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PRODUCTION MODEL ANALYSIS ON ATLANTIC BIGEYE TUNA

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1. Introduction

The recent status of the utilization of the resource of Atlantic bigeye tuna, which is most likely to be comprised of a single stock, was estimated to be close to or at the maximum sustainable yield (MSY) level for the years since 1980 (ICCAT 1985). Among various stock assessment techniques, a production model analysis has been continuously employed for evaluation of the bigeye stock. This report updates the last analysis (Kume 1985a) by adding 1983 catch and effort data and preliminary 1984 catch data, especially by treating in detail with longline data which account for major portion of the bigeye catch.

2. Material and method

2-1. Catch data : The latest catch information by ICCAT (pers. comm.) was referred to the data up to 1984.

2-2. Catch and effort data : Japanese catch and effort data up to 1983 were employed as basic data, which cover almost entire area of bigeye catch distribution and share large portion of the longline catch.

2-3. Effort standardization : Adjustment of efficiency of deep longlining (Kume 1985b) was done using newly estimated correction factors for 1983. Annual rate of deployment of deep longline operation and gear efficiency of deep longlining over conventional longlining in 1983 are listed in Table 1. Using Japanese longline data, estimation of overall effective effort was made by Honma's method (1973), incorporating with adjustment of deep longline efficiency (Table 2). As input data in production model, estimated effort, catch and hook rates are shown in Table 3 for the years 1961-84. Amount of effort for 1984 was estimated assuming 1983 cpue would be applicable.

2-4. Production model : Generalized production model "PRODFIT" by Fox (1975) was employed. The number of year classes in the catch (parameter k) was chosen as 4, and shape parameters in the model runs were m = 0, 1, 2 and variable. Other parameters in the calculation were selected following Fox's suggestion.

3. CPUE trends.

As mentioned in the above section, wide coverage of the Japanese longline data in time, space and catch can generate reliable index of the stock abundance by catch-per-effort data (cpue). The cpue trends are also important in understanding the results of production model. The annual changes in cpue's of the whole Atlantic and of north and south Atlantic for the years 1961-83 are shown in Fig. 1. Each of the cpue's in three areas indicates similar long-term trend in the gradual decline. From this trend, it is suggested that the level of the cpue's in recent years has been rather stable but declined at about 60-65 % of the initial exploitation. This is also indicative of the recent level of adult or spawning biomass, because the longline catch has been composed of medium- and large-sized individuals (Kume 1985b).

4. Production model results.

The results of the computation of the fitting the data to the model are summarized in Table 4 and Fig. 2. Among the models in different curves depending upon shape parameter (m), the input data fitted best to the cases of m = 0 and m = variable (Table 4). Corresponding maximum sustainable yields (MSY or Y-max) are 145,900 and 145,700 MT, respectively. Estimates of MSY for m = 1 and 2, with less degree of fitness, are 76,100 MT and 66,500 MT, respectively. These results are much the same to those calculated by using preliminary 1983 catch data at the last SCRS meeting (ICCAT 1985). It is still uncertain which one of presently estimated curves will describe the stock behavior in the future. The present results, however, suggest that the bigeye fishery in recent years has been operating at the level close to or at the MSY level, but never exceeded beyond this level.

References

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Table 1. Annual rate of deployment of deep longline operation and its gear efficiency over conventional longline in 1983.

	Area*			
	1	2	3	4
Annual rate (%)	11	68	82	37
Gear efficiency	1.75	1.25	1.16	1.07

* Area is referred to Fig. 1 of Kume 1985b.

Table 2. Catch, effort and CPUE (hook rate) on Atlantic bigeye tuna by the Japanese longline fleet, 1961-83. For 1980-83, deep longline efficiency is adjusted.

