NOTE ON UPDATED TAG-RECAPTURE GROWTH ANALYSES FOR NORTH ATLANTIC ALBACORE

BY

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ABSTRACT

Updated estimation of observed pattern in growth is presented based on release and recapture data analysis obtained from spanish tagging programs in the Cantabrian Sea, 1986 - 1993.

RESUMEN

Se presenta un análisis actualizado del modelo de crecimiento observado basado en los datos de marcado/recaptura obtenidos a partir de los programas de marcado españoles en el mar Cantábrico, desde 1986 - 1993.

INTRODUCTION

One of the aims of the Special Program of Albacore (PSG) was the use of marking studies to investigate growth patterns in the albacore population among other biological aspects that are frequently analyzed from tagging experiments.

A recent study that used the Fabens analytical method (Fabens,1965) to obtain estimates of asymptotic size and growth rate constant was that of Ortiz de Zarate et al. 1994. That study used the tag recapture data from the surface fisheries through 1992. Growth results found in that study differed slighlty from previous analyses with the estimate of the asymptotic size parameter, L_∞ lower than that in previous studies (106 cm vs 124 and 114 cm) and the growth rate parameter, k, was slightly higher (0.32 vs 0.22 and 0.26). These results were explained to be largely due to the lack of the larger and older individuals in the data set. However, similar size at age values were yielded as in other albacore growth analyses.

Ortiz de Zarate et al. (1994) observed that with increasing size an apparent negative bias in the residual of recapture size was present indicating that the expected recapture size modeled was smaller than the observed data. They considered that this was not unexpected since the data set contained few large fish but also noted that this might be partially due to not including terms for individual variability into the model.

Likewise, they noted that earlier albacore growth analyses (Bard 1981, WG 1989) did not consider either the effect of individual variation in growth on results and suggested that this be considered in analyzing the albacore growth pattern.

This study updated the tag recapture growth analysis of Ortiz de Zarate et al. (1994) using least squares methods and attempted to incorporate individual variability into growth parameter estimation.

MATERIALS

The total number of fish released from 1986 to 1991 included a total of 12,288 fish. Recoveries obtained during the period between 1986 and 1993, comprised a total of 393 recaptured albacore

As in the previous study, information recorded for each tag and recaptured fish used in this analysis included the date, location, length and gear. Size was recorded in fork length to the nearest one centimeter.

Tagged fish are caught during the months of June through November by the surface fleets: bait boat, troll, gillnets, and mid-water trawl.

The data analyzed were selected according to the protocol as in the previous study. The analysis set included recovered fish that were at liberty more than 180 days, assuming that after this period the fish would have mixed, an amount of positive growth could be expected, and bias caused by seasonal changes in growth would be eliminated. The size distribution of release fish is shown in Figure 1 and the data set is included in Table 1.

MODELS INVESTIGATED

Four models were fitted to the updated mark-recapture data to obtain growth parameter estimates, asymptotic size (L_∞) and growth rate constant (K) according to von Bertalanffy (1938) growth model.

The first fit was Fabens non-linear least squares (LS) model applied as in SCRS/93/97. The Fabens method assumes model error to be a random normal variate and error variance constant with increasing time at liberty.

The second fit used the Maximum Likelihood Estimation (MLE) model outlined in Hampton (1991). The variability in recapture size was included by means of the observed variance calculation for 5 cm release size groups.

Two other fits to the data included terms for variation in individual asymptotic size and in growth rate. The Kirkwood and Sommers (1984) model, accounting for varying asymptotic size was used with an added term for model error, as suggested in Hampton (1991). The fourth fit was that of Sainsbury (1977, 1980) and included terms for variability in both asymptotic size and in growth rate. These two fits were made using MLE functions given by Hampton and parameter estimates were obtained using the Simplex algorithm (Nelder and Mead 1965).

individual variation in the L ∞ and K parameters were not supported by the data.

