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Proposals for improved figures in the tropical tunas executive summaries

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Summary

In this paper, we undertake a critical review of the figures included in the tropical tuna executive summaries (ES) prepared by the IOTC Secretariat. The main outcome is that some 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 figures concerning fishing maps, catch at size and numbers of fish sampled for purse seine and combined fisheries, fishing maps and tag-recoveries maps, yearly average weights combining catches by all gears, etc. Our recommendation is that new additional figures should preferably be presented in the ES, as they are more informative than the current figures. The conclusion is that the executive summaries should be examined and validated each year by the species working groups, and not solely by the Scientific Committee.

1- Introduction

This work is examining the various figures that are presented by the IOTC scientific Committee in its executive summaries (ES) concerning tropical tunas. It appears that de facto the ES, particularly the figures, have been seldom deeply discussed by scientists, during the previous sessions of the working party on tropical tunas (WPTT) and during the annual session of the Scientific Committee. While these ES are clearly of key importance to convey the most important scientific information upon each tuna stock, several figures appear to be somehow questionable. This paper will discuss the various figures used and will propose various alternate or additional figures that could/should be usefully included in these summaries. These proposals should be discussed by the incoming Scientific Committee in order to decide what should be kept, amended or added to the current set of figures.

2- Fishing maps

The current ES 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 ES). Alternatively, fishing maps for major periods (example shown for yellowfin by figure 1).

a. Developing fisheries, mainly longliners 1952-1979,
b. Intermediate period 1980-2005,

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c. Current period, for instance with 2 maps covering the average periods 2006-2010 and 2011-2014, similar to the maps in the present ES reports, should also be presented

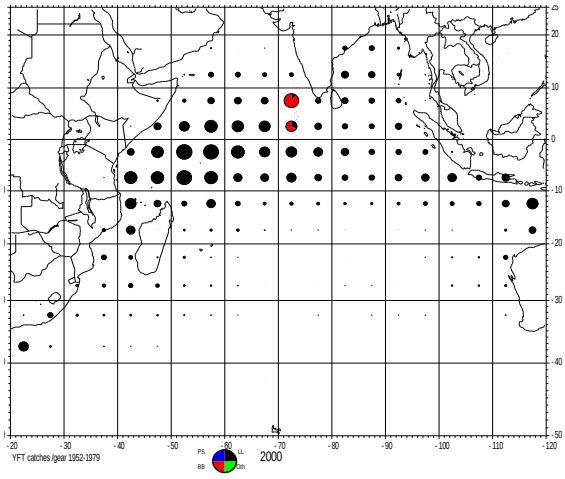


Figure 1a: yellowfin catches by gear 1952-1979

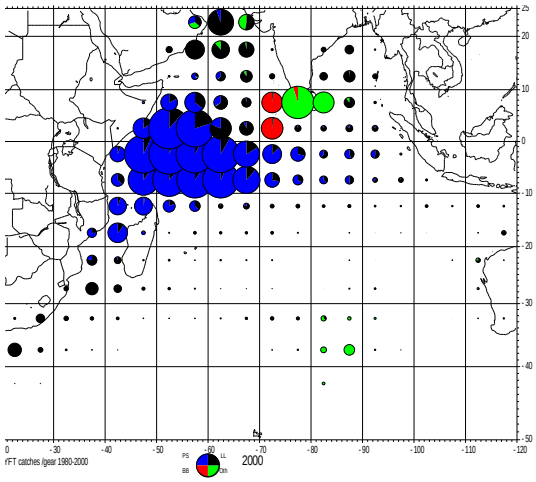


Figure 1b: yellowfin catches by gear 1980-2000

Another addition for yellowfin and bigeye ES would be to show average maps of adults yellowfin and bigeye caught by longliners since the beginning of fisheries (figure 2) to illustrate the size of the habitat utilized by the adult component of those fisheries.

