REPORT OF THE 2021 ICCAT INTERSESSINAL MEETING
OF THE SUBCOMMITTEE ON ECOSYSTEMS AND BYCATCH
(Online, May 5-10, 2021)

"The results, conclusions and recommendations contained in this Report only reflect the view of the Subcommittee on Ecosystems and Bycatch. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission reviews them at its Annual meeting. Accordingly, ICCAT reserves the right to comment on, to object to and/or to endorse this report, until it is finally adopted by the Commission."

1. Opening, adoption of the Agenda and meeting arrangements

The Conveners opened the meeting welcoming the participants. The Assistant Executive Secretary reminded the participants that there would not be an opportunity to meet in September to finalize the Subcommittee's workplan and recommendations. The Subcommittee adopted the agenda with minor revisions. The Agenda is listed in **Appendix 1**, the list of participants in **Appendix 2**, the list of presentations and papers in **Appendix 3**, and abstracts provided by the authors in **Appendix 4.** Rapporteurs were assigned as follows:

Item 1, 15	N.G. Taylor
Item 2-7	A. Hanke, M.J. Juan-Jordà
Item 8	S. Jiménez
Item 9	N.G. Taylor, C. Santos
Item 10-11	N.G. Taylor
Item 12	A. Hanke, A. Domingo, Miguel Santos
Item 13	A. Hanke and A. Domingo
Item 14	G. Diaz, N.G. Taylor

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

SCRS/P/2021/021 provided an overview of the advances in monitoring of environmental variability and the integration of this variability into the fisheries assessment of tunas as well as ecosystem reporting for the western Mediterranean.

The Subcommittee recognized the recent albacore assessment integrated environmental variability into the advice and that interactions were identified for bigeye and yellowfin tuna as well. It was indicated that the effect of environmental variability was being explored for swordfish in the Balearic Islands and small tunas. It was also noted the importance of this variability on CPUE estimation but that it needed to be used in the models appropriately.

The Subcommittee recognized the role of environmental variability in the estimation of MSY, target species distribution, prey species distribution, productivity, and the economics of fishing. The role of the Working Group on Stock Assessment Methods (WGSAM) in correctly integrating environmental variability in assessment related methods was recognized as well as the inability to interact with this working group because of the concurrent nature of the two meetings. It was recommended that in the future these meetings should be separated in time. Lastly, it was noted that there were many examples of the use of environmental data to inform assessments within the SCRS working groups and that these should be identified and given priority for reporting within the ecosystem report card.

SCRS/2021/079 provided a summary of the tuna-climate work completed in 2018 as part of the FAO-implemented Common Oceans I Program, which focused on modeling the impacts of climate change on the productivity and distribution of tropical tuna fisheries in the Pacific Ocean. The presentation then included a description of the new work that is being proposed under the second phase of the Common Oceans Program. The new initiative sought to improve the current understanding of climate change impacts on global tuna resources by RFMOs and member states, and to increase the global, regional, and national commitment to development and implement climate adaptive Ecosystems-Based Fisheries Management / Ecosystem Approaches to Fisheries Management (EBFM/EAFM) plans for tuna fisheries.

The presenter requested feedback on how best to proceed with projecting climate change impacts on tuna fisheries in ICCAT using methods like those developed in the Pacific and advice on how best to integrate the proposed activities into the normal scientific committee peer review processes at ICCAT with the eventual aim of advising the Commission on potential actions needed to mitigate against adverse climate impacts.

It was noted that the second phase of the FAO/GEF-funded, Common Oceans ABNJ Tuna Project is aiming to come online in 2022. There are several anticipated activities under the EBFM/EAFM theme of potential interest to the Subcommittee in addition to the work summarized in SCRS/2021/079, which build upon recommendations made at the 2019 ABNJ Tuna I EAFM Symposium (http://www.fao.org/in-action/commonoceans/news/detail-events/en/c/1208387/), including capacity building on EBFM, development of approaches to quantify and validate indicators of different ecosystem dimensions in support of tuna fishery management decisions, and a case study on the incorporation of EBFM/EAFM in a developing economy tuna fishery management system.

The Subcommittee welcomed the information and recommended that the Common Oceans Tuna Project maintain connection with the Subcommittee and Secretariat and seek collaborations with the anticipated projects, where appropriate. It was noted that the proposed models need to be considerate of a wide range of ocean variables in order to adequately account for climate change impacts on tuna and tuna-like species, including thermocline depth, micro-nekton and sea surface temperatures effects on the distribution and biology of larval, juvenile and adult stages.

The Subcommittee also recognized the need for good data to validate the models, particularly catch, fishing effort, length frequencies of target species, and release-recapture tagging data. It was also emphasized that there are strong synergies between the proposed Common Oceans project and several current and/or planned initiatives including 1) an active project evaluating the impacts of climate change on a range of species (including tuna) in the Atlantic and Mediterranean, as well as assessing the potential socio-economic impacts on the fishing industry and 2) an SCRS led proposal to generate ecosystem models for validating that proposed indicators are responsive to what they are intended to monitor.

2.1 *Review adequacy of existing indicators against proposed new ones, and progress on the development of methods for screening and validation*

SCRS/P/2021/019 provided an overview of potential methods for screening and validation of ecosystem indicators based on the Sargasso Sea case study. The Subcommittee noted the dependencies on the data from a variety of bodies and institutions and questioned the mechanisms that would facilitate the exchange of data. It was agreed that this was a problem for the Subcommittee. It was explained that the Sargasso Sea case study was being funded under the Fonds français pour l'environnement mondial and the GEF Common Oceans Program. These projects bring together a range of partners from disciplines including Fisheries Management, Biodiversity, Oceanography, Environmental Policy, and Computer Science. A range of methods are being developed by others (see the International Conference on Marine Data and Information Systems https://imdis2021.seadatanet.org/programme), and the Sargasso Sea case study hopes to take advantage of these. It was explained that Imperial College would conduct an elicitation exercise with scientists and stakeholders in the region, and an intention was to validate indicators for the report card, e.g., by comparing EFFDIS to AIS data.

2.2 *Review development of case studies and ecoregions*

It was reported that the Sargasso Sea case study and the Tropical Atlantic case study continue to be supported.

3. Review how to improve the reporting of the impact of ICCAT fisheries on the ecosystem

SCRS/2021/069 presents the terms of reference for intersessional work associated with the ecosystem report card. These terms of reference were subsequently modified by the Subcommittee and the updated version can be found in **Appendix 5**. It was noted that the TOR should consider the work described in SCRS/2021/71, which prioritizes species to be included in the ecosystem report card and which may further inform on the scope of the EcoCard reporting through constraints related to ICCAT's management responsibilities to tunas and tuna-like species. Further it was requested to update the TOR for considering the role of the ongoing work on case studies in report card development.

4. **Discuss content of presentation to Panel 4 on "Possible use of Ecosystem Report Card by Panel 4"**

The Subcommittee reviewed proposed content for a presentation to Panel 4 on the ecosystem report card. It indicated that in addition to a presentation, a short paper would be required to be submitted by the Subcommittee Convenors before June 4 to permit an exchange of questions and answers prior to the meeting. It was suggested that the presentation be short and simple and should describe the objective for the report card as well as how it can be used for management decisions.

5. **Discuss plans for collaborative workshop to discuss the relevance and the methodology used to delineate candidate ecoregions within the ICCAT Convention area in order to foster discussion on operationalizing the EBFM**

SCRS/2021/070 provided a concept note and TOR for an ICCAT Ecoregion Workshop. The objective of the workshop is to identify regions within the ICCAT Convention area that will support the implementation of an ecosystem-based fisheries management framework. The Subcommittee provided comment on the TOR and the updated version can be found in **Appendix 6**.

Currently, the workshop is supported by funding until December 31, 2021. The Subcommittee recognized the workshop tasks and objectives would be difficult to achieve over 4 days in a virtual meeting format setting and recommended that the workshop be conducted face-to-face if possible, with optional virtual participation. Thus, it was acknowledged that the Subcommittee would have to reapply for funds given that existing funds could not be carried forward. It was noted that multiple datasets would need to be examined for the workshop and it was recommended to also organize a data preparatory session in advance of the workshop date. This would serve to identify relevant data layers for analysis and identify data gaps in advance.

