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A comparison between stocks and 2011 stock assessment results of yellowfin in the Indian and Eastern Pacific oceans

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Summary

This paper makes a comparison between yellowfin stocks exploited in the Indian Ocean and in the Eastern Pacific ocean, their biology, their exploitation by fisheries and their stock status as they have been estimated in 2011 by IOTC and IATTC scientists. The paper shows good similarities in the biology and the exploitation of these 2 stocks by recent fisheries, but major divergences in all the stock assessment results, for instance concerning the stock sizes, the stock recruitment relationship and their exploitation rates. It is recommended that a joint working group between IOTC and IATTC scientists be organised to address this serious issue in order to understand the differences and reach more realistic assessment results. Such compatibility in the stock assessment parameters and results scales, for instance in the estimated levels of biomass, should be considered as a legitimate scientific goal, when these tuna stocks are showing major biological & fishery similarities.

Résumé

Cet article fait une comparaison des 2 stocks d'albacores exploités dans les océans Pacifique Est et Indien. Il compare les caractéristiques biologiques et de l'exploitation par les pêcheries de ces 2 stocks, ainsi que les résultats des évaluations des stocks obtenues en 2011 par les scientifiques de l'IATTC et l'IOTC. Les grandes similarités dans la biologie et l'exploitation de ces 2 stocks sont tout d'abord analysées et comparées. Les très fortes divergences visibles dans tous les résultats des évaluations de stocks, par exemple les tailles des biomasses des 2 stocks, leur recrutement, les taux de mortalités par pêche sont ensuite analysées. Il est recommandé qu'un groupe de travail conjoint IOTC-IATTC travaille soit organisé sur cette question importante afin de comprendre les différences et de parvenir à des évaluations de stocks plus réalistes. Cette compatibilité des paramètres et des évaluations, au moins au niveau de leurs échelles, par exemple celles des biomasses estimées, doit être considérée comme un objectif scientifique légitime, du fait des grandes analogies observées dans la biologie de ces 2 stocks et dans les pêcheries qui les exploitent.

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1- Introduction

The goal of this paper is (1) to compare the main biological characteristic of the two yellowfin stocks exploited in the Indian and Eastern Pacific oceans based on the scientific literature published upon these 2 stocks, (2) to compare the fisheries exploiting these 2 stocks from the IOTC and IATTC fishery data base, and (3) to compare the detailed results of the most recent stock assessments done in 2011 by the IATTC (Da Silva & Maunder 2011) and by the IOTC (Langley et al 2011).

2- Biology of the yellowfin stocks in the Eastern Pacific Ocean (EPO) and Indian oceans.

The biological characteristics observed on these 2 stocks are showing major similarities in the major biological characteristics of the 2 yellowfin stocks exploited in the Indian ocean and the EPO.

✓ Sex ratio at size

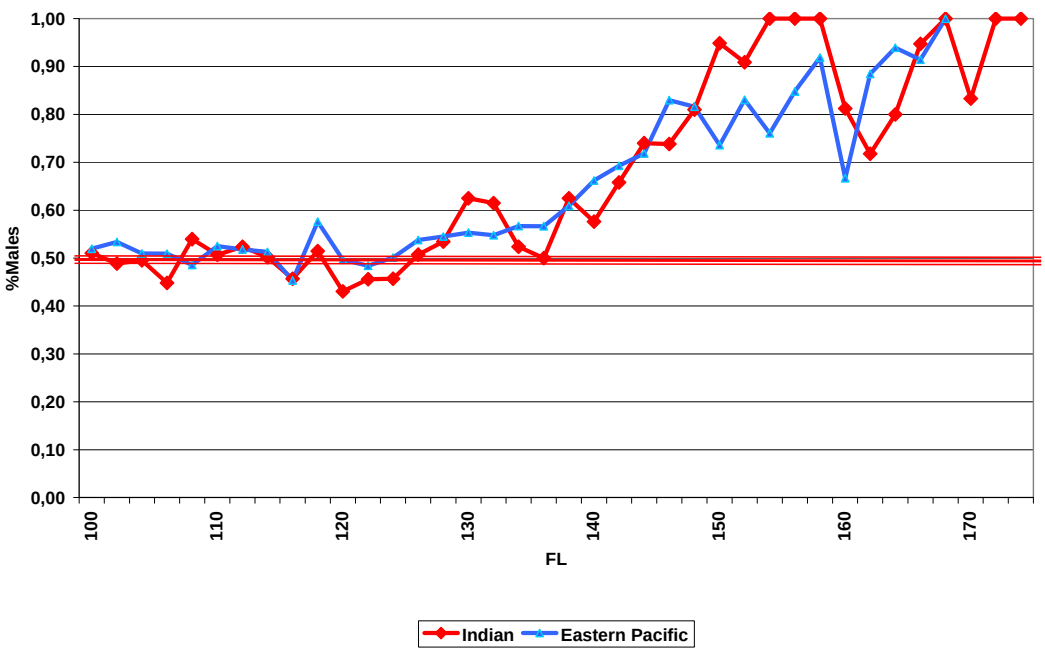

Figure 1: Average sex ratio at size observed in the IO and the EPO

Sex ratio at size are very similar in both oceans, as in the IO & the EPO: male yellowfin starting to be dominant at sizes over 130-140 cm, and widely dominant at sizes over 145 cm.

