

RECENT STATUS OF THE MEDIUM AND LARGE BLUEFIN TUNA
POPULATION IN THE ATLANTIC OCEAN

By

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1 Recent aspect of bluefin catch by Japanese longliners

Most of bluefin tuna catch by the Japanese longliners is obtained from areas W-1, W-2, W-3, W-5 and E-1, E-3, E-4 in recent years as shown in Figure 1. The sizes of bluefin tuna in the catch of the Japanese longliners mainly consist of the small fish, 2 to 5 years old (70-150 cm) in the areas W-2, W-3, E-1 as well as the large fish, 9 years old and older (above 200 cm) in the areas W-5, E-3, E-4, and medium sized fish is small in longline catch (Fig. 4).

Trend of fishing effort (nominal number of hooks set) by fishing area in the recent years shown in Figure 2 indicates that the fishing effort has increased in the area W-5 and it increased rapidly from 1974 to 1975 but decreased sharply in 1976 in the area E-3. The fishing effort for another areas leveled off or decreased. As reduction of the fishing effort exerted in the area E-3 in 1976 was substantial, the total fishing effort in 1976 seems to have decreased considerably than in 1975. The bluefin catch in 1976 has decreased, comparing to 1975, in the Eastern region (areas E) including the Mediterranean Sea and increased in the Western region (areas W) (Fig. 3).

As for the change in hook rates by fishing area in recent years, wide fluctuations in hook rates were observed in the area W-2 and W-3. Hook rates in 1976 for these areas are likely to remain in the high level as in 1975, though not shown as the annual hook rate and fishing effort for these areas are calculated in the manner as is mentioned in the footnote of Fig. 2.

As shown in Figure 4-1, fish with a mode at 110-120 cm are dominant in the length composition of 1976 fishing season (from Dec., 1976 to Feb., 1977) in the areas W-2 and W-3. This modal group may have related with the strong year class which appeared as the 1973 year class.

Annual fluctuation of the hook rate in the area E-1 has been wide and the hook rate of this area has decreased remarkably from 1975 to 1976. However, it is doubtful whether the hook rate in 1976 reflects real relative abundance of the fish in this area due to scarcity of data in 1976.

In another areas in which the large individuals are pursued, no consistent decreasing tendency of the level of the hook rates (cpue) is observed in recent years.

2 Status of stock for the medium and large fish

Catch of large fish by the longline fishery had increased to 5,000 tons level in 1974, but in compliance with fishery regulation enforced in 1975, catch remains in about same level since that year. Considering the recent status in hook rates for the medium and large fish mentioned previously, the stock level of the medium and large fish as a whole does not appear to be changing in a substantial scale in recent years.

Regionally, the increase of bluefin catch in the Gulf of Mexico after 1974 was remarkable. The cpue increased from 1974 to 1975 and decreased slightly from 1975 to 1976. Two sets of decrease-ratio of the cpue, i.e. ratio of 1976 hook rate to 1975, were calculated. One for peak fishing season during April-May and averaging the hook rates of the two months in each year turns out 0.87. The other for during March-June, summing up catch and hooks separately and calculating the cpue for each year, makes 0.76.

Using the latter value and assuming that the change in cpue represents that in the stock level, the stock size decreased by 24 % from 1975 to 1976 and total mortality coefficient during the period is estimated to be 0.274. Assuming $M = 0.2$, then $F = 0.074$, and the rate of exploitation (E) results in about 0.065. The catch in 1976 totals about 10 thousands, therefore, the stock size is estimated to be about 150 thousands. This may differ from the past estimates for the recent population level of large fish in the Western Atlantic Ocean (ICCAT Rep. Part I-1976; 1977).

On the other hand, on the basis of the estimated catch in number by age during 1974-1976 (Table 1), we analyzed the stock level of the medium and large fish as follows. Data sources from which the estimates in Table 1 were obtained are shown in Tables 2-4.

