

TANZANIAN WATERS

A TUNA HUB IN THE INDIAN OCEAN



by Jean-Pierre HALLIER & Alain FONTENEAU

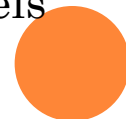
INDIAN OCEAN TUNA TAGGING SYMPOSIUM

- Grand Baie, Mauritius, 30th October – 02nd November 2012

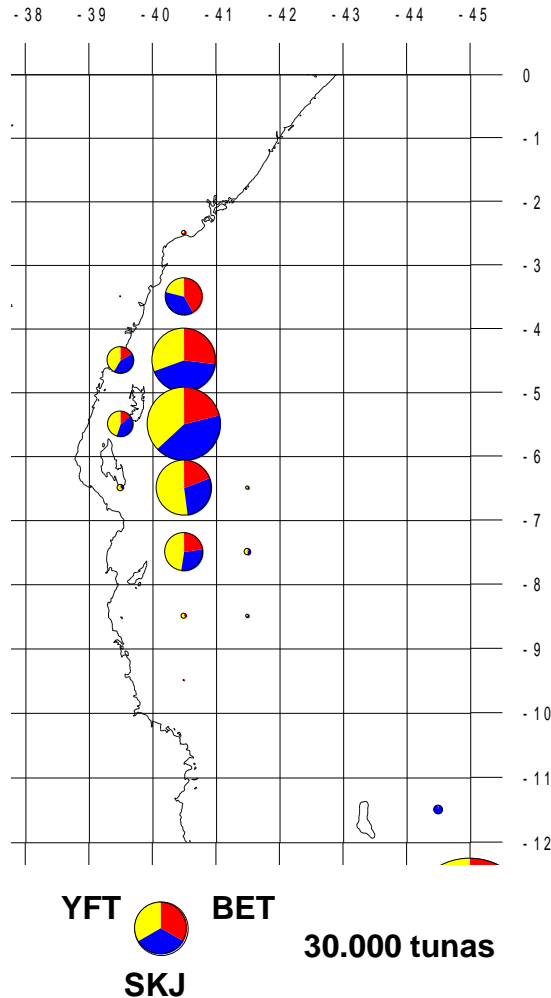
TAGGING OFF TANZANIA:

A MAJOR TAGGING HOT SPOT FOR THE 3 SPECIES

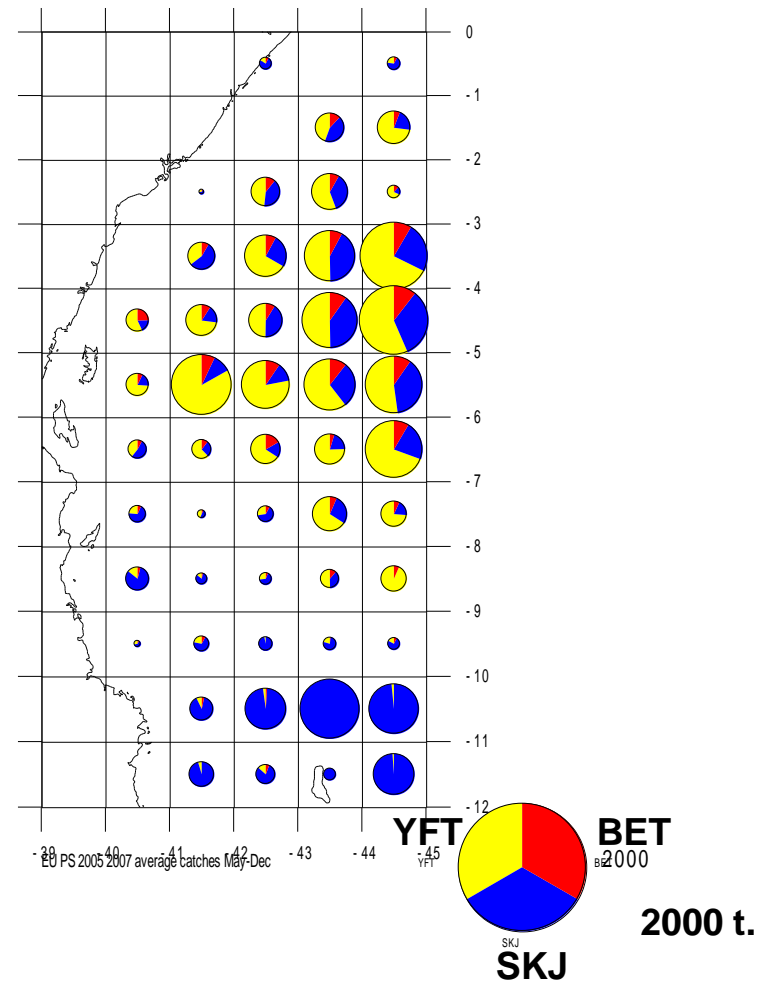
- Of the 168,163 tuna tagged by the RTTP, 133,465 tunas were released off Tanzania: 46,675 YFT, 51,777 SKJ & 34,439 BET, i.e. a large percentage (79.4 %) of the 2005-2007 RTTP tagging period.
- This coastal area is positioned outside the main fishing zones of the main fisheries, but showing a significant biomass of YFT, SKJ and BET that were tagged by the 2 RTTP pole and line vessels using a peculiar fishing technique: **the « Association School Fishing Technique » or ASFT.**
- **It seems that this tuna local biomass is quite small and highly mobile: its functioning being as in airport HUB, where many planes are doing a short stop over, but quickly moving towards remote airports.**
- **This presentation will analyse the dynamics of this potential Tuna HUB:**
 -  It will review the **tagging operations and the recoveries** obtained from these tagging
 -  It will analyse the detailed tagging operations: **the ASFT technique and the repeated recoveries of tagged tunas** by the tagging vessels



(I) TANZANIAN TAGGING: TAGGING AND RECOVERIES



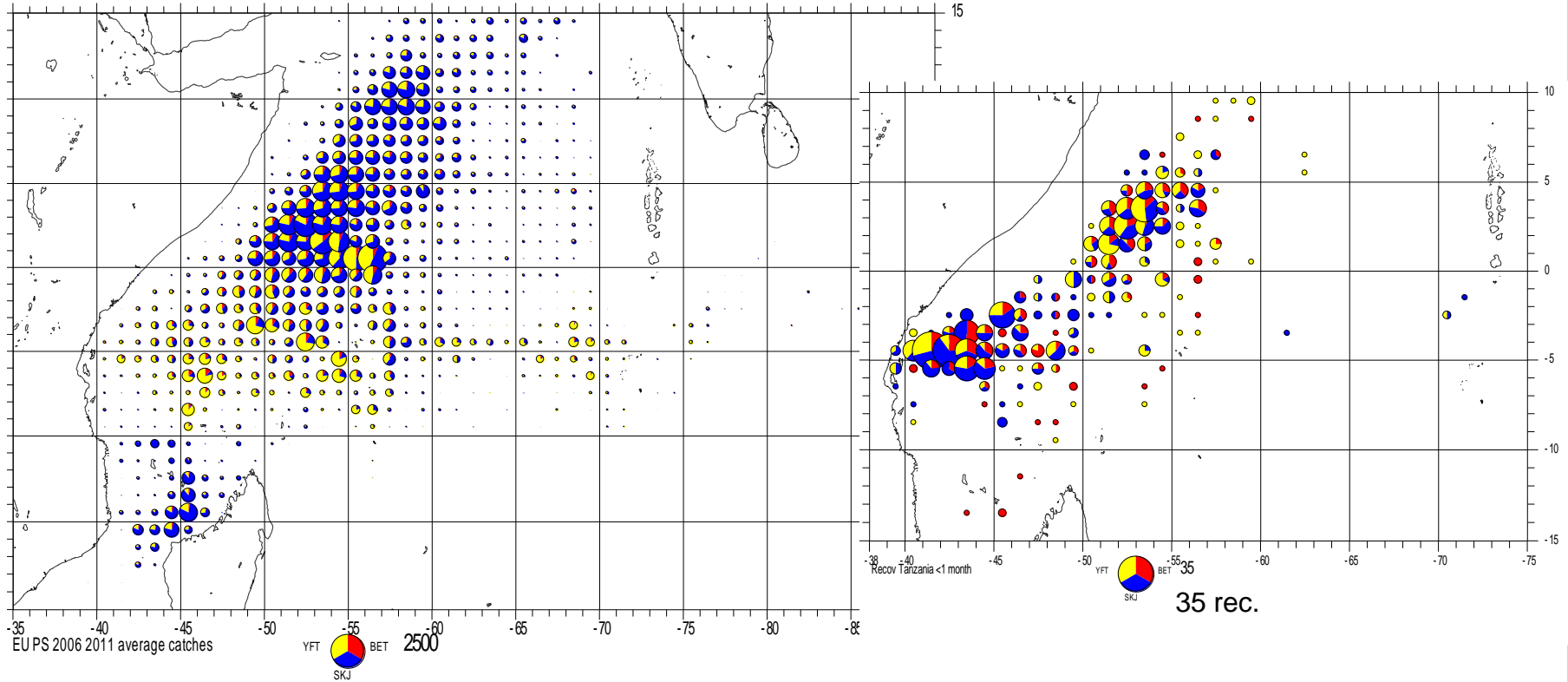
Tanzanian Tagging area (2005-2007)



Average catches of PS during the periods of Tanzania tagging (average catches in May to December, 2005-2007)