The Subcommittee recognized that the IOTC had undertaken a similar workshop and this resulted in the following perspectives: a) care must be taken to ensure that this is more than an interesting science exercise and therefore has relevance to a RMFO's mandate of managing individual species, b) oceanographic features play a primary role in delineating the regions and given that the oceanography is dynamic care must be taken to consider the advantages and disadvantages of allowing the ecoregion boundaries to be static or dynamic c) the workshop should be designed so that participants are not simply making decisions based on a pre-analysis and be designed to encourage discussions and exploration of alternative analyses. Further it was noted that it might be more difficult to create ecoregions within the Atlantic as opposed to the Indian Ocean due in part to its size and that it may be difficult for the data that ICCAT collects for statistical purposes to conform to the ecoregion boundaries.

The Subcommittee indicated that it would be important to base the regions on the core areas of tuna and tuna-like species and the communities that emerge from the areas of overlap. This approach is very similar to that of defining global and regional chorotypes (Fattorini 2015, https://doi.org/10.1111/jbi.12589).

6. **Review how the Commission can develop an informal meeting format for the SCRS to work with managers to progress on SCRS-advisory processes that need more involved input from managers**

The Subcommittee, which is currently developing the ecosystem report card, needs more working-level feedback from managers in order to provide the Commission with valuable strategic advice and continue developing advice on EBFM implementation options for ICCAT (i.e., in the development and implementation of assessments and management frameworks that incorporate species interactions, fleets interactions, habitats, environmental drivers and climate change into fisheries management.

SCRS/P/2021/071 presents a method demonstrating how risk assessment approaches can be used to inform the management priorities of ICCAT in the context of the developing EBFM framework and ecosystem reporting. The presenter emphasized that the main purpose of the presentation was to show the process involved in developing this risk-based approach to the Subcommittee. It was emphasized that the results were preliminary and inputs and feedback from the group on the approach and methods used were welcomed.

The Subcommittee discussed the rank criteria used in the analysis and suggested to add a separate ranking for the species with no information, so that the lack of information is treated differently, although it was pointed out that by treating the information at family level, the majority of species carried at least some information. The Subcommittee noticed that the catch reported to ICCAT was sometimes more than that reported by FAO so that the ratio of the two became greater than 1. The presenter explained that this ratio was only utilized to examine the significance of catch reported to ICCAT, therefore, that all figures greater than 0.9 were treated as the same rank.

The Subcommittee noted that risk assessment approaches are very useful tools that are used to identify issues, evaluate risks which are then used to identify priorities. It was noted that step 1 of the approach, which aimed to identify fish assemblages potentially relevant to ICCAT EBFM, had some similarity with the ecological risk assessments (productivity-susceptibility assessments (PSA) that rank species vulnerability to fishing gears). However, the presenter clarified that step 1 differed from the PSA, only utilizing the vertical and horizontal distribution characteristics of the species to identify the extent of overlap with tunas and tuna fisheries. The Subcommittee recognized the novelty in step 2 and 3 of the approach, which aimed to identify species of importance for management and management gaps for possible improvement. The presenter highlighted that the current results showed very similar results to the Ecological Risk Assessments (ERAs) conducted in ICCAT, even using a totally different set of information.

The Subcommittee noted that a risk assessment must identify issues and then calculate their risk values based on potential consequences/impacts and their corresponding likelihoods, typically using a Consequence and Likelihood (C-L) matrix, which is informed by different lines of evidence. It was asked why the current methods were not calculating these C-L matrices and why only the likelihoods are shown in the table. The presenter explained that the proposed approach is for a preparatory phase moving toward the EBFM and that once the situation would become more mature, it would be preferable to move toward the C-L matrix developed in Fletcher's methodology for risk assessments.

The Subcommittee noted that the risk-assessment example presented only included ecological bycatch risk and asked if it was intended to include other ecological risks as well as social and governance risks, as often risk assessments involving managers feed-back do not only cover ecological risks. The presenter explained that the current tool aims to identify the priority species for management that can be controlled through managing tuna fisheries. At this moment, the presenter did not intend to expand to cover social and governance aspects.

The Subcommittee commented that there are other international regulations creating lists of endangered species (i.e., CITES, Bonn Convention) and suggested to use these instead of the IUCN Red List status if available, since the published IUCN Red List status is partly outdated as the Red List evaluations occur every 5-10 years. The presenter clarified that the information on CITES, Bonn Convention, and some assessment results by RFMOs were already incorporated, and ready to be used. The example used the IUCN Red List only because it covered a greater number of species in a consistent way, and provided assessments covering the range from less concerned to seriously concerned.

The Subcommittee suggested to revise the ICCAT bycatch species list as in the past some erroneous species have been detected in the list (e.g., some benthic species in the list are believed to not overlap with ICCAT fisheries). The presenter pointed out that the exercise utilized a number of references of bycatch and was not strictly relying on the list of ICCAT bycatch species, and noting the similar problem during the process, welcomed the Subcommittee to revise the ICCAT bycatch species list.

The Subcommittee commented that risk assessments are increasingly used to communicate to managers strategic advice and priorities and noted the proposal of linking the risk assessment work with the EcoCard work would be very beneficial. It was further noted that the risk assessment being conducted is focusing on identifying priority species overlapping with tuna fisheries in the ICCAT Convention area and the manageable part of the system (fisheries). It was noted the EcoCard has a different role of monitoring the direct and indirect impacts of fishing and other external stressors like climate and can complement the risk assessment by identifying issues for later analysis of their risks, and also the need to continue to improve knowledge on how ecosystems dynamics can also impact fisheries. It was also noted the interest to explore the utility of risk assessments for case study areas such as ecoregions.

The Subcommittee recommended to continue development of this tool by 1) incorporating information on the distribution of other species with potential interactions with tunas and tuna fisheries, in particular crustaceans, cephalopods, ctenophores, seabirds, marine turtles, and marine mammals, 2) improving a rank criteria on stock status of species, taking into account, but not limited to, the CITES, Bonn Convention, IUCN Red Lists, and assessment results, and 3) repeat the analysis with updated inputs, and identify the gaps and priority areas in the current management, and to report the output at the 2022 Meeting of the Subcommittee on Ecosystems and Bycatch.

7. Review and adopt definition of "marine mammal interactions" to facilitate indicator development

There was not enough time during the current meeting for duly discussing and providing a clear definition of "marine mammal interactions". The Subcommittee will review a definition at the 2022 meeting.

7.1 Review the availability of information on these interactions between marine mammals and ICCAT fisheries

SCRS/2021/074 provided a preliminary overview of the depredation of tunas and tuna-like species by marine mammals, their economic impacts, and the human-wildlife interaction. The Subcommittee noted the data limitations associated with this issue and the difficulty in quantifying depredation given the reliance on observer reporting. It was indicated that the range of species to consider is greater than what was described and that the additional papers could be made available to expand the analysis. It was questioned whether the occurrence of depredation scales with vessel density and if this was a consideration in the analysis. It was recognized that the sound of fishing vessels was an attractant affecting depredation rates. Continued development of this work was encouraged, and it was requested to provide annual estimates of depredation for inclusion as an indicator in the Marine mammal component of the ecosystem report card.

8. Sea turtles

SCRS/2021/76 updated the outputs from the collaborative work to assess the impact of pelagic longline and purse seine fleets on sea turtles in the Atlantic and Indian Oceans (Anon. 2020). The most immediate objective of this process includes to determine the spatial-temporal trends of the incidental catch of sea turtles in pelagic longline and purse seine fisheries in these oceans, and date permitting, include a study case for the Mediterranean Sea. Data on bycatch of sea turtles and fishing effort at the set level from the pelagic longline fleets of Brazil, Canada, Spain, Portugal, South Africa and Uruguay, and purse seine fleets of Spain and France were integrated (1998-2018). Several environmental variables have been extracted for each fishing set. Analyses are expected to be conducted this year.

