A COMPARISON OF INITIAL STATISTICAL CATCH-AT-AGE AND CATCH-AT-LENGTH ASSESSMENTS OF EASTERN ATLANTIC BLUEFIN TUNA

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SUMMARY

A concern associated with existing Atlantic bluefin tuna age-based assessments using VPA is that the catch-at-age data inputs are obtained by the cohort-slicing method, which is approximate and might introduce appreciable bias into the results. Current custom in such circumstances is rather to fit the assessment model directly to the basic catch-at-length data available, under the assumption of invariance of the distributions of length-at-age of the fish over time, with statistical models used to formulate the likelihoods maximised in the model fitting process. Initial results are presented for a process of comparing the 2010 ICCAT SCRS VPA assessment of the eastern plus Mediterranean stock with first a statistical catch-at-age assessment approach which also uses the same cohort-sliced catch-at-age inputs, and then a statistical catch-at-length method which fits instead to catch-at-length distributions. Spawning biomass estimates for both the statistical catch-at-age and -at-length analyses are appreciably larger than for the corresponding VPA assessment, which suggests that the specifications of the relationships between the fishing mortality on the plus group and that on immediately younger ages in the VPA merit reconsideration.

1. Introduction

The longer term objective of this work is the development of a two-stock assessment of the North Atlantic bluefin tuna population which takes mixing between the fish of western and of eastern origin into account, in particular by using new information from electronic tags and from otolith microchemistry in the model fitting process (i.e. similar to the model developed by Nathan *et al*., 2011). This should provide a more realistically based assessment of the bluefin tuna in the North Atlantic (and Mediterranean) and would also provide Operating Models for testing candidate Management Procedures for this resource (i.e. in the planned Management Strategy Evaluation, or MSE, process).

However a concern with that model, and indeed with the models used currently by ICCAT that assume separate stocks, is that they are fit to catch-at-age data derived using the rather coarse approach of cohort-slicing, which might be introducing considerable bias into the results. Given the increase in computing power that has become available over the most recent decade, current custom in such circumstances is rather to fit the assessment model directly to the basic catch-at-length data available, usually under the assumption of invariance of the distributions of length-at-age of the fish over time, which considerably simplifies the analysis. Rather than utilise VPA, which makes the assumption (the more poorly justified in cases where cohort-slicing is used to provide the catch-at-age values input) that the resultant catch-at-age values are error free, statistical models (Statistical Catch at Age, SCAA for age data or Statistical Catch at Length, SCAL when the length data are input directly) are used to formulate the likelihoods maximised in the model fitting process.

Thus the first step required in addressing the longer term objective for this work is the development of SCAL assessments for the western and eastern (plus Mediterranean) components of the fishery treated as separate stocks as in current ICCAT assessments. In this paper, initial results are presented by way of comparing one of the 2010 ICCAT SCRS VPA assessments (Run 13) of the eastern plus Mediterranean stock of North Atlantic Bluefin tuna (NABFT) with first two versions of a SCAA approach which also uses the same cohort-sliced catch-at-age inputs, and then a SCAL method which fits instead to catch-at-length distributions.

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2. Data and Methods

The data utilised are documented in Appendix A. The choice of historic catch estimates that has been made is the same as used for the assessment option Run 13 (one of the preferred runs reported, here for the scenario without inflated catch) from the 2010 ICCAT assessment meeting (ICCAT, 2010).

The details of the SCAA and SCAL methodologies are provided in Appendix B, which also lists the values input for certain parameters for the associated models. Both SCAA and SCAL applications fit to the same data series for both CPUE and age (or length) information as did Run 13 of ICCAT (2010), and make the same assumption for values of (age-dependent) natural mortality (though see below).

Some of the specific choices made within these methodologies for the analyses presented here are simpler than may eventually prove optimal, in line with the initial nature of these analyses. To mention some of the more important, which will be subject to subsequent sensitivity investigation:

- The stock-recruitment form fit is of the Beverton-Holt type, but for practical purposes reflects expected recruitment as independent of spawning biomass through fixing steepness h = 0.98). The standard deviation of the residuals of log recruitment about this relationship is assumed to have the value σ_R = 0.4.
- To assist stabilise estimation, the resource is assumed to be at its deterministic pre-exploitation equilibrium with the corresponding age structure at the start of the period considered (1950).
- Though some changes in selectivity at age/length over time have been introduced to improve fits to the catch-at-age/length data, the times of such changes have been restricted to occur outside periods for which the data are linked to catch rate series which serve as indices of abundance. This is (for the moment) to avoid the complications that otherwise arise as to how best to calibrate/normalise catchability q across such changes.
- Inverse variances for individual CPUE data points (generally provided by prior GLM standardisation analysis for each such series) are used as weights in the fitting procedure without allowance for additional variance, i.e. the associated uncertainty is taken to be dominated by sampling variability effects.
- Catch-at-age and catch-at-length contributions to the overall log-likelihood are downweighted by multiplicative factors of 0.1 and 0.05 respectively. This is necessary to take account of the non-independence of such data (fish of similar age or size tend to group together, so that the tuna caught in, for example, the same longline set do not constitute independent samples). However the magnitudes specified for these weights are somewhat arbitrary; the ratio of the length to the age weight is based on the fact that there are about twice as many length classes as age classes considered in the fitting process.

For the SCAL assessment, the distributions of length at age are assumed to be normal with CVs of 20% about their means (Fig. 1 shows the growth curve and the distributions of length-at-age used for the SCAL run).

3. Results

First attempts at fitting the SCAA model revealed a phenomenon familiar with similar applications to Southern Bluefin Tuna (SBT): there are too few very old/large fish in the catch to be consistent with the assumption that the longline fisheries (which generally take larger fish that the other components of the fishery) cannot be sampling these fish uniformly from the older part of the population, unless natural mortality increases very rapidly at older ages. For SBT (see CCSBT, 2009), a combination of a domed selectivity at age (selectivity decreasing with age at older ages) and natural mortality at age increasing at the oldest ages is used for base case assessments. Here two "extreme" alternatives have been considered for the SCAA implementations: "Increasing *M*" (SCAA1) for which the longline selectivity remains flat at large ages, but *M* increases above age 15 (see Table B1), and "Decreasing *S*" (SCAA2) where the longline selectivity may decrease from age 15. The extent of the increase or decrease is estimated in the model fitting procedure. For SCAL only the first of these options has been considered thus far.

A brief summary of key results for these three models is provided in Table 1, which includes values for the contributions of various data sources and penalties to the (penalised) log likelihood, as well as estimates of current depletion expressed in terms of spawning biomass. The brevity of presentation is deliberate at this stage: given the initial nature of these results, it would not be appropriate to focus on more than broad features at this time.

Fig. 2 compares the spawning biomass time series estimated for the three model implementations, and also shows the results from Run 13 of ICCAT (2010). All the new model runs estimate spawning biomasses substantially larger than does the VPA of Run 13; the larger values are for SCAA2, which is unsurprising because with domed shaped selectivity there is a large component of "cryptic" (low availability) older fish that are still alive, whereas the SCAA1 assessment treats these as dead.

In contrast, comparisons of recruitment time series in Fig. 3 show lesser differences, though the new model implementations all show generally higher recruitment over the last decade. The fluctuations in recruitment for the two SCAA runs manifest clearly high correlation with those for the Run 13 VPA, but the patterns differ for the SCAL assessment. Similarly patterns of residuals about the assumed effectively constant expected recruitment (see Fig. 4) differ qualitatively for SCAL compared to SCAA: for both the former runs, recruitment estimates tend to be below average in the 1960's and 1970's, and above average in the 1990's and early 2000's, but any such pattern is much weaker for the SCAL run.

The fits to the various CPUE indices in Fig. 5 are not "bad", given the evident noise in these data. Though the SCAA2 model provides an overall better fit to all the data (see the $-\ell nL$ overall values in Table 1), note that this is through improving the fit to the fleet CAA data at the expense of the fit to the trends in the CPUE indices themselves, as readily evident from inspection of Fig. 5.

Fig. 6 shows the estimated selectivity at age vectors for the two SCAA runs, together with their fits (which are generally good) to the age distribution proportions averaged over years, together with the dependence of natural mortality M on age for the two cases. Note that sharp increases in M and correspondingly sharp drops in selectivity are needed to fit the low proportions of older fish in the longline catches. The fits to the distributions of proportions of catch at length averaged over years under the SCAL model are similarly good (Fig. 7). However bubble plots showing residuals to these fits by both year and age or length show some clear non-random patterns (Figs 8 and 9 respectively).

4. Discussion

There are many assumptions and value choices that have had to be made for these initial SCAA and SCAL assessment runs. Feedback from meeting participants on these, and on how they might be improved/rendered more reliable would be appreciated, particularly also to inform extension of this approach to a supposedly separate western stock.

Issues for possible further examination for this analysis for the east plus Mediterranean include:

- Allowing more flexibility in respect of variation over time of the selectivity at age and at length vectors to reduce the systematic trends in the residual bubble plots of Figs 8 and 9. For example random walk models allowing (but penalising) changes in selectivity over time, together with selection of age ranges over which to normalise selectivity to maintain a comparable catchability q across such changes (as for SBT in CCSBT, 2009), need to be pursued, Heavier penalties, or the use of parametric forms, need to be considered to provide smoother variation in selectivity with age or with length.

- Different functional forms for the decrease in longline selectivity at larger ages and increase in natural mortality at these ages need to be explored.
- Sensitivity to different weightings of the catch-at-age or -at-length data relative to the CPUE data in the log likelihood requires investigation.
- Sensitivity to the assumption of starting at pre-exploitation equilibrium in 1950 needs to be examined.
- Extension of the formulation to admit the possibility of errors in estimates of annual catches by different components of the fishery merits consideration.
- Attempts should be made through the fitting process to estimate *M* (at age), stock-recruitment steepness *h* and the standard deviation of length at age about the estimates provided by the growth curve. Note that the last reflects not only the actual variation, but also the consequences of the birth date for fish within each year-class being spread over a period of the year.
- Random effects models used to reflect and estimate the extent of variation in selectivity and recruitment variation, perhaps later extended to a full Bayesian estimation approach, should be explored.

However it seems unlikely that any of these factors would change a primary feature of the results thus far, which is the appreciably larger spawning biomasses suggested by these approaches compared to the conventional VPA approach used at present in ICCAT.

5. Conclusion

Essentially the difference in spawning biomass estimates provided by the SCAA and SCAL approaches compared to those from the ICCAT VPA is a consequence of different relationships between the fishing mortality on the plus group and that on immediately younger ages. The justifications for the specifications utilised for the VPA in this respect are not strongly founded, and this work does suggest that they merit re-examination.

Acknowledgements

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Table 1: Results for the two SCAA and the SCAL assessments of this paper. See text for an explanation of the options for increasing natural mortality *M* or decreasing Japanese longline selectivity *S* with age at large ages. Biomass units are mt, and K^{sp} refers to the pre-exploitation equilibrium spawning biomass.

	SCAA1	SCAA2	SCAL
	Increasing *M*	Decreasing *S*	Increasing *M*
-lnL:overall	-9942.7	-9958.8	-4347.2
-lnL: CPUE	362.4	448.7	359.5
-lnL: fleet CAA/CAL	-9402.2	-9502.6	-4188.1
-lnL: index CAA/CAL	-941.2	-947.5	-610.8
-lnL: RecRes	38.2	42.6	57.4
Sel smoothing penalty	-	-	34.8
K^{sp}	856575	1690620	958953
B^{sp}_{2009}	322414	869822	612003
B^{sp}_{2009}/K^{sp}	0.38	0.51	0.64

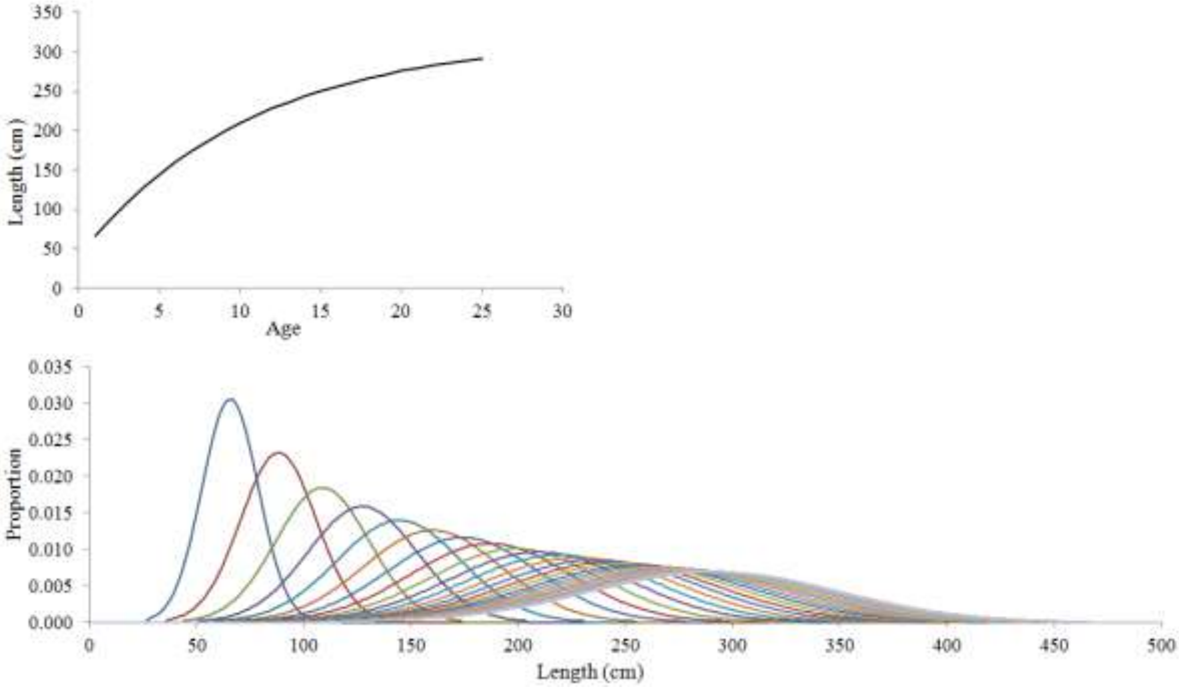

Figure 1: Growth curve and associated length-at-age distributions assumed.

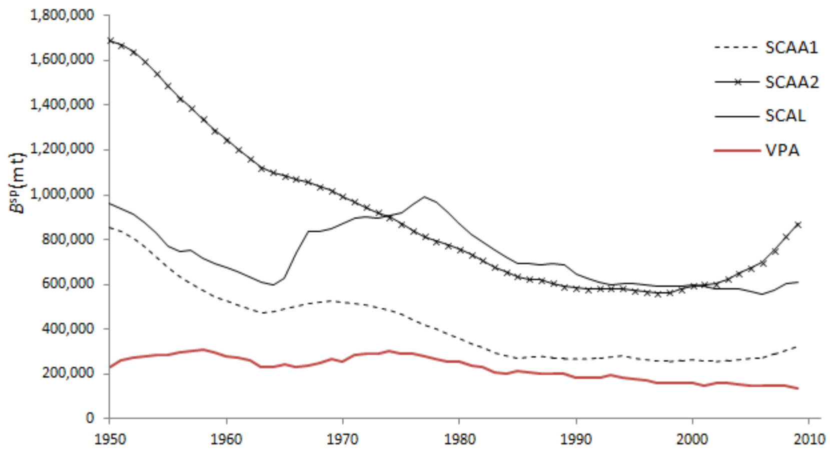

Figure 2: Spawning biomass trajectories. The notation convention used here and below is that VPA refers to Run 13 from ICCAT (2010), SCAA1 is Statistical Catch at Age with increasing *M* at large ages, SCAA2 has Japanese longline selectivity dropping at large ages while *M* stays fixed, and SCAL is Statistical Catch at Length with *M* increasing at large ages as for SCAA1.

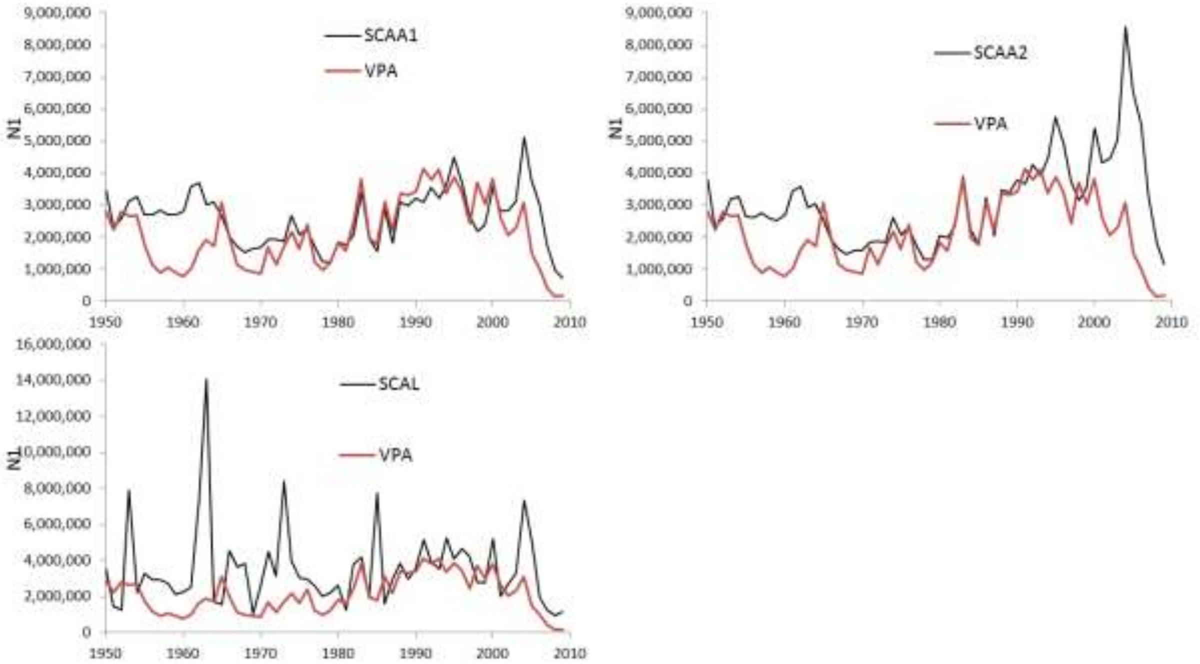

Figure 3: Recruitment (number of 1-year-olds, N_1) trajectories for the four assessments.

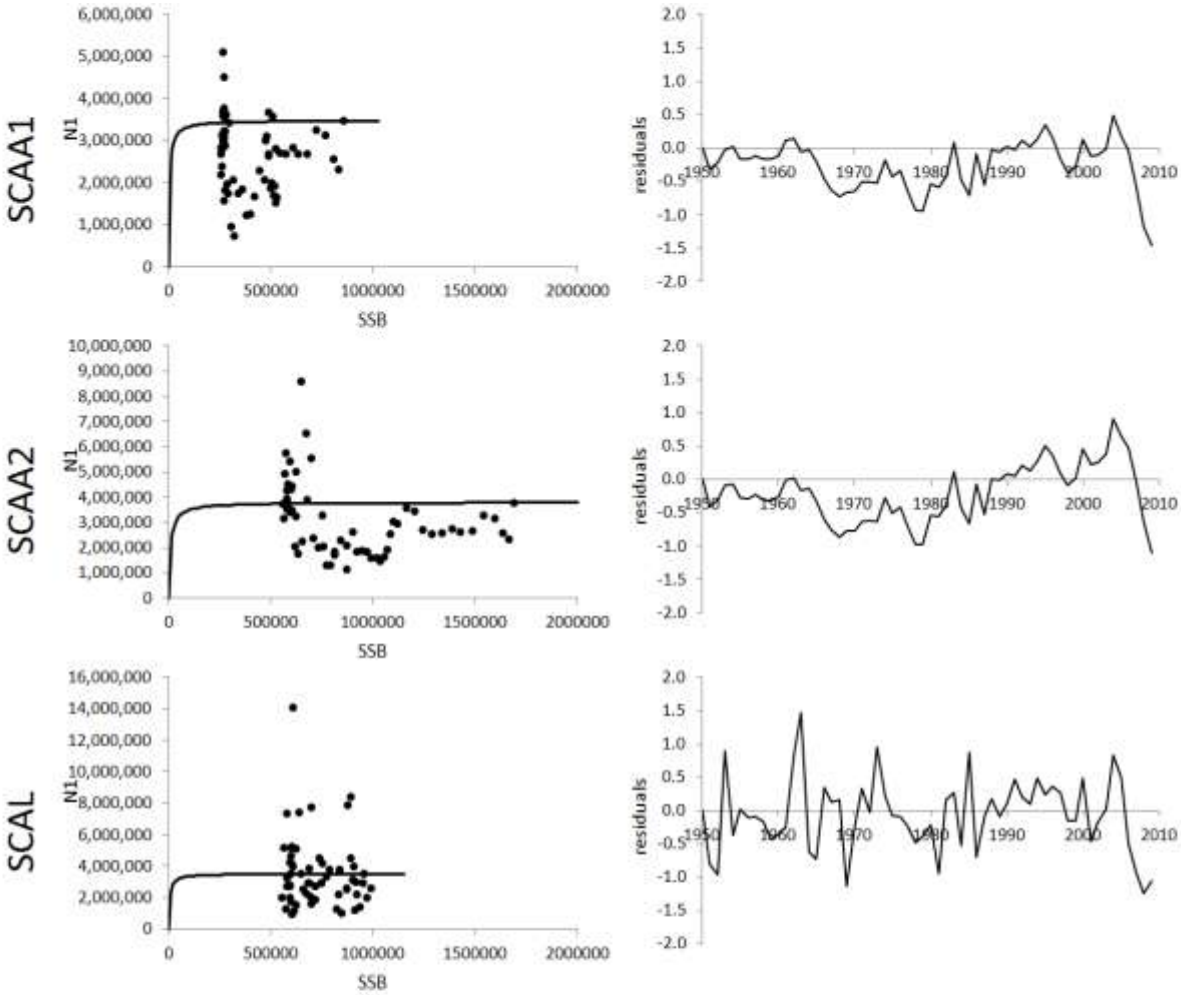

Figure 4: Stock-recruitment relationships (left-hand column) and time series of stock-recruitment residuals for the three new assessments..Spawning stock biomass (SSB) is in mt.

