REPORT OF THE 2019 ICCAT SUB-COMMITTEE ON ECOSYSTEMS MEETING
(Madrid, Spain 8-12 April, 2019)

1. Opening, adoption of agenda and meeting arrangements

The meeting was held at the ICCAT Secretariat in Madrid, 8-12 April 2019. The ICCAT Executive Secretary Mr. Camille jean Pierre Manel addressed the Sub-Committee and welcomed the participants and expressed his appreciation of the participants and for their scientific contributions to such meetings. The convener of the Sub-Committee on Ecosystems, Dr Alex Hanke (Canada) opened the meeting and welcomed the participants. He noted that Dr Andrés Domingo, co-convener of the Sub-Committee, was unable to attend the meeting. Dr Hanke described the objectives and logistics of the meeting. The Sub-Committee proceeded to review the Agenda, which was adopted with a few changes (**Appendix 1**).

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

Sections	*Rapporteur*
Item 1	Nathan Taylor
Item 2	Nathan Taylor
Item 3	Maria José Juan-Jordá, Laurie Kell, Eider Andonegi, YonatSwimmer, Rui Coelho
Item 4	Alex Hanke
Item 5	Alex Hanke
Item 6	Nathan Taylor, Mauricio Ortiz
Item 7	Guillermo Diaz
Item 8	Bruno Giffoni, Miguel Santos
Item 9	Rui Coelho, Daniela Rosa
Item 10	Rui Coelho
Item 11	Alex Hanke
Item 12	Alex Hanke

2. Review the progress that has been made in implementing ecosystem-based fisheries management and enhanced stock assessments

Presentation SCRS/P/2019/014 provided an overview of lessons learned and the main research outputs from an EU project to advance the operationalization of the Ecosystem Based Fisheries Management (EBFM) in ICCAT and IOTC. Research outputs included a list of candidate ecoregions to guide ecosystem planning, a list of ecosystem indicators to guide the development of ecosystem assessments and two pilot ecosystem plans.

Document SCRS 2019/052 presented the pilot ecosystem plan for the tropical ecoregion of the Atlantic Ocean, which included an ecosystem overview for the area, conceptual models that highlight the ecosystem interactions that need to be monitored, and a proposal of ecosystem indicators to monitor the cumulative impact of fisheries on the tropical ecoregion. It also presented proposed activities to foster the development, use, and implementation of ecosystem plans in ICCAT.

The Sub-Committee had a broad discussion about these two papers and about EBFM in general. Pilot ecosystem plans developed at this stage could be a conceptual exercise that seeks to create awareness about the ecosystem planning process and initiate a discussion about what elements could be part of it. The Sub-Committee noted that there are many activities described in the document that are already under way. These include identifying the components of the EBFM framework, defining the conceptual management goals and operational objectives, developing indicators for an ecosystem report card, defining regions for reporting and conducting ecological risk assessments.

Further, the Sub-Committee was informed that the FAO Common Oceans/ABNJ Tuna project is organizing a second EBFM joint tuna RFMO workshop to explore options for advancing the operationalization of the EBFM in July 2019. The results from this workshop will be reported in the 2020 meeting of the Sub-Committee.

Document SCRS/2019/055 updated the work done on the Sargasso Sea case study, which could be considered as a Northwest Atlantic "ecoregion", and demonstrated how a Sargasso Sea case study could help in the development of EBFM by providing a better understanding of the impacts of environmental pressures, the use of fisheries independent data to validate indicators, and the use of elicitation to identify stakeholder requirements.

The Sub-Committee discussed the paper and noted that some of the methods used were promising, notably the use of species distribution mapping and AIS data available from open data sources. These additional data sources could be used to supplement the assessment of ICCAT species.

The Sub-Committee recognized the benefits of the proposed case study such as the significant body of work on the ecology and biological oceanography of the Northwest Atlantic, the Sargasso Sea Commission's access to a range of data providers and portals (e.g. Global fishing watch, NASA, AquaMaps, OBIS, SEAMAP, MiCo) and the proposed development of indicators for the habitat, fishing pressure and environmental pressure components of the report card.

The Sub-Committee suggested that all the case studies being proposed or in development remain consistent with the ecosystem report card and build upon the ecological risk assessments currently being conducted by the Sub-Committee.

3. Review the progress on developing an Ecosystem Report Card for ICCAT including the development of status and pressure indicators, reference levels

3.1 Review adequacy of existing indicators against proposed new ones

Retained Assessed Species

The Sub-Committee discussed the update of the multispecies B/B_{MSY} and F/F_{MSY} indicators. These indicators were not easily updated since the B/B_{MSY} and F/F_{MSY} ratios of some assessed species were undetermined (i.e., stock status based on F0.1 strategy). The Sub-Committee recommended to update the multispecies B/B_{MSY} and F/F_{MSY} indicators and categorize those stocks with undetermined ratios in a different category. The Sub-Committee also recommended to plot the terminal B/B_{MSY} and F/F_{MSY} ratios of all stocks into one Kobe plot to have a global picture of the overall state of all ICCAT assessed stocks. The Sub-Committee also recognized that the future updates of this indicator would need to consider how to deal with stocks whose TAC is determined by management procedures.

Retained Non-assessed Species

The Sub-Committee discussed several potential methods for monitoring the state of fish species caught and retained by ICCAT fisheries for which their exploitation status is unknown. The Sub-Committee proposed to test the following methodology divided into three steps to derive indicators for this ecosystem component:

I. Summarize the state of data and knowledge

   a. Generate a list for non-assessed ICCAT species including teleost, sharks and rays that are retained
   b. Identify and summarize data sources: databases of the distribution of ICCAT species (e.g. https://www.aquamaps.org/), life history fish characteristics (e.g. FishBase) and Fleet distribution (AIS)

II. Determine productivity/susceptibility PSA

c. Estimate productivity, e.g. based on life history traits
d. Estimate susceptibility based on spatial and temporal overlap between species distributions and fleet

III. Validation analysis

e. Validate the analysis by comparing the PSA scoring with stocks that have a stock assessment

Seabirds

The seabird small working group reported that they were unable to finalize the seabird indicator at this meeting due to a number of issues: i) only two members of the group were present at this meeting, and ii) consultation is required with other key members. The small working group indicated that progress can be made intersessionally and it is hoped there will be a proposed indicator available for 2020.

Non-retained Sharks

Document SCRS/2019/043 presented a standardized CPUE for bigeye thresher shark using detailed observer data from the Portuguese pelagic longline fleet. This work was prepared and presented to open the discussion on a potential indicator for non-retained sharks in ICCAT.

The Sub-Committee questioned if a Delta method had been tested to standardize the CPUEs. The authors clarified that because there is a high percentage of zero catch sets (overall ~70%, >90% in some years), the binomial component of the Delta method could have problems to converge. It was further noted that the model used (Tweedie GLM, in this specific case using a compound Poisson-Gamma distribution) uses a combined distribution, fitting just one model that can deal with both the discrete mass of zeros and the continuous component for the positive values.

The Sub-Committee discussed that as the bigeye thresher is mainly a tropical and sub-tropical species, it would be worth exploring using data from those regions only; this would also decrease the proportion of zero catch sets in the dataset. It was also suggested to estimate a standardized CPUE for different species in the same model and look at the trend of the ratios between species.

It was discussed that if this indicator is to be used in the report card, more fleets should contribute to this work, as currently it is only representing the Portuguese longline fleet. A concern of how this indicator would be updated was also raised, as it would be difficult for CPCs to update this standardized CPUE on a yearly basis.

The choice of species (bigeye thresher) was discussed and it was clarified that this species had been chosen because it was identified as the most vulnerable in longline fisheries in the last ERA carried out for ICCAT sharks (Cortés *et al*., 2015). Thus, it was assumed that as the most vulnerable species, the bigeye thresher would represent the worst-case scenario within the non-retained shark species. Also, the bigeye thresher would be the last species to recover due to its low productivity.

The goal and objective of the indicator, presented in the checklist (**Appendix 6**), were discussed, as currently, there is a contradiction between the chosen indicator and the goal/objective. The current objective of the indicator is that there should be a reduction in interactions and in mortality. However, if abundance of a species is increasing this could lead to more interactions and increased mortality, even though the population status is improving. It was agreed that a standardized CPUE is a proxy for abundance and that the objective should be changed to match this. It was noted that for non-retained sharks the goal should be to minimize adverse effects of the fisheries and assure that biomass of those species increases (or at least stabilizes and does not continue to decline). Therefore, it was agreed that an increasing CPUE time series would be a good indication that the impacts are being reduced and the population is recovering; while on the other hand a decreasing trend should raise concerns as it would reflect declines in abundance, possibly due to increasing fishing mortality (given those are K-selected species).

