Northwest Atlantic   Fisheries Organization

SCIENTIFIC COUNCIL MEETING – JUNE 2017

An Assessment of the Cod Stock in NAFO Divisions 3NO

by

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Abstract

Cod within Divs. 3NO are assessed on a three year cycle by SC. There was a special request from Fisheries Commission to assess this stock in 2017 ahead of its scheduled assessment year of 2018. However, due to workload issues during the 2017 June SC meeting and the certainty that the status of the stock and associated advice would not change relative to the previous assessment, SC did not fulfill the request for a full assessment. Nevertheless, the analyses necessary for the full assessment had been completed (without projections) and are documented here.

Cod in Divisions 3NO inhabit the southern Grand Bank of Newfoundland. The stock declined dramatically during the mid-1980's and has been under a fishing moratorium since 1994. Estimates from a population model utilizing the ADAPTive framework (Gavaris 1988) indicate that the spawner biomass increased after 2010 and has been steady at 23000-25000 t over the past four years. The 2017 estimate of 25,000 t represents 42% of B_{lim} (60,000 t). Fishing mortality (ages 4-6) has been below F_{lim} (0.3) in 13 consecutive years. The strong 2005 and 2006 year classes observed in previous assessments continue to be strong in 2017 and at ages 12 and 11 comprise 70% of the total spawner biomass. More recent year classes, however, do not appear strong, which raises concern for the stock going forward. Despite the recent increase in SSB, overall abundance estimates have not increased, suggesting the growth in SSB is primarily a result of survival and growth of existing spawners rather than strong new cohorts entering the SSB.

Introduction

The Divisions 3NO cod stock occupies the southern part of the Grand Bank of Newfoundland. Fish are distributed over the shallower parts of the bank in summer, particularly in the Southeast Shoal area (Div. 3N), and on the slopes of the bank in winter when cooling occurs. Some seasonal mixing between fish in Division 3O and Subdivision 3Ps may occur. This stock has been under moratorium to all directed fishing both inside and outside the Regulatory Area since February 1994. In 1998 the Scientific Council Report recommended that there should be no directed fishing for cod in Div. 3N and 3O in 1999 and that by-catches in fisheries targeting other species should be kept at the lowest possible level. All subsequent assessments have re-iterated this advice.

This assessment updates the status of the stock, based primarily on a population model incorporating Canadian spring and fall research vessel surveys conducted in Div. 3NO. Population and spawner stock biomass estimates for 1959-2017 are provided from ADAPT utilizing the catch at age and calibrated using three Canadian research vessel surveys.

Nominal catch and catch at age

Catches from this stock peaked at 227,000 tons (t) in 1967, mainly by the former USSR and Spain, but declined steadily thereafter to 15,000 t in 1978. From 1979 to 1991 catches ranged from 20,000 to 50,000 t (Table 1, Fig. 1). A consecutive decline in TAC's in the early 1990's reduced catches to a level of about 10,000 t in 1993 the last full year of a directed fishery. Total catches since the moratorium (Table 1, Fig. 1), increased from 170 t in 1995, peaked at about 4 800 t in 2003 and have been between 600 t and 1100 t since that time. The total catch in 2016 was 666 t. The Canadian catch in 2015 and 2016 made up 26% and 22% respectively of the total catch and was taken predominantly (80%) as bycatch from the yellowtail flounder bottom trawl fishery (Table 2).

Sampling data for 2015-2016 was available from Spanish (González-Costas et al., MS 2016, 2017), Portuguese (Vargas et al., MS 2016, 2017), Russian (Fomin and Pochtar MS 2016, MS 2017) and Estonian (Tõrra et al. MS 2016, Hubel and Sirp MS 2017) otter trawl fisheries. Commercial sampling data were not available from Canada for 2015-2016. Therefore length frequency data from Spain were applied to Canadian catches, since similar ages were historically sampled by Canada and Spain. The total catch-at-age from by-catches in 2015-2016 (Fig. 2) was compiled in the most judicious manner possible given the sampling deficiencies noted (Table 3). The catch-at-age for non-Canadian fleets was constructed by applying Canadian survey age length keys to the available length sampling. A review of the sampling over the period 1995-2016 used to produce a catch-at-age for this stock (Table 4) indicates considerable sampling deficiencies.

In 1996, 1997, and 1998 the sampling was considered to be inadequate to develop a catch-at-age. An approach for developing catch at age for this period based on using an average partial recruitment pattern is presented in Stansbury et al. (1999). For 1999, 2000 and 2013 there are also gaps in the data but catch at age was estimated via the use of sampling collected by other contracting countries and by making use of Canadian research vessel survey age length keys. Age length keys available for 2013 did not adequately cover the range of ages sampled in the catch and a gap from age 11 to 16 was filled by eye. Sampling data for the 2014 Canadian catch was not available for the assessment so catch at age was estimated using annual length frequency data from EU Spain, which historically sampled cod in a size range similar to that by Canada. For 2014, there was no autumn survey to provide age length keys. Therefore, autumn 2013 keys were applied to the autumn 2014 catch.

Catch-at-age and mean weights-at-age from the fisheries in the 1959-2016 period are presented in Table 4 and Table 5. Generally, abundant age classes observed in 2012 and earlier catch at age tracked through to 2016. Inadequate sampling also presents problems for computing mean weight at age. To fill the 1996-1998 gaps, a geometric mean was computed at each age, using the three nearest non-zero values on either side of the three year window.

Research vessel survey data

Stratified-random bottom trawl surveys have been conducted in spring by Canadian research vessels in Divs. 3N and 3O since 1971 and 1973, respectively, with the exceptions of 1983 in Div. 3N, and 1974 and 1983 in Div. 3O. The stratification scheme used for these surveys is based on depth (Fig. 3, Table 6). The surveys from 1991 onwards covered areas to a maximum of 732m (400 fathoms) but prior to this only covered to a maximum of 367m (200 fathoms). In 2006 survey coverage was incomplete and the 2006 spring survey is not considered an index of population size. Surveys from 1971 to 1982 were conducted by the research vessel *A.T. CAMERON* and those since 1984 were conducted primarily by the *WILFRED TEMPLEMAN* or its sister ship *ALFRED NEEDLER* (Table 7). The 2014 spring survey was conducted by the *TELEOST.* All index strata were covered in this survey but set coverage of these index strata was reduced (95/134 sets completed). Set coverage improved in 2015 (122/134 sets completed) and 2016 (131/134 sets completed) and all index strata were completed.

Autumn surveys have been carried out in Divisions 3NO from 1990 to 2008 using the *WILFRED TEMPLEMAN* for strata less than 732 m. Starting in 1995 the *Teleost* was used for sampling strata greater than 732m to a maximum depth of 1463m (800 fathoms), but coverage has not been consistent in these greater depths. Because of vessel difficulties in 1996 the *ALFRED NEEDLER* conducted the survey in strata less than 732m. In

2009 the autumn survey was conducted by the *ALFRED NEEDLER* with only partial coverage of Div. 3N strata greater than 732m by Teleost. The Autumn survey of Divisions 3NO in 2014 was not completed due to vessel mechanical issues. All index strata were completed in 2015 (120/121 sets completed). In 2016, one index stratum (stratum 336) was not completed (only one successful set) but otherwise the set coverage was good (120/121 sets completed).

In the autumn of 1995, the Campelen 1800 shrimp trawl with rockhopper footgear was introduced in the Canadian groundfish survey, replacing the Engel 145 Hi-rise trawl that had been previously used. The Campelen trawl is towed at 3.0 knots for 15 min instead of 3.5 knots for 30 minutes in the case of the Engel trawl. The selectivities of the two nets were estimated in comparative fishing experiments in 1995 and 1996 and were found to be markedly different, with the Campelen being far more effective at catching small cod and slightly less effective at catching large cod (Warren 1997; Warren et al. 1997). Conversion of Engels catches to Campelen equivalent catches are reported by Stansbury (1996, 1997).

The location of fishing sets for the Spring and Autumn surveys and the standardized total weight of fish caught at each station are demonstrated in Fig. 4 and Fig. 5 respectively. It is clear from these plots that the largest survey catches of 3NO cod in recent years have come from southern 3N in the NAFO Regulatory Area. However, catches in the NRA in 2015 and 2016 were not as large as those in the two years prior. The lack of large fishing sets results in lower stratum-specific estimates of biomasses (Fig. 6 and Fig. 7).

Abundance and biomass estimates for the entire stock area are presented in Table 8-Table 15. Trends in the total abundance and biomass estimates are plotted for the index strata (<200 fathoms) in Fig. 8-Fig. 9. Spring abundance and biomass estimates were extremely low in both Div. 3N and Div. 3O from 1994 to about 2006. Survey indices increased after 2006, particularly from 2011-2014 and particularly in Div. 3N, but the 2015-2016 estimates are much lower. The swept area survey biomass estimate from index strata (<200 fathoms) surveyed in 3NO combined for 2016 spring is 16,788 t and for autumn is 46,667 t.

Analysis

Maturity at age

Annual proportion mature was modeled by fitting a probit model with a logit link function by cohort to observed proportions mature at age from sampling conducted during Canadian spring surveys. The model fitted the data for all cohorts from 1953 to 2007, except for the 1991 and 2000 cohorts. The estimated age at 50% maturity (A50) ranged between 5.6 and 7.4 years for cohorts produced from the 1950's to 1980's (Fig. 10). Age at 50% maturity declined between 1980 and the late 1990's from approximately 6.8 to 4.5. Age at 50% maturity increased from about 4.5 years in the late 1990s to over six years of age in the mid-2000s, but in subsequent years has decreased again to just above five years of age. The estimated proportion of females mature at age from the fitted cohort model is given in Table 19. Estimates for the 1991 and 2000 cohorts were produced by averaging the observed proportions from the two adjacent years. As the estimation is by cohort, special considerations are needed to fill the older ages for the starting years, and also for the younger ages for current years. These values were produced by averaging estimates from the 3 previous and 3 subsequent years for the appropriate age (shaded cells in Table 19). Estimated annual maturities for 1975-2016 are plotted (Fig. 11) to show trends for selected ages. These trends generally reflect the overall change in size at maturity.

Sequential Population Analysis

Survey Indices: Cohort Tracking

The assessment of this stock utilizes a sequential population analysis applying the ADAPT framework (Gavaris 1988) estimation of population size. Before updating the assessment, cohort tracking and consistency within the survey data are explored by a number of illustrative and standardized age-disaggregated plots, including (a) age-disaggregated plots of mean number per tow 3NO, (b) pair-wise scatter plots and correlations of age-disaggregated survey data (log-scale) and (c) standardized proportions by age across years (SPAY). In the SPAY plots the annual index proportions were standardized at each age to have a mean of 0 and a variance of 1.

For the Canadian Spring survey, the 1989 and 1990 year classes were the most dominant in the series from 1990 to 2008 (Fig. 12) but at different ages. For example, the 1989 year class was dominant at ages 2, 4, 7, 9 and 10 whereas the 1990 year class was dominant at ages 3 and 8. The 2006 year class shows up strong as age 3 in 2009. In 2015 and 2016 this cohort continued to show up as strong at ages 9 and 10 respectively. Pairwise plots and correlations (Fig. 13) indicate generally good tracking between ages for cohorts.

For the Canadian Autumn survey the 1989 and 1990 year classes were amongst the most dominant in the series (Fig. 15) and also illustrate a similar pattern as the spring. The 1989 year class was dominant at ages except 7 whereas the 1990 cohort is only dominant at age 7, 8. The 1997 and/or 1998 cohorts were also very apparent at ages 3-9, something not so obvious in the spring series. A decline in density is also quite dramatic by age 5 for most cohorts. The pairwise plots and correlations (Fig. 16) also indicate generally good tracking between ages for cohorts although correlations were not as good as in the spring.

Standardized indices by age for the Canadian Spring and Autumn surveys are compared in Fig. 18. The EU-Spain survey is also included for comparison. The results indicate generally good tracking for the Canadian surveys.

ADAPTive Framework

The catch at age (Table 4) was used in a sequential population analysis applying the ADAPT framework (Gavaris 1988). The catch for age 2 is from the NAFO SCR Docs series presented from 1988 to 1998. Zero catch was assumed for age 2 in years 1959-1987. Due to inadequate sampling of removals, total catch for 1996-1998 was proportioned by age using the average partial recruitment vector from 1990-93 (from a previous ADAPT run) with the fully recruited F estimated from a catch projection so as to match the observed catch (further details in catch-at-age section). Catches since that time have been based on fishery sampling although for some contracting parties constructing catch at age required using Canadian RV age-length keys (see Table 3).

The ADAPT was calibrated with Canadian RV survey indices at age from spring 1984-2005 and 2007-2016 (Table 16), autumn 1990-2013 and 2015-2016 (Table 17) and a Canadian juvenile survey 1989-94 (Table 18) to estimate population numbers $N_{i, t}$,

where i = 3 to 12, for t = 2017 (10 parameters) and i =12, for t=1994 to 2016 (23 parameters),

and Catchabilities
  $q1_i$ where i = 2 to 10 for the Canadian Research Vessel survey spring (RV1) (9 parameters)
  $q2_i$ where i = 2 to 10 for the Canadian Research Vessel survey autumn (RV2) (9 parameters)
  $q3_i$ where i = 2 to 10 for the Juvenile Research Vessel survey (RV3) (9 parameters)

The following structure was imposed:
    natural mortality was assumed to be 0.2,
    fishing mortality on the oldest age (12) set equal to the average F for ages 6 to 9 for years 1959-1993,
    no "plus" age class,
    equal weighting of all indices,
    no error in the catch numbers-at-age.

Input data were:

> Catch numbers at age,
> Ci,t   where i = 2 to 12 and t = 1959 to 2016 ,
> Canadian Research Vessel survey estimates of mean numbers per tow-at-age (Campelen or Campelen equivalent values),
> RV1i,t   where i = 2 to 10 and t = 1984 to 2005 and 2007-2016, spring
> RV2i,t   where i = 2 to 10 and t = 1990 to 2013 and 2015-2016, autumn
> and Canadian juvenile Research Vessel survey estimates of mean numbers per tow-at-age (Yankee 41.5 shrimp trawl in August – September)
> RV3i,t   where i = 2 to 10 and t = 1989 to 1994 .

The objective function minimized is

$$SS = \sum_{s,i,t} \{\ln(RV_{s,i,t}) - \ln(q_{s,i} N_{i,t})\}^2$$

where s= Survey 1 to 3 , i =age 2 to 10, t= year of survey.

This particular model formulation was selected since it follows the accepted VPA from the last assessment in 2013 and effectively deals with problems associated with zeros in the catch matrix at the age 12 (by estimating survivors at age 12 in these years). The statistics associated with the ADAPT output are given in Table 20. The mean square error of the residuals of the model fit was 0.599 based on an estimation of 60 parameters. For the survivors estimated in 2017, the relative error in the parameter estimates decreased with age from a high of 56% at age 3 to 23% at ages 11 and 12.

The estimated survey catchabilities (q's) with associated standard errors are also provided in Table 20 and Fig. 19. Survey catchabilities (q's) generally decrease with age for all three surveys with the spring and autumn tending to having similar q's for ages 7-10. The Yankee 41.5 (juvenile survey) catchability for age 2 is much higher than that for the Campelen surveys.

Diagnostic residual plots from the ADAPT run are presented in Fig. 20-Fig. 21. Overall the spring and autumn surveys show little pattern in the residuals, although there are some year effects. These are evident in the spring survey in 1987, 1993, 1996 and 1998 (mostly positive) and 1989, 1995, 2002 (mostly negative). The fall 1997 estimates have large negative residuals, particularly for ages 5, 6 and 7. The residuals for 2015 and 2016 spring and autumn surveys are negative for most ages.

Bias-adjusted estimates of population numbers (Fig. 22) and fishing mortality at age (Fig. 23) are given in Table 21 and Table 22 respectively. The age 2 value in 2015 is the geometric mean of the 2012-2014 age 2 estimates from the ADAPT. Population numbers remain low. There was a small increase between 2006-2008 but there has been a leveling or declining trend since that time. No good recruitment (Fig. 24) has been observed since 2009 (i.e. the 2006 year class).

The relatively strong 2005 and 2006 cohorts noted in previous assessments continue to be relatively strong in 2017. The strength of these year classes is still low relative to historic estimates. Fishing mortality (Table 22, Fig. 23) on the prominent age groups in the fishery has been very low since 2008 (< 0.1).

Beginning of year mean weight-at-age calculated from the commercial catch is presented in Table 23. These weights are used to calculate biomass, given in Table 24. Stock biomass reached an historic low in 1995. Biomass slowly increased over the 2004-2012 period and has remained stable at 25,000-28,000 t since that time. The maturities computed from the cohort model were applied to the population numbers to compute the spawner stock biomass (Table 25, Fig. 25). SSB increased after 2010 and has been steady at 23,000-25,000 t over the past four years. The 2017 estimate of 25,101 t represents 42% of Blim (60,000 t). The relatively strong 2005 and 2006 cohorts account for 70% of the SSB in 2017 at ages 10 and 9 respectively.

<u>Retrospective analysis</u>

A retrospective analysis was conducted to investigate whether systematic trends were apparent in the population modeling. A 5 year period was chosen to evaluate whereby a complete year of data was removed, one year at a time in succession (for catch at age and survey indices at age), and the estimation with identical structure to the VPA formulation above was repeated for each case. The resulting retrospective patterns do not show any consistent bias in the assessment (Fig. 26).

References

Fomin, K., and Pochtar, M. 2016. Russian Research Report for 2015. SCS Doc. 16/10. Ser. No. N6562.

Fomin, K., and Pochtar, M. 2017. Russian Research Report for 2016. SCS Doc. 17/11. Ser. No. N6686.

Gavaris, S. MS 1988. An adaptive framework for the estimation of population size. CAFSAC Res. Doc. 88/29, 12p.

González-Costas F., Ramilo,G., Román, E., González-Troncoso, D., Casas, M., Sacau, M., Guijarro, E., and Lorenzo, J. MS 2017. Spanish Research Report for 2016. NAFO SCS Doc. 17/4, Ser. No. N6656.

González-Costas F., Ramilo,G., Román, E., Casas, M., Sacau, M., Guijarro, E., González-Troncoso, D., and Lorenzo, J. MS 2016. Spanish Research Report for 2015. NAFO SCS Doc. 16/5, Ser. No. N6539.

Hubel, K., Sirp, S. 2017. Estonian Research Report for 2016. NAFO SCS Doc. 17/09, Ser No N6681.

Rideout, R.M., Ings, D.W., Brattey, J., and Dwyer, K. 2015. An assessment of the cod stock in NAFO Divisions 3NO. NAFO SCR Doc. 15/34, Ser. No. N6460.

Stansbury, D.E. MS 1996. Conversion factors from comparative fishing grids for Engels 145 otter trawl on the FRV Gadus Atlantica and the Campelen 1800 shrimp trawl on the FRV Teleost. NAFO SCR Doc. 96/77.

Stansbury, D.E. MS 1997. Conversion factors from comparative fishing grids for Engels 145 otter trawl and the Campelen 1800 shrimp trawl used on research vessels. NAFO SCR Doc. 97/31.

Stansbury, D.E., P.A. Shelton, E.F. Murphy and J. Brattey. MS 1999. An assessment of the cod stock in NAFO Div. 3NO. NAFO SCR Doc. 99/62 (revised), Ser No. N4121, 41p.

Tõrra, T., Sirp, S., and Hubel, K. MS 2016. Estonian Research Report for 2015. NAFO SCS Doc. 16/08, Ser. No. N6554.

Vargas, J., Alpoim, R., Santos, E. and Ávila de Melo, A.M. MS 2016. Portuguese Research Report for 2015. NAFO SCS Doc. 16/09, Ser. No. N6555.

Vargas, J., Alpoim, R., Santos, E. and Ávila de Melo, A.M. MS 2017. Portuguese Research Report for 2016. NAFO SCS Doc. 17/05, Ser. No. N6658.

Warren, W.G. MS 1997. Report on the comparative fishing trial between the Gadus Atlantica and Teleost. NAFO Sci. Coun. Studies 2: 81-92.

Warren, W.G., Brodie, W., Stansbury, D., Walsh, S., Morgan, J., and Orr, D. MS 1997. Analysis of the 1996 comparative fishing trial between the Alfred Needler with the Engel 145 trawl and the Wilfred Templeman with the Campelen 1800 trawl. NAFO SCR Doc. 97/68.

Table 1. Catch (t) of cod in NAFO Divisions 3NO.

Year	Canada	Others	Total	TAC
1953	39884	26313	66197	
1954	17392	117369	134761	
1955	6053	108303	114356	
1956	5363	59519	64882	
1957	9641	80549	90190	
1958	4812	43239	48051	
1959	3687	60683	64370	
1960	3408	76269	79677	
1961	5428	67296	72724	
1962	3235	31749	34984	
1963	5079	64663	69742	
1964	2882	61579	64461	
1965	4229	94958	99187	
1966	6501	102418	108919	
1967	3446	223338	226784	
1968	3287	162224	165511	
1969	3664	114041	117705	
1970	4771	106790	111561	
1971	2311	123985	126296	
1972	1736	101638	103374	
1973	1832	78597	80429	103000
1974	1360	72029	73389	101000
1975	1189	42985	44174	88000
1976	2065	22218	24283	43000
1977	2532	15072	17604	30000
1978	6246	8472	14718	15000
1979	9938	17913	27851	25000
1980	5589	14402	19991	26000
1981	6096	18248	24344	26000
1982	10185	21420	31605	17000
1983	11374	17445	28819	17000
1984	8705	18398	27103	26000
1985	18179	18720	36899	33000
1986	18035	32610	50645	33000
1987	18652	22967	41619	33000
1988	19727	23423	43150	40000
1989	13433	19782	33215	25000
1990	10620	18226	28846	18600
1991	12056 [2]	17396 [3]	29454	13600
1992	7859	4893 [3]	12752	13600
1993	5370	5276 [3]	10646	10200
1994	47	2655 [3]	2702	6000 [5]
1995	64	108 [3]	172	ndf
1996	99	75 [3]	174	ndf
1997	286	97 [3]	383	ndf
1998	396	151 [3]	547	ndf
1999	568	351 [3]	919	ndf
2000	207	843 [3]	1050	ndf
2001	560	750 [3]	1310	ndf
2002	444	1750 [3]	2194	ndf
2003	818	4052 [3]	4870 [4]	ndf
2004	442	492 [3]	934	ndf
2005	461	263 [3]	724	ndf
2006	108	492 [3]	600	ndf
2007	203	645 [3]	848	ndf
2008	247	676 [3]	923	ndf
2009	165	918 [3]	1083	ndf
2010	107	839 [3]	946	ndf
2011	44	823	867	ndf
2012	26	708	734	ndf
2013	226	887 #	1113	ndf
2014 [1]	197	537 #	734	ndf
2015	151	435	586	ndf
2016	147	519	666	ndf

[1] Provisional
[2] Includes an estimate of 4000 t deemed misreported to Div. 3L.
[3] Includes estimates by Canadian Surveillance and by NAFO Scientific Council.
[4] Catch could not be precisely estimated but is in the range of 4, 280 - 5, 460 tons
[5] There has been no directed fishery since February 1994.

Table 2. Cod landings (t) by month and gear from NAFO Divisions 3NO by Canada in 2015 and 2016.

| 2015 | Canada (N) | | | | | | Canada (M) | | | | |
| | 3N | | 3O | | | | 3N | | 3O | | |
Month	Ottertrawl	Longline	Ottertrawl	Gillnet	Longline	Other	Ottertrawl	Longline	Ottertrawl	Longline	
Jan			0.952								
Feb											
Mar	0.13		2.20								
Apr	0.04	0.40	18.13		0.96				2.23	0.04	
May	0.37	0.67	2.82					6.49	2.07	0.96	
Jun	9.46	0.59	33.02					2.95		0.11	
Jul								1.20		2.38	
Aug	0.29		14.16	0.08				0.75		0.06	
Sep	0.19		14.82					0.56		7.01	
Oct	3.09	0.38	18.05								
Nov	1.10		0.97								
Dec	4.22		2.47								
	18.88	2.04	107.58	0.08	0.96	0.00	0.00	11.96	4.30	10.55	156.35

| 2016 | Canada (N) | | | | | | Canada (M) | | | | |
| | 3N | | 3O | | | | 3N | | 3O | | |
Month	Ottertrawl	Longline	Ottertrawl	Gillnet	Longline	Other	Ottertrawl	Longline	Ottertrawl	Longline	
Jan	12.38		0.291								
Feb	3.43		2.01		0.13						
Mar			4.87							0.03	
Apr			18.42		0.04			0.03	0.33	1.42	
May			0.48					2.42	0.37	2.09	
Jun	7.31	0.36						0.33		3.41	
Jul	17.85	0.35						0.33		0.06	
Aug	1.63	0.62	0.18	0.51				1.20			
Sep	16.51	0.36	8.13			0.24					
Oct	2.45		7.84								
Nov	15.18		5.52								
Dec	8.88		0.21								
	85.62	1.69	47.95	0.51	0.17	0.24	0.00	4.31	0.71	7.01	148.21

Table 3. A review of sampling used to compile catch at age for 3NO cod. Highlighted years note use of Canadian RV age/length keys to some commercial catches. Details for the estimation of catch at age for previous years are available in Rideout et al. (2015).