Applying the F values in 1974 (age-specific F for 6 years and older fish) estimated for the whole Atlantic bluefin tuna (Table 4)*, the stock in number at the beginning of 1974 is estimated to be about 60 thousands. If the fishery exploits the bluefin stock following to the manner shown in Table 1, by 1976 the fish aged from 11 to 14 which forms important part of the large fish would almost completely disappear from the catch. This is not the case (Fig. 5). It would be assumed, therefore, that considerably larger stock size than the above estimated one should be expected to sustain the catch of the large fish in 1977 which probably is parallel to that in 1976.

As stated in the early part, in the North Atlantic region, the catch of the medium fish taken by longliners is small and catch information on the medium fish caught by other fisheries is scarce. These situations seem to make difficult estimating the stock level of the medium and large fish. It should be considered that small catch of the medium fish does not necessarily mean the small population level of the medium fish, i.e. it might imply possible existence of unavailable stock to the existing fisheries.

Length composition of the large fish taken by longliners in the Gulf of Mexico shown in Figure 4-3 indicates that there is an increasing size of fish that dominated in the longline catch from 1975 to 1977. If this phenomenon is related with the strong year class, it could be possible to relate this phenomenon further with the 1965 year class which is supposed to have been strong year class, judging from the time lag. Given this is the case, there is a possibility that the year class in 1967 assumed to be also strong will recruit in the Gulf of Mexico as large fish in and after 1978.

Therefore, the size composition of bluefin tuna in the Gulf of Mexico in and after 1978 is highly informative to the problems of assessing the stock status in the area.

3. Relation between small and medium-large fish fisheries with reference to adult stock and yield-per-recruit.

We discussed here the changes in relative stock abundance of adult (to initial level) under the following two types of fisheries, on Y/R basis.

Type 1.

Whole Atlantic Ocean
Small fish fishery for ages 1-5
Medium-large fish fishery for ages 6-17+
Assuming ages 6-17+ fish as adult stock

Type 2

Northwestern Atlantic Ocean
Small fish fishery for ages 1-5
Medium-large fish fishery for ages 10-17+
Assuming ages 10-17+ fish as adult stock

Age-length and length-weight relationship used here are as follows;

$$L_t = 447.88 (\text{cm}) (1 - e^{-0.053(t+1.592)})$$

(Cited from Sakagawa and Coan 1974)

$$W (\text{kg}) = 0.0000317 \times L^{2.9044} (\text{cm})$$

* Calculated from the historical catch data by age made available by Dr. Parks.

Figures 6 and 7 show relation between relative abundance of adult stock and yield-per-recruit against fishing mortalities of the two fisheries of small and medium-large fish of Type 1 and Type 2, respectively.

The range of fishing mortality of medium-large fish fishery of Type 2, corresponding to various level of adult stock, is wider than that of Type 1. For example, to keep adult stock at 20-30 % of initial level, various combination of fishing mortality of two fisheries are obtained as follows.

Type 1.

Small fish fishery	F^P	0.3	0.25	0.20	0.15	0.10
Medium-large fish fishery	F^P	0.03	0.08	0.04-0.14	0.10-0.21	0.17-0.30

Type 2.

Small fish fishery	F^P	0.3	0.25	0.20	0.15	0.10
Medium-large fish fishery	F^P	0.04	0.13	0.07-0.25	0.16-0.38	0.28-

References

ICCAT 1976. Data Record, Vol.8, 339 p.

ICCAT 1977. Report for biennial period, 1976-77, Part 1 (1976), 223 p.

Sakagawa, G.T. and A.L.Coan. 1974. A review of some aspects of the bluefin tuna (THUNNUS THYNNUS THYNNUS) fisheries of the Atlantic Ocean. ICCAT Collective Volume of Scientific Paper, Vol. II (SCRS-1973), 259-313.

Southeast Fish. Center and Woods Hole Oceanogr. Inst. 1975. The U.S. bluefin tuna fishery, 1975, SCRS/75/88, p. 0890-0901.