The Marquardt-Levenberg algorithm (Levenberg 1944; Marquardt 1963) was used to find least squares estimates (unweighted) of the growth rate parameter, K, and the asymptotic size, L ∞, for the direct observations of length increment and time out. Although this model does not account for individual variation, the results from this fit were chosen to be presented because this model gave the only fit that provided reasonable results for both growth parameters for the albacore population.

Non-linear least squares parameter estimates of the growth rate, K, and L ∞, were found to be 0.306 and 108 cm for our data set of 243 fish (Table 2). These results suggest that the estimates of L ∞ are quite variable for these data (CV=0.54). The estimate of the CV of the growth rate parameter, K, was 0.15.

These results may be compared with those from earlier tagging studies (Anon 1990 and Ortiz de Zarate et al. 1994) when modelling size at some specific age by simple comparisons across studies.

For comparison purposes a t_0 value equal to -1.246 was estimated assuming a fork length of 55 cm at age = 1.08, as derived from the observed mode in the size distribution of released individuals as plotted in Figure 1.

DISCUSSION and CONCLUSIONS

As in the previous study, the LS estimate of L ∞ is still smaller according to maximum observed size in the commercial catches from the North Atlantic stock (FL = 120 cm). We believe this value may be low due to lack of large fish in the recapture data. Only a very few fish were recaptured over 80 cm in length, which is quite far from largest size observed in the stock.

These updated LS values of L ∞ and K, are in reasonable agreement with estimates from prior tagging analysis, although the data set input between studies are different. These results are given in Table 3.

Plots of the residual errors in observed-expected growth against recapture size are shown in Figure 4 for the Fabens LS fit. These results are similar to previous results and again suggest that the

Plot of the residuals from observed and predicted recapture size againts time at liberty are given in Figure 5 for the Fabens LS fit. This figure shows, that for the longest period of time at liberty in the data set, a larger number of observations exist with a predicted recapture size greater than observed. This observation could be an artifact of sampling for few observations existed in the data set having large at liberty times or this could be related to model performance.

The Fabens method used in the analysis to fit the von Bertalanffy equation does not allow the variance of the growth increment to vary with the initial length respectively. It has been shown that these variances are a function of the independent variable, initial length, whenever there is individual variability in K or L infinity (Sainsbury 1980). The effects of this analysis could be varied and begins with too much weight given to observations of the dependent variable, growth increment, in the region where its variance is high. Then the results of the analysis would be sensitive to bias affecting obervations in this region of the independent variable, initial length.

Individual differences in growth can also have an effect on the description of the growth of a group and not incorporating the individual variability can result in biased estimates of the mean of parameter values used to described the population.

Results from the MLE approach were in disagreement with those from LS and the model did not fit the data well. Of the reasons that might explain this performance is the lack of sufficient number of individuals in the data series having large increment size and long time at liberty pairs of observations.

This study was based upon recaptures of released individuals from the surface fisheries of ages one or two. The surface fisheries mainly target immature fishes of age five or less. It is not likely that recoveries from the surface fisheries will provide observations for longer time periods. Growth patterns modelled through these data represent the growth of fish of age five or less.

Estimates of K and L_∞ from tag recapture data were updated through LS methods. The estimate of L infinity had large variance and the model did not fit the data well. Future tag recapture data growth analyses could incorporate effects of model error.

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Table 1. Albacore tag-recapture data used in the analysis (N = 243).

Release size mm	Recapture size mm	Days at liberty	Release size mm	Recapture size mm	Days at liberty
530	670	262	790	860	238
550	690	282	540	670	285
550	640	289	520	640	295
550	650	297	570	660	300
460	650	303	550	660	305
770	860	311	540	620	315
510	600	316	510	670	316
560	660	322	630	680	323
560	650	324	600	720	323
620	680	326	520	610	327
550	690	329	590	730	331
700	830	329	590	720	331
470	670	332	570	680	332
640	800	332	590	740	333
600	660	334	580	710	335
660	740	335	710	810	335
610	790	337	640	720	337
670	750	337	690	820	337
560	750	338	600	820	338
650	700	339	540	600	340
570	630	340	570	660	340
620	710	340	650	800	341
680	740	342	680	770	342
550	630	343	560	630	343
680	770	343	590	720	344
640	770	344	600	650	344
660	740	344	520	670	345
570	710	346	520	680	347
560	670	347	580	690	347
610	700	347	550	700	348
560	700	348	650	840	348
660	720	348	550	680	349
600	770	349	650	840	349
610	730	351	600	730	352
560	720	353	580	710	353
650	720	353	570	710	354
590	670	354	670	730	354
590	720	355	700	780	355

Table 1. (Continued).