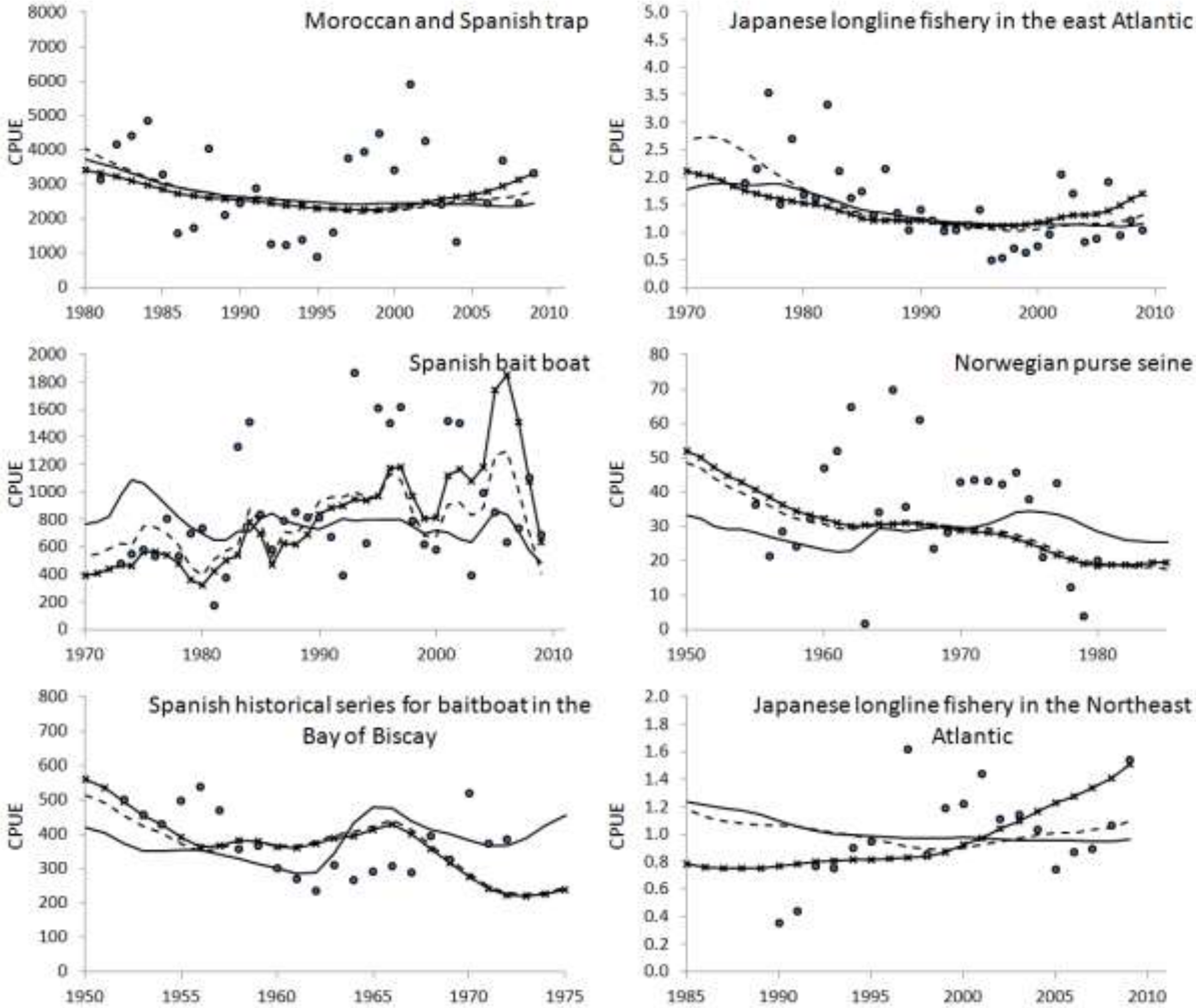

Figure 5: Fits of the new assessment models to the various CPUE series (dashed line=SCAA1, full line with crosses=SCAA2, full line=SCAL)

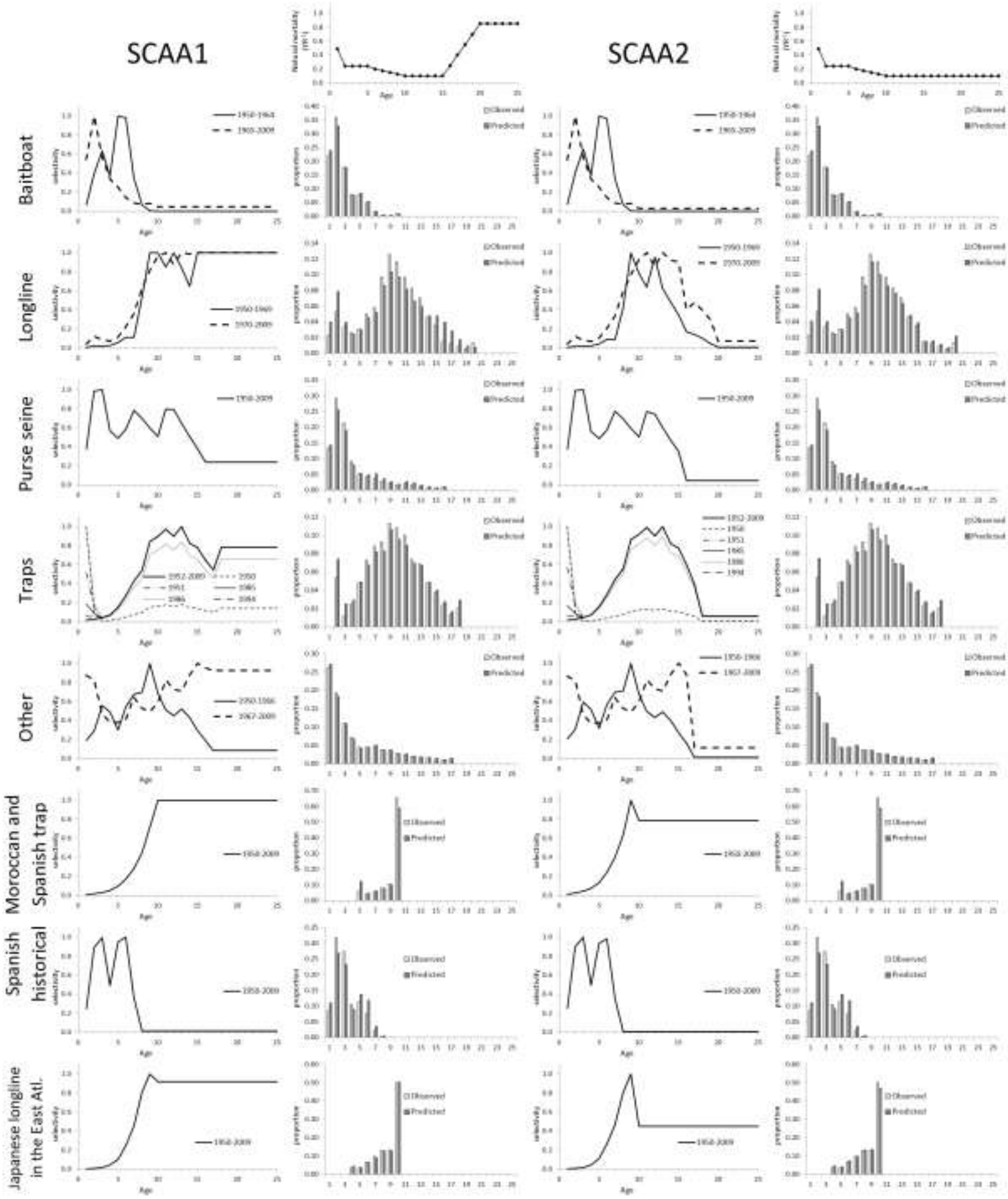

Figure 6: Estimated selectivities-at-age and fits to the CAA data (as averages over all the years with data available) for the SCAA1 (two left-hand columns) and SCAA2 (two right-hand columns) assessments. The input vectors for natural mortality at age for each assessment are shown opposite the title at the top of each column. Note that the first five rows refer to catches at age in the associated fisheries, whereas the final three rows relate to such catches associated with indices of abundance to which the model is fit.

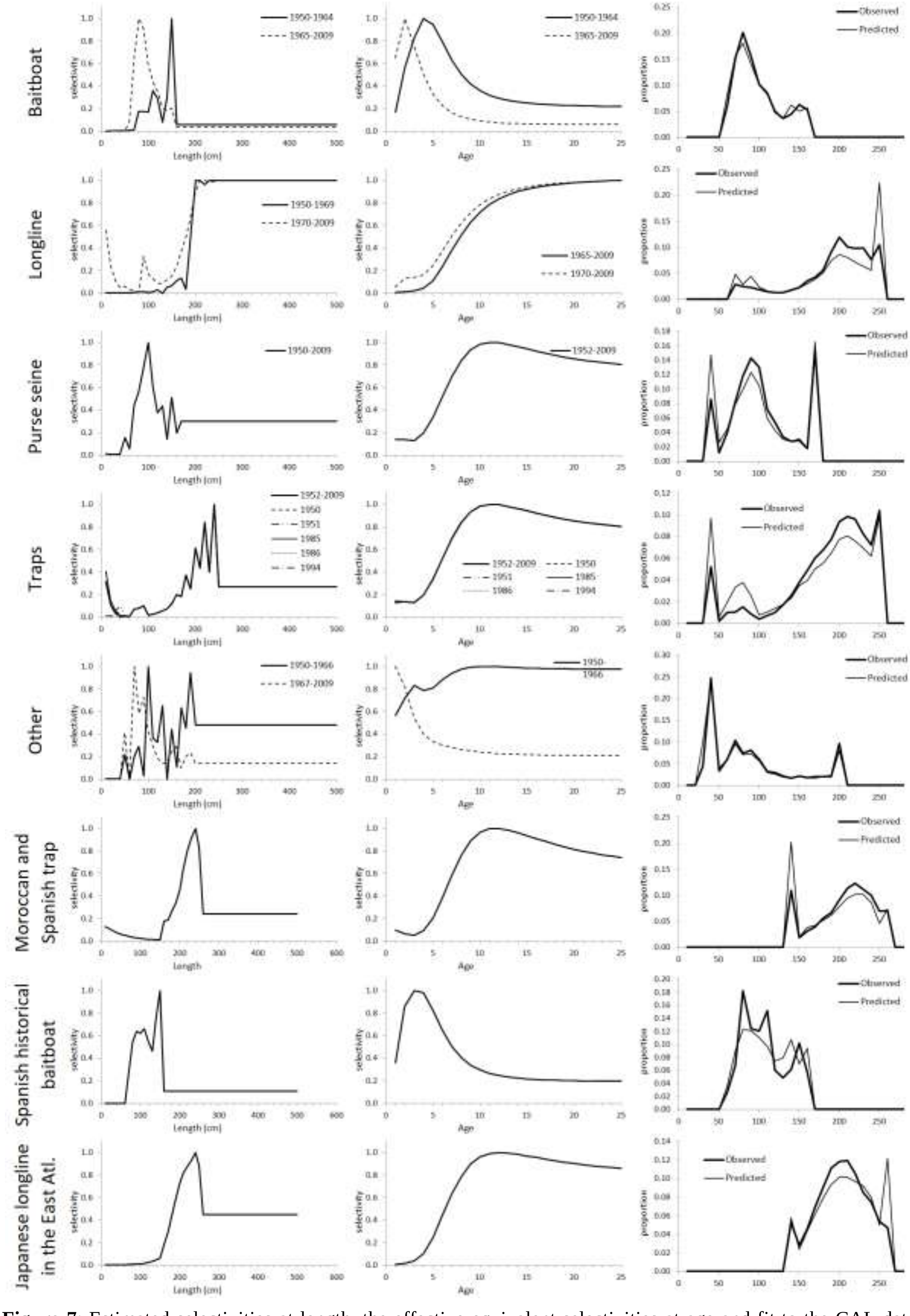

Figure 7: Estimated selectivities-at-length, the effective equivalent selectivities-at-age and fit to the CAL data (as average over all the years with data available) for the SCAL assessment. Note that the first five rows refer to catches at age in the associated fisheries, whereas the final three rows relate to such catches associated with indices of abundance to which the model is fit.

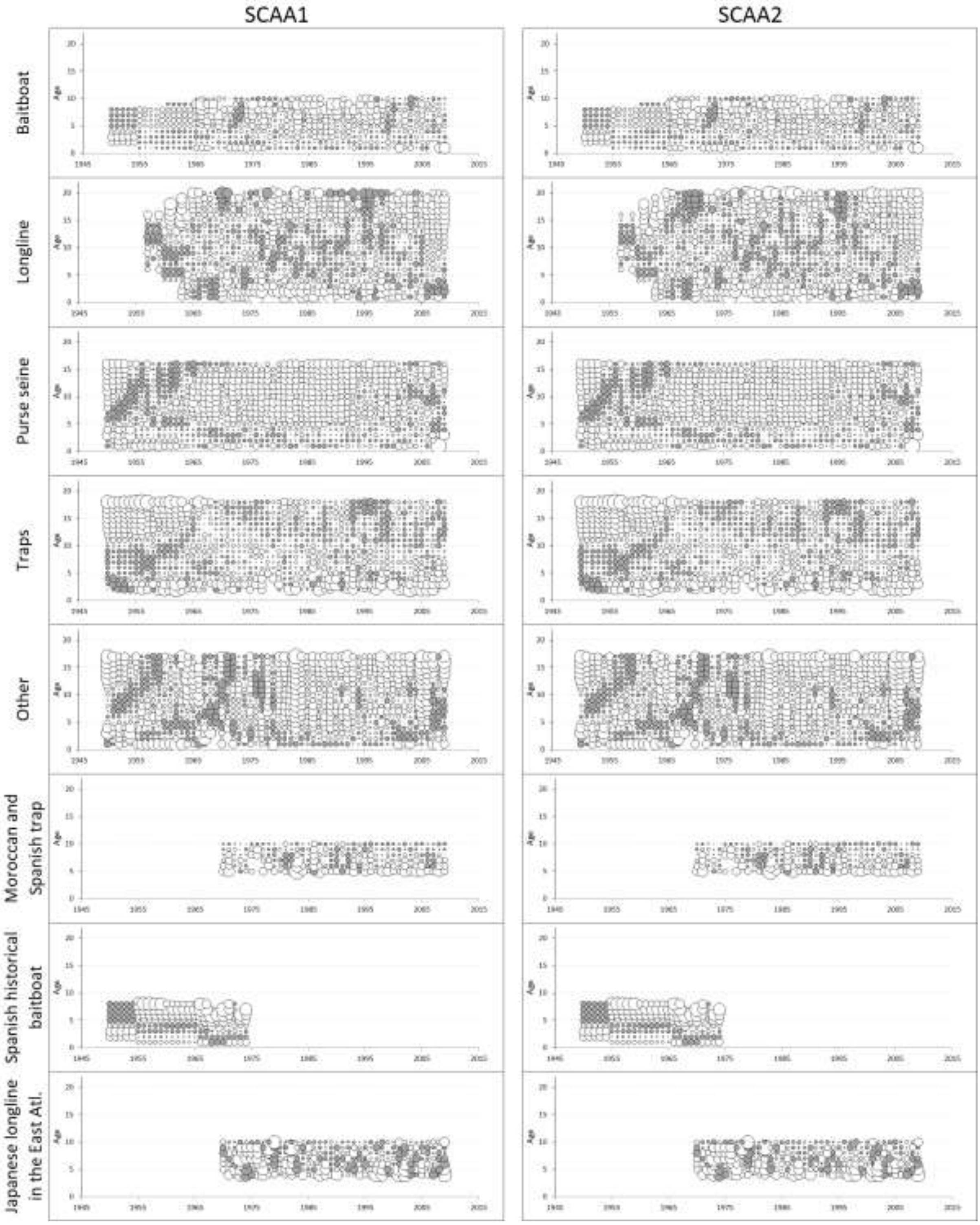

Figure 8: Bubble plots of the CAA standardised residuals for the SCAA1 (left-hand column) and SCAA2 (right-hand column) assessments. The size (area) of the bubble is proportional to the magnitude of the corresponding standardised residual. For positive residuals the bubbles are grey, whereas for negative residuals the bubbles are white.

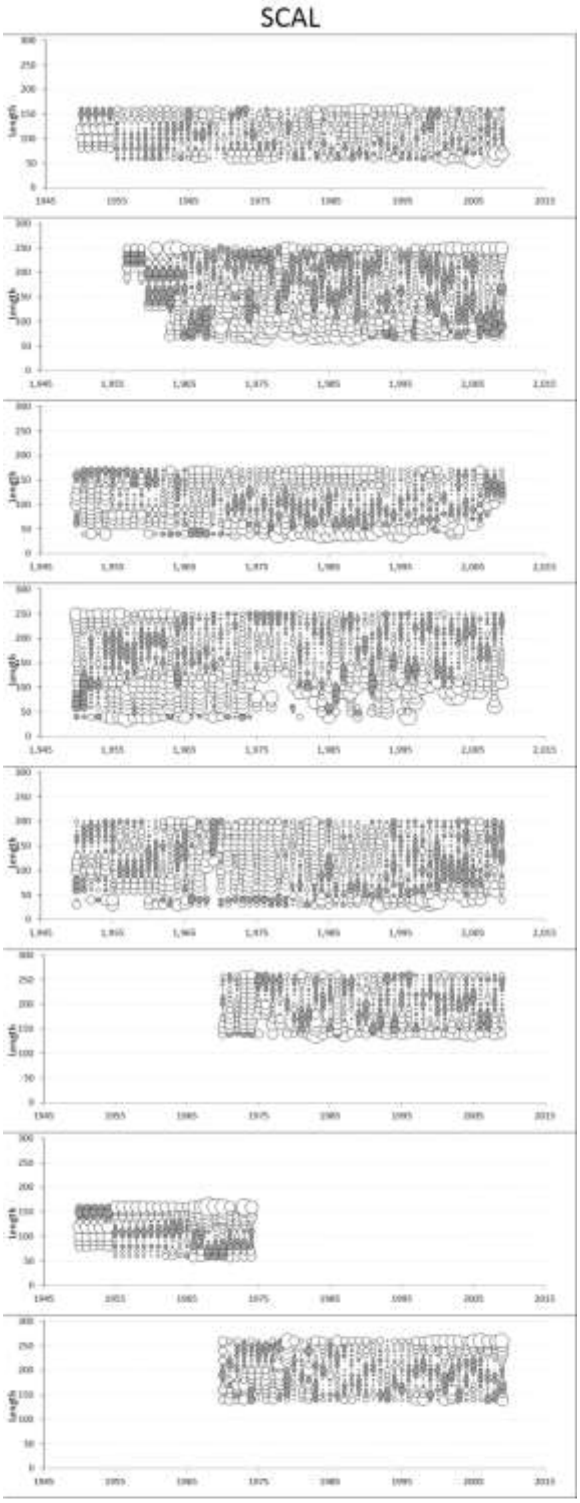

Figure 9: Bubble plots of the CAL standardised residuals for the SCAL assessment. The size (area) of the bubble is proportional to the magnitude of the corresponding standardised residual. For positive residuals the bubbles are grey, whereas for negative residuals the bubbles are white.

Appendix A: Data

The data listed below are from ICCAT (2010) for Run 13, or as kindly provided by Laurie Kell of the ICCAT Secretariat.

Table A1: Catches in mt.

	Baitboat	Longline	Purse seine	Traps	Other
1950	2865.0	0	2856.9	12198.0	6948.7
1951	3979.0	0	7259.3	9717.0	7840.1
1952	3786.0	0	15752.8	9831.0	7600.3
1953	3556.0	0	11281.0	14626.0	7866.3
1954	4430.0	0	13390.5	11576.0	5455.6
1955	4448.0	0	14294.6	11671.0	9199.3
1956	2791.0	0	5932.5	16323.0	2375.2
1957	3154.0	33.0	7057.6	20026.0	4045.0
1958	2829.0	2.0	7004.1	20918.0	2116.6
1959	3052.0	56.0	3628.8	14443.0	3512.5
1960	1198.0	481.0	6725.8	13320.0	2235.5
1961	1453.0	223.0	12019.0	10619.0	2553.2
1962	1537.0	2484.0	10777.3	11875.0	1884.0
1963	1178.0	2418.0	3119.1	6531.0	2244.1
1964	1079.0	882.0	4781.1	8140.0	1697.1
1965	1820.0	834.0	3846.8	9044.0	1313.4
1966	3347.0	581.0	4653.7	5373.0	702.0
1967	1805.0	441.0	6981.9	7877.0	2203.0
1968	1474.0	808.0	4547.0	4872.0	918.0
1969	1826.0	601.0	5148.7	5988.0	894.0
1970	3017.0	343.0	3269.3	3180.0	857.0
1971	3055.0	383.0	4586.8	2211.0	720.0
1972	3032.0	497.0	5045.5	1837.0	276.0
1973	3142.0	611.0	5257.5	1546.0	182.0
1974	2348.0	4651.0	9577.7	2382.0	168.0
1975	2918.5	4323.0	11677.0	2027.0	266.3
1976	1709.8	3291.0	14830.0	2008.0	354.6
1977	2813.3	2445.0	10989.0	1717.0	753.3
1978	3593.0	912.0	7556.0	1458.0	1125.5
1979	2033.9	970.0	6369.0	1350.0	1500.2
1980	1499.8	1255.0	8978.0	1251.0	1266.5
1981	1222.5	917.0	8795.0	1446.0	1393.1
1982	884.3	4255.0	12786.0	3673.0	809.8
1983	1882.4	3606.0	10746.0	3274.0	2294.0
1984	3961.1	2737.0	10261.0	4507.0	2961.0
1985	2281.5	1778.6	11305.0	2390.0	4255.1
1986	1413.8	1644.8	9609.2	1740.0	4839.6
1987	1820.8	1723.4	8857.0	1953.0	3865.5
1988	1936.0	2396.0	11198.0	3658.0	4929.7
1989	1970.6	2083.2	9450.0	2789.0	4768.1
1990	1717.9	2522.0	11304.0	4376.0	3326.8
1991	1592.6	6066.3	13291.0	2993.0	2485.7
1992	1298.7	6416.2	18269.0	2186.0	3679.1
1993	3495.1	5058.9	19321.0	2001.0	4391.7
1994	1979.6	9223.7	26296.0	2834.0	6406.8
1995	2807.4	12867.2	24046.0	1924.0	5646.0
1996	4989.6	12959.0	26344.0	2522.0	3992.3
1997	3524.9	10206.4	25006.0	4367.0	4050.6
1998	2561.5	7049.1	21983.0	4259.0	3865.1
1999	1496.4	6483.2	15636.0	3711.0	5129.3
2000	1821.9	7052.3	17341.3	3735.4	3815.3
2001	2275.1	7053.0	17324.4	4762.6	3190.1
2002	2568.0	5510.8	18540.3	3750.6	3400.5
2003	1379.6	5226.6	17657.5	2302.5	4597.1
2004	1807.0	4638.2	19862.5	2137.3	2935.7
2005	2022.9	5814.6	23345.9	2522.7	2139.4
2006	1115.6	4649.6	20352.1	2717.6	1854.4
2007	2031.5	4361.1	22951.5	3883.0	1288.9
2008	1794.4	4740.5	12858.3	3317.2	1343.3
2009	1259.6	3165.2	9468.4	3262.1	3072.8

Table A2: Commercial catches-at-age used in the SCAA.