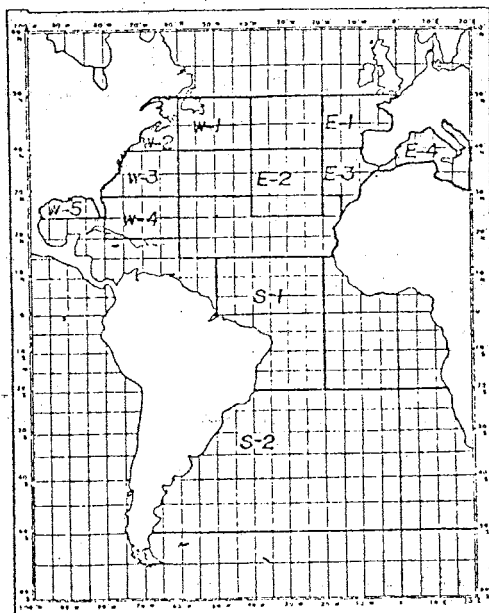


Fig. 1. Fishing areas of Japanese longline fishery in the Atlantic Ocean.

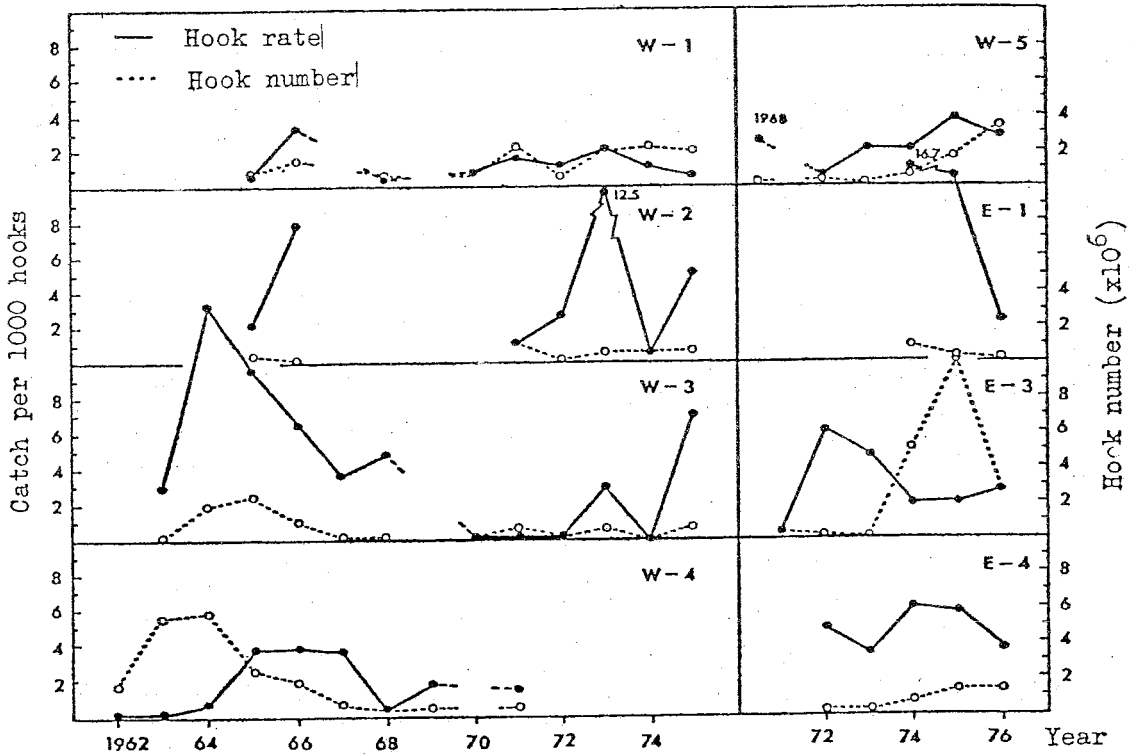


Fig. 2. Annual changes in hook rate of bluefin tuna (catch/1000 hooks) and hook number, by area, of Japanese longline fishery.

Note: Preliminary estimate for 1976.
 The month whose catch was less than 29 fish is excluded.
 For areas W-1 to-3 each value is shown for the period from June to next May.
 For area E-4 hook rate and hook number of June are excluded.

