REPORT OF THE 2022 ICCAT ATLANTIC SWORDFISH DATA PREPARATORY SESSION

(Online, March 21 to 1 April 2022)

"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

The meeting was held online, 21 March to 1 April 2022. The northern swordfish rapporteur Kyle Gilespie (Canada) opened the meeting with the Species Group (the Group) coordinator Dr. Rui Coelho (EU-Portugal) and the southern rapporteur, Denham Parker (South Africa). The ICCAT Executive Secretary, welcomed and thanked the participants, highlighting the difficulties of working online during the COVID-19 pandemic. The Chairman proceeded to review the Agenda which was adopted without changes (**Appendix 1**).

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

Sections	*Rapporteur*
Items 1, 11	Taylor, N.G.
Item 2	Rosa, D.
Item 3	Palma C., Mayor C., Garcia, J., Rosa, D.
Item 4	Coelho, R., Lauretta, M. Parker, D., Mourato, B., Kimoto, A., Coelho, R., Gillespie, K., Parker, R., Hanke, A.
Item 5	Schirripa, M., Ortiz, M. Parker, D.
Item 6	Gillespie K., Hordyk, A., Rosa, D. Miller, S.
Item 7	Taylor, N.G., Kimoto, A., Ortiz, M.
Item 8	Brown, C., Hanke, A. Duprey, N.
Item 9	Taylor, N.G.

2. Review of historical and new information on biology

Presentation SCRS/P/2022/008 provided an update on the ICCAT swordfish biology programme. The programme is a collaborative project between institutes from 15 ICCAT CPCs and its goal is to address life history uncertainties important in the ICCAT swordfish assessments and MSE. A brief review was given on the number of swordfish sampled, sampling coverage, and the sampling materials obtained from fish in each of the stocks. The programme, now entering its fifth year, is now focusing on filling spatial-temporal gaps and analyzing samples for age and growth, reproduction, and stock differentiation.

The Secretariat informed the Group on a possible extension of phase 4, to allow for better use of the available funds and to fill additional gaps related to the collection of samples under the current phase. It was noted that for this phase most of the funds are already allocated to processing while a smaller portion is available for sampling, however this extension would be considered by the Group.

Presentation SCRS/P/2022/005 showed an update on the age and growth component of the biology programme for swordfish. For this component, both spines and otoliths are being collected and processed for comparison of age readings between both structures. Readings have started for the North Atlantic stock, and growth modelling will be conducted after the readings are finalized. The Group acknowledged and thanked the authors for the presentation. Document SCRS/2022/061 presented information with regards to conversion factors between Straight Lower Jaw Fork Length (S-LJFL) and Curved Lower Jaw Fork Length (C-LJFL) for swordfish in the North Atlantic. Sex and Month had a large effect on the predictions while Area had less of an effect. The differences between C-LJFL and S-LJFL increase as specimens grow to larger sizes.

The Group considered this work to be extremely important and useful. It was noted that the conversion between curved and straight LJFL would be most impacted in the spawning season. The authors noted that a difference was found particularly in the northwest in the months from July to September, with the fish being in a better condition (more curve), however this would only translate in around 1 cm difference. It was further noted that this would probably be due to feeding, as that area is not a spawning ground. This work is ongoing and further sampling and analysis will be conducted.

A question was asked if the Group would decide to use the curved or straight fork length. It was noted that both have been used to report Task 2 data. Moreover, with the standardization of the analysis on the size data (SCRS/2022/060), the Secretariat has converted all sizes to straight LJFL, as this should be the standard measurement type to be used in the assessment.

It was noted that the current paper only presented equations to estimate curved LJFL from straight LJFL. The authors provided an updated version before the end of the meeting (aiming at publication of the document in the ICCAT Col. Vol. Sci. Pap.) that includes conversions for both measurements (i.e., straight LJFL to curve LJFL, and vice-versa). It was also agreed that the Secretariat would update the size revisions to be used in the stock assessment based on those new equations.

3. Review of fishery statistics and tagging data

The Secretariat presented to the Group the most up to date (as of 20 March 2022) fishery statistics information available in the ICCAT database system (ICCAT-DB) in relation to swordfish (*Xiphias gladius*, SWO) for both Atlantic stocks (SWO-N: North Atlantic; SWO-S: South Atlantic). The datasets revised by the Group includes, Task 1 nominal catches (T1NC), Task 2 catch and effort (T2CE), Task 2 size frequencies (T2SZ), Task 2 catch-at-size estimated/reported by CPCs (T2CS), and the most recent CATDIS estimations (T1NC catches distributed by trimester and 5x5 squares, between 1950 and 2020). The CATDIS, published in the ICCAT Statistical Bulletin Vol. 47, reflects the SWO T1NC information received until January 2022. The existing swordfish conventional tagging (and electronic tagging at a minor extent) information was also presented and revised by the Group.

3.1 Task 1 (catches) Data

After the large and comprehensive revision made by this Group in 2017 (detailed in Appendix 5 of Anon. 2017a), where the entire catch series (1950-2015) of both SWO Atlantic stocks (SWO-N and SWO-S) were fully revised and updated (reduced unclassified gears, gap completion, reclassified erroneous gears, corrections to sampling areas and stocks, etc.), no major corrections were made to T1NC for that period. Only the catches for the period 2015-2020 were addressed in detail at this meeting.

The T1NC gaps identified on both SWO Atlantic stocks (catch series period: 2015-2020) for the most important flag/gear combinations, were completed with carry overs (average of the previous three years). The gap completion table is summarised in **Table 1**. By default, all the T1NC gaps completed with this approach are considered preliminary and must be replaced by CPC official statistics in the future.

In addition, some preliminary catches were obtained during the meeting for the Venezuela artisanal drift gillnet fleet (2015-2020), the Senegal longline, handline and gillnet fleets (2020). An historical recovery on SWO-N catches was presented by Costa Rica for National mid-scale longline fleet fishing on Costa Rica EEZ waters and covering the period 1999 to 2020 (SCRS/2022/047).

Finally, the Group adopted all the T1NC updates described above, noting that some catches of Marrocco and Senegal still have to be finalized by the end of March 2022. The revised T1NC catches are presented in **Table 2** (total catches by stock and major gear, between 1950 and 2020) and **Table 2a** (total landings and dead discards by major gear and flag, between 1990 and 2020)**.** Graphically, the total SWO catches for the Atlantic stocks are presented in **Figure 1** (SWO-N) and **Figure 2** (SWO-S). A dashboard to dynamically navigate through T1NC was also prepared by the Secretariat (**Figure3**)

In relation to the progress made on reporting SWO discards (DD: discarded dead; DL: discarded live; DM: mortality estimates obtained from DL) in T1NC by ICCAT CPCs, the Secretariat informed that, very little progress has been made. Very few CPCs have reported discards (DD and DL shown in **Table 3**). The Group reiterated the need to improve the reporting of both dead and alive discards.

Only one document with historical revisions of T1NC was presented at the meeting. Document SCRS/2022/047 presented a historical revision of the swordfish (*Xiphias gladius*) landings of the Costa Rican mid-scale longline fleet (in recent years about three vessels with length overall ranging from 15 to 20 meters) fishing in the Caribbean Sea for the period 1999 to 2020. The swordfish catches in their majority are bycatch. The basic information (number of longline vessels and corresponding catches) is recorded and managed by the Costa Rica Institute of Fisheries and Aquaculture.

The Group congratulated Costa Rica for the work in providing this totally new catch series with 17 years to ICCAT. The catch series covers a much larger period then the last five years in which Costa Rica is a Cooperating party to ICCAT. The Group also encouraged Costa Rica to expand its work in understanding the seasonality of the SWO catches in this poorly known area of the Caribbean Sea.

The Group mentioned the importance of having scientific documents involving T1NC revisions to validate and improve the current T1NC held in ICCAT.

The Secretariat also presented to the Group the most recent update to CATDIS with SWO estimates (derived T1NC information with catches distributed by trimester and in 5x5 squares, reflecting the catch and effort space-time available in ICCAT). The SWO maps with catches by decade (1950-2020) and gear are presented in **Figure 4**. The overall SWO catches (all years) by gear are presented in **Figure 5**.

The CATDIS is the main source of catch information entering into SS3 modelling approaches when working with quarterly catch series. This update reflects the T1NC information received until 31 January 2022. In order to have both T1NC and CATDIS synchronised, additional changes to T1NC since that date need to be incorporated into CATDIS. The Group adopted 1 April 2022 as the deadline to have completed this for both T1NC and CATDIS.

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

The SWO standard SCRS catalogues (T1NC and T2CE/SZ/CS availability, ranked by importance in the total SWO stock production within the period 1991 to 2020) were updated and presented to the Group (SWO-N in **Table 4**, and SWO-S in **Table 5**). The SCRS catalogue is an instrument that allows to see a combined view of Task 1 and Task 2 datasets by major fishery.

Task 2 catch and effort (T2CE)

T2CE datasets are identified in the SCRS catalogues with the character "a". The Secretariat reminded the Group that these catalogues no longer show (since 2015, as recommended by the SC-STAT) T2CE datasets with poor time-area resolution (e.g.: datasets aggregated by year and/or datasets with 10x20/20x20 geographical grids aggregation levels) available in the ICCAT-DB but usually not used in any scientific work. The rationale behind this is to encourage CPCs to report improved datasets to ICCAT to replace those identified as "poor" in terms of time-area resolution.

The Secretariat informed the Group that very minor improvements were made to T2CE (when compared with T2CE data available in the 2017 Stock Assessment session, Anon. 2017b) in both SWO Atlantic stocks. There are however, several incomplete T2CE longline series (Belize, Korea Rep., Namibia and Vanuatu) affecting both SWO Atlantic stocks, which would require full revisions. The Group recommended that CPC scientists use standard SCRS catalogues as a tool to identify any missing data.

Task 2 size frequencies

Task 2 size samples and catch at size, respectively, must be reported to ICCAT in two different electronic forms:

- ST04-T2SZ: observed size frequencies (T2SZ)
- ST05-T2CS: CPC estimations of the size composition of the catches (T2CS). Also known as reported CAS.