The advances of this collaborative process were considered positive by the Subcommittee. It was clarified that the maps showing the bycatch for the main sea turtle species included the nominal CPUE of sea turtles at 1x1 degree cells, (turtles/1000 hooks in longline and turtles/number of sets in purse seine), over the total study period (1998-2018). However, future analyses will model the variation of the catch rate over time, considering covariates. Based on the current data, longline data could be analyzed by groups of years, while purse seine data could be at the year level. It was asked about data gaps that could be addressed before analyses. Some researchers have expressed the intention to collaborate, and this could fill several gaps in the North and Central Atlantic and Indian Oceans. For purse seine, other types of data on sea turtles were discussed. These included turtles observed aggregating on FADs or turtles that were entangled on these devices. The inclusion of the information could provide a more comprehensive analysis of the interactions of sea turtles with purse seine fisheries. The usefulness of turtle bycatch for gathering information on their migration in the Mediterranean was commented. It was suggested that this could be considered in the collaborative work. There were consults on the environmental variables extracted for both databases, longline and purse seine, and suggestions were made to collaborate in obtaining additional variables that could be useful. The inclusion of information on tagged turtles as well as on the proposed management units was discussed and considered important.

SCRS/2021/067 presented information on the stranding of sea turtles in Algeria recorded since 2019. Loggerhead turtle (*Caretta caretta*) was the most represented species. The discovery of a loggerhead turtle nest in Collo (Skikda) confirms the nesting of turtles on the Algerian coast and offers new perspectives for the study of sea turtles in Algeria. The wilayas (provinces) which have the most coast inaccessible by land (cliffs) and the least urbanized, are those with the fewest reports of strandings. The number of strandings in three areas of the Algerian coast was relative to the length of the beaches in each area. This is related to the greater and easier observation efforts at the beaches compared to the cliffs and rocky shores. The analysis of the distribution of fishing vessels by wilaya shows that the Central and Eastern areas which have more cases of strandings also have the largest fishing fleet, particularly vessels engaged in small-scale fishing which mainly use driftnets and set nets. These fishing gears are the leading cause of marine turtle mortality in Algeria. Other factors, such as the morphology and orientation of the coast, the influence of the Algerian current and the surveillance effort, considerably influence the number of strandings per province and per area. Surveys need to be extended to better understand this phenomenon along the Algerian coast.

The Subcommittee understood that it was important information and that it could contribute to the ongoing collaborative work.

9. Effect of the mitigation measures: intra and inter taxa

SCRS/2021/068 showed that at-haul-back mortality rate, CPUE, and MPUE did not improve with different size of C-hook, but rather tended to be higher relative to tuna hooks. The use of the C-hooks did not reduce the hook swallowing which can lead to post-release mortality and the mortality rate may be greatly influenced by environmental factors such as soak time and water temperature.

The Subcommittee requested some clarification about specific hook sizes and the degree of offset presented in the analysis, noting that combining differently sized circles and different offsets could result in confounding the results. Further, it was noted that the differences in CPUE and MPUE appear to be non-significant for most of the species; one positive point was that despite the lack of clear differences between fish species, there were large effects on sea turtle survival. There was no agreement with the conclusion that circle hooks exacerbate mortality.

With respect to hook sizes, the authors responded that it was difficult to clarify different hook size categories and align different hook-size scales to make them comparable for the analysis. Regarding the degree of offset, it was noted that beyond minor variance in the offset caused during manufacturing, the degree of offset was the same for all hooks (just under 10º). The tuna hooks were generally smaller than circle hooks. The authors further noted that they made no effort to determine the degree of significance because it was a Bayesian analysis. Clarification on how to interpret the Bayesian credibility intervals was requested. In response, the authors noted that using the Bayesian paradigm, the term significance did not really apply but that in any case, the important variable to consider was the fishing mortality for specific species.

The Subcommittee requested clarification regarding bait size noting that bait size and types have been shown to affect shark bycatch. In response, it was noted that bait sizes were controlled in the experiment and typically ranged between 20-30 cm in dorsal length.

The Subcommittee noted its appreciation that more experimental work on this subject had been done. They requested: clarification about how circle hooks and tuna hooks did not differ in hooking location, the differences between J hooks and tuna hooks, as well as how the mortality of bite-offs was estimated. In response, the authors noted: that there are other major factors affecting hooking location like bait type and environment (notably light levels); with respect to the difference in hook types, the authors were not aware of any studies that rigorously compared these.

With respect to the conclusion that mortality rate of bite-offs without using wire leaders may be overestimated, the group asked for some clarification on whether sharks that escape by biting off after swallowing the hook eventually experienced a high-rate of mortality after their escape, and thus is not overestimated. In response, the authors noted that the effect of circle hooks on post-release mortality was not directly examined in this study, so it was unclear, but that it might be possible to evaluate it by referring to previous studies that had examined circle hook effect on post-release mortality.

SCRS/2021/066 was a meta-analysis of the effects of hook, bait, and leader type on retention and at-haulback mortality rates of target, desirable and unwanted bycatch species. It showed that circle hooks significantly reduce retention rates of loggerhead and leatherback sea-turtles and billfishes, including swordfish. By contrast, the retention of shortfin mako when circle hooks were used was higher. Changing from tuna hooks to circle hooks did not significantly affect retention rates of any of the species.

The Subcommittee discussed how bait was accounted for in the meta-analysis and, why there were such differences in haul-back mortality due to bait. In response, the authors were uncertain noting that there were many confounding effects like bait type, environmental variables, leader type, and soak time. The Subcommittee further noted that one way to account for such effects in future meta-analyses would be to use covariates.

SCRS/2021/072 updated two meta-analyses (Reinhardt *et al*. 2018, Coelho *et al*. 2020) regarding hook type and species catchability. For Reinhardt *et al.* (2018), a transcription error on coding hook type was identified, which led to an incorrect number of hooks by hook type being reported and thereby an incorrect calculation of catch rates. When this error was corrected, the differences in catch rates between hook types were no longer significant. In the case of updates to Coelho *et al.* (2020) and Reinhardt *et al.* (2018), the authors of SCRS/2021/072 had access to the original data for one of the component studies, Foster *et al.* (2012), and noted that there was a major disparity in the effort by bait type associated with each hook type that was not accounted for, leading to a confounding effect (the use of mackerel bait was demonstrated to increase SMA catch rates in the same study by 162%-329%). This update divided the data into two studies by bait type, eliminating the confounding effect. Coelho *et al.* (2020), presented in SCRS/2021/066, reported the relative risk (RR) of retention rates with circle hooks vs. J-hooks as 1.23 (95%, CI: 1.02 to 1.50). After updating Foster *et al*. (2012) into two studies, the RR dropped to 1.16 (95% CI: 0.98 to 1.38), a result also indicating that the differences in catch rates between hook types was no longer significant for the shortfin mako.

The Subcommittee noted that Foster *et al*. (2012) included the use of tuna hooks. Since these hooks behave differently from J-hooks, it was discussed the possibility that the author removes them from the analysis. It was also suggested that in meta-analyses, studies with small sample sizes should be removed.

Following these comments of the Subcommittee a revised version of the document was made available (v2). Due to time constraints the Subcommittee did not discuss the revised results.

9.1 *Factors effecting bycatch and interactions*

SCRS/P/2021/018 provided an update of a collaborative activity conducted within the ICCAT Shark Research and Data Collection Program on shortfin mako shark movements, habitat use and diving behavior in the Atlantic Ocean. The study included deploying 53 electronic pop-up tags (miniPAT and sPAT) in shortfin mako specimens throughout the Atlantic. Results showed that tagged shortfin makos moved towards or remained over shelf and slope waters, which challenges the typical view of shortfin mako being mostly an oceanic species and hints at the importance of continental margin areas for the species.

The Subcommittee discussed the benefits of collaborative work among the various research teams working in the Atlantic. It was also suggested that future tagging on shortfin mako should be carried out in areas were tagging information is missing, namely the Southeast Atlantic. The Subcommittee was informed that data from 19 tags from South Africa were available and could be used to update the work presented. In response, it was explained that the work presented was recently submitted to a peer reviewed journal but that the information of those 19 tags would be very useful for future work and could be included in the post-release mortality study on shortfin mako that is under preparation.

The Subcommittee highlighted that besides tagging data, genetic information is essential to help to better delineate management unit areas for shortfin mako. It was also suggested to check to what extent the movements showed by the study overlap the geographical areas of highest catches of shortfin mako (or highest CPUEs observed).

Finally, a question was made on whether the data presented would be accessible for other scientists as it contains relevant information for other ongoing studies. The Secretariat informed the Subcommittee that the framework for accessing the data is the ICCAT data policy, which was revised by the SCRS in 2020, but which the Commission has not yet approved.