✓ Growth

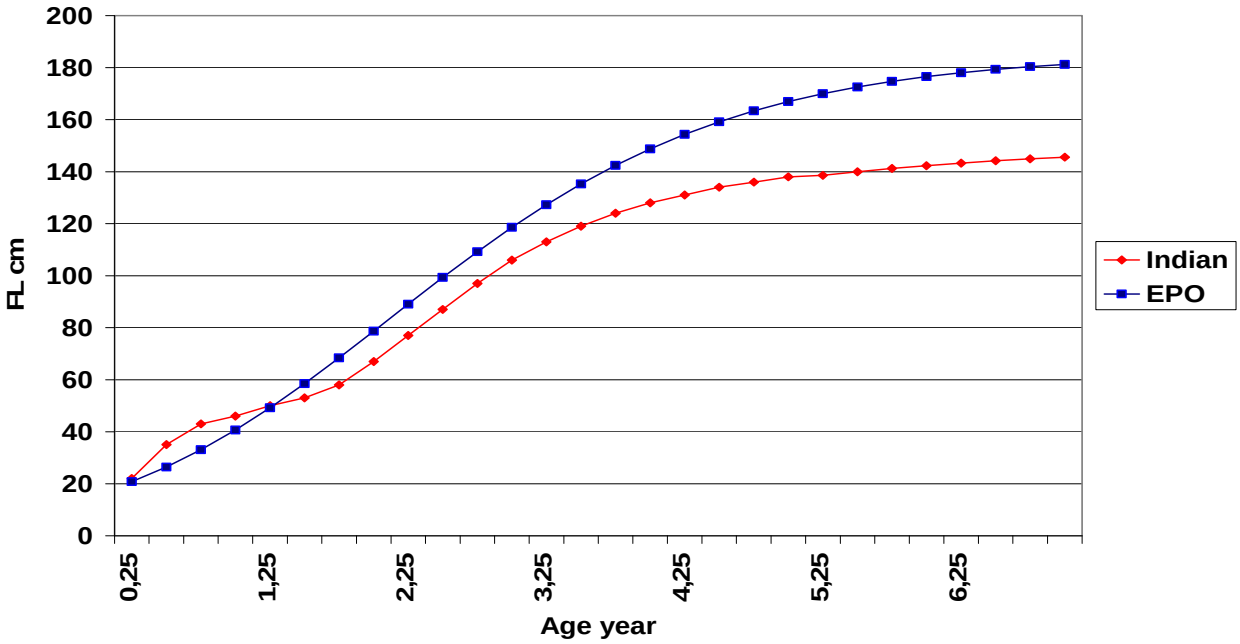

Figure 2: Growth estimated for the yellowfin stocks in the EPo and IO

Similar yellowfin growth are estimated in both oceans, but with a more pronounced 2 stanza growth curve and a lower asymptotic size estimated in the Indian Ocean. These differences will be later discussed in paragraph 3.4.

✓ Spawning biology:

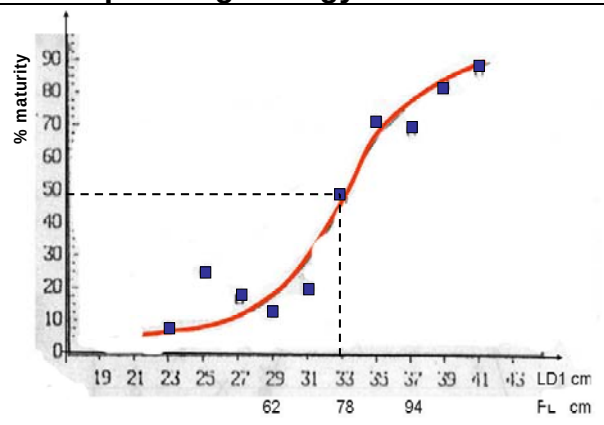

Figure 3a : Ogive of yellowfin maturity in the IO (Hassani and Stequert 1990)

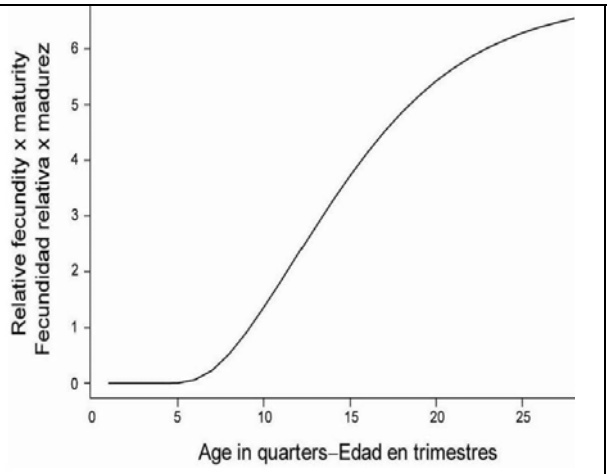

Figure 3b : Ogive of yellowfin maturity in the EPO (Da Silva & Maunder 2011)

Similar yellowfin size & age at first maturity in both oceans. Full maturity & 50% of spawning at less than **1 meter** in both oceans, i. e. at an age of about 2 to 2.5 years in both oceans (a lower size at maturity observed in the Indian Ocean). The EPO models assumes a more realistic fecundity increases with age of females, but not the IOTC model.

✓ **Same maximum sizes**

Same larger sizes: 165 cm & same levels of significantly caught larger sizes: 158 cm in the IO & 160 cm in the EPO: these 2 sizes corresponding to 99% of adult sizes caught during recent years.(see also figure 6)