	Sampling	Canada	Spain	Portugal	Other
2005	Bycatch in Canadian ottertraw l fishery w as adequetly sampled providing frequencies and keys. Length frequencies provided by Spain and Russia w ere used in conjunction w ith Canadian Research Surveys keys to create catch at age for Spain, Portugal, Russia and Estonia.	2/LL 4706/OT	6109/OT		125/OT
2006	Canadian cod bycatch w as taken mainly in the ottertraw l and gillnet fishery for redfish and hake , sampling w as limited mainly to frequencies. Canadian autumn research keys w ere used. Frequencies provided by Portugal and Russia w ere used in conjunction w ith Canadian autumn research keys to compile catch at age for Portugal, Spain, Estonia and Lithuania.	44/GN 478/OT		3269/OT	125/OT
2007	Canadian cod by catch w as taken in the ottertraw l fishery for yellow -tail, redfish and hake. The ottertraw l fishery w as sampled by observers. About 40 % of the Canadian catch w as taken in longline fisheries and no sampling exist for this catch	1457/ OT NO LL	401 (135 mm mesh) /OT No sampling for 280mm mesh	376 (130mm mesh)/OT; 18 (280mm mesh)/OT	811 /OT /Russian fishery
2008	Canadian cod by catch w as taken in the ottertraw l fishery for yellow -tail, redfish and hake. The ottertraw l fishery w as sampled by observers. About 25 % of the Canadian catch w as taken in longline fisheries and no sampling exist for this catch	1796 OT NO LL	408 OT	41 OT for 3O	519 OT
2009	Canadian cod by catch w as taken in the ottertraw l fishery for yellow -tail, redfish and hake. The ottertraw l fishery w as sampled by observers. About 20 % of the Canadian catch w as taken in longline fisheries and no sampling exist for this catch. Canadian research survey keys used to age all catch	246/OT length and 24 aged fish	511(130mm, 3N)/OT; 98(280mm, 3N)/OT	1935 OT	
2010	Canadian cod by catch w as taken in the ottertraw l fishery for yellow -tail and amounted to 109 t. Canadian research survey keys used to age all catch	90 comercial and 997 research ages	1354 measured	2467 130mm and 223 280mm mesh measured	171 measured
2011	Canadian cod by catch w as taken in the ottertraw l fishery for yellow -tailand amounted to 54 t. Canadian research survey keys used to age all catch.	23 commercial and 959 research aged	396 measured	5042 measured	100 measured
2012	Canadian cod by catch w as taken in the ottertraw l fishery for yellow -tailand amounted to 26 t. Canadian research survey keys used to age all catch	1441 research ages	2411 measured	4484 measured	
2013	Canadian cod bycatch w as taken primarily in the ottertraw l fishery for yellow tail flounder. The ottertraw l fishery w as sampled by observers. Q4 length frequencies for otter traw ls (130 mm) from Spain applied to Q4 Canadian otter traw l catch. Canadian research survey keys used to age all catch.	1120 / OT and 66 aged fish	174 (130 mm, 3NO)/OT, 865 (280mm, 3N)/ OT	6293 (130 mm, 3NO)/OT, 561 (280mm, 3N)/OT	387 OT/Estonia
2014	Canadian cod bycatch w as primarily taken in the ottertraw l fishery for yellow tail flounder. Annual length frequencies for EU Spain otter traw ls (130 mm) applied to all Canadian otter traw l catch. Canadian research survey keys from spring 2014 used to age 2014 spring catch, but fall 2013 keys used to age fall catch.	no length or age data available	454 (130 mm, 3NO)/OT, 795 (280 mm, 3NO)/OT	4327 (130 mm, 3NO)/OT, 84 (280 mm, 3N)/OT	none
2015	Canadian cod bycatch w as taken in the ottertraw l fishery for ..... Annual length frequencies for EU Spain otter traw ls (130 mm) applied to all Canadian otter traw l catch. Canadian research survey keys from spring and fall 2015 w ere used to age all catch.	no length or age data available	246 (130 mm, 3N)/OT, 539 (280 mm, 3NO)/OT	7460 (130 mm, 3NO)/OT	101 OT/Estonia , 255 OT/Russia
2016	Canadian cod bycatch w as taken in the ottertraw l fishery for yellow tail flounder and w itch flounder. Annual length frequencies for EU Spain otter traw ls (130 mm) applied to all Canadian otter traw l catch. Canadian research survey keys from spring and fall 2016 w ere used to age all catch.	no length or age data available	141 (130 mm, 3O)/OT, 902 (280 mm, 3NO)/OT	1888 (130 mm, 3NO)/OT	221 OT/Estonia , 40 OT/Russia

Table 4. Catch at age used in this assessment for Divisions 3NO cod ('000s).

Cn	2	3	4	5	6	7	8	9	10	11	12
1959	0	1711	13036	5068	6025	3935	1392	757	926	1220	103
1960	0	1846	6503	22050	3095	2377	2504	583	387	898	242
1961	0	812	4400	11696	15258	2014	1672	847	196	25	245
1962	0	1026	3882	2206	1581	3594	773	668	433	226	216
1963	0	313	5757	11210	4849	1935	3840	1165	608	322	208
1964	0	6202	15555	19496	7919	2273	1109	788	328	37	112
1965	0	1013	7611	7619	13258	9861	4827	1081	1248	163	141
1966	0	753	18413	19681	11795	8486	4467	1829	1694	122	57
1967	0	20086	62442	50317	18517	4774	4651	236	180	71	45
1968	0	16359	56775	48608	18485	6337	1592	505	178	90	45
1969	0	8154	12924	26949	11191	2089	1393	518	292	134	202
1970	0	2105	19703	10799	9481	3646	1635	541	149	227	90
1971	0	950	26900	30300	11700	3500	2500	500	200	100	50
1972	0	69	19797	12289	13432	5883	1686	285	216	78	74
1973	0	10058	27600	15098	5989	1971	972	707	243	137	116
1974	0	6425	9501	10907	10872	2247	2147	1015	676	428	257
1975	0	671	8781	3528	2505	3057	1059	921	461	252	152
1976	0	4054	7534	5945	1084	211	238	44	37	13	9
1977	0	607	2469	2531	1500	572	177	209	65	41	25
1978	0	920	4337	2518	818	354	102	58	51	8	5
1979	0	72	3827	9208	2784	883	265	58	17	12	7
1980	0	266	1055	3812	2275	761	222	92	31	8	13
1981	0	505	1091	1262	2297	1902	574	192	94	41	13
1982	0	305	1978	1591	1012	1528	1492	595	211	162	27
1983	0	1179	647	1893	1204	686	1152	774	238	81	41
1984	0	58	1000	1411	2324	1220	720	918	551	106	42
1985	0	57	2953	6203	3036	2519	797	459	533	261	97
1986	0	153	2865	6423	4370	1512	948	558	373	349	135
1987	195	516	422	3491	3445	1213	653	845	494	398	404
1988	256	277	318	1527	6347	3955	1009	567	425	249	142
1989	127	1917	2182	1502	1260	1887	1284	485	233	168	100
1990	410	1064	4505	4341	895	422	721	581	439	150	83
1991	6028	1103	673	995	544	282	368	568	502	383	202
1992	83	4508	1769	837	612	235	64	99	128	153	100
1993	33	1314	3209	637	479	321	74	25	39	49	53
1994	0	232	2326	1117	125	93	26	8	1	0	0
1995	0	0	72	20	40	2	0	1	0	0	0
1996	2	4	5	3	17	25	3	2	3	1	0
1997	1	12	18	11	5	31	45	5	4	5	3
1998	1	3	23	21	10	5	28	41	4	4	5
1999	46	94	41	101	40	14	6	23	55	3	2
2000	10	356	339	87	62	21	12	4	13	12	2
2001	10	187	302	160	11	43	23	7	2	9	12
2002	100	218	550	427	141	9	27	13	3	1	6
2003	43	337	810	1274	669	133	5	18	8	2	1
2004	11	37	45	50	92	73	21	1	7	3	1
2005	1	1	1	2	4	28	55	20	1	3	2
2006	45	214	168	82	21	5	10	2	2	0	0
2007	4	205	289	93	25	9	6	9	10	2	0
2008	1	4	58	165	41	20	2	3	20	13	7
2009	12	262	167	136	90	26	11	1	4	7	16
2010	249	214	459	195	75	39	13	0	2	0	1
2011	44	187	56	133	44	47	46	7	4	1	0
2012	26	217	197	38	96	35	16	14	5	1	0
2013	21	169	239	151	41	121	54	24	10	4	0
2014	60	194	144	156	59	55	29	13	4	2	0
2015	10	60	101	51	82	32	9	38	7	2	0
2016	12	81	103	77	30	45	30	5	29	15	0

Table 5. Catch weight at age used in this assessment for Divisions 3NO cod.

Cw	3	4	5	6	7	8	9	10	11	12
1959	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1960	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1961	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1962	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1963	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1964	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1965	0.42	0.82	1.25	1.95	2.82	3.39	3.98	4.68	5.25	6.17
1966	0.48	0.90	1.35	2.14	3.16	4.21	6.34	7.69	8.46	10.24
1967	0.48	0.90	1.35	2.14	3.16	4.21	6.34	7.69	8.46	10.24
1968	0.48	0.90	1.35	2.14	3.16	4.21	6.34	7.69	8.46	10.24
1969	0.48	0.90	1.35	2.14	3.16	4.21	6.34	7.69	8.46	10.24
1970	0.48	0.90	1.35	2.14	3.16	4.21	6.34	7.69	8.46	10.24
1971	0.48	0.90	1.35	2.14	3.16	4.21	6.34	7.69	8.46	10.24
1972	0.54	0.97	1.44	2.08	2.89	3.56	5.95	7.95	8.32	10.14
1973	0.57	1.00	1.43	2.19	3.63	4.63	6.25	9.56	11.17	13.99
1974	0.42	0.73	1.20	1.96	2.86	4.67	7.32	5.46	8.40	7.51
1975	0.38	0.89	1.28	2.13	3.14	4.16	5.53	6.74	5.27	7.09
1976	0.50	0.91	1.41	2.33	3.25	4.03	6.67	8.74	9.14	12.49
1977	0.57	1.00	1.48	2.48	3.51	4.74	7.17	8.81	11.70	11.47
1978	0.72	1.05	1.55	2.25	3.74	4.61	6.19	7.23	9.48	12.87
1979	0.65	0.98	1.39	2.09	2.87	3.70	4.75	7.15	7.98	10.11
1980	0.71	1.04	1.69	2.50	3.69	5.49	7.98	9.22	10.60	12.61
1981	0.90	1.27	1.84	2.69	3.55	5.33	7.13	9.10	9.01	10.15
1982	0.94	1.17	1.50	2.20	3.83	5.26	7.49	8.80	9.82	12.28
1983	0.85	1.17	1.87	2.63	3.80	5.20	6.27	8.08	8.99	11.01
1984	0.79	1.15	1.51	2.28	3.04	4.05	5.76	7.22	8.92	12.61
1985	0.48	0.86	1.37	2.05	3.25	4.65	6.62	8.32	9.15	11.13
1986	0.39	1.01	1.52	2.16	3.49	5.41	7.95	9.82	9.94	9.88
1987	0.49	0.82	1.30	1.83	2.89	4.76	7.26	8.95	9.85	12.59
1988	0.74	1.00	1.38	1.79	2.23	3.77	5.12	6.88	9.37	11.07
1989	0.51	0.97	1.60	2.24	3.27	4.61	7.08	8.31	9.47	12.25
1990	0.55	1.01	1.46	2.51	2.73	4.14	5.02	8.37	9.29	11.25
1991	0.55	0.85	1.59	2.30	3.83	5.56	7.53	9.04	11.98	13.98
1992	0.33	0.65	1.06	1.80	2.82	4.85	5.56	7.43	8.64	10.65
1993	0.36	0.78	1.35	1.84	2.82	4.11	5.87	7.76	8.79	8.67
1994	0.27	0.46	0.91	1.63	1.84	4.04	4.94	7.54	3.44	7.52
1995	0.42	0.75	1.21	2.03	2.29	2.08	6.60	6.22	6.41	8.03
1996	0.42	0.78	1.30	1.99	2.68	3.38	4.70	5.98	6.41	8.03
1997	0.42	0.78	1.30	1.99	2.68	3.38	4.70	5.98	6.41	8.03
1998	0.42	0.78	1.30	1.99	2.68	3.38	4.70	5.98	6.41	8.03
1999	0.50	0.94	1.59	2.07	2.23	2.83	3.99	6.05	6.73	7.38
2000	0.60	0.82	1.45	2.39	3.44	2.90	2.64	3.78	5.25	6.07
2001	0.58	1.09	1.38	2.07	4.06	5.22	5.32	5.51	7.51	8.60
2002	0.67	1.01	1.52	2.24	3.38	5.15	5.99	7.11	8.47	9.32
2003	0.67	0.94	1.40	2.02	3.01	4.10	7.63	7.74	8.52	9.23
2004	0.69	0.92	1.38	2.17	3.03	3.93	5.79	8.54	9.70	8.77
2005	0.49	1.41	2.46	3.43	3.95	4.94	5.90	9.30	10.28	11.42
2006	0.68	1.11	1.36	2.05	2.60	3.26	4.66	7.07	7.39	14.86
2007	0.61	1.00	1.39	2.52	2.90	4.71	5.16	6.75	6.67	8.39
2008	0.35	1.04	1.59	1.95	2.91	2.63	5.84	5.90	6.36	10.03
2009	0.46	0.65	1.31	2.16	2.68	3.80	4.55	8.20	7.51	8.81
2010	0.33	0.67	0.89	1.95	2.73	3.14	6.04	4.42	10.06	10.19
2011	0.49	0.62	1.13	1.60	3.47	4.77	5.53	4.72	5.58	9.68
2012	0.55	0.75	1.13	1.64	1.91	4.20	5.64	6.50	8.72	9.68
2013	0.43	0.70	1.12	1.52	2.17	2.29	4.60	6.05	6.54	12.04
2014	0.46	0.82	1.22	1.39	2.06	2.05	3.02	6.69	6.96	10.47
2015	0.56	0.84	1.24	1.87	2.27	2.41	2.96	3.35	4.05	14.34
2016	0.51	0.73	0.98	1.34	2.51	2.61	2.60	4.21	4.72	15.27

Table 6. Details on the stratification scheme used for the assessment of 3NO cod.

NAFO Div.	Depth Range (fathoms)	Strata	Area Sq. mi.
3N	0-30	375	1593
		376	1499
	31-50	360	2992
		361	1853
		362	2520
		373	2520
		374	931
		383	674
	51-100	359	421
		377	100
		382	647
	101-150	358	225
		378	139
		381	182
	151-200	357	164
		379	106
		380	116
	201-300	723	155
		725	105
		727	160
	301-400	724	124
		726	72
		728	156

NAFO Div.	Depth Range (fathoms)	Strata	Area Sq. mi.
3O	31-50	330	2089
		331	456
		338	1898
		340	1716
		351	2520
		352	2580
		353	1282
	51-100	329	1721
		332	1047
		337	948
		339	585
		354	474
	101-150	333	151
		336	121
		355	103
	151-200	334	92
		335	58
		356	61
	201-300	717	166
		719	76
		721	76
	301-400	718	134
		720	105
		722	93

Table 7. Information on the timing and vessel/trip numbers for the Canadian Spring and Autumn surveys.

Year	Spring Survey			Autumn Survey		
	Vessel(s) & Trips	Start Date (mm/dd)	End Date (mm/dd)	Vessel(s) & Trips	Start Date (mm/dd)	End Date (mm/dd)
1984	AN 27	04/28	05/08			
1985	AN 43	04/11	04/25			
1986	WT 47	04/18	05/04			
1987	WT 58-60	04/23	05/14			
1988	WT 70	04/21	05/05			
1989	WT 82	04/20	05/06			
1990	WT 95-96	05/05	06/01	WT 101-102	11/22	12/09
1991	WT 105-106	04/19	05/11	WT 113-115	10/19	11/10
1992	WT 119-120	04/22	05/13	WT 128-130	10/20	11/05
1993	WT 136-137	04/27	05/18	WT 144-146	10/24	11/12
1994	WT 152-153	04/30	05/22	WT 160-161	10/25	11/13
1995	WT 168-169	05/03	05/27	WT 176-177	09/26	10/26
1996	WT 188-189	05/07	05/30	WT 200, TEL 42, AN 253	11/24	12/17
1997	WT 204-208	04/30	06/04	WT 212-214	09/26	11/05
1998	WT 221-222	05/12	06/04	WT 229-233, TEL 76	10/10	12/16
1999	WT 238-241	05/11	06/07	WT 244-247	10/13	11/22
2000	WT 315-318	05/11	06/09	WT 319-323, TEL 338-339	10/11	12/05
2001	WT 367-369	05/05	06/06	WT 372-373, TEL 357	09/22	10/29
2002	WT 419-424	04/27	05/29	WT 427-428, TEL 411-412	10/05	10/26
2003	WT 479-481	05/08	06/04	WT 485-487, TEL 469	09/23	11/07
2004	WT 546-548	05/12	06/08	WT 557-558	10/31	11/23
2005	WT 618-621	05/09	06/19	WT 627-628,630, TEL 608-609, AN 657	10/04	11/19
2006				WT 704-706	09/30	10/21
2007	WT 759-762	05/03	06/29	WT 770-772, TEL 750-751	10/06	11/14
2008	WT 827-829	05/23	06/22	WT 835-837	10/03	11/01
2009	AN 904-906	05/13	06/11	AN 913-916, TEL 894-895	10/02	11/12
2010	AN 932-934	05/08	06/06	AN 942-944, TEL 979	09/30	12/12
2011	AN 403-404	05/08	05/30	AN 409-413	09/29	11/20
2012	AN 417-420	04/27	06/03	AN 424-426	09/30	11/05
2013	AN 432-434	04/24	05/22	AN 438-442	09/19	10/18
2014	TEL 139-140	05/29	06/17			
2015	AN 452-454	05/10	06/03	AN 458-461	09/25	10/26
2016	TEL 159, 169-170	05/19	05/31	AN 466-467,469	09/16	11/07

Table 8. Cod abundance (000's) from Canadian spring RV surveys in Division 3N. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates from non-sampled strata.

Year	375	376	360	361	362	373	374	383	359	377	382	358	378	381	357	379	380	Total Index	1 std	723	725	727	724	726	728	Total >200
									Index Strata (<200 fathoms)												Deep Strata (≥200 fathoms)					
1984	22089	147797	135352	29059	67895	27237	10331	62	2317	1754	0	2677	2457	1519	0	780	207	451532	158609	nf	nf	nf	nf	nf	nf	-
1985	12272	147	26907	49961	19854	4121	768	0	0	2428	3538	5711	43405	12844	11460	3164	3646	200225	28273	nf	nf	nf	nf	nf	nf	-
1986	2219	779	9656	5531	5348	1585	85	0	39989	461	22	4024	6253	8170	440	4963	521	90046	35723	nf	nf	nf	nf	nf	nf	-
1987	6163	87946	31417	47380	116529	11626	922	958	7094	6335	59	4318	2103	388	(1428)	7	926	324172	93197	nf	nf	nf	nf	nf	nf	-
1988	3104	2509	35568	15258	6794	2600	871	680	5531	0	178	5277	1903	3155	11	44	1484	84966	15707	nf	nf	nf	nf	nf	nf	-
1989	4821	593	1043	9049	6986	3067	51	494	1622	420	1572	3946	1597	3705	68	204	957	40195	5707	nf	nf	nf	nf	nf	nf	-
1990	3205	265	2991	6571	8320	1560	384	46	811	0	3293	8218	2725	3630	880	1305	2043	46246	7797	nf	nf	nf	nf	nf	nf	-
1991	110	118	892	2549	1109	221	26	62	1187	0	0	1037	867	200	2504	2289	3822	16992	4214	1970	401	833	69	0	0	3273
1992	146	0	2705	797	58	0	128	0	1679	0	0	16327	3671	88	2651	8698	862	37809	5893	13573	nf	2144	112	0	0	15829
1993	73	0	898	828	116	0	0	0	2172	28	0	3358	602	0	68	540	20457	29139	20236	43	0	1444	9	0	0	1496
1994	0	0	0	102	0	0	0	0	0	48	0	108	220	13	429	190	0	1109	521	32	95	222	34	0	0	383
1995	0	69	0	619	0	0	0	0	0	0	0	155	96	113	23	66	32	1171	655	0	73	211	17	70	43	414
1996	0	165	449	1077	39	39	85	0	33	0	0	310	163	160	90	204	471	3283	787	46	34	1394	0	0	0	1474
1997	131	0	86	549	50	50	38	0	138	0	0	261	136	13	20	194	6239	7906	6106	77	16	109	50	12	0	264
1998	292	1272	823	2258	139	35	0	0	26	7	0	41	96	0	219	72	48	5327	1583	53	49	55	61	0	0	218
1999	5259	103	150	2650	1042	77	85	0	58	0	45	1254	38	150	73	58	96	11137	1968	0	33	44	0	0	0	77
2000	329	206	41	1869	1271	0	0	0	29	0	134	69	209	0	282	21	117	4577	1098	139	361	383	0	0	0	883
2001	351	41	82	510	1078	193	128	0	87	0	0	3111	108	1152	872	642	511	8865	3107	3179	661	528	45	0	0	4413
2002	131	0	453	1997	193	77	43	0	29	0	0	234	44	0	168	105	23	3495	880	1658	148	446	62	36	0	2350
2003	263	41	659	892	39	0	0	0	0	0	0	8940	1523	113	110	129	609	13318	8976	550	0	50	8	0	0	608
2004	175	1004	2552	3035	314	39	0	0	0	7	0	155	1000	300	43	49	207	8878	3353	85	0	0	9	0	0	94
2005	877	41	1784	2185	260	193	43	46	463	199	579	1045	365	7489	60	65	145	15839	6363	0	0	0	0	0	0	0
2006																										
2007	11213	18046	11271	17801	3983	435	43	0	927	138	102	4380	1635	307	158	93	14	70544	11497	19	0	0	0	0	13	32
2008	14846	11599	10290	9023	1425	87	192	46	1332	1204	0	4591	2798	1828	23	10	95	59389	8949	0	0	0	nf	0	0	0
2009	394	330	1957	3271	762	390	0	0	8108	17	0	97233	4214	22	9656	241	186	126781	97974	81	12	105624	0	0	0	105717
2010	1402	1871	700	2337	900	0	85	0	0	96	45	4154	6283	49	43	1222	31985	51172	32121	11	6	439	0	5	0	461
2011	52412	371	864	821	265	270	43	0	0	30	0	12	61	11	6820	1326	323	63629	51873	69	593	1068	0	22	11	1763
2012	2260	124	4392	3417	4151	1682	4269	93	8513	7146	0	3002	3263	4967	135	110	1147	48673	9517	10	217	46	nf	7	0	280
2013	1972	660	1171	2129	847	1964	1323	211	8867	9410	79	9244	3260	13	662	557	391	42760	11212	45	10	35	0	0	0	90
2014	682	137	755	1020	1040	555	192	424	27316	11122	5785	318	3276	2466	41	97	170	55396	29066	0	0	13	0	0	0	13
2015	565	516	412	5319	1634	495	0	46	1042	392	267	4746	2132	10009	305	29	2074	29983	10047	0	0	0	0	0	0	0
2016	175	495	4898	807	501	563	0	46	434	0	0	325	218	1052	4791	3235	487	18026	5458	0	14	506	0	0	0	521

Table 9. Cod biomass (t) from Canadian spring RV surveys in Division 3N. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	375	376	360	361	362	373	374	383	359	377	382	358	378	381	357	379	380	Total Index	1 std	723	725	727	724	726	728	Total >200
									Index Strata (<200 fathoms)												Deep Strata (≥200 fathoms)					
1984	6951	16514	21635	19816	75056	33166	14844	497	305	144	0	814	686	758	0	378	407	**191972**	30721	nf	nf	nf	nf	nf	nf	-
1985	26015	706	16845	52290	29628	5223	1508	0	0	217	254	897	4557	5345	6291	1186	2108	**153070**	18986	nf	nf	nf	nf	nf	nf	-
1986	20840	2926	3745	60545	31028	4336	1325	0	2614	137	83	1708	1074	2885	634	1571	362	**135813**	34396	nf	nf	nf	nf	nf	nf	-
1987	13377	9060	4115	49876	142872	14456	1815	1648	771	1703	41	4214	355	245	(566)	9	1008	**245567**	38873	nf	nf	nf	nf	nf	nf	-
1988	22932	6492	3755	25431	19700	9645	5816	234	631	0	58	1305	436	779	32	37	650	**97934**	13093	nf	nf	nf	nf	nf	nf	-
1989	24907	1244	2125	19331	26333	8910	928	569	211	45	775	1685	428	214	64	97	493	**88359**	12759	nf	nf	nf	nf	nf	nf	-
1990	15980	3754	10388	29860	36987	5747	5002	609	100	0	295	1079	396	792	271	315	697	**112271**	14230	nf	nf	nf	nf	nf	nf	-
1991	1818	1468	1022	16487	4301	847	512	222	66	0	0	129	144	395	328	844	670	**29254**	8642	662	186	486	30	0	0	1364
1992	2309	0	1431	395	661	0	29	0	112	0	0	2625	409	15	699	2567	180	**11433**	2788	3415	nf	805	32	0	0	4252
1993	1134	0	45	3422	1508	0	0	0	429	9	0	1683	244	0	46	203	9729	**18451**	9859	30	0	313	9	0	0	352
1994	0	0	0	63	0	0	0	0	0	8	0	162	63	56	235	120	0	**708**	289	26	32	86	22	0	0	166
1995	0	51	0	47	0	0	0	0	0	0	0	133	75	44	24	46	9	**429**	120	0	8	41	26	31	26	132
1996	0	62	457	647	21	9	11	0	36	0	0	131	84	40	18	66	100	**1682**	553	35	19	677	0	0	0	731
1997	92	0	15	378	317	168	136	0	199	0	0	104	109	2	9	104	3457	**5090**	3438	80	9	71	40	5	0	205
1998	108	75	12	682	407	9	0	0	1	15	0	73	80	0	221	25	13	**1721**	496	77	10	25	191	0	0	303
1999	3225	4	315	3496	946	50	11	0	114	0	9	1171	21	16	51	12	18	**9461**	3021	0	13	6	0	0	0	19
2000	54	43	19	533	1328	0	0	0	194	0	27	23	184	0	242	8	14	**2669**	1362	270	163	180	0	0	0	613
2001	592	6	589	241	1110	8	30	0	54	0	0	1818	92	708	676	536	71	**6529**	1995	2233	443	295	100	0	0	3071
2002	88	0	244	1856	22	11	15	0	7	0	0	327	16	0	158	74	14	**2832**	1522	1598	100	96	36	12	0	1842
2003	1229	458	1417	1987	2	0	0	0	0	0	0	14117	739	12	204	68	97	**20329**	14168	956	0	25	25	0	0	1006
2004	89	286	84	299	2134	2	0	0	0	29	0	258	377	49	60	22	36	**3726**	2160	46	0	0	6	0	0	52
2005	632	1	1798	2582	1746	74	10	42	71	298	239	611	118	2276	59	82	53	**10692**	2768	0	0	0	0	0	0	0
2006																										
2007	2669	528	1057	7983	5449	603	6	0	2385	33	79	3049	1101	171	262	72	6	**25452**	5245	60	0	0	0	0	4	64
2008	2016	1810	8204	1619	2499	3	327	9	434	990	0	4361	711	702	28	5	51	**23769**	3653	0	0	0	nf	0	0	0
2009	208	451	89	885	128	76	0	0	9025	8	0	39777	1927	2	3063	242	18	**55898**	40813	168	5	33157	0	0	0	33330
2010	43	4913	0	82	1595	1245	0	26	160	1423	32	3946	641	14002	18	5	0	**28131**	14733	56	34	377	0	2	0	469
2011	11042	56	248	302	463	135	8	0	0	23	0	6	33	1	5469	1019	61	**18865**	12119	125	476	950	0	17	15	1583
2012	2407	398	15514	1764	2970	878	3227	32	8550	4683	0	3025	4331	3184	297	149	558	**51966**	11191	13	51	41	nf	16	0	121
2013	1271	63	2393	3842	1400	1587	951	158	14188	8663	74	18176	5130	1	1298	742	183	**60120**	15879	178	7	54	0	0	0	239
2014	45	25	940	55	956	565	470	192	54329	19272	9802	341	4205	2783	79	273	196	**94527**	57143	0	0	12	0	0	0	12
2015	898	4011	1240	5527	5014	792	0	22	2388	434	797	11035	2070	2822	716	69	469	**38303**	6279.6	0	0	0	0	0	0	0
2016	11	16	219	119	451	22	0	3	36	0	0	1203	39	322	6140	2058	39	**10678**	6344.8	0	28	237	0	0	0	265

