**INTERNATIONAL COMMISSION**
**for the**
**CONSERVATION of ATLANTIC TUNAS**

# R E P O R T
# for biennial period, 2020-21
# PART II (2021) - Vol. 2
# English version SCRS

MADRID, SPAIN 2022

# INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

## *CONTRACTING PARTIES*

*(at 31 December 2021)*

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, Sao Tomé & Principe, Senegal, Sierra Leone, South Africa, St. Vincent and the Grenadines, Syria, The Gambia, Trinidad & Tobago, Tunisia, Turkey, 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<br>(since 23 November 2021) | Z. DRIOUICH, MOROCCO<br>(since 23 November 2021) | R. CHONG, CURAÇAO<br>(since 23 November 2021) |

| ***Panel No.*** | ***PANEL MEMBERSHIP*** | ***Chair*** |
|---|---|---|
| *-1- Tropical tunas* | Angola, Belize, Brazil, Cabo Verde, Canada, China (P.R.), Côte d'Ivoire, Curaçao, El Salvador, Equatorial Guinea, European Union, France, Gabon, Ghana, Guatemala, Guinea (Rep.), Guinea-Bissau, Honduras, Japan, Korea (Rep.), Liberia, Libya, Mauritania, Mexico, Morocco, Namibia, Nicaragua, Nigeria, Panama, Philippines, Russian Federation, Sao Tomé & Principe, 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, Brazil, 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, Turkey, United Kingdom of Great Britain and Northern Ireland, United States, and Venezuela. | Japan |
| *-3- Temperate tunas, South* | Belize, Brazil, China (P.R.), European Union, Japan, Korea (Rep.), Namibia, Panama, Philippines, South Africa, United Kingdom of Great Britain and Northern Ireland, United States and Uruguay. | South Africa |
| *-4- Other species* | Algeria, Angola, 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, Sao Tomé & Principe, Senegal, Sierra Leone, South Africa, St. Vincent and the Grenadines, Trinidad and Tobago, Tunisia, Turkey, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, and Venezuela. | Algeria |

## *SUBSIDIARY BODIES OF THE COMMISSION*

| | ***Chair*** |
|---|---|
| STANDING COMMITTEE ON FINANCE & ADMINISTRATION (STACFAD) | D. WARNER-KRAMER, United States<br>(since 23 November 2021) |
| STANDING COMMITTEE ON RESEARCH & STATISTICS (SCRS)<br>Sub-Committee on Statistics: G. Díaz (United States), Convener<br>Sub-Committee on Ecosystems and Bycatch: A. DOMINGO (Uruguay), A. HANKE (Canada), Conveners | G. MELVIN, Canada<br>(since 5 October 2018) |
| CONSERVATION & MANAGEMENT MEASURES COMPLIANCE COMMITTEE (COC) | D. CAMPBELL, United States<br>(since 25 November 2013) |
| PERMANENT WORKING GROUP FOR THE IMPROVEMENT OF ICCAT STATISTICS AND CONSERVATION MEASURES (PWG) | N. ANSELL, European Union<br>(since 21 November 2017) |
| STANDING WORKING GROUP TO ENHANCE DIALOGUE BETWEEN FISHERIES SCIENTISTS AND MANAGERS (SWGSM) | E. PENAS LADO, European Union.<br>(since 23 November 2021) |

## *ICCAT SECRETARIAT*

*Executive Secretary:* CAMILLE JEAN PIERRE MANEL
*Assistant Executive Secretary:* MIGUEL NEVES DOS SANTOS
*Address:* C/Corazón de María 8, Madrid 28002 (Spain)
*Internet:* www.iccat.int - *E-mail:* info@iccat.int

**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, 2020-2021, Part II (2021)"***, 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 27th Regular Meeting of the Commission (online, 15-23 November 2021) 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 2-d, 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*
*Commission Chairman*

**REPORT OF THE STANDING COMMITTEE ON RESEARCH AND STATISTICS (SCRS)**
*(Online, 27 September - 2 October 2021)*

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**REPORT OF THE 2021 STANDING COMMITTEE ON RESEARCH AND STATISTICS (SCRS)**
*(Online, 27 September – 2 October 2021[1])*

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

*Letter from SCRS Chair (31 May 2021)*

I sincerely hope this letter finds you healthy and comfortable in these troubled times. For a second consecutive year the COVID-19 pandemic has imposed a number of restrictions on the operational capability of the SCRS and its Subcommittees and Working Groups. In this context, I would like to thank all the Officers, rapporteurs, participants and the Secretariat for their efforts and cooperation in achieving their intersessional, subgroup, and committee goals and objectives.

This year, given the continuing pandemic, we have again established 4 priorities, namely the executive summary for those stocks assessed (bigeye tuna, Mediterranean albacore and western bluefin tuna), workplans, responses to the Commission and recommendations with financial implications, to provide our advice to the Commission. I am pleased to announce that most meetings to date have met their objectives, adopted their reports, and provided revisions to the Secretariat within a reasonable period of time, allowing these to be translated, published and disseminated through the usual channels.

As was done last year, it is our intention to advance with the adoption by correspondence of sections of the 2021 SCRS report in advance to the Plenary meeting, once the sections have been adopted by the different Groups. This will allow the Plenary to focus on the essential business for 2021. Accordingly, once we have the input from each Species Group, it will be translated into the 3 official ICCAT languages and circulated among the CPCs' Head Scientists for adoption by correspondence. While this is not ideal, it does provide an open and transparent mechanism to provide up to date scientific advice for specific stocks where information is available. It is anticipated that this adoption by correspondence process (of specific sections of the whole SCRS report) will be completed prior to the Species Groups week meetings of 17 September, at the latest. As such, once the agenda items have been adopted by correspondence, they will not be reopened for discussion at the Plenary. This will hopefully allow the SCRS to dedicate sufficient time to discuss, during the online Plenary meeting, the remaining essential business.

During the period of adoption by correspondence, I will work closely with the SCRS Vice Chair and the Secretariat, to gather and include to the extent possible the CPCs' comments. Due to the limited time available, for the adoption by correspondence I would appreciate that the Head Scientists of ICCAT CPCs focus on the scientific content of the document, keeping any editorial suggestions they might have to a minimum, to ensure the 17 September deadline is met. Our aim is to give the Commission the 2021 SCRS report soon after the plenary is adjourned, as is common practice in ICCAT, so ICCAT CPCs are able to draft their management proposals based on up-to-date SCRS advice before the deadline fixed by the Commission Chair.

Dr Gary Melvin

The 2021 Meeting of the Standing Committee on Research and Statistics (SCRS) was held online and opened on Monday, 27 September 2021 by Dr Gary Melvin, Chair of the Committee. Dr Melvin welcomed all the participants to the annual meeting and requested a moment of silence in tribute to Prof. Dr Fábio Hissa Vieira Hazin that passed away in June 2021 victim of COVID-19. Finally, he thanked the work of all rapporteurs, scientists and the Secretariat for all their input and work carried out during a busy and difficult year due the pandemic.

The ICCAT Executive Secretary, Mr. Camille Jean Pierre Manel, addressed the meeting, welcomed all the participants, and noted how much the ICCAT Community misses Prof. Dr Fábio Hissa Vieira Hazin. Finally, he congratulated all the scientists and the Secretariat staff who contributed to the work of the SCRS throughout 2021 with significant progress. He noted that in 2021, as in previous years, the upward trajectory in the number of meetings has persisted and has increased the overload for both the SCRS and the Secretariat. He raised his concerns and noted that the current workload for the Secretariat staff is unsustainable and compromises the contribution of the Secretariat. Mr. Manel provided several metrics to

[1] Part of this report was adopted by correspondence during July and August 2021 (see item 23 for details).

demonstrate that a similar increase in human resources has not accompanied the increasing number of meetings and related workload at the Secretariat. He then called for a solution that reconciles a limitation of the number of meetings and an adjustment of the Secretariat's resources. Finally, he reiterated that the Secretariat is always committed to assisting the SCRS and the other subsidiary bodies of the Commission and expressed the hope that the SCRS will meet in face-to-face format soon. The Executive Secretary speech is contained in **Appendix 1**.

## 2. Adoption of Agenda and arrangements for the meeting

The Tentative Agenda was slightly modified and is provided in **Appendix 2**. Full assessments were carried out this year on bigeye tuna (BET), western bluefin tuna (W-BFT) and Mediterranean albacore (M-ALB). Additionally, intersessional meetings were held for albacore (ALB), bluefin tuna (BFT), billfishes (BIL), small tunas (SMT) and swordfish (SWO), Subcommittee of Ecosystems and the Working Group on Stock Assessment Methods (WGSAM). Additionally, several meetings of the MSE Technical Group of bluefin tuna and tropical tunas were also held, as well as an Intersessional Meeting of Panel 2 that involved a high number of SCRS delegates.

The following scientists served as rapporteurs of the various species sections (Agenda item 9) of the 2021 SCRS Report.

ALB - Albacore - H. Arrizabalaga (Atlantic), J. Ortiz de Urbina (Med.)
BET - Bigeye tuna - D. Die
BFT - Bluefin tuna general - G. Melvin (Coordinator), J. Walter (West), E. Rodriguez-Marín (East)
Task 1 reported catch (Secretariat)

The Secretariat served as rapporteur for all other Agenda items.

## 3. Introduction of Contracting Party delegations

The Executive Secretary introduced the 27 Contracting Parties present at the 2021 meeting: Algeria, Brazil, Canada, China (P.R.), Côte d'Ivoire, Egypt, El Salvador, European Union, Gabon, Ghana, Guatemala, Japan, Korea (Rep.), Liberia, Libya, Mexico, Morocco, Norway, Panama, Russian Federation, Senegal, Tunisia, Turkey, 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 the following Cooperating non-Contracting Party, Entity, or Fishing Entity (Chinese Taipei), one non-Contracting Party (Montenegro), inter-governmental organization (Food and Agricultural Organization – FAO) and non-governmental organizations (Defenders of Wildlife, Ecology Action Centre – EAC, EUROPÊCHE, Federation of Maltese Aquaculture Producers – FMAP, International Seafood Sustainability Foundation – ISSF, Marine Stewardship Council – MSC, PADI Aware Foundation, Pew Charitable Trusts – PEW, The Ocean Foundation, The Shark Trust and Worldwide Fund for Nature – WWF) were admitted as observers and welcomed to the 2021 meeting of the SCRS (see **Appendix 3**).

## 5. List of scientific documents and presentations

As of 25 September 2021, a total of 157 scientific papers and 63 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 Documents and Presentations is attached as **Appendix 4**.

Besides the scientific documents and presentations, there are 14 reports of intersessional meetings and regular Species Groups meetings, 45 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 2021 Secretariat Report on Research and Statistics related to fisheries and biological data submitted for 2020, which included revisions to historical data. The activities and information included in this report refer to the period between 1 October 2020 and 22 August 2021 (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, due to the impact of the pandemic on the SCRS activities the Secretariat dedicated a lot of additional work to the preparation of and attendance to SCRS meetings, as well as supporting the Commission and SCRS Officers on planning the rescheduling of the meetings and manage all related correspondence work. Moreover, it participated extensively in stock assessment activities, and conducted extensive work related to coordination and management of external support to 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 oversaw auditory and accounting responsibilities, as well as IT support for each programme. As in the past, during 2021 the Secretariat actively participated in all data collection and research programmes components. Finally, the Secretariat highlighted the effort being made on the development of the ICCAT Integrated Online Management System (IOMS), a system designed to manage online all the ICCAT data requirements in the future. This is a long-term project intended to entirely replace the current ICCAT data reporting system. One new software developer was hired for a short-term period (12 month) to work full-time on the IOMS implementation, based on a grant agreement signed with the EU.

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 Secretariat reiterated to the CPCs the Commission's requirement of using the most recent standard electronic forms for data submission and complete all the information requested.

The Secretariat has continued the series of periodic publications developed throughout the history of ICCAT, which includes: 77 (completed issues 6 to 11) and already published issues 1 to 8 of volume 78 of the *ICCAT Collective Volume of Scientific Papers*; *Part I of the Biennial Period 2020-2021*, 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 2021. Volume 47 of the Statistical Bulletin will be published in an electronic version and will provide the catches and other statistics series for the period 1950 to 2019, and will be available in late 2021.

Following the 2019 and 2020 requests regarding the update and expansion of Chapter 2 of the ICCAT Manual, in 2021 the Secretariat hired experts to revise the current chapters for the following small tunas and shark species: bonito (*Sarda sarda*), bullet tuna (*Auxis rochei*), frigate tuna (*A. thazard*), king mackerel (*Scomberomorus cavalla*), little tunny (*Euthynnus alletteratus*), Spanish mackerel (*Scomberomorus maculatus*), blackfin tuna (*Thunnus atlanticus*), blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), porbeagle (*Lamna nasus*), common thresher (*Alopias vulpinus*), bigeye thresher (*Alopias superciliosus*), oceanic whitetip (*Carcharhinus longimanus*), scalloped hammerhead (*Sphyrna lewini*), smooth hammerhead (*S. zygaena*) and great hammerhead (*S. mokarran*). In addition, new species chapters were prepared for the following small tunas and shark species: wahoo (*Acanthocybium solandri*), serra Spanish mackerel (*S. brasiliensis*), cero (*S. regalis*), plain bonito (*Orcynopsis unicolor*), silky shark (*C. falciformis*), longfin mako (*I. paucus*), crocodile shark (*Pseudocarcharias kamoharai*) and pelagic stingray (*Pteroplatytrygon violacea*). These chapters are now being revised and translated by the Secretariat, and later SCRS experts will be requested to make final revisions to the chapters prior to their publication in 2022.

The ICCAT website, in the three official languages of the Commission, continues to be updated on a regular basis to provide better service to users. Development of the webpage and search engine for scientific documents has been completed. This new tool enables searches for SCRS documents published in the ICCAT Collective Volume of Scientific Papers since 1973, by using different parameters and criteria. For that purpose, a new bibliographic database of published SCRS documents was developed.

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 2021 the funds have been used as follows:

- *Participation at SCRS meetings:* Due to the pandemic all SCRS meetings were held online, and therefore no financial assistance was required to attend the meetings.

- *Improvement of statistics:* With the support of the Japan Capacity-Building Assistance Project (JCAP-2), the project on rebuilding the statistical and fisheries data collection system in Liberia was concluded; in addition, an expert was hired to evaluate the current fisheries data base system of Senegal and propose a model for improvement.

- *Enhancement of scientific capacity building:* JAP-2 has also approved the financial support for a 3-month training in research laboratories of two young researcher from Senegal and Uruguay.

- The following SCRS activities were (and/or are being) funded:

    - Short-term contract extension to AOTTP awareness and tag recovery activities in Senegal;
    - Short-term contract extension to AOTTP awareness and tag recovery activities in Côte d'Ivoire;
    - Short-term contract for continuation of the ICCAT tropical tunas MSE work;
    - Short-term contract for collection of biological samples for growth study on billfish in the eastern Atlantic;
    - Short-term contract for collection of biological samples for studies on genetics, growth and maturity - SMTYP;
    - Two short-term contracts for ICCAT for update of ICCAT Manual chapter 2 (small tunas section);
    - Short-term contract for ICCAT swordfish biological samples collection for growth, reproduction and genetics studies;
    - Short-term contract for modelling approaches: support for the ICCAT North Atlantic swordfish from MSE process;
    - Short-term contract for addition of swordfish distribution model to the longline simulator study;
    - Short-term contract for ICCAT North Atlantic albacore tuna reproductive biology study:
    - Short-term contract for ICCAT South Atlantic albacore tuna reproductive biology study:
    - Short-term contract to improve the working framework for assessment of the North Atlantic albacore management strategy;
    - Short-term contract for peer review of the North Atlantic swordfish management strategy evaluation (MSE) code and algorithms;
    - Electronic PSAT tagging of Atlantic swordfish, Atlantic albacore and Atlantic pelagic sharks;
    - Study on the genetic structure of the shortfin mako shark stock based on mitochondrial analysis;
    - Short-term contract for ICCAT for update of ICCAT Manual Chapter 2 (sharks section).

In March 2021, taking into account the increase in functions and the cross-functionality of IT, since March 2021, Mr. Jesús Fiz, the ICCAT IT Manager, has been developing his activities under the direct supervision of the Executive Secretary. Mr. Jesus Garcia joined the Secretariat staff, with the objective of keeping up to date the tagging data received by the Secretariat, further develop the related relational databases and web- based tools to facilitate data analysis. In addition, in April 2021, Mr. Dashiel Portel was hired for a 12-month period, as a Software Developer for the IOMS project.

Finally, references were made to international cooperation. Specifically, the Secretariat presented the project proposals putted forward for the second phase of the FAO Common Oceans/ABNJ Tuna Phase II project, which includes one on compliance, one on the IOMS system, one on testing Ecosystem Indicators, and another one on harmonization among t-RMFOs.

FAO Common Oceans/ ABNJ Tuna II Project noted and welcomed the involvement of the Secretariat in the next phase of the project, which is anticipated to begin sometime in 2022. ICCAT is a founding member of the Project's Steering Committee, which comprised 23 partners during phase 1, including all five tuna RFMOs. FAO sees ICCAT's continued engagement in phase 2 as critical to building upon successes achieved so far, and acknowledge the Secretariat's intention to continue in this role. In consultation with t-RFMOs and other partners, over the past year and a half, FAO has been developing the final Project proposal to be submitted for GEF approval by the end of the year. Tuna II focuses on four main components: 1) Strengthening management of tuna fisheries, including implementation of the precautionary and the ecosystem approaches; 2) Strengthened Monitoring Control and Surveillance to improve fisheries data, compliance with CMMs and to tackle IUU fishing; 3) Reduction of environmental impacts of tuna fisheries; and 4) Knowledge Management, Communication and Monitoring and Evaluation, all of which will include ICCAT's involvement. FAO's intent for Tuna II is to build upon successes and fill gaps identified in Tuna I. Further, it should be noted that a number of ICCAT CPCs have also partnered in phase 1 and have expressed support, including the intent to co-finance the activities of phase 2. FAO welcomes broad engagement in the Project and invite other interested CPCs to consider partnering and participating in the anticipated activities. A background document was provided the Secretariat regarding successes in phase 1 and anticipated activities in Phase 2.

The Committee supported the engagement of ICCAT in the 2nd Phase of the GEF/FAO Common Oceans Areas Beyond National Jurisdiction Tuna Project (2022-2027) considering the benefits to ICCAT from the Project, and recommended the Commission reaffirm its decision to continue to partner with the FAO Common Oceans/ABNJ Tuna programme.

## 7. Review of national fisheries and research programmes

In accordance with the Revised Guidelines for the preparation of Annual Reports (ICCAT Ref. 12-13), only information relative to new research programmes (Part I of the Annual Report) was presented to the Committee. The Committee considered the need to include information of interest for its work, separating it from the Annual Report which, with its current structure, is more geared to providing information to the Commission on compliance. The Committee reiterated the need to follow the *Revised Guidelines for the preparation of the Annual Reports* including the Summary Tables.

### *Algeria*

The national catches of tuna and tuna-like species recorded in 2020 are around 500,95 t for swordfish from a quota of 1655 t, 1648,68 t for bluefin tuna including 900 kg of dead individuals recorded during the live tuna fishing campaign by tuna purse seiners and 1334,424 t for small tunas. Shark catch data have been collected in the context of monitoring shark species for two species of shark that are taken as bycatch and accidentally: around 2,345 t of blue shark (*Prionace glauca*) and 24,216 t of thresher shark (*Alopias vulpinus*). 23 Algerian-flagged tuna purse seiners, with a length of between 21.8 m and 40 m, have participated in the live bluefin tuna fishing campaign. This campaign was divided into two (2) joint fishing groups. As a result of this fishing, 1648,68 t of bluefin tuna have been caught from the quota of 1655 t that was allocated to Algeria, and of this amount caught, 900 kg of dead bluefin tuna have been recorded, representing 10 specimens. The national programme for sampling on landing continues in national ports, which allows for regular information on swordfish (*Xiphias gladius*) to be collected regularly. It has been possible to carry out sampling for size and weight. The number of individuals sampled is 101 specimens with a total weight of 2250 kg, and a size range between 95 cm and 210 cm.

### *Brazil*

In 2020, the Brazilian fleet fishing for tunas and tuna-like fish consisted of 332 fishing boats, including about 263 artisanal and small-scale. The Brazilian catch of tunas and tuna-like fish, including marlins, sharks and other species (e.g. wahoo, dolphinfish, etc.) was 46,801 t (live weight), slightly lower than catches recorded in 2020, when 48,081 t were landed. Most of the catches were done by handline fishery (17,964 t, i.e. 38%), in associated schools, targeting tropical tunas, mainly YFT (11,038 t). The baitboat fishery accounted for the second largest catch in 2020, representing 36% (16,807 t) of the total tuna and tuna like-fish caught this year, with SKJ responding for 87% of the fish landed, in weight (14,590 t). Longline catches reached 9,283 t, representing 20% of the total, being made mainly of BSH (2,904 t), SWO (1,871 t), YFT (1,203 t), and BET (1,390 t). About 42% 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. Thanks to the support provided by the Secretary of Aquaculture and Fisheries (SAP) of the Ministry of Agriculture, Livestock and Supply (MAPA) to the Scientific Subcommittee of the Standing Committee for the Management of the Tuna Fisheries in Brazil, several scientific activities were continued in 2020, 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 are harvested in Canadian waters from May through December. The adjusted Canadian quota for 2020 was 635.65 t which includes a 79.44 t transfer from Mexico and a 4.78 t transfer from France (in respect of Saint Pierre and Miquelon). Canada's total Atlantic bluefin tuna landings in 2020 was 591.6 t, including 447.74 t from the directed fishery and 132.5 t from the mixed swordfish and tuna pelagic longline fishery. There were 4.5 t of observed dead discards in 2020, 0.086 t from the longline fleet and 4.4 t from bottom trawl-fisheries (e.g. halibut).

The swordfish fishery in Canadian waters takes place from April to December. Canada's adjusted quota for 2020 was 1845.2 t, which included transfers to Canada of 35 t from each of Japan and Chinese Taipei, 100 t from the European Union, and a 150 t transfer from Senegal and an underage (2018) of 202.2 t. Canadian nominal landings in 2020 were 1333 t, resulting in an underage of 511.9 t. The Canadian tonnage taken by longline was 1283.7 t (or 96.2 per cent of the catch), while 49.8 t were taken by harpoon. Only 54 of the 77 licensed swordfish longline harvesters were active in the 2020 fishery.

The other tunas (albacore, bigeye and yellowfin) are at the northern edge of their range in Canada and are harvested from April through November. In 2020, other tunas accounted for approximately 9%, by weight, of the commercial large pelagic species landed in Atlantic Canada.

The Canadian Atlantic statistical systems provide 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 landing, and verify log record data.

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 programmes, and biological sampling. Currently, Canada's leadership role extends to ecosystem related issues and to the SCRS itself with assessment support for bluefin tuna, North Atlantic swordfish and porbeagle shark. In 2020, Canada's biological sampling programme of bluefin tuna sampled tissue which addresses questions related to mixing, age at length and supports diet, lipid, histological and genetic analyses of the catch. The bluefin tagging research in Canada also addresses questions related to mixing, migration and the distribution of bluefin tuna within the Canadian EEZ. In 2020, 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. In late 2020 Canada also became involved in coordinating an international sampling programme for albacore tuna. For sharks, recent research has been 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 programme.

***China (P.R.)***

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 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 programme, bycatch regulation, CDS and market-related measures, compliance training. We set a catch limit for each vessel for target and bycatch stocks strictly in accordance with respective ICCAT Recommendations. Severe sanctions will be imposed on fishing vessels that violate management measures. These include 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 participate. During the meeting, we circulate the new ICCAT Recommendations that come into force, which have been translated into Chinese. We also reiterate key compliance issues, such as catch limit, VMS, observer deployment, logbook, bycatch, transhipment and so on. Non-compliance behaviour by tuna fishing vessels will be punished.

***Côte d'Ivoire***

In the Côte d'Ivoire EEZ and in international waters, two fishing vessels regularly carry out their activities; industrial and artisanal fishing vessels.

In 2020, a total amount of 10301189 kg of fish managed by the Commission was landed by vessels flagged to Côte Ivoire and canoes operating in the Atlantic. This quantity is significantly lower than that obtained in 2019.

Catches comprise tuna (95%) and sharks and billfish (5%).

Analysis of data on large tunas shows that yellowfin is predominant (4459514 kg), followed by skipjack (989692 kg).

There are low levels of albacore and bigeye in the catches and no quota overrun has been observed.

As regards small tunas, LTA is predominant (1815164 kg) followed by BON (1756732 kg).

Production of FRI which is usually close to that of LTA has decreased considerably (178166 kg).

***Egypt***

Egypt started the fishing season with one fishing vessel *SAFINAT NOOH*, with ICCAT registration number AT000EGY00010 and national registration number 4274 in the port of Alexandria, which was authorized for JFO with Libya under No. 2021-006 for fishing season 2021. The allocated quota of BFT for Egypt for the fishing season 2021 is 330 t and *SAFINAT NOOH* has fished the allowable quota 326.700 t. In addition, Egypt has assigned 1% of its total quota for bycatch, even though Egypt has not recorded any bycatch for this season. It should also be noted that Egypt has recorded tuna-like species in 2019, approximately 5 t of swordfish, 1006 t of little tunny, 278 t of albacore, and 696 t of *Scomberomorus* spp. According to the 2019 yearly statistical book published by the General Authority for Fish Resources Development (GAFRD), tuna and tuna-like species, mainly *Scomberomorus* spp and *Euthynnus alletteratus*, were caught by purse seiners, longliners and trammel fishing vessels in coastal fisheries within the territorial waters. The total catch of tuna-like species, from 2015 - 2019 was 2008.315 t - 1985.000 t, respectively. Egyptian regulations prohibit catching and trading of sharks and sea turtles.

***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 produces 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. 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 application of the General Law on Fisheries and Aquaculture Management and Promotion. In 2020 four purse seine vessels operated, taking a total catch of 26,166 t of tropical tunas, which break down as follows: 14,875 t of SKJ, 8,813 t of YFT, 1,518 t of BET, and 960 t of frigate tuna (*Auxis thazard*). El Salvador complied with all the ICCAT management measures applicable to its fisheries, in particular, as regards the fishing possibilities authorised under Recommendation 19-02 for tropical tunas. In the case of BET, it should be noted that under Rec. 19-02, a catch limit of 1553 t was established for El Salvador, and the catches of this year did not exceed the limit referred to.

***European Union***

This report presents the fishing activities performed by the EU fleet in the ICCAT Convention area in 2020. The EU Member States with fleets actively fishing in the ICCAT Convention area in 2020 were the following: Croatia, Cyprus, France, Greece, Ireland, Italy, Malta, the Netherlands, Portugal, and Spain. The report covers also, where relevant, the fishing activity of the United Kingdom's fleet. The EU fleet is composed of around 6,000 commercial vessels with 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. Most of the species and stocks regulated by ICCAT and targeted by the EU vessels are: Atlantic and Mediterranean bluefin tuna, Atlantic swordfish, Mediterranean swordfish, tropical tuna (skipjack, yellowfin and bigeye tuna), Atlantic albacore, Mediterranean albacore, blue and white marlins, sharks and small tuna species (bullet tuna, Atlantic bonito, frigate tuna, little tunny and dolphinfish). Some of these species are caught as bycatch. In 2020, the UK fleet composed of two UK vessels fishing for the EU quota. The UK fleet operates in the Atlantic and targets northern albacore with pair trawl gear. In 2020, the total reported EU and UK catches for the main species regulated by ICCAT in the Atlantic Ocean and Mediterranean Sea amounted to 197,821 t, which represents a decrease of 24% compared to 2019, partly due to the COVID-19 pandemic. The EU and UK fishing patterns remained consistent compared to previous years, with 47% of the 2019 catches corresponding to tropical tunas (yellowfin, bigeye and skipjack), 17% to sharks, and 14% to albacore. SKJ, YFT, BSH, ALB, BFT, BET and SWO continued to be the most important resources exploited by the EU and UK fishing fleets. 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. Research activities related to ICCAT fisheries are also carried out at national level by the EU Member States and the United Kingdom.

***Gabon***

Tuna is taken as bycatch by the national fisheries. In addition, in order to capitalise on this resource, the fisheries administration issued in 2020 licenses to foreign purse seiners. These purse seiners have essentially targeted yellowfin tuna (*Thunnus albacores*), bigeye tuna (*Thunnus obesus*) and skipjack tuna (*Katsuwonus pelamis*). During this year, the administration has continued to collect historical data on the national fisheries. Moreover, the fishing season has been impacted by the COVID-19 pandemic, limiting action by the administration and fishing activities.

***Ghana***

The tuna industry in Ghana exploits skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*). There are 18 baitboats, and 17 purse seiners 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 black skipjack (*Euthynnus alletaratus*). A total of 90,253.50 t of tuna was landed in 2020. The purse seine and baitboat fleets accounted for 88% and 12% of total catch, respectively. Skipjack was

the most dominant (66%) followed by yellowfin (28%) and bigeye (3%). Other tuna-like species amounted to 3% of the total catch. More than 90% of the fishing of both fleets was on FADs. Moratorium on fishing on FADs was observed during the months of January and February. 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 are incorporated in the 2020 AVDTH database. Beach sampling of billfishes continued off the western coastline of Ghana from artisanal drift gillnet operators with a decrease in catches of sailfish while blue marlin increased slightly compared to 2019 landings. There were no white marlin and swordfish landed in 2020. Sharks 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. Driftnets are also used in capturing sharks which are consumed locally with no bycatch and discards in the fishery.

***Guatemala***

The State of Guatemala is part of 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 and panels to which it belongs. We have worked together with the industry, providing them with the necessary tools, which have been reviewed, reconciled and approved by the Commission. In Guatemala, the main hydrobiological resource in international trade are the tuna fisheries, which is a sophisticated, technological fishery with national and international monitoring. Therefore, it is important to manage and conserve these fisheries, adopting Resolutions and Recommendations responsibly, and upholding a commitment to make the necessary efforts to achieve the best supply of data and information. In addition, contacts have been made with other Contracting Parties of the Commission. For its part, Guatemala is aware of its obligations and rights in relation to the Commission in participating in meetings, providing information to the scientific committee, maintaining open communication, and providing management measures for fishing tropical tunas and tuna-like species in the Convention area, and for the vessels flying the Guatemalan flag.

***Japan***

Longline is the only tuna-fishing gear deployed by Japan at present in the Atlantic Ocean. The coverage (provisional) of the logbook from the Japanese longline fleet in 2020 is estimated to be 83%. In 2020, the number of fishing days was 12,000, which was 76% of past ten years' average. The catch of tunas and tuna-like fishes (excluding sharks) in 2020 is estimated to be about 20,000 t, which is about 81% of the past ten years' average. In 2020, the most dominant species was bigeye tuna, representing 48% of the total tuna and tuna-like fish catch in weight. The second most dominant species was bluefin tuna occupying 16% and the third one was yellowfin tuna (15%). A total of 707 fishing days were monitored by observers in 2020 covering 5.7% of the total operations.

***Korea (Rep. of)***

In 2020, Korea only has a longline fishery for tunas and tuna-like species in the Atlantic Ocean, and the coverage of data reporting was 100%. 10 Korean longline vessels were engaged in fishing in the Atlantic Ocean, and fishing effort (number of days fished) was 1,238 days, which has decreased by 25% compared to 2019. The total catch was 2,283 t, which has also decreased by 28% compared to 2019. The catches of Atlantic bluefin tuna, bigeye tuna and yellowfin tuna were 247 t (11%), 587 t (26%) and 579 t (25%), respectively. All Atlantic bluefin tuna was caught within 20°-30°W in the north of 55°N. Except for fishing operations targeting Atlantic and southern bluefin tunas, most fishing efforts were focused in the areas of 15°-40°W of 0°-20°N and 0°-10°E of 5°-30°S. In 2020, no scientific observer was deployed onboard due to COVID-19 pandemic.

***Liberia***

Nominal catches were reported for the period under review to ICCAT on August 31, 2021. Some management measures have been put in place to ensure proper management of Liberia's tuna fisheries such as: a more comprehensive access agreement guideline for the foreign tuna fishing fleet, effective Monitoring Control and Surveillance Unit, VMS requirement for all tuna fishing vessels and a minimum of 15% Observer coverage for all tuna companies and daily reporting of catches and logbook by individual vessel to NaFAA through the Research and Statistics Division.

***Libya***

Total catch of bluefin tuna during the year 2020 was (2235 t). Bluefin tuna was targeted and caught by 15 Libyan purse seiners. Individual quotas for chosen vessels were distributed on the basis of national criteria. The fishing operations for BFT took place in Libyan territorial waters and F.A.O. fishing areas 2.2 and 3.2 in the Mediterranean Sea. All ICCAT conservation measures on BFT-E were respected, and VMS data and fishing reports were transmitted regularly to ICCAT. Regional observers were appointed on catching vessels for monitoring and controlling the fishing activities. All fishes caught were exported to the reported farms (EU Malta, Turkey and Tunisia) where the eBCD system was activated. No traps or farms were operated. No incidental catch of (sea turtle, seabird and sharks) was recorded.

***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 enforcement 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 caught incidentally such as: skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), Atlantic bluefin tuna (*Thunnus thynnus*), sharks and swordfish, among others.

The legal framework that regulates this fishery in Mexico includes the General Law on Sustainable Fisheries and Aquaculture (LGPAS), and the Official Mexican Standard NOM-023-SAG/PESC-2014 which governs exploitation of tuna species by longline vessels in waters of federal jurisdiction of the Gulf of Mexico and Caribbean Sea, which is updated periodically for the purpose of incorporating the regulations adopted by ICCAT.

The Secretariat of Agriculture and Rural Development (SADER), through the National Commission of Aquaculture and Fisheries (CONAPESCA) is the national authority in charge of implementing policies, programmes and regulations that facilitate the 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 18037.4 t in 2020 compared to 15221 t in 2019, which is a volume increase of 18.5%. The main species caught off the coasts of Morocco are bluefin tuna, swordfish, bigeye tuna, yellowfin tuna, skipjack tuna, 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. In terms of science, the National Institute of Fisheries Research (INRH), through its 6 Regional Centres, which cover the entire Moroccan coastline, has strengthened collection of biological data on the main species (bluefin tuna and swordfish). The Regional Centre of the INRH in Tangier coordinates collection and analysis of all these data. In recent years, monitoring of other species has started, 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 series of scientific papers, and the Task 2 data, submitted by Moroccan researchers to the various SCRS scientific meetings, for the purposes of tuna stock assessments.

***Norway***

Norway was allocated a quota of 300 t of eastern bluefin tuna (*Thunnus thynnus*) for 2020. In addition to this 5% of the unused quota from 2019 was carried over to 2020. Thus, the total Norwegian quota in 2020 was 311.95 t. Due to bad weather conditions, the quota was not exhausted. Numerous observations of Atlantic bluefin tuna continued to be made, also in 2020, 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 all individual Atlantic bluefin tuna caught in 2020. Norway continuously works on present and historical data on tuna and tuna-like species and aims at incorporating the data on these species into an ecosystem perspective. Norway participated in Management Strategy Evaluation (MSE) related meetings on bluefin tuna and in the SCRS annual science meeting in 2020.

***Russia***

*Fishery:* In 2020 and 2021 a specialized (purse seine) tuna fishery fleet flying the Russian flag did not carry out any operations. In 2020 trawl vessels caught 2635 t of 4 tuna species and 1281 t of Atlantic bonito as bycatch in the Eastern-Central Atlantic.

In the first half of 2021 the trawl vessels caught 255 t of 4 tuna species and 450 t of Atlantic bonito.

*Research and statistics*: In 2020 observers of the Atlantic branch of VNIRO (AtlantNIRO) collected biological and fishery materials on tuna species onboard trawl vessels in the Eastern-Central Atlantic (area BIL94B according to the ICCAT classification). Fish length and weight were measured, fish sex, gonads maturity stages and stomach fullness degree were determined. Species of the small tunas group occurred in trawls as bycatch from one individual specimen or up to a few tons. Material on frigate tuna, bullet tuna, Atlantic black skipjack, oceanic skipjack and Atlantic bonito in the amount of 4786 specimens was collected for weight measurements and 1137 for biological analyses.

*Implementation of the ICCAT conservation and management measures*: In the 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 on compliance with restrictions for 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 2020, the Senegalese industrial tuna fleet fishery comprises six (6) 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*), and two (2) longline vessels and three (3) small cord boats targeting swordfish. The artisanal fisheries target and/or bycatch billfish (marlins and sailfish), large tunas, small tunas (Atlantic black skipjack, king mackerel, Atlantic bonito, frigate etc.) and shark.

In 2020, total catches of tropical tunas by the gears of Senegalese baitboats and purse seiners were around 36,418 t (42,126 t in 2019). The total catch of six (6) Senegalese baitboats is estimated at 2169 t in 2020 (2,433 t in 2019): 925 t of skipjack, 731 t of yellowfin, 512 t of bigeye, and 1 t of frigate. Tropical tuna catches of Senegalese purse seiners are estimated at 34,249 t in 2019: 8,633 t of yellowfin, 20,931 t of skipjack, 2,188 t of bigeye tuna and 2,497 t of small tunas. It should be noted that 83% of catches are taken under floating objects (FOB). In 2020, the fishing efforts undertaken by industrial tuna fleets were 1072 fishing days and 987 days at sea for baitboats and 1825 fishing days and 1786 days at sea for Senegalese purse seiners.

In 2020, the total catch of all species combined of fleets amounts to 92 t, of which 54 t of swordfish were taken by longliners and 10 t by small cord boats using line. It should be noted that the catches have decreased sharply i.e. 82% compared to 2019 (502 t). For the artisanal fisheries, the catches of all species combined are estimated at 8,158 t in 2020 i.e. a 26% decrease compared with 2019 (11,007 t).

***Tunisia***

The tuna and tuna-like species management and conservation plans are essentially governed by the provisions of Law No. 94-13 of 31 January 1994 and its implementing texts. In 2020, as for previous years, these plans were supported by implementation of all the control programmes (onboard observer 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 2020 bluefin tuna fishing campaign, Tunisia adjusted its fishing capacity in accordance with the methodology adopted by ICCAT

(Recs. 18-02 and 19-04). Based on this methodology, Tunisia established a fishing plan, allocating individual quotas to 49 vessels to fish for bluefin tuna in 2020. 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 competent authority, in addition to catch documentation, has attained a scientific observer coverage of more than 5% of its tuna fisheries. Allocation of quotas for bluefin tuna fishing and fine-tuning of gears targeting swordfish have greatly reduced bycatch; in 2020, there was no bycatch of sea turtles, sea birds or sea mammals reported by the national and scientific observers programme. Total catches of bluefin tuna in 2020 amounted to 2,653.377 t, with 2,650.577 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.

***Turkey***

Total marine fisheries production of Turkey was 364,400 t during the year 2020. The portion of tuna and tuna-like fishes in total catch was 26,824 t including Mediterranean swordfish. In 2020, the amount of catch of bluefin tuna, swordfish, albacore, bullet tuna, Atlantic bonito and little tunny was 2,252.0 t, 402.4 t, 16.2 t, 1,069.8 t, 22,742.7 t and 340.9 t, respectively. Most bluefin tunas were caught by purse seiners, which have an overall length of 35-62 meters. Fishing operations were conducted intensively off Antalya Bay in the south of Turkey and in the Central Mediterranean region close to Malta. Bluefin tuna catches started on 15 May and finished on 1 July. Conservation and management measures for swordfish, bluefin tuna fisheries and farming are regulated by national legislation through notifications, considering ICCAT's related regulations.

***United Kingdom***

The 2020 United Kingdom (Overseas Territories) Annual Report provides information for the United Kingdom Overseas Territories (UKOTs) of Bermuda, the British Virgin Islands, St Helena (including Ascension Island and Tristan da Cunha) and Turks and Caicos Islands. For 2020, metropolitan UK activity is covered by the European Union's Annual Report. For 2021 onwards a single UK report will be submitted covering both metropolitan UK and the UKOTs.

The fishing fleets associated with the UKOTs are small-scale and deploy limited effort which is mostly conducted within close proximity to shore. Offshore fishing is associated with seamounts within the EEZs. The typical fishing gear utilised is rod-and-reel, trolling, pole-and-line, and handline which reduces issues with incidental capture of non-target bycatch species more typically associated with longline and purse-seine fishing techniques. In 2020, a single longline vessel (<20 m) operated in the UKOT of Bermuda.

Catches across the UKOTs significantly decreased in 2020, with 232 t landed in total (St Helena 94 t, and Bermuda 138 t). The reduction in catch when compared with 2019 was due to the local fishing industry undergoing restructure, resulting in less ICCAT species caught in 2020, including a 72% reduction in the quantity of yellowfin tuna landed compared to St Helena's 2019 catch (223 t less yellowfin tuna). While there was no commercial activity in 2020 for the UKOTs of Turks and Caicos Islands and British Virgin Islands, these UKOTs remain interested in developing and diversifying offshore fisheries to support their economic development.

A fish tagging programme continued in St Helena, with an additional 1,888 fish of ICCAT species tagged in 2020 (1,458 yellowfin tuna, 419 skipjack tuna, 7 wahoo, 3 little tunny and 1 bigeye tuna). This work contributes to scientific research to study the movement, growth and habitat use of pelagic species in the St Helena EEZ (under the AOTTP and Blue Belt Programme). Conventional tags were also deployed in Bermuda under the AOTTP.

***United States***

Total (preliminary) reported U.S. catch of the main tunas (YFT, SKJ, BET, ALB, BFT) and swordfish, 2020 was 7,562 MT, which is an increase of about 13% from 6,670 MT in 2019. This total catch includes estimates of dead discards for the tropical tunas, BFT, and SWO. Swordfish catches (including estimated dead discards) decreased from 1,758 MT in 2019 to 1,498 MT in 2020, and provisional landings from the U.S. fishery for yellowfin tuna increased in 2020 to 3,664 MT from 2,625 MT in 2019. In 2020, U.S. vessels fishing

in the northwest Atlantic caught an estimated 1,183 MT of bluefin tuna, a decrease of about 8 MT compared to 2019 (1,191 MT). Provisional skipjack tuna landings increased by about 22 MT to 68 MT from 2019 to 2020, bigeye tuna landings decreased by 13 MT compared to 2019 to an estimated 816 MT in 2020, and albacore landings decreased from 2019 to 2020 by 111 MT to 332 MT. U.S. government (NOAA) and university scientists, working independently or in collaboration (including collaborations with scientists from other CPCs), conducted research in 2020 involving a variety of ICCAT and bycatch species. Such research included development of abundance indices, tagging to investigate movements, habitat usage and post-release mortality, and the collection and analysis of biological samples to study topics such as age, growth, stock structure, spawning areas, fecundity, and genetics (including direct estimates of stock size). Additional topics included the influence of environmental factors on distribution and catch rates, and the development of stock assessment models and operating models as part of management strategy evaluations.

***Uruguay***

In 2020, the Uruguayan tuna fleet did not carry out any activity. This inactivity was due to several factors. Moreover, the pandemic (COVID-19) caused a decrease in fishing activity and research at national level, and many activities were suspended which was 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 Atlantic albacore stock assessment meeting, the porbeagle stock assessment meeting, and the Subcommittee on Ecosystems meeting. The control work in ports of third party flag vessels, which began in 2009, was continued. In-port inspections were carried out to determine what species are landed, what their origin is and controlling the formal aspects of the vessels documentation. All ICCAT Recommendations approved at the 2020 Commission meeting have been implemented into Uruguayan law, and are currently in force through degree.

***Venezuela***

In 2020, the Venezuelan fleet directed at pelagic resources which operated in the Atlantic Ocean was made up of 87 industrial vessels: 82 longliners, 3 purse seiners and 2 baitboats. This year some 3,576.267 t of catches of tuna and tuna-like species were taken in the Atlantic Ocean, of which 3,521.501 t correspond to landings and 54.766 t to discards. 81.60% of landings are tuna, yellowfin tuna (*Thunnus albacares*) being the most important (54.79%), while skipjack tuna (*Katsuwonus pelamis*), albacore (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), blackfin tuna (*Thunnus atlanticus*) and frigate tuna (*Auxis thazard*) reached 17.49%, 6.98%, 2.25%, 0.06% and 0.01%, respectively. Bycatch of tuna-like species comprised billfish, including sailfish (*Istiophorus albicans*) (10.32%), and oceanic shark whose landings represent 1.96%, blue shark (*Prionace glauca*) being the most significant within this group (1.67%). 58.73% of landings were taken by the longline fishery, 39.80% by the purse seine fishery and 1.47% by the baitboat fishery. In 2020 research continued on the large pelagics fishery; these include tuna, billfish and shark.

***- Cooperating Non-Contracting Parties, Entities and Fishing Entities***

***Chinese Taipei***

In 2020, the number of our authorized fishing vessels in ICCAT waters was 85 with 55 targeting bigeye tuna and 30 targeting albacore, and the total catch of tuna and tuna-like species was about 26,072 t. Albacore was the most dominant species, which accounted for 51% of the total catch in weight, followed by bigeye tuna with catch accounting for 35% of the total catch. In general, Chinese Taipei fully implemented ICCAT conservation and management measures in 2020. 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 completely 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/spearfish, northern and southern Atlantic albacore and swordfish. The catches of those species were well below catch limits allocated by ICCAT for 2020. Regarding the requirements of ICCAT shark recommendations, Chinese Taipei has taken several measures, including

enhancing data collection and the prohibition of retaining, transshipping, landing, storing, or selling bigeye thresher sharks, hammerhead sharks, oceanic whitetip sharks, silky sharks, and north Atlantic shortfin mako. We have carried out a scientific observer programme in ICCAT waters since 2002. In 2020, 14 observers were deployed on fishing vessels operating in the Atlantic Ocean, and the observer coverage rate was 5.72% and 6.49% for albacore and bigeye tuna fleets, respectively. The research programmes conducted by scientists in 2021 included researches on bigeye tuna, albacore tuna, and swordfish. The research results were presented at the inter-sessional 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.

## 8. Reports of intersessional SCRS meetings

The reports of the intersessional meetings held in late 2020 (after the end of the SCRS correspondence process) and throughout 2021 were posted on the ICCAT current meetings webpage.

### *8.1 2020 Third Intersessional Meeting of the Bluefin Species Group*

The online Third Intersessional Meeting of the Bluefin Tuna Species Group (Anon., 2021a) was held from 1 to 3 December 2020. The Group focused on several decision points regarding the MSE process. After the review of the Operating Models (OMs) and their robustness, it was decided to remove the mixing axis from the interim reference grid due to its low impact/influence, keeping 1% as default mixing value (of western origin bluefin in the eastern Atlantic) and to use 20% for the robustness test. It was also decided to use the senescence vector in the low M/high Maturity OMs. The Group discussed the initial poll for plausibility weighting and decided to conduct it among the participants of this meeting before February 2021. The workplan for 2021 and the SCRS MSE roadmap was updated at this meeting, including the detailed schedule for reconditioning of the current OMs that incorporates the data up to 2018. The Group also reviewed the most recent CMPs results in a Shiny-App, and the external review of the GBYP aerial surveys.

The detailed report is provided here.

### *8.2 Intersessional Meeting of the Billfishes Species Group*

The 2021 Intersessional Meeting of the Billfish Species Group was held online from 8 to 12 March (Anon., 2021b). The main topics for discussion included the review of the Enhanced Programme for Billfish Research (EPBR) activities and its progress. Although the COVID-19 pandemic impacted much of the field research activities in 2020, most of the laboratory work has been resumed. The Group was informed on the biological sampling of hard parts for age and growth studies and that upcoming workshops are scheduled for standardizing protocols among laboratories and creating a reference set for the main billfish species. Ideally in-person workshops would facilitate expertise exchange for these activities. It was also indicated that the research on the reproductive biology of the blue marlin in the Gulf of Mexico is expected to start this year under a new MoU between the parties. Finally, on the genetic study for the identification of white marlin and roundscale spearfish, it was indicated that it would require a substantial increase in funding and number of samples collected per year to be able to provide results, something that would likely require a larger and more dedicated study, expanded beyond the fleets/CPCs that have participated in the sampling. There was concern about the feasibility of such a study. It was also noted that some stored samples were destroyed due to contamination.

The Group also discussed and agreed on the Terms of Reference (ToRs) for the small scale (artisanal) fisheries workshops in the Caribbean and West African regions, recommending having in-person meetings and extending the participation to non-ICCAT parties in order to achieve the workshop objectives. It was thus recommended to schedule these workshops for 2022 (West Africa) and 2023 (Caribbean). On a related matter, the Group also suggested that CPCs provide a summary of the status and inventory of small scale (artisanal) fisheries that catch billfish to design tools for better data collection and reporting of fisheries statistics. The Group was informed on an ongoing study of alternative methods for estimation of discards from fisheries with bycatch of billfish, and proposals for evaluating the methods were suggested. The Group reiterated the importance for CPCs to comply with the requirements and submit the data on billfish discards for all ICCAT fisheries. A proposal for Electronic Monitoring (EM) in longline fisheries was presented to the Group.

Two subgroups were initiated to address the Commission requests on Electronic Monitoring Systems (Rec. 19-05, para 20) and potential technical changes to the terminal gear and fishing practices that could reduce bycatch and bycatch mortality (Rec. 19-05, para 21). Both subgroups will report to the Billfish Species Group in September. It was recommended that expertise from other Species Groups and Subcommittees be incorporated in these Subgroups, as these topics are broadly relevant across ICCAT species and fisheries.

The detailed report is provided here.

### *8.3 Tropical Tunas MSE Technical Group Meeting*

In 2020, the SCRS reviewed the progress of the tropical tunas MSE process. It was noted that a technical meeting for MSE would be necessary to make progress on MSE and was included in the 2021/22 workplan. However, due to time constraints and the impact of the COVID-19 pandemic, the SCRS was not able to develop additional work on the multi tocks tropical tunas MSE (bigeye, yellowfin and eastern skipjack stocks) in 2020, nor the revision of the roadmap adopted by the Commission in 2019. Therefore, it was decided that a technical meeting should be held in early 2021 to revise the roadmap mainly focused on identifying the major sources of uncertainty to be considered for the multi-stock MSE.

The Tropical Tunas MSE Technical Working Group met online from 29 to 31 March 2021 (Anon., 2021c). During the meeting the state of development of MSE operating models for western SKJ was reviewed, as well as the stock-specific operating models for YFT, BET, SKJ, and multi-stock options. The meeting also addressed the major axis of uncertainty for operating models including performance metrics, updating of the roadmap for the MSE process (including single stock vs. multi-stock), communication, and capacity building.

The Group agreed to continue work already begun for western SKJ and to revise existing Operating Models (OMs) to consider the current hypothesis of stock structure that should include data from all western fisheries. With respect to OM development, the Group agreed to examine diagnostics from stock assessment models to define/improve the uncertainty factors that were most important for the MSE and agreed to a set of axes of uncertainty, candidate performance metrics, updating of roadmap for Tropical Tunas MSE Process (including single stock vs. multi-stock), communication, and capacity building. Research recommendations were deferred until the meeting of the Tropical Tunas Species Group later in September 2021.

The detailed report is provided here.

### *8.4 First Intersessional Meeting of the Bluefin Species Group (and western BFT Data Prep)*

The First Intersessional Meeting of the Bluefin Tuna Species Group meeting was held online from 5 to 13 April 2021 (Anon., 2021d). The Group reviewed and focused on the work progress on BFT MSE. The Group made several important decisions for MSE, that include the input data (catch and indices) and other specifications for reconditioning the OMs, interim adoption of the reference grid and plausibility weighting, revision of robustness test, and the list of key performance statistics. The Group also discussed currently developing CMP results and created further guidance for the developments. The lists of characteristics of each CMP and mathematical descriptions were gathered in appendices. Detailed workplans on procedure for agreeing on reconditioning outcomes and process for trimming performance statistics were discussed. The Group reviewed and adopted the terms of reference for the MSE code revision.

In addition, the Group reviewed the progress made and took decisions on future activities by three technical subgroups on: abundances indices, assessment models and growth on farms. GBYP activities were also reviewed, namely the results of the recently held workshops (on Close-kin analysis and Electronic tagging), and a discussion held on the aerial surveys external review. The Group acknowledged that, since the tagging and Close-kin activities will eventually provide inputs for the MSE, the MSE developers should be consulted when identifying priorities.

Substantial attention was given to the preparation of the 2021 western BFT stock assessment, namely to the discussions related to catch estimates, abundance indices and stock assessment models. The Group discussed the impact of data treatments on the stock assessments, other possible stock assessment methods, and the number of projection years. It was agreed that model platforms and set-up will follow the

2020 assessment (Virtual Population Analysis (VPA) and Stock Synthesis (SS)), with exception of revised indices of abundance would include data up to 2020. The Group adopted the detailed specifications for the assessment advice and the terms of reference for an external review of the assessment. The Group also reviewed ongoing works for catch rate updates requested by the Commission, and for the catch size composition for the Mediterranean purse seine fleets except for fleets previously revised (EU-Spain and EU-France).

The detailed report is provided here.

### *8.5 Bluefin Tuna MSE Technical Group Meeting*

The online 2021 Intersessional Meeting of the Bluefin Tuna MSE Technical Group was held from 5 to 10 July 2021 (Anon., 2021e). The Group reviewed the reconditioned operating models and robustness test, and found the lack of fit obtained with two OMs when using the standard approach. *Ad hoc* approaches to correct the lack of fit were proposed and the Group recommended the final reference grid with the approaches. The Group reviewed the current list of robustness tests, and revised and prioritized 12 robustness tests.

Updates on developing Candidate Management Procedures (CMPs) and the comparisons of all CMPs were demonstrated and the Group suggested an approach for further refinement of CMPs. It was discussed selecting, for potential inclusion in CMPs, all indices except Canadian Rod & Reel in the Gulf of St. Lawrence (GSL), US Rod & Reel over 177 cm, and the Canadian acoustic survey after 2017.

The Group further discussed towards selecting an MP and adoption by the SCRS and the Commission. The Group proposed a process for condensing CMPs into 2-3 top performers for future consideration, and the list of performance measures was updated with 7 key ones as main outputs. The Group also discussed messaging on MSE for the SCRS and Commission, and suggested to create "MSE-ambassadors" and a Communication Team to prepare an Executive Summary and slides for the dialogue between the SCRS and PA2. A detailed workplan from July 2021 to November 2022 was proposed.

Additional details provided in item 17.2.

The detailed report is provided here.

### *8.6 Second Intersessional Meeting of the Bluefin Tuna Species Group*

The Second 2021 Intersessional Meeting of the Bluefin Tuna Species Group was held online from 2 to 9 September 2021.The main focus of this meeting was on the: BFT MSE and the path forward for presenting results to the Commission: responses to the Commission; draft of the Executive Summary for W-BFT; workplan for 2022; and the recommendations. The Group reviewed the reconditioned Operating Models (OMs), and the further works requested to the MSE Consultant at the July BFT Technical Group meeting. Reconditioned OMs generally showed more consistency in fits to the indices relative to the original OM reference grid, and improved the ability to estimate key parameters. The Group discussed and adopted the current reference grid and the plausibility weighting of OMs.

The Group also discussed Candidate Management Procedures (CMP) results and Performance Measures. The comparisons of CMPs were reviewed and the Group found that OM plausibility weights had a minimal impact on CMP performance for both the eastern and western stocks, but there are differences between deterministic and stochastic results. The list of Performance Measures was updated, and the process to condense CMPs into 2-3 was discussed. The MSE Code review has been conducted and indicated that ICCAT can be confident about the validity of implementation of the main code components. To enhance a dialogue with the Commission, MSE Communications Team was established, and the materials for both informal and formal dialogue with Panel 2 are in preparation The Group reviewed GBYP activities that have been held this year, and recommended to continue funding to support the essential work of GBYP.

The detailed report (Anon., 2021f) is provided here.

### *8.7 Western Bluefin Tuna Stock Assessment Meeting*

The online 2021 Western Bluefin Tuna Stock Assessment Meeting (Anon., 2021g) was held from 30 August to 1 September 2021. Following the data preparatory meeting, the Group reviewed preliminary assessment results by VPA and Stock Synthesis with model diagnostics and sensitivity analyses. In the 2021 stock assessment, in addition to the new information for 2019 and 2020, the treatments of several indices have changed from those in 2020: US Rod & Reel less than 144 cm indices were combined into a single index and the combined Canadian handline index was separated.

VPA model diagnostics indicate problematic performance, strong retrospective patterns, sensitivity to age 1 in recent years in the catch-at-age and poor fit to some indices, and bias between deterministic and stochastic results. The Group agreed that these diagnostic results precluded the VPA model from further development and provisioning of management advice.

The Stock Synthesis model include new assumptions for some of the selectivities. The new selectivities assume dome shapes where logistic shapes were assumed in the 2020 assessment. After the review, the Group agreed to modify further and accepted as the final Stock Synthesis model, and projections were conducted to provide management advice. The fishery status for 2020 was determined to be not overfishing with greater than 95% probability.

The report is available here.

*Discussion*

The Rapporteur for the western Atlantic bluefin tuna stock provided a summary of the Western Bluefin Tuna Stock Assessment. It was noted that the Committee had agreed to provide management recommendations using only the Stock Synthesis model - until they received the report from the external review that neither the VPA nor the Stock Synthesis models were suitable for management advice. It was emphasized that the Committee had followed an appropriate process to choose the Stock Synthesis model initially, and later appropriately considered the external review in recommending caution in the management advice.

The Committee discussed the possible effect of mixing between the eastern and western stocks on the advice. It was noted that the current stock assessment has been conducted for the bluefin tuna in the West Atlantic, however the stock specific indices i.e., the Gulf of Mexico, provide the western stock biomass trend. The stock-specific indices supported an increase in the western stock. Moreover, mixed-stock indices in the West Atlantic also showed an increase. The Committee noted that in future evaluations, the mixed-stock dynamics would be captured in the MSE and close-kin mark recapture (CKMR).

### *8.8 Bigeye Tuna Data Preparatory Meeting*

The Bigeye Tuna Data Preparatory Meeting was held online from 22 to 30 April 2021 (Anon., 2021h). The Group reviewed the new data on fisheries, biology, and tagging. The catch data submitted for 2020 was incomplete and the Group agreed to use 2019 as the last year for the assessment models. Updates on growth, sex ratios, tagging parameters, and indices of abundance were presented including recent data collected by the AOTTP. A new maximum age for BET of 17 years was adopted (versus former lifespan of 15 years) and consequently, new estimates of natural mortality by age, lower than the previous estimates, were adopted for the upcoming assessment. The Group recommended using the Joint longline and the Buoy echo-sounder indices of abundance for assessment models and using a grid approach with natural mortality, steepness, and Sigma R as main sources of uncertainty for the BET assessment. The Group revised the fleet structure for the assessment models aiming to standardize it for all three species of tropical tunas for consistency in assessment approaches and MSEs operating models. Surplus production models (JABBA, MPB) and a catch integrated model (Stock Synthesis 3) will be used for the assessment of BET.

The Group agreed to support the remaining tag and recovery activities for tropical tunas from the AOTTP and recommended seeking financial support to ensure the recovery of long-term recaptures (multi-year), as described in the meeting report, and to fill some gaps in ageing and validation research that were left incomplete at the end of the ATTOP.

The detailed report is provided here.

### *8.9 Bigeye Tuna Stock Assessment Meeting*

The Bigeye Stock Assessment meeting was held online between 19 and 29 July 2021 (Anon., 2021i). The Group reviewed updates of catch statistics and indices of abundance since the data preparatory meeting and estimated catches in 2020 (59,919 t) and 2021 (61,500 t TAC) for use in stock projections. The stock status was assessed using two production models (JABBA, MPB) and a statistical integrated model (Stock Synthesis) using data for 1950-2019. Uncertainty of data inputs and model structure was integrated with a grid model approach considering natural mortality vectors as estimated from different assumptions of maximum age (17, 20, and 25 yrs), steepness of stock productivity (0.7, 0.8, 0.9), and standard deviation of recruitment (Sigma R, 0.2, 0.4, 0.6).

All models results showed similar trends of relative biomass and fishing mortality, with differences in recent status, however, like in the assessment of 2018, management advice is derived only from Stock Synthesis. Details of the results are presented in the Report of the 2021 Bigeye Stock Assessment Meeting (Anon., 2021i) and the Bigeye Tuna Executive Summary (section 9.1).

The meeting also discussed and prepared a draft text for the responses to the Commission, the 2022 workplan and the recommendations to the Commission that can be found elsewhere in this report (items 19, 20 and 21).

The detailed report is provided here.

### *8.10 Working Group on Stock Assessment Methods Meeting*

The Intersessional Meeting of the Working Group on Stock Assessment Methods was held online from 5 to 7 and 10 May 2021 (Anon., 2021j). The Group discussed broad themes and agreed on several recommendations related to: ICCAT MSEs, standard diagnostics for stock assessment models, CPUE standardization, and an upgrade to the longline simulator (LLSIM). The general progress of the overall ICCAT MSE effort (North Atlantic albacore, Atlantic bluefin tuna, North Atlantic swordfish and tropical tunas) was reviewed and the Group noted the importance of a clearer two-way communication between scientists, managers, and other stakeholders throughout the process. The Group recommended several ways to increase this two-way communication: (1) ensure that terminology used in MSE communications adheres the tRFMO MSE glossary of terms; (2) reinstate regular meetings of the Standing Working Group to Enhance Dialogue between Scientists and Managers (SWGSM); (3) create a stronger connection between the ICCAT Secretariat and the tRFMO MSE Working Group; (4) support the existing outreach efforts of the ICCAT Secretariat; and (5) utilize existing communication and visualization tools such as the Shiny App "SLICK'. Furthermore, the Group recommended that a second, "Executive Summary" version of the interactive MSE visualization tool intended to aid in consultation and decision making (harveststrategies.org; Slick Decision Analysis) be developed that includes only key metrics and graphics essential to the understanding of the MSE results, geared towards more lay audiences.

The Group recommended the SCRS routinely apply objective criteria for model plausibility in the form of standard diagnostics for all ICCAT stock assessments that are intended for management (e.g. TAC) advice. These criteria shall be based on best practice in using model diagnostics for evaluating (1) model convergence, (2) fits to the data, (3) model consistency (e.g. retrospective patterns) and (4) prediction skill, as well as biological plausibility criteria. The Group recommended that the model diagnostics applied be similar, but not limited to, those described in Carvalho *et al*., 2021. The Group noted that key diagnostics, such as residuals run tests, retrospective analysis, and hindcast cross-validation are available in the R package 'r4SS' and 'ss3diags', as well as 'a4adiags' for the statistical catch-at-age (SCA) model FLa4a. These packages are to be included in the ICCAT website stock assessment software catalogue to facilitate this process. The Group further recommended that SCRS meetings in preparation for stock assessment evaluations routinely include a presentation and discussion of model(s) and the diagnostics of the previous assessment being used to provide management advice. The presentations should identify model uncertainties, biases and/or possible misspecifications, which should be considered when specifying an uncertainty grid to be submitted at the subsequent stock assessment meeting.

Several ongoing studies related to LLSIM were discussed: further development of the swordfish species distribution model (SDM) to the LLSIM study, swordfish habitat distributions using a swordfish SDM, simulation of longline CPUE estimates using the LLSIM, and testing a generalized bycatch estimation

software in development by the LLSIM. The Group also discussed the desirability of including environmental variables in CPUE standardization. It was shown that the LLSIM is a very useful operating model for testing bycatch estimation and CPUE standardization methods, therefore the Group recommended to further explore the tools to estimate bycatch of species such as, but not limited to, billfish and shark using LLSIM as a means to address the SCRS general needs.

The detailed report was provided here.

### *8.11 Intersessional Meeting of the Small Tunas Species Group*

The Intersessional Meeting of the Small Tunas Species Group was held online from 17 to 20 May 2021. The Group revised the most up-to-date information available in the ICCAT database for the 13 major small tuna species, namely the fishery statistics and the conventional tagging. No major updates were made at the meeting to the existing catches. Very little improvements were made over the last year on the reduction of unclassified gears, on the replacement of the SCRS carryovers by official statistics, on data gaps completion, and on historical recoveries. The species DOL (*Coryphaena hippurus*) was finally removed from the official list of small tuna species, in line with Rec. 19-01. The Group also reviewed the available and new information on biology, other life-history parameters of small tunas and stock structure.

In addition, an update of the work conducted on Data Poor Methods and related developments on appropriate approaches for future assessments and the provision of advice related to small tuna stocks were also carried out. The status of the Small Tuna Year Programme (SMTYP) was reviewed, particularly regarding the collection of biological samples aiming growth, maturity and stock structure studies on little tunny (LTA, *Euthynnus alletteratus*), Atlantic bonito (BON, *Sarda sarda*) and wahoo (WAH, *Acanthocybium solandri*), which were conducted within the short-term contract issued to a consortium of 10 institutions (7 CPCs) by the ICCAT Secretariat. Preliminary results of the research conducted on SMTYP were presented, namely on genetics (for LTA, BON and WAH), reproduction (for BON) and growth (for LTA and BON). Eight revised and one new subchapter on 9 small tuna species were presented for later update of Chapter 2 of the ICCAT Manual. The priorities that should be taken into account in terms of the specimens and areas to be sampled during the new SMTYP short-term contract were revised. Finally, the workplan for 2022 and general recommendations with and without financial implications were discussed for final adoption by the SCRS. Finally, The Group thanked the coordination work carried out by the Rapporteur (Flávia Lucena Fredou, from Brazil) over the past years and welcomed the new Group Rapporteur Constance Diaha, from Côte d'Ivoire.

The detailed report was provided here.

### *8.12 Intersessional Meeting of the Swordfish Species Group*

In 2020, the SCRS elaborated a workplan for 2021 that included a meeting for the Swordfish Species Group with the major focus on the progress of the swordfish biological and stock structure project, and the continued development of the North Atlantic swordfish MSE process. The meeting was held online from 31 May to 7 June 2021 (excluding weekend days).

With regards to the northern Atlantic SWO MSE, the work done in 2020 and early 2021 was reviewed. Changes were made in the OM to update the stock synthesis software version, reduce redundancy in the OM grid, and include the possibility of assessing minimum size limits by including discards and the associated mortality. In early 2021 the North Atlantic MSE code was externally peer-reviewed, with the outcomes presented to the Group. The recommendations provided by the external peer-reviewers are being addressed. The 2021 and 2022 North Atlantic swordfish MSE workplan was discussed, which included: finalizing the OM uncertainty grid, OM validation, performance metrics, advice intervals, and exceptional circumstances. Finally, the ICCAT MSE roadmap was revised by the Group.

Several updates regarding the swordfish programme were presented, including the outcomes of the biology workshop held in March 2021. Additionally, updates were provided in the life history components, including age and growth (both Atlantic and Mediterranean stocks), and stock structure based on genetics. The Group discussed priorities for further stages of the swordfish programme. Priority areas for sampling and planning for Phase 4 (July to December 2021) and 5 (2022) should be areas where there are currently no or very limited samples, such as in the eastern Mediterranean and the southern parts of the South Atlantic. The ToRs for phase 4 of the swordfish programme were adopted.

Stock assessments for North and South Atlantic swordfish were originally planned by the SCRS to take place in 2021, however those did not take place. As such, there was some initial planning for the next stock assessment of those two stocks, now tentatively planned for 2022. Discussion focused on data inputs, potential corrections to historical size structure data, and development of both fleet specific CPUEs as well the continuation of the combined CPUE index.

The detailed report was provided here.

### *8.13 Intersessional Meeting of the Albacore Species Group (and Med ALB Stock Assessment)*

The Albacore Species Group intersessional meeting including the Assessment of the Mediterranean Stock was held online from 22 to 30 June 2021 (Anon., 2021m). The Group reviewed the new data on fisheries, indices of abundance, biology and tagging for the North Atlantic and Mediterranean stocks. The catch submitted for 2020 was incomplete and it was agreed to use 2019 as the terminal year for the Mediterranean albacore stock assessment. This stock was evaluated using a Bayesian Surplus production model, with eight indices of abundance and assuming a Fox model. The status of the Mediterranean albacore stock in 2019 was estimated to be overfished and overfishing was occurring, although it should be noted that not all potential sources of uncertainty were considered in the assessment model. Constant catch projection scenarios of the Mediterranean albacore stock status showed that the current catch level (~2,700 t) would recover the biomass to the $B_{MSY}$ level with greater than 50% probability within a time frame of around ten years.

However, some projections with catch levels above MSY, predicted small biomass ratios and high F ratios indicating the potential risk for the stock to collapse.

For the North Atlantic albacore (N-ALB) stock, the main inputs of catch, size, Age Length Key (ALK) and tagging information were revised in preparation for the new reference case using the stock synthesis model that will also update operating models for the N-ALB MSE. The Group reviewed Panel 2 protocols for exceptional circumstances for the N-ALB. The Group made no determinations regarding the existence of exceptional circumstances in 2019 as final indicators have not been adopted, however, no concerns were noted on catches or indices of abundance. In their workplan, the Group continued to support the research programmes for the three stocks of albacore, with focus on biology (e-tagging, reproduction) and the N-ALB MSE process.

The detailed report was provided here.

*Discussion*

The Rapporteur presented the results of the 2021 Mediterranean albacore stock assessment highlighting the main conclusions of the stock status, trends, future projections, and management advice. It was also summarized the 2021 albacore progress on biological research activities and the N-ALB MSE programme. The Committee requested clarifications on the stock projections and associated K2MS. The Rapporteur explained that the Bayesian model considers both observation and model errors, resulting in wide confidence intervals in the projections, and confirmed that current projections indicate that catches over 3600 t are not sustainable and present an increasing risk of stock collapse, while catches about the recent average catches (about 2,700 t) would allow the stock biomass to increase in the near future.

## 9. Executive Summaries on species

The COVID-19 pandemic continued to impose a number of restrictions on the operational capability of the SCRS and its Species Groups. Therefore, to provide scientific advice to the Commission, the SCRS has concentrated on updating the Executive Summary for only those species which have undergone a stock assessment in 2021 (bigeye tuna, western bluefin tuna and Mediterranean albacore).

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.*

### *9.1 BET – BIGEYE TUNA*

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., 2021h) and the Report of the 2021 Bigeye Tuna Stock Assessment Meeting (Anon., 2021i).

#### *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 Anon., 2021i.

#### *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 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 4,700 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 (FADs). The estimated total numbers of FADs released yearly has increased since the beginning of the FAD fishery, especially in recent years. During 2015-2020, bigeye landings in weight caught by longline fleets represent 45%, purse seine fleets 36%, baitboat 10% 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 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 79,524 t in 2015. Catches averaged 77,241 t in the period 2015-2019. The preliminary catch reported for 2020 was 57,486 t, below the TAC of 62,500 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 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 this report.

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 catch for *faux poissons* was estimated by the Group.

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 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. The Committee plans to update this analysis in 2022 to include the most recent years of data.

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, 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 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% CI of 0.71 and 1.37) and was not undergoing overfishing (median $F_{2019}/F_{MSY}$=1.00 and 80% confidence interval (CI) of 0.63 and 1.35). The average of MSY was estimated as 86,833 t with (80% CI of 72,210 and 106,440) 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***

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[2], 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.

[2] During the 2021 BET assessment in July, the catch for 2020 was estimated to be 59,919 from Task 1 data and by interpolating some of the missing data for certain fleets. If the same procedure used in July to estimate the 2020 catch was applied to the data available on September 17 the estimated 2020 catch would be 59,951 t. The reported Task 1 catch as of September 17 is smaller 56,432 t, but it remains preliminary as there are still some fleets that have not provided Task 1 reports.

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 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**).

It needs to be noted that the estimated catches for 2020 and the assumed catches for 2021 (= TAC = 61,500 t) result in a strong reduction of fishing mortality and a growth in SSB in those two first years of the projection period. This leads to a prediction that the BET stock at the end of 2021 will be in a significantly better status (probability of being in the green zone > 80%) than the stock at the end of the last year of the assessment in 2019 (probability of being in the green zone = 41%) (**BET - Figure 12**). The rapid change in probabilities of overfishing and overfished during 2020 and 2021 are the result of the fact that estimated stock status 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**).

Future constant catches of 61,500 t, equal to the TAC established in Rec. 19-02, are expected to continue to prevent overfishing ($F<F_{MSY}$) with greater than 90% probability and to prevent the stock from becoming overfished with greater than 80% probability for the entire projection period (**BET-Table 4**).

The more optimistic outlook presented in this 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 relatively low catches of BET for 2020 and 2021. 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 Recommendation 15-01 which entered into force in 2016 and Recommendation 18-01, and in Rec. 19-02 to 62,500 t and 61,500 t for 2020 and 2021 respectively. Catches exceeded the TAC every year from 2016-2019 some years by more than 20%. 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 CPS not previously under catch limits. Such new limits may have contributed to the declines in reported catch for 2020 which is lower than the TAC, although such decline may have also been partly due to the effects of COVID-19 in fishing operations.

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, 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 ($1^{o}x1^{o}$) 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. Such closure may have contributed to the lower catches of BET estimated for 2020.

### *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 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 (2020) Yield | 57,486 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]<br>Overfishing: No[3] |
| Conservation & management measures in effect: | Rec. 16-01, Rec. 18-01, Rec. 19-02<br>– Total allowable catch for 2020-2021 was set to 62,500 and 61,500 t respectively for Contracting Parties and Cooperating non-Contracting Parties, Entities or Fishing Entities.<br>– Specific limits of number of longline boats; China (65), Chinese Taipei (75), Philippines (5), Korea (14), EU (269) and Japan (231).<br>– Specific limits of number of purse seine boats; EU (34) and Ghana (17).<br>– No fishing with natural or artificial floating objects from 1 January to 31 March in 2021, throughout the Convention area.<br>– No more than 300 FADs active at any time by vessel.<br>– Use of non-entangling FADs. |

[1] Combined result of stock synthesis 27uncertainty grid runs. Median and 10 and 90% percentile in brackets.
[2] Reports for 2020 reflect 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.

| | | | 1991 | 1992 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | | | 97211 | 100106 | 113790 | 134932 | 128047 | 120767 | 110255 | 107954 | 121425 | 103434 | 91636 | 75802 | 87596 | 90043 | 67954 | 59192 | 69895 | 63172 | 76427 | 76074 | 76749 | 71317 | 66976 | 75307 | 79795 | 79338 | 78617 | 72971 | 75484 | 57486 |
| Landings | A+M | Bait boat | 17748 | 16258 | 16472 | 20358 | 25697 | 18352 | 21289 | 19190 | 22203 | 12150 | 14388 | 8465 | 11237 | 20244 | 13122 | 10631 | 10579 | 6335 | 11565 | 7853 | 12849 | 10510 | 9214 | 8726 | 8014 | 6787 | 8436 | 7977 | 7344 | 6777 |
| | | Longline | 61655 | 62484 | 62891 | 78908 | 74872 | 74930 | 68312 | 71857 | 77227 | 72011 | 56123 | 47351 | 55356 | 49400 | 37961 | 34182 | 46231 | 41063 | 43533 | 42516 | 37899 | 34930 | 32245 | 36769 | 40378 | 36344 | 35186 | 32062 | 34061 | 27438 |
| | | Other surf. | 332 | 513 | 622 | 967 | 551 | 353 | 534 | 428 | 672 | 451 | 766 | 221 | 447 | 286 | 716 | 527 | 431 | 192 | 241 | 476 | 957 | 961 | 2764 | 4950 | 5958 | 6395 | 7146 | 4571 | 5878 | 5411 |
| | | Purse seine | 15535 | 19216 | 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 | 27108 | 16798 |
| Landings(FP) | A+M | Purse seine | 1941 | 1636 | 2290 | 2032 | 1667 | 540 | 993 | 989 | 1184 | 1363 | 257 | 214 | 867 | 1019 | 1026 | 542 | 692 | 772 | 1081 | 994 | 1277 | 823 | 632 | 609 | 989 | 1187 | 972 | 1049 | 1069 | 1030 |
| Discards | A+M | Longline | 0 | 0 | 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 | 14 | 29 |
| | | 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 | 36 | 0 | 38 | 2 | 10 | 3 |
| 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 | 3 | 0 | 253 | |
| | | Barbados | 0 | 0 | 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 |
| | | Belize | 0 | 0 | 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 |
| | | Brazil | 350 | 790 | 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 |
| | | Canada | 26 | 67 | 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 | 102 |
| | | Cape Verde | 151 | 305 | 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 |
| | | China PR | 0 | 0 | 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 |
| | | Curaçao | 0 | 0 | 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 |
| | | Côte d'Ivoire | 0 | 0 | 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 |
| | | EU-España | 14705 | 14656 | 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 |
| | | EU-France | 5590 | 6877 | 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 |
| | | EU-Ireland | 0 | 0 | 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** |
| | | 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 | 7 | 0 | 7 |
| | | 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 | |
| | | EU-Portugal | 5718 | 5796 | 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 |
| | | El Salvador | 0 | 0 | 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 |
| | | FR-St Pierre et Miquelor | 0 | 0 | 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** |
| | | Gabon | 0 | 0 | 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 | |
| | | Ghana | 4090 | 2866 | 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 | 2933 |
| | | Great Britain | 0 | 0 | 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** |
| | | Grenada | 65 | 25 | 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 |
| | | Guatemala | 0 | 0 | 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 |
| | | Guinea Ecuatorial | 0 | 0 | 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 |
| | | Guinée Rep | 0 | 0 | 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** |
| | | Honduras | 0 | 44 | 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 | |
| | | Iceland | 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 | **0** |
| | | Japan | 30356 | 34722 | 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 | 9579 |
| | | Korea Rep | 802 | 866 | 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 | 610 |
| | | Liberia | 13 | 42 | 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 |
| | | Libya | 0 | 508 | 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** |
| | | Maroc | 206 | 81 | 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 |
| | | 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 | 1 | 0 | 0 | 0 | **0** |
| | | Mexico | 0 | 0 | 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 |
| | | Namibia | 0 | 0 | 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 |
| | | Nigeria | 0 | 0 | 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** |
| | | Norway | 35 | 0 | 0 | 0 | 0 | 0 | 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 | 7446 | 9991 | 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 | 1183 |
| | | Philippines | 0 | 0 | 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** |
| | | Russian Federation | 0 | 5 | 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** |
| | | S Tomé e Príncipe | 3 | 4 | 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 | 6 | 11 |
| | | Senegal | 10 | 5 | 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 | 2700 |
| | | Sierra Leone | 0 | 0 | 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 | |
| | | South Africa | 72 | 43 | 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 |
| | | St Vincent and Grenadin | 154 | 818 | 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 |
| | | Trinidad and Tobago | 263 | 0 | 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 |
| | | UK-Bermuda | 0 | 0 | 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 |
| | | UK-Sta Helena | 3 | 10 | 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 |
| | | 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 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | USA | 975 | 813 | 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 | 805 |
| | | 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 | |
| | | Uruguay | 20 | 56 | 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** |
| | | Venezuela | 476 | 270 | 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 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NCC | Chinese Taipei | 13850 | 11546 | 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 |
| | | 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 | 6 | 25 | 34 | 53 | 2 | 4 |
| | NCO | Argentina | 22 | 0 | 0 | 0 | 0 | 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 | 10 | 7 | 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 | |
| | | Cambodia | 0 | 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 | |
| | | Congo | 12 | 12 | 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 | |
| | | Cuba | 34 | 56 | 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 | |
| | | Dominica | 0 | 0 | 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 | |
| | | Faroe Islands | 0 | 0 | 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 | |
| | | NEI (ETRO) | 357 | 364 | 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 | |
| | | NEI (Flag related) | 8982 | 6146 | 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 | |
| | | 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 | 4 | 1 | 0 | 0 | 1 |
| | | Seychelles | 0 | 0 | 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 | |
| | | Sta Lucia | 0 | 1 | 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 | 17 |
| | | Togo | 6 | 2 | 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 | |
| | | Vanuatu | 470 | 676 | 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 | |
| Landings(FP) | CP | Belize | 0 | 0 | 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 | |
| | | Cape Verde | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 28 | 37 | 38 | 61 | 102 | 40 | 22 | 45 | 97 | 0 | 0 | 0 | 0 | 0 | |
| | | Curaçao | 0 | 0 | 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 | |
| | | Côte d'Ivoire | 0 | 0 | 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 | |
| | | EU-España | 625 | 571 | 764 | 605 | 371 | 58 | 255 | 328 | 487 | 474 | 0 | 0 | 223 | 244 | 143 | 88 | 49 | 190 | 250 | 211 | 216 | 98 | 80 | 143 | 0 | 0 | 0 | 0 | 0 | |
| | | EU-France | 653 | 686 | 1032 | 970 | 713 | 314 | 437 | 467 | 553 | 607 | 229 | 205 | 446 | 397 | 222 | 79 | 26 | 51 | 150 | 122 | 394 | 192 | 56 | 54 | 0 | 0 | 0 | 0 | 0 | |
| | | Guatemala | 0 | 0 | 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 | |
| | | Guinée Rep | 0 | 0 | 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 | |
| | | Panama | 0 | 0 | 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 | |
| | NCO | Mixed flags (EU tropical | 663 | 379 | 494 | 457 | 582 | 169 | 301 | 193 | 143 | 281 | 28 | 8 | 198 | 378 | 294 | 189 | 348 | 337 | 375 | 324 | 257 | 0 | 0 | 0 | 989 | 1187 | 972 | 1049 | 1069 | 1030 |
| 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 | 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 | 36 | 0 | 38 | 2 | 10 | 3 |
| | | 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 | 26 | 13 | 17 |
| | | 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 | 1 | 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 | |
| | | 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 | 0 | 0 | 12 |
| | NCC | Chinese Taipei | 0 | 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 | 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 ($F <= F_{MSY}$)

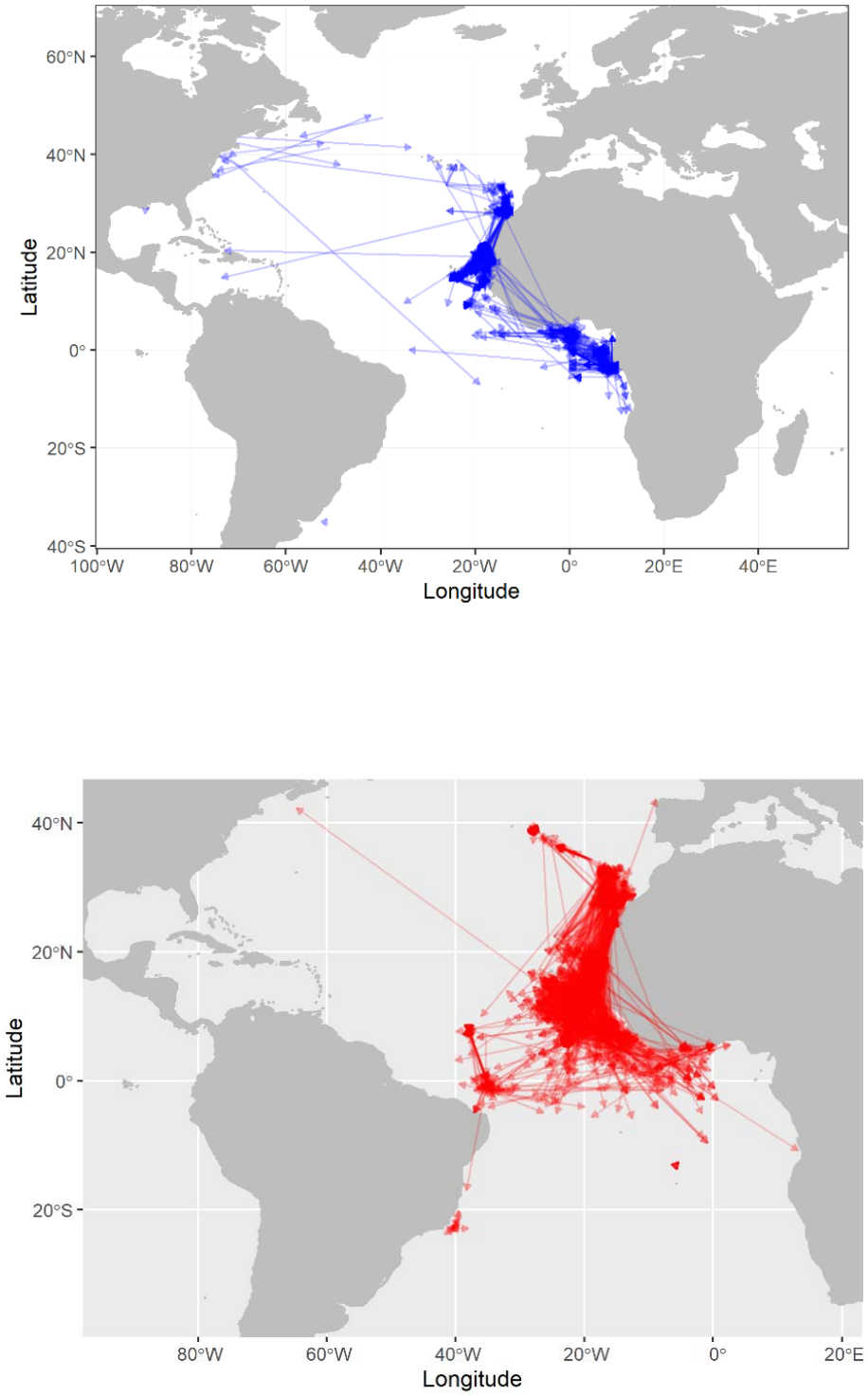
| TAC (1000s mt) | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| 37.5 | 100% | 100% | 100% | 100% | 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 ($SSB >= SSB_{MSY}$)

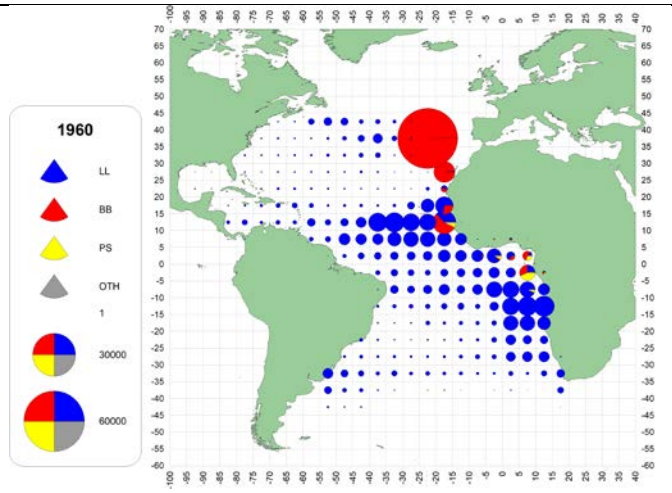
| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 85% | 91% | 96% | 98% | 99% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| 37.5 | 85% | 91% | 96% | 98% | 99% | 100% | 100% | 100% | 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 <= $F_{MSY}$)

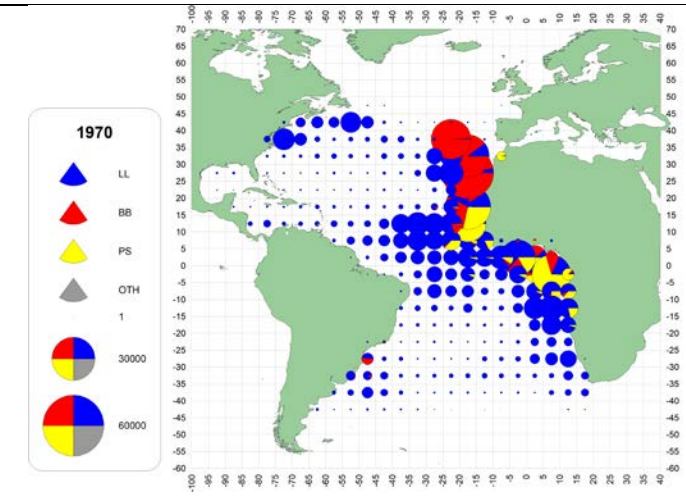
| TAC (1000s mt) | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | 85% | 91% | 96% | 98% | 99% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| 37.5 | 85% | 91% | 96% | 98% | 99% | 100% | 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% |



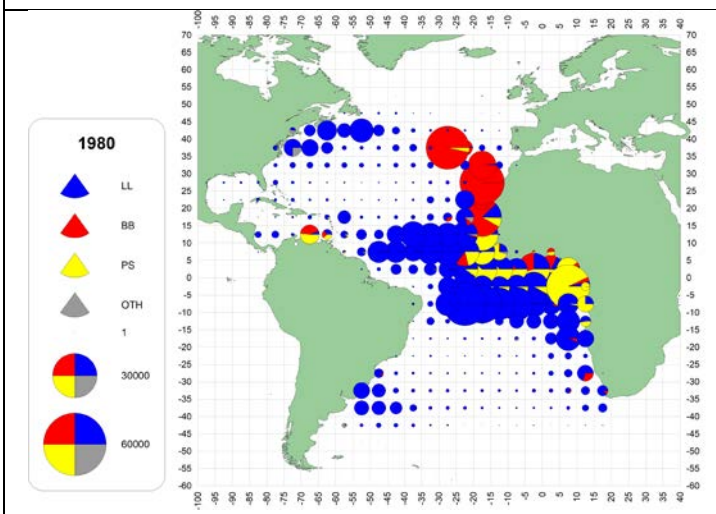

**BET-Figure 1.** Apparent movements (straight line distance between the tagging location and that of recovery) calculated from conventional tagging of Atlantic bigeye tuna from the historical ICCAT tagging database (top panel) and the current AOTTP activities (bottom panel).