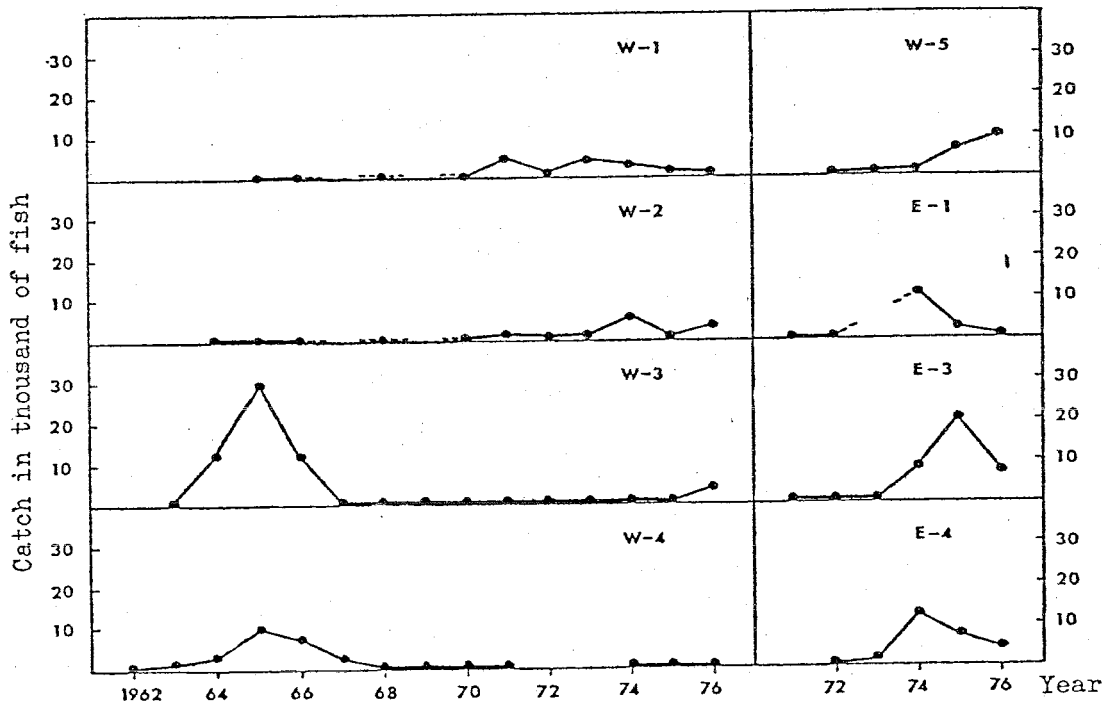


Fig. 3. Annual catch of bluefin tuna by Japanese longline fishery.