✓ **Natural mortality at age**

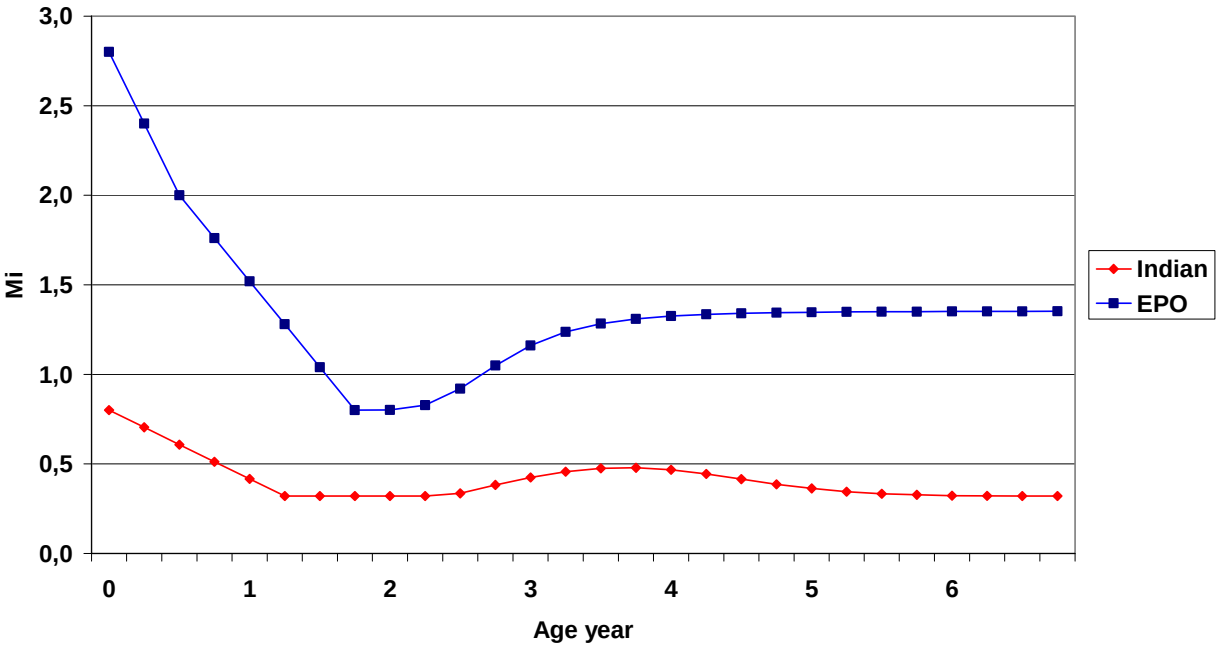

Figure 4: Natural mortality at age estimated in the IO and EPO in the stock assessment models.

A totally different natural mortality at age assumed in the IO & the EPO stock assessment

3- Yellowfin stocks and fishery data in the Eastern Pacific Ocean (EPO) and Indian oceans.

The comparison between the main characteristics of fisheries exploiting these 2 stocks are also showing major similarities in the fisheries exploiting the 2 yellowfin stocks in the Indian ocean and in the EPO.

3-1- Total yellowfin catches

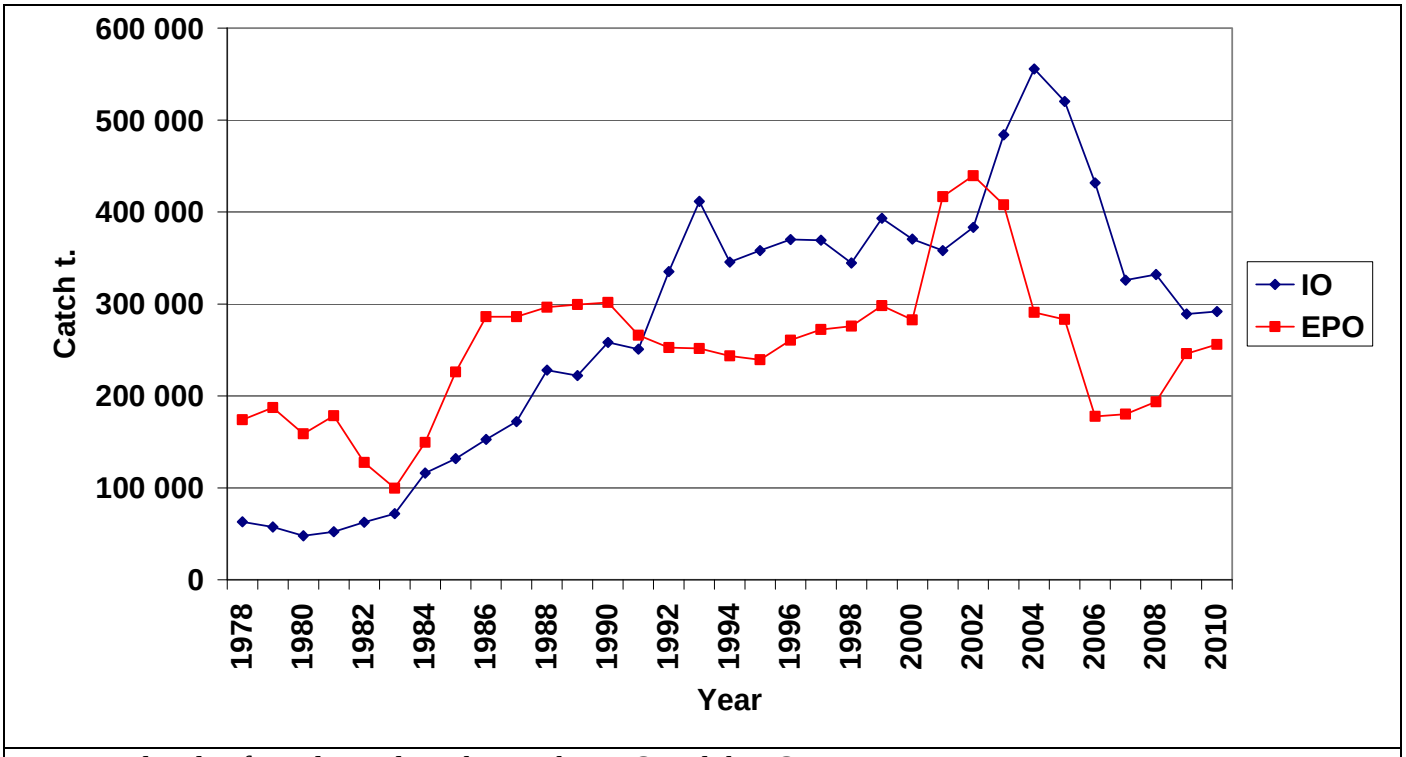

Figure 5: levels of yearly total catches in the EPO and the IO

- Average catches 1990-2010: IO=370.000 t. vs EPO=280.000 t.
- 3 best yearly catches: average IO=520.000 t. (2004-2006) and EPO=420.000 t. (2003-2005), noting a strange similarity between these 2 patterns of very high catches in the IO & EPO?

