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STOCK ASSESSMENT OF SOUTH ATLANTIC ALBACORE BY PRODUCTION MODEL ANALYSIS, 1967-83

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SUMMARY

This study updates the previous production model analysis on the status of the South Atlantic albacore fishery. Revised data for 1967-1969 and 1982 as well as preliminary data for 1983 are used in this study. In addition, two cases were analyzed. In Case 1, effective effort was expressed in effective hooks and in Case 2, effective effort was expressed in effective fishing intensity. The estimated MSY of albacore ranged from 23,030 MT to 25,520 MT for Case 1, and from 23,050 MT to 25,660 MT for Case 2. Both catch and effort in 1983 were far below the estimated MSY level.

RESUME

Cette étude met à jour les analyses antérieures du modèle de production sur l'état de la pêcherie de germon de l'Atlantique sud. Les données révisées de 1967-1969 et 1982, ainsi que les données préliminaires de 1983, sont utilisées dans ce document. En outre, deux cas ont été analysés. Dans le 1er cas, l'effort effectif est exprimé en hameçons effectifs, et dans le 2ème cas, en intensité de pêche effective. La PME estimée du germon va de 23.030 à 25.520 TM dans le 1er cas, et de 23.050 à 25.660 TM dans le 2ème. Les prises et effort de 1983 sont très inférieurs au niveau estimé de la PME.

RESUMEN

Se actualizan los análisis de anteriores modelos de producción sobre la situación de la pesquería de atún blanco en el Atlántico Sur. Se utilizan para este estudio datos revisados de 1967-1969 y 1982 así como datos provisionales para 1983. Además, se analizaron dos casos. En el Caso 1, se expresaba el esfuerzo efectivo en anzuelos efectivos y en el Caso 2, el esfuerzo efectivo se expresaba en intensidad de pesca efectiva. El RMS estimado del atún blanco osciló de 23.030 t a 25.520 t para el Caso 1, y de 23.050 t a 25.660 t para el Caso 2. Tanto la captura como el esfuerzo en 1983 estuvieron muy por debajo del nivel estimado del RMS.

Introduction

This study updates the previous production model analysis on the status of South Atlantic albacore fishery (Sun and Yang, 1984). Revised data for 1967-1969 (ICCAT Historical Statistical Bull. Vol. 2, 1982) and 1982 (ICCAT Statistical Bull. Vol. 12, 1983) as well as preliminary data for 1983 (provided by ICCAT secretary, 1984) are used in this study.

Data and Analytical Method

The PRODFIT (Fox, 1975) computer program was used to estimate the parameters of the generalized stock production model (Pella and Tomlinson, 1969) for the catch and effort data. The number of significant year classes contributing to the albacore fishery's catch in the South Atlantic Ocean was set first at 3 (K=3) and then at 4 (K=4), following Bartoo and Coan (1983), Sun and Yang (1984). Two types of data were necessary for PRODFIT:

1) Total annual catch

Annual albacore catch data in the South Atlantic Ocean from 1967 to 1983 were compiled from ICCAT Statistical Bulletins (ICCAT, 1982, 1981, 1983, 1984). These data are shown in Fig. 1 and Table 2.

2) Standardization of effort

Longline effort measured in hooks was chosen as the standard measure of fishing effort for South Atlantic albacore fishery because nearly all the southern stock catch is exploited by longline boats (Fig. 1). The detailed procedure for the standardization of longline fishery effort using Honma's method (1979) is described by Yang and Sun (1984). The two effective effort cases outlined in this report were used as inputs to PRODFIT. In Case 1, effective effort was expressed in effective hooks and in Case 2, effective effort was expressed in fishing intensity (effective hooks per 5^{o} square). The results of the standardization of longline fishing effort appear in Sun and Yang ( ) and Table 1. This effective effort statistic was then raised to the total catch, the results of which are shown in Table 2.

Result

Catch and Standardized Effort

From 1967 to 1972, annual total albacore catch in the South Atlantic Ocean fluctuated between 15,880 and 33,260 metric tons (MT). From 1974 to 1981, It became fairly stable between 17,540 and 23,590 MT. In 1982, the total catch increased to 28,970 MT, but then dropped to its minimum of 13,500 MT in 1983 (Table 2, Fig. 1). Effective effort rose rapidly from 1968 and reached its high value of about 93.20 million hooks (1.19 million hooks per 5^{o} square) in 1973. It then fluctuated between 70.0 to 80.8 million hooks (0.90 to 1.14 million hooks per 5^{o} square) during the years 1974 to 1980. Reaching its maximum of 118.66 million hooks (1.51 million hooks per 5^{o} square) in 1982, it then decreased to its lowest value, 59.69 million hooks (0.75 million hooks per 5^{o} square), in 1983.