Release size mm	Recapture size mm	Days at liberty	Release size mm	Recapture size mm	Days at liberty
570	700	363	600	750	363
560	700	364	560	720	364
650	760	364	700	850	364
550	670	365	550	810	716
560	780	365	610	720	365
640	830	365	840	940	365
690	810	366	560	680	367
580	740	367	640	750	367
660	790	367	570	720	368
530	720	369	550	720	369
570	740	369	550	630	370
560	670	370	650	760	370
560	690	371	590	680	371
620	720	371	540	650	372
660	810	372	710	820	373
570	700	374	680	770	374
580	770	375	550	680	376
580	740	376	540	670	377
590	750	379	540	690	380
580	680	380	590	710	380
560	730	381	670	830	381
710	880	381	660	790	382
740	890	382	580	760	383
680	800	383	550	680	384
910	1000	384	600	710	386
550	630	387	620	720	387
770	860	388	540	650	389
540	720	389	560	710	390
580	770	390	670	770	390
560	720	391	540	670	396
590	710	398	650	770	398
650	820	398	560	700	399
560	700	399	800	860	399
590	750	400	670	830	402
570	830	403	640	790	403
590	710	404	550	710	405
720	840	407	650	760	408
680	760	427	660	880	429
690	910	430	490	720	594

Table 1. (Continued).

Release size mm	Recapture size mm	Days at liberty	Release size mm	Recapture size mm	Days at liberty
510	750	700	570	800	700
540	750	702	540	800	704
550	845	706	510	760	708
530	780	708	550	840	708
560	820	708	570	750	708
540	870	710	560	720	710
580	750	710	530	900	711
550	770	712	520	850	714
530	720	715	600	710	715
580	770	719	530	760	720
590	860	722	560	830	723
530	700	727	510	760	731
570	800	732	580	830	736
550	720	737	560	840	741
580	870	742	520	830	743
590	840	743	510	760	746
690	880	746	540	830	747
540	770	748	530	840	749
550	780	751	560	850	753
530	770	763	550	840	764
540	800	766	590	820	767
590	860	768	540	740	771
580	870	777	590	770	795
570	800	809	570	910	827
600	760	1014	560	800	1047
550	800	1068	570	920	1111
560	790	1115	570	920	1118
530	870	1169	550	890	1170
520	870	1395			

Table 2. Results of the least squares fit of the von Berlanffy growth model to Spanish North Atlantic albacore mark-recapture data (n = 243).

Source	Sums of Squares	Mean Square
s2(i)	139293000.0000	575590.9300
s2(i)-average[s2]	1259712.0000	5205.4213
s2(i)-Model s2(i)	404386.4000	1677.9520

		Variances and Covariances	
Parameter	Estimate	S_∞	k
S_∞	1082.091	3383.31220	-2.64657
k	.306	-2.64657	.00211

$$s = 1082.091 - 622.091 \cdot \exp(-.306 \cdot \blacktriangle t)$$

Table 3. Growth parameters estimates derived from different studies for North Atlantic Albacore.