Table 10. Cod abundance (000's) from Canadian spring RV surveys in Division 3O. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	Index Strata (<200 fathoms)																		Total Index	1 std	Deep Strata (≥200 fathoms)						Total >200
	330	331	338	340	351	352	353	329	332	337	339	354	333	336	355	334	335	356			717	719	721	718	720	722	
1984	7687	3826	23133	10504	77593	40966	0	5871	432	1891	14485	2217	0	0	0	0	0	0	188606	24310	nf	nf	nf	nf	nf	nf	-
1985	7816	1903	9631	9324	17410	17487	2204	2367	3399	5634	885	1826	42	17	4031	234	0	0	84210	12468	nf	nf	nf	nf	nf	nf	-
1986	3672	737	8848	10184	116600	9709	2746	2811	1104	1356	134	2195	104	125	28	1310	68	13	161744	93579	nf	nf	nf	nf	nf	nf	-
1987	11207	1882	20017	144754	71037	35545	28804	131760	29727	1782	2361	65041	561	17	205.45	25	8	4	544739	121065	nf	nf	nf	nf	nf	nf	-
1988	5332	1411	6560	2799	13208	55656	44053	5208	2881	2315	483	2250	0	8	43	120	12	50	142388	39654	nf	nf	nf	nf	nf	nf	-
1989	1594	784	19973	1941	6053	10374	4686	5524	3082	10302	27	587	374	8	978	139	16	130	66572	11285	nf	nf	nf	nf	nf	nf	-
1990	4943	(1052)	8355	3593	6182	14360	6437	13021	5646	2113	1609	391	135	141	191	538	96	109	67860	10620	nf	nf	nf	nf	nf	nf	-
1991	1411	157	24229	2544	2051	9659	1285	22096	677236	22222	1556	8933	685	158	2317	1202	27	541	778308	672162	3701	274	190	15	0	0	4180
1992	201	31	2263	330	1040	3815	4188	503	29324	6846	604	1663	966	5484	935	962	1263	2639	63059	22768	336	749	72390	0	569	149	74193
1993	369	0	827	118	347	1318	220	1657	293274	229388	402	1402	509	433	234	1126	339	420	532383	272306	1615	301	348	100	15	0	2379
1994	0	0	131	283	248	1287	0	13826	0	130	0	0	2184	599	50	528	156	487	19907	13914	1441	443	11	503	211	0	2609
1995	0	0	261	0	0	1100	282	1089	2376	522	0	0	10	0	7	198	52	13	5910	1824	242	164	5	102	29	0	542
1996	4777	345	2089	1428	520	1104	670	327	3153	2478	46	65	682	8	2548	182	485	92	21000	4659	27	21	84	0	6	11	149
1997	509	0	160	529	453	927	0	765	432	681	0	0	1447	128	6	94	211	70	6411	1513	176	39	103	7	103	6	434
1998	4310	8343	895	173	277	1278	564	8194	720	1239	121	4583	194	25	50	26	36	82	31111	12292	20	5	5	0	12	0	42
1999	4037	452	15015	1770	1631	14932	507	8370	8121	9389	497	4864	25	17	44	28	37	67	69804	14900	37	107	5	0	7	0	156
2000	8680	2635	6571	3682	12046	5481	1693	1278	27653	3032	40	587	92	0	39	70	13	96	73690	14846	122	18	7	0	0	0	147
2001	1519	3858	7006	567	1820	3372	397	2746	816	1130	282	163	71	42	234	54	278	62	24415	3171	838	134	67	0	7	17	1063
2002	616	220	3264	189	545	1730	321	379	672	478	201	33	20	92	31	1017	357	149	10312	1796	183	0	9	18	17	0	227
2003	270	63	1044	330	217	754	220	2557	96	565	0	33	9	0	21	19	4	22	6224	2402	114	21	19	0	0	0	154
2004	1204	1725	970	283	43	877	139	440	3271	366	0	0	10	67	65	17	0	67	9545	2217	553	8	5	0	0	0	566
2005	5090	1976	9095	519	1127	5989	887	1868	0	452	80	246	10	0	6	0	0	0	27346	6772	34	52	0	0	0	0	86
2006																											
2007	3818	502	4700	923	2080	22182	18473	4545	1296	1130	138	3130	48	7	50	44	4	50	63119	12101	44	0	0	0	0	0	44
2008	2504	27036	4700	354	7106	12625	529	710	4081	1000	0	0	9	17	21	17	4	15	60727	26891	170	0	48	0	0	0	218
2009	1514	215407	2176	13691	520	5790	0	1089	23834	956	0	0	0	0	50	634	12	35	265709	213186	180	21	12	0	0	0	213
2010	3800	63	9269	226	515	2524	176	1415	21503	1377	80	94	27	0	25	11	32	28	41164	20330	154	23	0	0	0	0	177
2011	2641	376	1649	451	303	2755	250	5471	0	464	179	217	9	33	62	28	4	28	14921	5418	54	0	0	0	nf	0	54
2012	2668	439	2008	944	1541	6073	1411	3064	192	149	121	33	23	8	0	0	8	29	18711	3995	15	0	0	0	0	0	15
2013	6269	1084	1392	661	1430	6344	3615	4674	0	0	80	0	10	0	0	12	5	0	25578	5702	0	0	0	0	0	0	0
2014	4310	376	4439	1495	763	5820	705	4735	792	0	604	1299	10	0	0	0	0	21	25370	5480	26	0	0	0	0	0	26
2015	1197	533	3916	803	1486	2310	294	5634	912	0	0	33	0	17	14	83	16	8	17256	5453	497	0	16	0	0	0	513
2016	845	753	3264	2549	1295	1341	3792	4309	14979	1695	0	98	0	19	85	7	0	4	35033	10134	nf	6	17	nf	10	0	33

Table 11. Cod biomass (t) from Canadian spring RV surveys in Division 3O. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	Index Strata (<200 fathoms)																		Total Index	1 std	Deep Strata (≥200 fathoms)						Total >200
	330	331	338	340	351	352	353	329	332	337	339	354	333	336	355	334	335	356			717	719	721	718	720	722	
1984	7888	4493	42678	13523	67964	51161	0	1759	4368	734	3323	946	0	0	0	0	0	0	198839	27418	nf	nf	nf	nf	nf	nf	-
1985	9282	4844	13539	10677	34186	41468	9360	1913	16971	2948	723	654	327	81	717	889	0	0	148579	19373	nf	nf	nf	nf	nf	nf	-
1986	4128	1282	23022	11909	89983	24013	1814	1104	4052	11533	72	564	408	119	28	4728	157	42	178959	57845	nf	nf	nf	nf	nf	nf	-
1987	11960	1963	19822	159580	113537	75699	15404	115219	12725	4258	934	6849	1819	34	256.53	119	38	15	540232	109863	nf	nf	nf	nf	nf	nf	-
1988	4443	2155	14399	16289	25082	81440	4469	15973	11606	995	491	1199	0	39	38	469	81	177	179345	35693	nf	nf	nf	nf	nf	nf	-
1989	3287	476	25187	5426	19588	43446	3974	1674	2136	5680	216	86	1472	43	533	291	15	153	113683	32915	nf	nf	nf	nf	nf	nf	-
1990	5042	(2191)	9226	10198	22130	38056	5836	4639	11158	3321	381	557	378	315	196	818	109	216	112578	15471	nf	nf	nf	nf	nf	nf	-
1991	264	233	10185	380	6532	22297	1255	4155	38888	5512	91	3293	868	110	326	1372	10	87	95858	35755	15218	143	88	7	0	0	15456
1992	31	222	11769	51	2043	16512	1763	96	3889	20523	87	189	270	1716	63	1009	274	305	60812	21564	436	179	12153	0	139	70	12977
1993	91	0	4934	1918	1187	8147	3229	217	107210	79021	43	1307	1645	371	167	1395	2498	383	213762	93050	1870	330	304	159	9	0	2672
1994	0	0	1824	159	129	1569	0	10423	0	805	0	0	8467	655	32	950	449	255	25716	11919	2094	727	16	791	222	0	3850
1995	0	0	3406	0	0	3748	603	2166	1685	1643	0	0	26	0	31	330	339	16	13992	3159	339	927	10	91	34	0	1401
1996	7035	974	1520	237	103	1514	117	189	1519	3267	5	84	1610	19	2321	256	673	46	21489	4831	57	37	95	0	3	28	220
1997	357	0	196	186	286	2869	0	614	1558	527	0	0	974	322	15	305	734	47	8990	3056	238	133	53	16	164	5	609
1998	12526	34685	5069	512	1888	5341	18	13037	2136	1720	441	2258	255	16	74	46	75	102	80197	36701	30	2	16	0	11	0	59
1999	8593	1105	9416	3857	5269	14308	1719	9671	1350	3095	1210	1088	26	18	26	72	207	108	61137	11993	47	243	11	0	20	0	321
2000	8401	6842	6982	2164	47572	8226	7130	628	4360	1040	1	218	77	0	13	98	37	442	94231	47545	108	59	20	0	0	0	187
2001	2296	1738	13092	1469	4266	11344	529	896	272	553	733	737	43	46	169	33	254	69	38539	6458	585	137	323	0	41	52	1138
2002	190	1251	2456	33	38	6932	4394	63	42	160	48	218	31	95	27	1241	437	142	17799	4457	164	0	22	18	25	0	229
2003	20	326	4712	25	38	3093	607	1623	462	171	0	474	13	0	2	18	8	26	11618	3229	190	33	39	0	0	0	262
2004	2806	8186	1625	1735	583	3130	758	173	906	891	0	0	2	96	51	87	0	131	21158	8974	1224	23	9	0	0	0	1256
2005	5951	773	1688	1901	1293	6446	141	1569	0	360	3	484	20	0	22	0	0	0	20650	4670	71	26	0	0	0	0	97
2006																											
2007	1345	218	3486	1178	237	9602	1129	2050	241	211	1	438	32	3	33	67	3	45	20318	5263	147	0	0	0	0	0	147
2008	1014	2641	2607	381	3401	9189	523	430	494	1399	0	0	6	20	17	28	5	19	22175	4487	191	0	74	0	0	0	265
2009	509	53267	2622	5325	65	5946	0	170	19689	504	0	0	0	0	48	227	26	53	88452	48368	110	48	19	0	0	0	177
2010	1614	506	1468	39	756	1463	5	460	1897	111	46	74	18	0	43	6	37	23	8567	2165	100	47	0	0	0	0	147
2011	1030	298	690	746	217	3347	1148	7367	0	87	781	471	34	34	98	81	11	82	16523	7243	151	0	0	0	nf	0	151
2012	696	527	239	824	2922	7950	12683	2694	54	63	25	55	19	7	0	0	20	74	28853	13497	23	0	0	0	0	0	23
2013	959	198	1374	88	172	5458	642	1479	0	0	6	0	12	0	0	24	15	0	10427	2086	0	0	0	0	0	0	0
2014	5896	332	1411	725	860	4048	4869	3772	1054	0	882	3296	60	0	0	0	0	50	27254	7632	140	0	0	0	0	0	140
2015	156	460	1840	345	1392	3478	2108	1577	341	0	0	156	0	38	41	147	20	45	12147	2840	479	0	29	0	0	0	507
2016	66	61	1733	319	197	751	466	950	764	610	0	2	0	14	150	20	0	8	6111	1329	nf	28	57	nf	25	0	110

Table 12. Cod abundance (000's) from Canadian Autumn RV surveys in Division 3N. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	Index Strata (<200 fathoms)																	Total Index	1 std	Deep Strata (≥200 fathoms)						Total >200
	375	376	360	361	362	373	374	383	359	377	382	358	378	381	357	379	380			723	725	727	724	726	728	
1990	5421	32419	28703	6273	12855	1336	879	530	702	243	210	766	550	nf	683	213	nf	**91783**	29227	nf	nf	nf	nf	nf	nf	-
1991	66596	455280	12311	14155	73045	22575	20754	530	0	nf	359	1500	2046	0	399	nf	798	**670348**	355442	0	nf	nf	0	nf	nf	0
1992	nf	354763	8311	20718	49583	1400	nf	nf	497	493	270	5063	1602	nf	194	596	nf	**443490**	286249	nf	0	nf	nf	nf	nf	0
1993	2047	260	3463	6177	1300	750	819	0	88	0	494	47	48	202	1526	655	48	**17924**	4041	97	80	878	17	0	nf	1072
1994	1947	312	0	7549	622	0	1034	0	0	7	0	94	10	0	57	81	16	**11729**	3576	0	0	11	0	0	0	11
1995	4954	3918	433	3751	901	69	57	46	29	7	0	55	10	0	20	32	57	**14339**	3284	0	12	9	0	0	0	21
1996	0	92	480	2005	103	129	64	0	51	12	32	14	0	230	38	52	24	**3326**	1341	43	22	267	19	10	76	437
1997	603	41	137	2156	898	50	43	0	29	0	0	15	17	8	0	79	16	**4092**	757	6	0	0	0	0	0	6
1998	329	1598	309	5761	792	149	171	46	0	0	0	247	10	13	124	13	0	**9562**	2228	0	7	0	0	0	0	7
1999	14518	361	2367	1733	7924	3004	512	0	0	21	134	340	1472	138		988	383	**33895**	9200	0	7	22	0	0	0	29
2000	8163	819	1132	3161	6478	341	85	0	550	21	134	1156	1785	338	168	164	563	**25058**	7551	0	0	49	0	0	0	49
2001	4492	876	2315	6780	6438	446	1836	0	290	481	0	342	226	1702	61	663	14	**26962**	4867	0	7	0	0	0	0	7
2002	2849	317	360	1173	314	149	256	0	463	51	45	437	476	13	10	47	465	**7425**	2909	0	14	11	0	0	0	25
2003	446	324	1242	4952	99	57	0	0	434	0	0	356	36	0	102	52	104	**8204**	1013	0	0	25	nf	0	0	25
2004	438	2062	1543	4282	198	149	171	46	116	206	0	279	315	2078	124	54	96	**12158**	3027	0	nf	0	0	0	43	43
2005	3671	7099	2036	12672	1882	106	0	0	608	35	89	512	1520	82	229	91	56	**30688**	11059	0	7	0	0	0	0	7
2006	3999	987	14200	4384	495	248	640	46	145	76	0	1024	1430	138	302	58	83	**28255**	13287	0	63	9	0	0	0	72
2007	4024	10516	12142	30180	4727	451	840	0	1319	297	316	4797	850	5858	56	73	32	**76478**	15069	31	0	0	60	0	0	91
2008	13586	20758	470	9431	14906	2253	3522	0	898	5475	0	3363	8824	3089	124	131	326	**87156**	21572	9	7	0	0	0	0	16
2009	4821	112129	6709	9198	520	469	1729	46	347	2586	158	584	3142	67	121	32	199	**142857**	74196	0	0	39	0	16	0	55
2010	10902	16032	4956	16569	1684	545	1195	46	319	467	0	552		114	113	40	32	**53566**	12251	17	nf	11	0	0	0	28
2011	6793	1804	3013	3257	870	485	1409	46	2734	3384	140	867	4646	11129	56	645	454	**41732**	12798	0	17	0	0	23	0	39
2012	2763	22786	2337	16183	2427	1634	1708	46	931	812	45	851	180	38	53	144	769	**53704**	10810	14	7	279	17	0	0	317
2013	25853	4691	5362	13612	6834	3518	14051	185	116	813	134	297	4872	2790	11	7	993	**84138**	21554	0	0	11	0	0	0	11
2014																										
2015	5478	2114	875	15167	792	545	683	0	596	289	0	93	3038	225	30	414	828	**31167**	4354.7	11	7	20	0	0	0	37
2016	4531	2217	11987	12252	1387	149	384	0	232	307	89	46	3751	224	34	17	1657	**39264**	10940	0	0	11	0	0	0	11

Table 13. Cod biomass (t) from Canadian Autumn RV surveys in Division 3N. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	375	376	360	361	362	373	374	383	359	377	382	358	378	381	357	379	380	Total Index	1 std	723	725	727	724	726	728	Total >200
							Index Strata (<200 fathoms)															Deep Strata (≥200 fathoms)				
1990	31395	5147	7585	24777	9636	9722	2501	216	39	122	129	404	362	nf	370	318	nf	92723	25023	nf	nf	nf	nf	nf	nf	-
1991	69276	80732	4456	16326	40955	26255	9699	164	0	nf	73	430	635	0	205	nf	117	249323	64135	0	nf	nf	0	nf	nf	0
1992	nf	116390	4572	12485	22852	4114	nf	nf	156	257	115	2464	461	nf	120	317	nf	164303	91007	nf	0	nf	nf	nf	nf	0
1993	3305	152	8072	12996	1576	254	1102	0	39	0	168	45	12	119	629	240	32	28741	7956	63	90	484	12	0	nf	649
1994	9447	993	0	12111	1001	0	2414	0	0	13	0	51	11	0	42	96	10	26189	7249	0	0	12	0	0	0	12
1995	3162	4035	1329	8626	337	39	15	54	12	11	0	61	8	0	46	20	26	17781	4298	0	10	3	0	0	0	13
1996	0	799	316	1717	28	49	26	0	36	11	92	9	0	117	19	27	12	3258	1199	24	13	97	40	15	34	223
1997	594	12	1226	3255	2581	26	45	0	25	0	0	80	21	5	0	108	10	7988	1681	18	0	0	0	0	0	18
1998	839	791	1258	3811	713	60	196	0	0	0	0	327	9	8	245	8	0	8265	3200	0	18	0	0	0	0	18
1999	2022	46	8681	1060	4955	1948	111	0	0	6	93	197	729	39		664	223	20774	5772	0	10	39	0	0	0	49
2000	8642	2677	1536	1986	2840	125	20	0	458	3	116	933	1156	86	311	129	178	21196	5346	0	0	34	0	0	0	34
2001	1490	2351	3183	3319	4146	324	1042	0	249	660	0	470	174	1583	172	675	3	19841	4203	0	6	0	0	0	0	6
2002	2135	813	217	4519	1597	154	172	0	601	68	12	467	276	9	9	79	879	12007	3490	0	6	11	0	0	0	17
2003	192	1025	2917	6749	582	1	0	0	814	0	0	358	43	0	66	53	48	12848	3571	0	0	10	nf	0	0	10
2004	47	23	5334	9089	54	14	31	6	94	382	0	105	99	1890	201	133	54	17558	6793	0	nf	0	0	0	44	44
2005	487	5798	2220	8438	3160	33	0	0	317	19	16	262	711	80	221	41	48	21851	6469	0	4	0	0	0	0	4
2006	6913	2112	12038	2887	1582	95	1501	34	217	89	0	468	832	34	184	38	37	29061	11576	0	49	3	0	0	0	52
2007	6277	910	2291	3624	1640	99	99	0	296	66	93	4112	486	3303	50	27	28	23401	7102	49	0	0	65	0	0	114
2008	5111	11121	2231	8548	6235	544	1015	0	456	1720	0	1613	2644	888	89	102	205	42522	12646	27	11	0	0	0	0	38
2009	3038	31762	7251	9296	247	815	793	23	328	1601	42	400	2144	21	214	33	106	58114	23590	0	0	17	0	13	0	30
2010	2963	17484	8031	4621	3604	315	755	51	257	310	0	638		165	130	55	26	39405	14438	27	nf	6	0	0	0	32.333
2011	3120	1139	10504	2562	834	286	661	22	3173	3416	180	1104	4836	5166	154	841	421	38419	9968	0	22	0	0	18	0	40
2012	1946	27994	11207	23494	2873	1635	427	34	1254	1102	13	974	138	15	116	254	850	74327	24017	66	16	534	40	0	0	656
2013	5440	4200	17535	12422	3913	5647	28073	244	66	994	96	266	9370	2856	43	8	1192	92366	32654	0	0	3	0	0	0	3
2014																										
2015	8095	2729	2716	10597	1022	171	1235	0	918	178	0	119	1808	76	17	341	657	30680	8058	18	13	18	0	0	0	49
2016	5571	943	19136	6320	276	154	245	0	307	92	37	17	2779	143	63	55	729	36866	11042	0	0	6	0	0	0	6

Table 14. Cod abundance (000's) from Canadian Autumn RV surveys in Division 3O. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	Index Strata (<200 fathoms)																		Total Index	1 std	Deep Strata (≥200 fathoms)						Total >200
	330	331	338	340	351	352	353	329	332	337	339	354	333	336	355	334	335	356			717	719	721	718	720	722	
1990	10709	507	20199	4158	29085	10248	1781	531	1721	1001	163	1580	21	6	nf	13	12	nf	81735	17121	0	0	nf	nf	nf	nf	0
1991	10264	6682	10334	5625	24185	24761	223	1605	1127	66	0	0	0	0	887	0	4	4	85767	15463	nf	0	0	nf	nf	0	0
1992	7036	222	857	7746	3558	2747	0	558	436	198	41	1712	10	0	64	0	0	0	25185	6229	nf	nf	nf	nf	nf	nf	0
1993	5271	222	6221	1859	10450	4710	0	239	2036	307	528	0	0	67	172	9	0	102	32193	7605	0	0	0	0	0	0	0
1994	2072	95	330	763	661	717	0	1036	242	0	41	0	0	0	0	0	0	0	5957	2162	0	5	0	0	0	0	5
1995	3946	760	2478	1668	2709	972	415	574	0	0	41	165	0	0	13	0	0	0	13741	2367	0	0	0	0	0	0	0
1996	277	31	261	94	196	284	0	473	0	0	0	337	nf	8	339	nf	132	40	2472	571	nf	37	0	nf	0	0	37
1997	1006	31	52	519	1684	1006	0	95	48	0	80	130	0	0	0	0	12	0	4663	916	0	0	0	0	0	0	0
1998	3113	408	835	1747	347	761	0	710	288	0	126	33	0	0	0	0	4	17	8389	1597	0	0	5	0	0	0	5
1999	6178	721	4804	5665	9244	2789	661	521	576	130		554	0	0	28	0	0	7	31878	5652	10	0	0	0	0	0	10
2000	4428	1505	3580	6945	11737	9419	0	255	624	82	40	33	10	42	14	0	4	25	38743	6086	0	3	0	0	0	0	3
2001	9339	265	209	2172	9013	6405	0	710	96	130	80	0	0	0	0	0	0	4	28423	3443	0	0	0	0	0	0	0
2002	4133	376	835	2408	2091	2980	0	326	331	0	322	6181	0	0	0	0	0	4	19987	6278	0	0	0	0	0	0	0
2003	1293	94	261	1369	1436	4780	44	331	48	174	443	0	0	0	0	0	0	0	10273	2516	0	0	0	0	0	0	0
2004	886	157	112	1039	842	1680	0	101	1296	0	46	37	0	0	28	0	0	0	6980	1681	0	0	0	0	0	0	0
2005	1533	470	3081	964	2327	3397	1146	0	946	143	80	32	0	0	0	0	0	0	14119	2807	0	0	0	0	0	0	0
2006	1485	345	2611	991	2526	4741	453	221	288	43	80	65	0	0	63	6	0	4	13922	2345	0	0	0	nf	0	0	0
2007	14991	4610	5065	1457	22015	32905	882	900	2358	7694	201	10610	27	0	38	0	0	4	103757	13838	0	0	0	0	0	0	0
2008	15403	1004	5993	2859	6586	6033	118	1631	912	297	268	1710	9	15	25	0	4	0	42867	11520	0	0	0	0	0	0	0
2009	6540	1157	1484	2822	6718	3042	44	473	43	87	46	58	0	nf	6	7	0	17	22544	3796	0	0	0	0	0	0	0
2010	3044	282	2402	1665	3075	9492	88	384	43	82	40	811	9	0	7	6	0	0	21430	4311	0	0	0	0	0	0	0
2011	3496	282	2611	2408	2080	6236	485	832	55	43	0	65	0	0	0	0	0	4	18597	4272	0	0	0	0	0	0	0
2012	10409	860	6313	1416	3566	6794	88	421	128	87	112	65	0	0	0	0	0	0	30259	6479	0	0	0	0	0	0	0
2013	4922	188	3916	1175	8133	4107	44	605	0	0	241	0	0	0	0	0	0	0	23332	4085	0	0	0	0	0	0	0
2014																											
2015	3079	282	5065	2630	2328	8501	265	1705	576	261	40	0	0	0	0	0	0	0	24731	5690	0	0	0	0	0	0	0
2016	1581	878	3290	1511	1684	9633	0	473	192	130	40	0	0	nf	0	0	0	0	19412	3592	0	0	0	0	0	0	0

Table 15. Cod biomass (t) from Canadian Autumn RV surveys in Division 3O. Both index strata and the most commonly fished deep strata are shown. The index strata are the basis for the assessment. Data for 1984-1995 have been converted to Campelan equivalent units. Values in brackets are estimates for non-sampled strata.

Year	Index Strata (<200 fathoms)																		Total Index	1 std	Deep Strata (≥200 fathoms)						Total >200
	330	331	338	340	351	352	353	329	332	337	339	354	333	336	355	334	335	356			717	719	721	718	720	722	
1990	6651	27	13966	3635	17027	21151	4593	1291	767	2331	1242	66	12	29	nf	16	13	nf	72817	11789	0	0	nf	nf	nf	nf	0
1991	2374	1047	7122	6247	21473	32262	56	1019	74	70	0	0	0	0	155	0	8	8	71915	12726	nf	0	0	nf	nf	0	0
1992	2574	191	2760	6711	3142	3137	0	109	254	373	64	896	12	0	31	0	0	0	20254	4404	nf	nf	nf	nf	nf	nf	0
1993	4278	267	3763	1231	9895	4920	0	245	1323	176	447	0	0	107	104	21	0	68	26845	7412	0	0	0	0	0	0	0
1994	1928	172	91	832	679	4775	0	1546	452	0	56	0	0	0	0	0	0	0	10531	3158	0	14	0	0	0	0	14
1995	6035	1455	5283	3149	5052	3195	2238	1052	0	0	46	161	0	0	15	0	0	0	27681	6346	0	0	0	0	0	0	0
1996	299	11	26	37	73	1340	0	367	0	0	0	258	nf	11	233	nf	300	39	2994	1397	nf	55	0	nf	0	0	55
1997	1779	85	167	951	4806	3220	0	159	0	0	276	96	0	0	0	0	16	0	11555	2467	0	0	0	0	0	0	0
1998	2027	735	1786	2108	815	1198	0	820	1	0	606	42	0	0	0	0	8	30	10176	1753	0	0	9	0	0	0	9
1999	2379	367	16088	2902	7355	9096	716	684	18	21		184	0	0	25	0	0	13	39848	15975	1	0	0	0	0	0	1
2000	1817	574	5978	5371	5249	14518	0	86	33	12	161	18	4	49	11	0	1	28	33910	6738	0	5	0	0	0	0	5
2001	5922	155	558	1785	8149	7207	0	810	41	91	50	0	0	0	0	0	0	2	24770	4051	0	0	0	0	0	0	0
2002	4037	481	493	2542	2296	4081	0	1407	960	0	447	8920	0	0	0	0	0	11	25675	8993	0	0	0	0	0	0	0
2003	1547	243	238	2028	2002	8617	2	566	62	111	769	0	0	0	0	0	0	0	16185	5988	0	0	0	0	0	0	0
2004	440	641	267	2663	685	3025	239	267	225	0	23	3	0	0	19	0	0	0	8499	2867	0	0	0	0	0	0	0
2005	1664	442	3592	3002	4017	4231	1604	0	31	25	145	4	0	0	0	0	0	0	18757	4624	0	0	0	0	0	0	0
2006	1347	713	1804	421	1348	4782	1105	185	312	17	25	26	0	0	51	6	0	9	12151	2469	0	0	0	nf	0	0	0
2007	1463	141	1010	1540	4093	19781	184	292	165	2891	111	11472	1	0	30	0	0	5	43179	16998	0	0	0	0	0	0	0
2008	1813	296	1220	1305	1907	3344	91	333	167	175	59	991	5	24	30	0	6	0	11766	2472	0	0	0	0	0	0	0
2009	3019	189	1712	1714	4705	4502	53	622	21	13	100	43	0	nf	4	6	0	33	16736	3409	0	0	0	0	0	0	0
2010	1596	214	508	940	3003	8294	64	210	38	50	2	651	14	0	11	4	0	0	15599	4027	0	0	0	0	0	0	0
2011	2049	198	3527	1500	2296	6939	1457	754	86	24	0	62	0	0	0	0	0	8	18900	4645	0	0	0	0	0	0	0
2012	10556	256	1587	1270	2896	7022	300	376	2	123	156	52	0	0	0	0	0	0	24596	6811	0	0	0	0	0	0	0
2013	1671	177	2502	890	5549	4081	12	629	0	0	11	0	0	0	0	0	0	0	15522	3010	0	0	0	0	0	0	0
2014																											0
2015	3282	145	409	827	3013	2511	1265	1059	85	72	42	0	0	0	0	0	0	0	12711	3285	0	0	0	0	0	0	0
2016	634	366	1279	1232	352	5296	0	629	5	9	0	0	0	nf	0	0	0	0	9801	2413	0	0	0	0	0	0	0

Table 16. Mean number per tow at age of cod from spring RV surveys in NAFO Divisions 3NO as calculated using the conversion from Warren (1997) for surveys in 1984-1995. Results for 1996 -2017 are actual Campelen surveys.