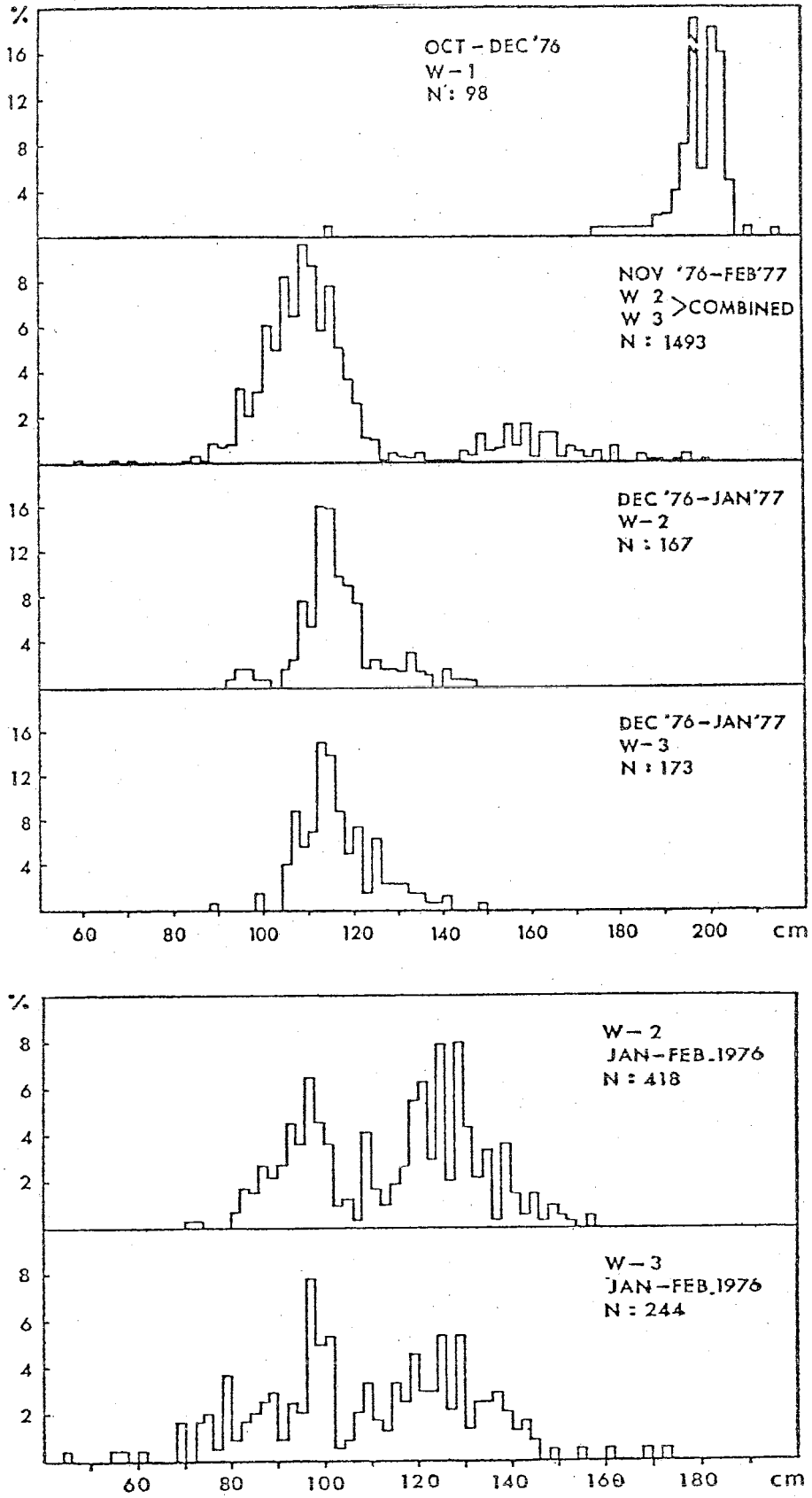


Fig. 4-1. Length frequency distribution of bluefin tuna caught by Japanese longline fishery in the areas W-1, 2 and 3.

