

## ANALYSIS ON THE ATLANTIC BLUEFIN TUNA STOCK

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## 1. Japanese longline catch in 1978 and 1979

The Japanese longline catch from the Atlantic and Mediterranean Sea decreased from 5,800 metric tons in 1977 to about 3,000 metric tons in 1978. This decreasing of catch during 1978 was mainly due to lowering catch (decreasing of operations) in the northeastern Atlantic, particularly in the mouth of the Strait of Gibraltar. It seems that the longline catch in 1979 is the same as that in 1978 or slightly less. In the Gulf of Mexico of the northwestern Atlantic the catch in 1978 and 1979 was about 8,000 fish (about 2,200 tons) respectively. The longline catch off New York was about 10,000 fish and 380 tons in 1978.

## 2. Trend in distribution of fishing effort and catch-per-effort in 1978 and 1979

## Northeastern Atlantic

In general longline fishing effort (in number of hooks) has showed a decreasing trend since 1975 in each area from E-1 to E-4 (Figs. 1 and 2). The bluefin fishery of longline in the Bay of Biscay (E-1) virtually ceased from 1976. In the area E-2 the bluefin catch is incidental in the bigeye fishery. In the Strait of Gibraltar (E-3) fishing effort during 1978 and 1979 reduced to half or so of the respective years before. Fishing effort in the Mediterranean Sea (E-4) has been kept at low level since 1977.

It is likely that the recent catch-per-effort of longline fishery in the northeastern Atlantic is not to be adequate indices of the available stock because of insufficient coverage of the fishing areas and seasons by the fishery.

## Northwestern Atlantic

During 1979 fishing effort for the areas W-1 to W-3 in the peak fishing season, first quarter of the year, increased slightly as compared with those in 1978. Fishing effort in the Gulf of Mexico (W-5) in 1979 was high in the first quarter but lowered in the peak season, second quarter, compared with the previous years (Fig. 3).

A sharp decline of catch-per-effort was observed for the areas W-1 to W-3 in the first quarter of 1979. Although the data in 1979 is provisional, some changes in availability or recruitment of the fish are suggested for this fishing season. This will be detailed a little more in the next section.

Catch-per-effort in the Gulf of Mexico from 1975 to 1979 are summarized as follows:

## Catch-per-effort in the Gulf of Mexico

| Year                 | 1975 | 1976 | 1977 | 1978 | 1979 |
|----------------------|------|------|------|------|------|
| Catch-<br>1000 hooks | 3.7  | 2.8  | 2.1  | 2.8  | 2.6  |

## 3. Length frequency distribution of the longline catches

No data on size frequency of longline catch during 1978 and 1979 are available up to now for the northeastern Atlantic.

Figure 4 shows length composition obtained off southern Newfoundland in 1978-79 (from one boat sample). The size of fish caught widely ranges from 90 cm to 250 cm in body length with a modal group between 160 cm and 170 cm. It is generally suggested that the fish distributed in this area is larger than that in the areas W-2 and W-3 (Shingu and Hisada, 1977, Fig.4-1, SCRS/77/79).

Figures 5 and 6 show catch-per-effort at 2 cm intervals in body length for the areas W-3 (includes W-2) and W-5 respectively up to 1979. In the area W-3 in 1978-79 season a major component of size composition consists of the fish from 140 cm to 150 cm in body length. It looks unusual that the fish less than 130 cm which was a large portion of the catch every year before 1977-78 season disappeared in the longline catches, though the data used here obtained from only three commercial boats. For the area W-5 (Gulf of Mexico) in 1979 the data on size composition (measured by Japanese fishermen) was obtained from two boats. From these two samples the major modal group is about 240 cm and smaller by 5-10 cm than those in 1977 and 1978.

In this section, to examine the disappearance of the fish less than 130 cm in the longline catches and decreasing of catch-per-effort in the areas W-2 and W-3 during 1978-79, we summarized the distribution of longline fishing effort and catch, by 1° areas, in the area north of 35°N and west of 45°W for two fishing seasons 1977-78 and 1978-79\*.

