

NOTE ON RELATIONSHIP BETWEEN RECENTLY ACQUIRED MARK RECAPTURE DATA AND
EXISTING AGE ESTIMATES FOR ATLANTIC BLUEFIN TUNA

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SUMMARY

Recent tag returns from Atlantic bluefin tuna extend available mark-recapture data from less than 10 years to 14 years. Lengths for age at recapture based on known or estimated ages at release and times at liberty are in reasonable agreement with existing length for age estimates based on studies of hard parts and analyses of mark-recapture data. A length asymptote of 314 cm and maximum age of about XXX seem reasonable.

RESUME

Les résultats obtenus récemment grâce au marquage de thon rouge de l'Atlantique ont permis d'étendre, de moins de 10 ans à 14 ans, la période pour laquelle on dispose de données de marquage/récupération. La taille à l'âge de la deuxième capture, calculée à partir de l'âge connu ou estimé lors de la première cap-

ture et du laps de temps écoulé, coïncide raisonnablement avec les estimations existantes de la taille à un âge donné faites à partir des études sur les pièces dures et de l'analyse des données de marquage/récupération. Une asymptote de la taille à 314 cm et un âge maximum d'environ XXX ans semble raisonnable.

RESUMEN

Unas recientes recuperaciones de marcas de atunes rojos en el Atlántico, amplían los datos disponibles de marcas y recapturas de menos de 10 a 14 años. Las tallas de edad en la recaptura- basadas en edades conocidas o estimadas a la liberación y sus épocas- concuerdan razonablemente con las estimaciones de talla=edad, basadas en estudios de las partes duras y análisis de datos de marcado-recaptura. Una asintota de talla 314 cm y de edad máxima de aproximadamente XXX, parece razonable.

INTRODUCTION

The present uncertainties about the growth and longevity of Atlantic bluefin tuna have been reduced by recently acquired mark-recapture data. There are considerable differences between existing age determinations for this species (Farrugio, 1979). Among the conclusions of the proceedings of the Atlantic bluefin tuna ageing workshop (Hunt, 1978) was the statement "Therefore, prior reports of ages of bluefin tuna beyond five years (and subsequent reports lacking validation) may be correct, or they may not be....especially beyond an age of 10 years." The deleterious effect of this lack of reliable growth data on stock assessments hardly requires emphasis.

Tagging and recovery data from conventional tags was one of the validation techniques mentioned in the above proceedings. Mason (*in* Hunt, 1978) listed much of the pertinent tag-recapture data then available. Parrack and Phares (1979) calculated a von Bertalanffy model for the growth of Atlantic bluefin tuna from these and other mark-recapture data.

METHODS AND DATA

Three returns obtained during the summer of 1979 in the program of the National Marine Fisheries Service and (formerly) the Woods Hole Oceanographic Institution extend the recorded time at liberty for tagged Atlantic bluefin from less than 10 years to 13-14 years. The data for these returns are in Table 1. In the following text, the returns are referred to by the numbers assigned to them in this table.

All of the fish were actually measured and weighed when recaptured. The release weight of 275 lbs (125 kg) for re-

turn no. 1 was estimated while the fish was alongside the vessel in the water, and cannot be regarded as exact. It seems reasonable, however, since the weights of 21 bluefin which were caught on the same longline set showed a distinct mode at 265 lbs (120 kg), with a range from 215 to 320 lbs (97.5-145 kg) (personal communication, P. C. Wilson, formerly of NMFS). The length data show a mode at 197 cm, corresponding to the weight of 275 lbs. The length of the fish when released is therefore estimated at 197 cm for purposes of age estimation. The fish involved in returns no. 2 and no. 3 were tagged on board the seine skiffs, affording much better opportunities for size estimation. The size differences between bluefin of ages I, II and III are very obvious and samples from the tagging sets were routinely measured. The estimated lengths of the fish may be slightly in error, but the errors could not be of sufficient magnitude to affect their estimated ages. Adding the times at liberty to the estimated ages when released, we obtain estimated ages when recaptured, which, with the sizes at recapture, are as follows:

Return no.	Release		Years at Liberty	Recapture		
	Length cm (est.)	Age ^a Years (est.)		Age Years (est.)	Length cm.	Weight kg.
1	197	8.8 ± 1	13.3	22 ± 1	279	288
2	78 ^b	2.2	14.1	16.3	256	397
3	75 ^b	2.2	13.1	15.3	251 ^b	329

^a Assuming birth date June 1 (Richards, 1976) and ages as estimated by Mather and Schuck, 1960.

