A REVIEW OF THE STATUS OF THE STOCKS OF ATLANTIC BLUEFIN TUNA

by

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SUMMARY

Historical trends in catches and catch-per-unit-effort for North Atlantic bluefin tuna fisheries are examined and the status of stocks reviewed and evaluated. Two management objectives are deemed advisable: 1) increase the size of the spawning stock, and 2) maximize yield-per-recruit. Methods for obtaining these objectives are discussed.

RESUME

Le présent document contient un examen des tendances historiques des captures et des prises par unité d'effort en ce qui concerne les pêcheries de thon rouge dans l'Atlantique Nord, et une révision et évaluation de l'état des stocks. Deux objectifs sont jugés recommandables en ce qui concerne la gestion: (1) augmenter l'importance du stock reproducteur, et (2) pousser au maximum la production par recrue. On traite des moyens d'atteindre ces objectifs.

RESUMEN

Se han examinado las sucesivas tendencias a través del tiempo en las capturas y la captura-por-unidad-de-esfuerzo de las pesquerías del atún del Atlántico Norte y se ha revisado y evaluado la situación de los stocks. Se desprende la conveniencia de apuntar hacia dos objetivos en las medidas de ordenación: 1) aumentar el volumen del stock reproductor, y 2) aumentar al máximo el rendimiento-por-recluta. Se han discutido los métodos para lograr dichos objetivos.

Various nations and international organizations have expressed concern in recent years over the status of stocks of bluefin tuna, Thunnus thynnus thynnus, in the Atlantic Ocean.[1] This concern was prompted by sharp declines in landings and catch rates in most of the traditional fisheries in the eastern North Atlantic as well as in the more recent high-seas longline fishery. In addition, other disturbing features are evident. The average size of large bluefin in various fisheries on both sides of the Atlantic has been gradually increasing, suggesting a sharp decline in recruitment to the adult stocks. High and increasing rates of recovery of tagged bluefin were obtained in the western North Atlantic surface fishery indicating high exploitation and mortality rates. Large quantities of small ($\leq$ 3 kg) bluefin were reported being caught in certain areas of the eastern Atlantic. Despite the excellent progress made in stock assessment in recent years by member nations of ICCAT, there was still a general feeling by some scientists that the available scientific information was insufficient to warrant the recommendation of any regulatory measures. It seems appropriate at this time that we re-evaluate the status of stocks of bluefin tuna in the North Atlantic through a brief summary of the statistical and biological data and of the analyses that have been performed. In addition, new studies have also become available that provide further information about the status of stocks of bluefin tuna.

Landings of giant bluefin tuna age 8+ (this is an arbitrary age and assumes that at this age, full maturity has been reached) in almost all of the fisheries in the eastern Atlantic and Mediterranean have declined drastically. The traditional trap fisheries in and around the approaches to the Mediterranean have all but disappeared. The Ibero-Moroccan trap fishery underwent significant fluctuations in catch from 1930 to 1958 but the declines never lasted more than three or four years, and the average annual catch during that period was about 11,000 metric tons. In 1959 landings began to decline steadily and in 1972 only 100 mt of giant bluefin tuna were landed (Figure 1). From 1959 to 1973 catches averaged about 2,200 mt per year. Catch-per-trap reached a high of around 11,000 fish in 1943 but began a steady decline to below 100 fish-per-trap in 1972 (Figure 2). Other trap fisheries have undergone similar declines. For 20 years the Spanish Barbate trap averaged over 18,000 bluefin per year; in 1972 it took only 338 fish (Rodriguez-Roda, 1973).

Catches in the Scandinavian and North Sea seine and line fisheries have fallen from an average of about 11,000 mt in the early 1950's to about 500 mt in the late 1960's and early 1970's (Figure 3).

The Japanese longline catch in the whole Atlantic is considerably below that in earlier years. Landings of bluefin have decreased

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[1] Report of the Sub-Committee on Stock Assessment, ICCAT Report 1969-1970

Report of the Sub-Committee on Stock Assessment, ICCAT Report 1970-1971

Report of the Sub-Committee on Stock Assessment, ICCAT Report 1971-1972

ICES Views Concerning Bluefin Tuna, SCRS/73/30

Views of the United States Concerning Atlantic Bluefin Tuna, Appendix 2 to Annex 3, ICCAT Report 1972-1973

Report of the Joint Meeting ICES-ICCAT Bluefin Tuna Working Groups: Charlottenlund Castle, 28 [sic] September 1974. ICES C.M. 1974/J:20, Pelagic Fish (Southern) Committee.

from around 12,000 mt in 1963 to an average of less than 1,000 mt from 1967 through 1972. Catch-per-unit-effort has decreased from a high of about 1.4 fish per thousand hooks in 1963 to less than 0.08 fish per thousand hooks in the period 1967-1971 (ICCAT, 1974, p. 113). Recent reports, however, indicate that good catches of bluefin have been made in the Mediterranean by the longline fleet in 1973 and 1974, the first years of a significant longline fishery in this area.