Sea Turtles

SCRS/P/2019/016 presented several challenges to identify and adopt indicators for sea turtles in the ICCAT Convention area.

The Sub-Committee agreed that single indicators, such as sizes of nesting populations or bycatch rates, would be inadequate for several reasons. Concerns with use of population data were discussed during the 2018 meeting of the Sub-Committee. With regards to bycatch rates, limited data is a primary concern, as are uncertainties regarding rates of mortality and other demographics such as incorporation of an individual's reproductive value and the time lag between turtle hatching and vulnerability to fishing gear.

During the 2018 meeting of the Sub-Committee, an identified need was a time series of bycatch rates of loggerhead and leatherback turtles from all gear types (not only longline) and by regions within the ICCAT Convention area. In response, it was proposed to conduct an analysis that involves a determination of multi-gear (longline and purse seine) population-level fisheries bycatch impacts on loggerhead and leatherback turtles within the ICCAT Convention area. The proposed work suggests using a method from Wallace *et al*. 2013that can be useful to identify conservation priorities. Specifically, the conservation priorities would be based upon an assessment of population characteristics and status for each Regional Management Unit (RMU), ''risk matrix' as well as a "threats matrix" to each RMU. The value of this approach is an ability to prioritize conservation efforts by gear type, region, and RMU. The limitation to this method is that it would not output a time series. However, this was not deemed necessary as it is possible to complete this assessment at regular intervals (e.g., every 5 years).

This approach is similar to a stock assessment in that it evaluates cumulative and relative impacts of bycatch while accounting for population - level considerations. For each relative loggerhead and leatherback turtle RMU, one could identify a bycatch impact score, which is a weighted median bycatch rate, with a measure of mortality rate (if reported—low, med, hi). The RMU Risk score is essentially a "population viability score". The Sub-Committee agreed to further discuss this approach.

This exercise would enable a clear identification of how to prioritize ICCAT efforts to minimize impacts on marine turtles in the Convention area, which has been a goal for the Commission since the adoption of ICCAT Recommendation 10-09.

There was discussion regarding the value in conducting this type of analysis and incorporating information regarding bycatch rates estimated during the intersessional work planned for seabirds and marine turtles during 2019.

Marine Mammals

Document SCRS/2019/048 examined the potential interactions of *Orcinus orca* with pelagic longline gear using computer generated habitat suitability maps and estimates of overall Atlantic longline fishing effort and catch by time-area strata (EFFDIS, CATDIS).

The Sub-Committee discussed how depredation rates might have implications for the assessment of the species, since this lost catch due to depredation is not accounted for in the assessments. Yet, it was noted the depredation estimates on albacore and swordfish appears to be low across all areas when compared to the total catches of these species in the ICCAT Convention area. However, it was recognized that depredation by sharks and other marine mammals was not quantified in this study.

The Sub-Committee discussed the utility of the species habitat suitability maps developed by AquaMaps informed by an environmental envelope based on sightings of orcas, and how these sources of information and the methodology could also be applied to examine the interactions (vulnerability, depredation, mortality) of fisheries with other marine mammal and bycatch species.

It was noted that the International Whaling Commission and ICES generate reports on the status of marine mammals for the Atlantic and Mediterranean, which can provide indicators on fishing interactions with marine mammals. The Sub-Committee suggested to follow this ongoing work and reports and to evaluate its potential usefulness for the Sub-Committee.

It is believed that the mortality of marine mammals with longline and purse seine fisheries is low, while the mortality with gillnets might be considerable. Future work on interactions should be focused on gillnet fisheries.

Food Web/Trophic Relationships

Document SCRS/2019/051 presented three indicators (total biomass in terms of weight, trophic level and replacement time) to examine the potential ecological effects of the purse seine fishery on the food web structure and functioning in the tropical Atlantic ecoregion.

Among the three indicators developed, the mean trophic level of the catches (MTLc) was proposed by the authors as the most appropriate and easy-to-monitor indicator to analyze potential effects of purse seine fisheries activity in the tropical area. It was noted this indicator is preliminary as there are plans to include, in future analyses, size-based information of the catches in order to better characterize the impacts of the different fishing methods (setting on FADs vs setting on free schools) on the ecosystem. This would facilitate the interpretation of the results.

The Sub-Committee discussed how the MTLc could reflect changes at the ecosystem level. Given the selective characteristics of this fishery, the limitation of using purse seine fishery related data to monitor ecosystem effects was discussed. The Sub-Committee suggested considering other fisheries that use more random fishing strategies, such as longliners and gillnets, yet it was noticed, difficulties related to data availability in these other fisheries due to low or no observer coverage.

The Sub-Committee discussed how the MTLc indicator captured the impacts of purse seiners and that it should be interpreted as a pressure indicator rather than a state indicator of the ecosystem. The mean trophic level derived from independent research surveys and ecosystem models, instead of fisheries dependent data such as catches, are more appropriate to characterize the state of the structure and function of food webs. A possibility of exploring combinations of this MTLc indicator and others such as those derived from ecosystem models was discussed. Other issues such as the need to include other fisheries operating in the area and the issue of including other data components such as the “faux poisson” into future analysis were highlighted during the discussion.

Due to the lack of consensus on the potential of this indicator to inform on the state of food web structure and functioning, the Sub-Committee decided not to use the current version of this indicator for the Ecosystem Report Card.

Fishing Pressure

It was discussed that there is a number of indicators that could be developed based on the number of vessels, and the fleet composition and characteristics. It was noted that quantifying fishing pressure might not be an easy task, as it is hard to define what measures should be used, in particular for the purse seine fishery.

As an alternative, it was proposed to use the fishing mortality derived from the single stock assessment models as an overall indicator of fishing pressure. The Sub-Committee noted that there is interest in determining fishing capacity by gear type and fishery.

Habitat

The suggested candidate indicator for the habitat component is the number of FADs lost in purse seine operations. It was discussed that the fate of FADs should also be considered because they might get stranded in vulnerable coastal habitats (e.g. coral reefs, beaches). It was suggested to collaborate with the industry to collect better information of the marine debris derived from FAD fisheries. The Sub-Committee also noted that impacts from other gears could form the basis for a habitat indicator.

It was noted that habitat is closely linked with the environmental pressure component if habitat had an influence on critical life stages of ICCAT species. Consequently, it might be advantageous if the same group of national scientists could work intersessionally on both the habitat and environmental pressures components.

Environmental Pressure

It was suggested that in order to advance on the development of an indicator for the environmental pressure component of the ecosystem report card, it would be advantageous to follow similar efforts by the IORC ICES group (see ICES Report on Ocean Climate (IROC)and the ICES Report on Ocean Climate 2017). However, the work will focus on the use of operational oceanography data sources. This work would be well aligned also with the recent developments of the European Commission initiative "Copernicus" and its Ocean State Report.

It was noted that the section could contain indicators informing about environmental variability (e.g. oceanographic processes) that directly affect tuna ecology, for example.

There was support to focus the work on two or three case study where each would link a species with a geographic area and an oceanographic process.

It was further suggested that the June meeting of ICES Working Group on Operational Oceanographic Products for Fisheries and the Environment (WGOOFE) could be used as an opportunity to involve non ICCAT experts in the indicator development.

Socioeconomic

There were no further updates on the indicator.

Ecosystem Report Card Indicator Adoption Protocol

Following the discussion on the indicators it was determined that the adoption of indicators for components of the ecosystem report card should follow the following guidelines:

1) A candidate indicator must be introduced as a document with an SCRS number and subsequently published. A standardized template for reporting is available. See for example Hanke 2018.
2) The goals and objectives for an ecosystem component cannot change without justification and approval by the Sub-Committee.
3) A candidate indicator must inform on the component objective.
4) A candidate indicator that has been approved to represent an ecosystem component must be recorded on the indicator checklist (**Appendix 5**).
5) Each meeting's indicator checklist must be included in the meeting report along with the indicator values.

3.2 Review ecosystem drivers of abundance and mode of action

No documents were submitted for review.

3.3 Review development of ecoregions

The Sub-Committee was provided a presentation that showed the relationship between ecoregions developed from biogeographical information, ICCAT fleet distribution and ICCAT target species distribution, regions based on the existing management boundaries, and the distribution of sea turtle regional management units (RMUs).

The Sub-Committee was not in favour of establishing fixed boundaries for the ecoregions in order to account for the changing nature of the oceanography, for example. However, it was noted that the ecoregions were useful in providing a general characterization of the Convention area and could be used to inform the development of ecosystem overviews and indicators for some components of the ecosystem report card. It was further agreed that groups working on indicator development should have the flexibility to define the unit areas of reporting and that these do not need to strictly conform with each other.