SCRS/2021/056 provided 42,961 biological observations of shortfin mako shark on Spanish longline fishery targeting swordfish across the oceans for the 1993-2019 period. It analyzed reproductive data of females: size distribution, sex-ratio, litter-size, embryos, nominal CPUE, the range of SST, and areas of parturition. Females had similar reproductive characteristics in all oceans, and presented high fecundity of litter, compared to other closely related lamnidae species. The data confirmed low availability of pregnant females in all areas observed and low occurrence of gestation and parturition suggesting either that these phases are more likely to occur in other areas, or that these pregnant females are not easily accessible to oceanic fishing gear.

The Subcommittee highlighted the importance of the study and suggested the authors to present it at the Sharks Species Group meeting, as it contains valuable information for the shortfin mako stock assessment.

A clarification was requested on one of the conclusions of the study on the possible high biomass of the mature female component that can have a high contribution to annual recruitment. It was clarified that it referred to a fraction of the population that is not usually caught by the longline gear, and therefore not included on longline CPUE input data in the assessment models.

10. Review feedback received from Species Groups regarding their needs and contributions towards incorporating/developing ecosystem including bycatch considerations and discuss additional mechanisms to effectively coordinate, integrate and communicate ecosystem-relevant research across the ICCAT Species Groups and within the SCRS

This item is discussed jointly with item 11 below.

11. Review mechanisms for SC-ECO to work across all Species Groups of the SCRS on the issues related with multi-species (e.g., environmental impacts, multi-species trade-offs, integration of ecological considerations into management procedures) similar to the Working Group on Stock Assessment Methods (WGSAM) or the Subcommittee on Statistics

The Subcommittee discussed both the importance of establishing dialogue with the Species Groups and WGSAM and the mechanisms by which this could be accomplished. It was noted that attempts had been made to establish dialogue with the officers of the SCRS following the meeting of the Subcommittee on Statistics, which they all attend, and by attending the individual Species Group meetings. Neither approach was successful so it was suggested that a) the SCRS Chair and Vice-Chair provide regular opportunities for SCRS officers or their proxies to meet and address issues of mutual interest related to the functioning of the SCRS for example: environmental impacts, climate change, multi-species trade-offs, integration of ecological considerations into management procedures pursue and b) the SCRS allocate time during the very last day of the Species Group week for a review of EBFM related papers (Science Fridays). Given the noted overlap of the WGSAM and Subcommittee on Ecosystems and Bycatch meetings and its effect on collaborative work, it was recommended that SC-ECO and WGSAM online meetings not be held concurrently and when in-person meetings are possible, that if there are planned overlaps, they should only cover the amount of time necessary to discuss topics of mutual interest. The Secretariat indicated that there has been an increase in their workload due to the increase in meetings and that decisions must be made to either reduce the total number or find ways to share time slots.

12. Recommendations

12.1 Recommendations with financial implications

Regarding the Ecosystems component:

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

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

Regarding the Bycatch component:

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

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

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

12.2 General recommendations

- The Subcommittee recommends that opportunities be made available on a regular basis so that SCRS officers or their proxies can address issues of mutual interest related to the functioning of the SCRS for example: environmental impacts, climate change, multi-species trade-offs, integration of ecological considerations into management procedures.

- The Subcommittee recommends that the Secretariat summarize those fleets for which CPCs have reported catches in Task 1 without the corresponding Task 2 catch and effort. The Secretariat should also estimate the percentage of those catches to the total Task 1 catches. The requested information should be presented at the next meeting of the Subcommittee on Statistics.

- The Subcommittee recommends that the Subcommittee on Statistics review the gaps in the catch-and-effort data in the ICCAT-DB (information to be provided by the Secretariat). Based on this review, the Subcommittee on Statistics should decide if it recommends uploading the current version of the EFFDIS to the ICCAT website or if the data gaps are significant enough to preclude the use of EFFDIS.

- The Subcommittee recommends that CPCs abide by the reporting obligation to report size samples collected by scientific observers using the ST04 form.

- The Subcommittee recommended set depth on the ST09 form be captured on the form as follows in **Table 2**.

Regarding the Ecosystems component:

- The Subcommittee recommends that that a definition of "marine mammal interactions" be discussed and adopted at the 2022 meeting of the Subcommittee on Ecosystems and Bycatch. Based on this definition, CPCs should explore the availability of information on these interactions between marine mammals and ICCAT fisheries.

– The Subcommittee identified the synergies possible between it and the WGSAM and noted that for the past 2 years these meetings have been held concurrently. The Subcommittee recommends that that SC-ECO and WGSAM online meetings not be held concurrently in order to facilitate these synergies. When in-person meetings are possible, the Subcommittee recommends that if there are planned overlaps, then any such overlap only cover the amount of time necessary to discuss topics of mutual interest.

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

– The Subcommittee recommended that the Common Oceans Tuna Project maintain connection with the Subcommittee and Secretariat and seek collaborations with the anticipated projects, where appropriate.

Regarding Bycatch:

– The Subcommittee recommends that the Secretariat, in collaboration with the SCRS and national scientists, review and update the list of by-catch species in the ICCAT database.

– The Subcommittee noted the relevant advances made by the collaborative research regarding interactions between ICCAT fisheries and marine turtles. To increase the value of this work to the SCRS and the Commission, the Subcommittee recommends more national scientists that hold relevant data on these interactions within ICCAT fisheries to join this collaborative research and make their data available.

– Meta-data analysis (Santos *et al.*, 2020) reviewed by the Subcommittee support the fact that large circle hooks are an effective mitigation measure to reduce sea turtle bycatch. Therefore, to increase the effectiveness of conservation measures for sea turtles, the Subcommittee recommends the use of circle hooks for shallow longline sets. However, experimental and metanalysis reviewed by the Subcommittee recognizes that circle hooks have varying impacts on other target and bycatch species as well as on fisheries. Therefore, the Subcommittee also recommends continued analysis of the efficacy of circle hooks and the trade-offs across species in using them.

13.   Subcommittee on Ecosystems and ByCatch Work Plan

Pertaining to Ecosystems Report Card Development:

Consistent with the ongoing exercise of developing an Ecosystem report card the Subcommittee drafted the following work plan. **Table 1** defines the specific tasks to be completed by the Ecosystem report card working groups prior to the 2022 Subcommittee on Ecosystems and Bycatch meeting.

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

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

Pertaining to the work of the sub-group:

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

Also, given there are many examples of the use of environmental data both within and outside the SCRS, it was recommended that these be identified and considered for use in the Ecosystem report card and to facilitate collaborative work with the Species Groups and external institutions as outlined in **Table 3**.

Pertaining to the Workshop on Ecoregion Development:

The Subcommittee developed TOR for a workshop to be held in 2022 with the objective of exploring how to define ecoregions within the ICCAT Convention area. The TOR are provided in **Appendix 6** of this report. In preparation for that workshop, the following timelines were established as laid out in **Table 4**.

Pertaining to other ecosystem items:

The Subcommittee recommended that the ecosystem convenor respond to the Panel 4 request to provide an overview of the Ecosystem report card. Additionally, it was recommended that the Subcommittee co-convenors, in cooperation with the SCRS Chair and Vice-Chair, draft revisions to the EBFM components of the SCRS strategic work plan that will be discussed and adopted in 2022. **Table 5** defines the tasking and timeline for providing the document for Panel 4 and for contributing to the SCRS Strategic Plan.

Pertaining to by-catch:

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

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

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

Advance the secondary objectives of the collaborative work on sea turtles.

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

Investigate available information on hotspots and/or areas with high BPUE to aid in the management of ICCAT fisheries with respect to bycatch species.

14. Other matters

14.1 Update on status of EFFDIS and form ST09

The Secretariat provided a review of the revision of EFFDIS, noting that in 2020 they had revised the methodology that had previously estimated lower effort values than what was reported effort. While the new estimation method corrected values for those CPCs that reported effort, the remaining issue is that there are some CPCs that report no effort. The Subcommittee recommended that the Secretariat review and report which CPCs are reporting total catch but not effort, and hence the fraction of reported effort that is missing. The Subcommittee requested that the Secretariat compile an estimate of the missing effort data to be presented at the September 2021 Meeting of the Subcommittee on Statistics.

