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# AN UPDATED STATISTICAL CATCH-AT-LENGTH ASSESSMENT FOR EASTERN ATLANTIC BLUEFIN TUNA

D. S. Butterworth[1] and R. A. Rademeyer[1]

*SUMMARY*

*Butterworth and Rademeyer (2013) provided an initial Statistical Catch-at-Length (SCAL) assessment of the eastern populations of North Atlantic bluefin tuna. The primary purpose in fitting to length- rather than to age-distribution data was to avoid the need to make use of the somewhat coarse cohort-slicing method to provide the latter. Here these analyses are updated using comparable inputs to those agreed for the initial 2014 updated VPA assessments. The results suggest a spawning biomass time series similar to that estimated by VPA over the 1975 to 2005 period, but lower after and appreciably higher before this period.*

*RÉSUMÉ*

*Butterworth et Rademeyer (2013) fournissait une évaluation initiale de la prise par taille statistique (SCAL) des populations orientales de thon rouge de l'Atlantique Nord. L'objectif principal de l'ajustement aux données de taille, plutôt qu'aux données de distribution par âge, visait à éviter de devoir utiliser la méthode de découpage des cohortes quelque peu grossière afin de fournir cette dernière. Dans le présent document, ces analyses ont été mises à jour au moyen de données d'entrée comparables à celles des évaluations initiales mises à jour de la VPA de 2014. Les résultats suggèrent une série temporelle de la biomasse reproductrice semblable à celle estimée au moyen de la VPA pour la période 1975-2005, mais inférieure après cette période et largement supérieure avant celle-ci.*

*RESUMEN*

*Butterworth y Rademeyer (2013) proporcionaba una evaluación inicial de la captura por talla estadística (SCAL) de las poblaciones de atún rojo del Atlántico norte. El propósito principal de ajustar a los datos de talla más que a los datos de distribución por edad es evitar la necesidad de utilizar el método de separación de cohortes, algo tosco, para proporcionar esta última. Estos análisis se actualizan utilizando datos de entrada comparables a los acordados para las evaluaciones mediante VPA actualizadas de 2014. Los resultados sugieren una serie temporal de la biomasa reproductora similar a la estimada mediante VPA para el periodo de 1975 a 2005, pero inferior después y apreciablemente mayor antes de este periodo.*

*KEYWORDS*

*Bluefin tuna, Stock assessment,*
*Statistical catch-at-length, Population dynamics, Eastern Atlantic*

[1] Marine Resource Assessment and Management Group, University of Cape Town, South Africa, doug.butterworth@uct.ac.za.

## 1. Introduction

Butterworth and Rademeyer (2013) introduced a statistical catch-at-length (SCAL) approach for the assessment of the eastern Atlantic (and Mediterranean) population of bluefin tuna. A particular purpose was to avoid the need for use of the crude cohort-slicing approach to provide catch-at-age data needed for application of the VPA assessment method conventionally applied to this resource.

The paper first describes the data used and the SCAL methodology. To the extent that comparable data and assumptions are concerned, these have been selected to attempt to duplicate similar choices for the current updated VPA assessments. This is followed by the SCAL results, and a brief discussion of their implications. It should be noted that the purpose of this paper is not to offer a comprehensive application of SCAL, exploring the implications of all possible associated sensitivities, but rather to provide a comparison to the VPA outputs together with a baseline for discussion towards refinement of the approach.

Note that the analyses reported below have been refined from those presented at the September 2014 ICCAT bluefin session, with revised results that differ in some important respects. These refinements include that the initial year spawning biomass an age structure are now estimated rather than assumed to correspond to pre-exploitation equilibrium, and that age dependence has been introduced to the CV of the distribution of length-at-age.

## 2. Data and Methods

The data used for these analyses are listed in **Appendix A**, and have been chosen to correspond to those used for the updated VPA (Run 7) from Bonhommeau *et al*. (2014) where possible.

The SCAL methodology is described in detail in **Appendix B**. **Figure 1** shows the growth curve together with the distributions of length-at-age which are assumed; the SCAL method applied treats these as time-invariant.

## 3. Results and Discussion

**Figure 2** compares the (Base Case) SCAL results for spawning biomass and recruitment with those from the updated VPA (Run 7). The SCAL spawning biomass estimates are similar to those from VPA over the 1975 to 2005 period, but lower after and appreciably higher before this period. The two series of recruitment estimates show similar trends, but the VPA estimates are considerably larger.

The fit to the stock recruitment curve assumed (essentially an absence of dependence of recruitment on spawning biomass over the range of the data) is shown in **Figure 3**. The residuals show no evidence of any broad mis-specification, though clearly there is some auto-correlation with periods of successively relatively good (particularly in more recent years) and relatively poor recruitment.

**Figure 4** shows the fits to the various CPUE series considered, together with standardised residuals. Except in a few instances (a few years at the start of the 1963-2006 Spanish bait boat and of the Japanese longline series), there is no indication of serious mis-specification.

Estimated selectivity functions (with respect to length, and their age-equivalents) and fits to the catch-at-length (CAL) data are shown in **Figure 5**. The fits to the data averaged over years are broadly good. The former perhaps need a slightly more complex form for selectivity-at-length, whereas the latter may be a reflection of over-aggregation, with different traps catching fish of different sizes. Consequently the CAL residual bubble plots show clear systematic patterns for these two cases, as well as for the “Other” fisheries, though those for baitboat and longline are somewhat better in that regard.

The shapes of the equivalent selectivity-at-age functions estimated for the fisheries which take the largest size bluefin are of particular importance. If domed, they indicate lesser selectivity of older fish, and consequently the spawning biomass estimates are elevated in absolute terms. These largest fish are taken in the longline and trap fisheries, and in both instances the estimated effective selectivity-at-age is domed (**Figure 5**).

**Table 1** lists some statistics for the Base Case SCAL assessment, which indicates the stock to be at 32% of its pre-exploitation level at present, down from 60% in 1950. This Table also shows contributions to the overall negative log-likelihood from the CPUE, CAL and recruitment residuals. These are shown in "expanded" form as profiles with respect to the average spawning biomass over the last five years in **Figure 6**. The recruitment residuals contribution is relatively smaller. The other two components show very similar behaviour, with the CPUE data favouring slightly lower biomasses over recent years, while the CAL data favour slightly higher values. One should note that the CAL contribution to the overall negative log-likelihood is downweighted by a multiplicative factor of 0.05 (see **Appendix B** section B.2.3) to allow for non-independence of these data. Qualitatively this is justified by the fact that there are data for more length groups than there are for the age groups which are relatively highly selected in a particular fishery. Nevertheless the downweighting factor chosen is very small and a case could be made for a higher value which could favour slightly higher recent spawning biomasses.

The overall negative log-likelihood in **Figure 6** shows a minimum that is relatively well determined. The actual minimum corresponds to a 2009-2013 average spawning biomass of 229 000 mt, with a 95% confidence interval of [155 000 mt; 303 000 mt]. **Figure 7** shows this together with results for a choice for the 2009-2013 average similar to that estimated by the VPA. The VPA result is outside the 95% confidence envelope for the SCAL results only for the 1950s and 60s and for the most recent years; however care must be taken in over-interpreting this interval given uncertainties about appropriate weightings for the various components of the negative log likelihood.

## 4. Concluding remarks

Clearly there are variations of the Base Case SCAL run for which sensitivities could be investigated. For example, the impact of assuming alternative relationships for the CV of the length-at-age distribution merits investigation, as does allowing for the possibility of time dependence in the stock-recruitment relationship (reflecting regime shifts, perhaps).

Of particular importance for future work would be ascertaining what aspects of the SCAL methodology (and associated assumptions) are driving the differences in spawning biomass compared to estimates from the VPA, especially for recent years.

The value of confirming estimates of current spawning biomass points also to consideration of other methods which might contribute to improving the precision of spawning biomass estimation. An obvious candidate would be the use of (genetics-based) close-kin information (Bravington *et al.* 2014) towards this ends. This approach has now been demonstrated to work well for Southern Bluefin Tuna; it would require careful refinement before being pursued with high priority for North Atlantic Bluefin tuna, but does come with related advantage of contributing also to the estimation of natural mortality.

## Acknowledgements

We thank Sylvain Bonhommeau for kindly providing the updated VPA results for the eastern Atlantic bluefin assessment.

## References

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**Table 1.** Results for the SCAL Base Case. Biomass units are mt, and $K^{sp}$ refers to the pre-exploitation equilibrium spawning biomass.

| | *Base Case* |
|---|---|
| -lnL:overall | -2336.1 |
| -lnL: CPUE | 38.3 |
| -lnL: fleet CAL | -2418.0 |
| -lnL: RecRes | 43.6 |
| $K^{sp}$ | 908107 |
| $B^{sp}_{1950}$ | 548952 |
| $B^{sp}_{1950}/K^{sp}$ | 0.60 |
| $B^{sp}_{2013}$ | 293100 |
| $B^{sp}_{2013}/K^{sp}$ | 0.32 |

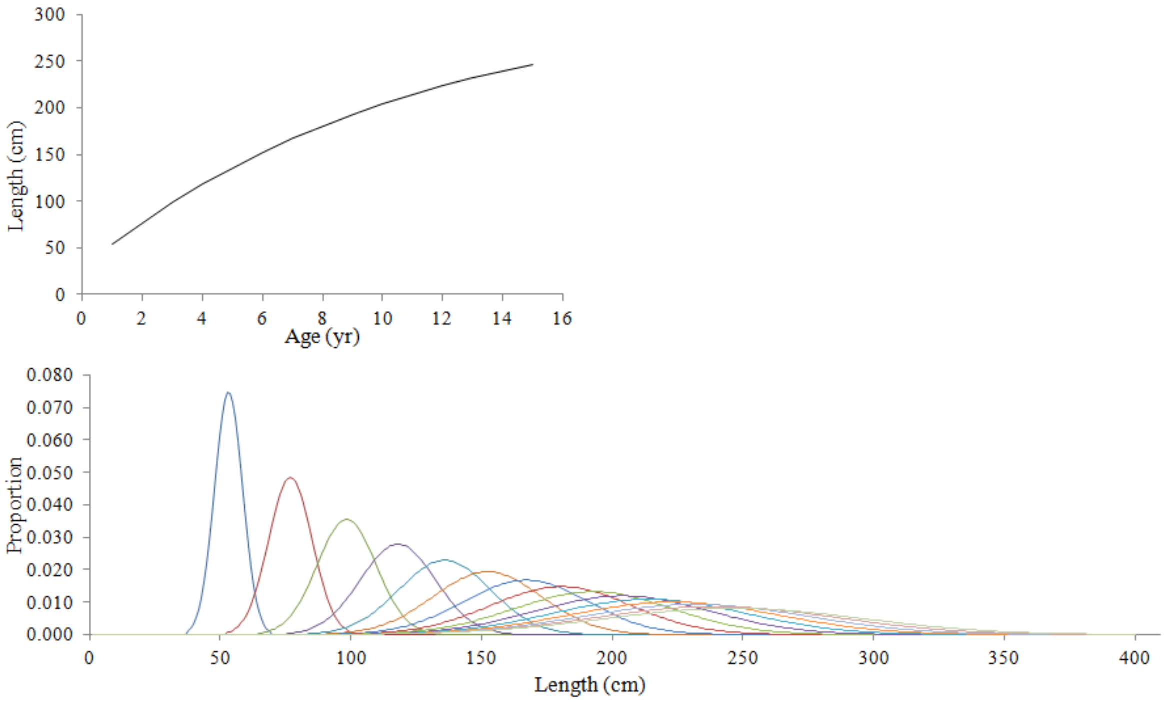


**Figure 1.** von Bertalanffy growth curve and associated length-at-age distributions assumed. See **Table B1** for details of the growth curve parameters. The length-at-age distributions are assumed to be normal with CVs decreasing linearly from 10% at age 1 to 20% at age 15.

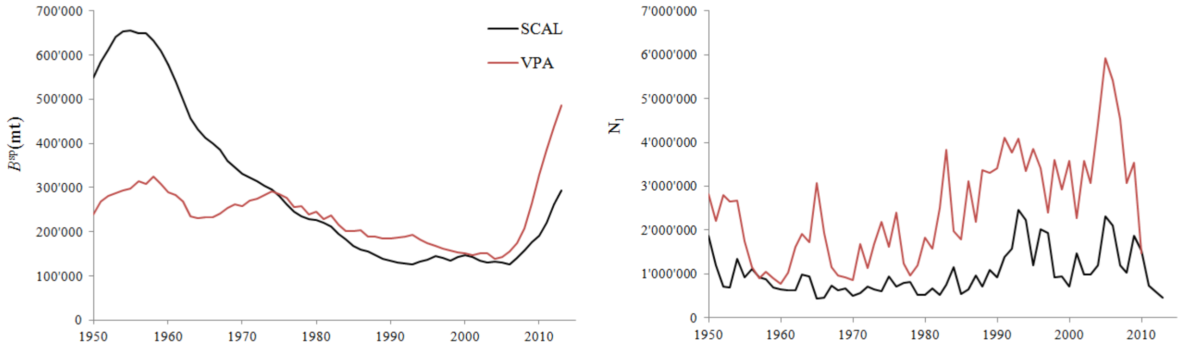


**Figure 2.** Spawning biomass and recruitment (number of 1-year-olds, $N_1$) trajectories for the SCAL Base Case and the VPA. VPA refers to Run 7 from Bonhommeau *et al*. (2014).

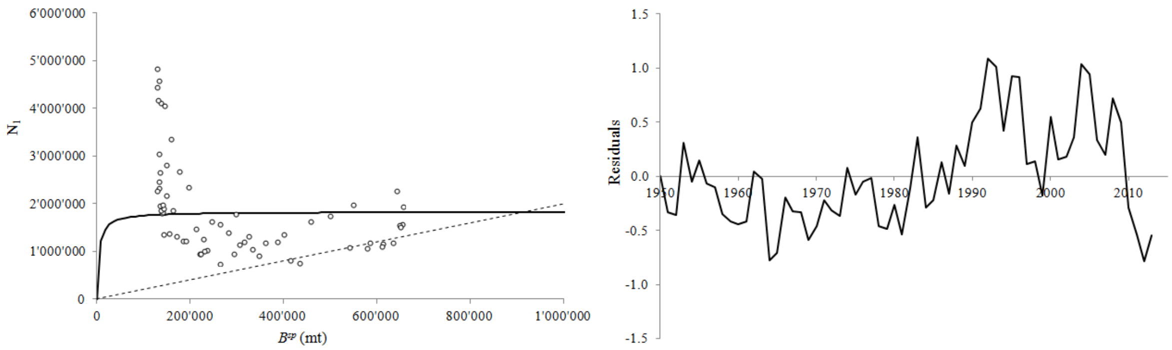


**Figure 3.** Stock-recruitment relationships (left-hand column) and time series of stock-recruitment residuals for the SCAL Base Case. Spawning stock biomass ($B^{sp}$) is in mt. The replacement line is also shown; this intercepts the stock-recruitment plot where $B^{sp} = K^{sp}$.

