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FC Working Group on Greenland Halibut Management
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# Greenland Halibut Updated SCAA Reference Case and Robustness Tests

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## INTRODUCTION

The Greenland halibut SCAA Reference Case (RC) and robustness test operating models (Butterworth and Rademeyer, 2010a) have been updated to take into account data now available up to 2009. The updated data (Appendix A) are:

1) 2008 and 2009 catches (Table A1) (Healey *et al*. 2010);

2) 2008 and 2009 commercial catches-at-age (Table A2) (Healey *et al.* 2010);

3) updated weights-at-age to age 20 (Table A3) (ages 1-13, Healey *et al.* 2010; ages 14-20+, Miller, pers. commn);

4) updated maturity-at-age to age 20 (Table A4) (Morgan, pers. commn);

5) 2008 and 2009 survey data: numbers-at-age (Table A5) and total weight per tow (Table A6).

The EU summer survey has been split into two series in order to make use of the deep-water portion (0-1400m) of the survey which has taken place since 2004. The model is therefore fit to four survey series: a) Canadian Fall survey (2J3K) (1996-2009), b) Canadian Spring survey (3LNO) (1996-2009), c) EU summer 0-700m survey (1995-2003) and d) EU summer 0-1400m survey (2004-2009).

In fitting the survey CAA, the plus and minus groups have been changed slightly compared to the assessments presented in Butterworth and Rademeyer (2010a). The table below compares the plus and minus groups used in each instance. The splitting of The EU survey series prompted the one change; the change for the Canadian Fall series was made because of the small proportions of fish in the age classes above 8.

| | Butterworth and Rademeyer (2010a) | | Updated assessment | |
|---|---|---|---|---|
| | minus | plus | minus | plus |
| Canadian Fall | 1 | 13 | 1 | 8 |
| EU (0-700m) | 1 | 11 | 1 | 9 |
| EU (0-1400m) | - | - | 4 | 11 |
| Canadian Spring | 1 | 8 | 1 | 8 |

Furthermore a selectivity smoothing penalty has been included in the negative log likelihood:

$$PenS = \sum_i \sum_{a=a^-+1}^{a^+-1} 3\left(S_{a-1}^i - 2S_a^i + S_{a+1}^i\right)^2 + \sum_{a=a^-+1}^{a^+-1} 3\left(S_{a-1}^{com} - 2S_a^{com} + S_{a+1}^{com}\right)^2$$

where

$S_a^i$ is the selectivity at age *a* for survey *i* (before adding variability);

$S_a^{com}$ is the commercial selectivity at age *a* (before adding variability); and

$a^-$ and $a^+$ are the minus and plus groups.

This addition was prompted by the large upward spike that otherwise occurs in selectivity at age 10 for the EU (0-1400m) survey. Introduction of this term hardly affects estimates of abundance trends.

In other respects the structure of these operating models remains identical to that detailed In Appendix B of Butterworth and Rademeyer (2009a), with two updates detailed in Butterworth and Rademeyer (2009b). In particular note that first order autocorrelation in time is estimated in fitting to the survey indices of abundance, and similarly in both time and age in fitting to the survey catch-at-age proportions. Fishing selectivity functions change at two-yearly intervals, with the extent of the change constrained by treating these as random effects with standard deviation $\sigma_\Omega$ = 2.0 for the commercial selectivity and $\sigma_\Omega$ = 0.5 for the survey selectivities.

**RESULTS AND DISCUSSION**

The following SCAA Reference Case (RC) and robustness test operating models for the Greenland Halibut, which are straightforward updates of those reported in Butterworth and Rademeyer (2010a), will be used in the MSE process.

0) Reference Case: Update of Case 2 of Butterworth and Rademeyer (2010b): Beverton-Holt, *h*=0.9, *M*=0.2, exponential decrease in selectivity for ages 11+;
1) RC with flat commercial selectivity (estimated in the fit to be 0.27) for ages 11+;
2) RC with flat commercial selectivity (fixed to 0.3, which is equal to the new XSA average value over 2005-2009) for ages 11+;
3) RC with *M*=0.1;
4) RC with *M*=0.2 for ages 0-10, linear increase to *M*=0.4 for age 14, and constant thereafter;
5) RC with *h* = 0.6 in the assessment, to simulate a stock that has a large maximum recruitment which has been severely recruitment-overfished;
6) RC with a modified Ricker stock-recruitment relationship: $R_y = \alpha B_y^{sp} \exp\left(-\beta\left(B_y^{sp}\right)^\gamma\right)$;
7) RC with fixed flat commercial selectivity (as in 2 above) and increasing *M* with age (as in 4 above).

The results of the SCAA variants explored are listed in Table 1, with corresponding biomass trajectories plotted in Fig. 1 and stock-recruitment relationships shown in Fig. 2. Results for the RC presented in Butterworth and Rademeyer (2010a) are shown in Table 1 and Fig. 1 for comparative purposes. The commercial and survey selectivities estimated in the RC are plotted in Fig. 3. The commercial selectivities of the two OMs with flat selectivity at older ages are also shown in Fig. 3. The RC stock-recruitment curve, and time series of recruitment and standardised recruitment residuals are shown in Fig. 4. The fit of the RC to the survey indices and the commercial and survey CAA are shown in Fig. 5. It is notable that these CAA residual plots (which are outputs after adjustment for auto-correlation) all now show few obvious and substantial patterns, and thus constitute a considerable improvement over results for this SCAA methodology (Butterworth and Rademeyer, 2009b) prior to this update of the data.

**REFERENCES**

Butterworth DS and Rademeyer RA. 2009a. Initial applications of Statistical Catch-at-Age assessment methodology to the Greenland Halibut resource. Document to co-operative industry/government project meeting on Greenland halibut assessment. Vigo 22-24 April, 2009 (22pp).

Butterworth DS and Rademeyer RA. 2009b. Extensions to SCAA applications reported in: "Further applications of statistical catch-at-age assessment methodology to the 2J3K-O Greenland

Halibut resource”. Document submitted to NAFO Working Group to evaluate alternative assessment models for the assessment of Greenland halibut. Dartmouth, 1-3 June, 2009 (27pp)..

Butterworth DS and Rademeyer RA. 2010a. Greenland Halibut SCAA robustness tests. NAFO SCR Doc. 10/1.

Butterworth DS and Rademeyer RA. 2010b. A comparison between XSA and SCAA assessments of Greenland Halibut based on the same input data. (Report provided to the NAFO Secretariat and SC Chair)

Healey BP, Mahé J-C and Morgan MJ. 2010. An assessment of Greenland Halibut (*Reinhardtius hippoglossoides*) in NAFO Subarea 2 and Divisions 3KLMNO. NAFO SCR Doc. 10/40, Ser. No. N5799

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Table 1: Results of fits of SCAA Reference Case and the intended robustness test operating models to the commercial catch and survey data. Values fixed on input rather than estimated are shown in **bold**. Quantities shown in parenthesis are Hessian-based CVs. Where autocorrelation coefficients are shown for fits to the survey catch-at-age proportions, they correspond to the following order of the surveys: Canadian Fall, EU 0-700m, EU 0-1400m and Canadian spring