The SWO standard SCRS catalogues show the availability of both T2SZ (character "b") and T2CS (character "c"). As for T2CE, these catalogues do not show T2SZ/CS datasets with poor quality (poor time-area detail, size/weight bins larger than 5 cm/kg) available in ICCAT-DB but usually not used in scientific work (like overall CAS matrix estimations). Overall, the tendency to report higher resolution T2SZ/CS datasets has been maintained in the last decade. For both stocks there is a lack of some important datasets in various years.

The Group considers that the Secretariat's ongoing (since 2010) Task 2 data recovery/improvement work should continue with active participation of the CPC scientists.

In the preparation of the current SWO data preparatory, USA recovered and provided to ICCAT the SWO dead discard size samples (T2SZ) for the period 1992-2009, a missing series unavailable in the ICCAT-DB (data recovery requested by this Group in 2017). This information was made available to the Group which approved it.

Other CPCs including Belize, Brazil, China PR, Côte d'Ivoire, Korea Rep., Panama, St. Vincent and Grenadines, and UK-Bermuda, should provide updates of Task 2 size data with higher resolution due to incomplete series or highly aggregated time are data. The Secretariat will provide support in those revisions.

No new SCRS documents that included Task 2 revisions or recoveries were presented to the Group by ICCAT CPCs. The Secretariat presented, however, a detailed analysis of all the T2SZ information available in the ICCAT-DB.

Document SCRS/2022/060 presented the size sampling data of North and South Atlantic swordfish stocks. Size data were reviewed, and preliminary analyses were performed for its use within the stock assessment models. The size samples data were standardized to straight-lower jaw fork length units and aggregated to size frequencies samples by main fleet/gear type, year, and quarter. For the North and South Atlantic stocks, the size sampling proportion among the major fishing gears is consistent with the proportion of the catch since 1990, and most of the size samples come from the longline fisheries. The number of fish measured has decreased substantially in the last decades from both the North and South Atlantic fisheries. A review of the size-frequency data by fleets indicated no unusual shift of size data around 1992/93, which had previously been noted, for the main longline fleets. Size frequency data were aggregated by year, quarter, and fleetID for 5 cm lower limit size-class bin.

The Secretariat informed the Group that the detailed analysis presented reflects the T2SZ information available in December 2021. The document should be updated with the most recent T2SZ presented to the Group, which contains new size data recently added (e.g.: USA discard T2SZ series, Spanish longline T2SZ series obtained from T2CS) and the new curved/lower jaw straight fork length relationships (SCRS/2022/061). While some CPCs report size samples from all sources in ST04, the Group noted that some CPCs reported SWO size samples recorded by Domestic Observer Programmes only using the ST09 form (i.e., not reported on ST04 at all). Size samples reported this way are not being included by the Secretariat in the preparation of Task 2 size samples (form ST04) to be used as input for the stock assessment models, as there is no information to determine if information is doubly reported. The Group agreed that all size samples (including dead and live discards), regardless of how they were collected, should be reported using the ST04 form.

3.3 Catch-at-size, Catch-at-age, Weight at Age

No updates of the overall catch-at-size (CAS) matrix estimates were made for this assessment. Thus, no catch-at-age/weight-at-age derived estimates were made.

3.4 Tagging data

The Secretariat presented a summary of swordfish conventional tagging updated. **Table 6** shows releases and recoveries per year and **Table 7** 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 6**), the density of recoveries in 5x5 squares (**Figure 7**) and the SWO apparent movement (arrows from release to recovery locations) (**Figure 8)**. In addition, the Secretariat also presented a swordfish dashboard to visualize tagging data dynamically and interactively (Snapshot in **Figure 9**).

The Group acknowledged the work of the Secretariat to develop the tagging dashboard and its usefulness. It was noted that under "Releases" the field "fleet" does not always match with the fleet that tagged the fish, but with a tagging programme, for example, tags reported as USA are sometimes tags distributed to other fleets to tag swordfish. The Group was informed by the Secretariat that the conventional tagging database is being revised aiming to recover (from the original files reported to ICCAT) and include the sex information. This was a request made by the Sharks Species Group.

The Secretariat has informed the Group that it has faced difficulties in incorporating the conventional tagging data reported by the USA between 2009 and 2016 (all species including SWO), and that the ICCAT-USA 2008 data exchange protocol on conventional tagging (Anon., 2009) may need a revision. The proposed solution by the Group to solve this problem is that the Secretariat works directly with USA scientists to (a) revise the existing data exchange protocol and (b) work on a complete submission by USA of all the conventional tagging datasets (which incorporates all the revisions to historical records).

In addition, the Group recommended that additional effort be devoted to recovering all SWO tagging data (conventional and electronic) from other projects outside ICCAT (see current ICCAT electronic tagging inventory at: https://www.iccat.int/Data/Tag/ElecTags_consolidation.7z).

Document SCRS/2022/052 presented results for tagging funded through ICCAT (16 tags) and NOAA (10 tags). Of the 26 tagged individuals, data for eight was analysed for horizontal and vertical movements. In both the North and South Atlantic swordfish moved in several directions and travelled considerable distances. Vertically, swordfish spent the night-time close to the surface and the daytime in deeper/cooler waters. Additional tags are available, and tagging will continue through 2022.

The author was asked about the tagging process. In the longline commercial vessels, swordfish are kept in the water as much as possible and tagged with a pole on the dorsal side below the dorsal fin base, the tags had a single tether. In the case of the harpoon fishery tagging, a harpoon was modified to tag, with one tag having a Domeier's dart and the other three being equipped with small titanium darts.

The Group was informed that tags from a batch with battery issues were replaced by Wildlife Computers and additional three goodwill tags were also provided.

Regarding future tagging events, it was noted that the areas close to the current stock boundaries are a priority, however tagging in other areas could also be possible. Canadian and Brazilian scientists showed interest in deploying the tags that have not yet been distributed. Additionally, USA and Canadian scientists have expressed interest in contributing with further tag data for the analysis with tags deployed in their domestic tagging programmes. The Group was informed of a tag deployed off Florida that was recovered by the EU-Spain fleet and will be returned through the assistance of IEO (*Instituto Español de Oceanografia*); this will allow for detailed data recovery (data recorded by the tag every 5 seconds).

The Group was also informed that one of the tags deployed in the Mediterranean has pop-up and is stranded in the beach. Attempts to recover it were made but it has not yet been possible to do so, therefore the Group considers to be important to have hand-held Argos receivers that could be used to recover tags (see Recommendations section).

The high post-release mortality rate and the high percentage of premature releases was noted, resulting in few analysed tag data despite the tagging effort. It was noted that tagging in commercial longline vessels could lead to these mortality rates, as swordfish, despite being in good condition could have been hooked for varying times, decreasing the chance of survival. Tagging in harpoon or sports fishing is expected to have a higher survivorship. Regarding premature releases, this happens in several species and few solutions have been put forward to mitigate this aspect. Double tethers can be considered, but those also present some logistical complications, especially when tagging in larger commercial vessels.

The Secretariat informed the Group that a new electronic database is being developed and the tagging data should be made available in the next 1-2 years. Some tagging data is already available in an OwnCloud for sharing data between those that are contributing data. This will be continued as more data becomes available.

4. Indices of abundance (individual and combined indices)

The Group reviewed 17 fleet specific indices of relative abundance: 10 indices for the North Atlantic stock, and 7 indices for the South Atlantic stock. North Atlantic indices included nine pelagic longline standardized catch-per-unit-effort (CPUE) indices, and a larval survey index from the northern Gulf of Mexico. All seven indices for the South Atlantic were pelagic longline standardized CPUE indices. Discussions highlighted the need to 1) distinguish between retained catches only versus indices that record kept and discarded fish, 2) indices metrics in weight versus numbers of fish, 3) spatiotemporal properties, 4) standardization model assumptions and diagnostics, and 5) age or size classes referenced by the index. These were noted as particularly important for determining use in Stock Synthesis versus production models, as well as the joint longline analyses. The Group discussed the CPUE evaluation table recommended by the Working Group on Stock Assessment Methods (WGSAM) for both stocks (**Table 8** and **10** for North and South Atlantic stocks, respectively). **Table 9** lists the index values for the North Atlantic, and **Table 11** lists the index values for the South Atlantic. **Figures 10** and **11** plot the indices by stock.

The following list provides a summary of the different indices recommended for use in the stock assessment, followed by a detailed section on each index considered and the Group discussions.

North Atlantic indices of relative abundance:

- Canada longlines (1962-2021): retained numbers of fish/(an effort offset) logbooks.
- EU-Portugal longlines (1999-2020: retained and discarded weight/effort, observer/self-reported
- EU-Spain longlines (1986-2019): retained weight of fish/effort, landing and voluntary trip records provided by the fleet, production models only.
- EU-Spain longlines Age-specific (1982-2019): retained numbers of fish/effort, ages 1-5, landing and voluntary trip records provided by the fleet, for Stock Synthesis only excluding the age-1 index for 2016-2019.
- Japan longlines (1976-1993, 1994-2020 except 2000-2005): retained numbers of fish/(an effort offset), logbooks.
- U.S. longlines (1993-2020): retained and discarded numbers of fish/effort, observers.
- Chinese Taipei longlines (1968-1989, 1997-2020): retained numbers of fish/effort, logbooks.
- Morocco longlines (2005-2020): retained weight/effort, landing reports, revision recommended (completed and accepted by the Group before the conclusion of the meeting).

South Atlantic indices of relative abundance:

- Brazil longlines (1994-2020): retained numbers of fish/effort, logbooks.
- EU-Spain longlines (1989-2019): retained weight of fish/effort, landings/ landing and voluntary trip records provided by the fleet.
- Japan longlines (1976-1993, 1994-2020): retained numbers of fish/(an effort offset), logbooks.
- Uruguay longlines (2001-2012): retained numbers of fish/effort, observers.
- Chinese Taipei longlines (1968-1990, 1998-2020): retained numbers of fish/effort, logbooks.
- South Africa longlines (2004-2020): retained weight of fish/effort, logbooks.

