DEFINITION OF CRITERIA TO IDENTIFY FAD AND FREE SCHOOL SETS BASED ON THE SPECIES COMPOSITION AND AVERAGE WEIGHT OF THE SAMPLES FROM THE INDIAN OCEAN EUROPEAN FLEET of PURSE SEINERS

by

Pallarés[1],P.; V. Nordstrom[2]; A. Fonteneau[2] ; A. Delgado de Molina[3] and J. Ariz[3]

Abstract

This document presents a procedure to identify tropical tuna sets as associated to FAD or free school when this information is not available. The procedure, based on sampling data, considers the weighted average weight and the Shanon-Waever diversity index as discriminant variables.

[1] Instituto Español de Oceanografía. Corazon de Maria, 8. 28002, Madrid. Spain

2 IRD. Seychelles

3 Instituto Español de Oceanografía. P.O. Box 1373. 38080. Santa Cruz de Tenerife. Spain

INTRODUCTION

Fishing mode is an important factor regarding the species composition and the size distribution of the tropical tuna sets. Methods used to correct the species composition and to calculate the size distribution of tropical tuna purse seine catches include the fishing mode as stratification variable. Nevertheless, this information is not always available in the log books and when the size and species samples are collected. In particular, this problem exists for the period before 2000, when the new sampling system was established. A total number of only 33 samples taken during the period 1991-1998 (on a total of 22867b samples, e.g. only 0.15%) were missing the information upon their association mode. Regarding the implementation of the overall data statistical procedure it is important to create a system to assign those undefined sets to one of the two groups (FAD or free school) defined.

After considering different options, two procedures were defined: a) assigning fishing mode to samples from the sighting code filled in the logbooks, b) creating criteria to automatically assign a fishing mode to each unidentified samples. The first procedure was applied to all logbooks and sampling data: sets with only a sighting code (birds) in the logbooks were classified as being "free school" in both logbooks and sampling data (after verification that the species composition and sizes were typical of this fishing mode).

This document presents the analyses conducted and the criteria defined to classify sets by fishing mode. The method proposed is similar to that used in the Atlantic (Fonteneau & Pallarés, 1998).

MATERIAL AND METHODS

For the analyses we used the purse seine sample data, all the European and associated fleets included, with good information on fishing mode from 1991 to 2003.

Based on the results of previous analyses of logbooks, multispecies sampling and observer data (Ariz et al., 1993, 1996, 1997, Fonteneau, A., 1993, Pallarés et al., 1995) we could identify the characteristics of FADs (multispecies and small sizes) and free school (monospecies and large fishes) sets. From this general pattern we considered primarily two variables:

- Average sample weight:

weight of sample/number of fishes all species

- Shanon- Weaver diversity index:

$$\sum_i^n (weight(i)/sampleweight) * \log(weight(i)/sampleweight)$$

i=species in the sample

n=number of species in the sample

The average weight was later weighted by the inverse of the number of species in the sample with the purpose of combining the two main characteristics of the sets in a single index

- Weighted average weight:

*(weight of sample/number of fishes all species)*1/n*

This variable resulted more discriminant than the unweighted average and was finally used.

Because of the marked seasonality of the Indian Ocean tuna fisheries and the changes in target species and fishing mode by season, we have included the area as a factor in the analysis. Ten areas were considered (Figure 1). Table 1 shows the total coverage, and coverage by area and fishing mode. The total number of samples used was 11685, 8483 on FADs and

3202 on free school sets. All these samples had well identified fishing modes. Only FADs and free school associations were included. Samples with fishing mode estimated from other sources as well as those corresponding to catches taken on the Coco de Mer sea mount were rejected as they are easily identified by their position. The higher number of samples corresponds to the traditional fishery areas (Somalia, NW Seychelles, SE Seychelles and Mozambique Channel), followed by Chagos area. Other areas such as the Arabian Sea or Indonesia than are explored only occasionally by the purse seine fleets had not enough information to be included in the analyses.

Sample weight was calculated converting the size distribution of sample in weight distribution. Conversions were conducted using the length-weight relationships recommended by the WPTT for each species.

Probability criteria were established through the Cumulative frequency distribution of the variables used minimizing the probability of error.

The method developed can be considered as an approach to the hypothesis testing. Assuming that the characteristics of the two type of sets are different: low diversity index value (0 or close to 0) and high average weight for the free school and high diversity index value (1 or close to 1) and low average weight for the FADs, we established the "null hypothesis" analyzing the Cumulative frequency of both variables for the two type of sets and identifying the values of each variable that minimizes the probability of errors type I (e.g. if we are identifying free school: free school sets classified as FAD sets) and II (FAD sets classified as free school). Usually, these probabilities are not symmetrical.

