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Assessment of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in October 2004

Évaluation du stock de morue (*Gadus morhua*) de la sous-division 3Ps de l'OPANO en octobre 2004

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Abstract

This document summarizes scientific information used to determine the status of the cod stock in NAFO Subdivision 3Ps off the south coast of Newfoundland. The current assessment provides revised estimates of the abundance of fish on 1 April 2004. Numbers-at-age are projected to 1 April 2005 by accounting for recorded catch up to the end of September 2004 and assumed catch for the remainder of the season to 31 March 2005. Sources of information available for this assessment were: reported landings from commercial fisheries (1959-March 2004), oceanographic data, a time series (1973-2004) of abundance and biomass indices from Canadian winter/spring research vessel (RV) bottom-trawl surveys, an industry offshore bottom-trawl survey (1997-2003), inshore sentinel surveys (1995-2003), science logbooks from vessels <35ft (1997-2003), and tagging studies (1997-2004). The fishery was still in progress at the time of the assessment and complete information on catch rates and age compositions from the 15,000 t TAC from 1 April 2004 – 31 March 2005 was not available. Several sequential population analyses (SPA) were carried out using reported commercial catches, calibrated with various indices. Spawner biomass estimates for 1 April 2004 from the various SPA formulations considered covered a wide range (88,000 to 130,000 t), and as in previous assessments, no single SPA formulation was considered to best represent absolute population size. However, estimated trends in 3+ population numbers and spawner biomass were generally consistent among SPA's; the SPA's indicated 3+ population numbers increased during 1998-2000, but have tended to decline during 2001-2004. Spawner biomass increased during 1993-1998, declined during 1999 to 2001, and increased during 2001-2003 reaching the highest level observed since 1977. The age composition of the current spawner biomass is unusual and in 2002-2004 comprised a high proportion of females that are mature at young ages. Recruitment in 3Ps has shown a long term decline, with a succession of relatively weak year classes produced during the mid-1990s. The year classes produced in 1997 and 1998 are estimated to be relatively strong, but these are followed by weak year classes (2000 and 2001). Medium term (3 yr) deterministic projections were conducted to provide managers with general insights into possible stock trends over the next three years. At a fixed annual TAC of 10,000, 15,000 or 20,000 t the projections suggested that spawner biomass would decline by 1 April 2007, but still remain well above the recommended biological limit reference point (B_{rec}). At a TAC option of 5,000 t the projections suggested spawner biomass would show a small increase by 1 April 2007. Two strong year classes (1997-1998) are well represented in the 2003 catch and these are likely to dominate the fishery in the coming years. However, these are followed by weak recruitment and current catch levels are unlikely to be sustainable in the long-term unless recruitment improves.

Résumé

Dans ce document, nous résumons les données scientifiques utilisées pour déterminer l'état du stock de morue dans la sous-division 3Ps de l'OPANO, située au sud de Terre-Neuve. L'évaluation fournit des estimations révisées de l'abondance de la morue au 1er avril 2004. Nous faisons une projection des effectifs par âge au 1er avril 2005 en tenant compte des prises déclarées jusqu'à la fin de septembre 2004 et des prises supposées pour le reste de la saison, soit jusqu'au 31 mars 2005. Voici les données utilisées pour l'évaluation : débarquements déclarés des pêches commerciales de 1959 à mars 2004, données océanographiques, une série chronologique (1973 - 2004) d'indices d'abondance et de biomasse obtenus par des relevés de navire de recherche (NR) canadien au chalut de fond effectués à l'hiver et au printemps, ainsi que des données de relevés au chalut de fond effectués en haute mer par l'industrie (1997 – 2003), de relevés par pêche sentinelle dans les eaux côtières (1995 - 2003), des journaux de bord des bateaux < 35 pi de longueur (1997 - 2003) et d'études d'étiquetage (1997 - 2004). Au moment de l'évaluation, la pêche battait encore son plein, de sorte que les données complètes sur les taux de capture et la composition par âge pour le TAC de 15 000 t couvrant la période allant du 1er avril 2004 au 31 mars 2005 n'étaient pas disponibles. Nous avons effectué plusieurs analyses séquentielles de population (ASP) reposant sur les prises commerciales déclarées, étalonnées par rapport à divers indices. Les estimations de la biomasse de reproducteurs au 1er avril 2004 obtenues par les diverses variantes de l'ASP variaient considérablement (de 88 000 à 130 000 t) et, comme cela était le cas lors d'évaluations antérieures, aucune ASP n'a été considérée comme représentant le mieux la taille absolue de la population. Par contre, les tendances estimées des effectifs de 3 ans et plus et de la biomasse des reproducteurs étaient généralement semblables d'une ASP à l'autre. Toutes les ASP ont montré, d'une part, que le nombre de morue de 3 ans et plus a augmenté de 1998 à 2000 mais a eu tendance à diminuer de 2001 à 2004 et, d'autre part, que la biomasse de reproducteurs a augmenté de 1993 à1998, diminué de 1999 à 2001, puis augmenté entre 2001 et 2003, pour atteindre le niveau observé le plus élevé depuis 1977. La composition par âge de la biomasse actuelle de reproducteurs est particulière; ainsi, durant la période 2002 – 2004, elle affichait un pourcentage élevé de femelles ayant atteint la maturité à un jeune âge. Le recrutement dans 3Ps a connu une déclin à long terme, une série de classes d'âge relativement peu abondantes ayant été produites au milieu des années 1990. Les classes d'âge 1997 et 1998 semblent relativement fortes, mais les suivantes le sont moins (2000 et 2001). Nous avons aussi effectué des projections déterministes à moyen terme, soit sur trois ans, à l'intention des gestionnaires des pêches, afin de leur donner une idée des tendances possibles du stock durant cette période. À un TAC annuel fixe de 10 000, 15 000 ou 20 000 t, les options indiquent que la biomasse de reproducteurs serait moins élevée le 1er avril 2007, bien qu'elle resterait nettement au-dessus du point de référence biologique limite (B_{rec}) recommandé, tandis qu'à un TAC de 5 000 t, les projections indiquent qu'elle aurait augmenté légèrement le 1er avril 2007. Deux fortes classes d'âge (1997 et 1998) étaient bien représentées dans les prises de 2003, et elles domineront probablement dans les prises au cours des prochaines années. Par contre, comme elles sont suivies d'un recrutement faible, il est peu probable que les niveaux actuels de capture se maintiennent à long terme à moins que le recrutement s'améliore.

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1. Introduction

This document gives the results of the regional assessment of the Atlantic cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps located off the south coast of Newfoundland (Figs 1, 2). The assessment was conducted in St. John's, Newfoundland during 12^{th}-15^{th} and 18^{th}-22nd October 2004. The directed cod fishery on this stock was reopened in May 1997 with a total allowable catch (TAC) set at 10,000 t. following a moratorium that had begun in August 1993. The TAC was subsequently increased to 20,000 t in 1998 and further to 30,000 t in 1999. The TAC was subsequently reduced to 20,000 t in 2000, and for the past four management years (ending 31 March 2005) has been set at 15,000 t.

The history of the cod fishery in NAFO Subdivision 3Ps and results from other recent assessments of this stock are described in detail in previous documents (Pinhorn 1969; Bishop et al. 1991, 1992, 1993, 1994, 1995; Shelton et al. 1996; Stansbury et al. 1998; Brattey et al. 1999a, b, 2000, 2001a, 2002a, 2003).

The present assessment incorporates various sources of information on 3Ps cod, including the April 2004 research vessel bottom-trawl survey data. The 2004/05 commercial fishery was still in progress at the time of the assessment meeting. Detailed information on catch-at-age up to the end of March 2004 was available and preliminary catch information up to 1 October 2004 was also used. Additional sources of information included: oceanographic data (Colbourne and Murphy 2004), science logbooks for vessels <35ft (1997-2003), industry logbooks for vessels >35ft (1998-2003), an industry trawl survey on St. Pierre Bank from 1997-2003 (McClintock 2003), inshore sentinel surveys from 1995-2003 (Maddock-Parsons and Stead 2004), and recaptures of tagged cod (received up to 10 September 2004) from tagging experiments conducted during 1997-2003 (Brattey and Healey 2004).

In the current analyses it was assumed that the entire 15,000 t TAC would be taken in the fishing season from 1 April 2004 to 31 March 2005, as outlined in the management plan released by DFO prior to the start of the season. The current assessment attempts to provide revised estimates of the abundance of fish on 1 April 2004. Numbers at age are first projected to 1 April 2005 by accounting for recorded catch up to the end of September 2004 and assumed catch for the remainder of the fishery to 31 March 2005. In a second step, a deterministic medium term (3 yr) projection was conducted, where numbers were projected from 1 April 2005 to 31 March 2007 under a range of fixed annual TAC options.

2. Environmental overview

Oceanographic data from NAFO Division 3P during the spring of 2004 were examined and compared to the previous year and the long-term (1971-2000) average (Colbourne and Murphy 2004). Temperature measurements on St. Pierre Bank show anomalous cold periods in the mid-1970s and from the mid-1980s to mid-1990s. Beginning in 1996 however, temperatures started to moderate, decreased again during the spring of 1997 and returned to more normal values during 1998. During 1999 and 2000 temperatures continued to increase, reaching the highest values observed since the late 1970s in some regions. During 2001-2003 however, temperatures cooled significantly to values observed during the mid-1990s with the average temperature during the spring of 2003 the coldest in about 13 years. Temperatures during the spring of 2004 warmed considerably over 2003 values to 1°C above normal in the surface layers and by almost 0.5°C in the near-bottom depths over St. Pierre Bank. The areal extent of <0°C bottom water during 2003 increased to the highest in about 13 years but decreased during 2004 to <10%, the lowest since 1988. The areal extent of bottom water with temperatures >3°C has remained relatively constant at about 50% of the 3P area during the past decade. On St. Pierre Bank bottom water with temperatures <0°C essentially disappeared during the warm years of 1999 and 2000. Cold water (<0°C) appeared again during 2001 to 2003 covering about 90%

of St. Pierre Bank in 2003. During the spring of 2004 it again disappeared with <0^oC water restricted to the eastern-most regions and the approaches to Placentia Bay. In general, temperatures during the spring of 2004 increased significantly over values observed during 2001-2003.

The dominant oceanographic signal potentially influencing cod habitat in this region is the volume of <0^oC water advected into the region from the eastern Newfoundland Shelf by the inshore branch of the Labrador Current around Cape Race. The spatial extent and temperature of this water mass that eventually makes its way onto St. Pierre Bank is governed by advection rates, vertical mixing by storms during the winter and spring, and surface heat flux.

3. Commercial catch

Catches (reported landings) from 3Ps for the period 1959 to 1 October 2004 are summarized by country and separately for fixed and mobile gear in Table 1 and Figs. 3a and 3b. Canadian landings for vessels <35 ft were estimated mainly from purchase slip records collected and interpreted by Statistics Division, Department of Fisheries and Oceans, prior to the moratorium. Shelton et al. (1996) emphasized that these data may be unreliable. Post-moratorium landings for vessels <35 ft have come mainly from a new dock-side monitoring program. Landings for vessels >35 ft come from logbooks. Non-Canadian landings (mainly France) are compiled from national catch statistics reported by individual countries to NAFO and there is generally a lag in the submission of final statistics; consequently, the most recent entries in Table 1 are designated as provisional.

The stock in the 3Ps management unit was heavily exploited in the 1960's and early 1970's by non-Canadian fleets, mainly from Spain and Portugal, with reported landings peaking at about 87,000 t in 1961 (Table 1, Fig. 3a). After extension of jurisdiction (1977), cod catches averaged between 30,000 t and 40,000 t until the mid-1980s when increased fishing effort by France led to increased total reported landings, reaching a high for the post-extension of jurisdiction period of about 59,000 t in 1987. Subsequently, reported catches declined gradually to 36,000 t in 1992. Catches exceeded the TAC throughout the 1980's and into the 1990's. The Canada-France boundary dispute led to fluctuations in the French catch during the late 1980's. A moratorium was imposed on all directed cod fishing in August 1993 after only 15,216 t had been landed, the majority being taken by the Canadian inshore fixed gear fishery (where inshore is typically defined as unit areas 3Psa, b, and c; Fig. 2). In this year access by French vessels to Canadian waters was restricted. Under the terms of the 1994 Canada-France agreement, France is now allocated 15.6% of the TAC, of which Canadian trawlers must fish 70%, with the remainder fished by small inshore fixed gear vessels based in St. Pierre and Miquelon.

Since 1997, most (~70%) of the TAC has been landed by Canadian inshore fixed gear fishermen, with most of the remaining catch taken by the mobile gear sector fishing the offshore, i.e. unit areas 3Psd, e,f,g,h (Table 1, Figs. 3a and 3b). This general pattern has been repeated throughout 1997-2003, although TAC's have ranged from 10,000 t to 30,000 t. During the 2003 calendar year, total reported landings were 15,260 t with the inshore fixed gear sector accounting for 74.3% of the total. In the 2004 calendar year to 1 October, the inshore fixed gear sector accounted for 69.1% of the reported landings of 7,901 t; the offshore mobile gear sector typically fishes in the late fall and early winter and this allocation had yet to be taken; inshore landings are also typically high in late fall (see below).

Line-trawl catches dominated the fixed gear landings over the period 1977 to 1993, reaching a peak of over 20,000 t in 1981 and typically accounting for 40-50% of the annual total for fixed gear (Table 2, Fig. 4). In the post-moratorium period, line-trawls have accounted for 16 to 23% of the fixed gear landings. Gillnet landings increased steadily from about 2,300 t in 1978 to a peak of over 9,000 t in 1987, but declined thereafter until the moratorium. Gillnets have been responsible for the dominant portion of the inshore catch since the fishery reopened in 1997, with gillnet landings exceeding 10,000 t (i.e. 50% of the TAC) for the first time in 1998, and approaching 18,000 t in 1999. Gillnets have typically accounted for 70-80% of the fixed gear landings since 1998. Gillnets accounted for a lower percentage of the fixed gear landings in 2001 (60%), partly due to a management restriction in their use that was removed part way through the fishery following extensive complaints from industry. Gillnets are also being used extensively in the offshore areas in the post-moratorium period (see below). Trap catches have varied over the time period, but have not exceeded 8,000 t and have declined from 1,167 t to negligible amounts (< 120 t) from 1998 onwards. Hand-line catches were a small component of the inshore fixed gear fishery prior to the moratorium (about 10-20%) and accounted for <5% of landings during most of the post-moratorium period. However, hand-line catch for 2001 shows a substantial increase (to 17% of total fixed gear) compared with the 1998-2000 period and this may reflect the temporary restriction in use of gillnets described above.

Monthly landings during 2003 and up to 1 October 2004 are summarized for inshore and offshore and for each gear type separately, in Table 3a. Inshore catches in 2003 have come mostly from gillnets with substantial gillnet landings (> 200 t) in most months except January-April. Line-trawls were fished inshore mostly during late summer and fall with highest monthly landings (>240 t) in September-November. Hand-line catches were taken mainly during August and September. In the offshore, otter trawl fishing by Canadian trawlers and vessels chartered by St. Pierre and Miquelon to fish the French allocation was concentrated mainly during the first and last quarters of the year. There was also a substantial offshore gillnet catch in 2003 with landings totaling over 2,700 t taken mostly during July-November. Line-trawl accounted for a small proportion of offshore landings. Overall, landings in 2003 were dominated by the directed gillnet fishery with the remaining catch taken by otter trawl, followed by hand-line and line-trawl, with negligible amounts taken by trap. Preliminary landings for 2004 show similar trends to those seen for the corresponding period in 2003.

The landings for the 2003 calendar year and the first nine months of 2004 are summarized by month and unit area in Table 3b. Inshore landings were low in April 2003 and came mostly from by-catch fisheries. Monthly trends in 3Psb and 3Psc show similar patterns, with peaks in July and November, whereas 3Psa shows a peak in September. The distribution of landings among the three inshore unit areas was almost identical to that of the preceding year (see Brattey et al. 2003) with Placentia Bay accounting for most of the inshore catch. In the offshore, landings tended to be more variable among unit areas. Unit area 3Psh typically accounts for most of the offshore catch, but landings from 3Pse and 3Psf were also high (>1,300 t). Overall, preliminary landings for the 2004 calendar year show similar spatial and temporal trends to those seen in 2003, except for an increase in landings from 3Psd during January-March, from 45 t in 2003 to over 200 t in 2004.

The distribution of post-moratorium catches among unit areas is illustrated in Fig. 5. The inshore (3Psa, 3Psb, and 3Psc) has consistently accounted for most of the reported landings. These have typically been highest in Placentia Bay (3Psc), ranging from 4,900 t to almost 12,000 t with typically 35-51% of the entire TAC coming from this unit area alone. Landings from 3Psa and 3Psb have been fairly consistent at about 1,100-3,200 t and generally 7-12% and 9-18% of the TAC, respectively. Most of the offshore landings have come from 3Psh and 3Psf (Halibut Channel and the southeastern portion of St. Pierre Bank), although the percentage coming from 3Pse (north central St. Pierre Bank) increased somewhat in 2002 and 2003 (6.4-9.2%) compared with preceding years (1.1-4.0%).

The 1 April 2003 to 31 March 2004 conservation harvesting plan placed various restrictions on how the 3Ps cod fishery could be pursued. Unit area 3Psd has remained closed to directed cod fishing by most vessel classes from 15 November to 15 April since 1998, due to possible mixing of northern Gulf cod into the western portion of the 3Ps stock area at this time of year. Spring closures were also imposed in several areas to avoid disruption of spawning activity. From 1997 to 31 March 2001, fishers with homeports west of the Burin Peninsula fished competitively with quarterly quotas, but an individual quota

(IQ) system was introduced in this area starting in the 2001/2002 management year and this has continued in subsequent years. In contrast, fishers in Placentia Bay have operated under an IQ system since 1998. A dockside monitoring system was introduced following the reopening of the fishery in 1997, and other restrictions, many of which varied according to vessel class, have included the amount of gear that could be fished, where fish could be landed, trip and weekly limits, and a small fish limit. Mesh size of gillnets was also restricted to a maximum of 6.5 inches. As in previous years, the 6.5" mesh limit in the directed cod fishery could be circumvented by gill-netters fishing the offshore portion of 3Ps because they could use much larger mesh size (8" and 10"), and more gillnets, when fishing for other species such as skate and white hake or monkfish and still keep some cod as by-catch.

3.1 Catch-at-age

Samples of length and age composition of catches were obtained from the inshore trap, gillnet, line-trawl and hand-line fisheries and the offshore otter trawl, gillnet, and line-trawl fisheries by port samplers and fishery observers. Sampling of the Canadian catch in 2003/2004 was intensive, with 9,000 otoliths collected for age determination and over 80,600 fish measured for length (Table 4A). The sampling was well distributed spatially and temporally across the gear sectors. Substantial landings in summer from inshore fixed gears (see Table 3) were sampled intensively, particularly line-trawl and gillnet. The smaller and more sporadic sampling of the offshore line-trawl catch reflects the small catch from that gear in 2003. Sampling during January-March 2004 has also been intensive with 1,815 otoliths collected for age and 11,816 fish measured for length (Table 4b).

Sampling of the French gillnet and otter trawl landings was also conducted with over 1,000 otoliths collected and over 4,900 length measurements taken in 2003 (Table 4a), plus 1,004 length measurements and 200 otoliths in January-March 2004 (Table 4b).

One significant portion of the catch from which no sample ages or lengths were provided concerns the catch from vessels based in Nova Scotia that operate in 3Ps and land their catch in Nova Scotia. These are typically larger vessels (>65 ft) fishing mostly line-trawls. The reported catch from this sector has ranged from 885 t in 1998 to 412 t in 2003 (see Table 1). Most of it is taken in the offshore of 3Ps. In addition, observer coverage on these vessels has been poor leading to concerns that the actual catch may be significantly higher than reported.

The age composition and mean length-at-age of commercial catches were calculated as described in Gavaris and Gavaris (1983). The average weights were derived from a standard length-weight relationship where log(weight)=3.0879*log(length)-5.2106.

During preparation for the 2004 assessment, a problem was detected and acknowledged in the catch-at-age data obtained from sampling of otter trawlers fishing the French allocation for the most recent period (from 2002 until the first quarter of 2004). The age composition of the French catch from the otter trawl fleet was not consistent with that obtained from sampling of the Canadian otter trawl allocation. Closer inspection of the data indicated that the length frequencies of samples from the 2004 French allocation taken in the processing plant were not consistent with those sampled on the same vessels by Canadian observers. In addition, an inappropriate age-length key had been used for the 2002-2004 period to assign the otter trawl catches to the appropriate ages. To rectify this problem, the catch-at-age for otter trawlers fishing the French allocation during 2002 and 2003 was recalculated using Canadian age-length keys; in addition, the catch-at-age for the first quarter of 2004 was recalculated using Canadian observer length-frequency samples (taken on board the vessels) and Canadian age-length keys for the appropriate season and gear sector. The total catch-at-age for 2002 (and the first quarter of 2003) has therefore been revised from that reported in Brattey et al. (2003). Catch-at-age for all gears combined based on sampling of

Canadian and French vessels in 2003 and January to March 2004 is summarized in Tables 5a, 5b, 6 and Figs. 6a and 6b.

In the 2003 landings from all gears combined, a wide range of ages are represented (mostly 3-14 year olds) with ages 5-7 (1996, 1997, and 1998 year classes) accounting for >65% of the total catch by numbers (Fig 6a). Six year old cod alone (1997 year class) accounted for about 32% of the total catch numbers. The age composition of the 2003 catch is consistent with the catch from 2002, with the 1997 year class dominating. The proportion of younger cod (ages 3-5) in the 2003 catch declined compared to 2002. Among older ages (8-14) there were no dramatic changes between these two years. The 1989 year class is still represented in the 2003 catch, although in terms of numbers it accounted for only 1.5% of the total. The catch from the first three months of 2004 is taken mainly by mobile gear in the offshore and comprised a range of ages from 5 to 15, with 6 and 7 year olds (1998 and 1997 year classes) predominating and age 15 (1989 year class) also well represented among the older ages.

Catch at age for the three main gear types for 2002 and 2003 is illustrated in Fig. 7a. The dominance of gillnet selectivity on ages 6-8 in 2002 and ages 6-7 in 2003 is apparent. In comparison, line-trawls caught mostly younger fish of ages 4-6. In 2003, six year olds were well represented in all gears including offshore mobile, suggesting that this age class was widely distributed across the stock area. Similar observations were made for this age class at age 5 in the 2003 assessment.

A time series of catch numbers-at-age (3-14) for the 3Ps cod fishery from 1959 to March 2004 is given in Table 6. It has been noted at recent assessments that there are discrepancies in the sum of the product check for the 1959-1976 catch at age. An attempt was made to clarify these discrepancies by checking for missing catch and by adding plus group catch, but neither of these adequately explained the discrepancies. Further investigation is ongoing to check the fixed weights used for the 1959-1976 period and to check the sampling protocols to see if either contributed to the discrepancies. Until these discrepancies are resolved, catch at age prior to 1977 will not be used in SPA analyses.

The catch-at-age data that are available indicate that in the pre-moratorium period the landings were dominated by young fish, typically aged 4-6, whereas in the post moratorium period slightly older ages (i.e. 5-8) have been more common; this probably reflects the switch in dominant gears from line-trawl to gillnet. For the 2003 fishery, 5, 6, and 7 year-old cod (1996-1998 year classes) dominated the final catch in terms of numbers. Note that although the TAC and total landings were similar in the past four management years, the composition of the catch has shown some notable changes. These changes appear to be reflecting the appearance of two strong year classes in the population, rather than any major change in the composition of the gears used in the fishery.

3.2 Weight-at-age

Mean weights-at-age in the 3Ps fishery (including landings from the commercial and food fisheries and the sentinel surveys) are given in Table 7a and Fig. 8a. Beginning of the year weights-at-age are given in Table 7b and Fig. 8b. It is helpful to recall that the mean weights-at-age are derived from the sampling of catches taken by several gears in various locations at various times of the year, and that the weights at age may therefore vary with season and gear, and possibly by geographic area. The annual means by gear may vary considerably. For example, mean weights-at-age in the 2002 3Ps fishery tended to be least in hand-line and greatest in offshore mobile gear (predominantly otter trawl) (Brattey et al. 2003), with the weight of the 1994 year-class at age 8 in the former being less than half the weight in the latter.