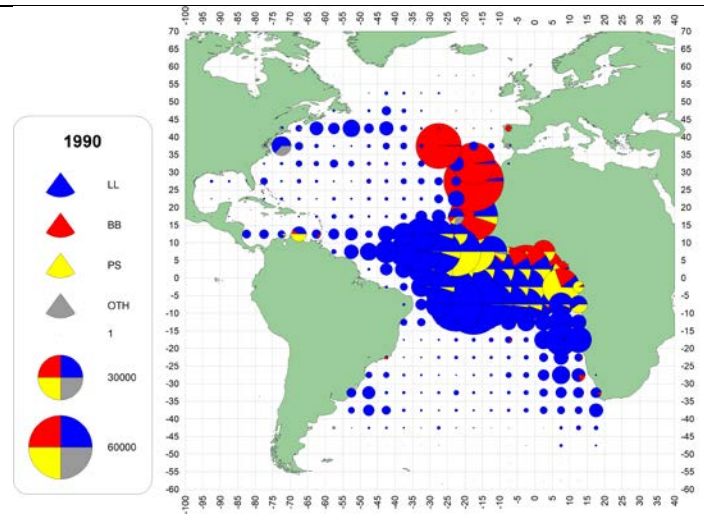

a. BET (1960-69)



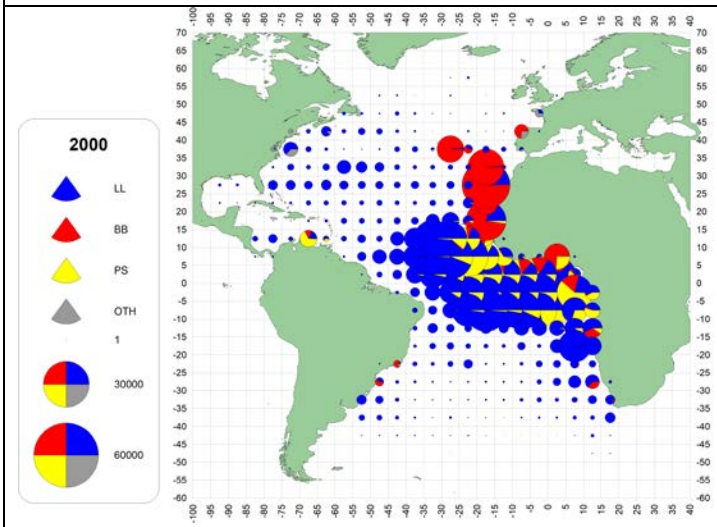

b. BET (1970-79)



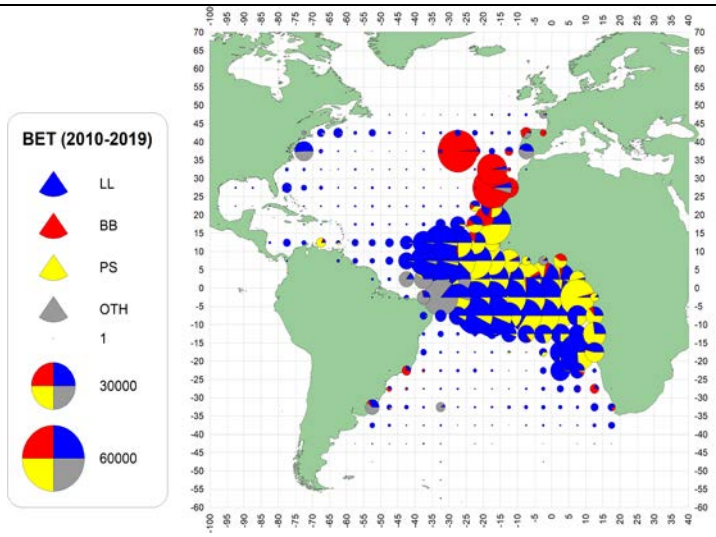

c. BET (1980-89)




d. BET (1990-99)

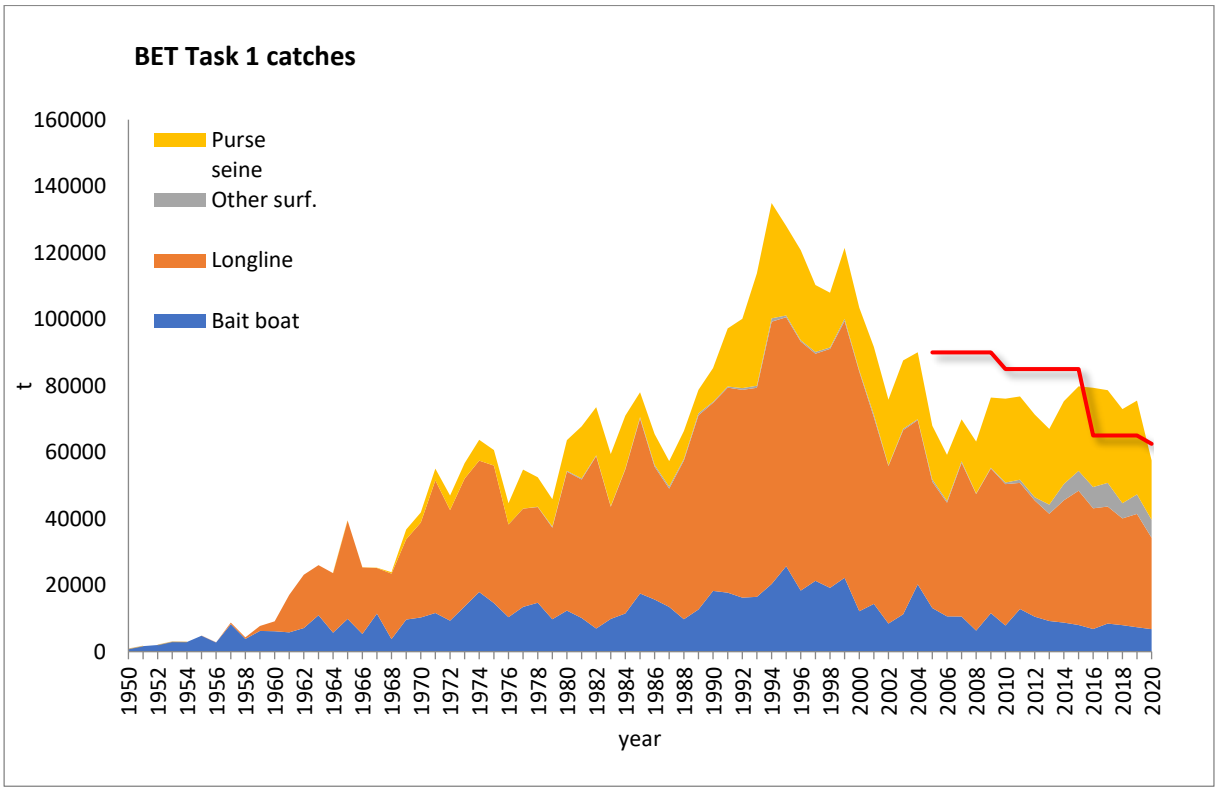



e. BET (2000-09)

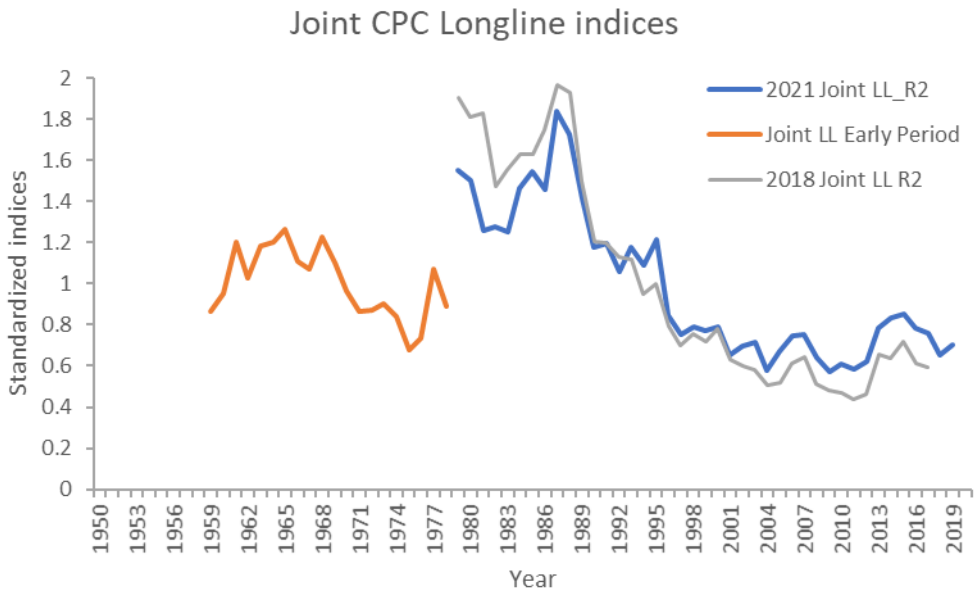



f. BET (2010-19)

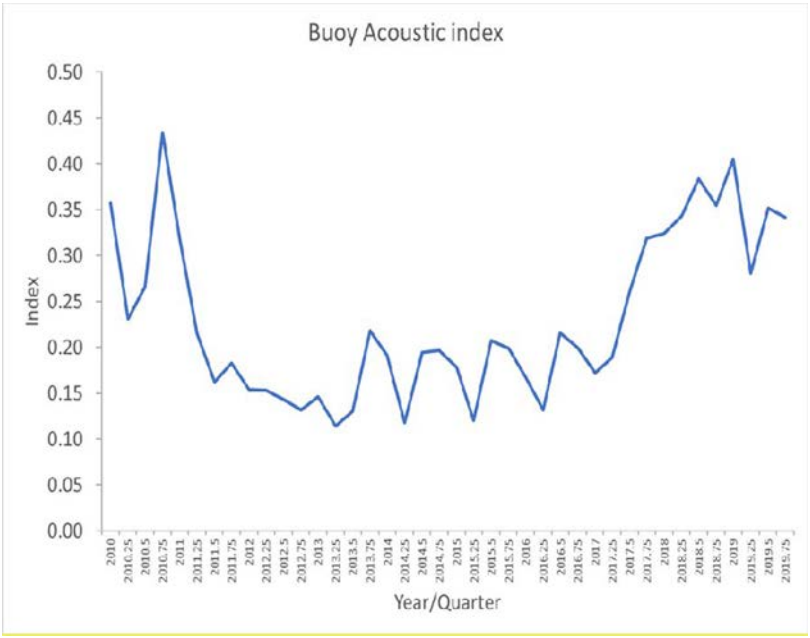
**BET-Figure 2 [a-f].** Geographical distribution of the bigeye tuna catch by major gears and decade. The maps are scaled to the maximum catch observed during 1960-2019.



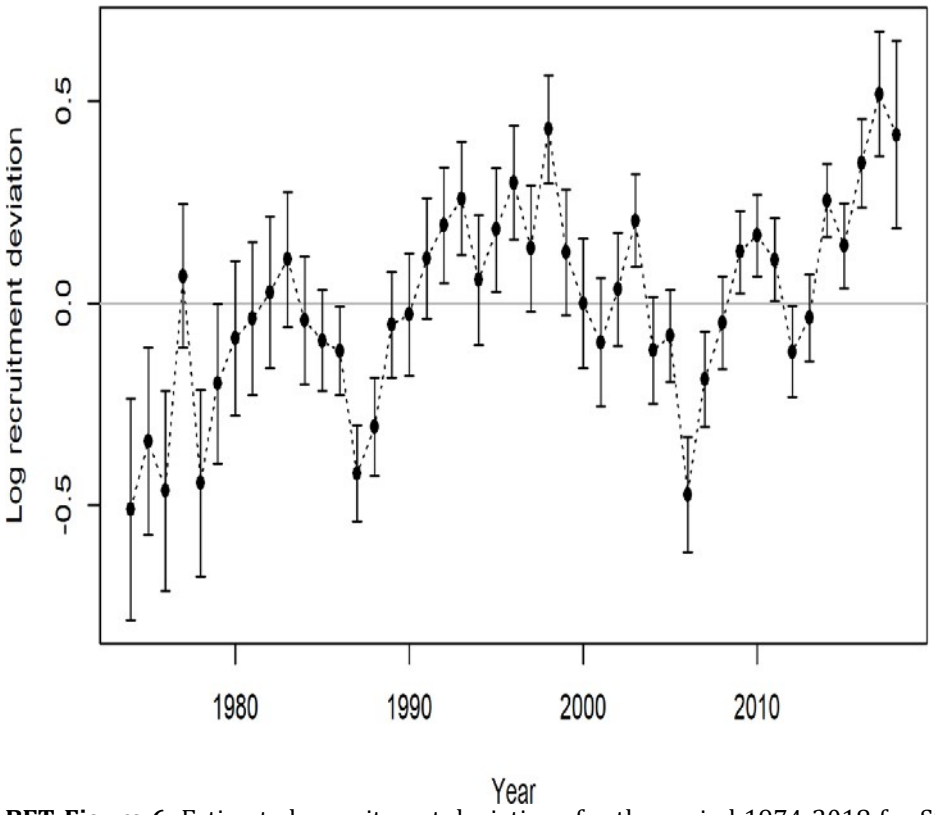

**BET-Figure 3.** Bigeye tuna estimated and reported catches for all the Atlantic stock (t). The value for 2020 represents catch reports until September 18, 2021.



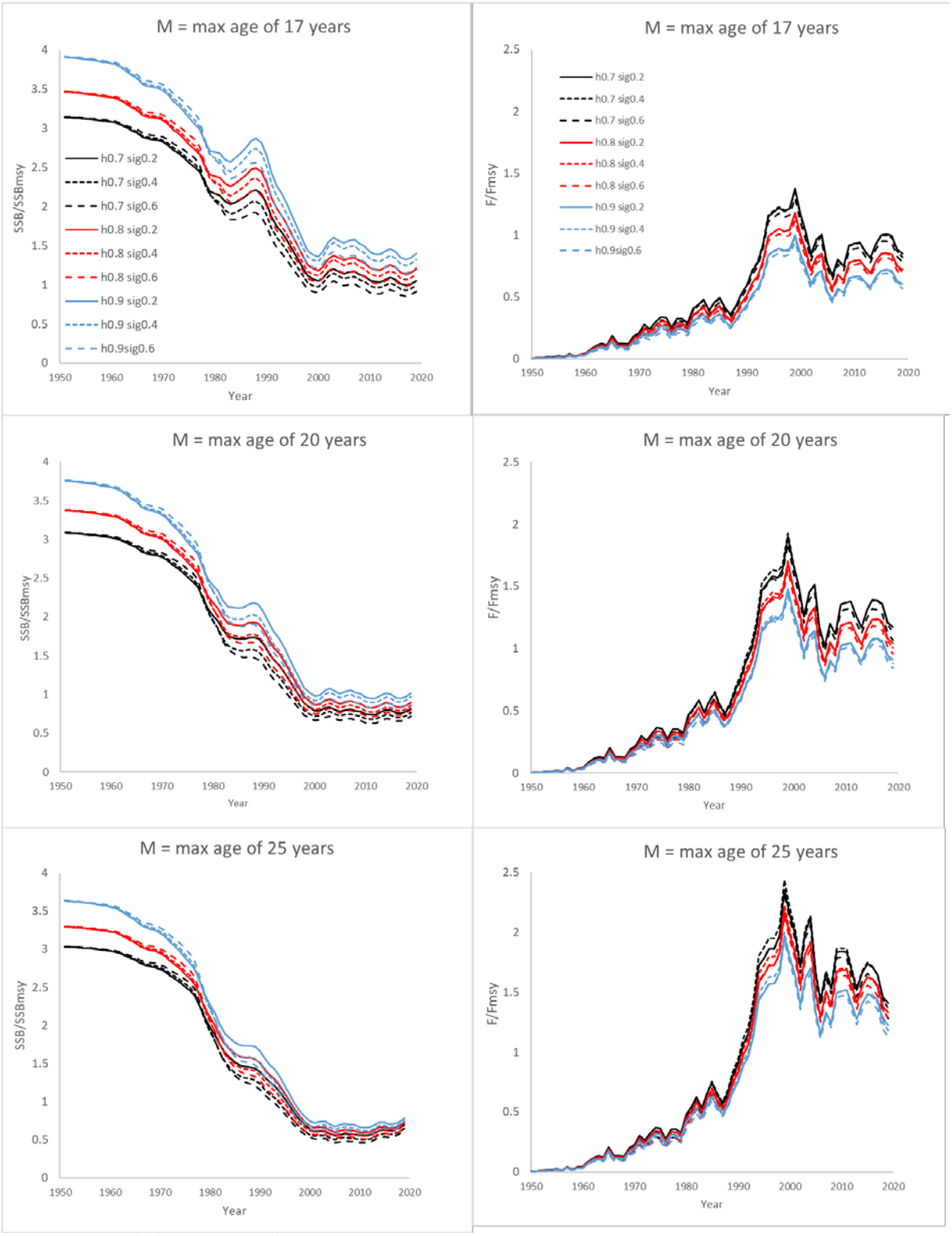

**BET-Figure 4**. Annual joint longline index for 1959 to 2019 that include two series Early period (1959-1978, Joint LL Early Period) and the late period (1979-2019, 2021 joint LL_R2) used in the 2021 stock assessment. For comparison the 2018 joint index late period (1979 – 2017) is presented (2018 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.



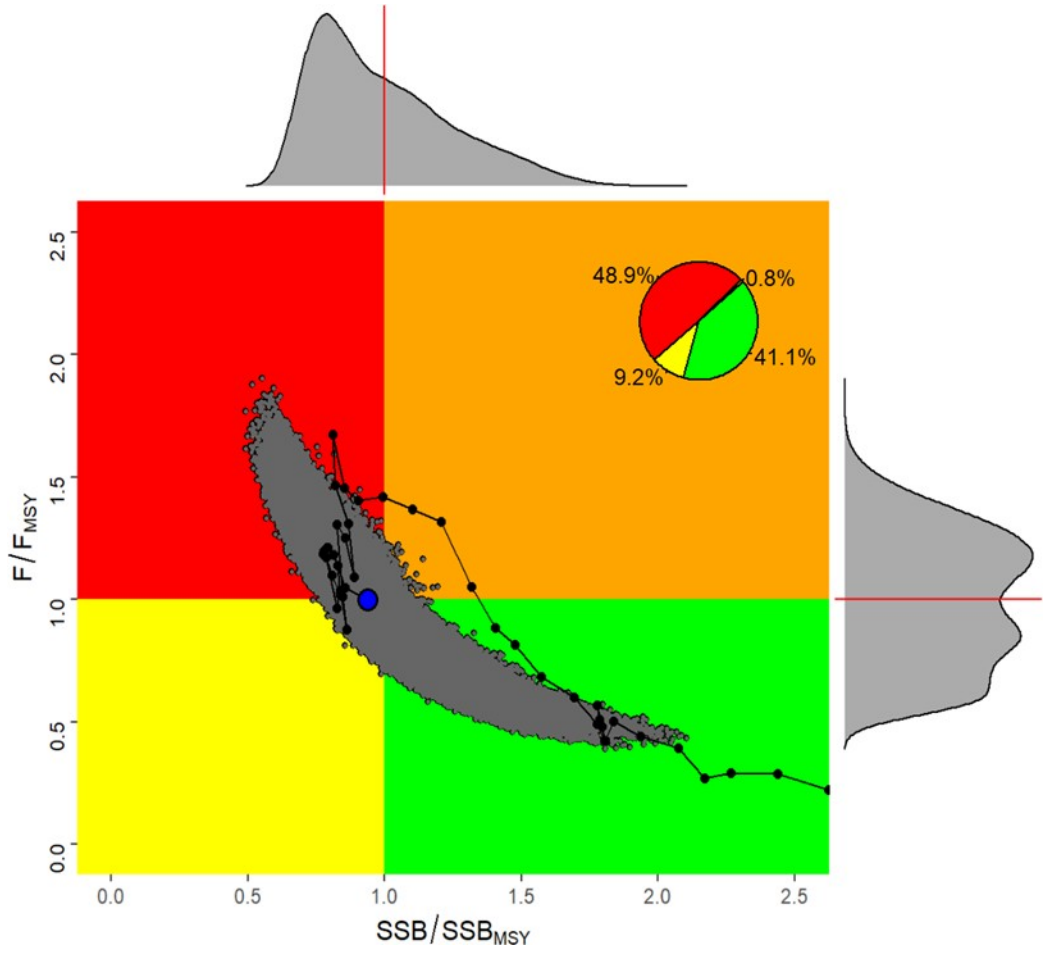

**BET-Figure 5.** Quarterly abundance index from acoustic buoys used in the FAD fishery for 2010 to 2019.



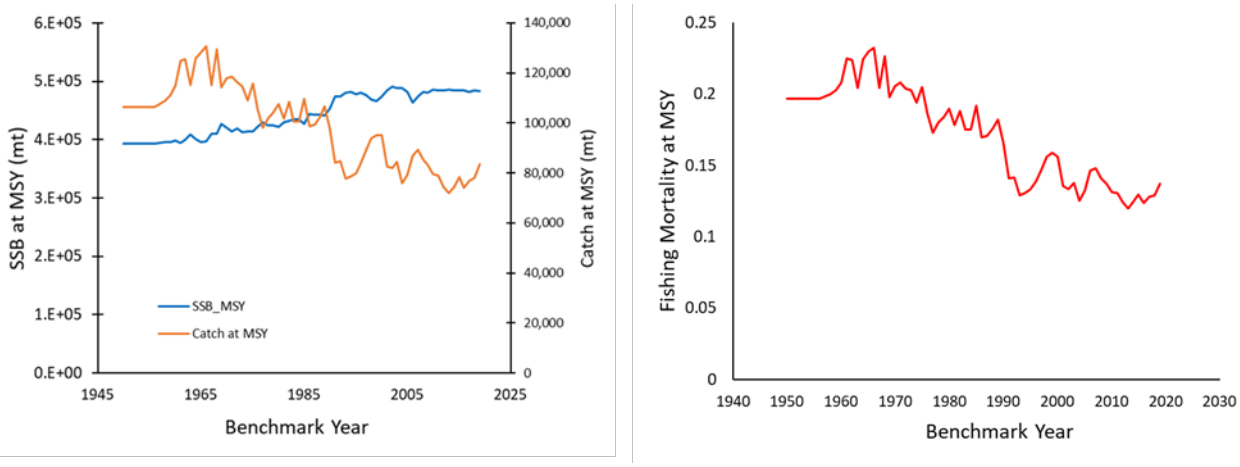

**BET-Figure 6.** Estimated recruitment deviations for the period 1974-2018 for Stock Synthesis reference case (see **BET-Table 2** for definition). The zero line represents the expected recruitment resulting from the previous year Spawning stock biomass. Positive values represent better than expected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



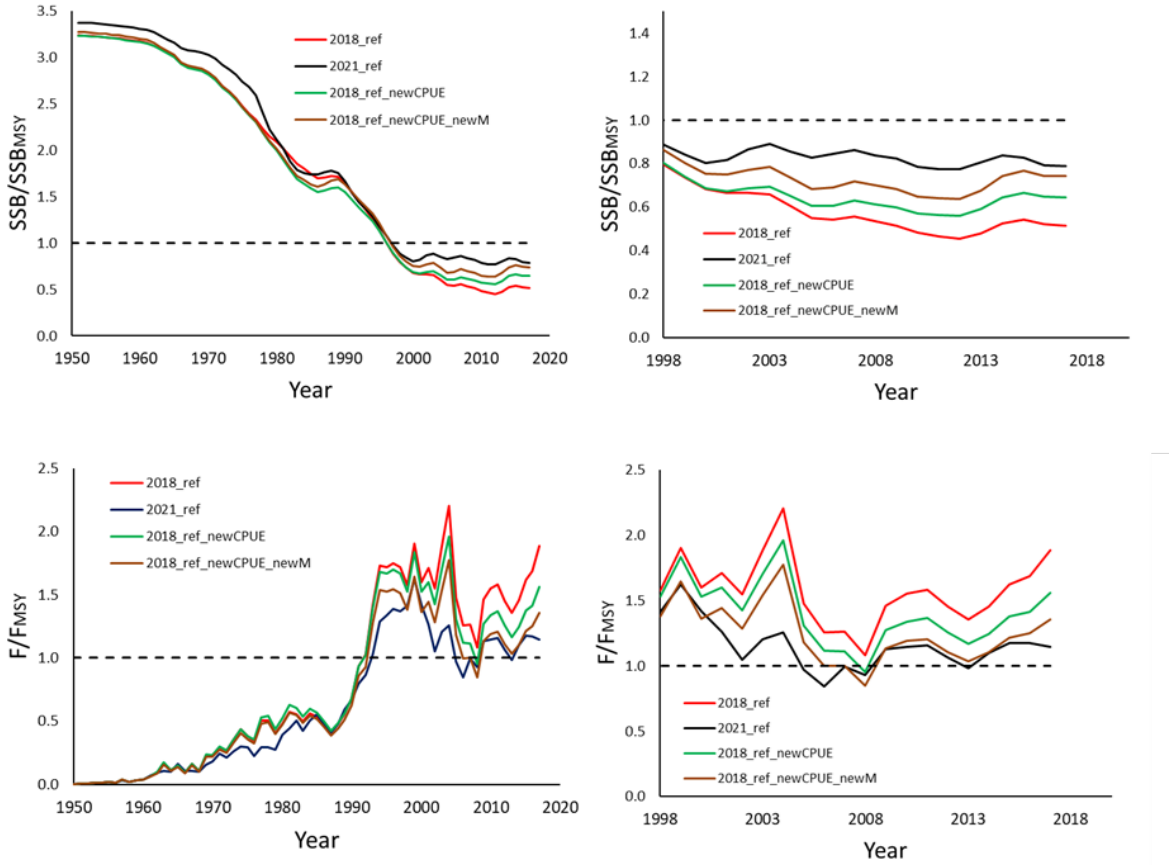

**BET-Figure 7.** Time series of stock status trends across the 27 Stock Synthesis models of the uncertainty grid. Panels in each row represent the different assumptions of maximum age and thus natural mortality. Left panels represent $SSB/SSB_{MSY}$ trends and right panels $F/F_{MSY}$ trends. Individual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

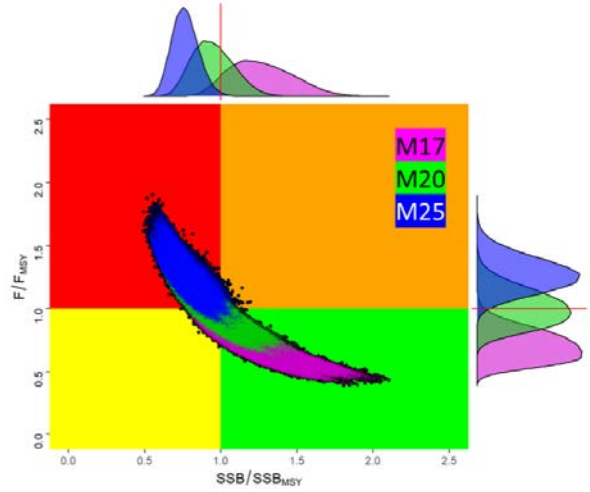



**BET-Figure 9.** Dynamic SSB/SSB$_{MSY}$ and catch at MSY (left panel) and F/F$_{MSY}$ (right panel) by benchmark year, demonstrating the effects of changes in selectivity for bigeye tuna using the Stock Synthesis 2021 reference case.

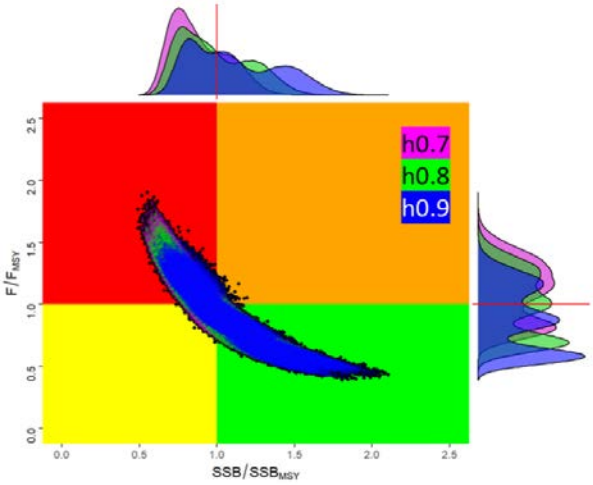



**BET-Figure 10.** Sensitivity runs showing time series of stock status trends (left panels 1950-2017, right panels 1998-2017, upper panels $SSB/SSB_{MSY}$ and lower panels $F/F_{MSY}$) demonstrating the effects of changes in stock status resulting from the incorporation of the 2021 joint longline index 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.

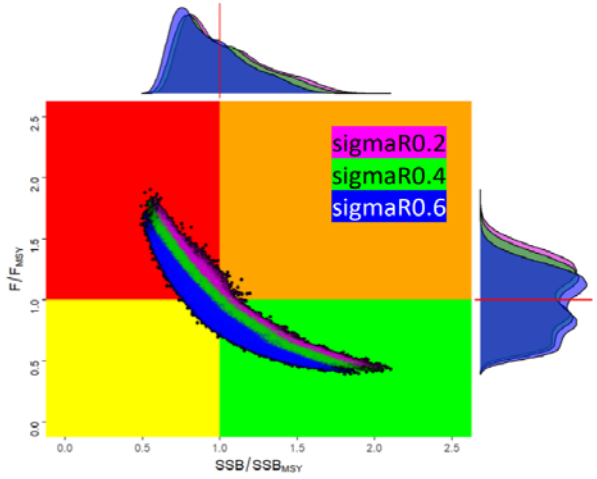
(a) effect of Maximum age(M)



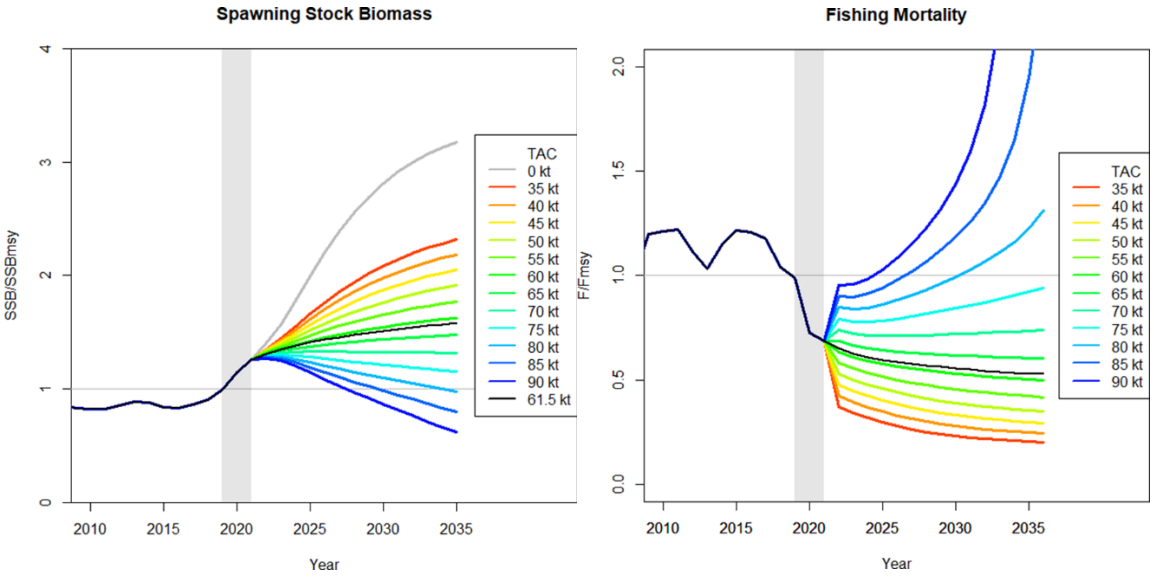

(b) effect of steepness (h)




(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.

### *9.2 BFTW - Bluefin Tuna - West*

#### *BFTW-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**, **BFTW-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. 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 2018 was 2,027 t, 2,306 t in 2019 and 2,179 t in 2020 (as of 18 August 2020) (**BFTW-Figure 1**).

The Committee notes that ongoing work conducted as part of the MSE process is evaluating the sensitivity to assumed stock of origin of the large historical catches from the South Atlantic. Future modelling considerations of these catches should consider that while these catches are currently assumed to be of western stock origin the true stock of origin remains unknown.

The Committee notes that the TAC in the West has not been caught for the last 7 years. Based on information received, the Committee considers that this is not due to low stock abundance but rather to market and operational conditions.

The most recent (2021) stock assessment (Anon., 2021g) used 10 CPUE and two survey indices up to and including the year 2020 (**BFTW-Figure 2**). Several indices were modified from the previous year, based on recommendations by the BFT Technical Subgroup on Abundance Indices, which conducted a series of data workshops to critically evaluate data treatments and recommend best practices. In particular, the indices of juvenile fish based on the US Rod and Reel fishery experienced substantial modifications. Previously they were two separate indices but have been combined into a single index that better accounts for the dynamics of the fishery. The modified indices are denoted with an asterisk in **BFTW-Figure 2**, and those not denoted represent strict updates.

Several indices exhibit trends that may be indicative of environmentally driven changes in availability. 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. For modelling the Committee chose to split the index and, as two years of data would be uninformative for the models, the years 2018 and 2019 were removed from the assessment until such time as the differences between the time periods can be reconciled.

#### *BFTW-3. State of the stock*

The SCRS cautions that conclusions from the latest assessment (Anon., 2021g), using data through to 2020, do not capture the full degree of uncertainty in the assessments and projections and an independent review recommended against using it for management advice. The various major contributing factors to uncertainties include mixing between the stocks, recruitment, age composition, age at maturity, the possibility of regime shifts, assumptions regarding selectivity, and indices of abundance. As in 2020 the 2021 assessment also applied two stock assessment methods (VPA and Stock Synthesis) but only Stock Synthesis was deemed suitable at this time for projections and specific management advice for the western stock. While the Committee is not recommending this iteration of the VPA for projection and quantitative management advice, it provides time series as a qualitative comparison. The models used in 2021 underwent substantial changes compared to strict updates of the 2020 models, including: revised indices; alternative assumptions about fleet selectivity; and, the addition of two years of data (2019 and 2020).

Estimates of the absolute biomass scale of the stock have fluctuated between the 2017, 2020 update and the 2021 Stock Synthesis assessment models highlighting one of the key unquantified uncertainties regarding absolute size of the population (**BFTW-Figure 3**). These absolute biomass estimates factor directly into the yield estimates under the $F_{0.1}$ strategy, which therefore contribute to that underlying uncertainty.

Previous stock assessments determined stock status based on MSY-related reference points using two alternative recruitment potential scenarios: a 'low recruitment' scenario and a 'high recruitment' scenario. Since 2017, assessments have not provided management advice based on MSY reference points. To deal with this recruitment uncertainty, the focus has been on giving short-term advice based on an $F_{0.1}$ reference point (taken to be a proxy for $F_{MSY}$) assuming that near term recruitment will be similar to the recent past recruitment. 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 15) 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.

Estimates from the Stock Synthesis model give a longer time series view of the population, (**BFTW-Figure 4**), capturing the higher recruitments estimated in the 1960s (although this is dependent on the assumption that the catches in the West were primarily of western rather than eastern origin fish). In 2017 the Stock Synthesis models estimated higher biomass than the VPA, but in 2020 the updated Stock Synthesis model and VPA estimates were similar in magnitude for the overlapping period 1979 – 2015. The 2021 Stock Synthesis models now estimate higher biomass than the VPA (**BFTW-Figure 4**), but quite similar biomass to the 2017 Stock Synthesis model (**BFTW-Figure 3**). In the 2021 Stock Synthesis model, total biomass in 2020 was 18% of biomass in 1950 and 46% of biomass in 1974. In contrast to the 2017 and 2020 assessments, the revised assessment did not estimate a long-term declining trend in recruitment since 2003 (**BFTW-Figures 3** and **4**). Additionally, the estimates for the most recent years indicated an increase in recruitment, informed by the revised juvenile index, as well as catch data. VPA gives qualitatively similar time series of recruitment and biomass, as well as improvement to stock status, as Stock Synthesis (**BFTW-Figure 4**).

The Committee notes that further work is being conducted as part of the GBYP to collect more data on mixing, movement and stock of origin. These data are being incorporated into the Management Strategy Evaluation whereby they should help refine understanding of stock mixing.

*Summary*

Stock Synthesis was projected to formulate advice using recent (2012-2017) mean recruitment with alternative spawning-at-age scenarios equally weighted across model scenarios. Current F (average of 2018-2020) relative to the $F_{0.1}$ reference point was 0.53 (0.49-0.58, 80% confidence interval), indicating that overfishing was not occurring (**BFTW-Figure 5**). Under the updated model, the current TAC (Rec. 20-06) is not likely to lead to overfishing relative to $F_{0.1}$ with 100% probability.

Management advice is based on a fishing mortality reference point to project short-term catches based on recent recruitments. $F_{0.1}$ was considered a reasonable proxy for $F_{MSY}$, although $F_{MSY}$ can be higher or lower than $F_{0.1}$ depending on the stock recruitment relationship, which in this case is poorly determined. $F_{0.1}$, while not dependent on the stock recruitment relationship, is sensitive to the assumptions regarding selectivity. In the 2021 assessment the overall selectivity was characterized as being substantially more dome-shaped than in previous assessments and this resulted in an approximately a 35% higher estimate of the value of $F_{0.1}$. A key element of the change towards a higher $F_{0.1}$ may also be the change in assumed selectivity towards smaller fish in the Gulf of St. Lawrence fishery in Canada.

***BFTW-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 formulating 2017, 2020 update, or 2021 revised models. The Committee is not evaluating if the stock is rebuilt because it has been unable to resolve the long-term recruitment potential. If an $F_{0.1}$ strategy were to continue to be applied, over the longer term the resource would fluctuate around the true, but unknown, value of $B_{0.1}$

whatever 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. Under this strategy, biomass may decrease at times because the stock is above $B_{0.1}$ or following lower recruitments.

The 2021 assessment indicates that recent (2012-2017) recruitments were higher than those estimated for the same period in the 2020 assessment and the averages assumed for the 2020 projections. In 2017 the population was projected to decline by ~7.5% from 2017 to 2020 at the current (2020) TAC of 2,350 t and in 2020 the population estimated to have experienced an 11.7% decline over the same time period. The current assessment estimates that the total biomass has actually experienced a 9% increase from 2017-2020.

With two additional years added to the 2020 assessment (2019-2020), substantial modifications made to the indices of abundance and to the model specifications, the assessment indicates that the overall biomass has increased. In contrast to previous assessments that have noted the passing of the peak biomass of the 2003-year class and below average recruitment in recent years, this assessment shows clear signs of several strong subsequent recruitment years. In particular, the 2017 recruitment appears to be high as evidenced by the index as well as catches, yet it would not have been evident in the 2020 model data.

The base model now assumes that most fleets have dome-shaped selectivity, whereas previously asymptotic selectivity was assumed. This change resulted in improvements in model diagnostics. It also had a major impact on TAC advice. The addition of data and revised indices included in the 2021 assessment were responsible for approximately 36% increases in deterministic yield at $F_{0.1}$ for the years 2022-2024 compared to the 2020 assessment results, while a combination of changes in model assumptions (in particular the change to an assumption of dome-shaped selectivity) and data were responsible for 64% of the change. The Committee noted that the VPA, which had somewhat lower biomass scale, was excluded from projections as the Committee considered the VPA was not suitable for projections. The impacts on yield advice from excluding the VPA are unknown but may have resulted in the now higher yields given that only Stock Synthesis is used for projections.

The time series of $F/F_{0.1}$ shows the fishing status over time relative to the year-specific estimate of $F_{0.1}$ (**BFTW-Figure 5**). Projections of total biomass and percent change in biomass at various fixed TACs and $F_{0.1}$ are provided in **BFTW-Table 2** and **BFTW-Figure 6**.

During discussions, it was suggested that dome-shaped selectivities might be warranted for some, but maybe not all of the fleets for which a change was imposed, and that additional approaches (e.g. improvements to abundance indices, assumption of senescence) might also have addressed model diagnostic issues, with differing implications for yield. Time constraints precluded examination of these alternatives during this assessment, just as the compressed assessment schedule in 2021 limited the Committee's ability to thoroughly review changes to the models and results.

The Committee reiterates that the effects of mixing and management measures on the eastern stock remain a considerable source of uncertainty for the outlook of the western stock. Consequently, changes to assessment and management approaches that take explicit account of mixing are a high priority.

Following receipt of the expert review which noted that the indices of abundance and composition data suggest that the current catch levels are sustainable and increases in catch may be possible, an empirical approach (Lauretta *et al*., 2021) and an MSE based approach (Butterworth and Rademeyer, 2021) also showed that both the western area and the western stock biomass are increasing and could support a moderate TAC increase in the western area in 2022. The empirical approach to evaluating the indices examined the annual percent change in the indices over years 2017-2020, noting that the Gulf of Mexico index values for the year 2020 were not available. The MSE based approach examined changes to SSB over the next five-year period at fixed TAC values.

In the current Kobe II matrix (K2SM), the difference in tons between a wide range of probabilities of overfishing is small (**BFTW-Table 1**). This is a result of not capturing the full scientific uncertainty in the K2SM. A practical solution applied in other management fora is to replace the model-estimated uncertainty with values derived from the variability in absolute biomass estimated by repeated assessments. In the current situation this would better account for the variability in absolute scale noted between the 2017, the 2020 and the 2021 Stock Synthesis models. While the SCRS did not employ this approach, at this time, the practical implications are that improved accounting for true scientific uncertainty would increase the buffer between the 50% probability of not overfishing and higher probabilities.

***BFTW-5. Effect of current regulations***

The 2021 assessment estimates that the biomass has increased by 9% over the time period 2017-2020. The current TAC recommendation (Rec. 20-06) is set to end in 2021 with new TAC advice requested by the Commission. Under the revised models. The current TAC is not likely to have led to overfishing relative to $F_{0.1}$ (**BFTW-Figure 5**). Rollover of the 2021 TAC in Rec. 20-06 is also expected to have not led to overfishing with high probability.

***BFTW-6. Management recommendations***

The Commission recommended total allowable catches (TAC) of 2,350 t in 2018, 2019 and 2020 (Rec. 17-06) and a rollover of the previous TAC for 2021 (Rec. 20-06). The Committee provides management options including the constant TAC scenarios shown in the Kobe II strategy matrix. The TAC for each year, and associated probability of not overfishing associated with each scenario are shown in **BFTW-Table 1**.

Variability in the estimation of the absolute scale of the population is an inherent property of stock assessment models. Uncertainty related to variability around the absolute scale of the population estimates has a direct impact on yield advice under an $F_{0.1}$ management strategy, yet it is not quantified within the K2SM.

The Committee has long highlighted the uncertainty in western BFT management advice given the varying fraction of eastern migrants in the western management area. The 2021 assessment advice is also subject to this uncertainty. Considering this, the additional sources of uncertainty noted previously, and the conclusions of the external review, the current advice should be used with caution (Note: the Committee re-iterates that the MSE does take mixing into account and addresses some key associated uncertainty concerns that arise if mixing is ignored).

Given these considerations, only 2 years have been included in the Kobe II Strategy Matrix (**BFTW-Table 1**), and the Committee advises that the Commission could implement a moderate increase to the current W-BFT TAC of 2,350 t. In determining this moderate increase, in addition to the K2SM, the Committee also draws the attention of the Commission to the results from the alternative approaches to evaluate the current change in the western biomass and its response to future harvests. Namely, the empirical approach indicated a 4% increase of the western area relative abundance and a 16% increase of the western spawning stock relative abundance, and the MSE approach indicated a 28% increase based on the TAC that maintains annual increases in the western stock SSB in the near term.

TAC should be reviewed annually by the Commission on the advice of the SCRS (which would be based on consideration of updates of the fishery indicators). This would permit the SCRS to, on any of those occasions, recommend that the next TAC be amended given sufficiently strong signals in the indicators. Notwithstanding the 2 years of catch levels provided in the Kobe matrix, the Committee reiterates the intention to provide a Candidate Management Procedure for the Commission to transition to a management procedure to set the TAC starting for 2023.

**SUMMARY TABLE**

Estimated mean of the Stock Synthesis models (two maturity specifications) for recent fishing mortality rate for each model was calculated 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 (2020) | 2,179* |
| $F_{CURRENT\ (2018\text{-}2020)}$ | 0.063 (0.059-0.067)[2] |
| $F_{0.1}$ | 0.118 (0.113-0.123)[3] |
| $F_{CURRENT\ (2018\text{-}2020)}/F_{0.1}$ | 0.53 (0.49-0.58)[2] |
| Estimated probability of overfishing ($F_{CURRENT\ (2018\text{-}2020)}$)/$F_{0.1}$) | <1% |
| Stock status[1] | Overfishing: No |
| Management Measures: | (Rec. 20-06) TAC of 2,350 t in 2021, including dead discards. |

* As of 20 September 2021.

[1] Biomass reference points to determine stock status were not estimated in the 2021 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 and reported catches (t) of bluefin tuna (*Thunnus thynnus*) by area, gear and flag.

| | | | | **1991** | **1992** | **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** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | | | | 29318 | 34128 | 36642 | 48881 | 49751 | 54009 | 53545 | 52657 | 52772 | 52775 | 52784 | 53319 | 52305 | 52125 | 51756 | 51812 | 62638 | 26460 | 21798 | 13195 | 11781 | 12688 | 14725 | 14887 | 18042 | 21033 | 25466 | 29794 | 33516 | 37144 |
| BFT-E | | | | 26389 | 31831 | 34258 | 46769 | 47303 | 51497 | 51211 | 50000 | 50000 | 50000 | 50000 | 50000 | 50000 | 50000 | 50000 | 50000 | 61000 | 24460 | 19818 | 11338 | 9774 | 10934 | 13243 | 13261 | 16201 | 19132 | 23616 | 27767 | 31211 | 34965 |
| | ATE | | | 6543 | 7396 | 9317 | 7054 | 9780 | 12098 | 16379 | 11630 | 10247 | 10061 | 10086 | 10347 | 7394 | 7402 | 9023 | 7529 | 8441 | 8243 | 6684 | 4379 | 3984 | 3834 | 4163 | 3918 | 4841 | 5969 | 7216 | 8157 | 9452 | 11308 |
| | MED | | | 19846 | 24435 | 24941 | 39715 | 37523 | 39399 | 34831 | 38370 | 39753 | 39939 | 39914 | 39653 | 42606 | 42598 | 40977 | 42471 | 52559 | 16217 | 13133 | 6959 | 5790 | 7100 | 9080 | 9343 | 11360 | 13163 | 16401 | 19610 | 21759 | 23657 |
| BFT-W | ATW | | | 2929 | 2296 | 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 | 2179 |
| Landings | ATW | | Longline | 903 | 689 | 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 | 571 |
| | | | Other surf. | 578 | 509 | 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 | 132 |
| | | | Purse seine | 237 | 300 | 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 | |
| | | | Sport (HL+RR) | 1083 | 586 | 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 | 1460 |
| | | | Traps | 0 | 1 | 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 |
| Discards | ATW | | Longline | 128 | 211 | 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 | 6 |
| | | | Other surf. | 0 | 0 | 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 |
| | | | Purse seine | 0 | 0 | 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 | |
| | | | Sport (HL+RR) | 0 | 0 | 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 | |
| Landings | ATW | CP | Brazil | 0 | 0 | 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** |
| | | | Canada | 485 | 443 | 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 | 553 |
| | | | FR-St Pierre et Miquelon | 0 | 0 | 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** |
| | | | Japan | 688 | 512 | 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 |
| | | | Korea Rep | 0 | 0 | 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** |
| | | | Mexico | 9 | 15 | 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 |
| | | | 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 | 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 |
| | | | 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 | 1582 | 1085 | 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 |
| | | NCC | Chinese Taipei | 0 | 0 | 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** |
| | | 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 | 0 | 0 | 74 | 11 | 19 | 27 | 19 | 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 (ETRO) | 23 | 17 | 0 | 0 | 0 | 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 | 0 | 0 | 429 | 270 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | Sta Lucia | 14 | 14 | 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 | |
| Discards | ATW | CP | Canada | 0 | 0 | 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 |
| | | | Japan | 0 | 0 | 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 |
| | | | Mexico | 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 | |
| | | | USA | 128 | 211 | 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 | 6 |

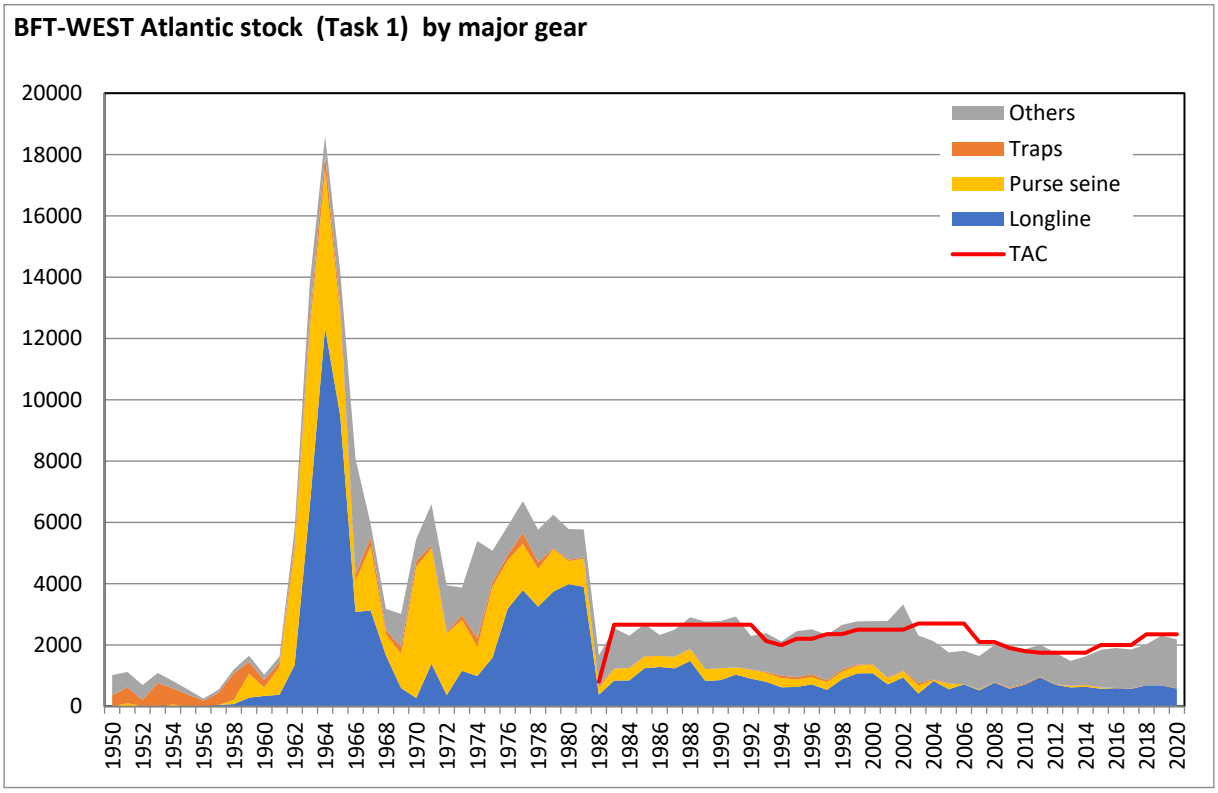
**BFTW-Table 1.** Kobe II matrix giving the probability that the fishing mortality rate (F) will be less than the F reference point ($F \leq F_{0.1}$, overfishing not occurring) over the next three years for alternative constant annual catches, based on results from the 2021 Stock Synthesis (combined two maturity specifications). Considering the uncertainties noted above and in previous sections, as well as the conclusions of the independent peer review, the Commission should interpret the results reflected in the Kobe strategy matrix with caution.

| TAC | 2022 | 2023 |
|---|---|---|
| 0 - 3000 | 100% | 100% |
| 3100 | 99% | 99% |
| 3200 | 98% | 98% |
| 3300 | 94% | 95% |
| 3400 | 91% | 89% |
| 3500 | 83% | 81% |
| 3600 | 71% | 70% |
| 3700 | 60% | 56% |
| 3800 | 45% | 48% |
| 3900 | 36% | 34% |
| 4000 | 25% | 23% |
| 4100 | 18% | 18% |
| 4200 | 11% | 10% |
| 4300 | 7% | 6% |
| 4400 | 5% | 4% |
| 4500 | 2% | 2% |
| 4600 | 1% | 1% |
| 4700 | 1% | 1% |
| 4800 - 5000 | 0% | 0% |

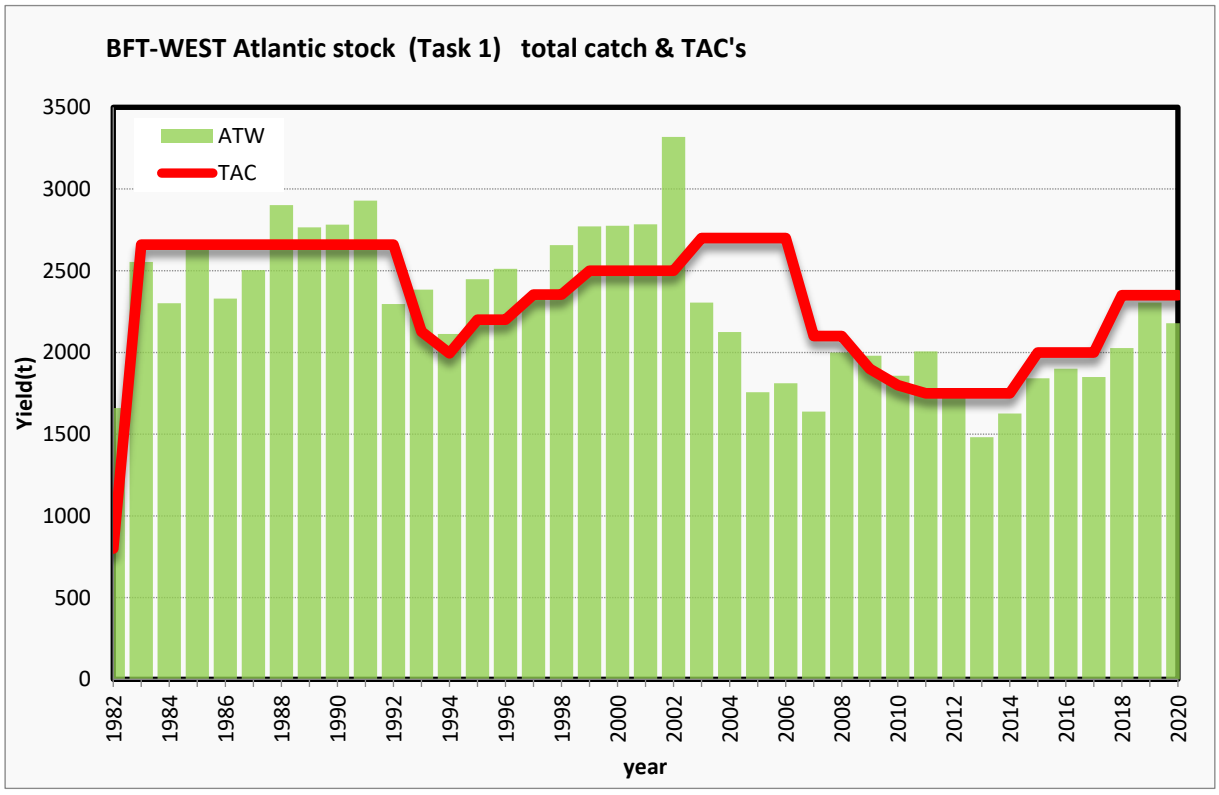
**BFTW-Table 2.** Percentage change in total stock biomass at the middle of the year relative to 2021 under alternative constant catch scenarios from the 2021 assessment, based on the projections from Stock Synthesis averaged across 2 maturity specifications. Stock Synthesis projections come from averaging the deterministic model runs. Values should be understood to have the same qualifications as the Kobe II strategy matrix since the projected biomass estimates are similarly uncertain.

| Catch | 2022 | 2023 |
|---|---|---|
| 0 | 5.9% | 15.3% |
| 2000 | 3.8% | 8.9% |
| 2200 | 3.6% | 8.2% |
| 2350 | 3.4% | 7.7% |
| 2400 | 3.4% | 7.6% |
| 2600 | 3.2% | 6.9% |
| 2800 | 2.9% | 6.3% |
| 3000 | 2.7% | 5.6% |
| 3200 | 2.5% | 5.0% |
| 3400 | 2.3% | 4.4% |
| 3600 | 2.1% | 3.7% |
| 3800 | 1.8% | 3.1% |
| 4000 | 1.6% | 2.4% |
| 4200 | 1.4% | 1.8% |
| 4400 | 1.2% | 1.1% |
| 4600 | 1.0% | 0.5% |
| 4800 | 0.7% | -0.2% |
| 5000 | 0.5% | -0.8% |

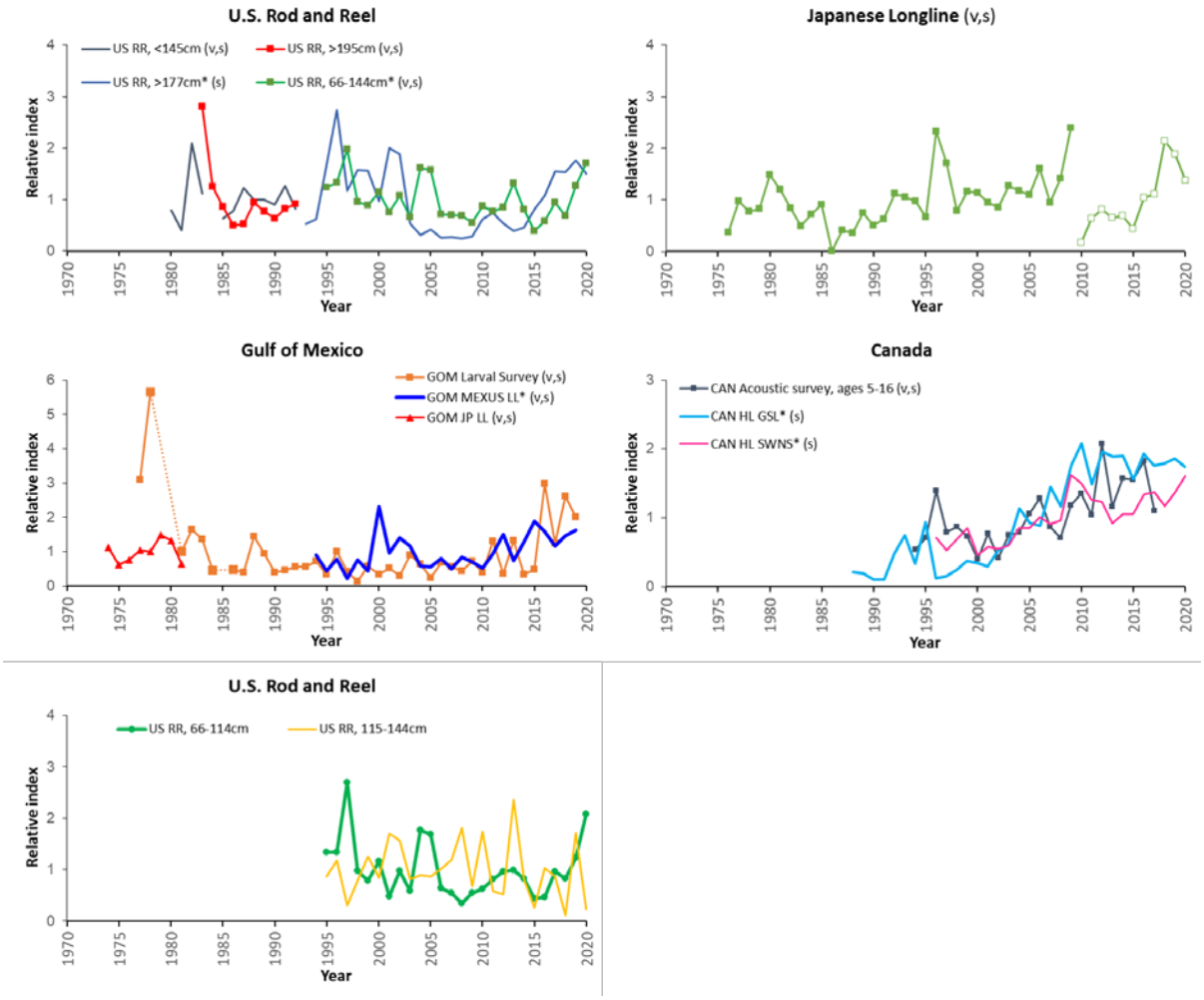
(a)



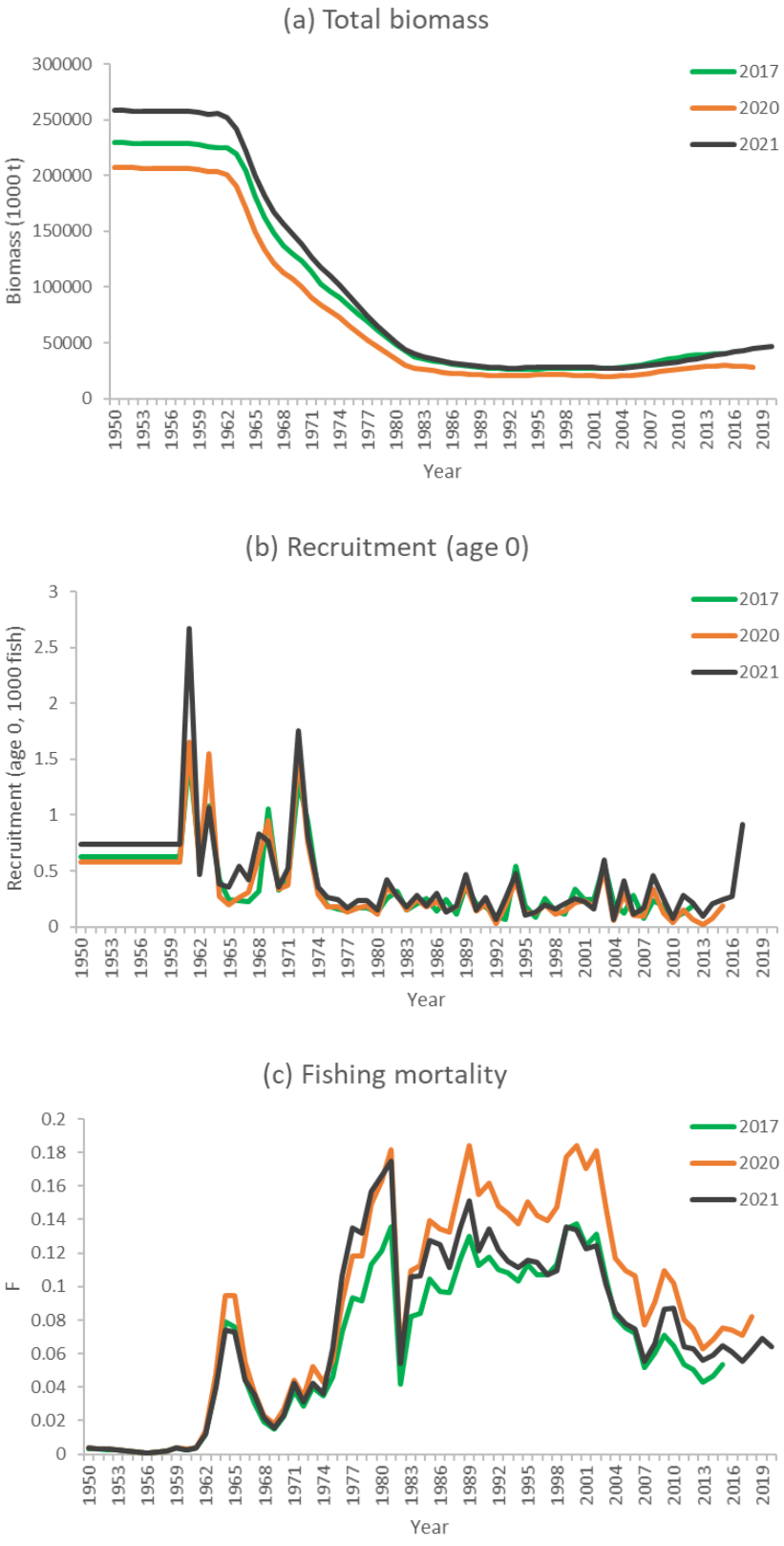

(b)



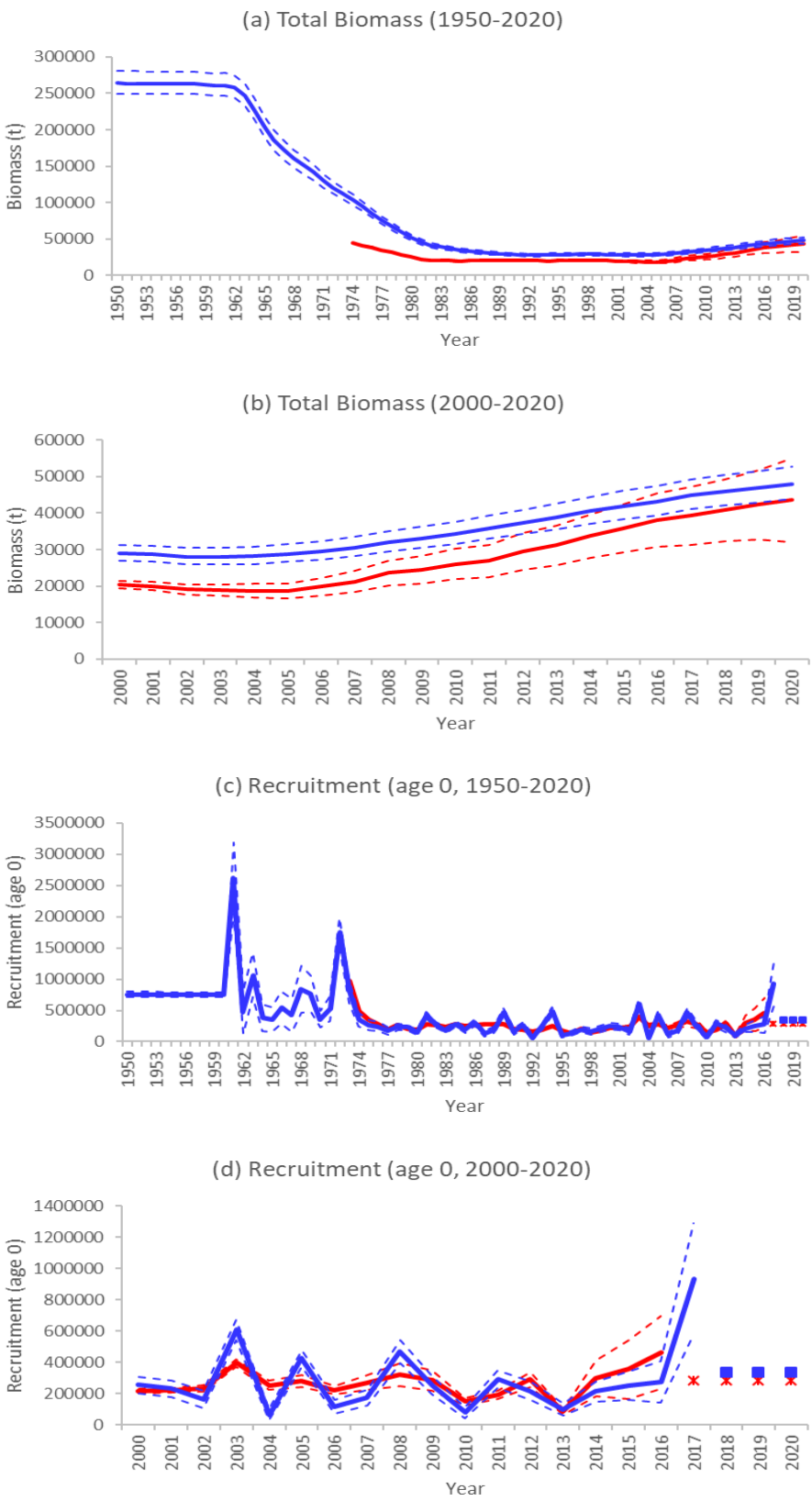

**BFTW-Figure 1**. Historical catches of western bluefin tuna: (a) by gear type and (b) TACs agreed by the Commission (which are shown for comparison).



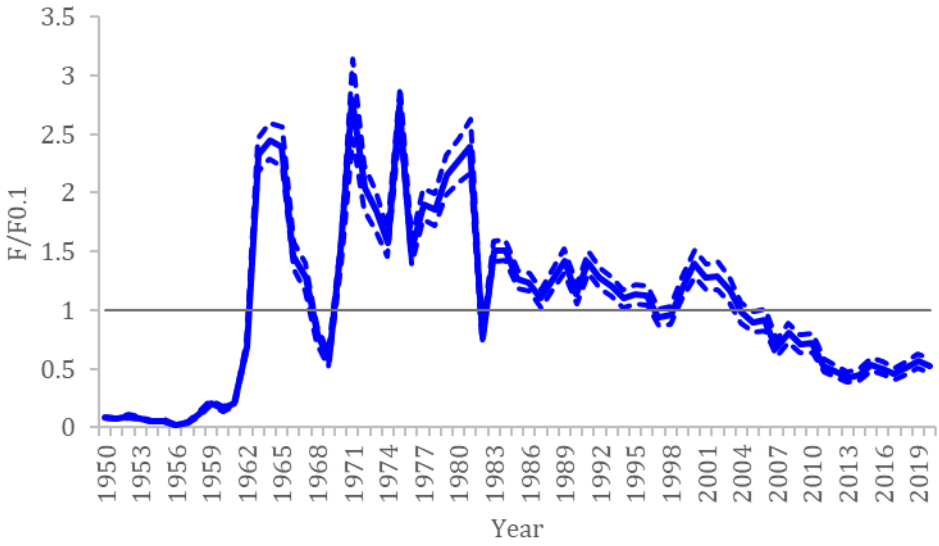

**BFTW-Figure 2**. Indices of relative abundance for western bluefin tuna. Indices denoted with "*" represent revised indices rather than strict updates of indices used in the 2020 stock assessment. Indices denoted with an "s" were used in Stock Synthesis and indices with a "v" were used in VPA. U.S. Rod and reel 66-114 and 115-144 indices are shown for illustrative purposes but were superseded by the combined 66-144 index. The 1986 low data point of the Japanese longline in the West Atlantic was removed in the Stock Synthesis models.




**BFTW-Figure 3.** Comparisons of (a) total biomass, (b)recruitment, and (c) fishing mortality by Stock Synthesis among 2017 (green), 2020 (orange), and 2021 (black) stock assessments for West bluefin tuna.

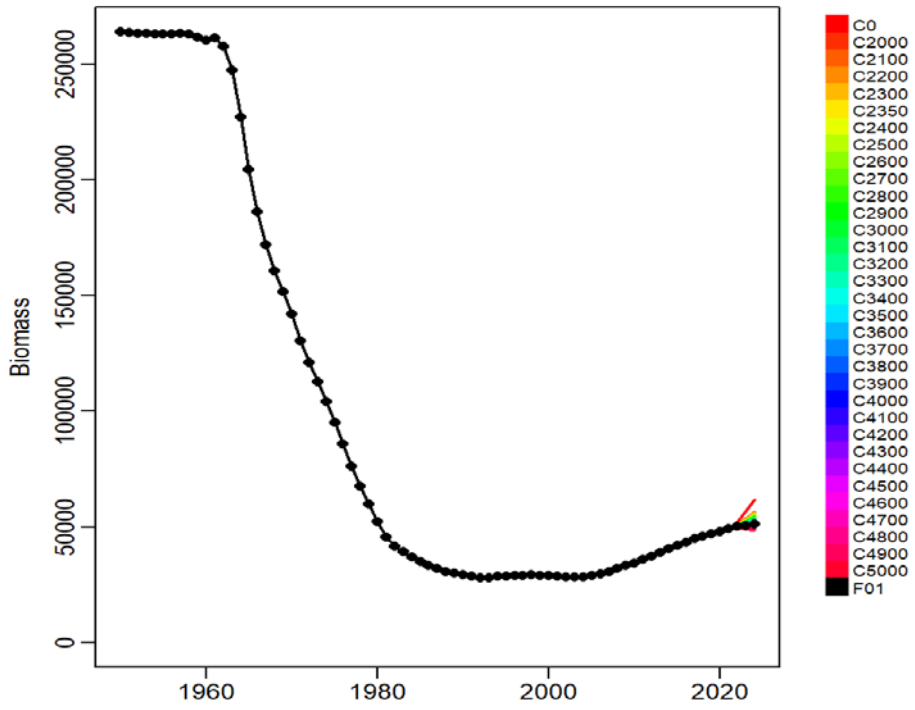



**BFTW-Figure 4.** Estimates of (a) total stock biomass for 1950-2020 and (b) for 2000-2020, and (c) recruitment (age 0) for 1950-2020 and (d) for 2000-2020 for the base VPA (red) and Stock Synthesis (blue) models from the 2021 assessment. The 80% confidence intervals are indicated with dashed lines. 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).

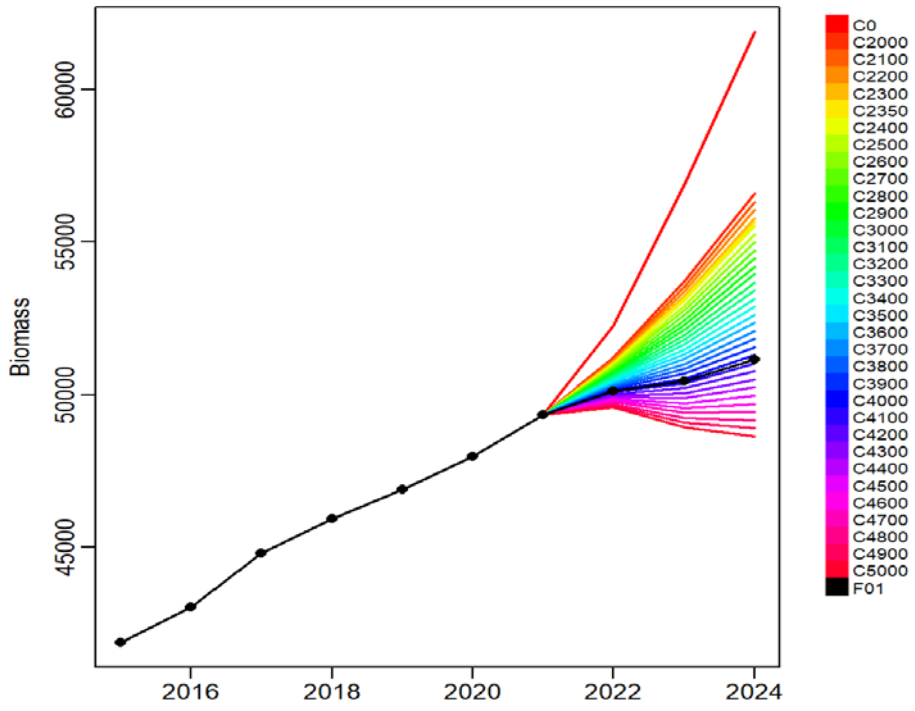



**BFTW-Figure 5.** Fishing mortality relative to the $F_{0.1}$ reference point as estimated by Stock Synthesis for the 2021 assessment. The 80% confidence intervals are indicated with dashed lines.

a)




b)




**BFTW-Figure 6.** Projected total stock biomass (mt) of bluefin tuna in the West Atlantic under alternative constant catch scenarios, averaged across maturity specifications for Stock Synthesis. The deterministic model runs are averaged across both maturity specifications. (a) Upper panel: 1950-2024, (b) lower panel: zoomed in to 2015 to 2024.

### *9.3 ALB-MED-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., 2021m).

#### *ALB-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-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-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 2019 and 2020, the reported landings were 2,484 t and 2,675 t, respectively, below those in the last decade (**ALB-Table 1** and **ALB-Figure 2**). The majority of the catch came from longline fisheries. EU-Italy is the main harvester of Mediterranean albacore, with around 50% of the catch during the last 10 years. In 2019 the Italian catch remained similar to the average over the last five years.

#### *ALB-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-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 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% CI), and the current biomass is below the $B_{MSY}$ level (0.57; 0.32-1.00, Median and 95% CI) (**ALB-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-Figure 4**).

### *ALB-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-Table 2**).

### *ALB-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-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-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-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-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** | |
|---|---|
| | **Mediterranean** |
| Maximum Sustainable Yield | 3,653.9 t (2,446-5,090 t)[1] |
| Current (2020) Yield | 2,675 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<br>Overfishing: YES |
| Management measures in effect: | Rec. 17-05: Time closure of two months (1 October-30 November) for longlines, aimed at protecting the Mediterranean swordfish juveniles.<br>A list of vessels authorized to target Mediterranean albacore implemented in 2017.<br>No increase of catch and effort until more accurate advice is delivered. |

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

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

| | | | | 1991 | 1992 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL | | | | 56327 | 69616 | 73087 | 71813 | 67518 | 60379 | 59586 | 59039 | 67062 | 70088 | 69918 | 60070 | 61470 | 53375 | 57728 | 67381 | 48794 | 42320 | 41663 | 40759 | 48743 | 53000 | 45814 | 42759 | 44385 | 49098 | 45067 | 49689 | 52882 | 51834 |
| | ATN | | | 27931 | 30851 | 38135 | 35163 | 38377 | 28803 | 29023 | 25746 | 34549 | 33124 | 26252 | 22716 | 25567 | 25957 | 35318 | 36963 | 21991 | 20483 | 15391 | 19411 | 19989 | 25681 | 24887 | 26655 | 25630 | 30395 | 28462 | 29728 | 34781 | 31188 |
| | ATS | | | 26016 | 36564 | 32814 | 35301 | 27554 | 28426 | 28022 | 30595 | 27656 | 31387 | 38795 | 31746 | 28005 | 22545 | 18882 | 24453 | 20283 | 18867 | 22248 | 19225 | 24126 | 25272 | 19424 | 13705 | 15201 | 14383 | 13825 | 17098 | 15616 | 17971 |
| | MED | | | 2379 | 2202 | 2138 | 1349 | 1587 | 3150 | 2541 | 2698 | 4856 | 5577 | 4870 | 5608 | 7898 | 4874 | 3529 | 5965 | 6520 | 2970 | 4024 | 2124 | 4628 | 2047 | 1503 | 2400 | 3554 | 4319 | 2780 | 2863 | 2484 | 2675 |
| Landings | MED | | Bait boat | 499 | 171 | 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 | |
| | | | Longline | 524 | 442 | 410 | 350 | 87 | 391 | 348 | 194 | 416 | 2796 | 2597 | 3704 | 4248 | 2335 | 1997 | 3026 | 4101 | 2694 | 2160 | 1719 | 2327 | 1959 | 1392 | 2343 | 3235 | 4258 | 2706 | 2378 | 2386 | 2497 |
| | | | Other surf. | 1198 | 1533 | 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 |
| | | | Purse seine | 110 | 6 | 559 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3557 | 2452 | 1362 | 2803 | 2237 | 24 | 1230 | 0 | 869 | 68 | 86 | 15 | 300 | 32 | 70 | 481 | 23 | 66 |
| | | | Trawl | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 5 | 4 | 9 | 0 | 2 | 1 | 5 |
| | | | Troll | 48 | 50 | 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 |
| Discards | MED | | Longline | 0 | 0 | 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 |
| Landings | MED | CP | EU-Croatia | 0 | 0 | 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 |
| | | | EU-Cyprus | 0 | 0 | 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 |
| | | | EU-España | 548 | 227 | 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 |
| | | | EU-France | 140 | 11 | 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 |
| | | | EU-Greece | 500 | 500 | 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 |
| | | | EU-Italy | 1191 | 1464 | 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 |
| | | | EU-Malta | 0 | 0 | 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 |
| | | | 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 | 0 | 0 | 0 | 0 | 0 | 429 | 0 | 316 |
| | | | 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 | 2 | 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 | 0 | 0 | 750 | 800 | 0 | 30 | 21 | 19 |
| | | | Maroc | 0 | 0 | 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** |
| | | | Syria | 0 | 0 | 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** |
| | | | Turkey | 0 | 0 | 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 |
| | | NCO | NEI (MED) | 0 | 0 | 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 | |
| | | | 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 | MED | CP | EU-Cyprus | 0 | 0 | 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 |
| | | | 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** |

**ALB-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 $B>B_{MSY}$

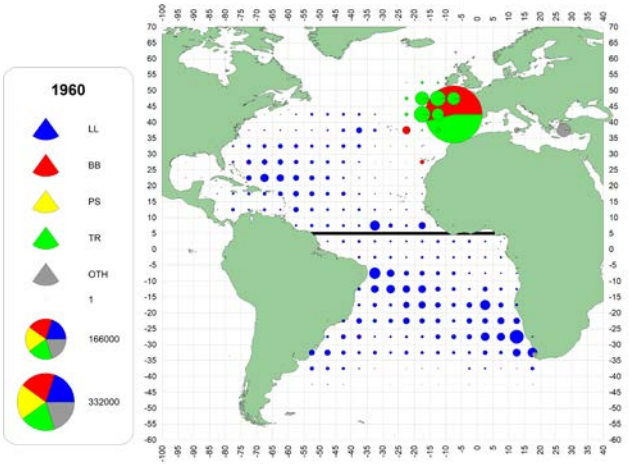
| TAC \| Year | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 18 | 35 | 52 | 66 | 76 | 83 | 88 | 91 | 94 | 95 | 97 | 97 | 98 | 98 |
| 500 | 18 | 32 | 47 | 60 | 71 | 78 | 83 | 87 | 90 | 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 $F<F_{MSY}$).

