2012 INTER-SESSION MEETING OF THE TROPICAL TUNA SPECIES GROUP

(Madrid, Spain - April 23 to 27, 2012)

1. Opening, adoption of Agenda and meeting arrangements

The meeting was opened by Mr. Driss Meski, Executive Secretary of ICCAT. Mr. Meski welcomed participants and highlighted the importance of the tropical tuna species, particularly this year when an ICCAT multi-annual program on the conservation and management for bigeye and yellowfin tuna will start. Dr. Daniel Gaertner, Skipjack Rapporteur, chaired the meeting on behalf of Dr. Joao G. Pereira, General Rapporteur of the Tropical Tunas Species Group.

The Agenda (**Appendix 1**) was adopted with some changes. The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**.

Dr. Gaertner reminded the Group that the objective of the meeting was defined in the 2012 Work Plan for Tropical Species approved by the SCRS (ICCAT, 2012). The Work Plan included the revision of biological parameters for the three species of tropical tunas and to explore methods to obtain accurate abundance indices from longline, baitboat and purse seine fisheries.

The following participants served as rapporteurs:

P. Pallarés	Items 1, 5, 9 and 10
A. Fonteneau	Item 2
S. Cass-Calay, C. Brown, D. Gaertner, E. Chassot, P. Pallarés	Item 3
A. Fonteneau, P. Bannerman	Item 4
A. Fonteneau, D. Gaertner	Item 6
A. Delgado de Molina	Item 7
D. Gaertner	Item 8

2. Revision of biological parameters of yellowfin, bigeye and skipjack, including a revision of parameters used in other oceans

Document SCRS/2012/045, which reviews the growth studies and parameters estimated by ICCAT scientists for yellowfin tuna, and used by the SCRS in its stock assessments, was presented to the Group. The main conclusion of this document was that stock assessment models of yellowfin tuna should use a multistanza growth curve, as this complex growth is based on a wide range of modal progressions observations and on multiple recoveries of tagged yellowfin tuna. Furthermore, it was also noted that the growth of yellowfin tuna estimated or used in stock assessment models today in other oceans (by IOTC, IATTC and WCPFC) reflects multistanzas and slower growth at younger ages. The SCRS has assumed this growth pattern since the early 1980s. On the other hand, the Gascuel et al (1992) growth curve presently used should be better explained by eco-biological considerations. Potential changes in this historical growth curve should also be studied, for instance, based on the analysis of recent modal progressions and on tagging results when the ICCAT tagging programme will be launched. The same paper also concluded, based on the sex ratio at size (**Figure 1**) constantly observed for yellowfin tuna in the Atlantic since 1973 (females significantly dominant between 120 and 140 cm, males being significantly dominant after 144 cm) and also on the recoveries by sex of large yellowfin tuna observed in the Indian Ocean, that the growth of male and female yellowfin tuna is probably significantly different, with female yellowfin tuna showing a much lower L infinity than males.

Document SCRS/2012/047 presented a simple length based analysis using purse seine length frequency data for yellowfin and bigeye from the Atlantic and Indian Oceans. Benefits of simple methods are their visual appeal, simple statistical basis, minimal assumptions and the ease with which estimates can be derived from different data sets. The study compared growth, selectivity and total mortality for the 4 stocks, from two species and two oceans. Simple length-based methods are valuable methods for stock assessments, both to reality check assumption of complex integrated stock assessment methods, such as Multifan-CL or SS3, and to provide hypotheses for running these methods. This is of particular importance since most of the discussions within a stock assessment working group are about selectivity of the fleets. Simple methods would help inform these discussions and allow stock and assessment experts to better communicate. This method can be used with catch at size by fleet as well as with total catch at size.

It was also noted on this point that statistical stock assessment models, such as Multifan-CL or SS3, should allow to estimate the best new growth curve, in statistical agreement with modal progressions, tagging results and the other parameters of the models. This type of work has been routinely done by IATTC and WCPFC, but not yet by ICCAT, as the first attempts by SCRS to use these complex models on the yellowfin tuna stocks were inconclusive.

One of the pending questions on yellowfin tuna growth remains the basic inconsistencies between the age readings of hard parts and the von Bertalanffy growth model proposed by Shuford et al (2007), and the Gascuel et al (1992) multistanza model (**Figure 2**). On the one hand, age readings of hard parts may contain errors in the estimated age, for instance in relation with the expertise of the reader, with the technology used, or with the frequency of rings (do we really have daily rings?). In the absence of validation of age readings done on tunas tagged with tetracycline injection, this question remains a pending one. It was noted that in general these reading errors tend to be minimal ones for small fishes (where there are large differences between hard part based and modal progression/tagging based growth curves), and potentially increasing with age of the fishes. This point has to be checked as difficulties of age readings tend to be different between species (for instance age readings being most often unsuccessful for skipjack tuna).

On the other hand, it has been hypothesized that selectivity bias could give the false impression of slow growth for the youngest fish in the fishery when calculated using modal progression. Simulations intended to investigate this have given some conflicting results. Langley, et al (2008) did not find this effect, but the more recent work of Kolody (2011) contained results which reflect this phenomenon. This question of the potential importance of selectivity bias would need more studies. It was noted that such studies will be conducted in the Indian Ocean (before the IOTC tagging symposium). The Group noted that Kolody (2011) assumed selectivity curves by fishing mode that did not reflect those observed in Atlantic fisheries, and therefore the Group recommended that the Kolody approach be attempted using assumed selectivity distributions based on Atlantic data.

It was also noted that large numbers of yellowfin tuna, skipjack tuna and bigeye tuna have been recently tagged in the Indian Ocean with tetracycline injections, and that the validation of these age readings will soon be available on the three species of tropical tunas. These results, which can be useful for future SCRS work, will soon be presented at the final symposium of the IOTC Tagging Programme (to be held in Mauritius, October 30 to November 2, 2012).

There was some discussion on the validity of the tagging results to estimate tuna growth: well measured recoveries at a known time tend to offer strong visual evidence of an observed growth during a given period, when age readings tend to be more questionable. However, growth studies of tagged tunas may also be biased if the fraction of the stock that has been tagged and recovered is not fully representative of the real population fished. Such selectivity bias may, for instance, exaggerate the phase of slow growth, if the fast growing tunas are moving quickly outside the fished zone. However, most tuna scientists expert in tagging tend to consider that if this theoretical bias is real, it is probably a minor one, for instance, when very large numbers of tunas have been recovered at a well known size and date and in the entire fished zone.

The scientific question that the maximum sizes observed in fisheries is often strongly dependent of the exploitation rates of the stock was introduced and discussed. They are no doubts, however, that very large fish were very abundant in virgin stocks of cod, and very rare in overfished stocks, this change in maximal sizes observed being due to overfishing and independent of the biological L infinity of the fish. However, it was noted that such major declines in maximum sizes have been seldom observed for Atlantic tunas. For example, the historical maximum sizes observed in the catches taken on virgin tuna stocks of yellowfin tuna and bigeye tuna, and today on fully exploited stocks, tend to be very similar. This peculiarity of most tuna stocks has not been studied by scientists. The extent to which selectivity or availability may affect this is not known. It is possible that changes in maximum size in the population might not be detected if the largest fish tend to escape the fishery.

The conclusion that yellowfin tuna growth, and possibly also bigeye tuna growth, appears to be distinct for males of females was also examined and discussed by the Group, taking note that such an hypothesis has not yet been envisaged in the IATTC and WCPFC stock assessments (the decline of females in the large tunas being explained by their higher natural mortality after spawning). This question was considered to be of great importance in stock assessment, as the estimation of female growth conditions the level of spawning biomass used as reproductive potential in current assessment models, and the subsequent potential recruitment for the stock. This important question would urgently need further investigations by SCRS.

Three presentations were also made comparing the biological parameters assumed or estimated in their stock assessment work by the ICCAT, the IOTC, the IATTC and the WCPFC:

- An overview of the ISSF Technical Report 2011-02 on the tuna steepness estimated by the various RFMOs on their various species, and indirectly doing this comparison.
- An overview of the IOTC document IOTC 2011 WPTT13-47 by AZTI, also comparing the biological characteristics recently estimated for the various tuna stocks.
- An informal presentation of the same results, but on the parameters used by RFMOs in their 2003-2005 stock assessments .

These presentations were useful to show the wide and often unjustified unexplained heterogeneity of the main biological parameters used in many tuna stock assessments. However, in most cases, the information available during the meeting was insufficient to create updated tables comparing the exact parameters used in the various stock assessments. This difficulty was due to the fact that many of these parameters are shown by figures in the reports, but not easily available in a format of tables or numbers. An additional complexity is due to the fact that in the stock assessment results the basic parameters are expressed using quarterly or yearly scales. All these scales need to be carefully and well standardized at the same yearly scale to allow their efficient and simple comparison.

The Group recommended that such standardized tables comparing the main biological parameters assumed or estimated in the various stock assessment models run by tuna RFOs should be developed by the ICCAT Secretariat and be made available as soon as possible to SCRS scientists.

Striking differences are, for instance, observed in the natural mortality at age estimated for yellowfin tuna and for skipjack tuna stocks in the various oceans, when this parameter is clearly of major importance (**Figure 3**) to condition the dynamics of the yellowfin tuna stocks. The Group also noted that despite its importance, natural mortality of tropical tunas used by the SCRS has been kept unchanged for more than 30 years, while these fixed levels have been seldom questioned by the SCRS. It was also noted that these levels of M may be questionable. For instance, it is highly unrealistic to assume that age 0 yellowfin tuna and bigeye tuna (less than 2 kg) have the same natural mortality than the much larger age 1 fish at about 5 kg of average weight (McGurk 1986, Peterson and Wreblowski 1984, Hampton 2000, Lorenzen 1996).

As an example of the widely different levels of natural mortality used by RFMOs and of the importance of natural mortality, document IOTC SC14-2011-46 comparing the most recent stock assessments of yellowfin tuna stocks done in 2011 in the eastern Pacific (IATTC) and Indian Oceans (IOTC), was presented to the Group. The total yearly catches on these two stocks are very similar:

However, in the eastern Pacific the natural mortality is assumed to be very high (close to 1.4), and as a consequence, the stock biomass is estimated at a very low level (much lower than 1 million tons), but this biomass is highly productive (and undergoing a very high F, as the catches are high, whereas in the Indian Ocean the natural mortality is estimated to be very low (close to 0.4), and the biomass very large, several million tons (and undergoing very low F).

This apparent heterogeneity between these two stocks may be very artificial and due to errors in the natural mortality at age used in one of the two (or both?) assessment models. As a consequence the estimated biomass, total and spawning biomass, may be questionable for both stocks, and this uncertainty is a various one.

This structural uncertainty on tuna natural mortalities needs to be better studied, as this parameter has always been a factor of major importance in most or all analytical tuna stock assessments, for instance, widely conditioning the potential interactions between fisheries.

Documents SCRS/2012/043 (YFT) and SCRS/2012/044 (BET) presented an elasticity analysis of the biological parameters with respect to biomass relative to B_{MSY} and F relative to $F_{MSY,}$ stock status variables used to construct the K2SM. Elasticity analysis could have been conducted to evaluate the impact of any parameter on any system value, e.g. $L_{infinity}$ on conversion of catch-at-size to catch-at-age, natural mortality on VPA estimates, selectivity on MSY reference points. However, the intention was to evaluate the relative importance of biological assumptions on the projections used to provide advice.