| | 0prev) Butterworth and Rademeyer (2010a) Reference Case | | | 0) Reference Case | | | | 1) flat commercial selectivitiy for ages 11+ estimated | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| '-lnL:overall | -630.8 | | | -701.0 | | | | -694.4 | | | |
| '-lnL:Survey | -29.9 | | | -36.0 | | | | -36.8 | | | |
| '-lnL:CAA | -222.8 | | | -231.6 | | | | -230.1 | | | |
| '-lnL:CAAsurv | -462.8 | | | -531.1 | | | | -530.7 | | | |
| '-lnL:RecRes | 17.6 | | | 18.9 | | | | 19.2 | | | |
| '-lnL:SelPen | 67.0 | | | 73.2 | | | | 77.2 | | | |
| SelSmoothing | - | | | 5.6 | | | | - | | | |
| $h$ | **0.90** | | | **0.90** | | | | **0.90** | | | |
| $M$ | **0.20** | | | **0.20** | | | | **0.20** | | | |
| $\theta$ | 0.31 | | | 0.24 | | | | 0.13 | | | |
| $\phi$ | 0.28 | | | 0.29 | | | | 0.34 | | | |
| $\rho$ - surveys | 0.60 | | | 0.57 | | | | 0.54 | | | |
| $\rho_{CAAage}$ | 0.28 | 0.35 | 0.35 | 0.48 | 0.31 | 0.31 | 0.23 | 0.48 | 0.30 | 0.32 | 0.23 |
| $\rho_{CAAyr}$ | -0.32 | -0.49 | -0.49 | -0.68 | -0.26 | -0.91 | -0.59 | -0.68 | -0.26 | -0.90 | -0.58 |
| $K^{sp}$ | 340 | | | 439 | (0.06) | | | 422 | (0.08) | | |
| $B^{sp}_{2009}$ | 37 | | | 21 | (0.34) | | | 16 | (0.33) | | |
| $B^{5-9}_{2009}$ | 128 | | | 126 | (0.11) | | | 109 | (0.11) | | |
| $B^{10+}_{2009}$ | 53 | | | 46 | (0.25) | | | 38 | (0.24) | | |
| $MSYL^{sp}$ | 0.18 | | | 0.15 | (0.15) | | | 0.16 | (0.16) | | |
| $B^{sp}_{MSY}$ | 60 | | | 67 | (0.17) | | | 69 | (0.16) | | |
| MSY | 27 | | | 26 | (0.06) | | | 26 | (0.09) | | |
| $\sigma_{comCAA}$ | 0.07 | | | 0.07 | | | | 0.07 | | | |
| Survey | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCA}$ | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | |
| CanFall | 421 | 0.17 | 0.02 | 451 | 0.15 | 0.02 | | 494 | 0.14 | 0.02 | |
| EU (0-700m) | 219 | 0.28 | 0.05 | 349 | 0.28 | 0.05 | | 365 | 0.28 | 0.05 | |
| EU (0-1400m) | - | - | - | 347 | 0.22 | 0.02 | | 386 | 0.23 | 0.02 | |
| CanSpr | 22 | 0.41 | 0.05 | 27 | 0.46 | 0.05 | | 29 | 0.45 | 0.05 | |
| $\sigma_R$_out | 0.21 | | | 0.21 | | | | 0.22 | | | |

| | 2) flat commercial selectivity for ages 11+ fixed to XSA value | | | | 3) $M$ = 0.1 | | | | 4) $M_{10-}$=0.2, $M_{14+}$=0.4, linear in between | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| '-lnL:overall | -690.6 | | | | -698.4 | | | | -701.6 | | | |
| '-lnL:Survey | -36.5 | | | | -31.4 | | | | -36.8 | | | |
| '-lnL:CAA | -218.3 | | | | -231.8 | | | | -232.0 | | | |
| '-lnL:CAAsurv | -530.6 | | | | -532.8 | | | | -530.8 | | | |
| '-lnL:RecRes | 19.9 | | | | 17.7 | | | | 20.0 | | | |
| '-lnL:SelPen | 69.6 | | | | 73.8 | | | | 72.7 | | | |
| SelSmoothing | - | | | | - | | | | - | | | |
| $h$ | **0.90** | | | | **0.90** | | | | **0.90** | | | |
| $M$ | **0.20** | | | | **0.10** | | | | **0.20** | | | |
| $\theta$ | 0.05 | | | | 0.26 | | | | 0.25 | | | |
| $\phi$ | 0.42 | | | | 0.30 | | | | 0.30 | | | |
| $\rho$ - surveys | 0.53 | | | | 0.64 | | | | 0.53 | | | |
| $\rho_{CAAage}$ | 0.48 | 0.31 | 0.32 | 0.22 | 0.48 | 0.30 | 0.32 | 0.24 | 0.48 | 0.31 | 0.32 | 0.23 |
| $\rho_{CAAyr}$ | -0.68 | -0.25 | -0.91 | -0.59 | -0.68 | -0.26 | -0.90 | -0.60 | -0.68 | -0.27 | -0.90 | -0.58 |
| $K^{sp}$ | 535 | (0.07) | | | 1754 | (0.07) | | | 166 | (0.05) | | |
| $B^{sp}_{2009}$ | 12 | (0.18) | | | 169 | (0.40) | | | 8 | (0.30) | | |
| $B^{5-9}_{2009}$ | 106 | (0.09) | | | 131 | (0.13) | | | 115 | (0.12) | | |
| $B^{10+}_{2009}$ | 32 | (0.16) | | | 206 | (0.37) | | | 30 | (0.22) | | |
| $MSYL^{sp}$ | 0.17 | (0.06) | | | 0.17 | (0.13) | | | 0.16 | (0.14) | | |
| $B^{sp}_{MSY}$ | 89 | (0.09) | | | 291 | (0.17) | | | 26 | (0.15) | | |
| MSY | 34 | (0.07) | | | 27 | (0.06) | | | 27 | (0.05) | | |
| $\sigma_{comCAA}$ | 0.07 | | | | 0.07 | | | | 0.07 | | | |
| Survey | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | |
| CanFall | 501 | 0.14 | 0.02 | | 670 | 0.20 | 0.02 | | 468 | 0.14 | 0.02 | |
| EU (0-700m) | 375 | 0.29 | 0.05 | | 366 | 0.29 | 0.05 | | 349 | 0.28 | 0.05 | |
| EU (0-1400m) | 398 | 0.23 | 0.02 | | 318 | 0.25 | 0.02 | | 371 | 0.23 | 0.02 | |
| CanSpr | 29 | 0.45 | 0.05 | | 34 | 0.47 | 0.05 | | 28 | 0.45 | 0.05 | |
| $\sigma_R$_out | 0.22 | | | | 0.21 | | | | 0.22 | | | |

| | 5) $h$=0.6 | | | | 6) Modified Ricker | | | | 7) fixed flat comm. sel. for ages 11+ (as in 2) and increasing $M$ with age (as in 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| '-lnL:overall | -697.7 | | | | -703.3 | | | | -693.8 | | | |
| '-lnL:Survey | -37.8 | | | | -34.2 | | | | -36.6 | | | |
| '-lnL:CAA | -230.7 | | | | -235.1 | | | | -222.4 | | | |
| '-lnL:CAAsurv | -528.3 | | | | -532.1 | | | | -531.3 | | | |
| '-lnL:RecRes | 18.7 | | | | 17.1 | | | | 20.8 | | | |
| '-lnL:SelPen | 74.7 | | | | 75.2 | | | | 70.2 | | | |
| SelSmoothing | - | | | | - | | | | - | | | |
| $h$ | **0.60** | | | | **1.43** | | | | **0.90** | | | |
| $M$ | **0.20** | | | | **0.20** | | | | **0.20** | | | |
| $\theta$ | 0.45 | | | | 0.22 | | | | 0.14 | | | |
| $\phi$ | 0.16 | | | | 0.37 | | | | 0.35 | | | |
| $\rho$ - surveys | 0.53 | | | | 0.63 | | | | 0.55 | | | |
| $\rho_{CAAage}$ | 0.48 | 0.31 | 0.31 | 0.23 | 0.48 | 0.31 | 0.31 | 0.22 | 0.48 | 0.31 | 0.32 | 0.23 |
| $\rho_{CAAyr}$ | -0.68 | -0.26 | -0.87 | -0.56 | -0.68 | -0.26 | -0.91 | -0.59 | -0.68 | -0.27 | -0.91 | -0.59 |
| $K^{sp}$ | 557 | (0.19) | | | 304 | (0.21) | | | 174 | (0.05) | | |
| $B^{sp}_{2009}$ | 42 | (0.27) | | | 22 | (0.46) | | | 8 | (0.20) | | |
| $B^{5-9}_{2009}$ | 114 | (0.12) | | | 142 | (0.15) | | | 120 | (0.08) | | |
| $B^{10+}_{2009}$ | 68 | (0.24) | | | 51 | (0.30) | | | 31 | (0.17) | | |
| $MSYL^{sp}$ | 0.28 | (0.09) | | | 0.24 | (0.23) | | | 0.16 | (0.07) | | |
| $B^{sp}_{MSY}$ | 157 | (0.20) | | | 72 | (0.20) | | | 28 | (0.09) | | |
| MSY | 19 | (0.19) | | | 31 | (0.10) | | | 29 | (0.05) | | |
| $\sigma_{comCAA}$ | 0.07 | | | | 0.07 | | | | 0.07 | | | |
| Survey | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | | $q$'s x$10^6$ | $\sigma_{surv}$ | $\sigma_{survCAA}$ | |
| CanFall | 469 | 0.14 | 0.02 | | 426 | 0.16 | 0.02 | | 462 | 0.14 | 0.02 | |
| EU (0-700m) | 291 | 0.24 | 0.05 | | 359 | 0.30 | 0.05 | | 347 | 0.28 | 0.05 | |
| EU (0-1400m) | 345 | 0.24 | 0.02 | | 317 | 0.22 | 0.02 | | 363 | 0.22 | 0.02 | |
| CanSpr | 27 | 0.44 | 0.05 | | 26 | 0.47 | 0.05 | | 28 | 0.45 | 0.05 | |
| $\sigma_R$_out | 0.21 | | | | 0.20 | | | | 0.22 | | | |