4.1 North Atlantic Indices

Japan longline CPUE (SCRS/2022/046): JPN LL

Japanese longline operational data were standardized by two separate regions (North and South of the 5°N latitude stock boundary) and split into two time periods (Early: 1976-1993, and Late: 1994-2020). Multiple GLMMs were tested, including alternative factor treatments and error distribution assumptions. A Bayesian spatiotemporal GLMM was applied for the base index assuming 1x1 spatial and quarterly strata. The index values for the period 2000-2005 were recommended to be excluded from the stock assessment models due to changes in the collected data structure. It was recommended to the author that the standardization of CPUE evaluate the effect of including the input data for 2000-2005 years within the spatiotemporal model of standardization used so that this might be reviewed for the 2022 Stock Assessment meeting (20-29 June 2022).

The Group noted that the 2017 CPUE showed a steep decline plus that 1974-1975, and 2020 CPUE were not used. The author answered that before 1975, there were no data about the hooks between floats and vessel name.

The Group noted the change in model structure from previous analyses that focused on a core fishery area to the wider data spatial coverage and application of the spatial mixed effects model. The model can be considered more robust to uncertainty in swordfish distribution relative to the core area assumptions. The final indices were the summarized posterior distributions of the least squared (LS) means (R-INLA), and it was noted that model uncertainty estimates, and credible intervals are not directly comparable to the estimates of CV and confidence intervals from maximum likelihood estimators used in the fixed effects GLMs.

The Group had some concerns in the trends and heterogeneity of the model residuals and suggested looking at plots of the residuals by predictor variable. The author agreed that there are some nonrandom residual patterns with regards to the predicted zero catch values, likely due to the occurrence of swordfish as a bycatch species and a considerable number of zero observations in the data. The author also noted that multiple model constructs were tested, and the final model was chosen based on goodness of fit and information criteria statistics.

The Group requested additional summary plots for the index, including:

1. A plot comparing the new index with the prior one used in the 2017 Stock Assessment.
2. Additional residual plots requested (Q-Q plots, residuals by factor).
3. Recalculate the standardization of the late period indices, excluding the 2000-2005 data.
4. Rescaling on the nominal series separately for the two periods as well as the two standardized CPUE series to better see the yearly effect.

The Group reviewed the requested summary plots. Morocco scientists presented the updated CPUEs using a random effect for the year: month interaction, including diagnostics. The Group noted that the diagnostics were in general acceptable, even though the QQ plot showed some extreme outliers. The Group asked for several additional plots, namely the residuals against the month and year predictors; these were shown during the meeting. There were also issues related with the calculation of the CVs, and those were to be corrected in the final version. The author agreed to update the paper with those new analysis. The Group agreed that the final index was accepted to be used in the assessment models.

The Group recommended the spatiotemporal mixed model approaches be further evaluated by the WGSAM. In particular, it would be highly informative if these types of models could be tested with LLSIM data to compare performance with the other GLM and GLMM approaches that have been previously simulation tested.

Canadian longline CPUE (SCRS/2022/048), CAN LL

Two indices of swordfish relative abundance for the Canadian longline fishery were presented. The first was a strict update of the index used in the 2017 Stock Assessment and the other included a habitat covariate. The Group commented that the drop in CPUE during the 1990s seemed to correspond with the trend in the habitat index. The authors mentioned the habitat index presented covered the entire spatial area, but the trend corresponding to the area fished may be different. The authors noted that a considerable amount of habitat values assigned to the Canadian data resulted in a zero-habitat score, despite those areas being a known hotspot for swordfish in the region. This was especially the case for inshore areas. The authors of the habitat index will further explore approaches to solve the issue, noting that in the oceanographic models the edges and areas close to shore are where errors are more likely to occur.

The Group discussed the splitting of the index during the 2017 Stock Assessment but confirmed the recommendation that the updated index be modeled as a continuous series in the 2022 Stock Assessment. The analyst clarified that the methods were updated to run all samples at an aggregated trip level to produce a continuous series, while the prior analysis treated the early trip-level data for the whole time period and at the set-level for more recent data.

Chinese Taipei longline CPUE (SCRS/2022/050), CTP LL

SCRS/2022/050 presented the abundance index of swordfish for the Chinese Taipei tuna longline fishery in the North Atlantic Ocean. To address the impact of a targeting shift from albacore to bigeye tuna, catch and effort data were standardized by period using generalized linear models. The early period starts from 1968 to 1989 and the late period from 1997 to 2020 with operation type information considered in the analysis. The abundance trend showed a decreasing trend in the very early period, but suddenly increased to a higher level during the early 1990s as a result of the targeting change, and then dropped sharply in the late 1990s and stabilized until present.

The Group discussed this updated analysis and especially with regard to the earlier period. The authors clarified that there were no differences between 1968 and 1989 compared to the last 2017 Stock Assessment, and that the differences in the analysis are in the more recent periods. The recommendation was to use the two period indices, one for the period 1968 to 1989, the second for the period 1997 to 2020, and excluding 1990-1996. The Group requested the figures comparing the nominal be rescaled for the two periods separately, which were provided during the meeting. Additionally, it was suggested that alternative targeting variables could be explored that look at catch clustering.

EU-Portugal longline CPUE (SCRS/2022/054), POR LL

SCRS/2022/054 provided standardized CPUEs for swordfish captured by EU-Portugal pelagic longline fishery in the North Atlantic Ocean. The analysis was based on data collected from fishery observers and self-sampling (where measurements were taken by the crew), collected between 1995 and 2020. In general, the nominal CPUE trends increased during the period with some inter-annual variability. Various models were tested, and the final model was a GLM Tweedie, with interactions and the use of the habitat index variable. The standardized CPUEs showed similar trends with an overall increase during the period, with some oscillations.

The Group asked about the depth of the fishing operations and especially if there was some deeper swordfish fishing, such as the meso-pelagic fishery in the Mediterranean. The authors clarified that this fleet always operates in shallow depths during the night, and that there are no meso-pelagic operations taking place. The Group also asked about the size distribution and if there had been any changes. The authors clarified that for this fleet the sizes have remained mostly stable along the entire period, with some increases in mean sizes around the late 2000s.

United States longline CPUE (SCRS/2022/055), USA LL

Annual indices of swordfish relative abundance in the western Atlantic Ocean for the period 1993 to 2021 were presented, based on the United States pelagic longline observer data. A negative binomial generalized linear model evaluated multiple factors considered to affect swordfish catch rates, including year, month, fishing area, gear characteristics, and environmental conditions. Significant factors included year, month, area, target species, sea surface temperature, hook type, bait type, day/night, and light sticks. Methods followed the previous analysis and recommendations and incorporated an additional six years of data (2016 to 2021).

The Group acknowledged the detailed information and model diagnostics provided, including the influence plots as particularly helpful to understand the factor effects on model standardization, as well as the usefulness of seeing the index time series with the various fleet regulations timing overlaid. The author agreed that the influence plots are a highly informative diagnostic and offered to share model code to be considered in the best practices guide for diagnostics in CPUE standardization.

The Group asked, with regards to the various hook types and fleet-wide regulations, if there was sufficient data and overlap in the transition period. The author explained that there was a period with experimental hook sets where hook type was tested, as well as a period of overlap in the data where both types were deployed. They further noted that those experiments were conducted in particular areas, and there could be some potential confounding effects. However, the author noted that there was significant work done on the model standardization for the last Stock Assessment in 2017, including testing different data treatments, factor inclusion, model structures, and explicit evaluation of hook type effects estimated across the data series and compared to the experimental treatment with overall good agreement between the two approaches.

Moroccan longline CPUE (SCRS/2022/056), MOR LL

A lognormal GLM of Moroccan longline swordfish CPUE was used to update the standardized index of abundance. The fleet targeted swordfish south of the Moroccan Atlantic Coast during the period 2005-2020. The analysis covered a total of 1796 trips. The index showed considerable fluctuations over the time series, with a decline observed to 2018, but increased since then.

The Group noted the relatively few factors included in the standardization (i.e., only year and month), and asked for clarification on the Year-Month interaction and model performance on the large number of model parameters for available data. The authors clarified that in some of the combinations there was no data, so parameters were not estimated for all the possible combinations (as seen in the degrees of freedom).

The Group asked for clarification on the index calculations from the LSMeans, given the year-month fixed interaction. It was noted it would be useful to provide a plot with the time series of the year effect for each month, as with an interaction the trends of the years for each of the months will be different. The Group noted options for alternative factor treatments, including modeling the interaction as a random effect. It was also noted that the LSMeans package in R estimated the yearly mean incorporating the interaction automatically. The Group requested a comparison on the provided index with a model that treated the year*month interaction as a random effect to validate the index estimates.

Gulf of Mexico larval index (SCRS/2022/059), GOM larval

Fishery independent indices of swordfish spawning biomass in the Gulf of Mexico were presented utilizing NOAA Fisheries ichthyoplankton survey data collected from 1982 through 2019. Indices were developed using the occurrence of larvae sampled with neuston gear using a zero-inflated binomial model, including the following covariates: time of day, month, area sampled, year, gear and habitat score. The habitat score was based on the presence/absence of other ichthyoplankton taxa and temperature and salinity at the sampling station.

The Group commented on the results with regards to the temperature and salinity, and that it would be useful to plot not only the frequency of occurrence of the positives but for all the distribution of all the tows carried out in the entire areas. The Group asked about the correlation between larval density and density of larval predators. The author pointed out that there is a plot in the paper with the occurrence of SWO larvae in comparison with other taxa, and that in most cases the p-values for the correlations are low.

The Group discussed the low number of specimens associated with the index, which ranged between 0 and 19 total individuals detected per year. Specifically, the Group questioned the timing and location of the survey relative to swordfish spawning areas/seasons, and how representative the survey may be compared to the total swordfish spawning biomass. The author pointed out that previous work in the Gulf carried out year-round surveys and found that most of the SWO larvae were found during the period of April and May, corresponding to the survey data collected for the study.

