

Movements & growth of tagged tunas in relation to set type: free school versus FAD sets.... & "inseparable" tunas.....

By Alain Fonteneau & Jean Pierre Hallier



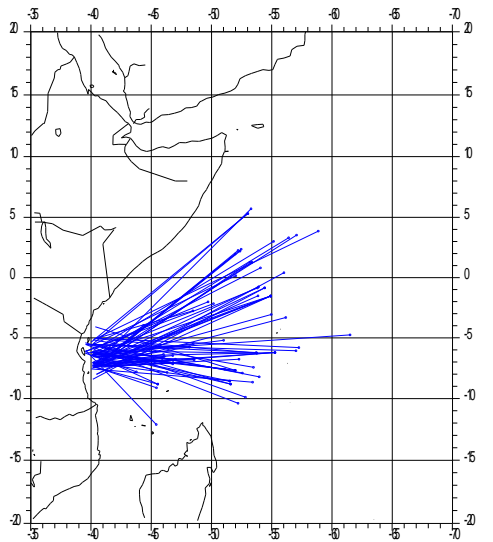
(1) Trajectories and speed of tunas tagged off Tanzania, later recovered on free schools or associated to FADs

- Types of association of tunas tagged off Tanzania, free schools or FADs, caught by Purse seiners have been often identified: 64 % of the PS recoveries,
- As Tanzanian tagging have been successful to tag large numbers of the 3 species in the **same and homogeneous time & area strata**, they offer a very interesting prospects to compare the recoveries of tunas tagged off Tanzania and later caught on FADs & on free schools
- This analysis is useful to revisit the hypothesis (by Marsac & al 2000) that *FAD seeded by purse seiners could act as **Biological trap**,; potentially changing the biology & movement patterns of all tuna species & sizes associated to FADs*
- On **limited durations of 4 months** following tagging kept:(1) because tunas associated to FADs are not spending permanently their entire life under FADs & (2) because tagging data show that after 4 month all the tunas, tagged and untagged tend, to be caught everywhere in the entire fished zone.
- All recoveries with known association and with a **limited uncertainty** in the recovery date and location have been selected: uncertainties in distance <180 miles and uncertainty in duration <15 days
- These selections reduce the number of recoveries by PS from **17,163 to 11,644** Tanzanian good recoveries.
- Selecting the recoveries during the first **121 days at liberty** reduces this sample to **3,299 recoveries**

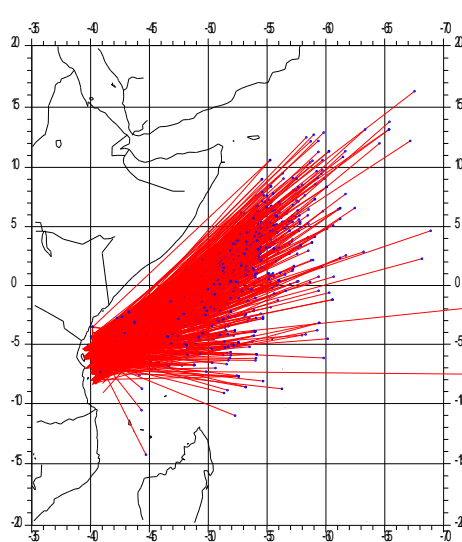
Following Tanzanian tagging, a great majority of recoveries have been obtained from FAD associated schools:

Recov OK <122 j				% recoveries	
Species	Free schools	FAD	Total	Free schools	FAD
YFT	78	1154	1232	6,3	93,7
SKJ	89	1301	1390	6,4	93,6
BET	26	650	676	3,8	96,2
Total	193	3 105	3 298	5,9	94,1

YELLOWFIN FAD vs Free schools recoveries



Tanzania YFT recov FS 1



Tanzania YFT recov FAD 10-120j

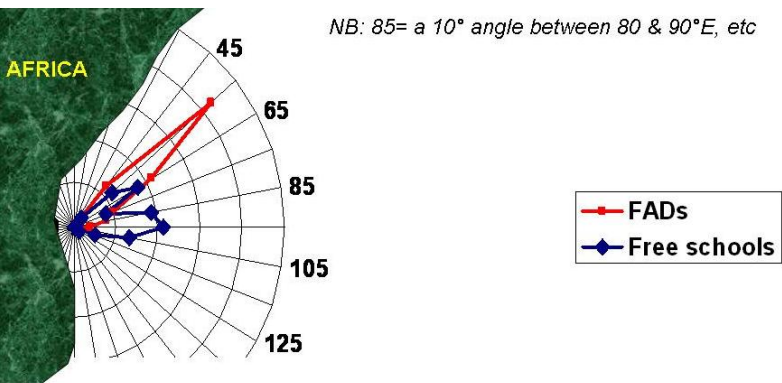
**FAD recoveries of YFT showing
Widely different speed & direction,
Compared to free schools recoveries**