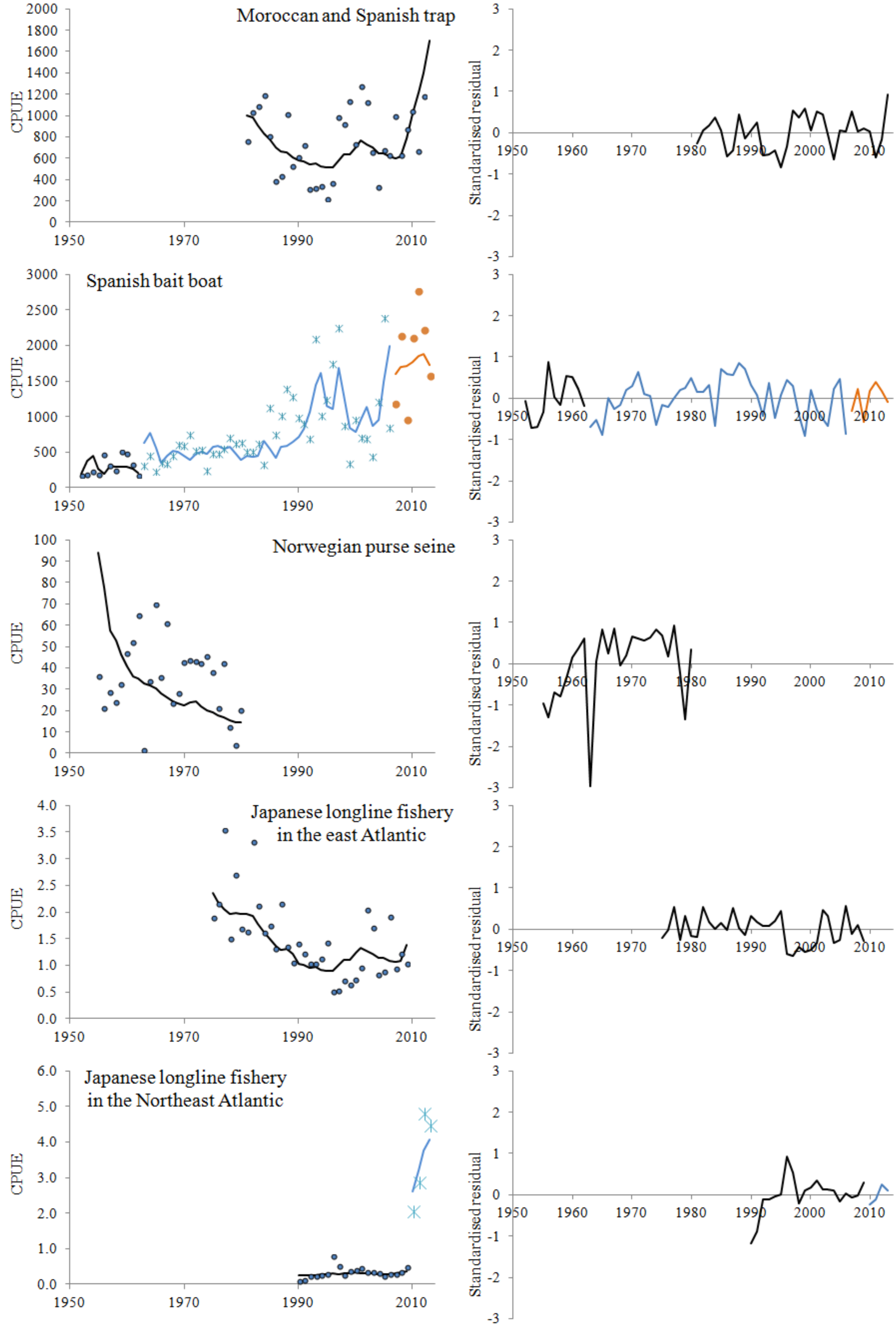


**Figure 4.** Fits of the SCAL Base Case to the various CPUE series and the corresponding standardised residuals.

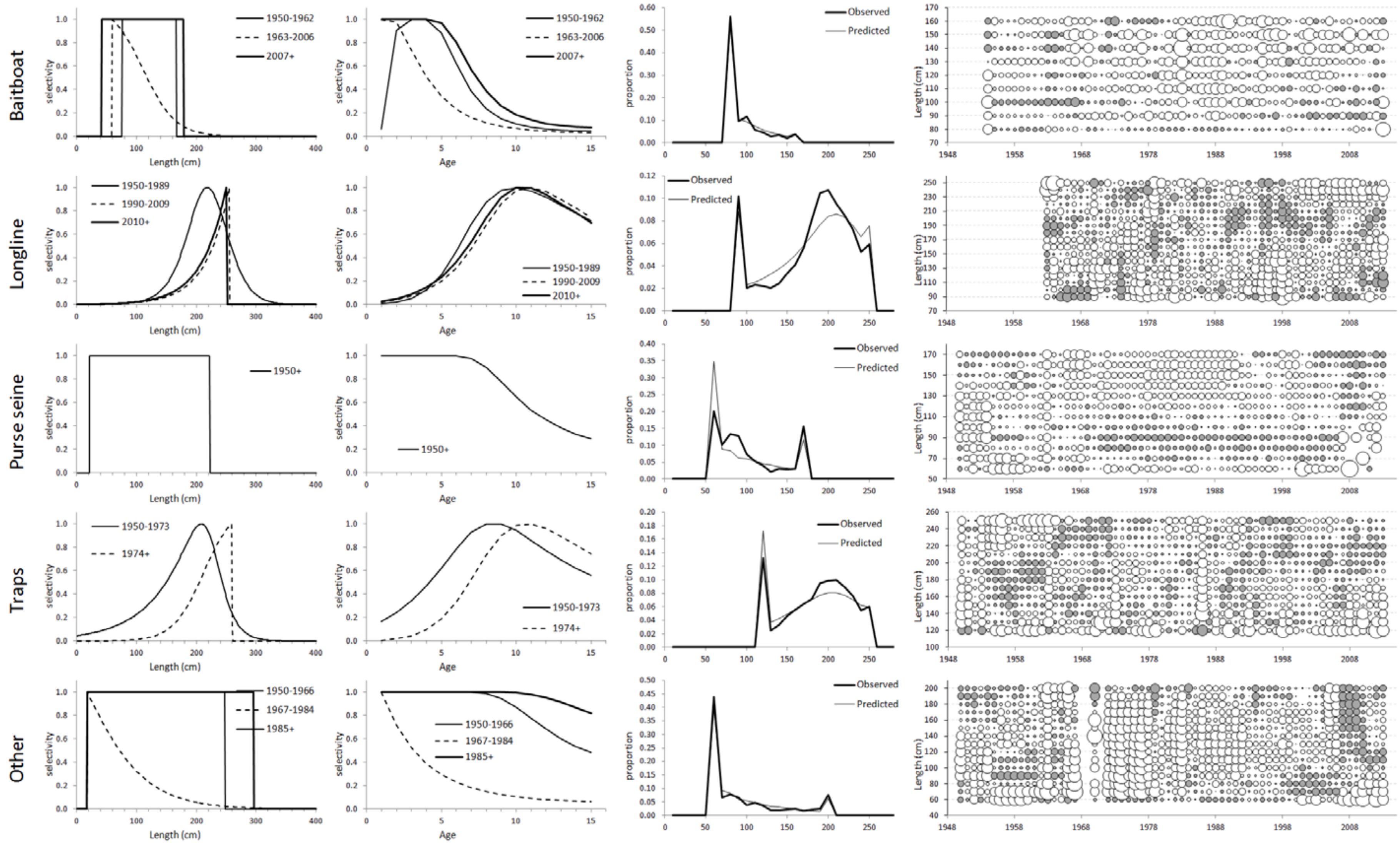


**Figure 5.** Commercial selectivities-at-length (first column), effective selectivity-at-age (second column), fits to the CAL data aggregated over years (third column) and bubble plots of the corresponding standardised residuals. The area of the bubble is proportional to the magnitude of the residual. For positive residuals the bubbles are grey, whereas for negative residuals the bubbles are white.

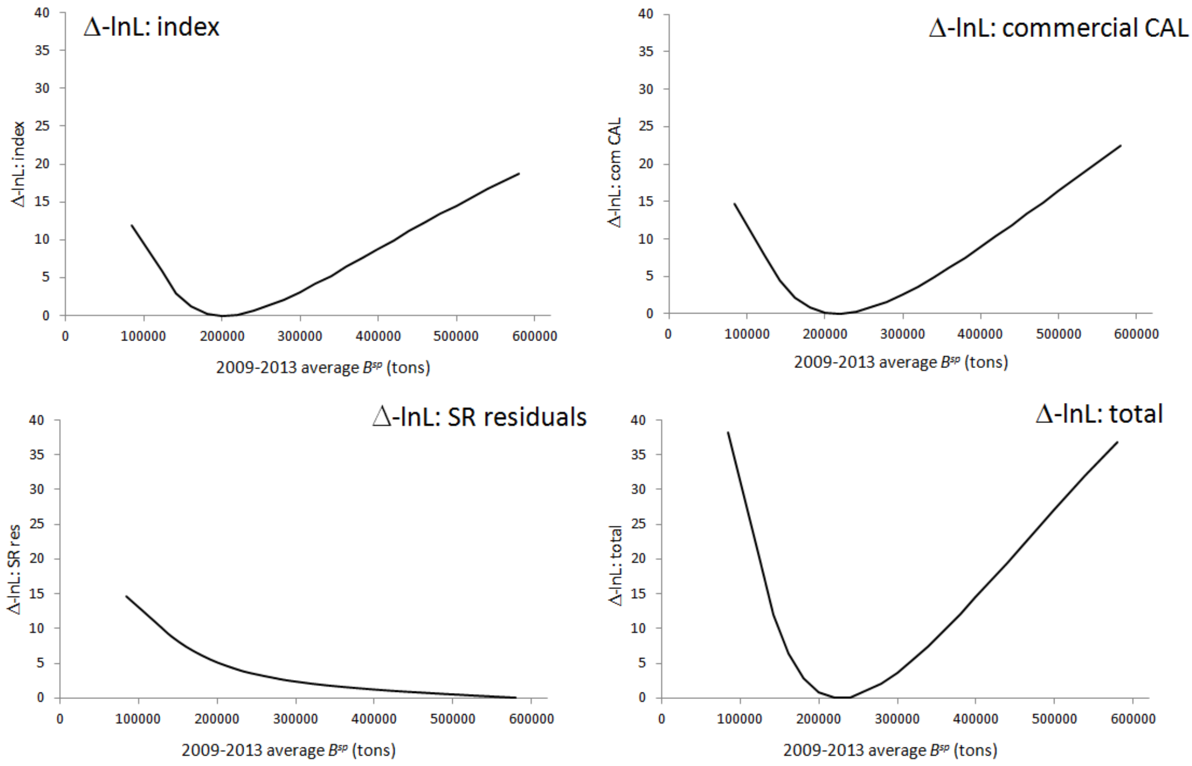


**Figure 6.** Likelihood profile on recent (2009-2013 average) spawning biomass.

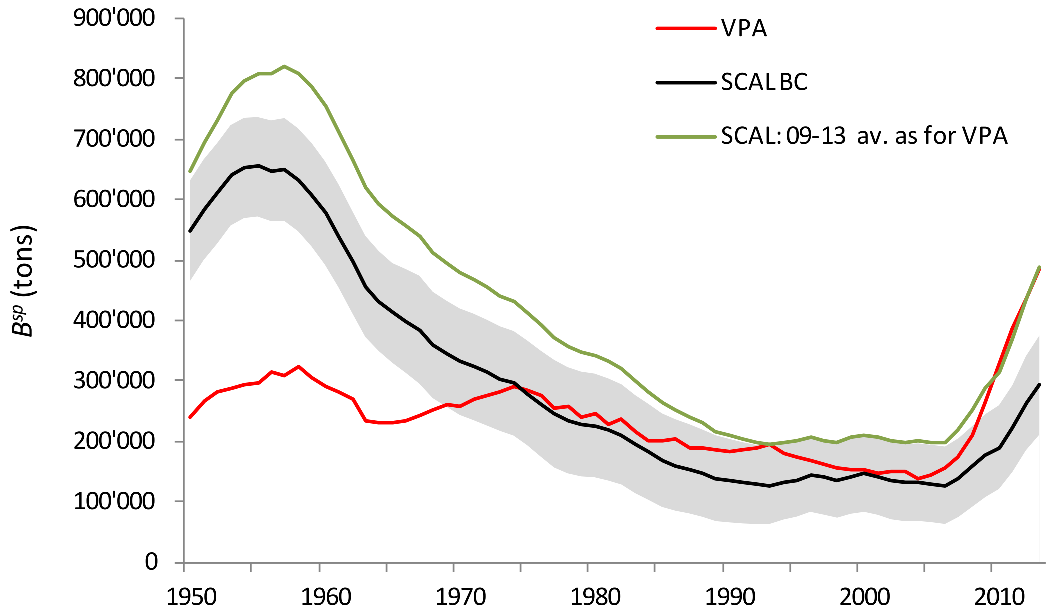


**Figure 7.** Spawning biomass trajectories for the SCAL Base Case (shaded area shows 95% CI), for a SCAL run constrained to have an average spawning biomass over the period 2009-2013 equal to that of the VPA (380'000 tons), and the VPA results for Run 7 from Bonhommeau *et al*. (2014).

**Appendix A**

**The data**

The data listed below are as for Run 7 from Bonhommeau *et al.* (2014).

**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 | 0.0 | 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 | 1642.0 | 875.5 |
| 1981 | 1222.5 | 917.0 | 8795.0 | 2011.0 | 828.1 |
| 1982 | 884.3 | 4255.0 | 12786.0 | 3673.0 | 809.8 |
| 1983 | 1882.4 | 3606.0 | 10746.0 | 3254.0 | 2293.9 |
| 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 | 9609.0 | 1740.0 | 4839.6 |
| 1987 | 1820.8 | 1723.3 | 8857.0 | 1953.0 | 3865.5 |
| 1988 | 1935.9 | 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 | 3326.7 |
| 1991 | 1592.6 | 6066.3 | 13291.0 | 2993.0 | 2485.7 |
| 1992 | 1298.6 | 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 | 5645.0 |
| 1996 | 4989.6 | 12959.0 | 26344.0 | 2522.0 | 3992.1 |
| 1997 | 3524.9 | 10206.0 | 25006.0 | 4367.0 | 4050.3 |
| 1998 | 2561.5 | 7049.1 | 21983.0 | 4259.0 | 3865.1 |
| 1999 | 1496.0 | 6483.2 | 15636.0 | 3711.0 | 5128.9 |
| 2000 | 1821.7 | 7052.3 | 17341.3 | 3735.3 | 3814.7 |
| 2001 | 2275.0 | 7053.0 | 17324.4 | 4762.6 | 3190.1 |
| 2002 | 2568.0 | 5510.8 | 18540.3 | 3750.6 | 3400.5 |
| 2003 | 1379.5 | 5226.5 | 17657.4 | 2302.4 | 4596.6 |
| 2004 | 1807.0 | 4638.2 | 19862.5 | 2137.3 | 2935.2 |
| 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 | 4360.8 | 22951.5 | 3883.0 | 1288.3 |
| 2008 | 1794.4 | 4740.5 | 12641.3 | 3317.2 | 1343.0 |
| 2009 | 1297.7 | 3301.9 | 11394.5 | 3308.3 | 752.9 |
| 2010 | 645.5 | 2068.9 | 5057.9 | 2587.8 | 787.0 |
| 2011 | 635.9 | 2025.7 | 4305.9 | 2301.6 | 503.6 |
| 2012 | 282.25 | 1750.15 | 6105.19 | 2436.58 | 276.57 |
| 2013 | 245.02 | 620.8 | 5113.22 | 1825.17 | 288.44 |