Year	AGE																				1+
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1984	0.00	0.16	53.39	41.57	21.35	7.17	5.04	1.51	0.72	1.36	1.15	0.61	0.25	0.10	0.03	0.05	0.08	0.05	0.01	0.00	134.60
1985	0.00	0.37	9.88	29.27	16.14	2.76	0.90	1.03	0.66	0.84	1.18	0.88	0.48	0.23	0.14	0.08	0.08	0.03	0.01	0.02	64.98
1986	0.00	0.38	12.77	3.63	17.87	11.53	2.11	0.82	0.58	0.42	0.61	1.02	0.51	0.31	0.15	0.08	0.04	0.04	0.03	0.03	52.93
1987	0.00	5.00	54.15	14.13	19.67	50.35	26.41	7.38	1.71	1.63	0.54	0.70	0.60	0.68	0.23	0.21	0.12	0.00	0.01	0.02	183.54
1988	0.00	0.18	26.45	12.91	1.02	0.47	1.10	1.13	0.66	0.67	0.75	0.35	0.44	0.69	0.55	0.21	0.11	0.11	0.04	0.03	47.87
1989	0.00	0.38	4.77	10.39	2.40	0.34	0.31	0.61	0.52	0.36	0.40	0.51	0.33	0.27	0.39	0.21	0.11	0.09	0.04	0.03	22.46
1990	0.00	0.90	7.25	6.77	3.80	1.46	0.25	0.41	0.52	0.61	0.46	0.34	0.34	0.16	0.37	0.44	0.22	0.14	0.06	0.05	24.55
1991	0.00	0.57	147.62	15.44	1.59	0.47	0.16	0.07	0.06	0.14	0.12	0.11	0.09	0.12	0.13	0.12	0.18	0.07	0.04	0.00	167.10
1992	0.00	0.00	10.07	9.66	0.24	0.11	0.09	0.03	0.03	0.08	0.11	0.13	0.14	0.12	0.10	0.09	0.09	0.06	0.01	0.01	21.17
1993	0.00	0.00	1.17	58.27	53.63	1.25	0.68	0.46	0.22	0.05	0.08	0.17	0.12	0.07	0.07	0.09	0.05	0.02	0.01	0.01	116.42
1994	0.00	0.00	0.22	0.91	1.63	1.05	0.07	0.12	0.07	0.07	0.02	0.04	0.05	0.07	0.02	0.03	0.01	0.00	0.03	0.01	4.42
1995	0.00	0.00	0.76	0.20	0.04	0.15	0.10	0.01	0.02	0.05	0.01	0.01	0.02	0.05	0.02	0.03	0.02	0.00	0.00	0.00	1.49
1996	0.00	0.10	1.35	1.65	0.44	0.24	0.57	0.56	0.05	0.04	0.03	0.02	0.00	0.00	0.03	0.02	0.00	0.01	0.00	0.00	5.11
1997	0.00	0.06	0.24	1.67	0.58	0.16	0.03	0.09	0.07	0.01	0.02	0.03	0.02	0.01	0.00	0.01	0.00	0.00	0.01	0.00	3.01
1998	0.00	1.71	0.16	0.51	1.23	0.52	0.17	0.13	1.35	1.61	0.15	0.03	0.01	0.03	0.00	0.02	0.01	0.00	0.00	0.00	7.64
1999	0.00	4.69	4.71	4.55	0.38	0.70	0.30	0.11	0.12	0.42	0.84	0.07	0.03	0.03	0.02	0.01	0.00	0.02	0.00	0.00	17.00
2000	0.00	2.15	6.46	4.58	0.69	0.10	0.20	0.29	0.07	0.06	0.57	1.10	0.13	0.02	0.00	0.01	0.02	0.00	0.00	0.00	16.45
2001	0.00	0.15	1.88	2.91	1.01	0.26	0.01	0.06	0.07	0.01	0.01	0.16	0.40	0.04	0.02	0.00	0.01	0.00	0.00	0.00	7.00
2002	0.00	0.23	0.66	0.98	0.40	0.23	0.10	0.01	0.06	0.01	0.02	0.01	0.03	0.16	0.00	0.01	0.00	0.00	0.00	0.00	2.91
2003	0.00	0.30	0.58	0.47	0.51	1.03	0.82	0.12	0.01	0.05	0.02	0.02	0.01	0.08	0.08	0.01	0.00	0.00	0.00	0.00	4.11
2004	0.00	1.18	1.12	0.50	0.19	0.13	0.18	0.18	0.07	0.02	0.08	0.02	0.03	0.02	0.02	0.10	0.01	0.00	0.01	0.00	3.86
2005	0.00	2.64	2.05	2.76	0.48	0.20	0.07	0.33	0.26	0.13	0.02	0.07	0.02	0.00	0.00	0.03	0.02	0.00	0.00	0.00	9.08
2006																					
2007	0.00	14.87	6.12	3.91	1.95	0.46	0.11	0.05	0.09	0.14	0.13	0.11	0.01	0.01	0.01	0.00	0.03	0.01	0.04	0.01	28.06
2008	0.00	0.36	12.89	9.63	1.37	1.03	0.21	0.07	0.01	0.02	0.18	0.14	0.08	0.00	0.02	0.01	0.01	0.01	0.01	0.00	26.05
2009	0.00	0.65	7.02	59.57	8.28	3.94	1.94	0.61	0.14	0.02	0.07	0.08	0.16	0.02	0.01	0.01	0.00	0.00	0.00	0.00	82.52
2010	0.00	4.30	4.21	3.09	5.08	1.57	0.64	0.36	0.06	0.01	0.02	0.01	0.04	0.02	0.00	0.01	0.00	0.00	0.00	0.00	19.42
2011	0.00	0.04	3.92	8.01	1.72	1.65	0.69	0.25	0.16	0.01	0.02	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	16.51
2012	0.00	1.13	1.04	3.80	3.01	0.70	2.56	0.94	0.34	0.32	0.06	0.05	0.03	0.07	0.08	0.01	0.01	0.00	0.00	0.00	14.16
2013	0.00	1.12	3.43	1.48	2.11	1.99	0.46	2.13	1.04	0.37	0.19	0.04	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	14.37
2014	0.00	1.21	1.40	2.16	0.61	2.59	2.78	0.57	3.90	1.46	0.23	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.96
2015	0.00	1.29	3.58	1.84	0.70	0.27	0.55	0.40	0.11	0.82	0.19	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.93
2016	0.00	1.94	6.20	1.38	0.51	0.28	0.14	0.23	0.20	0.03	0.16	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.15

Table 17. Mean number per tow at age of cod from Autumn RV surveys in NAFO Divisions 3NO as calculated using the conversion from Warren (1997) for surveys in 1984-1994. Results for 1995 -2017 are actual Campelen surveys.

Year	AGE																				1+
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1990	0.00	18.89	6.15	3.25	3.56	1.73	0.37	0.29	0.38	0.40	0.24	0.20	0.09	0.15	0.07	0.16	0.21	0.07	0.02	0.03	36.26
1991	0.00	14.87	129.66	4.36	2.19	2.73	1.33	0.37	0.31	0.53	0.37	0.45	0.33	0.27	0.21	0.12	0.38	0.16	0.06	0.00	158.70
1992	0.00	0.41	49.65	65.00	4.70	1.02	0.61	0.18	0.03	0.03	0.07	0.00	0.06	0.12	0.03	0.03	0.02	0.03	0.08	0.00	122.07
1993	0.00	1.30	0.72	3.63	3.59	0.30	0.27	0.18	0.10	0.02	0.02	0.06	0.04	0.04	0.05	0.06	0.02	0.01	0.02	0.00	10.43
1994	0.00	0.00	0.62	0.28	0.96	1.32	0.16	0.04	0.06	0.01	0.01	0.03	0.03	0.02	0.06	0.01	0.03	0.02	0.01	0.00	3.67
1995	0.00	1.15	1.02	0.46	0.20	0.94	1.64	0.11	0.05	0.06	0.05	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.72
1996	0.00	0.08	0.74	0.29	0.06	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	1.26
1997	0.00	0.03	0.10	0.40	0.33	0.14	0.06	0.28	0.28	0.05	0.04	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	1.74
1998	0.00	1.67	0.29	0.20	0.32	0.11	0.06	0.01	0.16	0.22	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01		3.09
1999	0.39	4.44	5.01	2.52	0.13	0.37	0.30	0.08	0.04	0.12	0.55	0.04	0.00	0.00	0.02	0.00	0.02	0.03	0.00	0.01	13.68
2000	0.07	2.12	3.77	4.75	1.81	0.20	0.24	0.11	0.03	0.01	0.03	0.24	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	13.33
2001	0.06	0.34	2.64	4.70	2.55	0.98	0.07	0.16	0.06	0.02	0.02	0.00	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	11.60
2002	0.13	0.33	0.61	1.13	1.58	1.31	0.39	0.03	0.06	0.04	0.00	0.03	0.03	0.05	0.01	0.00	0.01	0.00	0.00	0.00	5.61
2003	0.16	0.96	0.27	0.26	0.35	0.78	0.83	0.14	0.01	0.02	0.05	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	3.71
2004	1.08	0.97	0.63	0.35	0.14	0.12	0.23	0.24	0.12	0.01	0.04	0.00	0.00	0.00	0.07	0.03	0.00	0.00	0.00	0.00	2.95
2005	0.27	4.24	2.42	1.24	0.23	0.07	0.06	0.27	0.38	0.10	0.00	0.04	0.01	0.03	0.00	0.02	0.03	0.00	0.00	0.00	9.14
2006	0.21	0.19	2.10	3.94	1.27	0.47	0.13	0.05	0.20	0.09	0.12	0.04	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	8.64
2007	0.15	13.95	15.61	3.70	3.28	0.44	0.18	0.05	0.05	0.14	0.23	0.06	0.00	0.02	0.01	0.01	0.01	0.00	0.00	0.00	37.74
2008	0.53	1.32	13.79	8.96	1.30	0.92	0.20	0.07	0.00	0.01	0.03	0.03	0.09	0.00	0.03	0.01	0.00	0.00	0.03	0.00	26.79
2009	0.08	3.25	8.10	16.37	5.11	1.07	0.65	0.12	0.06	0.00	0.00	0.03	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.00	34.83
2010	0.29	4.52	3.37	2.07	3.09	1.38	0.41	0.30	0.21	0.05	0.00	0.03	0.02	0.07	0.01	0.00	0.00	0.00	0.00	0.00	15.53
2011	0.13	0.66	3.10	3.55	0.73	2.99	0.82	0.32	0.24	0.03	0.03	0.01	0.00	0.06	0.01	0.00	0.01	0.00	0.00	0.00	12.56
2012	0.64	4.16	2.12	2.95	2.25	0.73	2.76	1.09	0.43	0.28	0.15	0.00	0.02	0.02	0.02	0.00	0.01	0.00	0.00	0.00	17.00
2013	0.16	5.19	5.98	2.07	2.25	2.50	0.86	2.26	0.80	0.25	0.15	0.10	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	22.43
2014																					
2015	1.18	3.52	3.19	1.36	0.72	0.30	0.52	0.25	0.14	0.36	0.16	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	10.57
2016	0.26	2.29	5.95	1.98	0.39	0.34	0.08	0.29	0.15	0.03	0.37	0.18	0.02	0.03	0.00	0.01	0.00	0.00	0.00	0.00	12.11

Table 18. Mean number per tow at age of cod from Juvenile Surveys conducted by Canada in Divisions 3NO during August and September.

Year	Age															1+
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1989	0.00	1.40	14.16	12.58	5.82	1.21	0.72	1.22	0.79	0.25	0.17	0.20	0.11	0.09	0.16	38.88
1990	0.00	60.88	11.62	6.53	8.99	3.62	0.67	0.50	0.63	0.53	0.28	0.21	0.04	0.08	0.27	94.85
1991	0.00	36.33	74.04	8.54	2.45	1.96	0.72	0.19	0.17	0.24	0.19	0.23	0.18	0.17	0.48	125.89
1992	0.00	0.84	12.28	12.89	1.42	0.69	0.52	0.22	0.05	0.03	0.03	0.00	0.02	0.10	0.13	29.22
1993	0.00	1.98	3.70	8.85	7.91	0.80	0.30	0.28	0.10	0.02	0.04	0.10	0.08	0.06	0.09	24.31
1994	0.00	2.75	4.03	1.25	4.07	4.79	0.41	0.08	0.13	0.05	0.01	0.05	0.06	0.08	0.09	17.85

Table 19. Estimated proportions mature for female cod from NAFO Divs. 3NO from DFO surveys from 1975 to 2012 projected forward to 2012 and back to 1954. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age. When the model did not fit the data for a particular cohort (I.e 1991 and 2000 cohorts) the average of estimates for the same age group from adjacent years was used; dark shaded cells are averages extrapolated forward or backward from the same age group from 3 previous (or next) years.

Year	Age 1	Age2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1954	0.0000	0.0004	0.0020	0.0112	0.0592	0.2424	0.5895	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1955	0.0001	0.0000	0.0020	0.0112	0.0592	0.2424	0.5895	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1956	0.0001	0.0003	0.0001	0.0112	0.0592	0.2424	0.5895	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1957	0.0003	0.0007	0.0018	0.0008	0.0592	0.2424	0.5895	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1958	0.0001	0.0016	0.0041	0.0102	0.0065	0.2424	0.5895	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1959	0.0000	0.0006	0.0079	0.0226	0.0555	0.0509	0.5895	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1960	0.0000	0.0000	0.0033	0.0393	0.1157	0.2512	0.3043	0.8856	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1961	0.0002	0.0001	0.0001	0.0168	0.1731	0.4251	0.6572	0.7809	0.9812	0.9972	0.9996	0.9999	1.0000	1.0000
1962	0.0000	0.0012	0.0009	0.0012	0.0825	0.5172	0.8069	0.9164	0.9667	0.9972	0.9996	0.9999	1.0000	1.0000
1963	0.0000	0.0002	0.0056	0.0099	0.0229	0.3206	0.8458	0.9594	0.9843	0.9958	0.9996	0.9999	1.0000	1.0000
1964	0.0000	0.0000	0.0010	0.0266	0.1000	0.3219	0.7124	0.9656	0.9926	0.9972	0.9995	0.9999	1.0000	1.0000
1965	0.0014	0.0000	0.0000	0.0049	0.1162	0.5526	0.9057	0.9286	0.9931	0.9987	0.9995	0.9999	1.0000	1.0000
1966	0.0000	0.0043	0.0005	0.0006	0.0234	0.3875	0.9321	0.9949	0.9856	0.9986	0.9998	0.9999	1.0000	1.0000
1967	0.0000	0.0001	0.0132	0.0067	0.0097	0.1037	0.7527	0.9935	0.9997	0.9972	0.9997	1.0000	1.0000	1.0000
1968	0.0000	0.0000	0.0012	0.0398	0.0820	0.1450	0.3587	0.9361	0.9994	1.0000	0.9995	0.9999	1.0000	1.0000
1969	0.0000	0.0000	0.0003	0.0090	0.1144	0.5429	0.7457	0.7301	0.9860	0.9999	1.0000	0.9999	1.0000	1.0000
1970	0.0032	0.0000	0.0001	0.0029	0.0665	0.2866	0.9405	0.9807	0.9290	0.9971	1.0000	1.0000	1.0000	1.0000
1971	0.0000	0.0093	0.0000	0.0009	0.0275	0.3582	0.5555	0.9953	0.9889	0.9844	0.9994	1.0000	1.0000	1.0000
1972	0.0000	0.0002	0.0269	0.0000	0.0101	0.2176	0.8140	0.7954	0.9996	0.9999	0.9967	0.9999	1.0000	1.0000
1973	0.0001	0.0000	0.0013	0.0754	0.0038	0.1018	0.7320	0.9717	0.9236	1.0000	1.0000	0.9993	1.0000	1.0000
1974	0.0000	0.0006	0.0001	0.0083	0.1939	0.2928	0.5582	0.9641	0.9963	0.9741	1.0000	1.0000	0.9999	1.0000
1975	0.0000	0.0003	0.0033	0.0017	0.0530	0.4148	0.9780	0.9337	0.9962	0.9995	0.9915	1.0000	1.0000	1.0000
1976	0.0000	0.0001	0.0020	0.0186	0.0221	0.2715	0.6763	0.9998	0.9937	0.9996	0.9999	0.9973	1.0000	1.0000
1977	0.0006	0.0001	0.0009	0.0142	0.0978	0.2269	0.7128	0.8603	1.0000	0.9994	1.0000	1.0000	0.9991	1.0000
1978	0.0001	0.0029	0.0014	0.0083	0.0935	0.3823	0.7922	0.9429	0.9478	1.0000	0.9999	1.0000	1.0000	0.9997
1979	0.0000	0.0005	0.0145	0.0133	0.0733	0.4248	0.7794	0.9802	0.9910	0.9817	1.0000	1.0000	1.0000	1.0000
1980	0.0002	0.0002	0.0034	0.0695	0.1140	0.4292	0.8410	0.9528	0.9984	0.9986	0.9937	1.0000	1.0000	1.0000
1981	0.0000	0.0007	0.0020	0.0236	0.2749	0.5518	0.8773	0.9743	0.9914	0.9999	0.9998	0.9979	1.0000	1.0000
1982	0.0000	0.0000	0.0035	0.0162	0.1460	0.6579	0.9218	0.9855	0.9963	0.9985	1.0000	1.0000	0.9993	1.0000
1983	0.0000	0.0001	0.0003	0.0163	0.1219	0.5474	0.9070	0.9912	0.9985	0.9995	0.9997	1.0000	1.0000	0.9998
1984	0.0000	0.0003	0.0008	0.0028	0.0726	0.5389	0.8953	0.9802	0.9991	0.9998	0.9999	1.0000	1.0000	1.0000
1985	0.0002	0.0002	0.0019	0.0058	0.0261	0.2703	0.9078	0.9837	0.9960	0.9999	1.0000	1.0000	1.0000	1.0000
1986	0.0000	0.0010	0.0021	0.0134	0.0409	0.2049	0.6369	0.9881	0.9977	0.9992	1.0000	1.0000	1.0000	1.0000
1987	0.0001	0.0000	0.0058	0.0194	0.0869	0.2358	0.7128	0.8925	0.9986	0.9997	0.9998	1.0000	1.0000	1.0000
1988	0.0011	0.0006	0.0002	0.0335	0.1570	0.3994	0.6908	0.9598	0.9752	0.9998	1.0000	1.0000	1.0000	1.0000
1989	0.0001	0.0043	0.0047	0.0031	0.1702	0.6371	0.8229	0.9418	0.9957	0.9947	1.0000	1.0000	1.0000	1.0000
1990	0.0000	0.0011	0.0170	0.0377	0.0441	0.5486	0.9431	0.9701	0.9915	0.9995	0.9989	1.0000	1.0000	1.0000
1991	0.0000	0.0000	0.0079	0.0645	0.2438	0.4047	0.8780	0.9936	0.9956	0.9988	1.0000	0.9998	1.0000	1.0000
1992	0.0000	0.0000	0.0004	0.0557	0.2155	0.7265	0.9092	0.9771	0.9993	0.9994	0.9998	0.9999	0.9999	1.0000
1993	0.0001	0.0004	0.0002	0.0121	0.3045	0.5225	0.9563	0.9933	0.9961	0.9999	0.9999	1.0000	1.0000	1.0000
1994	0.0004	0.0008	0.0040	0.0153	0.2825	0.7646	0.8134	0.9945	0.9995	0.9993	1.0000	1.0000	1.0000	1.0000
1995	0.0002	0.0030	0.0078	0.0418	0.5844	0.9266	0.9602	0.9455	0.9993	1.0000	0.9999	1.0000	1.0000	1.0000
1996	0.0004	0.0014	0.0229	0.0683	0.4952	0.9922	0.9975	0.9944	0.9857	0.9999	1.0000	1.0000	1.0000	1.0000
1997	0.0000	0.0026	0.0130	0.1536	0.4059	0.9282	0.9999	0.9999	0.9992	0.9964	1.0000	1.0000	1.0000	1.0000
1998	0.0000	0.0001	0.0170	0.1076	0.5837	0.8642	0.9917	1.0000	1.0000	0.9999	0.9991	1.0000	1.0000	1.0000
1999	0.0000	0.0000	0.0009	0.1035	0.5240	0.9155	0.9834	0.9991	1.0000	1.0000	1.0000	0.9998	1.0000	1.0000
2000	0.0000	0.0003	0.0011	0.0135	0.4356	0.9095	0.9882	0.9982	0.9999	1.0000	1.0000	1.0000	0.9999	1.0000
2001	0.0006	0.0002	0.0066	0.0278	0.1676	0.8377	0.9892	0.9985	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
2002	0.0011	0.0028	0.0067	0.1366	0.4280	0.7473	0.9718	0.9988	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
2003	0.0006	0.0055	0.0163	0.1598	0.7908	0.9514	0.9775	0.9957	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
2004	0.0024	0.0028	0.0259	0.1370	0.8429	0.9891	0.9981	0.9984	0.9994	1.0000	1.0000	1.0000	1.0000	1.0000
2005	0.0025	0.0110	0.0131	0.1142	0.6316	0.9934	0.9995	0.9999	0.9999	0.9999	1.0000	1.0000	1.0000	1.0000
2006	0.0001	0.0094	0.0484	0.0588	0.3844	0.8725	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2007	0.0008	0.0007	0.0344	0.1889	0.2267	0.7516	0.9680	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2008	0.0013	0.0037	0.0039	0.1179	0.5160	0.5791	0.9361	0.9931	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2009	0.0004	0.0045	0.0159	0.0202	0.3343	0.8299	0.8659	0.9861	0.9986	1.0000	1.0000	1.0000	1.0000	1.0000
2010	0.0000	0.0026	0.0162	0.0664	0.0991	0.6534	0.9571	0.9680	0.9971	0.9997	1.0000	1.0000	1.0000	1.0000
2011	0.0021	0.0000	0.0165	0.0565	0.2385	0.3696	0.8762	0.9903	0.9930	0.9994	0.9999	1.0000	1.0000	1.0000
2012	0.0015	0.0082	0.0005	0.0981	0.1783	0.5796	0.7575	0.9637	0.9979	0.9985	0.9999	1.0000	1.0000	1.0000
2013	0.0012	0.0065	0.0314	0.0213	0.4131	0.4403	0.8585	0.9433	0.9901	0.9995	0.9997	1.0000	1.0000	1.0000
2014	0.0012	0.0049	0.0265	0.1122	0.5013	0.8199	0.7404	0.9639	0.9888	0.9973	0.9999	0.9999	1.0000	1.0000
2015	0.0012	0.0049	0.0194	0.1022	0.3305	0.9789	0.9672	0.9118	0.9916	0.9979	0.9993	1.0000	1.0000	1.0000
2016	0.0012	0.0049	0.0194	0.0786	0.3228	0.6584	0.9995	0.9948	0.9740	0.9981	0.9996	0.9998	1.0000	1.0000
2017	0.0012	0.0049	0.0194	0.0786	0.3848	0.6662	0.8827	1.0000	0.9992	0.9927	0.9996	0.9999	0.9999	1.0000
2018	0.0012	0.0049	0.0194	0.0786	0.3848	0.7678	0.8931	0.9671	1.0000	0.9999	0.9980	0.9999	1.0000	1.0000

Table 20. Estimated survivors and catchabilities in linear scale from ADAPT.

ORTHOGONALITY OFFSET.........			0.000367			
MEAN SQUARE RESIDUALS			0.599246			

Survivors			Standard	Relative		Relative
Year	Age	Estimate	Error	Error	Bias	Bias
1994	12	121.00	77.80	0.64	14.90	0.12
1995	12	64.70	28.30	0.44	4.98	0.08
1996	12	37.60	12.60	0.34	1.96	0.05
1997	12	78.80	24.20	0.31	3.63	0.05
1998	12	109.00	35.00	0.32	5.44	0.05
1999	12	54.20	18.20	0.34	2.81	0.05
2000	12	58.70	17.20	0.29	2.41	0.04
2001	12	515.00	139.00	0.27	18.20	0.04
2002	12	243.00	64.80	0.27	8.49	0.04
2003	12	34.50	9.19	0.27	1.18	0.03
2004	12	42.60	12.00	0.28	1.55	0.04
2005	12	73.80	21.30	0.29	2.74	0.04
2006	12	79.80	24.60	0.31	3.28	0.04
2007	12	19.60	5.94	0.30	0.85	0.04
2008	12	124.00	39.40	0.32	5.65	0.05
2009	12	268.00	82.50	0.31	11.70	0.04
2010	12	187.00	56.90	0.31	8.09	0.04
2011	12	52.80	15.40	0.29	2.22	0.04
2012	12	34.70	10.80	0.31	1.57	0.05
2013	12	61.20	16.50	0.27	2.17	0.04
2014	12	128.00	33.90	0.26	4.39	0.03
2015	12	409.00	100.00	0.25	12.80	0.03
2016	12	445.00	107.00	0.24	14.00	0.03
2017	3	5380.00	3010.00	0.56	884.00	0.16
2017	4	1680.00	687.00	0.41	149.00	0.09
2017	5	653.00	262.00	0.40	52.30	0.08
2017	6	752.00	266.00	0.35	47.00	0.06
2017	7	324.00	111.00	0.34	18.60	0.06
2017	8	949.00	278.00	0.29	42.20	0.04
2017	9	1030.00	266.00	0.26	37.80	0.04
2017	10	400.00	99.70	0.25	13.40	0.03
2017	11	1870.00	420.00	0.23	53.20	0.03
2017	12	951.00	215.00	0.23	27.30	0.03

			Standard	Relative		Relative
Catchabilities	Age	Estimate	Error	Error	Bias	Bias
RV Spr	2	0.001030	0.000151	0.147000	0.000004	0.004000
RV Spr	3	0.001410	0.000206	0.146000	0.000006	0.004000
RV Spr	4	0.000703	0.000104	0.148000	0.000003	0.005000
RV Spr	5	0.000483	0.000073	0.151000	0.000003	0.006000
RV Spr	6	0.000345	0.000053	0.154000	0.000002	0.006000
RV Spr	7	0.000338	0.000053	0.158000	0.000003	0.008000
RV Spr	8	0.000326	0.000053	0.162000	0.000003	0.009000
RV Spr	9	0.000321	0.000053	0.166000	0.000004	0.011000
RV Spr	10	0.000406	0.000069	0.169000	0.000006	0.014000
RV_Fall	2	0.001080	0.000179	0.165000	0.000006	0.006000
RV_Fall	3	0.001130	0.000187	0.165000	0.000007	0.006000
RV_Fall	4	0.000803	0.000135	0.169000	0.000006	0.007000
RV_Fall	5	0.000677	0.000117	0.173000	0.000006	0.008000
RV_Fall	6	0.000547	0.000097	0.178000	0.000005	0.010000
RV_Fall	7	0.000379	0.000070	0.184000	0.000005	0.012000
RV_Fall	8	0.000373	0.000071	0.191000	0.000005	0.015000
RV_Fall	9	0.000270	0.000054	0.198000	0.000005	0.018000
RV_Fall	10	0.000368	0.000078	0.212000	0.000009	0.025000
RV_Juvenile	2	0.003530	0.001120	0.319000	0.000161	0.046000
RV_Juvenile	3	0.001850	0.000588	0.318000	0.000084	0.045000
RV_Juvenile	4	0.001330	0.000426	0.319000	0.000061	0.046000
RV_Juvenile	5	0.001090	0.000349	0.321000	0.000049	0.045000
RV_Juvenile	6	0.000794	0.000257	0.323000	0.000035	0.044000
RV_Juvenile	7	0.000578	0.000190	0.329000	0.000026	0.045000
RV_Juvenile	8	0.000455	0.000152	0.334000	0.000022	0.048000
RV_Juvenile	9	0.000290	0.000099	0.340000	0.000016	0.053000
RV_Juvenile	10	0.000256	0.000089	0.348000	0.000016	0.064000

Table 21. Estimated bias adjusted population numbers ('000) from ADAPT for cod in NAFO Divs. 3NO.