(I) Tanzania Tagging: Tagging and Recoveries

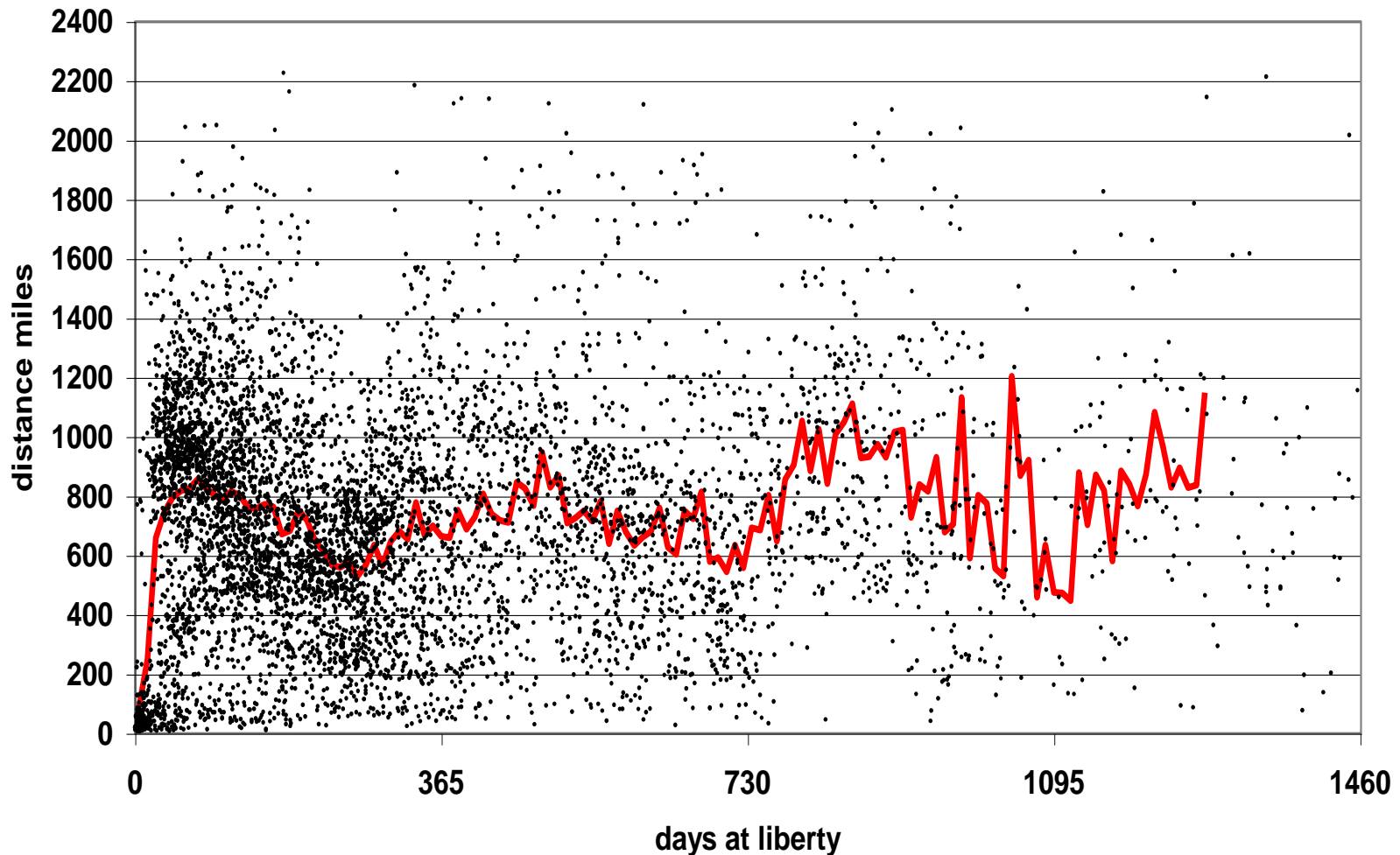


Average catches of EU PS
during the 2005-2011 period

Short term recoveries of Tanzanian tagging
(<1 month)



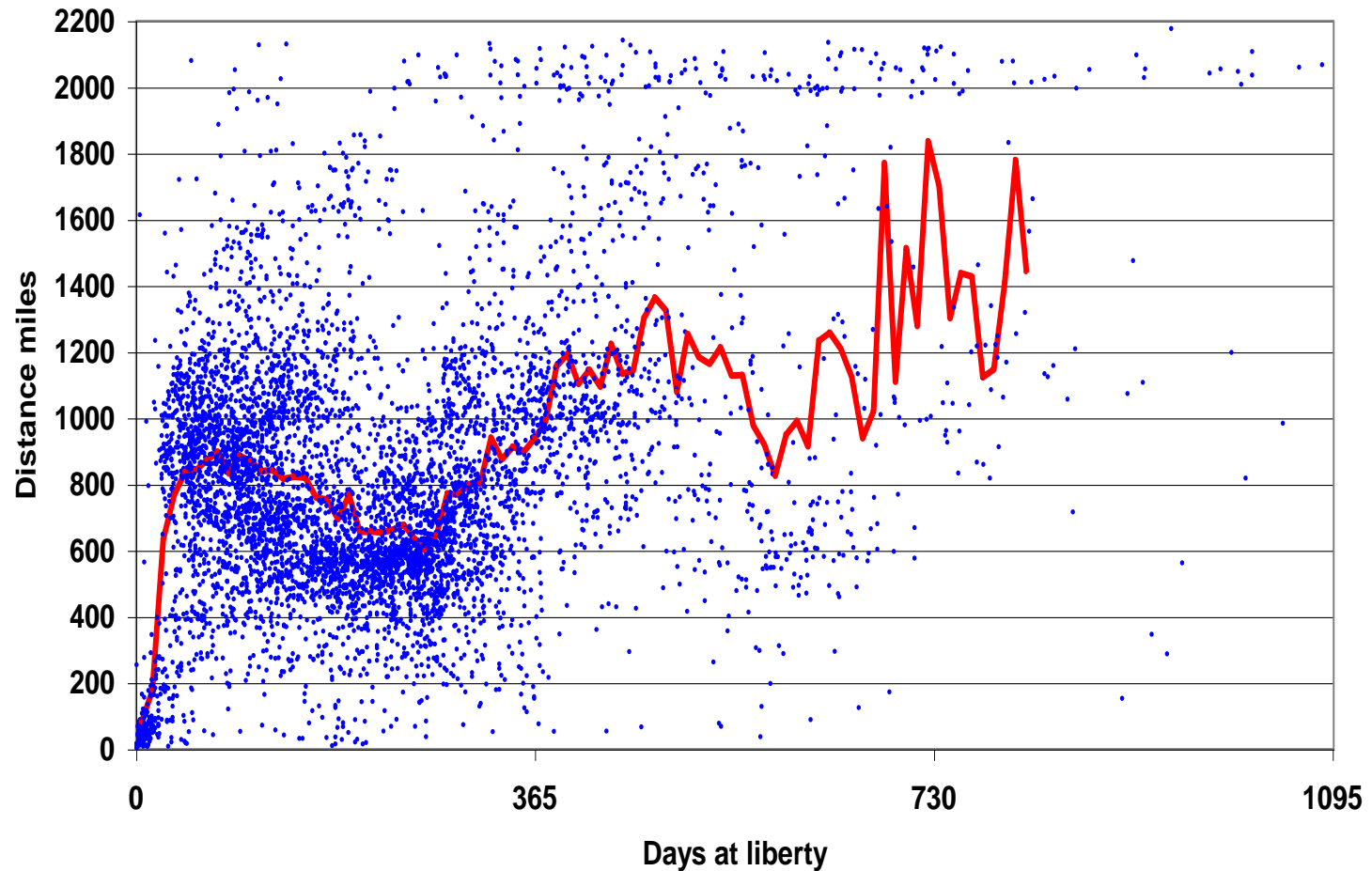
(I) Tanzania Tagging: YFT recovery dispersal (mixing)



Distances between tagging & recovery position of all YFT tagged off Tanzania with well known positions & duration at sea



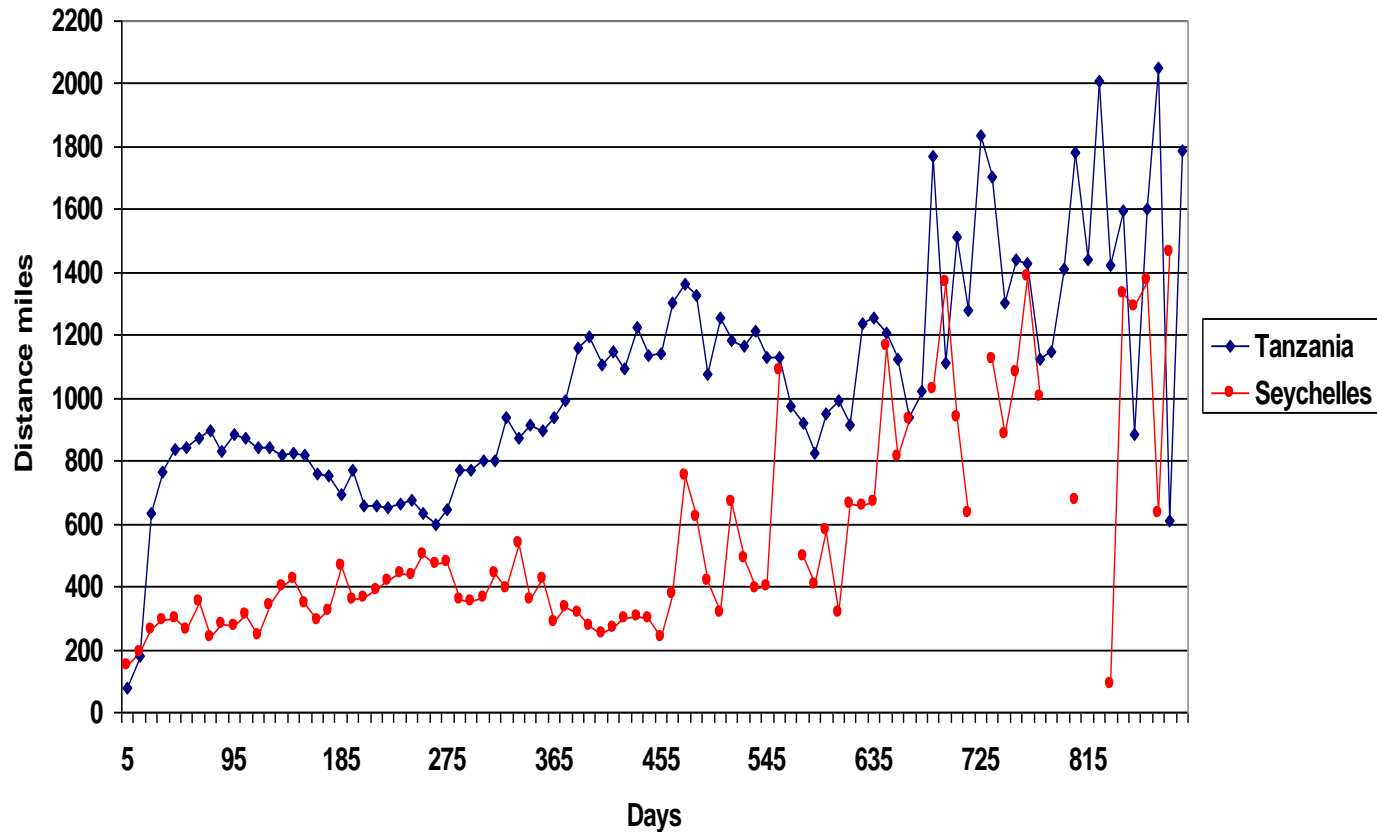
(I) Tanzania Tagging: SKJ recovery dispersal (mixing)



Distances between tagging & recovery position of all SKJ tagged off Tanzania with well known positions & duration at sea

(I) Tanzania Tagging: SKJ dispersal (mixing)