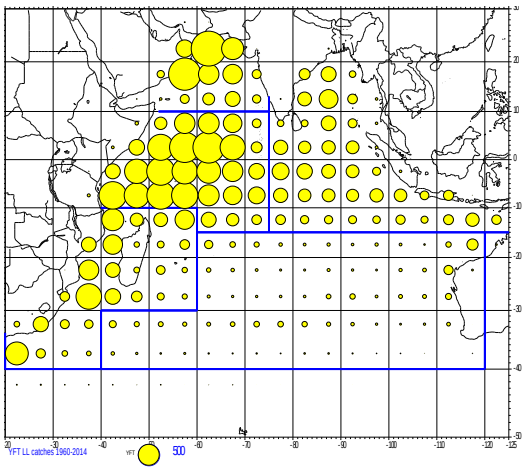


Figure 2a: Yellowfin LL catches 1955-2014

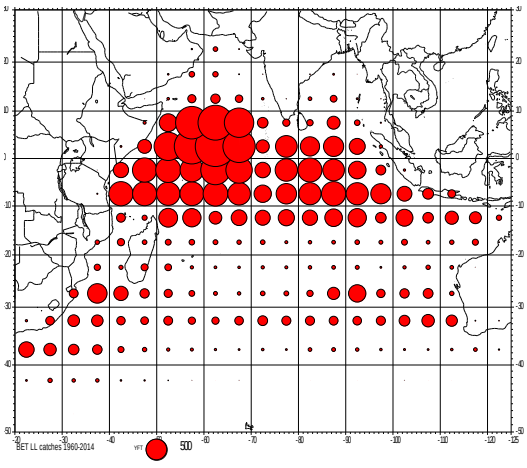


Figure 2b: Bigeye LL catches 1955-2014

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 ES. The choice of the best maps to present in the Executive summaries should be discussed and decided by scientists at the WPTT.

3- 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 (Fig. 3). Such indicator was indeed presented in the ES until 2014, but surprisingly, it has disappeared from the ES resulting from the WPTT in 2015 where only average weight by gear is presented.

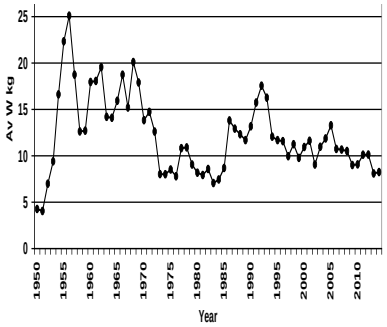


Figure 3a: Average weight of yellowfin

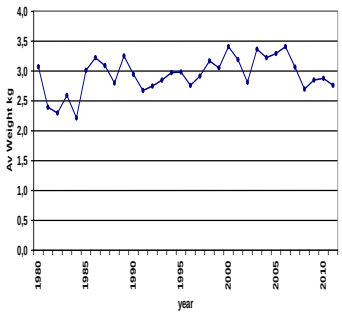


Figure 3b:Average weight of skipjack

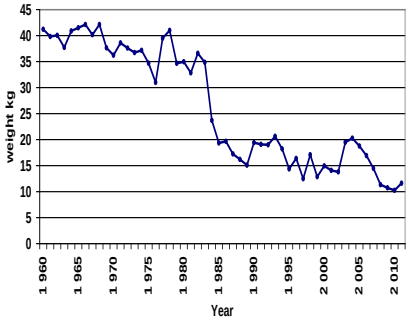


Figure 3c:Average weight of bigeye

For instance, figure 3 highlights important information. 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. These average weights can also be compared to the theoretical weight optimizing the yield. Furthermore, it should also be noted that this basic indicator is never fully visible in the input or output of the stock assessment models.

The ideal figure showing the average weight in each ES should in fact show the average weight of each gear, but also, and more importantly, the average weight of the combined fisheries (Figure 4).

