

## ANALYSIS OF PURSE SEINE SET TIMES FOR FAD AND FREE SCHOOL ASSOCIATIONS IN THE ATLANTIC AND INDIAN OCEANS

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### SUMMARY

*This paper analyses a sub set of recent observer data taken on French and Spanish purse seiners fishing in the Atlantic and Indian Oceans. Its goal is to analyse and compare the set times relative to sunrise of FAD and free schools sets in each ocean. This analysis indicates that set times are equivalent for French and Spanish fleets, and equivalent in both oceans. A wide majority of FAD sets have been observed in the morning (80%), and frequently before sunrise or during the hour after sunrise (44% of sets), but some FAD sets are also done at any time of the day by both fleets. On the contrary, free school sets have been observed in + or - equal proportion at any time of the day between sunrise and sunset showing a small decline in the afternoon. The paper also recommends developing in-depth statistical studies of a wider sample of these observer data.*

### RÉSUMÉ

*Cet article analyse un sous ensemble de données récentes recueillies par des observateurs embarqués sur des senneurs français et espagnols dans les océans Atlantique et Indien. Son but est d'analyser et de comparer les horaires par rapport au lever du soleil des lancers de senne réalisés sur des bancs sous DCP et sur des bancs libres dans les deux océans. L'analyse indique que les horaires des lancers sont équivalents pour les flottilles française et espagnole ainsi que dans les deux océans. Une grande majorité des calées sous DCP ont été observées le matin (80%), et fréquemment avant le lever du soleil ou dans l'heure qui suit ce lever (44%), certaines calées sous DCP étant toutefois réalisées durant toute la journée pour les deux flottilles. Au contraire, les calées sur bancs libres ont été observées en proportion plus ou moins égale durant toute la journée entre le lever et le coucher de soleil en présentant une légère baisse pendant l'après midi. Ce document recommande également de réaliser des études statistiques détaillées d'un échantillon élargi de données d'observation.*

### RESUMEN

*En este documento se analiza un subconjunto de datos recientes recopilados por los observadores embarcados en cerqueros franceses y españoles que pescan en los océanos Índico y Atlántico. Su objetivo es analizar y comparar los horarios de los lances de cerco realizados por las dos flotas en bancos libres y DCP en cada océano. Este análisis indica que los horarios de los lances son semejantes en ambas flotas y océanos. La gran mayoría de los lances observados en DCP se realizaron por la mañana (80%) y frecuentemente antes de la salida del sol o durante la hora siguiente al amanecer (44% de los lances), aunque también se observó que ambas flotas realizaron algunos lances sobre DCP en cualquier momento del día. Por el contrario se observó una proporción más o menos igual de lances sobre bancos libres en cualquier momento del día entre el amanecer y el atardecer, con un ligero descenso durante la tarde. Se recomienda que se realicen análisis estadísticos más completos con una muestra más amplia de observaciones.*

### KEYWORDS

*Purse seining, Atlantic, Indian Ocean, observers, setting time, fishing effort*

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## 1. Introduction

The time of the setting operations on FAD and on free schools relative to time of sunrise is an important parameter in the purse seine tuna fisheries, as it widely conditions the daily searching pattern and the effective fishing effort targeting free or FAD associated schools. Surprisingly, when this important parameter has been well identified since the early eighties by many observers in both the Indian and Atlantic oceans, there has never been any scientific paper or working documents submitted to ICCAT or IOTC doing an analysis of these observed setting times as a function of the sunrise times. When this question has been recently analysed in the Indian Ocean by Moreno et al. 2008, this paper was based on interview with skippers, and not on scientific observations done at sea by observers. The goal of this paper will be to analyse a sub set of recent data obtained by observers on the Spanish and French fleets of purse seiners active in the Atlantic and Indian ocean and these results will be discussed in the context of the fishing effort exerted by these fleets and in comparison with the same results obtained by interview with skippers in the Indian Ocean or from observers in the Pacific ocean.