Production Model Analysis

Catch and standardized effort data for Cases 1 and 2 in the South Atlantic albacore fishery (Table 2) were used as inputs to the PRODFIT computer program in order to estimate the parameters of the production models (m=0.0, m=1.001 and m=2.0).

Case 1

For Case 1, effective effort was expressed in effective hooks.

The results of the estimated maximum sustainable Yield (MSY) and optimum fishing effort (f_{opt}) are compared in Table 3 with the 1983 observed catch and effort data. Table 3 also lists the optimal value of catch per unit effort (U opt) and the degree of fit (r^2). Estimated yield curves for K=3 and K=4 are shown in Figs 2 and 3.

For K=3, the best fitted model (r^2=0.662) was the broad flat-topped equilibrium yield curve (m=0.0) and the estimated MSY was 24,870 MT at infinite amount of fishing effort. The poorest fitted model (r^2=0.569) had a parabolic-shaped equilibrium yield curve (m=2.0), and an MSY of 24,320 MT with an f_{opt} of 91.09 million effective hooks. The skewed dome-shaped equilibrium curve (m=1.001, r^2=0.621) gave an estimated MSY of 23,740 MT for f_{opt} at 89.23 million effective hooks.

For K=4, when m=0.0 (r^2=0.578), the estimated MSY was 25,520 MT and f_{opt} was infinite. At m=2.0 (r^2=0.535), the estimated MSY was 23,330 MT and the f_{opt} was 90.74 million effective hooks. At m=1.001 (r^2=0.562), the estimated MSY was 23,030 MT and f_{opt} was 92.26 million hooks.

Case 2

For Case 2, effective effort was expressed in fishing intensity (effective hooks per 5^o square). The results shown in Table 4 and Figs 4 and 5 are similar to those of Case 1. For K=3, the best fitted model (r^2=0.669) was m=0.0 with a predicted MSY of 24,700 MT with infinite fishing effort. The poorest fitted model (r^2=0.573) was m=2.0, and had an estimated MSY of 24,320 MT with f_{opt} at 1.16 million hooks per 5^o square. At m=1.001 (r^2=0.626), estimated MSY was 23,750 MT and f_{opt} was 1.13 million hooks per 5^o square.

For K=4, when m=0.0 (r^2=0.581), the estimated MSY was 25,660 MT and the f_{opt} was infinite. At m=2.0 (r^2=0.537), the estimated MSY was 23,330 MT and the f_{opt} was 1.16 million hooks per 5^o square. At m=1.001 (r^2=0.565), estimated MSY was 23,050 MT and f_{opt} was 1.18 million hooks per 5^o square.

Conclusion

From the addition of the preliminary 1983 data and the 1967-1969 and 1982 revised data, results the best fitting model: m=0.0. This is the same results as that of the past years' production model analyses (Sun and Yang, 1984). However, the degree of fit index (r^2) in this study shows improvement over that of the previous report.

Based on the deterministic production model analyses for Cases 1 and 2, the 1983 preliminary catch figure (13,500 MT) is less than the predicted equilibrium MSY and 1983 effort was about 0.65 times less than that needed to produce the equilibrium MSY. Both catch and effort in 1983 were far below the estimated MSY level.

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Table 2. Catch, effective effort and fishing intensity data for the total south Atlantic albacore fishery, 1967-1983.

Year	Catch* (10^3 tons)	Effective effort (10^6 hooks)	Fishing intensity (10^4 hooks/5°sq.)
1967	15.88	24.00	29.80
1968	25.69	51.82	67.56
1969	28.49	61.35	77.36
1970	23.65	63.97	80.97
1971	25.02	68.53	87.73
1972	33.26	89.16	114.26
1973	28.23	93.20	118.87
1974	19.70	70.63	90.31
1975	17.54	70.02	89.67
1976	19.20	73.82	94.53
1977	21.26	76.86	98.14
1978	22.99	88.82	114.26
1979	22.33	74.93	95.27
1980	22.10	81.50	103.60
1981	23.59	114.88	146.15
1982	28.97	118.66	150.90
1983	13.50	59.69	74.91

* ICCAT report catch (see Table 1.)

