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A Revision of the Catch-At-Age Matrix for Pollock (*Pollachius virens*) in Divisions 4VWX and Subarea 5

by

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Abstract

The 1984 commercial catch at age was examined in detail and the variance associated with post stratification aggregative procedures was analyzed. This analysis compared the results of taking all samples within a year as a single entity versus aggregating samples by area, gear, and time of year. The variance in a one stage sampling of age composition for ages 2-5 and 8^+ was reduced by stratification using the above criteria whereas for ages 6-7 it did not produce any gains. A new catch at age was constructed and documented to allow a thorough examination of the variance associated with each matrix. Results of the stratification procedures were used wherever possible in the revision of the catch at age for pollock for the period 1970-1985.

Résumé

Les prises par âge de la pêche commerciale en 1984 ont été étudiées en détail et la variance liée à des méthodes d'agrégation post-stratification a été analysée. Cette analyse a comparé les résultats obtenus lorsqu'on considère tous les échantillons au cours d'une année comme une entité distincte, comparativement aux résultats obtenus avec l'agrégation des échantillons par région, engin de pêche et temps de l'année. La variance dans un échantillonnage en une étape de la composition de l'âge pour les âges 2-5 et 8+ a été réduite par stratification à l'aide des critères indiqués ci-dessus, tandis que pour les âges 6-7, cette méthode n'a pas apporté d'amélioration. Une nouvelle prise par âge a été élaborée et documentée pour permettre une étude approfondie de la variance liée à chaque matrice. Les résultats des méthodes de stratification ont été utilisés, chaque fois que la chose était possible, pour la révision des prises par âge pour le goberge pendant la période de 1970 à 1985.

Introduction

The representation of a population through the aggregation of samples poses a number of problems, including the choice of stratification procedures, sampling intensity, aspects of precision and bias and accuracy. Inevitably there is a cost associated with any form of aggregation, which can be deduced through changes in the estimates of sample variance. One reason to look at these problems in detail with respect to fisheries management is that these data are the basic input for cohort or Virtual Population Analysis (VPA) upon which advice is generated. The underlying assumption that the population is both biologically and statistically representative is therefore of crucial importance. Previously, there has been a tendency to keep these sets of criteria separate, because it has yet to be shown that aggregation based on purely statistical considerations, consistently reflects such biological phenoemena as spatial inhomogeneity or the relative strength of cohorts and incoming recruits.

The natural approach to the statistical aspect of the problem would be to document the change in variance as aggregation procedures work through a hierarchy of predefined strata. Such an analysis would be based on the comparison of combinations of subsamples of a possible sample to give an estimate of the variance within a sample (Cochran 1977). However, such detailed subsampling is often impossible, and thus strata (as defined by gear, time, and area) are not generally represented in direct proportion to landings by each criterion. Moreover, it is not certain that the combinations of data used to form such strata aggregates are derived from similar statistical distributions (Smith and Maguire 1983).

To simplify the problem, and still leave some understanding as to the variance structure of the data, we have examined the data for 1984 in detail, in an attempt to understand whether or not the stratification procedures used in the rest of the matrix are influencing the variance to an undue degree. The results of these analyses are described below together with a presentation of the catch-at-age matrices themselves.

Methods

Catch-at-age data for 1984 were aggregated by area (Divisions 4VW, 4X, and Subarea 5) by gear (OTB TC4+) and time of year (Jan-Apr, May-Aug, Sept-Dec) (Table 1). The effectiveness of the stratification was assessed by looking at successive age intervals (which would be normalized to fit the underlying assumption of the model in use) using parameters defined in Hoeisaeter and Matthiesen (1979), Smith and Maguire (1983), Mohn et al. (1985), and Gavaris and Smith (1986):

$$V_{ran} = 1/n \left[\sum_i W_i \, s_i^2 + \sum_i (y_i - y_{st})^2\right]$$

$$V_{st} = \sum_i W_i^2 \, s_i^2 \, / \, n_i$$

where W_i are the strata weights, s_i the strata standard deviation, y_i the

strata means and y_{st} the weighted overall mean. V_{ran} is the variance for a simple random model and V_{st} is the variance for the stratified model. Gains or losses due to stratification can thus be directly assessed using the formula:

$$\text{Gain} = (V_{ran} - V_{st}) / V_{st}$$

A gain of 1 is equivalent to halving the variance of the estimated mean. Construction of the catch-at-age matrices followed on from the above analyses using the Marine Fish Division age/length system (QUIK), which produces variances according to Gavaris and Gavaris (1983).

Results

I) Estimation of the Effects of Stratification in Sampling

As shown in Table 1, the gains as derived by Cochran's and Hoeisaeter's methods were very similar for ages 3-7; for ages 8-10 the latter showed higher gains in stratification but in general there was always a gain in terms of variance where representation tended to diminish (i.e. at older ages). Overall the gains derived from pooling ages were only appreciable (20-30% when ages 3-6 were combined) when large aggregates were formed. There was a loss when ages 6-8 were combined, which although small (approximately 14-18%), indicates some diversification in length-at-age in these ages across areas. Moreover, the impact of strong year-classes appears to enhance the gains made by stratification rather than increasing homogenization of the population. When compared to proportions-at-age in the R.V. surveys (Figure 1), these findings are borne out.

An analysis of this type should be an essential part of the annual process of aggregation and post-hoc stratification, because it may be that a reduction in a variance estimate-at-age could in turn influence the weighting given to a particular point in a regression analysis of cohort results versus an independent estimate of exploitation. Moreover, the question of the types of distributions from which these data are obtained is one which at present is generally overlooked, but which could be of immense importance (eg. see Smith and Maguire, 1983; in which a compound multinomial distribution assumption was considered more appropriate than a series of simple multinomial distributions for combining length frequency samples). Without an idea of the variance structure of aggregates and the gains or losses associated with stratification as derived above, such analyses will continue to sit outside the general framework of fisheries assessment.

II) Construction of Catch-At-Age Matrices

Based on the results obtained for 1984, stratification by gear, area, and age was set up as in Table 1 whenever possible, to reconstruct the catch-at-age matrix for pollock. Given below are the sources of data for the various sub-matrices that go into the final matrix, including one for Canada, U.S.A., Foreign, and USSR.

CANADA:

Age compositions were derived via MFD age length system (QUIK) using R.V. survey length weight regression parameters as indicated (Table 2). In the case of missing information (resulting from incomplete or limited sampling) samples were prorated as indicated:

1) OTB-1,2 (TC4+) Division 4X and Subarea 5 1970-1985 data available for complete series.

2) OTB-1,2 (TC4+) Divisions 4VW 1971, 1972 based on proportions in (1).

3) OTB-1,2 (TC1-3) Divisions 4VWX + Subareas 5 1970-1978 based on proportions in (1) and (2).

4) GN, LL, etc. Divisions 4VWX and Subarea 5 1970-1974 based on proportions in (1).

The catch, weights at age, and sums of products plus the variance of the catch at age are given (Tables 3 and 4). A comparison between the variance from the catch matrix constructed above and one in which there was no stratification of samples showed that there was a gain in stratification for partially recruited age groups (i.e. ages 2, 3, 4, and 10, 11, 11+) but a loss in some fully recruited ages (Table 5). For strong year-classes however, the benefit for stratification was noticeable at all ages.

U.S.A.:

Sampling of USA catch was extremely limited prior to 1973 and age length keys were not available until 1977. Consequently, estimates of the age composition of the USA catches from 1973 to 1976 were obtained by applying USA length frequencies and Canadian age length keys with Canadian length frequencies being applied to USA landings for months in which USA data were unavailable (Clark et al. 1981). Because of inconsistencies in the USA data and the associated sums of products, the age composition of the USA component of the catch from 1970 to 1976 was based on the proportions derived from the Canadian catch-at-age matrix for Division 4X and Subarea 5 (OTB 1-2, TC 4+).

Since 1977, USA length frequencies and age length keys have been applied independently to their respective component of the fishery by gear type, and the catch and weight at age supplied by N.M.F.S. (R. Mayo, pers. comm.) (Table 6a). Substantial differences, especially in the years 1973 to 1976, in the catch-at-age and weight-at-age in this new matrix invalidate the matrix used in previous assessment documents. Table 6b gives the ratio of the old USA catch-at-age to the new.

Foreign (except USSR but including Newfoundland):

Estimates were based on Canadian commercial samples from Divisions 4VW as most of the distant water fleet catches since 1963 have been taken in Divisions 4VW (Table 7).

U.S.S.R.:

Age composition for the small mesh USSR fishery was based on proportions derived from Canadian research vessel summer groundfish surveys conducted from 1970 through 1985 (Table 8).

Total Catch At Age:

The total catch-at-age and weight-at-age matrices are given (Table 9a), plus the results of a cohort analysis to examine the differences between populations given by the catch-at-age matrix used to generate the 1985 advice and that given here (Table 11). Identical conditions for the cohort analysis were used (F_t = .35, average PR). The population (2 + numbers), recruitment (age 2) and population biomass were not significantly different in any year, although some changes in the weight-at-age were observed due to changes in the U.S.A. matrices. It is thus concluded that the matrix presented will not effect the outcome of advice given in the long term with respect to previous advice; however the matrices are now internally consistent and their formulation can be repeated without difficulty. Table 9b gives the ratio of the new total catch at age to the old.

A comparison of observed and predicted catch-at-age for 1985 is found in Table 10. Differences between the 2 vectors were small for ages 3-5; large changes between ages 6, 7, and 11 were due to changes in the new catch-at-age matrix.

Research Conclusions and Recommendations

Changes in the variance of samples associated with post stratification can be observed: in poorly represented classes within samples, aggregation procedures reduce variance estimates in absolute terms. However, the effects on distributional aspects have not been examined. Sampling of the catch by length categories introduces the high likelihood that the commercial samples will be represented by compound multinomial distributions. Therefore to assess the rigor of aggregation procedures it is necessary that these initial data be i) normalized by looking at aggregates of length categories, ii) characterized according to the Pearson family of distributions (of which there are 11); iii) aggregated according to membership of the Pearson family; and iv) comparisons made between samples constrained to a single Pearson distribution. The moments of such analyses should then be examined in the light of stratification by those used in this assessment (i.e. area, gear, and season).

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Table 1. Strata used and results of analyses for various age groups.

Strata 1 4X and 5; Jan-Dec OTB TC4+; 9 samples

Strata 2 4VW; Jan-Apr; OTB TC4+; 6 samples

Strata 3 4VW; May-Aug; OTB TC4+; 15 samples

Strata 4 4VW; Sept-Dec; OTB TC4+; 9 samples

Age Composition	Gain (Cochran, 1977)	Gain (Hoeisaeter & Matthiesen, 1979)
3	.0181	.0598
4	.0671	.1181
5	.1364	.1902
6	-.2725	-.2267
7	-.1769	-.1250
8	.0573	.1084
9	.0861	.1513
10	.5716	.6769
11	-.0898	-.0472
3 + 4 + 5	.0149	.0738
3 + 4	.0021	.0515
3 + 4 + 5 + 6	.2192	.2908
6 + 7 + 8	-.1885	-.1412

Table 2. Grouping of catch by gears and time period for estimation of removals-at-age. OTB trawls are primarily stern bottom trawls, but there are some side trawls; GN are gillnets, LL are longlines, and others are primarily inshore fisheries.

Year	Period	Tonnage Class	Gears	No. of Samples	Area	Number Aged	Number Measured	Catch (t)	Weight-Length Relationship a	b	Cruise	
1970	April	TC 4+	OTB	1	4VW	55	966	1870	0.01427	2.93733	Cameron 175/176	July 1970
	Jan-Dec	TC 4+	OTB	5	4X+5	178	1348	4135	0.00937	3.07143	Cameron 175/176	July 1970
1971	no samples - 4VW											
	Jan-Dec	TC 4+	OTB	5	4X+5	170	889	6465	0.03004	2.74758	Cameron 188/189	July 1971
1972	no samples - 4VW											
	Jan-Dec	TC4 4+	OTB	6	4X+5	182	1101	11399	0.01871	2.89470	Cameron 201/202	July 1972
1973	Jan-Dec	TC 4+	OTB	7	4VW	276	1564	3155	0.018154	2.88880	Cameron 212/213	July 1973
	Jan-Dec	TC 4+	OTB	11	4X+5	416	2208	10725	0.014285	2.93835	Cameron 212/213	July 1973
1974	Jan-Dec	TC 4+	OTB	3	4VW	136	733	2426	0.01676	2.89081	Cameron 225/226	July 1974
	Jan-Dec	TC 4+	OTB	24	4X+5	762	5470	13371	0.02385	2.80718	Cameron 225/226	July 1974
1975	Jan-Dec	TC 1-6	GN, LL, Other	1	4VWX+5	32	224	6331	0.02286	2.83914	Cameron 236/237	July 1975
	Jan-Dec	TC 4+	OTB	5	4VW	188	1259	3891	0.01676	2.89081	Cameron 236/237	July 1975
	Jan-Dec	TC 4+	OTB	18	4X+5	716	4451	12102	0.02286	2.83914	Cameron 236/237	July 1975
1976	Jan-Dec	TC 1-6	GN, LL, Other	2	4VWX+5	63	445	7687	0.00588	3.13928	Cameron 250/251	July 1976
	Jan-Dec	TC 4+	OTB	7	4VW	306	1790	2230	0.00996	3.03793	Cameron 250/251	July 1976
	Jan-Dec	TC 4+	OTB	22	4X+5	803	5354	9041	0.00588	3.13928	Cameron 250/251	July 1976
1977	Jan-Dec	TC 1-6	GN, LL, Other	1	4VWX+5	30	256	4880	0.03096	2.76665	Cameron 265/266	July 1977
	Jan-Dec	TC 4+	OTB	16	4VW	736	4321	6794	0.01251	2.99009	Cameron 265/266	July 1977
	Jan-Dec	TC 4+	OTB	36	4X+5	1420	8182	9028	0.03046	2.76665	Cameron 265/266	July 1977
1978	Jan-Dec	TC 1-6	GN, LL, Other	10	4VWX+5	179	1821	6152	0.027	2.81326	Cameron 279/280	July 1978
	Jan-Dec	TC 4+	OTB	14	4VW	529	4786	5899	0.02081	2.86517	Cameron 279/280	July 1978
	Jan-Dec	TC 4+	OTB	31	4X+5	1019	8513	10446	0.0270	2.81326	Cameron 279/280	July 1978
1979	Jan-Dec	TC 1-6	GN, LL, Other	3	4VWX+5	137	938	7685	0.01350	2.95963	Cameron 292/293	July 1979
	Jan-Dec	TC 1-3	OTB	2	4VWX+5	56	387	6092	0.01350	2.95963	Cameron 292/293	July 1979
	Jan-Apr	TC 4+	OTB	3	4VW	99	853	1331	0.04196	2.67328	Hammond 13/14	March 1979
	May-Aug	TC 4+	OTB	28	4VW	875	8458	5008	0.01358	2.97418	Cameron 292/293	July 1979
	Sept-Dec	TC 4+	OTB	1	4VW	23	194	1710	0.00924	3.05383	Hammond 26/27	Oct 1979
	Jan-Apr	TC 4+	OTB	5	4X+5	161	1179	3414	0.0114	2.98252	Hammond 13/14	March 1979
	May-Aug	TC 4+	OTB	5	4X+5	174	1547	3246	0.01350	2.95963	Cameron 292/293	July 1979
	Sept-Dec	TC 4+	OTB	1	4X+5	37	266	982	0.00388	3.26457	Hammond 26/27	Oct 1979

Table 2. Continued.

Year	Period	Tonnage Class	Gears	No. of Samples	Area	Number Aged	Number Measured	Catch (t)	Weight-Length Relationship a	b	Cruise	
1980	Jan-Dec	TC 1-6	GN, LL, Other	3	4VWX+5	55	377	9351	0.04400	2.6941	Cameron 306/307	July 1980
	Jan-Dec	TC 1-3	OTB	9	4VWX+5	286	2135	6685	0.04400	2.6941	Cameron 306/307	July 1980
	Jan-Apr	TC 4+	OTB	9	4VW	282	2023	2315	0.01931	2.84627	Hammond 33/34	March 1980
	May-Aug	TC 4+	OTB	2	4VW	88	833	3849	0.03871	2.70659	Cameron 306/307	July 1980
	Sept-Dec	TC 4+	OTB	10	4VW	335	2462	3235	0.00864	3.08543	Hammond 42/43	Oct 1980
	Jan-Apr	TC 4+	OTB	10	4X+5	320	2650	4307	0.00782	3.06568	Hammond 33/34	March 1980
	May-Aug	TC 4+	OTB	6	4X+5	172	1418	3409	0.04400	2.69410	Cameron 306/307	July 1980
	Sept-Dec	TC 4+	OTB	12	4X+5	444	2541	2380	0.00820	3.09256	Hammond 42/43	Oct 1980
1981	Jan-Dec	TC 1-6	GN, LL, Other	8	4VWX+5	216	1810	9829	0.01246	2.98215	Hammond 64/65	Oct 1981
	Jan-Dec	TC 1-3	OTB	27	4VWX+5	901	6010	6268	0.01859	2.92225	Cameron 321/322	July 1981
	Jan-Apr	TC 4+	OTB	8	4VW	224	2099	3903	0.00581	3.12942	Hammond 48/49	March 1981
	May-Aug	TC 4+	OTB	5	4VW	143	1261	1342	0.03077	2.76718	Cameron 321/322	July 1981
	Sept-Dec	TC 4+	OTB	4	4VW	130	937	8417	0.00847	3.07881	Hammond 64/65	Oct 1981
	Jan-Apr	TC 4+	OTB	4	4X+5	244	1915	4223	0.00976	3.01206	Hammond 48/49	March 1981
	May-Aug	TC 4+	OTB	2	4X+5	64	532	558	0.01589	2.9225	Cameron 321/322	July 1981
	Sept-Dec	TC 4+	OTB	2	4X+5	66	488	4956	0.01246	2.98215	Hammond 64/65	Oct 1981
1982	Jan-Dec	TC 1-6	GN, LL, Other	14	4VWX+5	402	2605	10980	0.03023	2.76957	Hammond 80/81	July 1982
	Jan-Dec	TC 1-3	OTB	18	4VWX+5	659	4348	7720	0.03023	2.76957	Hammond 80/81	July 1982
	Jan-Apr	TC 4+	OTB	7	4VW	229	1686	2659	0.01446	2.91396	Hammond 71/72	March 182
	May-Aug	TC 4+	OTB	7	4VW	228	1623	3043	0.0377	2.75290	Hammond 80/81	July 1982
	Sept-Dec	TC 4+	OTB	4	4VW	146	912	4033	0.00469	3.22032	Needler 002/003	Oct 1982
	Jan-Apr	TC 4+	OTB	9	4X+5	293	2172	1628	0.01055	2.99328	Hammond 71/72	March 1982
	May-Aug	TC 4+	OTB	5	4X+5	203	1197	3645	0.03023	2.76957	Hammond 80/82	July 1982
	Sept-Dec	TC 4+	OTB	11	4X+5	396	2606	3665	0.00874	3.08571	Nedler 002/003	Oct 1983
1983	Jan-Dec	TC 1-6	Gn, LL, Other	13	4VWX+5	499	3487	8264	0.01149	2.98690	Needler 12/13	July 1983
	Jan-Dec	TC 1-3	OTB	38	4VWX+5	1252	9585	9492	0.01149	2.98690	Needler 12/13	July 1983
	Jan-Aug	TC 4+	OTB	38	4VW	1171	9812	7864	0.02903	2.76587	Needler 12/13	July 1983
	Sept-Dec	TC 4+	OTB	7	4VW	162	1994	1029	0.01134	3.00190	Needler 17/18	Oct 1983
	Jan-Aug	TC 4+	OTB	29	4X+5	1022	8078	5516	0.01149	2.98690	Needler 12/13	July 1983
	Sept-Dec	TC 4+	OTB	1	4X+5	43	356	396	0.01047	3.03012	Needler 17/18	Oct 1983
1984	Jan-Dec	TC 1-6	GN, LL, Other	14	4VWX+5	347	2862	7038	0.02339	2.8404	Needler 31/32	July 1984
	Jan-Dec	TC 1-3	OTB	32	4VWX+5	1119	8642	14184	0.02339	2.8404	Needler 31/32	July 1984
	Jan-Apr	TC 4+	OTB	12	4VW	346	3024	2080	0.01171	2.96209	Needler 24/25	March 1984
	May-Aug	TC 4+	OTB	15	4VW	345	3180	3091	0.02134	2.84581	Needler 31/32	July 1984
	Sept-Dec	TC 4+	OTB	15	4VW	431	3410	3550	0.01134	3.00190	Needler 17/18	Oct 1983

Table 2. Continued.