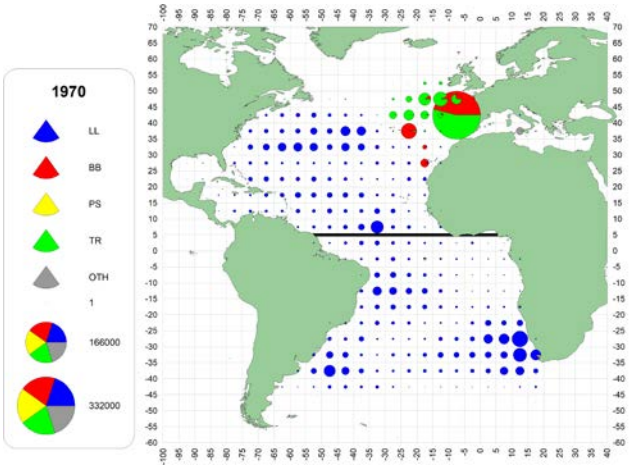
| TAC \| Year | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 18 | 35 | 52 | 66 | 76 | 83 | 88 | 91 | 94 | 95 | 97 | 97 | 98 | 98 |
| 500 | 18 | 32 | 47 | 60 | 71 | 78 | 83 | 87 | 90 | 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-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).

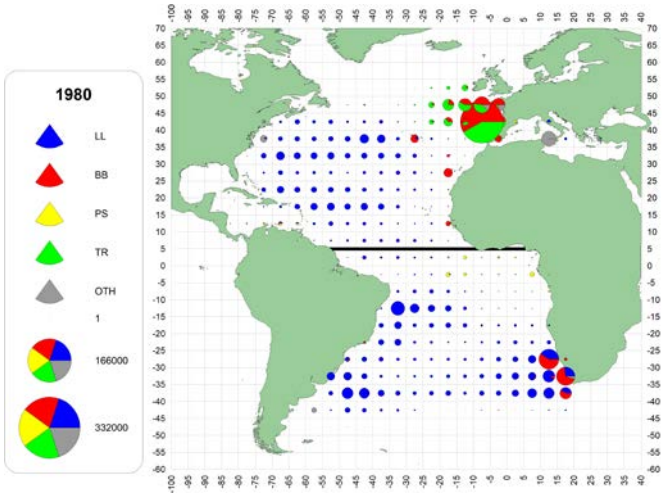
| TAC | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 500 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1000 | 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 |



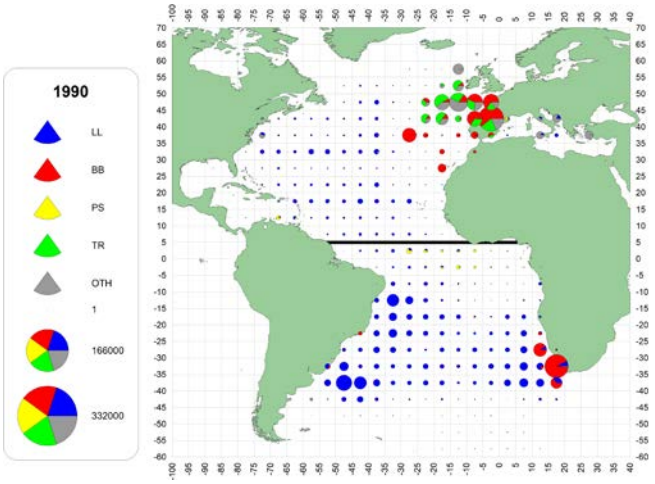

a. ALB (1960-69)



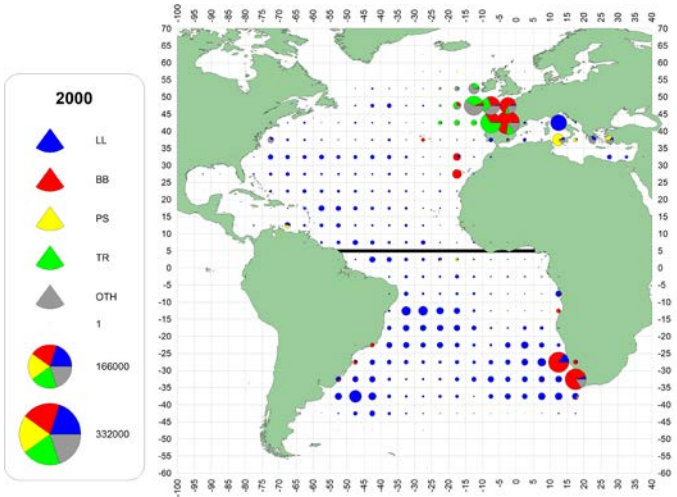

b. ALB (1970-79)



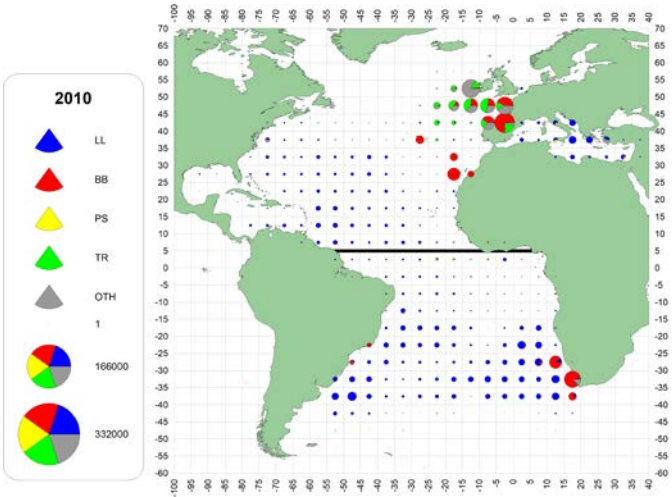

c. ALB (1980-89)




d. ALB (1990-99)

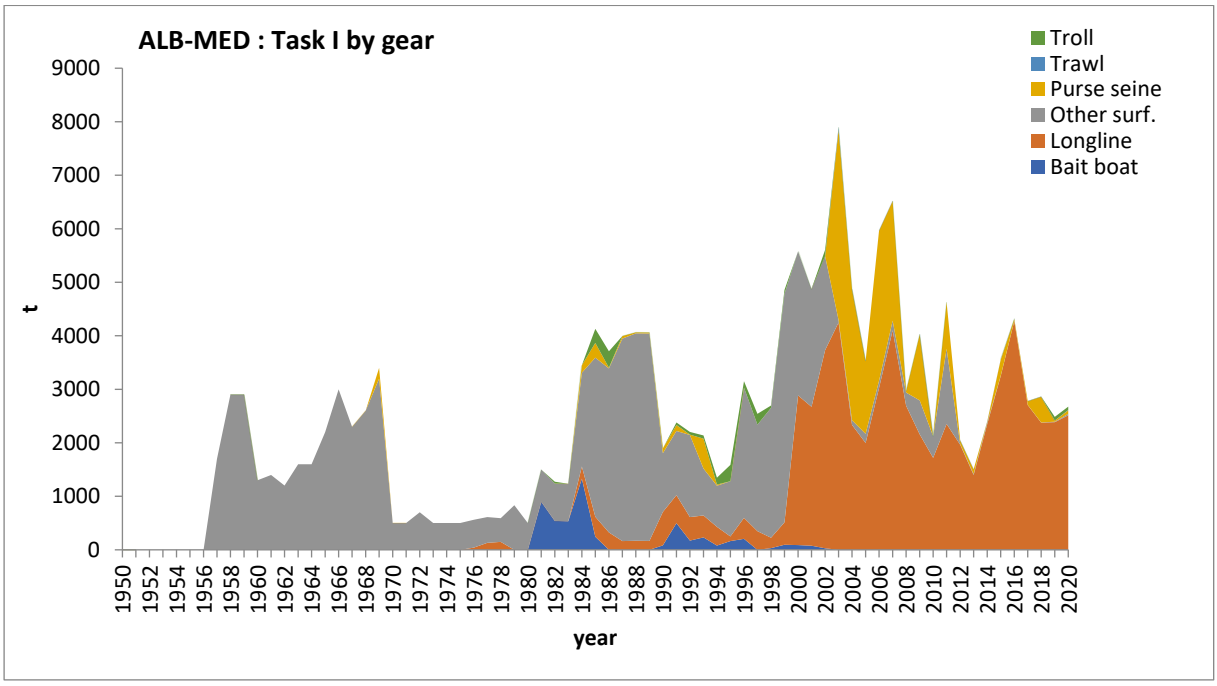



e. ALB (2000-09)

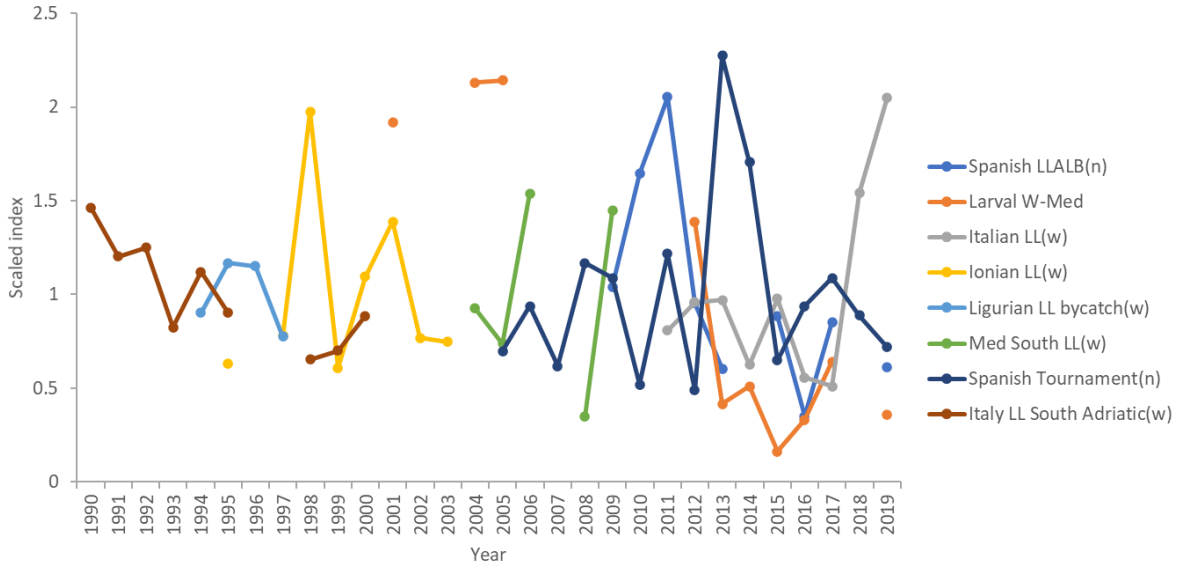



f. ALB (2010-18)

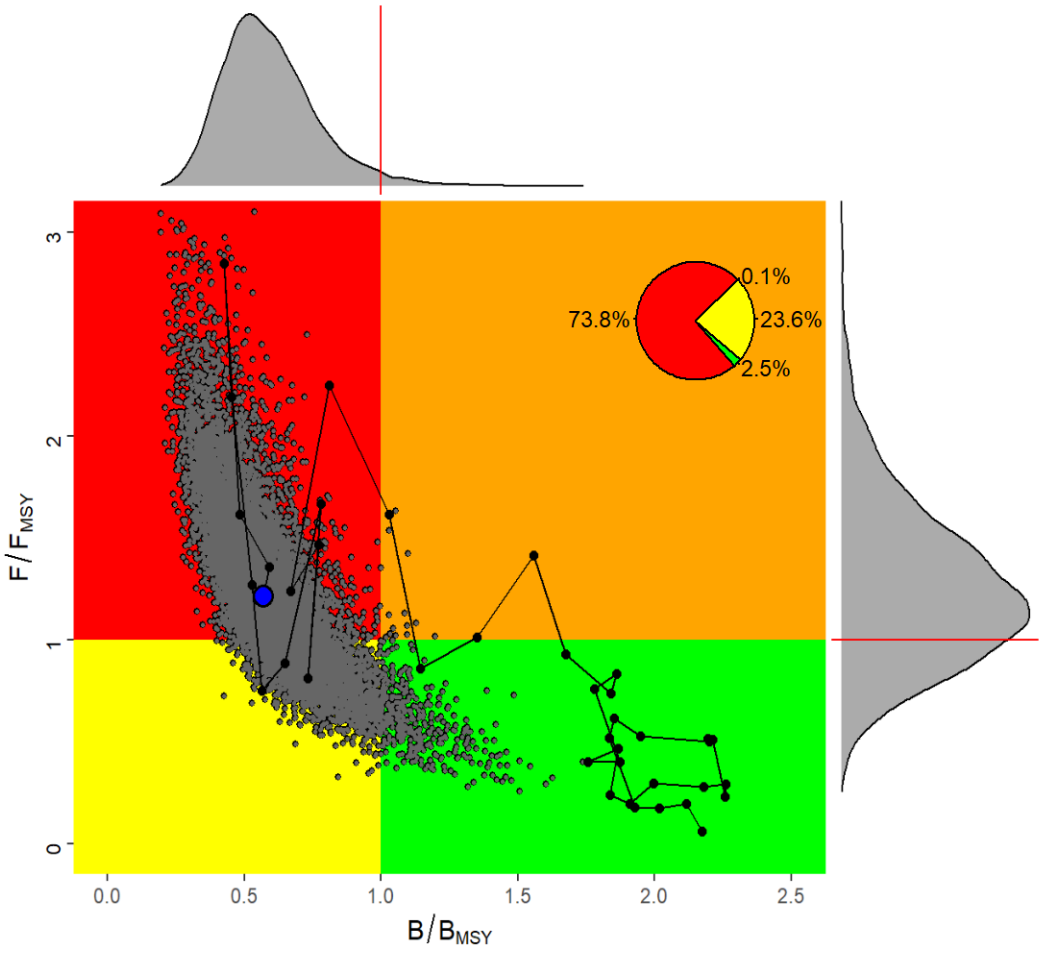
**ALB-Figure 1.** Geographic distribution of accumulated albacore catch by major gears and decade (1960-2018). Prior to the 1990s, baitboat and troll catches were assigned to only one 5ºx5º stratum in the Bay of Biscay. Plots are scaled to the maximum catch observed from 1960 to 2018 (last decade only covers 9 years).



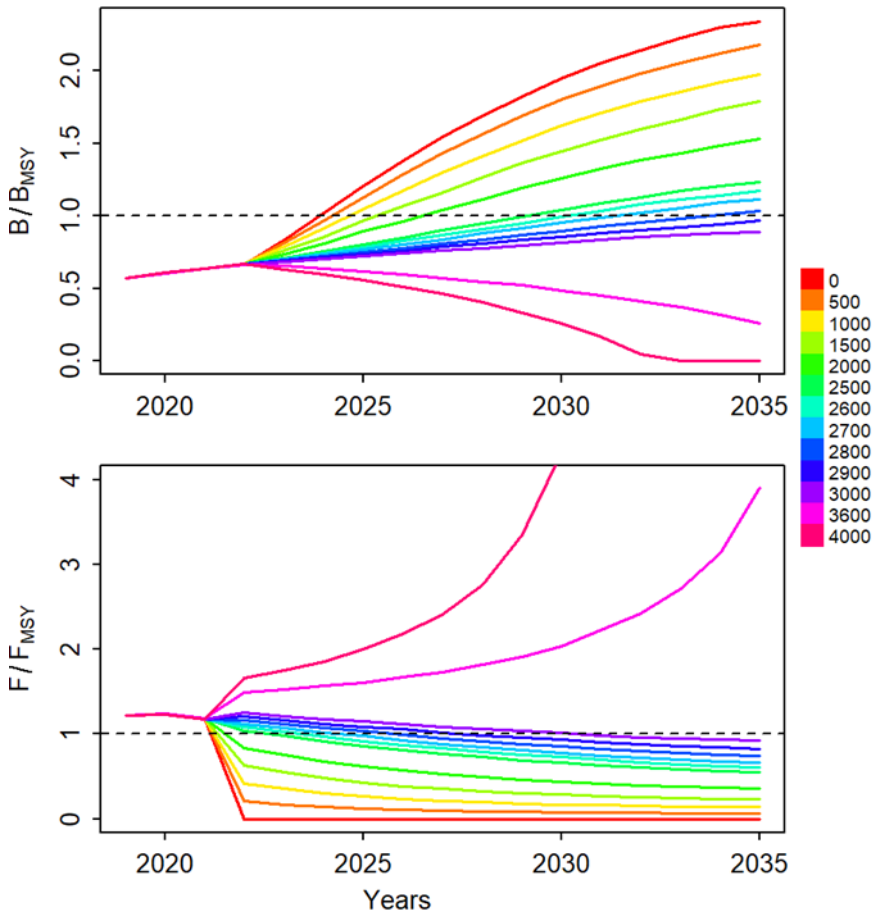

**ALB-Figure 2**. Total albacore catches reported to ICCAT (Task 1) by gear for the Mediterranean stock.




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




**ALB-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-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.

### *9.4 Task 1 catches for all major ICCAT species (excluding those contained in items 9.1 to 9.3 of this report)*

The Task 1 catches for all major ICCAT species excluding those contained in the Executive Summaries provided in item 9.1 to 9.3 of this report, are provided as **Appendix 13.**

Several concerns were expressed by the Committee as regards the reported Task 1 reported catch levels for following species:

*Yellowfin tuna*

The Committee wants to draw the attention of the Commission to the reported landings of the three species of tropical tunas in 2020. The 2020 catch of BET of 57,486 t is 24% lower than the average of the previous three years (75,691 t). The 2020 catch of SKJ of 225,379 t is 20% lower than the average of the previous three years (281,430 t). The 2020 catch of YFT of 148,894 t is 9% higher than the average of the previous three years (136,251 t). The Committee was unable to determine whether such shifts in catch levels are the results of natural variability in abundance and/or availability of the different species, of shifts in fishing operations caused by the measures contained in Rec. 19-02, or the effects of COVID-19 on fishing operations.

Of concern to the Committee are the preliminary reported catches of yellowfin tuna in 2020 because they largely exceed the TAC (110,000 t) and represent the highest landings since 2016. According to the 2019 assessment, constant catches from 2020 onwards above 120,000 t are expected to further degrade the condition of the yellowfin stock (2019 YFT summary YFT-Table 2 in *Report for Biennial Period 2018-2019, Part II (2019), Vol. 2*). Constant catches of 140,000 to 150,000 t are associated with a 13-23% probability of stock biomass declining to less than 20% of the level that supports MSY. The Committee also noted, that in making YFT stock projections in 2019 the Committee assumed catches of 131,000 t for 2018 and 2019 and that 150,000 t was the highest constant catch for projections. Current estimates of catch for 2018 (136,000 t) and 2019 (135,000 t), are greater than the catch assumptions made in 2019. Therefore, projections produced in 2019 are likely to be somewhat optimistic and furthermore, cannot inform the Commission of consequences of catches larger than 150,000 t.

*Blue shark*

The Committee highlighted that the reported Task 1 catches for the South Atlantic stock of blue shark in 2020 (33,652 t) exceeded the Total Allowable Catch (TAC) of 28,923 t, as established in ICCAT Rec. 19-08 (para 2). With regards to the North Atlantic blue shark stock, the 2020 catches (20,827 t) were below the established TAC (of 39,102 t) established in ICCAT Rec. 19-07.

*Billfish*

The Committee noted that catches of sailfish stocks in 2017 (1,648 t SAI-E and 1,245 t SAI-W), 2018 (935 t SAI-E and 1,519 t SAI-W), 2019 (2,015 t SAI-E and 1,361 t SAI-W) had surpassed in most cases the catch limits of Rec. 16-11. In 2020 available catches, albeit still incomplete, are estimated to be 1,182 t SAI-E and 1,152 t SAI-W, thereby exceeding the catch limit for SAI-W.

## 10. Reports of Research Programmes

### *10.1 Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)*

GBYP Phase 10 started on 1 January 2020, with an initial duration of 12 months, but which was later extended for 7 months (until 31 July 2021) so as to allow to carry out within this phase the pilot aerial survey designed as an alternative to the aerial surveys in 2020, which were cancelled due to COVID-19. Phase 11 started on 1 January 2021 with an initial duration of 12 months.

The most relevant research activities carried out during this reporting period (October 2020-October 2021) have been:

***a) Data mining, recovery and management*** **–** During Phase 10 there were no tasks related to data recovery requiring contracts. The activities in this area consisted of in-house desk work focused on development of relational databases to enable proper storage and analysis of raw data relevant for BFT management, i.e. data related to BFT farming and the growth in farms study, biological data and electronic tagging data. This in-housework is continuing through Phase 11 and encompasses collection and evaluation of relevant data not previously available to the SCRS.

***b) Aerial survey on bluefin tuna spawning aggregations*** **–** 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, who identified several issues with work done so far. The code has therefore been fully revised and the whole series of indices re-calculated. In addition, the design-based analysis method used previously has been supplemented by a model-based method which, once fully developed and implemented, will allow generation of a more accurate index. In 2021, a pilot aerial survey has been carried out in the Balearic Sea area, following the recommendations from the external experts, which were ratified by the SCRS Bluefin Tuna Species Group. It was developed in the usual area and, in addition, replicates were also performed over an extended surrounding area. The pilot survey included not only the standard human observer-based system but also a continuous recording of high-resolution images in a 600 m strip over all the surveyed transects, which have been post-processed to explore the feasibility of using automatic digital systems for BFT aerial surveys. The aerial survey index was not used in the 2021 MSE OM-reconditioning exercise, given that the corrected results were not available in time, but it will be included in the next steps of the MSE process.

***c) Tagging*** **–** Conventional tagging continued as a complementary activity, providing support to national teams. Although conventional tag reporting has improved since implementation of the GBYP tag awareness and rewards programme, the recovery rate remains low. Deployment of electronic tags has further enhanced the knowledge on bluefin tuna behaviour and helped address several previous hypotheses. These data have been used within the framework of MSE development. Following a new strategic approach, which allowed to better deal with the COVID pandemic and to increase its efficiency, the GBYP tagging programme in 2020 was developed in close cooperation with existing consolidated national programmes in the North Atlantic, deploying a total of 15 archival and 41 satellite tags. In view of the good results obtained so far, in 2021, the same approach is being followed, and 80 satellite and 5 archival tags will be deployed within the framework of 9 Memoranda of Understanding signed with different institutions on both sides of the North Atlantic and around the Mediterranean. In addition, in March 2021, an online Electronic Tagging Workshop was held, providing recommendations for improving and optimizing BFT tagging campaigns.

***d) Biological studies*** **–** Biological sampling was focused on collecting tissue samples and otoliths for the purpose of better determining the population structure and mixing and improving the accuracy of the age length key, used for the stock assessment and MSE. In 2020, the biological analyses methodologies were refined and further improved. The results from otolith microchemistry continue to show important interannual variations in the mixing proportion of West and East stock individuals in the East Atlantic. The results of genetic analyses confirmed the previous hypothesis on BFT connectivity mediated through the areas where interbreeding occurs, such as the Slope Sea, although numerous questions regarding population structure and dynamics remain. In addition, a new cost-efficient tool was developed, which includes more than 7000 genetic markers suitable for BFT population genetics, including sex determination, kinship finding and origin assignment. A revision of otolith age estimates provided in previous phases by an Australian company specialized in fish ageing under GBYP contracts was carried out within the calibration exercise among ICCAT expert readers, which will allow to incorporate 4000 new length-age data to the next eastern stock assessment The studies on growth on farms, already initiated in 2019 following the Commission's request, continued in four farming facilities, including two studies based on tagging for determining individual growth trajectories and two studies relying on intensive monitoring with stereoscopic cameras, food supply and environmental conditions to determine the seasonal growth rates by size group and its environmental drivers. Also, a new pilot study using acoustic and IAS techniques was carried out. The information from all these studies is being used to elaborate the SCRS response to the Commission request on growth in farms. In February 2021, an online workshop was held with the specific objective to evaluate the financial, logistic and scientific feasibility of implementing close kin mark recapture study for BFT. The ongoing biological studies will focus on conducting analyses focused on solving population structure uncertainties and provide more accurate estimations of BFT mixing proportions.

***e) Modelling –*** The work on MSE development continued, to ensure that the OM scenarios agreed by the former GBYP Core Modelling Group (CMG) can be run; that third parties can use the OM to evaluate candidate MPs (CMPs) with their own specifications; and that a set of agreed summary statistics that can be used by decision makers to identify the MP that robustly meets the management objectives, is provided. An external MSE code review has also been initiated. In addition, GBYP has continued providing financial support to various experts for their attendance to MSE Technical Group meetings.

The report is attached as **Appendix 5**.

*Discussion*

The GBYP Coordinator presented to the Committee a summary of results and work carried out in the previous year within each line of activity (i.e. data recovery, independent indices, biological studies, tagging and MSE). The summary of GBYP contributions to the scientific advice was also provided, highlighting the inputs to the Bluefin Tuna Stock Assessment and the MSE process. Finally, the draft proposal of tasks to be carried out within next GBYP Phase 12, including the associated budget. In addition, a reference was made to short and mid-term planned activities, including the presentation of a proposal for a strategic plan for the forthcoming years.

The Committee acknowledged the importance of GBYP, especially in terms of its contribution to the provision of scientific advice for bluefin tuna management. It also recognized there has been substantial progress in the work of the Programme over the past few years.

The Committee commented that funding for GBYP may not be continuous. Therefore, it was suggested the Committee prepare a clear list of priorities and research needs, in order to identify those tasks that should be carried out within the Programme and those that should be the responsibility of the CPCs that exploit this fishing resource. A suggestion was made to increase electronic tagging in the Mediterranean Sea and extend fishery independent indices to more than a single area in the Mediterranean.

It was reiterated that GBYP activities are directly guided by the GBYP Steering Committee, which ensures the SCRS research needs are duly integrated in the GBYP yearly plans. It was also highlighted that external experts are often invited to provide scientific advice and guidance through their participation in dedicated GBYP workshops, whose recommendations are later discussed within the SCRS Bluefin Tuna Species Group meetings.

### *10.2 Atlantic Ocean Tropical tuna Tagging Programme (AOTTP)*

The ICCAT-AOTTP (**Appendix 6**) formally ended on 28 February 2021. The programme reached the majority of its final targets since it last reported to the SCRS via the 2020 advice to the Commission process. Much progress has been achieved during the AOTTP and the 'objectively verifiable indicators' in the original logical framework of the Grant Contract have been met. Inevitably, however, the COVID-19 pandemic has caused problems and some delays in the provision of deliverables. One contract aiming at tagging in the NW Atlantic was short on the number of fish targets.

During the project, 53 contracts were awarded related to the different activities carried out (e.g. tagging surveys, awareness and recovery, data analysis, etc.). Overall, at least 1867 days at sea (target 1800 days) were spent on 580 tagging cruises throughout the tropical Atlantic. Tag and release targets (120,000 fish), compromised by the pandemic, were almost reached, with 119,429 fish (99.6% of the target) being tagged and released (R-1) with conventional tags in the high seas and in the EEZs of more than 20 different countries. A total of 597 electronic tags (pop-ups and internals) were deployed and are already providing new scientific information on tuna migrations. Scientists and technicians from developing countries tagged over two-thirds of all the fish. The AOTTP made a concerted effort to have female scientists and technicians participate in the field work on this project, as they continue to be under-represented in fisheries related studies. Formal tag-recovery and awareness raising infrastructures were set up in 13 countries, with less formal arrangements in another 5 locations, including Japan and China (P.R). Despite the very few numbers of recaptures reported by longliners, a total of 17,162 tags were recovered with metadata so far (overall recovery rate is 14%) for which rewards (t-shirts, caps, lottery entry, cash, and mobile phone top-ups) were provided. Tag-seeding experiments for estimating the reporting rate, started relatively late in the project and are still ongoing during 2021, with an extensive network of observers throughout the Atlantic and

reporting rates for the most important purse seine fleets are: 69%, 77.3%, and 68% for BET, SKJ, and YFT, respectively. A total of 21,417 fish were double-tagged, and tag-shedding rates were estimated, while 9,123 fish were chemically tagged which is improving our ability to age hard parts from recaptures. ICCAT-AOTTP partners from Brazil, Senegal and Australia created a pan-Atlantic Otolith Reference Set to standardize age-determination of tropical tunas and routine ageing is ongoing. Otolith ring deposition rate validation and training was also organized with contractors from Australia providing expertise. All AOTTP data were uploaded into ICCAT relational databases using smartphone and messaging applications. These were also used to maintain communication between the AOTTP and the many field operatives around the Atlantic Ocean. Training in all aspects of tagging at sea, tag-recovery, and data transmission methodologies took place throughout the project. ICCAT-AOTTP also organized a number of otolith-reading, capacity-building workshops on tagging-data analyses during the project which were very successful. Two contracts for data analysis were awarded: one to investigate mortality and movement/migration; and the other to study growth. The YFT tuna stock was assessed in 2019 by the SCRS and age and tag-recapture data collected by the AOTTP proved to be very important. The AOTTP Final Symposium - originally planned for June 2020 in Senegal - could not take place due to the COVID-19 pandemic and was replaced by an Online Symposium in January 2021. Several oral presentations of the AOTTP symposium have been submitted for a Special Issue publication in the *Fisheries Research* peer-review journal.

The final report was reviewed by the main funding Agency and was recently considered approved. The report is available here.

### *10.3 Small Tunas Year Programme (SMTYP)*

Between 2018 and 2021, 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, whereas in 2020 a new consortium was set up involving 11 entities from 9 CPCs, and a new contract signed. The objective of the latter contract was to collect biological samples to: i) fill the specific gaps for estimating the growth and maturity parameters for BON and LTA in the Atlantic and the Mediterranean Sea; ii) estimate growth and maturity parameters for LTA and BON, and provide preliminary results for WAH; and, iii) determine the stock structure for BON, LTA and WAH.

A number of documents and presentations were provided during 2021 Intersessional Meeting of the Small Tunas Species Group (Anon, 2021k), 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 2021-2022. These priorities are presented in the small tunas workplan for 2022 (item 19.1.7), which also contains details on other relevant research activities to be developed throughout 2022-2024 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 to these stocks.

The SMTYP report is attached as **Appendix 7**.

*Discussion*

The Committee highlighted the importance of these resources for coastal States and congratulated the Small Tunas Species Group for the results achieved. In addition, the Committee supported the ongoing research activities and suggested reviewing some relevant studies conducted and presented in the past to the SCRS, a task that is now facilitated with the scientific documents search tool developed by the Secretariat for the *ICCAT Collective Volumes of Scientific Papers.*

### *10.4 Shark Research and Data Collection Programme (SRDCP)*

The Shark Species Group (SSG) continued the work on the age and growth of the South Atlantic shortfin mako study with the incorporation of samples from Japan, Namibia, and Brazil. Sample processing is currently being carried out and should be completed by the end of 2021.Therefore, final results are planned to be provided to the Shark Species Group in 2022.

The population genetics study to estimate stock structure and phylogeography of shortfin mako continued, as previous results showed some inconsistency between genetic population structures predicted from mitochondrial and nuclear DNA analyses. To answer these questions two genome-wide analysis approaches were used: whole mitochondrial genome analysis and nuclear-genome-wide single-nucleotide polymorphism. The results obtained may support a scenario that consists of the establishment of geographically isolated populations, subsequently generating genetic divergence, followed by secondary contact between the divergent populations.

The post-release mortality study on shortfin mako caught on pelagic longline fisheries continued. A total of 43 tags (14 sPATs and 29 miniPATs) have been deployed to date for this project in the northwest, northeast, tropical northeast and equatorial region, and southwest Atlantic. Data available from 35 of the 43 tagged specimens revealed a 22.9% rate of post-release mortality. Data from 41 of the 43 tags deployed were also available for the satellite telemetry study to gather and provide information on stock boundaries, movement patterns and habitat use by the shortfin mako shark. A total of 1,656 tracking days have been recorded to date with results showing that shortfin makos moved in multiple directions and travelled considerable distances. Twenty-four additional tags from other projects involving the same partners were also deployed in these same areas. 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 showed evidence of site fidelity and were identified as possible key areas for shortfin mako. The results of this project were recently published in Santos *et al*., 2021.

Tag deployment has continued with the remaining miniPATs, for both telemetry studies, which will be done during the second semester of 2021 and throughout 2022, depending on the opportunities, considering the current difficulties with onboard missions due to the pandemic. In addition, porbeagle electronic tagging 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, to potentially contribute to their assessment and management. A total of five tags have been deployed by EU-Portugal and EU-France in the Northeast Atlantic, Bay of Biscay/Celtic Sea area, and central North Atlantic. Deployment of remaining tags are 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 2021 and 2022, depending on the tagging opportunities.

Finally, since 2018, a total of 19 miniPATs were deployed by EU-Portugal, USA and Uruguay on silky (11), oceanic whitetip (6), smooth hammerhead (1) and scalloped hammerhead (1) sharks, which were deemed by the SCRS to be priority species. Multiple tags acquired during 2019 and 2020 had to be returned to the manufacturer due to battery failures and could not be deployed as originally planned in 2020. Those tags, and tags acquired in 2021 are planned to be deployed throughout 2021 and 2022.

The report is attached as **Appendix 8**.

### *10.5 Enhanced Programme for Billfish Research (EPBR)*

The EPBR continued its activities in 2021, although with restrictions due to the COVID-19 pandemic situation. The Secretariat coordinates the transfer of funds, information, and data. The overall programme coordinator and eastern Atlantic coordinator during 2021 was Dr Fambaye Ngom Sow (Senegal) and Ms. Karina Ramírez López (Mexico) remaining as coordinator for the western Atlantic. The original plan (1986) for EPBR included the following objectives: (1) to provide more detailed catch and effort statistics, particularly for size frequency data; (2) to initiate the 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 aspects to improve billfish assessments. The original plan was revised by the Group, to overcome the data gap

issues, in particular artisanal fisheries of developing CPCs, taking into account the findings of these 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 US Data Fund has been supporting the EPBR activities.

In July 2020a new contract was awarded to Centre de Recherches Océanographiques de Dakar/Thiaroye (ISRA/CRODT, Senegal) to continue the activities of the previous contract for a 12 months period (until June 2021). Over this period, EPBR engaged research teams from Senegal, Côte d'Ivoire and Gabon sampling for billfishes from artisanal fleet and a EU research team from Portugal, which have significantly enhanced the collection of samples onboard industrial vessels operating in the same area and support 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). A total of 452 samples have now been collected from those species both by artisanal and industrial fleets, and sampling processing and analysis is ongoing. Soon a new contract shall be signed to continue the activities throughout the second semester of 2021. All otoliths collected were sent to the Fish Ageing Services in Australia for age reading. The first steps of this work are ongoing, and results are expected to be provided within the next months.

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 on Atlantic blue marlin in the Gulf of Mexico. Unfortunately, albeit the efforts made by the Secretariat and the western coordinator of the EPBR, the signing of the contract has been delayed due to Mexican regulations and administration. Accordingly, the Secretariat is currently waiting for an alternative to be provided on how to implement this study.

The EPBR report is attached as **Appendix 9**.

### *10.6 Other research programmes (on albacore and swordfish)*

Research Programmes are used by ICCAT as a mechanism to help focus, coordinate and complement national research activities. The programmes usually center on improving biological knowledge and fishery data for a particular species, and usually last several years.

Currently there are ongoing Research Programmes for several Species Groups in ICCAT, namely bluefin tuna, sharks, marlins and small tunas. Besides those, significant scientific work is ongoing for other Species Groups, such as albacore and swordfish, even though the related Groups do not yet have formally established Research Programmes. In the case of swordfish, since 2018, research has been conducted on a contractual basis and includes sampling, ageing and growth studies, tagging, maturity and reproduction studies, and genetics studies. Whereas in the case of albacore, apart from the MSE work, only in 2021 research has been conducted on a contractual basis for the reproductive study in both North and South Atlantic albacore.

Although the Committee agreed that during this year (2021) both the Albacore and Swordfish Species Groups should develop formal Research Programmes, which in both cases should include the Atlantic and Mediterranean stocks, that goal was not achieved due to the workload. However, the two Groups committed to draft those projects proposals as soon as possible. Such proposals should include descriptions of the various research activities that the Groups are proposing, and timeframes for such work to be carried out. Updates of the work carried out should be provided regularly to the SCRS.

In the case of the tropical tunas, since the AOTTP was only closed in 2021, the Species Group has not yet discussed this matter.

## 11. Report of the Subcommittee on Statistics

The 2021 meeting of the Subcommittee on Statistics was conducted online on 4 September 2021. Mr. Carlos Palma, acted as Convener of the Subcommittee. The Subcommittee welcomed all the participants and acknowledged the work of the Secretariat in the support provided to this Subcommittee and to the SCRS in general. In the report, the Convener referenced the 2021 Secretariat Report on Statistics and Coordination of Research (**Appendix 10**) which has detailed explanations of the work done by Secretariat including the current CPCs reporting status (SCRS Report Cards which used the filtering criteria to validate 2020 Task 1 Task 2 data submissions), improvements made in statistics (historical revisions and recoveries) and the associated data management tools (databases, infrastructure, applications, etc.), and progress made on various Secretariat ongoing projects (historical data recoveries, IOMS, etc.). The SCRS "scorecard on Task 1/2 data availability", approved by the SCRS in 2019, was also presented (for the third year) covering the period 1991 to 2020.

Special emphasis was given once again to the failure of most CPCs to comply with the mandatory reporting of both dead and live discards in Task 1, as required by the Commission, and the important need to improve this aspect in the short term.

The Convener also summarised the status of addressing the 2020 Subcommittee's recommendations, reiterating the need to continue advancing on those that have not been fully addressed, and the need for active participation of species group rapporteurs and CPC statistical correspondents in the Subcommittee. It was recalled that many decisions made by this Subcommittee usually affect the entire ICCAT community, such as the set of proposals aiming to improve and normalise the ICCAT coding system, as well as important changes made to statistical and tagging forms. These forms, revised every year, always contain important updates (e.g. since 2016, all the Task 2 information must be reported by month, Task 1 and Task 2 forms allow submissions of data from multiple years at once, etc.). Since 2020, the Task 1 nominal catches form (ST02-T1NC) has included two additional columns aimed to inform the raising factors used to obtain the live/round weight catches equivalent of the landings and the discards. The outcome of this inclusion was not yet fully addressed during the meeting (**Table 1 of Appendix 11**) but plans to revise the conversion factors reported by the ICCAT CPCs should be properly addressed in near the future.

The Subcommittee acknowledged the progress made on the ICCAT Online Managing System (IOMS), in particular its release into production on 1 August 2021 in order to work online with the 2021 Annual Reports (experimental year). This adjustment to the IOMS workplan was approved by the Commission's Online Reporting Technology Working Group during its 2021 intersessional meeting (report available here). Phase 1 development (one year: May 2019 to April 2020) has been completed, IOMS Phase 2 development started in May 2020 and it has been planned for two years. The Phase 3 workplan, is currently under approval by the Commission, and contains the development of the first statistical module (the Task 1 nominal catches manager), a proposal made by this Subcommittee. The Subcommittee acknowledged the importance of the IOMS project to the future of ICCAT and reiterates its full support for the IOMS project, its development and support from the Commission and the CPCs.

Finally, the Subcommittee presented to the SCRS its 2021/2022 workplan (see details in section 19.1.2 of this report).

The Report was adopted and is attached as **Appendix 11**.

*Discussion*

The Committee congratulated the Convener of the Subcommittee on Statistics for the challenging but excellent work done. Some CPCs requested that some cells on their report card (**Appendix 10**) be revised to include their latest revisions. The Secretariat confirmed that, all the corrections and/or updates arriving during the SCRS meeting will be made for the plenary section of the Commission.

The Committee noted the importance of the Secretariat's ongoing work on the development of dashboards for exploring dynamically statistical (Task 1) and conventional tagging data, and the role these tools can have in the work of this Committee, the Committee and all the ICCAT subsidiary bodies. Therefore, it strongly recommended an investment in these type of tools in the future.

## 12. Report of the Subcommittee on Ecosystems and Bycatch

The online Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch met between 5 and 10 May 2021. Pertaining to ecosystems, the Subcommittee reviewed: progress on developing an ecosystem report card for ICCAT; how to improve the reporting of the impact of ICCAT fisheries on the ecosystem; plans for collaborative workshop to discuss the relevance and the methodology used to delineate candidate ecoregions within the ICCAT Convention area in order to foster discussion on operationalizing the Ecosystems Based Fisheries Management; developing an informal meeting format for the SCRS to work with managers on SCRS-advisory processes that need more manager input; what was the availability of information on interactions between marine mammals and ICCAT fisheries.

Pertaining to bycatch, it reviewed: progress on collaborative work of sea turtle and presentation of the next steps, the effect of the mitigation measures, factors effecting bycatch and interactions, mechanisms for SC-ECO to work across all Species Groups of the SCRS on the issues related with multi-stocks (e.g. environmental impacts, multi-stocks trade-offs, integration of ecological considerations into management procedures). It developed its recommendations and its workplan for 2022.

The detailed report is provided in **Appendix 12**.

## 13. Discussions at the Intersessional Meetings of Panel 1 relevant to the SCRS

During the First Intersessional Meeting of the Panel 1 (1-2 July 2021) the SCRS Chair presented the SCRS's latest progress as regards tropical tunas. He noted that the efficacy of the FAD closure period in reducing catches of skipjack and juvenile yellowfin and bigeye tunas could not yet be fully reviewed. Dr Melvin also informed the Panel that the study of the impact on effort of a certain number of FAD sets for purse seiners has not been commenced due to the COVID-19 pandemic. Dr Melvin also informed Panel 1 about the limited availability of FAD set data, which are restricted to recent years, given that most CPCs have not submitted historical data. Dr Melvin indicated that it was difficult for the SCRS to include 2020 data in the 2021 analysis as these will not be available until 31 July 2021. Dr Melvin confirmed that even with the continued improvement in reporting for 2020, the analysis would take between two and three years to provide scientific advice on limiting FAD sets.

Several CPCs requested SCRS guidance on requirements regarding biodegradable FADs. The Panel requested that the SCRS provide advice within the framework of the 2021 bigeye stock assessment on the issues of number of FADs per vessel and closure period.

Observers also emphasized the need to make progress in the management strategy evaluation (MSE) processes to help the Commission regulate these valuable tuna stocks.

During the Second Intersessional Meeting of the Panel 1 (1-3 September 2021) the SCRS Chair provided a presentation on the results of the recent stock assessment of the bigeye tuna stock, noting that the Committee had not yet revised the assessment, and therefore the results should be considered preliminary.

The SCRS Chair, as well as the Tropical Tunas Coordinator replied to several questions put by the Panel, but no further requests to the SCRS were made, other than the current responses to the Commission, which are addressed under item 21 of this report.

## 14. Discussions at the Intersessional Meetings of Panel 2 relevant to the SCRS

The SCRS Chair informed the SCRS on the discussions and decisions taken during the intersessional meeting of the Panel 2 (2-5 March 2021). The text below is consistent with the Panel 2 report that is provided here.

***Growth on farms***

A summary of SCRS work in relation to updating the growth table for the fattening period was presented by the Coordinator of the GBYP. The work consisted of three complementary approaches: determining the growth of individual fish using tagging, monitoring of selected cages, and comparing estimated weights at

caging to weights at harvesting using electronic Bluefin Tuna Catch Documents (eBCD). The GBYP Coordinator showed some of the preliminary results of these studies. In addition, the GBYP Coordinator highlighted some potential future research steps including the use of acoustic tags and hydrophones to determining individual growth trajectories. Finally, the GBYP Coordinator provided a global overview of the programme's plans to develop a database system for integrating stereoscopic camera, harvesting, eBCD, ROP and VMS data that would allow for a more integrated analysis of this information.

The Panel expressed thanks to the GBYP Coordinator and to the CPCs involved in this study. One aspect of concern to Panel 2 was that there is the potential for bias to quantify growth by taking into account the difference between the individual weight at caging, derived from the length at first measurement given by stereoscopic cameras, and the individual weight at harvest time. The Panel recalled the background to the request to update the growth rates and the fact that some unusually high growth rates could not be explained, and that this led to suspicions by both importing and farming CPCs that illegal activities may have taken place between caging and harvesting. Looking at the difference in weight between caging and harvesting would therefore likely result in including any bias potentially related to such activities and would not provide an accurate representation of the maximum growth rates. The Panel added that it is therefore important that the SCRS takes this into account before using this study to produce the updated maximum growth rate table.

The Panel inquired how the growth rates calculated across multiple studies would be integrated. In response the GBYP Coordinator noted the request from the Commission was to explicitly consider the different sites and the subsequent analysis would highlight the differences.

The Chair confirmed that weight at capture, which would be estimated based on the length at caging and the length weight relationship for wild fish, was to be used for the growth rate estimation.

***Draft protocol for Northern Albacore Exceptional Circumstances***

The Rapporteur for the SCRS Albacore Species Group presented a "Brief Update on North Atlantic Albacore Exceptional Circumstances". He provided an overview of what exceptional circumstances were, and under what circumstances they could be considered triggered. To determine if such exceptional circumstances exist, additional data (catch, CPUE, etc.) would be needed. Different indicators could be used for different circumstances – depending on if there is a new benchmark assessment, application of the harvest control rule, etc. Taking into account the Panel 2 discussions and input provided by CPCs to the March 2020 Panel 2 meeting, the SCRS updated the list of indicators to detect such exceptional circumstances. The rapporteur referred to 2020 examples demonstrating how modelling output was examined to check if exceptional circumstances had occurred.

The Panel 2 Chair noted the need to discuss the process, i.e., the next step on the understanding that the list of indicators had been finalized with those changes. The SCRS responded that they would provide additional or alternative text on the definition of the "full range of values", and how this set of indicators would be evaluated and reported. The SCRS would also further consider how to reflect the concepts associated with the "Catch" criteria, which were currently reflected in the table under two different principles and evaluated on different timelines. They would reflect the results of these discussions in their responses to the Commission in the September SCRS report.

The Panel Chair noted that his question was broader than just the SCRS's work, in that it was about what the next steps for the SCRS and Panel 2 would be with the objective of adopting a management procedure (MP) in 2021. The Panel agreed that the so-called metarule reflected in the Chair's 2020 proposal for a northern albacore exceptional circumstances protocol, should form a good basis for further work. The Panel requested the Chair explain the next steps and timing necessary to finalize a protocol at the November 2021 Commission meeting. In response, the Chair's proposal was as follows:

- Panel 2 should send material to the Albacore Species Group in June for their review. To this end, the Chair would revise, based on input received to-date, the draft exceptional circumstances protocol included in Appendix 8 of the Report of the Intersessional Meeting of Panel 2 in 2020. The draft protocol includes the list of indicators for determining exceptional circumstances and metarules, such as a decision tree to guide Commission action in the event exceptional circumstances are triggered.

- The Chair will provide a timeline for revising this document and circulating it to Panel 2 members for review before sending it to the SCRS Albacore Species Group in June.

The SCRS representative stressed that once those indicators are agreed, the SCRS would have to examine in much greater detail what can or should transpire in the event that exceptional circumstances are triggered. This would require a great deal of coordination between the SCRS and Panel 2. The Panel agreed that this should occur.

In a related matter, the Panel noted that exceptional circumstances need not be finalized and incorporated into an MP before it could be adopted by the Commission by November. They noted that in the event it was not possible to complete the protocol for the exceptional circumstances, it was their view that the MP could be adopted, if that was the decision of Panel 2 and the Commission. The Chair noted that, given his experience with southern bluefin tuna, it would be prudent to try to agree to the exceptional circumstance protocol when the MP is adopted, but it was not required. The Panel added that they thought it should be possible to have adopted an exceptional circumstances protocol in time for the Commission but did not rule out adopting an MP without this protocol having been agreed.

***Brief overview of BFT MSE work***

The Rapporteur for western Atlantic bluefin tuna presented a "Brief Update of the Bluefin MSE process". He outlined sets of key milestones for future MSE work in 2021 and 2022 as follows:

2021 Key Milestones:

- To adopt a reference grid of operating models;

- To implement a plausibility weighting scheme for the grid;

- Initiate an independent peer review of the MSE code;

- To refine a set of index and model-based candidate management procedures (CMP) under development from six individual developer teams;

- The operating models will also be 'reconditioned' - a process which will bring them up to a terminal year of 2019 and will incorporate the most recent index improvements which will occur as part of the bluefin tuna workplan;

- Selection of a limited number CMPs to be presented to the Commission (Panel 2);

- Dialogue Meeting with Panel 2 in the 2021 Commission meeting. The primary purpose of these initial CMPs will be to illustrate the process, elucidate the inherent management trade-offs, gauge the acceptability of CMPs and be provided with recommendations for their further refinement.

2022 Key Milestones:

- During 2022, further dialogue with Panel 2 will be critical to refining these initial CMPs to best achieve acceptability across the various trade-offs;

- Develop guidance on developing exceptional circumstances provisions (to be finalized by the end of 2023) and associated management responses (assuming that the CMP could be adopted without the exceptional circumstances having been agreed to);

- SCRS continues to refine (improve) CMPs;

- Presentation of CMPs (no more than 3) to Commission at the 2022 annual meeting for potential adoption of one of these for 2023 TAC advice.

The Panel Chair commented that there were differences in the steps applied for MSE in bluefin tuna vs. albacore. It was noted that there was an urgent need for an updated dialogue to clarify the adequacy of candidate MP as well as the adequacy of the existing management objectives. The principal concern was why the existing CMPs did not consider the status quo procedure (or some approximation of it). Secondly, they inquired about how the "adequacy" of a given MP would be defined. In response, the SCRS Officer concurred that dialogue was essential, but that it would be most useful once the Group had made some progress. With respect to the definition of adequacy, this would be determined in terms of a set of performance metrics. He noted that while the status quo MP (i.e. single stock, single area models) would not be evaluated, management advice would be provided for the eastern and western stock individually.

The Panel did not necessarily agree that the dialogue should occur only after good progress on BFT MSE was made. Managers needed to be consulted on the suitability of MPs in case there were problems with the proposed CMPs that could compel the SCRS to substantially revise their work. The SCRS was open to that dialogue but inquired how such a dialogue could be fit into the tight calendar between now and the Commission. The hope was that there would be a chance to discuss the BFT MSE at the dialogue meeting before the Commission. The Chair noted that the SCRS would need to provide several CMPs in order to allow managers to choose an MP. The Panel reiterated that spatial interactions and differences in the population size would make it particularly challenging and that having a contingency plan to implement the *status quo* management procedure should any CMP fail, or if the process itself fails to generate agreement on OMs or CMPs would be prudent. It was noted that, in fact, regular assessments were planned in 2021 for W-BFT and in 2022 for E-BFT. The Panel concurred that more interactions between BFT MSE scientists and the Commission managers would be beneficial noting that unlike albacore, bluefin tuna would involve changing the existing paradigm from essentially single stock single-area management practice to a multi-area, mixed stock paradigm. The Panel inquired further what the intention of the November BFT MSE meeting was, noting that all CPCs would be aware that this was their opportunity to provide feedback to the SCRS about the BFT MSE. The Chair clarified that the meeting would be held as a Panel 2 meeting focusing on BFT MSE.

The Panel requested that the SCRS provide CMPs that are independent for each stock, i.e., separate management areas. The SCRS responded that indeed management advice would be provided in CMPs for each separate area but that the stocks would be linked biologically in the operating models. The SCRS also further noted that there would be the opportunity to have further dialogue in 2022 and explore improvements to existing CMPs.

During the 2nd Intersessional Meeting of Panel 2 (13-15 September 2021) the SCRS Chair provided a presentation A Brief SCRS Update on BFT Management Strategy Evaluation (MSE) and Workplan, focusing on the calendar for 2021 and 2022. Despite some delays, the plan to provide the expected outputs for 2022 and 2023 was on good track.

A Panel 2 BFT MSE meeting to be held in November 2021 should enable policy discussion, including on implementation of management procedure, operational management objectives, statistics, dialogue between scientists and managers, and expected progress in 2022. A separated MSE Ambassador Program was proposed with informative purposes, with a two-hour session in each official ICCAT language. The Panel 2 supported engaging stakeholders and scientists in the process.

Panel 2 also requested the SCRS to produce and circulate in consultation with the Secretariat an invitation to the Ambassador Program Sessions, specifying the details including the timing and content. It was agreed that: (i) the Ambassador Program Sessions shall be limited to accredited members and observers of ICCAT, but the number of delegates per CPC will not be limited; (ii) interventions are based on individuals rather than CPCs as this is for information sharing and not for any decision-making; and (iii) recording of the session will be conducted.

In 2022, it was expected to increase involvement of stakeholders and communication. Three intersessional meetings were proposed. The adoption of a management procedure by the Commission was expected in the 2022 annual meeting to provide advice on the level of TACs in 2023 and thereafter.

## 15. Discussions at the Intersessional Meeting of Panel 4 relevant to the SCRS

The SCRS Vice Chair informed the SCRS on the discussions and decisions taken during the Intersessional Meeting of Panel 4 (held online from 6-8 July 2021). The text below is consistent with the Panel 4 intersessional meeting discussions, with the report available here.

***Circle hooks***

At the request of the UK for the SCRS to provide clarification regarding the use of circle hooks in relation to catches of shortfin mako sharks, the Vice Chair of the SCRS gave a presentation on the effects of circle hooks on targeted species and desirable and unwanted bycatch. It was highlighted that these updates were recently presented at the 2021 Subcommittee on Ecosystems and Bycatch (SC-ECO) meeting. Overall, the Vice Chair highlighted the SC-ECO recommendations that state, to increase the effectiveness of sea turtle mitigation measures, circle hooks should be used in shallow longline sets and, that call for "continued analysis of the efficacy of circle hfexceptionooks and the trade-offs across species in using them".

In discussions of terminal gear modifications, the Vice Chair noted that under the auspices of the Billfish Species Group, a technical subgroup was created to address the request by the Commission detailed in Rec. 19-05 paragraph 21. This subgroup provided feedback to the SCRS Billfish Species Group during the September meeting, on both modifications to terminal gear and fishing practices. This feedback proposed study designs and recommendations pursuant to paragraph 21 of Rec. 19-05 (see item 21.16 in this report).

***Northern swordfish (N-SWO) MSE process***

The Vice Chair of the SCRS gave a presentation on the progress and status of the N-SWO Management Strategy Evaluation (MSE). The Vice Chair described the current Operating Model (OM), which uses specifications similar to the 2017 assessment model. The revised OM grid contains 216 OMs and covers a broad range of variables related to different management objectives. Panel 4 was provided with a website (https://iccat.github.io/nswo-mse/) that contains links to trial specifications documents, Candidate Management Procedures (CMP), and other important details for the N-SWO MSE. The Vice Chair also described the various performance metrics with the MSE.

As regards the exceptional circumstances, the Vice Chair highlighted that the MSE roadmap indicates in 2021 that the SWGSM/PA4 is supposed to recommend a draft EC protocol for N-SWO. However, considering the present efforts from PA2 and the Albacore Species Group to develop an EC Protocol for northern albacore, and the preference for consistency in EC decision rules, where appropriate, the Swordfish Species Group recommended a delay in the development of a N-SWO EC Protocol until PA2 and the Albacore Species Group have completed that process and the outcomes can be considered in the context of the swordfish MSE. Panel 4 did not express any concerns with this approach.

Other items were presented by the SCRS Vice Chair requesting inputs from the Commission, related with what should be the percentage probabilities of achieving each candidate management objective (i.e., define percentages in Rec. 19-14), the time periods over which to calculate performance metrics, and the period of the advice intervals. The Vice Chair also requested feedback on whether the interim limit reference (LRP) should be maintained at $0.4*B_{MSY}$, according to ICCAT Rec. 17-02. Feedback on numerous points were provided and the Panel agreed it would be useful to organize a dialogue between the Commission and the SCRS in 2022. Regarding the probability for achieving the PMs, it was suggested that both 50% and 60% for stock status were sensible given previous plans, a less than 5-10% probability for being below $B_{LIM}$ for safety, and a 15-25% maximum change in TAC related with stability. It was also suggested that, given the lifespan of the species, both short and medium options (corresponding to 1-10 and 11-30 years, respectively) should be considered for the time frame to calculate the PMs.

Finally, the Panel requested if the SCRS could provide advice on a catch limit of swordfish for 2022, as the current TAC expires in 2021.

***Ecosystem Report Cards***

The Co-convener of the Subcommittee on Ecosystems and Bycatch (SC-ECO) presented information on the possible use of the Ecosystem Report Card, including some examples to highlight the various components that would be of particular interest to fisheries managers. The future challenges of the Ecosystem Report Card were discussed, including the need for feedback, support, and specialized expertise. It was particularly highlighted the importance of continued dialogue with Panel 4.

## 16. Discussions at the Intersessional Meeting of IMM relevant to the SCRS

SCRS Vice Chair informed the SCRS on the discussions and decisions taken during the 14th Intersessional Meeting of the Working Group on Integrated Monitoring Measures (IMM) (held online from 14-17 June 2021). The text below is consistent with the Report of the 14th Intersessional Meeting of the IMM that is available here.

***Minimum standards for Electronic Monitoring Systems***

The SCRS Vice Chair presented the progress of the SCRS work regarding Electronic Monitoring Systems (EMS). He described the status of EMS trials and previous work completed in purse seine fisheries. Recommendations with regards to minimum standards for purse seine fleets wishing to voluntarily implement EMS are mentioned in the *Report for Biennial Period 2016-2017, Part I (2016), Vol. 2* and the *Report for Biennial Period 2016-2017, Part II (2017)*. With regards to longline fisheries the Vice Chair reported that the SCRS does have at this stage recommendations for minimum standards, and on the creation of an SCRS subgroup within the Billfish Species Group, aiming: 1) collecting and analyzing past studies comparing data products from observers and EMS; 2) beginning to describe the status of knowledge on EMS; 3) identifying possible knowledge gaps and the need for additional experimental trials; and 4) reviewing the draft EMS guidelines produced by the IMM when needed.
This subgroup provided feedback to the September 2021 SCRS Billfish Species Group, on the state of knowledge for these topics, next steps and recommendations, including a response to the Commission pursuant to paragraph 20 of Rec. 19-05 (see item 21.15 in this report).

There was broad support to establish a working group on EMS given its highly technical nature. However, given the identified delays in EMS trials by CPCs, it was agreed to defer the question of establishing an EMS working group to the 2021 Commission meeting.

***Reporting form for lost and abandoned gear (Rec. 19-11)***

The PWG Chair discussed ongoing dialogue between some CPCs and the Secretariat on the development of reporting forms related to lost and abandoned gear. The Secretariat noted that currently existing one (CP 51) covers lost/abandoned and the other (CP 52) covers found gear. The Secretariat has not yet received any completed forms from CPCs.

## 17. Progress related to work developed on MSE

Since the September 2020, the SCRS has further developed substantial work on the ongoing ICCAT MSE processes. Additional details are provided below (items 17.1 to 17.5).

### *17.1 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. This HCR imposes an $F_{TARGET}=0.8*F_{MSY}$, a $B_{THRESHOLD}=B_{MSY}$, a $B_{LIM}=0.4B_{MSY}$ and an $F_{MIN}=0.1F_{MSY}$ (see **ALB-Figure 12** of the Northern Albacore Executive Summary, item 9 of the *Report for Biennial Period 2018-2019, Part II (2019), Vol. 2*), with a maximum TAC of 50,000 t and a maximum TAC change of 20% when $B_{CURR}>B_{THRESHOLD}$. Recommendation 17-04 also requested that the SCRS pursue an independent peer review during 2018, to develop criteria for the identification of exceptional circumstances, to test several variants of the interim HCR with the aim to adopt a long-term management procedure (MP) in 2020, and to produce a single consolidated report on the albacore MSE process.

Since 2018, the peer review requested in Rec. 17-04 has been conducted, the recommendations by the peer reviewer have been addressed and the single consolidated report has been produced and updated. The variants of the interim HCR have also been tested and their merits described in the Executive Summary.

In view of adopting a long-term MP, the Committee has specified the elements of the current stock assessment approach, that could be used to specify the MP to be adopted.

In 2021, the Committee provided input on the exceptional circumstances protocol that Panel 2 is developing and suggested some refinements of the indicators proposed last year. Since the final indictors have not been adopted, the Committee made no determinations regarding the existence of exceptional circumstances; however, no concerns were noted based on the current definition of catch and CPUE indicators.

In addition, the ALB Species Group is developing a new reference case that will form the basis for a new benchmark stock assessment and the basis of OMs developments using a different model platform from the one based on the 2013 stock assessment.

### *17.2 Work conducted for bluefin tuna*

The ICCAT Bluefin Tuna Species Group has made substantial progress on MSE throughout 3 intersessional meetings, and several informal meetings. The MSE Consultant contracted by ICCAT GBYP under the supervision of the BFT Technical Subgroup on MSE (partially funded by ICCAT GBYP) has worked extensively on the updates of the Operating Models (OMs) and comparisons of Candidate Management Procedures (CMPs), following the recommendations made at online meetings in December 2020, April and September 2021.

After all intersessional work, the Committee adopted the reference set of OMs with the set of Robustness test OMs. At the April meeting, the Committee decided to recondition the OMs to reflect catch and index data through 2019. The reconditioned OMs were reviewed and accepted at the September meeting. The reference grid of OMs contains 4 factors: Recruitment (3 levels), Spawning fraction/Natural mortality rate for both stocks (2 levels), Scale (4 levels), and Length composition weighting in likelihood (2 levels). The Group also adopted the plausibility weights for OMs. The MSE Code review has been conducted by the expert contracted by ICCAT GBYP, and indicated that ICCAT can be confident about the validity of implementation of the main code components. The Trial Specification Document (TSD) for BFT OMs is now relatively complete, and Shiny App to review the OMs has been well-developed (https://apps.bluematterscience.com/ABTMSE/).

The Committee also has been discussing Candidate Management Procedures (CMPs) results, performance measures, and the process to condense CMPs into a reduced subset. The list of indices for potential inclusion in CMPs was updated, and it was decided to include the revised GBYP aerial survey index. Many CMPs (8 types, 5 tunings, 32 CMPs total) have been improved and the Group have reviewed the comparisons of CMP results with some key performance measures. The progress and key documentation related to the BFT MSE can be reviewed on the website (https://iccat.github.io/abft-mse/). Finally, to enhance a dialogue with the Commission, a MSE Communications Team was established, and the materials for both informal and formal dialogue with Panel 2 are in preparation.

*Discussion*

The Western BFT Rapporteur provided an overview of progress made for the MSE and plans for future MSE activities (outlined in item 17.2). The Committee commended the hard work of the many people involved in moving the BFT MSE forward. It was noted that much of the movement dynamics in the Operating Models were based on electronic tags but that there were relatively few fish tagged in the Mediterranean Sea. In addition, it was noted that both the performance of MPs and how each MP is constructed also mattered. The GBYP Coordinator responded that all tagged fish were now sampled for stock of origin. The Rapporteur further noted that, in response to the concerns raised in Panel 2, they would provide information about each CMP. Specific details and mathematical specifications for each CMP in consideration are provided as Appendix 5 to the Second BFT Species Group meeting held in September (Anon., 2021f). An additional question arose about the Ambassador Programme, specifically asking if there were dates available. In response to the latter question, the Secretariat responded that the workshops would be held between 13 and 15 October 2021 and that an official circular would be distributed soon.

### *17.3 Work conducted for northern swordfish*

Work on North Atlantic swordfish MSE started in 2018. ICCAT awarded a contract for operating model and management procedure development to an expert team. In 2019 a new contract was awarded to a different contractor and most of the work in 2019 was devoted to conditioning the Operating Model (OM). The Committee agreed to use the Base Case stock synthesis assessment from 2017 to set up the initial OM design

based on a factorial design (i.e. grid) to develop scenarios that represent the main uncertainties identified. This grid was constructed and provided following the MSE workshops/courses organized by ICCAT in 2018, that resulted in a paper presented to the SCRS (Rosa *et al.*, 2018a). The current OMs are composed of an uncertainty grid of 288 Stock Synthesis III (SS3) models with alternative assumptions including a range of assumed values for natural mortality, variance in recruitment deviations, and steepness of the stock-recruitment relationship, and other assumptions such as degree of observation error in the indices of abundance. For 2020, the ICCAT MSE roadmap requested completing the work on conditioning the OM and start the development of candidate management procedures (CMPs). The same contractor from 2019 was awarded the 2020 contract to continue this work. Much of the work conducted in 2020 has been related to exploration and validation of the OM grid of models and the development of a framework with examples of development of CMPs. In 2020, besides having some time dedicated to MSE issues at the SWO intersessional meeting, an additional 2-day online meeting (4-5 June 2020) was scheduled to further discuss in more detail issues related with the OM grid of models and start the development of CMP. There was additional discussion on robustness OMs, advice and assessment intervals, and development of criteria for identifying exceptional circumstances. The report of that N-SWO MSE dedicated meeting is published (Anon., 2020a).

In 2021, the contractor continued the work in collaboration with the Committee and most of the discussions and developments were regarding development of the performance metrics, finalizing the OM grid, and evaluating the relative importance of the uncertainties to the selection of the CMPs. A potential issue with the size composition data used in OM conditioning was identified, which is currently being investigated by the Secretariat. Results from preliminary evaluation of CMPs suggest that the three levels of natural mortality and steepness are most consequential for the performance of the CMPs. Finally, in 2021 the MSE code was externally peer-reviewed. For 2022, the workplan is to continue the work, mostly to continue CMP development, as defined in the ICCAT MSE roadmap. Preliminary results would be presented to the Commission at an intersessional meeting of Standing Working Group on Dialogue between Fisheries Scientists and Managers (SWGSM) or Panel 4 (if one takes place in 2022) and more complete results at the Commission meeting in later 2022.

### *17.4 Work conducted for tropical tunas*

The Commission's priority schedule for MSE, required a slow-down in the progress of MSE for tropical tunas (TRO MSE), however, limited activities continued in 2021. Following the recommendations of the Committee, the Tropical Tunas MSE is made of two MSE programmes, developing in parallel: the multi-stocks MSE for the BET, YFT and E-SKJ tuna species and the Western-SKJ MSE. The Committee have made progress on MSE by supporting the work of MSE Consultants contracted by ICCAT and throughout three intersessional meetings, one specific for the TRO MSE (Anon., 2021c) and two intersessional meetings of the Tropical Tunas Species Groups (in April (Anon., 2021h) and July 2021 (Anon., 2021i)). Progress focused on updates of the Operating Models (OMs), identification of the major axes of uncertainty, and definitions of performance metrics.

During the Tropical Tunas MSE meeting in March priority was given to the development of OMs for W-SKJ MSE by defining ToRs and funding requirements for the W-SKJ MSE. The Committee recommended the expansion of the OM of the W-SKJ MSE to include all fisheries in the western Atlantic area. The Committee agreed on an initial set of major sources of uncertainty to be considered for the definition of grid(s) of uncertainty for the multi-stocks and the W-SKJ MSEs. Based on the experiences of other ICCAT MSE programmes, the Committee made recommendations on a list of performance metrics, diagnostics, and graphical display of MSE results that can be applied for both tropical tunas MSE programmes.

The Committee updated the MSE road map delineating a workplan schedule that includes meetings with the Commission and in particular with Panel 1 to advance in the definitions of TRO MSE objectives, performance indicators, protocols of exceptional circumstances, and overall schedule for implementation. The scheduled 2022 SKJ stock assessment will update biological and fisheries information for the conditioning of the OMs in each of the TRO MSE programmes.

The Committee agreed that capacity building for MSE should be a priority for the SCRS. The Committee supported the Brazil MSE training courses funded by JCAP-2. The courses targeting scientists took place in August 2021, with the participation of 49 scientists from 14 countries.

*Discussion*

The Rapporteur provided a summary of MSE work on western skipjack. The Committee inquired how the species group would consider the planned skipjack assessment into the close-loop simulations that they had so far undertaken. The Rapporteur noted that that the Tropical Tunas Species Group would update the operating models according to the results gained of the assessment.

The Committee further inquired about how climate change and other ecosystem aspects would be considered for this MSE, and more broadly, noted that guidance is needed on how such dynamics would be considered for the SCRS in general. In response, the Rapporteur noted that broader guidance would be useful but for this specific application, primarily on Brazilian fisheries, that the group working on the project had seen evidence for some productivity changes, and these were the basis for the climate scenarios considered.

### *17.5 Review of the Roadmap for the ICCAT MSE processes adopted by the Commission in 2019*

In 2019 during the Annual Meeting of the Commission, a new roadmap for ICCAT MSE processes was adopted and a request was made to the SCRS to review it. In 2020 the SCRS discussed and reviewed the document during the SCRS Process and Protocol Meeting, and changes were incorporated. Additional reviews were made more recently by the Bluefin Tuna, Albacore, Swordfish and Tropical Tunas Species Groups. The updated version of the MSE roadmap is available in **Appendix 15**.

## 18. Update of the stock assessment software catalogue

The Secretariat has maintained the ICCAT software catalogue and the GitHub site. In 2021, a new tool page for "ss3diags" has been added in the GitHub to support stock assessments.

## 19. Consideration of plans for future activities

### *19.1 Annual workplans and research programmes*

*19.1.1 Subcommittee on Ecosystems and Bycatch workplan and research plan*

*Pertaining to Ecosystems Report Card Development:*

Consistent with the ongoing exercise of developing an Ecosystem report card, the Committee drafted the following workplan. **Table 19.1.1.1** defines the specific tasks to be completed by the Ecosystem report card working groups prior to the 2022 Subcommittee on Ecosystems and Bycatch meeting.

**Table 19.1.1.1** Tasks to be completed by the Ecosystem report card working groups prior to the 2022 Meeting Subcommittee on Ecosystems and Bycatch.

| Date | Component | Task | Who |
|---|---|---|---|
| May 2021 to April 2022 | | Update prototype report card components with new indicators. | |
| | Retained Species: Assessed | Update $B_{RATIO}$ and/or $F_{RATIO}$ values from recent assessments and deal with F0.1 issue. | Committee participants |
| | Retained Species: Not assessed | Perform PSA for select retained unassessed species. | Committee participants |
| | Non-Retained Sharks | Increase the scope of the data used in the analysis. Include other gear types. | Committee participants |
| | Turtles | Perform risk assessment for loggerhead and leatherback turtles and indicator development. | Committee participants |
| | Seabirds | Create indicator based on the total interactions, total mortality, or alternatives. | Committee participants |
| | Mammals | Discuss collaborations with IWC and ICES. | Committee participants |
| | Food web and trophic relationships | 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 |
| | Habitat | Create indicators to monitor climate-induced and fishing-induced habitat changes in ICCAT species. | Committee participants |
| | Socio economic | Develop a process to extract the socio-economic data. | Committee participants<br>Bycatch Coordinator |
| | Fishing Pressure | Develop an indicator based on fishing effort or capacity.<br>Develop indicator based on marine debris. | Committee participants<br>Secretariat |
| | Environmental Pressure | Develop indicators that are generic. | Committee participants |
| | Case Studies | Extend DIPSIR approach to more components in the NW Atlantic Ocean (i.e., Habitat, Environmental Pressures, Fishing Pressure).<br>Tropical Ecoregion case study (test EAFM tools including Ecosystem Overview Report, Ecosystem Risk assessment, Ecosystem models). | Committee participants |

*Pertaining to the work on the quasi-quantitative risk assessment approach:*

The Committee recommended that work continue on developing the "Fletcher risk management approach" in order to facilitate the prioritization of species for management when implementing the ecosystem-based approach to fisheries management. The development of this tool may include: 1) incorporating information on the distribution of other species with potential interactions with tunas and tuna fisheries, in particular crustaceans, cephalopods, ctenophores, seabirds, marine turtles, and marine mammals; 2) improving a rank criteria on stock status of species, taking into account, but not limited to, the CITES, Bonn Convention, IUCN Red Lists, and assessment results; and 3) repeating the analysis with updated inputs, and identification of the gaps and priority areas in the current management. This update will be reviewed at the 2022 Meeting of the Subcommittee on Ecosystems and Bycatch.

*Pertaining to the work of the subgroup:*

The Committee recommended that a subgroup perform intersessional work as outlined in the ToRs provided in Appendix 5 of the meeting report. Additionally, it was recommended to clarify whether the term EBFM or EAFM best describes the work of the Subcommittee. The terms EBFM and EAFM are used interchangeably by Subcommittee participants whereas new ICCAT treaty text (ANNEX 6.2 to the *Report for Biennial Period 2018-2019, Part II (2019), Vol. 1*) uses EAFM. These terms may have different meanings in some countries, and leads to confusion when they are used interchangeably. Consequently, the subgroup will review how this terminology is being used, clarify the definition of EAFM and EBFM at the 2022 meeting, and agree on which will be used by the Committee.

Also, given there are many examples of the use of environmental data both within and outside the SCRS, it was recommended that these be identified and considered for use in the Ecosystem report card and to facilitate collaborative work with the Species Groups and external institutions as outlined in **Table 19.1.1.2**.

**Table 19.1.1.2.** Summary of meetings and tasks for the subgroup working to improve the reporting of the impact of ICCAT fisheries on the ecosystem and clarifying the definitions of EAFM and EBFM:

| ***Date*** | ***Component*** | ***Task*** | ***Who*** |
|---|---|---|---|
| July 2021, 3 days | Subgroup | Set the work and divide tasks | Convenor:<br>Participants: |
| October 2021, 2 days | Subgroup | Present work and discuss progress | |

*Pertaining to the Workshop on Ecoregion Development:*

The Committee developed ToRs for a workshop to be held in 2022 with the objective of exploring how to define ecoregions within the ICCAT Convention area. The ToRs are provided in Appendix 6 of the Report of the 2021 Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch (Anon., 2021n). In preparation for that workshop, the following timelines were established as laid out in **Table 19.1.1.3**.

**Table 19.1.1.3.** Timelines for the workshop on ecoregion development.

| *Date* | *Component* | *Task* | *Who* |
|---|---|---|---|
| December 2021, 2 days | Data preparatory meeting | Identify and review data sources that will be used to develop ecoregions. | Subcommittee participants |
| March 2022, 4 days | Workshop | Develop ecoregions (see ToRs) | Subcommittee participants |

*Pertaining to other ecosystem items:*

The Committee recommended that the ecosystem convenor respond to the Panel 4 request to provide an overview of the Ecosystem report card. Additionally, it was recommended that the Subcommittee Co-convenors, in cooperation with the SCRS Chair and Vice Chair, draft revisions to the EBFM components of the SCRS strategic workplan that will be discussed and adopted in 2022. **Table 19.1.1.4** defines the tasking and timeline for providing the document for Panel 4 and for contributing to the SCRS Strategic Plan.

**Table 19.1.1.4** Timelines and tasking for preparation of Panel 4 report.

| ***Date*** | ***Component*** | ***Task*** | ***Who*** |
|---|---|---|---|
| June 2021 | Panel 4 request | Submit document and presentation to Panel 4 | Subcommittee and Ecosystem Convenor |
| July 2021 | Panel 4 request | Present work on the Ecosystem report card | Ecosystem Convenor |
| May 2021 – June 2022 | SCRS Strategic workplan | Review and update components related to EBFM and Bycatch | Bycatch and ecosystem Convenors |
| June 2022, 5 days | 2022 Ecosystem Meeting | | |

*Pertaining to bycatch:*

- Continue the collaborative work on marine turtles' bycatch, in order to respond to the Commission on the impact of ICCAT fisheries on sea turtles, by having a face-to-face meeting in 2021 or the beginning of 2022 and present a final document at the 2022 Meeting of the Subcommittee on Ecosystems and Bycatch.

- Revise the list of bycatch species that are found in the ICCAT database, in conjunction with the Secretariat and national scientists for the purposes of validating those species for ultimate use in research and reports (e.g. ecosystem components).

- Advance the research and analysis on bycatch mitigation techniques, assessing the gaps, potential study designs, and the validation of these insofar as inter and intra-taxa effects.
- Advance the secondary objectives of the collaborative work on sea turtles.

- Explore the use of scientific reference points as a tool for assessing and managing ICCAT fisheries with respect to bycatch species.

- Investigate available information on hotspots and/or areas with high Bycatch per Unit Effort (BPUE) to aid in the management of ICCAT fisheries with respect to bycatch species.

*19.1.2 Subcommittee on Statistics workplan*

The following tasks represent continuous database improvements and maintenance that will continue during 2021 and beyond. The priority tasks (including the ones postponed in 2019/2020) for 2021/2022 include:

- 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 tagging database redesign, including the addition of the model structure for electronic tagging;
- 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 (currently only the Vessel registry database is under this migration process).

*19.1.3 Albacore workplan*

The Mediterranean and South and North Atlantic albacore stocks were assessed in 2021, 2020 and 2020, respectively. Between 2018 and 2021 advice was provided for adoption of a long-term Management Procedure for North Atlantic albacore.

The main objectives for 2022 are to build a new reference case for the North Atlantic stock assessment, evaluate exceptional circumstances for this stock, and to continue research activities for all the stocks, as well as to revise and integrate the three research proposals into a single reference document. One intersessional meeting is envisaged (5 days, scheduled within April to July).

***North Atlantic stock proposed workplan***

a) Exceptional circumstances:

- Prepare T1 dataset and carry over provisions including 2020. *Responsibility:* Secretariat. *Deadline:* one month before the meeting.

- Update (up to 2020) the following yearly standardized CPUEs, in weight (if possible). *Deadline:* one month before the meeting. *Deliverable:* SCRS documents, following the standards provided by the WGSAM. *Responsibility:* CPCs.

    - Japanese longline (single area)
    - Chinese Taipei longline (single area)
    - US longline
    - Venezuela longline
    - Spanish baitboat

- Determine whether Exceptional circumstances occur, according to the indicators developed. *Responsibility:* EU-Spain. *Deadline:* one week before the Intersessional meeting. *Deliverable:* SCRS document.

b) Stock Synthesis reference case:

- Update (using data up to 2020) the following quarterly standardized CPUEs. *Deadline:* 6 weeks before the meeting. *Deliverable:* SCRS documents, following the standards provided by the Working Group on Stock Assessment Methods (WGSAM). Responsibility: CPCs.

    - Japanese longline (3 periods, 2 areas (North and South of 30ºN))
    - Chinese Taipei longline (3 periods, 2 areas (North and South of 30ºN))
    - US longline
    - Venezuela longline
    - Spanish baitboat

- According to the fleet structure agreed in 2021, the Secretariat will prepare SS inputs. *Deadline:* 4 weeks before the meeting. *Deliverable:* SS inputs. *Responsibility:* Secretariat + modelers team + MSE contractor + Chair and other interested participants. Input data and preliminary results will be made available to the group in advance of the meeting.

- SS models will be fit to the data, and models evaluated using diagnostics proposed by WGSAM. Key sensitivities will be identified in order to inform the decision by the working group to select a reference case as well as main sensitivities, following the MSE Roadmap. The 2013 reference case as well as the MSE uncertainty grid will be taken as a reference. *Deadline:* one week before the intersessional meeting. *Deliverable:* SCRS Document. *Responsibility:* MSE contractor.

c) Research:

- The Committee reiterated the need for a comprehensive Albacore Research Programme (see **Addendum 1** to Albacore workplan). For 2022, the priority is to continue the reproductive biology (including aging of analyzed individuals, using spines) and electronic tagging studies. *Deadline:* one week before the Species Group meeting. *Deliverable:* SCRS documents. *Responsibility:* V. Ortiz de Zarate (reproductive study) and H. Arrizabalaga (e-tagging study).

***South Atlantic stock proposed workplan***

The Committee stressed the need to start incorporating research activities for this stock into the Albacore Research Programme (see **Addendum 2** to Albacore workplan). Consistent with the North Atlantic Albacore Workplan, the priority for 2022 is to consolidate activities on reproductive biology (including aging of analyzed individuals, using spines) and start electronic tagging. *Deadline:* one week before the Species Group meeting. *Deliverable:* SCRS documents. *Responsibility:* Brazil, Uruguay, South Africa, Chinese Taipei.

***Mediterranean albacore stock proposed workplan***

In 2022, 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 2022 are, first 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 second, 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;

3. Design seascape indicators for key oceanographic processes 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.

***Addendum 1 to the Albacore Workplan***

**North Atlantic Albacore tuna Research Programme**

The Albacore Species Group proposes to pursue a coordinated, comprehensive four-year research programme on North Atlantic albacore to advance knowledge of this stock and be able to provide more accurate scientific advice to the Commission. This plan is based on the plan initially presented in 2010, which was based on a document by Ortiz de Zárate (published in 2011) that has been revised according to new knowledge, reconsidering the new priorities and reducing the total cost.

The research plan will be to focus on three main research areas: biology and ecology, monitoring stock status and management strategy evaluation, over a four-year period (2021-2024).

***Biology and ecology***

The estimation of comprehensive biological parameters is considered a priority as part of the process of evaluating North Atlantic albacore stock capacity for rebounding from limit reference points. Additional biological knowledge would help to establish priors for the intrinsic rate of increase of the population, as well as the steepness of the stock recruitment relationship, which would facilitate the assessment. Among the key biological parameters are those related to the reproductive capacity of the North Atlantic albacore stock, which include sex-specific maturity schedules (L50) and egg production (size/age related fecundity). In order to estimate comprehensive biological parameters related to the reproductive capacity of the North Atlantic albacore stock, an enhanced collection of sex-specific gonad samples needs to be implemented throughout the fishing area where known and potential spawning areas have been generally identified. The collection of samples needs to be pursued by national scientists from those fleets known to fish in the identified areas and willing to collaborate in the collection of samples for the analysis. Potential CPCs that could collaborate with the sampling programme may include (but not limited to): Chinese Taipei, Japan, USA and Venezuela. Expected results will include a comprehensive definition of sex-specific maturity development for albacore, spatial and temporal spawning grounds for northern albacore, estimate of L50 and size/age related fecundity.

The Committee also recommended further studies on the effect of environmental variables on CPUE trends of surface fisheries. The understanding of the relationship between albacore horizontal and vertical distribution with the environment will help disentangle abundance signals from anomalies in the availability of albacore to surface fleets in the Northeast Atlantic.

It is also proposed to conduct an electronic tagging experiment to investigate the spatial and vertical distribution of albacore throughout the year. Given the typically high cost of these experiments, and the difficulties tagging albacore with electronic tags, it is proposed to deploy 50 small size pop-up tags in different parts of the Atlantic where albacore are available to surface fisheries (to guarantee good condition and improve survival), namely the Sargasso Sea and off Guianas, off USA/Canada, Azores-Madeira-Canary Islands, and the Northeast Atlantic. Internal archival tags will also be considered for multiyear tracks.

Finally, the existence of potential subpopulations in the North Atlantic has been largely discussed in the literature. While recent genetic studies suggest genetic homogeneity (Laconcha *et al.* 2015), otolith chemistry analyses (Fraile *et al.,* 2016) suggested the potential existence of different contingents, which could also have important management implications. Thus, in order to clarify the existence of potential contingents, the Committee proposes expanding the area studied in Fraile *et al.,* 2016 to the entire North Atlantic, as well as to address inter-annual variability through multiyear sampling and analysis of otolith chemistry.