In the western North Atlantic, landings of large bluefin in the U.S. and Canadian fisheries have increased over the past few years, probably due in great part to an increase in effort because of high prices offered for fresh bluefin for export. Landings of giant bluefin by the U.S. and Canadian seine, trap, handline, harpoon, and sport fisheries will approximate 1,000 mt in 1974 compared to an average of about 600 mt throughout the 1960's. Lenarz (MS) has completed a cohort analysis based on available data of catch for the Atlantic as a whole and the western Atlantic alone. This analysis indicates that abundance of large fish has declined to a point in 1968-1971 that is well below levels that existed in 1960-1963. His data also suggest that the stocks of adult bluefin in the western North Atlantic will continue to decline through 1974 but would then level off or possibly even increase providing fishing mortality does not increase.

Counts of giant bluefin tuna conducted by aircraft and surface vessels in the Bahama Islands in 1951, 1952, and 1953 are approximately 50% above similar counts obtained in 1974 (personal communication, L. R. Rivas, NMFS, Miami, Florida). Approximately 75,000 adult bluefin tuna were estimated to have migrated along the eastern edge of the Gulf Stream past the islands of Cat Cay and Bimini during May and June of 1974.

In many of the fisheries for large bluefin tuna in the eastern North Atlantic and Mediterranean the average size has been steadily increasing over the past 10 to 20 years. In the Spanish Barbate trap the average weight between 1930 and 1946 was about 120 kg. In 1947 the average weight began to increase until by 1971 it was over 200 kg (Figure 4). In the Norwegian purse seine fishery the average weight of giant bluefin has increased from about 160 kg in the period 1956-1960 to almost 300 kg in the period 1966-1971. In the western North Atlantic similar increases have occurred. In the 1950's the average weight of giant bluefin tuna captured by rod and reel in the Bahama Islands was about 209 kg. By the early 1970's this had increased to about 266 kg (Table 1).

Assuming that availability factors have not changed, these observations imply a decrease in recruitment to the adult stocks. Other possible reasons for this increase in average size are that migration and distribution patterns have changed, or that one or more unusually large year-classes are moving through the fisheries and are dominant in the catches. Lenarz's (MS) studies indicate that year-classes in the early 1950's and again in 1965 (measured at age-1) were significantly greater than in the intervening years

(Figure 5). He cautions, however, that the estimate of a large 1965 year-class may be due merely to the assumption that the age composition of the Bay of Biscay fishery is the same as in the northwest Atlantic purse seine fishery. It is possible that the very large bluefin in the catches from the various large fish fisheries in the Atlantic are the survivors of those large year-classes in the 1950's. In any event, the increase in average size does probably represent a decrease in the recruitment.

The surface fisheries for small fish on both sides of the Atlantic have undergone wide fluctuations in catch (Figure 6). Landings of small bluefin from the Bay of Biscay fell from a peak of over 5,000 mt in 1954 to a low of around 1,000 mt in 1960 and 1964. Landings of small bluefin from the northwest Atlantic by the U.S. and Canadian purse seine fishery peaked at just over 5,000 mt in 1963 and 1964; declined to about 500 mt in 1968; rose to over 4,000 mt in 1970; and declined again to about 1,500 mt in 1973. Landings in 1974 were approximately 900 mt.

Recruitment and/or availability to these fisheries obviously varies considerably, however, recruitment does not appear to have collapsed despite rather large apparent reductions in the abundance of the spawning stock, particularly in the eastern Atlantic. Sakagawa (1974) showed that in the northwest Atlantic seine fishery the catch-per-unit-effort of ages 1-2 and ages 3-4 has generally increased. He cautions, however, that the analysis does not take into account the improved efficiency of the fleet through increased use of aircraft spotting and other reasons. In the early 1970's the catch-per-unit-effort showed a downward trend (Figure 7).

There is little information available from the eastern Atlantic on recent year-class strength. Lenarz (MS) states that catch-per-unit-effort data for the Spanish trap fishery suggests that there were significant fluctuations in year-class strength from the beginning of the surface fishery.

