UPDATE OF DATA ON BILLFISH CAUGHT BY ABIDJAN CANOE FLEET, 1988-1995

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Amon Kothias, J.B., T. Joanny, A. Hervé, F.X. Bard

Centre de Recherches Océanologiques (CRO),
P.O. Box V-18, Abidjan, Côte d'Ivoire

1. Introduction

A peculiar small scale fishery of canoes using drifting small gillnet is operating off Abidjan. It settled in 1984 and the effort increased regularly , due to the good market conditions.The operations take place at nightime at a short range of Abidjan. The trips are daily. The vessels are 13m long canoes powered by a 40CV outboard motor. The net with large mesh was designed by Ghanaian fishermen in 1974 and is known as "nifa-nifa" net. (Mensah and Doyi, 1992)
The targetted fish are large pelagic fish such as sharks (Carcharinus sp), blue marlin (Makaira nigricans), sailfish (Istiophorus platyperus), swordfish (X. gladius) and to lesser extent tunas (T obesus, T albacares).The catch is moderate, less than 500 MT per year. But the originality of this fishery is that it is a multispecific fishery, very constant in space, because of the short range of canoes. It has been regularly monitored since 1988 by CRO and therefore produce a consistent serie of data over 1988-1994.The methods used are described by Bard and Konan (1992), Joanny et al, 1994. CPUE has been used for computing an index of abundance for sailfish by Farber and al. (1994).
The purpose of the present paper is to gather and synthetise the data collected for the three main species (blue marlin, sailfish, swordfish) over 1988-1994 and partially (7 months data) for 1995. Eventually an index of abundance is computed for each main species using a GLM procedure under SAS system.

2 Material and methods

Every morning at Abidjan canoe port, canoes with gillnet unload the fish caught during the night on the pier. All the major species landed are recorded and length size of sailfish, blue marlin, swordfish and large (over 1 m) sharks are measured. For billfish and swordfish the length measured is from fork of the tail to lower jaw, at the lowest centimeter for sailfish, lowest 5 cm for the two others. The measure is made using a flexible tape, therefore it takes in account the curve of the side of the fish and should be corrected by a coefficient of 0.95.
As nearly every fish is measured, it can be considered as an exhaustive sampling. Using length-weight relationship available in the ICCAT litterature it is possible to estimate the weight of fish landed, as there is currently no official weighting for artisanal fisheries in Africa.

The number of trips by night is registered, and the montly CPUE expressed in Kilogram per trip computed. An environmental parameter, the sea surface temperature off Abidjan recorded. This parameter is important as a seasonal coastal upwelling develops along the Ivorian (and Ghanaian) shores, affecting the availability of small pelagic fish, and maybe large pelagic fish (Bard and Koranteng 1995).

On the basis of these data a yearly index of abundance is computed using a multiplicative model made additive by the Ln transform. This last model is an analysis of covariance written:

$$Ln\,[(CPUE)ij+1] = Ln[(YEAR)i] + \alpha iLn[(SST)ij] + (Err)\,ij$$

where (CPUE)ij is the jth monthly average catch per unit effort in the year i
(YEAR)i are effect of the years 1988 to 1995
(SST)ij the jth monthly average sea surface temperature of the ith year . They are daily measured off Abidjan and range from 20°c to 29°c.
(Err)ij are the error terms. They are assumed to be independant and normaly distributed
There is no area effect as the fishing area is restricted to vicinity of Abidjan. For 1995 only the eight first monthly averages catches per unit effort are available
Computations were run using the procedure GLM (General Linear Model) of the SAS software of ORSTOM in Côte d'Ivoire.

3- Results and discussion

The annual standardized indices of abundance, as well as the quantities caught for each of the three species appear respectively in the following tables. Figures (annex) display the indices of abundance compared to the CPUE. It can be observed that the correction by standardization is more importante for sailfish (the dependent variable is Ln(rvo+1)). It can be explained by the closer link between the sea surface temperature and the abundance of the species. This is reflected in the large F value (196.49) as compared to the much lower values for the two other values which are 0.67 for the blue marlin (the dependent variable is Ln(mar+1)) and 17.34 for the swordfish (the dependent variable is Ln(res+1)).
The overall picture of the annual indices of abundance show a moderate decline for the billfish and nearly no variation for the swordfish. However given the narrowness of the exploited areas, it has to be carefully decided between two explanations:
If it is a rather local model of production'' because of a slow rate of exchange with offshore populations, as the effort clearly increased over the range of years (following tables), it could be ascertained that decrease of abundance is caused by higher efforts.
Or is that relecting a general decrease of abundance of the species in eastern tropical atlantic ?.
Tagging experiments could help to address the point. Up to now, among billfish only 3 tags have been recorded on blue marlin landed in Abidjan. Two on blue marlins caught offshore by large purse seiners and one on a blue marlin caught by the gillnet fishery. All these three fishes have been tagged in Caribbean Sea near St Thomas. Sport fishermen tags now casually small blue marlins off Abidjan and the availability of new tags supplied by Dr Prince could improve the situation. But no recovery has been so far reported