***Monitoring of stock status***

The Committee recommended that the joint analysis of operational catch and effort data from multiple fleets be undertaken, following the example of other SCRS Species Groups. This would provide a more consistent view of population trends, compared to partial views offered by different fleets operating in different areas. The analysis is suggested for both longline fleets operating in the central and western Atlantic, and surface fleets operating in the Northeast Atlantic. However, this task has lower priority since the iteration of the Management Procedure requests using individual indices.

Finally, given the limitations of the available fishery dependent indicators, the Committee mentioned the need to investigate fishery independent abundance indices. Although the Committee is aware that, in the case of albacore, there are not many options to develop such fishery independent indices of abundance, it is proposed to conduct a feasibility test using acoustics during baitboat fishery operations to improve the currently available indices. A fine scale analysis for surface fisheries catch of albacore recruits (Age 1) is suggested to analyze the feasibility of designing some transect-based approach for a recruitment index.

***Management Strategy Evaluation***

The Committee recommends that further elaboration of the MSE framework be developed for albacore, considering the recommendations by the 2018 external review, the Working Group on Stock Assessment Methods and the Albacore Species Groups, as well as the guidance of the Commission and the Joint t-RFMO

MSE Group initiative. Now that an HCR is in place and advice for adopting a long-term MP has been provided, the Committee realizes that the OMs were conditioned with data up until 2011, so it is time to start working towards reconditioning them using more recent data. The Committee decided to start working towards a Stock Synthesis based reference case and use this as a basis to reconditioning the OMs after reconsidering the axes of uncertainty. The process to adopt a new grid of OMs and reference tests will take several years. Once this is achieved, it is important to improve observation error models (e.g. by considering the statistical properties of CPUE residuals in future projections) and to test alternative management procedures (e.g. empirical harvest control rules, alternative stock assessment models such as Jabba or Delay Difference models).

The total requested funds to develop this research programme was estimated to be €942,000, with €600,000 to cover priority 1 tasks. The research programme will be an opportunity to join efforts from an international multidisciplinary group of scientists currently involved in specific topics and fisheries.

***Budget***

| ***Research aim*** | ***Priority*** | *Approximate 4-year cost (€)* |
|---|---|---|
| **Biology and Ecology** | | |
| Reproductive biology<br>(spawning area, season, maturity, fecundity) | 1 | 100,000 |
| Environmental influence on<br>NE Atlantic surface CPUE | 2 | 20,000 |
| Distribution throughout the Atlantic (e-tags) | 1 | 350,000 |
| Population structure: contingents | 3 | 100,000 |
| **Monitoring stock status** | | |
| Joint Atlantic longline CPUE | 3 | 30,000 |
| Joint NE Atlantic surface CPUE | 3 | 12,000 |
| Feasibility of fisheries independent survey | 3 | 180,000 |
| **Management Strategy Evaluation** | | |
| Development of MSE framework | 1 | 150,000 |
| | **Total** | **942,000** |

***Timeline***

| ***Research aim*** | *2021* | *2022* | *2023* | *2024* |
|---|---|---|---|---|
| **Biology and Ecology** | | | | |
| Reproductive biology (spawning area, season, maturity, fecundity) | x | x | x | |
| Environmental influence on NE Atlantic surface CPUE | x | x | | |
| Distribution throughout the Atlantic (e-tags) | x | x | x | x |
| Population structure: contingents | x | x | x | x |
| **Monitoring stock status** | | | | |
| Joint Atlantic longline CPUE | x | x | | |
| Joint NE Atlantic surface CPUE | x | x | | |
| Feasibility of fisheries independent survey | | x | x | x |
| **Management Strategy Evaluation** | | | | |
| Operating models: | | | | |
| - Stock Synthesis based reference case | x | x | x | |
| - New OM reference grid and robustness tests | | x | x | x |
| Observation error: | | | | |
| - Project CPUEs with error structures | | | x | |
| Management Procedures: | | | | |
| - JABBA, Delay difference, empirical | | | x | x |
| Communication: | | | | |
| - Determine additional minimum standards for performance metrics (currently only prob(Green)>0.6) | x | x | x | x |

***Addendum 2 to the Albacore Workplan***

**South Atlantic albacore tuna research programme**

***Background information***

Despite South Atlantic albacore being an important resource to fleets from several countries, it is perhaps one of the tuna stocks within ICCAT that has the least information available on its bio-ecology parameters and more data deficiencies for monitoring stock status, even if this information is essential for management measures. Thus, this proposal's main objective is to improve the current knowledge on the bio-ecology and fisheries for South Atlantic albacore, providing important information and more accurate scientific advice to the Commission.

The project proposal follows that already underway for the North Atlantic stock, so as to avoid discrepancies in scientific information between the South and North Atlantic. The research plan will be focused on two main research areas: biology and ecology, and monitoring stock status, during a four-year period (2021-2024).

***Biology/ecology and stock structure***

Important gaps in basic biological parameters such as size at first maturity, fecundity, age-growth, and others still persist for this stock, bringing considerable uncertainty to stock assessments as well as to the implementation of fisheries management and species conservation measures. Therefore, to estimate these different biological parameters a broad biological sampling programme should be implemented in different areas of the South Atlantic (east and west sides and high and low latitudes), taking into account the knowledge of potential breeding and feeding areas.

Sampling would be carried out by national scientists from the countries that actively fish the species in the South Atlantic in the different areas. Potential CPCs that could collaborate in this sampling effort would be (but not limited to): Brazil, Japan, Namibia, South Africa, Uruguay and Chinese Taipei.

Similar knowledge gaps exist with regards to the ecology of the species, particularly the effects of oceanographic conditions on the space-time distribution, migration, definition of areas and periods of reproduction and feeding, as well as the vertical habitat of albacore. This is also relevant information to better understand the availability of the species for surface (baitboat) and sub-surface (longline) fisheries and the trends in the abundance indexes.

In this case, information from fisheries (gear, catch and effort) and the environment (temperature, chlorophyll, currents, climate indices and others) would be used in the analyses to assess possible effects of climate variability on the distribution and fishing conditions of albacore in the southern Atlantic Ocean.

It is intended to implement electronic tagging experiments (pop-up archival tag/miniPAT) to evaluate and better understand the migration processes undertaken by the species between breeding (West) and feeding (East) areas (**Figure 1**) and also to determine the vertical movements, behaviour, and habitat use in the light of environmental conditions. Due to the difficulty of tagging albacore tuna and the costs of such study, miniPAT tags will be used (n=50) in two areas where baitboat fisheries can ensure the catch of fish in good conditions for tagging. One in Brazil (Rio de Janeiro), where the target species of this fishery is skipjack (W-SKJ), but it also catches a fair amount of albacore, and another in South Africa, where historically the species is caught by this fishing method.

As a complement to these tagging experiments, a preliminary investigation into the West-East connectivity of the South Atlantic albacore stock will be implemented based on analysis of parasitic communities and parasite genetics from fish sampled offshore Brazil and South Africa. Fish that undertake lengthy migrations within their life, such as tuna species, expose themselves to areas with various parasites which ultimately increases their chances of parasite transmission (Lester and MacKenzie, 2009). Parasites can be used as biological tags. The idea is that fish can only become infected with a particular parasite if the fish moves into the endemic area of that parasite (Lester and MacKenzie, 2009). Thus, to the extent that there are behavioral differences between stocks with respect to distribution and migration, parasites can be used to assign stock as they are evidence of migration history. Parasites have been considered as biotags for bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*T. albacares*) in Indonesian waters (Lestari *et al.,* 2017).

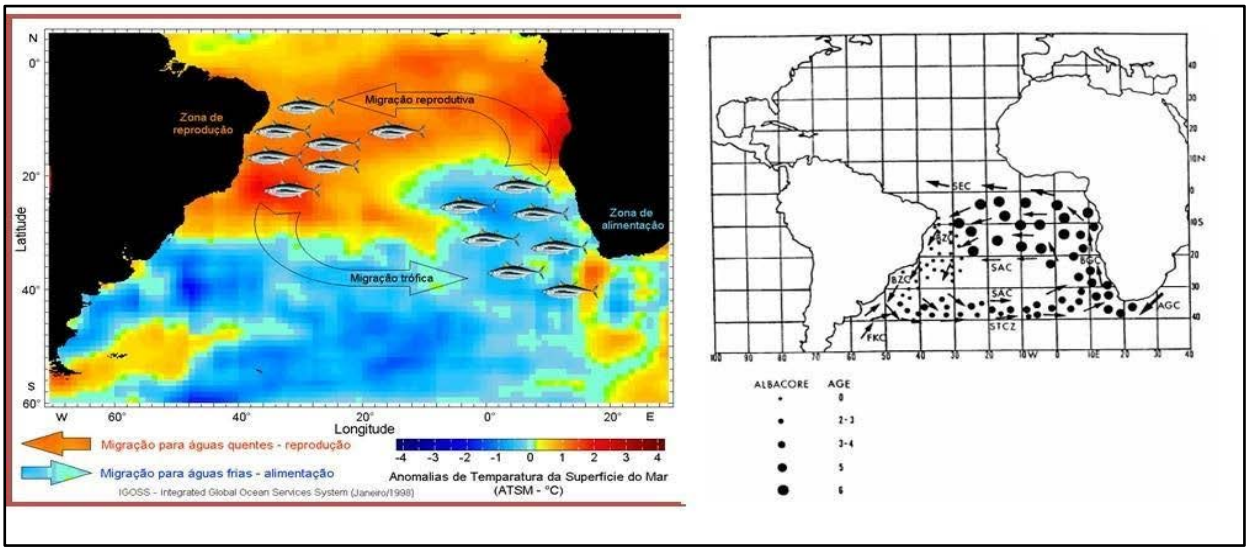



**Figure 1**. Representative scheme of albacore West-East connectivity in the southern Atlantic Ocean through migratory processes (Travassos, 1999a, 1999b) and the spatial distribution of catches by age (Coimbra, 1999).

***Monitoring of stock status***

To improve methods of evaluating status of the South Atlantic albacore stock, the Committee intends to perform a joint analysis of catch and effort of different fleets, generating joint standardized series of abundance indexes following work already accomplished by other Species Groups. This analysis should be considered both for longline fleets operating in different regions in the South Atlantic (e.g. Brazil, Japan, Uruguay and Chinese Taipei) and for surface fleets (baitboat) operating in the Southeast Atlantic (e.g. Namibia, South Africa).

***Budget***

The total requested funds to develop this research plan are €605,000, with €450,000 to cover priority 1 tasks. The research programme will be an opportunity for international collaboration between CPC scientists with multidisciplinary expertise and experience in specific topics and fisheries.

| ***Research aim*** | ***Priority Tasks*** | ***Approximate 4-year cost (€)*** |
|---|---|---|
| **Biology / ecology and stock structure** | | |
| Reproductive biology (spawning area, season, maturity, fecundity) | 1 | 100,000 |
| Age-growth | 3 | 50,000 |
| Environmental influence on CPUE | 4 | 30,000 |
| Migration / vertical movements (e-tags) | 1 | 350,000 |
| Analysis of parasitic communities (biotag) and parasite genetics | 3 | 30,000 |
| **Monitoring stock status** | | |
| Joint South Atlantic longline CPUE | 2 | 30,000 |
| Joint South Atlantic surface CPUE | 2 | 15,000 |
| | **Total** | **605,000** |

***Timeline***

| *Research aim* | *Year 1* | *Year 2* | *Year 3* | *Year 4* |
|---|---|---|---|---|
| **Biology / ecology and stock structure** | | | | |
| Reproductive biology (spawning area, season, maturity, fecundity) | X | X | X | |
| Age-growth | X | X | | |
| Environmental influence on CPUE | X | X | | |
| Migration / vertical movements (e-tags) | X | X | X | |
| Analysis of parasitic communities (biotag) and parasite genetics | X | X | X | |
| **Monitoring stock status** | | | | |
| Joint South Atlantic longline CPUE | X | X | | |
| Joint South Atlantic surface CPUE | X | X | | |
| **Availability of information and results** | | | **X** | **X** |

*19.1.4 Billfish workplan*

***Sailfish stock assessment***

Noting that the last stock assessment for East and West sailfish (Anon., 2017a) were conducted in 2016 with catch data until 2014 and given that catches of both sailfish stocks have increased since the implementation of Rec. 16-11 para 1(a) (that limits catch levels SAI-E 1,270 and SAI-W 1,030 t), the Committee recommends that the next sailfish stock assessment be scheduled for 2022/23. The Committee noted that catches of sailfish stocks in 2017 (1,648 SAI-E and 1,245 SAI-W), 2018 (935 SAI-E and 1,519 SAI-W), 2019 (2,015 SAI-E and 1,361 SAI-W) had surpassed in most cases the catch limits of Rec. 16-11. In 2020 available catches, albeit still incomplete are estimated to be 1,182 SAI-E and 1,152 SAI-W, thereby exceeding the catch limit for the SAI-W.

To complete the planned stock assessment of sailfish, the Committee will need to conduct two meetings:

a) An intersessional Data Preparatory meeting in July 2022 (5 days) to collate and analyze all the existing information required for stock assessment, using data through 2021 (assuming online meeting);

b) A Stock Assessment session in about February-March 2023 (5 days), using data through 2021.

Work related to the Stock Assessment:

a) Review sailfish stock structure
b) Identify and select CPUE indices through 2021
c) Advance in the use of a combined CPUE index
d) Review and update sex-specific length data through 2021
e) Review and update Fleet composition
f) Update biological parameters for use in the Stock Assessment
g) Review models to be used for stock status
h) Diagnostics and validation of stock assessment model(s)

***Catch (Task 1), Catch and Effort, and Size Data (Task 2)***

Important white marlin catches occur in the tropical and subtropical central Atlantic by both CPC and non-CPC fisheries, mainly in the Caribbean Sea and off West Africa. Catch and effort statistics for billfish species remain incomplete for many of the coastal and industrial fishing countries. Therefore, all countries catching billfishes (directed or bycatch) should report species-specific catches, catch and effort, and size information by as small area as possible, and by month.

- The Committee suggested the Secretariat work with the experts hired to review the billfishes artisanal fisheries in the eastern Atlantic and Caribbean regions to develop the Terms of Reference, agenda and list of participants to be invited to workshops for developing CPCs to improve the collection, analysis and the transmission of data in order to improve data collection and statistics of billfish. The first of these workshops shall be organized in 2022 in the West Africa region and in the Caribbean for 2023. In addition, it was recommended to engage Western Central Atlantic Fishery Commission (WECAFC) in this process, particularly to address the issues raised in Rec. 19-05, para 16.

- Efforts should be made by all CPC fishing in the Mediterranean Sea to improve the collection of catch data of billfishes in this region.

***Discards***

The Committee noted that to date only a few countries have ever reported billfish discards and using such limited information the estimates of dead discards are around 2-3%. Having the total catches, including dead and live discards, and estimates of post-release mortality is important for stock assessment purposes. As such, the Group emphasized the need for all CPCs to comply with the mandatory requirements to report discards (both dead and alive) for billfishes. The Committee supports the recommendation made in 2020 by the Subcommittee on Ecosystems on discards and endorses the participation of this Group if the workshops take place in 2022.

In response to Rec. 19-05, paragraph 20, in collaboration with other SCRS Species Groups, continue the work to develop minimum standards for electronic monitoring of ICCAT fisheries as a supplement to the human observer programme.

***CPUE***

- *Sports fisheries CPUEs*: Conduct the work to collect and incorporate any data which informs on the historical evolution of fishing practices which could affect catchability. There may still be issues related with increasing catchability in sports fisheries over time that are not fully taken into account in the CPUE standardization.

- *Joint CPUE*: Noting the joint CPUEs for longline fleets which use fine scale operational data have improve the assessment models for other species, investigate the possibility for doing these analyses for billfishes together with other SCRS species and SCRS Species Groups.

- *Compare observer and logbook data CPUEs indices*: National scientists are encouraged to develop both observed data and logbook CPUEs indices within their fleets.

***Life history parameters***

Continue the sampling of hard part for the growth studies on billfish caught off West Africa:

- Organize an in-person workshop in 2022 on age reading of billfish to enhance current expertise in the eastern Atlantic and to standardize processing and reading protocols between laboratories.

- Continue the research and biological sampling of blue marlin from the Gulf of Mexico Mexican longline fisheries.

*19.1.5 Bluefin tuna workplan for 2022*

The Bluefin Species Group (BFT SG) gives priority to the MSE process but also recommends focused research efforts from specified technical subgroups (TSG). The Committee recommends conducting an eastern and Mediterranean data preparatory meeting in 2022 and continuing the work of the technical subgroups to refine new model approaches. The Committee recommends that the next stock assessment be postponed to 2023. This was a carefully measured decision by the Committee, based on workload in what is likely to remain a virtual meeting environment for much of 2022 and the need to be able to focus on the MSE. This will give the modelling subgroup the necessary time to develop and test new modelling approaches and to allow for the Committee to more adequately evaluate the models.

These TSGs will be tasked with addressing specific issues outlined under (3, below) and possibly funded through specific calls for tenders. The TSG will present scientific papers on the subjects to the 2022 BFT SG meetings.

Given the priority placed upon the MSE process and aiming for an eastern assessment in 2023, the Committee recommends two meetings for MSE and an E-BFT data preparatory meeting. The BFT SG intends to complete the MSE, incorporating feedback from the Commission through repeated dialogue with Panel 2.

The BFT SG workplan is described in more detail in Appendix 9 to the Report of the Second 2021 Intersessional Meeting of the Bluefin Tuna Species Group (Anon., 2021f).

**The workplan for 2022 is as follows:**

1. Hold three meetings: number of days for the meetings will depend on the format, online vs in-person.

    a) 1st MSE intersessional meeting (4 days) in about April;

    b) E-BFT data preparatory meeting in May (5 days) with data until 2021;

    c) 2nd MSE intersessional meeting (5 days) in about September.

2. Work and dialogue related to MSE

    a) CMP developers continue work to refine CMPs. BFT TSG MSE and BFT SG continue MSE work.

    b) Dialogue with Panel 2:

        1) Panel 2 November-December 2021 (present MSE update and CMP/indicators)

        2) Panel 2 March 2022 (present update on CMP results)

        3) Panel 2 May-June 2022 (present update on CMP results)

        4) Panel 2 October/November 2022 (present update on CMP results)

3. Task technical subgroups. The purpose of the TSGs 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 TSG will be tasked with the following topics:

    a) BFT Technical Subgroup on Abundance Indices. Consider revisions to trap indices and possible inclusion of other indices.

    b) BFT Technical Subgroup on Assessment Models: Research to develop alternative assessment models for E-BFT such as: Stock Synthesis and Age-Structured Assessment Program (ASAP).

    c) BFT Technical Subgroup on Growth in Farms. To continue with the studies to identify growth rates in weight and size during the fattening period. The study of growth from different methodological approaches should be combined to address a definitive estimate of farm growth by 2022.

4. Responses to the Commission work

Continue the analysis to estimate catch rates, defined as nominal CPUE per vessel size category and main gear type (national scientists and Secretariat staff).

5. In addition to the aforementioned SCRS meetings, other workshops organized directly by GBYP will require the involvement of BFT SG.

    1. Technical workshop for the design and evaluation of the feasibility of a biological sampling scheme for the implementation of the CKMR approach to the Atlantic BFT eastern stock

    2. Workshop on BFT electronic tagging, focused on the development and joint use of a global ICCAT e-tagging database

    3. Workshop on the coordination and standardization of BFT larval surveys and potential development of larval basin scale indices

    4. Workshop on coordination of BFT biological sampling at international level

*19.1.6 Sharks workplan for 2022*

Given that the last stock assessment for blue shark (Anon., 2016) was held in 2015, in preparation for the planned stock assessment of blue shark in 2023, the Group will conduct the following activities:

- Hold a 7-day long Data Preparatory (DP) meeting[3] (in July) to collate and analyze all the existing information required for stock assessment, using data through 2021.

- Hold a 10-day Stock Assessment session in first half of 2023, using data through 2021.

The following tasks will be required:

- Define the modeling and CPUE series analytical teams (well before the DP meeting);

- Identify appropriate CPUE indices for use in blue shark stock assessment model (for DP meeting);

- CPCs provide CPUE series going through 2021 for the DP meeting;

- If possible, CPCs provide sex-specific length-composition information going through 2021 for the assessment. CPCs should use SCRS data catalogue to identify size-data gaps (for the DP meeting);

- 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 (for DP meeting);

- Continue to gather and analyze available size information for blue shark (BSH) by sex and region (for DP meeting);

- Identify fleets based on spatial/selectivity considerations (for DP meeting);

- Review any new life history information for BSH in the Atlantic (for DP meeting);

- After the 2021 data become available, they should be prepared in the format needed for the assessment (after the DP meeting but before the assessment meeting);

- Consider, together with the Working Group on Stock Assessment Methods, alternative stock assessment methods (as per Kell, 2021, other SCRS papers, and the fisheries literature);

- Consider the use of conventional mark-recapture (possibly sex-specific) data for the 2023 assessment;

- Review of the SRDCP activities and progress;

[3] The online meeting may be broken into 2 sessions with a few days between these.

- Continue and/or expand participation in the Subgroup on Technical Gear Changes from the Billfishes Species Group in order to participate in the tasks assigned to it (see Anon., 2021o);

- Continue and/or expand participation in the Subgroup on Electronic Monitoring Systems from the Billfishes Species Group in order to participate in the tasks assigned to it (Anon., 2021p);

*19.1.7 Small tunas workplan 2021-2023*

This workplan foresees both short and long-term objectives (see specific timeframes below).

*Progress on the biological studies of small tunas:*

- *Background/objectives:* The SMTYP started in 2016-2017 with the initial aim of recovering small tunas 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 (FADURPE) was established to continue these studies. The programme is ongoing and currently covers different activities related to biological studies.
- *Priority:* High (1st priority with financial implication).
- *Leader/Participation*: In 2021, 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.

*Conventional tagging, recovery and awareness activities:*

- *Background/objectives:* Following the AOTTP tagging activities and results of the SMTYP from 2018 to 2021, the Committee recognized the importance of increasing conventional tagging, recovery and awareness campaigns aimed at artisanal fisheries, and the support for further conventional tagging of wahoo in the Canary Islands and little tunny in the Gulf of Cadiz and the Alboran Sea (Portugal and Spain). The latter correspond to the areas where AOTTP did not promote tagging campaigns of these species. This would complete the information provided by the programme (growth, reproduction and stock structure) in order to define stock boundaries for those species.
- *Priority:* High (2nd highest priority with financial implication).
- *Leader/Participation*: EU-Spain and EU-Portugal, with collaboration of CPCs willing to participate.
- *Timeframe*: A SCRS paper or presentation will be presented during the next Species Group meeting.

*Revision of small tunas L/W relationships at stock level:*

- *Background/objectives*: There are several L/W equations available for small tunas at local level, and several more are currently being developed by various CPCs/national scientists. The Committee recommends that joint analyses are carried out using detailed data collected by observer, so that L/W relations that are representative of the stocks at regional level can be presented and adopted by ICCAT.
- *Priority*: High.
- *Leader/Participation*: EU-Spain, with collaboration of CPCs willing to participate/share L/W data from observer and sampling programmes. EU-Spain and Portugal, Morocco and Brazil have already committed to participate. Other CPCs are expected to join this collaborative effort.
- *Timeframe*: The leader (Pedro Pascual, EU-Spain) will soon circulate a data template and CPCs are invited to submit individual observations of length (cm, SFL) and weight (g, total weight) data on this template by January 2022. A SCRS paper will be presented to the next meeting of the Group in 2022.

*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 2022. 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: Pedro G. Lino and Rubén Muñoz-Lechuga (EU-Portugal).
- *Timeframe*: A SCRS paper will be presented annually to the Species Groups or intersessional meeting.

*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 2022 the Group will develop the specific ToRs and an agenda for a proposed workshop on data-limited models before the 2022 intersessional meeting.
- *Priority:* Medium (2nd 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 workshop in Data-Limited models could be held immediately after (back-to-back) the 2022 Intersessional Meeting of the Small Tunas Species Group, which would allow for reduction of travel related costs. This workshop should be updated in 2024, also in the format back-to-back with the 2024 Intersessional Meeting of the Small Tunas Species Group. SCRS papers are to be presented annually to Species Group meetings or intersessional meeting.

*Calibration and adopting internationally agreed maturity scales:*

- *Background/objectives*: During 2020 ICCAT Workshop on Small Tunas Biology Studies for Growth and Reproduction, studies on small tunas 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 solandrii, Auxis rochei, A. thazard*.
- *Priority:* Low (3rd 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 in 2023. Also, SCRS papers are to be presented annually to Species Group meetings or at intersessional meetings.

*19.1.8 Swordfish workplan*

**North and South Atlantic**

Assessments for North and South Atlantic swordfish were conducted in 2017 (Anon., 2017b). The next assessment is tentatively scheduled for 2022. The Committee requests to conduct two Species Group meetings in 2022: a data preparatory meeting (5-days in person) that will include a MSE component (4 days in-person, the MSE component would occur the week immediately before or after the data preparatory component) and a session for stock assessments (5 days in-person). In addition, the MSE technical team will continue to work intersessionally online to advance the technical work. The meetings (data-preparatory and stock assessment session) will be dedicated mainly to the Atlantic (North and South stocks)

assessments, but an agenda item on MSE will be included to advance the MSE work. Within the data-preparatory meeting, some time will be allocated to updates on the progress of the swordfish biological and stock structure projects. A third meeting of a more technical nature is requested and will be dedicated mainly to discussion and progress on the MSE work.

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.

A list of recommended work for the Swordfish Species Group was identified as high priority areas where continued efforts are required for North and South Atlantic swordfish. The list is organized in such a way that priorities for 2022 work are listed first, followed by other tasks that are part of other ongoing work.

***Priorities for completion in 2022***

*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 2022.
- *Timeframe:* Started in 2018 and is currently ongoing; request for funds to continue throughout 2022 (see Table in Recommendations section 7 of this report for detailed estimated costs).

*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 will be circulated by 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. Deadline for the next stock assessment (2022). An ICCAT paper is planned to be presented with the results at the 2022 swordfish data preparatory meeting.

*Update the North Atlantic combined CPUE index:*

- *Background/objectives:* Previous North Atlantic SWO assessments have used a combined CPUE index using operational data provided by several CPCs (Spain, Canada, Japan, USA, Portugal and Morocco). Specifically, previous stock assessments from 2006, 2008, 2012 used this index in the production models used to develop scientific advice, while in the last assessment (2017) it was used in production models for continuity runs, as well as verification with the SS3 model used for advice. This index is also planned to be used in the ongoing MSE work.
- *Priority:* High Priority.
- *Leader/Participation:* A combined index should be developed through a scientific collaboration among scientists from the following CPCs (Spain, Canada, Japan, USA, Portugal and Morocco) with support from the Secretariat. The N-SWO Rapporteur will coordinate the participation of the various contributors.

- *Timeframe:* Data should be submitted in early 2022, so that a preliminary analysis can be carried out, shown and discussed at the data preparatory meeting. The terminal year should be further discussed and agreed at the September Species Group meeting.

*Larval index work*:

- *Background/objectives:* An initial swordfish larval index was presented in the swordfish data preparatory meeting for the North Atlantic, in the last stock assessment in 2017 (Anon., 2017b). And in the 2021 intersessional meeting work was presented on a larval index for the Mediterranean (Tugores *et al*., 2021). The Committee recognized the value of adding fishery-independent indexes to the stock assessment, but there were still concerns about the surveyed area and sample sizes (n). Therefore, the Committee recommended including this work in the swordfish workplan to determine if those issues can be solved and this or other fishery independent indices can be improved and used in the future.
- *Priority:* High priority.
- *Leader/Participation:* Led by the United States for the North Atlantic and by EU.Spain for the Mediterranean.
- *Timeframe:* Should be completed for the next stock assessment (2022), if possible. ICCAT papers should be presented at the swordfish data preparatory meeting in 2022.

*Improvements on input data to the South Atlantic assessment*:

- *Background/objectives:* Given the uncertainties with regards to CPUE inclusion in the assessment models noted in the previous South Atlantic assessment, the Committee strongly encourages national scientists to progress on CPUE development. Additionally, other data (e.g. sizes, biology) that can improve the assessment should also be provided.
- *Priority:* High priority.
- *Leader/Participation:* CPC scientist and stock assessment modellers.
- *Timeframe:* In 2022, for the next South Atlantic swordfish stock assessment.

*Complete N&S-Atlantic stock assessment processes*:

- *Background/objectives:* Assessments for North and South Atlantic swordfish are tentatively scheduled for 2022. If possible, the Committee should take into account emerging work on stock structure, growth and maturity and environmental effects, as well as historical life history parameters.
- *Priority:* High priority.
- *Leader/Participation:* CPCs and stock assessment modellers.
- *Timeframe:* Data for the stock assessments will be reviewed at the data preparatory meeting, as well as a discussion on the assessment models. The final analysis will be presented, discussed and agreed at the stock assessment session.

*Estimate swordfish discards, including dead discards and live releases:*

- *Background/objectives:* The Committee continues to note that there is a general lack of reported discard data by most CPCs, which is important to inform the stock assessment and ongoing MSE work. As such, the Committee encourages national scientists to use their domestic observer programmes information to estimate discards, including dead discards and live releases, if possible. The estimations should go back in time as much as possible, and the estimation methods should be presented to the Committee.
- *Priority:* High priority.
- *Leader/Participation:* National scientists.
- *Timeframe:* To be presented in time for the next stock assessment, at the data preparatory meeting.

*Priorities related with 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 during 2019, 2020, and 2021. 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.
- *Priority:* High priority.
- *Leader/Participation:* MSE contractor; core MSE technical team.
- *Timeframe:* Ongoing (see ICCAT MSE roadmap).

*Work to be completed until the end of 2021:*

- Resolve potential historical size composition data issues.
- Continue analysis on CPUE and length comp data weightings.
- Continue work on analyses related to minimum size limits and discarding estimation.
- Conduct OM validation and "red-face" tests.
- Propose candidate performance metrics to PA4.
- Continue development of an exceptional circumstances protocol.
- Developer will respond to reviewer´s concerns.
- Discuss the process for CMP tuning.
- Continue development of CMPs.

*Work to be completed during 2022:*

- Participate in the general ICCAT MSE process review.
- Update data and CPUEs to 2020 (or 2021) and re-condition OM grid.
- Continue refining cMPs and propose to PA4.
- Continue work on performance metrics and exceptional circumstances in collaboration with PA4.

***Priorities for ongoing work (ongoing past 2022)***

*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 USA, with the participation of CPCs with PSAT data.
- *Timeframe:* Started in 2018, ongoing to date; to continue in 2021.

*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 USA 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 before the next stock assessment.
- *Priority:* High priority.

- *Leader/Participation:* Lead by USA, with participation of other CPCs.
- *Timeframe:* Ongoing, to be considered at the next stock assessment.

*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. 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:* High priority.
- *Leader/Participation:* Antonio Di Natale and Fulvio Garibaldi will coordinate, with participation of national scientists willing to collect and collaborate with these data.
- *Timeframe:* To be developed in 2021-2022, and be completed by 2023. A progress paper should be presented to the SWO species group intersessional meeting in 2022, and the final paper in 2023.

***Activities pertaining to the 2017 External Assessment Reviewer (specific work for progressing MSE for N-Atlantic SWO and other activities to take in consideration in the next stock assessment)***

*MSE work:*

- *Background/objectives:* MSE needs to be able to incorporate AMO effect and spatial distribution and changing catchability in the operating model. From this, it seems feasible to test whether a simple combined CPUE could be an accurate indicator of stock trends. MSE could either take a detailed and technical approach (e.g. spatial and oceanographic effects on the CPUE indices and subsequent effect on the assessment), or it could take a management-oriented approach to investigate possible changes in the HCR. While both goals could be done at the same time, it might be better to tackle these as different projects in order to have high stakeholders engagement in the HCR project. With regards to the management-oriented approach which has been requested by the ICCAT Commission, the work started in 2018 with an initial development of an MSE framework. A new contract (new contractor) was awarded in 2019, and the work continued mostly to develop the framework for the conditioning of the Operating Model. The work carried out in 2021 is mostly to finalize the conditioning of the Operating Model and start testing alternative management procedures. The reviewer noted that the full and detailed documentation of the MSE framework and a Trial Specifications document should be produced. This document has been completed.
- *Priority:* High priority.
- *Leader/Participation:* A Contractor started this work in 2018. A new contract (different contractor) was awarded in 2019, which continued this work in 2020 and 2021, and will continue during 2022.
- *Timeframe:* Process started in 2018. Funds requested to continue in 2022, taking into account the ICCAT Commission schedule regarding swordfish MSE work (see ICCAT MSE roadmap and Recommendations section for estimated costs).

*Clear presentation on CPUEs:*

- *Background/objectives:* The reviewer encouraged more explicit, clear presentation and comparison of CPUE trends by fleet and area and season. Outliers need to be identified and potentially down-weighted in combined indices and assessments. The Committee notes documentation developed by the WGSAM on CPUE analysis best practices (Forrestal *et al*., 2019).
- *Priority:* High priority.
- *Leader/Participation:* All CPCs that present CPUE series for the next assessment.
- *Timeframe:* Next stock assessment.

*Sensitivity analysis for catches/discards:*

- *Background/objectives:* Conduct sensitivity analysis with estimated total catch, including plausible degree of discard/retained catch ratio changing over time.

- *Priority:* High priority.
- *Leader/Participation:* Stock assessment modellers and scientists involved in the assessment.
- *Timeframe:* Next stock assessment.

**Mediterranean**

For the Mediterranean stock, the last assessment was conducted in 2020 (Anon., 2020b). The next assessment should take place not before 2024 but, in order to monitor stock trends, essential fisheries indicators (e.g. catch, indices of abundance), should be reviewed in 2022.

Given the above needs and taking into account the questions raised during the latest assessment a workplan should be developed aiming to:

- Review relevant fisheries and biological data.
- Update estimates of standardized CPUE indexes for the most important fisheries.
- Obtain estimates of discard misreporting.

Additionally, the Committee should develop a workplan aiming to better identify the effects of the environment on swordfish biology, ecology and fisheries. Future CPUE analyses should evaluate the benefits of taking into account important 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.

- *Time-frame:* by the next stock assessment (2024).
- *Priority:* Medium.
- *Participation*: all CPs.

*19.1.9 Tropical tunas workplan for 2022*

**Stock assessment schedule**

The Committee proposed holding an assessment for skipjack in 2022.

The Group proposed that the assessment of the western and eastern stocks of Atlantic skipjack tuna attempts to use stock synthesis models. Changing assessment platforms from production models to stock synthesis requires additional work and, hence the Committee recommended that the stock assessment process include a data preparatory meeting, an assessment meeting and significant intersessional work to prepare the inputs and model structure for stock synthesis. The Group also agreed that these meetings can be conducted earlier than usual in the year and recommended that 2020 be used as the terminal year.

The Group recommended that an external expert be contracted to review the 2022 skipjack stock assessment process and that this expert participates in both the data preparatory and the assessment meetings.

Noting the importance of relative abundance indices in stock assessment, the Committee recommended that various relative abundance indices be prepared for the 2022 skipjack stock assessment meeting:

- A PS CPUE index, that should provide additional information on the components of FOB fishing effort (including number of FAD deployments, operational FOB buoys, FOB fishing sets) and the relationship between these components.
- A PS acoustic buoy index.
- BB CPUE indices for western and eastern Atlantic BB fisheries. The Group noted that some of BB CPUE indices have been prepared in the past by the Secretariat and encouraged national scientists to provide BB CPUE indices for the 2022 skipjack stock assessment.
- A larval index for the Gulf of Mexico.

In spite of noting that the relative contribution of longline fisheries to SKJ catches is generally low, the Committee encourages national scientists from CPCs with significant SKJ catches, to estimate relative abundance indices from CPUE data.

The Committee also recommended that alternative CPUE standardization methods are explored, in particular for purse seine and baitboat CPUE indices.

Length-weight conversion factors are an important component of the development of basic stock assessment catch inputs. The Committee therefore recommended that length-weight conversion factors be reviewed and updated by national scientists in collaboration with the Secretariat prior to the skipjack stock assessment meeting.

The Committee noted the importance of having guidance on fleet structure and recommended that a table of landings of skipjack per fleet be prepared by the Secretariat. The Committee also recommended that decisions on fleet structure for the Stock Synthesis model to be used in the stock assessment be consistent with the fleet structure previously used for YFT and BET.

The Committee noted that various tasks should be conducted with data from the AOTTP tagging programme, including:

- Investigating differences in growth rates among skipjack stocks and areas by updating of analyses already conducted with AOTTP tag recovery data;
- Evaluating movement rates between regions using AOTTP tag recovery data;
- Updating the tag capture/recapture matrix;
- Evaluating the usefulness of analyzing SKJ spines collected in the frame of the AOTTP programme to provide additional information on SKJ ageing. The Committee recommended that this last task be conducted before the end of 2021 so that the data can be ready before the 2022 SKJ data preparatory meeting.

**2022 Research programme**

The highest priority for this Committee is to support the research for the stock assessment of skipjack tuna in 2022.

The second highest priority for the Committee is to continue their support for the post-AOTTP programme, including taking advantage of the data generated by the programme and enhancing their value by conducting further analyses that can support stock assessments, MSE and responses to the Commission.

The Committee will focus the 2022 Tropical Tuna MSE work on:

1. Advance in the definitions of TRO MSE management objectives and performance indicators. Further details are provided in the MSE roadmap (**Appendix 15**).

2. Continuing to make progress on the stand alone MSE for the western stock of skipjack as detailed in Huynh *et al*., 2020. Additionally, exploring the inclusion of an OM which includes catches other than from Brazil.

*Floating Object (FOB) management and fishing closures*

The Committee noted ongoing discussions at the level of the Commission and Panel 1 on the management of FOB fisheries. The Group recommended to:

(i) Explore the relationship between FOB management measures, including limitations of FOB fishing sets, number of FOB operational buoys, and number of FOB buoy / FAD deployments;
(ii) Assess the efficiency (e.g. reduction of BET and YFT juveniles catches) and the appropriateness of the FOB closures in Rec. 19-02 (i.e. duration of the closure, choice of the closure period, etc.).

Noting that that the Committee had experienced issues when attempting to address requests for the Commission, often due to imprecise terminology regarding FOB fisheries, and noting that the FAD Working Group last met in 2017, the Group recommended that the FAD Working Group be revitalized in 2022.

The Committee recommended that the relationship between catch limits and full fisheries closures be further explored.

Finally, the Committee noted that some of the submitted ST-07 forms (Task 3 – Activity of Trop support vessels authorized to operate in the ICCAT Convention area) are incomplete. More specifically, information on the 'Fishing Vessel Association' is not being include (Columns H, I, J in form ST-07). The Committee recommends that CPCs fully complete all required fields in form ST-07. Failing to do so greatly decreases the SCRS ability to complete analyses requested by the Commission.

*Other responses to the Commission*

The Committee will need to support through their research responses to the Commission on the outstanding questions identified by the Committee and detailed in the section on Commission responses of this report.

Particular attention should be paid to the significant changes seen in the preliminary reports of the landings of the three species of tropical tunas in 2020, with large decreases in the catch of BET and SKJ, and an increase in the catch of YFT, and of recent changes in average weight of fish caught by the major gears. The Committee should start evaluating the effects of Rec. 19-02 on fishery indicator for the three species, specifically to changes in fishing patterns (spatial, seasonal, FOB/Free school) in the period since Rec. 19-02 came into effect.

*19.1.10 Methods workplan (WGSAM)*

The workplan for 2022 includes the following components:

1. Evaluation of the products provided by the bycatch estimation methodology contract;

2. Development of advice and/or guidelines on bycatch estimation;

3. Report on a review of the practices for constructing the stock assessment uncertainty grid in terms of, but not limited to, grid size, parameter selection and range, hypothesis and model plausibility weighting.

### *19.2 Intersessional meetings proposed for 2022*

As a preamble to the presentation of the SCRS calendar for 2022, the Committee believes it is necessary to highlight the context in which the work has been developed.

During the last two years, the Committee has suffered the impact derived from the pandemic situation, which has introduced challenges conducting its activities and providing deliverables. In addition to this already difficult situation, there has been a substantial increase in the number of meetings and requests from the Commission. These additional demands have been generating a level of activity that strongly affects the work, particularly bearing in mind the effective number of hours during online meetings as compared to in-person meetings, the current expertise assigned by the CPCs, and the current human resources available at the Secretariat. Accordingly, the Committee is facing increasing challenges and difficulties to provide the scientific advice requested by the Commission in due time and in keeping with the high standard that has been the practice in ICCAT.

In 2021 the Committee discussed and adopted the workplans of its subsidiary bodies which were developed in consideration of the overall requests from the Commission and the needs of the different subsidiary bodies to fully address those requests. In this context, the workplans contained in item 19 of this report, are an attempt to address those scientific priorities identified individually by the SCRS subsidiary bodies while aiming to provide the scientific advice set by the Commission.

Year after year the Committee has a busy schedule of critical assessments. Based on decisions taken in recent years by the Commission and the limitations faced by the Committee, the 2022 calendar of the intersessional meetings should include the stock assessments for North and South Atlantic swordfish, East and western skipjack, eastern Atlantic and Mediterranean bluefin tuna, East and West Atlantic sailfish, and North and South Atlantic blue shark. However, the different Species Groups felt that it was not possible under the current situation, and therefore the workplans they put forward only include the assessment of Atlantic swordfish and skipjack stocks, as well as several key data preparatory meetings (swordfish, skipjack, blue shark and sailfish, each with two stocks and eastern bluefin). These workplans also include further development of five ongoing MSE processes (for northern Atlantic albacore and swordfish, for bluefin tuna, for western skipjack and a multi-stock for tropical tunas), a number of research programmes and several challenging responses to the Commission that would require substantial analytical effort by the Committee.

According to these workplans, the meetings that would be necessary to address the different issues are listed below. The number of days is based on virtual meetings. Should meetings resume in person, then the calendar (and corresponding number of days) will be reduced accordingly.

Original meetings and respective duration proposed in the SCRS subsidiary bodies workplans is provided **Table 19.2.1**.

Scheduling all the listed meetings in the 2022 calendar is absolutely impossible and undesirable and led to discussions on priorities. Different views were expressed and discussed, including the topic of whether to conduct a 2022 eastern Atlantic and Mediterranean bluefin tuna stock assessment. It was noted that conducting this assessment would require difficult trade-offs such as postponing one of the other proposed assessments and possibly slowing down progress on the BFT MSE. Accordingly, the proposed 2022 calendar provided herein does not accommodate this important assessment, neither does it include the requested data preparatory meetings for blue shark and sailfish, nor an intersessional meeting for small tunas. In order to provide the best balance of workload and the provision of scientific advice to the Commission, the Committee proposes a schedule that postpones to 2023 the stock assessments for eastern Atlantic and Mediterranean bluefin tuna, as well as those for the East and West Atlantic sailfish and North and South Atlantic blue shark.

The Committee recognizes that these choices have some trade-offs and that they may not necessarily match the Commission's expectations and views. Therefore, the Committee will be available to review the schedule based on a rank of priorities set by the Commission for 2022 related to the stock assessment and MSE schedule for 2022 and subsequent years. This process will need to be considerate of the constraints imposed on workflow and amount imposed by the pandemic, in particular the limited capacity of CPCs to provide national scientists that are capable to support the SCRS, as well as the limitations of the currently available human resources at the Secretariat.

**Table 19.2.1.** List of official ICCAT meetings requested by Working Groups on their workplans.
N.B. not all meetings could be accommodated in the calendar.

| Requested meetings | Duration (No. days) |
|---|---|
| *Subcommittee on Ecosytems and Bycatch* | |
| • Intersessional meeting of SC-ECO | 5 |
| *Subcommittee on Statistics* | |
| • SC-STATS meeting (during Species Groups' week) | 2 |
| *Albacore Species Group* | |
| • Intersessional meeting | 5 |
| • Meeting during Species Groups' week | 2 |
| *Billfish Species Group* | |
| • Data preparatory meeting for sailfish | 5 |
| • Meeting during Species Groups' week | 1 |
| *Bluefin Tuna Species Group* | |
| • Bluefin tuna MSE (SCRS: Commission) meeting | 1 |
| • Bluefin tuna MSE Technical Group meeting | 4 |
| • Eastern Atl. Bluefin tuna data preparatory meeting | 7 |
| • Bluefin tuna MSE (SCRS: Commission) meeting | 1 |
| • Bluefin tuna MSE Technical Group meeting | 7 |
| • Meeting during Species Groups' week | 2 |
| • Bluefin tuna MSE Technical Group meeting | 1 |
| *Shark Species Group* | |
| • Data preparatory meeting for Atlantic blue shark | 7 |
| • Meeting during Species Groups' week | 2 |
| *Small Tunas Species Group* | |
| • Intersessional Meeting of Small Tunas Species Group | 4 |
| • Meeting during Species Groups' week | 2 |
| *Swordfish Species Group* | |
| • Data preparatory meeting for Atlantic swordfish | 6 |
| • Swordfish MSE Technical Group meeting | 4 |
| • Atlantic swordfish stock assessment | 8 |
| • Meeting during Species Groups' week | 1 |
| *Tropical Tunas Species Group* | |
| • Data preparatory meeting for skipjack | 5 |
| • Skipjack stock assessment | 5 |
| • Tropical tunas MSE Technical Group meeting | 2 |
| • Meeting during Species Groups' week | 2 |
| *Working Group on Stock Assessment Methods* | |
| • Intersessional Meeting of WGSAM | 5 |
| *Standing Committee of Research and Statistics* | |
| • SCRS Annual meeting | 6 |
| **Total** | **102** |

## 2022 SCRS Calendar

| | MON | TUE | WED | THU | FRI | SAT | SUN | MON | TUE | WED | THU | FRI | SAT | SUN | MON | TUE | WED | THU | FRI | SAT | SUN | MON | TUE | WED | THU | FRI | SAT | SUN | MON | TUE | WED | THU | FRI | SAT | SUN | MON | TUE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **January** | | | | | | 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** | | | | | | | | | 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 | | |
| **March** | | 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 | | | | | | |
| **April** | | | | | 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 | | | | |
| **May** | | | | | | | 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 | |
| **June** | | | 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 | | | | | | |
| **July** | | | | | 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 | | |
| **August** | 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** | | | | 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 | | | | |
| **October** | | | | | | 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** | | 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 | | | | | | |
| **December** | | | | 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 | | | |

BFT MSE
COM intersessional
SWO MSE
COM intersessional
SC-ECO
COM intersessional
SKJ Stock Assessment
BFT MSE Tech. Group(*)
SCRS
On-line reporting WG
TT MSE
SHK intersessional
BFT MSE
Commission meeting
SKJ Data Preparatory
Atl-SWO Data preparatory
SWO MSE(+)
BFT MSE Tech. Group(*)
WGSAM
E-BFT Data preparatory
E-BFT DP
BFT MSE
Atl-SWO Stock Assessment
Atl-SWO SA
SCRS Species Groups(*)
SCRS Plenary

(*) Meetings of SC-STATS, ALB, BFT, BIL, SHK, SMT, SWO and TRO (+) SC STATS will be on 19 Sep 2022 Free day in ICCAT Meeting of technical nature Commision meetings/Secretariat meeting preparation/holidays

### *19.3 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 online, from 26 September to 3 October 2022 and the Species Groups meeting from 19 September to 24 September 2022.

Should the pandemic situation improve throughout 2022 and the conditions allow to return to in-person meetings with the participation of all ICCAT CPCs, the SCRS Plenary meeting will be held in Madrid (Spain).

## 20. General recommendations to the Commission

### *20.1 General recommendations to the Commission that have financial implications*

The Committee requests the Commission to provide the Secretariat with the necessary financial means to support and organize the SCRS meetings with simultaneous interpretation (i.e. interpreters, larger rooms to accommodate the associated logistics and concurrent meetings), as currently occurs in all Commission intersessional meetings. The Committee consider such funding is essential to ensure all CPCs can have equal conditions and effective engagement to the SCRS meetings. The estimated cost for online meetings amounts to €6,450 per day. In the case of in-person meeting travel and hotel cost should be added.

*20.1.1 Subcommittee on Ecosystems and Bycatch*

*Regarding the Ecosystems component:*

- The Committee requests financial assistance to support the work to complete a development of a quasi-quantitative tool for evaluating species of priority for management, by 1) incorporating species with potential interaction with tunas and tuna fisheries, including crustaceans, cephalopods, ctenophores, seabirds, marine turtles, and marine mammals. The output will be reported to the 2022 SC-ECO. After its review, this joint meeting of scientists, stakeholders and managers would be held in 2023 to review the assessment results and a way forward.

- The Committee requests financial assistance to support the attendance of five to seven CPC scientists at a collaborative workshop to discuss the relevance and the methodology used to delineate candidate ecoregions within the ICCAT Convention area to foster discussion on operationalizing the EBFM.

*Regarding the Bycatch component:*

- The Committee requested financial assistance to support the attendance of five to eight CPC scientists at a collaborative workshop to continue the evaluation of ICCAT fisheries impact on marine turtles, with the use of detailed fishery observer data. This is in support of an ongoing process that will continue over the coming years.

The table below contains the overall funding requests made by the Subcommittee for 2022:

| **Subcommittee on Ecosystems** | **2022** |
|---|---|
| **Other fisheries related studies (including data recovery, experts, etc.)** | |
| Expert to development a quasi-quantitative tool for evaluating species of priority for management | €6,000 |
| **Workshops/meetings** | |
| Collaborative workshop to discuss the relevance and the methodology used to delineate candidate ecoregions | €15,000 |
| Workshop on evaluation of impact of ICCAT fisheries on marine turtles | €15,000 |
| **TOTAL** | **€36,000** |

*20.1.2 Subcommittee on Statistics*

- The Committee recommended continued development of front-end applications for making and publishing graphically dashboards of ICCAT statistical datasets and provide the necessary financial resources for its full implementation (€6,000).

*20.1.3 Albacore*

The Committee recommends continued funding of the Albacore Research Programme for North and South Atlantic stocks, as well as to start funding the research for the Mediterranean stock. For the next three-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 2022 the Committee recommended to continue electronic tagging and reproductive biology studies (with associated aging of samples) in the North and South Atlantic, and to progress on the North Atlantic albacore MSE. These are all considered to be high priority tasks, with an estimated cost of:

  i. €40,000 for tagging (€20,000 for each stock);

  ii. €45,000 for reproductive biology and related ageing (€22,500 for each stock);

  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 N-ALB MSE work. This high priority task requires €20,000 funding for 2022.

More details of the proposed research and economic plan are provided in the 2022 Albacore Workplan (item 19.1.3 of this report).

- The Committee supports the continuation of larval data collection in the Balearic Sea and other spawning areas (e.g. central and eastern Mediterranean), and recommends further research related to the use of larval indices to complement fisheries dependent data in stock assessments, including development of larval habitat models, corrected abundance indices and their impact in the assessment. This is considered a secondary priority task, with an estimated cost of €33,000 for 2022.

| **Albacore** | 2022 (€) | 2023 (€) | 2024 (€) |
|---|---|---|---|
| **Tagging, rewards and awareness** | 40,000* | 40,000 | **20,000**** |
| **Biological studies:** | | | |
| Reproduction | 35,000* | 25,000 | |
| Age and growth | 10,000* | | |
| **Sample collection and shipping** | 5,000* | 5,000 | |
| **Other fisheries related studies (including data recovery, etc.)** | | | |
| Mediterranean ALB larval index related studies | 33,000 | 33,000 | |
| **Workshops/meetings** | | | |
| **Equipment** | | | |
| **MSE** | 20,000 | 30,000 | 30,000 |
| **TOTAL** | **143,000** | **133,000** | **50,000** |

* Funds to be evenly split between North/South stocks. In case of budget reduction, the southern stock has priority.

** Funds only for the southern Atlantic stock.

*20.1.4 Billfish*

The highest priorities for 2022 are to support the objectives established by the billfish workplan and those of the Enhanced Programme for Billfish Research (EPBR), that have been delayed or kept on hold due to the COVID-19 issue:

- Continue the growth study of the three priority billfish species in the eastern Atlantic;
- Initiate/continue reproduction study of blue marlin in the Gulf of Mexico;
- To fund a Workshop on small scale fisheries (artisanal) in the West Africa region. The objective is collecting detailed information describing their fishery (ies) and sampling programmes, aiming to improve the collection and submission of billfish fisheries data in these regions (€25,000);
- Technical workshop on age reading in 2022 to standardize protocols, start the aging reference set and reading guidelines (€25,000), and a second workshop in 2023 that should focus on building a reference set for both spines and otoliths (€25,000).

Breakdown of the requested billfishes estimated budget for the period 2022 and 2023.

| **Billfishes** | **2022** | **2023** |
|---|---|---|
| **Tagging, rewards and awareness** | | |
| **Biological studies:** | | |
| Reproduction | | |
| Age and growth | 15,000 | 15,000 |
| Genetic (WHM/RSP kits) | 5,000 | 5,000 |
| Other (identify) | | |
| Other fisheries related studies (including data recovery and collection of fisheries statistics in the field in West Africa) | 10,000 | 10,000 |
| **Sample collection and shipping** | 10,000 | 10,000 |
| **Consumables** | 5,000 | 5,000 |
| **Workshops/meetings** | | |
| Workshop on data collection and reporting on artisanal fisheries in the West of Africa in 2022 and in the western Atlantic in 2023 | 25,000 | 25,000 |
| Technical workshop for age reading | 25,000 | 25,000 |
| Stock assessment 2023 reviewer | | 10,000 |
| **Total** | **95,000** | **105,000** |

*20.1.5 Bluefin tuna*

Should funding for the essential work of the GBYP be reduced in the future, the SCRS would recommend that alternative funding arrangements such as research set-asides be considered by the Commission. The Committee looks forward to working with the Commission to develop creative solutions should the need arise.

For 2022 the Committee recommends the Commission:

- Continued funding to support the essential work of GBYP including funding of tagging and reward (€280,000), biological studies (€160,000), sample collection and shipping (€100,000), other fisheries related studies (e.g. fisheries independent indices: €400,000), workshops (€80,000), MSE development process (€160,000), and the coordination (€320,000):

- Three meetings devoted to MSE refinement and dialogue with Panel 2 (coordinated by the GBYP)
- Three meetings of the Bluefin Tuna Species Group (2 MSE meetings and E-BFT data preparatory meeting)
- Support for the specified sub-group (SG) on E-BFT modelling (the request would be for travel for the modelling sub-group to an in-person meeting [maximum of 9 modelers to be supported])
- External expert to review E-BFT assessment to attend both DP and SA meetings in 2022 (€10,000)
- Support the Ambassador meetings (to be held in 2021) and potential continuation into 2022

- The Committee request further funding of the GBYP for the period 2022-2026.

- The Committee supports a review of the overall MSE process (all species) at ICCAT in the near future.

The table below contains the overall funding requests for bluefin tuna (including GBYP) for 2022:

| **Bluefin tuna** | 2022 |
|---|---|
| **Tagging, rewards and awareness** | |
| Electronic and conventional tagging, rewarding and awareness | €280,000.00 |
| **Fishery Independent Indices** | |
| **Biological studies:** | |
| Microchemistry | €40,000.00 |
| Age and growth | €40,000.00 |
| Genetic | €80,000.00 |
| **Other (if any,** i.e. fisheries independent indices**)** | |
| Aerial surveys | €350,000.00 |
| Development of Model-based approaches | €50,000.00 |
| **Sample collection and shipping** | €100,000.00 |
| **Workshops/meetings** | |
| GBYP workshops (TBD, probably further WS for BFT sampling coordination and Close Kin) | €80,000.00 |
| **MSE** | |
| Progress of the BFT MSE + process review | €160,000.00 |
| **Sub-TOTAL** | **€1,180,000.00** |
| **Programme coordination** (include staff salaries, SC external member contract, SC members travel and ICCAT staff participation) | €320,000.00 |
| **TOTAL** | **€1,500,000.00** |

*20.1.6 Sharks*

- Provide funding for the SRDCP for Year 8 (€90,000) to: i) complete work on South Atlantic shortfin mako age and growth (€5,000); ii) continue shortfin mako stock differentiation (additional nuclear-genome analysis for 100-200 samples in line with samples analysed in the mitogenomics) and start stock differentiation for blue shark and porbeagle (€25,000); iii) continue work on movement and habitat characterization of silky, oceanic whitetip, longfin mako and hammerhead sharks through satellite tagging (€40,000), including rewarding (€5,000).

- Considering hiring an external reviewer for the stock assessment of Atlantic North and South blue shark stocks (€10,000).

The table below contains the overall funding requests for sharks (including SRDCP) for 2022:

| Activity: | 2022 (€) |
|---|---|
| Tagging (FAL, OCS, SPL, SPZ, LMA) | 45000 |
| Biological studies: | |
| Age and growth (S. Atl. SMA) | 5000 |
| Genetic (SMA, BSH, POR) | 25000 |
| Other (identify) | 5000 |
| External reviewer stock assessment | 10000 |
| **Total** | **90,000** |

*20.1.7 Small tunas*

The Committee recommended the following activities which will have financial implications during the period of 2022 to 2024 in order of priority from highest to lowest:

- Continuing support to the SMTYP: The Committee recommended continuing with the ICCAT SMTYP research programme activities in 2022-2024 to further improve the biological information (improving geographical coverage for growth, maturity and stock identification) for *Acanthocybium solandri* (WAH) and beginning new sampling studies for *Auxis thazard* (FRI) and *A. rochei* (BLT). Costs for 2022 are estimated at €55,000.

- Regional workshop on the application of data-limited methods to assess small tuna stocks: Data-limited models include integrated, length, and catch based models. With such tools it is possible to estimate the status of the population and, depending on the method used, provide reference point to the fishery. Such approaches require inputs from biologists and fisheries experts. As such, the Committee recommended that an in-person workshop be held to advance with the data-limited models applied to some small tunas species. This workshop could be held immediately after (back-to-back) the 2022 intersessional meeting of the Small Tunas Species Group, which would reduce traveling costs. This workshop results should be updated in 2024, also in the format back-to-back the 2024 intersessional meeting of the Small Tunas Species Group. Costs are estimated at €30,000 per workshop, which would allow for participation of 2 experts and 8-10 national scientists.

- New chapter ICCAT Manual: The Commission adopted in 2019 Rec. 19-01, regarding the new ICCAT list of tuna and tuna-like fishes and elasmobranchs that are oceanic, pelagic, and highly migratory. Accordingly, the Committee recommended that a new chapter of the ICCAT Manual be added, on the narrow-barred Spanish mackerel (*Scomberomorus commerson*). The costs to conduct such work are estimated to be €1,000.

- Workshop on maturity staging in 2023 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 €25,000, which would allow for participation of 1 expert and 8-10 national scientists.

- The Group supports the WGSAM initiative that all ICCAT publications be OCRed to make the contents searchable and indexed.

The table below contains the overall funding requests made by the Subcommittee for 2022:

| **Small tunas** | 2022 (€) |
|---|---|
| **Biological studies:** | |
| Reproduction | 15,000 |
| Age and growth | 15,000 |
| Genetic | 15,000 |
| **Sample collection and shipping** | 10,000 |
| **Other fisheries related studies (including data recovery, etc.)** | |
| New chapter of ICCAT Manual (*Scomberomorus commerson*) | 1,000 |
| **Workshops/meetings** | |
| Workshop on application of data-limited methods | 30,000 |
| **Equipment** | |
| **TOTAL** | **86,000** |

*20.1.8 Swordfish*

- *Biology and stock structure study - Swordfish Year Programme (SWOYP)* (this recommendation applies to both the North and South Atlantic and Mediterranean stocks): 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 continues for 2022 and is provided with financial support. The costs for continuing such work in 2022, for each project item, would be the following, for each study item (Priority: High):

  - *Satellite tagging work:* €10,000 for 2022, requested mainly to cover expenses with deployments of previously acquired tags and some tagging equipment (tagging poles, etc.).
  - *Reproduction:* €15,000 for ongoing work processing and analysing of gonads.
  - *Age and growth*: €90,000, divided as: €10,000 to finish processing spines and otoliths collected under previous phases; €30,000 for a trial bomb-radiocarbon age validation study. €50,000 for a trial study on comparison of 3 structures (vertebrae, spines and otoliths).
  - *Genetics:* €110,000; divided as: €100,000 for continued population analysis of tissues samples for stock differentiation; €10,000 for a pilot study on epigenetic ageing, to be completed in conjunction with the bomb radiocarbon study.
  - *Age and growth reference set workshop:* €20,000 for 7-8 participants plus 2 experts (workshop should be scheduled as 5 in-person days).
  - *Sampling and shipping* (priority on missing areas/sizes as defined in the project summary): €10,000.
  - *MSE for N-SWO*: Delivering MSE results for northern swordfish according to the schedule agreed upon by the Commission will be very challenging and require time and resources. Funding to start this work was provided in 2018, and a contractor was hired to start the work. The Committee recommended funding for continuing the swordfish MSE work for 2022 and 2023. Funds requested for 2022 to continue this work are €90,000 (priority: High)

The Table below contains the overall funding requests made for the Swordfish Year Programme (SWOYP) for 2022:

| **Swordfish** | **2022 (€)** |
|---|---|
| **Tagging, rewards and awareness** | |
| Electronic tagging, rewarding and awareness | 10,000 |
| **Biological studies:** | |
| Reproduction | 15,000 |
| Age and growth | 90,000 |
| Genetic | 110,000 |
| Other (if any, identify) | |
| **Sample collection and shipping** | 10,000 |
| **Workshops/meetings** | |
| Age and growth reference sets workshop | 20,000 |
| **MSE** | |
| Progress of the N-SWO MSE | 90,000 |
| **TOTAL** | **345,000** |

*20.1.9 Tropical tunas*

The highest priority for 2022 is to support the skipjack assessment by providing the required support to the SCRS scientists and the Secretariat to prepare the data required for the assessment, by investing in ageing spines collected in the framework of the AOTTP and by contracting an external expert to review the full stock assessment process.

The second highest priority is to continue to invest in the recovery of AOTTP tagged fish and maintenance of the tagging database. The Secretariat has already secured the funds for continuing tagging and recovering up to 1,400 tropical tunas in the NW Atlantic during 2022. The third highest priority is to advance the development of the multi-stock MSE and the western skipjack MSE.

The Table below contains the overall funding requests for tropical tunas for 2022 and 2023:

| **Tropical tunas** | **2022** | **2023** |
|---|---|---|
| **Tag recovery and maintenance of AOTTP database** | €55,000 | €49,000 |
| **Biological studies:** | | |
| Age and growth of BET | | €15,000 |
| Age and growth of SKJ | €15,000 | |
| **MSE** | | |
| Western SKJ | €25,000 | €25,000 |
| Multi-stock MSE | €50,000 | €75,000 |
| **Stock assessments**<br>Reviewer for SKJ | €10,000 | |
| **Total** | €155,000 | €164,000 |

*20.1.10 Working Group on Stock Assessment Methods (WGSAM)*

- *Bycatch estimation tool*: The Committee recommended that tools similar to those presented during the meeting (i.e. SDM/LLSIM and the bycatch estimation tool) be further explored as a means to address the SCRS general need to estimate bycatch of species such as, but not limited to, billfish and shark. The Group further recommends that this work be carried out using the WGSAM 2021 funds and that an expert to be contracted to further develop and evaluate these tools.

- *Website engine search tool for scientific papers:* Considering the difficulties to make an easy and fast search of a document published in the ICCAT Collective Volumes of Scientific Papers, the Committee recommends that the ICCAT Secretariat implement, as soon as possible, the development of a filter-based webpage system which, as a minimum, should include the following fields: name(s) of the author(s), title of the paper, abstract, keywords, year, volume, issue, pages of the publication and SCRS reference number. Since all ICCAT publications have been fully digitized, the Committee recommends that these documents be OCRed to make the contents searchable and indexed. For that purpose, funds should be made available for hiring a dedicated staff or, as an alternative, issue a short-term contract to ensure indexing of all SCRS papers published.

The table below contains the overall funding requests made by the WGSAM for 2022:

| **Working Group on Stock Assessment Methods** | **2022 (€)** |
|---|---|
| **Other fisheries related studies (including data recovery, experts, etc.)** | |
| Tool for estimate bycatch of species | 35,000 |
| Published SCRS documents to be OCRed to make the contents searchable and indexed | 10,000 |
| **TOTAL** | **45,000** |

### *20.2 Other general recommendations*

*20.2.1 Subcommittee on Ecosystems and Bycatch*

- The Committee recommends that opportunities explored on a regular basis so that SCRS officers or their proxies can address issues of mutual interest among Species Groups, for example: environmental impacts, climate change, multi-stocks trade-offs, and the integration of ecological considerations into management procedures.

- The Committee noted the relevant advances made through the collaborative research regarding interactions between ICCAT fisheries and sea turtles. To increase the value of this work to the SCRS and the Commission, the Committee recommends that more national scientists with relevant data on these interactions within ICCAT fisheries join this collaborative research and make their data available.

- Recognizing the increasing interest and importance of environmental impacts, climate change, multi-stocks trade-offs and integration of ecological considerations into management procedures and the lack of opportunity for Species Groups to meet on these issues, the Committee recommends that the SCRS allocate time during the very last day of the Species Group week for a review of EBFM/EAFM related papers (Science Fridays).

*20.2.2 Subcommittee on Statistics*

- The Committee recommends that the Secretariat includes in its annual Secretariat Annual Report on Research and Statistics, a summary table with, but not limited to, the total number by species of seabirds, sea turtles, marine mammals, and ICCAT prohibited species discarded dead or released alive reported by each CPC using the ST09-DomObPrg form.

- The Committee recommends that the Secretariat requests that CPCs identified as having reported T2CE datasets with incomplete information on effort (catches without effort), report revisions to ICCAT with the missing effort included and whenever possible the catches of the three major shark species (POR, BSH, SMA). The Secretariat should estimate the fractions of the total longline catches that do not have sufficient effort information in T2CE and estimate the impact of those datasets on the estimations of EFFDIS. These analyses completed with the gaps identified on the SCRS species catalogues should be presented at next Subcommittee on Ecosystems.

*20.2.3 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. In addition, the Committee recommends that research plans for North and South Atlantic stocks be revised and integrated, together with the Mediterranean Research Plan, within a single document – Albacore Year Programme (ALBYP), following the practice of other Species Groups (e.g. small tunas, sharks, billfishes, etc).

- 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 WGSAM to estimate unreported of catches.

*20.2.4 Billfish*

- Given the misidentification of roundscale spearfish and white marlin in the reported fisheries statistics, the Committee reiterated its concern regarding uncertainty in white marlin stock assessment results. Therefore, the Committee continues to recommend that research to address this problem should continue to be supported by the Commission. As a complement, or alternative, to the genetics study, the Committee recommends that the morphological characteristics as described in the ICCAT Guide for the Identification of Atlantic *Istiophorids* (as well as any other characteristics approved by the Billfish Species Group), be used by onboard observers to identify the species.

- The Committee emphasized the need for all CPCs to comply with the mandatory requirements to report discards (both dead and live) for billfishes. It was noted that to date only 7 CPCs (out of 68 CPCs or fishing entities) have ever reported billfish discards. Having the total catches, including dead and live discards, and estimates of post-release mortality is important for stock assessment purposes.

*20.2.5 Bluefin tuna*

- Habitat and environmental variables represent an important source of variability in existing indices of BFT relative abundance, the Committee recommends continued explorations of factors that may account for differential availability or catchability.

- The Committee reiterates the importance to continue the work in developing and implementing alternative assessment models for both Atlantic stocks of BFT and to consider revisions to trap indices and possible inclusion of other indices.

*20.2.6 Sharks*

- Considering the need to improve stock assessments of pelagic shark species impacted by ICCAT fisheries and bearing in mind 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.

- Methods for mitigating shark bycatch in fisheries need to be investigated and applied.

*20.2.7 Small tunas*

- The Committee recommends that opportunities be created, on a regular basis, for SCRS officers or their representatives to address issues of mutual interest related to the performance and interests of the different SCRS groups.

- The Committee recommends that CPCs provide indices of abundance and size-frequency sample data, preferably from fishery independent surveys and/or other national programmes, which would substantially improve stock assessments.

*20.2.8 Swordfish*

- The Committee continues to note that there is a general lack of discard data reported by most CPCs, including dead discards and live releases. The Committee reminds CPCs that the reporting of discards is required and is essential for assessing the stocks status. Such information is required to be provided by CPCs well in advance of the next stock assessment. The Committee also strongly recommends that both dead and live discards be estimated by each CPC and reported to ICCAT, back in time as much as possible.

- Considering the implications for stock assessment and the MSE process, the Committee recommends that CPCs statistical correspondents should inform the Secretariat and SWO Species Group about the methodology used for collecting swordfish length and if it changed over time (curved or straight LJFL). The Secretariat will confirm with the statistical correspondents on the types of measurements submitted for swordfish.

*20.2.9 Tropical tunas*

- Given how sensitive stock assessments of tropical tunas are to natural mortality assumptions and the paucity of data on maximum age, research should continue on the estimation of natural mortality for the three species of tropical tuna. This should be done by continued collecting and ageing of specimens of the three species and by taking advantage of the AOTTP data to provide estimates of survival.

- The SCRS should continue to conduct research on the impacts of spatial and total fishing closures of surface fisheries, including the effects of limitations on FAD operations, as these impacts are of great interest to the Commission. The Commission, however, should help the SCRS by ensuring that CPCs provide the necessary detailed information on fishing operations required to conduct these analyses.

*20.2.10 Working Group on Stock Assessment Methods (WGSAM)*

- Two-way communication among managers, scientists and stakeholders is a key part of the MSE process, particularly when a request to develop and test a management procedure is being drafted. The Committee recognized that this two-way communication between the SCRS and the Commission needs to increase as all SCRS MSEs continue to progress. The Committee recommended several ways to increase this two-way communication: (1) ensure that terminology used in MSE communications adheres the tRFMO MSE glossary of terms (Anon., 2018); (2) reinstate regular meetings of the Standing Working Group to Enhance Dialogue between Scientists and Managers (SWGSM); (3) create a greater connection between the ICCAT Secretariat representative and the tRFMO MSE Working Group; (4) support the existing outreach efforts of the ICCAT Secretariat; and (5) utilize existing communication and visualization tools such as the Shiny App "SLICK'. Furthermore, the Committee recommends that a second, "Executive Summary" version of the interactive MSE visualization tool intended to aid in consultation and decision making (harveststrategies.org; Slick Decision Analysis) be developed that includes only key metrics and graphics essential to the understanding of the MSE results, geared towards a more lay audience.

- The Committee recommends that the SCRS routinely apply objective criteria for model plausibility for all ICCAT stock assessments that are intended for management (e.g. TAC) advice. These criteria shall be based on best practice in using model diagnostics for evaluating (1) model convergence, (2) fits to the data, (3) model consistency (e.g. retrospective patterns) and (4) prediction skill, as well as biological plausibility criteria. The Committee recommends the model diagnostics applied are similar, but not limited to those described in Carvalho *et al*., 2021. The Committee noted that key diagnostics, such as residuals run tests, retrospective analysis, and hindcast cross-validation are available in the R package 'ss3diags', within the JABBA modelling framework, as well as 'a4adiags' for the statistical catch-at-age (SCA) model FLa4a and that these packages be included in the ICCAT website stock assessment software catalogue to facilitate this process.

## 21. Responses to Commission's requests

### Tropical tunas

#### *21.1 Discards in purse seine fisheries, Rec. 17-01, para 4*

**Background:** *In 2020, the SCRS shall assess the effectiveness of this Recommendation and submit recommendations to the Commission regarding potential improvements.*

The Committee was unable to provide a detailed response this year. It must be stressed that a previous study (Sarralde *et al*., 2007) conducted with observers on board Spanish purse seiners in the mid-2000s estimated these discards were small, (0.2 t per free school set and 1.1 t per FOB set. New guidelines and best practices adopted by fleets and the discard prohibition (Rec. 17-01) that entered into force in 2018 suggest that current discards are probably fewer than the levels indicated in the study by Sarralde *et al*., 2007.

#### *21.2 Discards in purse seine fisheries, Rec. 17-01, para 5*

**Background:** *In 2020, the SCRS shall also undertake work to examine the benefits according to the objectives defined above of retaining non-targeted species catches and present its recommendations to the Commission. The work should take into account all species that are usually discarded on all major gears (i.e., purse-seines, longlines and gillnets), and should look at fisheries that take place both on the high seas and in waters under national jurisdiction and the feasibility of both retaining on-board and processing of the associated landings.*

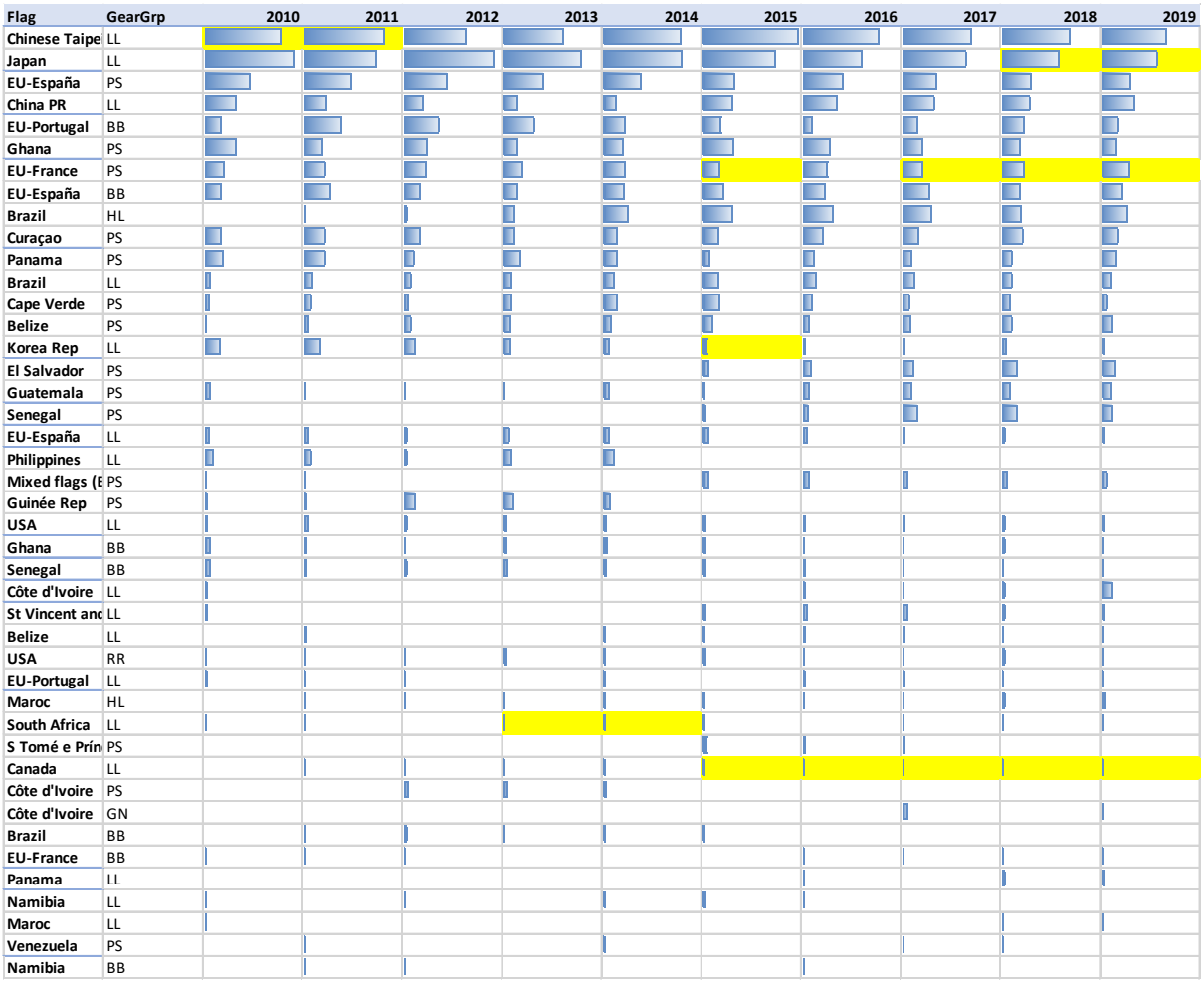
Task 1 table in the Bigeye Executive Summary (see item 9.1 of this report) shows that the earliest reports of bigeye discards come from 2011 but sporadic submissions of bigeye discards start in 2015 and are just limited to very few CPCs. The Committee needs reliable data to provide a response to this request but discard reports are too inconsistent to be currently of use to develop a response.

Information on discarded fish should be provided as part of the Task 1 Nominal catch estimation (ST02). The observers form (ST09) should be used to submit bycatch information. The ST02 form currently allows the reporting of landings, discards and discards alive, but this is not the case for ST09. Moreover, the information on the ST09 is provided in numbers and represents just a fraction of the total, giving an incomplete picture of discards.

Reports of discards from the purse seine fleets that have been reported in ST02 and since 2019 in ST09 are included in the Coordinator's Report on Activities of the ICCAT/Japan Capacity-building Assistance Improvement Project (Phase 2) (JCAP-2) 2020/2021. Discards of the purse seine fleet are probably small because 1) most of the bycatch (particularly small tunas species and other bony fish) form part of the so called *faux poissons*, and 2) of the discard prohibitions in Rec. 17-01.

It was noted that Rec. 17-01 is not exclusively directed to purse seine fleets (para 5) but also to the other major gears targeting tropical tunas. **Table 21.2.1** shows the most important CPCs and gears contributing to the bigeye tuna catch and reporting discards in ST02 or ST09.

**Table 21.2.1.** Combinations of CPCs and gears reporting bigeye tuna catches in the ICCAT Convention area. Only those that are responsible of more than 1000 tons in the decade are shown. They are ordered from high to low according to total catch in the 2010s. Blue bars indicate BET catch levels. In yellow are highlighted those combinations of CPC-gear-year that have provided dead discard reports.




### *21.3 The TAC for 2022 and future years, Rec. 19-02, para 3*

**Background:** *The Total Allowable Catch (TAC) for bigeye tuna shall be 62,500 t in 2020 and 61,500 t in 2021. The TAC for 2022 and future years shall be considered in 2021 on the basis of SCRS advice.*

Refer to the outlook section of the Bigeye Tuna Executive Summary (item 9.1 of this report) for this response.

### *21.4 Fishing prohibited with FADs, Rec. 19-02, para 28*

**Background:** *1 January to 28 February for 2020 and 1 January to 31 March in 2021, 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. SCRS should provide this advice to the Commission in 2020.*

The Committee noted that an analysis of historical monthly catches will be of limited use because it would not reflect the behaviour of fleets under the current FAD closure described in Rec. 19-02. Furthermore, it was also noted that the Commission request refers to catch in 2020 and 2021 but such catch data were not available to the Committee this year.

The Committee recalled a study presented to the AOTTP symposium (Perez *et al*., 2020). This study evaluated the efficiency of two moratoria (Rec. 15-01 and Rec. 98-01) using AOTTP tagging data. While the study concluded that both moratoria were efficient for limiting recaptures on juvenile skipjack and yellowfin during the November-February period, no conclusion could be drawn for bigeye due to the limited number of bigeye tuna released inside and outside the FAD time area closure.

The Committee agreed to continue to work on this response in 2022 and to conduct the following analyses:

- prepare a table with the recent evolution of monthly PS tropical tuna catches by fishing mode and species, using Task 2 information from 2010 to 2020, indicating the different time area FAD closures that have been in place. The table should include percentages across months by species and across species by month.
- An analysis identifying months that minimize yellowfin and bigeye juveniles while maintaining skipjack catches.
- Derive from the most recent Stock Synthesis results for YFT and BET, appropriate indicators of the evolution of fishing mortality of one-year old for the major surface fleets.

***21.5 Maximum number of FAD sets which should be established per vessel or per CPC, Rec. 19-02, para 31***

**Background:** *With a view to establishing FAD set limits to keep the catches of juvenile tropical tunas at sustainable levels, in 2021 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 2020 the required historical FAD set data. 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 2021 Commission meeting.*

Fishing effort associated with FADs is a complex interaction of factors such as number of FADs deployed, FADs monitored by vessel, technology of the buoy, use of supply vessels,

A recent SCRS paper prepared for Panel 1 (Ortiz M. and Mayor C., 2021) included tables that are somewhat helpful to respond to this request. The document contains information on the catch, effort in fishing time, number of FAD deployments, FAD loss, types of FADs and other variables for the purse seine fleets. Such information, unfortunately, can be challenging to interpret. For example, locations of lost FADs denote the last position that a given FAD transmitted. Such positions can represent FADs that are too far to be retrieved and therefore lost to the fleet when the beacon ceases to transmit. They can also represent positions where another vessel retrieves the FAD and reuses the FAD, and in the process the beacon is disconnected.

The Committee noted that the data requested from fleets deploying FADs in Rec. 19-02 do not always include the precise data that would be necessary to evaluate recommendations about an appropriate number of FAD sets. For example, when reporting catch and effort, CPCs have the option to report activities using one of multiple effort metrics. Most CPCs have not reported effort in number of FAD sets.

Any potential evaluation the SCRS could do on the number of maximum number of FAD sets would depend on having sufficient data on past and current number of FAD sets. The Committee notes that any guidance provided to the Commission on this matter would be on the maximum number of FAD sets per fleet and not per CPC or vessel.

In summary, there is not enough information to provide advice on the maximum number of FAD sets per vessel as requested by the Commission.

### *21.6 Impact of support vessels on the catches of juvenile yellowfin and bigeye tuna, Rec. 19-02, 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 2020.*

Very few submissions of information and often inconsistent have been received in the Secretariat to help responding to this request. **Table 21.6.1** shows the number of supply vessels by Flags and fleets that have provided ST07 form by year. As seen in this table, availability of data is limited. For most of the ST07 forms submitted there is no information available to make the linkage between catches of the PS vessels and the supporting supply vessel(s). The Committee was informed about analyses that are currently being conducted by EU scientists in the context of the standardization of the PS FAD CPUE and that incorporate a supply vessel effect in the standardization process. It is expected that this work will be finished by the time of the skipjack assessment in 2022 and will provide additional information to this request by the Commission.

The Committee is unable to provide a final response to this request from the Commission.

**Table 21.6.1.** Number of supply vessels reported by Flag/fleet with the ST07 Supply vessel forms by year to the ICCAT Secretariat. The blank cells indicate no reporting, 0 indicates no support vessels reported, and positive values the number of supply vessels in each year.

| Num Supp Vessels | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Status** | **Flag** | **Flag/fleet** | **2013** | **2014** | **2016** | **2018** | **2019** | **2020** |
| **CP** | **EUROPEAN UNION** | ESP | | | | | 4 | |
| | | FRA | | | | | 0 | 0 |
| | **PANAMA** | PAN | | | | | 4 | |
| | **CURAÇAO** | CUW | 1 | 1 | | | 2 | 2 |
| | **BELIZE** | BLZ | | | 1 | | 4 | 3 |
| | **EL SALVADOR** | SLV | | | | | | 1 |
| | **SENEGAL** | SEN | | | | | 1 | |
| | **UNITED KINGDOM** | BMU | | | | | 0 | |
| | | GBR | | | | | 0 | 0 |
| | | SHN | | | | | 0 | 0 |
| | | TCA | | | | | 0 | 0 |
| | | VGB | | | | | 0 | 0 |
| | **LIBYA** | LBY | | | | 0 | | |
| | **MEXICO** | MEX | | | | | 0 | |
| | **EU_FRA (St-Pierre et Miquelon)** | SPM | | | | | 0 | |
| **NCC** | **Bolivia** | BOL | | | | 0 | 0 | 0 |
| **NCO** | **Non-contracting parties** | LCA | | | | | 0 | |
| **Total Supp Vessels** | | | **1** | **1** | **1** | **0** | **15** | **6** |

***21.7 SCRS recommendation on presence of a human observer on board in accordance with Annex 7 and/or an Electronic Monitoring system, Rec. 19-02, para 55***

**Background:** *For longline vessels flying their flag 20 meters length overall (LOA) or greater targeting bigeye, yellowfin and/or skipjack in the Convention area, CPCs shall ensure a minimum of 10% observer coverage of fishing effort by 2022, through the presence of a human observer on board in accordance with Annex 7 and/or an Electronic Monitoring system. For this purpose, the Working Group on Integrated Monitoring Measures (IMM WG), in cooperation with the SCRS, shall make a recommendation to the Commission for endorsement at its 2021 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 Secretariat*

*In 2020 CPCs are encouraged to conduct trials on electronic monitoring and report the results back to the IMM and the SCRS in 2021 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.*

Refer to item 21.15 of this report.

***21.8 Refine the MSE process in line with the SCRS roadmap and continue testing the candidate management procedures, Rec. 19-02, 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.*

An updated roadmap in the format produced by the Commission was prepared for the tropical tunas MSEs on the basis of the detailed list of activities agreed during the Tropical Tunas MSE Technical Group Meeting (Anon. 2021c) and presented in Table 22 of the Report of the 2021 Bigeye Stock Assessment Meeting (Anon. 2021i). This roadmap was integrated with the roadmaps for other species MSE (see item 17.5 of this report).