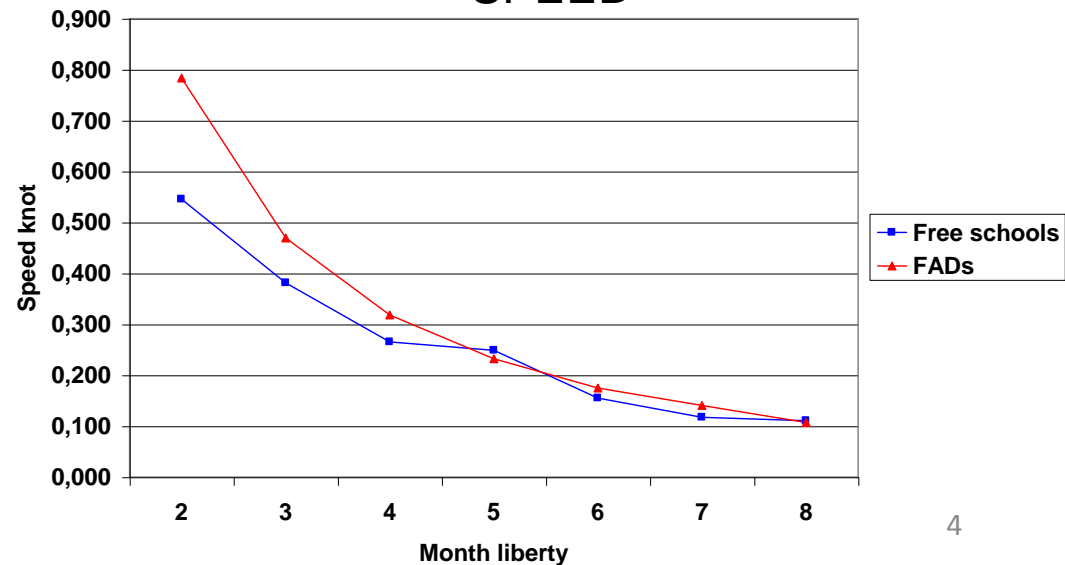
Free schools recoveries

FAD recoveries

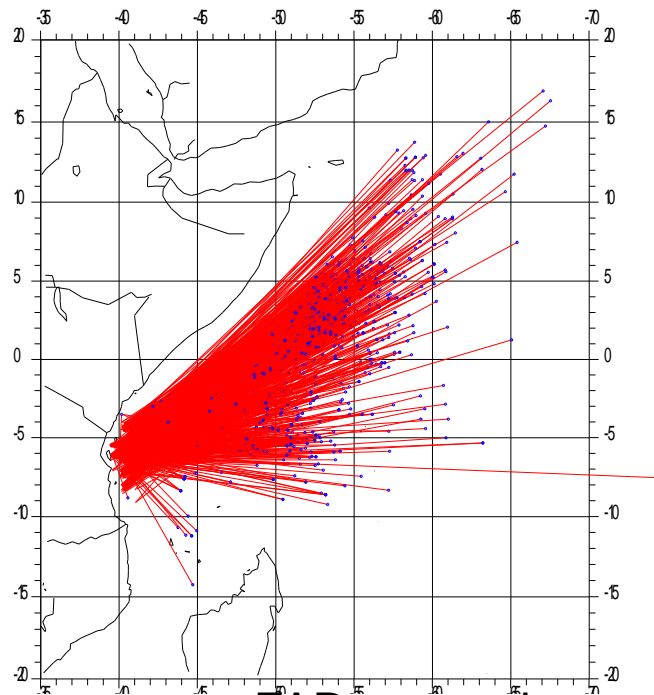
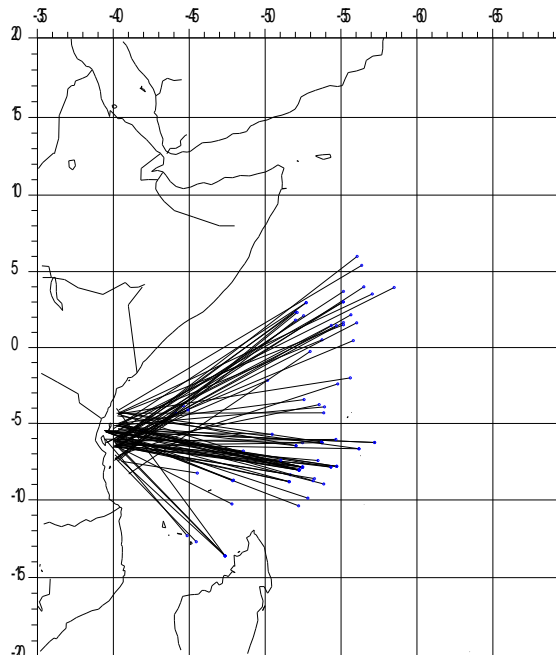
SPEED



A widely/totally different direction of YFT movements between FAD and free schools individuals



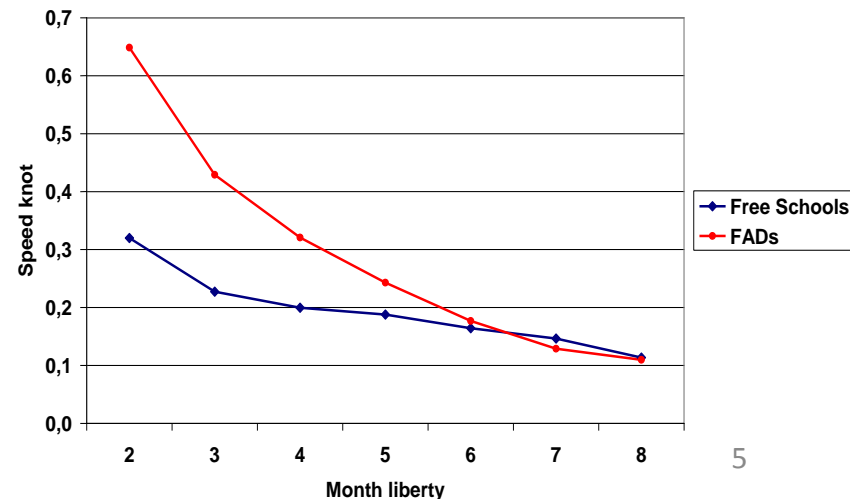
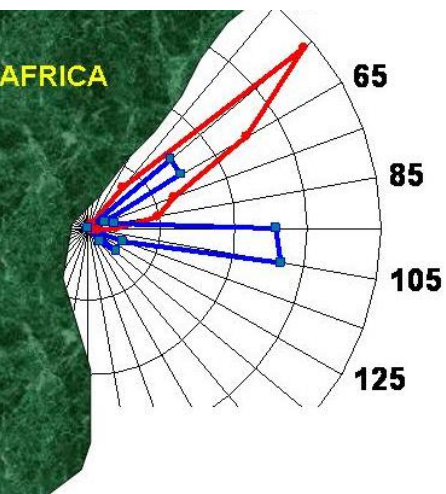
SKIPJACK FAD vs Free schools recoveries



