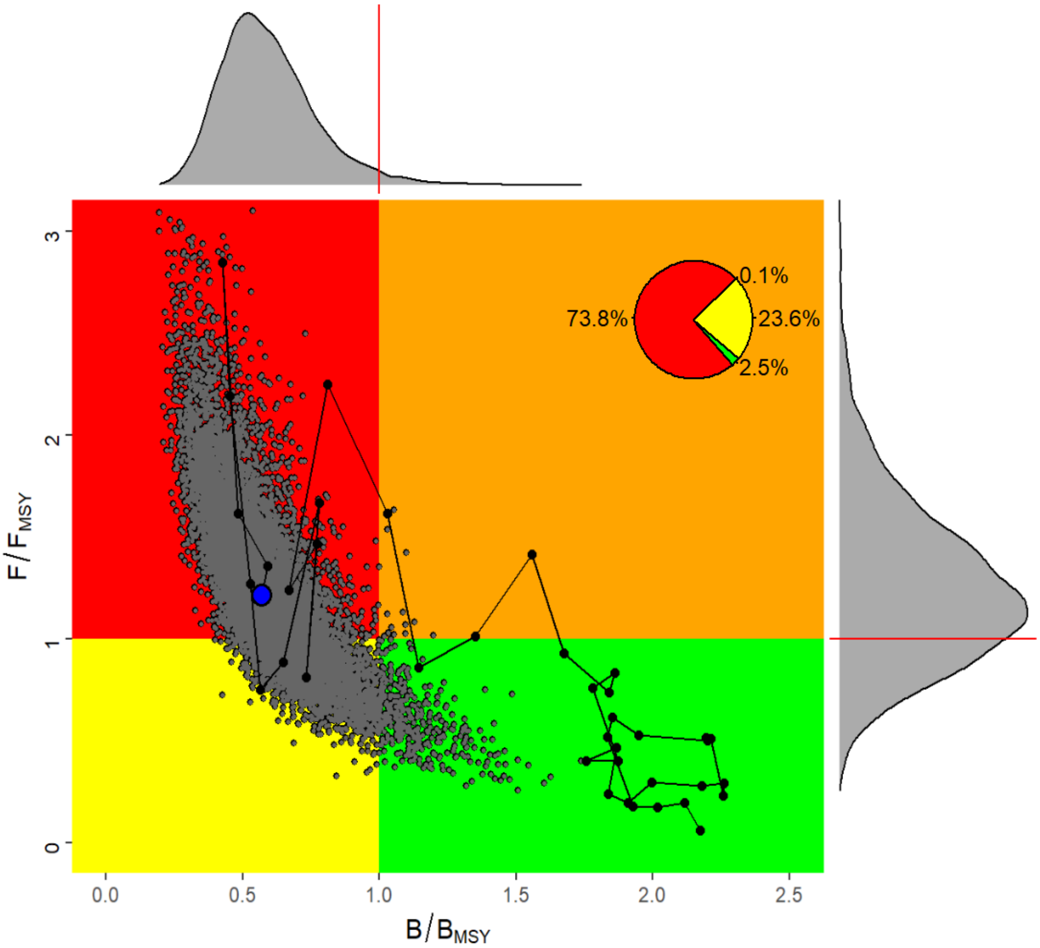
ALB-Figure 1. Geographic distribution of accumulated albacore catch by major gears and decade (1970-2021). Prior to the 1990s, baitboat and troll catches were assigned to only one 5ºx5º stratum in the Bay of Biscay. Plots are scaled to the maximum catch observed from 1970 to 2021 (last decade only covers 2 years).



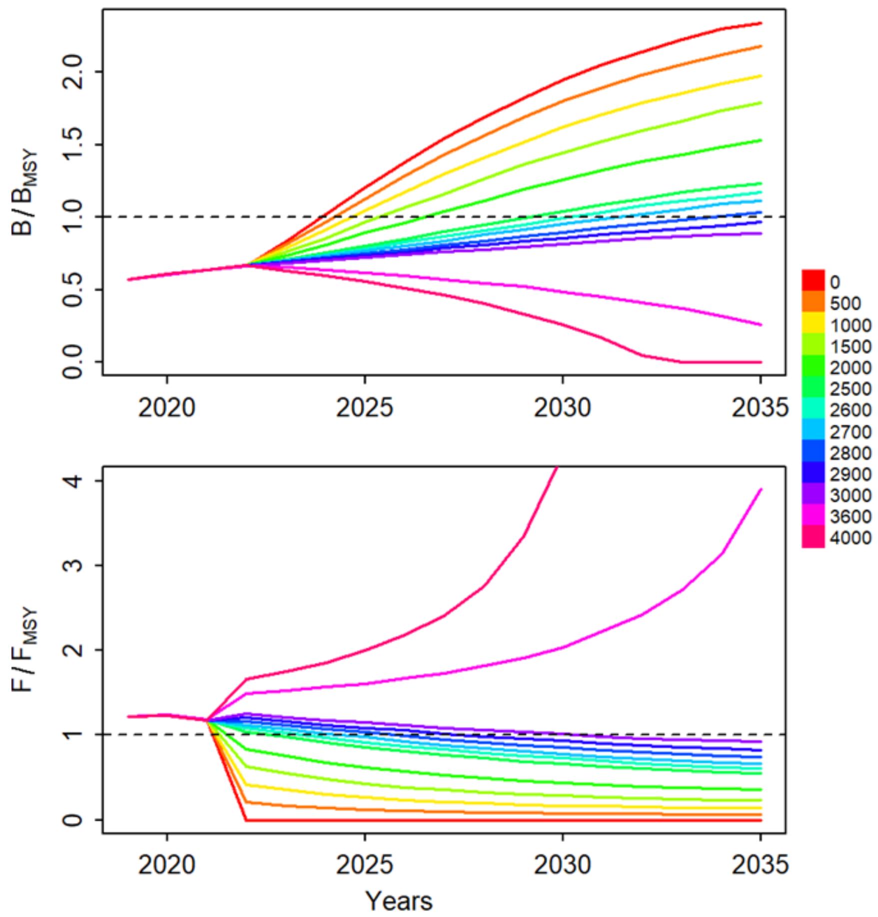
ALB-MD-Figure 2. Total albacore catches reported to ICCAT (Task 1) by gear for the Mediterranean stock.



ALB-MD-Figure 3. Mediterranean albacore. Abundance indices used in the 2021 Assessment of the Mediterranean albacore stock (Anon., 2021c). n and w refer to abundance indices in number and weight, respectively.



ALB-MD-Figure 4. Mediterranean albacore. Stock status trajectories of B/BMSY and F/FMSY over time (1980-2019) with uncertainty around the current estimate (Kobe plots) for Bayesian surplus production model, as well as probability of being overfished and overfishing (red, 73.8%), of being neither overfished nor overfishing (green (2.5%), of being overfished but not overfishing (yellow, 23.6%) and of overfishing but not overfished (orange, 0.1%). The probability distributions shown in each axis represent uncertainty around current B/BMSY and F/FMSY.



ALB-MD-Figure 5. Trends of projected relative stock biomass (upper panel, B/B_{MSY}) and fishing mortality (bottom panel, F/F_{MSY}) for Mediterranean albacore under different fixed catch scenarios of 0–4,000 t (Note: MSY ~3,600 t; average catch between 2017 and 2019 ~2,700 t), based upon the projections of the Bayesian surplus production model. Each line represents the median of 15,000 MCMC iterations by projected year.

9.6 BFT – Atlantic bluefin tuna

In 2022, the ICCAT Commission adopted a Management Procedure (MP) for both the western Atlantic and eastern Atlantic and Mediterranean management areas (Rec. 22-09). The adoption of the MP represents a foundational change in how bluefin tuna (BFT) will be managed. This approach links eastern and western area Total Allowable Catch (TACs) under one management framework, providing joint management advice, and requires the Executive Summaries for the East and West BFT (BFT-E and BFT-W) to have common or closely related sections. The MP frees the assessment process from having to provide annual TAC advice and allows the stock assessment process to return to its traditional strengths which are to provide a determination of relative stock status. According to the adopted MP, stock assessments will continue to be conducted but on a more reduced frequency. The next assessment will be held in 2026 or 2027, pending further dialogue between the Committee and the Commission.

Until such time as a new assessment occurs, the Committee retains the stock status determination from the most recent assessments (West, Anon., 2021d) and East Atlantic and Mediterranean (Anon., 2022d). Previous stock assessments utilized $F_{0.1}$ as a reasonable proxy for F_{MSY} as fishing at $F_{0.1}$ would, over the longer term, allow the resource to fluctuate around the true, but unknown, value of $B_{0.1}$ regardless of the future recruitment level. The $F_{0.1}$ strategy compensates for the effect of recruitment changes on biomass by allowing higher catches when recent recruitment is higher and reducing catches when recent recruitments are lower. Given that it remains unknown whether future stock assessments will be able to estimate a stock-specific F_{MSY}, $F_{0.1}$ remains a useful proxy to evaluate overfishing status. The Committee notes that $F_{0.1}$ was not used to evaluate status within the Management Strategy Evaluation (MSE) as the true F_{MSY} was known within each of the operating models.

The final remaining task for full adoption of the MP is to define the exceptional circumstances (EC) protocols. The Committee has been working with Panel 2 to develop an EC protocol that, if determined to have occurred and to be consequential for TAC advice, could result in suspending or modifying the application of the MP (section 19.18). As the MP is a package of management advice across both East and West BFT, an EC determination applies jointly to both stocks.

Annually, the Committee evaluates the updated indices of abundance for determination of EC. Based upon the current draft EC protocols (section 19.18), the Committee provides details and results of such determination in section 19.17.

BFT-1. Biology

Atlantic bluefin tuna have a wide geographical distribution but live mainly in the temperate pelagic ecosystem of the entire North Atlantic and its adjacent waters, for example the Gulf of Mexico, Gulf of St Lawrence and the Mediterranean Sea. Historical catch information documents the presence in the South Atlantic (**BFT-Figure 1**). Electronic archival tagging information has confirmed that bluefin tuna can tolerate cold as well as warm water temperatures while maintaining a stable internal body temperature. Bluefin tuna preferentially occupy the surface and subsurface waters of the coastal and open-sea areas, but archival electronic tagging and ultrasonic telemetry data indicate that they frequently dive to depths of more than 1,000 m. Bluefin tuna are a highly migratory species that seems to display a homing behavior and spawning site fidelity to primary spawning areas in both the Mediterranean Sea and the Gulf of Mexico. Evidence indicates spawning in other areas, for example the vicinity of the Slope Sea off the Northeast USA and more recently the Cantabrian Sea, though the persistence and importance of these other areas as spawning grounds remain to be determined. Electronic tagging is also resolving the movements to the foraging areas within the Mediterranean and the North Atlantic and indicates that bluefin tuna movement patterns vary by tagging site, by month of tagging and according to the age of the fish. The reappearance of bluefin tuna in historical fishing areas (e.g., Norway and, more recently, the Black Sea) suggest that important changes in the spatial dynamics of bluefin tuna may also have resulted from interactions between biological factors, environmental variations and a reduction in fishing effort.

The fisheries for Atlantic bluefin tuna were managed as two separate management units, but now are managed with an MP that explicitly considers the mixing of the two biological populations. However, TAC advice remains area specific with separation at the 45 W meridian.

The ICCAT Atlantic-Wide Bluefin Tuna Research Programme (GBYP), as well as national research programmes, have provided the basis for improved biological studies. Substantial progress has been made in estimating regional, time varying mixing rates for Atlantic bluefin tuna, using otolith stable isotope and genetic analyses. Research on the larval ecology of Atlantic bluefin tuna has advanced in recent years through oceanographic habitat suitability models. Direct age estimation, using otoliths and dorsal fin spines from both stock areas, have been calibrated between readers from several institutions resulting in stock specific age length keys and a new growth model for the western population. Otolith preparation and reading protocols have been updated to minimize bias in age estimation. Following Rec. 18-02 para 28, a research study of growth in farms was launched in 2019 at five locations, and a new database will be created to integrate all the data from stereo-camera measurements and harvesting operations. Additionally, a Sub-group on Growth of BFT in Farms was established in 2020 within the BFT Species Group. This Sub-group was created to ensure that the best scientific data would be provided to the Commission.

Currently, the Committee assumes for assessment purposes that eastern Atlantic and Mediterranean bluefin tuna contributes fully to spawning at age 5. There are also indications that some young individuals (of age 5) of unknown origin caught in the West Atlantic are mature, but there is considerable uncertainty with regards to their contribution to the western stock spawning. Therefore, the Committee has considered two spawning schedules for the western stock; one identical to that used for the East and one with peak spawning at age 13. However, the latest review of reproductive biology has shown that both the current vectors for spawning fraction at-age might be biased, and that the magnitude of that bias is unknown. Juvenile growth is rapid for a teleost fish, but slower than for other tuna and billfish species. Fish born in June attain a length of about 30-40 cm and a weight of about 1 kg by October. After one year, fish reach about 4 kg and 60 cm in length. At 10 years of age, a bluefin tuna is about 200 cm and 170 kg and reaches about 270 cm and 400 kg at 20 years of age. Bluefin tuna is a long-living species, with a lifespan of about 40 years as indicated by radiocarbon deposition and can reach 330 cm straight fork length (SFL) and weigh up to 725 kg. In 2017, the Committee revised the natural mortality assumptions, and adopted a single new age specific natural mortality vector for both stocks.

Important electronic and conventional tagging activity has been conducted for both juvenile and adult fish for several years in the Atlantic and Mediterranean by the ICCAT GBYP, National Programmes and non-governmental organizations (NGOs). Contributions from e-tag data from all groups are supporting ongoing efforts to provide important insights into bluefin tuna stock structure, distribution, mixing and migrations, and are helping to estimate fishing mortality rates and to condition the MSE operating models. Three workshops organized by the GBYP on larval indices, close-kin mark-recapture and electronic tagging were held in 2023. In these workshops there has been a large participation and contributions that have allowed progress and planning in the three research areas.

East bluefin tuna

BFT-E-2. Fishery trends and indicators – East Atlantic and Mediterranean

Reported catches in the East Atlantic and Mediterranean (**BFT-Figure 1**) reached a peak of over 50,000 t in 1996 and then decreased substantially, stabilizing at around the TAC levels established by ICCAT for the most recent period (**BFT-E-Figure 1**). Catches between 2018 and 2022 (as of September 2023) were respectively 27,782 t, 31,134 t, 35,038 t, 35,095 t, and 35,102 t for the East Atlantic and Mediterranean, of which 19,624 t, 22,090 t, 24,164 t, 24,786 t, and 24,625 t were reported for the Mediterranean for those same years (**BFT-Table 1**). The Committee is aware of ongoing, unquantified, IUU catches that represents a serious impediment to being able to determine the productivity of the stock and to provide reliable TAC advice. In response, the Committee urges identification and quantification of IUU catches so that it can provide more accurate biomass-based catch advice and obtain more accurate scientific understanding of stock productivity.

Available information has demonstrated that catches of bluefin tuna from the East Atlantic and Mediterranean were seriously under-reported between the mid-1990s through 2007. The Committee estimated that the realized total catch during this period was likely of the order of 50,000 t to 61,000 t per year, based on the number of vessels operating in the Mediterranean Sea and their respective catch rates. Since the 2017 bluefin tuna stock assessment (Anon., 2018a), these estimates (1998-2007) have been treated as the actual catches.

During the 2022 stock assessment meeting (Anon., 2022d), the decision was made to use ten abundance indices up to 2020 (seven CPUE series and three fisheries independent indices, **BFT-E-Figure 2**). The current MP uses five indices in each management area (in the East, two CPUE indices and three surveys, **BFT-Figure 2**).

BFT-E-3. State of the stock

There have been considerable improvements in data quality and quantity over the past few years; nevertheless, important gaps remain in the temporal and spatial coverage for detailed size and catch-effort statistics for several fisheries, especially in the Mediterranean before the implementation of stereo video cameras in 2014. The catch at size (CAS) and catch-at-age (CAA) of the NEI catch (1998-2007) were revised.

Three modelling platforms were used to conduct the assessment of the BFT-E in 2022. As in previous assessments, a virtual population analysis (VPA) was conducted, and two additional platforms, Stock Synthesis (SS) and the age-structured assessment programme (ASAP), were applied.

The three models showed similar trends in spawning stock biomass (SSB), with a progressive decline in SSB from the 1970s until the implementation of a Recovery Plan developed in 2006 (Rec. 06-05). Since the late 2000s there has been a strong increase in SSB, although the magnitude and rate of increase differ among the three models, with VPA indicating the lowest biomass while ASAP indicates the largest increase. Uncertainty in the rate and magnitude of the increase in SSB is evident for all three platforms and in the sensitivity tests conducted for each platform, especially in recent years (**BFT-E-Figure 3**). The fishing mortality of the age group 2-5 and age 10+ fish showed an increasing trend since the 1970s, whereas the F for both the age group 2-5 and age 10+ shows a drastic decline in fishing mortality since the establishment of the 2006 Recovery Plan (**BFT-E-Figure 3**). Recently, fishing mortality has been increasing, however, when average over all three models, fishing mortality is still below fishing mortality target.

Recruitments estimated by the three assessment platforms show considerable variability, especially over the recent period. In general, however, there are two distinct periods, one with low recruitments before 1990 and the other with higher recruitments thereafter (**BFT-E-Figure 3**).

The current perception of the stock status depends on recruitment estimates which are highly uncertain. The different models showed a relatively wide range of stock status estimates relative to the $F_{0.1}$ reference level, ranging from overfishing to not overfishing ($F_{CURRENT}/F_{0.1}$): VPA = 1.16; SS = 0.72 and ASAP = 0.54. To inform stock status, the Committee recommended that the results of the three models be considered equally, by integrating the results. The resultant point estimate of F_{CUR} is below $F_{0.1}$ ($F_{CURRENT}/F_{0.1}$= 0.81; 95% CI 0.48-1.62), indicating a stock status determination of not overfishing. Furthermore, fishing mortality rates are much lower than those during the 1998-2007 period.

BFT-E-4. Outlook

The Committee considers that the three assessment platforms (VPA, SS and ASAP) have disparate and highly uncertain estimates of recent recruitment and absolute biomass, which would make short-term catch advice based on $F_{0.1}$ not robust in terms of both the consequences of taking a particular TAC and the accuracy of absolute $F_{0.1}$ estimate.

The adopted management procedure accounts for many of the long-standing uncertainties regarding stock mixing, biomass-based reference points and recruitment that created uncertainty for the outlook for the stock. Furthermore, the Committee is no longer providing projections, TAC advice or Kobe 2 strategy matrices derived from the stock assessments using an $F_{0.1}$ strategy, as the MP provides TAC advice that was simulation tested to achieve MSY-based management objectives.

BFT-E-5. Effect of current regulations

The Committee noted that reported catches in 2022 are in line with the TACs. However, the Committee has been informed of the existence of unquantified illegal catches.

The TAC of 36,000 t was originally implemented in 2020, and was retained in 2021 (Rec. 20-07), and 2022 (Rec. 21-08). The combination of size limits and the reduction of catch implemented since 2007 has certainly contributed to a rapid increase in the abundance of the stock.

The TAC recommendation for 2022 is unlikely to have resulted in overfishing relative to $F_{0.1}$. The three-year TACs from the adopted management procedure are, by design, intended to ensure a high probability of maintaining stock status above B_{MSY} and avoiding overfishing.

BFT-E-6. Management recommendations

The management plan established in Rec. 22-08 and based on the MP for BFT sets a TAC for BFT-E of 40,570 t for 2023 to 2025.

According to the proposed EC provisions reviewed in 2023 and outlined in section 19.18, no EC exists that would warrant deviating from the TAC advice under the MP.

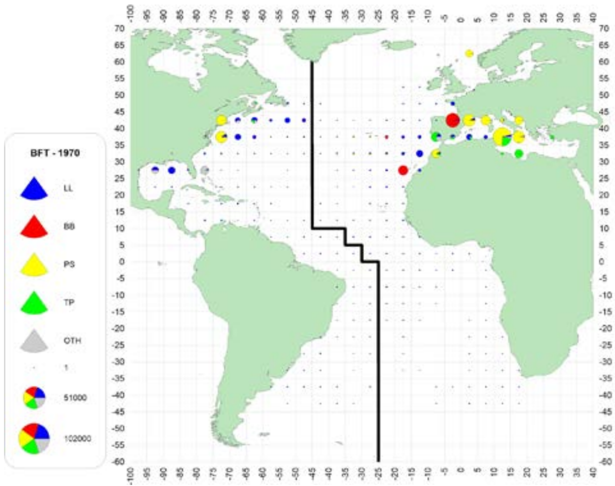
EAST ATLANTIC AND MEDITERRANEAN BLUEFIN TUNA SUMMARY	
Current reported catch (2022)	35,102 t*
$F_{CURRENT}/F_{0.1}$[2] (2020)	0.81 (0.48-1.62)[1]
Stock Status (2020)[3]	Overfishing: No
TAC 2023-2025	40,570 t

[1] Mean and approximate 95% CI from integrating across the uncertainty for each model.
[2] $F_{CURRENT}$ refers to the geometric mean of the estimates (a proxy for recent F levels) for 2017-2020 for VPA, and for 2018-2020 for ASAP and SS. For the VPA and ASAP, F is measured as apical F, for SS F is exploitation rate in biomass.
[3] Biomass reference points to determine stock status were not estimated since the 2017 assessment due to uncertainty in recruitment potential.
* As of September 2023.

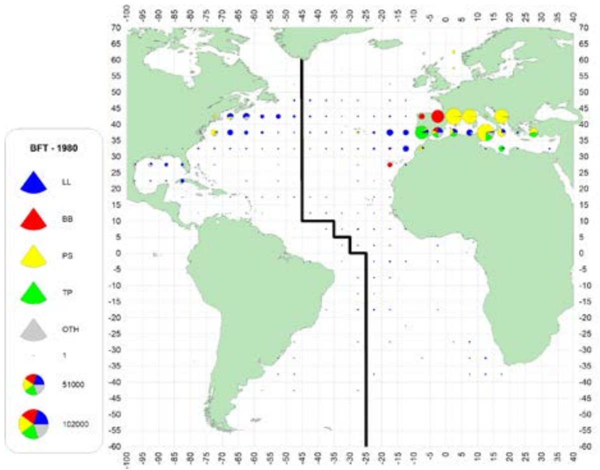
BFT-Table 1. Estimated catches (t) of Northern bluefin tuna (*Thunnus thynnus*) by area, gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				36642	48881	49751	54009	53545	52657	52772	52775	52784	53319	52305	52125	51756	51812	62638	26460	21798	13195	11781	12688	14725	14887	18055	21313	25515	29809	33440	37308	37404	37802
BFT-E				34258	46769	47303	51497	51211	50000	50000	50000	50000	50000	50000	50000	50000	50000	61000	24460	19818	11338	9774	10934	13243	13261	16214	19412	23665	27782	31134	35038	35095	35102
	ATE			9317	7054	9780	12098	16379	11630	10247	10061	10086	10347	7394	7402	9023	7529	8441	8243	6684	4379	3984	3834	4163	3918	4841	5968	7216	8157	9044	10874	10308	10477
	MED			24941	39715	37523	39399	34831	38370	39753	39939	39914	39653	42606	42598	40977	42471	52559	16217	13133	6959	5790	7100	9080	9343	11372	13444	16450	19624	22090	24164	24786	24625
BFT-W	ATW			2384	2113	2448	2512	2334	2657	2772	2775	2784	3319	2305	2125	1756	1811	1638	2000	1980	1857	2007	1754	1482	1627	1842	1901	1850	2027	2306	2269	2310	2700
Landings	ATE		Bait boat	3884	2284	3093	5369	7215	3139	1554	2032	2426	2635	1409	1902	2282	1263	2436	2393	1260	725	636	283	243	95	172	1085	1195	692	845	936	1031	1026
			Longline	2802	2311	4522	4212	4057	3789	3570	3736	3303	2896	2748	2064	2700	2033	1705	2491	1951	1194	1125	1139	1167	1194	1467	1829	2208	2730	3128	3313	3249	3294
			Other surf.	976	590	555	273	60	387	404	509	558	631	521	290	424	831	502	181	297	124	35	49	141	210	193	261	295	340	320	381	359	368
			Purse seine	24	213	458	323	828	700	726	661	153	887	490	1078	1197	408	0	0	2	1	0	0	2	0	0	42	49	11	56	190	147	106
			Sport (HL+RR)	0	25	0	0	237	28	33	126	61	63	109	89	11	99	11	12	11	44	51	53	46	43	104	35	101	118	92	156	267	245
			Traps	1631	1630	1152	1921	3982	3586	3960	2996	3585	3235	2116	1978	2408	2895	3788	3166	3164	2292	2137	2311	2564	2376	2905	2716	3362	4258	4594	5889	5255	5434
	MED		Bait boat	48	0	206	5	4	11	4	38	28	1	9	17	5	0	0	0	38	1	0	2	2	9	25	0	50	56	72	103	81	88
			Longline	2470	6993	8469	9856	7313	4117	3338	3424	4144	3234	3484	3036	3427	3408	3269	2376	1344	1242	962	587	605	588	776	1523	1184	1518	1485	1889	1657	1785
			Other surf.	371	776	545	417	282	284	228	728	354	340	198	197	175	81	85	0	0	1	1	1	20	29	3	37	1	34	51	32	65	58
			Purse seine	20065	27948	23799	26021	24279	31792	33798	33237	33043	34044	37291	37869	36639	38363	48994	13540	11448	4986	4293	6172	7982	8184	9993	11340	14493	17128	19515	20872	21987	21591
			Sport (HL+RR)	1238	2307	3562	2149	2340	1092	1533	1773	1167	1520	1404	1325	619	494	117	149	160	448	356	202	240	289	373	308	439	582	611	865	740	717
			Traps	749	1691	942	951	613	1074	852	739	1177	515	221	154	112	125	93	152	144	281	165	125	222	232	192	227	272	300	353	399	252	384
	ATW		Longline	712	539	491	545	382	764	915	858	610	729	186	644	425	565	420	606	366	529	743	478	470	498	553	562	559	664	675	576	653	913
			Other surf.	406	307	384	429	293	342	279	283	201	107	139	97	89	85	63	78	121	107	147	117	121	119	138	93	123	77	168	134	175	209
			Purse seine	295	301	249	245	250	249	248	275	196	208	265	32	178	4	28	0	11	0	0	2	29	38	34	0	0	0	0	0	0	
			Sport (HL+RR)	854	804	1114	1032	1181	1108	1125	1121	1650	2036	1399	1139	924	1005	1023	1134	1251	1009	888	917	692	810	1085	1204	1144	1263	1450	1543	1444	1521
			Traps	29	79	72	90	59	68	44	16	16	28	84	32	8	3	4	23	23	39	26	17	11	20	6	10	13	3	4	4	4	0
Discards	ATE		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9	8	1	4
	MED		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
			Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	12	9	11	2	9	10	6	4	5	4	2
	ATW		Longline	88	83	138	167	155	123	160	222	105	211	232	181	131	149	100	159	207	174	202	224	145	139	19	29	10	17	7	8	31	54
			Other surf.	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	2	4	3	3
			Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4	5	0	0	0	0	0	0	
			Sport (HL+RR)	0	0	0	0	14	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATE	CP	Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			China PR	0	0	0	0	0	85	103	80	68	39	19	41	24	42	72	119	42	38	36	36	38	37	45	54	64	79	89	101	101	72
			EU-Denmark	37	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3	6
			EU-España	4962	3137	3819	6186	9519	4565	4429	3493	3633	4089	2172	2801	3102	2339	3680	3536	2409	1550	1483	1329	1553	1282	1655	1986	2509	2489	2729	3289	2953	3301
			EU-France	1099	336	725	563	269	613	588	542	629	755	648	561	818	1218	629	253	366	228	135	148	223	212	254	343	350	461	462	557	559	540
			EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Ireland	0	0	0	0	14	21	52	22	8	15	3	1	1	2	1	1	1	2	4	10	13	19	14	32	16	17	6	16	16	20
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
			EU-Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	91	363	169	199	712	323	411	441	404	186	61	27	82	104	29	36	53	58	180	223	235	243	263	327	429	450	475	592	614	583
			EU-Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Great Britain	0	0	1	0	1	1	12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	2	5
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	0	**0**
			Guinée Rep	0	330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Iceland	0	0	0	0	0	2	27	0	0	1	0	0	0	0	0	0	0	0	2	5	4	30	37	6	0	0	0	1	1	
			Japan	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	2351	1904	1155	1089	1093	1129	1134	1386	1578	1905	2262	2514	2773	2779	2867
			Korea Rep	0	4	205	92	203	0	0	6	1	0	0	3	0	1	0	0	0	0	0	0	0	0	0	161	181	208	232	247	242	252
			Maroc	415	720	678	1035	2068	2341	1591	2228	2497	2565	1795	1953	2389	1923	2418	1947	1909	1348	1055	990	960	959	1176	1433	1703	2164	2476	3089	2884	2704
			Norway	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	44	51	12	49	194	152	123
			Panama	0	1	19	550	255	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	**0**
			Sierra Leone	0	0	0	0	0	0	0	93	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NCC	Chinese Taipei	6	20	4	61	226	350	222	144	304	158	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Faroe Islands	0	0	0	0	0	67	104	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	6	2	2
			NEI (ETRO)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	223	68	189	71	208	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	MED	CP	Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	9	34	40	47	56	100	156	168	148	178
			Algerie	1097	1560	156	638	829	1674	1760	2083	2098	2056	1504	1440	1500	1673	1489	1311	0	0	0	69	244	244	370	448	1038	1300	1437	1649	1650	1650
			China PR	0	97	137	93	49	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

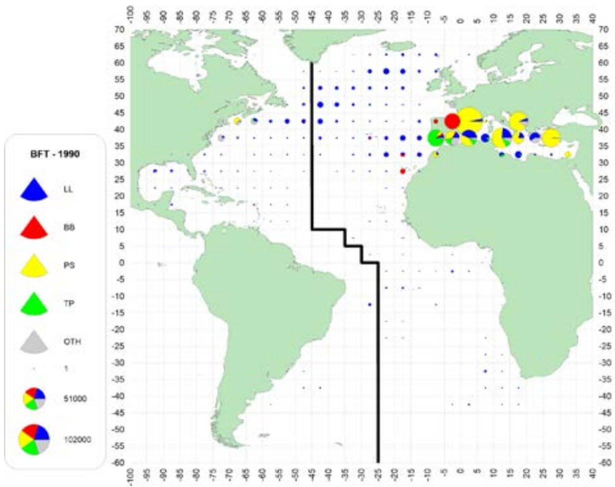
				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Croatia	1058	1410	1220	1360	1105	906	970	930	903	977	1139	828	1017	1022	825	834	619	389	371	369	384	385	456	515	630	738	827	903	903	816
			EU-Cyprus	14	10	10	10	10	21	31	61	85	91	79	105	149	110	1	132	2	3	10	18	17	18	22	59	110	133	151	153	169	168
			EU-España	2018	2741	4607	2588	2209	2000	2003	2772	2234	2215	2512	2353	2758	2689	2414	2465	1769	1056	942	1064	948	1164	1238	1467	1688	2706	2660	2774	3228	2760
			EU-France	6995	11843	9604	9171	8235	7122	6156	6794	6167	5832	5859	6471	8638	7663	10200	2670	3087	1755	805	791	2191	2216	2565	3054	3661	4360	4919	5316	5289	5303
			EU-Greece	439	886	1004	874	1217	286	248	622	361	438	422	389	318	255	285	350	373	224	172	176	178	161	195	218	235	267	313	354	327	424
			EU-Italy	5379	6901	7076	10200	9619	4441	3283	3847	4383	4628	4981	4697	4853	4708	4638	2247	2749	1061	1783	1788	1938	1946	2273	2725	3196	3860	4286	4731	4699	4727
			EU-Malta	259	580	590	402	396	409	449	378	224	244	258	264	350	270	334	296	316	136	142	137	155	160	182	212	261	308	338	387	382	387
			EU-Portugal	164	306	313	274	37	54	76	61	64	0	2	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	77	77	155	99	124	181	263	122	327	67
			Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Japan	793	536	813	765	185	361	381	136	152	390	316	638	378	556	466	80	18	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Korea Rep	0	684	458	591	410	66	0	0	0	0	0	700	1145	26	276	335	102	0	0	77	80	81	0	0	0	0	0	0	0	**0**
			Libya	635	1422	1540	1388	1029	1331	1195	1549	1941	638	752	1300	1091	1327	1358	1318	1082	645	0	756	929	933	1153	1368	1631	1792	2052	2228	2232	2223
			Maroc	79	1092	1035	586	535	687	636	695	511	421	762	827	108	463	641	531	369	205	182	223	309	310	322	350	439	407	444	365	410	862
			Panama	467	1499	1498	2850	236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	41	0	34	0	0	0	0	40	47	57	66	72	79	0	79
			Tunisie	2132	2773	1897	2393	2200	1745	2352	2184	2493	2528	791	2376	3249	2545	431	2679	1932	1042	852	1017	1057	1047	1248	1486	1783	2102	2380	2653	2730	2659
			Türkiye	3084	3466	4219	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	879	665	409	519	536	551	555	1091	1324	1515	1284	1771	2258	2266	2295
		NCC	Chinese Taipei	328	709	494	411	278	106	27	169	329	508	445	51	267	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Gibraltar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	14	16	15	17	20	22	25
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	1	1	0	0	0	0	1
			Israel	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	427	639	171	1058	761	78	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (combined)	0	773	211	0	101	1030	1995	109	571	508	610	709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (inflated)	0	0	0	0	0	9471	16893	16458	15298	15880	18873	18376	14164	18343	28234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Serbia & Montenegro	0	0	2	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Yugoslavia Fed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATW	CP	Brazil	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0**
			Canada	459	392	576	597	503	595	576	549	524	604	557	537	600	733	491	575	530	505	474	477	480	463	531	466	472	508	666	642	626	613
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			FR-St Pierre et Miquelon	0	0	0	0	0	0	1	0	0	3	1	10	5	0	4	3	2	8	0	0	0	0	9	0	0	0	0	0	0	**0**
			Japan	581	427	387	436	322	691	365	492	506	575	57	470	265	376	277	492	162	353	578	289	317	302	347	345	346	406	406	407	410	657
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Mexico	17	4	23	19	2	8	14	29	10	12	22	9	10	14	7	7	10	14	14	51	23	51	53	55	34	80	39	28	63	60
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	0	0	0	1	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	**0**
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	1237	1163	1311	1285	1334	1235	1213	1212	1583	1840	1426	899	717	468	758	764	1068	803	738	713	502	667	877	1002	986	1013	1185	1178	1177	1311
		NCC	Chinese Taipei	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	0	0	0	0	0	0	0	0	0	74	11	19	27	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	0	0	429	270	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	2	43	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	ATE	CP	Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9	8	1	4
	MED		Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	5	2	2	4	5	6	4	5	4	2
			EU-Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	**0**
			Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	0	0	0	0	0	0	0	0	**0**
			Tunisie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	5	5	0	0	0	0	**0**
			Türkiye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	**0**
	ATW		Canada	0	0	0	0	6	16	11	46	13	37	14	15	0	2	0	1	3	25	36	17	0	0	3	8	1	3	3	5	5	6
			Japan	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
			USA	88	83	138	171	155	110	149	176	98	174	218	167	131	147	100	158	204	150	166	206	159	143	22	24	10	15	6	8	28	50



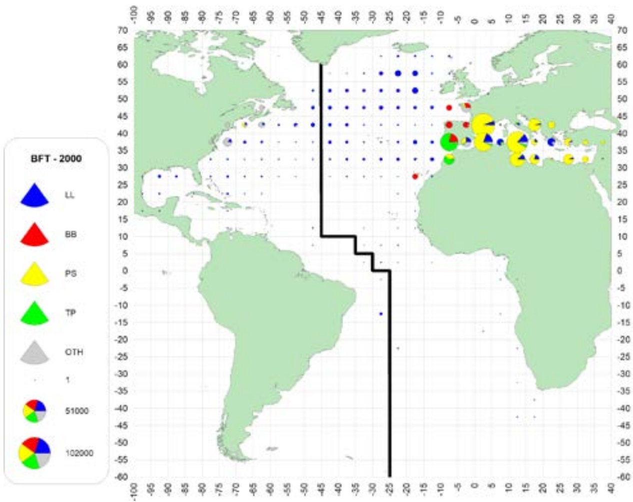
a. BFT (1970-79)



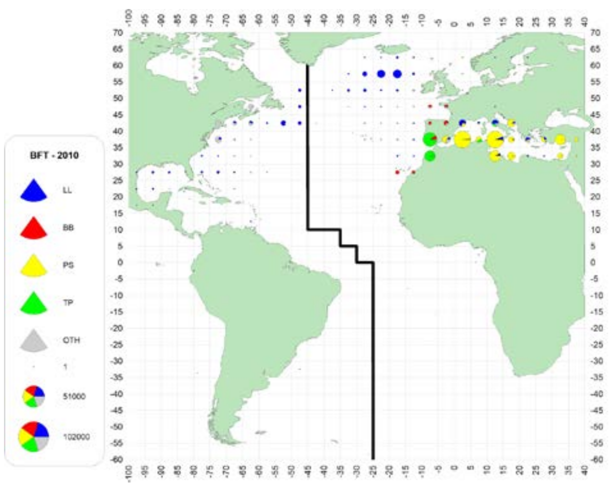
b. BFT (1980-89)



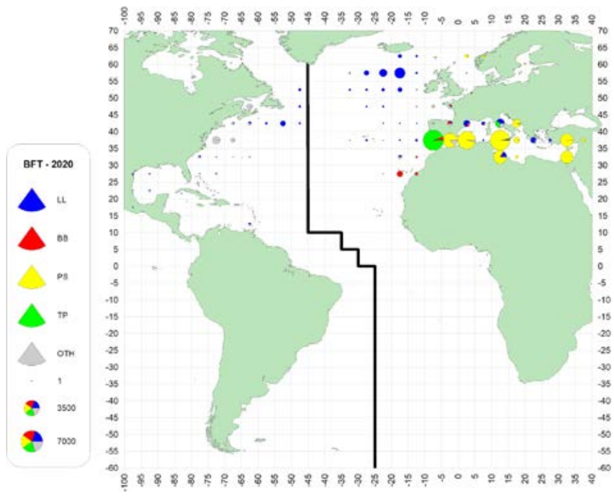
c. BFT (1990-99)



d. BFT (2000-09)

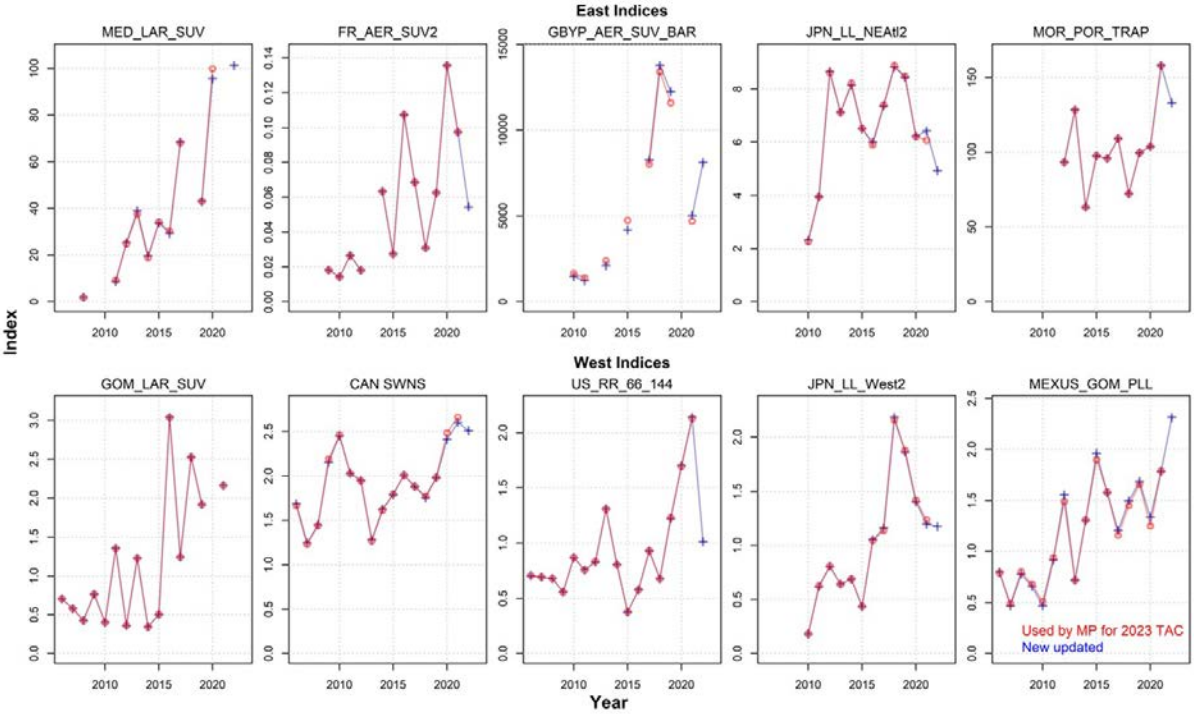


e. BFT (2010-19)

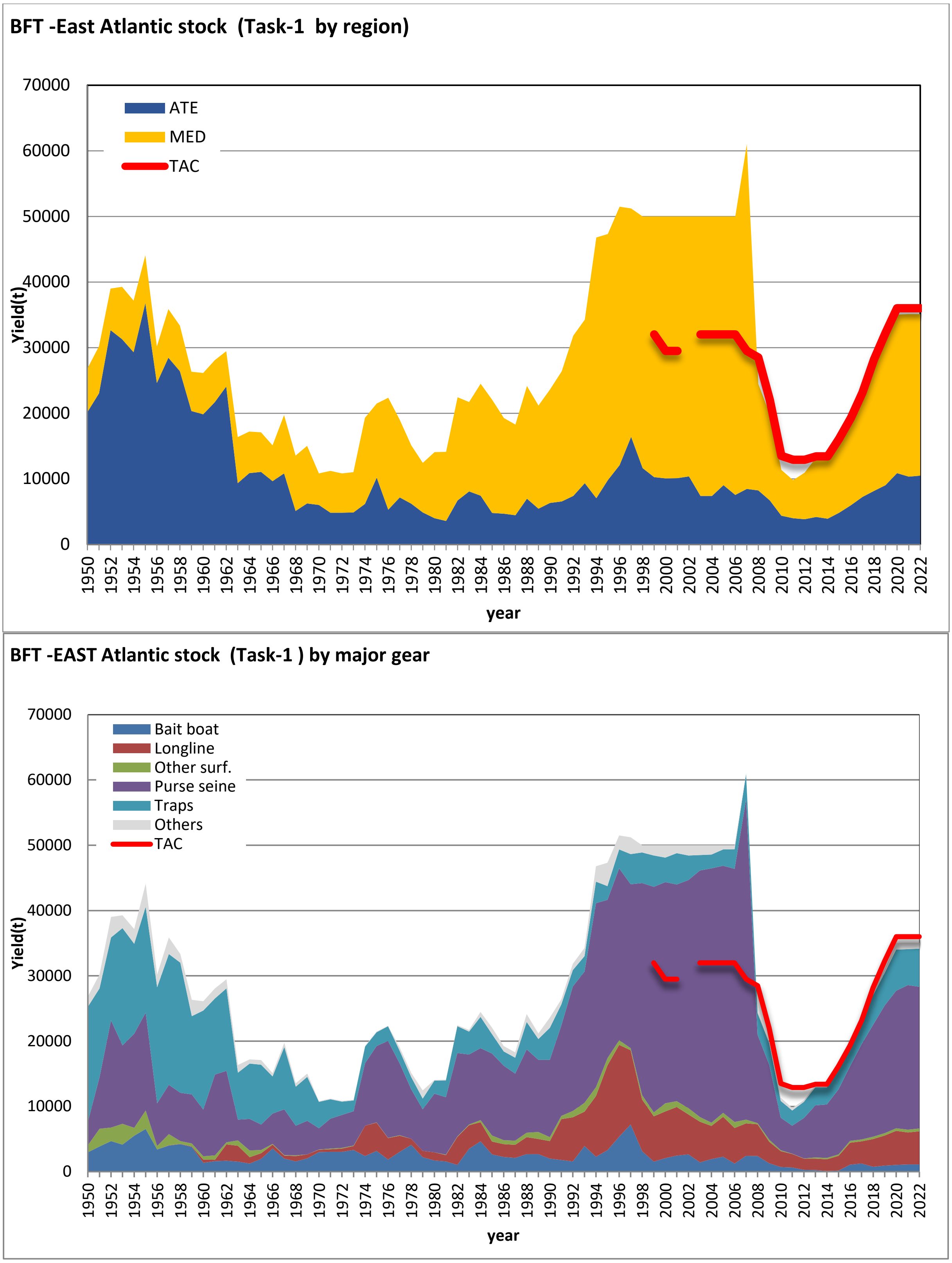


f. BFT (2020-21)

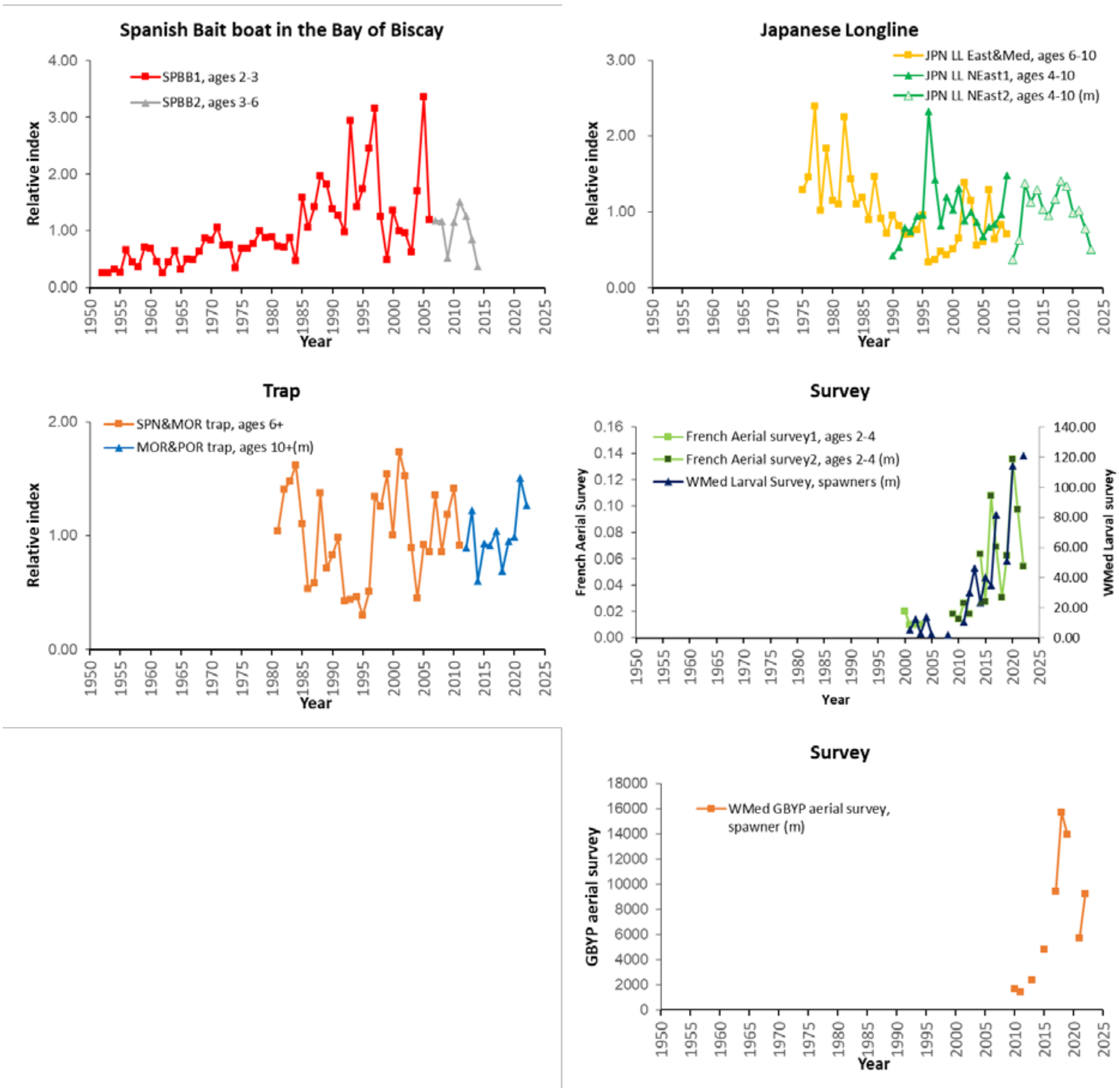
BFT-Figure 1. Geographic distribution of bluefin tuna catches per 5x5 degrees and per main gears from 1970 to 2021 (last decade only covers 2 years).



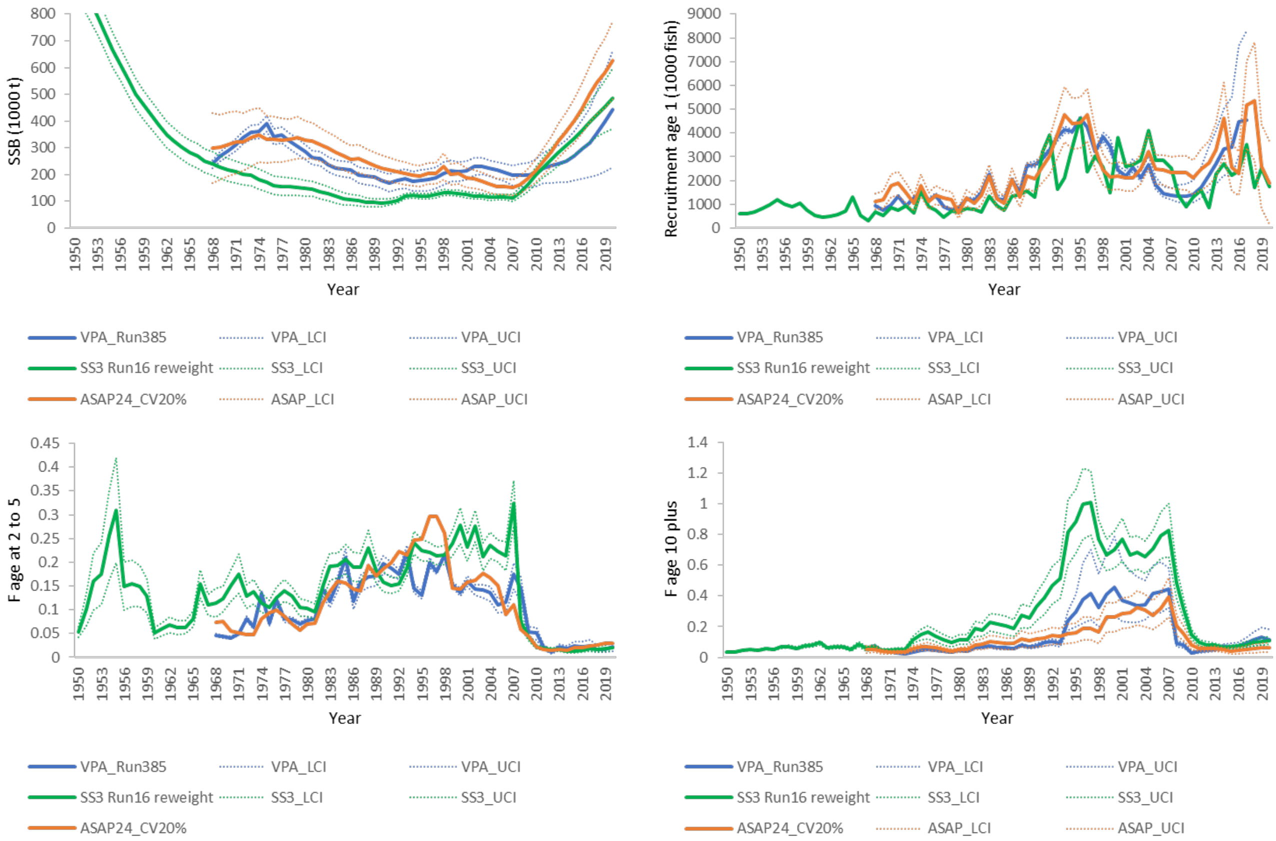
BFT-Figure 2 Comparison of the indices used in the MP calculations in 2022 (with data up to 2021, red) and the updated versions of these indices using data up to 2022 (blue).



BFT-E-Figure 1. Reported catch for the East Atlantic and Mediterranean from Task 1 data from 1950 to 2022 split by main geographic areas (top panel) and by gears (bottom panel) together with unreported catch estimated by the Committee from 1998 to 2007 and TAC levels since 1998.



BFT-E-Figure 2. Plots of the updated fishery dependent and independent indicators used for the East Atlantic and Mediterranean bluefin tuna stock. All fishery dependent indicators are standardized series and scaled to their averages. Indices denoted with a 'm' are used in the management procedure. The Spanish BB series was split in two series to account for changes in selectivity patterns, and the latest series was calculated using French BB data due to the sale of the quota by the Spanish fleet. The Japanese longline CPUE for the Northeast Atlantic was split in 2009/2010 and the French aerial survey index was split in 2008/2009.



BFT-E-Figure 3. Comparisons of the trends in estimated spawning stock biomass (SSB), recruitment (age 1), F at age 2 to 5, and F at age 10 plus group between base cases by model platform: VPA (blue lines), Stock Synthesis (green lines), and ASAP (orange lines). The time series of recruitments for the VPA have the terminal three years removed as it is standard practice not to consider these due to their estimates being unreliable.

9.7 BFT-W-Western bluefin

BFT-W-2. Fishery indicators

The total catch for the West Atlantic peaked at 18,608 t in 1964, mostly due to the Japanese longline fishery for large fish off Brazil (that started in 1962) and the U.S. purse seine fishery for juvenile fish (**BFT-Table 1**, **BFT-W-Figure 1**). Catches dropped sharply thereafter to slightly above 3,000 t in 1969 with declines in longline catches off Brazil in 1967 and in purse seines (**BFT-Figure 1**). Catches increased to over 5,000 t in the 1970s due to the expansion of the Japanese longline fleet into the Northwest Atlantic and Gulf of Mexico and an increase in purse seine effort targeting larger fish for the sashimi market. Catches declined abruptly in 1982 from close to 6,000 t in the late 1970s and early 1980s with the imposition of a catch limit. The total catch for the West Atlantic, including discards, fluctuated without trend after 1982, reaching 3,319 t in 2002 (the highest since 1981, with all three major fishing nations indicating higher catches). Total catch in the West Atlantic subsequently declined steadily to 1,638 t in 2007 and then fluctuated without pronounced trend. The catch in 2020, 2021 and 2022 was 2,269 t, 2,310 t and 2,700 t, respectively (as of 18 September 2023) (**BFT-W-Figure 1**).

The Committee notes that ongoing work conducted as part of the MSE process evaluated the sensitivity to assumed stock of origin of the large historical catches from the off Brazil and found that management procedure (MP) performance was insensitive to the stock of origin of these catches.

The Committee notes that the Total Allowable Catch (TAC) in the West has not been caught for the last 10 years. Based on information received, the Committee considers that this is not due to low stock abundance but rather to market and operational conditions.

For continuity of information, the Committee presents the indices used in the 2021 western bluefin stock assessment (Anon., 2021d) and their updated time series, however the primary source of information on recent indicators comes from the update of the five indices used for the current MP. The current MP uses five indices in each management area (**BFT-Figure 2**). The indices are individually weighted by the inverse of their variance in the MP and are used to develop an overall index that is used to determine the TAC according to specifications outlined in Rec. 22-09. Annually, the Committee evaluates the updated indices for determination of exceptional circumstances (ECs). The Committee evaluated the indicators for determination of ECs according to the proposed protocols and results are provided in section 19.17.

The most recent 2021 western bluefin stock assessment (Anon., 2021d) used 10 catch per unit effort (CPUE) and two survey indices up to and including the year 2020 (**BFT-W-Figure 2**). As noted previously, several indices exhibit trends that may be indicative of environmentally driven changes in availability and three of these indices (Can-GSL, US RR>177 and Canada Acoustic index) were not recommended for use in MPs. As in 2017 and 2020, the Stock Synthesis assessment reconciled the conflicting trends in some Canadian and United States indices under a hypothesis of environmentally mediated availability of fish to the two regions. The Canada Acoustic index experienced a very low value for 2018 and subsequently also for 2019; it appears that the index is in a state of transition, possibly due to environmentally driven changes in the spatial distribution of the fish or of their prey. The 2021 western bluefin stock assessment split the index and, as two years of data would be uninformative for the models, the years 2018 and 2019 were removed until such time as the differences between the time periods can be reconciled.

BFT-W-3. State of the stock

Until such time as a new assessment occurs, the Committee retains the stock status determination from the most recent assessments. In 2021, Stock Synthesis with alternative spawning-at-age scenarios equally weighted across model scenarios was used to determine stock status but not specifically to provide TAC advice. Current F (average of 2018-2020) relative to the $F_{0.1}$ reference point was 0.53 (0.49-0.58, 80% CI), indicating that overfishing was not occurring. The Committee retains the time series of estimated biomass, recruitment and fishing mortality between the two models run in the 2021 western bluefin stock asessment (SS and VPA (**BFT-W-Figure 3**)). As in the 2020 assessment, two spawning fraction scenarios (a young age at spawning, consistent with the eastern stock and older age of spawning with 100% spawning contribution at age 13) were considered in the assessment methods. Rather than presenting two series of spawning stock biomass (SSB) based on these two spawning fraction scenarios, total biomass is presented as this does not depend on which of these scenarios is selected.

The Committee has added a figure that shows the trajectory of $F/F_{0.1}$ for the most recent three Stock Synthesis and VPA assessments (2017, 2020, 2021), illustrating that trend in stock status relative to $F_{0.1}$ are quite similar across model platforms and across assessment years (**BFT-W-Figure 4**). The similarity in stock status relative to overfishing across models and model runs illustrates the utility of using the stock assessments to provide overfishing status, despite many well-documented uncertainties.

BFT-W-4. Outlook

In 1998, the Commission initiated a 20-year rebuilding plan designed to achieve SSB_{MSY} with at least 50% probability. As indicated above, the Committee did not use biomass-based reference points in previous stock assessments. The Committee is not evaluating if the stock is rebuilt because it has been unable to resolve the long-term recruitment potential.

The adopted MP accounts for many of the long-standing uncertainties regarding stock mixing, biomass-based reference points and recruitment that created uncertainty for the outlook for the stock. Furthermore, the Committee is no longer providing projections, TAC advice or Kobe 2 strategy matrices derived from the stock assessments using an $F_{0.1}$ strategy, as the MP provides TAC advice that was simulation tested to achieve MSY-based management objectives.

As noted above, stock assessments will continue to be valuable in providing status checks, to determine whether the MP is achieving the goal of maintaining stock status as well as to estimate recent recruitment. For continuity, the Committee provides the previous time series of $F/F_{0.1}$ showing the fishing status over time relative to the year-specific estimate of $F_{0.1}$ (**BFT-W-Figure 4**) and will update this figure with the next scheduled stock assessment.

BFT-W-5. Effect of current regulations

The 2021 and 2022 TAC recommendations were unlikely to have led to overfishing relative to $F_{0.1}$. The three-year TACs from the adopted MP are, by design, intended to ensure a high probability of maintaining stock status above B_{MSY} and avoiding overfishing.

BFT-W-6. Management recommendations

The Commission adopted a TAC of 2,350 t in 2021 (Rec. 20-06), and a moderate increase to 2,726 t in 2022 (Rec. 21-07) and, with the adoption of the management procedure in 2022 (Rec. 22-09), TAC of 2,726 t for 2023, 2024, and 2025 (Rec. 22-10).

According to the proposed EC provisions reviewed in 2023 and outlined in item 19.18 of this report, no EC exist that would warrant deviating from the TAC advice under the MP.

Summary table

The estimated mean of the SS models (two maturity specifications) for recent fishing mortality rate for each model was calculated as the geometric mean of F over 2018 to 2020 relative to the F reference point, $F_{0.1}$ (a proxy for F_{MSY}). The values in parenthesis represent the approximate 80% confidence intervals from the hessian-based standard errors or multivariate lognormal approximation approach.

WEST ATLANTIC BLUEFIN TUNA SUMMARY	
Current catch including discards (2022)	2,700 t*
$F_{CURRENT\ (2018-2020)}$	0.063 (0.059-0.067)[2]
$F_{0.1}$	0.118 (0.113-0.123)[3]
$F_{CURRENT\ (2018-2020)}/F_{0.1}$	0.53 (0.49-0.58)[2]
Estimated probability of overfishing ($F_{CURRENT\ (2018-2020)}$)/$F_{0.1}$)	<1%
Stock status (2020)[1]	Overfishing: No
Management Measures:	Rec. 22-10: TAC of 2,726 t in 2023, 2024 and 2025, including dead discards.

* As of 18 September 2023.

[1] Biomass reference points to determine stock status were not estimated in the 2021 BFT-W stock assessment due to uncertainty in recruitment potential.

[2] Mean and approximate 80% confidence interval from the multivariate lognormal approximation approach from the assessment.

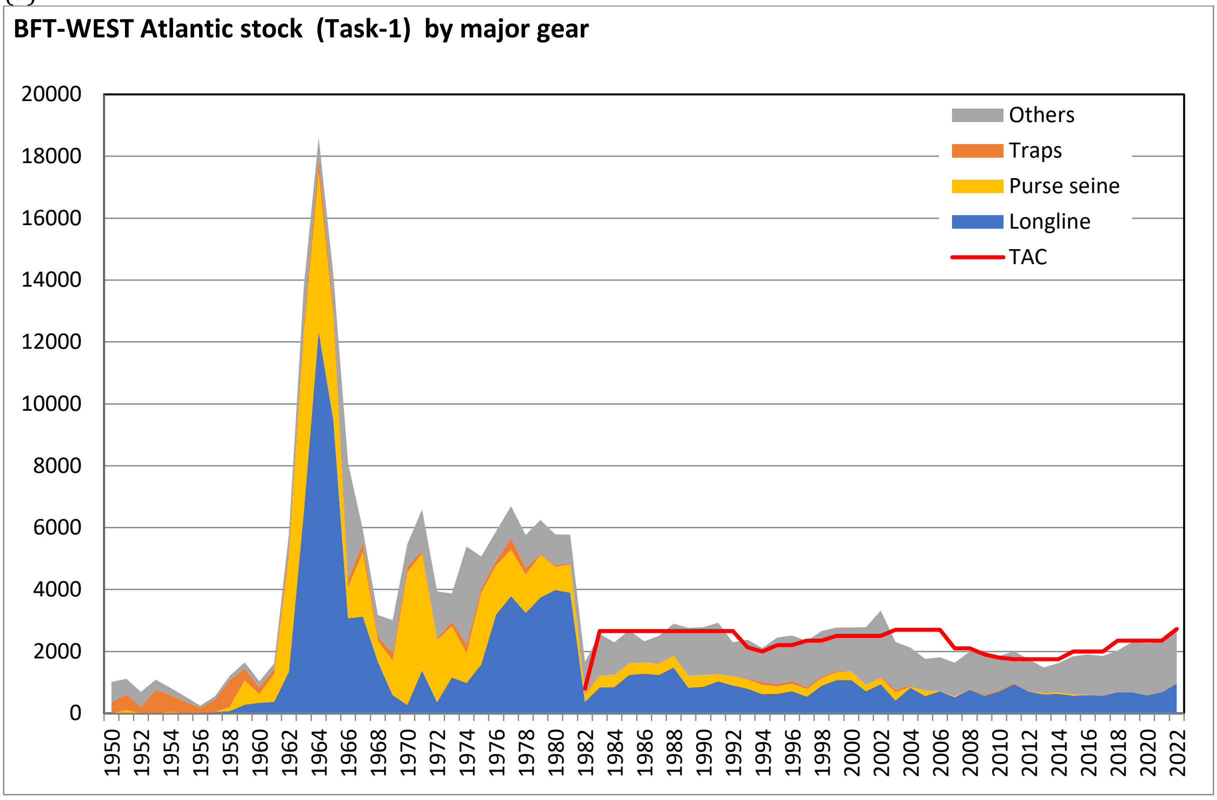
[3] Mean and approximate 80% confidence interval from the hessian-based standard errors.

BFT-Table 1. Estimated catches (t) of Northern bluefin tuna (*Thunnus thynnus*) by area, gear and flag.

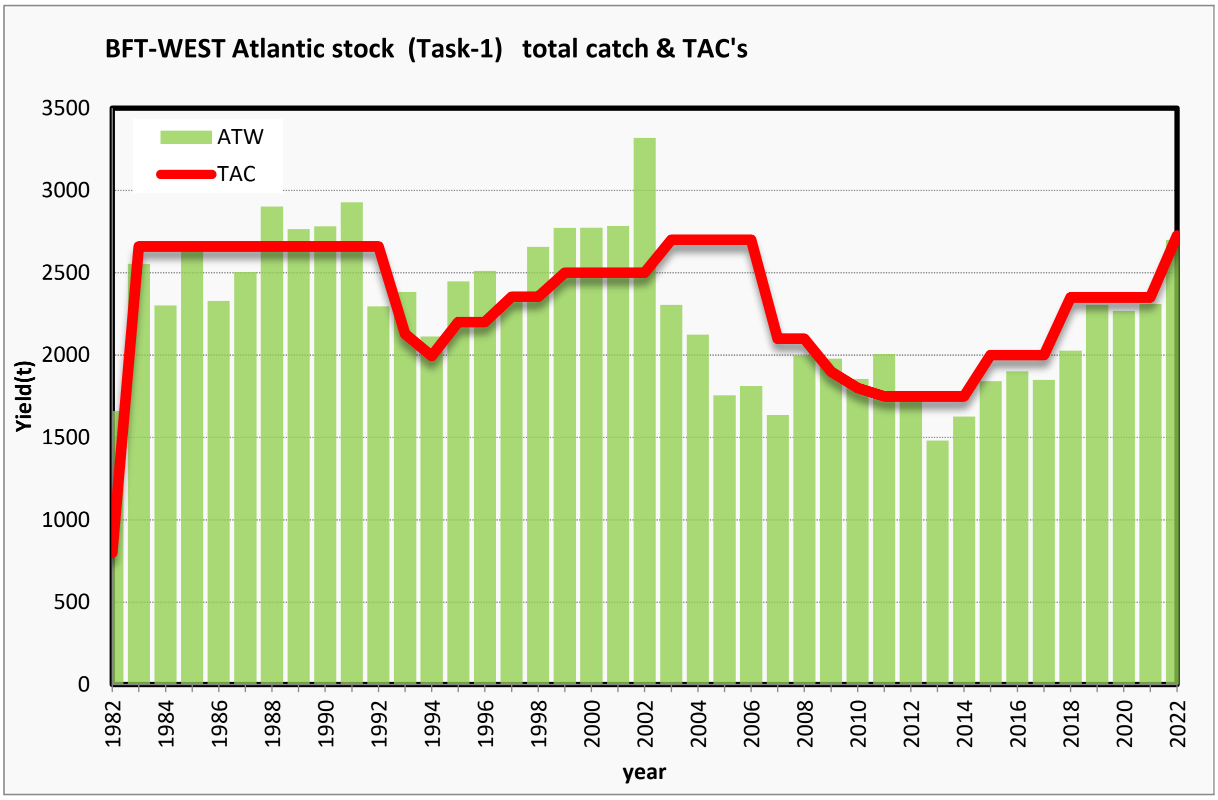
				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				36642	48881	49751	54009	53545	52657	52772	52775	52784	53319	52305	52125	51756	51812	62638	26460	21798	13195	11781	12688	14725	14887	18055	21313	25515	29809	33440	37308	37404	37802
BFT-E				34258	46769	47303	51497	51211	50000	50000	50000	50000	50000	50000	50000	50000	50000	61000	24460	19818	11338	9774	10934	13243	13261	16214	19412	23665	27782	31134	35038	35095	35102
	ATE			9317	7054	9780	12098	16379	11630	10247	10061	10086	10347	7394	7402	9023	7529	8441	8243	6684	4379	3984	3834	4163	3918	4841	5968	7216	8157	9044	10874	10308	10477
	MED			24941	39715	37523	39399	34831	38370	39753	39939	39914	39653	42606	42598	40977	42471	52559	16217	13133	6959	5790	7100	9080	9343	11372	13444	16450	19624	22090	24164	24786	24625
BFT-W	ATW			2384	2113	2448	2512	2334	2657	2772	2775	2784	3319	2305	2125	1756	1811	1638	2000	1980	1857	2007	1754	1482	1627	1842	1901	1850	2027	2306	2269	2310	2700
Landings	ATE		Bait boat	3884	2284	3093	5369	7215	3139	1554	2032	2426	2635	1409	1902	2282	1263	2436	2393	1260	725	636	283	243	95	172	1085	1195	692	845	936	1031	1026
			Longline	2802	2311	4522	4212	4057	3789	3570	3736	3303	2896	2748	2064	2700	2033	1705	2491	1951	1194	1125	1139	1167	1194	1467	1829	2208	2730	3128	3313	3249	3294
			Other surf.	976	590	555	273	60	387	404	509	558	631	521	290	424	831	502	181	297	124	35	49	141	210	193	261	295	340	320	381	359	368
			Purse seine	24	213	458	323	828	700	726	661	153	887	490	1078	1197	408	0	0	2	1	0	0	2	0	0	42	49	11	56	190	147	106
			Sport (HL+RR)	0	25	0	0	237	28	33	126	61	63	109	89	11	99	11	12	11	44	51	53	46	43	104	35	101	118	92	156	267	245
			Traps	1631	1630	1152	1921	3982	3586	3960	2996	3585	3235	2116	1978	2408	2895	3788	3166	3164	2292	2137	2311	2564	2376	2905	2716	3362	4258	4594	5889	5255	5434
	MED		Bait boat	48	0	206	5	4	11	4	38	28	1	9	17	5	0	0	0	38	1	0	2	2	9	25	0	50	56	72	103	81	88
			Longline	2470	6993	8469	9856	7313	4117	3338	3424	4144	3234	3484	3036	3427	3408	3269	2376	1344	1242	962	587	605	588	776	1523	1184	1518	1485	1889	1657	1785
			Other surf.	371	776	545	417	282	284	228	728	354	340	198	197	175	81	85	0	0	1	1	1	20	29	3	37	1	34	51	32	65	58
			Purse seine	20065	27948	23799	26021	24279	31792	33798	33237	33043	34044	37291	37869	36639	38363	48994	13540	11448	4986	4293	6172	7982	8184	9993	11340	14493	17128	19515	20872	21987	21591
			Sport (HL+RR)	1238	2307	3562	2149	2340	1092	1533	1773	1167	1520	1404	1325	619	494	117	149	160	448	356	202	240	289	373	308	439	582	611	865	740	717
			Traps	749	1691	942	951	613	1074	852	739	1177	515	221	154	112	125	93	152	144	281	165	125	222	232	192	227	272	300	353	399	252	384
	ATW		Longline	712	539	491	545	382	764	915	858	610	729	186	644	425	565	420	606	366	529	743	478	470	498	553	562	559	664	675	576	653	913
			Other surf.	406	307	384	429	293	342	279	283	201	107	139	97	89	85	63	78	121	107	147	117	121	119	138	93	123	77	168	134	175	209
			Purse seine	295	301	249	245	250	249	248	275	196	208	265	32	178	4	28	0	11	0	0	2	29	38	34	0	0	0	0	0	0	
			Sport (HL+RR)	854	804	1114	1032	1181	1108	1125	1121	1650	2036	1399	1139	924	1005	1023	1134	1251	1009	888	917	692	810	1085	1204	1144	1263	1450	1543	1444	1521
			Traps	29	79	72	90	59	68	44	16	16	28	84	32	8	3	4	23	23	39	26	17	11	20	6	10	13	3	4	4	4	0
Discards	ATE		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9	8	1	4
	MED		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
			Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	12	9	11	2	9	10	6	4	5	4	2
	ATW		Longline	88	83	138	167	155	123	160	222	105	211	232	181	131	149	100	159	207	174	202	224	145	139	19	29	10	17	7	8	31	54
			Other surf.	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	2	2	4	3	3
			Purse seine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4	5	0	0	0	0	0	0	
			Sport (HL+RR)	0	0	0	0	14	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATE	CP	Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			China PR	0	0	0	0	0	85	103	80	68	39	19	41	24	42	72	119	42	38	36	36	38	37	45	54	64	79	89	101	101	72
			EU-Denmark	37	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3	6
			EU-España	4962	3137	3819	6186	9519	4565	4429	3493	3633	4089	2172	2801	3102	2339	3680	3536	2409	1550	1483	1329	1553	1282	1655	1986	2509	2489	2729	3289	2953	3301
			EU-France	1099	336	725	563	269	613	588	542	629	755	648	561	818	1218	629	253	366	228	135	148	223	212	254	343	350	461	462	557	559	540
			EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Ireland	0	0	0	0	14	21	52	22	8	15	3	1	1	2	1	1	1	2	4	10	13	19	14	32	16	17	6	16	16	20
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
			EU-Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Portugal	91	363	169	199	712	323	411	441	404	186	61	27	82	104	29	36	53	58	180	223	235	243	263	327	429	450	475	592	614	583
			EU-Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Great Britain	0	0	1	0	1	1	12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	2	5
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	0	0
			Guinée Rep	0	330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Iceland	0	0	0	0	0	2	27	0	0	1	0	0	0	0	0	0	0	0	2	5	4	30	37	6	0	0	0	1	1	
			Japan	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	2351	1904	1155	1089	1093	1129	1134	1386	1578	1905	2262	2514	2773	2779	2867
			Korea Rep	0	4	205	92	203	0	0	6	1	0	0	3	0	1	0	0	0	0	0	0	0	0	0	161	181	208	232	247	242	252
			Maroc	415	720	678	1035	2068	2341	1591	2228	2497	2565	1795	1953	2389	1923	2418	1947	1909	1348	1055	990	960	959	1176	1433	1703	2164	2476	3089	2884	2704
			Norway	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	44	51	12	49	194	152	123
			Panama	0	1	19	550	255	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
			Sierra Leone	0	0	0	0	0	0	0	93	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		NCC	Chinese Taipei	6	20	4	61	226	350	222	144	304	158	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCO	Faroe Islands	0	0	0	0	0	67	104	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	6	2	2
			NEI (ETRO)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	223	68	189	71	208	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	MED	CP	Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	9	34	40	47	56	100	156	168	148	178
			Algerie	1097	1560	156	638	829	1674	1760	2083	2098	2056	1504	1440	1500	1673	1489	1311	0	0	0	69	244	244	370	448	1038	1300	1437	1649	1650	1650
			China PR	0	97	137	93	49	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Croatia	1058	1410	1220	1360	1105	906	970	930	903	977	1139	828	1017	1022	825	834	619	389	371	369	384	385	456	515	630	738	827	903	903	816
			EU-Cyprus	14	10	10	10	10	21	31	61	85	91	79	105	149	110	1	132	2	3	10	18	17	18	22	59	110	133	151	153	169	168
			EU-España	2018	2741	4607	2588	2209	2000	2003	2772	2234	2215	2512	2353	2758	2689	2414	2465	1769	1056	942	1064	948	1164	1238	1467	1688	2706	2660	2774	3228	2760
			EU-France	6995	11843	9604	9171	8235	7122	6156	6794	6167	5832	5859	6471	8638	7663	10200	2670	3087	1755	805	791	2191	2216	2565	3054	3661	4360	4919	5316	5289	5303
			EU-Greece	439	886	1004	874	1217	286	248	622	361	438	422	389	318	255	285	350	373	224	172	176	178	161	195	218	235	267	313	354	327	424
			EU-Italy	5379	6901	7076	10200	9619	4441	3283	3847	4383	4628	4981	4697	4853	4708	4638	2247	2749	1061	1783	1788	1938	1946	2273	2725	3196	3860	4286	4731	4699	4727
			EU-Malta	259	580	590	402	396	409	449	378	224	244	258	264	350	270	334	296	316	136	142	137	155	160	182	212	261	308	338	387	382	387
			EU-Portugal	164	306	313	274	37	54	76	61	64	0	2	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	77	77	155	99	124	181	263	122	327	67
			Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Japan	793	536	813	765	185	361	381	136	152	390	316	638	378	556	466	80	18	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Korea Rep	0	684	458	591	410	66	0	0	0	0	0	700	1145	26	276	335	102	0	0	77	80	81	0	0	0	0	0	0	0	**0**
			Libya	635	1422	1540	1388	1029	1331	1195	1549	1941	638	752	1300	1091	1327	1358	1318	1082	645	0	756	929	933	1153	1368	1631	1792	2052	2228	2232	2223
			Maroc	79	1092	1035	586	535	687	636	695	511	421	762	827	108	463	641	531	369	205	182	223	309	310	322	350	439	407	444	365	410	862
			Panama	467	1499	1498	2850	236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	41	0	34	0	0	0	0	40	47	57	66	72	79	0	79
			Tunisie	2132	2773	1897	2393	2200	1745	2352	2184	2493	2528	791	2376	3249	2545	431	2679	1932	1042	852	1017	1057	1047	1248	1486	1783	2102	2380	2653	2730	2659
			Türkiye	3084	3466	4219	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	879	665	409	519	536	551	555	1091	1324	1515	1284	1771	2258	2266	2295
		NCC	Chinese Taipei	328	709	494	411	278	106	27	169	329	508	445	51	267	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Gibraltar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	14	16	15	17	20	22	25
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	1	1	0	0	0	0	1
			Israel	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	427	639	171	1058	761	78	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (combined)	0	773	211	0	101	1030	1995	109	571	508	610	709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (inflated)	0	0	0	0	0	9471	16893	16458	15298	15880	18873	18376	14164	18343	28234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Serbia & Montenegro	0	0	2	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Yugoslavia Fed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATW	CP	Brazil	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0**
			Canada	459	392	576	597	503	595	576	549	524	604	557	537	600	733	491	575	530	505	474	477	480	463	531	466	472	508	666	642	626	613
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			FR-St Pierre et Miquelon	0	0	0	0	0	0	1	0	0	3	1	10	5	0	4	3	2	8	0	0	0	0	9	0	0	0	0	0	0	**0**
			Japan	581	427	387	436	322	691	365	492	506	575	57	470	265	376	277	492	162	353	578	289	317	302	347	345	346	406	406	407	410	657
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Mexico	17	4	23	19	2	8	14	29	10	12	22	9	10	14	7	7	10	14	14	51	23	51	53	55	34	80	39	28	63	60
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	0	0	0	1	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	**0**
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	1237	1163	1311	1285	1334	1235	1213	1212	1583	1840	1426	899	717	468	758	764	1068	803	738	713	502	667	877	1002	986	1013	1185	1178	1177	1311
		NCC	Chinese Taipei	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	0	0	0	0	0	0	0	0	0	74	11	19	27	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			ICCAT (RMA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	0	0	429	270	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	2	43	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	ATE	CP	Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	9	8	1	4
	MED		Albania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	5	2	2	4	5	6	4	5	4	2
			EU-Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	**0**
			Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	0	0	0	0	0	0	0	0	**0**
			Tunisie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	5	5	0	0	0	0	**0**
			Türkiye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	**0**
	ATW		Canada	0	0	0	0	6	16	11	46	13	37	14	15	0	2	0	1	3	25	36	17	0	0	3	8	1	3	3	5	5	6
			Japan	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
			USA	88	83	138	171	155	110	149	176	98	174	218	167	131	147	100	158	204	150	166	206	159	143	22	24	10	15	6	8	28	50

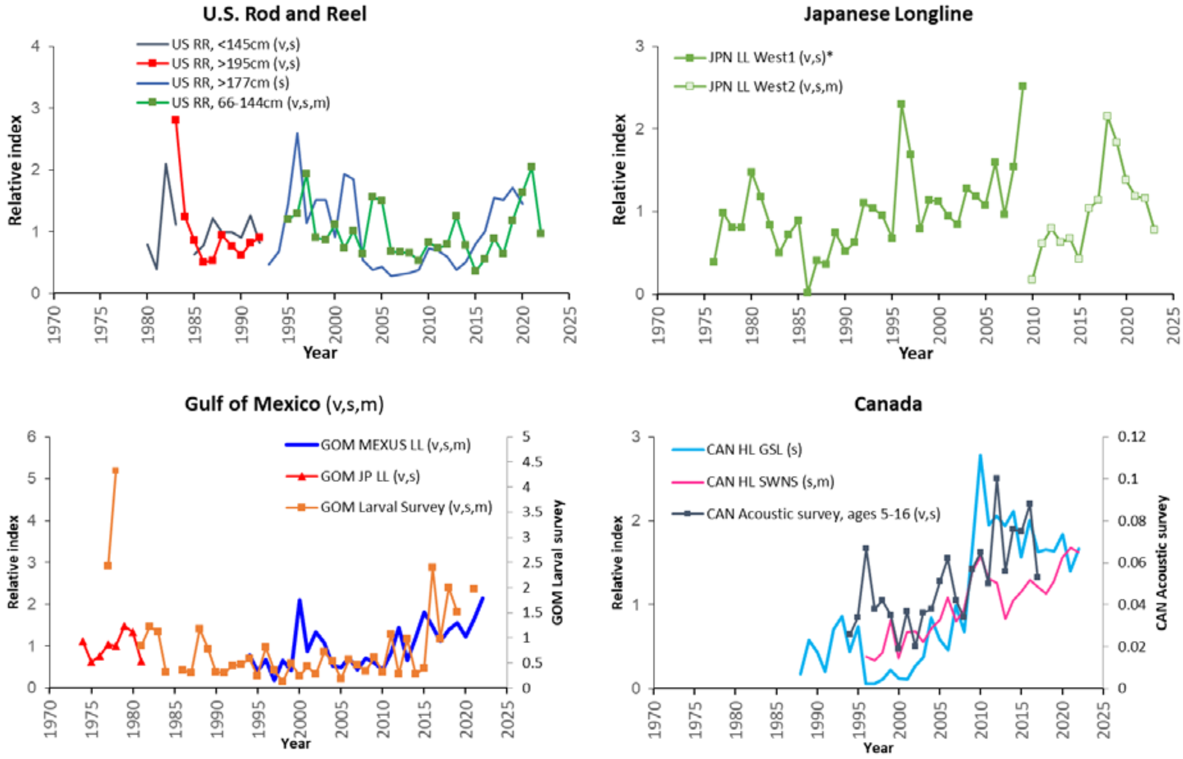
(a)



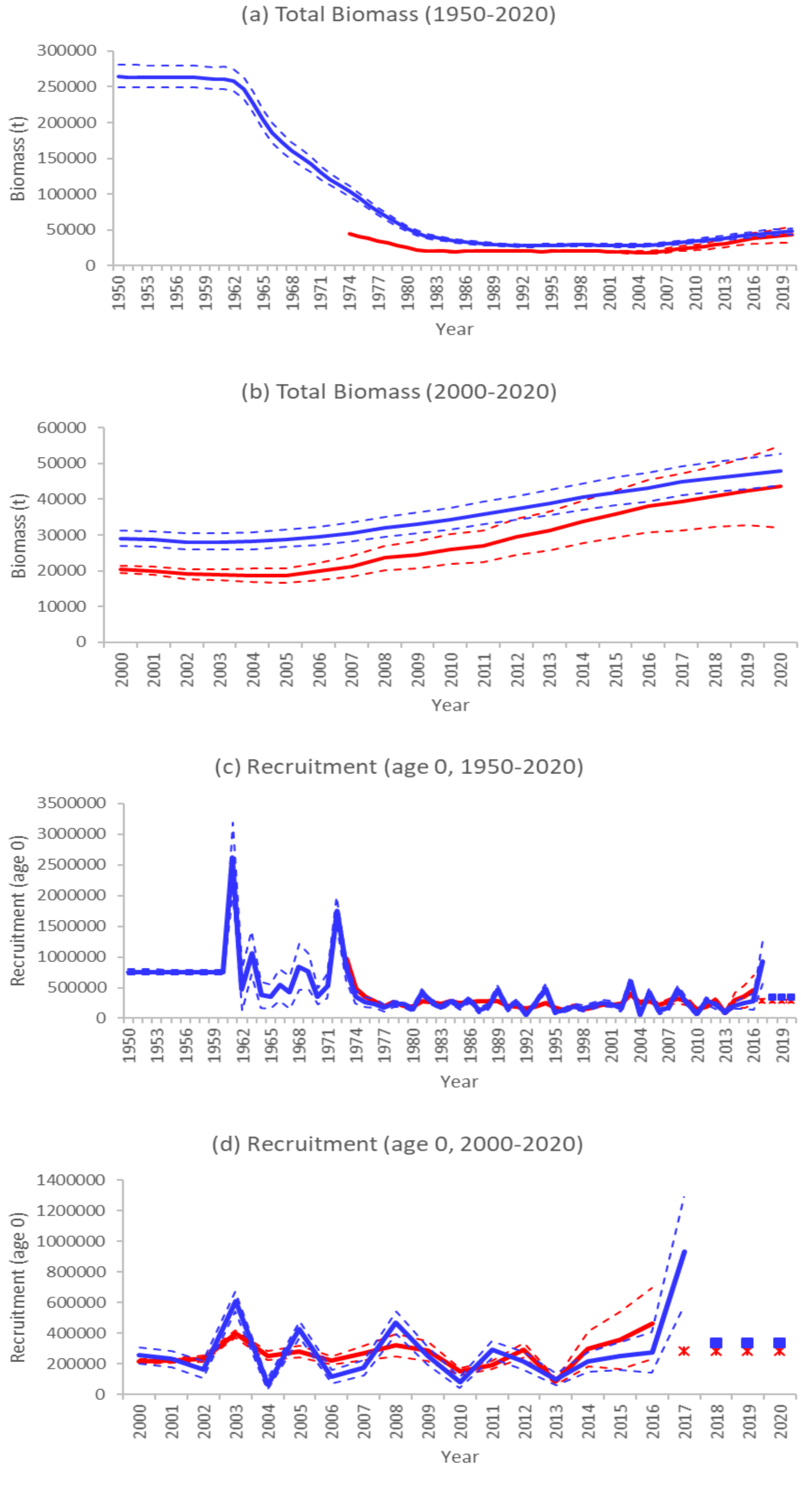
(b)



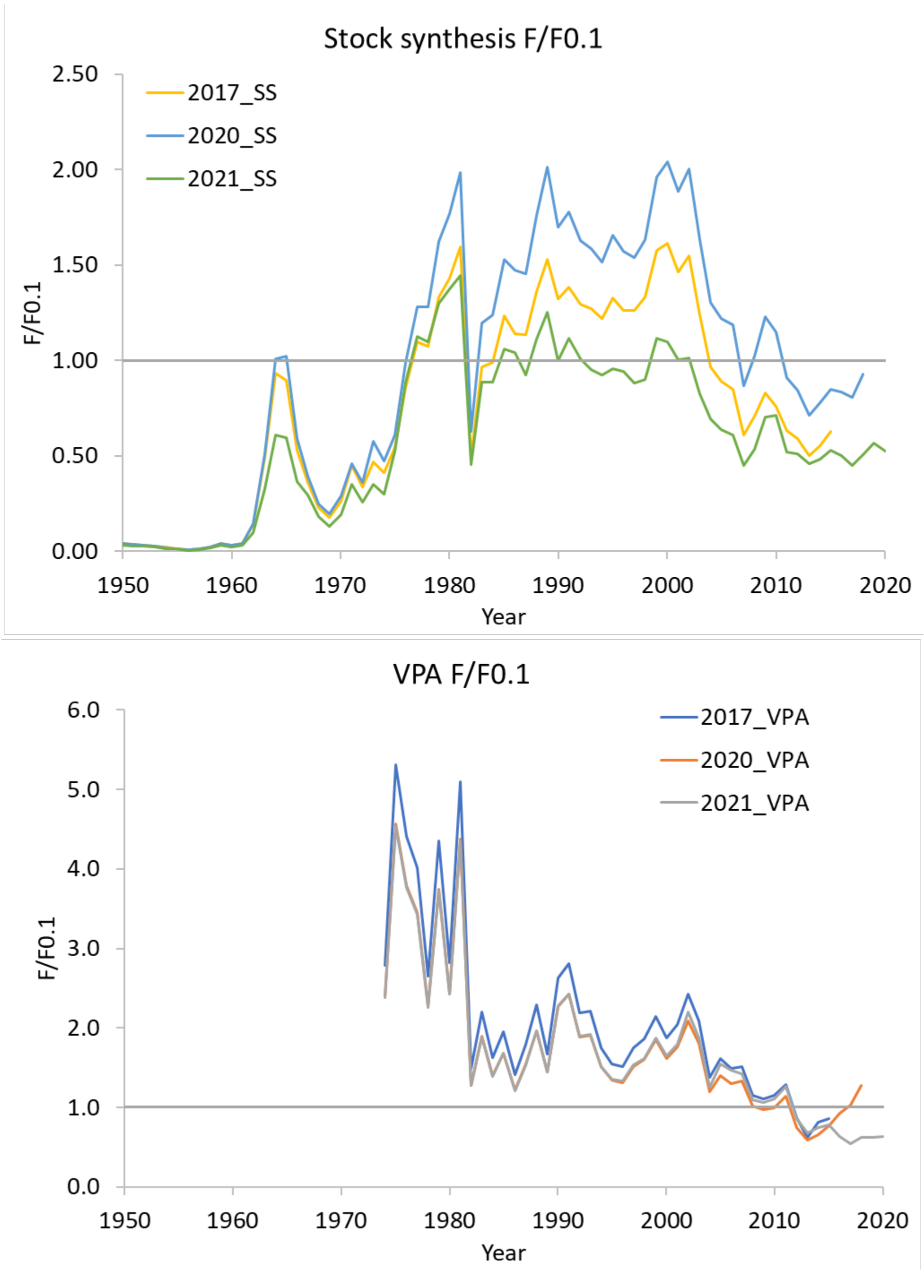
BFT-W-Figure 1. Historical catches of western bluefin tuna: (a) by gear type and (b) TACs agreed by the Commission (which are shown for comparison).



BFT-W-Figure 2. Indices of relative abundance for western bluefin tuna. Indices denoted with an "s" were used in Stock Synthesis, indices with a "v" were used in VPA and indices with a 'm' are used in the management procedure. (*) The 1986 low data point of the Japanese longline in the West Atlantic was removed in the Stock Synthesis models.



BFT-W-Figure 3. Estimates of (a) total stock biomass for 1950-2020 and (b) for 2000-2020, and (c) recruitment (age 0) for 1950-2020 and (d) for 2000-2020 for the base VPA (red) and Stock Synthesis (blue) models from the 2021 assessment. The 80% confidence intervals are indicated with dashed lines. Recruitment estimates for the recent years (2017-2020 for VPA; 2018-2020 for Stock Synthesis) have been replaced by the average recruitment in the recent 6 years (2012-2017).



BFT-W-Figure 4. a. Fishing mortality relative to the $F_{0.1}$ reference point as estimated by Stock Synthesis (a) and VPA (b) for the 2017, 2020 and 2021 assessments.

9.8 SBF - South bluefin

The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is charged with assessing the status of southern bluefin tuna. Each year the SCRS reviews the CCSBT report in order to know the research on southern bluefin tuna and the stock assessments carried out. The reports are available from the CCSBT.

9.9 BUM - Blue marlin

The most recent assessment for blue marlin was conducted in 2018 through a process that included a data preparatory meeting in March 2018 (Anon., 2018b) and an assessment meeting in June 2018 (Anon., 2018c). The last year of fishery data used in the assessment was 2016.

BUM-1. Biology

The central and northern Caribbean Sea and northern Bahamas have historically been known as the primary spawning area for blue marlin in the western North Atlantic. Recent reports show that blue marlin spawning can also occur north of The Bahamas in an offshore area near Bermuda at about 32º-34º N. Ovaries of female blue marlin caught by artisanal vessel in Côte d'Ivoire show evidence of pre-spawning and post-spawning, but not of spawning. In this area females are more abundant than males (4:1 female/male ratio). Coastal areas off West Africa have strong seasonal upwelling, and may be feeding areas for blue marlin.

Atlantic blue marlin inhabit the upper parts of the open ocean. Blue marlin spend the majority of their time in the mixed surface layer (58% of daylight and 84% of nighttime hours), however, they regularly make short-duration dives to maximum depths of around 300 m, with some vertical excursions down to 800 m. They do not confine themselves to a narrow range of temperatures but most tend to be found in waters warmer than 17°C. The distribution of time at depth is significantly different between day and night. At night, the fish spent most of their time at or very close to the surface. During daylight hours, they are typically below the surface, often at 40 to 100+ m. These patterns, however, can be highly variable between individuals and also vary depending on the temperature and dissolved oxygen of the surface mixed layer. This variability in the use of habitat by blue marlin indicates that simplistic assumptions about habitat usage made during the standardization of catch per unit effort (CPUE) data may be inappropriate.

BUM-2. Fishery indicators

The decadal geographic distribution of the catches is given in **BUM-Figure 1**. The Committee used Task 1 catches as the basis for the estimation of total removals (**BUM-Figure 2**). Total removals for the period 1990-2016 were obtained during the 2018 blue marlin data preparatory meeting (Anon., 2018b) by modifying Task 1 values with the addition of blue marlin that the Committee estimated from catches reported as billfish unclassified. Additionally, the reporting gaps were filled with estimated values for some fleets.

During the 2018 blue marlin assessment it was noted that catches from 2013, 2014, and 2016 had been above the recommended TAC, and this continues to be the case for 2017. Over the last 20 years, Antillean artisanal fleets have increased the use of Moored Fish Aggregating Devices (MFADs) to capture pelagic fish. Catches of blue marlin caught around MFADs are known to be significant and increasing in some areas, however reports to ICCAT on these catches are incomplete. Although historical catches from some Antillean artisanal fleets have been recently included in Task 1 there is still an unknown number of Antillean artisanal fleets that may have unreported catches of blue marlin caught around MFADs. It is important that the amount of these catches be documented. Recent reports from purse seine fleets in West Africa suggest that blue marlin is more commonly caught with tuna schools associated with FADs than with free tuna schools. It is noted that blue marlin catches continued to decline until 2022. Preliminary Task 1 catches of blue marlin (**BUM-Table 1**) in 2021 and 2022 were 1,762 t and 1,680 t, respectively. These catches are likely underestimated because few CPCs have reported discards.

A series of indices of abundance for blue marlin were presented and discussed during the 2018 Blue Marlin Data Preparatory Meeting (Anon., 2018b). Ten CPUE series were used in the assessment. The standard errors from the CPUE standardized series were applied as weighting factors in all assessment models. All estimated standardized CPUE indices for blue marlin showed a sharp decline during the period 1960-1975, and thereafter have fluctuated around lower levels (**BUM-Figure 3**).

BUM-3. State of the stocks

A full stock assessment was conducted for blue marlin in 2018 (Anon., 2018c), applying to the available data through 2016, using both surplus production and age-structured models. Both models estimated similar annual trends of biomass and fishing mortality (**BUM-Figure 4.1** and **4.2**). The results of the 2018 assessment indicated that the estimated B/B_{MSY} and F/F_{MSY} were such that the current stock status is overfished and undergoing overfishing. Since the mid-2000s, the biomass has ceased to decline and fishing mortality has shown a declining trend since its peak in 2003.

The 2018 results are similar to those of the 2011 assessment. The estimated MSY was determined to be 3,001 t with 10% and 90% confident limits of 2,399 to 3,537 t. The current status of the blue marlin stock is presented in **BUM-Figure 5.** The probability of being in the red quadrant of the Kobe plot was estimated to be 54%. The probability of being in the yellow quadrants of the Kobe plot was estimated to be 42% and that of being in the green quadrant only 4%. However, the Committee recognizes the high uncertainty with regard to data and the productivity of the stock.

BUM-4. Outlook

A combination of projection results from the Bayesian Surplus Production model and the age structure model was used to produce the advice outlook, including the Kobe strategy matrices. Projections were made by assuming the current reported catch for 2016 (2,036 t, estimate available at the time of the assessment) will have also been taken in 2017 and 2018. According to these projections the catches of 2,000 t (close to catches reported in 2015, 2016 and 2017) will only provide a 46% probability of being in the green quadrant by 2028. In contrast, a TAC of 1,750 t will allow the stock to rebuild with more than 50% probability by the year 2028 (**BUM-Figure 6; BUM-Table 2**).

BUM-5. Effect of current regulations

A 2006 recommendation (Rec. 06-09) established that the annual amount harvested by pelagic longline and purse seine vessels and retained for landing must be no more than 33% for white marlin and 50% for blue marlin of the 1996 or 1999 landing levels, whichever is greater. Furthermore, in 2012, the Commission established a TAC for 2013, 2014, and 2015 of 2,000 t (Rec. 12-04), placed additional catch and commerce restrictions in recreational fisheries for blue marlin and white marlin, and requested methods for estimating live and dead discards of blue marlin and white marlin/spearfish. The Commission further strengthened the plan to rebuild blue marlin stock by extending for 2016, 2017, 2018, and 2019 the annual limit of 2,000 t for blue marlin (Rec. 15-05, Rec. 18-04). The Commission established a landings limit of 1,670 t beginning in 2020 (Rec. 19-05). Landings in 2020 and 2021 exceeded the limit in Rec. 19-05 and were below the limit in 2022.

The Committee is concerned with the significant increase in the contribution from non-industrial fisheries to the total blue marlin harvest and that the landings from these fisheries are not fully accounted for in the current ICCAT database. The Committee expressed its serious concern over this limitation on data for future assessments. Such data limitation impairs any analysis of the current regulations.

Currently, ICCAT Rec. 22-12 and four ICCAT Contracting Parties (Brazil, Canada, Mexico, and the United States) mandate or encourage the use of circle hooks on their pelagic longline fleets. Recent research has demonstrated that in some longline fisheries the use of non-offset circle hooks resulted in a reduction of billfish mortality, while the catch rates of several of the target species remained the same or were greater than the catch rates observed with the use of conventional J hooks or offset circle hooks.

More countries have started reporting data on live releases since 2006. Additional information has come about, for some fleets, regarding the potential for modifying gears to reduce the bycatch and increase the survival of marlins. Such studies have also provided information on the rates of live releases for those fleets. However there is not enough information on the proportion of fish being released alive for all fleets, to evaluate the effectiveness of the ICCAT recommendation relating to the live release of marlins.

BUM-6. Management recommendations

The 2018 assessment confirmed the advice provided in 2011 that catches of 2,000 t (current TAC) would have allowed the stock to increase in size. Because the catches have generally exceeded 2,000 t, the stock has not increased at the time of the 2018 assessment. The Committee recommends that the Commission should find ways to make sure that the catches are not allowed to exceed established Landings limit. Because the stock has not rebuilt catches (landings and dead discards) need to be lower than the current landings limit. Catches of 1,750 t or less were expected to provide at least a 50% chance of rebuilding by 2028.

The Committee recommends that if the Commission wants to further reduce fishing mortality and to reduce the chance of exceeding any established limits or TAC, the Commission could consider doing so by modifying Rec. 19-05 para 4 so that fishermen are always required to release all marlins that are alive at haul back through methods that maximize their survival.

ATLANTIC BLUE MARLIN SUMMARY

Maximum Sustainable Yield	3,056 t (2,384 – 3,536 t)[1]
Current (2022) Yield	1,680 t[2]
Relative Biomass (SSB_{2016}/SSB_{MSY})	0.69 (0.52 – 0.91)[1]
Relative Fishing Mortality (F_{2016}/F_{MSY})	1.03 (0.74 -1.50)[1]
Stock Status (2016)	Overfished: Yes [96% prob][3]
	Overfishing: Yes [54% prob][3]
Conservation and Management Measures in Effect:	Rec. 18-05 and Rec. 19-05 Landing limit of 1,670 t beginning in 2020.

[1] Combined Bayesian surplus production model and age structured assessment model results. Values correspond to median estimates, 80% confidence interval values are provided in parenthesis.
[2] 2022 yield should be considered provisional.
[3] Based on the Kobe plot proportions by quadrant.

BUM-Table 1. Estimated catches (t) of Atlantic blue marlin (*Makaira nigricans*) by area, gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL	A+M		3135	4216	4187	5366	5670	5637	5326	5395	4376	3807	4316	3106	3470	3070	4263	3602	3121	3001	2744	2740	2131	2749	2087	2133	2454	1633	1898	1879	1762	1680
Landings		Longline	2306	3115	3088	3983	4450	4422	3933	3965	2829	2083	2342	2013	2267	2102	2643	2555	2125	2023	1571	1432	1169	1593	1309	1334	1539	1148	1398	1042	769	750
		Other surf.	588	870	869	1119	950	1033	1238	1302	1400	1459	1650	884	1126	826	1399	739	782	781	880	944	761	899	554	514	722	360	395	691	791	659
		Sport (HL+RR)	114	120	77	68	132	130	72	69	123	216	305	174	51	103	179	269	152	177	237	289	142	200	112	220	93	64	42	78	151	193
Landings(FP)		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
Discards		Longline	127	111	153	197	139	51	83	60	22	37	19	34	24	38	42	37	40	19	56	70	55	54	106	52	73	44	55	58	46	39
		Other surf.	0	0	0	0	0	1	0	0	2	11	0	1	1	0	0	1	21	1	0	5	4	3	5	13	27	17	9	11	5	8
Landings	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	**0**
		Barbados	21	19	31	25	30	25	19	19	18	11	11	0	0	25	0	0	0	9	13	14	11	12	34	11	24	21	13	22	12	9
		Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3	3	7	47	19	8	5	13	1	6	0	2	0	**0**
		Brazil	147	81	180	331	193	486	509	467	780	387	577	195	612	298	262	182	150	130	63	48	114	105	89	79	64	37	20	13	2	3
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	**0**
		China PR	0	62	73	62	78	120	201	23	92	88	89	58	96	99	65	13	77	100	99	61	45	40	44	50	40	42	46	37	4	10
		Curaçao	40	40	40	40	40	40	40	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	2	0	15	2	**0**
		Côte d'Ivoire	104	151	134	113	157	66	189	288	208	111	171	115	21	8	132	66	72	54	17	48	48	87	15	72	44	32	163	41	148	6
		EU-España	44	55	40	158	122	195	125	140	94	28	12	51	24	91	38	55	160	257	131	190	147	209	287	225	321	0	0	0	4	95
		EU-France	139	149	154	197	232	257	285	305	329	340	340	345	360	361	358	395	265	281	284	263	162	303	196	167	209	279	386	282	131	170
		EU-Portugal	15	11	10	7	3	61	20	22	18	8	32	27	48	105	135	158	106	140	54	55	25	23	46	50	57	74	18	28	37	36
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**0**
		FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Gabon	1	2	0	304	5	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Ghana	236	441	471	422	491	447	624	639	795	999	415	470	759	405	683	191	140	116	332	234	163	236	88	44	162	60	44	53	278	121
		Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Grenada	33	52	50	26	47	60	100	87	104	69	72	45	42	33	49	54	32	69	53	32	63	63	56	53	54	62	69	49	18	45
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	23	0	15	0	**0**
		Japan	926	1523	1409	1679	1349	1185	790	883	335	267	442	540	442	490	920	1028	822	731	402	430	189	280	293	296	430	287	357	293	304	335
		Korea Rep	13	56	56	144	56	2	3	1	1	0	0	1	6	33	64	91	36	85	57	34	24	10	3	26	25	25	13	20	12	10
		Liberia	0	0	87	148	148	701	420	712	235	158	115	188	304	162	274	76	56	46	133	94	178	293	35	127	10	1	2	2	9	25
		Maroc	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	4	7	82	0	0	27	0	**0**
		Mexico	3	13	13	13	13	27	35	68	37	50	70	90	86	64	91	81	93	89	68	106	86	67	72	66	60	68	51	39	43	29
		Namibia	0	0	0	0	0	0	0	0	0	3	0	5	9	57	0	50	2	23	10	0	8	36	8	32	57	84	53	51	70	8
		Panama	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	21	0	14	12	**0**
		Philippines	0	0	0	0	0	7	71	38	0	0	0	0	0	0	0	8	0	3	4	1	2	2	0	0	0	0	0	0	0	**0**
		Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		S Tomé e Príncipe	25	28	33	36	35	33	30	32	32	32	32	9	21	26	66	68	70	72	74	76	78	81	11	10	13	5	88	34	109	75
		Senegal	0	9	0	2	5	0	0	0	11	24	32	11	1	5	91	114	61	41	64	164	45	72	10	82	39	25	21	358	73	332
		South Africa	0	0	0	0	0	0	0	0	1	4	0	0	0	0	2	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0
		St Vincent and Grenadines	2	2	2	1	1	0	1	0	0	20	0	0	0	0	1	3	2	1	0	0	2	0	0	0	2	2	1	2	2	**0**
		Trinidad and Tobago	2	16	28	14	50	16	20	51	17	16	9	11	7	14	16	34	26	22	25	46	48	48	35	19	0	0	0	0	1	**0**
		UK-Bermuda	11	15	15	15	3	5	1	2	2	2	2	2	2	2	2	2	0	1	2	2	3	3	3	2	1	2	1	1	1	1
		UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		UK-Sta Helena	0	0	2	2	1	2	4	4	3	4	1	1	2	2	3	4	2	2	2	12	2	1	1	0	0	0	0	0	0	**0**
		UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USA	80	88	43	43	46	50	37	24	16	17	19	26	16	17	9	13	6	4	6	14	9	1	9	19	13	20	17	17	22	22
		USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Uruguay	0	3	1	1	26	23	0	0	0	1	5	3	2	8	5	0	6	1	0	0	0	0	0	0	0	0	0	0	0	**0**
		Venezuela	86	122	117	148	142	226	240	125	84	88	120	101	160	172	222	130	120	151	116	143	111	139	150	185	194	125	148	125	121	72
	NCC	Chinese Taipei	685	663	467	660	1478	578	486	485	240	294	319	315	151	99	233	148	195	153	199	133	78	62	61	75	73	74	40	70	76	40
		Costa Rica	0	0	0	0	0	0	3	2	2	0	0	2	1	3	2	11	9	12	19	14	19	34	53	48	74	35	27	15	24	11
		Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	39	75	**0**
	NCO	Benin	6	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cuba	69	39	85	43	53	12	38	55	56	34	3	4	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Dominica	0	0	0	0	0	0	0	0	64	69	75	36	44	55	58	106	76	76	60	0	0	85	62	49	74	52	45	64	54	54

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		Dominican Republic	0	0	0	0	41	71	29	23	23	115	207	142	30	38	47	67	60	65	100	98	99	96	73	170	0	0	0	0	0	
		Jamaica	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Mixed flags (FR+ES)	146	133	126	96	82	80	83	147	151	131	148	171	150	136	135	139	164	178	186	181	191	173	176	0	0	0	0	0	0	
		NEI (BIL)	0	0	0	0	0	0	0	53	184	258	167	89	7	160	209	205	177	0	34	0	0	0	0	0	0	0	0	0	0	
		NEI (ETRO)	174	326	362	435	548	803	761	492	274	17	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	8	12	0	2	5	4
		Sta Lucia	0	0	0	0	4	1	0	10	5	9	18	17	21	53	46	70	72	58	64	119	99	111	53	91	134	93	82	78	61	85
		Togo	0	0	0	0	23	0	73	53	141	103	775	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Ukraine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	7	8	6	3	2	0	0	0	0	0	0	0	
Landings(FP)	CP	EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Discards	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
		Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	0	**0**
		EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	1	4	3	5	7	6	0	0	2	0	**0**
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	6	11	12	9	5	5	8
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	0	**0**
		Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	8	16	9	2
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	1	0	0	0	0	0	0	**0**
		Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	0	**0**
		UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USA	127	111	153	197	139	52	83	60	25	49	19	35	25	36	42	38	42	19	50	39	55	53	81	25	47	22	24	20	9	18
	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	24	27	26	16	22	21	20	18

BUM-Table 2. Kobe II matrices for Atlantic blue marlin giving the probability that $F<F_{MSY}$, $B> B_{MSY}$ and the joint probability of $F<F_{MSY}$ and $B>B_{MSY}$, between 2019 and 2028, with various constant catch levels based on Bayesian Surplus Production model and stock synthesis model base case model results.

a) Probability that $F<F_{MSY}$.

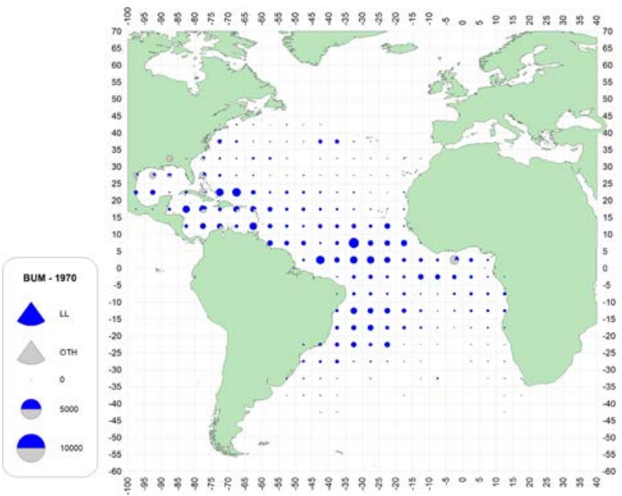
Catch (t)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0	100	100	100	100	100	100	100	100	100	100
1000	98	98	98	98	98	98	98	98	98	98
1250	92	93	93	93	93	94	94	94	94	94
1500	84	85	85	86	87	87	87	88	88	89
1750	73	74	76	77	78	79	80	80	80	81
2000	60	62	64	66	67	69	70	71	72	73
2250	45	48	51	53	55	57	58	59	61	62
2500	33	36	38	40	42	44	46	48	49	51
2750	23	25	27	29	31	32	34	35	37	39
3000	15	17	18	20	21	23	24	26	27	30
3250	9	10	10	11	12	13	15	17	19	22
3500	6	7	7	7	9	10	12	14	17	19

b) Probability that $B>B_{MSY}$.

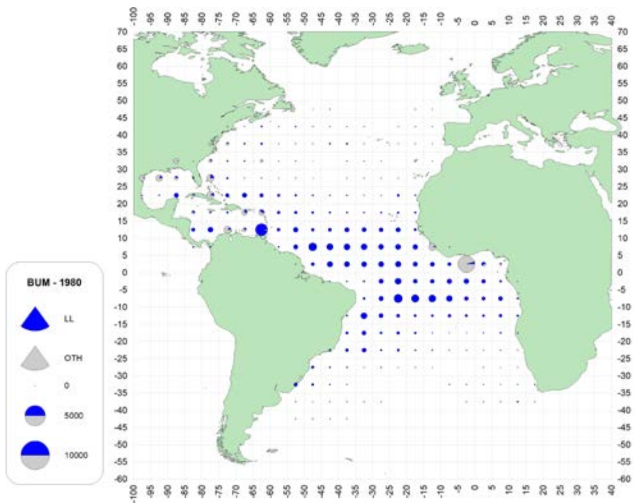
Catch (t)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0	11	21	34	47	59	68	75	80	84	86
1000	11	18	26	35	43	51	57	63	68	71
1250	11	16	24	31	39	46	52	57	61	66
1500	11	16	22	28	34	40	46	51	56	60
1750	11	15	20	26	31	36	41	46	49	53
2000	11	14	19	24	28	32	36	40	43	46
2250	11	14	17	21	24	27	31	34	37	39
2500	11	13	16	18	21	24	27	29	31	33
2750	11	12	14	17	18	20	21	23	24	26
3000	11	12	13	14	16	17	18	19	19	20
3250	11	11	12	12	13	14	14	14	15	15
3500	11	11	11	11	11	11	11	11	11	11

c) Probability that $F<F_{MSY}$ and $B>B_{MSY}$.

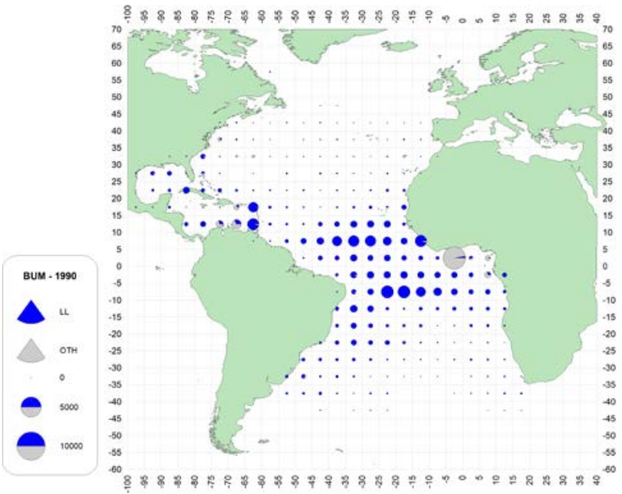
Catch (t)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
0	11	21	34	47	59	68	75	80	84	86
1000	11	18	26	35	43	51	57	63	68	71
1250	11	16	24	31	39	46	52	57	61	66
1500	11	16	22	28	34	40	46	51	56	60
1750	11	15	20	26	31	36	41	46	49	53
2000	11	14	19	24	28	32	36	40	43	46
2250	11	14	17	20	24	27	31	34	36	39
2500	11	13	15	18	20	23	26	28	30	32
2750	11	12	13	15	17	19	20	22	23	25
3000	11	10	12	12	14	15	16	17	18	18
3250	9	8	8	9	10	10	11	11	12	12
3500	6	6	6	6	7	7	7	7	8	8



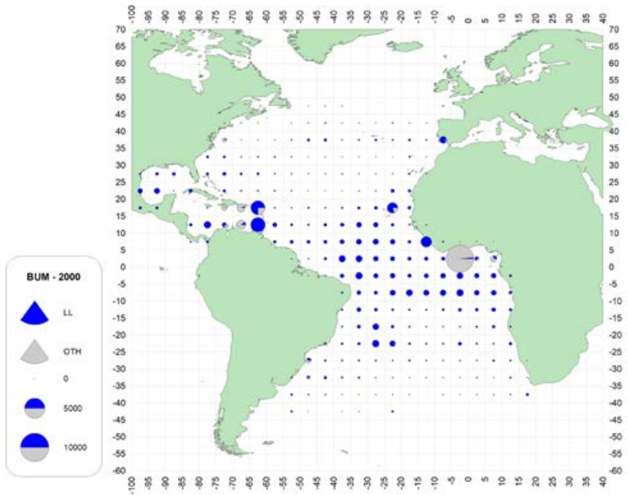
a. BUM (1970-79)



b. BUM (1980-89)

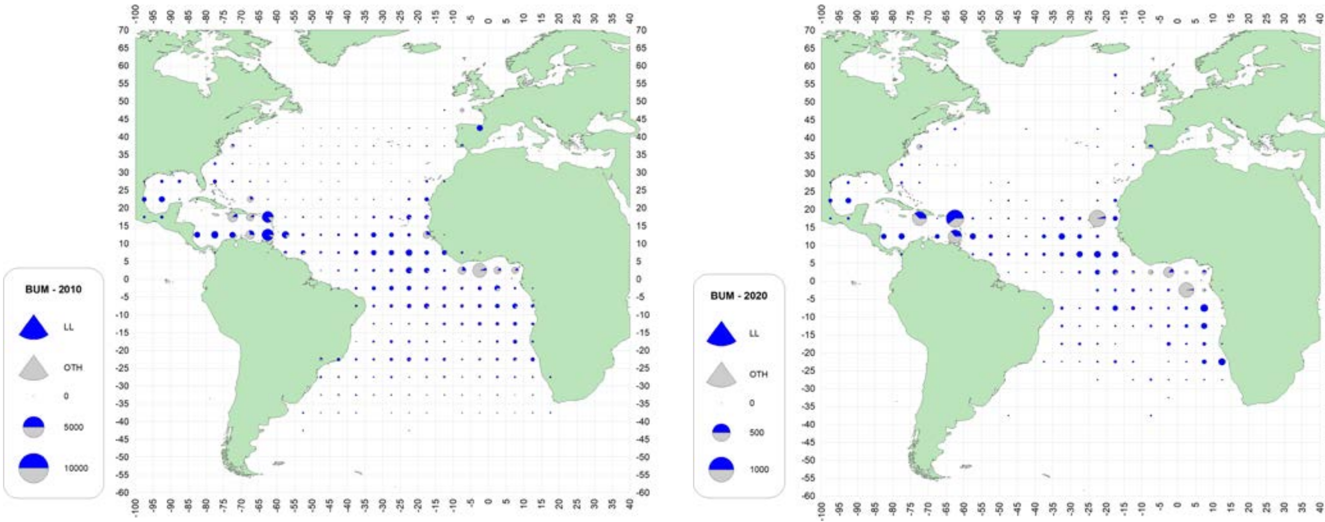


c. BUM (1990-99)



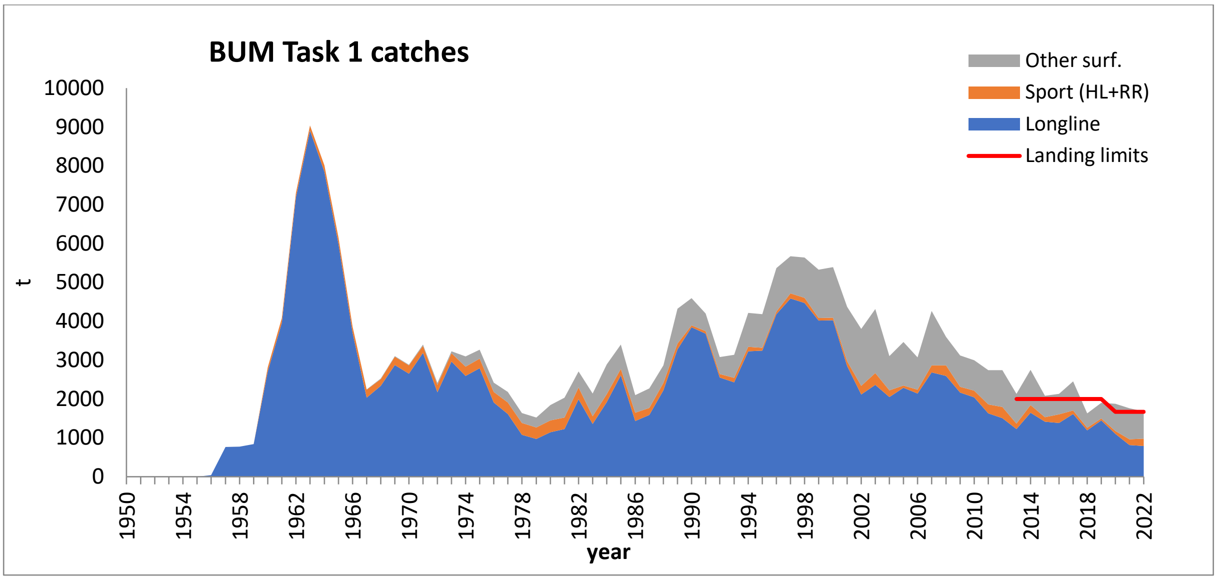
d. BUM (2000-09)

BUM-Figure 1. Geographic distribution of blue marlin total catches by decade (last decade only covers 2 years).

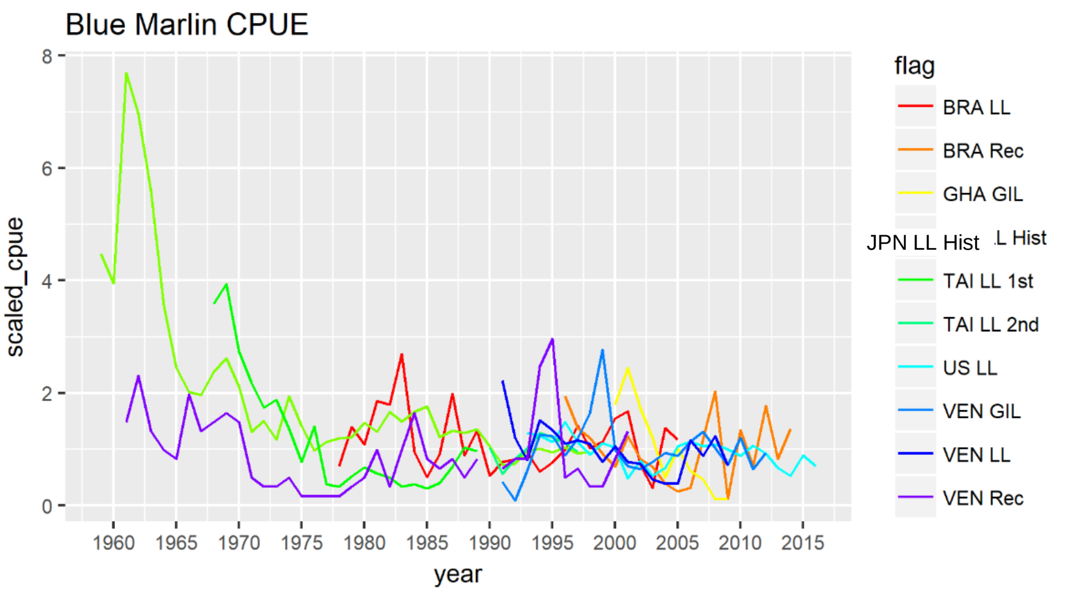


e. BUM (2010-19)

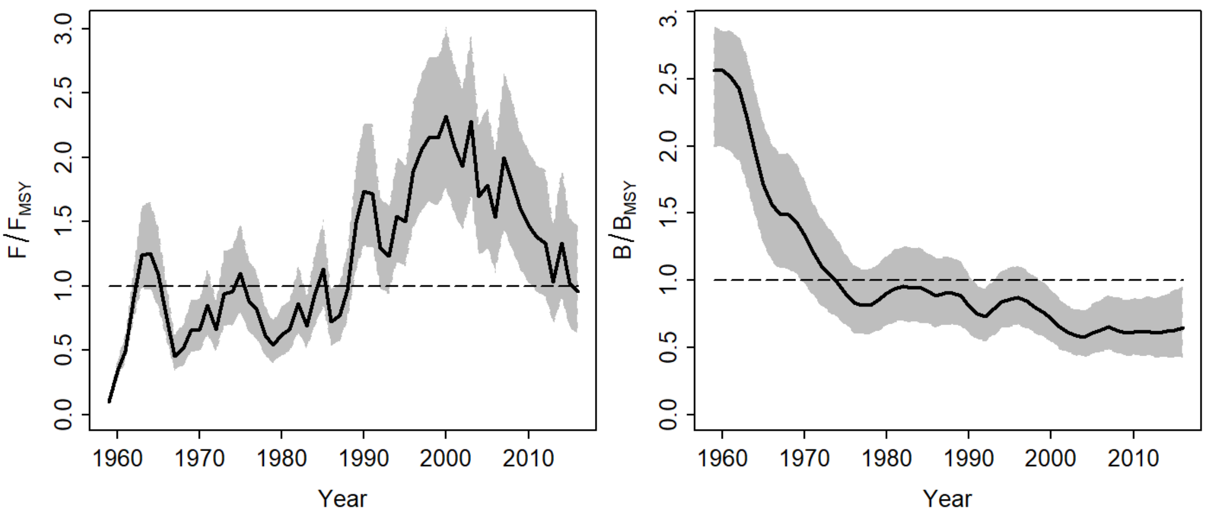
f. BUM (2020-21)



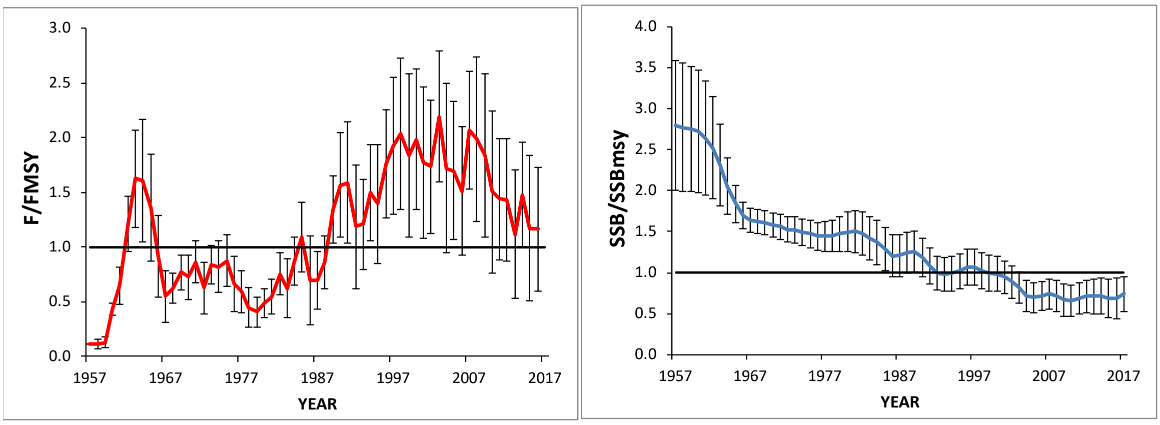
BUM-Figure 2. Atlantic blue marlin (*Makaira nigricans*) Task I catches (landings + dead discards) (t) by gear type between 1950 and 2022.



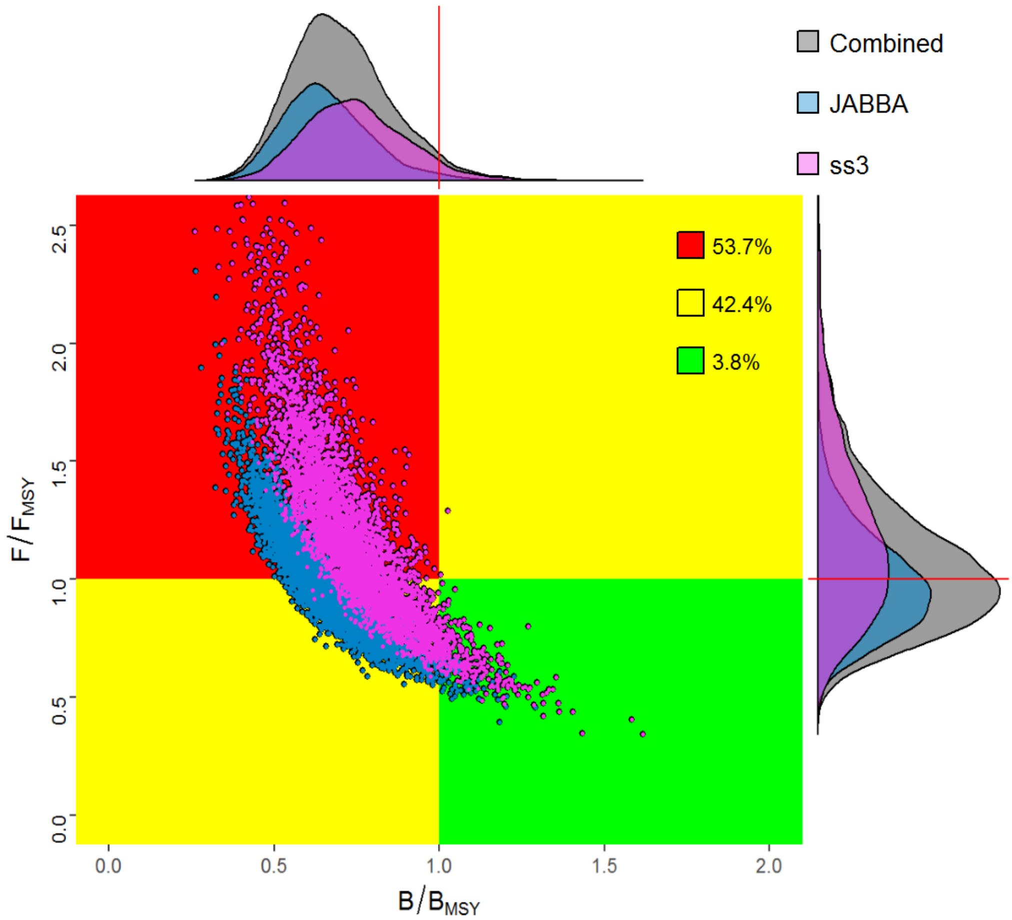
BUM-Figure 3. Plot of the indices of abundance used in the 2018 blue marlin stock assessment.



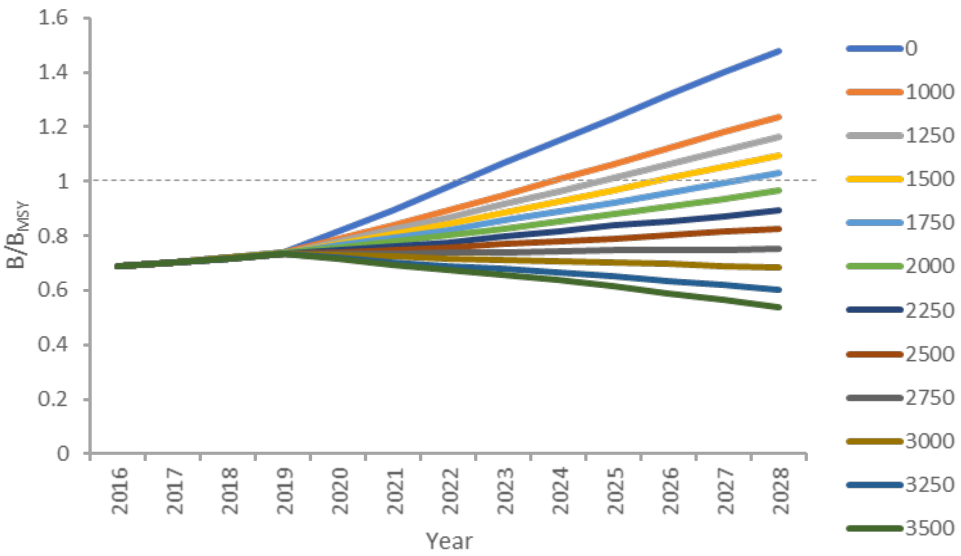
BUM-Figure 4.1. Trends in harvest rate relative to F_{MSY} and biomass relative to B_{MSY} for the Bayesian surplus production model (JABBA) fits to Atlantic blue marlin. Shaded grey area indicates 95% C.I.



BUM-Figure 4.2. Trend in SSB/SSB_{MSY} and F/F_{MSY} for the stock synthesis model, including approximate 95% confidence intervals.



BUM-Figure 5. Combined Kobe plots for the final base cases of Bayesian Surplus Production model (JABBA, blue) and Stock Synthesis model (SS3, pink) models for the Atlantic blue marlin.



BUM-Figure 6. Combined results of projections of B/B_{MSY} for Atlantic blue marlin for both the stock synthesis model and Bayesian Surplus Production model base case models under different constant catch scenarios.

9.10 WHM - White marlin

The most recent assessment for white marlin was conducted in 2019 through a process that included a 2019 White Marlin Data Preparatory Meeting (12-15 March 2019) (Anon., 2019) and 2019 White Marlin Stock Assessment Meeting (10-14 June 2019) (Anon., 2020c) The last year of fishery data used in the assessment was 2017.

WHM-1. Biology

White marlin spawning areas occur mainly in the tropical western North and South Atlantic, predominantly in the same offshore locations in their normal range. In the North Atlantic, spawning activity has been reported off eastern Florida (USA), the Windward Passage (between La Hispaniola and Cuba), and north of Puerto Rico. Seasonal spawning concentrations have been noted northeast of Hispaniola and Puerto Rico, and off the East coast of Hispaniola. Spawning activity has also been reported for the equatorial Atlantic (5°N-5°S) off northeastern Brazil, and in the South Atlantic off southern Brazil.

Previous reports have mentioned that spawning takes place during austral and boreal spring-summer. In the North Atlantic, reproduction events occur from April to July, with spawning activity peaking around April-May. In the equatorial Atlantic (5°N-5°S), spawning occurs during May to June, and in the South Atlantic, reproduction events take place from December to March.

White marlin inhabits the surface mixed layer of the open ocean. Although they spend about 50% of daylight hours and 81% of nighttime hours in the warmer waters of the mixed surface layer, they do explore temperatures ranging 7.8-29.6°C. However, a negligible amount of time is spent at temperatures less than 7 °C below the mixed surface layer. Information from pop-up satellite archival tag (PSAT) data indicated frequent short-duration dives extending to >300 m depths, although most dives ranged from 100 to 200 m. Two types of diving behavior have been identified for white marlin, (1) a shorter duration V-shaped dive, and (2) a U-shaped dive characterized as those confined to a specific depth range for a prolonged period. These patterns, however, can be highly variable between individuals and also vary depending on the temperature and dissolved oxygen of the surface mixed layer. Therefore, it is important to consider vertical habitat use and the environmental factors that influence it during the standardization of CPUE data.

All white marlin biological material sampled prior to the confirmation of the presence of roundscale spearfish (*T. georgii*) in 2006, are now presumed to contain an unknown proportion of roundscale spearfish. Therefore, reproductive parameters, growth curves and other biological studies previously thought to describe white marlin may not accurately represent this species. The Committee reviewed recent scientific nomenclature for billfish (Colette *et al*., 2006) and adopted the scientific name of *Kajikia albida* (Poey, 1860) for white marlin in ICCAT.

WHM-2. Fishery indicators

It has now been confirmed that white marlin landings reported to ICCAT include roundscale spearfish in significant numbers, so that historical statistics of white marlin most likely comprise a mixture of the two species. Studies of white marlin/roundscale spearfish ratios in the western Atlantic have been conducted, with overall estimated ratios between 23-27%, although they varied in time and space. Previously, these were thought to represent only white marlin. However, there is little information on these species ratios in the eastern Atlantic.

The decadal geographic distribution of the catches is given in **WHM-Figure 1**. The Committee used Task 1 catches as the basis for the estimation of total removals (**WHM-Figure 2**). Total removals for the period 1990-2017 were obtained during the 2019 White Marlin Stock Assessment Meeting (Anon., 2020c) by modifying Task 1 values with the addition of white marlin that the Committee estimated from catches reported as billfish unclassified. The dead discards were estimated for those longline fleets that have not reported dead discards (2010-2018) based on data from fleets that had reported dead discards.

Additionally, the reporting gaps for some fleets were completed using estimates based on catch values reported for years before and/or after the gap(s) years.

Preliminary Task 1 catches of white marlin and roundscale spearfish, as well as the combined WHM/roundscale spearfish (RSP) Task 1 used in the stock assessment is presented in **WHM-Table 1**. For combined white marlin and roundscale spearfish the catches in 2019, 2020, 2021 and 2022 were 288, 191, 130 and 144 t respectively, compared to 268 t reported for 2018. Landings for 2022 are preliminary.

A series of indices of abundance for white marlin were presented and discussed during the 2019 White Marlin Data Preparatory Meeting (Anon., 2019) and the 2019 White Marlin Stock Assessment Meeting (Anon., 2020c). Following the guidelines developed by the SCRS Working Group on Stock Assessment Methods (WGSAM), 14 catch per unit effort (CPUE) series were available and 13 selected for their inclusion in the final assessment models. In general, the indices showed no discerning trend during the latter part of the time series examined (**WHM-Figure 3**). During the 2019 stock assessment, all standardized CPUE indices for white marlin showed a sharp decline during the period 1960-1991, and variables patterns and no consistent trend among indices thereafter (**WHM-Figure 3**).

WHM-3. State of the stock

A full stock assessment was conducted for the combined white marlin/roundscale spearfish in 2019, applying to the available data through 2017, using both surplus production and age-structured models, which included estimations of management benchmarks. As recommended by the Committee in 2010, the model configuration was an effort to use all available data on white marlin, including lengths, dimorphic growth patterns, steepness and other biological data. Although it is believed that the modeling methods employed were relatively robust, the input data for the models were very likely less so. Perhaps the most important uncertainty was that associated with the catch data and some of the biological parameters of their life history. The uncertainty of the magnitude of the catch is especially a problem with the landings and discards data reported after 1998 when recommendations promoting or mandating the release of billfish that were alive at haulback. This led to a decrease in reported landings but not necessarily a decrease in fishing and/or release mortality. This apparent drop in landings led to a marked decrease in the estimates of F/F_{MSY} from 2002-present, however the Committee considers that this trend is likely overly optimistic due to unreported catch and unaccounted release mortality. The Committee addressed this issue by including estimates of dead discards for the longline fisheries.

The results of the 2019 assessment indicated that the stock of Atlantic white marlin was overfished but not undergoing overfishing (**WHM-Figure 4**). The probability of being in the red quadrant of the Kobe plot was estimated to be 1%. The probability of being in the yellow quadrants of the Kobe plot was estimated to be 99% and that of being in the green quadrant less than 1%. The estimated MSY was determined to be 1,495 t with approximate 95% confidence intervals of 1,316 t - 1,745 t.

Generally, all models estimated similar annual trends and values of both B/B_{MSY} and F/F_{MSY}. Relative fishing mortality has been declining since the late 1990s and is now most likely to be below F_{MSY} (**WHM-Figure 5**). Relative biomass has probably stopped declining over the last ten years prior to the assessment, but still remains well below B_{MSY} (**WHM-Figure 5**). There is considerable uncertainty in these results. These results are conditional on the reported catch being a true reflection of the fishing mortality experienced by white marlin. The Committee reiterated that this evaluation is for both stocks of white marlin and roundscale spearfish, and that the presence of unknown quantities of roundscale spearfish in the catches and data used to estimate relative indices of abundance increases the uncertainty of white marlin stock status and outlook for this species.

WHM-4. Outlook

All assessment models estimated that the stock has been less productive than usual (e.g., lower recruitment) since the 1990s, which can be observed in **Figure 5** wherein relative biomass has not increased by much despite relative fishing mortality having declined considerably over that time period. Projections were carried out using the assessment models, but those projections assumed higher productivity into the future. This resulted in projections of the stock building quickly in the future, responding with much more productivity in the future than has been observed for the past two decades, even when the same levels of catch are assumed into the future as have been experienced by the stock in the past 20 years.

As such, the Committee considered the projections to be overly optimistic and did not support their use to develop Kobe strategy matrices.

WHM-5. Effect of current regulations

A 2006 recommendation (Rec. 06-09) established that the annual amount harvested by pelagic longline and purse seine vessels and retained for landing must be no more than 33% for white marlin and 50% for blue marlin of the 1996 or 1999 landing levels, whichever is greater. Furthermore, in 2012, the Commission established a TAC for 2013, 2014, and 2015 of 400 t (Rec. 12-04), placed additional catch and commerce restrictions in recreational fisheries for blue marlin and white marlin, and requested methods for estimating live and dead discards of blue marlin and white marlin/spearfish. In 2019, the Commission further strengthened the plan to rebuild white marlin stock by imposing a landings limit to 335 t for white marlin/spearfish (Rec. 19-05).

The Committee is concerned with the significant increase in the contribution from fishing by artisanal and small-scale fleets to the total white marlin harvest and that these fisheries are not fully accounted for in the current ICCAT statistics. The Committee expressed its serious concern over this limitation on data for future assessments. Such data limitation precludes any analysis of the current regulations. In addition, the Committee expressed concern about the status of white marlin due to the misidentification of spearfishes in the white marlin catches. This situation adds uncertainty to the stock assessment results.

Currently, ICCAT Rec. 22-12 and four ICCAT Contracting Parties (Brazil, Canada, Mexico, and the United States) mandate or encourage the use of circle hooks on their pelagic longline fleets. Research has demonstrated that in some longline fisheries the use of non-offset circle hooks resulted in a reduction of billfish mortality, while the catch rates of several of the target species remained the same or were greater than the catch rates observed with the use of conventional J hooks or offset circle hooks.

The Committee noted that more countries have started reporting data on live releases in 2006. However, there is not enough information on the proportion of fish being released alive to evaluate the effectiveness of the ICCAT recommendation, relating to the live release of white marlin.

WHM-6. Management recommendations

The Committee notes that Rec. 19-05 states "An annual limit of [1,670 t for blue marlin and] 335 t for white marlin/roundscale spearfish".

In 2012, the Commission adopted Rec. 12-04, intended to reduce the total harvest to 400 t in 2013-2015 to allow the rebuilding of the white marlin stock from the overfished condition. Subsequently, the Commission extended the 400 t annual catch limit to 2016-2018 (Rec. 15-05), 2019 (Rec. 18-04), and in 2019 (Rec. 19-05) established a landings limit of 335 t. Although there is some evidence of slow rebuilding in recent years, the Committee noted that catches have exceeded the 400 t landings limit in every year since its initial implementation and warns that if catches continue to exceed the landings limit, the rebuilding of the stock will proceed more slowly, or be put at risk of further declines. Further reductions in fishing mortality are likely to speed up the rebuilding of the stock. Unfortunately, the inability to accurately estimate fishing mortality will continue to compromise the Committee’s ability to predict and monitor the stock’s recovery period. This is due to the inadequate reporting of discards, as well as the lack of reports from some artisanal and recreational fisheries that take marlin species.

- Measures should be taken to ensure that monitoring and reporting of all landings and discards, including live releases, are appropriate, accurate, and complete. This will likely require improvements to the observer programs of many CPCs, as well as the implementation of discard estimation methods using those data.

- Efforts should be made, building on previous work, to fully account for the catches of artisanal and all recreational fisheries.

Given the overfished status of the stock and the uncertainties in the data, including for both total removals and indices of abundance:

- the Commission, at the minimum, should ensure that catches do not exceed current TAC until the stock has fully recovered.

Given that experimental research has demonstrated that in longline fisheries the use of circle hooks resulted in a reduction of marlin catch rates and haulback mortality, and noting that they have different impacts on both target and bycatch species; then to reduce the chance of exceeding any established landings limit or TAC, the Commission should consider:

- the use of non-offset circle hooks,
- the release of all marlins that are alive at haul back in ways that maximize their survival.

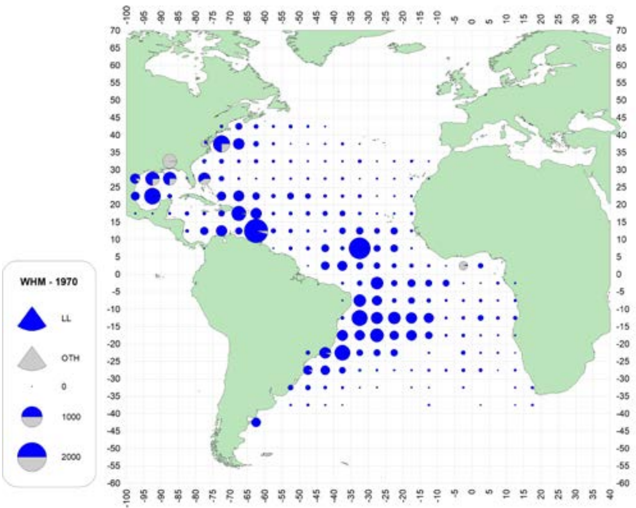
ATLANTIC WHITE MARLIN/ROUNDSCALE SPEARFISH SUMMARY	
MSY	1,495 (1,316 – 1,745) t[1]
Current (2022) Yield	144 t [2]
Relative Biomass: B_{2017}/B_{MSY}	0.58 (0.27-0.87)[1]
Relative Fishing Mortality: F_{2017}/F_{MSY}	0.65 (0.45-0.93)[1]
Stock Status (2017)	Overfished: Yes [99% prob][3] Overfishing: Not [99% prob][3]
Conservation and Management Measure in Effect:	Rec. 18-04 and Rec. 19-05. Landing limit of 335 t beginning in 2020 Minimum size for recreational fisheries (168 cm Lower Jaw Fork Length (LJFL))

[1] Median of combined estimates from 2 Stock Synthesis models and 1 JABBA model with approximate 95% confidence intervals.
[2] 2022 yield should be considered provisional.
[3] Based on the Kobe plot probability by quadrant.