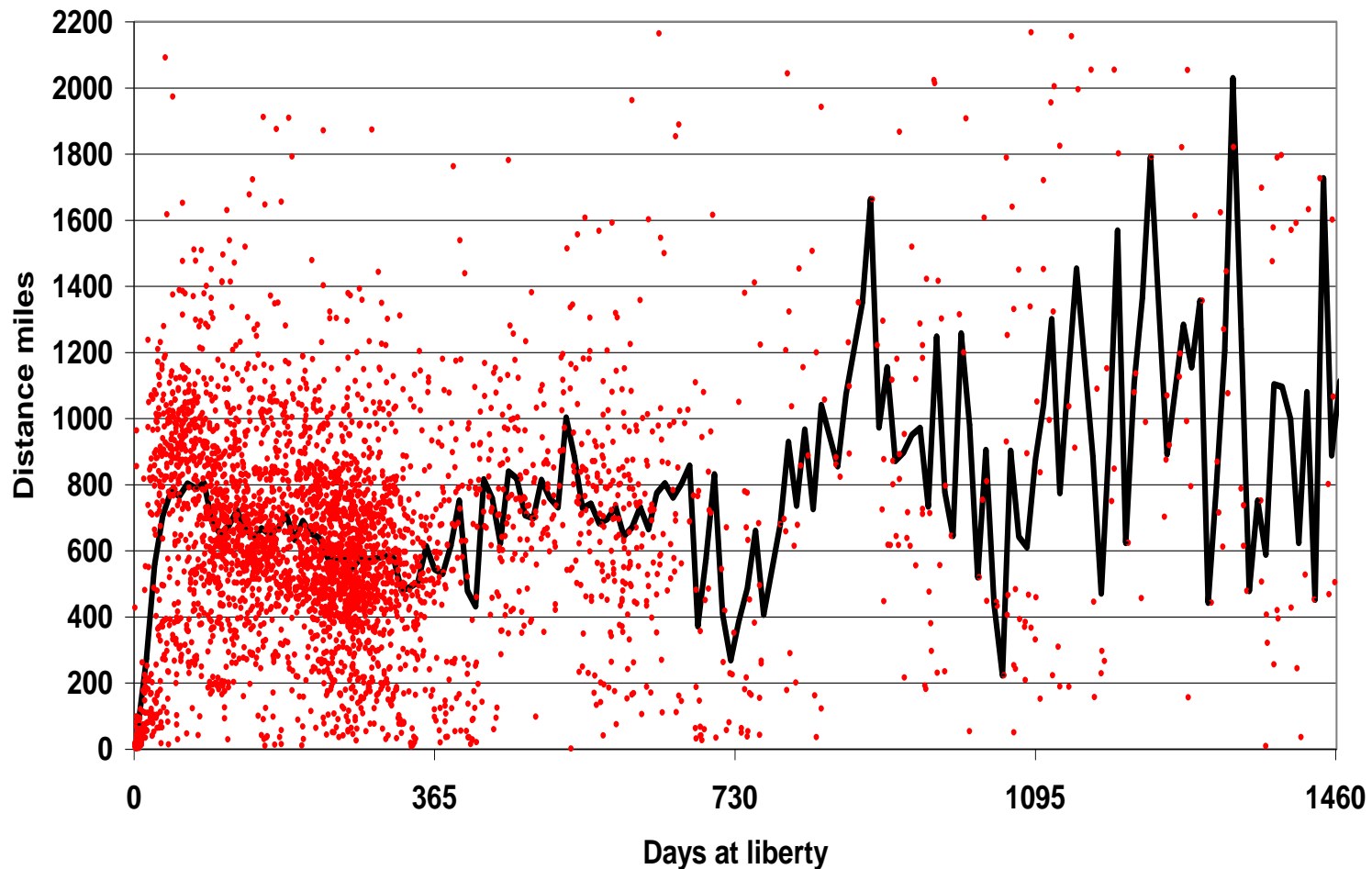
Distance SKJ Tanzania & Seychelles tagging



SKJ dispersal is more pronounced for Tanzania Tagging than for Seychelles Tagging; this last area being at the heart of the PS fishing zone



(I) Tanzania Tagging: BET recovery dispersal (mixing)



Distances between tagging & recovery position of all BET tagged off Tanzania with well known positions & duration at sea

CONCLUSION ON TANZANIA TAGGING & RECOVERIES

- A small area off Tanzania / Kenya provided most of the RTTP-IO tag releases (almost all BET).
- This area offered the opportunity not only to tag large number of tuna but to tag the three tropical tuna species targeted by the RTTP-IO.
- This area is very moderately fished by tuna fleets (PS and LL). Therefore most short-term recoveries were avoided.
- This area also offer a unique advantage: tunas move out of the area very quickly in different directions and generally on long distances. Therefore mixing of the tagged fish is achieve very quickly; a perquisite condition for use of tagging-recovery data in stock assessment models.



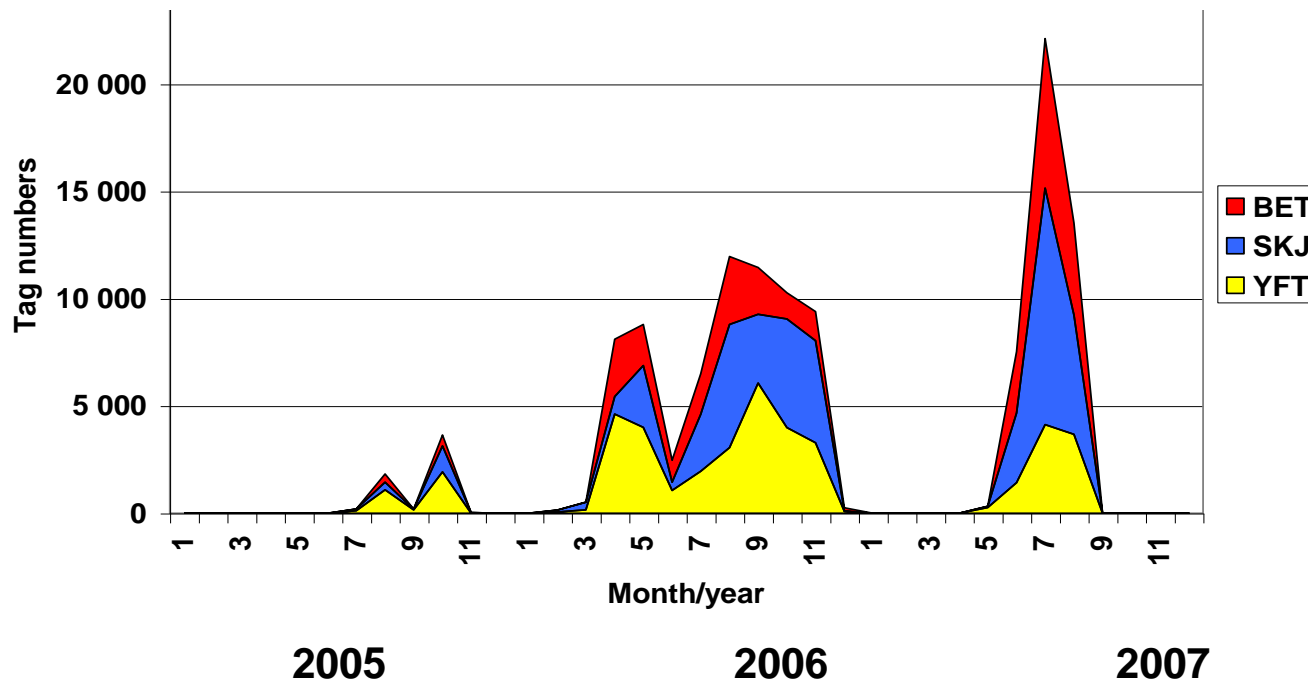
(II) THE ASFT: TECHNICAL AND HISTORICAL CONTEXT

- Tropical tuna are known to form associations with floating objects (anchored or drifting) called Log or Fish Aggregating Device (FAD), and they sometimes also associate with vessels drifting at sea.
- Off Mauritania and Senegal in West Africa, pole-and-line fishermen have developed the « **Association School Fishing Technique - ASFT** » in which an association of a tuna school with a tuna fishing vessel is maintained day and night during weeks and months while fishing, drifting or slowly steaming.
- With this ASFT, this fleet increased its yields 3 folds in the eighties.
- The associated schools are always made of the 3 tropical tuna species Yellowfin, Skipjack and Bigeye (at juvenile sizes for YFT and BET).
- The school can be split or exchanged between vessels. Therefore the implementation of this technique requires at least two vessels.
- This efficient fishing technique have been successfully developped in Canary Islands but with little success elsewhere.



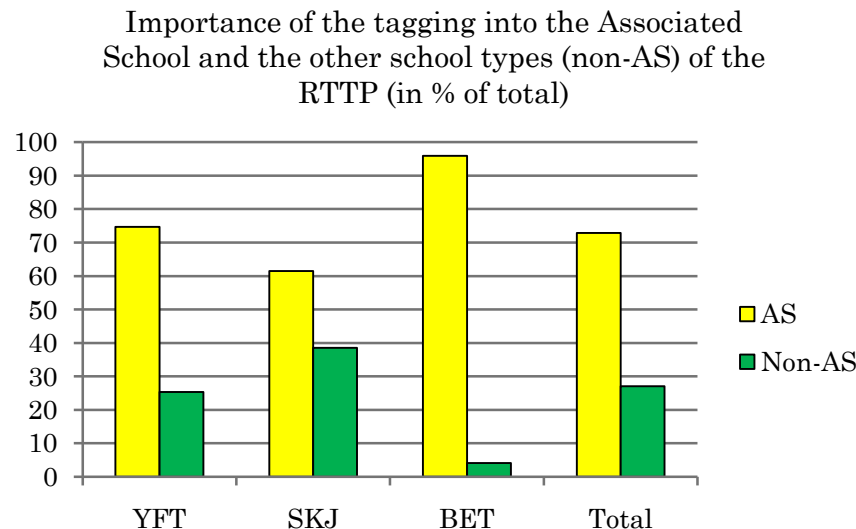
(II) THE ASFT: TAGGING PERIODS

- The RTTP-IO vessels came from this African pole-and-line fishery therefore they had a good knowledge of this fishing technique.
- When they first prospect the Tanzanian-Kenyan coasts in 2005 the vessels noted the presence of the 3 species in mixed surface schools.
- In April 2006, they succeeded in developing the ASFT and the experience was reiterated in 2007.
- All school searching in the vicinity of the AS fishing zone reveal a very low school abundance. According to skippers only one mixed species school was present; others were small fast moving schools of SKJ.



