Proposals for improved figures in the tropical tunas statistical summaries (Presented at WPTT18 as IOTC–2016–WPTT18-33)

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Abstract

In this paper, we undertake a critical review of the figures included in the tropical tuna 2015 reports presenting the **main statistics of tropical tunas**. The main outcome is that several of these figures do not reflect the information in the most appropriate manner, notably missing to showcase interesting characteristics and changes in the tropical tuna fisheries. Hence, we propose various alternative or additional figures concerning fishing maps, catch at size and numbers of fish sampled for purse seine and combined fisheries, rates of log book data, fishing maps and tag-recoveries maps, yearly average weights combining catches by all gears, etc. Our recommendation is that new figures should preferably be presented in the appendix of the TT report, as they are more informative than the current figures. Our conclusion is that these appendices are very important and that they should be better examined and validated each year by the species working groups.

1- Introduction

This work is examining the various figures that are presented by the TT WG in its statistical appendices on each species of tropical tunas. These appendices and their figures are of major importance as the basic fishery and scientific data shown in these reports are widely conditioning all stock assessment results. It appears that de facto these figures have been seldom deeply discussed by scientists, during the previous sessions of the working party on tropical tunas (WPTT). These appendices are the only documents that convey the most important scientific information upon each tuna stock, but in our view, several of their figures appear to be somehow questionable while some important figures may be missing in these appendices. This paper will discuss the various figures used and will propose various alternate or additional figures that could/should be usefully included in these IOTC documents.

2- Yearly catches and quality of C/E data

2-1 Yearly catches by each gear.

While the appendices contain some information of catches by gear (figure 1a) they do not show the yearly levels and trends of the yearly catches of each gear, a figure probably more important that the catch by flag. This valuable basic information is for instance shown by figure 1b.

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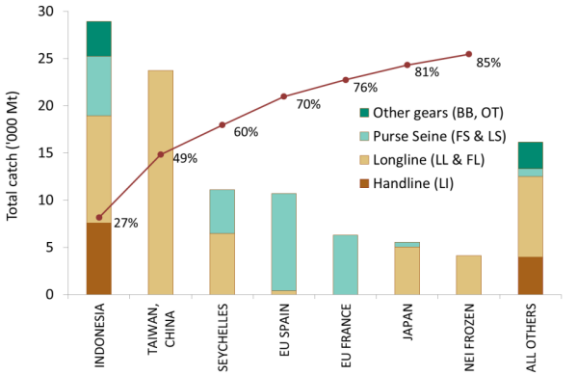


Figure 1a: Figure from the appendix showing catches by gear and flag

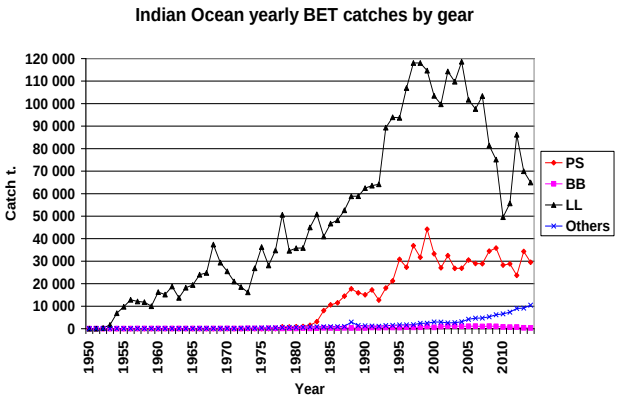


Figure 1b: Recommended figure showing the yearly catches of BET by gear

Our recommendation is that this figure 1b should preferably be visible in the appendices of each species because it carries more important scientific information than the present figure 1a.

2-2 PS yearly catches on FADs and on free schools

The increasing amount of FAD associated catches by the Indian Ocean PS fisheries is an increasing source of worry because of the large quantities of small YFT and small BET in these catches. As most PS fisheries have been permanently well followed by scientists, these data submitted to the IOTC allow to show for each species the amount of catches associated to FADs or floating logs. Our view is that this basic information should be well visible in the appendices. Two types of figures could for instance be envisaged to show this information, for instance figure 2 that is simultaneously showing the yearly FAD & free schools catches, or figure 3 showing for each species the percentages of catches associated to FADs (or to natural logs).

