REPORT OF THE 2021 ICCAT INTERSESSIONAL MEETING OF THE SWORDFISH SPECIES GROUP
(Online, 31 May - 7 June 2021)

"The results, conclusions and recommendations contained in this Report only reflect the view of the Swordfish Species Group. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission revise them at its Annual meeting. Accordingly, ICCAT reserves the right to comment, object and endorse this Report, until it is finally adopted by the Commission."

1. Opening, adoption of agenda and meeting arrangements

Due to the outbreak of Coronavirus (COVID-19) the meeting was held online from 31 May to 7 June 2021. Dr. Rui Coelho (EU-Portugal), the Swordfish Species Group ("the Group") coordinator and Dr. Kyle Gillespie (Canada) northern Atlantic Swordfish rapporteur Chaired the meeting. Dr. Gillespie opened the meeting and welcomed participants. Mr. Camille Manel (ICCAT Executive Secretary) welcomed the participants and thanked the efforts made to remotely attend the meeting.

The Secretariat provided information on how to use the on-line ZOOM platform for the meeting. The Chairs reviewed the Agenda, which was adopted with minor changes (**Appendix 1**).

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

Sections	Rapporteur
Items 1, 9	M. Neves dos Santos
Item 2	C. Palma, C. Mayor, J. Garcia
Item 3	A. Hordyk, K. Gillespie
Item 4.1	R. Coelho, K. Gillespie
Item 4.2	A. Hordyk
Item 4.3	M. Schirripa, D. Rosa
Item 4.4	N. Taylor
Item 4.5	A. Hordyk, A. Hanke
Item 4.6	C. Brown
Item 5.1, 5.6, 5.7	K. Gillespie
Item 5.2	D. Rosa
Item 5.3	N. Bezerra, F. Arocha
Item 5.4	G. Gioacchini, O. Carnevali
Item 5.5	A. Hanke, D. Rosa
Item 5.8	R. Coelho
Item 6	R. Coelho, K. Gillespie
Item 7	R. Coelho, K. Gillespie, M. Neves dos Santos
Item 8	D. Parker, M. Neves dos Santos

2. Review of fishery statistics

The Group reviewed the most up-to-date swordfish (SWO) fishery statistics (T1NC: Task 1 nominal catches; T2CE: Task 2 catch & effort; T2SZ: Task 2 size frequencies; T2CS: Task 2 catch-at-size reported) and conventional tagging data, available in the ICCAT database system (ICCAT-DB). The three swordfish stocks (SWO-N: North Atlantic; SWO-S: South Atlantic; SWO-M: Mediterranean) were presented individually. **Tables 1 A/B/C**, are the corresponding SCRS catalogues on fisheries data availability for the period 1990-2019 (2020 statistics still preliminary).

2.1 Task 1 (nominal catches) data

For the three swordfish stocks (SWO-N, SWO-S, and SWO-M) only minor revisions were made to the most recent years when compared to the corresponding SWO statistics adopted at the 2020 SCRS annual meeting. In line with the work done with other ICCAT species, the Secretariat continues its progressive work aiming to eliminate the SWO catches with unclassified gears (UNCL and SURF) by reclassifying them with the correct gear, and also with the elimination of historical LL gear codes discontinued by the SCRS (LLHB, LLFB, LLMB) by reclassifying them into the new LL codes (LLSWO, LL-surf, etc.). No gap completion analyses has been made this time to the current T1NC on the three stocks. The Group adopted the SWO Task 1 catches presented by the Secretariat and discussed the need for 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) reported by ICCAT CPCs and recorded in the ICCAT database system (ICCAT-DB; see recommendations in section 7 of this report).

The Group observed again that the SWO discards (both dead and alive) reported by the ICCAT CPCs are still very incomplete despite being mandatory. The lack of reported discards underestimates the total removals of each SWO stock per year, which may have negative impacts on the stock assessment process (e.g.: wrong perception of stock status). Despite this outcome, the Group strongly recommends that both dead and live discards be estimated by each CPC and reported to ICCAT for new and historical catch records.

Table 2 presents the final SWO T1NC estimations by stock/gear group and year. **Figure 1** presents the T1NC estimations by gear group and year for the three swordfish stocks.

SWO-N (North Atlantic swordfish stock)

After the large reclassification made by this Group in 2020 (Anon, 2020) the unclassified gear group (gears "UNCL", "SURF") for SWO-N only represents about 0.1% of the total catches between 1950 and 2019 (**Table 2**), where longline accounts for more than 90% of the total catches.

SWO-S (South Atlantic swordfish stock)

The situation is similar the SWO-S stock in terms of unclassified gears, with gears "UNCL" and "SURF" being less than 0.6% of the total catches between 1950 and 2019 (**Table 2**). The longline catches represent more than 95% of the total catches.

SWO-M (Mediterranean Sea swordfish stock)

After the large revision made during 2020 (Anon, 2020) by this Group, the unclassified gears ("UNCL", "SURF") has been reduced to less than 1% of the total catches between 1950 and 2019 (**Table 2**). The total catches are mostly attributed to longlines (64% of the total) and gillnets (34% of the total). The gillnet catch series are residual since 2011.

Some important SWO-M catch series for which the Group could not find a proper solution (requests pending from 2020), and no progress was made over this year, are:

- EU-Spain UNCL catches between 1992 and 2007 could contain GILL (a fraction only). This gear reallocation requires the participation of Spanish scientists.
- NEI (MED) catch series for GILL (1984 to 1992) and LL (1980 to 1992) have no flag association (both series estimated at the 1992 GFCM-ICCAT joint meeting). This could lead in the future (after a full recovery of all the GILL and LL catch series) to double counting those catches.

This Group should continue to make efforts to address and solve these problems in the future.

2.2 Task 2 (catch-effort and size samples) data

As shown in the swordfish SCRS catalogues (**Tables 1A, B** and **C**) both Atlantic stocks are reasonably well covered in the last 30 years (1990-2019) in terms of Task 2 coverage, with the SWO-N (score = 7.9) in a slight better shape than SWO-S (score = 7.0). The Mediterranean stock (SWO-M) is in a comparable worst shape (score = 4.4). The ICCAT standard scorecard adopted by the SCRS in 2019 with all the species and stocks (**Table 3**) allows to compare three-time scales (10, 20 and 30 years) among all ICCAT managed species/stocks.

Important gaps in both T2CE and T2SZ still exists. As for other ICCAT species, the Secretariat has in place since 2014, a long-term project aiming to (a) recover missing Task 2 datasets, and to, (b) improve the level of Task 2 resolution and harmonization (replacing year/trimester by month, replacing 20x20/10x20/10x10 grids by 1x1 and 5x5, harmonise efforts by gear, harmonise/improve size/weight classes, etc.). This work supported by the SCRS (committed to a long-term improvement of ICCAT statistics) requires the participation and full commitment of the ICCAT CPC scientists. The Secretariat is using the SCRS catalogues as one of the important instruments used to request revisions to ICCAT CPCs.

Three documents were presented on fisheries statistics:

SCRS/2021/017 presents the problem created by the collection of curved LJFL in SWO by some observers' groups, in contrast with the standard straight LJFL measurements. This issue, in the absence of a published ICCAT code for the curved LJFL (CLJFL exists but it is not published in the SCRS forms), induced a mixing of different measures in ICCAT Task 2 database, created possible biases in the assessments after 2016, and made the results of several scientific papers that used these measurements difficult to be compared with previous papers. The paper also reviews the main regulations on the minimum size, detecting those where the type of measurement is not well defined, and considers the legal implication. Therefore, the authors propose several recommendations which the Group reviewed, and the conclusions are reflected in the Recommendation section.

The Secretariat pointed out that, independently from the type of measurement, it should be useful to have a precision range associated with each type. Also raised was the problem of taking measures in difficult conditions on board. The Group expresses its interest in the issue and its will to take into account the recommendations. It was also recommended that, due to difference in condition between male and females, sex specific conversion factors be examined. The importance of standard and correctly reported measurements was highlighted especially from a minimum size enforcement standpoint. The discussion centered on types measurement collected from various CPCs. It was mentioned that observer programs in Venezuela, Uruguay and USA have historically collected curved fork length. On the other hand, Mediterranean fleets (e.g. Italian, Spanish, Greece) are measuring in straight LJFL and in most recent years the curved LJFL on the Domestic Observer Programmes. From a practical perspective, it was recognized that measuring straight LJFL at sea is problematic. This discrepancy in reported measurements is an issue and should be taken into consideration when reporting stock assessment parameters. The Secretariat and CPCs indicated that they will be taking steps to ascertain which type of measurement is reported by CPCs.

SCRS/2021/092 reported on evidence that the swordfish is slowly returning to the Black Sea and adjacent areas, after several decades of absence. The first evidence from the Marmara Sea is from 2016, while the first catches in the SW part of the Black Sea were made in 2018. All the information is coming from Turkey, while no data are available for the other coastal states, possibly showing that the swordfish is progressively returning to the Black Sea. All events are documented also with all the available information and pictures. This new information, which is very positive, shows the recovery of an ancient distribution area by this species and the author recommends that local scientists monitor this space recovery.

The Group welcomed the new information.

SCRS/2021/096 provides a comparative analysis of the SWO size measurements of the Chinese Taipei longline fleet in the Atlantic Ocean, obtained by the National Data Collection System (2002 to 2019). The comparison was made to explore potential inconsistencies between the data from logbooks and the records from onboard observers. Larger and juvenile swordfish were both captured in open waters of tropical Atlantic Ocean. Swordfish larger than 150 cm LJFL account for a larger proportion of the catch for the Chinese Taipei longline fishery. Small swordfish (<125 cm LJFL) were recorded by observers, but rarely shown in the logbooks because the captains and crews did not bring the fish onboard and released the fish directly.

Questions centered around which data were reported to ICCAT and how length measurements were obtained. The presenter indicated that Task 2 data are from logbooks and observer data are also reported since 2015, which was confirmed by the Secretariat. Furthermore, the presenter clarified that length of discarded fish were estimated not measured and that the proportion of live and dead discard is unknown. It was suggested that methodology should be developed to integrate logbook and observer data and that this paper highlights the importance of observer programs. Given the new information, the Group inquired if Chinese Taipei will be submitting revised data. The presenter indicated that revised submissions are possible. The Group thanked the authors for their analysis and encouraged Chinese Taipei and other ICCAT CPC scientists to use their Domestic Observer Programme information to estimate SWO discards (if possible, separated into dead and alive) and report them to ICCAT.

2.3 Tagging data

The Secretariat presented a summary of swordfish conventional tagging updated in terms of total number of records, valid records and records under review. **Table 4** shows releases and recoveries per year and **Table 5** shows the number of recoveries grouped by number of years at liberty. Three additional figures summarise geographically the SWO conventional tagging available in ICCAT. The density of releases in 5x5 squares (**Figure 2**), the density of recoveries in 5x5 squares (**Figure 3**), and the SWO apparent movement (arrows from release to recovery locations) shown in **Figure 4**.

3. Review of work done in 2020/early 2021 on North Atlantic Swordfish MSE

The Chair gave a presentation (SCRS/P/2021/040) with an overview of the MSE work for the northern swordfish in late 2020 and early 2021. The last stock assessment of swordfish, conducted in 2017 and using data up to 2015, estimated the spawning biomass to be close to SB_{MSY}, and fishing mortality to be below F_{MSY}.

The operating model uncertainty grid for the MSE was first developed in 2018, with 7 axes of uncertainty and a total of 288 OMs. Based on an examination of the preliminary results from this uncertainty grid, the MSE modeling group made three changes so far in 2021: 1) the conditioning model was updated to the latest version of Stock Synthesis 3 (v3.24 to v3.30); 2) two axes of the uncertainty grid (CPUE CV and effective sample size of the length composition data) were collapsed in to a single axis with three levels of relative weighting between the two data streams; and 3) the model was updated to include a retention curve and an assumed level of 88% discard mortality on the undersized fish.

The Group briefly discussed these changes, particularly the data-weighting and discard mortality, and noted that they would be discussed in more detail in later sections of the meeting.

4. Further development of the MSE workplan and roadmap for ICCAT North Atlantic Swordfish MSE process

4.1 Implications of the new MSE roadmap adopted by the Commission

The SWO Coordinator presented the latest version of the MSE roadmap adopted by the Commission. After presentation and discussion of the MSE work (sections 4.2 to 4.6 of this report), the roadmap was again discussed and edited. Most of the activities related with the SWO MSE progress seem to continue to be on time for possible adoption of an interim MP by the Commission in late 2022. One activity that was delayed was the work on the exceptional circumstances, as the Group noted that at this point, it might be better to see how ALB progresses on that point, and also that it is possible to adopt an interim MP before work on exceptional circumstances in completed.

The roadmap with the new edits introduced at the meeting is presented in **Appendix 5**. The MSE roadmap will be further analyzed and edited as needed at the September SWO Species Group meeting, after the update of the MSE status then.

4.2 Discussion on the MSE code review

On behalf of the contractor (Landmark Fisheries Research), S. Johnson presented the *Peer review of the north Atlantic swordfish management strategy evaluation (MSE) code and algorithms* (SCRS/2021/097). The review focused on 2 main areas: 1) documentation of the code and 2) examination and simulation testing of the code.

The contractor discussed three major recommendations for the documentation. In particular, the contractor stressed the need for a more detailed description of the algorithms used to collapse the two-sex, multi-fleet Stock Synthesis 3 (SS3) model into the single-sex and aggregated fleet operating model (OM) used for simulation testing of management procedures in the MSEtool package.

Next, the contractor summarized seven major code recommendations. He noted that the plus-group calculation code was incorrect, and the error would bias the simulated population under recruitment process errors. The MSE contractor agreed that this was an important issue to be fixed and noted to the Group that this error did not impact the analyses done so far and would be fixed before simulation testing of management procedures would commence.

The contractor recommended additional testing related to the aggregated selectivity model. First, a sensitivity analysis of the weights used to average the aggregated fleet selectivity, and second, that additional projection uncertainty axes changing the selectivity pattern in the projection period given the uncertainty in the estimates used to define the aggregated selectivity.

The third major code recommendation was to relax the convergence criterion of the Newton-Raphson algorithm used to calculate fishing mortality from the total allowable catch (TAC) limit and recommended a relative error instead of an absolute error. The contractor also recommended the removal of redundant and commented out code from the MSE package to improve readability and reduce the likelihood of errors in future applications of the code.

The next recommendation was to compare the simulated length-composition data from the aggregated fleet model used in the MSE testing to the predicted data from the SS3 models, after aggregating according to the weighting used for the selectivity model. This would be especially important given that the simulated length data may be used by candidate management procedures to generate TAC advice.

The final major code recommendation was to investigate why the simulated catches from the model were not constant when tested with constant catch management procedures. There was some discussion in the Group if this could be related to the discarding or to the previously mentioned issue with the plus-group calculations. The contractor noted that either of these options could be possible, or it could be related to some other issue, such as a lack of discard induced mortality within the total mortality term in the Baranov catch equation. MSE analysts should do further testing to understand the cause of the issue and fix any issues related to it.

The Group discussed if there were benefits to simulating a larger number of age-classes in the OMs, instead of a relatively large proportion of the population accumulating in the age 25+ plus-group. The contractor noted that this was possible to do but would likely lead to increased computational requirements that would be unlikely to impact the population dynamics in any meaningful way.

The contractor concluded by noting that, in general, the SWOMSE package and its dependent package MSEtool were good examples of applied scientific computing software, that would help identify suitable management procedures for the SWO fishery after the Major recommendations are addressed.

The Chair of the Swordfish Species Group thanked S. Johnson and Landmark Fisheries Research for their thorough review of the MSE documentation and code.

4.3 Discussion of finalizing the reference set of OM's

The Group was presented with paper SCRS/2021/098 on data weighting within the OM. The data weighting investigation compared three different methods of varying the weighting of the length-composition data and the CPUE indices within the OM. The intent of the work was to include the uncertainty in the proper

weighting of each data source into the overall uncertainty grid. The results of the investigation showed that the method (Method 2) that fixed the lambda of the length data at 1.0 and varying the lambda on CPUE data best described the uncertainty that should be included in the uncertainty matrix.

It was noted that a weight of 0.10 on CPUE produced a higher percent change than the 0.05 weight. It was explained that the resulting estimates when changing weight on data sources are not linear, and that the differences might be metric specific, for example, the 0.05 weight on CPUE had the biggest percent change in virgin biomass, but not on stock status. Further exploration of model results is still necessary to fully understand these dynamics.