Baitboat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1950	0	1767	1202	2271	21856	17533	4987	780	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	2453	1669	3154	30354	24350	6926	1082	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	2334	1588	3001	28881	23169	6590	1039	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	2193	1492	2819	27127	21761	6190	976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	2731	1859	3512	33794	27110	7711	1216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	10395	51418	66228	24365	17474	10152	2539	393	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	4983	29054	32025	12202	13402	8898	2364	369	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	5531	28170	35108	12892	15981	10256	2734	427	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	4910	25028	31022	11359	14494	9323	2492	390	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	7446	36930	46906	16810	11986	6530	1613	249	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	2740	10306	12080	6490	5958	3540	950	162	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	4288	15519	18526	10080	5957	2983	759	141	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	4732	17303	20695	11022	6019	2862	714	135	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	3315	13004	15400	7458	4983	2564	658	116	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	3156	13030	15411	6825	4364	2125	535	93	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	5484	22908	27251	11575	5530	2114	480	91	11	8	63	173	291	198	106	38	12	4	0	0	0	0	0	0	0
1966	6462	73088	76938	16734	4278	929	51	5	1	3	36	138	303	252	160	55	15	8	2	1	1	0	0	0	0
1967	4332	26641	42612	10051	788	151	104	77	44	7	42	111	268	290	210	89	30	10	2	1	1	0	0	0	0
1968	19422	22073	14220	10766	3804	664	21	25	22	1	8	81	215	209	221	193	105	53	4	1	1	0	0	0	0
1969	29810	68778	21490	6010	802	280	17	0	0	0	6	111	277	286	370	146	36	7	1	1	0	0	0	0	0
1970	36432	63297	20359	14239	6900	2969	1054	297	0	0	11	55	358	545	731	510	213	99	17	4	2	0	0	0	0
1971	2790	54543	21368	11773	11888	3030	659	179	0	3	15	72	294	524	737	659	389	239	88	28	12	0	0	0	0
1972	2543	52188	7680	4293	7721	6333	3114	1198	302	0	11	72	358	665	890	762	430	253	74	22	11	0	0	0	0
1973	2360	47655	15576	3018	1963	2278	3611	3531	2649	206	3	29	209	498	762	730	508	402	130	54	16	8	2	0	0
1974	2792	53344	14370	7207	1949	470	68	27	37	91	19	116	156	250	459	456	382	348	134	159	52	6	5	1	3
1975	17806	108264	10507	5287	1118	357	28	23	4	5	71	108	254	571	589	699	733	820	328	218	40	35	34	30	2
1976	1862	43438	10729	1363	1190	838	371	40	0	1	0	173	70	238	575	983	320	462	202	152	202	3	0	0	6
1977	10184	85175	18740	6492	559	195	161	68	0	39	0	139	300	592	338	605	624	668	294	216	125	155	69	53	38
1978	56071	67259	9972	13989	5479	1319	134	26	89	238	350	604	1274	842	1230	1027	681	179	26	15	15	7	18	26	43
1979	12520	12345	15490	14030	3551	1313	497	100	674	430	82	109	234	132	287	145	207	444	220	93	93	22	16	16	27
1980	49709	23891	7649	1973	2620	2242	1215	160	104	44	131	225	252	147	164	270	131	89	66	47	35	10	3	0	2
1981	31335	36300	4160	1537	636	554	398	159	22	37	111	417	324	221	170	154	45	111	60	55	43	20	7	0	2
1982	17659	29546	6998	2379	1540	545	490	255	47	0	2	46	23	0	33	30	24	23	10	6	25	0	0	0	3
1983	176457	45237	4094	1040	165	82	13	45	2	126	209	366	263	230	42	63	66	41	14	6	8	4	1	1	1
1984	42596	154684	27394	7387	7625	3898	655	309	21	193	97	2	1	0	95	0	0	0	0	0	0	0	0	0	0
1985	61077	92483	30022	5444	1402	637	105	9	13	26	65	182	130	91	65	26	13	0	0	0	0	0	0	0	0
1986	96079	42511	4948	4590	914	379	47	1	19	24	44	44	108	56	31	19	10	9	0	0	0	0	0	0	0
1987	31544	118753	2425	3527	2013	1388	170	21	102	113	11	64	32	11	51	51	0	0	0	0	0	0	0	0	0
1988	209885	57499	6849	2146	1559	719	336	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	143974	87060	6928	2171	856	417	110	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	80878	38906	21056	3653	4879	612	14	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	51216	65539	7220	4448	2266	800	444	174	68	122	32	0	51	0	0	0	0	0	0	0	0	0	0	0	0
1992	36473	65479	8546	1902	809	493	49	5	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	32171	157787	46810	14318	3301	1301	184	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	110962	31765	14425	6608	3550	347	5	24	22	29	14	22	22	36	22	36	36	0	0	0	0	7	0	0	0
1995	149749	78918	36625	4479	726	230	11	3	0	0	0	0	0	0	5	8	11	0	0	11	22	11	17	11	5
1996	261506	80919	75309	28217	8897	631	124	35	43	93	72	34	39	32	7	39	12	11	14	19	3	0	0	0	3
1997	98846	56027	54317	11455	3876	313	70	108	262	324	217	253	292	196	353	375	359	270	157	154	33	2	3	0	19
1998	54041	57070	28668	23678	1243	895	590	117	26	60	97	192	167	118	87	97	82	62	49	28	35	0	0	0	0
1999	4847	5419	4282	12421	12090	2712	698	101	76	46	35	33	28	13	7	21	0	0	11	0	7	0	0	0	0
2000	39115	21077	12013	4244	5800	3395	1005	1359	831	293	137	66	39	16	4	2	2	1	81	0	0	0	0	0	0
2001	1066	104849	24086	5157	1418	1994	1190	295	662	307	222	192	110	34	21	13	12	6	4	3	2	1	0	0	0
2002	31353	88701	44277	4202	1145	255	384	436	461	378	231	155	70	36	25	8	7	10	2	1	1	1	1	1	2
2003	4882	34256	12039	1045	1802	965	217	479	1401	918	888	285	85	35	18	5	8	2	1	0	0	0	0	1	1
2004	62230	60361	9068	6033	1581	705	365	107	221	533	490	231	88	54	35	11	0	1	2	0	0	0	0	0	0
2005	121336	44510	25280	3449	2890	511	170	80	51	84	227	184	74	11	10	8	3	1	0	0	0	0	0	0	0
2006	27126	20420	15081	6863	1334	1116	503	92	66	79	205	40	85	72	2	0	0	0	0	0	0	0	0	0	0
2007	1	33743	18087	18227	4673	1990	709	156	105	556	188	110	78	28	9	9	3	1	0	0	0	0	0	0	1
2008	323	33856	24367	15960	2541	110	427	248	316	336	272	225	121	82	48	19	8	4	2	1	1	1	1	1	1
2009	47	13463	15304	5695	2181	3232	994	341	317	198	161	99	40	30	18	8	3	2	2	0	0	1	1	0	0

Longline	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1957	0	0	0	0	0	2	4	10	8	10	33	54	25	16	6	2	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	1	0	1	2	3	1	1	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	3	7	17	14	17	56	91	42	28	10	3	0	0	0	0	0	0	0	0	0
1960	0	0	0	30	136	184	101	631	1202	563	159	201	61	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	11	57	77	42	252	506	251	85	102	47	12	7	4	2	1	0	0	0	0	0	0	0
1962	0	0	0	203	705	905	522	3621	6114	2488	761	1076	178	0	0	0	0	0	0	0	0	0	0	0	0
1963	44	90	119	137	578	1043	417	1918	4791	3558	1123	1110	853	94	7	15	51	65	15	0	0	0	0	0	0
1964	35	70	36	30	27	173	176	552	1856	1270	394	462	275	60	47	12	0	0	0	0	0	0	0	0	0
1965	71	144	47	61	121	211	159	437	1136	693	245	406	560	315	177	85	44	21	5	2	1	0	0	0	0
1966	56	115	78	77	35	123	92	195	431	438	331	327	382	232	143	75	43	22	6	4	1	0	0	0	0
1967	15	35	48	44	27	69	126	229	440	545	295	165	168	83	76	62	43	23	10	9	5	3	1	1	1
1968	83	105	106	105	46	146	111	217	452	810	565	349	413	249	367	85	53	45	21	20	9	6	1	2	2
1969	42	70	71	70	50	114	137	415	491	435	246	283	297	172	165	94	86	58	26	18	13	8	1	1	0
1970	2	4	1	2	10	30	67	209	175	147	52	49	74	30	61	73	112	130	89	98	51	30	16	12	4
1971	0	0	6	2	5	59	121	106	226	252	262	155	141	81	73	37	63	53	32	39	25	22	12	6	9
1972	12	18	28	30	18	149	53	188	365	397	191	227	313	182	96	53	22	20	3	0	0	0	0	0	0
1973	10	20	33	41	25	77	58	177	275	435	296	520	423	272	159	60	256	21	6	0	0	0	0	0	0
1974	137	407	2587	2172	2598	3129	400	1541	1346	3413	2663	3137	4217	2990	1821	751	506	424	263	98	52	22	6	12	16
1975	18	226	182	1189	673	671	515	936	1035	2764	3955	4674	5412	3976	2584	1260	941	708	562	259	155	60	15	24	44
1976	2	63	116	172	397	474	354	490	576	1184	1903	1990	3865	1814	1779	886	511	751	201	132	84	52	32	28	37
1977	0	25	48	79	91	384	770	1196	1980	1812	1948	1392	1425	1036	1156	488	314	58	82	0	16	0	0	8	0
1978	0	0	34	166	237	264	399	219	53	313	90	133	406	10	1933	23	15	42	50	0	145	112	0	145	369
1979	0	25	50	165	234	1195	1382	2656	1726	583	208	99	54	33	43	25	21	8	5	3	0	0	0	0	0
1980	0	8	120	100	198	258	479	703	931	929	1183	635	376	187	92	37	16	22	16	2	14	0	0	0	0
1981	9	18	84	33	121	225	423	916	892	641	755	832	208	175	147	63	105	123	22	20	36	6	6	0	1
1982	0	34	206	255	204	848	1288	5065	769	938	2563	2112	2384	6083	862	115	308	390	384	159	207	41	41	41	0
1983	22	187	363	516	1235	1420	2186	2551	2089	4134	1984	1133	1753	1270	831	199	171	53	24	0	2	4	0	0	0
1984	38	161	175	216	473	733	1031	2016	1862	2827	2082	907	802	453	259	215	249	46	55	29	8	8	8	0	0
1985	44	245	269	201	447	599	608	608	613	849	1082	1023	1433	1034	645	350	272	161	127	52	63	36	9	26	33
1986	53	287	477	386	978	876	572	580	790	1542	1511	1147	1199	555	322	64	48	27	21	1	3	1	1	1	2
1987	0	155	108	198	209	641	1089	1002	994	1022	985	1000	1126	1033	622	394	157	82	23	5	0	0	0	0	0
1988	9	113	365	361	258	540	1374	1730	1742	1763	1811	907	1184	785	586	227	159	84	40	7	39	19	2	0	1
1989	17	651	941	874	685	919	1692	1583	1432	1282	1160	419	685	676	511	239	206	99	62	28	63	5	5	85	240
1990	434	1041	1002	505	775	1151	1551	2038	2747	2967	1849	924	697	502	345	235	126	62	50	63	10	27	30	7	91
1991	2528	1060	997	989	772	1582	2374	2629	7735	7214	6889	2456	1383	687	375	284	217	148	100	138	269	22	104	108	205
1992	1302	2176	986	1626	2542	1843	1699	2644	5058	3798	5872	3675	3174	2595	1726	645	480	390	109	118	74	29	12	0	0
1993	2785	8605	1542	1491	2894	3425	2580	1489	1592	2963	3257	2067	1750	1212	1036	304	489	272	441	192	624	28	175	102	714
1994	25505	20297	3650	3767	2606	2646	6630	5738	5307	5403	4396	2041	4193	2902	2764	702	2428	105	529	303	18	0	0	0	37
1995	504	1048	1637	2324	2909	8189	6478	4587	6048	4953	5183	5383	6051	6088	2595	2557	1851	1421	965	617	483	373	185	87	781
1996	942	3299	723	1351	1884	2942	5257	6297	7954	7538	7062	5278	5329	3762	2875	2417	1728	1388	1022	567	437	300	184	119	447
1997	30499	28510	8479	3831	3758	3559	5180	7135	9246	7174	6827	4418	3348	2123	1243	1215	749	580	336	232	115	377	89	15	165
1998	0	39	139	393	543	1428	2580	3198	5273	7422	7245	3605	3081	2255	820	1003	496	382	322	189	49	17	3	14	3
1999	671	454	701	2585	4704	2550	4105	7189	6024	6412	5057	3306	2113	1171	358	382	223	139	67	102	58	30	11	27	51
2000	722	1152	568	3692	3087	4411	3272	5499	7496	6290	4555	3442	2489	2272	1163	309	72	33	28	11	16	24	5	30	23
2001	1044	4296	8980	1557	1179	4502	8391	9584	8111	5977	4416	2505	1523	711	734	411	60	102	33	0	6	14	4	0	0
2002	1512	5244	3558	1667	1278	1496	3939	8030	8386	4266	3519	2270	1467	608	312	221	81	70	15	13	47	9	2	21	6
2003	6375	6578	6604	3780	3124	3360	3048	3808	5165	7092	3696	1961	1020	576	382	182	109	91	22	34	30	2	2	15	17
2004	2462	3999	1975	2313	1954	1863	4200	3316	2888	4244	3827	2458	1435	686	417	452	183	122	57	98	18	25	9	2	14
2005	257	1781	1003	1185	2058	2656	3337	3660	4706	5833	5590	3144	1697	645	400	294	61	40	38	25	7	9	5	2	8
2006	7619	11257	17521	1530	1507	2664	3151	2946	2490	2557	2277	1340	1019	601	558	131	67	50	35	27	33	6	8	10	17
2007	1200	30270	7425	3307	2292	2231	2343	4403	3843	3167	2737	1774	1160	646	498	170	85	41	108	30	3	6	6	2	12
2008	243	25642	8297	7987	5242	2569	5255	5441	3733	3885	2692	1717	1373	780	760	373	113	77	24	11	45	9	4	3	10
2009	798	7917	3723	1978	1257	6747	3666	2896	3211	1728	1074	702	506	285	213	111	72	43	19	7	24	6	4	1	7

Table A2 cont.

Purse seine	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1950	26672	30835	260	714	1853	19600	7124	551	244	461	209	109	95	61	34	14	6	2	0	0	0	0	0	0	0
1951	3209	3790	2003	3435	6784	19700	35706	11288	2967	877	1102	242	217	139	76	31	12	5	1	0	0	0	0	0	0
1952	827	992	1808	3098	2342	20794	35733	51087	27595	6745	1999	1217	504	351	193	78	32	14	3	0	0	0	0	0	0
1953	2478	2922	1819	1678	6089	12052	28016	29192	18653	5824	1733	1041	598	340	185	78	30	9	0	0	0	0	0	0	0
1954	3719	4305	92	178	1883	3155	10885	8432	13055	15637	10088	10228	4291	2115	1090	408	102	44	4	0	0	0	0	0	0
1955	390	9973	21556	8375	7213	12961	7648	11706	8237	10158	14836	12354	6667	2652	1187	307	36	32	0	0	0	0	0	0	0
1956	274	6851	14753	5422	742	2205	1060	1070	764	1621	3901	5839	5428	3349	1871	913	389	91	24	15	2	3	2	0	0
1957	275	6874	14801	5440	404	3310	11106	6948	5611	4016	5802	5000	2687	998	375	119	40	5	5	2	0	0	2	0	0
1958	3001	12187	19090	7573	19917	15866	5725	5935	3107	2305	2270	2297	1553	1587	1226	727	338	152	19	14	1	0	0	0	0
1959	172	4295	9248	3398	286	354	677	592	1225	1402	2497	3282	2841	2068	1196	504	165	45	10	0	0	0	0	0	0
1960	1778	9577	11448	5869	16760	11713	3487	2595	2314	3152	3860	6402	2823	2112	1064	531	238	84	19	3	0	1	0	0	0
1961	3197	16279	19560	9199	20921	14256	4042	1066	2248	3258	6442	9443	8162	5411	3252	1832	896	342	94	32	12	1	0	0	0
1962	2129	10942	12295	5468	11252	6999	1962	469	407	690	2454	7708	8819	7499	5182	3070	1502	625	162	78	10	3	0	0	0
1963	2476	12317	13980	4859	8379	5314	1478	357	435	1483	3518	683	435	237	160	128	102	66	20	17	5	6	2	1	0
1964	8707	31093	30371	12315	10845	5908	3965	378	109	621	1259	1102	1138	1118	1201	1060	754	500	141	127	35	21	9	4	2
1965	6236	20209	17423	7991	4525	1787	488	78	34	62	124	438	946	1660	2132	1015	1281	695	242	163	72	36	6	2	4
1966	27951	38529	52656	25601	8065	2411	576	41	0	142	422	274	407	504	732	821	674	427	149	115	20	16	14	3	12
1967	53118	44623	64081	31959	10092	3208	1012	217	187	256	278	313	608	814	1079	1418	1398	1088	549	448	257	158	67	39	41
1968	2209	24018	41360	29153	8942	2760	453	359	82	50	134	150	211	251	367	479	448	478	260	270	120	81	45	24	25
1969	12787	40185	52818	27367	9847	1839	843	1049	777	297	261	361	378	483	637	567	731	703	273	227	132	77	11	7	1
1970	2286	12850	15132	5699	3333	3366	2701	1807	1812	1514	1090	1149	153	158	75	151	233	295	282	222	116	88	38	27	0
1971	661	34588	29449	4810	825	1121	2982	4285	3817	2099	976	473	366	418	614	492	462	459	315	341	213	166	94	45	73
1972	3308	98524	72286	13434	2864	1146	829	544	1442	312	249	276	405	499	673	535	481	395	247	187	93	45	45	14	7
1973	4397	38931	62815	9029	2556	1732	2925	1478	3782	1005	612	426	503	585	695	581	437	427	262	248	134	128	77	57	45
1974	41382	90507	35112	45733	7901	2461	2553	2594	6458	1460	960	949	1251	1441	1796	1271	969	898	518	536	312	232	136	73	106
1975	65168	241398	70414	17106	9456	6359	3845	2050	2911	1645	1018	1883	2751	1996	1701	1175	793	745	381	383	278	319	175	122	357
1976	14948	153206	229064	45867	16293	4623	2663	1361	2172	1058	1070	1248	1845	1659	1799	1534	1187	876	699	534	260	198	74	78	181
1977	56514	190801	62129	38392	5880	3742	2733	973	399	511	963	980	1552	1536	1830	1606	1230	1065	895	776	473	398	177	162	398
1978	35326	111386	120418	10168	1551	440	1801	3074	725	1911	1046	838	642	728	992	970	385	431	331	647	375	172	36	23	20
1979	3293	32509	67985	31188	1904	549	217	324	225	1150	1003	556	1213	1623	1162	804	963	898	238	335	387	2	0	0	0
1980	65559	106562	100271	32111	6883	2152	882	901	839	1507	1995	1198	1001	1751	1320	928	1134	635	271	132	313	84	49	13	24
1981	35583	268896	106041	14055	9231	4137	1713	1244	1210	1072	1363	885	756	415	355	305	132	217	83	115	63	50	40	52	57
1982	400822	224987	164062	32388	5135	1408	1032	1075	1081	1219	1378	1499	1217	783	498	289	194	198	73	50	45	16	12	20	26
1983	253996	138046	111887	25280	9386	2880	5362	2696	1799	4728	1379	873	1339	1084	1067	215	138	8	58	5	7	3	1	1	1
1984	70897	381448	47830	17845	7755	3237	2244	1641	1243	1631	1450	1781	2561	1326	913	578	379	251	119	59	53	24	28	13	9
1985	38750	205131	219293	43017	7978	3410	554	281	261	597	839	1181	897	574	228	166	90	52	21	4	4	4	0	0	0
1986	334457	153547	97780	50478	7831	3126	1804	710	713	393	450	870	674	401	308	181	82	58	25	24	21	7	11	6	10
1987	151581	271059	121151	26339	6849	2544	1291	664	674	1088	607	450	353	211	123	79	33	4	2	0	0	0	0	0	0
1988	372753	125252	204977	40121	8704	4038	1929	1541	1130	1420	712	540	304	157	81	72	34	9	9	5	3	5	7	8	2
1989	151764	265245	84560	45605	22205	976	2230	818	429	773	329	351	107	172	122	120	65	26	27	17	8	14	21	25	6
1990	283400	266844	165449	47367	27448	1844	508	912	1175	1562	677	359	312	207	120	71	66	68	17	13	10	7	3	2	2
1991	148265	316817	170422	43184	32918	1617	537	1043	2231	3262	2086	956	642	358	107	148	145	112	67	26	23	9	2	0	10
1992	77716	420932	264527	44504	14155	8383	7528	4235	3516	5748	3540	1816	826	241	138	194	72	8	5	4	4	0	0	0	0
1993	166824	490085	295455	41400	14007	5580	7211	6458	5456	5693	4955	1859	786	439	362	582	89	88	60	38	32	38	21	17	47
1994	102244	416511	134161	39531	26305	17099	14716	12815	13044	14841	12973	9748	3730	1133	660	430	272	204	175	119	69	32	31	14	71
1995	153156	217120	247772	53029	41206	21134	11362	9628	3611	7176	11905	8080	3425	1039	408	177	99	29	20	9	4	6	2	0	2
1996	98066	548430	225708	132284	30964	13313	9437	7008	6856	7001	12068	6060	2776	1129	188	72	36	0	8	0	6	0	0	0	0
1997	105959	357772	112776	84684	46711	30212	16441	15497	16891	15878	3236	556	184	240	363	85	99	169	85	136	56	0	0	0	0
1998	223427	369253	229617	107787	41848	65530	3139	2258	788	1111	996	1042	1183	540	189	243	180	112	91	48	26	23	17	11	23
1999	221130	217003	119208	67812	13620	4133	2680	1854	14584	8530	1236	2098	739	655	231	147	116	77	33	31	20	30	3	0	0
2000	790197	333553	169733	33759	12785	18603	3896	2481	1449	1158	1186	959	799	709	501	463	229	161	177	137	100	72	45	33	93
2001	10030	300220	79224	72693	15972	8172	15154	5491	2468	18855	8168	1612	853	419	647	362	365	277	39	41	44	26	9	0	44
2002	13436	345202	132866	52157	24410	10490	3366	2826	3783	5486	15150	2104	2058	807	1464	523	703	361	341	147	166	0	54	0	63
2003	13809	100143	34121	24070	32167	15893	10035	7388	3320	10597	13912	9874	2648	1323	1242	1062	108	181	518	388	64	27	27	0	54
2004	59953	139077	132007	19999	7752	16806	20315	2535	8898	14556	17373	2633	1900	1063	1329	1003	596	188	341	62	64	82	123	0	95
2005	106541	300103	74825	51666	17397	14177	12852	8831	5985	25267	21217	4699	459	356	182	1	178	1	1	0	176	0	1	0	0
2006	148481	78083	193607	32933	7184	18480	3691	5046	33143	9592	9743	5588	3104	297	46	137	114	69	0	0	0	0	0	0	0
2007	0	29529	14173	132495	51103	15921	12166	4395	18700	11110	25508	9075	912	864	431	263	348	262	284	88	0	50	0	0	335
2008	1	0	7314	36022	37652	18725	9226	7055	7410	3944	2370	2207	1870	1190	781	522	399	150	135	64	55	30	17	32	122
2009	0	0	276	41530	18756	17863	25080	12904	3863	3125	8256	698	203	175	141	100	79	48	26	12	18	12	5	8	35

