A PROPOSAL TO MANAGEMENT OF BLUEFIN TUNA STOCK IN THE WESTERN ATLANTIC BASED ON INFORMATION OBTAINED BY SEPTEMBER, 1986

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SUMMARY

A proposal for management of bluefin tuna in the western Atlantic was made by analyses of updated information.

RESUME

Une proposition portant sur la gestion du thon rouge dans l'Atlantique ouest est formulée à partir d'analyses effectuées sur l'information actualisée.

RESUMEN

Se hizo una propuesta sobre ordenación del atún rojo en el Atlántico occidental basada en un análisis de información actualizada.

The purpose of this report is to study the contents of the stock assessment in the Western Atlantic bluefin tuna stock obtained in the two years of 1984 and 1985 and to make a proposal to the management of this stock.

Difference on the evaluation of SCRS between 1984 and 1985

A meeting was held for evaluation of the bluefin tuna stock by ICCAT scientists (ICCAT 1985a, 1986) in Dartmouth in 1984 and in Miami in 1985. In order to clarify differences on the evaluation between these two meetings, we have summarized the catch-at-length, parameters and analysis methods used in these meetings, as well as the analysis results in Table 1.

With regard to the length composition, the data for one year of 1984 was added in the Miami meeting. Other than this, there is no substantial change, but the method of length-age conversion has been greatly changed. While the growth equation of Parrack and Pharse (1979) was applied to all length classes in the Dartmouth meeting, the growth equation and results of age determination based on the otoliths of the Canadian catch were concurrently applied in the Miami meeting. That is, the length-age conversion was conducted by applying the annual age composition based on the otolith to the length classes of 255 cm and larger and the growth equation as done before to other length classes. Accordingly, the catch-at-age data prepared by the Miami meeting is substantially different in the compositions of 18-year old and older during the period of 1975 to 1982, when compared with the catch-at-age data of the Dartmouth meeting (Table 2).

In the Dartmouth meeting, two natural mortalities of 0.10 and 0.18 were proposed, and after a series of calculations conducted to estimate the population number, 0.18 which would bring in more pessimistic evaluation was adopted. However, the natural mortality was changed to 0.10 in the Miami meeting. Also, in the Miami meeting, several partial recruitments were assumed and one of them was selected as a result of preliminary analysis.

Since there was no CPUE indicating the abundance of small and medium fish of up to 9-year old, the population number of small and medium fish from the 1971 cohort to 1979 cohort was determined by an estimated fishing mortality coefficient based on the mark-recapture data in the Dartmouth meeting. On the adult fish of 10-year old and older, VPA was conducted using the objective function of Parrack (1986). In the Miami meeting, for the reason that the individuals marked in 1980 had not been sufficiently mixed in the population (Turner 1986), other mark-recapture data were abandoned also. In this meeting, no tagging data was used and instead one CPUE each on small fish and medium fish and five CPUEs on large fish, including the larval survey data, or total seven CPUEs were used for the VPA tuning.

The Dartmouth meeting confirmed that the natural mortality would cause a substantial fluctuation of the population number of adult fish. In other words, if the natural mortality was 0.10, the abundance of adult fish in 1983 would be greater than that of 1970, but if the natural mortality was 0.18, the former would only be 45% of the latter. Although the annual fluctuation of adult fish was substantially influenced by the natural mortality, the annual fluctuation of the year class strength recruited at the age of one was not influenced by the natural mortality of this degree (Fig. 1). As a result of setting the natural mortality to 0.10 in the 1985 Miami meeting, it estimated that number of fish recruited at the age of one would be 127,000, about half of the value determined in the Dartmouth meeting, and additionally it estimated that the abundance would greatly decrease on all fish of small, medium and large since 1970.

One of the reasons for arriving at a pessimistic conclusion in the 1985 Miami meeting, compared with the Dartmouth meeting of the preceding year, is the estimate of population number of 1973 cohort which is the dominant year class. In other words, while the Dartmouth meeting estimated the ratio of the 1973 cohort as being adult fish in 1983 would be 36% (67% if the natural mortality was 0.10 which was abandoned in the year but adopted the next year), the Miami meeting estimated it only 1.3%. This means that the 1973 cohort, which was reported as being the dominant year class, was not a dominant but ordinary since the time it was one year old.