The Group agreed on the use of one axis of uncertainty (changing the lambdas on CPUE) instead of having the CPUE CV and ESS axis, however further investigation into the exact weight of the different data sources is still necessary.

The presenter also showed how including discard mortality influenced the estimates of yield, retained and discarded.

This analysis assumes that the selectivity is the same before and after the implementation of the minimum size regulation, however if fishermen have moved away from areas with small swordfish the selectivities have changed.

Currently an 88% discard mortality is being applied, modelled as to include at-haulback mortality and post-release mortality, and also assumes that all fleets have the same discard mortality. It was noted that this estimate is from a work on at-haulback mortality of swordfish (Coelho and Muñoz-Lechuga, 2019), and that this value is related to fish under 125 cm LJFL, as it was found that at-haulback mortality decreases with increasing swordfish size. Concerns were raised as to if this value is too low (post-release mortality should be added) or if it applies to all fleets (some might have lower at-haulback mortality e.g. due to circle hook usage, fish size, SST).

It was suggested that discard mortality could be an axis of uncertainty in the grid, or as robustness OM. The Group agreed to keep the 88% discard mortality and agreed to explore alternative discard mortality in Robustness OMs.

The Group acknowledged the progress done in this work and supports further analysis and implementation on the grid.

Documents SCRS/2021/099 and SCRS/2021/100 were presented and discussed together.

Document SCRS/2021/099 presented an update to the operating model uncertainty grid. The revised grid has 6 axes of uncertainty, with 2-3 levels within each axis, for a total of 216 OMs. The results found the three levels of natural mortality (M), three levels of steepness (h), and three alternative weightings of the indices and length composition data had the largest impact on the variability in the estimated stock dynamics. Down-weighting the CPUE indices resulted in markedly higher estimates of stock status, particularly when M and h were in the highest levels.

Document SCRS/2021/100 presented OM fit to indices (CPUEs) and length composition data. Plots of the fits to these input data are shown for the three levels of relative weighting to the CPUE and length composition data and the three levels of natural mortality. In general, the overall fits to the CPUE indices were poorest for the OMs where M = 0.3. The estimated stock status for these OMs was the highest (mean spawning biomass relative to spawning biomass at maximum sustainable yield >2), although the variability in the estimates was also the highest for this level.

The author showed the length composition data that has an apparent "shift" between the pre-implementation of the minimum size measure and the post-implementation for some fleets. Results currently presented are "corrected" for this apparent shift, until further analysis is performed to discover the reason for this. Several explanations for this apparent shift were discussed, one possible explanation is that data is reported in different size bins and bin assignment could be different between the two periods, it could also be a length type issue, or possibly different conversion factors being applied between different periods. The Secretariat agreed to investigate the reason behind this shift in the coming months.

The author noted this work was a preliminary look and the results should be considered more for the approval of methodology as opposed to final results.

The Group discussed the various graphics and possible explanations for some of the observed patterns. Some patterns discussed were the spread of the population trends and the bimodality of the density plots. It's possible that some of these patterns are a result of the steps in the uncertainty grid (e.g. step of 0.10 in natural mortality and steepness).

Several aspects of the fit to CPUE were discussed. It was noted that there is conflicting signal between CPUE and length data when M values are high (M=0.3). It was also noted that it looks like CPUE fit is best for fleets that catch larger fish than for fleets where catch is composed of smaller fish.

Following the discussion to each document there was a more general discussion of the current development of the MSE and future steps.

During the several presentations under these sections, the Group was presented with several changes to the OM grid that were introduced by the Core Modeling Team. After a presentation as to why the changes were made the Group agreed to the recent changes to the OM grid (collapsing the two effective sample size (ESS) and CPUE CV axes to a single axis that deals with weights of data sources). The relative weighting of the two data sources will be further explored. Moreover, the Group agreed with using the Stock Synthesis software version update, from version 3.24 to version 3.30, as presented in Schirripa and Hordyk (2020).

There was a short discussion on the inclusion of the environmental effect, this axis does not seem to influence the stock status or trends. It was noted that despite not seeming to have an effect in the historical period, the AMO effect should be considered in the projections. There was also a comment that the recent genetic studies seem to indicate that there is mixing between the South and North Atlantic stocks and also between the North and Mediterranean stock, and it is still unknown how this would impact the stock estimates.

There was a general discussion on the details of accounting for discard mortality in the OM grid, the current swordfish minimum size regulation, the appropriate modeling of the regulation, and the details of the discard mortality rate selected. The authors explained that, given the various nuances of the minimum size regulation (e.g., the 15% allowance, in numbers, of undersized fish, when the 125 cm LJFL exception is taken), it was not possible to model the regulation exactly with the current OM. However, the manner in which it is being modeled should be sufficient to evaluate the effects of this, or similar, regulations. The Group discussed the value being used for discard mortality (88%) and how this rate was arrived at, how it can change in relation to several covariates (e.g., temperature, fish size, gear type) and how it can vary between fleets. The authors agreed that while all of these factors do in fact influence the actual discard mortality rate, with a discard mortality as high as 88%, changes of plus or minus ±10% would not significantly change the results of investigations into the effects of the regulation.

The Group then briefly weighed the merits of the minimum size regulation in general and whether, given the high rate of discard mortality and the 15% undersized fish allowance, the regulation was having the desired conservation effect. However, it was pointed out that nothing had been presented at this meeting to suggest this conclusion could be reached and that further work needed to be done before any conclusions could be drawn. Consequently, the decision was made to continue investigation of size data and the impacts of the minimum size regulation and its potential role in the North Atlantic Swordfish MSE.

The Group discussed the work presented on data weighting and thought that further investigation was warranted. However, an inquiry was made as to exactly what question was being asked in order to guide the continued investigation. In response, the Group discussed that since the CPUE data and the length data provided differing evidence with regard to the status of the stock, that they represented two, equally plausible, hypotheses. And as such, each hypothesis should be represented within the OM grid. The Group felt that more work should be conducted before the set of observational lambdas were finalized but did not recommend any specific course of action.

The Group agreed that the use of a select set of standard stock assessment diagnostics, such as those presented at the 2021 Working Group on Stock Assessment Methods meeting (WGSAM), were an appropriate way forward to help with determining OM grid model plausibility. These diagnostics could include, but not be limited to, hindcast-cross validation, tests of convergence and tests of model stability. The Group discussed that perhaps such diagnostics need not be run on all models contained within the OM grid, but rather a selected few that represented more extreme hypotheses. The plausibility of some models with regards to stock status estimates or trends, for example, in some models the stock had suffered almost no depletion, was questioned. The development of plausibility tests to check for combinations that are not biologically sensible was also discussed.

4.4 Discussion on performance metrics

Document SCRS/2021/094 concluded that the key MSE Performance Indicators for the northern SWO MSE should be the probability that the stock is in the green quadrant of the Kobe matrix, the probability that the stock is above the Limit Reference Point, mean catches, and the average variability in yield between time periods. Additional precision from the Commission is needed over what time period Performance Indicators are to be calculated, required probabilities in Res. 19-14, the assessment period interval, and if/what additional Performance Indicators should be presented.

The Group discussed how to consider risk and how these statistics should be averaged across many OMs. By way of a response, it was noted that one way to consider the mean risk was as the product of the probability of an event and the consequences of that event; lacking some sort of cost function to describe the consequences of a given event it was not possible to calculate risk. With respect of averaging across OMs, it was noted that the Group had a number of options: present results for a smaller reference set; they could attempt to weight each OM quantitatively; or they could use equal weights for each OM.

The Group discussed the list of possible performance metrics that had been compiled for northern albacore. It was noted that in the in the initial discussions about Performance Indicators for the stock, PA2 had proposed a very large list of indicators that was subsequently pared down. The Group agreed that as an initial proposal, they would use the set of key performance metrics and the larger list that had been used for albacore as a place to start discussion with Panel 4 about Performance Indicators.

The Group discussed Radar plots (also known as Spider Plots) as a way to present the performance of a given MP. Some in the Group liked these plots, others did not. One drawback was how to interpret the plot´s area. Some noted that these plots need not be considered as a quantitative tool, i.e. that it should not be examined by area at all but rather as a tool about how to look at each axis individually. The Group agreed that as long appropriate explanation for interpreting them, RADAR plots may prove to be useful.

4.5 Discussion on start testing of candidate management procedures

The Group discussed:

1. The acceptability of model based and empirical cMPs
2. The data that would be simulated for cMP development
3. The SLICK cMP performance evaluation tool.

It was noted that cMP development had been delayed by progress in developing an agreed upon reference grid of operating models. Nevertheless, it was agreed that the Group did not need to be prescriptive with respect to the development of particular kinds of cMPs (model-based vs empirical) and it should be left to managers to decide which type of MP was preferred based on the performance of their metrics. It was discussed that the functioning of empirical MPs were easy for managers to understand and that model based MPs can require more inputs, need to be evaluated for fit and require more computing time during simulation testing, however in principle it was acknowledged that it would not be an issue to include a variety of surplus production type models in the MSE package. An advantage of a model-based MP is its ability to provide reference point and absolute biomass estimates whereas an empirical MP does neither. Finally, it was clarified by the MSE developer that any cMPs provided would be run against the reference grid in preparation for the next meeting of the Group. It was noted that OpenMSE has 128 CMPs built into the package that are available for testing and the Group is encouraged to develop or continue to develop custom MPs.

The discussions on which data should be simulated for cMP development concluded that in order to ensure the greatest diversity of cMPs for testing, the individual regional indicators, combined index and catch composition should be projected. Developers would then have maximum flexibility to design their best performing MP. It was noted that updates of the combined index will not be provided as a regular contribution of the Secretariat and that it will depend on CPC scientists or an external contractor to complete. Further, it was noted that confidentiality issues may affect the generation of the combined index into the future. It was suggested that if an index based on the combined index was selected for providing advice, then there may be extra incentive to overcome confidentiality issues. Also, it was noted that the strict data sharing rules of the USA is not expected to affect its ability to participate in future combined index updates. The availability of fleet CPUEs into the future was an important consideration in terms of what should be projected and it was noted that the advantage of a combined fleet index was that it may be robust to the unavailability of a CPC's data. There was, however, discussion on how robust the combined index would be to missing data, as discussed in section 4.6.

In the case of length-based indicators, the dependency on the Secretariat was recognized for providing the necessary length composition data. It was indicated that an advantage of length-based indicators was that they are relatively easy to calculate and thus could also be used to detect exceptional circumstances (although concerns were raised about the ability to do so on an annual basis, as discussed in section 4.6). Given that length-based indicators could be tested in a closed loop simulation, their usefulness for providing TAC advice could be evaluated.

With respect to the properties of the projected indicators, it was clarified that the projected indicators would mimic the properties of the real-world index. Thus, both the stimulated and real-world indices would represent the relative abundance for the same indexed age groups and the simulated index has the appropriate error added in order to simulate the performance of the real-world index.

With respect to the time scale for review of CPUE indices used in the MP, it was clarified that this would occur in the year of the MP update year. However, if a CPUE index was considered appropriate for use in monitoring for exceptional circumstances, there would not be an annual requirement for review. The index data would be updated and the base model rerun in each year except in an MP update year when a review and potential revision of the base model would occur.

The Group reviewed the Shiny application, called Slick (https://harveststrategies.org/management-strategy-evaluation/presenting-mse-results/shiny-app/) that demonstrated the relative performance of competing cMPs for a suite of performance metrics using a variety of visualization options. The Group recognized the usefulness of the package for assisting with cMP selection and suggested potential refinements. It was recognized as a useful tool for managers to appreciate the trade-offs when attempting to achieve multiple management objectives. The standardized approach for visualizing MSE data from any MSE process was considered a very useful attribute.

4.6 Proposal on criteria for determining exceptional circumstances

Advice intervals

The Group was presented with a table (**Table 5**) outlining a candidate framework for advice intervals. The table summarizes the frequency of MP application, relative to MP implementation, stock assessments, EC evaluations, and the data requirements for each component. It was proposed that the application of the MP could occur in the third year of each 3-year MP advice interval, with exceptional circumstances monitoring occurring whenever the relevant data for this evaluation are updated. TAC would be fixed through each interval, to enhance catch stability. Under this proposal, stock assessments would be planned to occur every sixth year of the cycle, but could be invoked earlier if triggered as a response to exceptional circumstances.

Concerns were raised about the demands of evaluating exceptional circumstances every year. However, it was noted that in most cases the check for the existence of exceptional circumstances is not expected to require major effort (e.g. catch, relative to TAC). Furthermore, some indicators used for monitoring would be unlikely to change much each year.

It was suggested that the impact of different advice intervals on MP performance could be assessed in order to inform the selection of interval length.

With respect to the timing of OM reconditioning, some questioned if it would be necessary to do so. The Group considered that reconditioning should only be necessary if and when there was strong evidence that conditions had changed enough to warrant reconditioning.

Overview

SCRS/P/2021/041 provided an overview of criteria used for detecting exceptional circumstances (ECs) among ICCAT MSE processes. ECs occur when reality diverges from scenarios that are simulated in the analyses conducted to adopt the harvest control rules. The presentation reviewed potential EC indicators, the criteria used to evaluate those indicators, the frequency at which criteria are evaluated and the decision process that occurs after ECs are detected. The presentation paid particular attention to the ongoing EC work of the Albacore Species Group and Panel 2 and noted if and where the Swordfish Species Group may consider diverging from that process.

The Group discussed several of the points raised in the presentation. It was noted that some potential approaches to evaluating exceptional circumstances could be difficult to carry out on an annual basis; for instance, the work involved with the length-based indicators may be prohibitive to do annually.

There was some discussion as to whether or not the unavailability of one CPC's data (temporarily, or permanently moving forward) from a combined index would necessarily trigger exceptional circumstances. It was noted that this could be tested in an assessment context by evaluating the impact of removing that CPC's data from the calculation of a combined index used in a model. A question arose as to whether or not such an absence of data for the combined index (e.g. missing data for a fleet that was included in the construction of the combined index, which was then used in the MP) could be tested within the MSE. The MSE contractor responded that that could be done, if the process for developing the index were modeled within the MSE.

The Group noted that the development of protocols for evaluating exceptional circumstances, and of defining appropriate responses if exceptional circumstances are declared, is advancing for both the North Atlantic ALB and BFT MSEs. It was also noted that there is a benefit to consistency in the protocols across species, while allowing for differences due to differences in fisheries, life history, and MP structure. Therefore, there was general agreement that development of exceptional circumstances protocols for SWO should have a lower priority relative to other needed work on the OMs and MSE, which would permit the protocol development to be informed by the work of the other Species Groups and Panels.

5. Update of the ongoing and future activities of the Atlantic and Mediterranean Swordfish Programme

5.1 Review of the 2021 Swordfish Biology Workshop Report

SCRS/P/2021/038 provided an overview of progress on the ICCAT swordfish biology program in the North and South Atlantic and Mediterranean. The author reviewed the program objectives related to the main project study areas: sampling, ageing and growth, reproduction and maturity, and genetics. There was a description of sampling materials collected and the spatial-temporal coverage relative to fishing catch, noting areas where further samples were required. The presentation briefly described progress related to the progress of the project study areas and described analysis next steps, noting that further analyses would target unknowns important to the stock assessment and MSE processes.

The Group thanked the labs and experts contributing to sample collection and analysis, noting the broad collaboration among the many Groups. There was brief discussion on priority locations for additional sample collections to fill spatial-temporal gaps (see section 5.5). There were offers from members of the Group to fill some of these gaps and the potential to obtain samples from additional gear types.

SCRS/P/2021/042 described the ICCAT swordfish biology workshop, held online 22-26 March 2021. The objectives of the workshop included creation of ageing and maturity reference sets and planning for next steps for analysis of spines, otoliths, gonads and tissue samples. The workshop included scientists from ICCAT CPCs, the ICCAT Secretariat, academia, private research institutes and invited experts. Major progress was made on developing a standardized set of protocols for both assessment of age and maturity

stage. The workshop participants reviewed initial results from project collaborators related to genetic analysis. A number of recommendations were developed to strengthen future sampling efforts and cataloguing of those samples.

The Group noted the progress related to creation of reference sets for ageing and maturity.

5.2 Update on ageing and growth analyses

Presentation SCRS/P/2021/037 showed an update on the age and growth component of the biology program for swordfish. For this component, both spines and otoliths are being collected and processed for comparison of age readings between both structures. Progress on this component under Phase 3 was made on the processing of further samples and the start of a reference set for both spines and otoliths. Future sampling needs was also presented.