Table 1: Nominal data of abundance for sailfish, blue marlin and swordfish

Years of cathes	Cathes of sailfish (kg)	cathes of blue marlin (kg)	cathes of swordfish (kg)	trips (number of canoes)
1988	67179	87698	12688	1826
1989	54528	64760	6747	1372
1990	61952	72418	9583	1970
1991	39881	77714	21394	3235
1992	70929	57672	15434	3925
1993	44397	110554	18868	4658
1994	43788	140001	22600	6268
1995	31094	100740	16225	4411

Table 2 : Standardized indices of abundance for sailfish, blue marlin and swordfish

Years of cathes	sailfish standardized cpue	blue marlin standardized cpue	swordfish standardized cpue
1988	22,594	33,398	5,165
1989	18,511	35,598	5,196
1990	21,782	40,181	3,908
1991	16,619	23,459	4,083
1992	11,097	13,790	1,880
1993	7,881	22,126	4,408
1994	6,830	19,125	2,758
1995	5,639	21,465	4,217

Sizes frequencies

The yearly length frequencies 1988-1995 for Sailfish, Xiphias and Makaira are displayed as an annex of this paper. Some remarks can be done:

For sailfish the size span is very constant and distribution similar to the features of the Senegalese fishery. Diouf, 1994 (and probably in Ghana). The size frequencies measured to the lower cm are not perfect, as obiously there is a preference from the sampler for figures 0 or 5. A moving average should be applied to the raw data. As described in Senegal, the sailfish are available only when sea surface temperature is warmer than 25 ° C. Therefore the fishing season is the two warm seasons (April-May and November -December.). At the end of the two last years 1993 and 1994, some social troubles (riots...) disturbed the fishing operations. Therefore the indices of
abundance of sailfish for these two years could be artificially lower than reality.

For blue marlin (Makaira), the size span is very broad but rather constant over the years. Two components or sizes appear: Small fish ranging from 140 cm to 220 cm are more common during the minor upwelling (January to March). Large fish , measuring more than 220 cm up to 400 cm are abundant. The fishing season is the best during the major upwelling season (June to October).The biggest fish recorded , observed in September 1994, was 400 cm long and weighted 647 kg.

For swordfish (Xiphias): The size span is very broad, from 60 cm to 260 cm which is a common feature for coastal swordfish populations. Fishing take place all the year round without any specific season.

4 Litterature cited

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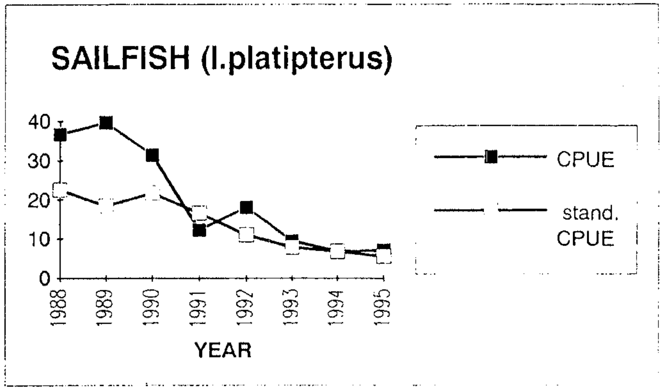