	Growth Parameters		
Author	L infinity	K	t_o
WS 1989 *	114.17	0.2284	-0.989
ORTIZ de ZARATE et al., 1994 **	106.2	0.320	-1.206
Present study **	108.21	0.306	-1.246

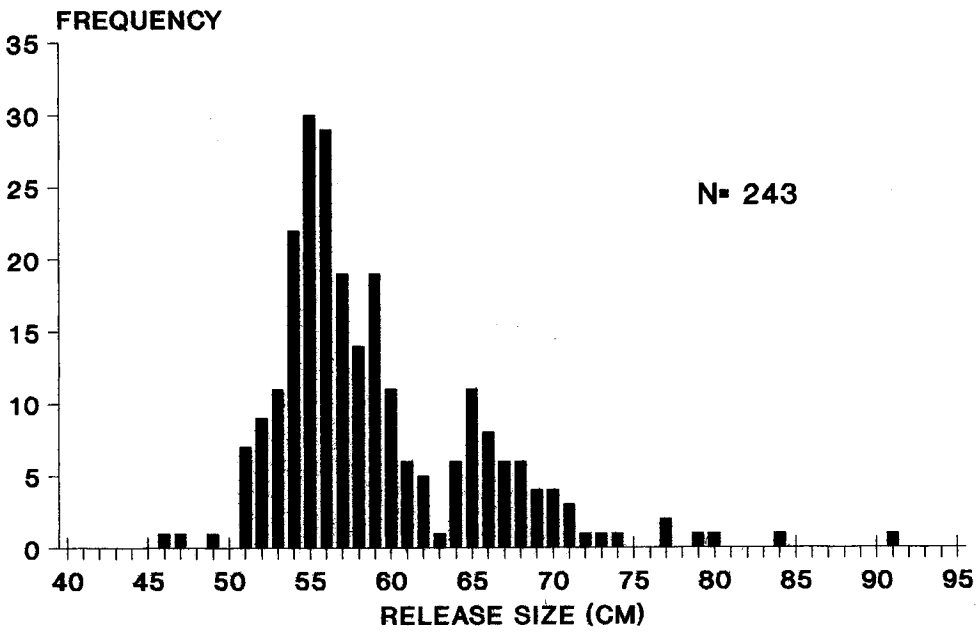


Figure 1. Size data for released tagged fish used in the growth analysis.

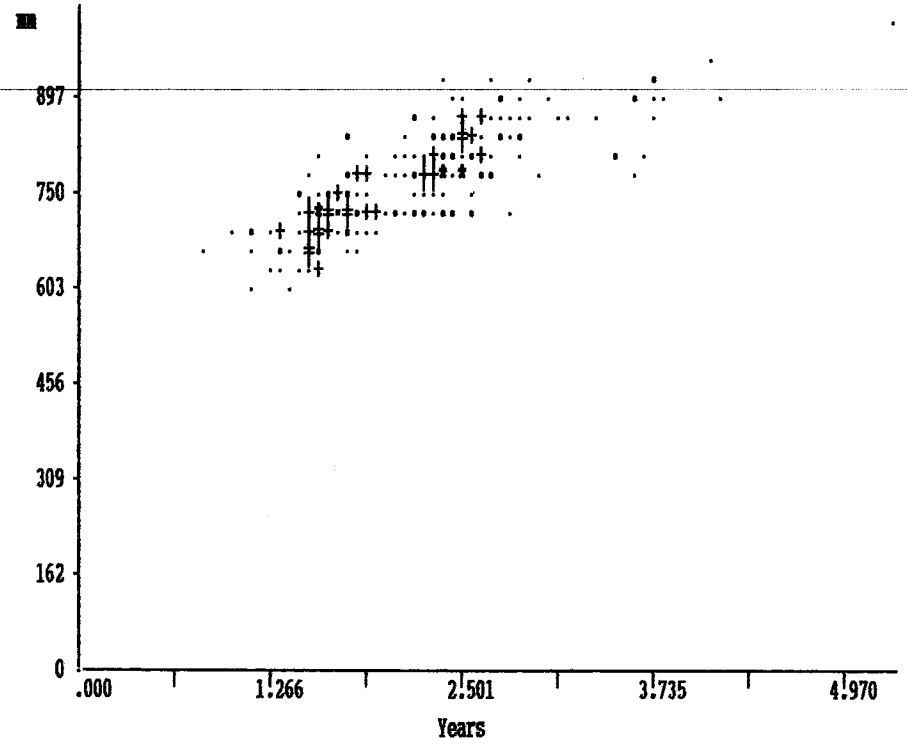
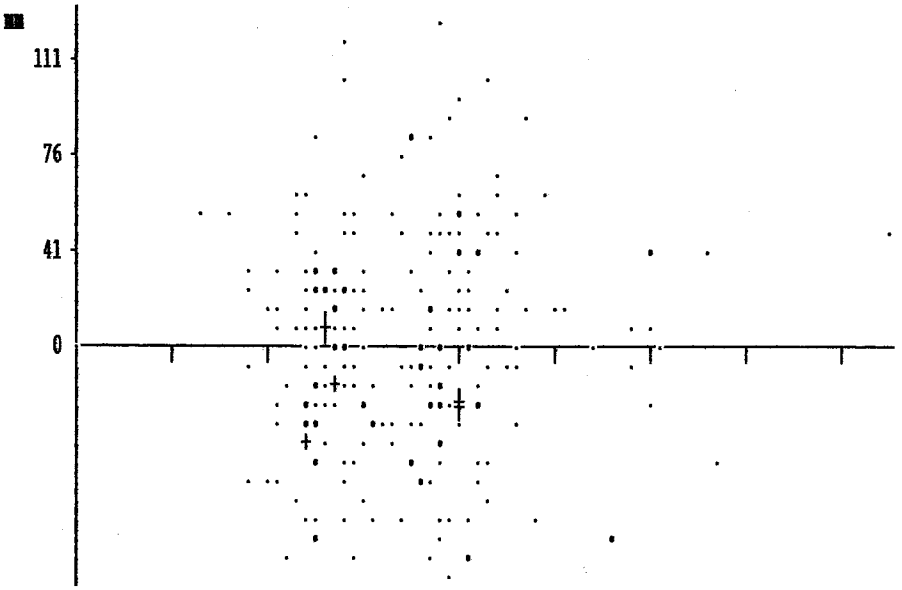