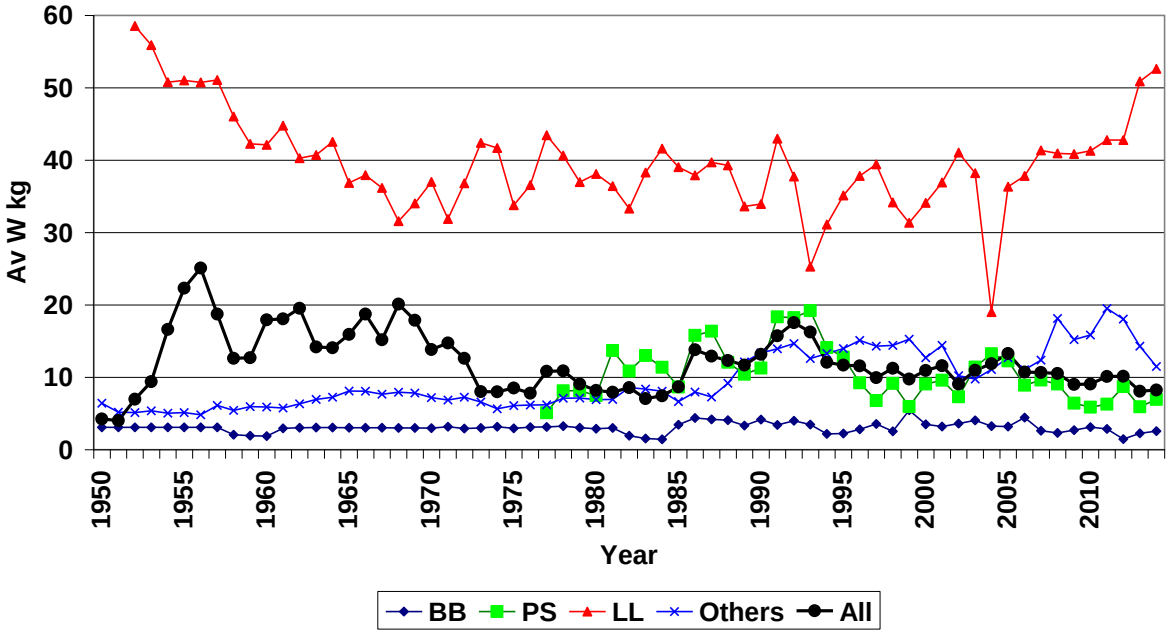


Figure 4: Average weight (kg) of yellowfin caught by each gear and by the combined fisheries

These average weights can also be compared to the theoretical optimal 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- Catch at size (CAS)

There are two sets of basic information concerning tuna sizes: i) the information on the number of fishes sampled; and ii) the information on 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 (like SPA), while the sampling data are now preferably used in most/all statistical stock assessment models (SS3, MFCL). The yearly number of sampled fishes in the catches of each gear is also an important factor that should be fully visible in the ES reports, preferably in comparison of the total catches landed by each gear as in fig. 5 and fig.6.

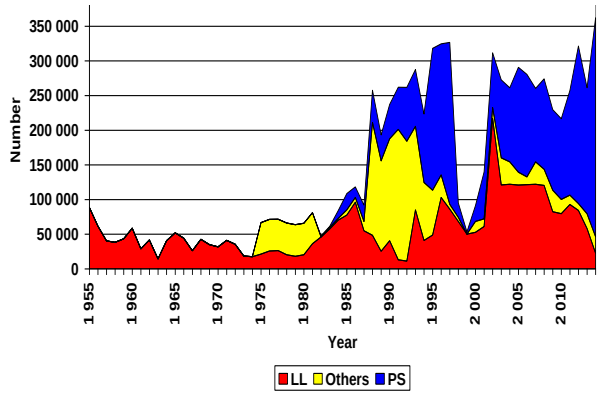


Figure 5: Number of yellowfin individuals sampled yearly in the Indian Ocean by gear

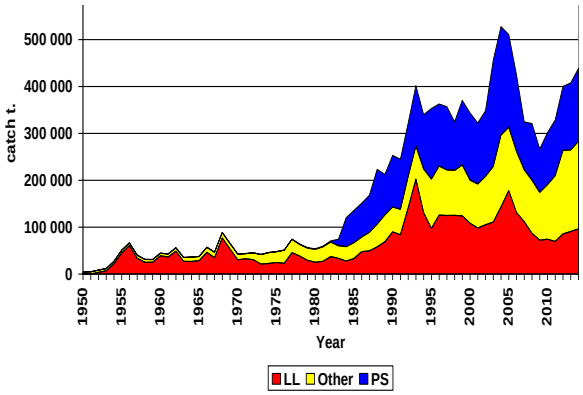


Figure 6: Yearly catches of yellowfin by gear in the Indian Ocean

A comprehensive ES should clearly show these two types of information, number of sampled tunas and estimated CAS, but this is not the case in the current IOTC ES 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.