The Group also commented on the high interannual variability, likely associated with the relatively low occurrence of a few specimens per year, and that the variability is likely outside the range of biological plausibility. This includes years with zero detections and resulting index values equal to zero, which does not likely characterize the stock spawning biomass changes over time. It was recommended that size-related mortality be considered for the next assessment. The index was excluded from the last assessment and is recommended to be excluded for this assessment.

EU-Spain longline indices (Ramos-Cartelle et al., 2022 and Mejuto et al., 2022), SPN LL

The authors provided a presentation summarizing the document presented in 2021 with updated swordfish indices from the Spanish longline fleet for the period 1986 to 2019. Ramos-Cartelle *et al.*, 2022 updated the swordfish standardized catch rates (in weight and in numbers), while Mejuto *et al.,* 2022 updated age-specific 1-5+ catch rates in number of fish also for the North Atlantic. The standardized CPUE for age 1 suggests a very positive phase of recruitments during 1997-2019, which resulted in positive effects on other ages including age 5+ and the subsequent demographic changes since mid-1990s onwards.

The indexes incorporated important changes in fishing strategy, including gear monofilament and fleet targeting. From the two alternative data treatments presented, the biomass index is recommended for use in the surplus production models, and the age-specific abundance indices for use in Stock Synthesis. The authors noted a reduction in the number of observations after 2011 fulfilling the strict sampling protocol established for the age-specific analysis, as well as a change in the current management system implemented at domestic level based on the strict annual quota per vessel that is likely causing an underestimate in the abundance index in relation to the fishing strategy of previous historical period. Additionally, the minimum size tolerance was unilaterally cancelled by the CPC at a domestic level between 2007 and 2009, but the confusion generated has been carried over to the present. Therefore, values of CPUE age 1 should be considered with caution since year 2010 but especially for the most recent periods and at least after 2015 in particular since they were probably underestimated. The authors of the paper recommend rejecting, at the very least, those values of age 1 since from 2016 (inclusive) onwards.

4.2 South Atlantic Indices

Five documents describing the standardization methods, and associated CPUE time series, were presented in the Data Preparatory meeting from the following CPCs: Brazil, EU-Spain, Japan, South Africa and Chinese Taipei. In addition, two sets of relative abundance indices from Uruguay, that had previously been presented (Pons *et al*., 2014 and Forselledo *et al.,* 2018) were made available to the Group as background documents but had not been updated. The Group noted that most of the indices that were available for the last 2017 Swordfish Stock Assessment (2017) had been updated, except for the Uruguay longline (where the fishery ended in 2012). The Group welcomed the increase in submissions of swordfish CPUE standardization papers from the South Atlantic since the previous Swordfish Data Preparatory meeting in 2017 and acknowledged the participation of the CPC scientists.

Brazilian longline indices (SCRS/2022/057), BRA LL

Standardized catch rates of swordfish from the Brazilian longline fleet were produced for the period 1994-2020. The analysis included catch and effort data distributed across a wide area of the Southern Atlantic Ocean, aggregated by 5x5 spatial squares. The standardization model was a GLM using a Delta Log-normal approach that included year, quarter, clusters, hooks per floats, number of hooks, and spatial square. The results indicate an initial decreasing trend between 1996 and 2001 that remained relatively stable thereafter to 2015. A steady decrease was observed at the end of the time series (2016-2020).

The Group acknowledged the updated methodology applied, particularly the data preparation processes, which resulted in the removal of the historical period (1978-1993) that was characterized by high variability yet flat overall trend. Under the revised data treatments, the splitting of the index in the previous assessment has now changed to a recommendation to use a continuous series from 1994 to 2020. Also, the authors explained that the American-type longline was introduced in the Brazilian fleet in 1994, when the swordfish became the target species, minimizing, at least partially, the impact of the target species change in the updated time series and used only logbook data, which differed from the used approach in the previous analysis

Spanish longline indices (Ramos-Cartelle et al., 2021), SPN LL

The authors provided a summary presentation of the updated EU-Spain longline index presented last year. Two indices (in weight and in number) were prepared for the period 1989-2019, each showing a period of stability (1993-2004) followed by a slight but sustained upward trend.

The Group noted that the recent increasing CPUE trend reported by EU-Spain for the South Atlantic was a result of an increase in the number of fish, in contrast to the North Atlantic where the observed increase in CPUE by EU-Spain was attributed to an increase in the average size of fish. The Group recommended evaluation of the targeting variable which was modeled as the fraction of SWO in the catch, particularly exploratory analyses that depict the relationship between the annual median/mean ratio and the estimated CPUE the index values. Further recommendations were made to explore alternative targeting metrics (e.g., the South African longline targeting cluster approach), but it was noted that the approach is more effective in fisheries with numerous species caught and less effective in those with a limited number of species observed.

Japan longline indices (SCRS/2022/046), JPN LL

The document is discussed in the previous section 4.1, and the recommendations are consistent with those for the North Atlantic indices. The recommendation is to use the index for the South Atlantic by two periods, 1976 to 1993, and 1994 to 2020. The additional data plots requested for the North Atlantic were also requested for the South.

Uruguay longline indices (Forselledo et al., 2017, Pons et al., 2014), URU LL

This was a historical series and remained unchanged from the previous assessment. This was from a fishery that has now ceased.

South Africa longline indices (SCRS/2022/049), ZAF LL

Standardized catch rates of swordfish from the South African longline fleet (2004-2020) were modeled using a GAMM with a Tweedie distributed error. A targeting factor was derived y clustering Principal Components Analysis (PCA) scores of the root-root transformed, normalized catch composition, and resulted in three clusters being included in the model. A definitive seasonal trend in catch rates was evident. Results indicate an initial decline (2004-2010) in CPUE followed by relative long-term stability thereafter, despite inter-annual variation.

The Group noted the variable *month* was fitted using a cyclic cubic smoothing function as opposed to the conventional method of treating seasonal parameters as factors, which resulted in a strong domed seasonality with a peak in June. The author indicated that the estimated seasonal pattern matched the observed seasonality of the fishery.

Chinese Taipei longline indices (SCRS/2022/051), CTP LL

SCRS/2022/051 presented the standardization of swordfish catch and effort data for the Chinese Taipei distant-water tuna longline fishery in the South Atlantic Ocean. The dataset was separated into three periods to consider changes in targeting, resulting in an early (1968-1990) and two late periods (1991-2020 and 1998-2020). In general, catch rates showed a decreasing trend through the 1970s, and stabilized during the 1980s. The trend started to decrease from the early 1990s, with a further drop to lower level in the late 1990s, and then stabilized over the two most recent decades (1998-2020).

The authors confirmed that catch ratios, as a proxy of targeting, were not explicitly included in the model but rather used to identify changes in targeting which were then treated as time blocks in the time series, resulting in the three various periods presented. Furthermore, the authors indicated that the periods 1968-1990 and 1998-2020 were considered most appropriate for stock assessment inclusion. Additionally, it was suggested alternative targeting variables could be explored that look at catch clustering.

4.3 Trends and correlations in the CPUE indices

The Group reviewed updated figures for trends and correlations of the CPUEs for each stock that were discussed at the 2017 Data Preparatory meeting. The aim was to identify CPUE data conflicts, understand the magnitude of correlation (both positive and negative) between CPUE indices, and capture the overall trends for the available indices. Especially the plot of the correlation matrix can identify similarities and dissimilarities of the indices. Generally, if indices represent the same stock components, then it is reasonable to expect them to be correlated. If indices are not correlated or negatively correlated, i.e., they show conflicting trends, this may result in poor fits to the data and bias in the estimates unless the models have some spatial structure. Therefore, the correlations can be used to select groups that represent a common hypothesis about the evolution of the stock. The Group also noted that the age range of catch and fishing areas for each fleet also need to be taken into account when the Group selects the indices for the stock assessment.

The Group reviewed **Figures 12** and **13** for the North and South Atlantic stocks.

North Atlantic

The following observations were made by the Group while reviewing the North Atlantic CPUE indices:

1. Indices in the NW Atlantic seem to have a general decreasing trend, while in the NE Atlantic are mostly increasing.
2. This pattern is similar to what had been observed in the last 2017 Stock Assessment. At the time the inclusion of an environmental effect in Stock Synthesis (related with AMO) allowed for the conflict to be reduced in the indices.
3. Some indices have relatively higher inter-annual variability when compared with others, especially in some years. The GOM larval survey is the index with the highest inter-annual variability.
4. The indices with the highest negative correlations indices (relative severity in brackets) were:
    a. EU-Spain LL and EU-Portugal LL (high)
    b. EU-Spain LL and Chinese Taipei LL1 (high)
    c. EU-Portugal LL and Japan LL2 (medium)
    d. EU-Portugal LL and Morocco LL (medium)
5. Positive correlations were observed between the following indices:
    a. EU-Spain LL and Japan LL1 (high)
    b. EU-Spain LL and Chinese Taipei LL2 (high)
    c. Canada LL and Chinese Taipei LL1 (medium)
    d. Gulf of Mexico larval survey and EU-Portugal LL (medium)

South Atlantic

The following observations were made by the Group while reviewing the South Atlantic CPUE indices:

1. Potential conflicting CPUE data between Japan LL2 (increasing) and Chinese Taipei LL2 (decreasing) from 2013 onwards.
2. The early period (1982-2002) of the Uruguay LL historical index has high annual variation.
3. The final point estimate (2012) of the Uruguay LL index deviates substantially from the previous years.
4. EU-Spain LL index has relatively low inter-annual variability, when compared with the other South Atlantic indices.
5. Negative correlations were observed between the following indices (relative severity in brackets):
    a. Brazil LL and Uruguay LL (high)
    b. EU-Spain LL and Brazil LL (high)
    c. EU-Spain LL and Chinese Taipei LL2 (high)
    d. Chinese Taipei LL2 and Japan LL2 (medium)
    e. Brazil LL and Japan LL2 (low)

6. Positive correlations were observed between the following indices:
   a. EU-Spain LL and Chinese Taipei LL1 (high)
   b. South Africa LL and Uruguay LL (high)
   c. Uruguay LL and Chinese Taipei LL2 (medium)
   d. EU-Spain LL and Japan LL2 (medium)

4.4 Determine indices to be used in the next assessment for the base-case and sensitivity runs CPUE table

The Group reviewed and updated the table (**Tables 8** and **9**), developed by WGSAM, describing the attributes of the CPUE indices that could be used in the modeling of the northern and southern swordfish stocks. A final decision on which indices to use was contingent on the evaluation of extra work assigned to particular index developers (Canada, Chinese Taipei, Japan, Morocco, Spain and Chinese Taipei). These extra tasks were to be completed before the conclusion of the meeting and were noted in the table.