For young cod (ages 3-6), weights-at-age computed in recent years tend to be higher than those in the 1970s and early 1980s (Table 7a; Fig. 8a). The converse is true for older fish. Sample sizes for the oldest age groups (>10) have been low in recent years due to the relative scarcity of old fish in the catch. Interpretation of trends in weights-at-age computed from fishery data is difficult because of among-year variability in the proportion at age caught by gear, time of year and location.

The overall mean weights-at-age computed for recent years have some notable features. First, it was stated in Brattey et al. (2003) that apparent growth from 2001 to 2002 was unusually low for the 1989-1991 year-classes, and nil for the 1988 year-class. The weights-at-age for 2002 have been recomputed, and growth from 2001 to 2002 now appears greater for all year-classes. Second, as noted by Brattey et al. (2003), weight-at-age appears to depend to some extent on year-class. For example, the 1989 and 1993 year-classes appear to be relatively heavy at age 9, whereas the 1991 and 1992 year-classes appear relatively light. For this reason, it is difficult to state in a few words how growth in recent years compares to growth in the past.

The apparent variability in growth of year-classes lead to the decision, during the 2002 assessment, to obtain projected weights-at-age for 2002 by projecting along each year-class, rather than by using an average of the weights-at-age in the previous *n* years. The projection to weight at age *a* was accomplished by starting with the weight at age *a*-1 in 2001, and assuming that each cohort would grow at an instantaneous rate equal to the average of the instantaneous growth rates attained by the previous 4 cohorts over the age interval from age *a*-1 to age *a*.

As illustrated by Brattey et al. (2003), the process of projecting weights-at-age along cohorts was more successful in projecting the pattern in weight-at-age in 2002 than the process of projecting with average weights-at-age in the previous 3 years. (It was also noted that the process of projecting along cohorts tended to overestimate the observed weights in 2002, particularly at ages 10 and older. This difference has probably been reduced if one compares the projected weights for 2002 with the recomputed observed weights for 2002.)

The method of projecting along cohorts was also used in 2003 to project mid-year weights-at-age for 2004. With a continuing interest in projecting for 3 years, and an interest in projecting for longer terms for purposes other than those directly related to the assessment, the method of projecting along cohorts was again explored. Projection of weight-at-age *a* in mid-2004 was conducted using the weight already attained by age *a*-1 in 2003 and assuming that the year-class would grow at a rate equal to the average of the instantaneous growth rates experienced by the previous 6 year-classes over the age interval from age *a*-1 to age *a*. The process was extended forward until cohorts in the 2003 weight-at-age vector reached age 14. Cohorts not in the 2003 weight-at-age vectors were introduced at age 3 in 2004 and subsequent years at a weight computed as the geometric mean of the age 3 weights-at-age in 2001-2003.

This method of projecting along cohorts was rejected by the meeting because the weight-at-age data were not statistically modeled, and because the weights-at-age computed for the 2001 and later cohorts appeared too high to some meeting participants. It was decided to revert to the previous method of projecting mean weights. Weights-at-age *a* from 2004 onward were computed as the geometric mean of weights-at-age *a* in 2001-2003.

4. Sentinel survey

The sentinel survey has been conducted in 3Ps since 1995 and there are now nine complete years of catch and effort data (Maddock-Parsons and Stead 2004). During 2004, the sentinel survey continued to produce a time series of catch/effort data and biological information collected by trained fish harvesters at various inshore sites along the south coast of Newfoundland. In 2004, there were 14 active sites in 3Ps, using predominantly gillnets (5½" mesh) in unit area 3Psc (Placentia Bay) and line-trawls in 3Psb and 3Psa (Fortune Bay and west). One 3¼ " gillnet was also fished at each of 6 sites in Placentia Bay one day per week. Fishing effort was reduced in 2003 to an average of 6 weeks. Fishing times averaged 10 weeks in 2001 and 2002, 8 weeks in 2000 as opposed to 6 weeks in 1999 and 12 weeks from 1995-1998. Most fishing takes place in fall/early winter. Maddock-Parsons and Stead (2001, 2003a, b, 2004) have produced a time series of weekly average catch rates and annual relative length frequencies (number of fish at length divided by amount of gear). Catch rates for 5½" gillnets in 2003 were lower than those reported for comparable times in 2002, whereas line-trawl catch rates showed a general increase despite much weekly variability.

As in previous assessments, an attempt was made to produce an age dis-aggregated index of abundance for the nine completed years in the gillnet (5½" mesh) and line-trawl sectors of the program; there is insufficient data from the 3¼" gillnets to develop an index for this gear. Sentinel fishers typically fish a control and an experimental site; the location of the control site is fixed, whereas the location of the experimental site can change only within the local area.

4.1 Standardized sentinel catch rates

The catch from 3Ps was divided into cells defined by gear type (5½" mesh gillnet and line-trawl), area (unit areas 3Psa, 3Psb, and 3Psc), year (1995-2002) and quarter. Age-length keys were generated for each cell using fish sampled from both the fixed and experimental sites; however, only fish caught at the fixed sites were used to derive the catch rate indices. Length frequencies and age-length keys were combined within cells. The numbers of fish at length are assigned an age proportional to the number at age for that particular cell length combination. Fish that were not assigned an age because of lack of information within the initial cell were assigned an age by aggregating cells until the data allowed an age to be assigned. For example, if there are no sample data in a quarter then quarters are combined to half-year, half-years are combined to year; if an age still cannot be assigned, then areas are combined for the year.

Catch-at-age and catch per unit effort (CPUE) data were standardized using a generalised linear model to remove site and seasonal effects. For gillnets, only sets at fixed sites during July to November with a soak time between 12 and 32 hours were used in the analysis. For line-trawl, sets at fixed sites during August to November with a soak time less than or equal to 12 hours where used in the analysis. Zero catches were generated for ages not observed in a set. Prior to modeling, data are aggregated within a gear-division-site-month-year-age cell. Sets with effort and no catch are valid entries in the model. Note that catch rates from the sentinel fishery are expressed in terms of numbers of fish, rather than catch weight as was used in the analyses of logbook data. This has important implications when comparing trends in these indices.

A generalized linear model (McCullagh and Nelder 1989) was applied to the sentinel catch and effort data for each gear type. The response distribution was specified as Poisson and the link function was chosen to be log. That is, the Poisson mean parameter μ_i is related to the linear predictor by

$$\log(\mu_i) = X_i^T \beta$$

where X_i^T is a vector of explanatory factors for catch observation *i* (i.e. month, site, age and year) and β is a vector of coefficients to be estimated from the data.

Thus catch is assumed to have a Poisson probability distribution with the mean related to the factors month nested within site and age nested within year by

$$\log(\mu_i) = \log(E_i) + month_{i(j)}\beta_j\left(site_{i(k)}\beta_k\right) + age_{i(l)}\beta_l\left(year_{i(m)}\beta_m\right),$$

where E_i is an offset parameter for fishing effort and j,k,l,m indicate the level for each of the four factors.

In the present assessment, the model adequately fitted data from gillnets and line-trawls.
Trends in standardized total (ages 3-10 combined) annual catch rates, expressed in terms of numbers of fish, are shown in Fig. 9a. For gillnets there is no trend over the period 1995-1997, but catch rates declined rapidly from 1997-1999 then remained stable but low. For line-trawls, catch rates show a decline from 1995, but have been relatively stable from 1997 to 2003.

Two standardized annual catch rate-at-age indices were also produced in the present assessment, one for each gear type. All effects included in the model were significant. The standardised gillnet and line-trawl catch rate-at-age indices for 1995 to 2003 are given in Table 8 and Fig. 9b. For gillnets, the catches during 1995-1997 were dominated by the 1989 and 1990 year-classes and for the subsequent period the 1992 year-class is well represented, although catch rates for the latter do not appear to be as strong. In 2001, the 1997 and 1998 year classes appear strong although these fish are still rather small to be caught effectively by 5½" mesh. However, in both 2002 and 2003 sentinel gillnet, the 1997 year class is only marginally better than the two preceding year classes at age 5 and the 1998 year class looks weak. Gill-net catch rates for all ages in 2003 are among the lowest in the time series. For line-trawls, catch rates were higher for the 1989 and 1990 year-classes during 1995 to 1996 followed by the weaker 1992 year-class. In the 2000-2002 sentinel line-trawl, catch rates improved for younger fish (3 and 4 year olds) compared to 1995-1999, but those for older fish continued to decline. The most recent age 3 estimate (the 2000 cohort) is the lowest in the series. The 2003 estimates for other ages have increased compared to the past few years, but remain lower than the estimates for the earlier part of the time series.

As described in recent 3Ps cod assessments, interpretation of the sentinel catch rate indices is difficult. Sentinel fisheries were free from competitive influences during 1995-1996 as the commercial fishery was closed. However, commercial fisheries may have had some disruptive influence on the execution of the sentinel fishery during 1997-2003, particularly in Placentia Bay. The concentration of fishing effort in Placentia Bay, primarily with gillnets, may have had a negative influence on the sentinel gill-net catch rates. Competition with commercial fishers for fishing sites, local depletion, inter-annual changes in the availability of fish to inshore, and shifts in the timing of sentinel fishing to accommodate periods of commercial fishing could all influence mean catch rates between years. The extents to which such effects influence catch rates are not fully understood. Nonetheless, the declines in sentinel gillnet catch rates when the fishery re-opened and continued low gillnet catch rate are interpreted as signs of concern. These declines are consistent with the inshore catch rate data from science log-books and the high estimates of exploitation from tagging in Placentia Bay. In contrast, the line-trawl catch rates, which mainly incorporate data from areas west of the Burin Peninsula, show less of a decline and rates have increased for younger fish in recent years. The trends in the sentinel line-trawl data are also consistent with those seen in the line-trawl data from science log-books (see below). Furthermore, in terms of year-class strength the sentinel line-trawl data are reasonably consistent with the DFO RV survey index (section 7.2) and the GEAC survey index (section 8).

5. Science logbooks

A new science logbook was introduced to record catch and effort data for vessels less than 35 ft in the re-opened fishery in 1997. The purpose of this logbook is for scientific stock assessments and not for quota monitoring or other controls on the fishery. Previously only purchase slip records were available for these size vessels, containing limited information on catch and no information on effort. Catch rates have the potential to provide a relative index of temporal and spatial patterns of fish density, which may relate to the overall biomass of the stock. There are currently data for 59,000 gillnet sets and 22,000 line-trawl sets directing for cod in the database. These data pertain to the inshore fishery, i.e. unit areas 3Psa, 3Psb, and 3Psc.

As in the previous assessment, effort was treated as simply the number of gillnets, or hooks for line-trawls (1000's), deployed in each set of the gear; soak times were not adjusted as the relationship between soak time, gear saturation and fish density is not known. Catch rates were expressed in terms of weight; catches are generally landed as head-on gutted and recorded in pounds; these were converted to kg by multiplying by 2.2026.

As observed in previous assessments, preliminary examination of the logbook data indicated that soak time for gillnets is most commonly 24 hours with 48 hours the next most common time period. In comparison, line-trawls are typically in the water for a much shorter period of time – typically 2 hours with very few sets more than 12 hours. In addition, the distribution of catches per set is skewed to the right for most gears (not shown). For gillnets, catches per set are typically 100-200 kg with a long tail on the distribution extending to 2 tons. The distribution of catches for line-trawls was similarly skewed.

The catch from 3Ps was divided into cells defined by gear type (gillnet and line-trawl), statistical area (numbered 29-37 and illustrated in Fig. 10b in [Brattey et al. 2002a]), and year (1997-2003). Prior to modeling, the data were aggregated by within each gear-year-month-location cell, and the aggregated data were weighted by its associated cell count. Catch per unit effort (CPUE) data were standardized to remove site and seasonal effects. Gillnet sets where the number of nets used was >30 were excluded to remove offshore gillnet activity from the analysis. Similarly, line-trawl sets where the number of hooks was <100 or >4,000 were excluded. Also, sets with missing amount of gear or missing location are excluded. Note that sets with effort and no catch are valid entries in the model.

In the present assessment, the model adequately fitted data from gillnets and line-trawls and two standardized annual catch rate indices were produced, one for each gear type. All effects included in the model were significant. Preliminary analyses indicated that catch rates were generally higher for both line-trawl and gillnet in Placentia Bay compared to inshore areas further west. In recent years, however, the east-west gap in gillnet catch rates has decreased as the catch rates in Placentia Bay have declined. In 2003, gillnet catch rates for eastern Placentia Bay and for the head of Placentia Bay (areas of high gillnet effort) were the lowest in the time series.

From model results for gillnets, catch rates have shown a downward trend during 1998-2000 and have subsequently been low but stable (Fig. 10). The gill-net catch rates have declined from about 37 kg per net in 1997 to 16.0 kg per net in 2001, but subsequently increased to about 21 kg/net in 2003. For line-trawls, catch rates declined from 320 kg/1000 hooks to 210kg/1000 hooks during 1997-1999, remained about the same during 2000-2002, and increased in 2003 to approximately 250 kg per 1000 hooks.

The observed trends in commercial catch rate indices for the inshore fishery are influenced by many factors. There have been substantial annual changes in the management plans in the post-moratorium period (Brattey et al. 2003). In addition, catch rates from mobile commercial fleets can be related more to changes in the degree of local aggregation of cod and can be a poor reflection of overall trends in stock abundance, particularly for stocks in decline. While this is likely to be a bigger problem with respect to otter-trawl derived catch rates, gillnets and line-trawls can also be deployed to target local aggregations. For inshore fisheries, catch rates can also be strongly influenced by annual variability in the extent and timing of inshore as well as long-shore cod migration patterns. Similarly, the changes in management regulations, particularly the switch from a competitive fishery to IQs can have a strong influence on catch rates that is unrelated to stock size. Consequently, inshore commercial catch rate data must be interpreted with caution. Where these data can be dis-aggregated into ages independently of the commercial catch at age data (as is the case with the sentinel survey) the information may be more easily interpreted in terms of stock size. Despite these issues, the initial declines in gillnet and line-trawl catch rates following the re-opening of the fishery in 1997 were cause for concern. The recent increase in catch rates for line-trawl in 2003 may, however, be reflecting the improved recruitment that is evident in other indices for the 3Ps stock (DFO RV survey, GEAC survey, sentinel line-trawl index).

6. Tagging experiments

A project involving tagging of adult (> 45 cm) cod has continued since the previous assessment, but on a smaller scale. During December 2003, cod were tagged in the offshore of 3Ps (3Psg/h) with the assistance of industry, but no tagging of cod was conducted in the inshore of 3Ps during the spring of 2004 (Brattey and Healey 2003, 2004). Recoveries of tagged cod from the fishery are used to provide information on movement patterns and to estimate exploitation rates on cod tagged in different regions of the stock area. Total numbers of cod released in 3Ps and reported as recaptured annually (up to 9 September 2004) from all areas combined are shown below.

Year released	**Number tagged**	**Numbers reported recaptured/year**							
		1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004***
1997	6,029	343	365	471	225	60	19	7	0
1998	9,941	.	543	1,072	543	183	67	26	5
1999	8,450	.	.	658	795	301	118	33	10
2000	9,803	.	.	.	678	805	345	137	21
2001	8,364	.	.	.	.	732	527	207	23
2002	9,939	.	.	.	.	.	626	637	86
2003	11,211	.	.	.	.	.	.	652	191

* to 9 September 2004.

Since 1997, over 63,700 cod have been tagged about 11,800 of these reported as recaptured, providing a substantial database of mark-recapture information. Typically over 1,300 recaptured tags are returned each year.

6.1 Estimates of exploitation (harvest) rate

Brattey et al. (2001b, 2002a, 2002b) and Brattey and Healey (2003, 2004) used data from post-moratorium tagging experiments to estimate annual exploitation rates for cod tagged in various regions of 3Ps. The number of reported recaptures from individual cod tagging experiments gives minimum estimates of the exploitation rates on the aggregations of cod that were tagged. However, in practice, not all fish survive tagging, some tags are lost from fish particularly in the first year, and not all recaptures of tagged fish are reported. Tagged (and untagged) cod also suffer natural mortality due to factors such as predation and disease. Accounting for these losses leads to a reduction in the number of tagged (and untagged) animals available to the fishery. The design of the tagging study enabled estimates of tagging mortality, tag loss and reporting rates to be made and these were incorporated when estimating exploitation (Brattey and Healey 2003). Double tagging was used to estimate tag loss rates and a high-reward tagging study was used to estimate reporting rates (Cadigan and Brattey 2003); tagging mortality was estimated by various methods including retaining batches of tagged cod in submersible enclosures (Brattey and Cadigan 2004). Exploitation rates were estimated for cod tagged in a specific area at a specific time (i.e. individual tagging experiments), irrespective of where recaptures came from. In this analysis no attempt was made to estimate population sizes using tag returns and commercial catches, because typically some harvesting occurs in an area different from where fish were tagged. This makes it difficult to convert local catches to local population biomass.

During 2001 and 2002, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (26% and 21%) compared to those tagged in Fortune Bay (11%, both years), Burgeo Bank/Hermitage Channel (7% and 5%) and Halibut Channel (2% and 1%), respectively. During 2003, mean annual exploitation estimates remained high for cod tagged in Placentia Bay (22.4%), but remained low (2-10%) for cod tagged elsewhere in 3Ps. Estimates for 2003 for cod tagged in 3Psd were among the lowest in the time series (1.7%). Some cod tagged in 3Psd are known to migrate into the northern Gulf stock area and these lower estimates may be partly due to closure of the directed cod fishery in neighbouring 3Pn4RS during 2003.

As in the previous assessment, mean exploitation was estimated to be much lower among cod tagged offshore (3Psh) throughout 1998-2003 in spite of substantial offshore landings. These low offshore exploitation rates are consistent with a large offshore biomass in relation to the magnitude of recent offshore catches. However, the offshore estimates of exploitation are considered more uncertain because of localized offshore tagging coverage and localized distribution of fishing activity in the offshore. There is also greater uncertainty in the reporting rates of tags from the offshore, and in the survival of fish caught for tagging offshore in deep (>200 m) water.

Tagging coverage of the offshore was expanded in 2003 to address some of these concerns, and to investigate whether winter catches in the offshore portion of 3Ps include northern Gulf cod. A total of 1,000 cod were tagged and released in 3Psg/h during the December 2003 industry trawl survey. Results to date are preliminary, but both the numbers of tagged cod returned and distribution of recaptures (all within 3Ps) are similar to those of cod tagged in the offshore of 3Ps during April (see Brattey and Healey 2004).

Movement patterns of cod inferred from the post moratorium tag returns have been quite consistent and suggest that the 3Ps stock comprises a complex group of sub-components that, at least as adults, do not mix thoroughly. The tagging suggests that there are coastal stock components that migrate extensively between Fortune Bay, Placentia Bay and in some years southern 3L, and that these do not mix extensively with cod in offshore regions of 3Ps. In addition, a portion of the offshore cod that over-winter in the southern edge of the Halibut Channel move onto the southeast corner of St. Pierre Bank during summer and fall, whereas others migrate seasonally inshore to Placentia Bay and the southern Avalon during summer. There is also mixing in western 3Ps with cod that migrate out of the neighbouring 3Pn4Rs stock area. The main consequences of the lack of thorough mixing within 3Ps is that local areas are prone to overexploitation and that it adds to the uncertainty of the sequential population analysis of the stock as a whole.

7. Research vessel survey

Stratified-random surveys have been conducted in the offshore areas of Subdiv. 3Ps during the winter-spring period by Canada since 1972, and by France for the period 1978-92. The two surveys were similar with regard to the stratification scheme used, sampling methods and analysis, but differed in the type of fishing gear and the daily timing of trawls (daylight hours only for French surveys). Canadian surveys were conducted using the research vessels *A.T. Cameron* (1972-82), *Alfred Needler* (1983-84), and *Wilfred Templeman* (1985-2003). From the limited amount of comparable fishing data available, it has been concluded that the three vessels had similar fishing power and no adjustments were necessary to achieve comparable catchability factors, even though the *A.T. Cameron* was a side trawler. The French surveys were conducted using the research vessels *Cyros* (1978-91) and *Thalassa* (1992) and the results are summarized in Bishop et al. (1994).

The stratification scheme used in the DFO RV bottom-trawl survey in 3Ps is shown in Fig 11. Canadian surveys have covered strata in depth ranges to 300 ftm since 1980. Five new inshore strata were added to the survey from 1994 (779-783) and a further eight inshore strata were added from 1997 (293-300). For surveys from 1983 to 1995, the Engel 145 high-rise bottom trawl was used. The trawl catches for these years were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation derived from comparative fishing experiments (Warren 1997; Warren et al. 1997; Stansbury 1996, 1997).

The Canadian survey results (in Campelen-equivalent units, see below) are summarized by stratum (Fig. 11) in terms of numbers (abundance) and biomass in Tables 9 and 10, respectively, for the period 1983 to 2003. Strata for which no samples are available were filled in using a multiplicative model. Timing of the survey has varied considerably over the period. In 1983 and 1984 the mean date of sampling was in April, in 1985 to 1987 it was in March, and from 1988 to 1992 it was in February. Both a February and an April survey were carried out in 1993; subsequently, the survey has been carried out in April. The change to April was aimed at reducing the possibility that cod from the adjacent northern Gulf (3Pn4RS) stock would erroneously be counted as part of the 3Ps stock. A portion of the Northern Gulf cod stock may cross the stock boundary into the Burgeo Bank area (see Fig. 1) and mix with 3Ps cod in winter in some years, and migrating back into the Gulf some time during the following spring. Campana et al. (1998, 1999, 2000) has suggested that mixing may be substantial and recent tagging studies suggest that it may extend into April in some years (Brattey et al. 2001b, 2002b; Brattey and Healey 2003). However, the extent, timing, and duration of mixing are variable and at present there is no reliable method to assign survey catches to the appropriate stock on an annual basis. Examination of the age composition of cod caught in the western portion of 3Ps during recent surveys (2001-2003) has revealed age-classes characteristic of 3Ps cod, i.e. the 1997 and 1998 year classes have been strongly represented. This pattern has continued in the 2004 survey (see below) indicating that recent survey catches of western 3Ps have not been dominated by cod from the neighbouring stock area.

7.1 Abundance, biomass, and distribution

A time series of trawlable abundance and biomass estimates from random stratified RV surveys is given in Tables 9 and 10. Details of the catch estimates by stratum, timing of the surveys, number of sets fished, and vessel(s) used are also given. Stratum boundaries are shown in Fig. 11. The abundance and biomass index estimates for the 2004 survey were 45.8 million fish and 80,560 t, respectively. The corresponding values for the 2003 survey were 48.7 million fish and 50,811 t. In the 2004 survey there were no major changes in the distribution of survey catches. The stratum with the largest catch was 319 located in Halibut Channel; this stratum accounted for 84.2% of the biomass index and 57% of the abundance index for the stock area.

Trends in the abundance index and biomass index from the RV survey of the index strata in 3Ps (depths less than or equal to 300 ftm, excluding the new inshore strata) are shown Fig. 12. The time series for both indices from 1983 to 1999 show considerable variability, with strong year effects in the data. Both abundance and biomass are low after 1991 with the exception of 1995, 1998, and 2001. The 1995 estimate is influenced by a single enormous catch contributing 87% of the biomass index and therefore has a very large standard deviation. The 1997 Canadian index was the lowest observed in the time series, which goes back to 1983, being less than half of the 1996 index. The size composition of fish in the 1997 RV survey suggested that this survey did not encounter aggregations of older fish, yet these fish were present in the 1996 survey and in subsequent commercial, sentinel, and survey catches. The minimum trawlable abundance index has declined from 88.2 million in 2001 to 45.8 million in 2004. The minimum trawlable biomass estimate for 2004 is marginally higher than the estimates for the two preceding years. In general, trends in the abundance and biomass indices depicted in Fig. 12 are difficult to discern due to high intra-annual variability. Excluding the 1995 and 1997 survey results would suggest the time series can be broadly divided into three periods – highest during 1983-1990, lowest during 1991-1996, and intermediate values during the most recent period 1998-2004.