The Group acknowledge the presentation and encouraged for the continuation of sample processing and analysis.

5.3 Update on reproduction and maturity analyses

There were no additional analyses available for presentation on reproduction and maturity.

5.4 Update on genetic analyses

Presentation SCRS/P/2021/039 provided a brief but comprehensive overview of all results achieved during the study. Regarding genome assembly and comparative genomic analysis already concluded, the authors presented total number of genes, genes shared with other fish, swordfish-specific genes, the gene families in expansion and in contraction and a general overview of the whole genome structure. The authors then discussed the results regarding the genetic population analyses. The PCA showed a strong genetic diversity (PC1=62.3%) between Mediterranean and Atlantic specimens, however BIL94B seems to be a mixing area. With the set of samples available, the preliminary genetic analyses confirmed two main SWO populations: Atlantic and Mediterranean, with two sub-population in the Atlantic (NA and SA). The report of the workshop showed that two possible sub-population have also been found for the Mediterranean although results do not allow us to clearly attribute populations to different fishing areas.

The Group asked if there is overlap among the populations. Details on the results presented in the previous meeting have been reiterated, there is a clear albeit limited allelic frequency typical of both the Atlantic and Mediterranean. Similarly, specimens fished in Atlantic showed allelic frequency of Mediterranean fish. All data confirm the sharing of allele frequencies between the 2 populations.

The Group asked if it is possible to do epigenetic analysis for the determination of age. The importance of the study of the epigenome in particular of the methylome for the determination of age was emphasized. This technique is already in use for other species including humans and some fish. The process requires optimization and standardization of a reference scale in which the specimens have been classified through conventional methods. At each age will be assigned a specific grade of methylation through which it will be possible to estimate the age of the specimen in question.

Finally, the Group requested details in the sex determination through genetic analysis (WGS). Information about the possibilities offered by the WGS results that should provide a set of genes for gender identification should be obtained. This will also make it possible to classify the sex of the landed specimens who arrived eviscerated. In addition, the WGS can make us identify a set of specific genes to quickly and inexpensively identify the different subpopulations.

5.5 Discussion on sampling activities

Presentations on the Biological Sampling Program and analyses related to ageing and genetics were reviewed by the Group. The Group acknowledged the significant effort and success of the Consortium in terms of the scope and numbers of the samples collected as well as the quality of the analyses. The program was compared with more successful broad scale efforts to collect data on marine turtles and sharks. The Group encouraged the consortium to continue their work and expand the list of contributors.

Discussion on priority sampling areas for the next phases

The Group suggested that priority areas for sampling in Phase 4 should include the area southwest of the Sargasso Sea between December and July where swordfish are known to spawn; the waters surrounding Cabo Verde archipelago; the Gulf of Mexico; the western Caribbean Sea; the eastern Mediterranean (e.g., Turkey) and the Mediterranean Sea during the winter months when there is no swordfish fishery. Analysts involved in ageing also indicated gaps in sampling associated with large and small swordfish and certain quarters when there is no fishing while analysts involved working on genetics requested more samples from the southern Atlantic and also expressed interest in obtaining historical samples of tissue.

It was questioned if young of the year samples would be useful. It was noted that for daily ring counts fish would have to be less than 70-80 cm LJFL. It was noted that while samples of fish between 70 and 80 cm LJFL could be provided from some areas (eastern Caribbean Sea), these samples are relatively rare. Nevertheless, even a few samples were considered important for resolving ageing questions related to daily growth. Discussion on where the samples of small fish could be obtained indicated that fleets observing the 125 cm minimum size threshold have a 15% allowance to retain undersized fish whereas those observing the 119 cm threshold would not be able to contribute without a research mortality allowance.

It was clarified that historical samples would be accepted by the consortium to inform on assessment related objectives and fill gaps in our knowledge about the biology of the species. The USA noted that it had resolved its data confidentiality issue for a large fraction (440/928) of the samples from 2002-2003 that it provided to the consortium allowing it to provide the requested month and 5-degree square information (440 specimens have time and location information provided). It also offered to provide samples from gears other than longline (buoy gear, deep drop lines, sport) which the group supported. Uruguay noted the inability to contribute samples during the pandemic due to lab closures and indicated that genetic and gonad samples from the area south and east of 20 degrees south latitude would be forthcoming.

Discussion on logistics of specific materials collection (e.g., gonads, otoliths, vertebrae)

The Group noted that shipping samples was a major logistical hurdle especially when a preservative was included with the sample. Coordination of the sampling to address the gaps identified by the Group and analysts was considered important and that this should also include a prioritization of the gaps given the uncertain funding situation. It was acknowledged that priority should be given to filling gaps that result in products which support the assessment. The need to increase the compensation for gonads was expressed given that these samples are more difficult to obtain and store.

5.6 Project Phase 4 planning and Terms of Reference

The Group reviewed Terms of Reference for Phase 4 of the biology project. Sampling and analysis will focus on addressing gaps noted in Section 5.5.

5.7 Planning for Phase 5

The Group briefly discussed priority analyses for future project phases, including age validation through bomb radiocarbon.

Update on SWO satellite tagging

The Group was informed about the status of the satellite telemetry tagging for swordfish. In 2019, eight miniPAT tags were deployed in swordfish by observers on EU-Portugal and EU-Spain vessels and the Uruguayan research cruise in the North and South Atlantic (Rosa *et al.,* 2020). In 2020 most onboard observer programs were stopped so there were no opportunities to deploy tags. In addition, because of the battery issues with wildlife computer tags, the tags had to be returned to the manufacturer for a battery replacement. The replacements and new tags have just arrived to ICCAT Secretariat (17 May 2021). Those tags are being distributed to the same teams that had them before (2018-2019), namely 12 tags for the Mediterranean (four for France-Corsica with Francois Poisson; 4 for Spain IEO-Malaga with David Macias; and 4 for Italy with Fulvio Garibaldi). Additionally, eight are scheduled for the Atlantic (IPMA-Rui Coelho, both for the NE Atlantic closer to the Iberian Peninsula and in the Equatorial stock mixing area).

In addition to those previous 2019-2020 tags now replaced, in 2021 there was the acquisition of 12 new tags. The original strategy was to deploy the tags in the Mediterranean and closer to the stock mixing areas (Med:NE Atlantic, and N:S Atlantic). The Group will continue to evaluate if tagging should be expanded beyond those priority areas. The SWO tagging coordinator will contact the existing teams immediately after the 2021 Swordfish Intersessional meeting to coordinating the shipment of tags aiming deployment during 2021. This process might be somewhat delayed as during this meeting the Secretariat received a communication from the tag manufacturer (Wildlife Computers) regarding a new issue on the tags software bug, which is expected to be solved soon. But as soon as that is solved by wildlife computers, the tags will be distributed.

5.8 Other biological information

SCRS/2021/059 summarized the biological samples collected for swordfish under the Chinese Taipei domestic observer program from 2019 to 2020. The samples were examined by fish size, gender, month, and sampling location. In total, biological samples were collected for 66 individuals for 1 year of sampling, which include length and weight data, anal fin spines, gonads and otoliths. Spine samples were available for juvenile swordfish under 120 cm LJFL for both sexes. However, otoliths were only available for male samples smaller than 90 cm LJFL. Both spine and otolith samples have been sent for further ageing analysis as part of the ICCAT swordfish biology programme.

In the discussion, the ability to collect complete sample sets for each specimen has been highlighted, as well as the importance of the onboard observers for this sampling activity. It is hoped that this work will continue also in 2021, even if problems related to the Covid 19 will be probably limited to the opportunity of collecting muscle samples for genetic analysis.

A preliminary analysis on the presence and distribution of swordfish larvae in the Balearic area was presented in SCRS/2021/093. Authors analyzed the possibility of applying TUNIBAL surveys to investigate the early life ecology of the Mediterranean swordfish, exploring the hydrographic preferences of larval habitats. The estimated larval index of swordfish in the period 2012-2016 shows an initial increase between 2012 and 2014, followed by a decrease of abundance between 2014 and 2016. Further work could include processing already collected data from recent years using the same methodology and, if gear standardization is possible, use of earlier samples.

During the discussion it was observed that the number of sampled larvae is rather low (36 in the period from 2012 to 2016), probably due to the fact that the survey was designed mainly for other species and to the different reproductive behavior of swordfish compared to the other tunas. Suggestions have been made regarding sampling strategies (depth and different types of bongo nets used (bongo 90 and 60) to optimize swordfish larvae catches and standardization of the results. As for the analysis of the data, which are still to be considered preliminary, it was suggested to test the use of negative binomial models to better accommodate for the numbers of larvae in the sample. It would then be fundamental to have information on the size of the larvae, to evaluate any overlap between different stations and to have an idea of the age in days, in order to be sure not to analyze the habitat preferences of adults rather than of the larvae themselves.

It was asked whether the larval samples were available for further ageing and genetic analysis. Unfortunately, the samples collected up to now have been preserved in formalin, which presents challenges for further genetic analysis. Although this is a preliminary work, pending further data and analysis, the Group recommends carrying on the research regarding swordfish larval habitats in the western Mediterranean region and to evaluate the possibility of incorporating additional hauls in the TUNIBAL surveys to specifically target the collection of swordfish larvae DNA samples.

6. Workplan for 2021

The 2022 workplan for the Swordfish Species Group is provided in **Annex 6**.

7. Recommendations

Recommendations with financial implications

- *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 Group 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 Group 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 expanses with deployments of previously acquired tags and some tagging equipment (tagging poles, etc.).

    - Reproduction: €15,000 for ongoing work processing and analyzing 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 a 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 Group 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 by 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-ATL MSE	90,000
TOTAL	345,000

General recommendations

- Independent review of ICCAT MSE processes: The Group reiterates a Recommendation from the WGSAM for a common Independent Peer Review team (1-3 reviewers) for an overall review of all ICCAT MSE approach, to start in 2022.

- 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 the SCRS to continue work on tools for visualization of performance metrics results, and to standardize the presentation of information across the various species groups MSEs.

- The Group continue recommending that the straight LJFL be the preferable measurement taken for swordfish length, because this type of measurement is particularly relevant when dealing with the minimum size regulation and even other biological issues (L0, L50, L100, length/age correlation, length/weight correlation). When it is not possible for practical reasons to take the straight LJFL, then the curved LJFL could be taken indicating the type of method, and whenever possible including the fish condition factor and the sex.

- The Group recommends reviewing and updating the ICCAT manual on swordfish, including taking into account the measurement issues.

- 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.

- The Group endorses the Recommendations that were developed during the SWO Biology Workshop (document to be made available possible later in the year).

8. Other matters

8.1 Indices of abundance

SCRS/2021/087 and SCRS/2021/088 were presented together and provide standardized catch rates (in weight and in number) of the EU- Spain surface longline fleet targeting swordfish for the North and South Atlantic stock, respectively. In both cases, an alternative-sensitivity MIXED procedure was performed measuring the CPUE in mean round weight per year, which was scaled in order to compare it with the standardized CPUE in weight per 1000 hooks. The North Atlantic indices of relative abundance show a slight

decrease until the mid-nineties after which CPUE increases with stable or slightly upward trends thereafter. The trend for the South indicates stability for the period 1993-2004 followed but a slight but sustained upward trend.

The Group acknowledged the work produced by the authors and it was confirmed that the North Atlantic index presented here was not incorporated in the previous assessment – rather the age-specific CPUE (presented in SCRS/2021/089) was used in the previous assessment. It was noted that the inclusion of "ratio" as a covariate could produce hyper-stable results that may not reflect the stock dynamics and that means to test and validate the model's consistency should be considered. A change in gear, with the introduction of new monofilament in the fleet around the year 2000. The Group suggested that both of these indices be updated and presented at the 2022 Data Preparatory meeting. The Group suggested that the authors explore reducing the number of ratio categories perhaps to as few as two.

SCRS/2021/089 reported standardized age-specific catch rates (in number of fish) for the EU-Spain surface longline fleet in the North Atlantic for the period 1982-2019. The standardized CPUE for age 1 suggests a very positive phase of recruitments during 1997-2019, which resulted in positive effects on other ages. The Group acknowledged the work of the authors and there was discussion relating to the rationale for filtering the data and the decision to exclude data that did not meet the 85% size-sampling coverage threshold. It was suggested that the potential bias resulting from this filtering procedure be explored, specifically any bias that may be introduced due to only sampling trips with relatively high catch rates or volumes.

The authors noted that they used the 'aging' program (Schunete and Fournier, 1980) established and recommended by ICCAT from 1991 to date to carry out the age slicing. It is the same one that was used in the VPA processes and to generate the CAA data for swordfish. Restrepo's contribution was not a new method, it is the adaptation of the original ICCAT system in FORTRAN to a QBASIC language for a more user-friendly management and implementation. The conversion from size to age used the growth curve for North Atlantic swordfish (Arocha *et al.*, 2003).

The Group asked if the annual CPC values for the individual age groups were increasing and decreasing in the same year of if there as a displacement in time which one might expect if a cohort were moving through the population. The authors confirmed that indeed cohorts were displaced in time and age in subsequent years. The Group requested that this index be updated and presented at the upcoming 2022 Data Preparatory Meeting.

8.2 Responses to the Commission

North Atlantic Swordfish

> 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]. Rec. 17-02, parag. 5

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

South Atlantic Swordfish

> 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. Rec. 17-03, parag. 12

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

9. Adoption of the report and closure

The report was adopted during the meeting. The Chairs, the SCRS Chair and the Secretariat thanked all the participants for their efforts to work effectively and efficiently during the meeting. The meeting was adjourned.

References

Anon. 2017. Report of the 2017 ICCAT shortfin mako stock assessment meeting (Madrid, Spain 12-16 June, 2017). ICCAT Collect. Vol. Sci. Pap. ICCAT, 74(4): 1465-1561.

Anon. 2020. Report of the 2020 Intersessional Meeting of the Swordfish Species Group (Online, 16-19 March 2020). ICCAT Col. Vol. Sci. Pap., 77(3): 1-78.

Arocha F., Moreno C., Beerkircher L., Lee D.W., Marcano L. 2003. Update on the growth estimates for the swordfish, *Xiphias gladius*, in the North-western Atlantic. Collect. Vol. Sci. Pap. ICCAT, 55(4): 1416-1429.

Coelho R., Muñoz-Lechuga R. 2019. Hooking mortality of swordfish in pelagic longlines: comments on the efficiency of minimum retention sizes. Rev. Fish Biol. Fisheries, 29: 453–463.

Hordyk A., Schirripa M.J. 2020. Initial evaluation of alternative assumptions of discard mortality on the estimated stock dynamics for North Atlantic swordfish. Collect. Vol. Sci. Pap. ICCAT, 77(3): 633-641.

Rosa D., Santos C.C., Macias D., Ortiz de Urbina J., Forselledo R., Miller P., Domingo A., and Coelho R., Hazin F., Hanke A., and Coelho R. 2020. Brief update on the satellite tagging of Atlantic swordfish. ICCAT Col. Vol. Sci. Paps., 77(3): 113-121.

Schirripa M.J., Hordyk A. 2020. Migrating the North Atlantic Swordfish stock assessment model to an updated version of stock synthesis with analysis of the current minimum size regulation. Collect. Vol. Sci. Pap. ICCAT, 77(3): 654-668.

Schnute J.T., Fournier D.A. 1980. A new approach to length frequency analysis: growth structure. Can. J. Fish. Aquat. Sci. 37: 1337-1351.

Table 1 [A/B/C]. Standard SCRS catalogues on statistics (Task 1 and Task 2) of SWO by stock, major fishery (flag/gear combinations ranked by order of importance) and year (1990 to 2019). Only the most important fisheries (representing ±97.5% of Task 1 total catches in this period) are shown. For each data series, Task 1 (DSet= "t1", in t) is visualised against its equivalent Task 2 availability (DSet= "t2") scheme. The Task 2 colour scheme, has a concatenation of characters ("a"= T2CE exists; "b"= T2SZ exists; "c"= T2CS exists) that represents the Task 2 data availability in the ICCAT-DB system.