Once we have defined the limits of reference they will be incorporated into the data processing system. These limits can be used in two ways: - to classify unknown fishing mode sets, - to validate sets with fishing mode information.

RESULTS AND DISCUSSION

Figures 2 and 3 show the average weight vs diversity index values by fishing mode. Generally data are in agreement with the typology of the sets defined, high frequency of diversity index equal to 0 and big average weight for the free school and big value of the diversity index and low weight for the FAD. Nevertheless there are a proportion of sets that do not follow the general rules. In particular, disagreements are more evident in the case of the diversity index.

By areas, figure 4 shows the Cumulative frequency for the two variables. As in the previous figures the diversity index does not seem to be a good criterium to distinguish the type of set. On the contrary, the Cumulative frequency of the weighted average weight shows clear differences between the FAD and free school sets.

Table 2 shows the average weights and diversity index chosen as reference limits and the corresponding probabilities for FAD and Free School sets for the areas considered. The limits selected correspond to the values that maximized the differences between the Cumulative frequencies of the two types of sets. For all the areas the characteristics of the FADs associated sets are homogeneous: 95% of sets have an average weight larger than 3 Kg and between the 97 to 99% have a diversity index different from 0. On the contrary, the characteristics of the free school sets are more variable and do not clearly follow a specific pattern. Consequently the efficiency of the procedure depends of the free school structure. Regarding the diversity index, the important amount of Zero values that appears in the free school sets makes difficult to use it as reference limit. However, the average weight seems to be more appropriate, at least for some areas. Table 3 summarized the criteria defined to assign fishing mode.

<u>Chagos :</u> For this area 3.5 kg. can be considered a good limit to identify the sets associated to FAD (<3.5) and free school (>=3.5) with a probability of error type I of 4% and a probability of error type II of 5%. In this area the percentage of free school sets with only one species is 73% and 88% the percentage of sets with 1 or 2 species. This is the reason why we have the lower percentage of errors for both variables average weight and also diversity index.

SE Seychelles and NW Seychelles: As in the previous area the percentage of free school sets with 1 or 2 species is high, 86 and 79% respectively. An average weight of 5.25 in the SE area implies a 2% of type I error and a 14% of type II error and an average weight of 3.25 kg. in the NW area implies a 4 and 13% of type I and II errors.

Somalia: For this area, the probability of errors I and II is higher than in the previous areas. An average weight of 1.5 kg. produces a 17% and 23% of probability of errors. Nevertheless, as the percentage of free school sets in this area is reduced (less than 4%) the probability of error should be considered irrelevant.

Mozambique Channel: This is the most difficult area to consider because the typology of fads and free school sets are close. Free school sets are often composed by several species of small size like the FAD sets. In order to improve the analysis in this area we considered time strata. However, due to the high seasonality of the fishery in this area (Mars to May) and the low activity of the fleets outside this period, the time component did not improve our results. So we can define 2 kg. as the average weight of reference, although the percentage of error is high ((22% and 26%), considering that our results reflect the reality in this area. Furthermore we can consider that the benefits of stratifying by fishing mode in this area would be less significant than in other areas.

Conclusion

As a conclusion, the proposed method do allow to estimate the association of sampled school on the rare schools sampled without this basic information. This procedure will allow to use all the size and species sampling done, even when this fishing mode was unknown. This estimation procedure is required for a very small number of historical samples, and in the present sampling only the well identified schools are sampled, then eliminating the need of this method for the recent data.

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Number of samples			
Area	Fishing mode		
	FAD	Free School	Total
Somalia	3450	123	3573
NW Seychelles	2485	1157	3642
SE Seychelles	822	1270	2092
Mozambique Channel	1529	487	2016
Chagos	130	165	295
Arabian Sea	53		53
Indonesia	14		14
Total	8483	3202	11685

Table 1.- Number of samples by area and fishing mode.

Area	Average Weight	Prob. FAD	Prob. Free School	Shanon Index	Prob. FAD	Prob. Free School
Somalia	1.5	83%	23%	0.05	2%	50%
NW Seychelles	3.25	96%	13%	0.20	9%	65%
SE Seychelles	5.25	98%	14%	0.25	17%	81%
Mozambique Channel	2	78%	26%	0.30	28%	71%
Chagos	3.5	96%	5%	0.15	5%	86%
Arabian Sea						
Indonesia						

Table 2.- Reference values of the variables used in the analysis (average sample weight weighted by the inverse of the number of species in the sample and diversity index) and the corresponding probability values obtained from the Cumulative frequency, by area.