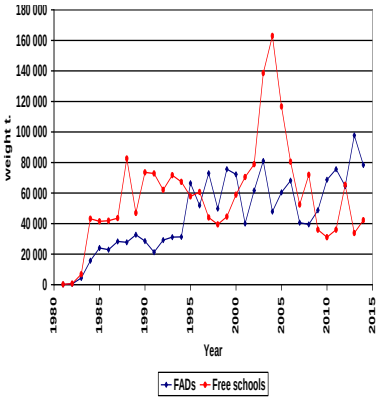


Figure 2a: Weight of yellowfin caught yearly by PS on FS & on FADs

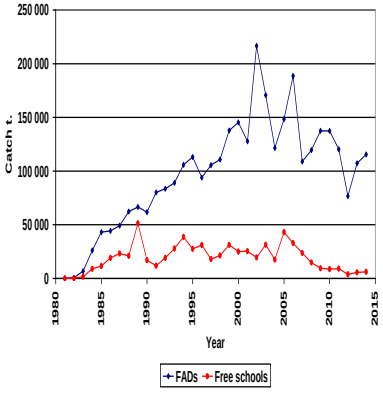


Figure 2b: Weight of skipjack caught yearly by PS on FS & on FADs

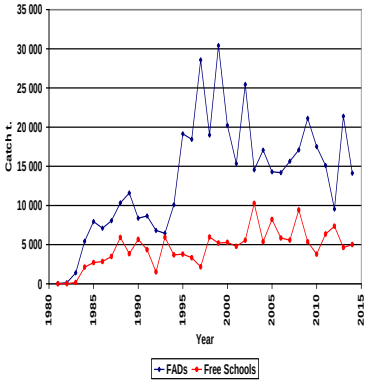


Figure 2c: Weight of bigeye caught yearly by PS on FS & on FADs

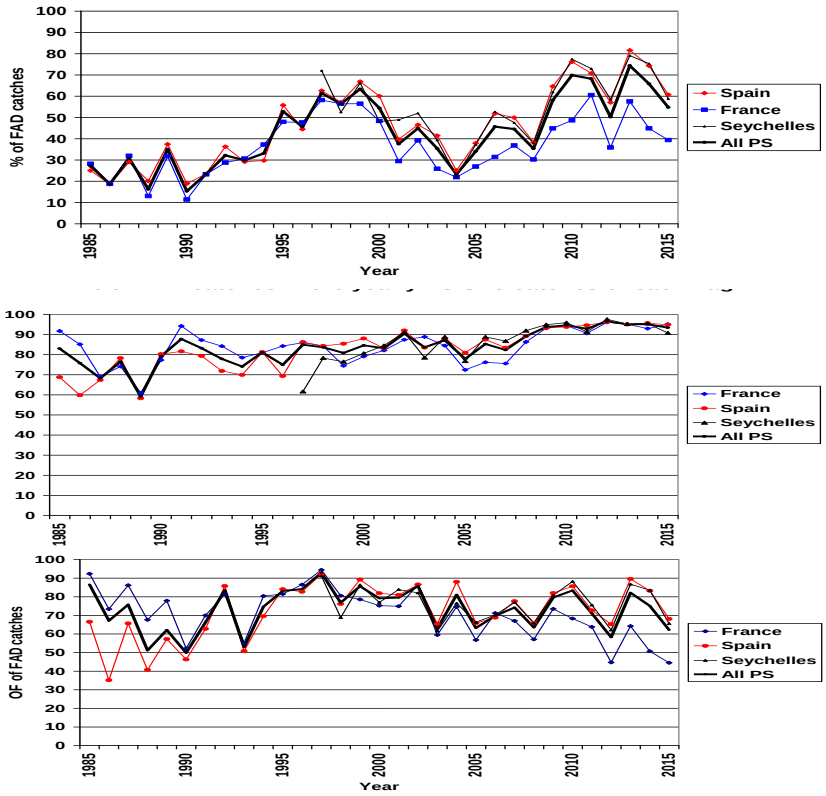


Figure 3: Yearly percentages of catches associated to FADs and logs, by flag: upper figure 3a YFT, middle figure 3b SKJ, and lower figure 3c BET.

Figures 2 and 3 are based on the same type of statistical information, but they carry quite distinct information. The TT working party should examine this question and it should make the final choice on the best way to summarize the information on the yearly changes of FAD and free schools fisheries in the Indian Ocean.

2-3- Coverage of detailed catch and effort data of the various gears

The rate of coverage of detailed log books data widely condition the quality of the fishery data and of all subsequent stock assessment analysis, because this information is essential to estimate for each species the monthly catches and fishing effort by small areas. Current appendices reports contain some brief overview of this question, but a simple and more efficient way to summarize and to show the yearly changes of this parameter would be to incorporate in the report the yearly ratios of detailed C/E data (monthly, by 1° or by 5°) and of total yearly landings. Figure 4 is showing an example of this basic figure.

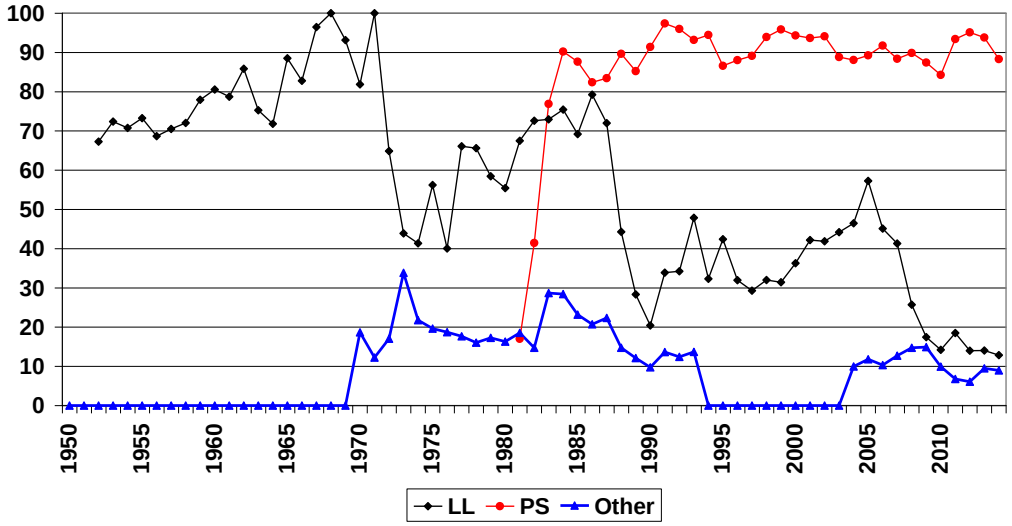


Figure 4: Yearly percentages of the total catches of YFT covered by detailed catch and effort statistics against their total year catches (for LL and PS and the other gears)