The method is a simple approach that allows the relative importance of the different biological processes. A limitation (as in many stock assessments) is that the biological processes are assumed to be known without error. Uncertainty about the form of processes (i.e., is M constant or varying at age) could be evaluated using multiple elasticity analyses, or by sensitivity analysis or by Management Strategy Evaluation. One of its main conclusions was that natural mortality of older fish was the major source of uncertainty in the yellowfin and bigeye K2SM that is 3 orders of magnitude more important than the next important parameter, i.e., the steepness of the stock recruitment relationship. However, in these assessments the K2SM are constructed mainly from scenarios based on different assumptions and catch and effort and selectivity. That M is the most important parameter is not surprising and it is well known that estimating M is difficult. The consequences are that the estimates from VPA are relative. However, this analysis showed that using relative estimates when constructing the K2SM does not make the scientific advice robust to uncertainty about M. Also, even if M was known without error, changes in M (both trends and random variability) would have a large effect.

In addition, the Group noted that natural mortality at age remains today a parameter very difficult to estimate. Tagging results offer an important means to estimate its level (Hampton 2000, Polacheck et al. 2007), but these direct estimates of M remain conditioned by various sources of uncertainties, especially for adult tunas. Alternative eco-biological models that have been increasingly developed during recent years (SEAPODYM, APECOSM, ECOPATH, etc.), may allow estimation of some of the components of natural mortality at age (e.g., size specific predation between species), but these prospects have still to be explored for tuna stocks. It was also noted that the Lorenzen method use by the SCRS in 2009 to estimate natural mortality at age of yellowfin was providing interesting estimates that should be further studied.

The Group recommended that a legitimate minimal target would be to better estimate the biological uncertainty in the level and profile of natural mortality at age, and to incorporate this uncertainty in the assessment models used.

There was also some discussion by the Group on the best ways to estimate catch at age from catch at size tables. While age slicing has been often done because of the simplicity of this method, there is no doubt that this method should not be used to estimate the catch at age of adult tunas (and especially if there is a differential growth of the two sexes). It was noted that some modern stock assessment methods (such as Multifan-CL and SS3) work directly on catch at size tables, but they remain highly complex to develop.

The Group also examined a comparison of the size distributions of yellowfin tuna and bigeye tuna caught by purse seine in the Indian and Atlantic Oceans. It was noted that the CAS of yellowfin tuna was clearly bimodal in both oceans, and showing two typical modes of juveniles and adults. However, it was noted that the modal sizes of large yellowfin tuna caught in the Atlantic were much larger than in the Indian Ocean (**Figure 4**). This difference in the large sizes taken in the two oceans has been also observed for the longline catches and since the beginning of the fisheries, and this could be explained by it probably corresponding to a biological difference in the $L_{infinity}$ of yellowfin tuna in these two oceans: larger asymptotic sizes in the Atlantic.

The Group also followed a verbal presentation on the EU sampling program done in the Abidjan tuna canneries (and in Seychelles) on the biological characteristics of tunas processed in the canneries (mainly large yellowfin tuna). This work will soon be presented as a 2012 SCRS document. This presentation has shown that a wide range of very interesting biological parameters have been collected by this program. Outside the large number of morphometric measurements collected, these results show well the seasonal variability of yellowfin tuna spawning activities, as a function of the sizes of fish caught by purse seiners (and the dominant spawning during the 1st quarter). These results also offer a continuous sampling of the yellowfin tuna sex ratio at size that has been observed in Abidjan since the early 1970s, and the large numbers of these sampled tunas allows evaluating when the sex ratio of given sizes is significantly different for males or females of yellowfin tuna (**Figure 1**).

It was recommended that this valuable biological data set should be analysed as soon as possible and these results presented to SCRS, as these biological results collected during many years are of great potential importance in most stock assessment work, especially for yellowfin tuna.

It was also recommended that these basic biological data should also be deposited and stored at the ICCAT Secretariat, in order to ensure their safe conservation and their future access and use by SCRS scientists. The structure and functioning of this potential biological database was questioned by the Working Group and by the

Secretariat, as various options of databases can be developed to keep track of this new set of heterogeneous biological information. Overall, the Group noted that raw biological data on morphometry (e.g., fork length) and reproduction (e.g., stage maturity) collected by research institutes are generally not available and accessible while such data can reveal very useful information to conduct comparative analyses between and among tuna species and stocks. The Group noted that similar data availability issues have been raised for other fish species in other areas (e.g., ICES). While some effort is currently being conducted toward the implementation of regional fisheries databases with standard formats (e.g.,FISHFRAME in ICES), some work remains to be done to develop formats and databases that could host basic biological data. This question will need further studies by the ICCAT Secretariat and decision by the SCRS.

3. Revision of the CPUE standardized process and methods used to combine indices

3.1 Application of a Quality Control Protocol (QCP) to the tropical CPUEs series (cf. Table 2, 2012 WG-SAM)

During the 2012 meeting, the Working Group on Stock Assessment Methods (WG-SAM) developed a set of tools to be used for the evaluation of CPUE series (Methods Working Group Report: Tables 1-2 and Figure 1) and asked that species groups use these tools, and provide feedback and recommendations. Therefore, the Group decided to evaluate, as an example, the eleven CPUE series used during the 2011 assessment of yellowfin tuna (Anon, 2012b). The Group evaluated each series to determine the adequacy of available documentation and the overall sufficiency of the CPUE series for use in various stock assessment models, including surplus production models, age structured models and fully integrated spatial models. Although the tools were time consuming to use, requiring about 30-45 minutes per CPUE series, the Group concluded that they were an effective instrument to focus discussion and ultimately, to inform decisions regarding the most appropriate use of CPUE series in stock assessment.

The instructions to the authors describing the required documentation for CPUE standardization (Methods Working Group Report, Table 1) were determined to be both useful and appropriate. In particular, the Group emphasized the need to include a complete description of model diagnostics, targeting variables (or trip selection procedures), management regulations, potential changes in selectivity and/or catchability and the spatial-temporal distribution of the available data. These descriptions are often lacking in CPUE documentation and are particularly valuable to evaluate the usefulness of CPUE series as indicators of relative abundance. To facilitate the development of appropriate model diagnostics, the Group recommended that the Secretariat make available to authors examples of code to produce diagnostics and some basic guidance on their interpretation. The Group also recognized that alternative, novel and improved methodologies may be introduced to the SCRS and are welcome. For these methods, the Group requests that appropriate model descriptions, evaluations and diagnostics be developed and distributed to the species groups.

The Group also evaluated the utility of the proposed elements to evaluate the sufficiency of CPUE series (Methods Working Group Report, Table 2) and found it to be both valuable and appropriate. For the eleven indices considered, the Group was able to reach a consensus regarding each element (**Table 1**) and also the overall sufficiency of the series for use in common stock assessment models (**Table 2**). Ultimately, the Group determined that some series were not appropriate for use in certain stock assessment models and made important recommendations to improve each CPUE series (**Table 2**). With regard to the elements included in the Methods Working Group Report Table 2, the Group recommended the following:

1. To improve speed and efficiency, some members would review one (or a few) CPUE series developed by other members and would provide an initial scoring of the elements. The Group should then review the initial scoring and develop a consensus opinion.
2. Reporting the numeric percent geographic coverage (% of 5×5 degree squares) in addition to the categorical sufficiency score (Element 2).
3. Including the following clarification, that "Catch fraction" be defined as "Catch fraction relative to total catch" and reporting the numeric percent of total catch in addition to the categorical sufficiency score (Element 4).
4. Revising the following clarification, that "Are there conflicts between the catch history and the CPUE response" to include the phrase "… of the fishery" (Element 8).
5. Adding four additional elements:

a) Are there changes in availability of the target species to the fishery (e.g. from species composition information)?

b) How appropriate was the definition of fishing effort?

c) Are size samples sufficient to construct indices in biomass (if necessary) and to explore changes in selectivity?

d) Is the fleet able and likely to move between fishing grounds?

6. To improve efficiency, the number of sufficiency categories should be reduced from 5 to 3 (e.g. poor, moderate and high; small, medium, large, etc.).

3.2 Methods to improve and combine the indices provided from different fisheries in a single combined index, including sensitivity analyses on the effect of different weighting criteria

The most common practice employed by the Tropical Tunas Group for combining multiple indices of relative abundance is through a GLM model. This approach considers as input the index and year of the standardized series, which are treated as fixed factors within the GLM model. The model assumes a lognormal error distribution. Optionally, a weighting factor can be considered. Among the alternative weighting schemes that have been considered in the past are: weighting by the proportion of the overall catch by year for the fishery covered by the index; the relative geographic coverage (e.g., the number of 5x5 degree squares covered); or weighting schemes based on the coefficients of variation (CV) of each series. This GLM method requires that the units of each index be the same (numbers or biomass). Also, if combining indices of different time periods, it is recommended each index be scaled by the mean of each series to a set of common years among all indices, when possible. The combined index values are obtained from the estimated LSMeans by year.

During its 2012 inter-sessional meeting, the Working Group on Stock Assessment Methods considered a number of alternative approaches to combine multiple indices into a single series, including a recently published approach for combining multiple CPUE series (Conn, 2010). The method uses a hierarchical framework for analyzing multiple indices with the goal of estimating a single time series of relative abundance. The method assumes that each index is a measure of relative abundance and is subject to process error. In simulation testing the method performed well (Conn, 2010). The author provided the r-scripts to the Methods Working Group so that the method could be evaluated for use by the SCRS.

The Tropical Tunas Group conducted a limited analysis comparing the implementation and results of the GLM approach and the hierarchical framework approach developed by Conn (2010). As inputs, the Group used a subset of the indices (**Figure 5**) which were for the surplus production models analyses during the 2011 yellowfin tuna stock assessment (Anon. 2012b). The selection of these indices was carried out through the exercises described in section 3.1.

The CV values used for the analysis were those provided in the documentation for each index. For cases in which a CV was not available, including the entire series for EU-PS3%, a value of 0.05 was assumed. The weighting factor used for the GLM approach was the inverse (*i.e.* 1/CV) of each CV value, giving greatest weight to the more precise index estimates.

The combined index series produced using the Conn (2010) approach is shown in **Figure 6**, along with the process standard deviations for each index. It is noted that analysts using the provided r-script should disable the DEBUG option to reduce run times. These results are compared to those of the GLM approach in **Figure 7**. The results are generally similar, but the performance of these methods using various indices and assumptions requires further exploration.

The Group noted that, should there be interest in utilizing the Conn (2010) approach for future work, careful consideration should be given as to how the input CV values might be modified to serve as proxies for alternative weighting schemes (such as proportion of overall catch or geographic coverage). The Group recommended that further exploration of these and other alternative methods be carried out. t is further recommended that the uncertainty around the combined index estimates be considered during the stock assessment analyses.