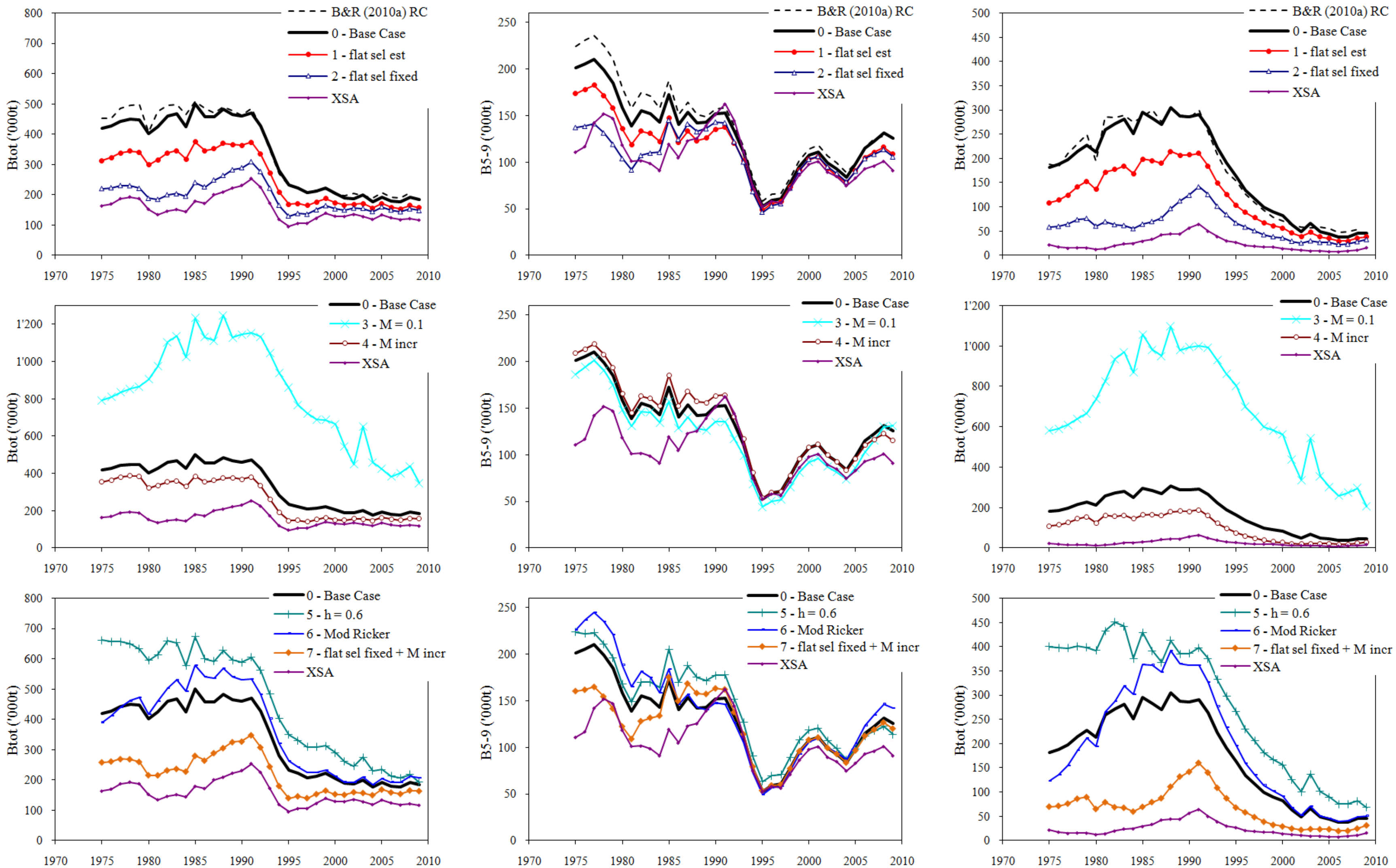


Fig. 1: Biomass trajectories for a series of SCAA variants and the 2009 XSA (Healey *et al*. 2010).

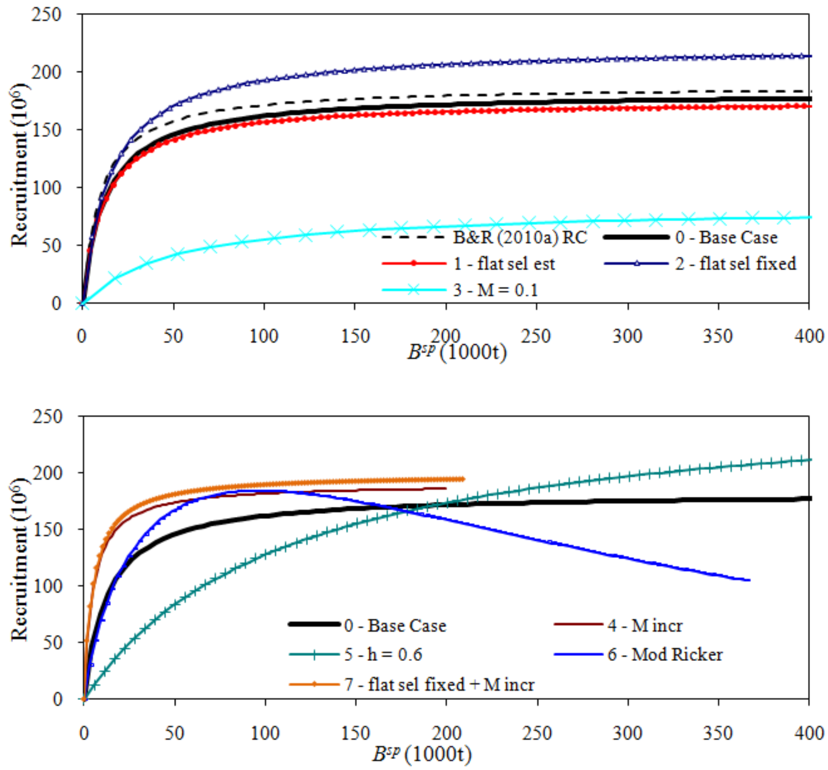


Fig. 2: Stock-recruitment relationships for a series of SCAA variants.

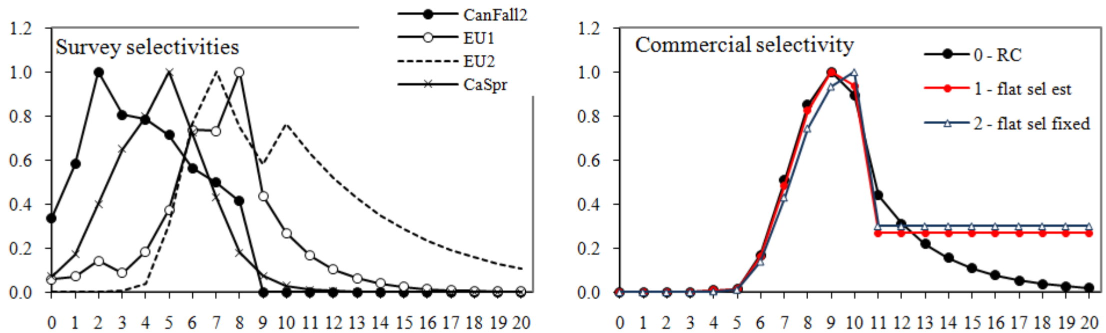


Fig. 3: Survey and commercial selectivities-at-age estimated for the RC. Commercial selectivity estimates are also shown for robustness tests 1) and 2) for which selectivity is flat for ages 11+.