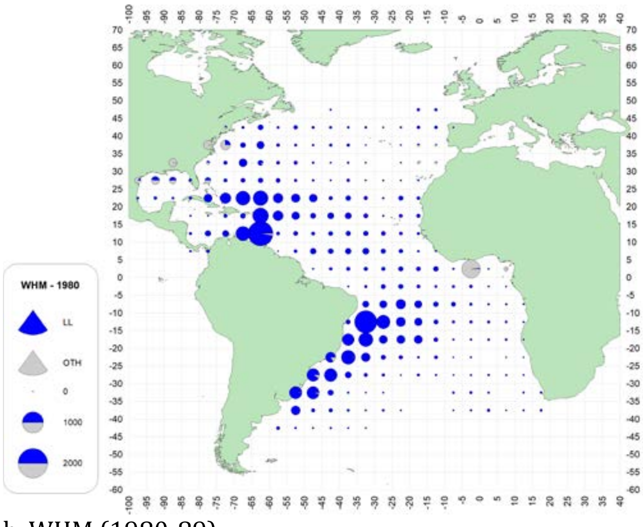
WHM+RSP -Table 1. Estimated catches (t) of Atlantic white marlin (*Kajikia albida*) and Roundscale spearfish (*Tetrapturus georgii*) by area, gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL	A+M		1681	2202	1880	1679	1513	1945	1786	1535	1078	1012	845	843	770	618	749	716	757	508	530	467	648	452	528	480	468	268	288	191	130	144
Landings		Longline	1528	2065	1720	1535	1367	1717	1638	1403	970	834	756	759	691	538	631	608	634	421	414	373	465	373	481	434	408	198	195	132	85	110
		Other surf.	56	64	36	56	62	189	85	89	86	139	71	55	60	65	81	84	95	68	85	62	56	61	34	33	42	26	30	43	35	29
		Sport (HL+RR)	30	30	22	24	14	6	6	2	4	6	1	1	1	2	1	2	2	6	4	6	116	7	3	4	5	10	3	7	3	2
Discards		Longline	67	43	101	65	70	32	57	41	17	29	17	27	17	12	36	21	24	12	27	24	11	11	10	9	12	34	60	10	8	4
		Other surf.	0	0	0	0	0	0	1	0	0	1	4	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	
Landings	CP	Barbados	29	26	43	15	41	33	25	25	24	15	15	18	16	33	22	24	26	6	3	5	6	6	10	14	17	22	11	14	10	10
		Belize	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Brazil	301	91	105	75	105	217	158	106	172	407	266	80	244	90	52	55	53	35	75	71	352	102	121	67	47	62	76	46	0	**0**
		Canada	0	4	4	8	8	8	5	5	3	2	1	2	5	3	2	2	1	2	1	2	3	5	3	1	2	1	1	1	2	1
		China PR	0	9	11	9	11	15	30	2	20	23	8	6	9	6	10	5	9	8	3	4	2	0	0	0	3	2	3	2	2	2
		Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	**0**
		Côte d'Ivoire	0	0	0	1	2	1	5	1	2	2	3	1	1	1	1	3	2	1	1	0	1	1	1	1	1	1	0	0	0	1
		EU-España	26	26	36	151	93	101	119	186	61	6	22	64	58	51	46	35	16	113	4	35	42	99	125	96	118	9	9	1	4	31
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
		EU-Portugal	0	0	0	0	0	1	1	0	0	1	5	19	30	22	2	35	40	11	18	25	10	9	7	11	13	0	0	1	9	1
		El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Gabon	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Ghana	22	1	2	1	3	7	6	8	21	2	1	1	1	0	1	4	4	3	1	1	1	1	1	1	0	0	0	0	0	**0**
		Grenada	0	0	0	0	0	0	0	1	15	8	14	33	10	12	11	17	14	0	0	0	0	0	37	15	9	11	19	14	1	11
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Honduras	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Japan	82	92	57	112	58	56	40	83	56	16	33	36	34	39	21	34	43	41	31	42	24	6	8	9	10	6	11	7	9	3
		Korea Rep	8	43	23	59	23	35	39	0	0	0	11	40	7	0	113	96	78	43	43	0	0	0	0	0	0	0	0	0	0	**0**
		Liberia	0	0	0	1	1	3	8	4	3	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
		Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
		Mexico	1	7	11	3	1	3	6	11	13	16	15	28	25	16	14	14	19	20	28	36	30	20	26	20	12	16	9	10	12	8
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Philippines	0	0	0	0	0	1	12	0	0	0	0	0	0	0	0	1	1	2	2	1	2	2	0	0	0	0	0	0	0	**0**
		S Tomé e Príncipe	17	21	21	30	45	40	36	37	37	37	37	21	33	29	35	36	37	38	39	40	41	42	17	15	13	1	10	16	20	27
		Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	**0**
		South Africa	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		St Vincent and Grenadines	1	0	0	0	0	0	0	0	1	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	5	9	0	**0**
		Trinidad and Tobago	1	11	18	8	32	10	13	4	2	5	12	6	6	5	12	10	11	15	14	39	33	38	32	20	0	0	0	0	0	**0**
		UK-Bermuda	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		USA	19	13	7	12	8	5	5	1	3	6	1	1	1	1	0	2	2	2	2	1	4	2	3	1	2	3	2	6	2	2
		USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Uruguay	2	3	0	1	24	22	16	21	20	1	9	2	5	9	3	6	5	5	0	0	0	0	0	0	0	0	0	0	0	**0**
		Venezuela	362	236	286	270	177	310	228	178	182	215	168	138	159	196	133	64	130	118	160	123	78	99	119	187	192	84	67	50	46	43
	NCC	Chinese Taipei	616	1350	907	566	441	506	465	437	152	178	104	172	56	44	54	38	28	20	28	15	7	7	10	10	5	6	2	2	4	1
		Costa Rica	0	0	0	0	0	0	3	14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cambodia	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Cuba	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Mixed flags (FR+ES)	12	11	9	7	7	9	8	12	13	12	13	13	11	10	9	10	12	12	37	0	0	0	0	0	0	0	0	0	0	
		NEI (BIL)	0	0	0	0	0	0	0	34	77	4	30	134	42	37	170	204	199	0	11	0	0	0	0	0	0	0	0	0	0	
		NEI (ETRO)	114	214	237	285	359	526	498	322	180	11	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Sta Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	1	1	0	1	0	0
		Togo	0	0	0	0	0	0	1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	2	19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

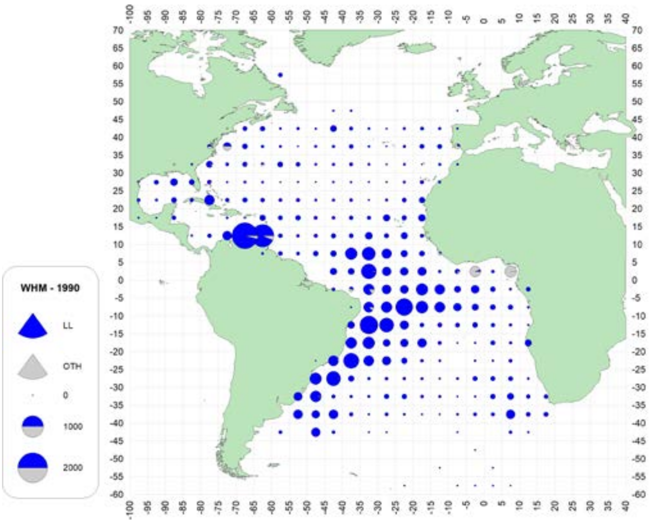
		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0
	Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	**0**
	Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	USA	66	42	100	65	70	33	58	41	18	33	17	27	17	10	8	10	14	8	23	21	10	11	8	3	5	2	2	1	1	1
	Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	54	1	0	**0**
NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	2	1	3	3	1	1
NCO	NEI (BIL)	1	1	1	0	0	0	0	1	0	0	0	0	0	1	10	11	11	2	2	2	1	0	0	4	6	3	0	3	2	



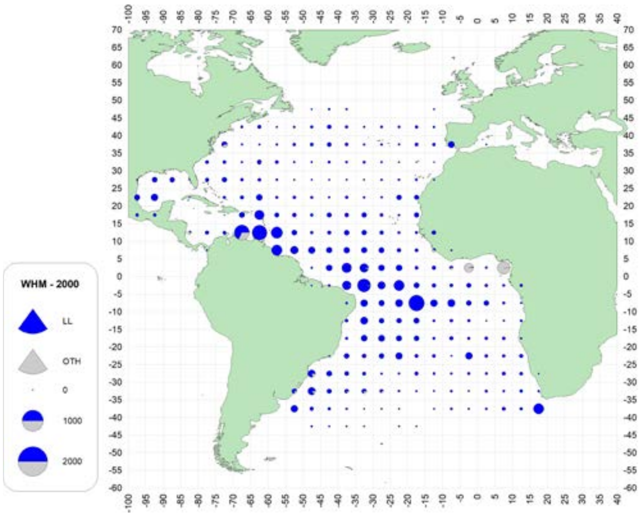
a. WHM (1970-79)



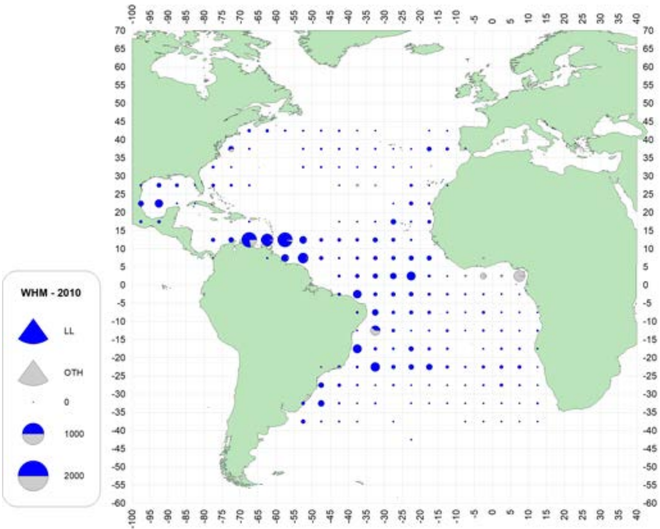
b. WHM (1980-89)



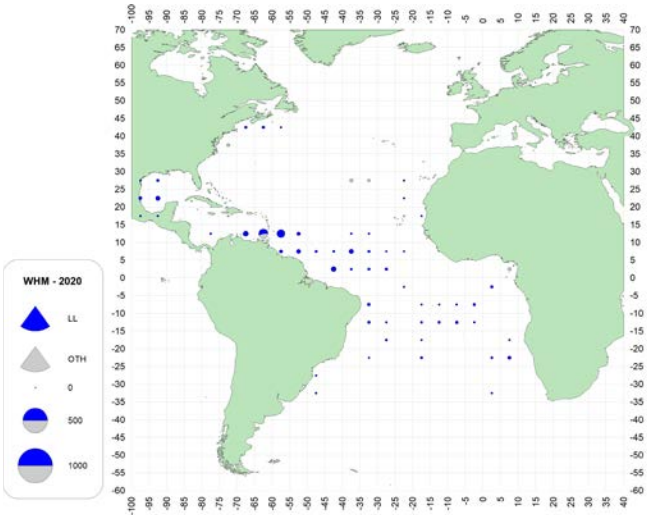
c. WHM (1989-99)



d. WHM (2000-09)

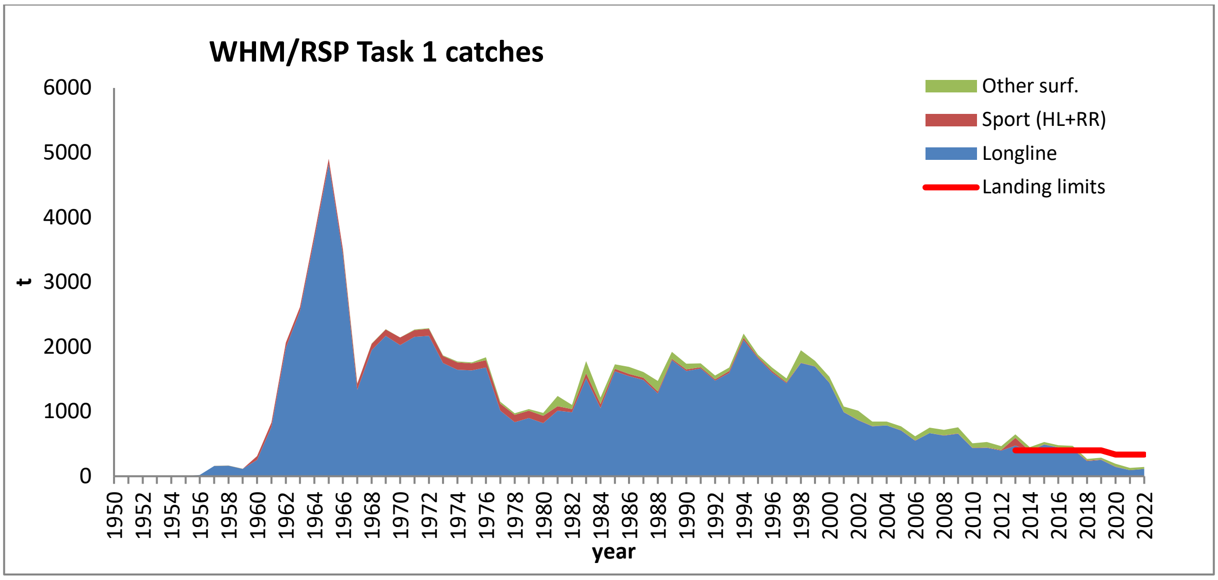


e. WHM (2010-19)

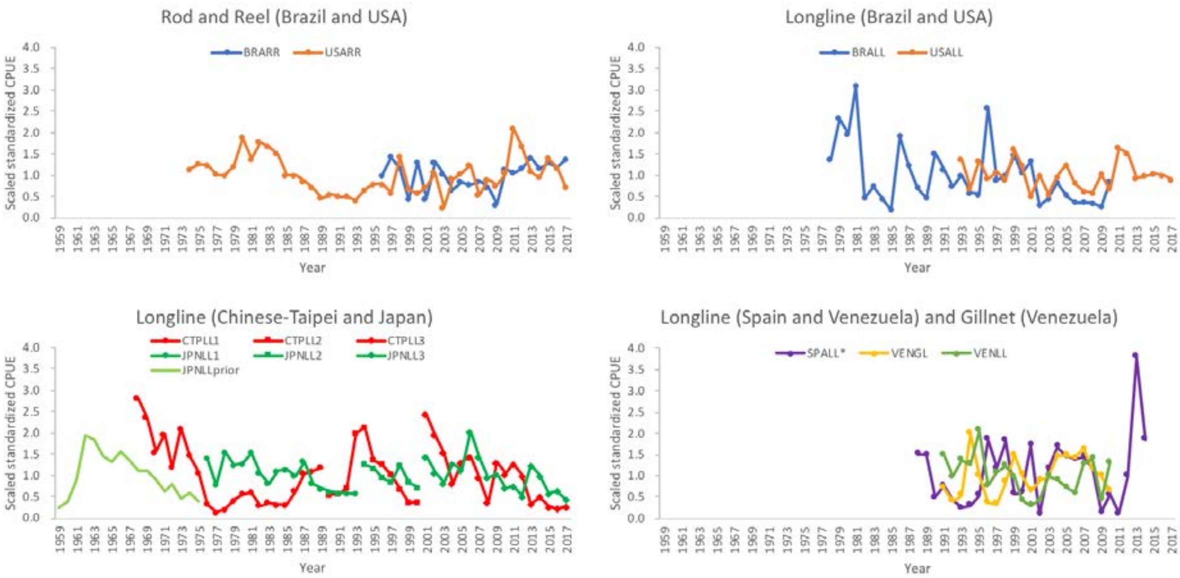


f. WHM (2020-21)

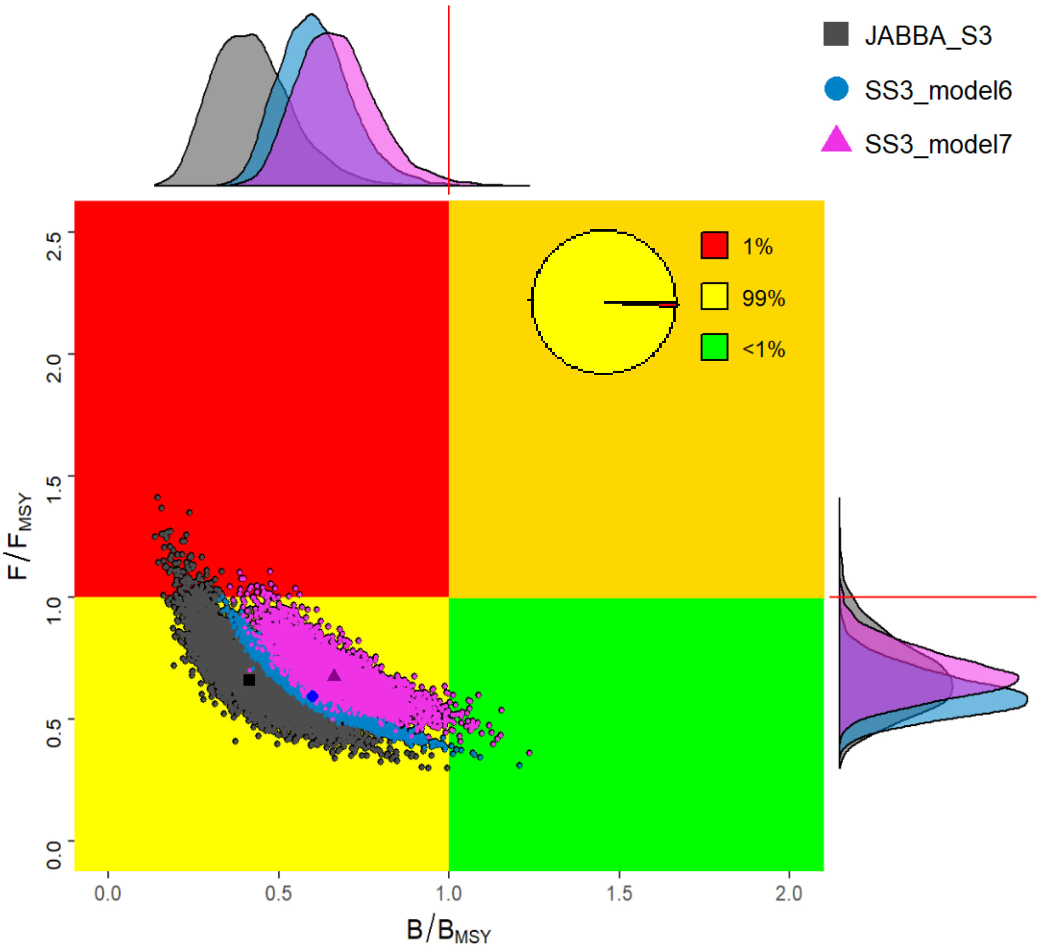
WHM-Figure 1. Geographic distribution of white marlin total catches by decade (last decade only covers 2 years).



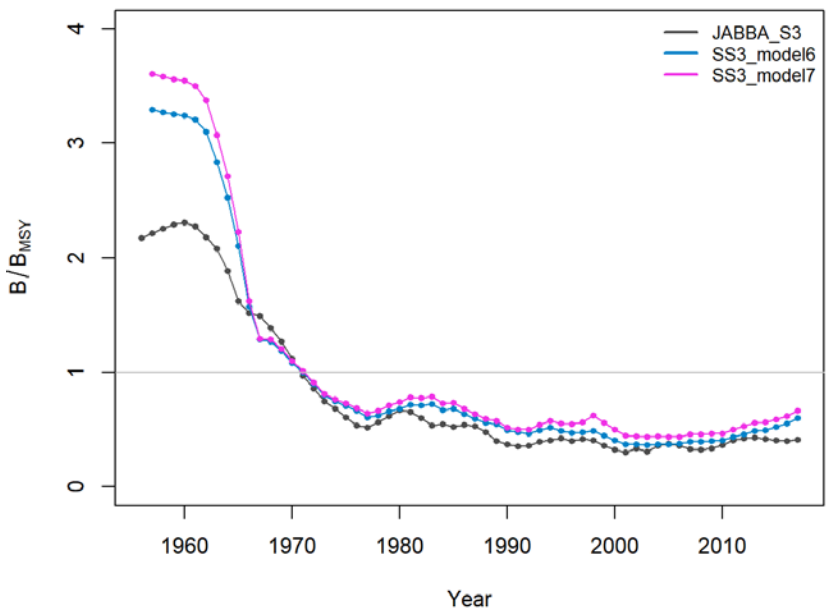
WHM-Figure 2. Total catch of white marlin and roundscale spearfish reported in Task 1 for the period 1956-2022.

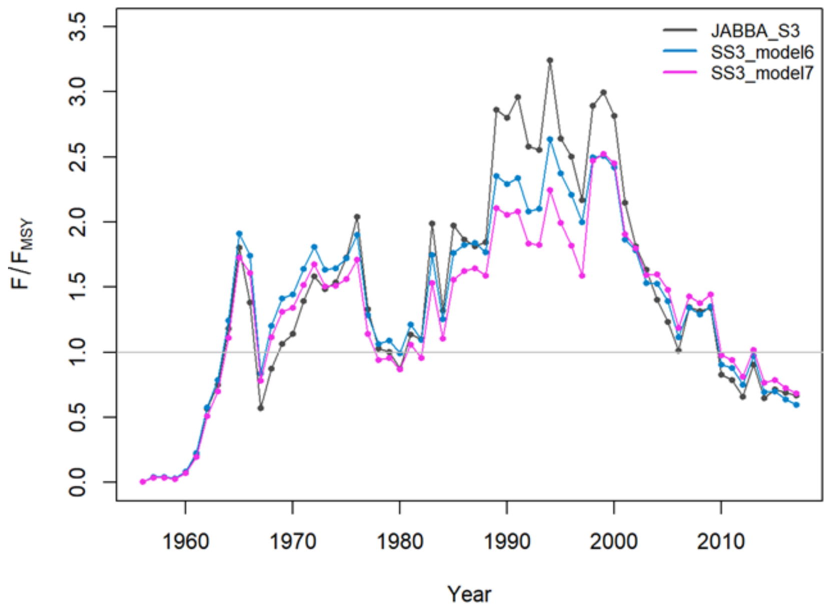


WHM-Figure 3. Standardized CPUE series used in the 2019 white marlin stock assessment. Spanish longline index* is used only for sensitivity analysis by JABBA.



WHM-Figure 4. Combined Kobe phase plots and pie chart from 2 Stock Synthesis runs (models 6 and 7, blue and pink, respectively) and 1 JABBA run (grey) in 2019 Atlantic white marlin stock assessment. The green quadrant corresponds to the stock not being overfished and no overfishing occurring and the red quadrant to the stock being overfished and overfishing occurring. The marginal densities plots for stock relative to B_{MSY} and harvest rate relative to F_{MSY} are also shown (top and right of large panel) are individual probabilities of Stock Synthesis and JABBA runs overlaid.





WHM-Figure 5. Historical estimates of biomass over biomass at MSY ratio (upper panel) and fishing mortality overfishing mortality at MSY ratios (lower panel) for the final base cases of JABBA (S3, black) and Stock Synthesis (models 6 and 7, blue and pink, respectively) models for the Atlantic white marlin.

9.11 SAI - Sailfish

The most recent stock assessments for East and West sailfish were conducted in the 2023 Atlantic Sailfish Data Preparatory and Stock Assessment Meeting (Anon., 2023b) held in June 2023 using catch data available to 2021, through a process that included a single meeting for the data preparatory and stock assessment. The previous stock assessment was conducted in the 2016 Sailfish Stock Assessment Meeting (Anon., 2017a) held in June 2016.

SAI-1. Biology

Sailfish have a mainly pan-tropical distribution in the Atlantic Ocean, with occasional catches reported from temperate waters. Based on life history information, migration rates, and geographic distribution of catch, ICCAT has established two management units for sailfish, eastern and western Atlantic stocks (**SAI-Figure 1**). However, two recent studies using mitogenome and genome-wide genetics for sailfish showed measured genetic differences between the Atlantic and the Indo-Pacific areas but not within the Atlantic, suggesting there is a single panmictic sailfish genetic stock in the Atlantic. The lack of evidence of a single stock in the current conventional tagging data warrants the need for deployment of electronic tags throughout the potential mixing range of Atlantic sailfish.

Sailfish is more coastally oriented than other billfish species. Conventional tagging data suggests they move shorter distances than the other billfish (**SAI-Figure 2**). Temperature preferences for adult sailfish appear to be in the range of 25-28°C. Sailfish generally seek out the warmest water available, and electronic tagging studies indicate that about 96% of darkness, 86% of twilight, and 82% of daylight hours are spent near the surface (Hoolihan *et al*., 2011). Vertical habitat use is more complex however, with frequent short duration excursions to deeper depths in excess of 100 m, with some dives as deep as 350 m.

Sailfish grow rapidly and reach a maximum size of around 160 cm for males and 220 cm for females, with a mean maximum age of at least 12 years. Estimates of length at 50% maturity (L50) are currently available for western Atlantic sailfish (146 cm LJFL for females and 135 cm LJFL for males); no values are available for eastern Atlantic sailfish.

Sailfish spawn over a wide area and year around. For the western stock, evidence of spawning has been detected in the Straits of Florida, and off the Venezuelan, Guyanese, and Surinamese coasts. In the southwestern Atlantic, spawning has been confirmed off the southern coast of Brazil between 20° and 27°S. Additional spawning areas occur in the eastern Atlantic off Senegal and Côte d'Ivoire. Timing of spawning can differ between regions, from the Florida Straits to the areas off Guyana. In the western Atlantic, sailfish spawn in the second and third quarter of the year, while in the southwestern Atlantic, they spawn during the austral summer.

SAI-2. Fisheries indicators

Sailfish are targeted by coastal artisanal and recreational fleets and are captured to a lesser extent as bycatch in longline and purse seine fisheries (**SAI-Figure 3**). Historically, catches of sailfish were reported together with spearfish by many longline fleets. In 2009 these catches were separated by the Committee (**SAI-Table 1**).

Several standardized CPUE data series were available in 2023 for the Atlantic sailfish stock assessment. For the eastern Atlantic stock, the indices of abundance used were: Senegal artisanal, Chinese Taipei longline, Japan longline (early and late), EU-Portugal longline, and EU-Spain longline. For the western Atlantic stock, the indices used were: Brazilian longline, Chinese Taipei longline, Japanese longline (early and late), EU-Spain longline, US longline observer, Venezuelan longline, and Venezuelan rod & reel (**SAI-Figure 4**). For both stocks, some of the available CPUE time series showed a decreasing trend while others showed an increasing trend. Therefore, there were clear conflicting trends among the indicators of stock abundance (**SAI-Figure 4**).

East Atlantic

The eastern stock is exploited by surface fisheries, mainly artisanal gillnet and troll, and to a lesser degree by purse seine, as well as longline and recreational fisheries. The main surface fisheries are carried out by the artisanal fleets of Côte d'Ivoire, Ghana and Senegal, followed by the industrial scale EU fleets (France and Spain) in the Gulf of Guinea and the waters of the tropical eastern Atlantic. The main longline fleets are EU-Spain, Japan, and Chinese Taipei fleets which operate in the central, eastern and western Atlantic. Total reported landings, increased abruptly after 1973, to peak above 5,000 t in 1975-1976, remaining relatively high (>2000 t), largely due to the incorporation of artisanal fishing effort by the traditional surface (gillnet and troll) fisheries (**SAI-Table 1**; **SAI-Figure 3a**). A generally decreasing trend in catch is apparent since 2008, mainly due to a decreased catch by the surface fisheries (gillnet and purse seine) (**SAI-Figure 3a**). Preliminary Task 1 catches of sailfish East in 2022 were 1,110 t, compared to 1,706 t reported for 2021 (**SAI-Table 1**).

West Atlantic

The western stock is exploited by longline, recreational fisheries, and by artisanal surface fisheries, drift-gillnet and longline. The main longline fleets include Brazil, EU-Spain, Panama, Venezuela and Grenada, which operate in the western and central Atlantic. The main surface fisheries are carried out by the artisanal longline fleets of Grenada and Venezuela in the Caribbean Sea and waters of the tropical western Atlantic, and those artisanal fleets operating around anchored FADs like those of Martinique and Guadalupe and the Dominican Republic.

Total reported landings steadily increased since 1960 to peak at 2,060 t in 2002 (**SAI-Figure 3b**). A steep decreasing trend of catch is observed from 2005, mainly due to a variable decreased catch by the surface (artisanal drift-gillnet) fisheries. Preliminary Task 1 catches of sailfish West in 2022 were 1029 t, compared to 876 t reported for 2021 (**SAI-Table 1**).

Although there has been progress, historical catches of unclassified billfish continue to be reported to the Committee, confounding sailfish catch estimates. Catch reports from countries that have historically been known to land sailfish continue to suffer from gaps and there is increasing ad hoc evidence of unreported landings in some other countries. These considerations provide support to the idea that the historical catch of sailfish continues to be underreported. This also seems to be the case in recent times where more and more fleets encounter sailfish as bycatch or direct targeting.

SAI-3. State of the stocks

Compared to the 2016 stock assessment, during the 2023 assessment further progress was made on the integration of new data sources, in particular standardized catch rate data, size data, and modeling approaches. For both stocks (East and West), uncertainty in data inputs and model configuration continued to be explored through sensitivity analysis. Conflicting trends in the available CPUEs challenged a clear interpretation of trends in abundance; results were sensitive to CPUEs included in the model.

East Atlantic

For the SAI-E stock, a single assessment platform was used for the stock assessment; Just Another Bayesian Biomass Assessment (JABBA), a Bayesian Surplus Production based model. The trajectories of B/B_{MSY} and F/F_{MSY} are shown in **SAI-Figure 5**. The stock was determined to be not overfished with B_{2021}/B_{MSY} = 1.83 (1.14 - 2.88), and not undergoing overfishing, with F_{2021}/F_{MSY} = 0.362 (0.212-0.585). The Kobe phase plot shows a typical anti-clockwise trajectory, with the stock status moving from underexploited through a period of unsustainable fishing to the overexploited phase and then to the recovery phase after a decrease in fishing mortality. The resultant stock status for 2021 has a 99% probability of being in the green quadrant of the Kobe phase plot, indicating that the stock is not overfished nor undergoing overfishing (**SAI-Figure 6**).

The Committee recognizes that there has been a substantial change in the stock status compared to the last stock assessment. This change can mainly be attributed to improved estimates of the life history parameters for the East sailfish stock. However, other factors may also contribute to this change including, the lack of some of the indices of abundance from small-scale fisheries (i.e., Côte d'Ivoire and Ghana).

West Atlantic

During the data preparatory and stock assessment meeting, the Committee agreed to combine the results from both JABBA and Stock Synthesis models to determine stock status and to conduct projections to estimate the K2SM. However, post-meeting examination of the Stock Synthesis results identified issues with the model solution that could not be addressed in time for the results to be presented here and included in the management advice. Therefore, the state of the stock for West Atlantic sailfish is based on the JABBA model runs.

The Bayesian surplus production model JABBA was applied. The trajectories of B/B_{MSY} and F/F_{MSY} are shown in **SAI-Figure 7**. The stock was determined to be overfished with B_{2021}/B_{MSY} = 0.96 (0.59-1.49), but not undergoing overfishing with F_{2021}/F_{MSY} = 0.585 (0.364-0.952). The Kobe phase plot shows a typical anti-clockwise trajectory, with the stock status moving from underexploited through a period of unsustainable fishing to the overexploited phase and then to the recovery phase after a decrease in fishing mortality (**SAI-Figure 8**). The resultant stock status in 2021 for the final model has a 57% probability of being overfished but not subject to overfishing (i.e., yellow quadrant of the Kobe phase plot). There is a 98% probability that the stock is not undergoing overfishing.

SAI-4. Outlook

East Atlantic

The Committee conducted JABBA stochastic stock projections for the SAI-E stock with eleven constant catch scenarios (0; 1,000 – 3,000 t with 250 t interval; 2,336 t MSY level). The annual medians of relative B/B_{MSY} and F/F_{MSY} are provided in **SAI-Figure 9**. The Kobe II Strategic Matrices (**SAI-Table 2**) were estimated and show the probability that overfishing is not occurring ($F<= F_{MSY}$), the stock is not overfished ($B>=B_{MSY}$), and the joint probability of being in the green quadrant of the Kobe plot (i.e., $F<= F_{MSY}$ and $B>= B_{MSY}$).

West Atlantic

The Committee conducted JABBA stochastic stock projections for the western stock also with ten constant catch scenarios (0; 1,000 – 2,000 t). The annual medians of relative B/B_{MSY} and F/F_{MSY} are provided in **SAI-Figure 10**. The Kobe II Strategic Matrices (**SAI-Table 3**) were estimated and show the probability that overfishing is not occurring ($F<=F_{MSY}$), the stock is not overfished ($B>=B_{MSY}$), and the joint probability of being in the green quadrant of the Kobe plot (i.e., $F<= F_{MSY}$ and $B>= B_{MSY}$).

Given the uncertainty projection probabilities should be interpreted with caution for both stocks. The probabilities of the stock biomass to fall below 20% B_{MSY} under different scenarios of constant catch are presented in **SAI-Table 4** and **SAI-Table 5** for the East and West sailfish stocks respectively.

SAI-5. Effect of current regulations

In 2016, the Commission established catch limits for both sailfish stocks (Rec. 16-11) and included several provisions that would allow the Committee to enhance data collection initiatives to reduce fishing mortality estimates and overcome data gap issues in all fisheries.

East Atlantic

It was established in Rec. 16-11 that if the total catch harvested in any year exceeds 1,271 t, the Commission shall review the Recommendation and effectiveness of this. Catches in 2019 (2,244 t) and 2021 (1,706 t) did exceed this amount.

West Atlantic

It was established in Rec. 16-11 that if the total catch harvested in any year exceeds 1,030 t, the Commission shall review the Recommendation and effectiveness of this, the reported catch levels in 2018, 2019, and 2020 exceeded this level.

In line with other ICCAT conservation measures, some countries have established domestic regulations to limit the catch of sailfish. Among these regulations are: the requirement of releasing all billfish from longline vessels, minimum size restrictions, use of circle hooks and catch and release strategies in sport fisheries.

Currently, Rec. 22-12 and four ICCAT Contracting Parties (Brazil, Canada, Mexico, and the United States) mandate or encourage the use of circle hooks on their pelagic longline fleets. Recent research has demonstrated that in some longline fisheries, the use of non-offset circle hooks resulted in a reduction of billfish mortality, while the catch rates of several of the target species remained the same or were greater than the catch rates observed with the use of conventional J hooks or offset circle hooks.

SAI-6. Management recommendations

As in the 2016 stock assessment, important sources of uncertainty still remain in the assessments of both the eastern and western stocks. Available abundance indices demonstrate conflicting trends for both stocks, and the Committee believes that reported catches, including dead discards, are significantly incomplete and unreported. These important sources of uncertainty should be taken into consideration by the Commission when adopting management measures. Nevertheless, it should be noted that there have been some improvements since the last assessment.

East Atlantic

The stock status of SAI-E indicates that the stock is not overfished and not undergoing overfishing. Given the number of unquantified uncertainties described above, the Commission should consider managing catch levels that will keep the stock in the green quadrant of the Kobe phase plot with a high probability.

West Atlantic

The Committee noted that while the reported catches in the past few years have been below the estimated MSY (1,612 t), the stock remains overfished. The Committee believes that the reported catches are significantly underreported. Given the important uncertainties described above, the Committee recommends that the results provided in the Kobe II Strategy Matrix be interpreted with extreme caution. Should the Commission choose to continue setting the catch level at 67% of the current MSY, that value will be 1,080 t.

ATLANTIC SAILFISH SUMMARY

	West Atlantic	**East Atlantic**
Maximum Sustainable Yield (MSY)	1,612 (1,357-1,968) t[1]	2,337 (2,003-2,833) t[1]
Current Yield (2022)	1,029 t[2]	1,110 t[2]
B_{2021}/B_{MSY}	0.96 (0.59-1.45)[1]	1.83 (1.14-2.88)[1]
F_{2021}/F_{MSY}	0.59 (0.36 - 0.95)[1]	0.36 (0.21 - 0.59)[1]
Overfished	Yes (59% prob.)[3]	No (99% prob.)[3]
Overfishing	No (98% prob.)[3]	No (100% prob.)[3]
Management Measures in Effect:	Rec. 16-11: Limit Atlantic sailfish Catches of either stock to the level of 67% of MSY	

[1] 95% credibility interval.
[2] 2022 yield should be considered provisional.
[3] As estimated from the Kobe plot probability in each quadrant.

SAI-Table 1. Estimated catches (t) of Atlantic sailfish (*Istiophorus albicans*) by area, gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				3228	2292	2445	3023	2604	2978	2922	3976	4603	4411	4137	4339	4059	3855	4138	3963	3755	3083	2890	2869	2325	2047	2251	2840	3067	2625	3721	2497	2582	2140
	ATE			1814	1171	1231	1880	1347	1363	1342	1980	2805	2351	2639	2612	2220	1916	2577	2229	2129	1853	1553	1591	1339	1163	1246	1422	1631	936	2244	1176	1706	1110
	ATW			1414	1121	1214	1143	1257	1615	1580	1996	1798	2060	1498	1727	1839	1939	1562	1734	1626	1230	1337	1278	986	884	1005	1419	1436	1688	1476	1321	876	1029
Landings	ATE		Longline	332	234	261	729	216	275	273	198	568	756	497	335	319	580	590	628	622	514	546	543	457	423	436	338	356	497	962	329	194	311
			Other surf.	1034	871	836	970	644	859	883	1231	1470	1496	1860	2057	1758	1289	1798	1493	932	900	870	985	754	730	749	1082	1175	435	1273	792	973	644
			Sport (HL+RR)	448	67	135	182	488	228	186	551	767	98	282	219	143	46	189	108	575	439	136	58	128	10	56	0	94	1	2	50	537	71
	ATW		Longline	958	651	581	453	641	1033	1102	1711	1661	1636	1161	1271	1704	1738	1300	1407	1154	1132	1215	1084	882	735	917	1330	1248	1513	1351	1273	746	921
			Other surf.	160	225	256	390	209	287	244	163	66	311	331	449	131	194	248	310	457	92	102	154	86	126	75	67	168	163	115	42	119	91
			Sport (HL+RR)	233	217	348	230	350	267	163	76	60	106	0	0	0	2	6	7	4	2	10	19	7	12	5	15	13	6	5	2	8	15
Landings(FP	ATE		Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79
Discards	ATE		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	6	1	4	2	6	5	2	4
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	1	0	1
	ATW		Longline	63	28	29	69	57	27	72	45	11	7	5	7	3	5	8	9	10	4	10	20	12	11	7	7	7	7	5	3	2	3
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ATE	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
			China PR	0	3	3	3	3	5	9	4	5	11	4	4	8	16	8	1	4	5	2	4	1	1	2	2	4	2	11	25	1	4
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			Côte d'Ivoire	40	54	66	91	65	35	80	45	47	65	121	73	93	78	52	448	74	24	108	192	80	99	55	38	405	35	959	404	336	60
			EU-España	42	8	13	42	48	15	20	8	195	245	197	169	202	214	227	239	318	206	197	257	229	302	333	225	236	277	324	86	84	234
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	11	8	31	8	2	11
			EU-Portugal	2	1	2	1	2	27	53	13	4	10	13	19	31	137	43	49	131	170	121	72	109	33	41	30	27	123	65	51	13	30
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0
			Gabon	3	3	110	218	2	0	0	0	0	0	4	4	1	0	0	0	0	0	0	0	0	4	0	0	5	0	0	2	1	0
			Ghana	693	450	353	303	196	351	305	275	568	592	566	521	542	282	420	342	358	417	299	201	220	191	99	238	267	82	78	68	0	0
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	3	0	0	0	2	3	5	3
			Honduras	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	27	45	52	47	19	58	16	26	6	20	22	70	50	62	144	199	94	115	143	157	71	59	36	52	45	47	62	48	30	14
			Korea Rep	2	5	5	11	4	0	0	0	0	0	0	0	0	0	0	0	1	0	10	1	6	10	2	6	15	9	8	10	5	1
			Liberia	0	0	33	85	43	136	122	154	56	133	127	106	122	118	115	0	0	0	0	0	0	0	0	0	59	11	50	47	3	25
			Maroc	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Namibia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	22	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	12	0	0
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			S Tomé e Príncipe	81	88	92	96	139	141	141	136	136	136	136	515	346	292	384	114	119	121	124	127	131	134	312	212	219	2	234	28	223	224
			Senegal	462	162	167	240	560	260	238	786	953	240	673	567	463	256	737	446	630	484	174	247	165	37	60	586	301	313	397	350	972	417
			Sierra Leone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	
			South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	4	0	0	0	1	5	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	157	38	58	24	56	44	66	45	50	62	49	15	25	36	109	121	80	21	52	54	42	17	21	23	26	21	16	17	6	2
		NCO	Benin	20	20	20	19	6	4	5	5	12	2	2	5	3	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	77	83	72	533	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mixed flags (FR+ES)	182	160	128	97	110	138	131	353	400	365	413	336	264	274	205	251	308	265	275	275	275	275	275	0	0	0	0	0	0	
			NEI (BIL)	0	0	0	0	0	0	0	28	269	408	213	55	1	105	43	20	11	0	44	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	27	51	57	69	86	127	120	77	43	3	2	16	7	8	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Togo	0	0	0	0	9	22	36	23	62	55	95	135	47	31	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ATW	CP	Barbados	50	46	74	25	71	58	44	44	42	26	27	26	42	58	42	0	0	18	36	36	39	44	54	56	42	20	15	15	20	18
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	5	0	12	0	0	52	8	7	4	3	0	11	19	62	104	42	0	1
			Brazil	243	129	245	310	137	184	356	598	412	547	585	534	416	139	123	268	433	71	138	108	76	57	72	59	39	43	17	28	24	11
			China PR	0	3	3	3	3	3	9	4	3	1	0	1	0	0	0	1	2	1	1	1	0	1	1	3	6	2	9	160	8	5

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Curaçao	15	15	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	13	19	36	5	20	42	7	14	309	414	183	160	89	134	214	361	412	275	190	184	203	244	311	207	454	256	228	57	67	240
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	10
			EU-Portugal	0	0	0	0	0	0	0	4	0	0	12	12	110	18	53	101	20	19	9	2	0	0	0	0	1	37	9	3	0	1
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Grenada	246	151	119	56	83	151	148	164	187	151	171	112	147	159	174	216	183	191	191	191	191	191	210	137	165	150	111	97	61	89
			Japan	1	8	2	4	17	3	10	12	3	3	10	5	22	4	1	33	43	36	12	16	7	11	12	13	7	3	18	3	7	8
			Korea Rep	3	4	4	12	4	0	0	0	0	0	0	0	0	0	0	0	1	0	40	3	1	1	0	0	0	0	0	0	0	**0**
			Mexico	2	19	19	10	9	65	40	118	36	34	45	51	55	41	46	45	48	34	32	51	63	42	35	47	51	24	27	20	24	17
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	415	0	461	378	417	198	122
			St Vincent and Grenadines	4	4	2	1	3	2	1	0	2	164	3	86	73	59	18	13	8	7	4	4	3	4	1	85	8	10	5	19	0	0
			Trinidad and Tobago	1	2	1	4	10	25	37	3	7	6	8	10	9	17	13	32	16	16	38	72	34	29	51	53	63	51	56	47	43	37
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	203	180	348	232	349	267	163	76	58	103	0	0	0	0	0	3	3	0	0	7	3	2	2	3	3	3	3	1	1	2
			Venezuela	341	223	180	255	279	515	367	261	249	277	327	509	607	1042	549	382	416	498	590	543	341	230	225	305	543	534	481	396	408	461
		NCC	Chinese Taipei	112	117	19	19	2	65	17	11	33	31	13	8	21	5	14	10	11	6	8	26	6	3	6	5	5	5	4	7	2	1
			Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	1	5	14	9	13	14	6	2	4	1
		NCO	Aruba	10	10	10	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	42	46	37	37	40	28	196	208	68	32	18	50	72	47	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	5	3	0	1	0	3	3	4	2	0	2	0	0	5	3	3	3	2	1	2	2	2
			Dominican Republic	50	90	40	40	101	89	27	67	81	260	91	144	165	133	147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (BIL)	0	0	0	0	0	0	0	297	268	0	0	0	0	68	81	252	17	0	21	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	15	27	30	36	46	67	64	41	23	1	1	9	4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
			Seychelles	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	2	3	2	3	1	1	4	2	0	0	0	1
Landings(FP	ATE	CP	EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Discards	ATE	CP	Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	1	0	1
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	6	1	4	2	4	2	2	3
	ATW	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			USA	63	28	29	69	57	27	72	45	11	7	5	7	4	5	7	10	10	4	10	19	11	11	6	7	6	6	5	3	2	2
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0

SAI-Table 2. Kobe 2 Strategic Matrices for the East Atlantic sailfish stock. Top: the probability that overfishing is not occurring ($F \leq F_{MSY}$); middle: the probability that the stock is not overfished ($B \geq B_{MSY}$); and bottom: the joint probability of being in the green quadrant of the Kobe plot (i.e., $F \leq F_{MSY}$ and $B \geq B_{MSY}$).

Probaility $F<=F_{MSY}$

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1000	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1250	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1500	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1750	100%	100%	100%	99%	99%	99%	99%	99%	99%	99%
2000	99%	99%	98%	98%	97%	97%	96%	95%	94%	94%
2250	98%	97%	95%	94%	92%	90%	88%	86%	84%	83%
2336	98%	96%	94%	91%	89%	87%	84%	82%	79%	77%
2500	97%	94%	90%	86%	83%	79%	75%	71%	68%	65%
2750	94%	88%	82%	75%	69%	64%	58%	52%	48%	44%
3000	90%	81%	72%	62%	54%	46%	40%	35%	30%	27%

Probability $B>=B_{MSY}$

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
1000	98%	99%	99%	99%	99%	99%	99%	100%	100%	100%
1250	98%	99%	99%	99%	99%	99%	99%	99%	99%	99%
1500	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%
1750	98%	98%	97%	97%	97%	97%	96%	96%	95%	96%
2000	98%	97%	97%	96%	95%	94%	93%	92%	91%	91%
2250	98%	97%	95%	93%	92%	90%	88%	86%	84%	82%
2336	98%	97%	95%	92%	90%	88%	85%	83%	81%	78%
2500	98%	96%	94%	91%	87%	84%	80%	77%	73%	70%
2750	98%	96%	92%	87%	82%	76%	71%	65%	60%	55%
3000	98%	95%	89%	83%	75%	67%	60%	52%	46%	40%

Probability $F<=F_{MSY}$ and $B>=B_{MSY}$

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
1000	98%	99%	99%	99%	99%	99%	99%	100%	100%	100%
1250	98%	99%	99%	99%	99%	99%	99%	99%	99%	99%
1500	98%	98%	98%	98%	98%	98%	98%	98%	98%	98%
1750	98%	98%	97%	97%	97%	97%	96%	96%	95%	96%
2000	98%	97%	96%	96%	95%	94%	93%	92%	91%	91%
2250	98%	96%	94%	93%	91%	89%	87%	85%	82%	81%
2336	98%	96%	93%	91%	88%	86%	83%	81%	78%	76%
2500	97%	93%	90%	86%	82%	78%	74%	71%	67%	64%
2750	94%	88%	82%	75%	69%	63%	58%	52%	48%	44%
3000	90%	81%	72%	62%	54%	46%	40%	35%	30%	27%

SAI-Table 3. Kobe II Strategic Matrices for the West Atlantic sailfish stock. Top: the probability that overfishing is not occurring ($F \leq F_{MSY}$); middle: the probability that the stock is not overfished ($B \geq B_{MSY}$); and bottom: the joint probability of being in the green quadrant of the Kobe plot (i.e., $F \leq F_{MSY}$ and $B \geq B_{MSY}$).

Probaility F<=F_{MSY}

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1000	95%	96%	97%	97%	98%	98%	98%	99%	99%	99%
1250	86%	87%	88%	89%	89%	90%	90%	90%	91%	91%
1500	74%	73%	72%	71%	70%	70%	69%	68%	68%	68%
1600	68%	66%	65%	63%	61%	60%	59%	57%	56%	55%
1700	63%	59%	56%	53%	51%	50%	47%	45%	44%	43%
1750	59%	55%	52%	49%	47%	45%	42%	40%	38%	37%
1800	56%	52%	48%	45%	42%	40%	37%	35%	33%	31%
1900	50%	45%	41%	37%	34%	30%	28%	26%	24%	22%
2000	45%	39%	34%	30%	26%	23%	21%	19%	16%	15%

Probability B>=B_{MSY}

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	68%	87%	95%	98%	99%	100%	100%	100%	100%	100%
1000	68%	75%	80%	84%	87%	89%	91%	92%	93%	94%
1250	68%	71%	74%	76%	78%	79%	81%	82%	83%	83%
1500	68%	67%	67%	66%	66%	66%	65%	65%	64%	64%
1600	68%	66%	64%	62%	61%	60%	58%	56%	55%	54%
1700	68%	64%	61%	58%	55%	53%	51%	48%	47%	45%
1750	68%	63%	60%	56%	53%	50%	47%	44%	43%	40%
1800	68%	62%	58%	53%	50%	47%	44%	40%	38%	36%
1900	68%	61%	55%	49%	45%	41%	36%	33%	30%	28%
2000	68%	59%	52%	45%	40%	35%	30%	27%	23%	21%

Probability F<=F_{MSY} and B>=B_{MSY}

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	68%	87%	95%	98%	99%	100%	100%	100%	100%	100%
1000	68%	75%	80%	84%	87%	89%	91%	92%	93%	94%
1250	68%	71%	74%	76%	78%	79%	81%	82%	83%	83%
1500	67%	66%	66%	66%	65%	65%	65%	64%	63%	63%
1600	65%	63%	61%	60%	58%	57%	56%	54%	54%	53%
1700	61%	58%	55%	52%	50%	48%	46%	44%	43%	42%
1750	59%	55%	52%	48%	46%	44%	41%	39%	38%	36%
1800	56%	52%	48%	45%	42%	39%	37%	34%	32%	31%
1900	50%	45%	41%	36%	34%	30%	28%	26%	24%	22%
2000	45%	39%	33%	30%	26%	23%	21%	19%	16%	15%

SAI-Table 4. Estimated probabilities of the East Atlantic biomass sailfish stock levels being below 20% of B_{MSY} during the projection period for a given catch level.

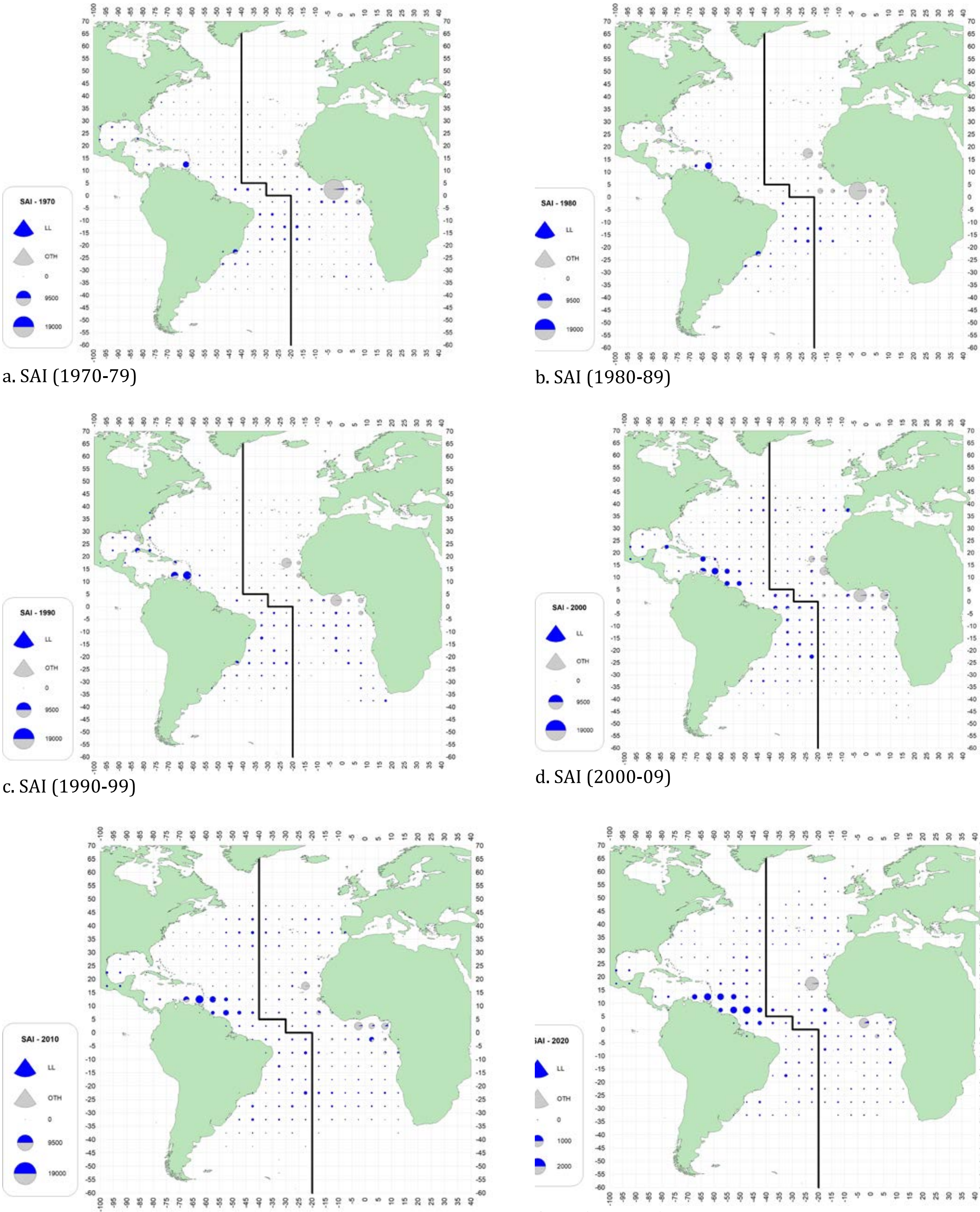
Probability of B < 20% of B_{MSY}

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1250	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1500	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1750	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2250	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
2336	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
2500	0%	0%	0%	0%	0%	0%	0%	1%	2%	3%
2750	0%	0%	0%	0%	0%	1%	1%	3%	5%	8%
3000	0%	0%	0%	0%	1%	2%	4%	7%	12%	17%

SAI-Table 5. Estimated probabilities of the West Atlantic biomass sailfish stock levels being below 20% of B_{MSY} during the projection period for a given catch level.

Probability of B < 20% of B_{MSY}

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1250	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%
1500	0%	0%	0%	1%	2%	2%	3%	4%	6%	7%
1600	0%	0%	0%	1%	2%	4%	5%	8%	10%	12%
1700	0%	0%	1%	2%	4%	6%	9%	12%	15%	18%
1750	0%	0%	1%	2%	4%	7%	11%	14%	18%	22%
1800	0%	0%	1%	2%	5%	9%	13%	17%	21%	25%
1900	0%	0%	1%	3%	7%	12%	18%	23%	29%	35%
2000	0%	0%	1%	5%	10%	17%	24%	31%	38%	44%



a. SAI (1970-79)

b. SAI (1980-89)

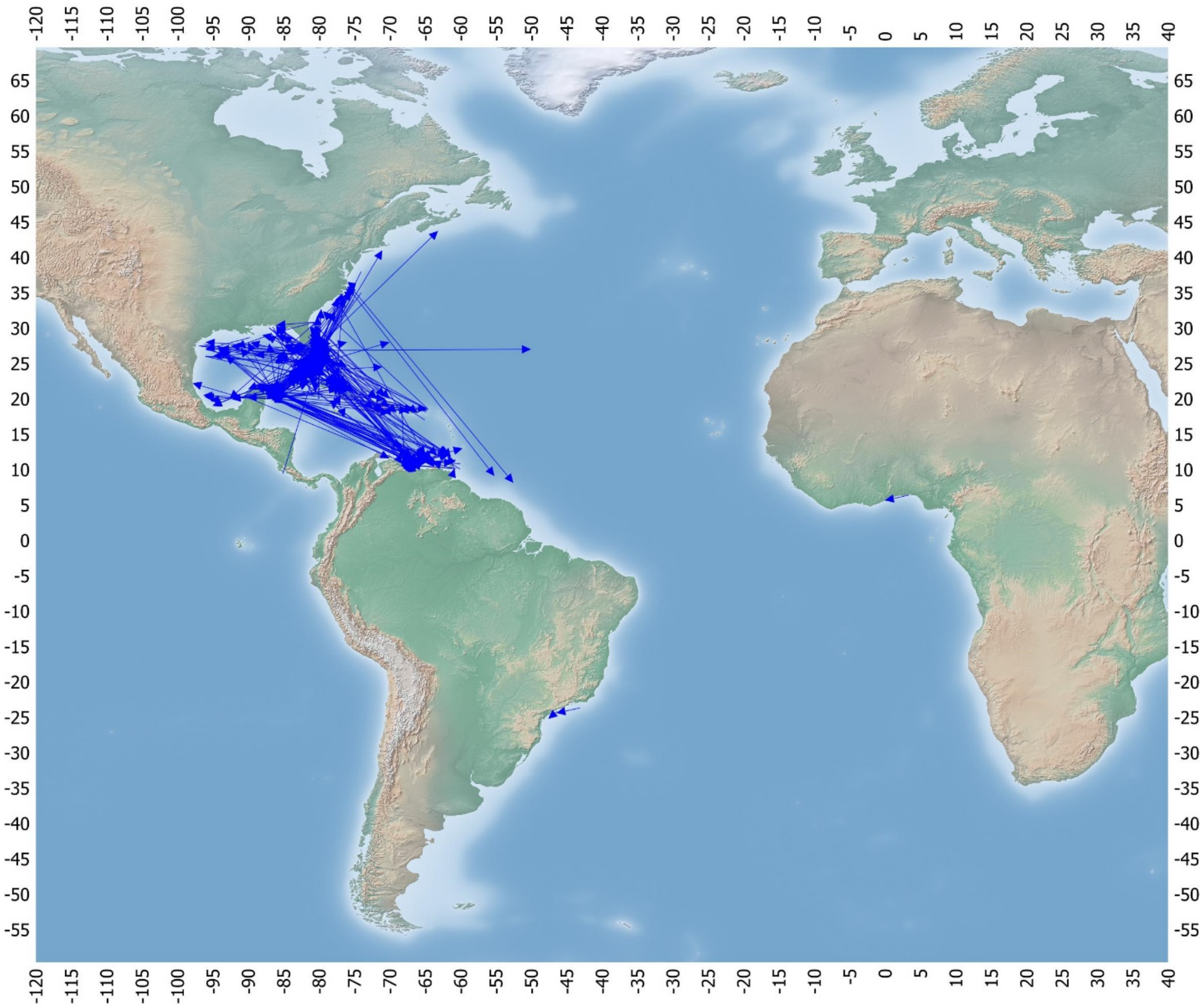
c. SAI (1990-99)

d. SAI (2000-09)

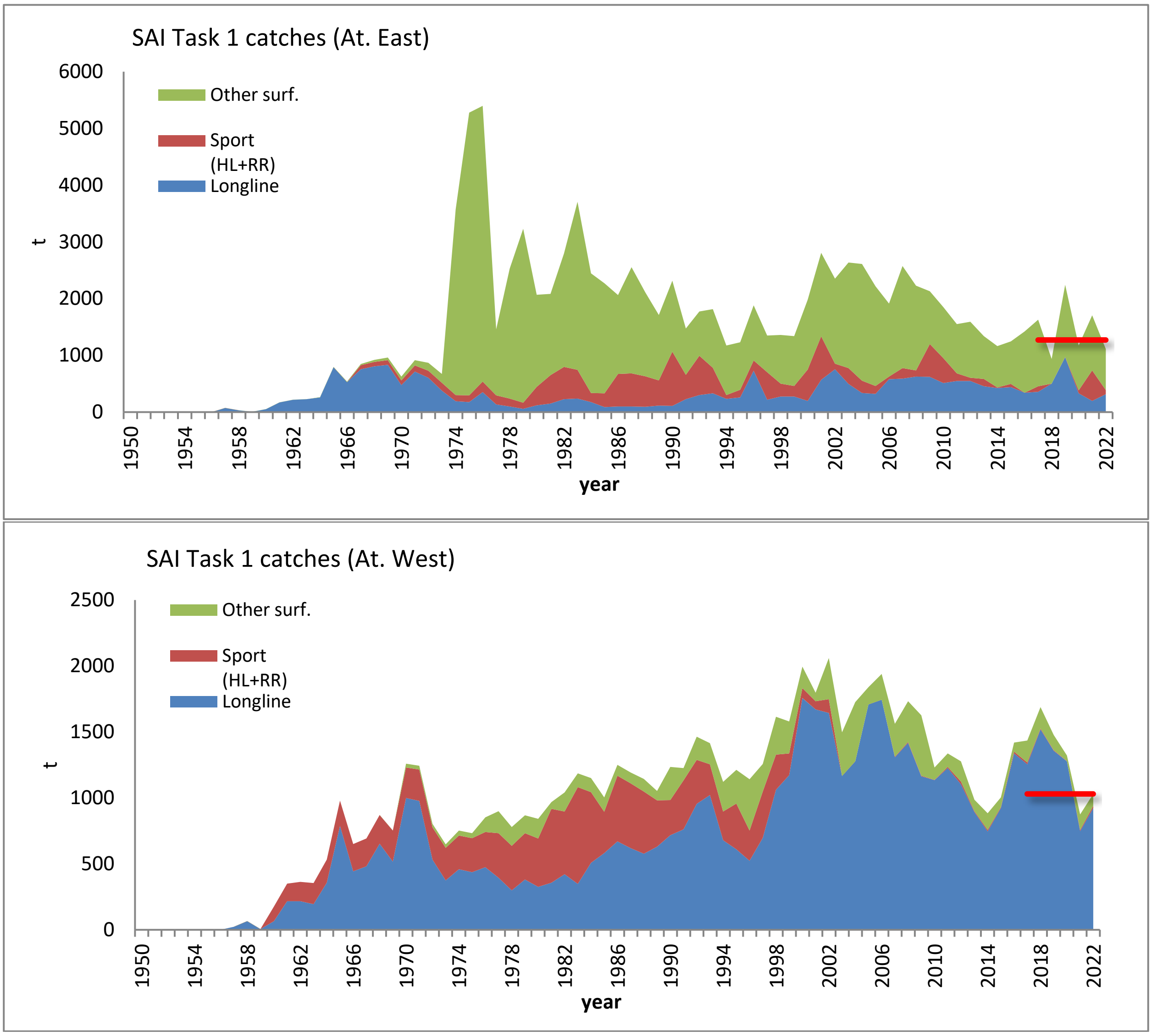
e. SAI (2010-19)

f. SAI (2020-21)

SAI-Figure 1. Geographic distribution of sailfish total catches by decade (last decade only covers 2 years). The dark line denotes the separation between stocks.

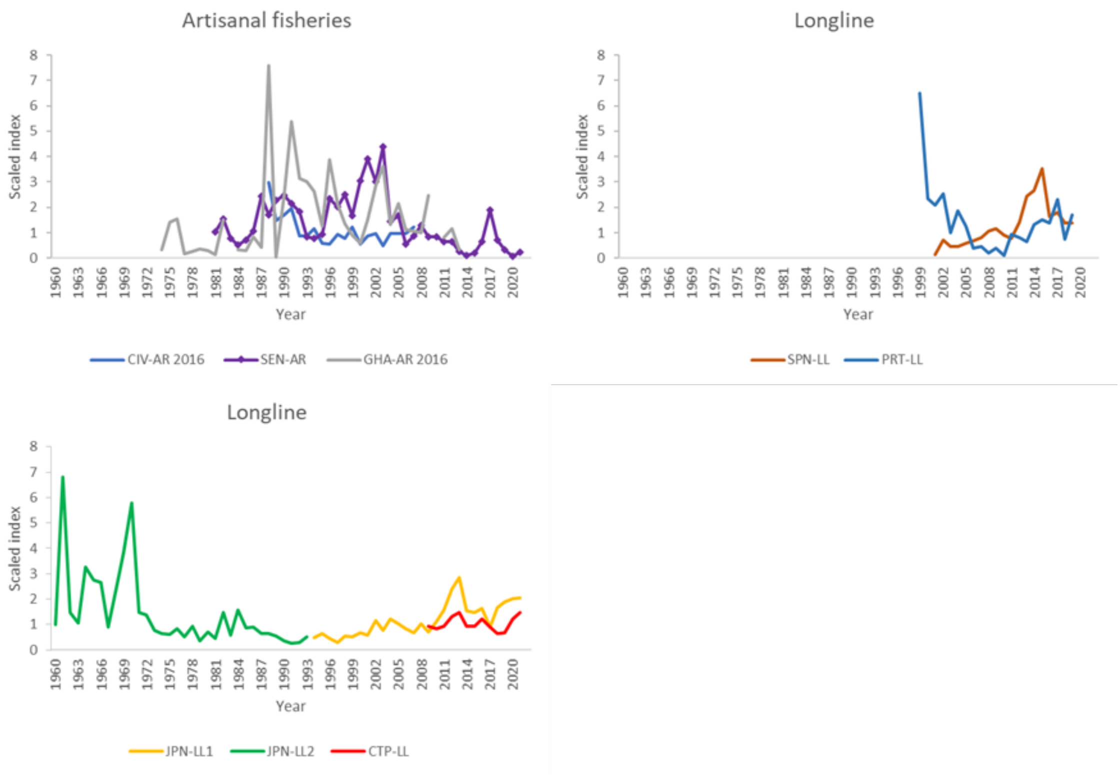


SAI-Figure 2. Conventional tag returns for Atlantic sailfish. Lines join the locations of release and recapture.

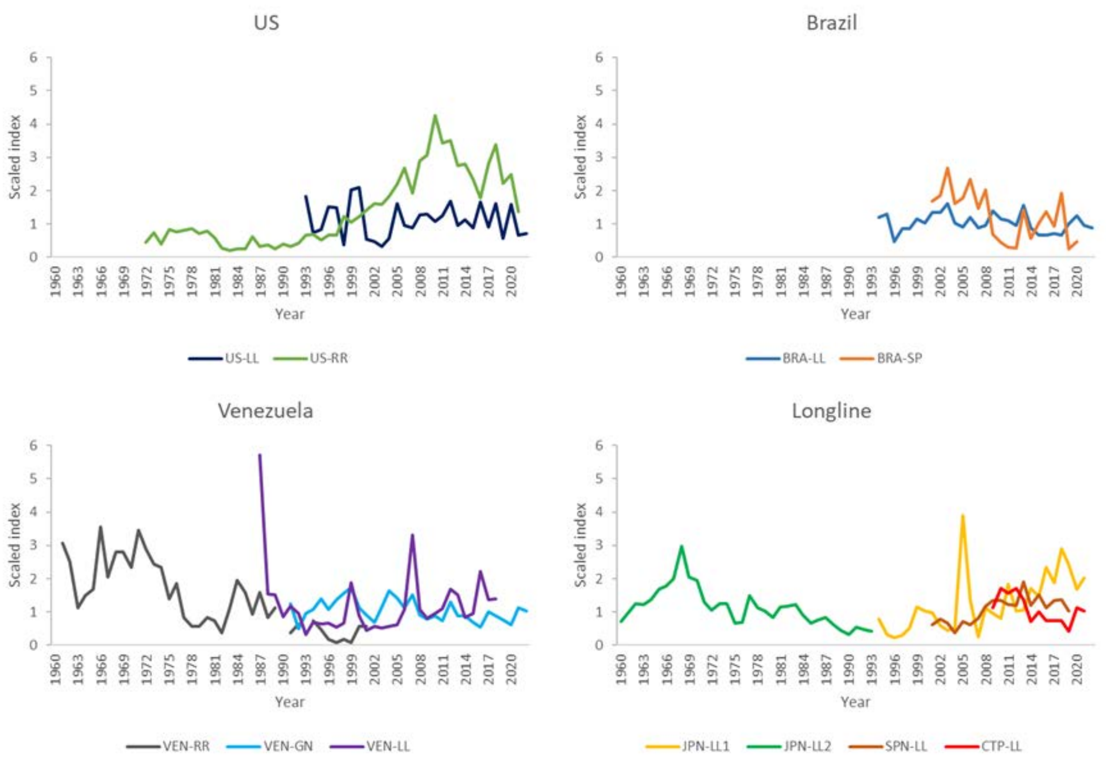


SAI-Figure 3. Task 1 catches of sailfish for each of the two Atlantic stocks, East and West. In 2017 catch levels of 1271 t and 1030 t that triggers the review of Rec. 16-11 were implemented, for East and West stocks, respectively.

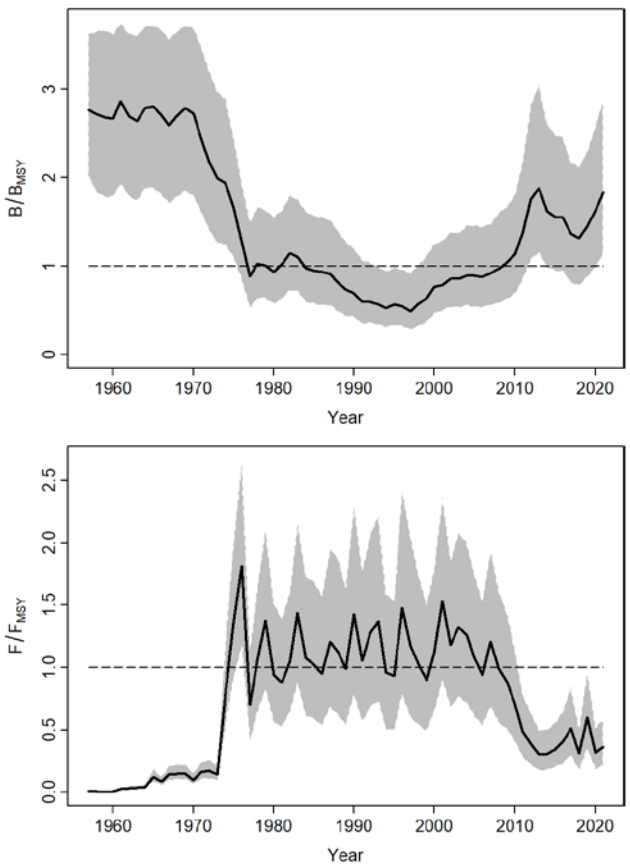
East Atlantic



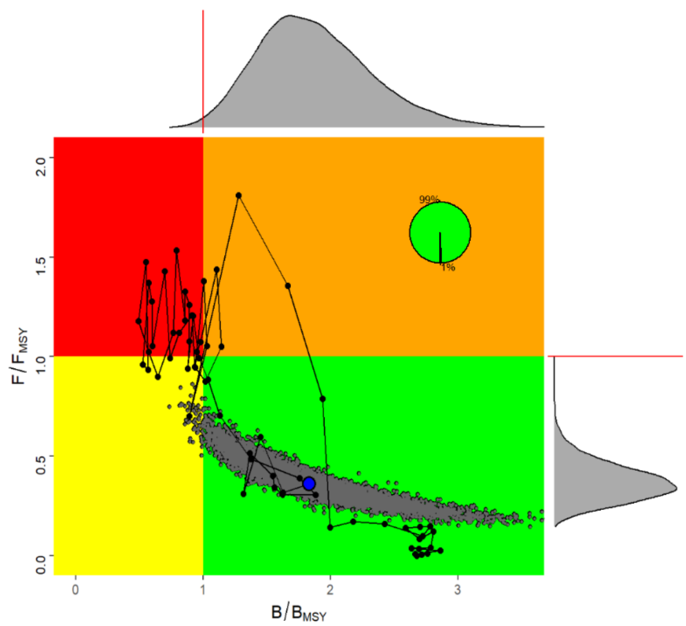
West Atlantic



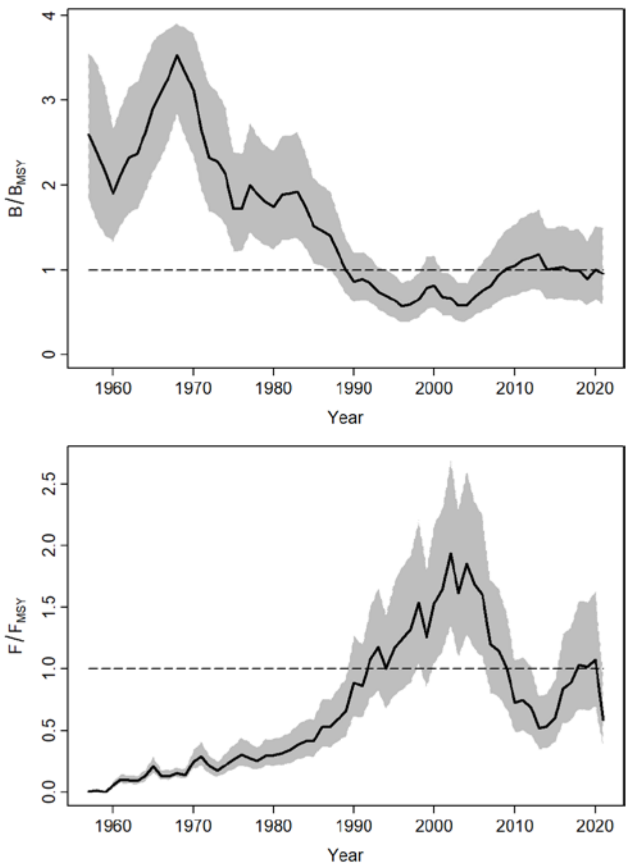
SAI-Figure 4. Relative abundance indices considered in the assessments of the East and West Atlantic sailfish stocks. All indices were scaled to the mean of each series prior to graphing.



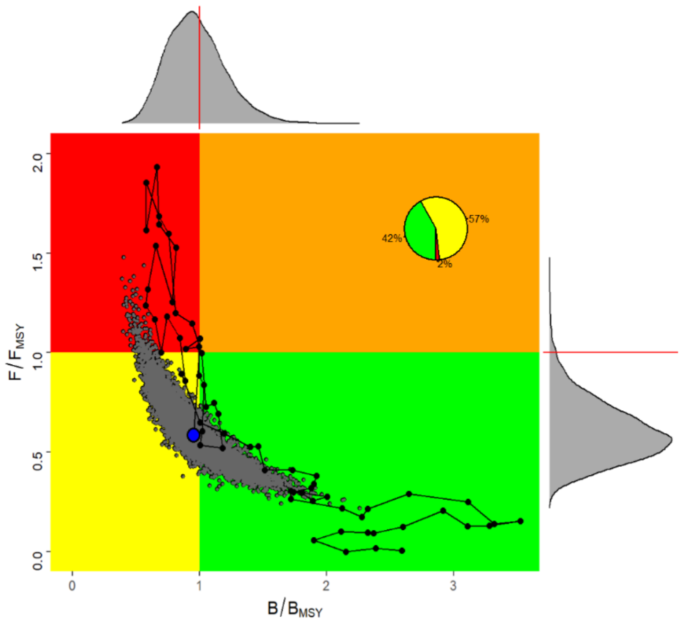
SAI-Figure 5. Estimated annual trend for the East Atlantic sailfish stock for B/BMSY (upper panel), and F/FMSY (lower panel) with 95% CI.



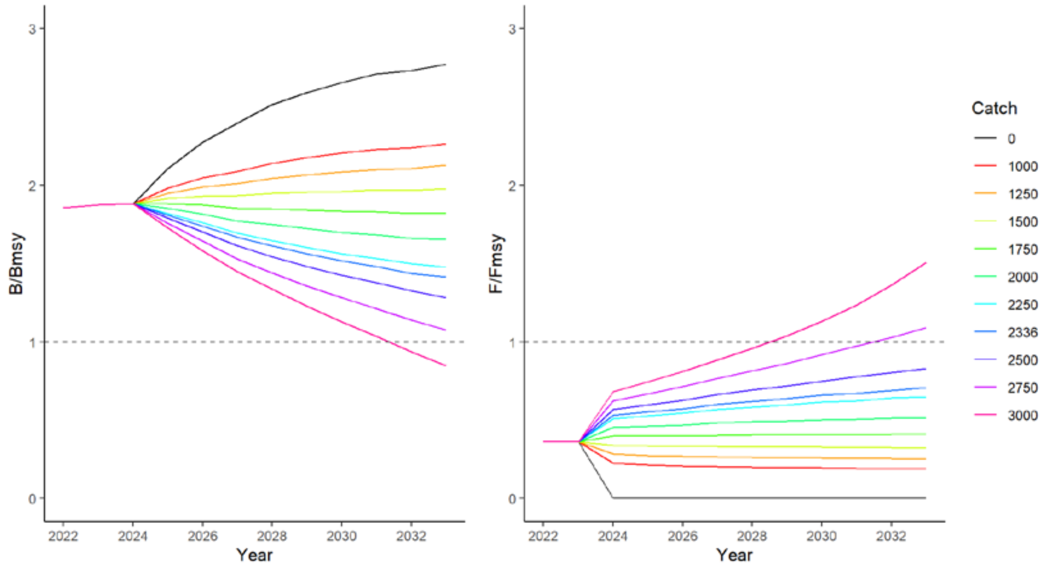
SAI-Figure 6. Kobe phase plot for the East Atlantic sailfish stock. Solid black dots and solid line indicate the stock status trajectory, with the blue dot indicating the terminal year (2021), and grey dots are the interactions for the terminal year with the marginal distributions plotted in the lateral axis.



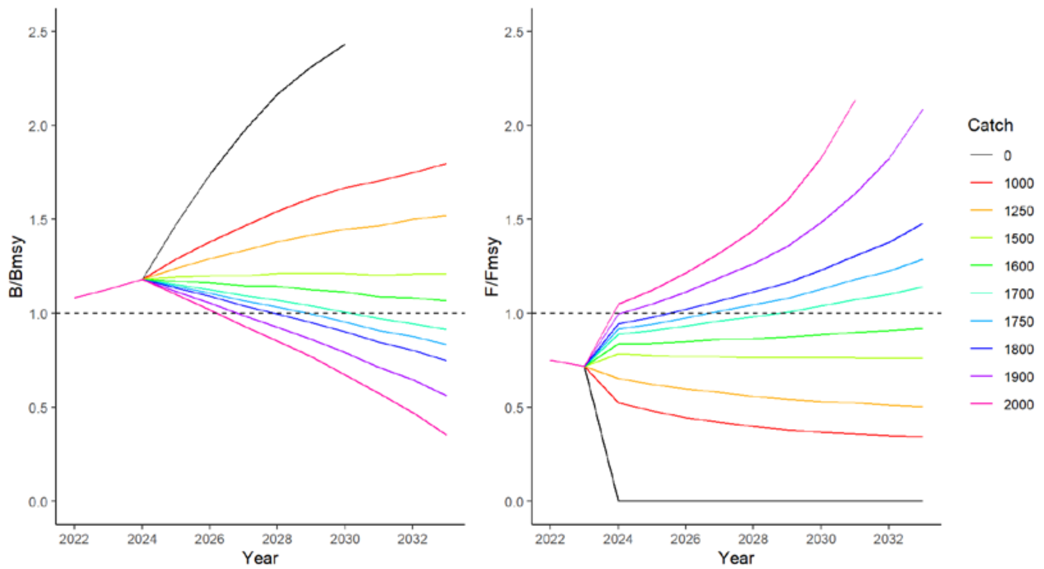
SAI-Figure 7. Estimated annual trend for the West Atlantic sailfish stock for B/B_{MSY} (upper panel), and F/F_{MSY} (lower panel) with 95% CI.



SAI-Figure 8. Kobe phase plot for the West Atlantic sailfish stock. Solid black dots and solid line indicate the stock status trajectory, with the blue dot indicating the terminal year (2021), and grey dots are the interactions for the terminal year with the marginal distributions plotted in the lateral axis.



SAI-Figure 9. Projections for B/B_{MSY} and F/F_{MSY} for the East Atlantic sailfish stock for various levels of future constant catch ranging from 1,000 – 3,000 t, including a zero-catch scenario starting in 2024. The initial catch for the years 2022-2023 was set to 1,586 t, which is the average catch of the recent three years (2019-2021). The projections were run until 2033 (10 years).



SAI-Figure 10. Projections for B/B_{MSY} and F/F_{MSY} for the West Atlantic sailfish stock for various levels of future constant catch ranging from 1,000-2,000 t, including a zero-catch scenario starting in 2024. The initial catch for the years 2022-2023 was set to 1,313 t, which is the geometric mean catch of the recent three years (2019-2021). The projections were run until 2033 (10 years).

9.12 SWO-AT - Atlantic swordfish

The status of the North and South Atlantic swordfish stocks was assessed in 2022, by means of applying statistical modelling to the available data up to 2020. Complete information on the data availability and assessment can be found in the Report of the 2022 ICCAT Atlantic Swordfish Data Preparatory Session (Anon., 2022e) and Report of the 2022 ICCAT Atlantic Swordfish Stock Assessment (Anon., 2022f). Statistics relevant to Atlantic swordfish is presented in the Report of the 2023 Meeting of the Subcommittee on Statistics, included as **Appendix 13** to this SCRS Report, and recommendations pertinent to Atlantic swordfish are presented in Item 18.

The Commission is scheduled to adopt a management procedure (MP) for North Atlantic swordfish in 2023. As the MP has not yet been chosen, the following text is reflective of stock status and advice as prepared by the Committee in 2022.

MSE development in 2024 requires that an exceptional circumstances (EC) protocol be developed for the stock. The Committee will work with Panel 4 to develop an Exceptional Circumstances (EC) protocol.

SWO-AT-1. Biology

Swordfish (*Xiphias gladius*) are members of the family Xiphiidae and are in the suborder Scombroidei. They can reach a maximum weight in excess of 500 kg. They are distributed widely in the Atlantic Ocean and Mediterranean Sea. In the ICCAT Convention area, the management units of swordfish for assessment purposes are a separate Mediterranean group, and North and South Atlantic groups separated at 5°N.

Swordfish feed on a wide variety of prey including groundfish, pelagic fish, deep-water fish, and invertebrates. They are believed to feed throughout the water column, and from electronic tagging studies, undertake extensive diel vertical migrations.

Swordfish mostly spawn in the western warm tropical and subtropical waters throughout the year, although seasonality has been reported in some of these areas. They are found in the colder temperate waters during summer and fall months. Young swordfish grow very rapidly, reaching about 140 cm lower-jaw fork length (LJFL) by age three, but grow slowly thereafter. Females grow faster than males and reach a larger maximum size. Tagging studies have shown that some swordfish can live up to 15 years. Swordfish are difficult to age, but about 50% of females were considered to be mature by age five, at a length of about 180 cm. However, the most recent information indicates a smaller length and age at maturity.

The analysis of the horizontal movements shows seasonal patterns, with fish generally moving towards the equator by winter and returning to the temperate foraging grounds in spring and summer. Broader areas of mixing between some eastern and western areas were also suggested. Results obtained by up satellite tags also fully confirm the previous knowledge that was available from fishery data: deep longline settings catch swordfish during the daytime as a bycatch, while shallow setting longliners target swordfish at night closer to the surface.

Beginning in 2018, an ICCAT Swordfish Biology Programme, encompassing all three ICCAT stocks, has been conducting studies on swordfish growth, reproductive biology, and genetic analysis for identification of stock boundaries and mixing. Since programme inception, 4,647 fish have been sampled for otolith, fin spines, gonads and other tissues. The three research areas address key uncertainties important for improving the scientific advice for management of the stocks. Within each of the project areas, important scientific advances have been made:

- Ageing and growth: standards for ageing spines and otoliths; preliminary work on new growth models.
- Reproductive biology: standards for classifying reproductive status of swordfish and preliminary updates to maturity schedules.
- Genetics: identified genetic markers important for stock differentiation; identified key stock mixing areas in the North-East Atlantic; identified subpopulations within the Mediterranean.

These biological studies are ongoing, and the collective work contributes to the next major advance in the assessment of swordfish status.

SWO-AT-2. Fishery indicators

Due to the broad geographical distribution of Atlantic swordfish (**SWO-AT-Figure 1**) in coastal and offshore areas (mostly ranging from 50ºN to 45ºS), this species is available to a large number of fishing countries. **SWO-AT-Figure 2** shows total estimated catches for North and South Atlantic swordfish. Directed longline fisheries from Canada, EU-Spain, and the United States have operated since the late 1950s or early 1960s, and harpoon fisheries have existed at least since the late 1800s. Other directed swordfish fisheries include fleets from Brazil, EU-Portugal, Morocco, Namibia, and South Africa. The primary bycatch or opportunistic fisheries that take swordfish are tuna fleets from Chinese Taipei, Japan, Korea (Rep.) and EU-France. The tuna longline fishery started in 1956 and has operated throughout the Atlantic since then, with substantial catches of swordfish that are produced as a bycatch of tuna fisheries. The largest proportion of the Atlantic catches is made using surface-drifting longline. However, many additional gears are used, including traditional gillnets off the coast of western Africa.

Trends by area (NE vs. NW Atlantic) in the CPUE indexes were consistent with the seasonal movement patterns observed in the electronic tagging data, as well as in the catches and sex-ratio distributions. Relationships observed for the eastern Atlantic were opposite to those in the western Atlantic. This pattern was correlated with the decadal cycling of the Atlantic Multidecadal Oscillation (AMO) as well as that of the North Atlantic Oscillation (NAO). Including the AMO as a covariate to area specific catchability within the assessment model helped reduce the conflicting directions of the various CPUE trends. Further analysis and hypothesis testing was recommended to determine if the relationship was due to a swordfish temperature preference, a change in prey distribution, or perhaps both. To support this hypothesis testing the Committee encouraged a group of swordfish scientists to work towards uniting the available North Atlantic swordfish CPUE data into a single dataset so that a more refined, area specific CPUE analyses could be conducted.

For both the North and South Atlantic some of the indices of abundance were affected by changes in gear technology and management that could not be accounted for in the CPUE standardization, and therefore some indices had to be split into consistent time periods.

Total Atlantic

The total Atlantic estimated catch (landings plus dead discards) of swordfish (North and South, including reported dead discards) in 2022 (19,092 t) was 9.5% lower than the reported catch of 2015 (21,097 t), the terminal data year in the previous assessment. Catch reports are considered to be nearly complete for 2022, however, few countries, which typically represent a small portion of the catch, have not yet reported their 2022 catches and because of unknown unreported catches, this value should be considered provisional and subject to further revision.

North Atlantic

For the past decade, the North Atlantic estimated catch (landings plus dead discards) has averaged about 10,400 t per year (**SWO-AT-Table 1**). The catch in 2022 (10,349 t) represents 51% of the 1987 peak in North Atlantic landings (20,238 t). These reduced landings have been attributed to ICCAT management measures, a reduction in total longline effort (Taylor *et al.,* 2020), and shifts in fleet distributions, including the movement of some vessels in certain years to the South Atlantic or out of the Atlantic. In addition, some fleets, including at least the United States, EU-Spain and EU-Portugal have changed operating procedures to opportunistically target tuna and/or sharks, taking advantage of market conditions and higher relative catch rates of these species previously considered as bycatch in some fleets. Recently, socio-economic factors, and oceanography patterns may have also contributed to the decline in catch. Task 1 and 2 data coverage is generally good, however the Committee noted the sparse discarding data for most CPCs as well as gaps in the catch and effort data for some CPCs.

Available longline CPUE series were evaluated by the Committee and certain indices were identified as suitable for use in the assessment models (Canada, Chinese Taipei, EU-Portugal, EU-Spain, Japan, Morocco, and USA). Trends in standardized CPUE series by fleets contributing to the stock assessment models are shown in **SWO-AT-Figure 3**. Most of the series have an increasing trend since the late 1990s but show a decrease or plateau in the more recent years. There have been some recent changes in United States regulations (such as time-area closures for other species like Atlantic bluefin tuna, among others) that may have impacted catch rates. The combined index used in the biomass models is shown in **SWO-AT-Figure 4.**

South Atlantic

The historical trend of catch (landings plus dead discards) can be divided in two periods: until 1980 and after 1980. The first one is characterized by relatively low catches, generally less than 5,000 t (with an average value of 1,824 t). After 1980, landings increased continuously up to a peak of 21,931 t in 1995, levels that are comparable to the peak of North Atlantic harvest (20,238 t in 1987). This increase of landings was, in part, due to progressive shifts of fishing effort to the South Atlantic, primarily from the North Atlantic, as well as other waters. Expansion of fishing activities by southern coastal countries, such as Brazil and Uruguay, also contributed to this increase in catches. The reduction in catch following the peak in 1995 resulted from regulations and was partly due to a shift to other oceans and target species. In 2022, the reported catch (8,743 t) is 60% lower than the 1995 reported catch (**SWO-AT-Table 1**).

Available longline CPUE series for South Atlantic swordfish were evaluated by the Committee and certain indices were identified as suitable for use in assessment models (Brazil, Chinese Taipei, EU-Spain, Japan, South Africa, Uruguay). The available indices are illustrated in **SWO-AT-Figure 5**.

Discards

Since 1991, very few fleets have reported dead discards (see **SWO-AT-Table 1**). The volume of North Atlantic reported dead discards reached a maximum of 1,138 t in 2000. Recent reported dead discards for the North Atlantic are significantly lower (113 t in 2020; 101 t in 2021; 74 t in 2022). For the South Atlantic, the reported discards peaked at 147 t in 2010. In 2021 and 2022, 128 t and 85 t of dead discards were respectively reported for the South Atlantic. The Committee continued to express concerns due to the low percentage of fleets that have reported annual dead discards (in t) and in many cases what has been reported is not necessarily scaled to the entire fishery.

SWO-AT-3. State of the stocks

North Atlantic

In 2022, two stock assessment platforms were used to provide estimates of stock status for the North Atlantic swordfish stock as a basis for management advice. There were: a Bayesian surplus production model (JABBA - Just Another Bayesian Biomass Assessment) and the integrated assessment model Stock Synthesis (SS).

The Committee noted that the 2022 assessment represents a significant improvement in the characterization of uncertainty of current stock status for North Atlantic swordfish using updated information and integration of JABBA. The Committee agreed that management advice for North Atlantic swordfish, including stock status and projections, should be based on JABBA and SS models.

There were important developments to the modelling in 2022. In particular, the SS model provided estimates of the full weight of dead discards due to the size limit (i.e., reported and unreported) in the estimation of stock status. This analysis is consistent with the request of the Commission that the SCRS monitor and analyse the effects of the minimum size limit (Rec. 17-02, paragraph 10). This capacity will also be useful in future MSE simulations.

Based on the combined results from the two stock assessment model platforms (Stock Synthesis and JABBA), the North Atlantic swordfish stock biomass was above B_{MSY} (median B_{2020}/B_{MSY} = 1.08 and 95% CI of 0.71 and 1.33) and fishing mortality was below F_{MSY} (median F_{2020}/F_{MSY} = 0.80 and 95% CI of 0.64 and 1.24) in 2020 (**SWO-AT-Figure 6**). The median MSY was estimated as 12,819 t with 95% CI of (10,864 t and 15,289 t).

The joint Kobe phase plot shows that JABBA model results provide wider range of uncertainty than the Stock Synthesis results. Probabilities of the stock being in each quadrant of the Kobe plot (**SWO-AT-Figure 9**) are 63% in the green (not overfished not subject to overfishing), 22% in the yellow (overfished but not subject to overfishing) and 15% in the red (overfished and subject to overfishing). The results point to a stock status of not overfished (37% probability of overfished status), with no overfishing (15% probability of overfishing taking place). The estimate of stock status in 2020 is very similar to the estimated status from the previous assessment in the terminal year (2015).

South Atlantic

In 2022, two stock assessment platforms were used to assess the South Atlantic swordfish stock. These were a Bayesian surplus production model (JABBA) and Stock Synthesis. While Stock Synthesis was explored in 2022, only the JABBA model was used for providing advice.

The Committee acknowledged the progress made to implement a Stock Synthesis model for the South stock for the first time, but revision of size data and further model development are still required before it can be fully used for management advice. As such, the Stock Synthesis model was considered preliminary, and the Committee agreed that stock status estimates and projections for management advice should be done using only the JABBA model. For the purpose of comparison of model results across platforms only, results from Stock Synthesis are presented in **SWO-AT-Figure 7** to illustrate the overall consistency among models.

Both models were consistent and suggested a decline in stock biomass as the fishing mortality increased in the 1990s. The final JABBA results estimated that B_{2020} was also below B_{MSY} (median = 0.77, 95% CIs = 0.53-1.13) while F_{2020} was marginally above F_{MSY} (median = 1.03, 95% CIs = 0.67-1.51) (**SWO-AT-Figure 8**). The JABBA's MSY_{2020} was estimated to be 11,481 t.

The southern swordfish stock biomass is overfished, and overfishing is occurring. The JABBA base case assessment indicates a 56% probability that the stock is within the red quadrant of the Kobe plot (**SWO-AT-Figure 10**).

SWO-AT-4. Outlook

North Atlantic

Based on the currently available information to the Committee, both the JABBA and Stock Synthesis base models were projected to the year 2033 under constant TAC scenarios of 9,000 to 16,000 t, as well as a zero-catch scenario.

For the projections, catches for 2021 and 2022 are assumed to be constant at 10,476 t (the catch value for 2020 at the time of the assessment). Different levels of constant catch are projected for the period 2023-2033 (**SWO-AT-Table 2**). The combined Stock Synthesis and JABBA projections show that a 13,200 t constant catch, which is the current TAC level (Rec. 22-03), will have a 60% probability of being in green quadrant in 2033. However, given that the estimated MSY (that is inclusive of dead discards) is 12,819 t and B_{2020}/B_{MSY}=1.08, catches above MSY will results in biomass declines over the projection period (**SWO-AT-Figure 11**). Under 2021 catch (9,729 t), there is an 84-87% probability of the stock being in green quadrant by 2033 (**SWO-AT-Table 2**).

South Atlantic

The 2022 assessment stock status results are similar to the 2017 assessment (Anon., 2017b), but updated information used in the 2022 assessment resulted in estimates of a less productive stock (MSY_{2020} = 11,481 t; MSY_{2015} = 14,570 t). Specifically, a new surplus production function was objectively derived using biological information, and updated CPUE indices.

Results of projections from the 2017 assessment indicated that if catches remained below 11,000 t, there was a 60% chance of the stock falling within the green quadrant by 2020. The average catch for the period 2016-2020 was 10,125 t, yet the assessment still indicates a 56% probability that the stock is within the red quadrant in 2020 (**SWO-AT-Figure 10**). The Committee notes that this apparent inconsistency can be explained by the lower productivity (see above) of the stock determined in the 2022 assessment.

Projections were conducted for the base case JABBA model under constant TAC scenarios of 6 to 15 thousand tons, as well as a zero-catch scenario (**SWO-AT-Figure 12**). Projections were implemented in 2023 and catches for 2021 and 2022 were assumed to remain constant (9,826 t) at the average from the previous three years. Using this three-year average (9,826 t) assumed in the 2022 stock assessment, the South Atlantic swordfish stock has a 55% probability of being in the green quadrant of the Kobe plot by 2033 (**SWO-AT-Table 3**).

SWO-AT-5. Effect of current regulations

For the North and South Atlantic, the most germane recommendations can be found in Rec. 22-03 and Rec. 22-04, modifying Recs. 21-02 and 21-03, respectively. Should an MP be adopted in 2023, it is expected that a new recommendation would replace these.

Catch limits

Rec. 17-02 set the TAC for North Atlantic swordfish for 2018 at 13,200 t. This TAC has remained in place for 2023 (Rec. 21-02, Rec. 22-03). The reported catch from 2018-2022 has averaged 9,982 t and has not exceeded the TAC in any year.

Rec. 17-03 set the TAC for South Atlantic swordfish at 14,000 t for 2018, this TAC was in place from 2018-2022 (Rec. 21-03). The reported catch from 2018-2022 averaged 9,531 t and did not exceed the TAC in any year.

Minimum size limits (Rec. 17-02)

There are three minimum size options that are applied to the entire Atlantic: 125 cm LJFL/25 kg with a 15% tolerance (of the number of swordfish *per landing*); or 119 cm LJFL/15 kg with zero tolerance and evaluation of the discards; and for dressed fish, cleithrum to keel length of 63 cm.

Since the implementation of the minimum landing sizes in 2000, the proportion of swordfish less than 125 cm LJFL reported in the landings (in numbers) has been generally decreasing in the North Atlantic and stable in the South. In the North Atlantic, the estimate was 33% in 2000 and decreased to 23% in 2015. In the South Atlantic the estimate was 18% in 2000, had a maximum of 19% in 2006 and decreased to 13% in 2015. The Committee notes that these estimates are based on low sample sizes, are uncertain and may be biased. They will remain uncertain until CPCs fully report size samples from the entire catch. A figure of the estimated absolute biomass and numbers of fish as well as estimated proportions of undersized fish in the catch that are discarded in the North Atlantic is shown in **SWO-AT-Figure 13**. The decreasing trend can be due to a decrease in encounter rate of undersized fish due to changes in fleet behaviour, or a decrease in recruitment over time, or a combination of both.

The Committee also noted high values of hooking mortality (ranging between 78-88%) on small swordfish (<125 cm LJFL) by surface longline fisheries targeting swordfish (**SWO-AT-Figure 14**). The post-release mortality of specimens discarded alive from commercial fishing gear is unknown. Evaluating other strategies to reduce fishing mortality on juvenile swordfish will need complete datasets on fishing effort and size data over the entire Atlantic and should take into account the effects of these strategies on other species. In view of the Commission objective to reduce fishing mortality on small swordfish, the Committee therefore recommends that future work should be carried out to determine more precisely the spatial distribution and magnitude of fishing effort, the size and sex distribution of undersized swordfish in the Atlantic, using high resolution observer data.

SWO-AT-6. Management recommendations

North Atlantic

The Committee recommends that the Commission adopt one of the MSE-tested management procedures (MPs) (see item 19.28, Response to the Commission's request), and that the TAC be set based on that MP for 2024 and beyond.

SWO-AT-Table 2 from the 2022 stock assessment shows the probabilities of maintaining $B>B_{MSY}$, maintaining $F<F_{MSY}$, and maintaining the stock in the green quadrant of the Kobe plot over a range of TAC options for North Atlantic swordfish over a period of 10 years. The combined Stock Synthesis and JABBA projections show that a 13,200 t constant catch, which is the current TAC level (Rec. 22-03), will result in a 60% probability of being in the green quadrant in 2033 (**SWO-AT-Table 2**). However, given that the estimated MSY (that is inclusive of dead discards) is 12,819 t, catches above MSY will results in biomass declines over the projection period (**SWO-AT-Figure 11**).

The Committee also recognizes that the above advice does not fully account for removals associated with the actual mortality of unreported dead and live discards, quota carryovers (15% in the North Atlantic), quota transfers across the North, and South stock management boundaries nor the total cumulative quota, which includes catch allocated to "other CPCs" and would fall above the TAC if achieved. The Committee emphasizes that the importance of this uncertainty be taken into consideration by the Commission when adopting a TAC.

South Atlantic

SWO-AT-Table 3 shows the probabilities of maintaining $B>B_{MSY}$, maintaining $F<F_{MSY}$, and maintaining the stock in the green quadrant of the Kobe plot over a range of TAC options for South Atlantic swordfish over a period through 2033. The current TAC of 14,000 t (Rec. 22-04) is unlikely (3% probability) to result in the stock being in the green quadrant of the Kobe plot by 2033. The reported catch for 2022 was 8,743 t. Catch levels less than 10,000 t will accelerate rebuilding.

The Committee also recognizes that as was the case for the northern stock, the above advice does not fully account for removals associated with the mortality of unreported dead and post release mortality of live discards, quota carryovers (30% in the South Atlantic) nor quota transfers across the North and South stock management boundaries. The Committee emphasizes the importance of these uncertainties and recommends that the stock be closely monitored in the upcoming years to confirm rebuilding.

ATLANTIC SWORDFISH SUMMARY		
	North Atlantic	***South Atlantic***
Maximum Sustainable Yield	12,819 t (10,864 t-15,289 t)[1]	11,481 t (9,793 t-13,265 t)[2]
Current (2022) TAC	13,200 t	14,000 t
Current (2022) Yield[3]	10,349 t	8,743 t
Yield in last year used in assessment (2020)[4]	10,668 t	9,020 t
B_{MSY} (CI)	57,919 t (23,666 t-153,156 t)[5]	74,641 t (60,179 t-92,946 t)[2]
F_{MSY}	0.15 (0.08-0.23) [5]	0.15 (0.12-0.19) [2]
Relative Biomass (B_{2020}/B_{MSY})	1.08 (0.71-1.33) [5]	0.77 (0.53-1.11)[2]
Relative Fishing Mortality (F_{2020}/F_{MSY})	0.80 (0.64-1.24)[5]	1.03 (0.67-1.51)[2]
Stock Status (2020)	Overfished: NO	Overfished: YES
	Overfishing: NO	Overfishing: YES
Management Measures in Effect	Country-specific TACs Rec. 22-03: Minimum size 125/119 cm LJFL[6]	Country-specific TACs Rec. 22-04: Minimum size 125/119 cm LJFL[7]

[1] Median from base case JABBA and Stock Synthesis models; range corresponding to the lowest and highest 95% CIs from the two models.
[2] Median and 95% CIs from base case JABBA model.
[3] Provisional and subject to revision.
[4] Based on catch data available in July 2021 for the stock assessment session.
[5] Median and 95% quantiles from base case Stock Synthesis and JABBA models.
[6] Associated alternatives listed in Rec. 17-02.
[7] Associated alternatives listed in Rec. 17-03.

SWO-AT-Table 1. Estimated catches (t) of Atlantic swordfish (*Xiphias gladius*) by gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				32868	34460	39036	33511	31567	26356	27124	27181	25139	23758	24078	25153	25544	25724	27935	23472	24814	24267	23914	24576	21282	20678	21097	21112	20833	19403	20334	19383	19352	19092
	ATN			16738	15501	17105	15222	13025	12329	11622	11453	10011	9654	11444	12071	12380	11528	12306	11102	12146	11672	12709	13890	12078	10708	10752	10501	10295	9025	10244	10445	9845	10349
	ATS			16130	18958	21931	18289	18542	14027	15502	15728	15128	14104	12634	13082	13163	14196	15629	12370	12668	12596	11205	10686	9204	9970	10345	10611	10537	10378	10090	8938	9508	8743
Landings	ATN		Longline	15804	14365	15864	13822	12204	11062	10717	9922	8678	8799	10334	11410	11531	10896	11478	10394	11504	11077	11796	12976	11366	10089	10194	9913	9462	8401	9340	9746	9226	9817
			Other surf.	526	428	715	812	370	782	376	393	432	240	486	341	516	409	546	465	485	441	511	512	513	463	391	483	684	472	600	587	517	457
	ATS		Longline	15739	17839	21584	17859	18299	13748	14823	15448	14302	13576	11714	12558	12915	13984	15318	11980	12301	12087	10854	10255	8958	9736	10047	10461	10281	10323	9975	8814	9332	8606
			Other surf.	391	1119	347	429	222	269	672	278	826	527	920	523	248	212	221	384	368	361	277	291	246	189	254	148	145	27	65	66	47	52
Discards	ATN		Longline	408	708	526	562	439	476	525	1137	896	607	618	313	323	215	273	235	151	148	392	391	199	156	167	105	149	152	304	113	100	71
			Other surf.	0	0	0	26	12	9	4	1	6	8	5	7	10	8	8	9	7	5	9	10	0	0	0	0	0	0	0	0	1	3
	ATS		Longline	0	0	0	1	21	10	6	1	0	0	0	1	0	0	91	6	0	147	74	140	0	46	43	2	111	26	50	57	128	85
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
Landings	ATN	CP	Barbados	0	0	0	33	16	16	12	13	19	10	21	25	44	39	27	39	20	13	23	21	16	21	29	20	21	18	10	12	13	8
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	112	106	184	141	142	76	1	3	59	145	117	111	121	70
			Brazil	0	0	0	0	0	0	0	117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Canada	2234	1676	1610	739	1089	1115	1119	968	1079	959	1285	1203	1558	1404	1348	1334	1300	1346	1551	1489	1505	1604	1579	1548	1188	782	995	1334	1377	1342
			China PR	73	86	104	132	40	337	304	22	102	90	316	56	108	72	85	92	92	73	75	59	96	60	141	135	81	86	92	96	44	38
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	30	0	0	0	0	0	0	0	0	0	26	8	17
			EU-Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	6598	6185	7176	5547	5140	4084	3996	4595	3968	3957	4586	5376	5521	5448	5564	4366	4949	4147	4889	5622	4084	3750	4013	3916	3586	3186	3112	3587	3235	3717
			EU-France	95	46	84	97	164	110	104	122	0	74	169	102	178	92	46	14	15	35	16	94	44	28	66	90	79	80	82	90	103	120
			EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Ireland	7	0	0	15	15	132	81	35	17	5	12	1	1	3	2	2	1	1	2	5	2	3	15	15	10	13	3	24	9	22
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	1961	1599	1617	1703	903	773	777	732	735	766	1032	1320	900	949	778	747	898	1054	1203	882	1438	1241	1420	1460	1871	1691	2392	2070	2165	1750
			EU-Rumania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	10	3	36	48	0	82	48	17	90	1	0	18	3	0	0	0	0	0	0	0	78
			Great Britain	2	3	1	5	11	0	2	1	0	0	0	0	0	49	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Grenada	13	0	1	4	15	15	42	84	0	54	88	73	56	30	26	43	0	0	0	0	0	0	39	29	36	36	22	15	4	14
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Iceland	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Japan	1126	933	1043	1494	1218	1391	1089	161	0	0	0	575	705	656	889	935	778	1062	523	639	300	545	430	379	456	325	355	406	370	499
			Korea Rep	19	16	16	19	15	0	0	0	0	0	0	0	51	65	175	157	3	0	0	0	64	35	0	9	19	9	9	14	13	17
			Liberia	14	26	28	28	28	28	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	95	5	7	3	8	0
			Maroc	39	36	79	462	267	292	119	114	523	223	329	335	339	341	237	430	724	968	782	770	1062	1062	850	900	900	950	950	936	955	1085
			Mexico	6	14	10	22	14	28	24	37	27	34	32	44	41	31	35	34	32	35	38	40	33	32	31	36	64	44	30	21	25	22
			Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Panama	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Philippines	0	0	0	0	0	0	0	0	1	4	44	5	0	8	0	22	28	0	17	36	9	14	0	0	0	0	0	0	0	**0**
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	41	87	113	148	44	43	49	78	146	112	89	121	33	6	**0**
			Sierra Leone	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	
			St Vincent and Grenadines	23	0	4	3	1	0	1	0	22	22	7	7	7	7	51	7	34	13	11	8	4	40	102	33	46	26	12	7	0	2
			Trinidad and Tobago	11	180	150	158	110	130	138	41	75	92	78	83	91	19	29	48	30	21	16	14	16	26	17	13	36	3	6	8	6	6
			UK-Bermuda	0	0	1	1	5	5	3	3	2	0	0	1	1	0	3	4	3	3	3	1	1	1	1	2	1	2	2	6	5	3
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	4	4	7	0	3	0	0	4	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	17	0	0	0	0	0	0	0	**0**
			USA	3783	3366	4026	3559	2987	3058	2908	2863	2217	2384	2513	2380	2160	1873	2463	2387	2730	2274	2551	3393	2824	1809	1581	1408	1294	1135	1449	1351	1142	1278
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	73	69	54	85	20	37	30	44	21	34	45	53	55	22	30	11	13	24	18	25	24	24	34	56	58	36	35	16	13	17
		NCC	Chinese Taipei	127	507	489	521	509	286	285	347	299	310	257	30	140	172	103	82	89	88	192	166	115	78	115	148	78	162	115	144	66	145
			Costa Rica	0	0	0	0	0	0	1	1	0	0	1	4	3	2	4	11	6	11	23	21	22	30	34	26	44	43	23	19	51	26
			Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	5	2	5	3	**0**
		NCO	Cuba	16	50	86	7	7	7	7	0	0	10	3	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	
			Faroe Islands	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			NEI (Flag related)	111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	
			Seychelles	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	0	1	0	0	0	0	0	0	0	0	0	2	3	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	35	29	14	0	0	0	10	23	15	2	4	7	0	0	0	0	0	0	
	ATS	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	18	0	0	13	0	0	0	34	74
			Belize	0	0	1	0	0	0	17	8	0	0	0	0	0	0	120	32	111	121	207	197	136	45	111	176	166	115	55	2	2	2
			Brazil	2013	1571	1975	1892	4100	3847	4721	4579	4082	2910	2920	2998	3785	4430	4153	3407	3386	2926	3033	2833	2384	2892	2599	2938	2410	2798	2863	2110	2823	2197
			China PR	0	0	0	0	0	29	534	344	200	423	353	278	91	300	473	470	291	296	248	316	196	206	328	222	302	355	211	89	37	188
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Côte d'Ivoire	14	20	19	26	18	25	26	20	19	19	43	29	31	39	17	24	145	156	58	89	133	68	48	58	41	57	123	19	14	24
			EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	6974	7937	11290	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402	5300	5283	4073	5183	5801	4700	4852	4184	4113	5059	4992	4656	4404	4224	4442	4470	3592
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	**0**
			EU-Lithuania	0	794	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	0	0	380	389	441	384	381	392	393	380	354	345	493	440	428	271	367	232	263	184	125	252	236	250	466	369	323	335	224	210
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Gabon	0	0	0	0	0	0	0	0	0	0	9	2	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Ghana	121	51	103	140	44	106	121	117	531	372	734	343	55	32	65	177	132	116	60	54	37	26	56	36	55	6	32	31	19	16
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Guinea Ecuatorial	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	**0**
			Honduras	0	0	6	4	5	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	5256	4699	3619	2197	1494	1186	775	790	685	833	924	686	480	1090	2155	1600	1340	1314	1233	1162	684	976	659	637	915	640	647	552	498	667
			Korea Rep	198	164	164	7	18	7	5	10	0	2	24	70	36	94	176	223	10	0	0	42	47	53	5	19	11	18	9	15	6	6
			Namibia	0	22	0	0	0	0	730	469	751	504	191	549	832	1118	1038	518	25	417	414	85	129	395	225	466	600	881	811	789	623	1100
			Nigeria	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Panama	0	0	0	0	0	29	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Philippines	0	0	0	0	0	0	0	0	6	1	8	1	1	4	58	41	49	14	35	15	35	58	0	0	0	0	0	0	0	**0**
			S Tomé e Príncipe	202	190	178	166	148	135	129	120	120	120	120	126	147	138	138	183	188	193	60	84	60	94	145	77	65	1	12	4	14	11
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	97	137	78	117	162	178	143	97	90	112	65	116	38	0	**0**
			South Africa	4	1	4	1	1	240	143	328	547	649	293	295	199	186	207	142	170	145	97	50	171	152	218	164	189	189	251	149	179	161
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	7	16	4	3	2	2	19	0	5	9	4	15	9	32	76
			UK-Sta Helena	0	0	0	0	0	0	0	0	20	4	2	2	0	0	0	0	0	0	0	0	5	6	2	0	0	0	0	0	0	**0**
			USA	0	0	0	171	396	160	179	142	43	200	21	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Uruguay	260	165	499	644	760	889	650	713	789	768	850	1105	843	620	464	370	501	222	179	40	103	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	846	2829	2876	2873	2562	1147	1168	1303	1149	1164	1254	745	744	377	671	727	612	410	424	379	582	406	511	478	416	446	346	296	406	335
		NCO	Argentina	14	24	0	0	0	0	38	0	5	10	8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
			Benin	28	25	24	24	10	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cambodia	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	192	452	778	60	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Mixed flags (FR+ES)	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Togo	8	14	14	64	0	0	0	0	0	0	0	9	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	11	26	6	3	0	3	1	3	0	1	1	0	0	0	0	0	0	
Discards	ATN	CP	Canada	0	0	0	0	5	52	35	50	26	33	79	45	106	38	61	39	9	15	8	111	59	12	8	11	21	5	2	2	3	2
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
			Japan	0	0	0	0	0	0	0	598	567	319	263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5	5	2
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	170	46	19	0	2	0	0	0	0	0	0	**0**
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			USA	408	708	526	588	446	433	494	490	308	263	282	275	227	185	220	205	148	138	223	217	120	137	137	90	111	140	287	91	90	61
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	7	18	4	18	7	7	14	2	5
	ATS	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	91	6	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	147	70	23	0	0	0	0	0	0	0	0	0	**0**

		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	USA	0	0	0	1	21	10	6	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	117	0	45	43	2	111	26	49	57	126	85

SWO-AT-Table 2. Joint probabilities of the North Atlantic swordfish stock being below F_{MSY} (top, overfishing not occurring), above B_{MSY} (middle, not overfished) as well as the joint probability of being above B_{MSY} and below F_{MSY} (bottom, green zone) in a given year for a given catch level based on 30,000 iterations of the MVLN approximation for Stock Synthesis and JABBA MCMC iterations.

Probaility $F<F_{MSY}$

TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0t	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
9000t	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%
10000t	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
11000t	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
12000t	79%	79%	79%	79%	79%	80%	80%	80%	79%	79%	79%
12500t	76%	76%	76%	76%	76%	76%	76%	76%	76%	76%	76%
12600t	75%	75%	75%	75%	75%	75%	75%	76%	75%	75%	75%
12700t	74%	74%	74%	74%	74%	74%	74%	74%	74%	74%	74%
12800t	74%	73%	73%	73%	73%	73%	73%	73%	73%	73%	73%
12900t	73%	72%	72%	72%	72%	72%	72%	72%	71%	71%	71%
13000t	72%	71%	71%	71%	71%	70%	70%	70%	69%	69%	68%
13100t	71%	70%	70%	69%	69%	68%	68%	67%	66%	66%	65%
13200t	70%	69%	69%	68%	67%	66%	65%	64%	63%	62%	61%
13300t	69%	68%	67%	66%	65%	63%	62%	61%	59%	58%	56%
13400t	68%	66%	65%	64%	62%	60%	59%	57%	55%	53%	51%
13500t	66%	65%	63%	61%	59%	57%	55%	53%	51%	48%	46%
13600t	65%	63%	61%	59%	56%	54%	51%	49%	46%	43%	41%
13700t	63%	61%	59%	56%	53%	50%	47%	44%	41%	38%	36%
13800t	62%	59%	56%	53%	50%	46%	43%	40%	37%	34%	32%
14000t	58%	55%	51%	47%	43%	39%	35%	32%	29%	27%	25%
15000t	38%	31%	25%	21%	25%	32%	32%	31%	31%	30%	29%
16000t	20%	15%	12%	11%	10%	10%	10%	9%	9%	9%	9%

Probability $B>B_{MSY}$

TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0t	75%	84%	90%	94%	96%	97%	98%	98%	99%	99%	99%
9000t	75%	78%	80%	82%	83%	84%	85%	86%	86%	87%	87%
10000t	75%	77%	79%	80%	81%	82%	83%	83%	83%	84%	84%
11000t	75%	76%	77%	78%	79%	79%	80%	80%	81%	81%	81%
12000t	75%	75%	76%	76%	77%	77%	77%	77%	77%	77%	77%
12500t	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
12600t	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
12700t	75%	75%	74%	74%	74%	74%	74%	74%	74%	74%	74%
12800t	75%	74%	74%	74%	74%	74%	74%	74%	74%	73%	73%
12900t	75%	74%	74%	74%	73%	73%	73%	73%	73%	72%	72%
13000t	75%	74%	74%	73%	73%	73%	72%	72%	72%	71%	71%
13100t	75%	74%	73%	73%	72%	72%	72%	71%	70%	70%	69%
13200t	75%	74%	73%	72%	72%	71%	71%	70%	69%	68%	67%
13300t	75%	74%	73%	72%	71%	70%	69%	68%	67%	66%	65%
13400t	75%	74%	73%	72%	70%	70%	68%	67%	65%	64%	62%
13500t	75%	74%	72%	71%	70%	68%	67%	65%	63%	61%	59%
13600t	74%	74%	72%	71%	69%	67%	65%	63%	61%	58%	55%
13700t	74%	73%	72%	70%	68%	66%	64%	61%	58%	55%	52%
13800t	74%	73%	71%	70%	67%	65%	62%	59%	55%	52%	48%
14000t	74%	73%	71%	68%	65%	62%	58%	54%	50%	45%	41%
15000t	74%	71%	66%	59%	47%	44%	42%	41%	39%	38%	36%
16000t	74%	69%	59%	48%	36%	27%	21%	18%	16%	15%	14%

Probability $F<F_{MSY}$ and $B>B_{MSY}$

TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0t	75%	84%	90%	94%	96%	97%	98%	98%	99%	99%	99%
9000t	75%	78%	80%	82%	83%	84%	85%	86%	86%	87%	87%
10000t	75%	77%	79%	80%	81%	82%	83%	83%	83%	84%	84%
11000t	75%	76%	77%	78%	79%	79%	80%	80%	80%	81%	81%
12000t	74%	75%	75%	76%	76%	76%	77%	77%	77%	77%	77%
12500t	73%	73%	74%	74%	74%	74%	74%	75%	75%	75%	75%
12600t	73%	73%	73%	73%	74%	74%	74%	74%	74%	74%	74%
12700t	72%	72%	73%	73%	73%	73%	73%	73%	73%	73%	73%
12800t	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%
12900t	71%	71%	71%	71%	71%	71%	71%	71%	70%	70%	70%
13000t	70%	70%	70%	70%	70%	69%	69%	69%	68%	68%	67%
13100t	70%	69%	69%	69%	68%	67%	67%	66%	66%	65%	64%
13200t	69%	68%	68%	67%	66%	65%	64%	63%	62%	61%	60%
13300t	68%	67%	66%	65%	64%	63%	61%	60%	59%	57%	56%
13400t	67%	66%	64%	63%	61%	60%	58%	56%	54%	53%	51%
13500t	66%	64%	62%	61%	59%	57%	55%	53%	50%	48%	46%
13600t	64%	62%	60%	58%	56%	53%	51%	48%	46%	43%	40%
13700t	63%	61%	58%	55%	53%	50%	47%	44%	41%	38%	36%
13800t	61%	59%	56%	53%	49%	46%	43%	40%	37%	34%	32%
14000t	58%	55%	51%	47%	43%	39%	35%	32%	29%	27%	25%
15000t	38%	31%	25%	21%	22%	32%	30%	29%	27%	26%	25%
16000t	20%	15%	12%	11%	10%	10%	10%	9%	9%	9%	9%

SWO-AT-Table 3. Estimated projection probabilities (%) for the reference case model for South Atlantic swordfish. Projection probabilities are provided for $F<=F_{MSY}$ (top); $B>=B_{MSY}$ (middle); $F<=F_{MSY}$ and $B>=B_{MSY}$ (bottom). Stochastic projections were conducted over the period 2023-2033 with a range of fixed TACs (6,000 – 15,000 t), including a zero catch-scenario. The 2021 and 2022 catches are assumed to be 9,826 t, which is the mean of the 2018-2020 reported catch.

Probability $F<=F_{MSY}$

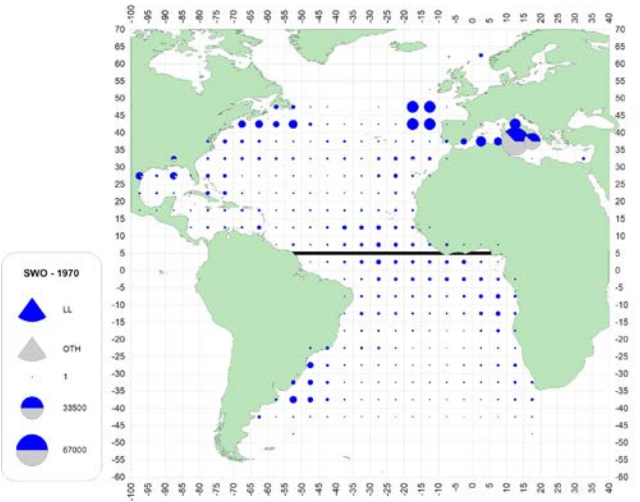
TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6000	95%	97%	98%	98%	99%	99%	99%	99%	100%	100%	100%
6500	92%	94%	96%	97%	98%	98%	99%	99%	99%	99%	99%
7000	88%	91%	93%	95%	96%	97%	97%	98%	98%	98%	98%
7500	82%	86%	89%	91%	93%	94%	95%	96%	96%	97%	97%
8000	75%	80%	83%	86%	88%	90%	91%	92%	93%	94%	95%
8500	68%	72%	76%	79%	82%	84%	85%	87%	88%	89%	90%
9000	59%	64%	68%	71%	74%	76%	78%	80%	81%	83%	84%
9500	51%	55%	59%	62%	65%	67%	69%	71%	72%	74%	75%
9826	46%	50%	53%	56%	58%	60%	62%	64%	65%	67%	68%
10000	43%	47%	49%	52%	54%	57%	59%	60%	62%	64%	65%
10500	35%	38%	40%	42%	44%	46%	48%	49%	50%	52%	53%
11000	29%	31%	32%	33%	35%	36%	37%	38%	39%	40%	40%
11500	23%	24%	25%	25%	26%	27%	27%	28%	28%	29%	29%
12000	18%	18%	19%	19%	19%	19%	19%	20%	20%	20%	20%
12500	13%	14%	14%	14%	14%	14%	14%	13%	13%	13%	13%
13000	11%	10%	10%	10%	10%	10%	9%	9%	9%	9%	9%
13500	8%	8%	7%	7%	7%	6%	6%	6%	6%	6%	5%
14000	6%	6%	5%	5%	5%	4%	4%	4%	4%	3%	3%
14500	5%	4%	4%	3%	3%	3%	3%	2%	2%	2%	2%
15000	4%	3%	3%	2%	2%	2%	2%	2%	1%	1%	1%

Probability $B>=B_{MSY}$

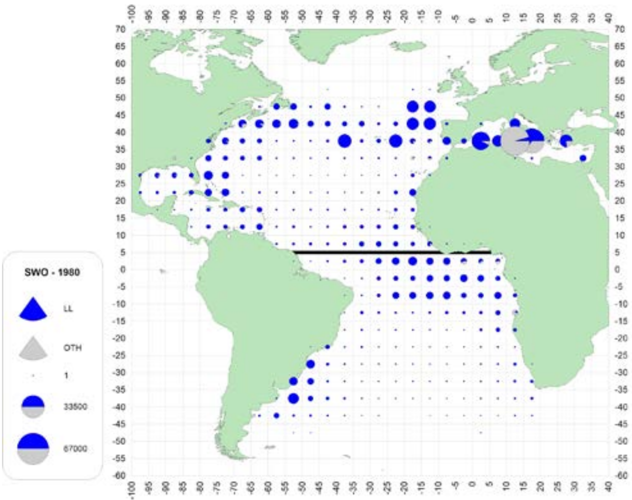
TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	21%	48%	74%	90%	96%	99%	99%	100%	100%	100%	100%
6000	21%	33%	46%	59%	70%	77%	83%	88%	92%	94%	95%
6500	21%	32%	44%	56%	66%	74%	80%	85%	88%	91%	93%
7000	21%	31%	41%	52%	62%	70%	75%	80%	85%	88%	90%
7500	21%	30%	39%	48%	57%	65%	70%	76%	80%	83%	86%
8000	21%	29%	37%	45%	53%	60%	65%	70%	74%	78%	81%
8500	21%	28%	34%	41%	48%	54%	59%	64%	68%	72%	75%
9000	21%	27%	32%	38%	44%	49%	53%	58%	61%	65%	68%
9500	21%	26%	31%	35%	39%	44%	48%	51%	55%	58%	60%
9826	21%	25%	29%	33%	36%	40%	43%	47%	50%	52%	55%
10000	21%	25%	29%	32%	35%	39%	41%	45%	47%	49%	52%
10500	21%	24%	27%	29%	31%	34%	36%	38%	40%	41%	43%
11000	21%	23%	25%	26%	28%	29%	30%	32%	33%	34%	35%
11500	21%	22%	23%	24%	24%	25%	25%	26%	26%	27%	27%
12000	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%
12500	21%	20%	19%	19%	18%	18%	17%	17%	16%	16%	16%
13000	21%	19%	18%	17%	16%	15%	14%	13%	13%	12%	12%
13500	21%	18%	17%	15%	14%	12%	11%	10%	10%	9%	9%
14000	21%	18%	15%	13%	12%	10%	9%	8%	7%	7%	6%
14500	21%	17%	14%	12%	10%	8%	7%	6%	6%	5%	4%
15000	21%	16%	13%	10%	8%	7%	6%	5%	4%	3%	3%

Probability $F<=F_{MSY}$ and $B>=B_{MSY}$

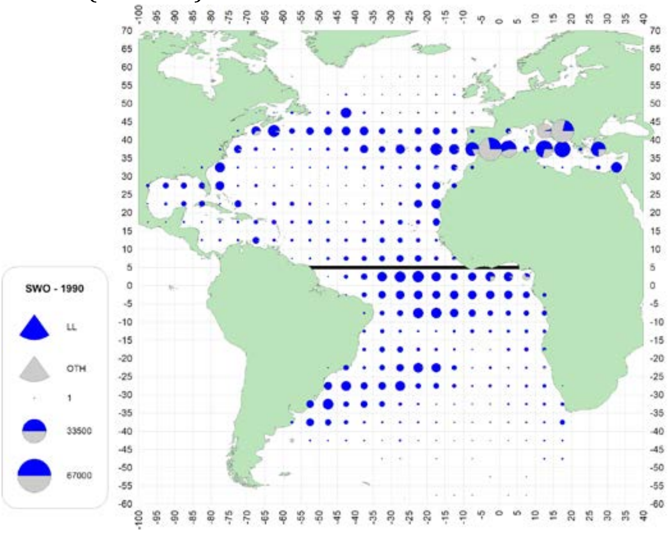
TAC (t)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	21%	48%	74%	90%	96%	99%	99%	100%	100%	100%	100%
6000	21%	33%	46%	59%	70%	77%	83%	88%	92%	94%	95%
6500	21%	32%	44%	56%	66%	74%	80%	85%	88%	91%	93%
7000	21%	31%	41%	52%	62%	70%	75%	80%	85%	88%	90%
7500	21%	30%	39%	48%	57%	65%	70%	76%	80%	83%	86%
8000	21%	29%	37%	45%	53%	60%	65%	70%	74%	78%	81%
8500	21%	28%	34%	41%	48%	54%	59%	64%	68%	72%	75%
9000	21%	27%	32%	38%	44%	49%	53%	58%	61%	65%	68%
9500	21%	26%	31%	35%	39%	44%	48%	51%	55%	58%	60%
9826	21%	25%	29%	33%	36%	40%	43%	47%	50%	52%	55%
10000	20%	25%	28%	32%	35%	39%	41%	45%	47%	49%	52%
10500	20%	23%	26%	29%	31%	33%	35%	38%	40%	41%	43%
11000	20%	22%	24%	25%	27%	28%	30%	31%	32%	33%	35%
11500	18%	19%	21%	22%	23%	23%	24%	24%	25%	26%	26%
12000	16%	16%	17%	18%	18%	18%	18%	18%	19%	19%	19%
12500	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
13000	10%	10%	10%	10%	9%	9%	9%	9%	9%	9%	8%
13500	8%	8%	7%	7%	7%	6%	6%	6%	6%	5%	5%
14000	6%	6%	5%	5%	5%	4%	4%	4%	4%	3%	3%
14500	5%	4%	4%	3%	3%	3%	3%	2%	2%	2%	2%
15000	4%	3%	3%	2%	2%	2%	2%	2%	1%	1%	1%



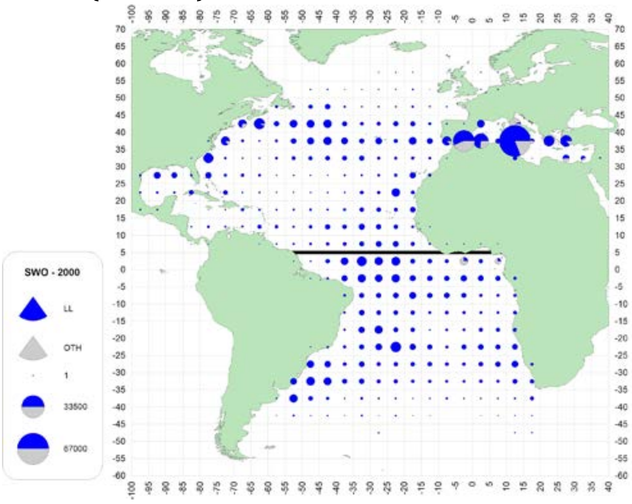
a. SWO (1970-79)



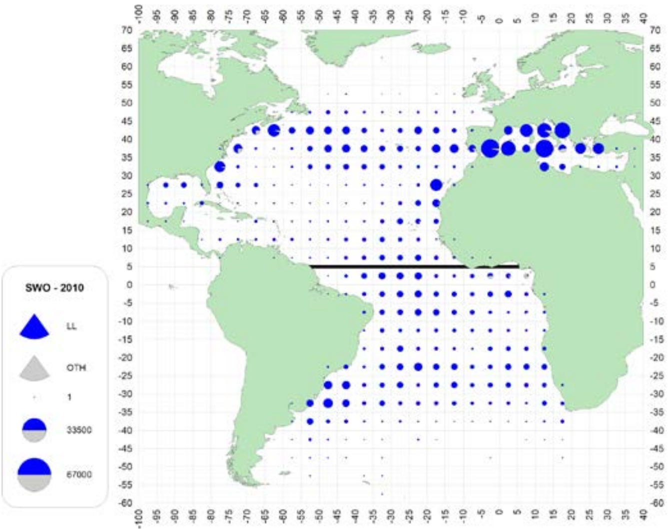
b. SWO (1980-89)



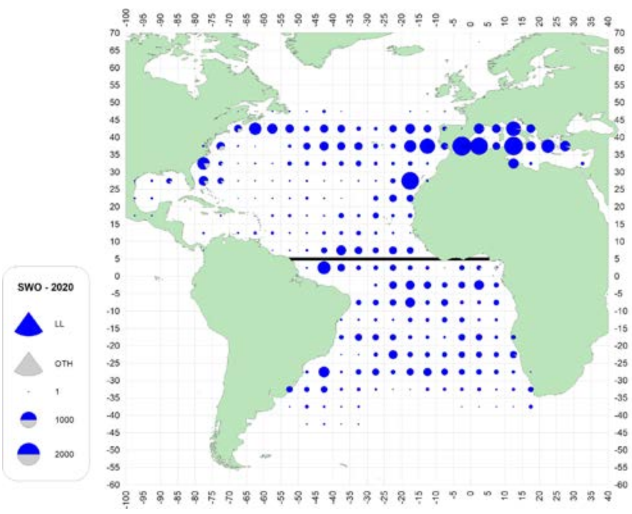
c. SWO (1990-99)



d. SWO (2000-09)

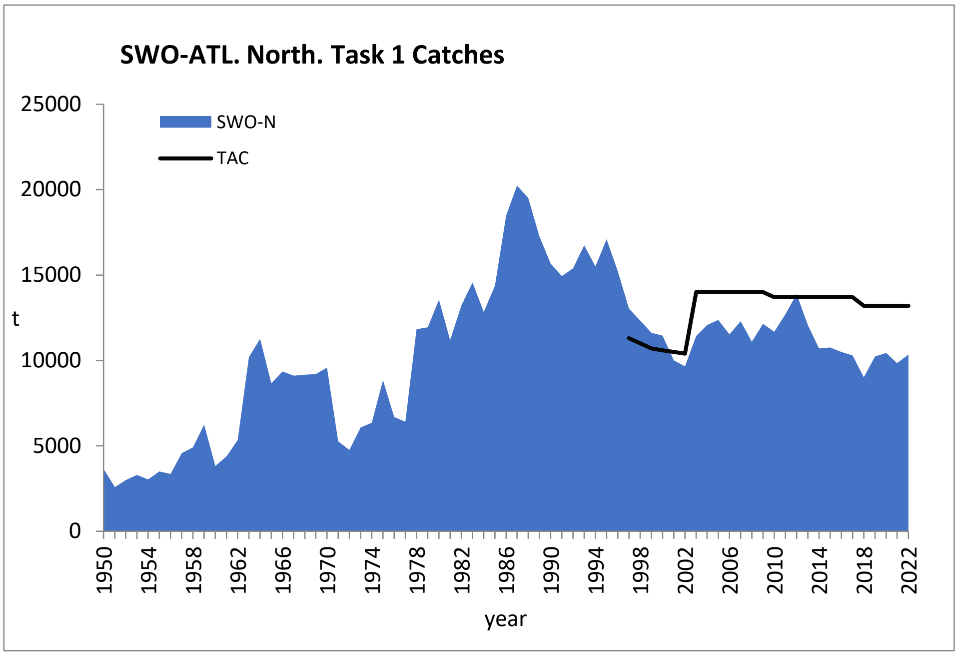


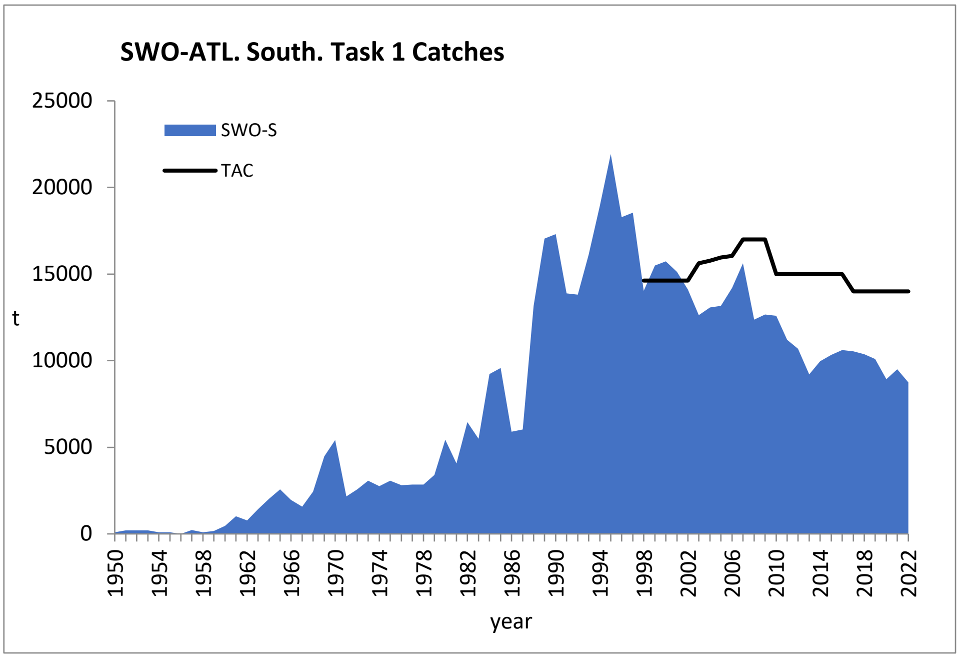
e. SWO (2010-19)



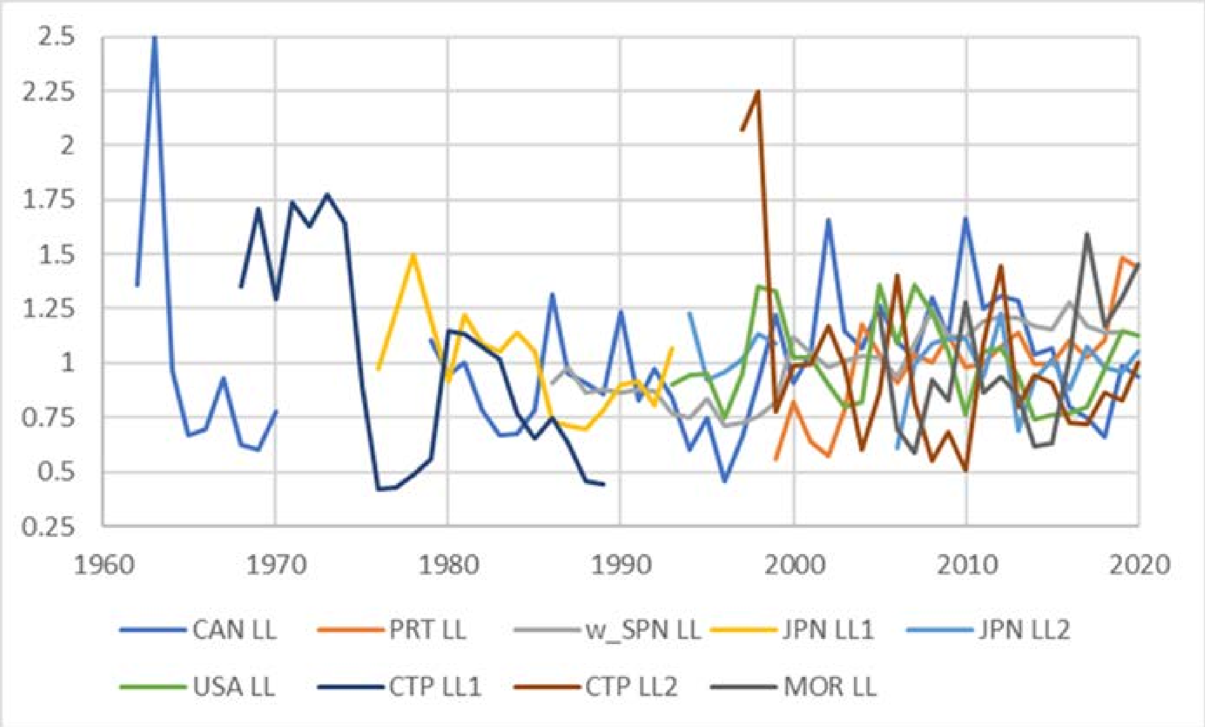
f. SWO (2020-21)

SWO-AT-Figure 1. Geographic distribution of swordfish cumulative catch (t) by gear, in the Convention area, shown on a decadal scale. The maps are scaled to the maximum catch observed during 1970-2021 (the last decade only covers 2 years).

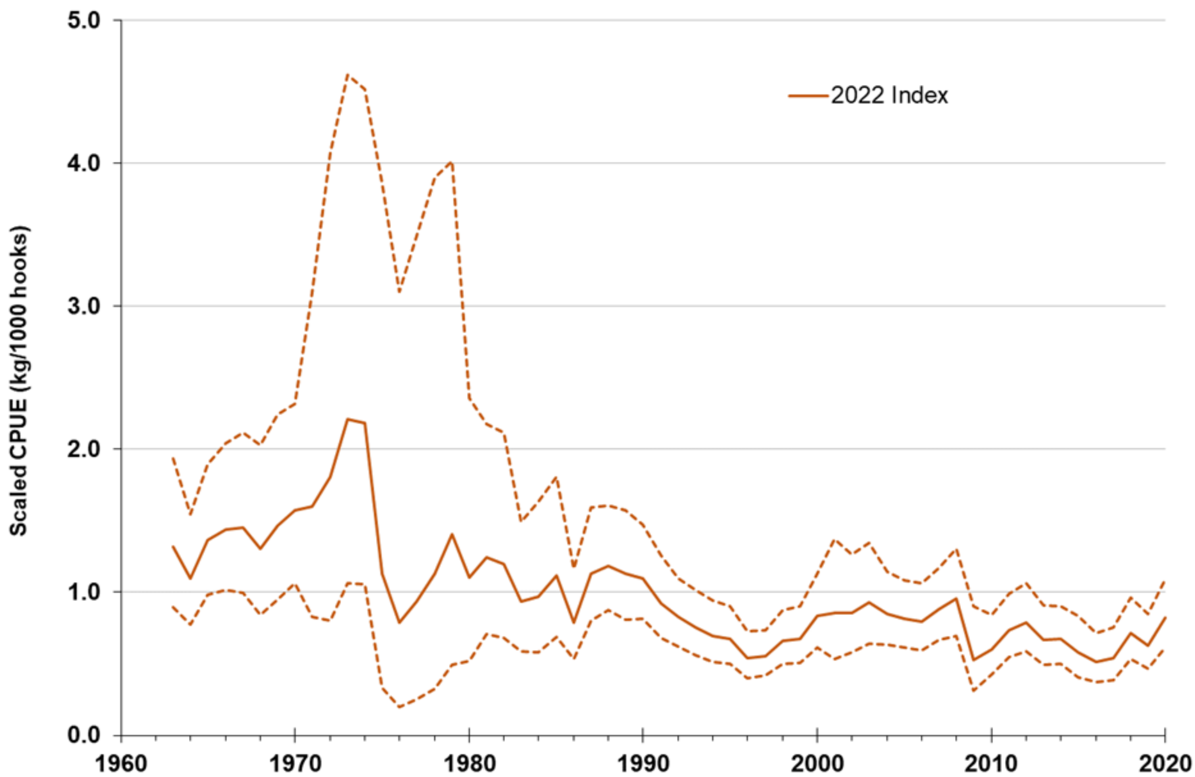




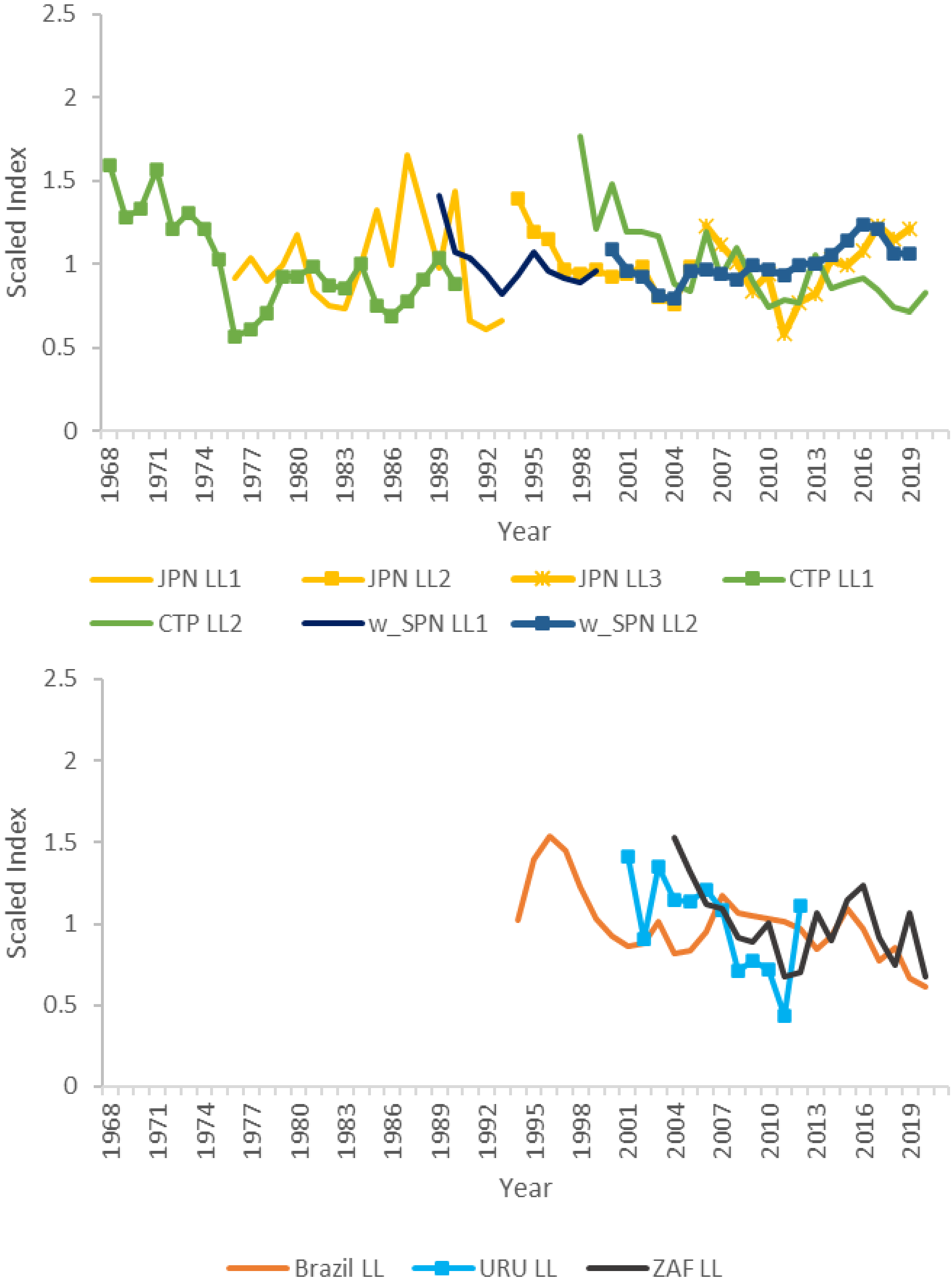
SWO-AT-Figure 2. North (top) and South (bottom) Atlantic swordfish catches (t, landings and dead discards) and TAC (t), for the period 1950-2022.



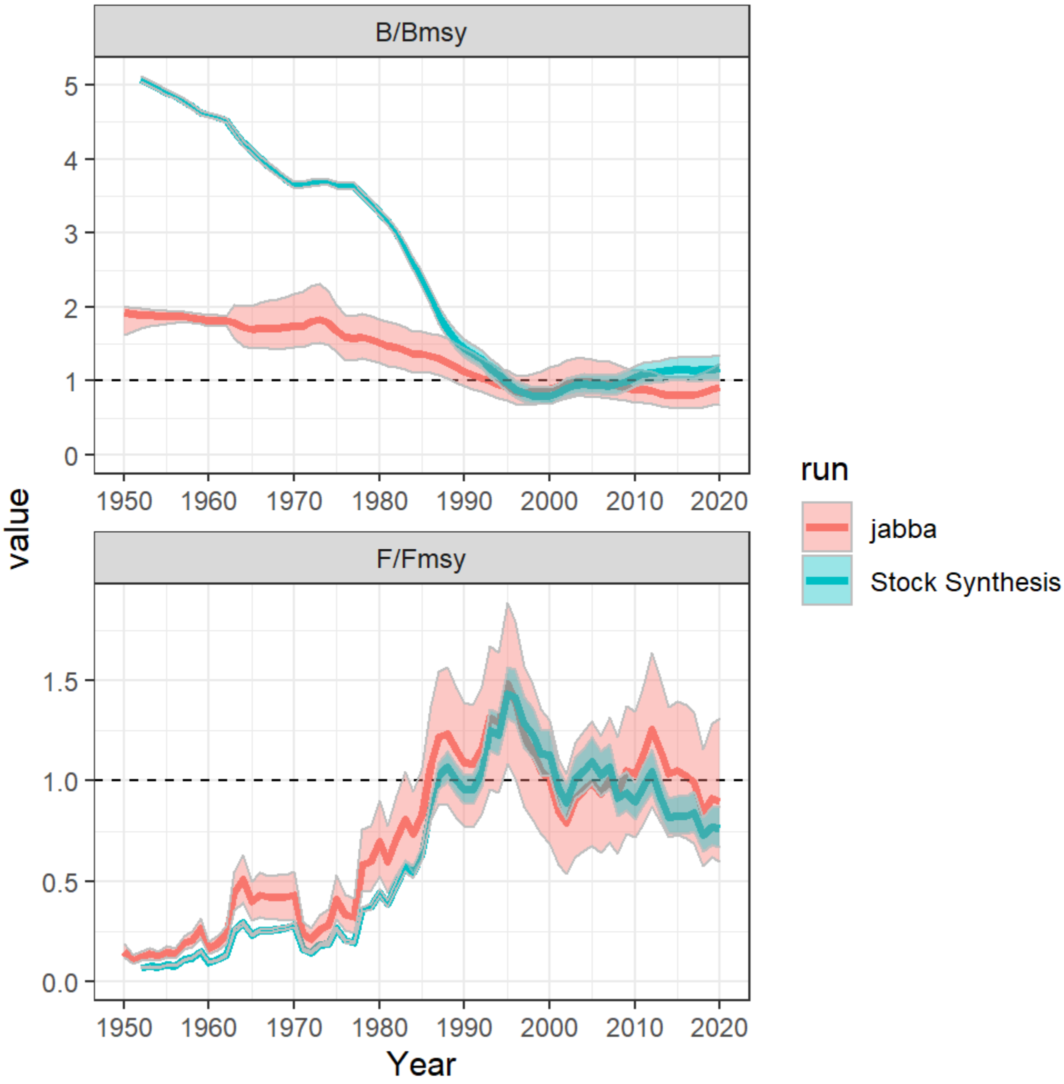
SWO-AT-Figure 3. Standardized CPUEs series provided by CPCs for the North Atlantic swordfish for the base continuity production model. The CPUE series were scaled to their mean for comparison purposes.



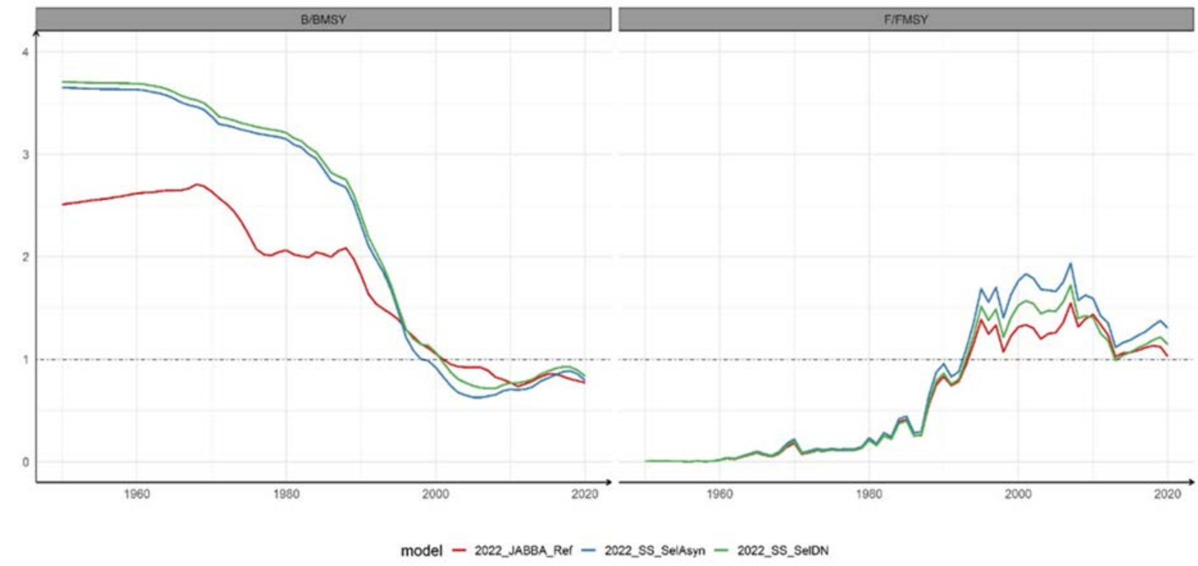
SWO-AT-Figure 4. Standardized combined biomass CPUE index for North Atlantic and 95% confidence intervals, used as the continuity run for the production models.



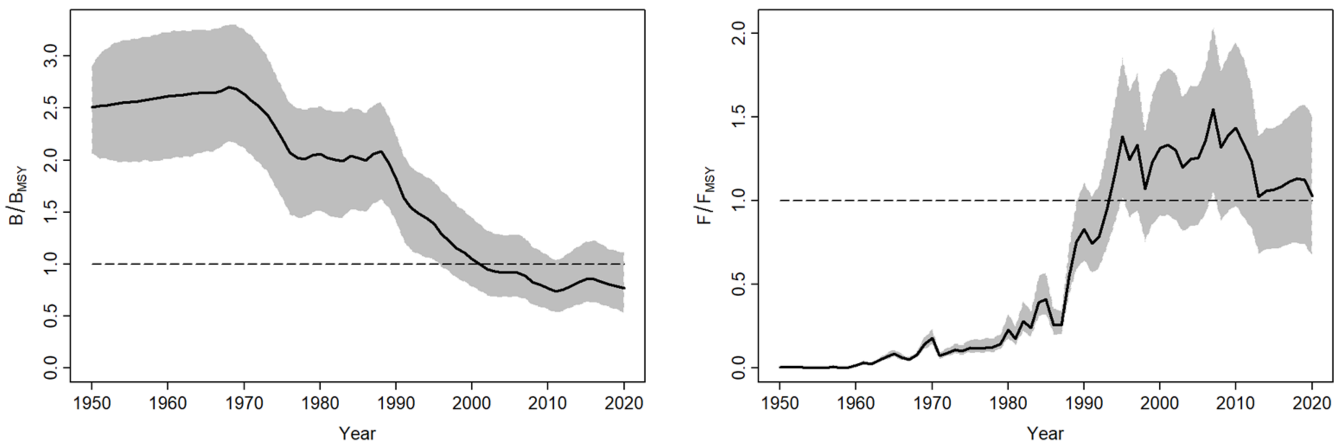
SWO-AT-Figure 5. Standardized CPUEs series for that were used in the assessment of the South Atlantic swordfish. Indices that were split (JPN, EU-SPN and CTP) are shown on the top, and the rest (BRA, URU and ZAF) are shown at the bottom. The CPUE series were scaled to their mean for comparison purposes.



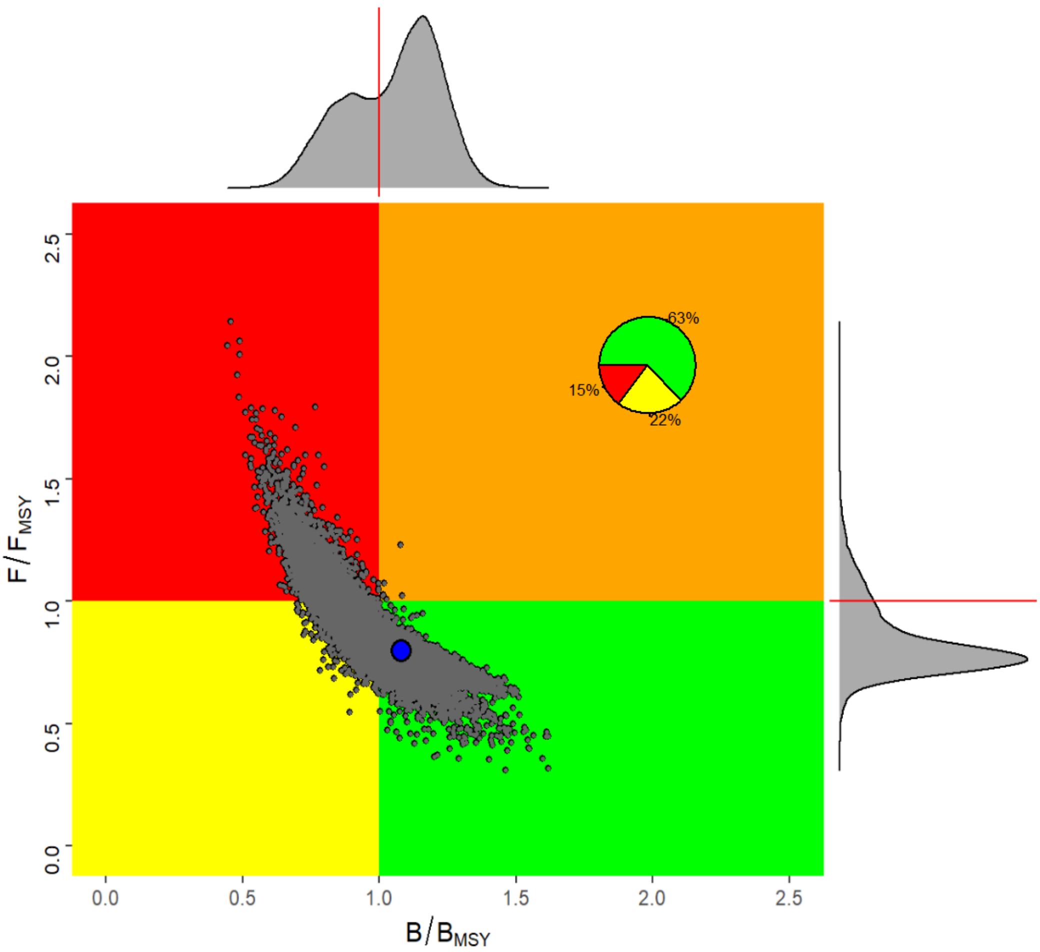
SWO-AT-Figure 6. Results from the two models used for management advice in the North Atlantic swordfish assessment: JABBA and Stock Synthesis. Trends in relative biomass (top) and fishing mortality (bottom). Uncertainty intervals are approximations of 95% credibility intervals.