**Table A2.** Commercial fleet catch-at-length numbers for each fleet considered.

| Baitboat | 30- | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1954 | 0 | 0 | 0 | 0 | 2117 | 614 | 1622 | 237 | 1072 | 678 | 7239 | 28317 | 23200 | 7524 | 4097 | 1216 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1955 | 0 | 0 | 1558 | 9646 | 22421 | 25314 | 19711 | 47609 | 13532 | 12049 | 6220 | 12395 | 8230 | 2567 | 1320 | 391 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1956 | 0 | 0 | 747 | 4624 | 11063 | 12226 | 9690 | 22858 | 6647 | 5877 | 4058 | 10152 | 7395 | 2349 | 1242 | 368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1957 | 0 | 0 | 826 | 5118 | 12277 | 13541 | 10749 | 25301 | 7372 | 6515 | 4603 | 11673 | 8542 | 2716 | 1438 | 426 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1958 | 0 | 0 | 731 | 4526 | 10878 | 11982 | 9523 | 22379 | 6531 | 5768 | 4141 | 10600 | 7781 | 2476 | 1311 | 389 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1959 | 0 | 0 | 1111 | 6877 | 15931 | 18032 | 14011 | 33936 | 9621 | 8573 | 4251 | 8121 | 5281 | 1640 | 837 | 248 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1960 | 0 | 0 | 359 | 2225 | 4499 | 4977 | 3578 | 8641 | 3673 | 3507 | 1913 | 4243 | 2998 | 945 | 508 | 160 | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1961 | 0 | 0 | 560 | 3469 | 6754 | 7634 | 5342 | 13262 | 5668 | 5462 | 2314 | 3967 | 2501 | 768 | 410 | 136 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1962 | 0 | 0 | 620 | 3840 | 7499 | 8501 | 5964 | 14845 | 6224 | 5986 | 2435 | 3929 | 2394 | 730 | 386 | 131 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1963 | 0 | 0 | 440 | 2722 | 5556 | 6265 | 4527 | 11127 | 4305 | 4080 | 1837 | 3340 | 2161 | 669 | 354 | 114 | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1964 | 0 | 0 | 423 | 2620 | 5486 | 6215 | 4561 | 11215 | 4021 | 3769 | 1649 | 2859 | 1793 | 551 | 288 | 91 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1965 | 0 | 0 | 739 | 4570 | 9564 | 10941 | 8019 | 19902 | 6879 | 6429 | 2434 | 3319 | 1769 | 522 | 260 | 89 | 13 | 6 | 63 | 231 | 334 | 196 | 63 |
| 1966 | 0 | 0 | 817 | 5061 | 32126 | 37110 | 22927 | 55835 | 10589 | 8630 | 2570 | 2154 | 533 | 118 | 12 | 2 | 1 | 3 | 36 | 182 | 388 | 270 | 94 |
| 1967 | 0 | 0 | 531 | 3281 | 11290 | 13043 | 12605 | 30794 | 6477 | 5401 | 730 | 292 | 91 | 71 | 90 | 63 | 44 | 7 | 42 | 158 | 347 | 355 | 151 |
| 1968 | 0 | 0 | 2637 | 16322 | 10057 | 11619 | 3841 | 10077 | 5772 | 5798 | 2302 | 1976 | 508 | 57 | 10 | 24 | 22 | 1 | 8 | 114 | 264 | 311 | 393 |
| 1969 | 0 | 0 | 3939 | 24398 | 31940 | 36897 | 6302 | 15508 | 3713 | 3255 | 552 | 423 | 178 | 85 | 0 | 0 | 0 | 0 | 6 | 154 | 356 | 503 | 221 |
| 1970 | 0 | 0 | 4875 | 30200 | 29454 | 34025 | 5243 | 14152 | 8899 | 6825 | 4147 | 3855 | 1751 | 1132 | 828 | 165 | 0 | 0 | 11 | 81 | 522 | 983 | 957 |
| 1971 | 0 | 0 | 226 | 1402 | 25215 | 29127 | 6081 | 15317 | 6207 | 6281 | 5945 | 7042 | 1974 | 822 | 495 | 100 | 0 | 3 | 15 | 102 | 434 | 973 | 1512 |
| 1972 | 0 | 0 | 141 | 873 | 24452 | 28309 | 2484 | 5236 | 2247 | 2346 | 2045 | 6787 | 3332 | 3133 | 2487 | 800 | 302 | 0 | 11 | 102 | 545 | 1201 | 1689 |
| 1973 | 0 | 0 | 187 | 1154 | 22101 | 25530 | 4649 | 11289 | 1999 | 1607 | 605 | 1691 | 1574 | 1380 | 3235 | 2994 | 2512 | 343 | 3 | 40 | 351 | 985 | 1951 |
| 1974 | 0 | 0 | 233 | 1443 | 24206 | 27961 | 10221 | 24887 | 4727 | 3840 | 1124 | 1104 | 309 | 120 | 33 | 22 | 37 | 55 | 38 | 114 | 257 | 545 | 1628 |
| 1975 | 0 | 0 | 2148 | 13305 | 51018 | 58935 | 2955 | 7512 | 2983 | 2872 | 646 | 669 | 220 | 93 | 12 | 20 | 4 | 3 | 70 | 141 | 343 | 932 | 3042 |
| 1976 | 0 | 0 | 48 | 1747 | 15067 | 26840 | 5989 | 6034 | 697 | 858 | 665 | 733 | 676 | 346 | 95 | 33 | 0 | 0 | 1 | 173 | 171 | 594 | 2047 |
| 1977 | 0 | 0 | 1004 | 8262 | 25875 | 57885 | 8458 | 11623 | 4915 | 2416 | 574 | 164 | 110 | 128 | 111 | 51 | 0 | 38 | 1 | 154 | 539 | 584 | 2939 |
| 1978 | 0 | 0 | 4486 | 50605 | 37076 | 30788 | 2753 | 6750 | 4484 | 9557 | 3854 | 2632 | 1003 | 201 | 46 | 21 | 102 | 219 | 352 | 831 | 1496 | 1473 | 2187 |
| 1979 | 0 | 0 | 1608 | 10625 | 3253 | 8504 | 5594 | 9821 | 5434 | 9069 | 2111 | 2229 | 843 | 484 | 250 | 20 | 750 | 354 | 82 | 163 | 246 | 331 | 1304 |
| 1980 | 0 | 0 | 6917 | 42530 | 9928 | 13560 | 3512 | 4275 | 1122 | 1014 | 1062 | 1970 | 1517 | 956 | 743 | 64 | 101 | 39 | 131 | 304 | 236 | 201 | 701 |
| 1981 | 0 | 0 | 3746 | 26170 | 25012 | 12064 | 1614 | 2876 | 1061 | 598 | 409 | 375 | 381 | 331 | 160 | 86 | 17 | 37 | 111 | 520 | 553 | 222 | 541 |
| 1982 | 0 | 66 | 2472 | 14151 | 9864 | 18638 | 3906 | 4427 | 1770 | 1151 | 1232 | 600 | 386 | 355 | 277 | 205 | 46 | 0 | 2 | 52 | 16 | 33 | 121 |
| 1983 | 0 | 713 | 33283 | 138203 | 8596 | 38473 | 5072 | 2069 | 1089 | 524 | 281 | 10 | 78 | 17 | 20 | 25 | 2 | 72 | 119 | 438 | 345 | 232 | 235 |
| 1984 | 0 | 0 | 2096 | 37819 | 19063 | 110343 | 31182 | 17669 | 9195 | 2754 | 6322 | 2623 | 3166 | 1584 | 445 | 284 | 23 | 192 | 97 | 2 | 1 | 0 | 95 |
| 1985 | 0 | 0 | 7873 | 50417 | 60121 | 28682 | 17876 | 16842 | 3045 | 3943 | 1010 | 703 | 480 | 164 | 22 | 0 | 0 | 26 | 39 | 130 | 247 | 104 | 65 |
| 1986 | 0 | 0 | 14743 | 80489 | 5464 | 25899 | 13489 | 3096 | 1282 | 3646 | 750 | 480 | 290 | 55 | 0 | 11 | 29 | 14 | 34 | 75 | 129 | 36 | 38 |
| 1987 | 0 | 0 | 3619 | 25170 | 61326 | 56370 | 4348 | 1638 | 932 | 2729 | 598 | 1818 | 1036 | 138 | 120 | 0 | 62 | 102 | 62 | 86 | 21 | 51 | 51 |
| 1988 | 0 | 671 | 88434 | 113618 | 32376 | 29472 | 4621 | 4225 | 1422 | 1368 | 1061 | 789 | 415 | 493 | 36 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 0 | 23 | 5904 | 108768 | 79781 | 30949 | 8687 | 3062 | 1412 | 1116 | 920 | 428 | 344 | 95 | 29 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0 | 278 | 13833 | 56317 | 12620 | 31672 | 12851 | 11964 | 1800 | 2372 | 4191 | 1652 | 432 | 14 | 1 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0 | 0 | 712 | 45513 | 21585 | 43736 | 6971 | 1694 | 5090 | 2447 | 2576 | 447 | 523 | 471 | 251 | 128 | 32 | 122 | 32 | 16 | 35 | 0 | 0 |
| 1992 | 0 | 751 | 11062 | 26333 | 6624 | 43517 | 21949 | 1765 | 1505 | 1050 | 756 | 281 | 548 | 22 | 43 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 238 | 3737 | 20099 | 68898 | 93411 | 15071 | 31935 | 8758 | 8528 | 2843 | 1253 | 726 | 661 | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 1434 | 27341 | 91397 | 11178 | 17943 | 4131 | 4814 | 3327 | 4088 | 1513 | 433 | 62 | 10 | 31 | 14 | 29 | 14 | 22 | 43 | 36 | 72 |
| 1995 | 0 | 0 | 24040 | 114513 | 18446 | 28001 | 64910 | 12177 | 5121 | 2299 | 725 | 282 | 210 | 19 | 7 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 93 |
| 1996 | 0 | 319 | 83794 | 160460 | 52815 | 42532 | 46611 | 26816 | 15497 | 17219 | 6598 | 2735 | 234 | 234 | 78 | 33 | 37 | 88 | 83 | 45 | 41 | 31 | 101 |
| 1997 | 0 | 171 | 26486 | 65516 | 21274 | 24129 | 57618 | 12041 | 5315 | 6645 | 3395 | 1951 | 237 | 106 | 42 | 106 | 205 | 360 | 237 | 288 | 382 | 382 | 1414 |
| 1998 | 0 | 157 | 34295 | 19312 | 25058 | 27809 | 15701 | 12909 | 20225 | 7688 | 1112 | 517 | 734 | 490 | 289 | 44 | 31 | 56 | 105 | 257 | 153 | 159 | 362 |
| 1999 | 0 | 2 | 1418 | 5458 | 2582 | 2444 | 2404 | 939 | 7163 | 5196 | 11015 | 3791 | 1733 | 1037 | 194 | 86 | 67 | 44 | 50 | 30 | 37 | 13 | 46 |
| 2000 | 0 | 0 | 607 | 31951 | 18065 | 8663 | 5900 | 4265 | 4281 | 2291 | 2305 | 4470 | 2488 | 624 | 758 | 1158 | 833 | 390 | 179 | 98 | 51 | 16 | 88 |
| 2001 | 0 | 0 | 0 | 631 | 41603 | 62489 | 10869 | 13175 | 3619 | 2682 | 1211 | 570 | 1233 | 1421 | 334 | 249 | 554 | 339 | 236 | 216 | 126 | 36 | 48 |
| 2002 | 0 | 0 | 176 | 28862 | 15099 | 59540 | 38584 | 20500 | 4075 | 1656 | 1005 | 359 | 158 | 71 | 156 | 383 | 375 | 420 | 260 | 177 | 91 | 47 | 39 |
| 2003 | 54 | 0 | 321 | 1296 | 20266 | 11152 | 11821 | 6210 | 828 | 399 | 593 | 1428 | 674 | 141 | 111 | 386 | 1142 | 1149 | 546 | 308 | 93 | 43 | 16 |
| 2004 | 0 | 0 | 65 | 38085 | 50135 | 33680 | 3922 | 5413 | 4912 | 1528 | 952 | 766 | 412 | 324 | 178 | 72 | 141 | 451 | 551 | 323 | 109 | 62 | 37 |
| 2005 | 0 | 0 | 0 | 82599 | 71765 | 7065 | 25822 | 3295 | 2495 | 1384 | 2010 | 1118 | 422 | 59 | 139 | 62 | 54 | 107 | 238 | 183 | 37 | 13 | 12 |
| 2006 | 0 | 0 | 0 | 8312 | 31898 | 7005 | 13495 | 1525 | 6101 | 1471 | 779 | 312 | 631 | 686 | 239 | 85 | 64 | 61 | 218 | 51 | 114 | 36 | 0 |
| 2007 | 0 | 0 | 1 | 0 | 5008 | 27117 | 3795 | 11733 | 16827 | 5635 | 2964 | 4011 | 1238 | 844 | 299 | 115 | 103 | 551 | 187 | 120 | 69 | 21 | 17 |
| 2008 | 0 | 0 | 1 | 11 | 11100 | 16097 | 19278 | 11538 | 8305 | 7541 | 2782 | 429 | 54 | 246 | 257 | 212 | 233 | 339 | 272 | 270 | 158 | 96 | 52 |
| 2009 | 0 | 0 | 0 | 47 | 930 | 8964 | 8222 | 7721 | 6143 | 2275 | 1252 | 1404 | 2325 | 1535 | 418 | 372 | 278 | 213 | 210 | 121 | 53 | 34 | 21 |
| 2010 | 0 | 0 | 0 | 66 | 1731 | 7823 | 12847 | 2035 | 2911 | 2001 | 1250 | 346 | 151 | 441 | 375 | 102 | 86 | 102 | 59 | 20 | 14 | 23 | 20 |
| 2011 | 0 | 0 | 0 | 0 | 656 | 5006 | 758 | 2895 | 2445 | 1379 | 1393 | 2119 | 1009 | 426 | 126 | 232 | 103 | 83 | 105 | 67 | 33 | 12 | 5 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 0 | 117 | 1683 | 2215 | 1268 | 1450 | 148 | 82 | 61 | 24 | 26 | 47 | 50 | 42 | 60 | 53 | 24 | 2 |
| 2013 | 0 | 0 | 0 | 0 | 8 | 0 | 441 | 10 | 216 | 411 | 237 | 247 | 22 | 223 | 27 | 116 | 31 | 73 | 156 | 172 | 212 | 95 | 41 |

