SCRS/1988/023

Col.Vol.Sci.Pap. ICCAT, 30 (2) : 276-282 (1989)

PROBLEMS IN THE STOCK ASSESSMENT OF WEST ATLANTIC BLUEFIN TUNA

N. Miyabe, Z. Suzuki
Far Seas Fisheries Research Laboratory, 5-7-1 Orido, Shimizu 424, Shizuoka Pref., Japan

SUMMARY

Problems involved in the stock assessment of west Atlantic bluefin tuna presently being conducted by the ICCAT SCRS were specified for such items as stock structure, amount of reported catch, CPUE series used in tuning VPA, etc. The result showed low credibility of the present stock assessment. Suggestions to improve the present assessment were given for some of the problems.

RESUME

Les problèmes concernant l'évaluation du stock ouest-atlantique de thon rouge menées à l'heure actuelle par l'ICCAT sont précisés pour certains points, tels que la structure du stock, le volume des prises signalées, les séries de CPUE utilisées pour l'ajustement des VPA, etc. Les résultats démontrent le peu de fiabilité des évaluations actuelles du stock. Des suggestions sont fournies dans le cadre de certains de ces problèmes en vue d'améliorer l'évaluation actuelle.

RESUMEN

Se especifican los problemas que implica la evaluación del stock de atún rojo del Atlántico Oeste, que actualmente lleva a cabo el SCRS de ICCAT, con respecto a la estructura del stock, volumen de la captura informada, series de CPUE empleadas en el ajuste del VPA, etc. El resultado es una menor credibilidad de la actual evaluación del stock. Se presentan sugerencias respecto a algunos de los problemas, con el fin de mejorar dicha evaluación.

Introduction

One of the characteristics of the fishery regulation presently implemented with the west Atlantic bluefin tuna is that the regulation is based on socio-economic compromise among the concerned countries rather than on scientific evidence. This is largely because of the fact that there has been failures to provide unequivocal scientific evidence from the SCRS to the concerned national administrators. Therefore, management of the west Atlantic bluefin stock has been left as a controversial issue for a long time. This paper on the west Atlantic bluefin stock aims at to clarify 1) the reasons why concrete scientific evidence cannot be provided and 2) to give more realistic ways to improve the present assessment.

Problems in stock assessment

1. Stock structure

The present VPA being done for the Atlantic bluefin tuna is based on hypothetical east and west Atlantic stocks separated approximately in the center of the Atlantic. Amount of transoceanic tagging recovery and analysis of trace elements in the vertebrae have provided the evidence to support the two stock hypothesis. However, there appear little studies as to magnitude of mixture between the two stocks from the analysis of tagging data. In this regard, it is informative to compare the number of transoceanic recovery between the Atlantic and Pacific bluefin tunas. The preliminary figures are:

	Number of release as of 1988	Number of recovery	Transoceanic recovery (% to the number of release)
Pacific	16723	2215	144 (0.86)
Atlantic	19635	2187	72 (0.37)

These figures were made available by personal communication with Mr. Y. Ishizuka (Far Seas Fisheries Research Laboratory) for the Pacific and from ICCAT data base for the Atlantic. Only one spawning ground is identified for the Pacific bluefin tuna in the area off Taiwan to southern Japan, whereas two separate spawning grounds in the Gulf of Mexico and the Mediterranean for the Atlantic bluefin.

Each pair of figures for the Pacific and the Atlantic is roughly the same for number of release and number of recovery. The difference in transoceanic recovery between the two oceans is strikingly small if it is considered that the completely mixing Pacific stock shows only 0.86 percent compared with 0.37 percent for the Atlantic stocks which are assumed to have negligible amount of mixture in conducting the present VPA.

In the other words, this cursory comparison indicates the significant mixture between the hypothetical two stocks in the Atlantic and may invalidate the entire VPA presently being done. Therefore, it is recommended to resume tagging for juvenile fish from the western Atlantic so that more realistic VPA model which permit immigration and emigration of the stock could be developed.