3-2- Patterns of catch at sizes

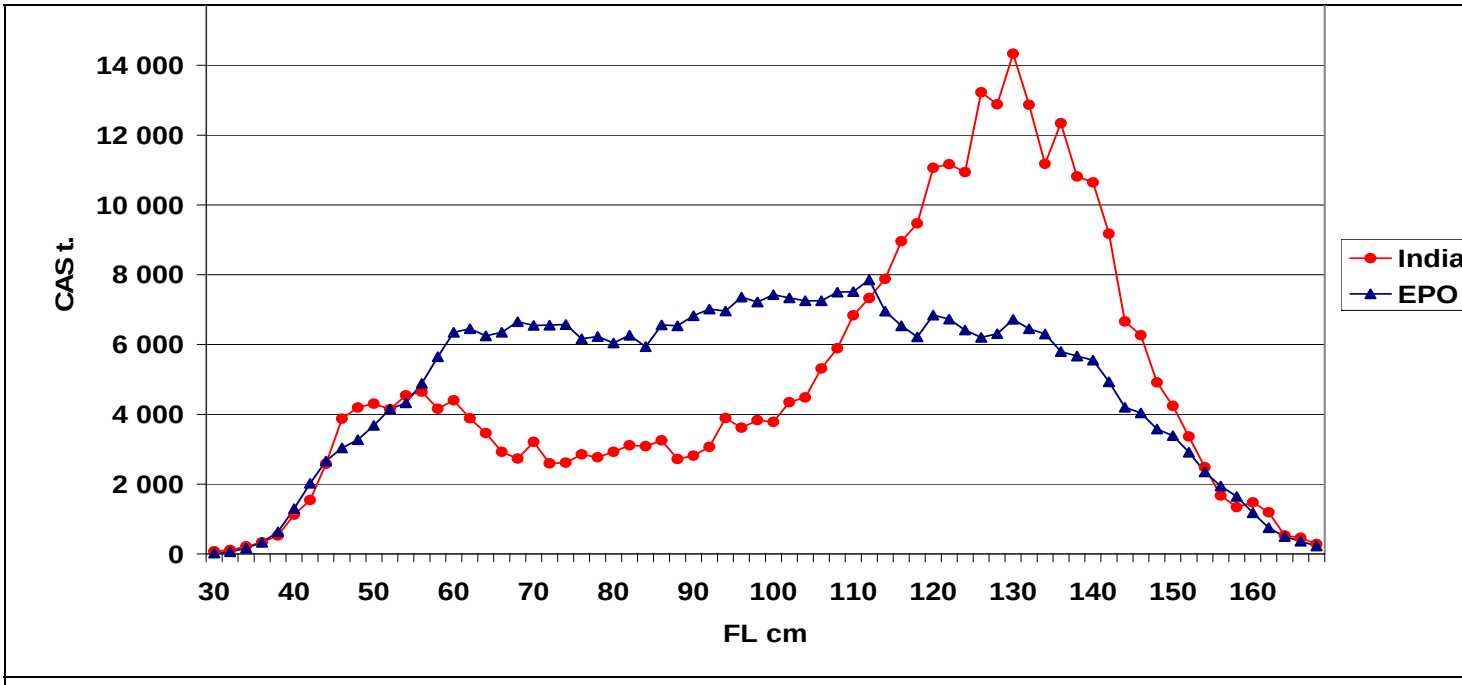

Figure 6: Average catch at size in the EPO & IO during recent years

Same sizes at recruitment in the EPO & IO: 40 cm. Very similar patterns and level of catch at size, medium size yellowfin being less vulnerable than in the Indian Ocean, when they are commonly taken by the EPO PS fishery associated to dolphins. Very large YFT are more abundant in the IO catches, as they are heavily targeted by both the purse seine fishery (free schools) and also by longliners (a gear that is not very active in the EPO, probably because the peculiar oceanographic conditions in this area)

3-3- Sizes of the area fished

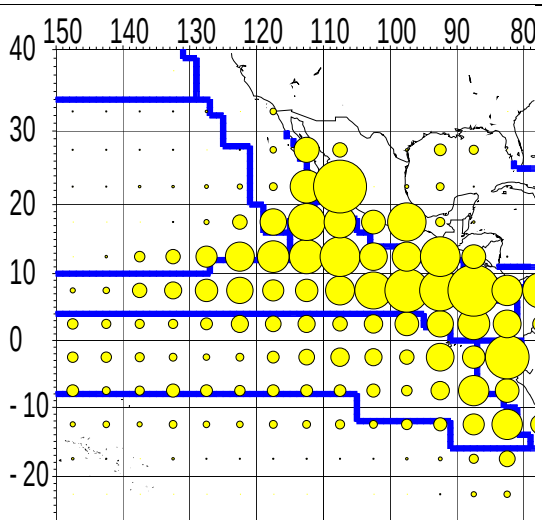

Figure 7a: Average catches of YFT in the EPO (1991-2005)

