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A PRODUCTION MODEL ANALYSIS OF NORTH ATLANTIC ALBACORE (THUNNUS ALALUNGA), 1957-1978

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SUMMARY

Two production model adjustments of the North Atlantic albacore stock between 1957 and 1978 are presented. The first adjustment, case A, is based on data from Shiohama and Yang for longline and Bard, Antoine, and González-Garcés for trolling and baitboat. The second adjustment, case B, is based on data from Shiohama, ICCAT and Yang for longline and Bard, Antoine, and González-Garcés for trolling and baitboat.

The production models show that the MSY of the North Atlantic albacore stock is between 55,000 and 65,000 t., with an optimum effort that can range between 85,000 and 105,000 standard baitboat fishing days.

Studies involving the prevailing tendency of the CPUE of all the fisheries show that no clear dominant trend exists, but rather that it is stable with slight fluctuations.

RESUME

Ce document présente deux ajustements du modèle de production au stock de germon de l'Atlantique nord entre 1957 et 1978. Le premier (cas A) est basé sur les données de Shiohama et de Yang pour la palangre, et sur celles de Bard, Antoine et Gonzalez-Garces pour ce qui est de la pêche à la ligne traînante et à l'appât vivant. Le second (cas B) est basé sur les données de Shiohama, ICCAT et Yang pour ce qui est de la palangre, et de Bard, Antoine et Gonzalez-Garces pour la pêche à la ligne traînante et à l'appât vivant.

Les modèles de production indiquent que la PME du stock de germon de l'Atlantique nord se situe entre 55.000 et 65.000 TM, avec un effort optimum oscillant entre 85.000 et 105.000 journées de pêche standard de canneur.

Les études portant sur la tendance de la CPUE de l'ensemble des pêcheries n'indiquent pas de tendance claire, mais plutôt un état stable avec de légères fluctuations.

RESUMEN

Se presentan dos ajustes de modelos de producción al stock de atún blanco del Atlántico Norte entre los años 1957 y 1978. Un ajuste, (caso A), se basa en datos de Shiohama y de Yang para el palangre y de Bard, Antoine y González Garcés para curricán y cebo vivo. El otro ajuste, (caso B), se basa en datos de Shiohama, ICCAT y Yang para el palangre, y de Bard, Antoine y González Garcés para el curricán y el cebo vivo.

Los modelos de producción indican que el RMS del stock del atún blanco del Atlántico Norte se encuentra entre 55.000 y 65.000 toneladas, con un esfuerzo óptimo que puede oscilar entre 85.000 y 105.000 días de pesca standard de cebo vivo.

Los estudios sobre la tendencia de la CPUE del conjunto de las pesquerías no indican que exista una tendencia clara, más bien parece estable con ligeras oscilaciones.

Introduction

Even though we are aware of the limitations involved in using production models in populations where there are different fisheries acting on different age groups, we decided to use these production models because of recommendations by the S.C.R.S. of the I.C.C.A.T. in 1979, in which the presentations of production models for the North Atlantic stock of this species are required.

In production models for this population presented in previous years the efforts are normalized , (Shiohama 1977; 1978; González-Garcés 1978; González- Garcés and Shiohama 1979). The SCRS Committee also created its own model in 1978 using the same process for effort normalization according to Shiohama's method, (op. cit.). Furthermore, in those papers the data on catch and effort was separated depending on the country where the landing was made, in surface fisheries or according to young people and adults in longline fishery.

In this paper the data is listed by fisheries depending on the fishing methods used: longline, baitboat, and trolling, and are compared standardized by baitboat fishing days and by means of a normalization.

The data on catch, in addition, is variable depending on the source. Consequently two model adjustments were made in accordance with the origin of the data used.

Data

A historical series of data, totalling 22 years, from 1957 to 1978 is used.

For longline fishing the proposed data has been revised by Shiohama (1980), ICCAT (1979) and Kume and Yang (1980).

