

**REPORT OF THE 2018 ICCAT SWORDFISH SPECIES GROUP MSE INTERSESSIONAL MEETING**  
(Madrid, Spain 16-20 April 2018)

## 1. Opening, adoption of Agenda and meeting arrangements

The meeting was held at the ICCAT Secretariat in Madrid, 16-20 April 2018. Dr. Rui Coelho (EU-Portugal), the Species Group (“the Group”) Coordinator and rapporteur for northern swordfish and meeting Chair, opened the meeting and welcomed participants. Dr. Miguel Neves dos Santos (Assistant Executive Secretary) addressed the Group on behalf of the ICCAT Executive Secretary, welcomed the participants and highlighted the importance of the meeting as a kick-off for the ICCAT Management Strategy Evaluation (MSE) regarding swordfish. The Chair proceeded to review the Agenda, which was adopted with minor changes (**Appendix 1**).

The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**. The abstracts of all SCRS documents presented at the meeting are included in **Appendix 4**. The following served as rapporteurs:

<i>Sections</i>	<i>Rapporteur</i>
Items 1 and 10	M. Neves dos Santos
Item 2	P. de Bruyn
Item 3	P. de Bruyn, M. Schirripa
Item 4	D. Die
Item 5	A. Hanke, R. Coelho, D. Rosa, M. Schirripa
Item 6	D. Die
Item 7	M. Neves dos Santos, M. Ortiz, A. Hanke
Item 8	R. Coelho
Item 9	M. Neves dos Santos, A. Hanke

## 2. Introduction to ICCAT Management Strategy Evaluation (MSE)/Management Procedures (MP) issues

The discussion concerning this agenda item were held together with the Bluefin tuna Species Group.

### 2.1 Where is ICCAT with MSE

The Chair of the SCRS summarized (SCRS/P/2018/019) the context around which the Management Strategy Evaluation (MSE) work is being conducted by ICCAT. He noted that ICCAT recommendations (Rec. [15-04] and Rec. [15-07]) adopted in 2015 cemented the decision of the Commission regarding the development of an MSE process and harvest control rules. Rec. [15-07] identified priority stocks Rec. [15-04] tasked the SCRS with the development of a harvest control rule for northern albacore.

The first recommendation identified albacore north, bluefin tuna, swordfish north and tropical tuna stocks as priority and established a work plan and timetable that were later modified every year by the SCRS and the Commission. Changes to the timetable were again adopted in 2017 by the SCRS which also defined the major steps of the technical work to be completed as part of the MSE. These steps were detailed in a timetable chart in the 2017 SCRS report which reflect the earlier dates that the SCRS could provide enough information to the Commission to consider harvest control rules for each stock: 2019 for bluefin tuna, 2020 for northern swordfish and 2021 for tropical tunas. The SCRS provided advice on a variety of HCRs for northern albacore in 2017 and the Commission adopted an interim harvest control rule in 2017 (Rec. [17-04]). The SCRS Chair also pointed out that in May 2018 the Standing Working Group on Dialogue between Scientists and Managers (SWGSM) will focus on MSE and that a synthesis of the results of the current meeting be provided to such meeting to facilitate discussions.

The Group thanked the Chair for this summary, and agreed that this information would be taken into account throughout the rest of the meeting.

## **2.2 What makes an MP an MP and an MSE an MSE**

Presentation SCRS/P/2018/020 provided a summary of what the potential uses of MSE might be, what types of Management Strategy are available as well as advice on MSE option best practice.

The Group welcomed the presentation made on behalf of the author and acknowledged its relevance to the ICCAT MSE process. The Group stressed that the best practices and caveats regarding the MSE process and associated Management Procedures (MPs) detailed in, this presentation are important to note moving forward in this process. Of particular note was the key observation that any MPs discussed and proposed should be clearly and fully specified so as to ensure complete reproducibility and reduce potential divergence in application.

## **2.3 Improving communication: the key requirement to improve the effectiveness of MSE processes**

Presentation SCRS/P/2018/018 advised that the use of management strategy evaluation (MSE) to design and test candidate fisheries management approaches is expanding globally. Participation of managers, scientists and stakeholders should be an integral component of the MSE process. Open and effective communication among these groups is essential for the success of the MSE and the adoption of the management approach based on it. The highly technical nature of MSE and newness of the approach to many audiences' present considerable communication challenges and have, unfortunately, slowed progress in some cases. The presentation drew on diverse experiences with MSE to identify two areas in which the implementation of MSE in multilateral fora may be improved: a) the use of formally constituted "dialogue groups" as a forum for exchange at the management-science interface, and b) development of engaging, yet uncomplicated, visual communication tools for conveying key results to different audiences at each stage. While the presentation's focus was on the MSE processes underway in the regional fisheries management organizations for tunas and tuna-like species, the advice provided is also pertinent for other fisheries pursuing MSE, international and domestic alike.

It was acknowledged that the need for a clear definition of MSE-related terms to be used by the Group is of fundamental importance, and indeed to standardise these terms across RFMOs. There is great uncertainty in the use of certain terms, which in many cases mean different things to different people. It was noted that this presentation provided a draft glossary of terms targeted at managers and stakeholders. This glossary is not exhaustive, however, and advice was given that it is envisioned that at the Joint Tuna RFMO MSE Working Group meeting to be held in June, that this glossary will be expanded and more technical definitions added.

The structure and composition of the various groups that need to work to develop an MSE is also important and advice on this was provided. These occur at 4 levels: a) Sub groups conducting highly technical work providing summarised scientific information to b) a larger scientific body for review (like the SCRS) with discussion in c) both formal and informal dialogue-type intermediary group(s) (incorporating input from stakeholders) before very summarised recommendations are passed on to d) the Commission. The Commission's Secretariat has a role to play in this process as well ensuring the fluid communication between these groups and the dissemination of vital information. It was noted that the SWGSM and Panel meetings may not be adequate intermediary groups to allow true dialogue among scientists, managers and stakeholders, potentially necessitating the formation of additional informal groups, especially for more complicated MSE processes like that for Atlantic bluefin tuna.

To facilitate the ongoing MSE process, it was strongly suggested that there is a need to develop an MSE specific webpage for ICCAT, providing background information on the progress and developments, including information such as MSE-related management recommendations and timelines, as well as technical MSE development. A timeline for this will be discussed later.

The need to standardise the presentation of MSE outputs was also discussed.

The Group discussed that the definition of management (including economic) objectives should be a primary step in the MSE process, although these objectives should start off very broad and then be refined iteratively as data become available and are integrated. In other RFMOs it has been generally accepted that the performance of the MP or underlying HCR is more important to managers than the internals of the

models. The objectives and outputs may be defined at the decision-making level, but the technical aspects of the modelling should not be constrained from the outset.