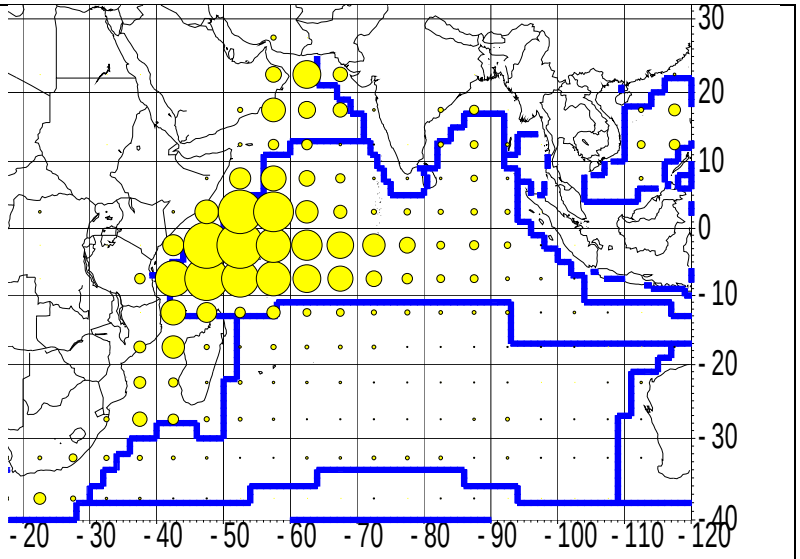

Figure 7a: Average catches of YFT taken by well identified fisheries in the Indian Ocean (1991-2005) (This map does not show the fisheries that are not covered by detailed C/E statistics)

Numbers of 5° squares with a yellowfin catch >5t during the 1991-2005 period are nearly identical in both oceans: 165 5° squares in the Eastern Pacific and 171 in the Indian Ocean, both fisheries being centered N&S of the Equator.

3-4- Stock assessment models and parameters

The Indian ocean stock has been assessed primarily using the MFCL model, but also the SS3 model (both models providing similar results), when the Eastern Pacific stock has been assessed only by SS3. The details of the multiple hypothesis and functioning rules are given in the original papers presenting these assessments, but overall, it can be considered that these 2 models MFCL and SS3 belong to the same family of complex statistical models, that are using a lot of detailed information on the fishes and fisheries which are often partial of missing or biased, thus often defined as hypothetical data

A first quick comparative look of the parameters used in the 2 models, would tend to indicate that their 2 major differences between the IO & EPO models are:

(1) a totally different levels of natural mortality, and

(2) a higher asymptotic size in the EPO, when the duration of the modelled exploited life span of the 2 stocks is identical: 7 years.

The similar modelled durations of exploitation life would be logical if the 2 stocks were showing similar growth and longevity patterns. The duration of 7 years used in the 2 models seems to be consistent with the estimated life expectancy of yellowfin: probably less than 10 years based on Pacific recoveries.

However, this similar 7-years modelled duration would be valid only if (1) Natural mortality is high and (2) equivalent in the 2 oceans, when at the low Natural mortality estimated in the Indian Ocean, a wider longevity, for instance 12 years (see figure 8), would be much more realistic, especially in the early years of low exploitation rates (for instance until 1980?). The maximal levels of biomass are observed at a totally different age in the 2 models, and the biomass of the YFT stocks would still be significant after a duration of 10 to 12 years at the low natural mortality assumed in the Indian Ocean.

This point has net been discussed by the IOTC but it should be further analyzed.

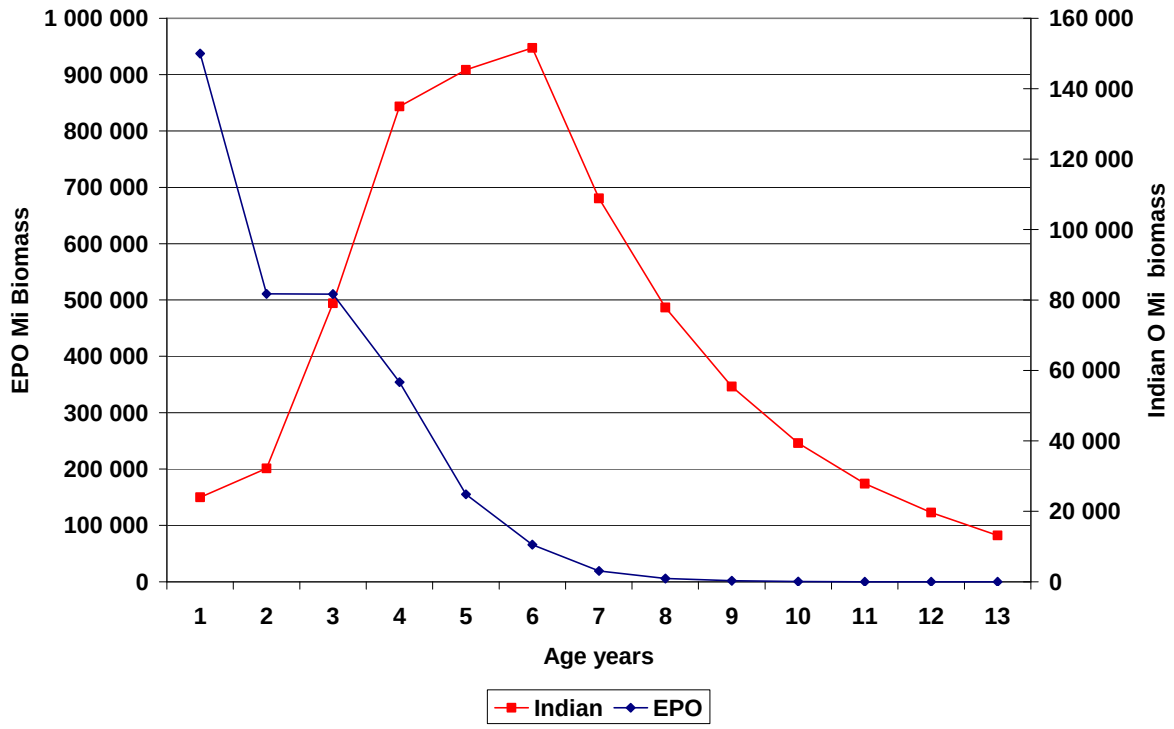

Figure 8: Simulated yearly biomass at age of 2 tuna virgin stocks, showing the natural mortalities and growth assumed in the EPO and in the IO.