**Table A2.** Continued.

| Longline | 30- | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 78 | 116 | 140 | 54 | 75 | 683 | 1065 | 591 | 153 | 308 | 4 | 0 | 0 |
| 1961 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 49 | 59 | 23 | 31 | 286 | 448 | 255 | 74 | 151 | 23 | 17 | 9 |
| 1962 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 395 | 591 | 713 | 281 | 388 | 3461 | 5387 | 2998 | 778 | 1555 | 23 | 0 | 0 |
| 1963 | 0 | 0 | 10 | 59 | 32 | 37 | 34 | 89 | 52 | 89 | 382 | 439 | 814 | 228 | 408 | 2776 | 4267 | 3034 | 1019 | 1715 | 386 | 37 | 146 |
| 1964 | 0 | 0 | 8 | 47 | 24 | 29 | 10 | 27 | 16 | 16 | 8 | 31 | 172 | 103 | 119 | 1019 | 1657 | 994 | 539 | 618 | 155 | 73 | 15 |
| 1965 | 0 | 0 | 17 | 94 | 51 | 59 | 12 | 34 | 34 | 34 | 75 | 103 | 145 | 97 | 126 | 632 | 992 | 582 | 236 | 589 | 528 | 323 | 178 |
| 1966 | 0 | 0 | 12 | 76 | 41 | 47 | 21 | 58 | 42 | 44 | 12 | 41 | 94 | 67 | 84 | 213 | 390 | 399 | 334 | 400 | 408 | 237 | 168 |
| 1967 | 0 | 0 | 3 | 21 | 12 | 15 | 15 | 32 | 20 | 29 | 16 | 15 | 57 | 96 | 105 | 228 | 404 | 503 | 299 | 190 | 179 | 109 | 171 |
| 1968 | 0 | 0 | 14 | 83 | 23 | 51 | 30 | 79 | 56 | 58 | 17 | 49 | 112 | 82 | 93 | 240 | 410 | 790 | 541 | 437 | 443 | 480 | 266 |
| 1969 | 0 | 0 | 9 | 56 | 15 | 34 | 20 | 53 | 37 | 39 | 17 | 51 | 86 | 75 | 137 | 409 | 410 | 445 | 249 | 333 | 324 | 238 | 326 |
| 1970 | 0 | 0 | 1 | 3 | 2 | 2 | 0 | 1 | 1 | 2 | 5 | 15 | 20 | 21 | 146 | 174 | 121 | 139 | 48 | 66 | 69 | 61 | 633 |
| 1971 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 2 | 2 | 3 | 14 | 47 | 75 | 81 | 103 | 214 | 217 | 248 | 195 | 162 | 102 | 318 |
| 1972 | 0 | 0 | 1 | 16 | 6 | 7 | 11 | 22 | 11 | 18 | 4 | 108 | 48 | 27 | 79 | 187 | 338 | 370 | 192 | 285 | 327 | 174 | 113 |
| 1973 | 0 | 0 | 2 | 13 | 8 | 8 | 10 | 25 | 20 | 29 | 8 | 24 | 61 | 43 | 79 | 177 | 251 | 394 | 256 | 608 | 447 | 304 | 358 |
| 1974 | 0 | 0 | 2 | 10 | 271 | 5 | 1288 | 1291 | 1071 | 1168 | 774 | 2086 | 1956 | 1386 | 456 | 1414 | 1225 | 3115 | 2597 | 3931 | 4681 | 3502 | 2389 |
| 1975 | 0 | 0 | 1 | 13 | 115 | 102 | 82 | 100 | 361 | 714 | 462 | 466 | 491 | 363 | 502 | 889 | 880 | 2822 | 4101 | 5822 | 5999 | 4401 | 4150 |
| 1976 | 0 | 0 | 0 | 4 | 9 | 52 | 79 | 24 | 73 | 147 | 226 | 265 | 297 | 264 | 276 | 459 | 511 | 1171 | 1836 | 2414 | 4462 | 2458 | 2866 |
| 1977 | 0 | 0 | 0 | 0 | 20 | 5 | 35 | 7 | 44 | 39 | 69 | 177 | 238 | 426 | 974 | 1133 | 1674 | 1760 | 1900 | 1649 | 1574 | 1590 | 1172 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 10 | 107 | 88 | 176 | 147 | 132 | 370 | 102 | 172 | 276 | 124 | 39 | 178 | 376 | 1927 | 909 |
| 1979 | 0 | 0 | 0 | 0 | 2 | 28 | 20 | 20 | 110 | 76 | 92 | 369 | 943 | 1070 | 2007 | 1717 | 1230 | 386 | 136 | 126 | 59 | 51 | 73 |
| 1980 | 0 | 0 | 0 | 0 | 0 | 15 | 48 | 62 | 50 | 40 | 75 | 189 | 197 | 295 | 514 | 606 | 979 | 763 | 1123 | 714 | 373 | 143 | 120 |
| 1981 | 0 | 2 | 0 | 4 | 17 | 5 | 26 | 55 | 18 | 26 | 88 | 42 | 208 | 241 | 564 | 753 | 701 | 592 | 705 | 774 | 287 | 224 | 393 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 75 | 292 | 81 | 80 | 185 | 581 | 563 | 3897 | 2159 | 646 | 813 | 2838 | 2678 | 7119 | 1526 | 1725 |
| 1983 | 0 | 0 | 5 | 17 | 45 | 143 | 170 | 239 | 183 | 455 | 745 | 717 | 991 | 1529 | 1945 | 1741 | 1840 | 3953 | 1957 | 1722 | 1954 | 1297 | 482 |
| 1984 | 0 | 0 | 12 | 9 | 58 | 81 | 85 | 80 | 163 | 160 | 232 | 332 | 526 | 785 | 1081 | 1858 | 3548 | 2493 | 2078 | 1242 | 706 | 493 | 629 |
| 1985 | 0 | 5 | 20 | 16 | 97 | 113 | 130 | 136 | 138 | 128 | 225 | 329 | 406 | 456 | 589 | 380 | 593 | 797 | 1077 | 1354 | 1524 | 1179 | 1231 |
| 1986 | 0 | 0 | 0 | 12 | 104 | 211 | 78 | 389 | 202 | 222 | 537 | 495 | 641 | 440 | 518 | 491 | 704 | 1384 | 1634 | 1564 | 1081 | 517 | 182 |
| 1987 | 0 | 0 | 0 | 0 | 58 | 87 | 26 | 89 | 104 | 100 | 120 | 292 | 501 | 735 | 748 | 785 | 798 | 982 | 972 | 1234 | 1212 | 1219 | 779 |
| 1988 | 0 | 0 | 0 | 0 | 25 | 86 | 72 | 289 | 178 | 250 | 132 | 190 | 479 | 1016 | 1019 | 1510 | 1419 | 1600 | 1811 | 1419 | 1132 | 877 | 602 |
| 1989 | 0 | 0 | 0 | 0 | 188 | 409 | 292 | 753 | 501 | 358 | 469 | 564 | 694 | 1110 | 1271 | 1257 | 1104 | 1080 | 1189 | 668 | 925 | 667 | 1054 |
| 1990 | 0 | 7 | 357 | 73 | 182 | 803 | 392 | 555 | 394 | 325 | 330 | 616 | 899 | 1002 | 1342 | 1961 | 2276 | 2524 | 1988 | 1149 | 741 | 594 | 723 |
| 1991 | 4004 | 4142 | 243 | 213 | 293 | 538 | 432 | 603 | 295 | 393 | 740 | 561 | 876 | 1562 | 1940 | 3163 | 7074 | 6294 | 7236 | 2934 | 1494 | 638 | 1761 |
| 1992 | 17 | 441 | 529 | 612 | 1246 | 736 | 507 | 798 | 795 | 611 | 1101 | 1626 | 1456 | 1300 | 2068 | 1972 | 4766 | 3505 | 6209 | 4302 | 3648 | 2606 | 1982 |
| 1993 | 1111 | 1389 | 589 | 1345 | 7248 | 1275 | 1448 | 193 | 870 | 1209 | 1545 | 2249 | 2031 | 1532 | 1469 | 1402 | 1648 | 2778 | 3231 | 2786 | 1841 | 1436 | 3345 |
| 1994 | 621 | 11959 | 16776 | 2929 | 15369 | 4554 | 1147 | 2425 | 2678 | 1811 | 950 | 2212 | 1587 | 4737 | 5024 | 4476 | 4870 | 3979 | 4574 | 5167 | 3527 | 3022 | 4136 |
| 1995 | 49 | 525 | 138 | 102 | 578 | 438 | 326 | 430 | 887 | 1014 | 2009 | 1902 | 5326 | 6157 | 3949 | 4328 | 6760 | 4635 | 5219 | 6939 | 6438 | 4144 | 9777 |
| 1996 | 0 | 0 | 26 | 748 | 892 | 2414 | 371 | 401 | 384 | 915 | 1001 | 1340 | 1628 | 2788 | 4487 | 5298 | 7443 | 7058 | 7374 | 7054 | 5938 | 4538 | 9220 |
| 1997 | 0 | 0 | 25767 | 3842 | 8745 | 19794 | 6727 | 3274 | 1632 | 2504 | 3042 | 902 | 2357 | 3224 | 4156 | 6057 | 8248 | 7305 | 7212 | 5408 | 3318 | 2479 | 4211 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 39 | 3 | 114 | 317 | 140 | 159 | 422 | 677 | 1556 | 1790 | 2742 | 3731 | 8142 | 7759 | 5016 | 3284 | 2085 | 2525 |
| 1999 | 0 | 0 | 70 | 473 | 137 | 96 | 385 | 543 | 739 | 1412 | 1860 | 3253 | 1431 | 2142 | 3822 | 5816 | 5854 | 6237 | 5677 | 4341 | 1945 | 1053 | 1212 |
| 2000 | 0 | 105 | 541 | 71 | 892 | 226 | 111 | 1239 | 1748 | 1507 | 1920 | 1419 | 2409 | 2519 | 2494 | 4142 | 6846 | 6745 | 4953 | 3762 | 4280 | 1990 | 741 |
| 2001 | 0 | 0 | 141 | 481 | 859 | 511 | 9577 | 2534 | 803 | 971 | 926 | 846 | 2614 | 5903 | 7414 | 7681 | 6610 | 6239 | 4747 | 2933 | 1531 | 1149 | 701 |
| 2002 | 85 | 931 | 591 | 75 | 2239 | 2285 | 2267 | 1671 | 1140 | 867 | 744 | 811 | 958 | 1737 | 3013 | 6813 | 7805 | 4708 | 3909 | 2720 | 1717 | 588 | 547 |
| 2003 | 0 | 1402 | 6852 | 1466 | 2927 | 3631 | 2957 | 3592 | 1926 | 1731 | 1616 | 1622 | 2555 | 2304 | 2392 | 3075 | 4651 | 6289 | 4993 | 2461 | 1201 | 649 | 542 |
| 2004 | 0 | 893 | 938 | 844 | 2627 | 1167 | 1544 | 1161 | 690 | 1523 | 1118 | 1293 | 972 | 1763 | 3415 | 2933 | 2834 | 3446 | 4396 | 3071 | 1600 | 735 | 1072 |
| 2005 | 0 | 45 | 25 | 82 | 456 | 393 | 1355 | 481 | 552 | 710 | 996 | 1553 | 1890 | 1731 | 2495 | 2756 | 4546 | 5812 | 5905 | 3476 | 1897 | 713 | 616 |
| 2006 | 1 | 46 | 31 | 2720 | 7883 | 6933 | 11872 | 6473 | 1296 | 786 | 624 | 1094 | 1402 | 2249 | 2643 | 2275 | 2197 | 2174 | 2747 | 1578 | 1151 | 847 | 475 |
| 2007 | 0 | 735 | 434 | 56 | 3164 | 27042 | 2109 | 4510 | 2548 | 1824 | 1377 | 1063 | 1395 | 1221 | 2390 | 3838 | 3319 | 2946 | 3103 | 2053 | 1279 | 824 | 531 |
| 2008 | 1 | 0 | 22 | 215 | 14760 | 9765 | 6566 | 4278 | 3821 | 2183 | 3161 | 2714 | 2062 | 1636 | 4727 | 4840 | 3434 | 3723 | 3109 | 2034 | 1462 | 931 | 854 |
| 2009 | 1 | 4 | 143 | 652 | 558 | 6618 | 3094 | 1231 | 1259 | 1275 | 768 | 636 | 2808 | 6578 | 1697 | 2517 | 3156 | 2020 | 1357 | 869 | 534 | 330 | 324 |
| 2010 | 0 | 1 | 46 | 15 | 188 | 105 | 1261 | 1421 | 3425 | 3306 | 2318 | 1059 | 730 | 554 | 2139 | 5138 | 2240 | 867 | 826 | 589 | 268 | 144 | 116 |
| 2011 | 0 | 0 | 0 | 0 | 74 | 23 | 80 | 580 | 1108 | 770 | 1256 | 750 | 598 | 309 | 318 | 714 | 3591 | 3358 | 1075 | 748 | 593 | 256 | 177 |
| 2012 | 0 | 0 | 6 | 7 | 74 | 139 | 294 | 384 | 2132 | 1271 | 351 | 198 | 127 | 180 | 488 | 422 | 924 | 2551 | 3088 | 1025 | 327 | 173 | 181 |
| 2013 | 1 | 11 | 3 | 30 | 36 | 39 | 265 | 411 | 2122 | 2224 | 807 | 353 | 262 | 177 | 153 | 1092 | 1608 | 1709 | 2253 | 1589 | 445 | 87 | 92 |