For longline fishery as a whole up to 1975 data from Shiohama and ICCAT was compared. Slight differences between the two were found, mainly in the period between 1968 and 1975. As we were unable to decide which of the two series of data was more suitable, we made adjustments to the models with Shiohama's data from 1957 to 1975, (case A), Table 1, and with that of Shiohama from 1957 to 1967, and ICCAT's data from 1968 to 1975, (case B), Table 2, separately. In both cases for 1976, 1977, and 1978 ICCAT's data was taken for all the countries that use longline except Taiwan. For that country data from Kume and Yang (SCRS/80/67) was used.

For the two surface methods of fishery, trolling and baitboat, we used data from Bard and González-Garcés (1980) and González-Garcés and Antoine (SCRS/80/). Baitboat data is shown in table 3, and trolling data in table 4.

Data concerning effort follows the same procedure as that for catch. Standardization was established using standard baitboat days comparing the CPUE average for each fishery. Ratios were derived such as the ratio of longline is equal to the CPUE longline average divided by the CPUE baitboat average.

$$I_{LL} = \frac{\overline{CPUE}_{LL}}{\overline{CPUE}_{BB}}$$

The baitboat ratio is 1 since it is compared with itself. The trolling ratio is

$$I_{TROL} = \frac{\overline{CPUE}_{TROL}}{\overline{CPUE}_{BB}}$$

In this way we arrive at the following ratios:

$$I_{LL} = \frac{0.394}{0.915} = 0.4306$$

$$I_{BB} = 1$$

$$I_{TROL} = \frac{0.450}{0.915} = 0.4918$$

The ratio of each fishery is multiplied by the efforts for each year, thus reaching a standardization of efforts to standard baitboat days. The total yearly effort is obtained by adding the standardized efforts of each type of fishing in each year.

An analysis of the variation of the CPUE in each fishery method over the years

In figures 1, 2 and 3 the yearly CPUE's for each type of fishing are shown. In figure 4, the variation of the CPUE of the stock as a whole is presented.

For longline (figure 1) since 1957 the prevailing tendency of the CPUE has been to decrease. In the early years of this fishery, which began in 1956, the CPUE dropped sharply but later, beginning in 1960, this trend has been only slight, although it does continue.

For baitboat (figure 2) there is a relatively stable period, with fluctuations, from 1957 to 1973, while from 1974 on, the CPUE levels seem higher. In general there seems to be an increase in baitboat CPUE.

Regarding trolling (figure 3) there also seems to be a slight but clear rising tendency starting in 1969.

In the stock as a whole (figure 4) there doesn't seem to be a clear prevailing tendency. A slight rising trend seems to exist starting in 1968, but, on the whole no clear tendency can be noticed.

An analysis of production models

Table 5 shows the total catch data and the total standardized effort for baitboat fishing days according to Shiohama's longline data, in addition to that of Kume and Yang for Taiwan in 1976, 1977, and 1978, (case A).

In table 6 the total catch and total standardized effort for baitboat fishing days data comes from Shiohama 1957 - 67; ICCAT 1968 - 75, and ICCAT with modifications from Kume and Yang for Taiwan in 1976, 1977, 1nd 1978, (case B).

The adjustments to case A appear in figure 5 and the corresponding numerical results in table 7. The adjustments to case B appear in figure 6 and the corresponding numerical results in table 8. The adjustments were made using Fox's PRØDFIT program (1975) with a k as the average effort for three years.

Comparing tables 7 and 8 we can see that the differences between the two cases are very small. Hence the difference in the data for both cases does not have a significant influence on the model results.

In case A as well as case B, the MSY level is between 55,000 t. and 65,000 t. and given that all of the fleets have been catching between 40,000 and 57,000 t. in the last 7 years, it can be concluded that they do not surpass the MSY. In figures 5 and 6 it can be observed that the fishery is on the lefthand side of the MSY, which should indicate a healthy fishery state at present. It also seems to confirm the observation put forward by González-Garcés and Shiohama (1979).

Conclusion

The MSY of North Atlantic albacore fishery is approximately 60,000t. The optimun effort is between 95,000 and 135,000 standard baitboat fishery days.