^b Converted to "caliper" length from "tape" length, assuming: caliper length = .958 tape length

VALIDATION OF PREVIOUS AGE DETERMINATIONS

These sizes for known (returns no. 2 and no. 3) or estimated (return no. 1) ages are compared with previous age determinations. Points corresponding with these sizes are plotted on the growth curves of Butler *et al.* (1977) (Figure 1) and Parrack and Phares (1979) (Figure 2). They are also plotted on the collections of length for age (Figure 3) and weight for age (Figure 4) curves reproduced by Farrugio (1979). Because of the uncertainty about the age at recapture for return no. 1, it is represented by three points, at ages XXI-XXIII. All of the points lie very close to the curve of Butler *et al.* (1978) for male bluefin. Unfortunately, the sexes of the recaptured fish were not reported. The point for return no. 1, if the age at recapture is assumed to be XXIII years, falls almost on the Parrack-Phares (1979) curve. The points for ages XXII and XXI are about five and eight cm above this curve, respectively. The points for returns no. 2 and no. 3 each lie about 8 cm above this curve. The points for all three returns lie near the center of the mass of linear growth curves reproduced by Farrugio (1979) (Figure 3), or would if the curves were extrapolated to reach ages XXI-XXIII. On the ponderal growth curves of Farrugio (1979), however, the point for return no. 1 apparently falls considerably below the extrapolations of all of the curves. The weight reported for this fish is indeed surprisingly low in relation to its length, even though it was caught in the "return" (postspawning) fishery when the fish are very lean, and eastern Atlantic bluefin generally are lighter for the same length than their western Atlantic counterparts (see Figure 1 in Farrugio, 1979). The weight for

return no. 3, on the other hand, lies close to the center of these curves with the exception of the Berry and Lee (1977) curve. The point for return no. 2 is actually beyond the range of Farrugio's curves, but seems to occupy a relative position close to that for return no. 3.

LONGEVITY

These tag returns together with other data also yield some clues as to the longevity of the Atlantic bluefin tuna. Return no. 3, 15 years old, 251 cm long and weighing 725 lbs (329 kg) falls into the modal group in the weight frequency distributions (Figure 5) of the U.S. handgear fishery for giant bluefin in each of the years 1976-1979. Return no. 2, 16 years old, 256 cm long and weighing 875 lbs (397 kg) falls into the second most important group (800-900 lbs, 363-408 kg) in the 1978 and 1979 landings (Figure 5). If the ages of these fish were normal for their sizes, their ages relative to the entire catch would have been average or slightly above average rather than exceptional. Return no. 1 was from a fish which was about 22 years old, 279 cm long and reportedly weighed 288 kg. This length would have corresponded to a weight of about 1,000 lbs (454 kg) in the U.S. late summer fishery. This would place it between the third and second heaviest weight groups represented in Figure 5, but several fish in the 1,000-1,100 lb (454-499 kg) and some in the 1,100-1,200 lb (499-544 kg) were taken in 1979. Three of these, weighing 1,080-1,120 lbs (490-508 kg), were 300 ± 1 cm long (personal communications, Capt. C. A. Mayo, Jr., and Capt. F. Cyganowski, both of Massachusetts). The von Bertalanffy growth curve shown in Figure 2 of Parrack and Phares (1979) (reproduced in part as Figure 3 in the cited

work and Figure 2 in the present document) indicates a length of about 297 cm for a bluefin XXX years old. Thus, the three individuals mentioned above were probably about XXX years old. Considerably larger bluefin have been recorded. The recent rod and reel record bluefin weighed 1,235 lbs (560 kg) and was 129" (328 cm) long (probably overall length) (personal communication, E. K. Harry, President, International Game Fish Association). This record has just been exceeded by a bluefin 303 cm long and weighing 1496 lbs (678 kg) caught in Canadian waters (personal communication, M. J. A. Butler, Huntsman Marine Laboratory, St. Andrews, New Brunswick, Canada). Sarà (1969) reported the capture of two bluefin weighing 625 and 685 kg (1,378 and 1,510 lbs), respectively, in traps off Sardinia in 1969.