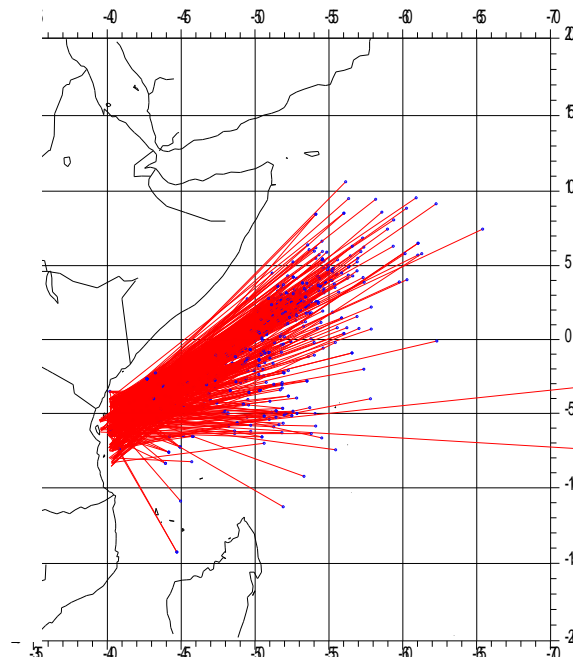
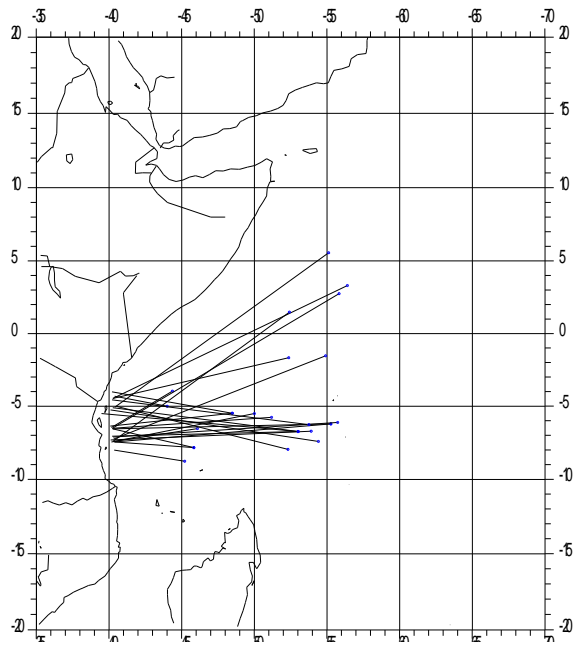
FAD recoveries of SKJ also showing widely different speed & direction, compared to free schools recoveries

Free schools recoveries

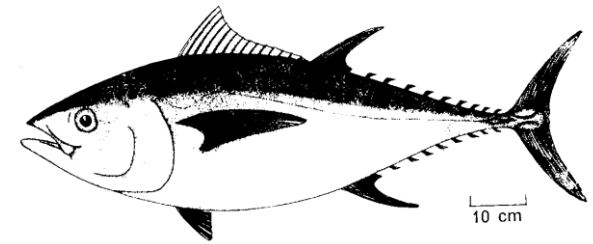
FAD recoveries



BIGEYE FAD vs Free schools recoveries

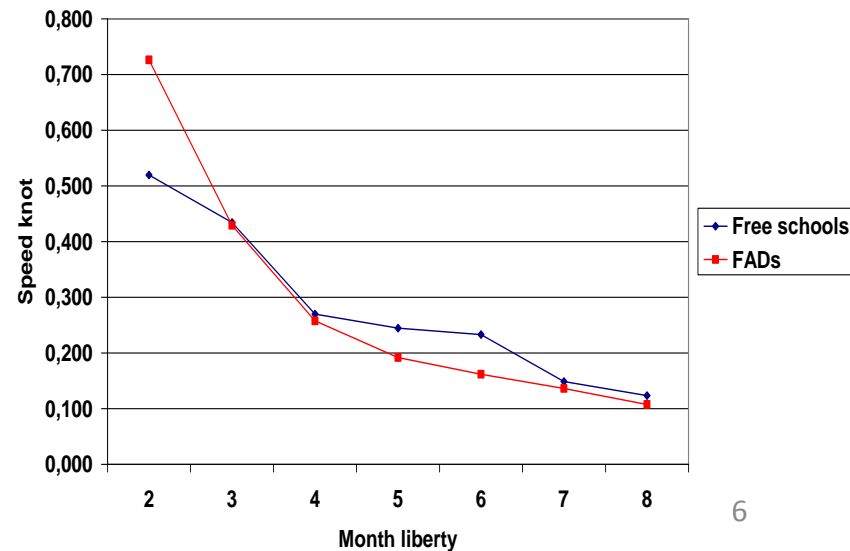
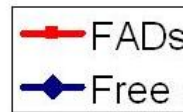
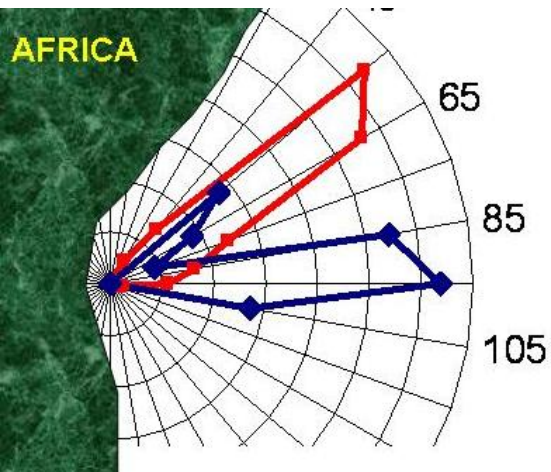