In the last three years the various fleets have caught between 51,000 and 57,000 t. applying an effort of between 67,000 and 80,000 baitboat fishing days.

No clear tendency in the CPUE of the whole fishing fleet was observed.

In general, and keeping the previously mentioned restrictions concerning model production for tuna in mind, the picture of the albacore stock in the North Atlantic is satisfactory and shows a good rate of exploitation.

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Fig. 1 .- CPUE evolution from 1957 to 1978 by longline fishery of North Atlantic albacore.

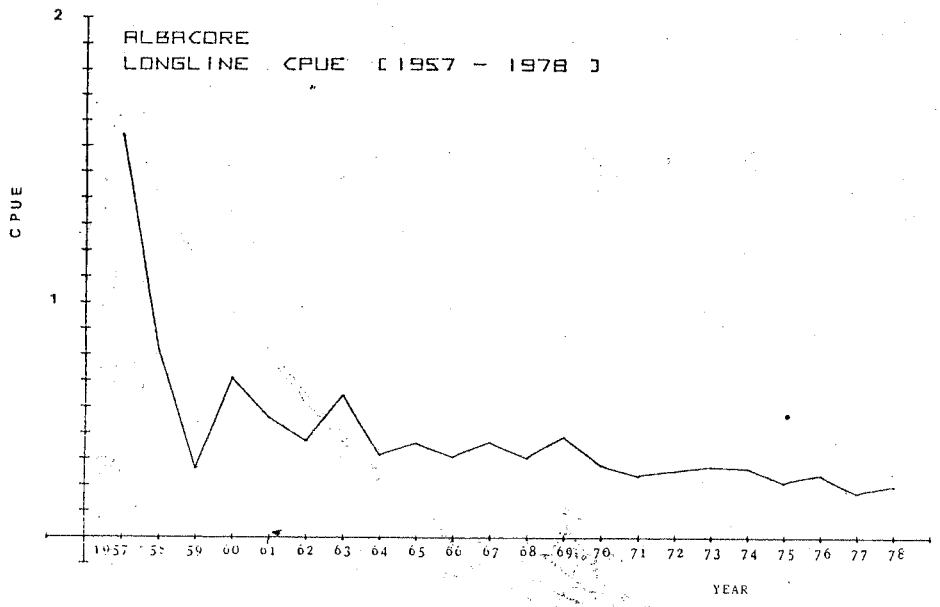


Fig. 2.- CPUE evolution from 1957 to 1978 by baiboat fishery of North Atlantic albacore.

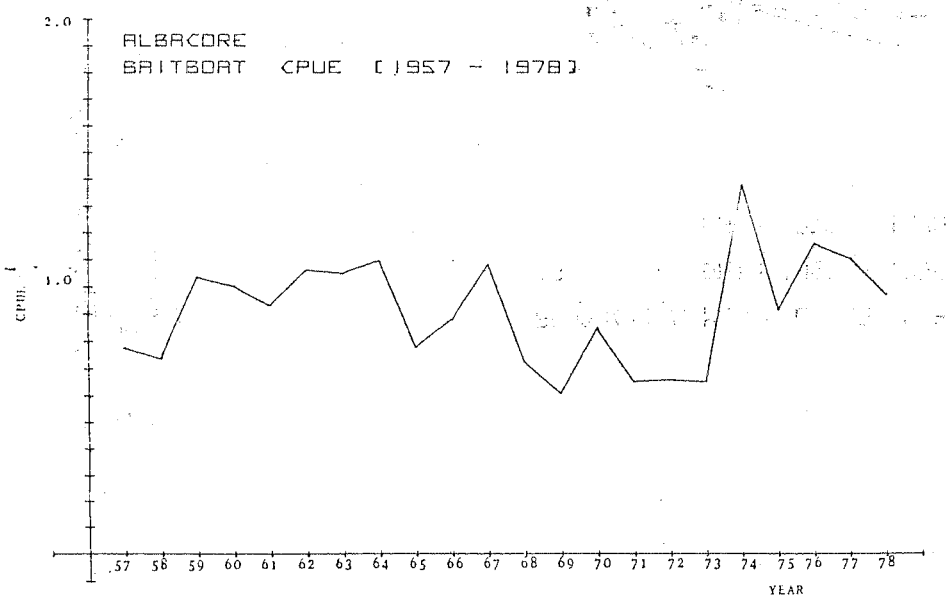


Fig. 3 .- CPUE evolution from 1957 to 1978 by trolling fishery of North Atlantic albacore.