Year	Period	Tonnage Class	Gears	No. of Samples	Area	Number Aged	Number Measured	Catch (t)	Weight-Length Relationship a	b	Cruise	
1984	Jan-Apr	TC 4+	OTB	6	4X+5	203	1575	728	0.00984	3.00564	Needler 24/25	March 1984
	May-Aug	TC 4+	OTB	2	4X+5	75	624	1563	0.02339	2.84041	Needler 31/32	July 1984
	Sept-Dec	TC 4+	OTB	1	4X+5	23	218	564	0.01047	3.03012	Needler 17/18	Oct 1983
1985	Jan-Dec	TC 1-6	GN, LL, Other	23	4VWX+5	442	3845	11631	0.01654	2.90193	Needler 48/49	July 1985
	Jan-Dec	TC 1-3	OTB	26	4VWX+5	694	5902	15673	0.01654	2.90193	Needler 48/49	July 1985
	Jan-Apr	TC 4+	OTB	10	4VW	278	2313	3464	0.01171	2.96209	Needler 24/25	March 1984
	May-Aug	TC 4+	OTB	18	4VW	491	4199	3687	0.01920	2.85330	Needler 48/49	July 1985
	Sept-Dec	TC 4+	OTB	14	4VW	379	3137	4514	0.01134	3.00190	Needler 17/18	Oct 1983
	Jan-Apr	TC 4+	OTB	2	4X+5	72	541	580	0.00984	3.00564	Needler 24/25	March 1984
	May-Aug	TC 4+	OTB	3	4X+5	111	766	829	0.01654	2.90193	Needler 48/49	July 1985
	Sept-Dec	TC 4+	OTB	2	4X+5	70	395	876	0.01047	3.03012	Needler 17/18	Oct 1983
*1986	Jan-June	TC 1-3	OTB	31	4VWX+5	370	6876	8353	0.00984	3.00564	Needler 24/25	March 1984
	Jan-June	TC 4+	OTB	36	4VW	422	8061	6077	0.01171	2.96209	Needler 24/25	March 1984
	Jan-June	TC 4+	OTB	6	4X+5	137	1631	1745	0.00984	3.00564	Needler 24/25	March 1984

* = G.N. Samples were not aged at this time.

Table 3a

OTB TC4+ 4X AND 5

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	5	98	306	27	103	113	48	13	16	4	107	20	77	10	0	2
3	97	349	832	619	2764	506	706	174	516	505	156	793	1360	356	80	70
4	294	555	944	2277	1257	1713	947	650	1345	1309	1032	321	630	1563	401	84
5	270	508	610	1455	1090	649	1427	806	1130	830	1780	897	164	189	550	181
6	165	406	355	194	438	672	316	844	410	435	766	973	388	30	56	228
7	102	137	185	80	140	280	223	351	412	189	194	269	412	111	7	49
8	54	60	42	23	79	90	56	143	74	70	58	63	122	179	14	8
9	31	1	36	26	26	33	4	30	27	12	31	66	55	75	11	15
10	15	2	10	26	28	38	1	12	8	9	9	27	23	29	10	22
11	3	0	23	5	13	27	2	5	4	1	5	2	18	6	2	13
12	0	0	33	2	5	24	7	15	4	0	1	1	1	9	7	5

OTB TC4+ 4X AND 5 WEIGHT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.97	1.67	1.06	0.95	0.85	0.86	0.63	0.87	1.18	0.78	1.13	1.01	0.91	0.71	0.00	1.10
3	1.84	2.32	1.86	1.37	1.44	1.34	1.27	1.14	1.30	1.22	1.66	1.66	1.28	1.20	1.31	1.49
4	2.93	2.12	2.93	1.89	2.00	2.09	1.89	1.80	1.93	1.73	1.89	2.68	2.73	1.66	2.07	2.28
5	3.79	3.15	4.44	2.63	3.04	3.08	2.67	2.57	2.68	2.33	2.27	2.74	3.38	2.88	2.67	3.15
6	4.59	4.00	5.29	3.96	4.08	4.01	3.62	3.35	3.74	3.34	2.94	3.12	4.20	3.95	3.24	3.66
7	5.78	5.00	5.95	4.84	4.99	5.21	4.33	4.24	4.49	4.27	3.96	4.06	4.41	4.73	4.56	4.07
8	6.41	6.24	6.52	6.07	6.00	6.50	5.26	5.50	5.74	5.60	5.74	5.46	5.45	5.16	5.32	5.48
9	7.56	7.25	6.84	6.47	6.57	7.61	6.86	6.18	6.92	6.84	7.32	6.07	6.58	5.99	4.68	6.49
10	6.75	9.62	7.60	7.21	7.24	7.60	6.70	7.17	7.32	7.30	8.28	6.83	8.15	6.46	6.20	6.11
11	9.29	0.00	6.81	9.33	7.94	8.47	7.24	7.73	8.39	9.64	9.38	8.21	10.00	8.12	5.74	5.97
12	0.00	0.00	9.56	10.70	8.70	9.99	9.99	11.39	9.60	0.00	11.59	12.53	14.21	8.69	7.07	7.25

S.P

4124.58 6460.03 11393.09 10722.64 13375.21 12101.21 9049.4 9034.17 10439.33 7627.04 10084.08 9740.5 8940.07 5903.89 2865.66 2291.55

Table 3b

OTB 4+ 4VW CATCH AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
2	0	13	28	81	11	18	40	16	2	23	9	4	36	4	0	0
3	13	48	76	185	153	263	131	957	93	190	30	101	1376	431	178	129
4	72	76	86	707	212	903	167	1579	955	1359	201	41	140	3556	770	958
5	41	70	56	368	241	347	239	408	857	1161	1307	211	43	136	2676	1020
6	54	56	32	56	172	288	93	222	215	628	985	1361	369	24	85	2140
7	102	19	17	20	32	68	55	115	199	102	486	1066	640	82	8	395
8	104	8	4	13	10	2	24	74	69	69	123	380	359	254	42	31
9	33	0	3	7	16	2	5	24	42	13	81	81	125	145	50	33
10	26	0	1	4	4	0	7	3	2	6	19	87	95	59	19	70
11	12	0	2	0	9	0	6	15	7	7	3	4	33	20	5	25
12	4	0	3	0	1	0	23	48	10	0	1	17	9	24	5	12

OTB 4+ VW WEIGHT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00
2	0.00	1.67	1.06	0.67	0.59	0.84	0.63	0.72	0.81	0.75	1.12	0.79	0.49	0.75	0.00	0.00
3	0.87	2.32	1.36	1.27	1.24	1.13	1.04	1.10	0.98	1.06	1.72	1.97	1.10	1.20	1.46	1.31
4	1.28	2.12	2.93	1.96	1.81	1.68	1.88	1.39	1.55	1.61	1.82	2.31	2.70	1.40	2.04	1.60
5	2.06	3.15	4.44	2.70	2.89	2.32	2.83	2.11	2.15	2.32	2.34	2.69	2.80	2.30	2.20	2.15
6	2.83	4.00	5.29	3.97	3.97	3.25	3.52	3.44	3.42	3.17	2.89	3.14	3.90	3.60	3.00	2.67
7	4.02	5.00	5.95	4.91	5.23	4.33	4.83	5.06	4.30	3.92	3.61	4.34	4.20	4.11	4.03	2.88
8	5.52	6.24	6.52	6.46	6.70	5.13	5.90	5.74	6.12	5.58	5.10	6.27	4.80	4.61	5.55	4.26
9	6.73	7.25	6.84	7.68	6.72	5.13	6.70	6.88	6.99	6.27	5.94	7.61	6.40	5.23	5.43	5.30
10	7.29	9.62	7.60	8.14	7.00	0.00	8.26	7.56	8.87	6.91	9.60	8.20	7.80	6.00	6.10	5.42
11	8.92	0.00	6.81	0.00	8.43	0.00	9.46	10.79	8.61	8.94	6.80	6.30	7.30	7.63	8.10	5.62
12	8.11	0.00	9.56	0.00	13.00	0.00	8.68	11.39	10.20	0.00	11.70	8.99	8.23	8.80	9.14	7.13

S.P.

1875.98 883.61 1038.59 3159.36 2418.01 3885.35 2234.1 6786.62 5902.43 8061.33 9409.93 13654.85 9735.91 8882.54 8711.82 11658.61

Table 3c.

OTB TC -3 4WWX5 CATCH AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3	40	94	72	33	34	36	7	5	17	10	17	14	38	21	22
3	55	145	256	539	855	202	344	281	154	1281	28	376	543	922	362	248
4	184	230	290	2000	431	686	455	554	582	839	229	233	520	2933	1529	702
5	156	210	187	1222	390	261	677	302	503	639	337	514	207	408	2366	1703
6	110	168	109	168	179	252	167	265	158	133	560	406	437	48	285	1842
7	102	57	57	67	50	91	113	116	155	45	189	258	321	97	38	315
8	79	25	13	24	26	24	33	54	36	0	75	74	137	77	74	58
9	32	0	11	22	12	9	4	13	17	0	45	18	62	45	73	52
10	21	1	3	20	9	10	4	4	3	0	3	15	30	12	38	66
11	8	0	7	3	6	7	4	5	3	0	1	3	14	9	3	17
12	2	0	10	1	2	6	11	16	4	0	0	4	8	12	7	29

OTB TC1 -3 WEIGHT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.97	1.67	1.06	0.74	0.82	0.66	0.63	0.79	1.14	0.86	1.03	1.07	0.71	0.89	1.46	0.93
3	1.73	2.32	1.86	1.35	1.43	1.27	1.22	1.11	1.25	1.37	1.88	1.81	1.48	1.27	1.81	1.66
4	2.61	2.12	2.93	1.91	1.97	1.95	1.89	1.51	1.77	1.86	2.61	2.41	2.51	1.83	2.44	2.33
5	3.56	3.15	4.44	2.64	3.01	2.82	2.70	2.42	2.45	3.20	3.39	3.04	3.53	3.10	3.02	2.88
6	4.16	4.00	5.29	3.96	4.05	3.78	3.60	3.37	3.63	3.69	4.31	3.66	4.08	4.21	4.03	3.37
7	4.90	5.00	5.95	4.85	5.03	5.04	4.43	4.44	4.43	4.88	5.28	4.71	4.72	5.03	5.51	3.69
8	5.82	6.24	6.52	6.21	6.08	6.47	5.39	5.58	5.92	0.00	6.01	6.02	5.66	5.47	6.21	4.15
9	7.13	7.25	6.84	6.73	6.63	7.47	6.83	6.49	6.96	0.00	6.97	6.83	6.21	6.05	6.31	6.40
10	7.09	9.62	7.60	7.33	7.21	7.60	7.01	7.25	7.63	0.00	7.91	7.08	7.07	7.36	6.30	6.30
11	8.99	0.00	6.81	9.33	8.14	8.47	7.68	10.02	8.53	0.00	8.34	8.20	8.30	8.02	9.08	6.78
12	8.11	0.00	9.56	9.66	9.53	9.49	9.73	10.96	10.03	0.00	0.00	9.45	8.44	9.26	9.82	7.63

S.P.

3015.272608 2674.92 3497.61 9295.856402 4621.51653 4183.001131 4602.98 3933.06 4142.943354 6085.3 6689.05 6261 7703.83 9492 14175.44 15668.16

Table 3d.

GH ALL TC 4VWX5 CATCH AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
2	2	26	56	10	35	0	0	0	0	52	0	0	0	0	0	0
3	41	93	151	219	935	0	7	0	7	729	26	27	67	68	56	11
4	123	147	171	804	425	211	142	30	110	1919	240	60	250	824	582	294
5	113	135	111	514	369	568	779	220	457	590	1288	363	134	464	1074	1072
6	69	108	64	69	148	425	348	769	413	389	717	1112	613	125	178	1653
7	43	36	34	28	47	345	595	119	351	147	142	724	828	211	34	285
8	23	16	8	8	27	14	78	119	61	102	4	157	402	286	73	24
9	13	0	7	9	9	0	21	22	45	20	2	32	130	144	60	29
10	6	1	2	9	9	7	0	0	4	0	0	11	14	56	17	53
11	1	0	4	2	4	0	4	0	5	6	0	21	18	13	7	19
12	0	0	6	0	2	0	0	0	0	0	0	0	4	10	1	9

GH ALL TC 4VWX5 WEIGHT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00
2	0.97	1.67	1.06	0.95	0.85	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00
3	1.84	2.32	1.86	1.37	1.44	0.00	1.71	0.00	2.29	0.85	2.33	2.13	1.52	1.65	2.15	1.51
4	2.93	2.12	2.93	1.89	2.00	2.57	2.52	2.07	2.78	1.23	2.75	2.49	2.99	2.33	2.81	2.32
5	3.79	3.15	4.44	2.63	3.04	3.72	3.13	2.89	3.38	3.08	3.79	3.27	3.90	3.50	3.12	3.08
6	4.59	4.00	5.29	3.96	4.08	4.13	3.94	3.71	4.36	3.69	4.21	3.68	4.42	4.22	4.15	3.45
7	5.78	5.00	5.95	4.84	4.99	5.11	4.79	4.80	4.96	4.54	4.80	4.24	4.57	5.07	5.81	3.89
8	6.41	6.24	6.52	6.07	6.00	6.87	5.90	5.14	6.22	5.48	9.10	5.19	5.31	5.36	6.11	4.82
9	7.56	7.25	6.84	6.47	6.57	0.00	7.20	6.75	6.60	6.72	7.62	6.73	5.58	6.32	6.03	6.53
10	6.75	9.62	7.60	7.21	7.24	8.34	0.00	0.00	6.54	0.00	0.00	7.41	6.84	6.81	6.78	5.98
11	9.29	0.00	6.81	9.33	7.94	0.00	9.20	0.00	7.97	8.48	0.00	7.62	7.13	8.50	7.35	6.69
12	0.00	0.00	9.56	9.66	9.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.62	7.88	11.22	8.16

S.P.

1726.79 1717.53 2074.79 3780.01 4522.41 6327.99 7677.45 4882.25 6150.56 7684.77 9353.91 9827.56 10983.96 8267.09 7028.7
11634.49

Table 3e.

CANADIAN CATCH AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	8	0	0	0	1	0	0
2	10	177	484	190	182	165	124	36	23	96	126	41	127	52	21	24
3	206	635	1315	1562	4707	971	1188	1412	770	2705	240	1297	3346	1777	676	458
4	673	1008	1491	5788	2325	3513	1711	2813	2992	5426	1702	655	1540	8876	3282	2038
5	580	923	964	3559	2090	1825	3122	1736	2947	3220	4912	1985	548	1197	6666	3976
6	398	738	560	487	937	1637	924	2100	1196	1585	3028	3852	1807	227	604	5663
7	349	249	293	195	269	784	986	701	1117	483	1011	2317	2201	501	67	1044
8	260	109	67	68	142	130	191	390	240	241	260	674	1020	796	203	121
9	109	1	57	64	63	44	34	89	131	45	159	197	372	409	194	129
10	68	4	16	59	50	55	12	19	17	15	31	140	162	156	84	211
11	24	0	36	10	32	34	16	25	19	14	9	30	83	48	17	74
12	6	0	52	3	10	30	41	79	18	0	2	22	22	55	20	55

CANADIAN WEIGHT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.63	0.00	0.00
2	0.97	1.67	1.06	0.75	0.83	0.86	0.63	0.79	1.14	0.77	1.12	1.01	0.77	0.84	1.46	0.94
3	1.75	2.32	1.86	1.35	1.43	1.27	1.23	1.11	1.26	1.18	1.77	1.74	1.24	1.25	1.67	1.55
4	2.66	2.12	2.93	1.90	1.98	1.99	1.94	1.52	1.81	1.54	2.10	2.54	2.70	1.67	2.37	1.99
5	3.61	3.15	4.44	2.64	3.02	3.10	2.80	2.48	2.60	2.64	2.81	2.91	3.52	3.13	2.68	2.76
6	4.23	4.00	5.29	3.96	4.05	3.87	3.73	3.49	3.88	3.39	3.48	3.35	4.18	4.12	3.85	3.15
7	5.01	5.00	5.95	4.85	5.03	5.07	4.65	4.50	4.60	4.34	4.16	4.32	4.45	4.83	5.41	3.46
8	5.88	6.24	6.52	6.19	6.06	6.51	5.62	5.45	6.00	5.54	5.57	5.92	5.19	5.09	5.96	4.40
9	7.18	7.25	6.84	6.67	6.62	7.47	7.04	6.55	6.84	6.62	6.52	6.88	6.11	5.84	5.90	6.16
10	7.06	7.62	7.60	7.32	7.22	7.69	7.71	7.25	7.37	7.14	9.05	7.75	7.63	6.48	6.34	5.91
11	9.01	0.00	6.81	9.33	8.12	8.47	8.67	10.02	8.38	8.79	8.40	7.54	8.02	8.06	7.69	5.22
12	8.11	0.00	9.56	10.35	9.36	9.87	9.19	11.30	10.03	0.00	11.64	9.23	8.65	8.72	8.76	7.57

S.P.

10742.62261 11736.09 16004.08 26957.3664 24937.14653 26497.55113 23563.93 24636.1 26635.26335 29458.44 35536.97 39483.91 37363.77 32545.52 32781.62 41252.81

Table 4. Variance associated with catch-at-age matrices.