Concerning the 2015 ES figures showing the numbers of tunas caught by PS on FADs and on free schools (FS), it should also be noted that the information about the fishing flags is of minor interest in this case and that a single figure simultaneously showing the yearly FAD & FS catches (as shown by figure 7) would be much more informative than the current ES figures.

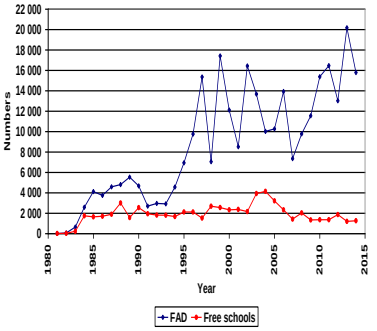


Figure 7a: Number of yellowfin caught by PS on FS and on FADs

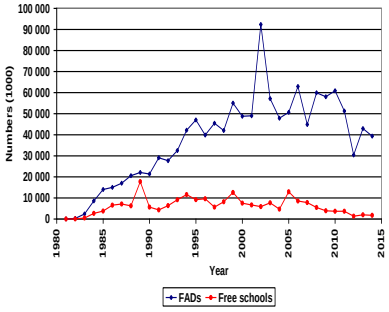


Figure 7b: Number of skipjack caught by PS on FS & on FADs

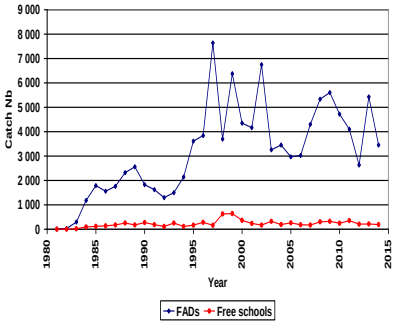


Figure 7c: Number of bigeye caught by PS on FS and on FADs

These figures showing the number of fishes caught yearly could also usefully be shown in weight for each school type (Fig. 8 a to 8 c) as such distributions are of fundamental importance, and show patterns that are quite distinct from the figures in numbers.

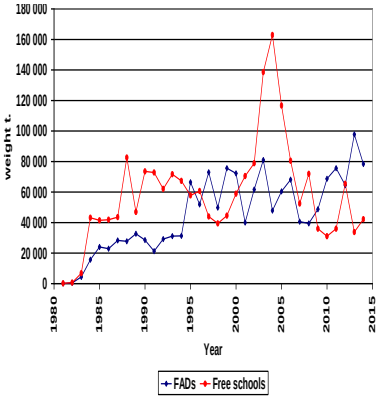


Figure 8a: Weight of yellowfin caught yearly by PS on FS and on FADs

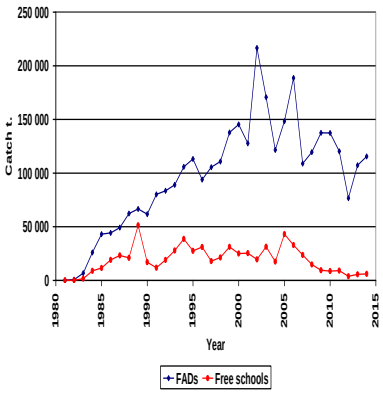


Figure 8b: Weight of skipjack caught yearly by PS on FS and on FADs

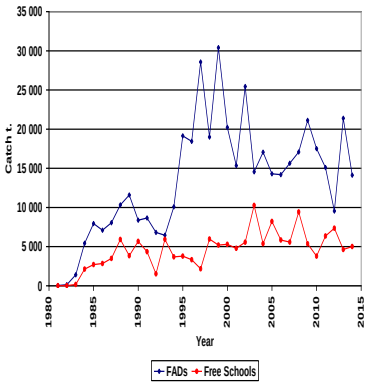


Figure 8c: Weight of bigeye caught yearly by PS on FS and on FADs

The ES figures must present explicitly the complex changes observed over time in the CAS by gear tables. In our view, the figures currently used do not achieve this goal. For instance, the current IOTC ES figures show the PS CAS by fishing mode using two independent figures and solely in numbers of fishes (Fig. 9 with yellowfin as an example). Moreover, the caption used for this particular figure is quite misleading, as this figure is not really showing the sampled sizes but the CAS, each yearly size being (presumably) expressed in percentages.

It should be noted that 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.