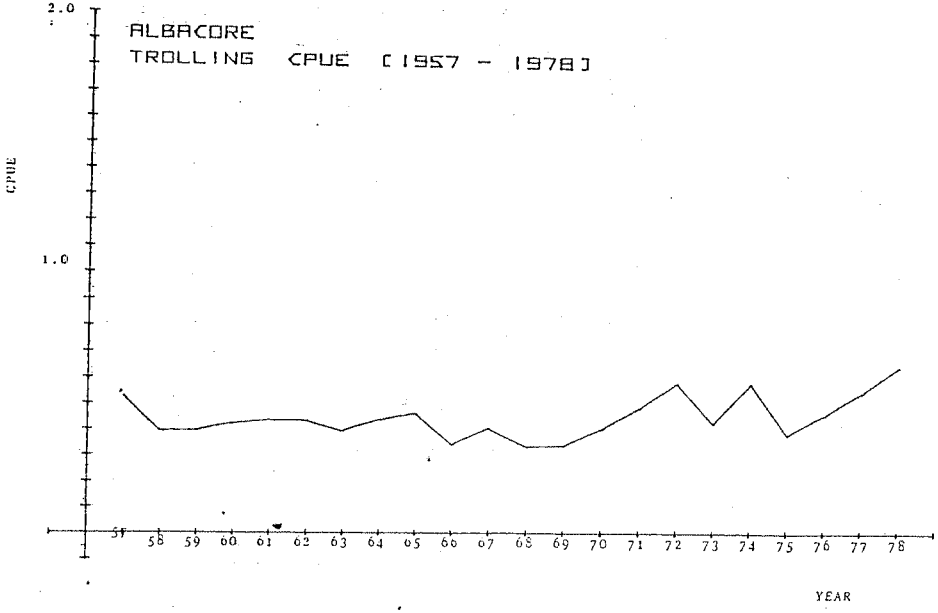
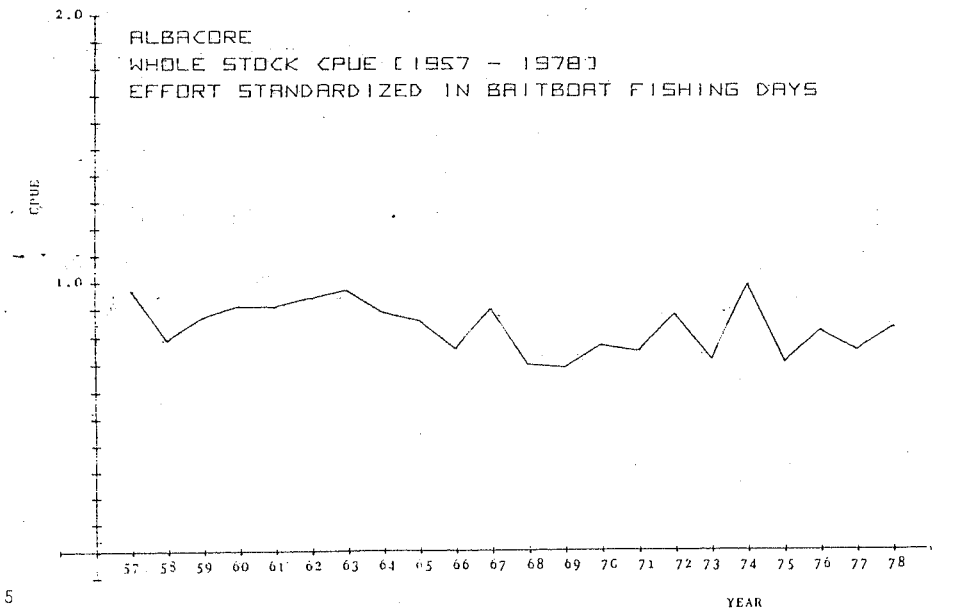


Fig. 4.- CPUE evolution from 1957 to 1978 by whole fishery of North Atlantic albacore.