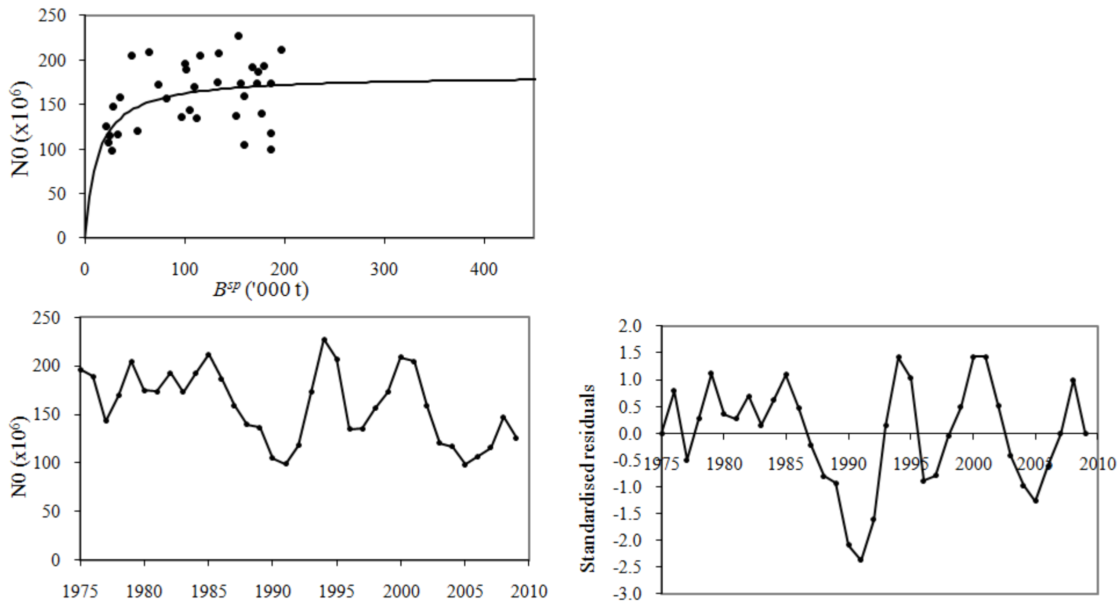


Fig. 4: Estimated stock-recruitment curve, and time series of recruitment and standardised residuals for the RC.

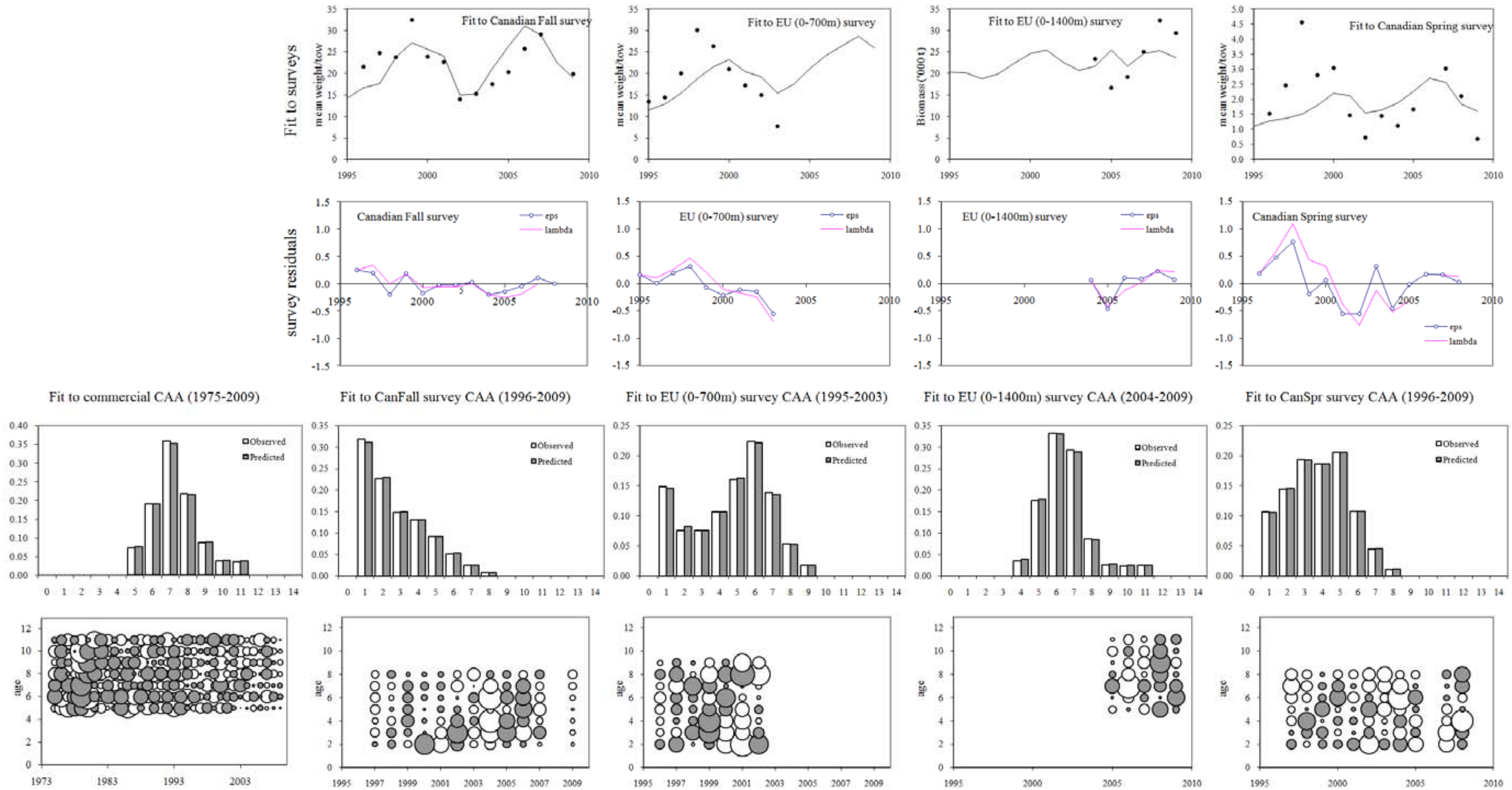


Fig. 5: Fit of the RC to the survey indices and the commercial and survey CAA. For the survey index residuals, lambda and eps refer respectively to before and after adjusting for the estimated autocorrelation. For the CAA bubble plots of residuals for the surveys, these also pertain to values after adjustment for estimated autocorrelation in both year and age. The size (area) of the bubbles are proportional to the magnitude of the corresponding standardised residuals. For positive residuals, the bubbles are grey, whereas for negative residuals, the bubbles are white.

# APPENDIX A – Data

**Table A1**: Landings (tons) for Greenland Halibut in Sub-area 2 and Div. 3KLMNO (Healey *et al*. 2010).

| Year | Landings (t) | Year | Landings (t) |
|---|---|---|---|
| 1960 | 938 | 1985 | 20347 |
| 1961 | 741 | 1986 | 17976 |
| 1962 | 588 | 1987 | 32442 |
| 1963 | 1621 | 1988 | 19215 |
| 1964 | 4252 | 1989 | 20034 |
| 1965 | 10069 | 1990 | 47454 |
| 1966 | 19276 | 1991 | 65008 |
| 1967 | 26525 | 1992 | 63193 |
| 1968 | 32392 | 1993 | 62455 |
| 1969 | 37275 | 1994 | 51029 |
| 1970 | 36889 | 1995 | 15272 |
| 1971 | 24834 | 1996 | 18840 |
| 1972 | 30038 | 1997 | 19858 |
| 1973 | 29105 | 1998 | 19946 |
| 1974 | 27588 | 1999 | 24226 |
| 1975 | 28814 | 2000 | 34177 |
| 1976 | 24611 | 2001 | 38232 |
| 1977 | 32048 | 2002 | 34062 |
| 1978 | 39070 | 2003 | 35151 |
| 1979 | 34104 | 2004 | 25486 |
| 1980 | 32867 | 2005 | 23225 |
| 1981 | 30754 | 2006 | 23531 |
| 1982 | 26278 | 2007 | 22747 |
| 1983 | 27861 | 2008 | 21178 |
| 1984 | 26711 | 2009 | 23156 |