**Table A2.** Continued.

| Purse seine | 30- | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 15217 | 0 | 3996 | 24752 | 13339 | 15409 | 72 | 188 | 112 | 492 | 501 | 1479 | 15066 | 10046 | 1617 | 549 | 226 | 340 | 206 | 242 | 116 | 68 | 28 |
| 1951 | 4230 | 0 | 480 | 2978 | 1605 | 1854 | 543 | 1450 | 867 | 1770 | 1867 | 5822 | 12989 | 23212 | 19212 | 11284 | 2924 | 680 | 1097 | 268 | 266 | 153 | 62 |
| 1952 | 385 | 0 | 123 | 770 | 410 | 474 | 288 | 1512 | 469 | 478 | 672 | 1295 | 12483 | 26269 | 18404 | 50877 | 25607 | 6586 | 2241 | 1283 | 715 | 389 | 163 |
| 1953 | 54178 | 0 | 366 | 2306 | 1228 | 1422 | 496 | 1315 | 776 | 867 | 693 | 5543 | 9218 | 13057 | 17819 | 29184 | 16276 | 7308 | 2433 | 1191 | 710 | 378 | 151 |
| 1954 | 192 | 0 | 558 | 3451 | 1861 | 2150 | 24 | 62 | 51 | 60 | 713 | 1267 | 1625 | 4409 | 9771 | 4098 | 9438 | 19339 | 15313 | 12094 | 5815 | 2789 | 782 |
| 1955 | 0 | 0 | 41 | 407 | 203 | 5653 | 18961 | 5360 | 6544 | 3060 | 5343 | 2016 | 7911 | 8645 | 5872 | 6781 | 9157 | 10610 | 12209 | 15183 | 8128 | 3604 | 609 |
| 1956 | 0 | 0 | 28 | 279 | 140 | 3884 | 12993 | 3660 | 4471 | 1846 | 355 | 437 | 1674 | 826 | 1081 | 599 | 653 | 1537 | 2242 | 5856 | 6530 | 4747 | 1892 |
| 1957 | 0 | 0 | 28 | 280 | 140 | 3897 | 13035 | 3672 | 4487 | 1850 | 352 | 302 | 1131 | 5666 | 9236 | 3843 | 5372 | 5608 | 4975 | 6151 | 3245 | 1312 | 234 |
| 1958 | 0 | 0 | 129 | 904 | 2683 | 5766 | 14816 | 6814 | 5802 | 2937 | 4391 | 15575 | 13290 | 4783 | 4283 | 3710 | 3488 | 2816 | 2149 | 2387 | 2102 | 2442 | 1593 |
| 1959 | 0 | 0 | 18 | 175 | 88 | 2435 | 8144 | 2294 | 2802 | 1156 | 177 | 140 | 67 | 238 | 650 | 297 | 957 | 1675 | 1808 | 3383 | 3562 | 2985 | 1004 |
| 1960 | 1195 | 0 | 264 | 1631 | 4107 | 3962 | 3961 | 8390 | 3497 | 3211 | 3886 | 12531 | 10017 | 3250 | 2100 | 1771 | 2271 | 2983 | 3523 | 4531 | 3854 | 2866 | 1183 |
| 1961 | 12870 | 0 | 478 | 2915 | 6832 | 6971 | 6496 | 14409 | 5541 | 5082 | 5065 | 15395 | 12180 | 3954 | 2196 | 1007 | 1540 | 3622 | 4574 | 10119 | 9706 | 7722 | 4139 |
| 1962 | 142608 | 0 | 355 | 1774 | 4593 | 4806 | 4070 | 8970 | 3105 | 3718 | 3035 | 7681 | 5977 | 1931 | 1067 | 503 | 334 | 586 | 1526 | 6536 | 11035 | 11222 | 6903 |
| 1963 | 796865 | 0 | 355 | 2183 | 5061 | 5509 | 4436 | 10305 | 3108 | 2867 | 2370 | 5941 | 4537 | 1451 | 825 | 356 | 454 | 1417 | 1519 | 788 | 405 | 284 | 384 |
| 1964 | 18917 | 0 | 1540 | 9538 | 12200 | 13708 | 9249 | 22389 | 7447 | 6831 | 3259 | 7171 | 5124 | 1673 | 901 | 366 | 186 | 598 | 1248 | 1213 | 1140 | 1867 | 3007 |
| 1965 | 623 | 0 | 1188 | 7057 | 7797 | 8908 | 5151 | 12888 | 4877 | 4550 | 1660 | 2349 | 1502 | 498 | 239 | 68 | 42 | 58 | 102 | 294 | 1127 | 3072 | 5119 |
| 1966 | 288479 | 51234 | 1156 | 7396 | 13653 | 18705 | 22747 | 32255 | 14697 | 13785 | 4031 | 4690 | 1534 | 499 | 156 | 35 | 0 | 142 | 421 | 305 | 469 | 903 | 2491 |
| 1967 | 461321 | 76221 | 1121 | 7232 | 15032 | 21799 | 29851 | 37512 | 18530 | 17082 | 4942 | 6281 | 2162 | 1052 | 116 | 214 | 137 | 245 | 275 | 364 | 718 | 1358 | 5848 |
| 1968 | 505125 | 0 | 261 | 2035 | 3476 | 11373 | 30581 | 15147 | 17357 | 16081 | 3625 | 6396 | 2050 | 338 | 354 | 214 | 28 | 50 | 134 | 182 | 229 | 443 | 2353 |
| 1969 | 15750 | 0 | 2653 | 16037 | 8955 | 23080 | 32763 | 27999 | 14022 | 15229 | 6025 | 2373 | 1347 | 474 | 810 | 788 | 689 | 326 | 241 | 454 | 471 | 800 | 3121 |
| 1970 | 24546 | 0 | 348 | 2366 | 4714 | 7212 | 6284 | 9364 | 3232 | 2756 | 1776 | 2045 | 2221 | 1836 | 1602 | 1207 | 1653 | 1486 | 1910 | 1148 | 157 | 189 | 1398 |
| 1971 | 42316 | 29 | 300 | 3894 | 10746 | 24662 | 18520 | 6368 | 3692 | 1581 | 369 | 330 | 856 | 2053 | 2879 | 3688 | 2984 | 1793 | 917 | 488 | 471 | 772 | 2756 |
| 1972 | 936 | 92 | 1727 | 2361 | 15722 | 78723 | 45952 | 19205 | 17825 | 6023 | 1745 | 1035 | 860 | 666 | 367 | 512 | 1326 | 317 | 260 | 340 | 543 | 846 | 2171 |
| 1973 | 0 | 4 | 369 | 5504 | 10924 | 27533 | 41597 | 17780 | 8909 | 2550 | 1532 | 1368 | 1325 | 1430 | 2475 | 3056 | 3388 | 925 | 612 | 506 | 666 | 946 | 2474 |
| 1974 | 2368 | 1856 | 30586 | 11324 | 15647 | 68069 | 20418 | 18964 | 22849 | 24327 | 5008 | 3452 | 1750 | 1677 | 1671 | 2347 | 4633 | 2871 | 945 | 1181 | 1671 | 2388 | 5274 |
| 1975 | 38651 | 2140 | 35017 | 25602 | 44238 | 170434 | 60000 | 35634 | 10245 | 9933 | 6798 | 5269 | 4480 | 3165 | 1459 | 2072 | 1855 | 2106 | 1056 | 2491 | 3183 | 2430 | 4938 |
| 1976 | 948 | 354 | 1973 | 9731 | 28920 | 65206 | 188745 | 90429 | 34500 | 21526 | 13818 | 5217 | 3018 | 2795 | 1225 | 1006 | 1524 | 1442 | 1072 | 1576 | 2176 | 2508 | 5910 |
| 1977 | 9294 | 10629 | 26910 | 33865 | 49962 | 67050 | 76900 | 34646 | 33622 | 12614 | 6076 | 3302 | 3101 | 2222 | 1278 | 481 | 308 | 508 | 974 | 1216 | 1849 | 2529 | 7390 |
| 1978 | 0 | 46 | 3593 | 17286 | 82729 | 18357 | 75981 | 52700 | 21243 | 5001 | 813 | 1256 | 371 | 1564 | 703 | 824 | 594 | 1368 | 1524 | 959 | 946 | 1152 | 3165 |
| 1979 | 2250 | 208 | 1041 | 1147 | 4851 | 17233 | 45098 | 24310 | 27690 | 12169 | 3552 | 1500 | 392 | 187 | 136 | 300 | 184 | 1156 | 1004 | 669 | 1947 | 1829 | 3524 |
| 1980 | 81 | 3128 | 28454 | 47949 | 46319 | 55725 | 76951 | 35518 | 24805 | 7587 | 4143 | 2256 | 1001 | 763 | 765 | 683 | 672 | 1477 | 1572 | 1749 | 2076 | 2141 | 3535 |
| 1981 | 2302 | 518 | 8893 | 25701 | 103975 | 109991 | 126060 | 34802 | 11862 | 3241 | 6870 | 4154 | 1367 | 1747 | 1117 | 1018 | 1000 | 980 | 1294 | 1186 | 714 | 560 | 1152 |
| 1982 | 818 | 6547 | 93867 | 165261 | 191120 | 99394 | 136240 | 75149 | 42118 | 13856 | 4985 | 2026 | 944 | 819 | 662 | 993 | 933 | 1104 | 1390 | 1860 | 1175 | 920 | 962 |
| 1983 | 49 | 2966 | 86318 | 125536 | 67865 | 73439 | 87736 | 54804 | 21574 | 9828 | 5821 | 4590 | 1853 | 2040 | 4542 | 2087 | 1614 | 4650 | 1367 | 1568 | 1471 | 1326 | 461 |
| 1984 | 0 | 11993 | 16004 | 29307 | 167398 | 196676 | 55555 | 20144 | 12111 | 9413 | 5747 | 2819 | 1857 | 1331 | 1643 | 1373 | 912 | 1470 | 1563 | 1986 | 2795 | 1528 | 1797 |
| 1985 | 5 | 376 | 10996 | 22281 | 63193 | 105627 | 101615 | 130493 | 52281 | 18280 | 6565 | 2948 | 2076 | 1366 | 246 | 247 | 221 | 525 | 912 | 1284 | 1027 | 530 | 380 |
| 1986 | 25 | 2705 | 84553 | 230356 | 44262 | 68595 | 100731 | 36862 | 52184 | 16171 | 5821 | 3370 | 2094 | 1477 | 989 | 557 | 576 | 391 | 476 | 980 | 834 | 602 | 453 |
| 1987 | 5 | 1305 | 29211 | 113214 | 57404 | 204733 | 99814 | 32360 | 20252 | 12436 | 4802 | 3135 | 1171 | 1088 | 654 | 516 | 612 | 1051 | 623 | 489 | 407 | 209 | 133 |
| 1988 | 26 | 3665 | 131094 | 221809 | 63191 | 52024 | 135034 | 78720 | 38254 | 19046 | 6998 | 4416 | 2178 | 1600 | 1349 | 892 | 761 | 1594 | 850 | 581 | 341 | 146 | 168 |
| 1989 | 12 | 1179 | 26450 | 108467 | 91955 | 161437 | 62390 | 44125 | 34774 | 31219 | 6675 | 1250 | 587 | 853 | 1851 | 654 | 394 | 794 | 354 | 395 | 342 | 196 | 353 |
| 1990 | 451 | 19816 | 129498 | 123270 | 142757 | 108799 | 129969 | 44950 | 30551 | 25430 | 5080 | 14087 | 532 | 335 | 631 | 652 | 1074 | 1433 | 721 | 413 | 385 | 188 | 270 |
| 1991 | 1097 | 4668 | 66390 | 79907 | 144042 | 143551 | 139795 | 51972 | 32565 | 25817 | 3928 | 20904 | 569 | 349 | 559 | 922 | 2002 | 2957 | 2361 | 1099 | 701 | 377 | 558 |
| 1992 | 0 | 19 | 17385 | 55207 | 123473 | 291451 | 157803 | 106628 | 47660 | 8459 | 2370 | 10274 | 4478 | 5399 | 5647 | 4800 | 3673 | 4656 | 5113 | 2082 | 869 | 296 | 348 |
| 1993 | 1711 | 916 | 111274 | 65736 | 205047 | 307925 | 191623 | 69950 | 28451 | 10931 | 10441 | 6936 | 4615 | 5560 | 5011 | 4986 | 3868 | 5182 | 5040 | 2005 | 819 | 639 | 1027 |
| 1994 | 30 | 943 | 16598 | 101541 | 229485 | 130521 | 101885 | 65507 | 29146 | 19142 | 15591 | 13516 | 14150 | 10457 | 8841 | 8218 | 11202 | 14130 | 14015 | 11078 | 3050 | 1302 | 1487 |
| 1995 | 3 | 236 | 34305 | 120037 | 56630 | 139232 | 169571 | 104514 | 29434 | 20176 | 15228 | 30112 | 13824 | 8257 | 7435 | 6468 | 4878 | 6102 | 12817 | 9486 | 3203 | 795 | 385 |
| 1996 | 0 | 3 | 27991 | 83352 | 367363 | 160007 | 157086 | 72772 | ##### | 33163 | 18630 | 12035 | 10211 | 7229 | 4337 | 5479 | 6477 | 6664 | 13303 | 6565 | 3245 | 311 | 120 |
| 1997 | 0 | 33 | 8380 | 95729 | 74332 | 232981 | 96151 | 53662 | 62233 | 37438 | 31065 | 27505 | 18525 | 12331 | 9742 | 12939 | 12927 | 16596 | 3492 | 641 | 426 | 461 | 644 |
| 1998 | 0 | 0 | 32641 | 287929 | 42811 | 196631 | 204229 | 60696 | 50905 | 56336 | 28135 | 41297 | 35771 | 2756 | 1427 | 1369 | 705 | 1070 | 1054 | 1165 | 1345 | 410 | 826 |
| 1999 | 786 | 5369 | 46618 | 132168 | 85863 | 169699 | 29859 | 82298 | 50611 | 24897 | 11595 | 5427 | 3176 | 2062 | 1306 | 1665 | 14563 | 8363 | 1385 | 1675 | 1315 | 719 | 459 |
| 2000 | 0 | 87799 | 463700 | 187730 | 157066 | 204495 | 162048 | 28463 | 17553 | 20894 | 17967 | 19011 | 13519 | 3823 | 2090 | 1776 | 1421 | 1161 | 1192 | 1094 | 935 | 876 | 1692 |
| 2001 | 0 | 0 | 0 | 43 | 221989 | 84959 | 48545 | 53459 | 41932 | 12894 | 10113 | 5793 | 5559 | 14488 | 3201 | 4706 | 2255 | 11482 | 15577 | 1665 | 930 | 683 | 1513 |
| 2002 | 1630 | 188 | 71 | 11674 | 140779 | 166268 | 134667 | 43093 | 27164 | 20102 | 11715 | 13694 | 8624 | 3098 | 1507 | 2500 | 3303 | 4827 | 15787 | 2803 | 2058 | 1543 | 3086 |
| 2003 | 5545 | 511 | 0 | 310 | 52588 | 54176 | 24506 | 16035 | 8127 | 15824 | 16463 | 17040 | 11940 | 9622 | 4080 | 6538 | 2869 | 8350 | 15766 | 10699 | 2614 | 2269 | 2535 |
| 2004 | 0 | 0 | 0 | 28003 | 87411 | 69545 | 107822 | 32115 | 15651 | 11505 | 5120 | 3717 | 8986 | 17616 | 9899 | 1236 | 8916 | 12158 | 19771 | 2633 | 1900 | 1771 | 4083 |
| 2005 | 0 | 0 | 251 | 71833 | 91996 | 157414 | 144642 | 34599 | 19496 | 12818 | 12353 | 5166 | 6878 | 11847 | 10403 | 6816 | 5864 | 20023 | 26462 | 4700 | 459 | 536 | 362 |
| 2006 | 0 | 0 | 6021 | 60946 | 132605 | 16407 | 159179 | 37844 | 29271 | 12779 | 4069 | 13362 | 8014 | 3769 | 1574 | 11154 | 25556 | 9285 | 10055 | 5606 | 3287 | 114 | 343 |
| 2007 | 0 | 0 | 0 | 0 | 20734 | 8858 | 207 | 16322 | 79765 | 36820 | 31712 | 22287 | 6365 | 11427 | 2390 | 6268 | 15448 | 10839 | 25658 | 9158 | 883 | 1241 | 1620 |
| 2008 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 8890 | 18994 | 28918 | 19087 | 26157 | 7547 | 9283 | 3676 | 9009 | 7183 | 4046 | 2618 | 2738 | 2571 | 1663 | 3036 |
| 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 276 | 0 | 11861 | 33452 | 13158 | 4767 | 15797 | 25102 | 478 | 12978 | 3909 | 3019 | 9338 | 789 | 281 | 224 | 401 |
| 2010 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 1061 | 3669 | 17300 | 2186 | 13784 | 6394 | 10443 | 3499 | 6242 | 3739 | 24 | 1 | 1 | 0 | 0 | 0 |
| 2011 | 0 | 0 | 21239 | 32181 | 9654 | 9654 | 3890 | 844 | 3630 | 6060 | 9523 | 7840 | 5926 | 7217 | 3671 | 3247 | 348 | 204 | 440 | 513 | 467 | 187 | 140 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 114 | 114 | 341 | 2058 | 671 | 458 | 2971 | 2051 | 5393 | 19331 | 21642 | 806 | 119 | 142 | 0 | 0 | 0 | 0 |
| 2013 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 991 | 661 | 2221 | 5533 | 11740 | 11334 | 7946 | 11507 | 15322 | 3188 | 1441 | 0 | 0 | 0 | 0 |