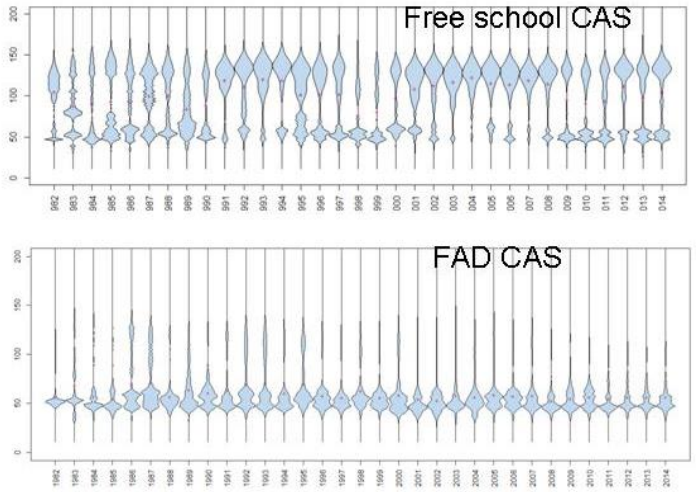


Figure 9. Yellowfin length frequency distributions for PS Free School and FAD fisheries catches (total amount of fish measured by 2 cm length class) from the 2015 yellowfin ES

In this regards, our suggestions are:

- CAS figures should be done (most often) in terms of weight caught by size classes. Whereas the IOTC ES figure showing the yellowfin CAS gives the impression that adult yellowfin have been seldom caught by this fishery, the reality is that about half the 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 (as shown in Fig. 10) is much more realistic and informative that the current ES figure.

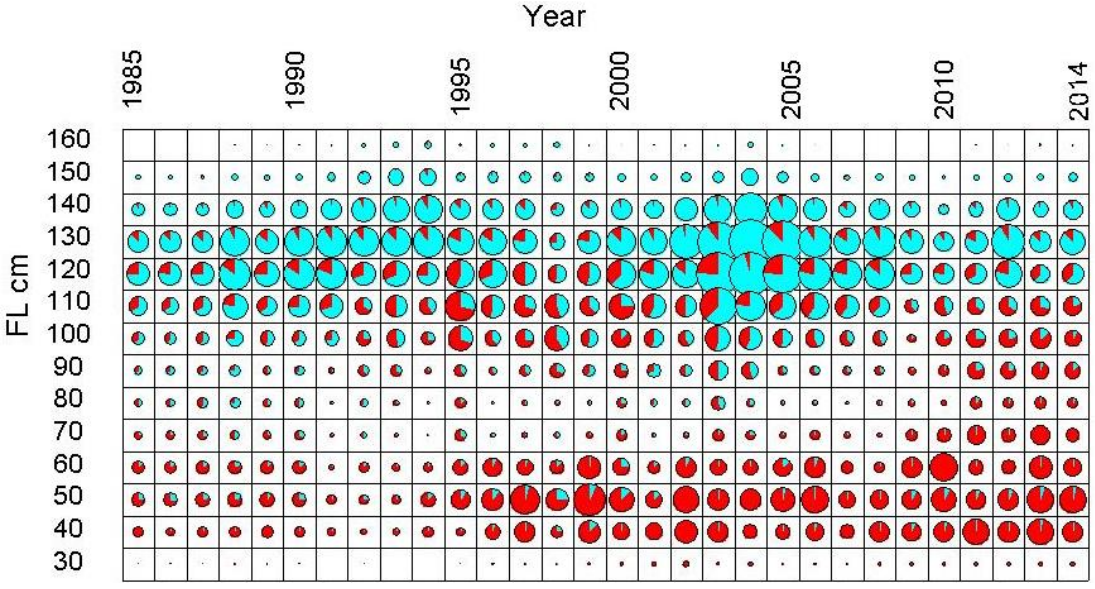


Figure 10: Yearly CAS of PS catches by fishing mode, in weight (FAD in red & free schools in blue)

Taking yellowfin as an example (Fig. 10), 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 current ES is to show 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 2015) (Fig. 11).