The survey data are also expressed in terms of catch rates (i.e. mean numbers per tow) for the survey as a whole (Fig. 13) and for the eastern and western portions of the stock area separately (Fig. 14). The trend for the eastern portion of the stock area is similar to that for the abundance and biomass indices for the stock area as a whole. Catch rates for the eastern portion show considerable variability, with strong year effects, but are generally higher in the 1980's, and low after 1991, and intermediate in the late 1990's and early 2000's. The 1995 estimate is influenced by a single large catch taken at the southern end of Halibut Channel. The catch rates for the western (Burgeo) portion, which has been surveyed in April since 1993, are extremely variable, but are generally higher than those for the eastern region. The value for 1998 is extremely high due to several large catches on Burgeo Bank and vicinity that may have included fish from the neighbouring northern Gulf (3Pn4RS) cod stock. The trends in recent years have diverged between indices for the eastern and western portions, with the eastern region showing a decline and the western region showing an increase, except in 2004 where this pattern is reversed. The overall trend in the combined index is a slightly downward in recent years.

The spatial distribution of catches of cod during the 2004 survey was examined for all ages combined (Fig. 15) and separately for ages 1-8 (Figs. 16-17). Brattey et al. (2003) showed that during 1999-2003 cod were caught over a considerable portion of NAFO Div. 3P with the largest catches typically in the southern Halibut Channel area, on Burgeo Bank and vicinity, in the outer portion of Fortune Bay, and in 3Pn. During these five years cod were consistently scarce in the deep water below the mouth of Placentia Bay and in the inner reaches of Hermitage Channel. Since 2000, catches of cod on the central portion of St. Pierre Bank have become progressively scarcer. In the 2003 survey, the distribution of cod was similar to that of the 2002 survey, with no large catches on St. Pierre Bank. In the 2004 survey (see Fig. 15) the distribution of survey catches shows no major changes from that of 2002-2003; no large catches were taken on the top of St. Pierre Bank, except in the extreme northern slope. Larger catches were taken mainly on Burgeo Bank, Halibut Channel and two locations in Fortune Bay.

The age-disaggregated distribution of survey catches is shown in Figs. 16 and 17. There were no large catches of 1 and 2 yr old cod. Large catches of 3 yr olds were taken only on the northern edge of St. Pierre Bank, with small catches on Burgeo Bank, Halibut Channel and the mouth of Placentia Bay. Large catches of 4 and 5 yr olds were taken in 3Pn, on Burgeo Bank, or in eastern Fortune Bay. Similarly, there were few large catches of older cod with 7 and 8 yr olds in Halibut Channel, on Burgeo Bank, or in 3Pn.

Colbourne and Murphy (2004) analyzed changes in the distribution of survey catches in relation to temperature. "The most evident trend in the numbers of cod caught per set is the high number of zero catches in the cold (<0°C) waters on St. Pierre Bank and regions to the east of St. Pierre Bank mainly from 1985 to 1998 and from 2001 to 2003. During 1999 and 2000 larger catches became more wide spread over the St. Pierre Bank region as the cold (<0°C) water disappeared from the area. In general, during most surveys large catches of cod occurred in the warmer waters (2°-6°C) along the slopes and areas to the west of St. Pierre Bank. In 2004 however, there was no observed shift in the distribution of cod over St. Pierre Bank corresponding to the increase in temperature as observed in 1999 and 2002. In addition, there were many low or zero catches in the warm (>3°C) deeper waters along the slopes of St. Pierre Bank and the Laurentian Channel in 2004 compared to most years. In general however, variations in the estimated abundance and biomass of cod in strata with water depths <92 m are significantly correlated with bottom temperatures for that depth range. However, there is no significant correlation between bottom temperatures and the abundance of cod for strata with water depths >100 m. Nevertheless, it appears that in general cod tend to avoid the colder portions of the thermal habitat in most years and consequently may change their spring distribution from one year to the next, depending on ocean climate conditions".

7.2 Age composition

Survey numbers at age are obtained by applying an age-length key to the numbers of fish at length in the samples. The current sampling instructions for Subdiv. 3Ps require that an attempt be made to obtain 2 otoliths per one cm length class from each of the following locations: Northwest St. Pierre Bank (strata 310-314, 705, 713), Burgeo Bank (strata 306-309, 714-716), Green Bank-Halibut Channel (strata 318-319, 325-326, 707-710), Placentia Bay (strata 779-783) and remaining area (strata 315-317, 320-324, 706, 711-712). This is done to spread the sampling over the survey area. The otoliths are then combined into a single age-length key and applied to the survey data. The resulting estimates of age-disaggregated mean numbers per tow are given in Table 11. It is in this form that the data are used in the calibration of sequential population analysis models. These data can be transformed into trawlable population at age by multiplying the mean numbers per tow at age by the number of trawlable units in the survey area. This is obtained by dividing the area of the survey by the number of trawlable units. For 3Ps, the survey area is 16,732 square nautical miles including only strata out to 300 ftms and excluding the relatively recent strata created in Placentia Bay. The swept area for a standard 15 min tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of trawlable units in the 3Ps survey is $16{,}732 \div 0.00727 = 2.3 \times 10^6$.

The mean numbers per tow at age in the RV survey for the entire index is given in Table 11A. Cod up to 20 years old were not uncommon in survey catches during the 1980's, but the age composition became more contracted through the late 1980s and early 1990s. Survey catches over the post-moratorium period have consistently shown few survivors from year-classes prior to 1989. Recent surveys (2000-2004) indicate that the 1997 and 1998 year classes are stronger than those seen through the mid-1990s, given that their catch rates are much higher and they track through the time series quite consistently. These 1997 and 1998 year classes also appear strong in recent GEAC surveys, and to a lesser extent in recent sentinel line-trawl (Table 8). The 1999, 2000, 2001 year classes all appear relatively weak and are much less strong than those of 1997 and 1998 at young ages (i.e. ≤ 4). This indication of poor incoming recruitment is cause for concern. Overall, the age composition of survey catches has expanded in recent years, but remains somewhat contracted relative to the mid-1980s with presently few fish older than age 15.

The age composition of the survey catches from the eastern and western portions of the stock area can be compared from 1993 onwards (Table 11B). Catches-at-age per tow have tended to be higher in the western portion of the stock area, with a notable year effect in 1998, when several age classes (3-9) appeared strongly in the survey catches; however, none of these year classes have subsequently appeared strongly in surveys in the western portion of 3Ps. The most notable finding in the recent (2000-2004) survey catches of western 3Ps is the consistently strong representation of the 1997 and 1998 year classes. These are also seen in the survey catches for eastern 3Ps. Another interesting finding is the strong representation of the 1999 year class in western 3Ps survey catches over the past 5 consecutive years. This year class is relatively weak in the DFO RV index for eastern 3Ps, in the DFO RV index for the entire stock (i.e. non-split index). The 1999 year class does not appear strongly in survey or commercial catches in the northern Gulf (3Pn4RS), suggesting it may be relatively strong only in the western portion of 3Ps. In general, the age composition of recent survey catches from eastern and western 3Ps have been consistent, except for the strong presence of the 1999 year class in the western region alone.

7.3 Size-at-age (mean length and mean weight)

The sampling protocol for obtaining lengths-at-age (1972-2004) and weights-at-age (1978-2004) has varied over time (Lilly 1998), but has consistently involved stratified sampling by length. For this reason, calculation of mean lengths and weights included weighting observations by population abundance at length (Morgan and Hoenig 1997), where the abundance at length (3-cm size groups) was calculated by areal expansion of the stratified arithmetic mean catch at length per tow (Smith and Somerton 1981).

Mean lengths-at-age (Table 12; Fig. 18a) varied over time. A peak occurred in the mid-1970s for young ages (3-4) and progressively later to 1980 for older ages. This peak does not track individual year-classes particularly well but, in general, year-classes born in the 1970s experienced faster growth than those born in the 1980s (Lilly 1996; Chen and Mello 1999a). There was a decline in length-at-age from the early 1980s to the late 1980s or the early to mid-1990s, with the duration of the decline increasing with age (Fig. 18a,b). There has been an increase since the mid-1990s, but not to the levels seen in the early 1980s. Year-to-year variability at older ages has been considerable (as much as 20 cm at age 10) during the past decade or so.

There has not yet been a thorough analysis to determine if these differences were caused mainly by environmental factors (e.g. temperature or prey availability), cohort factors (e.g. cohort abundance or distribution) or any of the numerous additional possibilities, such as changes in maturation schedules (Chen and Mello 1999b) or size-selective fishing mortality. Variability associated with sampling or processing could also be important.

An exploration of the effects of environmental factors such as temperature has not been conducted because there appears to be negative growth at ages less than 10 for at least 2 cohorts during each of the intervals 1977-1978, 1980-1981, 1989-1990 and 1993-1994 (Lilly 1998). Such extreme year effects could result from the existence within 3Ps of groups of fish with different growth rates, coupled with annual variability in the proportion of the age sample taken from each of those groups. This possibility is discussed further by Lilly (1996), but has not yet been explored.

Much of the high variability in length-at-age at older ages (say 7-10) in recent years appears to be caused by cohort effects. For example, the 1989, 1990 and 1992 year-classes were relatively long at age, whereas the 1988, 1991 and particularly the 1987 year-classes were relatively short (Fig. 18c). The 1995 year-class also appears to be relatively short at age (Fig. 18d). The relatively small size of the 1995 year-class may also be seen in plots of length at age (age-length key) of those cod sampled during the GEAC surveys in 2002 and 2003 (see, for example, McClintock 2004). There has not yet been an investigation of the reasons for such cohort effects. The apparent slow growth of the 1991 and 1995 year-classes is clearly not related to intra-cohort competition, since these are small year-classes.

Selectivity characteristics of the research trawl are also of concern for accurate estimation of size-at-age at younger ages, particularly ages 1 and 2. It may be assumed that estimation at younger ages has improved since the change to the Campelen trawl in 1996.

An important contributor to variability in the estimates of size-at-age at older ages is the increase in range of sizes within a cohort as it ages, combined with a decrease in sample size at length, the latter being a simple consequence of declining abundance.

As expected, the patterns in mean weight-at-age (Table 13; Fig. 19a,b) appear to be very similar to those in length-at-age. The high year-to-year variability at older ages in recent years, noted above for length-at-age, is much more pronounced in weight-at-age, with weights-at-age in some years being more than twice that in others. The weight-at-age estimates may include more sampling variability than the length-at-age estimates in years prior to 1990 because they are based on much smaller sample sizes (Lilly 1998). The weight-at-age data also include variability associated with among-year and within-year variability in weight at length (condition).

7.4 Condition

The somatic condition and liver index of each fish were expressed using Fulton's condition factor $((W/L^3)*100)$, where W is gutted weight (kg) or liver weight (kg) and L is length (cm). Condition and liver index at age were calculated as described above for size-at-age.

Mean somatic (gutted) condition at age (Table 14; Fig. 20A) was variable from 1978 to 1986 and relatively constant from 1986 to 1992. It dropped suddenly in 1993, rose to an intermediate level in 1996-1998 and subsequently declined, although the most recent values have returned to an intermediate level. Condition at age could be influenced by changes in length-at-age (see above) combined with the tendency for condition calculated with Fulton's formula to increase with body length. For this reason, condition at length (Fig. 20B) might be more appropriate than condition at age as an indicator of changes in condition over time. In addition, much of the apparent annual variability in the survey data is related to the timing of the surveys (Lilly 1996). When mean condition in each of three length groups was plotted against the median date of sampling during the survey (Fig. 20C), there was a gradual decline in condition from the earliest median date (Feb. 7) to approximately late April, after which there was an increase. The time course of changes from late April onward is poorly defined because of the paucity of observations. Sampling of cod caught during sentinel surveys in the inshore in 1995 revealed a similar decline in condition during the winter and early spring, with a minimum in roughly late April to early June (Lilly 1996).

Mean liver index at age (Table 15; Fig. 21A) had a pattern similar to that seen in somatic condition, except that the values in 1983 were more clearly at higher levels than during other years in the early 1980s and there was a more pronounced peak in the late 1980s and early 1990s. When the values for specific size groups (Fig. 21B) were plotted against the median date of sampling (Fig. 21C), there was a very pronounced decline in liver index during winter and early spring. A similar decline was evident in samples from the 1995 sentinel survey (Lilly 1996).

From the above, it is clear that the low levels of somatic condition and liver index in recent years (1993-2004) are mainly a consequence of sampling near the low point of the annual cycle and not indicative of a large and persistent decline in well-being. Nevertheless, it is also apparent that there was some annual variability within this recent time period. To explore this a little further, percentiles of gutted condition and liver index were calculated for all cod of a relatively wide size range (40-59 cm) sampled during the 1993-2004 period. There was considerable variability in gutted condition (for the period 1993-2003: median = 0.693; 90^{th} percentile range = 0.597 – 0.792; n = 1814). The distributions did not vary much among years, but the medians in 1996, 1998, and 2003 were somewhat higher than in other years (Fig. 22). Percentiles for liver index were also highly variable (for the period 1993-2003: median = 0.0174; 90^{th} percentile range = 0.0064 – 0.0376; n = 1825). Median liver index was highest in 1998 and 2003 and lowest in 1999 and 2001. Reasons for these small annual differences have not been investigated, but they are undoubtedly complex.

7.5 Maturity and spawning

The gonads of samples of cod collected during annual DFO winter/spring bottom-trawl surveys were visually inspected and assigned to the category “immature” or “mature” according to the criteria of Templeman et al. (1978). Mature fish were further classified as maturing, spawning, or spent (see Morgan and Brattey 1996). Visual inspection is not always totally accurate and there can be difficulties in classifying some stages; for example, mature fish that are skipping a spawning year may be erroneously classified as immature or vice-versa and mature fish that have recently shed a batch of hydrated eggs may be classified as maturing when they are in fact spawning. The extent to which these errors influence the estimation of proportion mature and proportion at each stage of maturation has not been fully evaluated. However, Bolon and Schneider (1999) showed using histological methods that the visual method of classification was reasonably accurate, but tended to slightly underestimate the proportion of spawning fish and overestimate the proportion of maturing fish among cod sampled in Placentia Bay when spawning was taking place.

As in the 2000-2002 assessments, maturation was estimated by cohort rather than by year; prior to 2000 maturation was estimated by year. In addition, data extending back to 1954 has been included in the current analyses. Annual estimates of age at 50% maturity (A_{50}) for females from the 3Ps cod stock, collected during annual winter/spring DFO RV surveys, were calculated as described by Morgan and Hoenig (1997). Trends in age at 50% maturity (A_{50})are shown in Fig. 23A and only cohorts with a significant slope and intercept term are shown; parameter estimates (and SE’s) for cohorts from 1954 to 1999 are given in Table 16. The estimated A_{50} was generally between 6.0 and 7.0 for cohorts from the mid-1950s to the early 1980s, but declined dramatically thereafter to a low of 5.1 in the 1988 cohort (Table 16, Fig. 23A). Age at maturity by cohort remained low but fairly constant for the 1988 to 1994 cohorts; estimates for the 1995 and 1996 cohorts appeared to be increasing, but are followed by a further decline for the 1997 and 1998 cohorts with the latter having the lowest A_{50} in the time series at 4.6 yr. Estimates for the oldest cohorts are more uncertain because only the oldest ages are available to estimate A_{50}. Similarly, estimates for the more recent cohorts are more uncertain because only younger ages from these cohorts are available to estimate A_{50}; nonetheless, these recent further declines may be of concern (Trippel 1995; Heino et al. 2002). Males show a similar trend over time (data not shown), but tend to mature about one year earlier than females. Annual estimates of the proportion mature at age are shown in Table 17; these were obtained from the cohort model parameter estimates in Table 16. The estimates of proportion mature for ages 3-8 show a similar increasing trend (i.e. increasing proportions of mature fish at young ages) through the late 1970s and 1980s, particularly for ages 5, 6, and 7 (Fig. 23B). Also, the model estimates for the proportion mature at age 6 in the 1997 and 1998 cohorts are much higher than those of recent cohorts at the same age and this has a substantial effect on the recent estimates of spawner biomass for this stock. In addition, the age composition of the spawning biomass may have important consequences in terms of producing recruits. A spawning stock biomass that consists mainly of older fish, or a broad age range, may result in a longer time span of spawning (Hutchings and Myers 1993; Trippel and Morgan 1994). Older, larger fish also produce more viable eggs and larvae (Solemdal et al. 1995; Kjesbu et al. 1996; Trippel 1998). Several characteristics of the spawning stock biomass (SSB) of 3Ps cod (and other NF fish stocks) were explored for variability and for relationships with the residuals from Beverton-Holt stock-recruit models (Morgan et al. 2000). Weighted mean age of the SSB, proportion of first time spawners, and proportion female all showed substantial variability over time, but the results were not consistent among the stocks examined and were difficult to interpret.

The time series of maturities for 3Ps cod shows a long-term trend as well as considerable annual variability. To project the maturities for 3Ps cod forward to 2010, for each age group the average of the last three estimates for the same age group was used (Table 17). To fill in missing age groups in the early part of the time series the average of the first three estimates for the same age was used. These values were available for projections of mature spawner biomass in the evaluation of TAC options (see Section 10.6).

Maturities of adult female cod sampled in three sub-areas of NAFO subdivision 3Ps during winter/spring RV bottom-trawl surveys from 1983-2003 are shown in Fig. 24. Note that immature fish are excluded from this analysis. The areas are defined as Burgeo Bank / Hermitage Channel (Strata 306-310 and 714-716), Southern 3Ps / Halibut Channel (all areas south of 45°34.5' N), and mid-3Ps which includes the remainder of the subdivision (excluding inshore strata 293-300 and 779-783). The timing of the survey varied through the time series, with surveys predominantly in April during 1983-84, March during 1985-1987, February from 1988-1992, and April from 1993 to 2002. There were two surveys (February and April) in 1993; only the April one is shown here. The three sub-areas show a consistent pattern of maturity stages across most of the time series, with maturing fish dominating in most years. The switch in timing from February to April clearly results in an increase in the proportions of spawning fish and a reduction or disappearance of fish that are spent from the previous year. When surveys were conducted in April, spawning and spent fish were found in each area; within any one year the proportion of spawning and spent fish tended to vary among sub-areas, but generally about 15-40% of the mature fish sampled were spawning or recently spent. The results from the 2004 survey show no dramatic changes from recent years. The results from the April 2003 sample from the Halibut Channel appear somewhat anomalous, with a high proportion of spent fish compared to other areas. The results also show that a substantial proportion (typically 20-40%) of the mature female cod sampled in the Burgeo area in the April surveys are spawning or spent and therefore, by definition, likely belong to the 3Ps stock. Most of the remaining adult females in Burgeo are maturing to spawn later in the same year and their stock affinities remain unclear.

Overall, cod in 3Ps appear to spawn over a significant portion of the year and at many locations within the stock area, and there appears to be no consistent peak in the spawning time. Spawning is spatially widespread and is known to occur on Burgeo Bank, St. Pierre Bank, and the Halibut Channel area, as well as inshore in Hermitage Bay (3Psa), Fortune Bay (3Psb) and Placentia Bay (3Psc). Spawning in Placentia Bay in recent years has been studied more intensively than elsewhere in 3Ps (Bolon and Schneider 1999; Lawson and Rose 1999; Bradbury et al. 2000).

7.6 3Ps cod maturation reaction norms

Probabilistic maturation reaction norms for 3Ps cod were also calculated, as described by Olsen et al. (2004). These reaction norms give maturation probabilities at specific ages and sizes. Typically, maturation will tend to occur at ages and sizes where the growth trajectories pass through the reaction norm midpoints (L_{p50}, age-specific lengths where the probability of maturing reach 50%). Examples showing maturation reaction norms of cod from Subdivision 3Ps are given in Fig. 25a (females) and Fig. 25b (males). These reaction norms have a negative slope, indicating that faster growing cod will tend to mature at younger ages and larger sizes as compared to slower growing cod. Also, male cod will typically mature at younger ages and smaller sizes as compared to female cod. Maturation reaction norms provide valuable information about the underlying causes of the temporal changes seen in A_{50} (Fig. 23A). Changes in maturity caused by improved or reduced conditions for growth (through phenotypic plasticity) will affect which part of the reaction norm that can be observed, but should not change the reaction norm itself. For cod from the 3Ps stock, however, there are marked temporal trends in maturation reaction norm midpoints (Figs. 26 and 27). These trends are similar to those seen in A_{50}, and indicate that a change in the underlying, evolved, maturation pattern – towards maturation at younger ages and smaller sizes - occurred in the late 1980s and early 1990s. From the early 1990s the maturation reaction norm midpoints vary with no clear trend (Fig. 26 and 27).

8. GEAC Stratified Random Trawl Survey

In 2003, the Groundfish Enterprise Allocation Council (GEAC) carried out a seventh consecutive fall bottom-trawl survey directed at cod with the intention of creating a series of annual fall surveys in 3Ps to complement current DFO RV surveys conducted in spring. DFO provides advice on the stratified random design and catch sampling. Results of the previous surveys are reported in McClintock (1999a, b, 2000, 2001, 2002) and for the most recent survey conducted during 28 November to 11 December 2003 in McClintock (2004). These surveys are carried out in late fall and cover a large portion of offshore 3Ps, but not the Burgeo Bank area (see McClintock 2003). The commercial trawler *M.V. Pennysmart* was used in all seven surveys. Tows are of 30 min. duration using an Engels 96 high lift trawl with a 135 mm diamond mesh cod end (not lined). The trawl was fitted with rock-hopper foot-gear and Bergen #7 trawl doors. Performance of the trawl was checked onboard using Scanmar net sensors (Netmind in previous years): bridge display of door-spread, opening, and clearance were recorded. A total of 89 successful stratified random tow sets were completed in the 2003 survey. Two sets (#8 and #9) were unsuccessful.

The mean cod catch per tow in 2003 was 45 fish with a mean catch weight of 136 kg. These are similar to recent survey values. The largest catch of 2,821 cod weighing 8,330 kg was from set 74 in stratum 318 near the mouth of the Halibut Channel at a depth of 218 m. The mean cod weight for all sets was 3.1 kg, slightly higher than the 2.19 kg per cod in 2002, but substantially less than the mean for 2000 (>5.0 kg).

The trawlable biomass index for 2003 was 69,661 t, somewhat less than the 2002 value of 92,200 t. (Fig. 28). The biomass index has shown considerable annual variability increasing by a factor of four between 1999 and 2000 and decreasing by a factor of 2.3 between 2000 and 2001. Survey coverage during 1997 was somewhat less than in subsequent years; hence the values for 1997 are for a slightly smaller area.

The abundance index for 2003 was 21.9 million fish, compared to 37.9 million in 2002. The abundance index is also variable, with lowest value in 1998 and the highest in 2001 (Fig. 28).

In terms of age composition, the 2003 catch (expressed as mean nos. at age per tow) was dominated by 5 and 6 year old cod (i.e. the 1997 and 1998 year classes, Table 18). This is consistent with previous GEAC surveys, other stock indices, and the commercial catch which have shown that these two age classes are well represented in the population. However, subsequent age classes (1999-2001) are much weaker not only in the GEAC survey catches, but also in other stock indices as well. Further information on catches from the 2003 GEAC survey is given in McClintock (2004). Overall, the GEAC survey is showing considerable annual variability, similar to the DFO RV survey that covers a wider area but is conducted in spring. However, the age compositions of the catches from the industry and DFO surveys are in reasonably close agreement, particularly in the most recent years. The catch-rate-at-age information from the GEAC surveys (1997-2003) is included as an index in the sequential population analysis (see Section 10).