***21.9 Efficacy that full fishery closures along the lines of those proposed in PA1_505A/2019, Rec. 19-02, 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[4] 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 did not advance the analysis of previous work on this closure. The Committee will attempt to conduct such analysis in 2022.

[4] Available upon request at the Secretariat or on the ICCAT website https://www.iccat.int/com2019/index.htm#en

### *21.10 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. 19-02, 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;*

The Committee can only presently report on capacity estimates of large-scale purse seine vessels (defined as vessels with ≥335 $m^3$ of fish hold-volume). The Committee intends to evaluate the capacity and number of other fleet components (e.g. support vessels, BB, LL) in the future.

In 2021, the Committee considered two documents that included capacity estimates for large-scale purse seine fisheries. Floch *et al.*, 2021 described the statistics of the French purse seine fleets targeting tropical tunas in the Atlantic Ocean and Restrepo *et al.*, 2021 included estimates of the current fishing capacity of all large-scale purse seiners targeting tropical tunas in the Atlantic, using a combination of data sources including the ICCAT authorized vessel records, ISSF records on purse seiners, AIS data and direct enquiries with some vessel owners. Based on Restrepo *et al.*, 2021, the Committee estimates that at least 74 - and possibly 80 - large-scale purse seiners were operating in the Convention area as of the first half of 2021. The combined Fish Hold Volume (FHV) of the 80 vessels was 114,864 $m^3$, which is equivalent to about 89,472 t of fish carrying capacity (**Table 21.10.1**). Given that large-scale purse seiners may make 5-8 trips a year, this suggests that the current capacity is higher than necessary to meet current catch recommendations. This capacity estimate is also larger than the prior estimates of capacity made by the Committee in 2019 (58 vessels) and in 2020 (68-72 vessels). The Committee notes that these estimates are intended to measure active capacity not potential capacity. In 2021, there were 88 large-scale purse seiners authorized to fish for tropical tunas in the ICCAT Convention area, these vessels should be considered as potential capacity.

The Committee wants to highlight to the Commission that there is a need to agree on a set of indicators of capacity which are useful to both the Commission and the Committee. The Committee favours indicators based on fish-hold volume metrics to minimize the influence of different crew operations. In developing indicators of active capacity, it will also be necessary to consider the effects of spatial-temporal changes in fishing activity due to fishing access agreements between ICCAT CPCs, as well as ICCAT Recommendations, given that both can influence and constrain fishing activity. Additionally, movement of fishing vessels from one RFMO Convention area to another complicates regional and global estimates of active fishing capacity. It would therefore be useful if tRFMOs joined forces towards the common challenge of managing global fishing capacity.

The Committee can only presently report on capacity estimates of large-scale purse-seine vessels (defined as vessels with ≥335 m3 of fish hold-volume). The Committee intends to evaluate the capacity and number of other fleet components (e.g. support vessels, BB, LL) in the future.

**Table 21.10.1.** Estimated number of large-scale purse seiners operating in the Atlantic Ocean from 2014 to 2018 (left; Table 2 of the 2019 SKJ Executive Summary in the *Report for Biennial Period 2018-2019, Part II (2019), Vol. 2*) and minimum and maximum numbers estimated for 2020 (Restrepo *et al.*, 2020) and 2021 (Restrepo *et al*., 2021).

| | SCRS 2019 | | | | | SCRS 2020 | | SCRS 2021 | |
|---|---|---|---|---|---|---|---|---|---|
| **FLAG** | **2014** | **2015** | **2016** | **2017** | **2018** | **2020 (Min)** | **2020 (Max)** | **2021 (Min)** | **2021 (Max)** |
| Neth. Antilles | 2 | - | - | - | - | - | - | - | - |
| Belize | 3 | 2 | 2 | 3 | 2 | 8 | 8 | 8 | 8 |
| Brazil | - | - | - | - | - | 0 | 1 | 0 | 1 |
| Cabo Verde | 3 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Curaçao | - | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 4 |
| Cote d' Ivoire | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| El Salvador | 0 | 2 | 4 | 4 | 4 | 4 | 4 | 3 | 3 |
| Morocco | - | - | - | - | - | 1 | 1 | 3 | 4 |
| Spain | 15 | 12 | 10 | 10 | 10 | 10 | 10 | 11 | 11 |
| France | 9 | 9 | 11 | 10 | 10 | 9 | 9 | 10 | 10 |
| Ghana | 12 | 12 | 13 | 13 | 15 | 16 | 16 | 16 | 17 |
| Guatemala | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Liberia | - | - | - | - | - | 2 | 2 | 2 | 2 |
| Panama | 2 | 3 | 2 | 2 | 2 | 3 | 6 | 5 | 6 |
| Senegal | 0 | 3 | 4 | 5 | 7 | 7 | 7 | 7 | 7 |
| Venezuela | - | - | - | - | - | 1 | 1 | 2 | 4 |
| **Total** | **49** | **53** | **55** | **55** | **58** | **68** | **72** | **74** | **80** |

***21.11 The SCRS and the Secretariat shall prepare TORs to carry out an evaluation of the monitoring, control and surveillance mechanisms in place in ICCAT CPCs. Rec. 19-02, 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 SCRS scientists to prepare a TOR for this work as soon as possible.*

The Committee and the Secretariat were unable to provide a detailed response this year.

***Atlantic swordfish***

***21.12 SCRS advice on conservation and management measures for North Atlantic swordfish, Rec. 17-02, para 5***

**Background:** *The Commission shall establish at its 2021 meeting conservation and management measures for North Atlantic swordfish on the basis of the SCRS advice resulting from the latest stock assessment as well as the Resolution by ICCAT on Criteria for the Allocation of Fishing Possibilities [Res. 15-13]. In support of this effort, the Commission shall consider development/management plans of coastal developing CPCs and fishing/management plans of other CPCs so that adjustments can be made to the existing catch limits and other conservation measures, as appropriate. In the event of the modification of its fishing/management plan, each CPC shall submit the updated version of its fishing/management plan to the Commission by 15 September.*

Since the stock assessment did not take place in 2021 as originally planned by the SCRS, the Committee is not in a position to provide the requested response to the Commission.

***21.13 Interim limit reference (LRP) of 0.4*$B_{MSY}$ or any more robust LRP established through further analysis, Rec. 17-03, para 12***

**Background:** *When assessing stock status and providing management recommendations to the Commission in 2021, the SCRS shall consider the interim limit reference (LRP) of 0.4*$B_{MSY}$ or any more robust LRP established through further analysis.*

Since the stock assessment did not take place in 2021 as originally planned by the SCRS, the Committee is not in a position to provide the requested response to the Commission.

***Blue marlin and white marlin***

***21.14 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.*

In general, there have only been two CPCs who have provided papers and information on the methods for estimating their discards from ICCAT fisheries of bycatch species such billfish. One paper was presented in 2020 by Canada (Gillespie, 2021). The Committee was supportive of the work done, but noted a few issues regarding the methodologies. Canada agreed to explore all those issues in the analysis that will be performed. In previous years the USA also provided an SCRS document (Santos *et al*., 2020) and additional information describing the methodology was provided in 2020. It was also indicated that during the last assessment of WHM Brazil has presented the methodology used by the CPC. The Committee has requested that an SCRS document be provided which includes the details of the methodology.

It is important for the Committee to understand what methodology CPCs have in place to estimate live and dead discards of marlins. Given the limited information provided, it could be interpreted that most CPCs do not have a methodology to estimate discards. The Committee reminds CPCs which 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 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 fisheries, the Committee was informed that there are no discards as all billfish specimens are retained and landed. As such in those cases the landings represent the total catch.

***21.15 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 to be analyzed, e.g. species, length, estimated weight, fishing operation details*
*d) 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.*

Following the Commission request contained in Rec. 19-05 (paragraph 20) a Subgroup within the Billfishes Species Group was created to start addressing this issue. The Subgroup noted that there are already minimum standards recommended by the Committee for Electronic Monitoring Systems (EMS) on purse seine fisheries (Ruiz *et al*., 2017) which were endorsed by the Commission. The Subgroup worked intersessionally during 2021, and at present the Committee does not yet have a final recommendation to provide to the Commission on the use of EMS for pelagic longline fisheries. The Subgroup is being expanded to incorporate participants from other Species Groups, and will continue to work on this issue in later 2021 and during 2022, aiming to provide a more consolidated answer to the Committee in 2022. The Committee agreed that this subgroup will report its findings to the Subcommittee of Statistics.

The expanded Subgroup will also be available to review the scientific component of any standards provided intersessionally by IMM.

***21.16 Explore potential technical changes to the terminal gear and fishing practices that could reduce bycatch and bycatch mortality (at-vessel and post-release). Design and implement a study(ies) to compare the effects of hook shape and size on catch rates. Rec. 19-05, para 21***

**Background:** *The SCRS shall, in collaboration with CPCs, explore potential technical changes to the terminal gear (such as hook shape, hook size, leader type, etc.) and fishing practices (e.g. timing, soaking time, bait, depths, areas) that could reduce bycatch and bycatch mortality (at-vessel and post-release). As part of this process, the SCRS in collaboration with CPCs shall design and implement a study(ies) to compare the effects of hook shape and size on catch rates (considering both hooking and retention rates), at-haulback mortality, and post-release mortality. The experimental design should account for the influence of leader material types and consider potential operational differences among regions and fleets.*

Following the Commission request contained in Rec. 19-05 (paragraph 21) a Subgroup within the Billfishes Species Group was created to start addressing the issue related with experimental studies for longline technological gear changes. The Committee recognizes that a large number of scientific studies on the effects of terminal gear (e.g. hook size and type) and fishing practices on catch rates and survival of several bycatch and target species are already available. The Committee will allocate effort reviewing and summarizing these studies. This review will inform the Committee in its further work on these issues. The Subgroup worked intersessionally during 2021, and at present the Committee does not yet have a final recommendation to provide to the Commission on the planning of experimental field studies to address this issue. The Subgroup acknowledged the importance of expanding in participation to include participants of other interested species groups within the SCRS. The Subgroup will continue to work on this issue in later 2021 and during 2022, aiming to provide a more consolidated answer to the SCRS in 2022. The Committee agreed that this Subgroup will report its findings to the Subcommittee of Ecosystems and Bycatch.

**Shortfin mako**

***21.17 The SCRS should provide advice. Rec. 19-06, para 11***

**Background:** *The Commission, at its 2020 annual meeting, shall adopt a new management recommendation for North Atlantic shortfin mako, taking into account the scientific advice from the SCRS and the results of the 2020 Panel 4 intersessional meeting, in order to establish a rebuilding plan with a high probability of avoiding overfishing and rebuilding the stock to $B_{MSY}$ within a timeframe that takes into account the biology of the stock.*

The SCRS reviewed several research papers that were potentially relevant for the management of SMA. However, the Committee is unable to draw conclusions or provide additional advice at this time based on this research. The Committee has no additional advice to that provided in 2019 (for details see item 9 of the *Report for Biennial Period 2018-2019, Part II (2019), Vol. 2*).

**Atlantic blue shark**

***21.18 Updated TAC advice in 2021, or at an earlier stage if enough information is provided. Rec. 19-07, para 2***

**Background:** *An annual TAC of 39,102 t for North Atlantic blue shark is established. The annual TAC may be revised subject to a decision of the Commission based on the updated advice of the SCRS in 2021, or at an earlier stage if enough information is provided by the SCRS.*

Since the stock assessment did not take place in 2021 as originally planned by the SCRS, the Committee is not in a position to provide the requested response to the Commission.

***21.19 Provide, if possible, options of HCR with the associated limit, target and threshold reference points for the management of this species in the ICCAT Convention area. Rec. 19-07, para 8***

**Background:** *In the light of the results of the next stock assessment of North Atlantic blue shark, the SCRS shall provide, if possible, options of HCR with the associated limit, target and threshold reference points for the management of this species in the ICCAT Convention area.*

Since the stock assessment did not take place in 2021 as originally planned by the SCRS, the Committee is not in a position to provide the requested response to the Commission.

***21.20 Update TAC advice in 2021. Rec. 19-08, para 2***

**Background:** *An annual Total Allowable Catch (TAC) of 28,923 t for South Atlantic blue shark is established. The Annual TAC may be revised subject to a decision of the Commission based on the updated advice of the SCRS in 2021, or at an earlier stage if enough information is provided by the SCRS.*

Since the stock assessment did not take place in 2021 as originally planned by the SCRS, the Committee is not in a position to provide the requested response to the Commission.

The Committee noted that the 2020 catches (of 33, 652 t) exceeded by about 16% the Total Allowable Catch (TAC of 28,923 t) for South Atlantic blue shark outlined in Rec. 19-08 (para 2).

***21.21 Provide, if possible, options of HCR with the associated limit, target and threshold reference points for the management of blue shark in the ICCAT Convention area. Rec. 19-08, para 8***

**Background:** *In the light of the results of the next stock assessment of South Atlantic blue shark, the SCRS shall provide, if possible, options of HCR with the associated limit, target and threshold reference points for the management of this species in the ICCAT Convention area.*

Since the stock assessment did not take place in 2021 as originally planned by the SCRS, the Committee is not in a position to provide the requested response to the Commission.

**Western Atlantic bluefin tuna**

***21.22 Provide advice to the Commission on the appropriate management measures, approaches, and strategies, including, inter alia, regarding TAC levels for the western Atlantic bluefin tuna stock for future years. Rec. 20-06, para 6 (17)***

**Background:** *17. In 2021, the SCRS will conduct a stock assessment for the western Atlantic bluefin tuna stock to incorporate the most recent available data, including any new abundance indices adopted by the Bluefin Tuna Species Group and provide advice to the Commission on the appropriate management measures, approaches, and strategies, including, inter alia, regarding TAC levels for that stock for future years. Such assessment shall be conducted in a way that does not negatively affect the other work of the SCRS, particularly the ongoing MSE process for bluefin tuna. In addition, an external expert will be contracted in accordance with the standard procedures of ICCAT. The expert will review the assessment in a manner consistent with established SCRS practices, prepare a report on their findings and present their findings/results to the Bluefin Tuna Species Group. No stock assessment will be required for the western Atlantic bluefin tuna stock in 2022 unless the SCRS is unable to perform an assessment in 2021.*

In 2021, the SCRS conducted a stock assessment for the western Atlantic bluefin tuna stock to incorporate the most recent available data up to 2020, including the revised abundance indices adopted by the Bluefin Tuna Species Group. The Committee provides advice to the Commission regarding TAC levels for the stock for 2022 and, in the absence of adoption of a Candidate Management Procedure, for year 2023. Such assessment was conducted in a way that did not negatively affect the other work of the SCRS, particularly the ongoing MSE process for bluefin tuna. In addition, an external expert was contracted in accordance with the standard procedures of ICCAT. The expert reviewed the assessment in a manner consistent with established SCRS practices, and a report was provided on their findings to the Bluefin Tuna Species Group. No stock assessment will be required for the western Atlantic bluefin tuna stock in 2022. The Committee management recommendations are provided in the item 9.2 of this report.

**Eastern Atlantic and Mediterranean bluefin tuna**

***21.23 SCRS to report to the Commission in 2021 on CPCs efforts to enhance the collection and analysis of biological samples from Atlantic bluefin tuna fisheries, such as through sample contributions to the coordinated sampling plan recommended by the SCRS. Rec. 20-06, para 8 (20)***

**Background:** *20. CPCs that harvest Atlantic bluefin tuna should contribute to the research, including that being undertaken through ICCAT's GBYP. CPCs should make or continue special efforts to enhance the collection and analysis of biological samples from Atlantic bluefin tuna fisheries, such as through sample contributions to the coordinated sampling plan recommended by the SCRS. The SCRS will report to the Commission in 2021 on these efforts. In addition, it is important to continue to explore sampling and/or other approaches for enhancing, and where needed developing, accurate abundance indices for juvenile bluefin tuna. CPCs should also make special efforts to ensure complete and timely submission of any collected data to the SCRS.*

In recent years, many CPCs have substantially increased their collection of biological material for aging, genetics, growth and reproduction and stock of origin through systematic sampling of the fisheries. Sample coverage for the CPCs that capture western bluefin tuna averages 15% of the landed catch (**Table 21.23.1**) and provides essential data for genetic close-kin mark recapture (CKMR) and for monitoring stock composition, growth, and reproduction. Improvements in coverage could be obtained through increased sampling and dedicated national programmes conducted in collaboration with the GBYP. Initial calculations conducted as scoping for close-kin mark recapture studies for both eastern and western bluefin tuna indicate that a minimum sample coverage should be equal or greater than 5% of each CPC's catch in number with larger samples sizes providing greater precision. Currently Gulf of Mexico longline and Japan longline fisheries have relatively low sampling coverage. The Committee supports increasing biological sampling coverage in Mexican and Japanese longline fisheries for future possible CKMR studies. To get representative spatial coverage, the Committee noted that this sampling should cover trips in all relevant BFT fisheries for a given CPC. In addition to getting samples from fishery sources, the Committee noted that increasing biological sampling from non-fisheries sources (e.g. larval survey and sampling at farms) would also help expand the sampling coverage and number samples for CKMR studies.

While the request for response 21.23 was specific to western bluefin tuna, the Committee notes the equal importance of similar sampling for eastern bluefin tuna. The Committee notes that ongoing work by national programmes in the eastern Atlantic and Mediterranean and the coordination of biological sampling by the GBYP (**Appendix 5** of this report) has increased biological sampling coverage and that similar considerations for spatial coverage, minimum sampling fraction and non-fishery sampling for eastern bluefin tuna also pertain.

**Table 21.23.1.** Western-area-CPC-based biological sampling by for bluefin tuna over years 2016-2019.

| Year | Total number of fish sampled* | Total catch in number | Total sample coverage (%) |
|---|---|---|---|
| 2016 | 1677 | 13218 | 13% |
| 2017 | 2374 | 13816 | 17% |
| 2018 | 2117 | 13923 | 15% |
| 2019 | 2617 | 17439 | 15% |

* Samples can include otoliths, gonads, genetic material, etc.

***21.24 The SCRS shall annually advise on the TAC. Rec. 20-07, paragraph 1 (Rec. 19-04, para 5)***

**Background:** *5. The total allowable catches (TACs), inclusive of dead discards, for the years 2021 and 2022 shall be set at 36,000 t, respectively, in accordance with the SCRS advice. However, the 2022 TAC shall be reviewed and amended, as appropriate, at the 2021 Commission annual meeting based on new SCRS advice in 2021.*

The updated eastern abundance indicators were examined (**Figures 21.24.1 and 21.24.2**) by the Group to evaluate whether or not it was necessary to change the current TAC advice of 36,000 t recommended for 2022 (Rec. 20-07). The inspection of the updated biomass indicators and the projections of 2017 assessment did not provide any evidence to alter the current management advice. No change in the current TAC advice of 36,000 t is recommended for 2022.

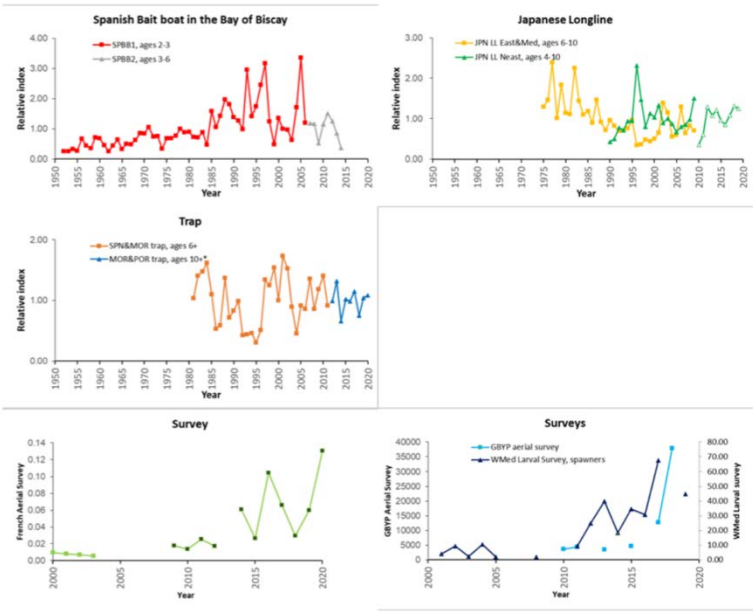



**Figure 21.24.1.** Updates of indices of abundance for the E-BFT presented in 2021.

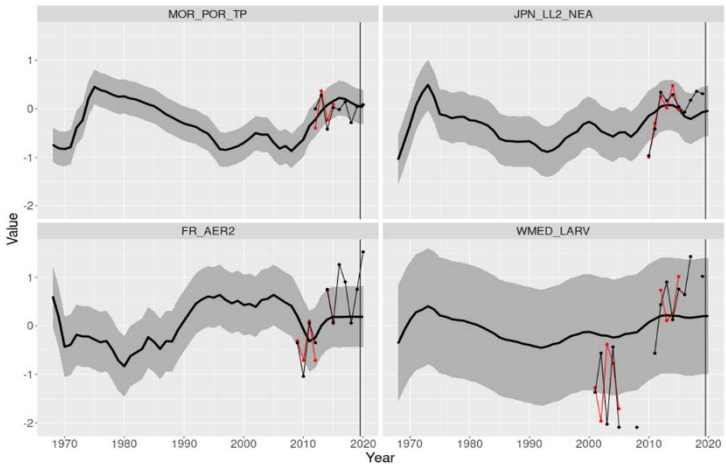



**Figure 21.24.2.** Updated indices (values post 2019, black line) compared with the 80% prediction intervals from the 2017 VPA projected forward with observed catches and 6-year average recruitment. Red points are the indices used in the assessment and black points are the updated or revised index values. Thick black lines are the central tendency of the population component corresponding to the index. To interpret the implications of points outside of the 80% intervals, 20% of the observations might fall outside of the interval by random chance. Note that the methodology used to produce the Western Mediterranean Larval Index has been substantially revised since the 2017 stock assessment, which produced notably different fluctuations between the original and updated indices.

***21.25 SCRS should review no later than 2021, and each time an eastern Atlantic and Mediterranean bluefin tuna stock assessment is performed, CPCs fishing capacity is commensurate with its allocated quota by using relevant yearly catch rates by fleet segment and gear proposed by the SCRS and adopted by the Commission in 2009. Rec. 20-07, para 4 (18)***

**Background:** *18. Each CPC shall adjust its fishing capacity to ensure that it is commensurate with its allocated quota by using relevant yearly catch rates by fleet segment and gear proposed by the SCRS and adopted by the Commission in 2009. Those parameters should be reviewed by the SCRS no later than 2021 and each time that a stock assessment for eastern Atlantic and Mediterranean bluefin tuna is performed, including specific rates for gear type and fishing area.*

The ICCAT Commission in 2019 requested to review and update the catch rates of fleets targeting E-BFT by main fishing gear and vessel size category to the SCRS. Since 2010 several changes and regulations have been implemented to the East bluefin tuna fisheries (Rec. 10-04, Rec. 12-03, Rec. 14-05, Rec. 18-02, Rec. 19-04) that impacted the activity of the fleets targeting this resource both in the Mediterranean Sea as well in the East Atlantic. During this period also, bluefin farming operations had become the main destination of the catches, particularly in the Mediterranean Sea, where the purse seine fleets are the main supplier of wild fish to the farms. And, the so-called "Joint-Fishing = Operations" (JFO), defined as "any operation between two or more purse seine vessels where the catch of one purse seine is attributed to one or more other purse seine vessels in accordance with a previously agreed allocation key" in Rec. 19-04 para 3 item g, have become the primary type of fishing operation for the East bluefin stock in terms of total catches (**Figure 21.25.1**).

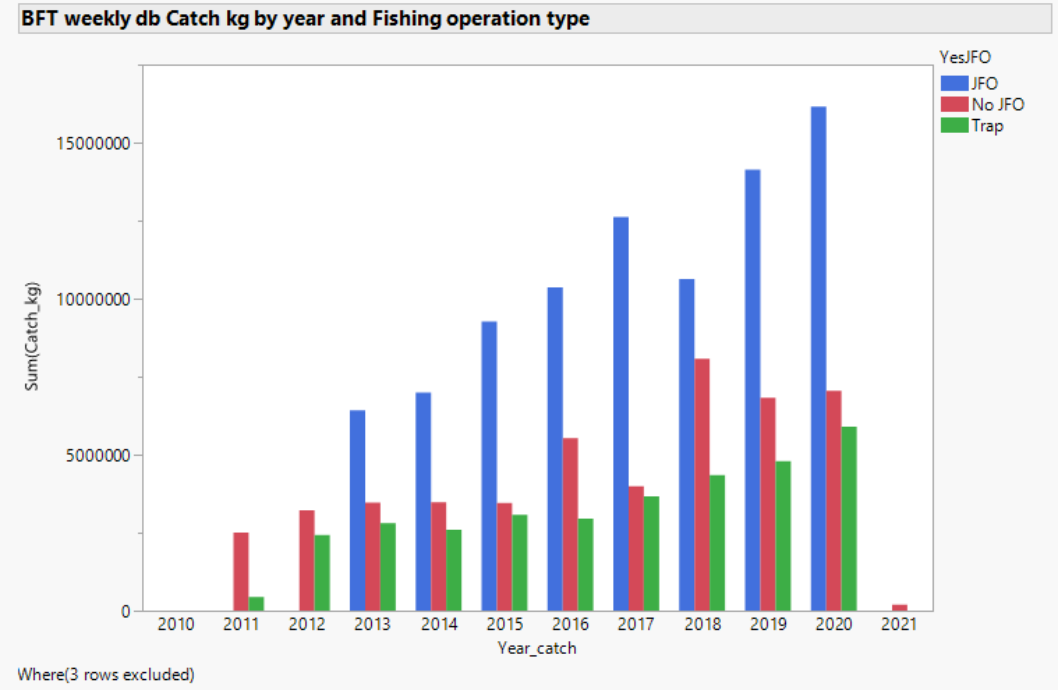



**Figure 21.25.1.** Annual trend of the E-BFT catch (kg) by the main type of fishing operations based on the information provided by the weekly/monthly reports 2011-2021. JFO refers to joint fishing operations between two or more purse seines (PS). No JFO refers to standard catch by a single PS, 2021 represents partial data submitted until February 2021.

Given these changes in the fisheries and the stricter management regulations in place on the East bluefin tuna stock, the SCRS outlined as the main objective to estimate catch rates, that we define as nominal CPUE (CPUE) per vessel (i.e. catch and effort, measured as fishing days from the VMS data that are associated with each vessel) rather than aggregated catches over a large group of vessels and time as was done by the SCRS in 2020. Ortiz *et al*., 2021a presented preliminary results of the analyses carried out by the Secretariat.

At the Secretariat, there are several sources of information on the catch and potential fishing effort for East bluefin tuna in addition to the regular fisheries statistics of Task 1NC and Task2 CE, that include data with information of catch and effort by vessel and/or fishing activity. These databases include:

a) The weekly/monthly reports of catches of bluefin tuna database, that extend from 2008 to present. In these data, JFO records included the "actual vessels" that performed the catch in addition to the "allocation catch" that represents only a catch value for TAC monitoring purposes;

b) The Bluefin Catch Documentation [BCD (2010-2016) and eBCD (2016-present)] databases, that record the catch by a vessel of bluefin tuna;

c) The Regional Observer Programme (ROP), these data are provided by the consortium to the Secretariat and include information on the catch and vessel(s) for those fishing operations on the East bluefin stock that are required to be monitored by current management regulations; and

d) The east bluefin VMS database (2008-present), that keeps records of vessel signals transmitted for authorized bluefin vessels.

The initial task has been to review and quality control the available data and summarize the information by the source evaluating what is the coverage of each source compared to the total catch, and what features for catch and effort units are useful to provide estimates of nominal CPUEs. One of the main issues with nominal CPUEs has to deal with the "JFOs", where due to management from ICCAT or national regulations, authorized vessels can share/redistribute catch allocations for monitoring purposes although they may not participate in the actual fishing operation. Indeed, JFOs are becoming the main option for CPCs, being reflected in the increased catch by JFO per year, but also the number of vessels registered under a given JFO (**Figure 21.25.2**). These allocations of catch within a JFO clearly do not represent actual or true nominal catch for individual vessels.

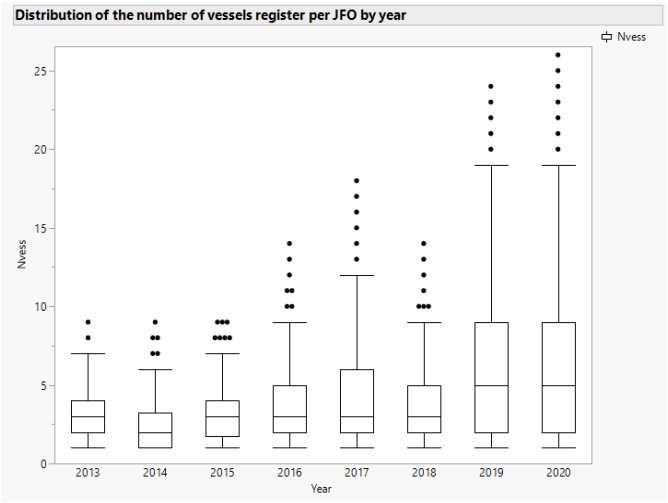



**Figure 21.25.2.** Box-plot distribution of the number of vessels registered per JFO 2013 - 2020.

Prior to 2010 the Commission required the registration of all vessels (> 20 m LOA) that participate in bluefin tuna fisheries, which is annually updated by CPCs. There are over 3000 vessels registered for E-BFT fisheries, however in reality a smaller proportion of these vessels (~12%) account for about 86% of the catch as reported in the weekly database (2013-2020). This "core" fleet is composed of vessels with a minimum annual catch of 5 t and at least 4 years of BFT reported catch, they represent a consistent and active fleet catching bluefin that can provide reliable estimates of catch rates per vessel category and gear. By linking the weekly database with the VMS and the eBCD data, it has been possible to estimate fishing effort (fishing days at sea), and catch/trip activity per vessel.

Preliminary results of CPUE by single vessel activity (i.e. fishing trip) are presented for the main fishing gear and by vessel size category. They show that purse seiners (PS) have overall higher CPUE compared to longliners (LL) or baitboats (BB) operations, and also higher for JFOs compared to single PS standard vessel operations (**Figure 21.25.3**). Analyses also have shown that from registered vessels, the "core" fleet that has operated more consistently in the fishery, do have high CPUE compared to those vessels that are more sporadic in catch and fishing activity (**Table 21.25.1**, **Figure 21.25.4**). Similar results were obtained for the LL fleet (**Figure 21.25.5**).

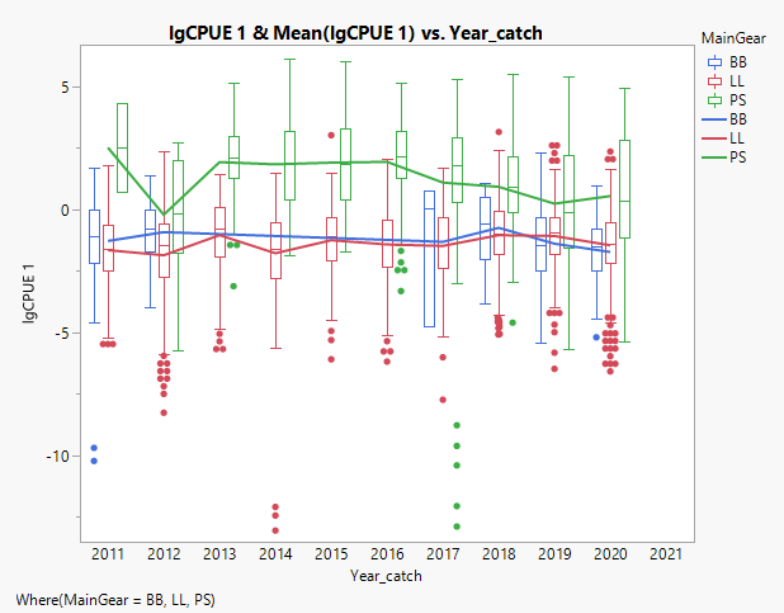



**Figure 21.25.3**. Distribution of the log-nominal E-BFT CPUEs (tones per day fishing) for the main fishing gears by year from the weekly dBase 2011 – 2020. Note that these CPUEs do not necessarily reflect the same treatment of the data as used to develop indices to monitor stock relative abundance.

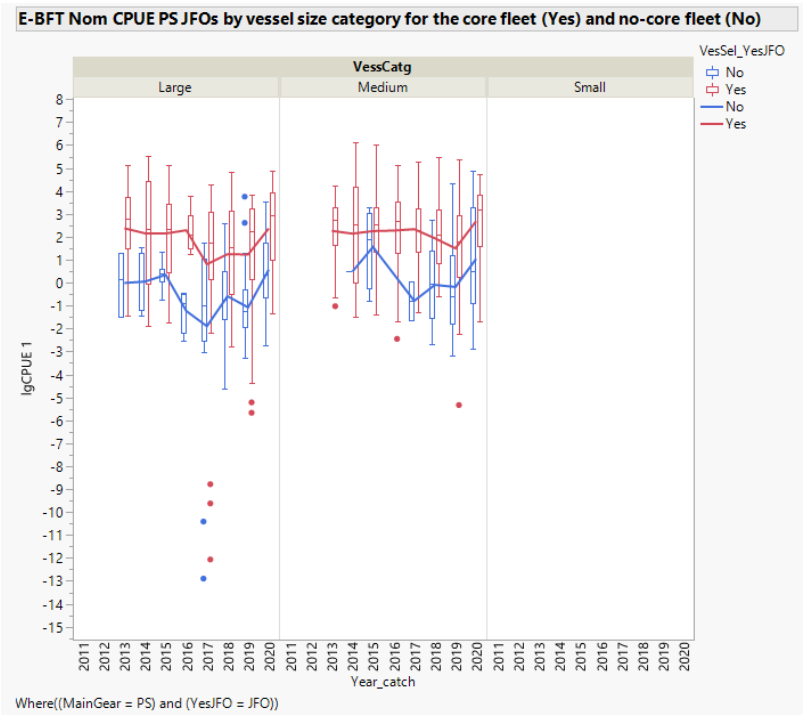



**Figure 21.25.4.** Distribution of E-BFT nominal log-CPUE (tonnes per day fishing) for the PS fleet registered as JFOs by vessel size category and "core" (Yes) vs rest of PS fleet (No) fleet 2013-2020.


**Figure 21.25.5.** Distribution of E-BFT nominal log-CPUE for the LL fleets standard fishing operations by vessel size category (Large, Medium, Small) and "core" (Red lines) *vs.* rest of LL fleet (Blue lines) fleet for the period 2013-2020.

**Table 21.25.5.** Preliminary estimates of nominal catch rates (CPUE, tones per day fishing) by vessel gear type, size category, and whether in JFO fishing operation (shaded rows) or not. "Core Fleet" is composed of vessels with a minimum annual catch of 5 t and at least 4 years of BFT reported catch values provided are the mean and upper 90% confidence bounds (5% low, 95% upper) of by vessel observed catch rates from the BFT weekly report dbase 2013 – 2020.

| Vessel category | Core Fleet | JFO fishing | Nominal CPUE mean t/day fishing | low 95% CPUE | upp 95% CPUE |
|---|---|---|---|---|---|
| PS Large LOA >= 40 m | Yes | Yes | 13.14 | 0.38 | 147.92 |
| PS Large LOA >= 40 m | No | No | 0.46 | 0.05 | 9.53 |
| PS Large LOA >= 40 m | No | Yes | 4.57 | 0.09 | 74.23 |
| PS Medium 24 <= LOA < 40 m | Yes | No | 15.37 | 1.82 | 90.76 |
| PS Medium 24 <= LOA < 40 m | Yes | Yes | 3.93 | 0.16 | 74.68 |
| PS Medium 24 <= LOA < 40 m | No | No | 1.06 | 0.03 | 25.87 |
| PS Medium 24 <= LOA < 40 m | No | Yes | 8.68 | 0.55 | 93.60 |
| PS Small LOA < 24 m | Yes | No | 1.61 | 1.18 | 2.21 |
| PS Small LOA < 24 m | No | No | 3.35 | 0.79 | 12.25 |
| LL Large LOA >= 40 m | Yes | No | 0.35 | 0.05 | 1.48 |
| LL Large LOA >= 40 m | No | No | 0.27 | 0.03 | 1.21 |
| LL Medium 24 <= LOA < 40 m | No | No | 0.03 | 0.00 | 0.16 |
| LL Small LOA < 24 m | Yes | No | 0.23 | 0.01 | 2.54 |
| LL Small LOA < 24 m | No | No | 0.10 | 0.01 | 2.26 |
| BB Medium 24 <= LOA < 40 m | Yes | No | 0.26 | 0.02 | 2.70 |
| BB Medium 24 <= LOA < 40 m | No | No | 0.25 | 0.01 | 3.92 |
| BB Small LOA < 24 m | Yes | No | 0.34 | 0.04 | 2.72 |
| BB Small LOA < 24 m | No | No | 1.00 | 1.00 | 1.00 |

The analysis will continue in 2022, with a focus on the estimation of average fishing activity by fleet components and estimation of fishing effort units for other gears such as the bluefin tuna traps. It is important to indicate, that the 2008 catch rates tables also provided an estimate of "Probable yields" by simply multiplying the catch rates times the number of register active vessels, and the Commission estimated fishing capacity by dividing the allocation by the catch rates. If the Commission intends to use newly provided CPUEs to calculate fishing capacity, it will be required to also have estimates of "potential fishing activity" in addition to the number of registered vessels, as the CPUE rates represent average catch (t) of bluefin per fishing activity (hours, days fishing, trip, etc.) and are NOT by year. Thus, simply multiplying these nominal CPUEs times the number of vessels will be inappropriate. Similarly, the catch rates from 2008 currently used by the Commission are not appropriate for fishing capacity calculations as noted in the *Report for Biennial Period 2018-2019, Part II (2019), Vol. 2.*

Given the current management regulations including seasonal closure/opening, quota allocation by CPC/vessel, and the type of fishing operation (JFO) that catch most of the bluefin tuna each year, an analysis of fishing effort needs to be done to estimate some equivalent unit of "potential number of days (trips)" per main gear and vessel category that can operate during a calendar year. Hence, this potential number of days * average CPUE per day would provide a more robust and consistent "annual probable yield" estimate.

Finally, it is noted that in 2020 Norway provided an SCRS document (Nøttestad *et al*., 2020) with an analysis of their purse seine fleet catch rates in the Northeast Atlantic. The SCRS invites CPCs to carry out their fleet catch rate analyses to contrast the results of the ongoing research study.

***21.26 SCRS to identify growth rates including in weight and size gains during the fattening period, and review and update the growth table published in 2009, and the growth rates utilized for farming the fish referred to under paragraph 35 c, and considering the difference among geographic areas (including Atlantic and Mediterranean) in updating the table. Rec. 20-07, para 8 (Rec. 19-04, para 28)***

**Background:** *28. The SCRS, on the basis of a standardized protocol to be established by the SCRS for the monitoring of recognizable individual fish, shall undertake trials to identify growth rates including in weight and size gains during the fattening period. Based on the result of the trials and other scientific information available, the SCRS shall review and update the growth table published in 2009, and the growth rates utilized for farming the fish referred to under paragraph 35 c, and present those results to the 2022 Annual meeting of the Commission. In updating the growth table, the SCRS should invite independent scientists who have appropriate expertise to review the analysis. The SCRS shall also consider the difference among geographic areas (including Atlantic and Mediterranean) in updating the table. Farm CPCs shall ensure that the scientists tasked by the SCRS for the trials can have access to and, as required by the protocol, assistance to carry out the trials. Farm CPCs shall endeavor to ensure that the growth rates derived from the eBCDs are coherent with the growth rates published by the SCRS. If significant discrepancies are found between the SCRS tables and growth rates observed, that information should be sent to the SCRS for analysis.*

In response to the request by the Commission, the SCRS initiated, through the GBYP, numerous farm-based field studies in different geographical areas and established a Subgroup to analyze the data and facilitate the elaboration of a single and coordinated answer, ensuring that the best scientific data would be provided to the Commission.

Limitations affecting the feasibility of providing sufficient data to update the table based on individual fish growth were identified in the planning phase of the studies. The tagging trials carried out showed that individual tagging had substantial impacts on survival and therefore would result in substantial loss of fish and commensurate losses. Thus, the representativeness of individual tagging is limited, and complementary methodological approaches had to be considered. The Subgroup concluded that different methodological approaches, from individual growth studies (based on tagging) and whole cage-based growth studies to a broader analysis based on the available length/weight data from stereo camera measurements at caging, harvesting sampling data and eBCDs, should be combined to address the Commission's request. A key finding of the new studies was that the previous assumption of only growth in weight in the farms was incorrect and new data provided increasing evidence of a faster increase in length during the farming period than for wild fish (Bridges *et al*., 2021, Alemany *et al*., 2021). There were also concerns that current L-W relationships (used to convert stereo camera length measurements to RWT) might not represent the L-W relationship applicable to certain geographical areas (Lino *et al*., 2021). The main outcomes of the various studies and analysis are summarized in Anon., 2021q.

The SCRS is mindful that the main use of the updated table/s (for different geographical areas) is for compliance purposes, and therefore the Commission needs values for maximum growth (clearly qualified) in farms under different environmental/farming conditions. Considering this objective and the importance of providing the best scientific advice possible, the SCRS believes that whilst sufficient progress had been made to put together preliminary updates of expected maximum growth in farms tables, the SCRS does not consider these final estimates as there are ongoing analyses of the data collected from the various studies.

Consequently, the Secretariat has put together two preliminary tables (Ortiz *et al*., 2021b). **Table 21.26.1** presents preliminary estimates of expected weight at harvest as function of the size/age at caging and the time (month) the fish is held in farms. **Table 21.26.2** shows the expected percent in weight gain by size/cage and caging time, compared to the weight at caging using the BFT weight size relationship for catches of the purse seine fleets in the Mediterranean Sea.

Due to time constraints, **Tables 21.26.1** and **21.26.2** only consider the whole farm caged fish population and are not split by geographical area or other parameters.

Completion of the finalized tables requires additional analyses. As these further analyses are completed, the objective will be to have definitive tables by 2022.

**Table 21.26.1.** Updated matrix table of the expected mean weight at harvest of farmed bluefin tuna as function of length and weight (straight fork length, FL; round weight, RWT) at caging (rows) and time in farms (columns, months after caging). The values in parenthesis correspond to the upper 90% confidence interval, which could be considered a reasonable proxy for the 'maximum' growth rate.

| | | Predicted wgt (kg) at harvest BFT farmed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Start Age | Size SFL cm | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 53 | | | | | | | | | |
| 2 | 77 | | | | | | | | | |
| 3 | 98 | | | | | | | | | |
| 4 | 118 | 57 (121) | 60 (124) | 63 (127) | 66 (131) | 69 (133) | 72 (137) | 75 (140) | 79 (143) | 82 (146) |
| 5 | 136 | 104 (168) | 107 (171) | 110 (175) | 113 (178) | 116 (181) | 120 (184) | 123 (187) | 126 (190) | 129 (193) |
| 6 | 152 | 146 (210) | 149 (213) | 152 (217) | 155 (220) | 158 (223) | 162 (226) | 165 (229) | 168 (232) | 171 (235) |
| 7 | 167 | 185 (250) | 188 (253) | 192 (256) | 195 (259) | 198 (262) | 201 (265) | 204 (268) | 207 (272) | 210 (275) |
| 8 | 180 | 219 (284) | 222 (287) | 226 (290) | 229 (293) | 232 (296) | 235 (299) | 238 (302) | 241 (306) | 244 (309) |
| 9 | 193 | 253 (318) | 257 (321) | 260 (324) | 263 (327) | 266 (330) | 269 (333) | 272 (337) | 275 (340) | 278 (343) |
| 10 | 204 | 282 (347) | 285 (350) | 289 (353) | 292 (356) | 295 (359) | 298 (362) | 301 (365) | 304 (369) | 307 (372) |
| 11 | 214 | 309 (373) | 312 (376) | 315 (379) | 318 (382) | 321 (385) | 324 (389) | 327 (392) | 330 (395) | 334 (398) |
| 12 | 223 | 332 (397) | 335 (400) | 338 (403) | 342 (406) | 345 (409) | 348 (412) | 351 (415) | 354 (418) | 357 (421) |
| 13 | 232 | 356 (420) | 359 (423) | 362 (426) | 365 (430) | 368 (432) | 371 (436) | 374 (439) | 378 (442) | 381 (445) |
| 14 | 240 | 377 (441) | 380 (444) | 383 (447) | 386 (451) | 389 (453) | 392 (457) | 395 (460) | 399 (463) | 402 (466) |
| 15 | 247 | 395 (459) | 398 (463) | 401 (466) | 405 (469) | 408 (472) | 411 (475) | 414 (478) | 417 (481) | 420 (484) |
| 16 | 253 | 411 (475) | 414 (478) | 417 (481) | 420 (485) | 423 (488) | 426 (491) | 430 (494) | 433 (497) | 436 (500) |
| 17 | 259 | 427 (491) | 430 (494) | 433 (497) | 436 (500) | 439 (503) | 442 (506) | 445 (510) | 448 (513) | 452 (516) |
| 18 | 264 | 440 (504) | 443 (507) | 446 (510) | 449 (513) | 452 (516) | 455 (520) | 458 (523) | 462 (526) | 465 (529) |
| 19 | 269 | 453 (517) | 456 (520) | 459 (523) | 462 (527) | 465 (529) | 468 (533) | 472 (536) | 475 (539) | 478 (542) |
| 20 | 273 | 463 (528) | 466 (531) | 470 (534) | 473 (537) | 476 (540) | 479 (543) | 482 (546) | 485 (549) | 488 (552) |
| 21 | 278 | 476 (541) | 480 (544) | 483 (547) | 486 (550) | 489 (553) | 492 (556) | 495 (559) | 498 (562) | 501 (566) |
| 22 | 281 | 484 (548) | 487 (552) | 491 (555) | 494 (558) | 497 (561) | 500 (564) | 503 (567) | 506 (570) | 509 (573) |
| 23 | 285 | 495 (559) | 498 (562) | 501 (565) | 504 (568) | 507 (571) | 510 (575) | 513 (578) | 517 (581) | 520 (584) |
| 24 | 288 | 503 (567) | 506 (570) | 509 (573) | 512 (576) | 515 (579) | 518 (582) | 521 (585) | 525 (589) | 528 (592) |
| 25 | 290 | 508 (572) | 511 (575) | 514 (578) | 517 (582) | 520 (584) | 524 (588) | 527 (591) | 530 (594) | 533 (597) |

**Table 21.26.2.** Updated matrix table of the expected mean percent weight gain of farmed bluefin tuna as function of length and weight (straight fork length, FL; round weight, RWT) at caging (rows) and time in farms (columns, months after caging). The values in parenthesis correspond to the upper 90% confidence interval, which could be considered a reasonable proxy for the 'maximum' growth rate.

| | | Expected percent wgt (kg) increase at harvest BFT farmed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Start Age | Size SFL cm | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 53 | | | | | | | | | |
| 2 | 77 | | | | | | | | | |
| 3 | 98 | | | | | | | | | |
| 4 | 118 | 87% (299%) | 97% (309%) | 108% (320%) | 118% (331%) | 128% (340%) | 138% (351%) | 149% (361%) | 159% (371%) | 169% (382%) |
| 5 | 136 | 127% (267%) | 134% (274%) | 141% (281%) | 148% (288%) | 154% (294%) | 161% (301%) | 168% (308%) | 175% (315%) | 181% (322%) |
| 6 | 152 | 130% (232%) | 135% (237%) | 140% (242%) | 145% (247%) | 150% (252%) | 155% (257%) | 160% (262%) | 165% (267%) | 170% (272%) |
| 7 | 167 | 123% (200%) | 126% (204%) | 130% (207%) | 134% (211%) | 137% (215%) | 141% (219%) | 145% (222%) | 149% (226%) | 153% (230%) |
| 8 | 180 | 112% (174%) | 115% (177%) | 118% (180%) | 121% (183%) | 124% (186%) | 127% (189%) | 130% (192%) | 133% (195%) | 136% (198%) |
| 9 | 193 | 100% (151%) | 102% (153%) | 105% (156%) | 107% (158%) | 110% (160%) | 112% (163%) | 115% (165%) | 117% (168%) | 120% (170%) |
| 10 | 204 | 90% (133%) | 92% (135%) | 94% (137%) | 96% (139%) | 98% (141%) | 100% (143%) | 102% (145%) | 104% (147%) | 106% (149%) |
| 11 | 214 | 80% (118%) | 82% (120%) | 84% (121%) | 86% (123%) | 87% (125%) | 89% (127%) | 91% (129%) | 93% (131%) | 95% (132%) |
| 12 | 223 | 72% (105%) | 74% (107%) | 75% (109%) | 77% (110%) | 79% (112%) | 80% (114%) | 82% (115%) | 83% (117%) | 85% (118%) |
| 13 | 232 | 64% (94%) | 66% (95%) | 67% (97%) | 69% (98%) | 70% (100%) | 72% (101%) | 73% (103%) | 74% (104%) | 76% (106%) |
| 14 | 240 | 58% (85%) | 59% (86%) | 60% (87%) | 62% (89%) | 63% (90%) | 64% (91%) | 65% (92%) | 67% (94%) | 68% (95%) |
| 15 | 247 | 52% (77%) | 53% (78%) | 55% (79%) | 56% (80%) | 57% (82%) | 58% (83%) | 59% (84%) | 61% (85%) | 62% (86%) |
| 16 | 253 | 47% (71%) | 49% (72%) | 50% (73%) | 51% (74%) | 52% (75%) | 53% (76%) | 54% (77%) | 55% (78%) | 56% (80%) |
| 17 | 259 | 43% (65%) | 44% (66%) | 45% (67%) | 46% (68%) | 47% (69%) | 48% (70%) | 49% (71%) | 50% (72%) | 51% (73%) |
| 18 | 264 | 39% (60%) | 40% (61%) | 41% (62%) | 42% (63%) | 43% (64%) | 44% (65%) | 45% (66%) | 46% (67%) | 47% (68%) |
| 19 | 269 | 36% (55%) | 37% (56%) | 38% (57%) | 39% (58%) | 40% (59%) | 41% (60%) | 42% (61%) | 43% (62%) | 44% (63%) |
| 20 | 273 | 33% (52%) | 34% (53%) | 35% (54%) | 36% (55%) | 37% (55%) | 38% (56%) | 39% (57%) | 40% (58%) | 40% (59%) |
| 21 | 278 | 30% (48%) | 31% (48%) | 32% (49%) | 33% (50%) | 33% (51%) | 34% (52%) | 35% (53%) | 36% (54%) | 37% (54%) |
| 22 | 281 | 28% (45%) | 29% (46%) | 30% (47%) | 31% (48%) | 31% (48%) | 32% (49%) | 33% (50%) | 34% (51%) | 35% (52%) |
| 23 | 285 | 26% (42%) | 26% (43%) | 27% (44%) | 28% (44%) | 29% (45%) | 30% (46%) | 30% (47%) | 31% (47%) | 32% (48%) |
| 24 | 288 | 24% (40%) | 25% (40%) | 25% (41%) | 26% (42%) | 27% (43%) | 28% (43%) | 28% (44%) | 29% (45%) | 30% (46%) |
| 25 | 290 | 23% (38%) | 23% (39%) | 24% (40%) | 25% (40%) | 26% (41%) | 26% (42%) | 27% (43%) | 28% (43%) | 29% (44%) |

***21.27 SCRS advice, not later than 2022, on possible extension on the fishing seasons for different gear types and/or fishing areas, without negatively influencing the stock development and by ensuring the stock is managed sustainably. Rec. 20-07, para 9 (Rec. 19-04, para 33)***

**Background:** *33. 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.*

No new information was presented to the Committee on this matter in 2021. The Committee has no scientific basis to recommend any particular fishing season configuration at this time.

The Committee has never provided advice on the appropriate length or timing of fishing seasons in relation to stock development, and the length of current fishing seasons was determined without the Committee's input.

In addition, as was said in 2020, this request is broad in scope considering the diversity of fleets, spatial coverage and seasonality. The Committee requests more details on the questions to be addressed in order to undertake the appropriate data compilation and analysis. Specific objectives of the request would be helpful given that some CPC fleets could not fill their quota during the fishing season. Assuming clarification is provided by the Commission to the SCRS in 2021 a response could be available for 2022.

***21.28 The SCRS shall report on National observer programmes. Rec. 19-04, para 83***

**Background:** *For the scientific aspect 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 that data. The SCRS shall also provide any recommendations to improve the effectiveness of CPCs observer programmes.*

No new information was provided in 2020 and 2021, possibly due to the constraints imposed by the global pandemic crisis. Therefore, the Committee was unable to review the methodologies used to estimate live and dead discards. Hopefully, this very important issue will be revisited once the pandemic is over, or its impact is reduced to a level that will allow more field work to be conducted.

***21.29 Programmes to estimate the number and weight of bluefin tuna to be caged – The SCRS should evaluate such procedures and results and report to the Commission. Rec. 19-04, para 99***

**Background:** *A programme using stereoscopic cameras systems or alternative methods that guarantee the same level of precision and accuracy shall cover 100% of all caging operations, in order to refine the number and weight of the fish. This programme using stereoscopic cameras shall be conducted in accordance with the procedures set out in Annex 9. In case of the use of alternative methods, those methods should be duly analysed by the SCRS, who should present its conclusions regarding their precision and accuracy for endorsement by the Commission during its Annual meeting before an alternative methodology can be considered valid for the purpose of monitoring the caging operations.*

*The quantities derived in the programme shall be used to decide if releases are required and the caging declarations and relevant sections of the eBCD shall be completed accordingly. When a release order has been issued, the farm operator shall request the presence of a national enforcement authority and an ICCAT regional observer to monitor the release.*

*The results of this programme shall be submitted by 15 September annually to the SCRS by all farming CPCs. The SCRS should evaluate such procedures and results and report to the Commission by the Annual meeting*

The specific analyses of transfer records to estimate minimum sample size that is representative of the bluefin tuna being caged have not been carried out yet, since full raw data from stereo camera videos are not still available to the Secretariat. If this is provided to the Secretariat, an ad hoc study on this matter could be planned and carried out within GBYP Phase 12. However, data from some growth in farms studies developed by the GBYP throughout 2020 and 2021 suggest that to allow fully representative and accurate analyses of the lengths and weight distributions at caging and harvesting, the current percentages of measured fish in such operations should be evaluated.

***21.30 SCRS shall provide new advice on the TAC for the following year when the goal of maintaining the biomass around B0.1 (to be achieved by fishing at or less than F0.1) is not achieved and the objectives of this plan are in danger. Rec. 19-04, para 114***

**Background:** *When, as a result of a scientific evaluation, the goal of maintaining the biomass around B0.1 (to be achieved by fishing at or less than F0.1) is not achieved and the objectives of this plan are in danger, the SCRS shall provide new advice on the TAC for the following year.*

The Committee concluded that there is no evidence to recommend a change in the current TAC advice for 2022. Further details are provided in the response 21.24 of this report.

***21.31 Standards and procedures for stereoscopic cameras systems in the context of caging operations Rec. 19-04, Annex 9, item 1 iii***

**Background:** *When the length measurements of the fish present a multi-modal distribution (two or more cohorts of distinct sizes), it shall be possible to use more than one conversion algorithm for the same caging operation. The most up to date algorithm(s) established by SCRS shall be used to convert the fork length of a single fish into weight, according to the size category of the fish measured during the caging operation.*

One recent study was presented to the SCRS related to length-weight relationships for bluefin tuna in the Gulf of Cadiz/Southern cost of Portugal (Lino *et al*., 2021), using data collected over 15 years from the Portuguese traps.

The Committee recommends using this new equation (1) for bluefin tuna that have a low condition factor, while migrating out of the Mediterranean after spawning, during the period June to August, that are caught by Portuguese traps:

$$RWT = 6.116E10^{-5} * SFL^{2.7494} \quad (1)$$ (Lino *et al.*, 2021)

where, RWT is the round weight (in kg) and SFL is the straight fork length (cm).

In addition, differences were found in the length-weight relationship from the Atlantic Moroccan trap data with the equation of Deguara *et al*., 2017. The Committee pointed out that the L-W equation applicable by Rodriguez-Marin *et al*., 2015 best fitted the Moroccan Atlantic catches transferred to cages.

With the adoption of the new Portuguese L-W equation, the Committee recommends four different equations to be used by the stereoscopic-system for the estimation of the BFT catches transferred to cages: Atlantic Moroccan traps (Rodriguez-Marin *et al*., 2015), Portuguese traps for the period June to August (Lino *et al*., 2021), purse seine catches for juveniles in the Adriatic Sea (Katavic *et al*., 2018) and purse seine catches in the Mediterranean (Deguara *et al*., 2017).

***21.32 SCRS shall review the specifications and, if necessary, provide recommendations to modify them. Rec. 19-04, Annex 9, item vi***

**Background:** *The report on the results of the stereoscopical 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.*

The Committee attended and revised some technical specifications on the procedures for the use of stereoscopic camera systems in the context of caging operations, as indicated in the responses to the Commission's requests: items 21.29, 21.31 and 21.33 of this report. The Committee will continue this process and revise other aspects of the technical specifications, such as the sampling methodology being applied at caging and the distances between the sampled fish and the stereo camera.

Recent advances in automatized techniques to measure caged fish have been presented in some SCRS documents and Panel 2 meetings and have the potential for future relevance. Furthermore, if these novel techniques are implemented, it would be easy to increase the percentage of sampled fish, up to a very high percentage at a lower cost.

***21.33 Method proposed for the calculation of a margin of error and range of the stereoscopic camera system, Rec. 19-04, Annex 9, section 2***

**Background:** *In accordance with what was agreed at the Intersessional Meeting of Panel 2 (March 2020) «Clarify section 2 of Annex 9 of Rec. 19-04, paragraph iii concerning the determination of the percentage range».*

During the Second Intersessional Meeting of Panel 2 (*13-15 September 2021*) the Chair requested to the SCRS to review and comment on the methods proposed in Annex 9 for the calculation of:

- Margin of error, and
- Range of the stereoscopic camera system

Currently used to estimate weight of bluefin tuna from the stereoscopic size measures and the information provided by the software package. The use of these estimates is indicated in the draft version of the Rec 19-04 paragraphs 167, 169, 178, 181. And more explicit in Annex 9, where this margin of error should be below + 5%, and the lower and upper range are used to verify values in eBCD, catch monitoring, and determine release procedures if applicable.

The proposed method is a 5-step calculation that uses the size measurement input of each fish measured, the estimated round weight (RWT) of each fish (using a user-defined weight-size relationship), the margin of size measure error (error%) provided by the software, the count of fish measured, and the total number of fish counted in the recording file (total count). The total number of fish count in the video file, as indicated by positive count (passing from donor cage to recipient cage) and discounting those counted fish in the opposite direction (negative count). It is expected that this video file will cover all fish transferred during a caging operation, therefore the estimated average weight times the total number of fish will correspond to the total weight of caged fish.

For the review and analysis, the Secretariat provided an example of stereo camera EXCEL file results commonly provided by CPCs, and from which data input for the calculations is expected. From this input data, the estimates of the mean, minimum, maximum, standard deviation, and number of observations for size and weight can be obtained. The proposed method then uses the size percent error to estimate a SFL minimum size, and SFL max size for each measurement, and their respective RWT minimum and RWT maximum values. Using these estimates by fish, the average round weight range is provided as the average of the RWT minimum estimates and the average maximum RWT. Step 4 estimates a margin of error percent on weight, simply as half the range divided by the average weight of the fish measured. In step 5 it is estimated the total weight of the fish caged and counted in the video file, as the average weight times the number of fish counted (total count), and using the percent weight error, they also provide a low and high range for this total weight.

Conclusions:

- This procedure simply uses the size error measurement from the video file and software to estimate some range for the estimated total biomass of caged fish.

- The procedures are computationally correct.

**Albacore**

***21.34 Taking into account relevant scientific advice, the Commission shall review, and revise Rec. 17-04 as amended by this Recommendation and Rec. 16-06 as amended by Rec. 20-03, including consolidation of relevant provisions into a single recommendation at its 2021 Commission meeting. Rec. 20-04, para 4 (18)***

**Background:** *18. This Recommendation amends paragraphs 3 and 4 of Rec. 16-06 and does not set a precedent for future implementation of HCRs. Taking into account relevant scientific advice, the Commission shall review and revise Rec. 17-04 as amended by this Recommendation and Rec. 16-06 as amended by Rec. 20-03, including consolidation of relevant provisions into a single recommendation at its 2021 Commission meeting.*

Following the Intersessional Meeting of Panel 2, the Committee was requested to:

1. Review the "ALB EC Protocol for SCRS review.doc".
2. Provide its plan to formalize i) a set of data to be used; and ii) stock assessment methods.

In response to item 1, during the Albacore Species Group meeting held in June (Anon. 2021m) the draft exceptional circumstances protocol distributed by PA2 Chair was revised. The review consisted mostly of specific edits and comments directly on the file "ALB EC Protocol for SCRS review.doc".

During the review of the protocol, the Committee tried to use the available scientific basis to inform the different alternatives proposed by PA2 in the indicators table. However, although the Committee has conducted substantial effort on the ALB MSE, the tests conducted so far are not enough to fully determine the number of CPUE series that need to be available and the percentage by which catch data are underreported, that would trigger an exceptional circumstance. While future tests could further inform these indicator values, the Committee is confident that the proposed indicators would be effective in detecting exceptional circumstances.

MSE testing was able to inform on the indicator for TAC implementation. A scenario (Bank and Borrow, Table 4 in Appendix 13), in which TAC is alternately 20% higher ("borrowing") and 20% lower ("banking") than TAC, has been tested within the MSE. Stock status objectives were achieved in this scenario, albeit with decreased stability in yield. On this basis, exceptional circumstances would be triggered if annual catch exceeded the TAC by more than 20%. It should be noted that successive years with catch exceeding TAC by 20% or more have not been tested in the MSE.

In response to item 2, an extract from Table 3 of the ALB Executive Summary (*Report for Biennial Period 2020-2021, Part I (2020), Vol. 2*) is shown below with the data and assessment specifications required to adopt the Management Procedure, that has been tested through MSE. These two components combined with the harvest control rule (HCR) and exceptional circumstances protocol provide the necessary technical specifications to assemble a full MP.

North Atlantic albacore specifications for the management procedure (MP) (from **ALB-Table 3** Executive Summary; *Report for Biennial Period 2020-2021, Part I (2020), Vol. 2*):

- Indices:

| *Index* | *First year* |
|---|---|
| Chinese Taipei LL late | 1999 |
| Japan bycatch LL | 1988 |
| Spanish baitboat | 1981 |
| US LL | 1987 |
| Venezuelan LL | 1991 |

- Software: *mpb*
- Model: Fox (biomass dynamic), with the following specifications:
- Catch time series start year: 1930
- Catch and CPUE time series final year: t-1 preferably (t-2 otherwise) where *t* is the year of the MP iteration (when the TAC is set for year *t*+1, *t*+2 and *t*+3).
- Biomass at the start of the time series = K
- Variance treatment for the CPUE indices: model weighted

## 22. Other matters

### *22.1 Update of Chapter 2 of the ICCAT Manual*

The Secretariat informed the Committee that three contracts were issued by the Secretariat to update seven subchapters of the small tunas (bonito, *Sarda sarda*; bullet tuna, *Auxis rochei*; frigate tuna, *Auxis thazard*; king mackerel, *Scomberomorus cavalla*; little tunny, *Euthynnus alletteratus*; Spanish mackerel, *Scomberomorus maculatus*; and blackfin tuna, *Thunnus atlanticus*) and nine subchapters of the sharks (blue shark, *Prionace glauca*; shortfin mako, *Isurus oxyrinchus*; porbeagle, *Lamna nasus*; common thresher, *Alopias vulpinus*; bigeye thresher, *Alopias superciliosus*; oceanic whitetip, *Carcharhinus longimanus*; scalloped hammerhead, *Sphyrna lewini*; smooth hammerhead, *Sphyrna zygaena*; and great hammerhead, *Sphyrna mokarran*) species sections of the ICCAT Manual Chapter 2.

Two of the contracts also include developing new subchapters for four small tunas species (plain bonito, *Orcynopsis unicolor*; wahoo, *Acanthocybium solandri*; serra Spanish mackerel, *Scomberomorus brasiliensis*; and cero, *Scomberomorus regalis*) and for four shark species (silky shark, *Carcharhinus falciformis*; longfin mako; *Isurus paucus*; crocodile shark, *Pseudocarcharias kamoharai*; and pelagic stingray, *Pteroplatytrygon violacea*).

These updated and new species subchapters that are being revised by contracted SCRS scientists will be possibly made available during the SCRS Plenary, and will enable the SCRS (and particularly the Small Tunas and Shark Species Groups) to review the new material in 2022 at the latest.

### *22.2 Election of the SCRS Chair*

Following ICCAT Circular #2584 of 20 April 2021, the Secretariat received two nominations for the position of SCRS Chair. However, these nominations were withdrawn after ICCAT Circular #4051 was disseminated on 9 June 2021, in which it was announced that the current SCRS Chair is available to continue serving in that position for another year.

Accordingly, Dr Gary Melvin (Canada) will remain as SCRS Chair until the end of 2022. Since the current Vice Chair will not be continuing, the Chair informed the Committee that his choice for the Vice Chair position is Dr Haritz Arrizabalaga (EU-Spain).

The Committee thanked Dr Rui Coelho for his dedication and hard work as SCRS Vice Chair during the past three years. In addition, it congratulated Dr Haritz Arrizabalaga for his availability to serve as Vice Chair until the end of 2022.

### *22.3 Exemptions from reporting requirements SHK 7005 and BIL 5001*

Several CPCs (i.e. *Billfish*: Algeria, Norway and Turkey; *Sharks*: Algeria, and Norway) submitted to the Secretariat requests for exemption of the requirement to submit information to the Commission regarding the implementation of billfish and shark conservation measures.

In 2019 the Shark and Billfish Species Groups provided the Committee a set of *Guidelines to assess the CPs requests for exemptions from reporting requirements SHK 7005 and BIL 5001*. The Committee considered those above preliminary guidelines and agreed that these should be further developed and reviewed in 2020 (item 20.6 of the *Report for Biennial Period 2018-2019, Part II (2019), Vol. 2*).

The Committee did not review those guidelines in 2020, nor in 2021. Accordingly, the current reporting requirements shall continue. This issue will be address in 2022.

## 23. Adoption of report

The following sections of this report were adopted by correspondence between June and August 2021: 1, 8.1, 8.2, 8.3, 8.4, 8.8, 8.10, 8.11, 8.12, 8.13, 9.3 (partially), 10.2, 14, 19.1.1, 19.1.3, 19.1.7, 19.1.8, 19.1.10, 20.1.1, 20.1.3, 20.1.7, 20.1.8, 20.1.10, 20.2.1, 20.2.3, 20.2.7, 20.2.8, 20.2.10, 21.12, 21.13, 21.32, 22.1 and 22.2 (partially).

Canada and the US presented a joint statement regarding the process the SCRS used in 2021 to adopt its Annual Report (**Appendix 17**).

The Chair thanked the SCRS for its hard work this year. Dr Melvin thanked the Secretariat staff for their excellent work, as well as appreciating their professional attitude, particularly noted within a difficult framework. Dr Melvin then expressed his appreciation towards the interpreters and to all participants.

The Report of the 2021 SCRS meeting was adopted and the 2021 Meeting of the SCRS was adjourned.

## APPENDICES

**Appendix 1**

### Opening address by Mr. Camille Jean Pierre Manel, ICCAT Executive Secretary

SCRS Chair and Vice Chair,
Species Groups Rapporteurs,
Scientific Delegates,
Dear Partners,
Interpreters,
Dear colleagues,

Good morning, good afternoon,

With renewed pleasure, I would like to extend a very warm virtual welcome to you all and I hope that you and your families are well. We meet this year in this unprecedented virtual format of SCRS meeting since it is not possible to hold an in-person meeting, due to the consequences of the terrible COVID-19 pandemic that we have been experiencing for at least the past 18 months, and which has entailed significant changes at all levels. At this point, please allow me to pay huge tribute to all our colleagues who are departed. I am thinking in particular of the chair Dr Fábio Hissa Vieira Hazin who was known by all and will be greatly missed.

I would like to kindly thank and commend all the scientists, as well as my colleagues at the Secretariat, for the immense efforts made throughout this year which continues to be marked by the pandemic. This work has enabled significant progress to be made on many issues so as to provide the basis, invariably much anticipated by the Commission, for its decision making. However, it should be noted that these results have thrown up challenges, following the upward trajectory in number of meetings over the course of this very intense year. This increase, which has been structural for the past few years, is a major challenge for us all, and I am referring to both the SCRS and the Secretariat.

For the Secretariat's part, allow me, Chair, dear colleagues, to highlight that this situation is becoming untenable, as it compromises the quality of our contribution. By way of illustration, we have experienced a 127% increase in the number of meetings compared to the average between 2007 and 2012 and an 82% increase compared to the average between 2013 and 2019, without a similar increase in human resources to adequately absorb this surplus, scientific/statistics resources having only increased by 17% compared to 2013. The number of reports produced follows the same upward trend while the number of translators has remained the same since 2004. Finally, the number of meeting days and participants also follows the same pattern. The resulting work is a real threat to staff as well as to our performance. This does not mean, however, that the Secretariat does not wish to meet its responsibilities, but rather that it reaffirms that we wish to continue to provide the best service to support both SCRS work and the work of the various Commission bodies. A solution which reconciles a limitation on the number of meetings and an adjustment of Secretariat resources appears to be imperative, and part of this solution undoubtedly lies with the SCRS.

Furthermore, mindful of the sheer size of your scientific agenda with the multiplicity of very complex issues, I request an additional contribution from you with a view to building a solution. In addition, you can rest assured that the Secretariat's commitment, which is invariably unwavering, is renewed for greater success in achieving the Commission objectives.

Before finishing, I would like to thank the Secretariat staff once again for its tireless work over the course of the year as well as last week so as to provide the bulk of the documents ahead of the meeting.

Finally, to end on a hopeful note, I would like to express the wish for us to meet in person in all our upcoming meetings.

I wish you every success in your work.

Stay healthy!

Thank you for your kind attention!

**Appendix 2**

## 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 Secretariat activities in research and statistics
7. Review of national fisheries and research programmes
8. Reports of inter-sessional SCRS meetings
   - 8.1 2020 Third Intersessional Meeting of the Bluefin Species Group
   - 8.2 Intersessional Meeting of the Billfishes Species Group
   - 8.3 Tropical Tunas MSE Technical Group Meeting
   - 8.4 First Intersessional Meeting of the Bluefin Species Group (and western BFT data prep)
   - 8.5 Bluefin Tuna MSE Technical Group meeting
   - 8.6 Second Intersessional Meeting of the Bluefin Tuna Species Group
   - 8.7 Western Bluefin Tuna Stock Assessment Meeting
   - 8.8 Bigeye Tuna Data Preparatory Meeting
   - 8.9 Bigeye Tuna Stock Assessment Meeting
   - 8.10 Working Group on Stock Assessment Methods Meeting
   - 8.11 Small Tunas Species Group intersessional Meeting
   - 8.12 Swordfish Species Group intersessional Meeting
   - 8.13 Albacore Species Group intersessional Meeting (and Mediterranean ALB stock assessment)
9. Executive Summaries on species:
   - 9.1 BET-Bigeye Tuna
   - 9.2 W-BFT-Western Bluefin Tuna
   - 9.3 ALB-MED-Mediterranean Albacore
   - 9.4 Task 1 catches for all major ICCAT species (excluding those contained in items 9.1 to 9.3 of this report
10. Reports of Research Programmes

10.1 Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)

10.2 Atlantic Ocean Tropical tuna Tagging Programme (AOTTP)

10.3 Small Tunas Year Programme (SMTYP)

10.4 Shark Research and Data Collection Programme (SRDCP)

10.5 Enhanced Billfish Research Programme (EBRP)

10.6 Other Research Programs (on Albacore and Swordfish)

11. Report of the Subcommittee on Statistics

12. Report of the Subcommittee on Ecosystems and Bycatch

13. Discussions at the Intersessional Meetings of Panel 1 relevant to the SCRS

14. Discussions at the Intersessional Meetings of Panel 2 relevant to the SCRS

15. Discussions at the Intersessional Meeting of Panel 4 relevant to the SCRS

16. Discussions at the Intersessional Meeting of IMM relevant to the SCRS

17. Progress related to work developed on MSE

17.1 Work conducted for northern albacore

17.2 Work conducted for bluefin tuna

17.3 Work conducted for northern swordfish

17.4 Work conducted for tropical tunas

17.5 Review the Roadmap for the ICCAT MSE processes adopted by the Commission in 2019

18. Update of the stock assessment software catalogue

19. Consideration of plans for future activities

19.1 Annual workplans and research programmes

19.1.1 Subcommittee on Ecosytems and Bycatch workplan

19.1.2 Subcommittee on Statistics workplan

19.1.3 Albacore workplan

19.1.4 Billfish workplan

19.1.5 Bluefin tuna workplan

19.1.6 Sharks workplan

19.1.7 Small tunas workplan 2021-2023

19.1.8 Swordfish workplan

19.1.9 Tropical Tunas workplan

19.1.10 Methods workplan (WGSAM)

19.2 Intersessional meetings proposed for 2022

19.3 Date and place of the next meeting of the SCRS

20. General recommendations to the Commission

20.1 General recommendations to the Commission that have financial implications

20.1.1 Subcommittee on Ecosystems and Bycatch

20.1.2 Subcommittee on Statistics

20.1.3 Albacore

20.1.4 Billfish

20.1.5 Bluefin tuna

20.1.6 Sharks

20.1.7 Small tunas

20.1.8 Swordfish

20.1.9 Tropical tunas

20.1.10 Working Group on Stock Assessment Methods (WGSAM)

20.2 Other general recommendations

20.2.1 Subcommittee on Ecosystems and Bycatch

20.2.2 Subcommittee on Statistics

20.2.3 Albacore

20.2.4 Billfish tuna

20.2.5 Bluefin tuna

20.2.6 Sharks

20.2.7 Small tunas

20.2.8 Swordfish

20.2.9 Tropical tunas

20.2.10 Working Group on Stock Assessment Methods (WGSAM)

21. Responses to the Commission's requests

22. Other matters

22.1 Update of Chapter 2 of the ICCAT Manual

22.2 Election of the SCRS Chair

22.3 Exemptions from reporting requirements SHK 7005 and BIL 5001

23. Adoption of report

**Appendix 3**

## List of participants [1]

### *CONTRACTING PARTIES*

### ALGERIA

**Benounnas**, Kamel
Chrecheur, Centre National pour le développement de la Pêche et de l'Aquaculture - CNRDPA, 11 Boulevard Colonel Amirouche, 42000, Tipaza
Tel: +213 243 26410, Fax: +213 243 26412, E-Mail: kamel_benounnas@yahoo.fr

**Ferhani**, Khadra
Centre National de Recherche et de Développement de la Pêche et de l'Aquaculture (CNRDPA), 11 Boulevard Colonel Amirouche, BP 67, 42415, Tipaza
Tel: +213 550 735 537, Fax: +213 24 32 64 10, E-Mail: ferhani_khadra@yahoo.fr; ferhanikhadra@gmail.com

**Kouadri-Krim**, Assia
Sous-Directrice infrastructures, industries et services liés à la pêche, Ministère de la Pêche et des Productions Halieutiques, Direction du développement de la pêche, Route des Quatre Canons, 1600
Tel: +213 558 642 692, Fax: +213 214 33197, E-Mail: assia.kouadri@mpeche.gov.dz; assiakrim63@gmail.com

**Moussa**, Mennad
11 boulevard Colonel amirouche. Bouismail Tipasa, 42044
Tel: +213 560 285 239, E-Mail: mennad.moussa@gmail.com

### BRAZIL

**Cardoso**, Luis Gustavo
Federal University of Rio Grande - FURG, Neslon da Silva Fangueiro Street, number 266, 96217292, Rio Grande - RS
Tel: +55 53 999010168, E-Mail: cardosolg15@gmail.com

**Costa Beltrão**, Tatiana *
Laboratório de Ecologia Marinha - Departamento de Pesca e Aquicultura - UFRPE, Rua Dom Manuel de Medeiros, s/n, Dois Irmãos, 52171900, Recife, Pernambuco
Tel: +55 819 972 88025, E-Mail: tatiana.beltrao.ac@hotmail.com

**Crespo**, Osman *
Marine Biologist, Universidade Federal Rural de Pernembuco, Rua Prf. Doutor Frederico Machado, 9901-862
Tel: +351 913 112 367, E-Mail: osman.crespo@gmail.com

**Ferreira de Amorim**, Alberto *
Professor, Centro de Pesquisa Pesqueira Marinha do Instituto de Pesca, Avenida Bartholomeu de Guzmao, 192, 11030-906, Santos
Tel: +55 13 3261 6571; +1 399 708 1779, Fax: +55 13 3467 4952, E-Mail: prof.albertoamorim@gmail.com

**Frédou**, Thierry *
Professor Associado, Universidade Federal Rural de Pernambuco - UFRPE, Departamento de Pesca e Aquicultura - DEPAq, Rua Dom Manuel Medeiros s/n - Dois Irmaos, CEP 52171-900, Recife/Pernambuco
Tel: +55 81 996 411 154, E-Mail: thierry.fredou@ufrpe.br

**Gomes Pimenta**, Eduardo
Coordenador de Grupo de Pesquisa e Extensão em Estudos da Pesca\GEPesca - UVA– Campus Cabo Frio, Universidade Veiga de Almeida - UVA, Estrada de Perynas, s/n, Campus Cabo Frio, CEP: 28.901-970, Recife
Tel: +55 22 2647 1600 ramal 1658/1659; +55 22 997 940 160, Fax: E-Mail: epimenta@uva.br

**Leite Mourato**, Bruno
Profesor Adjunto, Laboratório de Ciências da Pesca - LabPesca Instituto do Mar - IMar, Universidade Federal de São Paulo - UNIFESP, Rua Carvalho de Mendoça, 144, Encruzilhada, 11070-100, Santos, SP
Tel: +55 1196 765 2711, Fax: +55 11 3714 6273, E-Mail: bruno.mourato@unifesp.br; bruno.pesca@gmail.com; mourato.br@gmail.com

[1] Delegates who only participated in the Species Groups.