14.1.1 Review of the Spatial Resolution for ST09 Reporting

It was recommended that Subcommittee review the ST09 form to determine if reporting at a spatial resolution of 10x10 degrees would be acceptable for use by those CPCs constrained by domestic confidentiality regulations and if a requirement to report in smaller areas would result in a substantial proportion of data not being reported. The Subcommittee noted that data reported with spatial resolution of 10x10 degrees is less useful than data at 1x1 and 5x5 to support scientific analysis and that introducing an additional reporting layer with a spatial resolution of 10x10 degrees could undermine the provision of information at a finer scale by other CPCs.

It should be noted that, due to domestic laws on confidentiality, some CPCs will not be able to report much of their data at resolutions of 5X5 degrees or finer resolution. The Subcommittee recommends CPCs to report observer data at the finest spatial resolution possible (1x1 preferable over 5x5) as per ICCAT requirements and the ST09 form. However, for those CPCs with data confidentiality issues that cannot submit observer data at 1x1 and/or 5x5 degrees grids, the Subcommittee encourages those CPCs to report observer data at the finest possible aggregation level to the SCRS.

Review of depth fields for ST09 to be added

Upon review the Subcommittee requested that in order to reflect depths more accurately, the codes could be modified slightly. The Subcommittee discussed the matter at great length and recommended that both set depth and hooks between floats be captured on the ST09 form as described in the Recommendation Section.

14.1.2 Review of ST09 LOA vessel size class reporting requirements

It was recommended that the Subcommittee review the ST09 form to determine if the reporting of the vessel size class (LOA) field could be optional instead of mandatory and if a requirement to report this field would result in a substantial proportion of data not being reported by those CPCs with domestic confidentiality regulations. The Subcommittee did not reach an agreement on this matter.

14.1.3 Guidance on the use of the ST09C subform, the species for which the reporting of this information is desirable, and if the use of the ST09C should be mandatory or remain optional

The Subcommittee discussed the reasons for not including all information from Domestic Observer Programs noting that some information, such as lengths are already reported on other forms. They also noted however that minor species, that are not included on ST04 form, could go unreported to ICCAT. One potential source of confusion that was discussed what that many CPCs may consider the ST04 to only include the main species.

The Subcommittee discussed the possibility that an alternative procedure might be developed to request specific observer data from CPCs. After discussing the relative pros and cons of reporting this information on ST09, the Subcommittee decided to keep ST09C subforum optional and to draft a recommendation reminding CPCs of their obligation to report length information on ST04.

14.2 FADS and fins

SCRS/2021/073 investigated different designs of organic, biodegradable FAD (bio-FAD) efficient for fishing. Results of those experiences show that i) the lifetime of bio-FADs that maintain the traditional FAD design with organic materials is shorter than that required by fishers ii) there are no clear alternatives to replace plastic, and that FAD size has increased in all three oceans. To address these problems, the Jelly FAD was designed to be neutrally buoyant with no netting panels, 6-12 kg of flotation and have minimum structural stress. Experimental FADs were deployed in the Pacific, Atlantic, and Indian Oceans. The paper recommends that FADs be made without netting, FADs be designed to endure physical stresses, and that FAD sizes be reduced to minimum.

The Subcommittee questioned if the experience of FAD projects conducted in the Mediterranean were considered in the development of Jelly-FADs and if consideration was given to the problem of the nylon rope that ends up on the bottom. It was indicated that the work in the Mediterranean was considered and that the major concern was the hanging appendage on the FAD.

SCRS/2021/080 showed that identical 3D printed fin replicas of CITES Appendix II listed sharks for 10 species and two families have been developed through a collaboration between TRAFFIC South Africa and the Department of Forestry, Fisheries and the Environment. The development of the 3D printed fins accompanied by QR codes, which link to dedicated webpages provide additional guidance on identification, will facilitate the traceability and enforcement of dried shark fins and allow for rapid and confident decision-making by relevant law enforcement officials.

The Subcommittee questioned why the approach worked better with wet fins and it was clarified that drying causes warping of the fins which is a problem for the detection algorithm. It was also noted that there was regional variation in the coloration of the fins.

15. Adoption of the report and closure

The report was adopted, and the meeting adjourned.

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Table 1. Tasks to be completed by the Ecosystem report card working groups prior to the 2022 Meeting Subcommittee on Ecosystems and Bycatch.

Date	Component	Task	Who
May 2021 to April 2022		Update prototype report card components with new indicators	
	Retained Species: Assessed	Update Bratio and/or Fratio values from recent assessments and deal with F0.1 issue.	Committee participants
	Retained Species: Not assessed	Perform PSA for select retained unassessed species	Committee participants
	Non Retained Sharks	Increase the scope of the data used in the analysis. Include other gear types.	Committee participants
	Turtles	Perform risk assessment for loggerhead and leatherback turtles and indicator development	Committee participants
	Seabirds	Create indicator based on the total interactions, total mortality, or alternatives	Committee participants
	Mammals	Discuss collaborations with IWC and ICES.	Committee participants
	Food web and trophic relationships	Continue work developing indicators to monitor the biomass structure, size structure and trophodynamics of the ecological communities in response to fishing pressure and environment (detail workplan in Andonegi *et al.* 2020).	Committee participants
	Habitat	Create indicators to monitor climate-induced and fishing-induced habitat changes in ICCAT species.	Committee participants
	Socio economic	Develop a process to extract the socio-economic data.	Committee participants By-catch Coordinator
	Fishing Pressure	Develop an indicator based on fishing effort or capacity. Develop indicator based on Marine debris.	Committee participants Secretariat
	Environmental Pressure	Develop indicators that are generic.	Committee participants
	Case Studies	Extend DIPSIR approach to more components in the NW Atlantic Ocean (i.e., Habitat, Environmental Pressures, Fishing Pressure). Tropical Ecoregion case study (test EAFM tools including Ecosystem Overview Report, Ecosystem Risk assessment, Ecosystem models).	Committee participants

Table 2. Proposed update to form ST09. Depth Range and Hooks between Floats are now required to be reported separately for each set using one of the 3 categories indicated for each metric. Optionally, the estimated depth of fishing may also be reported when known.

FOpDepthCode	Hooks between Floats (HBF)	Estimated depth range value in 10m increments (optional)
Shallow	1-5 h/f	
Medium	6-12 h/f	
Deep	12+ h/f	

Table 3. Summary of meetings and tasks for the subgroup working to improve the reporting of the impact of ICCAT fisheries on the ecosystem and clarifying the definitions of EAFM and EBFM:

Date	Component	Task	Who
July 2021, 3 days	Sub-group	Set the work and divide tasks	Convenor: Participants:
October 2021, 2 days	Sub-group	Present work and discuss progress	

Table 4. Timelines for the workshop on ecoregion development.

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

Table 5. Timelines and tasking for preparation of Panel 4 report.

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

<div align="right">**Appendix 1**</div>

Agenda

1. Opening, adoption of the Agenda and meeting arrangements

Pertaining only to Ecosystems

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

    2.1 Review adequacy of existing indicators against proposed new ones, and progress on the development of methods for screening and validation
    2.2 Review development of case studies and ecoregions

3. Review how to improve the reporting of the impact of ICCAT fisheries on the ecosystem

4. Discuss content of presentation to Panel 4 on "Possible use of Ecosystem Report Card by Panel 4"

5. Discuss plans for collaborative workshop to discuss the relevance and the methodology used to delineate candidate ecoregions within the ICCAT convention area to foster discussion on operationalizing the EBFM

6. Review how the Commission can develop an informal meeting format for the SCRS to work with managers to progress on SCRS-advisory processes that need more involved input from managers

7. Review and adopt definition of "marine mammal interactions" to facilitate indicator development

    7.1 Review the availability of information on these interactions between marine mammals and ICCAT fisheries

8. Sea Turtles

    8.1 Review progress on collaborative work of sea turtle and presentation the next steps
    8.2 Others

9. Effect of the mitigation measures: intra and inter taxa

    9.1 Factors effecting bycatch and interactions

10. Review feedback received from Species Groups regarding their needs and contributions towards incorporating/developing ecosystem including bycatch considerations and discuss additional mechanisms to effectively coordinate, integrate and communicate ecosystem-relevant research across the ICCAT Species Groups and within the SCRS