The trace element analysis (Calaperice 1986) indicates 0 to 5% and 9.9 to 12.7% east to west or west to east transoceanic migrations for juvenile and giant Atlantic bluefin tuna, respectively. However there are no follow-up studies with adequate number of samples to conclude the degree of transoceanic migrations on the basis of trace element analysis. Furthermore, it should be demonstrated if physiologically active part such as the vertebrae can retain the whole history of the environment of bluefin in terms of trace elements unchanged throughout its life span. One of the practical way to validate this method is to study Pacific bluefin. All specimens from the Pacific stock must show the same chemical pattern in the early life history period because only one spawning area is evident.

2. Catch-at-age

There are a number of problems in tuning the Atlantic bluefin and several improvements have been proposed (e.g., Collie 1987). Among them, reliable partial recruitment fishing mortality (PRF) and selection and weighting of CPUE series appears to be major items be solved. However, one of the important point missing in the discussion of the tuning problems by CAL method (SCRS 1988a) is sampling error of the catch itself. As stated in the stock structure section, significant amount of error appears to be contained in the catch-at-age matrix, other than aging problems. There are several more aggravating factors concerning the errors in catch-by-age. One is inaccuracy of sport fishing catch. It is natural to assume the catch of the sport fishing is difficult to collect due to wide spread sources of the catch composed of countless individual anglers. Another factor relates with the strict fishing regulation now imposed inevitably incurs intentional underreporting. Incidental catch of giant bluefin discarded dead amounts to 355 tons in 1986 in the Gulf of Mexico (SCRS 1988b). Considering these problems, the sensitivity analysis should base on artificially constructed perfect catch-by-age table (Nagai and Miyabe 1987) which indicated CAL could not recover true values under minor amount of error (10-20%) in catch-at-age matrix.

3. CPUE series

The Japanese longline fishery has been providing the best CPUE series covering almost whole distribution of the Atlantic bluefin and the longest time series. This high value of the Japanese longline CPUE makes a clear contrast to CPUE's obtained from sport fisheries operated only within a very coastal areas thus subject to quite sensitive to availability problem due to environmental influence as well as generally low quality of catch and effort statistics compared to the Japanese longline data. The larval survey information which is not based on a systematic annual grid line survey further requires so many assumptions that it would be wise not to use it as an tuning index. Furthermore, the CPUE series of the larval survey has several years without observation. In fact, trend of the CPUE calculated from the larval survey (SCRS 1988b) dose not accord to that from the Japanese longline CPUE series in the Gulf of Mexico (Honma et al. 1985). Qualitative superiority of the Japanese longline data among the various CPUE series should be taken into account in weighting the CPUE series.

4. Calculation of the Japanese longline CPUE

The Japanese longline CPUE has been standardized by GLM and used for tuning the VPA. Two sets of the CPUE were available; one, age group specific CPUE (3 to 5, 6 to 7 and 8 to 9 years old) obtained from observer data within US 200 mile zone, the other, for the whole west Atlantic stock, without discriminating age group. Since US observer data cover only short period of recent years and localized area, the CPUE series is probably not informative. Here, the Japanese longline CPUE series from the west Atlantic stock was divided into two age groups, 3 to 5 and 6 to 8 years old groups to have more narrow age groups so that the tuning become more meaningful. Procedure to calculate the CPUE series is as follows.

1. Japanese longline catch and effort data for 1975-1987 by 5° square, month and kind of bait were used. Data for 1987 were preliminary.

2. A fishing season from November to February was selected, i.e., CPUE of 1985-1986 fishing season represents the abundance of year 1986, and major longline fishing ground was defined (Fig. 1).

3. To obtain better CPUE series as an input for the purpose of tuning VPA, size specific CPUE indices were developed. Length frequency (Fig. 2) was built for 1974-1987 by two months interval (e.g. Nov.-Dec. and Jan.-Feb.) and inshore-offshore area (divided by 65° W). Due to the lack of length data for 1974 and 1975, those two years were excluded for the calculation. Nominal CPUE including zero value was split into two age specific indices based on the percentage of each age group.

4. GLM was applied to obtain annual trend of the CPUE. The model used is additive type after logarithmic transformation.

$$CPUE = C + Y + M + A + MA + e$$

where CPUE: Catch in number of bluefin divided by nominal number of hooks and multiplied by 1,000 plus a constant
C : overall mean
Y : factor of year (November to February)
M : factor of month
A : factor of area (5° squares)
MA : interaction term between M and A
e : error term

Constraints($e^{\Sigma Y}=0.0$, $e^{\Sigma M}=0.0$, $e^{\Sigma A}=0.0$) were set to reduce the number of parameters to be estimated. Number of available observations used in this analysis were listed in Table 1 by month and area.