There is no doubt that the vectors of natural mortality at age used in the EPO and IO are still widely hypothetical[2]: often obtained by a "crystal ball" or from a statistical "best fit" from an over parameterized statistical model. The increase of female natural mortality assumed in the EPO is possibly questionable, if compared to the results obtained in the Indian ocean. Sexed

[2] With a small potential advantage for the Indian Ocean low natural mortality, because it is based on the analysis of multiple yellowfin recovery results (using Brownie Petersen method).
However, these Indian Ocean preliminary estimates of low Mi would need to be confirmed by further statistical analysis

recoveries of adult yellowfin in the IO show a differential growth between males and females (a larger L infinity for males), thus explaining the differential sex ratio which has been observed worldwide for all YFT fisheries .

The asymptotic sizes used in the models are interesting to compare and to validate, keeping in mind that these asymptotic sizes should be the average length of the oldest fishes in the cohorts, not the largest sizes of the largest fishes. The IO asymptotic size of 145 cm (from Eveson & Million 2008) may be a bit small, but as only 5% of the total catches of large yellowfin over 1 meter are caught by fisheries over this size of 145 cm, such level may also be acceptable (it should be validated by a new analysis of recent recoveries). On the opposite, the very high asymptotic size in the EPO may be extremely high & biologically unrealistic as such very large sizes have never been observed even for the virgin stock[3].

These parameters would clearly need comparative biological studies.

4-Stock assessment results:

4-1- MSY estimated in both oceans

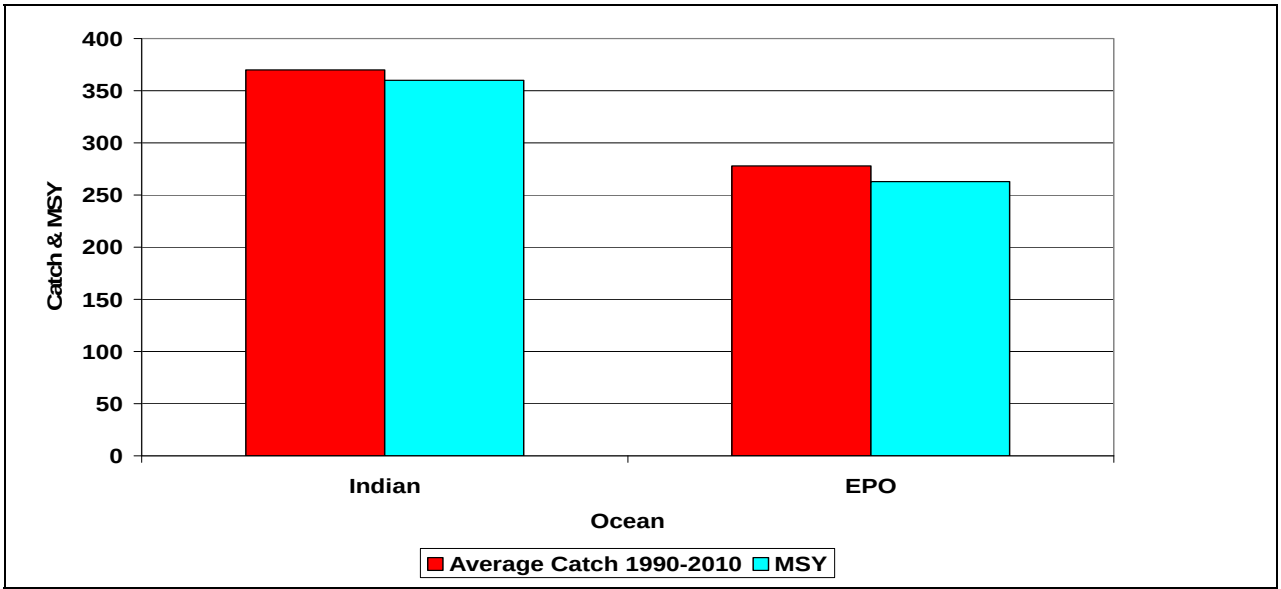

Figure 9: Average catches observed and estimated MSY in the IO and EPO.

The levels of estimated MSYs are in the same order of magnitude for the 2 stocks, being simply in proportion of recent maximal catches observed in the 2 areas (Figure 9)

4-2- Levels of recruitment

[3] The very large L infinity in the EPO being compatible with sizes of NBA players, not with the average size of adult American.