#### ***2.4 The MSE/MP Trials Specification document***

The ICCAT GBYP Core modelling Group external contractor presented the Trial Specifications document, and elaborated thereon based on the work thus far of the Core modelling Group. It was stressed that the Trial Specifications document is a living document that will evolve over time and should be constantly updated. This document as presented to the Group will be included in an annex in the bluefin tuna MSE 2018 intersessional meeting report. The Group stressed that trial specification documents should be developed for all species undergoing an MSE process (including one for the northern albacore MSE, which was used to provide advice to the Commission in 2017). In order to facilitate this, it was recommended that a template for a trial specification document be created, based on the current example that could be used for other species.

#### ***2.5 An example of initial MP results and their graphical presentation***

Document SCRS/2018/047 provided details on an initial exploratory exercise in which simple fixed proportion MP control rules are applied using composite abundance indices for the East and West areas, where these composites take weighted averages over standardized values of the agreed indices and are then averaged over the last three years for which they would be available.

The Group noted that the simplicity of presenting results is key. Too many outputs can be confusing and complicate the recommendations and outputs. Zeh plots, worm plots and basic projections are very useful to communicate information among scientists, but more simplified graphics showing the tradeoffs among key performance metrics (e.g., catch and stock status) are likely a sufficient level of detail for the Commission. Intermediate levels of detail are required for the intermediary bodies previously identified.

The need to reduce the volume of model results was also discussed. Models that show very similar results could be removed as duplication is not beneficial. In addition, it may often be necessary to integrate results across models, although this should be done with caution so as not to hide or mask any uncertainties or key outcomes. In addition, the weighting of models is also important, based on relative plausibility. There are several ways of doing this with several examples available from other fora, and these should be discussed and defined. When presenting results, it was agreed that it is best not to disaggregate all the information but instead beneficial to cluster outputs to the extent possible (to make them simpler), but ensuring no important details are masked or omitted.

#### ***2.6 LRPs in assessments and in MSE/MPs (related to SWO agenda)***

The Group were informed that the Swordfish Species Group were looking at methods to better define limit reference points or to verify that the currently adopted LRP for this species is suitable. The Group acknowledged that it is important to define exactly what is meant by an LRP as differences in definition in different fora can lead to confusion. Also, at this stage it was agreed that an LRP is necessary, but how it can be estimated needs further discussion, possibly at the species-specific meetings.

#### ***2.7 Multi-year support for MSE***

The Group strongly stressed that it is clear that MSE is a multi-year process (2-3 years minimum) that requires funding and technical support throughout its duration. The Commission needs to be made aware of this requirement and the necessary resources must be made available for the process to succeed.

#### ***2.8 Roadmap***

The Group agreed that the MSE roadmap needs to be more detailed and likely extended for a longer period. The final roadmap must include other stocks, and realistic deadlines for each key milestone for advancing the MSE processes (including guillotines dates: dates in which final decisions must be made where re-visiting these decisions will not be entertained). In addition, clear objectives/deliverables should be defined for the various groups and planned meetings well in advance to allow CPCs to plan their participation. It is important that each group has different responsibilities and will provide decisions and

recommendations of varying technical levels and complexities. The role of each Working Group needs to be clearly defined, and their decision-making responsibilities defined and agreed upon. The Group stressed that more time and dedicated meetings are required to advance the MSE process, and this should not be conducted on the periphery of other meetings. A proposal is required to define the flow of the MSE process, which can be based on experiences in other RFMOs/organisations in which MSE has been successfully conducted.

Finally, the Group agreed that the roadmap contains two key schedules: a short-term schedule to complete the current implementation of MSEs; and a schedule of the frequency of the revisions of the MPs (i.e. reviews of the MSE). Review schedules may be agreed and finalised, but there should be a clearly defined process to allow earlier reviews/revisions of the MSE (i.e. exceptional circumstances).

### 3. Review of any work done to date on swordfish MSE

A presentation was given on swordfish MSE work done in 2011 (Kell *et al.*, 2012). While the work was preliminary and not intended for management purposes, it did serve as an important demonstration of how the MSE process can be conducted and how the results of such could be communicated. This work used a VPA as the Operating Model (OM) and a surplus-production model as the estimation model. Different forms for the S/R relationship as well as CV around the CPUE were used to represent different hypotheses regarding the productivity of the stock and error in the observational data. This paper demonstrated that simple projections are less precautionary and do not take into account all the uncertainty inherent in the stock dynamics. In addition, the  $B_{\text{trigger}}$  had a greater effect on average annual variation (AAV) than on the actual estimated values with a lower value of  $B_{\text{trigger}}$  resulting in lower variability. Also, in reality catches, harvest (and hence fishing effort) and stock trends show great variability and do not follow the smooth trends implied by the median projections. Future Harvest Control Rules (HCRs) development should take this into account, possibly restricting inter-annual variability in TACs and fishing effort. Although this work is considered preliminary and much additional effort is needed, the benefit of the MSE process is clear.

A second presentation was given reviewing previous swordfish MSE work that was completed in 2016 (Schirripa, 2016). This study compared how swordfish was actually managed in the past and its outcomes versus the outcomes had it been managed with either of two harvest rules both before and after it was overfished. The tradeoffs of the various management scenarios were compared with a radial plot that show how well each of the harvest control rules met the stated management objective. The summary of the comparisons was that the use of the simple harvest control met the management objective of quickly recovering the swordfish stock the tradeoff was short term yield and variation on the catch. Furthermore, a small buffer on  $B/B_{\text{MSY}}$  and  $F/F_{\text{MSY}}$  target increased safety a great deal and with only a very small decrease in catch. This led to a discussion on the importance of communicating the results of an MSE to managers that captured the important outcomes while at the same time not making the graphics so complex that they could not be understood.

### 4. Limit Reference points and MSE

The Group discussed the background to the establishment of limit reference points (LRPs) for northern albacore and swordfish, and agreed ideally such LRP should be set on the basis of information on the biology and ecology of each stock. The Group also noted that when such information was not available that the LRPs established for other similar stocks could be used as proxy. Additionally the Group accepted that the choice of the value of LRP can be influenced by considerations of risk perceptions held by the managers.

The Group noted that the albacore MSE process agreed to define an LRP for the northern stock of albacore, however, the bluefin tuna MSE has not. The Group expressed a preference to maintain  $0.4 \cdot B_{\text{MSY}}$  as the current LRP for northern swordfish (ICCAT Rec. [17-02]). The Group noted, however, that when considering the main uncertainty axes to be incorporated into the MSE it may be useful to consider more robust alternative LRP values, in accordance to the ICCAT Rec. [17-02] (e.g., values such as  $0.35 \cdot B_{\text{MSY}}$  and  $0.45 \cdot B_{\text{MSY}}$ ). Acknowledging the difficulties in estimating biological LRPs, the Group recommended that adjustments can be made in the MPs in order to minimize the risk of exceeding the LRPs.

## 5. Discussion of potential Operating Models applicable for swordfish. Conditioning of Operating Models

The Group revisited the 2017 North Atlantic swordfish stock assessment (Anon., 2017), to identify the uncertainties that could be addressed in the MSE process. The main sources of uncertainty identified in Stock Synthesis model, were:

- Gear selectivity;
- Length compositions effective sample size;
- Sensitivity to CPUE series;
- Steepness;
- Natural mortality;
- Variance of recruitment deviations.