Age	YEAR 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
4X+5 OTB 4+																	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3.8	1962.1	4168.8	124.3	295.9	298.9	44.5	10.1	51.4	3.5	123.0	42.4	548.1	9.9	0	3.7	0
3	184.2	6002.8	12803.4	8279.7	10458.7	1763.8	1794.3	157.0	1124.9	3396.3	806.6	2957.4	1277.8	934.3	238.5	39.6	9.1
4	1203.5	6656.1	13263.7	19930.1	10624.3	3594.6	4025.8	781.2	3191.1	8759.6	6168.9	10509.5	894.2	1275.9	2058.4	130.4	306.8
5	1449.3	6689.3	7823.4	14584.1	3996.8	2763.5	3942.3	1435.1	2942.0	8482.5	8333.9	19573.1	576.5	317.7	1810.8	552.3	600.1
6	972.5	3370.7	4841.4	1087.7	1519.6	1735.9	1252.6	1442.5	1214.5	2597.1	4626.1	18671.8	1069.1	42.1	353.7	592.8	723.8
7	359.9	941.7	2295.9	248.4	412.1	663.6	569.4	621.1	784.9	858.2	1040.5	1570.5	1024.9	203.9	10.6	127.5	377.2
8	200.2	247.1	451.6	53.8	134.9	245.2	108.5	147.7	120.0	202.5	118.7	327.6	235.0	175.0	25.4	12.7	6.5
9	75.3	1.2	406.4	51.5	46.8	90.3	3.4	31.1	35.9	16.2	43.4	315.2	181.6	136.5	12.1	20.7	1.1
10	61.8	1.9	53.3	47.8	38.6	99.9	1.1	11.1	10.8	6.1	16.3	122.9	111.8	37.8	8.3	22.5	5.7
11	2.3	0	352.2	6.3	15.1	66.5	1.4	5.2	2.8	0	1.6	3.5	1.7	5.0	4.6	21.5	5.9
11+	0	0	78.7	0.7	9.8	55.9	3.5	13.0	1.9	0	0	0	0	6.5	0	4.2	6.7
4VW OTB 4+																	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1.0	0	0	0
2	0	1962.1	4168.8	86.8	63.3	32.7	64.0	61.7	4.0	27.7	3.4	7.0	165.2	16.8	0	0	0
3	34.7	6002.8	12803.4	614.5	1859.3	738.7	182.1	7921.1	238.3	341.8	87.01	234.9	1429.4	4394.5	321.0	376.5	29.7
4	124.5	6656.1	13263.7	2111.9	3071.4	1710.6	319.3	9584.0	2860.1	6838.7	875.8	159.9	877.2	7525.3	4110.3	1931.8	655.1
5	135.6	6689.3	7823.4	1609.0	2570.2	1065.1	432.4	2642.8	3008.3	7835.9	7499.8	1954.1	131.9	2603.0	4518.1	5697.2	2199.1
6	148.9	3370.7	4841.4	119.2	1601.6	474.4	244.1	512.8	600.7	1615.0	8621.8	8655.4	2193.0	37.1	293.5	6624.9	4082.7
7	725.1	941.7	2295.9	24.6	298.9	91.3	117.4	145.8	461.9	380.8	4162.9	10056.3	2789.5	277.5	5.2	3053.3	3628.5
8	934.9	247.1	451.6	13.2	49.3	1.1	30.2	98.3	128.1	85.2	488.3	3969.8	1332.6	447.7	31.6	78.9	388.7
9	329.4	1.2	406.4	6.2	115.3	1.1	7.0	25.2	88.5	20.1	470.9	726.0	542.5	296.0	33.9	46.3	12.7
10	201.5	1.9	53.3	2.9	18.3	0	12.7	2.5	2.2	10.5	16.7	975.3	275.6	161.3	12.5	84.6	38.3
11	0	0	352.2	0	42.7	0	9.2	51.6	10.3	0	5.2	16.3	111.1	30.5	3.4	37.5	58.8
11+	17.3	0	78.7	0	0	0	49.1	181.9	14.4	0	0	0	20.2	49.5	1.8	15.6	85.8

Table 4 . (Continued)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
									YEAR								
4VWX+5 GN TC 1-6																	
1	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	N
2	-	-	-	-	-	0	0	0	31117.0	1410.0	0	0	0	0	0	0	O
3	-	-	-	-	-	0	58.5	0	187839.0	9830.0	372.2	106.4	62.5	207.8	230.3	16.1	T
4	-	-	-	-	-	1125.5	3975.1	95.7	98993.3	21834.0	8056.9	366.3	517.6	1314.5	3950.9	1460.8	
5	-	-	-	-	-	27886.3	13472.5	5431.7	725.1	12303.3	28905.4	5700.9	1149.4	1705.4	4292.1	9726.7	A
6	-	-	-	-	-	2992.4	12791.6	8095.1	680.0	9994.6	28632.7	11159.8	4546.8	473.1	811.1	10845.0	V
7	-	-	-	-	-	16118.8	7965.6	5013.4	537.9	2723.3	6368.7	8858.6	5553.2	740.9	68.8	3184.3	A
8	-	-	-	-	-	96.6	1259.5	2704.3	63.6	1092.1	0	1615.4	2945.2	867.8	124.8	101.6	I
9	-	-	-	-	-	0	76.7	56.3	46.9	108.6	0	168.0	1006.2	400.6	109.0	48.4	L
10	-	-	-	-	-	0	0	0	1.4	0	0	37.8	58.0	153.2	32.2	101.4	A
11	-	-	-	-	-	0	0	0	2.9	0	0	95.0	56.3	23.8	10.5	37.7	B
11+	-	-	-	-	-	0	0	0	0	0	0	0	11.0	25.5	0	14.8	L
																	E
4VWX+5 OTB 1,2 TC 1-3																	
1	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0
2	-	-	-	-	-	-	-	-	-	194.8	9.4	11.2	14.5	107.6	68.5	98.5	0
3	-	-	-	-	-	-	-	-	-	31705.0	117.4	397.1	520.1	3374.0	1500.3	976.4	147.7
4	-	-	-	-	-	-	-	-	-	38874.0	1013.2	521.4	878.5	4163.6	7331.5	6071.8	1909.7
5	-	-	-	-	-	-	-	-	-	17159.7	2284.1	919.7	691.1	839.1	7663.6	13807.9	4100.1
6	-	-	-	-	-	-	-	-	-	7313.5	2484.3	740.0	1253.0	62.0	1248.9	13466.7	7273.4
7	-	-	-	-	-	-	-	-	-	1151.2	972.5	364.5	969.5	99.8	88.8	3507.0	6324.1
8	-	-	-	-	-	-	-	-	-	0	284.8	84.2	362.6	86.8	131.6	681.2	98.4
9	-	-	-	-	-	-	-	-	-	0	107.1	19.6	150.7	51.2	131.4	112.5	55.5
10	-	-	-	-	-	-	-	-	-	0	5.0	14.3	56.7	10.7	77.7	141.1	106.5
11	-	-	-	-	-	-	-	-	-	0	1.1	2.3	21.7	7.5	5.7	34.2	28.7
11+	-	-	-	-	-	-	-	-	-	0	0	1.4	12.3	6.8	15.5	59.5	8.7

Table 5. Comparison of Stratified and Nonstratified Variance matrices

STRATIFIED CATCH AT AGE VARIANCE 20/ 9/86

	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	1	0	0
2	1636	135	60	727	134	68	102
3	36426	1382	3695	3289	8910	2290	1408
4	76306	16112	11557	3167	14279	17451	9594
5	45781	47021	28147	2548	5465	18284	29784
6	21520	58442	39227	9061	614	2707	31629
7	5113	12542	20849	10337	1322	173	9872
8	1379	890	5996	4875	1577	313	874
9	144	620	1228	1881	884	286	227
10	16	37	1150	502	363	130	349
11	0	7	117	190	66	24	130
11+	0	0	1	43	88	17	94

NONSTRATIFIED CATCH AT AGE VARIANCE 20/ 9/86

	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	1	0	0
2	458	1046	46	3215	333	39	26
3	9206	4249	1937	6536	25467	5613	3580
4	22651	16363	2908	4012	29884	29406	11636
5	22306	23712	8425	2153	2639	31534	21905
6	10286	13829	10662	4959	208	2367	23262
7	2195	3768	5866	5259	464	133	6876
8	523	608	1698	2540	597	213	474
9	163	347	634	798	305	333	407
10	82	150	473	423	109	109	485
11	55	45	152	333	41	46	225
11+	0	22	183	201	65	13	108

STRATIFIED ÷ NONSTRATIFIED VARIANCE 20/ 9/86

	1979	1980	1981	1982	1983	1984	1985
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	3.57	0.13	1.30	0.23	0.40	1.74	3.92
3	3.96	0.33	1.91	0.50	0.35	0.41	0.39
4	3.37	0.98	3.97	0.79	0.48	0.59	0.82
5	2.05	1.98	3.34	1.18	2.07	0.58	1.36
6	2.09	4.23	3.68	1.83	2.95	1.14	1.36
7	2.33	3.33	3.55	1.97	2.85	1.30	1.44
8	2.64	1.46	3.53	1.92	2.64	1.47	1.84
9	0.88	1.79	1.94	2.36	2.90	0.86	0.56
10	0.20	0.25	2.43	1.19	3.33	1.19	0.72
11	0.00	0.16	0.77	0.57	1.61	0.52	0.58
11+	1.00	0.00	0.01	0.21	1.35	1.31	0.87

Table 6a.

USA CATCH AT AGE 14/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	5	74	154	16	67	87	58	20	92	202	192	595	105	29	42	198
3	93	264	418	364	1804	390	847	293	726	1359	416	1446	1162	815	510	1852
4	282	420	474	1338	820	1319	1136	943	550	1773	1955	645	694	2071	1859	681
5	260	384	307	855	711	500	1712	681	649	1039	1556	1855	296	659	2962	1652
6	159	307	178	114	286	517	379	826	631	500	964	762	767	193	641	1852
7	98	104	93	47	91	216	268	326	936	243	542	372	376	364	115	289
8	52	45	21	14	52	69	67	261	349	285	195	258	298	177	161	82
9	30	1	18	15	17	25	5	99	270	114	168	98	172	128	125	99
10	14	2	5	15	18	29	1	62	134	47	78	123	96	120	105	123
11	3	0	12	3	8	21	3	20	84	25	36	33	95	83	42	52
12	0	0	16	1	5	18	8	195	211	112	76	125	196	206	115	118

USA WEIGHT AT AGE 14/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.97	1.67	1.06	0.95	0.85	0.86	0.63	0.91	0.77	0.71	0.88	0.59	0.39	0.67	0.83	0.71
3	1.84	2.32	1.86	1.37	1.44	1.34	1.27	1.31	1.23	1.20	1.19	1.22	0.87	0.96	1.18	0.93
4	2.93	2.12	2.93	1.89	2.00	2.09	1.89	1.85	1.77	1.93	1.83	2.43	2.23	1.67	1.78	1.84
5	3.79	3.15	4.44	2.63	3.04	3.08	2.67	2.92	3.07	3.05	2.83	2.99	3.49	2.95	2.55	2.80
6	4.59	4.00	5.29	3.96	4.08	4.01	3.62	3.61	4.06	3.97	3.68	3.89	4.08	4.21	3.20	3.60
7	5.78	5.00	5.95	4.84	4.99	5.21	4.33	4.65	4.67	5.33	4.39	4.79	4.88	4.95	4.75	4.95
8	6.41	6.24	6.52	6.07	6.00	6.50	5.26	5.98	5.63	5.75	5.75	5.59	5.58	5.66	5.48	6.35
9	7.56	7.25	6.84	6.47	6.57	7.61	6.86	7.02	6.42	6.80	6.45	6.35	6.45	6.60	6.13	6.71
10	6.75	9.62	7.60	7.21	7.24	7.60	6.70	7.00	6.69	7.57	7.17	7.05	6.81	7.03	6.68	7.18
11	9.29	0.00	6.81	9.33	7.94	8.47	7.24	7.26	7.40	7.84	7.74	7.84	7.60	7.54	7.46	7.36
12	0.00	0.00	9.56	9.66	9.04	9.99	9.99	8.15	7.75	8.31	8.77	8.05	8.23	8.90	8.52	9.13

S.P.

3966.37 4891.35 5720.31 6298.1 8739.85 9309.5 10857.79 13057.07 17714.31 15541.71 18281.3 18171.67 14357.87 13968.22 17762.28 19367.52

Table 6b.

RATIO OF OLD US CATCH AT AGE TO NEW 28/ 4/87

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	1.00	1.01	1.00	103.69	4.69	1.62	2.10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.04	1.00	1.00	1.59	1.59	2.71	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.25	1.00	1.00	0.91	1.33	1.97	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	0.54	1.69	0.64	0.71	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.05	1.00	1.01	1.36	0.63	0.50	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.24	1.00	1.02	2.26	1.26	0.57	1.21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.38	1.04	1.05	5.29	1.85	0.61	1.55	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.13	2.00	1.06	1.73	1.63	0.84	2.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.57	1.50	1.20	1.00	1.78	0.97	7.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.67	1.00	1.08	0.00	1.75	0.81	3.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 7.

FOREIGN (OTHER AND NFLD) CATCH AT AGE 20/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985 1'
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
2	1	124	161	175	8	6	31	1	0	2	1	0	3	1	1	1
3	59	458	438	399	113	81	101	63	7	14	2	7	112	23	16	20
4	327	725	495	1525	156	278	129	104	73	101	14	3	11	191	71	148
5	186	667	323	794	177	107	184	27	65	86	93	14	4	7	246	158
6	245	534	184	121	126	89	72	15	16	47	70	88	30	1	8	331
7	464	181	98	43	24	21	42	8	15	8	34	69	92	4	1	61
8	473	76	23	28	7	1	19	5	5	5	9	24	29	14	4	5
9	150	0	17	15	12	1	4	2	3	1	6	5	10	8	5	5
10	118	0	6	9	3	1	5	0	0	0	1	6	8	3	2	11
11	55	1	12	1	7	1	5	1	1	1	0	0	3	1	0	4
12	18	1	17	1	1	1	18	3	1	1	0	1	1	1	0	2

FOREIGN (OTHER AND NFLD) WEIGHT AT AGE 20/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00
2	0.00	1.67	1.06	0.67	0.59	0.84	0.63	0.72	0.81	0.75	1.12	0.79	0.49	0.75	0.00	0.00
3	0.87	2.32	1.86	1.27	1.24	1.13	1.04	1.10	0.98	1.06	1.72	1.97	1.10	1.20	1.46	1.31
4	1.28	2.12	2.93	1.96	1.81	1.68	1.88	1.39	1.55	1.61	1.82	2.31	2.70	1.40	2.04	1.60
5	2.06	3.15	4.44	2.70	2.89	2.32	2.83	2.11	2.15	2.32	2.34	2.69	2.80	2.30	2.20	2.15
6	2.83	4.00	5.29	3.97	3.97	3.25	3.52	3.44	3.42	3.17	2.89	3.14	3.90	3.60	3.00	2.67
7	4.02	5.00	5.95	4.91	5.23	4.33	4.83	5.06	4.30	3.92	3.61	4.34	4.20	4.11	4.03	2.88
8	5.52	6.24	6.52	6.46	6.70	5.13	5.90	5.74	6.12	5.58	5.10	6.27	4.80	4.61	5.55	4.26
9	6.73	7.25	6.84	7.68	6.72	5.13	6.70	6.88	6.99	6.27	5.94	7.61	6.40	5.23	5.43	5.30
10	7.29	9.62	7.60	8.14	7.00	0.00	8.26	7.56	8.87	6.91	9.60	8.20	7.80	6.00	6.10	5.42
11	8.92	0.00	6.81	0.00	8.43	0.00	9.46	10.79	8.61	8.94	6.80	6.30	7.30	7.63	8.10	5.62
12	8.11	0.00	9.56	0.00	13.00	0.00	8.68	11.39	10.20	0.00	11.70	8.99	8.23	8.80	9.14	7.13

S.P.

8526 8425 5981.999998 6814 1778 1198 1723 446 451 597 667 879 793.9999998 478.1850659 802 1801

Table 8.

USSR CATCH AT AGE 14/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	78	1076	0	1053	0	0	35	0	0	0	27	61	26	0	0	1
3	26	1107	0	301	717	8	52	14	37	14	31	4	422	68	1	5
4	0	196	717	602	181	244	104	14	31	155	94	3	1	133	7	36
5	26	28	143	0	98	138	259	8	35	164	173	6	0	0	18	18
6	26	0	0	0	49	163	69	22	29	60	54	30	0	0	1	48
7	0	28	0	0	21	16	35	8	15	16	29	19	1	0	3	9
8	0	0	0	0	7	61	0	8	8	6	8	8	1	0	3	5
9	0	0	143	151	7	12	0	6	6	0	2	4	0	0	1	4
10	0	0	143	0	21	0	17	0	6	0	0	3	0	0	2	2
11	26	0	0	0	28	0	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	21	0	0	0	0	0	0	0	0	4	0	1

USSR WEIGHT AT AGE 14/ 9/86

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.41	0.48	0.00	0.45	0.00	0.00	0.46	0.00	0.00	0.00	0.77	0.66	0.49	0.00	0.00	0.32
3	1.09	0.92	0.00	0.78	1.02	1.11	1.06	0.88	0.80	1.23	1.29	1.49	0.66	0.65	1.04	1.38
4	0.00	2.22	1.16	2.25	1.47	1.66	1.74	1.68	1.55	1.73	1.87	1.74	1.78	1.11	2.69	1.56
5	3.30	3.68	3.02	0.00	2.68	3.05	2.63	2.83	2.82	2.51	2.26	2.88	0.00	0.00	2.88	2.46
6	4.78	0.00	0.00	0.00	4.91	3.50	3.42	3.75	4.29	3.70	2.99	3.61	0.00	0.00	3.92	2.82
7	0.00	4.71	0.00	0.00	5.52	5.62	4.77	4.86	4.46	4.31	3.26	4.26	4.17	0.00	4.80	2.86
8	0.00	0.00	0.00	0.00	7.01	6.71	0.00	5.79	6.57	5.98	6.30	5.38	4.99	0.00	4.92	3.86
9	0.00	0.00	9.33	6.80	7.01	8.01	0.00	6.70	8.01	0.00	6.46	7.44	0.00	0.00	4.86	5.50
10	0.00	0.00	6.24	0.00	7.74	0.00	7.27	0.00	6.33	0.00	0.00	8.87	0.00	0.00	5.27	4.41
11	9.78	0.00	0.00	0.00	8.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.71	5.58
12	0.00	0.00	0.00	0.00	10.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.34	0.00	7.59

S.P.

527.6847862 2206.41081 3494.805801 3086.631634 2347.299404 2002.795803 1459.05408 266.824 499.553184 1024.206995
947.9305395 358.335987 298.68795 225.6642255 117.8394804 335.7178125 0

Table 9a. Commercial catch-at-age and weight-at-age.

TOTAL CATCH AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0	0	0	0	0	0	0	6	0	0	0	2	0	0
2	94	1451	799	1434	257	258	247	57	115	300	345	697	261	82	64	224
3	384	2463	2171	2626	7341	1450	2188	1782	1540	4072	669	2754	5042	2664	1203	2335
4	1282	2348	3177	9253	3482	5334	3079	3874	3646	7455	3766	1305	2246	11271	5218	2903
5	1052	2003	1737	5208	3077	2570	5277	2452	3696	4509	6733	3859	848	1863	9873	5803
6	629	1579	922	722	1399	2405	1444	2962	1872	2192	4116	4732	2604	421	1253	6094
7	911	562	484	285	405	1037	1321	1043	2083	750	1616	2777	2630	869	205	1403
8	785	230	111	110	208	261	277	664	602	537	472	965	1348	987	371	213
9	287	2	236	245	99	82	43	176	410	160	335	304	554	645	325	237
10	200	6	170	83	92	85	36	81	157	62	110	271	266	279	193	347
11	108	1	60	14	75	56	24	46	104	40	45	63	181	132	60	131
12	24	1	85	5	37	49	67	277	230	113	78	148	219	266	135	175

TOTAL WEIGHT AT AGE

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.63	0.00	0.00
2	0.49	0.77	1.06	0.52	0.83	0.86	0.61	0.83	0.84	0.73	0.96	0.62	0.57	0.78	1.02	0.73
3	1.59	1.69	1.86	1.28	1.39	1.28	1.23	1.14	1.23	1.19	1.40	1.47	1.11	1.15	1.47	1.05
4	2.37	2.13	2.53	1.93	1.95	1.98	1.91	1.59	1.80	1.64	1.95	2.49	2.55	1.66	2.15	1.92
5	3.37	3.16	4.32	2.65	3.00	3.06	2.75	2.60	2.67	2.72	2.79	2.95	3.51	3.06	2.63	2.75
6	3.90	4.00	5.29	3.96	4.08	3.85	3.67	3.53	3.94	3.52	3.51	3.43	4.15	4.16	3.51	3.23
7	4.59	4.99	5.95	4.36	5.06	5.07	4.59	4.56	4.63	4.65	4.21	4.38	4.51	4.88	5.14	3.73
8	5.70	6.24	6.52	6.25	6.10	6.55	5.55	5.66	5.79	5.66	5.65	5.83	5.27	5.16	5.75	5.13
9	6.99	7.25	8.35	6.81	6.65	7.57	6.99	6.80	6.58	6.75	6.48	6.73	6.22	6.01	5.98	6.36
10	7.17	9.62	6.45	7.38	7.33	7.57	7.55	7.06	6.75	7.46	7.73	7.46	7.34	6.71	6.51	6.24
11	9.16	0.00	6.81	8.66	8.45	8.32	8.64	8.84	7.59	8.19	7.87	7.69	7.79	7.71	7.53	6.65
12	8.11	0.00	9.36	8.14	9.87	9.72	9.15	9.09	7.94	8.24	8.85	8.23	8.27	8.85	8.56	8.51

S.P.

23762.67739 27258.85081 33201.1958 43156.59804 37802.27593 39007.84673 37603.77408 38405.994 45300.12854 46621.35897
55433.20054 58872.93599 52814.32795 47217.58929 51463.73748 62757.04781

Table 9b.