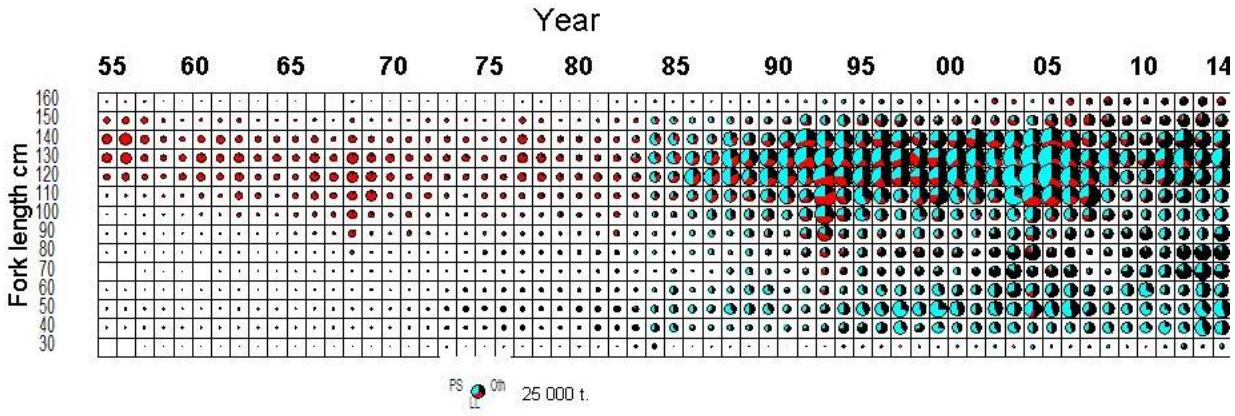


Figure 11: Yearly CAS by gear of yellowfin, in weigh, 1955-2014.t

This figure 11 is somehow complex, and it may need some time to explore its components, but it summarizes better that any of the current ES figures 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, in black (most of these catches with very limited or no size sampling at all) that are now catching all yellowfin sizes, often in greater quantities than the other gears (especially at medium sizes)

5- 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 (figure 12) showing the density of tagged and of recovered tunas, but not at all the magnitude and the direction of movements.

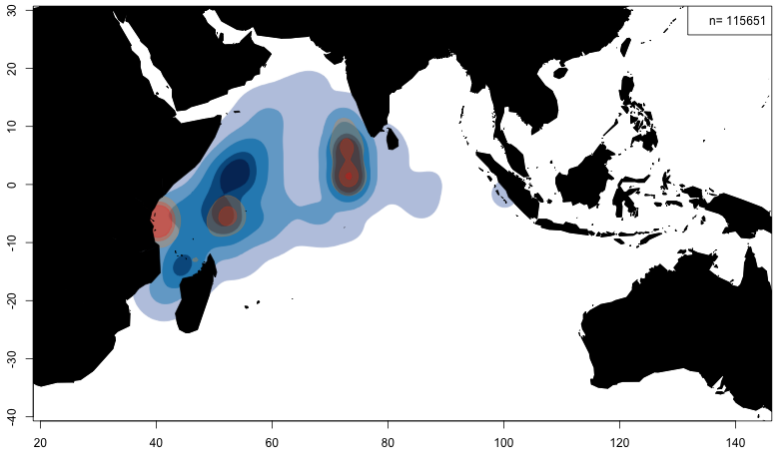


Figure 12: IOTC figure showing the skipjack tagging and recoveries based on a density map (current ES figure)

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

(1) **Tagging locations**: in the current ES 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. 13.