The result is shown in Figs. 3, 4 and Table 2. As an adding constant in the logarithmic transformation, three levels of constant (0.1, 1.0 and 10.0) were tested. All cases showed similar trend but the best residual pattern (Fig. 4) was found for CPUE indices of both age groups when 0.1 was added to CPUE.

CPUE for 3-5 age group was fairly high in 1977 and 1978 indicating that 1973 year class was dominant. After 1978 it has been stable with moderate fluctuations. CPUE for 6-8 age groups showed consistently stable trend with low CPUE in 1976 and 1983. During 1977-1981 and in 1985 and 1987 CPUE was high and at about the same level. These CPUE trends are in accordance with the past works for the Japanese longline CPUE (ICCAT 1988b, Davis and Turner 1988).

5. VPA tuning

As there are so many uncertainty on the credibility of the present VPA analysis for the Atlantic bluefin tuna, crosschecking of the VPA estimates with other independent information and actual fishing performance is of primary importance. This process appears to have been lacking almost completely in the stock assessment.

Juvenile fish (1-5 years old fish)

For any type of VPA, it is highly difficult to give reliable population size estimates for younger cohorts not fully exposed to the fisheries. Separable VPA (Pope and Shepherd 1982) has been applied to the west Atlantic bluefin stock to set partial recruitment for the fish not fully recruited to the fisheries. Although SVPA searches for the least square estimate of partial recruitment, it can be said that the results depend solely on catch-at-age data under several arbitrary assumptions. This necessitates to check the result of the present VPA, especially magnitude of absolute stock size, by other independent information. According to the present VPA, recruitment at age one in some of recent years is as small as down to 20 to 30 thousand fish. Therefore, the situation may happen again in the near future as disclosed in 1982 SCRS in which it was noted that the number of projected population size was smaller than the actual catch in several age classes. Most practical way to verify quickly whether or not the recent recruit level is that low is to conduct tagging experiment and estimate its population size independently. If the present VPA is reliable one, then tagging experiments for juvenile, say age two to five, will show high recovery rate of around 20% in 1988 (cf. Tables 4 and 10 of SCRS 1988b.

Medium fish (6-9 years old fish)

The Japanese longline fishing is only one major segment which takes the medium fish among the west Atlantic bluefin fisheries. Therefore, the monitoring catch by this fishery for medium fish should be continued. As mentioned in juvenile section, preferential increase of monitoring catch to this fishery from less informative fisheries may verify whether or not the low recruit level in recent years indicated by the VPA is correct.

Large fish (10 years and older)

There appears no practical way to tune the VPA for large fish segment at present except to initiate experimental longline fishing compatible with the historical Japanese longline data in the Gulf of Mexico. It should be recognized that the experimental longline fishing be urgently taken because time without any reliable indices for the spawning population is running in vain after the Japanese longline operation terminated in 1982.

Gaps between the result of assessment and the fishing performance

Intuitive doubt on the present VPA for the west Atlantic bluefin stock stems from a gap with fishing performance, especially that from the Japanese longline fishery. There have been observed stable CPUE trends for the Japanese longline fisheries capturing juvenile and medium fish. Except for Canada, both Japan and the USA, two major fishing countries for the west Atlantic bluefin, have been filling or even exceeding in some years the respective quotas without significant changes in all segment of fisheries. On the other hand, the VPA has been showing a steep decline for all segments of age groups.

In the case of heavily overfished southern bluefin tuna, the Japanese longline CPUE has been decreasing consistently over nearly two decades and the catch could not fill the quota despite of a high level of the fishing effort (Kono 1988). The VPA for the southern bluefin tuna verifies the decrease of the population size which has been in accordance with the poor fishing performances. The Japanese longline fishermen are fully aware of this critical stage of the southern bluefin stock through their own operations as well as through scientific stock assessment jointly done among Australian, Japanese and New Zealand scientists in which no serious disagreement was addressed for the result of the analysis. Therefore, they comply with a very severe fishing regulation.

However, in the case of the west Atlantic bluefin stock, it is common to see completely different views among the scientists working for the stock status. The risk of further decline in recruitment and juvenile stock appears small judging from stable Japanese longline CPUE trend as long as the present level of harvest continues.