Pop #s Bias Adj(analytical)	2	3	4	5	6	7	8	9	10	11	12	Total
1959	63623	53067	92911	19327	16484	12049	4268	3076	3217	2287	324	270633
1960	98989	52090	41903	64326	11271	8099	6336	2246	1838	1803	786	289687
1961	130098	81045	40981	28451	32902	6449	4497	2947	1315	1157	675	330518
1962	94606	106515	65621	29586	12832	13314	3473	2185	1652	900	925	331609
1963	135041	77456	86281	50223	22233	9081	7673	2149	1189	964	534	392824
1964	195489	110562	63133	65447	31040	13843	5695	2858	722	432	500	489720
1965	252970	160052	84924	37711	36087	18299	9287	3665	1632	298	320	605245
1966	221171	207114	130125	62667	24021	17671	6202	3302	2030	239	99	674641
1967	121541	181079	168890	89951	33653	9146	6895	1137	1076	183	87	613638
1968	154111	99509	130150	82351	28883	11073	3234	1531	719	719	86	512366
1969	96818	126175	66743	55815	24240	7265	3431	1228	801	429	508	383452
1970	101649	79268	95947	43016	21651	9853	4073	1563	542	394	231	358186
1971	74517	83223	62998	60832	25515	9253	4802	1872	795	310	121	324238
1972	42189	61010	67279	27529	22783	10441	4442	1704	1083	471	164	239096
1973	44126	34542	49888	37315	11560	6720	3316	2127	1138	693	316	191741
1974	27764	36128	19252	16285	17044	4127	3733	1842	1108	713	444	128441
1975	32970	22732	23796	7288	3683	4318	1379	1147	605	307	204	98428
1976	54572	26994	18005	11618	2819	800	837	198	132	90	31	116096
1977	50070	44680	18449	8004	4213	1338	466	471	123	75	62	127950
1978	20911	40994	36033	12881	4283	2105	584	223	199	43	25	118280
1979	23722	17121	32732	25593	8280	2770	1405	386	130	117	28	112285
1980	33074	19422	13952	23350	12704	4283	1476	912	264	91	85	109614
1981	26374	27079	15661	10472	15685	8354	2822	1009	664	188	68	108374
1982	42559	21593	21714	11838	7436	10773	5129	1794	653	459	117	124066
1983	49825	34844	17404	15994	8259	5176	7444	2860	935	346	230	143318
1984	39693	40793	27464	13665	11389	5677	3620	5057	1647	552	210	149767
1985	10693	32498	33346	21583	9916	7234	3551	2316	3314	854	357	125662
1986	7819	8755	26556	24639	12102	5394	3665	2191	1483	2233	465	95302
1987	15588	6401	7030	19155	14403	5993	3059	2149	1292	879	1514	77469
1988	15505	12586	4776	5375	12545	8696	3816	1917	1003	616	364	67199
1989	6207	12464	10055	3623	3030	4612	3587	2218	1061	441	281	47578
1990	6865	4967	8478	6270	1623	1354	2088	1786	1380	659	211	35680
1991	24684	5251	3110	2929	1298	532	730	1063	941	736	405	41678
1992	7868	14792	3307	1941	1506	576	185	269	365	324	261	31393
1993	801	6366	8066	1132	841	686	261	94	132	184	128	18691
1994	505	626	4031	3732	360	262	275	147	54	73	107	10173
1995	969	414	305	1232	2053	183	132	201	114	44	60	5706
1996	1342	793	339	185	991	1645	148	108	164	93	36	5843
1997	466	1097	646	273	149	796	1324	118	86	132	75	5162
1998	2809	381	887	512	213	117	624	1044	92	67	103	6851
1999	5975	2299	309	706	401	166	91	485	817	72	51	11373
2000	5554	4851	1798	216	487	292	123	69	377	620	56	14442
2001	2168	4538	3650	1167	99	343	220	90	53	297	496	13121
2002	990	1766	3547	2716	811	71	242	159	67	42	235	10646
2003	889	720	1249	2409	1839	537	50	174	119	52	33	8072
2004	1704	689	289	305	837	907	320	37	126	90	41	5344
2005	4661	1385	531	196	205	603	676	243	29	97	71	8696
2006	4405	3815	1133	434	158	164	468	504	181	23	77	11362
2007	8111	3566	2930	776	281	111	130	374	411	146	19	16856
2008	13375	6637	2735	2138	552	208	83	101	298	327	118	26572
2009	2704	10949	5431	2187	1602	415	152	66	80	226	256	24068
2010	5508	2203	8728	4295	1668	1230	316	115	53	62	179	24357
2011	4393	4285	1611	6732	3341	1298	972	247	94	42	51	23064
2012	1497	3557	3339	1268	5391	2695	1020	754	196	73	33	19825
2013	2174	1202	2716	2556	1004	4327	2175	821	605	156	59	17796
2014	1411	1761	832	2008	1957	785	3434	1732	650	486	124	15181
2015	2400	1101	1267	551	1504	1549	593	2785	1406	529	396	14082
2016	5503	1956	848	946	405	1157	1239	478	2246	1145	431	16354
2017	2651	4494	1528	601	705	305	907	987	386	1813	924	15303

Table 22. Bias adjusted fishing mortality from ADAPT for cod in NAFO Divs. 3NO.

F Bias Adj(analytical)	2	3	4	5	6	7	8	9	10	11	12	Fbar6-9	Fbar4-6
1959	0.000	0.036	0.168	0.339	0.511	0.443	0.442	0.315	0.379	0.868	0.428	0.428	0.339
1960	0.000	0.040	0.187	0.470	0.358	0.388	0.566	0.335	0.263	0.782	0.412	0.412	0.339
1961	0.000	0.011	0.126	0.596	0.705	0.419	0.522	0.379	0.179	0.024	0.506	0.506	0.476
1962	0.000	0.011	0.067	0.086	0.146	0.351	0.280	0.408	0.339	0.322	0.296	0.296	0.100
1963	0.000	0.004	0.076	0.281	0.274	0.267	0.788	0.891	0.813	0.456	0.555	0.555	0.210
1964	0.000	0.064	0.315	0.395	0.328	0.199	0.241	0.360	0.684	0.099	0.282	0.282	0.346
1965	0.000	0.007	0.104	0.251	0.514	0.882	0.834	0.391	1.721	0.902	0.655	0.655	0.290
1966	0.000	0.004	0.169	0.422	0.766	0.741	1.496	0.921	2.208	0.811	0.981	0.981	0.452
1967	0.000	0.130	0.518	0.936	0.912	0.839	1.305	0.259	0.203	0.553	0.829	0.829	0.789
1968	0.000	0.199	0.647	1.023	1.180	0.972	0.768	0.448	0.317	0.148	0.842	0.842	0.950
1969	0.000	0.074	0.239	0.747	0.700	0.379	0.586	0.618	0.509	0.419	0.571	0.571	0.562
1970	0.000	0.030	0.256	0.322	0.650	0.519	0.578	0.476	0.359	0.983	0.556	0.556	0.409
1971	0.000	0.013	0.628	0.782	0.694	0.534	0.836	0.347	0.323	0.436	0.603	0.603	0.701
1972	0.000	0.001	0.389	0.668	1.021	0.947	0.536	0.203	0.247	0.201	0.677	0.677	0.693
1973	0.000	0.385	0.920	0.584	0.830	0.388	0.388	0.453	0.267	0.245	0.514	0.514	0.778
1974	0.000	0.218	0.771	1.287	1.173	0.896	0.980	0.913	1.083	1.052	0.991	0.991	1.077
1975	0.000	0.033	0.517	0.750	1.327	1.441	1.740	1.959	1.705	2.097	1.617	1.617	0.865
1976	0.000	0.181	0.611	0.814	0.546	0.342	0.374	0.279	0.366	0.173	0.385	0.385	0.657
1977	0.000	0.015	0.159	0.425	0.494	0.629	0.538	0.661	0.859	0.899	0.580	0.580	0.359
1978	0.000	0.025	0.142	0.242	0.236	0.204	0.213	0.337	0.330	0.231	0.247	0.247	0.207
1979	0.000	0.005	0.138	0.500	0.459	0.429	0.232	0.181	0.155	0.120	0.325	0.325	0.366
1980	0.000	0.015	0.087	0.198	0.219	0.217	0.181	0.118	0.138	0.102	0.184	0.184	0.168
1981	0.000	0.021	0.080	0.142	0.176	0.288	0.253	0.235	0.169	0.274	0.238	0.238	0.133
1982	0.000	0.016	0.106	0.160	0.162	0.170	0.384	0.451	0.437	0.489	0.292	0.292	0.143
1983	0.000	0.038	0.042	0.140	0.175	0.158	0.187	0.352	0.327	0.298	0.218	0.218	0.119
1984	0.000	0.002	0.041	0.121	0.254	0.269	0.247	0.223	0.456	0.237	0.248	0.248	0.139
1985	0.000	0.002	0.103	0.379	0.409	0.480	0.283	0.246	0.195	0.408	0.354	0.354	0.297
1986	0.000	0.019	0.126	0.337	0.503	0.367	0.334	0.328	0.323	0.189	0.383	0.383	0.322
1987	0.014	0.093	0.068	0.224	0.305	0.252	0.267	0.562	0.541	0.681	0.346	0.346	0.199
1988	0.018	0.025	0.076	0.373	0.801	0.686	0.343	0.392	0.621	0.583	0.555	0.555	0.417
1989	0.023	0.185	0.272	0.603	0.606	0.592	0.497	0.275	0.276	0.538	0.492	0.492	0.494
1990	0.068	0.268	0.863	1.375	0.915	0.418	0.475	0.440	0.429	0.288	0.562	0.562	1.051
1991	0.312	0.262	0.271	0.465	0.612	0.859	0.797	0.870	0.868	0.836	0.785	0.785	0.450
1992	0.012	0.406	0.872	0.636	0.587	0.590	0.477	0.515	0.485	0.724	0.542	0.542	0.698
1993	0.046	0.257	0.571	0.945	0.964	0.715	0.372	0.346	0.392	0.346	0.599	0.599	0.827
1994	0.000	0.520	0.985	0.398	0.478	0.491	0.110	0.062	0.021	0.000	0.000	0.285	0.620
1995	0.000	0.000	0.300	0.018	0.022	0.012	0.000	0.005	0.000	0.000	0.000	0.010	0.113
1996	0.002	0.006	0.016	0.018	0.019	0.017	0.023	0.021	0.020	0.012	0.000	0.020	0.018
1997	0.002	0.012	0.031	0.045	0.038	0.044	0.038	0.048	0.052	0.043	0.045	0.042	0.038
1998	0.000	0.009	0.029	0.046	0.053	0.048	0.051	0.044	0.049	0.068	0.055	0.049	0.043
1999	0.009	0.046	0.158	0.171	0.116	0.098	0.075	0.054	0.077	0.047	0.044	0.086	0.149
2000	0.002	0.084	0.232	0.580	0.151	0.083	0.114	0.066	0.039	0.022	0.040	0.103	0.321
2001	0.005	0.046	0.096	0.164	0.130	0.149	0.122	0.090	0.042	0.034	0.027	0.123	0.130
2002	0.118	0.146	0.187	0.190	0.212	0.150	0.131	0.094	0.050	0.027	0.029	0.147	0.196
2003	0.055	0.714	1.209	0.857	0.507	0.317	0.116	0.121	0.077	0.043	0.034	0.265	0.858
2004	0.007	0.061	0.188	0.199	0.129	0.093	0.075	0.031	0.063	0.037	0.027	0.082	0.172
2005	0.000	0.001	0.002	0.011	0.022	0.053	0.094	0.095	0.039	0.035	0.032	0.066	0.012
2006	0.011	0.064	0.178	0.233	0.158	0.034	0.024	0.004	0.012	0.000	0.000	0.055	0.190
2007	0.001	0.065	0.115	0.141	0.103	0.094	0.052	0.027	0.027	0.015	0.000	0.069	0.120
2008	0.000	0.001	0.024	0.089	0.085	0.112	0.027	0.033	0.077	0.045	0.068	0.064	0.066
2009	0.005	0.027	0.034	0.071	0.064	0.072	0.083	0.017	0.057	0.035	0.071	0.059	0.056
2010	0.051	0.113	0.060	0.051	0.051	0.036	0.046	0.000	0.042	0.000	0.006	0.033	0.054
2011	0.011	0.049	0.039	0.022	0.015	0.041	0.054	0.032	0.048	0.027	0.000	0.035	0.025
2012	0.019	0.070	0.067	0.034	0.020	0.014	0.017	0.021	0.029	0.015	0.000	0.018	0.040
2013	0.011	0.168	0.102	0.067	0.046	0.031	0.028	0.033	0.018	0.029	0.000	0.034	0.072
2014	0.048	0.129	0.211	0.089	0.034	0.080	0.009	0.008	0.007	0.005	0.000	0.033	0.111
2015	0.005	0.062	0.092	0.107	0.062	0.023	0.017	0.015	0.006	0.004	0.000	0.029	0.087
2016	0.002	0.047	0.144	0.094	0.085	0.044	0.027	0.012	0.014	0.015	0.000	0.042	0.108

Table 23. Beginning of year mean weights at age calculated from commercial catches of cod in Divs. 3NO.

Year\Age	3	4	5	6	7	8	9	10	11	12
1959	0.301	0.664	1.001	1.622	2.572	3.129	3.670	4.419	4.843	5.691
1960	0.301	0.587	1.012	1.561	2.345	3.092	3.673	4.316	4.957	5.691
1961	0.301	0.587	1.012	1.561	2.345	3.092	3.673	4.316	4.957	5.691
1962	0.301	0.587	1.012	1.561	2.345	3.092	3.673	4.316	4.957	5.691
1963	0.301	0.587	1.012	1.561	2.345	3.092	3.673	4.316	4.957	5.691
1964	0.301	0.587	1.012	1.561	2.345	3.092	3.673	4.316	4.957	5.691
1965	0.287	0.587	1.012	1.561	2.345	3.092	3.673	4.316	4.957	5.691
1966	0.351	0.615	1.052	1.636	2.482	3.446	4.636	5.532	6.292	7.332
1967	0.351	0.657	1.102	1.700	2.600	3.647	5.166	6.982	8.066	9.308
1968	0.351	0.657	1.102	1.700	2.600	3.647	5.166	6.982	8.066	9.308
1969	0.351	0.657	1.102	1.700	2.600	3.647	5.166	6.982	8.066	9.308
1970	0.351	0.657	1.102	1.700	2.600	3.647	5.166	6.982	8.066	9.308
1971	0.338	0.657	1.102	1.700	2.600	3.647	5.166	6.982	8.066	9.308
1972	0.397	0.682	1.138	1.676	2.487	3.354	5.005	7.100	7.999	9.262
1973	0.504	0.735	1.178	1.776	2.748	3.658	4.717	7.542	9.423	10.789
1974	0.289	0.645	1.095	1.674	2.503	4.117	5.822	5.842	8.961	9.159
1975	0.246	0.611	0.967	1.599	2.481	3.449	5.082	7.024	5.364	7.717
1976	0.354	0.588	1.120	1.727	2.631	3.557	5.268	6.952	7.849	8.113
1977	0.420	0.707	1.161	1.870	2.860	3.925	5.375	7.666	10.112	10.239
1978	0.617	0.774	1.245	1.825	3.046	4.023	5.417	7.200	9.139	12.271
1979	0.514	0.840	1.208	1.800	2.541	3.720	4.679	6.653	7.596	9.790
1980	0.531	0.822	1.287	1.864	2.777	3.969	5.434	6.618	8.706	10.031
1981	0.789	0.950	1.383	2.132	2.979	4.435	6.256	8.522	9.114	10.373
1982	0.843	1.026	1.380	2.012	3.210	4.321	6.318	7.921	9.453	10.519
1983	0.731	1.049	1.479	1.986	2.891	4.463	5.743	7.779	8.894	10.398
1984	0.757	0.989	1.329	2.065	2.828	3.923	5.473	6.728	8.490	10.647
1985	0.331	0.824	1.255	1.759	2.722	3.760	5.178	6.923	8.128	9.964
1986	0.269	0.696	1.143	1.720	2.675	4.193	6.080	8.063	9.094	9.508
1987	0.343	0.566	1.146	1.668	2.498	4.076	6.267	8.435	9.835	11.187
1988	0.646	0.700	1.064	1.525	2.020	3.301	4.937	7.067	9.158	10.442
1989	0.362	0.847	1.265	1.758	2.419	3.206	5.166	6.523	8.072	10.714
1990	0.442	0.718	1.190	2.004	2.473	3.679	4.811	7.698	8.786	10.322
1991	0.506	0.684	1.267	1.832	3.101	3.896	5.583	6.737	10.014	11.396
1992	0.215	0.598	0.949	1.692	2.547	4.310	5.560	7.480	8.838	11.295
1993	0.318	0.507	0.937	1.397	2.253	3.404	5.336	6.569	8.081	8.655
1994	0.162	0.407	0.842	1.483	1.840	3.375	4.506	6.653	5.167	8.130
1995	0.309	0.450	0.746	1.359	1.932	1.956	5.164	5.543	6.951	5.255
1996	0.309	0.573	0.986	1.552	2.332	2.781	3.125	6.284	6.314	7.173
1997	0.309	0.573	1.005	1.606	2.310	3.007	3.982	5.301	6.193	7.173
1998	0.282	0.573	1.005	1.606	2.310	3.007	3.982	5.301	6.193	7.173
1999	0.386	0.628	1.114	1.638	2.106	2.754	3.672	5.328	6.346	6.877
2000	0.442	0.639	1.163	1.951	2.669	2.543	2.732	3.887	5.632	6.394
2001	0.444	0.805	1.067	1.730	3.115	4.237	3.931	3.813	5.330	6.717
2002	0.569	0.767	1.285	1.762	2.643	4.569	5.590	6.151	6.834	8.364
2003	0.571	0.795	1.188	1.753	2.600	3.722	6.264	6.807	7.782	8.841
2004	0.483	0.785	1.138	1.745	2.474	3.442	4.876	8.072	8.664	8.647
2005	0.324	0.985	1.505	2.173	2.931	3.868	4.819	7.340	9.371	10.525
2006	0.554	0.736	1.385	2.243	2.987	3.587	4.796	6.460	8.287	12.359
2007	0.473	0.824	1.240	1.855	2.435	3.502	4.097	5.607	6.864	7.874
2008	0.254	0.799	1.263	1.645	2.712	2.762	5.245	5.516	6.552	8.178
2009	0.380	0.474	1.166	1.851	2.285	3.329	3.458	6.921	6.658	7.486
2010	0.243	0.552	0.760	1.595	2.427	2.900	4.790	4.485	9.086	8.748
2011	0.400	0.454	0.866	1.196	2.599	3.608	4.166	5.337	4.968	9.868
2012	0.481	0.605	0.836	1.360	1.749	3.818	5.186	5.990	6.416	7.302
2013	0.317	0.620	0.912	1.307	1.886	2.092	4.393	5.841	6.517	10.249
2014	0.336	0.595	0.926	1.247	1.765	2.110	2.633	5.546	6.488	8.274
2015	0.491	0.617	1.005	1.512	1.780	2.227	2.464	3.180	5.208	9.990
2016	0.416	0.637	0.906	1.289	2.170	2.437	2.504	3.528	3.972	7.867
2017	0.414	0.616	0.946	1.350	1.905	2.258	2.534	4.085	5.223	8.710

Table 25. Estimated spawner biomass using annual ogives, beginning of the year weights and bias adjusted population numbers from ADAPT for cod in NAFO Division 3NO.