Such figure is showing well the very good yearly coverage of log book data on most PS fisheries, their heavily declining rates of coverage in the LL fisheries and the very low rate of detailed C/E data in most other fisheries (the exception being the Maldivian BB fishery that has been well covered during most years)

3- Fishing maps

The current appendices show several fishing maps that only cover the last 10 years. Unfortunately, the major historical changes that occurred in the various fisheries are not reminded, while they are important to represent the baseline from which the current fisheries trends can be depicted and understood. An easy way would be to show fishing maps by decade and during recent years (e.g. as in the ICCAT executive summaries). Alternatively, fishing maps for major periods (example shown for yellowfin on figure 5).

a. Developing fisheries, mainly longliners 1952-1979,
b. Intermediate period 1980-2005,
c. Current period, for instance with 2 maps covering the average periods 2006-2010 and 2011-2014, similar to the maps in the present appendices reports, should also be presented

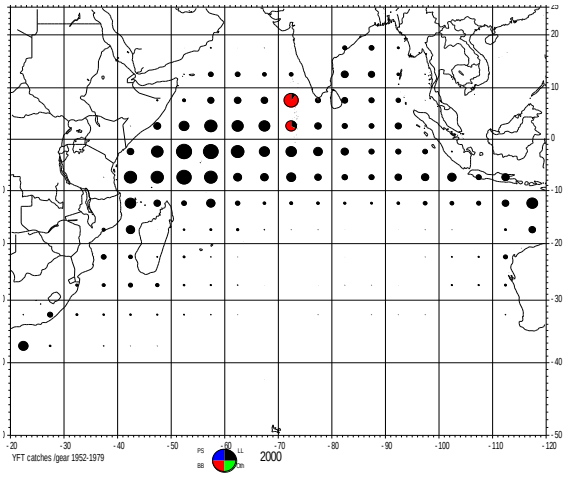


Figure 5a: yellowfin catches by gear 1952-1979

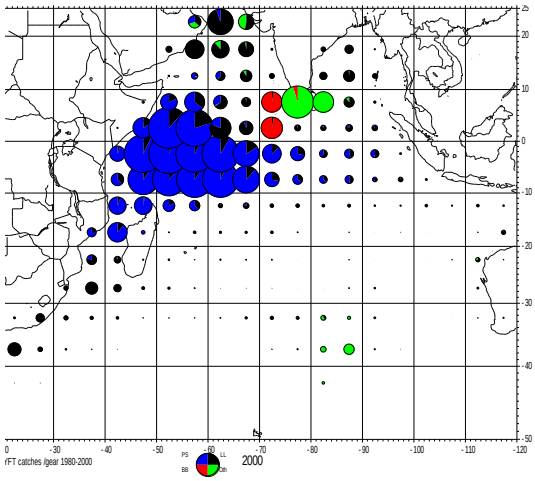


Figure 5b: yellowfin catches by gear 1980-2000

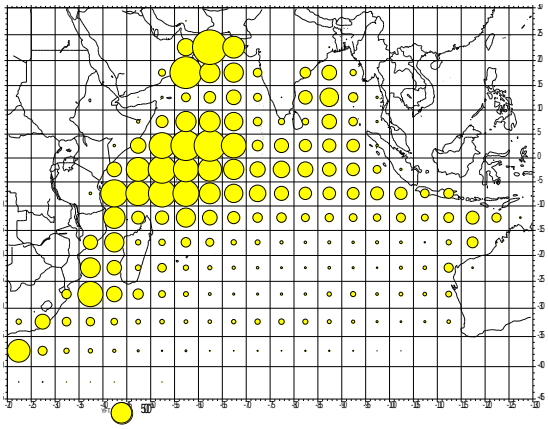


Figure 6a: Yellowfin LL catches 1960-2014

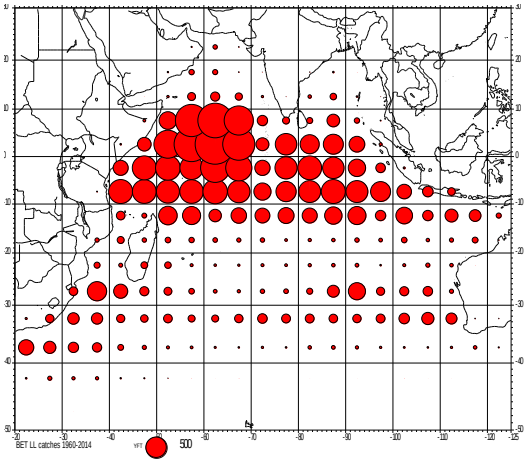


Figure 6b: Bigeye LL catches 1960-2014

Another addition for yellowfin and bigeye appendices would be to show average maps of adults yellowfin and bigeye caught by longliners since the beginning of fisheries (figure 6 a YFT and 6b BET) in order to illustrate the size of the habitat utilized by the adults of each stock.

Alternate series of maps could also be done by 10 years period (as in the ICCAT reports) in order to show the historical changes of fishing zones for all fisheries that have been submitting geo-referenced data.

Fishing maps and the periods covered should be flexible and adapted to the peculiarities of species and fisheries considered, instead of standard maps for all species as it appears in the current appendices. The choice of the best maps to present in the Executive summaries should be discussed and decided by scientists during the WPTT meeting.