Taking into consideration the identified uncertainties, the Group discussed different options for conditioning the OM, which could be Stock Synthesis based; by either using only the uncertainties identified during the stock assessment or by considering further sources of uncertainty that were not identified at the time, but that the Group considers important to be incorporated in a MSE framework. The other option for conditioning the OM is to use a customized population model that can use similar options to what was done in the assessment that would mimic the dynamics to which uncertainties can be added.

The Group acknowledged that using Stock Synthesis as the population model could have some advantages, as it is already very flexible and could incorporate a range of uncertainties. It has the advantage of having been one of the models used in the 2017 North Atlantic swordfish stock assessment and can produce both historical estimations as well as forecasting. Also, it is a model widely used worldwide, which code has been extensively reviewed and it is supported by existing MSE software.

The preliminary operating model conditioning for the IOTC Swordfish MSE (Mosqueira *et al.*, 2017) was presented. It explores the role of the structural uncertainty in the current stock assessment by means of a grid of SS model fits. The grid included uncertainties in the selectivity function, growth and age-at-maturity, natural mortality, steepness, effective sampling size, CPUE series, CPUE scaling, catchability increase and recruitment deviations. Each population model run, carried out using the same input data, has a different combination of assumed parameters and variables.

The Group acknowledged the progress done in IOTC. It was also noted that in studies conducted in the south-west Pacific estimated ages from fin rays or otoliths produced different growth rates and longevity, and this was considered during the IOTC Swordfish MSE process. This uncertainty has not been so far considered for Atlantic stocks, as growth studies using otoliths are not available, but could also be another additional source of uncertainty in the biology of the species.

Presentation SCRS/P/2018/021 discussed an example DLMtool operating model for North Atlantic swordfish. The northern swordfish operating model was populated from a Maximum Likelihood Estimation (MLE) run of Stock Synthesis using a function provided in the R package DLMtool. The SS input and output files included some accounting for uncertainty in various aspects of the operating model and helped populate the custom parameter slot of the operating model by simulation sampling for a) size vulnerability; b) recruitment variation; c) growth ( $W_{t,age}$ ,  $K$ ,  $L_{inf}$ ); and d) steepness of the stock-recruitment curve and e) historical patterns in exploitation rate. Additionally, the MLE fit of SS, also produced a number of point (MLE) values for various other parameters and variables that are likely to be uncertain. However, custom parameters were introduced to reflect uncertainty in natural mortality rate, length at 50% maturity and stock depletion. The model also accounted for critical areas of uncertainty related to discarding rate, TAC, TAE and size limit adherence. Implementation error in the adherence to management advice was set to a maximum overage of 50%. Errors in the observation of the data were included using an imprecise-biased observation model.

The Group discussed the functionality of the DLMtool and its ability to base OM development on SS output files. It was noted that the major axes of uncertainty could be reflected in a series of SS models, which could then be simulation tested within the DLMtool environment using up to 120 predefined management procedures. The Group recognized the ability of the DLMtool to further characterize uncertainty relative to management implementation, observation error and bias, process error and bias, and the variance of values

not included as structural uncertainties. Furthermore, the Group recognized the potential of the tool to identify additional structural uncertainties for OM development, run MSE analyses quickly and support the interpretation of SS model outputs.

From the previous discussions, the Group noted several sources of uncertainty that could be considered for the OM conditioning. The following list of uncertainties identified below could be considered for the uncertainty grid or as robustness tests:

- Gear selectivity (e.g. double normal, logistic)
- Length compositions effective sample size
- Steepness (e.g. 0.6, 0.75, 0.9)
- Natural mortality (e.g., 0.1, 0.2, 0.3, age-specific)
- Stock structure and mixing
  - Location of current boundary: either horizontal at 5<sup>o</sup>N as is currently the case, or as suggested by Schirripa *et al.* (2017)
  - Mixing between East and West within the stock boundaries (e.g. area model to capture movement dynamics)
- Environmental considerations and behaviour
  - Recruitment failure or success (cyclic trends/regime shift)
  - Cyclic movement of adult swordfish
  - Oxygen minimum zone (i.e. vertical displacement of individuals)
- Seasonal dynamics (stock/fleet)
- Spatial sexual segregation of the stock (real or observed)
- Effect of the minimum size recommendation [Rec. 17-02]:
  - Unreported discards
  - Discard mortality
  - Implementation options (119 cm or 125 cm LJFL)
- Catchability increase
  - Catchability changes by fleet (e.g. gear changes; other effects not accounted for in the CPUE standardization)
  - Consider CPUE conflicts (by area, NW/NE Atlantic)

In addition to the uncertainties to be considered in the development of the OM, the Group also discussed that an implementation error model be developed to account for total catches exceeding the TAC and the overage of catches by some fleets.

## **6. Development of an MSE workplan for swordfish**

The contract of the external expert was not finalized prior to the meeting, therefore the Group did not benefit from the presence of such expert during the discussions of this item. For this reasons, the Group requested that the expert provides an additional deliverable within a timeframe of one month after contract signature, consisting of a workplan that takes into consideration the discussions and conclusions from this meeting. As such, the expert should communicate with the Group to agree on the content of this deliverable.

The Group was unable to discuss in detail the work plan for swordfish MSE beyond accepting the plan for work for 2018 which includes the development of the operating model (OM) framework, defining a set of OM models describing the major axes of uncertainty and the initial conditioning of these alternative OMs. The external SWO MSE expert will report progress on work conducted during 2018 to the SCRS Species Group meeting in September. At that point the Group will develop a more detailed plan of activities for MSE to be considered by the SCRS plenary in October, taking into consideration that an inter-sessional meeting should be conducted in 2019 with a major focus on the MSE process (see workplan in section 9.1).

## **7. Progress on other research lines of the Atlantic swordfish workplan**

### **7.1 SCRS science envelope**

The Secretariat provided detailed explanation on the decisions taken by the Commission in November 2017 regarding the science budget for 2018 and 2019.

The total science budget proposed for all species in 2018 includes new ICCAT funds provided by the Commission (€50,000), and the leftover funds that had been previously committed to other scientific programmes (i.e. EPBR). The funds allocated for 2018, however, were not sufficient to cover all the research requests proposed by the SCRS in September 2017. As a result the ICCAT Secretariat took the initiative to approach a willing CPC for additional funding. This funding was obtained recently from the EU, for strengthening the scientific basis for decision-making in ICCAT. These additional funds have been provided for a specific list of activities that was developed on the basis of the SCRS Sub-Committees and Working Groups work plans for 2018.

In order to access these funds in 2018, Working/Species Groups defined specific research activities that required funding. The Secretariat is liaising with the SCRS Chair and the Species Groups rapporteurs to define terms of reference (TORs) required for developing Call for tenders that will subsequently be advertised by ICCAT. TORs should contain specific milestones and deliverables to be achieved as part of all funded activity. Contracts issued through Call for tenders have the advantage that initial partial payments can be provided shortly after the contract is signed.