	3	4	5	6	7	8	9	10	11	12	SSB
1959	126	1396	1073	1362	18267	11827	11078	14177	11069	1846	72220
1960	51	966	7534	4421	5779	17348	8096	7912	8932	4471	65509
1961	1	405	4985	21835	9939	10859	10620	5661	5733	3842	73881
1962	29	45	2471	10362	25192	9841	7758	7111	4461	5263	72532
1963	131	501	1166	11129	18011	22759	7768	5112	4775	3040	74393
1964	34	985	6627	15600	23125	17002	10419	3107	2139	2847	81886
1965	2	245	4436	31131	38863	26664	13368	7034	1477	1822	125043
1966	37	45	1540	15223	40885	21259	15089	11216	1504	726	107524
1967	836	740	964	5930	17901	24984	5875	7494	1473	809	67006
1968	40	3409	7440	7121	10329	11042	7904	5020	5798	801	58904
1969	13	395	7036	22368	14089	9137	6255	5589	3458	4725	73065
1970	2	181	3152	10547	24097	14568	7502	3774	3177	2148	69149
1971	0	38	1845	15537	13367	17430	9659	5464	2499	1123	66962
1972	652	2	316	8306	21136	11851	8523	7691	3756	1520	63752
1973	22	2766	169	2090	13517	11786	9268	8584	6527	3402	58130
1974	1	104	3459	8354	5766	14817	10686	6303	6392	4065	59947
1975	19	25	373	2442	10476	4441	5809	4249	1632	1574	31041
1976	19	197	288	1322	1424	2976	1037	920	707	250	9140
1977	16	185	908	1787	2727	1572	2534	940	760	635	12065
1978	35	230	1499	2987	5079	2214	1143	1434	389	307	15319
1979	128	364	2266	6331	5487	5123	1791	850	891	271	23502
1980	35	798	3424	10165	10005	5583	4947	1744	790	854	38344
1981	42	351	3982	18454	21832	12194	6257	5654	1714	699	71179
1982	63	361	2386	9843	31874	21844	11295	5166	4335	1232	88399
1983	7	297	2883	8979	13576	32927	16402	7274	3072	2395	87810
1984	25	75	1318	12674	14372	13920	27650	11078	4686	2236	88036
1985	21	161	706	4716	17876	13134	11945	22940	6944	3553	81996
1986	5	249	1151	4266	9190	15186	13289	11950	20310	4424	80019
1987	13	77	1908	5663	10674	11128	13450	10898	8647	16940	79397
1988	2	112	897	7643	12135	12090	9230	7090	5639	3805	58643
1989	21	27	780	3394	9182	10831	11409	6882	3563	3015	49104
1990	37	229	329	1784	3157	7453	8520	10616	5784	2178	40088
1991	21	137	905	962	1449	2825	5911	6335	7368	4611	30523
1992	1	110	397	1851	1333	777	1496	2726	2860	2951	14503
1993	0	50	323	614	1477	883	498	866	1486	1112	7309
1994	0	25	888	409	393	922	664	361	377	866	4905
1995	1	6	537	2586	339	243	1039	629	303	314	5998
1996	6	13	90	1526	3827	409	332	1031	587	256	8076
1997	4	57	111	221	1838	3982	471	456	815	539	8496
1998	2	55	301	296	268	1875	4156	490	415	740	8598
1999	1	20	412	601	343	251	1782	4356	457	353	8576
2000	2	16	109	864	770	312	190	1464	3490	360	7577
2001	13	82	209	144	1056	931	353	203	1581	3335	7906
2002	7	372	1494	1068	183	1104	891	414	285	1963	7780
2003	7	159	2263	3068	1365	186	1087	809	408	294	9646
2004	9	31	293	1445	2239	1101	178	1017	780	355	7447
2005	6	60	181	442	1765	2616	1172	213	907	748	8110
2006	102	49	231	310	490	1679	2418	1170	190	946	7586
2007	58	456	218	392	261	455	1533	2305	1006	147	6831
2008	7	258	1393	525	528	227	529	1645	2146	966	8224
2009	66	52	852	2460	821	499	227	553	1506	1919	8956
2010	9	320	324	1738	2858	887	547	238	562	1564	9047
2011	28	41	1390	1477	2955	3474	1022	500	207	500	11594
2012	1	198	189	4249	3571	3752	3904	1172	470	242	17749
2013	12	36	963	578	7007	4292	3569	3532	1016	605	21610
2014	16	56	933	2001	1026	6984	4511	3596	3155	1026	23304
2015	11	80	183	2226	2666	1205	6804	4464	2751	3960	24349
2016	16	42	277	344	2509	3004	1165	7909	4547	3390	23204
2017	36	74	219	634	513	2048	2500	1567	9463	8048	25101
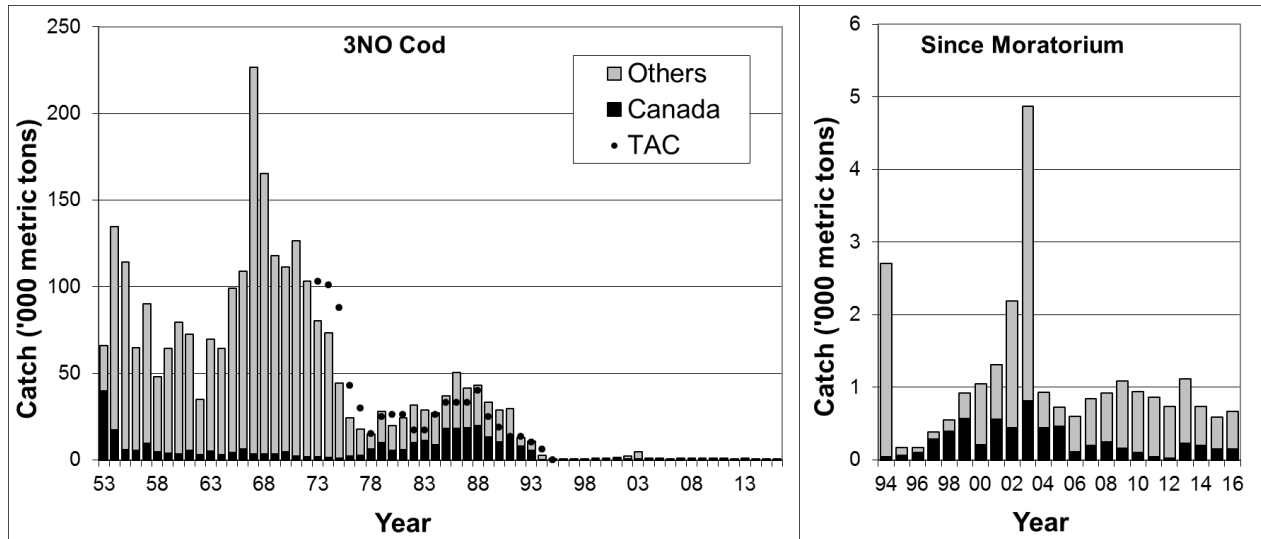
Fig. 1.   Catches of cod in NAFO Divs. 3NO. The panel on the right represents catches since the moratorium in Feb. 1994.
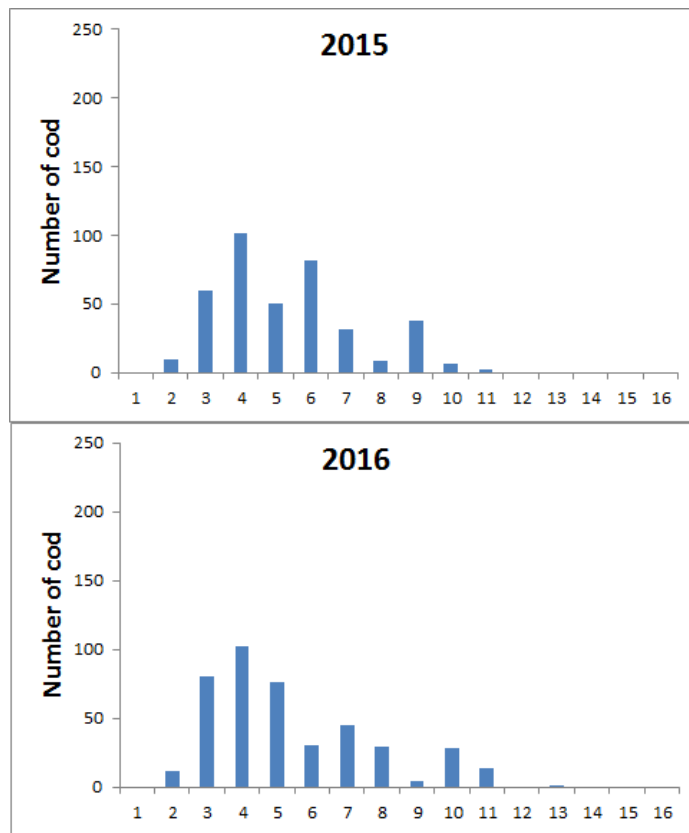
Fig. 2.   Plot of recent catch-at-age estimates for cod from NAFO Divs. 3NO.
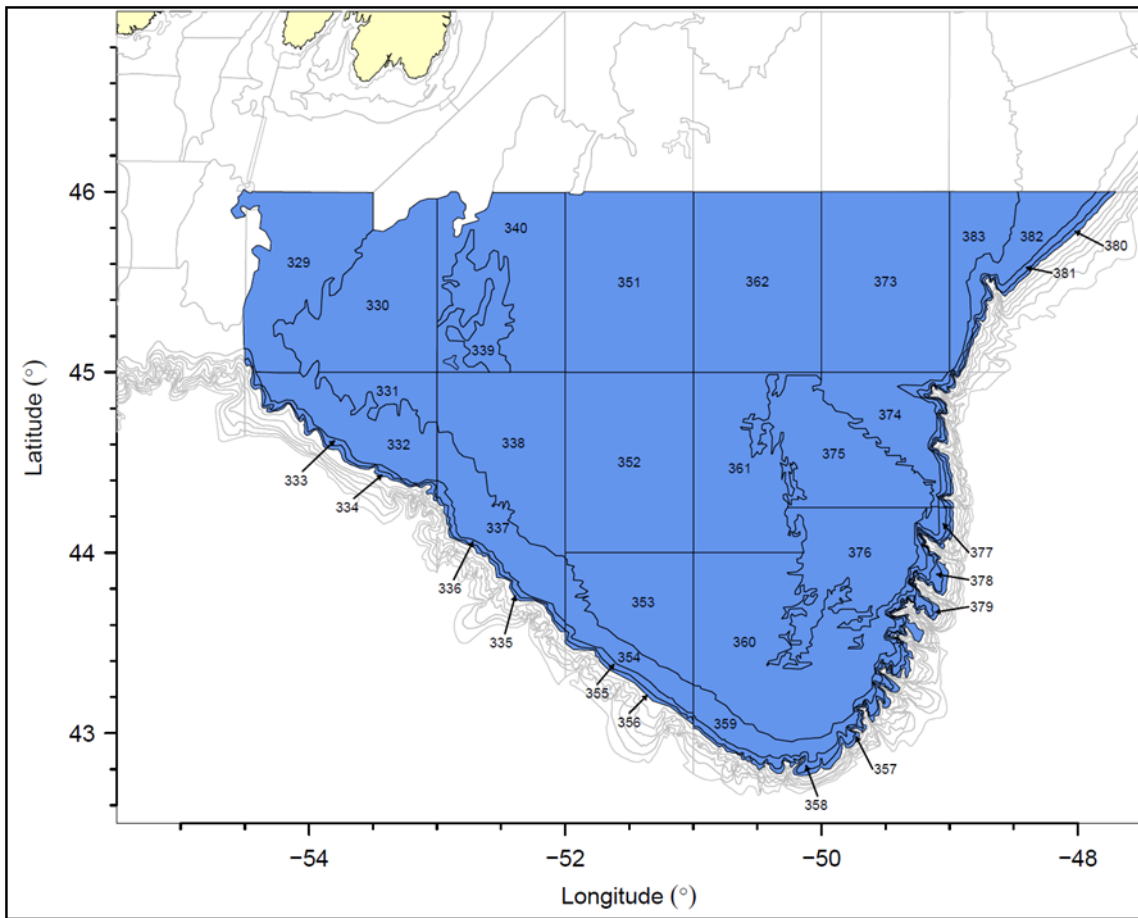
Fig. 3.   Stratification scheme for Divs. 3NO. Index strata for Divs. 3NO cod are highlighted blue.
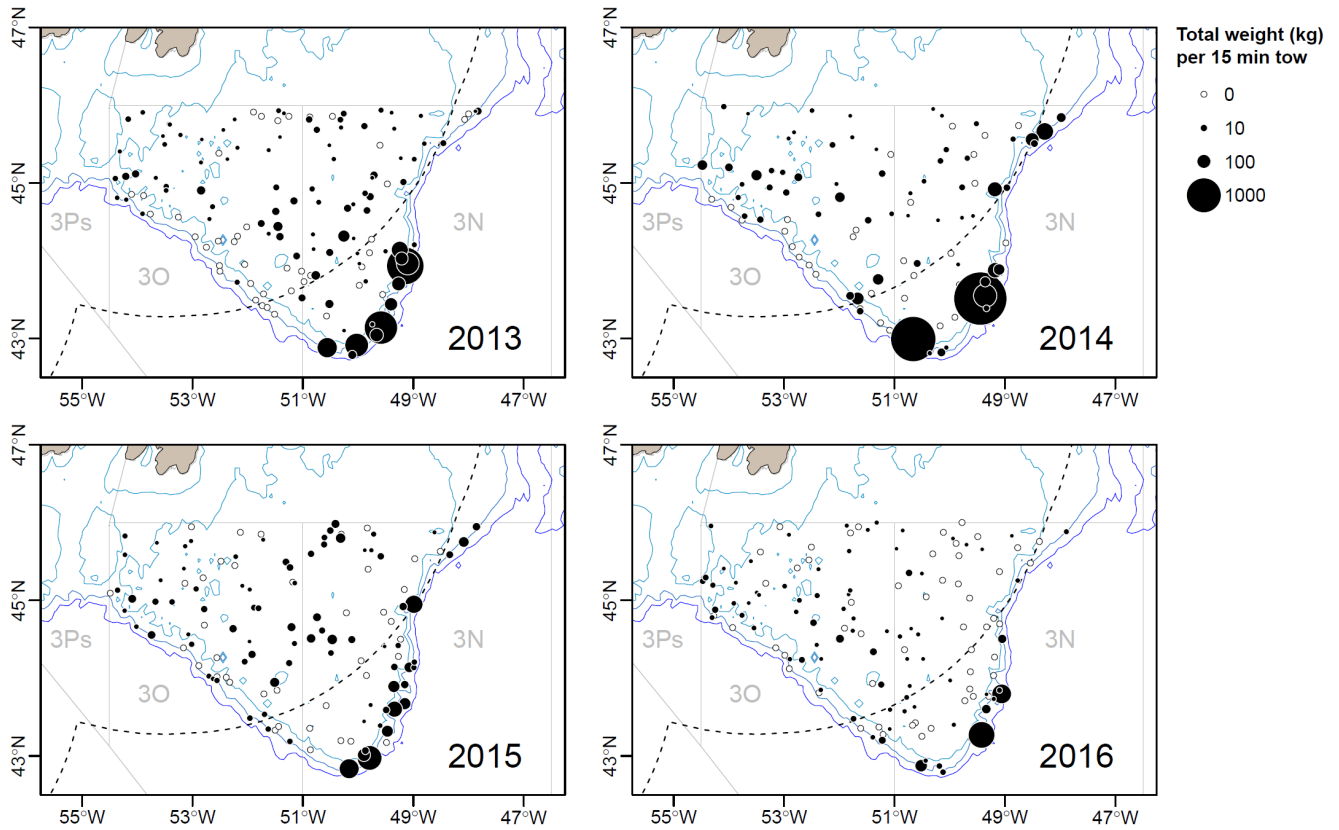
Fig. 4.   Distribution plots demonstrating Spring survey set locations and total weight of fish caught at each location. Symbol area is proportional to catch weight.
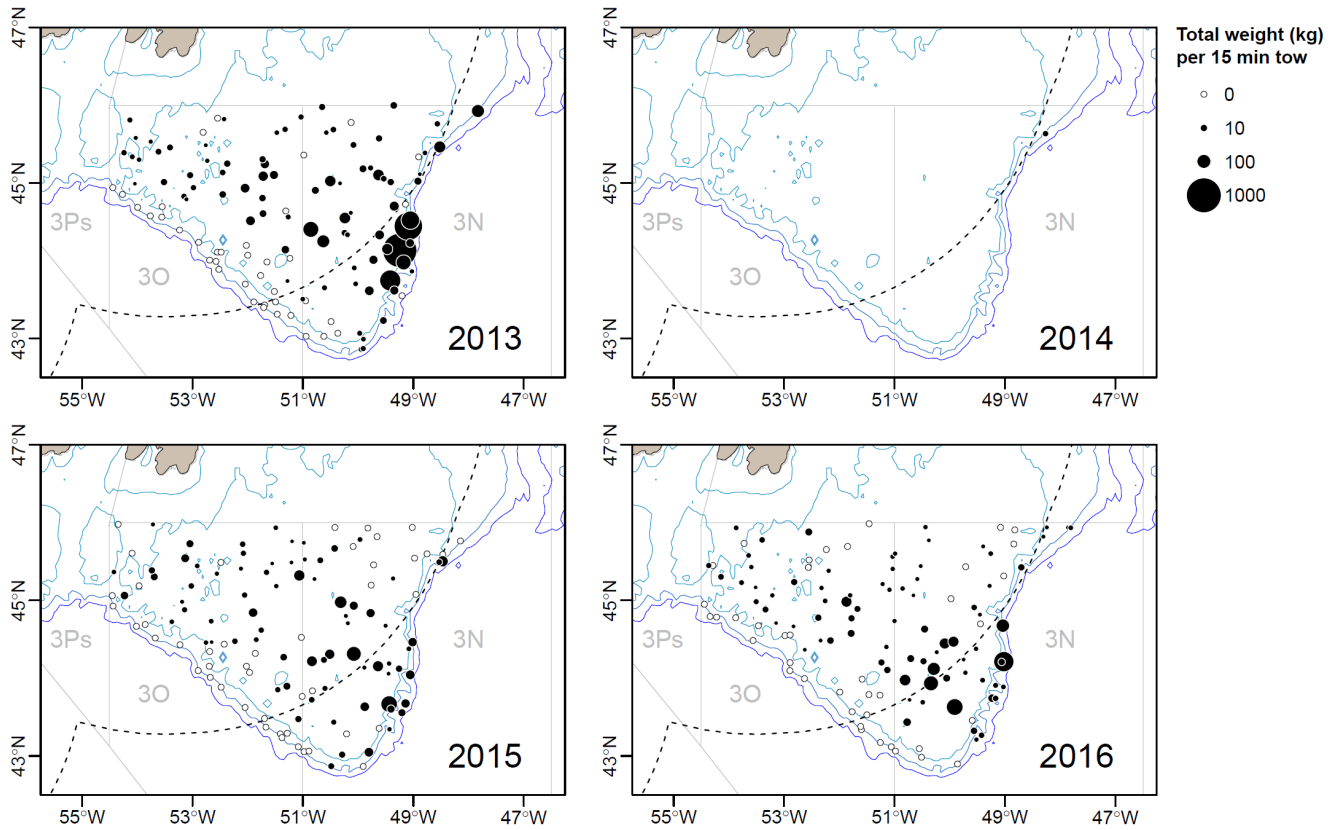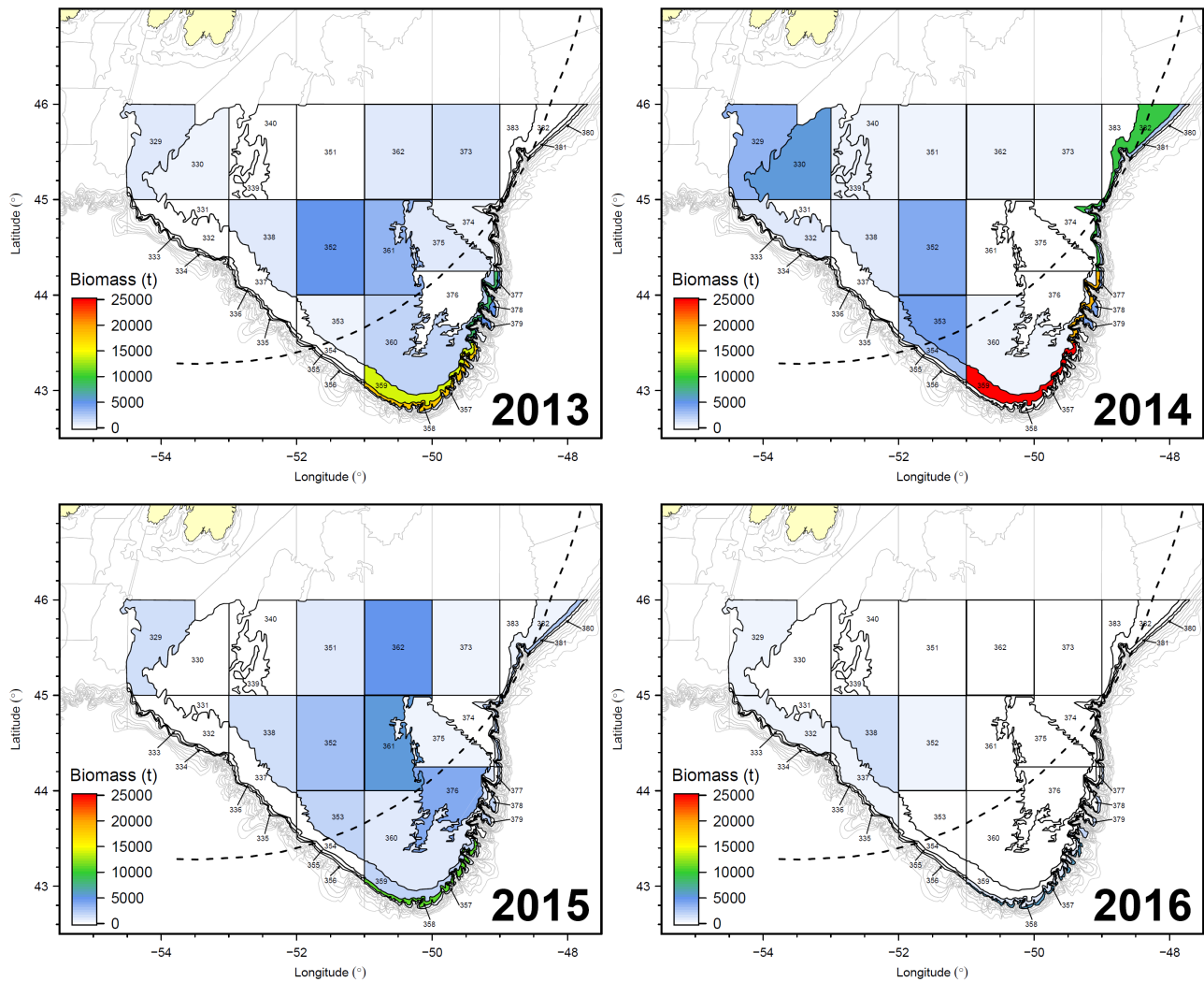
Fig. 5.   Distribution plots demonstrating Autumn survey set locations and total weight of fish caught at each location. Symbol area is proportional to catch weight.

Fig. 6.   Spring biomass distribution plots for 2013-2016. Individual strata are colour-coded based on stratum specific biomass estimates from Canadian RV surveys.
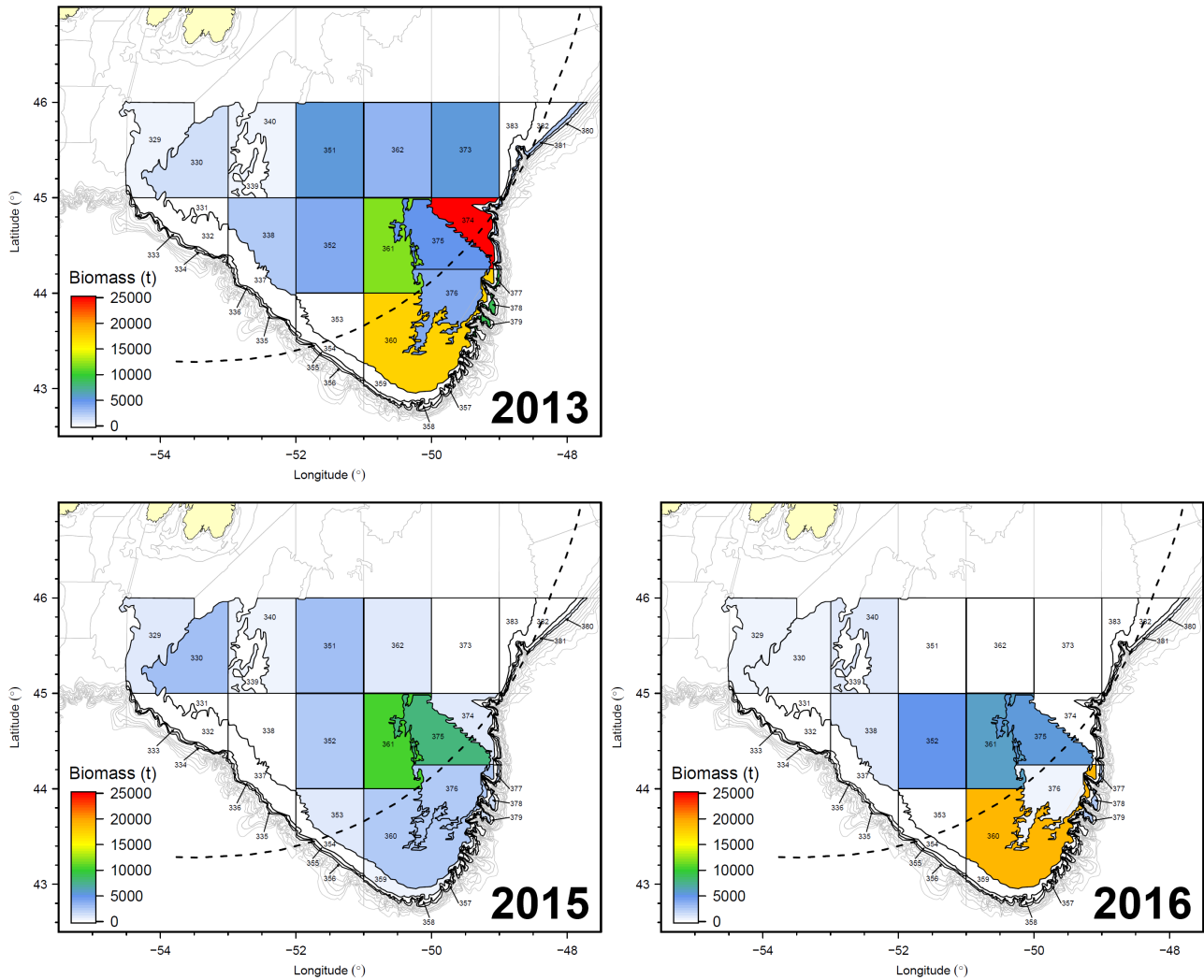
Fig. 7. Autumn biomass distribution plot for 2013-2016 (note that the survey was not completed in autumn 2014). Individual strata are colour-coded based on stratum specific biomass estimates from Canadian RV surveys.
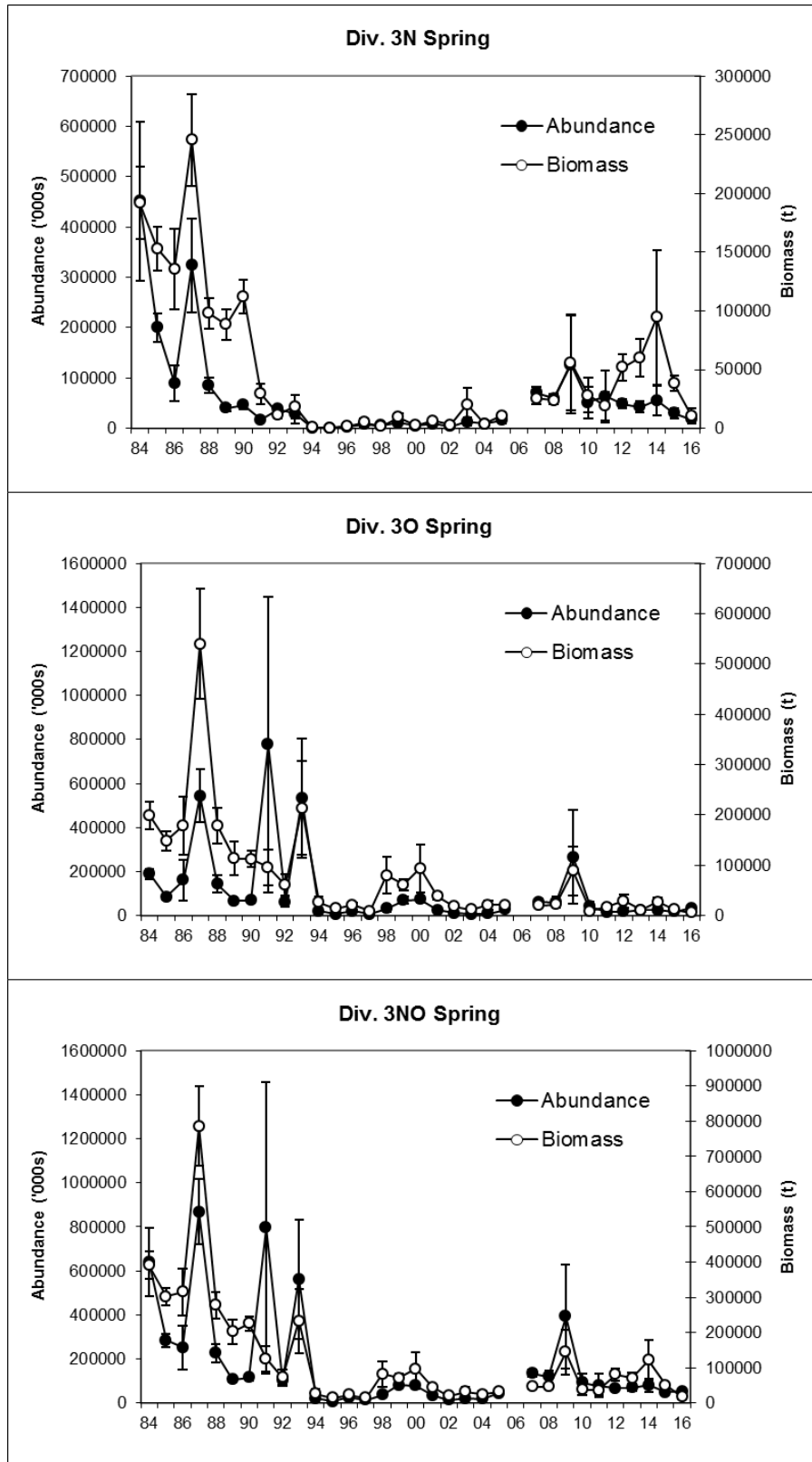
Fig. 8.   Abundance (000's) and biomass (t) for the Canadian Spring Research Vessel survey series with 1 standard deviation for strata<200 fathoms.
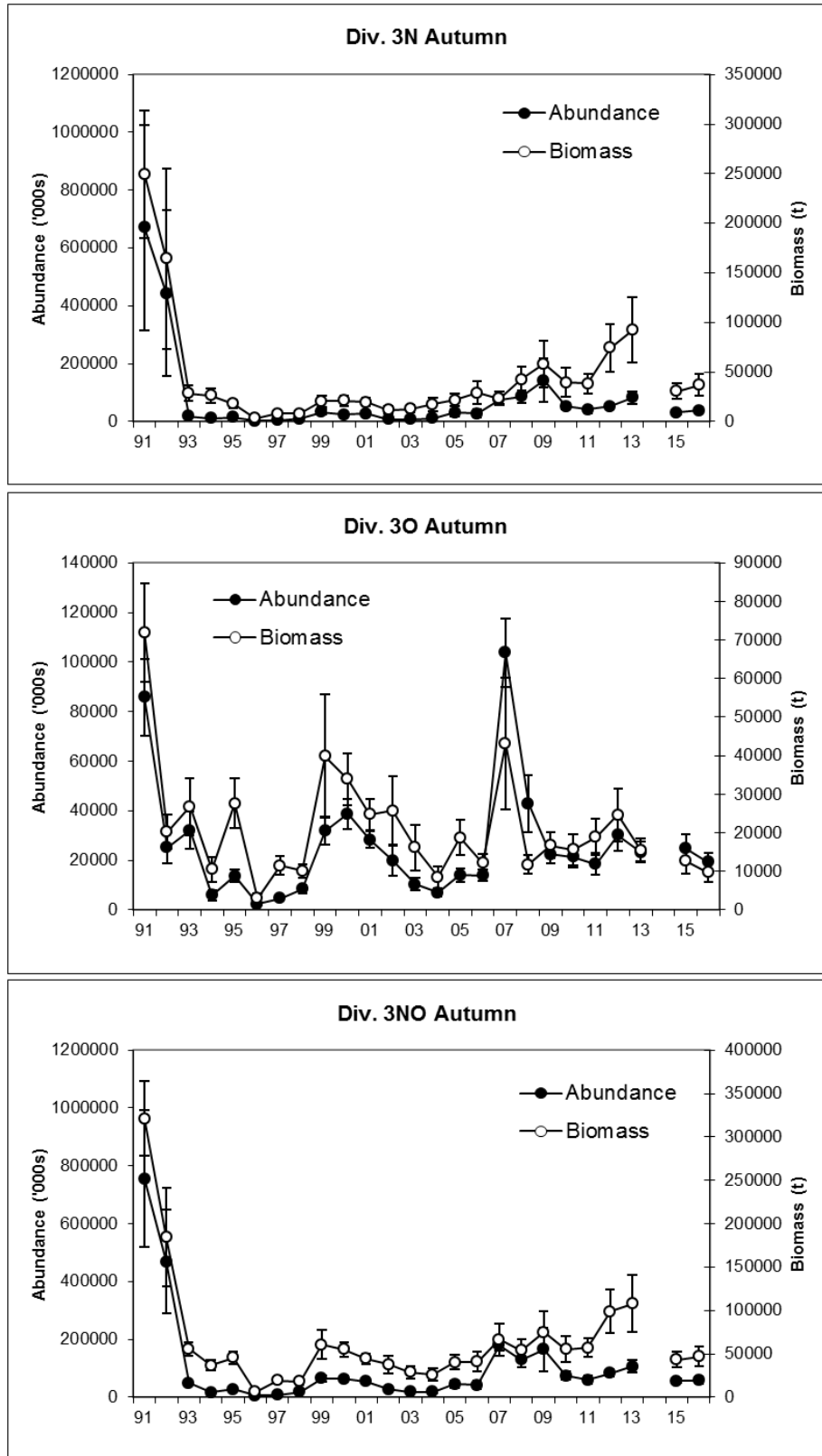
Fig. 9.   Abundance (000's) and biomass (t) for the Canadian Autumn Research Vessel survey series with 1 standard deviation for strata<200 fathoms.
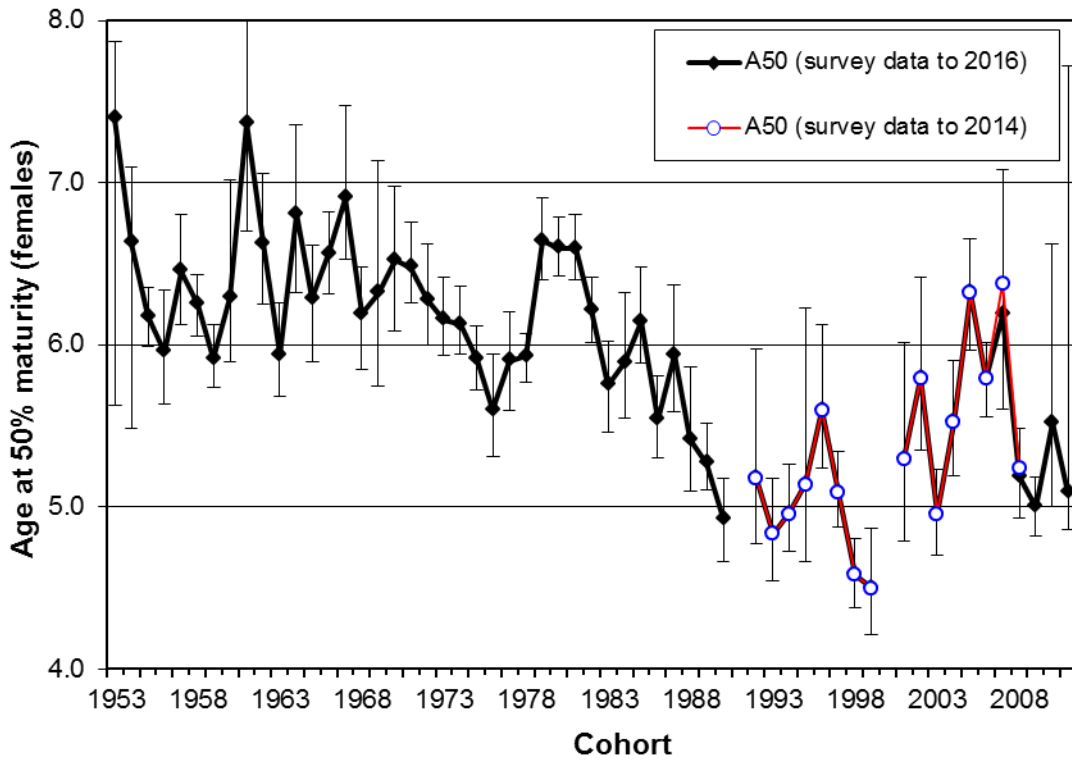
Fig. 10. Age at 50% maturity by cohort for female cod sampled during DFO spring research vessel bottom-trawl surveys of NAFO Divs. 3NO. Error bars are 95% fiducial limits.
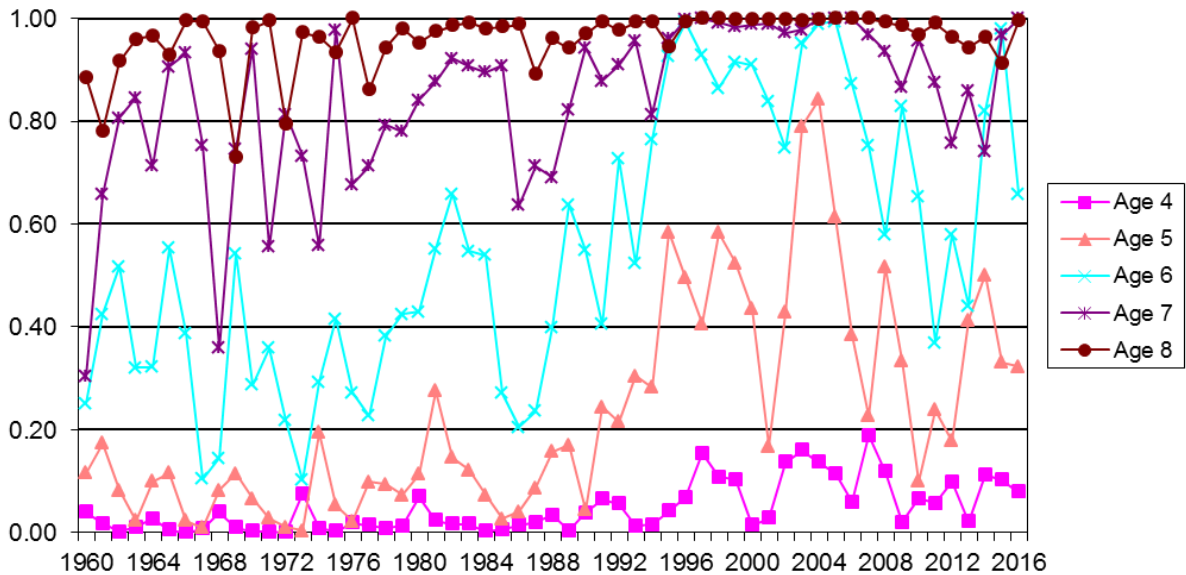
Fig. 11. Estimated proportions mature at ages 4-8 for female cod sampled during Canadian research vessel bottom-trawl surveys in NAFO Divs 3NO. Model fitted by cohort to observed proportions mature.