**Table A2**. Catch at age matrix (000s) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO (Healey *et al*. 2010).

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 0 | 0 | 0 | 0 | 334 | 2819 | 5750 | 4956 | 3961 | 1688 | 702 | 135 | 279 | 288 |
| 1976 | 0 | 0 | 0 | 0 | 17 | 610 | 3231 | 5413 | 3769 | 2205 | 829 | 260 | 101 | 53 |
| 1977 | 0 | 0 | 0 | 0 | 534 | 5012 | 10798 | 7346 | 2933 | 1013 | 220 | 130 | 116 | 84 |
| 1978 | 0 | 0 | 0 | 0 | 2982 | 8415 | 8970 | 7576 | 2865 | 1438 | 723 | 367 | 222 | 258 |
| 1979 | 0 | 0 | 0 | 0 | 2386 | 8727 | 12824 | 6136 | 1169 | 481 | 287 | 149 | 143 | 284 |
| 1980 | 0 | 0 | 0 | 0 | 209 | 2086 | 9150 | 9679 | 5398 | 3828 | 1013 | 128 | 53 | 27 |
| 1981 | 0 | 0 | 0 | 0 | 863 | 4517 | 9806 | 11451 | 4307 | 890 | 256 | 142 | 43 | 69 |
| 1982 | 0 | 0 | 0 | 0 | 269 | 2299 | 6319 | 5763 | 3542 | 1684 | 596 | 256 | 163 | 191 |
| 1983 | 0 | 0 | 0 | 0 | 701 | 3557 | 9800 | 7514 | 2295 | 692 | 209 | 76 | 106 | 175 |
| 1984 | 0 | 0 | 0 | 0 | 902 | 2324 | 5844 | 7682 | 4087 | 1259 | 407 | 143 | 106 | 183 |
| 1985 | 0 | 0 | 0 | 0 | 1983 | 5309 | 5913 | 3500 | 1380 | 512 | 159 | 99 | 87 | 86 |
| 1986 | 0 | 0 | 0 | 0 | 280 | 2240 | 6411 | 5091 | 1469 | 471 | 244 | 140 | 70 | 117 |
| 1987 | 0 | 0 | 0 | 0 | 137 | 1902 | 11004 | 8935 | 2835 | 853 | 384 | 281 | 225 | 349 |
| 1988 | 0 | 0 | 0 | 0 | 296 | 3186 | 8136 | 4380 | 1288 | 465 | 201 | 105 | 107 | 129 |
| 1989 | 0 | 0 | 0 | 0 | 181 | 1988 | 7480 | 4273 | 1482 | 767 | 438 | 267 | 145 | 71 |
| 1990 | 0 | 0 | 0 | 95 | 1102 | 6758 | 12632 | 7557 | 4072 | 2692 | 1204 | 885 | 434 | 318 |
| 1991 | 0 | 0 | 0 | 220 | 2862 | 7756 | 13152 | 10796 | 7145 | 3721 | 1865 | 1216 | 558 | 422 |
| 1992 | 0 | 0 | 0 | 1064 | 4180 | 10922 | 20639 | 12205 | 4332 | 1762 | 1012 | 738 | 395 | 335 |
| 1993 | 0 | 0 | 0 | 1010 | 9570 | 15928 | 17716 | 11918 | 4642 | 1836 | 1055 | 964 | 401 | 182 |
| 1994 | 0 | 0 | 0 | 5395 | 16500 | 15815 | 11142 | 6739 | 3081 | 1103 | 811 | 422 | 320 | 215 |
| 1995 | 0 | 0 | 0 | 323 | 1352 | 2342 | 3201 | 2130 | 1183 | 540 | 345 | 273 | 251 | 201 |
| 1996 | 0 | 0 | 0 | 190 | 1659 | 5197 | 6387 | 1914 | 956 | 504 | 436 | 233 | 143 | 89 |
| 1997 | 0 | 0 | 0 | 335 | 1903 | 4169 | 7544 | 3215 | 1139 | 606 | 420 | 246 | 137 | 89 |
| 1998 | 0 | 0 | 0 | 552 | 3575 | 5407 | 5787 | 3653 | 1435 | 541 | 377 | 161 | 92 | 51 |
| 1999 | 0 | 0 | 0 | 297 | 2149 | 5625 | 8611 | 3793 | 1659 | 623 | 343 | 306 | 145 | 151 |
| 2000 | 0 | 0 | 0 | 271 | 2029 | 12583 | 21175 | 3299 | 973 | 528 | 368 | 203 | 129 | 104 |
| 2001 | 0 | 0 | 0 | 448 | 2239 | 12163 | 22122 | 5154 | 1010 | 495 | 439 | 203 | 156 | 75 |
| 2002 | 0 | 0 | 0 | 479 | 1662 | 7239 | 17581 | 6607 | 1244 | 659 | 360 | 224 | 126 | 81 |
| 2003 | 0 | 0 | 0 | 1279 | 4491 | 10723 | 16764 | 6385 | 1614 | 516 | 290 | 144 | 76 | 85 |
| 2004 | 0 | 0 | 0 | 897 | 4062 | 8236 | 10542 | 4126 | 1307 | 529 | 289 | 184 | 87 | 75 |
| 2005 | 0 | 0 | 0 | 534 | 1652 | 5999 | 10313 | 3996 | 1410 | 444 | 244 | 114 | 64 | 46 |
| 2006 | 0 | 0 | 0 | 216 | 1869 | 6450 | 12144 | 4902 | 1089 | 372 | 136 | 47 | 32 | 40 |
| 2007 | 0 | 0 | 0 | 88 | 570 | 3732 | 11912 | 5414 | 1230 | 472 | 163 | 80 | 41 | 29 |
| 2008 | 0 | 0 | 0 | 29 | 448 | 3312 | 10697 | 5558 | 1453 | 393 | 115 | 46 | 26 | 15 |
| 2009 | 0 | 0 | 0 | 61 | 476 | 3121 | 8801 | 7276 | 1949 | 508 | 206 | 67 | 31 | 34 |