### **7.2 Stock structure**

The Group reviewed two presentations given at previous SCRS meeting (SCRS/P/2017/06 and SCRS/P/2017/07) that showed how possible stock structure hypotheses based on genetics (Bremer *et al.*, 2005) and environmental conditions (Goodyear *et al.*, 2017; Schirripa *et al.*, 2017) could be used to guide the current stock structure work. Other information demonstrated how the current PSAT tagging data is being utilized in a Species Distribution Model to estimate geographical distribution of swordfish habitat over time.

The Group discussed these results and thought they would be useful to help address the proposed work in the 2018 and 2019 work plan. Particularly, the Group decided that the priority areas for deploying the PSAT tags should be the Gibraltar area (North Atlantic / Mediterranean boundary) and both sides of the current hypotheses North South Atlantic boundary.

### **7.3 Size/sex distribution**

Document SCRS/2018/036 provided an update on an ongoing size and sex-ratio distribution study for swordfish in the Atlantic. The study that aims to enhance the current knowledge of the species spatial and seasonal dynamics in the Atlantic, gather data collected from Canada, Côte d'Ivoire, EU-Portugal, Venezuela and Chinese-Taipei fisheries. Preliminary analysis shows the differential sex ratios of swordfish in particular area-seasons, consistent with earlier analysis carried out in the early 2000.

The Group acknowledged the effort made by the authors to collect and analyze the available information from different CPCs. However, it was noted that it was lacking information from some major fisheries. Accordingly, in order to avoid potential bias due to lapse arising from data gaps, the Group strongly encouraged scientists from other main swordfish fleets in the Atlantic to collaborate in this study, namely through the provision of relevant data. The Group was informed that Chinese-Taipei, Morocco, United States scientists are processing additional data that is expected to be provided soon. The Group also request to include data from observer programmes that measure fish below the minimum size.

The Group recommended that future analysis should include spatial-explicit model of the distribution of sex by size class.

### **7.4 Length-weight relationships**

Document SCRS/2018/035 provided an update on an ongoing study on length-weight relationship for swordfish in the Atlantic. The study that aims to revise the current SCRS relationships for the North and South Atlantic. The authors gathered data collected from Canada, EU-Portugal and Chinese-Taipei fisheries.

The Group acknowledged the effort made by the authors to collect and analyze the available information. However, it was noted that it was lacking information from some of the major fisheries. Accordingly, in order to avoid potential bias due to lapse arising from data gaps, the Group strongly encouraged scientists

from other main swordfish fleets in the Atlantic to collaborate in this study, namely through the provision of relevant data. The Group was informed that Chinese-Taipei and Venezuelan scientists are processing additional data that is expected to be provided soon.

The Group noted the need to clearly define the description of the unit of weight reported by fleet, as swordfish “dress weight” likely vary substantially between fleets in the Atlantic Ocean, particularly between those fleets that deliver fresh vs. frozen fish. It was also suggested to complement these analyses taking into consideration variations associated with season and fish condition factors.

### **7.5 Other studies**

Document SCRS/2018/043 presents a relative habitat size for swordfish stock based on a global habitat model. The objective of this study is to have a relative prior information of the carrying capacity (K) for swordfish by main oceanic basin. It used the worldwide historic standardized CPUE from the Japanese swordfish fleet in 5x5 degree and a suite of environmental variables (SST, sea surface height, mixed layer depth, chlorophyll, etc.) from assembled data from several oceanographic models. Results indicated a similar or slightly smaller carrying capacity for the South swordfish vs North swordfish, but higher K for the Indian and Pacific Ocean stocks. The low K was assigned for the Mediterranean Basin, although authors indicated the lack of environmental data of the eastern Mediterranean.

The Group noted that the model did not properly predict a suitable habitat in some traditional swordfish fishing grounds such the Grand Banks in the northwest Atlantic, a traditional hot-spot for swordfish catches by the Canadian and US fleets. Accordingly, the Group encouraged the authors to continue developing this study.

## **8. Recommendations**

Below are provided a lists of draft Recommendations that will be revisited at the Species Group meeting in September 2018.

### *Recommendations for the Commission (with financial implications)*

- a) To continue to provide financial support for the ongoing research activities related with the swordfish work plan, including genetics, reproduction, ageing and tagging (additional details available in section 9 of this report).
- b) To continue to provide financial support related with the North Atlantic Swordfish MSE (details available in section 9 of this report).

### *Recommendation for the SCRS*

- a) To conduct an intersessional swordfish Species Group meeting in 2019. The major focus will be the North Atlantic Swordfish MSE process, with some time also devoted to other ongoing activities related with the swordfish work plan.
- b) For the Working Group on Stock Assessment Methods (WGSAM) to consider the appropriateness of an ICCAT Age and Growth workshop general to all Species Groups, that could include experts from other RFMOs.
- c) For the Sub-Committee of Statistics to create a relational database for the swordfish biological data, similar to the ongoing efforts for bluefin tuna.

### *Recommendation for the Swordfish Species Group*

- a) Establish criteria for accepting life history relationships and characteristics that include clear descriptions of area sampled, model fit diagnostics, descriptions of number sampled and data ranges. It is also required that the relationships and characteristics be accompanied by a traceable reference and that the measured format of the fish for each conversion formula be clearly described.
- b) Establish and use definitions and codes for dressed formats that are consistent with those developed by the Bluefin Species Group where appropriate.
- c) For CPCs to provide additional data for the ongoing studies in the workplan (validation of the length weight relationships and analysis on the distribution by size and gender).
- d) For CPCs to provide support with the sampling of structures for studies in the workplan (genetics, reproduction, ageing).

## 9. Other matters

### 9.1 Ongoing activities in 2018 and 2019 (workplan)

The Group revised the 2018 workplan on the basis of the overall budget available for this year for the Swordfish Species Group. The table below summarizes the activities to be conducted during 2018 and related decisions taken by the Group:

<i>Activity</i>	<i>Amount (€)</i>	<i>Needs</i>	<i>Action to be taken</i>
Reproductive biology study	20,000	To collect gonads samples and provide preliminary analysis results	Draft ToR for a Call for tenders aiming the collection of samples for reproduction, and genetics studies, and provide preliminary analysis results. To include collection of samples for ageing study.
Genetics study for stock differentiation	50,000	To collect tissue samples and provide preliminary analysis results	
Sampling collection and shipping	5,000	Fish to be tagged and additional collection and shipping of samples.	
e-tagging	50,000	Purchase PSAT tags and satellite transmission. Deploying PSAT.	Secretariat to proceed with acquisition. Thirteen tags to be split between the North/South Atlantic and North/Mediterranean stocks
<b>Total</b>	<b>125,000</b>		

The Group was also informed that there is a specific budget line for the ongoing northern Swordfish MSE process, which will cover the costs for contracting an expert and any costs related with coordination with the Swordfish Species Group, the Swordfish Coordinator, SCRS Chair and the ICCAT Secretariat.