Conclusion and recommendation

From the analysis previously made, it is concluded that credibility of the present stock assessment is very low and therefore, can not provide any quantitative scientific base to amount of allowable catch or replacement yield. It should be borne in mind that further reduction of the monitoring catch now being allowed adds an unretrievable uncertainty to scientific analysis of the stock status. Following practical actions be taken to verify and improve the present VPA.

1) resumption of tagging experiments from the western Atlantic to obtain magnitude of interstock mixture and current exploitation level of west Atlantic juvenile.

2) initiation of experimental longline fishing compatible with the historical Japanese longline data in the Gulf of Mexico to obtain reliable CPUE for the spawning bluefin.

References

Calaprice, J. R. 1986: Chemical variability and stock variation in northern Atlantic bluefin tuna, ICCAT, CVSP Vol. 24, 222-254.

Collie, J. S. 1987: Evaluation of virtual population analysis tuning procedures as applied to Atlantic bluefin tuna, ICCAT CVSP Vol. 28, 203-220.

Davis K. S. and S. C. Turner 1988: Standardized catch rates of bluefin tuna in the United States Fishery Conservation Zone for 1983-1986, ICCAT, CVSP, Vol. 28, 243-252.

Honma, M., T. Matsumoto and H. Kono 1985: Comparison of two abundance indices based on Japanese catch and effort data by one-degree and five-degree squares for the Atlantic bluefin tuna in the Gulf of Mexico, ICCAT CVSP Vol. 22, 254-264.

Kono, H., 1988: Assessment of the southern bluefin tuna stock, SBFWS/88/13 (document presented to seventh meeting of Australian, Japanese and New Zealand scientists on southern bluefin tuna), 13 pp.

Nagai and Miyabe 1988: Simulation study for appraising the validity of Parrack's VPA tuning method, ICCAT CVSP Vol. 28, 170-177.

Pope, J. G. and J. G. Shepherd 1982: A simple method for the consistent interpretation of catch-at-age data, J. Con. Int. Explor. Mer 140, 176-184.

SCRS 1988a: Report for biennial period, 1986-87, Part II (1987), ICCAT, 299 pp.

" 1988b: 1987 species group reference document (Background Report), ICCAT, 89 pp.

Table 1. Number of observations for CPUE analysis by month and area.

Year	Nov	Dec	Jan	Feb	A1	A2	A3	A4	A5	A6	A7	A8	A9	Total
75-76	9	12	7	5	8	7	4	2	1	6	5	0	0	33
76-77	13	16	11	8	6	7	8	9	4	4	4	6	0	48
77-78	15	14	13	4	4	7	10	9	4	7	1	4	0	46
78-79	17	15	21	5	5	8	9	10	4	8	5	6	3	58
79-80	17	11	17	7	6	3	8	9	8	8	2	5	3	52
80-81	17	28	20	13	7	11	10	11	9	8	5	8	9	78
81-82	19	21	11	5	4	9	6	6	6	6	6	8	5	56
82-83	12	13	10	14	5	4	9	9	6	6	4	5	1	49
83-84	10	12	13	8	3	3	7	8	6	5	5	4	2	43
84-85	11	12	15	11	6	4	6	8	6	8	5	5	1	49
85-86	0	0	15	6	4	2	2	4	1	2	2	3	1	21
86-87	14	15	9	0	7	2	4	6	5	4	6	3	1	38
Total	154	169	162	86	65	67	83	91	60	72	50	57	26	571

Table 2. Statistical results of CPUE analysis.

Age group	Number of observations	Number of parameters	R square	F statistic
3 - 5	571	47	0.51	11.97
6 - 8	571	47	0.45	9.30