Traps	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1950	159868	184817	1878	4483	5665	7792	14157	13436	21157	10523	4165	1163	569	364	208	88	33	38	0	0	0	0	0	0	0
1951	23332	27579	14796	12688	4677	6057	10383	10344	16612	8737	4122	2122	1578	1011	551	222	86	37	8	0	0	0	0	0	0
1952	2384	2889	5487	3368	4962	7030	12232	12055	19295	10023	4577	2179	1566	1013	557	227	91	41	10	0	0	0	0	0	0
1953	9734	11518	7553	7110	7422	10447	18374	17984	26599	14735	6524	2932	2014	1287	728	305	118	34	0	0	0	0	0	0	0
1954	6608	7679	461	3331	5341	8036	13458	13643	22933	13655	6904	2157	1291	930	528	225	115	31	7	0	0	0	0	0	0
1955	250	324	388	1504	5819	8674	14611	14702	25228	15859	7669	1140	166	281	180	86	79	8	3	0	0	0	0	0	0
1956	53	121	884	2115	9131	13085	22929	22398	37026	21239	9838	1412	175	268	171	82	72	2	3	0	0	0	0	0	0
1957	13	392	1503	9757	7847	31910	37279	26045	13887	19266	14033	5023	2439	2671	3318	1362	218	6	3	0	0	0	0	0	0
1958	15123	575	445	7442	24322	22920	27826	26990	22393	9862	12278	9088	3883	3478	4116	1983	182	268	74	170	206	73	24	0	0
1959	38	23	931	1881	3159	9727	10715	12857	19713	18108	12717	7626	4381	2410	567	32	13	6	168	111	0	0	0	0	0
1960	8	16	115	1302	4184	8415	10881	17276	23978	17100	9411	5433	2945	1583	655	59	22	11	57	83	0	0	0	0	0
1961	11	21	223	1016	1785	7738	5154	11033	23230	16728	7462	3196	1736	849	445	99	24	12	2	0	0	0	0	0	0
1962	2	3	7	804	3457	9693	5763	15898	21883	16297	9930	4105	2405	984	384	106	61	42	10	0	0	0	0	0	0
1963	21	43	56	933	2285	3197	3362	2988	3153	9530	9391	4380	2541	1118	397	110	98	82	19	0	0	0	0	0	0
1964	185	589	2281	6180	4775	3346	6543	3069	2265	5296	10099	8706	4722	1603	860	210	65	0	0	0	0	0	0	0	0
1965	252	511	472	2681	2659	5082	7278	3041	1579	2320	4067	6757	8592	5208	2687	1119	778	279	6	0	0	0	0	0	0
1966	319	37	122	1872	4432	9592	4807	3240	2700	2114	3246	3203	3722	2078	982	251	48	31	0	0	0	0	0	0	0
1967	801	10	674	1439	5274	8083	12157	2523	3601	6353	3596	2295	3006	3358	2482	1209	388	173	70	24	10	0	0	0	0
1968	0	0	111	862	3778	2678	8274	4568	1505	1861	3063	2132	2388	1151	1083	845	339	134	25	6	0	0	0	0	0
1969	487	1749	48	623	3535	3528	2690	4530	2769	2300	2323	2783	3151	2183	1756	1406	784	757	129	139	19	0	0	0	0
1970	7	16	4	119	364	1551	1834	2419	2915	3554	2390	1283	1688	780	452	432	168	154	30	11	4	0	0	0	0
1971	0	0	37	41	160	614	1515	1643	1731	1180	684	740	608	898	620	604	440	340	94	20	5	0	0	0	0
1972	7	18	30	105	132	374	858	877	908	765	1526	973	984	512	523	461	230	88	33	49	8	0	0	0	1
1973	297	9	28	76	189	235	302	512	698	709	1063	696	888	650	496	290	267	219	34	48	21	12	3	0	7
1974	0	0	22	67	314	474	707	587	816	868	1480	834	1051	746	1280	601	347	283	103	58	26	0	20	0	5
1975	15	17	0	103	476	483	448	364	443	404	690	796	1402	1140	999	632	397	225	77	32	19	30	2	0	8
1976	0	0	11	48	266	513	468	268	166	345	574	833	1149	1028	988	677	427	309	194	105	36	17	9	25	33
1977	8	19	14	21	104	388	487	294	249	472	686	738	945	813	850	555	392	235	118	82	33	15	9	8	22
1978	0	0	0	0	69	222	312	437	406	416	421	702	715	604	702	493	221	208	133	145	62	38	3	0	0
1979	0	0	0	16	320	458	474	602	737	848	824	487	578	537	414	281	243	183	55	60	24	3	0	0	0
1980	232	2	5	40	103	218	582	385	406	474	727	688	730	544	460	356	241	124	52	17	17	0	0	0	0
1981	0	0	176	247	445	980	1521	1995	872	835	1048	865	758	204	202	130	56	39	10	13	8	5	3	3	15
1982	0	6	791	523	862	855	2339	2480	2777	2384	2165	2063	2075	1436	696	443	256	284	111	38	19	4	2	4	4
1983	0	28	86	165	471	814	946	1224	1388	3142	2016	1691	2217	1499	1544	269	184	94	65	47	94	1	0	0	0
1984	210	1106	686	528	618	1430	1503	2057	4521	5206	3938	3462	1708	872	560	256	70	158	91	21	21	42	0	0	0
1985	3837	0	70	482	297	817	583	626	860	1810	2017	1742	1621	963	528	480	239	116	68	38	10	27	6	6	27
1986	4712	23525	1133	0	0	61	213	175	289	448	929	1426	1179	813	551	320	204	94	52	28	33	7	2	0	18
1987	0	3	91	1085	993	580	558	408	694	771	1140	1547	1323	937	599	371	213	83	44	22	26	6	1	0	14
1988	228	49	59	59	193	947	1070	908	861	940	2214	1754	3076	2445	1683	1025	575	218	99	46	17	4	6	7	0
1989	236	0	3	31	341	1447	2352	2995	1785	1324	1581	1019	1333	1145	394	405	338	258	79	63	23	24	19	16	43
1990	0	0	4	47	782	1656	3834	5685	7084	2709	2061	745	1426	1109	862	307	329	331	86	64	49	34	15	10	9
1991	352	2259	4194	3644	1896	2708	1290	1762	2810	3254	1949	679	647	402	370	309	345	344	128	74	66	25	6	0	23
1992	31	146	101	82	434	1164	2438	2073	1966	2365	2509	1071	684	272	217	133	93	52	32	25	20	0	0	0	0
1993	8	27	30	78	86	228	302	649	1149	1280	1358	1230	974	595	1013	497	238	258	129	57	45	26	34	40	15
1994	4620	1	237	477	2988	4584	2387	1360	1064	1154	1680	989	963	774	568	439	299	177	134	116	127	98	49	38	149
1995	308	0	28	281	448	571	382	569	1600	1418	1563	830	688	531	301	389	268	150	140	110	64	68	38	30	74
1996	466	30	123	1680	1825	1725	916	832	947	1027	1172	610	818	733	568	616	686	457	220	201	208	133	79	52	98
1997	0	38	196	1552	4352	3137	1889	2594	2735	2707	4549	2229	1874	1173	611	789	546	246	124	108	139	57	39	23	40
1998	0	0	8	55	381	1371	1910	2244	3759	3107	4001	2516	2148	1248	756	823	358	214	118	100	72	29	33	7	28
1999	0	0	258	575	567	907	850	1234	1446	1748	3743	2622	1952	1304	1099	1037	283	299	197	118	72	80	24	13	68
2000	0	0	5	3356	3267	2985	2415	2980	3218	3476	3909	2018	1049	987	389	269	177	92	73	45	14	2	3	2	9
2001	0	40	958	2639	3501	3621	3362	3835	4773	4529	3966	2605	1512	1156	479	230	127	98	70	39	27	22	12	8	24
2002	0	27	907	1228	1489	1463	1443	2321	2576	3474	3290	2588	2093	1182	798	527	192	106	81	82	31	17	7	4	8
2003	0	1	43	403	842	1070	891	1717	3432	2314	1769	1123	904	732	392	204	117	53	22	11	5	2	4	5	17
2004	0	16	82	182	439	492	411	619	1824	3286	1793	1345	1005	829	463	241	99	81	26	8	10	10	3	0	0
2005	0	9	57	105	267	473	858	1468	1537	3299	3194	2034	1247	737	265	176	78	60	14	5	5	1	0	0	5
2006	0	9	44	463	722	2285	2521	2831	2874	1799	3303	1563	923	1438	658	353	90	106	36	9	35	35	26	26	0
2007	0	11	78	291	736	3340	3379	3738	2554	1002	1510	2167	1704	1455	1276	507	278	172	91	23	23	0	0	0	1
2008	15	350	98	152	294	407	531	1219	2586	3302	2452	2265	1941	893	895	924	152	377	240	178	3	1	0	0	0
2009	0	0	16	292	767	841	806	1620	2363	2173	1830	2221	2486	1881	1299	489	220	85	40	26	19	6	4	2	3

Table A2 cont.

Other	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1950	40881	47280	586	1516	4204	14589	11833	7936	12114	6119	2315	464	146	93	53	22	9	2	0	0	0	0	0	0	0
1951	7953	9411	5153	5099	5190	9641	17403	10811	13278	6471	2871	897	538	345	188	76	29	13	3	0	0	0	0	0	0
1952	1211	1466	2781	1729	2804	6838	11852	14290	14039	5782	2638	1354	1019	801	478	231	78	28	12	2	0	2	0	0	0
1953	4190	4960	3267	3121	3965	5850	10914	10802	14972	7653	3566	1546	1026	707	377	159	63	15	8	0	0	4	0	0	0
1954	4471	5185	200	386	1790	2706	5029	4710	7938	5174	4019	2496	1693	978	573	263	134	67	28	21	9	15	0	0	0
1955	2248	10894	19138	7698	4511	6069	9033	9179	13701	7871	5339	3844	2397	1393	629	297	66	38	10	0	0	0	0	0	0
1956	146	3642	7841	3049	314	581	220	541	1460	2002	1724	1183	1239	873	542	258	110	32	10	4	0	0	0	0	5
1957	272	6880	14791	5525	554	751	1482	1094	1580	2104	2652	2760	2511	1457	773	394	156	99	52	24	18	14	15	7	51
1958	130	3261	7877	3215	1027	378	1097	1571	1282	636	509	918	880	778	630	382	95	108	29	13	9	7	7	3	25
1959	170	4259	9365	3555	748	745	566	786	1671	1825	1367	1478	2584	2166	1229	549	186	96	34	15	11	8	9	4	32
1960	239	2922	6428	5881	3167	1284	2043	1477	1663	1355	567	540	791	690	346	107	32	11	0	0	2	0	0	0	0
1961	318	4268	8949	8082	2976	2796	2020	1624	1815	1472	1020	385	484	386	471	250	69	19	17	4	0	0	0	0	0
1962	84	1446	2823	3088	2413	3919	2443	2016	1234	695	228	370	383	277	213	228	89	24	3	13	12	0	0	0	0
1963	196	4440	8484	7640	3831	2524	2649	1566	383	659	606	462	209	298	120	4	3	2	1	0	0	0	0	0	0
1964	1400	8626	13234	11224	3295	1804	2124	812	277	166	111	559	16	27	33	31	23	15	4	4	1	1	0	0	0
1965	1395	5191	5901	6328	2600	2052	2682	1184	218	267	151	36	29	42	58	66	48	19	2	2	1	0	0	0	0
1966	4649	495	331	824	1285	3889	1054	535	56	34	103	59	59	37	12	0	0	0	0	0	0	0	0	0	0
1967	7321	95	425	489	1154	2051	2819	403	505	1008	701	697	655	482	607	539	328	190	128	51	30	33	23	19	63
1968	0	0	32	228	923	594	1901	911	218	112	170	156	297	93	95	129	73	45	42	37	33	25	15	13	20
1969	0	0	0	209	1236	1120	768	1081	231	316	147	232	275	182	187	222	93	107	18	24	3	0	0	0	0
1970	341	757	184	522	323	89	91	143	797	846	1117	723	164	155	22	15	9	5	2	0	0	0	0	0	0
1971	0	0	0	24	34	55	204	170	174	165	145	166	238	387	398	286	175	100	48	28	12	0	0	0	0
1972	102	249	280	295	106	32	54	44	50	32	32	51	83	147	155	125	74	37	13	7	3	0	0	0	0
1973	698	982	220	73	39	29	52	39	40	23	26	39	47	56	72	47	30	18	9	4	2	0	0	0	0
1974	668	20	34	42	26	22	39	40	39	45	33	44	60	62	56	34	21	17	6	3	1	0	0	0	0
1975	777	2098	1379	370	139	62	38	67	88	94	52	72	97	77	41	22	21	10	3	1	1	1	0	0	1
1976	696	178	74	56	42	44	41	28	34	121	155	175	199	159	88	61	50	52	13	8	5	2	0	1	2
1977	715	458	132	91	43	129	212	172	150	280	370	389	203	236	251	172	118	79	48	35	16	8	1	4	14
1978	7174	9523	2187	2427	1202	324	100	94	125	155	156	184	211	294	329	286	253	189	109	82	39	31	6	6	14
1979	156	1473	1959	1776	1194	286	588	1017	689	496	501	383	305	478	454	403	396	244	131	93	46	30	16	16	41
1980	17768	9424	3449	1147	1635	1477	845	346	436	417	363	275	305	299	207	131	141	76	41	8	8	0	0	0	1
1981	24487	15442	3932	1055	902	318	482	624	510	532	894	555	391	237	175	125	83	69	19	28	14	9	6	6	2
1982	10666	7012	2516	452	242	159	147	162	162	183	214	201	165	208	161	50	76	84	78	34	44	9	8	9	0
1983	236225	13457	2006	649	281	144	234	209	191	534	353	263	209	154	134	24	20	2	5	0	0	3	0	0	0
1984	49086	65476	4448	3902	2053	730	403	523	774	1068	982	999	804	626	384	219	173	108	59	30	25	20	15	6	3
1985	22622	29337	23598	3786	1317	1605	1074	1435	1583	1678	2114	1673	1204	1184	798	371	271	97	117	111	59	9	11	9	18
1986	170290	25410	6154	5049	1134	1197	721	727	1390	1598	1691	2060	1963	1943	1015	342	232	158	96	33	7	2	43	29	4
1987	50691	35633	6605	3990	3457	2624	4828	1888	1197	1538	1446	1265	742	604	303	287	119	47	30	1	23	69	92	46	114
1988	204492	17893	9637	2510	1543	2875	5554	1825	1467	1737	1712	2201	1002	526	480	144	96	48	11	4	36	80	94	47	233
1989	161223	56353	11436	2786	2078	1583	2756	1312	1028	1305	1160	1679	1422	867	411	233	134	79	120	93	101	76	102	124	249
1990	92285	21928	7960	2266	3508	2187	1232	1743	1802	1651	1976	991	585	329	174	129	64	33	103	140	82	3	10	7	26
1991	40903	16274	3251	2099	1404	855	495	555	1892	1753	2752	785	358	144	37	23	6	6	32	41	32	0	1	1	44
1992	113825	39584	5958	2287	1149	780	1388	1727	2203	3733	2341	793	241	327	241	71	23	20	13	5	1	0	0	0	40
1993	78940	91819	18241	6764	4076	2782	1343	708	1160	1021	2067	985	391	367	330	113	179	54	99	59	108	1	84	52	148
1994	61516	33721	19469	6331	4682	3572	3845	4566	4221	3837	2817	1515	1389	835	1046	365	690	58	134	75	2	0	0	0	4
1995	149367	25704	11117	5438	8321	9003	3870	2914	2487	2599	1430	1487	703	624	499	342	258	137	68	37	44	8	5	4	16
1996	82526	37227	12520	7080	4978	3785	2337	1134	1461	1451	1683	898	790	776	430	292	208	97	75	25	29	0	4	8	3
1997	71304	30874	13606	6067	7780	4978	1887	1718	2011	1961	1320	733	641	336	347	205	126	79	87	15	4	10	6	4	20
1998	68200	48140	27182	6740	1352	7635	1251	2969	3232	1621	618	383	163	197	120	76	7	10	12	3	2	1	2	1	27
1999	61762	49809	12949	8788	5331	3266	1974	1618	5540	3271	1151	586	254	138	125	122	144	53	60	40	30	16	10	6	871
2000	59591	34214	13089	8402	11182	5736	1692	1722	1727	1162	1075	682	407	253	161	95	93	60	43	30	21	7	4	3	19
2001	3242	60588	21173	8013	2889	2688	2060	1930	1730	2281	1030	283	131	100	64	63	37	19	21	16	8	4	6	4	6
2002	13516	52092	25516	5901	3220	2385	1981	1523	1870	1252	1445	521	426	265	144	84	45	22	38	29	16	16	0	5	20
2003	5968	57445	17767	4841	4967	2354	3088	1555	2132	3283	4108	1948	622	196	194	66	31	14	3	4	8	11	0	0	0
2004	34036	30471	9693	4568	1193	2223	2389	1178	1063	1712	2129	618	390	259	159	188	96	65	44	33	31	27	22	16	21
2005	87608	72625	24447	2890	2164	780	99	61	28	138	227	66	52	31	12	12	11	8	6	4	3	2	3	2	4
2006	45681	51819	29308	3170	1213	1484	590	113	66	228	291	116	74	62	24	22	24	18	12	10	8	6	8	5	7
2007	308	3445	2287	5196	1903	1868	1598	733	1196	519	1070	367	48	37	25	7	10	3	1	1	1	1	1	1	1
2008	172	3271	1662	6927	5867	5363	3953	2950	2185	705	546	424	467	510	342	290	320	143	117	53	48	38	21	39	35
2009	504	1238	1172	3373	1605	2322	2599	1457	654	298	697	70	41	22	20	5	3	2	1	1	1	0	1	0	2

Table A3: Commercial fleet catch-at-length used in the SCAL.