Area	Criteria
Somalia	FADs < 1.5 Kg.
NW Seychelles	FADs < 3.25 Kg.
SE Seychelles	FADs < 5.25 Kg.
Mozambique Channel	FADs < 2 Kg.
Chagos	FADs < 3.5 Kg.
Arabian Sea	
Indonesia	

Table 3.- Average weight established as threshold to identify the fishing mode.

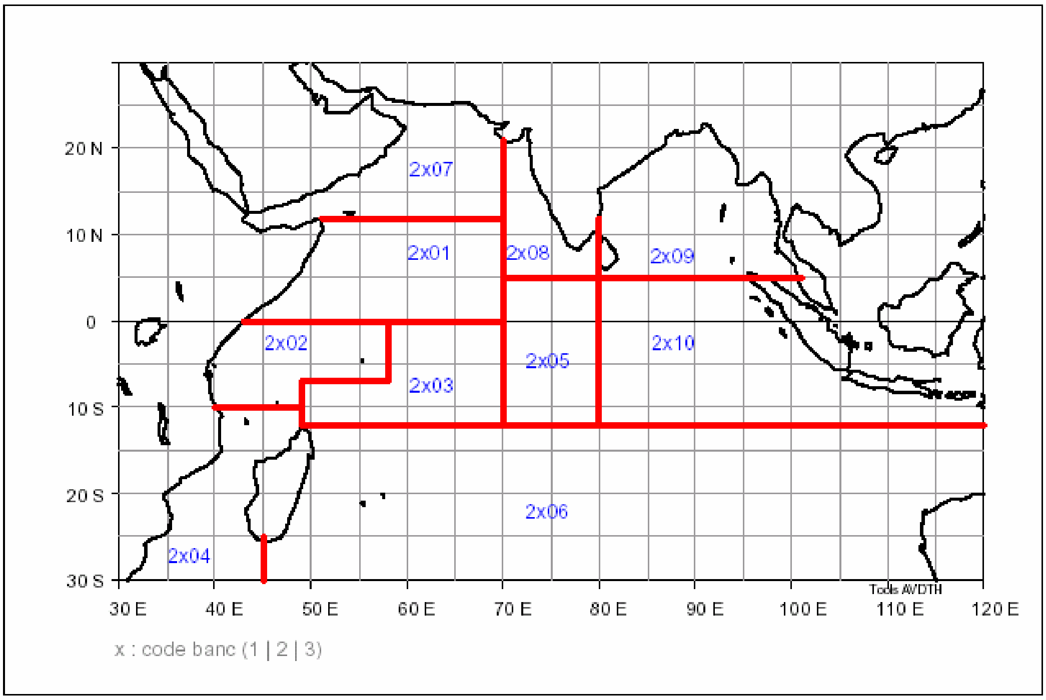

Figure 1.- Areas considered in the analysis: 2x01= Somalia, 2x02= NW Seychelles, 2x03=SE Seychelles, 2x04=Mozambique Channel, 2x05= Chagos, 2x07= Arabian Sea and 2x10= Indonesia.

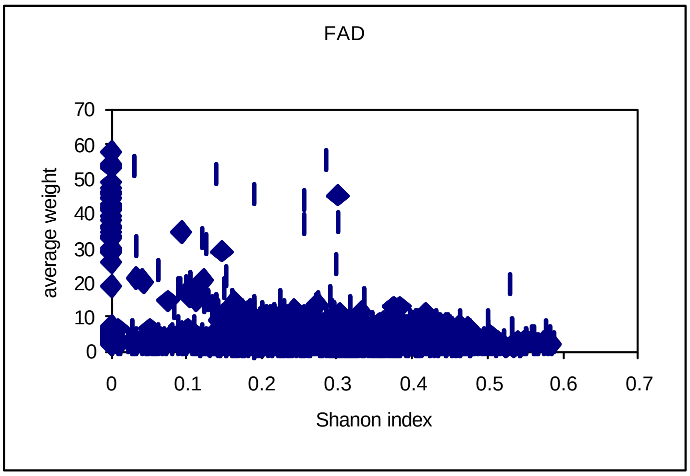

Figure 2.- Average sample weight (unweighted) vs diversity index from FAD sets.

