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CPUE for yellowfin tuna stock assessments (STECF-16-17)

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Abstract

Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. This report deals with 6.9. CPUE for yellowfin tuna stock assessments.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

CPUE for yellowfin tuna stock assessments (STECF-16-17)

THIS REPORT WAS ISSUED DURING THE PLENARY MEETING HELD IN BRUSSELS, 24-28 OCTOBER 2016

Background

The relationship between catch per unit effort (CPUE) and abundance is central to stock assessment models and thus, changes in this relationship will ultimately result in changes in scientific diagnostic and associated management advice. In tuna fisheries, commercial data are traditionally used to compute CPUE and to derive indices of abundance for stock assessments, due to the lack of fishery-independent information. Nominal efforts are usually standardized to account for difference among vessels, areas, seasons, and years. Changes in catchability related with improvements of fishing technology over time are difficult to capture because relevant information on non-conventional fisheries is rarely collected.
Tuna RFMOs have requested European scientists to define the fishing effort units for drifting fishing aggregative devices (DFAD) and free school sets in order to standardize European purse-seiner CPUEs. Standardized indices of abundance from the purse seine fishery are valuable because they refer to species or parts of the tropical tuna populations that are not targeted by longlines (longline CPUES are currently used in assessments). The European Workshop on CPUE standardization held in July 2016 in Fuengirola, Spain, has initiated a "data rescue" of non-conventional fisheries data1; the development of a framework for CPUE standardization analyses, with the assistance of an external European expert in statistical modeling.
In 2016 yellowfin tuna stock assessments in the Indian and Atlantic oceans are due. Following the work of the aforementioned workshop, the EU aims to provide tuna RFMOs with standardized CPUEs from the European purse seine fleet for yellowfin tuna in the Indian and Atlantic oceans, to be used as input in corresponding assessments.

To prepare STECF opinion, an ad-hoc contract was carried out in order to:

a) develop a general template for standardizing tropical tuna CPUE caught by purse seiners targeting (1) free schools and (2) drifting fishing aggregative devices (dFADs).

b) If the application of the CPUE standardization framework to large yellowfin tuna caught in free schools shows realistic results, the methodology would be extended to juvenile yellowfin caught under drifting FADs.

[1] non-conventional fisheries datas refers to data that are not obtained from the current data sources (e.g. logbooks, sampling, observers data, etc), such as type of buoys, Info on supply vessels (association PS-Supply vessels), Ratio number of FADs deployed /number of buoys activated, etc. The data rescue refers to the fact that these non-conventional datasets are often lost, kept in peoples laptops, remain unused and are not as available as logbooks, so the participants in the July WG had to dig a little deeper to obtain them.

The work has been conducted in collaboration under the overall guidance of the EU tuna scientists who participated at the tropical tuna CPUE2 workshop held in IEO Fuengirola, July 19th-22nd, 2016.

The report consists of

1. A scientific document on purse seiner CPUE standardization that contributes to the next IOTC yellowfin stock assessment working Group.
2. Software script (in R or similar programming language), fully documented, for diffusion among tropical tuna scientists.

Request to the STECF

STECF is requested to review the report.

STECF comments

The report of the ad-hoc contract describes the challenging task of standardizing the EU tropical tuna purse seine CPUE to obtain a reliable index of relative abundance to be used in the stock assessment of Indian Ocean yellowfin tuna in November 2016. This fishery is characterized by the existence of two main fishing modalities (i.e. free schools and FADs (Fish Aggregative Devices)). Recently, an increase of the number of FADs used has been observed and new technologies have been introduced in the fishery, including new generations of buoys that are able to estimate the biomass aggregated under FADs and remotely inform the fishing vessels. Also, the use of supply vessels, which help purse seiners in different tasks (e.g. seeding, visiting, replacing FADs at sea), has increased, together with evolving fishing strategies, existence of bilateral agreements to fish in different countries' EEZ, the presence of piracy, etc. Therefore, standardizing the CPUE of the EU tropical tuna purse seine fishery in the Indian Ocean requires a large amount of information, which is not routinely collected, as well as a proper statistical methodology.

The main tasks of the ad-hoc contract were fulfilled by the contractor, in collaboration with several EU scientists that participated in a dedicated workshop. The report describes the definitions of effort units that were adopted, the auxiliary data that the group was able to rescue, and the standardization framework adopted. As a result of the contract, separate standardized CPUE indices were produced for each of the two main fishing modalities (free schools and FADs, Figure 1). For each fishing modality, two submodels were combined; one that models the probability to find tuna schools and another one that models the biomass of the tuna schools found.

The STECF considers that the outcome of the work conducted is satisfactory, as standardized CPUEs of the purse seine fleet will be available to be used in future tuna stock assessments. However, STECF considers that some improvements could be made to further standardize the CPUEs.

In terms of data, although some auxiliary or "non-conventional" data (namely, data that are not routinely collected by scientists) were compiled, some of the variables (such as the number of active buoys or the link between supply vessels and purse seiners) were incomplete (i.e. available only for one part of the EU fleet, or for one of the areas), or not disaggregated enough to be included in the models (e.g. only yearly time series). Thus, the STECF endorses the recommendation by the expert workshop to collect and provide that auxiliary information, to the extent possible, on a set by set basis in order to improve future analyses and be able to better understand the effects of these variables on the nominal CPUEs.