9. Mixing with adjacent stocks

Fishers and scientists have recognized that some mixing occurs between cod from the south coast of Newfoundland (3Ps) and the northern Gulf of St. Lawrence (3Pn4RS). The mixing is generally perceived to take place in the western portion of 3Ps during the winter months (approximately November to April). Details of the history of scientific investigations and current debates about the mixing issue are described in Brattey et al. (2003). At the October 2004 assessment there was little new information presented on the mixing issue, although Brattey and Healey (2004) summarized updated information from tagging and reported winter landings from the mixing area (3Psa/d during November-April) for 2003/04. Information from tag returns indicate that exploitation of cod tagged in 3Psd during April was low in 2003 (1.7%). Landings from the mixing area in 2003 increased somewhat over the previous year to approximately 500 t (see Table 3b), but Brattey and Healey (2004) concluded that removals of cod from the mixing area in the past two years are likely to have little influence on the dynamics of the neighbouring 3Pn4RS cod stock.

10. Sequential Population Analysis (SPA)

10.1 Description of SPA analyses conducted during the previous (2003) assessment

In the 2003 assessment, results from five SPA models / formulations were reported and these were similar to those used in the 2001 and 2002 assessments. An updated summary of the inputs used in each of the five SPA runs conducted during the 2003 assessment (with some corrections) is given in Table 19. These comprised two formulations of Quasi-Likelihood SPA (QLSPA-2003, Run A and Run B), one of Extended Survivorship Analysis (XSA-2003, Run C), and two of ADAPT (ADAPT-2003 Run D and Run E) (see Brattey et al. 2003). These models were applied to the catch data from 1977 onwards (except for Run A, for which the catch data back to 1959 was used). Several age-disaggregated tuning indices were available for calibrating the SPA's (though not all of them were used in each formulation). These were: the DFO winter/spring research vessel trawl survey index (RV index, split or non-split with respect to the Burgeo Bank strata, depending on the model/formulation), A. T. Cameron index, Sentinel line-trawl index, Sentinel 5½ " gillnet index, and the fall industry trawl survey (GEAC) index. The ages and years that were available for each index are described in Brattey et al. (2003).

At the 2003 assessment it was concluded that QLSPA Run A would not be considered in further assessments. When this formulation was initially presented in the 2000 assessment, the time-series for the GEAC trawl survey index was too short and it was not incorporated. The time series for the GEAC trawl survey index in the 2004 assessment will extend to seven years (1997-2003); consequently, it was not considered informative to continue a formulation that excluded the GEAC index and QLSPA Run A was dropped during the current (2004) assessment.

10.2 Comparison runs and inputs available for SPA analyses in the 2004 assessment.

In the 2004 assessment, as a starting point the identical model/formulations used for providing scientific advice in the 2003 assessment were rerun using the same inputs updated with one more year of data. The ages and years available for each index for the 2004 assessment are as follows:

Index	Ages	Years
A. T. Cameron	2-14	1977-1982
RV Index (non-split)	2-14	1983-2004
RV Index split (eastern)	2-14	1983-2004
RV Index split (western)	2-14	1993-2004
Sentinel gillnet	3-10	1995-2003
Sentinel line-trawl	3-10	1995-2003
Industry trawl (GEAC)	2-14	1997-2003

In these analyses, QLSPA Run A was dropped and the XSA rerun inadvertently included a non-split index and so was not directly comparable, leaving three comparison runs. These were QLSPA-2003 Run B, ADAPT-2003 Run D and ADAPT-2003 Run E each updated with one more year of data. Inspection of plots of the model fits and the residuals (not shown) indicated that none of these runs appeared to fit the data better than any of the others; in addition, fits to the data in all of these runs were poor. As in the 2003 assessment, there was a wide range in the estimates of population numbers (Fig. 29a), population biomass (Fig. 29b) and spawner biomass (Fig. 29c) from these runs, but the trends were similar. The addition of one more year of data did not have a major effect on the stock size estimates for preceding years within any of the three runs, i.e. no retrospective patterns were evident.

The inputs available for reconstructing the 3Ps stock were reconsidered in detail, in an attempt to find improvements. The main issues discussed around each of the inputs are described below:

Catch-at-age: Concerns have been expressed during previous 3Ps cod assessments about the quality of the catch-at-age information, particularly for the period prior to 1977 when non-Canadian fleets accounted for much of the total reported landings. Attempts to reconstruct the catch-at-age information for this period have revealed substantial problems. For some years the product of weights-at-age and numbers-at-age (the sum-of-products) differs from the total catch weight by as much as 30%. The data available for this historical period are not available in electronic format and catch-at-age is extremely difficult to reconstruct from various paper records from numerous fleet sectors and countries that fished the stock at that time.

An attempt was made prior to the current assessment to determine if reconstruction and inclusion of a plus group (14+) in the data would solve the problem with the sum of products; while this resulted in some improvement for some years, it was clear that this was not the only issue involved. To date, it has not been possible to rectify the problem with the sum-of-products because it may be due to a suite of factors. The conclusion reached at the current assessment was that the catch-at-age prior to 1977 was not as reliable as that from 1977-2003 and should not be used in SPA's until the problems were more fully understood and rectified. In the 2004 assessment, a consistent catch-at-age matrix has been available for use in all SPA analyses, comprising the period 1977-2003 and ages 2-14, with no plus group.

The potential significance of excluding catch data on cod aged >14 was also discussed, and it was acknowledged that failure to include these older fish in the analyses had the potential to introduce bias in the assessment, if the proportion of the total stock at these older ages was high or changed significantly over time. It was also acknowledged that due to infrequent occurrence in samples, there was no reliable time series of weights-at-age for these older fish, making it difficult to reconstruct the relative importance of these older ages, particularly for the pre-moratorium period. Cod older than age 14 were considered to represent a small proportion of the population during the moratorium and post-moratorium periods (1993 onwards), although the age-structure of the catch has been expanding since 1997.

In previous assessments, there has been extensive discussion about the potential influence of including non-3Ps cod in the catch-at-age matrix, particularly with respect to cod from the northern Gulf in catches taken in western 3Ps during the winter months (November-April). Various methods of addressing the problem of stock mixing have been considered in assessments of these two stocks. No new insights into how to address the stock mixing issue in SPAs were presented at the 2004 assessment, although it was noted that management measures in recent years have reduced the winter catches from the mixing area to only 260 t in 2002/03 with an increase to 500 t in 2003/04 (Table 3b). Estimates of exploitation for cod tagged in this area during April have declined to less than 2% (see Brattey and Healey 2004). It was concluded that catches from the mixing area in winter are too low to have significant influence on the adjacent 3Pn4RS cod stock, but they should continue to be carefully monitored and minimized to reduce the potential for impact on the 3Pn4RS stock.

<u>A. T. Cameron index</u>: This index precedes the DFO RV survey index and covers the period 1977-1982; it has little influence on the sensitivity analyses conducted at the 2004 assessment but is nonetheless included as an index in all SPA's.

<u>RV Survey index</u>: The DFO RV trawl survey index has the longest time-series (1983-2004) of any of the indices available for calibration of the SPA. In previous assessments, it has been acknowledged that this index is highly variable and has strong year effects, particularly in 1995 and 1997. In 1995, the survey index was strongly influenced by a single enormous catch which accounted for 87% of the survey biomass index. In 1997, the survey index was anomalously low and appeared to "miss" fish that were present in the 1996 survey and in commercial, sentinel, and survey catches in subsequent years. The high 1995 DFO RV survey values have a considerable influence on the SPA as evidenced by the large residuals around the 1995 values. Various approaches to dealing with this problem have been discussed in the past, including omitting the survey tow with the large catch. In the 2004 assessment, the 1995 DFO RV survey values were externally down-weighted in one SPA analyses (QLSPA-2004 Run B) so that residuals for the 1995 survey were less influential.

The DFO research vessel trawl survey index can also be influenced by incursions of non-3Ps fish into the survey area, particularly in western 3Ps when northern Gulf (3Pn4RS) cod may be present at the time of the survey (April). In some of the analyses conducted in recent assessments, the 3Ps survey index has been split into two tuning indices, one for the eastern and one for the western regions of 3Ps, in an attempt to account for potential stock mixing. However, at the 2003 assessment (Brattey et al. 2003) examination of the relative year class strengths in 3Ps and the northern Gulf revealed that survey catches from the western region of 3Ps during 2001-2003 were dominated by year classes characteristic of 3Ps cod; this pattern has continued in the 2004 survey catch from western 3Ps where the 1997 and 1998 year classes continue to be well-represented. Consequently, splitting the survey index was not considered appropriate in the 2004 assessment and all SPA's incorporated DFO research vessel trawl survey data as a single index. It was acknowledged that in the future there may be years when significant mixing will occur and influence survey catch rates, and that the data should be carefully examined for such occurrences. At present there is no reliable method to assign survey catches to the appropriate stock on an annual basis. Given that the degree of mixing varies annually and possibly with age, assigning fixed proportions of the survey catch to each stock was not considered a suitable method of addressing the mixing issue.

<u>Sentinel indices</u>: The sentinel indices for gillnet and line-trawl are based on catch rates in gear set close to shore. The trends in catch rates, particularly in those for gillnet, initially showed steep declines after the fishery opened and have generally remained at a lower level, except in the sentinel line-trawl in the most

recent year (2003). The trends are not consistent with those seen in offshore trawl indices, although the latter are highly variable and clear trends are difficult to discern. The sentinel gillnet index is based primarily on data from Placentia Bay and shows trends that are inconsistent among sites as well as no cohort signal in recent years, which contrasts strongly with other indices. Comments from sentinel gillnet participants suggest that at some sites this index has been strongly influenced by competitive effects associated with high effort from the reopened fishery during 1997-2003 (but not during 1995-1996 when the commercial fishery was closed). In addition, recaptures of cod tagged in the inshore during spring suggest that there is a coastal component of the stock that remains inshore throughout the year; consequently, trends in the sentinel gillnet catch rate index could be strongly influenced by changes in the size of a local inshore component of the stock rather than the stock as a whole. Given these concerns, the sentinel gill net index was omitted from SPA analyses conducted during the 2004 assessment.

The sentinel line-trawl index is based mainly on data from the western portion of the inshore of 3Ps. Sentinel line-trawl participants have not reported the competitive effects reported by gill-net participants and the line-trawl index shows less of a decline. This index also has cohort signals that are reasonably consistent with those of other indices, and has therefore been included in SPA analyses conducted during the 2004 assessment.

GEAC survey index: The industry trawl survey of the offshore portion of 3Ps has been conducted since the fall of 1997 (McClintock 2004) and now has a long enough time series to be potentially useful as an index in SPA's. The main issue with respect to the GEAC survey has been coverage; this has varied slightly since the survey began. Most notably, in 1997 a smaller area was surveyed and several strata (numbers 322, 324, 708, 712, and 713) were not fished. These included two large strata at the mouth of Placentia Bay, and some deep-water (>200 fathoms) strata at the southern edge of the continental shelf. To address this inconsistency in survey coverage, it was concluded that it would be most expedient to omit the 1997 survey results from the GEAC index for SPA's conducted at the 2004 assessment as there was insufficient time available to re-compute the index using only strata that were fished in all years. Thus, the GEAC index incorporated data from the 1998-2003 surveys in all SPA's conducted during the 2004 assessment.

10.3 New SPA analyses conducted during 2004 assessment.

10.3.1 QLSPA.

A flexible feature of QLSPA is the incorporation of *F*-shrinkage to assist when estimating stock numbers at the oldest age. In QLSPA Run B this resulted in a substantial and statistically significant dome in the commercial fishery partial recruitment pattern. Shrinkage was applied to the ratio of *F* at an older age and the average *F* at the previous three ages. The default expectation is that this ratio should be close to one, although in Run B the ratio was shrunk to 0.5 which resulted in a significantly better overall fit.

A new finding in this assessment was that the evidence for the dome comes primarily from improved fitting of the 1995 DFO RV survey index. The relevance of improving the fit to this anomalous index is questionable; therefore, it was decided to reduce the external estimation weight for the DFO RV survey index in 1995 by ⅔'s and re-evaluate what type of *F*-shrinkage was appropriate. The rationale for the reduction in estimation weights was to limit the influence of the 1995 DFO RV index to be more similar to indices for other years. Even with the ⅔'s down-weighting the 1995 residuals were still very large, and even greater changes in the weights may be warranted.

To reduce confounding of parameters it was also decided to constrain the catchability coefficients (q's) in the various indices to be equal for ages 13 and 14. This seemed reasonable because there is little reason to think that the q's would be different for these ages. With these changes, particularly the reduction in 1995 DFO RV survey index estimation weights, it was concluded that shrinkage to one was more appropriate. This was specifically applied as three F ratio parameters (see below). Strong shrinkage was determined to be appropriate, and the shrunk parameter estimates were approximately 1.

Note that the catch rate for age 10 in the sentinel line-trawl index was mistakenly omitted in some previous QLSPA's, and its inclusion in this run represents another modification, albeit inconsequential. Otherwise the cohort model and estimation strategy was the same as for QLSPA Run B from the 2003 assessment.

A comparison of stock size estimates from the new 2004 formulation and Run B (from October 2003) is given in Fig. 30a. In this figure the results from another run are shown (flat pr model) which is identical in formulation to Run B (2003) except for the new F constraints and amount of shrinkage. Clearly the differences in F constraints have a substantial impact on the absolute SSB estimates, although the trends are broadly similar. In the new formulation described above, SSB is estimated to be at the highest level since 1977. However, note that recruitment estimates for recent years (age 3 in 2002-2004, i.e. 1999-2001 year classes) are relatively weak and these have not yet entered the fishery.

This new formulation suggests fairly high fishing mortality rates at ages 7 and older (see Fig. 30b). Note that the fishing mortality in 2004 is only based on part of the catch (i.e. catch for Jan-Mar). The partial recruitment patterns estimated in this run are flat after ages 7 or 8.

As in previous QLSPA runs, the fit of the new formulation to the tuning indices is often poor (see Fig. 30c). The differences between indices and model predictions are often large, and some trends are worryingly different (i.e. the sentinel line-trawl declines more rapidly than the model predicts). The patterns in age-specific residuals also indicate poor fits and are not shown to save space. The overall fit of the model was considered to be poor in light of these findings; similar conclusions were made regarding ADAPT formulations described below.

10.3.2 XSA

In the 2004 assessment, several SPA formulations using Extended Survivors Analysis (XSA, Darby and Flatman 1994) were also explored. Analyses were conducted to examine the effect of various degrees of shrinkage, as well as the inclusion/exclusion of ages 13 and 14 from the GEAC and DFO RV indices. In general, these sensitivity analyses gave similar trends in stock size (not shown), although strong shrinkage resulted in slightly higher estimates, as did omission of ages 13 and 14 from the indices. As with other models, the XSA model fits were poor (not shown) and there were no strong indications that one particular XSA formulation fitted the data better than any of the others. To illustrate the trends from the XSA analyses, we used one run (labeled Run C) which excluded ages 13 and 14 from the indices and incorporated minimal shrinkage. Output from this run is shown in the comparisons described below.

10.3.3 ADAPT

In the current assessment, several SPA formulations using ADAPT (Gavaris, 1988) software were explored. Sensitivity analysis with different index data included in estimation and differences in the estimation structure of the ADAPT model were explored. In particular, analyses were conducted to examine, (a) the effect of including/excluding age 13 and 14 data from the GEAC and RV indices, (b) the usage of F-constraints post-moratorium (as opposed to estimating the numbers at age 14 from 1993 onward), and (c) exclusion of anomalous 1995 Canadian RV index data. These runs showed that while trends in the results were quite similar, stock size estimates covered a wide range. Runs that excluded ages 13 and 14 gave higher estimates of stock size, as did runs which assumed a domed fishery selectivity pattern as opposed to a more flat-topped one (see below). It was agreed to retain the formulation of ADAPT-2004 Runs D and E for illustrative purposes. Of note, it was decided not to exclude the 1995 RV index data from the ADAPT-2004 analyses as RV index data for other years (such as 1997) also have substantial (but opposite) year-effects. Furthermore, the data for age 13 and age 14 in the GEAC and DFO RV survey indices were excluded due to a high prevalence of zeros at these ages which are treated as missing values in ADAPT.

The results of two of the ADAPT Runs are presented to illustrate stock trajectories under opposing assumptions of fishery dynamics. In Run D, a domed partial recruitment pattern was used to compute fishing mortality on age 14. Alternately, in Run E, a flat-topped partial recruitment assumption was applied to obtain fishing mortality at age 14. The overall fits of these two ADAPT formulations were similar and there were no clear indications that one formulation fitted the data better than the other; in fact neither model fitted the data well. In both ADAPT formulations, the differences between indices and age-aggregated model predictions for specific years were sometimes large, particularly for the DFO RV survey index in 1995 and 1997, and for the GEAC index in 2001 (see Figs. 31 and 32). The patterns in age-specific residuals are also poor and are not shown to save space.

10.4 Results from four SPA formulations presented at the 2004 assessment

Four SPA runs were used to illustrate the uncertainty in stock size estimates and to illustrate trends in stock size from these analyses. A summary of details of the inputs and estimation procedures used in each of the four SPA runs from the 2004 assessment is given in Table 20. Note that there is no QLSPA-2004 Run A in the current assessment; also, the other runs have been labeled Run B, Run C, etc., but the inputs and formulations are different from Runs B, C, etc conducted during the previous (2003) assessment. All runs have been labeled with the model, year, and run number.

Results from QLSPA-2004 Run B, XSA-2004 Run C, and ADAPT-2004 Runs D and E are presented. These illustrate trends in 3+ population numbers (Fig. 33a), 3+ population biomass (Fig. 33b), spawner biomass (Fig. 33c), age composition of the spawner biomass (Fig. 33d), recruitment expressed as the number of 3 year olds (Fig. 33e), and fishing mortality (expressed as the average *F* on ages 5-10; Fig. 33f). These figures indicate considerable uncertainty about the absolute size of the 3Ps cod population. However, as in the 2002 and 2003 assessments the trends in the estimates from the various formulations are similar.

Note that in the current assessment, the two ADAPT formulations described above were used in the Stock Status Report (DFO, 2004) to illustrate the uncertainty in absolute estimates of stock size and to show trends in stock size. One of the ADAPT formulations incorporated a domed selectivity pattern (referred to as ADAPT-2004 Run D in this document, but Run 1 in the Stock Status Report) and the other a flat topped selectivity pattern (referred to as ADAPT-2004 Run E in this document, but Run 2 in the Stock Status Report). It is emphasized that these two analyses are not considered to be “preferred” or “accepted” relative to the other SPA runs. These two analyses incorporate opposing assumptions about commercial fishery selectivity.

The estimates of 3+ population numbers from the four SPA analyses show a persistent decline from a peak in the early to mid-1980’s to a minimum through the mid 1990s (Fig. 33a). Stock numbers did not increase much during the moratorium (August 1993- May 1997) because recruitment was poor at that time (see below). However, during 1998-2000 population numbers increased, but have subsequently declined in the most recent period (2000-2004). The peak around 2000 appears to be driven largely by the stronger incoming 1997 and 1998 year classes with the slight decline reflecting subsequent recruitment that is weaker. ADAPT-2004 Run D tends to give the highest estimates of population numbers, particularly for the most recent period, whereas the other three runs give similar but lower estimates of population numbers. Note that for all four SPA formulations the recent peak in population numbers in the early 2000's is substantially lower than the peak estimated for the early to mid-1980s.

The estimates of the biomass of cod 3 years and older from the four SPA runs show a peak in the mid-1980s followed by a steady decline to a minimum around 1993/1994 (Fig. 33b). Following the onset of the moratorium, estimates of population biomass increased during 1994 to 1998. Population biomass subsequently leveled off or decreased slightly during 1998-2000 coincident with the resumption of fishing and an increase in the TAC from 10,000 t in 1997 to 30,000 t in 1999. During 2000 to 2003 most runs indicate that stock size has increased again albeit slightly. The resumption of the increase is coincident with reductions in TAC to 15,000 t in the most recent years. Note that the slight increase in biomass in 2000-2003 contrasts somewhat with the trajectory for population numbers for the same period; the increase in population biomass is mostly due to fish growth and not greater numbers of fish. The estimates of 3+ biomass from the five runs cover a broad range, particularly in the most recent period, with ADAPT-2004 Run D again giving the highest estimates. However, for all SPA formulations considered, the estimates of 3+ biomass for the early 2000's are still substantially lower than the peak estimated for the mid-1980's.

The estimates of spawning stock biomass (SSB) from the four runs all show similar temporal trends, and the estimates cover a wide range throughout the time series (Fig. 33c). Two peaks in spawner biomass are evident, one in the mid-1980s, and another in the late 1990's. There is also an increasing trend in the most recent years. The most noticeable features of the trajectories for spawning stock biomass are (1) SSB declined persistently from the mid-1980s to the early 1990's, (2) SSB grew rapidly during the moratorium resulting in a recent peak in SSB that is almost as high as the peak of the mid 1980s, and (3) the estimates for SSB for 2001-2004 show a marked increase with current estimates of SSB the highest observed in the available time series (since 1977). This increase in the most recent period contrasts with the trends described above for population numbers and 3+ biomass. A marked change in the age at maturity of cod within 3Ps (see Figs. 23A and 23B), specifically a declining age at maturity, is an important factor generating the high estimates of SSB for the post moratorium period. The increase in SSB since 2001 is generated largely by the appearance of two relatively strong year classes (1997 and 1998) that show unusually high proportions mature at young ages (i.e. ages 4 and 5, see Fig 23B). Trends in the size and age composition of the SSB estimates from the two ADAPT formulations, where SSB is grouped into relatively young spawners (i.e. ages 3-6) and older spawners (i.e. ≥ 7), are shown in Fig. 33d. In both SPA formulations, close to 50% of the SSB in 2003 and 2004 is comprised of relatively young ($\leq$6 yr old) spawners.

The size of the SSB alone may not be a sensitive measure of the reproductive and recruitment potential of the 3Ps stock (Marshall et al. 1998; Morgan and Brattey 2005). The spawning biomass in the post-moratorium period appears to be comprised of a higher proportion of younger females compared to the period prior to the late 1980s and may therefore not be as effective at producing recruits. Although SSB is estimated to be high in the recent period, the composition of the spawning biomass is not the same as it was in the 1970's and early 1980's and recent information on recruitment suggests that the reproductive potential of the spawning biomass in the current period may be lower.

The trends in the estimates of recruitment (numbers of 3 year olds) from the four SPA runs are generally consistent; the only exceptions are for the 3 year olds in 1992 (1989 year class) and in 2000-2001 (1997 and 1998 year classes) which are estimated to be stronger in ADAPT-2004 Run D compared to the other runs (Fig. 33e). Overall, recruitment shows considerable annual variability, but as pointed out in previous assessments, there is an overall downward trend in recruitment up to the late 1990s. All four model estimates in the current assessment suggest that the downward trend may have been temporarily ameliorated by the 1997 and 1998 year classes which appear to be much stronger than those observed throughout the early to mid-1990s. However, the estimates of recruitment for the most recent period (1999-2001 year classes) are weak and, as reported in the 2003 assessment, this is cause for concern. With a succession of relatively weak year classes feeding into the exploitable population in the near future, current catch levels may not be sustainable unless recruitment improves. It is noteworthy that the SSB, although relatively large, has produced only two strong year classes in the period 1990-2001 and many of the others are among the weakest observed in the time series.

The trends in the estimates of fishing mortality (average of ages 5-10) from the four SPA runs suggest that there was a general increasing trend from about 1984 to a peak in 1992 (Fig. 33f). The rapid decline from 1992 to 1994 coincided with the moratorium, with the subsequent increasing trend following the reopening of the fishery in 1997 and increases in the TAC from 10,000 t in 1997 to 30,000 t in 1999. Estimates of fishing mortality for the post-moratorium period are low among all SPA runs, and have declined in some runs since 2001 when the TAC was reduced to 15,000 t. The post-moratorium estimates of fishing mortality are not as high as those observed for this stock in the late 1980's. Note that these estimates are for the stock as a whole; ongoing estimates of exploitation from recent tagging studies (1997-2003) suggest that fishing mortality in some local regions such as Placentia Bay may be substantially higher.