**Table A3**. Catch weights-at-age (kg) matrix for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO (ages 1-13: Healey *et al*. 2010; ages 14-20+: Miller pers. commn).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 0.000 | 0.000 | 0.126 | 0.244 | 0.609 | 0.760 | 0.955 | 1.190 | 1.580 | 2.210 | 2.700 | 3.370 | 3.880 | 4.560 | 5.920 | 7.140 | 7.890 | 8.916 | 9.718 | 10.204 |
| 1976 | 0.000 | 0.000 | 0.126 | 0.244 | 0.609 | 0.760 | 0.955 | 1.190 | 1.580 | 2.210 | 2.700 | 3.370 | 3.880 | 4.560 | 5.920 | 7.140 | 7.890 | 8.916 | 9.718 | 10.204 |
| 1977 | 0.000 | 0.000 | 0.126 | 0.244 | 0.609 | 0.760 | 0.955 | 1.190 | 1.580 | 2.210 | 2.700 | 3.370 | 3.880 | 4.560 | 5.920 | 7.140 | 7.890 | 8.916 | 9.718 | 10.204 |
| 1978 | 0.000 | 0.000 | 0.126 | 0.244 | 0.609 | 0.760 | 0.955 | 1.190 | 1.580 | 2.210 | 2.700 | 3.370 | 3.880 | 4.560 | 5.920 | 7.140 | 7.890 | 8.916 | 9.718 | 10.204 |
| 1979 | 0.000 | 0.000 | 0.126 | 0.244 | 0.609 | 0.760 | 0.955 | 1.190 | 1.580 | 2.210 | 2.700 | 3.370 | 3.880 | 4.560 | 5.920 | 7.140 | 7.890 | 8.916 | 9.718 | 10.204 |
| 1980 | 0.000 | 0.000 | 0.126 | 0.244 | 0.514 | 0.659 | 0.869 | 1.050 | 1.150 | 1.260 | 1.570 | 2.710 | 3.120 | 4.420 | 5.040 | 7.020 | 10.100 | 11.413 | 12.440 | 13.062 |
| 1981 | 0.000 | 0.000 | 0.126 | 0.244 | 0.392 | 0.598 | 0.789 | 0.985 | 1.240 | 1.700 | 2.460 | 3.510 | 4.790 | 5.940 | 8.060 | 8.710 | 9.580 | 10.825 | 11.800 | 12.390 |
| 1982 | 0.000 | 0.000 | 0.126 | 0.244 | 0.525 | 0.684 | 0.891 | 1.130 | 1.400 | 1.790 | 2.380 | 3.470 | 4.510 | 5.850 | 7.530 | 8.680 | 11.500 | 12.995 | 14.165 | 14.873 |
| 1983 | 0.000 | 0.000 | 0.126 | 0.244 | 0.412 | 0.629 | 0.861 | 1.180 | 1.650 | 2.230 | 3.010 | 3.960 | 5.060 | 6.060 | 7.310 | 8.600 | 11.300 | 12.769 | 13.918 | 14.614 |
| 1984 | 0.000 | 0.000 | 0.126 | 0.244 | 0.377 | 0.583 | 0.826 | 1.100 | 1.460 | 1.940 | 2.630 | 3.490 | 4.490 | 5.730 | 6.850 | 8.330 | 9.570 | 10.814 | 11.787 | 12.377 |
| 1985 | 0.000 | 0.000 | 0.126 | 0.244 | 0.568 | 0.749 | 0.941 | 1.240 | 1.690 | 2.240 | 2.950 | 3.710 | 4.850 | 6.130 | 7.160 | 8.920 | 11.800 | 13.334 | 14.534 | 15.261 |
| 1986 | 0.000 | 0.000 | 0.126 | 0.244 | 0.350 | 0.584 | 0.811 | 1.100 | 1.580 | 2.120 | 2.890 | 3.890 | 4.950 | 6.090 | 7.640 | 9.810 | 10.100 | 11.413 | 12.440 | 13.062 |
| 1987 | 0.000 | 0.000 | 0.126 | 0.244 | 0.364 | 0.589 | 0.836 | 1.160 | 1.590 | 2.130 | 2.820 | 3.600 | 4.630 | 5.480 | 6.670 | 7.850 | 9.840 | 11.119 | 12.120 | 12.726 |
| 1988 | 0.000 | 0.000 | 0.126 | 0.244 | 0.363 | 0.569 | 0.805 | 1.163 | 1.661 | 2.216 | 3.007 | 3.925 | 5.091 | 5.858 | 7.233 | 8.485 | 11.444 | 12.932 | 14.096 | 14.800 |
| 1989 | 0.000 | 0.000 | 0.126 | 0.244 | 0.400 | 0.561 | 0.767 | 1.082 | 1.657 | 2.237 | 2.997 | 3.862 | 4.919 | 5.812 | 7.002 | 7.547 | 9.659 | 10.915 | 11.897 | 12.492 |
| 1990 | 0.000 | 0.000 | 0.090 | 0.181 | 0.338 | 0.546 | 0.766 | 1.119 | 1.608 | 2.173 | 2.854 | 3.731 | 4.691 | 5.686 | 7.082 | 8.776 | 9.826 | 11.103 | 12.102 | 12.707 |
| 1991 | 0.000 | 0.000 | 0.126 | 0.244 | 0.383 | 0.592 | 0.831 | 1.228 | 1.811 | 2.461 | 3.309 | 4.142 | 5.333 | 6.189 | 7.301 | 9.363 | 9.546 | 10.787 | 11.758 | 12.346 |
| 1992 | 0.000 | 0.000 | 0.175 | 0.289 | 0.430 | 0.577 | 0.793 | 1.234 | 1.816 | 2.462 | 3.122 | 3.972 | 5.099 | 6.197 | 7.170 | 8.267 | 10.057 | 11.364 | 12.387 | 13.006 |
| 1993 | 0.000 | 0.000 | 0.134 | 0.232 | 0.368 | 0.547 | 0.809 | 1.207 | 1.728 | 2.309 | 2.999 | 3.965 | 4.816 | 5.917 | 7.151 | 8.487 | 9.793 | 11.066 | 12.062 | 12.665 |
| 1994 | 0.000 | 0.000 | 0.080 | 0.196 | 0.330 | 0.514 | 0.788 | 1.179 | 1.701 | 2.268 | 2.990 | 3.766 | 4.882 | 5.984 | 7.540 | 7.688 | 9.456 | 10.685 | 11.647 | 12.229 |
| 1995 | 0.000 | 0.000 | 0.080 | 0.288 | 0.363 | 0.531 | 0.808 | 1.202 | 1.759 | 2.446 | 3.122 | 3.813 | 4.893 | 5.957 | 6.928 | 7.471 | 9.311 | 10.521 | 11.468 | 12.042 |
| 1996 | 0.000 | 0.000 | 0.161 | 0.242 | 0.360 | 0.541 | 0.832 | 1.272 | 1.801 | 2.478 | 3.148 | 3.856 | 4.953 | 5.876 | 6.848 | 7.946 | 8.369 | 9.456 | 10.307 | 10.823 |
| 1997 | 0.000 | 0.000 | 0.120 | 0.206 | 0.336 | 0.489 | 0.771 | 1.159 | 1.727 | 2.355 | 3.053 | 3.953 | 5.108 | 5.914 | 6.633 | 8.280 | 8.290 | 9.368 | 10.211 | 10.721 |
| 1998 | 0.000 | 0.000 | 0.119 | 0.228 | 0.373 | 0.543 | 0.810 | 1.203 | 1.754 | 2.351 | 3.095 | 4.010 | 5.132 | 5.884 | 6.445 | 7.269 | 8.218 | 9.286 | 10.122 | 10.628 |
| 1999 | 0.000 | 0.000 | 0.176 | 0.253 | 0.358 | 0.533 | 0.825 | 1.253 | 1.675 | 2.287 | 2.888 | 3.509 | 4.456 | 5.195 | 6.131 | 7.481 | 8.623 | 9.744 | 10.621 | 11.152 |
| 2000 | 0.000 | 0.000 | 0.000 | 0.254 | 0.346 | 0.524 | 0.787 | 1.192 | 1.774 | 2.279 | 2.895 | 3.645 | 4.486 | 5.082 | 5.909 | 6.919 | 8.363 | 10.157 | 11.071 | 11.625 |
| 2001 | 0.000 | 0.000 | 0.000 | 0.249 | 0.376 | 0.570 | 0.830 | 1.168 | 1.794 | 2.367 | 2.950 | 3.715 | 4.585 | 5.075 | 6.129 | 7.196 | 7.433 | 8.400 | 9.156 | 9.613 |
| 2002 | 0.000 | 0.000 | 0.217 | 0.251 | 0.369 | 0.557 | 0.841 | 1.193 | 1.760 | 2.277 | 2.896 | 3.579 | 4.407 | 5.181 | 5.631 | 6.584 | 7.076 | 7.345 | 7.426 | 7.797 |
| 2003 | 0.000 | 0.000 | 0.188 | 0.247 | 0.389 | 0.564 | 0.822 | 1.199 | 1.651 | 2.166 | 2.700 | 3.404 | 4.377 | 5.296 | 5.913 | 6.737 | 9.566 | 11.462 | 12.494 | 14.408 |
| 2004 | 0.000 | 0.000 | 0.180 | 0.249 | 0.376 | 0.535 | 0.808 | 1.196 | 1.629 | 2.146 | 2.732 | 3.538 | 4.381 | 5.099 | 6.127 | 7.086 | 7.489 | 8.463 | 9.225 | 9.686 |
| 2005 | 0.000 | 0.000 | 0.252 | 0.301 | 0.396 | 0.564 | 0.849 | 1.247 | 1.691 | 2.177 | 2.705 | 3.464 | 4.264 | 4.726 | 5.745 | 6.576 | 6.637 | 7.500 | 8.328 | 8.744 |
| 2006 | 0.000 | 0.000 | 0.129 | 0.267 | 0.405 | 0.605 | 0.815 | 1.092 | 1.495 | 1.874 | 2.396 | 3.139 | 3.747 | 4.298 | 5.225 | 6.236 | 6.603 | 6.977 | 7.605 | 7.985 |
| 2007 | 0.000 | 0.000 | 0.000 | 0.276 | 0.389 | 0.581 | 0.833 | 1.137 | 1.500 | 1.948 | 2.607 | 3.057 | 3.869 | 4.579 | 5.294 | 5.437 | 7.088 | 8.009 | 8.730 | 9.167 |
| 2008 | 0.000 | 0.000 | 0.000 | 0.278 | 0.404 | 0.617 | 0.891 | 1.195 | 1.605 | 2.038 | 2.804 | 3.247 | 4.232 | 4.400 | 5.800 | 6.831 | 8.014 | 9.056 | 9.871 | 10.364 |
| 2009 | 0.000 | 0.000 | 0.000 | 0.279 | 0.390 | 0.599 | 0.862 | 1.158 | 1.611 | 2.099 | 2.549 | 3.118 | 3.432 | 3.856 | 4.776 | 5.596 | 5.089 | 5.751 | 6.268 | 6.582 |