Baitboat	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1950	0	0	0	0	893	859	587	0	67	1884	10865	21759	6411	3386	2125	262	0	0	0	0	0	0	0
1951	0	0	0	0	1241	1193	816	0	93	2616	15082	30220	8904	4703	2951	364	0	0	0	0	0	0	0
1952	0	0	0	0	1181	1135	776	0	88	2489	14332	28754	8472	4475	2808	346	0	0	0	0	0	0	0
1953	0	0	0	0	1109	1066	729	0	83	2338	13461	27007	7957	4203	2638	325	0	0	0	0	0	0	0
1954	0	0	0	0	1381	1328	908	0	103	2913	16770	33645	9913	5236	3286	405	0	0	0	0	0	0	0
1955	0	0	3487	9412	28222	20373	29065	36859	14308	10540	9577	13441	3751	1774	1059	131	0	0	0	0	0	0	0
1956	0	0	1671	4512	13734	9904	14068	17670	6874	5486	7085	11446	3272	1629	996	123	0	0	0	0	0	0	0
1957	0	0	1890	5327	15395	10899	15859	19248	8015	6053	8108	13167	3768	1882	1153	142	0	0	0	0	0	0	0
1958	0	0	1719	4713	13832	9479	14357	16665	7137	5307	7345	11952	3421	1713	1052	130	0	0	0	0	0	0	0
1959	0	0	2576	6892	20473	14158	21314	25592	10485	7298	6424	6689	2409	1129	672	83	0	0	0	0	0	0	0
1960	0	0	888	2202	5946	3693	5750	6193	4175	2995	3133	4681	1327	656	408	65	6	0	0	0	0	0	0
1961	0	0	1351	3343	8924	5695	8531	9766	6430	4493	3315	6164	1147	532	330	65	11	0	0	0	0	0	0
1962	0	0	1525	3685	10050	6229	9737	10714	7075	4842	3396	4049	1104	504	311	66	12	0	0	0	0	0	0
1963	0	0	1184	2633	7845	4256	8021	7242	4945	3187	2738	3488	964	457	284	50	6	0	0	0	0	0	0
1964	0	0	1226	2523	8118	3026	8638	6671	4666	2774	2424	2098	788	371	231	39	5	0	0	0	0	0	0
1965	0	0	2201	4345	14490	6666	15663	11431	8018	4088	3242	3050	785	339	209	44	8	11	91	263	316	163	47
1966	0	0	1829	6849	41043	28660	34375	42702	10957	6960	2730	1739	389	75	10	2	1	6	60	223	380	233	71
1967	0	0	1187	3560	14425	10753	18878	23656	6819	4253	595	237	86	71	73	73	26	11	53	196	374	310	115
1968	0	0	5901	13458	12849	8474	5758	8167	6560	4788	2505	1602	339	37	8	31	13	1	20	152	276	320	321
1969	0	0	8818	21676	40806	26027	9446	11968	3983	2575	514	377	157	51	0	0	0	0	24	197	377	483	160
1970	0	0	10915	25901	37630	23917	7880	11821	9679	5632	4142	3700	1631	944	695	99	0	1	16	157	818	1033	751
1971	0	0	506	3402	32214	20712	9116	12040	6887	5554	7185	5828	1617	652	416	60	0	5	23	152	551	1032	1275
1972	0	0	315	2930	31256	19617	3723	3883	2507	2045	2756	6664	3580	2676	2089	722	181	0	20	164	695	1251	1415
1973	0	0	417	2925	28235	18052	6970	8613	2045	1314	710	1711	1586	1903	2798	1553	1770	206	8	73	485	1055	1708
1974	0	0	522	3341	30924	20539	15323	19034	4800	3096	1399	938	265	104	9	37	22	91	21	138	298	617	1473
1975	0	0	4809	14921	65181	40509	4432	5945	3343	2295	655	596	188	56	4	23	1	7	71	193	509	910	2837
1976	0	0	264	2624	21279	20512	6908	4522	672	888	640	750	553	342	70	26	0	0	66	107	238	760	1813
1977	0	61	2041	8629	37893	45418	10068	9446	4552	1988	417	364	103	125	103	31	0	38	46	154	661	598	2755
1978	0	4	14796	41952	44226	20813	4138	5545	5977	8580	3538	2266	769	158	37	27	149	219	385	1025	1392	1578	1889
1979	0	0	3615	8559	4918	7413	7226	7894	7057	7355	2120	1886	805	405	200	160	700	289	60	207	224	342	1259
1980	0	44	19156	30874	13561	9507	4485	3152	1211	935	1391	1809	1399	961	545	88	67	76	136	315	226	249	608
1981	0	28	11373	20492	26490	8292	2139	2343	970	501	443	387	374	288	157	73	7	37	214	549	465	251	467
1982	0	166	6334	10731	12748	15901	3769	3973	1572	1260	1059	552	342	369	265	181	20	0	8	46	10	36	111
1983	0	4769	51814	114958	13765	32803	3679	1972	902	518	183	33	55	15	20	0	1	4	123	531	349	97	205
1984	0	51	5353	36463	36463	104623	18831	17836	8208	2957	5952	2548	3074	1190	244	282	15	192	97	1	0	95	0
1985	0	16	9254	56445	58248	28040	18268	13395	3134	3405	825	649	420	128	22	0	0	26	0	195	208	91	52
1986	0	249	33567	60367	8461	26852	9436	2645	1873	3025	645	462	211	49	0	11	20	14	30	108	95	41	28
1987	0	38	7596	24473	74264	40875	3169	1397	1557	2125	755	1814	780	130	93	0	0	0	11	75	21	0	0
1988	0	4861	103483	95600	38746	20285	4599	3582	1349	1323	1042	725	407	403	24	6	0	0	0	0	0	0	0
1989	0	170	20776	109225	72168	22753	7845	2275	1283	1164	844	267	307	92	21	3	2	0	0	0	0	0	0
1990	0	1826	21980	50312	13257	29587	12443	10013	1567	2922	3645	1476	301	14	2	3	4	0	0	0	0	0	0
1991	0	0	3333	43068	26779	37708	2875	4545	2300	2733	2048	402	543	412	243	84	68	103	16	51	0	0	0
1992	0	2196	15658	18657	15958	37892	18020	1699	1324	1111	577	433	353	16	43	0	28	0	0	0	0	0	0
1993	7	466	6854	20694	94779	65321	21083	25525	8963	7306	2337	1196	688	498	8	5	0	0	0	0	0	0	0
1994	0	12	2278	49293	65513	12950	15623	4602	4011	3833	3680	1144	366	38	10	23	22	22	29	7	50	20	72
1995	0	317	42884	96816	18451	35376	55851	10109	4355	1993	607	264	162	16	4	3	0	0	0	0	0	0	77
1996	0	1263	119510	132501	52690	36563	47489	23613	15510	15208	6210	1854	273	170	70	32	43	91	82	44	29	38	60
1997	3	1129	38146	54564	23511	31120	49436	9646	5779	6072	3211	1394	202	77	37	92	255	285	235	340	231	493	1238
1998	6	1801	38600	13191	10854	22873	15648	14126	18234	5900	908	608	604	482	242	43	24	26	84	263	105	159	208
1999	0	53	3153	3612	4222	2111	2221	1514	7329	6512	9688	3205	1674	787	156	74	53	54	38	28	47	1	46
2000	0	41	1476	33485	17039	7499	5589	4306	3714	2108	2873	4262	1981	621	861	1114	735	334	160	87	42	13	7
2001	0	0	37	1856	61949	40689	13463	10428	3588	2193	1034	773	1309	1164	292	327	435	296	255	203	82	35	43
2002	0	0	1258	27459	25059	56243	36966	15260	3363	1674	800	337	118	85	200	398	378	369	240	152	78	42	35
2003	0	0	329	3145	20754	11215	11160	4443	683	375	871	1237	538	134	144	526	1240	879	531	223	82	35	14
2004	0	0	207	51313	54662	15202	4951	4524	4254	1000	811	668	369	332	153	80	194	485	510	256	99	81	23
2005	0	0	1	103899	47472	10375	22293	2433	1929	1456	2081	900	301	66	129	63	58	147	216	158	19	11	10
2006	0	0	0	19291	23362	6713	11124	2615	5167	1289	695	380	621	670	163	61	74	87	165	77	100	7	0
2007	0	0	0	0	8771	23116	4315	13690	15147	4146	3845	3397	855	713	283	105	264	426	160	100	60	20	12
2008	0	0	1	41	13803	16780	18814	10130	8336	6682	2012	270	68	288	242	202	260	322	282	247	143	83	44
2009	0	0	0	39	2185	9384	7767	7694	5536	1755	1276	1431	2396	1166	316	305	251	196	163	103	48	28	18

Longline	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1957	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	8	10	4	35	51	33	18	2
1958	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	3	2	1	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	10	17	7	59	87	56	31	3
1960	0	0	0	0	0	0	0	0	0	5	107	84	148	68	99	777	1133	418	147	276	0	0	0
1961	0	0	0	0	0	0	0	0	0	2	44	36	62	29	41	326	477	181	76	138	20	15	7
1962	0	0	0	0	0	0	0	0	0	26	539	430	754	351	510	3936	5737	2124	744	1392	0	0	0
1963	0	0	22	48	41	30	51	72	60	124	450	402	768	278	553	3114	4835	2322	1007	1593	280	22	146
1964	0	0	17	38	31	21	15	22	18	12	14	36	180	124	152	1170	1719	834	558	513	124	64	9
1965	0	0	35	77	65	42	17	34	34	35	98	76	159	114	141	716	1055	438	260	619	496	276	145
1966	0	0	27	62	52	35	31	50	45	38	13	56	88	65	104	258	395	384	346	416	367	210	140
1967	0	0	7	17	16	13	21	26	24	27	12	22	61	98	130	256	440	457	280	197	153	108	152
1968	0	0	31	67	36	39	44	68	61	49	18	66	105	80	117	277	415	570	558	448	407	449	237
1969	0	0	20	45	24	26	29	46	41	33	21	63	75	87	161	455	422	386	261	362	279	225	297
1970	0	0	1	2	2	1	0	1	1	2	8	18	15	46	139	189	126	110	48	82	51	73	612
1971	0	0	0	0	0	0	0	5	1	2	3	21	41	102	68	155	163	284	223	160	156	101	299
1972	0	0	3	11	8	6	11	20	12	15	4	115	43	25	103	207	363	332	203	310	292	170	81
1973	0	0	5	11	9	7	14	22	21	25	8	31	39	42	95	189	274	383	394	401	434	246	332
1974	0	0	4	135	16	258	1291	1293	827	1383	1532	1088	2199	1152	1037	857	1498	3135	2974	4192	4657	2909	2042
1975	0	0	2	19	121	90	87	102	530	688	362	487	449	395	502	836	1104	2988	4760	5916	5834	3866	3649
1976	0	0	0	2	9	33	48	45	59	180	239	271	255	297	267	458	571	1205	1988	2581	4450	2410	2686
1977	0	0	0	0	13	4	35	11	44	41	55	183	274	501	1012	1200	1631	1796	1928	1714	1443	1565	1017
1978	0	0	0	0	0	0	19	6	115	96	164	203	226	116	98	123	280	127	35	174	372	1935	901
1979	0	0	0	0	2	22	26	18	93	72	92	375	948	1145	1979	1759	1168	357	143	108	57	54	62
1980	0	0	0	0	0	13	55	58	59	40	113	144	234	297	512	616	943	777	1130	683	347	143	104
1981	0	2	1	2	17	2	40	18	21	33	79	63	201	291	610	783	675	842	695	667	262	220	368
1982	0	0	0	0	0	27	14	109	306	15	133	200	629	594	3226	1900	622	1421	2254	2947	6909	1431	1679
1983	0	0	3	9	28	127	170	218	241	425	806	696	1076	1704	1891	1707	1845	4083	1718	1865	1948	1052	431
1984	0	1	11	6	73	68	64	93	164	166	233	392	528	843	1126	2086	3521	2372	1959	1240	656	382	621
1985	0	8	16	21	114	106	124	148	133	144	266	332	390	557	529	358	695	868	1166	1546	1358	962	1088
1986	0	0	0	14	115	180	161	324	176	287	549	601	537	407	536	487	770	1426	1581	1596	1025	412	157
1987	0	0	0	0	71	64	49	63	111	104	157	344	573	783	737	847	820	971	1077	1343	1221	980	515
1988	0	0	0	3	39	63	139	222	230	219	132	192	628	1001	1066	1553	1359	1753	1618	1333	1193	793	550
1989	0	0	0	15	214	393	364	664	491	404	462	548	777	1158	1189	1265	1081	1095	1164	657	906	652	1013
1990	1	71	296	74	358	653	493	486	346	334	340	679	860	1080	1364	2031	2297	2510	1885	1126	690	535	687
1991	4802	3342	245	216	373	433	465	571	227	515	665	511	991	1522	2129	3049	7582	7556	5405	2851	1262	538	1758
1992	88	453	554	652	1251	610	438	674	802	592	1245	1577	1406	1517	1905	2097	4678	3655	6194	4064	4027	2333	1736
1993	1100	1349	662	1935	6101	1200	1186	229	852	1155	1778	2037	2662	1433	1475	1495	1518	2765	3369	2701	1723	1408	3325
1994	2937	12947	13993	5371	13223	3763	977	2170	2449	1884	1023	2032	1626	5125	4634	4623	5002	3678	4555	5147	3573	2947	4120
1995	136	431	123	231	548	362	351	336	858	898	1953	1851	6154	5570	3942	4470	6841	4648	5501	7186	5976	4156	8797
1996	0	2	204	505	2203	1151	364	343	424	982	1059	1258	1787	2784	4884	5856	7424	7244	7254	6888	5921	4310	8306
1997	0	2576	21557	3396	16242	12742	5990	2031	1792	2553	2502	1127	2455	3572	4228	6489	8247	7442	6996	5043	3176	2288	3645
1998	0	0	0	0	8	23	15	47	211	139	135	474	961	1702	2206	2429	4915	7959	7385	4603	2723	1990	2331
1999	0	14	42	433	85	124	203	529	771	1675	2101	2836	1563	2404	4509	5420	6572	5883	5361	3795	1665	850	1113
2000	0	168	404	140	877	145	149	1053	1765	1516	2033	1522	2833	2596	2440	4546	7574	6401	4850	3944	3253	1751	379
2001	0	0	272	485	609	2060	6636	2366	803	936	704	1172	3392	5507	8116	7315	6420	5769	4453	2660	1304	1183	460
2002	98	1154	333	175	2814	2150	1930	1663	1076	1051	636	989	1013	3714	6246	13136	11067	7325	5260	1240	1611	579	533
2003	20	3234	5089	1453	3330	3106	3422	3013	1908	1695	1483	1963	2436	2259	2531	3324	5096	6430	4177	2234	1012	590	458
2004	34	959	830	870	2402	1126	1552	1085	930	1222	1253	1260	854	2152	3418	2845	2810	3828	4353	2787	1116	697	930
2005	0	16	25	81	446	575	1236	435	576	819	1011	1732	1713	1768	2535	2901	4713	6214	5877	3008	1424	632	483
2006	0	53	119	4440	8880	6285	13812	3897	1190	600	771	1013	1358	2148	2543	2377	2120	2144	2598	1524	1128	788	356
2007	0	946	118	426	6530	22440	2736	4715	1874	1708	1307	1059	1344	1844	2957	3477	3387	3148	2761	1826	1027	787	403
2008	0	0	9	513	17741	7227	6018	3792	3878	2189	2981	2658	1742	2139	4697	4783	3471	3564	3000	1912	1360	946	639
2009	0	11	220	575	1110	7178	2256	1081	1240	864	656	857	6960	11646	2522	4961	5897	2801	1646	852	556	303	284

Table A3 cont.

Purse seine	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1950	13699	0	9746	20233	17041	10487	387	153	129	468	490	5150	10664	10047	1866	436	106	479	211	123	106	58	21
1951	3384	0	1172	2435	2050	1342	814	1190	997	1580	1837	8852	8085	21875	23681	8188	1591	673	1107	273	244	330	49
1952	308	0	299	631	523	365	430	1379	535	381	659	2747	10489	26165	27859	52613	17223	4329	1859	1244	662	331	128
1953	43343	0	901	1884	1573	1043	737	1082	888	733	2164	7782	5364	13057	26657	24761	14398	3745	1637	1139	834	327	110
1954	154	0	1359	2821	2378	1466	35	57	52	104	1026	1390	2106	6958	6274	6057	11781	15585	18270	10360	4677	2212	558
1955	0	0	98	390	404	9412	10196	5311	9991	2405	5328	5007	9796	6048	3511	10183	7828	8524	16499	13528	6514	2817	375
1956	0	0	67	268	319	6466	11127	3627	4091	1397	340	1114	1474	611	772	783	705	1282	3461	6548	4088	3850	1439
1957	0	0	67	269	320	6487	11163	3839	4104	1402	309	486	3006	7488	5325	5537	5151	4121	6085	5498	2644	920	172
1958	0	0	432	1371	3455	7822	14181	4909	5663	3322	9474	18580	6283	3473	3511	4699	2833	2038	2774	2306	2146	2209	1223
1959	0	0	42	168	200	4053	6974	2273	2964	878	169	119	301	436	397	548	1103	1266	2630	3432	3518	2438	725
1960	956	0	896	1916	5943	2486	7309	4350	4014	3214	7947	14572	4279	2266	1742	2166	2111	2394	4672	4447	3576	2374	875
1961	11583	0	1612	3175	10347	4094	12589	7263	6403	4599	10002	17723	5222	2732	1797	847	1997	2892	6766	10499	9078	6672	3208
1962	139176	0	1098	3921	7171	2620	8313	4887	3697	3280	5343	8713	2566	1330	887	336	351	517	2547	8048	11108	10036	5450
1963	764989	0	1242	2211	8137	2892	9409	4581	3722	2151	4205	6590	1962	1003	685	236	646	1505	1376	692	370	265	344
1964	18780	0	4483	8401	18968	7718	18356	11006	8853	4626	5460	7596	2180	1134	750	205	235	755	1267	1184	1232	1903	2650
1965	499	0	3250	6097	12011	9045	11009	6580	5510	3172	2222	2244	669	341	182	25	45	59	127	441	1398	3330	4487
1966	280125	30740	2668	8972	17555	17590	27131	25858	16108	11025	4413	3984	1293	455	72	26	0	180	468	271	509	1041	2251
1967	451069	55717	2557	6998	19369	21489	34261	30237	20392	13405	5696	5390	1842	765	133	208	152	234	287	440	784	1563	5441
1968	669183	0	834	3977	4705	15974	28401	13619	19235	12272	4484	5552	1536	340	348	363	28	67	148	191	243	524	2208
1969	12600	0	6312	13402	12957	24851	33007	22886	15271	13625	4909	2211	1039	513	873	752	405	299	263	465	504	873	2930
1970	19837	0	833	2290	6071	8574	7469	7609	3307	2399	1803	2049	2199	1806	1490	985	1848	1865	1610	722	155	224	1358
1971	40586	78	329	5394	11780	27028	14310	6551	2964	1379	271	416	1013	2275	3110	3598	2743	1578	830	432	513	805	2600
1972	748	142	1208	3525	23148	77749	44093	21567	10291	5670	1539	1801	749	674	383	534	1298	294	269	346	607	897	1978
1973	0	34	563	6225	14500	26819	43276	17734	5581	2412	1540	1175	1284	1519	2514	3702	2643	809	598	490	742	935	2310
1974	2419	2133	31735	11016	20574	66167	21373	15342	23554	23029	4406	3148	1564	1713	1758	2914	5389	1365	1000	1169	1845	2612	4850
1975	38162	3766	36469	26919	76577	151008	50342	30414	8902	10671	5748	5183	3858	3085	1729	1826	2341	1535	1081	2675	3181	2609	4901
1976	1001	408	2374	19005	27875	97544	165373	80478	31298	18402	13176	4919	2839	2710	1155	926	1938	1066	1124	1752	2232	2587	5356
1977	8598	13424	27661	36084	56888	87474	49009	32496	30773	11275	5453	3183	2841	2145	1042	443	336	582	1038	1415	1926	2638	6783
1978	1	225	6051	27513	72026	31855	70245	55147	11753	4245	1511	389	408	1611	659	860	607	1976	1016	874	962	1314	2823
1979	2297	149	318	3333	5775	20283	48529	22513	25369	10942	3130	3163	335	169	140	299	262	1038	1056	773	2109	1671	3300
1980	244	6421	37055	40478	44417	69658	66628	33461	20102	6886	5930	2031	937	744	761	677	675	1550	1646	1775	2237	2002	3233
1981	2096	956	15549	22720	106741	141136	92706	30616	8638	3289	6704	3923	1292	1852	1012	1090	923	958	1443	1019	726	489	1084
1982	1340	13558	112253	187158	153434	101502	140555	66862	31548	11523	4106	1756	963	702	752	975	940	1155	1467	1786	1220	702	884
1983	160	7378	87319	117019	53123	77363	103488	32229	18680	8063	5544	4490	1799	2158	4847	1631	1813	4425	1277	1565	1513	1182	414
1984	1	195	16915	82917	152269	167116	45863	20109	9556	8957	4842	2709	1607	1752	1331	969	1277	1247	1748	2587	3169	1440	1442
1985	19	952	9653	20527	87761	118810	99634	129476	43153	14381	5859	2630	2014	542	254	224	263	596	1021	1278	928	430	324
1986	152	6507	164062	138185	40609	89478	73472	39287	46520	11810	5214	3049	2045	1361	913	497	578	376	575	961	811	539	383
1987	59	3270	50144	96177	106531	156479	86375	28688	18131	9984	4746	2430	1062	1047	633	520	733	954	584	480	358	395	103
1988	199	8988	128440	213164	78380	60442	124113	65424	34119	14839	6760	3307	2313	1367	1296	861	1578	905	678	566	288	142	140
1989	69	2816	39909	99828	120166	135896	54565	47253	30499	22962	6118	3079	575	940	1798	575	651	491	390	407	294	284	306
1990	1626	35548	130396	122515	143523	307600	109674	40111	28699	18540	5136	13212	496	327	664	699	1069	1418	671	395	353	174	244
1991	415	14253	64611	85124	154803	134984	117169	48117	28641	18505	4233	20114	521	367	624	1016	2458	2985	1909	1045	621	336	505
1992	0	35	15277	50467	167260	245831	108289	99166	36906	7656	2599	11306	4571	5555	5355	3761	3369	5761	3315	1993	718	178	284
1993	0	1647	117080	79509	247252	333718	114164	63618	21389	10724	11192	6122	5358	5491	4696	4399	3998	5163	4077	1590	669	893	550
1994	64	1069	18982	118721	225025	114482	97210	49945	24049	19503	25298	15199	13019	8780	8001	7619	11461	14061	15049	7534	2686	1136	1396
1995	16	953	45007	189400	69096	145386	156499	95574	27991	18357	18516	29512	10407	6858	7606	5076	4973	7897	11912	8216	2594	614	319
1996	0	97	23353	95392	460007	81352	122556	102010	64874	32918	14036	9420	9261	6898	4900	4915	6505	9685	10281	6204	2658	273	96
1997	0	330	12121	100216	107281	207394	72047	76942	44365	33477	28552	24175	16258	11342	9800	13265	13996	11261	2562	641	398	433	616
1998	0	477	41245	267922	88409	169618	197701	58916	50730	52005	19992	38001	32333	1754	1425	1158	962	855	1108	1366	1054	391	730
1999	0	8955	30083	178120	55548	155111	49670	82872	43656	22045	9114	5540	1679	2205	1372	1409	14773	8156	1251	2158	833	577	408
2000	0	474587	71220	273110	80359	198355	154893	20560	20258	18613	18761	18472	10249	3258	1983	1910	1238	1131	1207	1048	900	853	1490
2001	0	0	3	127	89619	55528	42685	66176	34309	11264	9112	4497	5755	14174	2720	4822	3072	17563	8364	1668	854	754	1208
2002	1729	29	915	11032	141812	168128	113593	39165	28443	15348	33383	10788	6006	2985	3681	2092	3220	6833	14247	2685	2039	1464	2357
2003	2413	215	0	14598	38488	52639	20869	14159	13903	12278	20407	11734	11438	5897	3650	6476	4376	8661	17661	6247	3023	1836	2291
2004	0	0	0	38397	77826	54792	104793	36013	13988	6599	4353	6215	13833	11454	8176	1024	10051	14354	17200	2448	1903	1329	3464
2005	0	0	201	101942	65989	225846	50451	36253	17064	9852	12790	9362	4935	8165	16610	430	6975	24744	20630	4699	635	182	359
2006	0	0	4885	70118	91586	8523	112272	7819	22488	4888	1724	564	445	344	168	140	8	74	467	274	566	114	298
2007	0	0	0	0	24152	2976	207	3457	20367	16344	18530	14373	2755	1459	1309	829	1004	1060	1271	740	989	883	1639
2008	0	0	0	0	0	0	768	6362	11474	14630	16195	11546	3203	839	614	969	2065	3319	2585	2171	2191	1189	1625
2009	0	0	0	0	0	0	0	760	11514	9930	8269	1500	874	775	417	490	1072	962	703	507	264	207	344