10.5 Spawner biomass limit reference points

The precautionary approach framework under development for management of domestic fisheries requires a spawning stock biomass limit reference point (B_{lim}) be computed for each stock. The risk that the stock may fall below this limit should be assessed with respect to catch options. In the current assessment, various candidate reference points were reviewed. B_{rec} (where rec=recovery) is the lowest spawner biomass from which a secure recovery has occurred. B_{rec} is recommended as being suitable for 3Ps cod as this stock has undergone two recovery cycles since 1977. Current spawning stock biomass was compared in relative terms with B_{rec}, defined as the spawning stock biomass at the beginning of 1994 (i.e. 36,000 t and 13,000 t for the two respective SPA formulations). The current spawning stock biomass is 3.6 times larger and 6.9 times larger than B_{rec} for the two ADAPT SPA formulations (see Fig. 33c), respectively.

10.6 Projections

In the current assessment, 3-year deterministic projections to 1 April 2007 were carried out for the two ADAPT SPA formulations (Runs D and E). In the first year the catch was assumed to be 15,000 t which is the TAC for the 1 April 2004 – 31 March 2005 management year. Fixed annual TAC options of 0, 5,000 t, 10,000 t, 15,000 t or 20,000 t were evaluated for the next two management years, i.e. the 2005/06 and 2006/07 fishing seasons. These projections were conducted to illustrate potential trends in the status of the stock over the next three years and they incorporate assumptions about growth, recruitment, maturation and both natural and fishing mortality that are consistent with recent observations.

The inputs for the projections are given in Table 21. Given that the nine months of a management cycle are in one calendar year and three months are in the next year, the TAC had to be split across the calendar years because the analyses are age based and fish increment an age on January 1 each year. In recent years the catches in 3Ps have been split in proportion 0.83 to 0.17 and this split was assumed for each projection period. The partial recruitment (PR) vector was computed from the average F's for the period 2001-2003 from the relevant SPA. For projections, the PR was calculated in each year, the average PR over three years computed for each age, and the averages were re-scaled to have a maximum of 1. The fishery has been dominated by gillnets in the recent period and most PR's consequently have a domed pattern. For recruitment during the projection period, the geometric mean numbers at age 3 in years 2002-2004 from the relevant SPA was used; this includes data from three year classes that are estimated to be relatively weak (1999 to 2001). The instantaneous rate of natural mortality was assumed to be 0.2 per year (18%) as used in previous assessments of 3Ps cod. The methods for estimating population weights-at-age (January 1), catch weights-at-age (mid-year), and maturity ogives are described in relevant previous sections. Given that the fishing season runs from 1 April to 31 March it is most appropriate to compare results from 1 April in one year (e.g. 2006.3) with 1 April in previous years to determine whether the population has grown or not. Furthermore, because the age composition is incremented only once each year (1 January) and beginning of year weights are applied, spawner biomass will always decrease under the combined effects of natural and fishing mortality during the 1 January to 1 April period.

In the first year of the projections the catch was assumed to be 15,000 t which is the TAC for the management year 1 April 2004 – 31 March 2005. At this catch level, the spawner biomass is estimated to decrease by approximately 7,000 t and 5,000 t for the two respective SPA formulations. These declines are consistent with the projections from the 2003 assessment.

The projections for the management years 2005/06 and 2006/07 were for fixed annual catch options ranging from 0 to 20,000 t in 5,000 t increments. At catch options ranging from 10,000 to 20,000 t both formulations indicated that spawner biomass will decline by 1 April 2007 (Table 22). At a catch option of 5,000 t both formulations indicated a small increase (2-4%) in spawner biomass by 1 April 2007. With no catch, both formulations indicated a modest increase (10-15%). Under all catch options considered for the two SPA formulations, the projected spawner biomass on 1 April 2007 was considerably greater than the recommended B_{lim}, i.e. would remain well above a level from which a secure recovery of the stock had occurred in the past.

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Table 1. Reported landings of cod (t) from NAFO Subdiv. 3Ps, 1959 - 1 Oct 2004 by country and for fixed and mobile gear sectors.

	Can. (Newfoundland)		Can. (Mainland)	France			Spain	Portugal	Others	Total	TAC
	Offshore	Inshore		St. Pierre & Michelon		Metro					
Year	(Mobile)	(Fixed)	(All gears)	Inshore	Offshore	(All gears)	(All gears)	(All gears)	(All gears)		
1959	2,726	32,718	4,784	3,078		4,952	7,794	3,647	471	60,170	
1960	1,780	40,059	5,095	3,424	210	2,460	17,223	2,658	4,376	77,285	
1961	2,167	32,506	3,883	3,793	347	11,490	21,015	6,070	5,553	86,824	
1962	1,176	29,888	1,474	2,171	70	4,138	10,289	3,542	2,491	55,239	
1963	1,099	30,447	331	1,112	645	324	10,826	209	6,828	51,821	
1964	2,161	23,897	370	1,002	1,095	2,777	15,216	169	9,880	56,567	
1965	2,459	25,902	1,203	1,863	707	1,781	13,404		4,534	51,853	
1966	5,473	23,785	583	-	3,207	4,607	23,678	519	4,355	66,207	
1967	3,861	26,331	1,259	2,244		3,204	20,851	980	4,044	62,774	
1968	6,538	22,938	585	-	880	1,126	26,868	8	18,613	77,556	
1969	4,269	20,009	849	-	2,477	15	28,141	57	7,982	63,799	
1970	4,650	23,410	2,166	1,307	663	35	35,750	143	8,734	76,858	
1971	8,657	26,651	731	1,196	455	2,730	19,169	81	2,778	62,448	
1972	3,323	19,276	252	990	446	-	18,550	109	1,267	44,213	
1973	3,107	21,349	181	976	189	-	19,952	1,180	5,707	52,641	70,500
1974	3,770	15,999	657	600	348	5,366	14,937	1,246	3,789	46,712	70,000
1975	741	14,332	122	586	189	3,549	12,234	1,350	2,270	35,373	62,400
1976	2,013	20,978	317	722	182	1,501	9,236	177	2,007	37,133	47,500
1977	3,333	23,755	2,171	845	407	1,734	-	-		32,245	32,500
1978	2,082	19,560	700	360	1,614	2,860	-	-	45	27,221	25,000
1979	2,381	23,413	863	495	3,794	2,060	-	-	-	33,006	25,000
1980	2,809	29,427	715	214	1,722	2,681	-	-	-	37,568	28,000
1981	2,696	26,068	2,321	333	3,768	3,706	-	-	-	38,892	30,000
1982	2,639	21,351	2,948	1,009	3,771	2,184	-	-	-	33,902	33,000
1983	2,100	23,915	2,580	843	4,775	4,238	-	-	-	38,451	33,000
1984	895	22,865	1,969	777	6,773	3,671	-	-	-	36,950	33,000
1985	4,529	24,854	3,476	642	9,422	8,444	-	-	-	51,367	41,000
1986	5,218	24,821	1,963	389	13,653	11,939	-	-	7	57,990	41,000
1987	4,133	26,735	2,517	551	15,303	9,965	-	-	-	59,204	41,000
1988	3,662	19,742	2,308	282	10,011	7,373	-	-	4	43,382	41,000
1989	3,098	23,208	2,361	339	9,642	892	-	-	-	39,540	35,400
1990	3,266	20,128	3,082	158	14,771	-	-	-	-	41,405	35,400
1991	3,916	21,778	2,106	204	15,585	-	-	-	-	43,589	35,400
1992	4,468	19,025	2,238	2	10,162	-	-	-	-	35,895	35,400
1993	1,987	11,878	1,351	-	-	-	-	-	-	15,216	20,000
1994	82	493	86	-	-	-	-	-	-	661	0
1995	26	555	60	-	-	-	-	-	-	641	0
1996	60	707 [2]	118							885	0
1997 [1]	122	7,205 [2]	79	448	1,191					9,045	10,000
1998 [1]	4,320	11,370 [2]	885	609	2,511					19,694	20,000
1999 [1]	3,097	21,231 [2]	614	621	2,548					28,111	30,000
2000 [1]	3,436	16,247 [2]	740	870	3,807					25,100 [4]	20,000
2001 [1]	2,152	11,187 [2]	856	675	1,675					16,546 [4]	15,000
2002 [1]	1,326	11,292 [2]	499	579	1,623					14,892 [4]	15,000
2003 [1]	1,869	10,600 [2]	412	734	1,645					15,260 [4]	15,000
2004 [3]	1,522	5,456	0	0	924					7,901 [4]	15,000

[1] Provisional catches

[2] Includes recreational fishery and sentinel fishery.

[3] Catch for Canada and France to 1 October 2004.

[4] TAC's are now set for the period 1 April to 31 March rather than by calender year and the TAC was 20,000 t for 2000-2001, and 15,000 t for subsequent management years.

Table 2. Reported fixed gear catches of cod (t) from NAFO Subdivision 3Ps by gear type. (Includes non-Canadian and recreational catch)

Year		Gillnet	Longline	Handline	Trap	Total
1975		4,995	4,083	1,364	3,902	14,344
1976		5,983	5,439	2,346	7,224	20,992
1977		3,612	9,940	3,008	7,205	23,765
1978		2,374	11,893	3,130	2,245	19,642
1979		3,955	14,462	3,123	2,030	23,570
1980		5,493	19,331	2,545	2,077	29,446
1981		4,998	20,540	1,142	948	27,628
1982		6,283	13,574	1,597	1,929	23,383
1983		6,144	12,722	2,540	3,643	25,049
1984		7,275	9,580	2,943	3,271	23,069
1985		7,086	10,596	1,832	5,674	25,188
1986		8,668	11,014	1,634	4,073	25,389
1987		9,304	11,807	1,628	4,931	27,670
1988		6,433	10,175	1,469	2,449	20,526
1989		5,997	10,758	1,657	5,996	24,408
1990		6,948	8,792	2,217	3,788	21,745
1991		6,791	10,304	1,832	4,068	22,995
1992		5,314	10,315	1,330	3,397	20,356
1993		3,975	3,783	1,204	3,557	12,519
1994		90	0	381	0	471
1995		383	182	0	5	570
1996		467	158	137	10	772
1997		3,760	1,158	1,172	1,167	7,258
1998	[1]	10,116	2,914	308	92	13,430
1999	[1]	17,976	3,714	503	45	22,237
2000	[1]	14,218	3,100	186	56	17,561
2001	[1]	7,377	2,833	2,089	57	12,357
2002	[1]	7,827	2,309	775	119	11,030
2003	[1]	8,313	2,044	546	35	10,937
2004	[2]	4,717	148	569	10	5,445

[1] provisional catch

[2] provisional catch to October 1st 2004

Table 3a. Reported monthly landings (t) of cod from NAFO Subdiv. 3Ps by gear type during 2003 and 2004 (to 1 October) including French, sentinel, and recreational landings.

2003	Offshore			Inshore				
MONTH	**Otter trawl**	**Gillnet**	**Line trawl**	**Gillnet**	**Line trawl**	**Handline**	**Trap**	***Total**
Jan	1146.6	0.0	21.1	166.0	121.4	2.2	0.0	1457.2
Feb	1220.0	16.4	33.7	25.7	30.1	0.0	0.0	1325.7
Mar	44.9	0.0	54.0	1.2	0.1	0.0	0.0	100.3
Apr	18.2	0.0	10.1	0.3	1.5	0.0	0.0	30.1
May	0.2	0.0	9.4	273.9	59.6	15.1	10.1	368.3
Jun	0.0	31.7	37.0	1043.5	23.5	28.6	14.8	1179.1
Jul	7.4	240.1	9.8	1604.5	50.1	76.3	9.5	1997.6
Aug	26.0	466.5	4.0	469.2	100.9	218.6	0.0	1285.2
Sep	24.3	1517.1	8.7	767.1	474.3	106.1	0.1	2897.8
Oct	67.1	174.3	11.1	357.4	247.1	28.3	0.0	885.2
Nov	511.7	277.8	0.2	1402.9	489.4	63.6	0.0	2745.6
Dec	496.0	11.2	75.1	200.2	171.7	6.9	0.3	961.3
TOTAL	3562.3	2735.1	274.2	6311.8	1769.6	545.7	34.9	15233.5

*total excludes 27.0 t catch with other gears

2004	Offshore			Inshore				
MONTH	**Otter trawl**	**Gillnet**	**Line trawl**	**Gillnet**	**Line trawl**	**Handline**	**Trap**	***Total**
Jan	1296.5	72.1	5.3	64.5	79.0	0.7	0.0	1518.1
Feb	933.8	4.9	9.4	16.7	1.6	0.1	0.0	966.6
Mar	137.5	0.0	9.7	0.0	0.5	0.0	0.0	147.6
Apr	0.7	0.0	0.0	1.6	1.8	0.0	0.0	4.1
May	0.0	0.0	0.0	317.4	27.6	3.9	2.8	351.6
Jun	0.0	1.8	0.0	1630.0	64.1	25.8	2.9	1724.6
Jul	0.0	43.0	0.2	1683.3	95.9	45.0	1.7	1869.2
Aug	0.0	9.3	0.0	348.9	214.3	67.5	2.9	642.8
Sep	0.0	1.1	0.0	522.6	59.4	5.4	0.0	588.5
Oct	.	.	.	. .		.	.	.
Nov	.	.	.	. .		.	.	.
Dec	.	.	.	. .		.	.	.
TOTAL	2368.5	132.2	24.6	4585.0	544.2	148.4	10.2	7813.1

Table 3b. Reported monthly landings (t) of cod from unit areas in NAFO Subdiv. 3Ps during 2003 and 2004 (to 1 October).

2003	**Inshore**			**Offshore**					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**Totals**
Jan	1.9	197.3	90.4	6.3	0.0	0.0	0.7	1160.6	1457.2
Feb	1.2	53.5	1.1	32.7	2.2	0.0	23.4	1211.7	1325.7
Mar	0.2	1.2	0.0	6.5	0.0	0.0	12.1	80.4	100.4
Apr	1.5	0.0	0.3	0.0	0.0	0.0	3.3	24.9	30.1
May	64.2	199.8	94.8	0.3	0.0	0.0	4.3	5.1	368.4
Jun	105.2	234.6	770.6	7.4	16.1	17.8	7.3	20.2	1179.2
Jul	161.3	310.1	1269.7	48.1	107.6	72.2	0.2	29.2	1998.4
Aug	134.9	229.0	425.0	26.7	279.4	130.8	7.5	52.1	1285.4
Sep	434.8	459.0	454.1	38.2	741.4	625.5	96.2	49.0	2898.1
Oct	236.0	134.1	262.9	10.1	159.8	64.7	0.5	17.3	885.4
Nov	153.8	571.5	1240.4	12.3	82.0	432.5	4.0	258.8	2755.4
Dec	32.7	146.1	215.8	45.4	12.3	14.8	11.4	498.4	976.8
Totals	1327.7	2536.1	4825.1	233.9	1400.9	1358.3	170.9	3407.7	15260.5

2004	**Inshore**			**Offshore**					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**Totals**
Jan	15.1	67.5	101.9	43.3	0.0	0.0	14.5	1316.1	1558.4
Feb	6.9	6.1	5.8	127.8	0.0	0.0	0.0	820.3	966.9
Mar	19.1	0.2	0.0	40.2	0.0	0.4	0.0	106.5	166.5
Apr	1.0	0.8	1.6	0.0	0.0	0.0	0.0	0.7	4.1
May	74.4	141.0	136.1	0.0	0.0	0.0	0.0	0.0	351.6
Jun	149.6	398.4	1181.2	0.3	1.5	0.0	0.0	0.1	1731.1
Jul	163.0	482.8	1184.2	11.0	0.0	3.5	1.8	27.0	1873.2
Aug	231.1	135.8	266.5	0.0	0.0	0.0	0.0	9.3	642.8
Sep	51.3	296.2	258.2	0.0	0.0	0.0	0.0	1.1	606.7
Oct									
Nov									
Dec									
Totals	711.7	1528.8	3135.5	222.6	1.5	3.9	16.3	2281.0	7901.4

Table 4a. Numbers of cod sampled (Canadian commercial fishery and sentinel survey) for length and age and available to estimate the 3Ps commercial catch-at-age for 2003.

Number Measured							
	Offshore			Inshore			
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Total
Jan	6100	0	0	693	227		7020
Feb	3255	0	132	436	383		4206
Mar	521	0	0		68		589
Apr	0	0	0	60	640		700
May	0	0	0	1856	1025	259	3140
Jun	0	0	0	4006	707		4713
Jul	0	625	0	8235	2307	1410	12577
Aug	237	1287	0	1117	3633	1290	7564
Sep	1677	4700	0	759	3735	613	11484
Oct	1154	1874	427	4100	3045	167	10767
Nov	3460	1510	190	5020	6762	266	17208
Dec	669	0	0	40			709
Total	17073	9996	749	26322	22532	4005	80677

Number Aged							
	Offshore			Inshore			
Qtr	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Total
1	1394		0	129	75		1598
2			0	483	224	92	799
3		1147	0	1329	726	416	3618
4	325	236	69	1023	1273	91	3017
Total	1719	1383	69	2964	2298	599	9032

Sampling by France for 2003 catch at age				
Qtr	Ottertrawl	Gillnet	Ottertrawl	Gillnet
	Measured		**Aged**	
1	3117		290	
3		672		200
4	684	446	400	200
Total	3801	1118	690	400

Table 4b. Numbers of cod sampled (commercial fishery and sentinel survey) for length and age and available to estimate the 3Ps commercial catch-at-age for Jan - Mar 2004.

Canada							
	Number Measured						
	Offshore			Inshore			
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Total
Jan	6100			693	227		7020
Feb	3255		133	436	383		4207
Mar	521				68		589
Total	9876	0	133	1129	678	0	11816
	Number Aged						
	Offshore			Inshore			
QTR	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Total
1	1222	116	102	152	192	31	1815
2							
3							
4							
Total	1222	116	102	152	192	31	1815

	Sampling used by France for Jan -Mar 2004 catch at age				
Qtr	Ottertrawl	Gillnet	Ottertrawl	Gillnet	
	Measured		**Aged**		
1	1004		200		
Total	1004		200		

Table 5a. Estimates of the average weight (kg), length (cm), and numbers-at-age (000's) for Canadian and French catches and the resulting total catch numbers-at-age for cod in 3Ps during 2003.

	Average		Catch			Canada	France	Grand
	Weigth	Length	Number		CV	(nos)	(nos)	Total
AGE	(kg.)	(cm.)	(000's)	SE	(Can.)	(000's)	(000's)	(000's)
1	0.00	0.00	0.00	0.00		0.00	0.00	0.00
2	0.36	34.71	0.43	0.19		0.43	0.00	0.43
3	0.68	42.40	15.03	1.77	0.12	14.96	0.06	15.03
4	0.97	47.62	301.45	10.09	0.03	288.48	12.98	301.45
5	1.57	55.57	879.01	22.42	0.03	791.90	87.13	879.01
6	2.11	61.31	1810.16	31.77	0.02	1584.26	225.95	1810.16
7	2.34	63.37	1138.97	29.01	0.03	995.76	143.24	1138.97
8	2.63	65.60	596.28	18.60	0.03	531.93	64.37	596.28
9	3.87	73.05	337.24	12.12	0.04	290.62	46.62	337.24
10	4.75	77.97	276.64	11.62	0.04	229.27	47.38	276.64
11	4.30	75.84	166.62	8.45	0.05	131.24	35.39	166.62
12	5.33	80.83	66.79	5.21	0.08	54.36	12.43	66.79
13	7.82	92.22	55.38	5.09	0.09	40.45	14.93	55.38
14	10.35	103.04	84.36	4.93	0.06	61.83	22.54	84.36
15	10.84	103.68	6.38	0.85	0.13	5.22	1.16	6.38
16	11.81	107.52	2.92	1.44	0.49	1.56	1.36	2.92
17	9.46	99.68	1.39	0.77	0.56	0.64	0.75	1.39
18	10.36	102.57	0.75	0.26	0.34	0.75	0.00	0.75
19	0.00	0.00	0.00	0.00		0.00	0.00	0.00
20	22.79	133.73	0.03	0.02	0.61	0.03	0.00	0.03
21	18.67	125.57	0.05	0.03	0.63	0.05	0.00	0.05
22	6.22	88.00	0.01	0.01	0.61	0.01	0.00	0.01
23	9.88	102.08	0.19	0.14	0.74	0.15	0.05	0.19
24	20.75	130.00	0.09	0.00	0.01	0.08	0.01	0.09
25	11.05	106.00	0.21	0.14	0.69	0.21	0.00	0.21

Table 5b. Estimates of average weight (kg), length (cm), and numbers-at-age (000's) for Canadian and French catches and the resulting total catch numbers-at-age for cod in 3Ps during Jan.-Mar. 2004. The French catch-at-age is based on Canadian observer frequency of French catch and Canadian age-length keys.

	Average		Catch			Canada	France	Grand
	Weigth	Length	Number		cv	(nos)	(nos)	Total
AGE	(kg.)	(cm.)	(000's)	SE	(Can.)	(000's)	(000's)	(000's)
1	0.00	0.00	0.00	0.00		0.00	0.00	0.00
2	0.00	0.00	0.00	0.00		0.00	0.00	0.00
3	0.33	34.00	3.51	0.05	0.02	3.51	0.00	3.51
4	1.00	47.82	0.99	0.24	0.24	0.99	0.00	0.99
5	1.05	48.99	47.47	6.24	0.13	43.23	5.18	47.47
6	1.67	56.61	273.92	10.57	0.04	198.62	48.27	273.92
7	2.28	62.88	310.10	9.85	0.03	199.89	88.63	310.10
8	2.54	64.51	122.44	7.39	0.06	90.36	40.97	122.44
9	2.58	64.30	35.12	3.17	0.09	30.67	8.27	35.12
10	6.63	87.28	25.03	1.89	0.08	17.27	15.20	25.03
11	8.48	95.41	26.19	1.73	0.07	17.49	13.86	26.19
12	5.83	82.25	12.04	1.36	0.11	9.33	4.42	12.04
13	9.55	99.82	6.46	0.82	0.13	4.14	2.95	6.46
14	12.37	109.22	10.42	1.14	0.11	6.61	2.89	10.42
15	13.26	111.67	25.60	1.85	0.07	15.58	5.60	25.60
16	12.74	110.37	3.33	0.63	0.19	2.06	0.77	3.33
17	0.00	0.00	0.00	0.00		0.00	0.00	0.00
18	20.75	130.00	0.05	0.05	1.09	0.04	0.00	0.05
19	0.00	0.00	0.00	0.00		0.00	0.00	0.00
20	9.23	100.00	0.35	0.22	0.63	0.19	0.15	0.35

Table 6. Catch numbers-at-age (000s) for the commercial cod fishery in NAFO Subdiv. 3Ps from 1959 to 31 March 2004.