The Group discussed whether the Canadian index should be split as in the 2017 Stock Assessment, and it was clarified that the Group in 2017 felt that it was justified because of the deviation of the nominal CPUE from the standardized CPUE. It should be noted however that other Species Groups (SKJ) encountering the same issue do not view a deviation from the nominal to be a criterion on which to evaluate the suitability of an index. It simply means the standardization is accounting for differences over time related to changes in q. The Group's final decision was to include the index as a single, continuous series in the 2022 Stock Assessment model.

Of the two Canadian CPUE series provided, the series that did not include habitat in the model was adopted due to concerns over having habitat suitability values of zero assigned to 20% of the fishing data which tended to occur in choice swordfish fishing areas.

It was agreed to drop the Japanese northern stock index values for 2000 to 2005 due to the low quality of the logbook data. It was also clarified that the CV for this index relates to Bayesian credible intervals derived from the posterior distribution of the estimates rather than by maximum likelihood estimation.

The USA indicators were based on strict updates and given that there was no support to include the larval survey in the 2017 Stock Assessment, it was recommended to exclude it from the current assessment. However, it was recognized that the larval index could be used post-assessment to compare its trend with the trend in the different components of the population.

The review of indices for the South Atlantic recognized that the updated Brazilian index is no longer split but is a continuous series from 1994 to 2020. Further, the Uruguayan indices were not updated due to the cessation of fishing.

Data inputs

The Group agreed to use Venezuela's recently submitted Task 1 and 2 data rather than catch estimates based on previous years; however, in Senegal's case it will be necessary to use an average of previous years catches to fill in missing catch.

It was noted that Canadian size composition data for the catch was submitted in form ST04 while form ST09 contains the at-sea-observer data including discards. It was recognized that the ST09 data should be submitted in form ST04 in order to be able to create the size compositions for the Canadian longline fleet. Given time constraints, a revision would not be possible in time to be included in the modeling, consequently it was agreed that Canada would provide the Secretariat with discard data in the requested format. Further, it was identified that several other fleets have provided discard size data in ST09. The most important of these was Chinese Taipei for which there is no evidence of catch below the legal limit in ST04. The Secretariat agreed to meld size composition data from forms ST09 and ST04 while attempting to avoiding duplication as much as possible.

Combined index

The Group discussed the creation of a combined index for the North that could be used in a surplus production model and to support the swordfish MSE. Many National Scientists (CAN, EU-Portugal, USA, and Chinese Taipei) have indicated that they are able to provide set level data by month and by 1x1 or 5x5 grid squares. It was noted by the USA that the resolution of the data will affect data set size because of confidentiality issues.

Morocco indicated that it could provide trip-level data for 5x5 grid cells and it was encouraged to conform with the request to the degree possible. For example, it was indicated that the depth of fishing could be a rough estimate. Japan's contribution of data by 5x5 grid square depends on receiving the necessary permissions. Spanish scientists are still to confirm data availability and co-authors of previous analyses will be consulted. It was noted that format for the additional information requested (i.e. the finer spatial-temporal resolution together with environmental data and gear features that have not already been submitted) was described in a template sent to National Scientists.

Noting that the data from National Scientists could be at different levels of aggregation, it was suggested to explore modeling techniques appropriate for this type of mixed data. It was noted that it was important to keep units consistent, most specifically, the type of catch (retained vs. retained and discarded) and units of measurement (number vs. weight).

Timeline

The Group reviewed and discussed the timeline for the delivery of assessment model inputs. The timeline was modified so that all model inputs sould be available by 15 April. Extra work related to the indices is to be completed during this meeting. Task 1 and Task 2 (including length composition for discarded lengths) related data inputs will be available by 7 April and data for the northern swordfish combined index is due on 10 April. The combined index should be available by 15 May 2022. No combined index will be developed for the South Atlantic because of time constraints.

It was proposed that a growth curve be developed from the samples from the Swordfish Sampling Programme and provided by 15 May for use in the assessment model. Concerns were expressed related to the proper vetting of the new growth information and the impact on the quality of the assessment work given the existing workload and time constraints. The Group resolved that estimating a new growth model must be given adequate time because of implications to the assessment outcomes. Accordingly, the Group agreed that establishing a new growth curve would occur in future assessment years but that time permitting and if the data are available, then a sensitivity run considering the new growth data may be considered.

It was also discussed whether to simply provide the new age information as an input to Stock Synthesis along with a prior based on the existing growth model and let Stock Synthesis estimate the growth curve, but concerns were expressed on how well the age data inputs would cooperate with the other data in the model. This approach also implies we are accepting the data. The Group discussed including the new growth information in a sensitivity analysis and it was felt that an uncertainty axis should be reserved for difficult to estimate parameters (e.g., steepness and natural mortality).

Finally, the Group recognized the importance of the combined index for advancing the work on northern swordfish MSE and the need to keep the MSE and assessment model inputs consistent.

Limit Reference Points

The Group briefly discussed the availability of new information for establishing a limit reference point (Blim) for the northern and southern Swordfish stocks. The interim Blim reference point is currently $0.4*B/B_{MSY}$ and new information is expected to be provided at the 2022 meeting of the WGSAM (31 May – 3 June 2022).

Projections

Guidance on how the projections will be conducted will be provided intersessionally.

5. Models to be used during the assessment and their assumptions

5.1 North

5.1.1 Surplus Production Models (ASPIC)

The surplus-production model incorporating covariates (ASPIC, Prager (1992)) will be used. The Group felt the continued use of this model would be educational in tracking the use of different modeling platforms over time.

Critical Model assumptions
In ASPIC catchability and selectivity of fisheries and indices are constant over the entire time period, any changes in catchability have to be modeled within the CPUE standardization process. There is an immediate response of the stock to fishing mortality, no age-delayed response.

Model Inputs
Catch and CPUEs non-age specific series. Catch should be Task 1 NC total removals (landings plus dead discards). To evaluate as sensitivity run by including mortalities estimates from the live discard reports.

Model outputs
Trajectories of F and B. Trajectories of relative F and B. Catchability q for each CPUE series. Confidence intervals. Carrying capacity K, B1/K, r. Projections

Diagnostics
Sum of Squares. Residual plots of the fits to CPUEs. Retrospective patterns. Jackknife evaluation of input CPUEs.

Key parameters
B1/K, K, r.

Uncertainties
The ASPIC model assessment model does not allow for the inclusion of uncertainty of the model inputs (e.g., CV of the CPUE series). In prior assessments, uncertainty in the CPUE series was incorporated by making separate runs using the median and upper and lower 95% confidence intervals, bootstrapping the results, and combining the bootstrap outputs. Running the model using different production functions was also deemed as being a way to assess uncertainty.

Model strengths and weaknesses
Because of the limited data requirements, this model is easier to be supported by the Secretariat. ASPIC is easy to use, and many National Scientists are familiar with its use. It is considered to be useful for data limited situations. ASPIC is fast to run and facilitates simulation testing. Because of the limited data requirements, it allows the use of longer time series where data from earlier periods are usually poor. It only estimates a few parameters, but these are typically the ones needed to provide management advice. ASPIC quickly produces diagnostics, bootstrap results, and projections. However, ASPIC as other SPMs does not necessarily reflect the true dynamics of the stock/fishery and it cannot take into consideration any variability in recruitment or changes in catchability. The model cannot accommodate changes in management regulations, like changes in minimum size, so this needs to be taken into account in the CPUE series. ASPIC often cannot resolve indices of abundance with conflicting trends.

5.1.2 Bayesian Surplus Production model - JABBA

The Bayesian Surplus Production model, Just Another Bayesian Biomass Assessment (JABBA); (Winker *et al.,* 2018) will be used. JABBA offers an implementation that models both process error and observation error. JABBA provides a user-friendly R to JAGS interface for fitting generalized Bayesian State-Space Surplus Production models with the aim to generate reproducible stock status estimates and diagnostics. JABBA is generalized in the sense that the production function can take on various forms, including conventional Fox and Schaefer production functions, and can be fit using a variety of error assumptions. Key parameters include carrying capacity (K), the maximum rate of population increase (r), and the ratio of stock biomass in the initial year to carrying capacity (Bo/K). The software enables Bayesian integration for computation of marginal posterior probability distributions for parameters and management variables and outputs for inclusion in Kobe plots.

Model assumptions
A one-year lag adequately characterizes the influence of annual stock biomass on future surplus production as in any production. Abundance indices are related to stock biomass via a constant of proportionality whereby there is no hyperdepletion or hyperstability in the index. Surplus production can be described by the Schaefer model, Fox model, or the flexible Pella-Tomlinson production function.

Model inputs
Catch series. CPUEs non-age specific. Priors for K, r, B0/K, process error deviates. A fixed value for the prior standard deviation in process error deviates. A CV for each abundance index that is constant over time, and if judged appropriate, an additive CV by year for each abundance index.

Model outputs
Posterior distributions for estimated parameters (r, K, Bo/K, sigma (index) if estimated, q(index)), stock biomass, MSY, annual F, F/F_{MSY}, B, B/B_{MSY}, and paired F/F_{MSY} and B/B_{MSY} estimates for Kobe plots.