The asymptotic lengths calculated by Butler *et al.* (1977) were 286 cm for males and 277 cm for females. These figures seem too low, since, as noted above, bluefin up to at least 300 cm long have been reliably recorded. The asymptote calculated by Parrack and Phares (1979), 313 cm, is close to the observed maximum. Considering the decrease in growth rate as the asymptote is approached, it seems certain that many of the bluefin in the 900-1,100 lb (408-544 kg) weight groups were XX to XXX years old, and that some of these and many of the larger individuals were over XXX years old.

CONCLUSIONS

Occurrences in nature, recorded as release-recapture data for tagged bluefin tuna which had been at liberty for 13-14 years, tend to confirm two separately derived von Bertalanffy linear growth models. The earlier of these (Butler *et al.*, 1977) was based on otolith readings from

giant bluefin taken in Canadian waters in 1975, and determinations for ages I-IV by Mather and Schuck (1960). The later, by Parrack and Phares (1979), was based on release-recapture data from bluefin tagging results, with a maximum time at liberty of less than 10 years. Sizes at recapture of two fish, whose ages at recapture were XV and XVI, respectively, and of a third whose age at recapture is believed to have been XXII \pm I, fall within 8 cm or less of the curve for male bluefin of Butler *et al.* (1977) and the curve of Parrack and Phares (1979). Length data from some very large bluefin indicate that the asymptotic length of 313 cm calculated by the latter authors is more realistic than those of 286 cm for males and 277 cm for females calculated by the former. The results tend to confirm both curves, but data from very large fish suggest that the Parrack-Phares version may be more accurate at very old ages. Both studies represent distinct advances, since previous works do not appear to have improved significantly over that of Sella (1929), which seems reasonably accurate up to age XIV. While further validation is obviously desirable these present data strongly support these two growth studies and justify their use in stock assessments.

These growth curves and size data for bluefin catches in several areas indicate that many of the largest bluefin are from XX to XXX years old, and that some of them are probably over XXX years old.

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Table 1.

Return Number	Date	Release		Size (est.) Length	Weight	Date	Recapture		Size (meas.) Length	Weight
		Lat. N	Lon. W				Lat. N	Lon. W		
1.	26 Mar '66	37°24'	67°03'		275 lbs.	30 Jul '79	36°09'	50°56'	279 cm	288 kg
2.	22 Jul '65	39°22'	73°28'	32"		9 Sep '79	42°43'	70°25'	101"	875 lbs
3.	21 Jul '66	39°52'	73°36'	30"-32"		11 Sep '79	41°51'	70°26'	103"	725 lbs

Measurements are tabulated as reported by the taggers and returners of the tags.

*Measured from snout to fork of tail with tape laid along the side of the fish (tape or curved measurement). Other lengths were measured from snout to fork of tail with calipers (caliper or straight measurement).