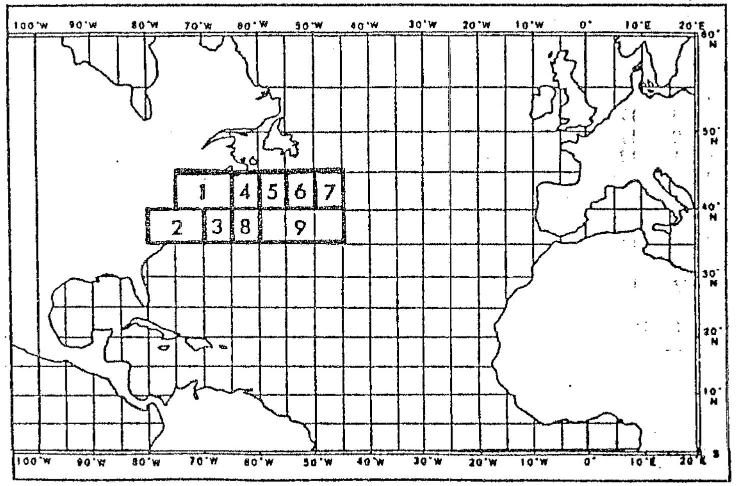

Fig. 1. Area division developed for CPUE analysis.

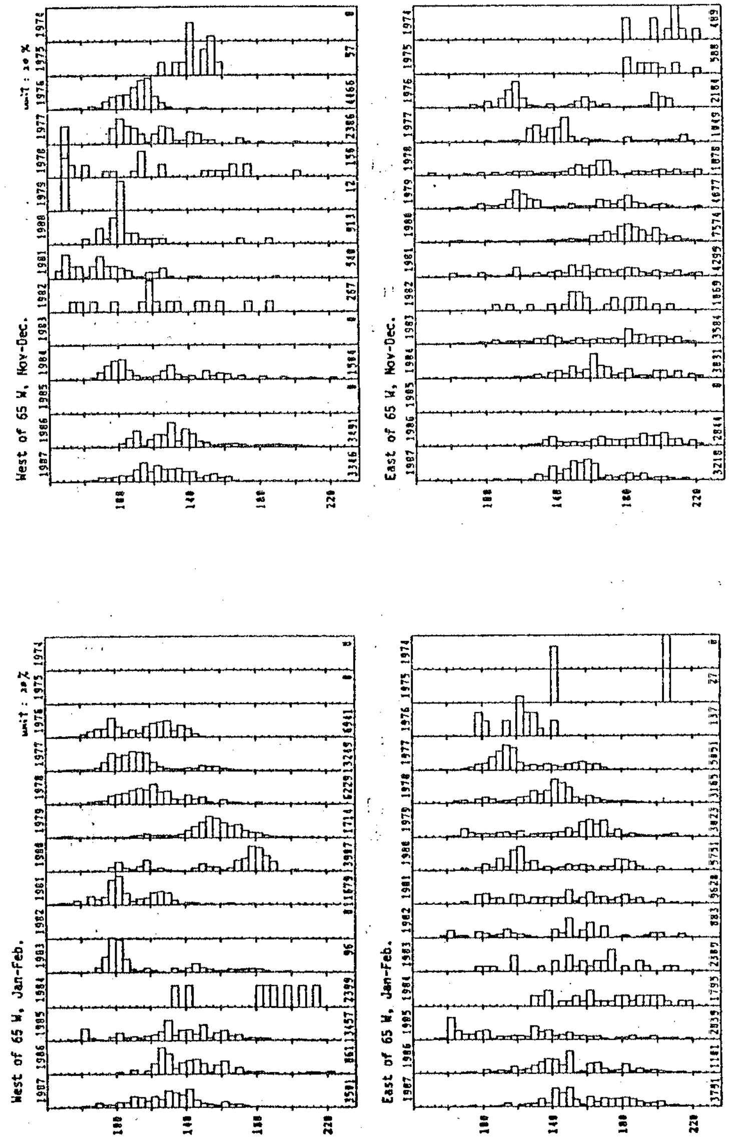

Fig. 2. Length frequency of west Atlantic bluefin caught by Japanese longline fishery by area (east and west of 65°W) and two months interval(Nov-Dec and Jan-Feb).