RATIO OF NEW TOTAL CATCH AT AGE TO OLD 25/ 4/87

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	0.65	1.35	0.95	0.70	0.49	0.82	0.98	0.49	0.24	0.90	0.50	1.08	1.28	0.99	0.96
3	0.62	1.19	0.93	0.92	0.88	0.74	1.06	1.03	0.16	0.86	1.00	1.02	1.10	1.04	0.96
4	0.60	0.99	0.74	0.93	0.90	0.87	1.04	1.02	0.77	0.87	1.02	1.00	0.98	0.99	1.00
5	0.68	0.98	0.76	0.93	0.79	1.05	1.09	0.97	1.06	1.05	1.09	0.98	0.99	0.98	1.00
6	0.80	0.97	0.78	0.82	0.92	0.95	0.99	0.98	1.15	0.95	1.10	1.02	1.00	0.97	1.06
7	1.16	0.91	0.84	0.70	0.55	0.98	0.83	0.99	1.08	0.91	1.02	0.98	1.01	0.97	1.02
8	1.68	0.83	0.41	0.41	0.45	0.57	0.66	0.96	1.03	0.89	0.94	0.95	1.01	0.96	1.01
9	1.34	0.05	0.96	0.94	0.34	0.49	0.48	0.96	1.05	0.96	0.86	1.06	0.66	0.99	0.89
10	1.39	0.04	1.53	0.79	0.44	0.83	0.47	0.89	1.05	0.57	0.82	0.86	0.95	0.92	0.97
11	1.87	0.00	0.61	0.12	0.20	0.67	0.40	0.90	1.04	0.72	0.74	0.85	0.89	0.72	0.88

Table 10. Comparison of observed and predicted catch-at-age for 1985.

Age	Year-Class	Observed (%) Numbers x 10^6	Predicted (%) Numbers x 10^6	Ratio of Numbers	Ratio of Percentages
2		224 (1)	310 (2)	0.73	0.50
3	1982	2335 (11)	2001 (12)	1.16	0.92
4		2903 (14)	2048 (12)	1.42	1.17
5		5803 (27)	4829 (28)	1.20	0.96
6	1979	8094 (38)	6805 (40)	1.19	0.95
7		1403 (7)	561 (3)	2.50	2.33
8		213 (1)	90 (.5)	2.40	2.00
9		237 (1)	185 (1)	1.28	1.00
10		347 (2)	179 (1)	1.94	2.00
11		131 (1)	83 (.5)	2.12	2.00

Table 11. Comparison of populations from cohort analysis using new and old catch-at-age matrices run with F_t 0.35, 1984.

Year Class	At Age 2 (#s) New	At Age 2 (#s) Old	New÷Old Ratio	Year Class	Population 2+ New	Population 2+ Old	New÷Old Ratio	Year Class	2+ Biomass New	2+ Biomass Old	New÷Old Ratio
1968	29.4	-	-								
69	41.4	-	-								
1970	26.7	-	-	1970	62.0	-	-				
71	52.5	-	-	71	86.6	-	-				
72	25.9	29.7	0.87	72	88.0	-	-				
73	36.1	36.0	1.00	73	115.5	-	-				
74	47.1	43.1	1.09	74	102.3	104.1	0.98	1974	146.6	147.1	1.00
75	56.0	52.5	1.07	75	104.9	107.1	0.98	75	154.6	158.3	0.98
76	33.2	40.4	0.82	76	120.6	115.6	1.04	76	154.5	172.6	0.90
77	8.2	11.7	0.70	77	142.0	134.4	1.06	77	178.6	169.6	1.05
78	22.8	21.1	1.08	78	137.5	136.5	1.01	78	197.9	177.1	1.12
79	107.2	102.6	1.04	79	107.8	108.1	1.00	79	177.3	187.1	0.95
1980	49.1	52.0	0.94	1980	92.7	93.3	0.99	1980	171.2	186.0	0.92
81	16.3	20.4	0.80	81	166.0	161.8	1.03	81	192.1	229.0	0.84
82	7.1	28.3	0.25	82	168.8	166.4	1.01	82	201.9	244.3	0.83
				83	139.9	141.2	0.99	83	195.5	190.4	1.03
				84	104.1	129.8	0.80	84	201.9	234.7	0.86

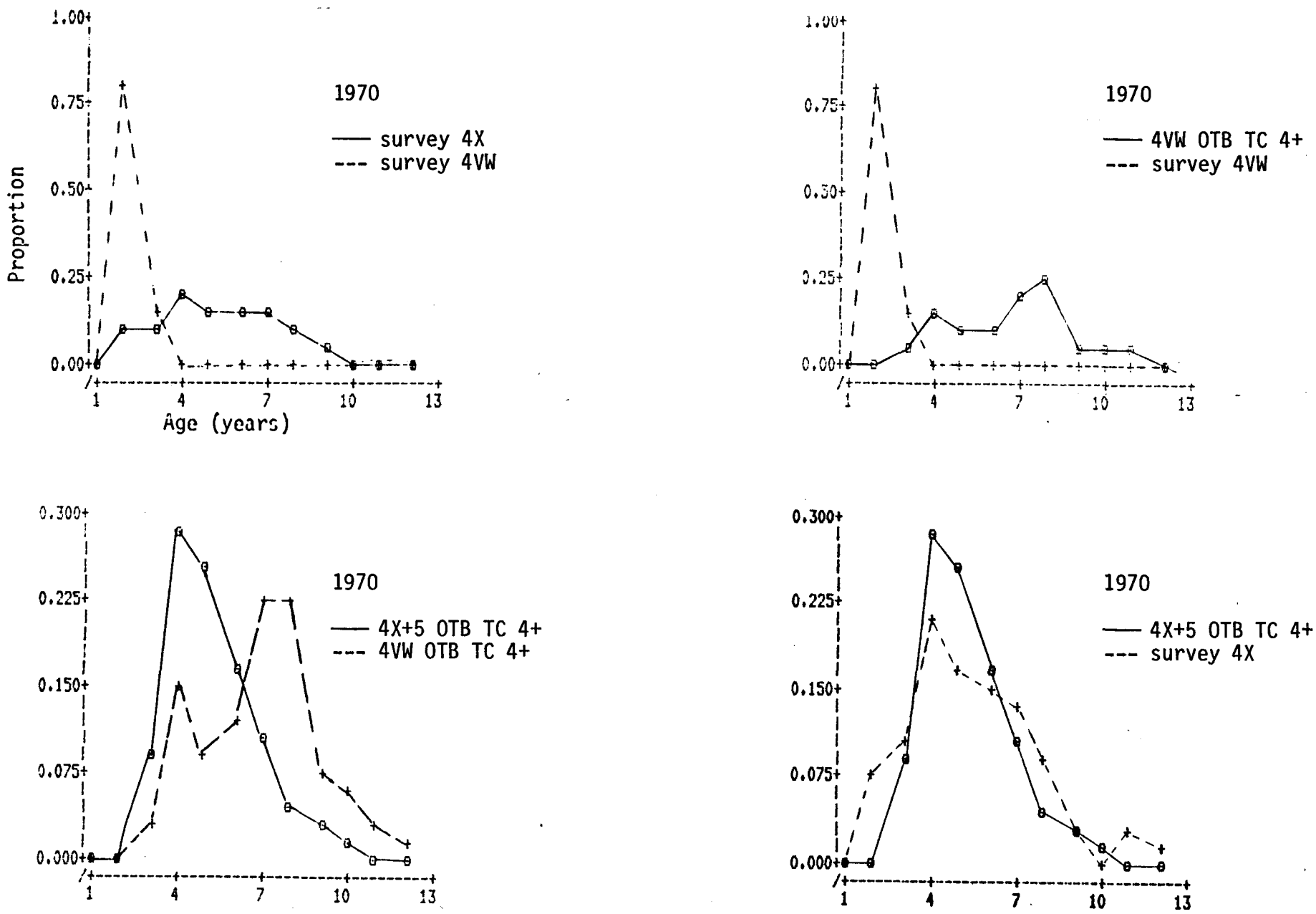
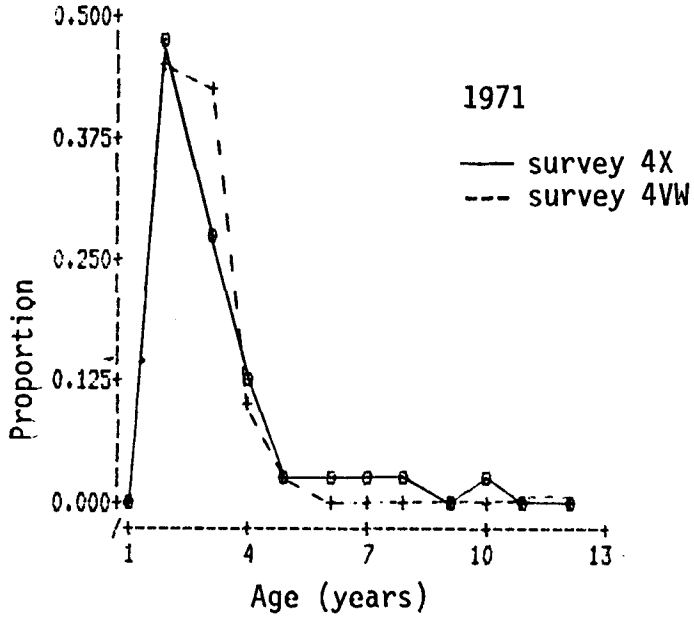
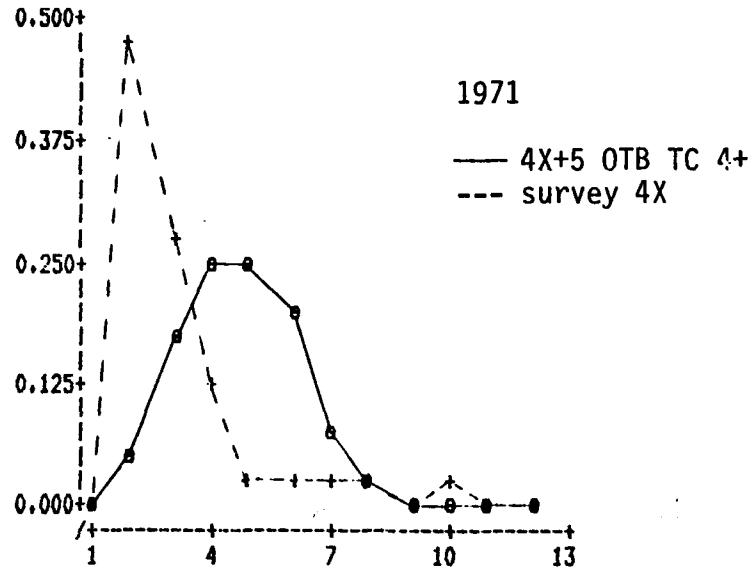
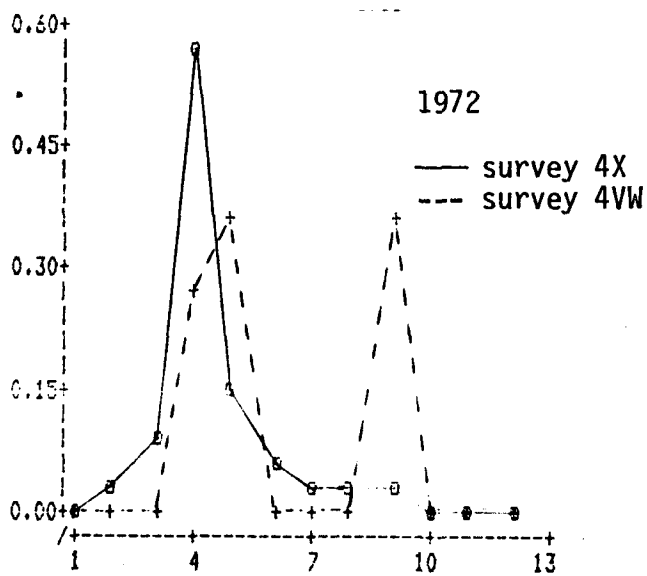
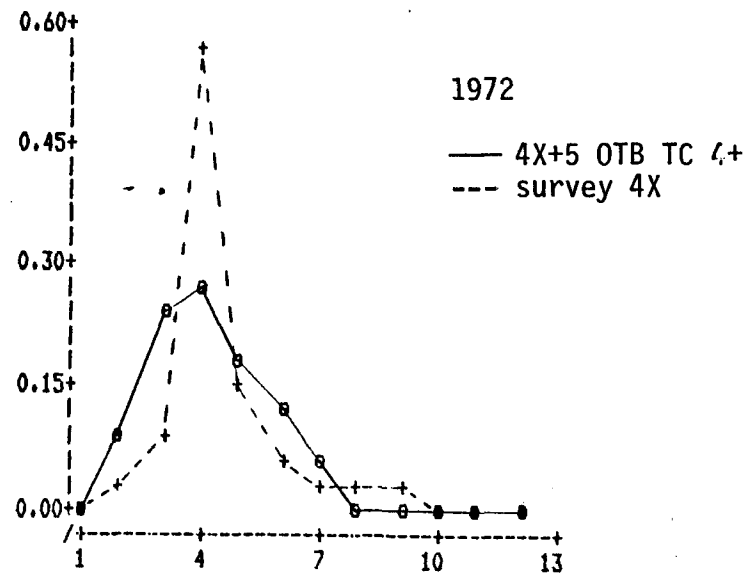


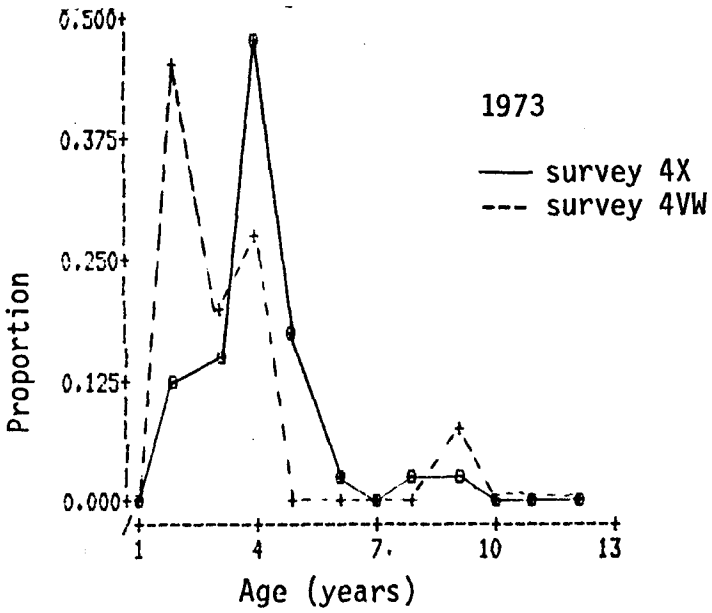
Figure 1. Proportion at age in research vessel catches in strata 42-66 (4VW) and 70-95 (4X) in Canadian commercial catches by OTB TC4+ in 4VW and in 4X+5, and in USA catches.

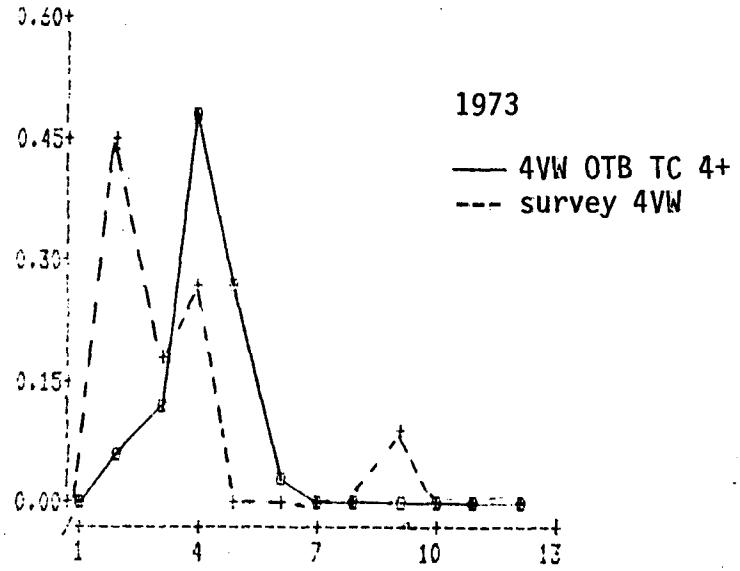

0.500+
0.375+
0.250+
0.125+
0.000+
Proportion
1971
survey 4X
survey 4VW
1
4
7
10
13
Age (years)

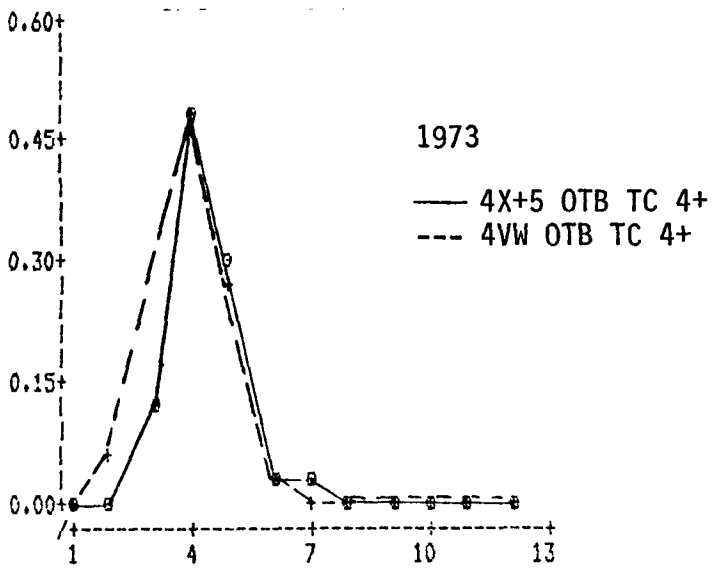

0.500+
0.375+
0.250+
0.125+
0.000+
1971
4X+5 OTB TC 4+
survey 4X
1
4
7
10
13

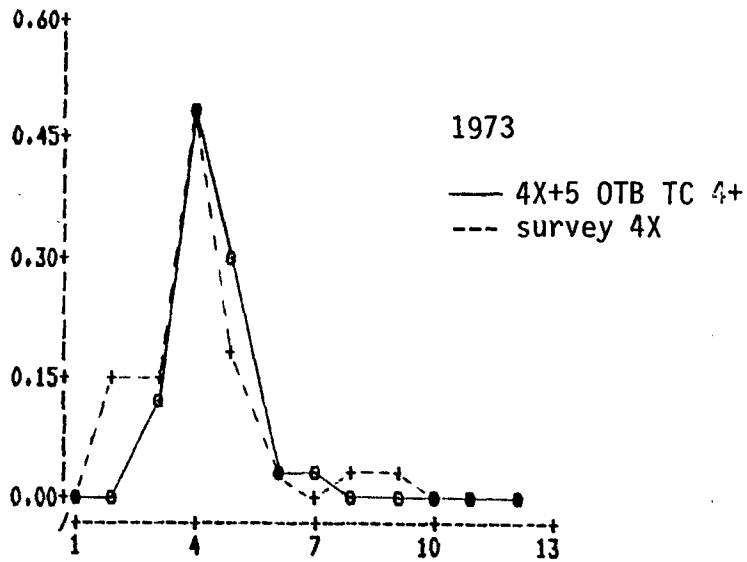

0.60+
0.45+
0.30+
0.15+
0.00+
1972
survey 4X
survey 4VW
1
4
7
10
13

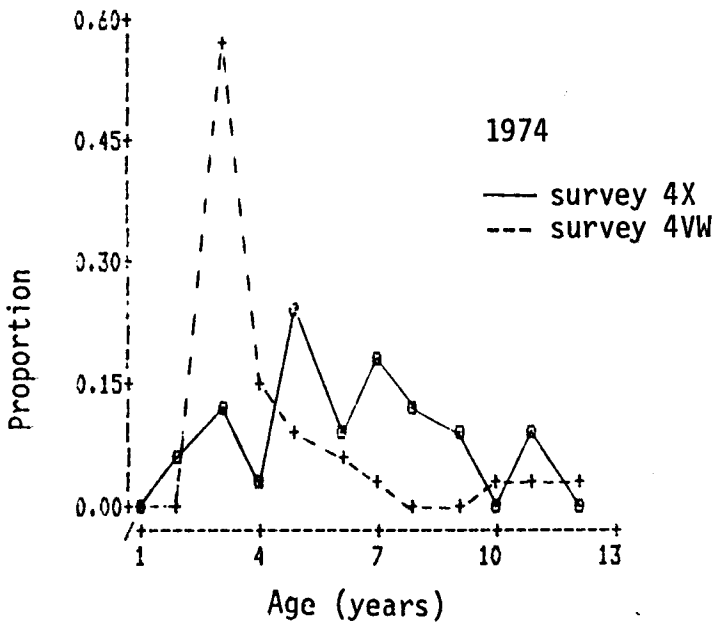

0.60+
0.45+
0.30+
0.15+
0.00+
1972
4X+5 OTB TC 4+
survey 4X
1
4
7
10
13

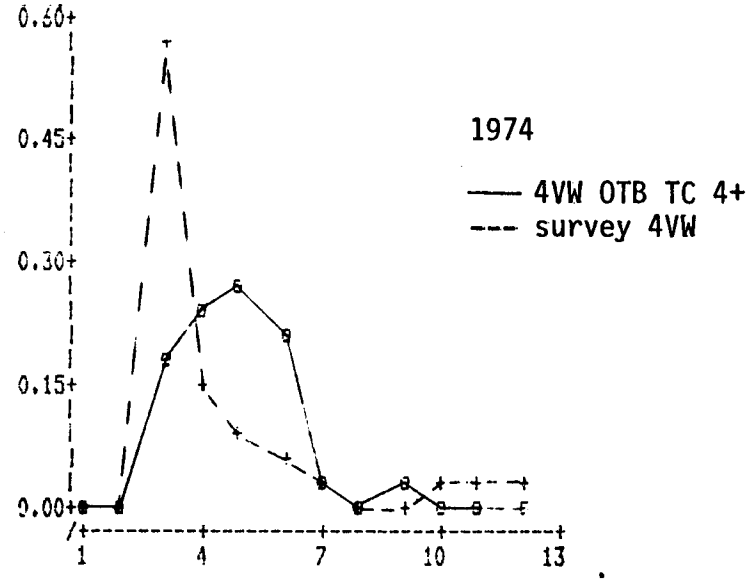

1973
survey 4X
survey 4VW
Proportion
Age (years)
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13