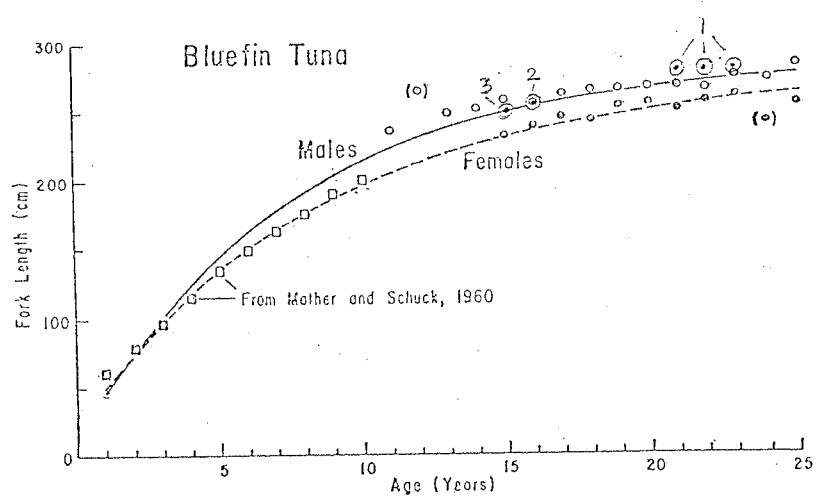


Figure 1. Separate fits of von Bertalanffy growth curves to mean fork length at age (as determined from otolith readings) for male and female giant bluefin tuna taken in Canadian waters in 1975 (bracketed values omitted). Mean sizes at age (series combined) from Mather and Schuck (1960) for ages 1-4 (closed squares) used in fitting both curves (from Butler, Caddy, Dickson, Hunt and Burnett, 1977). Points in circles represent lengths of tagged fish at ages when recaptured.

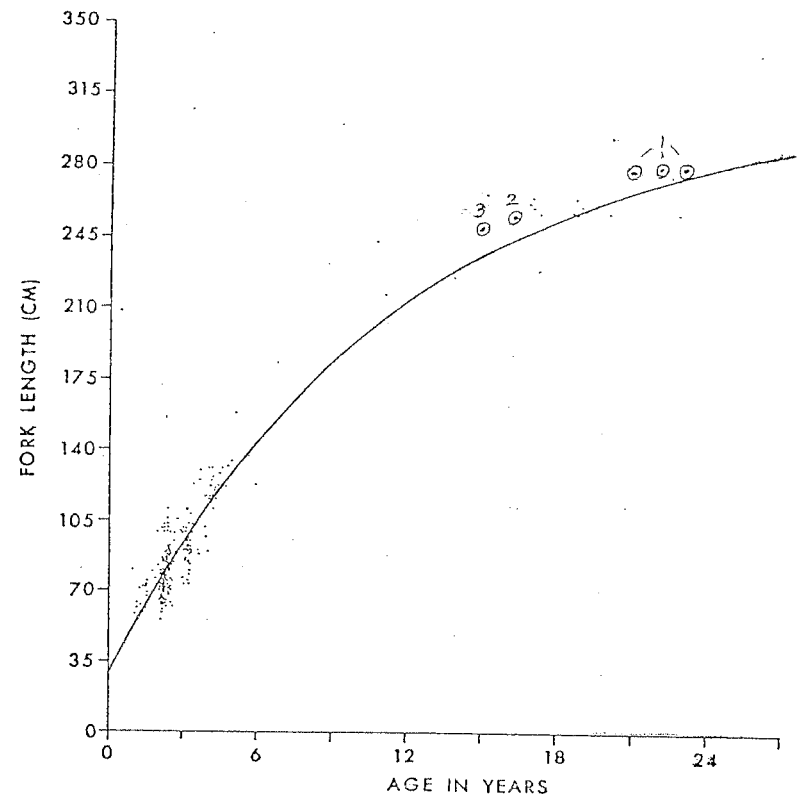


Figure 2. The von Bertalanffy growth model for Atlantic bluefin tuna derived from mark-recapture data (from Parrack and Phares, 1979). Points in circles represent lengths of tagged fish at age when recaptured.