## 2. Material and method

A subset of recent EU observer data in the Atlantic and Indian oceans have been used and analysed. A total of 6385 sets, 2366 on FADs, and 4125 on free schools have been observed in the present data set, these observations being taken during the 1997-2008 period for the Spanish and French fleets (1997-1999 corresponding to the Atlantic bigeye programme, when all the observations in the Indian ocean are from the period 2003-2008<sup>5</sup>).

In the observer data, the GMT time of each set has been recorded (beginning and end of the set), but the exact times of sunrise have never been noticed by observers. The first task of this work was, knowing the exact date and position of the set, to estimate for each set the local time relative to sunrise (using the ad hoc astronomical equations allowing to estimate this time). Knowing the exact sunrise time, each set has been assigned at a relative delta time, i.e. the estimated duration (in hours and minutes) between the beginning of the set, before or after sunrise. This delta time is estimated in number of minutes for all sets, on FAD and on free schools, for Spanish and French vessels and these durations have been later grouped by 1 hour classes, class 0 being the hour between sunrise and 59 minutes after sunrise (and so on). The goal of this paper will be to review and to discuss the observed patterns of the timing of these sets.

## 3. Results

### 3.1 FAD sets

The distribution of observed time setting as a function of the exact time of sunrise are given by the following **Figures 1 and 2** show the numbers of FAD sets by the two fleets in the two oceans. Taking into consideration that the timing of sets are very similar in the two oceans, the same results are also shown in percentages combining the observations in the two oceans (**Figure 3**), showing the percentage of sets by time and the cumulated catches as a function of sunrise time (**Figure 4**).

The analysis of the FAD set timing as a function of sunrise shows that a large proportion of the FAD sets are done in the early morning, before or just after sunrise, this timing being very similar for Spanish and for French purse seiners, and in the Atlantic as well as in the Indian Ocean: 47% (Spain) and 42% (France) of the FAD sets being initiated within less than one hour after sunrise, and 82% & 79% of these sets being initiated by the French and Spanish fleets before noon (more exactly less than 6 hours after sunrise). Then the percentage of FAD sets during the afternoon appears to be quite low for the two fleets (18% and 21%), and at similar rates in the two oceans.

### 3.2 Free schools sets

The distribution of observed time setting on free schools as a function of the exact time of sunrise are given by **Figures 5 and 6** show the numbers of free schools sets by the two fleets in the two oceans.

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<sup>5</sup> DCR: all the EU observer data collected since 2003 have been routinely funded by the EU Commission under its DCR framework of routine observers.

These figures show a quite stable proportion of free schools sets at any time of the day, but often showing a slight decline during the afternoon. Furthermore, it can also be noted that some sets before sunrise have been observed on French purse seiners in both the Atlantic and Indian oceans (at an average delay of 19 minutes before sunrise, i.e. during the period of limited sun light, between the end of the night and sunrise). Taking into consideration that the timing of sets has been relatively similar in the two oceans, the same results are also shown in percentages combining the observations in the two oceans in the following **Figure 7**, showing the percentage of free schools sets by time (**Figure 7**) and the cumulated observed catches on free schools as a function of sunrise time (**Figure 8**).

#### 4. Discussion

The results of this first analysis are probably significant but they are still provisional ones, because of the limited size of the observed sample (compared to the greater number of observed sets potentially available) and because of the limited analysis presently done. This preliminary analysis would tend to reach the main following conclusions:

- Setting times relative to sunrise is confirmed to be widely different for FAD and free schools: sets on FAD schools being most often observed during the morning, and often before or just after sunrise. This conclusion is well shown by **Figures 9 and 10**.
- Similar results have been observed in the western Pacific (see **Figure 11** taken from Harley *et al.* 2009) and also in the eastern Pacific (Martin Hall personal communication, unpublished data), two oceans where the very early sets done before sunrise are even more dominant in percentage than in the Atlantic or Indian oceans: sets on drifting FADs being never observed in the western Pacific during the day (only on anchored FADs). These significant and interesting differences in the timing of FAD sets relative to sunrise should be better understood, but they are probably due to differences in tuna behaviour when associated to FADs, as a function of different environments in these FAD fishing areas.
- On the opposite, when some sets on free schools have been also observed just before sunrise on French purse seiners (but never on Spanish purse seiners) in both the Atlantic and Indian oceans, these free schools sets tend to be observed in more or less stable proportion during the entire day. An apparent decline of the percentage of free schools can be also noted in the present sample: 57 % of free schools sets observed before midday, and 43 % during the afternoon.
- Setting times on FAD schools tend to be very similar in the two oceans.
- Setting times on FAD schools tend to be also very similar for French and Spanish purse seiners. This result is in contradiction with the conclusion of the paper by Moreno and al 2008 when they concluded, based on interview of skippers, that: “*There was a clear difference regarding the diel time of fishing, as most of the French fishing masters will fish around DFADs at any time of the day if tuna are detected, while Spanish generally restrict their fishing operations to 1-4 hours after sunrise*”. Our present results, based on scientific observations, are reaching an opposite conclusion and they are probably more realistic than personal testimonies obtained from skippers.
- There was no analysis done and no conclusion obtained on the time and space variability of set times or on the catches by set (by species and sizes) as a function of setting times, but this analysis should be interesting to do.

It is also interesting to estimate at the global scale of the EU purse seiners fishing in the Atlantic and Indian oceans, the setting times pattern as a function of sun rise time. This approximation has been obtained (**Figure 12**) based on the average percentage of FAD and free schools sets during recent years: an average of 60% of sets on FADs and 40% on free schools (period 1997-2007), and weighting the two vectors of observed percentages of sets/time intervals by these 40/60% factors.

This figure indicates that FAD sets are highly dominant in % during the two one-hour intervals , before and after sunrise, when they appear to be in similar numbers during the seven subsequent hourly intervals (i.e. until the beginning of the afternoon). During the late afternoon, the number of sets tend to decline for both FAD and free schools, and the numbers of free schools sets tend to be increasingly dominant.

These estimated results are widely global and provisional estimates, but they are probably indicative of the average patterns of free and FAD schools settings. Further analysis combining all the observer data and the detailed log book data, by ocean and by country, would be necessary to better analyse the variability of the global pattern shown by **Figure 12**.

## 5. Conclusion

As a conclusion, the present observations and conclusion are probably significant but they are still obviously preliminary and provisional: due to the need to better validate the data, a need to develop an ad hoc statistical analysis of the data base and a need to expand the files used in the analysis, trying to cover the whole period covered by observer data, i.e. since 1980<sup>6</sup> (nearly 30000 sets have been observed). Unfortunately these observer data are not yet available on a standardized form and in a fully validated data base; the most important validation in this type of study would be to check that all the observer data are using the same reference GMT time, and not some types of local time used on board the observed vessel. Such validation could easily be done, based on searching activities of the observed vessel, but it has not yet been done. It would also be necessary in this recommended future work to analyse and to model the potential changes of these observed setting times during the period 1980 to now, and analysing the time and area statistical variability of these setting times. It should also be necessary to analyse potential changes in the sizes of FAD and free schools sets, as well as potential changes in their species composition of the tuna caught, as a function of relative timing of these sets.

This better knowledge of time settings as a function of the fishing mode is clearly of great potential importance in a better understanding of the fishing efforts that are exerted by purse seiners targeting FADs and on free schools. They could also offer a valuable additional input for the future management and potential limitation of the FADs use.