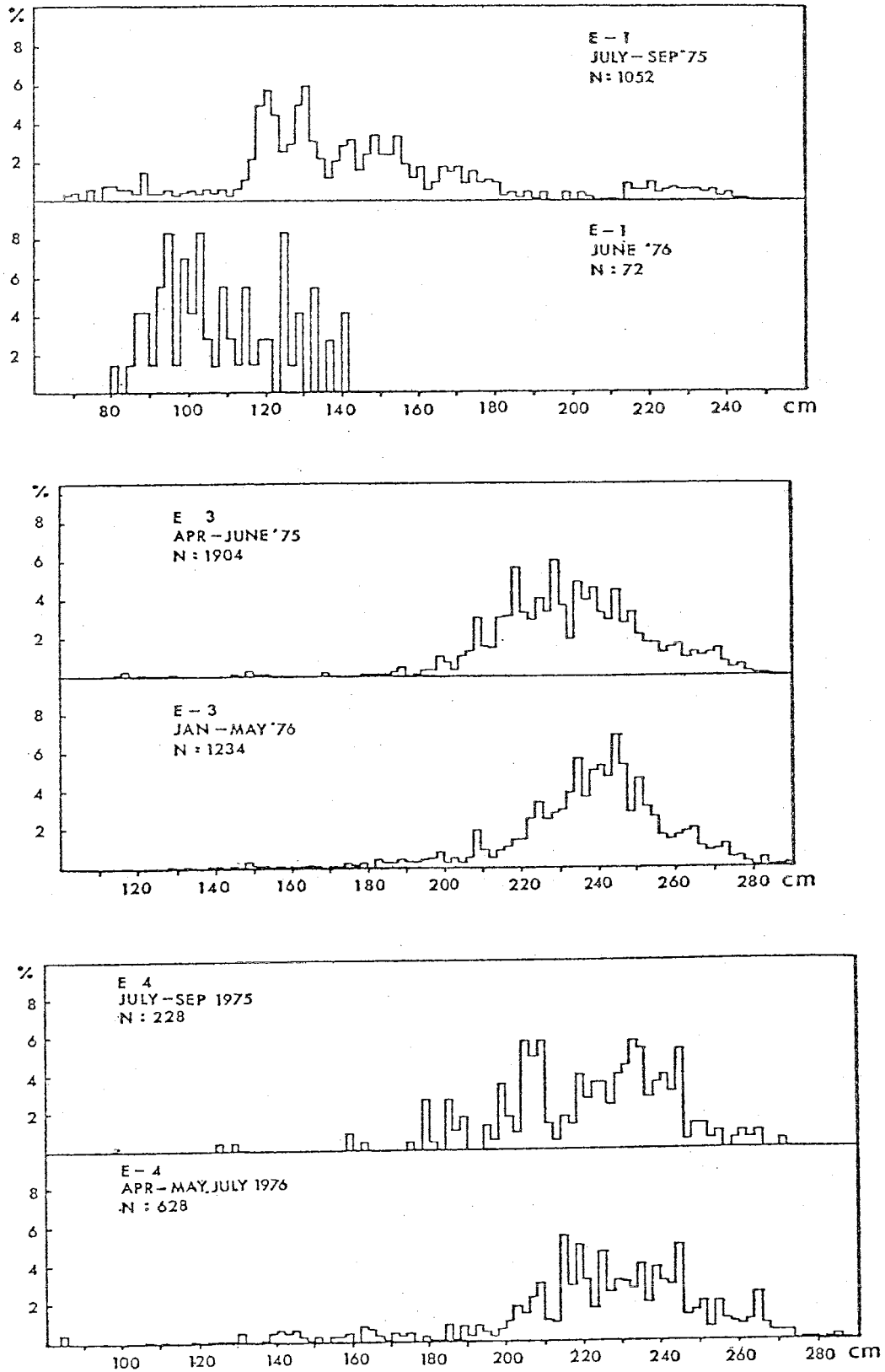


Fig. 4-2. Length frequency distribution of bluefin tuna caught by Japanese longline fishery in the areas E-1, 3 and 4.

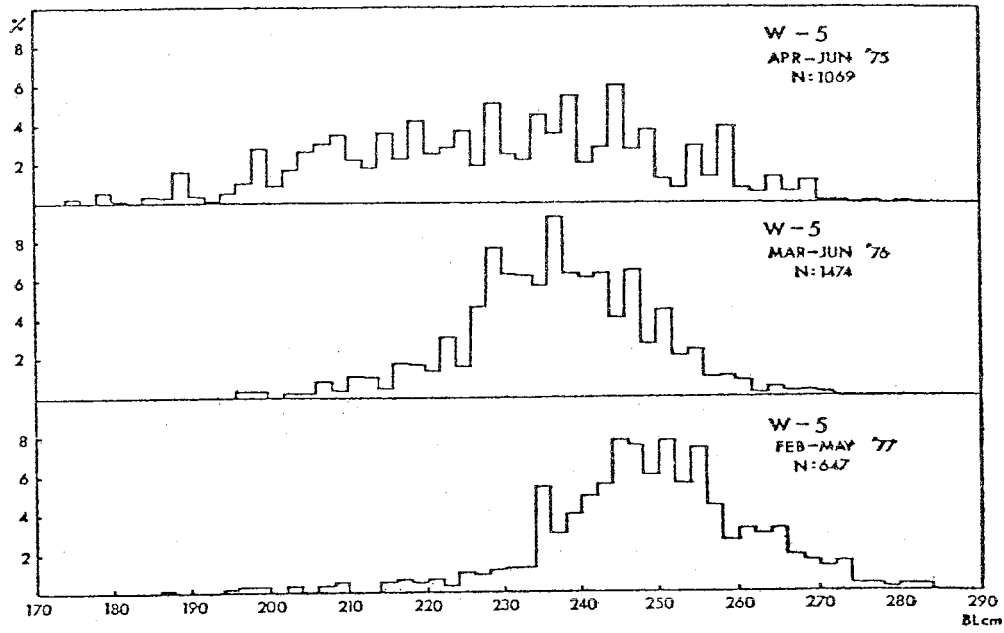


Fig. 4-3. Length frequency distribution of bluefin tuna caught by Japanese longline fishery in the area W-5.