A. SWO-N stock (1990-2019)

						T1 Total	15672	14934	15394	16738	15501	17105	15222	13025	12329	11622	11453	10011	9654	11442	12068	12377	11478	12302	11050	12081	11558	12539	13868	12069	10678	10712	10405	10207	8931	10148			
Species	**Stock**	**Status**	**FlagName**	**GearGrp**	**DSet**	**1990**	**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**	Rank	%	%cum
SWO	ATN	CP	EU-España	LL	t1	5736	6506	6351	6392	6027	6948	5519	5133	4079	3993	4581	3967	3954	4585	5373	5511	5446	5564	4366	4949	4147	4885	5620	4082	3750	4013	3915	3586	3186	3112	1	39.0%	39%
SWO	ATN	CP	EU-España	LL	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ac	ac	abc	ac	1		
SWO	ATN	CP	USA	LL	t1	4967	4399	4124	4044	3960	4452	4015	3399	3433	3364	3316	2498	2598	2757	2591	2273	1961	2474	2405	2691	2204	2572	3347	2812	1816	1593	1389	1301	1106	1458	2	22.9%	62%
SWO	ATN	CP	USA	LL	t2	ab	ab	ab	ab	ab	ab	ab	ab	ab	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	2		
SWO	ATN	CP	Canada	LL	t1	819	953	1487	2206	1654	1421	646	1005	927	1136	923	984	954	1216	1161	1470	1238	1142	1115	1061	1182	1351	1502	1290	1383	1489	1473	1034	753	965	3	9.6%	72%
SWO	ATN	CP	Canada	LL	t2	ab	ab	ab	ab	ab	ab	ab	ab	ab	abc	abc	bc	abc	abc	abc	abc	bc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	3		
SWO	ATN	CP	EU-Portugal	LL	t1	463	757	497	1950	1579	1593	1702	902	772	776	731	731	765	1032	1319	900	949	778	747	898	1054	1202	882	1438	1241	1420	1459	1871	1670	2346	4	9.2%	81%
SWO	ATN	CP	EU-Portugal	LL	t2	ab	abc	ac	ab	ab	ab	ab	ab	ab	ab	abc	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	4		
SWO	ATN	CP	Japan	LL	t1	1051	992	1064	1126	933	1043	1494	1218	1391	1089	759	567	319	263	575	705	656	889	935	778	1062	523	639	300	545	430	379	456	325	369	5	6.1%	87%
SWO	ATN	CP	Japan	LL	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	bc	bc	bc	abc	abc	abc	abc	abc	abc	abc	abc	ab	ab	ab	ab	ab	ab	ab	ab	5		
SWO	ATN	CP	Maroc	LL	t1	24	92	41	27	7	28	35	239	101	35	38	264	154	223	255	325	333	229	428	720	963	700	700	1000	1000	800	800	750	950	950	6	3.3%	90%
SWO	ATN	CP	Maroc	LL	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	bc	abc	abc	abc	abc	abc	bc	abc	a	a	abc	bc	abc	ab	abc	abc	abc	6		
SWO	ATN	NCC	Chinese Taipei	LL	t1	269	577	441	127	507	489	521	509	286	285	347	299	310	257	30	140	172	103	82	89	88	192	193	115	85	133	152	96	169	122	7	1.9%	92%
SWO	ATN	NCC	Chinese Taipei	LL	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ab	ab	ab	ab	ab	ab	ab	ab	ab	abc	abc	abc	abc	abc	abc	7		
SWO	ATN	CP	Canada	HP	t1	92	73	60	28	22	189	93	89	240	18	95	121	38	147	87	193	203	267	258	248	176	208	97	275	233	98	85	175	34	33	8	1.1%	93%
SWO	ATN	CP	Canada	HP	t2	ab	ab	ab	ab	ab	ab	ab	ab	ab	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	8		
SWO	ATN	CP	China PR	LL	t1				73	86	104	132	40	337	304	22	102	90	316	56	108	72	85	92	92	73	75	59	96	60	141	135	81	86	92	9	0.8%	94%
SWO	ATN	CP	China PR	LL	t2				-1	-1	-1	-1	-1	a	a	a	a	a	a	a	a	ab	a	ab	ab	ab	ab	ab	ab	a	ab	abc	abc	abc	ab	9		
SWO	ATN	CP	Trinidad and Tobago	LL	t1	66	71	562	11	180	150	158	110	130	138	41	75	92	78	83	91	19	29	48	30	21	16	14	16	26	17	13	36	3	6	10	0.6%	95%
SWO	ATN	CP	Trinidad and Tobago	LL	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	a	a	a	a	a	a	a	a	a	a	a	a	ab	ab	ab	a	ab	10		
SWO	ATN	CP	EU-España	GN	t1	646	124	316	202	150	223	20																								11	0.5%	95%
SWO	ATN	CP	EU-España	GN	t2	ac	ab	b	-1	-1	-1	-1																								11		
SWO	ATN	CP	USA	HL	t1				38			0	1		5	9	9	12	21	23	35	33	125	94	125	129	121	155	105	88	77	76	62	132	206	12	0.5%	96%
SWO	ATN	CP	USA	HL	t2				-1			-1	b	b	c	bc	bc	c	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	bc	12		
SWO	ATN	CP	EU-France	TW	t1						13	13	97	164			60		74	138	102	178	91	46	14	12	32	15	13	35	25	63	87	76	74	70	13	0.4%	96%
SWO	ATN	CP	EU-France	TW	t2					a		-1	-1	-1			-1		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	ab		-1	-1	ab	-1	bc	13		
SWO	ATN	CP	Maroc	GN	t1	19	9	4	2	13	32	322	13	179	60	51	243	64	98	76	9						80									14	0.3%	96%
SWO	ATN	CP	Maroc	GN	t2	-1	-1	-1	-1	-1	-1	-1	-1	c	ac	ac	ac	-1	b	b	b						-1									14		
SWO	ATN	CP	Belize	LL	t1																		9	1	112	106	184	141	142	76	1	3	59	145	117	15	0.3%	97%
SWO	ATN	CP	Belize	LL	t2																		a	a	ab	ab	ab	ab	a	a	ab	a	ab	abc	ab	15		
SWO	ATN	CP	USA	GN	t1	535	82	86	92	88	74	78	0	36		0		0		0			0		0			0				0			16	0.3%	97%
SWO	ATN	CP	USA	GN	t2	ab	ab	ab	ab	ab	ab	ab	ab	ab		-1		-1		-1			-1		bc			c				c		c		16		
SWO	ATN	CP	Korea Rep	LL	t1	51	3	3	19	16	16	19	15								51	65	175	157	3		170	46	83	35	2	9	19	9	11	17	0.3%	97%
SWO	ATN	CP	Korea Rep	LL	t2	ab	a	ab	a	a	a	a	a				a				a	a	a	a	a		a	-1	abc	abc	b	abc	abc	abc	ab	17		
SWO	ATN	CP	Venezuela	LL	t1	4	73	101	68	60	45	74	11	7	9	30	12	25	29	46	48	15	19	5	8	16	13	18	20	18	29	53	52	31	31	18	0.3%	97%
SWO	ATN	CP	Venezuela	LL	t2	b	b	b	b	b	b	b	b	b	ab	ab	b	b	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	a	a	a		18		

B. SWO-S stock (1990-2019)

Species	Stock	Status	FlagName	GearGrp	DSet	1990	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	Rank	%	%cum
T1 Total						17305	13893	13813	16130	18958	21931	18289	18542	14027	15502	15728	15128	14104	12634	13082	13163	14245	15629	12411	12727	12698	11352	10686	9191	9970	10345	10661	10557	10403	10104			
SWO	ATS	CP	EU-España	LL	t1	6166	5760	5651	6974	7937	11290	9622	8461	5832	5758	6388	5789	5741	4527	5483	5402	5300	5283	4073	5183	5801	4700	4852	4184	4113	5059	4992	4654	4404	4224	1	42.0%	42%
SWO	ATS	CP	EU-España	LL	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ac	ac	ac	ac	1		
SWO	ATS	CP	Brazil	LL	t1	1696	1312	2609	2013	1571	1970	1892	4100	3844	4721	4579	4075	2903	2917	2984	3780	4430	4243	3413	3386	2926	2984	2831	2381	2892	2594	2935	2406	2792	2859	2	21.8%	64%
SWO	ATS	CP	Brazil	LL	t2	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	a	a	a	a	a	a	a	a	a	a	a	ab	ab	2		
SWO	ATS	CP	Japan	LL	t1	6708	4459	2870	5256	4699	3619	2197	1494	1186	775	790	685	833	924	686	480	1090	2155	1600	1340	1314	1233	1162	684	976	659	637	915	640	658	3	12.8%	77%
SWO	ATS	CP	Japan	LL	t2	ab	ab	ab	ab	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ab	ab	ab	ab	ab	ab	ab	3		
SWO	ATS	NCC	Chinese Taipei	LL	t1	896	1453	1686	846	2829	2876	2873	2562	1147	1168	1303	1149	1164	1254	745	744	377	671	727	612	410	428	496	582	451	554	480	527	472	395	4	7.7%	84%
SWO	ATS	NCC	Chinese Taipei	LL	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ab	ab	ab	ab	ab	ab	ab	ab	ab	abc	abc	abc	abc	abc		4		
SWO	ATS	CP	Uruguay	LL	t1	302	156	210	260	165	499	644	760	889	650	713	789	768	850	1105	843	620	464	370	501	222	179	40	103							5	2.9%	87%
SWO	ATS	CP	Uruguay	LL	t2	a	a	a	a	a	a	a	a	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab							5		
SWO	ATS	CP	Namibia	LL	t1					22					374	452	607	504	187	549	832	1118	1038	518	25	408	366	22	129	395	225	466	600	881	811	6	2.5%	90%
SWO	ATS	CP	Namibia	LL	t2					a					a	-1	ab	a	-1	a	ab	ab	ab	ab	ab	ab	a	ab	a	a	a	abc	abc	abc		6		
SWO	ATS	CP	EU-Portugal	LL	t1						380	389	441	384	381	392	393	380	354	345	493	440	428	271	367	232	263	184	125	252	236	250	466	369	323	7	2.1%	92%
SWO	ATS	CP	EU-Portugal	LL	t2						a	a	ab	ab	ab	ab	ab	a	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	7		
SWO	ATS	CP	China PR	LL	t1									29	534	344	200	423	353	278	91	300	473	470	291	296	248	316	196	206	328	222	302	355	211	8	1.6%	93%
SWO	ATS	CP	China PR	LL	t2							a	a	a	a	a	a	a	a	a	a	a	ab	ab	ab	ab	ab	ab	abc	ab	abc	abc	abc	ab		8		
SWO	ATS	CP	South Africa	LL	t1						1			240	143	327	547	649	293	295	199	186	207	142	170	145	97	50	171	152	218	164	189	189	251	9	1.2%	95%
SWO	ATS	CP	South Africa	LL	t2						-1			ab	ab	ab	ac	abc	ab	ab	ab	ab	ab	ab	ab	ab	a	ab	ab	ab	ab	ab	ab	ab	ab	9		
SWO	ATS	CP	Ghana	GN	t1	146	73	69	121	51	103	140	44	106	121	117	531	372	734	343	55	32	65	177	132	116	60	54	37	26	56	36	55	6		10	1.0%	96%
SWO	ATS	CP	Ghana	GN	t2	-1	-1	-1	-1	-1	-1	ab	b	ab	b	ab	ab	ab	ab	ab	ab	ab	ab	a	ab	a	a	a	a	a	a	a	a	a		10		
SWO	ATS	CP	S Tomé e Príncipe	TR	t1	181	179	177	202	190	178	166	148	135	129	120	120	120	120	126	147	138	138	172	188	193	60	84	60	94	145	77	65			11	0.9%	96%
SWO	ATS	CP	S Tomé e Príncipe	TR	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1			11		
SWO	ATS	NCO	Cuba	LL	t1	448	209	246	192	452	778	60	60																							12	0.6%	97%
SWO	ATS	NCO	Cuba	LL	t2	a	-1	-1	-1	-1	-1	-1	-1																							12		
SWO	ATS	CP	Senegal	LL	t1																		77	138	195	180	264	162	178	143	97	173	160	92	166	13	0.5%	98%
SWO	ATS	CP	Senegal	LL	t2																		-1	a	-1	a	a	a	a	a	a	a	-1	-1	-1	13		

C. SWO-M stock (1990-2019)

Species	Stock	Status	FlagName	GearGrp	DSet	1990	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	Rank	%	%cum
T1 Total						16018	15746	14709	13265	16082	13015	12053	14693	14369	13699	15569	15006	12814	15694	14405	14622	14915	14227	13683	13235	14754	12640	11046	10070	10969	11983	12300	10390	8681	8176			
SWO	MED	CP	EU-Italy	LL	t1	2617	2442	3518	3260	3844	3035	2617	2458	2458	2680	2639	2236	1841	5844	5452	5560	5253	4564	5246	5438	5919	5313	4474	3304	3921	4883	4540	3882	2289	2461	1	28.6%	29%
SWO	MED	CP	EU-Italy	LL	t2	b	ab	ab	b	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	b	ab	ab	b	bc	abc	abc	abc	abc	abc	abc	abc	abc	abc	bc	ac	1		
SWO	MED	CP	EU-Italy	GN	t1	6105	5698	4077	3070	3921	4264	2657	3632	3632	3632	4863	4152	1698	2540	1483	1891	2373	1948								0					2	15.5%	44%
SWO	MED	CP	EU-Italy	GN	t2	ab	ab	ab	ab	ab	b	b	b	b	b	ab	b	-1	b	b	b	b	-1								-1					2		
SWO	MED	CP	EU-España	LL	t1	1438	1132	790	1293	1402	1351	1040	1184	1409	867	1396	1402	1421	1165	930	860	1405	1648	2063	1994	1785	1730	1580	1605	2019	2289	1732	1487	1470	1548	3	10.9%	55%
SWO	MED	CP	EU-España	LL	t2	ac	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	3		
SWO	MED	CP	EU-Greece	LL	t1	1344	1904	1456	1568	2520	974	1237	750	1650	1520	1960	1730	1680	1230	1129	1424	1374	1907	989	1132	1494	1306	877	1731	1344	761	761	392	350	745	4	9.8%	65%
SWO	MED	CP	EU-Greece	LL	t2	ab	ab	ab	ab	ab	ab	-1	-1	ab	ab	ab	ab	b	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab	b	ab	ab	ab		4		
SWO	MED	CP	Maroc	GN	t1	866	1186	1883	2068	2109	1518	2461	4653	2905	2979	2503	2266	2230	1629	1299	722	603	615	587	477	410	387									5	9.1%	74%
SWO	MED	CP	Maroc	GN	t2	-1	-1	-1	-1	b	-1	-1	-1	c	bc	abc	abc	b	b	b	b	b	b	abc	-1	abc	abc									5		
SWO	MED	CP	Maroc	LL	t1	371	508	807	517	527	169	273	245	323	259	205	754	1149	1670	1954	1801	1455	1107	1713	1388	1501	800	1003	963	968	604	1395	1350	1368	982	6	7.1%	81%
SWO	MED	CP	Maroc	LL	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	bc	abc	abc	abc	abc	abc	abc	ab	6		
SWO	MED	CP	Tunisie	LL	t1	176	181	178	354	298	378	352	346	414	468	483	567	1138	285	791	791	949	1024	1232	1233	1238	1267	1265	1262	1302	1307	1273	1377	1338	934	7	6.1%	87%
SWO	MED	CP	Tunisie	LL	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	a	a	a	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	7		
SWO	MED	CP	Algerie	LL	t1	173	173	6	173	185	247	247	247	178	126	166	439	347	238	174	93	496	492	977	570	560	234	433	467	693	705	842	755	725	517	8	2.9%	90%
SWO	MED	CP	Algerie	LL	t2	b	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	a	a	-1	-1	ab	ab	ab	ab	ab	-1	-1	-1	ab	8		
SWO	MED	CP	Algerie	GN	t1	539	389	389	389	415	560	560	560	590	531	599	642	467	427	233	311	87	108													9	2.0%	92%
SWO	MED	CP	Algerie	GN	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1													9		
SWO	MED	CP	EU-Malta	LL	t1	135	129	85	91	47	72	72	100	153	187	175	102	257	163	195	362	239	213	260	266	423	532	503	460	376	489	410	330	308	407	10	1.9%	94%
SWO	MED	CP	EU-Malta	LL	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	ac	ac	ac	-1	-1	-1	abc	bc	ab	abc	ab	ab	ab	abc	ab	abc	abc	abc	abc	abc	ab	10		
SWO	MED	CP	Turkey	GN	t1	243	100	136	292	533	306	320	350	450	230	370	360	300	274	317	341	337	352													11	1.4%	95%
SWO	MED	CP	Turkey	GN	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	ab	ab	ab	ac	c								11		
SWO	MED	CP	Turkey	LL	t1													70	76	69	84	73	71	441	344	382	217	76	111	71	45	90	556	544	386	12	0.9%	96%
SWO	MED	CP	Turkey	LL	t2													-1	-1	-1	-1	-1	-1	a	a	a	ab	a	ab	abc	abc	bc	ab	abc	abc	12		
SWO	MED	CP	EU-Italy	UN	t1																				329	921	694	718		0				0	8	13	0.7%	97%
SWO	MED	CP	EU-Italy	UN	t2																b				-1	-1	-1	-1		b				-1	-1	13		

Table 2. Swordfish Task 1 nominal catches (t, landings and dead discards) by stock, major gear, and year. The catches for 2020 a preliminary and incomplete.