## References

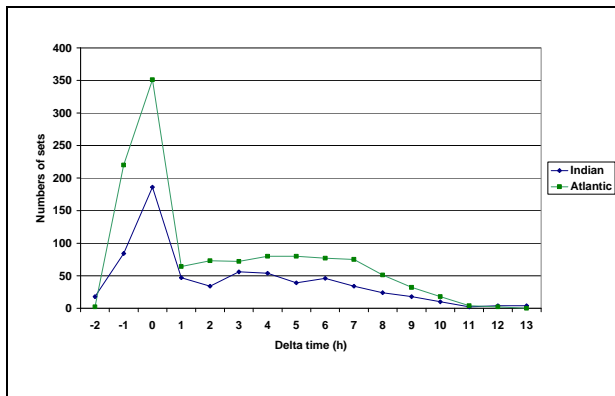
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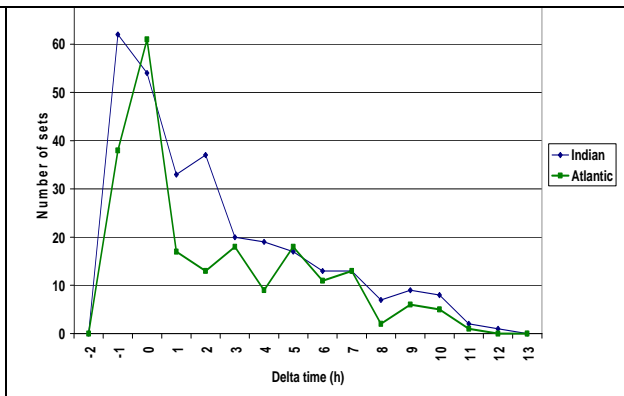
<sup>6</sup> The first observed set in this large data base being observed in September 1980 by Fonteneau, off Abidjan, on board the French purse seiner Gevred and its captain, Michel Marec.

**Table 1.** Number of FAD and free schools sets observed in each ocean for French and Spanish purse seiners used in the present analysis.

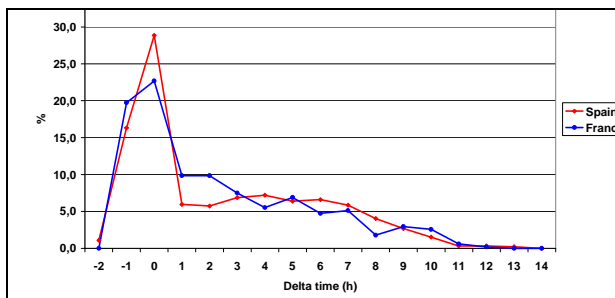
	<i>Atlantic</i>	<i>Indian Ocean</i>	<i>Total</i>
FAD Espagne	1199	660	1859
FAD France	212	295	507
Total FAD	1411	955	2366
Free schools Espagne	1762	498	2260
Free schools France	779	1086	1865
Total Free schools	2541	1584	4125
Total sets	4303	2082	6385



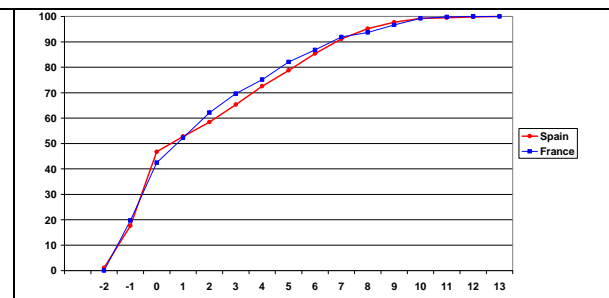
**Figure 1.** Numbers of FAD sets by one-hour intervals relative to sunrise observed in the Atlantic and Indian Oceans by Spanish purse seiners (time 0 corresponds to sets done between sunrise and the 60 following minutes, and so on) (red squares: Atlantic, blue line: Indian Ocean).



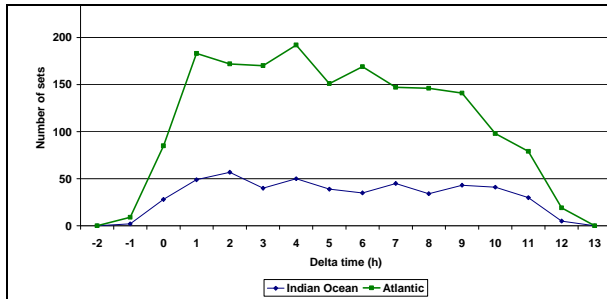
**Figure 2.** The same as Figure 1, but for French purse seiners.