[2] The scientists who participated in the meeting already provided the available information and would clarify any doubt that the contractor would raise. All results will be shared and discussed with the WG, and all suggestions will be taken into account when producing the final report.

With regard to the modelling framework, the STECF suggests providing more details to justify some of the options. Alternative effort units should be considered, especially when modelling the probability of finding free schools of yellowfin tuna schools. The contractor used the proportion of successful sets as the response variable, but since fishing sets occur only on already detected schools, it is proposed to consider using the total number of sets per time unit as an alternative.

Some key variables that were modelled as factors using GLMM could be modelled using splines (e.g. year) or cyclic splines (e.g. month) with GAMM, to consider the autocorrelation structure. Additional efforts are required to consider year:month interactions, as these account for changes in seasonality that can be important in these tuna fisheries. The current model considers the possible changes in the spatial structure of the stock using the interaction between year and grid. Also in that case, a GAMM might be used to avoid using year as a factor and in order to take into account the autocorrelation between years in the spatial structure.

The STECF also suggests better documenting the results and diagnostics of the different models. The report lists the variables that ended up in the final model, but it is suggested to expand the information with plots of the data exploration analysis, residual plots, convergence diagnostics and deviance tables. This allows better justifying the selected variables and reporting the contribution of each variable to the final model. Also, a better documentation of the different steps of the R scripts would also be useful.

Finally, the STECF suggests making an effort to comment and interpret the two different trends obtained, in the light of other available (e.g. longline) CPUEs and stock assessment outputs (e.g. SSB). The standardized CPUE on free schools seems variable but rather constant over time, while the CPUE for FADs shows a clear increasing trend (Figure 1). The nominal CPUE for free schools suggests some potential decrease in the efficiency of the EU fleet targeting free schools, which might be linked to the increased use of FADs. If the purse seine CPUE time series will be used in stock assessments, the experts should evaluate whether there are variables that affected the trends that could not be included in the standardization. Since more FAD-related information needs to be collected and included in the standardization, the STECF believes that possibly, the upward trend of the FAD standardized CPUE series yet reflects, at least partially, the technological creep instead of increasing resource abundance.

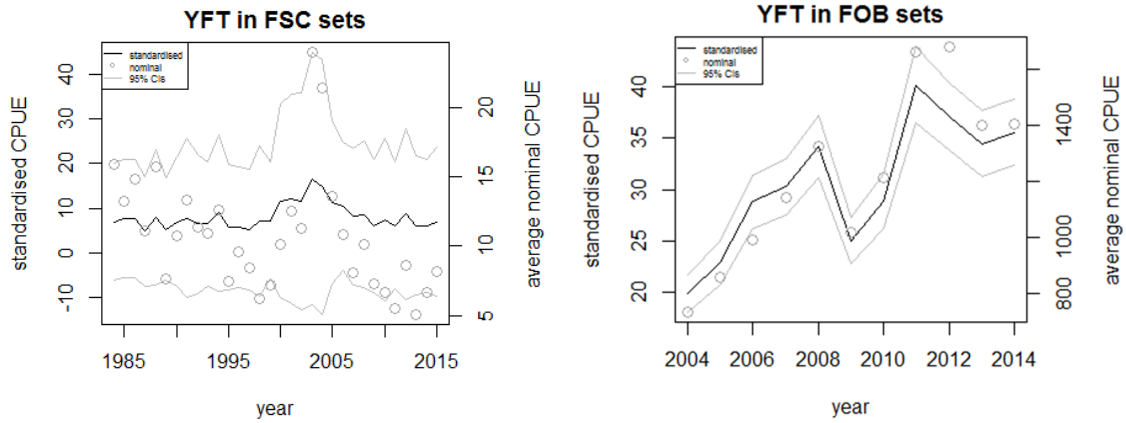

Figure 1. Standardised yellowfin tuna CPUE for free-school sets (left) and sets on Fish Aggregating Devices (FADs, right).

STECF conclusion

The applied CPUE standardization framework is appropriate and the analyses represent the state of the art for the standardization of the CPUE of the EU tropical tuna fleet. However, the standardization of this CPUE remains challenging because of all the changes happening in the fisheries. Additional fine scale data on auxiliary variables are required, especially for the FAD fishery, to improve the standardization. Meanwhile, the standardized CPUE for FADs is likely to, at least partially, reflect changes in efficiency rather than stock abundance. STECF concludes nevertheless that the work represents a useful addition to what is currently used by the tuna

RFMO and that the two CPUE time series should therefore be presented to IOTC. A plan regarding additional data collection and further model exploration should be established after the presentation of the work to IOTC.

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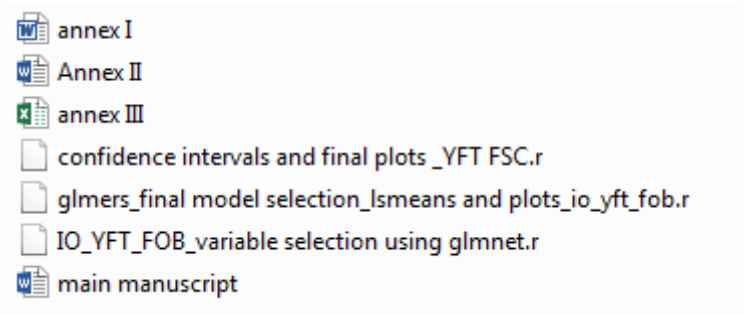
Background Documents

The following background documents



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