3.3 Revision of factors affecting CPUE in purse seine (FADs, echo-sounders, satellites, etc.) and baitboat fisheries (FADs, schools associated with BB)

The Group was informed that an doctoral student from the *Institut de Recherche pour le Développement* (IRD) is working on the impact of the introduction of new technology on the French purse seine fishery by fishing modes. Based on an update of dates of introduction on board of new equipments collected during the EU project "Esther", the goal of this study is to explore potential changes in the spatial dynamics of the French fleet. Results showed that new technology on board impacted directly on the number of free-school sets (i.e., large yellowfin tuna) while the catch per set on FAD (i.e., targeting small tunas) was modified with regards to magnitude and spatio-temporal distribution as a consequence of both new fishing devices and time-area regulations on FAD fishing.

Even though there is a consensus on the increase in the fishing power for purse seine fleets, the difficulty to integrate a continuous implementation of a large number of fishing devices in the traditional GLM standardization procedure was highlighted. It was noted that the impact of new technology likely differed between the two main fishing modes (free school and FADs). Different suggestions were made by the Group in order to analyse the effect of new technology on board:

- Removing first larger spatio-temporal effects in CPUEs and using a lower number of vessels whose equipment has been well identified might be an alternative.
- Comparing direct estimates of abundance by eco-sounder on FADs with CPUE or estimating the density of FADs with buoy signals were also suggested. It was also noted that one of the conclusion of the EU Esther Research Program was that CPUE in the purse seine fishery is the result of different activities (e.g., searching for a cluster of tuna schools, searching a school within a cluster, the rate of successful sets and the catch per set) for which the impact of each new technology might be easier to detect rather than on the whole CPUE.
- It was suggested that interviewing retired captains could be a way to supplement historical information on the modernization of equipment on board purse seiners.

A presentation was made during the Group on the description of a recent dataset of buoys associated with FADs provided by fishing companies to IRD for the French component of the EU purse seine fishing fleet. Preliminary data analyses indicated that the number of FADs per French purse seiner varied in 2010 between 70 and 100 according to season. Emission duration for the buoys was highly variable with some buoys spending up to 600 days at sea and travelling distances up to 6,000 km. Based on the data available for the French fleet component in the Atlantic Ocean, the mean number of FADs deployed by Spanish purse seiners in the Indian Ocean in 2010, as reported to the Indian Ocean Tuna Commission (IOTC), and assumptions on the mean number of FADs for the Ghanaian purse seiners, the total number of drifting FADs in the Atlantic in 2010 was estimated to vary between about 2,500 and 9,000 by quarter.

The Group welcomed the good cooperation with the fishing industry for accessing such a valuable dataset and recognized the considerable interest of buoy data for improving knowledge on purse seine CPUE. The Group noted that information on FAD density and area extent covered by FADs, in conjunction with data on position of fishing sets, could provide insights into fishing effort related to FAD-fishing. The Group noted that some analyses were ongoing on the data and that results would be presented at the ISSF workshop on purse seine CPUE planned in July 2012.

It was also mentioned that attempts to express the density and probability of the presence of FADs have been made on the basis of VMS-based individual trajectories of purse seiners (Bez et al, 2011). The Group noted the major interest of VMS data and strongly recommended that such data be available for scientific analyses such as for the estimation of abundance indices.

3.4 Alternative indices of abundance of recruits and juveniles

For juveniles, the only index available for assessment is that based on the purse seine fishery fishing on FADs. Standardization was made using delta model and, in this particular case, the method combines separate generalized linear modeling (GLM) analyses of the proportion of the species in the catch and the overall (all three species) catch rates to construct a single standardized index.

Taking into account problems related to the species composition of juveniles, and bearing in mind that the catch by species is estimated from sampling data, the Group recognized the interest of a standardized juvenile global index instead of independent indexes by species. However, the Group considered that the GLM approach is not able to fully explain catchability changes.

The Group agreed that alternatives to the GLM approach, such as estimates of density from information on both buoys and sets on FADs distributions, should be explored.

4. Review of current status of work conducted by the Working Group on the improvement of Ghanaian statistics

4.1 Revision and integration of Task II catch-effort and size data

The Group reviewed the work done by the 2011 Inter-sessional Tropical Tunas Species Group on the Ghanaian Statistics Analysis (Anon. 2012a) and agreed with its conclusions and recommendations. In this regard, revised and improved total catch and Task II (Catch-Effort/Size) series have been developed by the 2011 Tropical Tunas Species Group for the historical period 1972 1995, based on a combination of Ghana and CI/EU new logbooks and size data. The recommends that these statistical estimates be used by SCRS in future stock assessments.

However, it was noted that data processing of the recent period (after 1996) has not been finalized due to the lack of several data sets for some years:

- For the years 2001, 2002, 2003, 2004, 2006, 2008, 2009, and 2010 have been processed and total catch by species and Task II have been well estimated:
- For the years 1996-2000, 2005, 2007 and 2011, it has not been able to estimate Task II due to a lack of time and lack of validated data. It was reported that the basic data are entered in the Ghanaian database and they are ready to be processed by the TT software. All the yearly amounts of "faux poissons" landed by Ghanaian vessels and freezers in Abidjan have been well identified by the Abidjan CRO sampling program. Species and sizes of these Ghanaian Abidjan landings have been estimated since 2005 and are now available to ICCAT scientists. It should be confirmed that "faux poissons" catches have been incorporated in the Ghanaian Task I and Task II data.

The data set collected and now available for this period (after 1996) is comprehensive in terms of quantity and quality of data collected and validated by Ghanaian scientists. However, two types of major uncertainties are still hampering the data processing of this period:

1) The fraction of the Ghanaian fleet that had carried out or still carry out at-sea transhipments, and their implications for estimates of the Task I and Task II.
2) The species composition of recent years of Ghanaian landings, although well sampled in Tema by experienced Ghanaian technicians, differs from the species composition observed in the FAD catches (Atlantic and worldwide), and from the species composition of Ghanaian catches estimated from the Tema canneries (**Figure 8**).

These differences in species composition are difficult to explain, and a review should be carried out to determine if they are real, a result of sampling bias, a result of data processing bias, or other causes. This issue should be investigated promptly and it is suggested that an ICCAT sampling operation be conducted in Tema under the control of a highly experienced scientist and technicians. This multi-species sampling should be done in parallel on the landing vessels and at the canneries, in conjunction with the species identification done by the cannery. This task should be included within the training activities planned during the summer 2012.

These samplings and their analysis should allow the validatation or correction of past multi-species sampling done on the Ghanaian landings. This Working Group recommended that data processing of the 1996-2011 Ghanaian total catch by species and Task II data be conducted prior to and presented at the species group meeting in September 2012. This work should be done in close cooperation between Ghanaian and EU scientists and experts in the use of the TTGhana software.

4.2 Collaboration plan between Ghanaian and IRD scientists as defined by the Tropical Species Group

Innovations in the East tropical tuna fisheries, with particular reference to the Ghanaian surface tuna fleets, have been significant over the past decades. Changes in fleet composition, fishing strategies and inadequacies in determining species composition of catches from segments of the Ghanaian fleet and other issues, has led to various working groups by ICCAT being formed, among others:

- Analysis of Ghanaian Task I and Task II (including size data), specifically in a comparative approach with the EU purse seine fishery operating in and around the same fishing grounds.
- Proposal of a sampling scheme as similar as possible as that used in the EU fishery including the revision of past Ghanaian statistics, if necessary, based on the comparative analysis.

The overall objective of the working groups defined in the 2011 Work Plan for Tropical Species and approved by the SCRS (ICCAT, 2012) was to improve Ghanaian statistics to be used in future ICCAT management and stock assessment programmes. The Working Group reviewed (SCRS/2011/087) all the Ghanaian statistical information (Task I and Task II) available in the ICCAT database system through special projects (i.e., the JDIMP Project), and also data provided by authorities from Abidjan (Côte d'Ivoire) and ISSF.

After having adopted the sampling protocol of the EU in 2005 (ICCAT, 2006-2009), as well as the data entry and validation software (AVDTH) (Lechauve, 2001) for purse seiners operating in the Atlantic Ocean and in accordance with SCRS recommendations (Annex 2, Chapter 4, *ICCAT Manual*), there have been some problems related to the application of the software. Some of these difficulties related to the fact that the validation system (AKADO software) is documented in French. This creates a barrier to the efficient interface in the system for English-speaking personnel. The AVDTH and AKADO software versions in use by Ghana continue to be bugged with incomplete documentation. Likewise, the TTGHANA software developed in 2005 to create the Task II catch and effort and sizes was out of date. A new improved version was used by the Working Group in 2011. Because of the complexity of the system due mainly to processing protocols, further assistance was needed to consolidate efforts made up to now.

Since most fisheries for tuna in the Atlantic Ocean are targeting the species relatively in the same way (i.e., fleet, gear, area), it became imperative that countries fishing and using the same approach to collect and process data (AVDTH protocol) should strengthen the statistical monitoring of the industrial purse seine fishery in the Gulf of Guinea. This initiative was put forward during the SCRS species group meeting in 2011 and was accepted by ICCAT along with its general recommendations in May 2011 at the Inter-sessional Meeting on the Ghanaian Statistics Analysis (Phase II) (Anon. 2012a).

The proposed project will focus on strengthening the sampling the Ghanaian tuna fishery and processing of the data with collaboration from experts from the IRD (*Institut de Recherche pour le Développement*, France), MFRD (Marine Fisheries Research Division, Ghana), CRO (*Centre de Recherches Océanologiques*, Côte d'Ivoire), CRODT (*Centre de Recherche Océanographiques de Dakar Thiaroye*, Senegal) and IEO (Instituto Español de Océanographía, Spain)

The project, envisaged to start in 2012 and end in 2014, will be organized in four main components, namely:

- Port sampling and observer on board program,
- Data management,
- Coordination and data processing, and
- Co-operation on scientific analyses.

These collaborative activities will ensure a more coordinated approach aimed at improved data collection in Ghana by way of training of scientists with the appropriate transfer of technology. Making available user-friendly software with explanations in English of the various components of AVDTH, such as the AKADO and T3 processes, would greatly enhance the efficiency of the work. The exchange of data and protocols on vessels landing elsewhere from their home port would give better insight into the positional analysis of vessels. The exchange of scientists and technicians and their participation in workshops and seminars at the local and international levels would facilitate regional coordination among national teams.

The detailed work plan on the collaborative project between the IRD and Ghana and other institutes' financial budgets and timelines are presented in SCRS/2012/041. This work plan was discussed and adopted by the Working Group and is attached as **Appendix 4**. This project will be funded in accordance with the protocol on the use of ICCAT funds, approved by the SCRS in 2011. In order to take advantage of this year's fishery activity, this Working Group recommends that the port sampling and training be conducted in 2012. The SCRS will set up a Steering Committee to evaluate the various stages of the project and its final results and, where appropriate, provide clear directives and advice along the project timeline.

5. Develop a Port and an associated Observer On-board Sampling Plan aimed at collecting fishery data on bigeye tuna, yellowfin tuna and skipjack tuna that are caught in the geographical area of the area/time closure

ICCAT Recommendation 11-01 requests the SCRS to develop, by 2012, a Port Sampling Plan aimed at collecting fishery data for bigeye, yellowfin, and skipjack tunas that are caught in the geographical area of the area/time closure referred to in paragraph 20 of the Recommendation. Data and information collected from this sampling program should include, at a minimum, the following: species composition, landings by species, length composition, and weights, as well as biological samples suitable for determining life history as practicable. This information should be submitted by country of landing and quarter.