**Table A2.** Continued.

| Traps | 30- | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 91094 | 0 | 23922 | 148171 | 79851 | 92242 | 673 | 1205 | 966 | 3616 | 3251 | 3170 | 4503 | 9574 | 9760 | 12268 | 18352 | 11271 | 4571 | 1337 | 694 | 407 | 168 |
| 1951 | 30757 | 0 | 3493 | 21655 | 11670 | 13478 | 4117 | 10597 | 6518 | 6867 | 2869 | 2421 | 3568 | 7031 | 7207 | 9507 | 14391 | 9285 | 4383 | 2391 | 1931 | 1109 | 452 |
| 1952 | 1110 | 0 | 354 | 2219 | 1183 | 1366 | 1033 | 4427 | 1603 | 1944 | 2848 | 2817 | 4122 | 8283 | 8474 | 11067 | 16719 | 10670 | 4894 | 2460 | 1914 | 1122 | 469 |
| 1953 | 212793 | 0 | 1439 | 9057 | 4825 | 5586 | 2253 | 5265 | 3422 | 4068 | 4273 | 4171 | 6126 | 12428 | 12717 | 16493 | 24780 | 15722 | 7005 | 3323 | 2455 | 1439 | 593 |
| 1954 | 341 | 0 | 991 | 6131 | 3308 | 3821 | 266 | 185 | 531 | 847 | 2973 | 3154 | 4869 | 9011 | 9454 | 12941 | 19701 | 14355 | 7262 | 2407 | 1653 | 1016 | 457 |
| 1955 | 56 | 0 | 38 | 231 | 126 | 144 | 258 | 107 | 616 | 924 | 3247 | 3393 | 5309 | 9705 | 10315 | 14190 | 21573 | 16613 | 8295 | 1261 | 334 | 287 | 175 |
| 1956 | 67 | 0 | 8 | 49 | 27 | 31 | 435 | 247 | 815 | 1361 | 5155 | 5226 | 7800 | 15348 | 16010 | 21123 | 31845 | 22435 | 10315 | 1599 | 331 | 276 | 164 |
| 1957 | 1 | 0 | 2 | 12 | 6 | 384 | 6 | 1155 | 2479 | 7622 | 5616 | 4538 | 22134 | 26707 | 26301 | 19668 | 10853 | 19372 | 14640 | 5586 | 2843 | 4764 | 2283 |
| 1958 | 173 | 1516 | 11343 | 2263 | 434 | 133 | 20 | 423 | 2207 | 5239 | 13288 | 15844 | 14230 | 17336 | 21765 | 21567 | 19645 | 9622 | 12006 | 10976 | 4847 | 6010 | 3600 |
| 1959 | 56 | 0 | 3 | 14 | 8 | 8 | 22 | 783 | 1644 | 591 | 1259 | 2925 | 5715 | 7520 | 8794 | 11288 | 17869 | 16243 | 14054 | 9241 | 4495 | 2415 | 343 |
| 1960 | 44 | 0 | 2 | 11 | 6 | 7 | 21 | 98 | 596 | 769 | 2467 | 3288 | 6393 | 8073 | 9372 | 17226 | 19753 | 15202 | 9411 | 6227 | 2781 | 1596 | 245 |
| 1961 | 374 | 0 | 3 | 14 | 7 | 9 | 24 | 205 | 549 | 651 | 789 | 2590 | 5964 | 4278 | 3359 | 13560 | 20116 | 14830 | 7462 | 3966 | 1484 | 755 | 160 |
| 1962 | 3501 | 0 | 2 | 0 | 2 | 1 | 4 | 4 | 239 | 716 | 1901 | 4922 | 6176 | 3581 | 7448 | 15883 | 18348 | 14591 | 9930 | 4752 | 2281 | 825 | 239 |
| 1963 | 152955 | 0 | 5 | 28 | 15 | 17 | 16 | 42 | 255 | 980 | 684 | 2166 | 2326 | 2804 | 1457 | 2221 | 2944 | 9124 | 9391 | 5177 | 2211 | 1030 | 327 |
| 1964 | 351 | 26 | 43 | 233 | 186 | 360 | 319 | 2434 | 3170 | 3368 | 2739 | 2346 | 2142 | 5217 | 2428 | 2228 | 2170 | 5130 | 10099 | 10197 | 4020 | 1722 | 317 |
| 1965 | 38 | 0 | 58 | 334 | 180 | 208 | 40 | 444 | 743 | 2811 | 1090 | 2248 | 3203 | 4828 | 5083 | 866 | 1586 | 2156 | 4067 | 8277 | 9658 | 5094 | 2598 |
| 1966 | 4245 | 754 | 4 | 24 | 13 | 14 | 6 | 141 | 188 | 1787 | 1715 | 7647 | 4265 | 3097 | 3493 | 2077 | 2387 | 1858 | 3229 | 3968 | 4063 | 1930 | 367 |
| 1967 | 8078 | 1335 | 1 | 6 | 4 | 5 | 5 | 780 | 598 | 781 | 2411 | 5517 | 6184 | 11250 | 1845 | 2329 | 3295 | 6003 | 3594 | 2925 | 4633 | 4241 | 2107 |
| 1968 | 1061 | 0 | 0 | 0 | 0 | 0 | 0 | 111 | 186 | 1120 | 2066 | 1833 | 2084 | 4528 | 6608 | 2080 | 1229 | 1782 | 3058 | 2556 | 2513 | 1497 | 1553 |
| 1969 | 35 | 0 | 470 | 30 | 1633 | 114 | 11 | 28 | 20 | 661 | 1219 | 3653 | 2046 | 1311 | 2804 | 3828 | 2356 | 2124 | 2360 | 3336 | 3592 | 2657 | 3545 |
| 1970 | 250 | 0 | 2 | 10 | 6 | 7 | 0 | 4 | 87 | 34 | 145 | 456 | 1312 | 1106 | 1783 | 1874 | 2707 | 3251 | 2390 | 1795 | 1573 | 785 | 852 |
| 1971 | 3071 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 2 | 78 | 3 | 179 | 479 | 1062 | 1104 | 1304 | 1597 | 964 | 796 | 862 | 907 | 1009 | 1591 |
| 1972 | 999 | 0 | 1 | 11 | 6 | 7 | 6 | 39 | 40 | 75 | 48 | 158 | 253 | 452 | 735 | 765 | 779 | 708 | 1526 | 1162 | 1036 | 730 | 918 |
| 1973 | 17446 | 730 | 1 | 6 | 4 | 4 | 4 | 24 | 15 | 70 | 100 | 173 | 140 | 200 | 287 | 461 | 606 | 667 | 1063 | 953 | 921 | 805 | 946 |
| 1974 | 1628 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 20 | 68 | 160 | 292 | 315 | 531 | 380 | 585 | 673 | 809 | 1480 | 960 | 1232 | 1416 | 1726 |
| 1975 | 0 | 0 | 15 | 29 | 8 | 0 | 0 | 0 | 23 | 107 | 266 | 356 | 310 | 334 | 195 | 393 | 343 | 379 | 697 | 1060 | 1684 | 1470 | 1525 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 18 | 43 | 110 | 286 | 370 | 351 | 250 | 172 | 131 | 342 | 574 | 1118 | 1309 | 1447 | 1955 |
| 1977 | 0 | 0 | 8 | 15 | 4 | 0 | 14 | 0 | 0 | 24 | 36 | 109 | 263 | 318 | 306 | 220 | 199 | 458 | 686 | 954 | 1031 | 1259 | 1572 |
| 1978 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 38 | 56 | 186 | 188 | 347 | 286 | 371 | 382 | 421 | 840 | 890 | 905 | 1393 |
| 1979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 12 | 119 | 290 | 356 | 362 | 337 | 639 | 544 | 889 | 824 | 613 | 741 | 587 | 896 |
| 1980 | 0 | 0 | 232 | 0 | 2 | 0 | 9 | 0 | 29 | 72 | 85 | 93 | 217 | 368 | 538 | 244 | 431 | 797 | 910 | 1044 | 1033 | 948 | 1191 |
| 1981 | 200 | 0 | 0 | 0 | 0 | 0 | 100 | 382 | 274 | 436 | 279 | 597 | 836 | 1039 | 1872 | 1501 | 898 | 1037 | 1451 | 1390 | 921 | 444 | 538 |
| 1982 | 0 | 0 | 0 | 0 | 0 | 8 | 289 | 523 | 169 | 488 | 502 | 405 | 749 | 1609 | 1702 | 2195 | 2265 | 2213 | 2163 | 3305 | 2070 | 1398 | 1219 |
| 1983 | 0 | 0 | 0 | 10 | 0 | 35 | 53 | 20 | 45 | 161 | 260 | 432 | 548 | 646 | 848 | 833 | 1315 | 3060 | 2016 | 2274 | 2504 | 1974 | 962 |
| 1984 | 0 | 0 | 84 | 56 | 406 | 532 | 350 | 392 | 378 | 338 | 360 | 526 | 1017 | 975 | 1488 | 1833 | 4002 | 4927 | 3932 | 3895 | 1897 | 1007 | 728 |
| 1985 | 18 | 0 | 3837 | 0 | 0 | 0 | 0 | 54 | 85 | 412 | 129 | 338 | 558 | 439 | 463 | 556 | 739 | 1740 | 2047 | 2016 | 1846 | 899 | 1044 |
| 1986 | 0 | 0 | 419 | 3077 | 14753 | 9442 | 1188 | 490 | 0 | 0 | 0 | 12 | 48 | 138 | 176 | 136 | 276 | 418 | 1007 | 1654 | 1421 | 788 | 768 |
| 1987 | 0 | 0 | 0 | 0 | 0 | 3 | 11 | 80 | 415 | 743 | 652 | 456 | 333 | 360 | 422 | 388 | 625 | 738 | 1189 | 1804 | 1608 | 952 | 822 |
| 1988 | 0 | 14 | 128 | 95 | 39 | 1 | 7 | 45 | 14 | 30 | 65 | 218 | 695 | 748 | 811 | 670 | 806 | 892 | 2231 | 2242 | 4005 | 2571 | 2157 |
| 1989 | 0 | 638 | 236 | 0 | 0 | 0 | 3 | 0 | 0 | 33 | 169 | 355 | 1171 | 1458 | 2639 | 1125 | 1580 | 1252 | 1632 | 1238 | 1869 | 956 | 1335 |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 13 | 52 | 683 | 151 | 663 | 2388 | 4745 | 3967 | 6543 | 2361 | 2080 | 916 | 2060 | 1114 | 1276 |
| 1991 | 0 | 0 | 352 | 0 | 228 | 1907 | 704 | 3129 | 1222 | 888 | 853 | 1798 | 1792 | 1115 | 1049 | 1495 | 2581 | 2977 | 2013 | 866 | 660 | 526 | 1377 |
| 1992 | 0 | 11 | 18 | 1 | 129 | 17 | 40 | 46 | 41 | 70 | 251 | 313 | 964 | 1533 | 1766 | 1598 | 1701 | 2237 | 2163 | 1215 | 690 | 323 | 382 |
| 1993 | 0 | 0 | 2 | 5 | 22 | 5 | 6 | 12 | 28 | 63 | 55 | 45 | 173 | 172 | 366 | 578 | 1113 | 1170 | 1380 | 1513 | 970 | 1249 | 1421 |
| 1994 | 0 | 0 | 0 | 4620 | 0 | 0 | 26 | 162 | 256 | 272 | 1558 | 2294 | 2936 | 2385 | 1100 | 1022 | 935 | 1108 | 1655 | 1251 | 1091 | 899 | 1678 |
| 1995 | 0 | 0 | 303 | 5 | 0 | 0 | 0 | 28 | 48 | 237 | 283 | 307 | 342 | 243 | 368 | 588 | 1555 | 1285 | 1588 | 1096 | 831 | 492 | 1370 |
| 1996 | 2 | 0 | 459 | 8 | 26 | 2 | 4 | 118 | 455 | 1333 | 2878 | 1433 | 1067 | 576 | 787 | 580 | 861 | 943 | 1215 | 746 | 1116 | 737 | 2787 |
| 1997 | 0 | 0 | 0 | 0 | 8 | 38 | 15 | 141 | 204 | 1461 | 3223 | 1863 | 2157 | 1320 | 1964 | 1839 | 2391 | 2433 | 4694 | 2637 | 2136 | 964 | 2214 |
| 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 7 | 101 | 199 | 347 | 1137 | 1432 | 1542 | 1787 | 3508 | 2729 | 4056 | 3140 | 2246 | 1112 | 1909 |
| 1999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 145 | 448 | 280 | 348 | 330 | 739 | 619 | 862 | 853 | 1356 | 1518 | 3805 | 3124 | 2234 | 1374 | 2452 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 313 | 1138 | 1875 | 2255 | 1820 | 1742 | 2388 | 2119 | 2749 | 3304 | 3945 | 2277 | 1202 | 896 | 722 |
| 2001 | 0 | 0 | 0 | 0 | 0 | 13 | 274 | 504 | 1426 | 1461 | 1984 | 2142 | 2559 | 2611 | 2487 | 3628 | 3827 | 4297 | 4065 | 3127 | 1778 | 951 | 698 |
| 2002 | 0 | 0 | 0 | 0 | 1 | 9 | 149 | 271 | 712 | 641 | 869 | 851 | 1044 | 978 | 1389 | 1912 | 2274 | 3231 | 3255 | 2992 | 2404 | 1123 | 1117 |
| 2003 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 5 | 73 | 240 | 482 | 708 | 716 | 708 | 674 | 2097 | 2868 | 2142 | 1793 | 1267 | 1125 | 707 | 467 |
| 2004 | 0 | 0 | 0 | 0 | 0 | 11 | 19 | 71 | 84 | 131 | 252 | 301 | 312 | 293 | 319 | 638 | 1749 | 3125 | 1843 | 1546 | 1266 | 786 | 521 |
| 2005 | 0 | 0 | 0 | 0 | 0 | 5 | 22 | 39 | 48 | 82 | 143 | 187 | 360 | 561 | 970 | 1082 | 1367 | 3211 | 3194 | 2345 | 1405 | 496 | 378 |
| 2006 | 0 | 0 | 0 | 0 | 0 | 3 | 20 | 29 | 279 | 227 | 496 | 433 | 1888 | 1656 | 2587 | 1709 | 1772 | 1732 | 1407 | 1757 | 1467 | 1266 | 805 |
| 2007 | 0 | 0 | 0 | 0 | 0 | 11 | 22 | 56 | 124 | 177 | 550 | 434 | 2842 | 2499 | 2981 | 2309 | 2126 | 971 | 1531 | 2589 | 1980 | 1870 | 1252 |
| 2008 | 0 | 0 | 0 | 12 | 120 | 229 | 35 | 67 | 61 | 120 | 200 | 150 | 322 | 337 | 497 | 1403 | 2306 | 3095 | 2455 | 2723 | 1856 | 1183 | 2102 |
| 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 336 | 367 | 645 | 606 | 582 | 965 | 1654 | 2080 | 2031 | 1883 | 2707 | 3031 | 2088 | 970 |
| 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 797 | 24 | 63 | 1020 | 1436 | 666 | 1565 | 3094 | 2345 | 2051 | 1769 | 1013 | 856 | 734 |
| 2011 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 107 | 440 | 583 | 458 | 322 | 201 | 370 | 778 | 985 | 1675 | 1857 | 2241 | 1732 | 1086 | 947 |
| 2012 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 2 | 78 | 530 | 457 | 215 | 208 | 676 | 1492 | 2539 | 2307 | 2354 | 1693 | 946 | 739 |
| 2013 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 19 | 18 | 9 | 101 | 157 | 174 | 279 | 838 | 1231 | 1117 | 1987 | 3276 | 2691 | 1539 | 1295 | 1049 |