**Lucena Frédou**, Flávia
Profesora Titular, Universidade Federal Rural de Pernambuco, Depto. de Pesca e Aquicultura, Rua Dom Manoel de Medeiros, s/n, Dois Irmãos, CEP: 51020-180, Recife/Pernambuco
Tel: +55 81 9641 0885, Fax: E-Mail: flavialucena@hotmail.com

**Martins**, Karla *
Marine ecology lab, DEPAq/UFRPE, R. Dom Manuel de Medeiros, s/n - Dois Irmãos, CEP: 52171-900, Recife, Pernambuco
Tel: +55 819 356 0269, E-Mail: kmartins.tuna@gmail.com

**Sant'Ana**, Rodrigo
Researcher, Laboratório de Estudos Marinhos Aplicados - LEMA Ecola do Mar, Ciência e Tecnologia - EMCT, Universidade do Vale do Itajaí - UNIVALI, Rua Uruquai, 458 - Bloco E2, Sala 108 - Centro, Itajaí, CEP 88302-901, Santa Catarina
Tel: +55 (47) 99627 1868, Fax: E-Mail: rsantana@univali.br

**Silva Batista**, Guelson *
Professor, UFERSA, Av. Francisco Mota, 572 - Bairro Costa e Silva, 59.625-900, Mossoró, Rio Grande do Norte
Tel: +55 859 850 32723, E-Mail: guelson@ufersa.edu.br

**Travassos**, Paulo Eurico
Professor, Universidade Federal Rural de Pernambuco - UFRPE, Laboratorio de Ecologia Marinha - LEMAR, Departamento de Pesca e Aquicultura - DEPAq, Avenida Dom Manuel de Medeiros s/n - Dois Irmãos, CEP 52171-900, Recife
Tel: +55 81 998 344 271, E-Mail: pautrax@hotmail.com; paulo.travassos@ufrpe.br

## CANADA

**Bowlby**, Heather *
Fisheries and Oceans, 1 Challenger Drive, Dartmouth, Nova Scotia, B2Y 4A2
Tel: +1 902 426 5836; +1 902 456 2402, Fax: +1 902 426 1506, E-Mail: heather.bowlby@dfo-mpo.gc.ca

**Duprey**, Nicholas
Senior Science Advisor, Fisheries and Oceans Canada - Fish Population Science, Government of Canada, 200-401 Burrard Street, V6C 3R2, Vancouver, BC
Tel: +1 604 499 0469; +1 250 816 9709, Fax: E-Mail: nicholas.duprey@dfo-mpo.gc.ca

**Gillespie**, Kyle
Fisheries and Oceans Canada, St. Andrews Biological Station, Population Ecology Division, 125 Marine Science Drive, St. Andrews, New Brunswick, E5B 0E4
Tel: +1 506 529 5725, Fax: +1 506 529 5862, E-Mail: kyle.gillespie@dfo-mpo.gc.ca

**Hanke**, Alexander
Scientist, St. Andrews Biological Station, Fisheries and Oceans Canada, 531 Brandy Cove Road, E5B 2L9, St. Andrews
Tel: +1 506 529 5912, Fax: +1 506 529 5862, E-Mail: alex.hanke@dfo-mpo.gc.ca

**Hordyk**, Adrian *
3048 Point Grey Rd, V6K 1B1, Vancouver
Tel: +1 604 992 6737, E-Mail: adrian@bluematterscience.com; a.hordyk@oceans.ubc.ca

**Minch**, Taryn *
Fisheries and Oceans Canada, St. Andrews Biological Station, 125 Marine Science Drive, E5B 0E4, St. Andrews, NB
Tel: +1 506 608 0171, E-Mail: taryn.minch@dfo-mpo.gc.ca

## CHINA, (P. R.)

**Feng**, Ji
Shanghai Ocean University, 999 Hucheng Huan Rd, 201306, Shangai
Tel: +86 159 215 36810, E-Mail: 276828719@qq.com; f52e@qq.com

**Zhang**, Fan
Shanghai Ocean University, 999 Hucheng Huan Rd, 201306, Shangai
Tel: +86 131 220 70231, E-Mail: f-zhang@shou.edu.cn

**Zhu**, Jiangfeng
Professor, Shanghai Ocean University, College of Marine Sciences, 999 Hucheng Huan Rd., 201306, Shanghai
Tel: +86 21 619 00554; +86 156 921 65061, Fax: +86 21 61900000, E-Mail: jfzhu@shou.edu.cn

## CÔTE D'IVOIRE

**Diaha**, N'Guessan Constance
Chrecheur Hydrobiologiste, Laboratoire de biologie des poissons du Département des Ressources Aquatiques Vivantes (DRAV) du Centre de Recherches Océanologiques (CRO), 29, Rue des Pêcheurs - B.P. V-18, Abidjan 01
Tel: +225 21 35 50 14; +225 21 35 58 80, E-Mail: diahaconstance@yahoo.fr; constance.diaha@cro-ci.org

## EGYPT

**Abdelnabi Fetouh**, Mohamed
Researcher, National Institute of Oceanography and Fisheries (NIOF), 14 Aly Abn Aby Taalep, Abo Qir, 11694, Alexandria, Cairo
Tel: +202 279 21341, Fax: +202 792 1339, E-Mail: ma_fotouh@outlook.com

**Abdou Mahmoud Tawfeek Hammam**, Doaa
General Manager of Agreements Administration (GAFRD), General Authority for fish Resources Development, Plot 210 - Sector II - City Center - 5t assembly, 32102901, Cairo
Tel: +202 281 17010, Fax: +202 281 17007, E-Mail: doaahammam01@gmail.com; gafrd_EG@hotmail.com

**Atteya**, Mai
Production Research Specialist, New Cairo
Tel: +201 003 878 312, Fax: +202 281 117 007, E-Mail: janahesham08@gmail.com

**El-Haweet**, Alaa Eldin Ahmed
Professor of fishery biology and management, President Assistant of Arab Academy for Science, Technology & Maritime transport., Ex-Dean of College of Fisheries Technology and Aquaculture, P.O.Box, 1029, 21411, Alexandria
Tel: +201 006 633 546, Fax: +203 563 4115, E-Mail: el_haweet@yahoo.com; elhaweet@hotmail.com; gafrd.egypt@gmail.com; Information@gafrd.org

**Magdy**, Walaa
Production Research Specialist, New Cairo
Tel: +201 021 854 600, Fax: +202 281 117 007, E-Mail: walaaswisspak@yahoo.com

## EL SALVADOR

**Aceña Matarranz**, Sara
CALVO, C/ Príncipe de Vergara 110, 4ª Planta, 28002, Madrid, España
Tel: +34 686 061 921, E-Mail: sara.acena@ctmcorporation.com

**Arranz Vázquez**, Cristina
CALVO, C/ Príncipe de Vergara, 110 4ª Planta, 28002, Madrid, España
Tel: +34 682 589 986; +34 917 823 300, E-Mail: cristina.arranz@ctmcorporation.com

**Chavarría Valverde**, Bernal Alberto
Asesor en Gestión y Política pesquera Internacional, Centro para el Desarrollo de la Pesca y Acuicultura (CENDEPESCA), Final 1ª Avenida Norte, 13 Calle Oriente y Av. Manuel Gallardo, 1000, Santa Tecla, La Libertad
Tel: +506 882 24709, Fax: +506 2232 4651, E-Mail: bchavarria@lsg-cr.com

**Galdámez de Arévalo**, Ana Marlene
Jefa de División de Investigación Pesquera y Acuícola, Ministerio de Agricultura y Ganadería, Final 1a. Avenida Norte, 13 Calle Oriente y Av. Manuel Gallardo. Santa Tecla, La Libertad,
Tel: +503 2210 1913; +503 619 84257, E-Mail: ana.galdamez@mag.gob.sv; ana.galdamez@yahoo.com

**Saca**, Francisco *
Director General del Centro de Desarrollo de la Pesca y la Acuicultura (CENDEPESCA), Final 1º Ave. Norte y ave. Manuel Gallardo, Santa Tecla, La Libertad
Tel: +503 2210 1760, E-Mail: francisco.saca@mag.gob.sv

**Sanisidro Araujo**, Jorge *
C/ Principe de Vergara 110 4ª Planta, 28033, Madrid, España
Tel: +34 91 782 3300, E-Mail: jorge.sanisidro@ctmcorporation.com

**Ubis Lupion**, Macarena
Calvopesca El Salvador, S.A., C/ Príncipe de Vergara, 110 4ª Planta, 28002, Madrid, España
Tel: +34 617 068 486; +34 91 782 33 00, Fax: E-Mail: macarena.ubis@ctmcorporation.com

**EUROPEAN UNION**

**Aláez Pons**, Ester
International Relations Officer, European Commission - DG MARE - Unit B2 - RFMOs, Rue Joseph II - 99 03/057, 1049, Bruxelles, Belgium
Tel: +32 2 296 48 14; +32 470 633 657, Fax: E-Mail: ester.alaez-pons@ec.europa.eu

**Álvarez Berastegui**, Diego *
Instituto Español de Oceanografía, Centro Oceanográfico de Baleares, Muelle de Poniente s/n, 07010, Palma de Mallorca, España
Tel: +34 971 133 720; +34 626 752 436, E-Mail: diego.alvarez@ieo.es

**Alzorriz**, Nekane
ANABAC, Txibitxiaga 24 entreplanta, 48370, Bermeo, Bizkaia, España
Tel: +34 94 688 2806; +34 650 567 541, E-Mail: nekane@anabac.org

**Amoedo Lueiro**, Xoan Inacio
Biólogo, Consultor Ambiental, Medio Mariño e Pesca, Pza. de Ponteareas, 11, 3ºD, 36800, Pontevedra, España
Tel: +34 678 235 736, E-Mail: tecnico@fipblues.com; lueiro72consultant@gmail.com

**Andonegi Odriozola**, Eider
AZTI, Txatxarramendi ugartea z/g, 48395, Sukarrieta, España
Tel: +34 661 630 221, E-Mail: eandonegi@azti.es

**Arrizabalaga**, Haritz
Principal Investigator, AZTI Marine Research Basque Research and Technology Alliance (BRTA), Herrera Kaia Portualde z/g, 20110, Pasaia, España
Tel: +34 94 657 40 00; +34 667 174 477, Fax: +34 94 300 48 01, E-Mail: harri@azti.es

**Báez Barrionuevo**, José Carlos
Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero de Fuengirola s/n, 29640, España
Tel: +34 669 498 227, Fax: E-Mail: josecarlos.baez@ieo.es

**Biagi**, Franco
Senior Expert Marine & Fishery Sciences, Directorate General for Maritime Affairs and Fisheries (DG-Mare) - European Commission, Unit C3: Scientific Advice and data collection, Rue Joseph II, 99, 1049, Brussels, Belgium
Tel: +322 299 4104, Fax: E-Mail: franco.biagi@ec.europa.eu

**Bridges**, Christopher Robert *
Heinrich Heine University, Düsseldorf AG Ecophysiology, Institute for Metabolic Physiology: Ecophysiology / TUNATECH GmbH Merowinger, Platz 1, 40225, Duesseldorf, Germany
Tel: +4901739531905, Fax: E-Mail: bridges@hhu.de; christopher.bridges@uni-duesseldorf.de

**Carnevali**, Oliana *
Universita Politecnica Delle Marche - Ancona, Department of Environment and Life Science, Via Breccie Bianche, 60131, Ancona, Italy
Tel: +39 338 264 2235; +39 71 220 4990, Fax: +39 071 220 46 50, E-Mail: o.carnevali@univpm.it

**Casini**, Michele
Swedish University of Agricultural Sciences (SLU), Institute of Marine Research, Turistgatan, 5, 45330, Lysekil, Sweden
Tel: +46 761 268 007, Fax: E-Mail: michele.casini@slu.se

**Castillo Gutiérrez**, Isabel *
Instituto Español de Oceanografía, Promontorio San Martin s/n, 39004, Santander, España
Tel: +34 942 291 716, E-Mail: isabel.castillo@ieo.es

**Coco**, Ornella *
Scientific Consultant and Lecturer in training and dissemination activities on Fisheries and Marine Biology, OCEANIS SRL, 89043, Salerno, Italy
Tel: +39 342 582 8477, E-Mail: ornellacoco.biomol@gmail.com

**Consuegra Alcalde**, Elena
Policy officer, Ministerio de Agricultura, Alimentación y Medio Ambiente - MAGRAMA, Unit of Agreements and RFMOs, Secretary General for Fisheries, C/ Velázquez, 144, 2ª Planta, 28006, Madrid, España
Tel: +34 91 347 60 66; +34 686 043 379, Fax: 91 347 60 42, E-Mail: econsuegra@mapa.es

**Del Cerro Martín**, Gloria
Secretaría General de Pesca, C/ Velázquez, 144 2ª Planta, 28006, Madrid, España
Tel: +34 91 347 5940, Fax: +34 91 347 6042, E-Mail: gcerro@mapa.es

**Déniz González**, Santiago Félix
Instituto Español de Oceanografía, C/ La Farola del Mar n º 22 - Dársena Pesquera, 38180, Santa Cruz de Tenerife, España
Tel: +34 646 152 724, E-Mail: santiago.deniz@ieo.es

**Di Natale**, Antonio
Director, Aquastudio Research Institute, Via Trapani 6, 98121, Messina, Italy
Tel: +39 336 333 366, E-Mail: adinatale@costaedutainment.it; adinatale@acquariodigenova.it

**Duparc**, Antoine *
Station IFREMER Boulevard, Avenue Jean Monnet CS 30171, 34200, Sète, France
Tel: +33 049 957 3205, E-Mail: antoine.duparc@ird.fr

**Fernández Costa**, Jose Ramón
Instituto Español de Oceanografía, Ministerio de Ciencia e Innovación, Centro Costero de A Coruña, Paseo Marítimo Alcalde Francisco Vázquez, 10 - P.O. Box 130, 15001, A Coruña, España
Tel: +34 981 218 151, Fax: +34 981 229 077, E-Mail: jose.costa@ieo.es

**Ferreira de Gouveia**, Lidia
Técnica Superior, Biologist, Direcçao Regional das Pescas, Direçao Serviços de Investigaçao - DSI, Av. do Mar e das Comunidades Madeirenses, 23 - 1º Esq., 9004-562, Funchal, Madeira, Portugal
Tel: +351 291 203270, Fax: +351 291 229856, E-Mail: lidia.gouveia@madeira.gov.pt

**Floch**, Laurent *
Database administrator, IRD, UMR, 248 MARBEC, Avenue Jean Monnet, CS 30171, 34203, Séte Cedex, France
Tel: +33 4 9957 3220; +33 631 805 794, Fax: +33 4 9957 32 95, E-Mail: laurent.floch@ird.fr

**Gaertner**, Daniel
Institut de Recherche pour le Developpement (IRD) UMR MARBEC (IRD/Ifremer/CNRS/UMII), CRH, CS 30171, Av. Jean Monnet, 34203, Sète Cedex, France
Tel: +33 4 99 57 32 31, Fax: +33 4 99 57 32 95, E-Mail: daniel.gaertner@ird.fr

**Garibaldi**, Fulvio
University of Genoa - Dept. of Earth, Environmente and Life Sciences, Dipartimento si Scienze della Terra, dell'Ambiente e della Vita (DISTAV), Corso Europa, 26, 16132, Genova, Italy
Tel: +39 335 666 0784; +39 010 353 8576, Fax: +39 010 357 888, E-Mail: largepel@unige.it; garibaldi.f@libero.it

**Gatt**, Mark
Ministry for Agriculture, Fisheries, Food and Animal Rights Fort San Lucjan, Triq il-Qajjenza, Department of Fisheries and Aquaculture, Ngiered Road, MRS 3303, Marsaxlokk, Malta
Tel: +356 229 26918, Fax: E-Mail: mark.gatt@gov.mt

**Gioacchini**, Giorgia
Universita Politecnica delle Marche ANCONA, Dipartimento Scienze della Vita e dell'Ambiente, Via Breccie Bianche 131, 60027, Ancona, Italy
Tel: +39 339 132 1220; +39 712 204 693, E-Mail: giorgia.gioacchini@univpm.it

**Gordoa**, Ana
Senior scientist, Centro de Estudios Avanzados de Blanes (CEAB - CSIC), Acc. Cala St. Francesc, 14, 17300, Blanes, España
Tel: +34 972 336101; +34 666 094 459, Fax: E-Mail: gordoa@ceab.csic.es

**Goujon**, Michel
ORTHONGEL, 5 rue des sardiniers, 29900, Concarneau, France
Tel: +33 2 9897 1957; +33 610 627 722, Fax: +33 2 9850 8032, E-Mail: mgoujon@orthongel.fr

**Grande Mendizabal**, Maitane *
AZTI - Investigación Marina. Marine Research. Itsas Ikerketa Gestión Pesquera Sostenible. Sustainable Fisheries Management. Arrantza-kudeaketa Jasangarria, Herrera Kaia - Portualdea z/g., 20110, Pasaia, España
Tel: +34 667 100 124; +34 667 100 124, Fax: E-Mail: mgrande@azti.es

**Grubisic**, Leon
Institute of Oceanography and Fisheries in Split, Setaliste Ivana Mestrovica 63 - P.O.Box 500, 21000, Split, Croatia
Tel: +385 914 070 955, Fax: +385 21 358 650, E-Mail: leon@izor.hr

**Guéry**, Loreleï
TA A-120 / D Campus international de Baillarguet, 34000, Hérault, France
Tel: +33 683 865 816, E-Mail: lorelei.guery@cirad.fr

**Herrera Armas**, Miguel Angel
Deputy manager (Science), OPAGAC, C/ Ayala 54, 2º A, 28001, Madrid, España
Tel: +34 91 431 48 57; +34 664 234 886, Fax: +34 91 576 12 22, E-Mail: miguel.herrera@opagac.org

**Kalogirou**, Stefan *
Department for fisheries management, Unit for Fisheries Policy, Swedish Agency for Marine and Water Management, Gullbergs Strandgata 15, 41104 Göteborg, Sweden Postal address: Box 11 930, 40439, Gothenburg, Sweden
Tel: +46 765386178, E-Mail: stefan.kalogirou@havochvatten.se

**Kaplan**, David *
Director Research, Institut de Recherche pour le Développement (IRD), UMR MARBEC (Univ. Montpellier, CNRS, Ifremer, IRD), Av Jean Monnet CS 30171, 34070, Sète Cedex, France
Tel: +33 499 573 225, Fax: E-Mail: david.kaplan@ird.fr

**Laborda**, Ane *
AZTI, Herrera Kaia. Portualdea z/g 20110 Pasaia, 48395, Gipuzkoa, España
Tel: +34 677 699 674, E-Mail: alaborda@azti.es

**Lino**, Pedro Gil
Research Assistant, Instituto Português do Mar e da Atmosfera - I.P./IPMA, Avenida 5 Outubro s/n, 8700-305, Olhão, Portugal
Tel: +351 289 700504, Fax: E-Mail: plino@ipma.pt

**Macías López**, Ángel David
Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Málaga, Puerto pesquero s/n, 29640, Fuengirola, España
Tel: +34 952 197 124; +34 619 022 586, Fax: +34 952 463 808, E-Mail: david.macias@ieo.es

**Magnolo**, Lorenzo Giovanni
Ministero delle Politiche Agricole Alimentari, Forestali e Del Turismo, Direzione Generale della pesca Marittima e dell'Acquacoltura, Via XX Settembre, 20, 0187, Roma, Italy
Tel: +39 0 646 652 818, E-Mail: lorenzo.magnolo@politicheagricole.it

**Maufroy**, Alexandra *
ORTHONGEL, 5 rue des sardiniers, 29900, Concarneau, France
Tel: +33 649 711 587, Fax: +33 2 98 50 80 32, E-Mail: amaufroy@orthongel.fr

**Maxwell**, Hugo
Marine Institute, Furnance, Newport, County Mayo, F28PF65, Ireland
Tel: +353 894 836 530, E-Mail: hugo.maxwell@marine.ie

**Merino**, Gorka
AZTI - Tecnalia /Itsas Ikerketa Saila, Herrera Kaia Portualdea z/g, 20100, Pasaia – Gipuzkoa, España
Tel: +34 94 657 4000; +34 664 793 401, Fax: +34 94 300 4801, E-Mail: gmerino@azti.es

**Molina Schmid**, Teresa
Subdirectora General Adjunta, Subdirección General de Acuerdos y Organizaciones Regionales de Pesca, Dirección General de Recursos Pesqueros, Ministerio de Agricultura, Pesca y Alimentación, Secretaría General de Pesca, C/ Velázquez, 144 2ª Planta, 28006, Madrid, España
Tel: +34 91 347 60 47; +34 656 333 130, Fax: +34 91 347 60 42, E-Mail: tmolina@mapa.es

**Muñoz Lechuga**, Rubén *
Assistant research, Instituto Português do Mar e da Atmosfera - I.P./IPMA, Avenida 5 de Outubro, s/n, 8700-305, Olhão Faro, Portugal
Tel: +351 289 700 500, E-Mail: ruben.lechuga@ipma.pt

**Ortiz de Urbina**, Jose María
Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O de Málaga, Puerto pesquero s/n, 29640, Fuengirola, España
Tel: +34 952 197 124, Fax: +34 952 463 808, E-Mail: urbina@ieo.es

**Ortiz de Zárate Vidal**, Victoria
Investigadora, Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Santander, Promontorio de San Martín s/n, 39004, Santander, España
Tel: +34 942 291 716, Fax: +34 942 27 50 72, E-Mail: victoria.zarate@ieo.es

**Pappalardo**, Luigi
Scientific Coordinator, OCEANIS SRL, Vie Maritime 59, 84043, Salerno, Italy
Tel: +39 081 777 5116; +39 345 689 2473, E-Mail: gistec86@hotmail.com; oceanissrl@gmail.com

**Parejo Lázaro-Carrasco**, Aída *
Instituto Español de Oceanografía - IEO, Promontorio San Martín s/n, Av. de Severiano Ballesteros, s/n, 39004, Cantabria, Santander, España
Tel: +34 942 29 17 16, E-Mail: aida.parejo@ieo.es

**Pascual Alayón**, Pedro José
Investigador, Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Canarias, Vía Espaldón, Dársena Pesquera, Parcela 8, 38180, Santa Cruz de Tenerife, España
Tel: +34 922 549 400; +34 686 219 114, Fax: +34 922 549 500, E-Mail: pedro.pascual@ieo.es

**Peristeraki**, Panagiota *
Hellenic Center for Marine Research, Institute of Marine Biological Resources and Inland Waters, P.O. Box 2214, 71003, Heraklion, Greece
Tel: +30 2810 337 830, Fax: +30 2810 337 822, E-Mail: notap@hcmr.gr

**Pignalosa**, Paolo *
Technical Director, OCEANIS SRL, Via Marittima, 59, 80056, Ercolano – Napoli, Italy
Tel: +39 81 777 5116; +39 335 669 9324, Fax: E-Mail: oceanissrl@gmail.com

**Pinto**, Cecilia *
Università di Genova DISTAV, Dipartimento di Scienze della Terra, dell'Ambiente e della Vita Corso Europa 26, 16132, Genova, Italy
Tel: +39 340 496 6905, E-Mail: cecilia.pinto@edu.unige.it

**Poisson**, François *
IFREMER - Centre de Recherche Halieutique, UMR MARBEC (Marine Biodiversity Exploitation and Conservation), Avenue Jean Monnet, CS 30171, 34203, Sète, France
Tel: +33 499 57 32 45; +33 679 05 73 83, Fax: E-Mail: francois.poisson@ifremer.fr; fpoisson@ifremer.fr

**Reyes**, Nastassia *
Institut de Recherche pour le Developpement (IRD) UMR MARBEC (IRD/Ifremer/CNRS/UMII, Av. Jean Monnet CS 30171, 34203, Sète, France
Tel: +33 499 573 231, Fax: E-Mail: nastassia.reyes@ird.fr

**Rodríguez-Marín**, Enrique
Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Santander, Promontorio de San Martín s/n, 39004, Santander, España
Tel: +34 942 291 716, Fax: +34 942 27 50 72, E-Mail: enrique.rmarin@ieo.es

**Rojo Méndez**, Vanessa
IEO Centro Oceanográfico de Canarias, C/ Farola del Mar nº 22, Dársena Pesquera, 38180, Santa Cruz de Tenerife, España
Tel: +34 922 549 400, Fax: +34 922 549 554, E-Mail: vanessa.rojo@ieo.es

**Rosa**, Daniela
PhD Student, Portuguese Institute for the Ocean and Atmosphere, I.P. (IPMA), Av. 5 de Outubro s/n, 8700-305, Olhao, Portugal
Tel: +351 289 700 504, Fax: E-Mail: daniela.rosa@ipma.pt

**Rouyer**, Tristan *
Ifremer - Dept Recherche Halieutique, B.P. 171 - Bd. Jean Monnet, 34200, Sète, France
Tel: +33 782 995 237, Fax: E-Mail: tristan.rouyer@ifremer.fr

**Ruiz Gondra**, Jon *
AZTI-Tecnalia, Txatxarramendi z/g, 48395, Sukarrieta (Bizkaia), España
Tel: +34 94 6574000; +34 667 174 375, Fax: +34 94 6572555, E-Mail: jruiz@azti.es

**Saber Rodríguez**, Sámar *
Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía. Centro Oceanográfico de Murcia, 30740, San Pedro del Pinatar, Murcia, España
Tel: +34 968 180 500, E-Mail: samar.saber@ieo.es

**Santiago Burrutxaga**, Josu
Head of Tuna Research Area, AZTI-Tecnalia, Txatxarramendi z/g, 48395, Sukarrieta (Bizkaia), España
Tel: +34 94 6574000 (Ext. 497); +34 664 303 631, Fax: +34 94 6572555, E-Mail: jsantiago@azti.es; flarrauri@azti.es

**Santos**, Catarina
PhD Student, IPMA - Portuguese Institute for the Ocean and Atmosphere, I.P., Av. 5 Outubro s/n, 8700-305, Olhao, Portugal
Tel: +351 289 700 500, Fax: +351 289 700 53, E-Mail: catarina.santos@ipma.pt

**Sarricolea Balufo**, Lucía
Secretaría General de Pesca, Ministerio de Agricultura, Pesca y Alimentación, Calle Velázquez, número 144, 28006, Madrid, España
Tel: +34 913 476 170, E-Mail: lsarricolea@mapa.es

**Sundelöf**, Andreas
Swedish University of Agricultural Sciences, Institute of Marine Research, Turistgatan, 5, SE-453 30, Lysekil, Sweden
Tel: +46 703 068 775, Fax: +46 5231 3977, E-Mail: andreas.sundelof@slu.se

**Thasitis**, Ioannis
Department of Fisheries and Marine Research, 101 Vithleem Street, 2033, Nicosia, Cyprus
Tel: +35722807840, Fax: +35722 775 955, E-Mail: ithasitis@dfmr.moa.gov.cy

**Tserpes**, George *
Hellenic Center for Marine Research (HCMR), Institute of Marine Biological Resources, P.O. Box 2214, 71003, Heraklion, Greece
Tel: +30 2810 337851; +30 697 665 8335, Fax: +30 2810 337822, E-Mail: gtserpes@hcmr.gr

**Zudaire Balerdi**, Iker *
AZTI, Herrera Kaia - Portualdea z/g., 20110, Pasaia, Gipuzkoa
Tel: +34 667 174 451, Fax: E-Mail: izudaire@azti.es

## GABON

**Angueko**, Davy
Chargé d'Etudes du Directeur Général des Pêches, Direction Générale des Pêche et de l'Aquaculture, BP 9498, Libreville Estuaire
Tel: +241 6653 4886, E-Mail: davyangueko83@gmail.com; davyangueko@yahoo.fr

## GHANA

**Aihoon**, Frank Kwesi
Member, Panofi Company Limited, 2nd Floor Park View Plaza, P. O. Box TT 581, Tema
Tel: +233 277 474 801, Fax: +233 303 206 101, E-Mail: faihoon@gmail.com

**Arthur-Dadzie**, Michael
Director of Fisheries, Fisheries Commission, Ministry of Fisheries & Aquaculture Development, P.O. Box GP 630, GA 231, Accra
Tel: +233 244 735 506; +233 266 094 245, E-Mail: michyad2000@yahoo.com

**Ayivi**, Sylvia Sefakor Awo
Senior Manager, Ministry of Fisheries and Aquaculture Development, Fisheries Scientific Survey Division, P.O. Box BT 62, Tema
Tel: + 233 2441 76300, Fax: +233 3032 008048, E-Mail: asmasus@yahoo.com

**Kwame Dovlo**, Emmanuel
Ag. Deputy Director, Fisheries Scientific Survey Division, P.O. Box GP 630, Accra
Tel: +233 243 368 091, E-Mail: emkwdovlo@yahoo.co.uk

## GUATEMALA

**López Bran**, Rubén
Km 22 Carretera al pacifico, edificio la Ceiba 3er, nivel, 01064, Villa nueva
Tel: +502 409 18336, E-Mail: rubenlopezbran@yahoo.com

**Martínez Valladares**, Carlos Eduardo
Km 22 Carretera al pacifico, edificio la Ceiba 3er, nivel, 01064, Villa nueva
Tel: +502 452 50059, E-Mail: carlosmartinez41331@gmail.com

## JAPAN

**Butterworth**, Douglas S.
Emeritus Professor, Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701, Cape Town, South Africa
Tel: +27 21 650 2343, Fax: E-Mail: doug.butterworth@uct.ac.za

**Daito**, Jun
Chief, Japan Tuna Fisheries Co-operative Association, 31-1, Eitai 2-Chome, Koto-ku, 135-0034, Tokyo
Tel: +81 356 462 382, Fax: +81 356 462 652, E-Mail: daito@japantuna.or.jp

**Fukuda**, Hiromu
Head of Group, Highly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 2-12-4 Fukuura, Kanazawa, Yokohama, 234-8648
Tel: +81 45 788 7936, E-Mail: fukudahiromu@affrc.go.jp

**Honda**, Hitoshi *
Scientist, Reserach Management Department, Highly Migratory Resources Division, Fisheries Resources Institute, National Research and Development Agency, Japan Fisheries Research and Education Agency, 5-7-1, Orido, Shimizu-ward, Shizuoka-city, Shizuoka-prefecture, 424-8633
Tel: +81 54 336 6000, Fax: +81 54 335 9642, E-Mail: hhonda@affrc.go.jp; honda_hitoshi48@fra.go.jp

**Hosokawa**, Natsuki
Technical Official, Ministry of Agriculture, Forestry and Fisheries, Fisheries Agency of Japan, 100-8907, Chiyoda-ku, Tokyo
Tel: +81 3 350 28460, Fax: +81 3 5646 2649, E-Mail: natsuki_hosokawa730@maff.go.jp

**Kai**, Mikihiko
Senior Reseacher, Tuna Fisheries Resources Group, Tuna and Skipjack Resources Department, National Research Institute of Far Seas Fisheries - NRIFSF, Japan Fisheries Research and Education Agency, 5-7-1, Orido, 424-8633, Shimizu, Shizuoka
Tel: +81 54 336 6045, Fax: +81 54 335 9642, E-Mail: kaim@affrc.go.jp; billfishkai@gmail.com

**Matsubara**, Naoto *
National Research Institute of Far Seas Fisheries, Fisheries Research Agency, Yokohama Laboratory, 2-12-4 fukuura, kanazawa-ku, 236-8648, Kanagawa
Tel: +81 45 788 7517; +81 45 788 5004, E-Mail: matsubaranaoto@affrc.go.jp; naotomatsubaraf91@gmail.com

**Matsumoto**, Takayuki
Highly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 5-7-1 Orido, 424-0902, Shimizu
Tel: +81 54 336 6000, Fax: +81 54 336 9642, E-Mail: matumot@affrc.go.jp; takayukimatsumoto2016@gmail.com

**Minami**, Hiroshi
Director, Highly Migratory Resources Division, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 5-7-1 Orido, 236-8648, Yokohama
Tel: +81 54 336 6000; +81 457 887 928, Fax: +81 54 335 9642, E-Mail: hminami@affrc.go.jp

**Miura**, Nozomu
Assistant Director, International Division, Japan Tuna Fisheries Co-operative Association, 2-31-1 Eitai Koto-ku, 135-0034, Tokyo
Tel: +81 3 5646 2382, Fax: +81 3 5646 2652, E-Mail: miura@japantuna.or.jp; gyojyo@japantuna.or.jp

**Morita**, Hiroyuki
Assistant Director, Responsible for the JCAP-2 Programme, International Affairs Division, Resources Management Department, Fisheries Agency of Japan, 1-2-1 Kasumigaseki, Chiyoda-Ku, 100-8907, Tokyo
Tel: +81 3 3502 8460, Fax: +81 3 3504 2649, E-Mail: hiroyuki_morita970@maff.go.jp

**Nagai**, Daisaku
Manager, Japan Tuna Fisheries Co-Operative Association, 31-1, Eitai 2-Chome, Koto-ku, 135-0034, Tokyo
Tel: +81 356 462 382, Fax: +81 356 462 652, E-Mail: nagai@japantuna.or.jp

**Nakatsuka**, Shuya
Deputy Director, Highly Migratory Resources Division, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 2-12-4, Fukuura, Kanazawa Kanagawa, 236-8648
Tel: +81 45 788 7950, E-Mail: snakatsuka@affrc.go.jp

**Ochi**, Daisuke
Researcher, Ecologically Related Species Group, National Research Institute of Far Seas Fisheries, Tuna and Skipjack Resources Department, Japan Fisheries Research and Education Agency, 2-12-4 Fukuura, Kanazawa, 236-8648
Tel: +81 45 788 7930, Fax: +81 45 788 7001, E-Mail: otthii@affrc.go.jp

**Okamoto**, Kei *
Highly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 5-7-1 Orido, Shimizu, 424-8633, Shizuoka
Tel: +81 54 336 5835, Fax: +81 54 335 9642, E-Mail: keiokamoto@affrc.go.jp

**Rademeyer**, Rebecca *
Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematic - University of Cape Town, Private Bag, 7700, Rondebosch, South Africa
Tel: +651 300 442, Fax: E-Mail: rebecca.rademeyer@gmail.com

**Satoh**, Keisuke
Bigeye and Yellowfin tunas Group, Highly Migratory Resources Division, Fisheries Resources Institute, National Research and Development Agency, Japan Fisheries Research and Education Agency (FRA), 2-12-4 Fukuura, 236-8648, Kanazawa
Tel: +81 45 788 7927, Fax: +81 45 788 5004, E-Mail: kstu21@fra.affrc.go.jp

**Semba (Murakami)**, Yasuko
Researcher, Tuna Fisheries Resources Group, Tuna and Skipjack Resources Division, National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu-ku, Shizuoka-City, 424-8633, Shizuoka
Tel: +81 5 4336 6045, Fax: +81 5 4335 9642, E-Mail: senbamak@affrc.go.jp

**Takeshima**, Hirohiko *
Tokai University, School of Marine Science and Technology, 3-20-1 Orido, Shimizu Ward, 4248610
Tel: +81 543 34 2016, E-Mail: takeshim@tsc.u-tokai.ac.jp

**Tsuda**, Yuichi
Skipjack and Albacore Group, Highly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 2-12-4 Fukuura, Kanazawa, 236-8648, Shizuoka
Tel: +81 45 788 7923, Fax: +81 45 788 7101, E-Mail: u1tsuda@affrc.go.jp

**Tsuji**, Sachiko
Researcher, Ecologically Related Species Group, National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency, 2-12-4 fukuura, kanazawa-ku, 236-8648, Yokohama, Kanagawa
Tel: +81 45 788 7931, Fax: +81 45 788 5004, E-Mail: sachiko27tsuji@gmail.com

**Tsukahara**, Yohei
ScientistHighly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Highly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 2-12-4, Fukuura, Kanagawa, Yokohama, 236-8648, Shizuoka
Tel: +81 45 788 7937, Fax: +81 54 335 9642, E-Mail: tsukahara_y@affrc.go.jp

**Uozumi**, Yuji
Adviser, Japan Tuna Fisheries Co-operation Association, Japan Fisheries Research and Education Agency, 31-1 Eitai Chiyodaku, 135-0034, Tokyo
Tel: +81 3 5646 2380, Fax: +81 3 5646 2652, E-Mail: uozumi@japantuna.or.jp

**Yokoi**, Hiroki *
Bigeye and Yellowfin tunas Group, Highly Migratory Resources Division, Fisheries Resources Institute, National Research and Development Agency, Japan Fisheries Research and Education Agency (FRA), 2-12-4 fukuura, kanazawa-ku, 236-8648, Yokohama
Tel: +81 45 788 7926, Fax: +81 45 788 5004, E-Mail: yokoih@affrc.go.jp

**KOREA REP.**
**Lee**, Sung Il
Scientist, National Institute of Fisheries Science, 216 Gijang-Haeanro, Gijang-eup, Gijang-gun, 46083, Busan
Tel: +82 51 720 2330, Fax: +81 51 720 2337, E-Mail: k.sungillee@gmail.com; k.sungillee@korea.kr

**Lee**, Mi Kyung
Scientist, National Institute of Fisheries Science, 216 Gijanghaean-ro, Gijang-eup, Gijang-gun, 46083, Busan
Tel: +82 51 720 2332, Fax: +82 51 720 2337, E-Mail: ccmklee@korea.kr; cc.mklee@gmail.com

**LIBERIA**
**Wehye**, Austin Saye
Director-Research & Statistics, National Fisheries and Aquaculture Authority (NaFFA), Fisheries Researchers, P.O. Box 1384, 1000, Monrovia, Montserrado
Tel: +231 886 809 420; +231 775 717 273, Fax: E-Mail: awehye@nafaa.gov.lr; austinwehye@yahoo.com

**LIBYA**
**Ensair Noser**, Hend
Researcher and Lecturer in Fish Biology at the Zoology Department, Faculty of Science at the University of Tripoli
Tel: +218 917 829 192, E-Mail: h.ensair@uot.edu.ly

**Shakman**, Esmail
Researcher and Lecturer in Fish Biology at the Zoology Department, Faculty of Science at the University of Tripoli., Al-Furnaje-Tripoli
Tel: +218 922 761 703, E-Mail: shugmanism@yahoo.com

**Showehdi**, Mohamed Lamin
Researcher and Lecturer in Fish diseases and Management (Fish parasitology), Tripoli
Tel: +218 924 150 795, E-Mail: M.showehdi@uot.edu.ly; mohamedelshwhdy@hotmail.com

**MEXICO**
**Ramírez López**, Karina
Instituto Nacional de Pesca y Acuacultura, Centro Regional de Investigación Acuícola y Pesquera - Veracruz, Av. Ejército Mexicano No.106 - Colonia Exhacienda, Ylang Ylang, C.P. 94298, Boca de Río
Tel: +52 5538719500, Ext. 55756, Fax: E-Mail: kramirez_inp@yahoo.com

**MOROCCO**
**Abid**, Noureddine
Chercheur et ingénieur halieute au Centre Régional de recherche Halieutique de Tanger, Responsable du programme de suivi et d'étude des ressources des grands pélagiques, Centre régional de l'INRH à Tanger/M'dig, B.P. 5268, 90000, Drabed
Tel: +212 53932 5134; +212 663 708 819, Fax: +212 53932 5139, E-Mail: noureddine.abid65@gmail.com

**Arbain**, Rabie
Société SGCPM, 16, rue antaki etg1 N 36, 99000, Tanger
Tel: +212 682 424 310, Fax: +212 539 529 999, E-Mail: ar_bain@hotmail.fr

**Baibbat**, Sid Ahmed *
Chef de Laboratoire des Pêches, Centre régional de DAKHLA, Institut National de Recherches Halieutiques (INRH), 2, BD Sidi Abderrahmane, ain diab., 20100, Dakhla
Tel: +212 661 642 573, Fax: E-Mail: baibat@hotmail.com; baibbat@inrh.ma

**Bensbai**, Jilali
Chercheur, Institut National de Recherche Halieutique à Casablanca - INRH/Laboratoires Centraux, Ain Diab près du Club équestre OULAD JMEL, Rue Sidi Abderrhman / Ain Diab, 20100, Casablanca
Tel: +212 661 59 8386, Fax: +212 522 397 388, E-Mail: bensbaijilali@gmail.com

**Chami**, Reda
Représentant de la société ORSEA FISH,
Tel: +212 661 448 035, E-Mail: redachami@kingpelagique.com

**El Joumani**, El Mahdi *
Ingénieur Halieute, Institut National de Recherche Halieutique "INRH", Laboratoire de pêche au Centre Régional de l'INRH-Laayoune, Avenue Charif Erradi N 168 Hay el Ouahda 01, Laayoune
Tel: +212 661 114 418, E-Mail: Eljoumani.mehdi@gmail.com

**Haoujar**, Bouchra
Cadre à la Division de Durabilité et d'Aménagement des Ressources Halieutiques, Département de la Pêche Maritime, Administrative, Nouveau Quartier Administratif, BP 476, 10150, Haut Agdal, Rabat
Tel: +212 253 768 8121, Fax: +212 537 688 089, E-Mail: haoujar@mpm.gov.ma

**Hassouni**, Fatima Zohra
Chef de la Division de Durabilité et d'Aménagement des Ressources Halieutiques, Département de la Pêche maritime, Nouveau Quartier Administratif, Haut Agdal, B.P.: 476, Rabat
Tel: +212 537 688 122/21, Fax: +212 537 688 089, E-Mail: hassouni@mpm.gov.ma

**Hmani**, Mounir
Secrétaire Général de l'Association Marocaine de la pêche aux madragues (AMPM), Société Al Madraba del Sur SARL, 66 Av. Mohamed V, 94000, Tanger
Tel: +212 539 932 550, Fax: +212 539 91 2555, E-Mail: almadrabadelsur@hotmail.com

**Layachi**, Mostafa *
E-Mail: mostafalayachi12@gmail.com

**Rouchdi**, Mohammed
Représentant du groupement YLARAHOLDING, Nouvelle Zone Portuaire Larache BP 138, Larache
Tel: +212 537 754 927, Fax: +212 537 754 927, E-Mail: rouchdi@ylaraholding.com

## NORWAY

**Nottestad**, Leif
Principal Scientist, Institute of Marine Research, Research Group on Pelagic Fish, P.O. Box 1870 Nordnesgaten, 33, 5817, Bergen,
Tel: +47 5 99 22 70 25, Fax: +47 55 23 86 87, E-Mail: leif.nottestad@hi.no

## PANAMA

**Díaz de Santamaría**, María Patricia *
Fundación Internacional de Pesca, Zona de Libre Proceso de Corozal, Edificio 297, Corozal
Tel: +507 378 6640; +507 657 32047, Fax: E-Mail: mpdiaz@fipesca.com

**Duarte**, Robert *
Calle 45, Bella Vista, Edificio Riviera, 0819-02398
Tel: +507 511 6057, E-Mail: rduarte@arap.gob.pa

**Franco**, Arnulfo Luis *
Asesor, Fundación Internacional de Pesca, Zona de Libre Proceso de Corozal, Edificio 297, Ancón
Tel: +507 378 6640; celular:+507 66194351, Fax: +507 317 3627, E-Mail: arnulfofranco@fipesca.com; arnulfol.franco@gmail.com

**Pino**, Yesuri
Autoridad de Los Recursos Acuáticos de Panamá (ARAP), Dirección de Investigación y Desarrollo, Avenida Justo Arosemena, calle 45 este, 05850,
Tel: +507 645 74963, E-Mail: yesuri.pino@arap.gob.pa

**Vergara**, Yarkelia
Calle 45, Bella Vista, Edificio Riviera, 0819-02398
Tel: +507 511 6008, E-Mail: yvergara@arap.gob.pa

## RUSSIAN FEDERATION

**Kolomeiko**, Fedor
Head of the «Regional Data Center» Department, Atlantic branch of VNIRO (AtlantNIRO), RESEARCH INSTITUTE OF FISHERIES AND OCEANOGRAPHY, 5 Dm. Donskoy Str., 236022, Kaliningrad
Tel: +7 4012 21 56 45, Fax: +7 4012 21 99 97, E-Mail: fed@atlantniro.ru

**Nesterov**, Alexander
Senior Research Officer, Atlantic Research Institute of Marine, Fisheries and Oceanography (AtlantNIRO), International Cooperation Department, Atlantic Branch of VNIRO, 5, Dmitry Donskoy Str., 236022, Kaliningrad
Tel: +7 4012 925 389, Fax: + 7 4012 219 997, E-Mail: nesterov@atlantniro.ru; atlantniro@vniro.ru

**SENEGAL**
**Sow**, Fambaye Ngom
Chercheur Biologiste des Pêches, Centre de Recherches Océanographiques de Dakar Thiaroye, CRODT/ISRA, LNERV - Route du Front de Terre - BP 2241, Dakar
Tel: +221 3 0108 1104; +221 77 502 67 79, Fax: +221 33 832 8262, E-Mail: ngomfambaye2015@gmail.com; famngom@yahoo.com

**TUNISIA**
**Hajjej**, Ghailen
Maître assistant de l'Enseignement Supérieur Agricole, Laboratoire des Sciences Halieutiques, Institut National des Sciences et Technologies de la Mer (INSTM), Port de pêche, 6000, Gabès
Tel: +216 75 220 254; +216 972 77457, Fax: +216 75 220 254, E-Mail: ghailen3@yahoo.fr; ghailen.hajej@instm.rnrt.tn

**Hayouni ep Habbassi**, Dhekra
Ingénieur principal, Direction préservation des ressources halieutiques, Direction Générale de la Pêche et de l'Aquaculture, Ministère d'Agriculture, des Ressouces hydrauliques et de la Pêche
Tel: +216 718 90784, Fax: +216 717 99401, E-Mail: hayouni.dhekra1@gmail.com; hayouni.dhekra@gmail.com

**Mejri**, Hamadi *
Directeur adjoint, Conservation des ressources halieutiques, Ministère de l'agriculture et des ressources hydrauliques et de la pêche, Direction Générale de la Pêche et de l'Aquaculture, 32, Rue Alain Savary - Le Belvédère, 1002, Tunis
Tel: +216 240 12780, Fax: +216 71 799 401, E-Mail: hamadi.mejri1@gmail.com

**Sohlobji**, Donia
Direction Générale de la Pêche et de l'Aquaculture, Ministère de l'Agriculture des Ressources Hydrauliques et de la Pêche, 32 Rue Alain Savary, 2036, Le Belvédère
Tel: +216 534 31307; +216 71 890 784, Fax: +216 71 799 401, E-Mail: doniasohlobji1@gmail.com; bft@iresa.agrinet.tn

**Zarrad**, Rafik
Chercheur, Institut National des Sciences et Technologies de la Mer (INSTM), BP 138 Ezzahra, Mahdia 5199,
Tel: +216 73 688 604; +216 972 92111, Fax: +216 73 688 602, E-Mail: rafik.zarrad@gmail.com

**TURKEY**
**Erdem**, Ercan
Ministry of Agriculture and Forestry, General Directorate of Fisheries and Aquaculture, Eskisehir yolu 9.Km Lodumlu-Cankaya, 06800, Ankara
Tel: +905 444 782 094, Fax: +903 12 258 3070, E-Mail: ercan.erdem@tarimorman.gov.tr

**UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND**
**Bell**, James
Centre for Environment, Fisheries and Aquaculture Science (Cefas), NR33 0HT, Lowestoft
Tel: +44 1 502 521 377, E-Mail: james.bell@cefas.co.uk

**Brookers**, Lauren *
E-Mail: Lauren.Brookes@defra.gov.uk

**Ellis**, Jim *
Fisheries Scientist, Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, NR33 0HT, Suffolk
Tel: +44 1502 524300; +44 1502 562244, Fax: +44 1502 513865, E-Mail: jim.ellis@cefas.co.uk

**Fletcher**, Fiona
Department for Environment, Food & Rural Affairs - DEFRA, BS1 5AH, Bristol
Tel: +44 771 742 2562, E-Mail: Fiona.Fletcher@defra.gov.uk

**Phillips**, Sophy
Fisheries Scientist, Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, NR33 0HT, Lowestoft
Tel: +44 1502 527754, E-Mail: sophy.phillips@cefas.co.uk

**Reeves**, Stuart
Principal fisheries scientist & advisor, Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, NR33 0HT, Lowestoft
Tel: +44 150 252 4251, E-Mail: stuart.reeves@cefas.co.uk

**Thomas**, Simon *
Bournemouth University, Fern Barrow, BH12 5BB, Dorset
Tel: +447791662590, E-Mail: bluedogfishing.simon@aol.co.uk

**Wright**, Serena
Fisheries Scientist, Centre for Environment, Fisheries and Aquaculture Science (Cefas), ICCAT Tagging programme St. Helena, Pakefield Road, NR33 0HT, Lowestoft
Tel: +44 1502 52 1338; +44 797 593 0487, E-Mail: serena.wright@cefas.co.uk

## UNITED STATES

**Ailloud**, Lisa *
Research Mathematical Statistician, NOAA, 75 Virginia Beach Dr, FL 33149, Miami
Tel: +1 305 361 4200, Fax: E-Mail: lisa.ailloud@noaa.gov

**Brown**, Craig A.
Chief, Highly Migratory Species Branch, Sustainable Fisheries Division, NOAA Fisheries Southeast Fisheries Science Center, 75 Virginia Beach Drive, 33149, Miami
Tel: +1 305 586 6589, Fax: +1 305 361 4562, E-Mail: craig.brown@noaa.gov

**Carlson**, John
NOAA Fisheries Service, 3500 Delwood Beach Road, 32408, Florida
Tel: +1 850 624 9031, Fax: +1 850 624 3559, E-Mail: john.carlson@noaa.gov

**Cass-Calay**, Shannon
Director, NOAA Fisheries, Southeast Fisheries Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, 33149, Miami
Tel: +1 305 361 4231, Fax: +1 305 361 4562, E-Mail: shannon.calay@noaa.gov

**Cortés**, Enric
Research Fishery Biologist, NOAA-Fisheries, Southeast Fisheries Science Center, Panama City Laboratory, 3500 Delwood Beach Road, Panama City
Tel: +1 850 234 6541; +1 850 814 4216, Fax: +1 850 235 3559, E-Mail: enric.cortes@noaa.gov

**Courtney**, Dean
Research Fishery Biologist, NOAA/NMFS/SEFSC Panama City Laboratory, 3500 Delwood Beach Road, 32408, Panama City Beach
Tel: +1 850 234 6541, Fax: E-Mail: dean.courtney@noaa.gov

**Díaz**, Guillermo
NOAA-Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Drive, 33149, Miami
Tel: +1 305 361 4227, Fax: E-Mail: guillermo.diaz@noaa.gov

**Die**, David
Research Associate Professor, Cooperative Institute of Marine and Atmospheric Studies, University of Miami, 4600 Rickenbacker Causeway, 33149, Miami
Tel: +1 305 421 4607, E-Mail: ddie@rsmas.miami.edu

**Farrugia**, Thomas *
U.S. House of Representatives, Committee on Natural Resources, 186 Ford House Office Building
Tel: +1 202 225 6065, Fax: +1 202 225 4723, E-Mail: tjfarrugia@alaska.edu; thomas.farrugia@mail.house.gov

**Forrestal**, Francesca
NOAA Fisheries, Southeast Fisheries Science Center, Sustainable Fisheries Division, 75 Virginia Beach Dr., 33149, Miami
Tel: +1 305 903 4535, Fax: E-Mail: francesca.forrestal@noaa.gov

**Keller**, Bryan
Foreign Affairs Specialist, Office of International Affairs and Seafood Inspection (F/IS), NOAA National Marine Fisheries Service, 1315 East-West Highway, 20910, Maryland
Tel: +1 202 897 9208, E-Mail: bryan.keller@noaa.gov

**Kroetz**, Andrea
NOAA, 3500 Delwood Beach Road, 32408, Florida
Tel: +1 618 214 8463, E-Mail: andrea.kroetz@noaa.gov

**Lauretta**, Matthew
Fisheries Biologist, NOAA Fisheries Southeast Fisheries Center, 75 Virginia Beach Drive, 33149, Miami
Tel: +1 305 361 4481, Fax: E-Mail: matthew.lauretta@noaa.gov

**Peterson**, Cassidy
NOAA Fisheries, 101 Pivers Island Rd, 28516, Miami, FL
Tel: +1 252 838 0885, E-Mail: cassidy.peterson@noaa.gov

**Schirripa**, Michael
Research Fisheries Biologist, NOAA Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Drive, 33149, Miami
Tel: +1 305 445 3130; +1 786 400 0649, Fax: +1 305 361 4562, E-Mail: michael.schirripa@noaa.gov

**Walter**, John
Research Fishery Biologist, NOAA Fisheries, Southeast Fisheries Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, 33149, Miami
Tel: +305 365 4114; +1 804 815 0881, Fax: +1 305 361 4562, E-Mail: john.f.walter@noaa.gov

**Zhang**, Xinsheng
NOAA/NMFS/SEFSC, 3500 Delwood Beach Rd., 32408, Florida
Tel: +1 850 234 6541 ext. 264, Fax: +1 850 235 3559, E-Mail: Xinsheng.Zhang@noaa.gov; Xinsheng.Zhang0115@gmail.com

## URUGUAY

**Domingo**, Andrés
Dirección Nacional de Recursos Acuáticos - DINARA, Laboratorio de Recursos Pelágicos, Constituyente 1497, 11200, Montevideo
Tel: +5982 400 46 89, Fax: +5982 401 32 16, E-Mail: dimanchester@gmail.com

**Forselledo**, Rodrigo
Investigador, Dirección Nacional de Recursos Acuáticos - DINARA, Laboratorio de Recursos Pelágicos, Constituyente 1497, CP 11200, Montevideo
Tel: +598 2400 46 89, Fax: +598 2401 3216, E-Mail: rforselledo@gmail.com

**Jiménez Cardozo**, Sebastián *
Vice-Convenor of ACAP's Seabird Bycatch Working Group, Constituyente 1497, 11200, Montevideo
Tel: +598 99 781644, Fax: E-Mail: jimenezpsebastian@gmail.com

## VENEZUELA

**Arocha**, Freddy
Instituto Oceanográfico de Venezuela, Universidad de Oriente, A.P. 204, 6101, Cumaná
Tel: +58 424 823 1698, Fax: E-Mail: farochap@gmail.com

**Bustillos**, Freddy *
Asesor de la Gerencia de Ordenación Pesquera del Instituto Socialista de la Pesca y la Acuicultura, Ministerio del Poder Popular de Pesca y Acuicultura, 1015, Caracas
Tel: +58 426 913 6036, E-Mail: fxpesca@gmail.com

**Miranda**, Jesús
Gerente de Ordenación Pesquera, Instituto Socialista de la Pesca y Acuicultura
E-Mail: mirandaj1201@gmail.com

**Narváez Ruiz**, Mariela del Valle
Lab. 34, Edif. Instituto Oceanográfico de Venezuela, Universidad de Oriente, Departamento de Biología Pesquera, Av. Universidad, Cerro Colorado, 6101, Cumaná
Tel: +58 412 085 1602, E-Mail: mnarvaezruiz@gmail.com

**Salas**, Aminta
Directora de Pesca Industrial, Viceministerio de Producción Primaria Pesquera y Acuícola, 1020, Caracas
Tel: +58 414 317 9050, E-Mail: pescaindustrialatunera@gmail.com

**Torres Sánchez**, Juana
Directora de Línea de la Oficina de Integración y Asuntos Internacionales, Ministerio del Poder Popular de Pesca y Acuicultura, 1020, Caracas
Tel: +58 414 182 2261, E-Mail: oai.minpesca@gmail.com

### *OBSERVERS FROM COOPERATING NON-CONTRACTING PARTIES, ENTITIES, FISHING ENTITIES*

**CHINESE TAIPEI**
**Chang**, Feng-Chen
Specialist, Overseas Fisheries Development Council, 3F., No14, Wenzhou St. Da'an Dist., 10648
Tel: +886 2 2368 0889 ext. 126, Fax: +886 2 2368 1530, E-Mail: fengchen@ofdc.org.tw; d93241008@ntu.edu.tw

**Cheng**, Chun-Ya
National Taiwan Ocean University, No. 2 Peining Rd, 202301, Zhongzheng
Tel: +886 2 24622192 ext. 5046, Fax: +886 2 24622192, E-Mail: lucky_8043@yahoo.com.tw

**Lin**, Wei-Ren *
Assistant, Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, No. 2 Pei-Ning Rd. Keelung, 202301
Tel: +886 2 24622192 ext. 5046, Fax: +886 2 24622192, E-Mail: willy20535@gmail.com

**Su**, Nan-Jay
Assistant Professor, Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, No. 2 Pei-Ning Rd. Keelung, Zhongzheng Dist., 202301
Tel: +886 2 2462 2192 #5046, Fax: +886-2-24622192, E-Mail: nanjay@ntou.edu.tw

**Yang**, Shan-Wen
Secretary, Overseas Fisheries Development Council, 3F., No. 14, Wenzhou Street, Da'an Dist., 10648
Tel: +886 2 2368 0889 #151, Fax: +886 2 2368 6418, E-Mail: shenwen@ofdc.org.tw

### *OBSERVERS FROM INTERGOVERNMENTAL ORGANIZATIONS*

**FOOD AND AGRICULTURE ORGANIZATION - FAO**
**Geehan**, James
Italy
E-Mail: james.geehan@fao.org

### *OBSERVERS FROM NON-CONTRACTING PARTIES*

**REPUBLIC OF MONTENEGRO**
**Divanovic**, Milica
Senior advisor for data entry, data processing and data reporting in fisheries (DCF-DCRF), Rimski trg 46, 81000 Podgorica
Tel: +38 220 482 270, E-Mail: milica.divanovic@mpsv.gov.me

### *OBSERVERS FROM NON-GOVERNMENTAL ORGANIZATIONS*

**DEFENDERS OF WILDLIFE**
**Cruz**, Orion *
Defenders of Wildlife, 1130 17th St NW, 20036, Washington DC, United States
Tel: +1 5419537380, E-Mail: OCruz@defenders.org

**Goyenechea**, Alejandra
Defenders of Wildlife, 1130 17th Street, NW, 20036-4604, Washington DC, United States
Tel: +1 202 772 3268, Fax: +1 202 682 1331, E-Mail: agoyenechea@defenders.org

**ECOLOGY ACTION CENTRE - EAC**
**Arnold**, Shannon
Marine Coordinator, Ecology Action Centre, 2705 Fern Lane, B3K 4L3, Halifax, Nova Scotia, Canada
Tel: +1 902 329 4668, Fax: E-Mail: sharnold@ecologyaction.ca

**Isnor**, Holly
Ecology Action Centre, 2705 Fern Lane, B3K 4L3, Halifax, Canada
Tel: +1 902 580 0600, E-Mail: hollyisnor@ecologyaction.ca

**EUROPÊCHE**
**Kell**, Laurence
Visiting Professor in Fisheries Management, Centre for Environmental Policy, Imperial College London, NR34 7JZ, Henstead, Suffolk, United Kingdom
Tel: +44 751 707 1190, E-Mail: laurie@seaplusplus.co.uk; l.kell@imperial.ac.uk; laurie@kell.es

**FEDERATION OF MALTESE AQUACULTURE PRODUCERS – FMAP**
**Deguara**, Simeon
AquaBioTech Ltd, Central Complex, Naggar Ste., Mosta, MST 1761, Malta
Tel: +356 994 23123, E-Mail: dsd@aquabt.com

**INTERNATIONAL SEAFOOD SUSTAINABILITY FOUNDATION – ISSF**
**Justel**, Ana *
ISSF-Spain, Plaza Santa María Soledad Torres Acosta 1, 5ª Planta, 28004, Madrid, España
Tel: +34 91 745 3075; +34 696 557 530, Fax: E-Mail: ajustel@iss-foundation.org

**Murua**, Hilario
Senior scientist, International Seafood Sustainability Foundation (ISSF), 1440 G Street NW, 20005, Washington, DC, United States
Tel: +34 667 174 433; +1 703 226 8101, Fax: E-Mail: hmurua@iss-foundation.org

**Restrepo**, Víctor
Chair of the ISSF Scientific Advisory Committee, ISS-Foundation, 1440 G Street NW, 20005, Washington DC, United States
Tel: + 1 305 450 2575; +1 703 226 8101, Fax: +1 215 220 2698, E-Mail: vrestrepo@iss-foundation.org; vrestrepo@mail.com

**MARINE STEWARDSHIP COUNCIL - MSC**
**Martín Aristín**, Alberto Carlos
Responsable de Pesquerías para España y Portugal de MSC, Marine Stewardship Council, Calle Rio Rosas, 36. 6-C, 28003, Madrid, España
Tel: +34 679 89 18 52, E-Mail: alberto.martin@msc.org

**PEW CHARITABLE TRUSTS - PEW**
**Galland**, Grantly
Officer, Pew Charitable Trusts, 901 E Street, NW, 20004, Washington, DC, United States
Tel: +1 202 540 6953; +1 202 494 7741, Fax: +1 202 552 2299, E-Mail: ggalland@pewtrusts.org

**Miller**, KerriLynn *
Pew Charitable Trusts, 901 E Street NW, 20004, Washington, D.C., United States
Tel: +202 540 6481, Fax: E-Mail: klmiller@pewtrusts.org

**Wilson**, Ashley *
Pew Charitable Trusts, The Grove, 248A Marylebone Road, NW1 6JZ, London, United Kingdom
Tel: +44 794 016 1154, E-Mail: awilson@pewtrusts.org

**Wozniak**, Esther *
The Pew Charitable Trusts, 901 E Street, NW, 20004, Washington DC, United States
Tel: +1 202 657 8603, E-Mail: ewozniak@pewtrusts.org

**THE OCEAN FOUNDATION**
**Fordham**, Sonja V *
Shark Advocates International, President, c/o The Ocean Foundation, suite 250, 1320 19th Street, NW Fifth Floor, 20036, Washington, DC, United States
Tel: +1 202 887 8996, Fax: E-Mail: sonja@sharkadvocates.org

**Miller**, Shana *
The Ocean Foundation, 1320 19th St., NW, 5th Floor, 20036, Washington, DC, United States
Tel: +1 631 671 1530, Fax: E-Mail: smiller@oceanfdn.org

**Pipernos**, Sara
The Ocean Foundation, 1320 19th St. NW, 20009, Washington DC, United States
Tel: +1 860 992 6194, E-Mail: spipernos@oceanfdn.org

**THE SHARK TRUST**
**Clark**, Martin *
The Shark Trust, 4 Creykes Court The Millfields, PL1 3JB, Plymouth, United Kingdom
Tel: +44 788 056 5393, E-Mail: martinc@theadvocacyhub.org

**Hood**, Ali
The Shark Trust, 4 Creykes Court, The Millfields, PL1 3JB, Plymouth, United Kingdom
Tel: +44 7855 386083, Fax: +44 1752 672008, E-Mail: ali@sharktrust.org

**WORLD WIDE FUND FOR NATURE – WWF**
**Buzzi**, Alessandro
WWF Mediterranean, Via Po, 25/c, 00198, Roma, Italy
Tel: +39 346 235 7481, Fax: +39 068 413 866, E-Mail: abuzzi@wwfmedpo.org

**SCRS CHAIRMAN**
**Melvin,** Gary
SCRS Chairman, St. Andrews Biological Station - Fisheries and Oceans Canada, Department of Fisheries and Oceans, 285 Water Street, E5B 1B8, St. Andrews, New Brunswick
Tel: +1 506 652 95783, E-Mail: gary.d.melvin@gmail.com; gary.melvin@dfo-mpo.gc.ca

**SCRS VICE-CHAIRMAN**
**Coelho**, Rui
Researcher, SCRS Vice-Chairman, Portuguese Institute for the Ocean and Atmosphere, I.P. (IPMA), Avenida 5 de Outubro, s/n, 8700-305, Olhão, Portugal
Tel: +351 289 700 504, Fax: E-Mail: rpcoelho@ipma.pt

**SCRS OFFICER**
**Parker,** Denham
Stock Assessment Scientist, Department of Environment, Forestry and Fisheries, 9 Martin Hammerschlag Way, 7800, Cape Town, South Africa
Tel: +27 21 402 3165; +27 82 660 7985, Fax: E-Mail: DParker@environment.gov.za; DenhamP@DAFF.gov.za

**EXTERNAL EXPERTS**
**Carruthers**, Thomas *
2150 Bridgman Ave, V7P 2T9, Vancouver, Canada
Tel: +1 604 805 6627, Fax: E-Mail: tom@bluematterscience.com

**Krusic-Golub**, Kyne *
Fisheries Scientist, Fish Ageing Services, 28 Swanston St, Queenscliff Victoria, 3225, Australia
Tel: +61 438 306 179, E-Mail: kyne.krusicgolub@fishageingservices.com

**Maunder**, Mark *
Inter-American Tropical Tuna Commission - IATTC, 8901, 92037-1509, La Jolla, United States
Tel: +1 858 546 7100, E-Mail: mmaunder@iattc.org

**Parma**, Ana *
Principal Researcher, Centro para el Estudio de Sistemas Marinos, CONICET (National Scientific and Technical Research Council), Blvd. Brown 2915, U 9120 ACF, Puerto Madryn, Chubut, Argentina
Tel: +54 (280) 488 3184 (int. 1229), Fax: +54 (280) 488 3543, E-Mail: anaparma@gmail.com; parma@cenpat-conicet.gob.ar

**FAO INVITED**
**Scott**, Gerald P.
FAO Common Oceans /ABNJ Tuna project, 11699 SW 50th Ct, Cooper City, Florida 33330, United States
Tel: +1 954 465 5589, E-Mail: gpscott_fish@hotmail.com

*****

**ICCAT Secretariat**
C/ Corazón de María 8 – 6ª planta 28002 Madrid – Spain
Tel: +34 91 416 56 00; Fax: +34 91 415 26 12; E-mail: info@iccat.int

**Manel,** Camille Jean Pierre
**Neves dos Santos,** Miguel
**Moreno,** Juan Antonio
**Cheatle,** Jenny
**Ortiz,** Mauricio
**Palma,** Carlos
**Kimoto,** Ai
**Taylor,** Nathan
**Alemany,** Francisco
**Campoy,** Rebecca
**De Andrés,** Marisa
**Donovan,** Karen
**García-Orad,** María José
**Peyre,** Christine
**Pinet,** Dorothée
**Gallego Sanz,** Juan Luis
**García,** Jesús
**Martín,** África
**Martínez Guijarro,** Ana Isabel
**Mayor,** Carlos
**Muñoz,** Juan Carlos
**Pagá,** Alfonso
**Peña,** Esther
**Tensek,** Stasa

**ICCAT INTERPRETERS**
**Baena Jiménez**, Eva J.
**Hof**, Michelle Renée
**Liberas**, Christine
**Linaae**, Cristina
**Meunier**, Isabelle
**Quenette**, Olivier Bertrand

**Appendix 4**

**List of SCRS documents and presentations**

| Reference | Title | Authors |
|---|---|---|
| SCRS/2021/001 | Report of the Tropical Tunas MSE Technical Group Meeting | Anonymous |
| SCRS/2021/002 | Report of the Intersessional Meeting of the Billfishes Species Group | Anonymous |
| SCRS/2021/003 | Report of the 1st Intersessional Meeting of the Bluefin Tuna Species Group | Anonymous |
| SCRS/2021/004 | Report of the Bigeye Tuna Data Preparatory Meeting | Anonymous |
| SCRS/2021/005 | Report of the Subcommittee on Ecosystems Intersessional Meeting | Anonymous |
| SCRS/2021/006 | Report of the Working Group on Stock Assessment Methods Intersessional Meeting | Anonymous |
| SCRS/2021/007 | Report of the Intersessional Meeting of the Small Tunas Species Group | Anonymous |
| SCRS/2021/008 | Report of the Intersessional Swordfish Species Group Meeting | Anonymous |
| SCRS/2021/009 | Report of the Albacore Species Group Intersessional Meeting (Including Med-ALB Stock Assessment) | Anonymous |
| SCRS/2021/015 | Description of Canada's proposed blue marlin, white marlin/roundscale spearfish discard estimation analyses | Gillespie K. |
| SCRS/2021/016 | Characterization of structural uncertainty in tropical tuna stocks' dynamics | Merino G., Die D., Urtizberea A., Laborda A. |
| SCRS/2021/018 | Further refinements of the BR CMP | Butterworth D.S., Rademeyer R.A. |
| SCRS/2021/019 | Review of the size distribution of caged eastern bluefin tuna (*Thunnus thynnus*) in Turkish farms 2014-2020 | Ortiz M., Karakulak S., Mayor C., Paga A. |
| SCRS/2021/020 | Update of the French aerial abundance index for 2020 and first attempt at accounting for the environmental effects on bluefin tuna availability in the Gulf of Lions | Rouyer T., Bal G., Derridj O., Fromentin J.M. |
| SCRS/2021/005 | Report of the Subcommittee on Ecosystems Intersessional Meeting | Anonymous |
| SCRS/2021/006 | Report of the Working Group on Stock Assessment Methods Intersessional Meeting | Anonymous |
| SCRS/2021/007 | Report of the Intersessional Meeting of the Small Tunas Species Group | Anonymous |
| SCRS/2021/008 | Report of the Intersessional Swordfish Species Group meeting | Anonymous |
| SCRS/2021/009 | Report of the Albacore Species Group Intersessional Meeting (Including Med-ALB Stock Assessment) | Anonymous |
| SCRS/2021/022 | On comparing CMPs across different development tunings and the associated pertinence of OM weighting | Butterworth D.S., Rademeyer R.A., Carruthers T.R. |
| SCRS/2021/023 | Report of the 2021 ICCAT GBYP Workshop on Close-Kin Mark Recapture for Eastern Atlantic Bluefin Tuna (Online, 8-9 February 2021) | Anonymous |

| Reference | Title | Authors |
|---|---|---|
| SCRS/2021/024 | Report of the 2021 ICCAT GBYP Workshop on Electronic Tagging for Atlantic Bluefin Tuna (Online, 15-16 March 2021) | Anonymous |
| SCRS/2021/025 | Updated indicators of relative abundance for bluefin tuna based on revised treatments of the Canadian fisheries data | Hanke A.R., *et al.* |
| SCRS/2021/026 | An updated index for western bluefin tuna from the US Gulf of Mexico longline fishery | Walter J.F. |
| SCRS/2021/027 | Length frequencies in the Canadian and USA rod and reel fisheries for Atlantic bluefin tuna | Maguire J.-J., Hanke A., Duprey N., Gillepsie K. |
| SCRS/2021/028 | Training an A.I. CPM for Atlantic bluefin tuna | Carruthers T.R. |
| SCRS/2021/029 | Summary of the Atlantic bluefin tuna MSE poll for plausibility weighting | Kimoto A., Walter J.F. |
| SCRS/2021/030 | Notes from the BFT CMP developers webinar in March 2021 | Walter J.F. |
| SCRS/2021/031 | Summary of input data (catch and size) used in the Atlantic bluefin tuna operating models in 2021 | Kimoto A., Carruthers T.R., Mayor C., Palma C., Ortiz M. |
| SCRS/2021/032 | Mathematical definition and updated progress of the EA cMPs | Andonegi E., Arrizabalaga H., Rouyer T., Gordoa A., Rodriguez-Marín E. |
| SCRS/2021/033 | Bluefin tuna larval indices in the Balearic Archipelago for the management strategy evaluation (strict update index for 2001-2019) | Alvarez-Berastegui D., Tugores M.P., Martín-Quetglas M., Leyva L., Reglero P. |
| SCRS/2021/034 | The United States rod and reel smaller size class bluefin tuna (*Thunnus thynnus*) indices of relative abundance; major revisions and recommendations | Lauretta M., Walter J.F., Brown C. |
| SCRS/2021/035 | Multinational pelagic longline index of bluefin tuna relative abundance in the Gulf of Mexico | Lauretta M., Ramirez K., Walter J.F., Brown C. |
| SCRS/2021/036 | Review of the Gulf of St. Lawrence bluefin tuna acoustic index of abundance | Minch T., Gillespie K. |
| SCRS/2021/037 | Preliminary analysis of bluefin tuna nominal catch rates by vessel size category and gear type | Ortiz M., Gallego J.L., Mayor C., Parrilla A., Samedy V. |
| SCRS/2021/038 | Investigation of model improvements for the U.S large (>177 cm) Atlantic bluefin tuna index of abundance | Hansell A., Becker S., Brown C., Cadrin S., Golet W., Lauretta M., Walter J.F., Kerr L. |
| SCRS/2021/039 | Development of a western large (>177 cm) Atlantic bluefin tuna index of abundance based on Canadian and USA rod and reel fisheries data | Hansell A., Hanke A., Becker S., Cadrin S., Lauretta M., Walter J.F., Golet W., Kerr L. |
| SCRS/2021/040 | The standardized bluefin CPUE of Japanese longline fishery in the West Atlantic up to 2020 fishing year | Tsukahara Y., Fukuda H., Nakatsuka S. |
| SCRS/2021/041 | Mathematical description and tuning results of a Candidate Management Procedure (TN_X) for MSE of Atlantic bluefin tuna | Tsukahara Y., Nakatsuka S. |
| SCRS/2021/042 | Yet further refinements of the BR CMP | Butterworth D.S., Rademeyer R.A. |
| SCRS/2021/043 | Report on the activities of the BFT Technical Subgroup on Growth in Farms | Deguara S., Alemany F., Ortiz M., Rodriguez-Marin E. |

| Reference | Title | Authors |
|---|---|---|
| SCRS/2021/044 | Recommendations of the BFT Technical subgroup on abundance indices for West Atlantic bluefin tuna | Anonymous |
| SCRS/2021/045 | Interannual variability in the larval survival of bluefin tuna (*Thunnus thynnus*) in the western Mediterranean spawning ground during 1990-2020 | Reglero P., Tugores P., Balbín R., Alvarez-Berastegui D., Øyvind F. |
| SCRS/2021/046 | Updated CMP results following second round of CMP refinements | Carruthers T. R. |
| SCRS/2021/047 | Atlantic bluefin tuna MSE topics for consideration and decision | Butterworth D.S., Carruthers T.R. |
| SCRS/2021/048 | Development of new model fisheries for simulating longline catch data with LLSIM | Goodyear C.P. |
| SCRS/2021/049 | Investigations into spatiotemporal patterns in swordfish habitat distributions | Goodyear C.P. |
| SCRS/2021/050 | Plausibility and uncertainty of basic data and parameter selection on stock assessments: a review of some input data used in the 2017 assessment of shortfin mako (*Isurus oxyrinchus*) of the northern Atlantic stock | Mejuto J., Fernández-Costa J., Ramos-Cartelle A., Carroceda A. |
| SCRS/2021/051 | Review of fishing operation and bigeye tuna catch by Japanese longline fishery in the Atlantic Ocean | Matsumoto T. |
| SCRS/2021/052 | Update of Trilateral Collaborative Study among Japan, Korea and Chinese Taipei for producing joint abundance indices for the Atlantic bigeye tunas using longline fisheries data up to 2019 | Kitakado T., Satoh K., Lee S.L, Su N.J., Matsumoto T., Yokoi H., Okamoto K., Lee M.K., Lim J.H., Kwon Y., Wang S.P., Tsai W.P., Chang S.T., Chang F.C. |
| SCRS/2021/053 | Update of information on Korean longline fishery focusing on bigeye tuna in the Atlantic Ocean | Lee S.L., Lee M.K., Lim J., Kwon Y. |
| SCRS/2021/054 | Standardization of bigeye tuna CPUE in the Atlantic Ocean by the Japanese longline fishery which includes cluster analysis | Matsumoto T., Yokoi H., K. Satoh |
| SCRS/2021/055 | Progress on characterization of structural uncertainty in tropical tuna stocks' dynamics with summary of discussions held during the Tropical Tuna MSE Meeting (29-31 March 2021) | Merino G., Die D., Urtizberea A., Laborda A. |
| SCRS/2021/056 | Biological observations of shortfin mako shark (*Isurus oxyrinchus*) on Spanish surface longline fishery targeting swordfish | García-Cortés B., Ramos-Cartelle A., Mejuto J., Carroceda A., Fernández-Costa J. |
| SCRS/2021/057 | Sex-Ratio du thon obèse *Thunnus obesus* (Lowé, 1839) capturé dans L'Océan Atlantique et débarqué au port de pêche d'Abidjan | Doffou Y.C., Diaha N.C., Amandè M.J., Guillou M., Lesage M., and Coquille P. |
| SCRS/2021/058 | Index of abundance of juvenile bigeye tuna in the Atlantic Ocean derived from echosounder buoys | Santiago J. *et al*. |
| SCRS/2021/059 | Catch and effort standardization for bigeye tuna (*Thunnus obesus*) caught in the Chinese Tapei distant-water longline fishery in the Atlantic Ocean | Su N.J., Lin W.R., Huang W.H. |

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| SCRS/2021/060 | Developing abundance index of bigeye tuna (*Thunnus obesus*) for the Chinese Taipei longline fishery in the Atlantic Ocean using boosted regression trees | Lin W.R., Su N.J., Huang W.H. |
| SCRS/2021/061 | Size composition of bigeye tuna (*Thunnus obesus*) caught in the Chinese Taipei distant-water longline fishery in the Atlantic Ocean | Su N.J., Huang W.H., Lin W.R. |
| SCRS/2021/063 | Pesquería de atún patudo (*Thunnus obesus*, Lowe 1839) en las Islas Canarias, período 1926 a 2019 | Pascual-Alayón P.J., Déniz S., Abascal F.J. |
| SCRS/2021/064 | Introduction to the ICCAT tuna factory sales data flow and database | Bodin N., Fiorellato F., Palma C., Mayor C. |
| SCRS/2021/066 | Effects of fishing gear configurations on target, desirable bycatch and unwanted bycatch species | Santos C., Rosa D., Coelho R. |
| SCRS/2021/067 | Sea turtles in Algeria | Benounnas K. |
| SCRS/2021/068 | Assessment of the effect of hook shape on fishing mortality of multi-taxa fish species using experimental longline operation data | Ochi D., Ueno S., Okamoto K. |
| SCRS/2021/069 | Terms of Reference for Ecocard intersessional work | Juan-Jorda M., Andonegi E., Alavarez D., Murua H., Coelho R., Kell L. Báez J., Hanke A. |
| SCRS/2021/070 | Concept note for ICCAT Ecoregione workshop "Identification of regions in the ICCAT Convention area for supporting the implementation of ecosystem-based fisheries management" | Juan-Jorda M., Andonegi E., Alavarez D., Murua H., Coelho R., Kell L. Báez J., and Hanke A. |
| SCRS/2021/071 | Quasi-quantitative risk assessment approach to facilitate prioritization in implementing ecosystem-based approach to fisheries management | Tsuji S. |
| SCRS/2021/072 | The effect of terminal gear modifications on the total mortality of the shortfin mako, *Isurus oxyrinchus* | Keller B.A., Reinhardt J.F., Swimmer Y., Brown C.A. |
| SCRS/2021/073 | The Jelly-FAD: a paradigm shift in bio-FAD design | Moreno G., Salvador J., Murua H., Uranga J., Zudaire I., Grande M., Murua J., Restrepo V. |
| SCRS/2021/074 | Depredation of tunas and tuna-like species by marine mammals: economic impacts of a human-wildlife interaction | LeGallic B. *et al*. |
| SCRS/2021/075 | A preliminary analysis of spatiotemporal patterns in swordfish habitat distributions | Schirripa M.J., Forrestal F., Goodyear C.P., Abascal F., Bubley W., Coelho R., Hanke A. |
| SCRS/2021/076 | Advances in the collaborative work to assess sea turtle bycatch in pelagic longline fleets (Atlantic and Indian Oceans and Mediterranean Sea) | Anonymous |
| SCRS/2021/077 | Additional data on the narrow barred Spanish mackerel (*Scomberomorus commerson*, Lacépède, 1800) in Libya and Palestine | Al Mabruk S.A.A., Di Natale A., Zava B. |
| SCRS/2021/078 | Testing a bycatch estimation tool using simulated blue marlin longline data | Babcock E.A., Goodyear C.P. |
| SCRS/2021/079 | Modelling the impacts of climate change on global tuna fisheries to support development and implementation of climate adaptive EAFM plans | Obregon P., Senina I., Bell J., Nicols S., Scutt Phillips J., Lehodey P., Kittinge J. |

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| SCRS/2021/080 | 3D printing of pelagic shark fins for use as a training and compliance tool | Bürgener M., Louw S., da Silva C. |
| SCRS/2021/081 | Étude de quelques paramètres de la biométrie, de la croissance et de l'histologie d'un thonidé mineur ; la thonine commune: *Euthynnus alletteratus* (Rafinesque, 1810), pêché dans la baie de Mostaganem | Benounnas K. |
| SCRS/2021/082 | Lack of genetic differentiation in the Atlantic distribution of wahoo | Ollé J., Pascual-Alayón P.J., Angueko D., Diaha N'G.C., Lucena Frédou F., Silva G., Viñas J. |
| SCRS/2021/083 | From data mining to the stock assessment of the SW Atlantic wahoo *Acanthocybium solandri* | Cardoso L.G., Frédou T., Hazin F., Travassos P., Sant'Anna R., Mourato B., Silva G., Cope J., Pons M., Cardoso C., Soares A., Barreto T., Lucena-Frédou F. |
| SCRS/2021/084 | The southward expansion of the distribution and fishing grounds of blackfin tuna *Thunnus atlanticus* in the southwestern Atlantic Ocean due to increasing water temperatures | Cardoso L.G., Sant'anna R., Freire M.A., Weigert F.C., Poubel M., Bezzerra N. |
| SCRS/2021/085 | Protocol for sampling, preparing and storing of first dorsal fin spine for small tuna species: a first step for ageing analysis | Muñoz-Lechuga R., Lino P.G. |
| SCRS/2021/086 | Updated life history parameters and estimates of spawning potential ratio for frigate tuna *Auxis thazard* stock in the Northeast Atlantic | Zapadaeva N. |
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| SCRS/P/2021/062 | South Atlantic albacore tuna reproductive biology study | Travassos P. |
| SCRS/P/2021/063 | Fisheries & biological data submitted during 2021 | ICCAT Secretariat |
| SCRS/P/2021/064 | Interim report of Phase 4 of ICCAT's swordfish biology program | Gillespie K. |

**Appendix 5**

## Report of the Atlantic-wide Research Programme for Bluefin Tuna (GBYP)

*(Activity report for the last part of Phase 10 and the first part of Phase 11 (2020-2021)*

### 1. Introduction

The ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP) was officially adopted by the SCRS and the ICCAT Commission in 2008, and it started officially 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 its results, as well as on budgetary and other administrative issues of the GBYP programme, from the very 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 meetings reports, are also readily available on the GBYP webpage.

The tenth phase of the GBYP officially started on 1 January 2020 following the signature of the Grant Agreement for the co-financing of the GBYP Phase 10 (SI2.819120) by the European Commission. The initial duration of the Phase was one year, but, in order to better adjust to the period of bluefin tuna fishing and harvesting operations, which condition many GBYP activities, it was extended for seven months, thus officially ending on 31 July 2021. The activities carried out during the first nine months of Phase 10 and their preliminary results were presented to the SCRS and the Commission in 2020 (Alemany *et al*., 2020) and approved. The eleventh phase of the GBYP officially started, following an EU request, on 1 January 2021, after the signature of the Grant Agreement for co-financing of Phase 11 (SI2.839201) by the European Commission, with a planned duration of one year. Although these two GBYP phases have been partially developed in parallel, this has not caused any major problems since each phase has a different and well defined workplan and budget, and every cost can be assigned unequivocally to the activities detailed in the respective Grant Agreements.

In general, although several tasks have been affected by the COVID-19 pandemic, most of the activities planned within both phases have been or are being implemented successfully. The activities in both phases have continued to be structured considering the same main lines of research established since the beginning of the programme, i.e. data recovery, biological studies, tagging, aerial surveys and modelling, but this does not mean that the workplans of these last two phases mimic those of the previous ones, since the specific activities are adapted every year in accordance with the SCRS research needs and Commission requests, continuously improving the methodologies and optimizing the working procedures year after year to increase the efficiency and quality of the advice. Moreover, some strategic shifts in the aim of several of these lines have been introduced in recent years. Thus, data recovery activities have shifted to data management, focusing on the consolidation and development of new relational databases, integrating all the information produced and gathered by the programme from the beginning. Aerial surveys have been thoroughly revised, and the research line has broadened its scope to other fishery independent indices. Tagging activities have also changed the strategic approach, being currently based on close cooperation with consolidated national tagging programmes, which has greatly increased the overall efficiency and reduced operational costs.

All activities carried out throughout GBYP Phase 10 and those launched during the first part of Phase 11, as well their final or preliminary results and the related coordination activities, are described and summarised in this report. Moreover, it also includes a proposal of activities to be carried out within Phase 12, for consideration and eventual support of the SCRS.

The COVID-19 pandemic has fully affected the development of Phase 10 and the launching of Phase 11 activities, but the experience gained over the first semester of 2020 has allowed GBYP to face successfully the challenges derived from the global scenario. The specific impacts on each line of research are detailed in the next chapters. Since the temporary closure of the ICCAT Secretariat headquarters in March 2020 was maintained throughout last year, the GBYP coordination team has continued to use telecommuting facilities to manage the programme without any significant impact on the coordination activities.

## 2. Coordination activities and general issues of GBYP programme management

The GBYP Steering Committee in Phase 10 comprises the SCRS Chair, the Western Bluefin Tuna Rapporteur, the Eastern Bluefin Tuna Rapporteur, the ICCAT Executive Secretary and/or his deputy. During 2020 and 2021, one contracted external expert also acted as a full member of the GBYP Steering Committee. In order to define the workplan and refine the ongoing activities, during Phase 10 the Steering Committee held four online meetings in April/June, November and December 2020, and in January 2021. In addition, its members have been constantly informed by the GBYP Coordination Team about the status of the activities through detailed reports provided on a bimonthly 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. The ICCAT Secretariat has provided technical and administrative support for all GBYP activities on a daily basis. In Phase 10, a total of 3 Calls for tenders and 12 official invitations were released, which resulted in 16 contracts awarded to various entities. In addition, one Call of expression of interest was published which resulted in 5 memorandums of understanding.

### *2.1 Financial aspects*

In Phase 10 the total budget was €2,000,000.00, thanks to contributions from the following donors: European Union (Grant Agreement) €1,600,000.00, Algeria €105,479.22, Japan €68,344.70, Morocco €64,962.81, United States of America €64,000.00, Libya €20,775.11, Canada €19,252.55, Egypt €13,007.74, Tunisia €11,764.30, Albania €7,718.45, China, €4,401.12, Korea €4,054.67, Iceland €3,239.33, Chinese Taipei €3,000.00, and the ICCAT Secretariat €10,000.00.

In Phase 11 the total budget is €1,600,000.00, thanks to contributions from the following donors: European Union (Grant Agreement) €1,280,000.00, Morocco €61,981.13, Japan €52,204.87, Tunisia €50,109.59, Libya €43,583.77, Turkey €43,503.81, Norway € 19,000.00, Canada €18,834.89, United States of America €8,420.00, Egypt €6,228.31, Albania €3,208.52, and China, €1,925.11.

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 11 will be used for the following Phases of GBYP. It should be noted that contributions for the current and previous GBYP Phases are still pending from some ICCAT CPCs.

The approved budget for Phase 10 and Phase11 is summarised in **Table 1**.

**Table 1.** Approved budget of GBYP Phases 10 and 11.

| Item | Phase 10 | Phase 11 |
|---|---|---|
| Coordination | €375,000.00 | €335,000.00 |
| Data Mining | €25,000.00 | €85,000.00 |
| Independent indices | €612,000.00 | €85,000.00 |
| Biological Studies | €620,000.00 | €602,000.00 |
| Tagging | €218,000.00 | €268,000.00 |
| Modelling | €150,000.00 | €225,000.00 |
| **Total** | €2,000,000.00 | €1,600,000.00 |

## 3. Summary of Phase 10 and Phase 11 GBYP scientific activities and results by main line of research

### *3.1 Data mining, recovery and management*

The original plan of activities in Phase 10 included a specific budget related to the data recovery, just in case some relevant datasets regarding presence, catches, length distribution and spatial patterns not previously available to the SCRS would be detected. Nevertheless, since no new relevant datasets were available, this activity was cancelled, which was reflected in the Amendment to the Grant agreement.

In addition, the workplan under the information and data management activity, continuing the new strategic approach initiated in Phase 9, also included in-house work to be carried out within the ICCAT Secretariat through close collaboration between the ICCAT Department of Research and Statistics, SCRS scientists and the GBYP coordination team, focused on the development of relational databases to allow proper storage and analysis of all raw data from GBYP funded research activities or other data relevant data sources for BFT management not included yet in current ICCAT DBs.

Specifically, the activities carried out under GBYP Phase 10 included:

- The design and creation of a database integrating the data related to BFT farming, including those from stereo camera measurements and harvesting operations, relating to and complementing them with data from eBCD and VMS systems.
- The design and creation of a database recording the information obtained from the GBYP studies on growth in farms.
- The initial tasks aiming at the implementation of the work plan for the creation of a broad biological data information system, as the inventory of the different data sets from consecutive GBYP biological studies and from the EU Data Collection Framework.
- Updating and improvement of the quality of the information from tagging activities, including the elaboration of the development plan for the design and building up of a common electronic tagging database.
- Storing the data form the aerial survey activity.

### *3.2 Stock indices: Aerial Survey on Bluefin Tuna Spawning Aggregations*

The GBYP Aerial Survey on Bluefin Spawning Aggregations was initially identified by the Commission as one of the three main research objectives of the programme, in order to provide fishery-independent trends of the eastern stock SSB. Up to now, GBYP has produced a 7-year long series of fisheries independent index of spawning stock abundance based on these aerial surveys over the 4 main spawning areas in the Mediterranean. The index has not been used in stock assessment yet, but the index from the Balearic Sea area is being used in MSE.

However, due to different reasons, this activity has not been developed regularly and has not followed homogenous methodologies and sampling strategies throughout the successive GBYP Phases. The method was finally normalized in 2015, reanalysing all previous datasets, thus providing standardized series of index. Nevertheless, a global revision of the results carried out within Phase 8 showed that no clear patterns in weight and/or abundance among years and areas were discerned yet, and the Coefficient of Variation of the indices remained high, suggesting that there was still room for further methodological improvements. Therefore, several activities aiming at detecting and quantifying potential sources of bias, as calibration surveys, and to improve as much as possible the accuracy of the currently available indices, through refining the sampling strategy and sighting methodology, were implemented in Phase 9, besides a reanalysis of the whole time series, including a complete revision of the raw database.

Due to the logistical impediments which were in place in the second trimester of 2020 because of the coronavirus crisis, it was impossible to complete all preparatory tasks for the 2020 campaign and therefore the summer 2020 aerial surveys were cancelled, besides a further field calibration exercise.