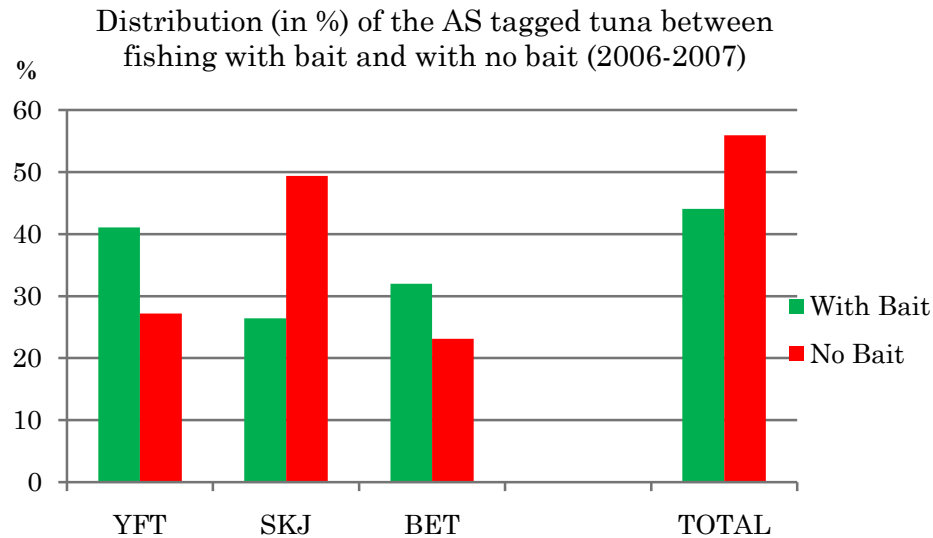
(II) THE ASFT: IMPORTANCE & NUMBER OF FISH TAGGED

- During the RTTP-IO, 168,163 tunas were tagged, 122,615 within the Associated School (AS) or 73% as illustrated below and 92% of Tuna Tagged off Tanzania.
- Almost all BET were tagged in the AS because BET is of the 3 tuna species the less vulnerable to pole-and-line except when it is close to the surface as in the case of the AS.



(II) THE ASFT: CONSTRAINTS AND CONDITIONS FOR THE ASFT IMPLEMENTATION

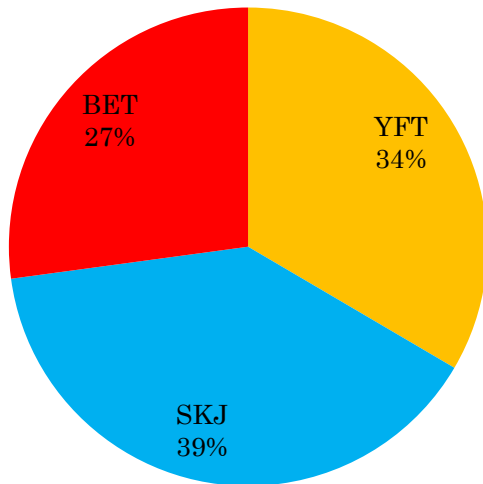
- Two vessels are necessary: hopefully the RTTP-IO chartered 2 pole-and-line vessels
- In 2006, the AS was exchanged 18 times between the two vessels and 13 times in 2007.
- In 2006, the AS was divided and regrouped 15 times between the two vessels and 8 times in 2007.
- Following a shortage of bait, fishing without bait was implemented with great success during long periods; a phenomena known off West Africa but never on the scale observed off Tanzania.
- Of the 629 days spent fishing with the AS by the two vessels in 2006 & 2007, about half of the time was spent fishing with bait and half without bait.



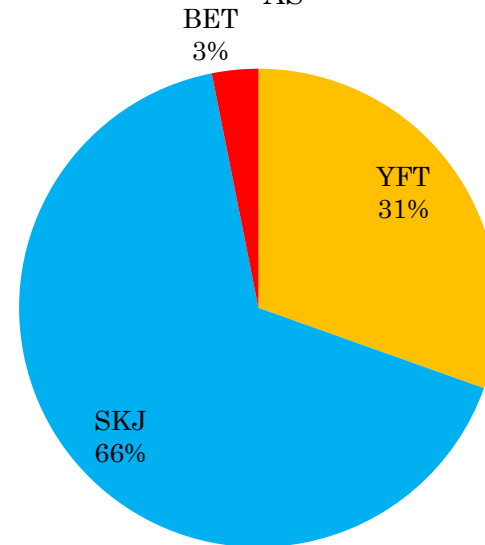
(II) THE ASFT: SPECIES COMPOSITION

- Within the AS the three species are well represented while basic pole-and-line fishing (on non-AS) is largely dominated by SKJ with a very low presence of BET.

Species composition of the fish tagged in the AS

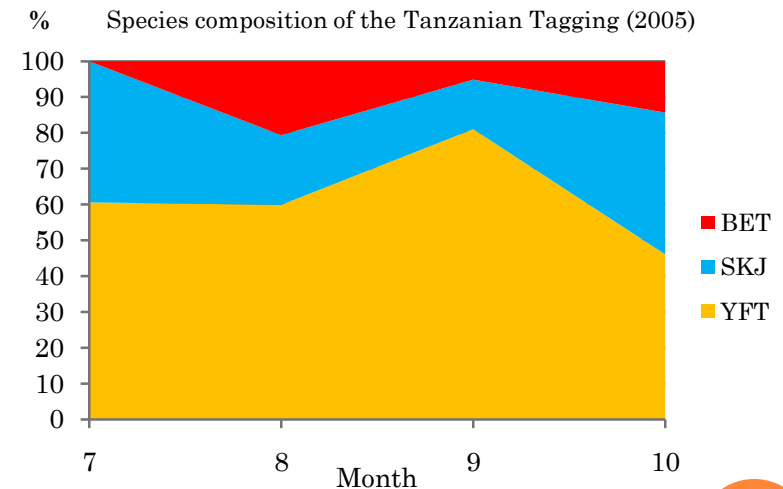
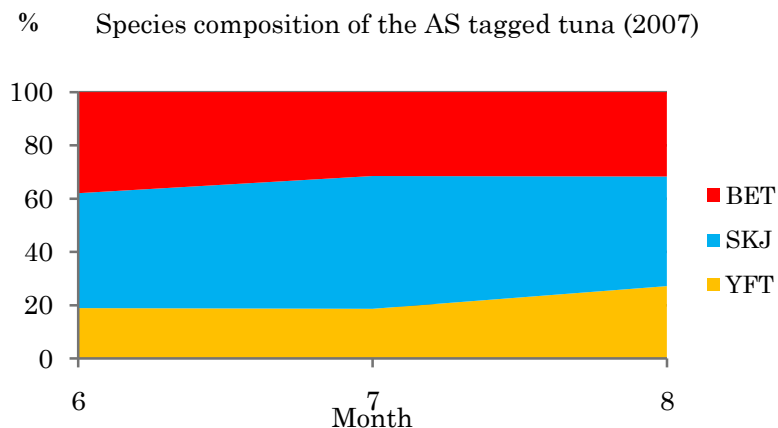
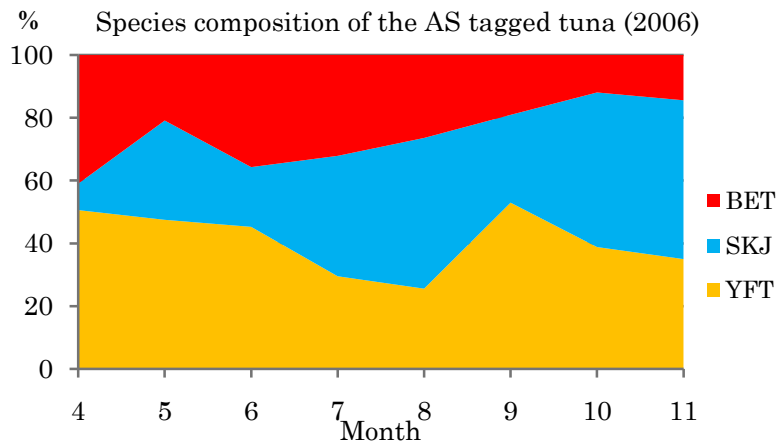


Species composition of the fish tagged outside the AS



(II) THE ASFT: SPECIES COMPOSITION WITH TIME

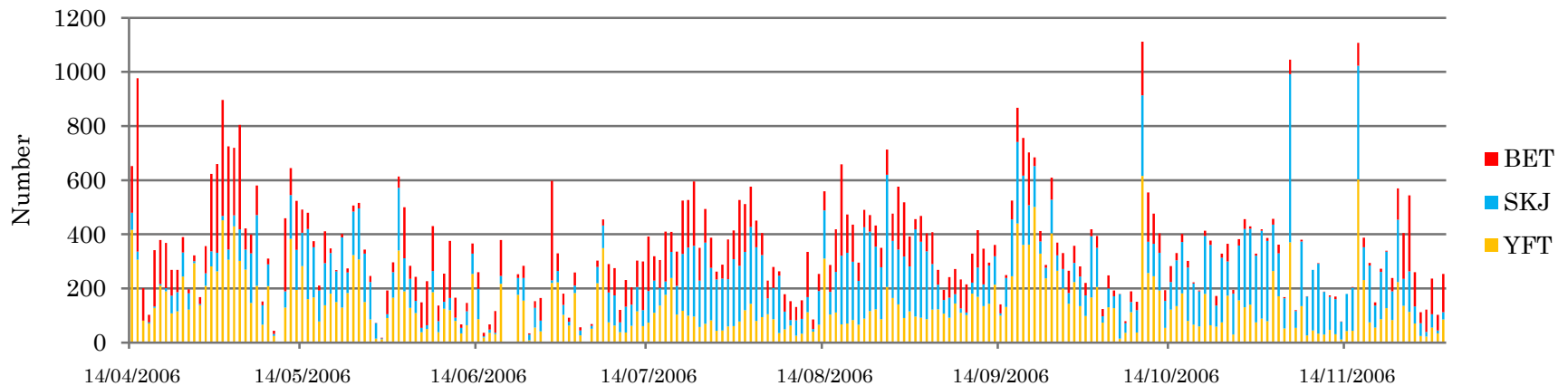
- The AS was fished from April to November in 2006 and from June to August in 2007.
- The same area was also fished in 2005 from July to October but no school was associated to the vessels at that time.