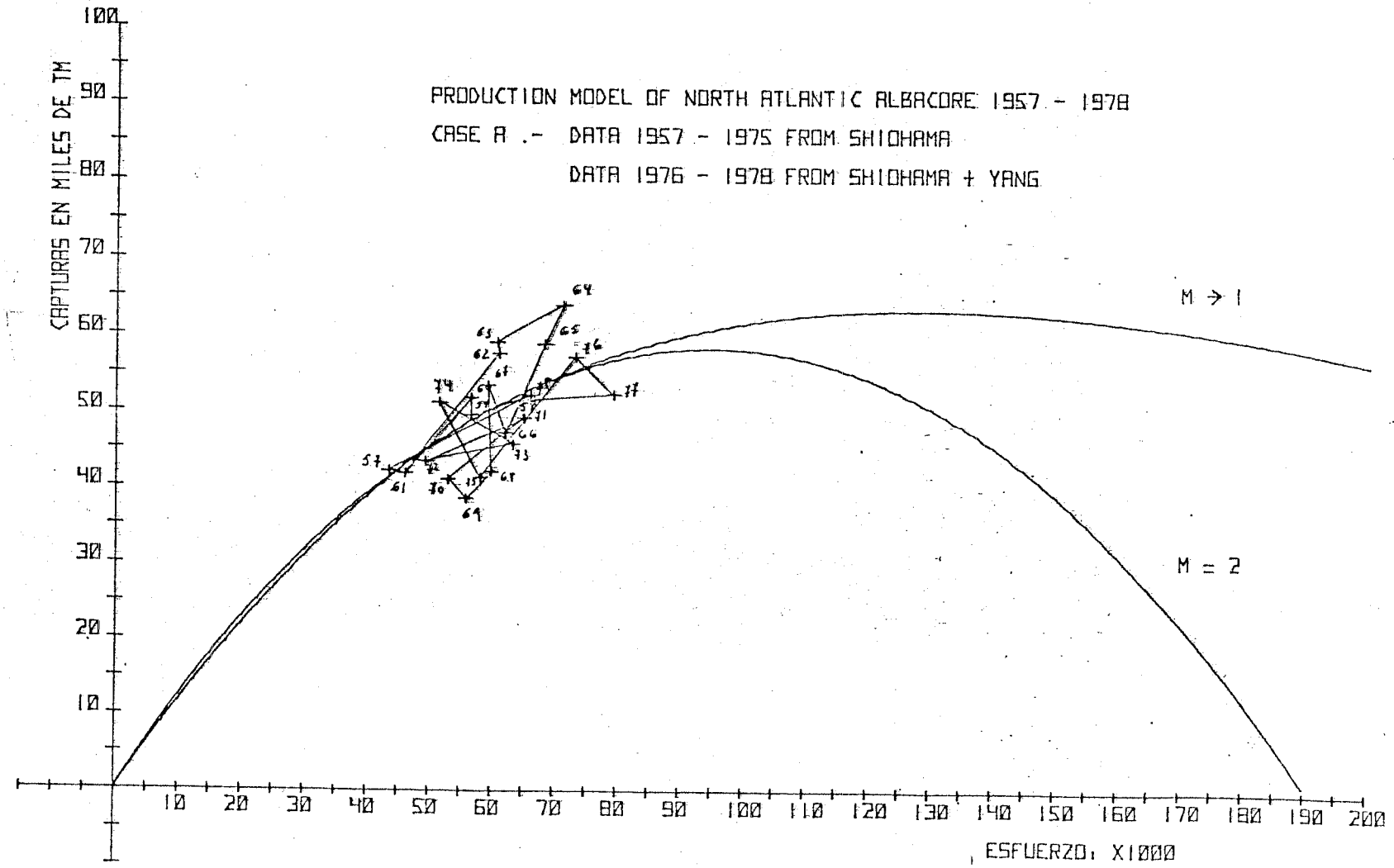


Fig. 5.- Fitting of a production model analysis to the North Atlantic albacore fishery (1957-1978). Case A.