11. Review mechanisms for SC-ECO to work across all Species Groups of the SCRS on the issues related with multi-species (e.g., environmental impacts, multi-species trade-offs, integration of ecological considerations into management procedures) similar to the Working Group on Stock Assessment Methods (WGSAM) or the Subcommittee on Statistics

12. Recommendations

    12.1 General recommendations
    12.2 Recommendations with financial implications

13. Work plan for 2022

14. Other matters

14.1 Update on status of EFFDIS and formST09 [~ 15 to 30 min]

14.1.1 The Subcommittee recommends that SC-ECO review the ST09form to determine if reporting at spatial resolution of 10x10 degrees would be acceptable for use by those CPCs constrained by domestic confidentiality regulations if a requirement to report in smaller areas would result in a substantial proportion of data not being reported

14.1.2 The Subcommittee also recommends that SC-ECO review theST09form to determine if the reporting of the vessel size class (LOA) field could be optional instead of mandatory if a requirement to report this field would result in a substantial proportion of data not being reported by those CPCs with domestic confidentiality regulations

14.1.3 The Subcommittee recommends that the SC-ECO provides guidance on the use of the ST09C sub form, the species for which the reporting of this information is desirable, and if the use of the ST09C should be mandatory or remain optional

14.2 FADs and fins

15. Adoption of the report and closure

<div align="right">**Appendix 2**</div>

<div align="center">**List of participants**</div>

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List of papers and presentations

Reference	Title	Authors
SCRS/2021/005	Report of the Intersessional Meeting of the Subcommittee on Ecosystems and Bycatch	Anonymous
SCRS/2021/056	Biological observations of shortfin mako shark (*Isurus oxyrinchus*) on Spanish surface longline fishery targeting swordfish	B. García-Cortés, A. Ramos-Cartelle, J. Mejuto, A. Carroceda and J. Fernández-Costa
SCRS/2021/066	Effects of fishing gear configurations on target, desirable bycatch, and unwanted bycatch species	Santos C., Rosa D., and Coelho R.
SCRS/2021/067	Sea turtles in Algeria	Benounnas K.,
SCRS/2021/068	Assessment of the effect of hook shape on fishing mortality of multi-taxa fish species using experimental longline operation data	Ochi D., Ueno S., and Okamoto K.
SCRS/2021/069	Terms of Reference for Ecocard intersessional work	Juan-Jorda M, Andonegi E., Alavarez D., Murua H., Coelho R., Kell L. Báez J., and Hanke A.
SCRS/2021/070	Concept note for ICCAT Ecoregion workshop "Identification of regions in the ICCAT Convention area for supporting the implementation of ecosystem-based fisheries management"	Juan-Jordà M, Andonegi E., Alavarez D., Murua H., Coelho R., Kell L. Báez J., and Hanke A.
SCRS/2021/071	Quasi-quantitative risk assessment approach to facilitate prioritization in implementing Ecosystem-Based Approach to Fisheries Management	Tsuji S.
SCRS/2021/072	The effect of terminal gear modifications on the total mortality of the shortfin mako, *Isurus oxyrinchus*	Keller B.A., Reinhardt J.F., Swimmer Y., and Brown C.A.
SCRS/2021/073	The Jelly-FAD: a paradigm shift in bio-FAD design	Moreno G., Salvador J., Murua H., Uranga J., Zudaire I., Grande M., Murua J., and Restrepo V.
SCRS/2021/074	Depredation of tunas and tuna-like species by marine mammals: economic impacts of a human-wildlife interaction	LeGallic B., *et al.*
SCRS/2021/076	Advances in the collaborative work to assess sea turtle bycatch in pelagic longline fleets (Atlantic and Indian Oceans and Mediterranean Sea)	Anonymous
SCRS/2021/079	Modeling the impacts of climate change on global tuna fisheries to support development and implementation of climate adaptive EAFM plans	Obregon, P., Senina, I., Bell, J., Nicols, S., Scutt Phillips, J., Lehodey, P., Kittinge, J.
SCRS/2021/080	3D printing of pelagic shark fins for use as a training and compliance tool	Bürgener, M., Louw, S., da Silva, C.

Number	Title	Authors
SCRS/P/2021/014	The Jelly-FAD: a paradigm shift in bio-FAD design	Moreno G., Salvador J., Murua H., Uranga J., Zudaire I., Grande M., Murua J., Restrepo V.
SCRS/P/2021/018	Movements, habitat use and diving behavior of shortfin mako in the Atlantic Ocean	Santos C.C., Domingo A., Carlson J., Natanson L.J., Travassos P., Macías D., Cortés E., Miller P., Hazin F., Mas F., Ortiz de Urbina J., Lino P.G., Coelho R.
SCRS/P/2021/019	Screening and validation of ecosystem indicators	Kell L., Tsontos V., Luckhurst B., and Roe H.
SCRS/P/2021/021	Advances on the monitoring of environmental variability and integration into the fisheries assessment of tunas for the EBFM in the western Mediterranean	Alvarez-Berastegui D., P. Reglero P., Tugores P., Saber S., Ortiz de Urbina J., Juzza M., Rotllán P., Mourre B., and Tintoré J.
SCRS/P/2021/024	Advances in the collaborative work to assess sea turtle bycatch in pelagic longline fleets (Atlantic and Indian Oceans and Mediterranean Sea)	Anonymous
SCRS/P/2021/026	Ocean sunfish (*Mola mola* Linnaeus, 1758) tagging program in the Mediterranean	Garcia–Barcelona, S., Nyegaard, M., Navarro, J., Macías, D., Miras, A., Conesa, M., Gómez-Vives, M.J., Ortiz de Urbina, J.

SCRS documents and presentations abstracts as provided by the authors

SCRS/2021/056 - Reproductive data of 92 pregnant females were observed in 19,905 females across the Atlantic, Indian, and Pacific oceans. Overall sex-ratio showed a slight but not significant predominance of females in the Atlantic and a slight but significant predominance of males in the Indian and Pacific. Litter-size varied from 3 to 17 (mean 11.6 embryos). The sizes of the females with embryos were ≥ 250cm FL. The SST range in which specimens were distributed was 12.7º-31.5ºC but 16.5º-28.5ºC for females with embryos. The results show that the lower the SST the greater the mean size of the embryos. Several areas for parturition are described but no restrictive seasonality was identified in any of the hemispheres neither within any ocean, suggesting diverse periods with a peak in the boreal autumn (33.3%) and in the southern spring (48.6%). The data confirms low availability of pregnant females in all areas observed and low occurrence of gestation and parturition suggesting either that these phases are more likely occur in other areas, or that these pregnant females are not easily accessible to this oceanic fishing gear.

SCRS/2021/066 - This paper describes part of the results of the EU Project "Evaluation of the effects of hooks' shape & size on the catchability, yields and mortality of target and by-catch species, in the Atlantic Ocean and adjacent seas surface longline fisheries". A meta-analysis of 35 publications totaling 54 experiments was conducted to assess effects of hook, bait, and leader type on retention and at-haulback mortality rates of target, desirable and unwanted bycatch species. Using circle hooks significantly lowers retention rates of loggerhead and leatherback sea-turtles and billfishes, including swordfish. By contrast, the retention of shortfin mako when circle hooks are used is higher. Fish bait significantly reduces the retention of loggerhead sea-turtles while silky shark showed opposite effects. Using wire leaders significantly increased retention of blue sharks and decreased retention of blue marlin. As for at-haulback mortality, it was significantly reduced for swordfish, blue marlin and blue shark when using circle hooks. Fish bait increased at haulback mortality of swordfish, blue shark, and oceanic whitetip. The effects of using wire leaders on at-haulback mortality were only possible to calculate for blue shark and were not significant. Data gaps were considerable for deep setting longlines, especially concerning changes from J to circle hooks. Changing from tuna hooks to circle hooks did not significantly affect retention rates of any of the species.