The Sub-Committee noted that the proposed ecoregions needed some modification. It was also noted that the sea turtle RMUs did not match either of the two regionalization options. The Sub-Committee noted that

this was work in progress that could be further informed by the activities of the IOTC on this particular issue.

4. Review mechanisms to effectively coordinate, integrate and communicate ecosystem-relevant research across the ICCAT Species Groups and within the SCRS

The Sub-Committee discussed the importance of effectively communicating with the Species Groups. The previous year's recommendation was to use the meeting agendas to exchange ecosystem related information. This was modified to include the participation of the Bycatch coordinator, or a proxy, in the Species Groups meetings and brief the Species Groups on the Sub-Committee's activities/needs, as well as solicit their feedback about how these activities could be useful for the Species Groups.

5. Review information on the trophic ecology and habitat of pelagic ecosystems that are important and unique for ICCAT species in the Convention area (Res. 16-23)

The Sub-Committee provided a response in 2018 and there are no further updates.

6. Data used for bycatch analyses

6.1 Update of ST09 forms

Document SCRS/2019/049 reported that the Secretariat has integrated into the ICCAT relational database system (ICCAT-DB) all the National Observer Program data (form ST09-NatObPrg) that have been submitted to the Secretariat and concluded, that data coverage across CPCs and years was incomplete.

SCRS/2019/050 showed that by changing the format of the ST09 form in 2017, the ability to address the Commission's request using these data may have been substantially reduced. The Sub-Committee noted that some of the Commission's requests did not necessarily imply that ST09 data be used to address them, but rather, that these requests could be addressed directly by the CPCs using their own National Observer Program information. The Sub-Committee also discussed the difficulties that CPCs had in providing this information, as well as the restrictions they might have in reporting this information due to confidentially rules.

The Sub-Committee recommends a group of national scientists work intersessionally with the Secretariat to review the current form. The revised ST09 form should conform with a Task II CE format and consider the following:

a) Fleet structure: vessel categories (e.g.: using LOA classes by gear).
b) Fishing activity: stratified by month and with a 5x5 grid geographical resolution, where each stratum, for example groups of fishing operations for the same vessel category in (a), should contain the observed nominal effort of that strata, and, the species catch composition, and if available.
c) Specimen biological characteristics: individual biological information including size, weight, sex, retained/discard fate from each stratum.

This will include discussions on integrating some of the information from ST11 that informs on the observer coverage.

The group will be led by Nathan Taylor (ICCAT Secretariat) with Daisuke Ochi (Japan), Stephanie Prince (UK), Carlos Palma (ICCAT Secretariat), Rui Coelho (SCRS Vice Chair), Guillermo Diaz (U.S.A.), Philippe Sabarros (EU-France), Lourdes Ramos (EU-Spain), and Jose Carlos Baez Barrionuevo (EU-Spain).

The proposed changes to the ST09 form will be presented and discussed at the 2019 meeting of the Sub-Committee on Statistics for its adoption.

6.2 Revisions and updates of the data used in bycatch analyses

SCRS/P/2019/015 provided an update of EFFDIS, a modelling approach to estimate overall Atlantic Fishing Effort for ICCAT longline and purse seine fleets. The Sub-Committee agreed that the Secretariat would do the following:

1. Present estimated and reported number of hooks in order to validate the EFFDIS estimates to the Sub-Committee at the current meeting
2. Make the code used for the analysis available
3. Revise catch and effort data to improve input data and find errors
4. Concurrently derive CATDIS and EFFDIS using the same data/spatial structure
5. Develop treatments for alternative longline fleet structures and hook depth
6. Explore alternative modelling procedures for effort estimation

Upon examination of the plot of predicted and reported number of hooks using EFFDIS and the Task II catch-effort data (item 1 above), the Sub-Committee noted that the EFFDIS analysis generated predicted effort that was inconsistent with the expectations. The expectation was that as Task II catch-effort information has become more complete after 2000 and with more CPCs reporting detailed data, then the predicted number of hooks should have matched the reported fishing effort more closely. However, the plot illustrated the opposite: after 2000 the predicted number of hooks did not match the reported hooks, estimating a substantially higher number of hooks. In addition, during periods where Task II data coverage was relatively incomplete (before 1990), both predicted and reported number of hooks were similar. The reasons for the departure after 2000 between the number of hooks predicted and the number of hooks reported could not be explored at the meeting. The Sub-Committee recommended that the Secretariat review the methodology and to explore alternative modeling processes. It was also recommended to use subsets of the Task II CE data after 2000 to cross validate the robustness of the proposed models.

The Sub-Committee reviewed the results of Japan's internal investigation for data reliability of some observer records. It was noted that Japan would revise and resubmit the ST09 data for 2017 to the Secretariat.

7. Seabirds

7.1 Feedback on collaborative process of assessing the impact of longline fisheries on by-catch of seabirds

BirdLife International presented initial results from the final workshop of the FAO ABNJ Global Seabird Assessment that was held in February 2019. The workshop brought together twenty-seven experts from fishing nations operating in the Southern Hemisphere and relevant international organizations, including ICCAT. The workshop objectives were to estimate a global seabird bycatch in pelagic longline fishing in the Southern Hemisphere with associated measures of uncertainty, to assess the population level impact of bycatch for key species, and to develop a toolbox of methods to estimate bycatch, with guidelines on the most appropriate approaches given various data-quality circumstances.

Prior to the workshop, the participants examined a range of methods to estimate seabird bycatch using their own national observer data and some combination of them. Three basic approaches were used as standard estimation procedures: two BPUE standardization (GAM and INLA) and one risk assessment (SEFRA). At the workshop, observer data by 5x5 degree and by quarter from nine sources were combined for a joint analysis, which represents the largest and most comprehensive seabird dataset ever compiled. The seabird density distribution estimated based on tracking data was also made available to the workshop. Total longline effort available from the tRFMOs was used to generate the estimates of total seabird bycatch.

All the approaches selected a model incorporating seabird density distribution data and resulted in quite similar estimates of total seabird mortality of around 30,000 to 40,000 individuals south of 20º South in 2016. All model approaches largely reduced the uncertainty observed when raising the BPUEs alone. The workshop concluded that it was of critical importance to include seabird distribution into the model and

agreed to take action towards making such information publicly available. The workshop stressed the importance of using a comprehensive dataset to cover global bycatch events.

The workshop also examined the impacts of bycatch on selected seabird populations, using a Population Viability Analysis (PVA), forward projection based on demographic data, and in the context of SEFRA.

At the time of the Sub-Committee meeting, the workshop report was still under review and it will become publicly available when finalized.

The Sub-Committee discussed some of the outcomes of the workshop. It was pointed out that white-chinned petrels comprised the majority of the bycatch but the impact on these populations could be considered minor. On the other hand, albatrosses have relatively low bycatch but the impact of this bycatch on the populations is significant. Therefore, these types of assessments should move towards becoming species specific instead of for all species combined. The Sub-Committee agreed that the approach of using tracking data and catch and effort data in 5x5 degrees could be used for other bycatch species.

The Sub-Committee acknowledged that this type of collaborative effort involving the sharing of different data sets can provide valuable results. It was pointed out that this type of collaborative work is already being used within ICCAT to develop joint CPUEs (e.g., bluefin tuna and swordfish) and that some CPCs have been collaborating on a similar approach with sea turtle and seabird data. However, it was also discussed that domestic confidentiality rules might preclude some CPCs from sharing their observer data and participating in this type of work.

The Sub-Committee inquired if the Global Seabird bycatch assessment will be conducted again or if it was a onetime exercise. It was explained that this joint effort was guided and funded by the FAO and it will be up to this organization to support this work in the future again. The Sub-Committee pointed out that conducting this type of work on a regular basis (e.g. every 5 years) would be extremely useful.

The Sub-Committee was also informed that within the frame of the CCSBT, Japan, New Zealand, Australia, and South Africa conducted a similar exercise to improve the SEFRA approach.

It was discussed by the Sub-Committee that the outcomes of the workshop could be helpful to advance its work in assessing the effectiveness of the adopted seabird mitigations measures (Rec. 11-09). Even though the estimated total seabird bycatch estimates corresponded to the entire Southern Hemisphere, the Sub-Committee was informed that estimates for the ICCAT Convention area could be obtained.

In summary, the Sub-Committee welcomed this joint global effort and acknowledged its valuable and significant contribution to the understanding of the impact of longline fisheries on seabird populations.

7.2 Review of progress on seabird interaction estimations and mitigation

Document SCRS/2019/056 used tracking data to assess the at-sea spatial distribution and longline bycatch risk of juvenile grey-headed albatrosses from the South Georgia Islands.