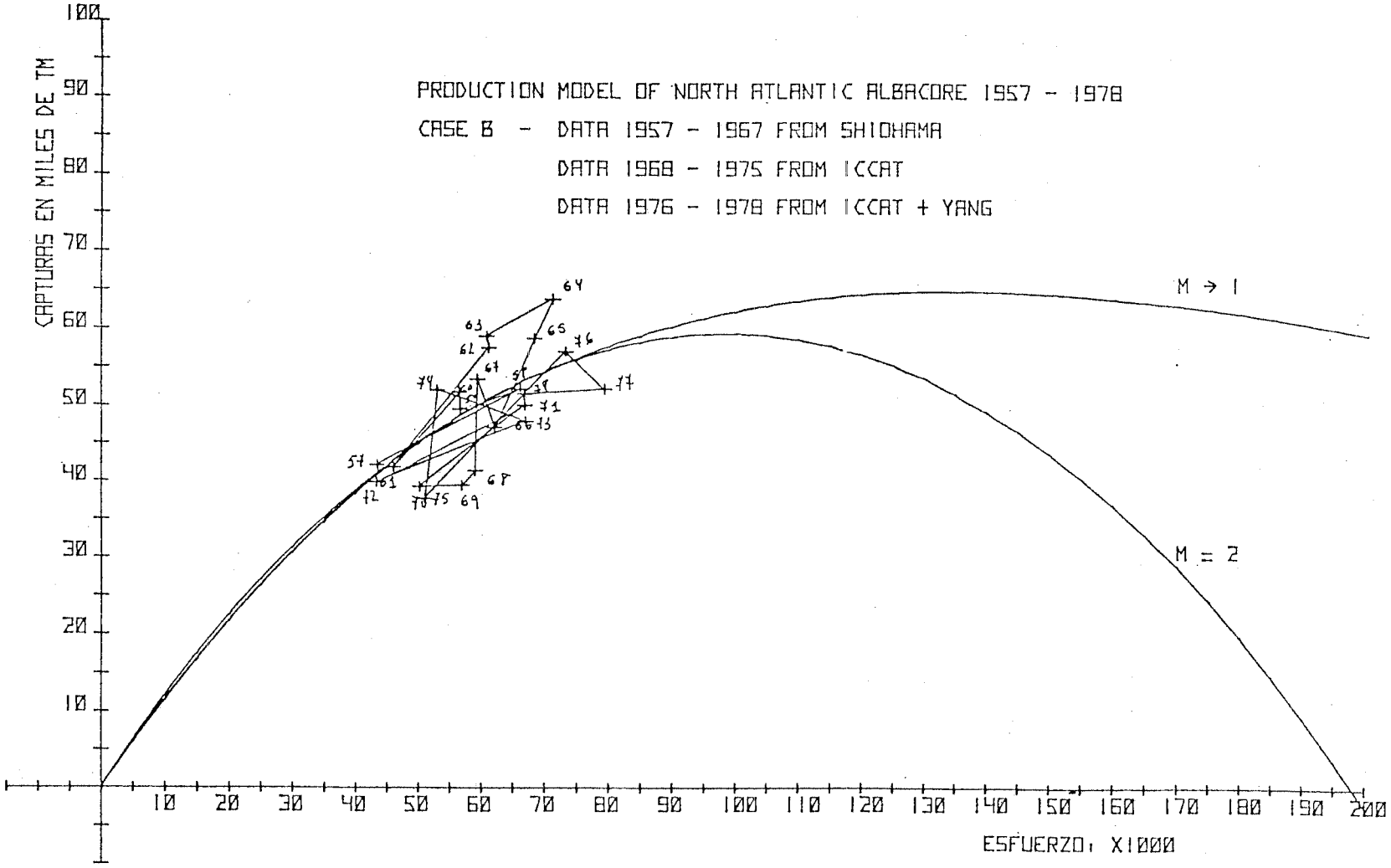


Fig. 6.- Fitting of a production model analysis to the North Atlantic albacore fishery (1957-1978). Case B.