Although recruitment to the younger age groups appears to have remained relatively stable on both sides of the Atlantic despite rather large reductions in the abundance of large fish, there is little or no information available on the relationship between the size of the spawning stock and recruitment. The information available, however, indicates severe reductions in adult stocks in the eastern Atlantic and reductions on the order of 30% in the western Atlantic, in both cases despite the existence of the relatively large year-classes of the 1950's. If the stocks of large (8+) fish continue to decline, it is inevitable that at some point a significant reduction in recruitment will result.

Analyses of migration and mortality of small bluefin in the northwest Atlantic based on tagging (Mather et al., 1974) indicate that the exploitation rate is extremely high while the young fish are in the fishery. It was noted, however, that the small bluefin in the northwest Atlantic fishing area are not a closed population, and the high exploitation rate may not apply to the entire population but just that proportion entering the fishery. Estimates of instantaneous fishing mortality from 1964 to 1968 ranged from 0.278 to 0.995 with an average of 0.573. The authors cautioned that these may be underestimated since most of the sources of error act to decrease the estimate of fishing mortality.

In a separate analysis of mortality in the western Atlantic, Lenarz (MS) calculated 4-year averages of age-specific F for the years 1960-1971. Results indicated that mortality on age groups 1, 2, and 3 was lowest in the period 1960-1963, and highest in 1964-1967 (Figure 8). In 1968-1971 mortality on age-1's decreased and overall mortality decreased as well.

Yield-per-recruit estimates (Lenarz, MS) show that there would be little value from a yield-per-recruit standpoint in increasing the size at first capture in the surface fishery unless fishing effort could be redirected to the older age groups. If effort could be redirected toward older fish, a significant increase in yield-per-recruit would occur. Implications with regard to current recruitment to the spawning stock in the western Atlantic are evident if year-class strength is assumed constant since 1960. The increased catches of small fish (ages 2-5) from 1962 through 1967 means that the age groups recruiting to the adult spawning stock in 1969 through 1974 would have been of lesser abundance than previously. The catches decreased after 1967, not, however, to the pre-1962 level, which means that recruitment of age groups to the spawning stock should increase somewhat in the mid-1970's. Thus, if year-class strength is maintained at present levels, and fishing mortality is reduced below previous high levels, the population of adults should begin to increase almost immediately, i.e. from 1975 onwards if effective action is taken then.

Two management objectives would seem advisable at this time:

1. Increase the size of the spawning stock

The spawning stock (8+) in the North Atlantic will continue to decline in abundance unless fishing mortality on the adult fish is reduced significantly and recruitment to the spawning stock is increased. There is no information available on the relationship between recruitment and the size of the spawning stock, however, it would seem prudent to prevent further declines in the abundance of spawners to assure the maintenance of adequate recruitment.

Increased recruitment to the spawning stock can be obtained by a reduction of mortality on the young fish assuming that year-class abundance remains relatively constant. An immediate reduction of fishing mortality on young fish would take from 5 to 7 years to have full effect on the abundance of the spawning stock.

The situation in the eastern Atlantic seems rather more severe than in the western Atlantic where the reduction in fishing mortality since 1968 should result in improved recruitment to the spawning stock after 1975. The stock structure question, however, is still not resolved, and Atlantic-wide action is preferable at this time.

Lacking exact calculations of population size, reductions in fishing mortality may best be achieved by setting catch limits as a percentage of the average catch over the last few years. Total allowable catches in 1975, for example, might be taken as 75% of the 1968-1971 average. The magnitude and timing of the recovery of the spawning stock is controlled by the extent of the reduction in fishing mortality, thus a range of options is available. In order to assure a reduction in F, however, a reduction in catch of at least 25% is probably required. A greater reduction in small fish mortality would result in a more rapid buildup of the younger aged spawners and this might be desirable since

it is likely that the same total spawning potential would require a greater biomass of the younger age-groups. It might, however, also be desirable to severely reduce the mortality on older fish, particularly on the short term, so that the remaining large fish are maintained until the entering fish have a chance to contribute significantly to the spawning biomass.

2. Maximize yield-per-recruit

Given the necessity of reducing fishing mortality and hence immediate yield, the corollary action of increasing yield-per-recruit is also advisable. The estimation of yield-per-recruit is complicated by age-specific variations in F. The decrease in overall F may in fact decrease yield-per-recruit to some extent if the distribution of F on age-groups is not changed. However, examination of the weight-at-age table (Table 2) indicates that shifting the fishing mortality from age groups 1-5 to older fish would almost certainly increase yield-per-recruit. The exact increase is dependent on how the mortality is distributed over the various age groups. Fishing mortality on 0's and 1's seems at present to be low and yield-per-recruit would not be increased by eliminating catches of these age groups. However, a minimum size protecting these age classes would be advisable to prevent the shifting of fishing mortality to these age groups in the future, which probably would have the effect of reducing yield-per-recruit.