	SWO-N														SWO-S										SWO-M									
YearC	BB	GN	HL	HP	HS	LL	PS	RR	TN	TP	TR	TW	UN	TOTAL	BB	GN	HL	HS	LL	PS	RR	TR	TW	UN	TOTAL	BB	GN	HL	HP	LL	PS	RR	TN	TP	TR	TW	UN	TOTAL
1950				2201		1445				0			0	3646		0								100	100					586						0	586
1951				1615		966				0			0	2581		0								200	200					580						0	580
1952			0	2027		966				0		0	0	2993		0								200	200					337						0	337
1953				2100		1203				0		0	0	3303		0								200	200					501						0	501
1954				2729		305				0			0	3034		0								100	100					452						0	452
1955				2883		619				0			0	3502		0								100	100					340						0	340
1956				2984		374				0			0	3358	0	0			1						1					393						0	393
1957				3467		1010				0		1	100	4578		0			124					100	224	250				395						0	645
1958				3929		875				0			100	4904	0	0			92						92	500				414						0	914
1959				4704		1428				0		0	100	6232		0			71					100	171	200				401						0	601
1960				2786		1042				0		0	0	3828		0			359					100	459	112				403						0	515
1961				2321		2060						0	0	4381		0			816					200	1016	112				500						0	612
1962				2140		3202							0	5342	0	0			769						769	112				591						0	703
1963				997		9193						0	0	10190	0	0			1418						1418	224				498						0	722
1964	9			316		10833				100		0	0	11258		0			2030						2030	112				686						0	798
1965	6		179	622		7759				86		0	0	8652		0			2578						2578	112				1423				1		224	1760
1966	15			782		8503				49			0	9349		0			1952						1952	336				1192						224	1752
1967	11			394		8679				23			0	9107		0			1577						1577	111				869				1		336	1317
1968	12		0	145		8985				30			0	9172		100			2348						2448	115		194		2570				1		560	3440
1969	11		0	185		9003				4		0	0	9203		200			4281						4481	133		277		3313						0	3723
1970	8		0	83		9484				3				9578					5426						5426	99		249		2993						0	3341
1971	11		0	0		5243				12			0	5266	2				2164						2166	76		402		4496				1			4975
1972	21		0	0		4717				28				4766					2580						2580	5247		513		5399				1			11160
1973	37		0	0		5929				8			100	6074					3078						3078	3985		388		4362							8735
1974	92		0	0		6267				3				6362					2753						2753	4684		462		4564				3			9713
1975	58	3	0	0		8778								8839					3062						3062	4219		416		3888							8522
1976	32	1	0	0		6663								6696					2812						2812	4914		312		4318							9544
1977	38		0	0		6370				1				6409		12			2840					3	2855	4791		417		4838							10046
1978	17	8	0	656		11125	2			11		2	6	11827		5			2829	12					2846	5377		756		5186					8		11327
1979		16	29	715		11177								11937		1			3374				28		3403	4980		475		5200							10655
1980		30	15	676		12831							6	13558		113			5287				31		5431	5216		501		6230							11947
1981		50	8	551		10583				1			4	11197		24			4039	4			9		4076	4873		461		6450							11784
1982		37	7	148		13023								13215		80			6364				3		6447	3730		356		6112							10198
1983		70	6	421		14062				4				14563		102			5383				7		5492	4016		366		6313				1			10696
1984		65	7	94		12664				2			1	12833		180		1	8986	12			23	26	9227	6658		294		6709				5			13666
1985	1	50	7	76		14240				5			4	14383		131			9224				3	228	9586	7816	1	298		7169				5		1	3	15294
1986	0	68	7	104		18283	15			5		0	4	18486	0	95			4982				2	815	5894	8130		469		8166							16765
1987	1	85	10	107		20029				6		0		20238		147			5797				2	84	6030	9219		325		8776							18320
1988	4	333	5	55		19126	0	0		2		0		19525		266			12602			216	4	84	13172	9645		468		10250				2			20365
1989	1	1510	8	182		15554	1			5			0	17261		191			16573			207	0	84	17055	9542		345		7875							17762
1990	0	1209	10	100		14215	16			38		9	75	15672		189			16705			181	230	0	17305	8280		379		7346				12			16018
1991	0	217	21	75		14491	5			8		42	75	14934		124			13496			179	93	0	13893	7971		397		7365	0			12			15746
1992	2	415	51	61		14739	3			24		24	75	15394	1	116			13422			177	97		13813	7076		0		7631	0			2			14709
1993	3	324	49	28		16212	8			3		16	95	16738		172			15739		2	202	16		16130	5819		0		7377	0			4		65	13265
1994	5	322	21	24		15073	5			14		37		15501	0	110			17839		1	190	24	794	18958	6978				8985				18		101	16082
1995	4	400	23	190		16390	8	1		13		38	38	17105		165			21584		1	178	2		21931	6648		11		6319	0			11		26	13015
1996	7	479	0	94		14384	99	7		8	1	117	26	15222	0	263			17860			166	1		18289	5998		10		5884				4		157	12053
1997	4	67	1	90		12643	11	16		8	0	172	12	13025		73			18320			148	1		18542	9195		12		5389				5		92	14693
1998	5	472		241		11538	41	10		2	1	10	9	12329		131	3		13758			135			14027	7577		12		6674				4	57	45	14369
1999	3	248	5	18		11241	40	21		13	2	26	4	11622	356	150			14829			129	38		15502	7372		0		6223				3	52	49	13699
2000	13	158	9	95		11058	23	16		6	2	72	1	11453	18	137			15450	4		120	0		15728	8335		11		7129				3	51	39	15569
2001	1	266	9	129		9573	17	2		7		6	2	10011	144	550	7		14302			120	5	0	15128	7420				7498	4			6		78	15006
2002	3	73	12	41		9406	1	22		4		83	8	9654	7	391			13577			120	10		14104	4695				8042				2		75	12814
2003	1	114	23	147		10951	1	6		7	0	156	37	11442	4	777	3		11714			120	16		12634	4870		7		10748	2	2		6	0	58	15694
2004	3	83	24	88		11719	1	25		3	2	112	7	12068	0	395			12558			126	2	0	13082	3332	112	5		10886	45	2		2		20	14405
2005	10	16	40	193		11851		62		5	3	187	11	12377		96	5		12915			147	1		13163	3265	175	6		11067	56	2		5		46	14622
2006	2	7	38	204		11061		53		8	0	97	8	11478		73	1		14033			138			14245	3400	72			11339	47			1		56	14915
2007	0	11	129	267		11748	0	68		8	7	54	9	12302		82	1		15408	0		138			15629	3023	1			11132	22			1		48	14227
2008	0	6	97	258		10576	0	76	0	2	2	24	9	11050		201	11		12027	0		172			12411	587	0	27		13025	12			2		30	13683
2009	1	34	128	248		11590	0	32	0	4	1	36	9	12081		178			12359	0		188	2		12727	477	0			12416	2		0	3	4	333	13235
2010	0	19	129	177		11112	1	52		5	0	55	8	11558	9	158			12337			193	1		12698	411	1			13407	3		1	2	3	926	14754
2011	1	86	121	208		12019	0	54		5	0	36	9	12539	49	164	4		11076	0		60	0	0	11352	388	1			11478	3		0	3	0	24	744	12640
2012	0	63	231	98		13346	0	71		2	1	45	12	13868	63	120	1		10395	23		84		0	10686	0	2			10264	34		0	3	15	727	11046
2013	1	4	181	275	0	11543	0	22	0	1	0	40	2	12069		168	3		8958	1		60			9191	2	4			10020	13		1	1	24	5	10070
2014	0	9	151	233		10215	0	35		0	0	33	0	10678		94			9781	0		94	0		9970	0	3	3	2	10886	7	0	3	1	0	10	53	10969
2015	0	31	128	98		10327	0	46		0	1	81		10712		104	5		10090	0		145			10345		1	5	32	11905	19			1		20	0	11983
2016	0	19	228	85		9935		27		1	0	108	0	10405		67			10517			77			10661	0	4	7		12247	17		3	1	2	17	1	12300
2017		95	266	175		9540	3	34	0		1	93	0	10207		74	1		10417	1		65			10557			4	35	10333	11		2	0	4	0	10390
2018	0	6	177	34		8566	0	36	0	0	2	107	1	8931		17	6		10375	5			1	0	10403		0	2	29	8620	17		1	0	12	0	8681
2019	34	11	264	33		9644	0	69		0	0	90	3	10148		17			10084				3		10104		0	3	28	8130	1		0	1	5	8	8176
2020				49		1300					1			1351																						
TOTAL	490	7590	2855	47251	0	662602	302	864	0	588	28	2008	971	725549	653	7003	49	1	530498	61	4	4272	656	3519	546716	0	222771	391	9753	415506	314	6	12	140	2	307	5132	654335
Ratios (%)	0	1	0	7	0	91	0	0	0	0	0	0	0.1	100	0	1	0	0	97	0	0	1	0	0.6	100	0	34	0	1	64	0	0	0	0	0	0	0.8	100

Table 3. Standard ICCAT scorecard on data availability by species and stock covering the period 1990 to 2019.

SCORECARD on Task 1/2 availability for the main ICCAT fisheries (final year: 2019)

				SCORES (by time series)			N. flag fisheries ranked			Change (%)
FisheryID	Spc. Group	Species	Species/stock	30 years (1990-19)	20 years (2000-19)	10 years (2010-19)	30 years (1990-19)	20 years (2000-19)	10 years (2010-19)	agains't 1989-18 (30 yrs)
1	Temperate tunas	ALB	ALB-N stock	7.10	7.42	7.40	12	14	11	-1%
2			ALB-S stock	5.65	5.98	6.09	10	10	9	2%
3			ALB-M stock	2.52	3.58	6.24	11	10	7	12%
4		BFT	BFT-E stock (ATE region)	6.00	7.16	8.78	10	8	8	2%
5			BFT-E stock (MED region)	3.38	4.46	5.85	28	21	17	2%
6			BFT-W stock	8.68	8.88	9.68	9	8	7	1%
7	Tropical tunas	BET	BET-A stock (AT + MD)	6.44	7.28	7.63	29	28	27	0%
8		YFT	YFT-E region	6.53	7.48	8.00	23	20	16	0%
9			YFT-W region	4.57	5.01	5.18	25	24	22	0%
10		SKJ	SKJ-E stock	6.89	7.79	7.92	18	16	15	-1%
11			SKJ-W stock	4.09	4.70	4.44	4	4	3	-12%
12	SWO & billfish	SWO	SWO-N stock	7.87	8.66	8.62	11	10	10	4%
13			SWO-S stock	7.03	7.26	7.09	9	9	9	3%
14			SWO-M stock	4.46	5.30	6.76	11	10	8	1%
15		BUM	BUM-A stock (AT + MD)	4.08	3.91	3.58	30	30	31	-1%
16		WHM	WHM-A stock (AT + MD)	5.29	5.37	5.71	17	18	16	-1%
17		SAI	SAI-E stock	3.07	3.66	3.42	14	13	11	2%
18			SAI-W stock	3.58	3.52	4.14	18	16	11	1%
19		SPF	SPF-E stock	2.92	5.45	5.00	3	4	3	30%
20			SPF-W stock	3.28	3.71	3.19	6	6	6	-1%
21	Major shark species	BSH	BSH-N region	3.74	4.98	7.00	5	5	4	6%
22			BSH-S region	4.18	5.81	6.82	6	6	7	6%
23		POR	POR-ANE stock	0.39	0.63	1.08	8	12	11	4%
24			POR-ANW stock	2.73	2.86	3.18	4	6	8	3%
25			POR-ASE stock	0.70	1.13	2.67	4	3	2	2%
26			POR-ASW stock	0.44	0.77	1.42	6	5	3	0%
27		SMA	SMA-N region	3.02	4.55	5.95	6	7	7	9%
28			SMA-S region	3.85	6.27	7.33	7	8	6	6%
29	Small tuna species	BLF	ATL	3.04	3.72	4.05	15	12	10	1%
30		BLT	A+M	0.94	1.51	2.78	22	20	18	17%
31		BON	ATL	2.16	2.66	3.04	35	28	22	12%
32			MED	0.74	1.26	1.51	8	8	8	-11%
33		BRS	A+M	0.92	1.38	2.50	3	3	1	0%
34		DOL	A+M	1.82	2.42	3.42	14	14	15	7%
35		FRI	ATL	4.45	5.38	5.74	28	23	21	3%
36		KGM	A+M	1.34	1.46	2.65	7	7	4	3%
37		LTA	ATL	3.77	4.67	5.26	32	25	21	4%
38			MED	0.54	0.82	1.12	18	15	12	21%
39		MAW	A+M	2.05	2.23	2.07	21	15	12	2%
40		SSM	A+M	0.50	0.00	0.00	4	3	3	-14%
41		WAH	A+M	1.71	2.24	2.13	36	28	20	1%

Table 4. Summary of SWO conventional tagging data available in ICCAT. Number of SWO releases by year and associated recoveries by year. Also shown, the number of releases in unknown state (pending), recoveries without release information (?), and recoveries without recovery dates (?).

Releases			Recoveries (year)																																																
Year	Total	Pending	?	1966	1968	1969	1970	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2012	2013	2014	2016	2018
1940	2	2																																																	
1961	2	2																																																	
1962	1	1																																																	
1963	2	2																																																	
1964	58	56		2																																															
1965	49	48				1																																													
1966	34	33				1																																													
1967	25	24																1																																	
1968	28	20			1	2	2	1	1						1																																				
1969	30	28					1				1																																								
1970	91	80					6	1		1	1	1		1																																					
1971	12	12																																																	
1972	7	7																																																	
1973	1	1																																																	
1974	32	30									1		1																																						
1975	25	23												1			1																																		
1976	10	10																																																	
1977	55	53													1	1																																			
1978	178	165													2	2	4	3	2																																
1979	118	113														3				1		1																													
1980	490	464														4	3	4	7		2	4	1				1																								
1981	267	240															2	8	8	6	1				1	1																									
1982	166	162																2		2																															
1983	162	156																	1	2	1	1			1																										
1984	168	163																			1	1				1		1	1																						
1985	204	194																				3	1	1	1	4																									
1986	404	387																					3	4	5	1						4																			
1987	411	393																					2	3	7	4			1	1																					
1988	475	460																						1	6	2	1	1	1		1	1	1																		
1989	217	214																								1			1	1																					
1990	531	520																								1	4		2	4																					
1991	1604	1551																									4	9	15	12	7	1		2	1			1				1									
1992	1697	1641																										5	21	17	6	4		2			1														
1993	1542	1481																											6	23	6	7	6	3	2	2	2		1	1		1	1								
1994	1919	1866	1																											5	15	5	9	8	2	4	1	2	1												
1995	1174	1137	1																												4	8	8	5	3	8															
1996	680	655																														6	5	5	4	4			1												
1997	769	741																															5	10	3	2	2	2		2		1					1				
1998	397	376	1																															2	6	4	4		2	2											
1999	258	250																																		1	3		2		2										
2000	193	181																																		1	7	3						1							
2001	159	157	1																																			1													
2002	282	271	4																																			2	3	2											
2003	253	244	2																																				2	1	2	1	1								
2004	284	265	6																																						6	3	2		1	1					
2005	344	333	4																																							4	1	2							
2006	779	759	10																																							1	4	3		1				1	
2007	352	339	2																																								2	2	4	2					1
2008	96	90	2																																									1	2		1				
2009	38	36																																												1	1				
2010	12	11																																														1			
2011	38	35																																													1	2			
2012	56	55																																															1		
2013	64	64																																																	
2014	16	16																																																	
2015	6	6																																																	
2016	19	18																																																	1
2017	3	3																																																	
?	14	3																													2	1	3				1	1			1				1		1				
Total	17303	16647	34	2	1	4	9	2	1	1	3	1	1	2	4	10	10	18	18	11	5	10	7	9	21	15	10	16	48	63	41	37	37	37	21	26	21	12	12	8	11	12	11	9	8	5	5	3	1	1	2

Table 5. Candidate advice intervals and data requirements for a 13 year period for Northern Swordfish MSE and assessment. "X" represents a required action or data need for stock assessment, running of the MP or determination of exceptional circumstances. This table is for discussion purposes only and requires input from SCRS plenary and the Commission.