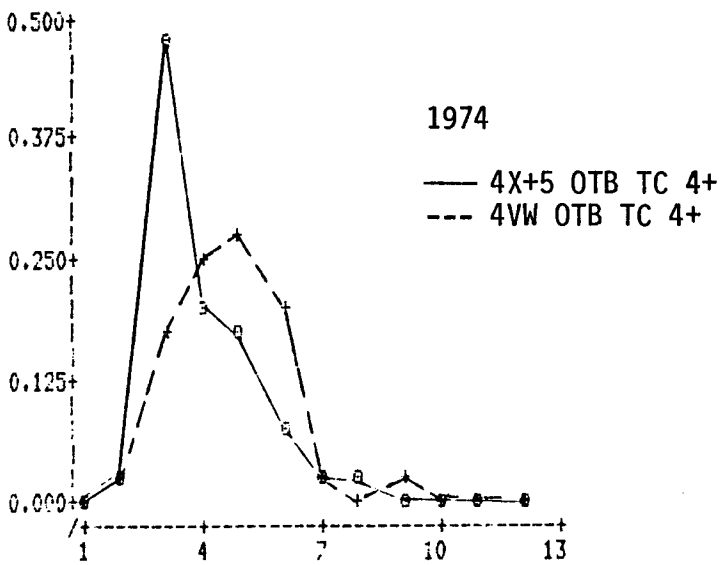

1973
4VW OTB TC 4+
survey 4VW
0.60
0.45
0.30
0.15
0.00
1
4
7
10
13

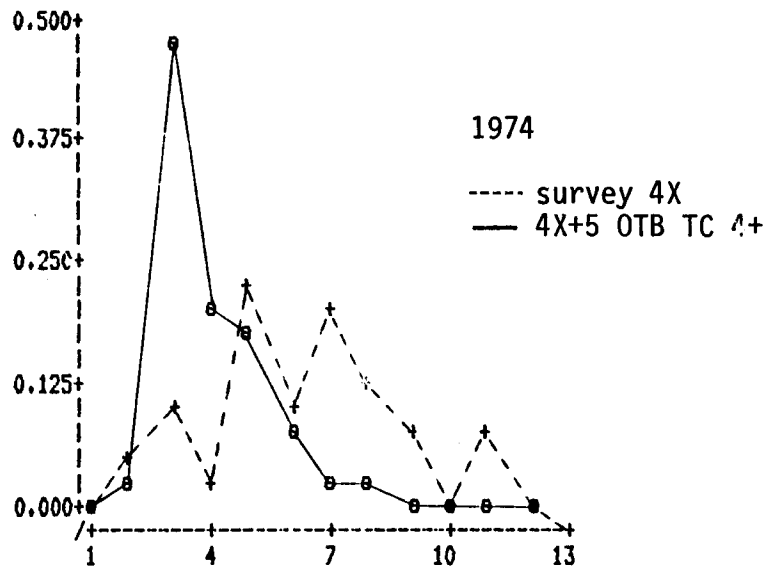

1973
4X+5 OTB TC 4+
4VW OTB TC 4+
0.60
0.45
0.30
0.15
0.00
1
4
7
10
13

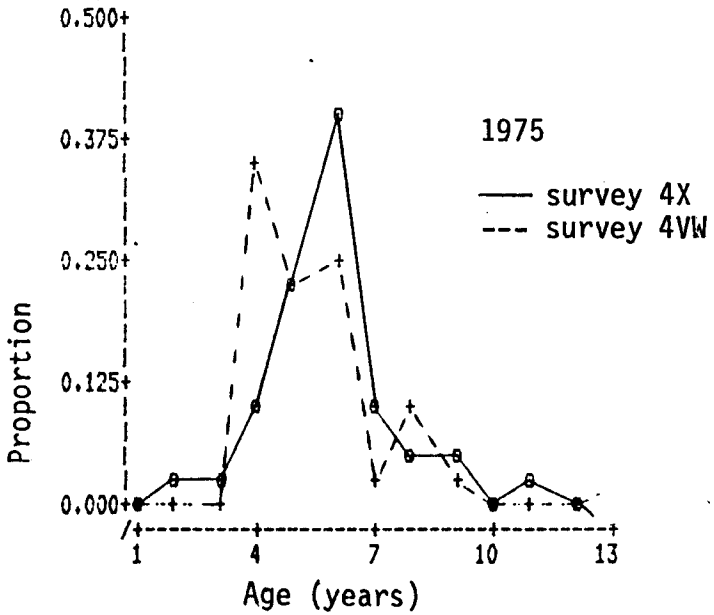

1973
4X+5 OTB TC 4+
survey 4X
0.60
0.45
0.30
0.15
0.00
1
4
7
10
13

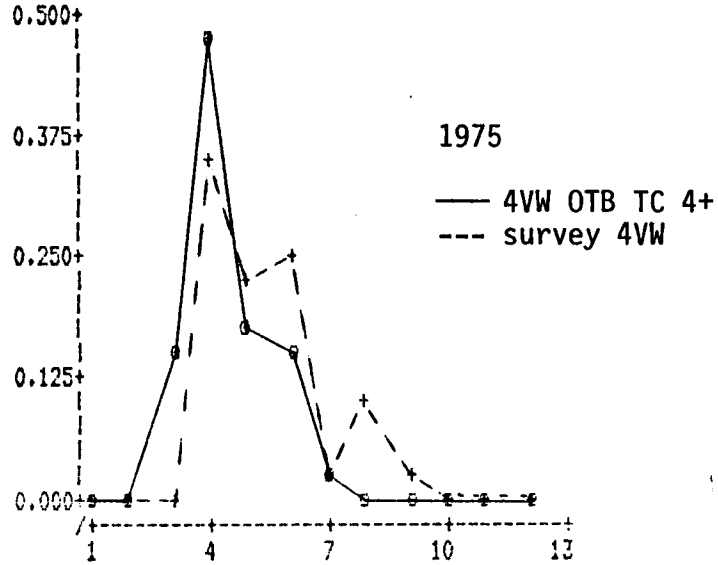

Proportion
0.60
0.45
0.30
0.15
0.00
1
4
7
10
13
Age (years)
1974
survey 4X
survey 4VW


0.60
0.45
0.30
0.15
0.00
1
4
7
10
13
1974
4VW OTB TC 4+
survey 4VW


0.500
0.375
0.250
0.125
0.000
1
4
7
10
13
1974
4X+5 OTB TC 4+
4VW OTB TC 4+


0.500
0.375
0.250
0.125
0.000
1
4
7
10
13
1974
survey 4X
4X+5 OTB TC 4+


0.500
0.375
0.250
0.125
0.000
Proportion
1975
survey 4X
survey 4VW
1
4
7
10
13
Age (years)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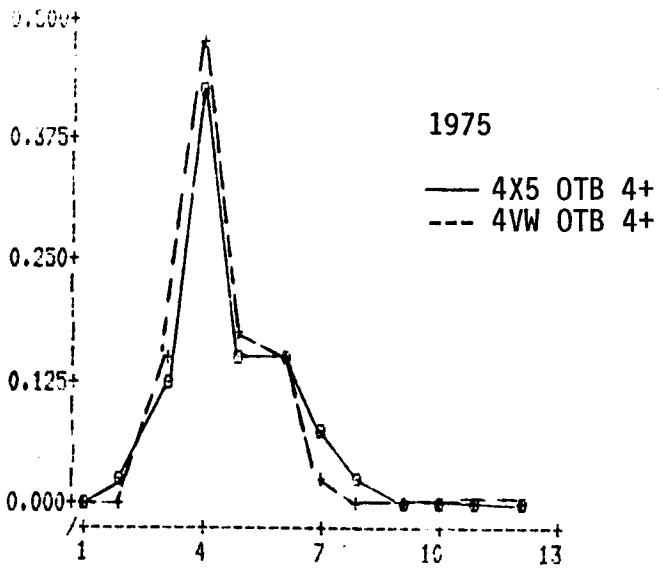
0.125
0.000
1975
4VW OTB TC 4+
survey 4VW
1
4
7
10
13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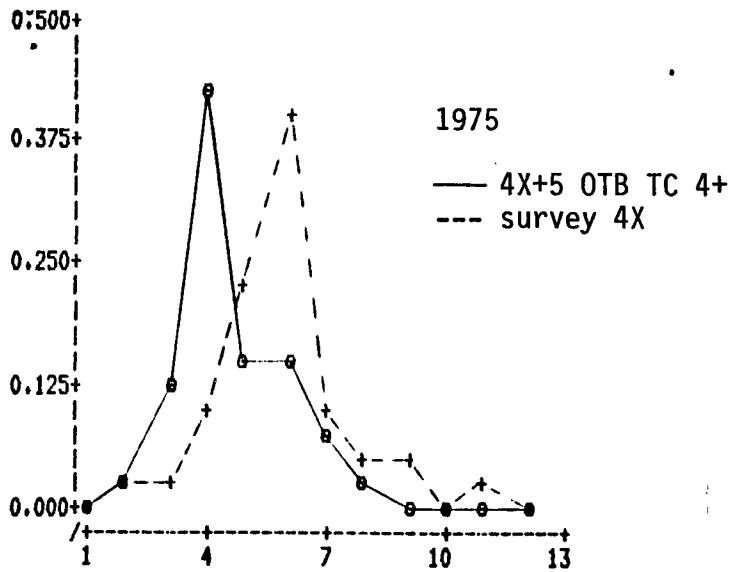
0.250
0.125
0.000
1975
4X5 OTB 4+
4VW OTB 4+
1
4
7
10
13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0.125
0.000
1975
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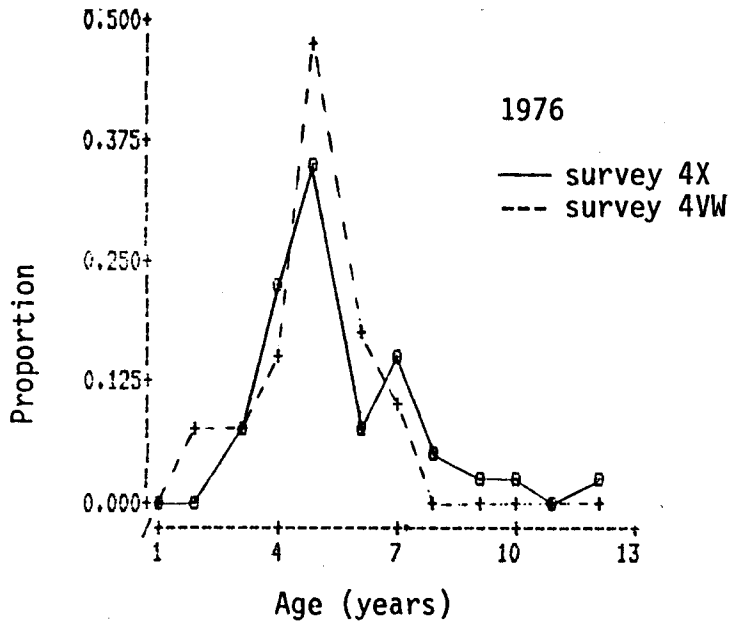
survey 4X
1
4
7
10
13


Proportion
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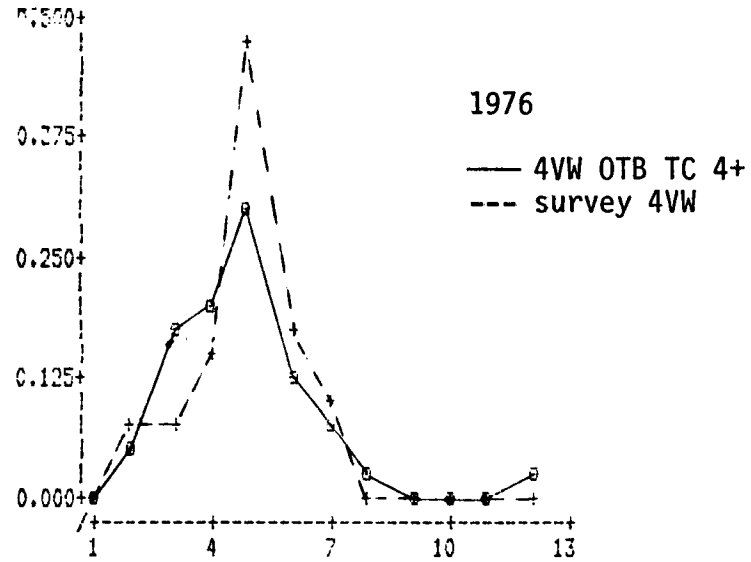
0.250
0.125
0.000
1
4
7
10
13
Age (years)
1976
survey 4X
survey 4VW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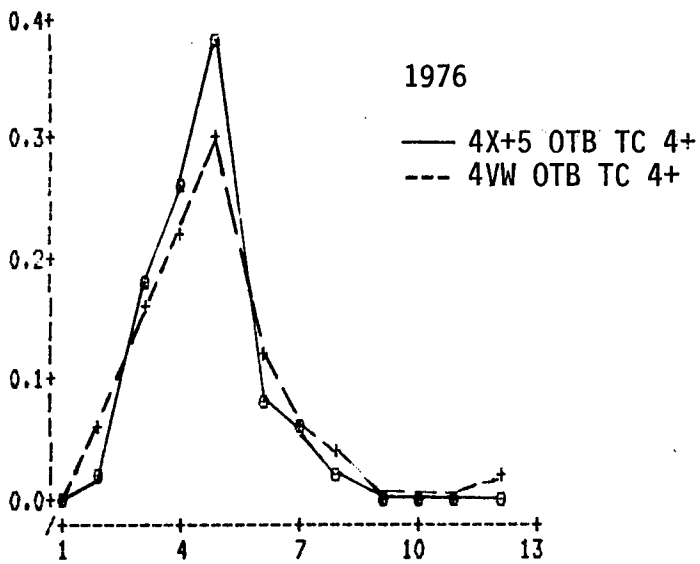
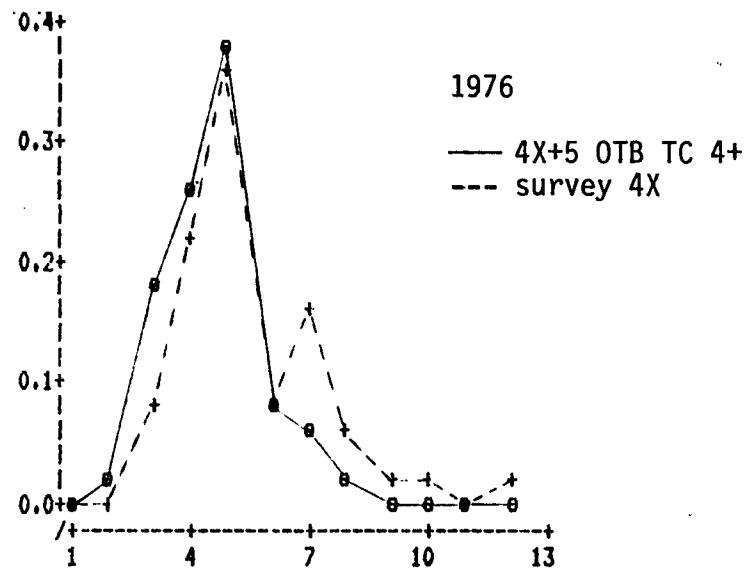
0.250
0.125
0.000
1
4
7
10
13
1976
4VW OTB TC 4+
survey 4VW