YEAR	CATCH IN NUMBER (1000)	YIELD IN WEIGHT (1000 MT)	EFFECTIVE HOOKS (MILLION)	HOOK RATE
1961	243.7	11.0	29.8	0.818
1962	367.9	15.7	54.0	0.681
1963	285.3	14.5	47.4	0.602
1964	343.7	17.3	61.1	0.563
1965	648.3	28.5	117.9	0.550
1966	232.1	17.6	48.1	0.483
1967	180.9	8.5	31.5	0.574
1968	204.6	10.3	31.2	0.656
1969	263.6	10.3	38.1	0.692
1970	187.3	9.0	33.5	0.559
1971	394.9	20.3	85.7	0.461
1972	346.0	18.1	79.5	0.435
1973	391.3	20.0	77.1	0.508
1974	457.3	20.9	69.0	0.663
1975	449.1	17.4	113.5	0.396
1976	171.0	7.3	50.6	0.338
1977	189.6	9.2	36.5	0.519
1978	209.2	9.3	48.9	0.428
1979	270.4	12.0	62.1	0.435
1980	451.3	20.5	98.6	0.458
1981	469.0	21.0	127.3	0.368
1982	698.7	32.9	149.1	0.469
1983	351.4	15.1	77.5	0.453

Table 3 Input fishery data in the production model analyses for Atlantic bigeye tuna, 1961-83. Deep longline effort was adjusted for 1980-83.

YEAR	HOOK RATE (NO/100 HOOKS)	MEAN WEIGHT (KG)	HOOK RATE (KG/100 HOOKS)	TOTAL CATCH (1000 MT)	TOTAL EFFORT (MILLION)
1961	0.818	45	36.8	17.0	46.2
1962	0.681	43	29.3	23.1	78.9
1963	0.602	51	30.7	26.0	84.7
1964	0.564	50	28.2	23.5	83.3
1965	0.550	50	27.5	39.2	142.5
1966	0.481	48	23.1	25.0	108.3
1967	0.567	50	28.4	24.7	87.1
1968	0.654	48	31.4	23.0	73.3
1969	0.691	44	30.4	35.4	116.4
1970	0.559	49	27.4	41.5	151.5
1971	0.462	47	21.7	54.9	252.8
1972	0.434	44	19.1	46.3	242.5
1973	0.508	40	20.3	56.3	277.1
1974	0.664	47	31.2	63.5	203.5
1975	0.396	50	19.8	60.6	306.1
1976	0.338	47	15.9	44.6	280.8
1977	0.519	49	25.4	54.1	212.7
1978	0.428	45	19.3	51.5	267.4
1979	0.435	44	19.1	45.1	235.6
1980	0.458	45	20.6	62.6	303.7
1981	0.368	45	16.6	67.0	404.6
1982	0.469	47	22.0	72.9	330.7
1983	0.453	43	19.5	62.2	319.3
1984	0.453	43	19.5	62.2	319.3

Table 4 Estimated population parameters obtained from production model analysis for Atlantic bigeye tuna, 1961-84.

m (shape parameter)	Degree of fit index	f-optimum (million hooks)	Y-max (1,000 MT)	1981-84 Catch (1,000 MT)
variable	.528	-	145.7	
0	.528		145.9	62.2-72.9
1.00	.524	631	76.1	
2	518	421	66.5	

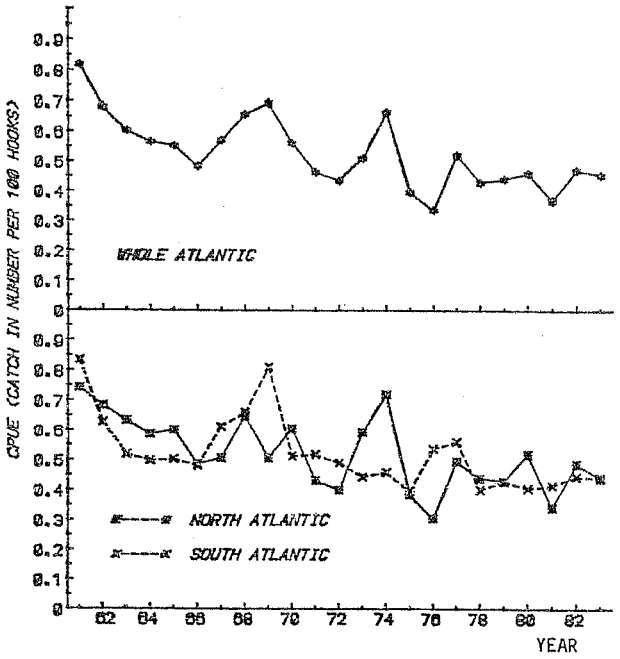

Fig. 1 Annual change in cpue of the Japanese longline fishery in the whole Atlantic (upper panel) and in the north and south Atlantic (lower panel), 1961-83. Deep longline efforts for 1980-83 were adjusted.