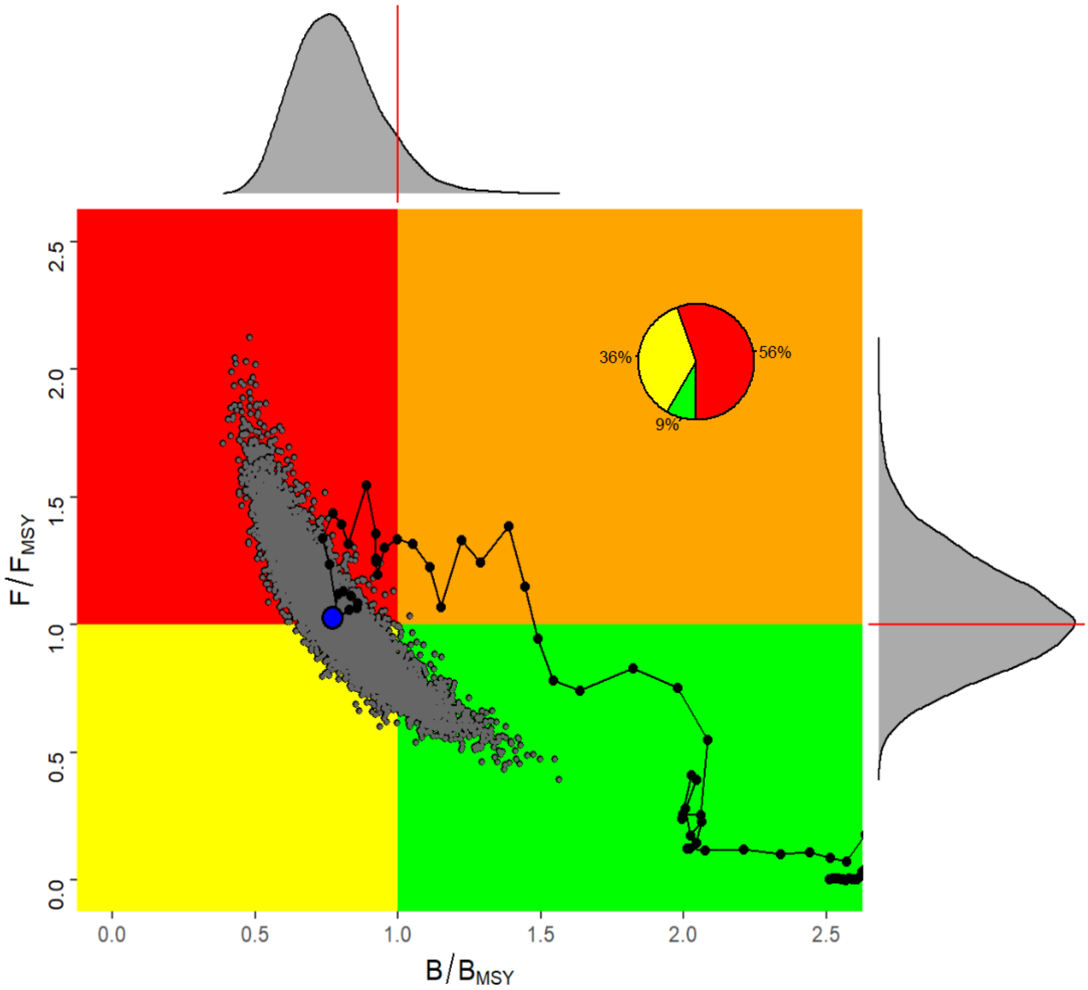
SWO-AT-Figure 7. Comparisons of B/B_{MSY} and F/F_{MSY} between JABBA base case and two SS runs for the South Atlantic swordfish stock.



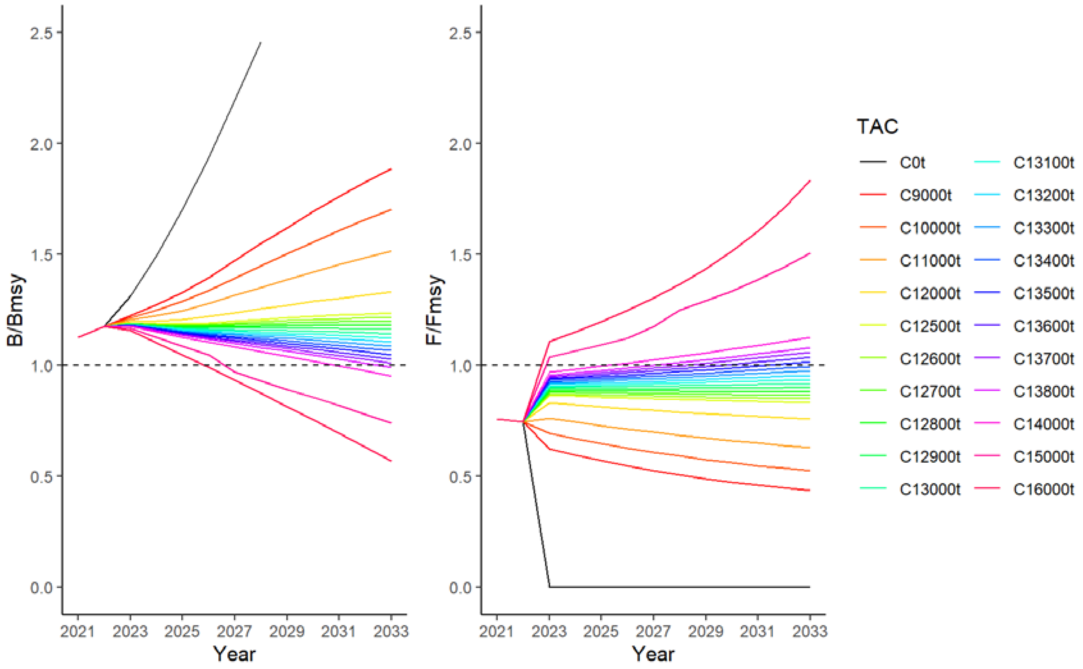
SWO-AT-Figure 8. South Atlantic swordfish biomass and fishing mortality rates relative to MSY levels, from the JABBA base case model. Grey areas represent 95% credibility intervals.



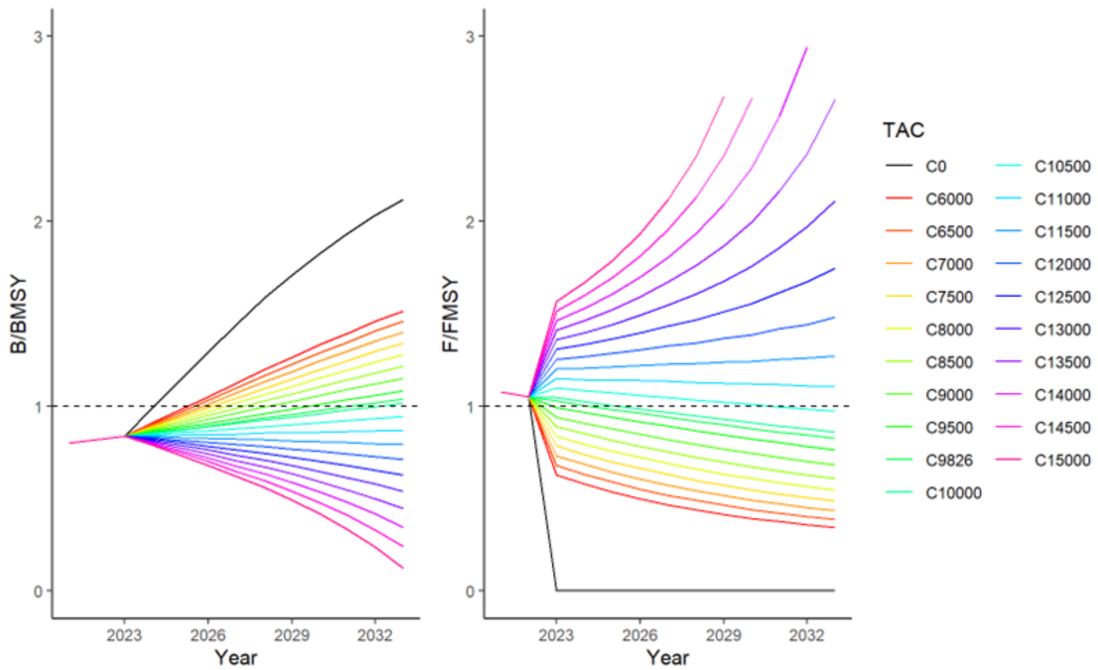
SWO-AT-Figure 9. Joint Kobe plot for the Stock Synthesis and the JABBA reference case models for the North Atlantic swordfish stock. For the Stock Synthesis run, the benchmark is calculated from the year-specific selectivity and fleet allocations and based on 15000 MVLN iterations for Stock Synthesis and 15000 MCMC iterations for JABBA. The blue point shows the median of 30,000 iterations for SSB_{2020}/SSB_{MSY} or B_{2020}/B_{MSY} and F_{2020}/F_{MSY} for the entire iterations from Stock Synthesis and JABBA. Grey points represent the 2020 estimates of relative fishing mortality and relative spawning stock biomass for 2020 for each of the 30,000 iterations. The upper graph represents the smoothed frequency distribution of SSB_{2020}/SSB_{MSY} or B_{2020}/B_{MSY} estimates. The right graph represents the smoothed frequency distribution of F_{2020}/F_{MSY} estimates. The inserted pie graph represents the percentage of each 2020 estimate that fall in each quadrant of the Kobe plot. All SSB for Stock Synthesis showed the values at the end of years. The blue dot is the median of the 2020 stock status.



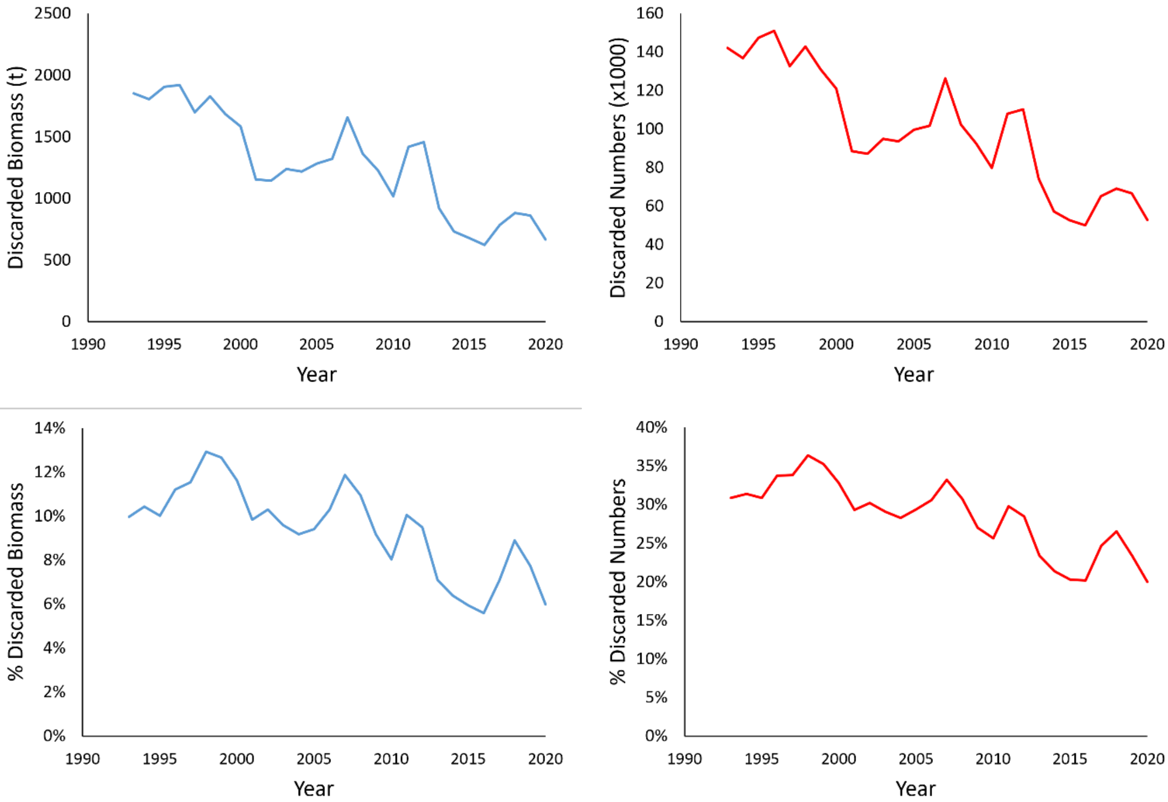
SWO-AT-Figure 10. Kobe plot for the JABBA reference base case model for southern Atlantic swordfish. The solid blue circle is the estimated median point with the respective uncertainties in the terminal year (2020). The pie chart represents the probabilities of stock being in the different colour quadrants (red 56%, yellow 36%, green 9%). The blue dot represents the 2020 stock status.



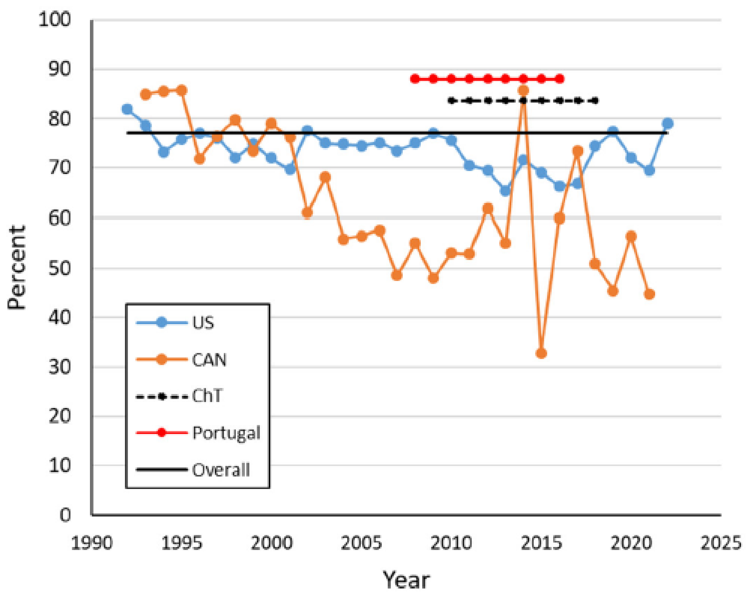
SWO-AT-Figure 11. Joint projections from Stock Synthesis and JABBA of biomass (or spawning stock biomass) at 0, 9-16 thousand t constant TACs for the North Atlantic swordfish stock for the period 2023-2033.



SWO-AT-Figure 12. Median trends of relative biomass (B/B_{MSY}) for the projected South Atlantic swordfish stock derived from the JABBA base case model at 0, 6-15 thousand t constant TACs for the period 2023-2033.



SWO-AT-Figure 13. Estimated total discards due to the minimum size regulation in absolute biomass and numbers (top row) and in biomass and numbers as a proportion of the catch (bottom row) for years 1992 to 2020, as estimated by Stock Synthesis.



SWO-AT-Figure 14. Direct observations of at-haulback mortality of fish below the minimum size limit in four longline fleets operating in the North Atlantic.

9.13 SWO-MD - Mediterranean swordfish

In 2019 the Mediterranean swordfish landings were the lowest observed since the full development of the fisheries in the mid-1980s. The most recent assessment of the stock was conducted in 2020, making use of the available catch, effort and size information through 2018. The present report summarizes assessment results and readers interested in more detailed information on the state of the stock should consult the Report of the 2020 Mediterranean Swordfish Stock Assessment (Anon., 2020d).

SWO-MD-1. Biology

Research results based on genetic studies have demonstrated that Mediterranean swordfish compose a unique stock separated from the Atlantic ones, although there is incomplete information on stock mixing and boundaries. Although mixing between stocks is believed to be low, past biological, genetic and tagging studies have suggested the possible occurrence of mixing between the Mediterranean and North Atlantic stocks, but further studies need to identify the degree of mixing. A brief review of past tagging experiments indicated that the existing results cannot provide robust information about mixing patterns and confirmed that further work is needed on this aspect.

According to previous knowledge, the Mediterranean swordfish have different biological characteristics compared to the Atlantic stocks. The growth parameters are different, and the sexual maturity is reached at younger ages than in the Atlantic.

In the western Mediterranean, mature females as small as 110 cm LJFL have been observed and the estimated size at which 50% (L50) of the female population is mature occurs at 142.2 cm. According to the growth curves used by the SCRS, these two sizes correspond to 2 and 3.5 year-old fish, respectively. An even lower L50 size for females has been estimated for the central Mediterranean, even though further confirmation is needed. Males reach sexual maturity at smaller sizes and mature specimens have been found at about 90 cm LJFL. Research on this aspect is on-going in the frame of the ICCAT swordfish project.

SWO-MD-2. Fishery indicators

Mediterranean swordfish landings showed an upward trend from 1965-1988, reaching a peak of 20,365 t (**SWO-MD-Table 1**, **SWO-MD-Figure 1**). The sharp increase between 1983 and 1988 may be partially attributed to improvement in the national systems for collecting catch statistics; thus, earlier catches may be higher than those appearing in Task 1 (**SWO-MD-Table 1**). Since 1989 and up to 2011, the reported landings of swordfish in the Mediterranean Sea have declined fluctuating mostly between 12,000 to 17,000 t. Since 2012 and up to 2022, following the implementation of the three-month fishery closure and the establishment of the list of authorized vessels, overall nominal fishing effort has been decreasing with catches below 10,000 t since 2018. In general, these catch levels are relatively high and similar to those of bigger areas such as the North Atlantic. Updated information on Mediterranean swordfish catch by gear type is provided in **SWO-MD-Table 1** and **SWO-MD-Figure 1**.

The Task 1 removals, including estimates of dead discards for 2018 that was used in the assessment was 8,677 t, which is the lowest annual catches since 1972. The biggest producers in the recent years of the assessment (2008-2018) are EU-Italy (40%), EU-Spain (15%), Morocco (11%), Tunisia (11%), EU-Greece (9%) and Algeria (5%). Also, EU-Cyprus, EU-Malta and Türkiye have fisheries targeting swordfish in the Mediterranean. Minor catches of swordfish have also been reported by EU-Croatia, EU-France, Japan, and Libya.

In recent years (2008-2022), the main fishing gears used are longlines (on average, representing around 97% of the annual catches) and gillnets. Since 2003, gillnets have been gradually eliminated following ICCAT recommendations for a general ban of driftnets in the Mediterranean. Minor catches are also reported from harpoon, trap and fisheries targeting other large pelagic species (e.g., albacore). From 1999 a deep longline (100-600 m depth; mesopelagic longline) gear has been gradually introduced and nowadays has partially replaced the surface longline gears in several Italian, French and Spanish swordfish fleets. This is particularly noteworthy, as these fisheries are among the largest within the stock area, and the changes have implications for the use of catch rates as indices of abundance in the stock assessments.

Standardised CPUE series from different longline fisheries targeting swordfish that were used in the 2020 stock assessment session, do not show a consistent pattern but most of them indicate declining trends in the most recent years. It should be noted that CPUE series did not cover the earlier years of the reported landings. No trend over the past 30 years was identified regarding the mean fish weight in the catches, but it should be noted that the volume of undersized discards in the Task 1 data may be underestimated in the last decade (**SWO-MD-Figure 2**).

SWO-MD-3. State of the stocks

Since the 2016 assessment (Anon., 2017c), there have been several changes both in fisheries operations and in the data available as input to the assessment models, which have undergone substantial revisions and the integration of new information. In addition, in 2020 stock assessment a Bayesian surplus production model, using a long series of data (1950 - 2018), was examined and was chosen for providing the scientific advice for the Mediterranean swordfish stock. Until 2016, advice was based on age structured models which were re-examined again. However, due to lack of indices of abundance for the earlier period, the input data for the age-structured models started in 1985, when the stock was already under high exploitation. From the age-structured models it was estimated that the stock was already overfished in 1985, although total catches had never exceeded MSY estimates from either age-structured or surplus production models prior to 1985. This was considered biologically implausible and it was deduced that these models were unable to properly estimate stock productivity due to data limitations (insufficient data series).

Under different assumptions about reporting levels of undersized fish in the catch, age-structured analysis including data from 1985-2018 indicated that current SSB levels are much lower than those in the 80s, while recruitment shows a declining trend in the last decade. Due to limited data for the earlier period of the fishery (See data catalogue in the Report of the 2020 Mediterranean Swordfish Stock Assessment, Table 2 (Anon., 2020d)), the age structured analysis failed to provide reliable estimates of stock productivity, and conclusions on the state of the stock were based on the surplus production model approach.

Results of the Bayesian surplus production model that used the whole catch series from 1950 to 2018, assuming also discard under-reporting in the last decade, indicated that stock biomass started declining from 1970 onwards, while fishing mortality starting exceeding F_{MSY} in the late 1980s when catches peaked (**SWO-MD-Figure 3**). The stock became overfished in the early 1990s following the full development of the fishery and the relatively high catches observed in middle-late 1980s. The analysis concluded that there is a 41.1% probability that the stock is overfished and overfishing is still occurring (red) and a 45.6% probability that the stock is overfished but overfishing is not occurring (yellow) (**SWO-MD-Figure 4**).

The Committee again noted the large catches of swordfish less than 4 years old and the relatively low number of large individuals in the catches. Fish less than four years old usually represent more than 70% of the total yearly catches in terms of numbers.

SWO-MD-4. Outlook

The assessment of Mediterranean swordfish indicates that the stock is most likely overfished and current fishing mortality is just below F_{MSY} levels. The stock has been in overfished state since the early 1990s because of the large catches in the 1980s and the selection pattern which captures many immature fish. Current catches are dominated, in terms of number, by fish less than 4 years old and the highest fishing mortality is corresponding to fish of age 3. Additionally, estimated recruitment has been declining for the last 10 years.

Projections of different catch levels, based on the output of the production model assessment indicate that TAC equal to 10,000 t would result in stock rebuilding with a 60% probability by the end of the projections period (2028). Projections were not carried out beyond 2028 due to uncertainty with the models. Probabilities increase if lower TACs are adopted. Projection results are summarized in **SWO-MD-Figure 5** and **SWO-MD-Table 2.** It should be noted, however, that these projection estimates are based on the assumption that future stock productivity will be around the average of the whole studied period. The declining recruitment in the most recent years, may indicate that stock productivity has decreased and in that case stock projections may be optimistic and should be interpreted with caution.

SWO-MD-5. Effect of current regulations

ICCAT imposed a Mediterranean-wide one-month fishery closure for all gears targeting swordfish in 2008, followed by a two-month closure since 2009. Through Rec. 11-03 and Rec. 13-04 the Commission has adopted additional management measures intended to bring the stock back to levels that are consistent with the ICCAT Convention objective. Those measures include an additional one-month closure accompanied by minimum catching size regulations, a list of authorized vessels, specifications on the technical characteristics of the longline gear, and onboard domestic observers on a given percentage of longline vessels. Recently, through Rec. 16-05, which replaced Rec. 13-04, a 15-year recovery plan has been adopted. In addition, increased catching size, and fishing capacity limitations were established, accompanied by TACs (10,500 t in 2017 Rec. 16-05, with a 3% annual reduction over the period 2018-2022) and a seasonal closure of the albacore fishery to reduce juvenile swordfish bycatches. The European Union introduced a driftnet ban for highly migratory species in 2002 and in 2003 ICCAT adopted a recommendation for a general ban of this gear in the Mediterranean (Rec. 03-04). Rec. 04-12 forbids the use of various types of nets and longlines for sport and recreational fishing for tuna and tuna-like species in the Mediterranean.

After the adoption of the aforementioned ICCAT Recommendations, reported catches have decreased significantly from the 2000s' level, making the catches of the period 2012-2022 among the lowest of the last three decades. In addition, reported catches of undersized swordfish have also decreased more than 50%, compared with the levels of the decade of 2000s. Importantly, based on observations onboard, the recent increase of the minimum catching size from 90 to 100 cm has resulted in discard increases (up to 600%) in some fisheries. Both hooking and post-release mortality are unknown for this stock but scientific work is ongoing on this issue. However, for the Atlantic very high values of hooking mortality (ranging between 78-88%) have been reported for swordfish less than 125 cm LJFL, and it is possible that similar high values also occur in the Mediterranean. The Committee showed concern that such discards are not being fully reported and reiterated that all dead discards should be reported in Task 1 nominal catches for all fisheries. Additionally, they should be included in the analysis of CPUE data trends. The additional measures foreseen under Rec. 16-05 have only recently been adopted and their effects cannot be fully evaluated.

The Committee assumes that the TAC in 2023 and afterwards remains the same as that of 2022 under Rec. 16-05 and requests the Commission's confirmation

SWO-MD-6. Management recommendations

Over the last 50 years stock biomass shows declining trends, starting with the period around 1970-1990, when the fishery was in a strong developing phase. In the following period until about 2010, declining trends were rather modest accompanied by small-scale fluctuations. In the most recent period, the stock biomass has continued to decline. As expected, fishing mortality followed an opposite trend with sharper increases during the 1980s. Current stock biomass is about 30% lower than that corresponding to MSY, while fishing mortality is around F_{MSY}. According to the Commission objectives the stock requires rebuilding and relevant scenarios were simulated assuming different levels of TACs. Analysis indicated that the probability of stock rebuilding by the end of the projection period (2028) is 60% if a TAC equal to 10,000 t is implemented. The probability increases if lower TACs levels are selected. As there are uncertainties on stock productivity, these estimates may be optimistic and should be interpreted with caution.

The Committee noted that since the establishment of minimum catching sizes, particularly after the recent size increase imposed through Rec. 16-05 the discard levels of undersized swordfish are increasing at least for certain fisheries and are largely dead. However, discards are not being reported for all fleets. Though an attempt has been made to statistically estimate discard levels and consider them in stock assessment models, the real volume of total discards is unknown due to this under-reporting. Such under-reporting leads to false estimates of the overall catch volume and consequently bias stock status estimates and projections of future stock size under different management measures.

MEDITERRANEAN SWORDFISH SUMMARY

Maximum Sustainable Yield	13,325 t (10,899 – 17,346 t)[1]
Current (2022) Yield	7,169 t
B_{MSY}	71,319 t (42,562 – 113,758)[1]
F_{MSY}	0.19 (0.12 - 0.34)[1]
Relative Biomass (B_{2018}/B_{MSY})	0.72 (0.38 - 1.29)[1]
Relative Fishing Mortality (F_{2018}/F_{MSY})	0.93 (0.42 - 1.68)[1]
Stock Status (2018)	Overfished: Yes Overfishing: No
Management Measures in Effect:	Driftnet ban, Rec. 03-04: Three-month fishery closure, gear specifications (number and size of hooks and length of gear), minimum catching size regulations, list of authorized vessels, fishing capacity restrictions, domestic observers onboard on longlines. TAC, Rec. 16-05: 10,500 t in 2017, 10,185 t in 2018, 9,879 t in 2019, 9,583 t in 2020, 9,296 t in 2021 and 9,017 t in 2022.

[1] 95% credibility intervals of 30,000 Markov chain Monte Carlo (MCMC) iterations from Bayesian surplus production models.

SWO-MD-Table 1. Estimated catches (t) of swordfish (*Xiphias gladius*) in the Mediterranean by gear and flag.

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL	MED		####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	8681	8176	7664	7512	7169
Landings		Longline	7377	8985	6319	5884	5389	6674	6223	7129	7498	8042	####	####	####	####	####	####	####	####	####	9131	9047	9718	####	####	8345	6938	8041	7603	7258	6946
		Other surf.	5888	7097	6696	6169	9304	7695	7476	8440	7508	4772	4945	3519	3555	3576	3094	658	819	1347	1162	782	49	83	78	53	57	61	45	60	66	132
Discards		Longline	0	0	0	0	0	0	0	0	0	0	0	9	113	16	19	1546	1396	1488	1191	1133	973	1168	1230	1369	1988	1682	89	0	188	90
Landings	CP	Albania	0	0	0	13	13	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Algerie	562	600	807	807	807	825	709	816	1081	814	665	564	635	702	601	802	468	459	216	387	403	557	568	671	550	528	517	501	447	472
		EU-Croatia	0	0	0	0	0	10	20	0	0	0	0	0	0	0	0	4	3	6	6	4	10	16	10	25	20	28	33	23	25	39
		EU-Cyprus	116	159	89	40	51	61	92	82	135	104	47	49	53	43	67	67	38	31	35	35	51	59	54	53	50	45	24	30	56	36
		EU-España	1358	1503	1379	1186	1264	1443	906	1436	1484	1498	1226	951	910	1462	1697	2095	2000	1792	1744	1591	1607	2073	2283	1733	1487	1387	1460	1434	1372	1462
		EU-France	0	0	0	0	0	0	0	0	12	27	20	19	22	20	14	14	16	78	81	12	66	127	182	179	113	86	71	110	96	66
		EU-Greece	1568	2520	974	1237	750	1650	1520	1960	1730	1680	1230	1120	1311	1358	1887	962	1132	1494	1306	877	1731	1344	761	761	392	350	745	657	686	371
		EU-Italy	6330	7765	7310	5286	6104	6104	6312	7515	6388	3539	8395	6942	7460	7626	6518	4549	5016	6022	5274	4574	2862	3393	4272	3946	2987	1779	2473	2250	2016	2079
		EU-Malta	91	47	72	72	100	153	187	175	102	257	163	195	362	239	213	260	266	423	532	503	460	376	489	410	330	308	407	361	391	380
		EU-Portugal	0	0	0	0	0	0	0	13	115	8	1	120	14	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	4	12	26
		Japan	4	2	4	5	5	7	4	2	1	1	0	2	4	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		Libya	0	0	0	0	0	11	0	8	6	0	10	2	0	16	0	0	0	0	0	0	0	0	585	960	30	70	26	22	19	21
		Maroc	2589	2654	1696	2734	4900	3228	3238	2708	3026	3379	3300	3253	2523	2058	1722	1957	1587	1610	1027	802	770	770	480	1110	1000	1013	982	951	924	891
		Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	28	0	0	0	9	4	0	0	0	0	0	0	0	0	**0**
		Tunisie	354	298	378	352	346	414	468	483	567	1138	288	791	791	949	1024	1011	1012	1016	1040	1038	1036	1030	1034	1007	1003	974	934	918	891	857
		Türkiye	292	533	306	320	350	450	230	370	360	370	350	386	425	410	423	386	301	334	190	80	97	56	35	77	441	427	414	402	390	379
	NCC	Chinese Taipei	1	1	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	NCO	NEI (MED)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discards	CP	Algerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	175	102	100	42	78	84	145	147	176	205	197	0	0	0	**0**
		EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EU-Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	84	89	0	188	90
		EU-Greece	0	0	0	0	0	0	0	0	0	0	0	9	113	16	19	27	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		EU-Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	724	751	817	734	618	456	538	670	623	907	535	0	0	0	**0**
		Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	343	278	301	160	201	193	198	123	285	350	355	0	0	0	**0**
		Tunisie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	221	221	222	227	227	226	272	273	266	374	364	0	0	0	**0**
		Türkiye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	43	48	27	10	14	16	10	20	151	148	0	0	0	**0**

SWO-MD-Table 2. Estimated probabilities of the Mediterranean swordfish stock (a) being below F_{MSY} (overfishing not occurring), (b) above B_{MSY} (not overfished) and (c) above B_{MSY} and below F_{MSY} (green zone) for a range of fixed total catches (0-15,000 t) over the projection horizon 2021-2028 based on joint projection MCMC posteriors of JABBA model runs ('Reference' and 'ASEM' models).

a) Probability that $F \leq F_{MSY}$

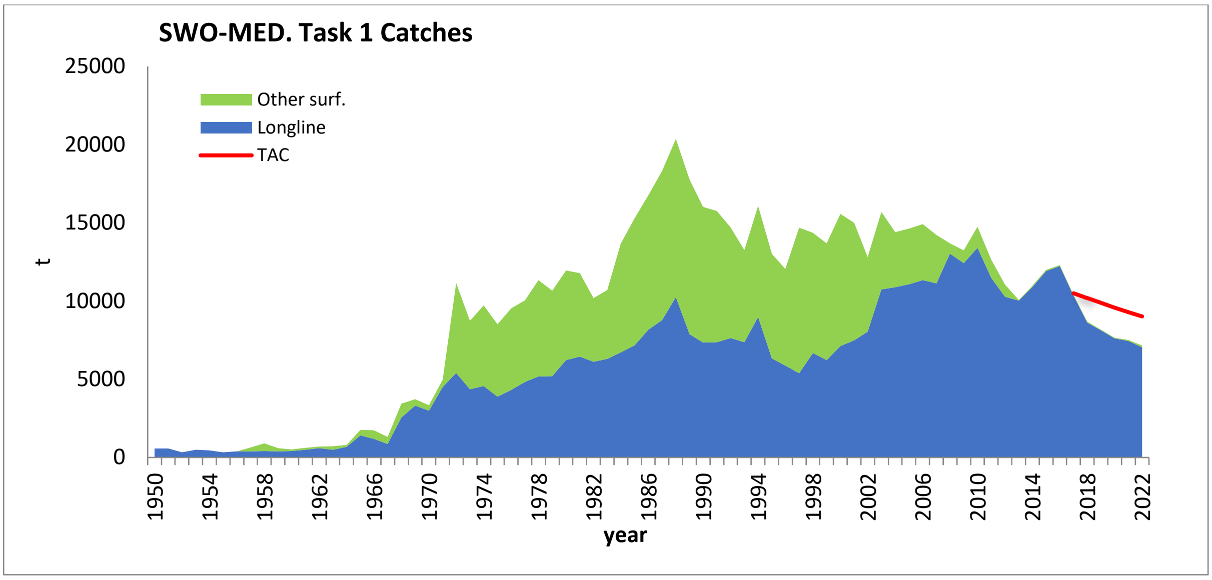
TAC | Year	2021	2022	2023	2024	2025	2026	2027	2028
0	100	100	100	100	100	100	100	100
7000	84	87	90	91	93	94	94	95
8000	76	80	83	85	87	88	90	90
9000	68	72	75	77	80	81	82	84
10000	58	62	65	68	70	72	73	74
10250	56	60	62	65	67	69	71	72
10500	54	57	60	62	64	66	68	69
10750	51	54	57	59	61	63	64	66
11000	49	52	55	57	59	60	61	63
11250	47	50	52	54	56	57	58	59
11500	45	47	49	51	53	54	55	56
11750	43	45	47	48	50	51	52	53
12000	41	43	44	46	47	48	49	50
12250	39	40	42	43	44	45	45	46
12500	37	38	39	40	41	42	42	43
12750	35	36	37	38	38	39	39	40
13000	33	34	35	35	36	36	36	36
14000	27	27	27	26	26	26	26	25
15000	22	21	20	20	19	18	18	17

b) Probability that $B \geq B_{MSY}$

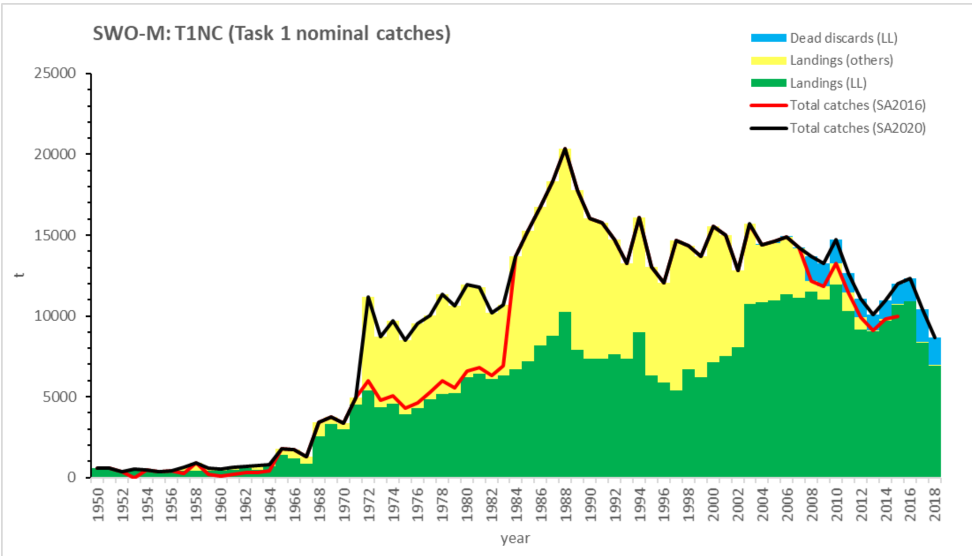
TAC | Year	2021	2022	2023	2024	2025	2026	2027	2028
0	31	52	71	84	92	96	98	99
7000	31	41	51	59	67	72	77	81
8000	31	39	47	55	61	67	71	75
9000	31	38	44	50	56	60	64	68
10000	31	36	41	46	50	53	57	60
10250	31	36	40	45	49	52	55	58
10500	31	35	39	43	47	50	53	56
10750	31	35	39	42	45	48	51	53
11000	31	35	38	41	44	47	49	51
11250	31	34	37	40	43	45	47	50
11500	31	34	37	39	42	44	45	47
11750	31	34	36	38	40	42	43	45
12000	31	33	35	37	39	41	42	43
12250	31	33	35	36	37	38	39	40
12500	31	32	33	35	36	37	38	38
12750	31	32	33	34	35	35	36	36
13000	31	32	33	33	34	34	34	34
14000	31	30	30	29	29	28	28	27
15000	31	29	27	26	24	23	22	21

c) Probability that $F \leq F_{MSY}$ and $B \geq B_{MSY}$

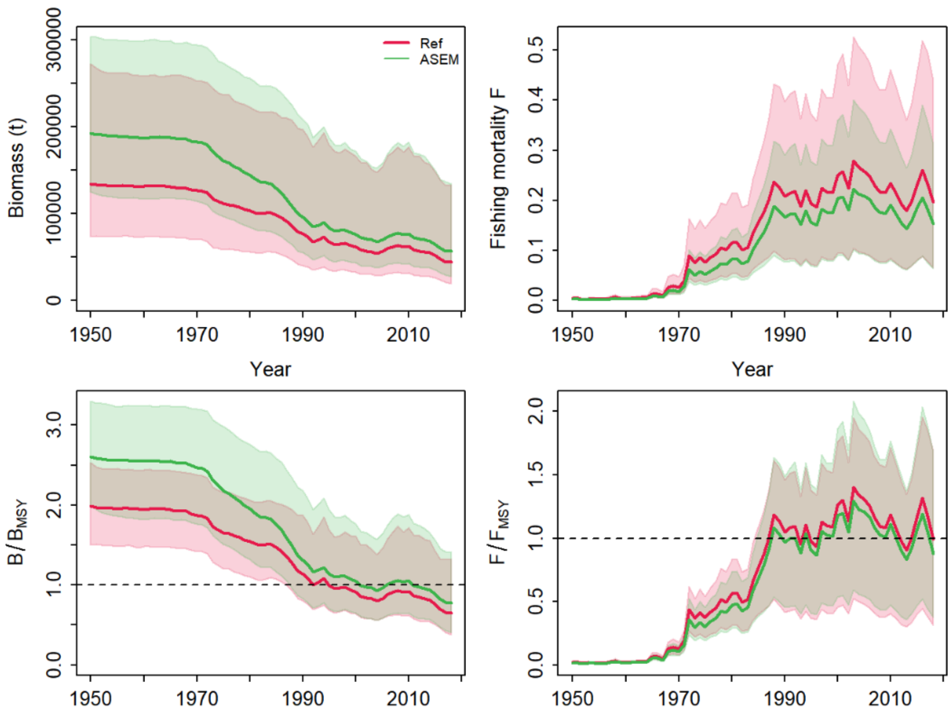
TAC | Year	2021	2022	2023	2024	2025	2026	2027	2028
0	31	52	71	84	92	96	98	99
7000	31	41	51	59	67	72	77	81
8000	31	39	47	55	61	67	71	75
9000	31	38	44	50	56	60	64	68
10000	31	36	41	46	50	53	57	60
10250	31	36	40	45	49	52	55	58
10500	31	35	39	43	47	50	53	56
10750	31	35	39	42	45	48	51	53
11000	31	34	38	41	44	47	49	51
11250	31	34	37	40	43	45	47	49
11500	30	34	37	39	41	44	45	47
11750	31	33	36	38	40	42	43	45
12000	30	33	35	37	38	40	41	43
12250	30	32	34	35	37	38	39	40
12500	30	31	32	34	35	36	37	38
12750	29	31	32	33	33	34	35	35
13000	29	30	31	31	32	32	33	33
14000	25	25	25	25	25	25	25	24
15000	21	20	20	19	18	18	17	17



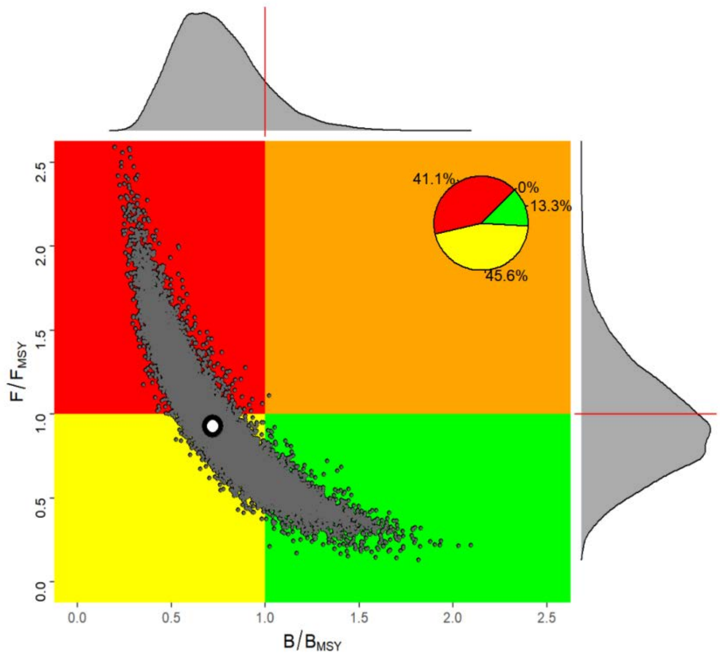
SWO-MD-Figure 1. Estimates of Task 1 swordfish catches (t) in the Mediterranean by major gear types, for the period 1950-2022, and corresponding annual TACs since 2017 (Rec. 16-05).



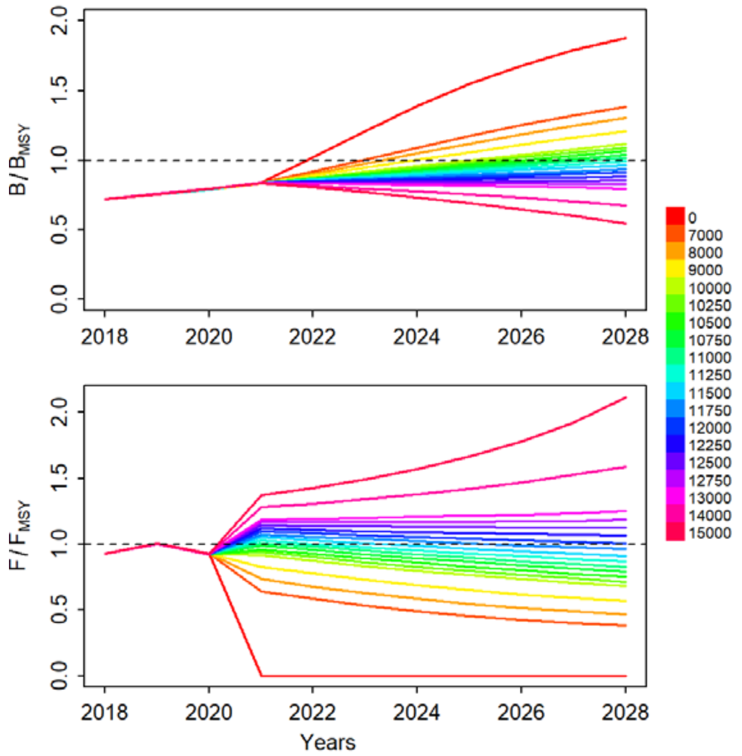
SWO-MD-Figure 2. SWO-M total nominal catches (T1NC, t) by year, showing total landings (LL and other gears) and dead discards (reported and estimated in Ortiz, 2020) as prepared for the 2020 assessment. The total catches used in the 2016 stocks assessment (Anon., 2017c) is shown for comparative purposes.



SWO-MD-Figure 3. Trends in biomass and fishing mortality (upper panels) and biomass relative to B_{MSY} (B/B_{MSY}) and fishing mortality relative to F_{MSY} (F/F_{MSY}) (bottom panels) for each scenario from the Bayesian state-space surplus production model fits to Mediterranean swordfish.



SWO-MD-Figure 4. Kobe phase plot showing the combined posteriors of B_{2018}/B_{MSY} and F_{2018}/F_{MSY} presented in the form of joint MCMC posteriors of JABBA model runs for Mediterranean swordfish. The probability of posterior points falling within each quadrant is indicated in the pie chart.



SWO-MD-Figure 5. Trends of projected relative stock biomass (at begin of year, upper panel, B/B_{MSY}) and fishing mortality (at end of year, bottom panel, F/F_{MSY}) of Mediterranean swordfish under different TAC scenarios (0 – 15,000 t), based upon the combined projections of JABBA model runs. Each line represents the median of 30000 MCMC iterations by projected year.

9.14 SMT - Small tunas

SMT-1. Generalities

The species under the Small Tunas Species Group include the following tuna and tuna-like species:

- BLF Blackfin tuna (*Thunnus atlanticus*)
- BLT Bullet tuna (*Auxis rochei*)
- BON Atlantic bonito (*Sarda sarda*)
- BOP Plain bonito (*Orcynopsis unicolor*)
- BRS Serra Spanish mackerel (*Scomberomorus brasiliensis*)
- CER Cero (*Scomberomorus regalis*)
- COM Narrow-barred Spanish mackerel (*Scomberomorus commerson*)
- FRI Frigate tuna (*Auxis thazard*)
- KGM King mackerel (*Scomberomorus cavalla*)
- LTA Little tunny (*Euthynnus alletteratus*)
- MAW West African Spanish mackerel (*Scomberomorus tritor*)
- SSM Atlantic Spanish mackerel (*Scomberomorus maculatus*)
- WAH Wahoo (*Acanthocybium solandri*)

Knowledge on the biology and fishery of small tunas is very fragmented. Furthermore, the quality of the knowledge varies according to the species concerned. This is due in large part to the fact that these species are often perceived to have little economic importance compared to other tunas and tuna-like species, and owing to the difficulties in conducting sampling of the landings from artisanal fisheries, which constitute a high proportion of the fisheries exploiting small tuna resources. The large industrial fleets often discard small tuna catches at sea or sell them on local markets mixed with other bycatches, especially in Africa. The amount caught is rarely reported in logbooks; however, observer programmes from purse seine fleets have recently provided estimates of catches of small tunas.

Small tuna species can reach high levels of catches and values in some years and have a very high relevance from a social and economic point of view, because they are important for many coastal communities in all areas and a main source of food. Their social and economic value is often not evident because of the underestimation of the total landing figures, due to the difficulties in data collection mentioned above. Several statistical problems are also caused by misidentification.

Scientific collaboration between ICCAT, Regional Fisheries Organizations (RFOs) and countries in the various regions is imperative to advance understanding of the distribution, biology and fisheries of these species.

SMT-2. Biology

Small tuna species are widely distributed in the tropical and subtropical waters of the Atlantic Ocean and several are also distributed in the Mediterranean Sea and the Black Sea. Some species extend their range even into colder waters, like the North and South Atlantic Ocean. They often form large schools with other small sized tunas or related species in coastal and high seas waters.

Generally, the small tuna species have a varied diet with a preference for small pelagics (e.g., clupeids, mullets, carangids, etc.). Small tunas are the prey of large tunas, marlins, sharks and marine mammals which at the same time are predators of small pelagics. The reproduction period varies according to species and areas and spawning generally takes place near the coast in oceanic areas, where the waters are warmer. A study conducted on the eastern coast of Tunisia has shown that the spawning area of the bullet tuna is offshore at the limit of the continental shelf and related to the high abundance of the zooplankton. A study recently carried out along the Gulf of Gabes (Ionian Sea-Mediterranean) indicated that the larvae of the bullet tuna were mainly concentrated between the isobaths 50 and 200 m, and the spawning grounds of this species were mainly offshore.

The growth rate currently estimated for these species is very rapid for the first two or three years, and then slows as they reach size-at-first maturity. Most small tuna species matures at small sizes, mostly between 30 and 50 cm, except wahoo for which size at first maturity varies between 92 and 110 cm. Information on the migration patterns of small tuna species is very limited, due to low tagging levels of these species. However, a new genetic study showed that there is a clear genetic heterogeneity for the bullet tuna among different geographical locations in the Mediterranean, suggesting that the population structure of this species in the Mediterranean is more complex than initially expected. In a recent preliminary genetic study conducted within the Small Tunas Year Programme (SMTYP) for little tunny, it was observed a strong population structure, separating into two clades the individuals from EU-Portugal and Tunisia, and those from Senegal and Côte d'Ivoire. Also, recent studies of the population structure of Atlantic bonito in three areas - MD (Tunisia and EU-Spain); AT-NE (EU-Portugal and Morocco) and AT-SE (Senegal and Côte d'Ivoire) - showed clear differential structure, being the location of Côte d'Ivoire the most genetically differentiated location.

Within ICCAT Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP), a total of nearly 8,000 little tunny were tagged off West Africa and western Atlantic between August 2016 and April 2019, with nearly 600 tags being recovered. This converts to a 7% tag recovery rate. Both tag-releases and recoveries of little tunny have occurred in 'coastal' waters between Mauritania and Côte d'Ivoire. The longest "time at liberty" observed (700 days) and migrated 929 nautical miles (NM). Little tunny have been tagged on both sides of the tropical Atlantic; however no cross-Atlantic movement has yet been reported, indicating rather coastal associated movements.

In 2018 and 2019, the open database provided in the 2016 Intersessional Meeting of the Small Tunas Species Group (Anon., 2017d) (Juan-Jordá *et al*., 2016) with a thorough review of the Scombridae life history parameters was considered as a starting point for a meta-database of the Atlantic small tunas species, and the Group considered this proposal for updating and sharing parameters and useful references. The Group determined the main life history parameters to be compiled (L_{INF}, k, t0, L50, A50, L_{MAX}, a (L-W), b (L-W), batch fecundity) and, that the areas defined by ICCAT previously (ICCAT Statistical Areas Map 4) were adequate for SMT and studies should be carried based on such spatial unities.

The updated database, available for all participants and stored in the ICCAT Owncloud, allowed for data mining, based on the most reliable parameters by region for each species and, spatial visualization of current status and data gaps in the life history parameters of SMT species were provided (**SMT-Table 2**). This information will be used to assess future research needs and for running Data Limit Models, when applicable.

SMT-3. Fisheries indicators

Small tunas are exploited mainly by coastal and artisanal fisheries, substantial catches are also made as target species and as bycatch by purse seine, mid-water trawl (i.e., pelagic fisheries of West Africa-Mauritania), handline and small-scale gillnets. Unknown quantities of small tuna also comprise the incidental catches of some longline fisheries. The increasing importance of FAD fisheries in the eastern Caribbean and in other areas has improved the efficiency of artisanal fisheries in catching small tunas. Various species are also caught by the sport and recreational fisheries.

Despite the scarce monitoring of various fishing activities in some areas, all the small tuna fisheries have high social and economic relevance for most of the coastal countries concerned and for many local communities, particularly in the Mediterranean Sea, in the Caribbean region and in West Africa.

SMT-Table 1 shows historical landings of small tunas for the 1990 to 2022 period although the data for the last years are preliminary. This table does not include species reported as "mixed" or "unidentified", as was the case in the previous years, since these categories include large tuna species. Of the total 13 species included in the Small Tunas Species Group, the seven most important represent about 92% of Task 1 nominal catches between 1950 and 2022. These are: BON (34%), LTA (14%), FRI (13%), SSM (11%), KGM (11%), and BRS and BLT (5% each). In 1980, there was a marked increase in the reported landings compared to previous years, reaching a first peak of 145,492 t in 1988 (**SMT-Figure 1**). Reported landings for the 1989-1995 period decreased to about 95,900 t in 1995, and then an oscillation in the values in the following years, with a minimum of 69,117 t in 2008 and a maximum of 171,281 t in 2022. The annual trend in the total catches by species are shown in **SMT-Figure 2**. Overall trends in the small tuna catch may mask declining trends for individual species because annual landings are often dominated by the landings of single species. These fluctuations seem to be related to unreported catches, as these species generally comprise part of the bycatch and are often discarded, and therefore do not reflect the real catch.

A preliminary estimate of the total nominal landings of small tunas in 2022 is 171,281 t. The Committee pointed out the relative importance of small tuna fisheries in the Mediterranean and the Black Sea, which account for about 32% of the total small tuna catches (1950 to 2022) in the ICCAT area.

Despite the recent improvements in the statistical information provided to ICCAT by several countries, the Committee noted that uncertainties remain regarding the accuracy and completeness of reported landings in all areas. There is a general lack of information on the mortality of these species as bycatch.

However, after the adoption of the SMTYP in 2012, significant historical catches, catch and effort and size data from the artisanal fisheries in the west of Africa (Senegal, Côte d'Ivoire and Morocco) and from the Mediterranean Sea (EU-Spain and EU-Italy) were recovered and made available to the Secretariat.

SMT-4. State of the stocks

In 2017, a Productivity and Susceptibility Analysis (PSA) was carried for the small tuna caught by longline and purse seine fisheries in the Atlantic. The study found that the top 3 stocks at risk in the Atlantic Ocean that should deserve most of the managers' attention were *E. alleteratus*, *A. solandri* and *S. cavalla*. This first analysis was very important in order to define priority species for stock assessment and biological data collection. However, this analysis will be improved by considering the 5 statistical ICCAT areas and the relevant fishing gears for each stock.

Also as an initial attempt to provide stock status of the SMT, the lengths distributions and the reference points obtained from length frequencies for the small tuna species in the Task 2 database, pooled by species, year and considering the South and North Atlantic are plotted in **SMT-Figure 3**. To avoid growth overfishing, catch length compositions should consist of fish at a size at which the highest yield from a cohort occurs (L_{OPT}). While to avoid recruitment overfishing, catches should comprise almost exclusively mature individuals (i.e., fish be >L50, the length at which 50% of fish are mature). Two reference points were used, i.e., P_{OPT} and P50, the proportion of individuals in the catch size data that are greater than L_{OPT} and L50, respectively. However, L_{OPT} is based on a per recruit analysis which ignores recruitment dynamics, for example the age/size structure and the distribution of a population which all determine productivity and hence sustainability and the formulation of robust management advice.

These data are replotted in **SMT-Figure 4** as an example of how they could be used as indicators of growth and recruitment overfishing. For example, if L_{OPT} is used as a target with a probability of 0.5 and a tolerance of ±0.25 to allow limited fluctuations around the target; then in **SMT-Figure 4a** green indicated that length compositions meet this target and red when exceeded. For recruitment overfishing, if 0.6 is used as a limit for P50, then any catches where less than 40% are mature fish are colored red (**SMT-Figure 4b**).

The plots show that in most cases poor yield optimization is occurring, but that recruitment overfishing is not. Although in two cases (WAH in the southern Atlantic and LTA in the North Atlantic) recruitment overfishing has increased in the recent period.

In 2018, preliminary results on the implementation of data-limited approaches for small tunas using simulation testing were provided and improved in 2019, when different approaches for the stock assessment of Atlantic and Mediterranean small tunas were carried out. Catch-based assessment models (Depletion Based Stock Reduction Analysis – DBSRA – and Simple Stock Synthesis – SSS) and Length based models (Length-based Spawning potential ratio – LSPR and Length-based integrated mixed effects model – LIME) were applied for 10 and 6 stocks, respectively. Also, the integrated assessment LIME, which used catch and length data, were applied for 6 small tuna stocks. Only LTA in the South East and WAH in the North West would show signs of overfishing for most of the models applied, deserving special attention in the future (**SMT-Table 3**).

Catch data are still incomplete for some species, regions and fleets, hampering the use of catch-based methods. At the moment, length-based methods show a more promising applicability for small tunas, although representative length distributions are still limited for some stocks. The use of length-based methods depends on how representative is the length data distribution by stock, since the size data available in T2SZ comes from different fleets with different gear selectivity. To deal with this issue, the Group recommended using length-data from all gears combined in order to get a better representation of the length distribution of the population, assigning equal weight to each fishing gear. It is important for all CPCs to report size data from all gears in order to get a representation of the length distribution of the entire population. Other length data, ideally from fishery independent surveys, could complement this information and improve the assessments.

A data-limited Management Strategy Evaluation (MSE) was also performed as preliminary exercise for WAH in the North West only. The MSE pointed out that management procedures based on catch-based methods are the most acceptable with respect a variety of performance metrics, while simulations for the length-based and fishing effort control methods did not present as satisfactory results (**SMT-Table 4**). The results from this initial exercise must be interpreted with caution because of considerable uncertainty in the parametrization of the operating model, which might strongly influence the performance of management procedures (MP)s.

The Group noted that PSA, Length-based model and, mainly MSE are good options in a data limited framework and that these approaches should be applied for the stocks which the assessment was not carried out yet and improve those already conducted when better data is available.

SMT-5. Outlook

There is no projection made by the Committee.

Additional work is being carried out under the SMTYP to address knowledge gaps as regards size data, stock identification and biological parameters, which are necessary for their assessment.

The Committee notes that the Atlantic Ocean Tropical Tuna Tagging Programme adopted by ICCAT was successfully tagging LTA, but more WAH should be tagged given that only one individual was recovered. The Committee also notes the need for an increase in the collection of information on recaptures of tagged fish by enhancement awareness campaigns, focusing on artisanal fisheries, particularly gillnet, small purse seine, longline and handline.

As part of its 2022 workplan, the Committee held a Workshop on Data Limited Assessment Methods for Small Tunas and a follow-up workshop is scheduled for late 2023 or early 2024, aiming applying potential management procedures and management performance measures for high-priority small tuna stocks.

SMT-6. Effect of current regulations

There are no ICCAT regulations in effect for small tunas. Several regional and national regulations are in place.

SMT-7. Management recommendations

The provision of robust management advice by the SCRS relies on accurate reporting of Task 1 and 2 data and life history parameters. However, due to the nature of small tuna fisheries (i.e., multi-gear, multi-species, artisanal fisheries, etc.), information on fisheries data is difficult to collect, however proper monitoring programs should be implemented by the CPCs. Therefore, although the Group has improved in applying a range of Data-limited models, the robustness still needs to be evaluated before they can be used to provide management advice to the Commission. Also, although the Group recognize that the use of Data-Limit models are important for small tunas as the first step for stock assessment, given the importance of some of species in terms of catches, more robust methods, such as those used for data rich species, should be applied in a near future, when more complete data are available.

SMT-Table 1. Reported landings (t) of small tuna species, by area and flag.

					1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BLF	TOTAL	ATL			3535	2719	4051	4488	3258	3395	3203	2483	4034	4756	1303	1926	1031	1937	1927	1669	1442	1837	2083	2849	2134	1152	1306	1920	1368	1557	1472	2653	2859	4802
	Landings			All gears	3535	2719	4051	4488	3258	3395	3203	2483	4034	4756	1303	1926	1031	1937	1927	1669	1442	1837	2083	2849	2134	1152	1306	1920	1368	1557	1472	2653	2859	4802
	Discards				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Landings		CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Brazil	22	38	153	649	418	55	55	38	149	1669	1	118	91	242	233	266	10	9	46	124	110	299	325	228	192	392	410	820	1691	2273
				Curaçao	65	60	50	45	45	45	45	45	45	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-España	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-France	1140	1330	1370	1040	1040	1040	1040	1040	1040	1040	0	0	0	0	0	0	0	32	19	26	0	14	12	14	14	6	28	15	17	30
				Grenada	253	189	123	164	126	233	94	164	223	255	335	268	306	371	291	290	291	291	291	291	291	0	0	0	0	0	94	73	0	
				Mexico	0	0	0	0	0	0	0	0	12	0	10	9	10	10	12	6	7	6	9	5	4	4	4	5	4	4	3	3	2	3
				St Vincent and Grenadines	53	19	20	18	22	17	15	23	24	24	0	0	0	0	0	0	0	0	0	0	11	0	0	0	5	0	9	6	0	0
				Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	0	5	5	5	5	5	5	5
				UK-Bermuda	5	7	4	5	4	6	6	5	4	5	9	4	5	8	7	6	7	9	8	11	11	15	20	17	17	16	10	7	12	9
				UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
				UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				USA	508	492	582	447	547	707	617	326	474	334	414	675	225	831	422	649	619	911	967	1919	1326	585	761	1265	946	1074	756	1628	1054	2403
				Venezuela	1224	21	624	758	498	1034	1192	696	1902	1211	319	732	225	237	777	231	293	331	473	237	191	88	81	197	33	42	4	2	5	3
			NCO	Cuba	54	223	156	287	287	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Dominica	15	19	30	0	0	0	79	83	54	78	42	20	38	47	29	37	45	41	37	39	37	39	24	34	34	17	24	8	0	
				Dominican Republic	133	239	892	892	231	158	18	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Jamaica	0	0	0	148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Sta Lucia	16	82	47	35	40	100	41	45	108	96	169	96	126	182	151	179	165	203	229	192	147	104	80	156	119	0	127	84	74	75
	Discards		CP	Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BLT	TOTAL				3420	5300	4301	5909	3070	2309	2646	3912	5796	6041	3794	6223	4231	4232	5617	6825	5557	7952	9484	6234	7653	3916	5571	5720	3348	4083	3432	3530	3683	5018
		ATL			70	100	0	0	0	28	263	902	1236	626	353	401	719	889	602	334	484	746	507	515	1158	367	755	467	232	228	215	184	209	40
		MED			3350	5200	4301	5909	3070	2281	2383	3010	4559	5416	3441	5823	3513	3344	5015	6491	5072	7206	8977	5719	6494	3549	4816	5253	3116	3855	3218	3347	3475	4978
	Landings	ATL		All gears	70	100	0	0	0	28	263	902	1236	626	353	401	719	889	602	334	484	746	507	515	1158	367	750	467	223	216	215	184	208	40
		MED		All gears	3350	5200	4301	5909	3070	2281	2383	3010	4559	5416	3441	5823	3513	3344	5015	6491	5072	7206	8977	5719	6494	3549	4816	5253	3116	3855	3218	3347	3474	4978
	Discards	ATL		All gears	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	9	12	0	0	0	
		MED		All gears	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	Landings	ATL	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	406	0	133	131	34	72	0	0	0	0
				Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	222	0	1	0	0	20	0	0
				EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	1	0	14	50	0	5	5	0	1	0	0
				EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	14	0	0	0	0
				EU-Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	76	0	6	14
				EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
				EU-Portugal	0	0	0	0	0	28	263	494	208	166	231	299	580	867	602	311	436	654	387	55	38	0	0	0	0	0	64	29	130	7
				Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
				Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Russian Federation	70	100	0	0	0	0	0	408	1028	460	122	102	139	22	0	23	48	67	119	366	703	352	345	336	62	125	75	134	64	19
				USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0
			NCO	Sta Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		MED	CP	Algerie	348	306	230	237	179	299	173	225	230	481	0	391	547	586	477	1134	806	970	1119	1236	577	1025	1984	1592	231	799	905	732	1802	3229
				EU-Croatia	52	22	28	26	26	26	26	0	0	0	0	0	0	0	0	0	0	8	13	9	10	12	15	15	25	37	27	15	17	54
				EU-España	648	1124	1472	2296	604	487	669	1024	861	493	495	1009	845	1101	3083	3389	726	3787	3227	1620	2654	735	1191	1081	2170	774	1026	986	511	266
				EU-France	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
				EU-Greece	1400	1400	1400	1426	1426	0	0	196	125	120	246	226	180	274	157	620	506	169	129	118	155	108	311	207	181	294	513	262	139	273
				EU-Italy	379	531	531	229	229	229	462	462	462	2452	1463	1819	866	143	158	342	732	574	653	613	892	0	0	1717	0	966	25	6	16	15
				EU-Malta	9	1	2	3	6	1	3	1	1	0	2	8	4	11	14	12	7	11	23	3	85	14	14	11	9	12	12	7	1	28
				Maroc	170	1726	621	1673	562	1140	682	763	256	621	246	326	50	199	35	83	336	525	237	194	237	171	811	200	0	442	50	96	91	52
				Syria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	75	87	81	84	83	83	0	0	0	0	0	0	0	0	0
				Tunisie	20	13	14	13	32	93	45	15	2300	932	989	1760	0	0	0	0	0	0	940	935	938	920	13	23	26	136	67	91	139	147
				Türkiye	324	77	0	0	0	0	316	316	316	316	0	284	1020	1031	993	836	1873	1081	2552	907	863	562	476	407	474	367	462	1070	737	809

					1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			NCO	Palestine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	130	81	21	104
				Serbia & Montenegro	0	0	2	6	6	6	7	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Yugoslavia Fed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Discards	ATL	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	9	12	0	0	0	0
		MED		EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
BON	TOTAL				30528	21719	21219	25134	24417	45253	37312	27151	27637	23925	14424	15832	78767	41951	15628	16814	23710	28921	36783	48280	24847	27993	15706	54868	22757	46584	29676	44619	28546	91503
		ATL			4531	6037	6030	7939	10340	15523	9143	5179	5400	8208	3307	4584	4391	9648	6381	6772	13691	16338	22341	8959	6482	4640	6712	10930	10959	11093	23931	17458	21817	35301
		MED			25997	15682	15189	17195	14078	29730	28170	21972	22237	15717	11117	11248	74376	32303	9247	10042	10019	12584	14442	39321	18365	23352	8993	43938	11798	35491	5745	27160	6728	56202
	Landings	ATL		All gears	4531	6037	6030	7939	10340	15523	9143	5179	5400	8208	3307	4584	4391	9648	6381	6772	13691	16338	22341	8959	6482	4640	6712	10930	10959	11093	23929	17458	21817	35296
		MED			25997	15682	15189	17195	14078	29730	28170	21972	22237	15717	11117	11248	74376	32303	9247	10042	10019	12584	14442	39321	18365	23352	8993	43938	11798	35491	5745	27160	6728	56202
	Discards	ATL			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5
		MED			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Landings	ATL	CP	Angola	49	20	9	39	32	0	2	118	118	118	0	0	138	0	931	0	1962	1997	131	267	1134	2	3	3	2	0	0	5	5	0
				Barbados	0	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	10	0	0	0	0
				Brazil	142	142	137	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	171	0	38	0	1	2	1	23	15	0	0	0
				Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	539	539	539	539	0	0	0	0	0	0	0	0	0
				Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	3	13	755	3	0	26	3	16	6	3510	42	2725	1757	6244	687
				EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-España	5	3	2	2	1	0	12	12	10	5	23	9	2	15	14	13	36	45	57	7	44	28	10	31	18	16	20	3	8	10
				EU-Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-France	1052	990	990	610	610	610	24	32	0	18	0	0	0	0	122	59	25	208	241	102	245	288	333	422	290	195	115	62	60	43
				EU-Germany	0	0	0	714	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	6	0	4	89	14	0	13	1	25
				EU-Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Ireland	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	56	125	91	108	100	0	0	0	0	0	0	0	0	0
				EU-Latvia	0	3	19	301	887	318	0	416	396	639	0	0	0	0	0	0	0	1019	2231	34	48	29	0	0	0	0	6604	518	522	1414
				EU-Lithuania	0	0	0	0	0	0	0	0	0	793	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	686	385	596	138	903
				EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	344	539	539	0	2047	104	1075	54	11	124	79	39	91	71	82	141
				EU-Poland	0	0	0	225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Portugal	145	56	78	83	49	98	98	162	47	61	40	50	38	318	439	212	124	476	461	321	184	22	25	570	368	257	382	168	248	148
				EU-Rumania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Gabon	0	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Great Britain	0	0	0	287	0	0	0	0	0	0	0	0	0	35	0	0	30	71	113	4	0	0	0	0	0	0	0	0	0	0
				Grenada	0	0	0	24	6	14	16	7	10	10	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	0	1	1	
				Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	59	32	0	3	4	5	6	4
				Maroc	1246	584	699	894	1259	1557	1390	2163	1700	2019	928	989	1411	1655	1053	1419	2523	109	145	235	89	90	174	850	1417	4081	5679	5470	4516	10512
				Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	1303	839	1850	2384	6890	9463	3193	514	1052	2543	4951	1546	1801	1927	5008	5386	10843
				Mexico	779	674	1144	1312	1312	1632	1861	1293	1113	1032	1238	1066	654	1303	1188	1113	1063	1046	1080	1447	1534	1115	1110	1188	1361	1440	1258	954	693	430
				Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
				Panama	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Russian Federation	0	0	0	0	0	4960	0	0	574	1441	461	16	79	316	259	52	368	1042	2293	848	125	416	308	850	666	573	617	1281	908	6969
				S Tomé e Príncipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	145	147	149	153	158	162	267	207	211	2	0	0	0	0
				Senegal	171	814	732	1012	1289	2213	2558	286	545	621	195	183	484	2304	1020	1380	4029	1677	2876	1453	514	1217	1711	1581	1226	1696	3982	1380	2915	2975
				Sierra Leone	0	0	0	0	0	0	0	11	245	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	15	18	0	16	23	27	15	6	20	0	0	0	0	0	0	0	0	0	0	0
				Trinidad and Tobago	17	703	169	266	220	30	117	117	56	452	188	280	81	7	16	38	68	68	14	9	16	16	0	16	16	16	16	16	16	16
				UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
				UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				USA	171	128	116	156	182	76	83	142	120	139	44	70	68	40	97	47	50	47	189	94	73	101	96	61	62	197	107	140	66	175
				USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Uruguay	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Venezuela	5	1661	1651	1359	1379	1659	1602	2	0	61	13	0	16	18	19	12	38	10	21	7	4	9	0	0	0	0	0	0	0	0

					1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	29	40	20	12	0	0	0	0	**0**
			NCO	Argentina	434	4	138	108	130	12	68	19	235	1	129	269	110	0	0	0	220	59	6	33	0	0	0	0	0	0	0	0	0	
				Benin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Cuba	0	0	0	0	0	230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Dominica	0	0	0	0	0	0	0	0	0	0	0	0	6	16	16	9	4	0	0	0	0	1	2	7	1	0	2	6	0	
				Georgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Germany Democratic Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Jamaica	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	1	0	
				Sta Lucia	4	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Togo	311	254	145	197	197	197	197	0	0	0	0	1583	1215	2298	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Ukraine	0	0	0	342	2786	1918	1114	399	231	656	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		MED	CP	Albania	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				Algerie	471	418	506	277	357	511	475	405	350	597	0	609	575	684	910	1042	976	1009	355	353	614	504	716	452	593	811	302	369	485	1216
				EU-Bulgaria	8	0	25	33	16	51	20	35	35	35	0	0	0	0	0	0	0	16	8	96	6	5	8	68	13	23	4	32	1	45
				EU-Croatia	6	70	0	0	0	25	120	0	0	0	0	0	0	0	0	0	0	59	41	31	56	56	34	20	22	28	42	31	24	13
				EU-Cyprus	0	0	0	0	0	0	0	14	0	10	10	6	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				EU-España	200	344	632	690	628	333	433	342	349	461	544	272	215	429	531	458	247	518	574	442	881	585	519	358	314	321	483	330	253	1967
				EU-France	6	0	0	0	0	0	0	0	0	27	0	0	0	0	15	34	20	23	13	12	30	25	103	60	217	52	86	57	45	51
				EU-Greece	2690	1581	2116	1752	1559	945	2135	1914	1550	1420	1538	1321	1390	845	1123	587	476	531	798	733	960	678	691	700	399	641	422	342	269	659
				EU-Italy	1238	1828	1512	2233	2233	2233	4159	4159	4159	4579	2091	2009	1356	552	610	1323	1131	964	1197	472	1245	1053	750	697	540	605	616	570	499	480
				EU-Malta	0	0	0	2	7	2	2	1	0	1	0	1	1	11	7	7	3	6	1	3	2	0	2	3	0	2	1	1	0	**0**
				EU-Rumania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				Egypt	640	648	697	985	725	724	1442	1442	1128	1128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				Libya	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	705	780	82	75	71	65	45	35
				Maroc	25	93	37	67	45	39	120	115	5	61	85	78	38	89	87	142	131	57	12	1	0	8	26	50	46	28	60	8	13	11
				Tunisie	792	305	413	560	611	855	1350	1528	1183	1112	848	1251	0	0	0	0	0	0	1425	1415	1413	1407	867	1290	1993	1986	2079	2612	2498	1832
				Türkiye	19548	10093	8944	10284	7810	24000	17900	12000	13460	6286	6000	5701	70797	29690	5965	6448	7036	9401	10019	35764	13158	19032	4573	39460	7578	30920	1578	22743	2595	49892
				USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			NCO	NEI (MED)	300	300	300	300	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Serbia & Montenegro	3	2	6	10	12	12	14	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Yugoslavia Fed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Discards	ATL	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
				Gabon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**0**
				UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		MED	CP	EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOP	TOTAL				630	791	703	2196	481	177	868	1207	1012	923	736	581	217	32	1047	533	449	287	377	681	662	952	2239	805	560	126	171	105	220	146
		ATL			378	615	588	2064	254	47	651	1062	858	786	713	573	215	32	875	426	442	273	335	657	641	939	1161	743	522	104	119	63	193	99
		MED			252	176	115	132	227	130	217	145	154	137	23	8	2	0	172	107	6	14	42	24	21	13	1078	62	38	22	52	43	27	47
	Landings	ATL		All gears	378	615	588	2064	254	47	651	1062	858	786	713	573	215	32	875	426	442	273	335	657	641	939	1161	743	522	104	119	63	193	99
		MED		All gears	252	176	115	132	227	130	217	145	154	137	23	8	2	0	172	107	6	14	42	24	21	13	1078	62	38	22	52	43	27	47
		ATL	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	5	3	1	2	11	21	7	1	2	0	0	0	0	0	1	1	1	0
				Maroc	348	598	524	2003	246	28	626	1048	830	780	706	503	132	0	634	391	273	199	213	642	555	867	1113	665	450	38	53	62	169	91
				Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				Senegal	29	16	63	60	5	18	24	14	28	6	7	70	78	29	240	33	158	53	115	14	84	72	48	78	72	66	66	0	23	8
			NCO	Benin	1	1	1	1	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		MED	CP	Algerie	198	153	92	119	224	128	216	135	145	128	0	0	0	0	0	0	0	0	9	7	3	3	2	2	1	0	1	0	0	4
				EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				Libya	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
				Maroc	14	23	23	13	3	2	1	10	9	9	20	7	1	0	172	107	6	14	30	15	16	8	8	33	3	8	6	35	11	1
				Tunisie	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	2	2	2	2	1068	27	33	14	45	7	17	43

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BRS	TOTAL	ATL		8049	7161	7006	8435	8004	7923	5754	4785	4553	7750	5137	3410	3712	3587	2253	3305	2681	1590	1055	613	853	698	389	1124	1032	1010	1118	773	707	991
	Landings		All gears	8049	7161	7006	8435	8004	7923	5754	4785	4553	7750	5137	3410	3712	3587	2253	3305	2681	1590	1055	613	853	698	389	1124	1032	1010	1118	773	707	991
		CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
			Brazil	842	1149	1308	3047	2125	1516	1516	988	251	3071	2881	814	471	1432	563	1521	1042	0	3	0	6	2	1	1	1	1	135	0	0	3
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Grenada	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Trinidad and Tobago	2130	2130	1816	1568	1699	2130	1328	1722	2207	2472	1867	2103	2720	1778	1414	1472	1498	1498	936	489	695	695	0	695	695	695	695	695	695	695
			Venezuela	5077	3882	3882	3609	3609	3651	1766	1766	1766	1766	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	29	29	0	0	0	0	**0**
			Guyana	0	0	0	211	571	625	1143	308	329	441	389	494	521	377	277	312	141	92	116	124	151	0	387	399	308	313	0	0	0	**0**
			Suriname	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	288	78	12	293
CER	TOTAL	ATL		450	490	429	280	251	251	1	4	6	1	2	1	1	1	0	0	0	0	2	0	0	1	1	0	1	1	1	0	0	0
	Landings		All gears	450	490	429	280	251	251	1	4	6	1	2	1	1	1	0	0	0	0	2	0	0	1	1	0	1	1	1	0	0	0
		CP	EU-France	400	400	400	250	250	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Grenada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			St Vincent and Grenadines	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
			Dominican Republic	50	90	29	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Jamaica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	0	0	0	0	0	0	0	3	5	1	2	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
COM	TOTAL	MED		770	688	1081	1398	1032	1164	1110	1007	1166	1941	1769	1634	1033	1101	1622	1861	1932	1670	987	645	540	752	828	1089	1183	1192	880	68	135	71
	Landings		All gears	770	688	1081	1398	1032	1164	1110	1007	1166	1941	1769	1634	1033	1101	1622	1861	1932	1670	987	645	540	752	828	1089	1183	1192	880	68	135	71
		CP	Algerie	471	418	506	277	357	511	475	405	350	597	839	609	575	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Egypt	299	270	530	1071	594	576	562	548	778	1301	903	986	426	1087	1564	1810	1689	1578	939	494	478	658	699	895	1019	1017	696	0	0	**0**
		NCO	Israel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	47	39	134	42	42	42	45	42	42	42	0	0	
			Lebanon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	49	67	52	69	59	0	0	
			NEI (MED)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Palestine	0	0	45	50	81	77	73	54	38	43	27	39	32	14	58	51	154	45	9	17	20	43	38	82	70	64	83	68	135	71
FRI	TOTAL	ATL		16797	13332	11816	13871	13980	14332	10589	8680	10151	5742	6096	8832	6154	8429	9789	7861	12384	14215	15471	18287	17597	17149	17074	21814	15703	17755	18397	18119	20669	16288
	Landings		All gears	3004	5300	5617	6631	9004	9531	4992	3054	4506	3893	3095	5086	2933	5918	6019	5296	8237	8633	10515	9735	11829	10941	11523	14056	11325	12523	13337	13235	17446	11769
	Landings(FP)			13793	8031	6200	7240	4976	4801	5597	5627	5646	1849	3001	3746	3221	2511	3770	2565	4147	5582	4956	8552	5768	6208	5410	7758	4299	5172	5032	4881	3214	4505
	Discards			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	141	0	78	60	27	3	9	14
	Landings	CP	Angola	4	6	21	29	12	31	2	38	38	38	0	0	0	0	95	0	63	19	59	39	22	47	2	1	0	0	0	0	0	**0**
			Belize	0	0	0	0	0	33	0	115	87	0	0	0	0	0	0	0	0	0	0	0	0	36	266	824	586	552	655	585	144	87
			Brazil	608	906	558	527	215	162	166	106	98	1117	860	414	532	603	202	149	313	204	347	259	227	293	308	271	445	282	109	272	100	69
			Cape Verde	115	86	13	6	22	191	154	81	171	278	264	344	300	318	378	574	1312	711	853	1811	2461	5418	3556	2324	1795	4988	2236	2282	3649	1276
			Curaçao	0	0	0	590	1157	1030	1159	1134	1006	713	507	497	0	150	106	485	364	0	235	238	481	1456	1151	1124	1576	1414	750	1071	1263	249
			Côte d'Ivoire	0	0	0	0	0	3	0	1	821	2	31	1356	4	354	541	14	813	161	297	38	2837	261	141	311	81	2	89	178	105	2
			EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	362	297	386	947	581	570	23	17	722	438	635	34	166	73	278	631	1094	950	877	1708	1234	1200	1682	2537	1608	1033	1129	926	1274	1381
			EU-Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	63	105	126	161	159	146	0	91	128	95	160	168	47	6	98	24	24	91	147	249	233	147	247	410	773	715	637	296	319	726
			EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8
			EU-Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	169	528	0	0	3529	272	253	163
			EU-Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	150	90	0	164	5	85	119	6	90	45	233	13	6	0	8
			EU-Portugal	0	0	0	0	1	31	5	9	28	5	4	7	212	3	250	13	0	0	0	0	0	0	1	2	3	1	3	0	1	1
			EU-Rumania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	435	793	895	1157	1071	960	964	52
			Gabon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	**0**
			Ghana	0	0	0	0	0	33	221	118	39	31	0	3	0	2577	2134	1496	2786	3604	2295	2469	2382	0	0	0	0	0	0	0	0	**0**
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	26	0	0	0	0	0	0	0	0	0	0	**0**
			Grenada	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	74	81	78	48	63	0	26	0	71	63	311	249	155	178	**0**
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	1	3	2	2	1
			Guinée Rep	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	96	94	332	503	236	0	0	0	0	0	0	0	**0**
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	1	**0**
			Maroc	306	190	707	716	2717	2315	764	629	486	591	236	696	227	52	135	179	9	19	862	554	55	21	90	125	200	3	93	492	209	166
			Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	269	169	377	492	1420	1953	661	101	211	806	996	311	362	394	1025	1005	2223

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Panama	118	341	328	240	91	0	0	0	0	0	0	394	975	970	1349	411	439	425	339	463	504	905	292	1356	1572	707	743	941	849	**0**
			Russian Federation	150	405	456	46	500	2433	477	12	25	308	56	56	63	6	6	12	113	270	912	113	217	139	249	545	389	430	305	753	153	115
			S Tomé e Príncipe	33	37	48	79	223	197	209	200	200	200	200	234	215	290	0	275	149	153	298	307	315	324	636	536	467	14	482	521	546	461
			Senegal	342	319	309	0	101	0	7	0	4	0	13	288	151	83	119	383	15	217	201	341	16	22	1407	1133	391	249	807	2498	6337	4774
			St Vincent and Grenadines	0	0	0	0	17	65	0	0	208	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Trinidad and Tobago	17	0	56	199	368	127	138	245	0	0	0	414	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
			USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	886	2609	2601	3083	2839	2164	1631	210	444	34	113	182	42	165	52	48	54	215	508	85	150	71	64	70	115	67	26	0	92	6
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	14	8	11	0	0	0	0	**0**
		NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Benin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Germany Democratic Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (ETRO)	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Ukraine	0	0	0	0	0	0	36	48	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Landings(FP)	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	154	71	86	78	107	0	0	0	0	0	0	0	**0**
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	144	84	200	189	188	428	130	271	256	268	745	537	163	238	183	191	0	**0**
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	29	55	29	36	225	233	139	214	149	224	0	0	0	0	0	0	326	**0**
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	177	81	236	0	0	0	0	0	0	0	**0**
			EU-España	8426	3990	3903	4495	3449	3154	3762	3385	3580	1074	1942	2450	1327	1423	2585	1685	2636	3117	3023	5770	2792	3289	1533	1753	1351	1069	1192	900	1154	1522
			EU-France	5367	4041	2297	2745	1527	1648	1836	2242	2066	775	1059	1296	1138	644	612	222	684	1214	815	1183	1466	1486	855	1046	468	886	864	731	1301	1227
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	303
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	142	75	69	99	53	105	25	150	42	65	0	0	0	0	0	0	131	804
			Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	168	0	24	37	0	174	518	542	672	441	0	0	0	0	0	0	0	**0**
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	274	230	251	297	261	157	230	158	234	92	0	0	0	0	0	0	303	648
		NCO	Mixed flags (EU tropical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2277	4422	2317	2979	2793	3060	0	
	Discards	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	141	0	78	60	26	3	9	13
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			Gabon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**0**
KGM	TOTAL	ATL		16331	14777	14930	17782	19815	16394	17717	16342	15408	17258	15863	12830	11766	8252	17936	7344	7826	11697	10452	10151	9712	11039	9913	10838	11257	11844	10058	14660	8788	8730
	Landings		All gears	16331	14777	14930	17782	19815	16394	17717	16342	15408	17258	15863	12830	11766	8252	17936	7344	7826	11697	10452	10151	9712	11039	9913	10838	11257	11844	10058	14660	8788	8730
	Discards			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Landings	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139	914	0	0	0	0	0	0	0	**0**
			Brazil	1380	1365	1328	2890	2398	3595	3595	2344	1251	2316	3311	247	202	316	33	0	0	1	1	0	0	0	0	0	0	0	190	305	550	56
			Grenada	0	0	0	2	4	28	14	9	4	5	0	0	0	0	0	0	0	0	0	0	0	0	13	4	5	4	18	11	2	
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	0	0	0	**0**
			Mexico	3289	3097	3214	4661	4661	3583	4121	3688	4200	4453	4369	4564	3447	4201	3526	3113	3186	3040	3130	3090	3335	3019	3281	3130	3233	3825	3231	2505	1821	1003
			Namibia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
			St Vincent and Grenadines	0	0	0	0	0	0	0	137	0	0	0	0	0	67	0	0	7	9	0	0	0	0	0	0	0	0	0	0	0	**0**
			Trinidad and Tobago	1192	0	471	1029	875	746	447	432	410	1457	802	578	747	661	567	1043	1001	1001	720	393	495	496	1	494	494	494	494	494	494	494
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	4
			USA	9616	7831	7360	7058	8720	7373	6453	6780	6603	6061	6991	7129	7123	2837	13482	3013	3541	7584	6523	6573	5641	6607	6257	6891	7325	7368	5910	10809	5618	6812
			Venezuela	801	2484	2558	2140	2139	340	2424	2424	2424	2424	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	2	2	4	5	0	1	0	1	**0**
			Guyana	0	0	0	0	270	440	398	214	239	267	390	312	245	168	326	174	91	59	75	90	99	0	358	314	192	143	1	0	0	**0**
			Suriname	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	212	534	301	330
		NCO	Antigua and Barbuda	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominica	0	0	0	0	0	0	36	35	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Dominican Republic	52	0	0	0	589	288	230	226	226	226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Jamaica	0	0	0	0	155	0	0	44	48	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
			Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
			Sta Lucia	0	0	0	1	4	0	0	9	1	1	0	1	1	1	2	0	1	3	4	1	1	0	0	0	0	0	0	0	0	1
	Discards	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
KGX	TOTAL	A+M		301	368	367	744	0	0	0	48	0	0	0	0	0	0	0	0	0	0	3	0	0	0	13	8	12	33	0	28	0	
	Landings		All gears	301	368	367	744	0	0	0	48	0	0	0	0	0	0	0	0	0	0	3	0	0	0	13	8	12	33	0	28	0	
		CP	Barbados	55	36	42	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	13	8	12	33	0	28	0	**0**
		NCO	Colombia	21	148	111	539	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Puerto Rico	84	86	134	106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Sta Lucia	141	98	80	50	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
LTA	TOTAL			13130	14399	12276	11569	14405	15719	12283	15319	16943	16723	17010	16357	11915	10128	18384	14213	17127	23080	25347	20865	21643	14224	24030	28885	29485	27020	25536	22340	18683	26842
		ATL		11872	13202	10381	9453	12804	12804	9407	11830	13955	14080	16327	14918	10873	8320	16472	11954	14170	20910	21679	16679	17010	10619	17456	19097	14338	19134	15793	14994	13390	17731
		MED		1258	1197	1894	2116	1601	2914	2876	3489	2988	2643	684	1439	1042	1808	1911	2259	2957	2170	3668	4186	4633	3605	6574	9788	15147	7886	9743	7346	5293	9111
	Landings	ATL	All gears	10321	10906	9655	8779	11910	11732	8672	10258	11566	13476	14961	13352	10172	7417	13962	10137	12137	17433	17511	13060	13260	7968	10965	12248	10753	15848	11984	12026	11523	16145
		MED		1258	1197	1894	2116	1601	2914	2876	3489	2988	2643	684	1439	1042	1808	1911	2259	2957	2170	3668	4186	4633	3605	6574	9788	15147	7886	9743	7346	5293	9110
	Landings(FP)	ATL		1551	2296	726	675	894	1073	735	1571	2389	604	1366	1566	702	903	2510	1817	2033	3477	4168	3619	3751	2651	6287	6849	3478	3221	3740	2967	1833	1577
	Discards	ATL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	204	0	107	64	69	1	35	8
		MED		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Landings	ATL CP	Angola	175	121	117	235	75	406	118	132	132	132	0	0	2	0	4365	0	128	1759	3455	1905	1085	10	6	1	4	3	0	6	7	**0**
			Brazil	985	1225	1059	834	507	920	930	615	615	615	0	320	280	0	0	0	0	0	22	581	0	0	0	0	0	34	0	113	38	1047
			Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Cape Verde	17	23	72	63	86	110	776	491	178	262	143	137	81	123	292	250	357	185	102	131	131	131	131	218	113	105	59	82	135	51
			Curaçao	0	0	0	0	0	0	0	0	0	5	9	0	0	0	0	0	0	38	38	76	57	0	0	0	0	0	3	2	105	20
			Côte d'Ivoire	339	251	253	250	155	136	9	123	1	0	0	153	287	427	2159	1791	1446	1631	50	1062	1433	152	102	111	1881	7583	2441	1815	1917	1293
			EU-España	0	0	10	55	27	110	6	2	22	8	1	489	50	16	0	38	35	136	168	71	52	112	381	477	185	148	89	10	11	255
			EU-Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	8	54	59	22	215	21	698	631	610	613	14	10	27	12	0	1	50	35	5	30	27	6	36	73	359	268	263	156	492	962
			EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	69	8	0	18	1	9	0	0	0	0	0	0	0	0	**0**
			EU-Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	45	72	72	218	320	171	14	50	0	2	16	19	21	24	43	10	6	5	14	4	18	0	0	7	31	35	43	3	6	23
			EU-Rumania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	15	31
			Gabon	0	0	0	182	0	18	159	301	213	57	173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Ghana	359	994	513	113	2025	359	306	707	730	4768	8541	7060	5738	783	1335	745	1692	1465	1001	1274	1138	0	0	0	0	0	0	0	0	**0**
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	15	23	38	0	0	0	0	0	0	0	0	0	**0**
			Grenada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	15	45	88	38	50	**0**
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	10	11	10	11	1
			Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	631
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	673	256	176	101	78	151	212	2	70	1	19	0
			Maroc	52	43	230	588	195	189	67	101	87	308	76	91	33	0	40	2	63	5	57	10	11	3	0	11	12	0	0	0	0	**0**
			Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	670	423	943	1222	3549	4878	1634	252	529	1287	2478	774	901	984	2558	2462	5548
			Panama	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	**0**
			Russian Federation	265	189	96	49	0	88	0	0	0	74	13	0	0	0	0	0	0	268	11	208	399	255	136	547	433	698	478	1742	304	232
			S Tomé e Príncipe	41	40	43	40	50	39	37	33	33	33	33	178	182	179	0	183	188	193	198	203	209	214	182	122	249	11	87	6	71	35
			Senegal	4724	4536	3613	1972	4174	4715	1607	3546	5176	2866	4394	3508	2699	3826	3885	5108	5683	6371	4910	2769	5912	3774	5065	4855	3841	3672	4757	3100	3718	791
			South Africa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			St Vincent and Grenadines	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	27	33	0	**0**
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	5	6	6	7	6	5	4	2	1	5	4	5	7	5	5	4	3	4	5	6	3	3	4	2	1	1	2	3	5	1
			UK-Sta Helena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	1286	1142	1312	2230	2015	1546	1623	1209	1451	1366	1492	1382	765	1351	1401	963	1244	1772	1875	2797	2333	2661	3537	3019	2577	2286	2580	2346	2146	5225
			USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	1889	2115	2115	1840	1840	2815	2247	2247	2247	2254	50	0	0	0	0	30	4	2	8	4	1	4	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	16	54	48	0	0	0	0	**0**

					1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Benin	53	60	58	58	196	83	69	69	69	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Cuba	13	15	27	23	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	
				Germany Democratic Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Israel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				NEI (ETRO)	0	20	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Sta Lucia	0	0	0	0	2	2	2	0	1	10	1	0	0	1	0	0	0	0	0	0	1	0	2	0	1	0	1	0	0	
		MED	CP	Algerie	495	459	552	554	448	384	562	494	407	148	0	158	116	187	96	142	119	131	98	6	157	341	204	268	444	298	242	233	195	792
				EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Croatia	2	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	28	25	44	37	43	31	19	42	34	31	31	49
				EU-Cyprus	11	23	10	19	19	19	16	19	19	19	0	0	0	0	6	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-España	0	0	15	18	9	15	0	8	82	32	0	41	262	116	202	212	86	299	488	441	235	300	456	384	486	289	640	493	413	578
				EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	42	0	0	0	1	0	0	0	4	7	9	12
				EU-Greece	0	0	0	0	0	0	0	195	125	132	0	0	112	69	72	183	148	165	301	276	363	289	271	501	299	489	635	955	408	644
				EU-Italy	0	0	0	0	0	0	0	0	0	16	24	38	34	203	224	486	1100	365	304	669	557	442	0	992	930	1032	1513	1204	803	767
				EU-Malta	0	0	0	0	0	0	0	0	0	1	1	1	1	3	2	5	3	7	5	21	9	4	7	1	6	6	7	3	2	6
				Egypt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	849	712	0	0	0	1003	0	0	0	0
				Libya	0	0	0	0	45	52	0	5	4	4	0	0	0	0	0	0	0	0	0	0	0	0	102	1100	48	80	65	55	30	25
				Maroc	0	0	1	0	1	14	8	0	0	3	1	0	9	0	331	19	24	1	0	0	0	0	0	3	0	0	0	0	0	0
				Syria	161	156	155	270	350	417	390	370	370	330	0	0	0	0	193	133	163	148	155	304	229	0	0	0	0	0	0	0	0	0
				Tunisie	242	204	696	824	333	1113	752	1453	1036	960	657	633	0	0	0	0	0	0	810	800	803	798	5165	6323	12434	4032	6152	4024	2940	5827
				Türkiye	0	0	0	0	0	500	750	750	750	750	0	568	507	1230	785	1074	1309	1046	1437	1645	1386	682	326	184	480	617	450	341	463	410
			NCO	Israel	119	119	215	119	119	119	119	119	119	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				NEI (MED)	200	200	200	200	200	200	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Palestine	0	0	0	90	59	61	60	60	60	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Serbia & Montenegro	28	21	35	22	18	20	18	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Yugoslavia Fed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Landings(FP)	ATL	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	223	51	238	144	133	0	0	0	0	0	0	0	0
				Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	45	76	265	214	189	262	266	179	438	178	850	458	128	146	132	109	0	0
				Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	39	42	50	160	185	167	209	284	284	0	0	0	0	0	0	426	0
				Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	162	56	12	0	0	0	0	0	0	0	0
				EU-España	707	1127	454	284	353	295	194	751	1197	209	656	508	206	213	1253	944	1181	1320	2067	1105	732	1182	1968	1885	1244	781	1102	831	329	752
				EU-France	844	1169	272	391	540	777	541	821	1192	396	710	1058	367	205	262	122	241	901	1061	675	693	565	870	732	296	470	493	273	510	399
				El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
				Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	35	178	92	118	17	121	43	126	145	64	0	0	0	0	0	0	171	213
				Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	15	0	21	2	0	358	260	666	1186	202	0	0	0	0	0	0	0	0
				Panama	0	0	0	0	0	0	0	0	0	0	0	0	35	191	577	368	228	106	250	259	72	30	0	0	0	0	0	0	396	200
			NCO	Mixed flags (EU tropical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2598	3774	1810	1825	2013	1753	0	
	Discards	ATL	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	204	0	107	64	69	1	35	8
				EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		MED	CP	EU-Croatia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MAW	TOTAL	ATL			1723	1278	1953	2910	1475	1496	971	1321	881	1393	646	352	480	571	847	616	684	2384	1333	1128	3016	1460	1242	1489	1286	7066	1810	839	2823	986
	Landings			All gears	1723	1278	1953	2910	1475	1496	971	1321	881	1393	646	352	480	571	847	616	684	2384	1333	1128	3016	1460	1242	1489	1286	7066	1804	839	2823	986
	Discards				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	
	Landings		CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	1650	249	221	1247	0	3	1	2	1	0	1	2	0
				Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	2	0	66	0	0	1	0	0	0	90	35	47	76	122	5827	601	305	392	312
				EU-Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Lithuania	0	0	0	0	0	0	0	0	0	298	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	10	0	0	0	0	0	0	0	0	0	0	0
				Gabon	0	140	145	79	60	85	61	102	53	48	82	67	37	87	93	17	22	30	34	46	42	13	37	21	56	87	137	42	195	191
				Ghana	466	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	207	319	176	203	275	193	152	110	434	493	524	164	191	79	206	2042	381
				Russian Federation	19	0	0	0	0	14	0	0	0	0	15	0	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
				S Tomé e Príncipe	5	6	6	8	7	8	5	6	6	6	6	21	12	13	0	91	93	96	98	100	102	105	13	11	72	0	26	107	38	34
				Senegal	1019	938	1614	2635	1046	878	700	987	617	794	532	262	431	196	435	329	278	331	749	610	1426	870	649	856	870	961	961	178	154	68
				USSR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

					1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			NCO	Benin	214	194	188	188	362	511	205	205	205	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Germany Democratic Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Ukraine	0	0	0	0	0	0	0	21	0	42	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Discards		CP	Gabon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
SSM	TOTAL	ATL			16317	14490	13697	16571	15403	8877	9837	8220	8383	9414	9793	8119	10472	6308	6118	5900	6199	11788	10916	10156	12684	7798	7741	8669	8332	4332	12651	16691	11763	11530
	Landings	ATL		All gears	16317	14490	13697	16571	15403	8877	9837	8220	8383	9414	9793	8119	10472	6308	6118	5900	6199	11788	10916	10156	12684	7798	7741	8669	8332	4332	12651	16691	11763	11530
			CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
				EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	3	14	18	11	16	6	4	0	0	0	0
				EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	1	26	16	0	2	20	7	2	0	0	0	1	0	0	0	0	0	0
				Gabon	0	0	0	0	0	0	0	0	0	265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Grenada	1	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
				Mexico	10066	8300	7673	11050	11050	5483	6431	4168	3701	4350	5242	3641	5723	3856	3955	4155	4251	4128	4026	3321	3581	3857	4077	3820	3701	4321	3870	2968	2157	1535
				Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				USA	5143	4380	3363	2866	3509	2968	3282	3893	4524	4613	4552	4477	4747	2425	2147	1746	1946	7639	6871	6829	9089	3922	3652	4825	4611	6	8778	13722	9605	9994
			NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	11	0	0	0	0	0
			NCO	Colombia	58	69	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Cuba	310	409	548	613	613	236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Dominica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Dominican Republic	739	1330	2042	2042	231	191	125	158	158	158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Jamaica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
				Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
				Sta Lucia	0	0	0	0	0	0	0	0	1	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WAH	TOTAL	ATL			2671	2143	2408	2516	3104	2497	2972	2035	2318	2226	2067	2613	2467	1829	2581	2176	2354	2381	2844	3729	5235	3526	2554	17320	6881	6482	4894	8542	3218	4375
	Landings			All gears	2671	2143	2408	2516	3104	2497	2972	2035	2318	2226	2067	2613	2110	1650	2296	1604	1883	2111	2367	3541	5128	3440	2548	17320	6866	6467	4887	8541	3217	4372
	Landings(FP)				0	0	0	0	0	0	0	0	0	0	0	0	357	179	285	572	471	269	477	85	0	0	0	0	0	0	0	0	0	0
	Discards				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	108	86	6	0	14	15	6	2	1	2
	Landings		CP	Barbados	91	82	42	35	52	52	41	41	0	0	34	45	26	41	36	27	17	30	29	22	21	17	10	11	10	7	9	7	5	11
				Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	29	27	34	23	33
				Brazil	33	26	1	16	58	41	0	0	0	0	405	519	449	111	75	76	70	19	357	213	477	153	312	404	322	150	23	57	21	30
				Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Cape Verde	326	361	408	503	603	429	587	487	578	500	343	458	449	555	524	351	472	470	470	445	445	445	445	490	228	298	293	196	151	117
				Curaçao	270	250	230	230	230	230	230	230	230	230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	16	3	1	11	0	5	5	12	9	95	1	25	1	1	1	61	62	19	0
				EU-España	22	20	15	25	25	29	28	32	38	46	48	305	237	110	66	38	73	53	87	35	50	41	50	59	51	79	61	53	45	54
				EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	46	45	38	159	61	79	58	61	51
				EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	4	3	9	8	10	2	0	0	0	0	0	0	3	0	0
				El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Grenada	96	46	49	56	56	59	82	51	71	59	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	18	15	
				Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	14	21	9	0	11	13	9	8	5
				Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	6	14	12	9
				Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
				Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	0	0	0	0	0	0	0	0	0	0	0	0
				Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	263	48	1591	46	122	13678	4271	4975	2707	7035	2026	603
				Mexico	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	16	12	18	15	12	14	15	11	9
				Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	91	240	120	86	111	99	210	373	228	0	109	0	77	123	111	50	107
				S Tomé e Príncipe	36	39	46	80	52	56	62	52	52	52	52	94	88	76	0	131	235	241	247	254	260	266	100	70	172	1	157	8	102	60
				Senegal	64	0	0	1	0	0	5	0	0	0	5	0	1	1	0	0	2	6	0	11	24	0	3	7	0	0	0	0	23	89
				South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				St Vincent and Grenadines	41	28	16	23	10	65	52	46	311	17	40	60	0	241	29	24	31	40	31	5	32	24	9	11	126	82	27	30	0	16
				Trinidad and Tobago	0	0	0	0	1	1	1	2	1	9	7	6	6	7	6	6	5	5	7	9	9	9	9	10	8	7	6	6	5	7
				UK-Bermuda	58	50	93	99	105	108	104	61	56	91	87	88	83	86	124	117	101	81	100	88	75	76	86	95	92	68	82	60	67	76
				UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	4	1	1	0	0	0	0	0	1	3
				UK-Sta Helena	35	26	25	23	19	10	15	15	22	25	18	17	11	20	13	18	29	19	31	12	16	16	10	15	16	9	5	5	6	5
				UK-Turks and Caicos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				USA	827	391	764	608	750	614	858	640	633	846	789	712	558	89	1123	495	522	653	584	999	460	1027	1153	2060	1204	530	974	633	455	2959
				Venezuela	514	542	540	487	488	360	467	4	17	13	9	7	16	13	33	9	25	28	23	38	32	27	30	64	51	45	46	40	31	56

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1132	1012	810	0	0	0	0	0	0	0	0
		Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	5	4	2	3	1	1	0
		Guyana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	NCO	Antigua and Barbuda	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Aruba	50	125	40	50	50	50	50	50	50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Benin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Dominica	59	59	58	58	58	58	50	46	11	37	10	6	8	15	14	16	10	13	13	0	0	20	10	10	6	3	10	5	0	
		Dominican Republic	7	0	0	0	325	112	31	35	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Jamaica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Saint Kitts and Nevis	0	0	0	0	0	0	0	0	0	0	7	6	7	0	0	0	0	0	0	0	0	0	6	9	14	13	0	9	0	
		Sta Lucia	141	98	80	221	223	223	310	243	213	217	169	238	169	187	0	171	195	199	0	0	148	155	87	147	110	0	127	70	77	71
Landings(FP)	CP	Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	40	0	0	0	0	0	0	0	0	0	0	0
		Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	92	9	55	60	22	29	25	4	0	0	0	0	0	0	0	0	0	0
		Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	13	7	31	57	23	78	9	0	0	0	0	0	0	0	0	0	0
		Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
		EU-España	0	0	0	0	0	0	0	0	0	0	0	0	92	63	44	224	262	136	240	56	0	0	0	0	0	0	0	0	0	0
		EU-France	0	0	0	0	0	0	0	0	0	0	0	0	28	10	3	16	26	26	17	0	0	0	0	0	0	0	0	0	0	0
		Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	68	11	21	28	7	0	8	0	0	0	0	0	0	0	0	0	0	0
		Guinée Rep	0	0	0	0	0	0	0	0	0	0	0	0	10	0	8	15	7	0	0	0	0	0	0	0	0	0	0	0	0	0
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	39	44	104	102	65	13	66	15	0	0	0	0	0	0	0	0	0	0
	NCO	Mixed flags (EU tropical)	0	0	0	0	0	0	0	0	0	0	0	0	28	30	44	97	26	39	0	0	0	0	0	0	0	0	0	0	0	
Discards	CP	EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	14	15	6	2	1	2
		Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		UK-British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	108	86	0	0	0	0	0	0	0	0

SMT-Table 2. Three 3 color classification indicating the missing parameters by species and areas. Grey squares represent the area where the species does not occur or is not exploited.

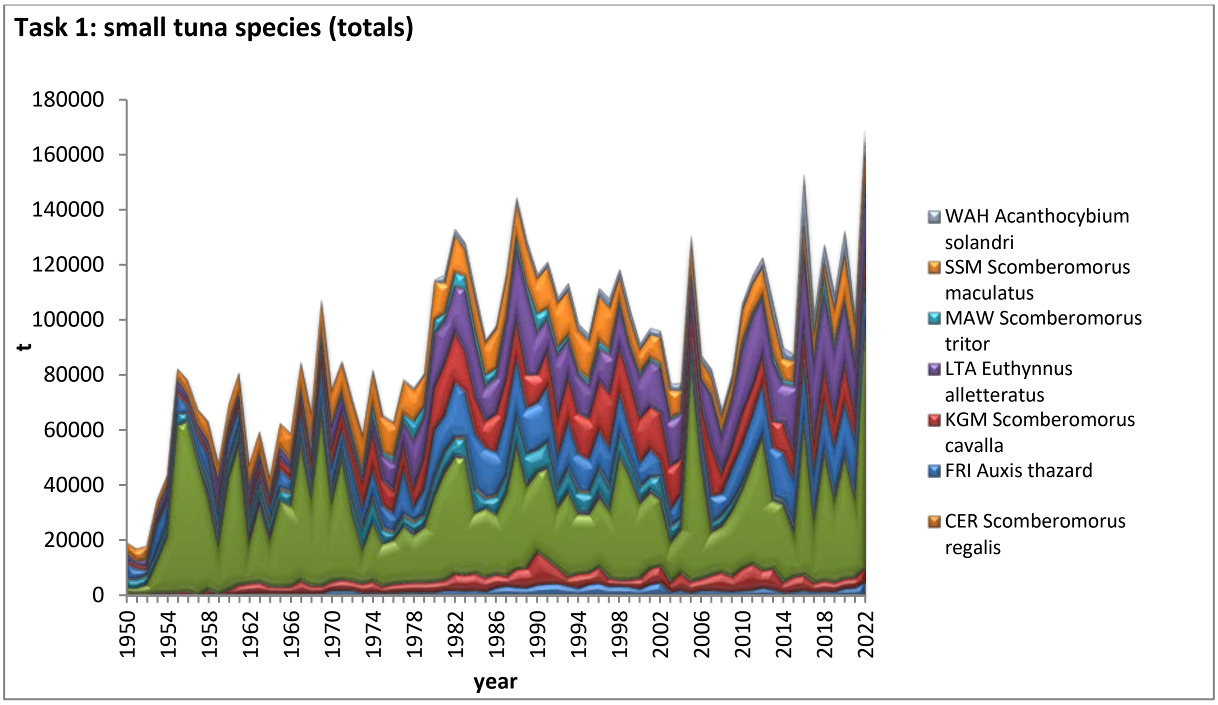
Species code	Areas				
	MEDI	**NE**	**SE**	**NW**	**SW**
BLF	out of range	out of range	out of range	Miss Tmax, T50 and Fmb	Miss Tmax, T50 and Fmb
BLT	Have all	miss L50, T50 and Fmb	miss a,b, Lmax Fmb	Miss all	Miss all
FRI	Miss all	Miss everything except Lmax and a,b,	Miss Lmax, L50, T50 and Fmb, a e b	Miss all	miss: Linf, K, t0, Tmax, T50, L50, Fmb
LTA	Have all	Miss T50, fmb	Miss all	Miss Fmb and T50	miss: Lmax, Linf, K, t0, Tmax, T50, L50, Fmb
BON	Have all	Miss T50, fmb	Miss all	Miss all	miss: Lmax, Linf, K, t0, Tmax, T50, L50, Fmb
BOP	Miss Fmb	miss: Linf, K, t0, Tmax, T50, L50, Fmb, a e b	Miss all	out of range	out of range
WAH	out of range	nf, K, t0, Tmax,	Miss all	Have all	miss: Linf, K, t0, Tmax, T50
BRS	out of range	out of range	out of range	Miss Fmb	Miss Fmb and T50
KGM	out of range	out of range	out of range	Have all	Miss Fmb
SSM	out of range	out of range	out of range	Miss Fmb	Miss all
CER	out of range	out of range	out of range	miss: Linf, K, t0, Tmax, T50, Fmb	Miss all
MAW	Miss all	miss: t0, Tmax, T50, Fmb	Miss all except Lmax	out of range	out of range
DOL	Miss Lmax, T50 and Fmb	Miss all except a and b	Miss all except Linf and k	Miss Lmax, T50 and Fmb	Miss L50, a,b, max, T50 and Fmb

SMT-Table 3. Summary of the current state of knowledge on the current stock status for small tunas in the Atlantic Ocean and the Mediterranean. Results taken from Pons *et al.*, 2019a. Red indicates values below reference levels (overfished) and green above reference values (not overfished).

Data limited Assessments							
	Last year assessed	Length based			Catch based		Catch+Length
		LBSPR	LIME	LBSPR	DBSRA	SSS	LIME
		Pons *et al.* (2019a)		Baibbat *et al.* (2019)	Pons *et al.* (2019b)		
		SPR	SPR		B/BMSY	B/BMSY	B/BMSY
LTA_SE	2014-2016	0.13	0.27	--	0.69	0.94	1.83
BON_NE	2014-2016	0.23	0.71	0.34	1.63	1.98	2.02
WAH_NW	2014-2016	0.37	0.29	--	1.02	1.34	0.86
WAH_NE	2014-2016	0.55	0.38	--	--	--	--
BON_Med	2014-2016	0.59	0.22	--	--	--	--
LTA_Med	2014-2016	0.66	0.62	--	1.88	2.33	1.08
LTA_NW	2014-2016	0.66	0.48	--	--	--	--
FRI_SE	2014-2016	0.79	0.53	--	1.79	2.65	1.10
FRI_NE	2014-2016	0.83	0.46	--	1.64	2.50	1.29
LTA_NE	2014-2016	0.90	1.00	--	--	--	--

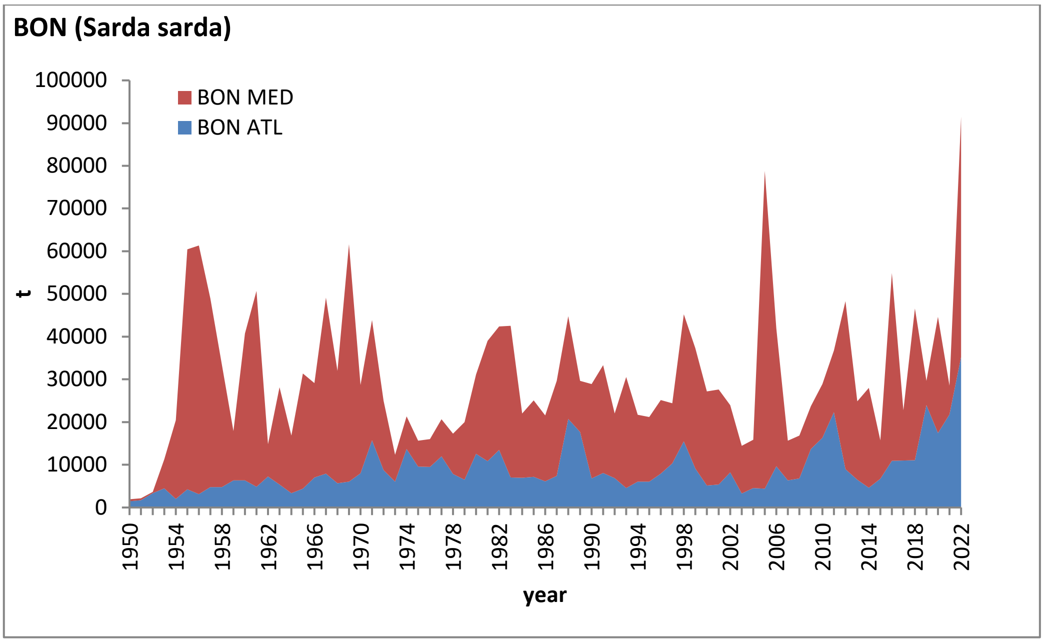
SMT-Table 4. Summary of the Northwest Atlantic wahoo management strategy evaluation results for selected MPs using the DLMtool package (Mourato *et al.*, 2019). Color cells coding is used to denote if the particular MP falls within acceptable performance metric criteria (green – acceptable and red – not satisfied). Probability of not overfishing (**PNOF**; $F<F_{MSY}$); probability of spawning biomass being higher than half of spawning biomass at maximum sustainable yield (**P50**; $SB>0.5\ SB_{MSY}$); probability of spawning biomass being higher than spawning biomass at maximum sustainable yield (**P100**; $SB>SB_{MSY}$);probability of average annual variability in yield being lower than 20% (**AAVY**; Prob. AAVY < 20%); probability of average yield being higher than half of reference yield (**LTY**; Prob. Yield > 0.5 Ref. yield). Acceptable management procedures were defined as those that supported **PNOF**>70%, **P50**>90%, **P100**>70%, **AAVY**>50% and **LTY**>50%.

Management Procedures	PNOF	P50	P100	AAVY	LTY
Length-based methods					
LBSPR	0.74	0.93	0.65	0.120	0.86
minlenLopt1	0.75	0.95	0.72	0.110	0.83
matlenlim	0.75	0.96	0.74	0.095	0.81
Catch-based methods					
AvC	0.70	0.95	0.76	0.630	0.78
CC1	0.71	0.95	0.76	0.640	0.76
SPMSY	0.81	0.98	0.86	0.110	0.43
DBSRA	0.61	0.98	0.81	0.450	0.74
Fishing effort control methods					
curE	0.75	0.93	0.66	0.130	0.85
curE75	0.87	0.97	0.78	0.150	0.80

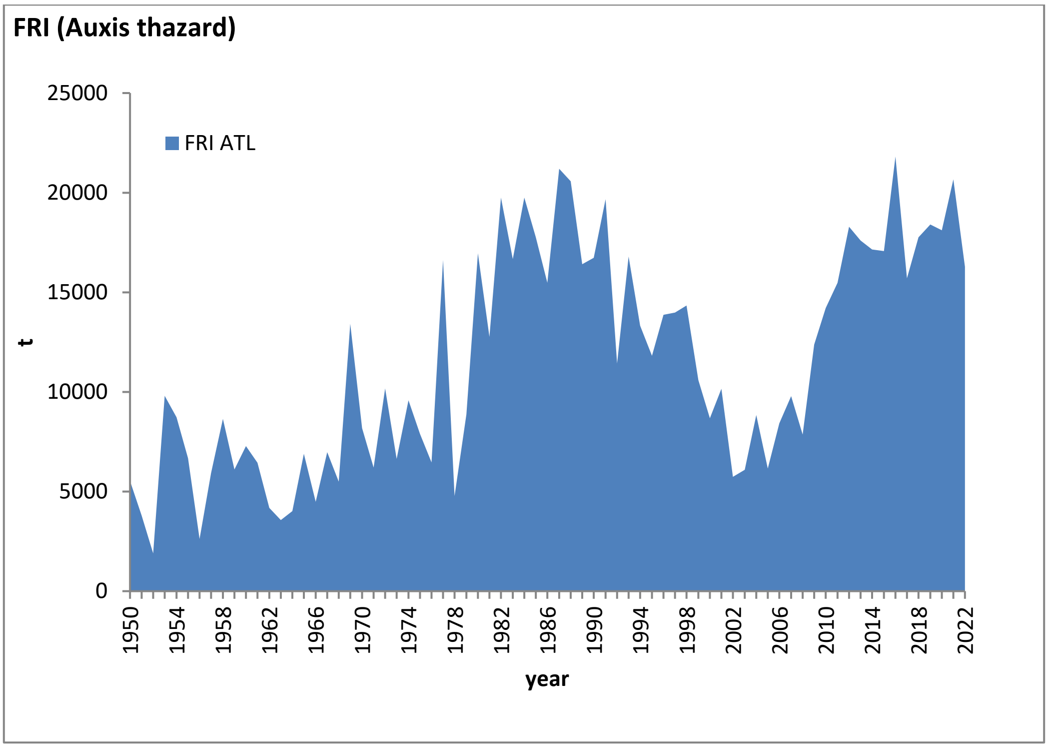


SMT-Figure 1. Estimated landings (t) of small tunas (combined) in the Atlantic and Mediterranean, 1950-2022. The data for the last three years are incomplete.

a)

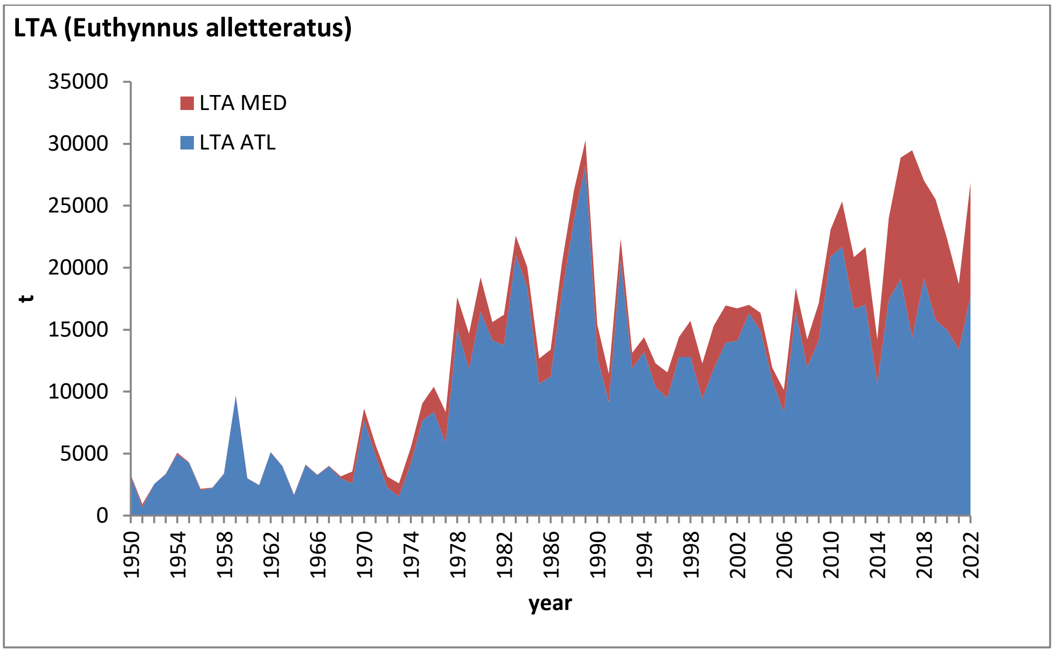


b)

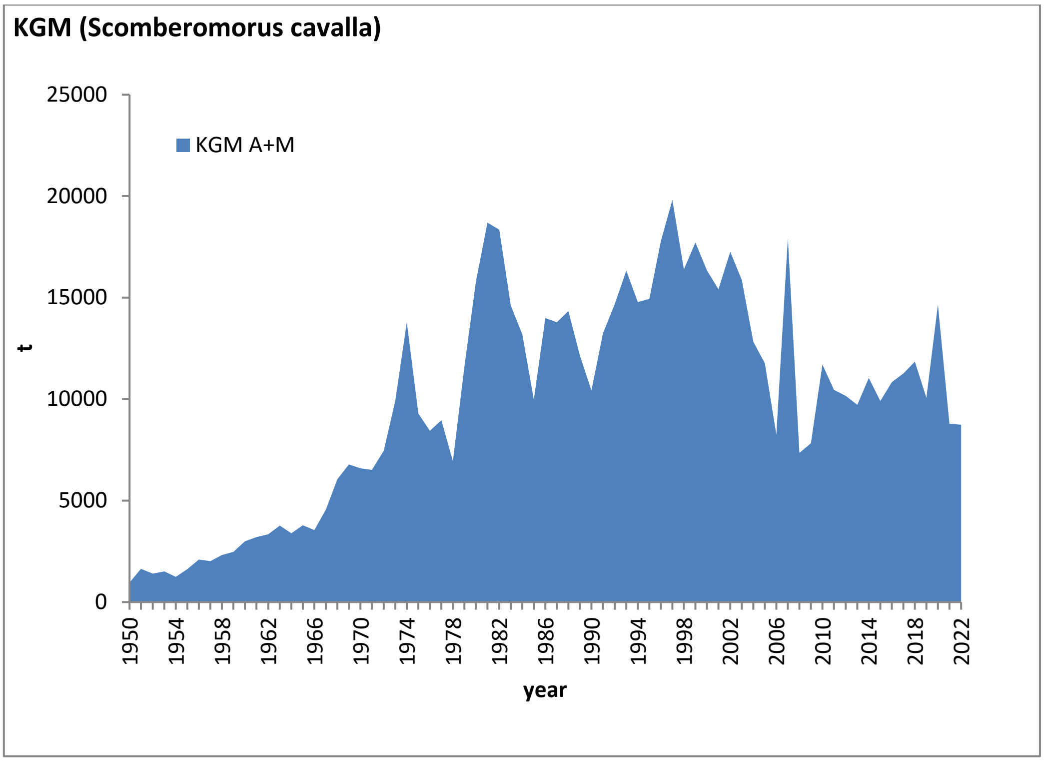


SMT-Figure 2. Estimated landings (t) of the major species of small tunas in the Atlantic and Mediterranean, 1950-2022. The data for the last years are incomplete.

c)

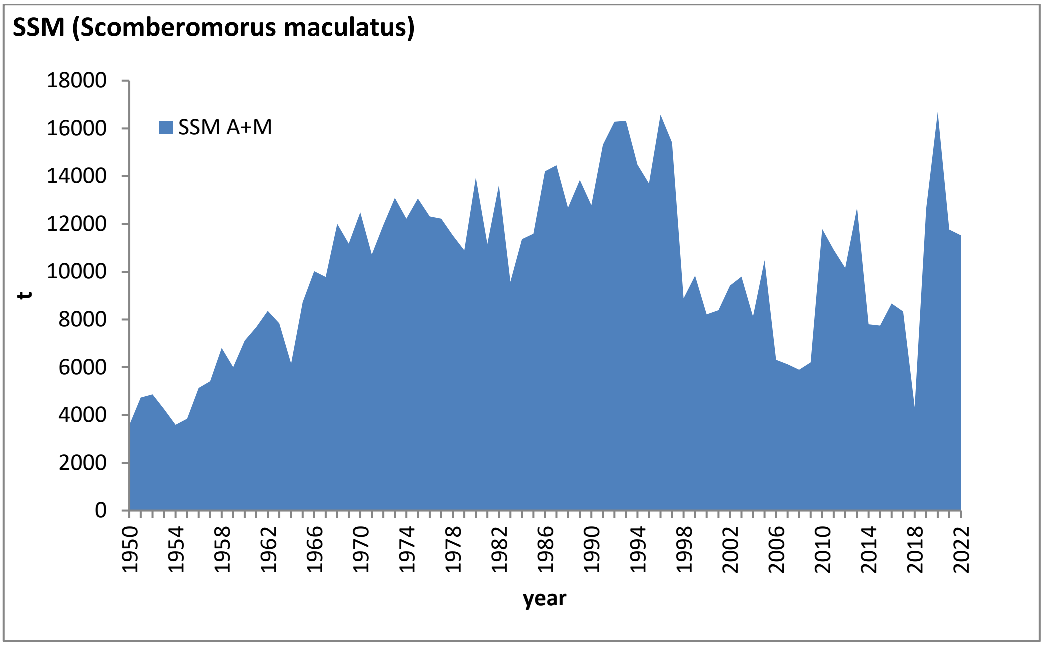


d)

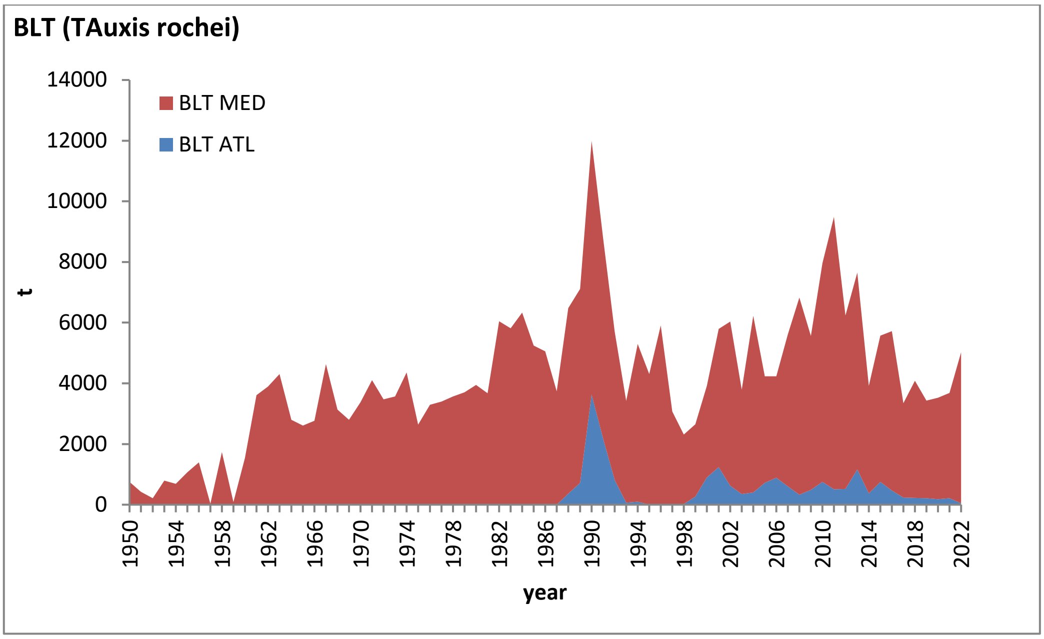


SMT-Figure 2. Estimated landings (t) of the major species of small tunas in the Atlantic and Mediterranean, 1950-2022. The data for the last years are incomplete.

e)

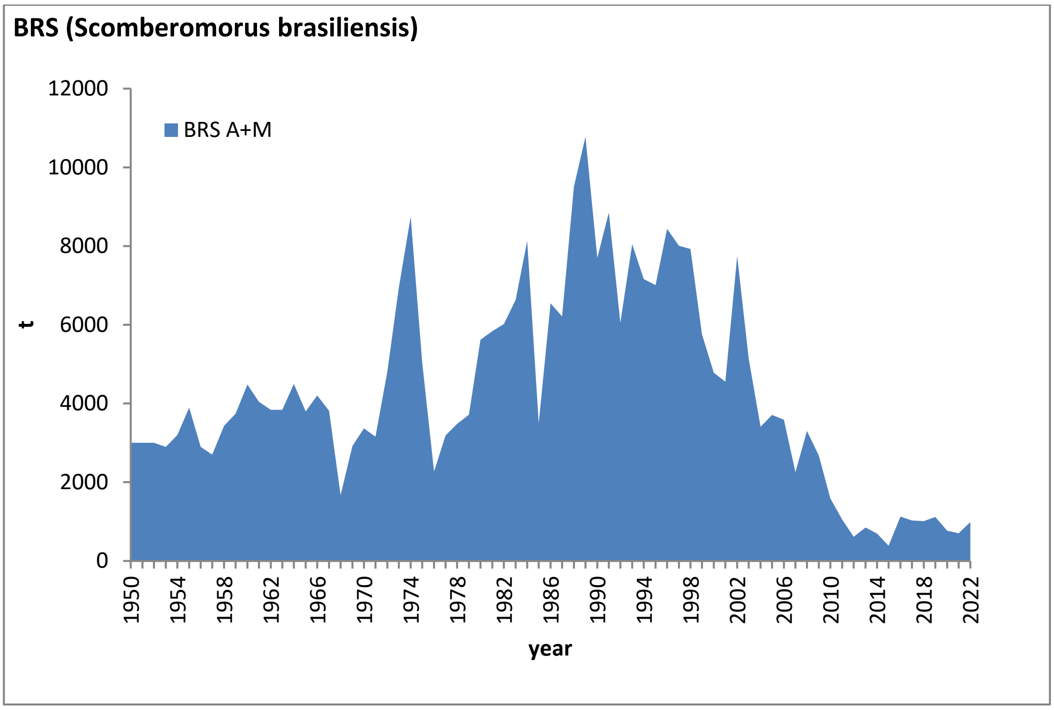


f)

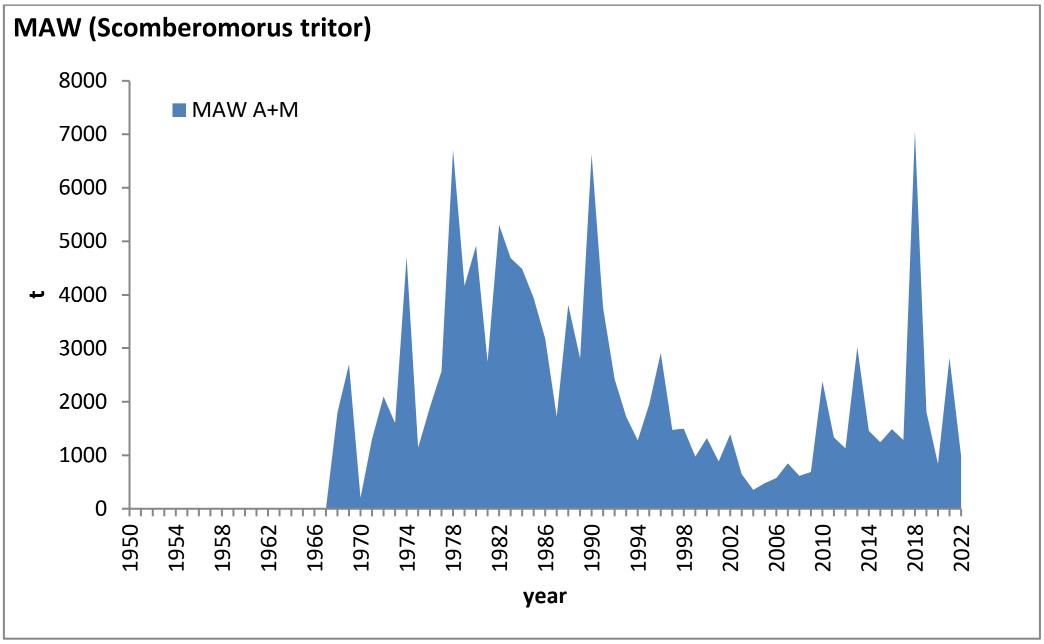


SMT-Figure 2. Estimated landings (t) of the major species of small tunas in the Atlantic and Mediterranean, 1950-2022. The data for the last years are incomplete.

g)

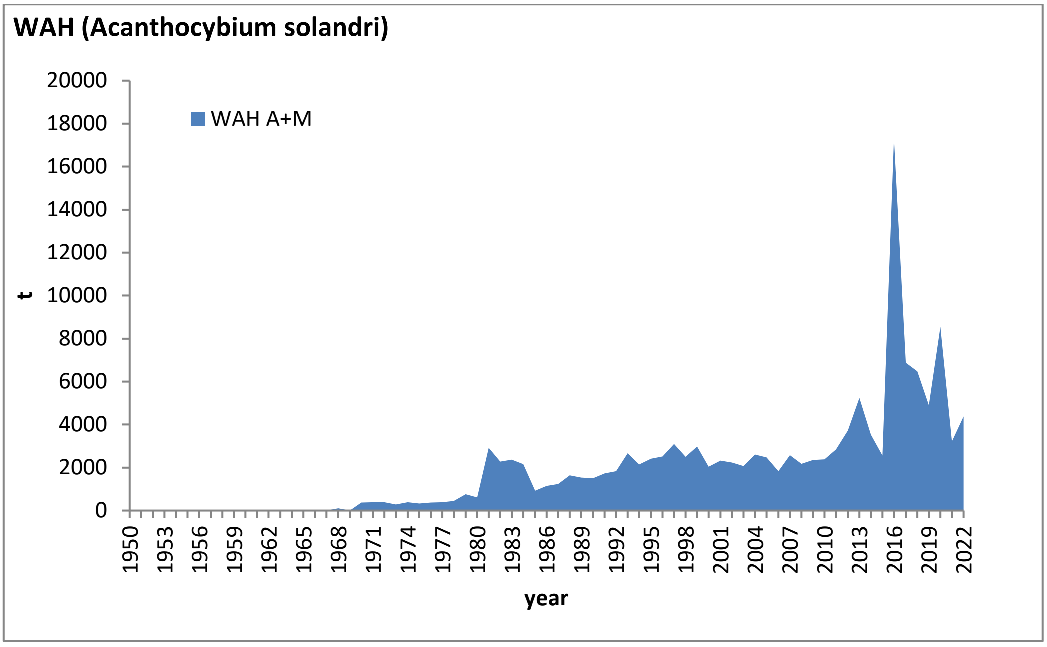


h)

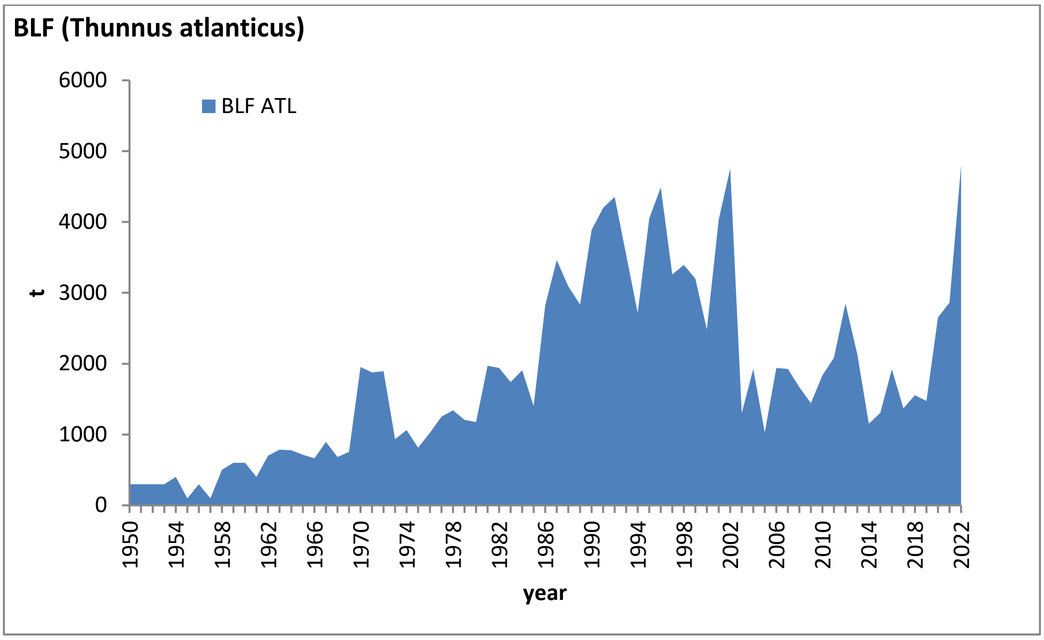


SMT-Figure 2. Estimated landings (t) of the major species of small tunas in the Atlantic and Mediterranean, 1950-2022. The data for the last years are incomplete.

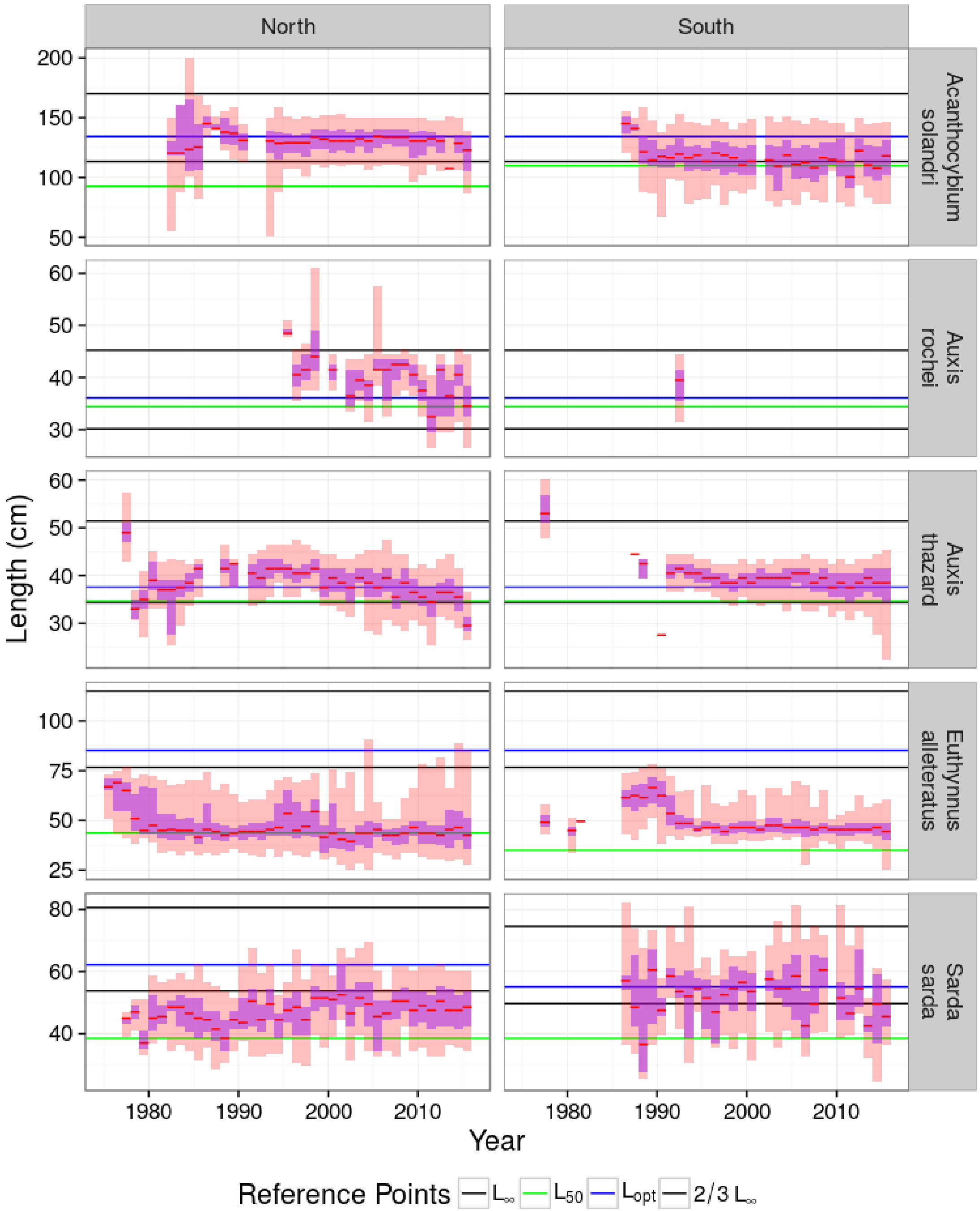
i)



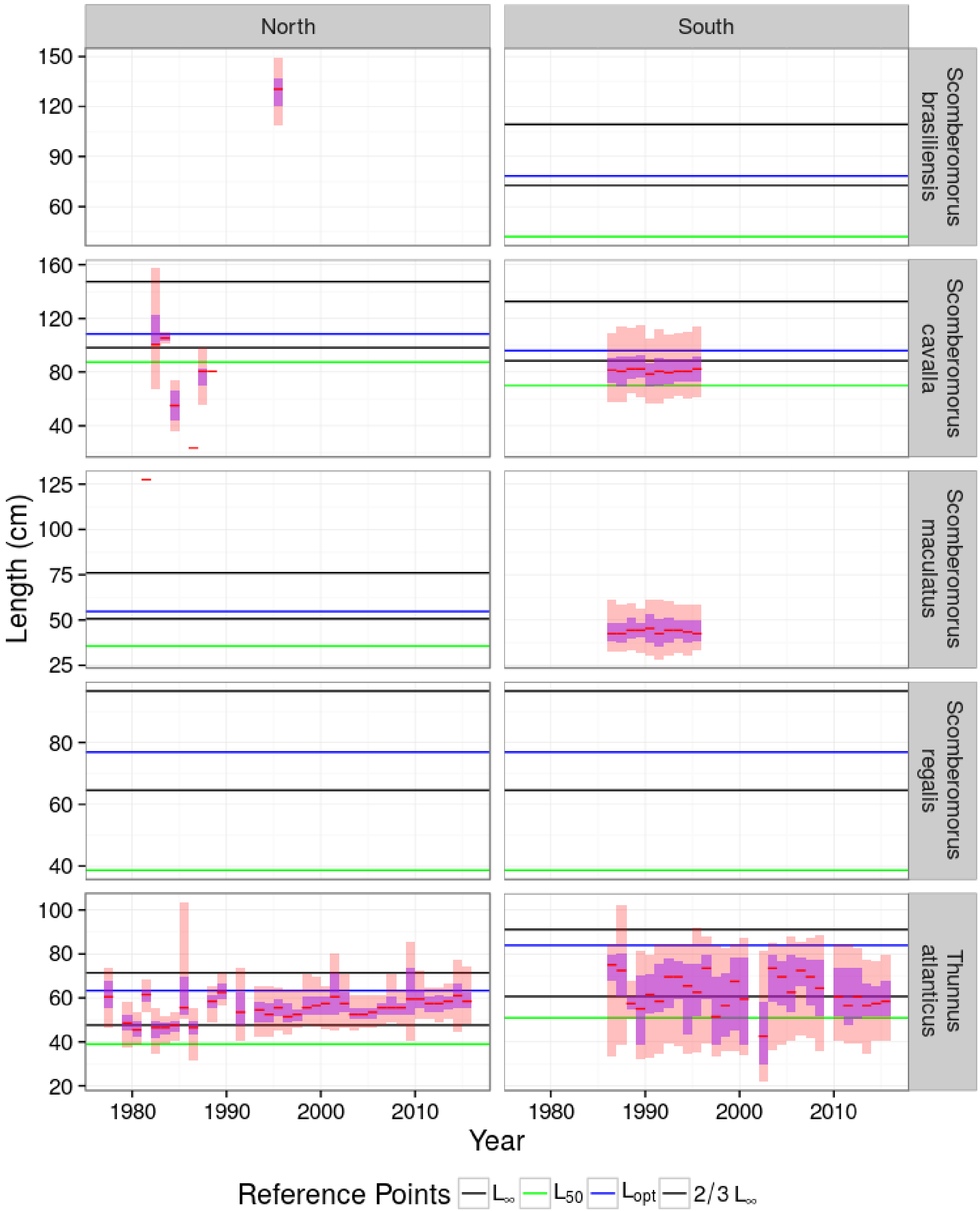
j)



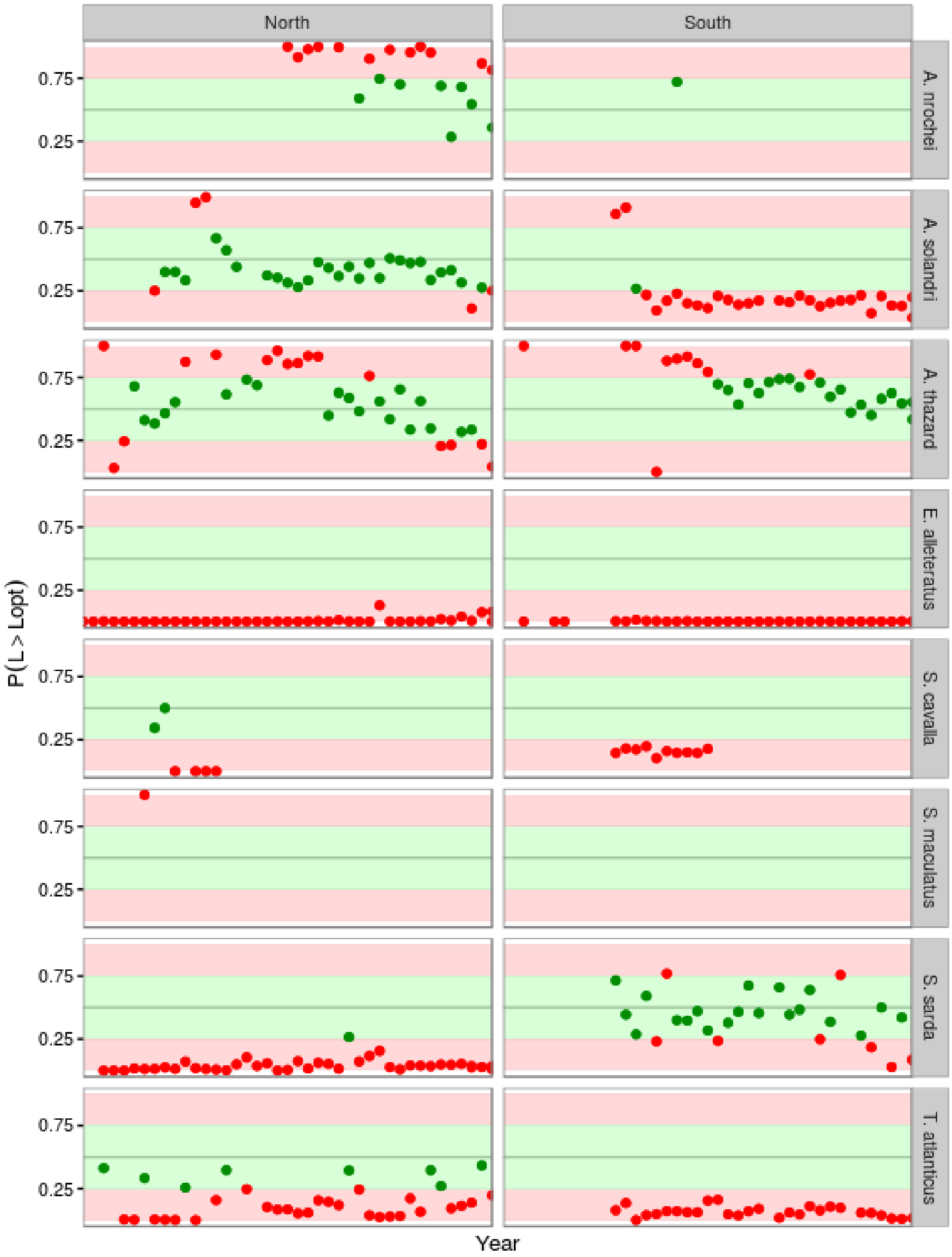
SMT-Figure 2. Estimated landings (t) of the major species of small tunas in the Atlantic and Mediterranean, 1950-2022. The data for the last years are incomplete.



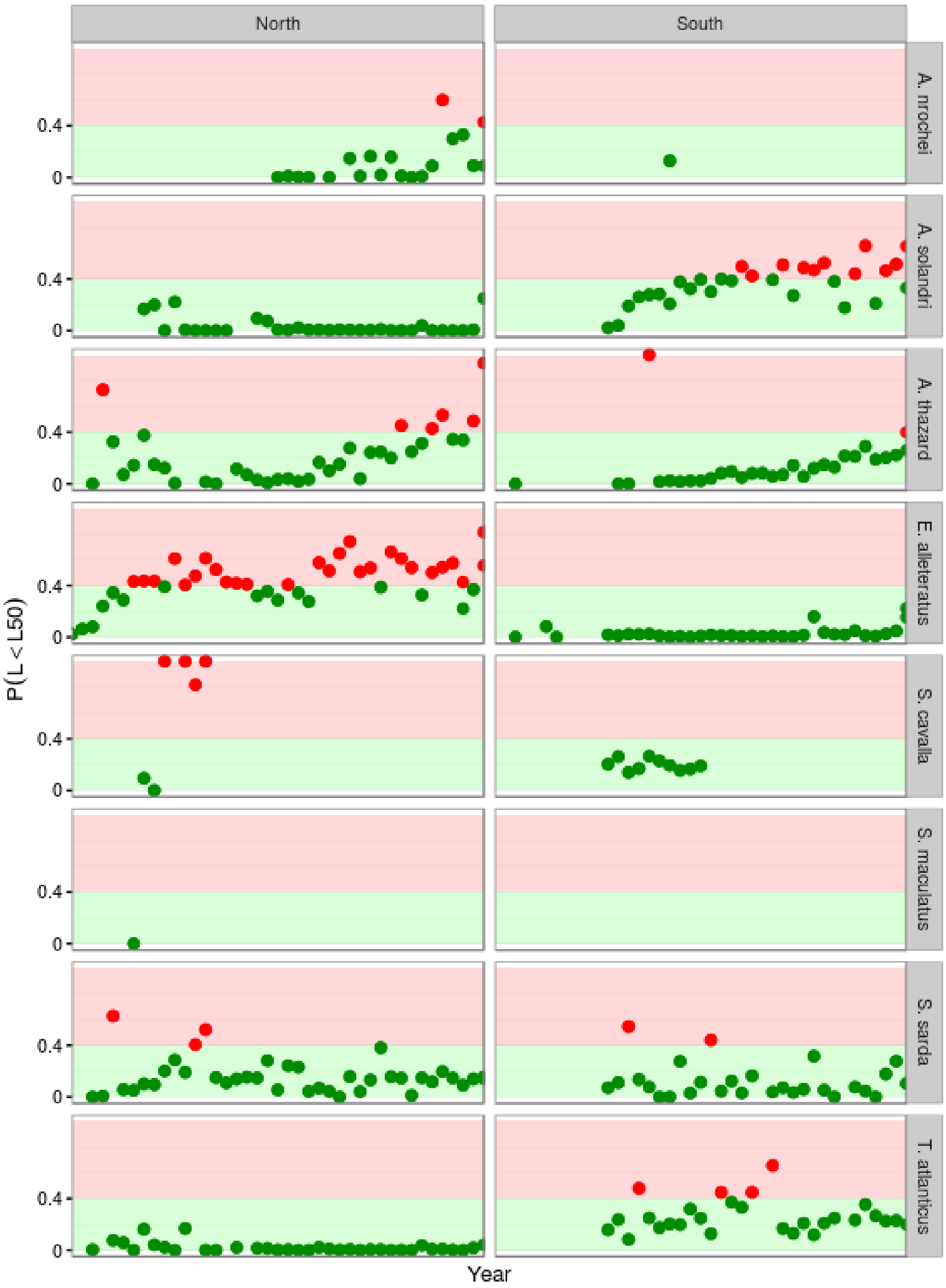
SMT-Figure 3a. Length distributions and reference points by species and Atlantic region for version 4 of Task 2 size data. The horizontal lines show the reference points i.e. asymptotic length (L_∞), length at 50% mature (L_{50}) and two estimates of the size at which a cohort reaches its maximum biomass (L_{OPT}) and its proxy (2/3~L_∞). The bars show the length distributions, i.e. median, interquartiles (5%, 95%).