FAD recoveries of BET also showing widely different speed & direction, compared to free schools recoveries (less difference in speed)

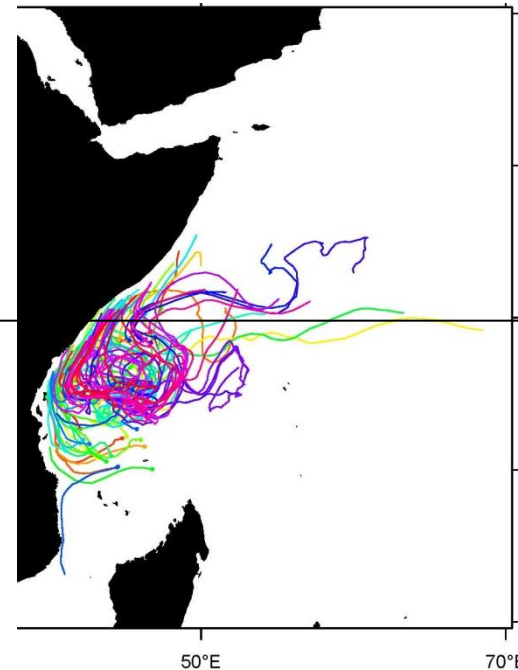
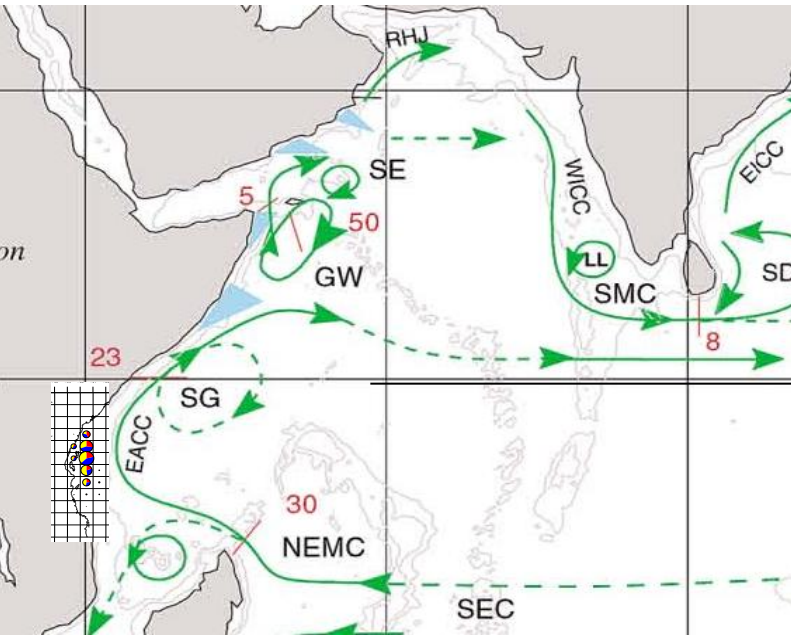