SCRS/2021/067 - Centre National de Recherche et de Développement en Pêche et en Aquaculture (CNRDPA), continue toujours à recenser les tortues marines échouées ; deux espèces ont été observées le long des côtes algériennes. Ce recensement nous a montré une domination de la tortue caouanne *Caretta caretta* (Linnaeus, 1758) et que la tortue-luth *Dermochelys coriacea* (Vandelli, 1761) est peu présentée. Les tortues marines vivent en mer toute l'année mais ont besoin, en été d'une plage du rivage pour se reproduire. Ces deux nécessités biologiques se traduisent inévitablement par d'importantes interactions entre les tortues et les activités humaines. Cette situation est d'autant plus aigüe en Méditerranée, exploitée par les pêches, polluée et dont littoral subit des pressions démographiques, touristiques et urbanistiques de plus en plus importants. Les populations méditerranéennes de tortues marines sont ainsi en danger. Le plan d'action du CNRDPA s'appuie sur la mise en place de réseaux et d'outils de la surveillance et d'un plan de gestion durable de la tortue marine et de ses habitats dans la région méditerranéenne.

SCRS/2021/068 - To evaluate the effect of circle hooks (C-hooks) on fishing mortality of fish species (blue shark, shortfin mako, striped marine and swordfish) other than sea turtles in experimental longline operations, Bayesian estimation using statistical models was used to examine whether there were differences in haulback mortality rate, CPUE, mortality per unit effort (MPUE), and hooking position between 3.8 sun tuna hooks and size-different C-hooks. The results showed that the haulback mortality rate, CPUE, and MPUE did not improve with either size of C-hook, but rather tended to worsen. In addition, the use of the C-hook did not reduce the hook swallowing which can lead to post-release mortality. In addition, the mortality rate may be greatly influenced by environmental factors such as soak time and water temperature. These results suggest that it is necessary to consider the trade-off between the effects on sea turtles and on multi-taxa fish species when discussing the use of C-hooks.

SCRS/2021/069 - We recommend that a sub-group is formed to work and discuss intersessionally on the applicability and functionality of the Ecosystem Report Card (EcoCard) as a tool for monitoring the impacts of ICCAT fisheries and contribute to the progress on the implementation of Ecosystem-Based Fisheries Management (EBFM) framework in ICCAT as requested by SCRS strategic research plan and ICCAT Commission mandate. To do so, the sub-group will consider ICCAT existing management system and boundaries and evaluate current monitoring and stock assessment framework. Therefore, the sub-group will be tasked to (1) review data availability and ICCAT management framework to inform the development of EcoCard, (2) summarize in a guideline document the history and current state of the EcoCard developments in ICCAT, highlighting its progress and main successes, as well as potential emerging concerns and inefficiencies, (3) seek feedback and synergies with other relevant work and processes across all species groups and subcommittees of the SCRS, and (4) make recommendations for improvements to make the Eco Card more functional and adaptable to end-user needs. A more functional EcoCard has the potential to (a) communicate more effectively the use of this tool to the wider ICCAT community including its main objective and purpose, (b) attract more research and participation for its development and create more synergies of the work across all species groups and subcommittees of the SCRS, and (c) identify research priorities as well as relevant gaps which will allow management planning and identification of priorities by the ICCAT Commission.

SCRS/2021/070 - The overall aim of the workshop is to advance in the identification of candidate ecologically meaningful regions that can serve as a basis to produce a more integrated ecosystem-based advice, and thereby support the implementation and operationalization of ecosystem-based fisheries management (EBFM) in the International Commission for the Conservation of Atlantic Tunas (ICCAT) convention area. The candidate regions should have boundaries that make ecological sense and are practical in informing fisheries management. The workshop will gather CPC national scientists and external experts from different scientific disciplines (e.g., biogeography, oceanography, ecology, fisheries, and fisheries management in the ICCAT area) to develop a "proof of concept" for broad-scale regionalization of the ICCAT convention area.

SCRS/2021/071 - The paper explored a way to identify the priority species for management through quasi-quantitative way. The paper first developed an indicator of overlaps with tunas and tuna fishing and apply them to fish species in order to filter a set of species that could interfere more closely with ICCAT tunas and tuna fishing. This set is served as a pseudo-community to evaluate potential management importance in terms of impacts of tuna catch. Then, the factors that were considered as important in deciding the management priority were selected and criteria to evaluate the individual species situation into 3-5 ranks were defined for each factor. In this exercise, significance of ICCAT tuna fisheries in the Atlantic catch, stock status, and availability evidence were selected as factor and rank was assigned to the list of species in a pseudo-community. Combined index of those assigned rank was supposed to indicate the significance in the management. This extremely simply approach identified relatively small number of significant species that have significant overlap with those already under the ICCAT management scheme. Although the evaluation against the existing management scheme could not be conducted due to time constraints, the approach explored seemed to be promising.

SCRS/2021/072 - Due to the overfished status of the North Atlantic shortfin mako, Isurus oxyrinchus, ICCAT has identified the need to better understand the effect of terminal gear modification as a mitigation measure in longline fisheries. Here we update two meta-analyses as one of the referenced studies was found to have a confounding variable that resulted in interpreting a bait effect as a hook effect. In both cases, significant differences in catchability are lost between hook types. For at-haulback mortality, the cited sources from the two meta-analyses were combined to maximize sample size; an updated model demonstrates a significant reduction of 10% in at-haulback mortality due to circle hook use. In review of additional publications, shortfin mako caught with circle hooks vs. J-hooks were twice as likely to be mouth hooked vs. foul or gut hooked, with the latter two being at least 4.5 times more lethal than mouth hooking. Overall, our paper demonstrates circle hook use is effective for reducing total mortality of the species and improves the probability of survival of shortfin mako incidentally captured in longlining fishing operations.

SCRS/2021/073 - Fishers and scientists in the three tropical oceans are investigating different designs of biodegradable FAD (bio-FAD) efficient for fishing. The tactic followed by most fishers is to maintain the same traditional drifting FAD (dFAD) design (submerged netting panels hanging from the raft) but made of organic ropes and canvas. Results of those experiences show that the lifetime of bio-FADs that maintain the traditional FAD design with organic materials, is shorter than that required by fishers. The short lifespan of those bio-FADs is due to the structural stress suffered by dFAD designs traditionally used. Thus, in order to use organic materials instead of the strong plastic and increase the lifespan of those bio-FADs, a paradigm shift is needed. Bio-FAD structures should be re-designed to suffer the least structural stress in the water. The present document aims at (i) summarizing what we learned across the different experiences testing bio-FADs in the three oceans, (ii) proposing a new concept in dFAD design, the Jelly-FAD design, and (iii) showing preliminary results of the tests of the Jelly- FAD.

SCRS/2021/074 - Depredation, i.e., the partial or complete removal of hooked fish from fishing gear by marine mammals, is attracting more and more attention from fisheries managers and the society in general, due to the growing concerns about the conservation of marine mammals' populations, and about Human-Wildlife interactions in general. This short background paper is presenting the key issues at stake for the Tuna fisheries, and in particular the potential economic impacts, both for the fishing industry and for the society. While some costs are directly endured by the vessels in terms of losses in production and gear damages, other costs can occur to implement unavoidable mitigation strategies. On the other hand, the depredation phenomenon can facilitate the feeding patterns of marine mammals, and thus contribute to their well-being. As such, depredation could be seen as a phenomenon generating a positive externality, which might allow for compensation, as it is the case in several land activities. In addition to the presentation of the impacts of depredation, the paper suggests that several integrated modelling approaches can be appropriately developed to capture the phenomenon.