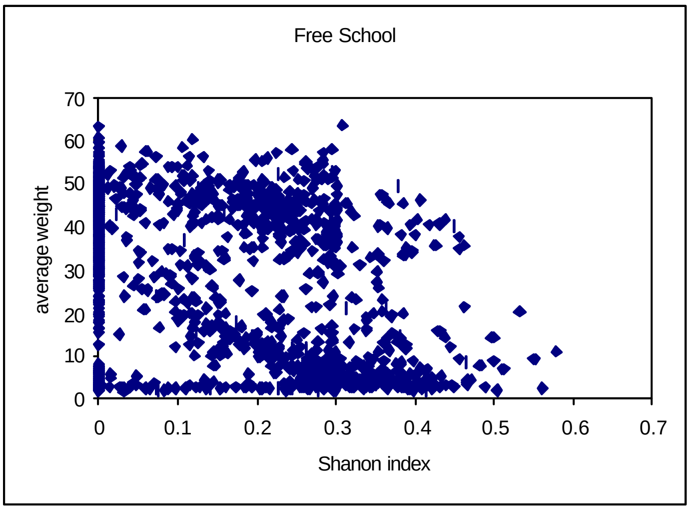

Figure 2.- Average sample weight (unweighted) vs diversity index from free school sets.

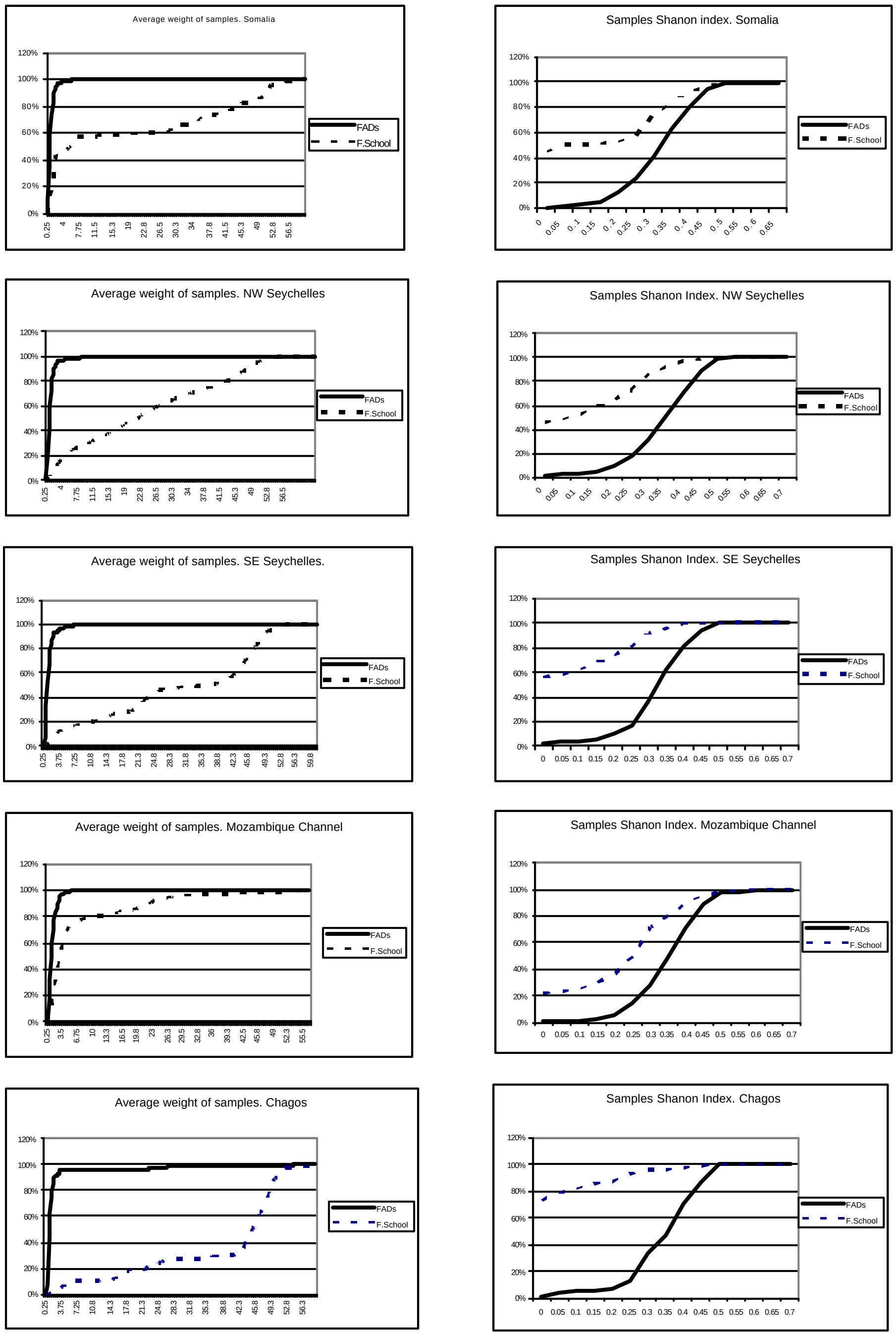

Figure 4.- Cumulative frequencies of average sample weight (weighted by the inverse of the number of species in the sample) and diversity index for FAD and free school sets by area.