Historical review of evaluation on the year class strength of 1973 cohort

Table 3 shows the evaluation of 1973 cohort referred to in the SCRS report. It indicates that SCRS was consistently evaluating the 1973 cohort as a dominant year class from 1974 to 1983. However, since the 1973 cohort was not as much as expected in the length composition of longline data of 1977 to 1978, a view has appeared in 1978 pointing out that the 1973 cohort might have become an ordinary class affected by the large catches of the surface fishery conducted in the preceding several years (ICCAT 1979). Nevertheless, the year class strength of the 1973 cohort was reconfirmed in 1979 (ICCAT 1980). In 1983, a report was made that a dominant 1973 cohort migrated into the Gulf of Mexico as spawning adult based on the incidental catch data of longline fishery mainly catching swordfish, which attracted the interest of scientists. The view on the year class strength of 1973 cohort changed in 1983, that is, the 1973 year class was only observed as the purse seine catch when the year class was small, and this means that the 1973 cohort was strong only relatively.

The SCRS's view of 1984 is essentially based on the catch-at-age data prepared in the Dartmouth meeting. However, according to VPA of this meeting, the one-year old fish of the 1973 cohort was twice to four times as much as that of one-year old fish of other year classes (1969 to 1980), as shown in Fig. 1, and the 1973 cohort can be regarded as a dominant year class. However, as mentioned earlier, VPA made at the 1985 Miami meeting determined that the 1973 cohort could no longer be regarded a dominant year class.

Although there is no essential difference in the catch-at-length data between the Dartmouth and Miami meetings, since the VPA method applied was different between the two meetings, the assessment results are quite different not only on the 1973 cohort but also on the population number of adult fish. The fact that SCRS had consistently regarded the 1973 cohort as a dominant year class up to 1983 and the new finding at 1983 SCRS, that is, migration of a dominant 1973 year class into the Gulf of Mexico, have been ignored.

Limit of VPA

In the Miami meeting, seven CPUEs were used for VPA calibration (ICCAT 1986). Among them, two were obtained through the longline fishery of spawning adult in the spawning area of Gulf of Mexico and survey activities on the larval fish born from the spawning adult. Since it is conceivable that all adults come to the spawning area, these two CPUEs should be representing the whole stock, if enough data was obtained. However, the larval survey was conducted only at 48-147 stations through one year in the Gulf of Mexico extending to about 10° in the latitude and about 20° in the longitude and, especially on larvae of bluefin tuna, only 34-292 of them were caught at 13-53 stations. Furthermore, the other five CPUEs only show the abundance of the fish which migrated into partial fishing areas. All CPUEs handled in the Miami meeting were analyzed on the supposition that they would represent the abundance of the whole stock of the same age class. However, there is no guarantee that these local abundance indices represent the whole stock.

As to the Parrack's VPA tuning procedure used in the Miami meeting, the estimated value of population number can be greatly varied when changing the combination of CPUEs selected for the tuning, as pointed by Nagai and Miyabe (1986). In other words, if the full series of West 2 is used as the CPUE of medium fish instead of Medium fish (5B), the fishing mortality coefficient of 13-year old or older fishes in 1984 is estimated as 0.113 and the population number of adults in 1985 is estimated at 57,000. Thus, the fishing mortality coefficient (terminal F) of 13-year old or older fishes is about half of the value determined in the Miami meeting but that the population number of adults is twice as much.

These examples show that there is a possibility of making a wishful stock evaluation depending on how CPUEs are selected, and we think this cannot be essentially changed even if the current VPA method is improved.

Proposal on stock management

As has been described, even the age composition of catches, the basic data for stock analysis, can be substantially varied if the method of length-age conversion is changed. At this moment, we cannot determine which composition would be appropriate; one obtained from the growth equation or one obtained by concurrently applying the growth equation and age determination by the otoliths. The common understanding is that either one would contain errors to some extent.

It seems that the range of natural mortality is grasped fairly correctly, but even so, it is difficult to estimate the absolute value. Also, the partial recruitment cannot be determined easily. The VPA tuning method contains various problems. A problem that we are most concerned of is that, since the parameters used for VPA and the population number and fishing mortality coefficients obtained by VPA have been changed year after year, the surplus production estimate submitted by SCRS is now doubted if it has been adjusted by selecting parameters at will.

Needless to say, stock analysis overcoming various problems is meaningful and we are not denying it. However, we consider that the view established in the 1984 Dartmouth meeting is correct on the bluefin tuna stock in the Western Atlantic, i.e., although estimates were obtained and agreed upon, the population estimates from VPA are not considered reliable enough to allow short-term surplus production estimates to be calculated (ICCAT 1985b).