4 - Sizes caught

4-1 Average weight

There is no doubt that one of the most important stock status indicator is the average weight caught by the combination of all the fisheries: this indicator is much more powerful than the average weight caught by each individual gear, as the yield per recruit and MSY are conditioned by changes in the combined average weight. Such indicator was indeed presented in the appendices until 2014, but surprisingly, it has disappeared from the appendices resulting from the WPTT in

2015 where only average weight by gear is presented. Therefore, we propose that the average weight by gear and for all gears combined be always presented in the same figure.

While the average weight of bigeye has been showing a major steady decline since the early eighties (due to FAD fisheries), the average weight of yellowfin caught has been fluctuating during the 1950-2014 period, with an overall decline between the early and the most recent years, but without a particular downward trend during the 1975-2014 period mentioned earlier for bigeye. The ideal figure showing the average weight in each appendices should in fact show the average weight of each gear, but also & more importantly the average weight of the combined fisheries, see figure 8.

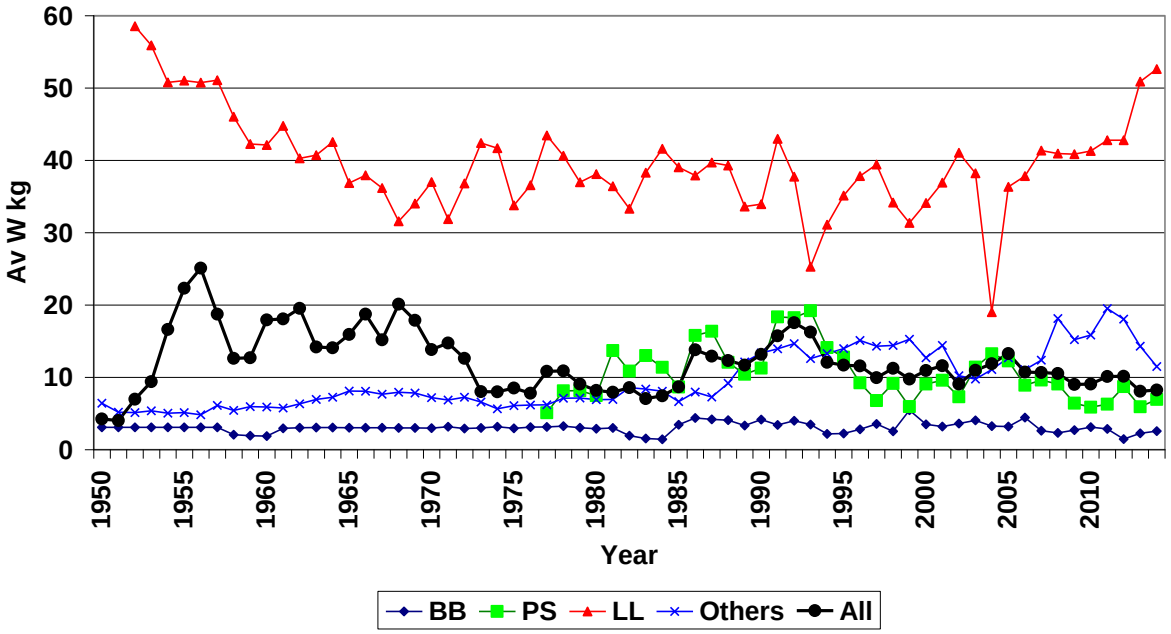


Figure 8: Average weight of yellowfin caught by each gear and by the combined fisheries

These average weights can also be compared to the theoretical weight optimizing the theoretical MSY of each stock. Furthermore, it should also be noted that this basic indicator is never fully visible in the input or output of the stock assessment models.

4-2 Numbers of tunas sampled yearly by gear and CAS

There are two sets of basic and important information concerning tuna sizes caught: i) the information on the number of fishes that have been sampled; and ii) the estimated numbers of fishes landed by each fishery (alias the Catch At Size or CAS). This distinction between sampling data and CAS is important to keep in mind as it reflects the magnitude of the substitution done from the actual sampling to produce the CAS, and indicates the potential uncertainty affecting the CAS if an important fishery is poorly sampled. The CAS data is the basic input in the traditional stock assessment methods (for instance in all sequential population analysis), while the sampling data are now preferably used in most/all statistical stock assessment models (SS3, MFCL). The yearly numbers of sampled fishes in the catches of each gear is also an important factor that should be fully visible in the appendices reports, preferably in comparison of the total catches landed by each gear as in fig. 9 and fig. 10.

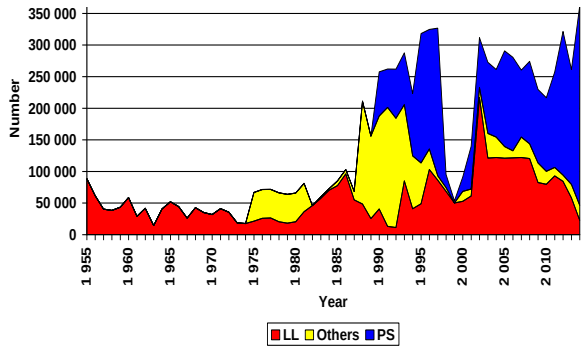


Figure 9: Number of yellowfin individuals sampled yearly in the Indian Ocean by gear