**Table A2.** Continued.

| Other | 30- | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 23324 | 0 | 6125 | 37937 | 20445 | 23618 | 251 | 335 | 344 | 1145 | 2119 | 2579 | 10355 | 10715 | 6438 | 7262 | 10519 | 6486 | 2555 | 607 | 178 | 104 | 43 |
| 1951 | 10483 | 0 | 1191 | 7381 | 3978 | 4594 | 1485 | 3639 | 2322 | 2797 | 2513 | 3361 | 5989 | 11532 | 10619 | 10135 | 11605 | 6908 | 3102 | 1025 | 658 | 378 | 154 |
| 1952 | 563 | 0 | 180 | 1127 | 601 | 694 | 521 | 2247 | 809 | 977 | 1498 | 1584 | 4054 | 8366 | 7165 | 13770 | 12412 | 6415 | 2834 | 1512 | 1260 | 933 | 453 |
| 1953 | 91604 | 0 | 619 | 3899 | 2077 | 2405 | 982 | 2271 | 1487 | 1788 | 2047 | 2403 | 3602 | 6888 | 7420 | 10104 | 12939 | 8148 | 3889 | 1806 | 1272 | 788 | 331 |
| 1954 | 231 | 0 | 671 | 4148 | 2238 | 2585 | 96 | 97 | 144 | 256 | 972 | 1076 | 1582 | 3165 | 3678 | 4188 | 6675 | 5630 | 3773 | 2936 | 2113 | 1199 | 656 |
| 1955 | 427 | 0 | 326 | 2112 | 1133 | 6005 | 16666 | 4868 | 5977 | 2885 | 2701 | 2346 | 3570 | 6452 | 6293 | 8075 | 12046 | 8208 | 5085 | 4400 | 3157 | 1508 | 544 |
| 1956 | 0 | 0 | 15 | 149 | 74 | 2064 | 6906 | 1946 | 2472 | 1052 | 155 | 210 | 474 | 110 | 264 | 714 | 1164 | 1971 | 1611 | 1073 | 1640 | 1146 | 561 |
| 1957 | 0 | 0 | 28 | 278 | 139 | 3925 | 12944 | 3742 | 4482 | 1931 | 365 | 283 | 396 | 869 | 1136 | 766 | 1424 | 2103 | 2347 | 2816 | 3190 | 1786 | 1070 |
| 1958 | 0 | 0 | 13 | 133 | 66 | 1848 | 6189 | 1795 | 2497 | 1143 | 721 | 439 | 207 | 666 | 1009 | 956 | 1280 | 659 | 499 | 870 | 1176 | 1167 | 795 |
| 1959 | 0 | 0 | 17 | 173 | 87 | 2413 | 8082 | 2467 | 2927 | 1221 | 251 | 800 | 375 | 330 | 470 | 594 | 1688 | 1356 | 1571 | 1475 | 3142 | 2673 | 1346 |
| 1960 | 767 | 0 | 35 | 275 | 141 | 1339 | 4810 | 2366 | 3257 | 3402 | 1767 | 1479 | 765 | 1857 | 1321 | 1192 | 1195 | 1242 | 545 | 532 | 930 | 813 | 286 |
| 1961 | 5649 | 0 | 44 | 352 | 165 | 1961 | 6997 | 3033 | 4701 | 4540 | 1276 | 2080 | 2229 | 1864 | 552 | 1831 | 1298 | 1389 | 984 | 540 | 400 | 640 | 544 |
| 1962 | 57663 | 0 | 31 | 51 | 48 | 666 | 2428 | 758 | 1589 | 2058 | 1451 | 2249 | 2441 | 1730 | 1846 | 1008 | 1148 | 658 | 198 | 356 | 436 | 418 | 432 |
| 1963 | 410364 | 0 | 13 | 186 | 75 | 2053 | 7420 | 2190 | 4358 | 4530 | 1176 | 3360 | 1745 | 2458 | 976 | 1280 | 102 | 653 | 606 | 530 | 148 | 410 | 11 |
| 1964 | 5187 | 0 | 261 | 1776 | 911 | 3855 | 10889 | 4051 | 6553 | 6123 | 1301 | 2592 | 1253 | 1692 | 730 | 530 | 277 | 166 | 111 | 557 | 19 | 50 | 89 |
| 1965 | 223 | 0 | 299 | 1806 | 960 | 2255 | 4525 | 2005 | 3315 | 4207 | 1004 | 1711 | 1205 | 1748 | 2110 | 182 | 223 | 262 | 151 | 39 | 38 | 75 | 151 |
| 1966 | 62116 | 11032 | 50 | 323 | 174 | 199 | 87 | 249 | 202 | 733 | 410 | 3089 | 1544 | 654 | 710 | 225 | 56 | 34 | 102 | 70 | 71 | 25 | 1 |
| 1967 | 73867 | 12205 | 8 | 58 | 33 | 58 | 114 | 333 | 225 | 233 | 476 | 1361 | 1378 | 2587 | 426 | 380 | 516 | 986 | 808 | 765 | 714 | 841 | 1298 |
| 1968 | 106840 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 62 | 269 | 549 | 407 | 469 | 1010 | 1504 | 343 | 184 | 107 | 181 | 188 | 299 | 137 | 421 |
| 1969 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 411 | 1286 | 613 | 358 | 748 | 835 | 188 | 282 | 161 | 262 | 314 | 246 | 519 |
| 1970 | 12004 | 0 | 68 | 477 | 273 | 307 | 0 | 171 | 239 | 373 | 220 | 2 | 88 | 5 | 106 | 221 | 698 | 845 | 1111 | 729 | 181 | 155 | 37 |
| 1971 | 42857 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 21 | 13 | 31 | 35 | 147 | 124 | 145 | 131 | 160 | 139 | 182 | 347 | 584 | 716 |
| 1972 | 19971 | 0 | 17 | 153 | 85 | 102 | 85 | 205 | 155 | 175 | 45 | 23 | 18 | 40 | 29 | 42 | 39 | 30 | 31 | 57 | 129 | 224 | 297 |
| 1973 | 39327 | 1646 | 5 | 28 | 268 | 309 | 65 | 161 | 43 | 43 | 20 | 23 | 18 | 39 | 27 | 37 | 30 | 22 | 26 | 46 | 65 | 94 | 120 |
| 1974 | 39327 | 1646 | 2 | 13 | 8 | 8 | 9 | 26 | 22 | 25 | 13 | 14 | 14 | 29 | 24 | 36 | 29 | 44 | 31 | 52 | 78 | 88 | 91 |
| 1975 | 39185 | 1640 | 11 | 72 | 951 | 1097 | 407 | 999 | 228 | 202 | 80 | 77 | 42 | 31 | 28 | 60 | 73 | 91 | 53 | 87 | 117 | 82 | 67 |
| 1976 | 39293 | 1645 | 6 | 36 | 66 | 106 | 29 | 49 | 28 | 34 | 20 | 26 | 32 | 34 | 19 | 21 | 35 | 116 | 153 | 195 | 252 | 168 | 204 |
| 1977 | 122251 | 14043 | 2 | 62 | 80 | 355 | 66 | 80 | 54 | 49 | 17 | 43 | 98 | 124 | 155 | 128 | 119 | 269 | 363 | 436 | 251 | 352 | 544 |
| 1978 | 102821 | 11606 | 44 | 5902 | 6303 | 3470 | 947 | 1427 | 684 | 1787 | 835 | 580 | 251 | 91 | 66 | 74 | 101 | 150 | 152 | 191 | 294 | 463 | 1104 |
| 1979 | 29621 | 1160 | 6 | 96 | 188 | 851 | 944 | 1149 | 890 | 1448 | 785 | 235 | 226 | 318 | 802 | 515 | 645 | 433 | 512 | 443 | 448 | 703 | 1536 |
| 1980 | 36353 | 854 | 2033 | 15607 | 3917 | 5477 | 1588 | 1911 | 612 | 585 | 653 | 1189 | 960 | 627 | 537 | 284 | 319 | 178 | 187 | 166 | 134 | 97 | 118 |
| 1981 | 6214 | 0 | 1382 | 21952 | 7487 | 7414 | 2258 | 2046 | 1396 | 435 | 500 | 92 | 96 | 123 | 249 | 250 | 181 | 207 | 293 | 330 | 159 | 117 | 116 |
| 1982 | 83125 | 8032 | 1343 | 10506 | 4820 | 3448 | 1573 | 1343 | 839 | 239 | 193 | 97 | 87 | 118 | 112 | 140 | 140 | 168 | 215 | 249 | 230 | 249 | 404 |
| 1983 | 226640 | 106617 | 40671 | 188731 | 9138 | 8926 | 1859 | 1332 | 408 | 391 | 279 | 107 | 92 | 139 | 204 | 136 | 183 | 520 | 356 | 329 | 232 | 192 | 60 |
| 1984 | 1638 | 310 | 13374 | 33705 | 19455 | 37527 | 11850 | 2575 | 3100 | 1352 | 1573 | 544 | 453 | 323 | 330 | 467 | 652 | 966 | 1063 | 1113 | 926 | 701 | 743 |
| 1985 | 9187 | 16855 | 6433 | 10595 | 10554 | 13263 | 10991 | 15134 | 4675 | 2066 | 1002 | 899 | 1132 | 715 | 938 | 1141 | 1388 | 1520 | 2097 | 1929 | 1418 | 1604 | 1142 |
| 1986 | 20718 | 12931 | 29570 | 126968 | 16245 | 10464 | 6009 | 2541 | 4503 | 1853 | 508 | 990 | 600 | 631 | 551 | 645 | 1239 | 1550 | 1607 | 2410 | 2296 | 2309 | 1069 |
| 1987 | 83027 | 25633 | 10699 | 31922 | 14467 | 21290 | 3583 | 3205 | 2858 | 2321 | 1473 | 2395 | 1688 | 2935 | 3096 | 1432 | 872 | 1484 | 1493 | 1418 | 787 | 695 | 838 |
| 1988 | 27855 | 4081 | 71561 | 112611 | 22198 | 7800 | 8587 | 5410 | 2791 | 1291 | 1200 | 758 | 2095 | 3614 | 3329 | 1263 | 1261 | 1517 | 1662 | 2562 | 1101 | 666 | 810 |
| 1989 | 17029 | 1547 | 63118 | 80361 | 38199 | 33531 | 3179 | 6864 | 4444 | 1315 | 1599 | 861 | 939 | 1725 | 1817 | 1029 | 816 | 1189 | 1090 | 1915 | 1924 | 597 | 1379 |
| 1990 | 33841 | 35563 | 14727 | 57764 | 10724 | 12003 | 5959 | 2591 | 1325 | 1385 | 2281 | 1860 | 1261 | 947 | 1005 | 1420 | 1652 | 1473 | 1727 | 1393 | 626 | 321 | 610 |
| 1991 | 34622 | 75604 | 5314 | 25324 | 10979 | 8391 | 1281 | 1841 | 1646 | 950 | 1070 | 578 | 528 | 399 | 318 | 643 | 1817 | 1535 | 2563 | 1130 | 386 | 67 | 194 |
| 1992 | 35183 | 14342 | 52263 | 65952 | 7106 | 25371 | 9740 | 2132 | 1898 | 1148 | 969 | 320 | 631 | 779 | 788 | 1654 | 2087 | 3627 | 2244 | 1074 | 254 | 443 | 259 |
| 1993 | 11208 | 6126 | 27173 | 47400 | 30475 | 58166 | 11387 | 10004 | 5372 | 2451 | 1784 | 2432 | 2145 | 1298 | 1001 | 605 | 1128 | 944 | 1784 | 1543 | 588 | 465 | 897 |
| 1994 | 10841 | 13227 | 11224 | 39672 | 17131 | 12240 | 14488 | 12456 | 4813 | 2845 | 2844 | 2910 | 2131 | 2693 | 2898 | 3934 | 3504 | 3189 | 3013 | 2498 | 1253 | 988 | 1467 |
| 1995 | 30057 | 29177 | 15465 | 103578 | 10468 | 11448 | 14914 | 4482 | 3082 | 3404 | 4790 | 5457 | 6170 | 3589 | 1898 | 2436 | 1963 | 2310 | 1486 | 1754 | 791 | 784 | 1050 |
| 1996 | 26950 | 25008 | 39116 | 29808 | 23464 | 13882 | 6680 | 6360 | 4483 | 3703 | 3181 | 2518 | 2455 | 1958 | 885 | 903 | 1225 | 1244 | 1717 | 1135 | 967 | 833 | 793 |
| 1997 | 556 | 4515 | 38508 | 29760 | 9039 | 17819 | 11211 | 5676 | 3515 | 2926 | 4518 | 4566 | 3621 | 1641 | 1610 | 1276 | 1723 | 1853 | 1447 | 905 | 743 | 480 | 615 |
| 1998 | 0 | 1878 | 34342 | 42496 | 10185 | 23127 | 24712 | 6734 | 5062 | 2017 | 655 | 3502 | 4473 | 973 | 1024 | 2630 | 3003 | 1830 | 686 | 363 | 219 | 217 | 176 |
| 1999 | 351 | 1648 | 5854 | 43401 | 25118 | 36145 | 3662 | 10743 | 5392 | 2785 | 4301 | 2415 | 1989 | 1382 | 1190 | 1316 | 5352 | 3165 | 1202 | 641 | 270 | 213 | 1379 |
| 2000 | 0 | 1559 | 22131 | 27542 | 25787 | 15476 | 9188 | 4556 | 3881 | 5593 | 6045 | 6579 | 3613 | 1303 | 1191 | 1282 | 1570 | 1089 | 1108 | 807 | 561 | 256 | 413 |
| 2001 | 0 | 0 | 1393 | 1274 | 27980 | 31838 | 10875 | 11919 | 5255 | 2651 | 1866 | 1692 | 1673 | 1665 | 876 | 1798 | 1403 | 1839 | 1523 | 354 | 182 | 105 | 206 |
| 2002 | 0 | 147 | 2152 | 10684 | 14018 | 31970 | 21573 | 10110 | 3824 | 2584 | 1629 | 1656 | 1638 | 1679 | 1084 | 1395 | 1598 | 1388 | 1512 | 640 | 551 | 298 | 308 |
| 2003 | 672 | 16 | 724 | 2713 | 35391 | 21438 | 14368 | 6705 | 2565 | 2066 | 1863 | 3513 | 2175 | 1967 | 1448 | 1442 | 1574 | 2817 | 4543 | 2108 | 674 | 328 | 167 |
| 2004 | 7952 | 2570 | 11469 | 15694 | 16741 | 18275 | 6469 | 4381 | 3015 | 1605 | 1176 | 634 | 1572 | 1862 | 1445 | 688 | 976 | 1429 | 2315 | 734 | 484 | 351 | 562 |
| 2005 | 459 | 2496 | 5718 | 48716 | 71889 | 28998 | 22402 | 6145 | 3231 | 730 | 862 | 1424 | 678 | 98 | 77 | 46 | 17 | 137 | 222 | 75 | 62 | 35 | 60 |
| 2006 | 243 | 1298 | 2475 | 12155 | 62554 | 20174 | 26017 | 2550 | 3523 | 748 | 473 | 753 | 980 | 799 | 291 | 93 | 47 | 192 | 303 | 143 | 94 | 73 | 123 |
| 2007 | 0 | 59 | 61 | 188 | 366 | 2790 | 902 | 1451 | 3561 | 1808 | 1325 | 924 | 1201 | 1478 | 682 | 718 | 969 | 556 | 1084 | 369 | 65 | 42 | 27 |
| 2008 | 0 | 0 | 3 | 143 | 1215 | 1914 | 582 | 722 | 1049 | 1850 | 1691 | 1376 | 1800 | 1371 | 818 | 1418 | 516 | 544 | 371 | 228 | 387 | 86 | 193 |
| 2009 | 0 | 0 | 13 | 162 | 61 | 853 | 703 | 468 | 795 | 1561 | 731 | 583 | 1333 | 1564 | 543 | 844 | 366 | 188 | 400 | 51 | 32 | 23 | 11 |
| 2010 | 0 | 1 | 36 | 0 | 142 | 127 | 867 | 563 | 1724 | 2919 | 2133 | 1738 | 1467 | 769 | 470 | 476 | 354 | 107 | 70 | 78 | 29 | 19 | 0 |
| 2011 | 0 | 0 | 0 | 0 | 265 | 84 | 278 | 2256 | 4372 | 1215 | 756 | 503 | 290 | 389 | 106 | 118 | 143 | 160 | 135 | 70 | 51 | 33 | 30 |
| 2012 | 0 | 0 | 2 | 4 | 22 | 66 | 80 | 103 | 1123 | 583 | 192 | 257 | 137 | 142 | 106 | 77 | 263 | 240 | 166 | 93 | 71 | 40 | 26 |
| 2013 | 0 | 43 | 11 | 0 | 25 | 35 | 91 | 305 | 751 | 933 | 252 | 104 | 133 | 98 | 102 | 99 | 194 | 334 | 234 | 116 | 85 | 153 | 233 |