The results of the study concluded that juvenile grey-headed albatrosses in the Atlantic Ocean spatially overlap mostly with the Japanese and Chinese-Taipei longline fishing effort. It was discussed that birds hatching in one ocean (e.g. Indian Ocean) can be found as juveniles in a different ocean basin (e.g. South Atlantic Ocean). Therefore, the potential juvenile bycatch mortality estimated in the South Atlantic Ocean might not entirely relate to changes in the South Georgia grey-headed albatross population. The Sub-Committee agreed that expanding this study to include tracking data from other populations in other oceans would be of great utility.

The Sub-Committee discussed that longline fleets operating in the area where they can interact with juvenile grey-headed albatross are already required to use seabird bycatch mitigation measures (Rec. 11-09).

7.3 Response on the effectiveness of seabird mitigation measures as per Rec. 11-09

The Sub-Committee recalled that the paucity of seabird by-catch data submitted to the ICCAT Secretariat following requirement for the implementation of mitigation measures still prevents the full assessment required by Rec. 11-09. Nevertheless, the Sub-Committee acknowledged that progress has been made towards addressing this issue.

The FAO Common Oceans/ABNJ Tuna project has achieved a preliminary estimate of seabird bycatch mortality for pelagic longline fisheries in the Southern Hemisphere for 2016 by 5x5 grid squares south of 20 degrees south latitude. The analyses aggregated the data from 2012 to 2016 to compensate for a paucity of seabird bycatch information collected by observers, and annual trends of estimates would only reflect a change in fishing time and area of overlap with seabird distribution. This means it is not possible to obtain the anticipated outcome of providing pre-regulation and post-regulation total estimates of bycatch. In addition, the project recognized that although a set of mitigation measures referred to in Rec. 11-09 could substantially reduce seabird bycatch if implemented in an appropriate way, quantitative measurements on proper implementation of certain mitigation measures are currently missing.

Collaborative work is in its 3rd year and ICCAT CPCs national scientists continue to analyse seabird by-catch based on detailed operational level observer data.

The Sub-Committee agreed to continue its effort to deliver the response to the Commission, taking into account data paucity, expected progress in development of a seabird indicator in the ecosystem report card (reported in Section 3), and all the historical works done including the CCSBT Scoping Paper presented at the 2016 meeting of the Sub-Committee.

8. Sea turtles

8.1 New information on the interaction of tuna fisheries with sea turtles

Document SCRS/2019/054 reported on a machine learning process to identify hard shell sea turtle bycatch by the Japanese deep setting longline fishery and to estimate the impact of the fishery on different marine turtle species.

The authors provided clarification for the two-step approach included in the machine learning process. The Sub-Committee noted that the assessment assumed that only two species occurred in the data which could have influenced the final result. The Sub-Committee inquired if pictures were taken for every single specimen caught as part of the protocol. The authors indicated that is the normal procedure except in cases when the turtle is not brought onboard.

Document SCRS/2019/058 provided a general overview of sea turtle strandings along the Algerian coast, based on surveys conducted by the national program that started in 2002.

The Sub-Committee noted that stranding is not a good proxy to estimate the sea turtle mortality associated with fisheries. It was also noted that factors known to be associated with strandings in other regions include coastal fisheries, disease, pollution, and seismic surveys. It is unclear if pelagic fisheries contribute to sea turtle stranding. It was also clarified that strandings are not always fatal. It was suggested that gut stomach content analyses and/or necropsy be included in the data collection program to better understand contributing factors.

SCRS/P/2019/021 provided a general overview of the Liberian fisheries impact on marine turtles.

The Sub-Committee requested clarification on the methodology used to estimate the overall catch of marine turtles. The author explained that it was based on the information collected by the observers and the extrapolation was done taking in to account the mean number of fishing hours and days per fishery. The Sub-Committee noted that most of the interactions were observed in the bottom trawl fishery, but that the interaction rates for longline or purse-seine fisheries remain unknown.

8.2 Discuss progress towards scientific collaboration among researchers of ICCAT CPCs to elaborate on the results obtained to date regarding knowledge of the impact of the fisheries on sea turtles

The Secretariat informed the Sub-Committee on the availability of funds to support the attendance of three to five National Scientists at a collaborative workshop to continue the joint analysis started in Uruguay in 2018. Planning on the particulars of the workshop location and date for 2019 are ongoing.

The Sub-Committee reiterated their support for this collaborative work and requested that the National Scientists participating in the workshop prepare a report documenting their progress and to present it to the 2020 meeting of Sub-Committee. In addition, and bearing in mind the need for input information for the Ecosystem Report Cards, the Sub-Committee recommended that the following aspects be considered:

- Creating species distribution maps
- Review and determine the best methods to determine BPUEs and the number of fisheries interactions at the species level

9. Effect of mitigation measures to reduce by-catch and mortality in ICCAT fisheries across taxa: intra and interspecific effects of the measures

Document SCRS/2019/029 presented post-release survival of silky and whale shark released from the net and post-release survival of rays from the deck, from at-sea trials conducted onboard a purse seine.

The Sub-Committee asked if the captain/crew were happy to participate in these maneuvers to release the sharks and about the safety of the crew. It was clarified that the fishers were not asked to handle large sharks that could present more danger and that all releases were from FAD sets where mainly juvenile silky sharks are found, that are easier to handle.

The Sub-Committee also asked about the additional time this hauling method would take. The authors clarified that the sharks are captured and released within 35 to 50 minutes, which is the time available while the purse seine is hauled and before the net space is too small to maneuver the speed boat, so no extra time was consumed. While this method seems to work well in FAD sets where mostly juvenile sharks are captured, it would be more complicated in free school sets, as the larger sharks captured in those sets do not usually seem interested in biting the bait and in any case would be dangerous to handle. In those cases, it was further noted that using this method (handline fishing and transporting to outside the net using a stretcher) may be limited to a few sharks due to the limited time.

The Sub-Committee asked if attractors have been tried to get sharks out of the net. The authors mentioned that this has been tried in the past with chum to attract sharks and remove them from the net with limited success. Future work is planned to determine sharks' responses to other attractors or repellents, e.g., lights and sound with the objective of getting them out of the net in order to avoid landing.

Document SCRS/2019/044 presented a preliminary meta-analysis on the effects of hook and bait type on the catch rate of elasmobranchs, turtles, and bony fishes in the surface pelagic longline fishery.

The authors clarified that traditionally the Portuguese fleet targets swordfish, using J-hooks and squid bait; but more recently fishers tend to use more a mix of fish, squid, and, sometimes artificial bait, depending on the bait species cost. Further, it was noted that while the main target is swordfish, in some areas and/or seasons blue shark is targeted and the gear is usually changed to use wire leaders. The authors further clarified that the study reports a meta-analysis using 24 references that come from different fleets, however only fisheries with shallow sets were used.

The Sub-Committee noted that although catch rates using circle hooks were reported to be higher for sharks, this could be due to bite-offs, which is believed to occur more often on J hooks. The reason is that relative to circle hooks, J-hooks tend to result more often in deep hooking (e.g., in the gut) making bite-offs more likely to occur. The authors added that the study is preliminary and there are plans to include additional variables such as leader material in future analysis, which could answer some of those issues. It was agreed that the results reported refer therefore to retention rates instead of catch rates. Not all bite-

offs are attributable to sharks: other taxa are also able to break the lines e.g., long snouted lancetfish, *Alepisaurus ferox*. Furthermore, post-release mortality of bite-off individuals is not known.

The Sub-Committee also discussed the limitations when interpreting the results of meta-analyses given the quality and number of the studies chosen for this meta-analysis and combining findings from controlled experiments and non-experimental data. The authors clarified that these are preliminary results and further work is ongoing to include information on other variables (e.g., leader material) as well as analyze at-haulback mortality.

Document SCRS/2019/053 presented a review on catch rates of commercial and bycatch species by hook type in pelagic tuna longline fisheries for shallow and deep setting.

The Sub-Committee acknowledged that most of the results of the scientific literature review presented in the document confirmed previous knowledge of the effect of hook type on the catch of target and non-target species (e.g., large circle hooks reduce the catch of sea turtles and tend to increase or not change the catch of tropical tunas). However, the Sub-Committee disputed some of the conclusions of the study with respect to sharks. Despite the author's conclusion that circle hooks increase shortfin mako mortality, it was noted that only one study out of the five referenced in this analysis reported significantly higher catch rates when using circle hooks, while the other four showed non-significant differences. The Sub-Committee questioned a perceived over-interpretation of data for a single species with variable results. It was agreed that more shark studies are needed and that these results should be considered preliminary at this time.

Document SCRS/2019/057 presented the progress on the code of good practices on the tuna purse seine fishery in the Atlantic Ocean which was to enable the adoption of mitigation measures in purse seiners. The adoption of this code of good practices resulted in an increase in observer coverage.