						Data requirements			
Year	**Stock assessment**	**Recondition OMs***	**MP run**	**MP advice implemented**	**Exceptional circumstances evaluated**	**Combined index (or other dependent indices)**	**Other CPUEs**	**Use/review catch**	**EC indicators**
0	?		X		X	X	X	X	X
1				X	X				X
2					X				X
3			X		X	X		X	X
4				X	X				X
5					X				X
6	X		X		X	X	X	X	X
7				X	X				X
8					X				X
9			X		X	X		X	X
10				X	X				X
11					X				X
12	X		X		X	X	X	X	X

* only if strong evidence for reconditioning exists

Table 6. Summary of SWO conventional tagging data: number of recoveries grouped by number of years at liberty in each release year. The last column shows the recovery rate (%) in each release year.

				Years at liberty									
Year		Releases	Recaptures	< 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 10	10+	15+	Unk	% recapt*
	1940	2	0										
	1961	2	0										
	1962	1	0										
	1963	2	0										
	1964	58	2		2								3.4%
	1965	49	1				1						2.0%
	1966	34	1				1						2.9%
	1967	25	1								1		4.0%
	1968	28	8	1	2	2	1		1	1			28.6%
	1969	30	2		1				1				6.7%
	1970	91	11	6		1		1	3				12.1%
	1971	12	0										
	1972	7	0										
	1973	1	0										
	1974	32	2		1		1						6.3%
	1975	25	2			1			1				8.0%
	1976	10	0										
	1977	55	2		1	1							3.6%
	1978	178	13	1	3	3	2	4					7.3%
	1979	118	5	2	1			1	1				4.2%
	1980	490	26	4	6	7	1		7	1			5.3%
	1981	267	27	8	10	5	2		2				10.1%
	1982	166	4	2	2								2.4%
	1983	162	6	2	2	1			1				3.7%
	1984	168	5		2				3				3.0%
	1985	204	10	2	2	1	1	3	1				4.9%
	1986	404	17	3	3	5	2		4				4.2%
	1987	411	18	5	6	4	1		2				4.4%
	1988	475	15	5	4	1		2	3				3.2%
	1989	217	3		1			1	1				1.4%
	1990	531	11	3	2	2	4						2.1%
	1991	1604	53	12	8	14	12	2	3	2			3.3%
	1992	1697	56	12	24	11	3	3	3				3.3%
	1993	1542	61	21	11	7	7	4	8	3			4.0%
	1994	1919	53	15	7	10	5	6	9			1	2.8%
	1995	1174	37	9	5	9	3	8	2			1	3.2%
	1996	680	25	10	3	7	2	2	1				3.7%
	1997	769	28	11	6	1	3	3	3	1			3.6%
	1998	397	21	6	4	5	1	2	2			1	5.3%
	1999	258	8	1	2	1	1	1	2				3.1%
	2000	193	12	5	5	1			1				6.2%
	2001	159	2		1							1	1.3%
	2002	282	11	4	3							4	3.9%
	2003	253	9	3	1	2		1				2	3.6%
	2004	284	19	5	2	3	1		2			6	6.7%
	2005	344	11	2	3	1	1					4	3.2%
	2006	779	20	4	3	1	1		1			10	2.6%
	2007	352	13	4	2	4				1		2	3.7%
	2008	96	6	2	1		1					2	6.3%
	2009	38	2		1	1							5.3%
	2010	12	1			1							8.3%
	2011	38	3	1	2								7.9%
	2012	56	1			1							1.8%
	2013	64	0										
	2014	16	0										
	2015	6	0										
	2016	19	1			1							5.3%
	2017	3	0										
Total		17289	645	171	145	115	58	44	68	9	1	34	3.7%

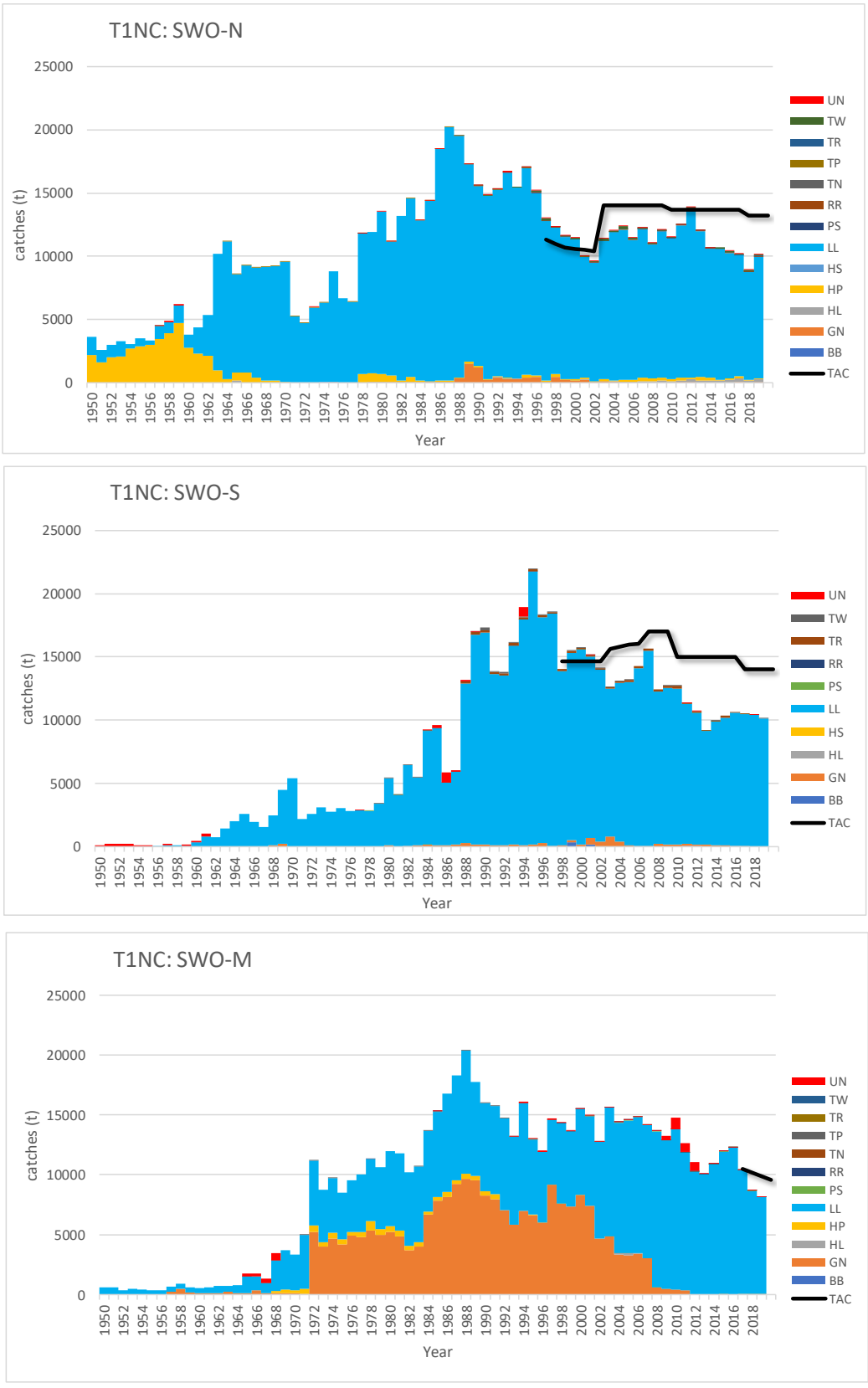

Figure 1 Swordfish Task 1 nominal catches (T1NC, t) of each stock (SWO-N top, SWO-S centre, SWO-M bottom) by gear group and year. Unclassified gear series (UN, containing gears UNCL and SURF) are shown in "red".

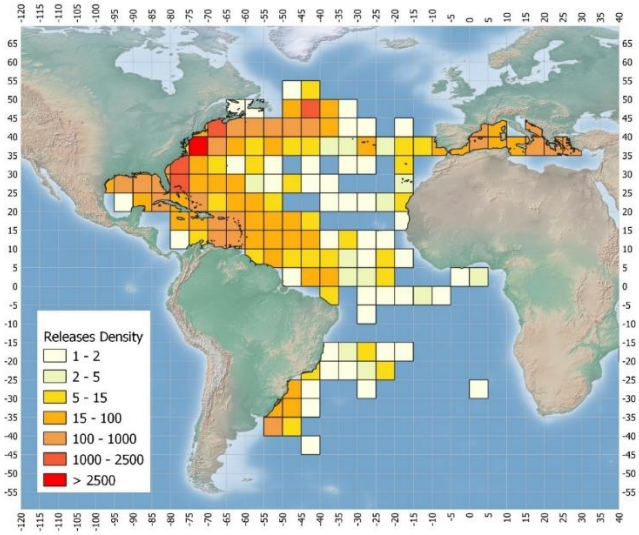

Figure 2. Density of SWO releases (5x5 square grid) on the conventional tagging available in ICCAT.

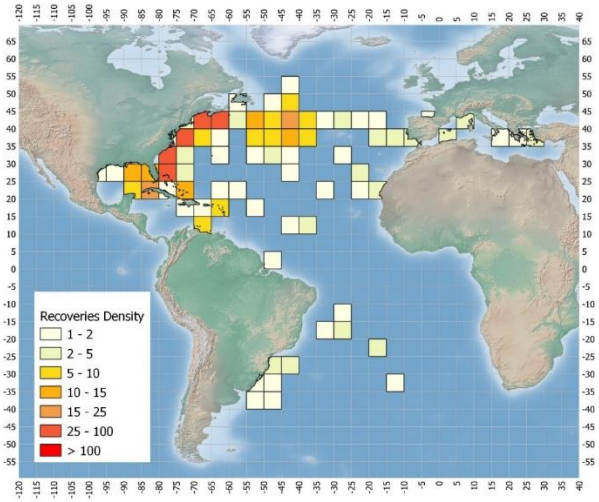

Figure 3. Density of SWO recoveries (5x5 square grid) on the conventional tagging available in ICCAT.

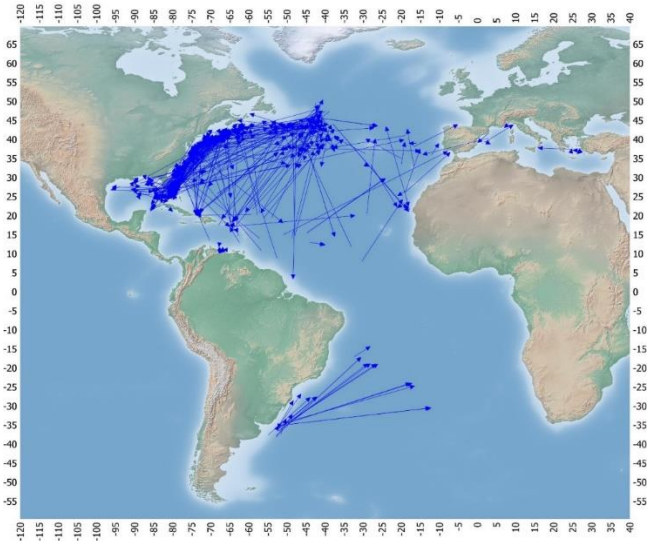

Figure 4. Straight displacement from the release to the recovery position (apparent movement) of the recaptured SWO specimens in ICCAT conventional tagging database.

Appendix 1

Agenda

1. Opening, adoption of agenda and meeting arrangements

2. Review of fishery statistics
    - 2.1 Task 1 (catches) data
    - 2.2 Task 2 (catch-effort and size samples) data
    - 2.3 Tagging data

3. Review of work done in 2020/early 2021 on North Atlantic Swordfish MSE

4. Further development of the MSE workplan and roadmap for ICCAT North Atlantic Swordfish MSE process
    - 4.1 Implications of the new MSE roadmap adopted by the Commission
    - 4.2 Discussion on the MSE code review
    - 4.3 Discussion on finalizing the reference set of OMs
    - 4.4 Discussion on performance metrics
    - 4.5 Discussion on start testing of candidate management procedures
    - 4.6 Proposal on criteria for determining exceptional circumstances

5. Update of the ongoing and future activities of the Atlantic and Mediterranean Swordfish Programme
    - 5.1. Review of the 2021 Swordfish Biology Workshop Report
    - 5.2. Update on ageing and growth analyses
    - 5.3. Update on reproduction and maturity analyses
    - 5.4. Update on genetic analyses
    - 5.5. Discussion on sampling activities
    - 5.6. Project Phase 4 planning and Terms of Reference
    - 5.7. Planning for Phase 5
    - 5.8 Other biological information

6. Workplan for 2021

7. Recommendations

8. Other matters

9. Adoption of report and closure

Appendix 2

List of Participants

CONTRACTING PARTIES

ALGERIA

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: assiakrim63@gmail.com

BRAZIL

Alves Bezerra, Natalia
Researcher, UFRPE, Rua Dom Manuel de Medeiros, s/n, Dois Irmãos, 52171-900 Recife, Pernambuco
Tel: +55 819 889 22754, E-Mail: natalia_pab@hotmail.com

CANADA

Busawon, Dheeraj
Fisheries & Oceans Canada, St. Andrews Biological Station, 125 Marine Science Drive, St. Andrews, NB E5B 0E4
Tel: +1 506 529 5889; +1 506 467 5651, Fax: +1 506 529 5862, E-Mail: Dheeraj.Busawon@dfo-mpo.gc.ca

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

Franceschini, Jaclyn
Fisheries and Oceans Canada, St. Andrews Biological Station, 125 Marine Science Drive St. Andrews, New Brunswick E5B1B3
Tel: +1 7058797391, E-Mail: j.franceschini@dal.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/ Biological Station, Fisheries and Oceans Canada, 125 Marine Science Drive, St. Andrews, New Brunswick E5B 2T0
Tel: +1 506 529 4665, Fax: +1 506 529 5862, E-Mail: alex.hanke@dfo-mpo.gc.ca

EUROPEAN UNION

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

Battaglia, Pietro
Researcher Stazione Zoologica Anton Dohrn (SZN) National Institute of Biology, Ecology and Marine Biotechnology SZN Sicilia Marine Centre Villa Pace, Contrada Porticatello 29, 98167 Messina, Italy
Tel: +39 081 583 3722, E-Mail: pietro.battaglia@szn.it; piebattaglia@gmail.com; battaglia.pietro@szn.it

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

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

Di Natale, Antonio
Director, Aquastudio Research Institute, Via Trapani 6, 98121 Messina, Italy
Tel: +39 336 333 366, E-Mail: adinatale@costaedutainment.it

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

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

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

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

Pinto, Cecilia
Università di Genova DISTAV, Dipartimento di Scienze della Terra, dell'Ambiente e della Vita Corso Europa 26, 16132 Genova Liguria, Italy
Tel: +39 340 496 6905, E-Mail: cecilia.pinto@edu.unige.it

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, E-Mail: daniela.rosa@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

Tserpes, George
Hellenic Center for Marine Research (HCMR), Institute of Marine Biological Resources, P.O. Box 2214, 71003 Heraklion, Crete, Greece
Tel: +30 2810 337851, Fax: +30 2810 337822, E-Mail: gtserpes@hcmr.gr

Tugores Ferra, Maria Pilar
ICTS SOCIB - Sistema d'observació y predicció costaner de les Illes Balears, Parc Bit, Naorte, Bloc A 2ºp. pta. 3, E-07121 Palma de Mallorca, España
Tel: +34 971 439 998, E-Mail: pilar.tugores@gmail.com; ptugores@socib.es

JAPAN

Ijima, Hirotaka
Associate Researcher, Highly Migratory Resources Division, Fisheries Resources Institute, National Research and Development Agency, Japan Fisheries Research and Education Agency, 2-12-4 Fukuura, Kanazawa, Kanagawa Yokohama 236-8648
Tel: +81 45 788 7951, E-Mail: ijima@affrc.go.jp

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

Nagai, Daisaku
Manager, Japan Tuna Fisheries Co-Operative Association, 31-1, EITAI 2-CHOME, Koto-ku, Tokyo 135-0034
Tel: +81 356 462 382, Fax: +81 356 462 652, E-Mail: nagai@japantuna.or.jp