The Recommendation also includes the establishment of an ICCAT Regional Observer Program to ensure observer coverage of 100% of all surface fishing vessels 20 meters LOA or greater fishing bigeye and/or yellowfin tunas in the area/time closure referred to in paragraph 20.

The Group considered that the information provided for these two programs is complementary and consequently both programs should be considered together.

5.1 Port Sampling Plan

Table 3 shows information on the surface fleets currently fishing in the equatorial area. Information includes: flag, gear, landing port as well as the number of vessels. By gear, purse seine is the most important surface gear fishing tropical tunas in the area, although a Ghanaian baitboat fleet is also operating fishing mainly in association with purse seine vessels. Purse seine fleets include 9 flags that can be classified in three main styles:

- European style fleet (EU-FR, EU-SP, Cape Verde, Panamá, Guatemala, Curaçao and one boat from Belize);
- Ghanaian style fleet (including PANOFI vessels which characteristics are close to "others" and are landing in Abidjan); and
- Other styles (Belize, Guinea Rep., Cape Verde and Côte d'Ivoire).

The group "Others" is characterized to have Korean financial interest. As regards the landing ports, Abidjan (Côte d'Ivoire) and Tema (Ghana) are the main landing ports for these fleets, although there are sporadic landings in other ports. Abidjan is the main landing port for the European and associated fleets as well as for the majority of the "Others" fleets and the PANOFI component of the Ghanaian fleet. Tema is the landing port for the Ghanaian fleet, other than PANOFI, and the Belizean fleet.

Currently, there are programs in Abidjan for sampling and monitoring the European and associated fleets and in Tema for the component of the Ghanaian fleet landing in this port.

The sampling programs in place are multi-species, with the double objective of estimating size distribution and species composition of the catch, stratified by time and, in the case of Abidjan, by area and fishing mode (FADs and free school). This multi-species sampling scheme has been considered by the SCRS as the best approach to correct bias in the species composition of the catch reported in the logbooks.

Based on this information, the Group developed the Port Sampling Plan as follows:

Size and species composition

- Multi-species sampling. In this scheme, the sample is taken randomly from the entire catch without any sort by species. The sample size should be 500 fish for small fish (<10 kg) and 50 fish for large fish. For small fish, considering that the proportion of the three main species is very different and taking into account that it is important to ensure a minimum sample size for all three species, all yellowfin tuna and bigeye tuna (species with a lower proportion in the catch) should be measured. On the contrary, skipjack tuna and other small tuna species should be measured until the mode in the size distribution appears and then the fish should only be counted (for more details on the Method see Annex 2 to Chapter 4 in the *ICCAT Manual*).

- Stratified by:
  - Time (month)
  - Area (areas should be defined as homogeneously as possible regarding sizes and species composition); the area affected by the time/area closure should be considered as stratum.
  - Fishing mode (FADs vs. Free school)
  - Size category (<10 kg =>10 kg)

- Sampling coverage: 1 fish per t (minimum coverage)

- Type of measure: FL for small fish and LD1 for large fish

Weight and biological sampling

- Weight information can be obtained through the Length/ Weight relationship adopted by the SCRS (see *ICCAT Manual*, Chapter 2).
- In addition, weight information can be obtained as part of biological sampling that includes genetic, maturity, sex ratio and other biological parameters. To reduce the cost, this biological sampling can be implemented through specific agreement with the canneries. Samples should be taken following the procedure defined in Chapter 4 of the *ICCAT Manual* for biological sampling.

In order to implement the sampling plan it is fundamental:

- To reinforce the sampling teams working in Abidjan and Tema.
- To ensure that all vessels from any flag landing in each landing port are sampled according to the established sampling scheme.
- To do this it is fundamental that the sampling teams can access all vessels landing at port, independently of their flag and including cargo vessels. Vessels should facilitate sampling and should provide them with all the information needed to accomplish the sampling plan (logbooks, well plan, etc.) catch.

5.2 ICCAT Observer Program

The Group recognized the importance of observer programs as a valuable and unique source of information for scientific purposes. Therefore, the Group recommended that the ICCAT Observer Program for tropical tunas also focus on the collection of scientific data.

Along these lines, information collected by observers should include, at least, the minimum standard defined by the Group on the harmonization of observer programs on board purse seine vessels across all tuna RFMOs. This Group met in March 2012 following the recommendation of the Joint tRFMO By-Catch Working Group.

Taking into account that national observer programs are regularly implemented in the area, the Group recommended that the Regional Observer Program follow similar protocols. The Group also recognized the interest of exploring alternatives, such as the use of electronic devices to record activities on board, understanding that these alternatives would not substitute observers but would be complementary to the observers' work.

With regard to sampling, the Group acknowledged the difficulty of conducting sampling on both main tuna species and on by-catch species and discards by observers. Therefore, it was recommended to coordinate observer programs with a reinforcement of port sampling in order to ensure good sampling coverage of the tuna catch. In this way, the observer can focus on sampling by-catch species and discards. However, if the port sampling does not reach a minimum coverage, the observers should sample the tuna catch.

6. Review of the work conducted on the implementation of a large-scale tagging program

The work by this Working Group has shown the severe uncertainties that remain today in the knowledge of many biological parameters of tropical tunas (YFT, SKJ and BET) in the Atlantic Ocean. These uncertainties are a major source of potential bias in the diagnosis of the status of the stock and in their subsequent KOBE plots and matrices.

This firm conclusion reinforces the recommendation made by the SCRS in 2010, and later approved by the Commission, that a large-scale tagging program of the three species of tropical tunas should be urgently conducted in the Atlantic to improve knowledge on these biological parameters. This tagging program should have a framework and scientific targets similar to those of the large-scale tagging program successfully conducted in 2005-2007 by the IOTC in the Indian Ocean (under EU-FED funds, following a request by Seychelles and Mauritius Island) .

As was the case for the recent successful Indian Ocean Tropical Tuna Tagging Program, funding of the ICCAT tagging program for an ambitious, but necessary, large-scale tagging program targeting tropical tunas in the Atlantic that has been recommended by SCRS and the Commission could possibly be obtained from EU DG-DEVCO within the framework of European Development Fund (EDF) programs with African, Caribbean and Pacific Group of States (ACP) countries. Several ACP countries have already expressed their interest in this ICCAT tagging program (Senegal, Mauritania, Ghana, Cap Verde, Côte d'Ivoire). However, the administrative situation of the tagging project has not progressed yet. Consequently, the Group recommends that a scientist should be in charge of promoting the launching of this tagging program. The Group also recommends that the corresponding costs of this promotion should be funded by ICCAT in order to allow contacts between CPCs' fisheries administrations and EU DG-DEVCO as well as to initiate the launching of the administrative and financial aspects of this potential EU project. The estimated budget for these promotional actions should be evaluated and presented to the SCRS for approval.

7. Presentation of the results of the joint tuna-RFMOs meeting on the harmonization of the purse seine observer programmes on tropical tuna

The Second Kobe Meeting of the tuna RFMOs established a Joint Technical Working Group on By-catch with the first 12 months' work plan for this group approved at the Third Kobe Meeting in July 2011. Included in this work plan is the "harmonization of by-catch data collected by tuna RFMOs" with the intended purpose of identifying the minimum data standards and data fields that should be collected across all RFMOs with a view to allowing interoperability. In establishing the minimum standards, it is recognized that these should maximize the detail recorded (where practical) so that data users can aggregate information to suit the questions asked. Harmonization of data across tuna RFMOs is desired to allow for more comprehensive reporting on the status of by-catch species, to assist with the identification of factors that cause or increase by-catch, and to evaluate the performance of mitigation methods. At the same time, improvements in quality of the data collection should help stock assessments and other functions of t-RFMOs.

A meeting of technical experts from tuna purse seine fisheries observer programs was convened from 5-9 March 2012, in Sukarieta, Spain, and provided the first opportunity for progress towards completion of this task for purse seine fisheries.

The objective of this meeting was to harmonize data collection systems to improve research on by-catch mitigation, stock assessment and other topics.

The technical experts considered the following issues relevant for the interoperability of observer data collected in the purse seine fisheries of tuna-RFMOs:

- √ Observer Coverage
- √ Definitions of TRIP
- √ Definitions of ZERO CATCH SETS
- √ Vessel Register
- √ Vessel Captain/Fishing Master Name
- √ Fishing Location Information
- √ Observer Placement
- √ Data Confidentiality
- √ Environmental Data
- √ Data Quality and Management
- √ Length Measurement of tuna discards
- √ Definition of Set types
- √ FAD Records
- √ Mitigation Measures

To prioritize the harmonization of data reporting across the t-RFMOs, the Group examined the current degree of similarity between the various observer data fields collected by each t-RFMO and provided a qualitative evaluation of interoperability, which are summarized in **Table 4**. A ranking of 'HIGH' indicates that most data fields and details are the same; 'INTERMEDIATE' indicates that some similarity in data fields and details exists; and 'LOW' indicates that there is little similarity in data fields and details. A "LOW" value is likely to result in restricted interoperability. Therefore, these data fields should be considered of high priority for harmonization across t-RFMOs.

In any case, the goal would be to establish a common minimum for all oceans, rather than collecting exactly the same information in all oceans.

8. Recommendations

Statistics

- The on-going data mining implemented in Angola for the catches of small tuna species should be extended to commercial tunas (e.g., multi-species sampling of the by-catch category). These data should be submitted to ICCAT.

- Regarding the non-confidential character of biological data sets (i.e., morphometric measurements and reproduction data) and their major interest for scientific analyses, the Working Group recommends that:
  - Each CPC provide a description of the available biological datasets in accordance with metadata standards (e.g., http://geonetwork-opensource.org/, http://www.mdweb-project.orgx;
  - An inventory of the metadata be published by the ICCAT Secretariat through the ICCAT or other appropriate website;
  - The ICCAT Secretariat explore the possibility of collaboration with other RFMOs and scientific bodies (e.g., ICES) and research labs (e.g., Dalhousie University) for the development of database tools for managing and sharing biological data.

- In order to facilitate the Species Group's revision of the adequacy of assumptions, data and methodologies used for standardizing CPUEs series, each scientific document related to this topic should include an annex describing the different items defined in the quality control protocol during the 2012 meeting of the Working Group on Stock Assessment Methods. On the basis of Task II data, the authors or, if this is not possible, the ICCAT Secretariat, will provide additional, useful information to evaluate factors potentially affecting the fishery analyzed (spatial catch distribution by periods, multi-species catches over time, etc.).

- Based on the resolutions adopted by other tuna RFMOs, it is recommended that the ICCAT Recommendation 11-01 related to operations on FADs be extended on a mandatory basis to all supply vessels regardless of their fishing flag. This recommendation should cover all the activities conducted by supply vessels (e.g., with detailed logbooks).

- The Working Group recommends the ICCAT Secretariat to urgently inform the CPCs which land their catches in other countries that the sampling teams can access all vessels landing at port, independently of their flag and including cargo vessels. Vessels should facilitate sampling and should provide these teams with all the information needed to accomplish the sampling plan (logbooks, well plan, etc.).