SMT-Figure 3b. Length distributions and reference points by species and Atlantic region for version 4 of Task 2 size data. The horizontal lines show the reference points i.e. asymtopic length (L_∞)), length at 50% mature (L_{50}) and two estimates of the size at which a cohort reaches its maximum biomass (L_{OPT}) and its proxy ($2/3 \sim L_\infty$). The bars show the length distributions, i.e. median, interquartiles (5%, 95%).



SMT-Figure 4a. Proportion of length distributions greater than LOPT by species and Atlantic region. 50% is used as a target reference point and so catches where the proportions of individuals greater than LOPT is >25% and <75% are coloured green.



SMT-Figure 4b. Proportion of length distributions less than L_{50} by species and Atlantic region; 40% is used as a limit reference point and so when the proportion of individuals less than L_{50} is >40% is coloured red.

9.15 BSH - Blue shark

A stock assessment for blue shark (*Prionace glauca*) was conducted for both Atlantic stocks in 2023 through a process that included the Blue Shark Data Preparatory Meeting (hybrid/Olhão, Portugal, 17-21 April 2023) and the Blue Shark Stock Assessment Meeting (hybrid/Madrid, Spain, 17-21 July 2023). The complete description of the stock assessment process and the development of management advice is found in the Report of the 2023 Blue Shark Data Preparatory Meeting (Anon., 2023c) and the Report of the 2023 Blue Shark Stock Assessment Meeting (Anon., 2023d). The previous Blue Shark Stock Assessment Session was held in Lisbon, Portugal, 27-31 July 2015 (Anon., 2016a).

BSH-1. Biology

Blue shark is a large pelagic shark that shows a wide geographic distribution in all oceans, from tropical to temperate waters worldwide, between 62º N and 54º S. It is distributed mainly in waters with temperatures ranging between 12ºC and 20ºC, although it can be found in a greater temperature range. Temperature preference is related to size and sex, and relative abundance decreases in equatorial waters and increases with latitude.

The blue shark is placental viviparous and has an average litter size of 35 individuals. Although high uncertainty regarding their biology remains, available life history traits (slow growth, late maturity and small litter size compared to teleosts) indicate that they are vulnerable to overfishing. A behavioral characteristic of this species is their tendency to segregate temporally and spatially by size and/or sex, during feeding, mating-reproduction, gestation and birth processes.

Tagging studies have suggested that they exhibit large-scale migratory behaviour and periodic vertical movement, but the lack of information on some components of the populations precludes a complete understanding of their distribution/migration pattern by ontogenetic stage and in some cases identifying their pupping/mating grounds. Although being one of the most well-know species, numerous aspects of its biology (such as natural mortality or steepness) are still poorly understood, particularly for some regions, which contributes to increased uncertainty in quantitative and qualitative assessments.

BSH-2. Fishery indicators

Reviews of the shark database resulted in recommendations to improve data reporting on shark catches. While reported and estimated catches for blue shark are still generally subject to higher levels of uncertainty than the major tuna stocks, they have been considered sufficiently complete for the purpose of stock assessment.

Due to the broad geographical distribution of blue shark in the Atlantic Ocean, in coastal and off-shore areas, this species is available to a large number of fisheries (mainly longline) and fishing countries. Total estimate catches of blue shark for the North and South Atlantic stocks are presented in **BSH-Table 1** and **BSH-Figure 1**. For the 2015 blue shark stock assessment, a reconstruction process of historical catches of blue shark was done by expert scientists from each CPC, using the most appropriate methodology for each case. Considerable differences between reported and reconstructed catches were noted for years prior to 2000 for the northern stock and prior to 2010 for the southern stock. After the years 2000 and 2010 for the northern and southern stocks, respectively, the reconstructed time series matches the reported Task 1 time series reasonably well. The reconstructed time series is still considered the best available estimations of catches for the northern and southern stocks. The Committee agreed during the 2023 blue shark stock assessment to submit those estimates for approval at the Subcommittee of Statistics for the inclusion in the official Task 1 nominal catch data.

Catches of both stocks of blue shark have had an increasing trend since early 1970s (**BSH-Figure 1**). Peak of reported catches for the North Atlantic corresponds to year 2016, with 44,085 t, and for the South Atlantic corresponds to year 2019, with 37,317 t (**BSH-Table 1**). The more recent reported catches in the North have decreased, while captures in the South have increased. Reported catches of blue shark in the Mediterranean still remain scarce, with a peak of 737 t in 2016 (**BSH-Table 1**). The Committee encourages CPCs fishing in the Mediterranean to submit their blue shark data.

Multiple standardized CPUE data series for blue shark were presented and evaluated during the 2023 Data Preparatory Meeting. For the North Atlantic stock eight indices of abundance were used (EU-Spain, EU-Portugal, Japan, Morocco, Venezuela, United States early and late, and Chinese Taipei), and six for the South (EU-Spain, Japan time blocks 1 and 2, a combined Brazil and Uruguay index, time blocks 1 and 2, and Chinese Taipei) (**BSH-Figure 2**).

BSH-3. State of the stocks

The 2023 blue shark stock assessment was conducted for the northern and southern Atlantic stocks only.

The 2023 blue shark stock assessment was conducted using two modeling approaches, Just Another Bayesian Biomass Assessment (JABBA), and integrated statistical assessment model, Stock Synthesis (SS3). Different model formulations considered to be plausible representations of the stock dynamics were used to characterize stock status. A more detailed description of the assessment is contained in the Report of the 2023 Blue Shark Stock Assessment Meeting (Anon., 2023d).

The Committee acknowledged the progress made for the 2023 blue shark assessment, with the improvements on the implementation of SS3 for the North stock, and the implementation for the first time for the South stock.

North Atlantic blue shark

Based on the combined results from the two stock assessment model platforms (SS3 and JABBA), the North Atlantic blue shark stock in 2021 was at the B_{MSY} level (B_{2021}/B_{MSY} = 1.00, with 95% confidence interval: 0.75-1.31) and was not experiencing overfishing (F_{2021}/F_{MSY} = 0.70, with a 95% confidence interval: 0.50-0.93) (**BSH-Figure 3**). The estimated joint MSY was 32,689 t (the geometric mean of both models, with a 95% confidence interval range of 30,403-36,465 t).

The joint Kobe phase plot indicates that there is a 49.6% probability that the stock currently falls within the yellow quadrant (overfished but not subject to overfishing), a 49.7% probability that the stock falls within the green quadrant (not overfished not subject to overfishing), and less than a 1% chance that it is in the red (overfished and subject to overfishing) or orange quadrants (not overfished but subject to overfishing) (**BSH-Figure 4**).

South Atlantic blue shark

Based on the combined results from the two stock assessment model platforms (SS3 and JABBA), the South Atlantic blue shark stock in 2021 was not overfished (B_{2021}/B_{MSY} = 1.29, with 95% confidence interval: 0.89-1.81) but is undergoing overfishing (F_{2021}/F_{MSY} = 1.03 with 95% confidence interval: 0.45 – 1.55) (**BSH-Figure 5**). The combined joint MSY was 27,711 t (geometric mean of both models, with 95% confidence interval range of 23,128 – 47,758 t).

The joint Kobe phase plot indicates that there is a 46.5% probability that the stock currently falls within the orange quadrant (not overfished but subject to overfishing), a 44.7% probability that the stock falls within the green quadrant (not overfished not subject to overfishing), and 8.02% probability of being in the red quadrant (overfished and subject to overfishing), with less than 1% chance that it is in the yellow quadrant (overfished but not subject to overfishing) (**BSH-Figure 6**).

BSH-4. Outlook

Based on the results obtained during the 2023 stock assessment, the Committee agreed to conduct stochastic stock status projections based on both the selected JABBA and SS3 Reference cases for both North and South Atlantic blue shark stocks, giving equal weighting to each model platform.

As the official reported blue shark Task 1 nominal catches for 2022 were not available at the time of the stock assessment meeting, the Committee agreed to use the average mean catch value of 2019-2021 in Task 1 nominal catches as the best estimate of the 2022 and 2023 expected catches. The estimated value for catches in 2022 and 2023 for the North Atlantic stock was 23,418 t and for the southern stock it was 34,983 t. These values were reviewed with the official catch reports at the species group meeting in September 2023 to evaluate if the catch assumptions for 2022 for both stock projections need further refinement. As estimated values for both stocks were above, but not much, the reported captures, the Committee considered that there was no need to modify projections.

North Atlantic blue shark

Projections were conducted for a range of fixed catches for the period 2024 to 2033. Eleven catch scenarios were applied, starting in a zero-catch scenario, and in intervals of 2,500 t from 20,000 t to 40,000 t, also including the estimated combined MSY level 32,689 t (**BSH-Table 2**). Additional information on projection settings is described in the Report of the 2023 Blue Shark Stock Assessment Meeting (Anon., 2023d).

The annual trends of the relative B/B_{MSY} and F/F_{MSY} stochastic projections of the current combined stock status for North Atlantic blue shark stock are presented in **BSH-Figure 7**. Projections indicated that future constant catches at or above 35,000 t would result in fishing mortality above F_{MSY}.

There is a transition period in the projections (2025-2029) where, the stock's probability of being in the green quadrant will decline and then will begin increasing (**BSH-Table 2**). This transition period may reflect the age structure and recent predicted average recruitment trends.

South Atlantic blue shark

Projections were conducted for a range of fixed catches for the period 2024 to 2033. Ten catch scenarios were applied, starting in a zero-catch scenario, and in intervals of 2,500 t from 15,000 t to 32,500 t, also including the estimated combined MSY level 27,711 t **BSH-Table 3**. Additional information on projection settings is described in the Report of the 2023 Blue Shark Stock Assessment Meeting (Anon., 2023d).

The annual trends of the relative B/B_{MSY} and F/F_{MSY} stochastic projections of the current combined stock status for South Atlantic blue shark stock are presented in **BSH-Figure 8**. If current catch levels (average of 2019-2021) of about 35,000 t are maintained, the stock is expected to rapidly decline in biomass, with a risk of falling below 20% of the estimated B_{MSY} reference level in a few years (**BSH-Table 4**).

BSH-5. Effect of current regulations

For the northern stock, Rec. 19-07 was adopted in 2019 with an annual TAC of 39,102 t. It set annual catch limit for certain CPCs (EU 32,578 t, Japan 4,010 t, Morocco 1,644 t). Other CPCs were requested to not exceed recent catch levels. This Recommendation was amended by Rec. 21-10, with no modifications to the TAC. The Committee noted that the catches have been below the TAC since Rec. 19-07 was implemented.

For the South Atlantic stock of blue shark, the Commission adopted Rec. 19-08, which in paragraph 2 established a catch limit of 28,923 t (based on the average of the final five years, 2009-2013, used in the 2015 assessment). This Recommendation was updated by Rec. 21-11, with no modifications to the TAC. The Committee noted that it appears that since the implementation of a TAC for the North Atlantic stock, since 2018 catches have increased in the South Atlantic (**BSH-Figure 1**). Since 2018, reported catches for the South Atlantic stock have been over the TAC set by Rec. 19-08, with average catches of 32,969 t for the period 2020-2022.

BSH-6. Management recommendations

While the 2022 realized catch (22,057 t) for the North Atlantic stock will maintain the stock in the green quadrant of the Kobe plot with a high probability, the Committee noted that the current TAC (39,102 t) would have a very low probability (3%) of maintaining the stock in the same quadrant by 2033. Therefore, the Committee recommends that the Commission reduces the current TAC to catch levels that will maintain the stock in the green quadrant of the Kobe plot with a high probability (see **BSH-Table 2**).

The 2021 South Atlantic blue shark stock status was estimated not to be overfished but undergoing overfishing. Recent catches (2019-2021; 34,983 t mean catch) are above the highest catch scenario used in the Kobe 2 Strategy Matrix and are not sustainable in the long term. Constant catches of 32,500 t (the highest constant catch scenario in the Kobe matrix) only have a 28% probability of being in the green Kobe quadrant by 2033. The Committee indicates that catches of 27,711t (the estimated 2021 MSY) or less will immediately stop overfishing and will keep in stock in the green quadrant of the Kobe plot with at least a 54% probability (**BSH-Table 3**).

NORTH ATLANTIC BLUE SHARK SUMMARY

Current Yield (2022)		22,057 t[1]
Maximum Sustainable Yield (MSY)		32,689 t (30,403 - 36,465 t)[2]
Relative Biomass	B_{2021}/B_{MSY}	1.00 (0.75 - 1.30)[3]
Relative Fishing Mortality	F_{2021}/F_{MSY}	0.70 (0.50 - 0.93)[4]
Stock Status (2021)	Overfished	No
	Overfishing[5]	No
Management Measures in Effect:		Rec. 19-07 Rec. 21-10

[1] Task 1 catch.
[2] Geometric mean of both models, SS3 and JABBA, with a 95% confidence interval.
[3] Median from SS3 and JABBA, with a 95% confidence interval.
[4] Combined result of SS3 multi-variate lognormal iterations and JABBA posterior. Median and 95% confidence interval in brackets.
[5] The probability of being overfished is 50%.

SOUTH ATLANTIC BLUE SHARK SUMMARY

Current Yield (2022)		31,727 t[1]
Maximum Sustainable Yield (MSY)		27,711 t (23,128 - 47,758 t)[2]
Relative Biomass	B_{2021}/B_{MSY}	1.29 (0.89 - 1.81)[3]
Relative Fishing Mortality	F_{2021}/F_{MSY}	1.03 (0.45 - 1.55)[4]
Stock Status (2021)	Overfished	No
	Overfishing	Yes
Management Measures in Effect:		Rec. 19-08 Rec. 21-11

[1] Task 1 catch as of 21 September 2023.
[2] Geometric mean of both models, SS3 and JABBA, with a 95% confidence interval.
[3] Combined results from both models, SS3 and JABBA, with a 95% confidence interval.
[4] Combined result of SS3 multi-variate lognormal iterations and JABBA posterior. Median and 95% confidence interval in brackets.

BSH-Table 1. Estimated catches (t) of blue shark (*Prionace glauca*) by area, gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				9602	11315	11588	10989	39566	36145	36972	40655	35243	34329	38161	37500	43778	45474	50607	54481	59146	66986	76230	65375	58585	64792	63355	70239	68662	68551	64593	54746	55412	53819
	ATN			9591	8605	8472	6740	29271	26668	26122	28161	21151	20458	23184	22054	22660	23517	27070	30882	35354	38929	40292	38912	37813	38131	40191	44085	40004	33979	27212	20963	21883	22057
	ATS			10	2704	3108	4246	10145	9414	10828	12448	14044	13854	14966	15320	21046	21768	23487	23518	23607	27799	35898	26421	20672	26253	22498	25417	28555	34514	37317	33709	33471	31727
	MED			0	6	8	2	150	63	22	45	47	17	11	125	72	189	50	81	185	258	40	42	100	408	665	737	103	58	64	73	59	36
Landings	ATN		Longline	7460	7660	7551	6136	28820	26266	25650	27573	20856	19644	22926	21780	22385	23278	26811	30518	35035	38644	39983	38725	37604	37886	39335	42875	38831	32779	25994	19566	20388	20670
			Other surf.	994	373	300	560	289	313	422	475	189	746	204	210	209	194	205	235	216	117	102	67	100	117	731	1123	1035	1087	1025	986	1087	673
	ATS		Longline	10	2704	3108	4246	10135	9405	10801	12448	14043	13849	14960	15320	21043	21762	23417	23503	23601	27785	35427	25878	20387	24308	21736	24643	27662	33561	36419	32630	32751	30083
			Other surf.	0	0	0	0	6	4	27	0	1	4	6	0	3	6	10	0	6	14	468	411	152	1831	635	634	668	854	558	603	495	1329
	MED		Longline	0	6	8	2	150	63	22	45	47	17	11	77	72	142	48	81	18	176	40	41	68	341	664	735	90	54	51	71	53	34
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	48	0	47	2	0	167	83	0	0	32	67	1	2	13	4	13	3	6	1
Discards	ATN		Longline	1136	572	621	45	161	88	49	113	105	68	55	63	66	45	53	129	102	167	205	119	109	128	124	88	138	112	193	411	407	713
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	2	1	0	0	0	0	0	0	0	0	0	1
	ATS		Longline	0	0	0	0	5	5	0	0	0	0	0	0	0	0	60	14	0	0	4	132	132	114	122	139	218	99	340	477	224	315
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	7	0	0	0	0	0
	MED		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Landings	ATN	CP	Barbados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	6	7	4	2	2	2	3
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114	461	1039	903	1216	392	4	6	201	317	369	301	349	311
			Brazil	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Canada	1702	1260	1494	528	831	612	547	624	581	836	346	965	1134	977	843	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
			Cape Verde	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			China PR	0	0	0	0	0	0	0	0	185	104	148	146	132	142	367	109	88	53	109	98	327	178	1	27	2	6	18	65	2	13
			EU-Denmark	0	1	2	3	1	1	0	2	1	13	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	24497	22504	21811	24112	17362	15666	15975	17314	15006	15464	17038	20788	24465	26094	27988	28666	28562	29041	30078	29019	27316	21685	16314	12325	13125	13057
			EU-France	322	350	266	278	213	163	399	395	207	221	57	135	120	99	161	119	84	122	115	31	216	112	262	352	124	94	80	57	49	46
			EU-Ireland	0	0	0	0	0	0	66	31	66	11	2	0	0	0	0	0	0	0	1	3	2	1	0	0	0	0	0	0	0	0
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Portugal	5726	4669	4722	4843	2630	2440	2227	2081	2110	2265	5643	2025	4027	4338	5283	6167	6252	8261	6509	3768	3694	3060	3859	7819	5664	5195	4507	3836	4300	4102
			FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	153
			Great Britain	0	0	12	0	0	1	0	12	9	6	4	6	5	3	6	6	96	8	10	8	10	10	12	17	11	6	3	3	4	5
			Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Japan	0	1203	1145	618	489	340	357	273	350	386	558	1035	1729	1434	1921	2531	2007	1763	1227	2437	1808	3287	4011	4217	4444	4111	3740	2130	1815	1985
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	537	299	327	113	0	10	103	92	113	48	16	0
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	10	3	8	0
			Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	661	975	1072	999	1389	873	1623	1475	1644	1524	1498	1636	1532
			Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93	0	0	0	0	0	0
			Mexico	0	0	0	0	0	0	0	0	6	2	3	4	3	3	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0
			Panama	0	0	0	0	0	0	9	0	0	0	0	0	0	254	892	613	1575	1026	1071	1224	289	153	555	262	324	437	242	162	84	111
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Senegal	0	0	0	0	0	0	0	0	0	456	0	0	0	0	43	134	255	56	148	5	12	17	13	17	19	15	14	14	14	0
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	119	0	0	0	2	0	0
			Trinidad and Tobago	0	13	4	5	4	7	8	12	19	6	3	2	1	1	0	2	8	9	11	11	8	10	4	2	2	0	0	0	0	1
			UK-Bermuda	0	0	0	0	1	2	0	3	4	5	4	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			USA	682	31	24	284	214	256	217	291	40	182	172	137	163	156	150	164	158	69	73	61	61	44	32	31	24	19	17	8	10	1
			Venezuela	23	18	16	6	27	7	47	43	47	29	40	10	28	12	19	8	73	75	117	98	52	113	130	117	108	112	56	59	11	9
		NCC	Chinese Taipei	0	487	167	132	203	246	384	165	59	203	171	206	240	588	292	110	73	99	148	94	113	77	220	259	42	122	8	38	49	11
			Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	6	14	8	5	3	2	0	0	0	0	0	0
	ATS	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	17	64
			Belize	0	0	0	0	0	0	0	0	0	0	0	37	259	99	236	109	148	273	243	483	234	171	105	167	200	222	165	15	21	0
			Brazil	0	0	0	743	1103	616	179	1687	2173	1971	2166	2103	2523	3334	2258	2407	1274	1500	2808	1607	2013	2551	2420	1334	2177	3011	3784	3435	4629	3328
			China PR	0	0	0	0	0	0	0	0	565	316	452	444	404	434	585	40	109	41	131	84	64	48	20	30	283	127	52	45	15	5
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92	16	9	8	247	1202	8	0	15
			EU-España	0	0	0	0	5272	5574	7173	6951	7743	5368	6626	7366	6410	8724	8942	9615	13099	13953	16978	14348	10473	11447	10133	10107	11486	13515	18497	14717	16778	14061
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Portugal	0	0	847	867	1336	876	1110	2134	2562	2324	1841	1863	3184	2751	4493	4866	5358	6338	7642	2424	1646	1622	2420	5609	6663	8015	6753	7350	5524	6092
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1583	396	436	479	416	414	413	446	1287
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	239	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	6	0	0	0	0	0	0
			Japan	0	1388	437	425	506	510	536	221	182	343	331	209	236	525	896	1789	981	1161	1483	3060	2255	3232	2277	2127	3112	3495	2338	1795	1394	956
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	222	125	112	61	10	71	252	87	192	156	55	6	0
			Namibia	0	0	0	0	0	0	0	0	2213	2316	1906	6616	3536	3419	1829	207	2352	2957	1439	1147	2471	2137	2775	1357	3290	2474	4120	3237	4694	
			Panama	0	0	0	0	0	0	168	22	0	0	0	0	0	0	0	521	0	0	0	0	0	0	0	0	0	0	0	15	0	1

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			S Tomé e Príncipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	147	152	156	206	183	182	190	94	11	50	25
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	203	51	60	105	18	15	11	15	39	22	25	0
			South Africa	0	0	0	0	0	23	21	0	83	63	232	128	154	90	82	126	119	125	318	158	179	524	402	356	418	403	292	52	181	100
			St Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0
			USA	0	0	0	0	0	0	0	0	4	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Uruguay	10	84	57	259	180	248	118	81	66	85	480	462	376	232	337	359	942	208	725	433	130	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	0	1232	1767	1952	1737	1559	1496	1353	665	1172	521	800	866	1805	2177	1843	1356	1625	2138	1941	2125	2128	1731	1853	1852	1276	716	1179	922	785
		NCO	Benin	0	0	0	0	6	4	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	MED	CP	Algerie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	4	2	3	5
			EU-Cyprus	0	0	0	0	0	0	0	9	0	0	3	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	146	59	20	31	6	3	3	4	8	61	3	2	7	48	38	39	37	53	65	58	40	19	18	34	14	8
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	5	15	7	0	2	2	2	2	1
			EU-Italy	0	0	0	0	0	0	0	0	0	0	0	113	1	106	46	75	175	208	0	0	57	347	0	18	59	17	33	26	33	13
			EU-Malta	0	1	1	1	2	2	2	1	1	1	0	0	0	0	1	1	2	1	1	2	2	4	5	3	4	2	2	2	1	3
			EU-Portugal	0	0	0	0	0	2	0	5	41	14	3	0	56	22	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	5	7	1	1	0	0	0	0	0	1	1	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	580	650	0	10	6	6	5	6
Discards	ATN	CP	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	16	32	71	4	193	173	365
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	157	204	258
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	1	29	0	25	1	0	36
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			UK-Bermuda	0	0	3	1	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			USA	1136	572	618	44	161	88	41	113	106	68	55	65	66	45	54	130	103	167	206	106	99	122	82	43	42	11	20	24	25	35
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	10	6	19	27	34	31	30	36	4	14
	ATS	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	175	316	92	122
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2	19	2	2	55
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
			USA	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	132	132	112	122	139	201	97	146	159	130	138
	MED	CP	EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BSH-Table 2. Kobe II Strategic Matrices for the North Atlantic blue shark stock combined models. a) the probability that overfishing is not occurring ($F \leq F_{MSY}$); b) the probability that the stock is not overfished ($B \geq B_{MSY}$); and c) the joint probability of being in the green quadrant of the Kobe plot (i.e., $F \leq F_{MSY}$ and $B \geq B_{MSY}$). The constant catch scenario of 32689 tons corresponds to the estimated MSY.

a) Probability $F \leq F_{MSY}$.

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
20000	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
22500	99%	99%	99%	100%	100%	100%	100%	100%	100%	100%
25000	95%	96%	96%	97%	98%	98%	99%	99%	99%	100%
27500	87%	87%	88%	89%	90%	92%	93%	94%	95%	95%
30000	75%	74%	74%	75%	76%	77%	78%	79%	80%	81%
32500	62%	60%	59%	59%	59%	59%	59%	59%	59%	59%
32689	61%	59%	58%	57%	58%	58%	58%	58%	58%	57%
35000	50%	47%	44%	43%	41%	39%	38%	37%	36%	35%
37500	40%	35%	31%	27%	24%	21%	19%	17%	15%	14%
40000	31%	24%	19%	14%	11%	8%	7%	5%	4%	4%

b) Probability $B \geq B_{MSY}$.

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	71%	83%	95%	100%	100%	100%	100%	100%	100%	100%
20000	59%	58%	62%	73%	84%	91%	95%	97%	98%	99%
22500	58%	56%	59%	68%	78%	85%	90%	93%	95%	97%
25000	56%	53%	55%	63%	71%	77%	82%	86%	88%	91%
27500	55%	51%	52%	58%	64%	69%	73%	76%	78%	81%
30000	54%	49%	50%	53%	58%	61%	63%	65%	67%	68%
32500	53%	48%	47%	49%	51%	53%	53%	54%	54%	54%
32689	53%	47%	46%	48%	50%	52%	53%	53%	53%	53%
35000	53%	46%	44%	43%	44%	43%	42%	41%	40%	38%
37500	52%	44%	40%	38%	35%	33%	30%	27%	24%	22%
40000	51%	42%	36%	32%	27%	22%	18%	15%	13%	10%

c) Probability $F \leq F_{MSY}$ and $B \geq B_{MSY}$.

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	71%	83%	95%	100%	100%	100%	100%	100%	100%	100%
20000	59%	58%	62%	73%	84%	91%	95%	97%	98%	99%
22500	58%	56%	59%	68%	78%	85%	90%	93%	95%	97%
25000	56%	53%	55%	63%	71%	77%	82%	86%	88%	91%
27500	55%	51%	52%	58%	64%	69%	73%	76%	78%	80%
30000	53%	49%	50%	53%	57%	60%	63%	65%	66%	67%
32500	51%	47%	46%	47%	49%	51%	51%	52%	52%	53%
32689	50%	46%	46%	47%	49%	50%	51%	51%	51%	51%
35000	46%	42%	40%	39%	38%	37%	36%	35%	34%	33%
37500	38%	33%	29%	26%	23%	21%	19%	17%	15%	14%
40000	30%	23%	18%	14%	11%	8%	7%	5%	4%	3%

BSH-Table 3. Kobe II Strategic Matrices for the South Atlantic blue shark stock combined models. a) the probability that overfishing is not occurring ($F<=F_{MSY}$); b) the probability that the stock is not overfished ($B>=B_{MSY}$); and c) the joint probability of being in the green quadrant of the Kobe plot (i.e., $F<= F_{MSY}$ and $B>= B_{MSY}$). The constant catch scenario of 27711 t corresponds to the estimated MSY.

a) Probability $F \leq F_{MSY}$.

Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
15000	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
17500	98%	99%	99%	99%	99%	99%	100%	100%	100%	100%
20000	95%	96%	97%	97%	97%	97%	98%	98%	98%	98%
22500	89%	90%	91%	91%	91%	91%	91%	92%	92%	92%
25000	80%	81%	80%	80%	79%	79%	78%	78%	78%	77%
27500	70%	69%	68%	66%	65%	64%	62%	61%	60%	59%
27711	69%	68%	67%	65%	63%	62%	61%	60%	59%	58%
30000	58%	57%	54%	52%	50%	48%	47%	45%	44%	43%
32500	47%	45%	42%	40%	37%	36%	34%	33%	32%	32%

b) F Probability $B \geq B_{MSY}$.

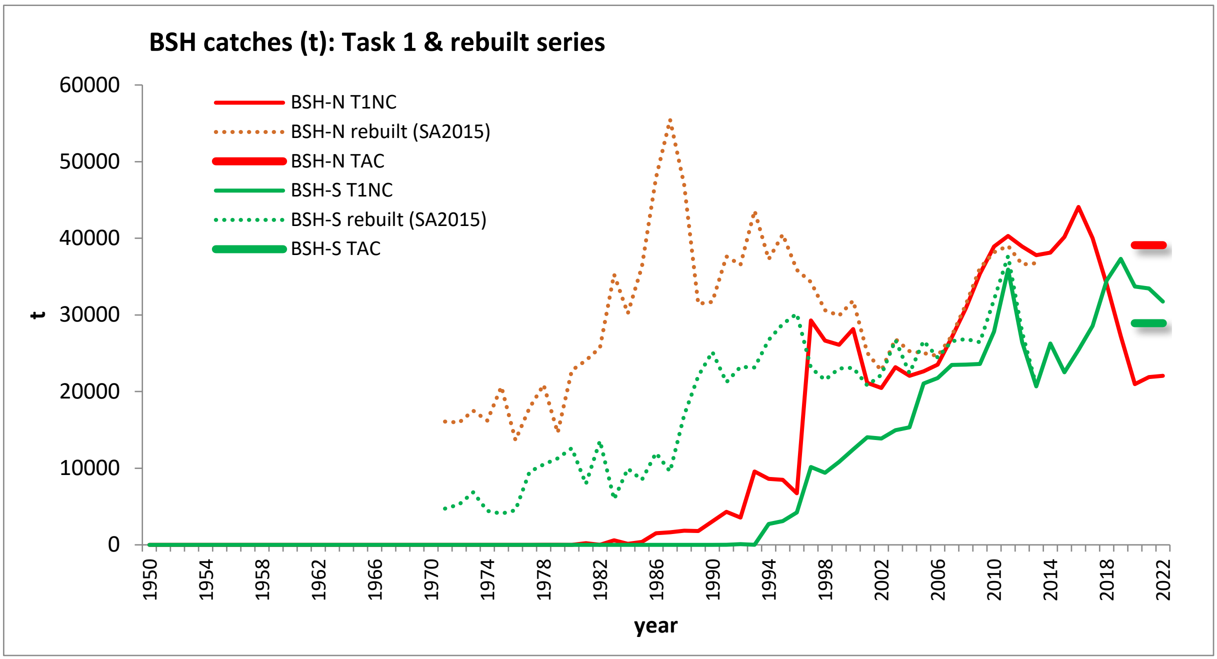
Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	93%	99%	100%	100%	100%	100%	100%	100%	100%	100%
15000	83%	89%	93%	95%	97%	98%	99%	99%	99%	99%
17500	81%	86%	90%	92%	94%	95%	96%	97%	97%	98%
20000	79%	83%	86%	88%	89%	90%	91%	92%	93%	94%
22500	77%	79%	81%	82%	82%	83%	84%	84%	85%	86%
25000	75%	75%	75%	75%	75%	74%	74%	74%	74%	73%
27500	72%	71%	69%	68%	66%	64%	63%	61%	60%	60%
27711	72%	70%	69%	67%	65%	63%	62%	61%	60%	58%
30000	70%	67%	63%	60%	57%	54%	52%	50%	48%	47%
32500	68%	62%	57%	52%	48%	45%	42%	40%	39%	38%

c) Probability $F \leq F_{MSY}$ and $B \geq B_{MSY}$.

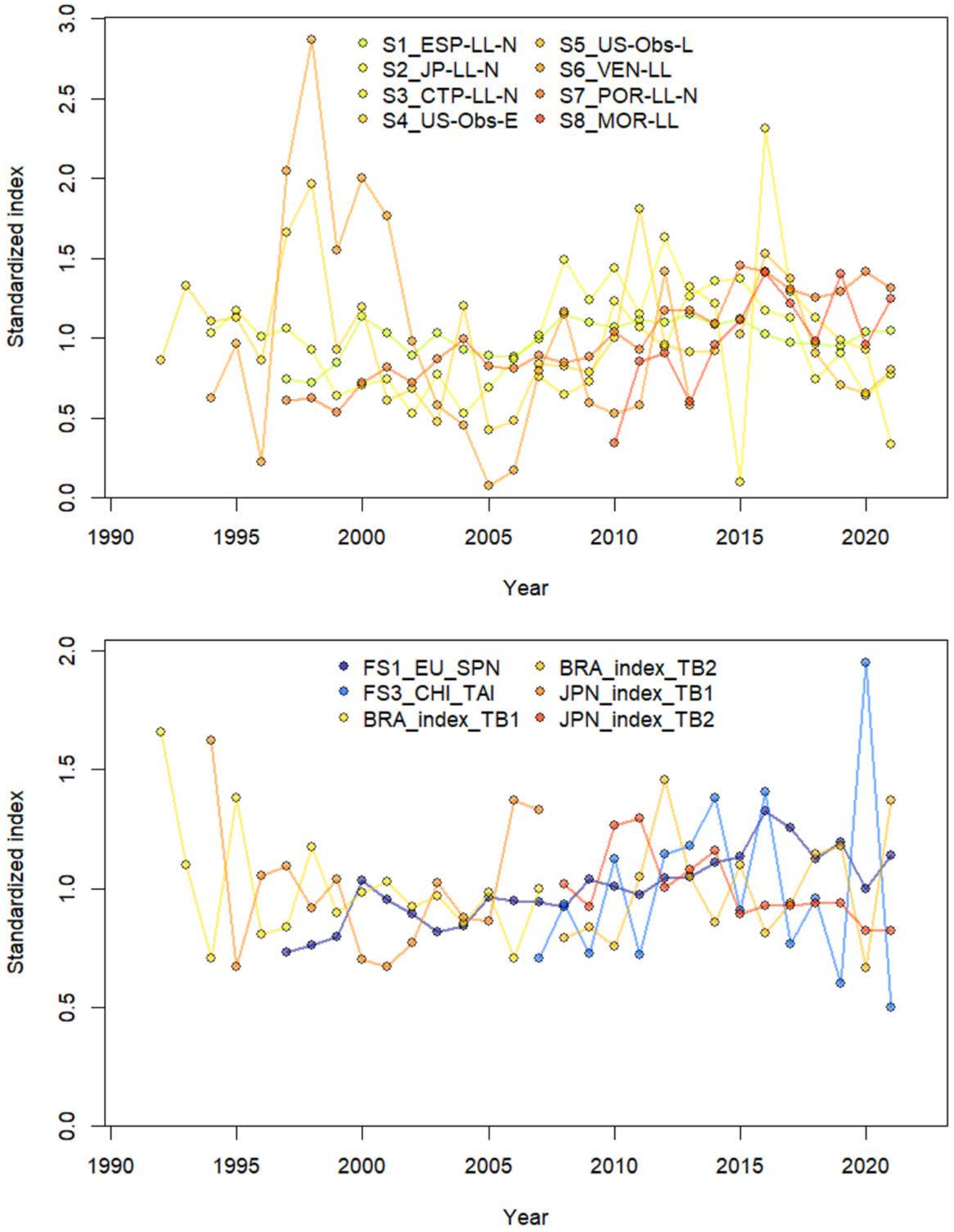
Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	93%	99%	100%	100%	100%	100%	100%	100%	100%	100%
15000	83%	89%	93%	95%	97%	98%	99%	99%	99%	99%
17500	81%	86%	90%	92%	94%	95%	96%	97%	97%	98%
20000	79%	83%	86%	88%	89%	90%	91%	92%	93%	94%
22500	77%	79%	81%	82%	82%	83%	84%	84%	85%	86%
25000	74%	75%	75%	75%	74%	74%	73%	73%	73%	72%
27500	68%	68%	67%	65%	63%	61%	59%	59%	54%	53%
27711	67%	67%	66%	63%	61%	60%	58%	56%	55%	54%
30000	58%	57%	54%	51%	49%	47%	44%	43%	41%	40%
32500	47%	45%	42%	39%	37%	34%	32%	31%	29%	28%

BSH-Table 4. Table Percent of the model runs that resulted in B levels ≤20% of B_{MSY} during the projection period for a given catch level for the South Atlantic blue shark stock.

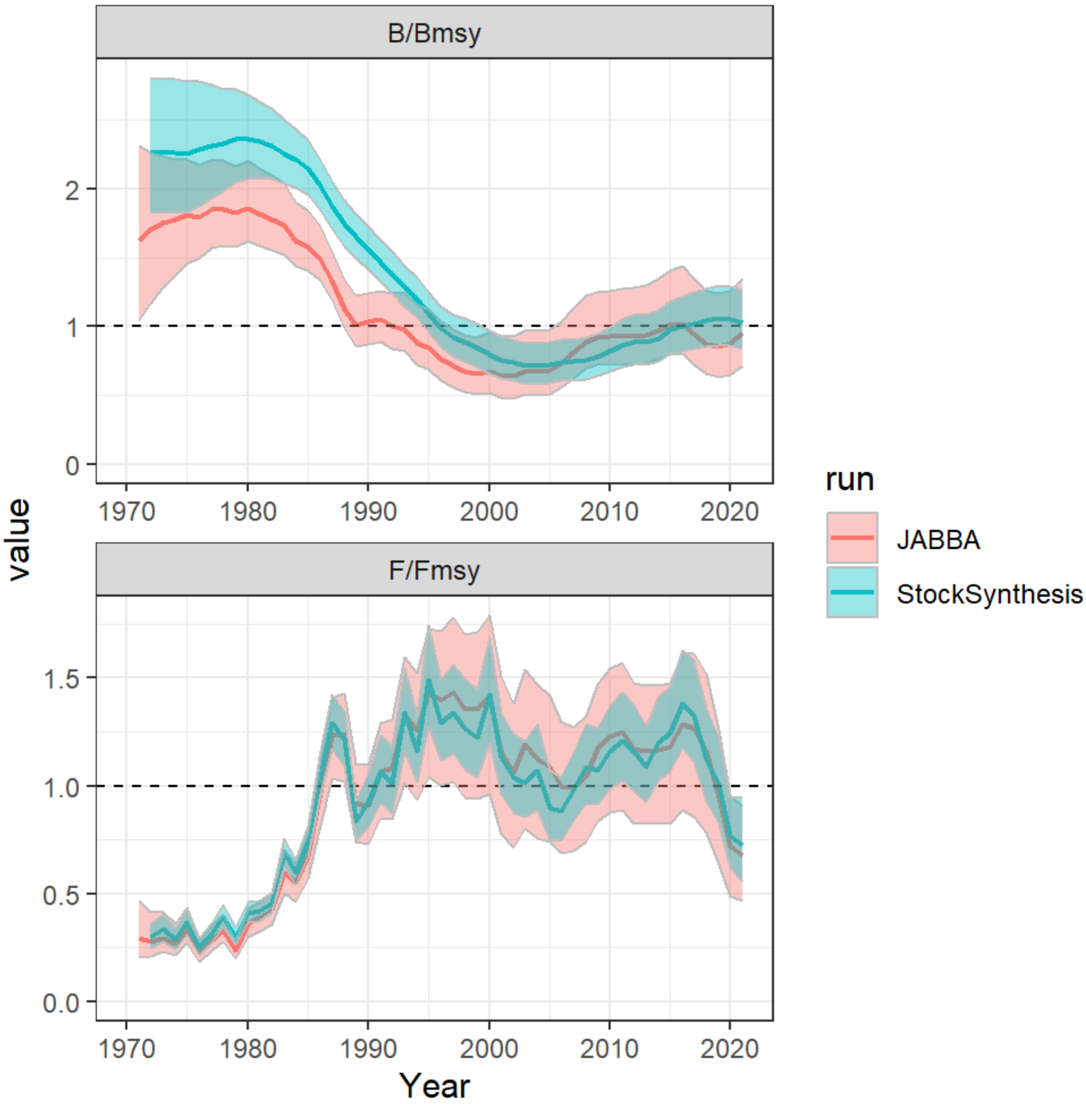
Catch (t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17500	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
22500	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
25000	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%
27500	0%	0%	0%	0%	1%	1%	1%	1%	2%	3%
27711	0%	0%	0%	0%	1%	1%	1%	2%	2%	3%
30000	0%	0%	0%	1%	1%	1%	2%	3%	5%	6%
32500	0%	0%	0%	1%	2%	3%	5%	8%	11%	16%



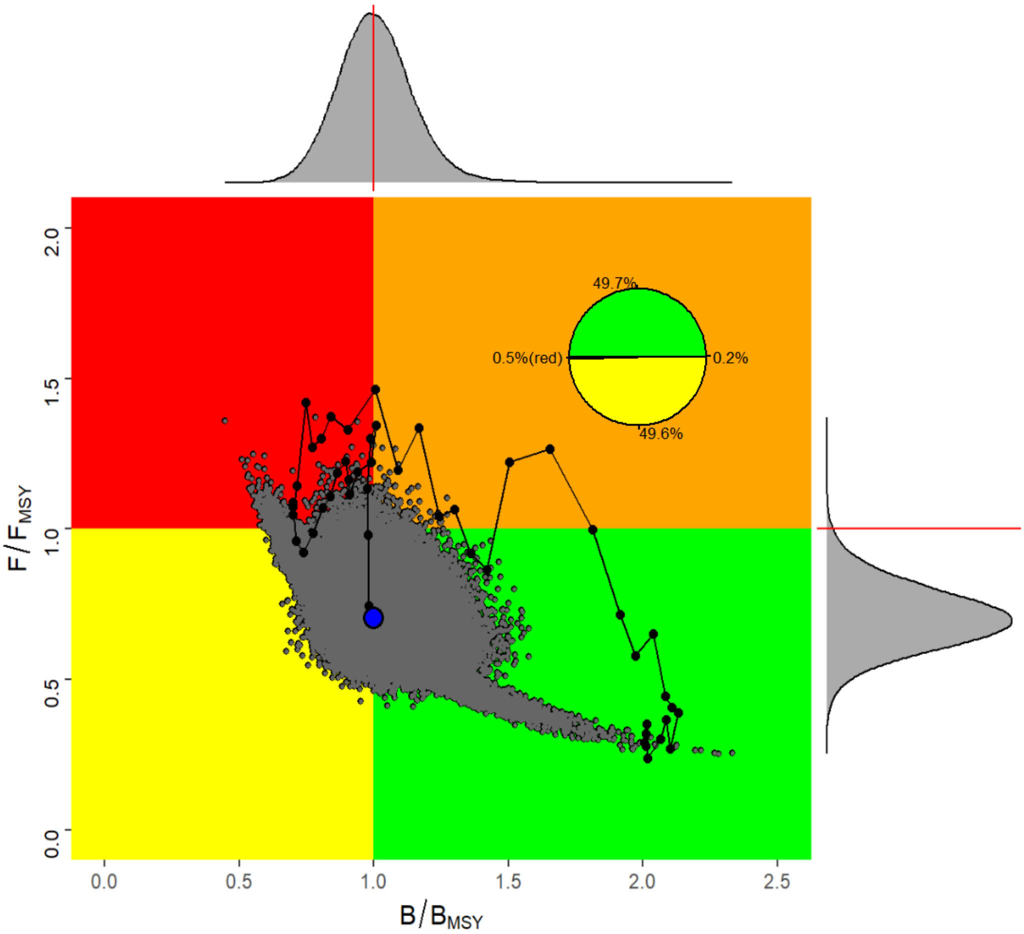
BSH-Figure 1. Blue shark catches of both stocks (BSH-N in red, BSH-S in green) reported to ICCAT (Task 1) and the rebuilt catch series estimated by the Committee.



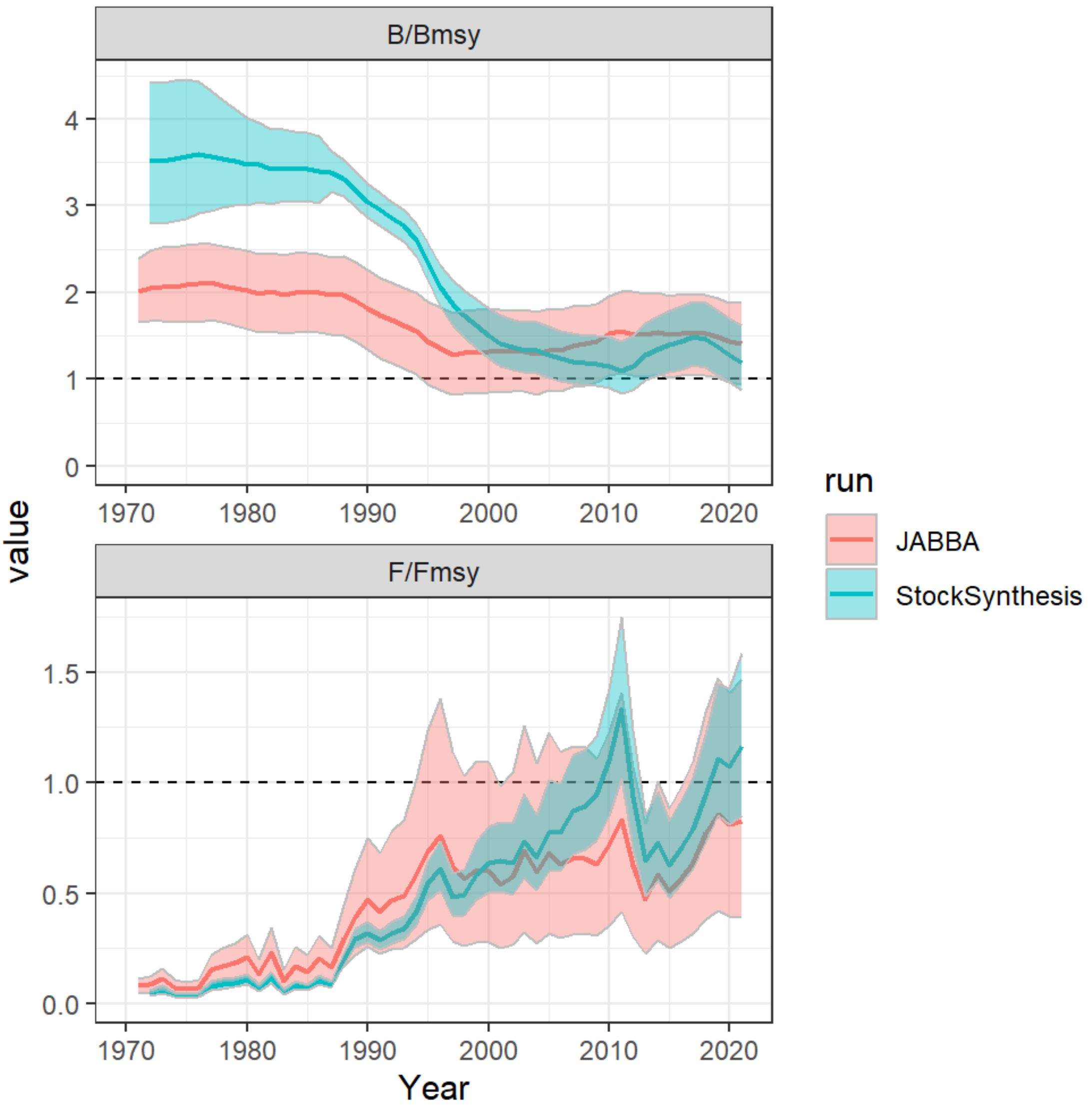
BSH-Figure 2. Standardized indices of abundance of blue shark for the northern stock (upper) and the southern stock (lower). All the indices shown were used in the 2023 stock assessments of North and South Atlantic blue shark (BSH) stocks.



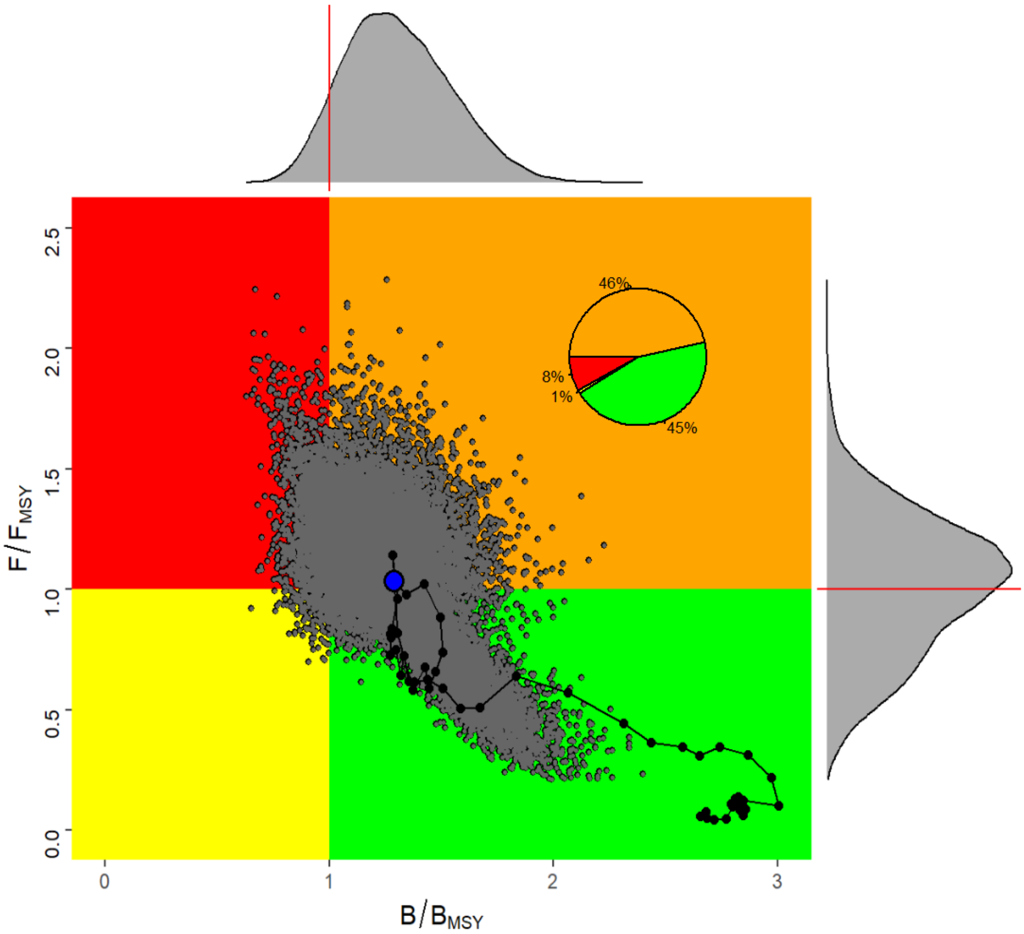
BSH-Figure 3. Estimated annual trends for the northern stock from JABBA (orange lines) and Stock Synthesis (green lines) for B/B$_{MSY}$ (JABBA) or SSB/SSB$_{MSY}$ (Stock Synthesis) (upper panel), and F/F$_{MSY}$ (lower panel) with 95% confidence interval.



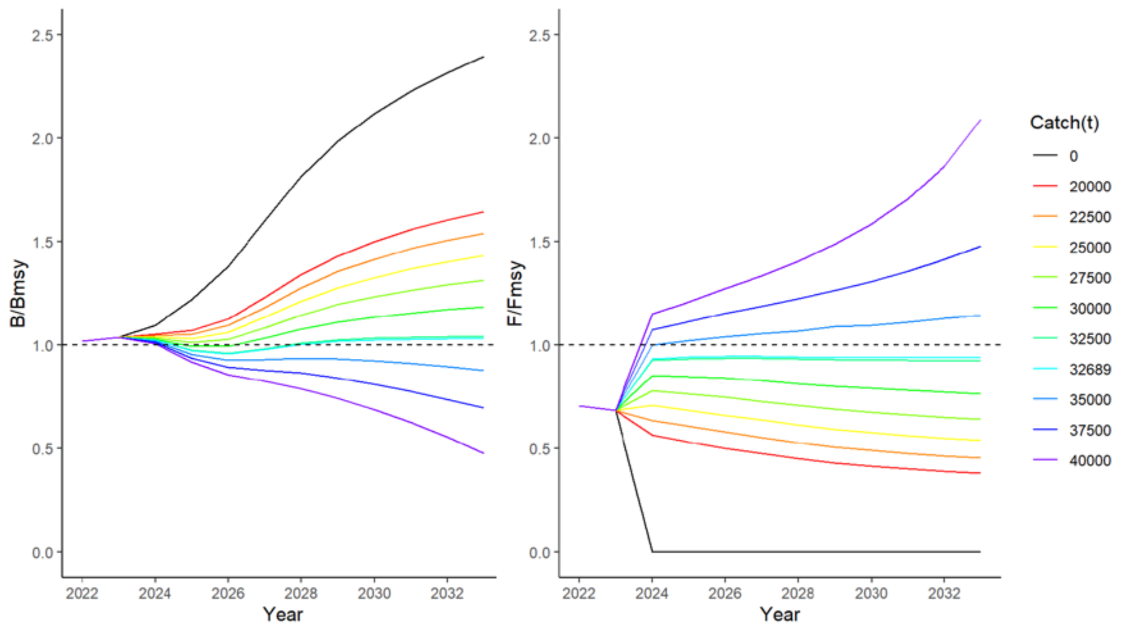
BSH-Figure 4. Joint Kobe phase plot from JABBA and Stock Synthesis for the North Atlantic blue shark stock. Solid black dots and solid line indicate the stock status trajectory, with the blue dot indicating the terminal year (2021), grey dots are the interactions from each model for the terminal year with the marginal distributions plotted in the lateral axis.



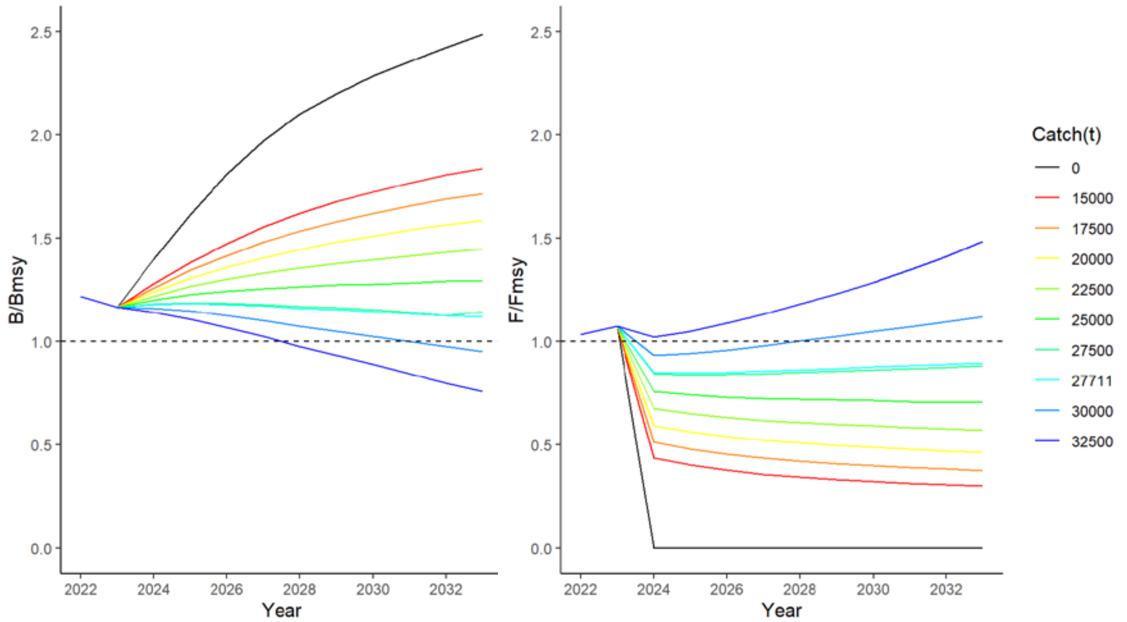
BSH-Figure 5. Estimated annual trends for the southern stock from JABBA (orange lines) and Stock Synthesis (green lines) for B/B_{MSY} (JABBA) or SSB/SSB_{MSY} (Stock Synthesis) (upper panel), and F/F_{MSY} (lower panel) with 95% confidence interval.



BSH-Figure 6. Joint Kobe phase plot from JABBA and Stock Synthesis for the South Atlantic blue shark stock. Solid black dots and solid line indicate the stock status trajectory, with the blue dot indicating the terminal year (2021), grey dots are the interactions from each model for the terminal year with the marginal distributions plotted in the lateral axis.



BSH-Figure 7. Projections for B/B_{MSY} and F/F_{MSY} based on both Stock Synthesis and JABBA reference cases for North Atlantic blue shark stock for various levels of future constant catch ranging from 20,000 – 40,000 t, including a zero-catch scenario starting in 2024. The initial catch for the years 2022-2023 was set to 23,418 t, which is the average catch of the recent three years (2019-2021). The projections were run until 2033 (10 years).



BSH-Figure 8. Projections for B/B_{MSY} and F/F_{MSY} based on both Stock Synthesis and JABBA reference cases for South Atlantic blue shark stock for various levels of future constant catch ranging from 15,000-32,500 t, including a zero-catch scenario starting in 2024. The initial catch for the years 2022-2023 was set to 34,983 t, which is the average catch of the recent three years (2019-2021). The projections were run until 2033 (10 years).

9.16 SMA - Shortfin mako

Both shortfin mako (*Isurus oxyrinchus*) stocks, North and South Atlantic, were assessed in 2017 (Anon., 2018d). In 2019, an intersessional meeting (Anon., 2020e) was held to update projections on the North Atlantic shortfin mako (*Isurus oxyrinchus*) stock based on the 2017 assessment.

SMA-1. Biology

Shortfin mako is a large pelagic shark that shows a wide geographic distribution, from tropical to temperate waters worldwide. Shortfin mako is an aplacental viviparous shark, with oofagy, which limits its fecundity to an average litter size of around 12 but increases the probability of survival of their young. Although there is still high uncertainty regarding its biology, available life history traits (slow growth, late maturity and small litter size) indicate that it is vulnerable to overfishing. A behavioral characteristic of this species is its tendency to segregate temporally and spatially by size and/or sex, during feeding, mating-reproduction, gestation and birth processes. Tagging studies have suggested that it exhibits large-scale migratory behaviour and periodic vertical movement, but the lack of information on some components of the populations precludes a complete understanding of its distribution/migration pattern by ontogenetic stage and in some cases identifying its pupping/mating grounds. Numerous aspects of the biology of this species are still poorly understood or completely unknown, particularly for some regions, which contributes to increased uncertainty in quantitative and qualitative assessments.

SMA-2. Fishery indicators

Earlier reviews of the shark database resulted in recommendations to improve data reporting on shark catches. Though global statistics on shortfin mako shark catches included in the database have improved, they are still insufficient to permit the Committee to provide quantitative advice on stock status for most stocks with sufficient precision to guide fishery management toward optimal harvest levels. While reported and estimated catches for shortfin mako are still generally subject to higher levels of uncertainty than the major tuna stocks, they have been considered sufficiently complete for the purpose of quantitative stock assessment, and are provided in **SMA-Table 1**.

The CPUE series available for the 2017 shortfin mako stock assessments showed decreasing trends since approximately 2010 for the North Atlantic stock and generally increasing trends since approximately 2008 for the South Atlantic stock (**SMA-Figures 1 and 2**).

SMA-3. State of the stocks

The 2017 assessment of the status of North and South Atlantic stocks of shortfin mako shark was conducted with updated time series of relative abundance and annual Task 1 catches (C1), life history, and with the inclusion of length composition data. An alternative series of catch data based on ratios of shark catches to catches of the main target species (C2) was also estimated and used in the assessments. The results obtained in this evaluation are not comparable to those obtained in the last assessment conducted in 2012 (Anon., 2013) because the input data and model structures have changed significantly: the catch time series are different (1950-2015 for the 2017 assessment and 1971-2010 for the 2012 assessment) and were derived using different assumptions; the catch per unit effort (CPUE) series in the North have been decreasing since 2010 (the last year in the 2012 assessment models); some of the biological inputs have changed (growth curve, natural mortality at age) and some are now sex specific for the North; with the new biological inputs the intrinsic rate of population growth (r_{MAX}) for the North Atlantic used to construct prior distributions is now about half that used in the 2012 assessment; and additional length composition data also became available for the North. Additionally, in 2012 only a Bayesian production model (BSP1) and a catch-free age-structured production (CFASPM) model were used, whereas more modeling platforms that more fully use the data available were explored in the current assessment (BSP2JAGS (Just Another Gibbs Sampler emulating the Bayesian production model), JABBA (Just Another Bayesian Biomass Assessment), C_{MSY} (Catch at MSY), and SS3 (Stock Synthesis 3)). It is the Committee's view that the 2017 stock assessment represents a significant improvement in our understanding of current stock status, for North Atlantic shortfin mako in particular. In particular, the production models assuming both observation and process errors fit the indices of abundance considerably better than models assuming only observation errors as used in the 2012 stock assessment.

For the North Atlantic stock, results of nine stock assessment model runs were selected to provide stock status and management advice. Although all results indicated that stock abundance in 2015 was below B_{MSY}, results of the production models (BSP2JAGS and JABBA) were more pessimistic (B/B_{MSY} deterministic estimates ranged from 0.57 to 0.85) and those of the age-structured model (SS3), which indicated that stock abundance was near MSY (SSF/SSF_{MSY} = 0.95 where SSF is spawning stock fecundity), were less pessimistic. F was overwhelmingly above F_{MSY} (**SMA-Figure 3**), with a combined 90% probability from all the models of being in an overfished state and experiencing overfishing (**SMA-Figure 4**).

For the South Atlantic stock, 4 assessment model runs (2 BSP2JAGS runs and 2 CMSY runs) were considered to provide stock status and management advice. The combined probability of the stock being overfished was 32.5% and that of experiencing overfishing was 41.9% (**SMA-Figure 5**). The combined probabilities from all the models of being in the red, yellow, and green quadrants of the Kobe plot are provided in **SMA-Figure 6**. Based on the diagnostics of model performance, the estimates of unsustainable harvest rates appear to be fairly robust at this stage whereas the biomass depletion and B/B_{MSY} estimates must be treated with caution. The Committee considers results for the South Atlantic to be highly uncertain owing to the conflict between catch and CPUE data. For both stocks, the CPUE series generally showed a trend similar to that of the catches, particularly the South Atlantic stock, which was problematic for the stock assessments based on production models.

SMA-4. Outlook

In 2017, projections could only be carried out with the BSP2JAGS production model for the North Atlantic and no projections could be conducted for the South Atlantic due to the uncertainty in stock status. The Committee noted that the Kobe II strategy matrices presented in 2017 may not reflect the full range of uncertainty in the outlook because projections were not carried out with SS3 due to technical reasons and because the model was still under development. In 2019, projections for the North Atlantic were carried out with Stock Synthesis only. The Committee noted that because the fishery mainly focuses on juvenile animals, the production models (BSP2JAGS and others) are only tracking juvenile abundance and thus the projections are not informative about trends in the mature population, which would lag behind the trends in the exploitable population by the number of years it takes new recruits to reach maturity.

The Committee combined the Stock Synthesis status results from two runs that were reflective of different productivity hypotheses (run 1 and run 3) for making projections (**SMA-Figure 7**). Projections were carried out to 2070 because they incorporate two generation times. Run 1 was added because the Committee recognized that it incorporates another hypothesis on the productivity of the stock (expressed through a different stock-recruit relationship) more in line with some of the production model estimates of productivity, but unlike production models, it can incorporate the necessary time lag effects caused by gear selectivity and the maturity of the stock. The projection results from the combined models showed that (**SMA-Table 2**): i) a zero total allowable catch (TAC) will allow the stock to be rebuilt and without overfishing (in the green quadrant of the Kobe plot) by 2045 with a 53% probability; ii) regardless of the TAC, the spawning stock fecundity will continue to decline until 2035 before any increases can occur owing to the time it takes juveniles to reach maturity; iii) to be in the green quadrant of the Kobe plot with at least 60% probability by 2070, the realized TAC has to be 300 t or less; and iv) a TAC of 700 t would end overfishing immediately with a 57% probability, but it would only have a 41% probability of rebuilding the stock by 2070. Although there is large uncertainty in the future productivity assumption for this stock, the projections show that there is a long lag time (ca. 20 years) between when management measures are implemented and when stock size starts to rebuild due to the biology of the species.

SMA-5. Effect of current regulations

The Commission adopted Rec. 17-08, which aims to reduce the fishing mortality to end overfishing of the northern stock of shortfin mako. It does this by strengthening data collection (including collection of statistics on discards, biological parameters, weight of landing products, etc.) and establishing regulatory options (including promoting fish releases in a manner that increases survival, establishing minimum sizes, etc.) for ICCAT CPCs. In response to this recommendation several CPCs have adopted national regulations. Rec. 17-08 was reviewed by the Commission in 2019.

The Committee conducted projections incorporating different hypotheses about stock productivity which suggested that the stock could rebuild to the biomass that supports MSY with a 60% probability if the TAC=0 by 2050. Additionally, the Committee also reviewed the probability of success of several of the measures contemplated in ICCAT Rec. 17-08 through additional projections for shortfin mako (using only the base run from Stock Synthesis – run 3). Specifically, alternative TAC, minimum size limit, and live release measures were explored with two tools: Stock Synthesis and the Decision Support Tool (DST). The Committee noted that fixed TACs with size regulations (210 cm fork length for females and 180 cm fork length for males) accelerated stock recovery. However, these projections implicitly assumed that fish released below the size limit had 100% post-release survival. The Committee also explored the effect of live release regulations (through reduction in fishing mortality but considering a post-release mortality rate of 25%) contemplated in Rec. 17-08 and found that all projection scenarios resulted in population declines until 2035 regardless of the fixed level of fishing mortality used and that the biomass that supports MSY was only reached by 2070 for the fishing mortality equal zero scenario.

Projections with the DST revealed that if fishers are unable to avoid catching shortfin makos and those discarded have a substantial mortality rate, then it is necessary to greatly decrease the retained catch to allow the stock to rebuild. Size limits and other strategies to release live sharks must be accompanied by a reduction in retained catch. The Committee thus concluded that a live release approach may be a way to reduce F if discard mortality rates are low, but other management measures such as reduction of soak time, time-area closures, and safe handling and best practices for the release of live specimens may also be required to further reduce incidental mortality. The Committee also noted that a slot limit that protects some mature age groups may be appropriate, although selectivity on those ages is low.

The Committee noted that North Atlantic catches increased from 3,282 t in 2015 to 3,357 t in 2016 and then decreased to 3,119 t in 2017, and that they further decreased to 1,461 t in 2018. It is not clear if the decrease can be attributed to Rec. 17-08 or to continued decrease in stock size. Projections (**SMA-Table 3**) indicate that this current catch will not allow the stock to rebuild by 2070 and overfishing will continue. 2019 is the first full year during which Rec. 17-08 applied. The Committee will not be able to review 2019 shortfin mako catches until after 31 July 2020 (noting that it will provide the Committee with only one year of data).

The Committee had insufficient information to determine which ICCAT recommendations regarding possible conservation measures (Rec. 17-08) were implemented for which fleet, making it difficult to evaluate the effect of the possible conservation measures by fleet in the projections. Nevertheless, a general evaluation of the effect of the conservation measures was undertaken which showed that they are insufficient to rebuild the stock within the specified timeframe.

SMA-6. Management recommendations

Precautionary management measures should be considered particularly for stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data and/or great uncertainty in assessment results. Management measures should ideally be species-specific whenever possible.

Considering the need to improve stock assessments of pelagic shark species impacted by ICCAT fisheries and bearing in mind Rec. 12-05 as well as the various previous recommendations which made the submission of shark data mandatory, the Committee strongly urges the CPCs to provide the corresponding statistics, including discards (dead and alive), of all ICCAT fisheries, including recreational and artisanal fisheries, and to the extent possible non-ICCAT fisheries capturing these species. The Committee considers that a basic premise for correctly evaluating the status of any stock is to have a solid basis to estimate total removals.

The Committee reiterates that the CPCs provide estimates of shortfin mako shark catches in both ICCAT and non-ICCAT fisheries for species that are oceanic, pelagic, and highly migratory within the ICCAT Convention area. The magnitude of shark entanglements in fish aggregating devices (FADs) should be investigated. Methods for mitigating shark bycatch in fisheries also need to be investigated and applied.

The Committee conducted new projections using two Stock Synthesis model scenarios that incorporated important aspects of shortfin mako biology. This was a feature that was not possible with the production model projections developed in the 2017 assessment (Anon., 2018d) and, therefore, the Committee considers the new projections as a better representation of the stock dynamics. The stock synthesis projections indicated that: i) a zero TAC will allow the stock to be rebuilt and without overfishing (in the green quadrant of the Kobe plot) by 2045 with a 53% probability; ii) regardless of the TAC (including a TAC of 0 t), the stock will continue to decline until 2035 before any biomass increases can occur; iii) a TAC of 500 t, including dead discards has only a 52% probability of rebuilding the stock to the green quadrant in 2070; iv) to be in the green quadrant of the Kobe plot with at least 60% probability by 2070, the realized TAC has to be 300 t or less; v) lower TACs achieve rebuilding in shorter time frames; and vi) a TAC of 700 t would end overfishing immediately with a 57% probability, but this TAC would only have a 41% probability of rebuilding the stock by 2070.

The Committee agreed that the projections that addressed the exceptions in Rec. 17-08 indicated that any retention of shortfin makos will not permit the recovery of the stock by year 2070. A range of TAC options with a range of time frames and associated probabilities of rebuilding are included in **SMA-Table 3**. Given the vulnerable biological characteristics of this stock and the pessimistic projections, to accelerate the rate of recovery and to increase the probability of success the Committee recommends that the Commission adopt a non-retention policy without exception in the North Atlantic as it has already done with other shark species caught as bycatch in ICCAT fisheries.

Given that fishery development in the South predictably follows that in the North and that the biological characteristics of the stock are similar, there is a significant risk that this stock could follow a similar history to that of the North stock. If the stock declines it will, like the North stock, require a long time for rebuilding even after significant catch reductions. To avoid this situation and considering the uncertainty in the stock status, the Committee recommends that at a minimum, catches should not exceed the minimum catch in the last five years of the assessment (2011-2015; 2,001 t with catch scenario C1 (Task 1 catches)).

The Committee emphasized that reporting all sources of mortality is an essential element to decrease the uncertainty in stock assessment results, and particularly the report of estimated dead discards for all fisheries. Although the reporting of dead discards is already part of the ICCAT data reporting obligations (Rec. 17-08), the requirement has been ignored by many CPCs. The reporting of dead discards and live releases is of the utmost importance.

The Committee indicated that additional measures can potentially further reduce incidental mortality, including safe handling and best practices for the release of live specimens (since post release survival can reach 77%). These and other measures are documented in papers published on the Bycatch Management Information System webpage of the Western Central Pacific Fisheries Commission (WCPFC). Gear restrictions/modification and time area closures also have the potential to reduce mortality. However, gear restriction/modification would require dedicated field work (e.g., the deployment of hook timers to measure the time that sharks are on the line), while the level of catch and effort data currently submitted to the Secretariat makes it difficult to evaluate time/area closures.

The Committee emphasized that the Kobe II Strategy Matrix (K2SM) does not capture all the uncertainties associated with the fishery and the biology of the species. In addition, the length of the projection period (50 years) requested by the Commission implies that estimates at the end of the projection period are highly uncertain. Therefore, the Committee advised that the results of the K2SM should be interpreted with caution. In particular, if the decrease in mature females is related not only to the catch of immature females, but to other, unknown causes, the management measures above may not lead to the recovery of the stock.

The Committee emphasizes that there will be a need for CPCs to strengthen their monitoring and data collection efforts by species to monitor the future status of the stocks, including but not limited to total estimated dead discards and the estimation of CPUEs using observer data.

NORTH ATLANTIC SHORTFIN MAKO SUMMARY

Current Yield (2022)		831 t[1]
Yield (2015)		3,227 t[2]
Relative Biomass	B_{2015}/B_{MSY}	0.57-0.95[3]
	B_{2015}/B_0	0.34-0.57[4]
Relative Fishing Mortality	F_{MSY}	0.015-0.056[5]
	F_{2015}/F_{MSY}	1.93-4.38[6]
Stock Status (2015)	Overfished	Yes
	Overfishing	Yes
Management Measures in Effect:		Rec. 21-09, Rec. 21-10, Rec. 04-10, Rec. 07-06 Rec. 10-06, Rec. 14-06

[1] Task 1 catch as of 21 September 2023.
[2] Task 1 catch used in the stock assessment.
[3] Range obtained from 8 Bayesian production and 1 SS3 model runs. Value from SS3 is SSF/SSF_{MSY}. Low value is lowest value from 4 production model (JABBA) runs and high value is from the SS3 base run.
[4] Range obtained from 8 Bayesian production and 1 SS3 model runs. Value from SS3 is SSF/SSF_0. Low value is lowest value from 4 production model (JABBA) runs and high value is highest value from 4 production model (BSP2JAGS) runs.
[5] Range obtained from 8 Bayesian production and 1 SS3 model runs. Value from SS3 is SSF_{MSY}. Low value is lowest value from 4 production model (JABBA and BSP2JAGS) runs and high value is from the SS3 base run.
[6] Range obtained from 8 Bayesian production and 1 SS3 model runs. Values from the production models are H (harvest rates). Low value is lowest value from 4 production model (BSP2JAGS) runs and high value is from the SS3 base run and highest value from 4 production model (JABBA) runs.

SOUTH ATLANTIC SHORTFIN MAKO SUMMARY

Current Yield (2022)		2,485 t[1]
Yield (2015)		2,686 t[2]
Relative Biomass	B_{2015}/B_{MSY}	0.65-1.75[3]
	B_{2015}/B_0	0.32-1.18[4]
Relative Fishing Mortality:	F_{MSY}	0.030-0.034[5]
	F_{2015}/F_{MSY}	0.86-3.67[6]
Stock status (2015)	Overfished	Possibly[7]
	Overfishing	Possibly[7]
Management Measures in Effect:		Rec. 21-11, Rec. 22-11, Rec. 04-10, Rec. 07-06, Rec. 10-06, Rec. 14-06

[1] Task 1 catch.
[2] Task 1 catch from the stock assessment.
[3] Range obtained from 2 Bayesian production (BSP2JAGS) and 2 catch-only (CMSY) model runs. Low value is lowest value from the CMSY model runs and high value is highest value from the BSP2JAGS model runs.
[4] Range obtained from 2 Bayesian production (BSP2JAGS) and 2 catch-only (CMSY) model runs. Low value is lowest value from the CMSY model runs and high value is highest value from the BSP2JAGS model runs.
[5] Range obtained from 2 Bayesian production (BSP2JAGS) and 2 catch-only (CMSY) model runs. Low value is from the BSP2JAGS model runs and high value is from the CMSY model runs.
[6] Range obtained from 2 Bayesian production (BSP2JAGS) and 2 catch-only (CMSY) model runs. Low value is lowest value from the BSP2JAGS model runs and high value is highest value from the CMSY model runs.
[7] The Committee considers that results have a high degree of uncertainty.

SMA-Table 1. Estimated catches (t) of Shortfin mako (*Isurus oxyrinchus*) by area, gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				5856	5844	8407	7702	5730	5863	4470	5190	4796	5531	7225	6528	6970	6620	6946	5684	6606	7270	6982	7347	5787	6743	6056	6122	5906	5552	4195	4597	3452	3316
	ATN			4114	3662	5307	5307	3537	3847	2859	2598	2682	3426	3987	4000	3695	3574	4158	3802	4542	4783	3722	4440	3604	3469	3282	3357	3119	2392	1886	1740	1196	831
	ATS			1743	2182	3100	2395	2187	2008	1606	2588	2107	2103	3235	2526	3259	3036	2786	1881	2063	2486	3258	2905	2183	3274	2774	2765	2786	3158	2309	2857	2256	2485
	MED			0	0	0	0	6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	2	0	0	0	0	0	1	0	0	0	1
Landings	ATN		Longline	3420	3310	3829	5054	3352	3672	2756	2270	2451	3155	3970	3572	3387	3302	3976	3623	4345	4588	3499	4147	3313	2577	2639	3119	2714	1998	1622	1625	521	18
			Other surf.	670	331	1448	252	183	175	99	320	231	271	17	429	308	273	175	169	177	193	215	273	286	880	632	230	401	369	207	39	31	29
	ATS		Longline	1732	2161	3085	2379	2163	1996	1596	2566	2090	2088	3204	2450	3245	2992	2745	1799	2057	2485	3196	2842	2149	3241	2760	2748	2620	3149	2291	2820	2234	2462
			Other surf.	11	21	15	16	25	12	10	22	18	15	31	76	14	43	30	82	7	1	62	55	34	31	12	13	162	7	8	29	9	3
	MED		Longline	0	0	0	0	6	8	5	4	7	2	2	2	17	10	2	1	1	2	2	2	0	0	0	0	0	0	0	0	0	0
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Discards	ATN		Longline	24	21	29	0	2	0	1	8	0	0	0	0	0	0	7	9	20	2	9	19	5	12	10	8	4	24	56	74	644	784
			Other surf.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	2	0	
	ATS		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	8	0	2	2	3	3	2	9	7	13	20
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0
	MED		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Landings	ATN	CP	Barbados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	3	0	0	0	0	**0**
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	28	69	114	99	1	1	1	9	12	2	0	3	**0**
			Canada	0	0	111	67	110	69	70	78	69	78	73	80	91	71	72	43	53	41	37	29	35	55	85	82	109	53	63	1	0	**0**
			China PR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	16	19	29	18	24	11	5	2	4	2	0	0	0	0	**0**
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	1964	2164	2209	3294	2416	2223	2051	1561	1684	2047	2068	2088	1751	1918	1814	1895	2216	2091	1667	2308	1509	1481	1362	1574	1784	1165	866	870	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2	0	0	0	1	1	2	1	0	1	0	1	1
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	796	649	657	691	354	307	327	318	378	415	1249	473	1109	951	1540	1033	1169	1432	1045	1023	820	219	222	264	276	272	289	342	202	1
			FR-St Pierre et Miquelon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	4	0	0	4	0	0	0	0	0	0	0	0	**0**
			Great Britain	0	0	0	0	0	0	2	3	2	1	1	1	0	0	0	1	15	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	425	214	592	790	258	892	120	138	105	438	267	572	0	0	82	131	98	116	53	56	33	69	45	74	89	20	4	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	27	15	8	2	1	3	5	4	0	0	**0**
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	**0**
			Maroc	0	0	0	0	0	0	0	0	0	0	147	169	215	220	151	283	476	636	420	406	667	624	947	1050	450	594	501	382	299	**0**
			Mauritania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	**0**
			Mexico	0	0	10	0	0	0	0	10	16	0	10	6	9	5	8	6	7	8	8	8	4	4	4	3	5	2	2	2	2	3
			Panama	0	0	0	0	0	0	1	0	0	0	0	0	0	0	49	33	39	0	0	0	19	7	0	0	0	0	0	0	0	**0**
			Philippines	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	17	21	0	0	2	0	2	2	2	68	68	26	0	0	**0**
			St Vincent and Grenadines	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	**0**
			Trinidad and Tobago	0	3	1	1	1	2	1	3	6	2	3	1	2	1	1	1	1	1	0	2	1	1	1	1	2	2	1	1	1	1
			UK-Bermuda	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	894	574	1658	400	345	296	198	414	350	372	106	477	422	353	319	296	314	350	332	371	363	961	572	271	302	165	57	48	39	40
			Venezuela	1	7	7	17	9	8	6	9	24	21	28	64	27	14	19	8	41	27	20	33	9	13	7	7	9	7	8	8	3	1
		NCC	Chinese Taipei	9	29	32	45	42	47	75	56	47	53	37	70	68	40	6	23	11	14	13	14	8	4	13	7	1	0	0	0	0	**0**
			Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	1	2	1	1	0	1	0	0	0	**0**
		NCO	Sta Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	
	ATS	CP	Angola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0	0	7	23
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	38	0	17	2	0	32	59	78	88	1	15	14	34	15	7	2	1	**0**
			Brazil	122	95	119	83	190	233	27	219	409	226	283	238	426	210	145	203	99	128	192	196	276	268	173	124	275	399	739	542	477	557
			China PR	34	45	23	27	19	74	126	305	22	208	260	68	45	70	77	6	24	32	29	8	9	9	5	3	1	0	0	0	0	**0**
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Côte d'Ivoire	10	20	13	15	23	10	10	9	15	15	30	15	14	16	25	0	5	7	0	20	34	19	11	13	161	4	8	14	9	1
			EU-España	772	552	1084	1482	1356	984	861	1090	1235	811	1158	703	584	664	654	628	922	1192	1535	1207	1083	1077	862	882	1049	1044	1090	799	650	657
			EU-Portugal	0	0	92	94	165	116	119	388	140	56	625	13	242	493	375	321	502	336	409	176	132	127	158	393	503	300	243	449	357	358
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Great Britain	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	701	1369	1617	514	244	267	151	264	56	133	118	398	0	0	72	115	108	103	132	291	114	182	109	77	96	93	53	1	0	0
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	13	7	7	4	4	18	8	9	1	0	0	0
			Namibia	0	0	0	0	0	0	1	0	0	459	375	509	1415	1243	1002	295	23	307	377	586	9	950	661	799	194	980	0	945	637	789
			Panama	0	0	0	0	0	0	24	1	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Philippines	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Senegal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	34	23	0	11	6	39	4	7	0	0	0
			South Africa	45	24	49	37	31	171	67	116	70	12	116	101	111	86	224	137	146	152	218	108	250	476	613	339	305	244	110	46	70	66
			UK-Sta Helena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Uruguay	28	12	17	26	20	23	21	35	40	38	188	249	146	68	36	41	106	23	76	36	1	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	31	65	87	117	139	130	198	162	120	146	83	180	226	166	147	124	117	144	203	150	157	158	152	92	85	64	42	52	35	13
		NCO	Vanuatu	0	0	0	0	0	0	0	0	0	0	0	52	12	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	MED	CP	EU-Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	6	7	5	3	2	2	2	2	2	4	1	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			EU-Portugal	0	0	0	0	0	1	0	1	5	0	0	0	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Discards	ATN	CP	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	20	22	26
			China PR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	2	1	5
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	585	588
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	14	141
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	28	18	13
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
			Mexico	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			UK-Bermuda	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			USA	24	21	28	0	2	0	1	8	0	0	0	0	0	0	7	10	20	2	9	18	5	11	8	6	4	2	1	3	4	10
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	22	5	12	1	2
	ATS	CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			China PR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	10	3
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	2	2	3	3	2	2	2	2	13
	MED	CP	EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

SMA-Table 2. Stock Synthesis model runs 1 and 3 combined Markov Chain Monte Carlo (MCMC, long chain) Kobe II risk matrix for North Atlantic shortfin mako projection results: Probability that the fishing mortality (F) will be below the fishing mortality rate at MSY ($F < F_{MSY}$; top panel), probability that the spawning stock fecundity (SSF) will exceed the level that will produce MSY ($SSF > SSF_{MSY}$; middle panel), and the probability of both $F < F_{MSY}$ and $SSF > SSF_{MSY}$ (bottom panel).

Probability that $F<F_{MSY}$.

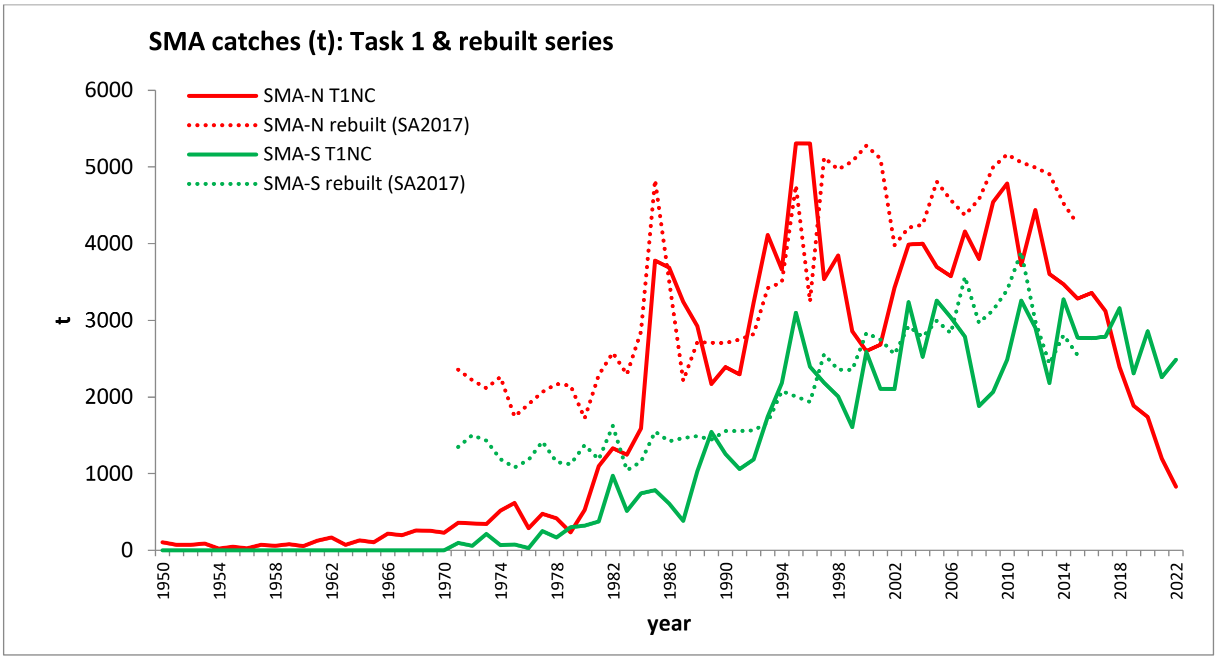
TAC (t)	2019	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
0	100	100	100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100	100	100	100
200	100	100	100	100	100	100	100	100	100	100	100	100
300	100	100	100	100	100	100	100	100	100	100	100	100
400	100	100	100	100	100	100	100	100	100	100	100	100
500	96	99	100	100	100	100	100	100	100	100	100	100
600	81	89	99	99	98	96	95	97	97	97	96	95
700	57	69	93	92	88	82	80	83	84	85	82	82
800*	32	45	76	77	70	63	62	64	67	67	65	63
900	15	24	57	58	51	46	44	47	51	49	49	48
1000	5	11	37	38	31	27	26	28	30	31	30	30
1100	2	4	19	21	17	13	11	13	14	14	14	13

Probability that $SSF>SSF_{MSY}$.

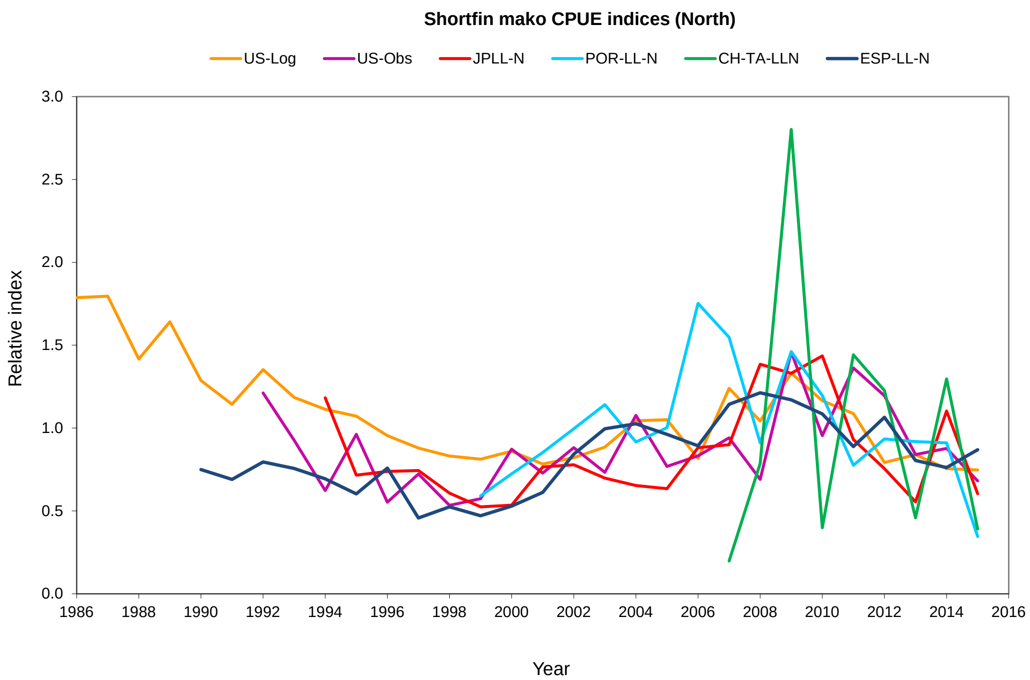
TAC (t)	2019	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
0	46	42	24	14	11	33	53	60	63	67	72	81
100	46	42	24	13	10	29	49	56	59	61	66	73
200	46	42	24	13	9	26	47	54	55	57	61	66
300	46	42	24	12	9	22	42	50	52	53	56	60
400	46	42	24	12	8	19	39	47	49	50	52	55
500*	46	42	24	12	7	17	34	42	45	47	49	52
600	46	42	24	12	7	14	28	37	40	41	43	47
700	46	42	24	11	6	11	23	31	34	35	37	41
800	46	42	23	11	6	10	19	26	27	28	30	32
900	46	42	23	11	5	8	16	20	21	21	23	24
1000	46	42	23	11	5	7	12	16	16	15	15	17
1100	46	42	23	10	5	6	10	12	12	11	10	10

Probability of being in the green zone ($F<F_{MSY}$ and $SSF>SSF_{MSY}$).

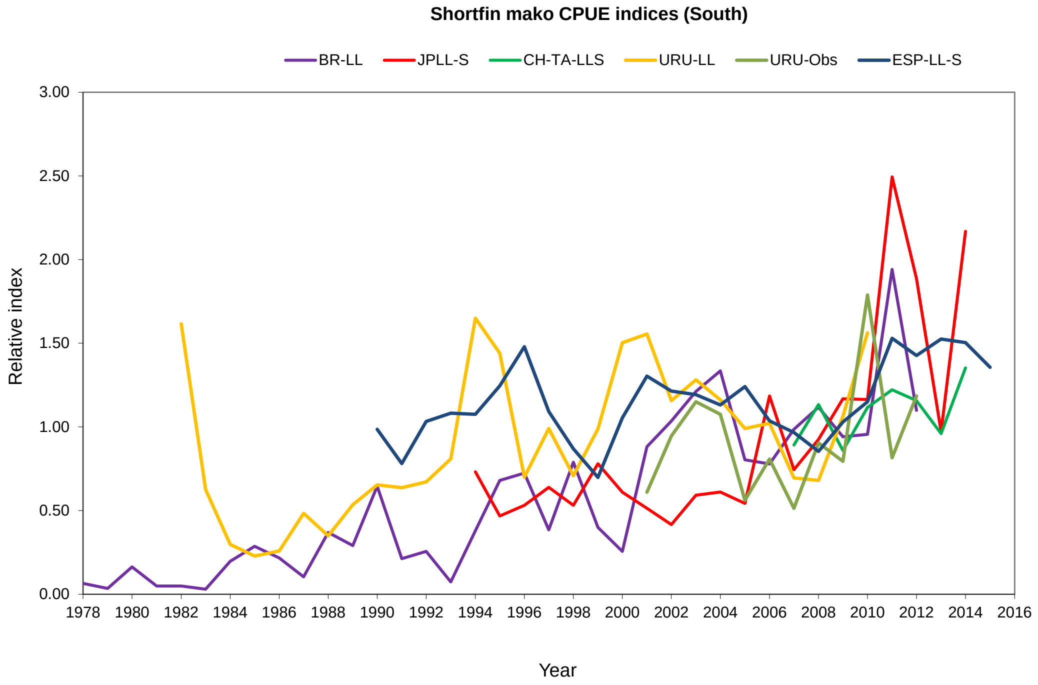
TAC (t)	2019	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
0	46	42	24	14	11	33	53	60	63	67	72	81
100	46	42	24	13	10	29	49	56	59	61	66	73
200	46	42	24	13	9	26	47	54	55	57	61	66
300	46	42	24	12	9	22	42	50	52	53	56	60
400	46	42	24	12	8	19	39	47	49	50	52	55
500*	46	42	24	12	7	17	34	42	45	47	49	52
600	45	42	24	12	7	14	28	37	40	41	43	47
700	41	41	24	11	6	11	23	31	34	35	37	41
800	27	34	23	11	6	10	19	26	27	28	30	32
900	14	21	23	11	5	8	15	20	21	21	23	24
1000	5	10	20	10	5	7	12	15	15	14	14	16
1100	2	4	14	9	4	5	7	9	9	8	8	8



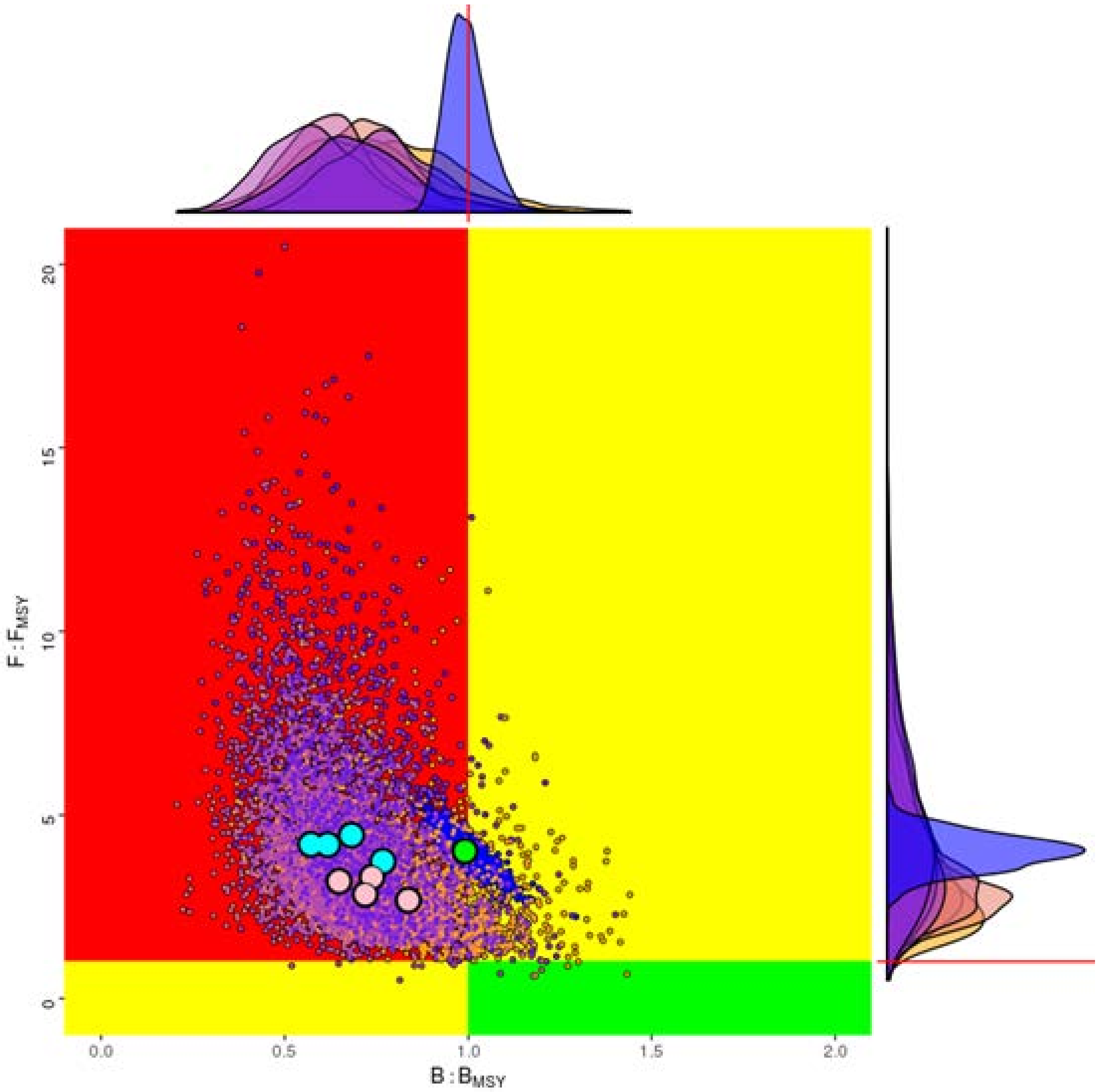
SMA-Figure 1. Shortfin mako (SMA) catches of both stocks (SMA-N in red, SMA-S in green) reported to ICCAT (Task 1) and estimated by the Committee.



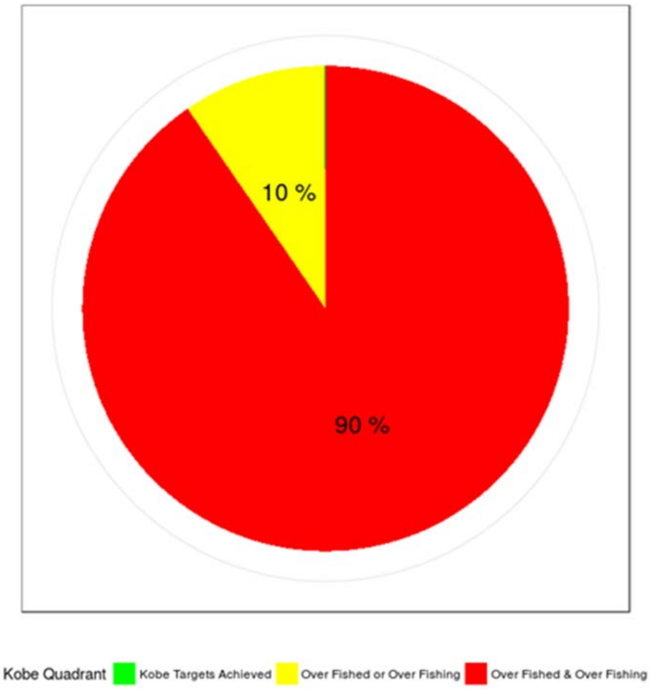
SMA-Figure 2. Indices of abundance for North Atlantic shortfin mako shark used in the 2017 stock assessment.



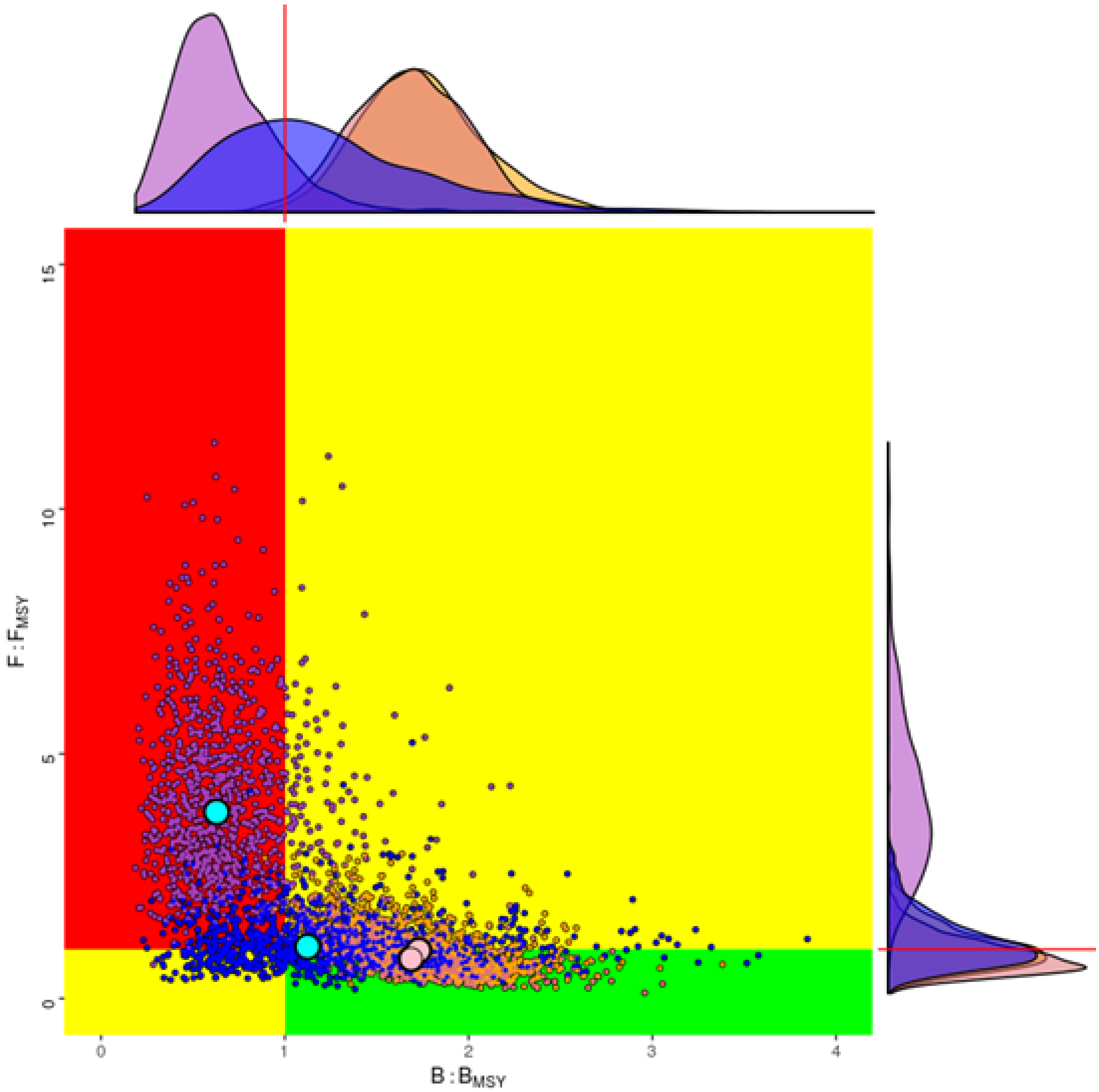
SMA-Figure 3. Indices of abundance for South Atlantic shortfin mako shark used in the 2017 stock assessment.



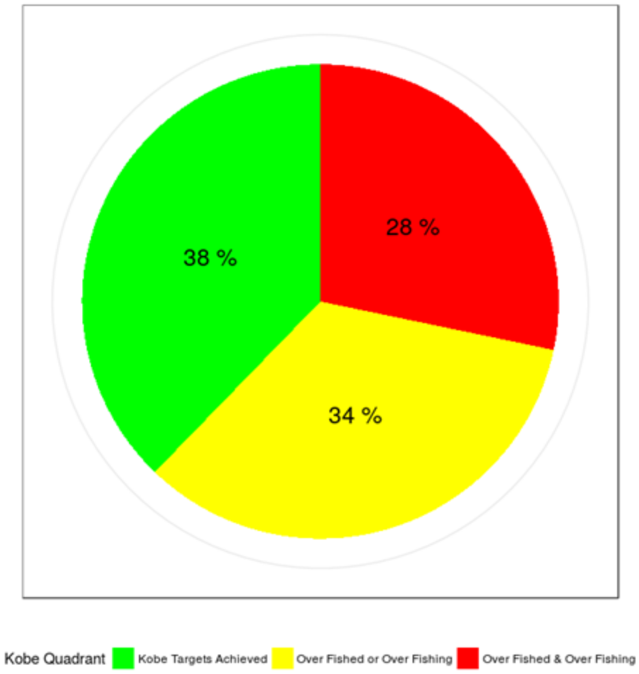
SMA-Figure 4. Stock status (2015) of North Atlantic shortfin makos based on Bayesian production models (4 BSP2JAGS and 4 JABBA runs) and 1 length-based, age-structured model (SS3). The clouds of points are the bootstrap estimates for all model runs showing uncertainty around the median point estimate for each of nine model formulations (BSP2JAGS: solid pink circles; JABBA: solid cyan circles; SS3: solid green circle). The marginal density plots shown are the frequency distributions of the bootstrap estimates for each model with respect to relative biomass (top) and relative fishing mortality (right). The red lines are the benchmark levels (ratios equal to 1).



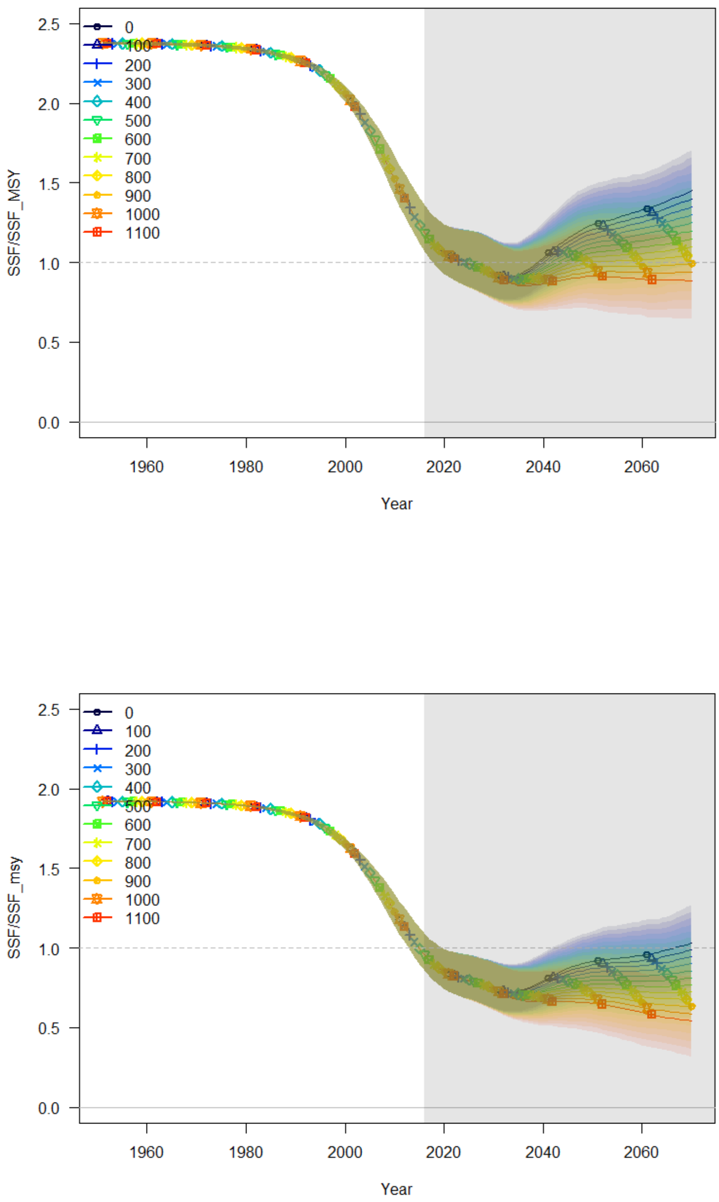
SMA-Figure 5. Kobe pie chart summarizing stock status (for 2015) for North Atlantic shortfin mako based on Bayesian production models (4 BSP2JAGS and 4 JABBA runs) and 1 length-based age-structured model (SS3). Probability of being in the green quadrant is less than 0.5%.



SMA-Figure 6. Stock status (2015) of South Atlantic shortfin makos based on a Bayesian production model (BSP2JAGS) and a catch-only model (C_{MSY}). The clouds of points are the bootstrap estimates for all models combined showing uncertainty around the median point estimate for each of four model formulations (BSP2JAGS: solid pink circles; CMSY: solid cyan circles). The marginal density plots shown are the frequency distributions of the bootstrap estimates for each model with respect to relative biomass (top) and relative fishing mortality (right). The red lines are the benchmark levels (ratios equal to 1).



SMA-Figure 7. Kobe pie chart summarizing stock status (for 2015) for South Atlantic shortfin makos based on a Bayesian production model (2 BSP2JAGS runs) and a catch-only model (2 C_{MSY} runs).



SMA-Figure 8. Constant catch projections (0 – 1100 t) from Stock Synthesis model run 1 (top panel) and run 3 (bottom panel) for the North Atlantic shortfin mako (Anon., 2020e). Solid lines are medians and shaded areas are 95% credible intervals.

9.17 POR - Porbeagle

This document contains the information on stock assessments conducted in different years. Three of the porbeagle stocks (Northwest, Southwest and Southeast) were assessed by the ICCAT SCRS in 2020. The Northeast stock was assessed in 2022 in a joint process with the International Council on the Exploration of the Sea (ICES). The Porbeagle Executive Summary updated catch information from all stocks. However, stock status elements for the southern and western stocks use the information from the 2020 ICCAT Porbeagle Stock Assessment Meeting (Anon., 2020f). The Northeast stock information has been updated with both new information from the catch and new information from the 2022 assessment. The decision was to keep results for all porbeagle stock together because the information from the Northwest and southern stocks was not updated in the 2022 assessment.

The latest information on the status of the porbeagle (*Lamna nasus*) stock is available in the Report of the 2020 ICCAT Porbeagle Stock Assessment Meeting (Anon., 2020f). In 2022 a joint ICES/ICCAT stock assessment was conducted for the northeast stock of porbeagle, for which results are included herein.

POR-1. Biology

Porbeagle is a large pelagic shark that shows a wide geographic distribution associated with cold-temperate waters. Porbeagle is an aplacental viviparous shark, with oophagy, which limits their fecundity to an average litter size of around four but increases the probability of survival of their young. Gestation period is 8 to 9 months. Median size at maturity is about 174 cm FL (fork length) or 8 years for males and 218 cm FL or 13 years for females, with mating taking place between September and November in the North Atlantic. Breeding frequency was determined to be annual, but a recent study found that at least a portion of the Northwest Atlantic population is biennial or possibly even triennial based on the finding of a resting stage. Although uncertainty regarding their biology remains, available life history traits (slow growth, late maturity and small litter size) indicate that it is vulnerable to overfishing. A behavioral characteristic of this species is its tendency to segregate temporally and spatially by size and/or sex during feeding, mating-reproduction, gestation and birth processes. Tagging studies have suggested that the species exhibits large-scale migratory behaviour and periodic vertical movement, but the lack of information on some components of the populations precludes a complete understanding of their distribution/migration patterns by ontogenetic stage and in some cases identifying their pupping/mating grounds. Numerous aspects of the biology of this species are still poorly understood or completely unknown, particularly for some regions, which contributes to increased uncertainty in quantitative and qualitative assessments.

The stock structure for porbeagle shark was first addressed in 2009 at the Joint ICCAT/ICES Porbeagle Stock Assessment Meeting (Copenhagen, Denmark, June 22 to 27, 2009) (Anon., 2010). Data at that time supported the view of restricted movements between the NE and NW Atlantic individuals. Therefore, it was concluded that in the North Atlantic there were two stocks. Regarding the South Atlantic, it was understood that there were two stocks, SW and SE, although the possibility was raised that both southern stocks would extend to the bordering oceans (Pacific and Indian). Since 2009, a number of mark-recapture, pop-up archival satellite tag (PSAT) studies have further examined the movements of porbeagle particularly in the North Atlantic Ocean. Nearly all of the long-term satellite tagging, conventional tagging, and survival tagging supports that porbeagle stocks in the Northeast Atlantic are separate from the Northwest. There is little tagging information from the South Atlantic. In addition to tagging studies, a study of genomic DNA suggests there is strong genetic subdivision between the North Atlantic and Southern Hemisphere populations but found no differentiation within these hemispheres. New information derived from fishery and research data from the South Atlantic, Pacific and Indian Oceans indicates that there is a continuous distribution of the species in the three oceans and that it ranges from 20° to 60° South latitude. Overall, there is insufficient data to define the appropriate number of stocks in the Southern Hemisphere.

POR-2. Fishery indicators

The Committee considered that, based on the most recent and best available information, there are two stocks in the North Atlantic (NW, NE) and likely a single stock in the South Atlantic. However, two areas (SW and SE) are considered for catch data reporting purposes in the South Atlantic (**POR-Table 1** and **POR-Figure 1**).

Few CPUE series were presented during the 2020 porbeagle assessment as management measures led to changes in the fishery that resulted in lack of sufficient data on porbeagle catch rates or changes in management that could not be accounted for in the CPUE standardization procedure.

Two standardized CPUE series were presented for the NW Atlantic stock: a Canadian fishery-independent survey and a Japanese pelagic longline fishery series based on observer data. The Canadian survey showed a decline from 2007 to 2017 but was deemed not to reflect abundance; the Japanese series showed a stable trend during 2000-2014 and an increase from 2014 to 2018, which could be attributable to an increase in juvenile sharks. A standardized CPUE series was presented for the SW stock based on data from Uruguayan longliners from 1982 to 2012. The Uruguayan tuna fleet can be divided into two well-defined periods: 1982-1992 Japanese-style longline (deep sets), and 1993-2012 American-style longline (shallow sets). The first period had higher standardized CPUE values, suggesting that fishing method factors such as set depth or bait type may have an effect on porbeagle catch rates.

For the 2022 NE Atlantic porbeagle assessment, 3 standardized CPUE indices were considered: a Norwegian longline CPUE series from 1950 to 1972, that shows a downward trend in the second half of the 1950s, but this trend seems to have stabilized in the early 1960s, followed by a slight increase in the late 1960s and early 1970s; a French longline CPUE series from 1972 to 2009, that shows that the relative abundance index obtained decreases in the 1970s, but thereafter varies without trend; a Spanish longline CPUE series from 1986 to 2007, that presents higher values in the 2000s, with large interannual variations. This index was previously used in the 2009 ICCAT-ICES assessment. Also, it was considered in the assessment a composite survey CPUE series constructed by combining CPUEs of a French commercial vessel, from 2000 to 2009, with CPUEs of a survey carried out in 2018-2019.

POR-3. State of the stocks

Due to changes in management practices that would have affected the development of CPUE series and potentially length composition data, in 2020 the Committee was constrained to use non-traditional stock assessment methods. Overfished stock status could only be determined for the NW stock and overfishing stock status, for the combined stocks in the North Atlantic and the South Atlantic. The Committee formally assessed the NE stock together with the ICES Working Group of Elasmobranch Fishes (WGEF) in 2021-2022.

Two modelling approaches were used to assess the status of porbeagle shark in the Atlantic and two additional methods were also explored. The Sustainability Assessment for Fishing Effects (SAFE) was used to evaluate whether the combined North and combined South Atlantic stocks were experiencing overfishing. The Incidental Catch Model (ICM) was used to evaluate whether the NW Atlantic stock was currently overfished and to determine the stock's capacity for future removals. Exploratory analyses that were not used to derive advice for the current assessment included the ICM fit to the South Atlantic stock, length-based approaches fit to the NW, SW, and SE stocks, and input control management options explored in a preliminary MSE approach for the NW stock. All of the exploratory approaches showed promise and could be further explored in future assessments.

Results of the SAFE approach indicated that neither the North Atlantic nor the South Atlantic stocks are undergoing overfishing. It was noted that while this is a data-limited approach, the overfishing status results were robust to the selectivity curve assumed and the post-release mortality value used in the computation of post-capture mortality. The Committee noted that for the South Atlantic results are in line with those found in the 2017 Southern Hemisphere (SH) porbeagle Areas Beyond National Jurisdiction (ABNJ) stock status assessment, with F/F_{MSY} values from both studies being of relatively similar magnitude (annual mean=0.063, range: 0.046 to 0.083 for 2006-2014 in the SH assessment vs. annual mean=0.113, range: 0.107-0.119 for 2010-2018 in the SAFE analysis).

An equal mix of annual and biennial reproduction was considered the most likely scenario for the porbeagle population in the NW Atlantic, so these productivity assumptions were used for the base case formulation of the ICM. Two alternate parameterizations of the ICM were evaluated to determine the model's sensitivity to life history assumptions as well as to the assumed population size in 2018. The first sensitivity analysis assumed a reproductive periodicity of only one year (annual reproduction), consistent with productivity assumptions in the 2009 assessment. The second assumed larger population size in 2018, so that predicted abundance in 2009 matched the value of 200,000 animals from the Canadian Statistical-Catch-at-Age model presented at the 2009 assessment. In all formulations, the stock was predicted to be overfished in 2018 with > 70% probability, even though abundance has been increasing since 2001. The scenarios differed in how far 2018 abundance was below the MSY proxy for biomass, with both sensitivity analyses suggesting that the population was closer to the reference point. The base case formulation of the ICM estimated biomass in 2018 to be 57% of the MSY proxy reference point (353,000 animals), giving a 98% probability of the stock being overfished.

Due to a lack of reporting, the magnitude of dead discards remains uncertain and post-release mortalities are not incorporated in this assessment, so there remains considerable uncertainty in the assessment of status. If actual total removals (unreported landings, dead discards, and post-release mortalities) do not largely exceed what has been estimated, then with the large reduction in recent reported removals, the Committee considers it unlikely that the stock is undergoing overfishing, but it considers that the stock remains overfished.

The Northeast Atlantic porbeagle stock has the longest recorded history of commercial exploitation for ICCAT sharks. During the 2009 assessment, a lack of CPUE data for the peak of the fishery was considered to add uncertainty in identifying the status relative to virgin biomass. This issue has been resolved in the 2022 assessment with the availability of the Norwegian longline CPUE series which begins in 1950, thus when catches were still above 3,000 t. The 2022 stock assessment was carried out using the Surplus Production Model in Continuous Time (SPiCT) model with priors agreed for the final benchmark assessment. The exploited biomass decreases below B_{MSY} in the early 1950s. Despite an increase in the 2010s due to the fishing restriction in place since 2010, B/B_{MSY} = 0.5 in 2022. The stock remains overfished, but overfishing is not occurring, consistent with the low values of current F.

POR-4. Outlook

Projections conducted with the ICM for the NW stock indicated that removals of less than 7,000 sharks (214 t) would allow rebuilding with a 60% probability by 2070 (a projection interval of 2.5 generations) and removals of less than 8,000 sharks (245 t) would allow rebuilding with a 50% probability by 2060 (**POR-Table 2** and **POR-Figure 3**). If removals remained similar to 2014-2018 (mean = 47 t), the stock was predicted to rebuild with at least a 50% probability between 2030 and 2035). However, the Committee emphasized that recent removals are very likely underestimated because few CPCs report dead discards, and post-release mortality of live discards was not taken into account.

During the 2022 porbeagle northeast stock assessment, long-term projections using constant catch were not presented because technical issues prevented projections from being carried out during the assessment. So, Kobe Strategy matrix was not created. Projections will be produced during the next porbeagle stock assessment.

POR-5. Effect of current regulations

In 2013 Uruguay prohibited retention of porbeagle sharks and Canadian directed fisheries for porbeagle have also been closed since 2013. From 2010–2014, successive EC Regulations had established a zero TAC for the Northeast porbeagle in EU waters of the ICES area and prohibited EU vessels to fish for, to retain on board, to transship and to land porbeagle in international waters. Since 2015 it has been prohibited for EU vessels to fish for, to retain on board, to transship or to land porbeagle, with this applying to all waters. Since 2021 porbeagle is also included on the list of prohibited species in UK waters. It has been forbidden to catch and land porbeagle in Sweden since 2004; and in 2007, Norway banned all direct fisheries for porbeagle. In 2017, a regulation was issued to ban all targeted fishing in Icelandic waters for spurdog, porbeagle and basking shark and stipulating that all viable catch in other fisheries must be released.

Estimated catches (based primarily on landings data) for the NE stock have steadily decreased since the species became prohibited in 2010 (21 t) to 15 t in 2022; for the NW stock catches of 284 t were estimated for 2013 but have decreased to 7 t in 2022; catches for the SE and SW stocks are insignificant, less than 4 t annually since 2015 for the SE and 0 t for the SW since 2013. Captures in the Mediterranean have historically been very low, less than 1 t since 1980 (**POR-Table 1** and **POR-Figure 1**). However, the Committee noted that these catches likely underestimate total removals because they do not include dead discards in many cases and reporting of post-release mortality of live releases is not required. Furthermore, the magnitude of porbeagle removals in non-ICCAT coastal fisheries is unknown but likely high.

The proportion of catches released alive has increased since 2015 following the implementation of Rec. 15-06, which obligates that CPCs require their vessels to promptly release unharmed, to the extent practicable, porbeagle sharks caught in association with ICCAT fisheries when brought alive alongside for taking on board the vessel.

Porbeagle was listed under Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2013. Among other things, CITES Appendix II carries a requirement that Parties issue export and import, as well as introduction from the sea, permits based on findings that the take is legal and sustainable. Development of these "non-detriment findings" and related permitting processes is underway.

Parties to the Convention on Migratory Species (CMS) have listed 29 elasmobranch species under its Appendices. Appendix II, which includes porbeagle, signals a commitment to international cooperation toward conservation.

Under current regulations, 2020 NW assessment and 2022 NE assessment indicate that both stocks have increased in the last 10 years, showing in the case of the NW a rebuilding trend since 2001.

POR-6. Management recommendations

The following management recommendations were agreed upon and included in the Executive Summary based on the 2020 ICCAT porbeagle stock assessment. During the 2022 SCRS meeting, section 1a was updated with the information reported by CPCs, and section 7 was discussed and agreed based on the results of the NE porbeagle stock assessment conducted during 2022 in a joint process between ICCAT and ICES.

The Committee recommends that the Commission work with countries catching porbeagle and relevant Regional Fisheries Management Organization (RFMOs) to ensure recovery of North Atlantic porbeagle stocks (e.g., ICES, Northwest Atlantic Fisheries Organisation (NAFO)). In particular, porbeagle fishing mortality should be kept at levels in line with scientific advice and with removals not exceeding the current level. New targeted porbeagle fisheries should be prevented, porbeagles retrieved alive should be released following best handling practices to increase survivorship, and all catches should be reported. Management measures and data collection should be harmonized as much as possible among all relevant RFMOs dealing with these stocks, and ICCAT should facilitate appropriate communication.

1. The SCRS needs cooperation from all CPCs to improve catch statistics, which is critical to advancing the assessments of all porbeagle stocks.

    a) Three CPCs have reported live discards of porbeagle for 2021. The Committee underlines that the reporting and quantification of live discards is critical, especially for a stock where all live animals must be released (Rec. 15-06); the Commission should find ways to encourage improved reporting of live discards.
    b) There is a need for CPCs to strengthen their monitoring and data collection efforts, including but not limited to improved estimates of dead discards and the estimation of CPUEs using observer data.
    c) The Committee requests CPCs revise their porbeagle catch series (landings, live discards, and dead discards) including incidental captures from their other non-ICCAT fisheries (gillnet, trawling, purse seiner, etc.) to allow the SCRS to incorporate all mortality sources into future assessments and reduce the uncertainty in stock status and projections.
    d) In addition, the Committee recommends that the ICCAT liaise with parties (e.g., other RFMOs) and engage in data mining to determine the total capture from non-ICCAT parties.

2. The Committee notes that management recommendations for porbeagle stocks under ICCAT responsibility are drafted for ICCAT fisheries. However, porbeagle stocks are subject to mortality from CPCs' coastal fisheries and countries that are not ICCAT Parties. Therefore, the Committee recommends that CPCs implement a live release requirement for all porbeagle caught in their waters and that ICCAT develop integrated management approaches (with other countries, other Regional Fisheries Bodies, United Nations Food and Agriculture Organization (FAO)) to assure the sustainability of Atlantic porbeagle stocks.

3. The Committee notes that some landings and the majority of discards go unreported, meaning that total mortality of porbeagle from all sources (i.e., landings, dead discards and live releases that subsequently die as a result of gear interactions) is underestimated. For the purposes of this assessment, the Committee estimated unreported landings and dead discards preliminarily that were 89% higher than reported but did not estimate mortality following live release. The Commission should be aware that actual removals are higher than what is being reported and Kobe matrices will be optimistic to the extent that removals are underreported.

4. Considering the underreporting of removals, and the current low stock status of the NW Atlantic stock (B_{2018}/B_{MSY}=0.57), the Committee recommends that total removals (i.e., the sum of landings, dead discards, and post-release mortality of live releases) do not exceed current levels (including unreported removals) to allow for stock recovery. Although the Kobe matrix might suggest that some increases in total removals could allow for potential recovery in the long term, the assessment suggests that the stock is productive enough to recover in a much shorter time frame if total removals are maintained at a lower level. This is consistent with Rec. 11-13 that overfished stocks be recovered in as short a period as possible. However, the Commission should be aware that actual removals (particularly dead discards and post-release mortalities of live releases) are higher than what is being reported and the Kobe matrix is overly optimistic to the extent that removals are underreported.

5. While there is large uncertainty in southern stock structure, new information suggests a single stock of porbeagle in the South Atlantic; the Committee had, until now, considered two stock units, SW and SE. Indeed, there may be a southern stock that extends across Indian and Pacific Ocean basins. More research on stock structure needs to be undertaken to determine an appropriate unit stock. Until this research is done, the Committee recommends leaving the management units as currently defined.

6. The Committee was not able to draw any conclusions on the overfished status of the southern stock(s). It noted that indeed, conventional data (e.g., landings, representative length compositions) cannot be collected for any northern or southern porbeagle stocks, so the Committee concluded that alternative (e.g., fishery independent) data collection methods that allow CPUE or length-frequency data (or other altogether different forms of data) to be collected are required to provide more reliable estimates of stock status in the North and in the South Atlantic.

7. Considering the underreporting of removals, the current stock status of the NE Atlantic stock B_{2022}/B_{MSY}=0.464 (0.15-1.43), and the lack of reliable projections to build Kobe II Strategy Matrix (K2SM), the Committee recommends that total removals (i.e., the sum of landings and estimated dead discards) at the very least shall not exceed the average reported ICCAT catch since the implementation of the zero TAC recommendation (i.e., 2010-2021 which current estimates would be 9.3 tons) to allow for stock recovery. Lower levels of removals will accelerate such recovery.

NORTHWEST ATLANTIC PORBEAGLE SUMMARY

Current Yield (2022)		7 t[1]
Relative Biomass	B_{2018}/B_{MSY}	0.57[2]
Fishing Mortality at MSY	F_{MSY}	0.049[3]
Relative fishing mortality	$F_{2010\text{-}2018}/F_{MSY}$	0.413[3]
Stock Status (2018)	Overfished Overfishing	Yes Not likely
Management Measures in Effect		Rec. 04-10, Rec. 07-06, Rec. 15-06

[1] Estimated catch for the Northwest stock as of 21 September 2023. Catch does not include all dead discards and includes no mortalities resulting from live releases.
[2] Value obtained with the ICM model. The reference point used (SPR_{MER}) is a proxy for B_{MSY}.
[3] Value obtained with the SAFE approach for the North Atlantic.

NORTHEAST ATLANTIC PORBEAGLE SUMMARY

ICES-ICCAT Yield in 2021[1]		7.95 t[2]
Relative Biomass	B_{2021}/B_{MSY}	0.464 (0.15-1.43)[2]
Fishing mortality at MSY	F_{MSY}	0.051 (0.0217-0.120)[2]
Relative fishing mortality	F_{2021}/F_{MSY}	0.013 (0.0024-0.073)[2]
Stock Status (2021)	Overfished Overfishing	Yes No
Management Measures in Effect		Rec. 04-10, Rec. 07-06, Rec. 15-06

[1] The value reported represents the total catches determined at the ICES-ICCAT Working Group on Elasmobranch Fishes (WGEF). While the Task 1 reported catch for the Northeast stock was 15.4 t, the catch shown does not include all dead discards and includes no mortalities resulting from live releases.
[2] Range obtained from reference case SPiCT with 95% Bayesian credibility intervals.

SOUTH ATLANTIC PORBEAGLE SUMMARY

Current Yield (2022)		0 t[1]
Relative Biomass	B_{2018}/B_{MSY}	Unknown
Fishing mortality at MSY	F_{MSY}	0.062[2]
Relative fishing mortality	$F_{2010\text{-}2018}/F_{MSY}$	0.113[2]
Stock Status (2018)	Overfished Overfishing	Undetermined Not likely
Management Measures in Effect		Rec. 04-10, Rec. 07-06, Rec. 15-06

[1] Sum of the estimated catch for the Southwest and Southeast Atlantic stock areas as of 21 September 2023.
[2] Value obtained with the SAFE approach for the South Atlantic.

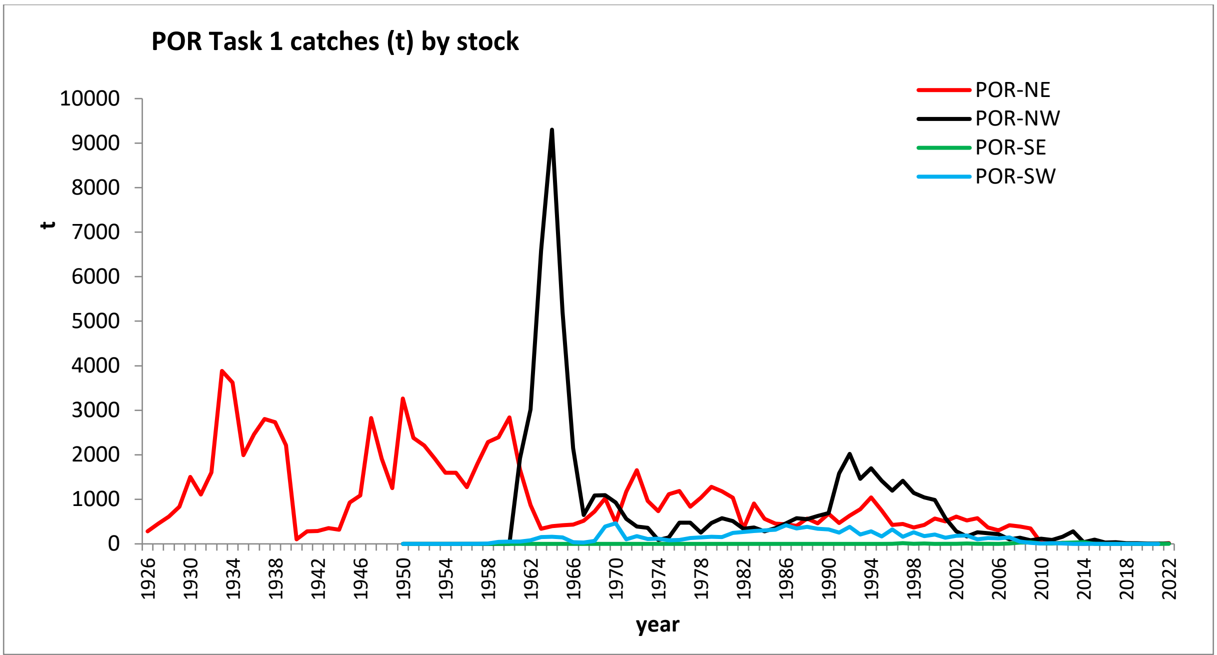
POR-Table 1. Estimated catches (t) of porbeagle (*Lamna nasus*) by area, gear and flag.

				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
TOTAL				2453	3027	2334	1951	2041	1776	1648	1769	1223	1074	887	954	740	642	671	619	495	152	120	225	323	78	104	41	48	27	16	14	15	22
	ANE			777	1045	749	428	444	371	424	567	506	610	527	578	367	302	421	391	349	21	14	25	10	5	8	9	8	4	0	3	5	15
	ANW			1462	1698	1415	1192	1418	1141	1046	988	574	282	164	264	237	217	101	141	84	114	85	162	284	35	93	30	39	19	16	11	10	7
	ASE			0	0	0	3	19	1	6	0	1	1	9	3	1	0	5	30	37	6	7	26	29	38	3	1	0	4	0	0	0	0
	ASW			213	284	170	327	159	261	172	214	141	181	187	105	133	122	143	55	26	10	14	12	0	0	0	0	0	0	0	0	0	
	MED			0	0	0	1	0	1	0	1	1	0	0	3	2	1	0	2	1	1	0	1	0	0	0	1	1	0	0	0	0	0
Landings	ANE		Longline	23	101	64	55	39	33	28	33	41	83	142	275	63	62	301	229	143	9	2	1	1	0	5	3	1	0	0	0	0	0
			Other surf.	754	943	685	373	405	338	396	533	465	527	385	303	305	240	120	162	206	13	12	24	9	5	3	6	7	4	0	3	5	9
	ANW		Longline	1462	1697	1413	1186	1406	1124	1034	985	566	269	151	252	226	208	91	131	67	83	68	134	248	14	15	10	10	6	0	0	0	
			Other surf.	0	0	2	6	12	18	12	3	8	13	13	12	12	8	11	9	12	20	15	23	30	7	9	5	8	3	12	5	1	0
	ASE		Longline	0	0	0	3	15	1	2	0	1	1	9	3	1	0	5	30	36	6	7	25	29	13	3	1	0	4	0	0	0	
			Other surf.	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	
	ASW		Longline	213	282	170	326	159	259	170	213	141	181	187	105	133	122	143	55	26	10	14	12	0	0	0	0	0	0	0	0	0	
			Other surf.	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	MED		Longline	0	0	0	1	0	1	0	1	1	0	0	2	2	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Discards	ANE		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	ANW		Longline	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	11	2	5	6	14	67	13	19	7	0	1	2	4
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	4	6	3
	ASE		Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ASW		Longline	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Landings	ANE	CP	EU-Denmark	91	93	86	72	69	85	107	73	76	42	21	20	4	3	2	1	0	0	0	2	0	0	0	0	0	0	0	0	0	**0**
			EU-España	21	52	19	41	25	25	18	13	24	54	27	11	14	34	8	41	77	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	633	820	565	267	315	219	240	410	361	461	303	413	276	194	354	311	228	0	2	4	0	0	3	0	1	0	0	0	0	2
			EU-Germany	1	0	0	0	0	2	0	17	1	3	5	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Ireland	0	0	0	0	0	0	8	2	6	3	11	18	3	4	8	7	3	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	1	1	1	1	1	1	0	7	4	10	101	50	14	6	0	3	17	7	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Sweden	3	2	2	1	1	1	1	1	1	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Great Britain	0	0	0	0	0	1	6	8	12	10	25	24	24	11	26	15	11	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Iceland	3	4	6	5	3	4	2	2	3	2	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	
			Japan	0	0	0	5	4	0	0	0	0	0	0	0	0	0	12	0	3	2	1	1	0	0	0	2	0	0	0	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**0**
			Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	**0**
			Norway	24	24	26	28	17	27	32	22	11	14	19	24	8	27	10	12	10	12	11	17	9	5	4	6	6	3	0	3	5	8
			Russian Federation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Faroe Islands	0	48	44	8	9	7	10	13	8	10	14	5	19	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ANW	CP	Barbados	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	3	13	1	2	1	1	1	0	0	0	**0**
			Canada	919	1575	1353	1051	1334	1070	965	902	499	237	142	232	202	192	93	124	62	83	30	33	19	9	4	2	2	1	0	0	0	**0**
			FR-St Pierre et Miquelon	0	0	7	40	13	20	0	13	2	1	2	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	35	29	15	10	9	19	41	47	52	21	7	20	27	18	5	10	10	11	13	48	98	0	0	0	0	0	0	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	13	20	3	0	0	0	0	0	0	0	0	**0**
			Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	38	79	26	58	41	9	2	1	1	1	0	0	0	0	0	0	0	2	9	19	27	6	8	4	8	3	12	5	1	0
			Venezuela	2	4	1	7	2	8	9	6	2	0	0	0	0	0	0	1	3	3	9	19	69	4	6	4	8	4	0	0	0	**0**
		NCC	Chinese Taipei	4	10	12	27	18	13	27	19	18	22	12	8	7	5	3	2	2	3	7	15	50	1	5	4	0	0	0	0	0	**0**
		NCO	Cuba	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Faroe Islands	465	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ASE	CP	EU-España	0	0	0	0	2	1	2	0	1	1	9	3	0	0	0	1	11	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

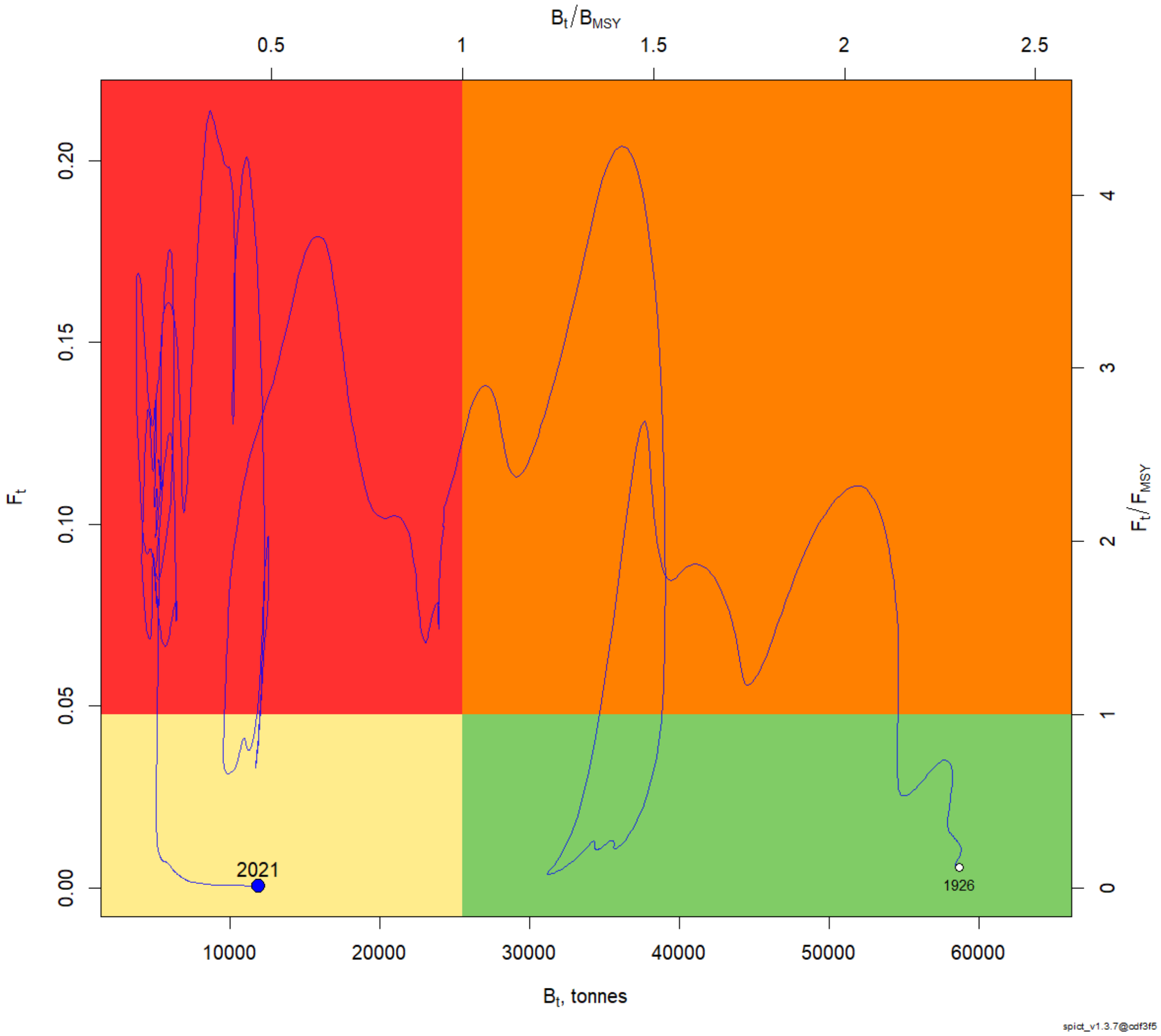
				1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
			Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	**0**
			Guinea Ecuatorial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	0	0	0	3	13	0	0	0	0	0	0	0	0	0	5	29	25	6	7	25	15	13	3	1	0	0	0	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	4	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**0**
		NCO	Benin	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	ASW	CP	Brazil	60	32	49	33	36	38	58	60	67	74	49	37	52	32	23	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**0**
			China PR	0	1	0	0	0	0	13	36	4	0	5	4	2	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	32	35	43	28	25	1	12	7	13	1	0	0	0	3	5	3	2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Poland	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-Portugal	0	0	0	0	1	0	0	0	1	1	1	4	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Japan	13	14	6	6	1	1	2	7	4	3	2	11	3	3	4	12	10	2	0	0	0	0	0	0	0	0	0	0	0	**0**
			Korea Rep	1	2	1	6	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Panama	6	24	4	21	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Philippines	0	0	0	0	0	0	0	0	0	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Uruguay	7	5	3	19	5	13	2	4	20	8	34	8	28	34	3	40	14	6	12	12	0	0	0	0	0	0	0	0	0	**0**
			Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	85	146	57	168	65	170	73	84	29	93	95	39	43	47	99	0	0	2	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Chile	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Cuba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Falklands	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			NEI (Flag related)	10	22	8	46	23	37	11	15	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Seychelles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	MED	CP	EU-Bulgaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU-Italy	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0	**0**
			EU-Malta	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	**0**
Discards	ANE	CP	EU-Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
			EU-Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	ANW	CP	Barbados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	1	1	0	0	0	**0**
			Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	3	3	5	8	6
			Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	1	1	1	5	1	1	0	0	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**0**
			UK-Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			USA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	1	2	7	34	1	9	1	0	0	0	**0**
			Venezuela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	1	3	14	4	7	4	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	1	11	4	0	0	0	0	0	**0**
	ASE	CP	Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			EU-España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Korea Rep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ASW	CP	El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
			Uruguay	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

POR-Table 2. Kobe II strategy matrix showing the probability of being above the overfished reference point (a proxy for B_{MSY}) by 5-year time period for removals scenarios ranging from 0 to 24,000 individuals (0-734 t) for porbeagle in the Northwest Atlantic.

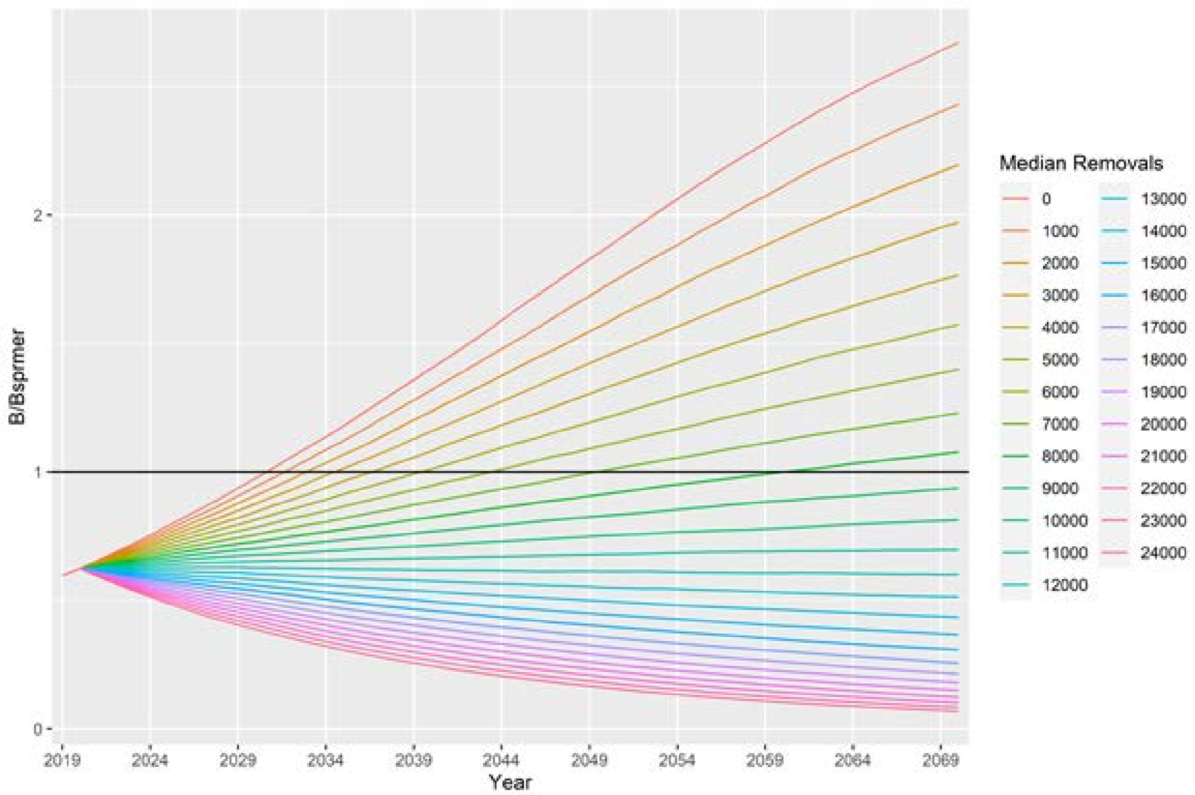
Animals (#)	Ton (mt)	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
0	0	2%	21%	47%	68%	83%	92%	96%	98%	99%	99%	100%
1000	31	3%	21%	44%	63%	77%	87%	92%	95%	97%	98%	99%
2000	61	2%	19%	40%	57%	71%	81%	87%	91%	94%	95%	96%
3000	92	1%	16%	35%	50%	62%	72%	79%	85%	88%	90%	92%
4000	122	2%	15%	32%	47%	58%	66%	73%	78%	82%	84%	87%
5000	153	2%	13%	27%	41%	50%	58%	64%	68%	72%	76%	78%
6000	183	1%	12%	25%	37%	45%	52%	57%	62%	65%	67%	70%
7000	214	2%	10%	22%	32%	39%	46%	50%	54%	57%	60%	62%
8000	245	2%	10%	19%	27%	34%	39%	44%	47%	50%	53%	55%
9000	275	2%	8%	17%	23%	30%	34%	38%	41%	43%	45%	47%
10000	306	2%	8%	14%	20%	25%	29%	31%	34%	36%	38%	39%
11000	336	1%	6%	13%	17%	21%	25%	27%	29%	31%	32%	33%
12000	367	2%	7%	11%	15%	18%	21%	23%	24%	26%	27%	28%
13000	398	2%	5%	9%	12%	14%	16%	18%	19%	20%	21%	22%
14000	428	2%	5%	7%	9%	12%	13%	14%	15%	16%	17%	18%
15000	459	1%	3%	5%	6%	8%	9%	10%	11%	11%	12%	12%
16000	489	2%	3%	4%	5%	6%	7%	8%	9%	9%	10%	10%
17000	520	2%	2%	3%	4%	5%	5%	6%	6%	6%	7%	7%
18000	550	2%	2%	2%	3%	3%	4%	4%	4%	5%	5%	5%
19000	581	2%	1%	2%	2%	3%	3%	3%	3%	3%	3%	4%
20000	612	2%	1%	1%	2%	2%	2%	2%	2%	2%	3%	3%
21000	642	2%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
22000	673	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
23000	703	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
24000	734	2%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%



POR-Figure 1. Porbeagle estimated catches by management unit.



POR-Figure 2. NE Atlantic porbeagle - Plot showing current status of northeast Atlantic porbeagle for the base case Surplus Production model in Continuous Time (SPiCT) model. Note that the step for the model is 1/16th of a year (0.0625).



POR-Figure 3. NW Atlantic porbeagle - Predicted relative abundance for annual removals ranging from 0 to 24,000 animals for the northwest stock, expressed as the biomass/biomass at SPR_{MER} ratio (a proxy for B_t/B_{MSY}) for the base case of the ICM. The horizontal line shows the reference point, and the projections extend for 50 years. Average removals from 2016-2018 were assumed for 2019 and 2020 and the projection starts in 2021.

9.18 Ecosystem and Climate Change Considerations

Since the current Executives Summaries template does not include a section on Ecosystem and Climate Change consideration, and until a new template for the Executive Summaries is approved by the Commission, the Committee is providing information on these matters for the consideration of the Commission below.

Bluefin tuna

For both stocks, ecosystem impacts on recruitment dynamics, fishery catchability, stock movement and productivity have long been considered by the Committee in previous stock assessments and index standardization. The Committee continues to pursue directed research to develop spatial temporal indices and to incorporate environmental covariates into index standardization and studies of stock mixing and movement from electronic and archival tagging, genetics and microchemistry. Furthermore, the Committee is embarking upon the key initial steps to support close-kin mark-recapture estimates of total spawning stock abundance to inform on possibly varying stock productivity.

The Committee considers that the recently adopted management procedure may represent, at least to some extent, climate-resilient management advice as the reference grid of operating models specifically included regime changes in stock productivity and wide ranges of both absolute abundance and biological productivity. Furthermore, the management strategy evaluation also incorporates essential data from electronic tagging, genetics and microchemistry that informs environmentally mediated dynamics.

Swordfish

For Atlantic and Mediterranean swordfish stocks, ecosystem impacts on recruitment dynamics, fishery catchability, stock movement, and productivity have long been considered by the Committee in previous stock assessments and index standardization. The Committee continues to pursue directed research to develop spatial-temporal indices, to incorporate environmental covariates into CPUE standardization, to develop studies on habitat suitability, and to use electronic archival tagging and genetics to understand environmental and climate change impacts on stock distribution and mixing.

The Committee continues to conduct work on a MSE for North Atlantic swordfish. The Committee is testing management procedures against simple environment and climate change scenarios using robustness tests. Tests available in late 2023 include differing assumptions on recruitment deviations in the projection period. This robustness testing will continue in 2024 and will examine other environmental factors and more realistic climate change scenarios as well as the corresponding impacts on swordfish. This work will result in the climate conditioned management advice being produced by the management procedure.

10. SCRS Science Strategic Plan

The SCRS Chair proposed that during 2024, he will work in consultation with the Committee to develop a new 6-year SCRS Science Strategic Plan, building on the 2015-2020 SCRS Science Strategic Plan. This new Strategic Plan should include:

- Carry out a new SWOT (strengths, weaknesses, opportunities and threats) analysis, and note differences from the analysis in the 2015-2020 Strategic Plan;
- Review the objectives defined in the 2015-2020 Strategic Plan, and evaluate the progress made toward the identified measurable targets;
- Update objectives and measurable targets, as appropriate;
- Develop a tentative 6-year schedule of meetings;
- Develop 6-year tentative research plans for each working group (this a new component);
- Develop a budget for the new strategic plan;
- Other appropriate element(s) identified by the SCRS.

One conceptual difference from the 2015-2020 Strategic Plan is that the new Strategic Plan would be a living document, with elements of the plan updated where and when appropriate (e.g., the tentative schedule of meetings and research plans updated to maintain a 6-year horizon).

Work on the development of the new Strategic Plan will be advanced through discussions during SCRS Officers' meetings as well as other ad hoc online working meetings, including relevant SCRS Officers and/or other interested SCRS scientists.