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

MOROCCO

Fatih, Rania
Direction des Pêches Maritimes au Département de la Pêche Maritime, 11000 Rabat
Tel: +212 659 366 729, E-Mail: r.fatih@mpm.gov.ma

Ikkiss, Abdelillah
Chercheur, Centre régional de l'Institut national de Recherche Halieutique à Dakhla, Km 7, route de Boujdor, BP 127 bis(civ), HAY EL HASSANI NO 1101, 73000 Dakhla
Tel: +212 662 276 541, E-Mail: ikkiss.abdel@gmail.com

Ouyahya, Hicham
Direction des Pêches Maritimes, Département de la Pêche Maritime
E-Mail: hicham.ouyahya@mpm.gov.ma

SOUTH AFRICA

Parker, Denham
Stock Assessment Scientist, Department of Environment, Forestry and Fisheries, 9 Martin Hammerschlag Way, 7800 Cape Town
Tel: +27 21 402 3165; +27 82 660 7985, E-Mail: DParker@environment.gov.za; DenhamP@DAFF.gov.za

TUNISIA

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

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

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; adomingo@mgap.gub.uy

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

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 Keelung
Tel: +886 2 24622192 ext. 5046, Fax: +886 2 24622192, E-Mail: lucky_8043@yahoo.com.tw

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

THE OCEAN FOUNDATION
Miller, Shana
The Ocean Foundation, 1320 19th St., NW, 5th Floor, Washington, DC 20036, United States
Tel: +1 631 671 1530, E-Mail: smiller@oceanfdn.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
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

INVITED EXPERT
Arocha, Freddy
Instituto Oceanográfico de Venezuela, Universidad de Oriente, A.P. 204, 6101 Cumaná Estado Sucre, Venezuela
Tel: +58 424 823 1698, E-Mail: farochap@gmail.com

Hordyk, Adrian
3048 Point Grey Rd, Vancouver British Columbia V6K 1B1, Canada
Tel: +1 604 992 6737, E-Mail: a.hordyk@oceans.ubc.ca; adrian@bluematterscience.com

Johnson, Samuel D.N.
Landmark Fisheries Research, 213-2414 Saint Johns Street, Port Moody, BC V3H2B1, Canada
Tel: +1 604 365 7133, E-Mail: samuelj@sfu.ca

*****

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
Mayor, Carlos
García, Jesús
Gallego Sanz, Juan Luis
Peña, Esther

Appendix 3

List of Papers and Presentations

Reference	Title	Author
SCRS/2021/017	Curvy? How an unconventional measuring system adopted by observers can bias the scientific understanding in swordfish (*Xiphias gladius* L. 1758) and the ICCAT database	Di Natale A. and Garibaldi F.
SCRS/2021/087	Updated standardized catch rates for the North Atlantic stock of swordfish (*Xiphias gladius*) from the Spanish surface longline fleet for the period 1986-2019	Ramos-Cartelle A., Fernández-Costa J., García-Cortés B., and Mejuto J.
SCRS/2021/088	Updated standardized catch rates for the South Atlantic stock of swordfish (*Xiphias gladius*) from the Spanish surface longline fleet for the period 1989-2019	Ramos-Cartelle A., Fernández-Costa J., García-Cortés B., and Mejuto J.
SCRS/2021/089	Standardized age-specific catch rates in numbers of fish for the North Atlantic swordfish (*Xiphias gladius*) inferred from data of the Spanish longline fleet during the period 1982-2019	Mejuto J., García-Cortés B., Ramos-Cartelle A., and Fernández-Costa J.
SCRS/2021/092	Is the Swordfish slowly returning to the Black Sea? Recent evidences	Di Natale A.
SCRS/2021/093	Larval habitats and catches of swordfish (*Xiphias gladius*) in the Balearic Islands (2001-2020): oceanographic drivers and opportunities for research	Tugores M.P., Alvarez-Berastegui D., Macías D., Martín M., Torres A.P., Ortiz de Urbina J.M., and Reglero P.
SCRS/2021/094	From objectives to Candidate Performance Measures for Northern Atlantic Swordfish MSE	Taylor N.G., Gillespie K., Miller S., Kimoto A., and Coelho R.
SCRS/2021/095	Biological samples of swordfish (*Xiphias gladius*) collected by observers from the Chinese Taipei longline fishery in the Atlantic Ocean during 2019-2020	Su N-J., Shiu Y-W., and Cheng C-Y.
SCRS/2021/096	Size composition of swordfish (*Xiphias gladius*) caught in the Chinese Taipei longline fishery in the Atlantic Ocean	Su N-J., Shiu Y-W., and Cheng C-Y.
SCRS/2021/097	Peer review of the north Atlantic swordfish management strategy evaluation (MSE) code and algorithms	Anonymous
SCRS/2021/098	An evaluation of data weighting for the ICCAT northern swordfish management strategy evaluation	Schirripa M., Rosa D., and Hordyk A.
SCRS/2021/099	Updates to the operating model uncertainty grid for the north Atlantic swordfish MSE	Hordyk A., Schirripa M., and Rosa D.
SCRS/2021/100	Summary of fits to CPUE indices for the updated north Atlantic swordfish operating model uncertainty grid	Hordyk A.

Reference	Title	Author
SCRS/P/2021/037	Update of the sample collection and sample processing: Ageing (spines and otoliths)	Anonymous
SCRS/P/2021/038	Interim Report of Phase 3 of ICCAT's Swordfish Biology Program	Anonymous
Reference	**Title**	**Author**
SCRS/P/2021/039	Update of genetic analyses: annotation genome sequencing and genetic population analysis	G. Giochinni
SCRS/P/2021/040	Northern Swordfish MSE Update	Anonymous
SCRS/P/2021/041	Development of Exceptional Circumstance Criteria for Northern Swordfish MSE	Anonymous
SCRS/P/2021/042	Report of the 2021 ICCAT Swordfish biology Symposium	Anonymous

Appendix 4

SCRS Document and Presentations Abstracts as provided by the authors

SCRS/2021/017 - The accurate fish body length measurements are an essential element of many scientific processes, including important biological ones and stock assessments. The length measurements are usually standardised by species. For swordfish, the basic length measurement is always the straight LJFL. In very recent years, some observers' teams adopted a different methodology for measuring the LJFL in swordfish. Besides several specific warnings during various ICCAT SCRS SWO SG meetings, these unconventional measurements are still taken, affecting both the scientific results of the Group and the ICCAT Task II data base for the species, because of the mixing of various length measurement systems. This short paper points out this situation, explaining in detail the standards, the problem, the consequences and the need to use the conventional measurement methodology or, in sub-order, to propose a new code for these specific LJFL to both Subcomstat and the SWO SG, for avoiding problems in the ICCAT SWO Task II data base.

SCRS/2021/087 - Log-normal Generalized Linear Models (GLM) were used to update the standardized catch rates (in weight and in number) of the Spanish surface longline fleet targeting swordfish during the period 1986-2019 in areas of the North Atlantic stock. Factors such as area, quarter, gear and bait as well as the fishing-targeting strategy - based on the ratio between the two most prevalent species and those most highly valued by skippers - were considered. The base case models explained 59% and 57% of CPUE variability in weight and in number of fish, respectively. The increases in relative abundance in number of fish and in weight between the lowest levels in record occurred during the mid-nineties and the values reached in the last year considered in the present analyse were around +65%.

SCRS/2021/088 – Updated standardized catch rates in number and in weight were obtained using General Linear Modeling (GLM) procedures from trips carried out by the Spanish surface longline fleet targeting swordfish in the South Atlantic stock during the period 1989-2019. The criteria used to define factors were similar to those used in previous contributions. The results explained 65% and 71% of CPUE variability in number and weight, respectively, pointing to very stable standardized CPUE and mean weight trends over time. The statistical diagnoses were highly satisfactory.

SCRS/2021/089 – Standardized ages specific 1-5+ catch rates in number of fish were updated for a period of 38 years using log-normal General Linear Model (GLM) from 11,842 trips (145,294 fishing days, 262.8 x106 hooks) of the Spanish surface longline targeting swordfish in the North Atlantic stock. The models took into consideration factors such as gear-style and a target variable to allow for the two most important changes in fishing strategy in recent periods. The base case models explained between 41%-46% of CPUE variability. The standardized CPUE for age 1 suggests a very positive phase of recruitments between periods 1997-2012 and also 1997-2019 with an overall mean of around double the relative abundance compared

to the 1982-1996 mean level. This positive phase had positive effects on other ages including ages 5+ and the subsequent demographic change since mid-1990s onwards which could be the main cause for explaining different availabilities by size and age and different average weights and overall CPUEs between different regions-fleets.

SCRS/2021/092 – The disappearance of the swordfish from the Black Sea about on the middle of the '70s was one of the major distribution problems of this species in the last decades. Its disappearance from the Black Sea, the Bosphorus, the Sea of Marmara and the Dardanelles is not clearly documented. No official reports are available about any evidence of the new presence of the swordfish in the Black Sea and in the other adjacent areas. This paper provides all the available evidences about the recent presence of the swordfish in the Strait of Dardanelles, in the Sea of Marmara and in the Black Sea in the last years, which is a very positive fact and shows the coming back of the species in one of the historical distribution areas. This information should be used for better studying the new presence of the swordfish in the area.

SCRS/2021/093 – Since 2001, ichthyoplankton and hydrographic surveys directed to tuna species have been conducted in the Balearic Islands, a main tuna spawning ground in the Mediterranean. These campaigns provide today key information about the interannual changes on larval abundances for Bluefin tuna and albacore, also allowing the investigation of the early-life ecology of various species. The Balearic Islands have been identified as a prominent oceanographic retention area within the western Mediterranean as well as the main spawning area for tuna species. Hence, the regular ichthyoplankton surveys become an opportunity to increase the knowledge of those species whose pelagic early-life stages are encountered during the summer in this area. This is the case of swordfish (*Xiphias gladius*). Here we analyse the possibility of applying those surveys to investigate the early life ecology of the Mediterranean swordfish, exploring the interannual changes on larval abundances and the hydrographic preferences of larval habitats.

SCRS/2021/094 - Here we provide a summary of how management objectives for the Northern Swordfish stock have been articulated in the Commission's Recommendations and Resolutions, the additional clarifications that need to be made in order to calculate these as Performance Indicators, and a summary of Performance Indicators that have been used in other Management Strategy Evaluations at the International Commission for the Conservation of Atlantic Tunas. We conclude with a list of key performance indicators which should at a minimum include: the probability that the biomass at time t is greater that the biomass that produces B_{MSY} and that the fishing mortality at time t is less than the fishing mortality that produces F_{MSY}. $P(Bt>B_{MSY} \& Ft<F_{MSY})$; the probability that the stock is above the limit reference point $P(B_t>B_{LIM})$, the mean catches over t simulation years and the average variability in yield between time periods. Additional precision from the Commission is needed over what time period Performance Indicators are to be calculated, the assessment period interval, and if additional Performance Indicators should be presented.

SCRS/2021/095 - The objectives of this study were to summarize the biological samples of swordfish under the observer program and to examine the samples by fish size, month, and location for further analysis of the biological parameters. In total, 66 swordfish were sampled from the Chinese Taipei tuna longline fleet, including 28 females and 38 males during 2019-2020. There were 63 individuals recorded with length data, for which 49 anal fin spines and 29 otoliths were collected. Small swordfish under 120 cm LJFL were sampled with length and spine samples for both males and females. Male samples were available throughout the year, while females were only sampled for half year from August to next January. Fish including those smaller than 90 cm LJFL were sampled with otoliths and spines available, and have been sent to the laboratory for ageing analysis to determine the age of the fish.

SCRS/2021/096 - This study aims to provide available fishery information regarding to size structure of swordfish in the Atlantic Ocean from the Chinese Taipei distant-water longline fishery during the period from 2002 to 2020. Size data were available from the data collection system and comparison was made to explore potentially inconsistent trends between the data from logbooks by captains and records from onboard observers. Small fish of swordfish were recorded by observers, but not shown in the logbooks records because the captains and crews did not catch the fish onboard and released, but some of the fish were recorded by the observers. Swordfish that were caught larger than 130 cm LJFL account for a larger proportion of the catch. The pattern in mean length seems to stabilize during the recent period from 2002-2019. Larger and juvenile fish were captured in open waters of tropical Atlantic Ocean.

SCRS/2021/097 - This paper presents a draft peer review of the source code in the SWOMSE R package and its dependencies in the openMSE package. A static code analysis for programming style and package structure was completed and followed by a line-by-line review of all R, TMB, and C++ functions for mathematical accuracy and potential performance bottlenecks, and finally, simulation tests on the package, including estimating model equilibria via simulation, and performing unit-tests on core functions. Particular attention was paid to the translation from a sex-structured, multi-fleet Stock Synthesis 3 assessment model to a single-sex, single-fleet operating model, and its effect on model equilibria. Overall, there were relatively few errors and omissions in the source code and documentation, which is encouraging given the nature and scope of the package; however, the population dynamics code implementing the plus group was incorrect, leading to positively biased variability in population biomass and fishing mortality. We demonstrate this error, as well as its correction, via simulation. Otherwise, we noted missing documentation for several key calculations, importantly, the specifics of how SS3 assessments were used to condition the SWOMSE operating model, and a tendency for the TAC to not be completely caught in low fixed TAC simulations.

SCRS/2021/098 - Management Strategy Evaluation requires the identification of the Operating Model specifications whose uncertainty brings about the greatest amount of uncertainty into the subsequent management advice. This study used a systematic approach to test three methods of describing the uncertainty in data weighting of the length compositional and the catch per unit effort data for the Northern Swordfish Management Strategy Evaluation. Method 1 held the CPUE lambda at 1.0 and varied the length compositional lambda. Method 2 held the length compositional lambda at 1 and varied the CPUE lambda. Method 3 varied both the CPUE and length compositional lambdas simultaneously and required fewest number of combinations. The greatest amount of variation in the estimates of SSB0, SSB2017 and SSB2017/SSB0 resulted from using Method 2. However, it was noted that not all nine lambda variations were necessary to capture an adequate amount of uncertainty.

SCRS/2021/099 - The operating model (OM) uncertainty grid for the management strategy evaluation (MSE) of the North Atlantic Swordfish fishery has been updated. The revised grid has six axes of uncertainty, with 2-3 levels within each axis, for a total of 216 OMs. This paper reports the convergence diagnostics of the 216 OMs and summarizes how the predicted stock dynamics and estimated stock status are influenced by the levels within each axis of uncertainty. The results found the three levels of natural mortality (M), three levels of steepness (h), and three alternative weightings of the indices and length composition data had the largest impact on the variability in the estimated stock dynamics. Down-weighting the CPUE indices resulted in markedly higher estimates of stock status, particularly when M and h were in the highest levels. The inclusion of the environmental covariate had very little influence on the predictions. These results can be used by the Swordfish Species Group to evaluate the suitability of the OM uncertainty grid and determine the final grid that will be used in the testing of candidate management procedures.

SCRS/2021/100 - Fits to the catch-per-unit-effort (CPUE) indices and the length composition data are shown for the 10 national fleets and 5 survey fleets used in the conditioning of operating models (OMs) for the North Atlantic swordfish fishery. Plots of the fits to these input data are shown for the three levels of relative weighting to the CPUE and length composition data. Other than this axis of relative weighting, the three levels of natural mortality (M) had the largest influence on the fits to the data. In general, the overall error in the fits to the CPUE indices, summarized as root mean square error, and to the length composition data was lowest for the OMs where M = 0.3. The estimated stock status for these OMs was the highest (mean spawning biomass relative to spawning biomass at maximum sustainable yield >2), although the variability in the estimates was also the highest for this level.

SCRS/P/2021/037 - Since 2018, ICCAT has been developing a biology program for swordfish. Within the project a specific component on the age and growth of the species in the Atlantic (including the Mediterranean Sea) was developed. For this component, both spines and otoliths are being collected and processed for comparison of age readings between both structures. Progress on this component under Phase 3 was made on the processing of further samples and the start of a reference set for both spines and otoliths, undertaken during the biology workshop, and which will continue intersessionally. Further sampling needs for spines is mostly from the eastern Mediterranean and southern south Atlantic. Regarding otoliths, sample coverage is lower than for spines and misses the west Atlantic and southern South Atlantic and most of the Mediterranean. The size range of the samples could be further complemented with small (<90 cm LJFL) and large fish (>200 cm LJFL). A preliminary plan for a study on validation of band pair deposition through bomb radiocarbon and a pilot study for comparing spines, otoliths and vertebrae was presented.