The Group reiterated that it would be beneficial that the studies listed in the table above should be a collaborative process, increasingly involving more scientists from all nations with major swordfish Atlantic and Mediterranean fisheries. Any additional CPCs that are interested in participating and can provide relevant samples/data and/or expertise in the projects are welcome.

Under the new research funding system, a Call for tenders was circulated by the Secretariat aimed at swordfish studies. The Group, in consultation with the Mediterranean swordfish rapporteur, developed those Terms of Reference, which are provided in **Appendix 5** to this report.

The Group was informed that under a US/EU-Portugal cooperative project conducted by the National Institutes (NOAA and IPMA, respectively), nine PSAT are available to be deployed during 2018 in the North Atlantic area. This work will be an additional in-kind contribution to the Swordfish Species Group work plan.

In addition, the Group also agreed to develop protocols for the processing and ageing of spines/otoliths for a cross-comparison.

The Group agreed to finalize the protocols for collection and processing of biological samples, aiming at reproduction and genetics that will be provided by the successful applicant to the Call for tenders for *Swordfish biological samples collection for growth, reproduction and genetics studies*.

What follows is a draft version of the Swordfish Species Group work plan for 2019 that will be finalized at the Species Working Group in September 2018. The table below provides summarized information regarding the Group decisions on research activities to be carried out during 2019.

<b>Activity</b>	<b>Amount (€)</b>	<b>Needs</b>
Reproductive biology study	20,000	To collect additional gonads samples, process all samples, and provide complete analysis of results.
Genetics study for stock differentiation	50,000	To collect additional tissue samples, process all samples, and provide complete analysis of results.
Age and growth	25,000	To collect and process hard structures for age and growth study. Organize a workshop to establish reference set for SWO aging (including attendance of experts).
Sampling collection, shipping and consumables	10,000	Fish to be tagged and additional collection and shipping of samples.
e-tagging	50,000	Purchase PSAT tags and satellite transmission. Deploying PSAT.
N-SWO MSE process	80,000	Continue the N-SWO MSE process
<b>Total</b>	<b>235,000</b>	

In addition to the above mentioned activities the Group also decided on a number of additional research activities, which have no financial implications. These are listed below:

- a) Update the validation of the length weight conversion with new data and include factors that account for spatial, temporal and flag effects and also develop conversions by month (for 2019);
- b) Update the analysis on the distribution of swordfish by gender, size class and gender-size class using spatial-temporal models (for 2019);
- c) Review the utility of the DLMtool/MSEtool for use by the Swordfish Species Group assessments;
- d) Considering the comments from the 2017 stock assessment reviewer, review how to improve the provision of CPUE updates for assessment purposes;
- e) Consider items included in the 2017 work plan.

## **10. Adoption of the report and closure**

The report was adopted by the Group and the meeting was adjourned.

## References

- Anon. 2017. Report of the 2017 ICCAT Atlantic Swordfish Stock assessment session (Madrid, 3-7 July, 2017). ICCAT Collect. Vol. Sci. Paps, 74(3): 841-967.
- Bremer J.A., Mejuto J., Gómez-Márquez J., Boán F., Carpintero P., Rodríguez J.M., Viñas J., Greig T.W., Ely B. 2005. Hierarchical analyses of genetic variation of samples from breeding and feeding grounds confirm the genetic partitioning of northwest Atlantic and South Atlantic populations of swordfish (*Xiphias gladius* L.). J. Exp. Mar. Biol. Ecol., 327(2):167–182.
- Goodyear C.P., Schirripa M., Forrestal F. 2017. Creating a species distribution model for swordfish: evaluations of initial habitat variables. ICCAT Collect. Vol. Sci. Pap., 74 (3): 1235-1250.
- Kell L.T., Mosqueira I., De Bruyn P., Magnusson A. 2012. An evaluation of limit and target reference points as part of a harvest control rule: an Atlantic swordfish example. ICCAT Collect. Vol. Sci. Pap., 68(4): 1630-1644.
- Mosqueira I., Rosa D., Fu D., Coelho R. 2017. Update on the conditioning of an operating model for the Indian Ocean swordfish stock. IOTC-2017-SC20-11: 8 pp.
- Schirripa M.J., 2016. Building a management strategy evaluation for northern swordfish: part I. ICCAT Collect. Vol. Sci. Pap. ICCAT, 72 (8): 2031-2041.
- Schirripa M.J., Abascal F., Andrushchenko I., Diaz G., Mejuto J., Ortiz M., Santos M.N., Walter J., 2017. A hypothesis of a redistribution of North Atlantic swordfish based on changing ocean conditions. Deep Sea Research Part II: Topical Studies in Oceanography, 140: 139-150.
- Schirripa M.J., Abascal F., Andrushchenko I., Diaz G., Mejuto J., Ortiz M., Santos M.N., Walter J. 2017. A hypothesis of a redistribution of North Atlantic swordfish based on changing ocean conditions. Deep Sea Research Part II: Topical Studies in Oceanography, 140: 139-150.

**Appendix 1**

**Agenda**

1. Opening, adoption of Agenda and meeting arrangements
2. Introduction to Management Strategy Evaluation (MSE)/Management Procedures (MP) issues
3. Review of any work done to date on swordfish MSE
4. Limit Reference points and MSE
5. Discussion of potential Operating Models applicable for swordfish. Conditioning of Operating Models
6. Development of an MSE work plan for swordfish
7. Progress on other research lines of the Atlantic swordfish work plan
  - 7.1. Science envelope
  - 7.2. Stock structure
  - 7.3. Size/sex distribution
  - 7.4. Length-weight relationships
  - 7.5. Other studies
8. Recommendations
9. Other matters
10. Adoption of report and closure

**Appendix 2**

**List of Participants**

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## LIST OF PAPERS AND PRESENTATIONS

<i>Reference</i>	<i>Title</i>	<i>Authors</i>
SCRS/2018/035	Gender specific length-weight conversions for North and South Atlantic swordfish	Hanke A., Coelho R., and Su N.-J.
SCRS/2018/036	An update of the revision of swordfish size and sex-ratios distribution in the Atlantic	Coelho R., Hanke A., Su N.-J., Bahou L., and Rosa D.
SCRS/2018/043	Relative habitat size for swordfish stocks based on a global habitat model	Arrizabalaga H., Erauskin M., and Coelho R.
SCRS/P/2018/018	Improving communication: the key requirement to improve the effectiveness of MSE processes	Miller S., Anganuzzi A., Butterworth D., Davies C., Donovan G., Nickson A., Rademeyer R., and Restrepo V.
SCRS/P/2018/019	Current state of MSE/HCR Process in ICCAT	Die D.
SCRS/P/2018/020	What makes an MP an MP and an MSE an MSE?	Punt A.E.
SCRS/P/2018/021	Operating model for North Atlantic swordfish ( <i>Xiphias gladius</i> )	Carruthers T.
SCRS/P/2017/006	Simulation of Harvest Control Rules for North Atlantic swordfish utilizing a historic perspective	Schirripa M.
SCRS/P/2017/007	North Atlantic swordfish stock synthesis configuration v1.0	Schirripa M.