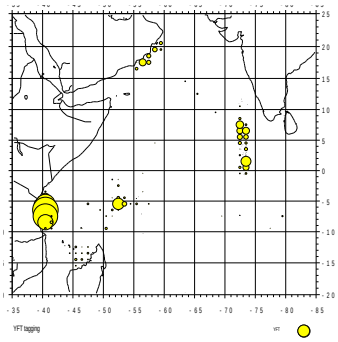


Figure 13a: Numbers of yellowfin tagged by 1° square

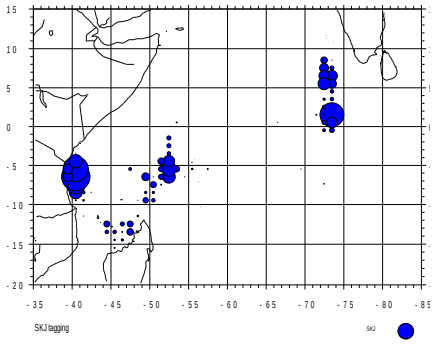


Figure 13 b: idem for skipjack

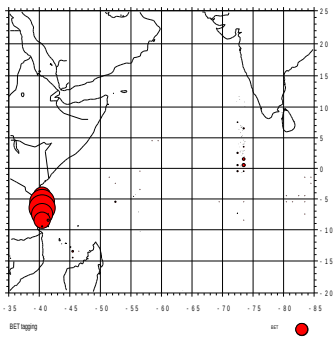
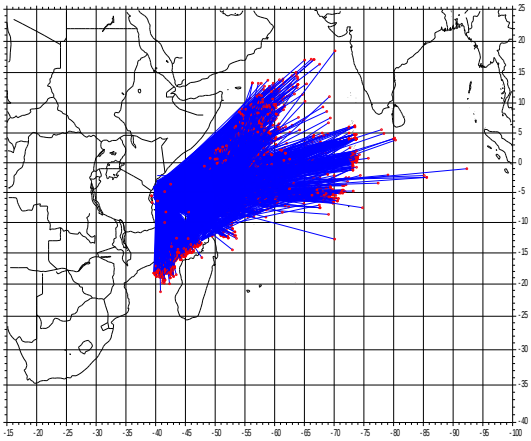


Figure 13 c; idem for bigeye

(2) **Apparent movements:** the current ES 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.14, 15 and 16. For instance, Figure 14 reveals clearly the existence of movements of skipjack tagged in Maldives towards the western IO whereas the current ES density map gives the false impression that these 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.

(3)



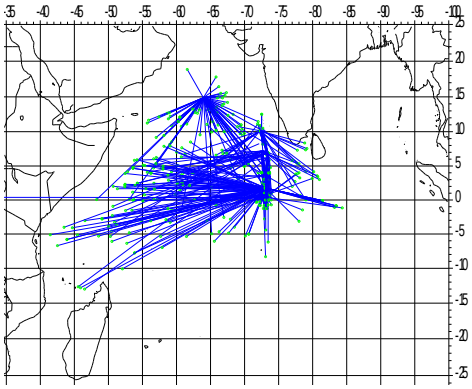
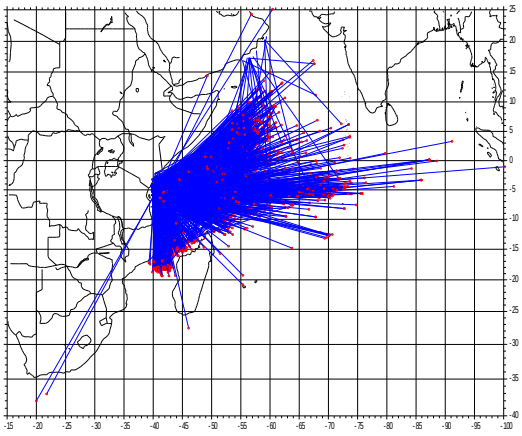


Figure 14 a & b: trajectories or skipjack recoveries from tagging done in the Western (top) and Eastern (bottom) IO (recoveries with more than 6 months at sea & distances > 500 miles). Green and red dots show the location of recovery



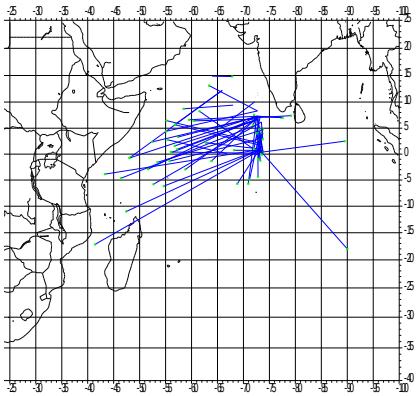


Figure 15 a & b: trajectories or yellowfin recoveries from tagging done in the Western (top) and Eastern (bottom) IO (recoveries with + than 6 months at sea & distances > 500 miles). Green and red dots show the location of recovery