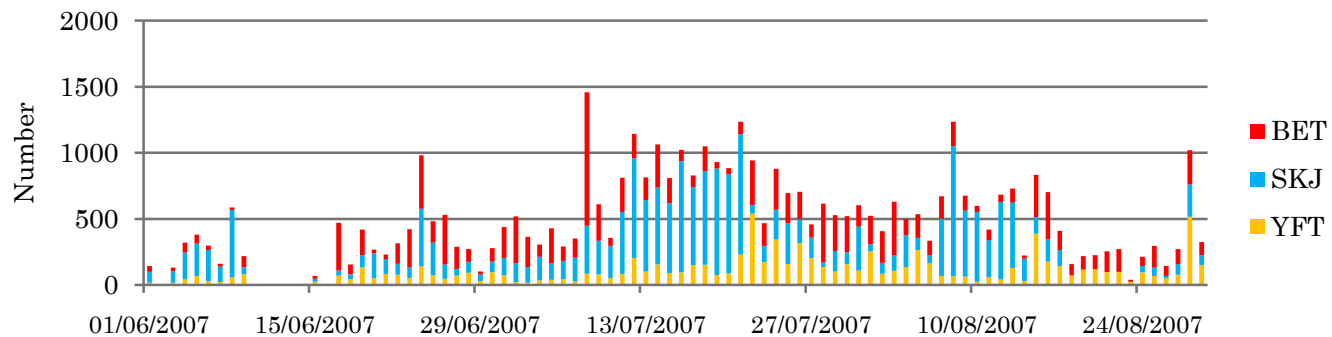
(II) THE ASFT: NUMBER OF FISH TAGGED DAILY

- While fishing in the AS, tagging was successful almost every day and sometimes very successful.

Daily tagging by species in the AS (2006)



Daily tagging by species in the AS (2007)



(II) THE ASFT:

CONSEQUENCES ON RECOVERIES BY THE TAGGING VESSELS

- As many fishing days were spent on the AS (629 days) and a very large amount of tuna were tagged (122,615), one can expect a large number of recoveries by the tagging vessels.
- At the most, the number of recoveries might be so high that it becomes unprofitable to continue tagging.
- Usually, while tagging, the rule is to throw on deck any tagged fish caught.
- With the AS and the numerous recoveries, I decided not to keep these recoveries on board but to record them and to throw them back to the sea (Re-Released tuna or RR tuna). All these data collected on the RR and OD fish constitute the data base used in the following analysis.
- However, some fell on deck or others were in poor conditions or the tag was badly placed, those were kept on board (OD tuna). These OD tuna were only a small fraction of recaptured tuna : 439.
- It turned out that the level of recoveries remained manageable and some tagged fish were caught several times and re-released (RR): up to 9 times for one SKJ, 7 times for 6 YFT and 4 times for one BET.
- Later, some of these tuna, that experienced RR, were recaptured by commercial or artisanal fishing vessels (1603 tuna).



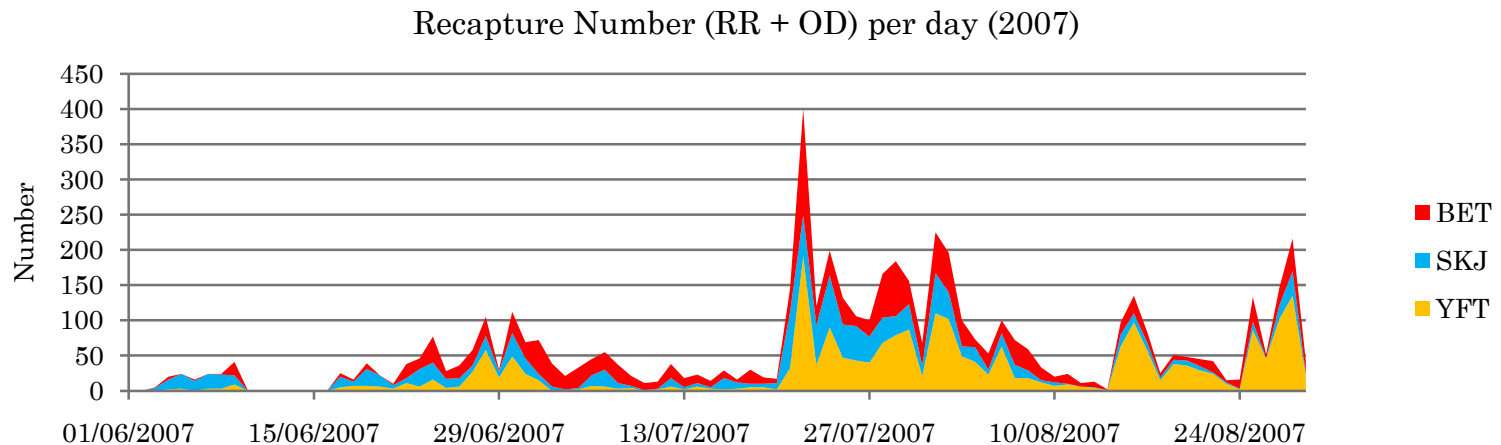
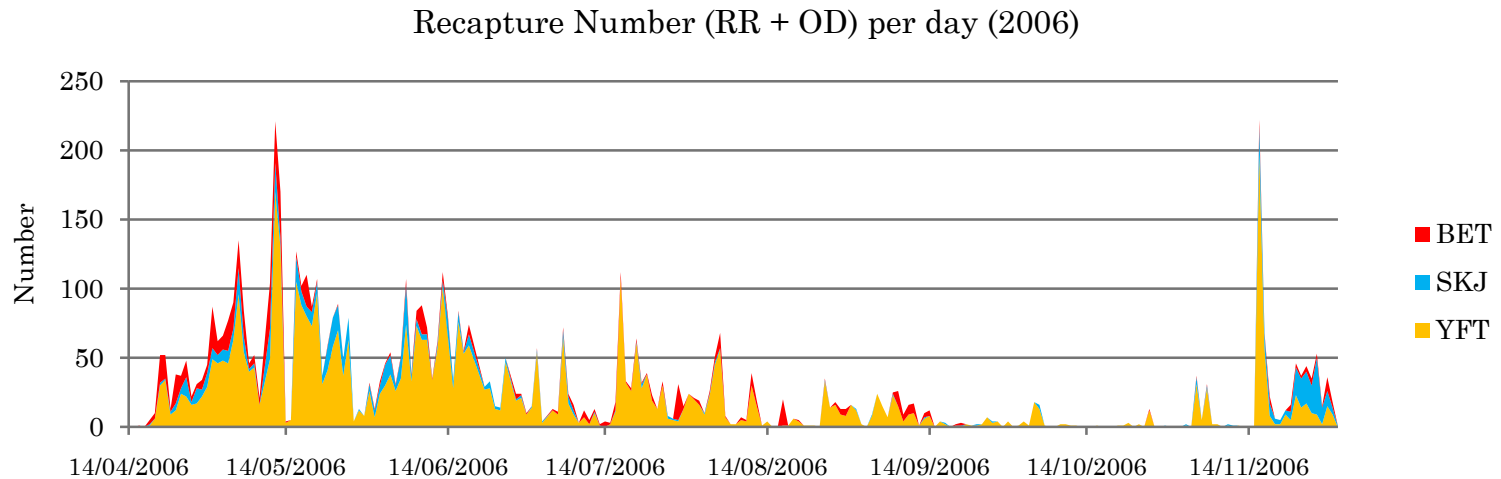
(III) RECOVERIES BY THE TAGGING VESSELS: THE RE-RELEASE

- We recorded 8,973 individual tagged fish recaptures (7.3% of all tuna tagged in the AS) which generated 11,449 recaptures as some tagged tuna show up several times.
- This 7.3% level is remarkably low considering the long period of time the AS was fished each year and the very large number of tag releases.
- Therefore with this low level of recaptures, it was possible to fish extensively with this fishing mode.



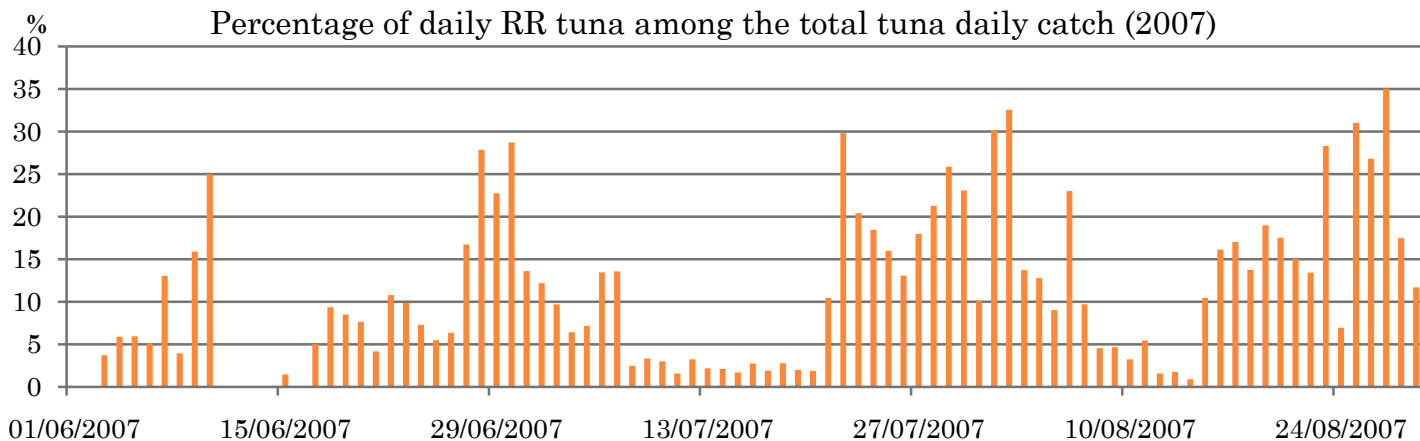
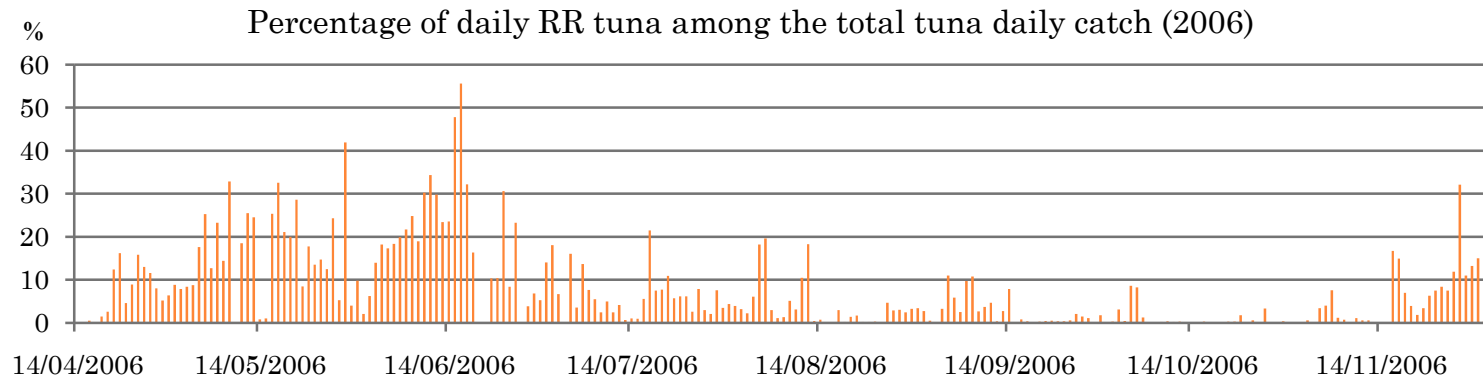
(III) RECOVERIES BY THE TAGGING VESSELS: DAILY RECAPTURES

- Figures below represent the RR + OD tuna registered per day.