Fishing effort during 1977-78 season concentrated on the two areas east of 55°W, north of 41°N and west of 63°W, 39°-40°N. In 1978-79, however, fishing effort in the latter area shows rather scattering trend (Fig. 7). The bulk of longline catch was made in the area west of 63°W and 39°-40°N in 1977-78 fishing season. On the contrary, the catch from

\* Catch and effort data were obtained from logbooks of 26 longliners.

the same area in 1978-79 season was far smaller (Fig. 8). Figure 9 shows a ratio of the catch in 5° x 5° areas to the total catch from the whole area for the years 1977-78 (lower figures in each 5° x 5° area) and 1978-79 (upper figures). In the area 65-75° W and 35-40° N 65 % of the total catch was made during 1977-78 but 20 % during 1978-79. On the other hand in the area 45-65° W and 40-45° N 22 % of the total catch was made during 1977-78 but 60 % in 1978-79. Therefore, the one of reason for not concentrating of longline fishing effort in 1978-79 season to the area west of 65° W may be that small fish was unavailable to the fishery possibly due to the oceanographic condition or some other reason.

#### 4. Recruitment of longline available population in the Gulf of Mexico

In the Gulf of Mexico rather stable catch-per-effort and size composition has been observed than the other fishing grounds. In a stable recruitment status, population number  $N$  could be expressed:

$$N = \sum_{t=0}^{\infty} R \cdot S^t = \frac{R}{1-S} \quad \dots \dots \dots (1)$$

where, R: Recruitment in number  
S: Survival rate ( $e^{-(F+M)}$ )  
t: Number of year  
M: Natural mortality coefficient

Therefore, catch  $C$  is

$$C = N \cdot E = \frac{RF}{F+M} = \frac{RqX}{M+qX} \quad \dots \dots \dots (2)$$

where, E: Exploitation rate ( $\frac{F}{M+F}(1-S)$ )  
q: Catchability coefficient ( $F=qX$ )  
X: Fishing effort

$$\text{then, } \frac{X}{C} = \frac{1}{R} \cdot \frac{M}{q} + \frac{1}{R} X \quad \dots \dots \dots (3)$$

Thus, equation (3) shows linear relation (Doi 1962). The data (nominal catch and effort) from the Gulf of Mexico (north of 25° N) during the period 1975-79 were fitted to equation (3). Figure 10 shows a relation between  $X$  and  $X/C$  ( $r=0.94$ ). If recruitment decreases or increase in some year a point of  $X/C$  of that year would drop significantly far above the line and vice versa.  $R \approx 15,200$  was obtained from equation (3). Annual  $F$ ,  $E$  and an average  $q$  were estimated, assuming  $M=0.1$ ,  $0.2$  and  $0.3$ , as follows:

|      | M = 0.1                    |       | M = 0.2                    |       | M = 0.3                    |       |
|------|----------------------------|-------|----------------------------|-------|----------------------------|-------|
|      | q=0.407 x 10 <sup>-4</sup> |       | q=0.815 x 10 <sup>-4</sup> |       | q=0.122 x 10 <sup>-3</sup> |       |
|      | F                          | E     | F                          | E     | F                          | E     |
| 1975 | 0.070                      | 0.064 | 0.141                      | 0.118 | 0.211                      | 0.165 |
| 1976 | 0.146                      | 0.129 | 0.291                      | 0.229 | 0.437                      | 0.309 |
| 1977 | 0.185                      | 0.161 | 0.370                      | 0.282 | 0.555                      | 0.373 |
| 1978 | 0.118                      | 0.106 | 0.236                      | 0.194 | 0.354                      | 0.260 |
| 1979 | 0.130                      | 0.116 | 0.260                      | 0.208 | 0.390                      | 0.282 |

If we can assume that  $M=0.2$  is the most likely value of natural mortality for bluefin tuna, then the catch rate by the longline fishery would be around 20 % in recent years. The method used here may be invalid when fishing effort vary largely year and year. Also, the result from the present analysis might be effective within the limits of the longline available population in the Gulf of Mexico.