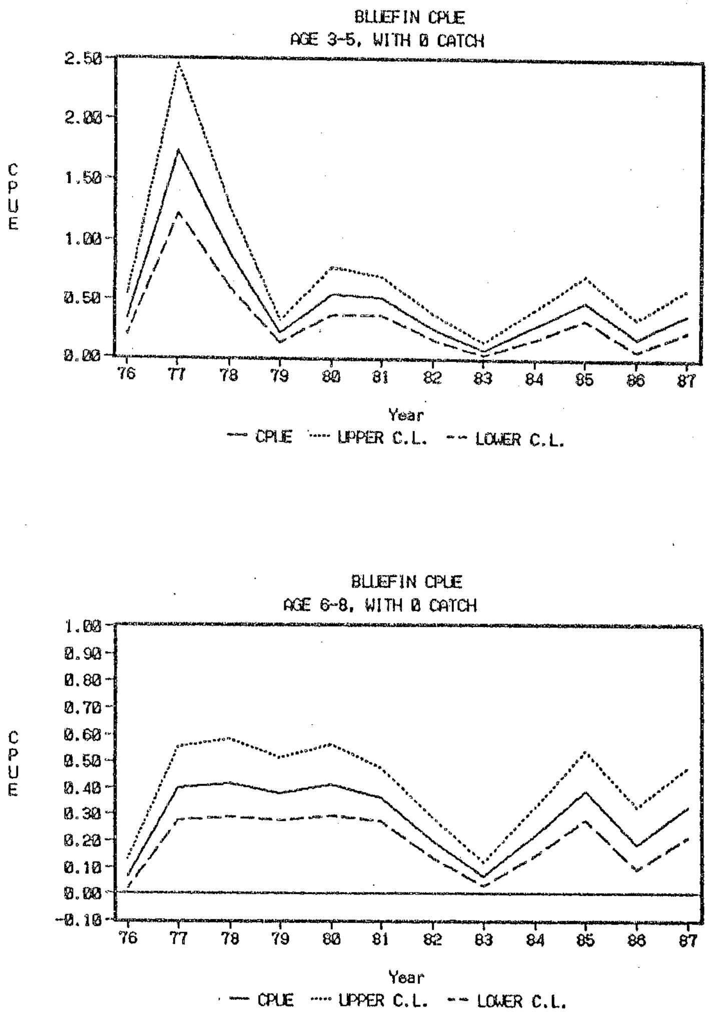

Fig. 3. Standardized CPUE for west Atlantic bluefin based of Japanese longline fishery. Fine line and dotted lines show estimated CPUE and its 95% confidence limits.

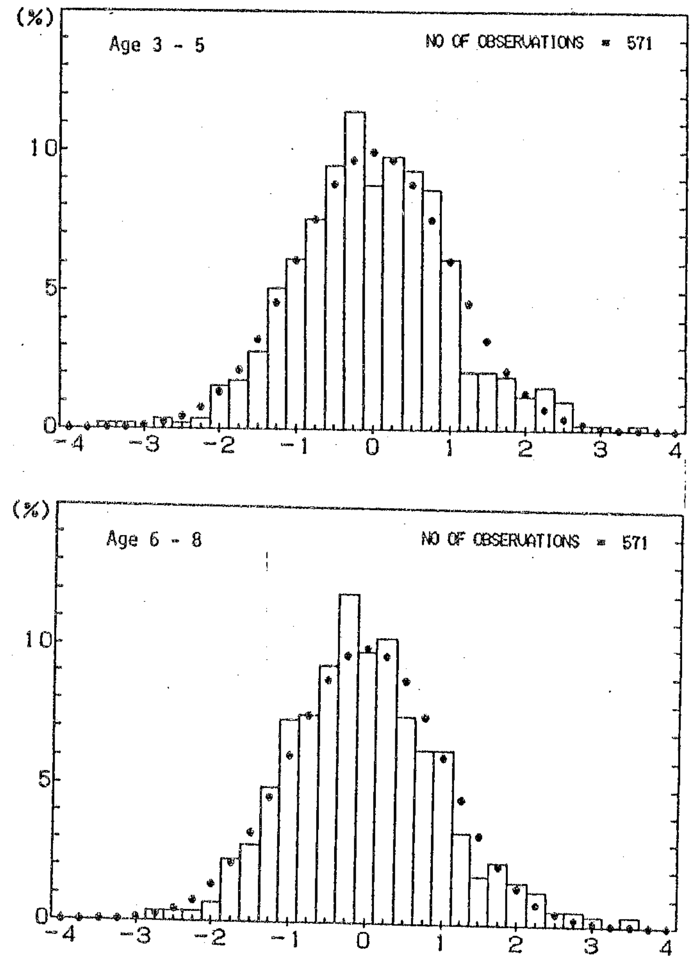

Fig. 4. Standardized residual pattern in CPUE analysis. Bars show observed histogram of residual, dots show expected normal distribution.