Free schools recoveries

FAD recoveries



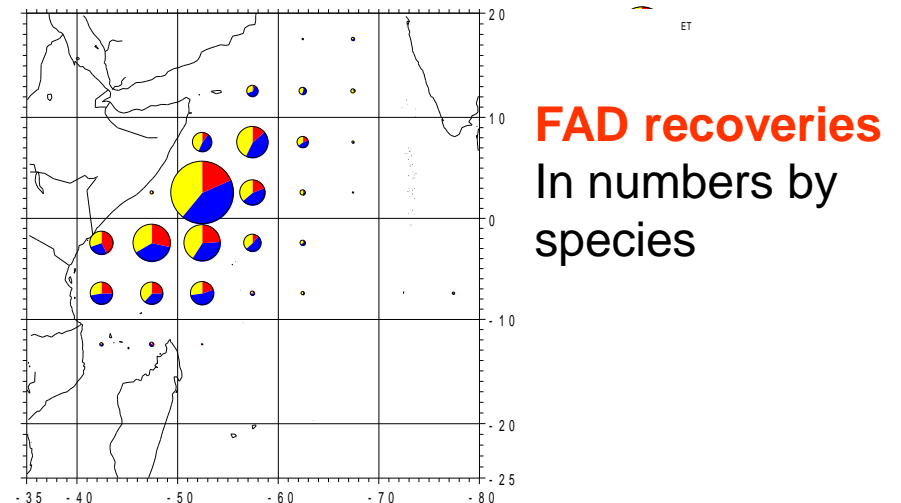
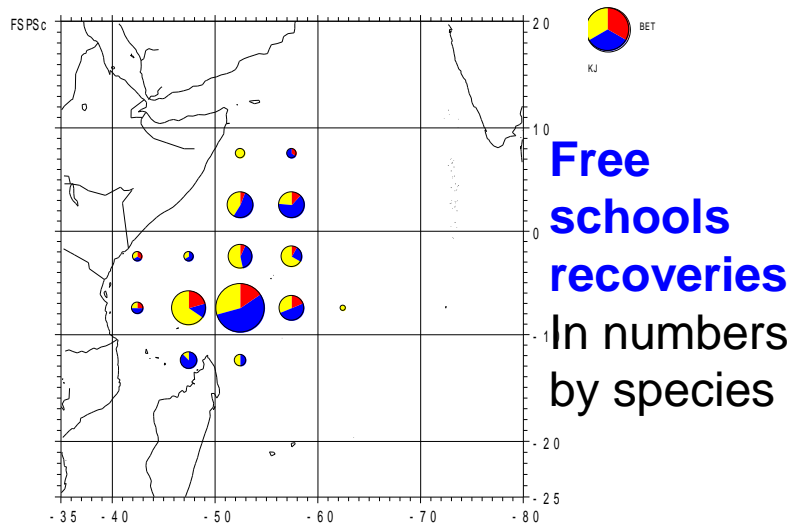
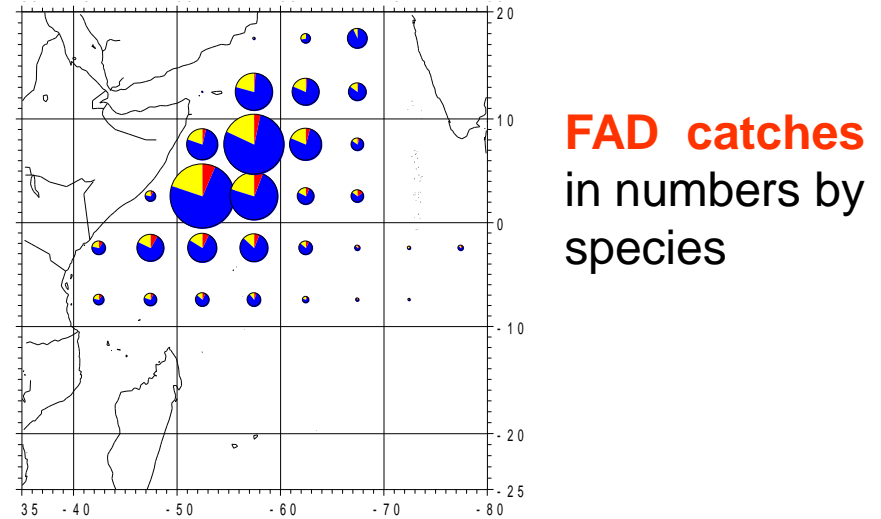
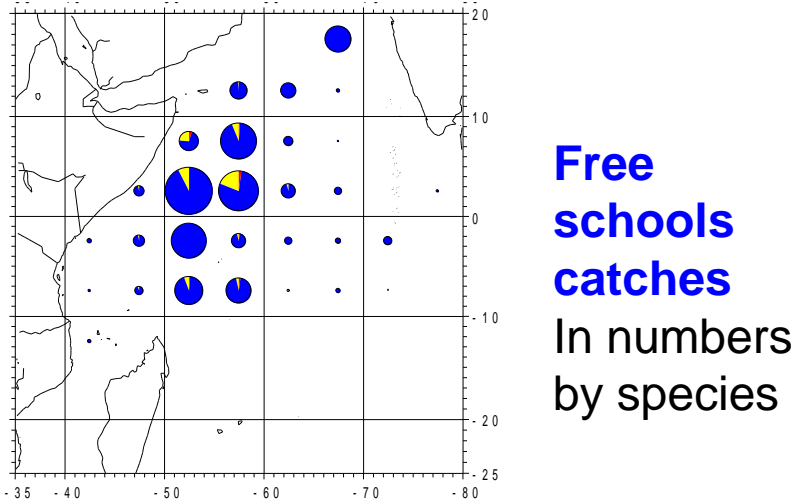
FADs off Tanzania are drifting fast towards Somali coast, towards an highly productive area rich in food for tunas



Surface currents during the S E monsoon, the period after the Tanzanian tagging, dominated by the Somalia current (Schott et McCreary 2011)

Observed drift of FADs seeded off Tanzanian waters (Equator to 10°S and West of 45°E) by French PS during the June to september period. These FADs have been drifting at an average speed of **0.7 knots**, similar to apparent speed of FAD recoveries