3NO cod, CAN_Spr
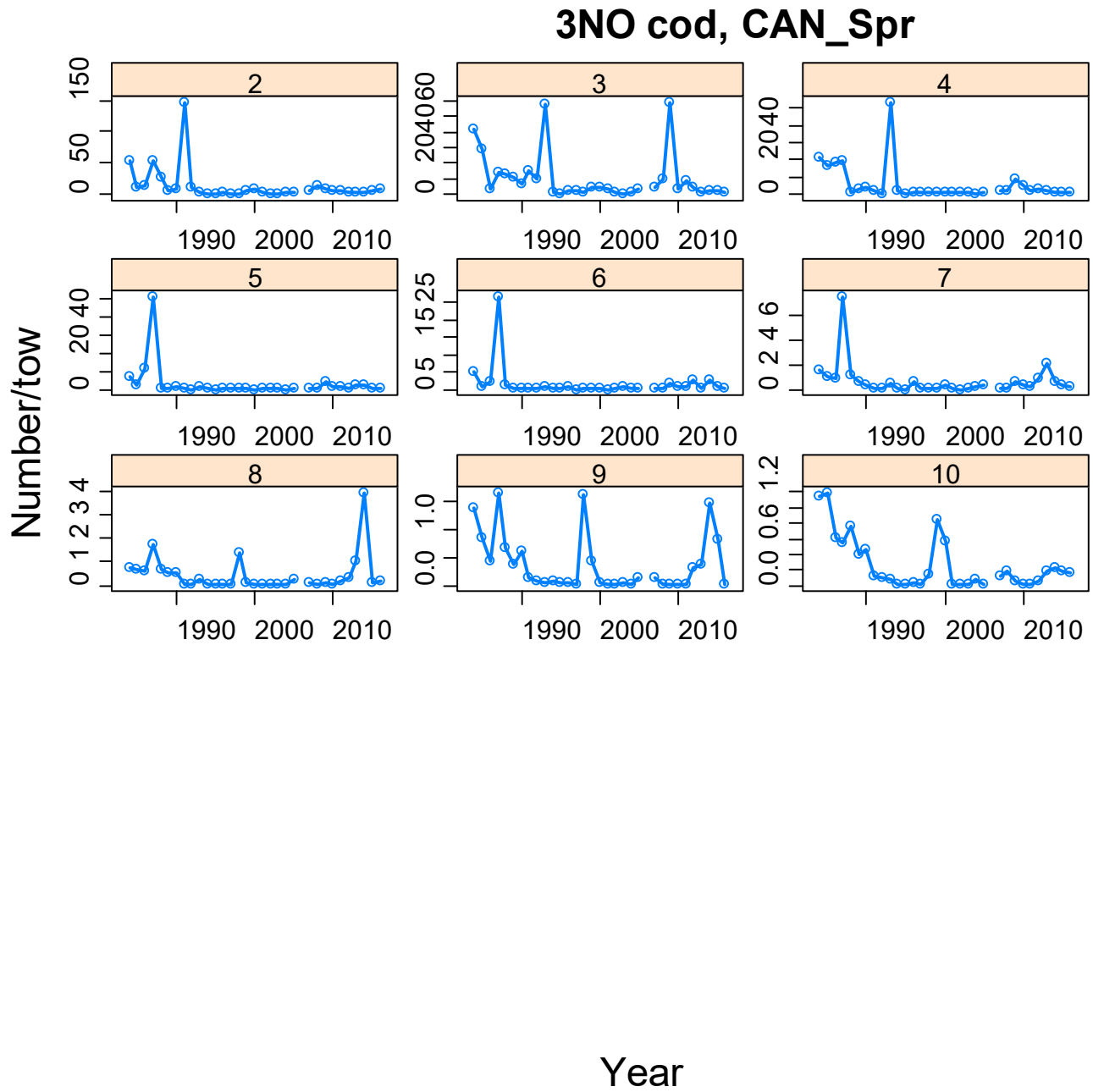
Fig. 12. Age by age disaggregated plots of mean number per tow from Canadian SPRING surveys from 1984-2016.
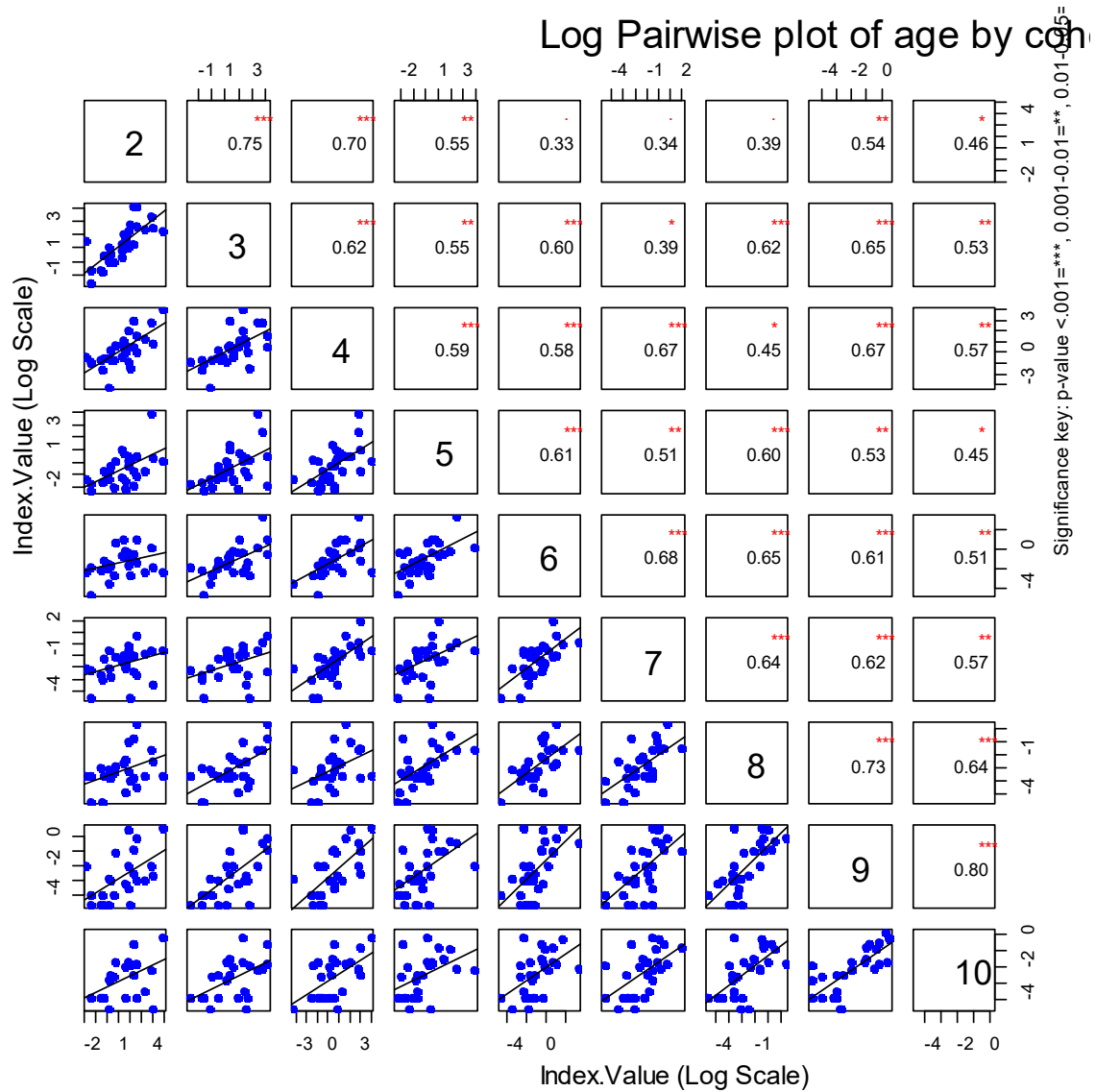
Fig. 13. Pair-wise scatter plot of age-disaggregated survey data (log-scale) from Canadian SPRING surveys in Divs. 3NO (1984-2016). Data points in the panels below the numbered diagonal compare the logarithm of survey data at different ages for a common cohort. The solid line in each panel is the linear least squares regression line with the correlation coefficient provided in the corresponding diagonal panel (p-values significantly different than 0 noted with asterisk (see key on right side of diagram).
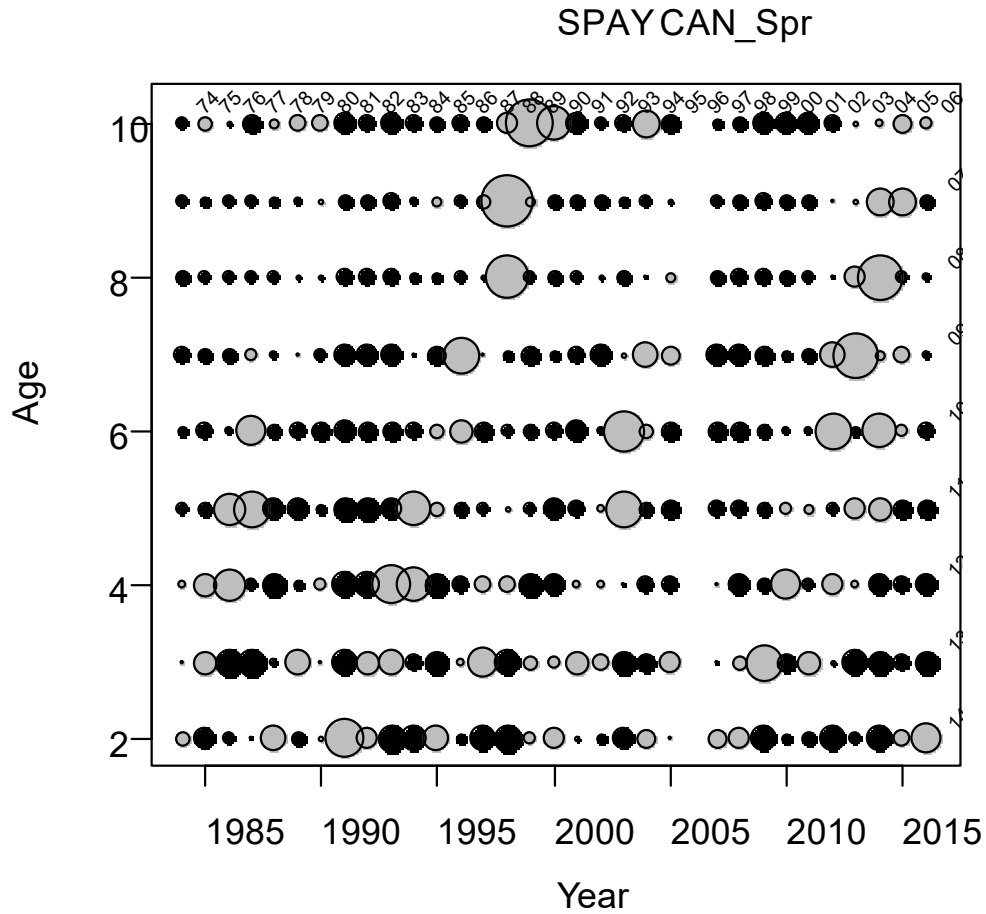
Fig. 14. Plot of standardized proportions at age across years (SPAY) for the Canadian Spring surveys in 3NO (1984-2016). Age disaggregated mean number per tow were converted to proportions within an age. For each survey-age, the survey data are standardized to have a mean of 0 and a variance of 1. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles.

3NO cod, CAN_F
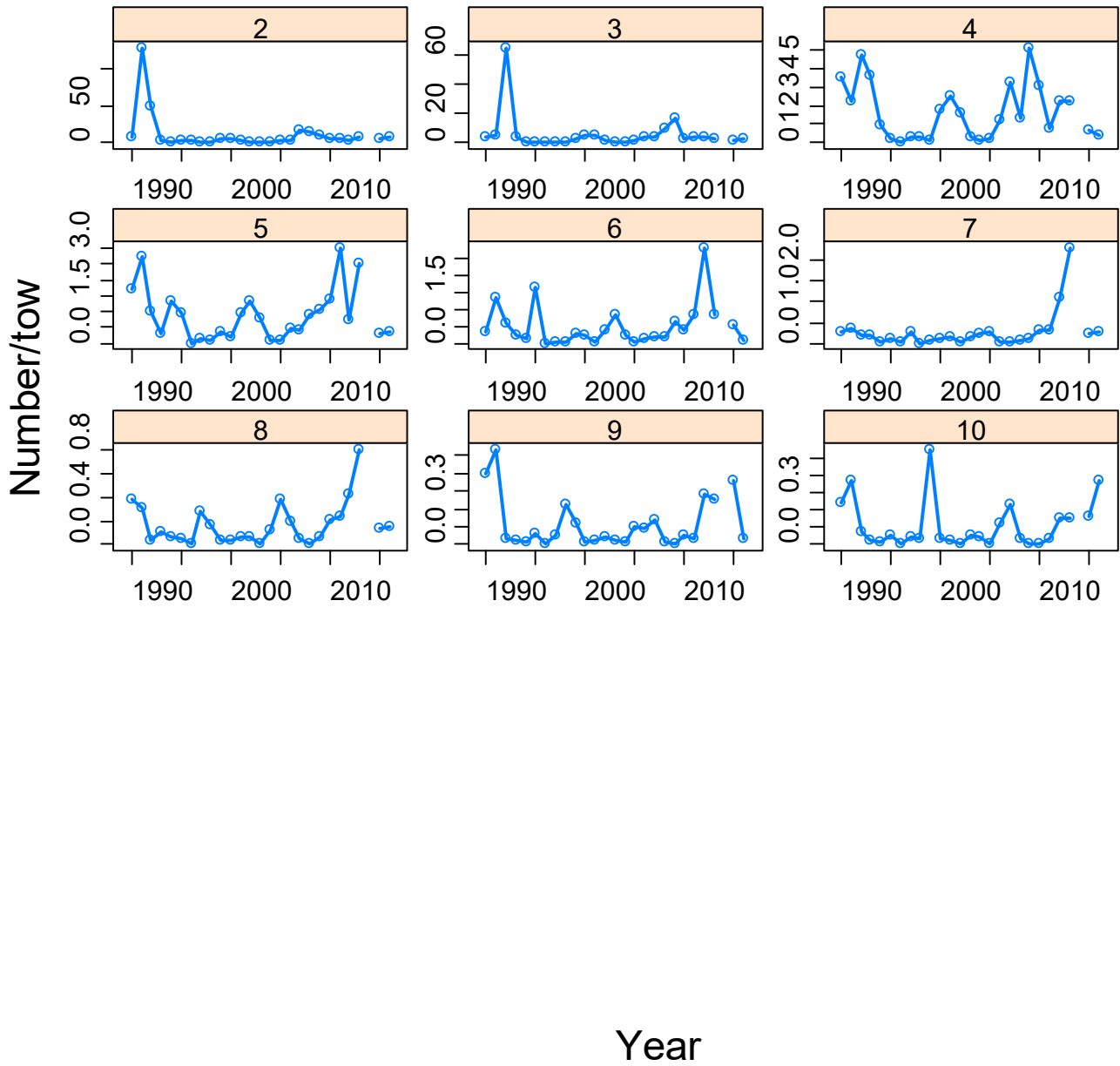
Fig. 15. Age by age disaggregated plots of mean number per tow from Canadian AUTUMN surveys from 1984-2016.

Log Pairwise plot of age by coh
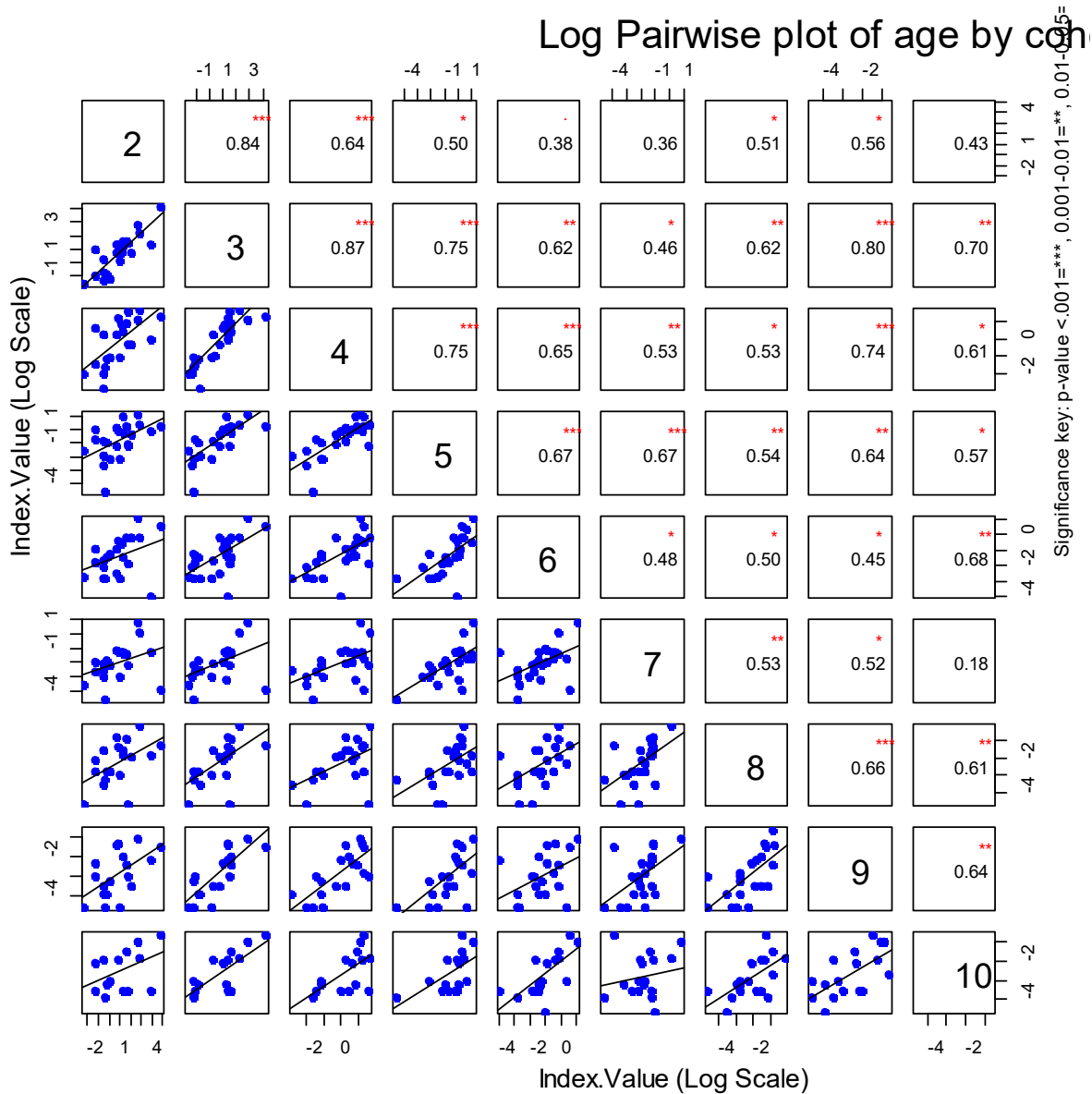
Fig. 16. Pair-wise scatter plot of age-disaggregated survey data (log-scale) from Canadian AUTUMN surveys in Divs. 3NO (1990-2016). Data points in the panels below the numbered diagonal compare the logarithm of survey data at different ages for a common cohort. The solid line in each panel is the linear least squares regression line with the correlation coefficient provided in the corresponding diagonal panel (p-values significantly different than 0 noted with asterisk (see key on right side of diagram).