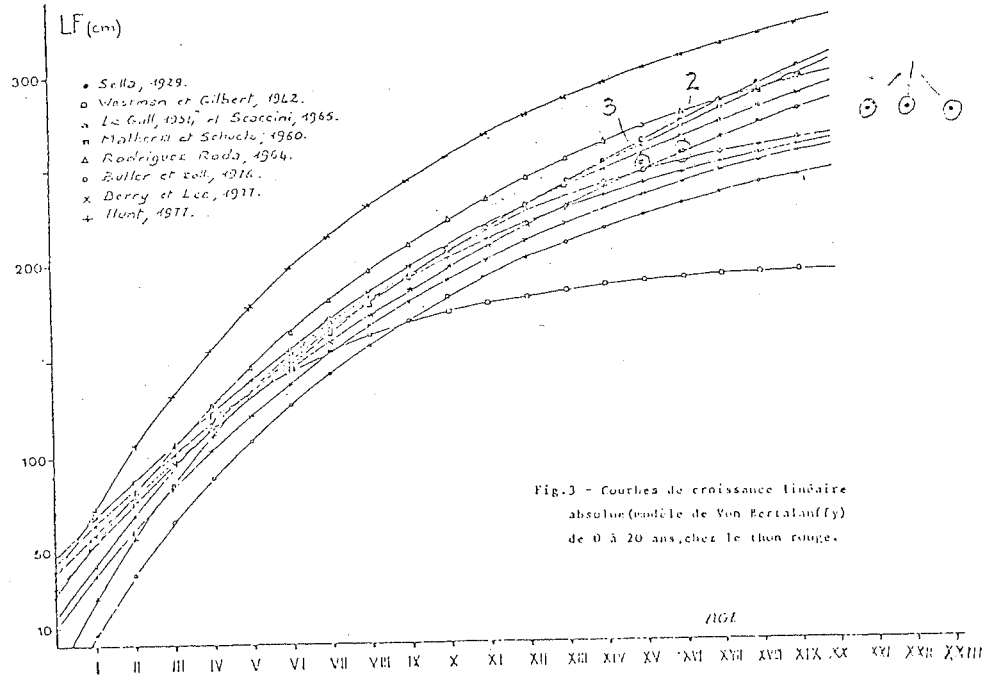


Figure 3. Absolute linear growth curves (von Bertalanffy model) from 0 to XX years (age scale extended to XXIII years) for bluefin tuna (from Farrugio, 1979). Points in circles represent lengths of tagged fish at ages when recaptured.

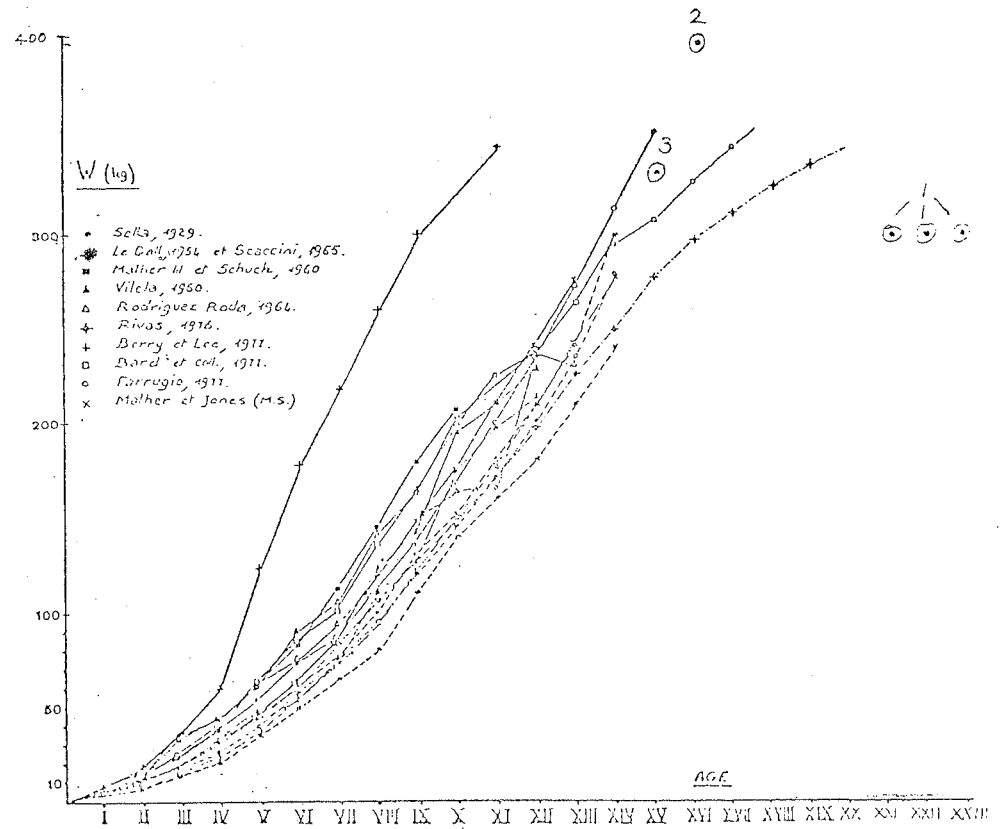


Figure 4. Absolute growth in weight up to the twentieth year (the age scale has been extended to XXIII years) after various authors (from Farrugio, 1979). Points in circles represent weights of tagged fish at ages when recaptured.