Traps	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1950	82003	0	58340	121120	102012	62798	884	995	1125	3871	3502	3048	5549	10027	9573	14115	17208	9775	3759	1141	636	349	128
1951	24606	0	8522	17702	14908	8767	6089	8707	7501	5769	2646	2397	4284	7344	7162	10939	13598	8189	3861	2271	1775	945	354
1952	888	0	863	1819	1510	1067	1443	4044	1838	1998	3038	2771	4980	8658	8395	12738	15774	9376	4261	2315	1763	956	370
1953	170234	0	3538	7398	6179	4117	3201	4351	3930	3895	4346	4081	7428	13001	12580	18957	23356	13788	6044	3084	2251	1236	457
1954	273	0	2415	5012	4225	2819	283	176	415	1082	3230	3371	5315	9421	9464	14176	18449	13415	5330	2197	1489	880	376
1955	45	0	92	189	180	116	263	104	376	1107	3522	3761	5497	10166	10323	15864	20029	15018	5300	969	251	277	169
1956	33	0	19	40	34	54	457	227	648	1794	5588	5449	8715	16080	15866	23171	29651	20768	7046	1187	255	265	158
1957	1	0	5	9	8	5	9	764	3312	7118	4230	8078	23732	25836	25464	16301	12747	17400	11414	5067	3092	6603	1587
1958	139	3299	10159	1410	438	84	30	132	1224	4949	12424	14935	13826	19995	19578	23454	15463	10101	12812	9428	4774	5152	2980
1959	45	0	6	12	10	9	33	104	1234	283	1054	2504	6841	7286	8783	12658	17316	17226	12391	8591	3383	1685	329
1960	35	0	4	9	7	8	32	83	584	609	2634	3538	7207	7519	10736	18314	19009	13911	8946	5130	2535	1144	220
1961	336	0	6	11	9	10	35	58	341	480	638	3292	5385	3888	4831	15200	19408	12732	6909	3213	1419	633	116
1962	3436	0	2	0	2	1	4	13	207	761	1899	6319	4553	4453	9204	16523	17934	13583	8949	4053	1948	634	200
1963	146836	0	11	21	19	14	24	34	98	409	914	1721	2526	2400	1429	2286	4169	9920	8173	4673	1807	826	202
1964	350	26	87	214	234	343	645	2256	2766	2659	2607	1965	2127	4662	2848	1681	2109	6194	11605	7777	3390	1353	233
1965	33	0	134	273	230	147	59	218	445	2197	844	3046	2856	5240	4038	987	2175	2233	4958	8709	8703	6277	2368
1966	4123	452	9	20	17	11	9	114	272	1478	1625	8856	3335	3418	3284	1953	2196	1970	3676	3950	3610	1605	255
1967	7899	976	2	5	5	4	7	10	318	788	2058	5940	6705	8174	1800	2600	3580	4864	3254	3348	4884	3736	1013
1968	985	0	0	0	0	0	0	0	61	745	2325	1133	2247	5033	5584	1524	1203	2042	3067	2321	2206	1512	1313
1969	28	46	384	395	1295	82	16	24	38	308	1635	3300	1499	1196	3410	3251	2137	2157	2502	3397	3308	2571	2959
1970	200	0	4	8	7	5	1	4	33	11	118	317	1376	1185	1703	1893	2823	3149	2260	1628	1411	856	651
1971	2946	0	0	0	0	0	0	0	2	4	5	67	448	1222	921	1179	1328	1021	741	766	825	835	1377
1972	799	0	3	9	8	6	8	42	33	46	57	101	178	448	479	783	611	777	1267	1381	738	724	636
1973	16907	438	2	5	4	3	6	10	17	60	85	150	133	222	239	458	493	677	882	776	872	616	704
1974	1605	0	0	0	0	0	1	1	25	80	170	279	274	520	409	571	536	580	1151	752	1023	1305	1288
1975	0	0	12	32	5	0	0	0	27	119	298	329	301	310	251	352	323	424	714	1143	1690	1402	1283
1976	0	0	0	0	0	0	0	0	7	48	139	272	360	349	205	144	131	378	683	1143	1355	1426	1699
1977	0	0	6	16	2	0	0	0	0	19	66	87	244	301	265	221	227	508	742	1003	1025	1245	1360
1978	0	0	0	0	0	0	0	0	0	0	31	61	193	212	327	309	360	382	585	846	870	932	1219
1979	0	0	0	0	0	0	0	0	0	15	119	312	345	344	417	602	626	827	804	607	752	578	797
1980	0	29	174	0	0	0	4	0	33	36	67	83	198	405	403	235	359	695	775	840	785	688	741
1981	160	0	0	0	0	1	62	151	119	167	160	529	728	1062	1626	1082	620	882	1055	1053	508	261	255
1982	0	0	0	0	0	10	434	409	192	523	425	410	931	1092	1765	2343	2064	2166	2482	3048	2086	1132	1088
1983	0	0	0	5	0	35	53	20	83	143	252	314	484	487	825	941	1334	3049	2181	2143	2413	1872	708
1984	0	7	77	42	518	462	266	455	308	350	310	582	912	1125	1367	2644	3638	4925	4236	3283	3012	916	647
1985	15	435	2966	0	0	0	7	49	165	341	142	400	429	466	464	602	824	2042	1908	2095	1611	855	847
1986	0	28	866	5007	14849	7176	992	322	0	0	0	29	53	169	150	176	306	478	1163	1622	1300	749	655
1987	0	0	0	0	0	2	23	111	522	747	582	632	336	387	406	427	659	767	1349	1782	1480	886	693
1988	0	26	133	82	31	1	15	39	14	43	61	349	682	729	816	684	837	1013	2320	2566	3849	2387	1798
1989	128	430	342	0	0	0	2	0	6	28	203	464	1291	1589	2462	1165	1568	3211	1651	1264	1826	683	1185
1990	0	0	0	0	0	0	0	4	17	72	610	187	1355	2360	4691	4086	6290	2101	1977	934	2015	1064	1173
1991	0	25	290	0	783	1401	1496	2495	1173	833	953	1758	1769	1028	1147	1624	2681	2893	1759	877	638	531	1259
1992	0	10	16	24	109	15	46	50	41	111	254	443	1119	1624	1686	1623	1801	2307	1928	1075	579	296	342
1993	0	1	3	7	19	4	6	15	32	57	56	66	173	208	413	650	1129	1303	1347	1415	929	1279	1228
1994	0	0	0	0	0	1	53	184	274	311	1508	3487	2475	1660	1364	780	1001	1215	1608	1237	1092	869	1524
1995	0	23	280	0	0	0	0	22	154	185	243	431	288	265	363	746	1519	1308	1565	1015	777	908	1243
1996	1	42	424	9	20	2	25	149	512	2039	2010	1487	998	648	720	550	946	978	1120	767	1108	727	2644
1997	0	0	0	1	14	33	28	130	653	2015	2487	2858	2016	1347	1938	1839	2481	2744	4480	2508	1965	1001	1953
1998	0	0	0	0	0	0	1	4	38	126	221	465	1164	1476	1580	1929	3376	2859	3993	2998	2080	1187	1576
1999	0	0	0	0	0	0	7	270	346	285	364	406	726	610	912	847	1459	1884	3852	2854	2102	1586	1972
2000	0	0	0	0	0	0	0	7	496	1249	1958	2213	1752	1836	2377	2605	2488	3877	3551	1881	1284	710	630
2001	0	0	0	0	0	37	348	616	1537	1531	2051	2087	2635	2556	2648	4014	3485	4513	4030	2614	1705	792	612
2002	0	0	0	0	1	22	185	328	744	668	887	632	1060	1036	1467	1972	2433	3294	3368	2762	2139	1126	901
2003	0	0	0	0	1	0	1	11	107	293	503	743	712	676	850	2472	2501	2286	1647	1179	1090	589	395
2004	0	0	0	0	0	15	26	76	108	130	253	325	307	282	336	963	1842	3114	1822	1348	1258	697	423
2005	0	0	0	0	0	9	20	42	63	85	147	229	366	620	1061	1170	1377	3461	3229	1980	1294	427	307
2006	0	0	0	0	0	3	19	53	314	237	480	696	1934	1711	2504	1561	1874	1747	1578	1347	1729	1078	637
2007	0	0	0	0	0	0	33	45	169	155	548	829	2896	2456	3047	2008	2159	911	1901	2316	2039	1730	1044
2008	0	0	1	18	177	169	41	83	78	144	175	182	328	367	633	1632	2517	2893	2575	2598	1622	1380	1849
2009	0	0	0	0	0	0	0	2	107	325	425	599	525	571	1021	1740	1902	1976	2075	2679	2910	1816	778

Table A3 cont.

Other	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1950	20996	0	14937	31011	26119	16084	305	281	402	1339	2270	4402	8682	10978	6447	8253	9789	5687	2074	423	163	90	33
1951	8387	0	2905	6034	5081	3334	2158	2995	2676	2558	2597	4100	5336	11450	11672	10431	10601	6033	2639	911	605	322	121
1952	451	0	438	924	767	542	729	2053	928	998	1593	1797	4147	8532	8675	14854	10576	5371	2449	1436	1214	806	354
1953	73284	0	1523	3185	2880	1773	1390	1877	1709	1736	2301	2542	3893	7157	8085	10867	12104	7154	3350	1636	1210	629	265
1954	185	0	1634	3391	2839	1767	109	91	160	366	1078	1084	3901	3495	3382	4923	6555	4887	3867	2712	1882	1014	537
1955	341	0	785	1777	1618	8946	14335	4798	5525	2530	2843	2544	4300	6459	6014	9462	11247	7174	5132	4222	2733	1235	425
1956	0	0	36	143	169	3437	5914	3928	2174	743	149	423	164	86	313	412	1044	2208	1015	1246	1540	953	433
1957	0	0	67	287	316	6437	11084	3607	4064	1408	273	293	658	902	664	935	1568	1691	2353	3092	2928	1469	859
1958	0	0	32	127	151	3077	5299	1725	1996	717	236	282	156	977	624	1365	827	605	593	988	1135	914	694
1959	0	0	42	166	198	4019	6921	2252	2576	887	168	549	343	377	379	818	1627	1599	1291	1712	3106	2303	942
1960	613	0	90	241	217	2217	4424	2237	3562	2629	1692	1127	931	1595	1281	1214	1337	1012	405	441	993	666	183
1961	5084	0	114	307	278	3258	6309	2819	5020	3433	1193	1993	1818	1744	670	1431	1320	1005	1078	444	403	685	407
1962	56275	0	38	55	70	1132	2124	797	1728	1773	1193	3041	1482	2109	1805	734	1203	483	193	338	461	382	367
1963	393948	0	41	174	166	3485	6462	2200	4648	2990	1658	2543	1951	2057	870	1164	178	1001	195	633	87	351	10
1964	5150	0	653	1482	1266	5648	9677	3806	7117	4522	1527	2257	1063	1518	850	301	111	111	609	6	24	52	80
1965	179	0	710	1490	1266	2782	4080	1873	3412	3265	919	1929	930	1910	1708	178	459	99	54	40	34	88	133
1966	60318	6619	124	263	224	149	132	214	225	494	299	3415	891	739	744	85	0	46	114	59	61	25	0
1967	72225	8922	21	48	43	84	118	79	137	218	309	1464	1418	1827	315	448	532	890	798	751	690	899	1124
1968	99240	0	0	0	0	0	0	3	16	171	597	218	489	1122	1217	220	153	110	191	142	250	141	357
1969	0	0	0	0	0	0	0	0	2	97	551	1130	424	294	896	593	161	232	177	261	256	281	398
1970	9603	0	177	395	341	211	41	184	307	285	149	2	87	89	109	139	871	1084	952	493	176	141	32
1971	81104	0	0	0	0	0	0	5	9	28	13	30	90	157	119	158	127	156	155	190	400	579	616
1972	15977	0	51	126	112	82	119	178	169	158	33	22	21	40	32	43	37	28	34	65	151	230	251
1973	38113	988	11	46	342	220	97	126	45	38	21	21	21	39	29	38	27	21	30	43	71	96	101
1974	38113	988	5	11	9	7	14	23	23	28	13	13	17	29	27	35	30	42	35	55	83	84	75
1975	37975	984	26	143	1214	807	610	770	240	169	85	67	39	27	39	61	70	90	54	95	116	74	50
1976	38080	987	13	33	90	81	36	41	30	33	23	26	31	34	18	18	38	135	167	204	238	146	192
1977	125908	8426	10	54	148	296	74	88	56	43	20	45	105	140	142	125	132	296	383	407	282	359	474
1978	105399	6965	1272	5076	6953	2407	1153	1220	884	1668	765	562	197	86	60	78	105	159	156	211	318	489	999
1979	27403	696	12	107	318	866	1053	994	942	1480	573	204	219	342	837	513	646	464	500	427	485	699	1407
1980	36524	529	6586	11279	5396	3855	2017	1417	693	555	882	1118	938	650	476	337	362	353	373	372	383	314	388
1981	5101	0	6638	17088	8164	6641	1816	2502	1168	754	502	184	216	326	440	553	380	498	720	625	378	249	324
1982	82419	6541	3727	8868	4581	2892	1067	1348	591	228	167	88	85	116	109	146	135	182	225	230	251	216	389
1983	289998	42904	73435	153369	8419	7408	1982	913	368	394	212	112	93	147	207	133	207	559	306	324	226	170	51
1984	1701	792	21816	26236	23944	35447	7301	3639	2084	1658	1205	525	401	304	343	471	774	920	1159	1094	888	613	626
1985	13596	13124	6432	10889	9678	18956	9883	15051	3532	1734	880	1002	1049	718	1065	1132	1403	1716	2134	1784	1442	1313	1041
1986	22639	11287	56289	100191	15292	9805	4421	2963	4363	1389	511	985	643	549	568	827	1167	1522	1843	2429	2421	1854	931
1987	90018	18818	17619	26155	18599	15010	3429	3532	2705	1916	1822	2020	1841	5340	2543	1332	1017	1472	1475	1369	780	558	735
1988	28601	3983	88620	99577	16524	8236	7875	5028	2395	1211	1130	1088	2230	3910	2612	1228	1356	1584	1742	2269	1049	605	770
1989	17220	12301	53834	74240	39581	24280	3247	7602	3144	1382	1556	827	1030	1855	1588	1015	847	1188	1261	1876	1706	594	1292
1990	40609	30019	23654	45337	11996	11208	4970	2250	1328	1564	2208	1751	1139	946	1091	1355	1294	1402	2009	1084	564	274	586
1991	66484	44788	6157	23538	10867	6729	1357	1759	1527	1002	960	547	512	380	329	541	1562	1950	2304	845	304	62	182
1992	40143	17890	67438	41108	11868	21554	8186	2125	1727	1096	766	524	402	748	867	1576	3133	2329	2317	747	404	348	180
1993	11276	5998	43807	30405	45740	43610	10996	8710	4735	2248	1883	2436	1973	1231	918	537	661	912	2080	1228	516	452	896
1994	13159	12000	13653	38423	14695	14058	12988	11217	4004	2909	2846	2689	2115	2873	2996	3784	3427	3251	2968	2155	1117	1121	1326
1995	34866	24551	31502	87723	9451	12382	12969	4104	3061	3598	4880	6036	5498	3023	2012	2482	1843	2268	1649	1478	694	815	883
1996	31303	20934	44326	23754	28885	7114	7775	5660	4155	3577	3249	2532	2385	1771	833	997	1189	1478	1501	1099	966	738	695
1997	1159	6485	44594	22902	10973	16795	9305	5504	3061	3305	4493	4460	3288	1529	1478	1522	1668	1802	1327	883	634	491	531
1998	19	4404	56625	36475	15144	19975	23953	5670	4129	1677	546	3899	4231	761	1476	2611	2787	1604	635	343	248	212	139
1999	132	616	6906	55257	13304	38464	4011	10659	4880	3063	3933	2691	1480	1380	1125	1267	5395	3145	1067	571	227	184	1353
2000	1	9234	14664	31277	23424	13441	8828	3883	4237	5637	6374	6061	3025	1228	1166	1402	1450	1088	1084	744	480	289	370
2001	0	144	1312	1492	28647	21609	12081	10628	4804	2011	1922	1731	1518	1592	1045	1786	1499	1993	1032	313	159	109	178
2002	0	289	2909	9556	19111	29128	20582	7804	3713	2291	1796	1753	1513	1506	817	1503	1438	1381	1393	605	504	267	272
2003	0	70	1186	5561	33817	19438	13017	5718	2726	1232	3299	2465	1936	2115	772	1490	1872	3095	4655	1378	605	306	138
2004	47	8669	4918	18097	17666	11040	6677	4404	2405	1653	574	1296	1656	1342	1511	494	889	1950	1790	722	409	297	543
2005	612	1914	7503	73478	56086	19536	20327	3588	2321	490	1820	883	211	48	71	35	37	163	181	78	51	20	55
2006	325	1014	2718	33773	48421	11100	14248	1487	2282	621	934	624	719	782	200	55	70	230	275	130	85	58	117
2007	0	77	26	78	512	1809	175	329	164	341	123	118	144	97	74	80	47	52	45	46	43	18	25
2008	0	0	7	139	1635	1233	325	406	615	1458	1704	2605	2005	948	812	987	354	473	436	475	691	455	1184
2009	220	163	136	129	118	543	214	128	436	397	378	344	269	197	270	209	166	94	74	49	36	16	14

Table A4: CPUE series used – values followed by associated standard errors are given.

	Mor&Sp_Trap		SpBB		SpBB_hist		JPLL_EastMed		NorPS		JPLL_NEA	
Units	numbers		biomass		biomass		numbers		biomass		numbers	
1952	-	-	-	-	501.78	17.82	-	-	-	-	-	-
1953	-	-	-	-	457.50	24.50	-	-	-	-	-	-
1954	-	-	-	-	428.84	17.30	-	-	-	-	-	-
1955	-	-	-	-	496.75	17.35	-	-	36.20	1.00	-	-
1956	-	-	-	-	537.53	17.38	-	-	21.25	1.00	-	-
1957	-	-	-	-	468.33	17.97	-	-	28.61	1.00	-	-
1958	-	-	-	-	356.49	17.32	-	-	24.13	1.00	-	-
1959	-	-	-	-	365.99	18.07	-	-	32.41	1.00	-	-
1960	-	-	-	-	299.89	17.56	-	-	46.83	1.00	-	-
1961	-	-	-	-	269.75	17.33	-	-	51.84	1.00	-	-
1962	-	-	-	-	236.13	17.59	-	-	64.67	1.00	-	-
1963	-	-	-	-	309.28	18.91	-	-	1.67	1.00	-	-
1964	-	-	-	-	266.71	17.80	-	-	33.98	1.00	-	-
1965	-	-	-	-	291.83	19.10	-	-	69.60	1.00	-	-
1966	-	-	-	-	306.86	18.21	-	-	35.71	1.00	-	-
1967	-	-	-	-	289.25	20.18	-	-	61.06	1.00	-	-
1968	-	-	-	-	393.57	19.70	-	-	23.53	1.00	-	-
1969	-	-	-	-	325.86	19.77	-	-	28.06	1.00	-	-
1970	-	-	-	-	519.46	21.67	-	-	42.76	1.00	-	-
1971	-	-	-	-	373.73	19.78	-	-	43.52	1.00	-	-
1972	-	-	-	-	385.24	20.37	-	-	43.05	1.00	-	-
1973	-	-	475.37	37.00	-	-	-	-	42.15	1.00	-	-
1974	-	-	549.35	39.00	-	-	-	-	45.72	1.00	-	-
1975	-	-	578.55	37.00	-	-	1.90	0.15	38.00	1.00	-	-
1976	-	-	535.41	38.00	-	-	2.15	0.12	21.16	1.00	-	-
1977	-	-	803.94	37.00	-	-	3.53	0.14	42.44	1.00	-	-
1978	-	-	536.42	37.00	-	-	1.50	0.15	12.28	1.00	-	-
1979	-	-	698.39	37.00	-	-	2.70	0.14	3.75	1.00	-	-
1980	-	-	734.46	46.00	-	-	1.69	0.16	20.14	1.00	-	-
1981	3145.86	58.40	171.46	40.00	-	-	1.63	0.17	-	-	-	-
1982	4151.93	33.70	378.39	39.00	-	-	3.32	0.13	-	-	-	-
1983	4402.08	33.70	1327.25	43.00	-	-	2.12	0.13	-	-	-	-
1984	4854.68	33.70	1510.94	41.00	-	-	1.62	0.12	-	-	-	-
1985	3288.16	33.71	835.48	37.00	-	-	1.75	0.15	-	-	-	-
1986	1556.12	27.05	580.21	40.00	-	-	1.32	0.14	-	-	-	-
1987	1713.63	27.04	793.36	39.00	-	-	2.16	0.13	-	-	-	-
1988	4026.80	27.02	849.48	40.00	-	-	1.35	0.14	-	-	-	-
1989	2091.12	25.09	813.43	36.00	-	-	1.05	0.16	-	-	-	-
1990	2433.10	22.46	813.93	36.00	-	-	1.41	0.14	-	-	0.35	0.32
1991	2871.90	21.50	672.37	40.00	-	-	1.21	0.13	-	-	0.44	0.27
1992	1256.65	22.48	392.98	41.00	-	-	1.03	0.14	-	-	0.77	0.16
1993	1233.91	21.53	1864.38	38.00	-	-	1.04	0.14	-	-	0.75	0.14
1994	1370.23	22.48	630.19	38.00	-	-	1.12	0.16	-	-	0.90	0.16
1995	888.94	22.50	1607.43	36.00	-	-	1.42	0.15	-	-	0.95	0.13
1996	1598.01	22.47	1502.25	36.00	-	-	0.50	0.22	-	-	2.53	0.13
1997	3754.01	22.45	1620.72	36.00	-	-	0.53	0.21	-	-	1.62	0.13
1998	3950.27	22.44	791.59	37.00	-	-	0.71	0.17	-	-	0.85	0.16
1999	4463.56	22.44	618.75	43.00	-	-	0.64	0.22	-	-	1.19	0.15
2000	3411.81	21.50	583.83	36.00	-	-	0.74	0.20	-	-	1.22	0.12
2001	5907.80	21.49	1515.54	46.00	-	-	0.96	0.17	-	-	1.44	0.12
2002	4240.52	21.50	1502.02	37.00	-	-	2.05	0.15	-	-	1.11	0.13
2003	2417.06	22.49	389.33	49.00	-	-	1.70	0.13	-	-	1.14	0.14
2004	1319.61	21.53	993.04	42.00	-	-	0.82	0.18	-	-	1.03	0.12
2005	2598.59	21.51	856.22	37.00	-	-	0.88	0.15	-	-	0.74	0.11
2006	2456.74	21.51	638.35	41.00	-	-	1.91	0.15	-	-	0.87	0.11
2007	3690.98	21.50	734.34	38.00	-	-	0.94	0.19	-	-	0.89	0.11
2008	2455.05	21.51	1102.28	43.00	-	-	1.22	0.17	-	-	1.06	0.12
2009	3330.17	21.50	686.62	44.00	-	-	1.04	0.24	-	-	1.54	0.11

Table A5: Catches-at-age associated with the CPUE series used in the SCAA.