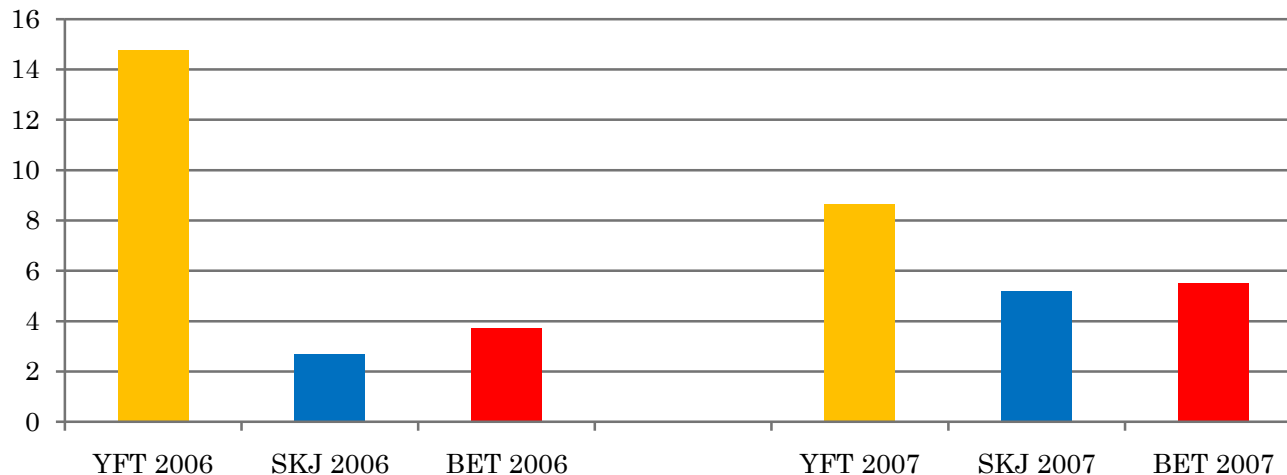
(III) RECOVERIES BY THE TAGGING VESSELS: RECAPTURES AS A FUNCTION OF THE TOTAL NUMBER OF TUNA TAGGED

- The 2 figures below represent the importance of the RR among the Total daily catch in the AS.
- The percentage of RR among the daily catch in the AS is variable and generally not related to the number of tagged tuna.



(III) RECOVERIES BY THE TAGGING VESSELS: RECOVERY RATES PER SPECIES

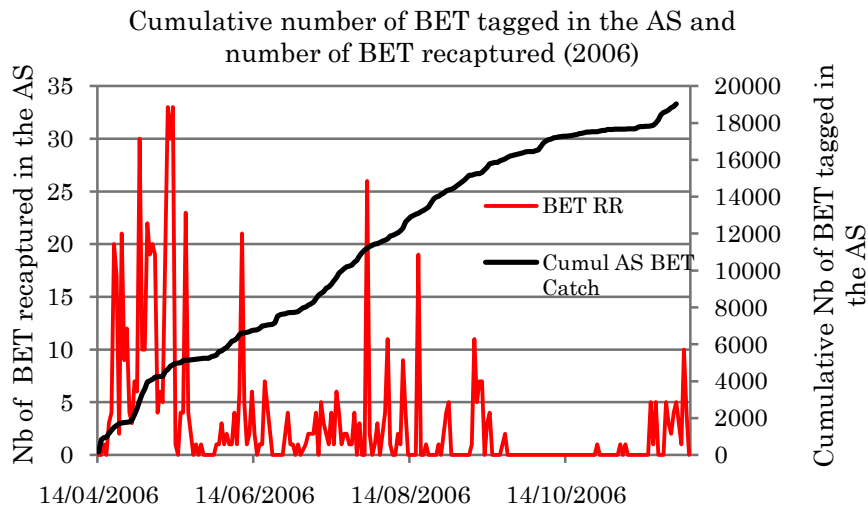
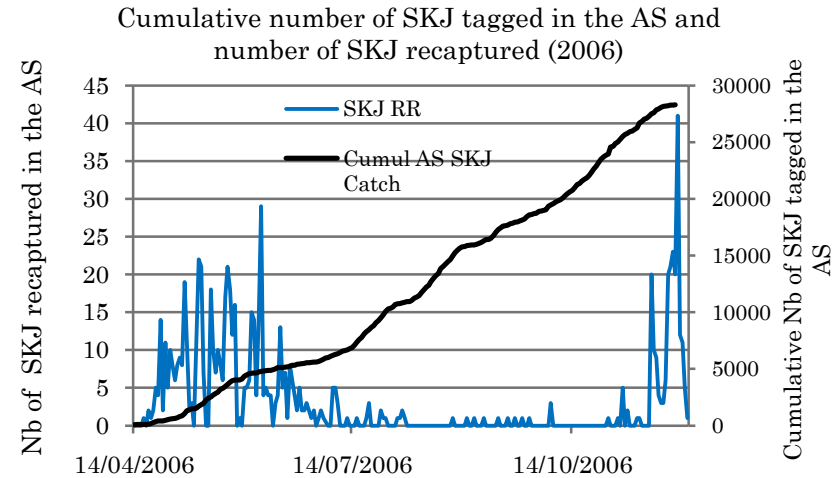
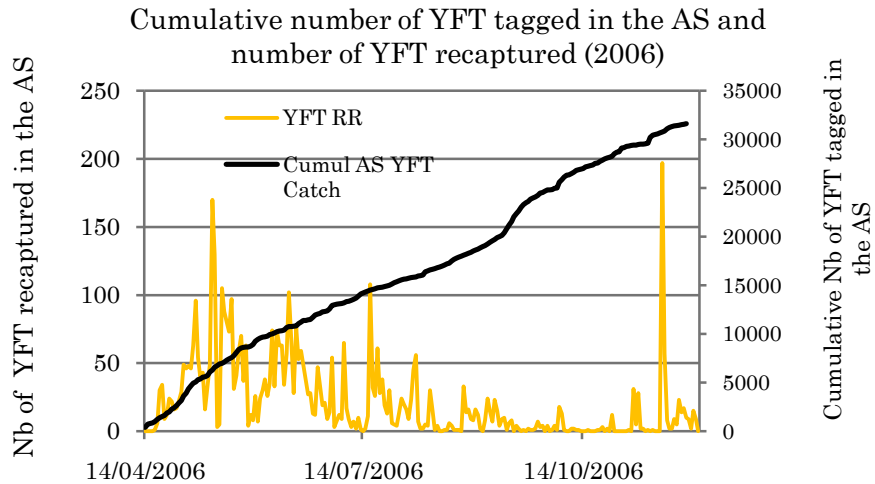
Recovery Rate in the AS (2006-2007)



- YFT Recovery rates are always the highest.
- SKJ & BET Recovery rates are lowest and quite similar.
- For memory SKJ is the most tagged and BET the less tagged in the AS but still in very large numbers.
- Apparently YFT remain in the AS for longer duration than SKJ and BET.



(III) RECOVERIES BY THE TAGGING VESSELS: RECAPTURES AND CUMULATED NUMBER OF TAGGED TUNA IN 2006



- The number of recaptures is not directly connected to the number of fish released in the AS.
- On the contrary, this number of RR increase during the first month for all three species then decreases remarkably to become nearly nil from mid-August to mid-November.
- The dynamic is not exactly the same according to species and vary with time.



(III) RECOVERIES BY THE TAGGING VESSELS: TAGGING & RECAPTURES IN 2006

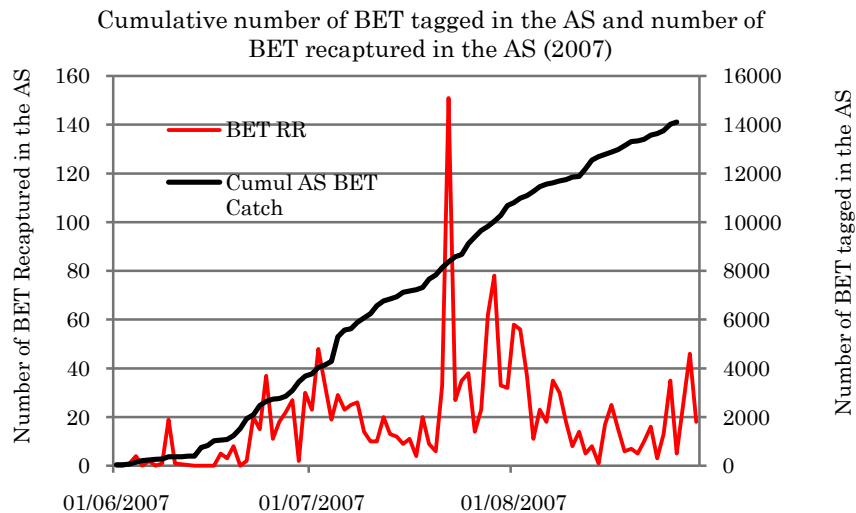
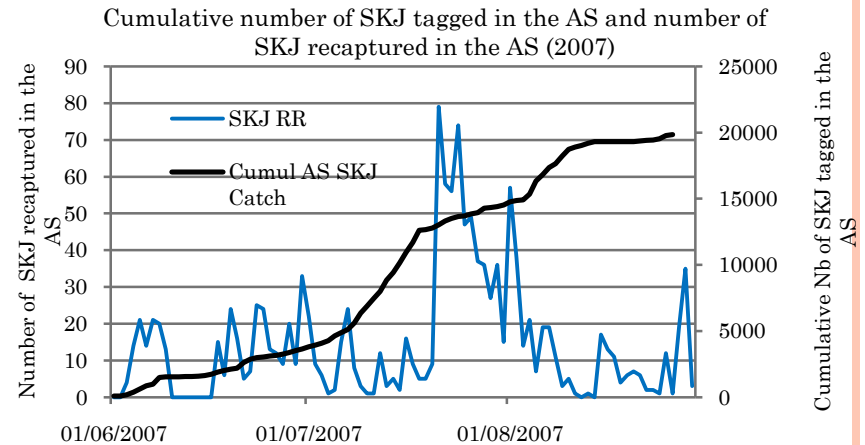
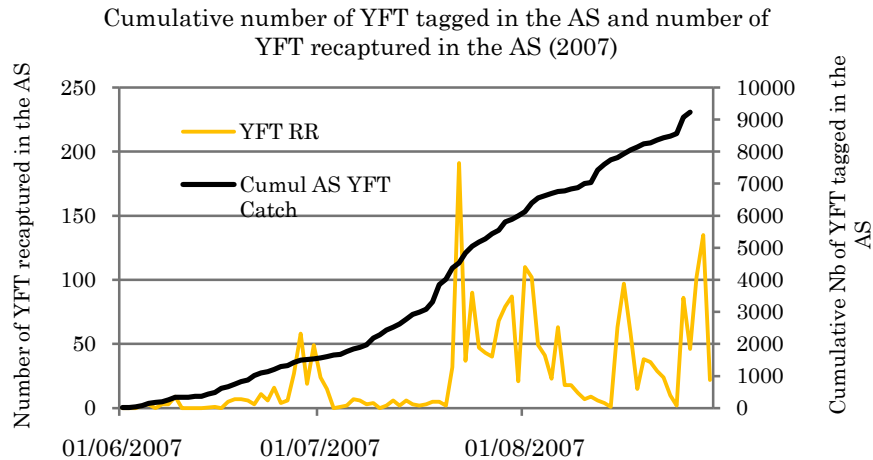
Some characteristics of the tuna dynamic in the AS of 2006:

- For YFT between 28/07 and 03/11, only 110 RR are registered (+2.7% over the cumulated number already recorded) while 9,030 YFT are released in the AS during the same period (+45.8%). It looks like that almost all these 9,000 YFT have immediately left the AS.
- For SKJ during the same period only 19 RR are registered (+3.7%) while, during the same period, 15,121 SKJ tags are added to the 8,831 that have already been released on 28/07 (+171%). Again, it looks like these 15,000 SKJ have immediately left the AS.
- For BET between 20/09 and 15/11, 3 RR (+0.5%) while the number of tagged BET in the AS increased by 11.8%. As for the two other species, it looks like 3,600 BET left the AS.
- For all species we noted some sudden bursts in the number of RR but for very short periods (at the most a few days). The daily number of RR fluctuate a lot while the number of releases is increasing regularly.
- YFT RR are in general more numerous than BET and SKJ RR. In fact their proportion among the total number of RR is much higher than their proportion among the different species tagged in the AS. This might imply a lower turn-over of YFT in the AS than the one of SKJ and BET.

However, these results imply for the three species a very high turn-over in the AS with a short duration spent in the school.



(III) RECOVERIES BY THE TAGGING VESSELS: RECAPTURES AND CUMULATED NUMBER OF TAGGED TUNA IN 2007



- Contrary to 2006 AS, the number of recaptures is more related to the number of fish released in the 2007 AS.
- The slow increase of the number of releases in the AS at the beginning resulted into low number of RR.
- Later, the sharp increase in the number of releases even if it is associated to RR increases, does not always match closely with the number of RR.
- However, the dynamic is less variable according to species. For instance we noted a burst in the number of RR for all species during the period 22/07 – 06/08.

(III) RECOVERIES BY THE TAGGING VESSELS: TAGGING & RECAPTURES IN 2007

Some characteristics of the tuna dynamic in the AS of 2007:

- There is no long period with very low number of RR as noted in 2006.
- After an initial period of low RR, the cumulative number of RR increase more or less as the cumulative number of releases in the AS. But still with a high variability.
- As for 2006, YFT RR are in general more numerous than RR of the two other species but at a level less pronounced than in 2006.
- However, these RR remain quite limited when compared to the number of releases in the AS. This imply again a high turn-over of the three species in the AS.



(III) RECOVERIES BY THE TAGGING VESSELS: CONCLUSIONS

- The number of RR when compare to the number of releases show a different pattern according to species, periods and years.
- This difference underlies a different but very active dynamic of the fish into the AS.
- The movements in and out of the school are obviously important. At some periods, most of the tagged fish seem to leave the school very quickly and are replaced by others. Fish that remained longer are few whatever the species.
- YFT Re-released are always higher than those of the two other species, a situation that can be explained by a better fidelity to the AS (lower proportion of the YFT leave the AS) or a lower abundance of this species in the AS (less YFT join the AS).
- The general figure is an AS where the three species are passing through quickly and regularly replaced by new comers, hence the term of Tuna Hub.



(IV) SUCCESSIVE RE-RELEASES

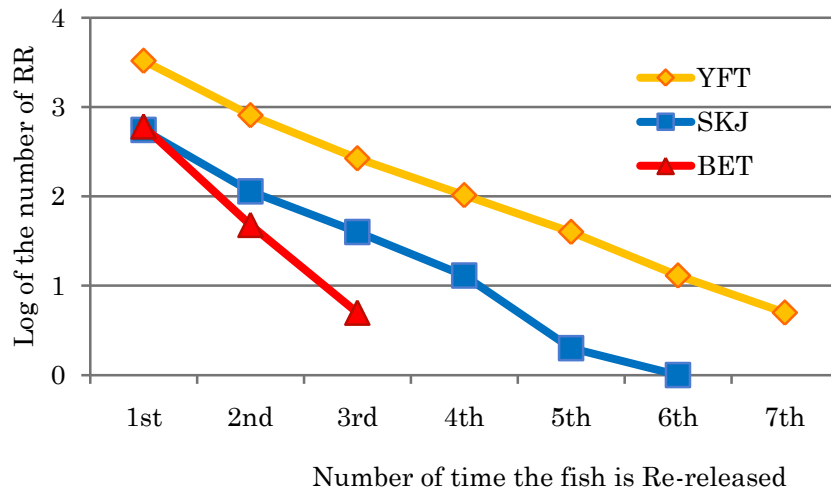
Successive releases of the same fish (2006-2007)

RR	NUMBER					PERCENTAGE			
	YFT	SKJ	BET	UNK	Total	YFT	SKJ	BET	Total
1st	4976	1511	2146	8	8641	74.12	76.24	93.22	78.48
2nd	1208	312	139	4	1663	17.99	15.74	6.04	15.10
3rd	349	103	16	1	469	5.20	5.20	0.70	4.26
4th	117	37	1		155	1.74	1.87	0.04	1.41
5th	42	11			53	0.63	0.55		0.48
6th	15	4			19	0.22	0.20		0.17
7th	6	2			8	0.09	0.10		0.07
8th		1			1		0.05		0.01
9th		1			1		0.05		0.01
Total RR	6713	1982	2302	13	11010				

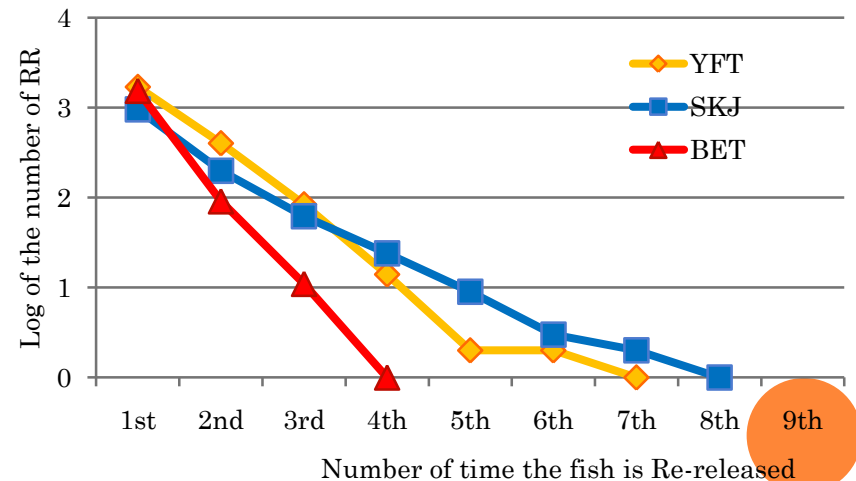
- ✓ At the most one YFT was recaptured 9 times and released each time.
- ✓ But most of the fish experienced only one recapture (78.5%) and less than 1% of the fish get recaptured more than 5 times.
- ✓ The levels of successive recaptures are more or less the same for YFT and SKJ but lower for BET (at the most 4 successive RR)
- ✓ This situation is slightly different between 2006 and 2007.

These results confirm the very turn-over within the AS

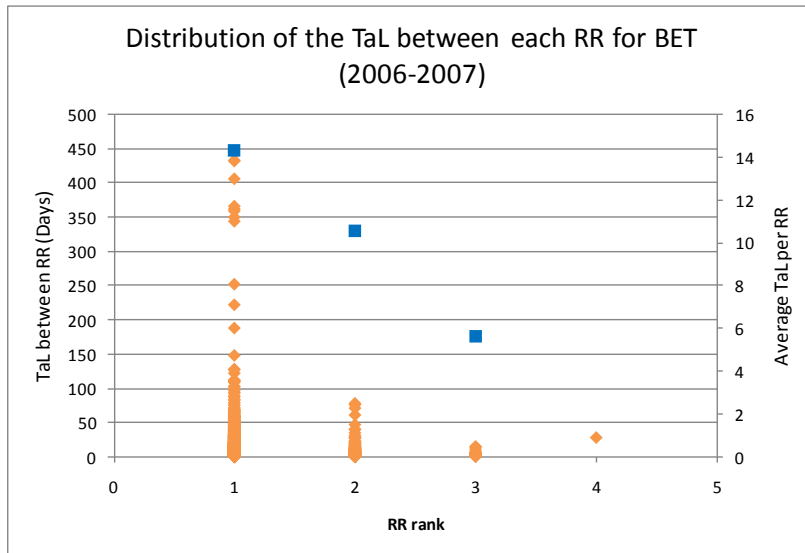
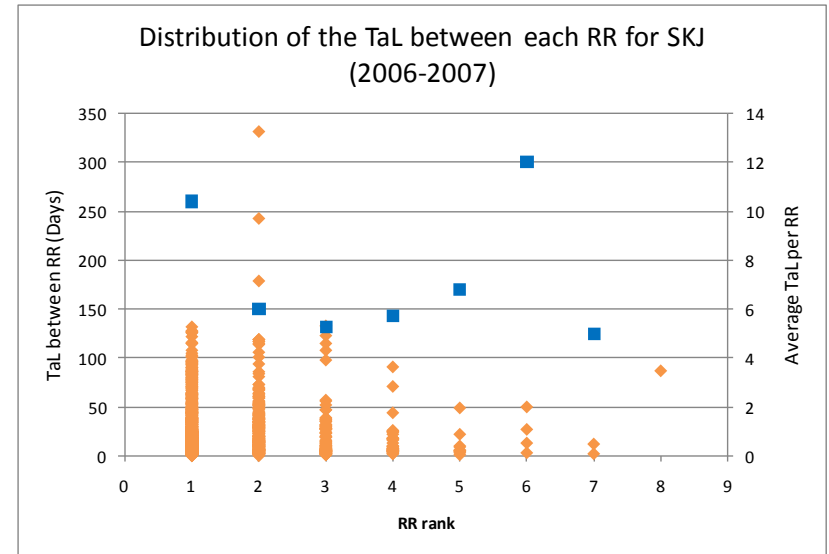
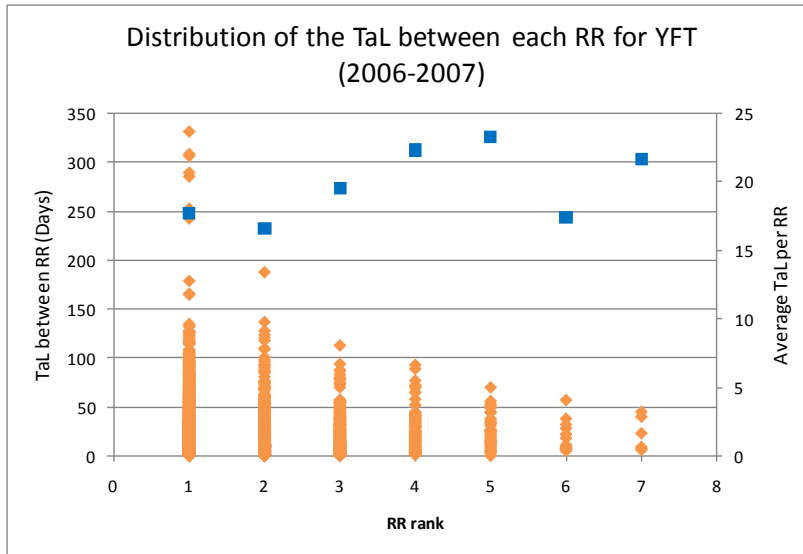
Distribution (in Log10) of the successive Recaptures Re-release by species (2006)