The development of fisheries in the Western Atlantic started behind of that in the Eastern Atlantic and the catch has always been small. Probably this is one of the reasons for underestimating the population number. Also, to acquire the confidence of administrators and parties related to fisheries, it is essential that the question (ICCAT 1986) is concretely clarified with regard to the population number of one-year old fish being evaluated so largely different by one digit even though the larvae density is the same between Eastern and Western Atlantic (Dicenta et al. 1980).

A monitoring system must be restudied to correctly grasp the stock condition along the purpose of the regulations adopted in November 1981 and while giving consideration to the actual results of information gathering made in the past. At the same time, efforts must be made to increase the accuracy of estimates on the catch-at-age and abundance indices, thereby stabilizing the annual evaluation results. If these are neglected, the evaluation will be continued endlessly based on insufficient data. It is possible to increase the catch for monitoring by paying attention to the fact that the mean age of the catch has gradually been raised (Nagai 1986). Although the 1982 cohort has been regarded as being strong (ICCAT 1984, 1985a), there is an actual case that the abundance of the 1982 cohort and small fishes that seemed to have been produced in 1983 was high in 1985 and even extremely passive longline fishery exceeded the catch for monitoring. Based on these points, we consider that to increase the catch up to the level of the minimum catch before the regulations were enforced, that is, about 3,900 ton of 1972, would be effective to the stock evaluation as well as to the stock utilization.

References

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Table 1. Summary table of parameters, estimation procedures and estimates obtained from VPA, and the results of related analyses.

	1984 Dartmouth	1985 Miami
Catch-at-length		
Length-age conversion	von Bertalanffy growth eq. by Parrack & Pharse (1979)	Canadian catch-at-age based on otolith age determination was used over 255 cm since 1975. von Bertalanffy eq. was also used for the fish smaller than 255 cm.
Catch-at-age		
Natural mortality M	0.18 (0.10)	0.10
Partial recruitment (PR)	Mark-recapture data were used for the fish younger than Age 9, while a constant q being assumed for Age 10+.	Nine partial recruitment curves were tested. Pattern B was selected for Ages 1-12.
Tuning VPA		
Objective function	Minimizing Res ($CPUE_{ob}$ - $CPUE_{cal}$)	(Same function was used)
CPUE series selected	CAN RR and JPN G.M. 1°-sq.	Four JPN LL series, two Canadian, and US larval data
Stock status		
N_1 (Geometric mean) in 10^3 fish	350 (250)	127
N_{1-5} (the 1983 values expressed in percent compared to 1970 level)	73 (120)	40
N_{6-9} (the 1983 values expressed in percent compared to 1970 level)	39 (190)	23
N_{10+} (the 1983 values expressed in percent compared to 1970 level)	45 (120)	22
Yield per recruit at F (kg)	18.1 (50.7)	54.4
Equilibrium yield (MT)	6,341 (12,668)	7,000
Surplus production	- (-)	4,400 (in 1986)
1973 year class strength $N_{1983,10}/N_{1983,10+}$ (%)	36 (67)	1.3

$CPUE_{ob}$: Standardized CPUE in some case nominal CPUE being used

$CPUE_{cal}$: Estimated CPUE using VPA values ($CPUE_{cal} = q\ N$)

Table 2. Comparison between the 1984 catch-at-age and that in 1985. The values indicate ratio of 1984/1985 catch-at-age.

Age	Year 1975	1976	1977	1978	1979	1980	1981	1982
18	5.726	1.834	2.080	2.143	1.334	1.383	2.102	0.478
19	1.566	1.568	1.206	1.319	0.893	3.743	8.882	0.480
20	1.179	2.020	1.220	1.516	0.894	2.075	4.717	0.479
21	0.433	1.114	1.202	0.746	1.578	1.221	1.881	0.480
22	0.204	0.336	0.625	0.505	0.963	0.444	0.838	0.480
23	0.348	0.284	0.441	0.534	2.307	0.496	0.901	0.481
24	0.226	0.280	0.146	0.323	0.324	0.616	0.629	0.475
25	0.443	0.136	0.244	0.532	0.314	0.411	0.297	0.481
26	0.426	0.174	0.256	0.348	0.681	0.275	0.637	0.467
27	15.000	0.682	0.586	1.604	1.169	0.212	0.387	0.474
28	6.000	1.600	25.000	2.654	30.000	0.162	0.661	0.485
29	1.000	2.000	0.364	34.000	17.000	0.510	0.219	0.483
30	0.053	1.000	5.000	1.269	18.000	0.235	0.219	0.023

Table 3. Histrical review for year class strength of the 1973 cohort from SCRS report.