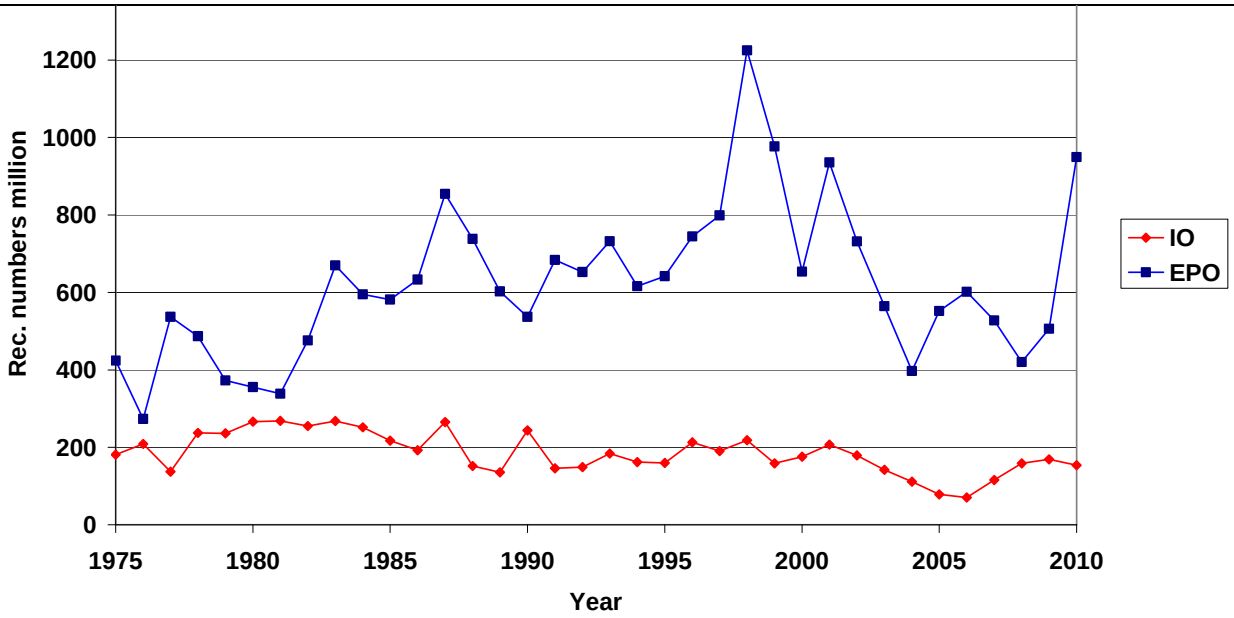

Figure 10: Yearly levels of recruitments estimated in the EPO and IO base case stock assessments

Yearly recruitment estimated at much larger levels in the EPO: a **ratio of 4.5** during the last 10 years. This is simply to « compensate » for the very large natural mortality assumed.

4-3- Levels of yellowfin stocks biomass

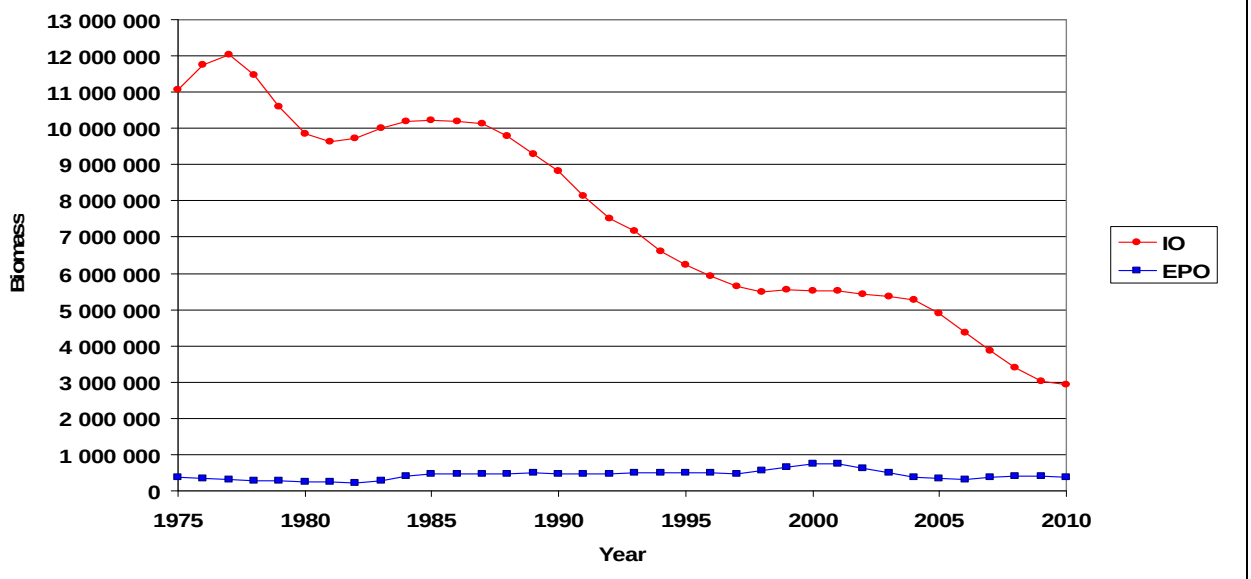

Figure 11: Yearly levels of stock biomass estimated in the EPO and IO base case stock assessments

Yearly biomass estimated at much lower levels in the EPO: Indian Ocean estimated biomass being 10 times larger than EPO estimated biomass (last 10 years)