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14	sum
1959	1,001	13,940	7,525	7,265	4,875	942	1,252	1,260	631	545	44	1	39281
1960	567	5,496	23,704	6,714	3,476	3,484	1,020	827	406	407	283	27	46411
1961	450	5,586	10,357	15,960	3,616	4,680	1,849	1,376	446	265	560	58	45203
1962	1,245	6,749	9,003	4,533	5,715	1,367	791	571	187	140	135	241	30677
1963	961	4,499	7,091	5,275	2,527	3,030	898	292	143	99	107	92	25014
1964	1,906	5,785	5,635	5,179	2,945	1,881	1,891	652	339	329	54	27	26623
1965	2,314	9,636	5,799	3,609	3,254	2,055	1,218	1,033	327	68	122	36	29471
1966	949	13,662	13,065	4,621	5,119	1,586	1,833	1,039	517	389	32	22	42834
1967	2,871	10,913	12,900	6,392	2,349	1,364	604	316	380	95	149	3	38336
1968	1,143	12,602	13,135	5,853	3,572	1,308	549	425	222	111	5	107	39032
1969	774	7,098	11,585	7,178	4,554	1,757	792	717	61	120	67	110	34813
1970	756	8,114	12,916	9,763	6,374	2,456	730	214	178	77	121	14	41713
1971	2,884	6,444	8,574	7,266	8,218	3,131	1,275	541	85	125	62	57	38662
1972	731	4,944	4,591	3,552	4,603	2,636	833	463	205	117	48	45	22768
1973	945	4,707	11,386	4,010	4,022	2,201	2,019	515	172	110	14	29	30130
1974	1,887	6,042	9,987	6,365	2,540	1,857	1,149	538	249	80	32	17	30743
1975	1,840	7,329	5,397	4,541	5,867	723	1,196	105	174	52	6	2	27232
1976	4,110	12,139	7,923	2,875	1,305	495	140	53	17	21	4	3	29085
1977	935	9,156	8,326	3,209	920	395	265	117	57	43	31	11	23465
1978	502	5,146	6,096	4,006	1,753	653	235	178	72	27	17	10	18695
1979	135	3,072	10,321	5,066	2,353	721	233	84	53	24	13	10	22085
1980	368	1,625	5,054	8,156	3,379	1,254	327	114	56	45	21	25	20424
1981	1,022	2,888	3,136	4,652	5,855	1,622	539	175	67	35	18	2	20011
1982	130	5,092	4,430	2,348	2,861	2,939	640	243	83	30	11	7	18814
1983	760	2,682	9,174	4,080	1,752	1,150	1,041	244	91	37	18	8	21037
1984	203	4,521	4,538	7,018	2,221	584	542	338	134	35	8	8	20150
1985	152	2,639	8,031	5,144	5,242	1,480	626	545	353	109	21	6	24348
1986	306	5,103	10,253	11,228	4,283	2,167	650	224	171	143	79	23	34630
1987	585	2,956	11,023	9,763	5,453	1,416	1,107	341	149	78	135	50	33056
1988	935	4,951	4,971	6,471	5,046	1,793	630	284	123	75	53	31	25363
1989	1,071	8,995	7,842	2,863	2,549	1,112	600	223	141	57	29	26	25508
1990	2,006	8,622	8,195	3,329	1,483	1,237	692	350	142	104	47	22	26229
1991	812	7,981	10,028	5,907	2,164	807	620	428	108	76	50	22	29003
1992	1,422	4,159	8,424	6,538	2,266	658	269	192	187	83	34	41	24273
1993	278	3,712	2,035	3,156	1,334	401	89	38	52	13	14	5	11127
1994	9	78	173	74	62	28	12	3	2	0	0	0	441
1995	3	7	56	119	57	37	7	2	0	0	0	0	288
1996	9	43	43	101	125	35	24	8	2	1	0	0	391
1997	66	427	1,130	497	937	826	187	93	31	4	1	0	4199
1998	91	373	793	1,550	948	1,314	1,217	225	120	56	15	1	6703
1999	49	628	1,202	2,156	2,321	1,020	960	873	189	110	21	8	9537
2000	76	335	736	1,352	1,692	1,484	610	530	624	92	37	16	7587
2001	80	475	718	1,099	1,143	796	674	257	202	192	28	13	5677
2002	155	607	1,451	1,280	900	722	419	355	96	70	71	14	6139
2003	15	301	879	1,810	1,139	596	337	277	167	67	55	84	5728
2004*	4	1	47	274	310	122	35	25	26	12	6	10	874

* January-March 2004 only

Table 7a. Annual mean weights-at-age (kg) calculated from lengths-at-age based on samples of the catch by commercial fisheries (including food fisheries and sentinel surveys) in Subdivision 3Ps in 1959-2004. The weights-at-age from 1976 are extrapolated back to 1959. The values for 2004 are extrapolations from the 2003 values as described in the text. The values for 2002 have been revised from the values presented in 2003.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1960	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1961	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1962	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1963	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1964	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1965	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1966	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1967	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1968	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1969	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1970	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1971	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1972	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1973	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1974	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1975	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1976	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1977	0.55	0.68	1.30	1.86	2.67	3.42	4.19	4.94	5.92	6.76	8.78	10.90
1978	0.45	0.70	1.08	1.75	2.45	2.99	4.10	5.16	5.17	7.20	7.75	8.72
1979	0.41	0.65	1.01	1.65	2.55	3.68	4.30	6.49	7.00	8.20	9.53	10.84
1980	0.52	0.72	1.13	1.66	2.48	3.60	5.40	6.95	7.29	8.64	9.33	9.58
1981	0.48	0.79	1.32	1.80	2.30	3.27	4.36	5.68	7.41	9.04	8.39	9.56
1982	0.45	0.77	1.17	1.78	2.36	2.88	3.91	5.28	6.18	8.62	8.64	11.41
1983	0.58	0.84	1.33	1.99	2.58	3.26	3.77	5.04	6.56	8.45	10.06	11.82
1984	0.66	1.04	1.40	1.97	2.64	3.77	4.75	5.56	6.01	9.04	11.20	10.40
1985	0.63	0.85	1.23	1.79	2.81	3.44	5.02	6.01	6.11	7.18	9.81	10.48
1986	0.54	0.75	1.18	1.84	2.43	3.15	4.30	5.50	6.19	8.72	8.05	11.91
1987	0.56	0.77	1.21	1.63	2.31	3.02	4.33	5.11	6.20	6.98	7.08	8.34
1988	0.63	0.82	1.09	1.67	2.17	2.92	3.58	4.98	5.61	6.60	7.46	8.92
1989	0.63	0.81	1.16	1.63	2.25	3.37	4.11	5.18	6.29	7.30	7.75	8.73
1990	0.58	0.86	1.27	1.85	2.45	3.00	4.22	5.09	6.35	7.60	8.31	10.37
1991	0.60	0.75	1.17	1.74	2.37	2.91	3.69	4.23	6.34	7.68	8.64	9.72
1992	0.46	0.69	1.04	1.56	2.23	2.89	4.14	5.54	6.42	7.82	10.40	11.88
1993	0.36	0.68	1.08	1.48	2.13	2.82	4.34	4.30	4.68	7.49	6.85	8.24
1994	0.62	0.82	1.30	1.86	2.05	2.75	3.59	4.38	6.29	7.77	6.78	8.07
1995	0.52	0.85	1.57	2.03	2.47	2.78	3.46	4.30	4.27	4.16	5.59	9.24
1996	0.67	0.98	1.48	2.05	2.53	2.94	3.23	4.03	4.82	4.68	7.26	9.92
1997	0.62	0.90	1.30	1.87	2.51	3.24	3.47	3.52	4.59	6.37	8.58	10.73
1998	0.62	1.02	1.57	2.05	2.42	3.10	4.04	4.13	4.62	5.21	6.39	9.69
1999	0.70	0.92	1.57	2.31	2.53	2.82	3.92	5.32	4.99	5.27	6.14	7.27
2000	0.62	0.90	1.36	2.07	2.74	2.81	3.15	4.60	6.54	6.12	6.42	7.73
2001	0.69	1.02	1.44	1.94	2.57	3.41	3.21	3.46	5.59	8.61	7.61	8.11
2002	0.57	1.02	1.54	2.04	2.32	3.10	4.33	3.90	3.87	6.05	8.89	7.94
2003	0.68	0.97	1.57	2.11	2.34	2.63	3.87	4.75	4.30	5.33	7.82	10.35
2004	0.65	1.04	1.53	2.24	2.57	2.77	3.19	4.56	5.68	5.19	6.17	9.10

Table 7b. Beginning of the year weights-at-age calculated from commercial annual mean weights-at-age, as described in Lilly (1998). The values for 2005 are extrapolated as described in the text.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1960	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1961	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1962	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1963	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1964	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1965	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1966	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1967	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1968	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1969	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1970	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1971	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1972	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1973	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1974	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1975	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1976	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.88
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.48	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.51	0.79	1.19	1.64	2.13	2.79	3.62	3.79	4.03	4.89	6.38	9.12
1999	0.62	0.76	1.26	1.91	2.28	2.61	3.49	4.64	4.54	4.93	5.65	6.81
2000	0.48	0.79	1.12	1.80	2.52	2.67	2.98	4.25	5.90	5.53	5.82	6.89
2001	0.58	0.79	1.14	1.62	2.31	3.06	3.00	3.30	5.07	7.50	6.83	7.22
2002	0.44	0.84	1.25	1.71	2.12	2.83	3.84	3.53	3.66	5.82	8.75	7.77
2003	0.49	0.75	1.27	1.81	2.19	2.47	3.46	4.53	4.09	4.54	6.88	9.59
2004	0.50	0.84	1.22	1.88	2.33	2.55	2.90	4.20	5.19	4.72	5.73	8.43
2005	0.50	0.77	1.28	1.80	2.46	2.81	3.08	3.45	4.98	6.26	5.57	6.85

Table 8. Standardized gillnet (5.5 in mesh) and line-trawl annual catch rate-at-age indices estimated using data from sentinel fishery fixed sites. Catch rates are fish per net for gill nets and fish per 1000 hooks for line-trawl. The 1997 and 1998 cohorts are shaded.

Gill net Year/Age	3	4	5	6	7	8	9	10	Totals
1995	0.02	0.11	4.77	10.04	5.86	2.82	0.38	0.14	23.85
1996	0.02	0.26	2.58	11.89	9.80	2.81	0.81	0.07	28.22
1997	0.01	0.24	5.51	5.11	8.60	7.70	0.94	0.68	28.66
1998	0.00	0.04	0.88	6.03	2.92	2.14	1.34	0.31	13.68
1999	0.06	0.07	0.56	0.91	1.44	0.64	0.30	0.29	5.41
2000	0.01	0.03	0.28	0.67	0.64	0.86	0.28	0.10	2.91
2001	0.03	0.17	0.39	0.81	0.63	0.33	0.31	0.13	2.81
2002	0.00	0.04	0.55	0.91	0.87	0.37	0.18	0.19	3.15
2003	0.02	0.06	0.22	0.90	0.42	0.15	0.07	0.03	1.85

Linetrawl Year/Age	3	4	5	6	7	8	9	10	Totals
1995	10.33	19.36	62.18	86.45	22.56	17.12	3.67	1.79	223.46
1996	9.26	33.35	31.54	50.18	51.57	14.38	7.98	1.87	200.14
1997	6.45	27.12	26.99	18.06	16.97	23.98	2.35	1.79	123.71
1998	9.08	20.19	23.42	18.35	6.81	10.24	12.07	2.17	102.34
1999	6.13	16.91	21.77	15.64	7.40	5.71	4.23	1.69	79.48
2000	16.52	35.58	33.29	21.91	9.61	8.34	2.75	1.17	129.16
2001	20.13	30.72	21.77	12.24	7.15	4.39	2.47	0.79	99.66
2002	14.58	30.41	27.55	9.63	5.94	2.05	1.14	0.89	92.18
2003	2.82	34.59	36.43	18.50	8.02	3.34	1.19	0.67	105.56

Table 9. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Division 3Ps (1983-2004 shown) . Shaded cells are model estimates. See Fig. 11 for locations of strata.

																							Tel 351			Tel 522
			Vessel	AN	AN	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
			Trips	9	26	26	45	55+56	68	81	91	103	118	133	135	150-151	166-167	186-187	202-203	219-220	236-237	313-315	364-365	418-419	476-477	523+546
Depth			Sets	164	93	109	136	130	146	146	108	158	137	136	130	166	161	148	158	176	175	171	173	177	176	177
range			Mean Date	30-Apr	13-Apr	13-Mar	15-Mar	7-Mar	5-Feb	9-Feb	9-Feb	10-Feb	14-Feb	13-Feb	11-Apr	15-Apr	16-Apr	22-Apr	12-Apr-97	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr
(fathoms)	Strata		sq. mi.	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<30	314		974	2527	134	96	0	0	211	30	45	0	0	0	0	74	0	0	77	57	1729	1531	153	67	19	117
	320		1320	3424	3473	1089	262	248	363	853	0	620	20	0	0	0	0	545	303	1292	3546	5183	1543	478	1601	396
31-50	293	5	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	107	292	601	394	219	131	120	375
	308		112	627	801	1741	0	169	247	15	77	31	62	39	308	701	223	177	262	4175	2704	1829	1094	285	77	2265
	312		272	6086	374	8026	56	318	580	62	0	56	0	37	0	0	87	37	19	100	461	1235	636	112	150	56
	315		827	1536	1183	1983	2920	483	190	228	57	439	33	0	0	0	0	1387	38	5721	2428	1895	1040	228	49	395
	321		1189	2355	954	210	82	867	238	36	102	535	0	0	20	0	0	345	18	49	894	1161	55	98	82	16
	325		944	666	312	0	81	152	43	146	130	1068	455	14	0	0	0	103	108	16	752	2824	1526	65	16	1120
	326		166	99	0	50	0	69	80	0	34	69	0	46	0	0	194	11	0	11	52	109	57	0	0	0
	783	1	229	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf	nf	47	16	110	86	142	13	95	16
51-100	294	5	135	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	176	901	362	170	195	613	455	288
	297	5	152	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	408	209	1892	7000	450	450	42	244
	307		395	1943	380	4347	15450	3586	8803	5524	2717	797	869	353	2826	12769	1087	1645	1123	23490	5879	6991	5665	833	22912	9328
	311		317	7907	1090	14968	3183	16905	17236	1599	2369	1134	218	145	392	2562	116	654	371	1652	2169	2864	610	780	349	2733
	317		193	8266	27	8190	4898	3487	2695	2363	226	1978	531	0	159	0	465	1195	451	173	305	1487	637	1049	372	199
	319		984	16321	4828	338	9526	25403	17258	5888	8144	25764	2883	647	3023	150	575	11477	1889	15600	11839	9327	58696	34398	2149	26117
	322		1567	8936	2694	10297	11946	9140	5030	7760	3745	5758	81	0	0	431	0	554	234	260	713	1529	413	633	263	649
	323		696	3606	3878	6830	8866	10627	4040	2134	120	2011	16	0	0	0	0	82	24	32	158	1001	941	64	19	0
	324		494	8885	7203	38157	720	1087	2395	0	353	2633	163	0	0	544	85	91	272	160	361	442	85	306	391	85
	781	1	446	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	307	280	195	276	1058	716	1564	261	215	1052
	782	1	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	302	0	nf	63	38	38	315	76	227	50	63
101-150	295	5	209	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	168	465	976	615	978	144	187	72
	298	5	171	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	110	1861	46	3450	670	371	5399	976
	300	5	217	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	584	1579	641	896	791	746	1370	168
	306		363	2110	75	574	1971	3845	2422	1265	8273	982	1116	389	2659	1273	350	1106	816	771	708	4191	949	246	277	666
	309		296	937	122	2484	4622	2443	3461	1771	3766	3122	244	95	1853	244	421	8190	260	11980	215	142	2056	13172	484	109
	310		170	133	94	203	351	304	896	6443	3414	13423	175	82	748	405	386	421	1380	105	131	187	505	485	1391	12
	313		165	68	23	238	0	409	136	2054	908	6866	2962	11	238	68	1124	182	0	454	91	113	3564	125	567	10
	316		189	240	117	78	26	78	87	1586	20669	3081	104		147	182	182	26	65	104	23	13	26	117	273	69
	318		129	6	0	974	27	710	18	4924	648	8855	5900	5051	2103	0	95656	630	1881	53	0	231	44	71	11943	275
	779	1	422	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	248	0	0	0	39	0	73	26	29	15	19
	780	1	403	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	0	nf	35	18	0	40	0	0	0	0
151-200	296	5	71	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	632	4	375	107	1924	735	303	2627
	299	5	212	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	643	49	0	13	131	160	214	44
	705		195	9	0	563	791	255	644	94	107	134	161	80	939	528	1113	418	241	376	24	54	83	241	232	267
	706		476	13	0	1097	557	9835	851	49	98	49	445	109	327	327	442	393	172	327	87	49	49	82	246	120
	707		74	3	0	836	560	753	1919	122	557	2682	1323	1817	494	219	448	2912	353	102	9	0	293	3079	143	121
	715		128	158	44	3216	1638	643	3724	167	2509	20768	2386	309	1748	2249	414	4117	516	5874	484	751	3013	1615	960	102
	716		539	167	25	371	7656	2768	3470	704	593	1216	3979	463	204	519	578	1764	91	3089	2428	196	99	1333	952	74
201-300	708		126	0	0	2119	451	14317	14490	113	1410	537	1300	813	1621	15842	2808	208	388	1464	947	0	35	151	329	85
	711		593	20	0	33	8227	392	387	218	544	9395	503	176	0	41	20	77	44	16	0	783	80	49	96	29
	712		731	0	117	620	419	67	536	141	1931	1730	716	1098	302	369	322	101	60	201	50	98	117	67	345	60
	713		851	33	285	117	117	1463	368	843	20233	6951	1806	2819	234	1405	893	652	901	61	78	176	364	320	372	127
	714		1074	43	980	6701	835	396	905	4753	20966	32838	15431	12120	1440	2428	2996	750	2765	485	173	151	3781	1346	1678	230
301-400	709	2	147	0	0	0	0	nf	30	10	nf	40	nf	4556	1087	nf	101	0	nf	0	0	10	30	0	611	0
401-500	710	1	156	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	32	nf	nf	nf	nf	0	nf	nf	nf	nf	nf
501-600	776	1	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	777	1	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	778	1	166	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	Total	3		77,124	29,213	116,546	86,238	111,219	93,723	51,885	104,745	155,522	43,882	26,713	21,785	43,330	110,985	40,250	15,122	78,250	39,438	46,543	88,209	61,895	48,737	45,832
	Total	4		77,124	29,213	116,546	86,238	111,219	93,753	51,895	104,745	155,562	43,882	31,269	22,872	43,912	111,393	40,530	18,290	83,997	45,537	60,428	95,405	65,775	57,813	51,776
	upper			107,185	53,111	618,003	126,503	169,378	153,606	79,714	177,819	240,690	64,676	49,856	29,586	72,419	1,325,521	64,189	21,365	166,891	55,196	60,749	147,318	119,231	109,897	95,755
	t-value			2.12	3.18	12.71	2.26	2.45	3.18	3.18	2.78	2.57	2.45	3.18	2.31	2.78	12.71	2.45	2.31	3.182	2.23	2.2	2.36	2.78	3.18	2.306
	std	6		14,180	7,515	39,466	17,801	23,767	18,831	8,746	26,286	33,139	8,487	7,273	3,377	10,464	95,558	9,771	2,703	27,857	7,066	6,457	25,046	20,624	19,233	21,649

[1] These strata were added to the stratification scheme in 1994.

[2] Strata 709 was redrawn in 1994 and includes the area covered by strata 710 in previous surveys. All sets done in 710 prior to 1994 have been recoded to 709.

[3] For index strata 0-300 fathoms in the offshore and includes esitmates (shaded cells) for non-sampled strata .

[4] totals are for all strata fished .

[5] These strata were added to the stratification scheme in 1997.

[6] std's are for index strata and do not include estimates from non-sampled strata.

Table 10. Cod biomass estimates (t) from DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps during 1983-2004. Shaded cells are model estimates. See Fig. 11 for location of strata.

																					Tel 351			Tel 522
		Vessel	AN	AN	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
		Trips	9	26	26	45	55+56	68	81	91	103	118	133	135	150-151	166-167	186-187	202-203	219-220	236-237	313-315	364-365	418-419	476-477	523+546
Depth		Sets	164	93	109	136	130	146	146	108	158	137	136	130	166	161	148	158	176	175	171	173	177	176	177
range		Mean Dat	30-Apr	13-Apr	13-Mar	15-Mar	7-Mar	5-Feb	9-Feb	9-Feb	10-Feb	14-Feb	13-Feb	11-Apr	15-Apr	16-Apr	22-Apr	12-Apr	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr
(fathoms)	Strata	sq. mi.	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<30	314	974	15936	733	59	0	0	104	20	240	0	0	0	0	212	0	0	32	8	595	829	46	5	0	10
	320	1320	8914	8700	6971	464	700	2299	1883	0	267	52	0	0	0	0	155	114	7766	6287	6761	601	932	2707	395
31-50	293 [5]	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	17	19	27	45	26	9	29	18
	308	112	1371	1157	1809	0	27	17	8	18	10	18	8	96	235	41	35	93	1461	1572	1088	184	48	12	1949
	312	272	1179	1080	3691	110	102	25	14	0	23	0	28	0	0	13	4	13	8	226	640	93	10	9	18
	315	827	4143	2686	661	4606	1211	1992	2453	129	614	38	0	0	0	0	869	14	20072	3771	3092	491	822	17	335
	321	1189	4121	1941	173	516	410	2201	506	24	146	0	0	37	0	0	8	2	0	1855	4582	2	5	2	2
	325	944	671	915	0	68	255	53	36	84	246	42	194	0	0	0	173	10	0	418	1307	340	10	3	568
	326	166	497	0	83	0	36	59	0	14	45	0	13	0	0	14	0	0	0	8	478	25	0	0	0
	783 [1]	229	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf	nf	0	0	14	16	6	0	2	1
51-100	294 [5]	135	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	24	40	19	7	26	47	22	14
	297 [5]	152	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	39	22	1697	2339	108	38	5	42
	307	395	2017	1441	8454	19930	4938	21706	6118	1033	171	126	70	1677	8984	250	633	332	16164	3784	5162	1578	197	26828	6055
	311	317	5706	1711	10086	703	8576	2484	755	265	112	25	15	100	593	35	64	51	169	3342	1661	26	145	13	182
	317	193	7095	62	15799	3571	1867	352	496	18	756	73	0	244	0	40	73	62	196	36	259	331	88	59	78
	319	984	6983	6989	1861	16211	18530	23773	14172	2702	2436	382	82	507	32	208	12785	287	28144	18019	8121	51570	38958	755	67844
	322	1567	9141	3904	2597	4571	3226	875	492	347	426	32	0	0	38	0	177	118	13	117	1893	193	32	26	38
	323	696	1730	3935	2862	5790	21015	514	562	28	160	41	0	0	0	0	89	15	112	227	643	305	7	1	0
	324	494	1790	787	24660	521	384	455	0	38	217	33	0	0	7	18	3	11	8	252	25	7	14	13	8
	781 [1]	446	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	113	40	22	16	64	49	36	13	17	61
	782 [1]	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	8	0	nf	2	7	1	7	0	27	1	3
101-150	295 [5]	209	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	24	139	45	61	124	8	26	4
	298 [5]	171	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	42	2608	148	2632	202	75	2735	488
	300 [5]	217	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	147	802	650	307	153	124	175	103
	306	363	2167	448	974	2479	3315	4713	605	2786	149	464	114	1820	950	191	194	312	618	553	5123	543	67	51	960
	309	296	1690	292	3305	5739	4513	5255	3154	3062	1166	50	15	2021	359	272	4922	87	9788	320	303	1118	15666	193	56
	310	170	283	209	503	604	383	862	812	938	880	40	13	378	374	228	124	206	72	145	330	488	209	263	4
	313	165	158	242	481	0	563	155	1390	305	472	280	12	152	43	1279	259	0	481	162	97	18231	122	807	4
	316	189	492	262	151	113	144	59	3838	13956	294	43		144	270	42	38	40	138	43	21	63	78	146	103
	318	129	25	0	2436	146	1359	196	17756	668	2339	1600	1709	1616	0	129689	1075	404	88	0	592	28	43	12705	506
	779 [1]	422	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	16	0	0	0	10	0	4	1	1	2	1
	780 [1]	403	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	0	nf	3	1	0	6	0	0	0	0
151-200	296 [5]	71	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	175	1	102	20	341	118	36	900
	299 [5]	212	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	282	231	0	1	411	655	315	35
	705	195	55	0	904	1063	273	1053	52	235	16	67	47	1143	652	1927	663	476	345	25	20	71	244	434	288
	706	476	72	0	3010	907	15334	1927	189	153	182	435	76	251	277	385	575	379	266	68	63	26	40	431	147
	707	74	11	0	1672	2779	1821	6883	411	459	1365	767	914	648	24	591	5408	72	121	21	0	360	3726	187	329
	715	128	589	99	6482	2738	1315	7420	345	1061	17037	1928	347	1743	2802	575	3807	233	6849	1127	1240	5599	2525	1188	114
	716	539	311	24	710	7731	3291	4722	779	1112	386	952	64	226	676	777	1457	44	1772	4106	229	92	554	735	75
201-300	708	126	0	0	4446	690	18385	42342	123	1220	1072	2419	368	1081	10036	5511	247	629	4389	1455	0	54	139	354	76
	711	593	26	0	62	10625	569	841	745	496	23174	360	290	0	30	27	82	43	11	0	1242	75	35	41	22
	712	731	0	410	1267	644	262	1042	207	1419	1523	1020	1305	243	819	372	118	151	267	25	64	65	25	264	39
	713	851	61	1023	154	544	2469	567	1096	30722	6295	2025	3263	374	1700	1545	1481	1101	48	143	123	273	235	261	172
	714	1074	265	3788	16731	2748	473	1476	7310	30866	32946	18902	12987	1739	2528	4161	924	3471	725	155	123	4113	1212	2306	183
301-400	709 [2]	147	0	0	0	0	nf	118	52	nf	27	nf	2457	736	nf	121	0	nf	0	0	5	59	0	383	0
401-500	710 [1]	156	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	19	nf	nf	nf	nf	0	nf	nf	nf	nf	nf
501-600	776 [1]	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	777 [1]	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	778 [1]	166	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	Total [3]		77,499	42,838	123,054	96,611	115,746	136,422	66,327	94,398	94,925	32,214	21,934	16,240	31,641	148,191	36,442	8,802	100,100	48,857	46,111	86,991	66,193	50,811	80,560
	Total [4]		77,499	42,838	123,054	96,611	115,746	136,540	66,379	94,398	94,952	32,214	24,391	16,976	31,684	148,425	36,482	9,579	103,996	51,624	51,610	88,484	67,308	54,559	82,230
	upper		112,007	50,251	434,252	140,924	185,889	679,921	101,515	170,365	170,491	45,569	22,297	22,297	54,348	1,791,842	54,585	14,193	160,874	71,356	60,876	148,519	134,681	127,771	218,043
	t-value		2.20	2.06	12.71	2.26	2.45	12.71	2.31	2.31	2.57	2.26	2.13	2.31	2.78	12.71	2.23	2.36	2.201	2.13	2.15	2.57	2.78	3.18	2.365
	std [6]		15,678	3,599	24,492	19,608	28,630	42,762	15,259	32,943	29,403	5,909	170	2,622	8,168	129,320	8,143	2,284	27,612	10,563	6,867	23,941	24,636	24,201	58,132

[1] These strata were added to the stratification scheme in 1994.