U.S. GIANT BLUEFIN TUNA HANDGEAR DATA — ACTUAL SIZE FREQUENCY OF FISH LANDED (THROUGH OCT 1979)

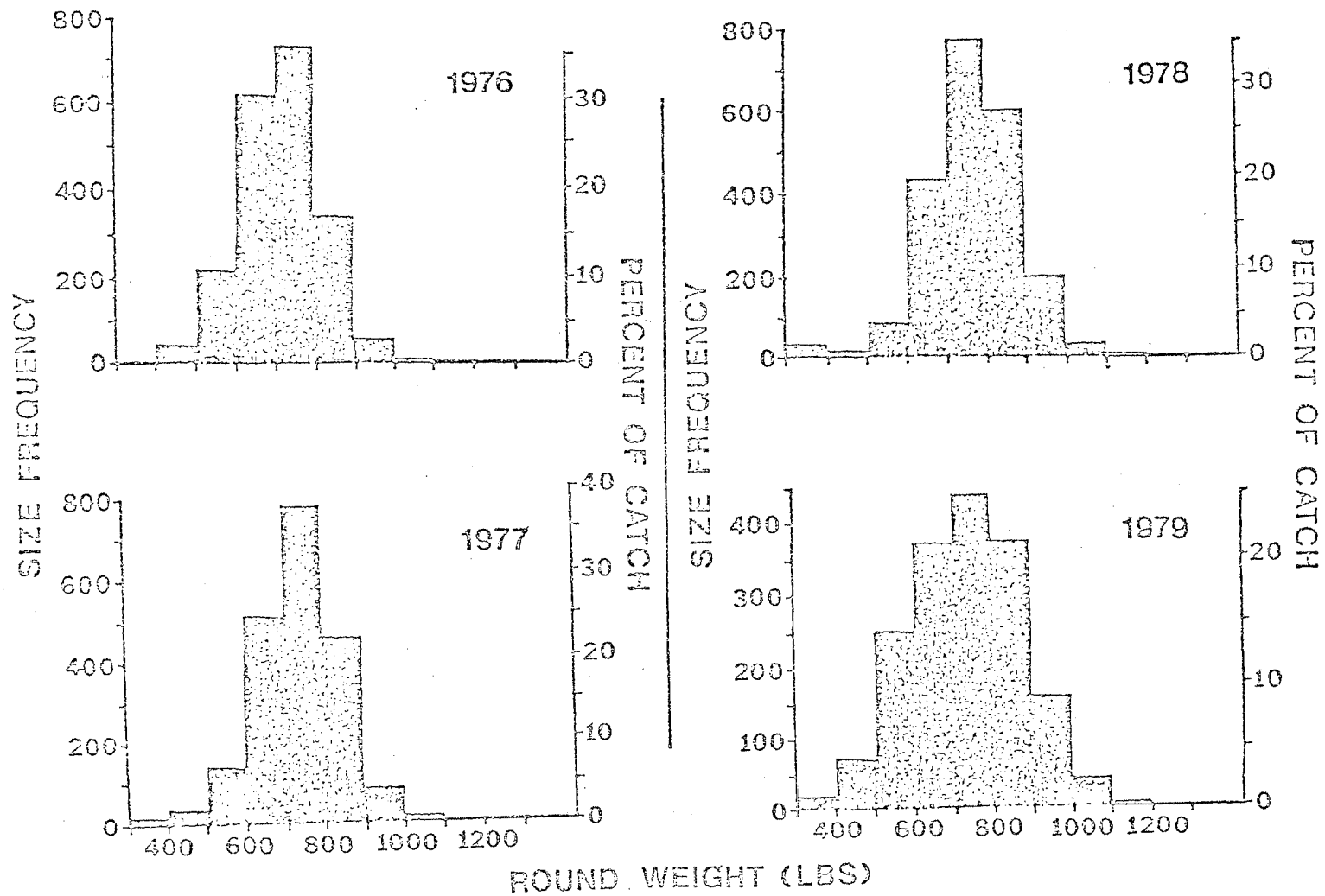


Figure 5. From Southeast Fisheries Center Status Report Atlantic Bluefin Tuna October 16, 1979.