0.4
0.3
0.2
0.1
0.0
1
4
7
10
13
1976
4X+5 OTB TC 4+
4VW OTB TC 4+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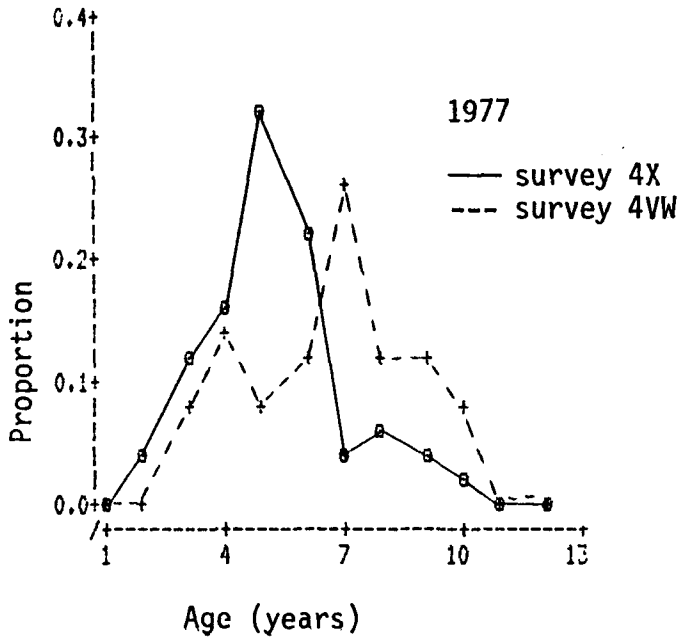
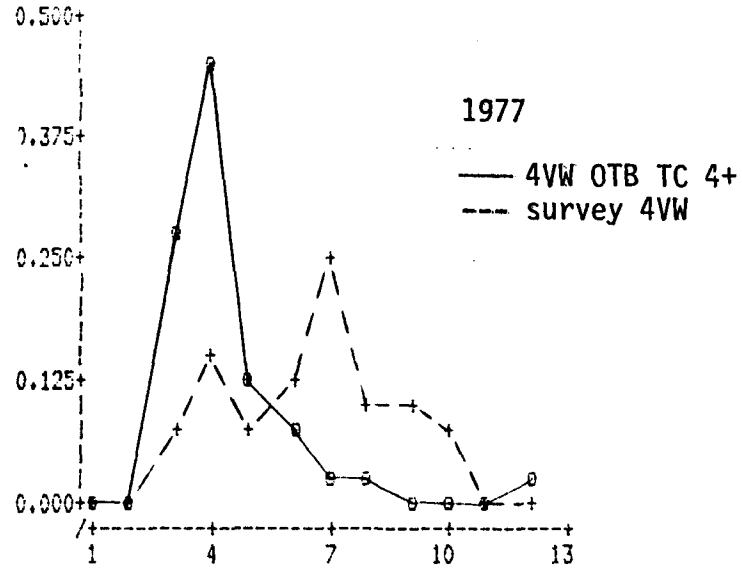
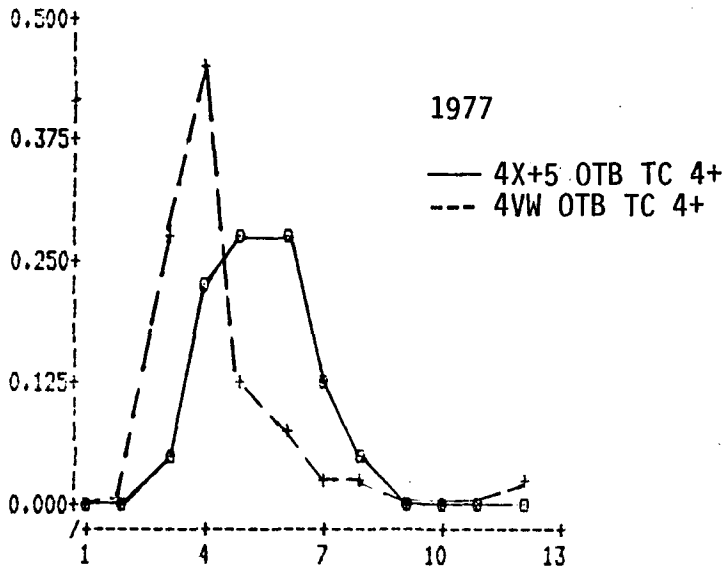
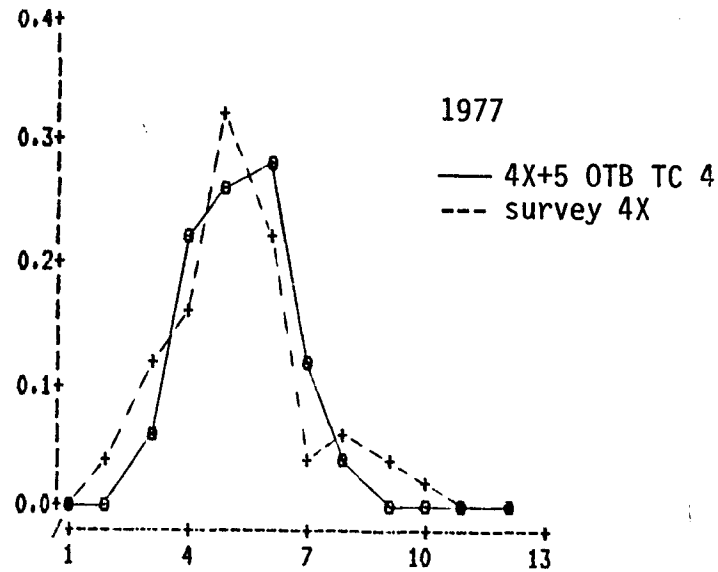
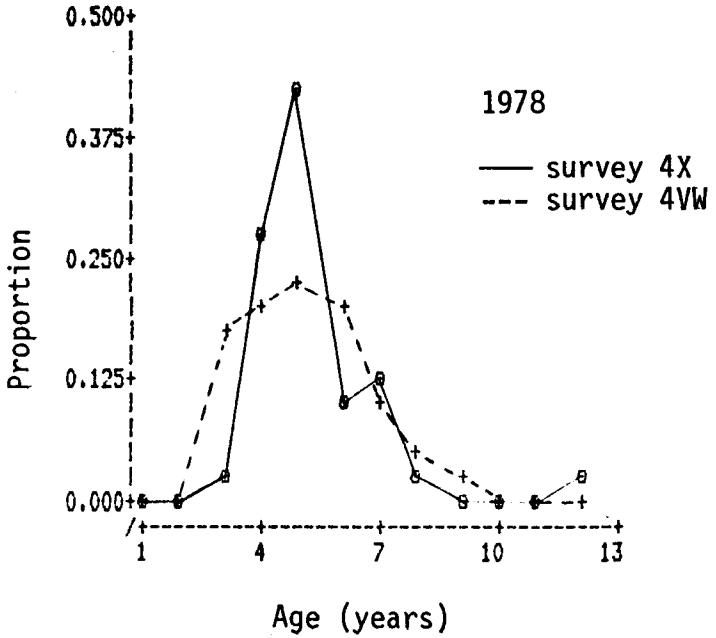
1
4
7
10
13
1976
4X+5 OTB TC 4+
survey 4X

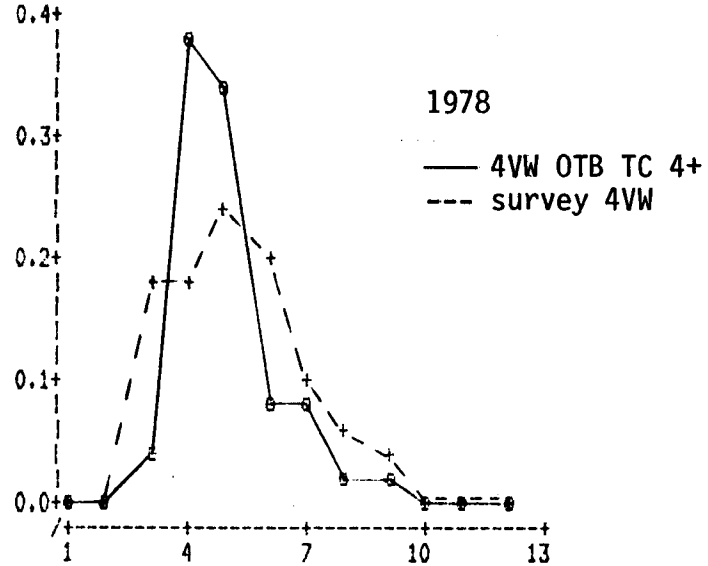

1977
survey 4X
survey 4VW
Proportion
Age (years)
0.4+
0.3+
0.2+
0.1+
0.0+
1
4
7
10
13

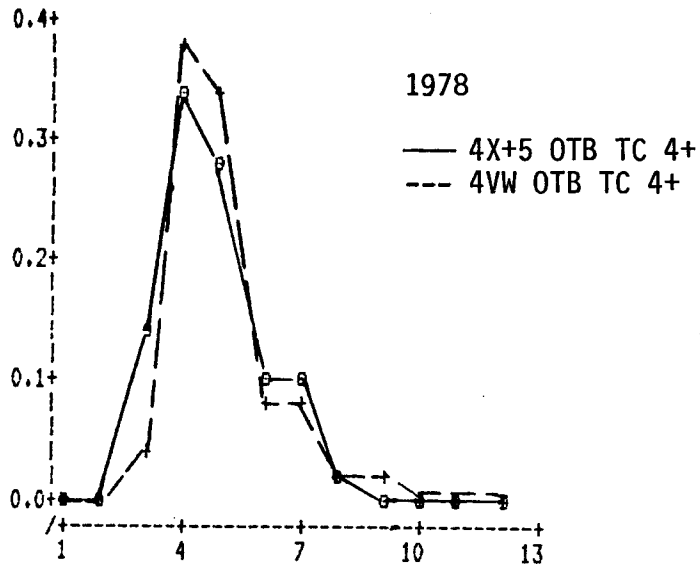

1977
4VW OTB TC 4+
survey 4VW
0.500+
0.375+
0.250+
0.125+
0.000+
1
4
7
10
13

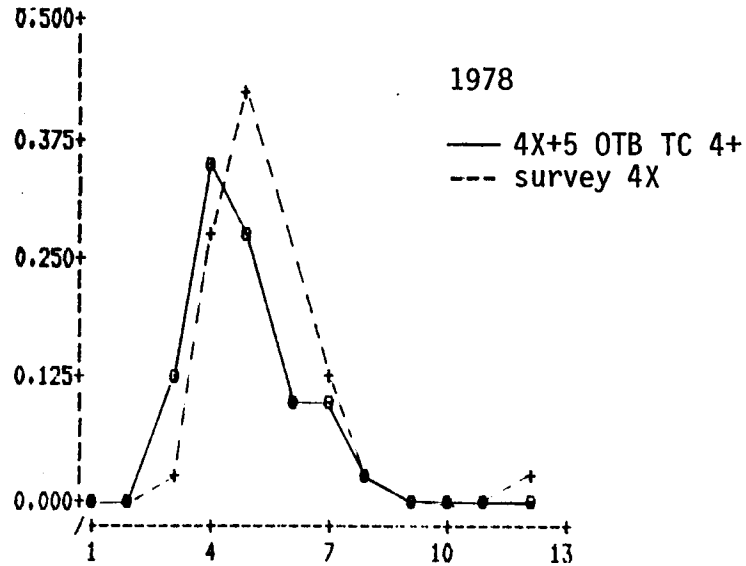

1977
4X+5 OTB TC 4+
4VW OTB TC 4+
0.500+
0.375+
0.250+
0.125+
0.000+
1
4
7
10
13

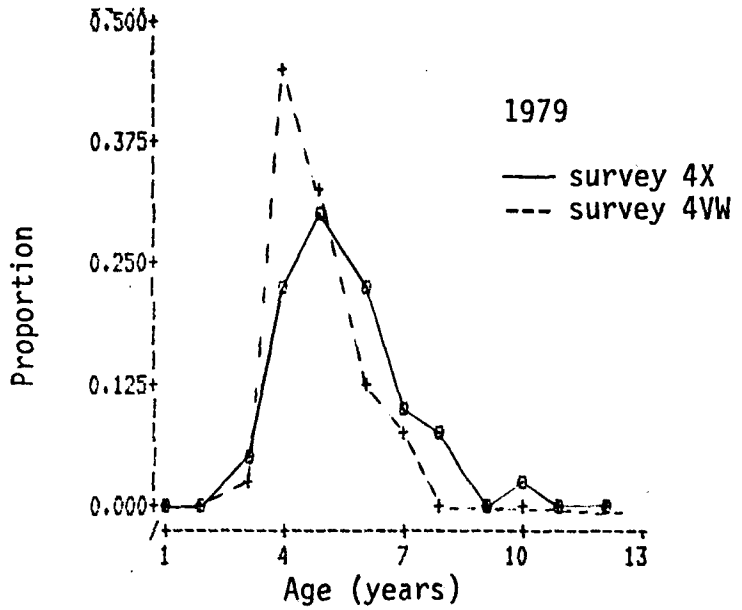

1977
4X+5 OTB TC 4
survey 4X
0.4+
0.3+
0.2+
0.1+
0.0+
1
4
7
10
13

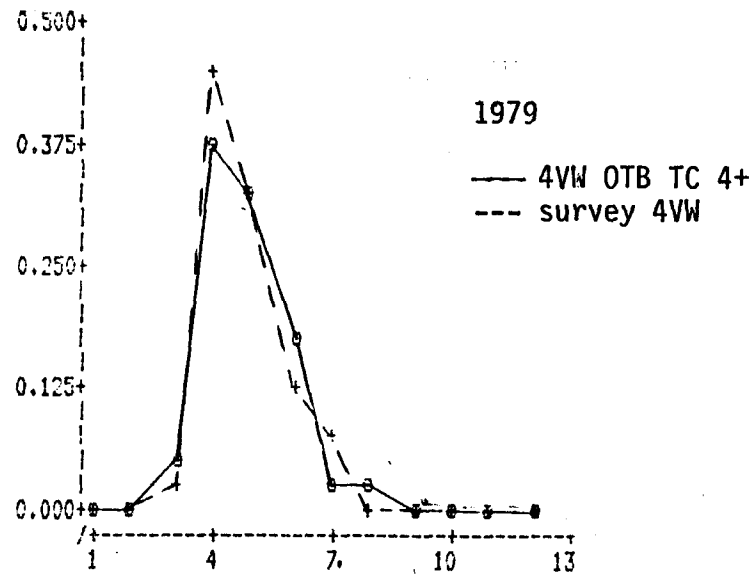

1978
survey 4X
survey 4VW
Proportion
Age (years)
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13

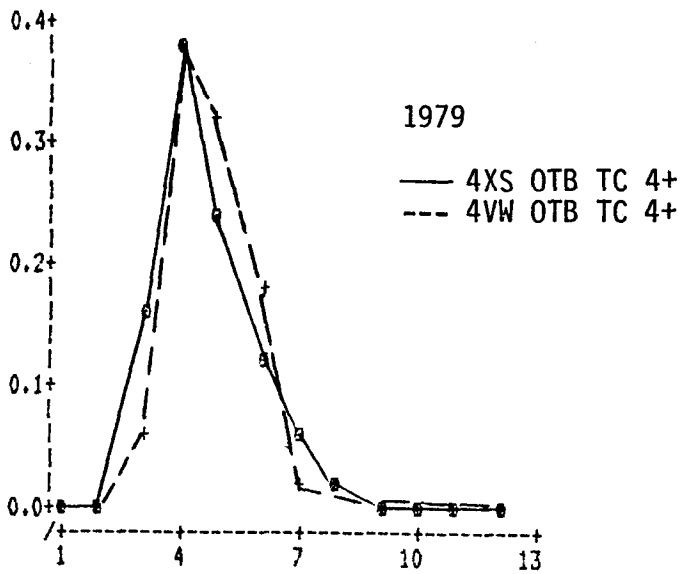

1978
4VW OTB TC 4+
survey 4VW
0.4
0.3
0.2
0.1
0.0
1
4
7
10
13

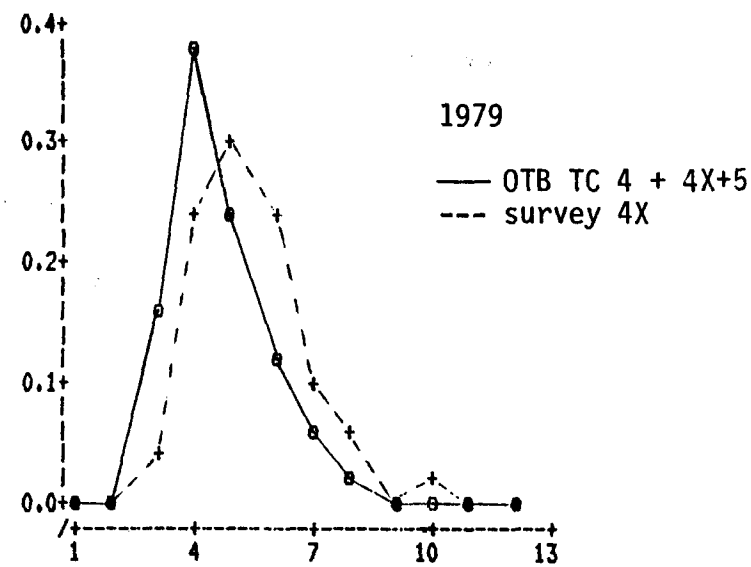

1978
4X+5 OTB TC 4+
4VW OTB TC 4+
0.4
0.3
0.2
0.1
0.0
1
4
7
10
13

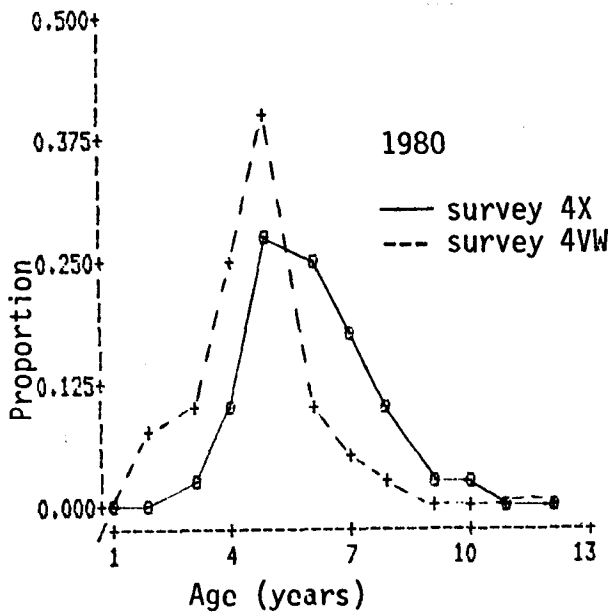

1978
4X+5 OTB TC 4+
survey 4X
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13

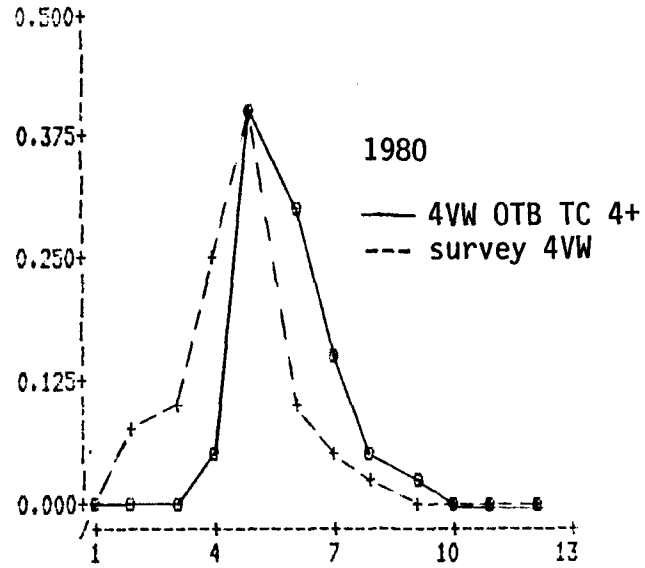

Proportion
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13
Age (years)
1979
survey 4X
survey 4VW

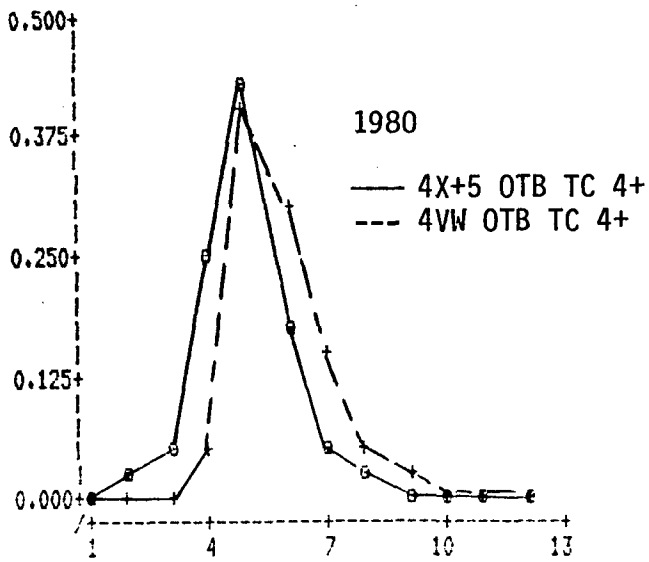

0.500
0.375
0.250
0.125
0.000
1
4
7
10
13
1979
4VW OTB TC 4+
survey 4VW

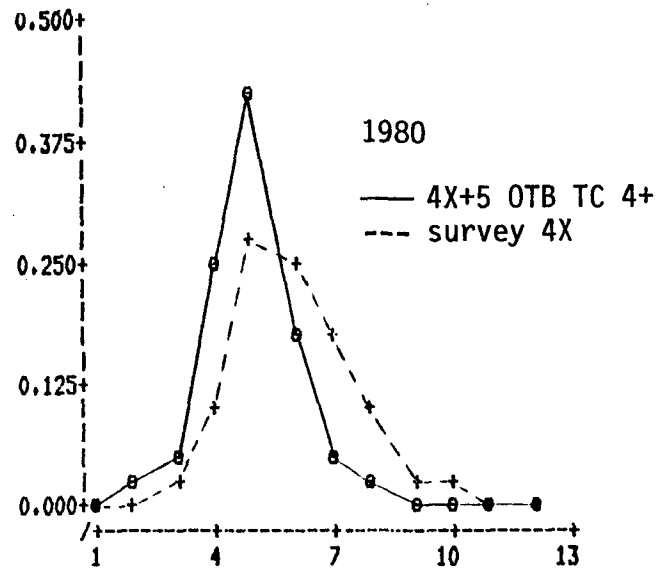

0.4
0.3
0.2
0.1
0.0
1
4
7
10
13
1979
4XS OTB TC 4+
4VW OTB TC 4+

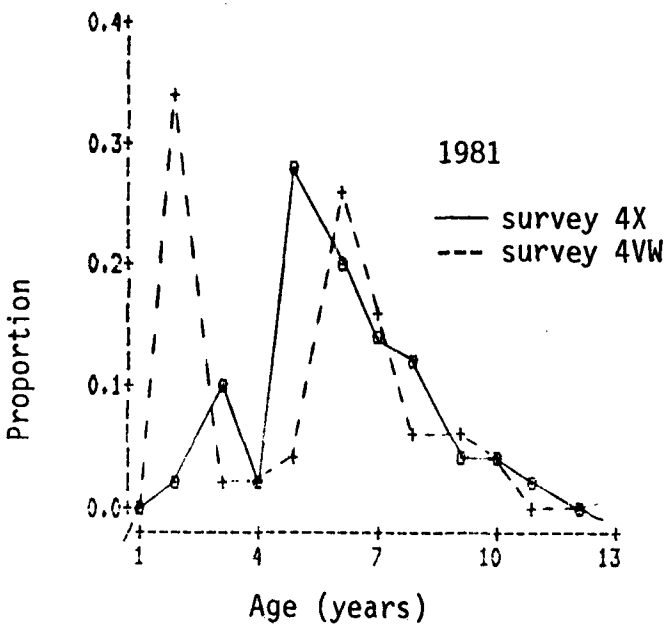

0.4
0.3
0.2
0.1
0.0
1
4
7
10
13
1979
OTB TC 4 + 4X+5
survey 4X

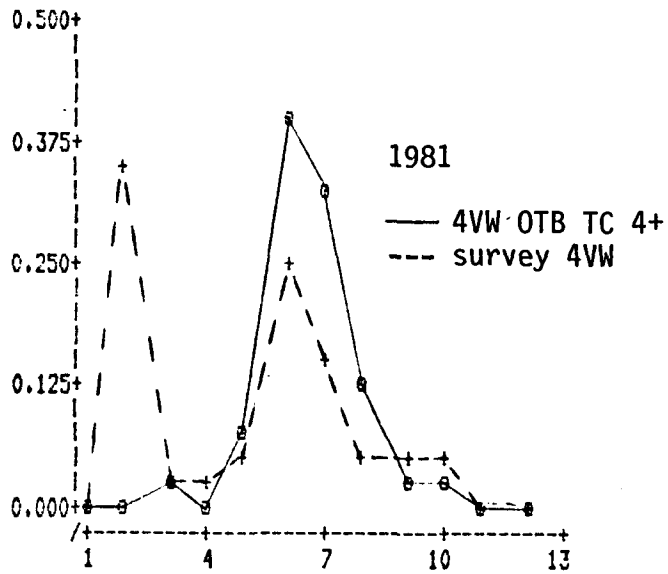

0.500
0.375
0.250
0.125
0.000
Proportion
1980
survey 4X
survey 4VW
1
4
7
10
13
Age (years)