LL

Año	C	f	U	f
1957	135	87	1.543	37
1958	945	1.322	0.715	569
1959	599	2.269	0.264	977
1960	1.131	1.857	0.609	683
1961	380	,826	0.459	356
1962	5.733	15.453	0.371	6.654
1963	14.629	26.941	0.543	11.601
1964	15.816	50.369	0.314	21.689
1965	14.175	39.485	0.359	17.002
1966	8.145	26.445	0.308	11.387
1967	5.442	14.992	0.363	6.456
1968	5.111	16.812	0.304	7.247
1969	6.866	17.880	0.384	7.706
1970	11.102	40.079	0.277	17.277
1971	9.675	40.822	0.237	17.603
1972	9.071	35.712	0.254	15.359
1973	17.615	65.000	0.271	27.985
1974	13.499	50.748	0.266	21.827
1975	12.430	58.357	0.213	25.082
1976	22.847	95.594	0.239	41.163
1977	20.122	117.673	0.171	50.670
1978	17.339	88.015	0.197	37.899

$\bar{U}$ = 0.394

f'= standardized effort

Table 1.- Catch, effort, CPUE and standardized effort at bait boat fishing days, by longline fishery, according to data from Shiohama (1957 - 1975) and Shiohama plus Kume and Yang (1976 - 1978).

LL

Año	C	f	U	f
1957	135	87	1.543	37
1958	945	1.322	0.715	569
1959	599	2.269	0.264	977
1960	1.131	1.857	0.609	683
1961	380	826	0.459	353
1962	5.733	15.453	0.371	6.654
1963	14.629	26.941	0.543	11.601
1964	15.816	50.369	0.314	21.689
1965	14.175	39.485	0.359	17.002
1966	8.145	26.445	0.308	11.387
1967	5.442	14.992	0.363	6.456
1968	4.505	14.819	0.304	6.381
1969	7.815	20.352	0.384	8.764
1970	9.375	33.845	0.277	14.574
1971	10.634	44.869	0.237	19.321
1972	5.514	21.709	0.254	9.348
1973	19.925	73.524	0.271	31.659
1974	14.383	54.071	0.266	23.283
1975	8.900	41.784	0.213	17.992
1976	22.847	95.594	0.239	41.163
1977	20.122	117.673	0.171	50.670
1978	17.339	88.015	0.197	37.899

$\bar{U}$ = 0.394

F'= standardized effort

Table 2.- Catch, effort, CPUE and standardized effort at bait boat fishing days, by longline fishery, according to data from Shiohama (1957 - 1967), ICCAT (1968 - 1975) and ICCAT plus Kume and Yang (1976 - 1978).

BB

Año	C	f	U	f'
1957	11.958	15.382	0.777	15.382
1958	17.258	23.394	0.738	23.394
1959	17.947	17.317	1.036	17.317
1960	17.539	17.467	1.004	17.467
1961	20.519	22.045	0.931	22.045
1962	20.848	19.620	1.063	19.620
1963	19.769	18.802	1.051	18.802
1964	19.928	18.189	1.096	18.189
1965	19.030	24.416	0.779	24.416
1966	16.132	18.326	0.880	18.326
1967	17.294	15.968	1.083	15.968
1968	13.478	18.544	0.727	18.544
1969	13.690	22.359	0.612	22.359
1970	14.188	16.731	0.848	16.731
1971	15.377	23.441	0.656	23.441
1972	7.762	11.743	0.661	11.743
1973	9.246	14.116	0.655	14.116
1974	16.695	12.124	1.377	12.124
1975	19.319	21.091	0.916	21.091
1976	20.306	17.505	1.160	17.505
1977	15.629	14.118	1.107	14.118
1978	11.659	11.970	0.974	11.970

$\bar{U} = 0.915$

f'= standardized effort

Table 3.- Catch, effort, CPUE and standardized effort at bait boat fishing days, by bait boat fishery, according to data from Bard, González - Garcés and Antoine.