Discussion

While the Committee had a favorable impression of strategic planning, it was noted that some aspects should be taken into consideration that would advance the work. First, the Committee noted that it would be beneficial to look at plans from other RMFOs. It was also noted that it would be ideal to have a meeting (preferable in-person) to discuss the related matters. Finally, it was noted that whatever the format of the meeting, it would be useful to engage a professional facilitator to structure the Committee's discussions and to assist in the development of the Strategic Plan.

11. Reports of Research Programmes

11.1 Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)

GBYP Phase 12 started on 24 March 2022 with an initial duration of 12 months, which was later extended until 23 July 2023. The extension allowed for the organization of some hybrid workshops that had been postponed due to the COVID-19 pandemic and the development of a pilot study on epigenetic ageing requested by the SCRS after the initial proposal for Phase 12 had been presented. Phase 13 started on 1 May 2023, with an initial duration of 12 months.

The most relevant research activities carried out or finished during this reporting period (October 2022-September 2023) have been:

a) Data recovery and management

During Phase 12, efforts have been centered on the design and implementation of new information systems on data from biological and electronic tagging studies, aiming at facilitating broad joint studies that are able to improve the parameterization of the models used for stock management. In the case of the biological data information system, work has been focused on the creation of structures to facilitate data sharing between different CPCs' research teams and ICCAT science programmes and for a proper data warehouse of both the biological data and the results from the analyses carried out on these samples. Moreover, significant progress has been made on the definition and concentration of data types, data needs, and uses. As regards electronic tagging data, the design of the ICCAT Electronic Tags Management System (ETAGS) database, which is able to manage both the metadata on electronic tagging operations and the raw data generated within all ICCAT or CPC e-tagging studies, has been completed. Its operability and performance have already been tested and the uploading of available datasets has been initiated, a task that will continue in Phase 13.

b) Fishery independent indices: GBYP aerial surveys and larval indices

Due to numerous uncertainties related to the aerial survey index, a thorough review of the GBYP aerial survey programme was carried out by external experts in 2020. Following advice from external experts, a pilot survey incorporating automated digital systems, covering both core and extended areas of the Balearic Sea, was carried out in June 2021. Moreover, a model-based approach, in addition to the classic design-based approach, was also explored. Considering the results from these activities, the GBYP Steering Committee (SC) decided to resume the aerial surveys in the western and central Mediterranean core spawning areas in 2022 and 2023. It was decided that the Levantine Sea would not be surveyed because previous results suggest that one of the basic assumptions to apply this methodology, i.e., spawners availability for aerial observations, is not met. The GBYP aerial index currently used within management strategy evaluation (MSE) management has been updated until 2022. In addition, the whole data set from 2017 to 2022 has been reanalyzed following a model-based approach that has considered a wide set of environmental variables, aiming at developing a habitat model that would constitute the basis to develop a methodology to fully standardize the index time series accounting for interannual environmental variability potentially affecting the spatial-temporal distribution of the spawners. Finally, GBYP also directly supported the improvement of larval indices based on surveys developed by ICCAT CPCs by organizing an ad hoc workshop aiming at identifying potential sources of uncertainty or inaccuracy, agreeing on a standard survey methodology and exploring the possibilities for expanding BFT larval index surveys to other spawning areas.

c) Tagging

GBYP conventional tagging has continued as a complementary activity by providing support to national teams. As regards the GBYP electronic tagging programme, the new strategic approach that was initiated in Phase 10 based on close collaboration with CPCs' tagging programmes has continued successfully in the following Phases. Thus, in Phase 12, seven memorandums of understanding (MoU) were signed with different research institutions, and as a result, 55 new pop-up electronic GBYP-owned tags were deployed by experienced tagging teams in the North Atlantic Ocean, targeting eastern stock individuals, and five additional tags owned by a farming company were deployed in the Mediterranean within the framework of an ad hoc MoU signed with ICCAT GBYP.

A new Call for Expressions of Interest to collaborate with the GBYP e-tagging programme was launched in July 2023 under GBYP Phase 13. As a result, 16 new proposals to collaborate with the GBYP e-tagging programme were received and 11 of them were awarded. Consequently, 11 MoUs have been or will be signed shortly to deploy 75 new GBYP-owned pop-up satellite archival tags (PSAT). The data obtained both from these GBYP-owned tags and from the tags pertaining to each of the awarded teams, deployed within the surveys covered by the signed MoUs, will be incorporated into the ICCAT ETAGS database.

Development of the GBYP e-tagging programme has further enhanced knowledge of bluefin tuna behaviour and has helped to address several previous hypotheses on BFT stock structure and spatial patterns. The data on BFT spatial patterns from GBYP etags have contributed to the elaboration of the movement matrix used within the framework of the BFT MSE process.

In addition, in Phase 12, GBYP organized a workshop on Atlantic bluefin tuna electronic tagging, aiming at reaching a broad consensus on the strategic planning of future electronic tagging and the best use of available tagging data. The workshop was attended by more than 60 scientists from 12 CPCs. During the workshop, multiple subjects were discussed and a list of priorities for future tagging campaigns were identified.

d) Biological studies

Biological sampling activities, including sampling of larvae, have continued in Phase 12, aiming at providing samples to better determine the population structure and mixing and improve the accuracy of the age length key used for the stock assessments.

Regarding microchemical analyses, the stable isotopes studies confirmed that individuals originated both in the Gulf of Mexico (GOM) and Mediterranean (MED) cross the 45°W management boundary, mixing with the other population in feeding aggregates of the Atlantic Ocean at variable annual rates, with the proportion of GOM-origin fish found to cross to the East being smaller than the proportion of MED-origin fish found to cross to the West. Individual origin has also been evaluated geographically to get an overview of the last decade. The results also showed a spatial separation of catches from both stocks within the North Atlantic Ocean, with the fisheries operating in the eastern North Atlantic being dominated by MED-origin fish and the western Atlantic coast catches dominated by GOM-origin fish, whereas central North Atlantic catches were composed by a mixture of stocks.

As regards genetic analyses, the results showed that interbreeding dynamics in the Slope Sea confirm a gene flow from the Mediterranean into the Slope Sea, which is probably a relatively recent event from the evolutionary point of view. Also, genomic regions of albacore origin, that are hypothesized to be related to adaptive traits, were found in the genome of Slope Sea and Mediterranean individuals, which will make it possible to search for specific genes and derived functions to understand how these affect the adaptive capability of BFT to the environment. The analyses towards the assignment of stock of origin showed varying mixing proportions of Mediterranean, Gulf of Mexico, and unassigned individuals across catch years, supporting the hypothesis, similar to microchemistry studies, that migratory patterns of Atlantic bluefin tuna are dynamic. Finally, a new tool for kin pair identification for future close-kin mark-recapture (CKMR) studies in Atlantic bluefin tuna, based on an array of more than 8,000 single nucleotide polymorphisms (SNPs), was developed.

In addition, further efforts were made to combine genetic and chemical markers to develop a method of population assignment that is able to provide new insights into Atlantic bluefin tuna population structure, given that some population structure traits can be masked when a single technique is used, as each one considers processes occurring on different temporal scales (i.e., individual life span vs. evolutionary).

Regarding sclerochonological studies, an in-depth review and update of bluefin tuna growth studies has been carried out, and a reference collection has been prepared for otoliths and spines to serve as quality control tool.

Moreover, a pilot study on the use of epigenetics for ageing Atlantic bluefin tuna individuals was carried out, with the aim of evaluating both the accuracy and the feasibility of the epigenetic method compared to direct ageing by otoliths readings.

Finally, a workshop on CKMR and biological sampling coordination was organized, focusing on the analysis of relevant factors for the implementation of the approach in the eastern BFT stock, with the goal of presenting a complete feasibility study to the SCRS in 2024. The workshop was attended by more than 50 scientists from eight CPCs.

e) Modelling

The GBYP Phase 12 activities in this line have covered the final stages of MSE development in support of management procedure (MP) adoption, including final tuning of candidate management procedures (CMPs), rescaling of latest index data, drafting of exceptional circumstances protocols and additional presentation materials in support of MP selection. In addition, they included the development of an exceptional circumstances app that can help design effective protocols given the various data types available for Atlantic bluefin tuna. Also, the computer code was commented on and supporting documentation developed that guide a technical user on how to reproduce and rebuild the Atlantic bluefin tuna Management Strategy Evaluation (ABTMSE) R package from scratch. Summing up, all MSE processes upstream of MP adoption are complete. Identification of exceptional circumstances protocols is outstanding and provides a link back to operating model specification if triggered.

The detailed report is attached as **Appendix 6**.

Discussion

The Committee congratulated the GBYP Team for the large amount of work that was done in the last reporting period and acknowledged the important contribution of the programme providing the scientific information for the provision of advice to the Commission. It was recognized that many of the achievements of the Committee would not have been possible without GBYP. The Committee also noted the important role of GBYP in the recent adoption of the Management Procedure for both the western Atlantic and the eastern Atlantic and Mediterranean management areas (Rec. 22-09).

The Committee inquired about the status of the biological and electronic e-tagging databases, being developed by GBYP. The GBYP Coordinator explained that while the biological database is in its early stages of development, the electronic tagging database is already operational.

The Secretariat will start populating the e-tagging database with the already available data, which also include data sets from other ICCAT research programmes. ICCAT CPCs teams holding e-tagging data are encouraged to provide their data too, as a way to promote cooperative and coordinated joint analyses, aiming the best scientific advice for the management of ICCAT species.

11.2 Small Tunas Year Programme (SMTYP)

Between 2018 and 2023, SMTYP continued collecting biological samples aimed at growth, maturity and stock structure studies on small tunas species (little tunny, LTA, *Euthynnus alletteratus*; Atlantic bonito, BON, *Sarda sarda*; and wahoo, WAH, *Acanthocybium solandri*). In that regard, a single contract was issued to a consortium of 12 institutions (11 CPCs) by the ICCAT Secretariat in 2018 that ended on 31 March 2019. In July 2019 a new contract was signed with the same consortium, while in 2023 a new consortium was set up involving 13 entities from 10 CPCs, and a new contract was signed. The objective of the latter contract was to collect biological samples to: i) fill specific size gaps for estimating the growth and maturity parameters for BON, LTA and WAH; ii) expand stock structure studies for frigate tuna (FRI) and bullet tuna (BLT) in the Atlantic Ocean and the Mediterranean Sea; iii) determine the growth and reproduction parameters for BON, LTA, and WAH; iv) refine the stock structure analysis for WAH, BON, and LTA and determinate the stock structure analysis for FRI and BLT; and, v) investigate genetic species differentiation between FRI and BLT.

A number of documents and presentations were provided during 2023 meeting of the Small Tunas Species Group, which presented results of the research conducted in the previous years within SMTYP. In addition, the Group identified the priorities that should be taken into account in terms of the species and areas to be sampled and revised the biological data to be collected under the SMTYP biological collection contract in 2023-2024. These priorities are presented in the Small Tunas Workplan for 2024 (item 17.1.8), which also contains details on other relevant research activities to be developed throughout 2023-2024 including: updating the biological meta-database, estimation of length-weight relationships representative at the stocks/regional level, calibration and adopting internationally agreed maturity scales and, further investigating and applying of data limited methods to be used for the provision of management advice for these stocks.

The SMTYP report is attached as **Appendix 7**.

11.3 Shark Research and Data Collection Programme (SRDCP)

The Shark Species Group (SSG) continued the study on the age and growth of the South Atlantic shortfin mako with the incorporation of samples from Japan, Namibia, and Brazil. Sample processing has now been completed, and all vertebrae are digitally photographed and uploaded into an age reading platform. The age readings have been taking place and preliminary readings are expected by the end of 2023, with preliminary growth curves in 2024. The lack of samples from the extremes of the size distribution, most notably from large shortfin mako, has been resulting in some convergence issues in the estimation of growth curves or biologically unreasonable, estimated parameters. Approaches to overcome the lack of samples from small and/or large size specimens will be explored through growth modelling once the age readings are complete.

In 2022, a study on genetic analysis of porbeagle in the Atlantic Ocean was initiated. A workplan to investigate the feasibility of whole mitochondrial genome sequencing (mitogenomics) for Atlantic porbeagle was presented in early 2022. Initially, mitogenomic analysis of 96 individuals from three localities in the Atlantic Ocean (Northeast, Northwest, and Southeast) were conducted and 92 mitogenomes were reconstructed successfully. The result of phylogenetic tree reconstruction clearly showed the existence of two distinct mitogenome clades in the Atlantic Ocean (North and South Atlantic clades). No genetic differentiation between East and West regions in the North Atlantic Ocean was observed. Next steps will include the incorporation to the analysis of new samples from the southwestern Atlantic in order to improve the spatial coverage of the study, by which it could lead us to the understanding of the connectivity of this species among areas of high interest (e.g., migrations between southeastern and southwestern Atlantic, southeastern Atlantic and southwestern Indian Ocean).

Studies on movements, stock boundaries, habitat use and post-release mortality of shortfin mako caught on pelagic longline fisheries continued. A total of 43 tags deployed in the Northwest, Northeast, tropical Northeast and equatorial region, and Southwest Atlantic have been used in the post-release mortality assessment. Data available from 35 of the 43 tagged specimens revealed a 22.9% rate of post-release mortality. Data acquired from the most recent tag deployments is being updated and analysed and should be presented during 2023. With regards to shortfin mako movements, stock boundaries and habitat use, the results of this project through the end of 2019 were published in Santos *et al*. (2021). Overall, a total of

53 tags (31 miniPATs and 14 sPATs ICCAT tags, and 8 additional miniPATs from other projects) have been deployed by observers from EU-Portugal, Uruguay, Brazil, EU-Spain and US in the temperate NE and NW, Equatorial, and SW Atlantic. The movement analysis showed that sharks tagged in the Northwest and Central Atlantic moved away from tagging sites and demonstrated low to no apparent residency patterns. In contrast, sharks tagged in the Northeast and Southwest Atlantic showed evidence of site fidelity; these sites were identified as possible key areas for shortfin mako. For the next phase of the project, 7 tags have already been deployed in the SW Indian Ocean, and the deployment of the remaining tags in the SE Atlantic has been proposed to determine possible movements between the SE Atlantic and SW Indian Ocean. However, some of those tags were from the batches that had battery problems, and so failed to transmit data. Results will be updated with the most recent data. Regarding the post-release mortality study, the results obtain so far will be updated for the upcoming shortfin mako 2024 assessment. Information from the latest tags deployed will be included, as well as information from other national tagging programmes that will be shared with the SRDCP.

The porbeagle electronic tagging was continued by teams from EU-France, EU-Portugal and Norway in the North Atlantic to better understand the movement patterns, stock boundary, and habitat use of this species in the Atlantic, and to potentially contribute to their assessment and management. To date, a total of 7 tags have been deployed by EU-Portugal and EU-France in the Northeast Atlantic, Bay of Biscay/Celtic Sea area, and central North Atlantic. In this more recent period, 3 ICCAT tags have been deployed by Norway, with one of those showing a long migration (~5,000Km) of a porbeagle specimen from colder northern Atlantic waters in the summer to warmer waters of the NE Atlantic in the winter. Remaining tags available for porbeagle had battery issues and had to be returned to Wildlife Computers for tag replacement. Part of those have now been returned, and continuation of deployment of tags is planned by scientists from EU-Portugal and Norway in the North Atlantic, and Uruguay in the South Atlantic, to be conducted during the rest of 2023 and 2024.

The movements, stock boundaries and habitat use of silky, oceanic whitetip, longfin mako, and hammerhead sharks in the Atlantic Ocean are also part of the SRDCP. A total of 27 miniPATs were deployed by EU-Portugal, the United States and Uruguay on silky (21), oceanic whitetip (8), smooth hammerhead (3) and scalloped hammerhead (1) sharks, which were deemed by the SCRS to be priority species. Multiple tags acquired in different years had to be returned to the manufacturer due to battery failures and could not be deployed as originally planned. From these species currently being tagged, it is noted that the silky shark in the NW Atlantic now has relatively good coverage. The oceanic whitetip also had some relatively good tagging in the equatorial region, and hammerheads are being prioritized mostly in the SW Atlantic and tropical eastern Atlantic. It has been discussed that the species selected for these tagging activities are not always commonly caught, and this represents a bigger challenge to achieve the proposed goal. The available tags are planned to be deployed throughout 2023 and 2024.

In 2023 a workshop on the Shark Research and Data Collection Programme (SRDCP) was held (hybrid, 13 to 15 July, Madrid, Spain). The aim of the workshop was to review the 10 years of the SRDCP, present and discuss the results obtained and the ongoing activities, and to discuss the perspectives for the coming years. Future steps for the second phase of the program were also introduced and discussed, including new species that are part of the ICCAT agreement, advances in available information on pelagic sharks outside of the SRDCP, activities to be continued, new activities to be included.

The report is attached as **Appendix 8**.

11.4 Enhanced Programme for Billfish Research (EPBR)

The EPBR continued its activities in 2023. The Secretariat coordinates the transfer of funds, information, and data. The overall programme coordinator and Eastern Atlantic Coordinator during 2023 was Dr Fambaye Ngom Sow (Senegal), and Ms Karina Ramírez López (Mexico) remained as the West Atlantic Coordinator. The original plan (established in 1986) for EPBR included the following objectives: 1) to provide more detailed catch and effort statistics, particularly for size frequency data; 2) to initiate an ICCAT tagging programme for billfish; and 3) to assist in collecting data for age and growth studies. These objectives have been expanded to evaluate adult billfish habitat use, study billfish spawning patterns, and billfish population genetics, as these are essential pieces of information for improving billfish assessments. The Group also revised the original plan in order to overcome the data gap issues, in particular in artisanal fisheries of developing CPCs, taking into account the findings of regional reviews.

The previously available specific funding for EPBR has now been combined with the general research fund (ICCAT Science Envelope). Project funding is now being allotted on a more competitive basis with other Species Groups. The United States Data Fund has been supporting the EPBR activities.

In July 2022 a new contract was awarded to Institut sénégalais de recherches agricoles (ISRA), Centre de Recherches Océanographiques de Dakar/Thiaroye (CRODT, Senegal) to continue the activities of the previous contract for a 12-month period (until December 2022). Over this period, EPBR engaged research teams from Senegal, Côte d'Ivoire and Gabon to sample billfishes from the artisanal fleet. An EU research team from Portugal was also engaged, which has significantly enhanced the collection of samples onboard industrial vessels operating in the eastern Atlantic area and supported the analysis of data on length and age for estimating the growth parameters of the main billfish species that occur in the eastern Atlantic (*Makaira nigricans*, BUM; *Kajikia albida*, WHM; and *Istiophorus albicans*, SAI). However, the contract signed in 2022 was canceled due to the difficulties encountered by the teams involved and only Centre de Recherches Océanologiques (CRO) (from Côte d'Ivoire) was able to collect samples, but due to logistics they had problems for shipping them. Accordingly, a new contract was signed in July 2023 to resume project activities. Apart from the 32 samples collected by CRO, 16 additional samples were collected by CRODT from July to August 2023. Overall, a total of 525 samples have now been collected from those three species. All otoliths collected until 2021 were sent to the Fish Ageing Services in Australia for age reading, and the data were made available to the Consortium and analysed. The preliminary results of a study to evaluate the use of otoliths to estimate the age and provide some preliminary otolith-based estimates of potential longevity of Atlantic blue marlin (*Makaira nigricans*), Atlantic white marlin (*Kajikia albida*) and Atlantic sailfish (*Istiophorus albicans*) were provided and presented during the Billfish Species Group meeting.

In 2023, a joint workshop on age reading was held in Instituto Português do Mar e da Atmosfera (IPMA, Portugal) (13-18 February, Olhão, Portugal). The major objectives were to enhance expertise among ICCAT scientists for these species by: i) sharing knowledge between experts; ii) standardize methodologies; and iii) review work already completed and progress plans for next steps in swordfish, billfishes and small tunas research programmes regarding ageing.

Following the SCRS request, in autumn 2019 through the ICCAT Science Envelope, a contract was proposed to the Dirección General Adjunta de Investigación Pesquera en el Atlántico, Centro Regional de Investigación Acuícola y Pesquera en Veracruz (Mexico) to develop a reproductive biology study of Atlantic blue marlin in the Gulf of Mexico. During September 2022, the Secretariat received a draft proposal for review, with the goal of signing a contract to initiate the study in the near future.

The report is attached as **Appendix 9**.

11.5 Albacore Year Programme (ALBYP)

Studies of albacore reproduction continued for both the North and South stocks.

In the North Atlantic, a consortium of scientists from EU-Spain, Canada, Venezuela and Chinese Taipei collected and processed 272 gonads from Venezuelan and Chinese Taipei longliners. First dorsal fin spines (n=163 from albacore collected in Venezuelan longliners) were also collected and analyzed to assign age and interpret maturity data. All the female albacore collected in the tropical area by Venezuela longliners were mature but exhibited no sign of spawning. Fecundity parameters were estimated using a reduced number of gonads (n=21) collected in May and June of 2021 and from July to September in 2022 (n=39) in the Central North Atlantic by Chinese Taipei longline vessels. Collection of albacore gonad and spine samples by observers on board the Chinese Taipei longline fleet continued in this area. A summary of the results obtained with samples from 2022 was presented in 2023.

In the South Atlantic, the reproductive biology study is being conducted by a consortium of scientists from Brazil, Uruguay, South Africa, Namibia and Chinese Taipei. Biological sampling is being carried out in the three main areas of abundance/fishing in the South Atlantic. So far gonads were collected by the Brazilian (145) and the Chinese Taipei tuna fleets (180). About 176 gonads of males (n=100) and females (n=60) have been histologically processed and analyzed to estimate L50. Results suggest that the spawning area in the South Atlantic is probably located between latitudes 5°S and 25°S. The study indicated that both male and female *Thunnus alalunga* maturation sizes are larger than previously assumed. Specifically, the L_{50} values were 102.3 FL and 96.3 FL for males and females, respectively. However, these results should be seen as preliminary, since the sample size and geographic range analyzed were limited.

Another component of the research programme relates to movements and habitat use of Atlantic albacore, which is being conducted by scientists from Brazil, EU, Japan South Africa, Uruguay and Chinese Taipei. In the North Atlantic, several tagging surveys targeting large individuals have been conducted off the Canary Islands, where 29 MiniPATs have been implanted. In addition, in the Bay of Biscay tagging has targeted small and medium size albacore, with 2 MiniPATs and 108 internal archival tags having already been deployed. Posters announcing €1,000 rewards were produced in Spanish, French, English, Portuguese, Chinese and Japanese, and distributed through collaborating Albacore Species Group participants from different CPCs. To date, data from 37 tracks have been gathered, which includes >4000 tracking days. It is worth noting that for the first time six full year tracks of juvenile albacore have been recorded. These juveniles visited shallow waters of the Bay of Biscay in subsequent summers, while inhabiting deeper waters in the central and western Atlantic during the winter as well as travelling south to the Canary Islands before returning to the Bay of Biscay. In the South Atlantic, attempts to deploy MiniPATs have not yet been successful. The teams will continue to deploy tags and an update of the results will be presented in 2024.

Finally, a short-term contract was issued to accomplish the technical tasks required to follow the Albacore Management Strategy Evaluation (MSE) schedule adopted by the Commission. According to this schedule, after adoption of the first ICCAT Management Procedure (MP) in 2021 (following adoption of a harvest control rule in 2017), it is necessary to check for the existence of exceptional circumstances on a yearly basis. In addition, in 2023 a new benchmark stock assessment using SS3 was scheduled, which should serve as a basis for conditioning new operating models for the second round of the MSE framework, expected to be delivered in 2026. Moreover, *Recommendation by ICCAT on conservation and management measures, including a Management Procedure and Exceptional Circumstances Protocol, for North Atlantic albacore* (Rec. 21-04) requires testing alternatives to the adopted MP. The contractors developed the SS3 model according to the model and fleet structure previously agreed by the SCRS and presented results to the Albacore Species Group. In addition, they presented the performance of MP variants requested in Rec. 21-04, namely those with varying levels of target fishing mortality, biomass thresholds, number of CPUE series, levels of underreporting, effect of carry over, TAC implementation error, and alternative stability clauses. They also produced the necessary plots for the Albacore Species Group to discuss the detection of exceptional circumstances, as requested by the Exceptional Circumstances Protocol contained in Rec. 21-04.

The report is attached as **Appendix 10**.

11.6 Swordfish Year Programme (SWOYP)

The Swordfish Year Programme was established in 2018 to address key uncertainties important for improving the scientific advice for management of the stocks. The three main research areas - ageing and growth, reproductive biology, and genetics - are each led by study coordinators who oversee work involving 21 institutions from 14 ICCAT CPCs/Cooperating Non-Contracting Parties. The work to date has been organized through a series of short-term contracts and in 2022 was formalized as an ICCAT research programme. Since project inception, 4,647 swordfish representing all three ICCAT managed stocks have been sampled for some combination of fin spines, otoliths, muscle tissue, gonads, and additional information has been collected on fish size, sex, maturity stage, and catch date, location and method. The SWOYP aims to improve knowledge of the stock distribution, age and sex of the catch, growth rates, age at maturation, maturation rate, spawning season and location, stock boundaries and mixing, thereby contributing to the next major advance in the assessment of swordfish status. In addition, tagging work supports studies on distribution, movement, and habitat use which are important for the development of a species distribution model.

In 2018 and 2019, emphasis was placed on sample collection and standardization of sampling methods and processing among member institutions. Samples were collected in the major fishing areas in the North and South Atlantic and Mediterranean. Since 2018, 4,647 samples have been collected from mostly longline fisheries, covering all three stocks. The majority of samples collected consist of an anal fin spine for aging, a piece of tissue for genetic analysis, and include data on fish size, sex, location and catch date. Within this sample set are 3,535 fin spines, 1352 otoliths, and 768 gonads. Subsequent processing and analysis of samples since 2019, has led to ageing and maturity reading efforts and calibration exercises. The resulting data have contributed to preliminary work on revised growth models, and maturity ogives. The genetic analyses have resulted in sequencing of the swordfish genome, identification of SNPs important for stock differentiation, and preliminary estimates of stock boundaries and mixing areas. Work within each of the project areas will continue in 2024 with continued processing of samples, readings of otoliths/spines and gonads, genetic analysis of tissues and collection of samples in areas where there are sampling gaps.

In 2023, SWOYP project leaders shifted their focus toward processing and analysis of a backlog of samples obtained in earlier project phases. This work has led the Committee to reach significant project milestones. In February 2023, SWOYP age readers and external experts refined swordfish ageing protocols and made significant progress on an age reading calibration exercise. Given the challenges of ageing swordfish (small size of swordfish otoliths and vascularization within fin spines), there still remains a great deal of uncertainty in existing age readings, particularly with age rings close to the otolith nucleus. In 2023, an age validation exercise was initiated. Bomb radiocarbon analysis was applied to 30 samples collected under the SWOYP sampling programme and preliminary results indicate that there has been age overcounting for early growth rings and that otolith mass is poor predictor for age. Additional validation analysis is required for better coverage and sample size across the swordfish age-length spectrum. This work will be conducted in unison with analysis on epigenetic ageing. The first steps in this new project area have identified appropriate CpG sites for which methylation rates may be measured. Should the technique be successful, the SWOYP may be better able to monitor for shifts in growth and maturity while not exclusively relying on the difficult to obtain otoliths. Reproduction and maturity analysis also continues to progress. In the current project phase 289 gonad samples were processed and prepared for histological analysis. This increase in gonad sample sizes is an important step in refining maturity ogives. Additional samples are needed from hypothesized spawning areas in the Sargasso Sea and Gulf of Guinea. Samples from these fish will be important for genetic differentiation of stocks, understanding stock spawning period, and better estimating fecundity and recruitment.

Tagging studies aim to analyse the vertical habitat-use and migration patterns of swordfish, and help to delimit the stock boundaries and mixing rate of swordfish between the Mediterranean Sea and the North and South Atlantic. Forty-four ICCAT funded tags have been acquired since 2018, when the tagging programme was implemented. To date, a total of 26 miniPAT tags have been deployed in the North (13) and South Atlantic (9) and the Mediterranean Sea (4). These studies indicate considerable horizontal movements and patterns of vertical movement through depth and temperature layers. These findings are important for improvements to the swordfish species distribution model which the Committee uses to better understand SWO catch rates. In 2023, a tagging trip in the eastern Atlantic resulted in two tag deployments. In 2023 the western Atlantic the tagging trip was, unfortunately, unsuccessful. In the North-Western Atlantic this may be due to a more northward distributional shift from typical summer feeding grounds.

The detailed report is attached as **Appendix 11**.

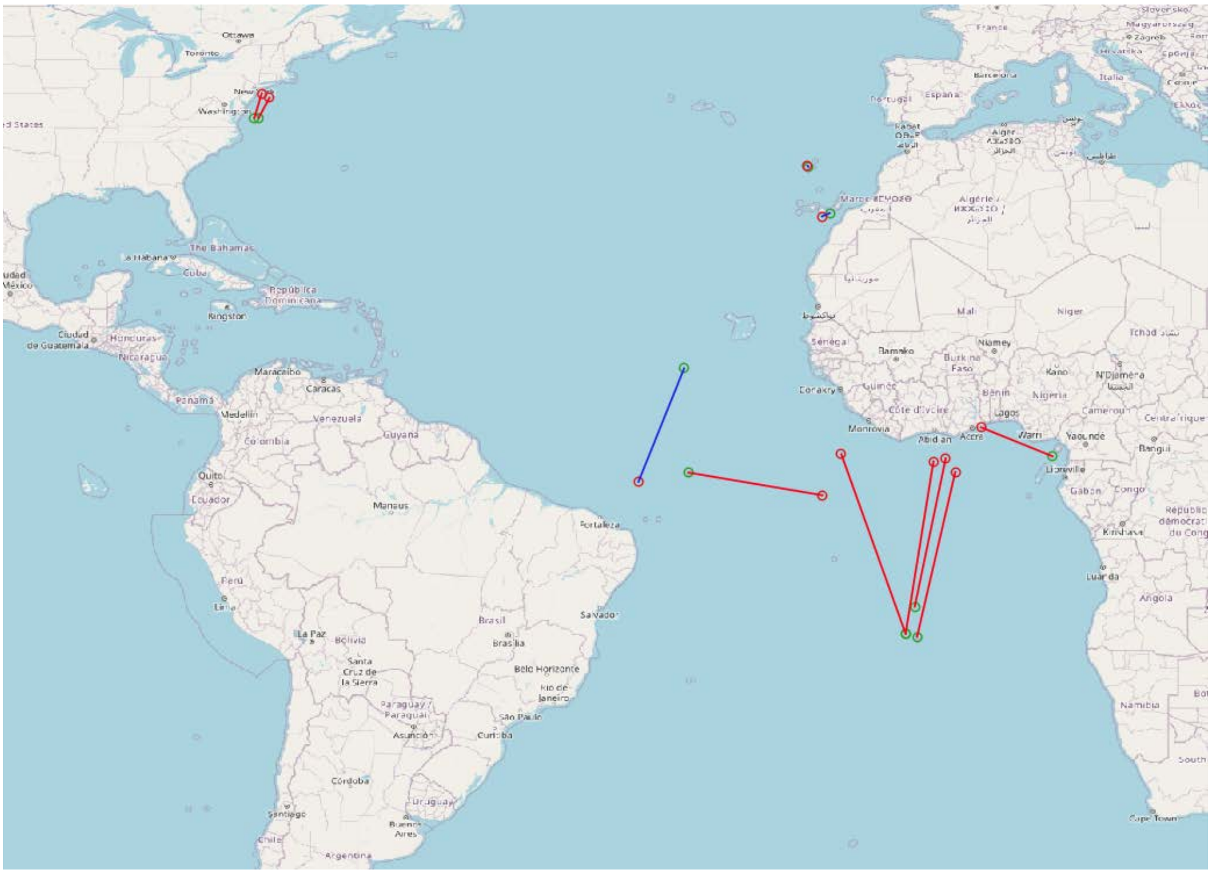
11.7 Other research activities (on tropical tunas)

After the closure of the Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP) the activities have focused into four main tasks: i) tag recovery and rewarding; ii) tag seeding experiments; iii) ageing study; and iv) tagging in the north-western Atlantic, an area which was short on the number of fish targets during AOTTP.

Two short-term contracts were issued Côte d'Ivoire and Senegal and teams in the field, to continue tag recovery and awareness campaigns, tag seeding experiments, and sample processing to age hard parts from recaptures. In addition to these, other ex-AOTTP teams have kept tag recovery activities at no or little cost. During the past 12 months a total of 12 recoveries were made, namely three of bigeye and nine of yellowfin. The table and figure below show additional details on these recoveries.

Species	*BET*	*YFT*	*SKJ*	***Total***
Conventional tags	3	9	-	**12**
Days at liberty (min-max)	1,535-2,445	331-1,567	-	

The figure below shows the tagging (green circles) and recovery (red circles) locations of the conventional tags recovered between October 2022 and September 2023. Blue lines correspond to bigeye tuna and red lines to yellowfin tuna.



As regards tag seeding experiments aiming the estimation of the reporting rate, during the reporting period a total of 96 experiments were made by the teams in Canary Islands, Côte d'Ivoire, Ghana and Senegal, as detailed below. Recovery rates are provided between parentheses as a percentage.

Location	*BET*	*YFT*	*SKJ*
Senegal		27 (74%)	28 (93%)
Côte d'Ivoire	5 (80%)	4 (75%)	7 (86%)
Canary Islands		5 (60%)	
Ghana	5 (100%)	6 (100)	9 (100 %)
Total	**10 (90%)**	**42 (76%)**	**44 (93%)**

In addition, within the short-term contract issued to the University of Maine targeting the deployment of 1,400 tags off the eastern coast of the United States, as of 30 June 2023 a total of 264 were deployed (18.8% of the target), as detailed in the table below.

Species	*Tagging area*	*Taggin target by area*	*Tagged until 05/08/2022*
Yellowfin tuna (YFT)	YF12 (North 30°N)	-	186
	YF30 and YF40	419	40
Bigeye tuna (BET)	BE10	-	22
	BE9	110	
	BE30 and BE 40	233	1
Skipjack (SKJ)	SJ08 (North 30°N)	58	
	SJ09, SJ30 and SJ40	580	11
Unknown (UNK)		-	4
	Total	**1,400**	**264**

Following the Tropical Tunas Species Group recommendation in early 2023, an extension of the short-term contract has been agreed with the Project Coordinator from the University of Maine until the end of 2024, to allow the completion of the tagging activities. However, as of 14 September 2023, the Secretariat has not yet received the formal acceptance of this extension (signing of the Addendum to the contract) by the University of Maine, although we are aware the activities are being carried out.

A draft proposal for the Tropical Tuna Research and Data Collection Programme (TTRaD) was presented (**Appendix 16**).

12. Report of the Meeting of the Subcommittee on Statistics

The Committee discussed two main issues related to the Subcommittee on Statistics. These were: i) when during the species groups meetings week should the Subcommittee on Statistics meet; and ii) how to address the problem of late data submissions.

The Committee agreed that the Subcommittee on Statistics should be moved to the beginning of the species groups meetings week. The Committee emphasized that it should nevertheless be scheduled for one day and a half.

The Committee agreed that new data submitted to the Secretariat after the set data submission deadline will be considered as late submissions. Late submissions received up to one week before the species group meeting would still be included in Task 1 tables. Any data submitted less than one week before or during the SCRS meeting will be updated by the Secretariat after the SCRS plenary. The updated information will be reported to the Commission's annual meeting. Corrections to data would be considered at any time.

13. Report of the Meeting of the Subcommittee on Ecosystems and Bycatch

The Committee approved the Report of the Meeting of the Subcommittee on Ecosystems and Bycatch which is contained in **Appendix 12**.

14. Discussions at the Intersessional Meetings of the Commission relevant to the SCRS

14.1 Intersessional Meetings of Panel 1

The SCRS Chair informed the Committee of the discussions and decisions regarding the tropical tunas MSE processes during the First Intersessional Meeting of Panel 1 (hybrid/Lisbon, Portugal, 27-31 March 2023) and the Second Intersessional Meeting of Panel 1 on Western Skipjack MSE (online, 5 May 2023).

First Intersessional Meeting of Panel 1

The text below is consistent with the Report of the First Intersessional Meeting of Panel 1.

The SCRS Chair provided a brief overview of the ongoing work developed by the SCRS regarding the tropical tunas MSE processes.

No decisions were made relevant to the SCRS, although a number of CPCs expressed support for the SCRS to update the Decision Support Tool, developed by the SCRS in 2018, with the most recent stock assessment results.

Second Intersessional Meeting of Panel 1 on Western Skipjack MSE

The text below is consistent with the Report of the Second Intersessional Meeting of Panel 1 on Western Skipjack MSE.

The SCRS Chair reviewed the operational management objectives and the following decision were taken:

On stock status: A 70% threshold was agreed upon for probability of green Kobe (PGK).

On safety: The SCRS Chair informed Panel 1 that the SCRS is recommending a B_{LIM} of 0.4. Following discussions on this topic, the SCRS Chair summarized that a 10% maximum acceptable probability was an acceptable number to many parties and could be used for initial testing, with the potential to explore reducing to the 5% mentioned by some parties.

On yield: Panel 1 agreed to evaluate yield performance of CMPs in the short (1-3 years), medium (4-10 years) and long (11-30 years) terms.

On stability: Panel 1 requested that initial testing evaluate a maximum total allowable catch (TAC) change between management periods of +/- 20%. In the case of model-based candidate management procedures (CMPs) where stock status would be calculated as part of the CMP. One CPC supported testing the testing of symmetrical and asymmetrical 20% or 30% maximum TAC change when the stock biomass is above B_{MSY}, with no limits on TAC change when the biomass was below B_{MSY} (following the example of the ALB-N management procedure (MP)).

Panel 1 supported continuing CMP testing with 3-year management cycles. One CPC reserved its position on the deliberation of the management cycle.

14.2 Intersessional Meeting of Panel 2

The SCRS Chair informed the Committee of the discussions and decisions taken during the Intersessional Meeting of Panel 2 (hybrid/Madrid, Spain, 7-10 March 2023), namely those related to the Exceptional Circumstances Protocol (ECP) for bluefin tuna.

The text below is consistent with the Report of the Intersessional Meeting of Panel 2.

Exceptional Circumstances Protocol (ECP) for bluefin tuna

The SCRS Chair presented the “Decision guide for developing Atlantic bluefin tuna Exceptional Circumstances” and recommended that the bluefin tuna EC Protocol closely mirror that previously adopted for northern albacore, using the three key principles from the *Recommendation by ICCAT on conservation and management measures, including a Management Procedure and Exceptional Circumstances Protocol, for north Atlantic albacore* (Rec. 21-04) as signals of potential EC.

The SCRS Chair presented the planned timeframe for developing an ECP, which, following the Intersessional Meeting of Panel 2, included a meeting of the BFT Technical Sub-group on MSE to incorporate any feedback from Panel 2 into a draft document. At the September SCRS Species Group meeting, the ECP will be discussed, being finalized in the SCRS Plenary.

After further discussion, Panel 2 agreed the following workplan:

1. Any additional comments on the bluefin tuna EC should be provided to the SCRS, through the Secretariat, by the end of March.
2. The SCRS will work on those comments and the feedback received during this meeting and will provide interim advice to Panel 2 by the end of June.
3. The Chair of Panel 2 will then produce a draft EC Protocol text as soon as possible, before Panel members take their respective summer holidays.
4. Panel 2 will have the opportunity to provide further input on the Chair’s draft protocol.
5. The Chair of Panel 2 will produce a second version for the SCRS to consider at the September Species Group meeting.
6. The SCRS will produce their final scientific advice at the September session.
7. The Chair of Panel 2 will revise the draft protocol as needed based on SCRS advice and submit it for consideration with a view to its adoption at the 2023 Annual Meeting.

Growth rate analysis and possible suggestion towards the update of growth table

Based on the document "The report of growth rate analysis and possible suggestion towards the update of growth table" submitted by Japan to the Intersessional Meeting of Panel 2 in March 2023, Panel 2 asked that the ICCAT Secretariat version of the growth table, which uses the 95th percentile as the benchmark for growth rate, be reviewed by the SCRS.

The SCRS Chair asked that Japan prepare an SCRS document and present it to the SCRS for review. This will help to determine the merit of reviewing the SCRS process and potentially including other data. The SCRS Chair considered it premature to reach a broad conclusion on the basis of the document submitted by Japan to the Intersessional Meeting of Panel 2 in March 2023, prior to review by the SCRS. The SCRS Chair advised that the next SCRS meeting where this issue could be considered is in September but that it already has a full schedule. Nevertheless, at least a workplan for undertaking this effort could be developed.

14.3 Intersessional Meetings of Panel 4

The SCRS Chair informed the Committee on the discussions and decisions taken during the two intersessional meetings of the Panel 4 on the Northern Atlantic swordfish MSE, held online on 6 March and 30 June 2023, respectively.

First Intersessional Meeting of Panel 4 on North Atlantic Swordfish Management Strategy Evaluation (MSE)

The text below is consistent with the Report of the First Intersessional Meeting of the of Panel 4 on North Atlantic Swordfish Management Strategy Evaluation (MSE).

The Panel agreed to the following regarding the operational management objectives:

On Stock Status: Revised phrasing: "The stock should have a [_]% or greater probability of occurring in the green quadrant of the Kobe matrix." Given the differing views expressed, it was noted that, as the SCRS was requesting input on a minimum threshold for initial testing, 51% would serve as a minimum threshold for initial testing while allowing the SCRS to assess higher values, including 60%, while ensuring consistency with the terms of the current SWO-N management measure.

On Safety: The Panel's revised phrasing: "There should be a [_]% or less probability of the stock falling below B_{LIM} at any point during the 30-year evaluation period." The Panel indicated a preference for the SCRS to test a range of values, namely 15%, 10%, and 5%.

On Stability: The Panel agreed that the SCRS should test CMPs using a 25% limit on TAC increases between management periods as well as with no limits on TAC changes.

Other key decisions included:

Determine key performance metrics for CMPs, their probability values, and over which years they are to be calculated:

- The Panel agreed all the performance statistics for Status, Safety, and Yield should be evaluated along these timeframes: Short term: 1-10 years, mid-term: 11-20 years, and long-term: 20-30 years.
- The Panel requested that the SCRS examine and provide information to the Panel on the performance statistics (e.g., probability of the stock being in the green quadrant of the Kobe plot (PGK), limit reference point (LRP), and average catch (AvC)) on a time series so that CMP performance can be assessed over the course of the evaluation period as well as at the terminal year.
- The SCRS should provide performance statistics for evaluating other aspects of stock status beyond PGK, such as probability of overfishing (POF), with the understanding that these additional statistics could need some modification to work in the SWO-N MSE.
- The SCRS was also asked to provide Catch in year 1 (C1) as an output of CMP testing to assess performance with respect to yield.

- The Panel agreed for the SCRS to set the interim LRP at 40% B_{MSY} as specified by the Commission in various SWO-N Recommendations, unless and until other analyses indicate that another value is more appropriate.

Identify any minimally acceptable levels for key performance metrics, which would eliminate a given CMP from further consideration if those criteria are not met:

- The Panel noted that the approach used for bluefin tuna could be followed for SWO-N where the safety and status management objectives had to be satisfied through the MSE testing process before the Panel considered the tradeoffs between stability and yield.

Provide feedback to the SCRS on an interval schedule for applying the adopted management procedure (MP), reviewing MP performance, and conducting stock assessments:

- The Panel agreed that a three-year management period should be the minimum, particularly in the case of empirical CMPs.
- The SCRS indicated its intention to update the proposed cycle in light of CPC comments and noted that longer or shorter management periods could be tested once the number of CMPs has been reduced.

Determine the types of CMPs to be developed (management actions; assessment model-based vs empirical procedures; etc.):

- The Panel agreed to the SCRS recommendation to allow for examination of both model-based and empirical CMPs, allow for various indices to be used in CMP development, and allow the CMPs to set the total allowable catch (TAC) for all of the North Atlantic region regardless of gear type.

Approval of process for narrowing (culling) of CMPs to retain a reduced subset for further development:

- Panel 4 agreed that the CMP culling process should generally follow the process used for the bluefin tuna MSE, as presented by the SCRS.

Other matters:

How to proceed regarding para 25 of the Recommendation by ICCAT on the conservation of the North Atlantic stock of shortfin mako caught in association with ICCAT fisheries *(Rec. 21-09) and the* Recommendation by ICCAT on the conservation of the South Atlantic stock of shortfin mako caught in association with ICCAT fisheries *(Rec. 22-11)*

- It was agreed to hold a meeting with stakeholders in early 2024, since it still ensures its objectives are met, including providing information to the SCRS so it can provide a response to the Commission in 2024.

Second Intersessional Meeting of Panel 4 on North Atlantic Swordfish Management Strategy Evaluation (MSE)

The Report of the Second Intersessional Meeting of the Panel 4 on Northern Atlantic Swordfish Management Strategy Evaluation (MSE), held on 30 June 2023, has not yet been adopted. What follows is a summary of the most relevant decisions that have implication for the SCRS.

Regarding the *Choice of a key performance metrics, timeframes, and minimum/maximum acceptable thresholds (if applicable) for each of the Status, Safety, Stability, and Yield objectives*, the following decisions were taken:

Status: stock being in the green quadrant of the Kobe matrix

- Due to differing views of the CPCs on whether to further limit or narrow the range of PGK values to be tested for the status management objective, the Panel decided to continue testing 51%, 60%, and 70%.

Safety: stock breaching the limit reference point (LRP)

- The Panel expressed a preference for testing LRP_{ALL} across the 30-year time frame as the primary performance metric agreed, noting that the SCRS would also test the three other LRP timeframes (short, medium, and long).
- The Panel agreed that the SCRS should continue to test 5%, 10%, and 15% as the threshold values for safety, with 15% acting as a filter to remove CMPs that do not satisfy this management objective.

Stability: change in TAC between management cycles (if desired)

- The Panel agreed to continue testing a stability clause of +/- 25%, as well as no limits for all CMPs, and, for model-based CMPs only, to add testing of both +/-25% when the stock is in the green quadrant of the Kobe plot and 25% for TAC increases and no limit on decreases when the stock is outside the green quadrant.
- With respect to primary performance metrics, the Panel agreed to use VarC while acknowledging that information on MaxVarC would still be provided.

Yield: catch levels

- The Panel asked that the SCRS to consider all four time span options for Yield (TAC1, TACshort, TACmedium, TAClong).

Regarding the *Tuning objective, including time frame*, after long discussions, the Panel agreed to:

- The SCRS recommendation to tuning to PGK_{SHORT} at three probability values (51%, 60%, and 70%) and using safety as a filter.
- The SCRS MSE technical team exploring alternative timeframes to see how CMP performance is affected.

Regarding the *Definition of minimum threshold for TAC change between management cycles*, based on the SCRS Chair suggestion, it was decided that the SCRS should proceed:

- with testing a value of 200 t. If the Panel considered, at a later stage, that the value was too high, it could consider a lower value or chose not to set a minimum TAC change threshold. The value would also be evaluated symmetrically, that is, the same tonnage in the case of an increase or decrease in TAC.

Regarding the *Prioritization of robustness OMs for analysis in 2023*, based on time constraints, the Panel agreed that:

- the prioritized list, in no particular order, of robustness tests would be as follows: climate change (recruitment), catchability (historical and projection), implementation error, size limits, and minimum threshold for TAC change.

14.4 Intersessional Meetings of the Electronic Monitoring Systems Working Group (WG-EMS)

The SCRS Chair informed the Committee of the discussions and decisions taken during the First and Second Intersessional Meetings of the Electronic Monitoring Systems Working Group (WG-EMS) (online, 15 February and 7 September 2023).

First Intersessional Meeting of the Electronic Monitoring Systems Working Group (WG-EMS)

The text below is consistent with the Report of the First Intersessional Meeting of the Electronic Monitoring Systems Working Group (WG-EMS).

Dr Rui Coelho (EU) provided an update on the work conducted by the SCRS Technical Sub-group on EM (Electronic Monitoring), since the Second Meeting of the Working Group on Electronic Monitoring Systems (WG-EMS) in June 2022.

Following discussions on what appeared to be a gap in the reporting fields between longline and purse seine, the SCRS Chair expressed the willingness of the SCRS to close this gap, including through exploring the availability of the Technical Sub-group on EM (Electronic Monitoring) to undertake a review of minimum data reporting fields for purse seine.

The SCRS Chair underlined the importance of the ongoing collaboration between WG-EMS and the SCRS on the development of the standards and indicated his desire to support where necessary both in the drafting sessions and further meetings on the run-up to the 2023 Annual Meeting.

The SCRS Chair agreed to review language in later drafts and participate where possible in drafting meetings and at the 16th Meeting of the Working Group on Integrated Monitoring Measures (IMM). He went on to note that a review of purse seine data fields that follows the same approach as those for longlines was not in the SCRS workplan and hence may increase the already heavy workload of the SCRS. Nonetheless, he noted the importance for the SCRS to prioritize the review of the purse seine data fields and, pending consultations with the Chair and members of the Technical Sub-group on EM (Electronic Monitoring) would seek to convene the Technical Sub-group on EM (Electronic Monitoring) to carry out this review and provide interim advice to the WG-EMS. This advice would also be presented to the SCRS Sub-committee on Statistics for review. Some CPCs underlined the importance of this contribution from the SCRS and thanked the SCRS Chair for his efforts.

Second Intersessional Meeting of the Electronic Monitoring Systems Working Group (WG-EMS)

Dr Rui Coelho (EU) provided an update on the work conducted by the SCRS Technical Sub-group on EM (Electronic Monitoring), on minimum standards for EMS in purse seine fisheries targeting tropical tunas, noting that a proposal on those ICCAT minimum technical standards as well as a review of WG-EMS draft tables on scientific data fields for both LL and PS would be submitted to the SCRS Subcommittee on Statistics (SC-STAT) and Plenary for review.

There were no other discussions relevant to the SCRS in this meeting.

14.5 16th Intersessional Meeting of the Working Group on Integrated Monitoring Measures (IMM)

The SCRS Chair informed the Committee on the discussions and decisions taken during the 16th Meeting of the Working Group on Integrated Monitoring Measures (IMM) (7-9 June 2023).

The Chair highlighted the work of the SCRS within the scope of the Electronic Monitoring Systems Working Group (WG-EMS), which recognized the importance of continued close coordination with the SCRS and periodic reviews of potential standards in light of technological advances. It was noted that the WG-EMS was mindful of striking a balance between standards that are for compliance and those for science. It was agreed that the WG-EMS further work on minimum standards will continue intersessionally by way of a drafting committee in July 2023 and the Second Meeting of the Electronic Monitoring Systems (EMS) Working Group in early September 2023.

15. Progress related to work developed on MSE

Since the September 2022, the SCRS has further developed substantial work on the ongoing ICCAT MSE processes. Additional details are provided below (items 15.1 to 15.5).

15.1 Work conducted for northern albacore

In 2017, the ICCAT Commission adopted an interim Harvest Control Rule (HCR) for North Atlantic albacore (Rec. 17-04), which represents the first HCR adopted in the history of ICCAT. In 2021, the Commission adopted the first full Management Procedure (MP) (Rec. 21-04), including the HCR, the specifications about how to determine stock status in the future, and an Exceptional Circumstances (EC) Protocol. The adopted HCR imposed an F_{TARGET}=0.8*F_{MSY}, a $B_{THRESHOLD}$=B_{MSY}, a B_{LIM}=0.4B_{MSY} and an F_{MIN}=0.1F_{MSY}, with a maximum Total Allowable Catch (TAC) of 50,000 t and a maximum TAC change of 25% in case of increase or 20% in case of decrease when B_{CURR}>$B_{THRESHOLD}$.

Since 2015, the SCRS has provided scientific advice and interacted with the Commission, to allow the Commission to adopt the recommendations mentioned above. This included testing several HCR variants, stability clauses, the effect of the carryover and additional scenarios about TAC implementation error. In addition, an independent peer review was conducted during 2018, criteria for the identification of EC were developed, and a single consolidated report was produced (Merino *et al*., 2020).

A short-term contract was issued to accomplish the technical tasks required to follow the albacore MSE schedule and Rec. 21-04 adopted by the Commission. The EC Protocol in Rec. 21-04 requires determining, on a yearly basis, if EC exist. In this regard, the contractors produced the necessary plots for the Albacore Species Group to discuss the detection of EC according to the EC protocol contained in Rec. 21-04.

Rec. 21-04 also required testing alternatives to the adopted MP, as well as determining the number of CPUE series and the level of underreporting that would trigger the occurrence of EC. The contractors evaluated the performance of MP variants requested in Rec. 21-04, namely with varying levels of target fishing mortality and biomass thresholds and evaluated the performance of the MP when only some of the CPUE series were available. They also completed tests with varying levels of underreporting during 2023.

Also, in 2023 a new benchmark stock assessment using SS3 was conducted. The contractors developed the SS3 model in collaboration with other participants of the Albacore Species Group, including discussion related to fleet structure and data, which were agreed by the Group. This model was used in the stock assessment as a reference case. After the assessment, the model was further revised to improve diagnostic performance. This model will serve as a basis for conditioning new operating models for the second round of the MSE framework.

15.2 Work conducted for bluefin tuna

The ICCAT Bluefin Tuna Species Group did not meet during the year and only met during three days at the SCRS species groups meeting where the primary task was to develop executive summaries, responses to the Commission, compile annual updates of the indices and draft Exceptional Circumstances (EC) Protocols. Substantial work was conducted intersessionally on the MSE, including an online meeting of the MSE technical team and additional work by the MSE contractor to inform quantitative measures for exceptional circumstances protocols. The Group developed draft EC Protocols (19.18) and provides a determination according to the protocols in 19.17. With the recent adoption of the management procedure and TAC being set for 2023-2025, this allowed the Group to focus on strategic science directions through GBYP-led workshops.

The first workshop was on larval indices to evaluate existing surveys and methodology and explore the possibilities for expanding surveys aiming at producing larval indices to other bluefin tuna spawning areas. A primary outcome of the meeting is a series of actions to standardize larval sampling and to ensure that larvae collected in the surveys can contribute to Close-Kin Mark-Recapture (CKMR) studies. The workshop participants also recommended the formation of an early life history technical subgroup and associated leads which the Bluefin Tuna Species Group endorsed.

The second workshop GBYP held was on CKMR focused on the analysis of relevant factors for the implementation of the approach in the eastern Atlantic bluefin tuna stock, with the goal of presenting a feasibility study, including a workplan with cost estimations, to the SCRS in 2024. The requirements for CKMR and the current knowledge of Atlantic bluefin tuna reproduction and population structure were reviewed, and examples of applications of CKMR methodologies in other fish species were provided. Sampling opportunities for eastern Atlantic and Mediterranean CKMR implementation were discussed and a list of recommendations for future steps and a tentative timeline and vision for the project was elaborated. The workshop participants recommended formation of a technical subgroup and associated leads on CKMR which the species group endorsed. The workshop also put forward an aspirational vision to be in a position, by 2027, for CKMR to inform potential reconditioning of the MSE operating models to address the greatest source of uncertainty in the MSE which are the absolute scale of the stocks. The Committee endorsed this goal and has placed necessary steps into the 2024 and 2025 workplan.

The third workshop was on Atlantic bluefin tuna electronic tagging with the goal of strategic planning of future electronic tagging and the best use of available tagging data. The state of the art in Atlantic bluefin tuna telemetry was reviewed and multiple subjects related to e-tagging, from methodological issues to knowledge gaps, were discussed. A new ICCAT information system to manage archival tags data, aiming to facilitate future joint studies, was presented. Finally, a strategic plan for further tagging to fill in identified gaps and improving stock assessment was drafted, including a list of priorities for future tagging campaigns.

Discussion

The Committee discussed the recommendations that they will provide to the Commission on EC and clarified that any responses drafted to the Commission should be based on their scientific recommendations and that the response to an EC determination remains a management decision.

The Committee inquired as to how the process of index improvement fits into the EC determination. The Rapporteurs responded that the national scientists are making continuous improvements to indices and that this is a specific part of the workplan. However, if these index changes result in different indices than what was used for the Management Procedure (MP) and for conditioning the Operating models (OMs), it would require reconditioning OMs to be able to use them in the MP. If a particular index was no longer supported by the Committee or no longer available, then it would be missing and potentially lead to ECs.

The Committee also inquired as to whether missing three or more indices in a given year would constitute an EC in each year. The Chair clarified that each year of three or more missing indices would be an EC, however the consequences of missing indices on the MP's ability to set TAC advice would increase with more years of missing data.

15.3 Work conducted for northern swordfish

The Committee has been developing a management strategy evaluation (MSE) framework for North Atlantic swordfish (SWO-N) for a decade. The process is scheduled to culminate with selection of a management procedure in 2023. In 2009, ICCAT called for development of a limit reference point for swordfish (*Supplemental Recommendation by ICCAT to amend the Rebuilding Program for North Atlantic Swordfish* (Rec. 09-02)), and the Commission adopted 0.4*B_{MSY} as the interim limit reference point in 2013 (*Recommendation by ICCAT for the conservation of North Atlantic swordfish* (Rec. 13-02)). Recommendation 13-02 also tasked the SCRS with development of a harvest control rule for SWO-N. In 2015, the Commission called for adoption of a management procedure (MP) based on an MSE for 8 priority stocks, including SWO-N (*Recommendation by ICCAT on the development of Harvest Control Rules and of Management Strategy Evaluation* (Rec. 15-07)). Technical work on the simulation framework began in 2018 through development of a factorial operating model (OM) grid constructed using the 2017 stock synthesis assessment model as a Base Case. The initial OM grid spanned a wide range of uncertainties and by 2020 the OM grid was composed of 216 Stock Synthesis III (SS3) models with uncertainty scenarios spanning a range of assumed values for natural mortality, variance in recruitment deviations, steepness of the stock-recruitment relationship, weight of catch per unit effort (CPUE) relative to length composition data and degree of observation error in the indices of abundance. The Committee examined which uncertainties were most important for driving SWO-N stock dynamics and by 2022 the OM grid was reduced to two uncertainties, steepness and natural mortality which formed the primary OM grid, with other parameters forming a set of robustness tests. The grid was conditioned with new data and model adjustments following the 2022 SWO-N stock assessment and work began in earnest on development of candidate management procedures (CMPs).

Following minor revisions to the OM grid values in 2023, the technical team consulted with ICCAT's Panel 4 on key elements of the MSE framework. Selection of a management procedure requires evaluation of candidate management procedures (CMPs) against predetermined performance metrics. The Committee worked with Panel 4 to better define management objectives, acceptable probability values for those management objectives, and time spans over which those probabilities should be calculated. A variety of model based and empirical CMPs were developed, tuned, and then evaluated for performance. Interactive tools were developed to show trade-offs among CMPs. A series of Panel 4 engagements, as well as ambassador communications sessions laid the groundwork for managers and stakeholders to understand MSE uncertainties and then provide guidance to the Committee on management priorities as well as priorities for robustness testing.

Based on guidance from Panel 4, in September of 2023, the Committee created a shortlist of CMPs for the Panel to consider for adoption. This list includes a variety of harvest control rules, each spanning the performance tradeoff space. An Exceptional Circumstances Protocol must be developed in collaboration with Panel 4 in 2024.

This new framework is a major shift in how the Committee and the Commission interact for the formulation of management advice. It should be expected that review of this process and the assumptions used to model stock dynamics be revisited on a regular basis. In 2023, Panel 4 and the technical team developed a schedule that defines when stock assessments and other checks be used to evaluate the performance of the MSE. This collaborative process between ICCAT scientists and managers will require continued engagement between the Committee and the Commission in coming years.

The Committee noted that although the core technical work has been thoroughly reviewed, a limited set of analyses require additional effort after the closure of the 2023 SCRS plenary. The swordfish MSE team is seeking the Committee's approval to complete this work intersessionally, in order to support Commission adoption of an MP in 2023. This work consists of the following items: 1) a data update to the North Atlantic combined index - data which became available during the SCRS plenary week. The CPUE model was previously reviewed and accepted by the Committee; 2) analyses as requested from Panel 4 at the 10-11 October 2023 meeting. The Committee will address minor analysis requests, such as: testing of caps/no caps for TAC change between management cycles for CMPs; alternative management cycle lengths; alterations to figures, tables, and the interactive results website.

Discussion

The Committee supported the swordfish MSE model conditioning, operating models, and Management Procedure development and testing. The Committee further agreed that the intersessional work described above could be completed after closure of this meeting.

The results of the CMP performance are summarized in **Appendix 18**.

15.4 Work conducted for SKJ-W

Following the recommendations of the Committee, the tropical tunas Management Strategy Evaluation (MSE) is made of two MSE programmes, developing in parallel: the multi-stock MSE for BET, YFT and SKJ-E tuna and the western skipjack (SKJ-W) MSE. The Committee has made progress on MSE by supporting the work of MSE consultants contracted by ICCAT and throughout its intersessional meetings (Anon., 2022g).

Progress on MSE simulations

A comprehensive evaluation of the management strategy for western Atlantic skipjack tuna was carried out in 2022, building upon the outcomes of the 2022 Skipjack Stock Assessment (Anon., 2022b). The assessment's complete range of uncertainties was considered within the uncertainty framework of reference operating models in the MSE. In 2023, the analysis homed in on assessing various Candidate Management Procedures (CMPs), focusing on key performance metrics related to the safety, stock status, yield, and stability of the western Atlantic skipjack tuna stock. Initial findings, primarily derived from implementing constant catch and empirical management procedures (MPs), were presented to Panel 1 in May 2023. Panel 1 provided valuable feedback, which the SCRS carefully incorporated into its ongoing CMPs development efforts. These latest comprehensive results have been detailed in Sant'Ana and Mourato (2023), a summary of the tables and figures are included in section 19.36.

In summary, the model-based CMPs, particularly those founded on surplus production models, demonstrated consistent and stable trends in line with recent stock assessment results. Thus, the model-based management procedures emerge as promising options for effectively managing the western Atlantic skipjack tuna stock and may form the foundation for CMPs to be considered by the Commission in 2023, aligning with the MSE roadmap. Given the intricate challenge of predicting climate change impacts on skipjack dynamics, encompassing distribution and productivity, climate change scenarios have not yet to be evaluated and implemented. Consequently, they are slated for future exploration within the western Atlantic skipjack tuna MSE framework, aside from all the work described in the SKJ-W MSE roadmap.

Capacity building on tropical tunas MSE

It is a consensus in ICCAT that there is a need to increase the capacity and understanding of their members, both scientists and managers of all CPCs, to fully engage and participate in developing and implementing MSEs. Also, it is in the interest of ICCAT that commissioners from all Contracting Parties have a sufficient understanding of MSE to participate in the process of decision-making on proposed CMPs. It is in the interest of the SCRS that a larger group of scientists can participate in the development of MSEs to make sure that all CPCs have a chance to contribute their expertise to the MSE process and to ensure that there is enough technical capacity within the SCRS to accomplish the MSE roadmap agreed by the ICCAT Commission. Furthermore, it is in this spirit that this Committee recommends that the SCRS and the Commission continue the investments in the capacity building programs.

During 2023, a new series of training courses on the MSE topic was started with the participation of scientists and managers from different ICCAT signatory CPCs. These processes of building capacity or levelling knowledge on the subject of MSE have proven to be an essential tool for communication and a better understanding of the processes that involve this type of approach. Unlike the first version of these courses conducted in 2022, where the approach included practical interaction, the focus of the 2023 courses is on the concepts that structure an MSE in this new stage. However, not only from a conceptual perspective but also from examples that are already observed in the daily life of the Tropical Tunas Species Group. Focusing on teaching methods such as problem-based learning, a more direct relationship can be built between the concepts and what the public has been following in their daily lives, whether in the scientific sphere or the field of management. The First Tropical Tunas Workshop on MSE (for scientists) (online, 13 June 2023) was successfully completed, and the Second Tropical Tunas Workshop on MSE (for managers) will be delivered on 13 October 2023. The plan is to continue this programme of capacity building and match the contents and focus of the courses to the needs of the Tropical Tunas Species Group as these needs evolve with the development of MSE initiatives.

Discussion

The Committee commended the work on MSE completed so far and inquired if the plan was to show the results to Panel 1 in 2023. The Rapporteur confirmed this, and that the hope was that an MP would be adopted this year.

The Committee agreed that the SKJ-W MSE is ready to be presented to Panel 1 as a package. However, it was noted that there is limited time for Panel 1 to review it before the Commission meeting in November 2023. The Committee noted that the robustness test including non-perfect implementation of MP was important, so it encouraged that this information be thoroughly presented to Panel 1. In response, the Rapporteur noted that the magnitude of effect on MP performance for the implementation scenarios was relatively small. Moreover, he indicated that the Tropical Tunas Species Group will work on the EC for the SKJ-W MSE and on the evaluation of climate change potential impacts in 2024.

15.5 Work conducted for multi-stock MSE

Progress on MSE simulations

Development of the multi-stock MSE, in 2023. Alternative multi-stock management objectives were proposed and discussed during the meeting of the Tropical Tuna Species Group (Merino *et al*., 2023a). The multi-stock operating models (OM) were presented to the Tropical Tuna Species Group, with a description of how the different fishery definitions have been used to aggregate a new multi-stock fishery structure. The OMs are conditioned from the model ensembles of the last Stock Synthesis stock assessments (yellowfin, 2019; bigeye, 2021 and skipjack, 2022). A series of statistical diagnostic tests were used to discuss the potential inclusion, exclusion or weighting of the different models but it was decided to retain all OMs as a first grid. However, as regards the Management Strategy Evaluation (MSE) development, the Tropical Tuna Species Group noted that it was open to incorporate additional sources of uncertainty such as those related to climate change. Also, a newly developed Observation Error Model (OEM) was presented, and it was considered adequate for the MSE. The next tasks to be completed include: 1) develop additional OMs as recommended by the Tropical Tuna Species Group, 2) propose and discuss alternative multi-stock management procedures (MPs) 3) evaluate MPs using the MSE simulation tool These tasks should define the Terms of references of 2023-2024 contracts for the multi-stock MSE. A detailed description of further developments of the multi-stock MSE is included in the MSE roadmap (see **Appendix 15** of this report).

Discussion

The Committee reviewed the developments on the tropical tunas multi-stock MSE and inquired on the next tasks. It was indicated that the multi-stock MSE is ready for an external review of the software. With regards to management objectives and development of CMPs, it was noted that due to the multi-stock structure of the MSE, trade-offs among stocks will impose a different approach for the definition and evaluation of management objectives. Accordingly, the Committee suggested to review the examples of multi-stock MSE on other RFMOs.

15.6 Review of the Roadmap for the ICCAT MSE processes adopted by the Commission in 2022

The Committee approved changes to the MSE roadmap, as adopted by the Commission in 2022, for the species northern albacore, northern swordfish, tropical tunas and western skipjack, as adopted which is contained in **Appendix 15**.

16. Update of the stock assessment software catalogue

The Secretariat has been maintaining the ICCAT software catalogue and the GitHub site. Following the recommendation by the Committee in 2022, the Surplus Production Model in Continuous Time (SPiCT) model has been incorporated in the ICCAT software catalogue in 2023.

17. Consideration of plans for future activities

17.1 Annual workplans and research programmes

17.1.1 Subcommittee on Ecosystems and Bycatch Workplan

Consistent with the ongoing exercise of developing an Ecosystem report card and implementing an Ecosystem Approach to Fisheries Management (EAFM) framework for ICCAT, the Subcommittee drafted the following work plan. The plan indicates specific tasks to be completed and organizes them according to priority for the coming year.

1. Pertaining to the work of the Sub-group on the Ecosystem Report Card

The Subcommittee recommended that the Sub-group on the Ecosystem Report Card continue to perform the "Terms of Reference for Ecocard intersessional work" provided in Appendix 5 of the Report of the 2021 Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch (Anon., 2021e).

Date	*Component*	*Task*	*Who*
December 2023, 3 days online	Sub-group on the Ecosystem Report Card	1. Review progress on the regular production and communication of the EcoCard to the SCRS (i.e., assessments updating pilot EcoCard). 2. Plan specific activities to obtain feedback from the Commission. 3. Review a draft of the "guideline document" shared prior to the next meeting of the Sub-group on the Ecosystem Report Card. 4. Create a questionnaire targeting the ICCAT community to support a scoping exercise. 5. Undertake a scoping exercise to: - Review the objectives of each ecosystem component, - Review objectives of EcoCard and each of the ecosystem components relative to the conceptual Driver-Pressure-State-Impact-Response (DPSIR) model, - Identify the attributes each component monitors, - Identify synergies and overlap among the ecosystem components.	Convenor: Participants:

1. Pertaining to the workshop on ecoregion development

The Subcommittee proposes:

1. To conduct a second ICCAT ecoregion workshop to refine the ecoregions delineations process (this includes every step of the process, from purpose, to methods to derive them, to refining of boundaries, to testing usefulness.

2. To develop pilot products such as a qualitative integrated bycatch assessment for two regions to test their utility. Alternatively, the product could be a report of sea turtle bycatch by Regional Management Unit (RMU) and species and ecoregion.

The development of a pilot product to test the utility of the ecoregions derived from the first workshop should occur in advance of the workshop.

Date	*Component*	*Task*	*Who*
January/February 2024, 3 days online	Pilot Product Review	Assess the relevance of the ecoregions	Subcommittee participants
March 2023, 3 days online	Workshop	Review and update ecoregions	Subcommittee

2. Pertaining to the development of a Risk Screening Tool

The key features of the tasks that remain are described below and may be partially or wholly addressed by a contractor.

1. The operational characteristics of fisheries

The tool will determine each species potential to interact with fishing operations and its potential to interact with tuna and tuna-like species based on the number of characteristics it shares with the ecological and behavioral characteristics/ habitat preferences of a given ICCAT species and respective fishing operation (a certain gear) for the former, and information on ecological/ biological intra-relationships for the latter.

2. Habitat data

Habitat information is a key factor in determining the potential to interact with ICCAT fisheries. Currently, the information utilized includes depth preference, salinity preference, behaviors (e.g., demersal, pelagic, cryptic), preference on specific characteristic terrains (e.g., coral reef, tide pools, inshore, oceanic, continental shelf, holes), main diets, and associates.

3. Interaction data

In order to identify a range of potential species of relevance to ICCAT, the key biological/ecological characteristics that may cause potential interference with the ICCAT fisheries need to be determined. This is achieved by examining the characteristics of the species that were caught by ICCAT fisheries. Through the use of machine learning algorithm, it is possible to identify a suitable combination of characteristics to predict the relevance of those species with no catch record in ICCAT fisheries. The characteristics utilised can be anecdotal but must be applicable universally over a broad range of species.

4. Automation of data acquisition

Data assemblage by experts assures high quality information, although it takes substantial time and effort and is subject to biases caused by variability in data availability, interests and expertise, etc. Automated data acquisition through a web-search could be superficial, and subject to errors but it allows broader coverage and once the proper web site is identified and mechanisms established, the acquisition of data itself is a rather quick process (and possible for continuous updates).

5. Modeling with machine learning

Machine learning algorithm allows to develop objective predicting models without assuming rationales connection input data and expected outputs with their estimates on uncertainty. The prediction power can also be designed to improve continuously given additional information.

June 2023 to June 2024		Collate data on habitat for seabirds, sea turtles and sea mammals and data on the interactions among species. Establish a link to ICCAT and FAO catch data. Correspond with additional information needs as required by modeling team.	Sachiko Tsuji
June 2023 to June 2024		Develop a model based on fish data that ranks impacts by ICCAT.	Modeling team /Contractor Contract period must occur between August 2023 and December 2023 in order to support progress on the tool.

3. Pertaining to the progress on case studies

While the Subcommittee recognizes that objectives of the various case studies are consistent with its own objectives, it is not currently engaged in ensuring their completion but does encourage the timely completion of the outputs.

The Subcommittee recognizes the utility of projects focused on modeling the Gulf of Mexico ecosystem and encourages groups to describe areas of mutual interest at the meetings in 2024 of the Subcommittee on Ecosystems and Bycatch or the Sub-group on the Ecosystem Report Card.

June 2023 to June 2024	Sargasso Sea Case Study	Extend DIPSIR (Driving Forces-Pressures-State-Impacts-Responses) approach to more components in the NW Atlantic Ocean ecoregion (i.e., habitat, environmental pressures, fishing pressure). Trial tools to demonstrate risk equivalency approaches.	Laurence Kell
	Tropical Ecoregion Case Study	Develop indicators for silky shark and giant manta rays using the Expansion-Assisted Iterative Fluorescence *In Situ* Hybridization (EASIFISH) approach. Identify trophic relationships for species using stomach samples. Develop ecosystem model and indicators for monitoring impacts on trophic relationships. Draft prototype Ecoregion Overview Report.	Eider Andonegi, María José Juan-Jordá
	Mediterranean Sea Case Study	1. Develop tools (e.g. web based) for monitoring marine extreme events with an impact on tuna ecology in key areas of the Mediterranean. 2. Explore the integration of indicators of early stage survival derived by environmental conditions into the assessment processes. 3. Provide updates for the environmental component of the ecosystem report card. 4. Explore outreach activities through the tuna dedicated education platform "planettuna.Com" 5. Conduct workshops at Mediterranean scale to find ways to align general objectives of ICCAT in this ecoregion with institutions in charge of i) ocean observation (e.g. Mediterranean Oceanographic Network for the Global Ocean Observing System (MonGOOS)) and ii) the implementation of the new objectives of the Barcelona Convention and the EU Biodiversity Strategy for 2030 (e.g., United Nations Environment Programme (UNEP)).	Diego Álvarez

4. *Pertaining to Ecosystems Report Card development*

The tasks outlined here are somewhat contingent on the outcomes of an elicitation process with the Commission and a review of progress by the Sub-group on the Ecosystem Report Card. Nevertheless, it is recommended that the teams continue to meet and develop or update the indicators for their respective ecosystem component in expectation of the Ecocard assessment process resuming in the near future.

Date	*Component*	*Task*	*Who*
No expectation of updates before September 2024		Update prototype report card components with new indicators	
No expectation of updates before September 2024	Retained species: Assessed	Update B_{RATIO} and/or F_{RATIO} values from recent assessments and deal with F0.1 issue	Committee participants
No expectation of updates before September 2024	Retained species: Not assessed	Perform Productivity-susceptibility Assessment (PSA) for select retained unassessed species	Committee participants Bycatch Coordinator
No expectation of updates before September 2024	Non retained sharks	Increase the scope of the data used in the analysis. Include other gear types	Committee participants
No expectation of updates before September 2024	Turtles	Perform risk assessment for loggerhead and leatherback turtles and indicator development	Committee participants
No expectation of updates before September 2024	Seabirds	Create indicator based on the total interactions, total mortality or alternatives	Committee participants
No expectation of updates before September 2024	Mammals	Discuss collaborations with the International Whaling Commission (IWC) and the International Council for the Exploration of the Sea (ICES)	Committee participants
No expectation of updates before September 2024	Trophic structure, Community and diversity indicators	Continue work developing indicators to monitor the biomass structure, size structure and trophodynamics of the ecological communities in response to fishing pressure and environment (detailed workplan in Andonegi *et al.*, 2020)	Committee participants
No expectation of updates before September 2024	Habitat	Create indicators to monitor climate-induced and fishing-induced habitat changes in ICCAT species	Committee participants
No expectation of updates before September 2024	Socio economic	Develop a process to extract the socio-economic data	Committee participants Bycatch Coordinator
No expectation of updates before September 2024	Fishing pressure	Develop an indicator based on fishing effort or capacity. Develop indicator based on Marine debris	Committee participants Secretariat
No expectation of updates before September 2024	Environmental pressure	Develop indicators that are generic	Committee participants

No expectation of updates before September 2024	Marine debris, Food webs and Trophic relationship	Informal discussion of the elements of the plans and potential indicators	Committee participants

5. Pertaining to other ecosystem items

The Subcommittee recommended that the Convener of Ecosystem Based Fisheries Management attend the Climate Change Experts Meeting in July 2023. Additionally, it was recommended that the Co-conveners of the Subcommittee on Ecosystems, in cooperation with the SCRS Chair and the SCRS Vice-chair, draft revisions to the Ecosystem Based Fisheries Management (EBFM) components of the SCRS strategic work plan that will be discussed and adopted in 2024.

Date	*Component*	*Task*	*Who*
May 2023 – June 2024	SCRS Strategic work plan	Review and update components related to EAFM and Bycatch	Subcommittee on Ecosystems Co-conveners
June 2024, 5 days	2024 Ecosystem Meeting		
One week in October 2024, 5 days	2nd Workshop on Turtles for the Mediterranean	Make progress on analysis of the information and generation of the defined products.	MED collaborative group and Bycatch Assessment and Mitigation Measures Convener

The Committee requests that given the rapid expansion of offshore wind development in areas of overlap with ICCAT species, fisheries and surveys, the Subcommittee consider developing a document that outlines the effects on ICCAT fisheries related to offshore wind and ICCAT species. Individual CPC scientists are encouraged to monitor progress of offshore wind development and its potential impacts as well as to participate in existing ICES working groups related to offshore wind. This topic will be discussed at the 2024 meeting of the Subcommittee on Ecosystems.

Pertaining to bycatch

1. Continue collaborative work on sea turtles.
2. Carry out a second workshop of five days focused on the bycatch of sea turtles (including the leatherback turtle) in the Mediterranean Sea.
3. Initiate a review process of the new seabird bycatch mitigation measures (Rec. 11-09 and Rec. 07-07).
4. Continue collaborative work with the Shark Species Group on bycatch.
5. Continue working in the Sub-group on Technical Gear Changes.
6. Continue reviewing and refining the list of bycatch species.

17.1.2 Subcommittee on Statistics Workplan and Research Plan for 2024

The Secretariat has been working since 2017 on the ICCAT Integrated Online Management System (IOMS). After being adopted by the SCRS and the Commission, the Commission's Meeting of the Online Reporting Technical Working Group (WG-ORT) has overseen the specifications and the governance of all the development process. The last WG-ORT intersessional meeting held online in 7-8 February 2023 (see the Report of the Meeting of the Online Reporting Technology Working Group (WG-ORT)) delineated the content of the future work to be presented at the 2023 Commission meeting for revision and approval. The IOMS went into production on 1 August 2021, and currently manages the ICCAT CPCs Annual Reports. The IOMS is a crucial long-term ICCAT project that requires the full involvement/commitment of the Secretariat.

Additionally, the following tasks represent ongoing database improvements and maintenance that will continue throughout 2023 and beyond. Priority tasks for 2023/2024 include:

- Upgrade all the ICCAT-DB system from MS-SQL server 2016 to MS-SQL server 2022;
- Replace the stand-alone MS-ACCESS Task 2 databases on the web by SQLite equivalent ones;
- Improve the "client applications" that manage the databases of the ICCAT-DB system;

- Continue the development of the statistical/tagging dashboards (dynamic querying);
- Continue the tagging database development for both conventional and electronic tagging;
- Continue the Biological Sampling database development (includes data recovery/integration);
- Continue the standardization of the electronic forms (TG: tagging forms, CP: compliance forms);
- Extend the automatic data integration tools for the standardized electronic forms;
- Continue the development of the Geographic Information System (GIS) project (create a PostGIS server and geo-reference for all the ICCAT data available in ICCAT-DB);
- The adaptation/migration of all the databases of the ICCAT-DB system to the new ICCAT IOMS system.

17.1.3 Working Group on Stock Assessment Methods (WGSAM) Workplan (June 2023 – June 2024)

1. Finalize details for the Bycatch Estimator Tool based on feedback from the training workshop for a broader audience.

2. Evaluate the progress of the Review of the ICCAT management strategy evaluation (MSE) process results.

3. Begin collecting some generalized catch per unit effort (CPUE) r-code that can be shared to help CPCs adhere to the CPUE paper minimum requirements.

4. Other species group requests: MCMC / MVLN Comparison study, Unification of MSE visualization tool.

17.1.4 Albacore Workplan for 2024

The Mediterranean, South Atlantic and North Atlantic albacore stocks were assessed in 2021, 2020 and 2023, respectively. In the case of North Atlantic albacore, a Management Procedure was adopted in 2021.

The main objectives for 2024 are to conduct a stock assessment for the Mediterranean stock (as required by Rec. 22-05), to continue developing the new management strategy evaluation (MSE) for the northern stock, to apply the exceptional circumstances protocol and to continue with the research as defined in the Albacore Year Programme (ALBYP).

One intersessional meeting is envisaged for data preparation and stock assessment of Mediterranean albacore (6-days, June-July).

North Atlantic stock proposed workplan

a) MSE development:

  - Condition the reference and robustness set of OMs using the SS3 model following the advice of the Albacore Species Group (ALB SG) and including climate change scenarios.

  - Develop the observation error model considering the statistical properties of each index in the projections.

  - Document the new MSE in a consolidated document. *Deadline:* 1 week before the species groups meetings. *Deliverable:* SCRS Document. *Responsibility:* MSE contractor.

b) Exceptional Circumstances Protocol:

  - Prepare T1 dataset up to and including 2022. *Responsibility:* Secretariat. *Deadline:* 1 month before the Species Group meeting.

  - Update (up to 2022, and if possible 2023) the following yearly standardized catch per unit effort (CPUEs), in weight (if possible). *Deadline:* one month before the species group meeting. Deliverable: SCRS documents, following the standards provided by the Working Group on Stock Assessment Methods (WGSAM). *Responsibility:* CPCs.

- Japanese longline (single area)
- Chinese Taipei longline (single area)
- US longline
- Spanish baitboat

- Determine whether exceptional circumstances occur, according to the indicators in the Exceptional Circumstances Protocol (Rec. 21-04). *Deadline:* 1 week before the species group meeting. *Deliverable:* SCRS Document. *Responsibility:* MSE contractor.

c) Research:

- The Committee reiterated the need to continue research activities within the ALBYP. For 2024, the priority is to continue the reproductive biology and electronic tagging studies. In addition, the group will conduct a review of the studies documenting climate effects on albacore populations.

- *Deadline:* 1 week before the species group meeting. *Deliverable:* SCRS documents. *Responsibility:* EU-Spain and Albacore Species Group.

South Atlantic stock proposed workplan

a) Research:

- The Committee reiterated the need to continue research activities within the ALBYP. Consistent with the North Atlantic Albacore Workplan, the priority for 2024 is to continue the reproductive biology and electronic tagging studies. In addition, the Group will conduct a review of the studies documenting climate effects on albacore populations. *Deadline:* 1 week before the species group meeting. *Deliverable:* SCRS documents. *Responsibility:* Brazil, with the support of partner CPCs South Africa, Uruguay, Chinese Taipei and Namibia.

Mediterranean albacore stock proposed workplan

a) Stock assessment:

The intention is to strictly update the JABBA model with data up until 2022, following the procedures of the last stock assessment. Following is a list of actions, responsibilities, and deadlines:

- Update T1 for Mediterranean albacore. *Responsibility*: Secretariat. *Deadline*: 1 week before the intersessional meeting.

- Update (until 2022), at least, the following yearly indices of abundance. *Deadline*: 1 week before the intersessional meeting. *Deliverable*: SCRS documents, following the standards provided by the WGSAM. *Responsibility*: CPCs.

  - Italian longline CPUE
  - Spanish longline CPUE
  - Larval index

- Update the JABBA model up until 2022. *Responsibility*: EU-Secretariat. *Deadline*: 1 week before the intersessional meeting. *Deliverable*: SCRS document.

- In addition, available size, maturity and selectivity information submitted by CPCs will be compiled and revised to consider providing advice on minimum size, closure periods and appropriate characteristics of the fishing gear for this stock. *Responsibility*: Secretariat, Albacore Species Group. *Deadline*: 1 week before the stock assessment meeting.

b) Research:

Research on Mediterranean albacore will focus on setting up an information network to promote collaboration among scientists working on this species in the Mediterranean. The main objective will be the development of a detailed research plan.

A more detailed study on the influence of the different abundance indices available on the results of the 2021 assessment will also be addressed.

Larval habitat modelling studies will continue in order to improve the larval indices independent of the fisheries. The objectives for 2024 are: primarily, to investigate the links between the environmental variability in Mediterranean spawning grounds (W-Med, Central Med, E-Med) and the spatio-temporal distribution of albacore during early life stages, developing larval habitat models and identifying main sources of environmental variability affecting catchability; and secondly, to assess how uncertainty on catchability affects the assessment model of Mediterranean albacore. The specific activities to conduct are associated to:

1. Homogenization of databases from different countries (including biological from ichthyoplankton surveys and environmental from hydrographical in-situ sampling in different spawning grounds);

2. Generation of remote sensing and oceanographic model data repositories and link with the larvae data from surveys to fill the Mediterranean Tuna Habitat Observatory, a case study by the Subcommittee on Ecosystems and Bycatch;

3. Design indicators for key oceanographic processes (e.g., heatwaves) with relevance to early life stages;

4. Test different modelling approaches for abundance standardization;

5. Run sensitivity analyses on the current assessment model for Mediterranean albacore considering the new information obtained.

Finally, analyses will continue to develop a growth model for the Mediterranean stock that integrates the different studies on the matter available to date.

17.1.5 Billfishes Workplan for 2024

Considering the recommendations from the SCRS, the Committee will work on developing a long-term research work plan (6 years) in 2024.

The last assessment for the blue marlin (BUM) stock was conducted in 2018 (Anon., 2018c). The next blue marlin stock assessment is proposed for 2024.

For the upcoming blue marlin stock assessment in 2024 two intersessional meetings will be held, the first meeting will be a data preparatory (DP) meeting to compile and analyze all existing information required for the stock assessment, and the second meeting will be the stock assessment (SA) meeting.

Several high priority tasks have been identified that require increased effort, including, but not limited to:

a) An intersessional hybrid data preparatory meeting in March 2024 (5 days) to collect and analyze all the existing information required for stock assessment, using data through 2022.
b) A stock assessment hybrid meeting in July 2024 (5 days), using data through 2022.

Work related to the data preparatory and stock assessment:

a) Review catch statistics
b) Identify and select catch per unit effort (CPUE) indices of abundance through 2022
c) Explore the estimation of a combined CPUE index for the longline gear with high resolution input data
d) Review and update sex-specific length data through 2022

e) Review and update fleet composition
f) Review and update biological parameters for use in the stock assessment
g) Review models to be used for stock evaluation
h) Implement the diagnostics and validation of stock assessment model(s) as recommended by the Working Group on Stock Assessment Methods (WGSAM)

Catch (Task 1), catch and effort, and size data (Task 2)

CPCs catching billfishes (directed or bycatch) should report species-specific catches, catch and effort, and size information by as small geographical area as possible, and by month.

Discards

The WGSAM developed a generalized tool for the estimation of bycatch. The Bycatch Estimator (BE) uses observer data combined with either total effort data from logbooks or with landings to estimate total bycatch. CPCs should make every effort to take advantage of this tool and participate in 2024 workshop in an effort to improve the estimation and reporting of discards.

Life history parameters

Continue the Enhanced Programme for Billfish Research (EPBR) activities including:

- The sampling of hard parts for the growth studies on billfish caught off West Africa mainly.

- Start the research and biological sampling of blue marlin from the Gulf of Mexico Mexican longline fisheries.

- Advance in direct validation of aging protocols through bomb radiocarbon, genetics and other latest scientific techniques.

Tagging

To continue the satellite tagging of blue and white marlin in the South Portugal coast in the recreational fishery.

Fishing mortality

To continue the work on estimation of fishing mortality by fleet/gear components for the billfish stocks as requested by Rec. 19-05 para 15.

17.1.6 Bluefin Tuna Workplan for 2024 and 2025

The Committee anticipates the Commission adopting an Exceptional Circumstances Protocol in 2023. The focus of the Committee for 2024 and beyond is to implement several strategic initiatives as follows, some of them being coordinated by a Technical Sub-group as a subsidiary body of the Bluefin tuna Species Group (BFT SG):

- Coordination of farm operations research (Technical Sub-group).
- Coordination on early life history (Technical Sub-group).
- Advanced genomic approaches to population size estimation (Close-Kin Mark-Recapture (CKMR)/Gene tagging) (Technical Sub-group).
- Coordination of BFT biological sampling.
- Coordination of BFT tagging including joint use of a global ICCAT e-tag database.
- Further refine the method of strict-updates for indices to be input to Management Procedures (MPs) ideally in coordination with the Working Group on Stock Assessment Methods (WGSAM).
- Further improvement of indices for consideration in future rounds of management strategy evaluation (MSE) conditioning (habitat/spatio-temporal modelling).
- Development of a rapid process for Exceptional Circumstances determination. Technology to transfer the code for plotting indices against their prediction intervals and running the MP.

- Evaluate the models to be used for future assessments.

The workplan for 2024 and 2025 is as follows:

1. Hold one intersessional meeting in 2024 focused on the elaboration of a proposal for the implementation of the CKMR methodology for BFT-E, in coordination with the ongoing CKMR study on BFT-W. Another intersessional meeting will be held in 2025, in the case the 2024 proposal is adopted, to refine the work plan for the implementation of a coordinated CKMR study for Atlantic BFT. At both intersessional meetings, special attention will be given to sampling plans and other research related to BFT biology (tagging, genetics, age, etc.). In addition, some of the research initiatives described above will also be addressed (four-day meetings in April-May, terms of reference to be determined).

2. Task for Technical Sub-groups. The purpose of the Technical Sub-groups is to create focused research teams to address specific issues. The teams can operate under their own timing and meeting schedule but will need to report back to the meetings of the BFT SG with their findings and are free to report electronically at any time deemed appropriate. Each technical sub-group will be tasked with the following topics:

   a) BFT Technical Sub-group on Farm Operations. Will address methodological improvements in the monitoring of transfers and in the estimation of the size and biomass of the tuna fattened in the farms.

   b) BFT Technical Sub-group on Early Life History. Coordination and standardization of BFT larval surveys and explore the possibilities for implementing new BFT larval index surveys, and habitat/spatial-temporal modelling.

   c) BFT Technical Sub-group on CKMR. Development of the feasibility study and of an appropriate CKMR statistical model. Design of an appropriate sampling scheme, and Identify funding opportunities.

3. Continue to support the Atlantic-Wide Bluefin Tuna Research Programme (GBYP) research programme that will focus on the development of the CKMR studies, tagging and electronic tagging database, biological studies including biological database development, assessment modelling and the continuation of the Aerial Surveys. Alternative avenues of funding will need to be sought given the budget constraints.

4. Annual index provision and determination of Exceptional Circumstances.

5. Work on Responses to the Commission.

17.1.7 Sharks Workplan for 2024

In preparation for the planned stock assessment of shortfin mako in 2024, the Group will conduct the following activities:

- Hold a 5-day long data preparatory meeting (in March) to collate and analyze all the existing information required for stock assessment, using data through 2022.

- Hold a 5-day stock assessment meeting (in June), using data through 2022.

The following tasks will be required for the shortfin mako assessment:

Data preparatory meeting

- Compile the sex-specific length-composition data from CPCs (as was done for 2017 shortfin mako stock assessment (Anon., 2018d)) for all relevant CPCs by January 2024.

- One month before the data preparatory meeting, the Secretariat will provide a summary of available conventional tag mark-recapture data, the data themselves so that they can be examined before the data preparatory meeting.

- If possible, present the relevant diagnostics from previous assessment models.

- CPCs provide catch per unit effort (CPUE) series going through 2022 (at least one week before the data preparatory meeting).

- Identify appropriate CPUE indices for use in shortfin mako stock assessment models.

- National scientists and the ICCAT Secretariat to use observer data and other potential techniques to estimate historical catches of fleets with significant catches where that information is missing.

- Define fleets based on spatial/selectivity considerations.

- Review any new life history information for shortfin mako in the Atlantic (including growth, maturity, natural mortality, and steepness). Come to final conclusions about these parameters for the purpose of the stock assessment model.

- If possible, review the methods used to generate the intrinsic growth rate, steepness from life-history parameters.

Intersessional and assessment meeting

- If possible, generate the distribution of steepness, intrinsic rate of growth etc., using the life-history parameters by one month before the stock assessment meeting.

- Consider, together with the Working Group on Stock Assessment Methods (WGSAM), alternative stock assessment methods and scenarios.

- Consider weighting schemes for stock assessment model scenarios.

- Define the potential set of ensemble models that may be considered at the stock assessment meeting.

Continue the activities of the Sharks Research and Data Collection Programme (SRDCP).

Continue and/or expand participation in the SCRS Sub-group on Technical Gear Changes in order to participate in the tasks assigned to it (see the Second Report of the Sub-group on Technical Gear Change, (Anon., 2022h)).

Continue and/or expand participation in the SCRS Sub-group on Electronic Monitoring in order to participate in the tasks assigned to it (see the Report of the Sub-group on Electronic Monitoring Systems: Proposal of draft ICCAT minimum technical standards for EMS in pelagic longliners (Anon., 2022i), and the Report of the 2022 Meeting of the Subcommittee on Statistics, Appendix 13).

17.1.8 Small Tunas Workplan for 2024

This workplan foresees both short and long-term objectives (see specific timeframes below).

- Have an intersessional meeting of the Small Tunas Species Group in 2025 for five days. The objectives of the meeting are: to organize all the data and information that have been obtained to date, to organize the length and catch position information, to present new life-history information and to review data-limited assessments that might be applied to SMT. There would be the workshop on ageing, growth, and reproduction before the intersessional meeting.

Progress on the biological studies of small tunas:

- *Background/objectives:* The Small Tuna Year Programme (SMTYP) started in 2016-2017 with the initial aim of recovering SMT historical data (statistical and biological data) from the main ICCAT fishing areas including a specific component of biological studies. A consortium led by the University of Girona (Spain) was established in 2018 for the collection of samples aiming at biological studies (reproduction and aging LTA, BON WAH) as well as stock (LTA, BON, WAH, FRI, BLT) and species (LTA, FRI, BLT) differentiation studies. In 2020, a new consortium led by Brazil (Fundação Apolônio Salles de Desenvolvimento Educacional - FADURPE) was established to continue these studies. The programme is ongoing and currently covers different activities related to biological studies.
- *Priority:* High (first priority with financial implication).
- *Leader/Participation*: In 2024, the consortium led by Brazil (FADURPE) will continue the biological studies (reproduction and aging) as well as stock and species differentiation studies.
- *Timeframe*: Ongoing work with annual updates scheduled to be provided to the SMT Species Group.

Updating and/or applying the data-limited models:

- *Background/objectives*: The Committee started applying data-limited methods in 2016 and, although the Committee has improved in applying a range of models, the robustness still needs to be evaluated before they can be used to provide management advice. In 2023 the Group will develop the specific Terms of Reference (ToRs) and an agenda for a proposed workshop on data-limited models before the 2024 species groups.
- *Priority:* High (highest priority with financial implication).
- *Leader/Participation*: Brazil and Morocco will continue to update the application of data-limited methods to SMT, with collaboration of CPCs willing to participate.
- *Timeframe:* A second workshop on data-limited models should be held in early 2024, engaging those participants that attended the first workshop and completed it successfully. SCRS papers are to be presented annually to species groups meetings or intersessional meetings.

Revision of small tunas length-weight (L/W) relationships at stock level:

The Group will undertake more work on this project once more samples have accumulated at some point after 2025.

Calibration and adopting internationally agreed maturity scales:

- *Background/objectives*: During 2020 ICCAT Workshop on Small Tunas Biology Studies for Growth and Reproduction (Saber *et al.*, 2020a), studies on SMT on growth and reproduction, including drafting protocols and training of sample processing and analysis of maturity stage, were carried out. However, the Committee feels that further work is still needed as regards the calibration and adopting internationally agreed maturity scales for *Acanthocybium solandri, Auxis rochei, Auxis thazard thazard.*
- *Priority:* High (third highest priority with financial implications).
- *Leader/participation*: Spain will continue to lead the reproduction studies, collaborating with CPCs willing to participate.
- *Timeframe:* A new workshop on maturity would be held, preferably toward the end of 2024. Also, SCRS papers are to be presented annually to species groups meetings or at intersessional meetings.

Updating the biological meta-database:

- *Background/objectives*: In 2016, the SMT Species Group started a biological meta-database. The Committee recognized the importance of continuously updating this database as new biological information becomes available, also developing criteria for replacing existing parameters when available. Such information is then provided to update the SMT Executive Summaries and will eventually be used for both qualitative and quantitative assessments for the different species and stocks.

- *Priority*: High.
- *Leader/Participation*: EU-Portugal, with collaboration of CPCs willing to participate, will continue to update the meta-database and provide updated information (in the form of SCRS papers or presentation) to the species group. The next update is planned for the next meeting of the Group in 2025. Scientists that have access to recent literature on SMT biology that can inform this database are encouraged to send that information to the SMTYP Coordinator and the SMT Species Group Rapporteur.
- *Leaders:* Dr Pedro G. Lino and Dr Rubén Muñoz-Lechuga (EU-Portugal).
- *Timeframe*: A SCRS paper will be presented annually to the 2025 species groups or intersessional meetings.

17.1.9 Swordfish Workplan for 2024

North and South Atlantic

Assessments for North and South Atlantic swordfish were conducted in 2022 (Anon., 2022f). The Committee requests a species group meeting in 2024 that will include a Management Strategy Evaluation (MSE) component (five days in-person) in addition to one MSE-specific meeting: to review and finalize robustness tests and advise Panel 4 on the development of an exceptional circumstances (EC) protocol. The MSE technical team will continue to work intersessionally online to advance the technical work. The Committee requires direction from Panel 4 on items related to MSE and requests one, one-day meeting with Panel 4 (online or in-person) in 2024 to discuss MSE work completed by the species group. The main species group meeting will be dedicated mainly to updating information for the Mediterranean assessment (anticipated for 2025), improving North and South CPUEs, and improving discard estimation methods. The Committee also requests a technical workshop (5 days, in-person) for an ageing, growth, and reproductive biology workshop associated with the Swordfish Year Programme (SWOYP) in early 2024.

The Committee noted that having in-person meetings would be more productive, but that, if needed, online meetings are also possible to advance the more technical work. A significant additional number of days would be needed if online meetings are required.

Workplan items

Life history Project:

- *Background/objectives:* An understanding of the species biology, including age, growth and reproductive parameters is crucial for the application of biologically realistic stock assessment models and, ultimately, for effective conservation and management. Given the current uncertainties that still exist in those biological parameters, the Committee recommends that more studies on swordfish life history are carried out. Those should be integrated with an ICCAT swordfish research plan that is provided in the recommendations with financial implications.
- *Priority:* High priority.
- *Leader/Participation:* A consortium led by Canada started this work in 2018. The work has progressed to date and is scheduled to continue in 2024.
- *Timeframe:* Started in 2018 and is currently ongoing; there is a request for funds to continue work throughout 2024.

Size/Sex distribution study:

- *Background/objectives:* The Committee recommends that a detailed size and sex distribution study is started in order to better understand the spatial and seasonal dynamics of swordfish in the Atlantic. This study should be carried out in a cooperative manner among scientists, involving as many fleets as possible and preferably using detailed fishery observer data. This is particularly important if future alternative management measures are considered, for example when considering spatial/seasonal protection areas for juveniles. The results could also inform on fleet specific discarding estimations. An informal data call was circulated in late 2021 to CPC scientists interested in participating in this collaborative work.

- *Priority:* High priority.
- *Leader/Participation:* Collaborative work of CPCs willing to participate/share data on size/sex/location from observer programmes.
- *Timeframe:* Started in 2018. An ICCAT paper was presented at the 2023 swordfish meeting. This work is to be completed in 2024.

Work related with northern MSE work:

- *Background/objectives:* The initial focus specific for North Atlantic swordfish, which began in 2018 and involved some development of the framework to use in the OM development, was further developed in subsequent years. Consistent with the MSE implementation roadmap adopted by the Commission, various components of the MSE framework are ongoing and are outlined below and in the ICCAT MSE roadmap. Additional work is needed on an EC protocol and robustness testing (including analysis on effectiveness of minimum size limits and climate change effects on swordfish).
- *Priority:* High priority.
- *Leader/Participation:* MSE contractor; core MSE technical team.
- *Timeframe:* Ongoing (see ICCAT MSE roadmap in **Appendix 15**).

Pop-up Satellite Archival Tag (PSAT) tag data request for joint analysis:

- *Background/objectives:* The Committee continues to encourage all CPCs to provide their swordfish PSAT tag data to an ad hoc study group. As a minimum the data should include the temperature and depth by hour, date and one-degree latitude*longitude square. This will contribute to support the improvement of CPUE standardization through the removal of environmental effects as well as the better definition of stock boundaries. This activity is linked with another from the WGSAM workplan.
- *Priority:* High priority.
- *Leader/Participation:* Led by the United States, with the participation of CPCs with PSAT data.
- *Timeframe:* Started in 2018, ongoing to date; to continue in 2024.

Continuing work on environmental effects:

- *Background/objectives:* Given the possibility of spatial and environmental effects being partially responsible for the conflicting trends of some of the influential indices of abundance, the Committee should further study this hypothesis during the coming years, use existing PSAT data to compliment this work, and determine how best to formally include these environmental covariates into the overall assessment process. The United States has taken a lead role in this investigation and likely collaborators would include scientists from Canada, Japan, and the EU (Spain and Portugal) as their indices of abundance are the most appropriate for this work. Expected deliverables would include quantified reduction in the conflicting indices of abundance from the temperate and tropic regions, which in turn should lead to a more stable stock assessment. Other products could include an increased understanding of the distribution of swordfish and perhaps a revisiting of the geographic structure of the data and the assessment. Ideally, this work should be done in collaboration with the Subcommittee on Ecosystems. This work should be expanded to include the Mediterranean. Given projected climate change effects, the Group will explore future scenarios with updated data sources. This will support MSE work on development of climate robust advice.
- *Priority:* High priority.
- *Leader/Participation:* Lead by United States, with participation of other CPCs.
- *Timeframe:* Ongoing, to be considered at the next stock assessment.

Application of methods to estimate dead discarding of swordfish in ICCAT fisheries

- *Background/objectives:* The Committee continues to note that dead discard reporting for all three swordfish stocks is poor. As such, the Committee notes the importance of applying dead discard estimation analyses (e.g. bycatch estimator tool developed at WGSAM) to swordfish stocks.
- *Priority:* High priority.
- *Leader/Participation:* WGSAM, CPC scientists.
- *Timeframe:* To be initiated in 2024.

Improving CPUEs:

- *Background/objectives:* Noting conflicting patterns in the catch per unit effort (CPUE) indices developed by CPC scientists, it is recommended that a CPUE Technical Group work intersessionally to review the CPUE data inputs, treatments, and model assumptions and methods be formed. The objective of this Technical Group will be to diagnose conflicting trends in the CPUEs and improve the quality of indicators used in swordfish stock assessment and SWO-N MSE. This Technical Group will also be tasked with developing code for reproducing the SWO-N combined index using ICCAT Task 2 catch and effort data. Develop methodology for estimating new index values without re-estimating historical values. In the case of the SWO-S, this Technical Group will also start to develop the process for estimating a combined index to improve the input data for the assessment models. To accomplish it, the ICCAT Task 2 catch and effort data will be the main data source, but also the detailed catch and effort data from different CPCs can ideally be used for this purpose, in case sharing data is possible.
- *Priority:* Medium priority.
- *Leader/Participation:* Collaborative work of CPCs scientists.
- *Timeframe:* Anticipated to start in 2024.

Exploring a closed loop simulation study for South Atlantic swordfish stock:

- *Background/objectives:* In the 2022 Atlantic Swordfish Stock Assessment Meeting (Anon., 2022f), Taylor *et al.* (2022) was presented which documented preliminary closed-loop simulations for southern Atlantic swordfish. The preliminary results showed that most of the candidate management procedures (CMPs) met minimal satisficing criteria. However, further work is still required. To be informative for management, this preliminary exercise would have to be expanded to include stock specific priors, a broader set of operating models, and finalized quantitative objectives.
- *Priority:* Medium priority.
- *Leader/Participation:* Secretariat/Rapporteur/Consultant.
- *Timeframe:* Started in 2022 and ongoing.

Development of sex-specific relationships between straight and curved Lower/Upper Jaw Fork Length:

- *Background/objectives:* The Committee noted that some CPCs are collecting straight LJFL/UJFL while others collect curved LJFL/UJFL. However, there is currently no adopted relationship between those 2 measurements in the *ICCAT Manual*. A LJFL/UJFL conversion was presented for the North Atlantic stock in 2022 and is expected to be adopted for inclusion in the *ICCAT Manual* but conversions are still not available for the Mediterranean and South Atlantic. As such, the Committee recommended that national scientists collect data and work on the estimation of those relationships. The measurement data should include stock of origin, sex and condition factor data.
- *Priority:* Medium priority.
- *Leader/Participation:* Dr Antonio Di Natale and Dr Fulvio Garibaldi will coordinate, with participation of national scientists willing to collect and collaborate with these data.
- *Timeframe:* The final paper in 2024.

Mediterranean

For the Mediterranean stock, the last assessment was conducted in 2020 (Anon., 2020d). The next assessment should be completed in 2025 for Mediterranean swordfish but, in order to monitor stock trends, essential fisheries indicators (e.g., catch, indices of abundance), should be reviewed in 2024.

Given the above needs and taking into account the questions raised during the latest assessment the workplan will include:

- Review relevant fisheries and biological data.
- Update estimates of standardized CPUE indexes for the most important fisheries.
- Obtain estimates of discard misreporting.
- Estimates of undersized catch.

Additionally, the Committee encourages national scientists to identify the effects of the environment on swordfish biology, ecology and fisheries. Future CPUE analyses should evaluate the benefits of taking into account important climate and oceanographic changes that have occurred recently in the Mediterranean Sea (e.g., eastern Mediterranean transient) and may have impacted the availability of the stock to some fisheries, and/or the recruitment success of the population.

- *Timeframe:* by the next stock assessment (2025).
- *Priority:* Medium.
- *Participation*: all CPs.

17.1.10 Tropical Tunas Workplan for 2024

The most recent stock assessment for yellowfin tuna was conducted in 2019 using catch and effort data through 2018. Note that catch reports for 2018 were incomplete at the time of the stock assessment meeting. The Group gave equal weight to surplus production model (JABBA, MPB) and integrated assessment model (SS) results. The combined results indicated that the stock was not overfished (B_{2018}/B_{MSY} =1.17) but was near the overfishing threshold (F_{2018}/F_{MSY} = 0.96). The median estimated MSY was 121,298 t. The Committee notes that the catches have been above the TAC every year since 2013, averaging nearly 136,400 t. Given that the Committee has expressed concern that catches above 120,000 t are expected to degrade the condition of the yellowfin stock if they continue, the Committee strongly recommends a stock assessment of yellowfin tuna be conducted in 2024.

Yellowfin Data Preparatory Meeting

The Committee considered the following workplan elements for the Yellowfin Data Preparatory Meeting, and requests that all data inputs be prepared through 2023 and submitted no less than 2 weeks prior to the meeting. We expect to develop both surplus production models (e.g., MPB, JABBA, ASPIC, BSP) and age structured models (e.g. SS). All elements of the workplan will require Secretariat support except item 6.

1. Update yellowfin catches (T1 and T2CE: catch and effort, T2SZ: size frequency) for all CPCs and fleets up until the year 2022.

2. Improve ICCAT Task 1 and 2 data, including complete the re-estimation of the historical Ghanaian statistics for yellowfin (bigeye and skipjack) up to 2022. The Group reiterates the need for scientists from the EU and Ghana to collaborate to adapt the T3 software and engage in capacity building to facilitate its use.

3. Evaluate the potential differences between the catches of tropical tunas estimated using the EU software T3 and those from other sources (e.g., recorded on sale slips at canneries) and requests the managers of the T3 software describe any necessary improvements and the implications of recommended changes.

4. Provide *faux poisson* estimates through 2022.

5. Prepare catch-at-size (CAS) by fleet or alternatively compile size samples by fleet, for 2019-2022. The highest priority is CAS for PS.

6. Prepare indices of abundance, including but not limited to those listed below. Index authors should describe potential changes in selectivity or catchability that have occurred as a result of changes in fishing behaviour, changes in fishing power including technological advances, regulatory actions etc. Authors should also provide relevant size frequency data to inform the parameterization of selectivity:

    a. The joint longline index using high resolution catch and effort information from the main longline fleets operating in the Atlantic (e.g., Japan, US, Brazil, Korea (Rep.) and Chinese Taipei).

    b. The echosounder-based buoy associated index (BAI)

c. The free school index for the EU purse seine fleet (EUPSFS index)

d. Other indices as possible

7. Update biological information, consider recent literature and AOTTP data:

   a. Growth curve

   b. Maximum age of yellowfin tuna

   c. Reproduction (e.g., maturity, fecundity)

   d. Review mortality and age vector and make revisions as needed

8. Update conventional and electronic tagging information about movements using most recent results of the AOTTP.

9. During the meeting, the Group will agree on the data to be used in the assessment in 2024 and on: Alternative assumptions for assessment models relating to:

   a. Stock structure alternatives

   b. Fleet structure and spatial structure

   c. Uncertainty grid member

   d. Initial projection specifications

10. Model development will occur intersessionally. Initial results will be made available to the working group no later than 2 weeks prior to the assessment meeting.

Yellowfin Stock Assessment Meeting

1. Review diagnostics of stock assessment models and select final stock assessment models to be used for management advice.

2. Review and finalize projections.

3. Prepare the final Kobe plot and K2SM.

4. Determine the appropriate management advice.

5. Prepare the detailed report of the stock assessment meeting.

6. Discuss and develop draft executive summary of yellowfin.

Improvement of basic fishery data

The Committee recommends the creation of an ad hoc group within the Tropical Tunas Species Group that will be charged with reviewing the quality of the basic data used in stock assessment (catch, effort and size data) contained in the ICCAT databases with the aim of:

– Reviewing the most important data gaps and sources of uncertainty in data reports provided to the SCRS;

– Provide guidance to CPCs on potential strategies for improving the quality of the data;

– Review work recently conducted on fishery indicators and presented during 2023 to develop a set of standard methods to reporting and communicating fishery indicators.

Similar efforts conducted by this Committee in the past, suggest that such a review needs to be done with full cooperation, collaboration and involvement of scientists from the CPC data providers. These scientists have the best knowledge about the challenges facing each country regarding data collection and reporting. They are also in the best position to implement guidance provided by the Committee.

The Tropical Tunas Species Group Coordinator will invite members of the SCRS and the ICCAT Secretariat to join this group and will coordinate the development of the terms of reference and process used by the group to reach the desired improvement in data quality. Terms of reference should clearly define the scope of the review and make sure that it focuses on data that are most important for the stock assessment and MSE processes as well as for providing responses to the Commission.

Improvement of biological parameters

The Committee will continue to support efforts to be involved in activities related to the AOTTP programme and the continuation of the analysis of the AOTTP data. These activities will provide data on recaptured tagged fish, and reporting rates of tagged fish through seeding experiments. The work will be focused on supporting tagging in the NW Atlantic and Gulf of Mexico, and the monitoring of recaptured fish and tag seeding in West Africa.

Biological parameters of all tropical stocks continue to have large associated uncertainty, and in particularly those related to growth models and ageing. Although tagging is providing valuable information on growth, it tends to be restricted to a narrow range of lengths and ages. The range is defined by the smallest fish that can be tagged, by the survival rate of those fish and reporting behaviour of different fleets. Growth of small fish and of large fish is therefore not well informed by tagging. The Committee has therefore been engaged in the collection of samples for ageing. This collection has been particularly fruitful in West Africa with the support initially of the AOTTP and currently of ICCAT.

Unfortunately, sample collections in West Africa are not generating sufficient information on small and large bigeye and small yellowfin. It is therefore proposed that the group make an effort to collect and age samples of such fish by developing a network of sample providers within the SCRS. The network will be developed by identifying the fisheries where such fish are more likely to be collected. Successful collection of such fish will improve growth models for both species and estimates of maximum age for bigeye tuna.

MSE

The Committee will continue to support the development of the SKJ-W and multi-stock MSE. Continued development of these MSEs is enhanced by the ability of all members of the Committee to have a basic understanding of the MSE process and to contribute to technical aspects of it. Members of the Committee will take advantage of training opportunities on MSE implemented by ICCAT and or the ABNJ project.

Multi-stock MSE

The Committee will adjust performance indicators for the multi-stock MSE based on feedback on operational management objectives obtained from the Commission. Feedback is expected either at the Annual Meeting in 2023, or alternatively after the appropriate meeting of Panel 1 in 2024. Such objectives are essential for a successful multi-stock MSE process as they need to be linked to specific performance indicators used in selecting a management procedure.

An external independent contractor will be appointed to review the conditioning of operating model and observational error models developed so far for the multi-stock MSE. TT Officers and the SCRS Chair will develop Terms of reference (ToRs) for the contract.

A technical Sub-group of the Tropical Tunas Species Group will be created to support the contracted development team and advance the multi-stock MSE process and to report periodically to the Tropical Tunas Species Group. Interim work and developments in the multi-stock MSE are subject to review and adoption by the Tropical Tunas Species Group.

SKJ-W MSE

For the SKJ-W MSE the Committee will start developing guidelines for exceptional circumstances and Climate Change scenarios.

Responses to Commission

The Committee will prepare responses to the Commission as necessary.

17.2 Intersessional meetings proposed for 2024

	MON LUN LUN	TUE MAR MAR	WED MER MIE	THU JEU JUE	FRI VEN VIE	SAT SAM SAB	SUN DIM DOM	MON LUN LUN	TUE MAR MAR	WED MER MIE	THU JEU JUE	FRI VEN VIE	SAT SAM SAB	SUN DIM DOM	MON LUN LUN	TUE MAR MAR	WED MER MIE	THU JEU JUE	FRI VEN VIE	SAT SAM SAB	SUN DIM DOM	MON LUN LUN	TUE MAR MAR	WED MER MIE	THU JEU JUE	FRI VEN VIE	SAT SAM SAB	SUN DIM DOM	MON LUN LUN	TUE MAR MAR	WED MER MIE	THU JEU JUE	FRI VEN VIE	SAT SAM SAB	SUN DIM DOM	MON LUN LUN	TUE MAR MAR
January Janvier Enero	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31						
February Février Febrero				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29					
																						SWOYP Wksp															
March Mars Marzo					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
															YFT or BUM Data Prep							SCRS Wksp															
April Avril Abril	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30							
								SMA Data Prep							BFT							TROP/PA1 MSE (TBD)		ECOREGIONS Wksp (online)													
May Mai Mayo			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				
								SWO (incl. MSE)							Med-ALB DP & SA														Sub-Committee on Ecosystems								
June Juin Junio						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
								WGSAM														YFT or BUM Assessment								SWO/PA4 MSE (online)							
July Jillet Julio	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31						
								SMA Stock Assessment																													
August Août Agosto				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
September Septembre Septiembre							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
																						Species Groups							SCRS								
October Octobre Octubre		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
November Novembre Noviembre					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
															Commission meeting																						
December Décembre Diciembre							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Free day in ICCAT / Jour libre à l'ICCAT / Día libre en ICCAT

Meeting of technical nature / Réunion à caractère technique / Reunión de carácter técnico

Secretariat meeting preparation/holidays / Préparation des réunions du Secrétariat/vacances / Preparación de las reuniones de la Secretaría/vacaciones

Workshop / Atelier / Taller

Given the current resources of the Secretariat and existing levels of support from CPCs in terms of scientist participation, the Committee only has the capacity to carry out three stock assessment processes during a year. In its calendar above, the Committee has taken into account requests from the Commission for specific stock assessments to be carried out in 2024, as follows:

1) Tropical tunas: yellowfin tuna (last assessed in 2019), to be followed by bigeye tuna in 2025;
2) Billfish: blue marlin (last assessed in 2018) to be followed by white marlin in 2025;
3) Sharks: North and South Atlantic shortfin mako (last assessed in 2019); and
4) Mediterranean albacore tuna (last assessed in 2021).

While the Committee notes the relatively recent assessment of the Mediterranean albacore tuna, there has been considerable work to improve data on ALB-MD, including the development of new indices. It is not clear however how impactful these improvements will be for a new assessment.

The Committee recognizes that the Commission may take into account many factors in requesting a stock assessment, but if the Commission maintains its request for a ALB-MD stock assessment to be carried out in 2024, it should be aware that there will be just three new years of data since the last assessment, including data from only one year of the rebuilding plan (2022).

Additionally, should ALB-MD be assessed in 2024, it will require the postponement of either YFT (with the resulting postponement of the planned BET assessment from 2025 to 2026) or BUM (with the resulting postponement of the planned WHM assessment from 2025 to 2026). Although the Committee considers that both YFT and BUM should be assessed soon, of these two the higher priority is YFT to be assessed in 2024.

The Committee also drew to the attention of the Commission that under the current Ref. 20-10, the SCRS can only hold meetings during several months of the year. The ability to expand meetings into more months would allow the SCRS to distribute its work over more months.

17.3 Date and place of the next meeting of the SCRS

The next meeting of the Standing Committee on Research and Statistics (SCRS) will possibly be held from 23 to 27 September 2024 and the Species Groups meeting from 16 to 21 September 2024. These meetings will be held in Madrid (Spain) and have a hybrid format.

18. General recommendations to the Commission

18.1 General recommendations to the Commission that have financial implications

Priorities and cost to incorporate in the budget the interpreting costs of the SCRS intersessional meetings

Further to the 2022 SCRS request to the Commission for the provision of interpretation services during all the SCRS intersessional meetings, the Commission followed the SCRS advice and agreed to set the criteria to rank the priorities of the meetings that would benefit from interpretation services. The five highest categories set for the prioritization of the provision of interpretation during SCRS intersessional meetings was as follows:

Rank of priority	***Meeting***
Category 1	Tropical Tunas Species Group meetings
Category 2	Sharks Species Group meetings
Category 3	Subcommittee on Statistics meetings
Category 4	Small Tunas Species Group meetings
Category 5	Subcommittee on Ecosystems and Bycatch meetings

In 2022 the Commission included in the regular budget for 2023, a total of €140,000 to cover the interpretations costs associated with the SCRS meetings up to Category 4.

Based on the above criteria, the SCRS Chair and the ICCAT Secretariat produced a draft table for the consideration of the Committee (**Table 1**), which took into consideration the tentative SCRS calendar for 2024. Accordingly, the estimated costs for the provision of interpretation to the SCRS intersessional meetings in 2024 would be as follows:

Table 1.

Requested meetings	*Duration (No. days)*	*Category 1*	*Category 2*	*Category 3*	*Category 4*	*Category 5*
*Tropical tunas Species Group**	13	€83,850	-	-	-	-
*Shark Species Group***	12	-	€77,400	-	-	-
Subcommittee on Statistics	2	-	-	€12,900	-	-
Small Tunas Species Group	2	-	-	-	€12,900	-
Subcommittee on Ecosystems and Bycatch	5	-	-	-	-	€32,250
Accumulative cost		**€83,850**	**€161,250**	**€174,150**	**€187,050**	**€219,300**

* Including a data preparatory meeting, a stock assessment meeting and a 3-day species group meeting.
** Including a data preparatory meeting, a stock assessment meeting and a 2-day species group meeting.

However, noting that the maximum number of meetings days with interpretation services during the September Species Group meetings is six, the total amount being requested to the Commission for this purpose is **€199,950.**

18.1.1 Subcommittee on Ecosystems and Bycatch

- Recognizing that environmental variability affects stock dynamics and stock status and that it should be taken into consideration when providing scientific advice, the Committee requests support to trial a risk equivalent management approach for a target species in order to demonstrate how to implement climate conditioned advice in an ICCAT assessment context. A total of €20,000 was requested.

- The Committee recommends holding a workshop to continue the collaborative work that assesses the impact of ICCAT fisheries on sea turtles in the Mediterranean and request funds to support the attendance of invited experts and the Secretariat. A total of €25,000 was requested.

The breakdown of the requested funds related to the Subcommittee on Ecosystems and Bycatch (SC-ECO) for the period 2024 and 2025 is detailed in the table below:

Subcommittee on Ecosystems and Bycatch	***2024***	***2025***
Workshops/meetings		
Support to trial a risk equivalent management approach for a target species	€20,000	€20,000
Workshop on evaluation of impact of ICCAT fisheries on marine turtles in the Mediterranean Sea and funds to support the attendance of invited experts and the ICCAT Secretariat	€25,000	€25,000
TOTAL	**€45,000**	**€45,000**

18.1.2 Subcommittee on Statistics

The Subcommittee on Statistics had no recommendations with financial implications for 2024, nor 2025.

18.1.3 Albacore

The Committee recommends continued funding of the Albacore Year Programme (ALBYP) for North and South Atlantic stocks, as well as to start funding the research for the Mediterranean stock. For the next two-years, research on the North and South albacore stocks will be focused on three main research areas (biology and ecology, monitoring of stock status, and management strategy evaluation):

– For 2024 the Committee recommends continuing electronic tagging and on reproductive biology studies (with the associated ageing of samples) in the North and South Atlantic, and to progress on the North Atlantic albacore MSE (ALB-N MSE). These are all considered to be high priority tasks, with an estimated cost of:

   i. €45,000 for tagging (€25,000 for North and €20,000 for South);

   ii. €41,500 for reproductive biology and related ageing (€29,000 for North and €12,500 for South);

   iii. Following the ICCAT MSE roadmap adopted by the Commission, the Committee recommends that the Commission provides the necessary financial means for the continuity of ALB-N MSE work. This high priority task requires €30,000 funding for 2024.

More details of the proposed research and economic plan are provided in the report of the ALBYP (item 17.1.4 and **Appendix 10** this report).

Breakdown of the requested funds related to albacore for the period 2024 and 2025 is detailed in the table below:

Albacore	***2024***	***2025***
Tagging		
Tagging, rewards and awareness	€45,000	€45,000
Biological studies:		
Reproduction	€25,000	€25,000
Age and growth	€10,000	€10,000
Genetic		
Other		
Sample collection and shipping	€6,500	€6,500
MSE		
Progress of the ALB-N MSE	€30,000	€30,000
TOTAL	**€116,500**	**€116,500**

18.1.4 Billfishes

The Committee recommends continued funding of the Enhanced Programme of Billfish Research (EPBR). For the next two years, research will be focused on the following areas by order of priority:

– Continue the growth study of the three priority billfish species in the eastern Atlantic; including the provision of laboratory equipment (Microscope);

– Initiate reproduction study of blue marlin (BUM) in the Gulf of Mexico;

– Conduct a Workshop on small-scale fisheries (artisanal) in the Central America and Caribbean regions, with the objective of collecting detailed information describing their fishery(ies) and sampling programmes, aiming to improve the collection and submission of billfish fisheries data in these regions (funding already available from 2023 science budget). The Committee is suggesting giving consideration to help the participation of selected non-ICCAT CPCs to this workshop by collaborating with FAO/WECAFC;

- Continue the electronic tagging of marlins (BUM/WHM) in the North-East Atlantic and start tagging activities in South-West Atlantic;

- Conduct a technical workshop that should focus on age reading and building a reference set for both spines and otoliths in 2025;

Breakdown of the requested funds related to billfish for the period 2024 and 2025 is detailed in the table below:

Billfish	***2024***	***2025***
Tagging		
Electronic tagging, rewarding and awareness (Portugal)	€10,000	€30,000
Electronic tagging, rewarding and awareness (Brazil)	€30,000	
Biological studies:		
Reproduction	€15,000	€15,000
Age and growth	€20,000	€20,000
Genetic		
Other (if any, identify)		
Sample collection and shipping	€10,000	€10,000
Stock assessment		
BUM assessment external review	€10,000	
WHM assessment external review		€10,000
Workshops/meetings		
Ageing workshop		€25,000
Equipment		
Microscope with high resolution for reading (SMZ25/SMZ18 Model)	€11, 000	
TOTAL	**€106,000**	**€110,000**

18.1.5 Bluefin tuna

The Committee recommends continued funding of the Atlantic-Wide Bluefin Tuna Research Programme (GBYP). For the next two years, research will be focused on the following areas by order of priority:

- Hold one intersessional meeting in 2024 (4 days) focused on the elaboration of a proposal for the implementation of the Close-Kin Mark-Recapture (CKMR) methodology for BFT-E, in coordination with the ongoing CKMR study on BFT-W. Sampling design and other research lines will also be addressed;

- Hold one intersessional meeting in 2025 (4 days), in the case the 2024 proposal be adopted, to refine the workplan for the implementation of a coordinated CKMR study for Atlantic BFT; Sampling plans and other research lines will also be addressed;

- Contribute to the modelling, genetic studies, and contracting of a genetic expert to advise the GBYP Steering Committee in relation to the CKMR feasibility study and eventual implementation;

- Contribute to other biological studies and biological database development required for stock assessment;

- Contribute to tagging research including electronic database further development;

- Contract experts to develop models to be used for future assessments;

- Contribute to GBYP aerial survey;

- Contribute to MSE general review.

Breakdown of the requested funds related to bluefin tuna for the period 2024 and 2025 is detailed in the table below:

Bluefin tuna	***2024 (GBYP Phase 14)***	***2025 (GBYP Phase 15)***
Tagging, rewards and awareness		
Electronic tagging, rewarding and awareness	€105,000	€105,000
Biological studies		
CKMR development	€95,000	€150,000
Sample collection, shipping, handling and maintenance	€50,000	€60,000
Other studies		
Fisheries independent index, GBYP aerial survey	€370,000	€380,000
Further development of assessment models	€25,000	€30,000
MSE		
MSE review	€5,000	
Workshops/meetings		
Proposal for the implementation of the CKMR methodology	*	€250,000
Program coordination	€350,000	€250,000
TOTAL	**€1,000,000**	**€1,000,000****

* Support to 2024 workshop covered under Phase 13 budget.
** Funding amount is tentative.

18.1.6 Sharks

The Committee recommends continued funding of the Shark Research and Data Collection Programme (SRDCP). For the next two years, research will be focused on the following areas by order of priority:

- Provide funding for the SRDCP for Year 10 to:

  i) Finalize analytical results on South Atlantic shortfin mako age and growth (€7,000).
  ii) Continue with stock differentiation analysis for porbeagle (Next Generation Sequencing (NGS)) (€25,000).
  iii) Continue on prioritized study on movement, habitat characterization and post-release mortality for shortfin mako (*Isurus oxyrinchus*), porbeagle (*Lamna nasus*), silky (*Carcharhinus falciformis*), oceanic whitetip (*C. longimanus*), longfin mako (*I. paucus*), hammerhead sharks (*Sphyrna* sp.), blue shark (*Prionace glauca*) and bigeye thresher (*Alopias superciliosus*) through satellite tagging, including tag-return rewards (€12,000).
  iv) Conduct electronic tagging campaigns (€100,000).
  v) Improve conventional tagging programme for sharks through the use of stainless steel dart tags (€7,000).
  vi) Continue the study on the reproductive biology of North Atlantic shortfin mako quantifying reproductive hormone concentrations from muscle tissue samples to determine maturity and reproductive status (€10,000).
  vii) Start age and growth study on one of the following ICCAT species (BSH, POR, SPZ, OCS, FAL and BTH) (€7,000), including shipping of samples (€2,000).

- Consider hiring one or more external experts to assist constructing a clear and comprehensive methodological approach to build an uncertainty grid for the stock assessment of Atlantic North and South shortfin mako shark stocks. The expert(s) should also participate in-person at the data preparatory and stock assessment meetings (€20,000).

A breakdown of the requested funds related to sharks for the period 2024 and 2025 is detailed in the table below:

Sharks	***2024***	***2025***
Tagging		
Electronic tagging, rewarding and awareness	€12,000	€12,000
Purchase of stainless steel dart spaghetti tags	€7,000	€7,000
Electronic tagging campaign	€100,000	€50,000
Biological studies:		
Reproduction (SMA North)	€10,000	€10,000
Age and growth (SMA South)	€7,000	
Age and growth (other species)	€7,000	€7,000
Genetic (POR)	€25,000	€25,000
Other (if any, identify)		
Sample collection and shipping	€2,000	
Workshops/meetings		
Workshop on Age and growth (2025)		€20,000
SMA stock assessment expert	€20,000	
Equipment		
TDRs and Hook-timers (long-term study, requested by Rec. 21-09)		€ 30,000
TOTAL	**€190,000**	**€161,000**

18.1.7 Small tunas

The Committee recommends continued funding of the Small Tunas Year Programme (SMTYP). For the next two years, research will be focused on the following areas by order of priority:

- *Continuing support to the SMTYP:* The Committee recommended continuing with the ICCAT SMTYP research programme activities in 2024 to further improve the biological information (improving geographical coverage for growth, maturity and stock identification) to fill the remaining gaps of the three species (WAH, LTA, BON) and continue the sampling for *Auxis thazard* (FRI) and *A. rochei* (BLT). Costs for 2024 (€15,000), since funds are still available from the 2023 budget (€22,500).

- *Conduct a second regional workshop (in person, 5 days) on the application of data-limited methods to assess small tuna stocks*: Following the workshop held in May 2023, the Committee recommended that the second part of the in-person workshop be held to advance research and application of data-limited methods to some small tuna species. This workshop should be held in 2024, involving the same instructors that organized the first workshop and experts that successfully completed it. The estimated cost is of €25,000, to cover the attendance of both participants and instructors.

- *Workshop (in person, 5 days) on maturity staging (reproduction) in 2024 for small tuna stocks:* This workshop would allow for calibration and adopting internationally agreed macroscopic and microscopic maturity scales for the new studied small tuna species. Costs are estimated at €20,000, which are available from the 2023 budget, and should allow for participation of 1 expert and up to 8 national scientists.

- *Workshop (in person, 5 days) on ageing in 2025 for small tuna species*: This workshop would allow for calibration and adopting internationally agreed methodologies to advance on the new studied small tuna species. The estimated cost to cover the attendance of 1 expert and up to 6 national scientists is of €30,000.

- *Morphometric and morphological comparison:* The Committee recommends doing a morphometric and morphological comparison between fresh/frozen specimens of *Euthynnus* spp. from the Northeast Temperate Atlantic and Mediterranean Sea (NETAM) and the eastern tropical Atlantic to assess if physical characters can be used to discriminate the two genetically different species.

Breakdown of the requested funds related to small tunas for the period 2024 and 2025 is detailed in the table below:

Small Tunas	***2024***	***2025***
Biological studies:		
Reproduction	€5,000	€7,500
Age and growth	€5,000	€7,500
Genetic	€5,000	€7,500
Other (if any, identify)		
Sample collection and shipping	**€7,500**	€10,000
Workshops/meetings		
Second Workshop of data-limited methods to assess small tuna stocks	€25,000	
Capacity building on small tuna ageing		€30,000
Equipment		
TOTAL	**€47,500**	**€62,500**

18.1.8 Swordfish

The Committee recommends continued funding of the Swordfish Year Programme (SWOYP). This recommendation applies to both the North and South Atlantic and Mediterranean stocks. For the next two years, research will be focused on the following areas by order of priority: an understanding of the species biology, including age, growth and reproductive parameters, as well as stock structure and mixing is crucial for the application of biologically realistic stock assessment models and, ultimately, for effective conservation and management. Given the current uncertainties that still exist, the Committee recommends as high priority to continue biological studies on swordfish. An ICCAT project on swordfish biology, genetics and satellite tagging started in 2018 and the Committee recommends that the project continue for 2024 and is provided with financial support. The Committee further recommends the use of a multi-stocks research cruise to fill spatial-temporal samples gaps that are common among ICCAT species groups.

The Committee recommends revising and updating the Longline section (chapter 3.1.2) of the *ICCAT Manual*, that was last updated in 2014. This concerns most of the species groups in ICCAT, as multiple species are captured in the various methods under longline fisheries. If accepted, such budget could be shared by the several species groups of concern (€3,000).

Several of the following activities will be funded through the 2024 ICCAT science budget, however, there are cases where additional budget will be needed, detailed below:

- *Satellite tagging work*: To cover expenses with deployments of previously acquired tags and some tagging equipment (tagging poles, etc.), and fund dedicated trips for tagging. Priority areas for the dedicated tagging trips are the NW Atlantic with the main objective to tag larger swordfish, the NE Atlantic to tag fish in the area between Gibraltar, West of the Iberia Peninsula, Madeira and Canary Islands as that is a mixture area for the 3 stocks, and the SW Atlantic as an area that is currently very poorly covered. The requested funds should cover around 7 tagging days in the NW Atlantic, 10 tagging days in the NE Atlantic and 10 tagging days in the SW Atlantic (all values are per year). The tagging trips should use fishing gear that is adapted to promote better chances of post-release survival (e.g., deep-drop buoy gear, rod and reel, shorter longlines deployed with short soaking times).

- *Reproduction*: Ongoing work processing and analysing gonads.

- *Age and growth*: Processing and analysis of spines and otoliths; continuation of a bomb-radiocarbon age validation study.

- *Genetics*: Continued population analysis of tissues samples for stock differentiation; continuation of a study on epigenetic ageing, to be completed in conjunction with the bomb radiocarbon study. The genetics study continued to identify stock differentiation, boundaries and mixing between North, South and Mediterranean swordfish. Using double digest restriction-site associated DNA (ddRAD) genetics techniques, samples will be analyzed from the central South Atlantic, Southwest Indian Ocean and eastern Mediterranean Sea in order to better define stock differentiation and boundaries. In addition, ddRAD analysis will be applied to new samples coming from areas of interest already studied in order to monitor for temporal trends in mixing among stocks. Samples from Northeast Atlantic will elucidate the rate of mixing of three stocks, if the mixing is constant or there are variations along the years and if there is genetic admixing among the three stocks. ddRAD analysis will also be applied to Mediterranean specimens caught in the Gibraltar Strait to confirm the absence of Atlantic specimens into the Mediterranean Sea. Epigenetic analysis will be mostly completed by analyzing an additional 30 samples by RRBS-SEQ (Reduced Representation Bisulfite Sequencing).

- *Close-kin study*: Continue work first initiated as a feasibility study for close-kin mark-recapture to develop a fishery independent index of abundance.

- *SWOYP strategic workshop*: 8 participants (workshop should be scheduled as two in-person days). This workshop is expected to take place in early 2024.

- *Age and growth reference set workshop*: 7-8 participants plus two experts (should be scheduled as five in-person days). The costs of this workshop will be covered by the 2023 funds.

- *Sampling and shipping*: Sampling priority on missing areas/sizes as defined in the project summary.

- *MSE for SWO-N*: (priority: high). The Swordfish Species Group is scheduled to continue development of an exceptional circumstances protocol and robustness tests in 2024.

Breakdown of the requested funds related to swordfish for the period 2024 and 2025 is detailed in the table below:

Swordfish	***2024***	***2025***
Tagging		
Electronic tagging, rewarding and awareness	€145,000	€145,000
Biological studies:		
Reproduction	€10,000	€10,000
Age and growth	€20,000	€20,000
Genetic	€100,000	€70,000
Other (close kin study)	€15,000	
Other (updating longline section of *ICCAT Manual*)	€3,000	
Sample collection and shipping	€7,000	
Workshops/meetings		
SWOYP Technical Workshop	€25,000	
MSE		
Progress of the SWO MSE	€95,000	€20,000
TOTAL	**€420,000**	**€265,000**

18.1.9 Tropical tunas

The Tropical Tuna Research and Data Collection Program (TTRaD), (**Appendix 16**) was developed intersessionally and used as the basis to define the top priority recommendations with financial implications for 2024 and 2025 (detailed below).

The highest priority is to advance the development of the multi-stock MSE and the western skipjack MSE, including training workshops and the independent technical review of the MSEs.

The next highest priority is to continue progressing the estimation of growth, maximum age and natural mortality for the three species of tropical tunas. This should be done by continued collecting and ageing of specimens of the three species and by taking advantage of the Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP) data. Initially, the work should focus on improving age/length sample collection and processing of small and large bigeye tuna.

Finally, the last research priority is to continue to invest in the recovery of AOTTP tagged fish, tag seeding and maintenance of the tagging database.

A breakdown of the requested funds related to tropical tunas for the period 2024 and 2025 is detailed in the table below:

Tropical Tunas	***2024***	***2025***
Tagging, rewards and awareness		
Tag recovery and maintenance of AOTTP database	€15,000	€25,000
Biological studies:		
Age and growth	€15,000	€25,000
Other studies		
MSE		
Western SKJ	€25,000	€25,000
Multi-stock MSE	€50,000	€75,000
Independent external review	€20,000	
Training workshops for scientists and stakeholders with interpretation	€50,000	
TOTAL	**€175,000**	**€150,000**

18.1.10 Working Group on Stock Assessment Methods (WGSAM)

- The Group recommends that a workshop be held on the use of the Bycatch Estimator Tool in 2024. This workshop shall be organized in cooperation with the current contractor and the costs of travel and daily subsistence allowance (DSA) will be covered for the contractors and selected participants. Details of the workshop will be developed within separate Terms of Reference that will be forthcoming.

- The Committee recommends that one common visualization tool should be adopted by all the ICCAT MSEs. This approach would streamline learning, understanding and updating a single application. Such interfaces currently in use include the "Slick" and "Shiny" applications. The unification of the resources supporting divergent efforts should be considered. The new Executive Summary format should take into consideration the agreed upon visualization tools and ensure a logical connectivity between the two forms of communications.

Breakdown of the requested funds related to the Working Group on Stock Assessment Methods (WGSAM) for the period 2024 and 2025 is detailed in the table below:

Working Group on Stock Assessment Methods (WGSAM)	***2024***	***2025***
Other (if any, identify)		
Other studies (TBD)*		€35,000
Unification of Shiny and Slick MSE tools	€5,000	
Workshops/meetings		
Workshop on the use of the Bycatch Estimator Tool	€40,000	
TOTAL	**€45,000**	**€35,000**

* Estimated, to be defined at the next meeting of WGSAM.

18.2 Other general recommendations

18.2.1 Subcommittee on Ecosystems and Bycatch

Recommendations for the ecosystem component of SC-ECO

– Recognizing that the *Resolution by ICCAT to standardize the presentation of scientific information in the SCRS annual report and in working group detail reports* (Res. 11-14) and the *Resolution by ICCAT to complete the standardization of the presentation of scientific information in the SCRS annual report* (Res. 13-15) support the inclusion of "information on the bycatches of the different fleet segments and fisheries, as well as other ecosystems considerations" in the Executive Summaries, the Committee recommended that the SCRS explore how to include ecosystem considerations in the species Executive Summaries and other sections of the SCRS annual report.

Recommendations for the bycatch component of SC-ECO

– The Committee recommends that the SCRS explore the mechanisms and processes for providing fine scale data to advance the work on the multispecies spatial distribution in longline fisheries.

18.2.2 Subcommittee on Statistics

The Subcommittee recommends that the reporting of Task 2 catch-at-size (Form ST05-T2CS) for YFT, BET, SKJ, SWO, BFT, and ALB be optional instead of mandatory, however CPCs are still required to report Task 2 sizes samples (Form ST04-T2SZ). As an alternative to the mandatory reporting of CAS, species groups can request that CPCs submit CAS on a case-by-case basis when such estimates are needed to conduct specific analysis. The updates of the CAS must be requested at least 6 months in advance of the deadline. Those species groups which anticipate the need for catch-at-size estimates in the next year, or which have a recurring need for such estimates, should include the specific catch-at-size data requirements in their workplan.

The observed CPCs late reporting of fishery statistics and biological data, combined with the overloaded calendars of recent years and the advancement of the SCRS annual meeting by one week, does not allow the Secretariat to have sufficient time to validate, process, store and prepare it in time for the SCRS annual meeting. In consequence, the Subcommittee recommends that the deadline for submission of all statistical data be changed to 15 July each year, allowing the Secretariat to validate and prepare in time the data for the SCRS annual meeting. The requested corrections must be submitted to the Secretariat no later than 15 days after receiving the request.

18.2.3 Albacore

- Due to the current limitations of the Mediterranean albacore stock assessment, the Committee recommends a network of researchers be established to work intersessionally on the development of a comprehensive and coherent research plan for this stock to be integrated within the ALBYP, together with the North and South Atlantic stocks research plans.

- The Committee recommends an increase in effort to complete the Task 1 data for Mediterranean albacore, this being one of the main uncertainties not quantified in the assessment. The Committee recommends that CPCs and the Secretariat work together to complete the Task 1 data in the ICCAT database before the next assessment, and to consider methods developed by the Working Group on Stock Assessment (WGSAM) to estimate unreported catches.

18.2.4 Billfishes

- The Committee noted that the sailfish catch per unit effort (CPUE) estimates spatially distributed along the equator on both sides of the Atlantic may indicate the possibility of exchange between the two stocks. Therefore, considering that genetic studies identify Atlantic sailfish as a single panmictic genetic stock, the Committee recommends that the EPBR find mechanisms to increase sailfish tagging efforts for both sides of the Atlantic in the equatorial regions.

- The Committee recommends that all SCRS documents that present updates to CPUE series used in previous assessments include all the required elements (e.g., diagnostics, deviance tables, tables, and graphs) to allow for their full review, following the recommendations from the 2023 Meeting of the Working Group on Stock Assessment Methods (Anon., 2023e) for CPUE evaluation.

18.2.5 Bluefin tuna

- The Committee recommends to fully explore the feasibility of applying CKMR methodology for bluefin tuna on both sides of the Atlantic. Implementation is already underway in the western Atlantic, and it recommends that as soon as technically and logistically feasible it be applied in the eastern Atlantic and Mediterranean Sea area. Sampling in the framework of the CKMR in the East Atlantic has sampling requirements that probably cannot be fully assumed by the GBYP considering the current availability of funds. Therefore, ways to ensure the availability of funds for the implementation of the CKMR approach to Atlantic BFT stocks should be explored.

- The Committee recommends the development of modelling that will allow further improvement of BFT management, specifically, further improvement of indices standardization to include spatiotemporal variation and the incorporation of new information in future rounds of MSE conditioning, as well as evaluation of the models to be used for future assessments.

18.2.6 Sharks

- Considering that the next ICCAT workshop for the improvement of statistical data collection and reporting on small scale (artisanal) fisheries will be held in the Caribbean region in 2024 and considering that sharks are caught as bycatch across almost all countries and all fleets in the Caribbean region associated to ICCAT fisheries, the Committee recommends that sharks are considered within the workshop to take place in the Caribbean region.

- Considering the need to improve stock assessments of pelagic shark species impacted by ICCAT fisheries and bearing in mind *Recommendation by ICCAT to replace Recommendation 16-13 on improvement of compliance review of conservation and management measures regarding sharks caught in association with ICCAT fisheries* (Rec. 18-06) as well as the various previous recommendations which made the submission of shark data mandatory, the Committee strongly urges the CPCs to provide the corresponding statistics, including discards (dead and alive), of all ICCAT fisheries, including recreational and artisanal fisheries, and to the extent possible non-ICCAT fisheries capturing these species, the Committee considers that a basic premise for correctly evaluating the status of any stock is to have a solid basis to estimate total removals.

18.2.7 Small tunas

– The Committee recommended that Statistical Correspondents and/or national scientists revise, update, complete, and submit their small tuna Task 1 nominal catches (T1NC) series to the ICCAT Secretariat. This revision should consider **Appendix 5** (SCRS catalogues), the split of "unclassified" gear catches to specific gear codes, and the completeness of Task 1 gaps identified. The Statistical Correspondent and/or national scientists of CPCs should correct inconsistencies identified in T2SZ series. For the 13 species of small tunas, the Task 2 size data (T2SZ) revision should have as reference, the stratification of the samples by gear, month, 1°x1°or 5°x5° squares, and straight fork length (SFL) size classes of 1 cm (lower limit). CPCs should further improve their estimates of total catches, as there are still important gaps in the basic data available. These data are required as inputs for most data-limited stock assessment methods. The ICCAT Secretariat should continue its work on the data recovery and making inventories of tagging data for small tuna species. This process will require active participation of the national scientists who hold such data.

– The Workshop on Data limited Assessment Methods for Small Tunas highlighted the minimum need for data from CPCs to allow for estimating stock status. The Committee recommended always estimating the L95 (length at full maturity) parameter in studies on maturity for all species, because it is essential for the stock assessment of data-limited species, such as the small tunas.

18.2.8 Swordfish

– Given the importance of including discards (dead and alive) in the reported catch, the Committee recommends developing and adopt standard methods for raising observed discards to the total effort and that these be reported in the Task 1 nominal catch data. The Committee recommends that fleets fishing where sampling gaps still remain collaborate with the SWOYP to provide samples that will address current uncertainties related to the assessment of the 3 swordfish stocks.

– The Committee recommends that CPCs make available biological samples from their fisheries to the SCRS. The SCRS relies on biological samples (e.g., fin spines/otoliths for determining age structure; tissue for close kin and stock mixing analysis, gonads for estimating maturity and fecundity) to estimate the status of ICCAT stocks and make science and management recommendations. The Committee stresses that it has been difficult obtaining these samples from CPCs and that they are vital to producing scientifically robust stock assessments. Within this sampling requirement should be an allowance for sampling by onboard observers on undersized swordfish in the Mediterranean that are dead at haulback.

18.2.9 Tropical tunas

– In preparation for the 2024 yellowfin tuna stock assessment, it is recommended that the Secretariat in collaboration with Ghana national scientists revise and update the fisheries statistics related to the Ghana tropical fisheries of Task 2 CE/SZ of 2020-2022. The Committee agreed that this is intended to be an immediate solution of data inputs for yellowfin stock assessment and recommends that during 2024 a long-term workplan be developed to consider the Ghana's capacity and resources for assuring the regular provisions of fisheries statistics of their tropical fisheries.

– Continuation on the improvement of T1FC, noting its relevance in the estimation of fishing capacity in the ICCAT Convention area. Including, an update for ST01-T1FC (fleet characteristics), to make mandatory the fishing effort (field "fishing days") in both sub-forms (ST01A and ST01B) and add two additional mandatory fields: International Maritime Organisation (IMO) number and carrying capacity for tropical tuna fisheries.

– For Tropical Tunas MSE projects, the Group recommends that the Commission, and a greater number of CPCs, provide additional funding and commit more resources to support the development of multi-stock MSE to be able to implement the Commission's MSE roadmap.

18.2.10 Working Group on Stock Assessment Methods

- The Committee recommended that the impact of climate change be considered in all ICCAT MSE applications, in either the reference or robustness set of operating models (OMs). These considerations could come in the form of generalized changes in productivity (e.g. extended periods of higher/lower than average recruitment) or, if possible, changes that have been shown to have a direct mechanism associated with them (e.g. changes in the spatial distribution of a stock). The species groups should consider recommending including “climate readiness” as a MSE management objective as a means of addressing paragraph 2 of the *Resolution by ICCAT on Climate Change* (Res. 22-13), as the Committee interprets its adoption of Res. 22-13 as elevation of “climate readiness” to be an additional Commission management objective.

- The Committee recognized the lack of information contained in some papers about indices of abundance and the subsequent difficulties that have ensued from including a large number of often times conflicting indices. Thus, the Committee recommended that all future SCRS papers that propose the use of a catch per unit effort (CPUE) index adhere to the list of minimum requirements put forth at this meeting so that better informed decisions can be made as to whether to include those indices in the stock evaluations.

19. Responses to the Commission’s requests

19.1 Based on the results presented by CPCs on their research trials, the SCRS shall advise the Commission on potential sea turtle mitigation measures for these fisheries, Rec. 22-12 para 4

Background: *CPCs with deep-set longline, gillnet, and where appropriate, shallow-set longline fisheries are encouraged to undertake research trials aimed at mitigating bycatch and reducing bycatch mortality, and increasing post release survival of sea turtles. Research should also examine the effects of hook sizes and shapes, fishing depths, fishing areas, and seasons. CPCs shall report the results of this research (including the tradeoffs among catch rates of target and bycatch species) to the SCRS. Based on the results of such research, the SCRS shall advise the Commission on potential sea turtle mitigation measures for these fisheries.*

The Committee did not have time to discuss this response in 2023 but will address it in 2024.

19.2 The SCRS should review the appropriateness of the southern boundary of this range and advise the Commission in 2023, Rec. 22-12 para 6

Background: *The SCRS should review the appropriateness of the southern boundary of this range and advise the Commission in 2023.*

In accordance with the Commission's request in the *Recommendation by ICCAT on the bycatch of sea turtles caught in association with ICCAT fisheries (combine, streamline, and amend Recommendations 10-09 and 13-11)* (Rec. 22-12) on the southern latitudinal limit of sea turtles, the Committee agreed that given the new available information on the distribution of the loggerhead turtle, this limit could be extended in the western South Atlantic to 40°S. For the eastern South Atlantic, it should be kept at 35°S as stated in the Recommendation. The limit for the division between eastern South Atlantic and western South Atlantic is proposed to be at 20°W.

19.3 The SCRS is requested to review periodically the provisions of this measure related to the spatio-temporal ecology of sea turtles, including their interactions and mortality associated with these fisheries, Rec. 22-12 para 7

Background: *In light of the potential impacts of climate change on ICCAT fisheries, including target stocks and bycatch species, the SCRS is requested to review periodically the provisions of this measure related to the spatio-temporal ecology of sea turtles, including their interactions and mortality associated with these fisheries.*

The Committee did not have time to discuss this response in 2023 but will address it in 2024.

19.4 The SCRS shall assess available information on the use of time-area fishing restrictions and closures in areas where there is a higher risk of interaction with sea turtles and advise the Commission, as appropriate, Rec. 22-12 para 10

Background: *The SCRS shall assess available information on the use of time-area fishing restrictions and closures in areas where there is a higher risk of interaction with sea turtles, and advise the Commission, as appropriate.*

The Committee did not have time to discuss this response in 2023 but will address it in 2024.

19.5 The SCRS shall assess the occurrence of exceptional circumstances (ECs), Rec. 21-04 para 4

Background: *The SCRS shall assess the occurrence of exceptional circumstances (ECs) and the Commission shall act in accordance with the Exceptional Circumstances Protocol sets out in Annex 2.*

According to the North Atlantic albacore Exceptional Circumstances (EC) Protocol in Rec. 21-04, indicators related to natural mortality (M), catch, catch per unit effort (CPUE), relative biomass and relative fishing mortality were revised.

The M at age vector adopted during the data preparatory meeting is not substantially different from the values of the Operating Models (OMs) used in the Management Strategy Evaluation (MSE) (**Figure 19.5.1**).