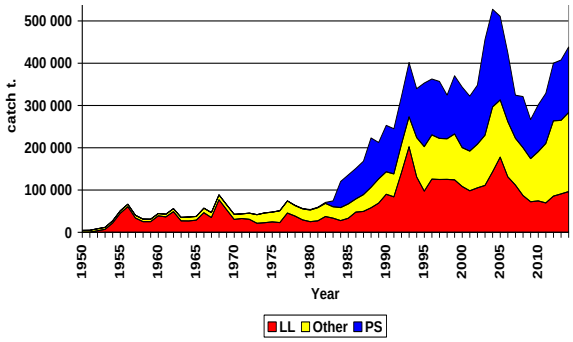


Figure 10: Yearly catches of yellowfin by gear in the Indian Ocean

A comprehensive appendix should clearly show the estimated CAS, but this is not the case in the current IOTC appendices that are only showing two distinct information for PS and LL: the estimated number of fishes caught (based on the estimated CAS) for PS catches, and the numbers of tuna sampled for LL catches

Our view is that the current appendix figures are not showing well the complex changes observed over time in the CAS by gear tables. In our view the figures currently used do not achieve this goal because of the following reasons:

- the present IOTC figures are for instance showing the PS CAS by fishing mode by two independent figures and solely in numbers of fishes (Fig. 11 with yellowfin as an example)

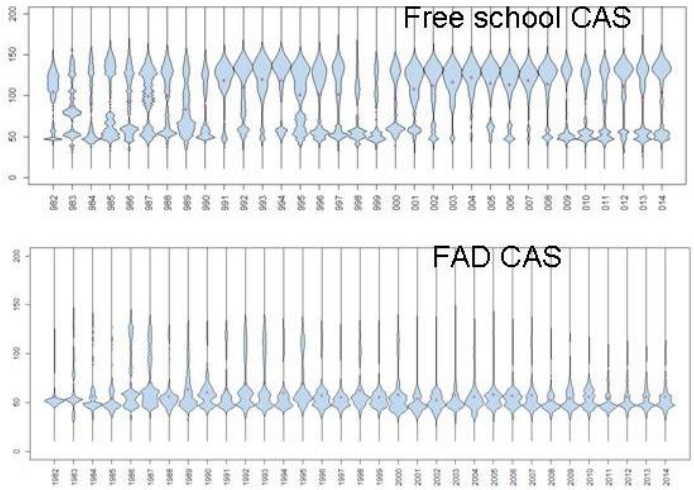


Figure 11: Yellowfin length frequency distributions for PS Free School & FAD fisheries catches (total amount of fish measured by 2 cm length class) from the 2015 yellowfin appendix.

Firstly, it should be noticed that the above title (from the appendix reports) is quite misleading, as this figure is not showing the sampled sizes, rather the CAS, with each yearly size being expressed in percentages. Secondly, while most stock assessment models are working in terms of numbers of fishes, the reality of fisheries data should be expressed through information in weight by size categories. In this regards, our suggestions are:

- CAS figures should be presented (most often) in weight caught by size classes. Whereas the IOTC appendix figure showing the yellowfin CAS gives a false impression that adult yellowfin have been seldom caught by this fishery, while the

reality is that about half of the total weight of yellowfin caught on FAD are composed of adult fishes.

- In the case of PS catches, the CAS figures should simultaneously show on the same figure all the FAD and free school catches.

Therefore, the use of a pie plot of catches by class in weight by the method proposed by Fonteneau (as shown in Fig. 12) is much more realistic and informative that the current CAS appendix figure. There is no doubt for example that based on the IOTC figure 11 a stock assessment expert cannot make any comment on the changes in sizes caught, while extensive scientific discussion may easily be developed on these changes as shown on figure 12. Such figure is necessary to clearly explain the causes of the observed changes in the average weight caught (for instance a decline in average weight may be due to increasing catches of small individuals, or to reduces catches of large fishes, this change being easily visible in our pie plots).

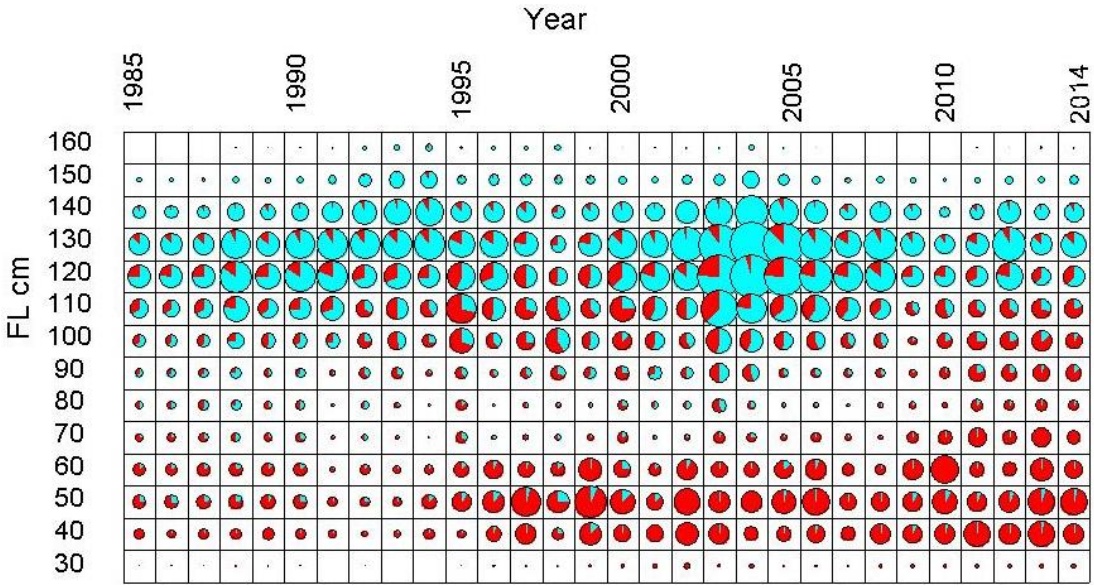


Figure 12: Yearly CAS of PS catches by fishing mode, in weight, by 10 cm of fork length (FAD in red & free schools in blue)