#### References

- Doi, T. 1962. Diagnosis of king crab resources off the Western Kamchatka coast, *Bull. Tokai Reg. Fish. Res. Lab.*, (33), 11-20.
- Shingu, C and K. Hisada. 1977. Recent status of the medium and large bluefin tuna population in the Atlantic Ocean, *SCRS/77/79*. ICCAT.

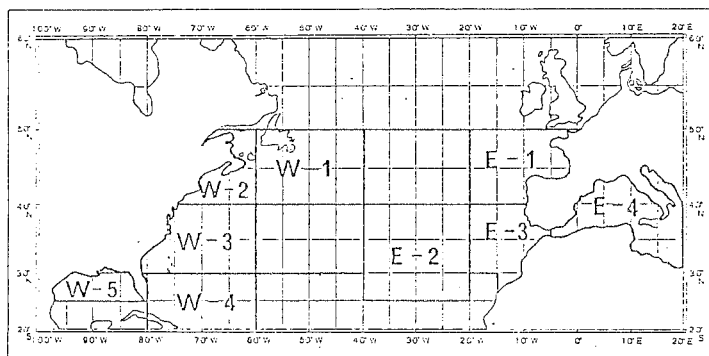


Fig. 1. Fishing areas of Japanese longliners for bluefin.

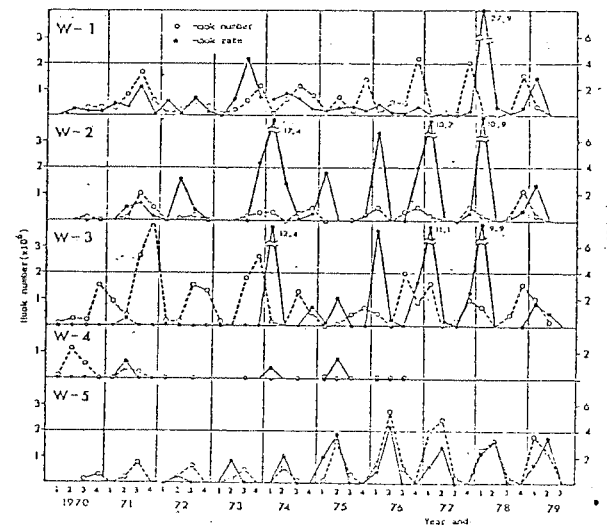


Fig. 3. Changes in fishing effort and catch-per-effort in the Japanese longline fishery. Data for 1978-79 are provisional.

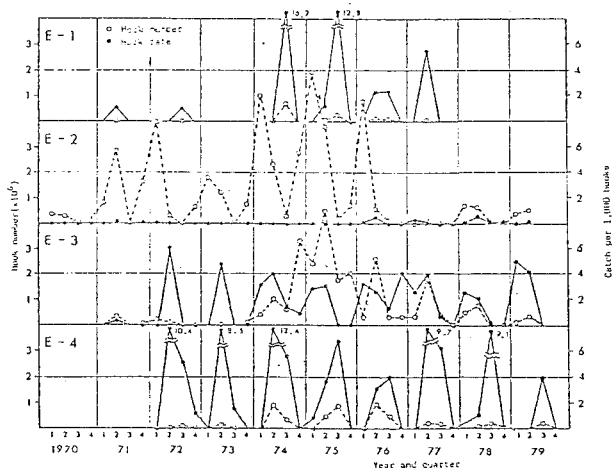


Fig. 2. Changes in fishing effort and catch-per-effort in the Japanese longline fishery. Data for 1978-79 are provisional.

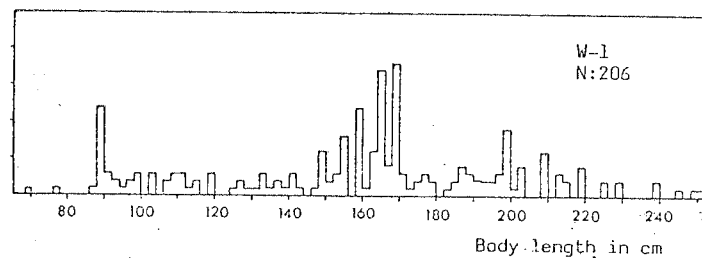


Fig. 4. Length composition of bluefin tuna caught by longline in the area south of Newfoundland, 1978-79