SCRS/2021/076 - A collaborative work to assess the impact of pelagic longline fleets on sea turtles in the Atlantic Ocean from an entirely scientific perspective was initiated in 2018. This report updates the advances achieved after the Workshop II (Malaga, Spain; SCRS/2020/40). The most immediate objectives of this process include to determine the spatial-temporal trends of the incidental catch of sea turtles in pelagic longline and purse seine fisheries in the Atlantic Ocean and southern Indian Ocean. For this purpose, fine scale bycatch data from several longline and purse-seine fleets, covering about 20 years, will be analyzed. In addition, bibliographical revisions on 1) the status of sea turtle populations and 2) of the interaction of sea turtles on other than tuna fisheries operating in the Atlantic and Indian Ocean and Mediterranean Sea, are being conducted to enable contextualization of the impact of tuna fisheries within a more global framework. A complementary objective is also being also considered. If the information allowed, a case study will be carried out in the Mediterranean Sea on the potential impact of the pelagic longline fisheries on sea turtles. For this purpose, the following would be considered 1) densities of sea turtles obtained in the aerial surveys of the GBYP, 2) distribution of the incidental catch of sea turtles in the pelagic longline fishery, and 3) situation of the populations in the Mediterranean Sea affected by these fisheries, if possible. To date, researchers have made available information on incidental capture of sea turtles in the Atlantic and southwest Indian Oceans from longline fleets of Brazil, Canada, Spain, Portugal, South Africa, and Uruguay, including the effort of foreign fleets that have operated in the EEZs of some of these countries. There are also data from the Spanish pelagic longline fleet from the Mediterranean. Regarding purse-seine fisheries, data are available from the Atlantic and southwest Indian Oceans for the fleets of Spain and France. During a virtual workshop (April 30th, 2021) the group decided to conduct the analyses from 1998 to 2018 based on the spatial-temporal coverage of the available information. Data on incidental catch of sea turtles and fishing effort at the set level were integrated (1998-2018). Several covariates, including sea surface temperature, chlorophyll-a, depth, changes in depth, distance to coastline and to some isobaths, the fraction illuminated of the moon and moon phases were extracted for each fishing set. Scientists from USA expressed their intention to provide data for their pelagic longline fleet in the Atlantic. Similarly, scientist from Spain expressed their intention to provide data from longline in the Atlantic and to extend the purse-seine data beyond the southwest Indian Ocean.

SCRS/2021/079 - The current paper summarizes (1) the work completed in 2018 as part of the FAO-implemented. Common Oceans I Program, which focused on modeling the impacts of climate change on the productivity and distribution of tuna fisheries in the Pacific Ocean, and (2) the new work that is being proposed under the second phase of the Common Oceans Program. The primary objectives of the newly proposed work are to improve our current understanding of climate change impacts on global tuna resources by RFMOs and member states, and to increase global, regional and national commitment to development and implementation of climate adaptive EAFM plans for tuna fisheries. With the submission of this paper, we hope to receive feedback from ICCAT on how best to proceed with projecting Climate Change impacts on global tuna fisheries using methods similar to those developed in the Pacific. We specifically wish to integrate the proposed activities into the normal scientific committee peer review processes at ICCAT with the eventual aim of advising the Commission on potential actions needed to mitigate against adverse impacts.

SCRS/2021/080 - Identical 3D replicas of CITES Appendix II listed sharks for 10 species and two families have been developed through a collaboration between TRAFFIC South Africa and the Department of Forestry, Fisheries, and the Environment. The entire process from scanning, printing, and painting has been documented and will be available online on the 4th of May 2021. The development of the 3D printed fins accompanied by QR codes, which link to dedicated webpages providing additional guidance on identification, will facilitate the traceability and enforcement of dried shark fins and allow for rapid and confident decision-making by relevant law enforcement officials.

<div align="right">**Appendix 5**</div>

Terms of Reference for Ecocard intersessional work

A sub-group is formed to work on and discuss intersessionally the applicability and functionality of the Ecosystem Report Card (EcoCard) as a tool for monitoring the impacts of ICCAT fisheries and contribute to the progress on the implementation of EBFM framework in ICCAT as requested by the SCRS strategic research plan and ICCAT Commission mandate. To do so, the sub-group will consider ICCAT existing management system and boundaries and evaluate current monitoring and stock assessment framework.

The following terms of reference will be addressed:

TOR 1. Create a *guideline document* which reviews the components of ICCAT's EcoCard and summarizes the development and current state of ICCAT's EcoCard. This baseline document may include:

    (i) The main scope and objectives for each of the EcoCard component.

    (ii) The data requirements to evaluate them considering ICCAT data requirements.

    (iii) The attributes the EcoCard components are meant to monitor as well as a list of candidate indicators.

    (iv) A proposal for possible thresholds of the candidate indicators that would trigger management actions (e.g. SCRS recommendation to management actions), applicable throughout the different EcoCard components.

    (v) The connections and synergies among the EcoCard components will be reviewed and described.

TOR 2. Identify successes and lessons learned since its creation as well as identify emerging concerns and inefficiencies, including the gaps, weaknesses, and strength in the monitoring framework for the estimation of the indicators of different components as well as develop a proposal to improve monitoring systems required.

TOR 3. Seek feedback and synergies with other relevant work and processes across all species groups and Subcommittees of the SCRS to make the EcoCard more functional and adaptable to end-use needs. This will include (1) identifying the ongoing relevant research in the SCRS and connect it to the EcoCard development, (2) considering the role of the ongoing work on case studies (Sargasso Sea case study and Tropical Region case study), (3) considering the ongoing work on risk assessment approaches to prioritize work, and (4) identify opportunities and collaborations with other organizations that can bring new expertise and resources.

TOR 4. Provide recommendations for improvements to make the EcoCard more functional and adaptable to end-user needs, and propose mechanisms for regular revision by the SCRS and feedback from the Commission to advance towards EBFM implementation in ICCAT.

Logistics and participants

The sub-group will work intersessionally and present their outcomes at the 2022 annual SC-ECO meeting for review, discussion and possible adoption of recommendations. All SC-ECO participants are invited to participate in this intersessional work. During the SC-ECO meeting it will be discussed who is responsible for convening the sub-group and how the call is made to bring all interested participants to participate.

<div align="right">**Appendix 6**</div>

Terms of Reference for an ICCAT Ecoregion Workshop

In 2020, the process used to delineate candidate ecoregions in the IOTC Convention area was presented to the SC-ECO. From this experience, the SC-ECO recommended convening a workshop in 2021 to advance in the identification of draft ecoregions and foster discussions on their potential use to facilitate the implementation and operationalization of EBFM within ICCAT.

The overall aim of the workshop is to advance in the identification of ecologically meaningful regions that can serve as a basis to produce integrated ecosystem-based advice, and thereby support the implementation and operationalization of EBFM in ICCAT.

During the workshop the following terms of reference will be addressed:

TOR 1. Review several world case studies (e.g. NAFO, ICES, CCAMLR, USA, Australia) in order to understand how pelagic regionalization have supported the implementation of EBFM in other organizations and countries.

TOR 2. Review the current reporting structure of ICCAT data and stock boundaries and discuss potential constraints on using ecoregions to structure ecosystem-based advice.

TOR 3. Discuss and develop a check list of evaluation criteria which identifies the factors to be considered when defining ecoregions in the ICCAT Convention area.

TOR 4. Review existing biogeographic classifications in the Atlantic Ocean, which are often used to inform the delineation of ecoregion boundaries and discuss their relevance in the context of ICCAT species and its fisheries.

TOR 5. Review existing data sets in terms of availability, quality and completeness to guide the choice of key data inputs for deriving the draft ecoregions. The data sets revised will include (i) existing biogeographic classifications, (ii) spatial distribution and catches of ICCAT species (e.g., oceanic tunas, billfishes, sharks, neritic species, other bycatch species), (iii) spatial distributions of ICCAT fisheries (e.g., baitboats, longlines, gillnets, purse seines) and (iv) other potentially relevant data layers.

TOR 6. Develop a baseline ecoregion proposal analyzing selected datasets using spatial analysis that will be adjusted with expert knowledge. The spatial analysis will include examining the spatial patterns of species compositions and fishing fleets dynamics across multiple biogeographic provinces, and clustering analyses to group biogeographic provinces according to their similarity in terms of species composition and fisheries composition. The use of quantitative approaches that link different data layers describing the ecosystems including fisheries, coupled with expert advice are often used to ecoregion delineation.

TOR 7. Test and validate the usefulness of the candidate ecoregions with respect to monitoring large scale changes in the ecosystem.

1.   Expected outputs

–   An evaluation checklist criterion with major factors to be considered to guide the development of draft ecoregions.
–   An understanding of the data layers and methods used for deriving the ecoregions with its strengths and weaknesses.
–   A proposal for candidate draft ecoregions.
–   A workshop report with an executive summary with the main outcomes to be presented at the SC-ECO meeting in 2022.

2.   Organization and participants

A four-full day in-person workshop is proposed to occur prior to the SC ECO meeting in 2022 (date to be determined). Depending on the evolution of the COVID-19 pandemic the workshop would be conducted face-to-face if possible, with optional virtual participation. The ICCAT SC-ECO is organizing the workshop and it has requested $15000 to support the travel costs of 6 -7 CPC scientists to the workshop. External experts will be invited to present relevant case studies (e.g. ICES, NAFO, CCAMLR, USA, Australia) during the workshop.