The management goals discussed here are in agreement with the goals listed by the Joint ICES-ICCAT Bluefin Tuna Working Group:

1. Short-term reduction in fishing intensity on giant fish to protect spawning stocks.
2. Long-term reduction in purse seine fishing of young fish to permit escapement of maturing fish.

The Group also added that a minimum size regulation would not necessarily be effective in the absence of regulation of mortality.

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Table 1. Lengths and weights of giant bluefin tuna from the Bahamas

	LENGTH (cm)			WEIGHT (kg)	
YEAR	N	RANGE	$\bar{X}$	RANGE	$\bar{X}$
1952	35	211-251	230	135-258	208
1953	30	204-250	230	145-280	207
1954	29	200-255	233	152-339	215
1955	35	210-257	230	153-311	208
1952-55:	129	200-257	231	135-339	209
1972	9	238-274	257	208-379	278
1973	49	213-286	253	147-346	258
1974	30	237-296	261	189-341	263
1972-74:	88	213-296	257	147-379	266

Table 2. - Age-length-weight key for Atlantic bluefin tuna. Data are from Mather and Jones (1972) and Mather (pers. comm.)

Age (years)	Fork Length (cm)	Weight (kg)
1	46-66	2.1-6.2
2	67-85	6.3-12.9
3	86-104	13.0-23.2
4	105-122	23.3-36.8
5	123-139	36.9-53.6
6	140-155	53.7-73.6
7	156-170	73.7-96.2
8	171-184	96.3-120.9
9	185-198	121.0-149.5
10	199-210	149.6-177.4
11	211-223	177.5-211.0
12	224-234	211.1-242.7
13	235-245	242.8-277.2
14+	246+	277.3+

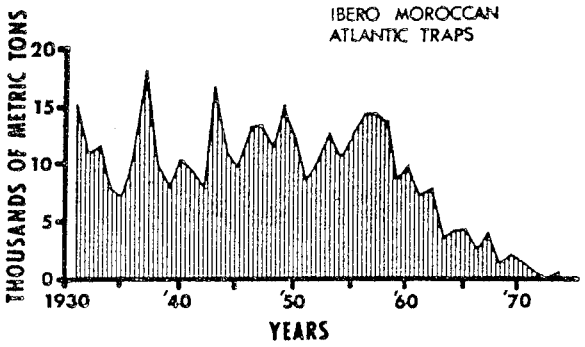


Figure 1. - Landings of bluefin tuna in thousands of metric tons from the Ibero-Moroccan Atlantic traps from 1930 to 1972 (taken from Mather, F.J. III, MS, Trends in bluefin tuna catches in the Atlantic Ocean and Mediterranean Sea).

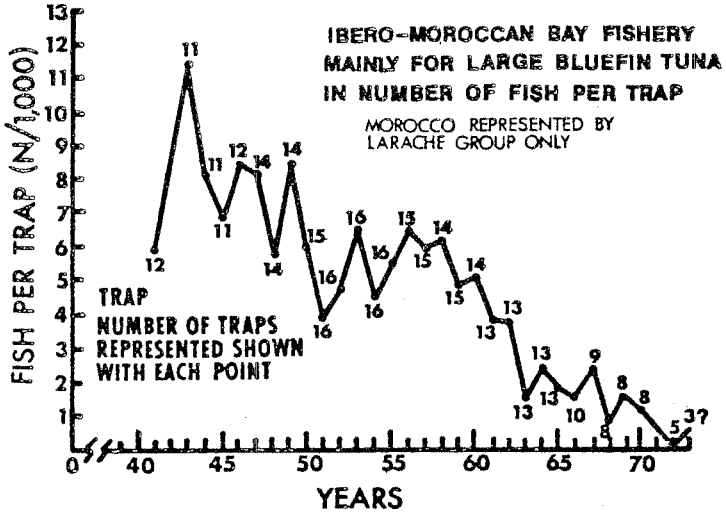


Figure 2. - Catch-per-unit-effort in number of fish caught per trap for the Ibero-Moroccan Bay trap fishery, 1940-1973 (taken from ICCAT Data Record, Vol. 3, 1974, p. 117).