**Table A4**: Proportion mature-at-age for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO (Morgan pers. commn).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 0.000 | 0.001 | 0.001 | 0.001 | 0.007 | 0.003 | 0.010 | 0.036 | 0.037 | 0.027 | 0.119 | 0.205 | 0.335 | 0.501 | 0.666 | 0.796 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1976 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | 0.012 | 0.006 | 0.020 | 0.063 | 0.067 | 0.064 | 0.205 | 0.335 | 0.501 | 0.666 | 0.796 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1977 | 0.000 | 0.000 | 0.000 | 0.002 | 0.002 | 0.004 | 0.022 | 0.013 | 0.041 | 0.107 | 0.117 | 0.143 | 0.335 | 0.501 | 0.666 | 0.796 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1978 | 0.000 | 0.000 | 0.000 | 0.001 | 0.004 | 0.005 | 0.009 | 0.038 | 0.029 | 0.083 | 0.177 | 0.196 | 0.290 | 0.501 | 0.666 | 0.796 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1979 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.007 | 0.009 | 0.018 | 0.064 | 0.060 | 0.158 | 0.277 | 0.310 | 0.499 | 0.666 | 0.796 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1980 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.003 | 0.012 | 0.017 | 0.036 | 0.108 | 0.123 | 0.282 | 0.406 | 0.453 | 0.709 | 0.796 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1981 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.021 | 0.034 | 0.070 | 0.177 | 0.232 | 0.451 | 0.549 | 0.604 | 0.856 | 0.883 | 0.934 | 0.964 | 0.980 |
| 1982 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.004 | 0.011 | 0.038 | 0.064 | 0.132 | 0.275 | 0.397 | 0.632 | 0.685 | 0.738 | 0.936 | 0.934 | 0.964 | 0.980 |
| 1983 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.008 | 0.021 | 0.067 | 0.119 | 0.236 | 0.401 | 0.588 | 0.782 | 0.795 | 0.839 | 0.973 | 0.964 | 0.980 |
| 1984 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.003 | 0.016 | 0.039 | 0.114 | 0.211 | 0.384 | 0.542 | 0.756 | 0.882 | 0.874 | 0.905 | 0.989 | 0.980 |
| 1985 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.008 | 0.029 | 0.071 | 0.190 | 0.345 | 0.558 | 0.676 | 0.870 | 0.940 | 0.925 | 0.946 | 0.995 |
| 1986 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.006 | 0.023 | 0.054 | 0.126 | 0.297 | 0.509 | 0.719 | 0.787 | 0.936 | 0.970 | 0.957 | 0.970 |
| 1987 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.002 | 0.015 | 0.060 | 0.099 | 0.215 | 0.434 | 0.672 | 0.838 | 0.867 | 0.969 | 0.986 | 0.975 |
| 1988 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.005 | 0.000 | 0.006 | 0.038 | 0.152 | 0.173 | 0.343 | 0.581 | 0.801 | 0.913 | 0.920 | 0.986 | 0.993 |
| 1989 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.015 | 0.001 | 0.023 | 0.092 | 0.332 | 0.285 | 0.498 | 0.715 | 0.888 | 0.955 | 0.953 | 0.993 |
| 1990 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.003 | 0.007 | 0.051 | 0.158 | 0.081 | 0.209 | 0.581 | 0.432 | 0.653 | 0.820 | 0.940 | 0.977 | 0.973 |
| 1991 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.010 | 0.017 | 0.154 | 0.971 | 0.249 | 0.406 | 0.794 | 0.592 | 0.781 | 0.892 | 0.969 | 0.989 |
| 1992 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.007 | 0.032 | 0.045 | 0.384 | 1.000 | 0.557 | 0.640 | 0.915 | 0.735 | 0.872 | 0.937 | 0.984 |
| 1993 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.003 | 0.003 | 0.021 | 0.097 | 0.111 | 0.680 | 1.000 | 0.826 | 0.822 | 0.968 | 0.841 | 0.928 | 0.964 |
| 1994 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.007 | 0.010 | 0.062 | 0.257 | 0.250 | 0.879 | 1.000 | 0.947 | 0.923 | 0.988 | 0.910 | 0.961 |
| 1995 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.017 | 0.028 | 0.168 | 0.526 | 0.471 | 0.961 | 1.000 | 0.986 | 0.969 | 0.996 | 0.951 |
| 1996 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.006 | 0.016 | 0.041 | 0.079 | 0.364 | 0.781 | 0.703 | 0.988 | 1.000 | 0.996 | 0.988 | 0.998 |
| 1997 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.014 | 0.039 | 0.097 | 0.203 | 0.606 | 0.920 | 0.864 | 0.997 | 1.000 | 0.999 | 0.995 |
| 1998 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.002 | 0.002 | 0.037 | 0.095 | 0.213 | 0.430 | 0.806 | 0.974 | 0.944 | 0.999 | 1.000 | 1.000 |
| 1999 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.004 | 0.001 | 0.009 | 0.017 | 0.092 | 0.212 | 0.405 | 0.692 | 0.922 | 0.992 | 0.978 | 1.000 | 1.000 |
| 2000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.003 | 0.011 | 0.009 | 0.042 | 0.124 | 0.211 | 0.409 | 0.632 | 0.870 | 0.972 | 0.997 | 0.992 | 1.000 |
| 2001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.009 | 0.028 | 0.069 | 0.181 | 0.533 | 0.412 | 0.640 | 0.812 | 0.952 | 0.990 | 0.999 | 0.997 |
| 2002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.007 | 0.026 | 0.070 | 0.364 | 0.529 | 0.902 | 0.648 | 0.820 | 0.916 | 0.983 | 0.997 | 1.000 |
| 2003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.006 | 0.024 | 0.072 | 0.166 | 0.817 | 0.851 | 0.987 | 0.829 | 0.921 | 0.965 | 0.994 | 0.999 |
| 2004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.005 | 0.022 | 0.074 | 0.188 | 0.346 | 0.972 | 0.967 | 0.998 | 0.927 | 0.968 | 0.986 | 0.998 |
| 2005 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.020 | 0.076 | 0.209 | 0.406 | 0.584 | 0.996 | 0.993 | 1.000 | 0.971 | 0.987 | 0.994 |
| 2006 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.022 | 0.078 | 0.234 | 0.466 | 0.663 | 0.788 | 1.000 | 0.999 | 1.000 | 0.989 | 0.995 |
| 2007 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.022 | 0.076 | 0.259 | 0.529 | 0.742 | 0.846 | 0.908 | 1.000 | 1.000 | 1.000 | 0.996 |
| 2008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.022 | 0.076 | 0.234 | 0.592 | 0.800 | 0.905 | 0.938 | 0.963 | 1.000 | 1.000 | 1.000 |
| 2009 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.006 | 0.022 | 0.076 | 0.234 | 0.529 | 0.858 | 0.933 | 0.969 | 0.977 | 0.986 | 1.000 | 1.000 |

**Table A5**: Survey data (mean numbers per tow) of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO (Healey *et al*. 2010)