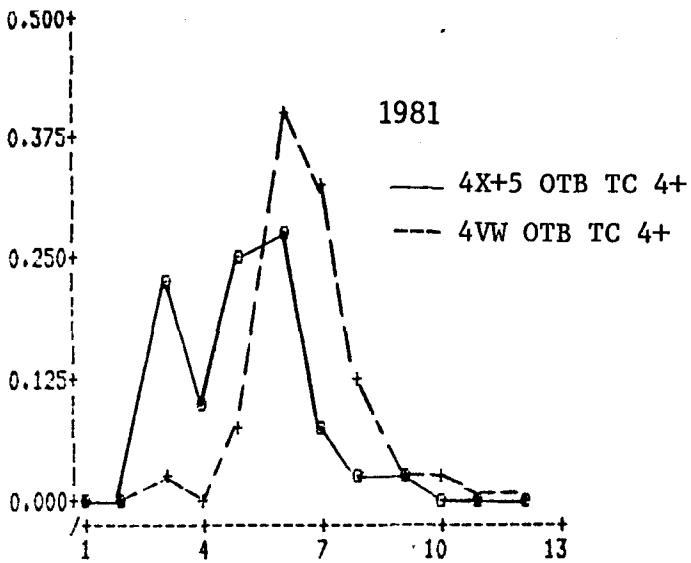

0.500
0.375
0.250
0.125
0.000
1980
4VW OTB TC 4+
survey 4VW
1
4
7
10
13

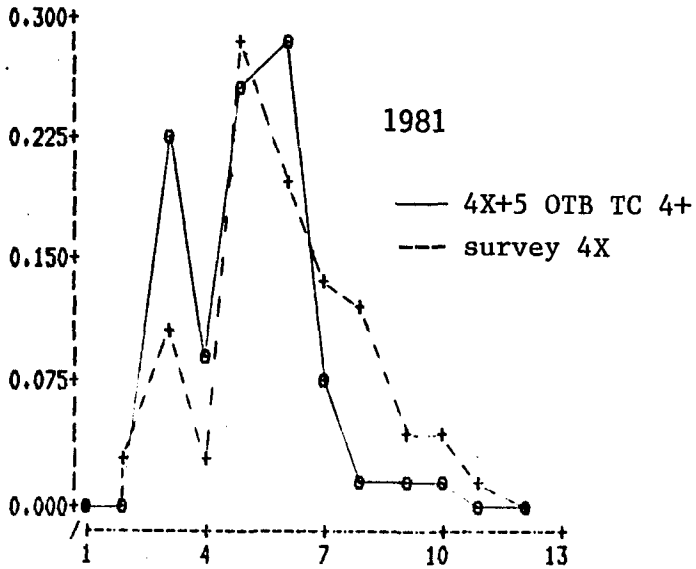

0.500
0.375
0.250
0.125
0.000
1980
4X+5 OTB TC 4+
4VW OTB TC 4+
1
4
7
10
13

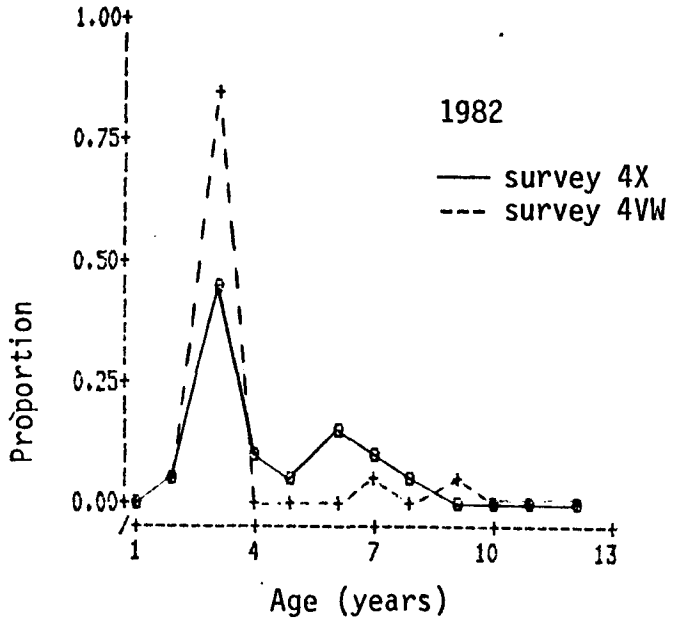

0.500
0.375
0.250
0.125
0.000
1980
4X+5 OTB TC 4+
survey 4X
1
4
7
10
13

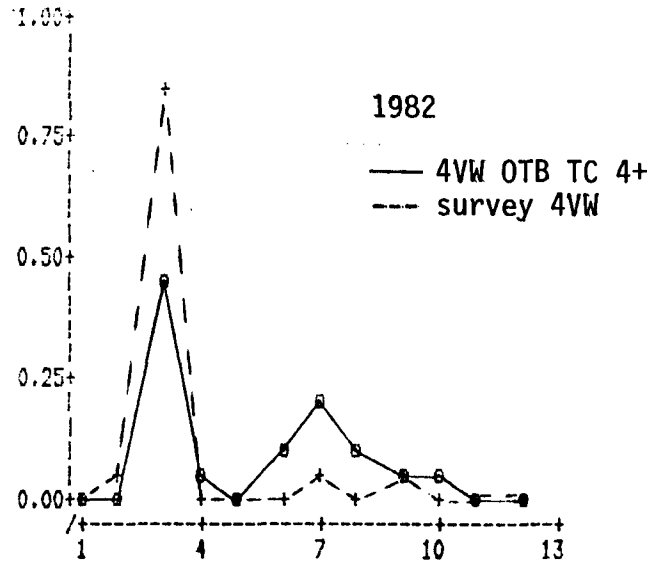

Proportion
0.4
0.3
0.2
0.1
0.0
1981
survey 4X
survey 4VW
1
4
7
10
13
Age (years)

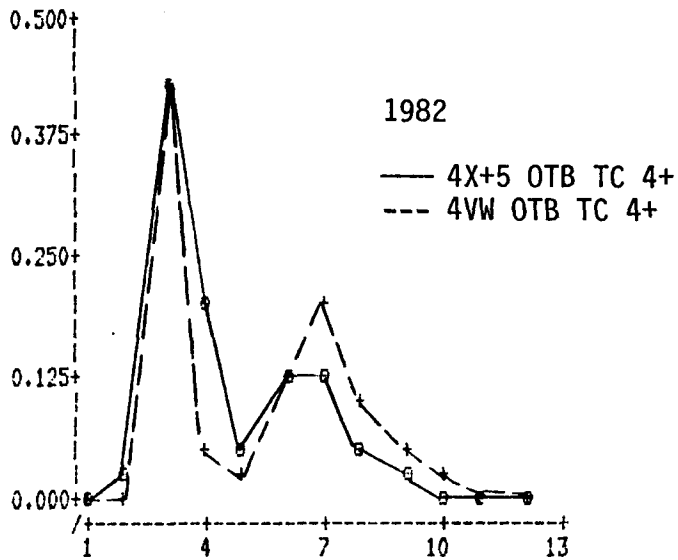

0.500
0.375
0.250
0.125
0.000
1981
4VW OTB TC 4+
survey 4VW
1
4
7
10
13

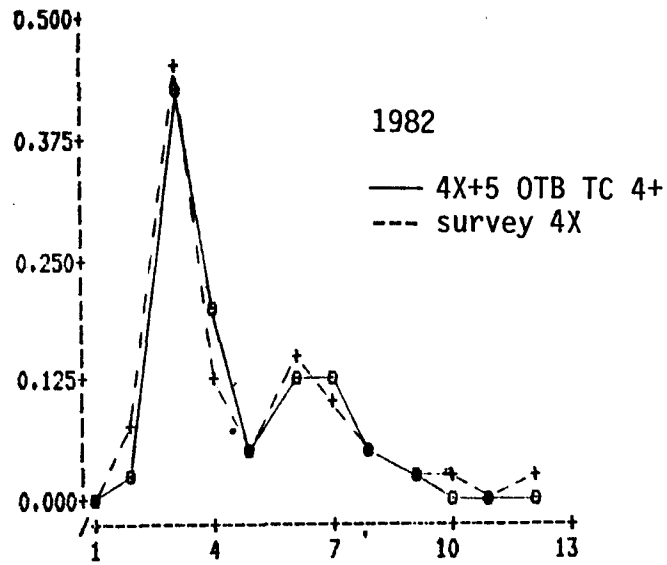

0.500
0.375
0.250
0.125
0.000
1981
4X+5 OTB TC 4+
4VW OTB TC 4+
1
4
7
10
13

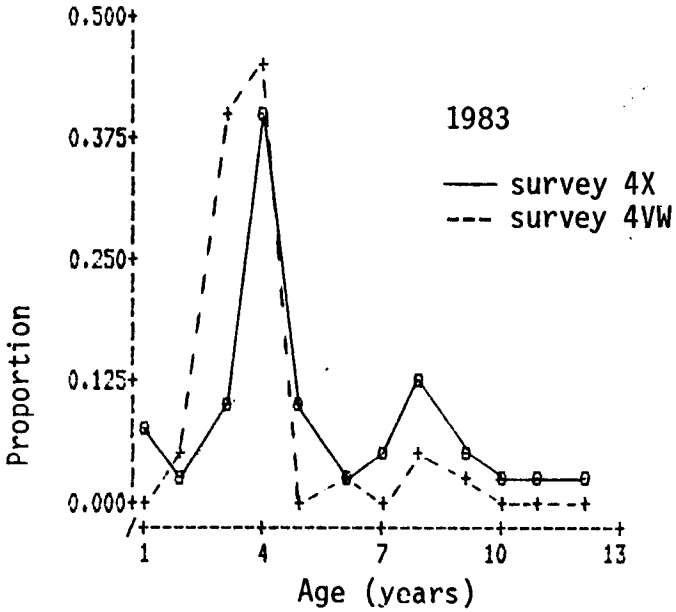

0.300
0.225
0.150
0.075
0.000
1981
4X+5 OTB TC 4+
survey 4X
1
4
7
10
13

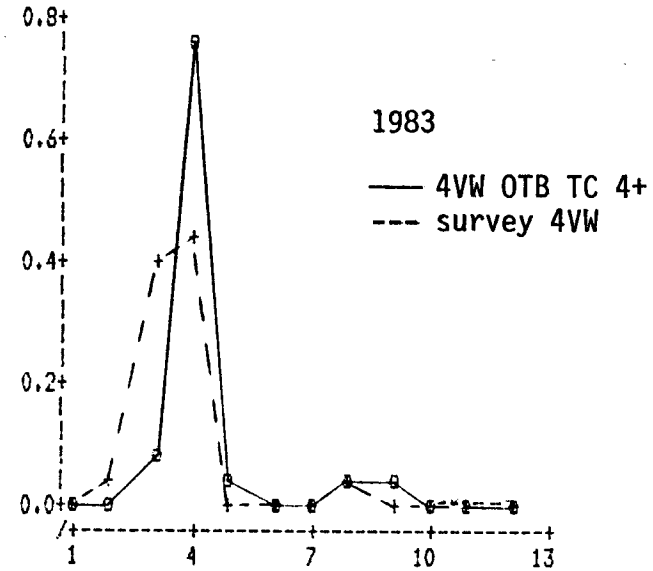

1982
survey 4X
survey 4VW
Proportion
Age (years)
1.00
0.75
0.50
0.25
0.00
1
4
7
10
13

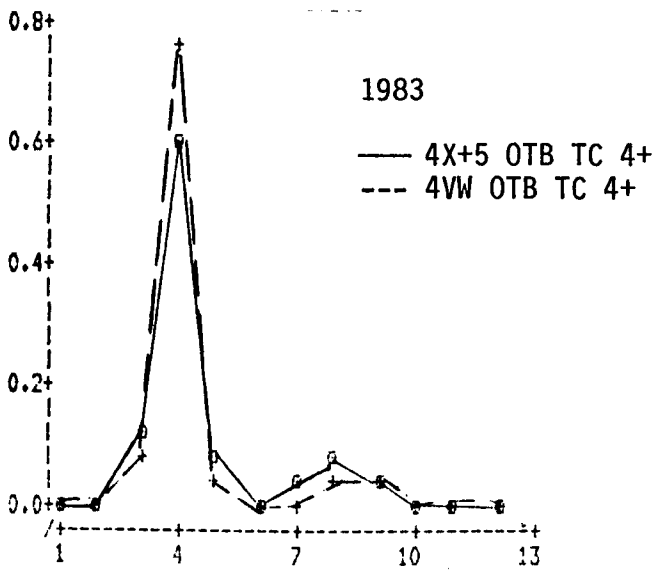

1982
4VW OTB TC 4+
survey 4VW
0.75
0.50
0.25
0.00
1
4
7
10
13

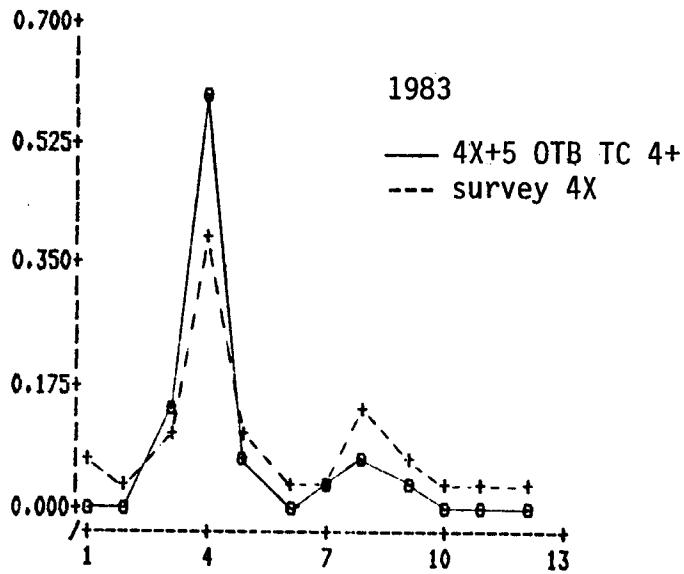

1982
4X+5 OTB TC 4+
4VW OTB TC 4+
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13

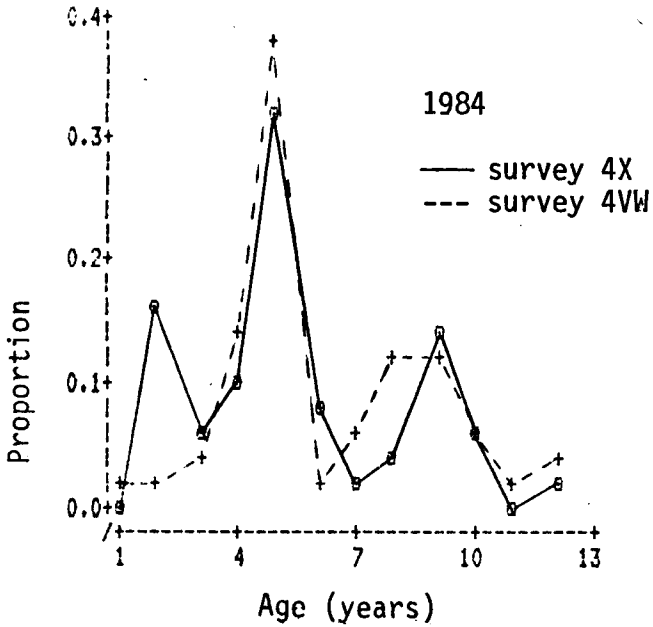

1982
4X+5 OTB TC 4+
survey 4X
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13

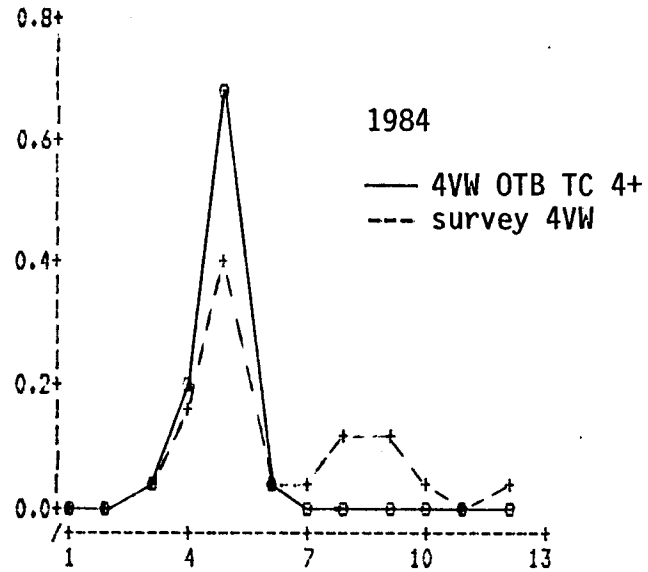

1983
survey 4X
survey 4VW
Proportion
Age (years)
0.500
0.375
0.250
0.125
0.000
1
4
7
10
13