The Sub-Committee questioned if using conveyor belts influenced shark survival. The authors clarified that sharks in the first brail are usually in better condition with a higher likelihood of survival, than the sharks coming subsequent brails which experience higher stress with an increase in mortality.

In response to a question about magnitude of observer coverage in the fishery, it was clarified that there is 100% observer coverage using both electronic and human monitoring but that this varies depending on the vessel type. The Sub-Committee noted that the post release survival of sea turtles was not confirmed with any tagging studies.

In the discussion about observer coverage the Sub-Committee reviewed and identified several relevant references that provide information on this topic. These included: Amande *et a*l. 2012; Babcock *et al*. 2003 Lennert-Cody, 2001; NMFS, 2004; Ruiz Gondra *et al*. 2017; and Sánchez *et al*. 2007.

10. Fish species caught as by-catch but not considered by other species groups

Presentation SCRS/2019/P/018 provided reported species (excluding tuna) caught by the purse seine fleet in Tunisian waters. This fleet targets mainly small tunas and catches of other fish species mostly as bycatch. The data reported come from port sampling carried out in the main landing sites.

The Sub-Committee asked about the representativeness of those bycatch species in this fishery. The authors clarified that it represents less than 4% of the catch, but still has an important economic value to the fishery,

The Sub-Committee also asked about the number of vessels in this fleet, which is not clear at this stage. It is further noted that there are plans to continue this study and incorporate data from fishery observers.

11. Other matters

11.1 Elaboration of Terms of Reference for a Proposed Call for Tenders to develop "An Inventory of Best Available Science on By-catch Mitigation Measures across Taxa"

The Sub-Committee agreed that at the present time it is premature to develop terms of reference for a call for tenders given that important information on this has been made available and needs to be reviewed.

The Sub-Committee noted the importance of developing an inventory of the best available science on by-catch mitigation measures across taxa. A paper entitled "Bycatch mitigation measures of protected and threatened species in tuna fisheries" by Zollett *et al.* 2019 is in review by the Endangered Species Research Journal which relates directly to this proposal.

Two FAO Good Practice guides were circulated among the Sub-Committee for review (Good Practice Guide for the Handling of Seabirds Caught Incidentally in Mediterranean Pelagic Longline Fisheries, and Good Practice Guide for the Handling of Sea Turtles Caught Incidentally in Mediterranean Fisheries). The guides included good practices for handling marine turtles and seabirds and focused on the Mediterranean Sea. The Sub-Committee evaluated these safe release and handling guides designed to minimize injury to incidentally captured sea turtle and seabird species and decrease post-release mortality. It was recognized that the seabird guide followed ACAP advice and so there was no technical objections to its content.

The Sub-Committee supported the idea for ICCAT to have access to additional guides that have a focus beyond the Mediterranean on its website. A link to the Bycatch Management Information System (BMIS), which focuses on bycatch mitigation and management in oceanic tuna and billfish fisheries, is recommended. The BMIS also holds information on Species Identification and Safe Handling and Release, including illustrated guides.

Other summary posters and guides (Poisson *et al*. 2012 and 2014) exist and have been translated to several languages, available on the ISSF website (Bycatch Best-Practice Posters). Additionally, the second chapter of the ISSF Longline Skipper Guidebook also focuses on bycatch mitigation and handling for species encountered as bycatch in these fisheries (i.e. sea turtles, seabirds and sharks). The chapter includes species descriptions and specific bycatch mitigation methods illustrated by pictures and videos. Infographics on sea turtles best handling practices in longline fisheries are also available in English and Spanish.

12. Recommendations

Recommendations without financial implications

- The Sub-Committee recognizes the need for more time at the next ecosystem meeting in order to address issues related with the development of the ecosystem report card. Therefore, the Sub-Committee recommends that more time be allotted to the discussion of this issue at the 2020 meeting.

- Upon review of the EFFDIS estimates, the Sub-Committee noted significant discrepancies with the Task II reported catch and effort. Given the wide use of this product, it is recommended that the Secretariat pull the existing EFFDIS dataset from the website to review it and correct the estimation methodology. The progress of this work should be presented at the 2019 meeting of the Sub-Committee on Statistics.

- Considering Rec. 13-11, the Sub-Committee once again recommends that the Commission take action to reduce sea turtle bycatch.

  Recent experimental and meta-data analyses presented to the Sub-Committee continue to indicate that large circle hooks are an effective measure in reducing sea turtle bycatch and could also increase post-release survival. The Sub-Committee acknowledges that while circle hooks are an effective sea turtle mitigation measure, they also have different impacts on both target and by-

catch species and, therefore, circle hooks should not be considered a mitigation measure for all bycatch species.

Taking into consideration the above scientific information, and that most sea turtle by-catch occurs on shallow longline sets, the Sub-Committee recommends the Commission to adopt the use of large circle hooks for shallow longline sets.

- In light of the discussions held during the meeting, the Sub-Committee supports the recommendation of the Shark Species Group that a study comparing the effects of hook type on retention rates, catch rates, and at haulback mortality of sharks be conducted. It is of utmost importance that the experimental design of the study accounts for the influence of leader materials types (wire vs nylon) and consider possible regional and fleet operational differences.

- The Sub-Committee recommends that a group of National Scientists and the Secretariat work intersessionally to develop a revised version of the ST09 form following the guidelines provided in this report. This new form will be presented at the 2019 meeting of the Sub-Committee on Statistics for its discussion and approval.

- In order to reduce the impact of the tropical purse seine fishery on sea turtles and elasmobranchs that interact with this fishery, the Sub-Committee recommends adopting an approved best fauna handling practices referred to in Section 11 of this report, which prioritizes crew safety.

- Acknowledging the value of collaborations between industry and scientists in the development of new tools and gears to assist in release operations, the Sub-Committee recommends that new mitigation approaches be further explored, e.g. sharks' release from the net. In addition, purse seine fleets should exclusively deploy non-entangling FADs. Further research and increased use of biodegradable FADs is encouraged, as stated in Rec. 16-01.

- In order to expand the knowledge on post-release survival rates, the Sub-Committee recommends further experiments to estimates the mortality and track post-release movements of species of concern.

- The Sub-Committee recommends the development of two ecosystem-based risk assessment studies: one for the Atlantic Ocean tropical area and another for the Sargasso Sea area. These risk assessments would aim to identify the high-risk ecosystem impacts in the Convention Area.

- The Sub-Committee recommends that the National Scientists participating in the marine turtle workshop prepare a report documenting their progress to present it at the 2020 meeting of Sub-Committee. In addition, and bearing in mind the need for input information for the Ecosystem Report Cards, the Sub-Committee recommended that the following aspects be considered:

    - Creating species distribution maps
    - Review and determine the best methods to determine BPUEs and the number of fisheries interactions at the species level

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Appendix 1

Agenda

1. Opening, adoption of the Agenda and meeting arrangements

Pertaining to Ecosystems

2. Review the progress that has been made in implementing ecosystem-based fisheries management and enhanced stock assessments

3. Review the progress on developing an Ecosystem Report Card for ICCAT including the development of status and pressure indicators, reference levels

    3.1 Review adequacy of existing indicators against proposed new ones
    3.2 Review ecosystem drivers of abundance and mode of action
    3.3 Review development of ecoregions

4. Review mechanisms to effectively coordinate, integrate and communicate ecosystem-relevant research across the ICCAT Species Working Groups and within the SCRS

5. Review information on the trophic ecology and habitat of pelagic ecosystems that are important and unique for ICCAT species in the Convention area

Pertaining to By-catch

6. Data used for by-catch analyses

    6.1 Update of ST09 forms
    6.2 Revisions and updates of the data used in bycatch analyses

7. Sea birds

    7.1 Feedback on collaborative process of assessing the impact of longline fisheries on by-catch of seabirds
    7.2 Review of progress on seabird interaction estimations and mitigation
    7.3 Progress on assessing effectiveness of Rec. 11-09

8. Sea turtles

    8.1 New information on the interaction of tuna fisheries with sea turtles
    8.2 Discuss progress towards scientific collaboration among researchers of ICCAT CPCs to elaborate on the results obtained to date regarding knowledge of the impact of the fisheries on sea turtles

9. Effect of mitigation measures to reduce by-catch and mortality in ICCAT fisheries across taxa: intra and interspecific effects of the measures

10. Fish species caught as by-catch but not considered by other species groups

11. Other matters

    11.1 Elaboration of Terms of Reference for a proposed Call for Tenders to develop "An Inventory of Best Available Science on By-catch Mitigation Measures across Taxa"