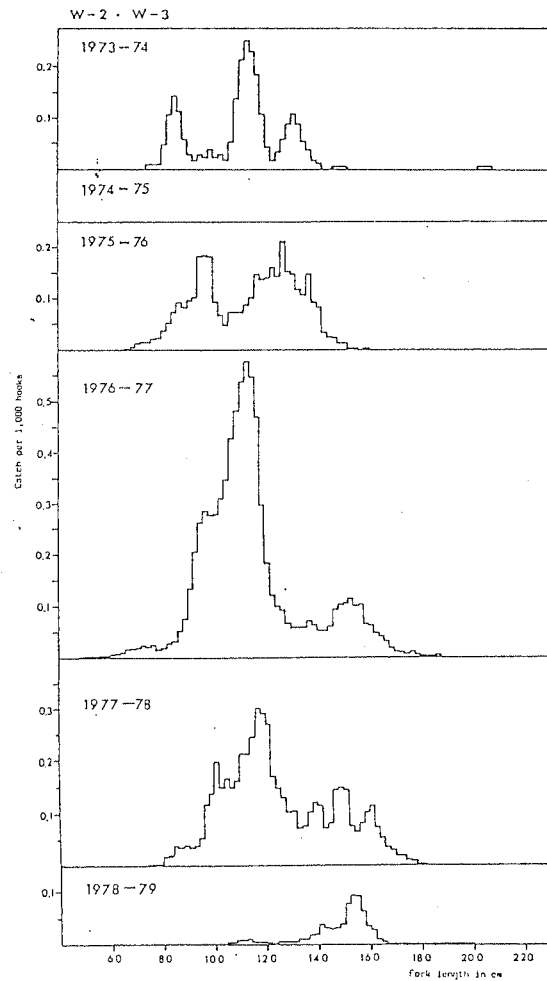


Fig. 5. Catch-per-effort by length class of bluefin caught by longline in the area W-2 and W-3. Data for 1978-79 are provisional.

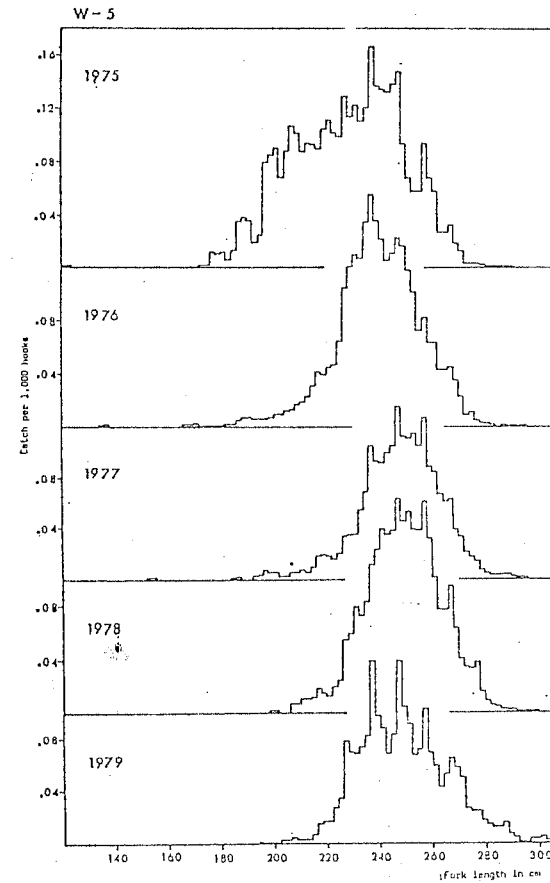


Fig. 6. Catch-per-effort by length class of bluefin caught by longline in the area W-5. Data for 1979 are provisional.