Figure 2. Recapture size versus expected age.



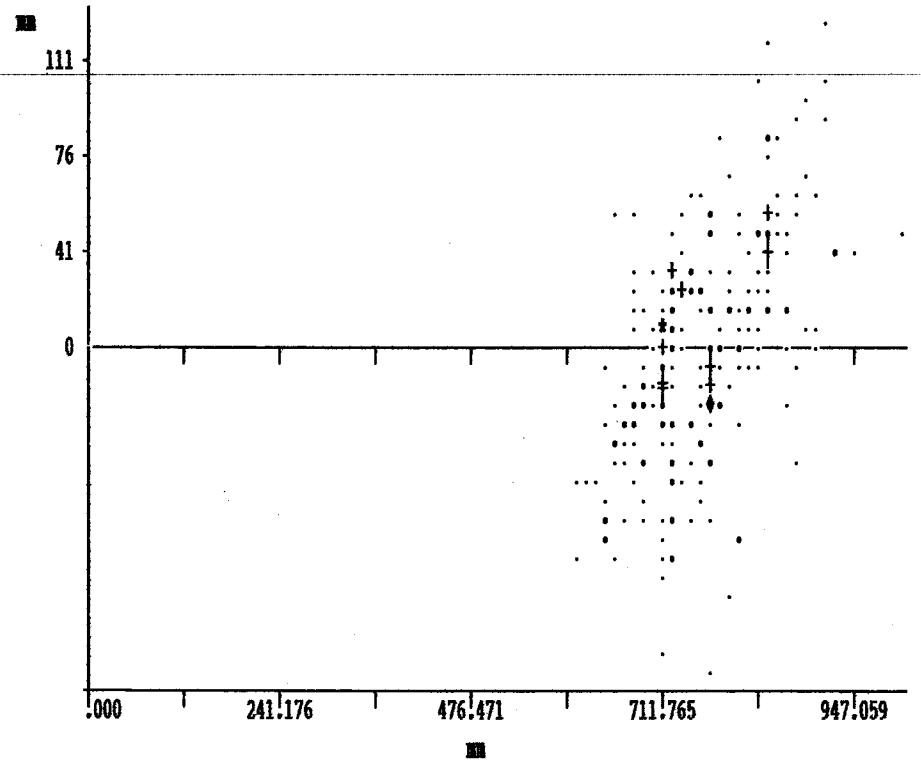
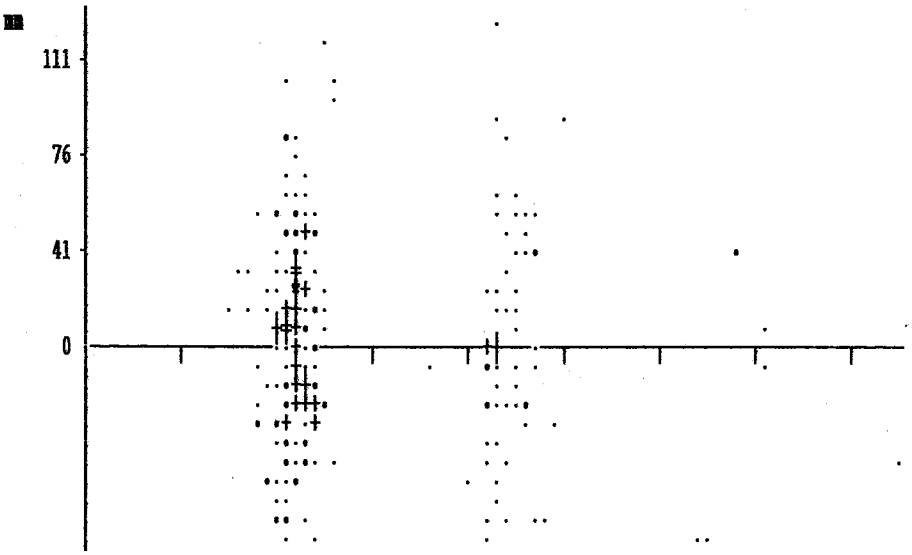
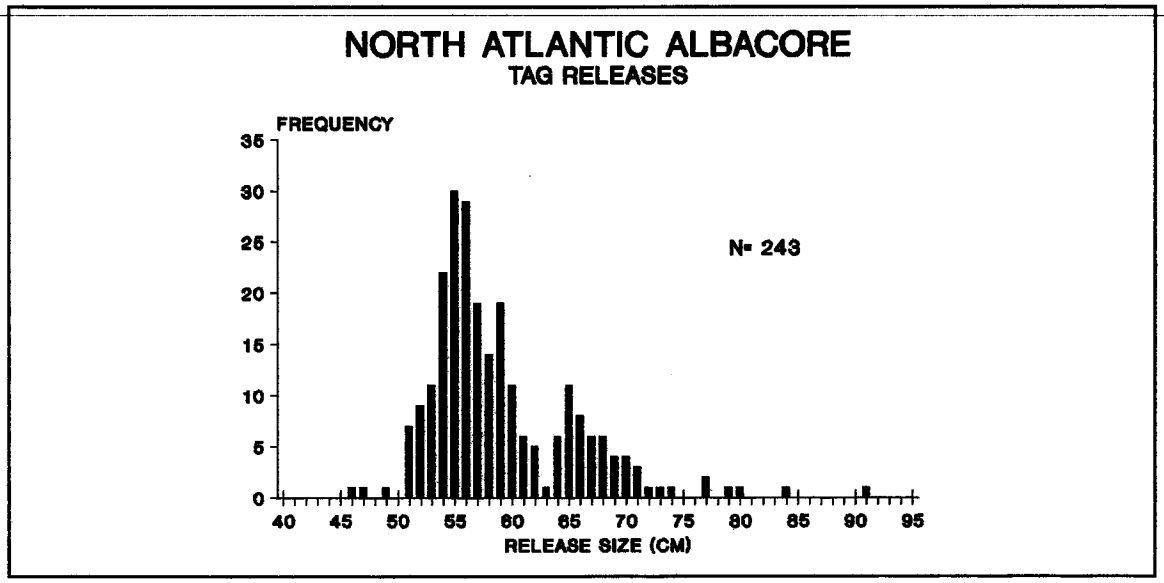


Figure 4. Observed minus estimated recapture length versus recapture size.





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