Diagnostics
Plots of lognormal residuals of observed versus predicted CPUE indices by fleet, Root-Mean-Squared-Error (RMSE) and associated residuals runs-test to quantitatively evaluate the randomness of CPUE model residuals. MCMC convergence plots, plots of posterior median process error deviates by year, together with probability intervals by year, plots of post model pre-data distributions, priors, and posteriors. Retrospective patterns plots and hindcast cross-validation prediction skill. Jackknife analysis of CPUEs.

Key parameters
r, K, B0/K, B_{MSY}/K.

Uncertainties
Uncertainties in estimated parameters, model variables, shown in posterior distributions, standard deviations, coefficients of variation, probability intervals. Option to include process variance for all modeled years or only starting in the year when the first abundance index becomes available. Observation variance is separated to distinguish between fixed input variance and estimable variance, where the estimable observation variance can be set to be the same value for all abundance indices or estimated separately for each index.

Model strengths and weaknesses
The model is not age structured, so it cannot handle changes in vulnerability at age. It uses available biological parameters data to develop a prior distribution for r, consistent with an equivalent stock age structure dynamics. Training is required to run the software proficiently. As with other surplus production models, it may be biologically inaccurate and therefore might not reflect the true dynamics of the stock. JABBA runs quickly and by default generates many useful plots and diagnostic tools for stock assessments. JABBA is implemented as a flexible, user-friendly open-source tool to promote reproducibility and provide a platform for future research.

5.1.3 Stock Synthesis (SS)

As with the 2017 Stock Assessment (Anon., 2017b), the model Stock Synthesis (Methot and Wetzel, 2013) will be used in the North.

Critical Model assumptions
The Group discussed the continuity model run, noting some inconsistencies in the 2017 Stock Assessment input data that would be updated. Modelers indicated that compared to the 2017 model configuration there are many changes to the configuration of the model this time, some of which could be labor intensive to do an exact continuity model run in both ways, among others

1. The inclusion of discards and discard mortality.
2. Different time(s) split of the Japan CPUE series.
3. Updates on input size frequency data and catch series.

All biological and life history parameters will be carried over from the 2017 Stock Assessment.

The document SCRS/2022/041 presented a review and update proposal for the fleet structure for the Stock Synthesis model for N-SWO., The Group discussed it and agreed to the following changes compared to the 2017 Stock Assessment fleet structure:

- Inclusion of a "harpoon fleet", as they inform the model on the population dynamics of the larger/ older fish component of the stock, and the potential productivity of the stock as catches of the harpoon fleet in the 1950s reached 5 thousand t per year, albeit they only average 150 t in recent years. There is sufficient size information from the harpoon fisheries to inform the model, and it was suggested to assume an asymptotic selectivity pattern for this fleet.
- To create "others fleet", that will include catches from other LL fleets not elsewhere included, as well as the catches from other gears. It was decided to mimic the selectivity pattern of the US fleet (Fleet ID 2), and not include size information from other gears.

A summary of the updated fleet structure, catch, size input data, index associated, time period and other specific suggestions for each fleet is presented in **Table 12.**

One aspect of the swordfish fishery not included in the 2017 assessment model is that of the minimum legal size limits adopted by ICCAT in 1991 (Rec. 90-02) and 1996 (Rec. 95-10). Rec. 90-02 required CPCs to adopt a minimum size limit of 125 cm LJFL (25 kg live weight) with a 15% allowance for undersized fish. Rec. 95-10 allowed CPCs the additional choice of adopting a 119 cm LJFL with no allowance for undersize fish. The 2022 assessment will explicitly take these regulations into account by estimating dead discards resulting from the regulations (in length) within the assessment model, based on length frequency data. Reported dead discards will therefore not be included in the "catch" section of input data, as is typically done with stock assessment approaches; it is assumed that these fish were discarded in compliance with the minimum size regulations. See Schirripa and Hordyk (2021) for details on this method.

The Group also discussed the time blocks for the JPN LL fleet in particular. It was noted that compared to 2017, the current CPUE from Japan LL N-SWO was split at different years, the authors indicated that in 2021 the split of the index in 1994 was due to changes in the fishing gear and operations that imply changes in selectivity, while in the 2017 CPUE index the split was in response to the implementation of ICCAT management regulation that affected the fishery. It was also discussed the split of the Canadian LL index as in the 2017 assessment. The recommendation was to use as a continue series the Canadian LL index. The final decisions on the time blocks suggested for the stock synthesis model are provided in **Table 13** for the Japan LL fleet.

Furthermore, the following settings for the stock synthesis model were agreed by the Group for the initial model configurations of the 2022 evaluation.

- Canada longline and Canada/US harpoon selectivity are asymptotic; all other fishery selectivity is allowed to be dome shaped.

- A retention function corresponding to the minimum size limit will be implemented for each fleet (**Table 12a**).

- Fleet (and year if appropriate to account for such changes as circle hooks) specific discard/at-haulback mortality will be used where available, otherwise an average value will be used.

– Steepness will be attempted to be estimated. If the estimate is not deemed reliable it will be fixed at the previously estimated value from the 2017 Stock assessment (Anon., 2017b and h = 0.88).

Model inputs
Stock Synthesis provides a statistical framework for calibration of a population dynamics model using a diversity of fishery and survey data. SS is most flexible in its ability to utilize a wide diversity of age, size, and aggregate data from fisheries and surveys. It is designed to accommodate both age and size structure in the population and with multiple stock sub-areas. Selectivity can be cast as age specific only, size-specific in the observations only, or size-specific with the ability to capture the major effect of size-specific survivorship. While SS can accommodate a multitude of data types two are required, those being a catch time series and an index of abundance. Conversely, a model can be built that incorporates multiple areas, seasons, sexes, growth and growth morphs, as well as tagging data. Environmental data can also be used to modulate most any parameter within the model. Size and age structure, size-at-age, ageing error and bias, and sex ratio can also be incorporated.

Stock Synthesis will use the size frequency input data as presented in document SCRS/2022/060 supplemented with size information provided during the meeting, with size samples aggregated by fleet structure, and year, in 5 lower limit size bins. Size data has been standardized to straight lower jaw fork length units using the curved-straight LJFL presented at the meeting (SCRS/2022/061). It was noted that size frequency data for the Canadian and Chinese Taipei fleets will be updated to include the size sampling observations from their Domestic Observer Programmes, data that is not included in the ST04-SZ forms. The Secretariat will provide catch and size data according to the fleet structure agreed by the Group (**Table 12**) in the input formats for the stock synthesis model.

The Group discussed at length the information provided on landed and dead-discards reported by CPCs (**Table 2 and 2a**), size information provided in ST04-SZ show swordfish samples below the current minimum size restrictions of 119 cm or 125 cm LJFL or equivalent in weight (Rec. 17-02 paras 9 and 10, Rec. 17-03 paras 6 and 7) for almost all fisheries (SCRS/2022/060) that include landed as well dead discards. It was requested to clarify if the series of CPUEs provided included also retained and discarded fish. This information is important to correctly allocate within the stock synthesis model the catch and size fraction of retained vs discarded components, although it was noted that management regulations provide the option of minimum size or minimum weight retention. It was indicated that recent studies suggest a swordfish mortality at haul back of about 79% (Coelho and Muñoz-Lechuga, 2019) for EU-Portugal longline fleet with traditional J-hooks, while for the US longline fleet that use circle hooks, this mortality is lower at about 70% (Diaz, 2020) noting that those values are for the overall size range in the SWO catch. Coelho and Muñoz-Lechuga (2019) also provide an at-haulback mortality estimation specific for specimens under 125 cm LJFL for the EU-Portugal LL fleet, which is about 85%. Other studies from the South Atlantic indicated lower mortality (71.5%) possibly associated with lower temperatures and larger size class of the fish occurring within this fishery (Anon., 2017a). Live discards and mortality associated information are important to properly assess the effects of the current ICCAT on the N-SWO minimum size regulations as requested by the Commission to the SCRS.

Model outputs
The SS model output is commensurate with the complexity of the model configuration and observational data. All estimated parameters are output with standard deviations. Derived quantities include typical management benchmarks such as MSY, F_{MSY} and B_{MSY}, and SPR. Typical matrices of numbers-at-age, growth, age-length keys are also provided.

Diagnostics
Diagnostics are routinely examined through either the graphical and numeric r4SS R package or the accompanying spreadsheet, graphical as well as numeric. Diagnostics are generally a display of residuals of the fit to the observational data and derived quantities. Numerical output is also available in the form of the Hessian matrix, correlation matrix, and a parameter trace output. When run in the Markov Chain Monte Carlo MCMC mode, the posteriors are also output.

Uncertainty
Uncertainty can be captured in at least three ways: parameter standard deviation, the creation of bootstrap data files, or through MCMC techniques. The ADMB C++ software in which SS is written searches for the set of parameter values that maximize the goodness-of-fit, then calculates the variance of these parameters using inverse Hessian and MCMC methods. A management layer is also included in the model allowing uncertainty in estimated parameters to be propagated to the management quantities, thus facilitating a description of the risk of various possible management scenarios, including forecasts of possible annual catch limits.

For this assessment the variance-covariance matrix will be used to produce the uncertainty around estimates of F/F_{MSY} and B/B_{MSY} following the multivariate- delta approach (Walter and Winker, 2020).

The Group discussed the integration of uncertainty of the assessment, considering a single model uncertainty with sensitivity runs or alternatively an uncertainty grid design as has been developed with other species evaluations such as bigeye (Anon., 2021) in ICCAT. It was noted that often an uncertainty grid is used for key parameters in the model that are not possible to estimate with available data, such as natural mortality, steepness, or maturity. For the N-SWO stock, no new biological parameters were discussed at this meeting, it is expected that ongoing research on age and growth studies (SCRS/2022/008, SCRS/2022/005) will provide an update on the growth function for N-SWO, however the Group will need to review in detailed these results before they can be incorporated in the stock assessment. Therefore, the Group suggested that single model uncertainty and sensitivity analyses will be the approach to evaluate uncertainty for the present N-SWO assessment. It was further noted that in previous assessments, uncertainty from different model platforms such SPM and age-structured models were integrated as alternative option(s) to show uncertainty, particularly if the results from these models do not show similar results. This option is available for the current assessment upon reviewing the results from SPM for the N-SWO.