Catches have been lower than the adopted Total Allowable Catch (TAC) for most years except for 2019, when it was exceeded by 3.5% (**Figure 19.5.2**).

Updated CPUE series fall within the 2.5%-97.5% percentile of the normalized CPUE values used to run the closed-loop simulations in the MSE. The only exception is the 2018 value of the Spanish baitboat CPUE, which is slightly larger than the 95% interquartile range used in the MSE (**Figure 19.5.3**).

Relative stock biomass and fishing mortality were compared against the 2.5% and 97.5% percentile range of values in any year from the OMs (**Figures 19.5.4 and 19.5.5**) as well as the 2.5% and 97.5% percentile range of values in any year produced by the accepted MP's production model during MSE testing (**Figures 19.5.6 and 19.5.7**). The Group noted that the relative biomass values estimated by the Stock Synthesis model are larger than those in the MSE for the period 1930-1957. Although, according to the protocol this was identified as an EC, it was not considered an impediment for the application of the MP. The estimates of MPB fall within the values (95% CI) estimated in the MSE, both in the OMs and MPs.

In summary, the Committee concluded that no Exceptional Circumstance(s) were identified that preclude the application of the MP to set the TAC for the period 2024-2026.

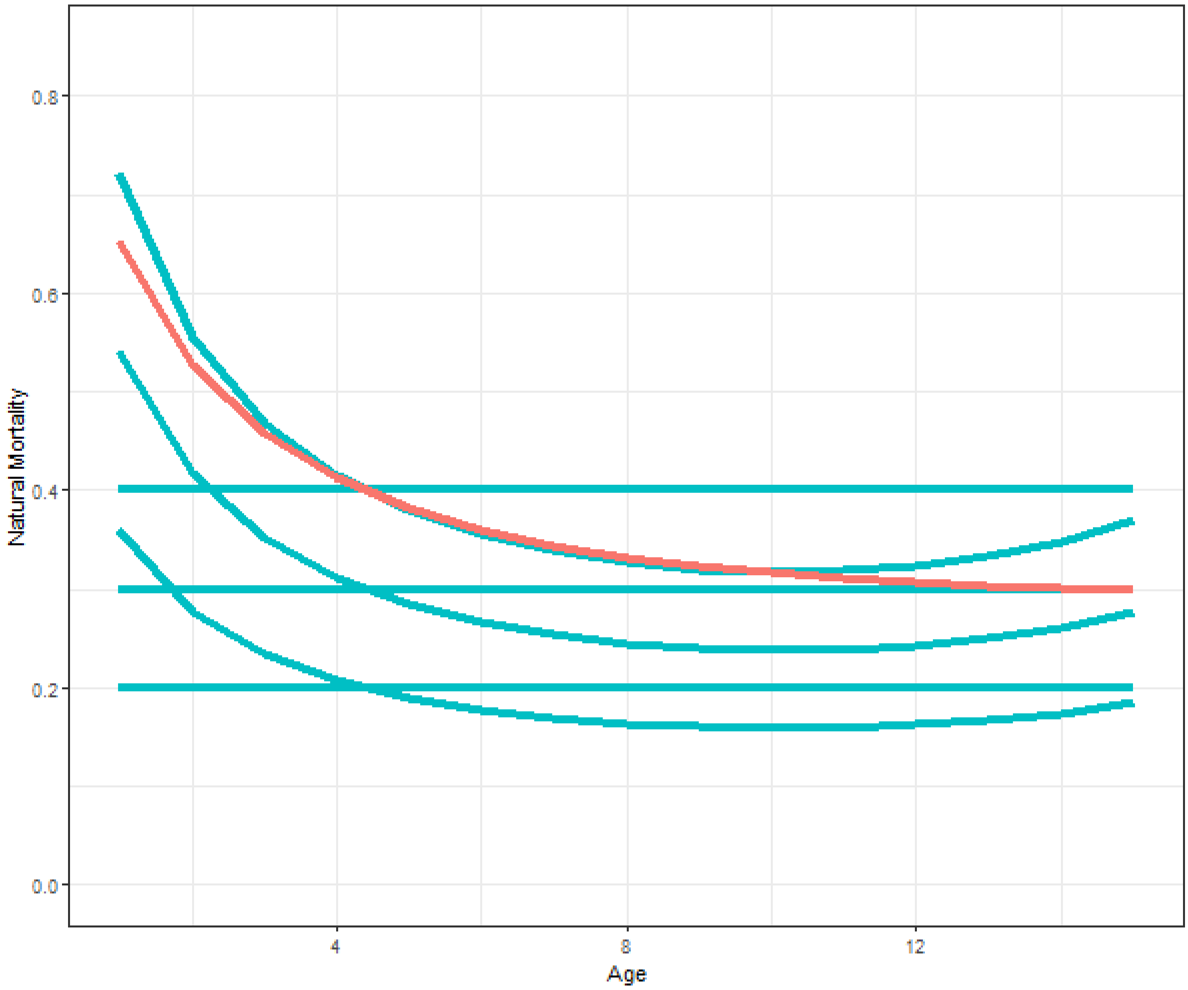


Figure 19.5.1. Natural mortality vector adopted during the data preparatory meeting (red line) and the values of natural mortality used in the MSE framework (blue lines).

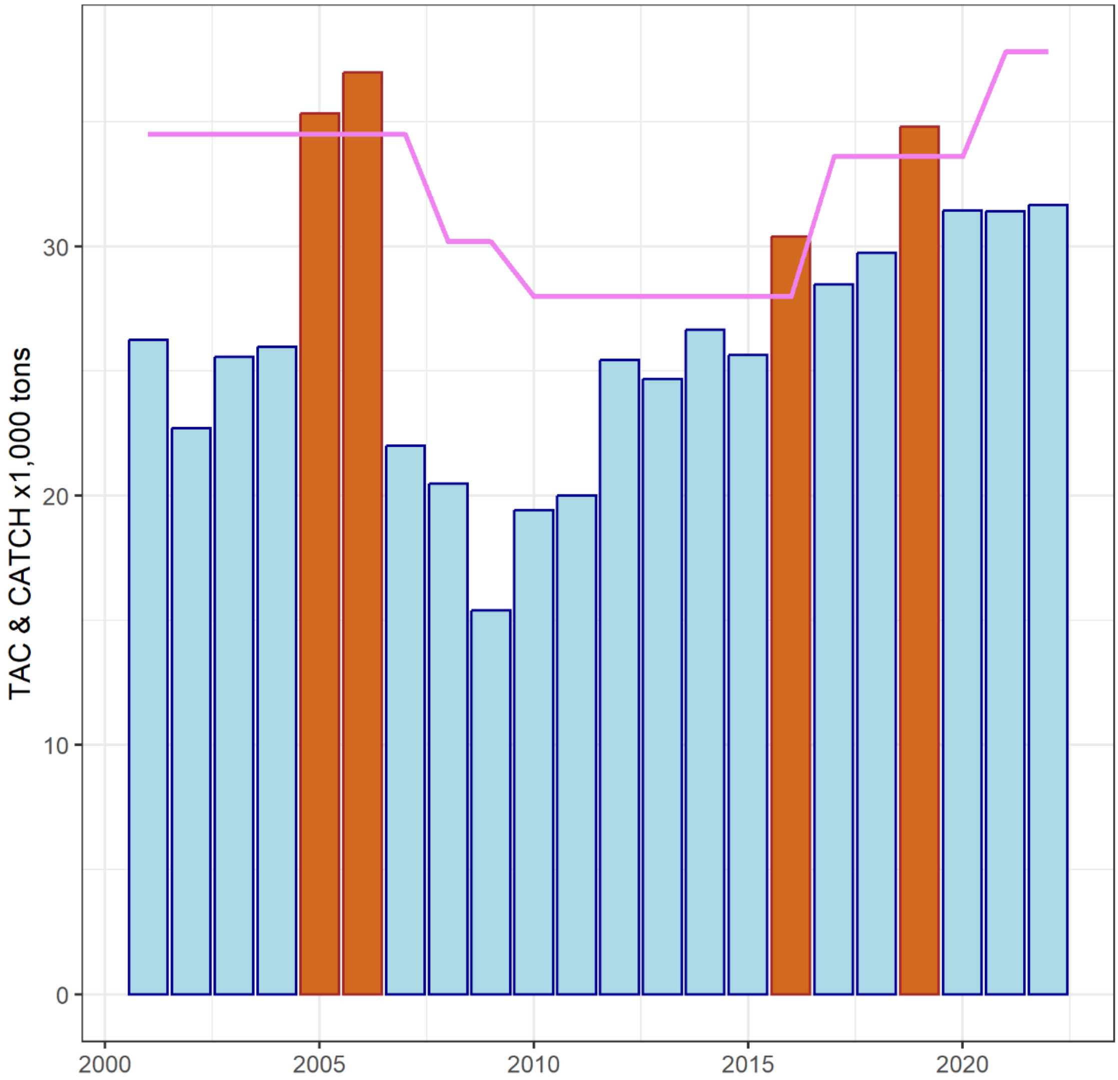


Figure 19.5.2. ALB-N reported catch (Task 1NC, bars) and TAC (solid line). Brown bars indicate years when the catch exceeded the TAC. Note that TAC established with the ALB-N HCR or the MP started in 2018.

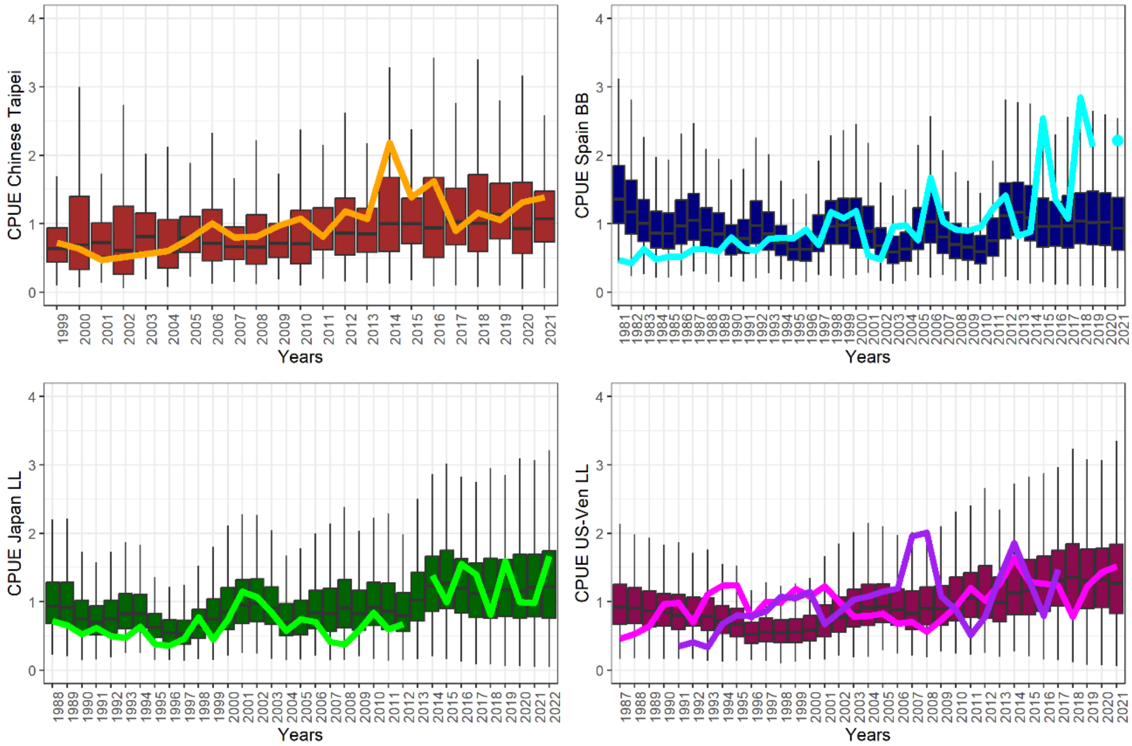


Figure 19.5.3. CPUE trajectories simulated in the MSE and standardized CPUEs available in 2023.

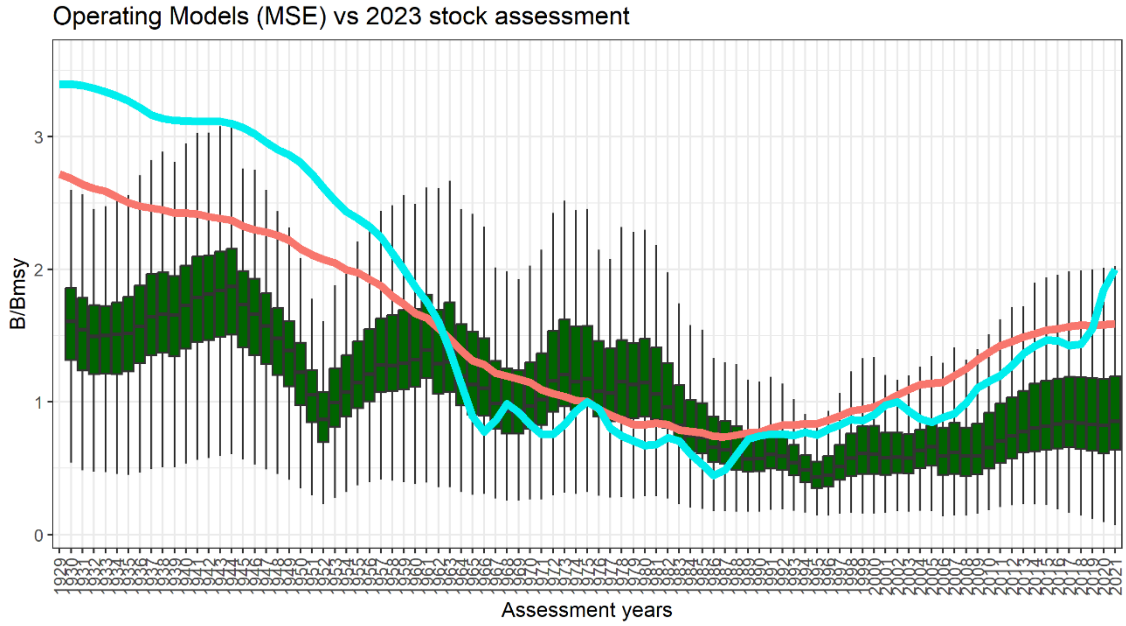


Figure 19.5.4. Relative biomass (B/B_{MSY}) estimated in the OMs of the MSE (green boxplot, boxes represent 50% CI and whiskers 95% CI) and estimates from the 2023 stock assessment (red is MPB and light blue is SS3).

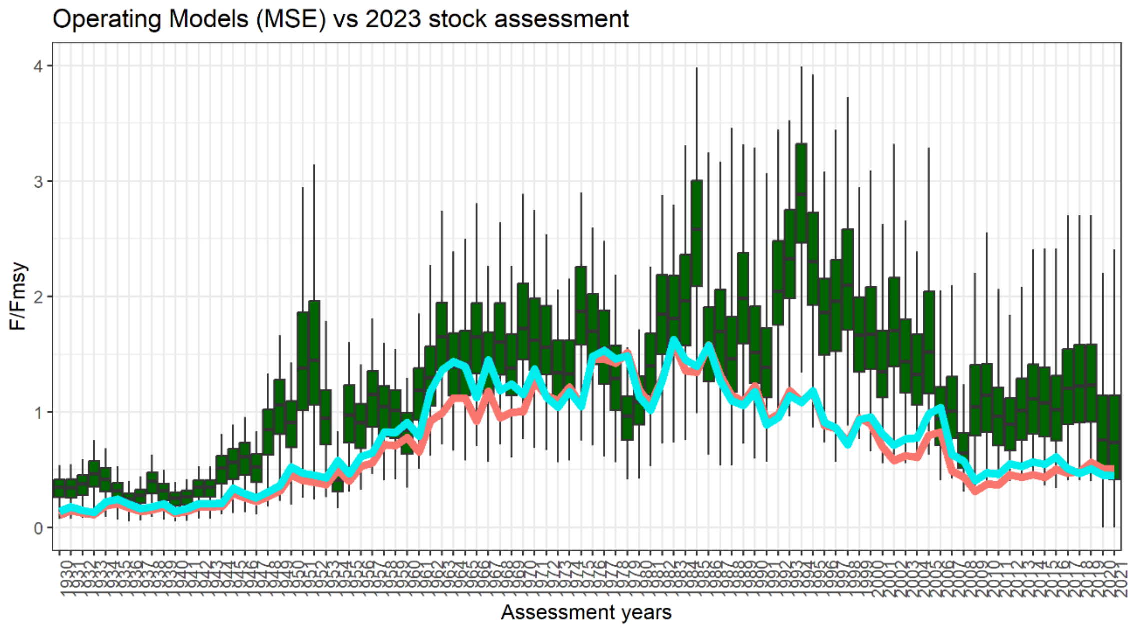


Figure 19.5.5. Relative fishing mortality (F/F_{MSY}) estimated in the OMs of the MSE (green boxplot, boxes represent 50% CI and whiskers 95% CI) and estimates from the 2023 stock assessment (red is MPB and light blue is SS3).

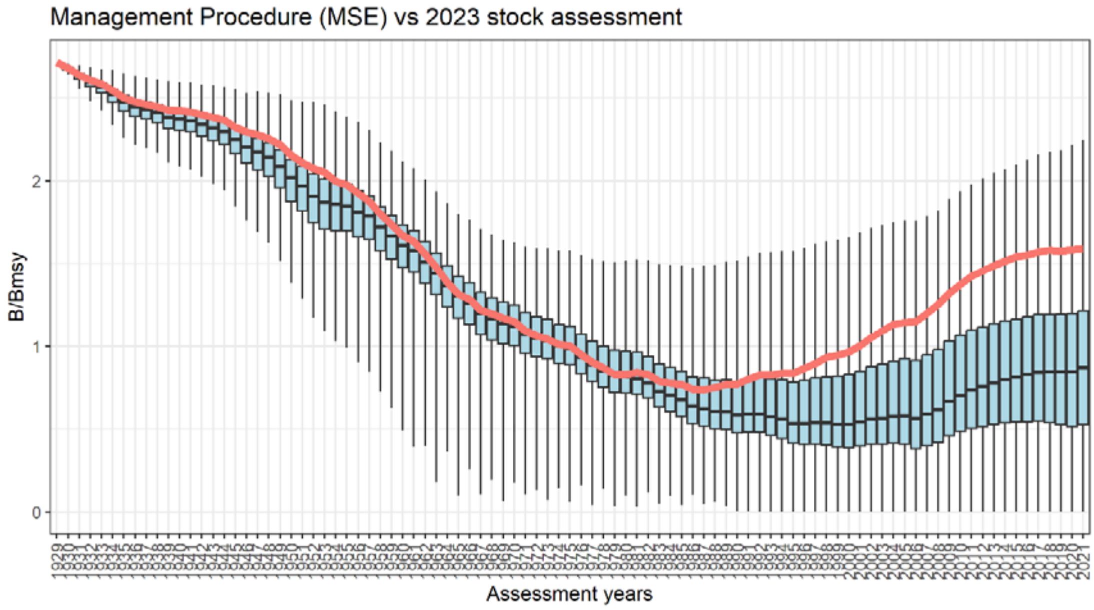


Figure 19.5.6. Relative biomass (B/B_{MSY}) estimated in the MPs of the MSE (green boxplot, boxes represent 50% CI and whiskers 95% CI) and estimates from the 2023 MPB stock assessment (red).

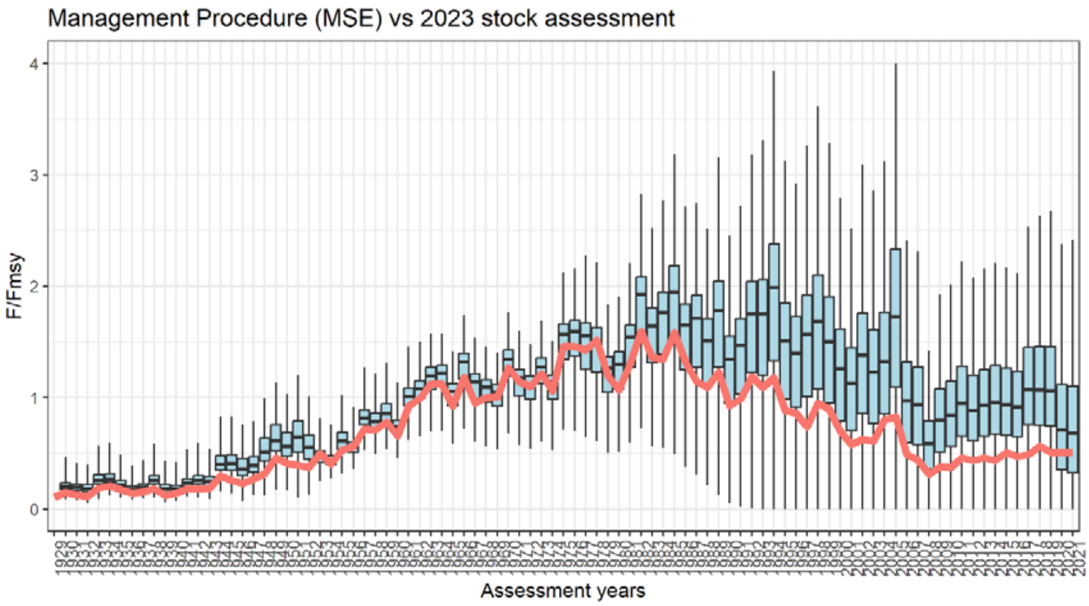


Figure 19.5.7. Relative fishing mortality (F/F_{MSY}) estimated in the MPs of the MSE (green boxplot, boxes represent 50% CI and whiskers 95% CI) and estimates from the 2023 MPB stock assessment (red).

19.6 The SCRS should undertake the following analyses, Rec. 21-04 para 14

Background: *During 2022-2023, the SCRS should undertake the following analyses to:*

(a) test further HCRs supporting the management objectives expressed in paragraph 2 above and associated with a range of control parameters wider than those explored for this Management Procedure and namely:

$$F_{TAR} = (0.8;\ 0.9;\ 1.0) * F_{MSY}$$
$$B_{THRESH} = (0.8;\ 0.9;\ 1.0;\ 1.1;\ 1.2) * B_{MSY}$$

The remaining control parameters shall remain as indicated by this Recommendation.

The Committee had already partially addressed this request in 2022, as contained in item 17.23 of the *Report for Biennial Period, 2022-23 Part I (2022), Vol. 2*. In 2023, the response is completed by adding information on the effects of underreporting.

The Committee evaluated the performance of the Management Procedure (MP) for North Atlantic albacore as well as the variants requested in Rec. 21-04. The management objective (to keep the stock in the green quadrant of the Kobe plot with at least 60% probability) was met for any B_{THRESH} value as long as F_{TAR} was kept at 0.8. When F_{TAR} increased to 0.9, only B_{THRESH} values at or above 1 would meet the management objective. For F_{TAR} equal to 1, none of the scenarios met the management objective (see **Table 19.6.1**).

In general, higher B_{THRESH} values are associated to better stock status and less risk, at the expense of less yield and mostly a larger variability in catch. Larger F_{TAR} values were also associated with higher yield. However, this was not always the case, and in general, percentual decreases in stock status, risk and stability were much larger than increases (if any) in yield (see **Table 19.6.1**).

(b) evaluate the number of catch per unit of effort (CPUE) series that need to be available and the percentage by which catch data are underreported, that would trigger an occurrence of Exceptional Circumstance.

Using the currently adopted MP, a test was conducted to understand the impact of using a reduced number of CPUEs. Both the pGreen (probability of being in the green quadrant of the Kobe plot) and the long-term yield statistics showed lower values compared to when the whole set of CPUE indices was used. However, results suggest that the management objective would still be achieved in the absence of one or several series of catch per unit of effort, except when the Japanese longline index was used alone (in which case pGreen=59.36%).

As for estimating the effects of underreporting, the Committee evaluated scenarios of unreported catches consistently exceeding the TAC in the future. The Committee concluded that unreported catch of 10% or more above the TAC would result in not achieving the management objective of being in the green quadrant of the Kobe plot with at least a 60% probability. The Group noted that this should be interpreted as a percentage (%) of catch above the TAC that is not reported.

The SCRS has currently no data or information to suggest that there is substantial underreporting of northern albacore catches.

Finally, the Committee updated (with the adopted MP) the analyses on the effects of the carryover, the systematic over/under catch (banking and borrowing scenario) and the effect of applying the 25%up-20%down stability clause when $B>B_{LIM}$ (instead of when $B>B_{MSY}$ as in the adopted MP). Management objectives (pGreen>60%) were met in all cases, and scores for other performance statistics are provided in **Table 19.6.1**.

Table 19.6.1. Estimated performance metrics for a series of alternatives to the MP adopted in Rec. 21-04 for North Atlantic albacore. In red, scenarios that are estimated to fall short in achieving the management objective of pGreen>60%. The adopted MP is indicated with an asterisk (*). pGr(%): Probability of being in the Kobe green quadrant; PBINT(%): Probability of B_{LIM}<B <B_{THRESH}; LongY(kt): Mean catch – Long term; MAP%: Mean absolute proportional change in catch.

Coordinates of HCR		Status	Safety	Catch	Stability
Bthreshold	Ftarget	pGr(%)	pBint(%)	LongY(kt)	MAP%
0.8	0.8	**64.68**	18.41	30.86	9.54
0.9	0.8	**67.21**	18.06	30.53	10.47
1*	**0.8***	**70.94**	**14.68**	**30.76**	**12.14**
1.1	0.8	**74.38**	11.74	31.37	15.49
1.2	0.8	**73.53**	10.65	31.2	16.47
0.8	0.9	**55.03**	22.29	31.65	10.16
0.9	0.9	**59.68**	20.35	31.53	12.51
1	0.9	**61.65**	18.03	31.2	14.2
1.1	0.9	**64.24**	16.5	31.21	20.53
1.2	0.9	**65.71**	13.53	31.37	17.07
0.8	1	**47.09**	28.35	31.79	10.75
0.9	1	**49.38**	24.65	31.54	13.39
1	1	**55.47**	22.35	31.09	16.09
1.1	1	**59.38**	18.21	31.33	18.77
1.2	1	**58.38**	18.12	30.92	24.15
Absence of CPUE					**Stability**
		pGr(%)	**pBint(%)**	**LongY(kt)**	**MAP%**
Miss 1 CPUE	Spain BB	**60.14**	22.43	30.00	15.35
	Japan LL	**62.79**	17.93	29.69	18.33
	Chinese Taipei	**67.50**	15.79	29.29	18.37
	US/Ven	**66.50**	14.36	29.69	20.03
Miss 2 CPUE	Sp/Jap	**64.29**	18.14	28.24	29.92
	Sp/ChT	**65.93**	15.79	28.47	27.94
	Sp/Ven/US	**61.14**	18.50	27.53	30.92
	Jap/ChT	**60.86**	21.29	28.07	29.66
	Jap/US/Ven	**65.86**	15.43	28.03	29.52
	ChT/US/Ven	**66.86**	17.57	27.37	41.58
Miss 3 CPUE	Spain Only	**66.93**	19.07	26.11	85.77
	Japan Only	**59.36**	18.93	25.56	128.47
	Chinese Taipei Only	**61.71**	20.64	27.20	38.50
	Ven/US Only	**68.29**	15.21	25.96	98.83
Carry Over					**Stability**
		pGr(%)	**pBint(%)**	**LongY(kt)**	**MAP%**
Carry Over	Historic	**84.62**	3.79	26.51	21.09
Bank and Borrow					**Stability**
		pGr(%)	**pBint(%)**	**LongY(kt)**	**MAP%**
Bank and Borrow	20%-20% TAC	**71.41**	13.53	29.81	37.13
Beyond Blim Stability					**Stability**
		pGr(%)	**pBint(%)**	**LongY(kt)**	**MAP%**
Beyond Blim Stability	20-25%	**65.44**	18.62	29.99	6.81

19.7 The SCRS will advise the Commission on the suitability of the alternative approach proposed by CPCs, Rec. 16-14 para 4b

Background: *b) Notwithstanding paragraph a), for vessels less than 15 meters, where an extraordinary safety concern may exist that precludes deployment of an onboard observer, a CPC may employ an alternative scientific monitoring approach that will collect data equivalent to that specified in this Recommendation in a manner that ensures comparable coverage. In any such cases, the CPC wishing to avail itself of an alternative approach must present the details of the approach to the SCRS for evaluation. The SCRS will advise the Commission on the suitability of the alternative approach for carrying out the data collection obligations set forth in this Recommendation. Alternative approaches implemented pursuant to this provision shall be subject to the approval of the Commission at the annual meeting prior to implementation.*

Morocco presented Serghini *et al.*, 2023 with a stratified sampling design as an improvement to the alternative scientific monitoring approach presented during 2022 to collect data from small scale/artisanal fisheries of bluefin tuna (Abid *et al.*, 2022), small tuna (Abid and Bensbai, 2022a) and swordfish (Abid and Bensbai, 2022b).

This alternative approach aimed at estimating discards covers other artisanal fisheries including pelagic sharks, tropical tunas and billfishes.

The Committee recognized that the new proposed methodology is at present the best possible alternative to an onboard observer programme in the multi-stock artisanal fisheries where observer coverage is not possible. This current methodology does not exclude the possibility of future technological solutions, including simplified EMS or others.

19.8 Develop recommendations for Electronic Monitoring Systems, Rec. 19-05, para 20

Background: *The Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG), in cooperation with the SCRS, shall work to develop recommendations on the following issues for consideration at the 2021 annual meeting of the Commission:*

a) Minimum standard for an electronic monitoring system such as:

i) the minimum specification of the recording equipment (e.g. resolution. recording time capacity, data storage type, data protection)

ii) the number of cameras to be installed at which points on board

b) What shall be recorded

c) Data analysis standards, e.g., converting video footage into actionable data by the use of artificial intelligence

d) Data to be analyzed, e.g. species, length, estimated weight, fishing operation details

e) Reporting format to the Secretariat

In 2020 CPCs are encouraged to conduct trials on electronic monitoring and report the results back to the PWG and the SCRS in 2021 for their review.

The Committee informs the Commission that it endorses the work carried out regarding the Minimum Standards for Electronic Monitoring Systems onboard Longliners described in Appendix 17 of the *Report for Biennial Period, 2022-23 Part I (2022), Vol. 2* and onboard purse seiners targeting tropical tunas described in **Appendix 17** of this report.

19.9 Develop recommendations for Electronic Monitoring Systems, Rec. 22-01 para 55

Background: *The Working Group on Integrated Monitoring Measures (IMM), in cooperation with the SCRS, shall make a recommendation to the Commission for endorsement at its 2023 annual meeting on the following:*

a) Minimum standards for an electronic monitoring system such as:

i) the minimum specifications of the recording equipment (e.g., resolution, recording time capacity), data storage type, data protection

ii) the number of cameras to be installed at which points on board

b) What shall be recorded

c) Data analysis standards, e.g., converting video footage into actionable data by the use of artificial intelligence

d) Data to be analyzed, e.g., species, length, estimated weight, fishing operation details

e) Reporting format to the ICCAT Secretariat

In 2023 CPCs are encouraged to conduct trials on electronic monitoring and report the results back to the IMM and the SCRS in 2023 for their review. CPCs shall report the information collected by the observers or the Electronic Monitoring System from the previous year by 30 April to the ICCAT Secretariat and to the SCRS taking into account CPC confidentiality requirements.

The Committee informs the Commission that it endorses the work carried out regarding the Minimum Standards for Electronic Monitoring Systems onboard longliners described in Appendix 17 of the *Report for Biennial Period, 2022-23 Part I (2022), Vol. 2* and onboard purse seiners targeting tropical tunas described in **Appendix 17** of this report.

19.10 The SCRS to advise to what extent the fishing seasons for different gear types and/or fishing areas might be extended and/or modified, Rec. 22-08 para 32

Background: *Not later than 2022, the Commission shall decide to what extent the fishing seasons for different gear types and/or fishing areas might be extended and/or modified based on the SCRS advice without negatively influencing the stock development and by ensuring the stock is managed sustainably.*

As indicated in the response to this request in 2021, the Committee has not received new information. The Committee has no scientific basis for recommending any particular fishing season configuration at this time. In addition, the Committee has never provided advice on the appropriate length or timing of fishing seasons in relation to stock development, and the length of the current fishing seasons was determined without input from the Committee. In most fisheries their activity is related to the temporal and spatial availability of bluefin tuna due to their trophic and reproductive migrations.

As indicated in 2020 and 2021, this request is broad in scope, considering fleet diversity, spatial coverage and seasonality. The Committee requests more detail on the issues to be addressed in order to conduct proper data compilation and analysis.

19.11 The SCRS shall report on the coverage level achieved by each CPC and provide any recommendations to improve the effectiveness of CPCs' observer programmes, Rec. 22-08 para 99

Background: *For the scientific aspects of the programme, the SCRS shall report on the coverage level achieved by each CPC, and provide a summary of the data collected and any relevant findings associated with those data. The SCRS shall also provide any recommendations to improve the effectiveness of CPCs' observer programmes.*

The Committee cannot respond to the observer coverage request this year due the lack of available/appropriate data. The SCRS reminds the Commission that Rec. 22-08 paragraph 98 states that the requirements and procedures required to undertake this analysis are to be developed by the Commission by 2023 taking into account CPC confidentiality requirements. In addition, paragraph 95 specifies a set of observer coverage rates that apply to implementing this Recommendation, thus it would be beneficial to define how these coverage levels are to be calculated so that potential problems with inconsistencies in defining coverage levels for different CPCs can be avoided. The SCRS looks forward to understanding what these requirements and procedures are so that it may design a data collection form and to subsequently provide recommendations on how to improve the effectiveness of CPC's observer programmes (specified in paragraph 99).

19.12 The SCRS should evaluate procedures and results related to the stereoscopic camera programme (or alternative methods) provided by CPCs and report to the Commission at the next annual meeting, Rec. 22-08 para 173

Background: *Each farm CPC competent authority shall submit the procedures and results related to the stereoscopic camera programme (or alternative methods) to the SCRS by 31 October annually. The SCRS should evaluate such procedures and results and report to the Commission at the next annual meeting.*

The procedure for the use of stereoscopic camera systems is well detailed in ICCAT Rec. 21-08, Annex 9, para 1. This procedure has not changed since the first application of this methodology as presented in ICCAT Rec. 14-04, Annex 9. Since the initiation of the use of the stereo camera, the Recommendations have required that the reports should be submitted with a specified list of information, but there is no requirement for stereo camera footage to be sent.

The SCRS has concerns whether the 20% minimum requirement (Rec. 21-08) for straight fork length (SFL) sampling intensity is sufficient or even necessary to have a representative sample of the fish in the cage population in certain situations, such as low/high size homogeneity of the fish being caged. Since the stereo camera footage available to the SCRS is limited and rarely corresponds to the full footage made by transfer operation, the Committee has not been able to assess this issue. This would require the design of a specific study. The CPCs should provide the Secretariat with the whole of the recordings of the stereoscopic cameras made in each transfer operation, so that the SCRS can take a random sample to analyze if the subsampling is being performed correctly. In order to be able to do this analysis, it would be necessary to have quality footages with the corresponding dongle of each stereo-camera. In order to meet the confidentiality requirements of these analyses, the Secretariat would be responsible for doing them. The specificity to perform these analyses would require a large amount of Secretariat time.

The SCRS will continue to investigate the use of artificial intelligence (AI) technology as a means of making the counting and size/weight determination of caged fish more accurate and less labour intensive and costly, namely through the use of recently developed high-tech automatic systems (e.g., Abid *et al.*, 2022).

The Committee was not able to review the technological detail of the stereoscopic camera system in 2023.

19.13 The SCRS should develop an algorithm to convert length into weight for fattened and/or farmed fish, Rec. 22-08 para 204/218

Background (para 204): *Until the SCRS develops an algorithm to convert length into weight for fattened and/or farmed fish, the determination of the weight of the carried-over fish shall be estimated using the most updated growth rates tables produced by the SCRS.*

Background (para 218): *The caging of the bluefin tuna at the farm of destination shall be subject to the requirements for caging operations laid down in paragraphs 156 to 171, including a video record to confirm the number and weight of the bluefin tuna caged and the verification of the operation by an ICCAT Regional Observer. The determination of the weight for caged fish from another farm, shall not apply until the SCRS has developed an algorithm to convert length into weight for fattened and/or farmed fish.*

This request refers to a requirement following an inter-farm transfer which could happen prior to or after harvesting of fish from the cage has taken place. The solution cannot be found by estimating a generic L-W relationship from fish harvested on the farms, as doing so would ignore the gain in weight and size as a function of time at the particular farm and depending on the initial size of the fish at caging.

This request is addressed with the updated growth table for BFT-E as a function of the initial size of the fish at caging and the time spent on the farm (see item 17.16 of the *Report for Biennial Period, 2022-23, Part I, Vol. 2*). In addition, we note that the analyses of the eastern Atlantic and Mediterranean bluefin tuna farm growth using the extensive regional observer programme (ROP) harvest database have shown no statistically significant differences between farms in the Mediterranean or East Atlantic, except for the operations in the Adriatic Sea with small bluefin (< 100 cm straight fork length (SFL) at caging) and this difference has been incorporated in the expected variance of weight-at-size of harvest of the updated farm growth table (Ortiz *et al.*, 2022).

Following the request made by Panel 2 during the Intersessional Meeting of Panel 2, 7-10 March 2023, Ortiz and Tsukahara (2023) uses an interpolation process to obtain values within the intervals of the updated farm growth table mentioned above. This interpolated table has intervals with 1-cm and 1-day (for 1st year at farm) to be precise enough for the BFT export/import monitoring. Since this table is very large, given the several months duration of the fattening process and the wide size range of the BFT, an Excel table has been provided to facilitate the use of the updated farm growth table with the interpolations. The SCRS reviewed the methodology and results and agreed with the proposed table.

19.14 The SCRS shall review the stereoscopic cameras systems specifications, and if necessary provide recommendations to modify them, Rec. 22-08 Ann. 9, item 1 vii

Background: *The report on the results of the stereoscopic programme should include details on all the technical specifications above, including the sampling intensity, the way of sampling methodology, the distance from the camera, the dimensions of the transfer gate, and the algorithms (length-weight relationship). The SCRS shall review these specifications, and if necessary provide recommendations to modify them.*

While the Committee addressed the issue of sampling intensity in response 19.12 to the Commission of this report, the Committee was not able to review the technological detail of the stereoscopic camera system in 2023.

19.15 Review on specific spawning times and areas of bluefin tuna in the western Atlantic, Rec. 22-10 para 18

Background: *The SCRS shall review any new available information related to the identification of specific spawning times and areas of bluefin tuna within the western Atlantic Ocean, including from those CPCs that harvest western Atlantic bluefin tuna, and advise the Commission on the results of this review for its consideration. Concerned CPCs are encouraged to work through the SCRS to develop advice for managing any identified times and specific areas under a precautionary approach. In addition, the SCRS shall advise on the efficacy of the Gulf of Mexico directed fishery restriction to reduce mortality of spawning age bluefin tuna.*

There was no new information available this year for the SCRS to review on specific spawning times and areas of bluefin tuna in the western Atlantic. Although it is difficult to quantify, the reduction of catch of BFT in the Gulf of Mexico (GOM) due to the directed fishery restriction in place since 1983 likely reduces fishing mortality of spawning age western population bluefin tuna. This is true even though the same tonnage may be harvested elsewhere in the West Atlantic as it is thought that the BFT in the GOM are entirely of western origin as opposed to other areas of western Atlantic where eastern BFT also occur at varying levels. Certain CPCs plan to conduct research to explore the efficacy of GOM directed fishery restriction, but at this time, the SCRS has been unable to conduct a substantive evaluation of the question on which to base new advice. However, it should be noted that the advice on catch levels of the SCRS in 2017 does not take into account the mixing of the two stocks, i.e., there is no differentiation of impacts on the two stocks between the catch in GOM and other areas of the western Atlantic Ocean in the assessment. In general, the efficacy of the protection of spawning areas of BFT has yet to be demonstrated.

19.16 Provide guidance on a range of fish size management measures and their impact on yield per recruit and spawner per recruit considerations, Rec. 22-10 para 22

Background: *The SCRS should provide guidance on a range of fish size management measures for western Atlantic bluefin tuna and their impact on yield per recruit and spawner per recruit considerations. The SCRS should also comment on the effect of fish size management measures on their ability to monitor stock status.*

The Committee reiterates its advice in 2012 in response to *Supplemental Recommendation by ICCAT concerning the western Atlantic bluefin tuna rebuilding program* (Rec. 10-03): "The Committee reviewed yield-per-recruit calculations using various selectivity patterns by gear based on the 2010 assessment results and for decreased selectivity pattern by up to 40% for ages 1 to 6 for the whole fishery based on the 2012 assessment results. The Committee recognized that Y/R and SSB/R could be improved by changing the selectivity pattern (decreasing the selectivity of ages 1-6 by 40% resulted in only modest improvements), but these would imply allocation changes with implications beyond strict Y/R and SSB/R considerations. In addition, the Committee was concerned that such changes in selectivity would affect the availability and utility of indices of stock sizes currently used in the assessment. Furthermore, regulations to decrease the catches of bluefin tuna aged 1-6 may have unintended negative consequences such as increased discard mortality, which may be difficult to monitor, and changes due to reallocation of effort which may be difficult to predict."

19.17 The SCRS shall assess the occurrence of exceptional circumstances annually, Rec. 22-09 para 9

Background: *The SCRS shall assess the occurrence of Exceptional Circumstances annually and the Commission shall act in accordance with the Exceptional Circumstances Protocol, developed based on scientific advice provided by the SCRS and adopted by the Commission.*

In accordance with the proposed specifications of Exceptional Circumstances (EC) Protocols outlined in section 19.18, the Committee has determined that they do not occur for the 2023 EC determination. This determination is based upon an evaluation of the criteria outlined in section 19.18 of this report, and elaborated, below.

a. Stock dynamics

i. *Indices.* The primary quantitative indicator for EC relates to the whether the combined indices fall outside of 95% prediction intervals. For 2022, neither of the combined indices fall outside of the 95% prediction intervals (**Figure 19.17.1**), resulting in no triggering of EC.

ii. *Abundance and life history or fishery dynamics*. As of this date, no new evidence that abundance, life history or fishery dynamics substantively different than those tested in the operating models has emerged.

b. Data availability for the MP

For 2022 nine out of 10 indices are updated, available and deemed acceptable for consideration by the Committee (**Figure 19.17.2**), indicating no triggering of EC for data availability. Only the Gulf of Mexico larval index is missing due to the research vessel being unavailable to conduct the larval survey in 2022. Although for some indices the strict update time series shows some slight variation from the time series used to set the Total Allowable Catch (TAC), the Committee has determined that these departures are not impactful on continuing with the current TAC advice based on the management procedures (MP). No indices have been missing for two or more years.

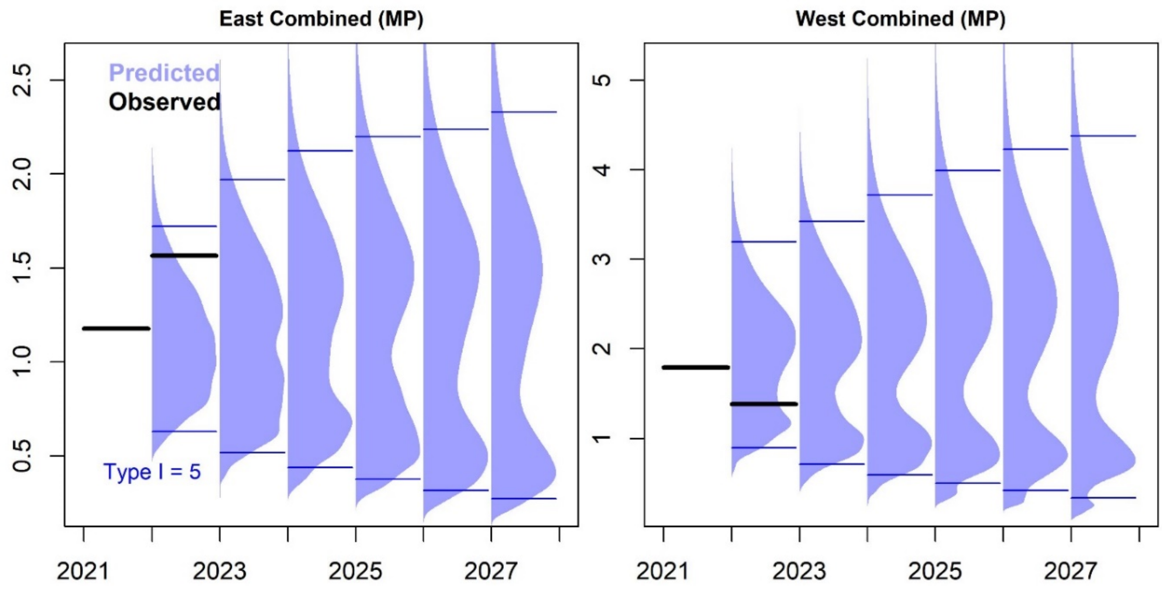


Figure 19.17.1. Standard marginal plots of observed composite indices (black bars) and distribution of predicted data (blue density distribution) for the reference grid of operating models (n =2304, 48 operating models, 48 simulations each). Blue bars represent the 95% prediction intervals.

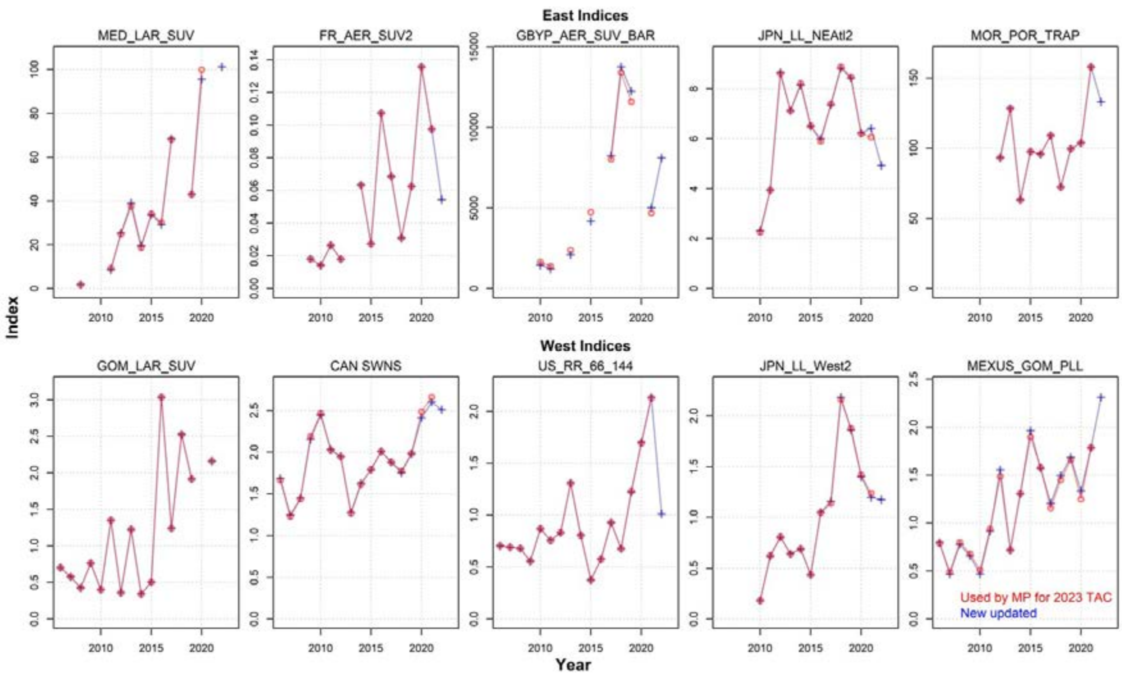


Figure 19.17.2. Plot of indices used in MP calculations (red) and the new updated indices (blue). Red values are original indices and blue values are strict updates of the indices through 2022.

19.18 The SCRS to provide scientific guidance on the Exceptional Circumstances Protocol for the BFT MP, Rec. 22-09 para 12

Background: *Panel 2, with scientific guidance from the SCRS, shall develop the Exceptional Circumstances Protocol for this MP, for review and adoption by the Commission at its 2023 annual meeting. The protocol will become Annex 4 of this Recommendation once adopted.*

The final remaining task for full adoption of the Management Procedure (MP) is to define the Exceptional Circumstances Protocols. The Committee provides scientific guidance on Exceptional Circumstances (EC) Protocol and comments on the Panel 2 text that, if determined to have occurred and to be consequential for Total Allowable Catch (TAC) advice, could result in suspending or modifying the application of the MP. Annually, the Committee will use the exceptional circumstances protocols to evaluate whether they have occurred, advise the Commission on their occurrence and, if they have, advise on a recommended management course of action. As the MP is a package of management advice across both East and West BFT, an EC determination applies jointly to both stocks and areas. However, triggering EC does not immediately result in TAC advice from the MP being rescinded; rather, it means that the SCRS will examine the indicators in the Exceptional Circumstances Protocols and determine if a change in advice is warranted. In certain situations, management recommendations following the triggering of EC may be specific to each area. In some cases, triggering of EC may not have sufficient consequences to warrant deviating from the MP.

Regarding the 'X%' of catch overages, the Committee cannot provide scientific rationale regarding what degree of TAC overage would constitute EC. The SCRS tested continuing TAC overages up to 20% and found that the MP was somewhat robust to such overages, albeit achieved through substantial cuts in TAC. As a result, the Committee considers that evidence for the catch being above the TAC is not, scientifically, a rationale for invoking EC, but is primarily a management issue. Almost certainly, substantial TAC overages would result in more catch taken out of the stock, reducing indices and resulting in a reduction in TAC. Hence this situation is not technically an EC for the MP. However, from the perspective of meeting other Commission objectives, as well as specifications of the overall management plan such as maintaining agreed-upon allocations and maintaining compliance, TAC overages even lower than 20% may be undesirable to the Commission. Should the Commission wish to include TAC overage as an EC, the percent overage should be determined on the basis of management objectives.

Regarding the bracketed '20%' reduction in TAC as an action to be taken in response to EC, the Committee cannot provide additional scientific guidance on a particular predetermined value of a reduction that would be appropriate. Rather the specific recommendation from the Committee should depend on the situation.

The Committee has been requested to provide more specific guidance on indicators for EC determination. The first criterion applies to stock dynamics and follows the standard approach of evaluating whether the indices provide evidence that the stocks are in states not previously considered to be plausible in the context of the management strategy evaluation. Observations are plotted over percentiles of the predicted data and a threshold probability interval is used to identify EC. For example, if an observation falls outside of a given probability interval for any given index, this would be evidence of EC. Given that the BFT MP has 10 indices there is very high probability (40%) of triggering EC in the first year with the probability increasing in every subsequent year for a 95% interval. As the 10 indices are consolidated into combined East and West indices, inversely weighted to their variance, in the formulae for the TACs, each combined index provides more accurate representation of the information used to set TACs. The proposed primary criterion for EC relative to the index values plots the most recently available index values over their prediction interval; here the 95% interval is used, which also corresponds to the 2.5% lower tail and 97.5% upper tail (**Figure 19.18.1**). The Committee recommends the simple and commonly employed 95% interval. In this example the most recent (2022) combined index values do not fall outside the prediction intervals and so would not trigger EC.

For added qualitative context the Committee will also examine the individual 10 indices in a similar plot (**Figure 19.18.2**). Such individual index evaluations may provide valuable context to how consequential a determination of EC made from the combined indices might be on TAC advice. A single plot of all the available individual indices by converting the predicted distributions as standard normal distributions with mean zero and standard deviation 1 provides a consolidated view of the 9 updated index deviations for 2022 from expectations (**Figure 19.18.3**).

The second and third criteria related to stock dynamics are abundance and life history or fishery dynamics. This would be evidence that the stocks are in states not previously considered to be plausible in the context of the management strategy evaluation (MSE). Such evidence would be evaluated after completion, presentation and acceptance by the SCRS; such evidence would need to be so consequential that it would meaningfully affect TAC advice from the MP. In response to a question from Panel 2, it is somewhat premature to specify what action to take as this would depend on the nature of the new evidence, the feasibility of reconditioning operating models based on such evidence and subsequent retuning of the MP.

The Committee proposes an additional criterion related to index availability to update the MP. The Committee conducted a simulation study indicating that the MP performs adequately with missing 2 of the 10 indices in any given year. Based on this, the Committee recommends an EC criterion of 3 or more indices missing in any given year. The rationale for evaluating this every year rather than at MP application is that it allows for the identification of a problem with data availability well prior to it becoming an issue for TAC setting. For example, if three or more indices are missing in year 1, this would be an EC but without any immediate consequence for the current TAC as it may only be an issue for using the MP to calculate the TAC in the next management cycle. Such a finding also in year 2 could have increasing consequence for the MP and such finding continuing in year 3 might have major consequences for the MP, possibly precluding its use in TAC setting. Such a sequential path of EC determination allows for early identification of a problem with indices that might motivate efforts to ensure the necessary resources to ensure index availability. Such a determination of index availability can be simply represented by time series of the previous and updated index values (**Figure 19.18.4**). In the current evaluation of EC, 9 out of 10 indices are available for 2022. The Committee supports the criterion of if two or more indices are missing for two or more consecutive years this also would constitute exceptional circumstances.

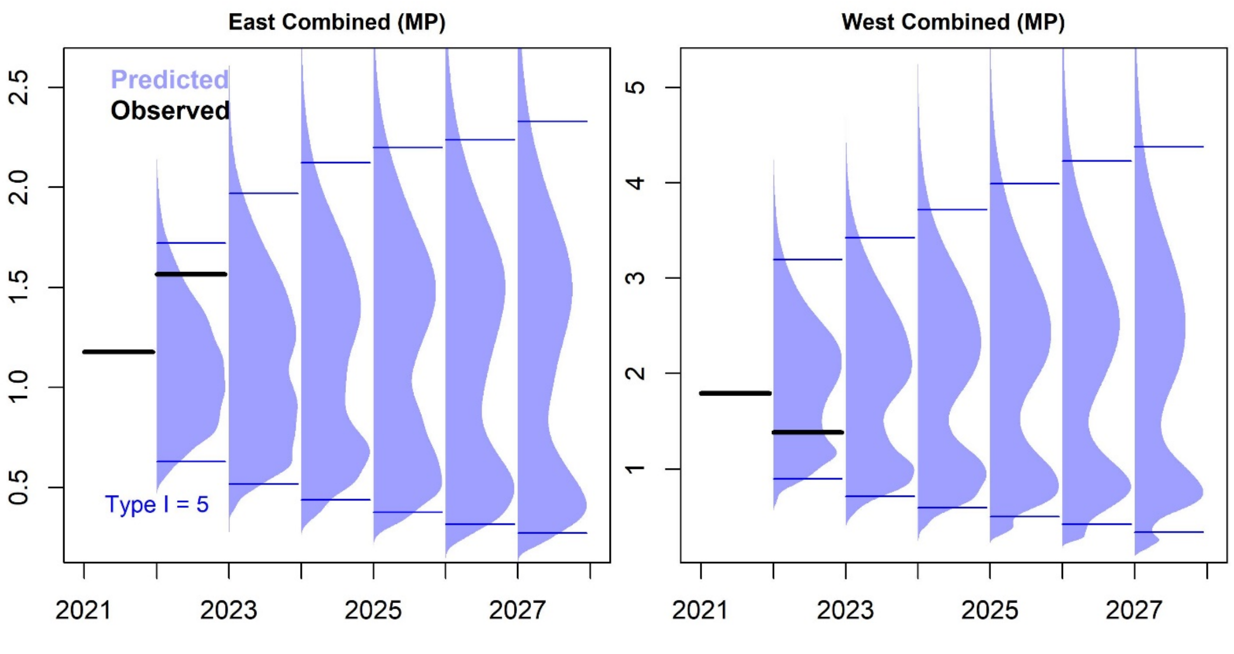


Figure 19.18.1. Standard marginal plots of observed composite indices (black bars) and distribution of predicted data (blue density distribution) for the reference grid of operating models (n =2304, 48 operating models, 48 simulations each). Blue bars represent the 95% intervals.

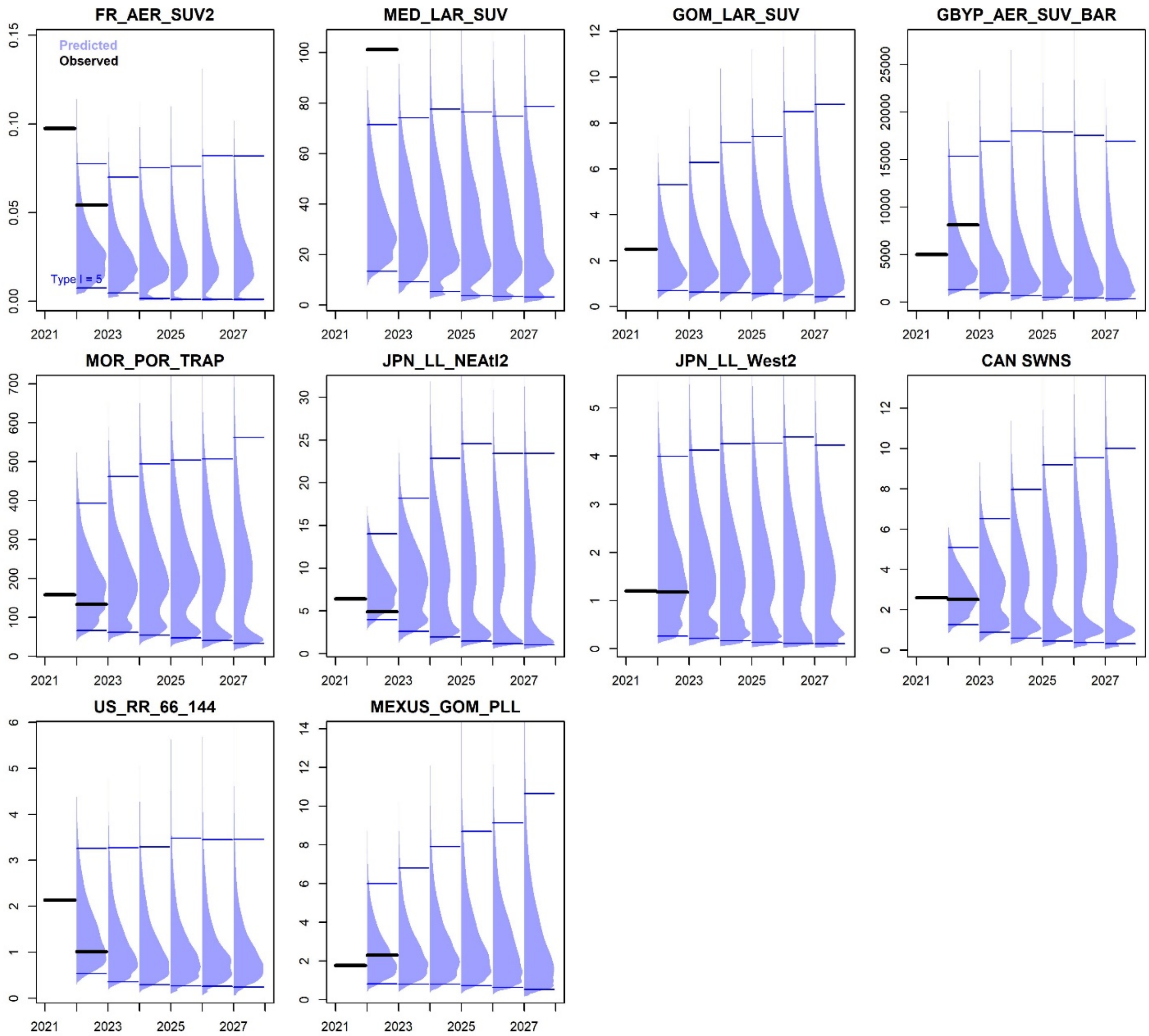


Figure 19.18.2. Plots of observed individual indices (black bars) and distribution of predicted data (blue density distribution) for the reference grid of operating models (n =2304, 48 operating models, 48 simulations each). Blue bars represent the 95% intervals.

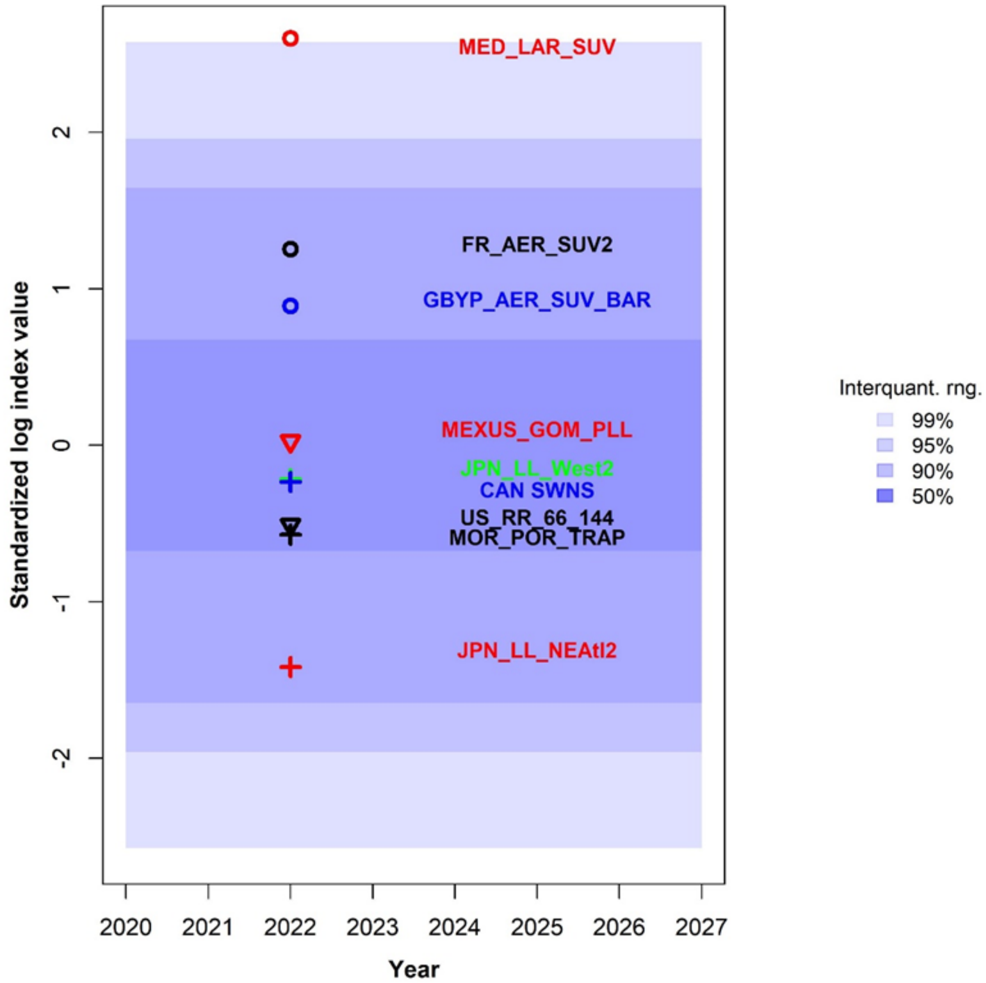


Figure 19.18.3. A consolidated representation of **Figure 19.18.2** on a single panel where predicted data from the MSE operating models and abundance index observations have been log transformed and standardized to mean 0, standard deviation = 1 for each year. Blue shaded regions are calculated from percentiles of a standard normal distribution corresponding to the 99%, 95%, 90% and 50% interquantile ranges of predictions across all operating models.

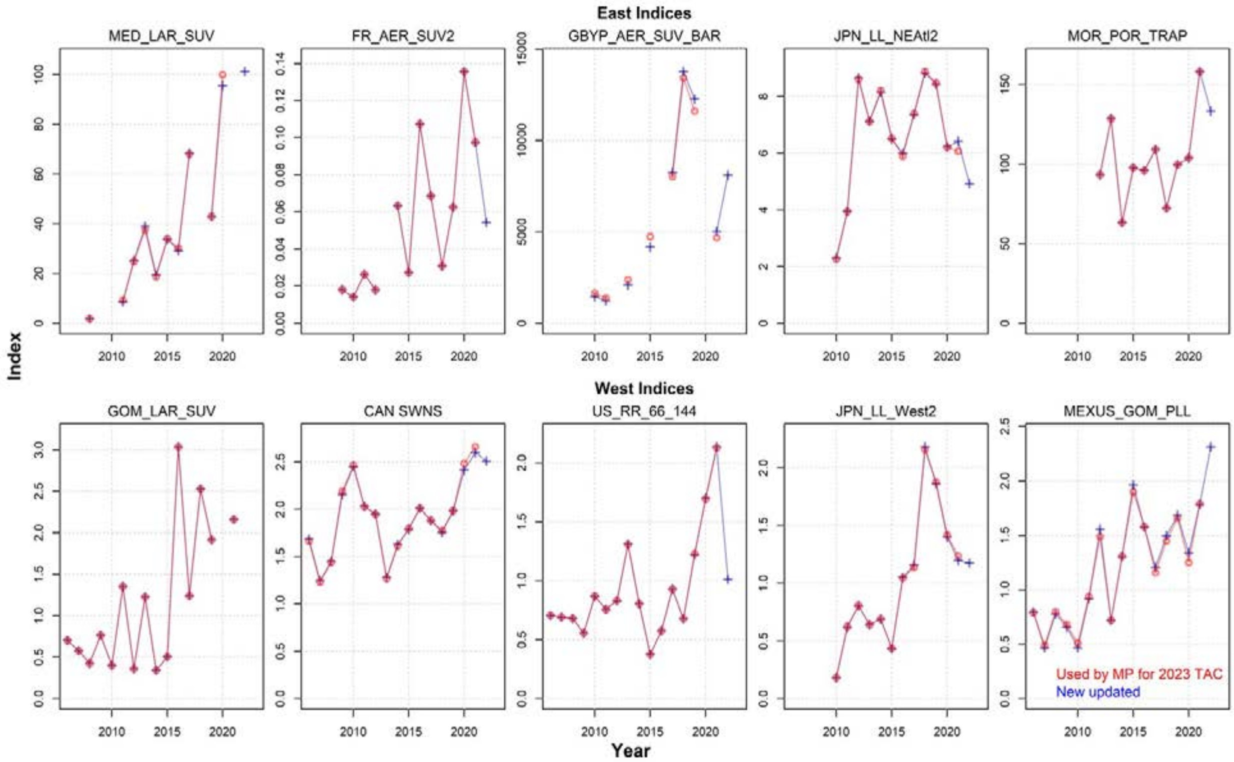


Figure 19.18.4. Plot of indices used in MP calculations (red) and the new updated indices (blue). Red values are original indices used to determine the 2023 TAC and used in MSE conditioning and blue are strict updates of the indices through 2022.

19.19 The SCRS and Panel 4 shall work together to test and confirm the appropriateness of the process to determine possible retention. Rec. 21-09 para 5a

Background: *During 2022 and 2023 the SCRS and Panel 4 shall work together to test and confirm the appropriateness of the approach in Annex 1, or alternative approaches, for determining the amount of permissible retention of North Atlantic shortfin mako in the future. Any alternative approaches shall take into consideration, among other factors, the relative contributions made by CPCs to conserve, manage, and rebuild the stock (including a CPC's performance in reducing its mortality in line with the objectives of previous ICCAT Recommendations 17-08 and 19-06) and other criteria as set out in Resolution 15-13, as well as the need to continue to incentivize individual CPC accountability to achieve fishing mortality reductions in line with the objectives of this rebuilding program. To assist with this work, the SCRS shall, as appropriate, provide to the Commission estimates of post release mortality and, where needed, estimates of dead discards, taking into account data submitted by CPCs and other relevant information and analyses.*

No alternative approaches to Annex 1 were proposed in 2023. The SCRS reiterates that in order to apply the Annex 1 approach in the best way possible, it is important that CPCs provide complete Task 1 data of shortfin mako retained catch, dead discards, and live releases. Furthermore, as requested in paragraph 13 of the Recommendation, it is also important that a document describing the statistical methodology used by CPCs to estimate dead discards and live releases be provided.

If a CPC's reporting of retained catch, dead discards, and/or live releases is incomplete or estimates are not considered to be scientifically sound, then the default approach used by the SCRS for filling in the 2022 data gaps is described in the response to paragraph 5c.

Two post-release mortality rate estimates were applied for estimating total fishing mortality. These are referred to in the response to paragraph 5c of this Recommendation.

19.20 Starting in 2023 and annually thereafter, the SCRS will calculate possible level of retention, including eligible CPCs' individual retention allowances, allowed in the subsequent year, and provide the results to the Commission, Rec. 21-09 para 5c

Background: *Starting in 2023 and annually thereafter, the SCRS will use Annex 1, unless an alternative approach to calculating future permissible retention is agreed (as per paragraph 5(a)), to calculate a possible level of retention, including eligible CPCs' individual retention allowances, allowed in the subsequent year, and provide the results to the Commission.*

The Committee reviewed all data submissions for northern shortfin mako for 2022. For those CPCs that had not submitted information on landings for 2022 nor dead discards, the Committee estimated the landings for these nations based on the average of the preceding two year's data. During the meeting, estimations on dead discards and live discards for EU-Spain and EU-Portugal were updated based on the statistical methodology presented.

The Committee discussed the statistics reported by Morocco. National scientists from Morocco noted that since the ban for shortfin mako, longline fleets have moved operational areas, and based on scientific onboard observers, there are no records of this species for 2022. It was also mentioned that Morocco will present a document with the statistical methodology for estimating dead discards and live discards. The Committee noted that if 70% of the captures corresponded to longline, the remaining 30% should be included as dead discards corresponding to the artisanal fisheries captures. The Committee also noted that these numbers should be updated next year after the statistical methodology is available.

The reported data and estimated missing landings and dead discards are presented in the table below:

	Landings					*Dead Discards*					*Live Discards*				
Flag	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Barbados															
Belize	12	2		3	3										
Canada	53	63	1	0	0	2	1	20	22	26	28	12	81	63	83
China PR	0	0	0	0	0		20	2	1	5		7	3	2	9
Chinese Taipei	0	0	0	0	0	22	5	12	1	2	10	2	6	1	1
Costa Rica	1	0	0		0										
Curaçao															
El Salvador															
EU-España	1165	867	869	0	0	232	201	333	585	588	131	113	187	329	330
EU-France	0	1	0	1	1	0	0		0	0		1		0	0
EU-Netherlands															
EU-Portugal	272	289	342	202	1			11	14	141			20	26	251
FR-St Pierre et Miquelon	0														
Great Britain		0	0	0	0			0							
Guatemala															
Japan	20	4	0	0	0		30	28	18	13			17	12	9
Korea Rep.	5	4			0	0	0			0					0
Liberia			10		10										
Morocco	594	501	382	299	0	0		0	0	102				0	0
Mauritania															
Mexico	2	2	2	2	3	0	0	0	0	0	0	1	1	1	1
Panama															
Russian Federation	0	0		0	0	0	0		0	0				0	0
Senegal	68	26			47										
St Vincent and Grenadines		3			3										
Sta Lucia			0	1	1										
Trinidad and Tobago	2	1	1	1	1	0	0	0		0					0
UK-Bermuda	0	0	0	0	0	0	0	0	0			0	0	0	0
UK-British Virgin Islands			0		0			0							
UK-Turks and Caicos			0		0										
USA	165	57	48	39	40	2	1	3	4	10		24	31	68	46
Venezuela	7	8	8	3	1										
Total	**2,367**	**1,829**	**1,664**	**552**	**110**	**26**	**57**	**76**	**897**	**887**	**39**	**47**	**160**	**252**	**729**

Considering all CPCs, the preliminary Committee estimates were as follows:

- Retained catch (landings): 110 t
- Dead discards: 887 t
- Live discards: 729 t

Using a post-release mortality rate of 23% (Miller *et al.*, 2020) the "total fishing mortality from all sources" (the value needed for Rec. 21-09, Annex 1, paragraph 1a) for 2022 was estimated as 1,164 t. Applying a 34% longline post-release mortality rate (Bowlby *et al.*, 2021), the total fishing mortality from all sources was estimated as 1,244 t.

According to Annex 1 of Rec. 21-09, these values are then subtracted from the amount established in Rec. 21-09, paragraph 4a, 250 t, to estimate the "dead bycatch retention allowance" in 2024 (see equation 1 below).

"limit from Rec. 21-09" – "fishing mortality 2022" = "dead bycatch retention allowance in 2024" (1)

If the "dead bycatch retention allowance" amount is negative, no retention is to be allowed in 2024.

The dead bycatch retention allowance was calculated to be -914 t or -994 t (depending on the post-release mortality rate used, see above). Therefore, the possible retention allowance for 2024 (calculated with Annex 1) is 0 t. In accordance with paragraph 1c of Annex 1, CPCs shall prohibit retaining onboard, transhipping, and landing, whole or in part, North Atlantic shortfin mako caught in association with ICCAT fisheries in year Y+1 (in this case 2024).

19.21 The SCRS shall review and approve the methods and, if it determines that the methods are not scientifically sound, the SCRS shall provide relevant feedback to the CPCs in question, Rec. 21-09 and Rec. 22-11 para 13

Background: *No later than 31 July 2022/23, CPCs that reported annual average catches (landings and dead discards) of North Atlantic shortfin mako over 1 t between 2018-2020 shall present to the SCRS the statistical methodology used to estimate dead discards and live releases. CPCs with artisanal and small-scale fisheries shall also provide information about their data collection programmes. The SCRS shall review and approve the methods and, if it determines that the methods are not scientifically sound, the SCRS shall provide relevant feedback to the CPCs in question to improve them.*

Once again, the Committee noted that only a few CPCs have submitted documents describing how they estimate their discards. CPCs that have complied in 2022 with this paragraph of Rec. 21-09 were Canada, China (P.R.), Japan, United States and Chinese Taipei. During 2023, three additional documents were presented:

EU-Portugal - Coelho *et al*. (2023) described the methodology to estimate dead discards and live releases of shortfin mako by its longline fleet in the North Atlantic using scientific observer data. The Committee noted that the methodology allows the estimation of total discards, and that hooking mortality was used to split the estimated discards into dead discards and live releases. The Committee inquired why this approach was used instead of estimating dead discards and live releases separately. Authors pointed out that the available size samples were too small to allow for the modelling of dead discards and live releases separately. However, authors agreed with the Committee's comments and is expected that in the future, once more information become available, it might be possible to use a modelling approach.

EU-Spain - The estimation of dead discards and live releases for the North and South Atlantic by the EU Spain longline fleet for the years 2018-2022 is described in Báez *et al*. (2023). Estimates presented are derived from the proportions of live and dead shortfin mako specimens recorded by the onboard observer programme in 2021 and 2022. Estimates demonstrated high consistency in the proportion of live and dead shortfin makos recorded by the observer programme for the northern stock in 2021 and 2022. Consequently, authors point out that these estimates are reliable and encourage the continuation of the observer programme. Authors also explained to the Committee that proportions are based in number of specimens recorded by the observers, but the mean weight of captures was used for the estimations in weight.

Chinese Taipei - The Committee reviewed Liu and Su (2023) that detailed the statistical methodology used to estimate dead discards and live releases of shortfin mako by the Chinese Taipei longline fleet in the South Atlantic. The total shortfin mako shark catch in number of the Chinese Taipei longline fleets in the South Atlantic was estimated by a multiplication of standardized catch per unit effort (CPUE) and total effort in the logbook of the Chinese Taipei longline fleets. The total live release and dead discards of shortfin mako were estimated by the live release and dead discard ratio obtained from observer's records multiplying the estimated annual catch in number. Dead discards and live release in weight were estimated by the multiplication of estimated dead discards and live released in number and the mean catch in weight. The Committee acknowledged the presentation of this methodology and found that the use of this type of methodology is appropriate to estimate discards.

19.22 The SCRS shall evaluate the completeness of Task 1 and 2 data submissions, including estimates of total dead discards and live releases. Whenever appropriate the SCRS shall inform the Commission on CPCs providing inappropriate data for inclusion in the calculation of the retention allowance, and shall estimate dead discards and live releases for those CPCs for use in the retention allowance calculation. Rec. 21-09 and Rec. 22-11 para 15

Background: *The SCRS shall evaluate the completeness of Task 1 and 2 data submissions, including estimates of total dead discards and live releases. If, after conducting this evaluation, the SCRS determines that significant gaps in data reporting exist, or, following the review in paragraph 13, that the methodology used by one or more CPCs to estimate dead discards and live releases is not scientifically sound, the SCRS shall inform the Commission that the data for those CPCs are inappropriate for inclusion in the calculation of the retention allowance. In this case, the SCRS shall estimate dead discards and live releases for those CPCs for use in the retention allowance calculation.*

For this response refer to the response to Rec. 21-09, paragraph 5c (see item 19.20 of this report).

19.23 The SCRS shall continue to prioritize research, together with the benefits and disadvantages for the objectives of the rebuilding programme, and identify other areas deemed helpful both to improving stock assessments and reducing shortfin mako mortality, Rec. 21-09 and Rec. 22-11 para 19

Background: *The SCRS shall continue to prioritize research into: identifying mating, pupping and nursery grounds, and other high concentration areas of North Atlantic shortfin mako; options for spatial-temporal measures; mitigation measures (inter alia, gear configuration and modification, deployment options), together with the benefits and disadvantages for the objectives of the rebuilding programme, aimed at further improving stock status; and other areas the SCRS deems helpful both to improving stock assessments and reducing shortfin mako mortality. In addition, CPCs are encouraged to investigate at-vessel and post-release mortality of shortfin mako including, but not exclusively through, the incorporation of hook-timers and of satellite tagging programmes.*

The Shark Research and Data Collection Programme (SRDCP) started in 2014 with its focus on different aspects of the life history, stock structure, and fisheries of the shortfin mako. Since then, a large amount of work has been done, producing very valuable information regarding the age and growth of the species, stock structure, movements, habitat use, and post release mortality. In 2023 the SRDCP included a line of research focused on the reproductive biology of this species. Also in 2023, a SRDCP workshop took place, the main objective was to review the progress of the programme and to identify the information gaps that need to be prioritized as mentioned in paragraph 19 of Rec. 21-09. Based on the discussion during the workshop, the Committee recommended increasing the number of shortfin mako specimens tagged (both electronic and conventional), trying to focus on those areas and life stages with less information. This study will contribute to improve the knowledge of the species distribution, habitat use, concentration areas, as well as for the post release mortality study. The use of hook-timers and mini data loggers (TDRs, temperature and depth recorders) has been proposed to be explored as a potential long-term line of research that can be included as part of the activities of the SRDCP for the following years. Additionally, the Committee continued its' work on technical gear changes to tackle mitigation measures and mortality reductions.

19.24 The SCRS shall launch a pilot project to explore the benefits of installing mini data loggers on the mainline and on the branchlines of longline fishing vessels targeting ICCAT species that have potential interactions with shortfin mako sharks, and shall provide guidance on the basic characteristics, minimum number and positions to install the mini data loggers, Rec. 21-09 and Rec. 22-10 para 20

Background: *Taking into account that hotspots of incidental catches may occur in areas and periods with specific oceanographic conditions, the SCRS shall launch a pilot project to explore the benefits of installing mini data loggers on the mainline and on the branchlines of longline fishing vessels which participate in the project on a voluntary basis targeting ICCAT species that have potential interactions with shortfin mako sharks. The SCRS shall provide guidance on the basic characteristics, minimum number and positions to install the mini data loggers with a view to have a better understanding of the effects of the soaking time, fishing depths and environmental characteristics underpinning higher incidental catches of shortfin mako.*

The design and implementation of a pilot study such as this will take several years to complete, so the Commission should not expect such a project to be undertaken quickly. During the 2023 Workshop on the Shark Research and Data Collection Programme (SRDCP) the Group proposed exploring the possibility of including in the activities of the SRDCP the use of hook-timers and mini data loggers as a potential long-term line of research for the following years. Importantly, this study will require a significant amount of funding (requested in the workplan for 2025) that would need to be added to the ICCAT SRDCP; the details of which will be specified in the SCRS budget. Other methodologies could be explored to determine hotspots of incidental catches, such as those based on modelling the effect of environmental conditions on the shortfin mako CPUE.

19.25 The SCRS shall provide to the Commission by 2023 updated advice on mitigation measures aimed at further reducing shortfin mako mortality, Rec. 21-09 para 21a

Background: *The SCRS shall provide to the Commission by 2023, and whenever new information becomes available, updated advice on mitigation measures aimed at further reducing shortfin mako mortality. For that purpose, by 30 April 2023, CPCs shall submit to the SCRS information by fishery on the technical and other management measures they have implemented for reducing total fishing mortality of North Atlantic shortfin mako sharks, except the CPCs that have already provided this information to the Secretariat. The SCRS shall review this information and advise the Commission on which tools and approaches have been most effective at reducing fishing mortality with a view to recommending specific measures that should be considered for adoption by the Commission.*

The Committee noted that few CPCs have submitted documents giving compliance to this Commission request. CPCs that have submitted documents in 2023 were Canada, Costa Rica, EU-Spain, Panama, United States, and Chinese Taipei. Most of these documents refer to the implementation of the non-retention allowance for the species, and how their fleets are requested to report the information, the implementation of observer programmes, safe handling procedures, and the needs of more scientific research. Documents presenting information on the use and effectiveness of different mitigation measures have been presented in the last few years by Portugal (Santos *et al*., 2023), United States (Diaz, 2020, Keller *et al*., 2020, and Santos *et al*., 2023), and Canada (Bowlby *et al*., 2021). This information on mitigation measures has been discussed on various occasions by the Sharks Species Group, and in the Subcommittee on Ecosystems and Bycatch.

In compliance with Rec. 22-11 para 22 on this same issue for South shortfin mako, Brazil sent a document containing the current regulations related to the prohibition on retention of this species.

19.26 The SCRS shall review the reported landings and discards of longfin mako shark to identify any unexpected inconsistencies that could be the result of misidentification between the two mako species, Rec. 21-09 and Rec. 22-11 para 22

Background: *The SCRS shall review the reported landings and discards of longfin mako shark to identify any unexpected inconsistencies that could be the result of misidentification between the two mako species, for the purpose of formulating management advice.*

The Committee reviewed the reported nominal catches of longfin mako shark in the last years. Insofar as the possible reporting of shortfin mako as longfin mako, no inconsistencies related to possible misidentification of the species were found.

19.27 The SCRS shall continue to refine the MSE and test candidate management procedures, Rec. 22-03 para 5

Background: *The SCRS shall continue to refine the MSE and test candidate management procedures in 2023. In support of this effort, the SCRS and Panel 4 shall hold two MSE dialogue meetings in 2023. At the 2023 ICCAT annual meeting, the Commission shall review the final candidate management procedures and select one for adoption and application to establish the TAC for 2024 and future years, including pre-agreed management actions to be taken under various stock conditions.*

The North Atlantic swordfish management strategy evaluation process is scheduled to select a management procedure in 2023 at the ICCAT annual meeting. Following several years of technical development, the SCRS engaged with Panel 4 in March and June 2023 (with plans for continued engagement in October and November 2023) to discuss key questions regarding the MSE process. Engagement with managers and stakeholders occurred during two “ambassador sessions” where swordfish MSE background, development, and management objectives were communicated. The Committee provided Panel 4 with an overview of swordfish biology, swordfish fisheries history in the North Atlantic, and uncertainties germane to management of the stock and development of a harvest control rule. The Committee received guidance from Panel 4 on management objectives, MSE specifications including robustness tests and CMP types, and timelines for the overall MSE implementation in the next decade. Following this guidance, the Committee will provide Panel 4 with a shortlist of candidate management procedures (CMPs) and their results (**Appendix 18**).

19.28 The SCRS shall monitor swordfish Southern Atlantic catch levels and report to the Commission annually, Rec. 22-04 para 2

Background: *The SCRS will monitor the catch levels in 2023, 2024, 2025 and 2026 and report to the Commission annually.*

Catch levels for South Atlantic swordfish in 2023 will be available in 2024 and will be provided to the Commission.

19.29 Fishing prohibited with FADs, Rec. 22-01 para 28

Background: *1 January to 13 March 2023, throughout the Convention area. This should be reviewed and, if necessary, revised based on advice by the SCRS taking into account monthly trends in free school and FAD-associated catches and the monthly variability in the proportion of juvenile tuna in catches. The SCRS should provide this advice to the Commission in 2023.*

With the intent to reduce mortality of juvenile tropical tunas, the Commission has established numerous spatial closures to surface fishing gear fishing on FADs in the Gulf of Guinea (Recs. 04-01, 08-01, 11-01, 14-01, 15-01) and the entire Atlantic (Recs. 19-01, 22-01). The Committee has provided a number of responses to the Commission evaluating the efforts by the Commission to reduce juvenile mortality using measures that include but are not limited to temporal-spatial closures. Last year, the Committee used statistics available at the Secretariat to prepare a comprehensive response that described the current state of knowledge regarding the monthly proportion of catches of juvenile tropical tunas in the floating objects (FOB) fisheries. It was not possible to update this analysis because the catch-at-size data are not yet available (as these are generally only prepared for stock assessments). However, the information is still relevant.

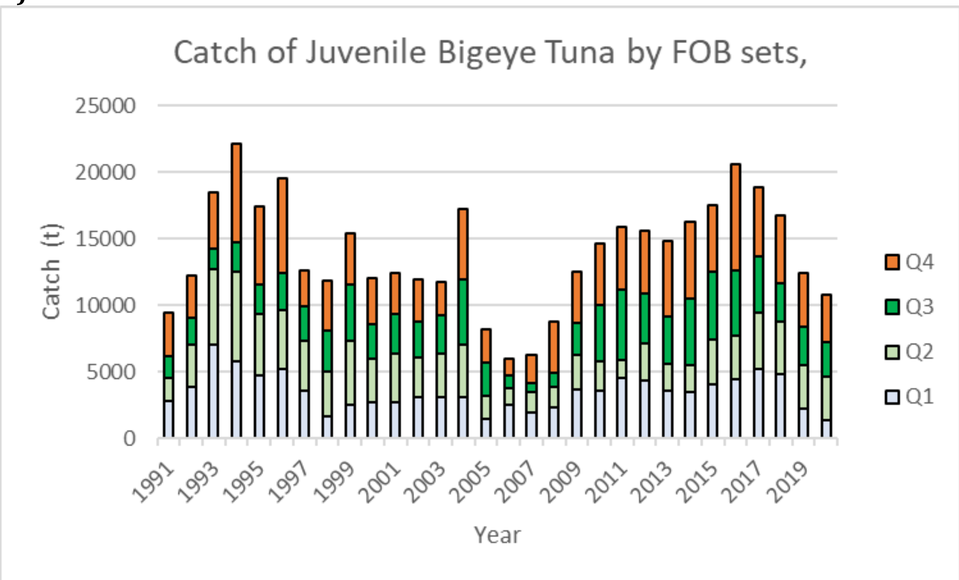
With regard to the stated objective to reduce juvenile mortality, there is evidence that catches of juvenile bigeye tuna have declined in recent years (**Figure 19.29.1A**). Current information suggests that the catches of juvenile bigeye in 2020 were the lowest since the mid-2000s, although the cause of that decline cannot yet be attributed fully to the current moratorium as COVID was a confounding factor. In contrast, catches of juvenile yellowfin tuna have increased significantly in recent years, and were at or near their historic high in 2020 (**Figure 19.29.1B**). The increases in the fraction of the total catches of yellowfin tuna that are taken on FOBs (**Figure 19.29.2**) originate from a combination of both increased catches on FOB, drops in the catches of other gears, and the increase of large-scale purse seiners operating in the Atlantic. Together, bigeye tuna and yellowfin tuna account for 20-30% of all tropical tuna caught in FOB sets, in which skipjack tuna is the target. The majority of those catches of yellowfin tuna and bigeye tuna in FOB sets are juvenile fish. Catches of these juvenile fish are much lower in free school sets (**Table 19.29.1**).

The Committee also notes that a new approach is available to identify spatiotemporal “hot-spots” where catches of juvenile bigeye and yellowfin tuna are particularly high. This approach could be useful to optimize the geographic and temporal scales of alternative moratoria. However, the Committee recognizes that juvenile yellowfin and bigeye tuna are present in the tropical regions of the eastern Atlantic Ocean throughout the year, so moratoria will not achieve their full potential if fishing effort increases or is simply redistributed to other months or areas not included in the moratoria that also contain high numbers of juvenile fish. The Committee also reiterates that increasing harvest of juvenile fish reduces the overall MSY (Response 19.4; *Report for Biennial Period, 2018-19 Part I (2018), Vol. 2*).

Table 19.29.1. Percent juvenile catch (t) by quarter for bigeye and yellowfin tuna caught in free school (FSC) and FOB sets for the period 2010-2020. Percentages were calculated from the catch at size data used in the latest assessment by considering that juveniles were fish of a size smaller than the size of a 3-year-old.

Fishing mode/ species	***Quarter 1***	***Quarter 2***	***Quarter 3***	***Quarter 4***
BET FOB	83.5%	82.9%	82.1%	84.4%
YFT FOB	62.7%	65.6%	67.5%	71.0%
BET FSC	15.2%	16.4%	18.2%	22.0%
YFT FSC	1.6%	2.3%	3.2%	4.9%

A)



B)

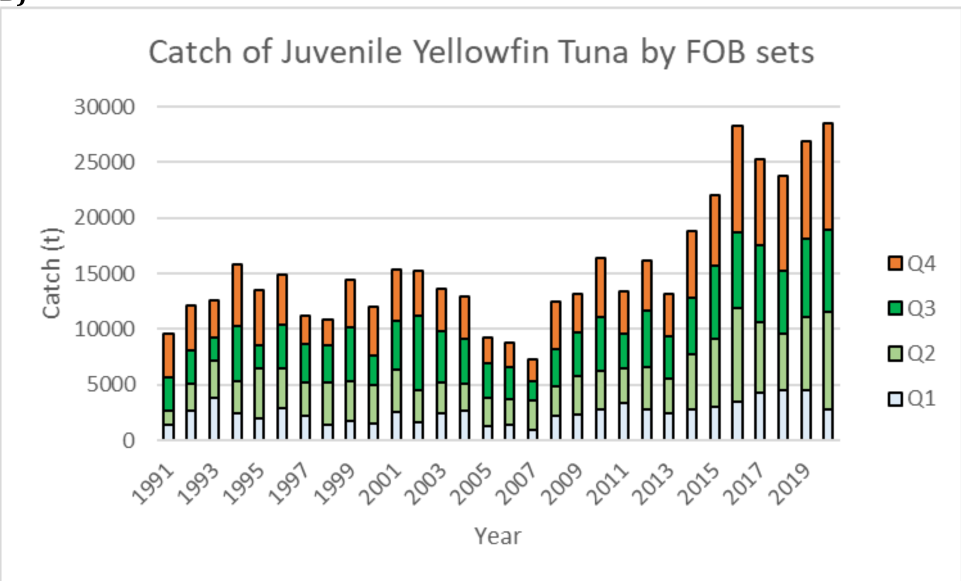


Figure 19.29.1. The annual catches (t) of juvenile bigeye (A) and yellowfin tuna (B) in the FOB fishery, by quarter.

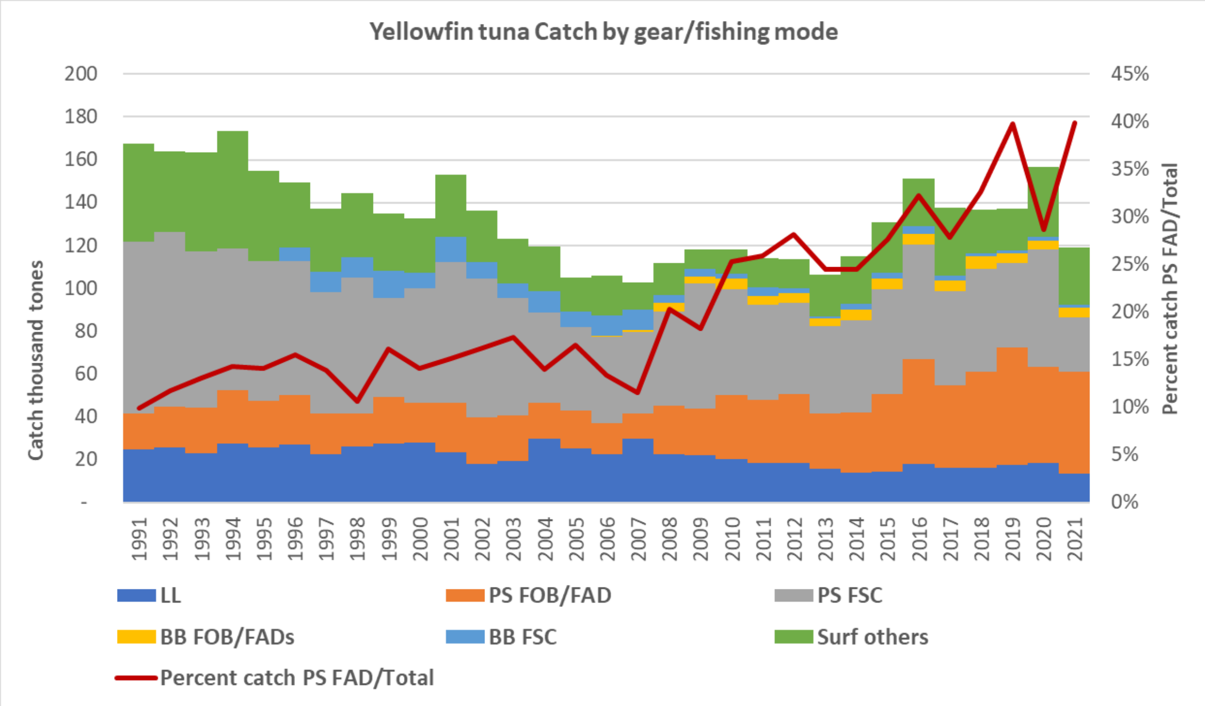


Figure 19.29.2. Annual catches of Atlantic yellowfin tuna by gear/fishing mode during the period 1991-2021 from CATDIS, and the fraction of the total catch in tons (solid red line) that is caught on FOBs. Note: The 2021 data are incomplete.

19.30 The SCRS to inform on CPCs that have provided by 31 July 2023 the required historical FAD set data, Rec. 22-01 para 31

Background: *With a view to establishing FAD set limits to keep the catches of juvenile tropical tunas at sustainable levels, in 2023 the SCRS should inform the Commission about the maximum number of FAD sets which should be established per vessel or per CPC. To support this analysis, CPCs with purse seine vessels shall urgently undertake to report to the SCRS by 31 July 2023 the required historical FAD set data in the format required by SCRS (Task 2 catch and effort through Form ST03-T2CE) for a minimum of the last five years. CPCs that do not report these data in accordance with this paragraph shall be prohibited from setting on FADs until such data have been received by the SCRS.*

In addition, each CPC with purse seine fishing vessels is encouraged not to increase its total fishing effort on FADs from its 2018 level. CPCs shall report the difference between the 2018 level and the 2020 level to the 2023 Commission meeting.

In 2021 the Committee provided a summary of the challenges faced by the Committee to provide an answer to this request (*Report for Biennial Period, 2022-23 Part I (2022), Vol. 1*). New information has been received recently from CPCs and is now uploaded to the ICCAT databases.

Ortiz *et al.* (2023) summarizes the current data on floating object (FOB)/ fish aggregating devices (FADs) deployments, that includes the historical data submissions by CPCs during the last years as requested by the Commission. **Table 19.30.1** shows a summary of the total catch (t) by main flag from purse seine (PS) fleets on FOB/FADs (from Task 2 CE) and the corresponding number of FOB/FADs deployed as reported in ST08-FADsDep statistical form. For the main PS fleets, historical data has been submitted from 2014/2015 onwards, however there is some information missing in recent years. Albeit not fully complete, the SCRS considers the current data are the best available data and acknowledges that the historical data do not have the detail information required in ST08 or ST03 T2-CE.

The Committee reiterates that the data provided on FADs are not sufficient to address the specific analyses requested by the Commission "the maximum number of FAD sets which should be established per vessel or per CPC". Because in order to carry out these analyses it will require to have both the catch associated with each FAD set and or deployed by vessel, and the overall number of sets by vessel during a given time period (fishing effort). Ortiz *et al*. (2023) also provided the summary of the annual fishing effort units reported by CPCs and the corresponding total tropical tunas catch on FAD or Free Schools (FCS) fishing modes (**Table 19.30.2**). As requested by the Commission, since 2018 most of the PS tropical tuna fleets have been reporting fishing effort in units of number of sets (or number of successful sets). Unfortunately, the CPCs stop reporting fishing effort in units of days fishing and as a consequence these two units of effort are not comparable, precluding a comprehensive analysis of catch rates for FAD fishing operations.

The Secretariat informed that current ICCAT data for tropical tunas do not have catches for a single vessel unit or by FAD. Catch Task 2 CE is reported at a resolution of 1 month and 1x1 degree, but not disaggregated by vessel or FAD-associated vessel fishing activity, therefore it is not possible to associate catches and number of sets by vessel. This detailed information and resolution would be only available at the national level likely from the vessel logbook forms. Therefore, the Committee recommends that national scientists perform for vessels fishing on FADs an analysis of the per vessel catch rates of tropical tunas on FADs and present it to the SCRS for their evaluation.

Table 19.30.1. Summary of the total tropical tunas catch (t) by flag-year from PS fisheries on FOB/FADs (Task 2 CE) and the corresponding total number of FOB/FADs deployed as reported in ST08-FADsDep form (yellow highlighted lines).

GearCode **PS**

Catch t per year/flag of PS on FAD

Number of FOBs deployed by year and Flag

FishMode	Flag	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
FAD	**Belize**	2,310	2,117	-	3,067	6,114	4,565	7,071	-	28,221	23,959	26,081	25,548	38,212
					-	-	-	-	-	-	4,539	1,663	2,746	-
	Cape Verde	7,140	10,202	6,333	9,866	22,122	21,946	13,255	7,392	7,680	5,728	5,082	606	-
					-	-	-	-	-	-	110	106	441	-
	Côte d'Ivoire	-	-	288	-	2,705	-	-	-	-	-	-	-	-
	Curaçao	14,830	17,574	17,564	19,292	22,340	24,332	28,956	25,644	25,889	20,827	15,686	17,451	5
					-	-	-	-	-	1,958	2,485	2,242	1,675	1,597
	El Salvador	-	-	-	-	-	7,865	23,403	17,197	19,951	21,623	19,513	13,237	15,645
					-	-	-	-	-	868	980	700	1,467	1,656
	EU-España	42,801	44,117	56,534	63,033	52,545	48,642	52,831	59,572	41,980	43,963	33,183	43,792	39,245
					-	-	-	6,232	6,159	7,622	7,782	4,731	4,565	3,843
	EU-France	15,932	13,305	16,677	16,989	20,998	23,222	21,905	21,702	24,307	23,391	15,281	21,089	27,106
					43	1,343	1,396	1,783	2,444	4,970	4,255	3,578	2,390	3,071
	Ghana	29,553	24,608	47,896	44,900	52,044	66,641	58,760	66,529	79,709	79,316	76,584	-	-
					-	9,100	-	17,600	24,825	-	-	-	-	-
	Guatemala	3,911	3,198	4,871	5,447	6,296	10,463	8,393	11,417	10,580	9,341	7,951	7,094	8,510
					-	-	-	-	-	2,658	-	436	403	262
	Guinée Rep	-	-	12,883	9,415	6,680	-	-	-	-	-	-	1,364	5,880
					-	-	-	-	-	-	-	-	-	198
	Maroc	-	-	-	-	-	-	-	-	-	-	405	855	1,137
					-	-	-	-	-	-	-	-	2	162
	NEI (ETRO)	348	-	-	-	-	-	-	-	-	-	-	-	-
	Panama	13,927	19,212	13,215	18,051	18,783	11,257	16,203	11,854	9,541	13,836	12,671	13,246	17,705
					-	-	-	-	-	2,287	3,413	4,201	3,759	2,409
	Senegal	-	-	-	-	-	4,953	18,002	32,019	38,943	44,227	35,051	33,784	-
					-	-	-	312	455	630	1,144	1,181	1,786	-
TOTAL Catch t		**130,751**	**134,333**	**176,261**	**190,061**	**210,628**	**223,885**	**248,779**	**253,327**	**286,799**	**286,211**	**247,487**	**178,065**	**153,446**
Total Number FOBs deployed		**-**	**-**	**-**	**43**	**10,443**	**1,396**	**25,927**	**33,883**	**20,993**	**24,708**	**18,838**	**19,234**	**13,198**

Table 19.30.2. Summary of the current Task 2 CE data for tropical tunas fleets by flag, fleet code, fishing mode (FOB/FAD, FSC Free schools, or unknown (n/a)) since 2010. Highlighted cells indicate reports of fishing effort type in number of set (NO.SETS) or number of successful sets (SUC.SETS), the values in the table indicate the actual total catch (t) of the three main species (BET, YFT, SKJ). Other acronyms: D.FISH number of days fishing, HOURS.SEA number of hours at sea.

Sum of Total T					YearC												
Flag	**FleetCode**	**FishMode**	**Eff1Type**	**Eff2Type**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Belize	BLZ-BZ-ETRO	FAD	FISH.HOUR	HOURS.SEA	2,310	2,117		3,067	6,114	4,565	7,071						
			NO.SETS	D.FISH									28,221	23,959	26,081	25,548	38,212
		FSC	FISH.HOUR	HOURS.SEA	1,906	1,488		5,246	3,251	2,948	2,068						
			NO.SETS	D.FISH									2,430	4,886	3,212	684	811
		n/a	NO.SETS	D.FISH								17,115					
Cape Verde	CPV-CV-ETRO	FAD	FISH.HOUR	HOURS.SEA	7,140	10,202	6,333	9,866	22,122	21,946	13,255	7,392	7,680	5,728	5,082		
			NO.SETS	(blank)												606	
		FSC	FISH.HOUR	HOURS.SEA	3,208	3,000	2,246	3,761	2,854	5,164	3,236	1,391	4,758	2,610	5,438		
			NO.SETS	(blank)												868	
Côte d'Ivoire	CIV-CI-ETRO	FAD	D.AT SEA	(blank)			288										
			FISH.HOUR	HOURS.SEA					2,705								
		FSC	FISH.HOUR	HOURS.SEA					2								
		n/a	NO.SETS	D.AT SEA				3,743									
Curaçao	CUW-CW-ETRO	FAD	FISH.HOUR	HOURS.SEA	14,830	17,574	17,564	19,292	22,340	24,332							
			NO.SETS	SUC.SETS							28,956	25,644	25,889	20,827	15,686	17,451	
				(blank)													5
		FSC	FISH.HOUR	HOURS.SEA	3,283	2,457	5,159	4,672	5,095	5,321							
			NO.SETS	SUC.SETS							5,765	6,025	11,172	8,255	6,858	5,745	
				(blank)													3
El Salvador	SLV-SV-ETRO	FAD	FISH.HOUR	HOURS.SEA						7,865							
			NO.SETS	SUC.SETS							23,403	17,197	19,951	21,623	19,513	13,237	15,645
		FSC	FISH.HOUR	HOURS.SEA						519							
			NO.SETS	SUC.SETS							2,525	6,300	6,379	3,469	6,653	4,944	4,470
EU-España	EU.ESP-ES-ETRO	FAD	FISH.HOUR	HOURS.SEA	42,801	44,117	56,534										
			NO.SETS	FISH.HOUR				63,033	52,545	48,642	52,831	59,572	41,980	43,963	33,183	43,792	39,245
		FSC	FISH.HOUR	HOURS.SEA	22,440	12,992	17,519										
			NO.SETS	FISH.HOUR				12,737	9,666	17,654	16,715	6,501	14,077	13,872	14,967	6,020	8,346
EU-France	EU.FRA-FR-ETRO	FAD	FISH.HOUR	NO.SETS	15,932	13,305	16,677	16,989	20,998	23,222	21,905	21,702	24,307	23,391	15,281	21,089	27,106
		FSC	FISH.HOUR	NO.SETS	21,433	23,685	17,323	22,356	22,055	19,805	26,774	24,028	26,908	19,086	15,029	10,204	15,784
Ghana	GHA-GH-ETRO-A	FAD	NO.SETS	SUC.SETS	28,668	22,850	23,142	16,321	15,386	20,432	19,255	17,429	27,551	37,148	38,413		
		FSC	NO.SETS	SUC.SETS	3,665	2,298	2,910	1,496	1,151	222	404	105	99	209	76		
	GHA-GH-ETRO-P	FAD	NO.SETS	SUC.SETS	**885**	1,758	24,755	28,579	36,658	46,209	39,506	49,101	52,158	42,168	38,171		
		FSC	NO.SETS	SUC.SETS	50	3	1,511	2,368	3,103	1,487	613	85	65	170	282		
Guatemala	GTM-GT-ETRO	FAD	FISH.HOUR	HOURS.SEA	3,911	3,198	4,871	5,447	6,296	10,463	8,393	11,417	10,580	9,341	7,951	7,094	
			NO.SETS	SUC.SETS													8,510
		FSC	FISH.HOUR	HOURS.SEA	2,805	2,376	2,771	3,259	3,665	1,702	3,022	3,869	2,504	3,246	2,252	1,722	
			NO.SETS	SUC.SETS													3,875
Guinée Rep	GIN-GN-ETRO	FAD	D.FISH	(blank)												1,364	
			FISH.HOUR	HOURS.SEA			12,883	9,415	6,680								
			SUC.D.FI	(blank)													5,880
		FSC	FISH.HOUR	HOURS.SEA					764								
			SUC.D.FI	(blank)													1,201
Maroc	MAR-MA-ETRO	FAD	D.FISH	(blank)													
			NO.SETS	(blank)											405	855	1,138
NEI (ETRO)	NEI.001	FAD	FISH.HOUR	HOURS.SEA	348												
		FSC	FISH.HOUR	HOURS.SEA	40												
Panama	PAN-PA-ETRO	FAD	FISH.HOUR	HOURS.SEA	13,927	19,212	13,215	18,051	18,783	11,257							
			NO.SETS	SUC.SETS							16,203	11,854	9,541	13,836	12,671	13,246	17,705
		FSC	FISH.HOUR	HOURS.SEA	3,432	1,456	4,885	3,687	3,858	2,377							
			NO.SETS	SUC.SETS							2,998	5,120	5,441	4,479	8,334	8,015	9,308
Senegal	SEN-SN-ETRO	FAD	NO.SETS	FISH.HOUR						4,953	18,002	32,019	38,943	44,227	35,051	33,784	
		FSC	NO.SETS	FISH.HOUR						473	2,343	1,460	5,130	3,002	6,031	6,839	
TOTAL					193,012	184,088	230,585	253,385	266,093	281,557	315,241	325,326	365,761	349,494	316,619	223,106	196,106

19.31 Further analysis shall be conducted by the SCRS on the impact of support vessels on the catches of juvenile yellowfin and bigeye tuna to be considered in 2023, Rec. 22-01 para 33

Background: *Further analysis shall be conducted by the SCRS on the impact of support vessels on the catches of juvenile yellowfin and bigeye tuna to be considered in 2023.*

The Committee provided a partial response to this request in 2021. The Committee provided some additional information on support vessels in Restrepo *et al*. (2022) by comparing the list of support vessels in the International Seafood Sustainability Foundation (ISSF) ProActive Vessel Register and the ICCAT record but was unable to determine which support vessels were active.

The Committee will endeavour to determine in 2024 the information it requires and the type of analysis to be conducted to answer the request of the Commission. The Committee is unable to provide a final response to this request from the Commission.

19.32 The SCRS shall refine the MSE process in line with the SCRS roadmap and continue testing the candidate management procedures, Rec. 22-01 para 62

Background: *The SCRS shall refine the MSE process in line with the SCRS roadmap and continue testing the candidate management procedures. On this basis, the Commission shall review the candidate management procedures, including pre-agreed management actions to be taken under various stock conditions. These shall take into account the differential impacts of fishing operations (e.g., purse seine, longline and baitboat) on juvenile mortality and the yield at MSY.*

A new roadmap of the MSE process was adopted at the 23rd Special Meeting of the Commission in 2022 and was posted to the ICCAT website. Since the roadmap was adopted the SCRS has advanced its work as follows:

- Continuation of the capacity building program to enhance the ability of scientists and managers from ICCAT CPCs to participate in the tropical tunas MSE process. In June 2023 a one-day trilingual training course on MSE for tropical tunas was delivered to 38 scientists from 14 different CPCs. A similar online course for ICCAT managers will be delivered in October 2023. The 2023 courses follow similar courses delivered in 2022 for Spanish and Portuguese speaking CPCs scientists and managers.

- Progress in the western skipjack (SKJ-W) stock MSE has followed the roadmap calendar and is described in section 15.4 of this report.

- Progress on the multi-stock MSE has been primarily related to the continued development of operating and observational error models and is summarized in section 15.5 of this report.

Given the above progress, the SCRS proposes the following changes to the roadmap for the multi-stock MSE:

For the 2023 section on SCRS development add:

- Developing operating and observational error models

- Capacity building workshops

For the 2024 section on SCRS development add:

- External peer review of Observation and Operating models

- Meetings of Technical Sub-Groups on MSE

- Initial development of candidate management procedures (CMPs) and testing of management procedures (MPs)

- Capacity building workshops

For 2025 and beyond section on SCRS development add:

- Presentation of MSE results to Panel 1
- SCRS to finalize MSE results, incorporating feedback from the Commission through Panel 1
- Capacity building workshops

The SCRS proposes the following change to the SKJ-W MSE roadmap:

- For 2024 develop climate change scenarios to test robustness of CMPs

The revised roadmap is also included in **Appendix 15** of this report.

19.33 Efficacy that full fishery closures along the lines of those proposed in PA1_505A/2019, Rec. 22-01 para 66a

Background: *Actions required from the SCRS and the Secretariat:*

a) The SCRS shall explore the efficacy that full fishery closures along the lines of those proposed in PA1-505A/2019[1] *might have to reduce the catches of tropical tunas to the agreed levels; and the potential of such scheme to reduce the catches of juvenile bigeye and yellowfin tunas, in line with recommendations from the SCRS;*

The Committee concluded in 2022 that work previously conducted on the evaluation of full fishery closures by Sharma and Herrera (2019) and Herrera *et al.* (2020) made appropriate assumptions about the dynamics of the tropical tuna stocks. To further refine these approaches, the Committee recommended that these evaluations be updated with the most current information available on catch, effort, biomass, biological parameters, etcetera.

The Committee also noted that recent analyses continue to highlight the influence of spatial closures and access agreements to the EEZ of coastal countries on the relationship between the catch of tropical tunas and the effort of the purse seine fishery. This suggests that the predictions of the catch of tropical tunas obtained from total purse seine effort will have considerable uncertainty as long as operations of the fishery respond to changes in access rights and or to changes in the spatial distribution of the stocks. It is therefore essential that any evaluation of total effort closures is accompanied by estimates of the uncertainty of the prediction that account for such potential changes in fleet distribution.

During 2023, the Secretariat in collaboration with the author scientists (Sharma and Herrera) attempted to update the evaluations as requested by the Commission. The authors kindly provided the algorithms and previous analyses, and the Secretariat proceeded with the updates of input data, including biological parameters (new vectors of maturity for YFT and SKJ), catch, effort, catch-at-size time series, and biomass estimates from the latest assessment of BET (2021).

Unfortunately, after the scrutiny of the fishing effort it was noted that for most of the PS tropical tuna fisheries, the CPCs since 2016 have been reported PS fishing effort in units of the number of sets (or the number of successful sets) following the request from the Commission recommendations (see **Table 19.30.2** from item 19.30 of this report). As the prior analyses have been performed using fishing effort in units of "fishing hours" it was not possible to find a comparable or equivalent unit of fishing effort for the recent period (2016-2021), precluding the update of the analyses presented in 2019.

In summary, the Committee could not update the analysis. In order to update the analysis, the Committee, therefore recommends that CPCs provide purse seine fishing effort in both units, fishing hours, and the number of sets.

[1] Available upon request from the ICCAT Secretariat or on the 2019 Commission meeting documents webpage.

19.34 Estimate of capacity in the Convention area, to include at least all the fishing units that are large-scale or operate outside the EEZ of the CPC they are registered in, Rec. 22-01 para 66b

Background: *Actions required from the SCRS and the Secretariat:*

b) The ICCAT Secretariat shall work with the SCRS in preparing an estimate of capacity in the Convention area, to include at least all the fishing units that are large-scale or operate outside the EEZ of the CPC they are registered in. All CPCs shall cooperate with this work, providing estimates of the number of fishing units fishing for tuna and tuna-like species under their flag, and the species or species groups each fishing unit targets (e.g., tropical tunas, temperate tunas, swordfish, other billfish, small tunas, sharks, etc.); this work shall be presented to the next meeting of the SCRS in 2020 and forwarded to the Commission for consideration.

In 2022, the Committee conducted an analysis of the completeness of active fleet statistics held by the Secretariat for large-scale purse seiners using estimates from Restrepo *et al.* (2022). This preliminary analysis showed that the number of purse seiners reported as active in the ICCAT database was higher (four more vessels in both years 2020 and 2021) than those reported by Restrepo *et al.* (2022). Discrepancies were possible due to a variety of factors including double-counting of vessels reflagged that year, and the inclusion of vessels recently sunk/scrapped, inactive vessels and/or smaller vessels. Additional details are available in Restrepo *et al*. (2022).

Preliminary analyses conducted in 2023 indicate that the situation has not changed much and that the number of large-scale purse seiners targeting tropical tunas remains around 70 to 80. The Committee notes that challenges remain to properly identify active vessels. To overcome these challenges, the Committee recommends the following improvements to ST01-T1FC as mandatory requirements for every vessel:

1) The International Maritime Organisation (IMO) Number or other unique vessel identifier,
2) Information about fishing capacity (fish hold volume in cubic meters, fish carrying capacity in metric tons, or both), and
3) The nominal number of days fished in the previous year for the Atlantic and Mediterranean.

The Committee requests that the Commission should require this information for large-scale vessels in all major fleets and fisheries as this issue is not limited to the tropical tuna purse seine fishery.

The Committee also recommends that the Secretariat review all Recommendations that refer to vessel records so that the required field codes are consistent with ST01.

The Committee also notes that it has not been able to estimate capacity for other fleet components (support, baitboat (BB) and longline (LL) vessels). If the recommended changes to ST01 are adopted, it should become easier to estimate capacity for these fleet components as well.

19.35 The SCRS and the ICCAT Secretariat shall prepare ToRs to carry out an evaluation of the monitoring, control and surveillance mechanisms in place in ICCAT CPCs, Rec. 22-01 para 66c

Background: *Actions required from the SCRS and the Secretariat:*

c) The ICCAT Secretariat shall identify a Consultant to carry out an evaluation of the monitoring, control and surveillance mechanisms in place in ICCAT CPCs. This work shall primarily focus on the evaluation of data collection and processing systems in each CPC, and the ability to produce estimates of catch and effort, and length frequency for all stocks under ICCAT management, with a focus on stocks for which input and/or output measures are in place; in preparing this work the Consultant shall evaluate how efficient the catch monitoring systems that each CPC has implemented are to achieve robust estimates of catches for the stocks subject to a TAC; the ICCAT Secretariat shall work with the SCRS scientists to prepare ToRs for this work as soon as possible.

In 2023, the Committee agreed to work with the Secretariat to develop the specific Terms of Reference (ToRs) for a consultant to carry out a technical evaluation in response to this request. The ToRs will be completed in 2023.

19.36 Development of Management Objectives for SKJ-W MP tested through MSE, Rec. 22-02 para 1 and 2

Background:

1. *Management objectives should be established for western Atlantic skipjack tuna consistent with the Convention's objective: to maintain populations at or above levels that will support maximum sustainable catch (usually referred to as MSY).*

2. *Panel 1 should undertake, during a 2023 intersessional meeting of Panel 1, the development of initial operational management objectives for western skipjack. To facilitate this development, the following conceptual management objectives should be considered:*

   a. *Stock Status - The stock should have a [XX% or greater] probability of occurring in the green quadrant of the Kobe matrix using a [X]-year projection periods as determined by the SCRS;*

   b. *Safety - There should be no greater than [XX%] probability of the stock falling below B_{LIM}[2]1 at any point during the X-year projection periods;*

   c. *Yield - Maximize overall catch levels in the short (1-3 years), medium (4-10 years) and long (11-30 years) terms; and*

   d. *Stability - Any changes in TAC between management periods should be [XX]% or less.*

After the Second Intersessional Meeting of Panel 1 (on Western Skipjack MSE) that took place in May 2023, the Commission had agreed in a threshold value of 70% of Probability of Green Kobe (PGK) for Stock Status; a 10% maximum acceptable probability to the stock falling below B_{LIM} for Safety; a maximum value of 20% for changes in Total Allowable Catch (TAC) for Stability, and; an evaluation of yield performance of candidate management procedures (CMPs) in the short (1-3 years), medium (4-10 years) and long (11-30 years) terms.

A management strategy evaluation (MSE) for western Atlantic skipjack tuna was developed in 2022 following reconditioning on outputs of the 2022 Skipjack Stock Assessment Meeting (Anon., 2022b). The full suite of uncertainties evaluated in the stock assessment was included in the MSE's uncertainty grid of reference operating models. In 2023, the analysis focused on an evaluation of the relative performance of a variety of candidate management procedures across a set of performance metrics regarding the safety, stock status, yield, and stability of western Atlantic skipjack tuna.

Preliminary results, based mainly on the implementation of constant catch and empirical management procedures, were presented to the Second Intersessional Meeting of Panel 1 (on western skipjack MSE) in May 2023. Panel 1 provided feedback, which the SCRS took into consideration when continuing its CMP development work. These new final results are described in Sant'Ana and Mourato (2023).

Tables 19.36.1 to 19.36.5 show the performance metrics estimated for each Management Procedure (MP) evaluated in the reference scenario (ensemble OMs 1-9). In summary, the CMPs based on empirical ratio and model-based, for this second, mainly those based on surplus production models, show a more stable performance along the metrics tested and projected for the next 30 years (**Tables 19.36.1 to 19.36.5**). **Figure 19.36.1** displays the probability of western skipjack stock being in each quadrant of a Kobe plot for 30 years based on each MPs tested for the reference scenario. Projected trajectories of the spawning stock biomass relative to Maximum Sustainable Yield (MSY) levels and the total catches are presented in **Figures 19.36.2 and 19.36.3**.

In this sense, the model-based MPs tested can be considered viable candidates for management of the western Atlantic skipjack tuna stock and can serve as the basis for MP adoption in 2023 consistent with the MSE roadmap.

[2] The SCRS will advise on an appropriated BLIM for western Atlantic skipjack tuna.

Finally, due to the complexity of predicting impacts of climate change on the distribution, productivity and other skipjack dynamics, climate change scenarios have not yet been evaluated or implemented and will instead be deferred to future work in 2024 of the SKJ-W MSE in conjunction with the Exceptional Circumstance (EC) as indicated in the MSE Workplan.

Table 19.36.1. Stock Status performance metrics (PGK_short, PGK_med, PGK_long and PGK) for each MP showing the averaged statistics of the ensemble Operating Models (OMs) included in the reference scenario - Perfect TAC implementation. The grey colour represents those cases where the values are consistent with the management objective defined by the Commission.

Management Procedures	Status			
	PGK_short	PGK_med	PGK_long	PGK
SP_06	0.401	0.448	0.338	0.37
SP_05	0.221	0.487	0.425	0.419
SP_04	0.861	0.937	0.91	0.912
SP_03	0.842	0.911	0.912	0.905
SP_02	0.883	0.949	0.909	0.916
SP_01	0.883	0.926	0.901	0.905
SPSS_100_40_SBMSY	0.879	0.957	0.916	0.922
SP_100_40_SBMSY	0.845	0.916	0.911	0.906
SCA_100_40_SBMSY	0.832	0.777	0.786	0.789
Islope1	0.831	0.95	0.961	0.945
Iratio	0.857	0.931	0.925	0.92
GB_slope	0.841	0.941	0.937	0.928
CC_40kt	0.588	0.402	0.266	0.33
CC_30kt	0.741	0.729	0.666	0.688
CC_20kt	0.83	0.947	0.965	0.947

Performance Metrics

Table 19.36.2. Stock Status performance metrics (PNOF and POF) for each MP showing the averaged statistics of the ensemble OMs included in the reference scenario - Perfect TAC implementation.

	Status	
Management Procedures	PNOF	POF
SP_06	0.611	0.389
SP_05	0.64	0.36
SP_04	0.966	0.034
SP_03	0.964	0.036
SP_02	0.967	0.033
SP_01	0.959	0.041
SPSS_100_40_SBMSY	0.97	0.03
SP_100_40_SBMSY	0.967	0.033
SCA_100_40_SBMSY	0.864	0.136
Islope1	0.986	0.014
Iratio	0.962	0.038
GB_slope	0.964	0.036
CC_40kt	0.362	0.638
CC_30kt	0.756	0.244
CC_20kt	0.988	0.012

Performance Metrics

Table 19.36.3. Safety performance metrics (LRP_short, LRP_med, LRP_long and LRP) for each MP showing the averaged statistics of the ensemble OMs included in the reference scenario - Perfect TAC implementation. The grey colour represents those cases where the values are consistent with the management objective defined by the Commission.

Safety

Management Procedures	LRP_short	LRP_med	LRP_long	LRP
SP_06	0.042	0.11	0.175	0.146
SP_05	0.085	0.115	0.139	0.128
SP_04	0.001	0.001	0.005	0.003
SP_03	0.001	0.002	0.006	0.004
SP_02	0	0.003	0.005	0.004
SP_01	0	0.005	0.008	0.006
SPSS_100_40_SBMSY	0.001	0.003	0.007	0.005
SP_100_40_SBMSY	0	0.002	0.003	0.003
SCA_100_40_SBMSY	0	0.019	0.013	0.013
Islope1	0	0.003	0.005	0.004
Iratio	0	0.006	0.007	0.006
GB_slope	0	0.007	0.015	0.012
CC_40kt	0.01	0.212	0.501	0.384
CC_30kt	0	0.044	0.14	0.103
CC_20kt	0	0.003	0.006	0.005

Performance Metrics

Table 19.36.4. Stability performance metrics (VarCmedium, VarClong and VarC) for each MP showing the averaged statistics of the ensemble OMs included in the reference scenario - Perfect TAC implementation. The grey colour represents those cases where the values are consistent with the management objective defined by the Commission.

Management Procedures	VarCmedium	VarClong	VarC
	Stability		
SP_06	0.951	0.687	0.629
SP_05	1	0.659	0.658
SP_04	0.181	0.123	0.108
SP_03	0.13	0.051	0.05
SP_02	0.153	0.125	0.106
SP_01	0.106	0.062	0.061
SPSS_100_40_SBMSY	0.192	0.13	0.12
SP_100_40_SBMSY	0.164	0.061	0.063
SCA_100_40_SBMSY	0.916	0.905	0.904
Islope1	0.019	0.016	0.013
Iratio	0.146	0.12	0.103
GB_slope	0.082	0.067	0.06
CC_40kt	0	0	0
CC_30kt	0	0	0
CC_20kt	0	0	0

Performance Metrics

Table 19.36.5. Yield performance metrics (AvC_short, AvC_med and AvC_long) for each MP showing the averaged statistics of the ensemble OMs included in the reference scenario - Perfect TAC implementation. The grey colour represents those cases where the values are equal or higher than the average of the total catches in the last four years (2019-2022).

Management Procedures	AvC_short	AvC_med	AvC_long
	Yield		
SP_06	44848	31568	33706
SP_05	56563	23795	32986
SP_04	16545	23015	24424
SP_03	22018	23254	24524
SP_02	9729	24204	24312
SP_01	9729	26418	24616
SPSS_100_40_SBMSY	9042	24140	24992
SP_100_40_SBMSY	21721	23464	24811
SCA_100_40_SBMSY	19668	25121	24183
Islope1	18363	19389	19678
Iratio	14367	19929	18414
GB_slope	16875	18014	16823
CC_40kt	39840	36713	27360
CC_30kt	29999	29647	27866
CC_20kt	20000	19986	19948

Performance Metrics

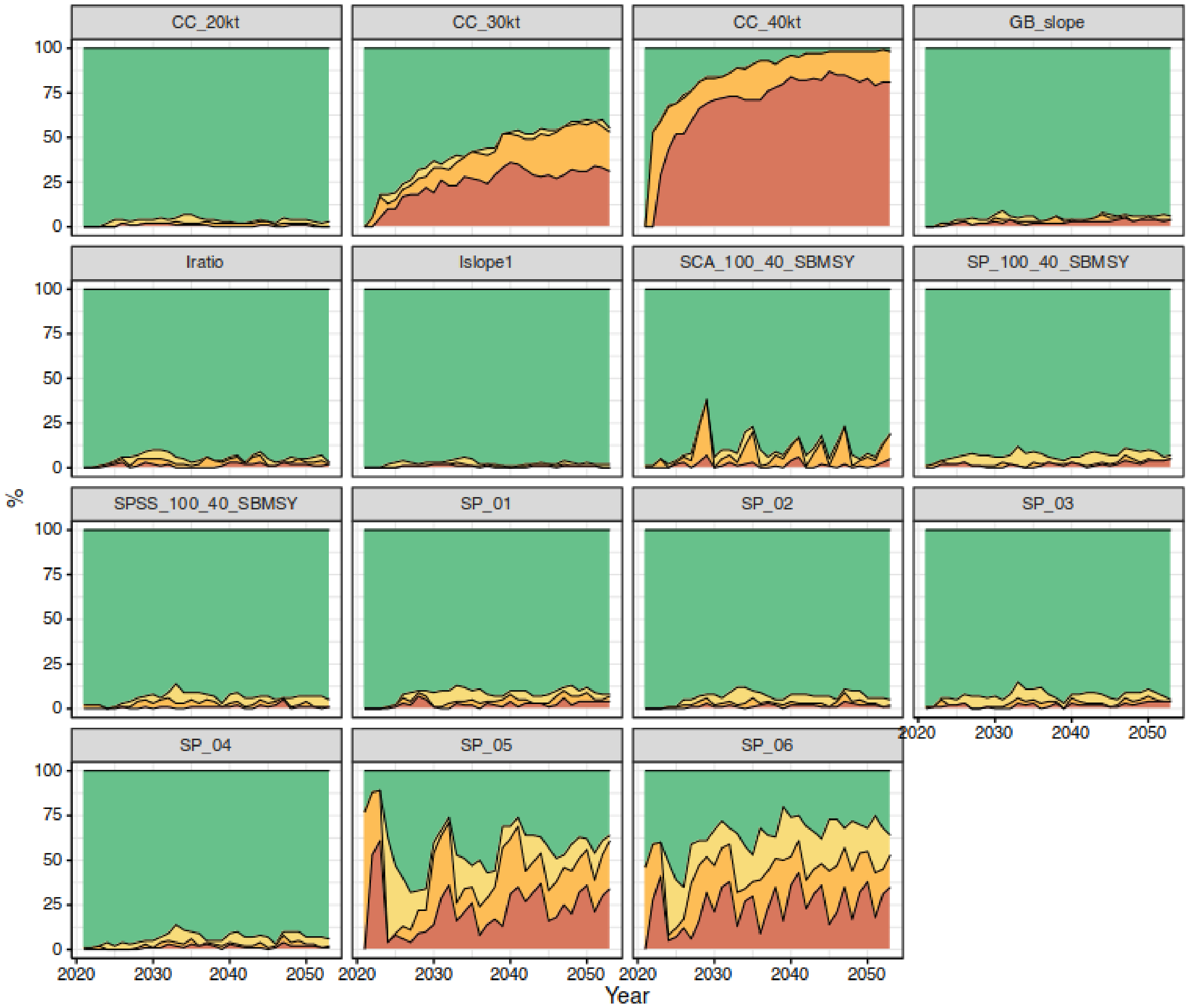


Figure 19.36.1. Time series of the probabilities of western skipjack stock being in each of the quadrants of the Kobe plot for the next 30 years of projection according to each of the MPs tested for the reference scenario (Ensemble OMs 1-9).

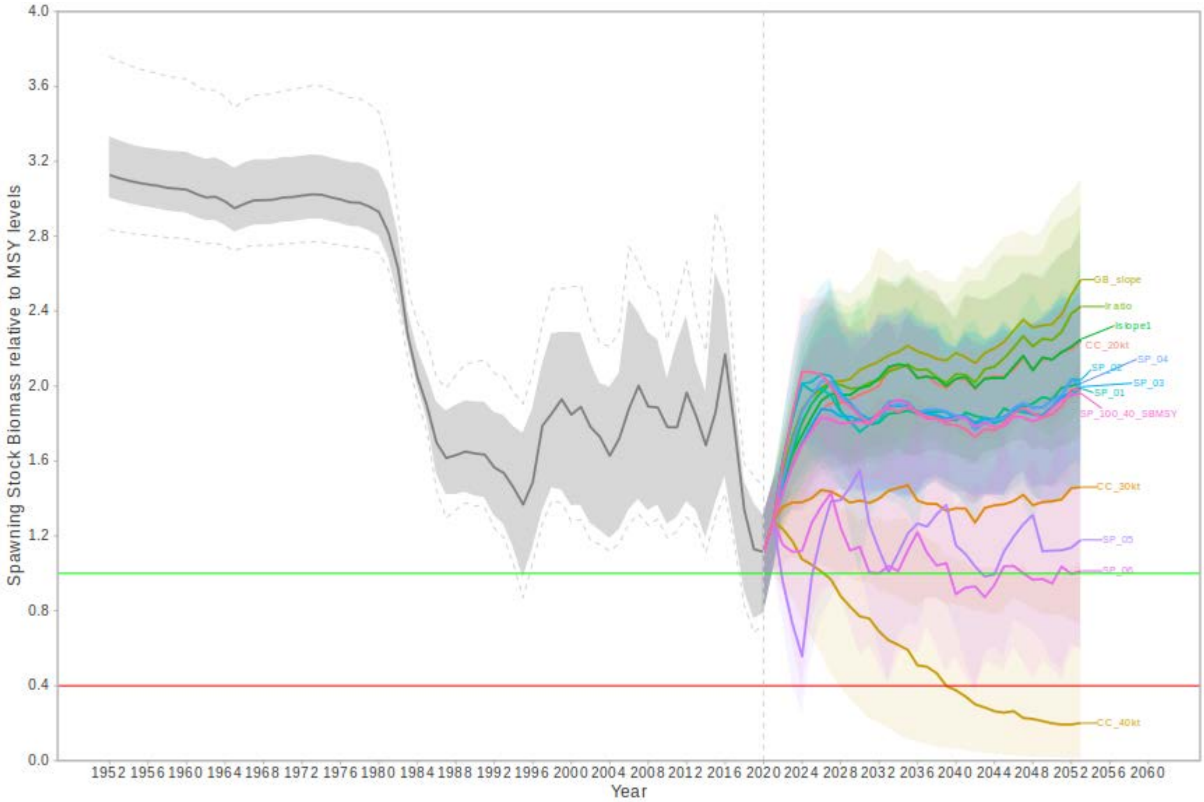


Figure 19.36.2. Time-series of the spawning stock biomass relative to MSY levels for the next 30 years of projection according to each of the MPs tested for the reference scenario (Ensemble OMs 1-9). Solid lines represent the median value; Shaded areas represent the 95% confidence intervals estimated to each MP.

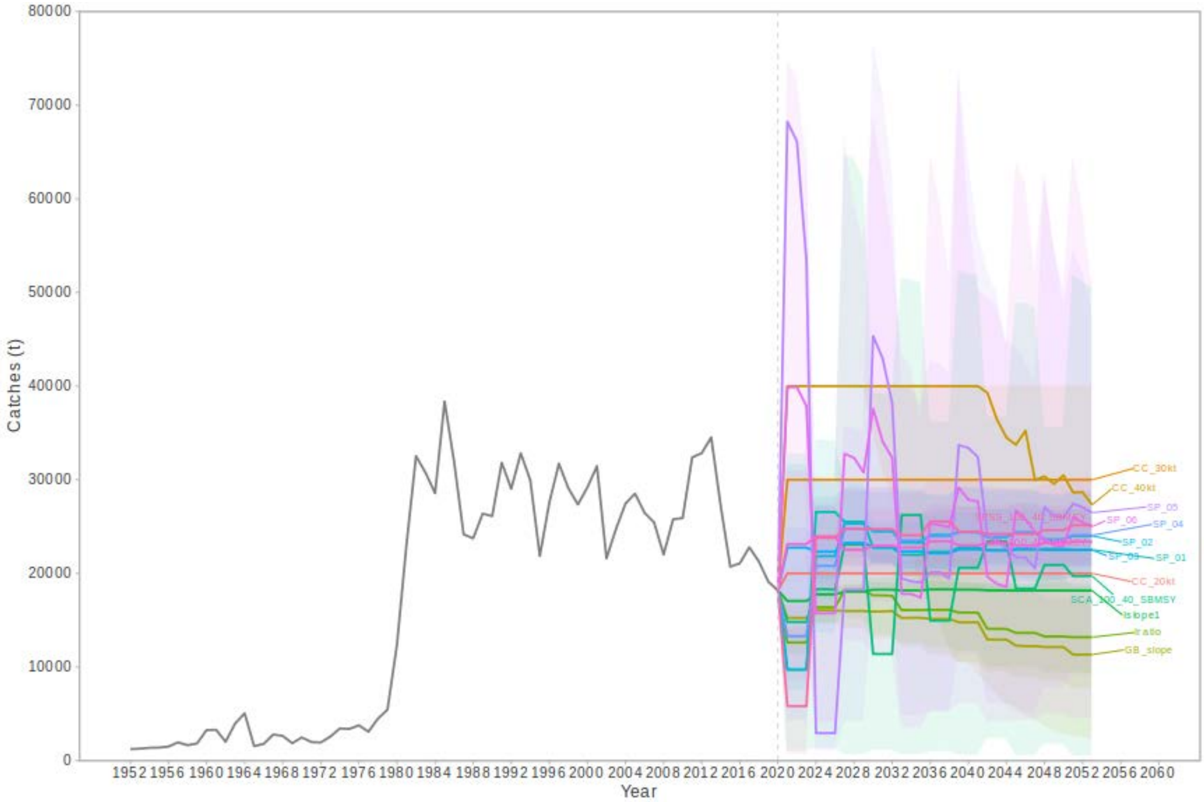


Figure 19.36.3. Time-series of the total catches for the next 30 years of projection according to each of the MPs tested for the reference scenario (Ensemble OMs 1-9). Solid lines represent the median value; Shaded areas represent the 95% confidence intervals estimated to each MP.

19.37 The SCRS shall review these data and determine the feasibility of estimating fishing mortality by commercial fisheries, Rec. 16-11 para 2

Background: *CPCs shall enhance their efforts to collect data on catches of sailfish, including live and dead discards, and report these data annually as part of their Task 1 and 2 data submission to support the stock assessment process. The SCRS shall review these data and determine the feasibility of estimating fishing mortality by commercial fisheries (including longline, gillnets and purse seine), recreational fisheries and artisanal fisheries.*

The Committee conducted a stock assessment of sailfish stocks in 2023 (Anon., 2023b). As part of the assessment the Committee attempted to estimate fishing mortality by commercial fisheries (including longline, gillnets and purse seine), recreational fisheries and artisanal fisheries for the West sailfish stock, using the integrated stock assessment model (SS3). However, due to data conflicts there were issues with model performance that could not be resolved given time limitations during the combined sailfish data preparatory and assessment meeting. The Committee expects to complete this work in the next year for both East and West stocks.

19.38 Revise the statistical methodology used to estimate dead and live discards and provide feedback to CPCs, Rec. 19-05 para 16

Background: *No later than 2020, CPCs shall present to the SCRS the statistical methodology used to estimate dead and live discards. CPCs with artisanal and small-scale fisheries shall also provide information about their data collection programmes.*

The SCRS shall review these methodologies and if it determines that a methodology is not scientifically sound, the SCRS shall provide relevant feedback to the CPCs in question to improve the methodologies.

The SCRS shall also determine if one or more capacity building workshops are warranted to help CPCs to comply with the requirement to report total live and dead discards. If so, the Secretariat in coordination with the SCRS should begin organizing the SCRS-recommended workshop(s) in 2021 with a view to convening them as soon as practicable.

The Committee noted that, since the response to this request provided in the *Report for Biennial Period, 2022-23 Part I (2022), Vol. 2*, several CPCs (Brazil, Canada, Morocco and the United States) have provided information on their statistical methodology to estimate dead and live discards of billfish species. The Committee did not receive additional methodologies from other CPCs in 2023.

In general, there remain very few papers and information provided from CPCs on the methods they employ for estimating discards. The Committee reiterates that it is important for the Committee to understand the methodology that has been put in place by the CPCs to estimate live and dead discards of marlins. The Committee reminds CPCs that have not yet presented documentation on the bycatch estimation methodologies used of the obligation to do so. Until the Committee can review the methodologies currently being used by these other CPCs, the Committee is not in a position to provide suggestions for any necessary improvements on those methods, and it hampers the ability to provide general recommendations on methodology for those CPCs that still do not have implemented methodology.

With regards to the artisanal and small-scale fisheries, the Committee was informed that generally there are no discards as all billfish specimens are retained and landed. As such, in those cases the landings represent the total catch.

To increase capacity building to estimate dead and live discards, the Committee developed and made available the Bycatch Estimation Tool. This tool is intended to provide a standardized method that CPCs can use to estimate such quantities as bycatch, dead and live discards and other aspects of their catch. The Committee will be conducting a workshop on the use of the Bycatch Estimation Tool in the summer of 2024. The Committee recommends that CPCs make every effort to take advantage of this tool and the workshop to address the issues indicated in this request.

20. New templates for Executive Summaries and Revised Publication Guidelines for the SCRS Plenary meeting report

A proposed new format for Executive Summaries, along with an example, was made available to the Committee for its consideration and potential endorsement. Before opening this item for discussion, the SCRS Chair commented that he had been receiving proposed edits and general comments from multiple parties during the meeting on this proposed new format. The Chair recalled that the initiative to develop a new format began some years ago, when the primary approach to developing management advice involved carrying out a stock assessment. Many of the comments received highlighted that the new format did not adequately address the provision of advice through an MSE-tested management procedure.

Considering these concerns, the Chair proposed that the new format be further developed during the next year, in order to more fully address the requirements of communicating management advice developed using an MP, along with other topics which had been raised such as the consideration of climate change impacts.

Discussion

The Committee noted that confining that discussion on the *New Template for Executive Summaries* to just the Committee's officers would limit the range and relevance of the feedback received. The Chair agreed that they would seek to get feedback from a broad range of participants.

With respect to process, some members of the Committee noted that aspects of the draft Executive Summaries, in particular the section proposed on Climate Change and Ecosystem considerations could be proposed for inclusion in the Executive Summaries at this year's Commission meeting. In response, the Chair noted that the Committee might want to refine the format of the entire template for Executive Summaries further before presenting it piecemeal to the Commission.

As regards the proposed *Draft Guidelines for the SCRS Plenary Meeting Report*, the Committee agreed that in principle it would be positive to summarize stock status in a short format for all species. However, the Committee indicated that simple colour version does not communicate the degree of uncertainty in each assessment. Accordingly, it suggested including the actual probabilities from the Kobe plot in stack bars, for those years for which actual evaluations were conducted. The Committee further noted that there was not a clear interpretation for how to present information for those stocks managed under Management Procedure within MSE processes. Finally, the Committee emphasized that the proposal would benefit from a wider discussion by the SCRS. Given the lack of agreement on the draft guidelines, the Committee proposed including this proposal for discussion within the process for drafting the new template for the Executive Summaries planned for 2024.

21. Other matters

No other matters were raised.

22. Adoption of report and closure

The Chair thanked the SCRS for its hard work this year. Dr Brown thanked the Secretariat staff for their excellent work, as well as appreciating their professional attitude. Dr Brown then expressed his appreciation towards the interpreters and to all participants.

The Report of the 2023 SCRS Meeting was adopted and the 2023 Meeting of the SCRS was adjourned.

Appendix 1

Opening address by Mr Camille Jean Pierre Manel, ICCAT Executive Secretary

SCRS Chair,
Species Groups Rapporteurs,
Scientific delegates,
Dear partners,
Dear interpreters,
Dear colleagues,
Present here in Madrid or attending online,

It is once again with pleasure that I welcome you to this SCRS Plenary.

First, on behalf of the Secretariat, allow me to offer my condolences to the Kingdom of Morocco and to Libya following the terrible disasters that they have recently experienced. I am convinced that the resilience of their people will enable them to overcome these ordeals very quickly. I would also like to pay a warm tribute to all the scientific delegate colleagues who are no longer with us, in particular Dr Yukio Takeuchi-san, delegate from Japan (from 1995 to 2015), who passed away last July, and the others for whom we have not received any information.

SCRS Chair and dear SCRS colleagues, this year has once again been an intense year of work with many successes, the fruit of everyone's commitment, as is the SCRS tradition. My warmest congratulations.

This performance continues to place increasing demands on the Secretariat, the main factor being the number of meetings of all kinds in which it is involved. And, the SCRS decided last year to reduce this number of meetings in an effort to lighten the calendar, but the overall scientific activity on record has increased, with a record number of meetings once again. This steady and worrying increase in the number of meetings has reached a critical point. The Secretariat is also aware of the excessive workload that we all have in our various roles, and while not wishing to complain, it is reiterated that the Secretariat's sole concern is to preserve the quality of its contribution with a fulfilled staff, and that it believes that there is an urgent need to find an appropriate limit to the number of meetings. The Secretariat can count on your invaluable support.

Before concluding, I would like to highlight the new context that will certainly impact ICCAT with the recent adoption of global instruments, namely the Kunming-Montreal Global Biodiversity Framework and the Agreement on Marine Biodiversity in Areas Beyond National Jurisdiction (BBNJ). Although the nature and extent of collaboration, consultation, cooperation and coordination with relevant global, regional, sub-regional and sectoral bodies has yet to be clarified, RFMOs will potentially have a role to play in relation to some provisions such as area-based management tools and environmental impact assessment.

I would like to conclude by warmly thanking all my colleagues in the Secretariat, who always do their utmost, and I would like to reiterate their renewed commitment in their constant quest to improve their contribution to the various bodies of the Commission, in this case the SCRS.

I wish you every success in your work, and thank you for your very kind attention!

Appendix 2

SCRS Agenda

1. General remarks by the SCRS Chair and the Executive Secretary
2. Adoption of Agenda and arrangements for the meeting
3. Introduction of Contracting Party delegations
4. Introduction and admission of observers
5. Admission of scientific documents and presentations
6. Report of ICCAT Secretariat activities on statistics and science
7. Review of national fisheries and research programmes
8. Reports of intersessional SCRS meetings

   8.1 First Meeting of the North Atlantic Swordfish Technical Sub-group on MSE

   8.2 Intersessional Meeting of the Tropical Tunas Species Group (including MSE)

   8.3 North Atlantic Albacore Data Preparatory Meeting (including MSE)

   8.4 Blue Shark Data Preparatory Meeting

   8.5 Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch

   8.6 Intersessional Meeting of the Small Tunas Species Group

   8.7 Meeting of the Working Group on Stock Assessment Methods (WGSAM)

   8.8 Intersessional Meeting of the Swordfish Species Group (including MSE)

   8.9 Sailfish Data Preparatory and Stock Assessment Meeting

   8.10 Atlantic Albacore Stock Assessment Meeting (including MSE)

   8.11 Climate Change Experts Meeting

   8.12 Blue Shark Stock Assessment Meeting

   8.13 Second Meeting of the North Atlantic Swordfish Technical Sub-group on MSE

9. Executive Summaries on species:

   9.1 YFT - Yellowfin

   9.2 BET - Bigeye

   9.3 SKJ - Skipjack

   9.4 ALB-AT - Atlantic albacore

   9.5 ALB-MD - Mediterranean albacore

9.6 BFT-E - Eastern bluefin

9.7 BFT-W - Western bluefin

9.8 SBF - South bluefin

9.9 BUM - Blue marlin

9.10 WHM - White marlin

9.11 SAI - Sailfish

9.12 SWO-AT - Atlantic swordfish

9.13 SWO-MD - Mediterranean swordfish

9.14 SMT - Small tunas

9.15 BSH - Blue shark

9.16 SMA - Shortfin mako

9.17 POR – Porbeagle

9.18 Ecosystem and Climate Change considerations

10. SCRS Science Strategic Plan

11. Reports of Research Programmes

11.1 Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)

11.2 Small Tunas Year Programme (SMTYP)

11.3 Shark Research and Data Collection Programme (SRDCP)

11.4 Enhanced Programme for Billfish Research (EPBR)

11.5 Albacore Year Programme (ALBYP)

11.6 Swordfish Year Programme (SWOYP)

11.7 Other research activities (on tropical tunas)

12. Report of the Meeting of the Subcommittee on Statistics

13. Report of the Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch

14. Discussions at the Intersessional Meetings of the Commission relevant to the SCRS

14.1 Intersessional Meetings of Panel 1

14.2 Intersessional Meeting of Panel 2

14.3 Intersessional Meetings of Panel 4

14.4 Intersessional Meetings of the Working Group on Electronic Monitoring Systems (WG-EMS)

14.5 16th Intersessional Meeting of the Working Group on Integrated Monitoring Measures (IMM)

15. Progress related to work developed on MSE

    15.1 Work conducted for northern albacore

    15.2 Work conducted for bluefin tuna

    15.3 Work conducted for northern swordfish

    15.4 Work conducted for SKJ-W

    15.5 Work conducted for tropical tunas multistock MSE

    15.6 Review of the Roadmap for the ICCAT MSE processes adopted by the Commission in 2022

16. Update of the stock assessment software catalogue

17. Consideration of plans for future activities

    17.1 Annual workplans and research programmes

        17.1.1 Subcommittee on Ecosystems and Bycatch Workplan

        17.1.2 Subcommittee on Statistics Workplan

        17.1.3 Working Group on Stock Assessment Methods (WGSAM) Workplan

        17.1.4 Albacore Workplan

        17.1.5 Billfishes Workplan

        17.1.6 Bluefin Tuna Workplan

        17.1.7 Sharks Workplan

        17.1.8 Small Tunas Workplan

        17.1.9 Swordfish Workplan

        17.1.10 Tropical Tunas Workplan

    17.2 Intersessional meetings proposed for 2024

    17.3 Date and place of the next meeting of the SCRS

18. General recommendations to the Commission

    18.1 General recommendations to the Commission that have financial implications

        18.1.1 Subcommittee on Ecosystems and Bycatch

        18.1.2 Subcommittee on Statistics

        18.1.3 Albacore

        18.1.4 Billfish

        18.1.5 Bluefin tuna

        18.1.6 Sharks

18.1.7 Small tunas

18.1.8 Swordfish

18.1.9 Tropical tunas

18.1.10 Working Group on Stock Assessment Methods (WGSAM)

18.2 Other general recommendations

18.2.1 Subcommittee on Ecosystems and Bycatch

18.2.2 Subcommittee on Statistics

18.2.3 Albacore

18.2.4 Billfishes

18.2.5 Bluefin tuna

18.2.6 Sharks

18.2.7 Small tunas

18.2.8 Swordfish

18.2.9 Tropical tunas

18.2.10 Working Group on Stock Assessment Methods (WGSAM)

19. Responses to the Commission's requests

20. New templates for Executive Summaries and Revised Publication Guidelines for the SCRS Plenary meeting report

21. Other matters

22. Adoption of the report

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Appendix 4

List of SCRS documents and presentations

Doc Ref	*Title*	*Authors*
SCRS/2023/001	First Meeting of the North Atlantic Swordfish MSE Technical Sub-group	Anonymous
SCRS/2023/002	Intersessional Meeting of the Tropical Tunas Species Group (including MSE)	Anonymous
SCRS/2023/003	North Atlantic Albacore Data Preparatory Meeting	Anonymous
SCRS/2023/004	Blue Shark Data Preparatory Meeting	Anonymous
SCRS/2023/005	Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch	Anonymous
SCRS/2023/006	Intersessional Meeting of the Small Tunas Species Group	Anonymous
SCRS/2023/007	Meeting of the Working Group on Stock Assessment Methods (WGSAM)	Anonymous
SCRS/2023/008	Intersessional Meeting of the Swordfish Species Group (including MSE)	Anonymous
SCRS/2023/009	Sailfish Data Preparatory and Stock Assessment Meeting	Anonymous
SCRS/2023/010	Atlantic Albacore Stock Assessment Meeting	Anonymous
SCRS/2023/011	Blue Shark Stock Assessment meeting	Anonymous
SCRS/2023/012	Second Meeting of the North Atlantic Swordfish Technical Sub-group on MSE	Anonymous
SCRS/2023/016	Final report for phase four of the ICCAT short-term contract: swordfish biological samples collection for growth, reproduction and genetics studies	Gillespie K., Hanke A., Coelho R., Rosa D., Carnevali O., Gioacchini G. Macías D.
SCRS/2023/017	Trophic dynamics and life history of Atlantic skipjack tuna (*Katsuwonus pelamis*) call for a 'forage fish approach' to management procedures	Bohorquez J., Galland G., Miller S.
SCRS/2023/018	Standardization of bigeye tuna CPUE in the Atlantic Ocean by the Japanese longline fishery	Matsumoto T.
SCRS/2023/019	Standardization of yellowfin tuna CPUE in the Atlantic Ocean by the Japanese longline fishery	Matsumoto T.
SCRS/2023/020	Options for Multispecies Management Objectives for tropical tunas	Merino G., Urtizberea A., Laborda A., Santiago J., Grande M., Arrizabalaga H.