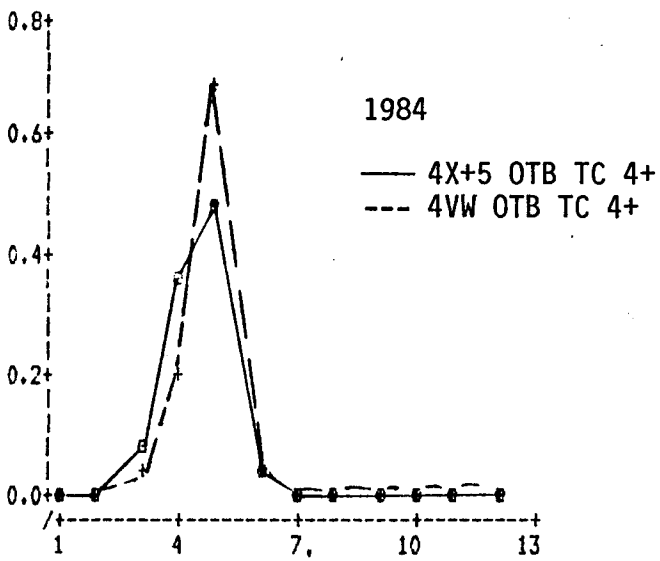

1983
4VW OTB TC 4+
survey 4VW
0.8
0.6
0.4
0.2
0.0
1
4
7
10
13

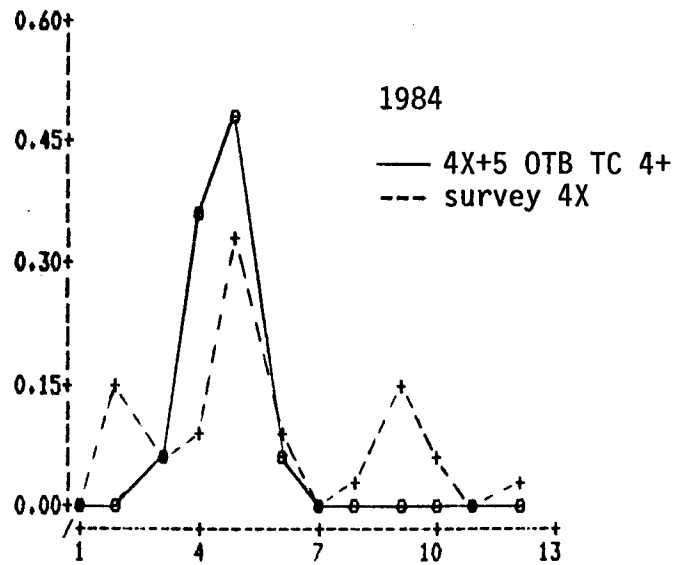

1983
4X+5 OTB TC 4+
4VW OTB TC 4+
0.8
0.6
0.4
0.2
0.0
1
4
7
10
13

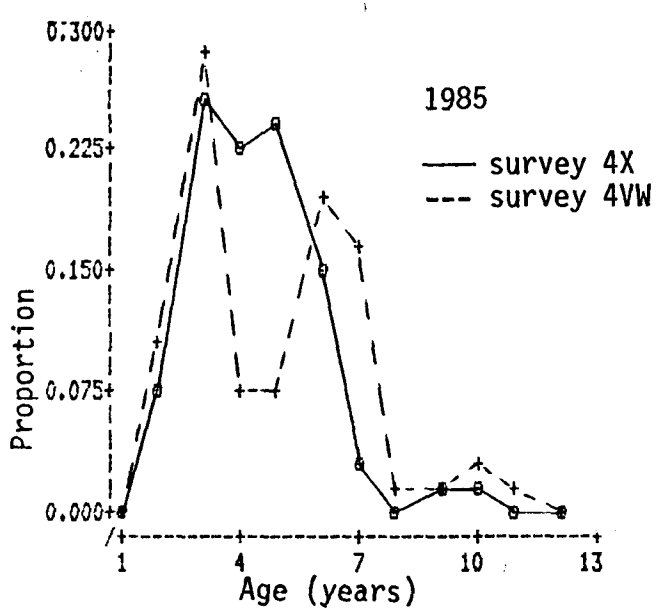

1983
4X+5 OTB TC 4+
survey 4X
0.700
0.525
0.350
0.175
0.000
1
4
7
10
13

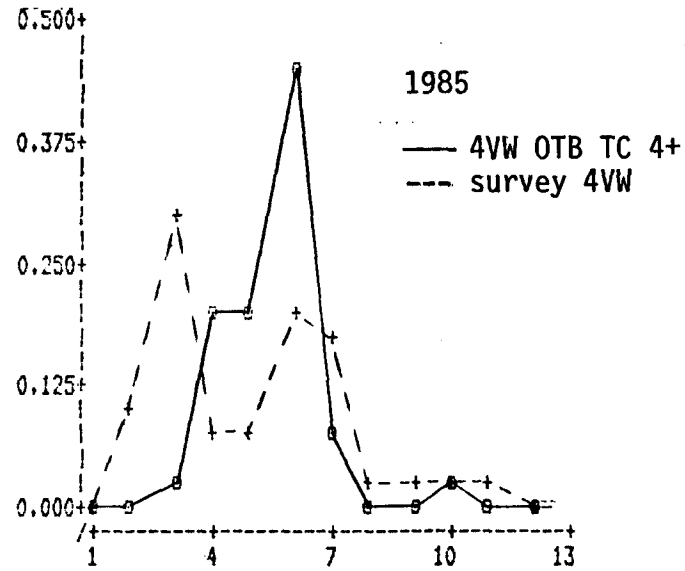

1984
survey 4X
survey 4VW
Proportion
Age (years)

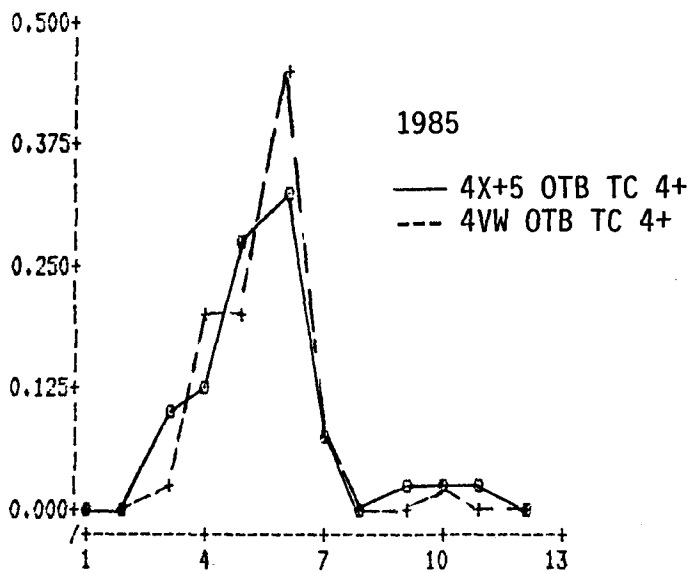

1984
4VW OTB TC 4+
survey 4VW

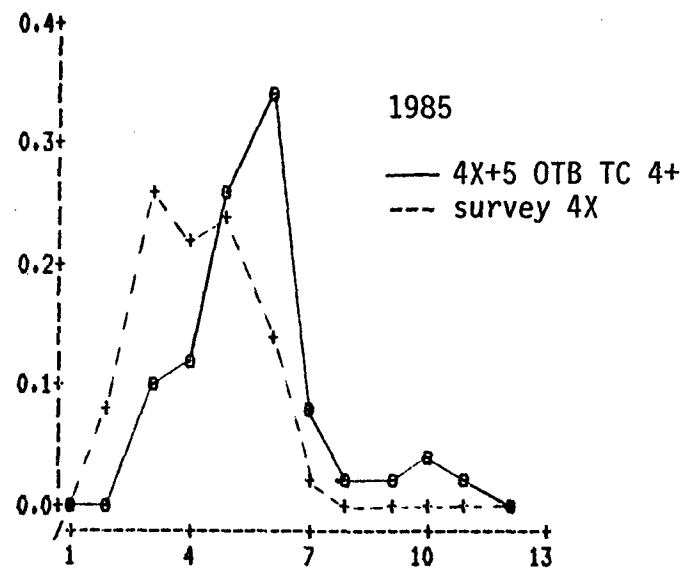

1984
4X+5 OTB TC 4+
4VW OTB TC 4+

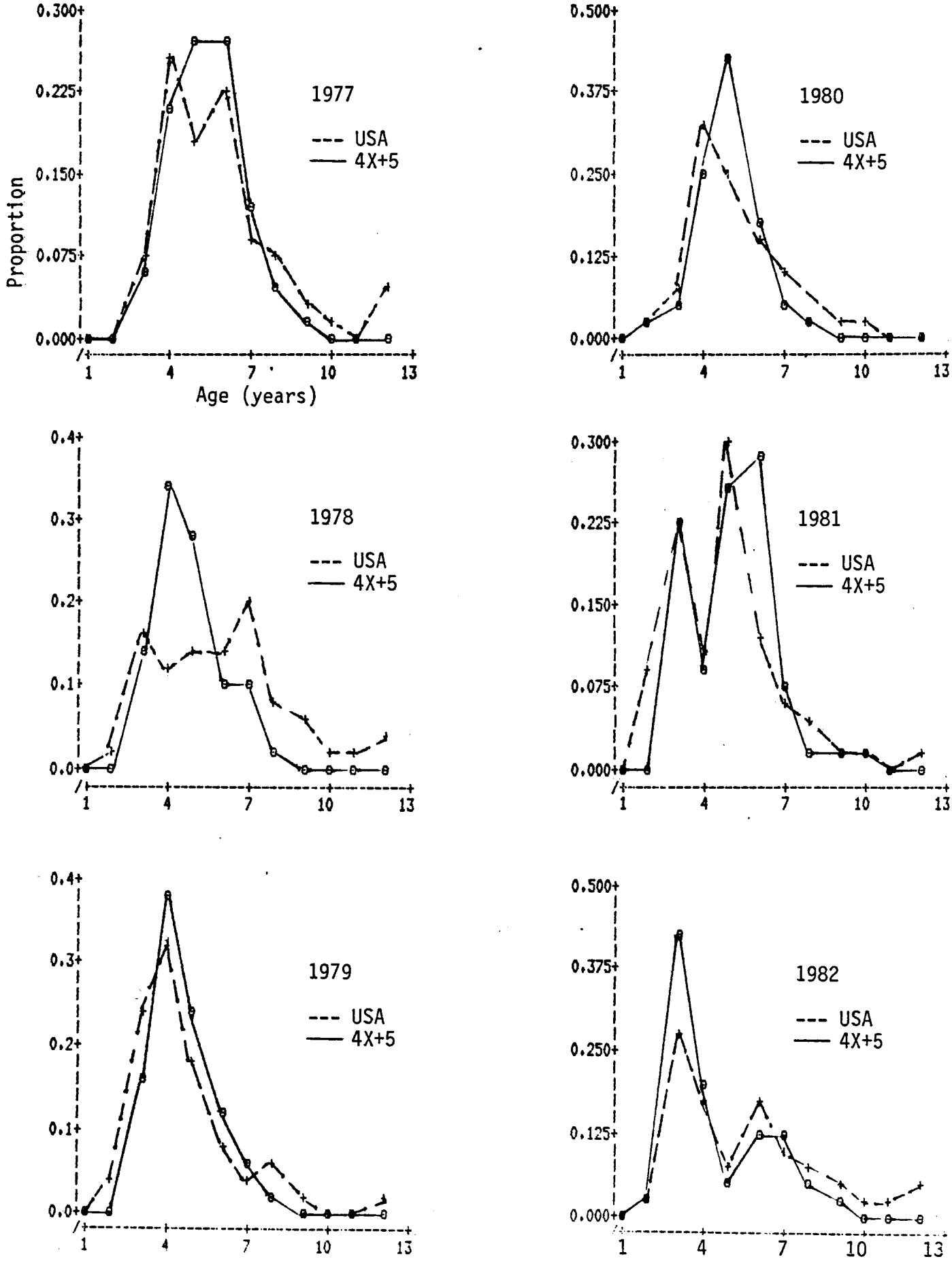

1984
4X+5 OTB TC 4+
survey 4X

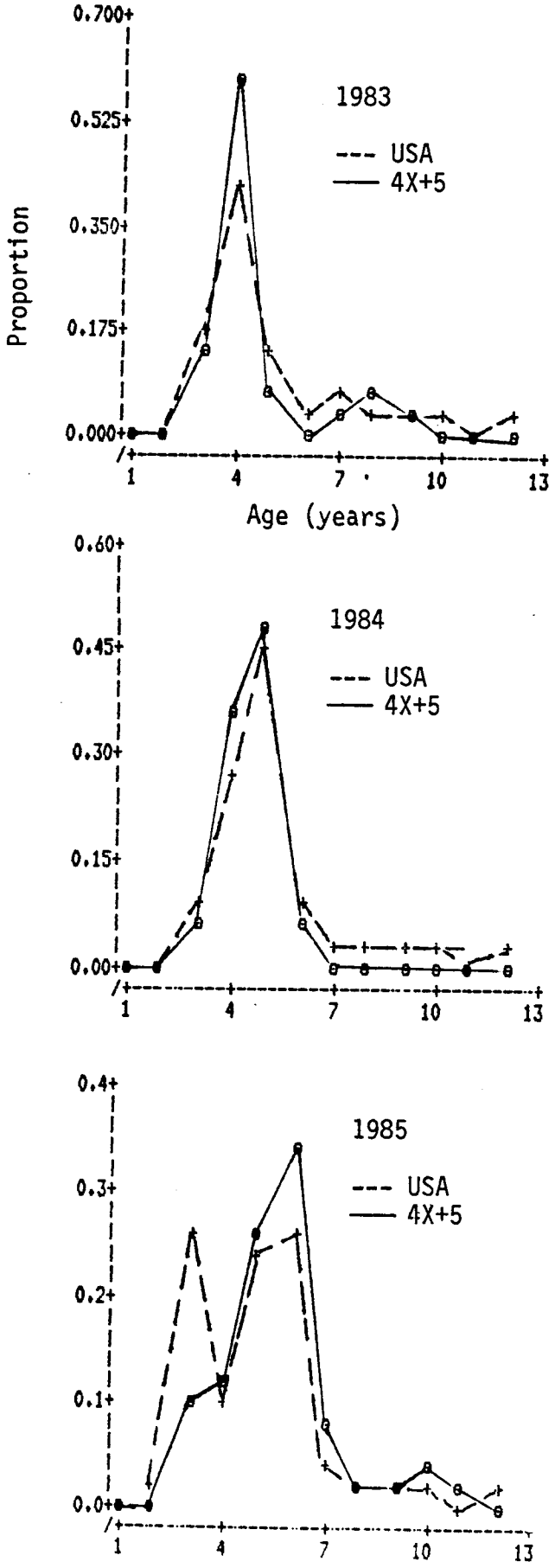

0.300
0.225
0.150
0.075
0.000
Proportion
1985
survey 4X
survey 4VW
1
4
7
10
13
Age (years)

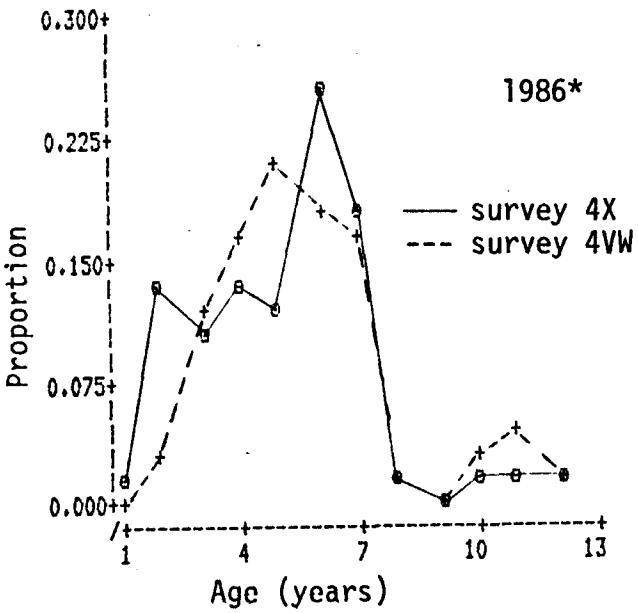

0.500
0.375
0.250
0.125
0.000
1985
4VW OTB TC 4+
survey 4VW
1
4
7
10
13

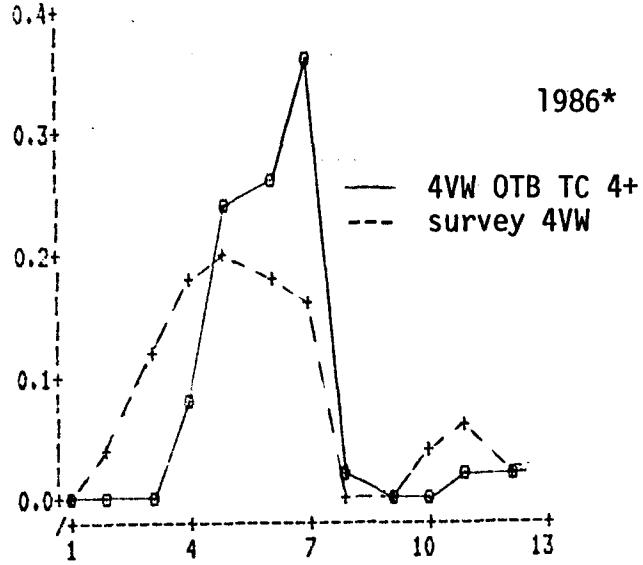

0.500
0.375
0.250
0.125
0.000
1985
4X+5 OTB TC 4+
4VW OTB TC 4+
1
4
7
10
13

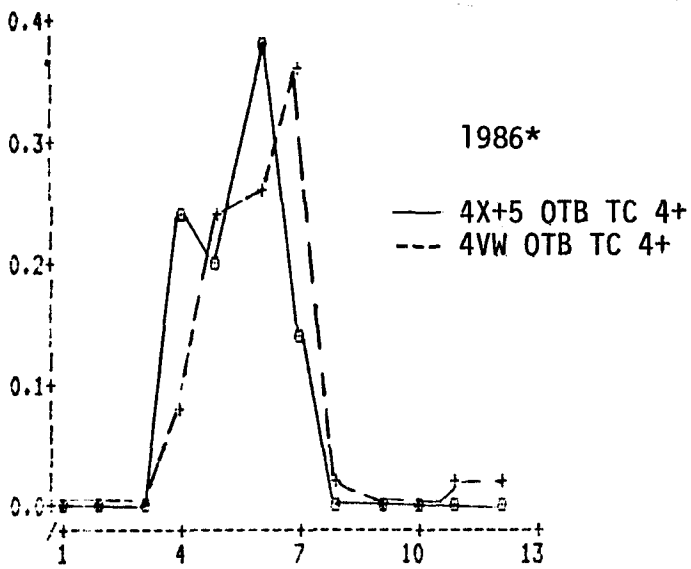

0.4
0.3
0.2
0.1
0.0
1985
4X+5 OTB TC 4+
survey 4X
1
4
7
10
13

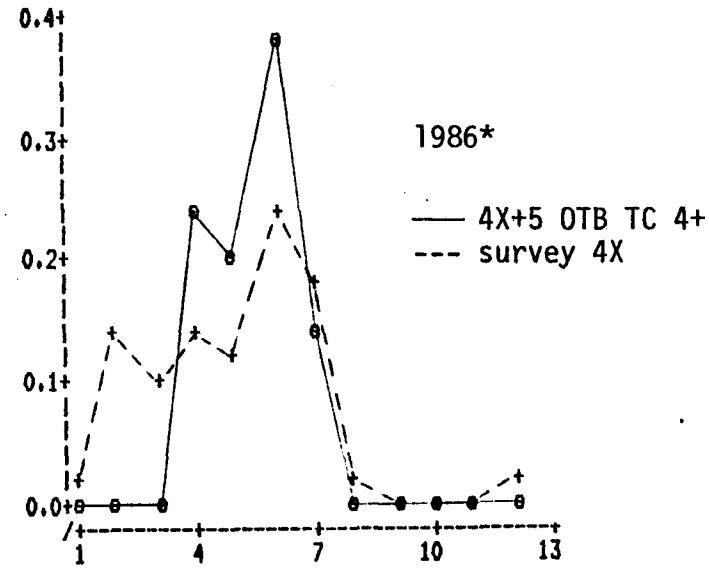

Proportion
Age (years)
1977
1978
1979
1980
1981
1982
--- USA
—— 4X+5


0.700+
0.525+
0.350+
0.175+
0.000+
Proportion
1983
--- USA
—— 4X+5
1
4
7
10
13
Age (years)
0.60+
0.45+
0.30+
0.15+
0.00+
1984
--- USA
—— 4X+5
1
4
7
10
13
0.4+
0.3+
0.2+
0.1+
0.0+
1985
--- USA
—— 4X+5
1
4
7
10
13









*1986 commercial catches for the first six months of the year only.