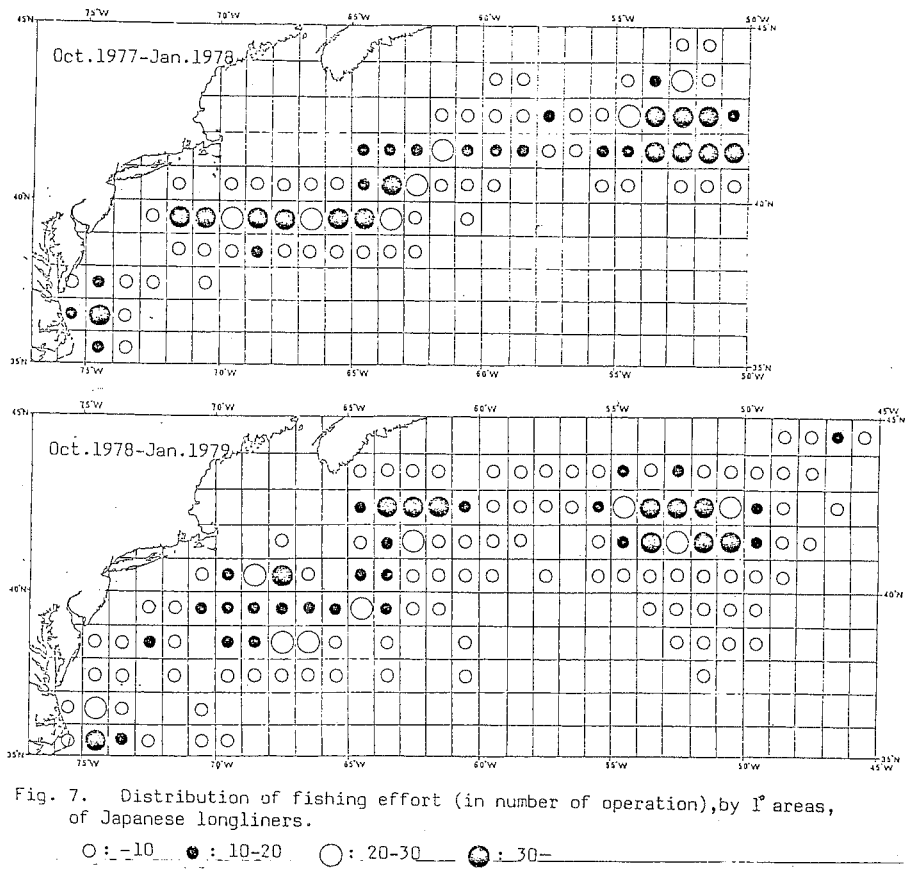


Fig. 7. Distribution of fishing effort (in number of operation), by 1° areas, of Japanese longliners.