SCRS/P/2021/038 – This presentation provides an update on progress associated with the ICCAT swordfish biology programme. The objective of the programme is to generate information that will support swordfish assessment and reduce uncertainty in key biological parameters. The programme has been running since 2018 and is nearing the end of Phase 3. The project is a collaborative effort from nearly 20 research labs from ICCAT CPCs. The focus of the initial phases (Phases 1 & 2) of the programme focused on the collection of biological samples (tissue, gonads, fin spines and otoliths) and associated fish data (location, size, date, gear) with preliminary analysis. In Phase 3 (mid-2020 to mid-2021), the programme shifted focus to filling key spatial-temporal sampling gaps, developing and implementing analysis standards, and analysis of data collected in Phases 1 and 2. The presentation outlines key events in Phase 3 and identifies objectives for Phases 4 and 5.

SCRS/P/2021/039 - This presentation is an overview of genetic results. Regarding genome assembly and comparative genomic analysis already concluded Authors presented total number of genes, genes shared with other fish, swordfish-specific genes, genes family in expansion and in contraction and a general overview of the whole genome structure. The authors then discussed the results from their genetic population analyses. Double digest restriction-site associated DNA (ddRAD) sequencing technology was applied to obtain 41277 SNPs for the analysis of genetic differences among 672 samples coming from NA, SA and MED populations. The authors showed an overview of all the statistical analyses that they optimized in a first set of 288 samples. A brief summary of main results achieved has been presented: All genetic analyses confirmed 2 main SWO populations: Atl and Med; Focusing on Atlantic specimens two subpopulation have been found: NA and SA subpopulation; Focusing on Mediterranean specimens two subpopulation have been found; the highest genetic differences were found between BIL95 and BIL97 samples and BIL95 and BIL92/94A; the lowest between BIL92/94A and BIL94B; an intermediate value was found between BIL92/94A and BIL97; BIL94B is an area in which it is possible to catch animal belonging NA, (9%) SA and (12%) MED populations; BIL92/94A specimens showed the worst situation of genetic diversity, in terms of Heterozygosity and allelic Richness and inbreeding coefficient. The authors concluded that ddRAD is a powerful tool to analyse genetic population and encourage to use this tool to annual monitoring of the status of the three populations.

SCRS/P/2021/040 - The North Atlantic swordfish MSE development process has been ongoing since 2018 and is scheduled to provide science advice to the Commission in 2022. The MSE population model base case is similar to the 2017 assessment model with uncertainties built around: natural mortality, recruitment variability, steepness, CPUE CVs, effective sample size of the length compositions, catchability increase, and an environmental variable. There were three major advancements in late 2020 and early 2021: upgrade of the population modeling platform (SS3.24 to SS3.30); reduction in the size of the OM grid through a combining of the CPUE and length composition axes; introduction of a retention curve estimate in the models. This last change addresses Res. 19-14. para 3 which asks that the SCRS introduce functionality in the OM grid for evaluation of minimum size limits as strategies for achieving management objectives. The presentation outlined next steps in the North Atlantic swordfish MSE process and provided an overview of items that require further input from the Commission.

SCRS/P/2021/041 - Exceptional circumstances (ECs) occur when there is an apparent divergence from scenarios that are simulated in the MSE analyses. The MSE roadmap indicates that in 2021, COMM (SWGSM/PA4) is to recommend an initial draft of a N-SWO EC protocol. A N-SWO EC Protocol would describe indicators for ECs, the criteria used to evaluate those indicators, the frequency at which these criteria are evaluated, and the decision process that occurs after ECs are detected. The ICCAT Standing Working Group to Enhance Dialogue Between Fisheries Scientists and Managers and the ICCAT Working Group on Stock Assessment Methods have both recommended that consistency be maintained among MSE processes for EC decision rules. This presentation reviews work already conducted on an EC protocol for Atlantic Albacore and notes where this Species Group may consider diverging from this protocol. Given that PA2 and the Albacore Species Group are still revising their EC protocol, the authors of this presentation suggest that PA4 delay adoption of a N-SWO EC Protocol until PA2 and the ALB Working Group have completed their work.

SCRS/P/2021/042 – In March 2021 the swordfish biology programme held an online workshop. The workshop was attended by CPC scientists, private research labs, academia, and invited experts. The objectives of the workshop were to review progress of the project; develop ageing and maturity reference sets; and identify gaps in sampling and analysis. The symposium participants developed best practices for

ageing of both spines and otoliths as well as macroscopic and histological imagery for gonads. There was discussion and planning for analysis via bomb radiocarbon for absolute estimates of age. Symposium participants were presented with detailed information on genetic analysis related to stock identification and stock boundaries. There was significant discussion and planning for addressing gaps in sampling and further analysis that will be important for supporting future assessments and the ongoing N-SWO MSE.

Appendix 5

Road map 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) may be necessary. The aspirational nature of this timeline assumes adoption of a final management procedure for northern albacore in 2020 and interim management procedures for bluefin tuna and northern swordfish in 2022 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, road map reflects progress to-date in some detail. For 2020 onward, more general steps for the SCRS and Commission are anticipated pending outcomes of the 2019 Annual Meeting.

	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
2015	- Commission established management objectives in Rec. 15-04			
2016	- SCRS conducted stock assessment - SCRS evaluated a range of candidate HCRs through MSE - PA2 identified performance indicators			- Commission identified performance indicators (Rec. 16-01)
2017	- SCRS evaluated the performance of candidate HCRs through MSE, using the performance indicators developed by PA2 - SWGSM narrowed the candidate HCRs and referred to Commission - Commission selected and adopted an HCR with associated TAC at the Annual Meeting (Rec. 17-04)	- SCRS conducted stock assessment - Core modelling group completed development of modelling framework	- SCRS conducted stock assessment	- SCRS reviewed performance indicators for YFT, SKJ, and BET - SWGSM recommended a multispecies approach for development of MSE framework
2018	- SCRS contracted independent expert to complete peer review of MSE code - Call for Tenders issued for peer review - SCRS tested the performance of the adopted HCR, as well as variations of the HCR, as requested in Rec. 17-04 - SCRS developed criteria for the identification of exceptional circumstances	- SCRS conducted joint MSE meeting on BFT/SWO - SCRS reviewed but could not adopt reference set of OMs - SCRS began testing candidate management procedures (MPs) - SWGSM considered qualitative management objectives - BFT WG reviewed progress and developed detailed road map - Commission adopted conceptual management objectives (Res. 18-03)	- SCRS conducted joint meeting on BFT/SWO MSE - SCRS contracted MSE technical expert to develop OM framework, define initial set of OMs, and conduct initial conditioning of OMs - SWGSM considered qualitative management objectives	- SCRS contracted with technical experts: start development of MSE framework (phase I) - SCRS conducted bigeye tuna stock assessment
	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*

2019	- SCRS addressed recommendations of the peer reviewer - SCRS updated performance of the interim HCR and variants - SCRS produced consolidated report on MSE 1. COMM: PA2 to consider 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 - SCRS continued to evaluate candidate MPs - At intersessional meeting, PA2 reviewed and developed initial operational management objectives and identified performance indicators - SCRS to hold December webinar to review OM progress 1. COMM: PA2 to review MSE progress and advise the Commission on next steps, including need for an update of the stock assessment to provide TAC advice for at least 2021	- SWO Species Group meeting - SCRS contracted with technical expert to develop initial MSE framework - Commission to consider, and if possible, adopt conceptual management objectives at the Annual Meeting	- SCRS conducted yellowfin tuna stock assessment
2020	1. COMM (PA2) to develop guidance intersessionally on a range of appropriate management responses should exceptional circumstances be found to occur (5-6, March, PA2 intersessional)	1. SCRS to conduct stock assessment update and develop TAC advice for 2021 and 2022	1. SCRS to continue development of MSE framework, including the finalization of operating model conditioning and the uncertainty grid	1. SCRS to conduct skipjack data preparatory meeting
	2. COMM (PA2) to review interim HCR and recommend MP to the Commission for possible adoption at the Annual Meeting (5-6, March, PA2 intersessional)		2. SCRS to develop example candidate MPs	2. SCRS to continue MSE development.
	3. SCRS to conduct NALB stock assessment (in June)	2. SCRS to initiate independent peer review of MSE code		
	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
2020	4. SCRS to evaluate existence of exceptional circumstances	3. SCRS to propose criteria for determining exceptional circumstances		3. COMM (PA1) to review and provide feedback on MSE progress either intersessionally or during the Annual Meeting *(Alternatively could take place in 2021)*

	5. COMM to: a. review and endorse guidance developed intersessionally on management responses in the case of exceptional circumstances b. review the interim HCR and adopt a long-term MP, including the TAC, at the Annual Meeting	4. COMM (PA2) – Intersessional Meeting (March)		4. COMM (PA1) to recommend initial operational management objectives and to review and revise the performance indicators agreed by the Commission in 2016, either intersessionally or during the Annual Meeting *(Alternatively, could take place in 2021)*
		4. COMM to review candidate MPs at the Annual Meeting		
		5. COMM to set TACs for at least 2021, based on stock assessment update, at the Annual Meeting		
2021	1. SCRS to have a data preparatory meeting to prepare inputs for a SS model		1. SCRS to continue development and testing of candidate MPs	1. SCRS to continue development and testing of candidate MPs
			2. SCRS to continue work on criteria for determining exceptional circumstances	2. SCRS to conduct skipjack stock assessment (timing to be determined)
			3. SCRS to initiate independent peer review of MSE code	3. SCRS to conduct bigeye data preparatory meeting (timing to be determined)
	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
2021			4. COMM (SWGSM/PA4) to recommend initial operational management objectives and identify performance indicators either intersessionally or during the Annual Meeting	4. SCRS to conduct bigeye stock assessment (timing to be determined)

		1. COMM (SWGSM/PA2) intersessionally to: - review MSE progress, review preliminary candidate MP results, and provide feedback to SCRS; - [recommend final operational management objectives and identify performance indicators]; and - develop guidance on a range of appropriate management responses should exceptional circumstances be found to occur	5. COMM (SWGSM/PA4) to review MSE progress, example candidate MP results, and provide feedback to SCRS, either intersessionally or during the Annual Meeting	
		2. SCRS to initiate independent peer review of MSE process		
		3. SCRS to complete MSE, incorporating feedback from Commission through PA2/SWGSM		
		4. SCRS to provide final advice to the Commission on criteria for determining exceptional circumstances	6. SCRS to conduct stock assessment (postponed to 2022)	
	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
2021		5. COMM (SWGSM/PA2) and SCRS to refine MP(s) and to review and finalize, as needed, guidance on a range of appropriate management responses should exceptional circumstances be found to occur	7. The Group will provide an update on the progress of the MSE to the Commission/PA4.	5. COMM (SWGSM/PA1) to review MSE progress, preliminary candidate MP results, and provide feedback to SCRS either intersessionally or during the Annual Meeting

		6. COMM to: a. review and endorse guidance developed intersessionally on management responses in the case of exceptional circumstances, and b. adopt an interim MP at the Annual Meeting, including a 3-year TAC	8. SCRS to continue work on the OM grid, including diagnostics (September species groups)	6. COMM (PA1) to finalize operational management objectives and performance indicators at the Annual Meeting
2022	1. SCRS to initiate independent peer review of MSE process			
	1. SCRS to develop a SS model for ALB		1. SCRS to conduct stock assessment (North and South Atlantic)	1. SCRS to continue MSE development, including developing and evaluating candidate MPs
			2. SCRS to finalize work on OM conditioning	2. SCRS to propose criteria for determining exceptional circumstances
			3. SCRS to provide advice to the Commission on criteria for determining exceptional circumstances	3. SCRS to initiate independent peer review of MSE code
				4. COMM (SWGSM/PA1) to develop guidance on a range of appropriate management responses should exceptional circumstances be found to occur
	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
2022			4. COMM (SWGSM/PA4) and SCRS to: - refine MP(s); - recommend final operational management objectives and identify performance indicators (early 2022)	5. COMM to review candidate MPs at the Annual Meeting
			5. SCRS to complete MSE, incorporating feedback from Commission through PA4/SWGSM	[…]

			6. COMM to: a) adopts an interim MP at the Annual Meeting, including the TAC	[…]
2023 and beyond*	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. COMM to review and finalize, as needed, guidance on a range of appropriate management responses should exceptional circumstances be found to occur. 2. 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. SCRS to complete MSE, incorporating feedback from Commission through SWGSM/PA1
2023 and beyond*	2. On the predetermined timescale for MP setting, SCRS to evaluate existence of exceptional circumstances	2. On the predetermined timescale for MP setting, SCRS to evaluate existence of exceptional circumstances	3. On the predetermined timescale, SCRS to evaluate existence of exceptional circumstances	2. SCRS to provide final advice to the Commission on criteria for determining exceptional circumstances

*Assumes that the workplan is accomplished as described.

2023 and beyond*	*Northern Albacore*	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
				3. SCRS to initiate independent peer review of MSE process
	3. COMM to continue use of the MP to set TAC at the Annual Meeting, on the predetermined timescale for MP setting	3. 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	4. COMM to continue setting TAC based on the MP at the Annual Meeting, on the predetermined timescale for MP setting	4. COMM (SWGSM/PA1) and SCRS to refine MP(s) and to review and finalize, as needed, guidance on a range of appropriate management responses should exceptional circumstances be found to occur
				5. COMM to: a) review and endorse guidance developed intersessionally on management responses in the case of exceptional circumstances, and b) adopt interim MP(s) at the Annual Meeting, including TACs, where applicable
2024 and beyond*	See 2023 row SCRS to improve Observation Error Model by incorporating statistical properties of CPUE residuals	See 2023 row	See 2023 row	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
	SCRS to test the available (i.e. production model) and alternative MPs (e.g. based on Jabba, or empirical)		1. On the predetermined timescale for MP setting, SCRS to evaluate existence of exceptional circumstances	2. On the predetermined timescale for MP setting, SCRS to evaluate existence of exceptional circumstances

*Assumes that the workplan is accomplished as described.

	Northern Albacore	*Bluefin Tuna*	*Northern Swordfish*	*Tropical Tunas*
2024 and beyond*	[…]	[…]	[…]	3. COMM to continue use of the MP to set management measures at the Annual Meeting, on the predetermined timescale for MP setting
			1. Consider reconditioning the OM when benchmark assessment are carried out	[…]
				[…]
				[…]

*Assumes that the workplan is accomplished as described.

LIST OF ACRONYMS:

BET = Bigeye tuna
BFT = Bluefin tuna
BFT WG = SCRS' Bluefin Tuna Working 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 6

Swordfish Workplan for 2022

North and South Atlantic

Assessments for North and South Atlantic swordfish were conducted in 2017 (Anon., 2017). The next assessment is tentatively scheduled for 2022. The Group requests to conduct a total of two meetings in 2022, namely a data preparatory meeting that will include a MSE component (total 5+4 days in-person, with the MSE component occurring the week immediately before or after the data preparatory component) and a stock assessments session (5 days in-person). In addition, the MSE technical team will continue to work intersessionally online to advance the technical work. The intersessional meetings (data-preparatory and stock assessment session) will be dedicated mainly to the Atlantic (North and South stocks) assessments, but an agenda point on MSE can 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. The third requested meeting is of a more technical nature and will be dedicated mainly to discussion and progress on the MSE work.

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

***Size/Sex distribution study*:**

- *Background/objectives:* The Group 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 between 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:* Colaborative 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 SWO 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, Morocco). Specifically, previous stock assessments from 2006, 2008, 2012 used this index in the productions models used for 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, 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 SG 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. 2017g). And in the 2021 intersessional meeting a work was presented on a larval work index for the Mediterranean (SCRS/2021/093). The Group 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 Group 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 SWO 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 Group 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 N&S-Atlantic SWO are tentatively scheduled for 2022. If possible the group should take into account emerging SWO-SWG 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 Group 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 MSE ongoing work. As such, the Group encourages national scientists to use their domestic observer programs information to estimate discards, including dead discards and live releases, if possible. The estimations should go backwards in time as much as possible, and the estimation methods should be presented to the SWO Species Group.
- *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 started in 2018, with 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:*
- *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 Group 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 US, with the participation of CPCs with PSAT tag 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 directions of some of the influential indices of abundance, the Group 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 were 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 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 US, 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 Group 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 Group recommends 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 this 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-Atl 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 client engagement in the HCR project. With regards to the management-oriented approach which has been requested by the ICCAT Commission, the work has 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, and that has been produced.
- *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 Group 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. 2020g). 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), it 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 Group 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