Table 1. Hook rate, catch in number, yield in weight, effective effort and fishing intensity of albacore in Taiwanese, Japanese and in the whole longline fishery in the South Atlantic Ocean, 1967-1983.

Year	Taiwanese Longline Fishery					Japanese Longline Fishery					Whole Longline Fishery			
	Hook rate (%)	Catch in number (10^3)	Yield* in weight (MT)	Effective effort (10^5 hooks)	Fishing intensity (10^3 hooks /5° sq.)	Hook rate (%)	Catch in number (10^3)	Yield* in weight (MT)	Effective effort (10^5 hooks)	Fishing intensity (10^3 hooks /5° sq.)	Catch in number (10^3)	Yield* in weight (MT)	Effective effort (10^5 hooks)	Fishing intensity (10^3 hooks) /5° sq.)
1967	3.58	41	1,059	11.3	15.0	3.60	437	7,719	121.3	149.7	865	15,883	840.0	298.0
1968	4.04	722	6,792	178.9	235.6	3.75	739	11,857	197.3	254.9	2,010	25,650	517.4	674.6
1969	2.87	850	12,546	296.4	375.0	2.22	244	6,331	110.0	137.5	1,651	28,493	613.5	773.6
1970	2.36	672	12,225	285.4	363.2	2.22	454	5,898	204.8	257.2	1,470	23,653	639.7	809.7
1971	2.71	1,272	17,491	470.2	603.0	2.25	218	3,218	97.0	123.0	1,801	25,022	685.3	877.3
1972	1.91	1,210	24,985	633.0	813.7	1.60	148	2,087	92.6	116.3	1,664	33,163	888.9	1,139.2
1973	1.57	1,099	22,157	700.9	896.5	0.97	38	277	39.7	48.1	1,426	28,131	928.7	1,184.5
1974	1.69	973	16,686	574.9	736.5	0.95	26	109	27.4	33.6	1,163	19,551	701.1	896.5
1975	1.99	1,032	13,384	519.4	666.0	0.98	27	306	27.3	34.4	1,345	17,382	694.0	889.3
1976	1.66	928	14,600	557.7	714.6	0.98	6	73	6.5	7.8	1,220	19,163	736.8	943.5
1977	1.87	1,074	16,092	573.3	732.3	0.62	8	105	12.2	15.4	1,401	20,979	758.4	968.5
1978	1.84	1,424	20,467	774.9	997.3	0.51	11	135	20.9	26.5	1,587	22,784	880.1	1,132.2
1979	1.62	1,074	20,340	663.9	844.7	0.35	8	105	22.3	27.7	1,155	21,826	732.5	931.3
1980	1.72	1,091	18,710	633.0	805.2	0.38	26	333	69.4	87.7	1,209	20,618	760.5	966.7
1981	1.43	1,102	18,187	773.0	991.1	0.29	40	558	140.0	170.4	1,239	20,335	990.4	1,260.0
1982	1.53	1,311	22,800	856.0	1,096.0	0.42	43	569 0	101.2	121.3	1,464	25,275	1,035.2	1,316.6
1983	1.47	617	9,500	420.0	527.2	—	—	—	—	—	753	11,600	512.9	649.7

* Data Source: 1967-1969, ICCAT Historical Statistical Bull. Vol. 2 (1982)
1970-1971, ICCAT Statistical Bull. Vol. 11 (1984)
1972-1982, ICCAT Statistical Bull. Vol. 13 (1985)
1983, Provided by ICCAT Secretary, 1984.

Table 3. Estimated production model parameters for south Atlantic albacore, 1967-1983. (case 1)

Number of significant year classes (K)	m	Uopt (MT /10^3 effective hooks)	fopt (10^6 effective hooks)	MSY (10^3 MT)	Degree of fit index (r^2)	1983 Actual catch (10^3 MT)	1983 Effort (10^6 effective hooks)
3	0.0	0	∞	24.87	0.662	13.50	59.69
3	1.001	0.266	89.23	23.74	0.621	13.50	59.69
3	2.0	0.267	91.09	24.32	0.569	13.50	59.69
4	0.0	0	∞	25.52	0.578	13.50	59.69
4	1.001	0.250	92.26	23.03	0.562	13.50	59.69
4	2.0	0.257	90.74	23.33	0.535	13.50	59.69