2J3K Canadian Fall, 1995-2009

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 98.68 | 47.82 | 32.01 | 9.54 | 6.28 | 2.47 | 0.84 | 0.19 | 0.18 | 0.04 | 0.02 | 0.01 | 0.02 |
| 1997 | 28.05 | 58.62 | 43.61 | 21.13 | 10.37 | 5.01 | 2.00 | 0.64 | 0.20 | 0.06 | 0.03 | 0.02 | 0.01 |
| 1998 | 23.35 | 25.07 | 31.19 | 21.87 | 10.86 | 4.45 | 2.07 | 0.57 | 0.13 | 0.06 | 0.03 | 0.02 | 0.02 |
| 1999 | 15.99 | 34.42 | 24.07 | 28.28 | 20.04 | 10.53 | 3.81 | 0.70 | 0.14 | 0.07 | 0.02 | 0.01 | 0.03 |
| 2000 | 38.57 | 21.94 | 16.43 | 13.20 | 13.76 | 7.21 | 2.16 | 0.50 | 0.06 | 0.03 | 0.02 | 0.00 | 0.01 |
| 2001 | 43.90 | 22.72 | 17.00 | 14.07 | 9.77 | 7.59 | 3.40 | 0.69 | 0.11 | 0.02 | 0.01 | 0.00 | 0.01 |
| 2002 | 40.67 | 24.08 | 12.50 | 9.68 | 6.03 | 1.97 | 0.72 | 0.19 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 |
| 2003 | 45.70 | 26.67 | 11.69 | 9.49 | 6.39 | 2.27 | 0.89 | 0.27 | 0.04 | 0.02 | 0.01 | 0.01 | 0.00 |
| 2004 | 32.49 | 32.93 | 13.89 | 12.31 | 9.21 | 2.68 | 1.20 | 0.36 | 0.08 | 0.03 | 0.01 | 0.00 | 0.01 |
| 2005 | 16.06 | 16.15 | 8.56 | 13.84 | 10.98 | 6.85 | 3.96 | 0.66 | 0.12 | 0.03 | 0.03 | 0.01 | 0.01 |
| 2006 | 32.34 | 17.98 | 8.50 | 17.60 | 13.03 | 9.11 | 4.18 | 1.15 | 0.18 | 0.03 | 0.02 | 0.01 | 0.00 |
| 2007 | 32.61 | 14.51 | 12.81 | 18.77 | 9.57 | 10.35 | 6.17 | 2.14 | 0.34 | 0.08 | 0.04 | 0.02 | 0.01 |
| 2008 | | | | | | Survey not completed | | | | | | | |
| 2009 | 50.62 | 19.15 | 11.40 | 8.42 | 9.89 | 5.40 | 3.59 | 1.39 | 0.25 | 0.08 | 0.02 | 0.01 | 0.01 |

EU Summer 0-700m, 1995-2003

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1995 | 12.41 | 2.54 | 2.23 | 1.91 | 2.66 | 5.10 | 3.77 | 2.12 | 1.31 | 0.26 | 0.07 | 0.02 |
| 1996 | 5.84 | 7.97 | 2.42 | 3.04 | 4.20 | 5.82 | 2.49 | 1.62 | 0.42 | 0.09 | 0.03 | 0.04 |
| 1997 | 3.33 | 3.78 | 6.00 | 6.50 | 7.11 | 8.46 | 4.99 | 2.15 | 0.66 | 0.22 | 0.03 | 0.02 |
| 1998 | 2.74 | 2.13 | 7.69 | 11.00 | 12.33 | 11.30 | 7.84 | 2.62 | 0.75 | 0.20 | 0.03 | 0.01 |
| 1999 | 1.06 | 0.70 | 3.01 | 10.47 | 13.41 | 12.58 | 5.55 | 1.82 | 0.35 | 0.10 | 0.01 | 0.00 |
| 2000 | 3.75 | 0.29 | 0.60 | 2.17 | 7.09 | 14.10 | 5.40 | 2.32 | 0.45 | 0.11 | 0.05 | 0.00 |
| 2001 | 8.03 | 1.43 | 1.81 | 0.99 | 2.79 | 7.79 | 6.63 | 3.21 | 0.18 | 0.05 | 0.01 | 0.00 |
| 2002 | 4.08 | 2.94 | 2.80 | 1.67 | 3.79 | 5.59 | 5.73 | 1.28 | 0.13 | 0.06 | 0.02 | 0.01 |
| 2003 | 2.20 | 1.00 | 0.61 | 1.51 | 2.48 | 2.94 | 1.93 | 0.47 | 0.13 | 0.10 | 0.02 | 0.01 |

EU Summer 0-1400m, 2004-2009

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 1.40 | 2.19 | 2.92 | 1.54 | 6.80 | 9.16 | 4.95 | 1.46 | 0.73 | 0.37 | 0.26 | 0.16 | 0.15 |
| 2005 | 0.36 | 0.53 | 2.09 | 1.73 | 5.28 | 6.79 | 3.42 | 0.99 | 0.26 | 0.41 | 0.23 | 0.13 | 0.06 |
| 2006 | 0.45 | 0.26 | 0.44 | 0.91 | 5.85 | 8.56 | 4.68 | 1.39 | 0.42 | 0.36 | 0.30 | 0.15 | 0.05 |
| 2007 | 0.25 | 0.05 | 0.39 | 0.29 | 3.84 | 9.09 | 8.57 | 2.88 | 0.72 | 0.59 | 0.30 | 0.17 | 0.07 |
| 2008 | 0.13 | 0.07 | 0.10 | 0.16 | 2.03 | 9.00 | 12.53 | 3.18 | 1.14 | 0.87 | 0.44 | 0.25 | 0.13 |
| 2009 | 0.05 | 0.01 | 0.03 | 0.08 | 1.13 | 6.80 | 11.43 | 3.55 | 0.93 | 1.03 | 0.36 | 0.28 | 0.25 |

3LNO Canadian Spring, 1996-2009

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|
| 1996 | 1.62 | 4.24 | 4.60 | 2.18 | 0.83 | 0.28 | 0.06 | 0.00 |
| 1997 | 1.16 | 3.92 | 5.16 | 3.23 | 1.46 | 0.51 | 0.10 | 0.01 |
| 1998 | 0.22 | 0.81 | 3.85 | 6.19 | 4.96 | 1.24 | 0.33 | 0.07 |
| 1999 | 0.29 | 0.55 | 1.15 | 1.98 | 3.39 | 1.09 | 0.24 | 0.05 |
| 2000 | 0.79 | 1.07 | 1.07 | 1.51 | 1.95 | 2.04 | 0.56 | 0.03 |
| 2001 | 0.57 | 0.71 | 0.74 | 0.68 | 0.80 | 0.72 | 0.28 | 0.02 |
| 2002 | 0.64 | 0.57 | 0.60 | 0.58 | 0.61 | 0.21 | 0.05 | 0.01 |
| 2003 | 0.93 | 2.14 | 1.66 | 1.57 | 1.06 | 0.21 | 0.05 | 0.01 |
| 2004 | 0.66 | 0.57 | 1.18 | 1.18 | 1.16 | 0.26 | 0.04 | 0.02 |
| 2005 | 0.35 | 0.31 | 1.09 | 0.95 | 1.37 | 0.82 | 0.21 | 0.03 |
| 2006 | | | Survey not completed | | | | | |
| 2007 | 1.60 | 0.52 | 0.80 | 0.40 | 1.41 | 1.49 | 1.12 | 0.18 |
| 2008 | 0.44 | 0.77 | 0.96 | 0.71 | 1.25 | 0.75 | 0.64 | 0.28 |
| 2009 | 0.27 | 0.22 | 0.19 | 0.39 | 0.45 | 0.26 | 0.13 | 0.07 |

**Table A6**: Survey data (kg per tow) for ages combined: 2J3K Fall and 3LNO Spr, and EU summer 0-700m and 0-1400m surveys (Healey pers. commn).

| | Canadian Fall 2J3K | EU summer (0-700m) | EU summer (0-1400m) | Canadian Spring 3LNO |
|---|---|---|---|---|
| 1995 | | 13.52 | | |
| 1996 | 21.58 | 14.42 | | 1.53 |
| 1997 | 24.80 | 20.01 | | 2.46 |
| 1998 | 23.83 | 30.13 | | 4.56 |
| 1999 | 32.48 | 26.37 | | 2.81 |
| 2000 | 23.89 | 21.08 | | 3.04 |
| 2001 | 22.69 | 17.25 | | 1.46 |
| 2002 | 14.07 | 15.05 | | 0.72 |
| 2003 | 15.31 | 7.73 | | 1.45 |
| 2004 | 17.45 | | 23.33 | 1.12 |
| 2005 | 20.34 | | 16.71 | 1.67 |
| 2006 | 25.73 | | 19.17 | |
| 2007 | 29.12 | | 25.10 | 3.03 |
| 2008 | | | 32.35 | 2.10 |
| 2009 | 19.88 | | 29.44 | 0.68 |