**SCRS DOCUMENTS AND PRESENTATIONS ABSTRACTS AS PROVIDED BY THE AUTHORS**

*SCRS/2018/035* - Data collected by National Observer Programs and submitted to ICCAT was used to estimate length-weight conversions for North and South Atlantic Swordfish stocks by gender. The conversions for the southern stock are from lower jaw fork length to dressed weight and to round weight for the northern stock. Estimates of weight at length are smaller for the southern stock and larger for the northern stock than those using the current ICCAT conversions.

*SCRS/2018/036* - The ICCAT Swordfish Working Group recommended a detailed size and sex-ratio distribution study to better understand the spatial and seasonal dynamics of swordfish in the Atlantic. A data call on detailed size/sex observer data was made in early 2018. To date, several CPCs submitted data, specifically Canada, Chinese Taipei, Côte d'Ivoire and EU-Portugal, with a total of 88,678 detailed swordfish records compiled in both hemispheres. The purpose of this document is to update the status of this work and present preliminary exploratory analysis of the data. This work is currently ongoing and will be updated as more data is received.

*SCRS/2018/043* - In this paper we propose proxies for relative habitat size of swordfish (SWO) stocks worldwide. For this, we first build a habitat model, that we use to calculate four alternative measures of habitat size, two based on habitat extension and two based on habitat quality. These are compared between them, as well as with previous estimates based on the number of 5<sup>o</sup>5<sup>o</sup> squares with positive CPUE. The indicators based on habitat extension suggest that the Pacific stocks have a larger habitat area compared to those in the Atlantic, with the Indian Ocean stock in the middle. However, when considering the habitat quality, the habitat of Atlantic stocks is comparable to that of the Pacific stocks, and higher than the Indian Ocean. The Mediterranean stock has the lowest habitat, according to all indicators. Having relative habitat size estimates for stocks of the same species could help establish priors for K, e.g. under the assumption of proportionality between K and habitat size.

*SCRS/P/2018/018* - Not provided by the author.

*SCRS/P/2018/019* - Not provided by the author.

*SCRS/P/2018/020* - Not provided by the author.

*SCRS/P/2018/021* - Not provided by the author.

**TERMS OF REFERENCE FOR  
SWORDFISH BIOLOGICAL SAMPLES COLLECTION  
FOR GROWTH, REPRODUCTION AND GENETICS STUDIES**

**Background and objectives**

As approved by the SCRS in 2017, the Swordfish Species Group aims in 2018 to initiate a biological sample collection programme to collect biological data for swordfish (SWO). This programme will improve knowledge of the stock distribution, age and gender of the catch, growth rate, age at maturation, maturation rate, spawning season and location and diet thereby contributing to the next major advance in the assessment of swordfish status, by permitting the development of more spatially and biologically realistic population models used in both an assessment and ICCAT Management Strategy Evaluation (MSE) context. This should translate into more reliable advice on stock status for an internationally and collectively managed resource. The Swordfish Species Group has identified this work to be of a very high priority which will address critical deficiencies in our understanding of the population dynamics and ecology of swordfish.

The objectives of this Swordfish Species Group project are to:

1. Resolve the spatial-temporal distribution of the three known swordfish stocks found within the Atlantic Ocean and Mediterranean Sea using a genetic analysis of tissue sampled from the catch of participating CPCs.
2. Resolve the age and size at maturity of the three known swordfish stocks found within the Atlantic Ocean and Mediterranean Sea using samples/measurements provided by participating CPCs.
3. Characterize the age composition of the catch and validate the growth curves for each swordfish stock.
4. Determine the spawning period and areas of each stock.
5. Identify the seasonal and spatial species composition of the swordfish diet using stomach content and/or tissues.
6. Develop a protocol/template based on genetic analysis that will allow for the assignment of tissue samples to a particular stock.
7. Develop a biological database that links the sample information to the age, stock origin, gender, size, diet and maturity data of each fish.
8. Update the ICCAT Manual with new pertinent information.

This work will be closely linked to the sampling programmes of CPCs that support the goals and objectives of ICCAT and the Swordfish Species Group. The points of contact for participants of this programme are the Swordfish Species Group rapporteurs for the Atlantic and Mediterranean stocks, with contributions from the Group members, the SCRS Chair and the ICCAT Secretariat.

As part of this biological study, scientific institutes and public or private entities are asked to submit tenders to provide biological data and samples as described below. The organization of scientific institutes in a consortium to submit one single offer project that could cover all areas would be highly preferable. All the data collected under the research programme shall be used only for scientific purposes and in accordance with ICCAT rules. Any other use of these data should be specifically authorized by ICCAT. Collection of samples shall be collected and appropriately balanced from the geographical areas/fleets that capture more swordfish. For reference, see **Figures 1 and 2** and **Table 1**.

**Contractor tasks**

The principle objective of the project is to determine the spatial-temporal distribution, age composition, diet, maturity schedule and age at maturity of Atlantic and Mediterranean Swordfish. Swordfish are landed in a broad range of ports bordering the Atlantic Ocean and Mediterranean Sea, and over a fishing season that spans the entire year. A further complication is that the species is sexually dimorphic based on size and potentially exhibit gender based spatial segregation.

The contractor will ensure that biological samples from this heterogeneous population will be made following a sampling design that ensures that the fishery is covered on a proportionate basis by gender, age, size, season and area.

The Contractor must develop the final specifications of the sampling design over the first month of the contract. Preference will be given to bids with large number of samples per area/month. This sampling design is to be approved by the Swordfish Species Group rapporteurs and the SCRS Chair, in consultation with the Swordfish Species Group participants. It must be noted that for biological sampling and analysis, small-scale and short term sampling is considered of little use for meeting the project objectives. As such tenders should be made on a **regional and collaborative basis**.

It is expected that the Contractor will use trained field technicians to obtain the necessary biological samples (fish length, weight, assess maturity, assess gender, classify stomach contents, collect fin or muscle tissue, anal fin spine, record sample meta data) on every fish sampled if possible. Recognizing the difficulty in collecting stomach samples, the sample will be considered complete if that component is missing.

The Contractor must ensure that all sample information is properly cross referenced, Quality Assured and Quality Controlled (QA/QC) and stored in a relational database. Uniquely identified tissue samples and anal fin spines must be sent to an entity to be determined amongst the Swordfish Species Group. Protocols used during the sampling must be based on current best practices and, in the case of tissue and anal fin spines, not interfere with further processing or cause degradation of the samples. Replicate tissue samples are required. These protocols must be approved by the Swordfish Species Group rapporteur before any collection starts.

#### **Contractor minimum qualifications**

- Documented multi-year experience research on large pelagic species with experience on fishery data collection and biological sampling.
- University degree in one of the following: fisheries science, marine biology, statistics, natural sciences, biological sciences, environmental sciences or closely related fields (in case of individual scientists).
- Excellent working knowledge of one of the three official languages of ICCAT (English, French or Spanish). A high level of knowledge of English is desirable.