Meeting Year	Description of the 1973 cohort
1973	-
1974	The 1973 year-class seems to have been good
1975	The data from the 1975 fisheries confirmed that the 1973 year-class is stronger than other recent ones.
1976	-
1977	The 1973 year class is strong and has for the past three years been the dominant year class in the purse seine catches, this year class is beginning to appear in the longline catch.
1978	In the West, the 1973 year-class was, at the time of recruitment, clearly extremely strong, relative to adjacent year-classes.
1979	The 1973 year-class was very abundant.
1980	The 1973 year-class was four to five times the average of other years.
1981	The very abundant 1973 year-class, although greatly reduced by heavy exploitation, make up about 40 percent of the adult stock at this time.
1982	-
1983	The committee noted some interesting observations for the western Atlantic. Incidental catches of bluefin by swordfish fishermen indicated that the strong 1973 cohort has entered the Gulf of Mexico spawning area in 1983.
1984	(The 1973 year-class) was observed only in the purse seine catch of small fish, which indicated a relatively strong year-class.
1985	-

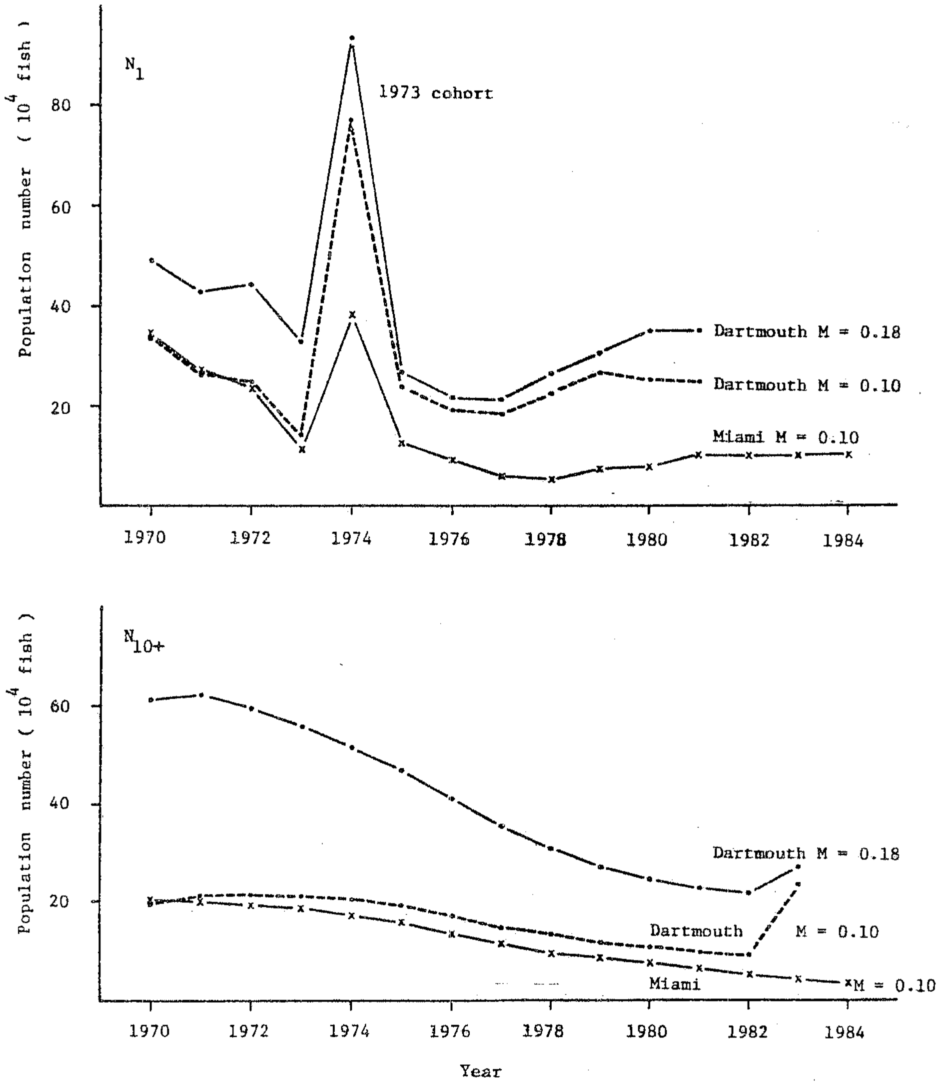

Fig 1 Comparison of population estimates obtained from VPA at the 1984 Darmouth meeting and 1985 Miami meeting.