Key parameters
Key parameters of SS are dependent upon the model configuration created. However, since it is age-structured the rate of natural mortality is most critical. The steepness parameter is also critical as it dictates the rate of compensatory population growth.

Strength and weaknesses
SS can utilize a great number of different types of data sources to build a custom model within a consistent framework. This is its greatest strength as it allows the user to build a model with flexibility equal to that of the data. Pre-processing of data is less than some other frameworks as it is fully integrated within the model structure. Similar to a BSPM, SS has full Bayesian capability. Unlike VPA, it can be run without a catch-age-matrix by using only lengths or without lengths entirely. Consequently, no age slicing is needed. It allows for ways to explain changes in observations data that are due to changes in management or environment. Nearly all parameters can be made time varying in several ways. Forecasting is done within the integrated framework of the model construction. Some of the limitations of SS include a limited number of proficient users within the SCRS. Furthermore, because of its ability to create very complex models it can be slow to run relative to SPMs like ASPIC, but only if it is highly parameterized (i.e., run time depends on model complexity). The framework is capable of many options, so the user must be aware of model parsimony.

The Group discussed the strengths and weaknesses of including in the assessment process a surplus-production model that is similar to those embedded within the R-package that is being used for the MSE effort. The model will be fully tested within the MSE process. While the software has gone through a code review is not maintained as part of the ICCAT stock assessment software catalogue and thus has not been accepted for use to provide formal management advice. While the Group recognized the benefits of using this model as it has potential for future use, the Group currently lacks the capacity to employ this model.

5.2 South

The Group discussed potential stock assessment models to be applied to the South Atlantic, noting that the 2017 Stock Assessment included two models: JABBA and BSP2. Management advice in 2017 was derived from the JABBA assessment and there was consensus that JABBA would again be used in 2022 given that a continuity assessment would be beneficial. BSP2 is discontinued and will not be included in the 2022 assessment.

For SPMs, structural and biological uncertainty is typically represented in the form of alternative values of r and the shape m of the production function, where Schaefer and Fox formulations are the most common choices. The Group requested that efforts be made to develop prior distributions for r based on known life history information. This has previously been implemented in two ways:

1. Unifying Parameterization between ASMs and SPMs for comparison purposes (Winker *et al.*, 2020);

2. In the absence of reliable size and/or age structure information and in cases where life history parameters are uncertain, the R package FishLife was used to determine probable life history parameters from FishBase and then to generate distributions from a Multivariate Normal random generator based on predicted means and covariance matrices derived from FishLife (Winker *et al.*, 2018).

JABBA-Select was discussed as a potential model option as it incorporates life history parameters and fishing selectivity and is therefore able to distinguish between exploitable and spawning biomass. However, this model is yet to be reviewed by the WGSAM and is not currently included in the ICCAT Stock Assessment Software Catalogue.

The Group discussed the use of Integrated Age-structured models (e.g., Stock Synthesis) for the South Atlantic assessment, given that the true dynamics (i.e., size-structure) of the stock may not be fully captured by SPMs. Pertinent to this was the introduction of the minimum size limit for swordfish, the effects of which would be best captured by an Integrated Age-structured model. Implementing an Integrated Age-structured model for the South Atlantic swordfish stock assessment is a priority for the future.

5.2.1 Bayesian Surplus Production model - JABBA

The Bayesian Surplus Production model, Just Another Bayesian Biomass Assessment (JABBA); (Winker *et al.*, 2018) will be used. For details see section 5.1.2 above.

5.3 Diagnostics

The procedures outlined in Carvalho (2021) and recommended by the WGSAM will be adhered to as closely as possible.

6. MSE matters

6.1 Review of current development state of the North Atlantic Swordfish MSE

SCRS/P/2022/009 provided an overview of progress on the N-Atl swordfish MSE. The process has been ongoing since 2018 and uses the 2017 North Atlantic swordfish Stock Synthesis assessment model as a base-case with 7 axes of uncertainty (steepness, natural mortality, sigmaR, weighting between CPUEs and length composition effective sample size, a catchability increase, and an environmental variable) used to construct an OM grid. The swordfish MSE technical team has conducted work on the simulation framework, performance metrics, and initial CMP development. In 2022 the OM grid will be revised, considering changes made to the 2022 SS3 assessment model.

The group acknowledged the summary of SWO MSE progress.

6.2 Presentation of the currently adopted MSE roadmap by the Commission

The currently adopted MSE roadmap by the Commission was shown to and discussed by the Group. One main item discussed was regarding Points 2 and 7 for 2022, that refer to dialogue with PA4 with regards to establishing operational management objectives and identifying performance indicators. Given that during 2022 there will be only a 1-day PA4 meeting in November, the Group suggested that the dialogue on this point may need to be continued into early 2023. To that end, the Group agreed there is likely the need for 3 meetings with PA4 during 2023: one earlier in the year for completion of those final management objectives and performance indicators, a second to receive feedback on CMPs format and construction, and a third later in the year (possibly just before the annual meeting) mainly for the SCRS to provide approximately 2-

3 selected CMPs to PA4 for consideration. SCRS has not had the opportunity to discuss with PA4 more refined objectives and the impact of various options on how CMP may be constructed. Having three meetings in 2023 allows there to be a back and forth between PA4 and SCRS to refine the CMPs (see Workplan, **Table 14**).

It was also agreed that a letter should be sent to the Chair of PA4 with the summary of the workplan, so that PA4 is aware of what the SCRS is expecting from PA4 with regards to SWO MSE inputs in later 2022 and during 2023, in each of those steps.

A revised version of the MSE roadmap reflecting those agreements from the Group is attached in **Appendix 5**.

It was noted that this version of the roadmap will continue to be worked by the Group during the year, and a final revision for the year will be prepared at the Species Groups meeting in September, after the new stock assessment has been conducted and the OMs have been reconditioned.

6.3 Further development of the MSE work during 2022

6.3.1 Discussion on reconditioning OMs considering new information from the stock assessment, and plans to finalize the OM grid

The Group discussed reconditioning the OMs considering the new information that is available for the 2022 stock assessment. The Group also discussed the plans to finalize the design of the OM grid.

One of the axes of uncertainty in the OM grid is related to including environmental effects when fitting the model to the CPUE indices. The Group acknowledged that if CPUEs were corrected for environmental effects, it might not be necesary to include an axis of uncertainty related to environment. The Group agreed to pay further attention to whether environment continues to be one of the main uncertainties, after the assessment is complete.

The Group discussed using the Combined Index as the main data source and decided that it would be useful to make the other indices also available to the cMPs. The data lags of the CPUE indices that are to be used in the upcoming stock assessment, with terminal year varying between 2019 and 2021, were discussed. The contractor confirmed that, from a technical perspective, the different terminal years for the CPUEs are not a problem for the MSE.

The Group also discussed how re-standardization of the indices in the future could impact the process of applying the cMP . For example, re-standardization of the indices in the future when new data are available may result in changes in the historical values of the index. However, the MSE assumes that the values of the historical indices will not change in the future. The Group discussed this issue and suggested conducting some analyses to investigate how much the re-standardization process is likely to change the values of the indices. For the Combined Index it was noted that a comparison between the different indices over time could provide some insight into this issue.

The Group also noted that an important assumption of the MSE is that the CPUE indices will be available in the future based on the same data sources and methods used in the past. In case of all indices there is a potential problem if for some reason the index cannot be generated in the future and then it cannot be used in an MP. And in the case of the Combined Index if a National Scientist cannot provide data in the future this assumption would not be met either. Accordingly, some analysis (e.g., dropping a data source one at a time) could be conducted to simulate potential impacts of not having all data sources.

The Group discussed the request to determine the impact of the minimum size limit on the fishery. After some discussion on the difficulties of doing this, for example the paucity of data on fish caught below the minimum size threshold, the Group determined that this could be a discrete analysis that is separate from the primary MSE and would be investigated once the OM conditioning is complete and the management procedures have been designed.

6.3.2 Review decisions points for MSE next steps including robustness tests (e.g., data lags), a red face protocol

The contractor presented an overview of the outstanding decision points for the MSE process (SCRS/P/2022/006).

During the presentation, the Trial Specification document (https://iccat.github.io/nswo-mse/TS/Trial_Specs.html) was also mentioned, where the current state of the swordfish MSE process is presented. This includes a description of the uncertainties in the grid, the contractor noted that the reasoning for the chosen uncertainties could be added to this description, instead of just stating the uncertainties and its levels.

The Group discussed the possibility of removing the relative weighting of the CPUE and catch at length (CAL) data from the uncertainty grid, as it may no longer be necessary if new features of the SS3 software that allows for the effective sample size (ESS) to be re-weighted in each OM in a relatively fast way are to be used. It was decided to re-visit this after the 2022 assessment has been finalized.

The Group discussed and agreed to move from the combined sex to the 2-sex operating models (OMs) in the MSE framework. It was agreed that it would be best for the structure of the OMs to replicate the structure of the SS3 models as closely as possible. This also allows for the possibility of larger differences in sex-specific life-history parameters (e.g. M), which current research suggests may be the case for swordfish. Spatial distribution of swordfish by sex was also discussed, in the current assessment a single area is considered and differences between sexes are given as probabilities of being male or female given the growth curve and selectivity applied, for example, larger fish in the catch have a higher probability of being female.

The Group discussed outstanding decisions related to OM validation and assumptions for the closed-loop simulation testing. Some robustness tests were briefly discussed, eg. simulating a recruitment failure, effect of the lack of data on undersized fish imposed by the minimum size regulation (e.g., setting the selectivity curves to start above the minimum landing size), mimicking the loss of data in the combined index, testing for different advice intervals. It was agreed that this work would be done once the OM grid conditioning was completed and could be addressed by the smaller MSE technical team who would report back to the Group later in the year.