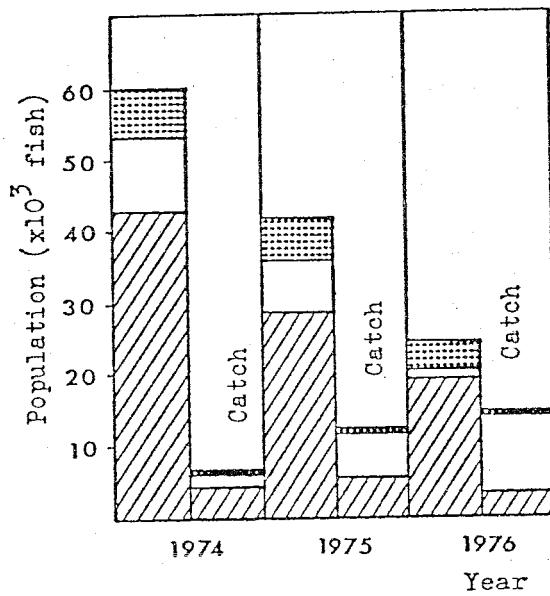


Fig. 5. Comparison between calculated population number and actual catch number, by age group, in the northwestern Atlantic from 1974 to 1976. See text for the process of calculation.

Ages 6-7 in 1974
 Ages 8-11 in 1974
 Ages 12-17+ in 1974

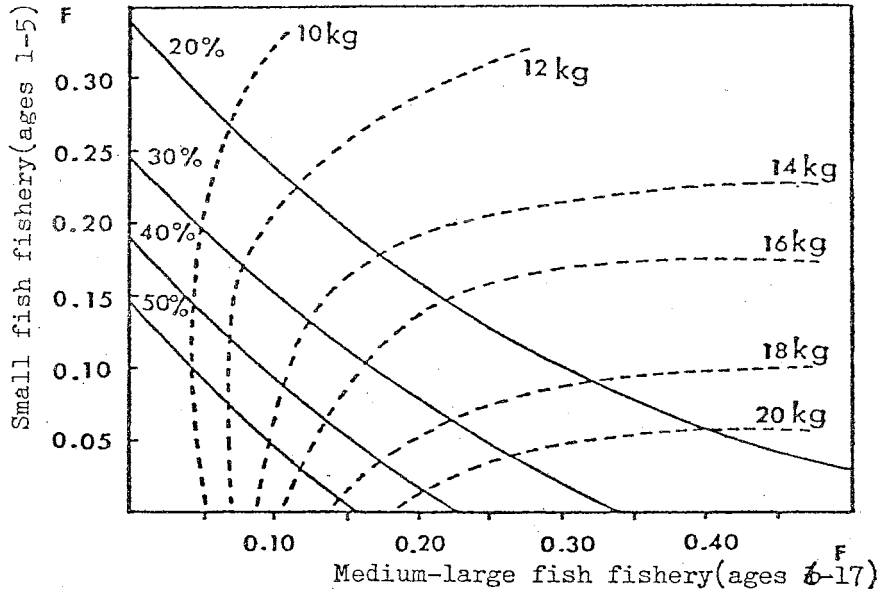


Fig. 6. Isometric curves of yield-per-recruit in kg (dotted lines) and relative stock abundance of ages 6-17+ to initial level (solid lines) against fishing mortalities of medium-large fish fishery and small fish fishery.