4-4- Estimated Fishing mortalities

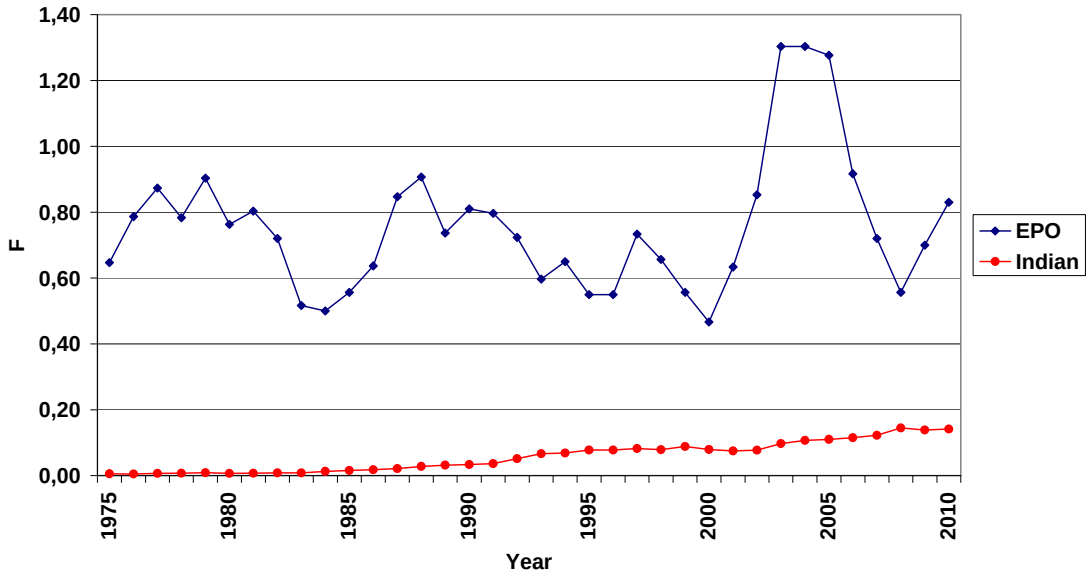

Figure 12: Yearly levels of fishing mortality estimated in the EPO and IO base case stock assessments

Subsequently, much larger fishing mortalities exerted in the EPO than in the IO.

4-5-Relationship between recruitment and spawning stock biomass

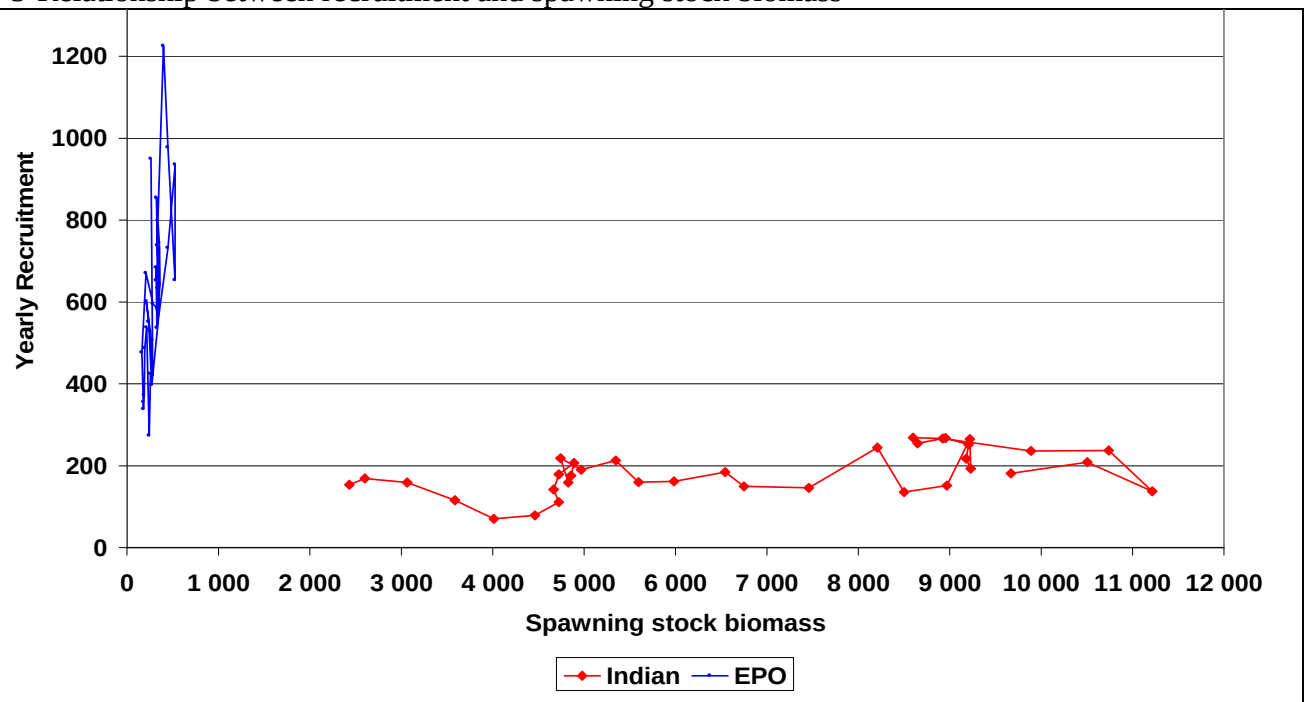

Figure 13: Stock recruitment relationship estimated in the EPO and IO base case stock assessments

An Indian Ocean yellowfin stock with an enormous fecund biomass producing quite low levels of recruitments

An EPO yellowfin stock with a very small fecund biomass producing much larger levels of recruitments than in the IO

5- Conclusion & recommendation

It is striking to note how much the yellowfin stocks & fisheries in the EPO and IO are very similar in all their basic characteristics, at least the visible ones, when surprisingly the best stock assessment results, obtained by the same kind of the "best" stock assessment models and by expert scientists, are totally incompatible in their trends and orders of magnitude.

On the other side, these EPO and IO stock assessment results are well accepted in each of the two RFO, IATTC & IOTC, as being realistic results that are using the best models and all the data, and then estimating well the status of their YFT stocks.

This major discrepancy needs to be urgently clarified. Therefore, it is highly recommended to organize as soon as possible an ad hoc WG between the IOTC and IATTC stock assessment experts, including other experts in biology and ecology of yellowfin, in order to clarify the causes of these major structural divergences. The goal of this WG would be to explore the working hypotheses driving the stock assessment process and to understand the convergences or divergences between the results of assessments. Some open questions could be addressed, for instance:

1) What are the most likely natural mortality vectors and growth patterns in the 2 oceans?
2) What is the impact of the working hypotheses on the stock assessment results?
3) What are the numbers of juvenile yellowfin recruited each year? swimming under FADs…..
4) What is the past and present biomass of yellowfin in the Indian and Eastern Pacific oceans?

This type of comparison between stock assessment hypotheses, methods and results should also be usefully be done at a global scale…

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