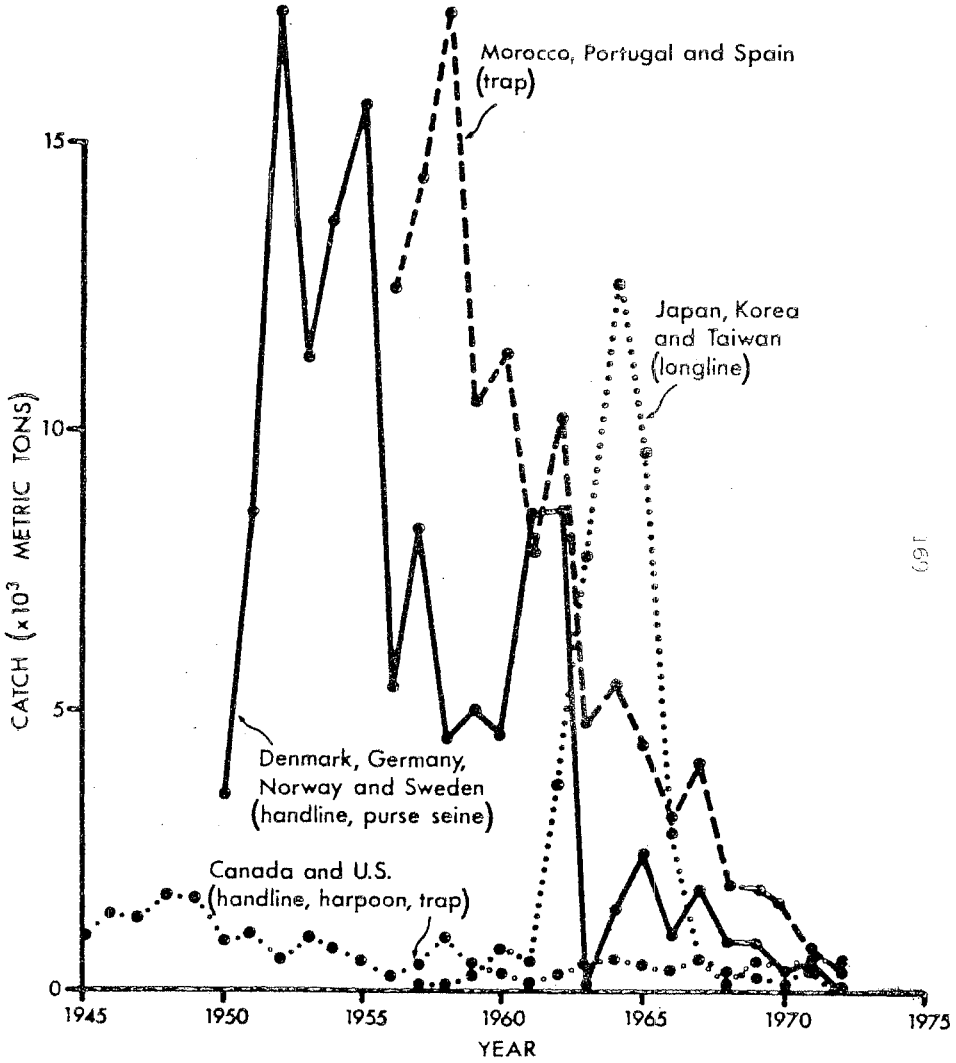
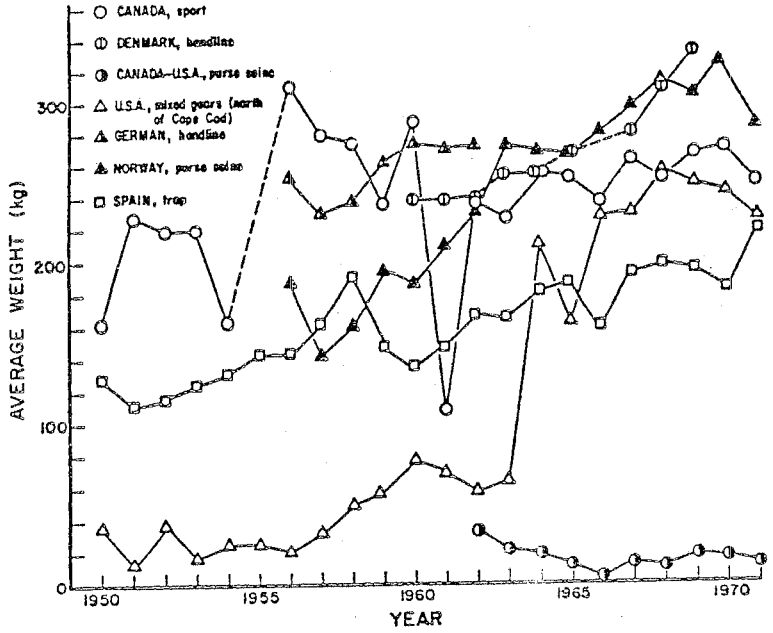
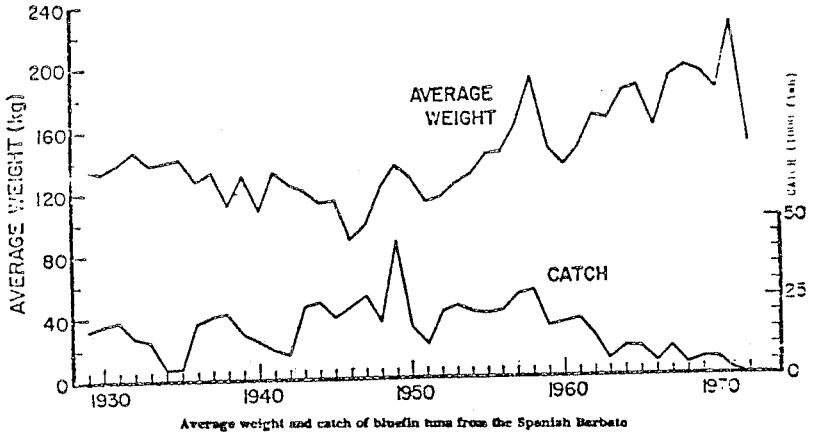