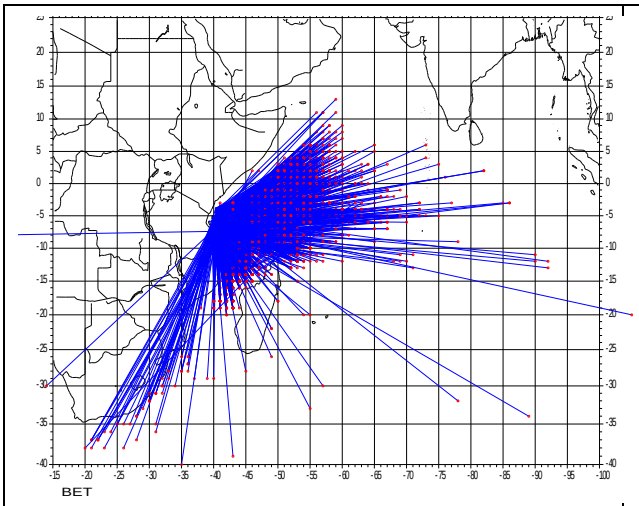


Figure 16 a: Trajectories or bigeye recoveries from tagging done in Western IO (recoveries with + than 6 months at sea & distances > 500 miles)

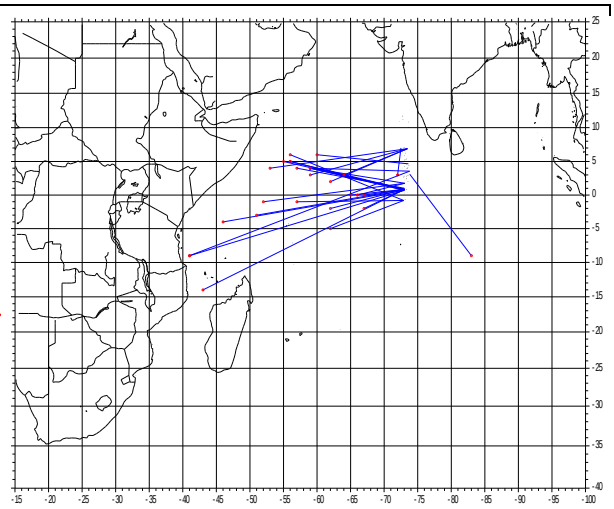


Figure 16 b: Trajectories or bigeye recoveries from tagging done in eastern IO (all recoveries)

These simple maps may not be ideal ones nor quantitative, but they provide useful visual information on the observed apparent movement of the recovered tunas that are not at all visible in the current maps.

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 ES at each session. The figures that are presented in the ES must be revisited by WPs participants. In this regards, we propose several amendments, with figures of the current ES replaced by other new figures thought to be more adequate, or new figures added to the current set (these proposals being summarized in the annex 1 of this document). Indeed, the number of figures in such ES cannot be limited by a specific quota. While it is fundamental to limit the size of the text in ES, the number and type of figures used should remain open to discussion by the WG: whenever necessary, more complex fisheries may need more figures and more complex figures or maps in order to show the complexity and changes in fish biological parameters and fisheries. However, it should be noted that the presently recommended figures would not increase the numbers of figures in the present ES[3] and they would widely facilitate the understanding of the ES.

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

Annex 1: Summarized recommendations

To summarize, the recommendations that we propose concerning alternate or new figures are the following ones. Each of these recommended figures is associated with 1 or 2 stars: * meaning that this improvement should/could be implemented next year or ** meaning that the final versions of the 2015 executive reports should incorporate these changes (because they are easily done and very important)

1. *** New fishing maps:**
   - Fishing maps by decades and for the recent years, to see trends and changes over time (the choices of these maps being left to the WG scientists)

2. **** Average weight**
   - Yearly average weights by species, showing on the same graph the weights by gear and for all gears combined (the latter being most important information, appearing in bold), based on the most recent CAS estimated by the IOTC Secretariat.

3. *** Catch at size**
   - Area plots showing in parallel, for each species, the yearly number of fish sampled by gear and the catch (in weight) for each gear, over the whole period of existing data
   - Various plots showing the estimated CAS in Numbers and in weight by fishing mode and gear
   - Pie plots showing yearly CAS by gear, in weight

4. **** Tagging and recovery**
   - In addition to the density map (or potentially without this map?): pie maps simply showing for each species the numbers of tunas tagged by 1° squares,
   - two maps for each species, each one with trajectory plots, showing the movements of long distance recoveries from the tagging programs done in the western and central Indian Ocean (mainly in Maldives)