#### **Deliverables**

1. A **SCRS document and a power point presentation** of the collections describing the representativeness of sampling by area, season, and gender will be made to the SCRS (Standing Committee for Research and Statistics) Swordfish Species Group meeting in 2018.
2. Labelled anal spines and tissue **samples are to be shipped** according to instructions determined by the Swordfish Species Group.
3. A **relational database** containing the sample data that **has undergone thorough QA/QC is to be provided. This database will reside at ICCAT Secretariat and** will be made available for distribution upon request.
4. A **draft final report** to be submitted at the latest by **7 December 2018 at the latest**, and shall include:
  - a) Executive summary;
  - b) Full description of the work carried out;
  - c) Detailed description of the sampling that has been realized.
5. The **final report** shall be updated taking into account the comments provided by the ICCAT Secretariat, the Swordfish Species Group rapporteurs and the SCRS Chair, be submitted **by 21 December 2018 at the latest**.

SWO MSE INTERSESSIONAL MEETING – MADRID 2018

**Table 1.** Catalogue of nominal catches and size data for the main swordfish fleets (ranked by cumulative catches) for the North Atlantic, South Atlantic and Mediterranean.

**North Atlantic**

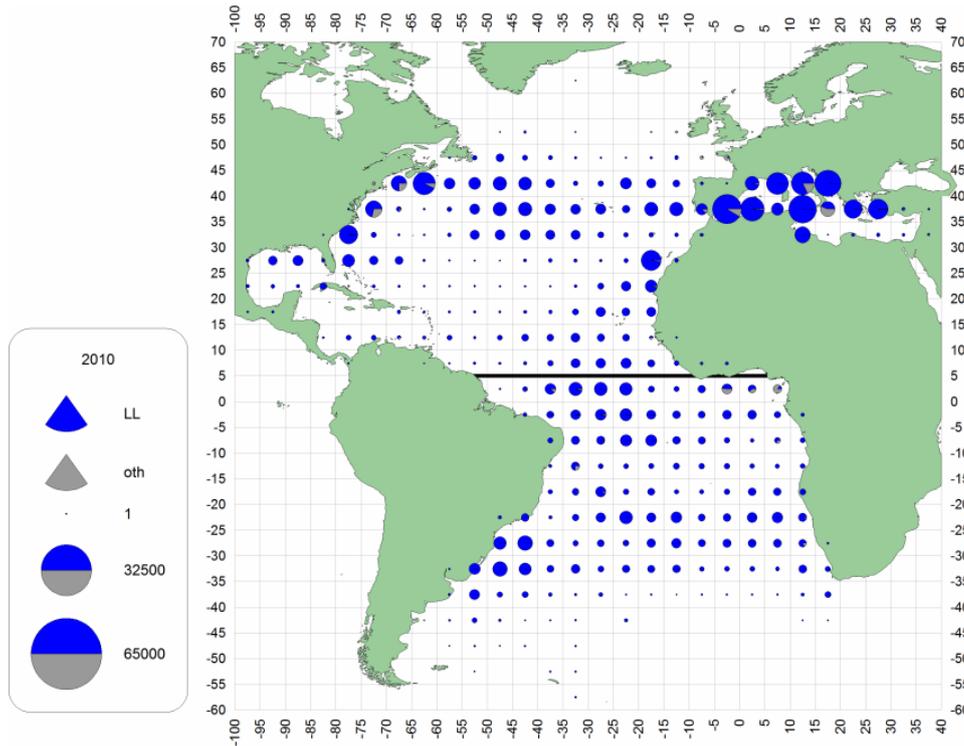
FlagName	GearGrp	DSet	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Rank	%	%cum
EU.España	LL	t1	5519	5133	4079	3993	4581	3967	3954	4585	5173	5511	5446	5564	4366	4949	4147	4885	5620	4083	3750	4013	2915	1	29.4%	29%
U.S.A.	LL	t1	4015	3399	3433	3364	3316	2498	2598	2757	2591	2273	1961	2474	2405	2691	2204	2572	3347	2812	1816	1593	1394	2	22.4%	62%
Canada	LL	t2	646	1005	927	1136	923	984	954	1216	1161	1470	1238	1142	1115	1061	1182	1351	1502	1290	1383	1489	1473	3	9.9%	72%
EU.Portugal	LL	t1	1702	902	772	776	731	731	765	1032	1319	900	949	778	747	896	1054	1202	882	1438	1241	1420	1171	4	8.6%	80%
Japan	LL	t1	1494	1218	1391	1089	759	567	319	263	975	705	656	889	935	778	1062	523	639	300	545	430	383	5	6.3%	87%
Maroc	LL	t1	35	239	35	38	264	154	223	255	325	333	229	428	720	963	700	700	1000	1000	800	520	6	3.8%	90%	
China Taipei	LL	t2	521	509	286	285	347	299	310	257	30	140	172	103	82	89	88	192	193	115	85	133	152	7	1.8%	92%
Canada	LL	t2	93	89	240	18	95	121	38	147	87	193	203	267	258	246	176	208	97	275	233	98	85	8	1.3%	93%
China PR	LL	t1	132	40	317	304	22	102	90	316	56	108	72	85	92	92	73	75	59	96	60	141	115	9	1.0%	94%
Trinidad and Tobago	LL	t1	158	110	130	138	41	75	92	78	83	91	19	29	48	30	21	16	14	16	26	17	13	10	0.5%	95%
U.S.A.	HL	t1	0	1	5	9	9	12	21	23	35	33	125	94	125	129	121	155	105	88	77	76	11	0.3%	95%	