Table 4. Estimated production model parameters for south Atlantic albacore, 1967-1983. (Case 2)

Number of significant year classes (K)	m	Uopt (MT /10^3 hooks/5°sq.)	fopt (10^4 hooks/5°sq.)	MSY (10^3 MT)	Degree of fit index (r^2)	1983 Actual catch (10^3 MT)	1983 Effort (10^4 hooks/5°sq.)
3	0.0	0	∞	24.70	0.669	13.50	74.90
3	1.001	21.06	112.74	23.75	0.626	13.50	74.90
3	2.0	21.05	115.54	24.32	0.573	13.50	74.90
4	0.0	0	∞	25.66	0.581	13.50	74.90
4	1.001	19.55	117.88	23.05	0.565	13.50	74.90
4	2.0	20.17	115.67	23.33	0.537	13.50	74.90

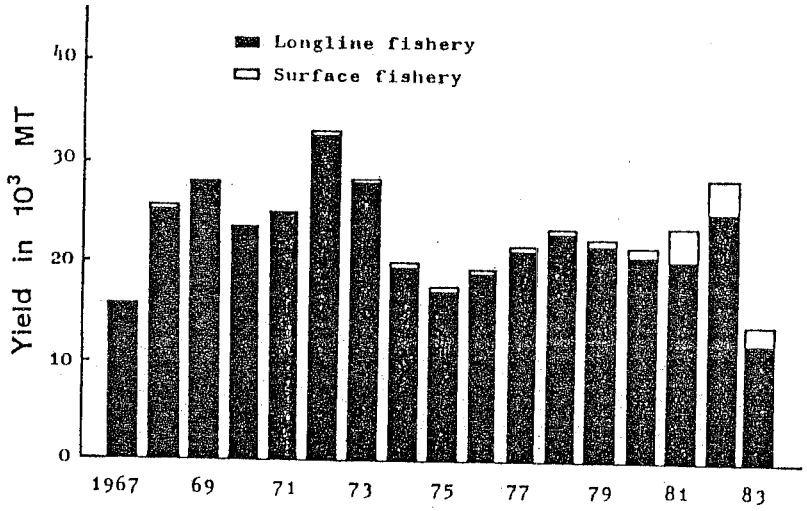

Fig. 1 Yield of albacore by gear in South Atlantic Ocean, 1967-1983.

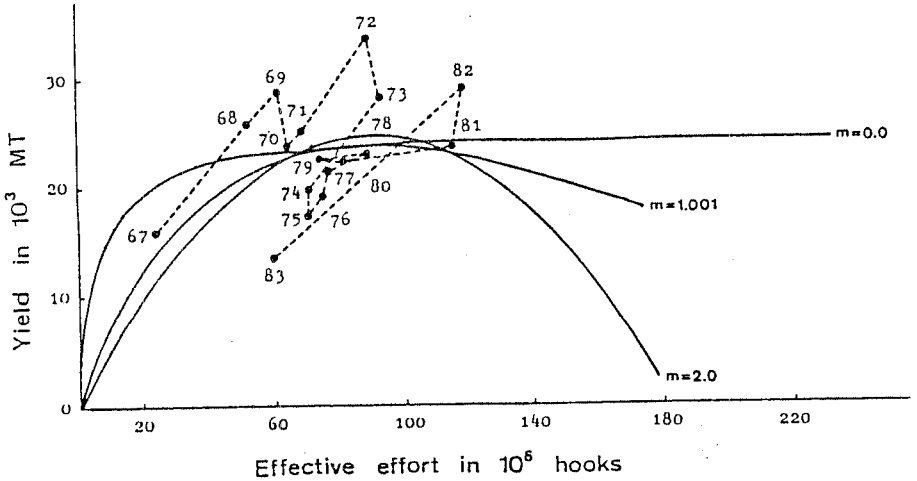

Fig. 2 Equilibrium yield curves and observed data for the South Atlantic albacore fishery and assuming three significant year-classes in the catch, 1967-1983. (Case 1)