Figure 3. - Landings of bluefin tuna from the Atlantic Ocean by various fisheries, 1945-1972. (Figure compiled from data from Hamre, et al., 1966; Miyake and Tibbo, 1972; and Miyake et al., 1973).



Estimated average weight of Atlantic bluefin tuna caught by various fleets.



Average weight and catch of bluefin tuna from the Spanish Barbate

Figure 4. - Estimated average weights of bluefin tuna caught by various fleets (upper figure) and average weights and catch of bluefin tuna from the Spanish Barbate trap (taken from ICCAT Data Record, Vol. 3, 1974, p. 171).

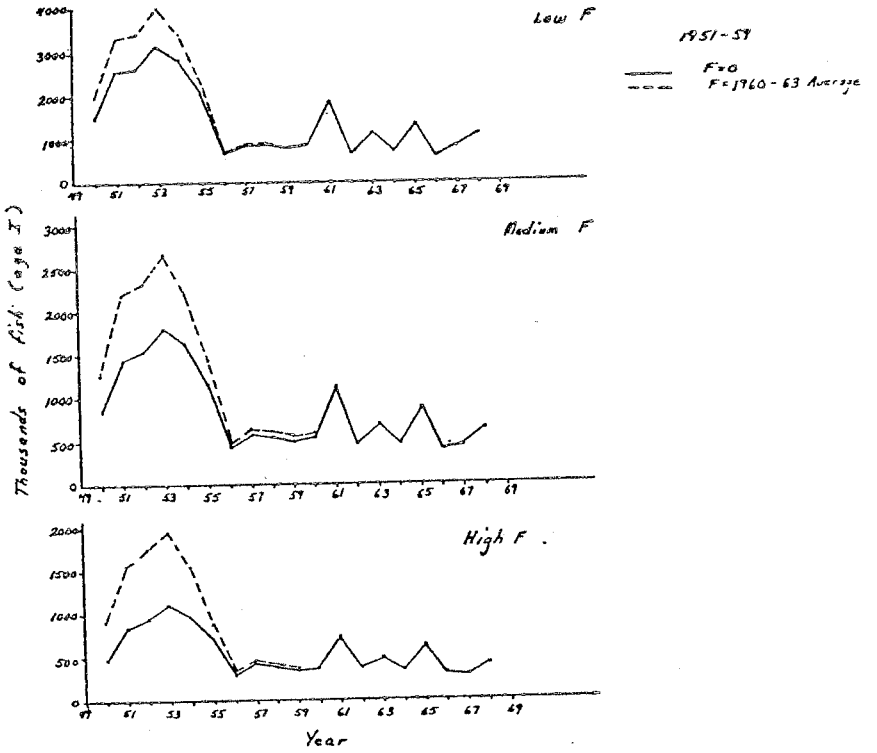


Figure 5. - Estimates of recruitment of age 1 bluefin to the western Atlantic Ocean (taken from Lenarz, MS).