TROL

Año	C	f	U	f'
1957	30.028	57.000	0.527	28.033
1958	33.945	86.000	0.395	42.295
1959	30.976	78.000	0.397	38.360
1960	33.072	78.000	0.424	38.360
1961	20.907	48.000	0.436	23.606
1962	30.943	71.000	0.436	34.918
1963	24.624	62.000	0.397	30.492
1964	28.058	64.000	0.438	31.475
1965	25.544	55.000	0.464	27.049
1966	22.791	66.000	0.345	32.459
1967	30.669	75.144	0.408	36.956
1968	23.393	69.419	0.337	34.140
1969	17.923	52.456	0.342	25.798
1970	15.706	38.489	0.408	18.929
1971	24.029	49.181	0.489	24.187
1972	26.517	45.192	0.587	22.225
1973	18.712	43.284	0.432	21.287
1974	20.958	35.800	0.585	17.606
1975	9.474	24.352	0.389	11.976
1976	13.918	29.902	0.465	14.706
1977	16.481	29.858	0.552	14.684
1978	22.567	34.500	0.654	16.967

$\bar{U} = 0.450$

f' = standardized effort

Table 4.- Catch, effort, CPUE and standardized effort at bait boat fishing days, by trolling fishery, according to data from Bard, González - Garcés and Antoine.

Año	Σ C	Σ f
1957	42.121	43.453
1958	52.148	66.258
1959	49.522	56.653
1960	61.742	56.627
1961	41.806	46.007
1962	57.524	61.198
1963	59.022	60.886
1964	63.802	71.349
1965	58.749	68.468
1966	47.068	62.178
1967	53.405	59.385
1968	41.982	59.931
1969	38.479	55.862
1970	40.996	52.937
1971	49.081	65.231
1972	43.350	49.327
1973	45.573	63.388
1974	51.152	51.557
1975	41.223	58.149
1976	57.071	73.374
1977	52.232	79.472
1978	51.565	66.836

Table 5.- Total catch and total standardized effort in Case A.

Año	Σ C	Σ f
1957	42.121	43.452
1958	52.148	66.258
1959	49.522	56.654
1960	51.742	56.510
1961	41.806	46.007
1962	57.524	61.192
1963	59.022	60.895
1964	63.802	71.353
1965	58.749	68.468
1966	47.068	62.172
1967	53.405	59.380
1968	41.376	59.065
1969	39.428	56.921
1970	39.269	50.234
1971	50.040	66.949
1972	39.793	43.316
1973	47.883	67.062
1974	52.036	53.013
1975	37.693	51.059
1976	57.071	73.374
1977	52.232	79.472
1978	51.565	66.836

Table 6.- Total catch and total standardized effort in Case B.

CASE A

m	MSY	E. Op	Op - CPUE	R	SSQ
0	106.798	—	—	0.167827	0.243773
1	63.297	129.370	0.4893	0.954597	0.243641
2	58.211	95.494	0.6096	0.982968	0.243342
Var. 0.27	72.120	275.372	0.2619	0.990473	0.243463

R = Degree of fit index

SSQ = Residual sum of squares

Table 7.- Results of production model analysus for the North Atlantic albacore (1957 - 1978) in Case A.

CASE B

m	MSY	E. Op	Op - CPUE	R	SSQ
0	113.084	—	—	0.157718	0.240856
1	64.898	135.809	0.4779	0.955139	0.240340
2	59.417	99.130	0.5994	0.983172	0.240278
Var. 0.27	76.036	305.853	0.2486	0.990580	0.240635

R = Degree of fit index

SSQ = Residual sum of squares

Table 8.- Results of production model analysis for the North Atlantic albacore (1957 - 1978) in Case B.