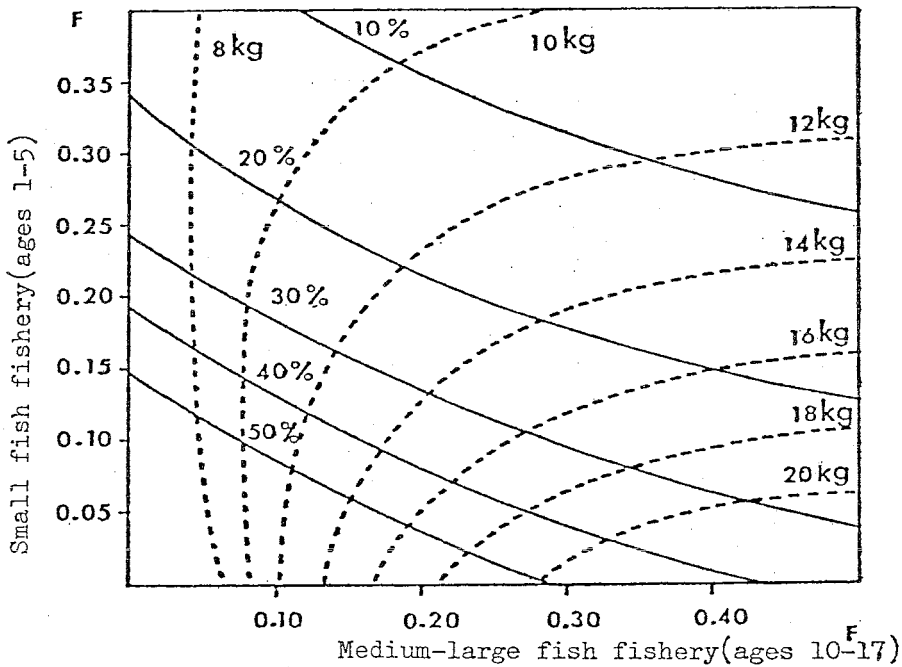


Fig. 7. Isometric curves of yield-per-recruit in kg (dotted lines) and relative stock abundance of ages 10-17+ to initial level (solid lines) against fishing mortalities of medium-large fish fishery and small fish fishery, when fishing mortality on ages 6-9 equal to zero.

Table 1. Estimated catch (in number) of bluefin tuna by Canadian, U.S.A. and Japanese fisheries in the northwestern Atlantic Ocean.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+
1974			132478			352	193	96	300	473	413	607	1112	917	820	590	332
1975			198844			586	464	246	745	1411	1393	1936	1957	1471	997	545	171
1976			133631			724	367	62	279	850	2143	4186	3447	1508	825	475	251

Table 2. Bluefin catch information of U.S.A., Canadian and Japanese fisheries in the northwestern Atlantic Ocean.

Year	U.S.A.			CANADA		
	1974	1975	1976	1974	1975	1976
Catch(small) ¹⁾	804 ^{M.T.}	1760	981	103	291	331
Catch(large) ¹⁾	731	964	766	664	350	475
Sport ¹⁾	332	122	50	-	-	-
Mean body weight(small) ²⁾		11.3 kg			10.3 kg	
Mean body weight(large) ²⁾		283 kg			340 kg	
Mean body weight(sport) ³⁾		7.7 kg				
Catch(small)	71150 ^{fish}	155752	86814	10000	28252	32136
Catch(large)	2583	3406	2707	1953	1029	1397
Catch(sport)	43117	15844	6494	-	-	-

1) ICCAT, Report for biennial period, 1976-77, Part 1 (1976)

2) ICCAT, Data Record, Vol. 8 (1976) P. 233, 234, 239, 240.

3) ICCAT, Working Document, SCRS/75/88, P. 0900, 0901.

Year	JAPAN		
	1974	1975	1976
Catch(small)	10328 ^{fish}	1408	10998
Catch(large)	1249	6402	10019
Length frequency	See Figs. 4		

Table 3. Japanese catch of bluefin tuna in the Gulf of Mexico

Age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+
1974	1	2		1	3	36	91	207	217	291	215	126	53	5	
1975	6	12		5	18	186	467	1060	1134	1491	1102	647	270	24	
1976		7		7	7	7	60	571	1983	3807	2645	771	140	7	7

Table 4. Age specific fishing mortality of ages 6-17+ in 1974 for the whole Atlantic Ocean.

Age	6	7	8	9	10	11	12	13	14	15	16	17
F	0.12	0.064	0.076	0.10	0.21	0.19	0.10	0.12	0.13	0.12	0.12	0.12