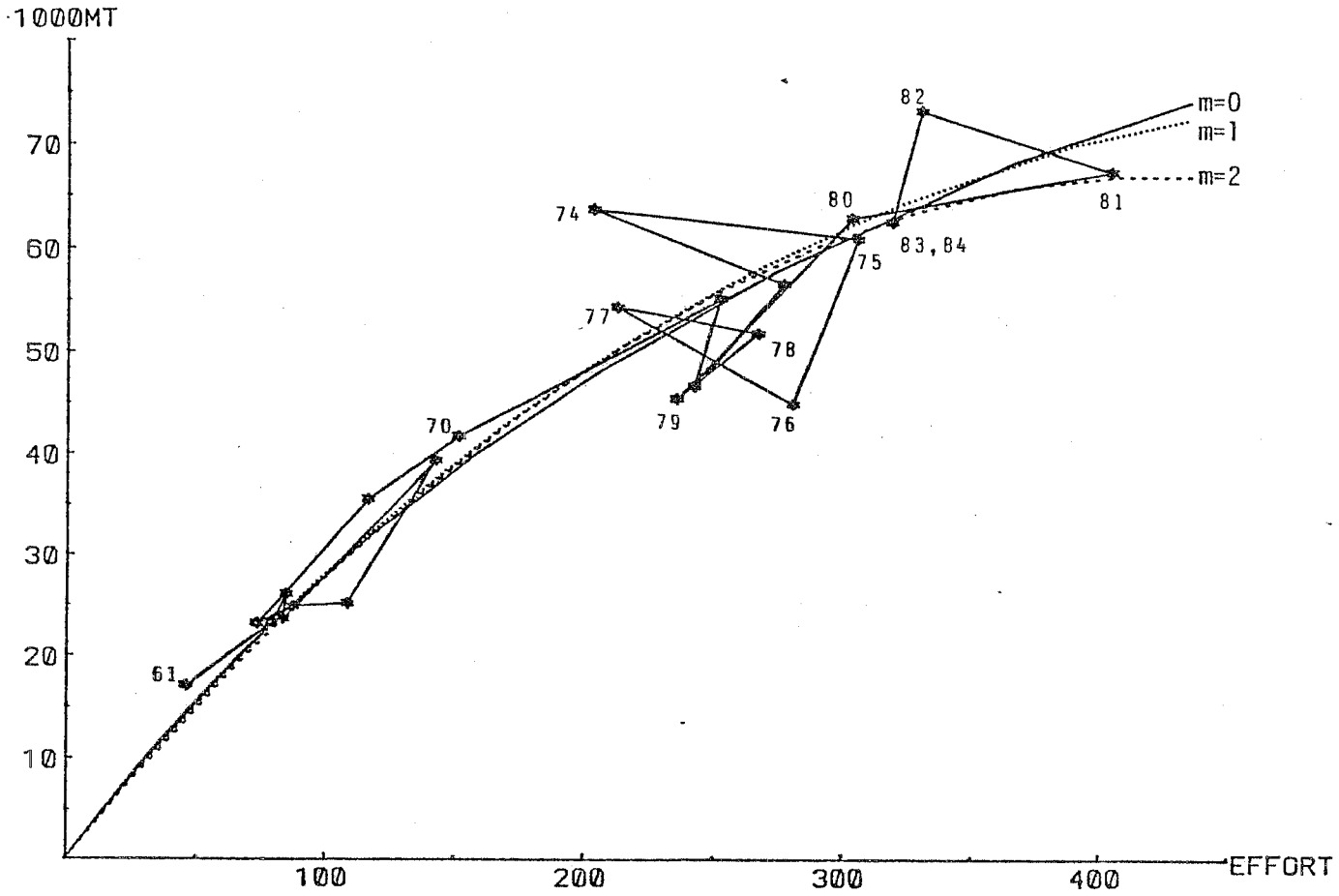

Fig. 2 Yield curves obtained from the production model analysis for bigeye tuna in the whole Atlantic, 1961-84.