In addition, given that the global revision of the aerial survey data carried out in 2019 raised various concerns about the representativeness of the index, the GBYP Steering Committee decided to perform an external review of the GBYP aerial surveys by independent experts within Phase 10. The external reviewers, considering some inconsistencies detected among the analyses carried out up to now, recommended to perform a new complete reanalysis of the whole time series. Moreover, they recommended to perform extended surveys covering buffer areas around the areas surveyed from 2017, to move to a model-based approach for data analysis and to explore the feasibility of using automated digital systems instead of human observers for aerial surveys.

Consequently, a pilot aerial survey covering an extended area over the Balearic Sea and including, in parallel to the usual human observer sightings, automatic continuous recording of high quality images over all the surveyed transects, has been carried out in 2021. Data from human observers sightings will be analyzed within GBYP Phase 11, providing a new point to the index time series used withing the framework of BFT

MSE. The results from the postprocessing of digital images have shown that this methodology is useful for detecting and quantifying BFT schools. Is has shown also that this technique allows to detect schools not sighted by human observers. The implications of all these findings will be fully analyzed within Phase 11, and the conclusions from these analyses will be taken into account for deciding on the sampling strategy and methodology to be followed in future aerial surveys.

Moreover, the CREEM team of the University of Saint Andrews - the original developers of the "Distance" software use for analyzing GBYP aerial surveys data -, conducted both a re-analysis of the whole available time series applying the same design-based approach followed in previous Phases, to eventually correct the results, and developed a preliminary model-based approach, focused on the Balearic Sea area and the 2017-2019 time period, to evaluate the feasibility and potential improvements derived from this alternative methodological approach. The re-analyses using the design-based approach showed that the new (corrected) abundance estimates are comparable to previous results for regions A, C and G, while for region E the new estimates are lower, although they are within confidence intervals of the new ones. With respect to the model-based methods, the results show that in the considered data set, the number of groups and group sizes from model-based approach are slightly higher than for the design-based approach, but are within the 95% confidence interval. The BFT Species Group in its second intersessional meeting in September 2021 decided to replace the previous aerial survey results with the revised survey results in the MSE.

### *3.3 Tagging activity*

The main objectives of tagging activities are the estimation of the natural mortality rates of bluefin tuna populations by age or age-groups and the evaluation of habitat utilization and large-scale movement patterns (spatio-temporal,), including estimates of mixing rates between stock units by area and time strata, of both juveniles and spawners. This line of research has faced two important problems from the very beginning of the GBYP programme, which have limited up to now the full achievement of the objectives. One is the very low recovery rate of conventional tags, which impeded the use of these data to estimate reliable mortality rates. Due to this, the GBYP SC decided to cancel the conventional tagging programme in Phase 4 and focus on electronic tagging instead, maintaining only complementary conventional tagging activities by providing tags and tagging equipment to different institutions or organizations, as well as maintaining the awareness and reward campaigns and the database, integrating all the results from recovered tags. The second major problem has been the relatively short time that most of the electronic pop-up tags have remained on the fish. These problems were addressed in Phase 9, by improving the deployment methodology and provision of specific training to the e/tagging teams, and developing specific actions focused on increasing the involvement of ICCAT observers and farms staff in tags detection and reporting. The results of these activities have become evident from 2019, since the average time on fish of tags programmed for 1 year, which was only 48 days in Phases 2 to 8, has increased to an average value of 245 in Phases 9 and 10. Regarding actions to improve the recovery rates, they have resulted in an increase of recoveries in the Mediterranean area. In total, in 2020 and the beginning of 2021 a total of 137 conventional and 10 e-tags have been recovered. In addition to these actions, another planned activity aiming the increase in efficiency of e-tagging programs was the organization of an open workshop, which resulted in a broad consensus on the strategic future planning and best use of the already available information from e-tags. After the initial cancellation of the in-person workshop, it was finally held online within Phase 10, which was attended by 60 participants from different CPCs that formulated a series of specific recommendations on e-tag deployment strategies and methodologies.

The specific objectives of the 2020 e-tagging campaign were 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 MSE modelling process, and to deepen the knowledge of spatial pattern of populations spawning in the eastern Mediterranean Sea. Unfortunately, the campaigns in the eastern Mediterranean and off Canary Islands, which required the participation of external experts, were cancelled due to mobility restrictions derived from the pandemic.

Consequently, efforts were concentrated on the stock mixing issue, focusing on campaigns in the North Atlantic. These campaigns were developed following a new strategic approach, consisting in taking advantage of synergies between existing consolidated national e-tagging programs and GBYP. To this end, a Call for cooperation was launched and the following Memorandum of Understanding was signed with 5 institutions (AZTI, DFO, DTU, IMR and MI) to deploy a total of 25 internal archival and 36 external pop-up

tags in different areas of North Atlantic, following the standard methodologies agreed at Olhão GBYP workshop carried out in 2019. Moreover, the cooperation with national teams allowed to promote the collaboration and methodological standardization among different research teams, as well as minimizing operational costs of the tagging activities. Considering the success of this new approach for the implementation of the GBYP e-tagging program, a new Call for Expression of Interest to collaborate with the GBYP e-tagging program was launched in June 2021. Within the framework of this Call, a total of 80 pop-up satellite and 5 internal archival tags were awarded to different CPC national teams and international consortiums (DTU – Denmark; IEO/University of Massachusetts - Spain/USA; IMR - Norway; MI/Stanford University - Ireland/USA; SLU - Sweden; Stanford University/DFO/Acadia University - Canada/USA; Stanford University/ACPR/Barcelona Zoo - USA/Spain; University of Genoa - Italy; CEFAS/Exeter University - United Kingdom), to be deployed on both sides of North Atlantic, targeting eastern stock individuals, and in the Mediterranean Sea.

Besides these activities, GBYP has supported e-tagging activities carried out independently by other institutions, by allowing the use of GBYP RMA in the case of BFT casualties during tagging operations and, in the case of the Italian branch of WWF Mediterranean Marine Initiative, the use of GBYP Argos system accounts for data transmission in such a way that the resulting data will be directly integrated in the GBYP database.

As regards conventional tagging, the GBYP programme has been maintained as a complementary activity, providing logistical support to several institutions. From March 2020 to March 2021, a total of 3,275 conventional tags have been 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, as microchemical and genetics analyses to investigate mixing and population structure, with a particular focus on identifying the age structure and the probable subpopulations. Population structure is a key uncertainty for bluefin tuna, given the possibility that more than two populations or contingents coexist in the Atlantic Ocean, while ICCAT managers so far assume two separate populations with no mixing, in contrast with the fact that the stock structure assumed for the stock assessment and management purposes must 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, the activities in Phase 10 were related to further understanding of the implications of the new spawning grounds in the Atlantic Ocean (Slope Sea and Bay of Biscay) and to mixing analyses to provide accurate information and more clear alternative hypotheses to the MSE process. In addition, GBYP has continued with the broad study to determine BFT growth in farms, in connection with ICCAT Rec. 20-07, paragraph 8.

Moreover, two online workshops related to these biological studies have been held within Phase 10, one on close-kin methods and the other on larval index surveys. The objective of the larval index surveys coordination workshop was to facilitate coordination between different CPCs national studies, while the objective of the close kin workshop was to provide insight on new achievements of the method and evaluate its potential use on the eastern BFT stock, with special focus on the assessment.

#### *3.4.1 Biological sampling and analyses*

Biological sampling

The level of biological sampling in Phase 10 has been comparable to that of Phase 9, focusing mainly on the Atlantic subregions where mixing potentially occurs, such as the Central Atlantic, Canary Islands and Morocco. In addition, adult BFT individuals have been sampled in the Mediterranean farms, aiming at guaranteeing the availability of enough biological samples to construct representative annual age length keys and for other analyses in the future. In 2020-2021 more than 3947 biological samples were collected. All GBYP samples were stored in the GBYP Tissue Bank, which is maintained by AZTI.

Biological analyses: Microchemistry

As concerns biological analyses, it was decided to combine both genetic and microchemical analyses on the same sample, whenever possible, to take advantage of the synergies between both approaches to determine the stock of origin.

Regarding otolith microchemistry, new carbon and oxygen stable isotope analyses were carried out in 202 otoliths of Atlantic bluefin tuna captured in the Canary Islands, Central North Atlantic (East and West of the 45ºW boundary) and the Norwegian Sea to determine their nursery area, and the results indicated that samples from the Northeast Atlantic, Norwegian Sea and Canary Islands were dominated by eastern origin individuals. These results are consistent with previous findings and suggest that Mediterranean bluefin tuna may be the principal contributor to the fisheries operating in the Northeast Atlantic. Fisheries operating west of the 45ºW meridian are supported by both Mediterranean and Gulf of Mexico populations, and the proportions of each stock contributing to the catches may vary from year-to-year.

Additionally, the existing baseline was aimed to be refined in order to increase its discrimination capacity by reducing the portion of the otolith targeted for analyses to the first three months of life, but the results showed that the discriminatory power of this new baseline was similar to that based on the 1-year otolith portion. Therefore, the oxygen stable isotopes are an important tracer to differentiate bluefin tuna from the Gulf of Mexico and Mediterranean population, but by itself is insufficient for substock structure investigations within the Mediterranean Sea. So, stable isotopes analyses were complemented with trace elements (Sr, Ba and Mg) analyses in a selection of otoliths from the Gulf of Mexico and Mediterranean Sea. The preliminary results suggest that the combination of stable isotopes and trace elements may considerably improve the ability to identify the origin of tuna from the mixing zones.

In relation to life history analyses, secondary ion mass spectrometry (SIMS) was used to measure δ18O throughout otolith growth profiles at a high temporal-resolution. Progress made in Phase 9 was built on in Phase 10 by using the relationship between temperature and δ18O in the otoliths of farmed fish to develop a fractionation equation to allow for a more accurate reconstruction of temperature histories and hence to infer the timing of movement away from the main spawning areas. So, comparison of relative changes across individuals allowed for the detection of groups of fish with characteristic migratory patterns. The results provide some support for the hypothesis that there is a migratory and a resident contingent within the eastern stock of Atlantic bluefin tuna.

Biological analyses: Genetics

Despite recent efforts on understanding the population structure and connectivity of Atlantic bluefin tuna, numerous questions remain. Perhaps the most important question is how much and since when the two presumed populations, Gulf of Mexico and Mediterranean, interbreed, and what is the role of the Slope Sea in this interbreeding. In previous GBYP phases RAD-seq data were used to tackle these questions, providing unprecedented information about the population structure of Atlantic bluefin tuna, revealing connectivity mediated through the Slope Sea, signals of adaptation and nuclear introgression from albacore. Therefore, in this Phase, genetic analyses have focused on further confirming previous results on the population structure of Atlantic bluefin tuna by using a new cost-effective tool, a genotyping array that includes more than 7000 genetic markers suitable for Atlantic bluefin tuna population genetics, and on testing assignment of feeding aggregates with an improved origin traceability panel through the use of an enlarged baseline. The results obtained with the array are consistent with those obtained with the RAD-seq data, and, additionally, has been proven useful to detect kins, making it suitable for applications such as Close-kin Mark Recapture.

The array-based analyses have confirmed that the Mediterranean individuals have all Mediterranean genetic background, that the Gulf of Mexico individuals include mostly Gulf of Mexico genetic background individuals but also Mediterranean and mixed background individuals, and that the western Atlantic individuals corresponding to potential Slope Sea spawners have mixed background. The array-based analyses also detect a potential chromosomal inversion that separates samples in three groups, two being homozygous for the inversion and one heterozygous. Altogether these results confirm previous findings on the population structure of Atlantic bluefin tuna, suggesting that the observed “unexpected” findings were not due to artifacts of the used methodology.

Concerning origin assignment, the results showed that improving the baseline by adding more Gulf of Mexico larvae and/or removing Mediterranean origin Gulf of Mexico adults do not result in significant changes in origin assignment rate. This suggests that the number of "incorrectly" assigned or unassigned individuals is most likely due to these individuals having a different genetic and catch origin or to having a mixed genetic background (due to a non-complete genetic isolation between spawning components).

In summary, the previous hypothesis on Atlantic bluefin tuna connectivity was confirmed and the presence of signals of adaptation require further studies.

Biological analyses: Ageing

In Phase 10, a second calibration with age estimates provided by the Fish Ageing Services laboratory (FAS), contracted by GBYP to provide age estimates from 4000 Atlantic bluefin tuna otoliths in previous phases, were performed to ensure that there was no systemic bias in age readings performed by SCRS experts compared to FAS age estimates. This calibration has shown that in spite the otoliths readings standardization workshop involving FAS and SCRS experts carried out in 2019 there are still differences in band counts between them, starting in specimens with more than 10 bands and more pronounced for older specimens. These differences in readings appear to be due to the fact that FAS uses the entire section of the otolith to count annual bands, whereas ICCAT readers focus on the inner part of the ventral arm. Therefore, there is a different band count at the end of the ventral arm, with a higher band count in the inner part of the ventral arm compared to the outer part. Analyses conducted to establish which reading is more appropriate, growth function estimation and cohort follow-up analysis, seem to indicate that ICCAT readers are more accurate than FAS readers.

In addition, a determination of the otolith edge type deposition along year cycle was carried out, consisting in a semi-direct validation method used to validate seasonal deposition, that is essential to make the appropriate age adjustment to assign properly the individuals to age classes after annual bands counting. The preliminary results of edge type and marginal increment analysis (MIA) in otolith of Atlantic bluefin tuna clearly indicate that opaque bands are fully formed in August to November. However, poor data in the early part of the year are determinant to reach any conclusive results. Further sampling effort during winter months are recommended to fully cover the year and examine the relationship between month and index of completion.

Larvae relates studies

Considering the previous findings of BFT larvae in the Bay of Biscay, new zooplankton samples from this area, taken in 2020, were analyzed looking for BFT larvae, with negative results. In addition, BFT larvae from surveys conducted in the Balearic spawning ground were sorted and identified for genetics to be applied in understanding population structure in the eastern stock and specially for potential close-kin analyses.

*3.4.2 Study on BFT growth in farms*

Pursuant to a special request by the Commission to the SCRS to provide an update on the potential growth rates of bluefin tuna in farming/fattening facilities, with the aim of improving the coherence within the growth rates derived from eBCD (initially requested under Rec. 18-02, paragraph 28, amended by Rec. 19-04, paragraph 28, and more recently by Rec. 20-07, paragraph 8), the GBYP launched in Phase 9, following the preparatory work finished in Phase 8, several lines of research on this topic, involving ad hoc experiments in selected farms along the eastern Atlantic and Mediterranean, which included individual tagging experiments in two areas (Atlantic Portuguese southern coastal waters and Adriatic sea) and intensive monitoring of farmed fish growth by means of stereoscopic cameras in four Mediterranean BFT farming areas (Spanish Western Mediterranean, Central Mediterranean - Malta, Adriatic - Croatia, and Levantine Sea - Turkey), besides desk work for database generation.

The activities in Phase 10 have consisted in the continuation of experiments initiated in 2019, where it was necessary, as well as the development of new pilot studies using acoustic and IAS techniques. Specifically, new contracts were signed with farms in Portugal (repetition of adult individual growth study by tagging techniques, Spain (a new pilot study using acoustic and IAS techniques, in parallel to seasonal growth monitoring by means of standard stereo-cameras), Malta (continuation of the study initiated in 2019,

monitoring the fish carried over from the previous season) and Croatia (continuation of the study initiated in 2019, including tagging experiments and seasonal monitoring by means of stereo-cameras). Similar studies had been planned to be carried out in Moroccan farms, but unfortunately were cancelled due to pandemic restrictions. The total duration of the studies has been variable, from around 6 to 16 months in adult fish, to 19 months for juveniles. In the case of the studies based on stereoscopic cameras, they have allowed to estimate seasonal growth rates in length and the total weight gain throughout the whole fattening period of each of the modal groups (annual cohorts) present in the cages for most of the areas where BFT is farmed. In addition, they have also allowed to relate these growth rates with environmental parameters and food supply, whereas the tagging experiments provided direct measurements of individual total growth gain, both in weight and length, as requested by the Commission. Detailed results from these studies were presented to the September 2021 SCRS BFT Species Group meeting. In order to integrate the results from these GBYP funded studies and those from other research lines in a single and coherent answer to the Commission, a SCRS BFT Subgroup on growth in farms was created in 2020.

In parallel to the GBYP funded field studies, and following the recommendations from such SCRS subgroup, in-house work oriented to the consolidation of data reported from stereo-cameras to ICCAT (2014-2018), already initiated during previous Phases, continued at the ICCAT Secretariat, through close collaboration between the Department of Research and Statistics and the GBYP Coordination team, aiming at developing an operative relational data base, linking data on estimated initial lengths and weights from stereo-cameras at caging with measures of real final weights and lengths at harvesting from the e-BCD system, as well VMS data, which at the same time provides crucial information for stock assessment (length distributions of the captures of purse-seine fisheries). Based on such DB, the ICCAT Secretariat Department of Research and Statistics has performed a broad study on the growth of caged fish in all the areas where BFT farming takes place, based on modelling the differences between weights at harvesting and at caging, as a function of fish size and duration of farming. The results from this broad desk study have allowed to build up a first version of the updated growth in farms table requested by the Commission, whereas the results of the GBYP funded field studies have complemented and validated the figures included in such reference table. These results have been presented at the September 2021 BFT SCRS Species Group meeting, and based on them the SCRS Technical Subgroup on Growth in Farms has elaborated a draft answer to the Commission, which will constitute the basis for a first SCRS answer to the Commission on this topic. The available data set from the different lines of research will be further analyzed throughout GBYP Phase 11, and the very final results will be provided to the SCRS to elaborate the definitive answer to the Commission, which will be presented in 2022.

### *3.5 Modelling approaches*

The modelling programme addresses the GBYP general objective 3, which is "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". The modelling activities started in Phase 2, and very soon it became evident that this line of study had greater importance than perceived at the time when the GBYP was conceived 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 which has represented a significant investment of time and resources by the Commission, CPCs and the scientists involved.

In Phases 10 and 11 the contract for modelling approaches was again awarded to Dr Tom Carruthers (Blue Matter Science, Canada), who initiated the work on MSE and modelling in 2014.

The main objectives in 2020 were:

- To ensure the OM scenarios agreed by the GBYP Core Modelling Group (CMG) in 2016 and revised in 2017, 2018 and 2019 by the BFT Technical MSE Group (formerly CMG) and the MSE BFT Group, can be run;
- That third parties can use the OM to evaluate candidate MPs (CMPs) of their own specifications; and
- To provide a set of agreed summary statistics that can be used by decision makers to identify the MP, including data and knowledge requirements, that robustly meets the management objectives.

These objectives have been largely achieved within the Phase 10 contract, which have seen a substantial step forward in the development of a comprehensive and defensible MSE framework from which to provide management advice. So, an interim reference operating model grid was identified that passed the majority of the 'red-face' tests identified by the group: spanning axes of uncertainty relating to recruitment regime, stock productivity (somatic growth and natural mortality rate), western stock mixing, scale and weighting of the length composition data. In addition, six independent developer groups have elaborated and tuned more than 25 CMPs. Moreover, the online Shiny App for presenting MSE results was fully updated and then revised adding features requested by the group. Lastly, functions were created that allow CMP developers to run MSEs locally and then load these to the Shiny App to view results.

Although the conditioned operating model (M3) and the data inputs are now sufficiently improved to be used in CMP selection, the progress map is essentially unchanged from that reported at the end of 2019. The MSE framework is complete but all components downstream of the Management Procedures and the Management Objectives are currently not finalized.

The plan for Phase 11 is mainly focused on the reconditioning of the Operating Models (OMs), in reconstructing the R package with new OM grid and OMs, in developing and consolidating the results of the Candidate management procedures (CMP).

Moreover, following BFT MSE Technical Group recommendations, a complete external review of the code of the three principal components of the Atlantic bluefin tuna MSE framework (the M3 ADMB model used to condition the operating model on data, the R Code to organize data and model inputs for use in the operating model conditioning and the R package that recreates the ADMB conditioning model equations), is being performed in 2021.

## 4. Outline of GBYP Phase 12 proposal

a) Data mining, recovery and management: Recovery of further data sets relevant for improving BFT management, if detected, and development of new databases to integrate and facilitate the analysis of the information generated by or made available to the GBYP programme (biological and e-tagging data).
b) Fishery independent indices: If recommended by the SCRS BFT Species Group, eventual development of new series of aerial surveys according to the conclusions from the global external review, the re-analysis of the available time series and the pilot survey carried out in Phase 10, as well as analysis of the data from such pilot survey carried out in Phase 11, besides feasibility studies for the development of alternative fishery independent indices, and application of habitat models to standardize fishery independent or dependent indices.
c) Tagging: Support to conventional tagging and tag awareness activities; development of electronic tagging campaigns, prioritizing areas according to assessment needs.
d) Biological studies: Maintenance of GBYP tissue bank, development of biological sampling and analysis aiming to ensure availability of samples and generation of basic data to cover research needs derived from SCRS recommendations.
e) Modelling: Continuous GBYP support to the development of the ICCAT BFT MSE process (funding developers and BFT MSE technical group workshops).

Total envisaged budget €1,500,000**

**Tentative budget subject to revision derived from BFT SG discussion and voluntary contributions from ICCAT CPCs.

**Appendix 6**

## Report of the ICCAT Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP)

The ICCAT Atlantic Ocean Tropical tuna Tagging Programme (AOTTP) final narrative report is provided here.

**Appendix 7**

## Report of the Small Tunas Year Programme (ICCAT/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 Year Research Programme for Small Tunas (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:

- Mediterranean and Black Sea: bullet tuna, Atlantic bonito, little tunny and plain bonito;
- West Africa: Atlantic bonito, little tunny tuna, West African Spanish mackerel, frigate tuna, wahoo;
- Caribbean Sea and Southwest Atlantic: blackfin tuna, wahoo, king mackerel and Spanish mackerel and dolphinfish.

### 2020/2021 activities

The ICCAT Secretariat launched in May 2020 a Call for tenders with the aim of implementing the main activities scheduled within SMTYP in 2020. The main objective of this Call was to: i) collect biological samples to fill the specific gaps for estimating the growth and maturity parameters for Atlantic bonito *Sarda sarda* (BON) and little tunny *Euthynnus alletteratus* (LTA) in the Atlantic and the Mediterranean Sea; ii) estimate growth and maturity parameters for LTA and BON, and provide preliminary results for WAH; and, iii) determine the stock structure for BON, LTA and wahoo *Acanthocybium solandri* (WAH). As a result, the Secretariat selected one proposal of a consortium of a number of institutions, including 9 CPCs to carry out the tasks aforementioned and issued a short-term contract, which due to the impact of the pandemic was extended until 30 June 2021.

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 (BON and 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 observed. **Objective I -** A total of 374 individuals were collected: 145 of BON, 139 of LTA and 90 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 II -** A preliminary analysis of the relationship between section spine diameter (mm) and fish size (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 III** - 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 | Overall Total |
|---|---|---|---|---|---|
| **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 |
| **Overall Total** | | 145 | 139 | 90 | 374 |

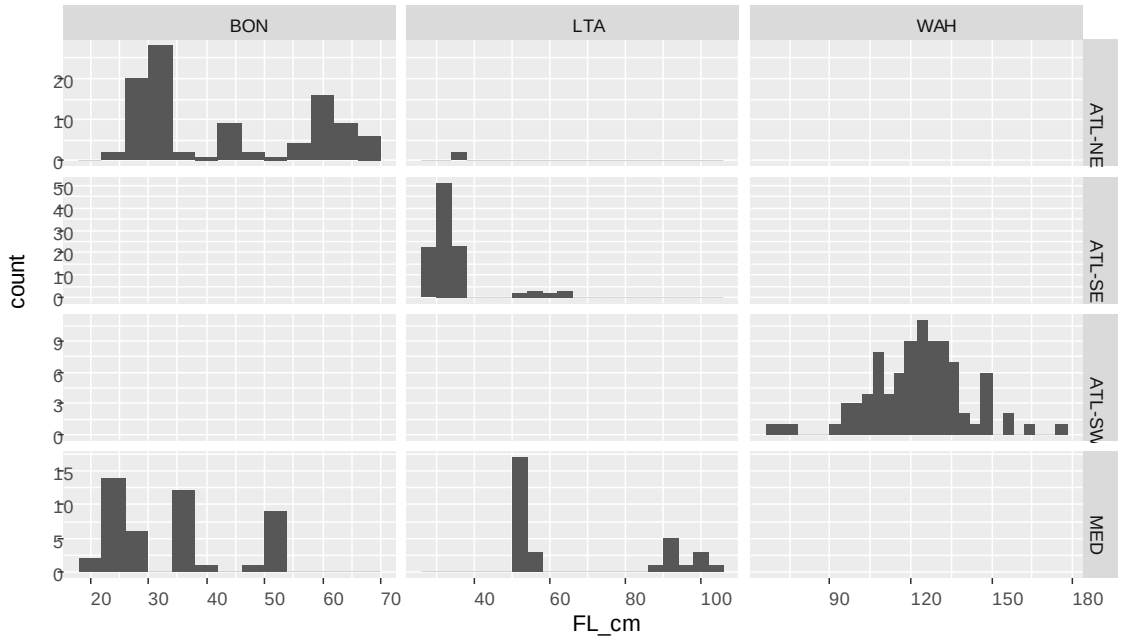


**Figure 1.** Length distribution of individuals by species and area, sampled during the 2020/2021 contract. for LTA (*Euthynnus alletteratus*), BON (*Sarda sarda*) and WAH (*Acanthocybium solandri*).

**Activities planned for 2021-2022**

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 program. 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 to: i) Conduct 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) Collect samples for FRI and BLT in the Atlantic Ocean and the Mediterranean Sea for stock structure studies; 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.

**Table 2.** Detailed information on sampling targets by species, size classes and regions to be carried out by species for 2021 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 | Cote 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 | Cote 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 | Cote 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 | Cote 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 | Cote d'Ivoire, Gabon, EU-Spain | ≤ 35 cm (20) and > 60 cm (10) |
| | | Med | Tunisia, EU-Spain, EU-Malta, Algeria | ≥ 60 cm (15) |

Nevertheless, these objectives could not 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 | EU-Portugal | P. Lino and Ruben Muñoz Lechuga |
| Reproduction | Instituto Español de Oceanografía- Málaga | EU-Spain | D. Macias, S. Saber and J.M. Ortíz |
| Stock structure | University of Girona | EU-Spain | J. Viñas |

**2018, 2019, 2020 and 2021 Expenditures and long-term planning**

The total expenditures within SMTYP during 2018, 2019 and 2020 amounted to €50,000, €60,000 and €85,000, respectively. To implement the main activities planned in the framework of SMTYP in 2021, a total budget of €45,000 was provided from ICCAT. The details of costs related to activities to be carried out in 2021 are shown in the **Table 4.**

**Table 4**. The detailed expenditures within SMTYP during 2020.

| Component | AMOUNT (€) |
|---|---|
| Coordination work (included bank taxes) | 3,850 |
| Sampling | 8,800 |
| Age and growth analysis | 5,000 |
| Analysis on reproductive biology | 10,000 |
| Stock structure analysis | 15,350 |
| Shipping | 2,000 |
| **TOTAL** | **45,000** |

**Table 5** provides the estimated research funds needed in the short and medium terms (2022 to 2024). These aim at concluding in 2021 the ongoing studies on BON, LTA, WAH, FRI and BLT. Furthermore, the requested funds envisage other activities related to the assessment of stock status using data-limited methods and investigate basic key biological parameters for other small tunas species to be prioritized by the Small Tunas Species Group.

**Table 5**. Required budget (in €) for the research activities to be carried out for the period of 2022-2024 under the ICCAT SMTYP.

| **Small tunas** | 2022 | 2023 | 2024 |
|---|---|---|---|
| **Biological studies:** | | | |
| Reproduction | €15,000 | €20,000 | €20,000 |
| Age and growth | €15,000 | €20,000 | €20,000 |
| Genetic | €15,000 | €20,000 | €20,000 |
| **Sample collection and shipping** | €10,000 | €10,000 | €20,000 |
| **Other fisheries related studies (including data recovery, etc.)** | | €5,000 | €5,000 |
| New chapter of ICCAT Manual (*Scomberomorus commerson*) | €1,000 | | |
| **Workshops/meetings** | | | |
| Workshop on application of data-limited methods | €30,000 | | €30,000 |
| Workshop on maturity staging | | €25,000 | |
| **Equipment** | | | |
| **TOTAL** | €86,000 | €100,000 | €115,000 |

**Appendix 8**

## Report of the ICCAT Shark Research and Data Collection Programme (ICCAT/SRDCP)

### 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 Shark 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. For the first three years the programme focused on biological and other aspects of the shortfin mako and contemplated extensive collaborative work among national scientists with the aim of contributing information to the 2017 Shortfin Mako Stock Assessment (Anon. 2018b). Activities under the SRDCP have continued since the beginning of it and extended to include other shark species such as porbeagle, silky shark, oceanic whitetip shark, and hammerheads.

### *2021 activities*

During the 2015 Blue Shark Stock Assessment Meeting (Anon. 2016b) and shortly thereafter, four project proposals covering different aspects of the life history, stock structure, and fisheries of the shortfin mako were presented: a pan-Atlantic age and growth study; a population genetics study to estimate the stock structure and phylogeography of Atlantic shortfin mako; a post-release mortality study focusing on pelagic longline fisheries; and a satellite tagging study for determining movements and habitat use. The following are the cumulative SRDCP activities conducted up to 2021.

### *Age and growth of shortfin mako in the Atlantic Ocean*

The project leaders for this study are Dr Rui Coelho, Daniela Rosa and Catarina Santos, national scientists from EU-Portugal, with participation of scientists and samples from EU-Portugal, United States, Uruguay Japan, Namibia, and Brazil. 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, an inventory of existing vertebral samples available at each national laboratory was compiled, and additional sampling was carried out. Samples were processed, and digital images were uploaded to an ICCAT online repository. Following a two-day age and growth workshop organized by NOAA-NEFSC (Narragansett Laboratory) with the participation of the involved scientists in June 2016 in which an initial reference set for ageing samples was established (Coelho *et al*., 2017). One biologist from each age-reading institution (EU-Portugal, USA 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, with the work 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. 2018b). 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, have been analysed (Rosa *et al*., 2018b). Given the poorly estimated parameters, the Group did not recommend the use of the growth curves for the South Atlantic stock at that time, and it was noted that more samples were still required to develop more credible growth curves, particularly specimens from the southeast region. A few samples from Japan and Namibia have been made available to this project since then. Additionally, in late 2019, a few hundred samples more from southern Brazil were also made available to the SRDCP and are now being processed by the IPMA, Portugal laboratory. Due to the COVID-19 pandemic, laboratory work has been much delayed during 2020, but has resumed with some restrictions in 2021. Sample processing is currently being carried out and should be completed by the end of 2021, and an updated work for the South Atlantic is planned to be provided to the Shark Species Group in 2022.

***Genetic analysis of shortfin mako in the Atlantic Ocean***

Dr Yasuko Semba, a national scientist from Japan took over as project leader for this study from Mr. Kotaro Yokawa. With funding from the SRDCP 2020 grant, two questions arising from previous studies on Atlantic shortfin mako were addressed: (1) the true picture of the spatiotemporal genetic heterogeneities of mitochondrial DNA in the equatorial and South Atlantic populations (Nohara *et al*., 2017), and (2) the reason for the inconsistency between genetic population structures predicted from mitochondrial and nuclear DNA analyses (Taguchi *et al*., 2016; Nohara *et al*., 2017). To answer these questions two genome-wide analysis approaches were used: whole mitochondrial genome analysis (mitogenomics) and nuclear-genome-wide single-nucleotide polymorphism (SNP) genotyping (genotyping-by-sequencing - GBS). For the mitogenomics, the research group performed whole mitochondrial genome sequencing based on the low-cost protocol developed past year for more than 190 individuals. For the GBS of nuclear-genome, genotyping of around 8,000 SNPs from 88 individuals was conducted. The results of a phylogenetic reconstruction based on mitogenome data sets clearly showed the existence of two distinct clades in the Atlantic Ocean, with a weak geographic pattern. Notably, the results of the analysis of GBS data sets demonstrated heterogeneities of the nuclear genome of Atlantic shortfin mako for the first time. These new findings may support a scenario that consists of the establishment of geographically isolated populations, subsequently generating genetic divergence, followed by secondary contact between the divergent populations.

During the remaining period of the 2021 project, the maternal genetic population structure of Atlantic shortfin mako will be clarified by the mitogenomics of over 200 individuals from about 10 sampling locations throughout the Atlantic Ocean. The GBS of the nuclear genome will also be carried out for a total of 96 individuals (half from the North and half from the South Atlantic sampling locations). Finally, from the current analyses of the two resultant large-scale data sets from mitochondrial and nuclear genomes, it is expected that progress will be made in the understanding of the reason for the inconsistency between genetic population structures predicted from mitochondrial and nuclear DNA analyses in previous studies and consequently gain a more accurate picture of the genetic population structure of Atlantic shortfin mako. The final results will be presented in the species group meeting next year.

***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, which was non-existent when the project started, to potentially contribute to their assessment and management. To that end, 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), 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%), 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 2021 and throughout 2022, depending on the opportunities, considering the current difficulties with onboard missions due to the pandemic. The results of this project with regards to the post-release mortality of the shortfin mako are being updated and analysed and are planned to be presented during 2022.

***Movements, stock boundaries and habitat use of shortfin mako in the Atlantic Ocean***

The project leaders for this study are Dr Rui Coelho and Catarina C. 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), 5 of the 20 miniPATs acquired have been deployed on shortfin mako and 3 tags were deployed on silky shark. Eight of these tags are planned to be deployed in the Indian Ocean in order to assess inter-ocean movements of shortfin mako. Four of the 20 tags acquired during Phase 4 (2018-2019) were deployed on shortfin mako and 6 on other vulnerable species (oceanic whitetip, silky shark, porbeagle and scalloped hammerhead). In

all, a total of 43 tags (29 miniPATs and 14 sPATs) were deployed by observers on EU-Portugal, Uruguay, Brazil, EU-Spain and US vessels in the temperate NE and NW, Equatorial and SW Atlantic. Data from 41 of the 43 tags/specimens are available for a total of 1,656 tracking days recorded. However, due to the battery issues with Wildlife Computer tags, several of the tags had to be returned for replacement, and those will be deployed during 2021, depending on the tagging opportunities. Twenty-four additional tags from other projects involving the same partners were also deployed in these same areas, covering both hemispheres and both sides of the Atlantic. The results of this project with regards to shortfin mako were recently published in Santos *et al.*, 2021. 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 makos 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. The main plan for the next phase of the project is to continue tag deployment for the tags that have remained to be deployed on SMA during the rest of 2021 and in 2022, depending on the opportunities, considering the current difficulties with onboard missions due to Covid-19. Those include tags currently in South Africa and in La Reunion (SW Indian Ocean) to determine possible movements between the SE Atlantic and SW Indian Ocean.

***Reproduction of shortfin mako and porbeagle in the Atlantic Ocean***

The point of contact for this study is 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 training was aimed at establishing 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 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 destinated 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 destinated for reproduction studies were extended for a 6-month period, there were no planned activities for 2021. However, it was not possible to conduct in 2021 the postponed activities of 2020.

***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 16 miniPATs acquired for this project were distributed to scientists from EU-France, EU-Portugal, and Norway, to be deployed in the North Atlantic, and 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, such as Canada's, which deployed 30 sPATs on shortfin mako and 30 sPATs on porbeagle during 2018-2019; and 12 new sPATs for porbeagle from a US/NOAA project that will be deployed in EU-Portugal, Uruguay, and United States vessels. To date, a total of five POR tags have been deployed by EU-Portugal and EU-France. Four sharks were tagged in the Northeast Atlantic, in the Bay of Biscay/Celtic Sea area. Three of these specimens tended to stay in the same general area and one appeared to travel west after a 3-month residency period in the Bay of Biscay. The one shark tagged in the central North Atlantic appeared to have died shortly after tagging. The remaining 11 tags available for porbeagle had battery issues and had to be returned to Wildlife Computers for tag replacement. Those tags

are planned to be deployed during the rest of 2021 and 2022, depending on the tagging opportunities and considering the still ongoing restrictions for onboard observers due to the Covid-19. The deployments are planned by scientists from EU-Portugal and Norway in the North Atlantic, and Uruguay in the South Atlantic.

***Movements, stock boundaries and habitat use of silky, oceanic whitetip, longfin mako, and hammerhead sharks in the Atlantic Ocean***

The project leaders for this study are Dr Andrés Domingo, Dr Rui Coelho, 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 have been ranked with high vulnerability in the ICCAT shark ERAs (Cortés *et al*., 2010 and Cortés *et al*., 2015), and some are currently prohibited to be retained in ICCAT fisheries (i.e., Rec. 10-07, Rec. 10-08, 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 USA 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, in early 2020 a total of 11 tags had to be returned for replacement. In early 2021, four of these tags were deployed on silky shark in the U.S. Gulf of Mexico. The remaining tags are planned to be deployed throughout 2021 and 2022, depending on the tagging opportunities and considering the still ongoing restrictions for onboard observers due to the Covid-19 pandemic. There is a planned 8-day expedition in 2021 in the Gulf of Mexico on the Florida State University R/V Apalachee to tag silky and oceanic whitetip sharks.

***Other activities***

Discussions continued intersessionally on the prospects of Close-Kin Mark-Recapture (CKMR) for shortfin mako sharks, as a robust way to assess abundance and productivity. There is already a strong sampling program in Brazil, and the capacity to do the necessary sampling in Namibia and South Africa from observer programs, 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. External funding has been set back by Covid-19, but opportunities are being investigated. External funding through 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 CITES-Introduction from the Sea Permit application has been submitted. The Shark Species Group in accordance with the SCRS recommendation and the decision taken by the Commission in 2020 decided that it was necessary to review and update the Chapter 2 of the ICCAT Manual as regards the pelagic shark species of the Atlantic Ocean and complete the chapter through the incorporation of new subchapters for silky shark (*Carcharhinus falciformis*), longfin mako (*Isurus paucus*), crocodile shark (*Pseudocarcharias kamoharai*) and pelagic stingray (*Pteroplatytrygon violacea*). The first draft of these revised and new chapter was made available to the Shark Species Group for review.

## 2022 Plan and activities

### *Age and growth of shortfin mako in the Atlantic Ocean*

In view of the need for additional vertebrae to develop reliable growth curves for the South Atlantic stock, the Shark Species Group will endeavour to analyse samples collected by Japan, Namibia, and Brazil in the South Atlantic and conduct final analyses. Additional samples from those CPCs have been provided and are currently at the IPMA (EU-Portugal) laboratory, for processing during the second semester of 2021, with plans of presentation of an updated growth curve for South Atlantic shortfin mako in 2022.

### *Genetic analysis of shortfin mako in the Atlantic Ocean*

During late 2021 and early 2022 the genetic analysis will be increasing the number of shortfin mako individuals analysed to more than 200 by using mitogenomics and especially GBS of the nuclear genome, which will be presented during the 2022 Shark Species Group meeting. Also, national scientists from Japan will start stock differentiation for blue shark and porbeagle, not excluding shortfin mako (additional nuclear-genome analysis for 100-200 samples in line with samples analysed in the mitogenomics) using two genome-wide analysis approaches and provide updated results, depending on the requests.

### *Post-release mortality of shortfin mako in the Atlantic Ocean/movements, stock boundaries and habitat use of shortfin mako in the Atlantic Ocean*

In late 2021 and 2022 we plan to finish the deployment of the remaining tags acquired since late 2018, including 4 tags by scientists from EU-France in the Indian Ocean, and at least 1 in the Northwest Atlantic, depending on the opportunities, considering the current difficulties with onboard missions due to pandemic. The final analyses of these projects are expected to be conducted during 2022 and will include additional tags deployed by South Africa.

### *Movements and habitat use of porbeagle in the Atlantic Ocean*

In late 2021 and 2022 we plan to finish the deployment of the available miniPATs acquired in recent years, which have not yet have been deployed. The deployments are planned by scientists from EU-Portugal and Norway in the North Atlantic, and Uruguay in the South Atlantic.

### *Movements, stock boundaries and habitat use, and post-release survivorship of silky, oceanic whitetip, longfin mako, and hammerhead sharks in the Atlantic Ocean*

The Shark Species Group decided that the 17 satellite tags acquired in late 2018 and 2019 for the SRDCP should be deployed on silky, oceanic whitetip, and hammerhead sharks, with priority given to silky sharks as this was ranked as the most vulnerable species in the 2010 ERA (Cortés *et al*., 2010). In 2020 we acquired additional tags to be deployed on silky, oceanic whitetip, longfin mako and hammerhead sharks to continue the project. In 2021 we acquired an additional 38 tags to be deployed by the various partners in different regions of the Atlantic. These will be deployed during the last quarter of 2021 and throughout 2022 on several species (i.e. FAL, OCS, LMA and SPN) and in various regions of the Atlantic.

## 2021 budget and expenditures

Due to some unforeseen issues, namely related to the Covid-19 pandemic, most of the 2020 budget was not expended. However, as a 6-month extension period was approved, it was possible to make use of the available funds which were redistributed together with the 2021 budget adopted by the Commission. These amount €140,000, as detailed in **Table 1**.

**Table 1**. 2021 SRDCP budget and 2020 redistributed funds.

| *Project* | *Participating CPCs* | *Project leader* | *Approved budget (€) 2021* |
|---|---|---|---|
| **SHORTFIN MAKO** | | | |
| Stock boundaries (Genetics) | EU, Japan, Uruguay, US, | Y. Semba | 25,000 |
| Age and growth (South Atlantic) | EU, Brazil, Uruguay, Namibia, Japan | R. Coelho, D. Rosa | 12,000 |
| | | | |
| **PORBEAGLE** | | | |
| Reproduction | EU, Canada, Japan, Uruguay, US, | E. Cortés | 10,000 |
| **SILKY, OCEANIC WHITETIP & HAMMERHEAD** | | | |
| Movements and habitat use (PSATs) | EU, Canada, Uruguay, US, Brazil | A. Domingo, R. Coelho, C. Santos, J. Carlson | 73,000 |
| **UPDATE ICCAT MANUAL CHAPTER 2 (SHARKS SECTION)** | | | |
| Review and update of the 9 species included and incorporation of 4 new species | | | 20,000 |
| | | **Total** | **140,000** |

**2022 budget and requested contributions**

The proposed budget for Year 8 of the SRDCP (2022) amounts to a total of €80,000 (**Table 2**). Funds are being requested for research on shortfin mako, porbeagle, silky, oceanic whitetip, longfin mako, and hammerhead sharks, distributed as follows:

- Shortfin mako/BSH/POR genetics (NGS - next generation sequencing, with additional samples from Uruguay): €25,000;

- South Atlantic shortfin mako age and growth study, including additional sample analysis and finalizing analytical results: €5,000;

- Sampling and shipping of samples: €5,000;

- Silky, oceanic whitetip, longfin mako and hammerhead sharks: €45,000 to study movement and habitat characterization studies for other priority ICCAT species (includes costs satellite use, tagging consumable, fish, crew compensation for helping with the tagging process, and rewarding).

**Table 2**. Proposed budget for 2022 SRDCP.

| *Project* | *Participating CPCs* | *Project leader* | *Budget requested (€) 2022* |
|---|---|---|---|
| **SHORTFIN MAKO, BLUE SHARK AND PORBEAGLE** | | | |
| Stock boundaries (Genetics) | EU, Japan, Uruguay, US, etc. | Y. Semba | 25,000 |
| Age and growth of Shortfin mako (South Atlantic) | EU, Brazil, Uruguay, Namibia, Japan | R. Coelho, D. Rosa, C. Santos | 5,000 |
| Sampling and shipping | All | | 5,000 |
| **SILKY, OCEANIC WHITETIP, LONGFIN MAKO & HAMMERHEADS** | | | |
| Movements and habitat use (Satellite, tagging materials, compensation for tagging work by the crews and rewarding) | EU, Canada, Uruguay, US, Brazil | A. Domingo, R. Coelho, C. Santos, J. Carlson | 45,000 |
| | | **Total** | **80,000** |

**Appendix 9**

**Report of the Enhanced Programme for Billfish Research (ICCAT/EPBR)**
*(Expenditures/Contributions 2021 and Programme Plan for 2022)*

## Summary and Programme objectives

The ICCAT Enhanced Programme for Billfish Research (EPBR) continued its activities in 2021, although with restrictions due to the COVID-19 pandemic situation. The Secretariat coordinates the transfer of funds and distribution of tags, information, and data. The overall programme coordinator and eastern Atlantic coordinator during 2021 was Dr Fambaye Ngom Sow (Senegal) and Ms. Karina Ramírez López (Mexico) remaining as coordinator for the western Atlantic.

The original plan (1986) for EPBR included the following objectives: (1) to provide more detailed catch and effort statistics, particularly for size frequency data; (2) to initiate the 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 expand to evaluate adult billfish habitat use, study billfish spawning patterns and billfish population genetics. The Billfish Species Group considers that these studies are essential to improve billfish 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.

## 2021 activities

In July 2020 a new contract was awarded to Centre de Recherches Océanographiques de Dakar/Thiaroye (ISRA/CRODT, Senegal) to continue the activities of the previous contract for a 12 months period (until June 2021). This new contract engages only the EU research team (from Portugal), which have significantly enhanced the collection of samples onboard industrial vessels operating in the same area 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).

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 on Atlantic blue marlin in the Gulf of Mexico. Unfortunately, albeit all the efforts made by the Secretariat and the western coordinator of EPBR, such contract was never signed. Accordingly, the Secretariat is currently evaluating together with the western coordinator of the EPBR, an alternative to implement this study.

In 2021 funds have been made 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 having traditionally provided the higher quality data in the past, to ensure the preservation of an uninterrupted time series of catch and relative abundance indices. However, no reimbursement has been requested.

In 2021, it should be noted that due to of the COVID-19 pandemic only the activity relating to the age and growth study has been carried out and is still ongoing. Specifically, a total of 452 samples have been collected to date both by artisanal and industrial fleets within the age and growth component of the project, and laboratory sample processing is ongoing.

All otoliths collected were sent to the Fish Ageing Services in Australia for age reading. The first steps of this work are ongoing, and results are expected to be provided within the next months.

All other activities of the billfish work plan for EPBR 2021 could only be partially performed, namely those involving mainly field work research, due to the COVID-19 restrictions imposed by local authorities.

A workshop is scheduled for standardizing protocols among laboratories and creating a reference set for the main billfish species. However, this workshop has not yet been scheduled, as it is believed that a presential workshop would very much facilitate expertise exchange for these activities.

**2022 plan and activities**

The highest priorities for 2022 are to support the objectives established by the billfish work plan and those of the EPBR, with specific emphasis on the collection of biological samples for growth and reproductive studies that are on hold due to the COVID-19 issue, enhance the collection of fisheries data in developing countries and resume the field and laboratory research activities as much as possible:

- support the collection of billfish biological samples off West Africa;
- support the blue marlin biological and photographic sampling in Gulf of Mexico;
- fund a workshop on growth and aging techniques involving researchers from both eastern and western Atlantic;
- support the monitoring of billfish catches from West African artisanal fishing fleets (i.e. Côte d'Ivoire, Ghana, São Tomé e Príncipe and Senegal);
- fund a regional workshop for CPC statistical correspondents on artisanal fisheries data collection in eastern Atlantic;
- 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 institutions.

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 2022 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 having traditionally provided the higher quality data in the past, 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 e Príncipe and Senegal.

***Biological studies***

The collection of biological samples for genetic study to differentiate white marlin and spearfish, will continue in 2022.

Continue 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. In 2022 increasing effort will be made for processing and analysing the available samples, which is expected to continue also in the following years. Such activities require the continuation of financial support from ICCAT and additional voluntary contributions from CPCs.

***Coordination***

*Training and sample collection*

Programme coordinators need to travel to locations not directly accessible 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 coordinator for the West. Coordinated activities between EPBR, 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*) (Anon. 2012).

**2021 Budget and expenditures**

This section presents a summary of the EPBR budget assigned for 2021, which amounted to €75,000 (**Table 1**). These funds were approved and allocated as follows: €15,000 for studies related to three billfish species (BUM, WHM and SAI) on: age and growth and genetics studies, sample collection and shipping; €5,000 for a marlin reproduction biology study, including the collection of photographic samples; €25,000 for the workshop on statistical correspondents for data collection in the eastern Atlantic and €4,000 for the development of an application for mobiles.

**Table 1**. 2021 EPBR budget.

| **Activity** | **Amount assigned** |
|---|---|
| Reproductive biology (western Atlantic) | €5,000 |
| Age and growth | €15,000 |
| Genetics | €5,000 |
| Sampling and shipping (eastern Atlantic) | €10,000 |
| Consumables | €5,000 |
| Monitoring eastern Atlantic fisheries | €10,000 |
| Workshop statistical correspondents (only 1 workshop) | €25,000 |
| **TOTAL** | **€75,000** |

**2022 budget and requested contributions**

The proposed 2022 budget, totaling €95,000 is detailed in **Table 2**. To achieve all its objectives in 2022 the programme will continue to require contributions from other sources, such as those voluntary contributions generously provided by the US and Chinese Taipei. **Table 2** also provides tentative budgets for the following year 2023 (€95,000).

Development of improved age and growth curves and estimates of maximum longevity of billfishes has been recommended by the Group. **Table 2** continues to include research funding allocations to conduct biological sampling and sample processing for age and growth of sailfish, blue and white marlins in the eastern Atlantic, as currently no age and growth information is available for the eastern stock of sailfish, nor for the two marlin species caught in that region. Additionally, now it includes funds for a workshop on growth and aging techniques involving researchers from both eastern and western Atlantic.

The consequence of the programme failing to obtain the requested budget will be to stop or reduce programme activities for 2022 and 2023 including: (1) collection and processing of genetic samples, collection and processing of gonad samples and hard structures (spines and otoliths), (2) size sampling and collection of statistics of catches from fleets in the eastern Atlantic, (3) enhancing regional sampling programmes. All these activities are critical to continue the improvement of the information available to the SCRS for billfish stock assessments.

**Table 2**. Breakdown of the requested EPBR estimated budget for the period 2022 - 2023.

| **Billfishes** | **2022** | **2023** |
|---|---|---|
| **Tagging, rewards and awareness** | | |
| **Biological studies:** | | |
| Reproduction | | |
| Age and growth | 15,000 | 15,000 |
| Genetic (WHM/RSP kits) | 5,000 | 5,000 |
| Other (identify) | | |
| Other fisheries related studies (including data recovery and collection of fisheries statistics in the field in West Africa) | 10,000 | 10,000 |
| **Sample collection and shipping** | 10,000 | 10,000 |
| **Consumables** | 5,000 | 5,000 |
| **Workshops/meetings** | | |
| Workshop on data collection and reporting on artisanal fisheries in the West of Africa in 2022 and in the western Atlantic in 2023 | 25,000 | 25,000 |
| Technical workshop for age reading | 25,000 | 25,000 |
| Stock assessment 2023 reviewer | | 10,000 |
| **Total** | **95,000** | **105,000** |

**Conclusion**

The EPBR is an important mechanism towards completing 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 to facilitate 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**

## 2021 Secretariat Report on Statistics and Coordination of Research

The final 2021 Secretariat Report on Statistics and Coordination of Research will be published in the *Report for Biennial Period 2020-2021, Part II (2021), Vol. 4.*

**Appendix 11**

**Report of the 2021 Meeting of the Subcommittee on Statistics**
*(Online meeting, 23 September 2021)*

## 1. Opening, adoption of Agenda and meeting arrangements

The Subcommittee on Statistics (SC-STAT) met online on 23 September 2021. The SCRS Chair, Dr. Gary Melvin (CAN) opened the meeting by firstly, expressing his thanks to the former SC-STAT Convenor (Dr Guillermo Diaz, USA) for his contributions over the years, and informed that the current meeting would be chaired by Mr. Carlos Palma (ICCAT Secretariat). The ICCAT Executive Secretary, Mr. Camille Manel, welcomed the Subcommittee and highlighted the importance of its work and the commitment of the Secretariat to support the work of SCRS and the Commission. The Chair of the Subcommittee, highlighting the complexity and time constraints associated to online meetings, reinforced the need to work efficiently focusing on the main subjects.

The Agenda was discussed and adopted (**Addendum 1 to Appendix 11**) without modifications. Dr Nathan Taylor and Mr. Carlos Mayor (ICCAT Secretariat) served as rapporteurs to the meeting. The List of Participants is attached as **Addendum 2 to Appendix 11**. The List the Documents presented during the meeting is summarised in **Addendum 3 to Appendix 11,** with the respective summaries provided in **Addendum 4 to Appendix 11.**

## 2. Summary of fisheries and biological data submitted during 2021 (Tasks 1, 2 and 3), including historical revisions

The Secretariat provided a summary of the data reported to date (an overview of the detailed 2021 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 2020 and 22 August 2021 (the Reporting Period). Furthermore, all the basic fisheries statistics and biological information have been presented by the Secretariat to the SCRS Working Groups during the SCRS intersessional meetings.

After six years of consolidated improvements and a slight decline in the two previous years (2018 and 2019) in terms of data provision, the Secretariat observed a slight improvement in data completion quality in the latest data submission (2020 data reported during 2021). The Secretariat needed to correct slightly less datasets to pass the SCRS filtering criteria than in the previous 2 years. However, the information submitted using old electronic forms (all others than the valid 2021) increased, with 11 ICCAT CPCs submitting information in old versions during the Reporting Period compared to 7 CPCs in 2020. The Subcommittee reminds the CPCs that, only the latest version of the electronic form is valid to submit 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, 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 expand whenever possible the automation of data integration and validation procedures.

The Secretariat applied to the 2020 datasets reported the SCRS filtering criteria to accept/reject statistical forms (2013 Report of the Subcommittee on Statistics, Addendum 2 to the 2021 Secretariat Report on Research and Statistics, Filters 1 & 2) adopted in 2013. The results are based on 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.

### *2.1 Basic Task 1 (T1FC and T1NC) and Task 2 (T2CE and T2SZ) statistics*

The Secretariat presented a summary of the 2020 data reporting status of the two datasets of Task 1 statistics: 1) the Fleet Characteristics (T1FC), and 2) the Nominal Catches (T1NC) using the standard SCRS Report Cards (Tables 1 and 2 of the 2021 Secretariat Report on Research and Statistics, respectively).

The T1FC electronic form (ST01) is used to collect information on individual vessels (subform ST01A) and summarized information for vessels less than 20 m LOA (subform ST01B). The overall reporting of T1FC for 2020 was 79% (59 flags) higher than the 69% (53 flags) observed for 2019. Four flags reported after the submission deadline, and the Secretariat made corrections to the information reported by 7 flags CPCs.

The T1NC electronic form (ST02) has 2 subforms: 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 2020 was 84% (63 flags) slightly higher than for 2019 data (62 flags corresponding to 81%). Five flags reported late, and the Secretariat made corrections to the datasets of 13 flags. Twelve CPCs (16%) have yet to report their 2020 T1NC. The Secretariat reminded the Subcommittee that the new version of the ST02 form (2021) incorporated two new fields aimed to report the conversion factors used to transform the landings and discards of each species, from product weight (head off, gutted, gilled and gutted, etc.) into round/live weight equivalent.

The T2CE electronic form (ST03) has not had any major change in recent years. The T2CE report card is presented in Table 3 of the 2021 Secretariat Report on Research and Statistics. A total of 52 flags (69%), including 2 late reporting flags, reported T2CE. A slight decrease when compared to the 2019 data (55 flags corresponding to 71%). Twenty-three flag CPCs (31%) have yet to report T2CE data for 2020.

The T2SZ report card (containing data from both ST04 and ST05 electronic forms) is presented in Table 4 of the 2021 Secretariat Report on Research and Statistics. A total of 45 flag CPCs (60%), including 1 late report, submitted 2020 size data. A total of 30 flag CPCs (40%) have yet to submit 2020 size data (reporting ratios in line with 2018 and 2019 T2SZ data submission).

The Secretariat informed that 9 flags CPCs reported no fishing activity on ICCAT species ("0" catches in all species) for the 2020 calendar year. The list of flags with "0" catch reports is published in the Table 5 of the 2021 Secretariat Report on Research and Statistics which presents a summarised view of all the Task 1 and Task 2 reporting status. The Secretariat also informed the Subcommittee that it continues to receive ST type forms with wrong ICCAT codes.

The Subcommittee acknowledged that for the second year the ST02 form required CPCs to report the Conversion Factors used to transform product weight into round weight, and that this new requirement might have contributed to the reduction in data quality reporting (not providing it, does not allow to pass the filtering criteria). The Subcommittee hopes that once all CPCs become familiar with this new field in the ST02 form, the data quality will once again improve. Table 1 presents a summary of the conversion factors reported with the new ST02 form version (2019 and 2020 data) by CPC and major species.

The Secretariat informed that, globally across all the Task 1 and 2 datasets, the most common deficiencies continue to be the forms incompleteness on the header and detailed sections, empty subforms (e.g. ST01B for small scale vessels; ST02B for "0" catches), use of non-ICCAT codes, and the use of old form versions. The Subcommittee discussed at length the reasons why some CPCs have cells appearing in "orange" (corrections made by the Secretariat and a CPC confirmation and/or revision) in the SCRS report cards (Tables 1 to 5 of the 2021 Secretariat Report on Research and Statistics). After some clarifications, the Subcommittee encouraged the CPCs needing clarifications on their reporting to contact the Secretariat individually to resolve these issues.

The Secretariat provided a demonstration of dashboard prototype with the most recent Task 1 nominal catches. This dashboard allows to visualise and query Task 1 catch series in multi dimensions online (web dissemination possibilities). The Secretariat asked if Species Groups would be interested in such dashboard for exploration of data relevant for their species. Such tools might be a way for members of the ICCAT community to easily check on the status of the available data. The Subcommittee commended the Secretariat for this kind of work as it might be of interest to the Species Groups, but also to publish it on the ICCAT website for general access to the public. The Subcommittee further inquired when such dashboard

could be made available for use. In response, the Secretariat noted that the current version is a prototype, but that after some refinements could be made available to the Species Groups. The Subcommittee noted that the dashboard will need to have documentation describing its functionality and that the SCRS would need to work through whether to report only final data or all data, including the new information that has not yet been verified by CPCs and viewed/adopted by the SCRS.

### *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 237 releases and 25 recoveries. With respect to the conventional tagging (summary in Table 7of the 2021 Secretariat Report on Research and Statistics), a total of 8,932 tags were deployed and 842 were recovered. On the same period, the Secretariat distributed about 3,800 conventional tags, primarily under the tagging projects of the GBYP.

The Secretariat presented a dashboard prototype with shark species (using the basis of the AOTTP dashboard displayed during the AOTTP symposium) and inform on the ongoing work on these type of data exploratory tools, and also the ongoing work to create a unified tagging database that includes all the conventional as well as the electronic data. The Subcommittee welcomed the Secretariat's work on these two important areas, stating their importance on data validation and exploratory work.

### *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 contributed historically with great improvements to the ICCAT fisheries statistics by recovering missing or incomplete catch series and biological samples. However, no major fisheries statistics dataset was recovered under these programmes during 2021.

All historical revisions made during the reporting period are presented in Table 13 (T1NC), Table 16 (T2CE), and Table 17 (T2SZ) of the 2021 Secretariat Report on Research and Statistics, which also contains the supported SCRS documents and the adoption status of the respective Species Group.

The Secretariat and the GBYP already finished the consolidation of the BFT stereoscopic cameras size data (period 2014 to 2018). This work should continue during the 2022 for the bluefin tuna 2022 Stock Assessment.

### *2.4 Other relevant statistics (observer data, VMS, BCDs, ISSF, etc.)*

Domestic Observer data is submitted using the 2021 version of the form ST09 (adopted in 2019). The Secretariat indicated that the number of CPCs submitting observer data using the ST09 form increased from 21 in 2020 (2019 data) to 27 in 2021 (2020 data) reporting periods (Annex 4 of the 2021 Secretariat Report on Research and Statistics). Table 9 of that report provides a summary of ST09-DomObPrg data reported for 2020 by discard fate and Species Group including sharks, sea turtles, and seabirds. Table 10 of the same report contains T1NC data for by-catch species for 2020. A summary of the information submitted on ST09 forms for sea turtles and seabirds is provided in Table 12 and 13 of the same report, respectively.

The Secretariat provided an overview with the statistical information available on tropical support vessels activity (form ST07) and FAD data (form ST08). Appendix 2 of the 2021 Secretariat Report on Research and Statistics provides a summary of FAD information received in FAD Management Plans and ST08 forms for 2020 (some datasets could require revisions). A short presentation was also given by the Secretariat summarising the work done during the 2021 Second intersessional meeting of Panel 1, where these matters were deeply discussed.

ISSF participating companies continue to provide the Secretariat with detailed information on catches (by vessel trip, species and commercial size category) from all their purchases. These correspond to the unloading of catches from tropical tunas (bigeye, yellowfin, skipjack) and albacore to canning plants around the world. The Secretariat informed the Subcommittee that in 2021 ISSF financed a short-term project to treat and consolidate this information received since 2010 (series 2010-2020) into a relational database.

This work occurred during the first half 2021, and preliminary results were presented at the 2021 Bigeye Data Preparatory Meeting (SCRS/2021/064). The Secretariat acknowledged the cooperation of the IOTC Secretariat who provided the ISSF data treatment software already developed for the same information.

### *2.5 Historical revisions*

A major update to Task 1 occurred within the Small Tunas Species Group that decided to include in the small tuna official list of species, the species *Scomberomorus commerson* (Lacepède, 1800) known as "narrow-barred Spanish mackerel" (FAO code: COM). Several COM catches series were included in Task 1, based on the historical recovery of COM catches in the Mediterranean Sea (Di Natale *et al.,* 2020) combined with the FAO catches series (National statistics reported to FAO) explicitly requested to FAO for that meeting. These COM Task 1 nominal catches (Table 13 of the 2021 Secretariat Report on Research and Statistics), adopted as preliminary, should be fully revised by the ICCAT CPCs.

All the other T1NC, T2CE and T2SZ dataset revisions (details in Tables 13, 16 and 17 of the 2021 Secretariat Report on Research and Statistics, respectively) were presented and approved by the respective Species Groups during the 2020 intersessional meetings.

### *2.6 Relevant documents to statistics*

Two documents were presented to the Subcommittee.

Carruthers *et al*., 2020 is the report of the Billfishes Subgroup on Electronic Monitoring Systems (EMS), reflecting the work carried out intersessionally by the Subgroup in 2021. It provides details on the EMS process and work done so far, with recommendations and plans for continuing the work during 2022. It also provides a draft response to the Commission following the request contained in ICCAT Recommendation 19-05 (paragraph 20). The Subgroup concluded that it would be important to expand the current subgroup (mainly a BIL Subgroup) to other Species Groups in ICCAT that also relate mostly with longline fisheries (e.g., SWO, Sharks, ALB, TROP LL component, etc.).

The Subcommittee discussed Carruthers *et al*., 2020. It noted that it was not clear how the EMS Subgroup would be interacting within the existing administrative framework of the SCRS and how feedback from other Species Groups would be compiled for the approval of the SCRS plenary. In response it was noted that the procedure for the moment was to operate like other informal subgroups within SCRS. It was noted that this Subgroup could be either a subgroup of the Subcommittee on Statistics or it could be an ad hoc Group of the SCRS (in this case a rapporteur of this Subgroup would need to be nominated). In addition, it was noted that in the long term, consideration of an expanded number of gear types, discussion of appropriate vessel sizes, and the experience from other RMFO and other Oceans where work on EMS is more evolved. Other Species Group rapporteurs expressed their preference that the EMS Subgroup be subsumed as a Subgroup of the Subcommittee on Statistics but the possibility of the Group being part of the Subcommittee on By-catch was also suggested.

Document SCRS/2021/159 notes that the UN Agreement on Straddling Stocks and UNCLOS requires reporting for all catches to the competent RFMO even for Non-contracting Parties of a given RFMO. There is evidence and inference that this is not always the case for the species managed by ICCAT. This implies that there are some impacts on the ICCAT catch statistics for all species concerned.

The Subcommittee noted that ICCAT had been engaged in efforts to recover data from some other regional fisheries bodies (GFCM, WECAFC, etc.), FAO and other CPCs to make its data complete. However, it considers it to be an extremely important subject to ICCAT and alternative measures should be studied to obtain catch information from Non-contracting Parties and countries that are not currently part of ICCAT. In addition, it noted that a proper venue to discuss the acquisition of these data through collaboration with FAO, other regional fisheries bodies, and CPCs, is the Commission itself.

## 3. Summary of Secretariat's standard (yearly based) data sets estimations

### *3.1 CATDIS and EFFDIS*

As in 2020, the lack of time did not allow the Secretariat to entirely update the CATDIS (1950-2018) in the usual period (June/July each year) for the nine major species. Only the bigeye tuna (1950-2019) and bluefin tuna (1950-2020) CATDIS were updated for the respective stock assessments. CATDIS is usually updated around the middle of each year, with special updates for the stock assessments to accommodate the most recent revisions in Task 1 and Task 2, which normally includes the latest year. Because there is always a time lag of "one year less" in CATDIS when compared with T1NC (e.g., latest CATDIS series cover 1950-2018 and the latest T1NC approved by the SCRS cover 1950-2019), the Secretariat must update the CATDIS several times within a year and independently for each species. Every year, this issue puts great pressure on the Secretariat to have all the information ready for the stock assessments (exacerbated by the increase in the number of meetings). This CATDIS "one year lag", a reiterative discussion of the Species Groups intersessional meetings, could be solved by simply "delaying the CATDIS annual estimations" (and the associated ICCAT Statistical Bulletin) by 6 to 7 months (middle of each year => end of same year/beginning of the next one). This approach greatly benefits from using the most recent statistics approved by the SCRS and the Commission at the annual meetings.

The Subcommittee agreed with the proposal, as specified below:

- Update the CATDIS (1950-2020) in December 2021 using the most recent statistics approved by the SCRS/Commission and publish the Statistical Bulletin Vol. 47 in January 2022. Extraordinarily, the Statistical Bulletin Vol. 47 to be published in January 2022 will have merged two CATDIS estimations (1st: 1950-2019; 2nd: 1950-2020).

- The following volumes will return to the normal publication schedule in January each year (Jan/2023: Vol. 48 with 1950-2021 series; Jan/2024: Vol. 49 with 1950-2022 series).

The Subcommittee also proposed that the Secretariat attempts to obtain estimations of CATDIS (focused on the most recent decades, depending on the availability of Task 2 catch & effort) for the four remaining major species: spearfish (SPF), blue shark (BSH), shortfin mako (SMA), and porbeagle (POR).

The Secretariat provided a status update of the EFFDIS (new methodology and a preliminary estimation, presented at Subcommittee on Ecosystems in 2020 and 2021). In response to the request by the SC-ECO that "Subcommittee on Statistics review the gaps in the catch-and-effort data (T2CE) in the ICCAT-DB", the Secretariat provided a graphical summary of the number of CPCs reporting longline data that had report T2CE data with effort measures in: a) number of hooks; b) other effort measures; c) no effort reported. The Secretariat's proposal was to:

- Identify CPCs T2CE datasets of type (b) and (c),

- Request those identified datasets to ICCAT CPCs as, revisions (a), and new data (b), both with effort measures in number of hooks, including the catches of the 3 major sharks species (blue shark, shortfin mako, and porbeagle) whenever possible.

The Subcommittee noted that when CPCs provide updates to their T2CE datasets, they follow the standard SCRS rules for revising historical data which includes 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 is complete and fully functional with an active connection between the size data and the substitution tables used for the CAS estimation. In 2021, the Secretariat has made two CAS partial updates: a) bigeye tuna (series 1975-2019); and b) western bluefin tuna (series 1950-2018). Both estimations were used on the respective stock assessments.

## 4. Brief overview of data deficiencies pursuant to *Recommendation by ICCAT on compliance with statistical reporting obligations* [Rec. 05-09]

### *4.1 2020 Report cards with SCRS validation criteria (Filters 1 and 2)*

The Secretariat applied, for the eight consecutive year, the SCRS filtering criteria (Filter 1 and 2, described in Addendum 2 to Appendix 8 of the *Report for Biennial Period 2012-2013, 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 2020 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 2021 Secretariat Report on Research and Statistics. The "orange" cells indicate the datasets that have not passed Filter 1. However, most of the Task 1 forms rejected were corrected by the Secretariat and provisionally (marked for revision) integrated into the ICCAT database system (ICCAT-DB). As for 2020 data submitted in 2021, Task 2 forms not passing Filter 1 were not corrected (left for subsequent revisions with the respective CPCs). Filter 2 criteria was applied, and the results were made available to the Subcommittee for testing purposes (lack of time to do demonstrations). Both filters were used on every Task 1 and Task 2 dataset received (scenario 2, methodology described in Palma and Gallego, 2015).

Although during the last 2 years the level of reporting has remained relatively constant, overall during the last eight years the Subcommittee and the Secretariat observed steady improvements in aspects such as the level of reporting (CPCs reporting ratios), slightly less "late-reporting", slight improvements in the level of completeness of the forms (less incomplete) and the level of resolution of some information (in particular Task 2). 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)*

*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 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 Annex 1 of the 2021 Secretariat Report on Research and Statistics, the SCRS catalogues on Task 1 and 2 data availability for the major ICCAT species for the last 30 years (1991 to 2020). The small tuna SCRS catalogues were also prepared and made available to the SCRS annual meeting. In addition, the Secretariat informed that, as recommended by the SCRS in 2020, the Secretariat has published, for the first time at the beginning of 2021, the two SCRS catalogues on the ICCAT website (www.iccat.int/en/accesingdb.html), with information submitted until the end of 2020.

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 this information should be reviewed by the Species Groups, in particular by those ones that are scheduled to conduct stock assessments in 2021.

The SCRS scorecard, in the format adopted by the SCRS in 2019, is presented in Table 6 of the 2021 Secretariat Report on Research and Statistics, with all the major ICCAT fisheries and covering the period 1991 to 2020.

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 removal and total mortality needed to conduct robust stock assessments.

## 5. Brief overview of ICCAT Integrated Online Management System (IOMS) work

The ICCAT Online Reporting Technology Working Group (WG TOR), whose mandate was established under Resolution 16-19, and extended through Recommendation 19-12, will govern all the IOMS implementation process. After postponing the 2020 meeting, an intersessional meeting of the WG-TOR was held in 2021 (see report) where it was decided to release into production the IOMS on 1 August 2012 with the objective of being an experimental year to handle the ICCAT CPCs annual reports (Part I/Annex 1 and Part II/Section 3). During all the process the Secretariat will support the ICCAT CPCs officers in the completion of the 2021 annual reports.

The European Union (EU) also contributed in 2021 with an additional budget for 1 year (EU project SI2839494, ~ €100,000) aiming to develop the IOMS dynamic help system. This budget allowed the Secretariat to hire an additional expert on front-end technologies for 12 months. The WG-TOR thanked EU for this contribution which will allow to improve the user's support on the utilisation of the IOMS.

The Secretariat gave a short "real-time" demonstration of the IOMS working already on the production environment, showing that various CPCs had already completed the 2021 Annual Report online.

The Chair informed that this Subcommittee maintains a strong collaboration with the WG-TOR since the beginning, where at the 2021 WG-TOR intersessional meeting, the proposal by the Chair of this Subcommittee to develop the Task 1 module manager on the next development phase (Phase 3) was accepted by the WG-TOR for a final approval by the Commission. This Subcommittee recognises the crucial importance of the IOMS in the future of ICCAT and reiterates the full support to continue with the IOMS implementation.

## 6. Workplan for 2022

The following tasks represent continuous database improvements and maintenance that will continue during 2021 and beyond. The priority tasks (including the ones postponed in 2019/2020) for 2021/2022 include:

- 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 tagging database redesign, including the addition of the model structure for electronic tagging;
- 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 (currently only the Vessel registry database is under this migration process).

## 7. Recommendations

### *7.1 Progress with prior year Recommendations of the Subcommittee*

*Ongoing Tasks*

- The Subcommittee recommends that the Secretariat continues the development of EFFDIS and present any updates at the next meeting of the SC-ECO.

- The Subcommittee recommends that the Secretariat in coordination with the WGs prepare a draft proposal for a workplan to guide the development of the Task 3 Biological database that will be presented at the next meeting of the Subcommittee.

- The Subcommittee recommends that the Secretariat prepare and make readily available the list of head of scientific delegations including their contact information and maintain it as a living document.

- The Subcommittee recommends that CPCs recover historical catch and effort data and apply the proper units of effort (i.e., number of hooks) and provide information on the type of longline gear deployed (i.e., American style or mesopelagic).

- The Subcommittee once again recommends that the Species Groups provide the Secretariat with the range of lengths and weights that are considered biologically acceptable for each species.

*Pending.* Nothing was received from the Species Groups during 2021

- The Subcommittee reiterates its support for the developing of the ICCAT Integrated Online Management System (IOMS) and the work of the Online Reporting Technical Working Group. As such, the Subcommittee recommends that the Commission fully supports this effort.

The Commission is fully supporting the work of the Online Reporting Technical Working Group.

### *7.2 Review of Recommendations from 2021 inter-sessional meetings*

The Subcommittee reviewed the recommendations for statistics from the 2021 intersessional meetings.

The following recommendations were endorsed by the Subcommittee:

*7.2.1 Billfish*

- Noting that the catches of billfish species are scarce and largely under-reported in the Mediterranean Sea, and taking into account that several CPCs had already implemented domestic observer programmes in BFT and SWO fisheries, the Group recommends the ICCAT CPCs with ICCAT fisheries in that area to duly provide their billfish catches (landings, dead discards and alive releases) for all species, including target, co-target and by-catch species.

- The Group recommends initiating a Subgroup to address the Commission request (Rec. 19-05, para. 20) to develop recommendations on the Electronic Monitoring Systems (EMS), particularly on longline fisheries from the scientific perspective. The Subgroup will incorporate expertise from other Species Groups and Subcommittees. The Group agreed that tasks of the Subgroup will include collection and analysis of past studies (e.g., reports and documents) regarding results from comparisons between observers and EMS, in order to start describing current knowledge, possible knowledge gaps and needs for additional experimental trials, and review the draft EM guidelines produced by the IMM. The Subgroup should report back to the Group, before considering submitting its findings to the SC-STATS in September this year.

- The Group also noted that according to ICCAT data catalogue, several CPCs have not reported statistical data for Atlantic recreational fisheries, despite the allocated financial resources made by the Commission to African western CPCs. The Group recommend investigating the difficulties and needs encountered by CPCs involved, aiming to improve the data collection and reporting.

*7.2.2 Tropical tunas*

- The Group recommended that the Secretariat work with those CPCs that are reporting Task 1 and 2 data using F.A.O gear codes instead of ICCAT gear codes to standardize their data submissions using the correct gear codes.

*7.2.3 Albacore*

- The Group recommends increasing efforts to complete Task 1 data for Mediterranean albacore, this being one of the main uncertainties not quantified in the assessment. The Group recommends that CPCs and the Secretariat work together to complete Task 1 data in the ICCAT database before the next assessment, and to consider methods developed by the WGSAM to estimate unreported catches.

- The Group recommends that CPCs with important Mediterranean albacore fisheries increase size sampling to facilitate the implementation of alternative age structured stock assessment models.

*7.2.4 Small tunas*

- Statistical Correspondent and/or national scientists should revise, update, complete and submit their small tuna T1NC series to the Secretariat. This revision should take into account 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 Task 2 datasets (T2CE: catch & effort; T2SZ: size samples). In addition, for the 13 species of small tuna, the T2SZ revision should follow the SCRS recommendation on the T2SZ stratification (month, gear, 1°x1° geographical squares for surface gears/up to 5°x5° squares for longlines, SFL size classes of 1 cm in lower limits). CPCs should further improve their estimates of total catches, as there are still important gaps in the basic data available. These data are required inputs for most of the data-limited stock assessment methods.
- The Secretariat should continue its work on the data recovery and the inventory process of tagging data for small tuna species. This process will require active participation of the national scientists that hold such data.

*7.2.5 Swordfish*

- The Group Recommended the future dissemination of T1NC information with both the positive catches and the "0" catches (whenever available discriminated by catch type: landings, dead discards, live releases) recorded in the ICCAT database system (ICCAT-DB).

- (*) The Group continues to note that there is a general lack of discard data reported by most CPCs, including dead discards and live releases. The Group reminds CPCs that the reporting of discards is required and is essential for assessing the stocks status. Such information is required to be provided by CPCs well in advance of the next stock assessment. The Group also strongly recommends that both dead and live discards be estimated by each CPC and reported to ICCAT, backwards in time as much as possible.

- The Group recommends that it is important for CPCs to also report data on discards-at-size for swordfish, in T2 data. This information is needed to address ICCAT Rec. 19-04, parag 3: "In the development of the operating models, the Commission would like the SCRS to allow for the evaluation of minimum size limits as strategies to achieve management objectives".

- The Group recommends that a specific code for the curved LJFL and curved UJFL (i.e. CLJFL and CUJFL) should be considered by SCRS SC-STAT for the inclusion among the ICCAT codes.

- (*) Considering the implications for stock assessment and the MSE process, the Group recommends that CPCs statistical correspondents should inform the Secretariat and SWO SG about the methodology used for collecting swordfish length and if it changed over time (curved or strait LJFL). The Secretariat will confirm with the statistical correspondents on the types of measurements submitted for swordfish.

- The Group recommends that the specification of the type of measurement (curved or strait LJFL) shall be included in any ICCAT Recommendation concerning size limits in swordfish.

*7.2.6 Working Group on Stock Assessment methods (WGSAM)*

- The Group noted the importance of having the historical sex information on the conventional tagging database. Such data are usually reported for sharks, but currently it is only available in the ICCAT database for the most recent years. Therefore, the Group recommends that the Secretariat makes a revision of the available historical sex information for inclusion in the conventional tagging database and make it available in the cases where such information was reported.

*7.2.7 Subcommittee on Ecosystem*

- The Subcommittee recommends that the Subcommittee on Statistics review the gaps in the catch-and-effort data in the ICCAT-DB (information to be provided by the Secretariat). Based on this review, the Subcommittee on Statistics should decide if it recommends uploading the current version of the EFFDIS to the ICCAT website or if the data gaps are significant enough to preclude the use of EFFDIS.

- The Subcommittee recommends that CPCs abide by the reporting obligation to report size samples collected by scientific observers using the ST04 form.

- The Subcommittee recommended set depth on the ST09 form be captured on the form as follows in **Table 2**.

- The Subcommittee recommends that the Secretariat, in collaboration with the SCRS and national scientists, review and update the list of by-catch species in the ICCAT database.

### *7.3 Future Recommendations*

*7.3.1 Recommendations without financial implications*

1. The Subcommittee recommends that the Secretariat include in its annual 'Secretariat's Annual Report on Research and Statistics' a summary table with, but not limited to, the total number by species of seabirds, sea turtles, marine mammals, and ICCAT prohibited species discarded dead or released alive reported by each CPC using the ST09-DomObPrg form.

2. The Subcommittee recommends that the Secretariat includes, as part of Filter 1 criteria, the completion of the subform ST02B (zero catch matrix) by the CPCs as part of their submission of the ST02-T1NC (nominal catches) form.

3. Given that the reporting in Task 1 is not complete and also not clear in some cases, the Subcommittee recommended that options to report birds, turtles, and marine mammals be removed from ST02 forms and that these rows be removed from the Secretariat's Annual Report on Research and Statistics.

4. The Subcommittee recommends that, where needed, the Secretariat updates the "read me" files associated with the different ICCAT Statistics Databases posted on the ICCAT Website.

5. The Subcommittee recommends that the Secretariat requests that CPCs identified as having reported T2CE datasets with incomplete information on effort (catches without effort), report revisions to ICCAT with the missing effort included and whenever possible the catches of the three major shark species (POR, BSH, SMA). The Secretariat should estimate the fractions of the total longline catches that don't have sufficient effort information in T2CE and estimate the impact of those datasets on the estimations of EFFDIS. These analyses completed with the gaps identified on the SCRS species catalogues should be presented at next meeting of the Subcommittee on Ecosystems.

6. The Subcommittee recommended that the Commission continue to support the development of the IOMS system.

7. To complete catch data series, the Subcommittee recommends that ICCAT develop a process to obtain catch statistics information from countries that are not currently part of ICCAT. It recommends that the acquisition of these data (through collaboration with FAO, other regional fisheries bodies, and CPCs) be elevated and addressed by the Commission itself.

*7.3.2 Recommendations with financial implications*

- The Subcommittee recommended continued development of front-end applications for making and publishing graphically dashboards of ICCAT statistical datasets and provide the necessary financial resources for its initial implementation (€6,000). The full development of these important tools will require additional funding.

*Billfishes*

- The Subcommittee Group recommended that the necessary funds for the implementation of Billfish Species Group Regional workshops in West Africa and Caribbean for the improvement of statistical data collection and reporting, to be estimated intersessionally aiming for the endorsement of these funds by the 2021 SCRS Plenary for the 2022-2023 budget.

## 8. Other matters

The Subcommittee acknowledged that, despite its already very heavy workload, the Secretariat continues to excel at its job. Therefore, the Subcommittee commended the Secretariat's staff for the excellent support they continue to provide to all the SCRS Species Groups and Subcommittees. In particular, taking into consideration the additional difficulties associated with conducting only online meetings due to the ongoing pandemic.

## 9. Adoption of the report and closure

The report of the meeting will be adopted during the SCRS Plenary meeting.

## References

Di Natale A., Bariche M., Lahoud I., Abouelmagd N., and El Aweet A.E.A. 2020. Fisheries of narrow-barred Spanish mackerel (*Scoberomorus commerson* Lacepède, 1800) in the southern and eastern Mediterranean and relevance of the species for ICCAT. Collect. Vol. Sci. Paps. ICCAT. 77(9): 85-99.

Carruthers T. 2020. Designing and testing a multi-stock spatial management procedure for Atlantic bluefin tuna. Collect. Vol. Sci. Pap. ICCAT. 77(2): 1015-1032.