Taking yellowfin as an example (Fig. 12), clear and distinct messages are conveyed through this kind of representation: i) variability and trend over time in the catches of large yellowfin caught under FADs; ii) smaller size of the adult component of yellowfin under FADs relatively to free schools; iii) the substantial proportion of large yellowfin caught under FADs relatively to juveniles (this important peculiarity of the Indian Ocean FAD fisheries should be fully visible).

Finally, another very important point that is missing in the current appendices is the yearly changes in the CAS caught by each gear. Such fundamental result can be easily represented by the same kind of figure (pie plots in weight) showing the yearly yellowfin CAS by gear (as it was estimated by the IOTC secretariat in September 2016) (Fig. 13).

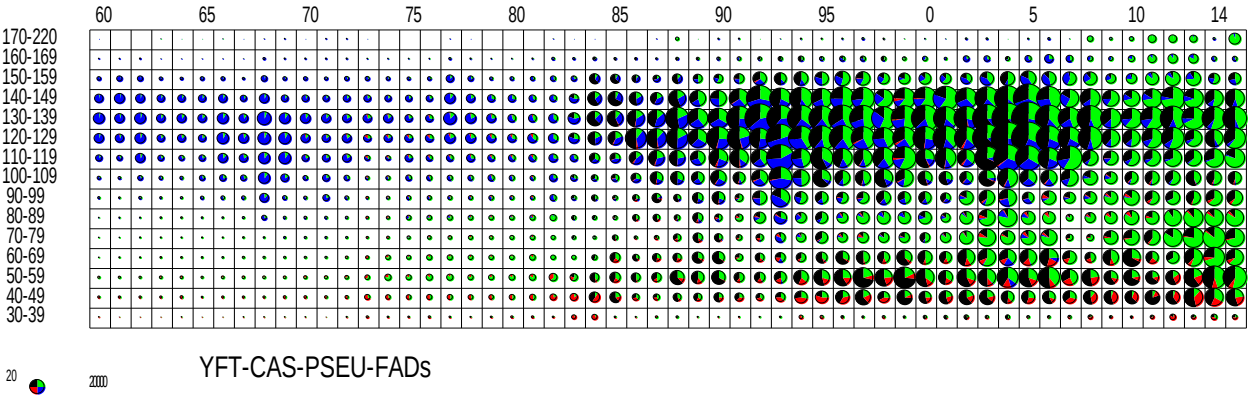


Figure 13: Yearly CAS by gear of yellowfin, in weight, by 10 cm of fork length (black PS, red BB, blue LL and green other gears)

It should be recognized that figure 13 is somehow complex[3], and that scientists may need some time to explore its components. However, such figure summarizes better that any other the main content of the CAS file, for instance:

- showing well the very low level of adult yellowfin catches in the LL historical fisheries, and the very low amount of catches by other surface fisheries during this early period
- the major increase of catches of small and of large yellowfin since the mid eighties by a combination of gears: PS, LL and other gears (driftnets and handlines)
- the increasing contribution of catches by other gears, shown in black (most of these catches being characterized by very limited or nonexistent size sampling) that are now catching all yellowfin sizes, often in greater quantities than the other gears (especially at medium sizes)

It should also be noted that this figure is the best and only way to understand the observed changes in the average weight of the landing, a fundamental parameter that is widely conditioning the yield per recruit and the biological productivity of each stock.

5- Tuna tagging and recovery

One of the most important results of tagging programs is the apparent movement of tagged tunas. It is then very important to show this results and the apparent displacement between tagging and recovery positions. The traditional maps done by other RFMO (WCPFC, IATTC, ICCAT) showing the linear trajectories between tagging and recovery location have no quantitative value, but they show explicitly the apparent mobility of tagged tunas and the potential exchange of tunas between fishing areas. By contrast the IOTC executive summaries are solely showing density maps (fig. 14) showing the density of tagged and of recovered tunas, but not at all the magnitude and the direction of movements.

[3] Taking note that this type of figure has been often used in various ICCAT executive summaries

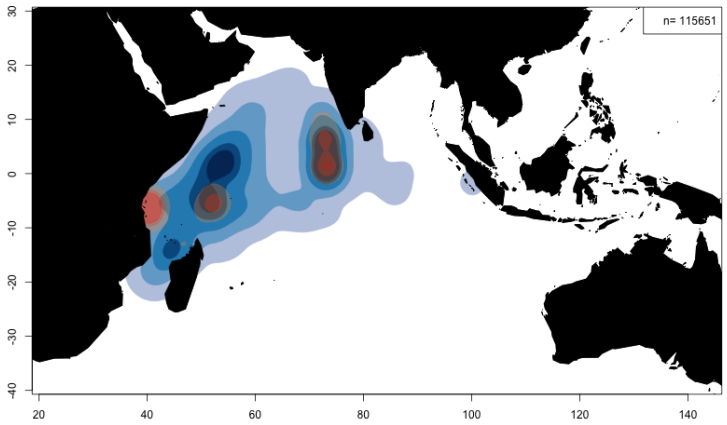


Figure 14: IOTC figure simultaneously showing the skipjack tagging and recoveries based on a density map (present appendix figure)

In our view, these maps are of very little interest or potentially misleading because:

(1) **Tagging locations**: in the current appendices figure, tagging locations are represented by a red shade, but this does not reflect the actual density of tagging. All three areas (Tanzania, Seychelles and Maldives) look very similar whereas the number of fish tagged was quite different. Moreover, skipjack tagging performed in the Mozambique Channel (5500 skipjack tagged) does not appear clearly. We propose to add for each species a map where tagging locations are represented by circles with size proportional to the number of fish tagged, as shown in Fig. 15.