12. Recommendations

    12.1 Recommendations without financial implications

13. Adoption of the report and closure

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Appendix 3

List of Papers and Presentations

SCRS/2019/029	At-sea tests of releasing sharks from the net of a tuna purse seiner in the Atlantic Ocean	Hutchinson M., Justel-Rubio A., and Restrepo V.
SCRS/2019/043	A potential indicator for non-retained sharks in support of an ICCAT ecosystem report card	Coelho R., Santos C., Rosa D., and Lino P.G.
SCRS/2019/044	Hook and bait type effects on surface pelagic longline catch rates: a meta-analysis for target, bycatch and vulnerable fauna interactions	Santos C.C., Rosa D., and Coelho R.
SCRS/2019/048	Indicators of *Orcinus orca* Interactions with Pelagic Longline Gear and in the ICCAT Convention Area	Hanke A., and Domingo A.
SCRS/2019/049	Databases and Metadata for ICCAT National Observer Program Data Submissions 2015-2018: an Analysis of Coverage and Completeness	Taylor N.G., Mayor G., Gallego J.L., Palma C., and Ortiz M.
SCRS/2019/050	Analytical possibilities and analytical limitations: assessing the suitability of 2015-2017 and 2018 ST09 forms to address ICCAT Commission Recommendations	Taylor N.G., Palma C., and Ortiz M.
SCRS/2019/051	In support of the ICCAT ecosystem report card: three ecosystem indicators to monitor the ecological impacts of purse seine fisheries in the tropical Atlantic ecoregion	Juan-Jorda M.J., Andonegi E., Murua H., Ruiz J., Lourdes R.M., Sabarros P., Abascal F., and Bach P.
SCRS/2019/052	Does ICCAT need ecosystem plans? A pilot ecosystem plan for the Atlantic Tropical Ecoregion	Juan-Jordá M.J., Murua H., Andonegi E., Baez Barrionuevo J.C., Abascal F., Coelho R., Todorovic S., Apostolaki P., Lynam C., and Perez A.
SCRS/2019/053	Review of Studies on Catch Rates of Commercial and Bycatch Species by Hook Type Using in Pelagic Tuna Longline Fisheries	Okamoto K., Ochi D., Oshima K., and Minami H.
SCRS/2019/054	Machine Learning Approach to Estimate Species Composition of Unidentified Sea Turtles that were Recorded on the Japanese Longline Observer Program	Okamoto K., Kanaiwa M., and Ochi D.
SCRS/2019/055	Toward Ecosystem-based Fisheries Management in the Sargasso Sea	Kell L., Luckhurst B.E., and Leach A.
SCRS/2019/056	At-sea Distribution and Fisheries Bycatch Risk of Juvenile Grey-headed Albatrosses From South Georgia (Islas Georgias del Sur)	Frankish C.K., Clay T., Small A., and Phillips C.
SCRS/2019/057	Progress on the Code of Good Practices on the tropical tuna purse seine fishery in the Atlantic Ocean	Grande M., Ruiz J., Murua H., Krug I., Arregi I., Goñi N., Murua J., Zudaire I., and Santiago J.
SCRS/2019/058	État des lieux sur la situation des tortues marines en Algérie	Benounnas K., and Tifoura A.
SCRS/P/2019/014	Selecting ecosystem indicators for fisheries targeting highly migratory species. An EU project to advance the operationalization of the EAF in ICCAT. What have we learned?	Juan-Jorda M.J., Murua H., Apostolaki P., Lynam C., Perez Rodriguez A., Baez Barrionuevo J.C., Abascal F., and Coelho, R.
SCRS/P/2019/015	EFFDIS: A Modelling Approach To Estimate Overall Atlantic Fishing Effort By Time Area Strata (update May 2019)	Beare D.
SCRS/P/2019/016	Challenges to Choose and Adopt Indicators for Sea Turtles on ICCAT Convention Area	Giffoni B., and Sales G.
SCRS/P/2019/018	List of Fish Species (Excluding Tuna) Accessory Caught by Purse Seine Fleet in Tunisian Waters	Hajjej Ghailen
SCRS/P/2019/021	Assessing the impact of fisheries on the sea turtle population in Liberia	Daniels, Roosevelt S.

Appendix 4

SCRS Documents and Presentations abstracts as provided by the authors

SCRS/2019/029 A research cruise in support of the International Seafood Sustainability Foundation (ISSF) bycatch reduction project was conducted on the tuna purse seine vessel PACIFIC STAR, during June-July 2018 in the eastern tropical Atlantic Ocean. During a 4-week period a group of three scientists joined the fishing trip with the following primary objectives: (1) Estimate post-release survival of sharks (from the net); (2) Test the feasibility of crew members releasing sharks from the net. Additionally, two other objectives were pursued opportunistically: (3) Estimate post-release survival of whale sharks (from the net); and, (4) Estimate post-release survival of rays (from deck). Preliminary results of these studies are presented.

SCRS/2019/043 This work follows the requests and ongoing work from the ICCAT Sub-Committee on Ecosystems to develop an Ecosystem report card, in this case related with non-retained sharks. As a starting point, the bigeye thresher shark was used given its low productivity and susceptibility to longline fisheries, determined in the last sharks ERA. The preliminary indicator developed now is based on a standardized CPUE from operational level fishery observer data, from the Portuguese pelagic longline fleet (2008-2016). This indicator should be considered preliminary, at this stage provided mostly for discussing at the SC-ECO, as it only has data from one fleet. If there is an interest to progress the development of these types of indicator, then it is recommended that detailed observer data from other fleets should be incorporated, especially fleets from CPCs that interact more with those pelagic shark species.

SCRS/2019/044 A meta-analysis of 24 publications was conducted to assess effects of hook and bait type on catch rates of target, bycatch and vulnerable species of the pelagic longline fishery. Catch rate analyses considering hook type, bait type and the combination of both variables were performed for 23, 18 and 17 species, respectively. Results showed that sea turtles interactions were reduced when using circle hooks instead of J-hooks. Swordfish had also a lower catch rate with circle hooks. In contrast, catch rates of the porbeagle, shortfin mako, tiger shark, crocodile shark, bluefin tuna and albacore were greater with circle hooks. Bait type alone did not seem to significantly influence the catch rates of the majority of the species examined. Results were mixed when considering the combined effects of hook and bait type. The results presented in this working document should be considered preliminary. Future work will take into account information on at-haulback mortality rates and expanded information on fishery characteristics.

SCRS/2019/048 Longline fishery interactions with Orcas constitute both a loss of the target species due to depredation and a potential for hooking or entanglement. The potential for Orcinus orca interactions with pelagic longline gear was estimated using computer generated habitat suitability maps and estimates of overall Atlantic fishing effort by time-area strata (EFFDIS). Depredation estimates of Swordfish and Albacore catch was based on the estimated longline catch by time-area strata (CATDIS). Annual trends in vulnerability, depredation and depredation per unit effort are provided by area across all seasons and fleets.

SCRS/2019/049 The Secretariat has integrated (reviewed, compiled, consolidated, and, harmonized) into the ICCAT relational database system (ICCAT-DB) all the National Observer Program data (form ST09-NatObPrg) that has been submitted to the Secretariat. We summarize some of the metadata for the compiled/stored data including the coverage of the submissions and of the data received. Of 107 forms received, only 58 could be compiled because the remaining forms did not meet basic data completeness criteria. The ST09 data integration process was complex and challenging due to various changes in the form structure over time, including changing in field names, data resolution, and inconsistent CPC use of the form versions. The longest continuous time series of observations that the SCRS has from ICCAT's National Observer program data is from 2014-2017 and there are only 6 CPCs that have submitted data that could be compiled to generate such a time series. There are 9 CPCs that have submitted data resulting in time series of 3 years long. 2018 data cannot immediately be considered part of this time series because, the resolution of the data is incompatible with respect to spatial and temporal resolution. Of the data that could be imported, a significant number of fields contained errors that need to be fixed, through re-submission before the data might be considered useable. The key areas moving forward with the storage and use of the ICCAT's National Observer Program data are to define and store information regarding each individual CPCs National Observer Program data and for the SCRS to define the objectives and planned use of the ICCAT's National Observer Program data.

SCRS/2019/050 We show that the by changing the format of the ST09 form in 2018 the SCRS reduced its ability the answer the number of questions corresponding to ICCAT Commission recommendations using this data, from 35 that could be addressed using the 2015-2017 versions of the form to just two that could be definitively addressed, 13 that could perhaps be addressed and 20 that could not be addressed using the 2018 version of the form. In order to make this claim, we compare 2015-2017 and 2018 versions of the ST09 data forms and assess their suitability to address questions arising from ICCAT Commission recommendations. We do this by first, reviewing ICCAT Commission recommendation and resolutions for references to National Observer Program data. For each corresponding recommendation or resolution, we define candidate scientific questions that could be answered in order to address that recommendation. Then we assess if that question could be addressed using the data in the 2015-2017 or the 2018 formats of ICCAT National Observer Program data. The analysis of whether or not each recommendation could be addressed using the NOP data could be much more thorough: an analysis similar to what has been presented here could be redone with a more in depth analysis by relevant species groups about what NOP program data (or other) would be needed to address a particular recommendation and how this data would regularly be made available in order to address the full complement of ICCAT recommendations relevant to the SCRS.