**South Atlantic**

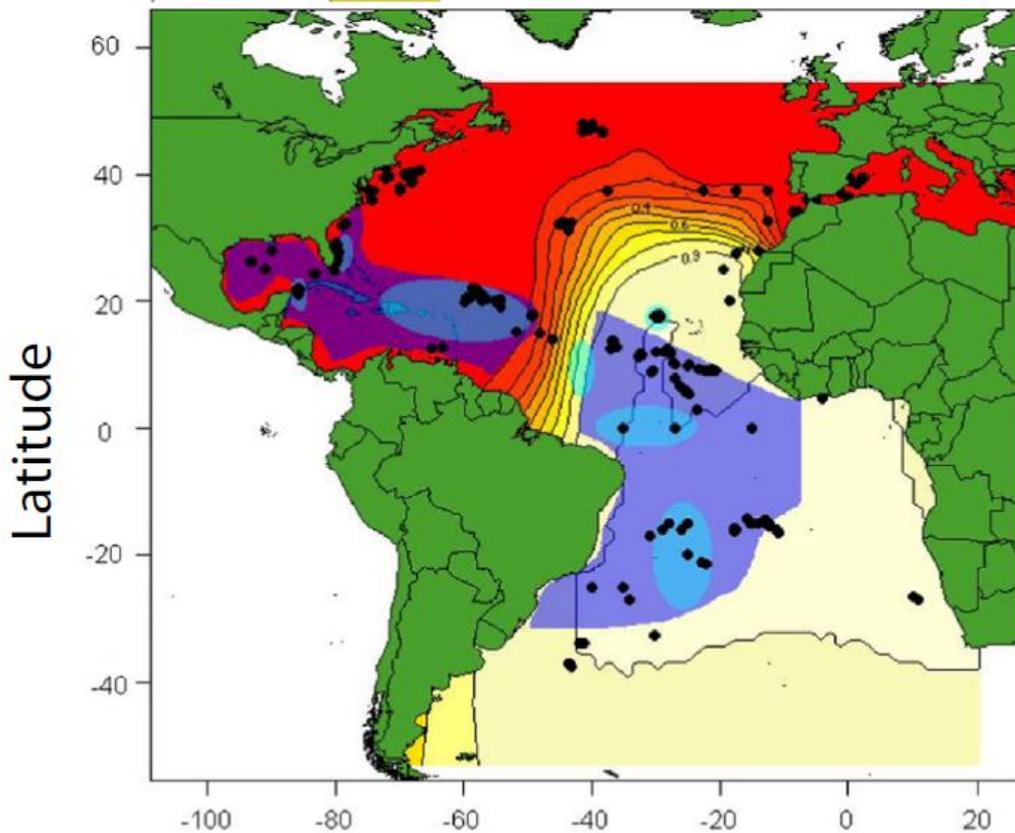
FlagName	GearGrp	DSet	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Rank	%	%cum
EU.España	LL	t1	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402	5300	5383	4073	5183	5801	4700	4852	4184	4113	5059	4992	1	42.1%	42%
Brazil	LL	t1	1892	4100	3844	4721	4579	4075	2903	2917	2914	3780	4120	3892	3152	3112	2657	2800	2831	1312	2890	2567	2	23.5%	66%	
Japan	LL	t2	2197	1494	1186	775	790	685	833	924	686	480	1090	2155	1800	1340	1314	1233	1162	684	975	657	639	3	8.3%	74%
China Taipei	LL	t1	2872	2562	1147	1168	1303	1149	1164	1254	745	744	377	671	727	612	410	429	496	582	451	554	490	4	7.4%	81%
Uruguay	LL	t1	644	760	899	650	713	789	766	850	1105	843	620	464	370	501	222	179	40	103	5	3.8%	85%			
Namibia	LL	t2	374	452	607	504	187	549	832	1118	1038	518	25	408	366	22	129	395	225	466	6	3.0%	88%			
EU.Portugal	LL	t1	389	441	384	381	392	393	380	354	345	493	440	428	271	367	232	263	184	125	252	236	250	7	2.5%	90%
China PR	LL	t1	29	54	344	200	423	353	278	91	300	473	470	291	296	248	316	196	206	328	222	8	2.0%	92%		
South Africa	LL	t1	240	141	327	547	649	293	295	199	186	207	142	170	145	97	50	171	152	218	184	9	1.6%	94%		
Ghana	GN	t1	140	44	106	121	117	531	372	734	343	55	32	65	177	132	116	60	54	37	26	56	36	10	1.2%	95%
S. Tomé e Príncipe	TR	t1	166	148	135	129	120	120	120	120	120	120	147	138	138	172	179	176	77	11	0.8%	96%				
Brazil	UN	t1	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	12	0.6%	97%	
Senegal	LL	t1	77	138	195	180	264	162	178	143	97	173	13	0.6%	97%											

**Mediterranean**

FlagName	GearGrp	DSet	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Rank	%	%cum
EU.Italy	LL	t1	2617	2458	2458	2680	2639	2236	1841	5844	5452	5560	5253	4564	4521	4687	5101	4579	3856	2848	3384	4213	3917	1	29.9%	30%
EU.España	LL	t2	1040	1184	1409	867	1396	1402	1421	1165	930	860	1405	1648	2063	1994	1785	1730	1580	1605	2019	2289	1732	2	11.7%	42%
EU.Greece	LL	t1	1237	750	1650	1520	1960	1730	1680	1230	1129	1424	1374	1907	989	1132	1494	1306	877	1731	1344	761	761	3	10.4%	52%
Maroc	GN	t1	2461	4653	2905	2979	2503	2266	2230	1629	1299	722	603	615	587	477	410	387	4	9.9%	62%					
EU.Italy	GN	t1	2657	3632	3632	3632	4863	5	2373	1948	5	8.4%	70%													
Maroc	GN	t2	273	245	323	259	205	754	1149	1670	1954	1801	1455	1107	1370	1110	1200	640	802	770	770	480	900	6	7.1%	77%
Tunisie	LL	t1	352	346	414	468	483	567	1138	285	791	791	949	1024	1011	1012	1016	1040	1038	1036	1030	1034	1007	7	6.2%	84%
EU.Italy	UN	t1	3	4152	1698	2540	1483	1891	5	329	694	718	3	32	8	5.0%	89%									
Algerie	LL	t1	247	247	133	99	52	93	496	492	802	468	459	192	356	384	549	558	666	9	2.3%	91%				
EU.Malta	LL	t1	72	100	153	187	175	102	257	163	195	362	239	213	260	266	423	532	503	460	376	489	410	10	2.2%	93%
Turkey	GN	t1	320	350	450	230	370	360	300	350	386	425	410	423	11	1.6%	95%									
Algerie	GN	t1	590	531	599	642	467	233	311	87	108	12	1.3%	96%												
Algerie	UN	t1	560	560	178	126	166	306	248	665	122	13	1.1%	97%												
Turkey	LL	t2	70	386	301	334	190	66	97	56	70	14	0.6%	98%												
EU.Cyprus	LL	t1	40	51	61	92	82	135	104	47	49	53	43	67	38	31	35	35	51	59	45	43	15	0.5%	98%	
EU.Italy	HP	t1	10	12	12	8	7	5	6	23	16	0.4%	99%													
EU.España	UN	t1	144	79	32	36	39	78	75	58	20	46	56	48	30	3	5	11	8	1	53	0	17	0.3%	99%	
EU.France	LL	t1	10	73	39	10	58	119	178	172	18	0.2%	99%													



**Figure 1.** Geographic distribution of swordfish cumulative catch (t) by gear, in the Convention area, shown for the 2010-2016 period (2017 SCRS Report - SWO Executive Summary, Anon. 2017).



**Figure 2.** Posterior probability contours range (from 1.0 in light yellow to 0.1 in red) for swordfish belonging to the South Atlantic population vs. all other populations (adapted from Smith *et al.*, 2015).

## References

Anon. 2017. Report for biennial period, 2016-17 Part I (2017) - Vol. 2 English version SCRS. p. 149.

Smith, B.L., Lu, C-P., García-Cortés, B., Viñas, J., Yeh, S-Y., Bremer, J.R.A. 2015. Multilocus Bayesian Estimates of Intra-Oceanic Genetic Differentiation, Connectivity, and Admixture in Atlantic Swordfish (*Xiphias gladius* L). PlosOne. <https://doi.org/10.1371/journal.pone.0127979>.