Mor&Sp_Trap

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1970	7	16	4	8	46	132	465	900	2001	2740	1779	1013	1249	737	427	282	168	104	30	13	4	0	0	0	0
1971	0	0	0	1	4	31	39	79	271	417	461	360	421	381	395	326	191	125	31	8	0	0	0	0	0
1972	7	18	39	53	16	75	90	162	217	208	408	345	419	282	152	139	31	19	0	0	0	0	0	0	0
1973	297	9	15	17	9	63	52	201	341	491	617	464	476	282	140	88	64	44	0	3	12	12	1	0	0
1974	0	0	2	2	2	6	5	9	19	20	24	21	28	18	14	7	5	3	0	0	0	0	0	0	0
1975	15	37	0	0	8	0	0	15	55	102	276	188	371	324	316	135	100	70	16	10	15	6	2	0	0
1976	0	0	0	0	0	0	0	15	17	142	209	317	327	297	271	200	105	125	55	20	11	0	7	11	0
1977	8	39	0	0	4	0	64	117	152	318	457	402	363	274	287	148	90	80	17	8	16	3	1	0	0
1978	0	0	0	0	0	10	34	167	195	122	138	309	393	260	258	105	82	70	34	4	15	0	0	0	0
1979	0	0	0	0	81	176	226	343	556	674	497	270	270	193	161	129	70	48	17	8	0	0	0	0	0
1980	232	0	0	0	39	126	483	270	254	421	473	459	461	290	266	228	114	52	27	14	8	0	0	0	0
1981	0	0	0	0	174	831	1271	1713	570	518	614	579	464	53	96	52	26	0	0	0	0	0	0	0	0
1982	0	0	0	3	162	565	2069	2044	2170	1667	1301	1844	1373	992	419	297	163	189	79	0	0	0	0	0	0
1983	0	0	0	0	1	2	2	291	529	1822	1456	1394	1707	1084	1133	188	142	94	47	47	94	1	0	0	0
1984	0	0	0	84	139	177	616	1231	3140	3749	2883	2489	1236	579	417	149	0	127	63	21	21	42	0	0	0
1985	0	0	70	481	263	651	537	541	720	1465	1642	1437	1380	777	432	380	194	99	58	22	10	27	4	4	27
1986	2476	12363	995	0	0	48	171	139	229	359	743	1138	941	648	438	256	163	75	42	23	26	6	1	0	14
1987	0	3	0	0	10	125	317	290	447	564	871	1253	1058	754	488	290	179	79	42	22	26	6	1	0	14
1988	186	39	59	59	188	859	990	819	745	800	1840	1450	2529	2005	1373	837	472	178	81	39	14	4	4	5	0
1989	236	0	2	31	253	1062	1684	1912	1419	1086	1190	748	989	830	428	281	231	178	58	46	16	19	14	11	34
1990	0	0	0	48	706	1527	3371	5075	6428	2332	1745	613	1260	977	781	253	276	280	73	54	41	28	15	8	8
1991	352	2259	4194	1641	1774	2361	1113	1446	2340	2715	1626	549	509	320	304	248	267	278	102	57	51	19	5	0	18
1992	31	146	77	78	316	984	2022	1482	1434	1733	1547	833	537	213	168	79	76	46	29	22	18	0	0	0	0
1993	8	27	21	9	25	99	164	420	894	1087	1190	1108	892	545	953	468	223	243	118	70	39	23	31	37	6
1994	3178	0	25	76	1740	2947	1606	795	802	1041	1575	900	900	723	543	438	285	176	126	113	113	98	48	35	145
1995	0	0	2	7	98	42	89	279	1080	1105	1224	735	539	409	223	278	205	113	93	76	42	49	30	26	32
1996	0	0	5	108	273	235	258	287	664	904	1104	596	806	713	503	600	684	435	203	183	207	133	68	52	98
1997	0	0	30	465	2092	2347	1491	2390	2607	2647	4521	2204	1852	1165	603	786	542	240	120	106	137	57	30	23	46
1998	0	0	2	42	298	1072	1490	1755	2953	2433	3131	1960	1664	967	575	638	270	167	89	76	55	23	10	6	19
1999	0	0	8	30	304	496	659	1198	1310	1638	3262	2169	1839	1083	687	836	213	158	117	109	72	59	21	10	62
2000	0	0	0	72	602	649	1225	2382	2904	3365	3787	1935	985	942	360	234	156	81	62	36	9	2	0	0	7
2001	0	0	0	449	1180	1624	1987	3159	4414	4260	3813	2683	1416	1071	405	193	114	88	58	27	14	14	9	8	11
2002	0	0	0	6	77	201	599	1711	2364	3315	3114	2513	2033	1132	752	504	181	98	73	54	24	13	5	3	0
2003	0	0	0	5	255	564	654	1576	3363	2247	1695	1062	861	691	373	182	105	48	15	8	3	0	0	0	0
2004	0	0	0	0	62	164	182	451	1700	3213	1715	1290	968	806	447	239	98	83	25	7	10	10	3	0	0
2005	0	0	13	3	60	252	668	1340	1438	3250	3156	2010	1227	725	259	175	78	58	14	5	5	0	0	0	0
2006	0	0	0	131	434	2054	2259	2779	1884	1754	1367	1517	904	1404	641	351	89	106	35	9	35	35	26	26	0
2007	0	0	0	216	713	3336	3341	3636	2449	920	1391	2052	1679	1427	1250	561	269	171	80	23	23	0	0	0	0
2008	0	0	1	2	73	147	362	3046	2477	3208	2382	2226	1884	852	885	907	135	374	240	178	3	1	0	0	0
2009	0	0	0	24	461	653	829	1520	2295	2106	1774	2178	2442	1859	1283	481	214	82	38	25	17	5	2	1	0

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1950	0	1152	784	1481	14258	11438	3253	513	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	1784	1214	2293	22069	17704	5036	794	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	1456	993	1872	18018	14455	4112	648	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	1458	992	1874	18034	14467	4115	649	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	2128	1448	2736	26326	21119	6007	947	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	10385	50543	65634	23242	6665	1481	73	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	4983	24229	31463	11142	3195	710	35	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	5316	25847	33564	11886	3408	757	37	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	4469	21728	28215	9992	2865	636	31	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	6966	33867	43979	15574	4466	992	49	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	2298	7731	9445	5467	1403	247	24	16	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	3769	12684	15492	8968	2300	405	38	27	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	4009	13490	16481	9540	2446	432	40	29	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	2256	7591	9274	5369	1376	244	23	16	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	1662	5593	6835	3957	1014	178	17	12	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	2578	8677	10600	6137	1574	279	27	20	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	1314	48057	44435	5224	978	195	15	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	658	19025	29912	1534	93	21	18	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	16599	12598	8433	249	28	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	14072	18309	7957	3150	270	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	29070	29779	7747	3391	274	78	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	680	21028	11448	2688	2047	490	88	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	1037	20862	3984	1429	2418	1969	978	374	92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	1497	27806	9201	1557	304	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	928	18661	11908	1837	388	127	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1970	0	0	0	0	2	5	0	40	41	33	6	5	10	0	4	0	2	0	0	0	0	0	0	0	0
1971	0	0	5	0	0	22	90	53	116	148	175	73	49	24	27	6	23	7	0	0	0	0	0	0	0
1972	4	0	7	9	6	103	26	151	240	284	113	144	213	109	61	37	36	16	3	0	0	0	0	0	0
1973	0	0	0	5	5	10	5	78	68	242	104	268	241	153	91	29	153	15	5	0	0	0	0	0	0
1974	127	386	2517	2109	2449	3026	358	1454	1186	3247	2521	2985	4044	2878	1751	721	491	414	258	96	51	21	6	11	15
1975	13	217	169	1170	462	642	492	884	943	2654	3868	4575	5298	3898	2542	1242	930	701	559	258	154	60	15	24	44
1976	2	43	99	63	271	354	204	354	405	1017	1793	1690	3587	1751	1671	850	497	731	195	128	82	50	31	27	38
1977	0	18	34	42	54	302	652	1224	1738	1591	1727	1177	1233	923	1029	436	282	51	73	0	19	0	0	7	0
1978	0	0	12	62	143	157	252	114	21	226	47	65	318	0	1597	0	0	32	40	0	121	93	0	121	308
1979	0	3	29	86	154	1072	1160	2264	1460	387	89	4	12	3	3	1	6	0	2	2	0	0	0	0	0
1980	0	0	75	43	92	172	358	539	694	693	912	479	289	142	53	22	13	13	12	2	11	0	0	0	0
1981	8	16	13	22	33	90	247	653	522	456	524	357	217	153	130	55	93	111	20	18	33	5	5	0	1
1982	0	0	37	200	79	432	850	4691	199	336	2282	1637	2335	5776	826	79	276	318	355	154	201	40	40	40	0
1983	4	44	185	361	1003	1303	1997	2327	1861	3812	1801	971	1648	1198	792	191	163	47	19	0	0	0	0	0	0
1984	1	0	65	151	397	635	947	1924	3684	2675	1962	806	738	411	242	197	233	41	52	29	8	8	8	0	0
1985	0	53	139	127	299	402	572	503	451	652	896	849	1243	897	540	288	225	136	118	48	56	33	0	22	33
1986	1	33	55	110	358	357	331	410	547	1076	1047	776	897	414	255	45	38	18	14	2	2	0	1	1	1
1987	0	0	16	41	101	451	922	821	781	776	719	681	825	746	472	281	113	53	19	5	0	0	0	0	0
1988	0	8	19	87	85	327	939	1187	1078	989	1026	486	757	530	357	165	110	57	35	5	28	9	2	0	1
1989	0	0	26	169	204	491	1220	1085	890	819	693	206	311	272	220	81	83	53	34	4	13	4	4	15	40
1990	0	5	46	65	439	837	1356	1690	2280	2169	1073	519	359	292	228	131	83	52	38	41	10	27	28	2	74
1991	0	180	270	729	503	1207	2084	2055	3856	3415	2334	963	664	427	337	246	206	135	133	119	241	21	98	191	198
1992	0	15	250	992	1870	1472	1579	1979	3244	2286	3240	2248	1831	1278	719	347	225	165	54	59	62	27	10	0	0
1993	0	38	130	1018	2179	2769	2027	1233	1228	2138	2188	1215	1104	751	649	154	296	182	324	129	489	25	95	53	547
1994	12	2	88	886	579	1031	3480	2519	2467	1624	1210	883	1293	695	746	211	456	71	80	85	18	0	0	0	35
1995	0	32	207	1332	1489	8617	4514	2935	4191	2540	2200	2347	2208	1256	794	679	600	185	255	132	55	0	27	27	56
1996	0	0	116	655	978	1683	3195	3995	4396	3428	2618	1485	1175	946	855	317	444	219	242	54	101	20	38	45	56
1997	0	0	15	116	403	1205	2316	3890	5672	2870	2508	1540	727	500	262	83	155	64	48	11	0	43	0	0	86
1998	0	0	66	195	251	928	2061	2547	4068	4799	3791	2034	1097	679	336	208	140	132	62	65	10	0	0	0	0
1999	0	184	189	1231	2814	1536	2546	4759	3553	3387	2292	1752	512	241	137	46	39	15	14	7	15	0	7	13	0
2000	0	7	71	682	1066	2539	2031	3462	4299	2746	1884	1552	721	668	375	104	36	7	9	0	0	14	0	19	0
2001	0	1	2	98	507	2658	6072	6442	3521	1580	837	323	223	322	354	248	2	1	0	0	0	0	0	0	0
2002	0	13	54	37	71	180	2132	5984	6159	2141	1612	1141	369	291	96	100	48	34	0	8	29	0	0	21	0
2003	21	181	713	1908	1987	2612	2360	2439	3232	5099	2313	1038	428	272	138	81	47	0	0	25	29	0	0	13	17
2004	26	339	258	696	528	1056	3319	2751	1738	2786	2618	1449	504	226	175	238	93	48	35	90	0	0	0	0	0
2005	4	133	219	266	412	646	1778	2131	3059	3612	3696	1478	378	62	81	26	0	0	6	0	0	0	0	0	0
2006	55	0	319	109	486	542	1632	1891	1690	1735	1406	621	409	145	33	0	0	0	0	0	16	0	0	0	0
2007	26	83	1824	1424	1267	1410	1416	3041	2436	1819	1635	971	426	189	225	61	29	8	79	9	0	0	0	0	0
2008	11	127	139	1171	3250	1510	4415	4426	2620	2534	1753	1004	797	407	431	90	40	43	11	0	40	5	0	0	0
2009	0	0	17	40	205	5744	2920	2281	2690	1138	486	179	122	67	79	21	9	8	7	0	15	0	0	0	0

Table A6: Catches-at-length associated with the CPUE series used in the SCAL.

Mor&Sp_Trap

	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1970	200	0	4	8	7	5	1	4	4	8	28	42	132	316	659	1000	2116	2406	1635	1254	1293	648	551
1971	2945	0	0	0	0	0	0	0	1	1	2	15	18	29	47	127	293	411	444	440	555	535	622
1972	799	0	3	9	8	6	8	42	26	21	4	28	62	70	112	135	191	228	416	452	442	254	157
1973	16907	438	2	5	4	3	6	10	10	8	4	33	32	39	100	220	323	520	606	559	475	223	211
1974	1605	0	0	0	0	0	1	1	2	0	1	4	4	4	4	11	18	19	24	28	30	20	14
1975	0	0	12	32	5	0	0	0	0	3	5	0	0	0	3	29	61	128	267	295	455	435	331
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	8	17	163	248	402	400	383	495
1977	0	0	6	16	2	0	0	0	0	2	2	0	2	38	82	120	140	345	470	494	372	397	333
1978	0	0	0	0	0	0	0	0	0	0	0	0	8	17	106	148	159	105	189	419	412	336	295
1979	0	0	0	0	0	0	0	0	0	3	52	63	154	178	182	427	508	580	458	345	303	218	248
1980	0	29	174	0	0	0	0	0	0	4	29	47	128	344	318	127	243	442	508	548	455	391	403
1981	160	0	0	0	0	0	0	0	0	0	35	445	613	886	1441	832	377	570	614	667	271	105	69
1982	0	0	0	0	0	0	0	0	0	31	87	75	755	1499	1499	1891	1524	1473	1593	2066	1409	737	672
1983	0	0	0	0	0	0	0	0	0	0	0	2	1	0	53	476	535	1828	1684	1583	1841	1417	565
1984	0	0	0	0	0	0	0	0	0	68	80	65	144	465	786	1711	2516	3565	3179	2305	1129	694	411
1985	14	0	0	0	0	0	7	49	165	337	117	406	329	437	406	510	681	1659	1540	1763	1329	718	745
1986	0	15	455	2631	7855	3772	521	169	0	0	0	16	42	135	119	140	243	380	929	1294	1037	596	524
1987	0	0	0	0	0	2	0	0	0	0	1	31	87	229	232	270	424	529	1039	1449	1188	705	586
1988	0	21	109	67	25	1	15	39	14	43	59	320	614	670	747	618	720	861	1927	2117	3162	1949	1469
1989	128	430	142	0	0	0	2	0	6	26	142	351	929	1134	1768	925	1238	1006	1235	931	1340	639	836
1990	0	0	0	0	0	0	0	1	14	60	555	153	1230	2184	4245	3680	5696	1808	1678	770	1802	951	984
1991	0	25	290	0	783	1401	1496	2495	1173	827	878	1586	1536	895	935	1350	2225	2428	1469	700	508	431	998
1992	0	10	16	24	109	15	43	31	40	92	184	356	964	1372	1304	1117	1353	1685	1408	832	440	232	253
1993	0	1	3	7	19	4	5	7	10	4	23	12	84	113	282	433	910	1111	1183	1283	843	1198	1135
1994	0	0	0	0	0	0	13	13	25	90	860	2212	1594	1125	932	536	789	1105	1504	1135	1019	823	1474
1995	0	0	0	0	0	0	0	2	2	15	72	33	32	55	149	428	1103	1007	1228	778	627	368	860
1996	0	0	0	0	0	0	1	7	33	141	155	111	194	169	234	241	746	871	1080	745	1087	722	2584
1997	0	0	0	0	0	0	1	28	186	681	1262	1339	1610	1054	1731	1727	2388	2689	4453	2478	1948	991	1928
1998	0	0	0	0	0	0	0	1	7	99	172	364	912	1150	1237	1512	2808	2238	3122	2332	1612	907	1212
1999	0	0	0	0	0	0	0	9	8	25	67	141	475	459	877	804	1529	1728	3355	2381	1746	1082	1447
2000	0	0	0	0	0	0	0	0	24	107	402	508	326	882	1840	2040	2268	3777	3421	1802	1202	657	533
2001	0	0	0	0	0	0	0	5	167	420	670	852	1302	1522	1889	3568	3205	4261	3877	2489	1582	684	489
2002	0	0	0	0	0	0	0	0	0	19	54	51	199	402	1016	1712	2244	3148	3282	2687	2065	1061	822
2003	0	0	0	0	0	0	0	0	0	35	148	346	344	477	725	2380	2433	2223	1571	1115	1026	559	311
2004	0	0	0	0	0	0	0	0	0	3	39	92	97	121	207	777	1740	3052	1749	1279	1211	678	419
2005	0	0	0	0	0	1	10	0	0	13	33	88	224	487	951	1076	1296	3419	3188	1953	1268	417	296
2006	0	0	0	0	0	0	0	0	79	66	329	499	1787	1563	2393	1411	1736	1723	1547	1307	1694	1053	632
2007	0	0	0	0	0	0	0	0	130	108	541	827	2893	2432	2951	1922	2080	817	1794	2270	2006	1697	1023
2008	0	0	0	0	0	0	1	0	0	14	46	62	130	261	525	1471	2452	2808	2514	2542	1551	1363	1613
2009	0	0	0	0	0	0	0	0	1	71	251	500	364	450	934	1672	1848	1937	2017	2627	2864	1796	749

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	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
1950	0	0	0	0	583	560	383	0	44	1229	7075	14195	4182	2209	1386	171	0	0	0	0	0	0	0
1951	0	0	0	0	902	887	593	0	67	1902	10951	21972	6474	3420	2146	285	0	0	0	0	0	0	0
1952	0	0	0	0	737	708	484	0	55	1553	8941	17939	5285	2792	1752	216	0	0	0	0	0	0	0
1953	0	0	0	0	737	709	485	0	55	1554	8949	17954	5290	2794	1753	216	0	0	0	0	0	0	0
1954	0	0	0	0	1076	1035	708	0	80	2269	13064	26210	7722	4079	2560	316	0	0	0	0	0	0	0
1955	0	0	3487	9412	27780	19948	28775	36859	14275	9609	4213	2679	580	99	8	1	0	0	0	0	0	0	0
1956	0	0	1671	4512	13317	9563	13794	17670	6843	4606	2020	1284	278	48	4	1	0	0	0	0	0	0	0
1957	0	0	1783	4813	14206	10201	14715	18849	7300	4914	2155	1370	297	51	4	1	0	0	0	0	0	0	0
1958	0	0	1499	4046	11942	8575	12370	15845	6137	4131	1811	1152	249	43	3	0	0	0	0	0	0	0	0
1959	0	0	2336	6307	18615	13367	19281	24698	9565	6439	2823	1795	389	67	5	1	0	0	0	0	0	0	0
1960	0	0	667	1728	4326	3052	3938	5368	3406	2397	935	574	128	27	13	17	6	0	0	0	0	0	0
1961	0	0	1093	2835	7097	5009	6457	8805	5588	3932	1533	942	209	43	23	28	11	0	0	0	0	0	0
1962	0	0	1163	3015	7550	5325	6870	9367	5945	4182	1630	1002	223	46	23	30	12	0	0	0	0	0	0
1963	0	0	655	1696	4249	2996	3868	5270	3345	2354	917	563	127	26	13	17	6	0	0	0	0	0	0
1964	0	0	482	1250	3130	2208	2849	3885	2465	1736	676	415	92	19	10	12	5	0	0	0	0	0	0
1965	0	0	748	1938	4855	3426	4418	6024	3824	2690	1049	645	144	31	15	21	8	0	0	0	0	0	0
1966	0	0	102	2188	27288	18782	20125	24449	3888	2201	644	413	102	26	6	1	0	0	0	0	0	0	0
1967	0	0	89	932	10282	7688	13705	16379	1474	572	71	28	12	12	12	8	2	0	0	0	0	0	0
1968	0	0	5084	11323	7280	4862	3880	4610	304	82	20	9	2	0	0	0	0	0	0	0	0	0	0
1969	0	0	4258	9822	10781	6968	3420	4471	2024	1363	209	72	11	0	0	0	0	0	0	0	0	0	0
1970	0	0	8847	20073	17739	11234	3301	4367	2172	1462	182	120	41	14	0	0	0	0	0	0	0	0	0
1971	0	0	73	1043	12275	8055	5107	6338	1636	1311	1254	981	260	93	53	8	0	0	0	0	0	0	0
1972	0	0	183	1289	12479	7845	1747	2221	810	723	872	2073	1114	837	658	223	55	0	0	0	0	0	0
1973	0	0	281	1785	16469	10536	4130	5081	1079	674	215	106	17	0	0	0	0	0	0	0	0	0	0
1974	0	0	167	1135	10818	7185	5362	6575	1299	786	225	210	67	20	0	0	0	0	0	0	0	0	0