[2] Strata 709 was redrawn in 1994 and includes the area covered by strata 710 in previous surveys. All sets done in 710 prior to 1994 have been recoded to 709.

[3] For index strata 0-300 fathoms in the offshore and includes esitmates (shaded cells) for non-sampled strata .

[4] totals are for all strata fished .

[5] These strata were added to the stratification scheme in 1997.

[6] std's are for index strata and do not include estimates from non-sampled strata.

Table 11A. Mean numbers per tow at age (1-20 only) in Campelen units for the Canadian research vessel bottom trawl survey of NAFO Subdiv. 3Ps. Data Data are adjusted for missing strata. There were two surveys in 1993 (February and April). The 1989, 1997, and 1998 cohorts are shaded.

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993.1 (Feb)	1993.3 (Apr)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Age
1	6.42	0.30	0.38	0.20	1.09	0.42	0.49	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.90	0.22	0.52	1.24	1.25	0.57	0.58	0.52	0.20	1
2	10.01	5.40	7.74	6.62	8.48	9.13	6.50	1.48	27.69	1.80	0.00	0.00	1.63	0.31	1.08	1.53	0.97	2.54	3.33	2.26	1.10	1.46	1.90	2
3	6.52	2.33	14.88	5.65	5.67	5.93	4.66	9.82	5.03	6.95	1.83	1.99	1.46	1.16	3.67	2.33	6.79	2.55	5.36	12.41	3.90	1.78	2.07	3
4	1.14	1.55	12.57	6.48	4.97	2.96	3.17	14.49	10.00	2.11	4.03	4.04	4.31	1.67	3.62	1.04	8.42	2.38	3.10	12.29	8.28	4.08	1.71	4
5	3.72	0.63	9.96	7.95	13.82	2.84	1.51	10.89	11.24	4.15	0.71	1.49	6.10	13.08	1.32	0.50	5.60	2.58	2.17	4.36	5.85	6.55	2.08	5
6	1.62	2.11	3.28	6.33	8.31	6.50	1.16	5.67	5.75	2.03	2.96	1.35	1.73	19.65	2.69	0.28	3.99	2.34	1.82	2.04	3.04	3.94	4.05	6
7	0.48	0.77	2.66	2.13	3.35	5.84	2.15	3.84	2.84	1.03	0.68	0.47	1.62	4.40	2.91	0.30	1.96	1.72	1.20	1.26	2.04	1.50	4.24	7
8	0.89	0.37	0.79	1.47	1.29	3.65	1.21	3.14	1.58	0.53	0.33	0.10	0.50	5.75	0.54	0.24	2.50	0.44	0.89	0.77	0.99	0.72	1.26	8
9	1.61	0.46	0.48	0.84	0.69	1.49	0.67	1.15	1.19	0.26	0.13	0.04	0.08	2.19	0.46	0.14	2.79	0.79	0.35	0.71	0.53	0.33	0.81	9
10	0.75	0.71	0.42	0.29	0.28	0.84	0.37	0.71	0.74	0.24	0.09	0.03	0.04	0.25	0.09	0.05	0.43	0.60	0.31	0.38	0.37	0.18	0.67	10
11	0.36	0.18	0.42	0.24	0.23	0.74	0.41	0.32	0.56	0.08	0.11	0.04	0.03	0.20	0.09	0.02	0.30	0.09	0.53	0.50	0.08	0.19	0.79	11
12	0.14	0.15	0.49	0.29	0.16	0.35	0.13	0.16	0.22	0.04	0.03	0.01	0.02	0.01	0.02	0.00	0.06	0.02	0.12	0.94	0.12	0.05	0.15	12
13	0.06	0.06	0.21	0.17	0.17	0.16	0.11	0.12	0.11	0.01	0.04	0.00	0.01	0.07	0.00	0.00	0.03	0.02	0.00	0.12	0.19	0.11	0.10	13
14	0.05	0.03	0.12	0.10	0.16	0.15	0.05	0.09	0.07	0.01	0.01	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.01	0.06	0.01	0.01	0.02	14
15	0.04	0.00	0.03	0.06	0.06	0.09	0.09	0.01	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.07	15
16	0.04	0.04	0.03	0.04	0.04	0.10	0.06	0.05	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	16
17	0.01	0.00	0.05	0.02	0.05	0.01	0.04	0.01	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17
18	0.02	0.03	0.02	0.00	0.04	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18
19	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19
20	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20

Table 11B. Mean numbers per tow at age (1-15 only) in Campelen units for the Canadian research vessel bottom trawl survey of the western (Burgeo area) and eastern portions of NAFO Subdiv. 3Ps. Data are adjusted for missing strata. There were two surveys in 1993. The 1989, 1997, and 1998 cohorts are shaded.

Western 3Ps (Burgeo area)

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Age
1	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.41	0.04	0.16	0.08	0.00	1
2	0.00	0.00	0.49	1.37	0.60	0.42	1.14	0.71	6.05	0.83	1.94	2.35	2
3	3.37	4.84	2.60	10.48	2.94	26.74	4.50	4.31	12.35	6.61	4.25	8.60	3
4	8.04	9.73	2.75	12.50	4.73	25.99	6.24	6.56	6.32	9.91	16.66	8.37	4
5	6.44	15.76	2.26	4.87	1.83	28.22	10.27	6.52	4.07	7.77	15.90	12.56	5
6	6.94	8.60	3.03	5.84	1.66	18.46	3.61	7.81	4.35	8.86	14.88	4.86	6
7	1.73	6.26	1.32	6.11	1.02	13.65	3.90	6.20	4.20	6.97	5.65	3.69	7
8	0.53	2.89	2.07	1.17	0.92	6.28	0.50	1.95	1.73	3.09	3.06	1.02	8
9	0.21	0.51	0.58	1.50	0.72	2.43	0.78	0.95	1.22	1.37	1.95	0.94	9
10	0.09	0.16	0.08	0.03	0.11	0.40	0.20	0.08	0.96	0.92	1.23	0.65	10
11	0.15	0.08	0.06	0.17	0.05	2.10	0.23	0.00	0.21	0.32	1.89	0.67	11
12	0.00	0.06	0.05	0.00	0.00	0.00	0.38	0.15	0.10	0.15	0.26	0.21	12
13	0.01	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.03	0.11	0.58	0.05	13
14	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	14
15	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15

Eastern 3Ps

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993F	1993A	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Age
1	7.28	0.32	0.37	0.22	1.26	0.39	0.56	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.98	0.35	0.60	1.67	1.50	0.68	0.69	0.55	0.26	1
2	11.41	5.77	7.50	5.76	9.46	10.13	6.76	1.51	30.70	1.92	0.00	0.00	1.81	0.24	0.98	2.32	0.82	2.68	4.25	1.78	1.25	1.12	2.04	2
3	6.63	2.53	13.83	5.79	5.94	6.44	4.24	5.14	4.40	5.32	2.19	1.73	0.73	0.92	1.96	1.70	1.84	1.94	5.26	14.31	3.04	0.72	1.03	3
4	1.08	1.59	12.11	4.25	5.14	2.20	1.98	10.97	3.01	0.79	4.75	2.60	2.92	1.19	1.89	0.48	2.04	1.00	2.07	12.75	7.93	1.86	0.66	4
5	3.24	0.50	7.93	6.18	13.45	1.75	0.74	6.71	4.50	1.14	0.48	0.60	3.72	15.65	0.62	0.17	1.68	1.81	0.82	3.71	5.30	4.47	0.80	5
6	1.36	2.00	2.89	3.93	8.32	4.31	0.51	3.02	2.82	0.62	1.16	0.49	0.65	22.81	1.79	0.09	1.08	2.00	0.88	1.23	2.00	1.66	4.56	6
7	0.42	0.52	1.76	1.48	2.74	4.41	1.45	1.75	1.24	0.33	0.12	0.28	0.73	2.93	2.38	0.14	0.64	1.34	0.52	0.63	1.13	0.20	5.87	7
8	0.93	0.38	0.45	0.95	1.08	3.02	1.07	2.26	1.11	0.12	0.08	0.05	0.17	3.60	0.35	0.11	2.50	0.35	0.62	0.52	0.61	0.05	1.67	8
9	1.78	0.43	0.37	0.40	0.53	1.24	0.54	0.55	0.80	0.04	0.05	0.01	0.01	2.27	0.16	0.04	2.91	0.83	0.26	0.59	0.35	0.09	0.17	9
10	0.82	0.78	0.22	0.15	0.16	0.57	0.30	0.29	0.96	0.06	0.01	0.00	0.03	0.29	0.10	0.02	0.27	0.69	0.39	0.13	0.26	0.01	0.39	10
11	0.42	0.17	0.38	0.20	0.14	0.45	0.32	0.18	0.42	0.01	0.01	0.01	0.01	0.23	0.07	0.01	0.07	0.04	0.64	0.54	0.01	0.00	0.23	11
12	0.15	0.15	0.39	0.29	0.15	0.16	0.11	0.04	0.26	0.01	0.03	0.00	0.01	0.00	0.02	0.00	0.04	0.02	0.10	1.21	0.10	0.01	0.03	12
13	0.06	0.06	0.20	0.14	0.23	0.08	0.10	0.03	0.12	0.00	0.01	0.00	0.01	0.07	0.00	0.00	0.00	0.03	0.00	0.09	0.16	0.02	0.00	13
14	0.07	0.02	0.08	0.07	0.21	0.18	0.05	0.05	0.10	0.00	0.02	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.06	0.02	0.01	0.03	14
15	0.05	0.00	0.03	0.02	0.09	0.09	0.10	0.00	0.03	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.01	0.09	15

Table 12. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdivision 3Ps in winter-spring 1972-2004.

Age	1972	1973	1974	1975	1976	1977
1	14.0	11.6	12.2	12.7	13.2	11.0
2	23.2	22.6	21.7	23.1	22.8	20.3
3	31.5	31.7	33.4	35.3	35.4	31.7
4	41.0	39.3	43.1	44.4	48.2	43.2
5	51.9	50.1	50.8	55.4	57.4	55.6
6	58.5	56.6	55.6	61.0	64.6	63.5
7	63.0	62.1	63.6	66.5	68.1	73.9
8	74.1	66.1	71.2	74.3	71.6	75.2
9	81.8	68.4	69.3	74.2	78.5	88.0
10	90.4	81.1	79.0	75.2	81.6	83.8
11	95.0	88.2	93.3	76.2	94.8	77.6
12	88.3	87.1	95.6	107.2	110.5	87.9

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1		10.8	14.6	14.6	13.2	10.3	12.0		11.0	10.7	9.2	12.0		9.5				
2	19.6	22.1	21.0	22.4	22.0	20.2	19.2	17.9	18.7	19.9	19.7	19.2	20.0	19.2	20.7		19.1	21.2
3	28.0	32.2	28.1	32.4	33.3	31.2	30.6	29.0	26.8	29.5	29.0	30.1	29.9	29.5	30.5	30.9	32.3	30.1
4	35.9	42.6	42.9	44.4	44.9	43.0	42.1	40.3	40.3	39.4	40.8	41.6	40.0	38.5	40.9	41.1	39.2	41.4
5	48.0	47.4	50.6	50.6	53.4	52.6	51.8	50.9	48.6	48.1	47.5	47.9	48.0	46.9	47.1	48.0	48.0	50.3
6	59.0	56.3	58.2	58.6	59.3	57.8	60.6	60.0	55.5	53.9	56.2	56.0	53.7	53.3	55.1	52.6	50.2	56.4
7	65.6	70.5	71.3	63.2	66.4	65.4	66.2	66.3	62.1	61.1	61.9	63.9	56.6	57.4	61.1	62.2	53.6	58.2
8	70.1	76.8	84.8	69.9	70.1	71.4	70.6	74.0	72.1	67.3	66.7	71.8	62.2	62.7	62.4	70.3	59.1	57.9
9	84.1	85.8	94.9	72.6	75.6	73.3	75.6	74.3	76.4	77.8	74.6	75.9	70.1	68.1	66.6	77.1	68.0	63.0
10	86.3	95.3	98.0	83.2	90.6	79.4	78.9	79.3	82.6	85.4	79.7	84.4	76.1	73.7	73.4	80.5	88.0	79.8
11	88.3	94.3	97.2	97.6	98.7	89.6	84.1	89.1	93.3	83.1	79.7	88.5	79.4	73.8	83.6	96.0	79.3	81.2
12	79.3	116.0	106.6	90.1	104.6	94.1	98.2	93.0	93.8	89.9	87.5	96.5	88.7	77.2	81.8	106.0	90.3	83.6

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	12.6	12.7	10.6	12.0	13.3	10.6	12.0	10.7	14.0
2	20.6	24.1	22.3	22.2	22.0	21.9	22.0	23.7	20.1
3	30.0	31.7	32.5	31.4	31.7	33.3	31.7	31.8	33.7
4	38.6	40.8	42.5	42.9	40.7	40.7	42.1	42.8	38.9
5	44.0	47.9	48.7	51.2	48.6	47.3	50.5	51.6	47.6
6	52.9	51.5	53.2	58.9	54.6	51.8	54.9	55.3	60.9
7	60.9	60.6	57.5	61.7	60.3	57.3	55.2	58.6	66.0
8	61.1	65.2	67.0	66.2	65.3	68.4	67.2	58.5	69.1
9	63.3	66.9	77.2	77.6	67.8	78.2	74.5	70.5	67.2
10	76.7	67.3	77.2	86.5	81.1	75.8	79.7	72.2	69.7
11	74.7	82.5	64.3	76.9	92.5	89.0	73.4	65.5	73.1
12	86.1		78.0	109.0	89.1	96.2	86.0	86.4	73.2

Table 13. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1978-2004. Entries in boxes are based on fewer than 5 aged fish.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1		0.011	0.027		0.040	0.010								0.012				
2	0.057	0.070	0.068	0.060	0.103	0.068	0.073		0.045		0.057	0.060	0.062	0.054	0.064		0.053	0.062
3	0.177	0.258	0.147	0.265	0.420	0.232	0.268	0.214	0.168	0.248	0.193	0.239	0.208	0.217	0.230	0.220	0.254	0.212
4	0.396	0.633	0.618	0.704	0.829	0.718	0.632	0.505	0.462	0.538	0.582	0.613	0.538	0.465	0.574	0.550	0.460	0.540
5	0.979	0.879	1.005	1.079	1.299	1.301	1.212	1.039	0.905	0.950	0.915	0.901	0.954	0.865	0.865	0.894	0.898	1.017
6	1.735	1.565	1.634	1.673	1.539	1.652	1.853	1.566	1.332	1.273	1.494	1.331	1.348	1.324	1.461	1.150	1.044	1.514
7	2.368	3.029	3.457	2.081	2.555	1.861	2.790	2.279	2.384	1.885	2.214	2.361	1.621	1.702	2.032	1.987	1.236	1.687
8	3.192	5.666	5.791	3.496	2.612	3.555	3.828	3.206	3.337	2.297	2.423	3.778	2.185	2.346	2.258	3.003	1.814	1.585
9	4.676	5.798	8.459	4.890	4.007	4.042	4.225	3.143	5.023	4.483	3.943	4.505	3.060	3.087	2.859	4.281	2.891	2.209
10	5.711	7.108	8.333	7.591	6.441	4.896	5.029	3.760	4.654	6.344	4.839	5.820	4.225	3.956	3.983	4.470	6.450	4.767
11	4.901	9.030	9.085	8.374	8.885	8.848	7.866		6.633	6.616	4.262	8.285	4.934	4.050	5.796	8.673	4.470	5.446
12	5.760		10.158	11.463	13.068	10.270	9.818	3.970	8.867	5.945	9.103	9.061	7.365	4.906	5.240	13.200	6.748	5.544

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.018	0.016	0.011	0.014	0.018	0.012	0.015	0.014	0.023
2	0.072	0.108	0.091	0.095	0.087	0.086	0.087	0.108	0.070
3	0.218	0.257	0.282	0.286	0.272	0.293	0.258	0.266	0.324
4	0.461	0.552	0.659	0.646	0.562	0.545	0.595	0.638	0.483
5	0.673	0.878	0.941	1.130	0.953	0.819	1.031	1.130	0.868
6	1.283	1.076	1.274	1.709	1.333	1.204	1.367	1.434	1.951
7	2.009	1.904	1.640	1.992	1.902	1.668	1.357	1.780	2.478
8	2.084	2.608	2.791	2.549	2.376	2.999	2.839	1.715	2.991
9	2.136	2.867	4.660	4.565	2.904	4.453	4.027	2.952	2.767
10	4.464	3.083	4.441	6.567	5.437	4.402	4.844	3.926	3.317
11	3.897	5.456	2.528	4.265	8.351	6.949	3.576	2.470	3.906
12	6.793		4.190	12.388	6.780	8.805	6.031	5.988	4.1973

Table 14. Mean gutted condition-at-age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2004. Boxed entries are based on fewer than 5 aged fish. Values for 2001 have been corrected from Brattey et al. (2001).

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1																		
2	0.702	0.629	0.595	0.599	0.660	0.632	0.651		0.699		0.644	0.681	0.623	0.641	0.598		0.627	0.630
3	0.745	0.678	0.620	0.718	0.731	0.742	0.734	0.706	0.698	0.736	0.713	0.725	0.680	0.706	0.711	0.657	0.675	0.687
4	0.733	0.715	0.680	0.748	0.740	0.777	0.735	0.704	0.704	0.725	0.739	0.739	0.726	0.710	0.732	0.711	0.677	0.690
5	0.753	0.702	0.703	0.724	0.722	0.766	0.703	0.680	0.733	0.735	0.731	0.734	0.744	0.720	0.716	0.700	0.705	0.702
6	0.730	0.712	0.709	0.745	0.676	0.794	0.711	0.714	0.709	0.717	0.731	0.741	0.743	0.746	0.733	0.663	0.680	0.708
7	0.744	0.699	0.724	0.729	0.699	0.737	0.728	0.739	0.721	0.735	0.736	0.748	0.735	0.741	0.735	0.677	0.660	0.703
8	0.716	0.775	0.734	0.763	0.690	0.725	0.726	0.714	0.717	0.720	0.736	0.780	0.726	0.738	0.727	0.698	0.676	0.665
9	0.737	0.749	0.765	0.748	0.731	0.744	0.730	0.733	0.676	0.768	0.777	0.793	0.735	0.753	0.738	0.758	0.687	0.701
10	0.793	0.803	0.715	0.810	0.751	0.793	0.741	0.740	0.719	0.770	0.789	0.834	0.764	0.777	0.732	0.684	0.732	0.725
11	0.681	0.648	0.784	0.790	0.758	0.819	0.808		0.798	0.779	0.783	0.827	0.794	0.765	0.766	0.786	0.691	0.750
12	0.725		0.759	0.843	0.833	0.865	0.834	0.681	0.789	0.774	0.813	0.852	0.793	0.794	0.744	0.852	0.717	0.753

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.754	0.727	0.898	0.673	0.594	0.963	0.638	0.876	0.684
2	0.697	0.674	0.660	0.675	0.666	0.665	0.680	0.671	0.675
3	0.706	0.717	0.699	0.704	0.696	0.684	0.694	0.700	0.716
4	0.709	0.725	0.720	0.697	0.707	0.686	0.688	0.702	0.707
5	0.695	0.702	0.704	0.694	0.688	0.680	0.676	0.703	0.677
6	0.713	0.683	0.680	0.688	0.677	0.722	0.690	0.697	0.705
7	0.715	0.693	0.689	0.690	0.674	0.659	0.666	0.701	0.705
8	0.722	0.714	0.725	0.686	0.674	0.699	0.712	0.674	0.715
9	0.671	0.713	0.757	0.722	0.698	0.702	0.728	0.674	0.720
10	0.758	0.751	0.742	0.762	0.754	0.695	0.740	0.649	0.730
11	0.725	0.785	0.748	0.722	0.784	0.732	0.669	0.669	0.710
12	0.760		0.784	0.737	0.712	0.773	0.734	0.712	0.734

Table 15. Mean liver index at age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2004. Boxed entries are based on fewer than 5 aged fish. Values for 2001 have been corrected from Brattey et al. (2001).

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1																		
2	0.0175	0.0142	0.0150	0.0118	0.0229	0.0247	0.0120	0.0236	0.0230	0.0304	0.0250	0.0279	0.0292	0.0250	0.0301		0.0304	0.0139
3	0.0223	0.0160	0.0114	0.0146	0.0244	0.0280	0.0167	0.0168	0.0233	0.0233	0.0227	0.0216	0.0213	0.0213	0.0200	0.0106	0.0144	0.0111
4	0.0203	0.0181	0.0143	0.0188	0.0228	0.0323	0.0179	0.0175	0.0196	0.0225	0.0275	0.0266	0.0293	0.0280	0.0242	0.0154	0.0138	0.0131
5	0.0227	0.0194	0.0189	0.0169	0.0230	0.0275	0.0142	0.0176	0.0214	0.0240	0.0281	0.0269	0.0335	0.0287	0.0315	0.0180	0.0197	0.0209
6	0.0253	0.0218	0.0204	0.0194	0.0163	0.0348	0.0144	0.0217	0.0230	0.0241	0.0280	0.0300	0.0357	0.0309	0.0309	0.0187	0.0221	0.0201
7	0.0256	0.0293	0.0262	0.0213	0.0207	0.0277	0.0195	0.0217	0.0237	0.0273	0.0279	0.0303	0.0376	0.0362	0.0263	0.0184	0.0170	0.0211
8	0.0323	0.0359	0.0370	0.0322	0.0203	0.0303	0.0191	0.0233	0.0268	0.0291	0.0312	0.0341	0.0334	0.0337	0.0368	0.0206	0.0211	0.0179
9	0.0284	0.0319	0.0381	0.0418	0.0225	0.0326	0.0188	0.0268	0.0303	0.0362	0.0357	0.0412	0.0349	0.0386	0.0400	0.0280	0.0208	0.0189
10	0.0326	0.0362	0.0328	0.0470	0.0258	0.0327	0.0328	0.0301	0.0383	0.0462	0.0439	0.0432	0.0411	0.0410	0.0379	0.0182	0.0423	0.0265
11	0.0256	0.0276	0.0381	0.0277	0.0356	0.0445	0.0330	0.0405	0.0435	0.0404	0.0495	0.0519	0.0471	0.0419	0.0473	0.0346	0.0232	0.0343
12	0.0379		0.0385	0.0415	0.0539	0.0462	0.0451	0.0435	0.0463	0.0482	0.0545	0.0689	0.0477	0.0373	0.0376	0.0379	0.0326	0.0247

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
1									
2	0.0252	0.0244	0.0247	0.0239	0.0241	0.0231	0.0235	0.0242	0.0242
3	0.0160	0.0208	0.0165	0.0205	0.0181	0.0145	0.0193	0.0214	0.0188
4	0.0161	0.0199	0.0206	0.0170	0.0152	0.0163	0.0155	0.0199	0.0156
5	0.0168	0.0201	0.0216	0.0167	0.0193	0.0158	0.0176	0.0210	0.0176
6	0.0201	0.0183	0.0249	0.0168	0.0191	0.0207	0.0203	0.0231	0.0259
7	0.0219	0.0230	0.0227	0.0210	0.0210	0.0171	0.0172	0.0265	0.0241
8	0.0231	0.0240	0.0346	0.0197	0.0222	0.0228	0.0198	0.0197	0.0217
9	0.0194	0.0273	0.0407	0.0294	0.0235	0.0266	0.0242	0.0310	0.0204
10	0.0303	0.0379	0.0424	0.0388	0.0342	0.0262	0.0271	0.0228	0.0222
11	0.0314	0.0396	0.0271	0.0234	0.0385	0.0288	0.0110	0.0225	0.0261
12	0.0202		0.0284	0.0260	0.0298	0.0345	0.0259	0.0334	0.0208

Table 16. Parameter estimates and standard errors (SE) for a probit model fitted by cohort to observed proportions mature at age for female cod from NAFO Subdiv. 3Ps based on sampling of surveys conducted during 1959-2004 (nf=no significant model fit). Estimates are given only for cohorts with a significant (*P* <0.05) slope and intercept term.