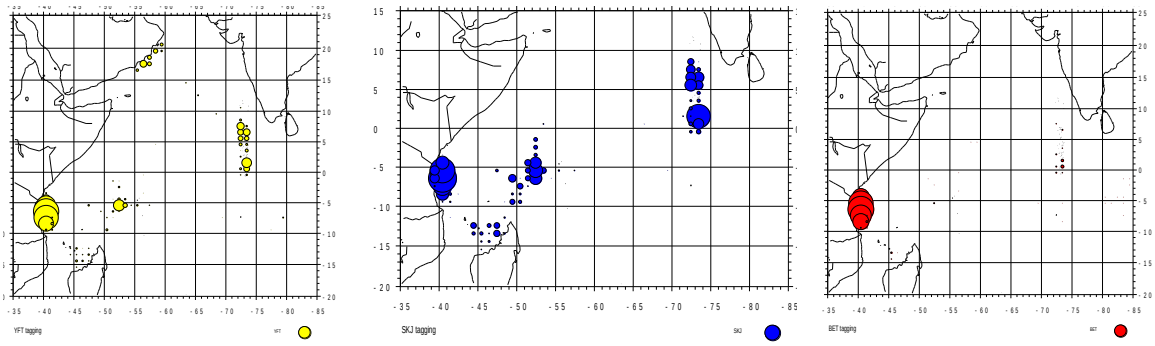
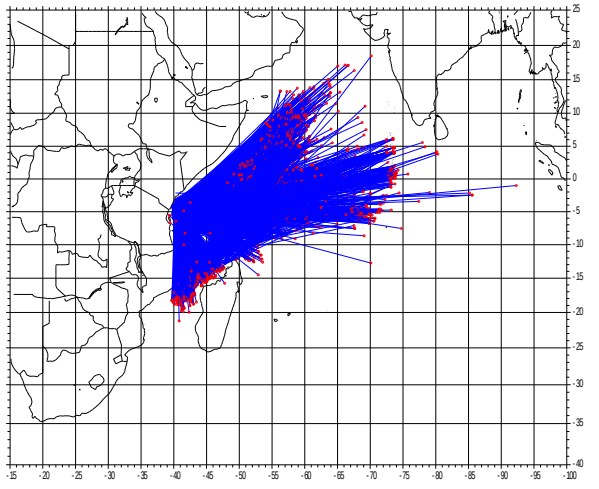


Figure 15a: Numbers of yellowfin tagged by 1° square

Figure 15 b: idem skipjack

Figure 15 c: idem bigeye

(2) **Apparent movements:** the current appendices figure does not provide any information on the observed movements of tagged tunas. We proposed to add a "trajectory map" for each species, as shown in Fig. 16 (yellowfin), Fig. 17 (skipjack) and Fig. 18 (bigeye). For instance, Figure 17 reveals clearly the existence of movements of skipjack tagged in Maldives towards the western IO whereas the current appendices density map gives the false impression that these 2 fishing areas are quite independent. Furthermore, it should also be noticed that the trajectory maps better depict the number of recoveries at the periphery of the fishing zones were the recoveries are quite rare but of great scientific value.



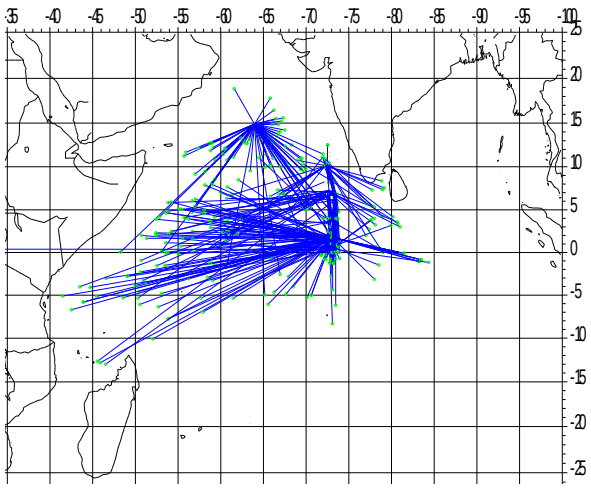
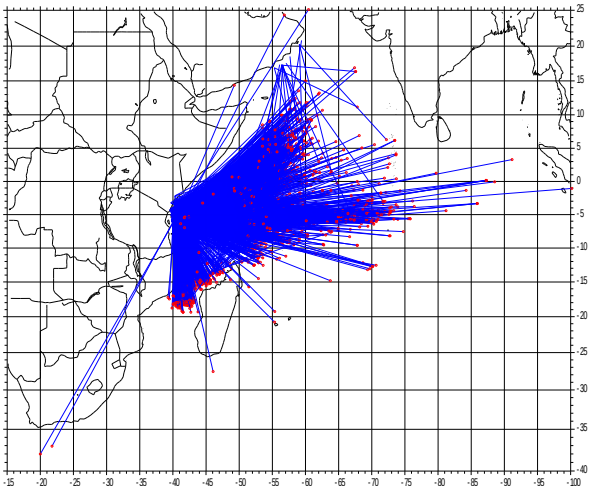


Figure 16 a & b: trajectories or skipjack recoveries from tagging done in the Western (top) & Eastern (bottom) IO.