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	40-	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
JP	0																						0
1970	0	0	0	0	0	0	0	0	0	0	2	3	1	7	17	50	26	23	4	12	3	5	2
1971	0	0	0	0	0	0	0	4	0	0	0	6	16	78	38	86	66	188	136	58	63	37	38
1972	0	0	0	2	0	0	2	7	0	4	1	88	19	8	72	133	244	237	122	201	198	118	59
1973	0	0	0	0	0	0	0	0	0	8	0	0	10	5	41	62	83	217	188	196	251	141	196
1974	0	0	0	125	10	249	1258	1254	797	1347	1499	1046	2127	1086	986	760	1349	2988	2824	3999	4479	2803	1981
1975	0	0	0	15	118	87	82	93	520	678	357	473	428	379	474	777	1018	2888	4665	5812	5713	3795	3609
1976	0	0	0	2	9	18	46	30	6	102	151	203	188	211	146	343	425	1036	1868	2211	4210	2284	2366
1977	0	0	0	0	12	0	31	6	27	18	28	131	229	427	883	1049	1430	1577	1709	1455	1254	1392	909
1978	0	0	0	0	0	0	6	0	50	50	99	136	147	38	37	48	215	71	0	97	286	1597	715
1979	0	0	0	0	1	4	17	8	51	40	40	323	854	998	1742	1465	940	174	29	10	3	4	10
1980	0	0	0	0	0	6	40	30	33	6	49	86	165	219	409	468	716	567	868	515	264	87	71
1981	0	2	1	2	15	2	2	9	19	21	13	33	84	175	437	562	354	456	468	385	216	193	328
1982	0	0	0	0	0	0	0	20	197	0	79	79	315	355	2797	1642	118	815	1969	2430	6535	1247	1497
1983	0	0	0	9	9	35	92	97	177	315	703	599	998	1585	1745	1498	1627	3790	1504	1723	1833	976	398
1984	0	0	0	1	0	0	21	22	113	126	198	327	475	771	1072	1973	3368	2239	1835	1117	597	354	576
1985	0	5	4	14	24	23	76	62	80	89	185	219	279	449	448	245	550	681	975	1301	1173	813	889
1986	0	0	0	0	8	8	31	33	58	93	241	273	192	229	334	318	582	977	1046	1142	775	314	108
1987	0	0	0	0	0	0	8	4	18	35	98	238	440	648	605	675	631	716	754	978	857	732	351
1988	0	0	0	0	0	8	2	14	58	47	49	125	399	694	770	998	789	880	882	817	774	482	387
1989	0	0	0	0	0	0	3	83	77	65	174	218	537	818	824	770	695	645	721	336	357	273	329
1990	0	0	0	2	0	3	22	5	37	154	161	439	672	950	1125	1733	1749	1838	1099	635	376	350	473
1991	0	0	0	0	0	0	119	211	61	390	529	326	762	1294	1903	2245	3326	3136	2205	1143	762	492	1622
1992	0	7	0	0	0	0	38	106	452	214	830	1305	1184	1317	1359	1510	2908	2205	3574	2356	2125	1003	907
1993	0	0	0	0	0	12	12	25	450	1001	1337	1614	1668	961	1208	1285	1093	2037	2283	1602	1083	867	2281
1994	0	0	0	0	0	0	0	22	230	341	286	469	706	2350	2220	2283	2094	1027	1376	1629	1024	785	956
1995	0	0	0	0	0	0	32	0	392	307	1241	823	4828	4120	2711	2814	4265	2270	2389	3282	1859	1198	1823
1996	0	0	0	0	0	0	0	21	167	449	540	539	934	1504	3068	3454	4122	3342	2649	1937	1629	1003	1522
1997	0	0	0	0	0	0	0	0	0	65	108	262	750	1592	1911	3646	4929	3174	2648	1564	804	471	476
1998	0	0	0	0	0	0	0	0	132	0	0	287	528	1376	1835	1704	3739	5438	3835	2245	1088	606	501
1999	0	0	0	0	0	27	27	27	167	699	1196	1886	984	1467	2750	3570	4124	3042	2612	1709	410	149	183
2000	0	0	0	0	0	0	4	190	353	285	542	627	1682	1641	1504	2804	4250	2813	2062	1705	1057	540	153
2001	0	0	0	0	0	1	1	0	1	100	8	441	2032	3284	5650	4290	2522	1714	874	390	354	651	106
2002	0	0	0	0	0	0	46	44	60	208	47	65	192	2493	4865	11287	9064	5360	3354	1975	870	277	307
2003	0	0	0	0	11	23	169	455	562	1204	698	1441	1936	1725	1697	2050	3352	4570	2822	1263	459	252	183
2004	0	0	0	0	9	252	79	139	177	444	337	397	395	1549	2831	2299	1612	2554	2964	1675	397	320	462
2005	0	0	0	0	6	23	133	81	139	167	147	273	470	719	1400	1570	3170	4112	3698	1208	383	123	41
2006	0	0	0	0	0	0	0	55	235	55	287	232	279	808	1362	1671	1475	1344	1707	715	481	99	16
2007	0	0	0	0	17	0	845	850	564	1113	767	614	749	872	2019	2269	2199	1868	1690	929	327	338	150
2008	0	0	5	0	37	34	49	79	235	762	1688	1940	997	1673	3944	3895	2625	2312	2021	1136	773	898	217
2009	0	0	0	0	0	0	9	17	15	13	15	428	8249	11089	2016	4527	5197	2287	1007	306	180	108	58

Appendix B - The Statistical Catch-at-Age Model

The text following sets out the equations and other general specifications of the SCAA followed by details of the contributions to the (penalised) log-likelihood function from the different sources of data available and assumptions concerning the stock-recruitment relationship. Quasi-Newton minimization is then applied to minimize the total negative log-likelihood function to estimate parameter values (the package AD Model Builder^{TM} (Fournier *et al*., 2011) is used for this purpose). The description below includes more options than used in this paper, but they have been included here for completeness as they may be used in later extensions.

B.1. Population dynamics

B.1.1 Numbers-at-age

The resource dynamics are modelled by the following set of population dynamics equations:

$$N_{y+1,1} = R_{y+1} \qquad \text{(B1)}$$

$$N_{y+1,a+1} = \left(N_{y,a}\, e^{-M_a/2} - \sum_f C_{y,a}^f \right) e^{-M_a/2} \qquad \text{for } 1 \le a \le m-2 \qquad \text{(B2)}$$

$$N_{y+1,m} = \left(N_{y,m-1}\, e^{-M_{m-1}/2} - \sum_f C_{y,m-1}^f \right) e^{-M_{m-1}/2} + \left(N_{y,m}\, e^{-M_m/2} - \sum_f C_{y,m}^f \right) e^{-M_m/2} \qquad \text{(B3)}$$

where

$N_{y,a}$ is the number of fish of age *a* at the start of year *y* (which refers to a calendar year),

R_y is the recruitment (number of 1-year-old fish) at the start of year *y*,

M_a denotes the natural mortality rate for fish of age *a*,

$C_{y,a}^f$ is the predicted number of fish of age *a* caught in year *y* by fleet *f*, and

m is the maximum age considered (taken to be a plus-group).

B.1.2. Recruitment

The number of recruits (i.e. new 1-year olds) at the start of year *y* is assumed to be related to the spawning stock size (i.e. the biomass of mature fish) at the mid-point of the preceding year by either a modified Ricker or a Beverton-Holt stock-recruitment relationship, allowing for annual fluctuation about the deterministic relationship:
for the modified Ricker:

$$R_y = \alpha B_{y-1}^{\mathrm{sp}} \exp\left[-\beta \left(B_{y-1}^{\mathrm{sp}} \right)^{\gamma} \right] e^{(\varsigma_y - (\sigma_{\mathrm{R}})^2/2)} \qquad \text{(B4)}$$

and for Beverton-Holt:

$$R_y = \frac{\alpha B_{y-1}^{\mathrm{sp}}}{\beta + B_{y-1}^{\mathrm{sp}}} e^{(\varsigma_y - (\sigma_{\mathrm{R}})^2/2)} \qquad \text{(B5)}$$

where
α, β and γ are spawning biomass-recruitment relationship parameters,

ς_y reflects fluctuation about the expected recruitment for year y, which is assumed to be normally distributed with standard deviation σ_R (which is input in the applications considered here); these residuals are treated as estimable parameters in the model fitting process.

B_y^{sp} is the spawning biomass in year y, computed as:

$$B_y^{sp} = \sum_{a=0}^{m} f_{y,a} w_{y,a}^{sp} N_{y,a} e^{-M_a \frac{T^s}{12}} \qquad \text{(B6)}$$

where spawning for the stocks under consideration is taken to occur T^s months after the start of the year (here $T^s = 6$) and some natural mortality has therefore occurred,

$w_{y,a}^{sp}$ is the mass of fish of age a during spawning, and

$f_{y,a}$ is the proportion of fish of age a that are mature.

B.1.3. Total catch and catches-at-age

The total catch by mass in year y is given by:

$$C_y = \sum_f \sum_{a=0}^{m} w_{y,a}^f \, C_{y,a}^f = \sum_f \sum_{a=0}^{m} w_{y,a}^f \, N_{y,a} \, e^{-M_a/2} \, S_{y,a}^f \, F_y^f \qquad \text{(B7)}$$

where

$w_{y,a}^f$ denotes the mass of fish of age a landed in year y by fleet f,

$C_{y,a}^f$ is the catch-at-age, i.e. the number of fish of age a, caught in year y by fleet f,

$S_{y,a}^f$ is the commercial selectivity of fleet f (i.e. combination of availability and vulnerability to fishing gear) at age a for year y; when $S_{y,a} = 1$, the age-class a is said to be fully selected, and

F_y^f is the proportion of a fully selected age class that is fished by fleet f.

The model estimate of the mid-year exploitable ("available") component of biomass for fleet f is calculated by converting the numbers-at-age into mid-year mass-at-age (using the individual weights of the landed fish) and applying natural and fishing mortality for half the year:

$$B_y^f = \sum_{a=0}^{m} w_{y,a}^f S_{y,a}^f N_{y,a} e^{-M_a/2} (1 - S_{y,a}^f F_y^f / 2) \qquad \text{(B8)}$$

B.1.4. Initial conditions

For the first year (y_0) considered in the model, the numbers-at-age are estimated directly for ages 1 to a^{est}, with a parameter ϕ which mimicking recent average fishing mortality for ages above a^{est}, i.e.

$$N_{y_0,a} = N_{\text{start},a} \qquad \text{for } 1 \le a \le a^{est} \qquad \text{(B9)}$$

and

$$N_{\text{start},a} = N_{\text{start},a-1} e^{-M_{a-1}} (1 - \phi S_{a-1}) \qquad \text{for } a^{est} < a \le m-1 \qquad \text{(B10)}$$

$$N_{\text{start},m} = N_{\text{start},m-1} e^{-M_{m-1}} (1-\phi S_{m-1}) \Big/ (1-e^{-M_m}(1-\phi S_m)) \tag{B11}$$

For the applications considered here however, the population starts at its pre-exploitation equilibrium level (K) with an equilibrium age-structure, with:

$$N_{\text{start},1} = K^{sp} \Bigg/ \left[\sum_{a=1}^{m-1} f_{\text{start},a} w^{sp}_{start,y} e^{-\frac{T_s}{12}\sum_{a'=1}^{a-1} M_{a'}} + f_{\text{start},m} w^{sp}_{start,m} \frac{e^{-\frac{T_s}{12}\sum_{a'=1}^{m-1} M_{a'}}}{1-e^{-\frac{T_s}{12}M_m}} \right] \tag{B12}$$

B.2. The (penalised) likelihood function

The model can be fit to (a subset of) CPUE, and commercial catch-at-age or catch-at-length data to estimate model parameters (which may include residuals about the stock-recruitment function, facilitated through the incorporation of a penalty function described below). Contributions by each of these to the negative of the (penalised) log-likelihood (- $\ell n L$) are as follows.

B.2.1 CPUE relative abundance data

The likelihood is calculated assuming that an observed CPUE index for a particular fishing fleet is log-normally distributed about its expected value:

$$I^i_y = \hat{I}^i_y \exp\left(\varepsilon^i_y\right) \quad \text{or} \quad \varepsilon^i_y = \ell n\left(I^i_y\right) - \ell n\left(\hat{I}^i_y\right) \tag{B13}$$

where

I^i_y is the CPUE biomass or abundance index for year y for gear/flag combination i,

$\hat{I}^i_y = \hat{q}^i \sum^m w^i_{y,a} S^i_{y,a} N_{y,a} e^{-M_a/2}(1-S^i_{y,a}F^i_y/2)$ is the corresponding model estimate of biomass or

$\hat{I}^f_y = \hat{q}^f \sum^m S^f_{y,a} N_{y,a} e^{-M_a/2}(1-S^f_{y,a}F^f_y/2)$ is the corresponding model estimate of abundance,

$\hat{q}^i$ is the constant of proportionality (catchability) for the CPUE series, and

ε^i_y from $N\left(0,\left(\sigma^i_y\right)^2\right)$.

The contribution of the CPUE data to the negative of the log-likelihood function (after removal of constants) is then given by:

$$-\ell n\, L^{\text{CPUE}} = \sum_y \left\{ \ell n\left(\sqrt{\left(\sigma^i_y\right)^2 + \left(\sigma^i_{Add}\right)^2} \right) + \frac{\left(\varepsilon^i_y\right)^2}{2\left[\left(\sigma^i_y\right)^2 + \left(\sigma^i_{Add}\right)^2\right]} \right\} \tag{B14}$$

where

σ^i_y is the standard deviation of the residuals for the logarithm of index i in year y (which is input), and

σ^i_{Add} is the square root of the additional variance for the CPUE series, which can be estimated in the model fitting procedure but has been set to zero in the applications considered here.

The catchability coefficient q^i for CPUE index i is estimated by its maximum likelihood value:

$$\ell n\hat{q}^i = 1/n_i \sum_y \left(\ln I_y^i - \ln \hat{B}_y^{\text{ex}}\right) \qquad \text{(B15)}$$

The model is fit to the following abundance index series (see Table A4):

1) Mor&Sp_Trap: Moroccan and Spanish (combined) trap
2) SpBB: Spanish bait boat
3) SpBB_hist: Spanish historical series for baitboat in the Bay of Biscay
4) JPLL_EastMed: Japanese longline fishery in the east Atlantic (south of 40N) and Mediterranean
5) NorPS: Norwegian purse seine from Task II
6) JPLL_NEA: Japanese longline fishery in the Northeast Atlantic (north of 40N)

Note that for the applications considered hear, selectivity at age $S_{y,a}^f$ is year-invariant over the period for which values of the index are available. More complex formulations are necessary should selectivity-at-age change over that period.

B.2.3. Commercial catches-at-age

The contribution of the catch-at-age data to the negative of the log-likelihood function under the assumption of an "adjusted" lognormal error distribution is given by:

$$-\ell\text{n}\, L^{\text{CAA}} = w_{CAA}\sum_f \sum_y \sum_a \left[\ell n\left(\sigma_{\text{com}}^f / \sqrt{p_{y,a}^f}\right) + p_{y,a}^f \left(\ell n\, p_{y,a}^f - \ell n\, \hat{p}_{y,a}^f\right)^2 / 2\left(\sigma_{\text{com}}^f\right)^2\right] \qquad \text{(B16)}$$

where

$p_{y,a}^f = C_{y,a}^f / \sum_{a'} C_{y,a'}^f$ is the observed proportion of fish caught in year y by fleet f that are of age a,

$\hat{p}_{y,a}^f = \hat{C}_{y,a}^f / \sum_{a'} \hat{C}_{y,a'}^f$ is the model-predicted proportion of fish caught in year y by fleet f that are of age a,

where

$$\hat{C}_{y,a}^f = N_{y,a}\, S_{y,a}^f\, F_y^f e^{-M_a/2} \qquad \text{(B17)}$$

and

σ_{com}^f is the standard deviation associated with the catch-at-age data, which is estimated in the fitting procedure by:

$$\hat{\sigma}_{\text{com}}^f = \sqrt{\sum_y \sum_a p_{y,a}^f \left(\ell n\, p_{y,a}^f - \ell n\, \hat{p}_{y,a}^f\right)^2 / \sum_y \sum_a 1} \qquad \text{(B18)}$$

The log-normal error distribution underlying equation (B16) is chosen on the grounds that (assuming no ageing error) variability is likely dominated by a combination of interannual variation in the distribution of fishing effort, and fluctuations (partly as a consequence of such variations) in selectivity-at-age, which suggests that the assumption of a constant coefficient of variation is appropriate. However, for ages poorly represented in the sample, sampling variability considerations must at some stage start to dominate the variance. To take this into account in a simple manner, motivated by binomial distribution properties, the observed proportions are used for weighting so that undue importance is not attached to data based upon a few samples only.

Commercial catches-at-age are incorporated in the likelihood function using equation (B16), for which the summation over age *a* is taken from age a_{minus} (considered as a minus group) to a_{plus} (a plus group).

The w_{CAA} weighting factor may be set to a value less than 1 to downweight the contribution of the catch-at-age data (which tend to be positively correlated between adjacent ages) to the overall negative log-likelihood compared to that of the CPUE data. Here, $w_{CAA} = 0.1$

In instance where catch-at-age data corresponding to a particular CPUE index is available, the data are treated in exactly the same manner as described above, with a specific selectivity S_a^i estimated for that index.

The model is fit to CAA data for each of the five fleets assumed in the model (baitboat, longline, purse seine, traps, other) (see Table A2) and CAA corresponding to the following CPUE series (see Table A5):

1) Mor&Sp_Trap: Moroccan and Spanish (combined) trap
2) SpBB_hist: Spanish historical series for baitboat in the Bay of Biscay
3) JPLL_EastMed: Japanese longline fishery in the east Atlantic (south of 40N) and Mediterranean

B.2.4. Commercial catches-at-length

Commercial catches-at-length are incorporated in the likelihood function in the same manner as the catches-at-age. When the model is fit to catches-at-length, selectivity is estimated as a function of length and then converted to selectivity-at-age:

$$S_{y,a}^f = \sum_l S_{y,l}^f A_{a,l} \qquad \text{(B19)}$$

where $A_{a,l}$ is the proportion of fish of age *a* that fall in the length group *l* (i.e., $\sum_l A_{a,l} = 1$ for all ages).

The matrix $A_{a,l}$ is calculated under the assumption that length-at-age is normally distributed about a mean given by the von Bertalanffy equation, i.e.:

$$L_a \sim N\left[L_\infty\left(1-e^{-\kappa(a-t_o)}\right);\theta_a^2\right] \qquad \text{(B20)}$$

where

θ_a is the standard deviation of length-at-age a, which is modelled to be proportional to the expected length-at-age *a*, i.e.:

$$\theta_a = \beta L_\infty\left(1-e^{-\kappa(a-t_o)}\right) \qquad \text{(B21)}$$

with β fixed here to 0.2.

Furthermore, in the model fitting to CAL, the weights-at-age used to compute the CPUE indices are weighted by the selectivity for the corresponding fleet:

$$\tilde{w}_{y,a}^i = \sum_l S_{y,l}^f w_l A_{a,l} \Big/ S_{a,l}^i \qquad \text{(B22)}$$

$\tilde{w}_{y,a}^i$ is the selectivity-weighted mid-year weight-at-age *a* for fleet *f* and year *y*; and

w_l is the weight of fish of length *l*;

The following term (replacing equation B15) is then added to the negative log-likelihood:

$$-\ell n\, L^{\text{CAL}} = w_{len}\sum_f\sum_y\sum_l\left[\ell n\left(\sigma_{\text{len}}^f / \sqrt{p_{y,l}^f}\right) + p_{y,l}^f\left(\ell n\, p_{y,l}^f - \ell n\, \hat{p}_{y,l}^f\right)^2 / 2\left(\sigma_{\text{len}}^f\right)^2\right] \qquad \text{(B23)}$$

The w_{len} weighting factor may be set to a value less than 1 to downweight the contribution of the catch-at-length data (which tend to be positively correlated between adjacent length groups) to the overall negative log-likelihood compared to that of the CPUE data. Here, $w_{len} = 0.05$

The model is fit to CAL data for each of the five fleet assumed in the model (baitboat, longline, purse seine, traps, other) (see Table A3) and CAL corresponding to the following CPUE series (see Table A6):

1) Mor&Sp_Trap: Moroccan and Spanish (combined) trap
2) SpBB_hist: Spanish historical series for baitboat in the Bay of Biscay
3) JPLL_EastMed: Japanese longline fishery in the east Atlantic (south of 40N) and Mediterranean

B.2.5. Stock-recruitment function residuals)

The stock-recruitment residuals are assumed to be log-normally distributed. Thus, the contribution of the recruitment residuals to the negative of the (now penalised) log-likelihood function is given by:

$$-\ell n L^{\text{pen}} = \sum_{y=y_1+1}^{y_2} \left[\varsigma_y^2 / 2\sigma_{\text{R}}^2 \right] \qquad \text{(B24)}$$

where

ς_y is the recruitment residual for year y, which is estimated for year y_1 to y_2 (see equation (B4)),

σ_{R} is the standard deviation of the log-residuals, which is input (here σ_{R}=0.4).

B.3. Estimation of precision

Where quoted, 95% probability interval estimates are based on the Hessian.

B.4. Model parameters

The model input parameters are given in Table B1.

Table B1: Input parameters (units are gm, cm and year as appropriate) (Length-weight, von Bertalanffy growth, maturity and natural mortality at age to age 15 from ICCAT, 2010).

Model plus group	25														
Length-weight	a=0.0000295, b=2.899														
Von Bertalanffy growth	K=0.093, L_{inf}=319, t_0=-0.97														
Maturity-at-age	50% maturity at age 4, 100% maturity at age 5														
Natural mortality	1	2	3	4	5	6	7	8	9	10-15	16	17	18	19	20+
Increasing M for 15+	0.49	0.24	0.24	0.24	0.24	0.20	0.18	0.15	0.13	0.10	0.25	0.40	0.55	0.70	0.85
Flat M for 15+	0.49	0.24	0.24	0.24	0.24	0.20	0.18	0.15	0.13	0.10	0.10	0.10	0.10	0.10	0.10
Stock-recruitment	Beverton-Holt, h=0.98, σ_R=0.4														

B.4.2. Fishing selectivity

For SCAA, the commercial fishing selectivities-at-age, $S^f_{y,a}$, are estimated separately for ages a_{minus} to a_{plus}. The selectivity is assumed to stay flat after a_{plus} if not otherwise specified. The selectivity is unchanged over a period, but can differ for each of specified different periods.

For SCAL, fishing selectivities-at-length are estimated rather than selectivities-at-age. These are estimated separately every 10 cm from l_{minus} to l_{plus}, assuming linear changes from the lowest to the highest length in each 10 cm group . The selectivity is assumed to stay flat after l_{plus} if not otherwise specified. The selectivity can differ over fixed periods. Details of the fishing selectivities used for both SCAA and SCAL are shown in Table B2.

Because of otherwise particularly large residuals at low ages in the fit to the trap CAA, the selectivity for age 2 (and for length 40cm in the SCAL model) has been estimated separately for the years 1950, 1951, 1985, 1986 and 1994.

A penalty is added to the total $-\ell n L$ to smooth the selectivities by penalising deviations from straight line dependence (the choice of a weighting of $w_{Ssmooth}$ = 3 for the analyses of this paper was made empirically):

$$pen^{\mathrm{Sel}} = \sum_f \sum_L w_{Ssmooth} \left(S^f_{L-1} - 2S^f_L + S^f_{L+1} \right)^2 \qquad \text{(B19)}$$

Table B2: Details of the selectivities estimated.

	Fitting to CAA			Fitting to CAL			Comments
	a_{minus} (yr)	a_{plus} (yr)	Number of parameters estimated	l_{minus} (cm)	l_{plus} (cm)	Number of parameters estimated	
Commercial fleet:							
Bait boat	1	10	9x2	60	160	10x2	Two selectivity periods: 1950-1964, 1965-2009
Longline	1	20	14x2	70	250	18x2	Two selectivity periods: 1950-1969-1970-2009. S=1 for age 15+/length 250cm+ in the case of increasing M from age 15
Purse seine	1	16	15	40	170	13	
Traps	2	18	16	40	250	19	S a_{minus}/l_{minus} estimated separately for years 1950, 1951, 1985, 1986, 1994
Other	1	17	16x2	30	200	17x2	Two selectivity periods: 1950-1966, 1967-2009
CPUE indices:							
Mor&Sp_Trap	5	10	5	140	260	12	
SpBB			-			-	Selectivity same as bait boat fleet
SpBB_hist	1	8	7	60	160	10	
JPLL_EastMed	4	10	6	140	260	12	
NorPS			-			-	Selectivity same as purse seine fleet
JPLL_NEA			-			-	Selectivity same as longline fleet