OM weighting was also briefly discussed, it was noted that for now equal weight is being given to all OMs. It was argued that choosing a reference set of OMs (12-16) could lead to interpretation that these models would have higher weight. It was explained that the reference set could allow for focusing on the interpretation on performance metrics for different cMPs. Ideally this set would represent runs with the biggest differences in cMP performance, but the performance metrics would still be produced across all the OMs.

The Group discussed some red-face tests i.e., the evaluation of the plausibility of OM results given the current state of knowledge of SWO life history and fisheries for the swordfish MSE. The Group reviewed these proposed protocols and noted that the red-face tests should focus on model results (e.g., biomass trends by sex over time) rather than the model structure and inputs which would be examined during the assessment process. Finally, the Group added a list of additional potential red-face tests that were needed, and further intersessional work is required.

6.3.3 Continue work on criteria for determining exceptional circumstances taking into account the exceptional circumstances protocol for N-ALB

A draft document describing exceptional circumstances protocols was presented and discussed by the Group. These protocols were based on those developed for albacore. The Group discussed the indicators, criteria, and frequency of the EC protocols, and updated the document to make it better reflect the swordfish fishery. It was noted that, while it was good to discuss these things now, the EC protocols could not be complete until the properties of the cMPs were known (e.g., which data are used).

It was also recommended that simulation work be conducted to inform the quantitative values specified in the EC protocols. For example, robustness tests could be conducted for detecting the situations that are most likely to result in undesirable outcomes for the fishery, and EC protocols could be designed to detect when those situations are likely to be occurring. It was also noted that, as the EC protocols were still in development, it would be best to not include the tables in the report.

6.3.4 Discussion on performance indicators and advice intervals

SCRS/P/2022/010 provided an update on the development of performance metrics and advice intervals for the swordfish MSE process. A candidate set of performance metrics based on conceptual objectives (see Res. 19-14) were presented to PA4 in 2021 and the feedback from the Panel was described. This base set of performance metrics requires additional work on probability calculations, time frames, and the trade-offs associated with selecting a particular set of probability calculations (see workplan).

It was recommended to change the AAVY (average annual variability in yield) metric, as the metric of interest is actually the change in catch between management cycles rather than every year. It was also suggested adding the Status metric of the probability of being in the green space of the Kobe plot ($SB>SB_{MSY}$ and $F<F_{MSY}$) into its two separate component metrics i.e., $SB>SB_{MSY}$, $F<F_{MSY}$ independently.

It was noted that it would be best for the Group to propose some specific approaches for calculating and interpreting performance to Panel 4 to select from. For example, simulation work could be conducted to inform on the trade-offs that are associated with different management intervals.

6.3.5 Continue work on development and testing of candidate management procedures

The contractor gave a presentation on the process for developing candidate management procedures (SCRS/P/2022/007). The Group discussed the various options for developing cMPs and noted that this is an important priority (see workplan). The contractor confirmed that it was possible to store additional information from any cMP (e.g., summary statistics of model fits) and return this information in the MSE.

6.4 Discussion on communications materials needed for engagement with stakeholders

The Group discussed the need to develop an engagement plan for interactions with managers and other stakeholders in the MSE. Having completed a few years of MSE development, the Group agreed that it is time to increase the dialogue to both present preliminary results and solicit feedback on key MP elements (e.g., operational management objectives, management cycle length).

The SCRS Chair noted that the SCRS has the responsibility to communicate MSE concepts, assumptions made, and guidance on how to interpret results. The SCRS should also provide the scientific basis for any related management decisions. However, while the SCRS should convey the need for managers to engage their stakeholders (e.g., industry, NGOs) in the process, it is the managers' role to determine the level of stakeholder engagement they deem appropriate for the process, at both the ICCAT and CPC level. In this way, it is important to recognize the distinction between the roles of scientists and managers in the process.

The Group noted that ICCAT is using its Panel structure for the bulk of stock specific MSE discussions. As a result, the Group supported Panel 4 as the venue for science-management dialogue on the MSE. Although the WGSAM recommended that Standing Working Group to Enhance Dialogue. Between Fisheries Scientists and Managers (SWGSM) meetings be used for MSE dialogue, the Group thought that Panel 4 would be more appropriate since discussions could be focused only on the NSWO MSE and meeting participation could be limited to the smaller group of CPCs with an interest in the stock. It was agreed that SWGSM meetings may be more appropriate for more general harvest strategy discussions and capacity building. The Group also supported the idea of hybrid dialogue meetings, where initial discussions could be informal, and then the meeting could move behind flags when the agenda featured decision points. Regardless of meeting structure, the SCRS Chair emphasized that it is critical to allow sufficient meeting time for comprehensive discussions on these complex topics.

The Group supported the establishment of a Swordfish MSE Ambassador Programme, similar to what has been done for Atlantic bluefin tuna. Ambassador meetings allow more informal discussions about the MSE since participants speak as individuals rather than from behind a flag. Convened as separate meetings in French, Spanish and English, rather than relying upon simultaneous interpretation, the bluefin Ambassador meetings have seen the most active participation to date of any of ICCAT's MSE dialogue fora. The Chair will work to identify the language-specific ambassadors for swordfish.

The Chair presented a table outlining an MSE engagement plan, including suggested meeting schedule with the objectives and decision points for each meeting (**Table 14**). The table will be shared with the Panel 4 Chair to outline intended progress, including objectives for the next Panel 4 intersessional meeting on 13 November 2022. The Group agreed that the communications Working Group would produce summary materials for review at the September Species Group meeting, with the aim to have them available to managers and stakeholders in advance of the Panel 4 intersessional.

The MSE Expert presented a walkthrough of Slick, the Shiny App for the NSWO MSE, which is accessible here (www.harveststrategies.org). Slick allows users to select CMP and OM parameters, as well as performance indicators of interest, to view customized MSE results. The app includes 11 different plot types with annotation to guide interpretation of the results. The Group commended the utility of Slick, while cautioning that it might contain too much information for Panel 4. It was suggested that perhaps Slick could be presented at one of the Ambassador meetings instead. The MSE Expert highlighted the flexibility of Slick and ability to expand its features, including plot types (e.g., to include violin plots).

7. Other matters

SCRS/P/2022/004 provided a history of the Canadian swordfish fishery. Changes influencing fishing dynamics were divided into five categories: fishing regulations; gears; spatial patterns; bycatch mitigation; and other qualitative observations. The author noted that several of the changes highlighted in the work should be considered when National Scientists filter data and analyse for abundance trends. The author recommended that there be thorough documentation of fleet dynamics and management changes in these fisheries so that these can be reflected in index standardization and assessments.

The Group acknowledged the presentation and congratulated the author on the work. There was discussion on the need for these types of narratives for other ICCAT CPCs and fleets. It was clarified that a document with the full results of this work will be published as a DFO (Fisheries and Oceans Canada) technical report in the coming months.

8. Recommendations and Workplan Relative to Data Preparatory Sections

8.1 Recommendations

To SCRS plenary on research funding

The Group recommends that a hand-held Argos electronic satellite tag receiver be purchased for use among ICCAT Species Groups. The receiver would help find the tag and thus scientists would be able to recover more detailed tagging data, retrieved directly from the tags.

To the SCRS and ICCAT Secretariat

The Group recommends that the straight-curved lower jaw fork length relationships presented in SCRS/2022/061 be adopted for use for lengths conversions in the 2022 Stock Assessment. Pending further data collection and analysis the Group recommends that the conversion be considered for the ICCAT list of approved conversions.

To CPCs

The Group recommends that the submission of size samples to the ICCAT Secretariat, as part of the CPCs Task 1 and 2 data submission obligations, be completed using the ST04-T2SZ statistical form. Size samples reported with the ST04-T2SZ form shall include all samples collected by the CPC from all fisheries and size samples of dead and live discards (when applicable) collected by its National Observer Programme. This recommendation does not preclude CPCs from the optional reporting of size samples collected by their National Observer Programme using the ST09-DomObPrg form.

To WGSAM

Noting the spatial-temporal CPUE standardization approaches presented in this meeting (e.g. R-INLA), the Group recommends that the ICCAT Working Group on Stock Assessment Methods evaluate these modeling approaches and provide recommendations on their use in index standardizations.

To National Scientists

The Group recommends that for future assessments, CPUE analysts form a small working group several months before the assessment data preparatory meeting. Noting the limited time within the data preparatory meeting for index review and short timelines for index revisions after the meeting, the small working group would allow for closer examination and detailed discussion on modeling approaches before formal submission of indices to the data preparatory meeting.

The Group recommends that National Scientists document the history of their fleets participating in ICCAT fisheries. Reviews should document changes in gears, local and national fishing regulations, spatial patterns and other relevant factors that influence how ICCAT species are caught. These reviews are important for better accounting of fleet structure and dynamics in CPUE standardizations and assessments.

To the SWO Species Group and the SCRS plenary on research funding

The Group recommends continued financial support of the ICCAT swordfish biology programme. The Group further recommends that a proposal be developed for formalization of a Research Programme similar to those in place for bluefin tuna, sharks, and billfish. The proposal should include the Atlantic and Mediterranean stocks and have descriptions of the various research activities that the Groups are proposing, and timeframes for such work to be carried out. Determining the final amount of this proposal will be addressed at subsequent SWO Species Group and Species Groups meetings.

8.2 Recommendations and workplan relative to the MSE sections

Recommendations

The Group recommends that the Slick Shiny App (accessible through www.harveststrategies.org) be used for presenting results and visualizations of tradeoffs associated with the MSE. Slick allows users to select CMP and OM parameters, as well as performance indicators of interest, to view customized MSE results.

Workplan

The Group developed a workplan (**Table 14**) for the remainder of 2022, including details on interactions needed with PA4 and other stakeholders needed in 2022 and 2023.

11. Adoption of the report and closure

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

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