SCRS/2019/051 In support of the ICCAT ecosystem report card, we estimated several indicators which could be used to monitor the state of the "Foodweb/Trophic relationships" ecosystem component. An ecosystem approach requires understanding the ecological effects of removing all animals through fishing, not only the bycatch or discards. In addition to the monitoring of the total biomass removed, it is also necessary to know the species composition of the total catch (whether they are retained or not), their life history traits and their ecological role in the foodweb. We used the available data from the European purse seine fishery catching tropical tunas in the eastern tropical Atlantic to examine the potential ecological effects of this fishery, on the foodweb structure and functioning, in the tropical Atlantic ecoregion. We compared the total biomass removed by the fishery in terms of weight, trophic level and replacement time among each purse seine fishing method (sets on floating objects-FOBs and sets on free schools-FSCs). By examining the temporal trends of several ecosystem indicators based on the total removals by the fishery and the trophic level and life history traits of the species removed, we intend to support the on-going ICCAT initiative to develop ecosystem status assessments and ecosystem report cards to monitor the effects of fisheries and climate in the Atlantic pelagic ecosystem. Data limitations and future research needs are also highlighted

SCRS/2019/052 The implementation of an Ecosystem Approach Fisheries Management (EAFM) in ICCAT has been slow and patchy, as it lacks a long-term plan, vision and guidance on how to operationalize it. Ecosystem plans are needed to formalize the process of operationalizing the EAFM by identifying and formalizing ecosystem goals and objectives, planning actions based on priorities, measuring performance of the whole fishery system, addressing trade-offs, and incorporating them in fisheries management. The Specific Contract N0 2 under the Framework Contract - EASME/EMFF/2016/008 provisions of Scientific Advice for Fisheries Beyond EU Waters has developed a pilot ecosystem plan for the tropical ecoregion of the Atlantic Ocean. In this document, we highlight the main potential benefits of developing ecosystem plans in ICCAT. Second, we briefly describe the main core elements developed in the pilot ecosystem plan for the Tropical ecoregion of the Atlantic Ocean. Third, we summarize our main thoughts and lessons learned in the development of this pilot ecosystem plan for one ecoregion within ICCAT. Last, we propose a list of actions, research activities and capacity building activities to foster the development, use and implementation of ecosystem plans in ICCAT. At this stage, the pilot ecosystem plan developed as part of this European research project seeks to create awareness about the need for ecosystem planning, initiate discussion about what elements need to be part of a planning process, and intent to be the foundation for future participatory and consultative ecosystem plans in the ICCAT convention area.

SCRS/2019/053 Tunas and swordfish are main target of the pelagic tuna longline fishery which incidentally non-targeted species such as sea turtles and sharks. There is a variety of hook types in terms of shapes and sizes, which are separated into three groups, i.e. "J" hooks, Japanese tuna hooks and circle hooks. This document overviewed catch rates for main species and bycatch species reported in the published scientific papers and documents.

SCRS/2019/054 Unidentified species is the major source of uncertainties to evaluate the impact of bycatch on sea turtle populations, so we tried to estimate species composition of unidentified sea turtles from operational circumstance via machine learning approach. We used bycatch data from the Japanese scientific observer program, which includes 10,490 operations and catch records of 141 loggerheads, 75 olive ridleys,

and 152 unidentified turtles. The random forest, which is a machine learning approaches, was conducted to estimate probability of the species identities (loggerhead or olive ridley). As training datasets, species-identified sea turtle bycatch number including set date, location, sea surface temperature and catch number of target and non-target species such as tunas, billfishes, other teleost fishes, sharks, and sea turtles. As a result, the probabilities of species identity were calculated. When the species was defined as identified (the probability larger than 0.7), the identified 111 turtles were identified as 16 loggerheads and 95 olive ridleys, and 41 could not be identified. We conclude that random forest approach will be helpful to improve the species estimation.

SCRS/2019/055 To help implement Ecosystem-Based Fisheries Management the Subcommittee on Ecosystems has developed a report card based on indicators for the different components of the ecosystem. Indicators are mainly based on fisheries dependent data and work is ongoing to develop indicators for Trophic Structure, Community and Diversity, Habitat and Social and Economics components. A task of SC ECO is to determine if detailed reporting to regions within the ICCAT convention area is possible and necessary. Therefore, we show how the Sargasso Sea can help in developing a better understanding of the impact of environmental pressure on the Atlantic and the importance of validating indicators using fisheries independent data, i.e. vessel AIS, remote sensing, electronic tag and oceanographic datasets. Implementing Ecosystem-Based Fisheries Management also requires a multistakeholder assessment; we therefore also conducted a preliminary elicitation exercise.

SCRS/2019/056 Grey-headed albatrosses (GHA) breeding at South Georgia are an ACAP Priority Population that is threatened by bycatch due to spatial overlap with pelagic longline fisheries in its non-breeding range. Despite continued archipelago-wide population declines, little is known about the distribution of younger life-history stages. Shipbased monitoring suggests that immature GHA are killed more frequently than adults by pelagic longline vessels targeting tuna in the southeast Atlantic, but it is not clear if this is because young age classes show greater spatio-temporal overlap with this or other fleets, or if they are more vulnerable to bycatch because of their naïve scavenging behaviour. Here we filled a notable gap in knowledge of at-sea distribution and potential fishery bycatch risk by analysing tracking data collected using platform terminal transmitters (PTTs) deployed on juveniles which fledged from Bird Island, South Georgia in May-June 2018, and comparing their distribution to that of adult GHA from the same colony. In the first 6 months post-fledging, the tracked juveniles made greater use of waters in the southeast Atlantic and southwest Indian Oceans than non-breeding adults, which spent more time in the southeast Pacific and southwest Atlantic Oceans. As a result, the major life-history stages (adult breeders, non-breeders, juveniles) differed in spatio-temporal overlap with particular pelagic longline fleets. Juvenile GHAs overlapped mostly with the Japanese fleet in April-June in the central Atlantic Ocean around Tristan da Cunha, and adults with the fleet of Chinese Taipei in July-September in the Pacific Ocean. The high overlap of juvenile GHAs with fisheries operating east of Tristan coincides with a bycatch hotspot previously reported by the Japanese Observer Programme. This suggests that the high bycatch of GHA in this area likely represents juveniles, and potentially immatures, from South Georgia. These results highlight the very important role that reducing bycatch in the pelagic longline fleets of Chinese Taipei and Japan would have in terms of reducing bycatch of, and hence threat to, this ACAP Priority Population.

SCRS/2019/057 The two Spanish tuna purse seiner associations, ANABAC and OPAGAC, established a voluntary agreement for the application of good practices to minimize the ecosystem impacts of purse seine fishing, by reducing mortality of incidental catch of sensitive species and the use of non-entangling FADs. This paper presents results on the use of FADs and sensitive fauna release for the period 2015 and 2017 in the Atlantic Ocean. More than 600 trips were monitored in 28 purse seiners and 8 support vessels by human observers onboard or by electronic monitoring system. Results show that the percentage of entangling FADs is nowadays a residual component, being the 81.3% of the FADs left at sea non-entangling FADs (i.e. totally constructed with not meshed material or ≤7 cm mesh size if open net is present). Overall, 37,468 vulnerable specimens were registered with a predominance of sharks (88% of the interactions). Sharks (other than whale sharks), mantas, rays and turtles are mainly released by hand from the deck. For mantas specific releasing tools are also used. Bycatch release time has been reduced since 2015, which is an indicator of the increased commitment of the crew and could contribute to higher post-release survival rates.