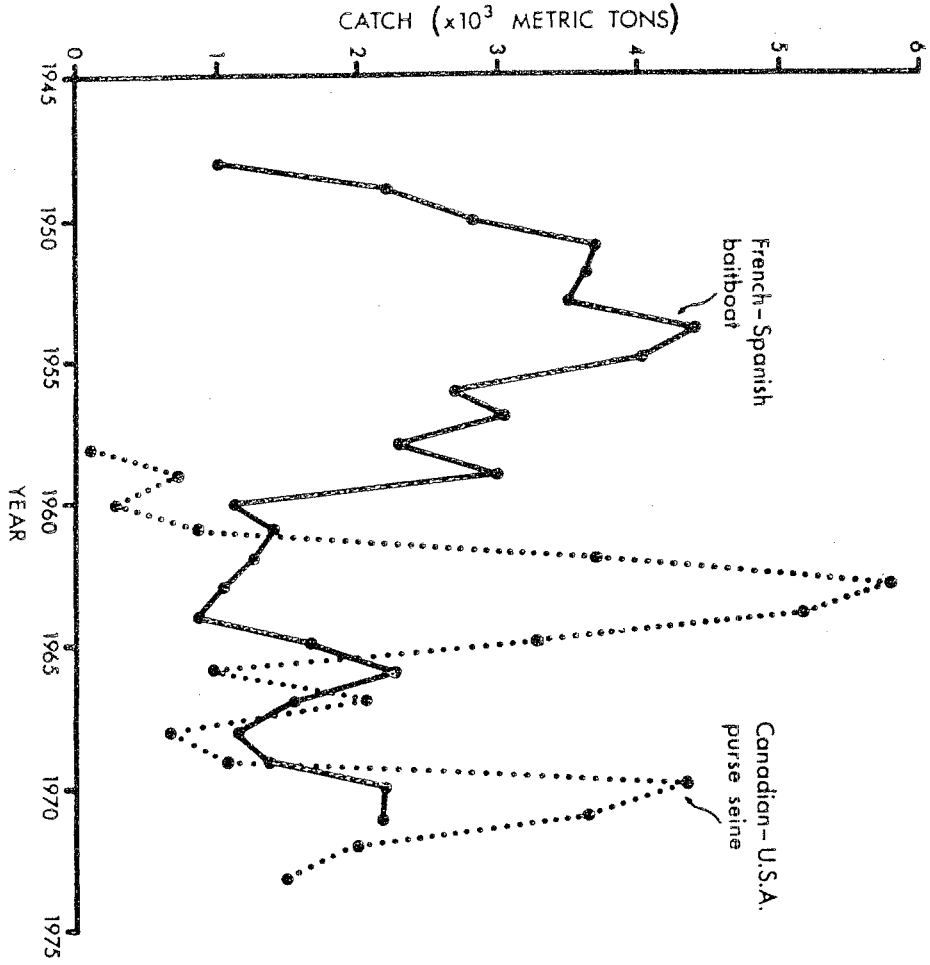


Figure 6. - Landings of bluefin tuna from the North Atlantic Ocean by the French-Spanish bait boat and troll fishery and the U.S.-Canadian purse seine fishery, 1948-1973 (Figure compiled from data from U.S. Fishery Statistics and Baird et al., 1973).