**Table A3.** CPUE series used – values followed by associated standard errors are given.

| | Mor&Sp_Trap | | SpBB1 | | SpBB2 | | SpBB3 | | JPLL_EastMed | | NorPS | | JPLL_NEA1 | | JPLL_NEA2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | numbers | | biomass | | biomass | | biomass | | numbers | | biomass | | numbers | | numbers | |
| 1952 | - | - | 179.22 | 0.43 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1953 | - | - | 184.74 | 0.53 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1954 | - | - | 226.46 | 0.41 | - | - | - | - | - | - | - | - | - | - | - | - |
| 1955 | - | - | 187.01 | 0.42 | - | - | - | - | - | - | 36.20 | - | - | - | - | - |
| 1956 | - | - | 470.53 | 0.43 | - | - | - | - | - | - | 21.25 | - | - | - | - | - |
| 1957 | - | - | 315.05 | 0.41 | - | - | - | - | - | - | 28.61 | - | - | - | - | - |
| 1958 | - | - | 252.25 | 0.41 | - | - | - | - | - | - | 24.13 | - | - | - | - | - |
| 1959 | - | - | 506.79 | 0.41 | - | - | - | - | - | - | 32.41 | - | - | - | - | - |
| 1960 | - | - | 485.16 | 0.43 | - | - | - | - | - | - | 46.83 | - | - | - | - | - |
| 1961 | - | - | 327.29 | 0.41 | - | - | - | - | - | - | 51.84 | - | - | - | - | - |
| 1962 | - | - | 180.12 | 0.46 | - | - | - | - | - | - | 64.67 | - | - | - | - | - |
| 1963 | - | - | - | - | 312.09 | 493.00 | - | - | - | - | 1.67 | - | - | - | - | - |
| 1964 | - | - | - | - | 457.40 | 415.00 | - | - | - | - | 33.98 | - | - | - | - | - |
| 1965 | - | - | - | - | 228.91 | 0.41 | - | - | - | - | 69.60 | - | - | - | - | - |
| 1966 | - | - | - | - | 349.10 | 421.00 | - | - | - | - | 35.70 | - | - | - | - | - |
| 1967 | - | - | - | - | 345.89 | 414.00 | - | - | - | - | 61.06 | - | - | - | - | - |
| 1968 | - | - | - | - | 447.00 | 422.00 | - | - | - | - | 23.53 | - | - | - | - | - |
| 1969 | - | - | - | - | 610.62 | 401.00 | - | - | - | - | 28.06 | - | - | - | - | - |
| 1970 | - | - | - | - | 594.66 | 431.00 | - | - | - | - | 42.76 | - | - | - | - | - |
| 1971 | - | - | - | - | 744.71 | 403.00 | - | - | - | - | 43.52 | - | - | - | - | - |
| 1972 | - | - | - | - | 525.63 | 413.00 | - | - | - | - | 43.05 | - | - | - | - | - |
| 1973 | - | - | - | - | 535.63 | 396.00 | - | - | - | - | 42.15 | - | - | - | - | - |
| 1974 | - | - | - | - | 245.39 | 439.00 | - | - | - | - | 45.72 | - | - | - | - | - |
| 1975 | - | - | - | - | 484.22 | 0.41 | - | - | 1.90 | 0.15 | 38.00 | - | - | - | - | - |
| 1976 | - | - | - | - | 483.96 | 414.00 | - | - | 2.15 | 0.12 | 21.16 | - | - | - | - | - |
| 1977 | - | - | - | - | 547.56 | 407.00 | - | - | 3.53 | 0.14 | 42.44 | - | - | - | - | - |
| 1978 | - | - | - | - | 705.26 | 412.00 | - | - | 1.50 | 0.15 | 12.28 | - | - | - | - | - |
| 1979 | - | - | - | - | 623.01 | 409.00 | - | - | 2.70 | 0.14 | 3.75 | - | - | - | - | - |
| 1980 | - | - | - | - | 634.81 | 446.00 | - | - | 1.69 | 0.16 | 20.14 | - | - | - | - | - |
| 1981 | 768.36 | 57.19 | - | - | 510.66 | 422.00 | - | - | 1.63 | 0.17 | - | - | - | - | - | - |
| 1982 | 1038.12 | 34.63 | - | - | 503.78 | 418.00 | - | - | 3.32 | 0.13 | - | - | - | - | - | - |
| 1983 | 1092.05 | 34.63 | - | - | 625.14 | 432.00 | - | - | 2.12 | 0.13 | - | - | - | - | - | - |
| 1984 | 1200.27 | 34.63 | - | - | 331.71 | 449.00 | - | - | 1.62 | 0.12 | - | - | - | - | - | - |
| 1985 | 814.46 | 34.64 | - | - | 1125.74 | 407.00 | - | - | 1.75 | 0.15 | - | - | - | - | - | - |
| 1986 | 394.33 | 28.05 | - | - | 751.21 | 419.00 | - | - | 1.32 | 0.14 | - | - | - | - | - | - |
| 1987 | 433.53 | 28.05 | - | - | 1008.43 | 415.00 | - | - | 2.16 | 0.13 | - | - | - | - | - | - |
| 1988 | 1014.56 | 28.03 | - | - | 1394.68 | 419.00 | - | - | 1.35 | 0.14 | - | - | - | - | - | - |
| 1989 | 531.45 | 26.09 | - | - | 1285.60 | 0.40 | - | - | 1.05 | 0.16 | - | - | - | - | - | - |
| 1990 | 614.37 | 22.60 | - | - | 986.51 | 407.00 | - | - | 1.41 | 0.14 | - | - | 0.08 | 0.32 | - | - |
| 1991 | 727.86 | 22.59 | - | - | 901.20 | 422.00 | - | - | 1.21 | 0.13 | - | - | 0.10 | 0.27 | - | - |
| 1992 | 313.95 | 22.63 | - | - | 695.16 | 427.00 | - | - | 1.03 | 0.14 | - | - | 0.22 | 0.16 | - | - |
| 1993 | 325.36 | 22.62 | - | - | 2093.55 | 403.00 | - | - | 1.04 | 0.14 | - | - | 0.23 | 0.14 | - | - |
| 1994 | 341.90 | 22.62 | - | - | 1007.03 | 419.00 | - | - | 1.12 | 0.16 | - | - | 0.26 | 0.16 | - | - |
| 1995 | 223.43 | 22.65 | - | - | 1235.91 | 405.00 | - | - | 1.42 | 0.15 | - | - | 0.29 | 0.13 | - | - |
| 1996 | 375.22 | 24.62 | - | - | 1739.29 | 398.00 | - | - | 0.50 | 0.22 | - | - | 0.77 | 0.13 | - | - |
| 1997 | 992.41 | 24.59 | - | - | 2246.41 | 404.00 | - | - | 0.53 | 0.21 | - | - | 0.50 | 0.13 | - | - |
| 1998 | 925.14 | 24.59 | - | - | 879.51 | 409.00 | - | - | 0.71 | 0.17 | - | - | 0.24 | 0.16 | - | - |
| 1999 | 1137.45 | 24.59 | - | - | 339.77 | 436.00 | - | - | 0.64 | 0.22 | - | - | 0.35 | 0.15 | - | - |
| 2000 | 739.23 | 22.59 | - | - | 960.44 | 402.00 | - | - | 0.74 | 0.20 | - | - | 0.38 | 0.12 | - | - |
| 2001 | 1284.62 | 22.58 | - | - | 704.49 | 447.00 | - | - | 0.96 | 0.17 | - | - | 0.45 | 0.12 | - | - |
| 2002 | 1130.42 | 22.58 | - | - | 687.42 | 423.00 | - | - | 2.05 | 0.15 | - | - | 0.34 | 0.13 | - | - |
| 2003 | 662.66 | 23.68 | - | - | 444.91 | 482.00 | - | - | 1.70 | 0.13 | - | - | 0.34 | 0.14 | - | - |
| 2004 | 332.36 | 22.62 | - | - | 1210.46 | 417.00 | - | - | 0.82 | 0.18 | - | - | 0.32 | 0.12 | - | - |
| 2005 | 677.39 | 22.59 | - | - | 2383.57 | 0.40 | - | - | 0.88 | 0.15 | - | - | 0.23 | 0.11 | - | - |
| 2006 | 633.94 | 22.60 | - | - | 850.09 | 0.48 | - | - | 1.91 | 0.15 | - | - | 0.28 | 0.11 | - | - |
| 2007 | 1000.60 | 22.59 | - | - | - | - | 1177.62 | 419.00 | 0.94 | 0.19 | - | - | 0.28 | 0.11 | - | - |
| 2008 | 634.18 | 22.60 | - | - | - | - | 2144.54 | 304.00 | 1.22 | 0.17 | - | - | 0.33 | 0.11 | - | - |
| 2009 | 876.71 | 22.59 | - | - | - | - | 955.29 | 305.00 | 1.04 | 0.24 | - | - | 0.48 | 0.11 | - | - |
| 2010 | 1042.24 | 23.66 | - | - | - | - | 2109.08 | 309.00 | - | - | - | - | - | - | 2.04 | 0.05 |
| 2011 | 674.97 | 22.59 | - | - | - | - | 2762.62 | 306.00 | - | - | - | - | - | - | 2.87 | 0.06 |
| 2012 | 1187.75 | 23.66 | - | - | - | - | 2216.18 | 390.00 | - | - | - | - | - | - | 4.81 | 0.07 |
| 2013 | 4285.56 | 33.12 | - | - | - | - | 1571.64 | 445.00 | - | - | - | - | - | - | 4.46 | 0.06 |

**Appendix B**

## The Statistical Catch-at-Length Model

The text following sets out the equations and other general specifications of the SCAL 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:

$$N_{y+1,1} = R_{y+1} \tag{B1}$$

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

$$N_{y+1,m} = \left( N_{y,m-1}\, e^{-M_{m-1}/2} - \sum_f C^f_{y,m-1} \right) e^{-M_{m-1}/2} + \left( N_{y,m}\, e^{-M_m/2} - \sum_f C^f_{y,m} \right) e^{-M_m/2} \tag{B3}$$

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*,

$C^f_{y,a}$ 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 a Beverton-Holt stock-recruitment relationship, allowing for annual fluctuation about the deterministic relationship:

$$R_y = \frac{\alpha B^{\text{sp}}_{y-1}}{\beta + B^{\text{sp}}_{y-1}} e^{(\varsigma_y - (\sigma_R)^2/2)} \tag{B4}$$

where

$\alpha$ and $\beta$ are spawning biomass-recruitment relationship parameters,

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

$B^{\text{sp}}_y$ is the spawning biomass in year *y*, computed as:

$$B^{\text{sp}}_y = \sum_{a=0}^{m} f_{y,a} w^{\text{sp}}_{y,a} N_{y,a} e^{-M_a \frac{T^s}{12}} \tag{B5}$$

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,

$w^{sp}_{y,a}$ 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:

$$C_y = \sum_f \sum_{a=0}^{m} w^f_{y,a}\, C^f_{y,a} = \sum_f \sum_{a=0}^{m} w^f_{y,a}\, N_{y,a}\, e^{-M_a/2} S^f_{y,a} F^f_y \tag{B6}$$

where

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

$S^f_{y,a}$ 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,

$F^f_y$ is the proportion of a fully selected age class that is fished by fleet *f* , and

$w^f_{y,a}$ denotes the selectivity-weighted mid-year weight of fish of age *a* landed in year *y* by fleet *f*, computed as:

$$\tilde{w}^f_{y,a} = \sum_l S^f_{y,l} w_l\, A_{a,l} \Big/ S^f_{a,l} \tag{B7}$$

with

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

$A_{a,l}$ 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.:

$$L_a \sim N\left[L_\infty\left(1 - e^{-\kappa(a-t_o)}\right); \theta_a^2\right] \tag{B8}$$

where

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

$$\theta_a = \beta L_\infty \left(1 - e^{-\kappa(a-t_o)}\right) \tag{B9}$$

with $\beta$ fixed here to 0.1 for age 1, 0.2 for age 15 and changing linearly for the ages in between.

Selectivity is estimated as a function of length and then converted to an effective selectivity-at-age:

$$S^f_{y,a} = \sum_l S^f_{y,l} A_{a,l} \tag{B10}$$

***B.1.4. Initial conditions***

For the first year ($y_0$) considered in the model (here 1950), the numbers-at-age are estimated directly for ages 1 to $a^{est}$, with a parameter $\phi$ which mimics recent average fishing mortality for ages above $a^{est}$ ($a^{est}$=7 here), i.e.:

$$N_{y_0,a} = N_{\text{start},a} \qquad \text{for } 1 \le a \le a^{est} \tag{B11}$$

and

$$N_{\text{start},a} = N_{\text{start},a-1} e^{-M_{a-1}} (1-\phi S_{a-1}) \qquad \text{for } a^{est} < a \le m-1 \tag{B12}$$

$$N_{\text{start},m} = N_{\text{start},m-1} e^{-M_{m-1}} (1-\phi S_{m-1}) \big/ (1-e^{-M_m}(1-\phi S_m)) \tag{B13}$$

**B.2. The (penalised) likelihood function**

The model is fitted to CPUE and commercial 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 (- $\ell\text{n}L$ ) are as follows.

***B.2.1 CPUE relative abundance data***

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

$$I_y^i = \hat{I}_y^i \exp\left(\varepsilon_y^i\right) \quad \text{or} \quad \varepsilon_y^i = \ell\text{n}\left(I_y^i\right) - \ell\text{n}\left(\hat{I}_y^i\right) \tag{B14}$$

where

$I_y^i$ is the CPUE biomass or abundance index for year *y* for gear/flag combination *i*,

$\hat{I}_y^i = \hat{q}^i \sum^m w_{y,a}^i S_{y,a}^i N_{y,a} e^{-M_a/2} (1 - S_{y,a}^i F_y^i / 2)$ is the corresponding model estimate of biomass or

$\hat{I}_y^f = \hat{q}^f \sum^m S_{y,a}^f N_{y,a} e^{-M_a/2} (1 - S_{y,a}^f F_y^f / 2)$ is the corresponding model estimate of abundance in numbers,

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

$\varepsilon_y^i$ from $N\left(0, \left(\sigma_y^i\right)^2\right)$.

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

$$-\ell\text{n}\, L^{\text{CPUE}} = \sum_y \left\{ \ell\text{n}\left( \sqrt{\left(\sigma_y^i\right)^2 + \left(\sigma_{Add}^i\right)^2} \right) + \frac{\left(\varepsilon_y^i\right)^2}{2\left[\left(\sigma_y^i\right)^2 + \left(\sigma_{Add}^i\right)^2\right]} \right\} \tag{B15}$$

where

$\sigma_y^i$ is the standard deviation of the residuals for the logarithm of index *i* in year *y* (which is input), and

$\sigma_{Add}^i$ 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:

$$\ell n\, \hat{q}^i = 1/n_i \sum_y \left( \ln I_y^i - \ln \hat{B}_y^{\text{ex}} \right) \tag{B16}$$

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

1) Mor&Sp_Trap: Moroccan and Spanish (combined) trap (1981-2013)
2) SpBB1: Spanish bait boat (1952-1962)
3) SpBB2: Spanish bait boat (1963-2006)
4) SpBB3: Spanish bait boat (2007-2013)
5) NorPS: Norwegian purse seine (1955-1980)
6) JPLL_EastMed: Japanese longline fishery in east Atl. (south of 40N) and Med. (1975-2009)
7) JPLL_NEA1: Japanese longline fishery in the Northeast Atl. (north of 40N) (1990-2009)
8) JPLL_NEA2: Japanese longline fishery in the Northeast Atl. (north of 40N) (2010-2013)

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

The indices' selectivities are taken to be the same as for the overall gear type, i.e.:
1) Mor&Sp_Trap: corresponds to trap
2) SpBB1, SpBB2, and SpBB3 correspond to baitboat
3) NorPS: corresponds to purse seine, and
6) JPLL_EastMed, JPLL_NEA1 and JPLL_NEA2 correspond to longline.

### *B.2.3. Commercial catches-at-length*

The contribution of the catch-at-length data to the negative of the log-likelihood function under the assumption of an "adjusted" lognormal error distribution (Punt and Kennedy 1997) is given by:

$$-\ell n L^{\mathrm{CAL}} = w_{len}\sum_f\sum_y\sum_l\left[\ell n\left(\sigma^f_{\mathrm{len}}/\sqrt{p^f_{y,l}}\right)+p^f_{y,l}\left(\ell n\, p^f_{y,l}-\ell n\,\hat{p}^f_{y,l}\right)^2/2\left(\sigma^f_{\mathrm{len}}\right)^2\right] \quad \text{(B17)}$$

where

$p^f_{y,l}=C^f_{y,l}/\sum_{l'}C^f_{y,l'}$ is the observed proportion of fish caught in year *y* by fleet *f* that are of length *l*,

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

where

$$\hat{C}^f_{y,l}=\sum_a N_{y,a}\,A_{a,l}S^f_{y,l}\,F^f_y\,e^{-M_a/2} \quad \text{(B18)}$$

and

$\sigma^f_{\mathrm{com}}$ is the standard deviation associated with the catch-at-length data, which is estimated in the fitting procedure by:

$$\hat{\sigma}^f_{\mathrm{com}}=\sqrt{\sum_y\sum_l p^f_{y,a}\left(\ell n\, p^f_{y,l}-\ell n\,\hat{p}^f_{y,l}\right)^2/\sum_y\sum_l 1} \quad \text{(B19)}$$

Commercial catches-at-length are incorporated in the likelihood function using equation (B17), for which the summation over length *l* is taken from length $l_{\mathrm{minus}}$ (considered as a minus group) to $l_{\mathrm{plus}}$ (a plus group). The values used here for $l_{\mathrm{minus}}$ and $l_{\mathrm{plus}}$ are given in **Table B1**.

**Table B1.** $l_{\mathrm{minus}}$ and $l_{\mathrm{plus}}$ (in cm) for each of the five fleets considered.

| | $l_{\mathrm{minus}}$ | $l_{\mathrm{plus}}$ |
|---|---|---|
| Baitboat | 60 | 160 |
| Longline | 70 | 250 |
| Purse seine | 40 | 170 |
| Traps | 40 | 250 |
| Other | 30 | 200 |

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 fleets assumed in the model (baitboat, longline, purse seine, traps, other) (see **Table A3**).

***B.2.4 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:

$$-\ell n L^{\text{pen}} = \sum_{y=y_1+1}^{y_2} \left[ \varsigma_y^2 / 2\sigma_{\text{R}}^2 \right] \tag{B20}$$

where

$\varsigma_y$ is the recruitment residual for year *y*, which is estimated for year $y_1$ to $y_2$ (see equation (B4)),

$\sigma_{\text{R}}$ is the standard deviation of the log-residuals, which is input (here $\sigma_{\text{R}}$=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 B2**.

**Table B2.** 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, 2012).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model plus group ($m$) | 15 | | | | | | |
| Length-weight | $a$=0.0000295, $b$=2.899 | | | | | | |
| von Bertalanffy growth | $\kappa$=0.093, $L_{\text{inf}}$=319, $t_0$=-0.97 | | | | | | |
| Maturity-at-age | 50% maturity at age 4, 100% maturity at age 5 | | | | | | |
| Natural mortality | 1 | 2-5 | 6 | 7 | 8 | 9 | 10+ |
| | 0.49 | 0.24 | 0.20 | 0.18 | 0.15 | 0.13 | 0.10 |
| Stock-recruitment | Beverton-Holt, $h$=0.98*, $\sigma_R$=0.4 | | | | | | |

* This high value was specified on input rather than estimated in the fit of the model given the absence of any clear trend in the stock-recruitment plot of **Figure 3**.

### *B.4.2 Fishing selectivity*

Fishing selectivities-at-length are estimated using a four parameters double-logistic form:

$$S_l = \left(1+e^{-a1(l-b1)}\right)^{-1}\left[1-\left(1+e^{-a2(l-b2)}\right)^{-1}\right] \quad \text{(B21)}$$

Details of the fishing selectivities used are shown in **Table B3**.

**Table B3.** Details of the selectivities estimated.

| | $l_{minus}$ *(cm)* | $l_{plus}$ *(cm)* | *Number of parameters estimated* | *Number of selectivity periods* |
|---|---|---|---|---|
| Bait boat | 80 | 160 | 4x3 | Three: 1950-1962, 1963-2006, 2007-2013 |
| Longline | 90 | 250 | 4x3 | Three: 1950-1989, 1990-2009, 2010-2013 |
| Purse seine | 60 | 170 | 4 | One |
| Traps | 120 | 250 | 4x2 | Two: 1950-1973, 1974-2013 |
| Other | 60 | 200 | 4x3 | Three: 1950-1966, 1967-1984, 1985-2013 |