SCRS/2019/058 Les tortues marines ou Testudines en Méditerranée comprennent 2 familles, 5 genres et 5 espèces mais en Algérie, seulement trois d'entre eux ont été observées le long des côtes algériennes. Notant une fréquentation plus importante pour la tortue caouanne Caretta caretta caretta (Linnaeus, 1758) et la tortue-luth Dermochelys coriacea coriacea (Vandelli, 1761), par contre la tortue verte Chelonia mydas

(Linnaeus, 1758) constitue l'espèce la plus rare. Le statut de ces espèces dans la liste rouge de l'UICN oscille entre vulnérable à en danger d'extinction (Claro& De Massary, 2012), ce qui mènent les organismes internationales et régionales d'établir des stratégies de gestion des populations des tortues marines que ce soit en méditerranées ou dans le monde. Dans ce contexte et avec son programme de suivi des échouages des Testudines en Algérie, le CNRDPA tente de mieux comprendre le comportement de ces espèces et leurs flux migratoires afin d'assurer la mise en place des mesures de conservation et de protection de ces animaux marins

SCRS/P/2019/014 The Specific Contract N0 2 "selecting ecosystem indicators for fisheries targeting highly migratory species-" under the Framework Contract - EASME/EMFF/2016/008 provisions of Scientific Advice for Fisheries Beyond EU Waters- addresses some scientific impediments and provides solutions that shall support the implementation of an EAFM in ICCAT and IOTC. This project (1) highlights properties of success from other regions of the world in operationalizing the ecosystem approach which could be transferred to ICCAT and IOTC, (2) provides a list of candidate ecosystem indicators to monitor the broader impacts of ICCAT/IOTC fisheries on the pelagic ecosystem, (3) proposes candidate ecoregions within the Atlantic and Indian Ocean which could be used to guide region-based ecosystem plans, assessments and research, (4) develops two pilot ecosystem plans for two case study regions, and (5) provides recommendations to foster the development, use, and implementation of ecosystem plans in ICCAT and IOTC.

SCRS/P/2019/015 A statistical modeling framework approach to estimating overall Atlantic fishing effort on tuna and tuna-like species has been developed by the ICCAT Secretariat and the SCRS using 'Task 1' and 'Task 2' databases. The problem arises because Task 1 data, which are thought to be totally comprehensive, are available only as annual totals for each species, flag and gear combination. Task 2 data, on the other hand, are more detailed and information is available for location and seasonality but are often incomplete. The challenge then is to combine both sources of information to produce the best estimates of fishing effort. The method described uses generalised additive models (GAMs) which model relevant variables (e.g. number of hooks set) from the Task 2 data as smooth functions of covariates of location (e.g. latitude, longitude, depth) and time (e.g. month and long-term trend). Once fitted the models are used to 'predict' values of catch-per-unit-effort as functions of any combination of the relevant covariates together with error or variance. Total effort is estimated by 'raising' with the Task 1 totals according to the formula : Effort (Task 1) = Catch (Task 1) / CPUE (Task 2). This formulation has been used in 2016, 2017 (also presented to the Ecosystems group) and most recently in April 2019 to provide raised estimate of longlining and purse-seining effort in the Atlantic. These most recent estimates, based on considerable improvements/changes to the original data, were plotted together with those done in 2017. There are indeed differences but the trends are qualitatively similar. The author of the approach, however, recommended that the method could and should be simplified, since the statistical modeling phase at the heart of the process is unnecessarily complex in this particular context. It would then also be more straightforward to reproduce.

SCRS/P/2019/016 Sea turtles are highly migratory animals with a long and complex life cycle. Among the several threats they face, fisheries have been recognized as the major one, since the late '80s. Here we come back to a basic, but an essential issue, to understand what are the necessary conditions that make a fishery catch a turtle. To know well those conditions is fundamental to find appropriate mitigation measures to reduce sea turtle capture and mortality. According to the information of sea turtle bycatch by the Brazilian pelagic longline fleets between 2000 and 2016, loggerhead and leatherback turtles are both species most impacted by this fishery in Southwestern Atlantic Ocean (SWA), representing almost 80% of the total amount of sea turtle captured by that fleet. These species are also the two species for which we have greater knowledge. Thus, here we used available information about loggerhead and leatherback population connectivity in the Southwestern Atlantic Ocean to answer some key questions related to choose and adopt indicators for monitoring sea turtles bycatch, such as: 1) Where do the loggerhead and leatherback turtles caught in the longline in SWA come from? 2) Which RMUs are being impacted by longline fishery in SWA? 3) Should we use information of nest abundance as an indicator of longline bycatch impact? Finally, we make a provocation about what does the SC-ECO/ICCAT have in hands to work with indicators and what are the current challenges for that.

SCRS/P/2019/018 The objective of this paper is to increase our knowledge about the fish by-catches (excluding tuna species) by purse seine fleet targeting small tuna in Tunisian waters. A total of 21 species of fish (excluding tuna species) has been identified during the study period (2014-2017). The species reported mainly belong to the family of Carangidae and Sparidae.

Appendix 5

Current version of the indicator checklist template

Component / Questions	Habitat	Trophic	Mammal	Socio-Eco	Sea bird	Sea turtle	Assessed	Not Assessed	Sharks	Fishing	Environment
Goal What is the conceptual management objective to be reflected in the report	Ensuring that the tuna fisheries will have minimal impacts on critical habitat	Ensuring that ICCAT fisheries will have minimal impacts on the structure and function of the communities.	Minimizing the interactions and mortality as practically as possible	Ensure overall sustainability of socio-economic benefits obtained from the ICCAT resources.	Minimizing the interactions and mortality as practically as possible	Minimizing the interactions and mortality as practically as possible	Ensuring long-term sustainability and optimum utilization of the retained stocks	Ensuring long-term sustainability and optimum utilization of the unassessed retained species in the convention	Minimizing the interactions and mortality as practically as possible	Monitor the pressures that affect the state of the different ecosystem components.	TBA
Objective What is the question that can be represented by an indicator(s)	Whether ICCAT fisheries impact on critical habitat	Whether trophic interactions and inter dependencies involving species that are affected by fishing are maintained	Determine if the interaction rates are being reduced.	Determine if the proportion of CPCs with decreasing year on year cash earned and production value is reduced	Whether the number of interactions and/or total mortality is reduced	Determine if the BPUE estimates for TTL and DKK is increasing.	Determine if the status of retained assessed stocks, based on biomass and fishing ratio indicators, is improving.	Determine if the harvest fraction of all unassessed retained species in the convention is increased	Whether the number of interactions and/or total mortality is reduced	Determine if the number of active PS vessels per category and number of hooks deployed by LL is increasing.	TBA
Status: (accepted, rejected, development)											
Updates • Frequency • Scripted/automatic											
Responsibility											
Reference											
Indicator • What is the indicator? • Scientific basis? • Responsive to pressure?											

• Ecosystem relevance? • Does it achieve the objective? • Possible to set targets? • State alternative indicators?											
Data • Do the data exist? • Where do they reside? • Is it readily accessible? • How to improve access?											
Capacity & Expertise • Level of participation • Knowledge of participants											
Regions • Data conform to ICCAT regions • Data conform to Pelagic regions • Regionalize?											
Secretariat • Is support required? • Type?											

Appendix 6

Completed checklist for non retained sharks

Component / Questions	non-retained Sharks
Goal What is the conceptual management objective to be reflected in the report	Ensuring that ICCAT fisheries will have minimal adverse impacts on non-retained shark species.
Objective What is the question that can be represented by an indicator(s)	Determine trends of relative biomass of non-retained sharks
Indicator • What is the indicator? • Scientific basis? • Responsive to pressure? • Ecosystem relevance? • Does it achieve the objective? • Possible to set targets? • State alternative indicators?	• - Standardized CPUE of bigeye thresher shark (BTH) • Ranked as the most vulnerable shark in the last ICCAT sharks ERA (Cortés et al., 2015); as the least resilient species it would be the last to recover from population declines. • Responsive to pressure? • Ecosystem relevance? • Indicator provides the time series of relative abundance; but currently is limited to data from one single longline fleet; further, the species chosen is mostly a tropical/sub-tropical species and will not represent well other areas. • Targets were not set at this time, as the purpose is to provide time series of relative biomass. Possible targets can be defined, for example to not have population declines of more than a certain percentage over a certain number of consecutive years. • Current indicator is for one single species impacted mostly by longline fisheries. Should develop additional indicators for purse seine and gillnets fisheries.
Data • Does the data exist? • Where does it reside? • Is it readily accessible? • How to improve access?	• Yes • IPMA, Portugal (sent to ICCAT under ST-09 forms) • Data is confidential and not publicly available (contains operational level fishery observer data). • Not applicable
Capacity & Expertise • Level of participation • Knowledge of participants	• Limited at this stage (only EU-Portugal data). Participation from other CPCs in encouraged and should be increased. • ICCAT has a Sharks Species Group with strong expertise on shark's biology and fisheries.
Regions • Data conforms to ICCAT regions • Data conforms to Pelagic regions • Regionalize?	• Data used is detailed operational level data. • Data conforms to Pelagic regions (which ones?) • Regionalize? Currently, all data available, covering multiple regions, was used. Due to the species main area of distribution, the analysis could be subset to the tropical and sub-tropical regions.
Secretariat • Is support required? • Type?	• No need for immediate support. Might be needed for longer term and periodical updates.