SPAY CAN_F
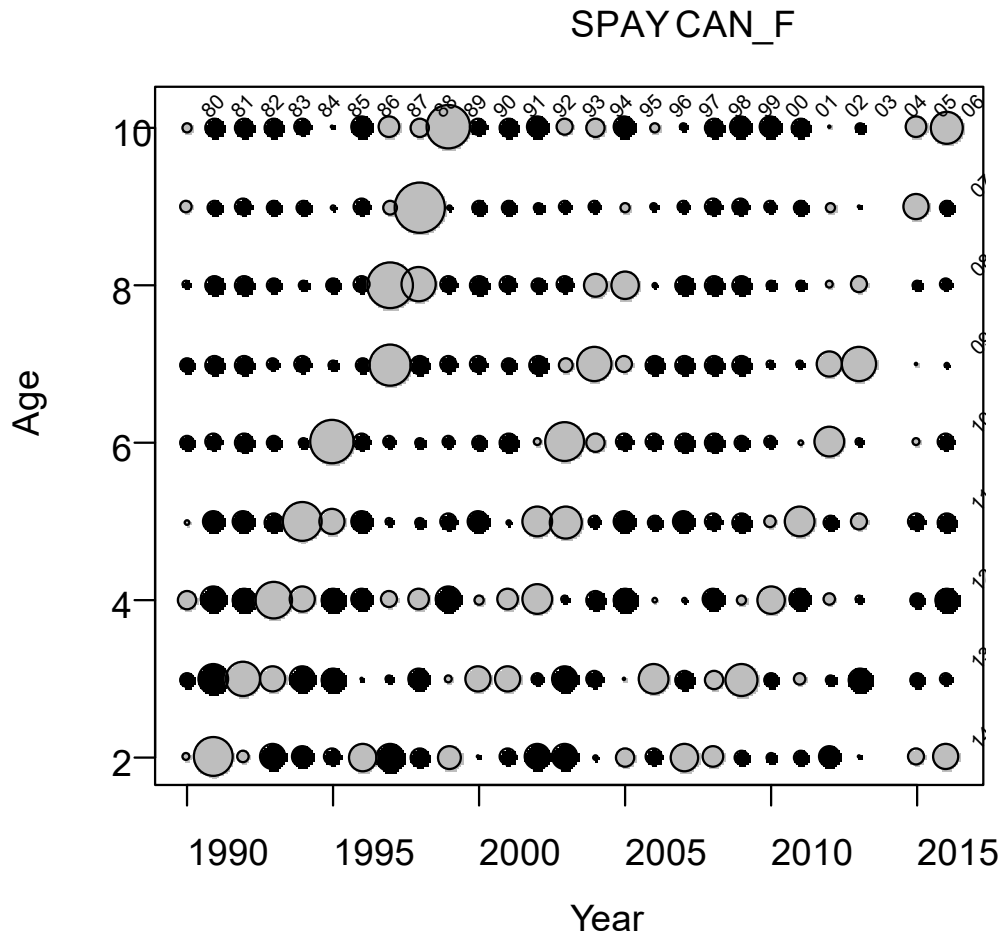
Fig. 17. Plot of standardized proportions at age across years (SPAY) for the Canadian Autumn surveys in 3NO (1984-2013). Age disaggregated mean number per tow were converted to proportions within an age. For each survey-age, the survey data are standardized to have a mean of 0 and a variance of 1. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles.
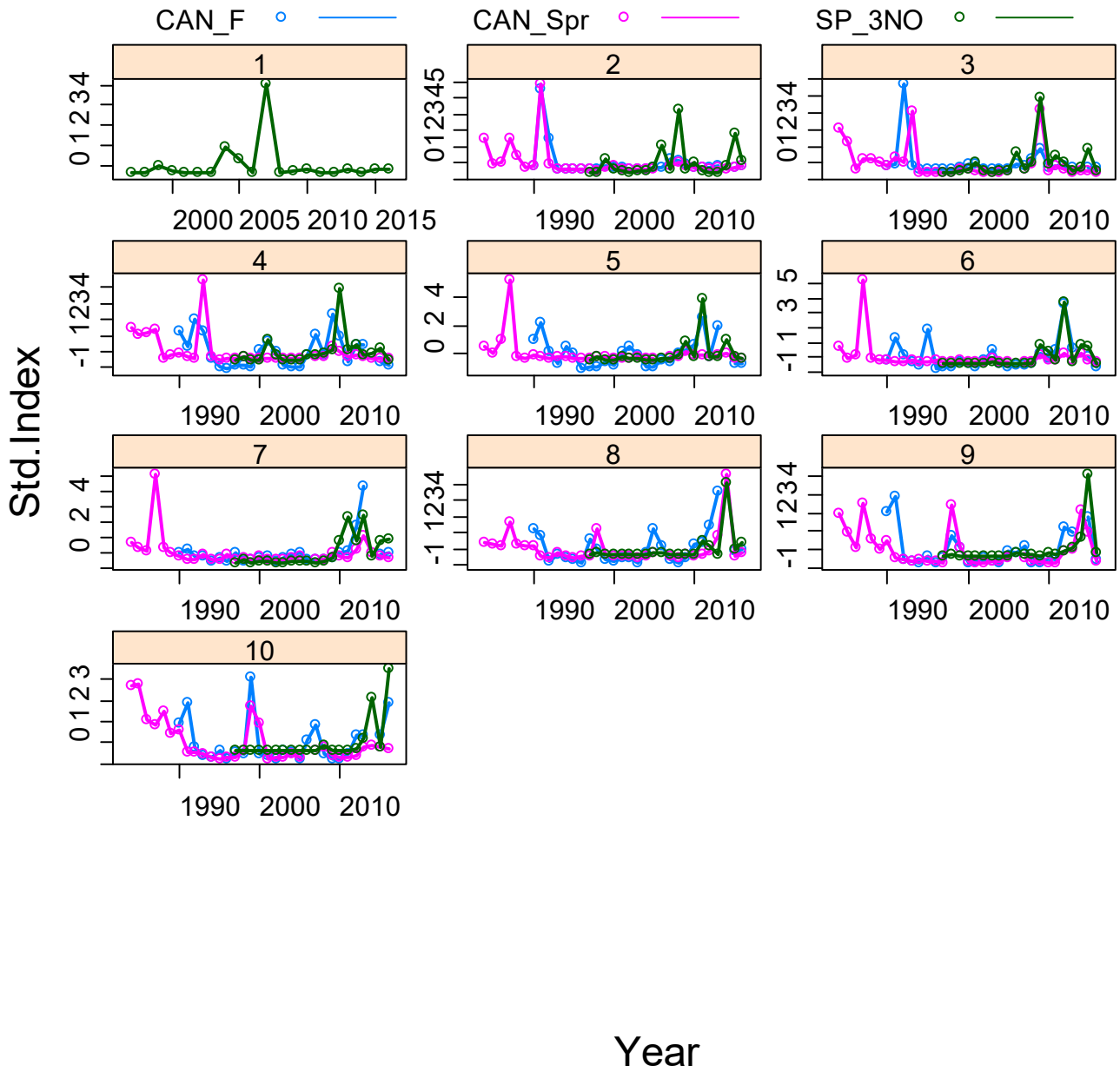
Fig. 18. Cohort consistency plots for survey indices for 3NO cod (Canadian SPRING, Canadian Autumn and Spanish 3NO). Plotted are standardized indices at age.
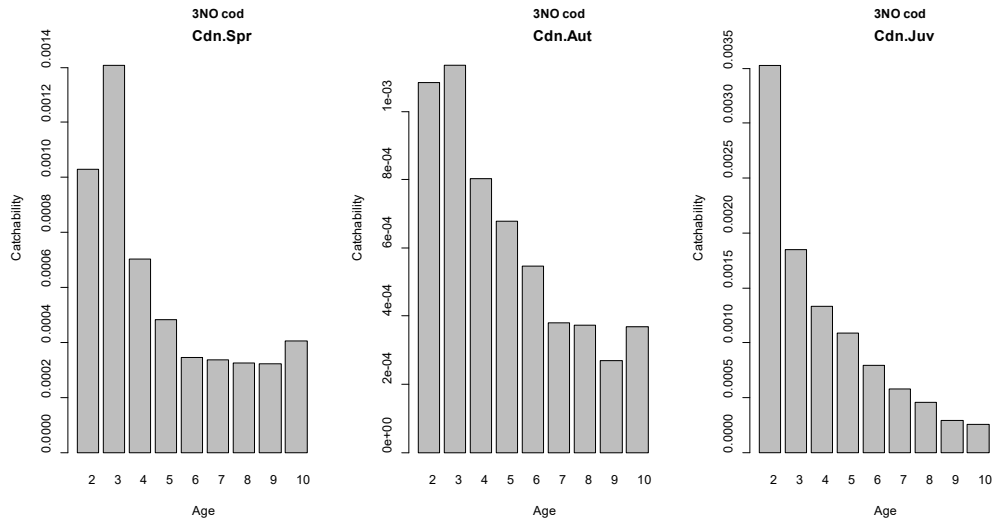
Fig. 19. Estimated catchabilities from ADAPT.
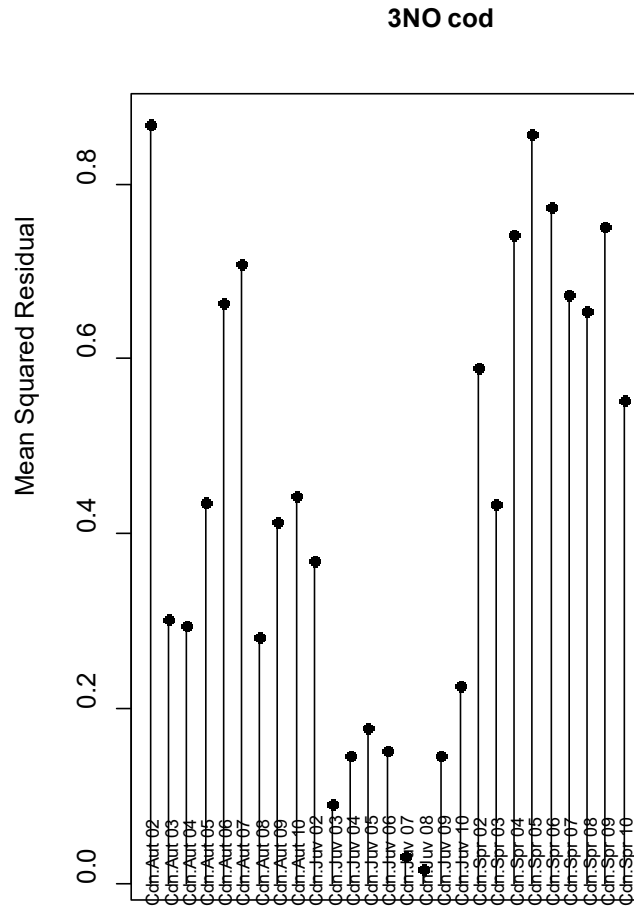
Fig. 20. Mean squared residual at age for each index in the ADAPT.
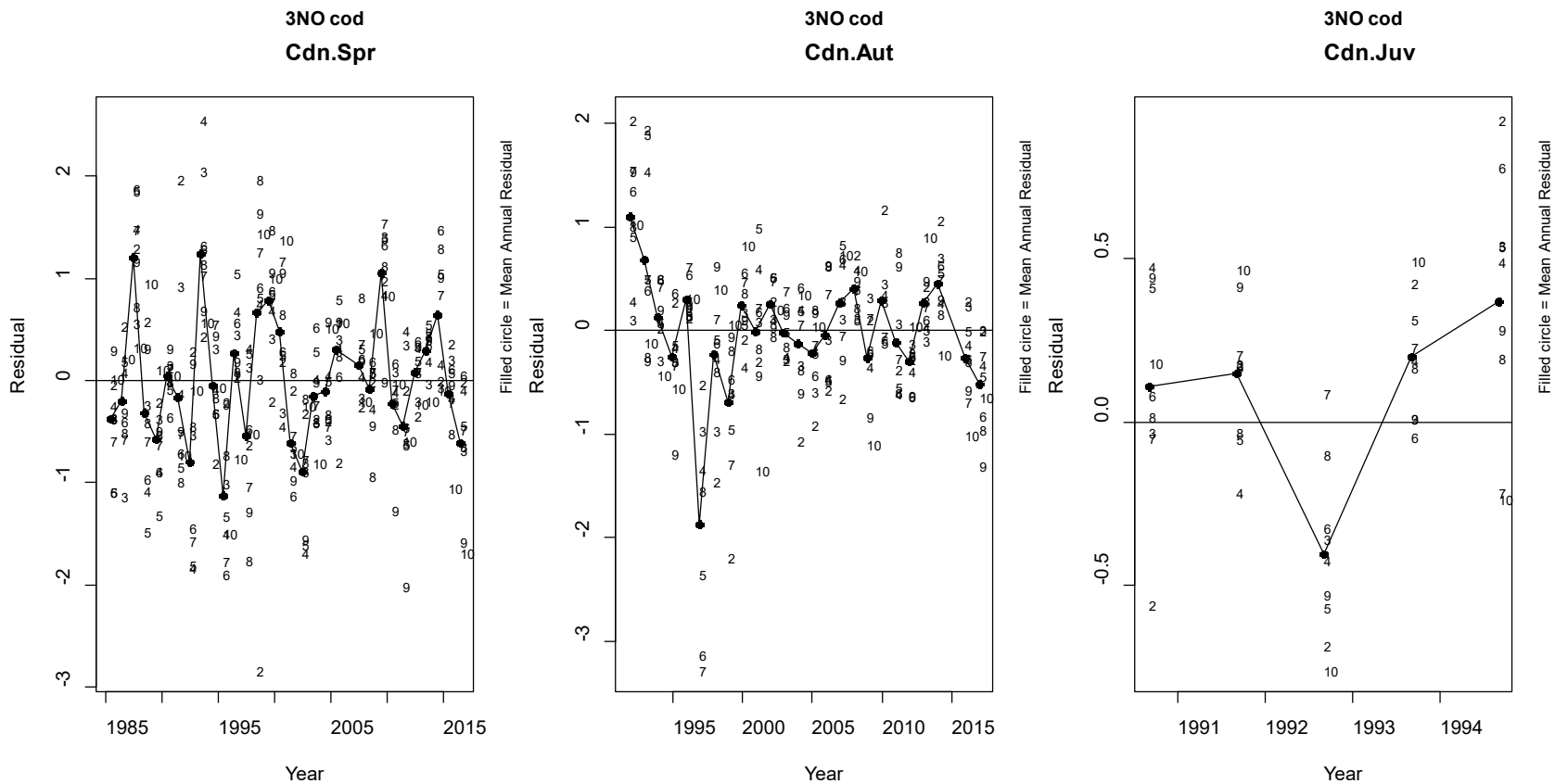
Fig. 21. Residuals at age for each index in the ADAPT.
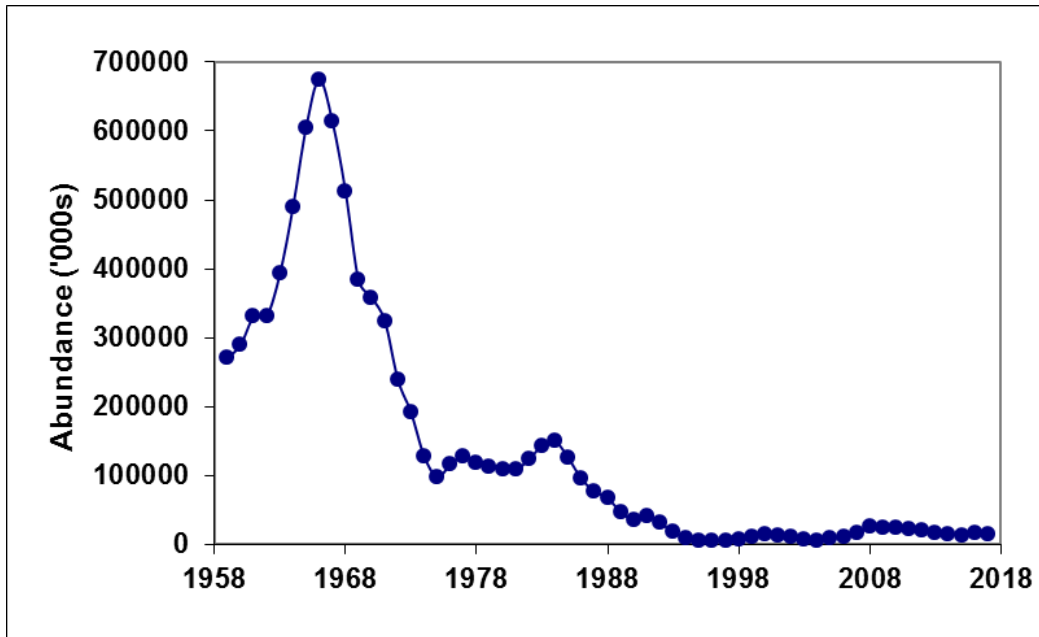
Fig. 22. Bias corrected Population Abundance for cod in Divs. 3NO as estimated from ADAPT
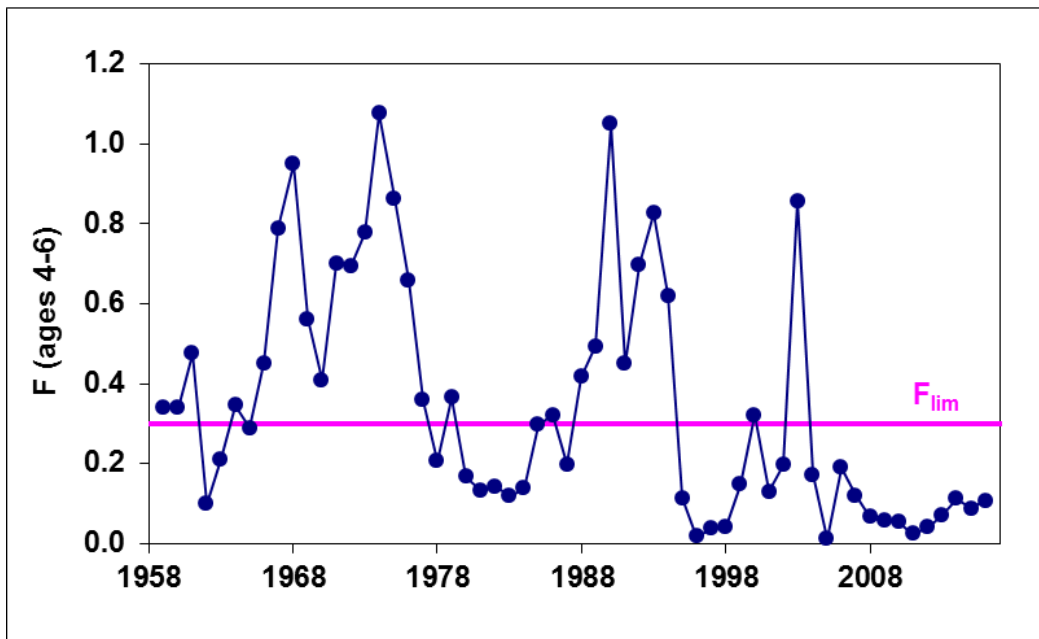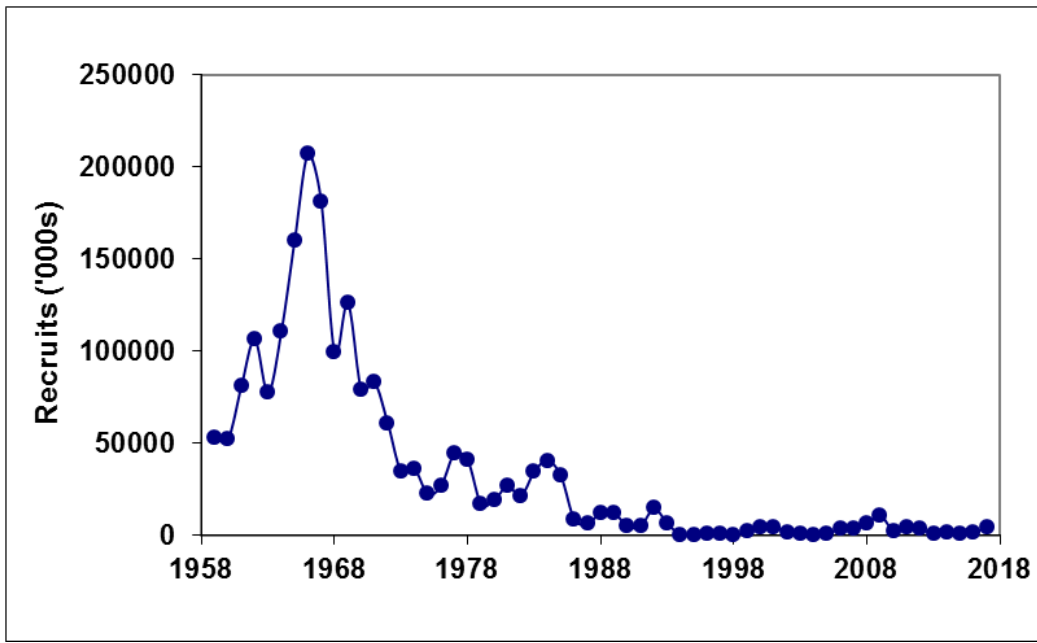

Fig. 23. Fishing Mortality for cod in Div. 3NO as estimated from ADAPT.

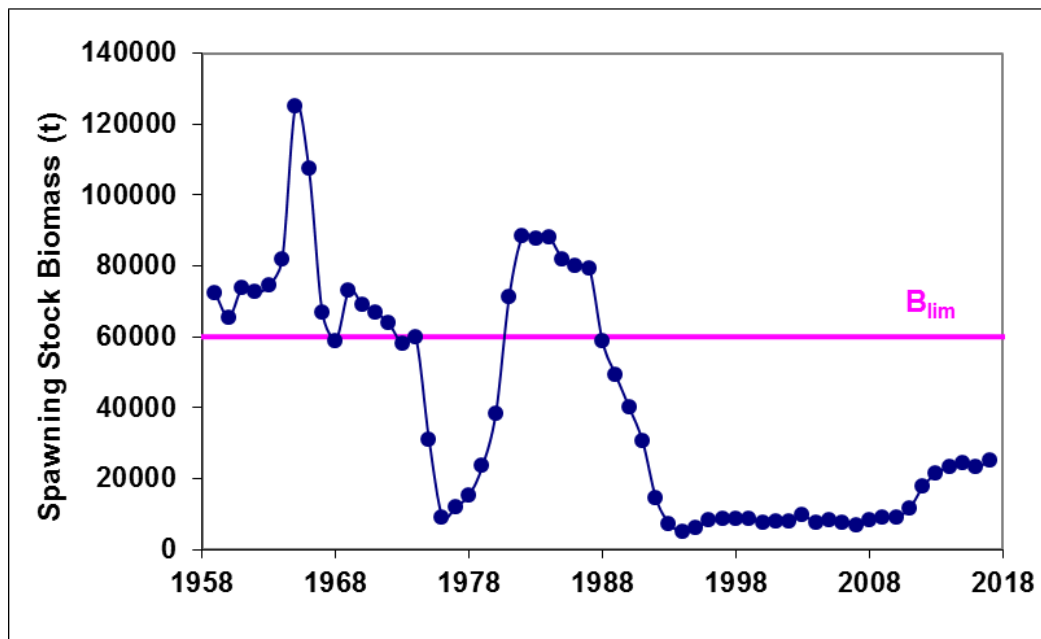Fig. 24. Age 3 recruits for cod in Div. 3NO as estimated from ADAPT.

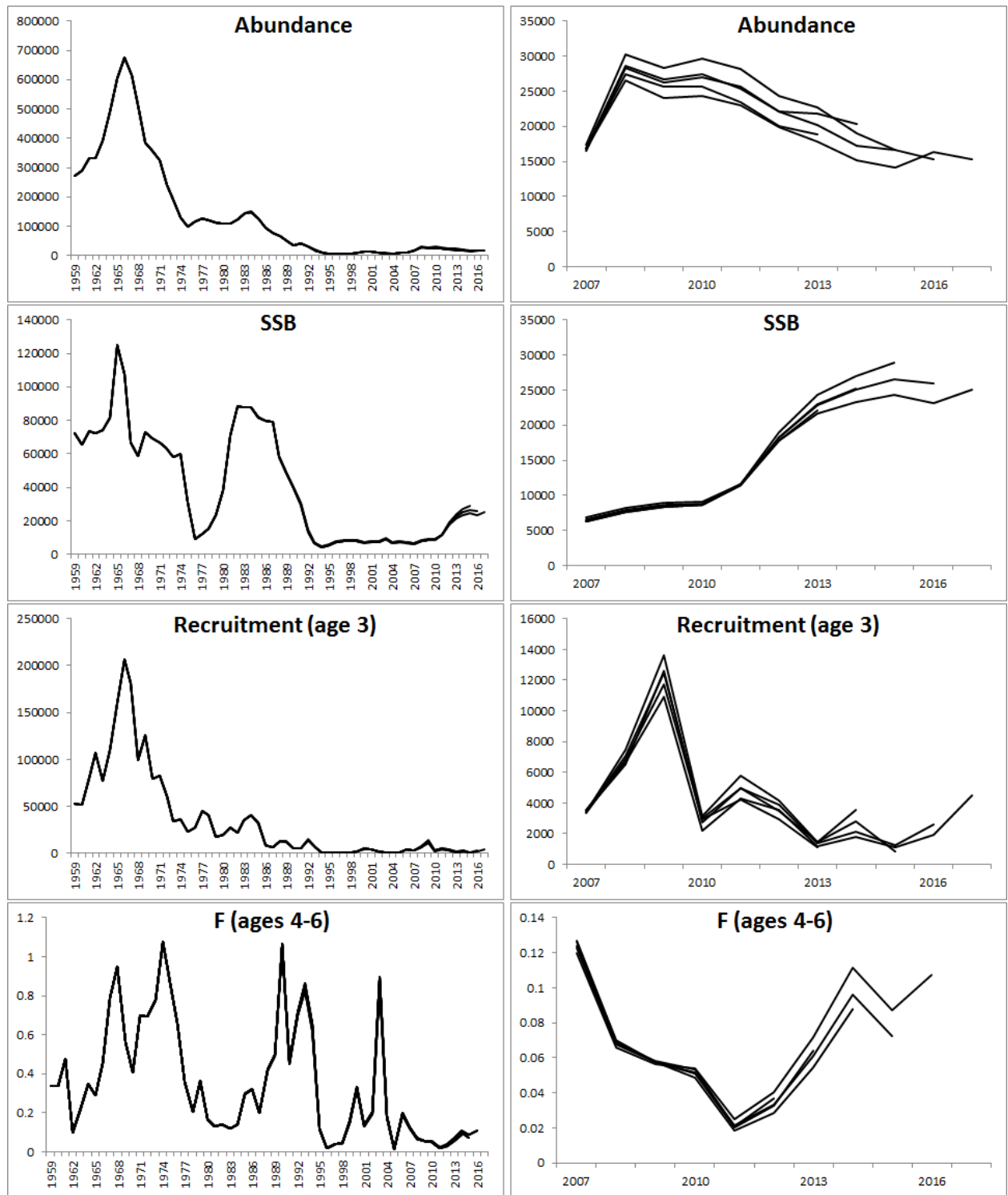Fig. 25. Spawner biomass for cod in Div. 3NO as estimated from ADAPT.

Fig. 26. Retrospective estimates of abundance, spawner biomass, age 3 recruits, and fishing mortality for cod in Div.
3NO.