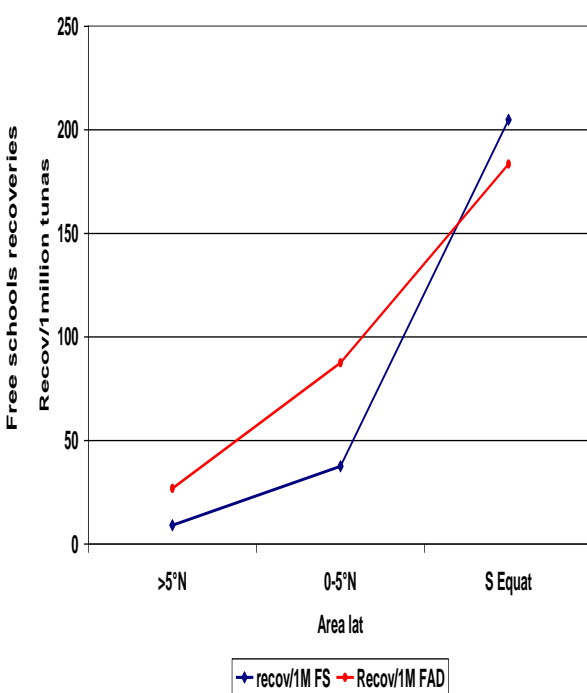
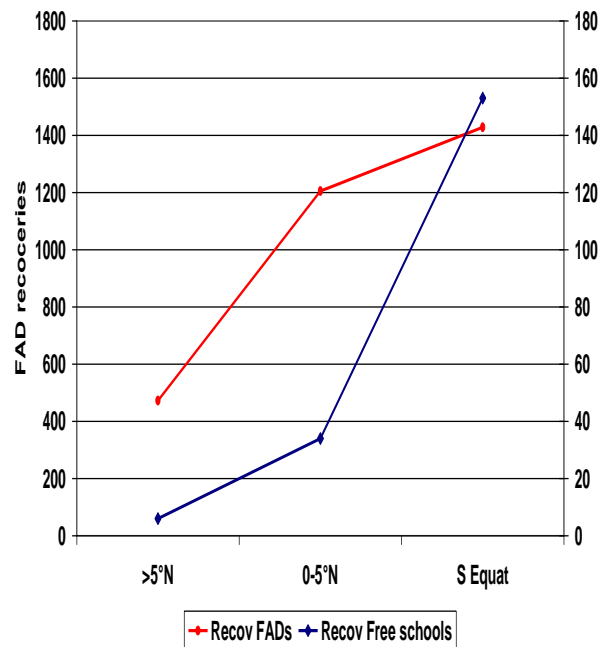
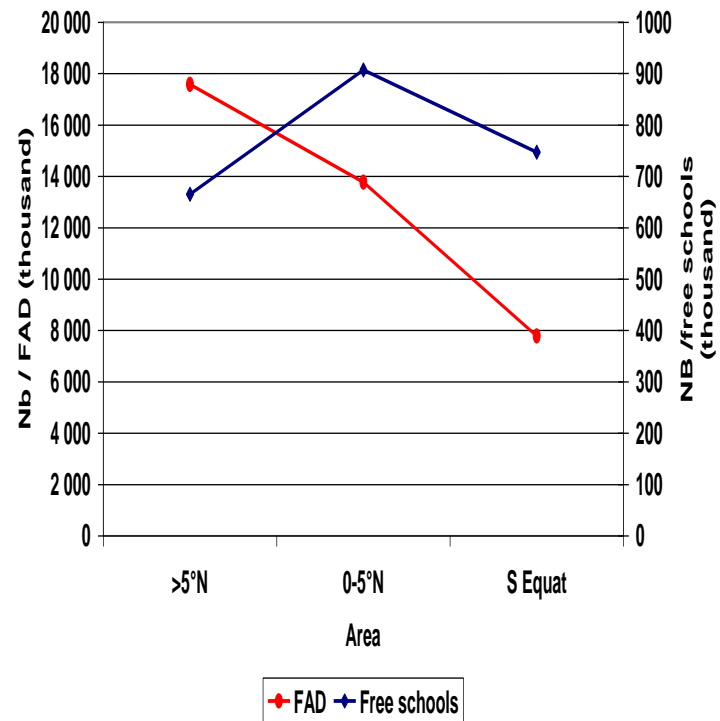
Catch at size of recovered sizes and recoveries of Tanzanian tunas during quarter 3 & 4 of the 2006-2007 period



FS PS recoveries <120 days

FAD PS recoveries <120 days







Numbers of recoveries /100000 tunas caught in the 4 month interval are:

- **North of 5°N:** much lower rates for free schools caught
- **Equator -5°N:** 87 recov/1 million fishes on FAD, vs only 37 on free schools,
- **South Equator** areas (close to the tagging latitudes): FAD & free schools rates of tagged tunas are much higher & very similar

Conclusion:

 the rarity of free schools recoveries in the Northern areas far from Tanzania is partly explained by the lower level of free school catches, but mainly by the rarity of tagged tunas in these free schools, & not by the absence of free schools catches

 FADs are introducing during the first quarter a biased movement pattern and peculiar mixing of tunas associated to them

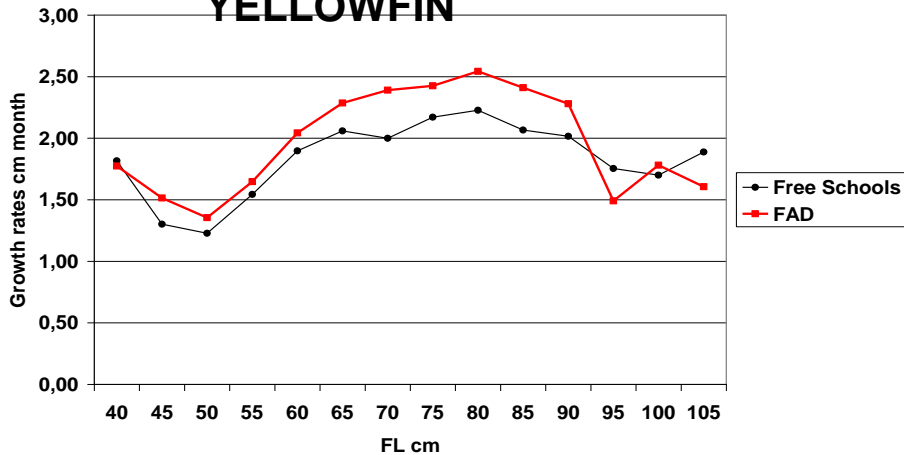
(2) Growth rates of FAD & free schools tunas:

Ajouter les incertitudes
sur moyennes?