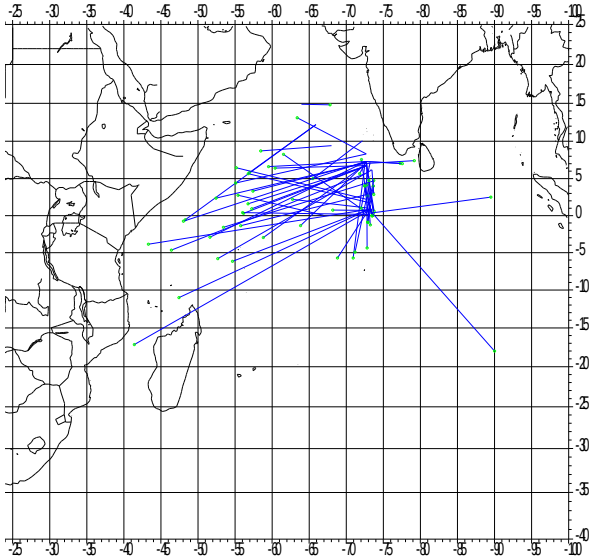


Figure 17 a & b: trajectories or yellowfin recoveries from tagging done in the Western (top) & Eastern (bottom) IO. Only recoveries with > 6 months at sea & distances > 500 miles are plotted

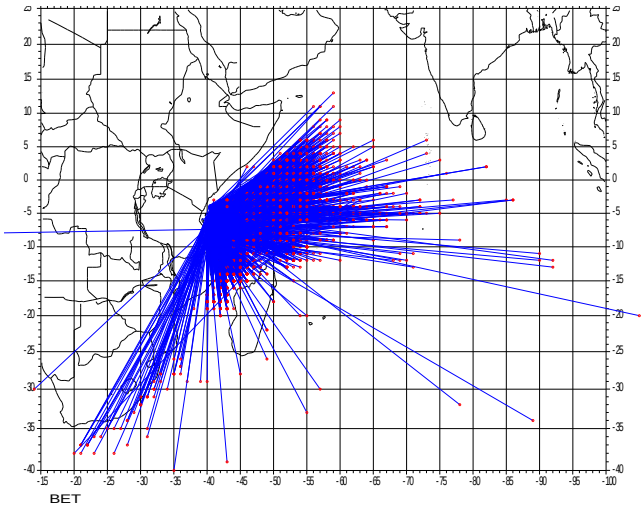


Figure 18 a: Trajectories or bigeye recoveries from tagging done in Western IO. Only recoveries with > 6 months at sea & distances > 500 miles are plotted

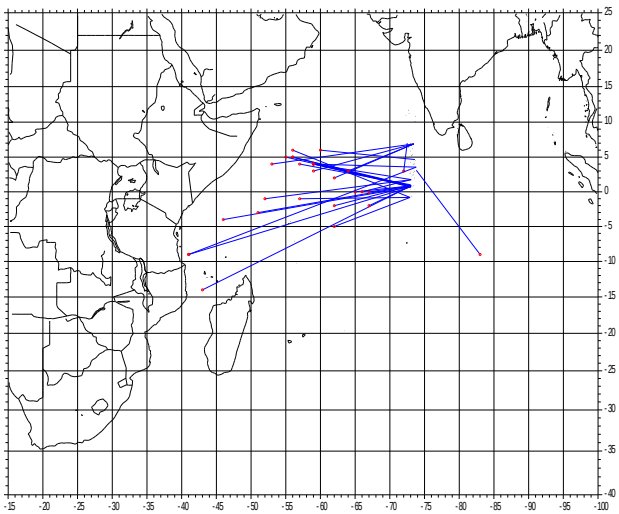


Figure 18 b: Trajectories or bigeye recoveries from tagging done in Eastern IO. Only recoveries with > 6 months at sea & distances > 500 miles are plotted

There is room for improvements for those different maps, however they provide useful visual information on the observed apparent movement of the recovered tunas that are not at all visible in the maps currently used in the report appendices.

6- Conclusion

As executive summaries are very important documents, the IOTC working parties must provide the best and most meaningful information to improve the quality of those appendices at each session. The figures that are presented in the current versions of the WPTT report must be revisited by WPs participants. In this regards, we propose several amendments, some figures being replaced by other ones thought to be more adequate, or new figures being added to the current set. Indeed, the number of figures in such appendices should not be limited by a specific quota. While it is fundamental to limit the size of the text in appendices, the number and type of figures used should remain open to discussion by the WG: when necessary, some fisheries may need more figures or maps in order to reflect the complexity and changes that occurred in those fisheries. However, it should be reminded that the set of figures recommended in this document would not increase the number of figures that are displayed in the in the current WPTT report's appendices[4] .Yet, we think they would contribute to a more comprehensive overview of the situation of fisheries and tuna species.

[4] For instance because they reduce the numbers of figures showing the yearly average weight from 12 to 3 figures.