Research

- In light of the time constraints and complexity for the complete MSE approach, elasticity simulations conducted to evaluate the impact of life parameters on the status of tropical stocks were presented during the this inter-sessional meeting as an alternative. For the future, it is recommended that such a promising approach include assumptions on sex-specific growth and sex-specific natural mortality by age. It was also suggested that these uncertainties be expressed in the Kobe projection matrices.

- Based on the proposal submitted and approved by the SCRS in 2010 (ICCAT, 2011), the Working Group recognizes that special funding is needed to assist the travel of an SCRS scientist who will be in charge of organizing contacts and technical tasks between CPCs' fishery administrations and the EU DG DevCo in order to promote the funding of this Atlantic Regional Tagging Program.

9. Other matters

No other matters were discussed.

10. Adoption of the report and closure

The Chairman thanked the meeting participants for the hard work done and the Secretariat for the assistance provided. The report was adopted and the meeting adjourned.

References

Anon. 2012a. Report of the 2011 Tropical Tuna Species Group Inter-sessional Meeting on the Ghanaian Statistics Analysis (Phase II) (Madrid, Spain, Maya 30 to June 3, 2011). Collect. Vol. Sci. Pap. ICCAT, 67. *In press.*

Anon. 2012b, Report of the 2011 ICCAT Yellowfin Tuna Stock Assessment Session (San Sebastian, Spain, September 5 to 12, 2012). Collect. Vol. Sci. Pap. ICCAT, 67. *In press.*

Bez, N., Walker, E., Gaertner, D., Rivoirard, J. and Gaspar, Ph. 2011, Fishing activity of tuna purse seiners estimated from vessel monitoring system (VMS) data. Can. J. Fish. Aquat. Sci. 68: 1998-2010.

Conn, P.B. 2010, Hierarchical analysis of multiple noisy abundance indices. Can. J. Fish. Aquat. Sci. 67: 108-120.

Fournier, D.A., Hampton, J. and Sibert, J.R.1998, MULTIFAN-CL: A length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore, *Thunnus alalunga*. Can. J. Fish. Aquat. Sci. 55: 2105-2116.

Fromentin, J.M. and Fonteneau, A. 2001, Fishing effects and life history traits: a case study comparing tropical versus temperate tunas. Fisheries Research 53(2001): 133-150.

Gascual , D., Fonteneau, A., Capisano, C. 1992, Modélisation d'une croissance en deux stances chez l'albacore (*Thunnus albacares*) de l'Atlantique Est. Can. J. Fish. Aquat. Sci., Vol. 51: 723-733.

Hampton, J. 2000, Natural mortality rates in tropical tunas: size really does matter. Can. J. Fish. Aquat. Sci.. Vol. 57, No. 5, pp. 1002-1010.

Langley, A., Hampton, J., Herrera, M. and Million, J. 2008, Preliminary stock assessment of yellowfin tuna in the Indian ocean using MULTIFAN-CL doi: IOTC-2008-WPTT-10.

ICCAT. 2006-2009, ICCAT Manual. International Commission for the Conservation of Atlantic Tunas. In: ICCAT Publications [on-line]. Updated 2009. [Cited 01/27/]. http://www.iccat.int/en/ICCATManual.htm, ISBN (Electronic Edition): 978-92-990055-0-7.

ICCAT, 2011, A Proposal for an Atlantic Ocean Tropical Tuna Tagging Program (AOTTP) (Addendum 2 to Appendix 5 to the 2010 Report of the ICCAT Standing Committee on Research and Statistics (SCRS). *In* Report for Biennial Period, 2010-11, Part I (2010) – Vol. 2 – SCRS. pp. 231-236.

ICCAT, 2012, Tropical Tunas Work Plan for 2012 (Appendix 4 to the 2012 Report of the ICCAT Standing Committee on Research and Statistics (SCRS). *In* Report for Biennial Period, 2010-11, Part II (2011) – Vol. 2 - SCRS. pp 221-222.

Kolody, D. 2011, Can length-based selectivity explain the two stage growth curve observed in Indian Ocean YFT and BET? IOTC-WPTT13-33 2011. Report of the Thirteenth Session of the IOTC Working Party on Tropical Tunas (Lankanfinolhu, North Malé Atoll, Republic of Maldives, 16-23 October 2011). IOTC-2011-WPTT13-R[E]: 94 pp.

Lechauve, J.J. 2001, AVDTH software.

Lorenzen, K. 1996, The relationship between body weight and natural mortality in fish: a comparison of natural ecosystems and aquaculture. J. Fish Biol. 49: 627-647.

Mc Gurk, M.D. 1986, Natural mortality of marine pelagic fish eggs and larvae: Role of spatial patchiness. Marine ecology progress series, Vol. 34, No. 3, pp. 227-242.

Pallarés, P. and Petit, Ch. 1998, Tropical tunas: New sampling and data processing strategy for estimation of composition of catches by species and sizes. Collect. Vol. Sci. Pap. ICCAT, 48(2): 230-246.

Peterson, I. and Wrobleski, S. 1984, Mortality rate in the pelagic ecosystem. Can. J. Fish. Aquat. Sci. 41: 1117-1120.

Polacheck, T., Paige Eveson, J., Laslett, G.M., Pollock, K.H., Hearn, W.S. and Hoenig, J.M. 2007, An integrated Brownie and Petersen model for estimating mortality rates and population size in a fisheries context with known reporting rates. FRDC Project 2002/015, 46p.

Shuford, R.L., Dean, J.M., Stequert, B. Morize, E. 2007. Age and growth of yellowfin tuna in the Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 60(1): 330-341.

Table 1. An evaluation of a proposed tool to evaluate indices of abundance (WG-SAM, Table 3.2). In this example, 11 indices submitted for the 2011 yellowfin tuna stock assessment were examined. In general, higher reliability indices will receive higher scores. For a detailed explanation of the scoring, see Table 2 of the WG-SAM.

ELEMENT	DESCRIPTION	EU-Dakar	Ven PS	US LL	U.S RR (MRFSS)	EU_FAD_PS
1	Diagnostics	4	1 - Not Standardized	4	3 to 4	3 to 4
2	Appropriateness of data exclusions and classifications (e.g. to identify targeted trips).	4	2	5	3	3
3	Geographical Coverage	1	2	3	2 or 3	5 for juveniles, lower for others
4	Catch Fraction (Relative to Total Catch)	1	2	1	1	4
5	Length of Time Series relative to the history of exploitation.	5	3	4	4	4.5 (1980+)
6	Are other indices available for the same time period?	(1, 5) Many for production models, represents unique age and	(1,5)Many but unique in this area - integrated model	2	2, Not for REC	(1,5) Many, but one of few available index for juveniles
7	Does the index standardization account for known factors that influence catchability/selectivity?	1	1	3, Change to circle hooks	2, No information, although index includes catch+discards+released alive	1
8	Are there conflicts between the catch history and the CPUE response? Note: Catch history of the fishery, not the stock.	?	?	?	?	?
9	Is the interannual variability outside biologically plausible bounds (e.g. SCRS/2012/039)	2	1	4	2	Not Available
10	Are biologically implausible interannual deviations severe? (e.g. SCRS/2012/039)	1.5	5	5	4	Not Available
11	Assessment of data quality and adequacy of data for standardization purposes (e.g. sampling design, sample size, factors available)	3. Data quality was high, but few factors available for analysis	1. Relatively Low, PP and BB fish together, not explored. Targeting not xplored	4. Data quality high, but does not include all important factors (hook type).	3. Moderate Some self reported data (discards)	3. Data quality was high, but few factors available for analysis
12	Is this CPUE time series continuous?	4.5	5	5	5	5

Table 1. (Continued). An evaluation of a proposed tool to evaluate indices of abundance (WG-SAM, Table 3.2). In this example, 11 indices submitted for the 2011 yellowfin tuna stock assessment were examined. In general, higher reliability indices will receive higher scorer. For a detailed explanation of the scoring, see Table 2 of the WG-SAM.

ELEMENT	DESCRIPTION	EU_PS3%	Brazil BB	JPN_LL	CHIN_TAIP_LL	BRA_LL	U.S. Mex GOM OBS
1	Diagnostics	1 - Not Standardized	1 - Not Described	4	3	3. Some diagnostics, some departure from expectations.	1. None provided! Delta Poisson - effort variable included as an offset.
2	Appropriateness of data exclusions and classifications (e.g. to identify targeted trips).	5 - No exclusions	1, Targeting variable not described, but generally target SKJ	3 Hooks per basket - May be deep and shallow sets.	3 or 4. Targeting is likely important. Should be explored (e.g. with species composition).	2. Strong outliers noted. Targeting not fully appropriate.	5. Approriate, although not fully documented. Discussed by author.
3	Geographical Coverage	5	1 or 2	5	5	3	3 (Entire GOM)
4	Catch Fraction (Relative to Total Catch)	5	1	2 (4% recently)	1	1	1 to 2 (3%)
5	Length of Time Series relative to the history of exploitation.	5 (1970+0	3 (1981 to 2006)	5 (1965+)	5 (since 1968)	4 (1980+)	3 (1992)
6	Are other indices available for the same time period?	1, Many	1, Many	1, Many	1, Many	(1, 5) Many but unique for area	(1, 4) Many, but one of few in GOM
7	Does the index standardization account for known factors that influence catchability/selectivity?	1, Not Standardized	1, Not described.	3: Not fully accounted for.	3	1	4. No accounting for change to circle hooks.
8	Are there conflicts between the catch history and the CPUE response? Note: Catch history of the fishery, not the stock.	?	?	4. No conflict noted, but not explored during fishery development (1955-1970).	5. No conflict noted	1. Conflict noted and strong	?
9	Is the interannual variability outside biologically plausible bounds (e.g. SCRS/2012/039)	5	1	4	3 to 4 (depending of time series)	1	3 to 4
10	Are biologically implausible interannual deviations severe? (e.g. SCRS/2012/039)	5	2 or 3	3 or 4	3 to 5	1	5
11	Assessment of data quality and adequacy of data for standardization purposes (e.g. sampling design, sample size, factors available)	2, Data quality is good, lacks factors for standardization.	1 - not described. Also, there are 7 different joint ventures that operate with different characteristics.	3: Conversion to biomass indices will require improved size frequency information. Little biological basis for SST^2 and SST^3 terms.	3	2. Multiple fleets with different characteristics. Many outliers.	4. Obs program, many factors present to evaluate. For some years MEX obs data was not available.
12	Is this CPUE time series continuous?	5	5	5	5	5	5

Table 2. Proposed guidance and recommendations regarding the most appropriate use of 11 yellowfin tuna indices. This evaluation was done to evaluate tools proposed by the WG-SAM. Final decisions regarding the use of the indices of abundance will be determined by the Species Groups during the data preparatory/assessment meetings.