Doc Ref	*Title*	*Authors*
SCRS/2023/022	Energy efficiency of the purse seine fishery, FAD vs free swimming school strategy	Grande M., Santiago J., Cabezas O.
SCRS/2023/023	Summary and review of the FOB/FADs deployed ST08-FADsDep ICCAT Database 2011 – 2021	Ortiz M., Mayor C.
SCRS/2023/024	Atlantic purse seine fisheries for tropical tunas in Central America and the Caribbean: Summary of status, trends, and impacts	Martinez C., Galdamez M., Robinson R., Pino Y., Mambie S., Chavarria B., Herrera M.
SCRS/2023/025	Simulation-Testing Model-Based and Design-Based Bycatch Estimators	Babcock E.A., Harford W.J., Gedamke T., Anderson S., Goodyear C.P.
SCRS/2023/026	Fisheries of the narrow-barred Spanish mackerel (*Scomberomorus commerson*, Lacépède, 1800) in the Palestinian area (South-eastern Mediterranean Sea)	Salah J., Tair M.A., Zava B., Di Natale A.
SCRS/2023/027	Fisheries of the bullet tuna (*Auxis rochei*, Risso, 1810) in the Palestinian area (South-eastern Mediterranean Sea)	Salah J., Tair M.A., Zava B., Di Natale A.
SCRS/2023/028	Review of Japanese longline fishery and its albacore catch in the North Atlantic Ocean	Matsumoto T.
SCRS/2023/029	Standardized CPUE for North Atlantic albacore by the Japanese longline fishery	Matsumoto T., Matsubara N., Tsuda Y.
SCRS/2023/032	Natural mortality of albacore tuna (T*hunnus alalunga*) from the North Atlantic Ocean	Artetxe-Arrate I., Lastra-Luque P., Arrizabalaga H., Cabello M., Merino G., Ortiz de Zárate V., Santiago J., Urtizberea A.
SCRS/2023/033	Update of input data (catch and size) for the North Atlantic Albacore Stock Synthesis in 2023	Kimoto A., Ortiz M., Palma C., Mayor C.
SCRS/2023/035	Regionally informed abundance indices of albacore tuna in the North Atlantic Ocean for the Chinese Taipei longline fishery	Su N-J., Shiu Y.W., Huang W.H.
SCRS/2023/036	Standardized indices of albacore, *Thunnus alalunga*, from the United States pelagic longline fishery	Lauretta M.
SCRS/2023/037	Spatial Distribution of Multispecies Longline Catch Per Unit Effort	Hyun Q., Carruthers T.
SCRS/2023/038	Blue Shark: Age and growth from ICCAT conventional tag data	Ramos-Cartelle A., Carroceda A., García-Cortés B., Fernández-Costa J., Mejuto J.
SCRS/2023/039	Data-Mining of Blue Shark Length of North and South Atlantic Stocks From the Spanish Surface Longline 1997-2021	García-Cortés B., Ramos-Cartelle A., Fernández-Costa J., Mejuto J.

Doc Ref	*Title*	*Authors*
SCRS/2023/040	Updated standardized catch rates for the North Atlantic stock of blue shark (*Prionace glauca*)	Mejuto J., Ramos-Cartelle B., García-Cortés B. Fernández-Costa J.
SCRS/2023/041	Updated standardized catch rates for the South Atlantic stock of blue shark (*Prionace glauca*)	Fernández-Costa J., Ramos-Cartelle A., García-Cortés B., Mejuto J.
SCRS/2023/042	Report of the 2023 ICCAT GBYP Workshop on Atlantic Bluefin Tuna Larval Indices (hybrid/Palermo, 7-9 February 2023)	Anonymous
SCRS/2023/043	Report of the 2023 ICCAT GBYP Workshop on Bluefin Tuna Close-Kin Mark-Recapture, including Biological Sampling Coordination (hybrid/Madrid, 14-16 March 2023)	Anonymous
SCRS/2023/044	Methods for estimating discards of shortfin mako (*Isurus oxyrinchus*) by the Portuguese longline fleet in the North Atlantic	Coelho R., Rosa D., Lino P.G.
SCRS/2023/045	Updated standardized CPUEs of blue shark in the Portuguese pelagic longline fleet operating in the North Atlantic (1997-2021)	Coelho R., Rosa D., Lino P.G.
SCRS/2023/046	Standardized catch rates of blue sharks in the western North Atlantic Ocean from the U.S. pelagic longline observer program.	Zhang X., Cortés E.
SCRS/2023/047	Review and preliminary analyses of conventional tagging data on Atlantic blue shark stocks (*Prionace glauca*)	Ortiz M., García J., Taylor N.
SCRS/2023/049	Spatio-temporal model for CPUE standardization: application to blue shark caught by Japanese tuna longline fishery in the South Atlantic from 1994 to 2021	Kai M.
SCRS/2023/050	Spatio-temporal model for CPUE standardization: application to blue shark caught by Japanese tuna longline fishery in the North Atlantic from 1994 to 2021	Kai M.
SCRS/2023/051	Structural uncertainty in RFMO relagic shark stock assessments: examples and recommendations resulting from two recent applications	Rice J., Courtney D.

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SCRS/2023/052	Summary of data from the Southwest of England blue shark fishery from 1953-2021	Thomas S., Alsop A., Chapman R.S., Collings M., Davis P., Faisey K.F., Forester M., Hodder L., Howell A., Malia O., Margetts D., McKie K.A., McMaster J.D., Murphy S., Narbett S., Newell S., Rogers J., Somerfield P.J., West D., Whittaker P., Wright S., Wyatt K., Uren D., Rudd H.S., Vas P., Jones G.
SCRS/2023/053	Age, growth and maturity of blue shark (*Prionace glauca*) in the Northwest Atlantic Ocean	Carlson J., Passerotti M., McCandless C.
SCRS/2023/054	Stock identification of Atlantic blue shark (*Prionace glauca*)	Carlson J., McCandless C, Passerotti M.
SCRS/2023/055	A preliminary study on standardized indices of blue shark from the Chinese longline fishery in the Atlantic Ocean during 2012 - 2021	Feng J., Zhang F., Li Y., Zhu Jiangfeng, Wu F.
SCRS/2023/056	Brief update on size distribution of blue shark (*Prionace glauca*) in the Caribbean Sea and adjacent waters of the North Atlantic Ocean caught by Venezuelan fisheries	Arocha F., Evaristo E., Marcano J.H., Narváez M.
SCRS/2023/057	Catch-per-unit-effort standardization for the southern Atlantic blue shark (*Prionace glauca*) based on Brazilian and Uruguayan longline fishery data	Cardoso L.G., Sant'Ana R., Forselledo R., Cardoso G., Mourato B., Domingo A., Kikuchi E., Travassos P.
SCRS/2023/058	Standardized Catch Per Unit Effort (CPUE) of blue shark (*Prionace glauca*) caught by the Moroccan longline fishery in the Atlantic	Serghini M., Ahmed B., Abid N., Najd A., Bensbai J.
SCRS/2023/059	Updated standardized CPUE, size and spatial distribution of the blue shark (*Prionace glauca*) caught by the Taiwanese longline fishery in the Atlantic Ocean	Liu K., Su K.U.
SCRS/2023/061	Comparison and Analysis of North Atlantic CPUE 2023 ICCAT BSH assessment	Rice J.
SCRS/2023/062	Report of the workshop on swordfish, billfishes and small tuna age reading	Anonymous
SCRS/2023/063	Atlantic sailfish standardized CPUE index and size distribution from the artisanal drift-gillnet fishery operating at the billfish hotspot, off La Guaira, Venezuela (1991-2022)	Narvaez M., Marcano L.A., Arocha F.

Doc Ref	*Title*	*Authors*
SCRS/2023/064	Standardized catch rates and size distribution for Atlantic sailfish from the Venezuelan pelagic longline fishery in the Caribbean Sea and adjacent waters of the western central Atlantic (1987-2018)	Arocha F., Ortiz M., Narváez M., Marcano J.H., Evaristo E.
SCRS/2023/065	Report of the Second Meeting of the Sub-group on the Ecosystem Report Card	Juan-Jordá M.J., Domingo A., Di Natale A., Inrh B., Luckhurst B., Brown C., Die D., Alvarez-Berástegui D., Díaz G., Murua H., Bell J., Stobberup K., Kell L., Schirripa M., Daisuke O., Obregon P., Lehodey P., Sabarros P., Scott R., Wanless R., Tsuji S., Jimenez S., Corrales X., Hanke A.
SCRS/2023/066	Terms of Reference for the Tropical Atlantic Ecoregion Case Study	Juan-Jordá M.J., Andonegi E., Murua H., Corrales X., Lopetegui L., Arrizabalaga H., Ruiz-Gondra J., Sabarros P., Ramos-Alonso M.L., Baez J., Alvarez D., Kell L., Die D., Hanke A.
SCRS/2023/067	Terms of Reference for the development of a pilot product to test the utility of ICCAT ecoregions for delivering advice-products to decision-makers	Juan-Jordá M., Ortuño G., Andonegi E., Murua H.
SCRS/2023/068	Terms of Reference for the development of decision support tool for providing integrated bycatch management advice to decision-makers	Juan-Jordá M.J., Ortuño G., Andonegi E., Grande M., Murua H.
SCRS/2023/069	Vulnerability status and efficacy of potential conservation measures for the East Pacific leatherback turtle (*Dermochelys coriacea*) stock using the Easi-Fish approach	East Pacific Leatherback Ad Hoc Joint Working Group of the Inter-American Tropical Tuna Commission, Inter-American Convention for the Protection and Conservation of Sea Turtles
SCRS/2023/071	Productivity-Susceptibility Analysis Tool	Leach A., Kell L., Mumford M.
SCRS/2023/072	Seasonal and Inter-Annual Variation in the Distribution of Leatherback Turtle Bycatch Occurrence Using a Spatio-Temporal Model with Japanese Longline Observer Data	Nishimoto M., Ueno S., Ochi D.
SCRS/2023/074	Development of a database supporting a quasi-quantitative risk assessment approach	Tsuji S., Nishimoto M.
SCRS/2023/075	Extending the driver-pressure-state-impact response casual chain framework to include human activities, welfare and management	Oenoto M, Leach B., Mumford J., Kell L.
SCRS/2023/076	Terms of Reference for the Sargasso Sea Case Study	Kell L.R., Luckhurst B., Leach A., Roe H.
SCRS/2023/077	An Update on Best Practices onboard French tropical tuna purse seiners of the Atlantic Ocean	Wain G., Maufroy A.

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SCRS/2023/078	Proposal to Review ICCAT Seabird Mitigation Measures	Jiménez S., Gianuca D., Debski D., Wade H., Butfield B.
SCRS/2023/079	Update the standardized catch rates of sailfish (*Istiophorus albicans*) caught as bycatch of the Spanish surface longline fishery targeting swordfish (*Xiphias gladius*) in the Atlantic Ocean	Ramos-Cartelle A., García-Cortés B., Mejuto J., Fernández-Costa J.
SCRS/2023/080	An index of vessel fishing power for the billfish tournament fleet (1982-2021)	Schueller A.M., Snodgrass D.J.G., Orbesen E.S., Schirripa M.
SCRS/2023/081	Update of input data (Catch and size) for the Atlantic sailfish (*Istiophorus albicans*) stock assessment models 2023	Ortiz M., Kimoto A., Palma C., Mayor C.
SCRS/2023/082	Update standardization of Atlantic sailfish (*Istiophorus albicans*) catch rates in the East Atlantic from the Portuguese pelagic longline fishery (1991-2021)	Coelho R., Rosa D., Lino P.G.
SCRS/2023/083	Terms of Reference for the Med tuna habitat observatory initiative	Alvarez-Berástegui D., Tugores M.P., Juza M., Hernandez-Carrasco I., Sanz-Martín M., Reglero P., Macías D., Balbín R., Lázaro G., Antoine L., Mavruk S., Cuttitta A., Russo S., Patti B., Torri M, Reyes E., Moure B., Orfila A., Gordoa A., Abascal C., Laiz R., Amengual J., Hidalgo M, Cabanellas-Reboredo M., Báez J.C., Juan Jordá M.J., Kell L., Hanke A., Die D., Tintoré J., Cardin V.
SCRS/2023/084	Quelques paramètres biologiques des trois espèces des thonidés mineurs ; la thonine commune : *Euthynnus alletteratus* (Rafinesque, 1810) ; la bonite à dos rayé : *Sarda sarda* (Bloch, 1793) et le bounitou : *Auxis rochei* (Risso, 1810) pêchés dans la zone centre d'Algérie	Benounnas K., Latreche M.
SCRS/2023/085	Delivery note on the dataset created under the short-term contract for work supporting a quasi-quantitative risk assessment approach	Tsuji S.
SCRS/2023/086	Progress in Developing a Quasi-Quantitative Risk Assessment Model to Support ICCAT EAFM	Tsuji S., Nishimoto M.
SCRS/2023/087	Reproductive biology of wahoo (*Acanthocybium solandri*) of eastern Atlantic	Puerto M.A., Gómez-Vives M.J., Pascual-Ayalón J.P., Diaha C.N'. G., Angueko D., Ortiz de Urbina J., Macías D.
SCRS/2023/088	Stock assessment model diagnostics for the 2016 sailfish assessment and their possible use in model weighting	Schirripa M.J.
SCRS/2023/089	Effects of fleet structure on reference points	Zhang F.

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SCRS/2023/090	Review of stochastic surplus production model in continuous time (SPiCT) methodology for the ICCAT software catalogue	Kimoto A., Ortiz M., Taylor N.G.
SCRS/2023/091	HBS is an unreliable index of fishing depth for US longlines	Goodyear C.P., Forrestal F., Schirripa M.
SCRS/2023/092	Catch rates of sailfish from the Brazilian longline fisheries in the western Atlantic (1991-2022)	Mourato B., Sant'Ana R., Kikuchi E., Cardoso L.G.
SCRS/2023/093	Estimated Atlantic sailfish catch rate for the Brazilian billfish sport fishing tournaments (2001-2020)	Mourato B., Sant'Ana R., Pimenta E., Amorim A.F.
SCRS/2023/095	Development state of the North Atlantic swordfish MSE process in May 2023	Gillespie K., Hordyk A., Schirripa M., Coelho R., Duprey N., Hanke A., Miller S., Rosa D., Rueda L.
SCRS/2023/098	Estimated sailfish catch-per-unit-effort for the U.S. recreational billfish tournaments (1972-2021)	Forrestal F., Lauretta M., Schirripa M.J.
SCRS/2023/100	Application of Management Procedure (Recommendation 21-04) for North Atlantic albacore	Merino G., Urtizberea, A., Arrizabalaga, H., Moron G., Santiago, J.
SCRS/2023/101	Robustness tests for North Atlantic albacore MSE, including new options for underreporting and natural mortality	Merino G., Urtizberea A., Arrizabalaga H., Artetxe-Arrate I., Luque P.L., Moron G., Santiago J.
SCRS/2023/103	U.S. Pelagic longline standardized indices of sailfish (*Istiophorus albicans*) relative abundance	Lauretta M.
SCRS/2023/104	A hierarchical cluster analysis of South Atlantic swordfish CPUE series	Taylor N.G.
SCRS/2023/105	CPUE standardization for sailfish (*Istiophorus platypterus*) caught in the Chinese Taipei tuna longline fishery in the Atlantic Ocean for 2009-2021	Su N-J., Huang W.H.
SCRS/2023/106	Standardization of Atlantic sailfish (*Istiophorus albicans*) CPUE in the eastern Atlantic from the Senegalese artisanal fishery	Ba K., Sow F.N.
SCRS/2023/107	Preliminary stock synthesis assessment model for northern Atlantic albacore	Urtizberea A., Merino G., Kimoto A., Ortiz M., Lauretta M., Schirripa M., Calay S., Brown C., Ortiz de Zárate V., Arrizabalaga H.
SCRS/2023/109	Spatio-temporal model for CPUE standardization: application to eastern Atlantic sailfish caught by Japanese tuna longline fishery from 1994 to 2021	Kai M.

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SCRS/2023/110	Spatio-temporal model for CPUE standardization: application to western Atlantic sailfish caught by Japanese tuna longline fishery from 1994 to 2021	Kai M.
SCRS/2023/111	Assessment of the eastern Atlantic sailfish stock using JABBA model	Mourato B., Sant'Ana R., Kikuchi E., Cardoso L.G., Sow F.N.; Arocha F., Kimoto A., Ortiz M.
SCRS/2023/112	Western Atlantic sailfish stock status with JABBA model	Mourato B., Mourato B., Sant'Ana R., Kikuchi E., Cardoso L.G., Sow F.N., Arocha F., Kimoto A., Ortiz M.
SCRS/2023/113	Updated U.S. conventional tagging database for Atlantic sailfish (1955-2022), with comments on potential stock structure	Orbesen E., Snodgrass D.J.G.
SCRS/2023/114	Refinement of the maximum age estimate of Atlantic sailfish (*Istiophorus platypterus*) with the clarification of long-term mark-recapture reports	Snodgrass D., Walter J.F., Orbesen E.S.
SCRS/2023/115	Estimates of vital rates and population dynamics parameters of interest for blue sharks in the North and South Atlantic Ocean	Cortés E., Taylor N.G.
SCRS/2023/116	Multivariate model estimates of life history parameters and productivity for north and south atlantic blue shark stocks multivariate model estimates of life history parameter and productivity for North and South Atlantic blue shark stocks	Taylor N.G., Cortés E.
SCRS/2023/117	*Thunnus alalunga* (Bonaterre 1788) reproductive biology study in South Atlantic	Travassos P., Araujo M.L.G, Rego M., Evencio J., Cardoso L.G., Parker D., Domingo A., Su N.J., Santana F.
SCRS/2023/118	Spatial distribution of albacore tuna by size caught in the Chinese Taipei longline fishery in the North Atlantic Ocean	Su N-J., Huang W.H.
SCRS/2023/120	South Atlantic blue shark stock assessment 1971-2021 using stock synthesis	Gustavo-Cardoso L., Kikuchi E., Rice J., Courtney D., Sant'Ana R., Leite Mourato B., Fernández C.
SCRS/2023/121	Update of input data (catch and size) for the Atlantic Blue shark (*Prionace glauca*) stock assessment models 2023	Ortiz M., Kimoto A., Palma C., Mayor C.
SCRS/2023/122	Model validation for selection and weighting of scenarios	Kell L.T., Winker H.
SCRS/2023/123	Exploratory analysis of blue shark catches, *Prionace glauca* in the Spanish Mediterranean waters	Ruida L., Baez J.C., García-Barcelona S., Moreno J., Macías D.

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SCRS/2023/124	JABBA runs for the North Atlantic blue shark	Fernández C.
SCRS/2023/125	Updates to multi-fleet ASAP runs for eastern Atlantic and Mediterranean bluefin tuna	Carrano C., Cadrin S.X., Kerr L.
SCRS/2023/126	Bayesian surplus production models for blue sharks using the legacy BSP software	Babcock E.A.
SCRS/2023/127	South Atlantic Blue shark stock: Just Another Bayesian Biomass Assessment	Sant'Ana R., Mourato B., Cardoso L.G., Kimoto A., Ortiz M.
SCRS/2023/128	Preliminary stock synthesis (ss3) model runs conducted for North Atlantic blue shark (1971-2021)	Courtney D., Fernández C., Rice J., Cardoso L.G., Kikuchi E.
SCRS/2023/130	Estimas del devenir de los ejemplares de marrajo dientuso (*Isurus oxyrinchus*) capturados de forma accesoria por la flota palangrera española en el océano Atlántico	Báez J.C., Salmerón F., Ceballos Roa E., Lourdes Ramos M., Abaunza P.
SCRS/2023/131	The statistical methodology used for estimate dead discards and live releases of South Atlantic shortfin mako	Anonymous
SCRS/2023/132	Methodology for implementing an alternative approach for monitoring artisanal fisheries catching tunas and associated species	Serghini M., Bensbai J., Abid N., Amina N., Baibbat S.A., Ikkis A., Layachi M., Hamdi H., Joumani M.
SCRS/2023/133	Report of the 2023 ICCAT GBYP Workshop on Atlantic Bluefin Tuna Electronic Tagging (hybrid/Madrid, 4-6 July 2023)	Anonymous
SCRS/2023/134	Estimate of live release and dead discards of the shortfin mako shark caught by the Taiwanese longline fishery in the South Atlantic Ocean	Liu K-M, Su K-Y.
SCRS/2023/135	Relative bluefin tuna abundance estimates for 2022 from the Canadian fishery	Hanke A.
SCRS/2023/136	A proposal to standardize the Task 1 nominal catch table in the Executive Summaries of the SCRS Annual Report	Díaz G.A., Duprey N.M.T., Palma C.
SCRS/2023/137	Size conversion factors for Mediterranean swordfish (*Xiphias gladius* l.) caught by Italian and Maltese longline fleets in the Mediterranean Sea	Pappalardo, L., Mifsud J., Pignalosa P.
SCRS/2023/139	Furuno stereoscopic camera UC-600	Kawai M., Ikegami A., Kumakura S.

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SCRS/2023/140	The standardized CPUE for Japanese longline fishery in the Atlantic up to 2023 fishing year	Tsukahara Y., Fukuda H., Nakatsuka S.
SCRS/2023/141	Development of Operating Models for the tropical tuna multispecies MSE	Moron, Urtizberea A., Laborda A., Santiago J., Merino G.
SCRS/2023/143	Approximation of Kobe posteriors from stock synthesis for North Atlantic blue shark	Kell L.T., Rice J., Winker H.
SCRS/2023/144	Evaluation of performance of candidate management procedures for the North Atlantic swordfish Management Strategy Evaluation	Hordyk A.
SCRS/2023/145	Review and diagnostics of the stock synthesis assessment model for northern Atlantic albacore	Urtizberea A., Lauretta M., Merino G., Kimoto A., Ortiz M., Schirripa M., Calay S., Brown C., Ortiz de Zárate V., Morón Correa G., Santiago J., Arrizabalaga H.
SCRS/2023/146	Bluefin tuna biological sampling	Zambetti A., Pignalosa P., Lombardo F.
SCRS/2023/147	Update of the standardized joint CPUE index for bluefin tuna (*Thunnus thynnus*) caught by Moroccan and Portuguese traps for the period 2008-2022, using a bayesian generalized liner model	Lino P.G., Abid N., Malouli M.I., Bensbai J., Coelho R.
SCRS/2023/148	Conversion factors update for tropical tunas caught with purse seine in the Atlantic Ocean	Fily T., Duparc A.
SCRS/2023/149	Update, homogeneity and improvement in the fishing indicators of the PS and BB tuna fleet of the Atlantic Ocean	Pascual P., Duparc A., Floch L., Lerebourg C., Depetris M., Deniz S., Rojo V., Ramos M.L., Abascal F., Casañas I.
SCRS/2023/150	Update the length-weight relationships and relative condition factor of the wahoo *Acanthocybium solandri* (Cuvier, 1832), little tunny *Euthynnus alletteratus* (Rafinesque, 1810), frigate tuna *Auxis thazard* (Lacepède, 1800), bullet tuna *Auxisrochei* (Risso, 1810) and Atlantic bonito *Sarda sarda* (Bloch, 1793) fish of the Atlantic Ocean	Pascual P., Casañas I., Déniz S., Abascal F. J., Daniela C., Ramos V.
SCRS/2023/151	Report of the Sub-group on Electronic Monitoring Systems: proposal of ICCAT minimum technical standards for EMS in purse seine fisheries targeting tropical tunas	Anonymous
SCRS/2023/154	Summary of the 2022 catch and release tagging (CHART) programme in southwest England	Ford J., Righton D., Ribeiro Santos A., Murphy S., McMaster J., Thomas S., Duffy M., Davis S., Arris M., Phillips S.

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SCRS/2023/155	Geographical and temporal variations in the morphometric relationships and sex ratios of farmed Atlantic bluefin tuna (*Thunnus thynnus) held* in Maltese cages	Haddi I., Galea J., Serrano J.G., Reinold S., Deguara S.
SCRS/2023/156	Population genomics reveal two species of porbeagle (*Lamna nasus*) in the Atlantic Ocean	Takeshima H., Tahara D., Semba Y.
SCRS/2023/158	Assessing larval abundances of Atlantic bluefin tuna in the western Mediterranean Sea: updating the Balearic larval index (2001:2022)	Álvarez-Berastegui D., Tugores M.P., Martín M., Torres, A.P., Santandreu M., Calcina N., Balbín R., Reglero P.
SCRS/2023/159	ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) activity report for Phase 12 and the first part of Phase 13 (2022-2023)	Alemany F., Tensek S., Pagá A.
SCRS/2023/160	Lessons learned using genetic based methodologies in the last 5 years of the GBYP program	Díaz-Arce N., Rodriguez-Ezpeleta N., Artetxe-Arrate I., Fraile I., Zudaire I., Arrizabalaga H.
SCRS/2023/161	Understanding migration and connectivity of Atlantic bluefin tuna with otolith chemistry	Artetxe-Arrate I., Brophy D., Lastra P., Arrizabalaga H., Nottestad L., Rodriguez-Marín E., Varela J.L., Rooker J., Tsukahara Y., Lino P., Fraile I.
SCRS/2023/164	Interpolation of the growth table for farming bluefin tuna	Ortiz M., Tsukahara Y.
SCRS/2023/165	Updated index of the Balfegó purse seine fleet (2003-2023)	Gordoa A.
SCRS/2023/166	Results of the albacore (*Thunnus alalunga*) reproductive biology study for the North Atlantic stock in 2022	Ortiz de Zárate V., Macías D., Su N.J., Dheeraj B., Puerto M.A., Gomez M.J., Rodriguez E.
SCRS/2023/167	Desing and exploitation of the AOTTP tagging database	Garcia J., Palma C., Mayor C.
SCRS/2023/168	Final Report for Phase Five of the ICCAT Short-Term Contract for continuation of the swordfish growth, reproduction and genetics studies: biological samples collection and analysis	Gilespie K., Hanke A., Coelho R., Rosa D., Carnevali O., Gioacchini G., Macías D.
SCRS/2023/169	Developing candidate management procedures for the western Atlantic skipjack tuna	Sant'Ana R., Mourato B.
SCRS/2023/170	Updates to indices used by the adopted management procedure for Atlantic bluefin tuna	Carruthers T.
SCRS/2023/171	Exceptional circumstances provisions for the Atlantic bluefin tuna management procedure	Carruthers T., Walter J., Hordyk A.R., Hanke A., Gillespie K., Duprey N., Marin E., Butterworth D.S.

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SCRS/2023/172	Secondary indicators of exceptional circumstances for Atlantic bluefin tuna including stock of origin and electronic tagging data	Carruthers T.
SCRS/2023/173	Proposal for the SCRS to implement a process to adopt fisheries indicators in support of assessments of tropical tunas and decision making processes by the ICCAT	Herrera M., Báez J.C., Martínez C., Pino Y., Guevara J., Robinson R., Galdámez M., Mambi S., Espinoza E., Carvajal J.M., Pacheco B., Chavarria B.
SCRS/2023/174	Quantifying the impacts of fleet selectivity patterns on maximum sustainable yields for tropical bigeye and yellowfin tunas	Vaughan N., Cass-Calay S., Díaz G.A.
SCRS/2023/175	Summary and review of the FOB/FADs deployed ST08-FadsDep ICCAT database 2011 - 2022	Ortiz M., Mayor C., Palma C.
SCRS/2023/176	*Thunnus alalunga* (Bonaterre 1788) reproductive biology study in South Atlantic	Travassos P., Araujo M.L., Rego M., Evencio J., Cardoso L.G., Kerwath S., Domingos A., Su N.J., Jagger C., Santana F.
SCRS/2023/177	Effect of missing surveys on the performance of the adopted NABT BFT MP	Butterworth D., Rademeyer R.A.
SCRS/2023/178	Report of 2023 ICCAT Regional Workshop in West Africa for the improvement of statistical data collection and reporting on small scale (artisanal) fisheries	Die D.
SCRS/2023/179	Workshop on the Shark Research and Data Collection Program (SRDCP)	Anonymous

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SCRS/P/2023/001	Update on ICCAT North Atlantic swordfish MSE	Hordyk A.
SCRS/P/2023/002	Overview of development of candidate management procedures	Hordyk A.
SCRS/P/2023/003	Review and discussion of key decisions and proposals for consideration at Panel 4	Hordyk A.
SCRS/P/2023/004	Development of an Agent-Based Bio-Economic Model of Pacific Tropical Tunas Fisheries (POSEIDON)	Vert-Pre K.A., Payette N., Carrella E., Lopez J., Powers B., Drexler M., Madsen J.K., Ananthanarayanan A., Aires-da-Silva A., Lennert-Cody C.E., Maunder M., Saul S., Bailey R.
SCRS/P/2023/005	U.S. tropical tuna fisheries indicators	Lauretta M.
SCRS/P/2023/006	Update of the catch-per-unit-effort standardizations for bigeye and yellowfin tuna based on Brazilian longline fishery data (1998 - 2022)	Sant'Ana R., Mourato B., Travassos P.
SCRS/P/2023/007	Atlantic Tropical Tunas Management Strategy Evaluation (MSE)	Laborda A., Merino G., Urtizberea A.
SCRS/P/2023/010	Evaluation of Exceptional Circumstances for North Atlantic albacore in 2023	Merino G., Arrizabalaga H., Urtizberea A., Santiago J.
SCRS/P/2023/011	Results of the Biology Reproductive Study: 2020-2022	ALB Consortium
SCRS/P/2023/012	Spanish baitboat CPUE index standardization	Ortiz de Zárate V., Ortiz M.
SCRS/P/2023/013	Preliminary Stock Synthesis assessment model for northern Atlantic albacore	Urtizberea A., Merino G., Kimoto A., Ortiz M., Lauretta M., Schirripa M., Brown C., Arrizabalaga H.
SCRS/P/2023/024	Recent trend in albacore catch rates from the Venezuelan pelagic longline fishery off the Caribbean Sea and adjacent water of the western central Atlantic for the period 2019-2022	Narvaez M., Evaristo E., Marcano J.H., Arocha F.
SCRS/P/2023/028	Updated North Atlantic albacore e-tagging research 2019-2023	Cabello M., Arregui I., Onandia I., Uranga J., Lezama-Ochoa N., Ortiz de Zárate V., Delgado de Molina R., Santiago J., Abascal F., Arrizabalaga H.
SCRS/P/2023/029	Ocean sunfish (*Mola mola* Linnaeus, 1758) monitoring program Spanish trap fishery in the western Mediterranean	García-Barcelona S., Nyegaard M., Navarro J., Varela J.L., Miras A., Conesa M., Gómez-Vives M.J., Asensio E., Guzmán Gómez S., Hernández Millán G., Tornero J., Puerto M.A., Macías D.
SCRS/P/2023/030	Reproductive biology of the blue shark (*Prionace glauca*) in the South Atlantic Ocean	Mas F., Cortés E., Coelho R., Defeo O., Forselledo R., Domingo A.
SCRS/P/2023/031	Blue shark (*Prionace glauca*) movements and vertical overlap with longline fishing gears in the southwestern Atlantic Ocean	Mas F., Cortés E., Coelho R., Defeo O., Miller P., Carlson J., Gulak S., Domingo A.

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SCRS/P/2023/032	Hooking mortality of blue sharks (*Prionace glauca*) caught by commercial longliners in the southwestern Atlantic Ocean	Max F., Cortés E., Coelho R, Defeo O., Jiménez S., Domingo A.
SCRS/P/2023/033	Summary of the distribution patterns and size data from observer programs used in the last blue shark stock assessment, with a discussion on options for updating in the new stock assessment	Coelho R.
SCRS/P/2023/034	Capture data and biological characteristics of the blue shark *Prionace glauca* in the Exclusive Economic Zone of Côte d'Ivoire	Konan K.J.
SCRS/P/2023/035	Continuity of Stock Synthesis Data Inputs and Structural Assumptions from 2015 to 2023 for North Atlantic BSH	Courtney D.
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SCRS/P/2023/037	A Myctophid Index as a potential indicator for the pelagic ecosystem	Scott R.
SCRS/P/2023/039	Scientific observer program on board Tunisian purse seiners fishing bluefin tuna	Zarrad R.
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SCRS/P/2023/041	Bycatch mitigation actions for pelagic longline targeting swordfish: South Adriatic (Central Mediterranean) case study	Carbonara P, Prato G., Niedermüller S., Buzzi A., Alfonso S., Neglia C., Zupa W., Bitetto I., Follesa M.C., Spedicato M.T.
SCRS/P/2023/043	Results on little tunny (*Euthynnus alletteratus*) reproduction under the Short-term Contract for ICCAT SMTYP for the biological samples collection for growth, maturity and genetics studies	Macías D., Puerto M.A., Gómez-Vives M.J., Hajjej G., Lino P.G., Muñoz-Lechuga R., Angueko D., Ngom Sow F.N., N'Guessan C.D., Lucena F., Silva G., Saber S., Ortiz de Urbina, J.
SCRS/P/2023/044	Update from the SCRS EMS Subgroup	Anonymous
SCRS/P/2023/046	Recommendation 22-12 and new Statistical Form ST12	Taylor N.G., Palma C., Mayor C.
SCRS/P/2023/047	Update of growth studies of little tunny (*Euthynnus alletteratus*) and Atlantic bonito (*Sarda sarda*) after the Workshop of age reading	Muñoz-Lechuga R., Muñoz-Lechuga R., Lino P.G., Silva G., Macias D., Sow F.N., Diaha N.C., Angueko D., Hajjej G.,Massa-Gallucci A., Baibbat S.
SCRS/P/2023/048	Using otolith shape analysis for spatial units differentiation of Genus Euthynnus in the eastern Atlantic	Muñoz-Lechuga R., Muñoz-Lechuga R., Silva G., Lino P.G., Diaha N.C., Angueko D., Sow F.N., Macías D., Massa-Gallucci A.
SCRS/P/2023/049	Updated summary on North Atlantic albacore MSE	Arrizabalaga H., Merino G.
SCRS/P/2023/050	Update from the SCRS on technical gear changes sub-group	Coelho R.
SCRS/P/2023/051	A Review of Reference Points, Objectives, and Performance Standards at tRMFOs	Taylor N.G., Miller S.
SCRS/P/2023/052	Northern swordfish management strategy evaluation (MSE) update to WGSAM	Gillespie K.
SCRS/P/2023/053	Small tunas studies in Brazil: An update	Frédou T., Lourenço M., Barreto T., Lucena-Frédou F.

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SCRS/P/2023/054	Summary of Activities of the Small Tunas Year Programme	Silva G.
SCRS/P/2023/055	Mise à jour de la relation taille-masse des thonidés mineurs capturés dans les eaux tunisiennes	Ghailen H.
SCRS/P/2023/056	Update the length-weight relationships and relative condition factor of the wahoo *Acanthocybium solandri* (Cuvier, 1832), little tunny *Euthynnus alletteratus* (Rafinesque, 1810), Frigate tuna *Auxis thazard* (Lacepède, 1800), Bullet tuna *Auxis rochei* (Risso, 1810) and Atlantic Bonito *Sarda sarda* (Bloch, 1793) fish of the Atlantic Ocean	Pascual-Alayón P., Déniz S., Chanto D., Abascal F.J., Casañas I
SCRS/P/2023/057	Overview Workshop on Data Limited Assessment Methods for Small Tunas	Frédou T.
SCRS/P/2023/058	Western Atlantic Skipjack Tuna MSE	Sant'Ana R.
SCRS/P/2023/059	Tuna Stock Assessment Good Practice Workshop	Maunder M., Hoyle S.D.
SCRS/P/2023/060	Update on the age and growth component of the Swordfish Year Programme	Rosa D., Busawon D., Quelle P., Krusic-Golub K.H., Andrews A., Garibaldi F., Mariani A., Di Natale A., Schirripa M., Alves Bezerra N., Su N., Gustavo Cardoso L., Arocha F., Lombardo S., Campello T., Santos M., Travassos P., Brown C., Hanke A., Gillespie K., Coelho R.
SCRS/P/2023/061	Swordfish size and sex-ratios distribution in the Atlantic	Rosa D., Schirripa M., Gillespie K., Macías D., Forselledo R., Mourato B., Mikihiko K., Arocha F., Su N., Kerwath S., Bahou L., Pappalardo L., Díaz G., P.G. Lino., Salmeron F., Ortiz de Urbina J., Cardoso L., Sant'Ana R., Travassos P., Santos M., Domingo A., Báez J., Hanke A., Brown C., Coelho R.
SCRS/P/2023/062	Update on the satellite tagging of swordfish under the Swordfish Year Programme	Rosa D., Gillespie K., Garibaldi F., Orbesen E., Gustavo Cardoso L., Snodgrass D., Santos C., Macías D., Ortiz de Urbina J., Forselledo R., Miller P., Domingo A., Santos M., Brown C., Coelho R.
SCRS/P/2023/063	Key Decision Points for Developing Operating Models for North Atlantic Swordfish MSE	Hordyk A., Schirripa M., Gillespie K.
SCRS/P/2023/064	Index Diagnostic Reports for North Atlantic Swordfish MSE	Hordyk A.
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SCRS/P/2023/066	Development and Tuning of Candidate Management Procedures for North Atlantic Swordfish MSE	Hordyk A.

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SCRS/P/2023/068	Updates and plans for future analysis on swordfish reproduction under the Short Term contract for ICCAT swordfish growth, reproduction and genetics studies	Macías D.
SCRS/P/2023/070	Update on S-SWO MSE	Taylor N.G.
SCRS/P/2023/071	Genetic structure and diversity, fitness, evolutionary potential and distribution of Atlantic and Mediterranean swordfish stocks: new insight from ddRAD and WGS analyses	Gioacchini G., Gillespie K.
SCRS/P/2023/072	Planning for Phase 6 of the ICCAT swordfish biology program	Gillespie K., Hanke A., Coelho R., Rosa D., Carnevali O., Gioacchini G., Macías D.
SCRS/P/2023/073	Research plans for phase five of the ICCAT Short-term Contract: swordfish biological samples collection for growth, reproduction and genetics studies	Gillespie K., Hanke A., Coelho R., Rosa D., Carnevali O., Gioacchini G., Macías D.
SCRS/P/2023/074	Summary of Panel 4 N-SWO MSE interactions in 2023	Gillespie K.
SCRS/P/2023/075	Updated indicators of Exceptional Circumstances	Merino G., Arrizabalaga, H, Urtizberea A., Moron G., Santiago J.
SCRS/P/2023/076	ICCAT Rec. 16-05 on discards of swordfish in the Mediterranean: contributions for more efficient management of the fishery	Garcia-Barcelona S., Ortiz de Urbina J.M., Francisco Moreno de la Rosa J., Rioja P., Macías D.
SCRS/P/2023/077	Genomic stocks delimitation for the sailfish	Ferrete B., Mourato B., Arocha F., Janke A.
SCRS/P/2023/078	Western Atlantic Sailfish Assessment SS3 2023	Schirripa M.
SCRS/P/2023/079	North Atlantic Albacore Stock Assessment, 25-29 June 2023 Status of Albacore Fishery at the Egyptian Mediterranean Coast	Saber M.
SCRS/P/2023/080	Overview of the tagging activities in the SRDCP	Coelho R., Domingo A.
SCRS/P/2023/081	Movements, habitat use and diving behavior of shortfin mako in the Atlantic Ocean	Santos C., Domingo A., Carlson J., Natanson L., Travassos P., Macías D., Cortés E., Miller P., Hazin F., Mas F., Ortiz de Urbina J., Lino P., Coelho R.
SCRS/P/2023/082	Overview of the age and growth studies in the SRDCP	Coelho R., Rosa D.
SCRS/P/2023/083	Age and growth of shortfin mako shark in the North and South Atlantic: status of the work and ongoing activities	Santos C., Santos C., Rosa D., Gustavo Cardoso L., Semba Y., Domingo A., Jagger C., Mas F., Forselledo R., Mathers A., Natanson L., Carlson J., Coelho R.
SCRS/P/2023/087	Overview of genetic work of ICCAT shark species	Semba Y., Takeshima H.

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SCRS/P/2023/088	Advances on the porbeagle (*Lamna nasus*) genetics study	Semba Y., Takeshima H.
SCRS/P/2023/089	Shark Research and Data Collection Programme (SRDCP): 2012-2023 A review	Cortés E., Domingo A.
SCRS/P/2023/090	Use of SRDCP products in stock assessments	Cortés E.,
SCRS/P/2023/091	Reproduction studies in the SRDCP_7_13_2023	Cortés E.
SCRS/P/2023/092	Post-release mortality of shortfin mako in the Atlantic Ocean using satellite telemetry	Miller P., Santos C., Carlson J., Natanson L., Cortés E., Mas F., Hazin F., Travassos P., Macías D., Ortiz de Urbina J., Coelho R., Domingo A.
SCRS/P/2023/093	Observation Error Model (OEM) for the tropical tuna multispecies MSE	Urtizberea A., Morón Correa G., Laborda A., Santiago J., Merino G.
SCRS/P/2023/094	Evaluation of Performance of Candidate Management Procedures for the North Atlantic Swordfish MSE	Hordyk A.
SCRS/P/2023/095	Review of the N-SWO MSE framework and recent interactions with Panel 4	Anonymous
SCRS/P/2023/096	Method for updating the North Atlantic swordfish combined index	Anonymous
SCRS/P/2023/097	SP, EA, WA, AT, FX MPs	Hanke A.
SCRS/P/2023/099	Identification of spatio-temporal dFAD hotspots of juvenile BET and YFT in the eastern Atlantic to define optimal moratorium zones	Akia S., Gaertner D., Guery L., Pascual P.
SCRS/P/2023/101	A preliminary growth study of bullet tuna (*Auxis rochei*) for ageing standardization using dorsal spines	Munoz-Lechuga R., Cabrera-Castro R., Lino P.G.
SCRS/P/2023/102	Science needs for highly migratory species related to offshore wind energy development	Hendon J.R., Serafy J.E., Walter J.F.
SCRS/P/2023/103	GBYP aerial survey index: E-BFT spawning stock estimates 2017 - 2022	Paxton C.G.M., Oedekovan C.S., Alemany F. Tugores M.P., Álvarez D., Burt, M.L., Chudzinska, M.
SCRS/P/2023/104	Report on the pilot study on epigenetic ageing technique for age estimation of Atlantic bluefin tuna	Davies C., Mayne B., Grewe P., Jones L.L, Farley J., Rodríguez-Marín E.
SCRS/P/2023/105	Benefit, concerns, and solutions of fishing for tunas with drifting fish aggregation devices	Pons M., Kaplan D., Moreno G., Escalle L., Abascal F., Hall M., Restrepo V., Hilborn R.
SCRS/P/2023/106	Advances on porbeagle electronic tagging	Junge C.
SCRS/P/2023/107	Stock Synthesis (SS3) Model for North Atlantic Blue Shark Kobe Plot Distribution Sensitivity Analyses	Courtney D., Rice J.
SCRS/P/2023/108	Life History parameters and reference databases update	Anonymous

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SCRS/P/2023/109	2023 ICCAT Blue Shark Stock Assessment	Anonymous

Appendix 5

2023 Secretariat Report on Research and Statistics

The final 2023 Secretariat Report on Statistics and Coordination of Research will be published in the *Report for Biennial Period 2022-2023, Part II (2023), Vol. 4.*

Appendix 6

Report of the ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)
(Activity report for the last part of Phase 12 and the first part of Phase 13 (2022-2023))

1. Introduction

The ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) officially started at the end of 2009 with the objectives of improving a) basic data collection, including fishery independent data; b) understanding of key biological and ecological processes; and c) assessment models and provision of scientific advice on stock status. The general information about GBYP activities and results, as well as information on budgetary and other administrative issues of the GBYP programme, from the beginning of the programme until today, are available on the GBYP webpage. All the relevant documents related to programme development, including final reports of every activity and the derived scientific papers, Annual Reports to the SCRS and European Union, GBYP workshops or Steering Committee (SC) meeting reports, are also readily available on the GBYP webpage.

Phase 12 of GBYP officially started on 24 March 2022 following the signing of the Grant Agreement for the co-financing of GBYP Phase 12 (Project 101091166) by the European Commission. The initial duration of Phase 12 was one year, but in order to hold all the workshops envisaged during this Phase, which were initially delayed until the end of the restrictions resulting from the COVID-19 pandemic, and to complete new priority research activities requested by SCRS, this Phase was extended for four months, until 23 July 2023, through a Grant Amendment. The activities carried out during the first five months of Phase 12 and their preliminary results were presented to the SCRS and the Commission in 2021 (Alemany *et al*., 2022) and approved. Following the timing imposed by the new funding agency - the European Climate, Infrastructure and Environment Executive Agency (CINEA) - Phase 13 of GBYP officially started on 1 May 2023, after the signing of the Grant Agreement (Project 101133291) by the European Commission, with a planned duration of one year. Although these GBYP phases have been partially administered in parallel (as has occurred in previous phases), this has not caused any major problems, since each Phase had specific work plans and budgets, and so costs can be unequivocally assigned to the activities detailed in the respective Grant Agreements.

Although some tasks over the last year have continued to be affected by the COVID-19 pandemic, such as the workshops that were postponed until the end of the COVID 19 restrictions, most of the activities planned within Phases 12 and 13 have been or are being implemented successfully. The specific activities in both Phases have been structured along the same main lines of research, i.e., data recovery and management, biological studies, tagging, aerial surveys (AS), and modelling. These have been adapted to SCRS research needs and Commission requests. Furthermore, the methodologies have been continuously improved and working procedures have been optimized to increase the efficiency and quality of the advice. The strategic shifts in several of these lines, initiated in Phase 10, have been consolidated. Accordingly, data recovery activities have shifted to data management, focusing on the development of new relational databases (DB), integrating all the information produced and gathered by the programme from the beginning. AS have been thoroughly revised and new methodological approaches for data analyses explored (i.e., development of new model-based approaches considering numerous environmental variables in order to account for the potential changes in spatial distribution of spawners derived from environmental variability. These changes will improve the accuracy of the index time series. Tagging activities have also been expanded in the new strategic approach following close cooperation with national tagging programmes. This change has greatly increased the overall efficiency and significantly reduced operational costs. Moreover, in Phase 12 a further strategic shift in biological studies has been implemented, which will progressively focus on reviewing studies based on all the data and results gathered in previous phases in order to reach sound scientific conclusions, instead of continuous generating new data sets (unless specific requests are needed).

All activities carried out throughout GBYP Phase 12 and those launched during the first part of Phase 13, as well their final or preliminary results and the related coordination activities, are described and summarised in this report.

As mentioned above, the COVID-19 pandemic continued to affect the implementation of Phase 12, but the experience gained over the 2020-2022 period has allowed GBYP to successfully face the challenges derived from this scenario, successfully organizing workshops in hybrid format and adapting day-to-day work to teleworking conditions. Given that the temporary closure of the ICCAT Secretariat headquarters in March 2020 has been maintained throughout 2022 and in-person work has only been partially resumed during 2023, as mentioned above, the GBYP Coordination Team has continued to use teleworking facilities to manage the programme, and this has not had any significant impact on the coordination and implementation of the activities.

2. Coordination activities and general issues of GBYP programme management

In Phase 12 and 13, the GBYP SC comprises the SCRS Chair, the Rapporteur for western bluefin tuna, the Rapporteur for eastern Atlantic bluefin tuna, the ICCAT Executive Secretary and/or his deputy, and one contracted external expert. In order to define the Phase 12 work plan and refine ongoing activities, the SC held an in-person meeting in Madrid, back to back with the SCRS Plenary meeting, in September 2022. In addition, SC members have been constantly informed by the GBYP Coordination Team about the status of the activities through detailed reports provided on a quarterly basis, and they have been regularly consulted by email on many issues.

The GBYP Coordination Team comprises the GBYP Coordinator, the Assistant Coordinator and the Database Specialist, in addition to an Administrative Assistant during 7 months of Phase 12. The ICCAT Secretariat has provided technical and administrative support for all GBYP activities on a daily basis. In Phase 12, a total of three calls for tenders and six official invitations were released, which resulted in 11 contracts awarded to various entities. In addition, one call for expressions of interest was published, which resulted in eight memorandums of understanding (MoU). During the first three months of Phase 13, two calls for tenders, one call for expressions of interest and one invitation have been launched. As a result, three contracts have already been signed and two contracts are in the process of being signed, and 11 MoUs have also been signed or are in the process of being signed.

2.1 Financial aspects

In Phase 12, the total budget was €1,500,000.00 thanks to contributions from the following donors: European Union (Grant Agreement) €1,200,000.00, Morocco €57,882.26, Tunisia €50,109.54, Japan €49,686.39, Türkiye €40,626.86, Algeria €29,170.26, Norway €24,287.66, Canada €21,327.38, Libya €12,917.23, Korea (Rep.) €3,525.11, Iceland €3,172.60, Albania €2,996.34, Chinese Taipei €2,000.00, China (P.R.) €1,797.80, and the United Kingdom €500.57.

In Phase 13, the total budget is €1,250,000.00 thanks to contributions from the following donors: European Union (Grant Agreement) €900,000.00, Morocco €66,280.30, Japan €55,782.93, Tunisia €47,258.00, Türkiye €46,575.34, Libya €45,643.84, Algeria €36,239.20, Canada €20,529.68, Norway €19,000.00, Albania €4,719.17, Iceland €4,012.64, and Korea (Rep.) €3,958.90.

The residual amounts of previous GBYP Phases were used to better balance the EU contribution and to compensate costs that were not covered by EU funding in various phases. Additional eventual residuals from the amounts provided in Phase 12 will be used for the following GBYP phases. It should be noted that contributions for current and previous GBYP phases are still pending from some ICCAT CPCs.

The approved budget for Phase 12 and Phase 13, as well the final expenditures of Phase 12, are summarised in **Table 1**. The percentage of executed budget in Phase 12 has been of 92.7%. The final costs were a bit lower than initially envisaged mainly because the workshops were finally organized as hybrid meetings, and not only presential as initially envisaged, and this has lowered the required budget. Other reasons have been the delay in the global review by external experts of the ICCAT MSE processes and the cancellation, due to force majeure reasons, of a tagging survey in Türkiye.

Table 1. Detailed funds available for GBYP Phases 12 and 13 and respective expenditures as at 11 September 2023.

	Budget Phase 12 (24 March 2022-23 July 2023)	***Expenditures***	***Budget Phase 13 (1 May 2023-23 July 2023)***	***Expenditures***
Electronic and conventional tagging, rewarding and awareness	€247,000	€269,550	€160,000	€1,583
Biological studies, including microchemistry, ageing and genetic	€334,200	€269,221	€120,000	
Fisheries independent indices: Aerial surveys	€60,000	€67,657	€385,000	€208,549
Sample collection and shipping	€115,800	€151,899	€80,000	
Workshops/meetings	€117,000	€66,243	€20,000	
BFT MSE	€142,000	€109,594	€35,000	
Programme coordination (include staff salaries, SC external member contract, SC members and Coordination team travels, equipment, consumables, overhead and ICCAT staff participation)	€484,000	€455,807	€440,000	€37,151
TOTAL	**€1,500,000**	**€1,389,970**	**€1,250,000**	**€247,283**

3. Summary of Phase 12 and Phase 13 GBYP scientific activities and results by main line of research

3.1 Data recovery and management

No data recovery activities have been carried out in Phases 12 and 13, given that no new relevant old data sets have been detected. Thus, all the efforts in this line have been devoted to the continuity of the strategic approach initiated in Phase 9, mainly based on in-house work developed within the ICCAT Secretariat to improve data management through close collaboration between the Departments of Statistics and Science, SCRS scientists and the GBYP Coordination Team. Specifically, the work has focused on the development of relational DBs to allow proper storage and analysis of all raw data collected within GBYP or other relevant data sources for BFT management not yet included in the current ICCAT DBs.

Specifically, the activities carried out under GBYP Phase 12 included:

- The tasks aimed at the implementation of the work plan for the creation of a broad biological data information system have continued, in close coordination with the ICCAT Secretariat Department of Statistics. These activities, initiated in previous phases, have mainly consisted of in-house desk work. In the case of the biological data information system, the work has been focused on data modelling and a data warehouse, progressing in the creation of structures to facilitate data sharing between different CPCs' research teams and ICCAT science programmes and a proper data warehouse of both the biological data and the results from the analyses carried out on these samples. Moreover, significant progress has been made on the definition and concentration of data types, data needs and uses. Simultaneously, a review of the condition of the samples collected in previous years and its recording in the inventory has been carried out.

- The update of the data repository to store the information from the AS activity.

- The project for developing an integrated Electronic Tags Management System (ETAGS) capable of managing the data from all the electronic tags released by ICCAT, or provided by CPCs' scientific teams, initiated in Phase 11 in close collaboration with the ICCAT Secretariat Department of Statistics, has been continued. This system will be used to manage both the metadata on electronic tagging operations and the raw data generated by these electronic tags, and will allow for the storage of data from all other ICCAT tagging programmes in the future. For this purpose, a second contract was signed with Dr Chi Hin Lam (Big Fish Intelligence Company Limited) to complete the adaptation of the system previously developed by this company to ICCAT needs. The design and programming of the final DB structure has been completed, and a trial has also been developed to confirm that different types of raw data set can be uploaded. This new DB was presented to the scientific etagging community within the framework of the GBYP workshop on electronic tagging in July 2023.

3.2 Stock fishery independent indices: GBYP aerial survey on bluefin tuna spawning aggregations and BFT larval surveys

3.2.1 Aerial surveys

The ICCAT GBYP AS on bluefin spawning aggregations was initially identified by the Commission as one of the three main research objectives of the programme. The survey provides fishery-independent trends on the minimum spawning stock biomass (SSB). However, due to budget and logistic limitations and different opinions about the best sampling strategies between successive SC members, this activity has not been implemented regularly and has not followed homogenous methodologies and sampling strategies from the very beginning. Moreover, the AS has faced numerous logistical challenges, which have resulted in changes in survey design and data processing to standardize methodologies and improve the accuracy of the index. Thus, in 2019, all historical GBYP AS data were revised and re-analysed for all the areas and years in a homogeneous way, producing a new fully standardised index time series. However, the new index time series exhibited substantial differences to prior time series and still showed a high interannual variability between and within areas, which raised new concerns about the estimation procedures and the overall efficacy of the survey. Therefore, in 2020 an in-depth revision of the whole GBYP AS programme was carried out by two external independent experts, who provided several recommendations for improvement. Recommendations included exploring the feasibility of incorporating automated digital observing systems, to extend, if possible, the surveyed areas, and to move from the classic design-based approach to a model-based approach aimed at overcoming the potential impact of interannual environmental variability on BFT spawner distributions and hence on index accuracy. Consequently, in 2021, under GBYP Phase 10, a pilot survey was performed in the Balearic Sea area incorporating both the standard human observers-based methodology and digital systems for automatic recording of images along the transects, and covering the usual core area as well as an extended area. In addition, a global reanalysis of the whole time series, applying both the design-based approach used from the beginning of the GBYP AS as well as a new model-based approach was carried out by the Centre for Research into Ecological and Environmental Modelling (CREEM) of the University of St Andrews, which was the original developer of the DISTANCE methodology applied for the design and analysis of GBYP AS at the beginning of the programme. With the available budget, the GBYP SC decided to resume, within GBYP Phase 11, the AS for bluefin tuna spawning aggregations in the core areas of the western and central Mediterranean Sea in 2022, specifically in the Balearic Sea (Area A), the Southern Tyrrhenian Sea (Area C) and the central-southern Mediterranean Sea (Area E), following the standard human observers-based methodology. It was decided that the Levantine Sea sub-area (Area G) would not be surveyed because the results obtained in previous campaigns suggest that one of the basic assumptions to apply this methodology, i.e., that the BFT spawners are fully available for aerial observations, is not realized. These 2022 GBYP AS were carried out without major problems, and recently, in June 2023, the same surveys were developed in the same areas of the western and central Mediterranean under Phase 13. The latter have faced some administrative problems as Maltese aerial authorities denied authorization for the embarkment of scientific observers as members of the working team and not as passengers in Malta, thus requiring the contracted company, Aerial Banners, to provide a special certificate which it did not have. This situation was totally unexpected, given that this and other companies contracted by GBYP have always obtained all the permits to perform the AS in Malta presenting exactly the same certificates as those presented this year. In addition, the same documentation was enough to get these permits in other countries (Spain, Italy, and Türkiye), not only in previous years, but also in 2023, indicating that there has not been any change in the international regulations, and that the problem was solely due to a change in the criteria of Maltese aerial authorities. As a result, approximately one third of area E, the one that necessarily must be covered from Maltese airports, has not been surveyed in 2023.

The results from 2022 surveys have been analysed within GBYP Phase 12, and those from 2023 surveys will be analysed during Phase 13. A new contract with the CREEM was signed to perform the analysis to update the aerial index time series until 2022 following the design-based approach and to reanalyse, in collaboration with the team from the Instituto Español de Oceanografía (IEO) and Consejo Superior de Investigaciones Científicas (CSIC) in charge of BFT larval indices, who are experts in BFT spawning habitat modelling, all the data set between 2017 and 2022 following a new model-based approach considering a wide pool of environmental variables. This work aims to produce in the near future a more accurate and fully standardized AS index time series, which is able to account for interannual variability in the spatial and temporal distribution of BFT spawners in the surveyed areas of the western and central Mediterranean derived from changes in the environmental scenario and not strictly from real changes in spawning stock abundance.

3.2.2 Larval surveys

In Phase 12, in addition to the direct funding of AS and AS data analyses, GBYP also directly supported the improvement of larval indices based on surveys developed by ICCAT CPCs by organizing and funding an ad hoc workshop on Atlantic bluefin tuna larval indices, which took place in Palermo, Italy, from 7-9 February 2023. It was organized in a hybrid format. The specific objectives were identifying potential sources of uncertainty or inaccuracy in tuna larval surveys, agreeing on a standard survey methodology to minimize potential sources of error or bias, and exploring the possibilities for expanding surveys aiming at producing larval indices for other bluefin tuna spawning areas. The survey strategies and sampling methodologies, as well those applied to the analyses of biological samples and data, were presented by all the research teams currently involved in studies on Atlantic bluefin tuna larval stages and discussed by the Group. Finally, a series of specific points aiming at standardizing methodologies and exploring the possibilities for implementing new BFT larval index surveys were addressed by the Group, producing a list of action points toward the achievement of this objective.

The workshop was attended by more than 40 scientists from five CPCs. The detailed report will be presented to BFT Species Group in September as the document SCRS/2023/042.

3.3 Tagging activities

The initial objectives of GBYP tagging activities were a) to estimate the natural mortality rates of bluefin tuna populations by age or age groups, and b) to evaluate habitat utilization and large-scale movement patterns (spatial-temporal), including estimates of mixing rates between stock units by area and time strata, of both juveniles and spawners. However, this line of research faced two important problems that limited the full achievement of these objectives: i) the very low recovery rate of conventional tags, which impeded the use of these data to estimate reliable mortality rates; and ii) the relatively short time that most of the electronic pop-up tags remained on the fish. Therefore, some new actions to overcome these problems were initiated in Phase 9, such as improving the deployment methodology, providing specific training to the e-tagging teams, and developing specific actions focused on increasing the involvement of ICCAT observers and farm staff in tag detection and reporting. The results of these activities have become evident from 2019, with the average time that the tags remain attached to the fish (programmed for one year) increasing from 48 days in Phases 2 to 8 to an average of 245 days in Phases 9 and 10. The first results from e-tagging surveys performed within Phase 11 showed the continuation of this trend, since many tags have remained on fish for the whole programmed one-year period. These actions to improve the recovery rates have resulted in an increase in recoveries in the Mediterranean area. From March 2022 to March 2023, a total of 123 conventional and 30 e-tags have been recovered.

As in previous seasons, the main specific objective of the Phase 12 e-tagging campaigns was to improve the estimations of the degree of mixing of western and eastern Atlantic bluefin tuna stocks in the different statistical areas over the year cycle, specifically considering the current needs of the management strategy evaluation (MSE) modelling process. The aim was to improve knowledge of bluefin spatial patterns, focusing on filling the current knowledge gaps in the spatial patterns of juvenile and young adult fish of the western stock and those of the BFT populations inhabiting the eastern Mediterranean. In light of the good results of the new strategic approach for implementing the GBYP e-tagging programmes initiated in Phase 10, a new call for expressions of interest was published as part of Phase 12 (ICCAT Circular #G-0433-20) for the deployment of a total of 54 pop-up satellite archival tags (PSAT) by experienced tagging teams in the Mediterranean and/or North Atlantic Ocean, targeting eastern stock individuals. As a result, seven proposals were awarded and MoUs were signed with:

- Technical University of Denmark (DTU) - six PSAT tags to be deployed in northeastern Atlantic waters (eastern North Sea, Skagerrak, Kattegat and Øresund).
- Institute of Marine Research (IMR) of Norway - five PSAT tags to be deployed in Norwegian waters.
- University of Maine - ten PSAT tags to be deployed on Atlantic bluefin tuna <185 cm CFL along the East coast of the United States (western Atlantic).
- The Marine Institute - five PSAT tags to be deployed in coastal waters off Ireland.
- Swedish University of Agricultural Sciences (SLU) - six PSAT tags to be deployed in Skagerrak, Kattegat or the Sound Straight.
- Stanford University in collaboration with Fisheries and Oceans Canada (DFO) and Acadia University - 18 PSAT tags (including nine Lotek and nine wildlife computers (WC) tags) to be deployed in Canadian waters.
- Government of Jersey in collaboration with Thunnus UK (a collaboration between the Centre for Environment, Fisheries and Aquaculture Science and the University of Exeter) - five PSAT tags to be deployed in Channel Island waters (waters of Jersey and Guernsey).

Most of these campaigns were completed before the end of Phase 12 (reports available on the GBYP web page), but one is still ongoing (MoU with the University of Maine) due to technical problem with the batteries, which obliged to send back the undeployed tags to the manufacturer for software upgrading when the problem was detected.

In Phase 13, a new call for expressions of interest to collaborate with the GBYP e-tagging programme was launched in July 2023. As a result, eleven MoUs will be signed, for the deployment of 75 additional GBYP-owned tags, as follows:

- Acadia institute, in collaboration with DFO and Stanford University - eight PSAT tags to be deployed in Canadian waters.
- Fundación AZTI - six PSAT tags to be deployed in the Bay of Biscay.
- DTU - eight PSAT tags to be deployed in northeastern Atlantic water (eastern North Sea, Skagerrak, Kattegat and Øresund).
- University of Exeter, in collaboration with the Centre for Environment Fisheries and Aquaculture Science (CEFAS) and the Government of Jersey - four PSAT tags to be deployed in Jersey territorial waters.
- University of Exeter - four PSAT tags to be deployed in Southwest England.
- Institute of Marine Research - eight PSAT tags to be deployed in Norwegian waters.
- The Marine Institute - eight PSAT tags to be deployed in the coastal waters off Ireland.
- SLU - eight PSAT tags to be deployed in Skagerrak, Kattegat and Öresund.
- Stanford University, in collaboration with Barcelona Zoo and the Centro Tecnológico Experto en Innovación Marina y Alimentaria (AZTI) - eight PSAT tags to be deployed off the Canary Islands.
- Stanford University - eight PSAT tags to be deployed in the waters off North Carolina.
- University of Genoa - five PSAT tags to be deployed in the Ligurian Sea.

Besides these activities, GBYP has supported e-tagging activities carried out independently by other institutions, whose results were considered a priority research need for the SCRS. Such support implied the sharing of relevant results with ICCAT and the permission of use of the GBYP Research Mortality Allowance (RMA) for any BFT casualties occurring during tagging operations. In other cases, such as the deployment of five PSAT tags in caged BFT before release by the farming company Balfegó S.L., the support consisted of the use of the GBYP Argos system accounts for data transmission so that the resulting data were integrated directly in the GBYP DB.

In addition, in Phase 12, GBYP has organized a workshop on Atlantic bluefin tuna e-tagging in hybrid format, aiming at reaching a broad consensus on the strategic planning of future e-tagging and the best use of available tagging data. The workshop was attended by more than 60 scientists from 12 CPCs. During the workshop, multiple subjects were discussed and a list of priorities for future tagging campaigns were identified. The detailed report will be presented to BFT Species Group in September as Anon. (2023f).

The GBYP programme has also provided logistical support to several institutions engaged in conventional tagging. From March 2022 to March 2023, a total of 2,675 conventional tags were delivered to 4 institutions.

3.4 Biological studies

One of the core activities of ICCAT GBYP are the so-called Biological Studies, including biological sampling and a series of studies based on the analysis of these samples, including microchemical and genetic analyses to investigate mixing and population structure, with a particular focus on identifying age structure and the existence of probable sub-populations. Population structure is a key uncertainty for bluefin tuna. Up to 2022, ICCAT managers acted under the assumption that there were two separate populations with no mixing. However, taking into account, among others, the outputs from GBYP biological studies, for years the possibility that two populations or contingents coexist in the Atlantic Ocean has been considered. Moreover, e-tagging studies, with an important contribution from GBYP, have demonstrated important mixing between both historically recognized East and West Atlantic BFT stocks. It is important that the stock structure assumed for stock assessment and management purposes be in line with the real population structure. If not, overfishing of less productive populations and under exploitation of the most productive ones can occur. Therefore, during its 2022 meeting, ICCAT adopted a new management system for BFT stocks based on the MSE approach, developed from 2014 thanks to GBYP support, in which the operating models (OMs) explicitly consider the existence of mixing.

Therefore, in Phase 12 several GBYP lines of research in BFT biology and ecology were continued from previous phases with the goals of allowing a deeper understanding of the implications of the new spawning grounds in the Atlantic Ocean (Slope Sea and Bay of Biscay) and to developing mixing analyses to provide accurate information and more clear alternative hypotheses about stock structure and spatial patterns to inform the MSE process. Moreover, in this Phase special attention has been paid to the consolidation of the new knowledge generated in the different lines of research developed throughout the last decade, carrying out necessary global reanalyses of available data and synthesizing the results generated in previous phases, in order to provide sound conclusions that can be directly applied to improve stock management.

3.4.1 Biological sampling and analyses

Biological sampling

During Phase 12, a total of 4,555 biological samples were collected (1,514 otolith samples, 1,221 fin spines, and 1,820 genetic samples) from 1,867 individuals. The goal of these activities was to provide data to fill the remaining knowledge gaps on BFT biology, ecology, and population structure, or to update such information. All these samples have been catalogued and stored in the GBYP biological tissue bank hosted by AZTI. In addition, the tissue bank and related information system have undergone a restructuring process to revise and standardize all the information gathered over the last ten years of the project, with the ultimate goal of creating a DB with an interface that is easily manageable for any user who requires it. In addition, 7,638 BFT larvae from the IEO-CSIC BFT 2022 larval survey (co-funded by the EU data collection framework (DCF)), were identified, sorted, and fixed following protocols to allow their future use in genetic analyses, making it possible in the short term to develop pilot studies aiming at determining the feasibility and improve the design of a close-kin mark-recapture (CKMR) study for the eastern BFT stock.

Biological analyses: Microchemistry

Regarding otolith microchemistry, in Phase 12, new carbon (δ13C) and oxygen (δ18O) stable isotope analyses were carried out on Atlantic bluefin tuna samples captured in the foraging grounds of the Atlantic Ocean. Results suggest that individuals from both the Gulf of Mexico (GOM) and Mediterranean (MED) cross the 45°W management boundary, mixing with the other population in feeding aggregates of the Atlantic Ocean, with this rate being different among years. The proportion of GOM-origin fish found to cross to the east is smaller than the proportion of MED-origin fish found to cross to the west. There may be two explanations for this finding: (1) fish originating in the GOM tend to move less, and (2) being a smaller stock in terms of production, the chances of finding a fish from the GOM are lower, or it could be a combination of both.

Individual origin has also been evaluated geographically to get an overview of the last decade. The results showed a spatial separation of catches within the North Atlantic Ocean: fisheries operating in the eastern North Atlantic dominated by MED-origin fish, western Atlantic coast dominated by GOM-origin fish, and central North Atlantic catches composed by a mixture of stocks. These results provide strong evidence of longitudinal population structuring of bluefin tuna in the North Atlantic Ocean and demonstrate the capacity of otolith chemistry to determine their natal origin, at both spatial and interannual time scales. Therefore, for effective stock management, it is important to monitor temporal variations in mixing ratios, especially in the current scenario of changing environment.

Biological analyses: Genetics

Regarding genetic analyses carried out within Phase 12, the results show that interbreeding dynamics in the Slope Sea confirm a gene flow from the Mediterranean into the Slope Sea, which is probably a relatively recent event from the evolutionary point of view (less than approximately 80 generations). The genetic mixing of Mediterranean and western origin individuals in the Slope Sea could have happened repeatedly in different years during the last decades. An increase in gene flow from 2008 to 2018 could not be confirmed, although this hypothesis could not be rejected. Also, genomic regions of albacore origin were found in the genome of Slope Sea and Mediterranean individuals for which whole genome sequencing data was available. The data suggested that variants of albacore origin are associated to adaptive traits. The identification of these regions will make it possible to search for specific genes and derived functions to understand how these affect the adaptive capability of the Atlantic bluefin tuna to the environment.

In this Phase, complete assignments of Atlantic bluefin tuna individuals from feeding aggregates along the North Atlantic captured in the different ICCAT areas, genotyped with the 96 single nucleotide polymorphism (SNP) traceability panel from GBYP Phase 6 to Phase 11, have been updated based on the knowledge on the population structure acquired during the GBYP programme. Overall, > 3,200 individuals captured at feeding aggregates showed varying mixing proportions of MED, GOM, and unassigned individuals across catch years, supporting the hypothesis that migratory patterns of Atlantic bluefin tuna are dynamic.

Finally, a new tool for kin pair identification for future CKMR studies in Atlantic bluefin tuna, based on an array of more than 8,000 SNPs have been developed and tested, analysing a set of 359 samples, in which four half and one full sibling pairs were identified. This study makes it possible to conclude that at least 2,000 SNP markers, among those included in the custom SNP array, were required for effective kin finding among eastern individuals. It was also found that the sex markers included in the 96 SNP traceability panel and the custom SNP array made it possible to correctly identify sex with a rate of 94%

Biological analyses: Integrated analyses

During this phase, further efforts have been made to combine genetic and chemical markers to develop a combined method of population assignment. Over the last ten previous Phases of the GBYP programme BFT-A individuals had been routinely analyzed to assign stock of origin based on otolith chemistry and genetic markers separately to investigate the degree of eastern and western population contribution to different mixing areas in the Atlantic Ocean. However, the use of both methods together can provide further insights into the complexity of the stock structure of the species and enhance the understanding of ecological and evolutionary processes that may help to identify stock units with a high degree of confidence. Here, two different approaches were followed: (1) Individual origin was re-assigned using an integrated classification model that includes both genetic and stable isotope data (i.e., Integrated approach) and (2) genetic and stable isotope data was used complementarily (i.e., Combined approach). The integrated method proved to increase the resolving power of stock discrimination in comparison to single approaches and resulted in lower numbers of unassigned individuals than otolith stable isotope only and genetic markers only models. The combined approach showed that insights into BFT-A population structure can be provided and can be masked when a single technique is used, or when both techniques are integrated, as it considers processes occurring at different temporal scales (i.e., individual life span vs evolutionary).

Biological analyses: Ageing

Regarding direct ageing, three subtasks have been completed. First, a review and update of bluefin tuna growth studies using calcified structures and methods combined with these structures has been carried out. It resulted in detailing the status of validation and standardization of the reading of each structure. Next, two reference collections of 200 samples have been prepared for otoliths and for spines (first spiny ray of the first caudal fin) to serve as quality control of these structures. Finally, a selection of otolith samples has been made to carry out the epigenetic study for the BFT-A of the East Atlantic and Mediterranean Sea. This selection has considered all possible factors that may influence the analyses.

3.4.2 Epigenetic Ageing

Although the Close-Kin Mark-Recapture method has already been implemented on western Atlantic BFT, the ICCAT SCRS is still evaluating the financial, logistic and scientific feasibility of implementing it on the eastern stock. One of the main issues that could prevent the implementation of CKMR is the high cost of age determination by means of classic schlerochronological methods. A potential solution would be the DNA methylation-based epigenetic ageing method, which has shown promising result in other commercial fish species. Yet, obtained age estimates may have quite high error margins compared to otolith derived ages.

Therefore, in Phase 12, GBYP has carried out a pilot study to evaluate the potential of using the epigenetics for ageing Atlantic bluefin tuna individuals, with the aim to evaluate both the accuracy and the feasibility of the epigenetic method compared to direct ageing by otoliths readings. The need for implementing this task was identified rather late, after the initial plan for Phase 12 was drafted so it implied reallocating funds dedicated to other activities and extending the duration of Phase 12.

Although several sub-tasks of this study have been completed, due to unexpected logistic problems, the overall study has not been terminated by the end of Phase 12. However, it is envisaged that all the pending tasks will be completed by September 2023 and the results will be available at the September 2023 BFT Species Group meeting.

3.4.3 Workshop on Close-Kin Mark-Recapture, including biological sampling coordination

In relation to the support of Biological Studies in Phase 12, GBYP organized a workshop on CKMR and biological sampling coordination, which took place in Madrid from 14-16 March 2023, following a hybrid format. It focused on the analysis of relevant factors for the implementation of the approach in the eastern Atlantic bluefin tuna stock, with the goal of presenting a feasibility study, including a workplan with cost estimations, to the SCRS in 2024. The requirements for CKMR and the current knowledge of Atlantic bluefin tuna reproduction and population structure were reviewed, and examples of applications of CKMR methodologies in other fish species were provided. The genetic studies carried out to date for BFT-A stock identification, kinship analyses, sex determination and epigenetic ageing, were summarized and discussed. It was proposed that a comparison be made between the two methodological approaches applied thus far for kinship determination in BFT-A, i.e., the one applied in the ongoing western stock CKMR study and the one developed under the GBYP programme, and that the possibility of including alternative techniques be explored. Sampling opportunities for eastern Atlantic BFT stock CKMR implementation were discussed. Finally, a list of recommendations for future steps and a tentative timeline for their implementation was elaborated.

The workshop was attended by more than 50 scientists from eight CPCs. The detailed report will be presented to BFT Species Group in September 2023 (Anon., 2023g).

3.5 Modelling approaches

The modelling programme addresses the GBYP general objective 3 "Improving assessment models and providing scientific advice on stock status through improved modelling of key biological processes (including growth and stock-recruitment), further developing stock assessment models including mixing between various areas, and development and use of biologically realistic operating models for more rigorous management option testing". Modelling activities started in Phase 2, and it soon became evident that this line of study had greater importance than perceived at the commencement of GBYP and that the amount of effort for this activity should be much larger than initially considered. In addition, the MSE process embarked upon by ICCAT has been an important initiative that has represented a significant investment of time and resources by the Commission, CPCs and the scientists involved.

In Phase 12, GBYP support has been provided to stock assessment and MSE processes through the contract of the expert in charge of MSE, and support has been provided to the BFT Technical Sub-group on MSE by funding the travel of the MSE process coordinator (Dr Doug Butterworth) whenever required.

In this Phase the contract for modelling approaches providing support to bluefin tuna stock assessment was again awarded to Dr Tom Carruthers (Blue Matter Science, Canada), who initiated work on MSE and modelling in 2014. The contract was envisaged to cover the activities until the end of 2022. Nevertheless, in February 2023 the BFT Technical Sub-group on MSE defined further MSE tasks necessary to meet the planned SCRS schedule. Therefore, another contract was provided to the modelling expert to cover the period until July 2023. Therefore, the contracts in Phase 12 covered the final stages of MSE development in support of management procedure (MP) adoption, including final tuning of candidate management procedures (CMPs), rescaling of latest index data, drafting of Exceptional Circumstances Protocols and additional presentation materials in support of MP selection. In addition, they included the development of an exceptional circumstances app that can help to design effective protocols given the various data types available to Atlantic bluefin tuna. Also, the computer code was commented and supporting documentation was developed to guide a technical user on how to reproduce and rebuild the ABTMSE R package from scratch.

More specifically, the principal developments in Phase 12 were the following:

- Finalization of shiny apps
- Finalization of the trial specific document (TSD)
- Rescaling of analyses allowing for an update of indices
- A variety of presentation and communications materials in support of MP adoption
- Documentation for building the ABTMSE R package and ECP app
- Open-source ECP R package that contains all code, functions and diagnostics
- A new ECP Shiny app for exploring and developing ECP for bluefin tuna
- Draft SCRS on ECP background and proposals for bluefin tuna
- Adopted MP code check

Summing up, all MSE processes upstream of MP adoption are complete. Identification of Exceptional Circumstances Protocols is outstanding and provides a link back to operating model specification if triggered.

Appendix 7

Report of the Small Tunas Year Programme (SMTYP)

Programme objectives

The status of small tuna stocks in the ICCAT Convention area is generally unknown. Nevertheless, these species have a high socio-economic relevance for a considerable number of local communities at the regional level, which depend on landings of these species for their livelihoods.

Fisheries statistics and biological data, which can provide a basis for assessing these resources and thus providing the Commission with appropriate scientific advice for their sustainable exploitation, are generally incomplete and not updated for these species.

The ICCAT Small Tunas Year Programme (SMTYP) was adopted by the SCRS in 2011 and approved by ICCAT during its 2012 annual meeting in Agadir (Morocco). The main objectives of the programme are recovery of historical series of Task 1 and Task 2 data, collecting the available biological data, and conducting biological studies, mainly on growth, maturity and stock structure for the main species of small tunas.

This programme has a wide geographical sampling coverage:

1. Mediterranean and Black Sea: bullet tuna, Atlantic bonito, little tunny and plain bonito;
2. West Africa: Atlantic bonito, little tunny tuna, West African Spanish mackerel, frigate tuna, wahoo;
3. Caribbean Sea and Southwest Atlantic: blackfin tuna, wahoo, king mackerel and Spanish mackerel and dolphinfish.

The SMTYP collected biological samples aiming at describing the growth, maturity and stock structure on these three small tunas species in 2018 and 2019. In 2019, results on stock structure of two of the three species (Altantic bonito (BON) and little tunny (LTA)) were provided and samples for growth and maturity were considered mostly satisfactory for the areas and species. In 2020, sampling priority was given to fill specific gaps necessary to obtain the growth and maturity parameters for LTA and BON from geographical areas that the Small Tunas Species Group identified as of high priority. This activity was heavily impacted due to the COVID-19, which has precluded most of the field and laboratory work to be carried out. However, considering the three proposed objectives, promising results were obtained.

Objective 1 - A total of 374 individuals were collected: 145 of BON, 139 of LTA and 90 wahoo (WAH) (**Table 1**). Initial target size classes were only accomplished for BON in the Mediterranean. Small individuals are still needed from the Northeast Atlantic, as well as from the Southeast Atlantic as no samples were obtained (**Figure 1**). For LTA there was also a shortage for all target sizes.

Objective 2 - A preliminary analysis of the relationship between section spine diameter (mm) and fish size (fork length (FL), cm), showed that the area effects (Northeast Atlantic, Mediterranean and Southeast Atlantic) for LTA were significant. No differences were observed between areas for BON. At this stage, no preliminary growth models were fit by area due to the low number of processed samples, particularly considering that the models have to be investigated at stock level. For WAH, for which preliminary results were required within the current contract for the Southwest Atlantic, from the 277 otoliths sampled for annual growth analysis, 157 slides were prepared (56%), 35 were already cut (13%), and 87 were embedded to be cut (31%). For the daily growth analysis, we have prepared 5 samples from an expected number of 75 otoliths, which corresponds to 6% of the overall available sampled specimens. Concerning the reproductive parameters, a total of 420 BON were used for the preliminary analysis of L_{50} using microscopic staging, and 876 fish were used for the preliminary analysis of L_{50} and spawning season combining macroscopic and microscopic data, considering the ICCAT area and the stocks units proposed within the frame of the project. L_{50} were estimated with confidence for only for the Mediterranean area. For the other areas, no estimates could be developed giving the narrow range of the size classes available. Concerning LTA, the analysis has been completed and readings of more than 250 LTA for all ICCAT areas being carried out.

Objective 3 - For BON, the new samples from the Morocco area showed no genetic differentiation, suggesting a genetic temporal stability for this area, and the hypothesis provided in the previous contract of a Northeast Atlantic boundary is maintained. The population genetic analysis of WAH presents a scenario of homogeneous distribution of genetic variation, which is expected in a species with high migratory potential and large effective population size.

Table 1. Summary of the number of samples collected within the SMTYP by region and species in 2020/21, within the short-term contract for ICCAT SMTYP for the biological samples collection for growth, maturity and genetics studies: LTA (*Euthynnus alletteratus*), BON (*Sarda sarda*) and WAH (*Acanthocybium solandri*).

Area	*Country*	*BON*	*LTA*	*WAH*	*Total overall*
ATL-NE	Mauritania	12			12
	Morocco	20			20
	Senegal	66			66
	Spain	2	2		4
ATL-NE Total		**100**	**2**		**102**
ATL-SE	Côte d'Ivoire		30		30
	Gabon		76		76
ATL-SE Total			**106**		**106**
ATL-SW	Brazil			90	90
ATL-SW Total				**90**	**90**
MED	Malta		7		7
	Spain	19	4		23
	Tunisie	26	20		46
MED Total		**45**	**31**		**76**
Total overall		**145**	**139**	**90**	**374**

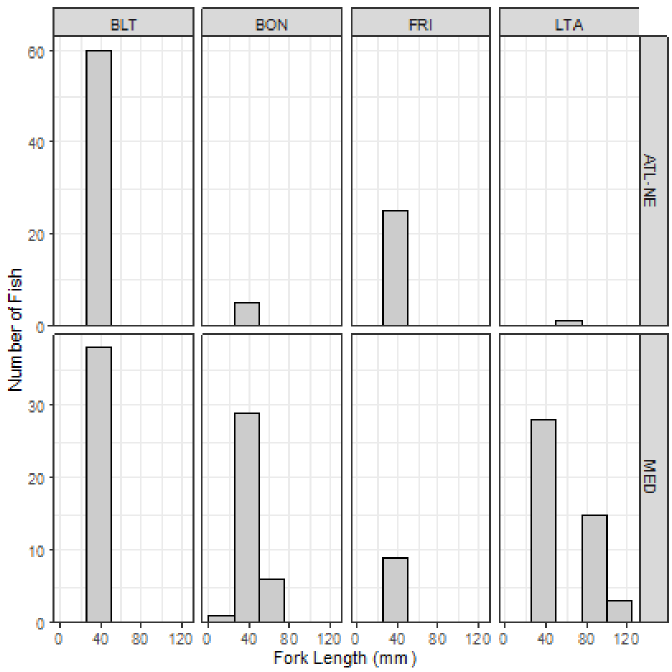

Figure 1. Histogram by size classes (fork length) for bullet tuna (BLT), BON, frigate (FRI), and LTA by sampled regions.

Activities developed in 2022/2023

In 2020, the main gaps of sampling for BON and LTA were covered, and the results related to the growth and maturity parameters were preliminary provided for all areas. Preliminary growth parameters for WAH were also provided. However, given the problems with the pandemic, there are still ongoing analysis and size gaps for the three species to be filled, hence the parameters were not yet fully estimated. Therefore, the SMTYP shall fill the size gaps and conclude the analysis of growth and reproduction for LTA, BON and WAH and, to prioritize similar studies for other species given their socio-economic importance, for the new cycle of the programme. Among the small tunas species, frigate (FRI) *Auxis thazard* and bullet tuna (BLT) *Auxis rochei*, were identified of special interest, namely on what concerns the stock structure.

Hence, during the period 2021-2022, the Group plans included: i) conducting additional sampling aiming to fill the specific gaps of the biological samples for estimating the growth and maturity parameters of BON, LTA, and WAH (**Table 2**); ii) collecting samples for FRI and BLT in the Atlantic Ocean and the Mediterranean Sea for stock structure studies; iii) determining the growth and reproduction parameters for BON, LTA, and WAH; iv) refining the stock structure analysis for WAH, BON, and LTA and determinate the stock structure analysis for FRI and BLT; and, v) investigating genetic species differentiation between FRI and BLT.

Activities planned for 2022-2023

The ICCAT Secretariat launched in April 2023 a call for tenders with the aim of implementing the main activities scheduled within SMTYP in 2023. The main objective of this call was to: a) provide final results of the growth, maturity and the stock structure for Atlantic bonito *Sarda sarda* (BON), little tunny *Euthynnus alletteratus* (LTA) and wahoo *Acanthocybium solandri* (WAH); b) present refined analysis results on stock structure for WAH, BON, LTA, and results for frigate tuna *Auxis thazard* (FRI) and bullet tuna *A. rochei* (BLT) in the Atlantic and the Mediterranean Sea. As a result, the Secretariat awarded a new contract to a consortium with a number of institutions, including 9 CPCs to carry out the tasks aforementioned until the end of September 2023. A new contract shall be awarded in fall 2023 to continue the 2023 activities and carried out the activities planned for 2024.

Table 2. Detailed information on sampling targets by species, size classes and regions to be carried out by species for 2021-2022 under the ICCAT SMTYP.

Species	*Research line*	*Area*	*CPCs involved*	*Target size classes and desirable number of samples (in brackets)*
Frigate (FRI)	Stock Structure	NE Atlantic	Senegal, EU-Spain, EU-Portugal, Morocco	All (100)
		SE Atlantic	Côte d'Ivoire, Gabon, EU-Spain	All (100)
		SW Atlantic	Brazil	All (100)
Bullet tuna (BLT)	Stock Structure	NE Atlantic	Senegal, EU-Spain, EU-Portugal, Morocco	All (100)
		SE Atlantic	Côte d'Ivoire, Gabon, EU-Spain	All (100)
		SW Atlantic	Brazil	All (100)
		Med	Tunisia, EU-Spain, EU-Malta, Algeria	All (100)
Wahoo (WAH)	Aging and growth, reproduction	NE Atlantic	Senegal, EU-Spain, EU-Portugal, Morocco	< 70 cm (10) and > 140 cm (10)
		SE Atlantic	Côte d'Ivoire, Gabon, EU-Spain	< 70 cm (20) and > 140 cm (15)
		SW	Brazil	< 70 cm (15) and > 140 cm (15)
Little tunny (LTA)	Aging and growth and reproduction	NE Atlantic	Senegal, EU-Spain, EU-Portugal, Morocco	> 60 cm (15)
		SE Atlantic	Côte d'Ivoire, Gabon, EU-Spain	> 60 cm (20)
		Med	Tunisia, EU-Spain, EU-Malta, Algeria	≥ 60 cm (20)
Atlantic Bonito (BON)	Aging and growth and reproduction	NE Atlantic	Senegal, EU-Spain, EU-Portugal, Morocco	≤ 40 cm (5) and > 60 cm (20)
		SE Atlantic	Côte d'Ivoire, Gabon, EU-Spain	≤ 35 cm (20) and > 60 cm (10)
		Med	Tunisia, EU-Spain, EU-Malta, Algeria	≥ 60 cm (15)

Nevertheless, as in previous years, these objectives cannot be achieved with the single financial support of ICCAT and will only be possible through additional external funding that hopefully will be made available by the significant voluntary contribution provided by ICCAT CPCs, as it has been specifically the case of the European Union.

Table 3 lists those responsible for coordinating the analysis and Institutions where samples will be stored are identified.

Table 3. Scientist responsible for coordinating the analysis and Institutions where samples will be stored.

Analysis	*Institution*	*Country*	*Coordinator*
Growth	Instituto Português do Mar e da Atmosfera (IPMA)	EU-Portugal	P. Lino and Rubén Muñoz Lechuga
Reproduction	Instituto Español de Oceanografía (IEO), Málaga	EU-Spain	D. Macías, S. Saber and J.M. Ortiz
Stock structure	University of Girona	EU-Spain	J. Viñas

Expenditures in 2022 and 2023

The total expenditures within SMTYP in 2018, 2019, 2020 and 2021 amounted to €52,917, €60,000, €97,694 and €50,000, respectively. The effective expenditures for that period were of €37,183, €44,531, €91,167 and €33,467respectively.

In 2022 and 2023 to implement the main activities planned in the framework of SMTYP, the total budget of provided by ICCAT amounted to €71,000 and €52,500, respectively.

The detailed fund available for SMTYP during 2022 and 2023 and respective expenditures as of 11 September 2023 are detailed in the table below.

	2022		*2023*	
Component	*Budget (€)*	*Exp. (€)*	*Budget (€)*	*Exp. (€)*
Reproductive studies	12,500	4,600	7,500	-
Genetics	10,000	3,200	7,500	-
Age and growth	12,500	2,400	7,500	-
Sample collection and shipping	10,000	4,320	10,000	-
Other studies (new chapter of ICCAT Manual)	1,000		-	-
Workshops/meetings	25,000	26,202.18	20,000	-
TOTAL	**71,000**	**40,722.18**	**52,500**	**-**

Appendix 8

Report of the ICCAT Shark Research and Data Collection Programme (SRDCP)

(Activity report for the period October 2022 - September 2023)

Background and programme objectives

During the 2014 Commission meeting, it was decided that an overall budget of €135,000 would be allocated to the Shark Research and Data Collection Programme (SRDCP). During the 2015 Blue Shark Data Preparatory Meeting (Anon., 2016a), the Sharks Species Group (SSG) reviewed the proposal for implementation of the SRDCP that had been prepared in 2014 and identified national scientists who would be in charge of preparing proposals for receiving funds to carry out each of the research topics listed in the original proposal. During the 2015 Blue Shark Stock Assessment Meeting (Anon., 2016b), and shortly thereafter, the following four project proposals covering different aspects of the life history, population structure, and fisheries of the shortfin mako were presented: a pan-Atlantic age and growth study; a population genetics study to investigate population structure and phylogeography; a post-release mortality study focusing on pelagic longline fisheries; and a satellite tagging study for determining movements and habitat use. For the first three years, the programme focused on these proposals and supported extensive collaborative work among national scientists with the aim of contributing information to the 2017 shortfin mako stock assessment (Anon., 2018d). Activities under the SRDCP have continued and been extended to include other shark species such as porbeagle, silky shark, oceanic whitetip shark, longfin mako and hammerheads.

2023 activities

The following are the cumulative SRDCP activities conducted up to 2023:

Age and growth of shortfin mako in the Atlantic Ocean

The project leaders for this study are Dr Rui Coelho, Ms. Daniela Rosa and Ms. Catarina Santos, national scientists from EU-Portugal, with participation of scientists, and samples, from Brazil, EU-Portugal, Japan, Namibia, United States and Uruguay. There are still uncertainties about the age and growth parameters of shortfin mako and this project aims to update the available estimates by ageing specimens from both stocks in the Atlantic. To that end, a first step was to create an inventory of existing vertebral samples available at each national laboratory and carrying out additional sampling. Vertebrae samples were processed, and digital images uploaded to an ICCAT online repository.

A first age and growth workshop was organized in June 2016 by NOAA-NEFSC (Narragansett Laboratory), with the participation of the involved scientists, and an initial reference set for ageing samples was established (Coelho *et al*., 2017). One biologist from each age-reading institution (EU-Portugal, United States and Uruguay) read and estimated the ages from all the samples, based on the agreed ages from the reference set, and growth models were developed based on those readings. For the North Atlantic, data from 375 specimens, ranging in size from 57 to 366 cm fork length (FL) for females and 52 to 279 cm FL for males, have been analysed. This initial work was completed in 2017 and presented in several SCRS papers (Rosa *et al*., 2017). The growth models presented in Rosa *et al.* (2017) for the North Atlantic were used in the 2017 Shortfin Mako Stock Assessment (Anon., 2018d). For the South Atlantic, data from 332 specimens, ranging in size from 90 to 330 cm FL for females and 81 to 250 cm FL for males were available at the time and have been analysed (Rosa *et al*., 2018). Given the poorly estimated parameters, at the time the Group did not recommend the use of the growth curves for the South Atlantic stock, and it was noted that more samples were still required to develop more credible growth curves, particularly with specimens from the southeast region.

Since then, additional samples from Brazil, Namibia and Japan have been made available, totaling 883 vertebrae samples that are now available to the SRDCP for the South Atlantic SMA stock. Due to the COVID-19 pandemic, laboratory work was much delayed during 2020, but resumed with some restrictions in 2021. Sample processing has now been completed, and all vertebrae have been digitally photographed and uploaded into an age reading platform. The age readings have been taking place and preliminary readings are expected by the end of 2023, with preliminary growth curves in 2024 aiming the stock assessment. The lack of samples from the extremes of the size distributions, most notably from large shortfin mako, has been resulting in some convergence issues in the estimation of growth curves or biologically unreasonable estimated parameters. Approaches to overcome the lack of samples from small and/or large size specimens are being explored through growth modeling once the age readings are complete (e.g., Bayesian models).

Genetic analysis of porbeagle in the Atlantic Ocean

The genetic population structure component of the SRDCP started in 2015, focused on shortfin mako (see previous reports for details). This study component is led by national scientist from Japan, Mr Kotaro Yokawa at the beginning, and by Dr Yasuko Semba since 2017. The genetic analysis of population structure of porbeagle started in 2022.

During the Sharks Species Group Meeting (hybrid, 20-21 September 2022) a perspective of the genetic population structure of porbeagle was presented, based on muscle tissue samples collected from northwestern, northeastern, and southeastern Atlantic (Merino *et al.,* 2022). Advances of this study were presented during the Workshop on the Shark Research and Data Collection Programme (SRDCP) (13-15 July 2023) (Semba and Takeshima, 2023) and during the Sharks Species Group meeting (20-21 September 2023) (Takeshima *et al.,* 2023). Results of the analysis were based on the nuclear-genome-wide single nucleotide polymorphism (SNP) genotyping on 96 Atlantic porbeagle. A total of 1,427 loci and 95 individuals were retained as the final data sets of the nuclear genome genotype after various filtering process. The result of Principal Component Analysis (PCA) plots and individual-based clustering using nuclear genome genotyping data sets were well consistent, in that two distinct genetic groups of porbeagle, North and South porbeagle, exist in the Atlantic Ocean. However, no genetic differentiation was found between samples collected from the Northeast and Northwest Atlantic. These inferences are also apparently consistent with the result of the mitogenomic study performed in the last year, and concordance between results from maternally inherited mitochondrial genome and biparentally inherited nuclear genome indicates complete reproductive isolation for at least two genetic groups in the Atlantic Ocean. These analyses suggest that there is a high probability that North and South porbeagle in the Atlantic Ocean are distinct species. However, data are still insufficient to draw conclusions on this inference, because samples from important areas (i.e., southwestern Atlantic) have not yet been included for both mitochondrial DNA and nuclear DNA. Also, there is still room to improve the nuclear analysis using the reference genome of this species currently under development. Next steps will include the incorporation to the analysis of new samples to improve the spatial coverage of the study, by which it could lead us to the understanding of the connectivity of this species among areas of high interest (e.g., migrations between the southeastern and southwestern Atlantic, southeastern Atlantic and southwestern Indian Ocean). During the remainder of 2023, nuclear genome analysis of 50 samples from the southwestern Atlantic Ocean (provided by Uruguayan scientists) will be performed.

Post-release mortality of shortfin mako in the Atlantic Ocean

The project leader for this study is Dr Andrés Domingo, a national scientist from Uruguay. The main purpose of this project is to quantify the post-release mortality of Atlantic shortfin makos on pelagic longlines to potentially contribute to their assessment and management. These data were non-existent when the project started. Survivorship Popup Satellite Archival Transmitting Tags (sPATs) were acquired and distributed to the participating laboratories for deployment in three main areas of the Atlantic: the Northwest Atlantic, the tropical Northeast Atlantic and equatorial region, and the Southwest Atlantic. A total of 14 sPATs have been deployed thus far by scientific observers from IPMA (EU-Portugal), Dirección Nacional de Recursos Acuático (DINARA) (Uruguay), NOAA (USA), Brazil and EU-Spain, and additional information from 29 miniPATs was also available to estimate post-release mortality. Of the 35 specimens with available information, eight died (22.9%), whereas the remaining 27 survived (77.1%) for at least the first 30 days after tagging. The updated results from this project were reported and published in Miller *et al.* (2020). Tag deployment has continued and deployment of remaining miniPATs will be done during the second semester of 2023 and throughout 2024, depending on the opportunities. Status and advances of this study were presented during the Workshop on the Shark Research and Data Collection Programme (SRDCP) (13-15 July 2023 (Semba and Takeshima, 2023)). The results obtained so far will be updated for the upcoming 2024 shortfin mako stock assessment. Information from the latest tags deployed will be included, as well as information from other national tagging programmes that will be shared with the SRDCP.

Movements, stock boundaries and habitat use of shortfin mako in the Atlantic Ocean

The project leaders for this study are Dr Rui Coelho and Ms. Catarina Santos, national scientists from EU-Portugal. The main purpose of this study is to use satellite telemetry to gather and provide information on stock boundaries, movement patterns and habitat use of shortfin mako in the Atlantic Ocean, to potentially contribute to their assessment and management. All Phase 1 (2015-2016) and Phase 2 (2016-2017) tags have been deployed (36 tags: 22 miniPATs and 14 sPATs). Regarding Phase 3 (2017-2018), of the 13 tags assigned to shortfin mako (out of 21 acquired tags, see **Table 1** below), 5 were deployed in the Atlantic Ocean and 8 were planned for deployment in the Indian Ocean (7 tags were already deployed) in order to assess inter-ocean movements of shortfin mako. Of the 20 tags acquired during Phase 4 (2018-2019), five were assigned and have been deployed on shortfin mako. More recently, three more tags were deployed in the Indian Ocean (2021 and 2022), with those being tags from previous project phases.

The results of this project through the end of 2019 with regards to shortfin mako were recently published in Santos *et al.* (2021). Overall, a total of 53 tags (31 miniPATs,14 sPATs, and 8 additional miniPATs from other projects) were deployed by observers on vessels from Brazil, EU-Portugal, EU-Spain, Uruguay and the United States in the temperate NE and NW, Equatorial and SW Atlantic. Data from 34 of the 53 tags/specimens were available for a total of 1,877 tracking days recorded. The movement analysis showed that sharks tagged in the Northwest and Central Atlantic moved away from tagging sites, showing low to no apparent residency patterns, whereas sharks tagged in the Northeast and Southwest Atlantic spent large periods of time near the Canary Archipelago and Northwest Africa, and over shelf and oceanic waters off southern Brazil and Uruguay, respectively. These areas showed evidence of site fidelity and were identified as possible key areas for shortfin mako. Shortfin mako spent most of their time in temperate waters (18–22°C) above 90 m; however, data indicated the depth range extended from the surface down to 979 m, in water temperatures ranging between 7.4 and 29.9°C. Vertical behaviour of sharks seemed to be influenced by oceanographic features, and ranged from marked diel vertical movements, characterized by shallower mean depths during the night, to yo-yo diving behaviour with no clear diel pattern observed.

More recently, in 2021 and 2022, three of the outstanding tags were deployed in the Indian Ocean. However, those tags were from the batches that had battery problems and were deployed before the communication from Wildlife Computers to return the tags. As such, those tags failed to transmit data. There is still one tag assigned to shortfin mako in the project for the SW Indian Ocean, that has been returned to Wildlife Computers and is currently being repaired/replaced.

Reproduction of shortfin mako and porbeagle in the Atlantic Ocean

The point of contact for this study has been Dr Enric Cortés, a national scientist from the United States. In 2017, a two-day hands-on training session on determination of reproductive maturity of porbeagle sharks was held at the Narragansett Rhode Island, NOAA Fisheries NEFSC Laboratory, led by Dr Lisa Natanson. The goal of the training was to establish standardized dissecting and sampling practices among researchers for more consistent collection of life history data. In 2020, a workshop on reproductive and other life history aspects of porbeagle and other pelagic sharks in the Atlantic Ocean was held at the Instituto Português do Mar e da Atmosfera (IPMA), in Olhão, Portugal. An overview of shark reproduction studies of porbeagle in the Northwest Atlantic Ocean was provided. Median size at maturity for males and females using data from all years was updated to 173.1 and 216.3 cm FL, respectively. There is no new information on the timing of mating, gestation period or average number of pups. The reproductive cycle of at least some portion of the population is biennial or triennial based on the finding of a resting stage. Workshop recommendations included an increase in hormone analysis to determine maturity and pregnancy of pelagic sharks, and to combine size data from various fleets to obtain more robust estimates of size at maturity and the overall reproductive cycle of porbeagle. Funds were designated for these reproduction studies, but due to different reasons, some associated with the COVID-19 pandemic, it was not possible to conduct sampling. Although some of the 2020 funds designated for reproduction studies were extended for a 6-month period, there were no planned activities for 2021, and it was not possible to conduct the postponed activities of 2020 in 2021. In 2022 it was decided to reactivate activities of this component of the SRDCP, a study on the reproductive biology of North Atlantic shortfin mako quantifying reproductive hormone concentrations from muscle tissue samples collected from stored vertebrae will start in late 2023.

Movements, stock boundaries and habitat use of porbeagle in the Atlantic Ocean

The project leaders for this study are Dr Andrés Domingo and Dr Rui Coelho, national scientists from Uruguay and EU-Portugal. The main purpose of this study is to use satellite telemetry to gather and provide information on stock boundaries, movement patterns and habitat use of porbeagle in the Atlantic Ocean, to potentially contribute to their assessment and management. Since the beginning of the programme, a total of 13 miniPATs acquired for this project were distributed to scientists from EU-France, EU-Portugal, and Norway, to be deployed in the North Atlantic, and to scientists from Uruguay to be deployed in the South Atlantic. Relevant to this activity and that related to shortfin mako, the Shark Species Group was informed of other ongoing national programmes that can contribute data. Other programmes include that of Canada, which deployed 30 sPATs on shortfin mako and 30 sPATs on porbeagle during 2018-2019; and a US/NOAA programme that will deploy 12 new sPATs for porbeagle on EU-Portugal, United States and Uruguay vessels.

To date, a total of seven POR tags have been deployed by EU-France, EU-Portugal, and Norway. In the initial years of the project, 2018/2019, five sharks were tagged in the Northeast Atlantic, namely three in the Bay of Biscay/Celtic Sea area and one in the central NE Atlantic. Of the specimens tagged in the Bay of Biscay, three tended to stay in the same general area and one travelled West after a 3-month residency period in the Bay of Biscay. The shark tagged in the central North Atlantic appeared to have died shortly after tagging. The remaining tags available for porbeagle at the time had battery issues and had to be returned to Wildlife Computers for tag replacement. Part of those have now been returned, and the programme resumed in later 2022 and 2023. In this more recent period, 3 tags have been deployed by Norway, with one of those showing a long migration (~5,000 km) of a porbeagle specimen from colder northern Atlantic waters in the summer to warmer waters of the NE Atlantic in winter.

Movements, stock boundaries and habitat use of silky, oceanic whitetip, longfin mako, hammerheads, bigeye thresher and blue sharks in the Atlantic Ocean

The project leaders for this study are Dr Andrés Domingo, Dr Rui Coelho, Ms. Catarina C. Santos, and Dr John Carlson, national scientists from Uruguay, EU-Portugal, and the United States. A 2018 review of satellite tags previously deployed on these species in the Atlantic revealed that only three silky sharks had been tagged off Cuba, and oceanic whitetip sharks were tagged only in the NW Atlantic, but almost nowhere else in the Atlantic. These sharks are considered priority species, as they have been ranked with high vulnerability in the ICCAT shark Ecological Risk Assessments (ERAs) (Cortés *et al*., 2010 and Cortés *et al*., 2015), and retention of some are currently prohibited in ICCAT fisheries (i.e. *Recommendation by ICCAT on the conservation of oceanic whitetip shark caught in association with fisheries in the ICCAT Convention area* (Rec. 10-07), *Recommendation by ICCAT on hammerhead sharks (family sphyrnidae) caught in association with fisheries managed by ICCAT* (Rec. 10-08), *Recommendation by ICCAT on the conservation of silky sharks caught in association with ICCAT fisheries* (Rec. 11-08)). The SCRS decided that of 17 satellite tags that were acquired in 2019 for the SRDCP, 9 should be deployed on oceanic whitetip and hammerhead sharks and 8 on silky sharks. A total of 5 silky sharks, 3 oceanic whitetips and 1 scalloped hammerhead were tagged with miniPATs in 2018 and 2019, by EU-Portugal, Uruguayan and U.S. scientists/ scientific observers (in collaboration with the Cape Eleuthera Institute, and Florida State University) in the U.S. Gulf of Mexico, Caribbean Sea, and Atlantic Ocean. These tags were acquired in previous years (2017-2018) but were only deployed during late 2018 and 2019. With respect to tags acquired in 2019, a total 2 silky sharks and 3 oceanic whitetips were tagged by EU-Portugal scientific observers in the Equatorial region of the Atlantic Ocean. In addition, 1 smooth hammerhead was tagged by the Uruguayan team in the Southwest Atlantic Ocean. Due to battery issues with Wildlife Computer tags, a total of 11 tags had to be returned for replacement in early 2020. During 2021 and 2022, 6 tags were deployed on silky sharks in the U.S. Gulf of Mexico and 2 on oceanic whitetips in the equatorial region of the Atlantic Ocean. During 2023, three more silky shark tags have already been deployed so far in the NW Atlantic.

From this species, which is currently being tagged, it is noted that the silky shark now has a relatively good coverage in the Northwest Atlantic. The oceanic whitetip also had some relatively good tagging in the equatorial region, and hammerheads are being prioritized mostly in the SW Atlantic and tropical eastern Atlantic. It has been discussed that the species selected for this tagging activities are mostly bycatch and not commonly caught, and this represents a bigger challenge to achieve the proposed goal. Deployment of the remaining tags is planned to continue during 2023 and for 2024, depending on the tagging opportunities.

Other activities

The prospects of Close-Kin Mark-Recapture (CKMR) for shortfin mako sharks has been discussed as a robust way to assess abundance and productivity. At the beginning of these discussions, there was already a strong sampling programme in Brazil, and the capacity to do the necessary sampling in Namibia and South Africa from observer programmes, without the complications of high-seas CITES permits that seem to be an impediment to sampling in the North Atlantic. Based on the 2019 study design, those three programs could, within a few years, provide enough samples from a wide geographic area to assess the sustainability of current combined catches from the South Atlantic shortfin mako population. However, mainly due to the COVID-19 pandemic and the CITES issue, since early discussions in 2019, there has not been recent advances in the SRDCP regarding the CKMR studies. During the 2023 SRDCP Workshop, the discussion on the possibility of conducting this study was resumed. It was agreed by the participants that it is not possible to start this study until finding a way to overcome the CITES issues of shipping samples between countries, and thus accelerate the process.

Also, in 2021, external funding through National Oceanic and Atmospheric Administration (NOAA) Fisheries-Office of Protected Resources has been sought to determine genetic connectivity and absolute abundance through Close-Kin Mark-Recapture for oceanic whitetip shark. Initially the project will focus on sequencing the genome of the oceanic whitetip using archived samples but will expand as more samples potentially become available through observer programs. A Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) - Introduction from the Sea permit application has been submitted.

In 2023 a Workshop on the Shark Research and Data Collection Program (SRDCP) (13-15 July 2023) was held. The aim of the workshop was to review the 10 years of the SRDCP, present and discuss the results obtained and the ongoing activities, and to discuss the perspectives for the coming years. A historical view of the SRDCP was presented. The activities carried out were addressed: age and growth studies; genetics; movements and habitat utilization; post-release mortality; reproduction studies; improvement of available information for population assessment; other activities. Also, the difficulties faced by the programme and possible ways to overcome them were discussed. Future steps for the second phase of the program were also introduced and discussed, including new species that are part of the ICCAT agreement, advances in available information on pelagic sharks outside of the SRDCP, activities to be continued, new activities to be included.

Table 1. List of ICCAT tags deployed and to be deployed by species. (Notes: *: tags to be deployed that are identified with * are all combined in the line with “LMA/FAL/OCS/SMA/BSH/Hammerheads”; ** tags deployed in those species are listed as species-specific in the lines above; *** some of those tags are currently (as of September 2023) in Wildlife Computers for battery issues fixing and/or replacement).

Species	*Deployed (n)*	*To be deployed (n)*
SMA	53	1
POR	8	4
SPL	1	(*)
SPZ	3	(*)
OCS	8	(*)
FAL	21	2
LMA/FAL/OCS/SMA/BSH/Hammerheads	(**)	39
Total	**94**	**46 (***)**
Grand total	**140**	

Expenditures in 2022 and 2023

The total budgets within SRDCP in 2018, 2019, 2020 and 2021 amounted to €100,000, €130,000, €163,400 and €40,000, respectively. The effective expenditures for that period were €97,568, €75,746, €128,952 and €25,000, respectively.

In order to implement the main activities planned in the framework of SRDCP, the total budget provided by ICCAT in 2022 and 2023 amounted to €70,000 and €79,000, respectively.

The detailed funds available for the SRDCP during 2022 and 2023, and respective expenditures as of 11 September 2023, are detailed in **Table 2.**

Table 2. SRDCP budget and expenditures in 2022 and 2023.

Year	*2022*		*2023*	
Component	*Budget (€)*	*Expenditures (€)*	*Budget (€)*	*Expenditures (€)*
Tagging	35,000	2,411.17	10,000	
Reproduction	-	-	10,000	
Age and growth	5,000		2,000	
Genetics	25,000	25,000	25,000	
Sampling	5,000		2,000	
Stock assessment			10,000	
Workshop			25,000	15,180.70
TOTAL	**70,000**	**27,411.17**	**79,000**	**15,180.70**

2024 Plan and activities

Age and growth of pelagic sharks the Atlantic Ocean

With regards to the ongoing work for shortfin mako, the main objective for 2024 is to complete the age estimations of the south Atlantic stock and prepare a preliminary growth analysis. All samples have been processed, and the age readings are being conducted during later 2023. A preliminary analysis is expected in early 2024.

Also starting in 2024, the SRDCP is considering starting the age and growth work for other species, keeping in mind that collection of new samples is now more complicated due to CITES listings. The first step that is being undertaken is a compilation of vertebrae samples that are currently available at each laboratory for each species, that will help establish priorities for the next years.

Genetic analysis of porbeagle in the Atlantic Ocean

During 2024, further analysis of mitochondrial genomics, with 40-50 samples from southwestern Atlantic (Uruguay samples), will be conducted. Additional analysis of both mitochondrial genome and nuclear genome for specimen derived from area adjacent to the Atlantic (e.g., tissue sample collected from areas between 20 and 40 degrees East) will be planned.

Post-release mortality of shortfin mako in the Atlantic Ocean/movements, stock boundaries and habitat use of shortfin mako in the Atlantic Ocean

With regards to the post-release mortality, the final analyses of that project will be prepared during 2024, and will include additional tags deployed by South Africa in the Southwest Indian Ocean (Réunion, France) according to the distribution paper that was prepared in previous years.

As for additional tagging, following the SRDCP workshop in 2023, it was decided to re-open the effort for tagging shortfin mako, with prioritization on knowledge gaps for the species. The main areas of interest for future tagging are the SW and SE Atlantic, as well as in more oceanic areas that have not yet been fully covered in the past. Another priority is to tag large adult females, noting that to date this has not been possible. The vast majority of the shortfin mako females captured in pelagic longlines are juveniles and this lack of knowledge on the large females distribution is a current caveat in terms of knowledge, that fits under the Commission requests in the *Recommendation by ICCAT on the conservation of North Atlantic stock of shortfin mako caught in association with ICCAT fisheries* (Rec. 21-09) and the *Recommendation by ICCAT on the conservation of the South Atlantic stock of shortfin mako caught in association with ICCAT fisheries* (Rec. 22-11). The plan for 2024 with regards to shortfin mako tagging is to put some effort in those tagging priorities, including some tags for the Southwest Indian Ocean (Réunion, France) and some tags for the Northwest Atlantic recreational fisheries where some large females are sometimes captured. Additional tagging opportunities under the established priorities will be explored.

Movements and habitat use of porbeagle in the Atlantic Ocean

In later 2023 and during 2024 we plan to finish the deployment of the available miniPATs acquired in recent years that have not yet have been deployed. The deployments are planned by scientists from the United States and Norway in the North Atlantic, and Uruguay and Brazil in the South Atlantic.

Norwegian scientists will coordinate an effort to compile and analyse existing data from POR satellite tags in the North Atlantic, including ICCAT tags and tags from other projects, to perform a wider scale study on the distribution patterns and habitat use of the species.

Movements, stock boundaries and habitat use, and post-release survivorship of silky, oceanic whitetip, longfin mako, hammerheads, bigeye thresher and blue sharks in the Atlantic Ocean

There are currently 46 tags that are assigned to those species, namely silky, oceanic whitetip, longfin mako, hammerheads, bigeye thresher and blue shark. Those are expected to continue being deployed later in 2023 and during 2024 in various regions of the Atlantic and depending on the priorities and tagging opportunities.

With regards to silky shark, the current coverage in the NW Atlantic is now good, so future efforts are being prioritized in other regions, especially the eastern Atlantic. With regards to hammerheads, the two current priority areas are the SW Atlantic and central eastern Atlantic. The species oceanic whitetip shark (*Carcharhinus longimanus*) (OCS) and bigeye thresher (*Alopias superciliosus*) (BTH) are being tagged opportunistically. With regards to blue shark, the addition of this species to the list was decided at the 2023 SRDCP workshop, giving prioritization to knowledge gaps for the species, namely tagging large and possibly pregnant females across the Atlantic, tagging in the NW Atlantic and Mediterranean with the objective of determining possible links between those stocks, and tagging in the area around South Africa along the ICCAT/Indian Ocean Tuna Commission (IOTC) boundary, also to improve knowledge in terms of stock structure.

Reproduction of shortfin mako in the Atlantic Ocean

During the Intersessional Meeting of the Sharks Species Group (16-18 May 2022) (Anon., 2022j) the opportunity to resume studies related to the reproductive biology of the shortfin mako in the North Atlantic were discussed. The studies will be focused on hormone analysis to determine maturity and reproductive state of the species. The SRDCP already has some experience with this analysis as previous studies have been carried out for porbeagle in the North Atlantic. Unfortunately, this study had to be paused due to the COVID-19 pandemic and the impossibility of sampling. Blood and tissue sampling and preliminary analysis of hormones for the North Atlantic shortfin mako will start in late 2023 and will continue in 2024.

Appendix 9

Report of the ICCAT Enhanced Programme for Billfish Research (EPBR)

(Expenditures/Contributions 2023 and Programme Plan for 2024)

Summary and Programme objectives

The ICCAT Enhanced Programme for Billfish Research (EPBR) continued its activities in 2023. The Secretariat coordinates the transfer of funds and distribution of tags, information, and data. The overall General Coordinator and East Atlantic Coordinator during 2023 was Dr Fambaye Ngom Sow (Senegal), and Ms. Karina Ramírez López (Mexico) remained as the West Atlantic Coordinator.

The original plan (established in 1986) for EPBR included the following objectives: 1) to provide more detailed catch and effort statistics, particularly for size frequency data; 2) to initiate an ICCAT tagging programme for billfish; and 3) to assist in collecting data for age and growth studies. During past Billfish Species Group meetings, the Billfish Species Group requested that the objectives of EPBR be expanded to evaluate adult billfish habitat use, study billfish spawning patterns, and billfish population genetics. The Billfish Species Group considers these studies to be essential for improving billfish stock assessments. Efforts to meet these goals since 2019 are highlighted below.

The specific funding for EPBR previously available has now been combined with the general research fund (ICCAT Science Envelope). Project funding will now be allotted on a competitive basis with other species working groups.

2023 activities

In July 2022, a new contract was awarded to Institut Sénégalais de Recherches Agricoles (ISRA), Centre de Recherches Océanographiques de Dakar/Thiaroye (CRODT, Senegal) to continue the activities of the previous contract for a 12-month period (until December 2022). This new contract also engaged the EU research team Instituto Português do Mar e da Atmosfera (IPMA, from Portugal), which significantly enhanced the collection of samples onboard industrial vessels in the East Atlantic and supported the analysis of data on length and age for estimating the growth parameters based on spines of the main billfish species that occur in the eastern Atlantic (*Makaira nigricans*, BUM; *Kajikia albida*, WHM; and *Istiophorus albicans*, SAI). However, this contract was canceled due to the difficulties encountered by the teams involved in this project. Only CRO was able to collect 32 samples, but they encountered difficulties to ship them.

In 2023, a joint workshop on age reading was held from 13-18 February in IPMA (Olhão, Portugal). The major objectives of the workshop were to further build capacity among ICCAT scientists for these species by: i)sharing knowledge between experts, ii) standardize methodologies, iii) review work already completed and advance plans for the next steps to follow for the swordfish, billfishes, and small tunas research programs. During the workshop, an update to the document presented at the Billfish Species Group meeting in September 2022 (Krusic-Golub *et al*., 2022) was presented showing the improvements made on age estimation for billfish species.

In July 2023, a new contract was signed to continue the activities on samples collection and age reading. Thus, 16 additional samples from the artisanal fleet were collected by CRODT from July to August. A total of 525 samples, from both the artisanal and industrial fleets, have been collected to date for use in age and growth studies and laboratory sample processing is currently ongoing. It should be noted that there is considerable difficulty in collecting samples of small and large specimens from the industry through observers in industrial and artisanal fleets.

All other activities of the 2023 Billfish Workplan for EPBR could only be partially performed, namely those involving mainly field work, due to the difficulties encountered by the teams involved in this project, the difficulty of deploying observers in the longline fleets and from adding additional tasks to the observer deployed in purse seiners.

Following the SCRS request, in autumn 2019 through the ICCAT Science Envelope, a contract was proposed to the Dirección General Adjunta de Investigación Pesquera en el Atlántico, Centro Regional de Investigación Acuícola y Pesquera en Veracruz (Mexico) to develop a reproductive biology study of Atlantic blue marlin in the Gulf of Mexico. During September 2022, the Secretariat received a draft proposal for review, with the goal of signing a contract to initiate the study in the near future.

In 2023, funds were available for sampling of artisanal and small-scale fisheries in the eastern Atlantic (Côte d'Ivoire, and Senegal). These funds were allocated to support the estimation of catch and effort statistics of fleets contributing the largest parts of the catch and/or those that in the past have traditionally provided the higher quality data to ensure the preservation of an uninterrupted time series of catch and relative abundance indices. However, no reimbursement has been requested.

2024 plan and activities

The highest priorities for 2024 are to support the objectives established by the Billfish Workplan and those of the EPBR, with specific emphasis on the collection of biological samples for the growth and reproductive biology studies that were on hold in 2019-2022 due to the COVID-19 pandemic, to enhance the collection of fisheries data in developing countries, and to resume field and laboratory research activities as much as possible. Specific activities include the following:

1. Support the collection of billfish biological samples off West Africa;

2. Support the blue marlin biological and photographic sampling in the Gulf of Mexico;

3. Fund a workshop on growth and aging techniques involving researchers from both the eastern and western Atlantic;

4. Support the monitoring of billfish catches from West African artisanal fishing fleets (i.e., Côte d'Ivoire, Ghana, São Tomé e Príncipe, and Senegal);

5. Fund a regional workshop for CPC statistical correspondents on artisanal fisheries data collection in the Central America region with the engagement in this process of the Western Central Atlantic Fishery Commission (WECAFC), particularly to address the issues raised in *Recommendation by ICCAT to establish rebuilding programs for blue marlin and white marlin/roundscale spearfish* (Rec. 19-05), para 16;

6. Fund the development of an App for mobile phones for the collection and report of fisheries data from artisanal fisheries in collaboration with local scientific institution;

7. Fund the satellite tagging of blue and white marlin off the South coast of Portugal.

All these activities depend on successful coordination, sufficient financial resources and adequate in-kind support by the CPCs involved. Details of EPBR funded activities for 2024 are provided below.

Shore-based sampling

Sampling of artisanal and small-scale fisheries to support the estimation of catch and effort statistics will be focused on fleets contributing the largest parts of the catch and/or those that in the past have provided high quality data, to ensure the preservation of an uninterrupted time series of catch and relative abundance indices. In the eastern Atlantic, monitoring and sample collection will be supported for the artisanal fisheries of Côte d'Ivoire, Ghana, São Tomé and Príncipe and Senegal.

Biological studies

The collection of biological samples for a genetic study to differentiate white marlin and spearfish will continue in 2024.

Efforts to finalize the collection of biological samples for age and growth studies for marlins and sailfish caught off West Africa, either from directed or bycatch billfish fisheries of both artisanal and industrial fleets, will also continue. In 2024, increasing effort will be made for processing and analyzing the available samples, which is expected to continue in subsequent years. Such activities require the continuation of financial support from ICCAT and additional voluntary contributions from CPCs.

In 2023, 7 satellite tags from Wildlife Computers were acquired for tagging blue and white marlin (BUM and WHM) off the South Portugal coast in the recreational fishery. These species are known to be present in this area during the summer and early autumn. To date, four trips have been completed, however there was no tagging of billfish so far with satellite tags. Additionally, IPMA/Portugal scientists collaborated with a recreational big-game fishing tournament that took place in southern Portugal in August, which encouraged the practice of catch and release. Two WHM were tagged with conventional tags during that event. This project is ongoing and further trips are being planned during September and October 2023 for satellite tag deployment. If tag deployment is not possible during 2023, tagging efforts will continue in 2024.

Coordination

Training and sample collection

Programme coordinators need to travel to less accessible locations to promote EPBR activities and ICCAT data requirements regarding billfish. This includes travel to West African countries, as well as the Caribbean and South America by the General Coordinator and the West Atlantic Coordinator. Coordinated activities between EPBR, ICCAT/Japan Capacity-Building Assistance Project (phase 2) (JCAP-2) and ICCAT data funds will continue to be required.

Programme management

The EPBR budget is now part of the ICCAT Science Envelope and management is assumed by the programme Coordinators, with the support of the Secretariat. Reporting to the SCRS is a responsibility of the Coordinators. Countries that are allocated budget lines for programme activities need to contact the respective programme Coordinators for approval of expenditures before the work is carried out. Invoices and brief reports on activities conducted need to be sent to the programme Coordinators and ICCAT to obtain reimbursement. Funding requests need to follow ICCAT protocols for the use of funds (see Addendum 2 to Appendix 7 of *Report for Biennial Period 2010-2011, Part II (2011), Vol. 2*).

Expenditures in 2022 and 2023

The total budgets within EPBR for 2018, 2019, 2020 and 2021 amounted to €19,865, €77,000, €28,000, and €75,000, respectively. The effective expenditures for that period were €19,865, €0, and €24,984, respectively.

In 2022 and 2023, in order to implement the main activities planned in the framework of the EPBR, the total budget provided by ICCAT amounted to €75,000 and €70,000, respectively.

The detailed funds available for EPBR during 2022 and 2023 and respective expenditures as at 11 September 2023 are detailed in the table below.

	2022		*2023*	
Component	*Budget (€)*	*Expediture (€)*	*Budget (€)*	*Expediture (€)*
Tagging			36,000	24,333.75
Age and growth	15,000	2,400	5,000	-
Sample collection and shipping	10,000	4,000	2,500	-
Consumables	5,000	2,000	2,500	-
Monitoring eastern Atlantic fisheries	10,000	1,600	5,000	-
SAI stock assessment			10,000	
Workshops	30,000	51,696.33	20,000	10,220.77
TOTAL	**70,000**	**61,696.33**	**81,000**	**34,554.52**

Conclusion

The EPBR is an important programme for meeting the goal of having the highest quality information to assess billfish stocks. The EPBR has been credited for major improvements in the data supporting the last ICCAT billfish assessments and the SCRS advice to the Commission. The EPBR is the only programme that focuses exclusively on billfish, and now has the added benefit of including sampling and data collection from both artisanal and industrial fleets. Therefore, programme continuation is paramount for facilitating the collection of biological and fishery information on billfish species. The EPBR will continue to require support from ICCAT and other sources to operate and address the needs of the Commission.

Appendix 10

Report of the ICCAT Albacore Year Programme (ALBYP)

Background and programme objectives

Since 2010, the Albacore Species Group (ALB SG) has designed a research programme to address key uncertainties that would allow for the improvement of the scientific advice for management of the species. The research programme has now been developed for both the northern and the southern stocks of Atlantic albacore and has been revised on several occasions according to new knowledge, priorities and cost estimates. The research plan is focused on three main research areas: biology and ecology, monitoring stock status, and Management Strategy Evaluation (MSE) for northern albacore. Funds for this research programme have become available since 2021, and were used to develop some of the key research topics as described below.

2023 activities

Since 2021, the Albacore Species Group has prioritized the following research topics: a reproductive biology study to improve knowledge on maturity and fecundity, an electronic tagging study to better understand the life cycle and habitat use, and MSE to follow the MSE schedule agreed by the Commission. The first two research items are being pursued for both the North and the South Atlantic stocks, while the third one is, for now, specific to the northern stock. The following are the cumulative ALBYP activities conducted up to 2023.

Reproductive biology of North Atlantic albacore

ICCAT funds were used to issue a contract to a consortium to undertake this project to improve knowledge of: (a) the reproduction and maturity for the northern Atlantic albacore stock, (b) sex-specific maturity ogives, (c) spatial and temporal spawning grounds, and (d) L_{50} and size/age related fecundity.

The project consortium is led by Dr Alex Hanke and Dr Dheeraj Busawon (Department of Fisheries and Oceans, DFO, Canada), assisted in the coordination of activities by Dr Victoria Ortiz de Zárate (EU-Spain, Instituto Español de Oceanografía - Consejo Superior de Investigaciones Científicas (IEO-CSIC)). Other scientists involved in the project include: Dr Freddy Arocha (Instituto Oceanográfico de Venezuela (IOV), Universidad de Oriente (UDO), Venezuela), Dr Nan-Jay Su (National Taiwan Ocean University, Chinese Taipei), Dr David Macías (EU-Spain, IEO-CSIC) and Dr Kadra Benhalima (DFO, Canada).

During December 2020 and 2021 the sampling plan was focused on pelagic longline fisheries either targeting albacore (Chinese Taipei fleet) or in which albacore were bycatch (Venezuela and Canada fleets). A subsample of fish were aged using the first dorsal fin ray (samples collected by Venezuela; n=163). Dorsal fin rays were processed and read using the methodology described in Ortiz de Zárate and Babcock (2016). Two readers made independent estimations of age of each sample and final age was determined by agreement. This analysis was completed in the first semester of 2022.

In order to determine maturing stage, gonads were also collected from albacore specimens. A total number of 284 gonads were collected, of which 271 were processed (199 from Venezuela and 72 from Chinese Taipei). Ocytes were classified into one of 6 classes according to their different developmental stages using similar terminology to that of Brown-Peterson *et al.* (2011). To determine the maturity stage and ovarian phase of each female, a microscopic maturity scale was applied to identify the Most Advanced Group of Oocytes (MAGO) in the ovary, the Post Ovulatory Follicles (POF) and Vitellogenic Oocytes development (Farley *et al*., 2013 and 2016; and Schaefer, 2001). To estimate fecundity parameters the following two approaches were used: the Weibel method for fecundity estimates (Weibel and Gómez, 1962; Weibel *et al*., 1966; Weibel, 1969) and a new dissector method (Sterio, 1984). Fecundity parameters were estimated on a reduced number of gonads (n=20) collected in May and June of 2021 and from July to September in 2022 (n=39) in the Central North Atlantic area by Chinese Taipei longline vessels.

In 2022, the collection of samples continued by the Chinese Taipei longline fleet that provided n=72 albacore gonads samples. They were taken in the Central North Atlantic area around 20° North latitude.

All the female albacore samples collected in the tropical area by Venezuela longliners were mature specimens, but exhibited no sign of spawning in 2021. These female albacores were classified as being in a resting stage and therefore were not used when estimating fecundity parameters.

The new findings on the reproductive biology of North Atlantic albacore obtained from the analysis of the 2020-2021 samples were presented at the Albacore Species Group meeting in September 2022. In 2023 the collection of albacore samples (gonads and spines) by the longline Chinese Taipei fleet continued in the Central North Atlantic area around 20° North latitude in central and western zones following the fishing activities of commercial fleet. The observers onboard have collected gonadas (n=281) and spines (n=231) from February to August. These samples will be analysed when the ChineseTaipei longline fleet ends the fishing season and will be shipped to the laboratory in charge.

Reproductive biology of South Atlantic albacore

Dr Paulo Travassos, a national scientist from Brazil, is the project leader for this short-term contract, with research activities being conducted with the participation and support of scientists from Brazil (Dr Mariana Rego, Dr Maria Lúcia Araújo, Dr Joaquim Evêncio Neto and Dr Luis Gustavo Cardoso), Uruguay (Dr Andrés Domingo and Dr Rodrigo Forselledo), South Africa (Dr Denham Parker, Dr Sven Kerwath), Namibia (Charmaine Jagger) and Chinese Taipei (Dr Nan-Jay Su).

Important gaps in scientific knowledge remain for albacore in the South Atlantic Ocean that need to be filled in. Thus, the objective of this research is to determine the spawning areas, spawning season, the age-size at maturity, and the fecundity of the southern Atlantic albacore, using samples/measurements provided by participating CPCs. This work is expected to generate vital information for the conservation of the species and the management of fisheries in the South Atlantic.

To achieve these objectives, biological sampling is being carried out in the three main areas in the South Atlantic (oceanic areas off Brazil/Uruguay and Namibia/South Africa). From September 2021 to date, samples have been collected in a joint effort by the partner countries with the aim of sampling on the largest possible space-time scale. However, only samples collected by the Brazilian (145 gonads) and the Chinese Taipei tuna fleets (180 gonads) have been included in the study so far. About 176 gonads of males (n=100) and females (n=76) have been histologically processed and analyzed to estimate L50.

Samples were collected from three different areas along de Brazilian coast: one located in the North (around 4°-6°S Recife fleet), with samples taken between September and November 2021, as well as from February 2022 to April 2023. The second area is located in the South (around 33°-34°S, Rio Grande fleet), with samples collected in February and July 2021. The third area is located around 22°-27°S with samples collected during November-December 2021 (Chinese Taipei fleet). Upon examining the frequency distribution of albacore caught by the three fleets, it was observed that there was a gradient in length composition based on latitude. The Recife fleet, operating at lower latitudes, caught the largest fork length sizes ranging from 91-125 cm. The Chinese Taipei fleet caught sizes ranging from 99-111 cm, while the Rio Grande fleet caught sizes ranging from 81-111 cm.

Based on histological criteria, it was found that 80% of female and 59.8% of male samples analyzed had reproductive activity. In males, the following maturation stages were observed: immature (4.7%), developing (35.5%), spawning capable (35.5%), active (16.8%), and regressing (7.5%). In females, the maturation stages were immature (3.3%), developing (16.7%), spawning capable (13.3%), active (55%), and regressing (11.7%). Based on the data generated for fish classified as capable of spawning and active, the spawning area of the species in the South Atlantic is probably located between latitudes 10°S and 25°S, where many active females are caught in the southernmost part of this area.

The study indicated that both male and female southern Atlantic albacore are mature at larger sizes than previously assumed. Specifically, the L_{50} values were 102.3 cm FL and 96.3 cm FL for males and females, respectively. However, these are preliminary findings, since the sample size and geographic range analyzed were limited. To gain a more precise understanding of the species' maturation sizes along its migratory path, further research with larger and more diverse samples is needed. The range of batch fecundity was found to be between 0.14 - 1.7 million oocytes based on a sample size of only six gonads. Thus, the analysis is yet preliminary. Nevertheless, there appears to be a correlation between ovarian weight and batch fecundity.

Out of the seventy-nine first dorsal fin spines collected, 25.3 have been cut and read, 31.6 have been embedded, and 43.0 have not yet been processed. The range of the number of rings in the analyzed spine sections was 7 to 8 rings, but the number of years is likely higher as the initial rings are not visible due to the vascularization zone of the spine.

Movements and habitat use of North Atlantic albacore

This project is led by Dr Haritz Arrizabalaga (AZTI, EU-Spain), in collaboration with scientists from EU-Spain (AZTI and IEO), and additional support from scientists from different CPCs involved in communication of tagging recoveries and rewards (EU-France, EU-Ireland, EU-Portugal, Japan and Chinese Taipei).

ICCAT funds are used mainly to purchase tags and to cover some of the deployment and satellite transmission costs, while other costs (additional tags, personnel, travel, etc.) are provided as in-kind contributions by participating institutions involved in tagging and analyses activities.

Since 2019, several tagging surveys have been conducted off the Canary Islands and in the Bay of Biscay. The surveys off the Canary Islands were conducted onboard baitboats and charter vessels targeting large individuals during the winter/spring. So far, 29 MiniPATs have been implanted (5 in 2019, 10 in 2020 and 14 in 2022). In the Bay of Biscay, surveys were conducted onboard baitboats used for the bluefin tuna acoustic survey, as well as on recreational and charter vessels using trolling gear, targeting small to medium size individuals during summer and autumn. So far, 108 internal archival tags (Lotek LAT 2810L) and 2 PSATS have been implanted in 2020-2023.

In order to increase the chances of recovering internal archival tags, posters announcing €1,000 rewards were produced in Spanish, French, English, Portuguese, Japanese and Mandarin Chinese and distributed through collaborating ALB SG participants from different CPCs. To date, we have collected data from 26 of the PSATs deployed, which account for an accumulated 1448 tracking days. Of the internal archival tags, 9 tags were recovered, eight of them with times at liberty above one full year. Unfortunately, two of them were recovered with the antenna broken, but the other six provided full year tracks. These recoveries, to our best knowledge, the longest recoveries for an albacore tuna in the Atlantic Ocean. These track cover more than a year in the life of a juvenile albacore that visited shallow waters of the Bay of Biscay in subsequent summers, while inhabiting deeper waters in the central and western Atlantic during the winter, as well as travelling south to the Canary Islands before returning to the Bay of Biscay. Updates of the results obtained thus far were presented to the Albacore Species Group during the Species Group meetings held in September 2022, the North Atlantic Albacore Data Preparatory Meeting (including MSE) (20-23 March 2023) (Anon., 2023a) and the Atlantic Albacore Stock Assessment Meeting (including MSE) (26-29 June 2023) (Anon., 2023h) (Cabello de los Cobos, 2023). In the near future, we will continue deploying the remaining purchased tags.

Movements and habitat use of South Atlantic albacore

The project leaders for this study are Dr Paulo Travassos and Dr Andrés Domingo, national scientists from Brazil and Uruguay, respectively. The main purpose of this study is to provide information about movement patterns and habitat use of albacore in the South Atlantic Ocean, to contribute to the assessment and management of the southern stock of the species.

Initially, a total of 6 miniPAT (WildLife Computers) tags have been made available by ICCAT. These tags arrived in Brazil in February 2022 and since then attempts have been made to tag some specimens off the Northeast coast of Brazil. Taking the opportunity of an expedition to tag yellowfin tuna around the Fernando de Noronha archipelago (Protuna Project, national research supported by the Brazilian government; CNPq

Process No. 445810/2015-7), an attempt to tag albacore in this area was conducted from 23-27 May 2022. However, no albacore were caught during this cruise and thus no fish were tagged. This region of the Fernando de Noronha archipelago does not have a high abundance of albacore and, furthermore, the time of year was not the most suitable for the presence of the species off the Northeast coast of Brazil. The greatest abundance of albacore occurs during the austral spring-summer periods, when the species seeks warm tropical waters for reproductive activity.

After that, no tagging cruise was carried out and then the six tags had to be sent to the manufacturer (WildLife Computers) to change tagware and battery. At the end of May 2023 another six miniPAT tags were delivered to restart the tagging work, with first tagging cruise expected in July/August 2023. In addition, three more miniPATs were sent to South Africa in July 2023. Unfortunately, attempts to deploy MiniPATs have not yet been successful. The teams will continue to deploy tags and an update of the results will be presented in 2024.

Management strategy evaluation (MSE) of North Atlantic albacore

ICCAT funds were used for a short-term contract to AZTI, coordinated by Dr Gorka Merino and Dr Agurtzane Urtizberea, to accomplish the technical tasks required to follow the MSE schedule adopted by the Commission in 2021. According to this schedule, after adoption of the first ICCAT Management Procedure (MP) in 2021 (following adoption of a harvest control rule in 2017), the existence of Exceptional Circumstances must be evaluated on a yearly basis (indicators depending on the year). In addition, a new benchmark stock assessment using SS3 was developed in 2023, which will serve as a basis for conditioning new operating models for the second round of the MSE framework. This new MSE is expected to be delivered in 2026 to allow the Commission to revise the MP if they wish to do so. Moreover, the *Recommendation by ICCAT on conservation and management measures, including a Management Procedure and Exceptional Circumstances Protocol, for North Atlantic albacore* (Rec. 21-04) requires testing alternatives to the adopted MP.

With regards to the OM development in the new MSE model framework for North Atlantic albacore, interested members of the ALB SG worked together with the ICCAT Secretariat and the contractors on the new model structure since 2021. The definition of the fleets, catch, CPUE and size data for the SS3 model was adopted at the 2023 Albacore Data Preparatory Meeting. In 2022, the contractors developed initial SS3 runs, and the results were presented at the September 2022 ALB SG meeting (Urtizberea and Merino, 2022). In 2023, the SS3 model was further developed and discussed at the Albacore Data Preparatory Meeting (Urtizberea *et al.*, 2023a) and the Albacore Stock Assessment Meeting (Urtizberea *et al.*, 2023b). At the 2023 Albacore Species Group meeting, the refined model (Urtizberea *et al.*, 2023c) was presented together with a set of model diagnostics, incorporating the suggestions by the ALB SG. This model produced very similar results to the model used to provide stock status in the 2023 stock assessment but showed a better performance with regards to diagnostics performance. The ALB SG accepted this model as a reference case to structure the OMs for the new MSE.

With regards to the MSE developed to support the adoption of Recommendations 17-04 and 21-04, the performance of MP variants requested in Rec. 21-04, was evaluated by the contractors in 2022 and 2023. These variants consisted of varying levels of target fishing mortality and biomass thresholds, as well as the effect of using only some of the CPUE series on MP performance (Merino *et al*., 2022). They also performed initial tests with varying levels of underreporting and updated the analyses regarding the effect of the carry over provision, implementation error, and alternative stability clauses. They also produced the necessary plots for the ALB SG to discuss the detection of Exceptional Circumstances (Merino *et al*., 2023a), as requested by the Exceptional Circumstances Protocol contained in Rec. 21-04. In 2023, additional robustness tests were developed for the newly adopted natural mortality vector (Merino *et al.,* 2023b).

Expenditures in 2022 and 2023

The total budget within ALBYP in 2018, 2019, 2020 and 2021 amounted to €94,375, €85,000, €130,000 and €100,000, respectively. The effective expenditures for that period were €41,832, €42,788, €163,644 and €133,988.58, respectively.

In 2022 and 2023, to implement the main activities planned in the framework of ALBYP, the yearly budgets provided by ICCAT amounted to €110,000 and €95,000, respectively. The detailed funding allocations and total expenditures for ALBYP as of 11 September 2023 are shown in the **Table 1** below.

Table 1. Details of funds available for ALBYP during 2022 and 2023 and respective expenditures as of 11 September 2023.

Year	*2022*		*2023*	
Component	*Budget (€)*	*Expenditure (€)*	*Budget (€)*	*Expenditure (€)*
Tagging	40,000	39,550.57	40,000	6,000
Reproductive	35,000	14,126	10,000	-
Age and growth	10,000	6,360	10,000	-
Sample collection and shipping	5,000	12,370.44	5,000	-
MSE	20,000	19,800	30,000	-
TOTAL	**110,000**	**92,207.01**	**95,000**	**6,000**

2024-2025 Plan and activities

Reproductive biology and aging of North Atlantic albacore

In view of the inherent difficulties in collecting mature albacore and the need for additional gonads samples to better cover the spatio/temporal strata of maturity and fecundity estimates in the North Atlantic sampling, additional sampling of gonads, spines and otoliths is planned through the end of the autumn and winter 2023 onboard longliners from Venezuela. Sampling activities will continue in 2024 to achieve a number of samples that will resume a comprehensive study on reproductive biology of northern albacore. When new samples are provided to the IEO laboratories involved, the analyses will be done using the same methods as previously used to estimate maturity stage and fecundity. The corresponding spine samples will be aged to determine the age of fish sampled for the reproductive staging and fecundity study.

In order to estimate the maximum age of albacore tuna to inform hypotheses about natural mortality, additional samples for aging (spines and otoliths) of large individuals (>100 cm SFL) are required (100-200 individuals per stock). A sample of spines, already aged, is available, and additional samples are and will be available to complete this study.

Reproductive biology and aging of South Atlantic albacore

Given that only samples collected by the Brazilian and Chinese Taipei tuna fleets have thus far been analyzed, priority will be given to collecting samples from the other partner countries (mainly Namibia and South Africa). Samples will be shipped to Brazil for analysis. It is anticipated that these samples will provide information about different spatial and temporal strata. This sampling effort should continue during 2024-2025.

Paired (otolith and spine) samples of large albacore will also be collected in order to verify natural mortality assumptions based on maximum age.

Movements and habitat use of North Atlantic albacore

During the rest of 2023 and 2024-2025, we plan to continue deploying additional tags using different tagging opportunities (commercial, research, charter and recreational vessels) with the intention to better characterize the life cycle of North Atlantic albacore and consider stock structure assumptions. Following the experience of recent years, deployments are planned by AZTI scientists in the Bay of Biscay and the Canary Islands but may be expanded to other areas if opportunities arise, especially in the western Atlantic if suitable tagging platforms are identified.

Movements and habitat use of South Atlantic albacore

Tagging activities will restart in the second half of 2023, and throughout the years 2024-2025, depending on availability of tags. The intention is to tag albacore caught by baitboats that target skipjack tuna off the Southeast coast of Brazil; albacore is caught in small proportions in this fishery. The advantage of this approach is that the tagged fish will be in good condition due to the characteristics of this fishing method. New attempts to tag the species will also be made in the Northeast region of Brazil from September to October, when the spawning season begins, thus increasing availability of adult fish. Additional tagging efforts will be conducted in South Africa.

Management strategy evaluation of North Atlantic albacore

In 2024 a new set of Reference and Robustness OMs will be structured using the reference case developed in 2023. A key development expected for this MSE is the simulation of the observed errors in abundance indices, which can be configured with a random error function or reproducing the statistical properties of the indices to the SS3 models. In 2024 and 2025, empirical and model-based MPs will be developed and evaluated. At least one of the MPs considered should the one adopted in Rec. 21-04.

Appendix 11

Report of the Swordfish Year Programme (SWOYP)

Background and programme objectives

Since 2018, the Swordfish Species Group has conducted a research programme to address key uncertainties important for improving the scientific advice for management of the species. The research programme encompasses all three ICCAT swordfish stocks and has been modified each year to respond to new knowledge, priorities and cost estimates. This programme aims to improve knowledge of the stock distribution, age and sex of the catch, growth rates, age at maturation, maturation rate, spawning season and location, stock boundaries and mixing, thereby contributing to the next major advance in the assessment of swordfish status. The SWOYP also encompasses an electronic tagging study to better understand swordfish life cycle and habitat use, and management strategy evaluation (MSE) for the North Atlantic stock to follow the MSE schedule agreed by the Commission collectively. These projects should translate into more reliable advice on stock status for this internationally and collectively managed resource. The Swordfish Species Group has identified this work to be of high priority and will address critical deficiencies in our understanding of the population dynamics and ecology of the stocks. The programme, which has been running on a short-term contractual basis since 2018, was formalized as a ICCAT research programme in 2022.

Overview of activities

The Swordfish Species Group (SWO SG) prioritized the following research topics: an ageing and growth study to improve knowledge of growth patterns among the stocks; a reproductive biology study to improve knowledge on maturity and fecundity; a genetics study to better define stock boundaries and estimate rates of mixing among the stocks; an electronic tagging study to better understand the life cycle and habitat use, and management strategy evaluation to follow the MSE schedule agreed by the Commission. These projects are overseen by a Consortium led by Canada (Dr Kyle Gillespie and Dr Alex Hanke, Fisheries and Oceans Canada) and administered by The Nova Scotia Swordfishermen's Association. Each of the three research areas are overseen by project leaders: ageing and growth (Dr Rui Coelho and Ms. Daniela Rosa, Instituto Português do Mar e da Atmosfera (IPMA)); reproduction (Dr David Macías (Instituto Español de Oceanografía (IEO)); and genetics (Dr Oliana Carnevali and Dr Giorgia Gioacchini (Università Politecnica delle Marche) (UNIVPM)). A total of 21 institutions from 14 ICCAT CPCs are involved in collection and analysis of samples. Three SWOYP biology workshops have been held: the first, in 2019, to refine and standardize sampling methods and sample processing; the second, in 2021 to review study results, and create ageing and histology reference sets and review results from a first calibration exercise; and a third in 2023 to progress ageing protocols, age calibration, age validation, and development of a reference set. Electronic tags have been used to support movement and habitat use studies in data-limited regions. ATL-N MSE, initiated in 2018 is being conducted by a core technical team and an outside contractor. The SWO SG is scheduled to deliver a final set of CMPs to the Commission in 2023.

Sample collection and coverage

Through all phases of this programme, 4,647 samples have been collected from longline fisheries, covering all three stocks. The majority of samples collected consist of an anal fin spine for aging, a piece of tissue for genetic analysis, and include data on fish size, sex, location and catch date. A subset of samples includes otoliths for aging or a piece of gonad for reproductive analysis.

Samples were collected in several of the major fishing areas in the North and South Atlantic and Mediterranean. Sampling in early project phases in the North Atlantic was concentrated in three areas: the Scotian Shelf, in the western Atlantic; along the 39°N parallel, in the eastern Atlantic; and off the western coast of Morocco in the eastern Atlantic. All three of these are major areas for swordfish catch. Samples obtained near the Strait of Gibraltar are of particular relevance to understand mixing between Atlantic and Mediterranean stocks. In later programme phases, a significant number of samples were obtained from the US East coast (billfish sampling area 92), however gaps remain in the Gulf of Mexico (BIL91) and the Caribbean (BIL93). Samples were also added from the coastal waters of Venezuela. In the cases of the Gulf of Mexico and Caribbean, there is relatively little swordfish catch, however, we anticipate that future sampling efforts will include data from these areas.

Sampling in the South Atlantic occurred between 5°N and 6°S, stretching from the coast of Brazil to the Gulf of Guinea. More than half the samples were obtained in this zone which spans two billfish sampling areas (BIL96 and 97). This is an area of significant swordfish catch in distant water fishing fleets. This is also as an assumed mixing area for North Atlantic and South Atlantic stocks. In addition, samples were collected in the waters of Brazil and off the coast of South Africa and Namibia. The South coast of Brazil and Uruguay and stretching east along the 30°S parallel is a major area for swordfish catch but so far have had limited sampling in this programme.

Mediterranean sampling occurred in three regions: the Balearic Sea, in the western Mediterranean; the Tyrrhenian and Adriatic Seas, in the central Mediterranean; and the Greek Islands. Sampling coverage of these seas appears somewhat representative of spatial-temporal patterns in the catch. More samples are required in the very western region of the Mediterranean, in the Alboran Sea and approaching the Strait of Gibraltar where there is suspected mixing between North Atlantic and Mediterranean stocks. Additional sampling is also required in the eastern Mediterranean in the Ionian and Aegean Seas.

Reproductive biology of swordfish in the Atlantic and Mediterranean

The reproductive biology study has the following objectives: a) improve knowledge on the reproduction and maturity for Atlantic and Mediterranean swordfish, b) obtain sex-specific maturity ogives, c) identify spatial and temporal spawning grounds and d) estimate of L_{50} and size/age related fecundity.

The sex of fish was determined via macroscopic observation and through histological analysis. 86.5% of samples were assessed for sex, while in the remaining 13.5% of samples, gonads were not available for assessment or were in a state where sex was ambiguous. Sex data are not typically collected in national sampling programmes, nor are these data required in ICCAT reporting, making it difficult to assess the representativeness of these data. In all regions, females outnumber males in the sample. The most extreme difference in sex ratio was observed in the Mediterranean, where only 30% of fish were assessed as male. This region also had the greatest level of uncertainty, where sex was unknown in approximately 30% of fish. Imbalance in sex ratios may be a result of inherent spatial zonation between sexes or it may be a result of males being classified as "unknown" at higher rates than females. For example, a large proportion of the sampled fish come from more northerly water where female swordfish are known to be at higher abundances.

Maturity was assessed on a six-point scale. Nearly a third of fish sampled had maturity states that were labelled as "undetermined", and these data require further verification. In some cases, histological data are available for samples and in these cases, macroscopic assessments of gonads will be compared to histological data.

A preliminary analysis of L_{50} comparing macroscopic and microscopic data was conducted in 2020 (Saber *et al*., 2020b). Altogether, 2,434 data on sex and macroscopic maturity for swordfish from the North and South Atlantic, and the Mediterranean Sea have been collected covering an ample size range (58 to 261 cm LJFL). About 768 gonad samples have been collected from the North Atlantic and the Mediterranean Sea. Further analysis will be conducted after increasing the sample size. See Saber *et al*. (2020b) for a preliminary analysis of the samples collected to date, and recommendations on next steps for data and sample collections. The descriptions of length frequencies by month/season and by stock of the swordfish sampled for maturity data are also provided.

Fish were classified as either immature (stage 1) or mature (stages 2 - 5). The L_{50} was estimated using the macroscopic maturity data. Sample gonads were sent to the coordinator of the reproductive studies in IEO-Málaga (Spain). Microscopic maturity stating of gonads was based on a modification of the criteria of Schaefer (2001) and Farley *et al.* (2013).

As expected, the analysis of the sex-ratio showed that females were more abundant than males, but further work is needed to verify if the sampling scheme is taking into account both sexes. The estimated L_{50} in the preliminary analysis for the three stocks was consistently lower than those adopted by the SCRS. However, it should be remarked that the significant number of histological sections of ovaries examined showed that females microscopically classified as immature were often incorrectly staged as developing (stage 2, mature) when using the macroscopic criteria. In 2023, an additional 42 samples from Chinese Taipei and 247 samples from Portugal have been processed. Histological analysis of these samples is ongoing.

Further calibration and exercises are needed to increase capacity within the Group to analyse gonad samples. Furthermore, samples are required from hypothesized spawning areas in the Sargasso Sea and the Gulf of Guinea.

Increasing the sampling of swordfish across the Mediterranean Sea and Atlantic Ocean is necessary to collect enough data for the reliable estimation of maturity and other reproductive traits, as is the validation of the macroscopic maturity data using the histological examination of gonads.