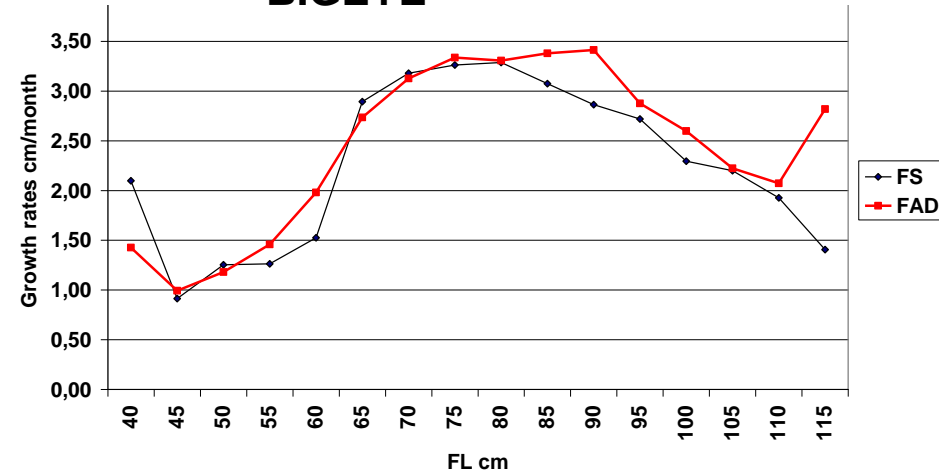
are they different?

YFT growth rates

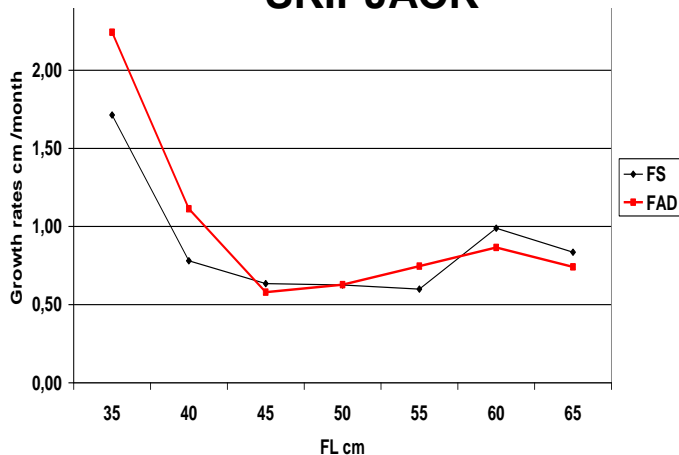
YELLOWFIN



BIGEYE




SKIPJACK




- All tunas tagged by RTTP & recovered with consistent species, with a well known recovery date and a good size at recovery: 4061 YFT, 5102 SKJ & 2505 BET
- Conclusion: all the apparent growth rates at size between tagging & recovery are very similar for tunas caught on free schools or associated to FADs
- but in most cases, growth rates of FAD associated tunas may be faster on FADs
- although these apparent differences may not be significant, it is clear that growth rates of FAD associated tunas was not reduced;


(3) Inseparable tunas?


Tunas that have been tagged and recovered + or - simultaneously, i. e. in the same time & area strata.

 If tagged tuna are moving randomly at the wide geographical scales of their oceanic feeding and spawning habitat, there is a very low probability that tagged tunas would be caught after several months or years in the same time & area strata.

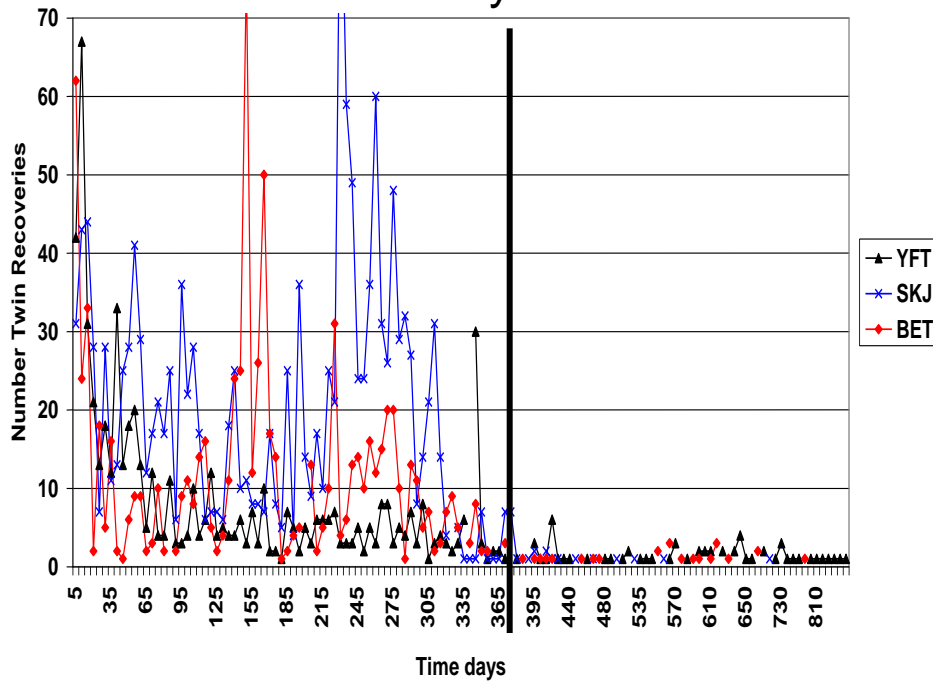
The goal of this analysis is to identify all the recoveries of YFT, SKJ and BET that can be classified in this strange category of "inseparable tunas"

 The analysis is based on the homogeneous & large scale Tanzanian tagging and selecting all recoveries with well known date and position (uncertainty in position <30 miles), i.e. on 11611 recoveries.