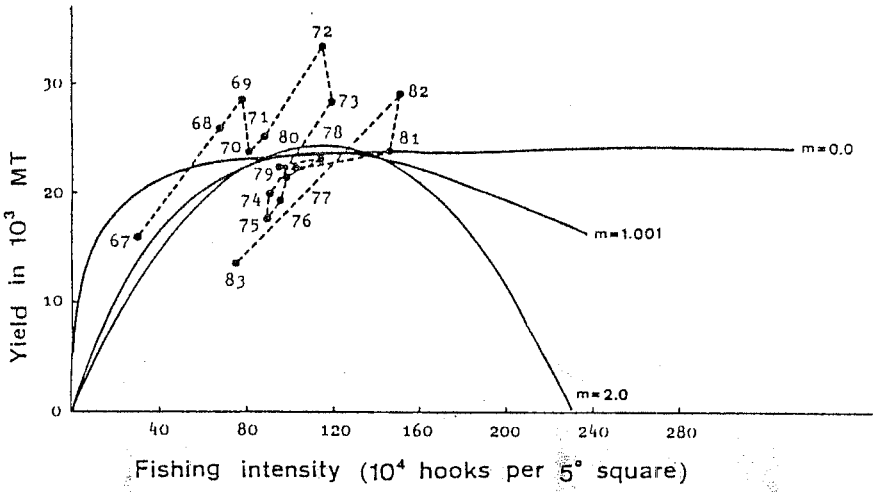

Fig. 4 Equilibrium yield curves and observed data for the South Atlantic albacore fishery and assuming three significant year-classes in the catch, 1967-1983. (Case 2)

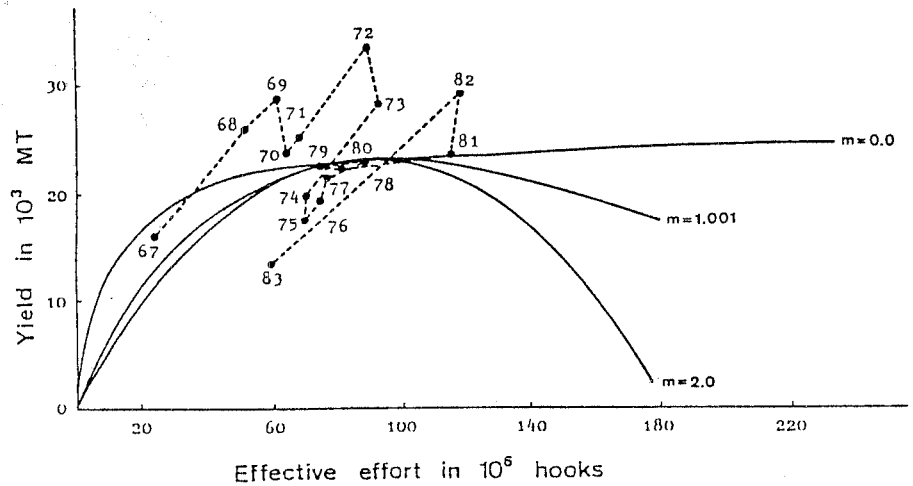

Fig. 3 Equilibrium yield curves and observed data for the South Atlantic albacore fishery and assuming four significant year-classes in the catch, 1967-1983. (Case 1)

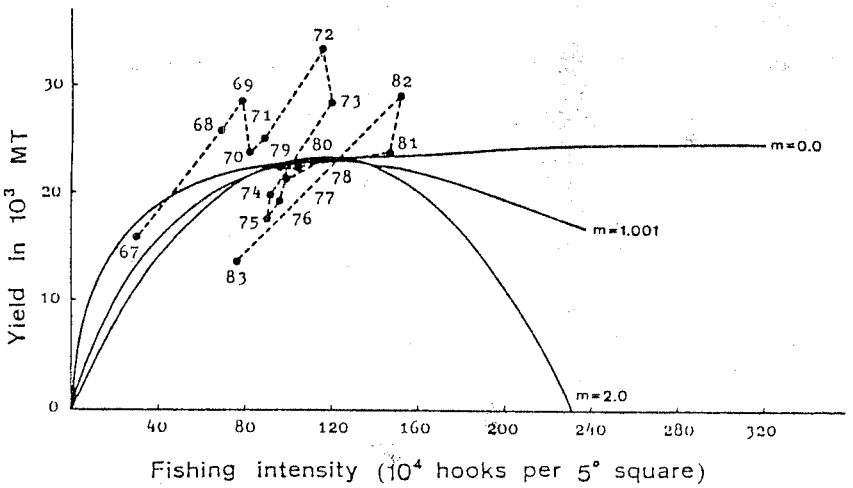

Fig. 5 Equilibrium yield curves and observed data for the South Atlantic albacore fishery and assuming four significant year-classes in the catch, 1967-1983. (Case 2)