Index	Surplus Production	Age Stuctured	Spatial	Comments and Recommendations
EU-Dakar	No	No	No	Requires improved understanding of factors that influence catchability and availability to fishery.
Ven PS	No	No	Yes for some applications	Requires standardization. Requires improved understanding of factors that influence catchability and availability to fishery.
US LL	Yes	Yes	Yes	Should evaluate the potential change in q due to circle hooks.
U.S RR (MRFSS)	No	No	No	Should improve approach to identify targeted trips. Should provide size composition. Can spatial coverage be improved with additional recreational data?
EU_FAD_PS	No	Yes	Yes	Variability year to year may be unrealistic, but trends may be important. Changes in catchability should be explored. The use of this index is recommended primarily because it is one of the only available data sources for recruits.
EU_PS3%	Yes, with sensitivity analysis of likely changes in q	Yes, with sensitivity analysis of likely changes in q	Yes, with sensitivity analysis of likely changes in q	Exercise caution before use of this index. Should improve understanding of likely changes in q. Request that EU scientists present information regarding q when the index is updated.
Brazil BB	No	No	No	A document was not evaluated at the 2011 YFT assessment meeting, although an earlier document (2008) might be evaluated. Based on our understanding at the 2011 assessment, the index quality could not be evaluated. If this index is to be reevaluated in the future, the appropriate documentation must be provided. A detailed evaluation of targeting and a standardization across the fleet characteristics must be provided.
JPN_LL	Yes	Yes	Yes	Improved explanation of changes in targeting and catchability. Evaluate the biological basis for inclusion of SST-squared and SST-cubed factors in the standardization. AF will provide.
CHIN_TAIP_LL	Yes	Yes	Yes	The index was developed in 4 stanzas to attempt to accommodate changes in targeting, data reporting requirements and q. Model preformance should be evaluated to determine whether parameter estimates were reasonable. The earliest stanza had relatively poor diagnostic performance. Stanzas must be evaluated seperately which was not done in this exercise.
BRA_LL	No	No	No	A detailed evaluation of targeting and a standardization across the fleet characteristics must be provided. Standardization procedures must produce LS_means by year.
U.S. Mex GOM OBS	See Recommendations	See Recommendations	See Recommendations	No index without diagnostics should be included. If apporiate diagnostics were made available, the index is appropriate for use. Must provide diagnostics. A delta-poisson was used with an offset variable to account for effort. Since this is an uncommon method, diagnostic should be provided to determine whether this error structure is more appropriate than the delta-lognormal model on catch/effort.

Table 3. Number of surface vessels existing in the ICCAT record of vessels and fishing in the Equatorial area by flag, gear and main landing port. This table does not include supply or cargo vessels.

Gear	*Flag*	*No. of boats*	*Landing port*	
PS	Belize	5	Tema	Abidjan
	Côte d'Ivoire	1		Abidjan
	Cap-Vert	5		Abidjan
	Curaçao	3		Abidjan
	Ghana	15	Tema	Abidjan
	Guinee Rep.	3		Abidjan
	EU_France	10		Abidjan
	EU_Spain	15		Abidjan
	Guatemala	2		Abidjan
	Total PS	59		
BB	Ghana	24	Tema	
	TOTAL	83		

Table 4. Ranking of the main data fields.

Data category	*Rank*
Harmonization of Effort Data	
Vessel Identification *(Information to uniquely identify vessels)*	HIGH
Vessel Trip Information *(Information to calculate trip duration, location and time)*	HIGH
Observer Information *(Information to uniquely identify captain/fishing master)*	HIGH
Crew Information *(Information to calculate crew number)*	HIGH
Vessel and Gear Attributes *(Information to detail vessel specification and equipment)*	HIGH
Daily Activities *(Information characterise vessel fishing and non-fishing activities during a trip allowing effort to be examined in finer resolution)*	INTERMEDIATE
School and Set Information *(Information to characterise school type and detection method)*	HIGH
Harmonization of catch data	
Catch Information *(weight and or numbers of target and bycatch species)*	INTERMEDIATE
Length Information *(weight and or numbers of target and bycatch species)*	LOW
Species of Special Interest *(weight, length, fate and description of interaction)*	INTERMEDIATE

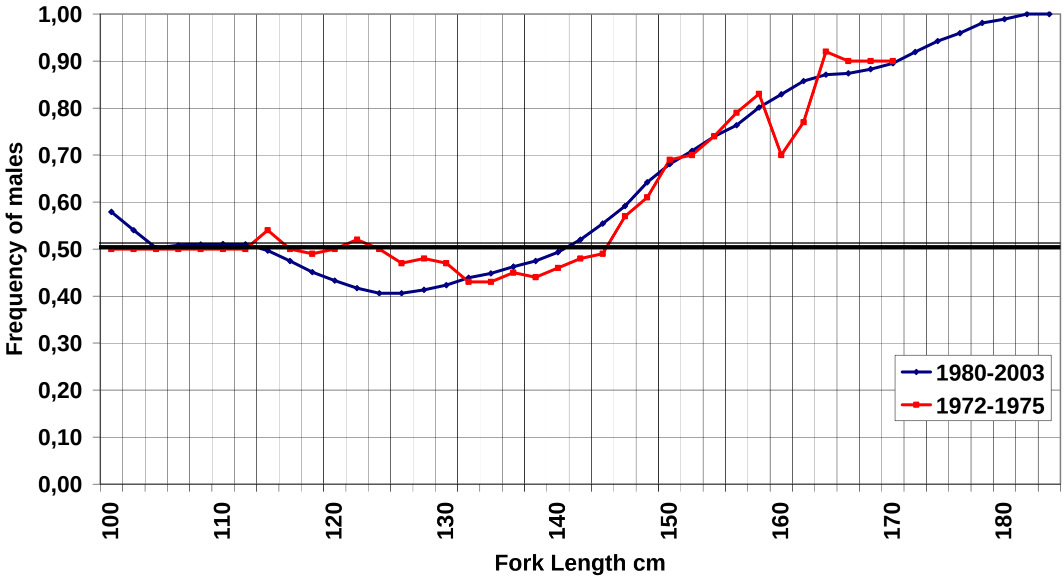

Figure 1. Sex ratio at size of yellowfin, proportion of males, in the eastern Atlantic observed in 1975 and in 2003 (The excess of females at intermediate/large sizes is highly significant (Chi2 test) because of the large number of fish sampled at these sizes).

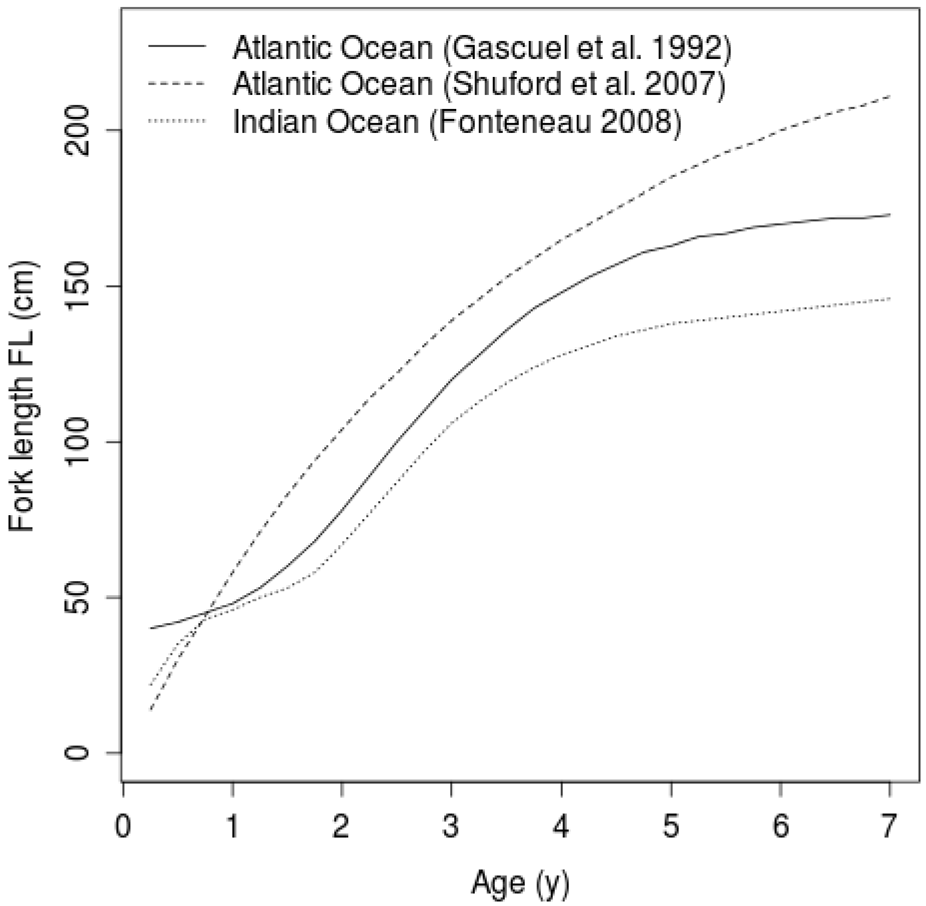

Figure 2. Yellowfin growth curves presently estimated in the Atlantic and in the Indian Oceans (a growth curve based on tagging results).

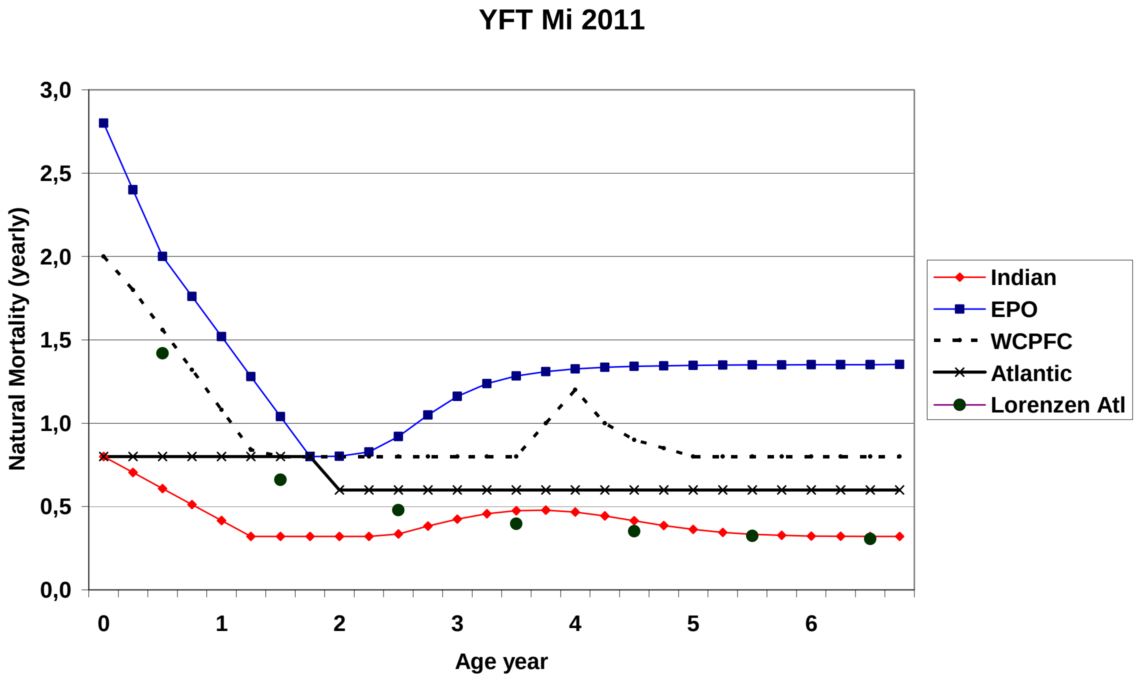

Figure 3. Natural mortality at age (yearly scale) presently estimated as used for yellowfin tuna by the various tuna RFMOs in their stock assessments.