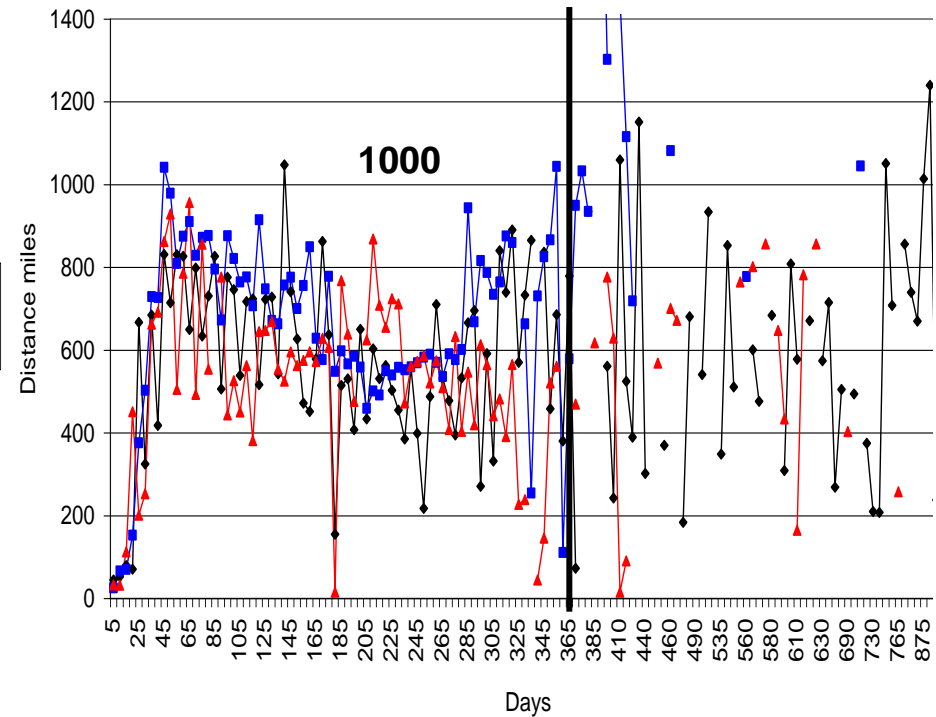
 All recoveries from Tanzanian tagging have been stratified & classified by periods of **5 successive days** & the subsequent dates of the subsequent recoveries have been also classified by periods of 5 days, and during a period of **3 years** after tagging.

 During each of these recovery periods, all the distances between all the recoveries have been calculated. All recoveries declared during the same period & at a distance lower than **100 and 30 miles** have been selected and classified as being 'inseparable tunas' categories 1 & 2.

1 year



1 year




Numbers of inseparable recovered tuna
(categ 1<100 mile):
mainly observed during the 1st year at sea
And more frequently for SKJ,
Less for BET,
Less for YFT


Average **distances** covered by inseparable
recovered tunas (categ 1<100 mile):
Observed at the large distances typical of the
IO recovered tunas
Similar distances for the 3 species
No visible yearly cycles in the recoveries of
these inseparable tunas


	YFT	SKJ	BET	Total
Total Tanzania recoveries	4 544	4 256	2 811	11 611
Total Twin Recov <100 miles	533	667	466	1 666
%	11,7	15,7	16,6	14,3
TWIN recov +1month <100 miles	345	507	322	1 174
% TWIN after 1 month	7,6	11,9	11,5	10,1
Twin recov +1month, <30 miles	278	419	283	980
% Twin recov +1month, <30 miles	6,1	9,8	10,1	8,4

These recoveries of inseparable tunas are quite significant in %:

 **10% of unseparable BET & SKJ** have been recovered after + than 1 month at sea caught (period of 5 days and cat 2 a distance < 30 miles)

 Such 10% rates of Unseparable Tunas that have been observed after **long durations and at large distances** from tagging area (about 600 miles from it) would have a low probability if the tuna mixing and movements were stochastic in the entire habitat of tropical tunas, an area covering an average surface exploited by PS >17 million mile² (i e a square with a 132 miles side);

 However, tagged & untagged tunas are probably most of the time concentrated in peculiar & small feeding & spawning areas, and never randomly scattered in their potential habitat, and this could explain these surprising recoveries.

 There is **no clear visible geographical pattern in the recovery locations of these inseparable tunas**, but they are frequently observed in the Mozambique Channel: a very small fishing zone, then increasing the probability of close recoveries?

Conclusion on FAD & free schools tunas

- There is a very strong drift of FADs that are moving (not migrating!) quickly in the coastal current along the East African coast towards Somalian waters, with their tagged tunas, at the speed of surface current.
- This statistical association between tagged tunas and the network of FADs drifting in the area was well visible during at least 3 months after the tagging.
- these tunas are quickly travelling towards a highly productive area, & without swimming efforts,
- Their growth appears to be **slightly faster or identical** to free schools tuna: this point should be further analyzed!
- These results would be a **confirmation of the potential effects of large numbers of FADs on the tuna movements**, the basis of the so called “ecological trap” envisaged by Marsac et al 2000.
- The fact that significant proportion of the recovered tunas have been tagged and recovered simultaneously, often at large distances, so called “**Inseparable tunas**”, is clear in the recovery data: especially during the first year and for skipjack. This rather strange but probably significant behavioural pattern should be further studied by scientists!