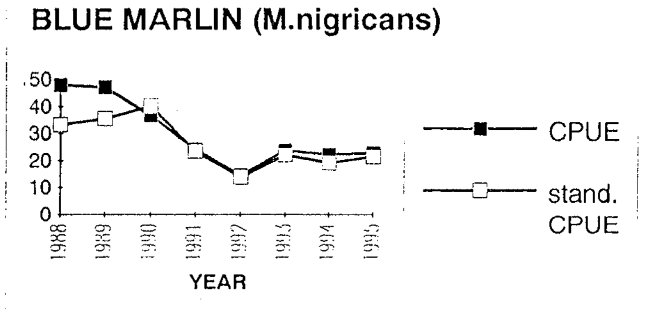

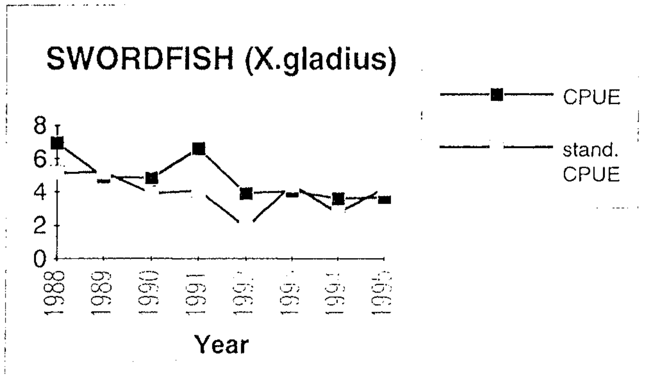

FIGURES : From top to bottom : Côte d'Ivoire sailfish ,blue marlin, and swordfish CPUE(Kg/trip) and standardized CPUE. Note that 1995 is incomplete

General Linear Models Procedure

Class Level Information

Class	Levels	Values
YEAR	8	88 89 90 91 92 93 94 95

Dependent Variable: Ln(RVO+1)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	93.99493854	11.74936732	28.72	0.0001
Error	80	32.72566107	0.40907076		
Corrected Total	88	126.72059961			

R-Square	C.V.	Root MSE	Ln(RVO+1)Mean
0.741749	24.16493	0.639586	2.646754

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Ln(YEAR)	7	13.61613886	1.94516269	4.76	0.0002
Ln(SST)	1	80.37879967	80.37879967	196.49	0.0001

YEAR	Ln(RVO+1) LSMEAN	Std Err LSMEAN	Pr > |T| H0:LSMEAN=0
88	3.16176128	0.18464491	0.0001
89	2.97172041	0.18513573	0.0001
90	3.12664922	0.18511658	0.0001
91	2.86914782	0.18881227	0.0001
92	2.49358219	0.18464679	0.0001
93	2.18406173	0.19295042	0.0001
94	2.05857289	0.18485575	0.0001
95	1.89320486	0.26563530	0.0001

```
  RESID                                               Cum.              Cum.
Midpoint                                      Freq   Freq   Percent   Percent
           |
  -1.5     |*                                    1      1      1.12      1.12
           |
  -1.0     |*********                            9     10     10.11     11.24
           |
  -0.5     |*********************               21     31     23.60     34.83
           |
   0.0     |**************************          26     57     29.21     64.04
           |
   0.5     |*********************               21     78     23.60     87.64
           |
   1.0     |*********                            9     87     10.11     97.75
           |
   1.5     |**                                   2     89      2.25    100.00
           ----+----+----+----+----+-
               5   10   15   20   25
                    Frequency
```

Dependent Variable: Ln(RMA+1)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	10.14088013	1.26761002	2.25	0.0320
Error	80	45.07701783	0.56346272		
Corrected Total	88	55.21789796			

R-Square	C.V.	Root MSE	LRMA Mean
0.183652	23.01829	0.750642	3.261066

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Ln(YEAR)	7	9.76466426	1.39495204	2.48	0.0237
Ln(SST)	1	0.37621587	0.37621587	0.67	0.4163

Least Squares Means

YEAR	Ln(RMA+1) LSMEAN	Std Err LSMEAN	Pr > |T| H0:LSMEAN=0
88	3.53837803	0.21670589	0.0001
89	3.60011902	0.21728193	0.0001
90	3.71851788	0.21725946	0.0001
91	3.19716224	0.22159685	0.0001
92	2.69402393	0.21670810	0.0001
93	3.14136344	0.22645353	0.0001
94	3.00204580	0.21695334	0.0001
95	3.11281463	0.31175911	0.0001

Dependent Variable: Ln(RES+1)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	11.45087491	1.43135936	4.46	0.0002
Error	80	25.66185319	0.32077316		
Corrected Total	88	37.11272810			

R-Square	C.V.	Root MSE	LRES Mean
0.308543	36.15428	0.566368	1.566532

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Ln(YEAR)	7	5.88811064	0.84115866	2.62	0.0172
Ln(SST)	1	5.56276427	5.56276427	17.34	0.0001

Least Squares Means

YEAR	Ln(RES +1) LSMEAN	Std Err LSMEAN	Pr > |T| H0:LSMEAN=0
88	1.81993382	0.16350729	0.0001
89	1.82442893	0.16394193	0.0001
90	1.59102359	0.16392497	0.0001
91	1.62686321	0.16719759	0.0001
92	1.05815590	0.16350896	0.0001
93	1.68852427	0.17086201	0.0001
94	1.32408825	0.16369400	0.0001
95	1.65227691	0.23522614	0.0001