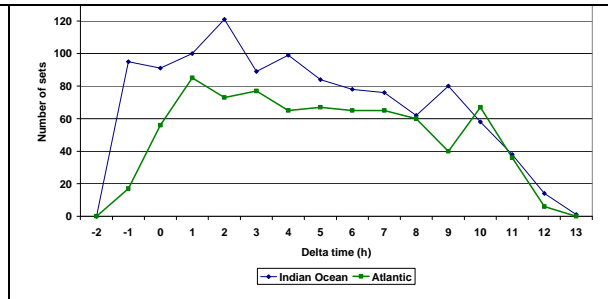
**Figure 3.** Percentage of FAD sets observed on the French and Spanish fleets as a function of sunrise exact time (time 0 corresponds to sets done between sunrise and the 60 following minutes, and so on).



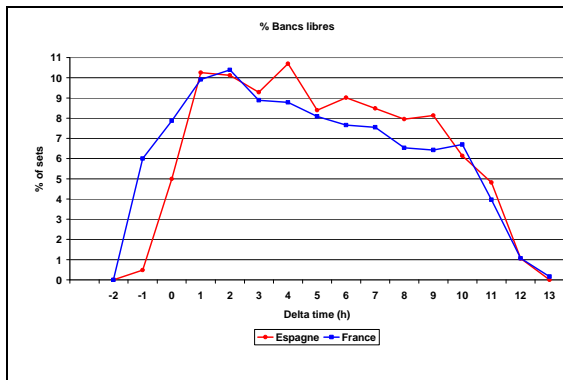
**Figure 4.** The same as Figure 3, but expressed in cumulated percentage of observed FAD associated catches.



**Figure 5.** Numbers of sets by one-hour intervals relative to sunrise observed in the Atlantic and Indian Oceans for free schools caught by Spanish purse seiners (Time 0 corresponds to sets done between sunrise and the 60 following minutes, and so on).



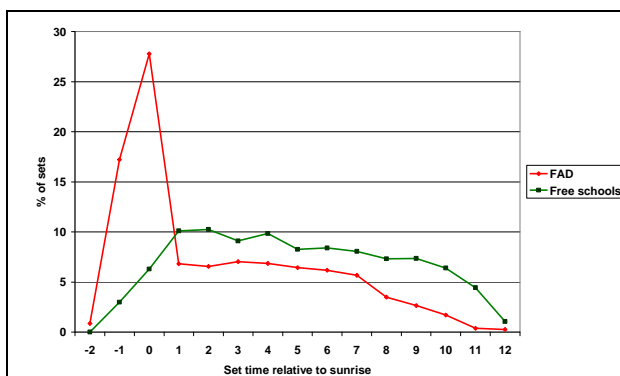
**Figure 6.** The same as Figure 5, but for French purse seiners.



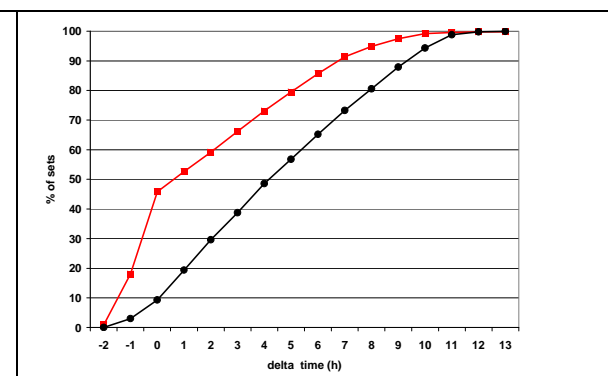
**Figure 7.** Percentage of free schools sets observed on the French and Spanish fleets as a function of sunrise exact time (time 0 corresponds to sets done between sunrise and the 60 following minutes, and so on).



**Figure 8.** The same as Figure 7, but expressed in cumulated percentage of observed catches on free schools.



**Figure 9.** Percentage of free and FADs schools sets observed on the purse seine fleet in the combined Atlantic and Indian Oceans, expressed as a function of sunrise time (time 0 corresponds to sets done between sunrise and the 60 following minutes, and so on).



**Figure 10.** Cumulated percentage of free and FADs schools sets observed on the purse seine fleet in the combined Atlantic and Indian Oceans, expressed as a function of sunrise time.