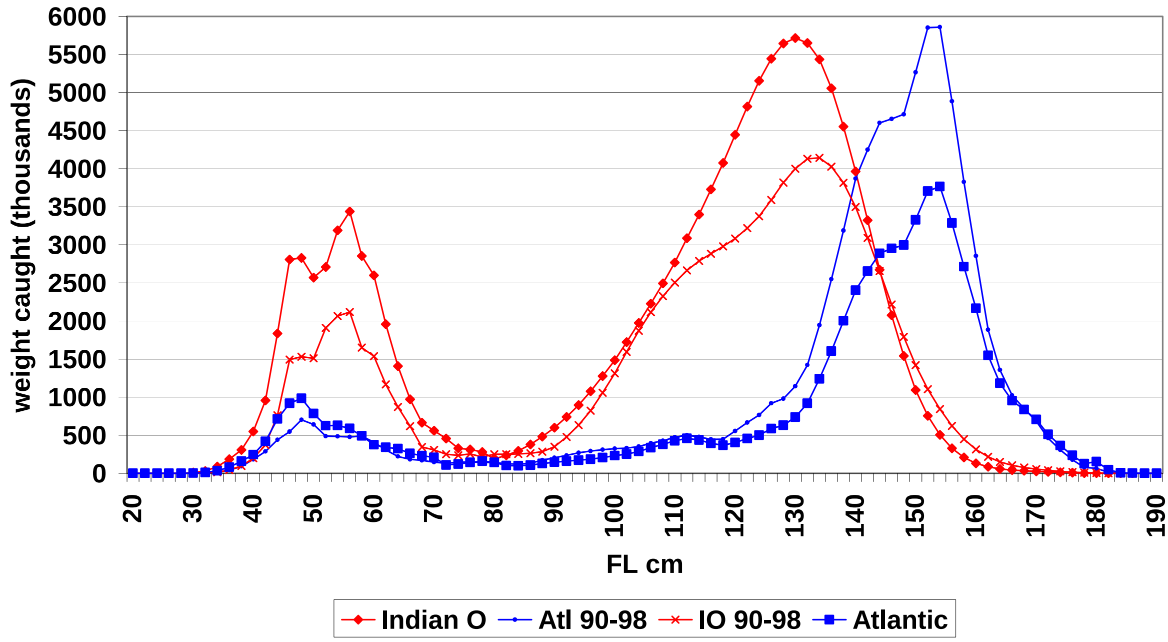

Figure 4. Average catch at size of yellowfin tuna (in weight) taken by EU purse seiners in the Indian and Atlantic Oceans during two recent periods.

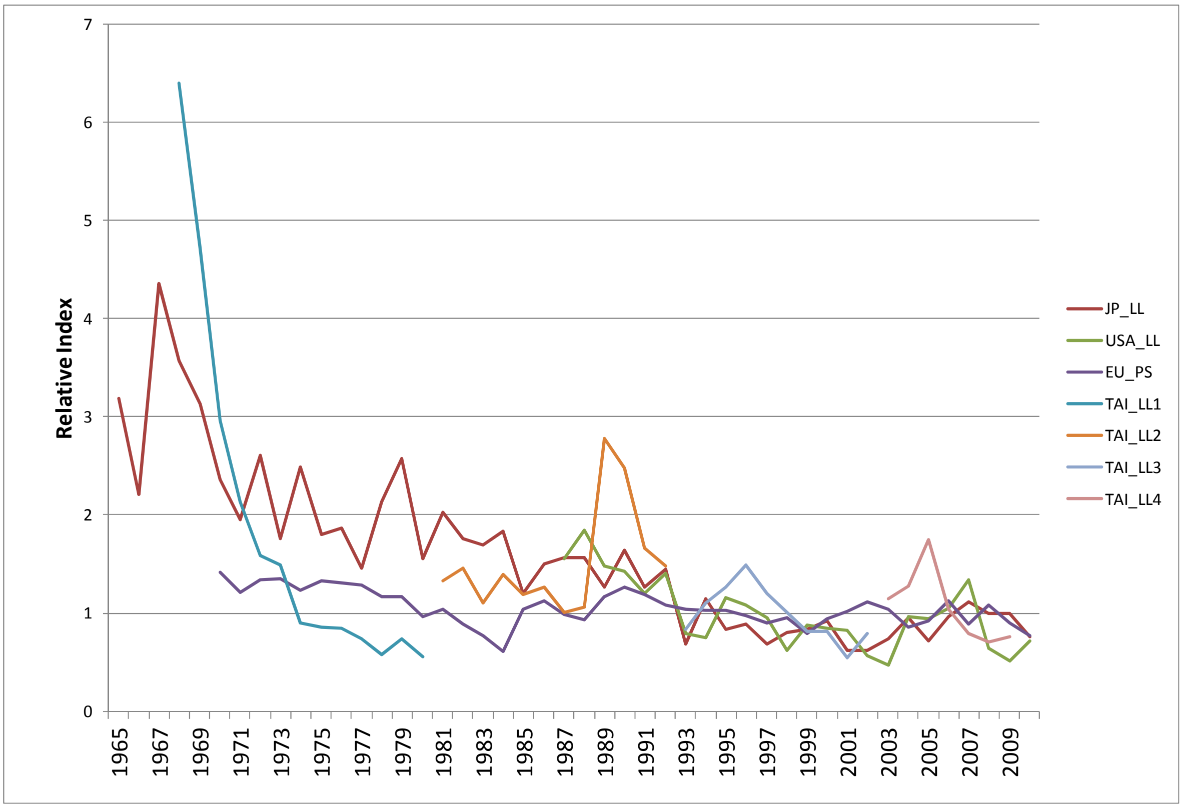

Figure 5. Relative abundance indices used for the calculation of a combined index.

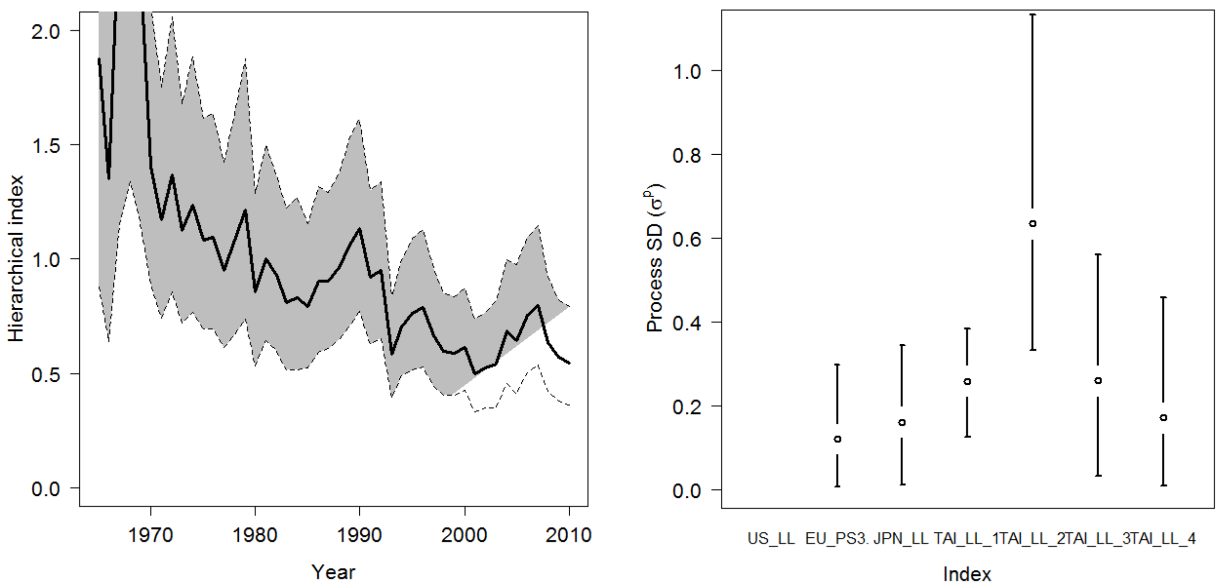

Figure 6. Results of the Conn (2010) approach for the combination of multiple relative abundance indices. The combined relative index values are shown with 95% confidence intervals (left panel); the process standard deviations for each index are shown in the right panel.

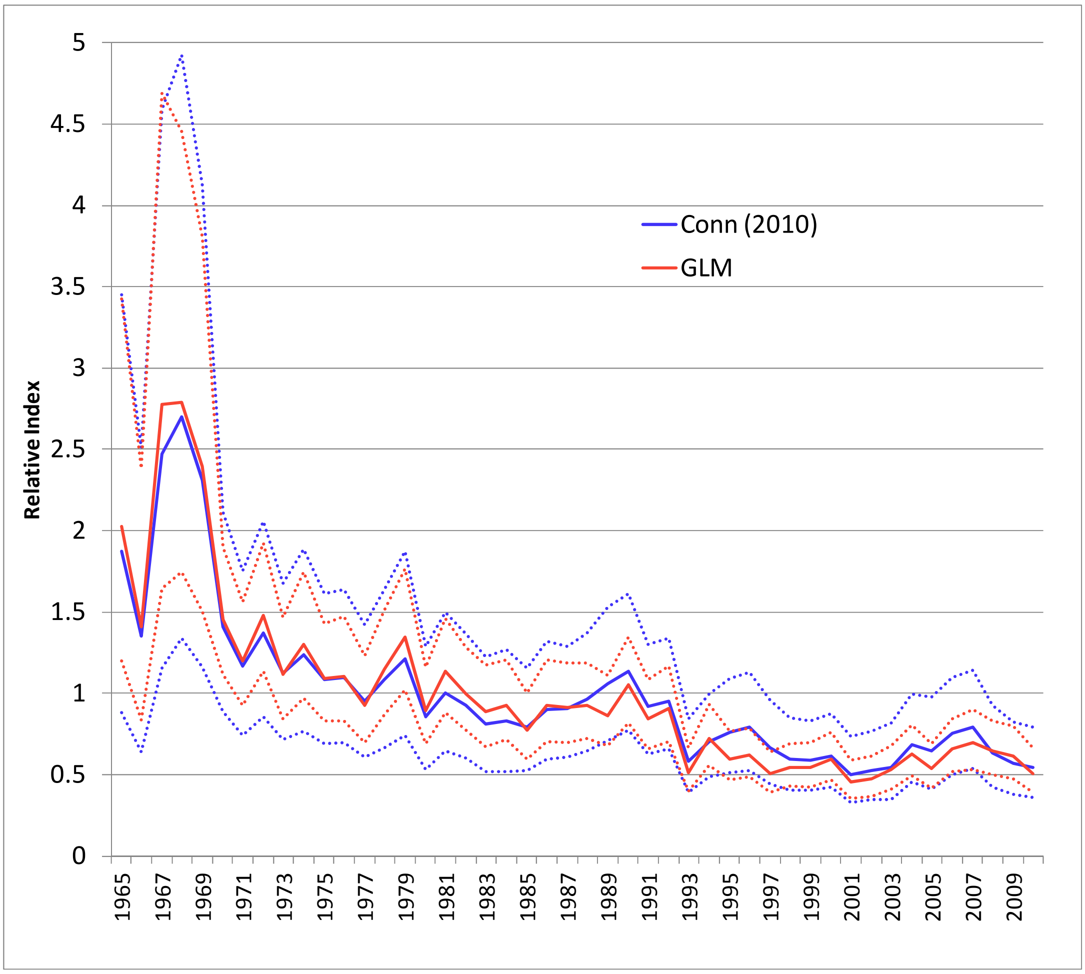

Figure 7. Comparison of the combined indices calculated using the Conn (2010) and GLM approaches. Combined relative index values are shown with 95% confidence intervals.