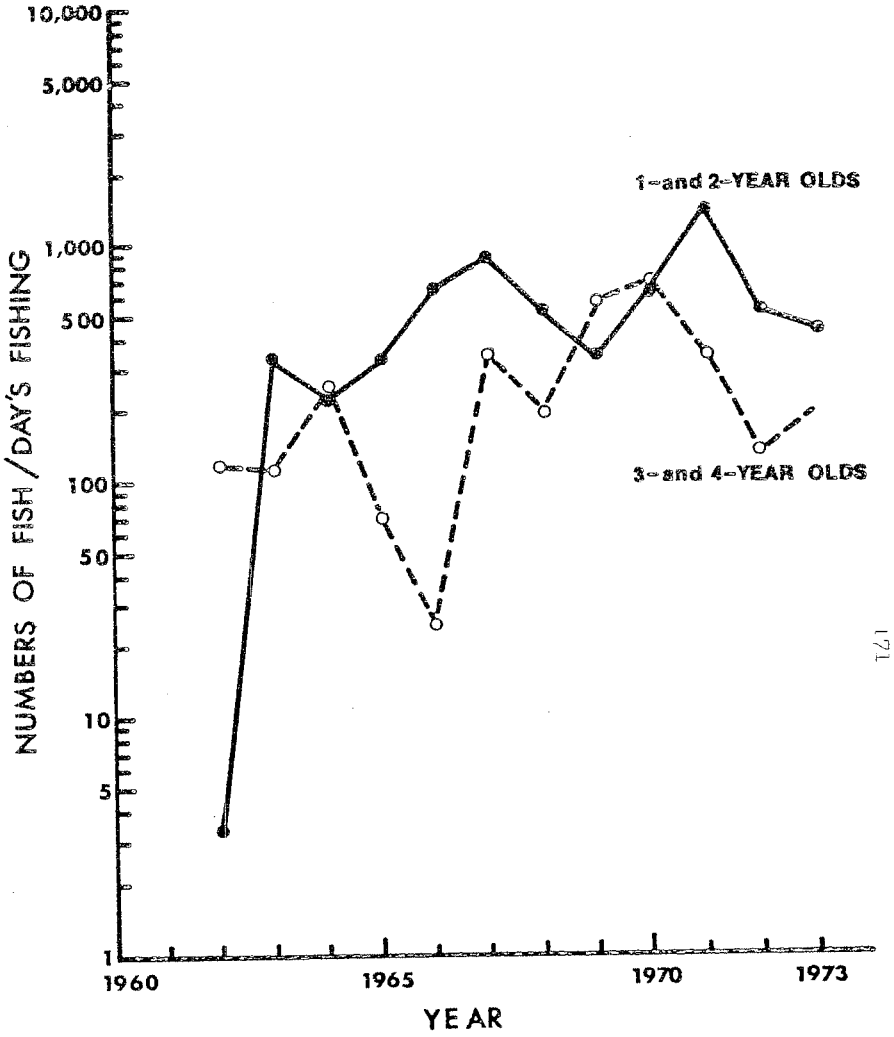


Figure 7. - Nominal catch rates of 1- and 2-year-old and 3- and 4-year-old bluefin tuna for Class 3 vessels in the purse seine fishery for bluefin tuna in the northwestern Atlantic (taken from Sakagawa, MS)

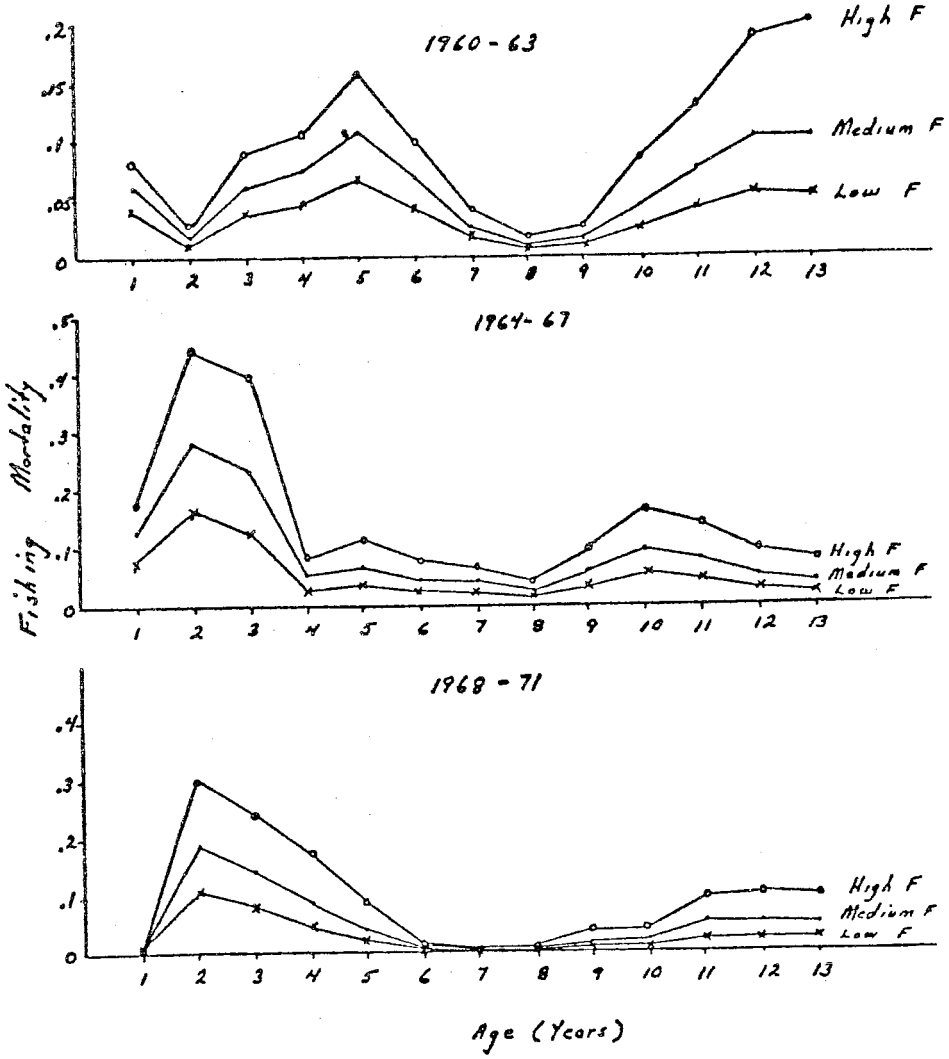


Figure 8. - Four year averages of age-specific fishing mortality for bluefin tuna in the western Atlantic Ocean (taken from Lenarz, MS).