**Table 1.** Conversion factors reported in T1NC for 2019 and 2020 (only when <> 1).

| | | | 1-Tuna (major sp.) | | | | | | | | | | 2-Tuna (small) | 4-Sharks (major) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PartyStatus | FlagName | GearGrp | ALB | BET | BFT | BUM | SAI | SKJ | SPF | SWO | WHM | YFT | WAH | BSH | POR | SMA |
| CP | Canada | GN | | | | | | | | | | | | | 1.7 | 1.48 |
| | | HL | | | | | | | | | | | | | | 1.48 |
| | | HP | | 1.25 | 1.25 | 1.25 | | | | 1.33 | 1.2 | 1.25 | | | | |
| | | LL | | 1.25 | 1.25 | 1.25 | 1.2 | | | 1.33 | 1.2 | 1.25 | | 1.22 | 1.7 | 1.48 |
| | | RR | | 1.25 | 1.25 | 1.25 | | | | | | 1.25 | | | | |
| | | TL | | 1.25 | | 1.25 | | | | | | | | | | |
| | | TP | | | | 1.25 | | | | | | | | | | |
| | | TR | | 1.25 | 1.25 | | | | | 1.33 | 1.2 | 1.25 | | | | |
| | | TW | | | | | | | | | | | | | 1.48 | |
| | EU-Cyprus | LL | | | | 1.13 | | | | 1.14 | | | | | | |
| | EU-Greece | LL | | | | | | | | 1.13 | | | | | | |
| | EU-Ireland | TW | | 1.11 | | | | | | 1.31 | | | | | | |
| | EU-Malta | LL | | | | 1.13 | | | | | | | | | | |
| | Japan | LL | | | | 1.16 | | | | | | | | 2.1 | 1.8 | 1.6 |
| | Korea Rep | LL | | | 1.13 | 1.16 | 1.2 | 1.2 | | 1.33 | 1.2 | 1.13 | | | | |
| | Norway | GN | | | | 1.22 | | | | | | | | | 1.3 | |
| | | LL | | | | 1.05 | | | | | | | | | | |
| | | PS | | | | 1.26 | | | | | | | | | | |
| | | RR | | | | 1.05 | | | | | | | | | | |
| | | TP | | | | 1.22 | | | | | | | | | | |
| | | TW | | | | 1.16 | | | | | | | | | | |
| | South Africa | BB | | 1.13 | 1.13 | | | | | | | 1.13 | | | | |
| | | LL | | 1.13 | 1.13 | | | | | 1.315 | | 1.13 | | 2.4 | | 1.46 |
| | Trinidad and Tobago | LL | | | 1.13 | | | 1.2 | | 1.33 | | 1.13 | | | | |
| | UK-Bermuda | LL | | 1.1 | 1.1 | 1.1 | | | | 1.3 | | 1.1 | 1.1 | | | |
| | | UN | | | | 1.1 | | | | | | | | | | |
| | UK-Sta Helena | BB | | | 1.13 | | 1.2 | | | | | 1.13 | 1.2 | | | 1.157 |
| | | RR | | | 1.13 | | | | | | | 1.13 | 1.2 | | | |
| | USA | GN | | 1.25 | 1.25 | | | 1.25 | | | | 1.25 | | | | 1.46 |
| | | HL | | 1.25 | 1.25 | | | 1.25 | | 1.33 | | 1.25 | | | | 1.46 |
| | | HP | | | | 1.25 | | | | 1.33 | | | | | | |
| | | LL | | 1.25 | 1.25 | 1.25 | | 1.25 | | 1.33 | | 1.25 | | | 1.46 | 1.46 |
| | | RR | | | | 1.25 | | | | | | | | | | |
| | | TP | | | | 1.25 | | | | | | | | | | |
| | | TR | | 1.25 | 1.25 | | | 1.25 | | 1.33 | | 1.25 | | | | 1.46 |
| | | TW | | 1.25 | 1.25 | | | 1.25 | | 1.33 | | 1.25 | | | 1.46 | 1.46 |
| | | UN | | 1.25 | 1.25 | | | 1.25 | | 1.33 | | 1.25 | | | | |
| NCC | Chinese Taipei | LL | | | 1.13 | 1.16 | 1.2 | 1.2 | 1.2 | 1.3 | 1.2 | 1.13 | | 1.54 | 1.54 | 1.54 |

(*) Japan used a y=a+bc linear equation (not forced to zero) as shown below:

| CnvFactorID | CfEquation | CfEquationType | Param_A | Param_B |
|---|---|---|---|---|
| <100 | Various (B) (a=0) | linear (y=bx) | 0 | 1=< b <= 2.4 |
| 101 | BET: WW=1.133*PW+2.980 | linear (y=a+bx) | 2.98 | 1.133 |
| 102 | YFT: WW=1.100*PW+3.698 | linear (y=a+bx) | 3.698 | 1.1 |
| 103 | SWO: WW=1.584*PW-0.479 | linear (y=a+bx) | -0.479 | 1.584 |
| 104 | WHM: WW=1.098*PW+3.655 | linear (y=a+bx) | 3.655 | 1.098 |
| 105 | BUM: WW=1.159*PW+1.834 | linear (y=a+bx) | 1.834 | 1.159 |
| 107 | SAI: WW=0.793*PW+6.938 | linear (y=a+bx) | 6.938 | 0.793 |
| 108 | SPF: WW=1.157*PW+5.517 | linear (y=a+bx) | 5.517 | 1.157 |

**Table 2.** Proposed update to form ST09. Depth range and hooks between floats are now required to be reported separately for each set using one of the three categories indicated for each metric. Optionally, the estimated depth of fishing may also be reported when known.

| *FOpDepthCode* | *Hooks between Floats (HBF)* | *Estimated depth range value in 10m increments (optional)* |
|---|---|---|
| Shallow | 1-5 h/f | |
| Medium | 6-12 h/f | |
| Deep | 12+ h/f | |

**Addendum 1 to Appendix 11**

## Agenda

1. Opening, adoption of Agenda and meeting arrangements
2. Summary of fisheries and biological data submitted during 2021 (Tasks 1, 2 and 3), including historical revisions
3. Summary of Secretariat's standard (yearly based) datasets estimations
4. Brief overview of data deficiencies pursuant to Rec. 05-09
5. Brief overview of ICCAT Integrated Online Management System (IOMS) work
6. Workplan for 2022
7. Recommendations (with special emphasis on those with financial implications)
8. Other matters
9. Adoption of the report

**Addendum 2 to Appendix 11**

## List of participants

***CONTRACTING PARTIES***

**BRAZIL**
**LeiteMourato**, Bruno
Profesor Adjunto, Laboratório de Ciências da Pesca - LabPesca Instituto do Mar - IMar, Universidade Federal de São Paulo - UNIFESP, Rua Carvalho de Mendoça, 144, Encruzilhada, 11070-100 Santos, SP
Tel: +55 1196 765 2711, Fax: +55 11 3714 6273, E-Mail: bruno.mourato@unifesp.br; bruno.pesca@gmail.com; mourato.br@gmail.com

**Travassos**, Paulo Eurico
Professor, Universidade Federal Rural de Pernambuco - UFRPE, Laboratorio de EcologiaMarinha - LEMAR, Departamento de Pesca e Aquicultura - DEPAq, Avenida Dom Manuel de Medeiros s/n - DoisIrmãos, CEP 52171-900 Recife Pernambuco
Tel: +55 81 998 344 271, E-Mail: pautrax@hotmail.com; paulo.travassos@ufrpe.br

**CANADA**
**Duprey**, Nicholas
Senior Science Advisor, Fisheries and Oceans Canada - Fish Population Science, Government of Canada, 200-401 Burrard Street, Vancouver, BC V6C 3R2
Tel: +1 604 499 0469; +1 250 816 9709, E-Mail: nicholas.duprey@dfo-mpo.gc.ca

**Hanke**, Alexander
Scientist, St. Andrews Biological Station, Fisheries and Oceans Canada, 531 Brandy Cove Road, St. Andrews, New Brunswick E5B 2L9
Tel: +1 506 529 5912, Fax: +1 506 529 5862, E-Mail: alex.hanke@dfo-mpo.gc.ca

**CHINA, (P. R.)**
**Feng**, Ji
Shanghai Ocean University, 999 Hucheng Huan Rd, 201306 Shangai
Tel: +86 159 215 36810, E-Mail: 276828719@qq.com; f52e@qq.com

**Zhang**, Fan
Shanghai Ocean University, 999 Hucheng Huan Rd, 201306 Shangai
Tel: +86 131 220 70231, E-Mail: f-zhang@shou.edu.cn

**CÔTE D'IVOIRE**
**Diaha**, N'Guessan Constance
Chrecheur Hydrobiologiste, Laboratoire de biologie des poissons du Département des Ressources Aquatiques Vivantes (DRAV) du Centre de Recherches Océanologiques (CRO), 29, Rue des Pêcheurs - B.P. V-18, Abidjan 01
Tel: +225 21 35 50 14; +225 21 35 58 80, E-Mail: diahaconstance@yahoo.fr; constance.diaha@cro-ci.org

**EL SALVADOR**
**Saca**, Francisco
Director General del Centro de Desarrollo de la Pesca y la Acuicultura (CENDEPESCA), Final 1º Ave. Norte y ave. Manuel Gallardo, Santa Tecla, La Libertad
Tel: +503 2210 1760, E-Mail: francisco.saca@mag.gob.sv

**Aceña Matarranz**, Sara
CALVO, C/ Príncipe de Vergara 110, 4ª Planta, 28002 Madrid, España
Tel: +34 686 061 921, E-Mail: sara.acena@ctmcorporation.com

**Sanisidro Araujo**, Jorge
C/ Principe de Vergara 110 4ª Planta, 28033 Madrid, España
Tel: +34 91 782 3300, E-Mail: jorge.sanisidro@ctmcorporation.com

**EUROPEAN UNION**
**Alzorriz**, Nekane
ANABAC, Txibitxiaga 24 entreplanta, 48370 Bermeo, Bizkaia, España
Tel: +34 94 688 2806; +34 650 567 541, E-Mail: nekane@anabac.org

**Amoedo Lueiro**, XoanInacio
Biólogo, Consultor Ambiental, Medio Mariño e Pesca, Pza. de Ponteareas , 11, 3ºD, 36800 Pontevedra, España
Tel: +34 678 235 736, E-Mail: tecnico@fipblues.com; lueiro72consultant@gmail.com

**Arrizabalaga**, Haritz
Principal Investigator, AZTI Marine ResearchBasqueResearch and Technology Alliance (BRTA), Herrera KaiaPortualde z/g, 20110 Pasaia, Gipuzkoa, España
Tel: +34 94 657 40 00; +34 667 174 477, Fax: +34 94 300 48 01, E-Mail: harri@azti.es

**Biagi**, Franco
Senior Expert Marine & Fishery Sciences, Directorate General for Maritime Affairs and Fisheries (DG-Mare) - European Commission, Unit C3: Scientific Advice and data collection, Rue Joseph II, 99, 1049 Brussels, Belgium
Tel: +322 299 4104, E-Mail: franco.biagi@ec.europa.eu

**Déniz González**, Santiago Félix
Instituto Español de Oceanografía, C/ La Farola del Mar n º 22 - Dársena Pesquera, 38180 Santa Cruz de Tenerife, España
Tel: +34 646 152 724, E-Mail: santiago.deniz@ieo.es

**Di Natale**, Antonio
Director, AquastudioResearchInstitute, Via Trapani 6, 98121 Messina, Italy
Tel: +39 336 333 366, E-Mail: adinatale@costaedutainment.it; adinatale@acquariodigenova.it

**Duparc**, Antoine
Station IFREMER Boulevard, Avenue Jean Monnet CS 30171, 34200 Sète Occitanie, France
Tel: +33 049 957 3205, E-Mail: antoine.duparc@ird.fr

**Fernández Costa**, Jose Ramón
Instituto Español de Oceanografía, Ministerio de Ciencia e Innovación, Centro Costero de A Coruña, Paseo Marítimo Alcalde Francisco Vázquez, 10 - P.O. Box 130, 15001 A Coruña, España
Tel: +34 981 218 151, Fax: +34 981 229 077, E-Mail: jose.costa@ieo.es

**Ferreira de Gouveia**, Lidia
Técnica Superior, Biologist, Direcçao Regional das Pescas, DireçaoServiços de Investigaçao - DSI, Av. do Mar e das Comunidades Madeirenses, 23 - 1º Esq., 9004-562 Funchal, Madeira, Portugal
Tel: +351 291 203270, Fax: +351 291 229856, E-Mail: lidia.gouveia@madeira.gov.pt

**Floch**, Laurent
Databaseadministrator, IRD, UMR, 248 MARBEC, Avenue Jean Monnet, CS 30171, 34203 Séte Cedex, France
Tel: +33 4 9957 3220; +33 631 805 794, Fax: +33 4 9957 32 95, E-Mail: laurent.floch@ird.fr

**Grubisic**, Leon
Institute of Oceanography and Fisheries in Split, Setaliste Ivana Mestrovica 63 - P.O.Box 500, 21000 Split, Croatia
Tel: +385 914 070 955, Fax: +385 21 358 650, E-Mail: leon@izor.hr

**Herrera Armas**, Miguel Angel
Deputymanager (Science), OPAGAC, C/ Ayala 54, 2º A, 28001 Madrid, España
Tel: +34 91 431 48 57; +34 664 234 886, Fax: +34 91 576 12 22, E-Mail: miguel.herrera@opagac.org

**Kalogirou**, Stefan
Department for fisheries management, Unit for Fisheries Policy, Swedish Agency for Marine and Water Management, GullbergsStrandgata 15, 41104 Göteborg, Sweden Postal address: Box 11 930, 40439 Gothenburg, Sweden
Tel: +46 765386178, E-Mail: stefan.kalogirou@havochvatten.se

**Lino**, Pedro Gil
ResearchAssistant, Instituto Português do Mar e da Atmosfera - I.P./IPMA, Avenida 5 Outubro s/n, 8700-305 Olhão, Faro, Portugal
Tel: +351 289 700504, E-Mail: plino@ipma.pt

**Macías López**, Ángel David
Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Málaga, Puerto pesquero s/n, 29640 Fuengirola Málaga, España
Tel: +34 952 197 124; +34 619 022 586, Fax: +34 952 463 808, E-Mail: david.macias@ieo.es

**Maufroy**, Alexandra
ORTHONGEL, 5 rue des sardiniers, 29900 Concarneau, France
Tel: +33 649 711 587, Fax: +33 2 98 50 80 32, E-Mail: amaufroy@orthongel.fr

**Ortiz de Zárate Vidal**, Victoria
Investigadora, Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Santander, Promontorio de San Martín s/n, 39004 Santander, Cantabria, España
Tel: +34 942 291 716, Fax: +34 942 27 50 72, E-Mail: victoria.zarate@ieo.es

**Pappalardo**, Luigi
Scientific Coordinator, OCEANIS SRL, Vie Maritime 59, 84043 Salerno Agropoli, Italy
Tel: +39 081 777 5116; +39 345 689 2473, E-Mail: gistec86@hotmail.com; oceanissrl@gmail.com

**ParejoLázaro-Carrasco**, Aída
Instituto Español de Oceanografía - IEO, Promontorio San Martín s/n, Av. de Severiano Ballesteros, s/n, 39004 Cantabria, Santander, España
Tel: +34 942 29 17 16, E-Mail: aida.parejo@ieo.es

**Rodríguez-Marín**, Enrique
Ministerio de Ciencia, Innovación y Universidades, Instituto Español de Oceanografía, C.O. de Santander, Promontorio de San Martín s/n, 39004 Santander, Cantabria, España
Tel: +34 942 291 716, Fax: +34 942 27 50 72, E-Mail: enrique.rmarin@ieo.es

**Rojo Méndez**, Vanessa
IEO Centro Oceanográfico de Canarias, C/ Farola del Mar nº 22, Dársena Pesquera, 38180 Santa Cruz de Tenerife, España
Tel: +34 922 549 400, Fax: +34 922 549 554, E-Mail: vanessa.rojo@ieo.es

**Ruiz Gondra**, Jon
AZTI-Tecnalia, Txatxarramendi z/g, 48395 Sukarrieta (Bizkaia), España
Tel: +34 94 6574000; +34 667 174 375, Fax: +34 94 6572555, E-Mail: jruiz@azti.es

**Santiago Burrutxaga**, Josu
Head of Tuna ResearchArea, AZTI-Tecnalia, Txatxarramendi z/g, 48395 Sukarrieta (Bizkaia) País Vasco, España
Tel: +34 94 6574000 (Ext. 497); +34 664 303 631, Fax: +34 94 6572555, E-Mail: jsantiago@azti.es; flarrauri@azti.es

**Thasitis**, Ioannis
Department of Fisheries and Marine Research, 101 Vithleem Street, 2033 Nicosia, Cyprus
Tel: +35722807840, Fax: +35722 775 955, E-Mail: ithasitis@dfmr.moa.gov.cy

**GHANA**
**Ayivi**, Sylvia SefakorAwo
Senior Manager, Ministry of Fisheries and Aquaculture Development, Fisheries Scientific Survey Division, P.O. Box BT 62, Tema
Tel: + 233 2441 76300, Fax: +233 3032 008048, E-Mail: asmasus@yahoo.com

**Kwame Dovlo**, Emmanuel
Ag. Deputy Director, Fisheries Scientific Survey Division, P.O. Box GP 630, Accra Tema
Tel: +233 243 368 091, E-Mail: emkwdovlo@yahoo.co.uk

**JAPAN**
**Miura**, Nozomu
Assistant Director, International Division, Japan Tuna Fisheries Co-operative Association, 2-31-1 Eitai Koto-ku, Tokyo 135-0034
Tel: +81 3 5646 2382, Fax: +81 3 5646 2652, E-Mail: miura@japantuna.or.jp; gyojyo@japantuna.or.jp

**Nakatsuka**, Shuya
Deputy Director, Highly Migratory Resources Division, Fisheries Resources Institute, Japan Fisheries Research and Education Agency, 2-12-4, Fukuura, Kanazawa Kanagawa, 236-8648
Tel: +81 45 788 7950, E-Mail: snakatsuka@affrc.go.jp

**Tsuji**, Sachiko
Researcher, Ecologically Related Species Group, National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency, 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa, 236-8648
Tel: +81 45 788 7931, Fax: +81 45 788 5004, E-Mail: sachiko27tsuji@gmail.com

**Uozumi**, Yuji
Adviser, Japan Tuna Fisheries Co-operation Association, Japan Fisheries Research and Education Agency, 31-1 Eitai Chiyodaku, Tokyo Koutou ku Eitai 135-0034
Tel: +81 3 5646 2380, Fax: +81 3 5646 2652, E-Mail: uozumi@japantuna.or.jp

**KOREA REP.**
**Lee**, Sung Il
Scientist, National Institute of Fisheries Science, 216 Gijang-Haeanro, Gijang-eup, Gijang-gun, 46083 Busan
Tel: +82 51 720 2330, Fax: +81 51 720 2337, E-Mail: k.sungillee@gmail.com; k.sungillee@korea.kr

**Lee**, Mi Kyung
Scientist, National Institute of Fisheries Science, 216 Gijanghaean-ro, Gijang-eup, Gijang-gun, 46083 Busan
Tel: +82 51 720 2332, Fax: +82 51 720 2337, E-Mail: ccmklee@korea.kr; cc.mklee@gmail.com

**MEXICO**
**Ramírez López**, Karina
Instituto Nacional de Pesca y Acuacultura, Centro Regional de Investigación Acuícola y Pesquera - Veracruz, Av. Ejército Mexicano No.106 - Colonia Exhacienda, YlangYlang, C.P. 94298 Boca de Río, Veracruz
Tel: +52 5538719500, Ext. 55756, E-Mail: kramirez_inp@yahoo.com

**MOROCCO**
**Baibbat**, Sid Ahmed
Chef de Laboratoire des Pêches, Centre régional de DAKHLA, Institut National de Recherches Halieutiques (INRH), 2, BD Sidi Abderrahmane, aindiab., 20100 Dakhla
Tel: +212 661 642 573, E-Mail: baibat@hotmail.com; baibbat@inrh.ma

**El Joumani**, El Mahdi
Ingénieur Halieute, Institut National de Recherche Halieutique "INRH", Laboratoire de pêche au Centre Régional de l'INRH-Laayoune, Avenue CharifErradi N 168 Hay el Ouahda 01, Laayoune
Tel: +212 661 114 418, E-Mail: Eljoumani.mehdi@gmail.com

**Layachi**, Mostafa
E-Mail: mostafalayachi12@gmail.com

**RUSSIAN FEDERATION**
**Kolomeiko**, Fedor
Head of the «Regional Data Center» Department, Atlantic branch of VNIRO (AtlantNIRO), Research Institute of Fisheries and OceanographY, 5 Dm. Donskoy Str., 236022 Kaliningrad
Tel: +7 4012 21 56 45, Fax: +7 4012 21 99 97, E-Mail: fed@atlantniro.ru

**Nesterov**, Alexander
Senior Research Officer, Atlantic Research Institute of Marine, Fisheries and Oceanography (AtlantNIRO), International Cooperation Department, Atlantic Branch of VNIRO, 5, Dmitry Donskoy Str., 236022 Kaliningrad
Tel: +7 4012 925 389, Fax: + 7 4012 219 997, E-Mail: nesterov@atlantniro.ru; atlantniro@vniro.ru

**SENEGAL**
**Sow**, Fambaye Ngom
Chercheur Biologiste des Pêches, Centre de Recherches Océanographiques de Dakar Thiaroye, CRODT/ISRA, LNERV - Route du Front de Terre - BP 2241, Dakar
Tel: +221 3 0108 1104; +221 77 502 67 79, Fax: +221 33 832 8262, E-Mail: ngomfambaye2015@gmail.com; famngom@yahoo.com

**TUNISIA**
**Mejri**, Hamadi
Directeur adjoint, Conservation des ressources halieutiques, Ministère de l'Agriculture et des ressources hydrauliques et de la pêche, Direction Générale de la Pêche et de l'Aquaculture, 32, Rue Alain Savary - Le Belvédère, 1002 Tunis
Tel: +216 240 12780, Fax: +216 71 799 401, E-Mail: hamadi.mejri1@gmail.com

**Zarrad**, Rafik
Chercheur, Institut National des Sciences et Technologies de la Mer (INSTM), BP 138 Ezzahra, Mahdia 5199
Tel: +216 73 688 604; +216 972 92111, Fax: +216 73 688 602, E-Mail: rafik.zarrad@gmail.com

**TURKEY**
**Erdem**, Ercan
Ministry of Agriculture and Forestry, General Directorate of Fisheries and Aquaculture, Eskisehir yolu9.KmLodumlu-Cankaya, 06800 Ankara
Tel: +905 444 782 094, Fax: +903 12 258 3070, E-Mail: ercan.erdem@tarimorman.gov.tr

**UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND**
**Bell**, James
Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft Suffolk NR33 0HT
Tel: +44 1 502 521 377, E-Mail: james.bell@cefas.co.uk

**UNITED STATES**
**Brown**, Craig A.
Chief, Highly Migratory Species Branch, Sustainable Fisheries Division, NOAA Fisheries Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 586 6589, Fax: +1 305 361 4562, E-Mail: craig.brown@noaa.gov

**Díaz**, Guillermo
NOAA-Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4227, E-Mail: guillermo.diaz@noaa.gov

**Die**, David
Research Associate Professor, Cooperative Institute of Marine and Atmospheric Studies, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149
Tel: +1 305 421 4607, E-Mail: ddie@rsmas.miami.edu

**Schirripa**, Michael
Research Fisheries Biologist, NOAA Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 445 3130; +1 786 400 0649, Fax: +1 305 361 4562, E-Mail: michael.schirripa@noaa.gov

**Walter**, John
Research Fishery Biologist, NOAA Fisheries, Southeast Fisheries Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +305 365 4114; +1 804 815 0881, Fax: +1 305 361 4562, E-Mail: john.f.walter@noaa.gov

**Zhang**, Xinsheng
NOAA/NMFS/SEFSC, 3500 Delwood Beach Rd., Florida, 32408
Tel: +1 850 234 6541 ext. 264, Fax: +1 850 235 3559, E-Mail: Xinsheng.Zhang@noaa.gov; Xinsheng.Zhang0115@gmail.com

**URUGUAY**
**Domingo**, Andrés
Dirección Nacional de Recursos Acuáticos - DINARA, Laboratorio de Recursos Pelágicos, Constituyente 1497, 11200 Montevideo
Tel: +5982 400 46 89, Fax: +5982 401 32 16, E-Mail: dimanchester@gmail.com

**Forselledo**, Rodrigo
Investigador, Dirección Nacional de Recursos Acuáticos - DINARA, Laboratorio de Recursos Pelágicos, Constituyente 1497, CP 11200 Montevideo
Tel: +598 2400 46 89, Fax: +598 2401 3216, E-Mail: rforselledo@gmail.com

**Jiménez Cardozo**, Sebastián
Vice-Convenor of ACAP's Seabird Bycatch Working Group, Constituyente 1497, 11200 Montevideo
Tel: +598 99 781644, E-Mail: jimenezpsebastian@gmail.com

**VENEZUELA**
**Arocha**, Freddy
Instituto Oceanográfico de Venezuela, Universidad de Oriente, A.P. 204, 6101 Cumaná Estado Sucre
Tel: +58 424 823 1698, E-Mail: farochap@gmail.com

**Narváez Ruiz**, Mariela del Valle
Lab. 34, Edif. Instituto Oceanográfico de Venezuela, Universidad de Oriente, Departamento de Biología Pesquera, Av. Universidad, Cerro Colorado, 6101 Cumaná Estado Sucré
Tel: +58 412 085 1602, E-Mail: mnarvaezruiz@gmail.com

***OBSERVERS FROM COOPERATING NON-CONTRACTING PARTIES, ENTITIES, FISHING ENTITIES***

**CHINESE TAIPEI**
**Chang**, Feng-Chen
Specialist, Overseas Fisheries Development Council, 3F., No14, Wenzhou St. Da'an Dist., 10648
Tel: +886 2 2368 0889 ext. 126, Fax: +886 2 2368 1530, E-Mail: fengchen@ofdc.org.tw; d93241008@ntu.edu.tw

**Lin**, Wei-Ren
Assistant, Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, No. 2 Pei-Ning Rd. Keelung, 202301
Tel: +886 2 24622192 ext. 5046, Fax: +886 2 24622192, E-Mail: willy20535@gmail.com

**Su**, Nan-Jay
Assistant Professor, Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, No. 2 Pei-Ning Rd. Keelung, Zhongzheng Dist., 202301
Tel: +886 2 2462 2192 #5046, Fax: +886-2-24622192, E-Mail: nanjay@ntou.edu.tw

***OBSERVERS FROM NON-GOVERNMENTAL ORGANIZATIONS***

**EUROPÊCHE**
**Kell**, Laurence
Visiting Professor in Fisheries Management, Centre for Environmental Policy, Imperial College London, Henstead, Suffolk NR34 7JZ, United Kingdom
Tel: +44 751 707 1190, E-Mail: laurie@seaplusplus.co.uk; l.kell@imperial.ac.uk; laurie@kell.es

**INTERNATIONAL SEAFOOD SUSTAINABILITY FOUNDATION – ISSF**
**Justel**, Ana
ISSF-Spain, Plaza Santa María Soledad Torres Acosta 1, 5ª Planta, 28004 Madrid, España
Tel: +34 91 745 3075; +34 696 557 530, E-Mail: ajustel@iss-foundation.org

**SCRS CHAIRMAN**
**Melvin**, Gary
SCRS Chairman, St. Andrews Biological Station - Fisheries and Oceans Canada, Department of Fisheries and Oceans, 285 Water Street, St. Andrews, New Brunswick E5B 1B8, Canada
Tel: +1 506 652 95783, E-Mail: gary.d.melvin@gmail.com; gary.melvin@dfo-mpo.gc.ca

**SCRS VICE CHAIRMAN**
**Coelho**, Rui
Researcher, SCRS Vice-Chairman, Portuguese Institute for the Ocean and Atmosphere, I.P. (IPMA), Avenida 5 de Outubro, s/n, 8700-305 Olhão, Portugal
Tel: +351 289 700 504, E-Mail: rpcoelho@ipma.pt

*****

**ICCAT Secretariat**
C/ Corazón de María 8 – 6th floor, 28002 Madrid – Spain
Tel: +34 91 416 56 00; Fax: +34 91 415 26 12; E-mail: info@iccat.int

**Manel**, Camille Jean Pierre
**Neves dos Santos**, Miguel
**Ortiz**, Mauricio
**Palma**, Carlos
**Taylor**, Nathan
**Kimoto**, Ai
**Gallego Sanz**, Juan Luis
**García**, Jesús
**Mayor**, Carlos
**Muñoz**, Juan Carlos

**Addendum 3 to Appendix 11**

**List of documents**

| *Reference* | *Title* | *Authors* |
|---|---|---|
| SCRS/2021/159 | The non-compliance with the UN agreement of straddling fish stocks by non-ICCAT CPC and impact on ICCAT statistics | Di Natale A. |
| SCRS/2021/165 | Report of the subgroup on electronic monitoring systems from the Billfish Species Group | Anonymous |

**Addendum 4 to Appendix 11**

**Summaries as presented by the authors**

*SCRS/2021/159*: The UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks includes obligations for reporting all catches to the competent RFMO even for non-contracting parties of a given RFMO. There are evidences and logic assumptions that this is not always the case for the species managed by ICCAT and this fact implies some impacts on the ICCAT catch statistics for all species concerned. This short paper, using some examples, points out the problem that should be tackled by ICCAT SCRS and the ICCAT Commission for trying to improve the current situation.

*SCRS/2020/165:* This report reflects the work that was carried out intersessionally by the Billfishes Subgroup on Electronic Monitoring Systems. We provide details on the process and work carried out, recommendations and plans for continuing the work in 2022. We also provide a draft response to the Commission following the request contained in ICCAT Rec 19-05 (paragraph 20).

**Appendix 12**

## Report of the 2021 Meeting of the Subcommittee on Ecosystems and Bycatch

The detailed report of the Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch is provided here.

**Appendix 13**

**Task 1 catches for all major ICCAT species (excluding those contained in items 9.1 to 9.3 of this report), as of 15 August 2021**

Available from the Secretariat in PDF format only.

**Appendix 14**

**Consolidated report for North Atlantic Albacore Management Strategy Evaluation**

*Version 21-1: June 2021*

Consolidated report for the North Atlantic albacore MSE is a living document that is under constant modification. The most recent version of the document (Version 21-1: June 2021) can be found here.

**Appendix 15**

## SCRS revised roadmap for the development of Management Strategy Evaluation (MSE) and Harvest Control Rules (HCR)

*Document adopted during the 2019 Commission meeting and revised by the SCRS in 2020 and 2021 (changes are underlined)*

This schedule is intended to guide the development of harvest strategies for priority stocks identified in Rec. 15-07 (North Atlantic albacore, North Atlantic swordfish, eastern and western Atlantic bluefin tuna, and tropical tunas). It builds on the initial road map that was appended to the 2016 Annual Meeting report. 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. The aspirational nature of this timeline assumes adoption of a final management procedure for northern albacore in 2021 and interim management procedures for bluefin tuna in 2022, and northern swordfish and tropical tunas as soon as 2023. However, the exact timeline for delivery is contingent on funding, prioritization, and other work of the Commission and SCRS.

* For 2015 through 2019, the road map reflects progress to-date in some detail. For 2021 onward, more general steps for the SCRS and Commission are anticipated pending outcomes of the 2021 Annual Meeting.

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2015** | - Commission established management objectives in Rec. 15-04 | | | Commission provided initial guidance for the development of harvest strategies for priority stocks, including tropical tunas [Rec. 15-07] |
| **2016** | - SCRS conducted stock assessment<br>- SCRS evaluated a range of candidate HCRs through MSE<br>- PA2 identified performance indicators | | | - Commission identified performance indicators (Rec. 16-01). Commission adopted MSE roadmap, including plan for activities for tropical tunas for 2016-2021 |
| **2017** | - SCRS evaluated the performance of candidate HCRs through MSE, using the performance indicators developed by PA2<br>- SWGSM narrowed the candidate HCRs and referred to Commission<br>- Commission selected and adopted an HCR with associated TAC at the Annual Meeting (Rec. 17-04) | - SCRS conducted stock assessment<br>- Core modelling group completed development of modelling framework | - SCRS conducted stock assessment | - SCRS reviewed performance indicators for YFT, SKJ, and BET<br>- SWGSM recommended a multi-stock approach for development of MSE framework |
| **2018** | - SCRS contracted independent expert to complete peer review of MSE code<br>- Call for Tenders issued for peer review<br>[…]<br>- SCRS tested the performance of the adopted HCR, as well as variations of the HCR, as requested in Rec. 17-04<br>- SCRS developed criteria for the identification of exceptional circumstances | - SCRS conducted joint MSE meeting on BFT/SWO<br>- SCRS reviewed but could not adopt reference set of OMs<br>- SCRS began testing candidate management procedures (MPs)<br>- SWGSM considered qualitative management objectives<br>- BFT WG reviewed progress and developed detailed road map<br>- Commission adopted conceptual management objectives (Res. 18-03) | - SCRS conducted joint meeting on BFT/SWO MSE<br>- SCRS contracted MSE technical expert to develop OM framework, define initial set of OMs, and conduct initial conditioning of OMs<br>- SWGSM considered qualitative management objectives | - SCRS contracted with technical experts: start development of MSE framework (phase I)<br>- SCRS conducted bigeye tuna stock assessment<br>[…] |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2019** | - SCRS addressed recommendations of the peer reviewer<br>- SCRS updated performance of the interim HCR and variants<br>[…]<br>[…]<br>- SCRS produced consolidated report on MSE<br>1. COMM: PA2 considered possible approaches that could be useful in developing guidance on a range of appropriate management responses if exceptional circumstances occur, including those implemented by other RFMOs | - SCRS held three BFT MSE Technical Group meetings with significant progress but advised at least one additional year of work needed<br>[…]<br>[…]<br>[…]<br>- SCRS continued to evaluate candidate MPs<br>- At intersessional meeting, PA2 reviewed and developed initial operational management objectives and identified performance indicators<br>[…]<br>- SCRS held December webinar to review OM progress<br><br>COMM: PA2 reviewed MSE progress and advised the Commission on next steps, including the need for an update of the stock assessment to provide TAC advice for at least 2021 | - SWO Species Group meeting<br>- SCRS contracted with technical expert to develop initial MSE framework<br>[…]<br>[…]<br>[…]<br><br>- Commission adopted conceptual management objectives at the Annual Meeting (Res. 19-14) | - SCRS conducted yellowfin tuna stock assessment<br>- SCRS agreed on developing a western skipjack (WSKJ) MSE and a multi-stock MSE (eastern skipjack, bigeye and yellowfin tuna)<br><br>Commission updated MSE roadmap for the period 2019-2024[2] and requests that the SCRS "*refines 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."* (Rec. 19-02) |
| **2020** | 1. COMM (PA2) developed guidance intersessionally on a range of appropriate management responses should exceptional circumstances be found to occur (5-6 March, PA2 intersessional) | 1. SCRS conducted stock assessment update and developed TAC advice for 2021 and 2022<br>[…]<br>[…]<br>[…] | 1. SCRS continued development of MSE framework, including the operating model conditioning and refinement of the uncertainty grid<br>[…]<br>[…]<br>[…] | COVID slowed progress on multi-stock MSE but SCRS developed a preliminary OM for WSKJ MSE.<br>[…]<br>[…]<br>[…] |

[2] https://iccat.int/mse/en/COM_ROADMAP_ICCAT_MSE_PROCESS_ENG.pdf

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2020** | 2. SCRS conducted NALB stock assessment (in June) | 2. COMM set TACs for at least 2021, based on stock assessment update, at the Annual Meeting (Rec. 20-06, Rec. 20-07). | 2. SCRS developed example candidate MPs | |
| | 3. SCRS evaluated existence of exceptional circumstances | 3. SCRS continued development of MSE framework including the operating model conditioning and the uncertainty grid | | |
| | […] | […] | | |
| | 4. COMM set new TAC for 2021 based on the HCR and 2020 assessment (Rec. 20-04) | […] | | |
| | | […] | | |
| **2021** | 1. SCRS prepared inputs for a new MSE framework using the Stock Synthesis (SS) model | 1. SCRS adopted reference grid and decided plausibility weighting | 1. SCRS continued development and testing of candidate MPs. SCRS continued work on the OM grid, including diagnostics | […]<br>[…]<br>1. Commission to review and provide feedback on:<br>- management objectives and performance indicators to be used for tropical tunas MSE<br>- proposed update of tropical tuna MSE roadmap |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2021** | 2. SCRS evaluated existence of exceptional circumstances | 2. SCRS initiated independent peer review of MSE code | 2. SCRS to continue work on criteria for determining exceptional circumstances and will be informed by the exceptional circumstances protocol developed by Panel 2 for northern albacore | 2. SCRS agreed on major sources of uncertainty to be considered in the MSE and candidate performance indicators for tropical tuna MSEs |
| | 3.COMM (PA2) met intersessionally to review interim HCR and recommend MP to the Commission for possible adoption at the Annual Meeting (4-5 March, PA2 intersessional) | 3. SCRS to continue development and testing of candidate MPs | 3. SCRS initiated independent peer review of MSE code | 3. SCRS conducted bigeye stock assessment |
| | 4. COMM to:<br>a. review and endorse guidance developed intersessionally on management responses in the case of exceptional circumstances<br>b. review the interim HCR and adopt a long-term MP, including the TAC, at the Annual Meeting | 4. SCRS/BFT SG initiated two additional subgroups on Indices and Modeling to address key issues. Subgroup on Growth in Farms continued its work | 4. COMM (SWGSM/PA4) to recommend initial operational management objectives and identify performance indicators either intersessionally or during the Annual Meeting | 4. SCRS recommended modifying OM for WSKJ to include the whole of the western Atlantic |
| | | 5. COMM (PA2) – Intersessional Meetings. Dialogue with Chair on MSE progress (March, September), initiate Ambassadors workshops in October | 5. COMM (SWGSM/PA4) to review MSE progress, example candidate MP results, and provide feedback to the SCRS, either intersessionally or during the Annual meeting | 5. JCAP/ICCAT Training workshops on MSE and HCR for Portuguese and Spanish speaking scientists and managers |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2021** | | 6. COMM review candidate MPs at the Annual Meeting (1-day prior). Dialogue with PA2 on CMPs, operational management objectives and performance indicators. Preliminary results of candidate MPs and tangible performance statistics values to be presented to show trade-offs. | 6. The Group will provide an update on the progress of the MSE to the Commission/PA4 | |
| | | […] | […] | |
| | | […] | | |
| **2022** | 1. SCRS to initiate independent peer review of MSE process | | | |
| | 2. SCRS to develop a new reference case using the SS model for Northern ALB | 2. COMM (SWGSM/PA2) intersessionally to:<br>- recommend final operational management objectives and identify performance indicators<br>- develop guidance on range of appropriate management responses should exceptional circumstances be found to occur<br>[…]<br>[…]<br>[…] | 2. SCRS to conduct stock assessment (North and South Atlantic)<br>[…]<br>[…]<br>[…] | 2. SCRS conducts skipjack stock assessments |
| | 3. SCRS to evaluate existence of exceptional circumstances | 3. SCRS to conduct data preparatory meeting for EBFT (based on work conducted by subgroups on models and indices) | 3. SCRS to recondition OMs considering new information from the stock assessment and finalize OM grid | 3. SCRS reconditions OMs for SKJ in WSKJ MSE model and ESKJ in mixed species MSE model in light of new SKJ assessments |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2022** | | 4. SCRS to complete MSE, incorporating feedback from Commission through PA2/SWGSM | 4. SCRS to continue work on criteria for determining exceptional circumstances and will be informed by the exceptional circumstances protocol developed by Panel 2 for northern albacore | 4. SCRS initiates development and testing of candidate Management procedures (CMP) for western SKJ |
| | | 5. COMM (SWGSM/PA2) and SCRS to present final CMPs for review. | 5. SCRS dialogue with SWGSM/PA4 on CMPs, operational management objectives and performance indicators | […]<br>[…]<br>5. The Commission (or Panel 1 intersessional or SWGSM) will provide feedback on evaluation criteria and WSKJ CMPs to be evaluated further |
| | | 6. COMM to:<br>a. review and endorse guidance developed intersessionally on management responses in the case of exceptional circumstances, and<br>b. adopt a MP at the Annual Meeting, including TAC | 6. COMM (SWGSM/PA4) and the SCRS to:<br>- refine CMP(s)<br>- recommend final operational management objectives and identify performance indicators<br>(2022 COMM meeting) | 6. Independent review of tropical tuna MSE process and technical review of Western SKJ MSE |
| | | 7. SCRS to continue work on criteria for determining exceptional circumstances and will be informed by the Exceptional Circumstances Protocol developed by Panel 2 for northern albacore | | |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2023*** | 1. Once an MP is adopted, SCRS to conduct assessments to ensure that the conditions considered in MP testing are still applicable to the stock. The first benchmark assessment is scheduled for 2023, where a SS reference case as well as a grid of reference and robustness OMs is to be adopted after reconsidering the main axes of uncertainty. | 1. Once an MP is adopted, SCRS to conduct assessments to ensure that the conditions considered in MP testing are still applicable to the stock | 1. SCRS to continue MSE, incorporating feedback from Commission through PA4/SWGSM | 1. SCRS to conduct yellowfin assessment |
| | 2. SCRS to evaluate existence of exceptional circumstances<br>[…]<br>[…] | 2. SCRS to provide final advice to the Commission on criteria for determining exceptional circumstances | 2. COMM to:<br>a) review candidate MPs intersessionally. Dialogue with PA4 on CMPs, operational management objectives and performance indicators. At this point the SCRS should have 2-3 candidate MPs and tangible performance statistics values to show trade-offs.<br>b) adopt an interim MP at the Annual Meeting, including the TAC | 2. Commission considers final evaluation of WSKJ MPs and adopts an interim WSKJ MP at the Annual Meeting |
| | 3. COMM to continue use of the MP to set TAC at the Annual Meeting, on the predetermined timescale for MP setting | 3. On the predetermined timescale for MP setting, SCRS to evaluate existence of exceptional circumstances | 3. COMM to review and finalize an exceptional circumstances protocol | 3. Independent technical review of multi-stock MSE |
| | | 4. COMM to continue use of the MP to set TAC based on the MP at the Annual Meeting, on the predetermined timescale for MP setting | | |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2024 *** | 1. SCRS to improve Observation Error Model by incorporating statistical properties of CPUE residuals | | 1. COMM to review and finalize, as needed, guidance on a range of appropriate management responses should exceptional circumstances be found to occur.<br>[…]<br>[…]<br>[…] | 1. SCRS tests final set of MP candidates for multi-stock MSE |
| | 2. SCRS to test the available (i.e. production model) and alternative candidate MPs (e.g. based on Jabba, or empirical) | | | 2. SCRS provides advice on exceptional circumstances for the implementation of the MP |
| | 3. SCRS to evaluate existence of exceptional circumstances | | | 3. Commission considers final evaluation of MPs for multi-stock MSE |
| | | | | 4. Oct -Dec Final delivery of multi stock MSE, including fully conditioned operating models and candidate management procedures to Commission |
| | | | | 5. Commission to:<br><br>a) review and endorse guidance on management responses in the case of exceptional circumstances, and<br>b) considers adopting interim MP(s) for BET, YFT and eastern SKJ |

| | *Northern Albacore* | *Bluefin Tuna* | *Northern Swordfish* | *Tropical Tunas* |
|---|---|---|---|---|
| **2025 and beyond*** | 1. According to the frequency outlined in the exceptional circumstances protocol, SCRS to evaluate existence of exceptional circumstances | 1. According to the frequency outlined in the exceptional circumstances protocol, SCRS to evaluate existence of exceptional circumstances | 1. SCRS to conduct assessments as per the agreed-to assessment interval to ensure that the conditions considered in MP testing are still applicable to the stock | 1. Once an MP is adopted, SCRS to conduct periodic assessments to ensure that the conditions considered in MP testing are still applicable to the stock |
| | 2. Commission to continue use of the MP to set management measures on the predetermined timescale defined in the MP setting | 2. Commission to continue use of the MP to set TAC based on the MP at the Annual Meeting, on the predetermined timescale for MP setting | 2. On the predetermined timescale, SCRS to evaluate existence of exceptional circumstances | 2. On the predetermined timescale for MP setting, SCRS to evaluate existence of exceptional circumstances |
| | 3. SCRS to conduct periodic assessments to ensure that the conditions considered in MP testing are still applicable to the stock | 3. Once an MP is adopted, SCRS to conduct assessments to ensure that the conditions considered in MP testing are still applicable to the stock | 3. COMM to continue setting TAC based on the MP at the Annual Meeting, on the predetermined timescale for MP setting | 3. Commission to continue use of the MP to set management measures on the predetermined timescale defined in the 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
**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**

## List of Statistical and Tagging Correspondents by Country

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| STAT Correspondent | Albania | Mr. Arian Palluqi | Arian.Palluqi@bujqesia.gov.al |
| STAT Correspondent | Algerie | Mme. Assia Kouadri-Krim | assia.kouadri@mpeche.gov.dz; assiakrim63@gmail.com |
| STAT Correspondent | Algerie | Mme. Sarah Cheniti | sarah.cheniti@mpeche.gov.dz |
| STAT Correspondent | Barbados | Mr. Christopher Parker | christopher.parker@barbados.gov.bb |
| STAT Correspondent | Barbados | Mrs. Joyce Leslie | joyce.leslie@barbados.gov.bb; Fisheries.Division@barbados.gov.bb |
| STAT Correspondent | Belize | Mrs. Delice Pinkard | delice.pinkard@bhsfu.gov.bz; sr.fishofficer@bhsfu.gov.bz |
| STAT Correspondent | Belize | Mrs. Valarie Lanza | valerie.lanza@bhsfu.gov.bz; director@bhsfu.gov.bz |
| STAT Correspondent | Brazil | Mr. Bruno Leite Mourato | bruno.mourato@unifesp.br; bruno.pesca@gmail.com; mourato.br@gmail.com |
| STAT Correspondent | Brazil | Mr. Carlos Eduardo Olynto de Arruda Villaça | carlos.villaca@agricultura.gov.br |
| STAT Correspondent | Brazil | Ms. Thaiz Figueiredo de Oliveira Reis | thaiz.figueiredo@agricultura.gov.br |
| STAT Correspondent | Cabo Verde | D. Carlos Alberto Monteiro | monteiro.carlos@indp.gov.cv; monteiro.carlos@imar.gov.cv |
| STAT Correspondent | Canada | Mr. Alexander Dalton | alexander.dalton@dfo-mpo.gc.ca |
| STAT Correspondent | Canada | Mr. Alexander Hanke | alex.hanke@dfo-mpo.gc.ca |
| STAT Correspondent | China P.R. | GENERAL - CHINA | admin1@tuna.org.cn |
| STAT Correspondent | China P.R. | Mr. Haiwen Sun | bofdwf@126.com |
| STAT Correspondent | Curaçao | Mr. Stephen A. Mambi | stephenmambi@yahoo.com; stephen.mambi@gobiernu.cw |
| STAT Correspondent | Egypt | Mr. Ahmed Salem | ahmedsalem.gafrd@gmail.com; Information@gafrd.org |
| STAT Correspondent | El Salvador | Licenciado Francisco Saca | francisco.saca@mag.gob.sv |
| STAT Correspondent | European Union | D. Antonio Lizcano Palomares | alizcano@mapa.es; orgmulpm@mapama.es |
| STAT Correspondent | European Union | D. Enrique Rodríguez-Marín | enrique.rmarin@ieo.es |
| STAT Correspondent | European Union | D. Jose Ramón Fernández Costa | jose.costa@ieo.es |
| STAT Correspondent | European Union | D. Luís Costa | luis.fm.costa@azores.gov.pt; info.drp@azores.gov.pt |
| STAT Correspondent | European Union | D. Pedro José Pascual Alayón | pedro.pascual@ieo.es |
| STAT Correspondent | European Union | Dña, Elena Consuegra Alcalde | econsuegra@mapa.es |
| STAT Correspondent | European Union | Dña. Victoria Ortiz de Zárate Vidal | victoria.zarate@ieo.es |
| STAT Correspondent | European Union | Dott. Corrado Piccinetti | corrado.piccinetti@unibo.it |
| STAT Correspondent | European Union | Dr. Daniel Gaertner | daniel.gaertner@ird.fr |
| STAT Correspondent | European Union | Dra. Lidia Ferreira de Gouveia | lidia.gouveia@madeira.gov.pt |
| STAT Correspondent | European Union | M. Philippe Sabarros | philippe.sabarros@ird.fr |
| STAT Correspondent | European Union | M. Laurent Floch | laurent.floch@ird.fr |
| STAT Correspondent | European Union | Mr. Brian MacKenzie | brm@aqua.dtu.dk |
| STAT Correspondent | European Union | Mr. Evgeny V. Romanov | evgeny.romanov@citeb.re |
| STAT Correspondent | European Union | Mr. Fabio Conte | f.conte@politicheagricole.it |
| STAT Correspondent | European Union | Mr. George Tserpes | gtserpes@hcmr.gr |
| STAT Correspondent | European Union | Mr. Imanuel Jeske | Imanuel.Jeske@ble.de |
| STAT Correspondent | European Union | Mr. João Gil Pereira | joao.ag.pereira@uac.pt |
| STAT Correspondent | European Union | Mr. Kostas Koutsis | kkoutsis@minagric.gr |
| STAT Correspondent | European Union | Mr. Lauri Vaarja | |

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| STAT Correspondent | European Union | Mr. Leon Grubisic | leon@izor.hr |
| STAT Correspondent | European Union | Mr. Mark Gatt | mark.gatt@gov.mt |
| STAT Correspondent | European Union | Mr. Pedro Gil Lino | plino@ipma.pt |
| STAT Correspondent | European Union | Mr. Peter Jørgen Eliasen | pejoel@mfvm.dk |
| STAT Correspondent | European Union | Mr. Rosen Vladev | r.vladev@iara.government.bg |
| STAT Correspondent | European Union | Mr. Rui Coelho | rpcoelho@ipma.pt |
| STAT Correspondent | European Union | Mrs. Conor O'Shea | conor.oshea@sfpa.ie |
| STAT Correspondent | European Union | Mrs. Savvas Kafouris | skafouris@dfmr.moa.gov.cy; skafouris80@gmail.com |
| STAT Correspondent | European Union | Mrs. Susan Coughlan | susan.coughlan@sfpa.ie |
| STAT Correspondent | European Union | Mrs. Vlasta Franicevic | vlasta.franicevic@mps.hr |
| STAT Correspondent | European Union | Ms. Elsemieke Rackwitsz | elsemieke.rackwitsz@rvo.nl |
| STAT Correspondent | European Union | Ms. Ilze Rutkovska | ilze.rutkovska@zm.gov.lv |
| STAT Correspondent | European Union | Ms. Irina Jakovleva | irina.jakovleva@zuv.lt |
| STAT Correspondent | European Union | Ms. Isabel Valentim | ivalentim@dgrm.mm.gov.pt; estat@dgrm.mm.gov.pt |
| STAT Correspondent | European Union | Ms. María Fernanda Luz Guia | |
| STAT Correspondent | European Union | Ms. Marjoleine Karper | marjoleine.karper@rvo.nl |
| STAT Correspondent | European Union | Ms. Sarah Borg | sarah.c.borg@gov.mt |
| STAT Correspondent | European Union | Ms. Veerle Plug | veerle.plug@rvo.nl |
| STAT Correspondent | European Union | Norbert Billet | norbert.billet@ifremer.fr |
| STAT Correspondent | European Union | Pascal Bach | pascal.bach@ird.fr |
| STAT Correspondent | European Union | Prof. Lidia Orsi Relini | largepel@unige.it |
| STAT Correspondent | European Union | Sra. Teresa Molina Schmid | tmolina@mapa.es |
| STAT Correspondent | European Union | UE-GENERAL | MARE-B2@ec.europa.eu |
| STAT Correspondent | European Union | UE-GENERAL | MARE-B2@ec.europa.eu |
| STAT Correspondent | European Union | UE-GENERAL | MARE-B2@ec.europa.eu |
| STAT Correspondent | European Union | UE-GENERAL | MARE-RFMO@ec.europa.eu |
| STAT Correspondent | Gambia | Mr. Momodou Sidibeh | mbailo85@hotmail.com |
| STAT Correspondent | Ghana | Mr. Paul Bannerman | paulbann@hotmail.com |
| STAT Correspondent | Ghana | Mrs. Sylvia Sefakor Awo Ayivi | asmasus@yahoo.com |
| STAT Correspondent | Grenada | Mr. Orlando Harvey | landokeri@yahoo.com |
| STAT Correspondent | Grenada | The Hon. Yolande Bain Horsford | pmoffice@gov.gd; foreignaffairs@gov.gd; agriculture@gov.gd |
| STAT Correspondent | Guatemala | D. Freddy Alejandro Góngora Benítez | freddy.gongora@gmail.com; dipescaguatemala@gmail.com |
| STAT Correspondent | Guatemala | Dña. Nancy Yesenia Sandoval Reyes | nsdipescagt@gmail.com; yesis81@hotmail.com;dipescaguatemala@gmail.com |
| STAT Correspondent | Guatemala | Ing. Carlos Francisco Marín Arriola | cfmarin1058@gmail.com; dipescaguatemala@gmail.com; visardespacho@gmail.com |
| STAT Correspondent | Guatemala | Licda. Rachel Rodas | mariarodasdpca.dipesca@gmail.com |
| STAT Correspondent | Guinea Bissau | Josepha Gomes Pinto | josephapinto@hotmail.com |
| STAT Correspondent | Guinea Ecuatorial | D. Andrés Ndong Micha | andresndongmicha@yahoo.es; sonapesca.sa@gmail.com |
| STAT Correspondent | Guinea Ecuatorial | D. Lorenzo Asumu Ndong | lorenzoasumu2013@gmail.com |
| STAT Correspondent | Guinea Ecuatorial | D. Pergentino Owono Nzamio Nzene | opergentino@yahoo.com |
| STAT Correspondent | Guinea Ecuatorial | D. Ruben Dario Nso Edo Abegue | granmaestrozaiko@yahoo.es |
| STAT Correspondent | Guinea Rep. | M. Amara Camara Kaba | amaragbe1@yahoo.fr; dnpmguinee2000@gmail.com |
| STAT Correspondent | Honduras | Ingeniero Cesar Alberto Fortín Carvajal | cesarfortindigepesca@gmail.com |
| STAT Correspondent | Iceland | Mr. Kristján Freyr Helgason | kristjanf@anr.is |

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| STAT Correspondent | Japan | Mr. Koji Uosaki | uosaki@affrc.go.jp |
| STAT Correspondent | Korea Rep. | Mr. Sung Il Lee | k.sungillee@gmail.com; k.sungillee@korea.kr |
| STAT Correspondent | Liberia | Mr. Alvin Slewion Jueseah | alvinjueseah@yahoo.com |
| STAT Correspondent | Libya | Dr. Hasan F. Gafri | gafrihasan@gmail.com; abdusalam.zbida@gmail.com |
| STAT Correspondent | Libya | Excmo. Sr. | secretaria@embajadadelibia.com; embajada@embajadadelibia.com; asuntosadministrativos@embajadadelibia.com |
| STAT Correspondent | Maroc | M. Bouchta Aichane | aichane@mpm.gov.ma |
| STAT Correspondent | Maroc | M. Hicham Grichat | grichat@mpm.gov.ma |
| STAT Correspondent | Maroc | M. Khalil Najem | najem@mpm.gov.ma |
| STAT Correspondent | Maroc | M. Noureddine Abid | noureddine.abid65@gmail.com |
| STAT Correspondent | Maroc | Mme. Bouchra Haoujar | haoujar@mpm.gov.ma |
| STAT Correspondent | Maroc | Mme. Fatima Zohra Hassouni | hassouni@mpm.gov.ma |
| STAT Correspondent | Mauritania | Dr. Cheikh Baye Braham | baye_braham@yahoo.fr; baye.braham@gmail.com |
| STAT Correspondent | Mexico | Dña. Isabel Cristina Reyes Robles | isabel.reyes@conapesca.gob.mx |
| STAT Correspondent | Mexico | Dña. Karina Ramírez López | kramirez_inp@yahoo.com |
| STAT Correspondent | Mexico | Dr. Ramón Isaac Rojas González | ramon.rojas@inapesca.gob.mx |
| STAT Correspondent | Namibia | Mr. Titus Iilende | titus.iilende@mfmr.gov.na |
| STAT Correspondent | Namibia | Ms. Taimi Shikongo | Taimi.Shikongo@mfmr.gov.na; tiemeshix@gmail.com |
| STAT Correspondent | Nicaragua | D. Miguel Angel Marenco Urcuyo | lobodemar59@gmail.com |
| STAT Correspondent | Nicaragua | Lic. Edward Jackson | ejackson@inpesca.gob.ni |
| STAT Correspondent | Nigeria | Mr. B.C. Udeh | avamire@hotmail.com |
| STAT Correspondent | Norway | Rune Mjorlund | rune.mjorlund@fiskeridir.no |
| STAT Correspondent | Panama | D. Raúl Alberto Delgado Quezada | rdelgado@arap.gob.pa; hsfs@arap.gob.pa; vms@arap.gob.pa |
| STAT Correspondent | Philippines | Mr. Benjamin F.S. Jr Tabios | tabios.bfar@yahoo.com.ph; btabios@bfar.da.gov.ph |
| STAT Correspondent | Philippines | Mr. Malcolm I. Sarmiento | |
| STAT Correspondent | Russian Federation | Atlantic branch of VNIRO ("AtlantNIRO") | atlantniro@vniro.ru |
| STAT Correspondent | S. Tomé e Príncipe | D. Graciano Do Espirito Costa | costaesprito7@yahoo.com.br |
| STAT Correspondent | S. Tomé e Príncipe | Dña. Aida Maria D'Almeida | aidadalmeida@yahoo.com.br |
| STAT Correspondent | S. Tomé e Príncipe | M. José Dias de Sousa Lopes | josediaslopes@yahoo.com |
| STAT Correspondent | Senegal | M. Mamadou Sèye | mdseye@gmail.com; mdseye1@gmail.com; mdouseye@yahoo.fr |
| STAT Correspondent | Senegal | M. Sidi Ndaw | sidindaw@hotmail.com; dopm@orange.sn |
| STAT Correspondent | Senegal | Mme. Fambaye Ngom Sow | ngomfambaye2015@gmail.com; famngom@yahoo.com |
| STAT Correspondent | Sierra Leone | Mr. Josephus C. J. Mamie | josephusmamie2013@gmail.com |
| STAT Correspondent | South Africa | Mrs. Melissa Goosen Meyer | melissag@daff.gov.za; mel.goosen@gmail.com |
| STAT Correspondent | St. Vincent and Grenadines | Mr. Leslie Straker | office.agriculture@mail.gov.vc |
| STAT Correspondent | St. Vincent and Grenadines | Mr. Nathaniel Williams | fishdiv@gov.vc; nwilliams@gov.vc; office.agriculture@mail.gov.vc |
| STAT Correspondent | St. Vincent and Grenadines | Ms. Nerissa Gittens | office.agriculture@mail.gov.vc |
| STAT Correspondent | Syrian Arab Republic | Dr. Abdel Latif Ali | eng.abdollateef@hotmail.com |
| STAT Correspondent | Trinidad & Tobago | Mrs. Louanna Martin | lmartin@fp.gov.tt; louannamartin@gmail.com |
| STAT Correspondent | Tunisie | Mme Donia Sohlobji | doniasohlobji1@gmail.com; bft@iresa.agrinet.tn |
| STAT Correspondent | Turkey | Dr. Ercan Erdem | ercan.erdem@tarimorman.gov.tr |
| STAT Correspondent | Turkey | Mr. Erdinç Günes | erdincgunes67@gmail.com |

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| STAT Correspondent | Turkey | Mr. Hasan Alper Elekon | hasanalper.elekon@tarimorman.gov.tr; hasanalper@gmail.com |
| STAT Correspondent | Turkey | Mr. Turgay Türkyilmaz | turgay.turkyilmaz@tarimorman.gov.tr |
| STAT Correspondent | Turkey | Mr. Ugur Özer | ugur.ozer@tarimorman.gov.tr |
| STAT Correspondent | Turkey | Ms. Burcu Bilgin Topçu | burcu.bilgin@tarimorman.gov.tr; bilginburcu@gmail.com |
| STAT Correspondent | U.K. | Dr. Tammy M. Warren | twarren@gov.bm |
| STAT Correspondent | U.K. | Mr. Callum Etridge | Callum.Etridge@marinemanagement.org.uk |
| STAT Correspondent | U.K. | Mr. Gerald Carl Benjamin | gerald.benjamin@sainthelena.gov.sh |
| STAT Correspondent | U.K. | Mr. Luc Clerveaux | LCLERVEAUX@gov.tc; lclerveaux@gmail.com |
| STAT Correspondent | U.K. | Mr. Matt Elliot | matt.elliott@marinemanagement.org.uk |
| STAT Correspondent | U.K. | Mr. Stuart Reeves | stuart.reeves@cefas.co.uk |
| STAT Correspondent | U.K. | Ms. Serena Wright | serena.wright@cefas.co.uk |
| STAT Correspondent | United States | Dr. Craig A. Brown | craig.brown@noaa.gov |
| STAT Correspondent | United States | Dr. Guillermo Díaz | guillermo.diaz@noaa.gov |
| STAT Correspondent | Uruguay | D. Andrés Domingo | dimanchester@gmail.com |
| STAT Correspondent | Venezuela | Sra. Eucaris del Carmen Evaristo | eucarisevaristo@gmail.com |
| STAT Correspondent | Bolivia | Sr. Contra Almte. Gonzalo Víctor Vigabriel Sánchez | intermar@mindef.gob.bo |
| STAT Correspondent | Chinese Taipei | Mr. Chien-Chung Hsu | hsucc@ntu.edu.tw |
| STAT Correspondent | Chinese Taipei | Mr. Ching-Chao Lee | chinchao@ms1.fa.gov.tw; chaolee1218@gmail.com |
| STAT Correspondent | Chinese Taipei | Mr. Ding-Rong Lin | dingrong@ms1.fa.gov.tw; lindingrong@gmail.com |
| STAT Correspondent | Chinese Taipei | Mr. Shan-Wen Yang | shenwen@ofdc.org.tw |
| STAT Correspondent | Chinese Taipei | Mr. Shih-Chin Chou | shihcin@ms1.fa.gov.tw; chou1967sc@gmail.com |
| STAT Correspondent | Chinese Taipei | Mr. Tsung Wen Lan | tsungwen@ms1.fa.gov.tw |
| STAT Correspondent | Chinese Taipei | Ms. Dorine Dung Chu Wei | dungchu@ms1.fa.gov.tw |
| STAT Correspondent | Chinese Taipei | Ms. Tsui-Feng Tracy Hsia | tracy@ofdc.org.tw |
| STAT Correspondent | CARICOM | Dr. Maren Headley | maren.headley@crfm.int; secretariat@crfm.int; crfmsvg@crfm.int |
| STAT Correspondent | Antigua and Barbuda | Mr. Joseph Daven | dcblack11@yahoo.com |
| STAT Correspondent | Benin | M. | agriculture@gouv.bj |
| STAT Correspondent | Benin | M. Jean Baptiste Degbey | jbdegbey@yahoo.fr |
| STAT Correspondent | Congo Rep | M. Maurice Iwari | |
| STAT Correspondent | Ecuador | Excmo. Sr. Guillermo Alejandro Morán Velázquez | gamv6731@gmail.com |
| STAT Correspondent | Faroe Islands | Mr. Andras Kristiansen | andrask@fisk.fo; fisk@fisk.fo |
| STAT Correspondent | Faroe Islands | Mrs. Ulla S. Wang | ullaw@fisk.fo |
| STAT Correspondent | Georgia | Dr. Akaki Komakhidze | |
| STAT Correspondent | Israel | Mr. Oren Sonin | orens@moag.gov.il |
| STAT Correspondent | Lebanon | Mr. Samir Majdalani | |
| STAT Correspondent | PAKISTAN | Mr. Maratab Ali Awan | fdcofpakistan@gmail.com |
| STAT Correspondent | Seychelles | Mr. Roy Clarisse Serge | royclarisse@gmail.com; Sadvisor@gov.sc |
| STAT Correspondent | St. Kitts & Nevis | Mr. Dishon Heyliger | dishon.heyliger@dmrskn.com |
| STAT Correspondent | Vanuatu | Mr. Robert Jimmy | robert.jimmy@gmail.com |
| STAT Correspondent | Vanuatu | Mr. Wayne Tony Taleo | ttaleo@gmail.com; ttaleo@vanuatu.gov.vu |

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| TAG Correspondent | Albania | Mr. Arian Palluqi | Arian.Palluqi@bujqesia.gov.al |
| TAG Correspondent | Barbados | Mrs. Joyce Leslie | joyce.leslie@barbados.gov.bb; Fisheries.Division@barbados.gov.bb |
| TAG Correspondent | Belize | Mrs. Delice Pinkard | delice.pinkard@bhsfu.gov.bz; sr.fishofficer@bhsfu.gov.bz |
| TAG Correspondent | Belize | Mrs. Valarie Lanza | valerie.lanza@bhsfu.gov.bz; director@bhsfu.gov.bz |
| TAG Correspondent | Brazil | Dr. Carlos Alberto Arfelli | arfelli@pesca.sp.gov.br |
| TAG Correspondent | Brazil | Mr. Alberto Ferreira de Amorim | prof.albertoamorim@gmail.com |
| TAG Correspondent | Brazil | Mr. Carlos Eduardo Olynto de Arruda Villaça | carlos.villaca@agricultura.gov.br |
| TAG Correspondent | Brazil | Mr. Paulo Eurico Travassos | pautrax@hotmail.com; paulo.travassos@ufrpe.br |
| TAG Correspondent | Cabo Verde | D. Carlos Alberto Monteiro | monteiro.carlos@indp.gov.cv; monteiro.carlos@imar.gov.cv |
| TAG Correspondent | Canada | Mr. Alexander Dalton | alexander.dalton@dfo-mpo.gc.ca |
| TAG Correspondent | Canada | Mr. Alexander Hanke | alex.hanke@dfo-mpo.gc.ca |
| TAG Correspondent | Canada | Mr. Mark Waddell | mark.waddell@dfo-mpo.gc.ca |
| TAG Correspondent | China P.R. | GENERAL - CHINA | admin1@tuna.org.cn |
| TAG Correspondent | China P.R. | Mr. Haiwen Sun | bofdwf@126.com |
| TAG Correspondent | Curaçao | Mr. Stephen A. Mambi | stephenmambi@yahoo.com; stephen.mambi@gobiernu.cw |
| TAG Correspondent | Egypt | Eng. Serag Eldien Abdel Hafiz | gafrd.egypt@gmail.com; Information@gafrd.org |
| TAG Correspondent | El Salvador | Licenciado Francisco Saca | francisco.saca@mag.gob.sv |
| TAG Correspondent | European Union | D. Enrique Rodríguez-Marín | enrique.rmarin@ieo.es |
| TAG Correspondent | European Union | D. Haritz Arrizabalaga | harri@azti.es |
| TAG Correspondent | European Union | D. Luís Costa | luis.fm.costa@azores.gov.pt; info.drp@azores.gov.pt |
| TAG Correspondent | European Union | D. Pedro José Pascual Alayón | pedro.pascual@ieo.es |
| TAG Correspondent | European Union | Dña. Victoria Ortiz de Zárate Vidal | victoria.zarate@ieo.es |
| TAG Correspondent | European Union | Dott. Corrado Piccinetti | corrado.piccinetti@unibo.it |
| TAG Correspondent | European Union | Dr. Daniel Gaertner | daniel.gaertner@ird.fr |
| TAG Correspondent | European Union | Dr. Jaime Mejuto García | jaime.mejuto@ieo.es |
| TAG Correspondent | European Union | Dra. Lidia Ferreira de Gouveia | lidia.gouveia@madeira.gov.pt |
| TAG Correspondent | European Union | Mr. Brian MacKenzie | brm@aqua.dtu.dk |
| TAG Correspondent | European Union | Mr. George Tserpes | gtserpes@hcmr.gr |
| TAG Correspondent | European Union | Mr. Imanuel Jeske | Imanuel.Jeske@ble.de |
| TAG Correspondent | European Union | Mr. João Gil Pereira | joao.ag.pereira@uac.pt |
| TAG Correspondent | European Union | Mr. Kostas Koutsis | kkoutsis@minagric.gr |
| TAG Correspondent | European Union | Mr. Mark Gatt | mark.gatt@gov.mt |
| TAG Correspondent | European Union | Mr. Pedro Gil Lino | plino@ipma.pt |
| TAG Correspondent | European Union | Mr. Peter Jørgen Eliasen | pejoel@mfvm.dk |
| TAG Correspondent | European Union | Mr. Ronan Cosgrove | cosgrove@bim.ie |
| TAG Correspondent | European Union | Mr. Rui Coelho | rpcoelho@ipma.pt |
| TAG Correspondent | European Union | Mr. Vassilis Papadopoulos | vpapadopoulos@dfmr.moa.gov.cy |
| TAG Correspondent | European Union | Mr. Vjekoslav Ticina | ticina@izor.hr |
| TAG Correspondent | European Union | Mrs. Panagiota (Nota) Peristeraki | notap@hcmr.gr |
| TAG Correspondent | European Union | Mrs. Vlasta Franicevic | vlasta.franicevic@mps.hr |
| TAG Correspondent | European Union | Ms. Elsemieke Rackwitsz | elsemieke.rackwitsz@rvo.nl |
| TAG Correspondent | European Union | Ms. Ilze Rutkovska | ilze.rutkovska@zm.gov.lv |
| TAG Correspondent | European Union | Ms. Irina Jakovleva | irina.jakovleva@zuv.lt |
| TAG Correspondent | European Union | Ms. Isabel Valentim | ivalentim@dgrm.mm.gov.pt; estat@dgrm.mm.gov.pt |

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| TAG Correspondent | European Union | Ms. Marjoleine Karper | marjoleine.karper@rvo.nl |
| TAG Correspondent | European Union | Ms. Sarah Borg | sarah.c.borg@gov.mt |
| TAG Correspondent | European Union | Ms. Veerle Plug | veerle.plug@rvo.nl |
| TAG Correspondent | European Union | Prof. Lidia Orsi Relini | largepel@unige.it |
| TAG Correspondent | European Union | UE-GENERAL | MARE-B2@ec.europa.eu |
| TAG Correspondent | European Union | UE-GENERAL | MARE-B2@ec.europa.eu |
| TAG Correspondent | European Union | UE-GENERAL | MARE-B2@ec.europa.eu |
| TAG Correspondent | European Union | UE-GENERAL | MARE-RFMO@ec.europa.eu |
| TAG Correspondent | Gambia | Mr. Malang Darboe | malang.darboe@gmail.com; malangdarboe@yahoo.co.uk |
| TAG Correspondent | Ghana | Mr. Paul Bannerman | paulbann@hotmail.com |
| TAG Correspondent | Ghana | Mrs. Sylvia Sefakor Awo Ayivi | asmasus@yahoo.com |
| TAG Correspondent | Grenada | Mr. Orlando Harvey | landokeri@yahoo.com |
| TAG Correspondent | Grenada | The Hon. Yolande Bain Horsford | pmoffice@gov.gd; foreignaffairs@gov.gd; agriculture@gov.gd |
| TAG Correspondent | Guatemala | D. Freddy Alejandro Góngora Benítez | freddy.gongora@gmail.com; dipescaguatemala@gmail.com |
| TAG Correspondent | Guatemala | Dña. Nancy Yesenia Sandoval Reyes | nsdipescagt@gmail.com; yesis81@hotmail.com;dipescaguatemala@gmail.com |
| TAG Correspondent | Guatemala | Ing. Carlos Francisco Marín Arriola | cfmarin1058@gmail.com; dipescaguatemala@gmail.com; visardespacho@gmail.com |
| TAG Correspondent | Guinea Bissau | Mário Abel Nbunde | nboma@hotmail.com |
| TAG Correspondent | Guinea Ecuatorial | D. Andrés Ndong Micha | andresndongmicha@yahoo.es; sonapesca.sa@gmail.com |
| TAG Correspondent | Guinea Ecuatorial | D. Lorenzo Asumu Ndong | lorenzoasumu2013@gmail.com |
| TAG Correspondent | Guinea Ecuatorial | D. Pergentino Owono Nzamio Nzene | opergentino@yahoo.com |
| TAG Correspondent | Guinea Ecuatorial | D. Ruben Dario Nso Edo Abegue | granmaestrozaiko@yahoo.es |
| TAG Correspondent | Guinea Rep. | Mr. Youssouf Hawa Camara | youssoufh@hotmail.com; youssoufh@yahoo.fr |
| TAG Correspondent | Honduras | Ingeniero Cesar Alberto Fortín Carvajal | cesarfortindigepesca@gmail.com |
| TAG Correspondent | Iceland | Mr. Kristján Freyr Helgason | kristjanf@anr.is |
| TAG Correspondent | Iceland | Mr. Thorsteinn Sigurdsson | steiniathafro@gmail.com |
| TAG Correspondent | Korea Rep. | Mr. Sung Il Lee | k.sungillee@gmail.com; k.sungillee@korea.kr |
| TAG Correspondent | Liberia | Mr. Alvin Slewion Jueseah | alvinjueseah@yahoo.com |
| TAG Correspondent | Libya | Dr. Hasan F. Gafri | gafrihasan@gmail.com; abdusalam.zbida@gmail.com |
| TAG Correspondent | Libya | Excmo. Sr. | secretaria@embajadadelibia.com; embajada@embajadadelibia.com; asuntosadministrativos@embajadadelibia.com |
| TAG Correspondent | Maroc | M. Noureddine Abid | noureddine.abid65@gmail.com |
| TAG Correspondent | Mauritania | M. Mohamed Elmoustapha Bouzouma | bouzouma@yahoo.fr |
| TAG Correspondent | Mexico | Dña. Isabel Cristina Reyes Robles | isabel.reyes@conapesca.gob.mx |
| TAG Correspondent | Mexico | Dña. Karina Ramírez López | kramirez_inp@yahoo.com |
| TAG Correspondent | Namibia | Ms. Taimi Shikongo | Taimi.Shikongo@mfmr.gov.na; tiemeshix@gmail.com |
| TAG Correspondent | Nicaragua | D. Miguel Angel Marenco Urcuyo | lobodemar59@gmail.com |
| TAG Correspondent | Nicaragua | Lic. Edward Jackson | ejackson@inpesca.gob.ni |
| TAG Correspondent | Nigeria | Mr. M.O. Oyebanji | samolayeni@yahoo.co.uk |
| TAG Correspondent | Norway | Mr. Leif Nottestad | leif.nottestad@hi.no |
| TAG Correspondent | Panama | D. Raúl Alberto Delgado Quezada | rdelgado@arap.gob.pa; hsfs@arap.gob.pa; vms@arap.gob.pa |
| TAG Correspondent | Philippines | Mr. Benjamin F.S. Jr Tabios | tabios.bfar@yahoo.com.ph; btabios@bfar.da.gov.ph |
| TAG Correspondent | Russian Federation | Atlantic branch of VNIRO ("AtlantNIRO") | atlantniro@vniro.ru |

| *Title* | *Parties* | *Name* | *Email* |
|---|---|---|---|
| TAG Correspondent | Russian Federation | Mr. Chernega Galina | oms@atlantniro.ru |
| TAG Correspondent | S. Tomé e Príncipe | D. Graciano Do Espirito Costa | costaesprito7@yahoo.com.br |
| TAG Correspondent | S. Tomé e Príncipe | Dña. Aida Maria D'Almeida | aidadalmeida@yahoo.com.br |
| TAG Correspondent | S. Tomé e Príncipe | M. José Dias de Sousa Lopes | josediaslopes@yahoo.com |
| TAG Correspondent | Senegal | Mme. Fambaye Ngom Sow | ngomfambaye2015@gmail.com; famngom@yahoo.com |
| TAG Correspondent | Sierra Leone | Mr. Josephus C. J. Mamie | josephusmamie2013@gmail.com |
| TAG Correspondent | South Africa | Dr. Denham Parker | DParker@environment.gov.za; DenhamP@DAFF.gov.za |
| TAG Correspondent | South Africa | Mr. Sven Kerwath | SKerwath@environment.gov.za; svenkerwath@gmail.com |
| TAG Correspondent | South Africa | Ms. Charlene Da Silva | Cdasilva@environment.gov.za |
| TAG Correspondent | Trinidad & Tobago | Mrs. Louanna Martin | lmartin@fp.gov.tt; louannamartin@gmail.com |
| TAG Correspondent | Tunisie | Mr. Rafik Zarrad | rafik.zarrad@gmail.com |
| TAG Correspondent | Turkey | Dr. Ercan Erdem | ercan.erdem@tarimorman.gov.tr |
| TAG Correspondent | Turkey | Mr. Erdinç Günes | erdincgunes67@gmail.com |
| TAG Correspondent | U.K. | Mr. David Righton | david.righton@cefas.co.uk |
| TAG Correspondent | U.K. | Mr. Stuart Reeves | stuart.reeves@cefas.co.uk |
| TAG Correspondent | United States | Mr. Eric Orbesen | eric.orbesen@noaa.gov |
| TAG Correspondent | United States | Mr. Derke Snodgrass | derke.snodgrass@noaa.gov |
| TAG Correspondent | Uruguay | D. Andrés Domingo | dimanchester@gmail.com |
| TAG Correspondent | Venezuela | Sra. Eucaris del Carmen Evaristo | eucarisevaristo@gmail.com |
| TAG Correspondent | Bolivia | Sr. Contra Almte. Gonzalo Víctor Vigabriel Sánchez | intermar@mindef.gob.bo |
| TAG Correspondent | Chinese Taipei | Mr. Shih-Chin Chou | shihcin@ms1.fa.gov.tw; chou1967sc@gmail.com |
| TAG Correspondent | Chinese Taipei | Mr. Tsung Wen Lan | tsungwen@ms1.fa.gov.tw |
| TAG Correspondent | Chinese Taipei | Ms. Dorine Dung Chu Wei | dungchu@ms1.fa.gov.tw |
| TAG Correspondent | CARICOM | Dr. Maren Headley | maren.headley@crfm.int; secretariat@crfm.int; crfmsvg@crfm.int |
| TAG Correspondent | PAKISTAN | Mr. Maratab Ali Awan | fdcofpakistan@gmail.com |
| TAG Correspondent | Vanuatu | Mr. Robert Jimmy | robert.jimmy@gmail.com |
| TAG Correspondent | Vanuatu | Mr. Wayne Tony Taleo | ttaleo@gmail.com; ttaleo@vanuatu.gov.vu |

**Appendix 17**

**Statement from Canada and the United States to the Plenary of the SCRS**

Canada and the United States expressed an objection to the process the SCRS used in 2021 to adopt its annual report, specifically re-iterating their objection to adopting executive summaries via correspondence without the ability to make modifications to text or figures at the plenary meeting (these objections were also made when a section of the annual report was distributed which included an executive summary for Mediterranean albacore). The SCRS Chair responded that due to limited time available in the online meeting format it was necessary to find efficiencies and have some material adopted by correspondence. Canada agreed that efficiencies were needed due to the difficult situation of conducting the annual meeting virtually and that the Chair, Officers of the SCRS, and the Secretariat had done a good job in finding many efficiencies in adopting some sections of the annual report via correspondence. However, the core text of the SCRS's annual advice (Executive Summaries and Responses to the Commission) are not areas that should have been adopted via correspondence. The process of adopting these sections via correspondence restricted the presentation of important information to the Committee on the important analysis and assessments conducted and the ensuing questions and answers which are used to help identify important changes the Committee might include as part of its advice. Canada suggested that if the SCRS online meeting requires more time, then it should clearly articulate this to the Commission and express the limitations of online meetings, rather than try to fit the SCRS plenary into the normal schedule of an in-person meeting. The United States supported the objection and added that it is particularly important that tables and figures associated with the management advice section should not be adopted by correspondence, even if changes are permitted in the management advice during the Plenary meeting, as the management advice and these tables and figures are linked.

**Appendix 18**

**List of Acronyms**

| | |
|---|---|
| ACPR | Associació Catalana per a una Pesca Responsible (Spain) |
| ADMB | Automatic Differentiation Model Builder |
| AIS | Artificial Intelligence Systems |
| ALB | Albacore (*Thunnus alalunga*) |
| ALB-MED | Mediterranean albacore |
| ALK | Age Length Key |
| ALR | Aquatic Living Resources |
| AMO | Atlantic Multidecadal Oscillation |
| AOTTP | Atlantic Ocean Tropical tuna Tagging Programme |
| ASAP | Age-structured Assessment Program |
| AZTI | Centro Tecnológico Experto en Innovación Marina y Alimentaria (Spain) |
| B | Biomass |
| BB | Baitboat |
| 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*) |
| BPUE | Bycatch per Unit Effort |
| BSH | Blue shark (*Prionace glauca*) |
| BUM | Blue marlin (*Makaira nigricans*) |
| CAA | Catch-at-age |
| CAS | Catch-at-size |
| CATDIS | Catch 5x5 distribution |
| CCSBT | Commission for the Conservation of Southern Bluefin Tuna |
| CEFAS | Centre for Environment Fisheries and Aquaculture Science (UK) |
| CI | Confidence Interval |
| CITES | Convention on International Trade of Endangered Species of Wild Fauna and Flora |
| CKMR | Close-Kin Mark-Recapture |
| CMG | Core Modelling Group (former MSE Technical Group) |
| CMM | Conservation and management measures |
| CMP | Candidate Management Procedure |
| CLJFL | Curved Lower Jaw Fork Length |
| COVID-19 | Coronavirus disease |
| 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) |
| CRODT | Centre de Recherche Océanographique de Dakar-Thiaroye (Senegal) |
| CUJFL | Curved Upper Jaw Fork Length |
| DB | Database |
| DFO | Fisheries and Oceans Canada |
| DG-MARE | Directorate-General for Maritime Affairs and Fisheries |
| DINARA | Dirección Nacional de Recursos Acuáticos (Uruguay) |
| DNA | Deoxyribonucleic acid |
| DPSIR | Drivers, pressures, state, impact and response model of intervention |
| DTU | National Institute of Aquatic Resources is an institute at the Technical University of Denmark |
| EAFM | Ecosystem Approach to Fisheries Management |
| EBCD | Electronic Bluefin tuna Catch Document |
| EBFM | Ecosystem Based Fisheries Management |
| EEZ | Exclusive Economic Zone |
| EFFDIS | Fishing effort 5x5 distribution |

| | |
|---|---|
| EM | Electronic Monitoring |
| EMS | Electronic Monitoring System |
| EPBR | Enhanced Programme for Billfish Research |
| ERAs | Ecological Risk Assessments |
| F | Fishing mortality |
| FAD | Fish Aggregating Devices |
| FAL | Silky shark (*Carcharhinus falciformis*) |
| FAO | Food and Agriculture Organization (United Nations) |
| FAS | Fish Ageing Services |
| FC | Fleet Characteristics |
| FHV | Fish Hold Volume |
| FL | Fork length |
| FOB | Floating object |
| FRI | Frigate tuna (*Auxis thazard*) |
| GBS | Genotyping-by-sequencing |
| GBYP | ICCAT Atlantic-Wide Bluefin Tuna Research Programme |
| GEF | Global Environment Facility (FAO Common Oceans/ABNJ Tuna Project) |
| GFCM | General Fisheries Commission for the Mediterranean |
| GIS | Geographic information system |
| HCRs | Harvest Control Rules |
| ICCAT | International Commission for the Conservation of Atlantic Tunas |
| ICES | International Council on the Exploration of the Sea |
| IEO | Instituto Español de Oceanografía |
| ILR | Interim Limit Reference |
| IMM | Working Group on Integrated Monitoring Measures |
| IMR | Institute of Marine Research (Norway) |
| IOMS | Integrated Online Management System |
| IOTC | Indian Ocean Tuna Commission |
| IPMA | Instituto Português do Mar e da Atmosfera (Portugal) |
| ISRA | Institut sénégalais de recherches agricoles (Senegal) |
| ISSF | International Seafood Sustainability Foundation |
| IUCN | International Union for Conservation of Nature |
| 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 |
| K2SM | Kobe II Strategy Matrix |
| LJFL | Lower Jaw Fork Length |
| LL | Longline |
| LLSIM | Longline simulator |
| LMA | Longfin mako shark (*Isurus paucus*) |
| LOA | Length Overall |
| LTA | Little tunny (*Euthynnus alletteratus*) |
| MI | Fisheries and Marine Institute of Memorial University of Newfoundland (Canada) |
| MIA | Marginal Increment Analysis |
| MiniPAT | Pop-up archival transmitting tag |
| MoU | Memorandum of Understanding |
| MP | Management Procedure |
| MPB | Biomass Production Model |
| MSE | Management Strategy Evaluation |
| MSY | Maximum Sustainable Yield |
| NC | Nominal Catches |
| NCC | Cooperating Non-Contracting Party, Entity or Fishing Entity |
| NGS | Next generation sequencing |
| NOAA | National Oceanic and Atmospheric Administration (US) |
| NOAA-NEFSC | National Oceanic and Atmospheric Administration Northeast Fisheries Science Center (US) |
| OCS | Oceanic whitetip shark (*Carcharhinus longimanus*) |
| OMs | Operating Models |

| | |
|---|---|
| POR | Porbeagle (*Lamna nasus*) |
| PS | Purse seine |
| PSAT | Pop-off Satellite Archival Tag |
| RAD-seq | Restriction site-associated DNA sequencing |
| RMA | Research Mortality Allowance |
| RMFO | Regional Management Fisheries Organization |
| RSP | Roundscale spearfish (*Tetrapturus georgii*) |
| RWT | Round weight |
| SAI | Sailfish |
| SC | Steering Committee |
| SCA | Statistical Catch-at-Age |
| SC-ECO | Subcommittee on Ecosystems and Bycatch |
| SCRS | Standing Committee on Research and Statistics |
| SC-STAT | Subcommittee on Statistics |
| SDM | Species Distribution Model |
| SFL | Straight fork length |
| SIMS | Secondary ion mass spectrometry |
| SKJ | Skipjack (*Katsuwonus pelamis*) |
| SLU | Swedish University of Agricultural Sciences (Sweden) |
| SMA | Shortfin mako |
| SMTYP | Small Tuna Year Programme |
| SNP | Single Nucleotide Polymorphism |
| sPAT | Survivorship Popup Satellite Archival Transmitting Tag |
| SPZ | Hammerhead shark (*Sphyrna zygaena)* |
| SRDCP | Shark Research and Data Collection Programme |
| SS | Stock Synthesis |
| SS3 | Stock Synthesis III |
| SSB | Spawning stock biomass |
| SSG | Sharks Species Group |
| SWGSM | Standing Working Group to Enhance Dialogue between Fisheries Scientists and Managers |
| TAC | Total Allowable Catch |
| ToRs | Terms of Reference |
| TSD | Trial Specification Document |
| TSG | Technical Subgroup |
| T1 | Task 1 |
| UJFL | Upper Jaw Fork Length |
| UNCLOS | United Nations Convention on the Law of the Sea |
| VPA | Virtual Population Analysis |
| WAH | Wahoo (*Acanthocybium solandri*) |
| WCPFC | Western Central Pacific Fisheries Commission |
| WECAFC | Western Central Atlantic Fishery Commission |
| WGSAM | Working Group on Stock Assessment Methods |
| WHM | White marlin (*Kajikia albida*) |
| WWF | World Wildlife Fund |
| YFT | Yellowfin (*Thunnus albacares*) |

**Appendix 19**

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