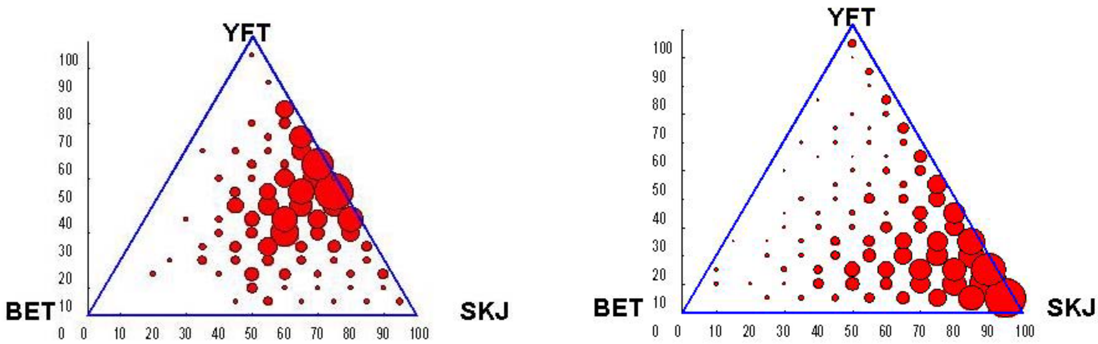

Figure 8. Ternary plot showing the frequency of multi-species composition of all samples taken on Ghanaian landings (left) and EU PS FAD catches (right) during the period 2008-2010.

Appendix 1

AGENDA

1. Opening, adoption of Agenda and meeting arrangements

2. Revision of biological parameters of yellowfin, bigeye and skipjack, including a revision of parameters used in other oceans

3. Revision of the CPUE standardized process and methods used to combine indices

   3.1 Application of a Quality Control Protocol (QCP) to the tropical CPUEs series (cf. Table 3.2, WG-SAM 2012)
   3.2 Methods to improve and combine the indices provided from different fisheries in a single combined index, including sensitivity analyses on the effect of different weighting criteria
   3.3 Revision of factors affecting CPUE in purse seine (FADs, echo-sounders, satellites, etc.) and baitboat fisheries (FADs, schools associated with BB)
   3.4 Alternative indices of abundance of recruits and juveniles

4. Review of current status of work conducted by the Working Group on the improvement of Ghanaian statistics

   4.1 Revision and integration of Task II catch-effort and size data
   4.2 Collaboration plan between Ghanaian and IRD scientists as defined by the Tropical Species Group

5. Develop a Port and an associated Observer On-board Sampling Plan aimed at collecting fishery data for bigeye tuna, yellowfin tuna and skipjack tuna that are caught in the geographical area of the area/time closure

   5.1 Port sampling Plan
   5.2 ICCAT Observer Program

6. Review of the work conducted on the implementation of a large-scale tagging program.

7. Presentation of the results of the joint tuna-RFMOs meeting on the harmonization of the purse seine observer programmes on tropical tuna

8. Recommendations

9. Other matters

10. Adoption of the report and closure

Appendix 2

LIST OF PARTICIPANTS

SCRS CHAIRMAN
Santiago Burrutxaga, Josu
Head of Tuna Research Area, AZTI-Tecnalia, Txatxarramendi z/g, 48395 Sukarrieta (Bizkaia), Spain
Tel: +34 94 6574000 (Ext. 497); 664303631, Fax: +34 94 6572555, E-Mail: jsantiago@azti.es

CONTRACTING PARTIES
ANGOLA
Kilongo N'singi, Kumbi
Instituto Nacional de Investigaçao Pesqueira, Rua Murthala Mohamed; C.Postal 2601, Ilha de Luanda
Tel: +244 2 30 90 77, E-Mail: kkilongo@gmail.com

EUROPEAN UNION
Chassot, Emmanuel
IRD, Centre de Recherche Halieutique Méditerranéenne et Tropicale, Av. Jean Monnet, B.P. 171, 34203 Sète Cedex, France
Tel: +33 499 573 224, Fax: +33 4 99 573 295, E-Mail: emmanuel.chassot@ird.fr

De Bruyn, Paul
AZTI - Tecnalia, Herrera Kaia Portualdea z/g, 20110 Pasaia Gipuzkoa, Spain
Tel: +34 94 657 40 00, Fax: +34 946 572 555, E-Mail: pdebruyn@pas.azti.es

Delgado de Molina Acevedo, Alicia
Ministerio de Economía y Competitividad, Instituto Español de Oceanografía, C.O. de Canarias, Apartado 1373, 38080 Santa Cruz de Tenerife, Islas Canarias, Spain
Tel: +34 922 549 400, Fax: +34 922 549 554, E-Mail: alicia.delgado@ca.ieo.es

Duarte, Rafael
European Commission -DGMARE, Rue Joseph II, 79, 02/21, 1000 Brussels, Belgium
Tel: +322 299 0955, E-Mail: rafael.duarte@ec.europa.eu

Fonteneau, Alain
9, Bd Porée, 35400 Saint Malo, France
Tel: +33 4 99 57 3200, Fax: +33 4 99 57 32 95, E-Mail: alain.fonteneau@ird.fr

Gaertner, Daniel
I.R.D. UR nº 109 Centre de Recherche Halieutique Méditerranéenne et Tropicale, Avenue Jean Monnet - B.P. 171, 34203 Sète Cedex, France
Tel: +33 4 99 57 32 31, Fax: +33 4 99 57 32 95, E-Mail: gaertner@ird.fr

GHANA
Bannerman, Paul
Ministry of Fisheries, Marine Fisheries Research Division, P.O. Box BT 62, Tema
Tel: +233 244 794859, Fax: +233 302 208048, E-Mail: paulbann@hotmail.com

JAPAN
Satoh, Keisuke
Tuna Fisheries Resources Group, Tuna and Skipjack Resources Division, National Research Institute of Far Seas Fisheries, Fisheries Research Agency of Japan, 5-7-1, Chome Orido, Shizuoka-Shi Shimizu-Ku 424-8633
Tel: +81 543 36 6044, Fax: +81 543 35 9642, E-Mail: kstu21@fra.affrc.go.jp

SENEGAL
Ngom Sow, Fambaye
Chargé de Recherches, Centre de Recherches Océanographiques de Dakar Thiaroye, CRODT/ISRA, LNERV - Route du Front de Terre - BP 2241, Dakar
Tel: +221 33 832 8265, Fax: +221 33 832 8262, E-Mail: famngom@yahoo.com

UNITED STATES
Brown, Craig A.
NOAA Fisheries Southeast Fisheries Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4590, Fax: +1 305 361 4562, E-Mail: Craig.brown@noaa.gov

Cass-Calay, Shannon
NOAA Fisheries, Southeast Fisheries Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4231, Fax: +1 305 361 4562, E-Mail: shannon.calay@noaa.gov

Díaz, Guillermo
NOAA-Fisheries, Southeast Fisheries Science Center, 1315 East-West Highway # 13562, Silver Spring, Maryland 20910
Tel: +1 301 713 2363, Fax: +1 301 713 1875, E-Mail: guillermo.diaz@noaa.gov

****

ICCAT SECRETARIAT
C/ Corazón de María, 8 - 6th -7th floor, 28002 Madrid, España
Tel: + 34 91 416 5600, Fax: +34 91 415 2612, E-Mail: info@iccat.int

Kell, Laurence
Ortiz, Mauricio
Palma, Carlos
Pallarés, Pilar

Appendix 3

LIST OF DOCUMENTS

SCRS/2012/037	The tuna fishery along the Angolan coast. Kilongo, K., Jonico, V. and Nsilulu, H.
SCRS/2012/041	Strengthening Ghanaian industrial purse seine fishery monitoring in the Gulf of Guinea. Banerman, P., Chavance, P. and Gaertner, D.
SCRS/2012/043	An evaluation of the importance of the assumed biological parameters for management advice; Atlantic yellowfin. Kell L. and de Bruyn, P.
SCRS/2012/044	An evaluation of the importance of the assumed biological parameters for management advice; Atlantic bigeye. Kell, L. and de Bruyn, P.
SCRS/2012/045	An overview of yellowfin tuna growth in the Atlantic: Von Bertalanffy or multistanza growth? Fonteneau, A. and Chassot, E.
SCRS/2012/047	A comparative analysis of Indian and Atlantic yellowfin and bigeye tuna size Data. Kell, L. and Fonteneau, A.

Appendix 4

Work Plan for the Collaborative Project Between the IRD and Ghana

Component	Action	Content	Persons concerned	Budget IRD	Budget Ghana	Total Budget
PORT SAMPLING	ACTION 1: Trainings	15 days training in Tema in 2012 (TR1) and 7 days in 2013 (TR2)	4 technicians from IRD (1), IEO (1) and CRO (2) and the full Ghanian team	18675		18675
	ACTION 2: Sampling authorisations	*to be defined*	ICCAT, Ivorian and Ghanian managers	no cost	no cost	no cost
	ACTION 3: Data exchange protocols	1-2 days meeting during the training session 1	1 technician from IRD and data manager from Ghana		Included in Action 1	
DATA MANAGEMENT	ACTION 4: Software specifications	Define precisely the software developpement to be done. This will be done during a four-day meeting in Sète (Fr) - WG1	IRD/computer scientists and fishery scientists of IRD and MFRD		2900	2900
	ACTION 5: AVDTH	Update software English version used by Ghana and train local team using it	2 scientists from IRD/CRO and the full Ghanian team		Training included in Action 1	
	ACTION 6: AKADO	Translation and improvement of data validation software	IRD/Computer scientist and computing private company	8000		8000
	ACTION 7: T3 +	Translation and adaptation of processing software T3+	IRD/Computer scientist and computing private company	17000		17000
	ACTION 8: ObServe	Transfer and probably adapt software	IRD/Computer scientist and computing private company	8000		8000
COORDINATION AND DATA PROCESSING	ACTION 9: Coordination	Participation of Ghana to the annual coordination meeting in Europe in May 2013 and May 2014 - WG2 and WG3	One scientist and the port sampler coordinator from Ghana, Senegal and Côte d'Ivoire (6 persons)	12320	6160	18480
EQUIPMENT		Equipment for Ghanian team	- Computers (3 and 1 server) - Ichtyometers(10)		8000	8000
			TOTAL	63995	17060	81055

Unit price		
pdg	145 €	PD Ghana
tgf	1,000 €	Travel Fr-Ghana or international
pdf	90 €	PD France
trg	200 €	Travel RCI-Ghana or regional