Distribution (in Log10) of the successive Recaptures Re-release by species (2007)



(IV) SUCCESSIVE RE-RELEASES: TIME-AT-LIBERTY BETWEEN RR

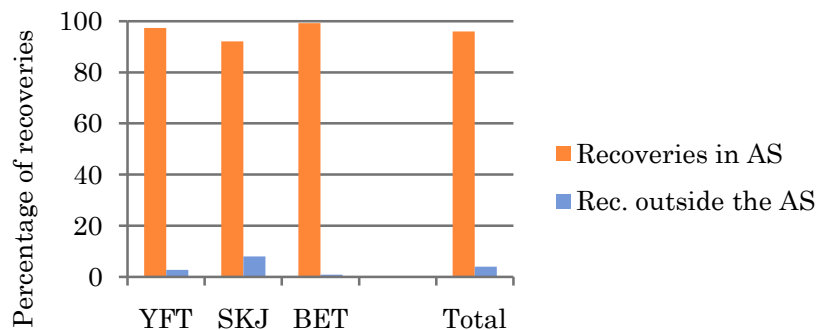


- ✓ The average number of days (TaL) between successive RR is quite stable for YFT (between 16.7 and 23.3 days, average 20 days)
- ✓ It is more variable for SKJ (between 5.7 and 12 days, average 8 days) and for BET with an average of 10 days for the first 3 successive RR (from 5.6 to 14.3 days).
- ✓ The individual TaL are very variable. This variability decrease with the RR rank because
 - 1) The probability to record many successive RR decrease drastically when the AS season progress;
 - 2) The number of RR become very low.

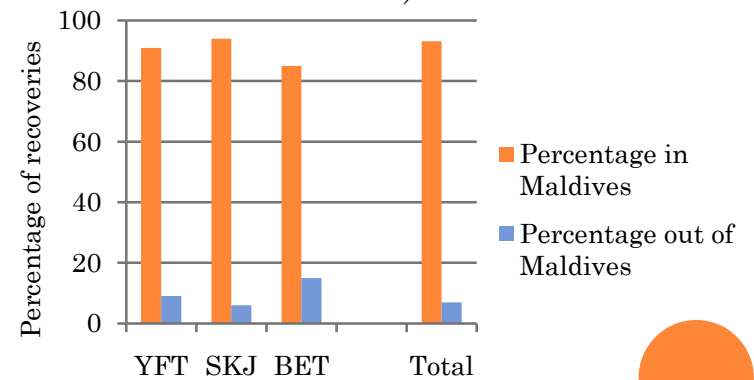
TUNA HUB IN THE INDIAN: A UNIQUE SITUATION

- Off Tanzania, the Tuna Hub offer a nearly perfect system for tuna tagging as we have seen.
- The ASFT was first developed off Mauritania-Senegal but it does not justify being called tuna hub in this region because there tuna present in the different schools associated to the pole-and-line vessels have a strong tendency to remain in this system not leaving quickly for joining free schools and not moving out rapidly and far away (Average recovery rate of 30% and TaL of 51 days).
- The Maldives is another example of tuna (mainly SKJ) trapped around the islands and their numerous FAD. Tuna joined the area from outside but once around the islands and anchored FADs they tend to stay and only a small fraction move away according to tag recoveries. Consequently Maldives does not behave like a Tuna Hub. However Maldives local recoveries have a very short average time-at-liberty (32 days) and an average recovery rate of. 16.2%. Furthermore tuna moving out to the East have lower probability to get recaptured and an even lower probability to get reported.

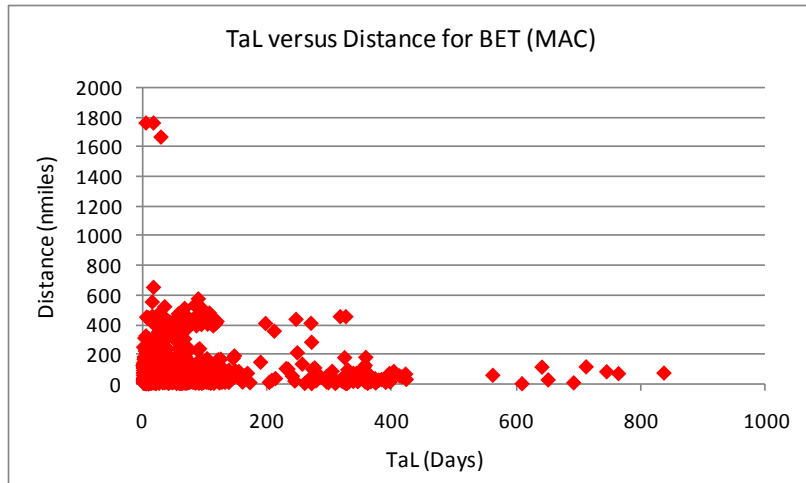
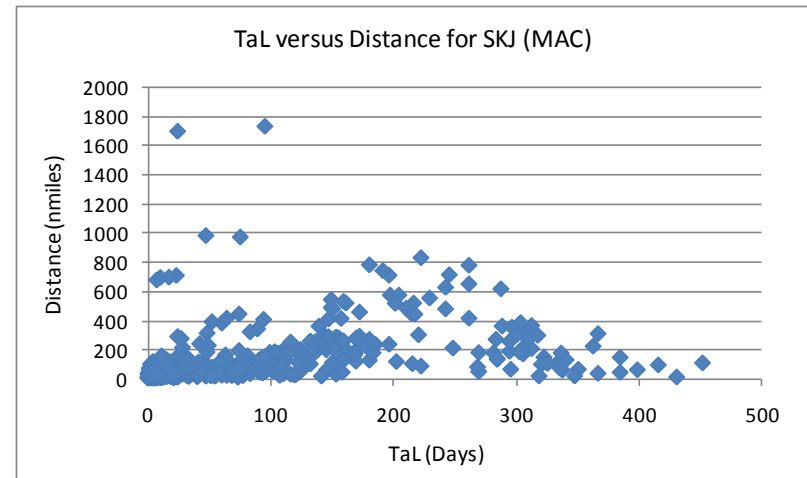
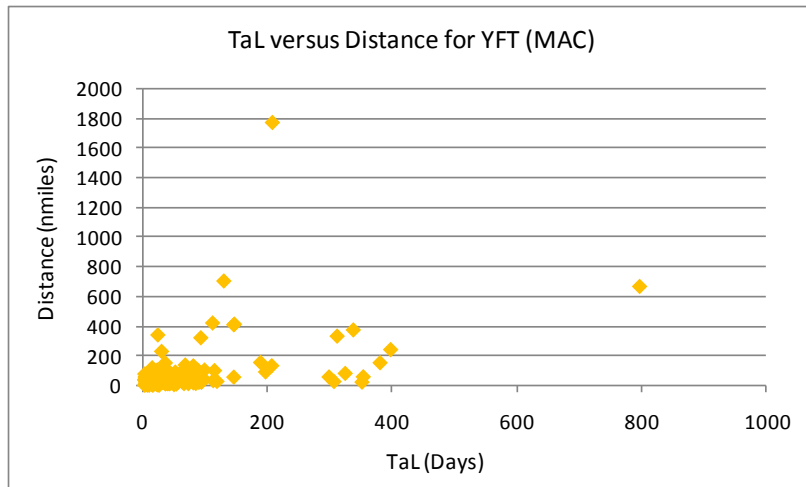
Percentage of recoveries in and out of the AS off
Mauritania-Senegal (MAC Programme, 1994-
2000)



Recoveries from Maldivian Tagging (2002-
2012)



TUNA HUB IN THE INDIAN: A UNIQUE SITUATION



The three species remain in the AS system even a year after for YFT and SKJ and two years after for BET. A very strong fidelity not found in the AS system of Tanzania



TUNA HUB IN THE INDIAN: CONCLUSIONS

- The AS was implemented in an area with low tuna abundance, but it permitted the release of a very large number of the 3 tuna species by implementing the ASFT.
- The tagged fish move out quickly and dispersed in the rest of the ocean. This unique situation permitted the extensive use of the ASFT.
- As for a plane hub: tunas were coming from different directions, passing through the Associated School, but remaining for short periods, & quickly moving fast in different directions, NE & Eastward. Hence the use of this Tuna Hub concept.
- Tuna recaptured by the tagging vessels in the AS were re-released. Most of them were recaptured only one time but some were recaptured several times. However this number of recaptures remain low.
- These re-released revealed a very active dynamics into the school which fluctuate according to species, periods and years.
- Some features remain : YFT tend to stay longer or to be renewed at a slower pace as their Recovery Rate was always higher than the one of the two other species and BET seem to remain the least.
- Considering the quite unique and large set of data collected in the AS, this presentation is a preliminary analysis, more quantitative analysis should be conducted.



THANK YOU