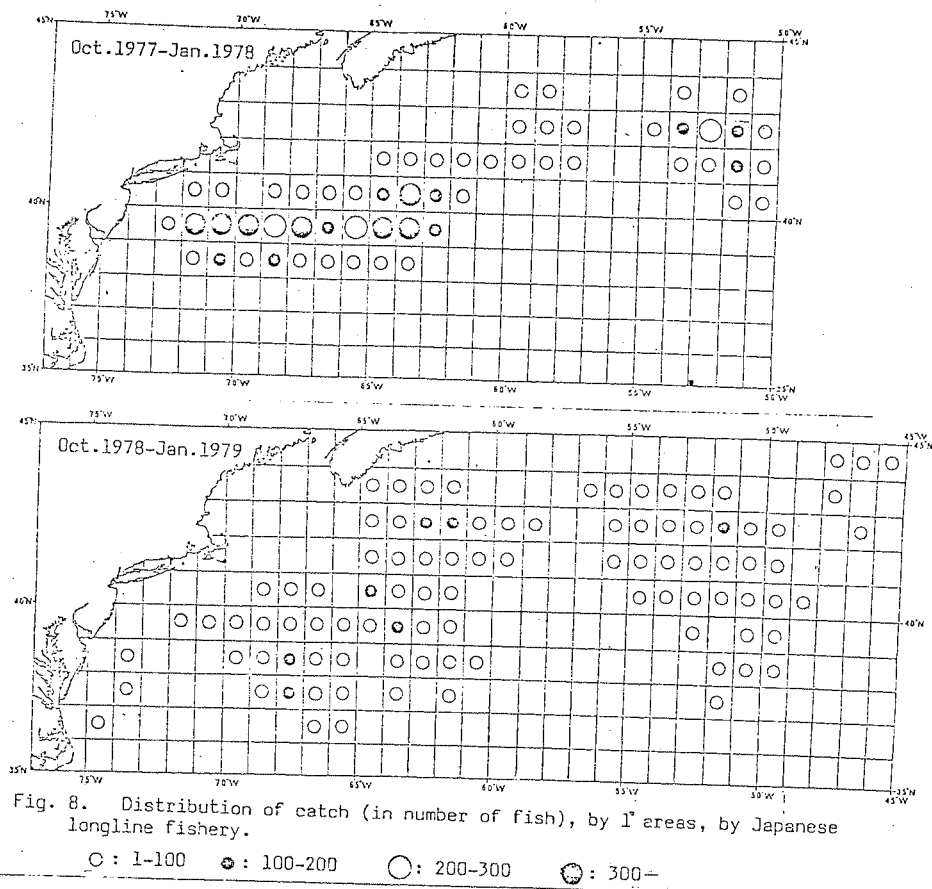


Fig. 8. Distribution of catch (in number of fish), by 1° areas, by Japanese longline fishery.

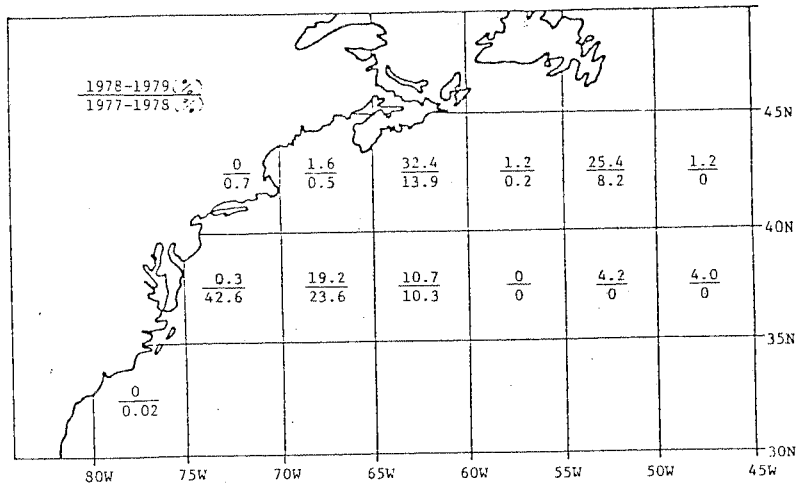


Fig. 9. Ratio (%) of the catch in 5° x 5° areas to the total catch by Japanese longliners for the years 1977-78 and 1978-79 fishing seasons.

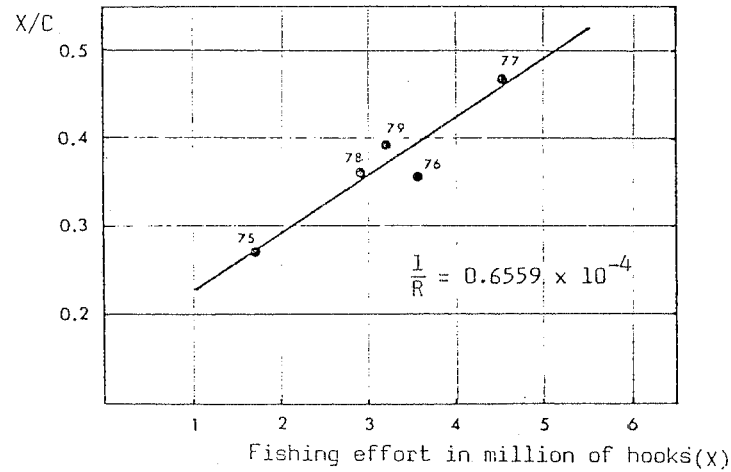


Fig. 10. Relation between fishing effort (X) and X/C from 1975 to 1979 in the Gulf of Mexico in Japanese longline fishery.