Ageing and growth in Atlantic and Mediterranean swordfish

The objectives of the ageing and growth study are to a) develop a standardized methodology for ageing spines and otoliths, b) validate ages through procedures such as bomb radiocarbon, and c) update the sex-specific growth formulas using new sample data and modeling techniques.

A total of 3535 spine samples (1396 males, 1774 females, 365 specimens with undetermined sex) were collected for this study from the North, South Atlantic and Mediterranean Sea. A total of 1352 otolith samples (583 males, 731 females, 38 specimens with undetermined sex) were collected for this study from the North, South Atlantic and Mediterranean Sea.

From the collected spine and otolith samples, 1093 spines, 288 otoliths for annual ageing and 56 otoliths for daily ageing have been processed for the North Atlantic. For the South Atlantic, 979 spines, 500 otoliths for annual ageing and 11 otoliths for daily ageing were processed. For the Mediterranean, 173 spines, 44 otoliths for annual ageing and 6 otoliths for daily ageing were processed.

Sectioning of spines and otoliths is performed at Fish Ageing Services (FAS; Australia). Preparation of spines follows Quelle *et al.* (2014). The second anal fin spine is embedded individually in resin for sectioning, two sections of approximately 0.5 mm were made at one distance of the condyle width (1D) and at half distance of the condyle width (0.5D). Smaller spines were sectioned with a modified gem cutting machine high speed saw, using a single pro slicer diamond blade, while larger spines were sectioned using an Isomet with a diamond wafering blade. Spine sections were preserved in a polyplex clear ortho casting resin and photographed under a dissecting microscope with a digital camera.

Before processing, whole otoliths were measured for length and width and photographed using a Leica M80 with transmitted light and 5x magnification. Otoliths were prepared for annual and daily age readings in thin transverse sections by grinding down the otolith in a 3-step process. Firstly, the otolith was fixed on the edge (end) of a slide using thermoplastic mounting media (Crystalbond 509) with the anterior side of the otolith hanging over the edge. Care was taken to ensure that the primordium was just on the inside of the glass edge. The otolith was then ground down to the edge using 400 and 800 grit wet and dry paper. The slide was then reheated, and the otolith was removed and placed (ground side down) on another slide and Crystalbond was allowed to cool. Once cooled the otolith section was ground horizontally to the grinding surface using varying grades (400, 800 & 1500 grit) of wet and dry sandpaper and finally 5um lapping film. During this process, the otolith preparation was continuously checked for the appropriate thickness (220μm – 250μm for annual readings or 50-80μm for daily readings). Otolith sections were preserved in a polyplex clear ortho casting resin and photographed at a 40x magnification using a Leica M80 dissecting microscope illuminated with transmitted light.

In 2022, a preliminary analysis of an age reading for the North Atlantic stock was completed. Multiple readers read both spines and otoliths and biases were found between readers for both structures. The maximum modal age in spines was 7 years and in otoliths 5 years. The mean length at age from spines was similar to the mean lengths at age from the Arocha *et al.* (2003) study. Sampling, processing, and age readings will continue under the program which will contribute to development of new sex-specific growth models for the three stocks.

During phase 5 of SWOYP a joint workshop for swordfish (SWOYP); billfishes (EPBR) and small tunas (SMTYP) was conducted with the objectives of enhancing expertise among ICCAT scientists by sharing knowledge, standardizing methodologies and reviewing the work already completed and further developing plans for next steps in these research programs.

A new SWOYP ageing and growth project area in 2023 was age validation via bomb radiocarbon analysis. The aim of this component of the age and growth is to use a well-developed reference system for age validation of broadbill swordfish to provide valid otolith age reading protocols and life history characteristics that are essential for sustainable fisheries management. A state-of-the-art method used to address these concerns - known as bomb radiocarbon (14C) dating - has been refined over the last 30 years. Technological improvements, coupled with insight on propagation of the bomb-produced 14C signal in aquatic ecosystems, are now available to resolve age estimation issues for challenging fishes, and specifically for recently collected, fast growing pelagic fishes.

Aged SWO otoliths were selected from archived specimens at the SWOYP (IPMA) and National Oceanic and Atmospheric Administration - Southeast Fisheries Science Center (NOAA-SEFSC) covering the collections made in the 1980s and 1990s to the 2010s and 2020s. From more than 1000 otoliths archived with SWOYP (IPMA), a series of SWO sizes and ages were selected for an analysis of otolith mass as a possible proxy for age that might elucidate maximum ages. This resulted in 30 SWO specimens that had both sagittal otoliths (one aged or to be aged and one intact for bomb 14C analysis) and covered a range of 88-258 cm Lower Jaw Fork Length (LJFL) with otolith masses of 0.234-4.267 mg. Selections were focused on collection years 2018-2019 to cover maximum sized fish available and to best utilize the post-peak 14C decline - young to old fish from a narrow collection period (1-2 years) would progressively trace more elevated 14C levels as calculated hatch years (derived from otolith age reading) extend back in time, toward the bomb 14C peak. Hence, the rate of 14C change recorded in the otolith core of aged fish would agree with the rate of change in environmental 14C. It is anticipated that this work will continue in future project phases.

Genetics, stock delineation, and mixing in Atlantic and Mediterranean swordfish

The objectives of the genetics study are to a) sequence the swordfish genome and identify genetic markers for differentiating between the three stocks, b) evaluate stock boundaries, and c) identify stock mixing areas.

The swordfish genome assembly was completed using a sequencing strategy that combined Oxford Nanopore (MinION) and Illumina (NovaSeq 6000) technologies following standard analysis in a well-established bioinformatics workflow.

By comparing the swordfish genome with that of other 19 fish species, the percentage of swordfish-specific genes and the percentage genes shared was identified. A Gene Ontology Enrichment Analysis (GOEA) was performed on several swordfish-specific orthologous groups to highlight their involvement on Biological Process, Molecular Function and Cellular component. Finally, the new assembled genome was used as a reference genome to guide the double digest restriction-site associated DNA (ddRAD) analysis. Accordingly, the rationale behind this strategy was based on: 1) the better performances (i.e. precision) of the genotyping when guided with a reference genome, and 2) the finer scale of resolution and the expanded set of biological questions that can be addressed when a reference genome is available.

Double digest restriction-site associated DNA (ddRAD) sequencing technology was applied to obtain more than 40,000 SNPs for the analysis of genetic differences among 672 samples collected from the North Atlantic, South Atlantic and Mediterranean stocks. In particular, from the North Atlantic, 322 samples were analyzed, of which 54 samples from BIL92, 12 samples from BIL93, 44 samples from BIL94A, 182 samples from BIL94B and 30 samples from BIL94C. From the South Atlantic a total of 105 samples were analysed of which 11 were from BIL96 and 94 from BIL97. Finally, from the Mediterranean, 243 samples were analysed of which more than 100 were from Balearic Islands. Samples were selected homogeneously not only on the basis of the catch area but also on the basis of gender, gonad maturity, length/weight, and period of catch.

To analyze genetic differentiation among samples, several statistical analyses including Principal Component Analysis (PCA), Discriminant Analysis of Principal Component (DAPC), pairwise genetic distances (heatmap matrix), NEIGHBOR-JOINING Cladogram were applied. Regarding genetic differentiation index such as, Fixation index (FST), Heterozygosity (both observed and expected), Observed heterozigosity related to single codifying genes, Inbreeding coefficient (FIS) and allelic richness (both mean and total) were also calculated. Genetic structure was evaluated quantifying allelic frequencies clusters and their distribution among samples. Two populations were clearly identified among the whole samples analyzed and considerable evidence on the presence of subpopulations within the two populations emerged from the first 288 samples analyzed, and in 2022 an additional 672 samples were analysed.

Also in 2022, Whole Genome Sequencing (WGS) analysis was completed on 30 samples from each stock in order to identify a set of SNPs that can be used to assign an unknown sample to one of the stocks and to identify sex-specific regions to assign sex to an unknown sample.

The coupling of SNPs and WGS analyses with a genome assembly showed that: 1) the Mediterranean stock is strongly genetically differentiated from the two Atlantic stocks; 2) the North Atlantic and the South Atlantic stocks are weakly differentiated, and their differentiation is detectable only with few statistical tests; 3) the coupling of genome-wide SNPs analysis with a genome assembly of the allelic richness is the optimal genetic diversity index to monitor these stocks; 4) the Mediterranean stock is losing allelic richness of important genes associated with detoxification, immune response, vitamin up-take and metabolism and serotonin signaling; 5) in the East-North Atlantic a mixing area for all three stocks was found and the presence of these animals should be considered when genetic variability is monitored in this area; 6) no animals belonging to the North Atlantic stock have been found in the Mediterranean Sea.

Building on work that identified genetic markers for stock differentiation, 200 samples were analyzed in 2023. Previous SWOYP genetic work has identified an area in the North-East Atlantic as a potentially important stock mixing area. Samples were from 150 swordfish caught in the Northeast Atlantic area in which all the three stocks (NA, SA and MD) have been sampled, in addition to 50 samples coming from MD area. These new samples will be analyzed and compared to samples sequenced in previous project phases, using an additional genetic analysis to report "F3 statistics". This statistical analysis represents an alternative way to measure the allele frequency correlations and relationship among the three stocks (NA, SA and MD) to better evaluate whether admixture exists. The integration of the analysis already carried out using the "Structure" genetic technique will provide further statistical support to the analysis.

New epigenetic techniques have led to advancements in age estimation by examining level of methylation in the genetic material. The goal of this project component was to conduct a pilot study to assess viability of these techniques in swordfish. To develop a pilot study on epigenetic ageing, we identify 1,311 CpG sites that were found to have appropriate methylation levels. These sites were identified as having significant correlation with fish age in other fish taxa (e.g. zebrafish), and therefore are promising for the swordfish age analysis the SWOYP would like to develop. The availability of whole genome sequencing expertise within the SWOYP will allow this programme to identify the conserved CpG sites related to ageing among the swordfish stocks.

This first step provided the SWOYP a swordfish dataset of age-related CpG sites that will be used to define swordfish epigenetic clocks by Reduced Representation Bisulfite Sequencing (RRBS). In the next SWOYP project phase, ten swordfish of different ages previously determined by otoliths analysis and confirmed by radiocarbon analysis, will be analyzed by RRBS.

Tagging

The objective of the swordfish tagging study is to analyse the vertical habitat-use and migration patterns of swordfish and help to delimit the stock boundaries and mixing rate of swordfish between the Mediterranean Sea and the North and South Atlantic. Fifty ICCAT funded tags have been acquired since 2018, when the tagging programme was implemented. To date, a total of 35 miniPAT tags (12 tags have been provided by NOAA) have been deployed in the North (n = 19) and South Atlantic (n = 12) and the Mediterranean Sea (n = 4). Additionally, 5 X-Tag tags have been deployed in the North Atlantic. Data from 10 tags, with deployment days between 67 and 240 days, show that swordfish moved in several directions, travelling considerable distances in both the North and South Atlantic Ocean, while having shorter displacements in the Mediterranean Sea. Regarding vertical habitat use, swordfish spent most of the daytime in deeper/colder waters, and were closer to the surface during the night-time, mostly between the surface and 50 meters in depth. Efforts to include in the analysis historical tags deployed by NOAA and DFO have started in 2023. Updates of this work are regularly provided to the SCRS/SWO SG with the latest one presented in Rosa *et al*. (2022). One dedicated trip for tagging was made in the Northwest Atlantic in 2023. Unfortunately, this trip was not successful. Approximately 20 electronic tags are available for deployment in 2024.

Management Strategy Evaluation in the North Atlantic

The Commission is scheduled to adopt a management procedure in 2023.

Following minor revisions to the OM grid values in 2023, the technical team consulted with ICCAT's Panel 4 on key elements of the MSE framework. Selection of a management procedure requires evaluation of candidate management procedures (CMPs) against predetermined management objectives. The technical team worked with Panel 4 to better define performance metrics, acceptable probability values for those management objectives, and time spans over which those probabilities should be calculated. A variety of model based and empirical CMPs were developed, tuned, and then evaluated for performance. Interactive tools were developed to show trade-offs for among CMPs. A series of Panel 4 engagements, as well as ambassador communications sessions laid the groundwork for managers and stakeholders to understand MSE uncertainties and then provide guidance to the MSE technical team on management priorities as well as priorities for robustness testing.

Based on guidance from Panel 4, in September of 2023, the SWO-N technical team created a shortlist of CMPs for the Panel to consider for adoption. This list includes a variety of harvest control rules, each spanning the performance trade-off space. An Exceptional Circumstances Protocol must be developed in collaboration with Panel 4.

This new MSE framework is a major shift in how the SCRS and the Commission interact for the formulation of management advice. It should be expected that review of this process and the assumption used to model stock dynamics be revisited on a regular basis. In 2023, Panel 4 and the technical team developed a schedule that define when stock assessments and other checks be used to evaluate the performance of the MSE. This collaborative process between ICCAT scientists and managers will require continued engagement between the SCRS and the Commission in coming years.

Expenditures in 2022 and 2023

The total budgets within SWOYP in 2018, 2019, 2020 and 2021 amounted to €199,000, €373,700, €280,614 and €343.480, respectively. The effective expenditures for that period were €149,895, €312,434, €194,734 and 292,134.47, respectively.

In 2022 and 2023, in order to implement the main activities planned in the framework of SWOYP, the total budget of provided by ICCAT amounted to €170,000 and €250,000, respectively.

The detailed fund available for SWOYP during 2022 and 2023 and respective expenditures as of 11 September 2023 are detailed in the table below.

Year	2022		2023	
Component	Budget (€)	Expenditure (€)	Budget (€)	Expenditure (€)
Tagging	10,000	2,640.25	20,000	-
Biological studies	15,000	6,000	5,000	-
Genetics	70,000	28,000	80,000	-
Age and growth	45,000	18,000	25,000	-
Sample collection and shipping	10,000	4,462.43	5,000	-
MSE			100,000	45,000
Workshops	20,000	22,642.89	15,000	
TOTAL	**170,000**	**81,745.57**	**250,000**	**45,000**

2024 Plan and activities

Sampling

The focus of SWOYP has largely shifted to analysis of samples already collected by the programme, however, sampling will continue in 2024, targeting spatial sampling gaps: the Gulf of Mexico, Caribbean, Strait of Gibraltar, the far Eastern Mediterranean, the mid-North Atlantic, southern Brazil and the area stretching East along the 30°S parallel. Additional effort will be invested in collecting gonads and otoliths as these materials have been more challenging to acquire. In addition, otolith-spine pairs in larger fish, will be collected to support the growth curve modelling. Additional CPCs and institutes are welcomed and encouraged to support sample collection and analysis.

Reproductive biology

The reproductive biology component of the SWOYP will continue in 2024 with processing and imaging of gonads. A reproduction, ageing and growth, and genetics workshop in 2024 will focus on creating a reference set of histological images and CPC scientists involved in the study will work to standardize their methods for determining maturity stage. Anticipating increased capacity in the group to evaluate maturity stage, we expect that the preliminary maturity ogives developed in previous project phases will be updated for the North Atlantic and Mediterranean stocks in 2024. Additional samples are required before this work can be initiated for the South Atlantic. Preliminary work will begin in 2024 to estimate fecundity by stock.

Ageing and growth

The ageing and growth component of the SWOYP will include the following in 2024: continued age readings from spines and otoliths, grow modeling, and age validation through bomb radiocarbon analysis. A core team of age readers has prepared a reference set of fin spines and otoliths and have conducted an initial calibration exercise. This Group will continue their readings to increase the number of samples included in the growth modeling. Bomb radiocarbon analysis, initiated in 2023, will continue. This analysis will allow for validation of age readings and will support epigenetic ageing work.

Genetics

Genetics work in 2024 will continue the population analysis of tissues samples coming from new areas (South Africa, Brazil, North Central Atlantic Ocean, Strait of Gibraltar, North African coast) for stock differentiation analysis. In 2023, the genetics team conducted a pilot study on epigenetic ageing, to correlate with otoliths, spines and the bomb radiocarbon study. This work is anticipated to continue in 2024.

Tagging

Tagging work will continue in 2024 with deployment of tags already on-hand. This work will continue to support studies on swordfish distribution, movement, and habitat use. These data will also support ongoing work on the swordfish species distribution model.

Management Strategy Evaluation

The Swordfish Species Group is scheduled to provide the Commission with a final set of CMPs by the end of 2023 for use in management advice for 2024. In 2024, the work will continue, mostly related to development of an Exceptional Circumstances Protocol and further development of robustness tests. The species group will also continue a preliminary simulation study to explore the suitability of MSE in the South Atlantic Stock.

Appendix 12

Report of the 2023 Meeting of the Subcommittee on Ecosystems and Bycatch
(*hybrid / Madrid, Spain, 8-12 May 2023)*

The Report of the 2023 Meeting of the Subcommittee on Ecosystems and Bycatch is provided here.

Appendix 13

Report of the 2023 Meeting of the Subcommittee on Statistics
(Hybrid/Madrid, Spain, 22-23 September 2023)

1. Opening, adoption of Agenda and meeting arrangements

The Subcommittee on Statistics (SC-STAT) annual meeting was held in Madrid on 22-23 September 2023, under a hybrid format. The Chair of the SC-STAT, Dr Pedro Lino (EU), opened the meeting. The Chair of the Subcommittee, highlighting the complexity associated to hybrid meetings, reinforced the need to work efficiently focusing on the main aspects.

The Agenda was discussed and adopted (**Addendum 1 to Appendix 13**) with modifications. Mr Carlos Palma and Mr Carlos Mayor (ICCAT Secretariat) served as rapporteurs to the meeting. The List of Participants is attached as **Addendum 2 to Appendix 13**. The List the Documents presented during the meeting is summarised in **Addendum 3 to Appendix 13**, with the respective summaries provided in **Addendum 4 to Appendix 13**.

2. Summary of fisheries and biological data submitted during 2022 (Tasks 1, 2 and 3), including historical revisions

The Secretariat provided a summary of the data reported at the time of the meeting (an overview of the 2023 detailed Secretariat Report on Research and Statistics) covering the activities and the information on fisheries statistics and biological data received (including revision to historical data) between 1 October 2022 and 6 September 2023 (the Reporting Period). Furthermore, all the basic fisheries statistics and biological information were presented by the Secretariat to the SCRS working groups during the SCRS intersessional meetings.

After five years of continuous improvements, the Secretariat observed a slight regression in data provision for years 2019 and 2020 (provided during 2020 and 2021, respectively), a slight improvement for 2021 data, and again a slight regression in data completion and quality for 2022 data. Compared to the previous year, more datasets only passed the SCRS filtering criteria after the corrections were made by the Secretariat (errors mostly linked to incomplete forms and invalid use of ICCAT codes). In addition, the information submitted using old electronic forms (versions prior to 2023) increased to a total of 8% of the nearly 1200 forms submitted during the Reporting Period, with 19 ICCAT CPCs submitting information in old form versions (14 ICCAT CPCs in 2022 providing 2021 data). The Subcommittee reminds CPCs that only the latest version of the electronic forms is valid to submit new and historical data as they incorporate the latest changes approved by the SCRS.

Regarding the activities conducted by the Secretariat, in the most recent years, in addition to the normal activities developed on statistics, publications, data funds management and others, the Secretariat is dedicating (apart from the usual preparation of the majority of the data sets required for each data preparatory meeting and each stock assessment) substantial additional work to stock assessment activities, whether participating actively in the assessment or coordinating and managing external support to the SCRS work. In addition, the statistical work requested to the Secretariat, together with some lack of adherence to deadlines established for data submission (slightly improved this year), continues to constitute significant additional work for the Secretariat. However, to partially mitigate the consequences of the already excessive workload, the Secretariat has been able to improve the automation of data integration and validation procedures.

The Secretariat applied to the 2022 datasets reported during the Reporting Period, the SCRS filtering criteria to accept/reject statistical forms (Filters 1 & 2, Addendum 2 to Appendix 8 of the *Report for Biennial Period, 2012-13, Part II (2013), Vol. 2*) adopted in 2013. The results are based on a total of 75 flags related to CPCs (50 CP + 1 CP [15 EU Member States] + 1 CP [5 UK flag States] + 5 NCC) with reporting obligations. The forms submitted with errors that the Secretariat was unable to correct until the end of the SCRS annual meeting were considered unreported data and shall require CPC revisions.

The overall reporting status for 2022 data (**Figure 1**), shows that 63 of the 75 flag CPCs (84%) have reported fisheries and biological information: 59 flags with catches (79%) and 4 flag CPCs reported no fishing activity (5%). During the week of the species group meetings, several ICCAT CPCs reported new or revised data for 2022 and prior years. This late reporting considerably hampered the ability of the Secretariat and the SCRS to conduct their work.

2.1 Basic Task 1 (T1FC and T1NC) and Task 2 (T2CE and T2SZ) statistics

The Secretariat presented a summary of the 2022 data reporting status of the two datasets of Task 1 statistics (T1FC: Fleet Characteristics, T1NC: Nominal Catches), and of the three datasets of Task 2 (T2CE: catch and effort; T2SZ: size frequencies; T2CS: catch-at-size) using the standard SCRS Report Cards (Tables 1, 2, 3 and 4 [for both T2SZ and T2CS] of the 2023 Secretariat Report on Research and Statistics, respectively).

The form ST01-T1FC is used to report T1FC information on individual vessels (sub-form ST01A) and summarized information for vessels less than 20 m LOA (sub-form ST01B). The overall reporting of T1FC for 2022 was 73% (55 flags) lower than the 81% (61 flags) observed for 2021. Two flags reported ST01 after the deadline, and the Secretariat made corrections to the information reported by 9 flags CPCs.

The form ST02-T1NC is used to report T1NC information and has two sub-forms: 1) ST02A used to report positive catches (landings, dead discards, and live releases), and 2) ST02B used to report "zero" catches. The overall reporting of T1NC data for 2022 was 84% (63 flags) lower than for 2021 data with 65 flags (87%) reporting this information. One flag CPC reported late, and corrections were made to the datasets of 13 flags. Twelve flag CPCs (16%) have yet to report their 2022 T1NC information.

The form ST03-T2CE (a single form) is used to report T2CE information (observed or raised to the total catches). A total of 51 flags (68%), including one late reporting flags, reported T2CE (similar to the values of 2020 data with 53 flags corresponding to 71% of the total). Twenty-four flag CPCs (32%) have yet to report T2CE data for 2022.

The T2SZ/CS report card covers 2022 data reported in both ST04-T2SZ and ST05-T2CS forms. A total of 41 flag CPCs (55%), including 2 late reporting flag CPCs, submitted 2022 size data. A total of 34 flag CPCs (45%) have pending the submission of 2022 size data. These indicators are slightly worse than the ones observed for 2020 and 2021 size data (**Figure 1**).

The Secretariat informed that four flag CPCs reported no fishing activity on ICCAT species ("0" catches in all species) for 2022 calendar year, well below the number observed in previous years. The list of flags with "0" catch reports is published in the Table 5 of the 2023 Secretariat Report on Research and Statistics, which presents a summarised view of the reporting status of all the Task 1 and Task 2 datasets for 2022.

The Task 1 and Task 2 dataset provisions over the last six SCRS meetings (**Figure 1**) gives the broader perspective of the ICCAT flag CPCs reporting status at the beginning of each SCRS annual meeting.

The Secretariat informed that, globally across all the Task 1 and 2 datasets, the most common deficiencies continue to be incompleteness of the header and detailed sections of the electronic forms, empty sub-forms (e.g., ST01B for small scale vessels; ST02B for "0" catches), use of non-ICCAT codes, and the use of old form versions. All these four types of deficiencies, identified with "orange" cells in the SCRS report cards (Tables 1 to 5 of the 2023 Secretariat Report on Research and Statistics), do not pass the SCRS filtering criteria and do require Secretariat explicit corrections (or data completion) and posterior confirmations and/or revisions by the CPCs. The Subcommittee reiterated the need for the ICCAT CPCs to pay a special attention to these four deficiency types in future submission. The Subcommittee also encouraged the statistical correspondents of the CPCs that need clarifications on their 2022 data reporting status to contact the Secretariat to resolve the problems identified.

The Secretariat also informed that T1NC dashboard is now fully operational and has been published on the ICCAT website. During 2023, improved versions of the T1NC dashboard were also prepared for the 2023 species groups intersessional meetings. The Subcommittee commended the Secretariat to continue the work on the development and maintenance of T1NC dashboards as an important means to properly disseminate T1NC information.

2.2 Tagging

The Secretariat provided a summary of the tagging data received by the Secretariat during the Reporting Period. The different laboratories and scientific institutions conducting electronic tagging in the ICCAT Convention area reported a total of 270 releases and 121 recoveries. With respect to the conventional tagging (details in Table 7 of the 2023 Secretariat Report on Research and Statistics), a total of 5,941 tags were deployed and 422 were recovered. In the same period, the Secretariat distributed about 2,075 conventional tags, primarily under the tagging projects of the Atlantic-Wide Research Programme for Bluefin Tuna (GBYP).

The Secretariat also informed on several ongoing projects on the conventional tagging such as, the database merge process (ICCAT, AOTTP, and GBYP), the integration of pending datasets received by ICCAT (e.g., some USA past submissions mostly with revisions), the recovery of the shark species sex information (with major advancements during 2022/2023), and the overall quality control checks on all tagging datasets. All these projects aim to increase the quality of the conventional tagging information managed by ICCAT. The Secretariat also presented improved versions of the conventional tagging dashboards and Map Viewer (interactive Geographic Information System (GIS) system) tools developed in the last couple of years, and it also presented a plan to release these visual tools on the ICCAT website during 2024 following the Subcommittee guidelines.

The Secretariat also informed on major progresses made on the ICCAT electronic tagging management system (ETAG) during 2022/23 with two phases already completed (for further details see the Report of the 2023 ICCAT GBYP Workshop on Atlantic Bluefin Tuna Electronic Tagging (Anon., 2023f) and the Report of the Atlantic-wide Research Programme for Bluefin Tuna (GBYP) (**Appendix 6** of the *Report for Biennial Period 2022-2023, Part II (2023), Vol. 2*).

The Subcommittee welcomed the Secretariat's progress on both conventional and electronic tagging activities and reiterates its full support for continuation of these activities.

2.3 Complementary data obtained within ICCAT data collection and research programmes (GBYP, AOTTP, EPBR, SMTYP and SRDCP)

The data recovery activities conducted within ICCAT research programmes (GBYP, AOTTP, EPBR, SMTYP and SRDCP) have historically resulted in great improvements to the ICCAT fisheries statistics by recovering missing or incomplete catch series and biological samples. However, no major fisheries statistics datasets were recovered under these programmes during the Reporting Period. All the historical revisions made during the Reporting Period are presented in Table 14 (T1NC), Table 17 (T2CE), and Table 18 (T2SZ) to the 2023 Secretariat Report on Research and Statistics, which also contains the supported SCRS documents and the adoption status of the respective species group. Some of these SCRS documents were associated with these programmes.

2.4 Other relevant statistics (observer data, VMS, BCDs, ISSF, etc.)

Domestic Observer data are submitted using the 2023 version of the form ST09-DomObPrg. The Secretariat indicated that the number of flag CPCs submitting observer data using the ST09 has shown a slight increase from 24 in 2022 (2021 data) to 29 in 2023 (2022 data) in the reporting periods (Appendix 4 to the 2023 Secretariat Report on Research and Statistics). Table 9 of that Report provides a summary of ST09-DomObPrg data reported for 2022 by discard fate and species group including sharks, sea turtles, and seabirds. Table 10 contains T1NC data for bycatch species for 2022. A summary of the information submitted on ST09 forms for sea turtles and seabirds is provided in Tables 12 and 13, respectively.

The Secretariat provided an overview with the statistical information available for FAD data (form ST08). Appendix 2 of the 2023 Secretariat Report on Research and Statistics provides a summary of FAD information received in FAD Management Plans and ST08 forms for 2022 (some datasets could require revisions). A short presentation was also given by the Secretariat summarising the work done during the Second Intersessional Meeting of Panel 1 on Western Skipjack MSE in 2023, where these matters were discussed in depth.

2.5 Historical revisions

Updates to Task 1 occurred during the Blue Shark and Sailfish Species Groups meetings in 2023 and are summarised in Table 14 of the 2023 Secretariat Report on Research and Statistics. All the other T1NC, T2CE and T2SZ dataset revisions (details in Tables 13, 16 and 17 of the 2023 Secretariat Report on Research and Statistics, respectively) were presented and approved by the respective species groups during the 2023 intersessional meetings.

2.6 Relevant documents to statistics

Five documents were presented to the Subcommittee.

Serghini et *al*. (2023) detailed the methodology proposed by Morocco for implementing an alternative approach for monitoring artisanal fisheries catching tunas and related species. The Subcommittee acknowledged the Moroccan scientists for this work and recognized that the proposed stratified port interviews are currently the best possible approach for small vessels where an onboard observer cannot be deployed. The Subcommittee recommended that the use of this methodology should not exclude future technological methodologies such as EMS or others.

Díaz *et al.* (2023) presented a proposal to standardize the Task 1 Nominal Catch tables in the Executive Summaries of the SCRS Annual Report, covering several improvements. The Subcommittee acknowledged this proposal and recommended that a group of experts involving the Subcommittee Convener, the authors, other interested national scientists, and the Secretariat be created to work intersessionally on this subject and present its work to this Subcommittee at the 2024 SCRS annual meeting.

Anon. (2023i) summarized the work that has been carried out to date by the Technical Sub-group on Electronic Monitoring Systems (EMS), since it was originally created in 2021. The work provides a summary of the main conclusions of the work that was carried out, and a proposal for draft minimum technical standards for implementation of EMS in purse seine vessels targeting tropical tunas in ICCAT fisheries. The Subcommittee agreed that the specification for the Minimum Standards was adequate for implementation.

The work also provides a draft response to the Commission following the request contained in the *Recommendation by ICCAT to establish rebuilding programs for blue marlin and white marlin/roundscale spearfish* (Rec. 19-05) (paragraph 20). Finally, the presenter opened the draft tables that have been provided by the Commission EMS Drafting Group, and that are awaiting input from the SCRS with regards to the data fields and descriptions that should be collected by EMS and reported for both longline and purse seine for scientific purposes. The Subcommittee agreed that the modifications proposed by the Technical Sub-group on Electronic Monitoring regarding scientific requirements that constitute information essential for stock assessment are acceptable and should be presented to the Commission.

García *et al.* (2023) presents the most important aspects of the design and the exploitation of the AOTTP tagging database developed by the same scientific programme. Its main goal is to describe the whole system (from data entry to data quality control) and provide guidance on the best ways to explore and analyse this information. The Subcommittee acknowledged the Secretariat work on the development of the AOTTP tagging system (now under integration with the existing ICCAT tagging databases) and congratulated the authors for this important document in the form of a user's manual.

Die (2023) contains the Report of 2023 ICCAT Regional Workshop in West Africa for the Improvement of Statistical Data Collection and Reporting on Small Scale (Artisanal) Fisheries. ICCAT conducted a workshop in Abidjan from 12-16 June 2023 to improve reporting and collection of fishery data in small scale fisheries. Twenty-one participants from twelve different ICCAT CPCs countries participated and provided national reports on their fishery data collection systems. Presentations of these reports revealed the diversity of methodologies and capacities across the region. Participants expressed a view of the need to take advantage of existing capacity by individual CPCs to improve the overall quality of data provided by West African CPCs. These national reports will be edited by the workshop Coordinator to provide a consolidated summary of the West African region data collection systems as a separate SCRS document. The document will be presented at an appropriate meeting in 2024. All workshop documents and course material were provided through Google Classrooms and mostly included published documents from ICCAT. The use of a dedicated learning platform like Google classrooms is a good way of supporting training and the SCRS should consider using this platform or other similar platforms for future training. Learning platforms have the advantage of providing specially designed tools for instructions and can be available for training after the workshop has been completed. Pre and post workshop questionnaires were completed by participants and will be used to evaluate the success of the workshop. A similar workshop is being planned for the region of the Caribbean and central America in early 2024.

After various interventions of the participants discussing the importance of these workshops on the improvement of ICCAT CPCs capacity building, the Subcommittee stated the importance these workshops and recommended their expansion to ICCAT CPC regions other than Africa.

3. Summary of ICCAT Secretariat's standard (yearly based) datasets estimations

3.1 CATDIS and EFFDIS

The CATDIS (catch distribution: estimation of T1NC for the nine major tuna and tuna-like species of ICCAT, stratified by year, flag, fleet, gear, fishing mode, catch type, trimester, and 5×5 degree squares) is one of the most used ICCAT catch estimations, particularly in the latest stock assessments of ICCAT using integrated stock synthesis models (SS3). The Secretariat has updated the CATDIS from 1950 to 2021 with the most recent statistical information available. The newly CATDIS estimations were published on the ICCAT website on 31 January 2023 (reflecting in detail the T1NC catches also published on the same date). The CATDIS was used in the majority of the 2023 SCRS intersessional meetings. Vol. 48 of the Statistical Bulletin was also updated with the most recent CATDIS (maps) estimates of the period 1950-2021. No other intermediate updates were required intersessionally by the SCRS species groups.

Once again, the CATDIS has not included the estimations of four additional species: spearfish (SPF), blue shark (BSH), shortfin mako (SMA) and porbeagle (POR), due to the lack of sufficient information in T2CE for these four species (as observed in the SCRS catalogues of these species). However, new attempts to estimate CATDIS for these 4 species should be made in the near future.

The Subcommittee acknowledge the Secretariat's additional efforts to synchronize the CATDIS estimations with the adopted SCRS statistics in relation to the times series coverage, which will greatly benefit the future work of the SCRS and reduce the number of partial CATDIS updates required intersessionally.

The EFFDIS estimations of Atlantic longline were published on the ICCAT website in 2023 (period 2000-2021), as recommended by the Subcommittee on Ecosystems and Bycatch (SC-ECO), and they will be published in the ICCAT website on a regular basis.

The Subcommittee acknowledged the Secretariat efforts and again commended the Secretariat to continue with the recovery and improvement of T2CE datasets.

The Subcommittee noted that when CPCs provide updates to their T2CE datasets, they must follow the standard SCRS rules for revising historical data which include the provision of a SCRS paper with the update of the methods used on the data recovery or associated estimations.

3.2 CAS (catch-at-size) and CAA (catch-at-age)

The catch-at-size (CAS) database are complete and functional, with an active connection between the size data and the substitution tables used for the CAS estimations. This year, the Secretariat has made no CAS updates in any of the six species.

The Subcommittee engaged in an extensive dialogue about the importance of CAS for the work of the SCRS to provide advice to the Commission, and the obligation of the ICCAT CPCs to report on a yearly basis CAS estimation for six species. The Subcommittee addressed this matter with a clear recommendation detailed in section 8 of this report.

4. Review of data deficiencies and ongoing data recovery plans pursuant to *Recommendation by ICCAT on compliance with statistical reporting obligations* (Rec. 05-09)

4.1 2022 Report cards with SCRS validation criteria (Filters 1 and 2)

The Secretariat has continuously applied in the last decade, the SCRS filtering criteria (Filters 1 & 2, described in Addendum 2 to Appendix 8 of the *Report for Biennial Period, 2012-13, Part II (2013), Vol. 2*, updated by the SCRS in 2016) to validate and accept Task 1 (form ST01 and ST02) and Task 2 (forms ST03, ST04 and ST05) statistics received under those official forms. The filtering criteria are also embedded in each one of these forms.

For 2022 data, Filter 1 was effectively applied, and the results are presented in the SCRS Report Cards (Tables 1, 2, 3, 4, and 5, with a summary in Figure 1 of the 2022 Secretariat Report on Research and Statistics contained in the *Report for Biennial Period, 2022-23, Part I (2022), Vol. 4*). Detailed results are described in the 2023 Secretariat Report on Research and Statistics. The SCRS Report Cards have been one of the most important instruments used to evaluate the CPCs data provisions to ICCAT. This tool has proven to be very effective in imposing strict reporting obligations and minimum data quality standards that will benefit the work of ICCAT in the future.

4.2 SCRS Score cards and catalogues of major ICCAT species (last 30 years)

The *Recommendation by ICCAT on compliance with statistical reporting obligations* (Rec. 05-09) recognized the need to establish clear process and procedures to identify data gaps, particularly those that limit the ability of the SCRS to conduct robust stock assessments and to find appropriate means to address those gaps and evaluate the effectiveness of the ICCAT conservation and management measures. Particularly to evaluate how reducing uncertainty can help reduce the risk of failing to meet management objectives.

The SCRS catalogues, contribute to comply with Paragraph 1 of Rec. 05-09. The Secretariat presented in Appendix 1 of the 2022 Secretariat Report on Research and Statistics contained in the *Report for Biennial Period, 2022-23, Part I (2022), Vol. 4*, the SCRS catalogues on Task 1 and 2 data availability for the major ICCAT species, by stock, for the last 30 years (1992 to 2021). The small tuna species SCRS catalogues were also prepared and made available to the SCRS annual meeting. As recommended by the SCRS in 2020, the Secretariat continues to publish the two SCRS catalogues on the ICCAT website (https://www.iccat.int/en/accesingdb.html), the latest ones published in January 2023 with the information approved by the SCRS and the Commission in 2022.

The Subcommittee acknowledged that data submissions have greatly improved during the last decade. However, major deficiencies still exist for some ICCAT stocks particularly for the historical data. Once again, the Subcommittee agreed that the SCRS catalogues should be reviewed by the Species Groups, in particular by those ones that are scheduled to conduct stock assessments in 2024.

The SCRS scorecard, in the format adopted by the SCRS in 2019, is presented in Table 6 of the 2023 Secretariat Report on Research and Statistics with all the major ICCAT fisheries and covering the period 1993 to 2022.

Despite the multiple recommendations made by the Subcommittee and different species groups, the reporting of total dead discards and live releases (see Section 2.4) continues to be very poor which impact the estimates of total biomass removals and total mortality needed to conduct robust stock assessments.

5. Brief overview of ICCAT Online Management System (IOMS) work

The ICCAT Online Reporting Technology Working Group (WG-ORT), whose mandate was established under Recommendation 16-19, and extended through Recommendation 19-12, governs all the IOMS implementation process. A Meeting of the Online Reporting Technology Working Group (WG-ORT) was held in 2023 where the existing workplan was revised and next few phases were planned. In 2023, the IOMS system was declared a mandatory platform for reporting scientific and management requirements, obtaining a satisfactory response from users. This year the dynamic help system and the optimization and redesign of the central module of the system were also carried out. The Secretariat planned an IOMS workshop (training sessions) to be held on 16 October 2023. This workshop will focus on the vessel management module.

For the 2023/2024 IOMS development period, the European Union (EU) has also granted two complementary contributions with an extraordinary budget to support the development of the IOMS vessel record module and the integration of the Fisheries Language for Universal Exchange – Transportation Layer (FLUX TL) system for managing EU vessels (and potentially other ICCAT CPC vessels) in a more efficient way. Additionally, one GEF/ABNJ project was approved to support the functionality to exchange IOMS information with third parties taking advantage of web services.

This Subcommittee maintains a strong collaboration with the WG-ORT since the beginning. The current development of the Forms Manager module in IOMS will improve version control and reduce the email burden for CPCs and the Secretariat. In addition, the Task 1 module manager is planned to be developed in Phase 4 by mid-June 2024. This Subcommittee recognizes the crucial importance of the IOMS in the future of ICCAT and reiterates its full support for the continued implementation of the IOMS.

6. Responses to the Commission

6.1 The SCRS will advise the Commission on the suitability of the alternative approach proposed by CPCs, Rec. 16-14 para 4b (item 19.7)

Background: *b) Notwithstanding paragraph a), for vessels less than 15 meters, where an extraordinary safety concern may exist that precludes deployment of an onboard observer, a CPC may employ an alternative scientific monitoring approach that will collect data equivalent to that specified in this Recommendation in a manner that ensures comparable coverage. In any such cases, the CPC wishing to avail itself of an alternative approach must present the details of the approach to the SCRS for evaluation. The SCRS will advise the Commission on the suitability of the alternative approach for carrying out the data collection obligations set forth in this Recommendation. Alternative approaches implemented pursuant to this provision shall be subject to the approval of the Commission at the annual meeting prior to implementation.*

Morocco presented Serghini *et al.* (2023) with a stratified sampling design as an improvement to the alternative scientific monitoring approach presented during 2022 to collect data from small scale/artisanal fisheries of bluefin tuna (Álvarez-Berastegui *et al*., 2023), small tuna (Abid and Bensbai, 2022a) and swordfish (Abid and Bensbai, 2022b).

This alternative approach aimed at estimating discards covers other artisanal fisheries including pelagic sharks, tropical tunas and billfishes.

The Committee recognized that the new proposed methodology is at present the best possible alternative to an onboard observer program in the multi-species artisanal fisheries where observer coverage is not possible. This current methodology does not exclude the possibility of future technological solutions, including simplified EMS or others.

6.2 Develop recommendations for Electronic Monitoring Systems, Rec. 19-05, para 20 (item 19.8)

Background: *The Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures (PWG), in cooperation with the SCRS, shall work to develop recommendations on the following issues for consideration at the 2021 annual meeting of the Commission:*

a) Minimum standard for an electronic monitoring system such as:
  - *i) the minimum specification of the recording equipment (e.g. resolution. recording time capacity, data storage type, data protection)*
  - *ii) the number of cameras to be installed at which points on board*

b) What shall be recorded
c) Data analysis standards, e.g., converting video footage into actionable data by the use of artificial intelligence
d) Data to be analysed, e.g. species, length, estimated weight, fishing operation details
e) Reporting format to the Secretariat

In 2020 CPCs are encouraged to conduct trials on electronic monitoring and report the results back to the PWG and the SCRS in 2021 for their review.

The Committee informs the Commission that the work carried out regarding the Minimum Standards for Electronic Monitoring Systems onboard Longliners described in Appendix 17 of the *Report for Biennial Period, 2022-23, Part I (2022), Vol. 4* and onboard purse seiners targeting tropical tunas described in **Appendix 17** of the *Report for Biennial Period 2022-2023, Part II (2023), Vol. 2,* has been finalized.

6.3 Develop recommendations for Electronic Monitoring Systems, Rec. 22-01 para 55 (item 19.9)

Background: *The Working Group on Integrated Monitoring Measures (IMM), in cooperation with the SCRS, shall make a recommendation to the Commission for endorsement at its 2023 Annual meeting on the following:*

a) Minimum standards for an electronic monitoring system such as:
  i) the minimum specifications of the recording equipment (e.g., resolution, recording time capacity), data storage type, data protection
  ii) the number of cameras to be installed at which points on board

b) What shall be recorded

c) Data analysis standards, e.g., converting video footage into actionable data by the use of artificial intelligence

d) Data to be analysed, e.g., species, length, estimated weight, fishing operation details

e) Reporting format to the ICCAT Secretariat

In 2023 CPCs are encouraged to conduct trials on electronic monitoring and report the results back to the IMM and the SCRS in 2023 for their review. CPCs shall report the information collected by the observers or the electronic monitoring system from the previous year by 30 April to the ICCAT Secretariat and to SCRS taking into account CPC confidentiality requirements.

The Committee informs the Commission that the work carried out regarding the Minimum Standards for Electronic Monitoring Systems onboard Longliners described in Anon. (2022i) and onboard purse seiners targeting tropical tunas described in Anon. (2023i), has been finalized.

7. Workplan for 2024

The Secretariat has been working since 2017 on the ICCAT Integrated Online Management System (IOMS). After being adopted by the SCRS and the Commission, the Commission's Online Reporting Technical Working Group (WG-ORT) has overseen the specifications and the governance of all the development process. The last Meeting of the Online Reporting Technology Working Group (WG-ORT) held in February 2023 delineated the content of the future work to be presented at the 2023 Commission meeting for revision and approval. The IOMS went into production on 1 August, 2021, and currently manages the ICCAT CPCs Annual Reports. The IOMS is a crucial long-term ICCAT project that requires the full involvement/commitment of the Secretariat.

Additionally, the following tasks represent ongoing database improvements and maintenance that will continue throughout 2023 and beyond. Priority tasks for 2023/2024 include:

- Upgrade all the ICCAT-DB system from MS-SQL server 2016 to MS-SQL server 2022
- Replace the stand-alone MS-ACCESS Task 2 databases on the web by SQLite equivalent ones
- Improve the "client applications" that manage the databases of the ICCAT-DB system
- Continue the development of the statistical/tagging dashboards (dynamic querying)
- Continue the tagging database development for both conventional and electronic tagging
- Continue the Biological Sampling database development (includes data recovery/integration)
- Continue the standardization of the electronic forms (TG: tagging forms, CP: compliance forms)
- Extend the automatic data integration tools for the standardized electronic forms
- Continue the development of the GIS project (create a PostGIS server and geo-reference for all the ICCAT data available in ICCAT-DB)
- The adaptation/migration of all the databases of the ICCAT-DB system to the new ICCAT IOMS system

8. Recommendations (with special emphasis on those with financial implications)

8.1 Review of recommendations from 2023 intersessional meetings

The Subcommittee reviewed the recommendations for statistics from the 2023 intersessional meetings. The following recommendations were endorsed by the Subcommittee:

Albacore

The conventional tagging database was shown to include some records that might not be accurate (e.g. unplausible positions, individuals way larger than the maximum length for albacore, length-weight pairs that diverge substantially from the albacore length-weight relationship, etc.). This might prevent it from being used for different purposes, so the Group suggested that the Secretariat improve existing protocols of data verification and work together with the national scientists to try to improve the quality of the database.

Research and statistics recommendations

The Committee recommends that CPCs and the Secretariat work together to complete the Task 1 NC data for Mediterranean albacore before the next assessment. The Group has identified this as one of the main uncertainties in past assessments, and recommended to consider methods developed by the WGSAM to estimate unreported catches.

The Group recommends the review and update of the fisheries statistics of Mediterranean albacore from the Egypt fleet(s) available in the ICCAT Secretariat databases.

Tropical tunas

Continuation on the improvement of T1FC, noting its relevance in the estimation of fishing capacity in the ICCAT Convention area.

Update for ST01-T1FC (fleet characteristics), to make mandatory the fishing effort (field "fishing days") in both sub-forms (ST01A and ST01B) and add two additional mandatory fields: IMO number and carrying capacity for tropical tuna fisheries.

That the contract with the University of Maine on tropical tuna tagging be amended as requested by the contractor, with the condition that reporting on project progress and tagging data submission is improved, as well as the communication with the ICCAT Secretariat.

Blue shark (data preparatory meeting)

The Group recalled that during the 2015 blue shark stock assessment (Anon., 2016b), times series of removals of this species were estimated for several CPCs. The Group recommends that the SC-STAT discusses the inclusion of these estimates in Task 1 time series in the ICCAT-DB.

The Group recommends that those CPCs for which these Task 1 time series were estimated review these estimates and provide the Secretariat with their updated Task 1 time series. In case CPCs do not disagree with the estimated time series or do not provide the Secretariat with an updated Task 1 data to replace the estimated time series, then the Task 1 removals estimated by the Group will be considered the official CPCs' Task 1 data.

The Group discussed that while data collected by scientific observers and reported with the ST-09 DomObProg ICCAT electronic form are not publicly available, the conventional tagging data also collected by observer programmes are. These publicly available tagging data include locations, sex and size of tagged individuals, and dates. It was unclear for the Group if this situation constituted a lack of consistency on the current policies regarding the dissemination of data collected by scientific observers. Therefore, the Group recommended that the Subcommittee on Statistics review the current policies regarding the dissemination of scientific data collected by domestic observer programmes and conventional tagging data and, if necessary, make recommendations to solve any potential lack of consistency.

The Group recommends for the ICCAT conventional tagging programme the use of Stainless Steel Dart Tags for sharks. The recommendation is based on new information available and presented to the Group that proves that the recapture rate of this type of tag is higher than the obtained with the conventional single dart plastic tags used by ICCAT.

Blue shark (stock assessment)

Recommendations without financial implications

Considering the need to reduce uncertainty in the stock assessments of pelagic shark species impacted by ICCAT fisheries and bearing in mind *Recommendation by ICCAT to replace Recommendation 16-13 on improvement of compliance review of conservation and management measures regarding sharks caught in association with ICCAT fisheries* (Rec. 18-06) and other previous recommendations which made the submission of shark Task 1 and 2 data mandatory, the Group once again strongly urges CPCs to provide the corresponding statistics, including estimates of discards (dead and alive) from all ICCAT fisheries, including recreational and artisanal fisheries, and to the extent possible non-ICCAT fisheries capturing these species. The Group considers that a basic premise for correctly evaluating the status of any stock is to have a solid basis to estimate total removals.

As a result of changes in the data reporting requirements over time, significant gaps in the historical shark data remain in the ICCAT-DB. Therefore, the Group once again reiterates previous recommendations that national scientists review the SCRS reports cards to identify shark data gaps and submit the missing data to the Secretariat to comply with ICCAT data reporting requirements. The Group recommends that national scientists from CPCs that in the past have reported shark data as part of a species complex explore the possibility of re-submitting those data at the species level.

The Group recommends that CPCs that catch blue sharks in the Mediterranean Sea provide the required Task 1 nominal catches (including estimates of dead and live discards) and Task 2 size and catch-effort data including historical time series. In addition, the Group also recommends that CPCs endeavour to increase their efforts to collect blue shark biological samples in the Mediterranean Sea.

The Group recommends promoting the activities of the SCRS Ad Hoc Working Group on Tagging Coordination and that national scientists further emphasize conventional shark tagging activities.

Recommendations with financial implications

The Group recommends that the Secretariat acquire and make available to the SCRS Species Groups high-performance computer Cloud resources to conduct tasks such as standard diagnostics, MCMC runs, stochastic projections, and uncertainty grids.

Subcommittee on ecosystems

Recommendations for the Ecosystem component of SC-ECO

None.

Recommendations for the Bycatch component of SC-ECO

The Subcommittee recommends that the SCRS explore the mechanisms and processes for providing fine scale data to advance the work on the multispecies spatial distribution in longline fisheries.

The Subcommittee recommends that the SCRS inform the Commission that the new ST-12 electronic form to report sea turtle data requested by Rec. 22-12 will not be available until 2024 at the earliest or 2025 at the latest. Once ST-12 is made available, CPCs should report their sea turtle data requested in Rec. 22-12 from 2022 onwards. The CPCs are reminded that the existing reporting requirements for sea turtles in form ST09 remain in effect.

The Subcommittee recommends that the Secretariat revise the ST-09 DomObsProg form to allow the collection of information regarding the implementation of EMS in different fleets, the % coverage of the EMS, the purpose of the EMS (i.e., scientific, compliance, or both), and if the data reported were collected by EMS or scientific observers. This can be done using a format that the Secretariat considers to be the most convenient to record such information. The revised ST-09 form should be presented at the 2023 meeting of the Subcommittee on Statistics for discussion.

Small Tunas Species Group

General recommendations

The Group recommended that Statistical Correspondents and/or national scientists revise, update, complete, and submit their small tuna T1NC series to the ICCAT Secretariat. This revision should consider Appendix 1 (SCRS catalogues) of the 2023 Secretariat Report on Research and Statistics, the split of "unclassified" gear catches to specific gear codes, and the completeness of Task 1 gaps identified. The Statistical Correspondent and/or national scientists of CPCs should correct inconsistencies identified in T2SZ series. For the 13 species of small tuna, the T2SZ revision should have as reference, the stratification of the samples by gear, month, 1°x1°or 5°x5° squares, and SFL size classes of 1 cm (lower limit). CPCs should further improve their estimates of total catches, as there are still important gaps in the basic data available. These data are required as inputs for most data-limited stock assessment methods. The ICCAT Secretariat should continue its work on the data recovery and making inventories of tagging data for small tuna species. This process will require active participation of the national scientists who hold such data.

Working Group on Stock Assessment Methods (WGSAM)

Recommendation without financial implications

The Group recommended that the Secretariat should maintain an archive of the computer software and documentation used in the various MSEs.

The Group recommended that the Secretariat update the MSE webpage of ICCAT's website to include capacity building materials and information pertinent to each of ICCAT's current five MSE processes, including trial specification documents, results summaries, Commission decisions and links to code and Shiny apps.

Swordfish Species Group

Recommendations without financial implications

Given the importance of including discards (dead and alive) in the reported catch, the Group recommends developing and adopt standard methods for raising observed discards to the total effort and that these be reported in Task 1 data.

Furthermore, the Group recommends that the submission of size samples to the ICCAT Secretariat, as part of the CPCs Task 1 and 2 data submission obligations, be completed using the ST04-T2SZ statistical form. Size samples reported with the ST04-T2SZ form shall include all samples collected by the CPC from all fisheries and size samples of dead and live discards (when applicable) collected by its National Observer Programme. This recommendation does not preclude CPCs from the optional reporting of size samples collected by their National Observer Programme using the ST09-DomObPrg form.

The Swordfish Species Group recommends that the Subcommittee on Statistics update the list of ICCAT accepted size conversions for North Atlantic and Mediterranean swordfish to reflect new analyses accepted by the Species Group.

Recommendations with financial implications

The Subcommittee recommends that the Committee develops a shared online ICCAT hosted ageing software. SmartDots (ICES, 2020) developed by ICES has been used for swordfish and discussed as an example for such platform. It was further noted that Canada is also developing a platform based on SmartDots. This software could be used by other ICCAT Species Groups.

Billfishes Species Group

Sailfish Data Preparatory Meeting

The Group noted that the Venezuelan longline observer programme has been suspended since 2019. Considering the broad importance of observer data to carrying out the work of the SCRS, the Group strongly recommends that the Venezuelan longline observer programme be promptly reinstated, and the data collected be reported to the ICCAT Secretariat following the guidelines adopted by the Commission and, if possible, with financial assistance from ICCAT.

The Group was made aware of potentially important sailfish landings from the Venezuelan artisanal offshore (VAOS) longline fleet that have not been reported to ICCAT since 2014. The Group recommends that efforts be made by Venezuelan national scientists to recover and report this fleet's landing statistics.

Important recreational fisheries have been developed in the West Africa region and, particularly in Senegal, the Group recommends that CPCs increase efforts to report current and historical recreational catches, fishing effort, and tagging data.

The Group recommends that CPCs continue with their efforts to improve and report their fishery indicators and fishery statistics including estimates of dead discards and live releases.

Future recommendations

The Subcommittee recommends that the reporting of Task 2 catch-at-size (Form ST05-T2CS) for YFT, BET, SKJ, SWO, BFT, and ALB be optional instead of mandatory, however CPCs are still required to report Task 2 Sizes Samples (Form ST04-T2SZ). As an alternative to the mandatory reporting of CAS, species groups can request that CPCs submit CAS on a case by case basis when such estimates are needed to conduct specific analysis. The updates of the CAS must be requested at least 6 months in advance of the deadline. Those working groups which anticipate the need for catch-at-size estimates in the next year, or which have a recurring need for such estimates, should include the specific catch-at-size data requirements in their workplan.

The Subcommittee recommends to update the format used to display the T1NC tables in the Executive Summaries.

The Subcommittee recommends that a subgroup composed by SCRS scientists and Secretariat staff be created to address the technical challenges related to modifying the TINC tables and present progress to the next SCRS annual meeting.

The observed CPCs late reporting (or close to the deadline) of fishery statistics and biological data, combined with the overloaded calendars of recent years and the advancement of the SCRS annual meeting by one week, does not allow the Secretariat to have sufficient time to validate, process, store and prepare these in time for the SCRS annual meeting. In consequence, the Subcommittee recommends that the deadline for submission of all statistical data be changed to 15 July each year, allowing the Secretariat to validate and prepare in time the data for the SCRS annual meeting. The requested corrections must be submitted before the 30 July (15 days after).

9. Other matters

Changes proposed to statistical (ST type) and tagging (TG type) electronic forms:

The Subcommittee adopted several updates (no structural changes) to ST forms:

- Rename field "PortZone" (majority of ST* forms) by "FleetSuffix" a more objective identifier of the three components used in the identification of a CPC fleet, and adapt the pertinent documentation (embedded form instructions and others)

- Add to form ST01-T1FC two additional fields (IMO and carrying capacity) in subform ST01A

- Make mandatory the two optional fields on effort in sub-form ST01A (FishDatl, FishDatl) for the remainder fisheries (for BFT-E it is already mandatory)

- In form ST02-T1NC

  - Add a new field to ST02A to identify Target/bycatch records
  - Adapt sub-form ST02B to accommodate the existing species/stock combinations of the SCRS scorecard (Table 6 of the 2023 Secretariat Report on Research and Statistics)
  - Add a special row that allows to assume the completion of an entire gear (column) with "0" on blank cells (avoiding the need to complete individually each 0 in those cells)

- Adapt form ST04-T2SZ to also accept local mark samples (PS-ETRO fisheries only)

- Add a field to form ST09 to differentiate EMS and Observer data types

These changes to the SCRS statistical forms (ST type) should be described in detail in a document, and the completion instructions embedded in each ST form updated in accordingly. All the ICCAT CPCs must consequently be informed of those changes.

Despite the Secretariat's continuously growing workload that has not been matched with the same grow in the available resources, the Secretariat continues to provide outstanding support to the SCRS species groups and subcommittees. The Subcommittee on Statistics deeply thanks the Secretariat for their hard work and it acknowledges that the Subcommittee's work would be significantly more difficult without the Secretariat's support.

The Subcommittee recognised Mr Carlos Palma's 23 years of service at the ICCAT Secretariat. Carlos' work during his years at the Secretariat has been nothing but absolutely outstanding. It was not possible for the Subcommittee on Statistics to put into words the positive impact the Carlos' contributions have had on the SCRS and especially on the Subcommittee's work. The Subcommittee could not thank Carlos enough for his support and hard work and it wished him the best of luck in his future endeavours.

10. Adoption of the Report

The Report of the Meeting of the Subcommittee on Statistics was adopted.

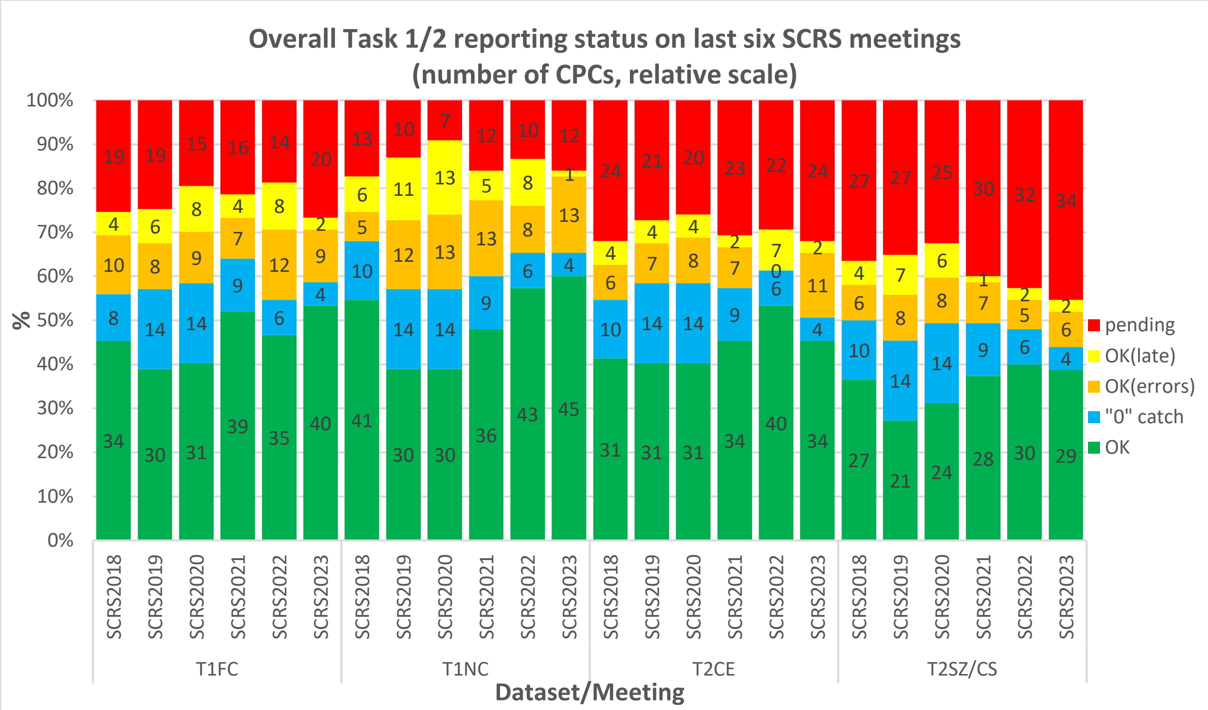

Figure 1. Overall evolution of the Task 1 (T1FC, T1NC) and Task 2 (T2CE, T2SZ/CS) reporting status (Report Cards in the 2023 Secretariat Report on Research and Statistics) over the last six SCRS annual meetings (between 2018 and 2023), covering the provisions of Task 1 and Task 2 datasets for each terminal year, by default the previous year of the meeting (e.g., 2017 data on the 2018 meeting, ..., 2022 data on the 2023 meeting).

Addendum 1 to Appendix 13

Agenda

1. Opening, adoption of Agenda and meeting arrangements

2. Summary of fisheries and biological data submitted during 2023 (Tasks 1, 2 and 3), including historical revisions

3. Summary of ICCAT Secretariat's standard (yearly based) datasets estimations

4. Review of data deficiencies and ongoing data recovery plans pursuant to *Recommendation by ICCAT on compliance with statistical reporting obligations* (Rec. 05-09)

5. Brief overview of ICCAT Online Management System (IOMS) work

6. Responses to the Commission

7. Workplan for 2024

8. Recommendations (with special emphasis on those with financial implications)

9. Other matters

10. Adoption of the Report

Addendum 2 to Appendix 13

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Addendum 3 to Appendix 13

List of SCRS documents

DocRef	*Title*	*Authors*
SCRS/2023/132	Methodology for Implementing an Alternative Approach for monitoring Artisanal Fisheries catching Tunas and associated Species.	Serghini M., Bensbai J., Abid N., Amina N., Baibbat S.A., Ikkis A., Layachi M., Hamdi H., Joumani M.
SCRS/2023/136	A proposal to standardize the Task 1 Nominal Catch table in the Executive Summaries of the SCRS Annual Report	Díaz G.A., Duprey N.M.T., Palma C.
SCRS/2023/151	Report of the Sub-group on Electronic Monitoring Systems: proposal of ICCAT minimum technical standards for EMS in purse seine fisheries targeting tropical tunas	Anonymous
SCRS/2023/167	Design and exploitation of the AOTTP tagging database	Garcia J., Palma C., Mayor C.
SCRS/2023/178	Report of 2023 ICCAT regional workshop in West Africa for the improvement of statistical data collection and reporting on small scale (artisanal) fisheries	Die D.

Addendum 4 to Appendix 13

Summaries of SCRS documents presented

SCRS/2023/132[1]: The document detailed the methodology proposed by Morocco for implementing an alternative approach for monitoring artisanal fisheries catching tunas and related species onboard observer cannot be deployed. The present study aims to evaluate bycatch and discard of various species in artisanal fisheries operating in the Moroccan Atlantic and Mediterranean waters, with a specific focus on tunas and tunas-like species. Additionally, the study aims to identify and define fishing areas in these regions. The assessment of these fisheries faces challenges due to several variables, including diverse habitats, a wide array of caught species, and the utilization of various fishing gears. To overcome these challenges, we propose implementing a stratified sampling strategy. Mathematical formulations were employed to describe the estimation processes for operational indicators including fishing effort, bycatch, and discard yield. This systematic approach ensures that the assessment process is more straightforward and precise, allowing for reliable analysis and interpretation of the data.

SCRS/2023/136: The document presented a proposal to standardize the Task 1 Nominal Catch tables in the Executive Summaries of the SCRS Annual Report, covering several improvements. Some of the recommended improvements included to standardize across all species groups, the procedures involved in the estimation of preliminary catches (to complete non-submitted catches) and the required corrections to Task 1 nominal catches (T1NC), discontinue the practice of filling up empty cells with a value of zero, include catches less than 0.5 t with the reported value instead of rounding it to zero, and including in the Executive Summaries two T1NC tables: one with the estimated catches by the Committee and one with the reported catches.

SCRS/2023/151: The document summarized the work that has been carried out to date by the Sub-group on Electronic Monitoring Systems (EMS), since it was originally created in 2021. The work provides a summary of the main conclusions of the work that was carried out, and a proposal for draft minimum technical standards for implementation of EMS in purse seine vessels targeting tropical tunas in ICCAT fisheries. The work also provides a draft response to the Commission following the request contained in ICCAT Rec. 19-05 (paragraph 20). Finally, the presenter opened the draft tables that have been provided by the Commission EMS Drafting Group, and that are awaiting input from the SCRS with regards to the data fields and descriptions that should be collected by EMS and reported for both longline and purse seine for scientific purposes. The Subcommittee agreed that the modifications proposed by the EMS Sub-group regarding scientific requirements that constitute information essential for stock assessment are acceptable and should be presented to the Commission.

SCRS/2023/167: The document presents the most important aspects of the design and the exploitation of the AOTTP tagging database developed by the same scientific programme. Its main goal is to describe the whole system (from data entry to data quality control) and provide guidance on the best ways to explore and analyse this information.

SCRS/2023/178: The document contains the Report of 2023 ICCAT Regional Workshop in West Africa for the Improvement of Statistical Data Collection and Reporting on Small-scale (Artisanal) Fisheries. ICCAT conducted a workshop in Abidjan from 12-16 June 2023 to improve reporting and collection of fishery data in small scale fisheries (SCRS/2023/178). Twenty-one participants from twelve different ICCAT CPCs countries participated and provided national reports on their fishery data collection systems. Presentations of these reports revealed the diversity of methodologies and capacities across the region. Participants expressed a view of the need to take advantage of existing capacity by individual CPCs to improve the overall quality of data provided by West African CPCs. These national reports will be edited by the workshop coordinator to provide a consolidated summary of the West African region data collection systems as a separate SCRS document. The document will be presented at an appropriate meeting in 2024. All workshop documents and course material were provided through Google Classrooms and mostly included published documents from ICCAT. The use of a dedicated learning platform like Google classrooms is a good way of supporting training and the SCRS should consider using this platform or other similar platforms for future training. Learning platforms have the advantage of providing specially designed tools for instructions and can be available for training after the workshop has been completed. Pre and post workshop questionnaires were completed by participants and will be used to evaluate the success of the workshop. A similar workshop is being planned for the region of the Caribbean and Central America in early 2024.

[1] Summary not received from author; Abstract used for completion.

Appendix 14

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Appendix 15

Revised Roadmap for the ICCAT MSE processes adopted by the Commission in 2022

This schedule is intended to guide the development of harvest strategies for priority stocks identified in *Recommendation by ICCAT on the development of Harvest Control Rules and of Management Strategy Evaluation* (Rec. 15-07) (North Atlantic albacore, North Atlantic swordfish, eastern and western Atlantic bluefin tuna, and tropical tunas). It builds on the initial roadmap that was appended to the 2016 Annual Meeting report, which has been revised regularly based on the SCRS advice and Commission decisions. It provides an aspirational timeline that is subject to revision and should be considered in conjunction with the stock assessment schedule that is revised annually by the SCRS.* Due to the amount of cross-disciplinary dialogue that may be needed, intersessional Panel meetings and/or meetings of the Standing Working Group to Enhance Dialogue between Fisheries Scientists and Managers (SWGSM) will be necessary. However, the exact timeline for delivery is contingent on funding, prioritization, and other work of the Commission and SCRS. Tasks are divided into four categories: Commission intersessionally, SCRS development, SCRS implementation, and Commission at Annual Meeting.

* For 2022, the roadmap reflects progress to-date in some detail. For 2023 onward, more general steps for the SCRS and Commission are anticipated pending outcomes of the 2023 Annual Meeting.

This version of the roadmap for the ICCAT MSE processes includes changes suggested by the SCRS in 2023, which are underlined in the table below.

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2022	COMM intersessionally		COMM (PA2) met intersessionally (March, May, July, October) to: - recommend final operational management objectives and identify performance indicators - consider final CMPs Ambassadors' workshops held in February and October.			

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2022	SCRS development	SCRS worked on a new SS model for NALB that will be used for future development of a new MSE reference grid. Per Rec. 21-04, the SCRS tested alternatives to the adopted MP, as well as determined the number of CPUE series and the level of underreporting that would trigger the occurrence of exceptional circumstances.	SCRS conducted stock assessment for BFT-E (based on work conducted by subgroups on models and indices). SCRS completed MSE, incorporating feedback from COMM provided at dialogue meetings with PA2.	SCRS conducted stock assessment (North and South Atlantic). SCRS reconditioned OMs considering new information from the stock assessment and finalized OM grid. SCRS continued development and testing of CMPs. SCRS continued work on criteria for determining exceptional circumstances.	SCRS conducted SKJ stock assessments. SCRS conducted preliminary conditioning of single-stock BET and YFT OMs.	SCRS conducted SKJ stock assessments. SCRS reconditioned OMs in light of new assessment. SCRS initiated development and testing of CMPs.
	SCRS implementation	SCRS evaluated existence of exceptional circumstances.				
	COMM at Annual Meeting		COMM adopted an MP at the Annual Meeting, including TAC for western stock and TAC for eastern/Med stock for 2023-2025.			[...]

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2023*	Commission intersessionally		COMM (PA2) to develop an exceptional circumstances protocol through an iterative consultation process with the SCRS that provides, inter alia, guidance on range of appropriate management responses should exceptional circumstances be found to occur.	COMM (PA4) to meet intersessionally (March, June, October), with SCRS participation, to: - discuss CMPs, operational management objectives, and performance indicators - refine CMP(s) - recommend final operational management objectives and identify performance indicators Ambassadors' meetings to be held.	COMM (PA1) dialogue with SCRS on management objectives and performance indicators to be used for tropical tunas MSE.	COMM (PA1) to meet intersessionally (October). SCRS to participate and provide an update on the progress of SCRS work.

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2023*	SCRS development	SCRS to initiate independent peer review of MSE process				
		New SS3 reference case developed for future conditioning of OMs. Reference and Robustness grid of OMs reconsidered. SCRS will finalize a grid of reference and robustness OMs based on Stock Synthesis as part of a new MSE, after reconsidering the main axes of uncertainty.	SCRS to provide final advice to COMM (PA2) on criteria for determining exceptional circumstances and inclusion in the exceptional circumstances protocol to be developed by Panel 2 in consultation with the SCRS.	SCRS to finalize MSE results, incorporating feedback from COMM through PA4.	SCRS to list major sources of uncertainty to be considered in the MSE for multi-stock tropical tuna MSEs. Developing operating and observational error models. Capacity building workshops.	SCRS to complete MSE, incorporating feedback from COMM through PA1.
	SCRS implementation	SCRS conducted assessment to ensure that the conditions considered in MP testing are still applicable to the stock. SCRS to evaluate existence of exceptional circumstances.	SCRS to evaluate existence of exceptional circumstances and advise on any necessary actions taking into account, to the extent possible, the latest draft of the exceptional circumstances protocol provided to the SCRS by 1 September 2023.			

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2023*	Commission at Annual Meeting	COMM to continue use of the MP to set 2024-2026 TAC at the Annual Meeting, on the predetermined timescale for MP setting. Per Rec. 21-04, COMM to review the MP, taking SCRS analyses into account.	COMM to adopt exceptional circumstances protocol as new Annex in MP (Rec. 22-09)	COMM to adopt an MP, including the TAC.		[...]
2024*	Commission intersessionally			COMM (PA4) to develop an exceptional circumstances protocol through an iterative consultation process with the SCRS that provides, inter alia, guidance on a range of appropriate management responses should exceptional circumstances be found to occur and continue any outstanding work from 2023.	[...]	[...]

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2024*	SCRS development	SCRS will finalize a grid of reference and robustness OMs based on Stock Synthesis as part of a new MSE. SCRS to improve Observation Error Model by incorporating statistical properties of CPUE residuals. SCRS to test the adopted MP on the new uncertainty grid.		SCRS to provide final advice to COMM (PA4) on criteria for determining exceptional circumstances and inclusion in the exceptional circumstances protocol to be developed by Panel 4 in consultation with the SCRS. The SCRS to continue to develop robustness scenarios.	SCRS to conduct yellowfin assessment. External peer review of Observation and Operating models. Meetings of Technical MSE Group. Initial development of candidate MPs and testing of MPs.	[...]
	SCRS implementation	SCRS to evaluate existence of exceptional circumstances in accordance with the EC protocol.	SCRS to evaluate existence of exceptional circumstances in accordance with the EC protocol.	SCRS to evaluate existence of exceptional circumstances and advise on any necessary actions taking into account, to the extent possible, the latest draft of the exceptional circumstances protocol. SCRS to evaluate the MP relative to robustness scenarios.	SCRS to develop clear educational material to explain how the 3 species interact in the proposed MSE and what information the SCRS needs from PA1 in order to begin constructing and testing the operating models, including capacity building workshops.	[...]

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2024*	Commission at Annual Meeting			COMM to adopt exceptional circumstances protocol as new Annex in MP.		[...]
2025 and beyond*	Commission intersessionally	PA2 will provide guidance to SCRS on management objectives and performance statistics.				
	SCRS develop-ment	SCRS to test alternative candidate MPs (e.g., based on JABBA, or empirical). SCRS to complete new MSE in 2026.	SCRS to review the MP in 2027-2028 as outlined in Rec. 22-09.	The SCRS to revise the MP in 202X-202X as indicated in Rec. 23-XX.		

		Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas (BET, YFT, Eastern SKJ)*	*Western Skipjack*
2025 and beyond*	SCRS implementation	SCRS to evaluate existence of exceptional circumstances in accordance with the EC protocol. SCRS to conduct periodic assessments to ensure that the conditions considered in MP testing are still applicable to the stock.	SCRS to evaluate existence of exceptional circumstances in accordance with the EC protocol. SCRS to conduct periodic assessments to ensure that the conditions considered in MP testing are still applicable to the stock.	SCRS to evaluate existence of exceptional circumstances in accordance with the EC protocol. SCRS to conduct periodic assessments to ensure that the conditions considered in MP testing are still applicable to the stock.	[...]	[...]
	Commission at Annual Meeting	COMM to continue use of the MP to set management measures on the predetermined timescale defined in the MP setting. Per Rec. 21-04, COMM to consider adoption of new MP in 2026.	COMM to continue use of the MP to set TAC on the predetermined timescale defined in the MP setting. COMM to review the MP in 2028.	COMM to continue use of the MP to set TAC on the predetermined timescale for MP setting.		[...]

*Assumes that the workplan is accomplished as described.

LIST OF ACRONYMS:

BET = Bigeye tuna
BFT = Bluefin tuna
BFT SG = SCRS Bluefin Tuna Species Group
COMM=Commission
CMP = Candidate Management Procedure
HCR = Harvest Control Rule
MP = Management Procedure
MSE = Management Strategy Evaluation
OM = Operating Model
SCRS = Standing Committee on Research and Statistics
SWGSM = Standing Working Group to Enhance Dialogue between Fisheries Scientists and Managers
TAC = Total Allowable Catch
TRO = Tropical tunas

Appendix 16

Draft proposal for the Tropical Tuna Research and Data Collection Program (TTRaD)

The Tropical Tuna Species Group proposes to pursue a coordinated, comprehensive multi-year research programme on Atlantic tropical tuna to advance knowledge of yellowfin tuna, bigeye tuna and skipjack stocks and be able to provide more accurate scientific advice to the Commission.

This proposal's main objective is to improve the current knowledge on the bio-ecology and fisheries for Atlantic tropical tunas stocks, providing important information and more accurate scientific advice to the Commission and building on research undertake during the Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP).

The research plan will be focused on a number of themes which will include biology, ecology and monitoring stock status, during a 6-year period (2024-2029). This plan will be reviewed annually to ensure that research items and priorities are kept up to date based on the latest stock assessments, management strategy evaluation (MSE) roadmap and climate change work plan.

The table below summarises the discussed research themes, topics, and items by species (Sp.) including preliminary high (H), medium (M) and low (L) prioritisation and estimated costs (including if work could be undertaken by NS = National scientists and Sec = Secretariat). Items defined as high are prioritised from 1 to 7.

Theme	***Topic***	***Sp.***	***Research items***	***Priority (H/M/L)***	***Estimated Cost (€k)***
1.Movements and stock structure	Stock structure	BET	- Check validity of stock unit	M	150
		YFT	- Check validity of stock unit - Migration and mixing of stocks with Indian Ocean units	L	
		SKJ	- Check validity of stock unit (western Atlantic and Gulf of Mexico; N/S East Atlantic) [analysis of tagging data within a meta-analysis approach]	M	150
	Spatial models	BET/ YFT	-Transition matrices from electronic tag data (analysis only)	L	
		All	Application of spatio-temporal models [e.g., VAST]	M/H	NS or 50
2. Biological parameters	Natural mortality, fishing mortality and survival	All	Improving Z estimates from AOTTP data (mainly PS fleets)	M/H	<25
		BET/ YFT	Additional work with AOTTP tagging data to reduce uncertainty of survival estimates and natural mortality	H	NS
		All	Improving Z estimates using other methods (CKMR/Tag releases approach)		
		All	Recovery of historical fishing mortality estimates		

Theme	*Topic*	*Sp.*	*Research items*	*Priority*	*Estimated Cost (€k)*
				(H/M/L)	
	Reproduction and spawning	All	Reproductive studies for maturity, fecundity, season, and sex-ratio [Representative sampling of hard and soft tissues and associated analytical techniques for studies of population genetics, stock composition, age composition, growth and total reproductive contribution by size and age]	M	NS or 60
		All	Genetic indicators for maturation/spawning of tropical tunas [feasibility study]	H (6)	100
	Allometry coefficients and conversion factors	All	Update length-weight relationships using more recent data sources (e.g., AOTTP) and accounting for gear selectivity	L	
		All	Assess the influence of conversion factors on stock evaluations	L	NS
2. Biological parameters	Age and growth	All	Routine ageing for annual age composition estimates with improved calculations of fractional ages (algorithm in Krusic-Golub and Ailloud (2023)	H (5)	40
		All	Targeted sampling [e.g., of small and large individuals] to improve estimation of growth curves and maximum ages	H (3)	40
		All	Research epigenetics for growth	M	200
		SKJ	Direct comparison of otoliths and fin spines from the same fish (e.g., IOTC-2021-SC24-INF02)	M	<25
		SKJ	Compare growth from tagging with growth from spines/otoliths	M	NS or <25
	Age validation	SKJ	Age validation using new methods (bomb radiocarbon validation etc.)	M	75
		All	Determine if there are any AOTTP samples (spines and otoliths) that still need to be aged/validated	M/H	Sec
3.Monitoring stock status	Abundance indices	YFT/ BET	Joint LL indices (estimate changes in catchability with time	H (1)	NS
		All	FAD related acoustic biomass indices (estimate catch composition)	H	NS
		All	Develop new fisheries dependent indices		

Theme	*Topic*	*Sp.*	*Research items*	*Priority*	*Estimated Cost (€k)*
				(H/M/L)	
		All	Develop new fisheries independent indices (close kin feasibility study for tropical tunas)	M/H	
	Tagging	All	Scoping report to summarise available tagging data for use in assessments	M	Sec
		All	Clean, subset and format tagging data for input into Stock Synthesis (e.g., Berger *et al.*, 2014 approach used in the Pacific) and test use in assessments	M/H	175 per year
4. MSE	Multi-stock	All	Identifying and incorporating additional sources of uncertainty for the OMs and observation error models	M/H	20
	Multi-stock	All	Develop and test candidate management procedures	H	100
	W SKJ and Multi-stock	All	External review of mixed species MSE and SKJ-W MSE	H (2)	40
5. Fleets and fisheries	Impacts of FADs on habitat and tuna behaviour/ecology	All	Movement of juveniles from FAD associated schools	M	NS
	FAD fishery characterisation, mortality, monitoring and control	All	Development of indicators for FAD fishery for the evaluation of effort change (e.g., effort creep) and assessment of different impacts	H	NS
		All	Evaluation of the implementation and effectiveness of mitigation measures	M/H	NS & Sec
		BET/ YFT	Project POSEIDON application to tropical tunas in the Atlantic (Vert-Pre *et al.*, 2023)	M	100
	Catchability		Estimate changes in fishing capacity in different fleets	M/H	100
	Carbon footprint		Carbon footprint of different fisheries	L	<25
6. Ecology, and behaviour	Ecology	All	Changes in productivity of tropical tunas in relation to the environment (e.g., Productivity linked to FADs and tagging data)	H	NS or <25
		YFT/ BET	Environmental habitat definition [Analysis of electronic tagging data (started during the AOTTP but incomplete)]	H (7)	50
		All	Analysis of the most vulnerable areas and times (linked to juvenile distribution)	L/M	
	Trophic interactions	All	Investigate predator-prey relationships	L	

Theme	Topic	Sp.	Research items	Priority (H/M/L)	Estimated Cost (€k)
			[Stomach content analysis, stable isotopes, soft and hard tissue, fatty acid analysis, DNA metabarcoding, etc.]		
7. Climate Change	Impact on tropical tunas linked to climate change workplan	All	Develop Climate Change scenarios for the SKJ-W MSE and multi-stock MSE	M	40
8. Tagging data	Continuation of tagging program data collection	All	Conventional tags	H (4)	50
		BET/ YFT	Electronic tags	M	

The Committee will further develop this long-term research strategy in 2024, including the addition of clear timelines for proposed research activities.

Appendix 17

ICCAT Minimum Technical Standards for Electronic Monitoring Systems (EMS) in Purse Seine Fisheries Targeting Tropical Tunas

1. Introduction

ICCAT Recommendations 19-05 and 19-02 requested the SCRS to work with the Working Group on Integrated Monitoring Measures (IMM) to develop minimum standards for Electronic Monitoring Systems (EMS). Within the SCRS this issue started to be addressed by the Billfishes Species Group in 2021. At the 2021 Intersessional Meeting of the Billfish Species Group (Anon., 2021f), a Technical Sub-group on Electronic Monitoring Systems was created dedicated to technical aspects of EMS and to address this Commission request. Requests for participation to all interested scientists were made during all communications with the SCRS, namely at the Species Groups and the Subcommittee on Statistics. A list of the current Sub-group participants can be consulted in **Addendum 1** of this report.

During the first phase of the work that took place in 2021, the Sub-group compiled a list of previous EMS works, focusing on reviewing EMS data collection in comparison with human observers. Each paper was assigned a reviewer within the members of the Sub-group. The main outcomes of these revisions were presented to the SCRS in the 2021 Report of the Sub-group on Electronic Monitoring Systems from the Billfish Species Group (Anon. 2021g).

During 2022, most of the work focused on developing the minimum standards for pelagic longline fisheries, that were presented to the Subcommittee on Statistics (SC-STATS) during the SCRS Species Groups Meetings in September 2022, and afterwards adopted by the SCRS plenary (Appendix 17 of the *Report for Biennial Period, 2022-23, Part I (2022), Vol. 2*).

For purse seine fisheries, it was noted there were already minimum standards agreed by the SCRS for fleets that voluntarily wished to adopt and implement those (see Ruiz *et al.* (2017)) and the Recommendations that are contained in the *Report for Biennial Period, 2016-17, Part I (2016), Vol. 2* and *Report for Biennial Period, 2016-17, Part II (2017) Vol. 2*). In 2022, it was also noted that the minimum standards for EMS in purse seine fisheries should also be addressed by the Sub-group, as well as other fisheries (e.g., gillnets) at a later stage.

During 2023, the main task of the Sub-group focused on purse seine fisheries targeting tropical tunas. This paper summarizes the work carried out for the purse seine fisheries and presents a proposal with the draft Minimum Technical Standards for EMS in purse seines targeting tropical tunas in ICCAT fisheries. We also provide a draft response for the Commission request within Rec. 19-05 (paragraph 20).

2. Comparison of what can be recorded with EMS vs human observers for purse seiners targeting tropical tunas

The work of the Sub-group during early 2023 focused mostly on completing and discussing what data can be recorded with EM systems versus at-sea human observers. As was previously done in 2021 and 2022 for pelagic longline fisheries (Anon., 2021g), the comparison was carried out using ICCAT form ST-09 that is currently used for reporting at-sea observer data (Form A on fishing activity, Form B on catches and Form C on samples).

The outputs of this comparative work are presented in **Addendum 2** of this report.

3. Proposed Draft ICCAT Minimum Technical Standards for EMS in Purse Seiners Targeting Tropical Tunas

Finally, the last phase of the work of the Sub-group during 2023 was to create a draft proposal for ICCAT minimum standards for EMS for purse seiners targeting tropical tunas. This draft proposal is presented in **Addendum 3** of this report.

4. EMS terminology

EMS uses specific terminology such as Electronic Monitoring (EM) records, EM analysis, EM data, etc. It will be important in the near future to have such terminology clearly defined. In this document we do not provide specific definitions of terminology as the Sub-group has not addressed this issue. However, we provide links herein to the work of other tuna Regional Fisheries Management Organization (t-RFMOs) that can be used as a basis for ICCAT in the interest of t-RFMO harmonization, namely for the Indian Ocean Tuna Commission (IOTC)[1] and the Inter-American Tropical Tuna Commission (IATTC)[2].

5. Draft answer to Commission request (Rec. 19-05, paragraph 20)

Following the Commission's request contained in Rec. 19-05 (paragraph 20) a Sub-group within the Billfishes Species Group was created in 2021 to address this issue.

The Sub-group worked inter-sessionally between 2021 and 2023. In 2021 most of the work was a revision of the knowledge, with the main conclusions presented in 2021 Report of the Sub-group on Electronic Monitoring Systems from the Billfish Species Group (Anon., 2021g). In 2022, the Sub-group addressed the pelagic longline fisheries, with a comparison of what could be collected with human observers vs EMS and drafted the minimum standards for EMS in pelagic longline fisheries. This work was presented to the Subcommittee on Statistics and adopted by the SCRS in 2022 (Appendix 17 of the *Report for Biennial Period, 2022-23, Part I (2022), Vol. 2*). In 2023, the work of the Sub-group focused the purse seine fisheries targeting tropical tunas, with a comparison of what data could be collected by human observers versus EMS, and created the draft proposal for ICCAT EMS minimum standards for purse seiners targeting tropical tunas.

With regards to pelagic longline fisheries, the summary of the main work and conclusions from the Subgroup is presented in the Report of the Sub-group on EMS: Proposal of draft ICCAT Minimum Standards for EMS in Pelagic Longliners (Anon., 2022i), and Annex 3 of that document provides specifically the ICCAT EMS minimum standards for pelagic longlines that was adopted by SC-STATS and the SCRS.

With regards to purse seine fisheries targeting tropical tunas, the summary of the main work and conclusions from the Sub-group is presented in Anon. (2023i). **Addendum 3** of this report provides the proposal of the ICCAT EMS minimum standards for purse seines targeting tropical tunas, that is now pending approval by the SC-STATS and the SCRS.

[1] Definitions in Annex 1 of IOTC Resolution 23/08 on Electronic Monitoring Standards for IOTC Fisheries.
[2] IATTC Resolution C-21-03 Definitions used in the implementation of an Electronic Monitoring System for the tuna fisheries of the Antigua Convention area.

Addendum 1 to Appendix 17

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Addendum 2 to Appendix 17

Tables with comparison between what can be recorded with human observers vs EMS using the current ICCAT ST-09 data fields for purse seine (PS) fisheries targeting tropical tunas

Three tables are provided namely for each form (A, B and C) contained in file ST-09, specifically: Form A - Fishing activity, Form B – Catches, Form C – Samples.

ST-09A DATA FIELDS			***Reported by human observers?***	***Reported by EMS?***	***Comments***
Fishing operations & fleets	Fish. Oper. (FO)	FO group ID	Not applicable	Not applicable	Coding variable applied post-processing
	Fleet attributes	Flag of Vessel (cod)	Yes	YES	Might be obtained from EMS installation ID
		Base port/zone	Yes	YES	
		Vessel (size class)	Yes	YES	
Temporal attributes	Year, month/trimester	Year	Yes	YES	Onboard equipment should integrate GPS or VMS as a minimum standard
		T. Period (ID)	Yes	YES	
Geographical attributes	Resolution and position (Lat, Lon)	Square type (cod)	Yes	YES	
		Lat (centroid) (± dd.ddd)	Yes	YES	
		Lon (centroid) (± dd.ddd)	Yes	YES	
Effort attributes	All fishing gears	Gear group (cod)	Yes	YES	
		No. Vessels	Not applicable	Not applicable	Grouping variable applied post-processing
		No. Fish. Oper. (observed)	Not applicable	Not applicable	Grouping variable applied post-processing
		Fish Oper. Type (cod)	Yes	YES	
		School type (cod)	YES	YES	Based on different data sources, such as vessel track previous to the set, catch composition, speed boat images, FAD images
	Longline (LL) only	LL type	Not applicable to PS	Not applicable to PS	
		No. Hooks (total)	Not applicable to PS	Not applicable to PS	
		No. hooks (observed)	Not applicable to PS	Not applicable to PS	

		Hook type (main)	Not applicable to PS	Not applicable to PS	
		Set depth (hooks per basket)	Not applicable to PS	Not applicable to PS	
Mitigation measures (MM) on bycatch species	Seabirds	MM 1	Not applicable to PS	Not applicable to PS	
		MM 2	Not applicable to PS	Not applicable to PS	
	Other bycatch	MM 3	YES	YES	
	Additional notes	Description (MM)	Not applicable to PS	Not applicable to PS	

ST-09B DATA FIELDS			***Reported by human observers?***	***Reported by EMS?***	***Comments***
Catch composition by fishing operation	Fish. Oper. (FO)	FO group ID	Not applicable	Not applicable	Coding variable applied post-processing.
	Species (attributes)	Species (cod)	YES	YES	Normally yes, but there could be difficulties in reaching the species level in some species groups. High-resolution cameras should improve species identification. For some taxonomic groups (e.g., turtles) the crew could be required to place the specimens in designated areas (e.g., calibrated areas) that would improve species identification and allow taking additional information such as sizes and condition.
		Targeted (Y/N)?	YES	YES	Might be possible to integrate with additional info from logbooks.
	Catches (retained)	Weight (kg)	Possible	Possible	For retained catch it might be necessary to integrate with additional information from logbooks or port sampling. EMS trials tried to estimate species composition by set, but without consistent results; we note that human observers have the same difficulty when estimating species composition. Because of the large catch volumes that can result in a set, and the speed with which the fish are put into the wells, species composition estimates – especially bigeye and yellowfin proportions – are likely more accurate if done via port sampling. Artificial intelligence applied on the conveyor belt showed preliminary promising results.
		Product type (cod)	YES	YES	
		Number (catch number)	Possible	Possible	
	Discards (number)	Dead (DD)	YES	Possible	Discards of tunas are usually composed of dead discards and can be estimated. The condition of other discarded species (e.g., sharks) can be doubtful. For discarded specimens, they can be released in various areas, so it would be necessary to either have more cameras or require that the releases are always done in the same place, although there may be logistic difficulties. Observers also face similar difficulties, as they cannot monitor the main and wells' decks simultaneously.
		Alive (DL)	YES	Possible	
		Unknown	YES	YES	
	Sampling (data)	No. sampled	YES	YES	

ST-09C DATA FIELDS			***Reported by human observers?***	***Reported by EMS?***	***Comments***
Specimens & fishing operations (FO)	Specimen Identifier	Unique specimen ID	Not applicable	Not applicable	Coding variable applied post-processing.
		FO group ID	Not applicable	Not applicable	Coding variable applied post-processing.
		Species (cod)	YES	YES	Normally yes, but there could be difficulties in identifying species level in some species groups (look-alike species). High-resolution cameras should improve species identification. For some taxonomic groups (e.g., turtles) the crew might be required to place the specimens in designated areas (e.g., calibrated areas) that would improve species identification and taking additional information such as sizes and condition.
Biological data (observed)	Sex	Sex (cod)	Possible only in some cases	NO	Handling bycatch in PS is more complex than LL, as the bycatch can be processed in several different places onboard. For observers, sex might be recorded only for elasmobranchs and turtles (visible externally), but because priority is given to quick release, this is not always achievable. For EMS it might be visible in very few cases. Additional cameras would be needed in specific and various places where bycatch is released. Current EMS configurations have the starboard camera too far away to distinguish the sex. For the target tunas it is not possible to collect sex information with either human observers or EMS.
	Size	Length (cm)	YES	Possible only in some cases	Retained specimens are passed through one specific area (i.e., conveyor belt) so it could be possible to have a calibrated area defined for taking size samples. For discarded specimens, they can be released in various areas, so it would be necessary to either have more cameras or require that the releases are always done in the same place, although there may be logistical difficulties.
		Size class type (cod)	YES	Possible only in some cases	

	Weight	Weight (kg)	YES	Possible in some cases but need adaptations	Both human observers and EMS can only do that in vessels that have scales, for taking individual weight of specimens. Most vessels do not have these onboard. If the vessels have scales, then the human observers can take weights directly. For EMS might be possible to put cameras facing the scales, or there might be a way to connect the scales to the EMS directly.
		Product type (cod)	YES	Possible in some cases but need adaptations	
	Samples obtained (Y/N)	Genetics (YN)?	YES	NO	Only possible to do biological sampling with human observers.
		Otoliths (YN)?	YES	NO	
		Stomach (YN)?	YES	NO	
		Gonads (YN)?	YES	NO	
Release attributes and others	Condition (external injuries)	Released (YN)?	YES	YES	
		Injuries (scale)	YES	Possible only in some cases	Discards of tunas are usually composed of dead discards. The condition and injuries of other discarded species (e.g., sharks, turtles) can be doubtful.
	Others	Tag number	YES	NO	
		Notes	YES	YES	

Addendum 3 to Appendix 17

Draft ICCAT Minimum Technical Standards for EMS in Purse Seiners Targeting Tropical Tunas

Objectives

For the SCRS, the priority for electronic monitoring systems (EMS) is to implement them in a way that will allow the collection of fisheries data that are usable for scientific purposes. The EMS should be designed in a way that complements, and to the extent possible, are consistent with what is currently collected by human scientific observers. The SCRS also recognizes that EMS are also being used for compliance and other purposes. As such, EMS should be implemented in a way that can address both scientific data collection and compliance objectives. EMS intended to address both objectives should be designed to at least meet the requirements of the more demanding objective. For instance, scientific data often must be collected at a finer (e.g., spatial, temporal) resolution than would be required for compliance purposes. In such a situation, meeting the minimum requirements needed for science would allow to address both objectives.

Structure (who is responsible)

While there are several possibilities for the EMS programme structure, the SCRS will discuss two: decentralized and centralized programmes. A "decentralized system" is where each CPC is responsible for EMS implementation in its own fleets, including the recordings, processing, data extraction and summarization, and submission of data to ICCAT (based on minimum standards to be adopted by the Commission). This is similar to what currently exists at the level of national observer programmes for scientific purposes in ICCAT, where each CPC is responsible for their own programmes and for reporting the required data to ICCAT. Since the cost of implementing this approach would be borne by the CPCs, there would be little financial costs for the Commission to develop or implement the programme and a lower administrative burden for the ICCAT Secretariat. A potential issue, however, is inconsistent implementation of the EMS requirements across the ICCAT members – as has been the case with regards to the implementation of ICCAT's minimum standards for scientific observer programs (Rec. 16-14).

Another approach to EMS is to establish a "centralized system" that would be coordinated at the ICCAT Secretariat level. The benefits of this approach include a more consistent implementation of EMS requirements across the ICCAT members. It might also benefit CPCs who lack the resources to set up their own local EMS databases and auditing infrastructure. There are, however, significant challenges that would be associated with this approach, particularly related to the financial costs to the Commission and the administrative burden for the ICCAT Secretariat. Among others, issues regarding data sharing and confidentiality would also need to be addressed.

There are important trade-offs associated with the approach selected. In addition, as has been done in the case of human observer programs in ICCAT fisheries, it may also be feasible to develop a combination of the two approaches depending on data and compliance needs of the fishery. These questions and trade-offs should be further considered by scientists and managers. Taking into consideration data needs and given the significant financial costs and other challenges associated with the implementation of centralized EMS, the Sub-group focused its work on the development of input related to a decentralized system. That said, a centralized programme or combination of approaches could be considered in the future. The Sub-group acknowledges, however, that such a structure or combination of approaches would require substantial additional work, as well as financial and administrative resources.

Periodic reviews

EMSs should undergo regular evaluations to ensure they reach the outlined objectives. These periodic reviews also give the opportunity to incorporate new technologies (i.e., improved cameras, artificial intelligence) as they become available, as well as to update and incorporate new objectives. A review framework should also allow for a faster implementation of the updated minimum standards, that can be reviewed and adapted as needed in the future.

***Standards described in this document*[1]**

1. Standards for onboard EMS technology, including equipment and camera system requirements, installation, and maintenance;
2. Standards for data storage requirements and what data are subject to those provisions;
3. Standards for data collection, review, and reporting to ICCAT;
4. Standards for data protection and potential privacy issues.

1) Standards for onboard EMS technology, including equipment and camera system requirements, installation and maintenance

EMSs have to be capable of resisting rough conditions at-sea with minimum human intervention. In many cases, proper maintenance and inspection can only be achieved at port, between fishing trips.

The vessel owner/operator is responsible for notifying the national authority and/or the EMS service provider if their EM system is not functioning properly.

The EMS must be linked to a receiver (e.g., Global Positioning System - GPS, Global Navigation Satellite System - GNSS) which records vessel location, speed, and heading information, and is directly and continuously logged by the control box. The receiver must be installed and remain in a location where it continuously receives a strong signal.

The EMS should have a battery backup system with capacity to provide power if the main power source from the vessel fails, to allow proper shutdown of the system and to not corrupt the data.

Access to administrative configuration tools and data must be password protected. The EMS must be proof against any manual data input or external data manipulation and record any attempt to tamper with the equipment or the archived data.

The specifications for selecting, installing, operating, and maintaining EMS and their equipment (cameras, sensors, data storage devices, etc.) onboard vessels should be based on performance standards rather than being prescriptive in terms of pure technical requirements.

The video cameras must be mounted and placed so as to provide clear and unobstructed views of the areas that are being covered (see **Table 1**). There must be sufficient lighting to clearly illuminate the area and the individual specimens captured. If vessels fish at night and use artificial lights to illuminate the deck, the quality of images under these circumstances should be checked to ensure there is not excessive glare.

Purse seine vessels should be equipped with a sufficient number of cameras to allow data collection to the required standards, noting that the number of cameras should be tailored to the specific types of vessels to ensure adequate coverage (e.g., large purse seiners with conveyor belts will need more cameras). See **Table 1** for the minimum areas to be covered in purse seiners, with sufficient resolution to determine the number, species, sizes and other details of the capture, and processing operations. An example of a 7-camera system to cover those areas is provided in **Figure 1**.

The crew should ensure that all specimens that are caught, even those that are released, are handled in a manner that enables the video system to record such specimens to the extent possible.

[1] For definitions see IOTC EM Terms and Definitions adopted by the IOTC Commission (See Definitions in Annex 1 of IOTC Resolution 23/08 on Electronic Monitoring Standards for IOTC Fisheries: https://iotc.org/documents/electronic-monitoring-standards-aus).

In most cases, video will be the primary data collection method, but it may be possible for some CPCs to collect the data needed for ICCAT submission using still images. Whichever the chosen method, the quality of the data must be sufficient to allow species identification and detailed measurements of specimens. To allow this, it is suggested that cameras recording video must have a resolution of no less than 720p, with a minimum frame rate of 5-10 FPS. Where still images are captured, it is suggested they are captured with a resolution of no less than 2 megapixel (2MP), with a rate of image capture determined by the characteristics of each fishing action covered. For both data collection methods, there will be different implications for data storage which will need to be considered by the CPCs at the point of implementation.

The EMS should operate independently from the crew during the trip, with the exception of some basic maintenance such as periodically cleaning the camera lenses.

It is, in general, not necessary for the videos to record 24h/day, but only when relevant operations are taking place. For purse seine vessels, the EMS should be capable of initiating video recording, and record only during the period of operations that must be recorded according to ICCAT requirements (e.g., setting, brailing, sorting, discarding, Fish Aggregating Devices (FAD) deployment-retrieval-visit) (see **Table 1** below for an example of camera locations/specifications). EMSs must continue to record for at least 30 minutes after the end of the brailing operation to ensure that there are recordings of the processing or discarding of all the specimens captured. The capability of initiating and ending the recording can be controlled by sensors that continuously monitor the hydraulic pressure signal; these hydraulic pressures from the sensors should be recorded and stored by the control box.

The system must include a control box that receives and stores the raw data recorded by the sensors and cameras.

A wheelhouse monitor must include a user interface to provide information about the functioning of the system and for the vessel operator to monitor the control box, and cameras. This can include details such as current date and time (synchronized via GPS/GNSS), vessel location, current hydraulic pressure reading, presence of a data disk, percentage used of the data disk, and video recording status.

The EMS should have a self-diagnostic test for functionality of the system components and record the outcome of the tests.

Table 1. Example of the minimum areas that should be covered with EMS deployment for PS. Note that some of the areas (e.g., conveyor belt) might need more than one camera to fully cover the activities.

Camera location	***Action covered***	***Possible data collected***
Work deck (Port side)	Brailing	Total catch by set
	Tuna discards	Total tuna discards by set
	Bycatch handling	Bycatch estimation
Work deck (Starboard side)	Bycatch handling	Bycatch estimation
In-water PS area	Brailing	Total catch by set
	Bycatch handling of big species (e.g., whale sharks, manta rays)	Total bycatch by set Best practices
	Bycatch release of big species (e.g., whale sharks, manta rays)	Total bycatch by set Best practices
Foredeck or amidships	FAD activity (deploying, replacement, reparation, etc.)	Total number of FAD activities by trip and FAD design
Well deck and conveyor belt	Catch well sorting	Species composition
	Bycatch discarded, released or retained	Total bycatch by set Species composition

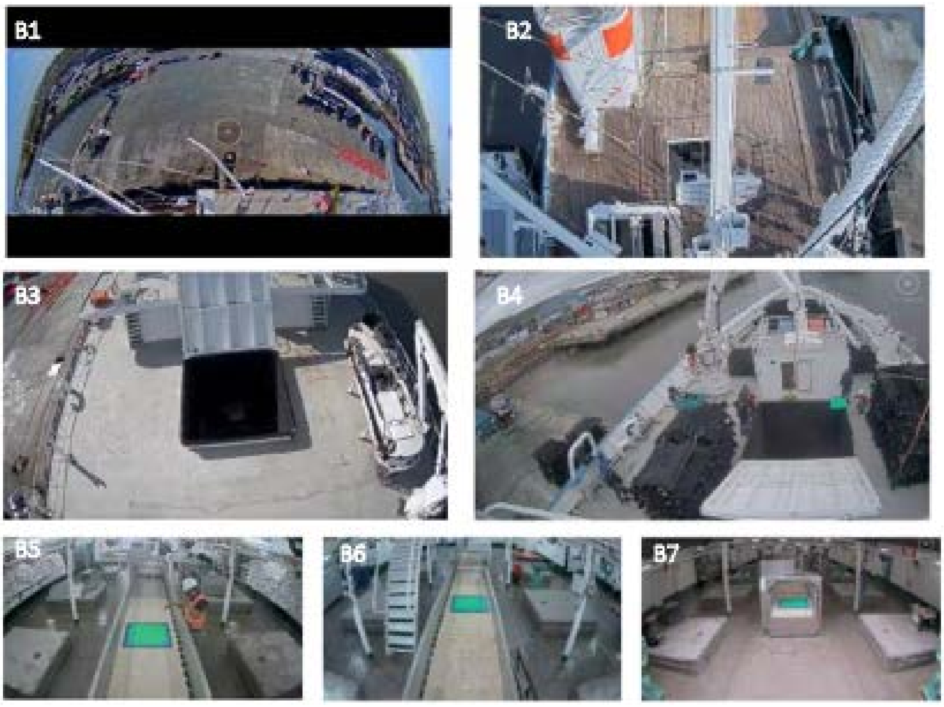

Figure 1. An example of a 7-cameras EMS (four in the upper deck and three in the well deck) installed in a purse seiner covering main areas of fishing and fishing handling operations including 1 more camera in the conveyor belt: (B1) 360˚ Panoramic view camera (e.g port side view), (B2) Crows nest stern view camera, (B3) Working deck crane view camera, (B4) Foredeck view camera, (B5) Conveyor belt stern view camera, (B6) Conveyor belt middle camera, and (B7) Conveyor belt bow camera (source: Digital Observer Services).

2) Standards for data storage requirements and what data are subject to those provisions

The control box must contain data storage systems adequate for the duration of the trip that each national program is designed to cover. Each vessel must have sufficient storage space for the specific trip duration.

Regulations relating to data storage and transmission should be flexible as new technology may allow for different ways of storing or transmitting data that are less logistically challenging or more efficient.

The system must be verified to be functioning properly before the start of each trip, remain powered on and positioned correctly for the duration of each trip.

3) Standards for data collection, review and reporting to ICCAT

EMS raw data (i.e, video recordings) will usually be managed by each flag CPC, which can designate a contracted EMS service provider for its national programme.

The review of the video footage for extraction of the data to be submitted to ICCAT should be done by the CPCs authorities directly, and/or by a contracted EMS service provider assuring that EMS records are analyzed by qualified and experienced EMS analysts.

Each CPC must assure that the EMS should be able to collect, to the extent possible, the observer data that are required to be submitted to ICCAT using the ST-09DomObsProg electronic form or any subsequent update of the form.

EMSs cannot fully replace all the functions of human scientific observer programs, such as biological sampling. Given that, EMS should be used as a complement or supplement to such programs, and a minimum human observer coverage should still be maintained for scientific purposes. This is currently 100% for purse seine vessels targeting tropical tunas as per Rec. 22-01.

The EMS analyses and data extraction require trained EMS analysts. One potential source are trained observers with at-sea experience, who are familiar with the fisheries and species identification. There may be the need for CPCs to train EMS analysts for their programmes. The ICCAT Secretariat might be involved in providing standardized training for EMS analysts or signoff/approve training programmes implemented by each CPC, to improve and harmonize the data processing and extraction from the various national programmes, if the Commission so decides.

The analysis software should make entering the EMS records and generating the EMS data as automatic as possible. This should include, among others, location, date, and time stamps on any activity identified by the cameras, as well as user-friendly tools to directly include information regarding the processed EMS data or reports, and generally expedite the EMS data analyses.

In tropical tuna PS fisheries, catch per set tends to be very large and processed very quickly, which makes it difficult to take size measurements onboards either with EMS or human observers. This may change for EMS with developments in Artificial Intelligence, but until then it is probably necessary to rely on sampling in port. Measurements could be taken in specimens from species that are discarded (e.g., sharks, turtles), and for that the catch will need to be positioned by the crew on one or more calibrated areas. A calibrated area is an area of known size, such as a hatch or area of the deck, that can be defined in the EMS analysis software (see example in **Figure 2** below).

Figure 2. Example of a calibrated hatch onboard a commercial fishing vessel. These areas will vary from vessel to vessel, depending on available surfaces and the species being measured. This image is provided as an example from a non-tuna fishery. For tuna and tuna-like fisheries, the defined areas will have to be larger to accommodate larger species (image source: Centre for Environment Fisheries and Aquaculture Science - Cefas).

Once data are collected, these should be subject to a quality control (QC) procedure, as is standard with most observer programmes, to ensure data quality. This procedure should be defined by each CPC and be repeatable. It may be necessary for minimum standards/requirements to be adopted by the Commission.

Any conversion factors (e.g., length-length or length-weight) used by the CPCs must be reported to ICCAT and they should be the conversion factors adopted by the SCRS, when available.

CPCs are responsible for reporting the data to the ICCAT Secretariat using the ICCAT ST-09DomObsProg electronic form, or any other forms that in the future might be developed and approved by the SCRS for EMS data reporting. Submission of EMS data should comply with the Task 1, 2, and 3 data submission deadlines established by the SCRS and adopted by the Commission.

4) Standards for data protection and potential privacy issues

With a decentralized program, in which each CPC is responsible for the implementation, recordings, extraction of data, and submission of data to ICCAT, the aspects relative to potential issues related to the privacy or confidentiality of the data will depend on national regulations and legislation. In a decentralized system, only the CPC that is responsible for the collection of the data has access to the original recordings. Those original data are therefore managed directly by each CPC national authority.

Data submitted to the Secretariat should follow the "ICCAT Rules and Procedures for the Protection, Access to, and Dissemination of Data" adopted by the Commission in 2022 (Annex 6.1 of the *Report for Biennial Period, 2022-23, Part I (2022), Vol. 1*).

Appendix 18

Candidate Management Procedures (CMP) results for North Atlantic swordfish management strategy evaluation (SWO-N MSE)

Introduction

The Commission is scheduled to adopt a management procedure (MP) for North Atlantic swordfish in 2023. To support the Commission in this decision making, the Committee has prepared several documents, a webpage, and an interactive online platform (SWO-N Shiny App) which present the final reporting of CMP performance and trade-offs relative to predetermined performance metrics. A Trial Specification Document provides a detailed description of technical elements for this MSE. This appendix provides a brief description of CMP results.

Methods

Operating models

Operating models for the SWO-N MSE were based on the 2022 stock assessment (Anon., 2022f), conducted with the Stock Synthesis 3 (SS3) assessment software. The operating models (OMs) were classified into two categories: the Reference Set, which spanned the key uncertainties in the 2022 stock assessment, and the Robustness OMs, a subset of the Reference Set that were modified to account for additional potential uncertainties.

Reference Operating Models

Natural mortality rate (M) and the steepness of the Beverton-Holt stock-recruit relationship (h) are the axes of uncertainty included in the reference set of operating models. Three values were selected for each parameter (M=0.1, 0.2, 0.3 and h=0.69, 0.80, 0.88), and nine operating models were conditioned with these assumed values. One OM of the Reference Set (M=0.2 & h=0.88) shared identical assumptions with the 2022 stock assessment.

Robustness tests

A set of Robustness OMs were developed to evaluate the impact of additional uncertainties that were not considered in the Reference Set. Five Robustness OMs were developed to consider additional uncertainties for the historical and projection periods. **Table 1** provides a summary of the Robustness OMs.

Management cycle testing

All CMPs are designed with a three-year management cycle. For a subset of CMPs, a four-year management cycle was tested and performance compared to the three-year versions.

Minimum TAC threshold testing

A subset of CMPs were tested for performance under a scenario where Total Allowable Catch (TAC) was not changed between management cycles if the CMP recommended a change in TAC of less than 200 t.

Performance Metrics

Panel 4 identified 10 performance metrics as primary criteria for comparing performance of CMPs (**Table 2**).

Candidate Management Procedures

A large number of CMPs were developed by the Committee and then reduced to a shortlist using a culling procedure approved by Panel 4. Five CMP types, each tuned to three tuning targets (51%, 60%, and 70% probability of being in the green quadrant of the Kobe plot in the short time period, years 1-10) were identified for inclusion on the shortlist. For each CMP type, where "a" script is added to the CMP name (e.g., "CE_a") the CMP was tuned to achieve 51% probability of being in the green zone of the Kobe plot in the short time period (years 1-10). The "b" and "c" scripts indicate that the CMP was tuned to achieve 60%, or 70% probability, respectively, of being in the green zone of the Kobe plot, Probability of Green Kobe (PGK), in the short time period (years 1-10). A description of each of these CMPs is found in **Table 3**.

Results and Discussion

Table 4 shows the performance of CMPs relative to the 10 performance metrics identified by Panel 4. For each of the CMPs a time series for fishing mortality, biomass, and TAC trends in the projections were plotted (an example time series plot for the CE_b is shown in **Figure 1**).

Given the structural differences in the CMPs, their performance differs across metrics. Trade-offs between the CMPs are shown in **Figure 2** for the OM reference set. This figure shows trade-offs in PGK against average TAC, the probability of not breaching the limit reference point (LRP) against average TAC, and the mean variation in TAC (shown as a negative value so lower values mean more variable) against TAC. Robustness tests in SWO MSE include scenarios that are often more challenging for the CMPs. **Figure 3** shows the same set of trade-offs as described above, but for Robustness scenario 3b.

Variability in TAC between management periods among the CMPs is shown in a violin plot (**Figure 4**). As per Panel 4's request, the Committee tested CMPs with and without limits in maximum change in TAC between management cycles. **Figure 4** shows the distribution of the absolute change in TAC for the CMPs. The width of the violin plot is proportional to the frequency of the absolute change in TAC (i.e., wider areas mean value is more common).

All short-listed CMPs achieved the minimum requirements for performance identified by Panel 4. Notably, all short-listed CMPs have a very high probability of not breaching the 0.4 B_{MSY} LRP (**Table 4**). In all cases CMPs achieved >95% probability of not breaching LRP in the entire projection period, and in most cases >98% probability of not breaching LRP in the entire projection period. The minimum acceptable probability for not breaching the LRP identified by Panel 4 is 85%.

In addition to the core list of Robustness scenarios, the Committee examined a scenario where management cycle length was four years instead of three (**Table 5**). The results showed the 4-year management cycles had only a small impact on the performance CMPs compared to the 3-year interval. The Committee also examined a scenario where TAC was not changed between management cycles if the CMP recommended a change in TAC less than 200 t (**Table 6**). The results showed the minimum TAC change of 200 t had no impact on the performance of the CMPs, as the change in TAC between management cycles was always greater than 200 t.

These results provide information that the Committee anticipates will support the Commission in selection of a MP for management of the North Atlantic swordfish stock.

Table 1. Description of the Robustness operating models (OMs) developed for the North Atlantic swordfish MSE.

Robustness OM	*Purpose*
R0	Reference OM for the Robustness tests
R1	Evaluate impact of an assumed 1 percent annual increase in catchability that is not accounted for in the standardization of the indices of abundance (historical & projection)
R2	Same as R2, but only for the historical period
R3a	Evaluate impact of cyclical pattern in recruitment deviations in the projection period; a proxy for impact of climate change on stock productivity
R3b	Evaluate impact of lower than expected recruitment deviations for first 15 years of projection period; a proxy for impact of Climate Change on stock productivity
R4	Evaluate impact of illegal, unreported, or unregulated catches. A 10% overage in TAC each year

Table 2. Summary of the Management Objectives and corresponding Performance Metrics (PMs) developed for the North Atlantic swordfish MSE.

Category	*Management Objective*	*PM Name*	*PM Description*
Status	The stock should have a [51, 60, 70]% or greater probability of occurring in the green quadrant of the Kobe matrix.	PGK_{short}	Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) in years 1-10 (2024-2033)
		PGK_{med}	Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) in years 11-20 (2034-2043)
		PGK_{long}	Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) in years 21-30 (2044-2053)
		PGK	Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) over all years (2024-2053)
		PNOF	Probability of Not Overfishing ($F<F_{MSY}$) over all years (2024-2053)
Safety	There should be a [5, 10, 15]% or less probability of the stock falling below B_{LIM} ($0.4*B_{MSY}$) at any point during the 30-year evaluation period.	LRP	Probability of breaching the limit reference point ($SB<0.4SB_{MSY}$) in any year (2024-2053)
Yield	Maximize overall catch levels.	TAC1	TAC (t) in the first implementation year (2024)
		$AvTAC_{short}$	Median TAC (t) over years 1-10 (2024-2033)
		$AvTAC_{med}$	Median TAC (t) over years 11-20 (2034-2043)
		$AvTAC_{long}$	Median TAC (t) over years 21-30 (2044-2053)
Stability	Any increase or decrease in TAC between management periods should be less than [25]%. [also test no stability limitation]	VarC	Mean variation in TAC (%) between management cycles over all years and simulations

Table 3. Summary of the shortlisted candidate management procedures that were developed and tested for the North Atlantic swordfish MSE.

Name	***Type***	***Abundance Indicator***	***Description***
CE	Empirical	Combined index	Attempts to maintain a constant exploitation rate in the projection period, based on the mean exploitation rate in the recent historical years.
MCC5	Empirical	Combined index	Mostly Constant Catch 5 (MCC) focuses on trying to provide a stable TAC. To do this it uses a base TAC which has the possibility of increasing by one step and decreasing by 2 steps. These steps are selected depending on the value of the current 3-yr average of the Combined Index compared to a 3-yr historical average (2017-2019). The minimum TAC set at 4 kt when the current 3-yr average of the Combine Index is less than half of the 3-yr historical average.
MCC7	Empirical	Combined index	Mostly Constant Catch 7 (MCC) focuses on trying to provide a stable TAC. To do this it uses a base TAC which has the possibility of increasing by four small steps and decreasing by 2 steps. These steps are selected depending on a value of the current 3-yr average of the Combined Index compared to a 3-yr historical average (2017-2019). The minimum TAC is set at 50% of the base TAC when the current 3-yr average of the Combine Index is less than half of the 3-yr historical average. When the 3-yr average of the Combined Index is calculated, a smoother is used to reduce its variability year-to-year.
SPSSFox	Model	Combined index	A Fox surplus production model with a harvest control rule that throttles F when estimated biomass is below target level.
FX4	Empirical	Combined index	The combined index is subjected to a median smoother of length 3 and then the deciles of the smoothed index are compared with the average of the most recent 3 years of data in order to find the appropriate percentile interval and associated percent TAC change. The percent TAC change adjusts a base TAC which varies according to the PGK_short tuning objective.

Table 4. Quilt table indicating performance metric values for each of the short listed CMPs. An interactive version of this table is available in the SWO-N MSE Shiny Application. This table shows 12 CMP configurations (rows) and 10 performance metrics (columns). The selection of the CMPs and performance metrics can be customized in the Shiny application. The cells are shaded indicating the range of values, with darker colors indicating more desirable outcomes for the various performance metrics. In this table TAC1 is estimated from the OMs. The final value for TAC1 will be calculated using the update to the Combined Index.

	MP	AvTAC_long	AvTAC_med	AvTAC_short	nLRP	PGK	PGK_med	PGK_short	PNOF	TAC1	VarC
	All	All	All	All	All	All	All	All	All	All	All
1	CE_a	11655.14	11387.05	13446.71	0.96	0.53	0.51	0.51	0.68	13462.5	0.16
2	CE_b	11651.06	11292.16	12768.65	0.97	0.61	0.59	0.6	0.74	12858.27	0.15
3	CE_c	11555.8	11218.02	12158	0.98	0.69	0.68	0.7	0.79	12247.38	0.15
4	FX4_b	12324.66	12632.78	12940.89	0.99	0.6	0.57	0.6	0.71	12940.89	0.1
5	FX4_c	12084.33	12379.07	12379.07	1	0.71	0.7	0.7	0.82	12379.07	0.1
6	MCC5_b	11188.4	11188.4	13426.08	0.99	0.58	0.56	0.6	0.68	13426.08	0.06
7	MCC5_c	12854.07	12854.07	12854.07	1	0.7	0.68	0.7	0.8	12854.07	0.06
8	MCC7_b	11564.15	11564.15	13141.08	1	0.59	0.57	0.6	0.71	13141.08	0.09
9	MCC7_c	12505.21	12005	12505.21	1	0.7	0.69	0.7	0.81	12505.21	0.09
10	SPSSFox_a	11792.19	11819.34	13462.5	0.97	0.53	0.51	0.51	0.67	13462.5	0.17
11	SPSSFox_b	11680.82	11603.5	12753.58	0.99	0.63	0.62	0.6	0.75	13292.91	0.16
12	SPSSFox_c	11571.51	11473.42	12189.85	1	0.72	0.7	0.7	0.82	12521.77	0.15

Table 5. Results for testing of an alternative management cycle length. CMPs CE, FX4, and MCC7 were tested with a 4-year management cycle and compared to the default where the management interval was every 3-years.

MP	*Interval*	*PGK*	*Mean Landings*	*VarC*
CE	3	0.43	10955	0.18
CE	4	0.44	11074	0.18
FX4	3	0.56	11027	0.09
FX4	4	0.56	11020	0.11
MCC7	3	0.47	11226	0.1
MCC7	4	0.47	11199	0.12

Table 6. CMPs CE, FX4, and MCC7 were tested with a minimum TAC change of 200 t and compared to the default where there was no minimum value for the TAC adjustment.

CMP	*Minimum TAC Change*	*PGK*	*Mean landings*	*VarC*
CE	None	0.43	10955	0.18
CE	200 t	0.43	10955	0.18
FX4	None	0.56	11027	0.09
FX4	200 t	0.56	11027	0.09
MCC7	None	0.47	11226	0.1
MCC7	200 t	0.47	11226	0.1

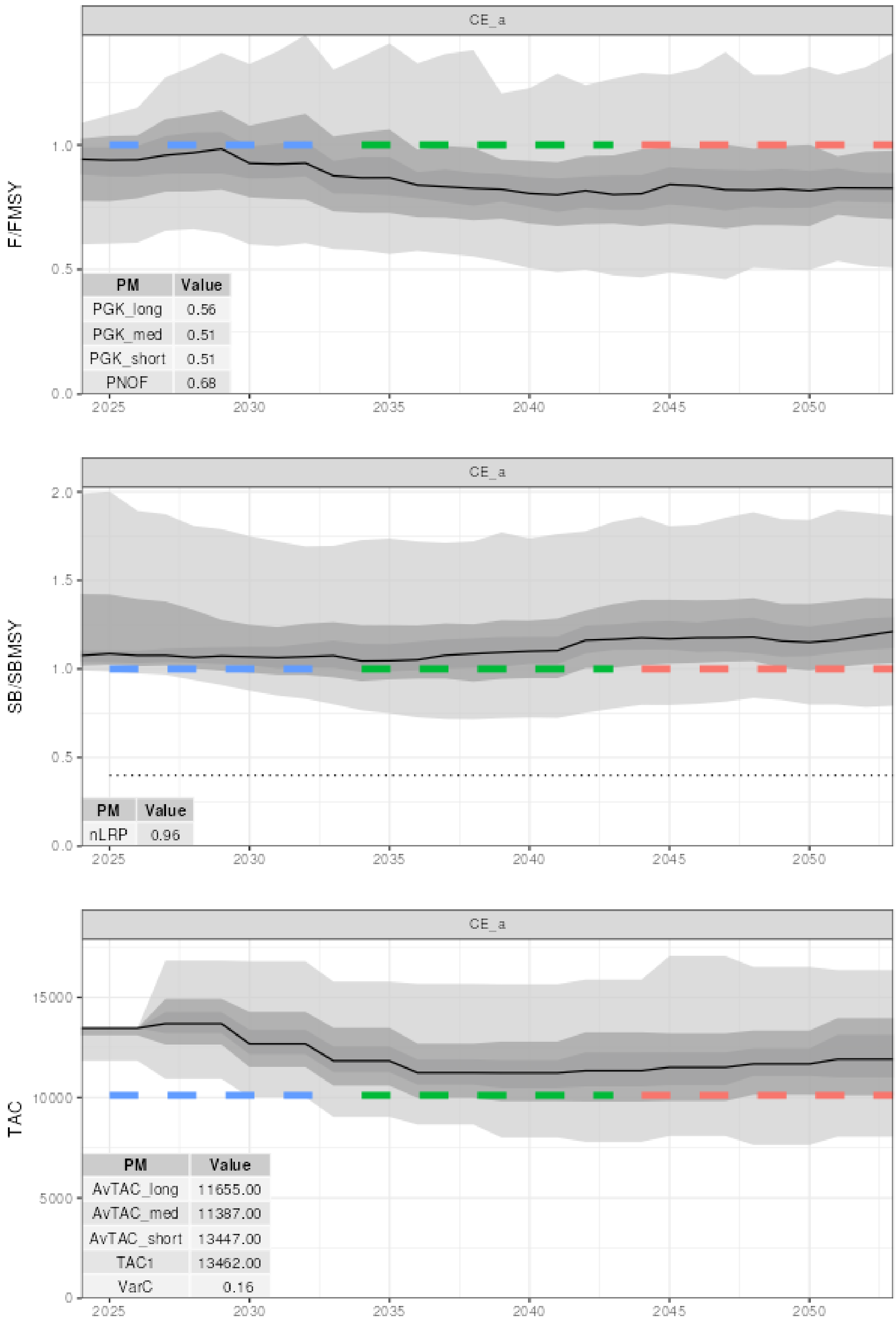

Figure 1. Time-series plots for one configuration of one of the CMPs (CE_a), showing the median (black line), 60th, 70th, and 90th percentiles (increasingly lighter shades of grey respectively) for F/F_{MSY} (top), SB/SB_{MSY} (center), and the TAC (bottom) over the 30-year projection period. This plot shows results for the nine reference operating models. Other plots are available for the Robustness models in the Shiny application. The performance metrics associated with this configuration of the CE_a CMP are shown in tables in the bottom left of each plot. The coloured dashed lines indicate the short (blue), medium (red), and long (green) time spans used in the performance metrics.

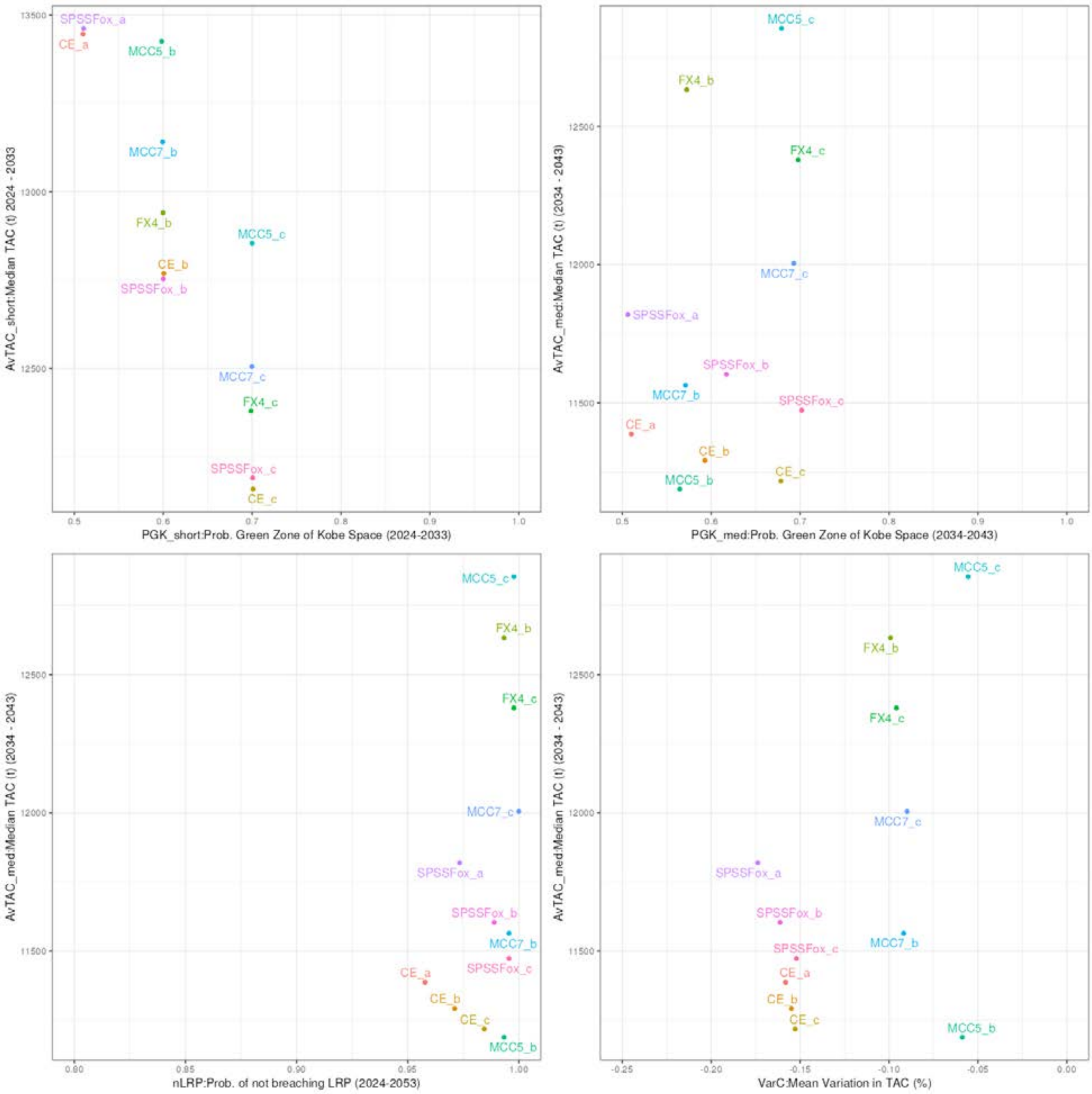

Figure 2. An example of a set of trade-off plots showing the results from 12 configurations of 5 CMPs for the Reference operating models. The plots show the trade-offs between the probability of being in the green space of the Kobe matrix (PGK) in the first 10 years of the projection period against the average TAC over this same period (top left), the PGK in years 11-20 against the average TAC over this same period (top right), the probability of not breaching the limit reference point against the average TAC in years 11 - 20 (bottom left), and the mean variation in TAC (shown as a negative value so lower values mean more variable) against the median TAC in the medium timeframe (bottom right).

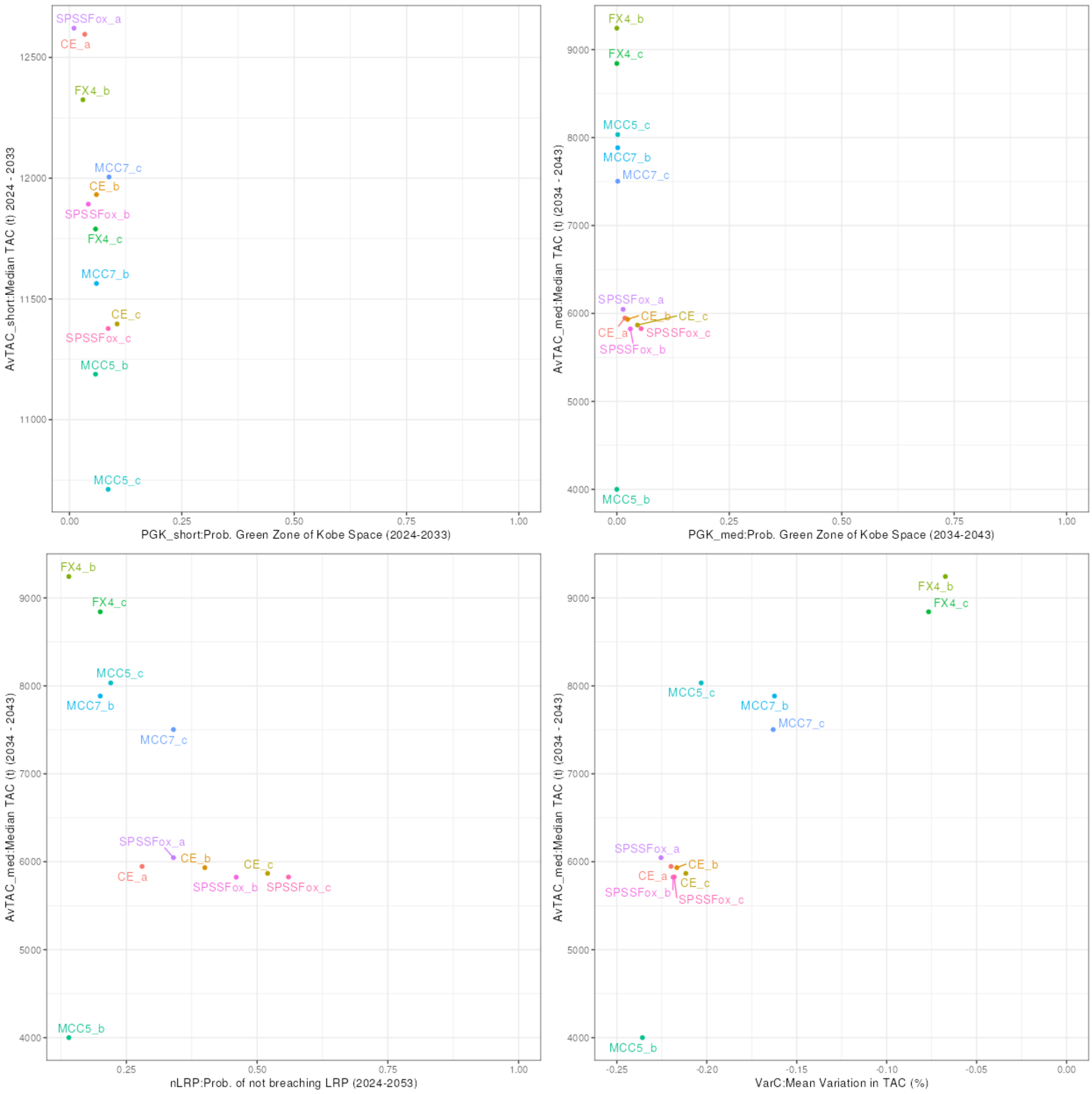

Figure 3. An example of a set of trade-off plots showing the results from 12 configurations of 5 CMPs for the Robustness operating model 3b (Climate Change). The plots show the trade-offs between the probability of being in the green space of the Kobe matrix (PGK) in the first 10-years of the projection period against the average TAC over this same period (top left), the PGK in years 11-20 against the average TAC over this same period (top right), the probability of not breaching the limit reference point against the average TAC in years 11-20 (bottom left), and the mean variation in TAC (shown as a negative value so lower values mean more variable) against the median TAC in the medium timeframe (bottom right).

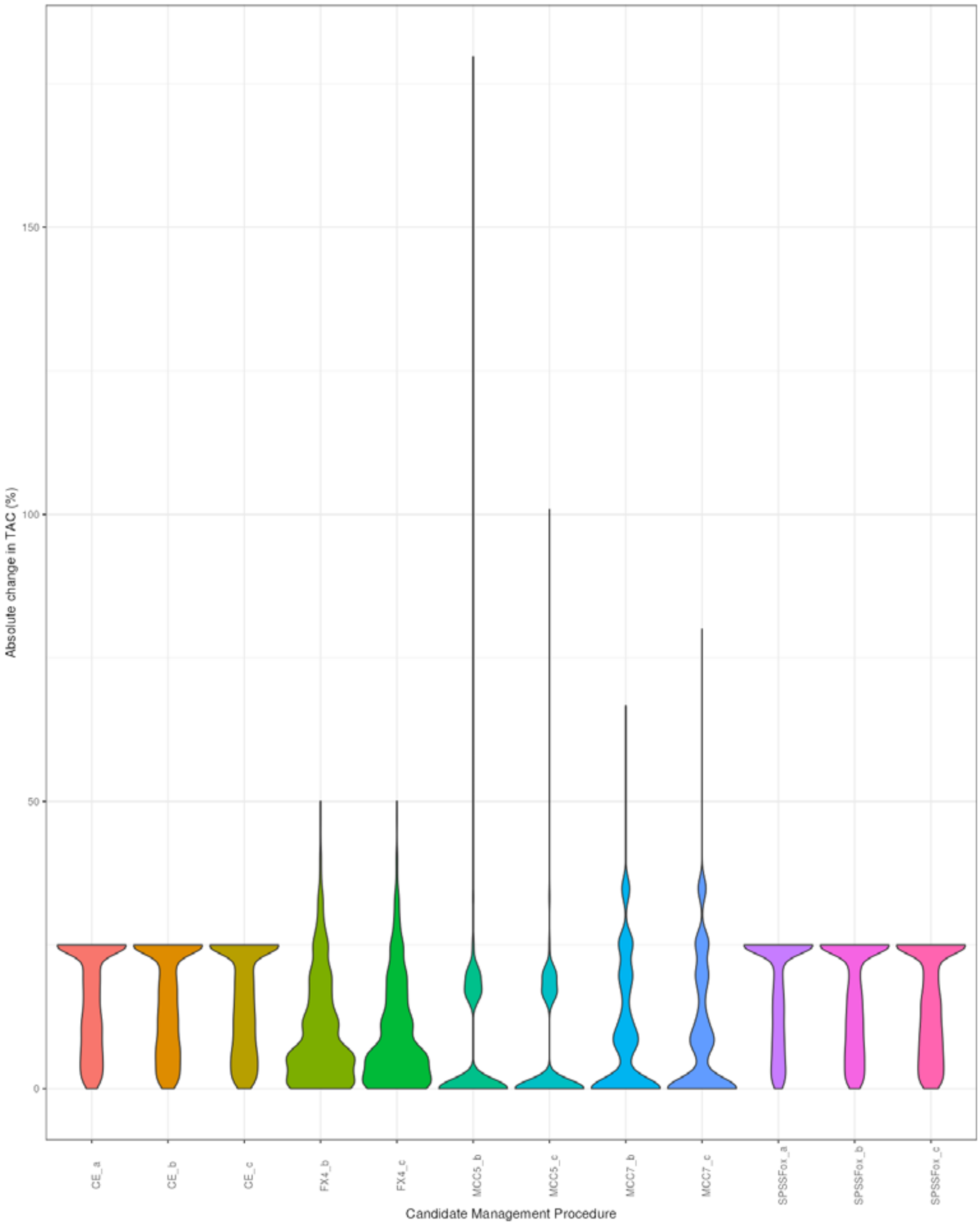

Figure 4. An example of a violin plot showing the distribution of the absolute change in TAC (y-axis) for five CMP configurations (x-axis). The width of the violin plot is proportional to the frequency of the absolute change in TAC (i.e., wider areas mean value is more common).

Appendix 19

List of acronyms

AAVY	Average Annual Variability in Yield
ABNJ	Areas beyond National Jurisdiction (UN)
ABTMSE	Atlantic bluefin tuna Management Strategy Evaluation
AI	Artificial intelligence
ALB	Albacore (*Thunnus alalunga*)
ALB SG	Albacore Species Group
ALBYP	Albacore Year Programme
AMO	Atlantic Multidecadal Oscillation
AOTTP	Atlantic Ocean Tropical tuna Tagging Programme (expired)
API	Application programming interface
AS	Aerial survey
ASAP	Age-structured Assessment Program
ASFA	Aquatic Sciences and Fisheries Abstracts
ATLAFCO	Ministerial Conference on Fisheries Cooperation among African States bordering the Atlantic Ocean
AU-IBAR	Inter African Bureau for Animal Resources
AZTI	Centro Tecnológico Experto en Innovación Marina y Alimentaria (Spain)
B	Biomass
BAI	Buoy associated index
BB	Baitboat
BBNJ	Biodiversity Beyond National Jurisdiction (UN)
BE	Bycatch Estimator
BET	Bigeye (*Thunnus obesus*)
BFT	Bluefin tuna (*Thunnus thynnus*)
BFT SG	Bluefin Tuna Species Group
BLT	Bullet tuna (*Auxis rochei*)
BON	Atlantic bonito (*Sarda sarda*)
BRS	Serra Spanish mackerel (*S. brasiliensis*)
BSH	Blue shark (*Prionace glauca*)
BSP	Bayesian Surplus Production model
BSP2JAGS	Just Another Gibbs Sampler emulating the Bayesian production model
BUM	Blue marlin (*Makaira nigricans*)
CAA	Catch-at-age
CAPAM	Center for the Advancement of Population Assessment Methodology
CAS	Catch-at-size
CATDIS	Catch distribution
CBD	Convention on Biodiversity
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CECAF	Fishery Committee for the Eastern Central Atlantic
CEFAS	Centre for Environment Fisheries and Aquaculture Science (UK)
CFASPM	Catch-free age-structured production
CI	Confidence Interval
CINEA	European Climate, Infrastructure and Environment Executive Agency (EU)
CITES	Convention on International Trade of Endangered Species of Wild Fauna and Flora
CKMR	Close-Kin Mark-Recapture
CLAV	Consolidated List of Authorised Vessels
CMP	Candidate Management Procedure
COFI	Committee of Fisheries (FAO)
COM	Commission
COVID-19	Coronavirus disease
CP	Contracting Party
CPCs	Contracting Parties and Cooperating Contracting Parties, Entities or Fishing Entities
CPUE	Catch per unit effort

CREEM	Centre for Research into Ecological and Environmental Modelling (University of St Andrews)
CRO	Centre de Recherches Océanologiques (Cote d'Ivoire)
CRODT	Centre de Recherche Océanographique de Dakar/Thiaroye (Senegal)
CSIC	Consejo Superior de Investigaciones Científicas (Spain)
CWP	FAO Coordinating Working Group on Fishery Statistics
DAPC	Discriminant Analysis of Principal Component
DB	Database
DBSRA	Depletion Based Stock Reduction Analysis
DCF	Data Collection Framework (EU)
ddRAD	Double digest restriction-site associated DNA
DFO	Fisheries and Oceans (Canada)
DINARA	Dirección Nacional de Recursos Acuático (Uruguay)
DNA	Deoxyribonucleic acid
DOALOS	Division for Ocean Affairs and the Law of the Sea (UN)
DOL	Common dolphinfish (*Coryphaena hippurus*)
DP	Data Preparatory
DPSIR	Driver-Pressure-State-Impact-Response
DR	Disaster Recovery
DSA	Daily subsistence allowance
DST	Decision Support Tool
DTU	Technical University of Denmark
EAFM	Ecosystem Approach to Fisheries Management
EASIFISH	Expansion-Assisted Iterative Fluorescence *In Situ* Hybridization
EBFM	Ecosystem Based Fisheries Management
EBSA	Ecologically and Biologically Significant Areas
ECOWAS	Economic Community of West African States
ECP	Exceptional Circumstances Protocol
EEZ	Exclusive Economic Zone
EFFDIS	Fishing effort distribution
EM	Electronic Monitoring
EMS	Electronic Monitoring System
EPBR	Enhanced Programme for Billfish Research
ERA	Ecological Risk Assessment
ETAGS	Electronic Tags Management System
eTUFF	Electronic Tag Universal File Format
F	Fishing mortality
FAD	Fish aggregating device
FADURPE	Fundação Apolônio Salles de Desenvolvimento Educacional (Brazil)
FAL	Silky shark (*Carcharhinus falciformis*)
FAO	Food and Agriculture Organization (UN)
FAS	Fish Ageing Services
FC	Fleet Characteristics
FCWC	Fisheries Committee for the West Central Gulf of Guinea
FHV	Fish Hold Volume
FIRMS	Fisheries and Resources Monitoring System (FAO)
FIS	Inbreeding coefficient
FL	Fork length
FLUX TL	Fisheries Language for Universal Exchange – Transportation Layer (UN)
FO	Fishing Operation
FOB	Floating object
FPS	Frames per second
FRI	Frigate tuna (*Auxis thazard*)
FSC	Free school
FST	Fixation index
GBS	Genotyping-by-sequencing
GBYP	Atlantic-Wide Bluefin Tuna Research Programme
GEF	Global Environment Facility (UN)
GFCM	General Fisheries Commission for the Mediterranean

GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GOEA	Gene Ontology Enrichment Analysis
GOM	Gulf of Mexico
GPS	Global Positioning System
H	Harvest rate
HCRs	Harvest Control Rules
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ICM	Incidental Catch Model
IEO	Instituto Español de Oceanografía (Spain)
IMM	Working Group on Integrated Monitoring Measures
IMO	International Maritime Organisation
IMR	Institute of Marine Research (Norway)
IOMS	Integrated Online Management System
IOTC	Indian Ocean Tuna Commission
IOV	Instituto Oceanográfico de Venezuela (Venezula)
IP	Internet Protocol
IPMA	Instituto Português do Mar e da Atmosfera (Portugal)
ISA	International Seabed Authority
ISRA	Institut sénégalais de recherches agricoles (Senegal)
ISSF	International Seafood Sustainability Foundation
IT	Information Technology
IUU	Illegal, Unreported and Unregulated fishing
IWC	International Whaling Commission
JABBA	Just Another Bayesian Biomass Assessment
JCAP-2	ICCAT/Japan Capacity-Building Assistance Project (phase 2)
JFO	Joint Fishing Operation
KGN	King mackerel (*Scomberomorus cavalla*)
K2SM	Kobe II Strategy Matrix
L	Length
L/W	Length-weight
LIME	Length-based integrated mixed effects
LJFL	Lower Jaw Fork Length
LL	Longline
LLSIM	Longline simulator
LMA	Longfin mako shark (*Isurus paucus*)
LOA	Length Overall
LRP	Limit Reference Point
LSPR	Length-based Spawning Potential Ratio
LTA	Little tunny (*Euthynnus alletteratus*)
LTY	Long-term yield
M	Natural mortality
MAGO	Most Advanced Group of Oocytes
MCC	Mostly Constant Catch
MCMC	Markov chain Monte Carlo
MED	Mediterranean
MEDAC	Mediterranean Advisory Council
MFAD	Moored Fish Aggregating Devices
MiniPAT	Pop-up archival transmitting tag
MonGOOS	Mediterranean Oceanographic Network for the Global Ocean Observing System
MoU	Memorandum of Understanding
MP	Management Procedure
MP	Megapixel
MPA	Ministry of Fisheries and Aquaculture (Brazil)
MPB	Biomass production model
MSC	Marine Stewardship Council
MSE	Management Strategy Evaluation

MSY	Maximum Sustainable Yield
MVLM	Multivariate lognormal Monte Carlo
MVLN	Multivariate lognormal
NAFO	Northwest Atlantic Fisheries Organisation
NAO	North Atlantic Oscillation
NC	Nominal Catches
NCC	Cooperating Non-Contracting Party, Entity or Fishing Entity
NEAFC	North East Atlantic Fisheries Commission
NEI	Not elsewhere included
NETAM	Northeast Temperate Atlantic and Mediterranean Sea
NGO	Non-governmental Organization
NGS	Next generation sequencing
NM	Nautical miles
NOAA	National Oceanic and Atmospheric Administration (United States)
NOAA-NEFSC	National Oceanic and Atmospheric Administration Northeast Fisheries Science Center (United States)
NPFC	North Pacific Fisheries Commission
NRIFSF	National Research Institute of Far Seas Fisheries
OCS	Oceanic whitetip shark (*Carcharhinus longimanus*)
OEM	Observation Error Model
OMs	Operating Models
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OTC	Oxytetracycline
PCA	Principal Component Analysis
PEW	Pew Charitable Trusts
PGK	Probability of green Kobe
PMs	Performance Metrics
PNOF	Probability of not overfishing
POF	Probability of overfishing
POF	Post Ovulatory Follicles
POR	Porbeagle (*Lamna nasus*)
PPFCN	Pan Pacific Fisheries Compliance Network
PS	Purse seine
PSA	Productivity and Susceptibility Analysis
PSAT	Pop-up satellite archival tag
PWG	Permanent Working Group for the Improvement of ICCAT Statistics and Conservation Measures
QC	Quality Control
RCG LP	EU Regional Coordination Group Large Pelagics
REC	Regional economic organisation
RFB	Regional Fishery Body
RFMO	Regional Fisheries Management Organization
RFO	Regional Fisheries Organization
RMA	Research Mortality Allowance
RMU	Regional Management Unit
ROP	Regional Observer Programme
RRBS	Reduced Representation Bisulfite Sequencing
RSN	Regional Fishery Body Secretariats' Network
RSP	Roundscale spearfish (*Tetrapturus georgii*)
SA	Stock assessment
SAFE	Sustainability Assessment for Fishing Effects
SAI	Sailfish (*Istiophorus albicans*)
SC	Steering Committee
SCBF	Special Capacity Building Fund
SC-ECO	Subcommittee on Ecosystems and Bycatch
SCRS	Standing Committee on Research and Statistics
SC-STAT	Subcommittee on Statistics
SEAFO	South East Atlantic Fisheries Organisation

SFL	Straight fork length
SH	Southern Hemisphere
SKJ	Skipjack (*Katsuwonus pelamis*)
SLU	Swedish University of Agricultural Sciences (Sweden)
SMA	Shortfin mako (*Isurus oxyrinchus*)
SMTYP	Small Tunas Year Programme
SNP	Single nucleotide polymorphism
sPAT	Survivorship Popup Satellite Archival Transmitting Tag
SPF	Spearfish (*Tetrapturus pfluegeri*)
SPiCT	Surplus Production Model in Continuous Time
SPL	Scalloped hammerhead shark (*Sphyrna lewini*)
SPN	Hammerhead sharks nei (Sphyrna spp.)
SPZ	Hammerhead shark (*Sphyrna zygaena)*
SRDCP	Shark Research and Data Collection Programme
SS	Stock Synthesis
SS3	Stock Synthesis 3
SSB	Spawning stock biomass
SSF	Spawning stock fecundity
SSG	Sharks Species Group
SSS	Simple Stock Synthesis
SST	Sea Surface Temperature
SUC.SETS	Successful sets
SWGSM	Standing Working Group to Enhance Dialogue between Fisheries Scientists and Managers
SWO	Swordfish (*Xiphias gladius*)
SWO SG	Swordfish Species Group
SWOT	Strengths, weaknesses, opportunities and threats
SWOYP	Swordfish Year Programme
TAC	Total Allowable Catch
TCI	Turks and Caicos Islands
TCN	Tuna Compliance Network
TDR	Temperature and depth recorder
TG	Tagging form
ToRs	Terms of Reference
TRO	Tropical tunas
TSD	Trial Specification Document
T1	Task 1
T1FC	Task 1 fleet characteristics
T1NC	Task 1 nominal catches
T2CE	Task 2 catch and effort data
T2SZ	Task 2 size data
TTRaD	Tropical Tuna Research and Data Collection Programme
U	Exploitation rate
UDO	Universidad de Oriente (Venezuela)
UJFL	Upper Jaw Fork Length
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNFSA	United Nations Fish Stocks Agreement
UNIVPM	Università Politecnica delle Marche (Ancona, Italy)
VAST	Vector Autoregressive Spatio-Temporal
VMS	Vessel Monitoring System
VPA	Virtual Population Analysis
VPN	Virtual Private Network
W	Weight
WAH	Wahoo (*Acanthocybium solandri*)
WC	Wildlife Computers
WCPFC	Western and Central Pacific Fisheries Commission
WECAFC	Western Central Atlantic Fishery Commission

WGEF	ICES Working Group on Elasmobranch Fishes
WG-EMS	Electronic Monitoring Systems Working Group
WGS	Whole Genome Sequencing
WGSAM	Working Group on Stock Assessment Methods
WHM	White marlin (*Kajikia albida*)
WT	Weight
WTO	World Trade Organization
YFT	Yellowfin (*Thunnus albacares*)

Appendix 20

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