Cohort	slope	slope_SE	intercept	intercept_se
1954	1.109	0.294	-8.170	2.444
1955	1.506	0.224	-10.263	1.612
1956	1.317	0.321	-9.459	2.222
1957	1.460	0.370	-10.325	2.353
1958	2.393	0.585	-16.452	3.620
1959	2.111	0.536	-13.020	2.936
1960	1.674	0.299	-10.668	1.758
1961	1.864	0.355	-11.472	2.067
1962	1.714	0.290	-10.512	1.704
1963	nf	nf	nf	nf
1964	1.927	0.241	-12.718	1.567
1965	2.419	0.598	-16.424	4.239
1966	1.549	0.240	-10.061	1.602
1967	1.688	0.378	-10.084	2.254
1968	2.140	0.289	-13.163	1.787
1969	1.683	0.304	-10.367	1.844
1970	1.526	0.231	-8.856	1.314
1971	1.312	0.140	-7.841	0.835
1972	1.412	0.145	-8.908	0.885
1973	1.452	0.167	-9.355	1.032
1974	2.004	0.197	-13.154	1.294
1975	1.785	0.217	-11.164	1.376
1976	1.355	0.206	-8.599	1.251
1977	2.507	0.350	-15.364	2.173
1978	1.792	0.168	-10.732	1.020
1979	1.030	0.114	-6.448	0.767
1980	1.427	0.141	-9.413	0.913
1981	1.743	0.178	-11.987	1.185
1982	2.009	0.206	-13.306	1.350
1983	1.894	0.261	-11.890	1.604
1984	2.232	0.298	-13.417	1.804
1985	2.699	0.373	-16.034	2.201
1986	2.583	0.293	-14.067	1.593
1987	2.253	0.223	-11.923	1.235
1988	2.773	0.411	-14.021	2.167
1989	1.885	0.158	-9.784	0.811
1990	1.789	0.190	-9.210	0.958
1991	2.487	0.497	-13.144	2.562
1992	2.602	0.390	-13.001	1.911
1993	1.895	1.296	-9.870	1.296
1994	1.601	0.197	-8.147	1.009
1995	1.652	0.219	-8.770	1.125
1996	1.736	0.243	-9.321	1.268
1997	3.079	0.457	-14.842	2.177
1998	2.838	0.394	-13.496	1.885
1999	3.482	0.740	-16.532	3.579

Table 17. Estimated proportions mature for female cod from NAFO Subdiv. 3Ps from DFO surveys from 1978 to 2004 projected forward to 2010. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age. Darkly shaded cells are averages of the three closest cohorts; boxed cells are the average of estimates for the adjacent cohorts. Lightly shaded cells are 1997 and 1998 cohorts.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.0009	0.0015	0.0050	0.0175	0.0607	0.1936	0.4697	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1956	0.0002	0.0026	0.0050	0.0175	0.0607	0.1936	0.4697	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1957	0.0003	0.0007	0.0078	0.0175	0.0607	0.1936	0.4697	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1958	0.0001	0.0011	0.0032	0.0233	0.0607	0.1936	0.4697	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1959	0.0000	0.0006	0.0040	0.0142	0.0675	0.1936	0.4697	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1960	0.0000	0.0000	0.0026	0.0149	0.0611	0.1801	0.4697	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1961	0.0001	0.0002	0.0001	0.0112	0.0535	0.2267	0.3996	0.7570	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1962	0.0001	0.0007	0.0012	0.0010	0.0463	0.1741	0.5693	0.6686	0.9133	0.9723	0.9914	0.9973	0.9992	0.9997
1963	0.0002	0.0004	0.0035	0.0102	0.0111	0.1729	0.4403	0.8563	0.8595	0.9723	0.9914	0.9973	0.9992	0.9997
1964	0.0001	0.0008	0.0028	0.0185	0.0783	0.1097	0.4738	0.7459	0.9641	0.9488	0.9914	0.9973	0.9992	0.9997
1965	0.0000	0.0005	0.0046	0.0177	0.0913	0.4124	0.5742	0.7949	0.9164	0.9918	0.9825	0.9973	0.9992	0.9997
1966	0.0000	0.0001	0.0028	0.0252	0.1041	0.3489	0.8528	0.9366	0.9435	0.9761	0.9982	0.9942	0.9992	0.9997
1967	0.0002	0.0000	0.0010	0.0159	0.1254	0.4285	0.7408	0.9795	0.9938	0.9863	0.9935	0.9996	0.9981	0.9997
1968	0.0002	0.0009	0.0001	0.0066	0.0846	0.4432	0.8286	0.9384	0.9975	0.9994	0.9968	0.9982	0.9999	0.9994
1969	0.0000	0.0012	0.0044	0.0012	0.0438	0.3413	0.8155	0.9689	0.9878	0.9997	0.9999	0.9993	0.9995	1.0000
1970	0.0002	0.0001	0.0066	0.0205	0.0130	0.2394	0.7496	0.9608	0.9951	0.9977	1.0000	1.0000	0.9998	0.9999
1971	0.0007	0.0009	0.0012	0.0345	0.0898	0.1290	0.6837	0.9489	0.9927	0.9992	0.9996	1.0000	1.0000	1.0000
1972	0.0015	0.0030	0.0049	0.0099	0.1619	0.3171	0.6246	0.9369	0.9915	0.9987	0.9999	0.9999	1.0000	1.0000
1973	0.0006	0.0054	0.0137	0.0257	0.0785	0.5110	0.6861	0.9492	0.9903	0.9986	0.9998	1.0000	1.0000	1.0000
1974	0.0004	0.0023	0.0197	0.0600	0.1243	0.4199	0.8497	0.9114	0.9953	0.9986	0.9998	1.0000	1.0000	1.0000
1975	0.0000	0.0016	0.0093	0.0696	0.2269	0.4332	0.8602	0.9683	0.9798	0.9996	0.9998	1.0000	1.0000	1.0000
1976	0.0001	0.0001	0.0067	0.0370	0.2174	0.5744	0.8044	0.9812	0.9940	0.9956	1.0000	1.0000	1.0000	1.0000
1977	0.0007	0.0005	0.0008	0.0280	0.1361	0.5077	0.8613	0.9568	0.9978	0.9989	0.9991	1.0000	1.0000	1.0000
1978	0.0000	0.0028	0.0030	0.0058	0.1096	0.3927	0.7930	0.9662	0.9917	0.9997	0.9998	0.9998	1.0000	1.0000
1979	0.0001	0.0000	0.0106	0.0176	0.0417	0.3446	0.7263	0.9343	0.9924	0.9984	1.0000	1.0000	1.0000	1.0000
1980	0.0044	0.0008	0.0004	0.0400	0.0963	0.2442	0.6919	0.9159	0.9814	0.9983	0.9997	1.0000	1.0000	1.0000
1981	0.0003	0.0123	0.0047	0.0048	0.1390	0.3884	0.7056	0.9056	0.9781	0.9949	0.9996	0.9999	1.0000	1.0000
1982	0.0000	0.0014	0.0336	0.0275	0.0558	0.3849	0.7910	0.9467	0.9762	0.9946	0.9986	0.9999	1.0000	1.0000
1983	0.0000	0.0002	0.0059	0.0888	0.1453	0.4202	0.7081	0.9575	0.9925	0.9943	0.9987	0.9996	1.0000	1.0000
1984	0.0000	0.0001	0.0012	0.0240	0.2145	0.5050	0.8989	0.9039	0.9926	0.9990	0.9987	0.9997	0.9999	1.0000
1985	0.0000	0.0003	0.0007	0.0066	0.0930	0.4334	0.8596	0.9909	0.9733	0.9988	0.9999	0.9997	0.9999	1.0000
1986	0.0000	0.0001	0.0020	0.0051	0.0365	0.2992	0.6818	0.9735	0.9993	0.9930	0.9998	1.0000	0.9999	1.0000
1987	0.0000	0.0000	0.0012	0.0132	0.0369	0.1781	0.6401	0.8572	0.9955	0.9999	0.9982	1.0000	1.0000	1.0000
1988	0.0001	0.0001	0.0004	0.0111	0.0817	0.2224	0.5533	0.8811	0.9439	0.9992	1.0000	0.9995	1.0000	1.0000
1989	0.0000	0.0006	0.0018	0.0053	0.0947	0.3715	0.6807	0.8762	0.9686	0.9792	0.9999	1.0000	0.9999	1.0000
1990	0.0004	0.0002	0.0057	0.0233	0.0732	0.4938	0.7971	0.9408	0.9759	0.9923	0.9925	1.0000	1.0000	1.0000
1991	0.0006	0.0024	0.0033	0.0516	0.2401	0.5399	0.9009	0.9631	0.9916	0.9957	0.9981	0.9973	1.0000	1.0000
1992	0.0000	0.0036	0.0158	0.0507	0.3412	0.8071	0.9458	0.9883	0.9943	0.9989	0.9992	0.9996	0.9990	1.0000
1993	0.0001	0.0000	0.0210	0.0956	0.4611	0.8313	0.9823	0.9962	0.9987	0.9991	0.9998	0.9999	0.9999	0.9997
1994	0.0004	0.0007	0.0005	0.1136	0.4102	0.9319	0.9791	0.9986	0.9997	0.9999	0.9999	1.0000	1.0000	1.0000
1995	0.0021	0.0027	0.0076	0.0155	0.4336	0.8207	0.9955	0.9978	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
1996	0.0008	0.0091	0.0163	0.0728	0.3530	0.8205	0.9679	0.9997	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
1997	0.0004	0.0038	0.0383	0.0925	0.4474	0.9499	0.9647	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1998	0.0000	0.0023	0.0176	0.1477	0.3853	0.8930	0.9985	0.9939	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
1999	0.0000	0.0004	0.0130	0.0772	0.4295	0.7941	0.9885	1.0000	0.9990	0.9999	1.0000	1.0000	1.0000	1.0000
2000	0.0000	0.0004	0.0065	0.0709	0.2805	0.7658	0.9596	0.9989	1.0000	0.9998	1.0000	1.0000	1.0000	1.0000
2001	0.0000	0.0000	0.0076	0.0961	0.3062	0.6450	0.9343	0.9932	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
2002	0.0000	0.0003	0.0018	0.1301	0.6325	0.7185	0.8944	0.9841	0.9989	1.0000	1.0000	1.0000	1.0000	1.0000
2003	0.0000	0.0003	0.0053	0.0669	0.7444	0.9653	0.9366	0.9753	0.9963	0.9998	1.0000	1.0000	1.0000	1.0000
2004	0.0000	0.0003	0.0053	0.0977	0.7457	0.9827	0.9978	0.9884	0.9946	0.9991	1.0000	1.0000	1.0000	1.0000
2005	0.0000	0.0003	0.0053	0.0977	0.7076	0.9917	0.9991	0.9999	0.9980	0.9988	0.9998	1.0000	1.0000	1.0000
2006	0.0000	0.0003	0.0053	0.0977	0.7076	0.9799	0.9998	1.0000	1.0000	0.9996	0.9997	1.0000	1.0000	1.0000
2007	0.0000	0.0003	0.0053	0.0977	0.7076	0.9799	0.9989	1.0000	1.0000	1.0000	0.9999	0.9999	1.0000	1.0000
2008	0.0000	0.0003	0.0053	0.0977	0.7076	0.9799	0.9989	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2009	0.0000	0.0003	0.0053	0.0977	0.7076	0.9799	0.9989	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2010	0.0000	0.0003	0.0053	0.0977	0.7076	0.9799	0.9989	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 18. Mean numbers per tow at age for the fall industry (GEAC) trawl survey of the offshore portion of NAFO Subdiv. 3Ps. Three relatively strong cohorts are highlighted (shaded cells).

Age/Year	1997	1998	1999	2000	2001	2002	2003	cohort
1	0.00	0.01	0.00	0.00	0.03	0.00	0.00	
2	0.29	0.06	0.34	1.64	0.21	0.00	0.22	
3	3.28	0.40	1.14	7.24	12.47	1.26	0.41	
4	9.42	1.76	1.71	2.86	26.74	16.77	2.46	
5	13.62	2.32	2.83	3.35	3.75	18.27	8.34	1998
6	3.02	1.81	3.58	5.18	2.14	2.88	9.28	1997
7	10.03	0.35	3.27	5.89	1.62	1.39	1.32	
8	11.97	1.64	0.51	3.99	1.34	1.18	0.73	
9	1.34	3.40	1.43	1.14	0.96	0.91	1.32	
10	0.54	0.40	1.36	5.83	0.10	0.46	0.48	
11	0.24	0.04	0.17	7.14	0.44	0.09	0.24	
12	0.04	0.13	0.10	0.79	0.58	0.27	0.00	
13	0.00	0.22	0.02	0.11	0.08	0.30	0.16	
14	0.00	0.00	0.00	0.17	0.05	0.00	0.15	1989
15	0.00	0.04	0.00	0.00	0.03	0.00	0.03	
Totals	53.79	12.58	16.46	45.33	50.54	43.78	25.14	

Table 19. Description of the five sequential population analysis runs conducted during the October 2003 assessment of NAFO Subdiv. 3Ps cod and reported in Brattey et al. (2003). The instantaneous rate of natural mortality (*m*) was assumed to be 0.2 per year for all ages. See text for details of indices.

Inputs	**QLSPA-2003 (Run A)**	**QLSPA-2003 (Run B)**	**XSA-2003 (Run C)**	**ADAPT-2003 (Run D)**	**ADAPT-2003 (Run E)**
Catch-at-age	1959-2003; ages 2-14	1977-2003; ages 2-14	1977-2003; ages 2-14	1977-2003; ages 2-14	1977-2003; ages 2-14
Indices					
A. T. Cameron	1977-1982; ages 2-14	1977-1982; ages 2-14	1977-1982; ages 2-14	1977-1982; ages 2-14	1977-1982; ages 2-14
RV split eastern	1983-2003; ages 2-14	1983-2003; ages 2-14	1983-2003; ages 2-14	-	1983-2003; ages 2-12[1]
RV split western	1993-2003; ages 2-12	1993-2003; ages 2-12	1993-2003; ages 2-12	-	1993-2003; ages 2-12
RV not split	-	-	-	1983-2003; ages 2-12	-
GEAC	-	1997-2002; ages 2-14	1997-2002; ages 2-14	1997-2002; ages 2-12	1997-2002; ages 2-14
Sentinel line-trawl	1995-2002; ages 3-9	1995-2002; ages 3-9	1995-2002; ages 3-10	1995-2002; ages 3-10	1995-2002; ages 3-10
Sentinel gillnet	1995-2002; ages 3-10	-	-	-	

[1] in the 2002 assessment ages 2-14 were used in the calibration, whereas in the 2003 assessment only ages 2-12 were used to minimize the influence of large numbers of zeros among the oldest ages.

Table 20. Details of the inputs and estimation procedures used in four SPA runs conducted during the October 2004 assessment of NAFO Subdiv. 3Ps cod (F=Fishing mortality, Fbar=average F, q=catchability coefficient; PR=partial recruitment vector)

QLSPA-2004 Run B:

M=0.2 for all years & ages.

Indices:
- -A. T. Cameron index 1977-1982; ages 2-14
- -RV Index (not split) 1983-2004; ages 2-14
- -GEAC index 1998-2003; ages 2-14
- -Sentinel line-trawl index 1995-2003; ages 3-10

Estimation:

-Quadratic Variance Model with self-weighting by survey index.
-RV Index extrinsic weight = 1/3 for all ages in 1995.
-RV Index extrinsic weight = 0 for age 2 prior to 1996, i.e. Engels portion.

-q's estimated separately for ages 2-12.
-Constant q's estimated for ages 13 and 14.
-Separate q's at age 13+ estimated before and after the 1995 gear change for the RV index.

-Constant ratio of F14 to Fbar(11-13) estimated for 1977-1993.
-Constant ratio F14/Fbar(11-13) estimated for 1998-2004 and F11/Fbar(8-10), F12/Fbar(9-11), F13/Fbar(10-12) in 2004.
-Constant ratio F11/Fbar(8-10), F12/Fbar(9-11), F13/Fbar(10-12) in 1993 and F11/Fbar(8-10) in 1994.
-These three ratio estimates were shrunk to a value of 1.

-Survivors aged 2-10 on 1 April 2004 are estimated.

XSA-2004 Run C:

M=0.2 for all years & ages.

Indices:

-A. T. Cameron index 1977-1982; ages 2-14
-RV Index (not split) 1983-2004; ages 2-14
-GEAC index 1998-2003; ages 2-14
-Sentinel line-trawl index 1995-2003; ages 3-10
q14=q13
F14 proportional to Fbar(11-13) from 1977-1992. Estimates shrunk towards 0.4 - very tight shrinkage (basically=0.4).
Minimum std error for population estimates from each cohort age=0.5
(An influence reduction measure to prevent fleets with few points from dominating.)

Survivors aged 2-14 in 2004 (Jan. 1) are estimated.

cont'd.

Table 20. Cont'd.

ADAPT-2004 Run D:

(Domed PR Run):
Catch at age: 1977-2004; ages 2-14
M=0.2 for all years & ages.

Indices:
-A. T. Cameron index 1977-1982; ages 2-14
-RV Index (not split) 1983-2004; ages 2-12
-GEAC index 1998-2003; ages 2-12
-Sentinel line-trawl index 1995-2003; ages 3-10

Estimation:
-F14=0.5*Fbar(11-13) from 1977-1992.
Survivors aged 2-14 in 2004 (Apr. 1) are estimated.
Survivors aged 14 for 1993-2003 are estimated.

ADAPT-2004 Run E:

(Flat-topped PR run):
Catch at age: 1977-2004; ages 2-14
M=0.2 for all years & ages.

Indices:
-A. T. Cameron index 1977-1982; ages 2-14
-RV index (not split) 1983-2004; ages 2-12
-GEAC index 1998-2003; ages 2-12
-Sentinel line-trawl index 1995-2003; ages 3-10

Estimation:
-F14=Fbar(11-13),1977-1993
-F10,1993=Fbar(7-9),1993
-F11,1993=Fbar(8-10),1993
-F12,1993=Fbar(9-11),1993
-F13,1993=Fbar(10-12),1993
-F14=Fbar(11-13),1998-2004
-F11,2004=Fbar(8-10)
-F12,2004=Fbar(9-11)
-F13,2004=Fbar(10-12)

Survivors aged 2-10 on 1 April 2004 are estimated

Table 21. Inputs and structure for the projection of 3Ps cod spawner biomass from 1 April 2004 to 1 April 2007 based on ADAPT SPA runs D and E from the October 2004 assessment.

Proportion of TAC or F

Year	Period From	To	Prop
2004	1-Apr	31-Dec	0.83
2005	1-Jan	31-Mar	0.17
2005	1-Apr	31-Dec	0.83
2006	1-Jan	31-Mar	0.17
2006	1-Apr	31-Dec	0.83
2007	1-Jan	31-Mar	0.17

Partial Recruitment

To be computed from the average of the PR for the period 2001-2003 from the relevant SPA

Method is to calculated the PR in each year, take the average, and then rescale the vector to have a maximum of 1

Run/Age	2	3	4	5	6	7	8	9	10	11	12	13	14
Run D	0.00	0.01	0.05	0.17	0.50	0.82	0.87	0.82	1.00	0.69	0.49	0.15	0.12
Run E	0.00	0.01	0.04	0.14	0.42	0.78	0.92	1.00	0.98	0.84	0.69	0.54	0.69

Recruitment at age 3

Geometric mean of numbers at age 3 in 2002-2004 from the relevant SPA

Run D	13,471
Run E	11,007

Natural mortality

M = 0.2

Population weight at age (Jan 1)

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14
2004	0.000	0.497	0.827	1.216	1.787	2.256	2.664	3.152	3.933	4.640	5.294	6.566	8.265
2005	0.000	0.497	0.804	1.234	1.755	2.211	2.703	3.381	3.883	4.257	5.437	7.263	8.406
2006	0.000	0.497	0.804	1.234	1.755	2.211	2.703	3.381	3.883	4.257	5.437	7.263	8.406
2007	0.000	0.497	0.804	1.234	1.755	2.211	2.703	3.381	3.883	4.257	5.437	7.263	8.406

Catch weights at age (mid-year)

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14
2004	0.000	0.6452	1.0028	1.5186	2.0275	2.41101	3.0311	3.7711	3.9989	4.5324	6.5217	8.0887	8.7362
2005	0.000	0.6452	1.0028	1.5186	2.0275	2.41101	3.0311	3.7711	3.9989	4.5324	6.5217	8.0887	8.7362
2006	0.000	0.6452	1.0028	1.5186	2.0275	2.41101	3.0311	3.7711	3.9989	4.5324	6.5217	8.0887	8.7362
2007	0.000	0.6452	1.0028	1.5186	2.0275	2.41101	3.0311	3.7711	3.9989	4.5324	6.5217	8.0887	8.7362

Maturity at age

Year/Age	2	3	4	5	6	7	8	9	10	11	12	13	14
2004	0.000	0.005	0.098	0.746	0.983	0.998	0.988	0.995	0.999	1.000	1.000	1.000	1.000
2005	0.000	0.005	0.098	0.708	0.992	0.999	1.000	0.998	0.999	1.000	1.000	1.000	1.000
2006	0.000	0.005	0.098	0.708	0.980	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2007	0.000	0.005	0.098	0.708	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 22. Comparison of results from 3-year deterministic projections (from 1 April 2004 to 1 April 2007) at fixed annual catch options ranging from 0 t to 20,000 t for the NAFO Subdiv. 3Ps cod stock. Results are given in terms of percent change in spawning stock biomass (SSB) on 1 April 2006 and 1 April 2007 for two ADAPT SPA formulations. Negative values (shaded cells) indicate lower SSB at the end of the projection period.

	% change in SSB from 119,655t (Apr.1/2004)				
ADAPT Run D	0 t	5,000t	10,000t	15,000t	20,000t
SSB (1 Apr. 2006)	2.59%	-1.39%	-5.35%	-9.31%	-13.27%
SSB (1 Apr. 2007)	9.50%	1.63%	-6.21%	-14.06%	-21.89%

	% change in SSB from 80,859t (Apr.1 2004)				
ADAPT Run E	0 t	5,000t	10,000t	15,000t	20,000t
SSB (1 Apr. 2006)	4.94%	-0.92%	-6.77%	-12.62%	-18.44%
SSB (1 Apr. 2007)	15.28%	3.71%	-7.84%	-19.39%	-30.90%

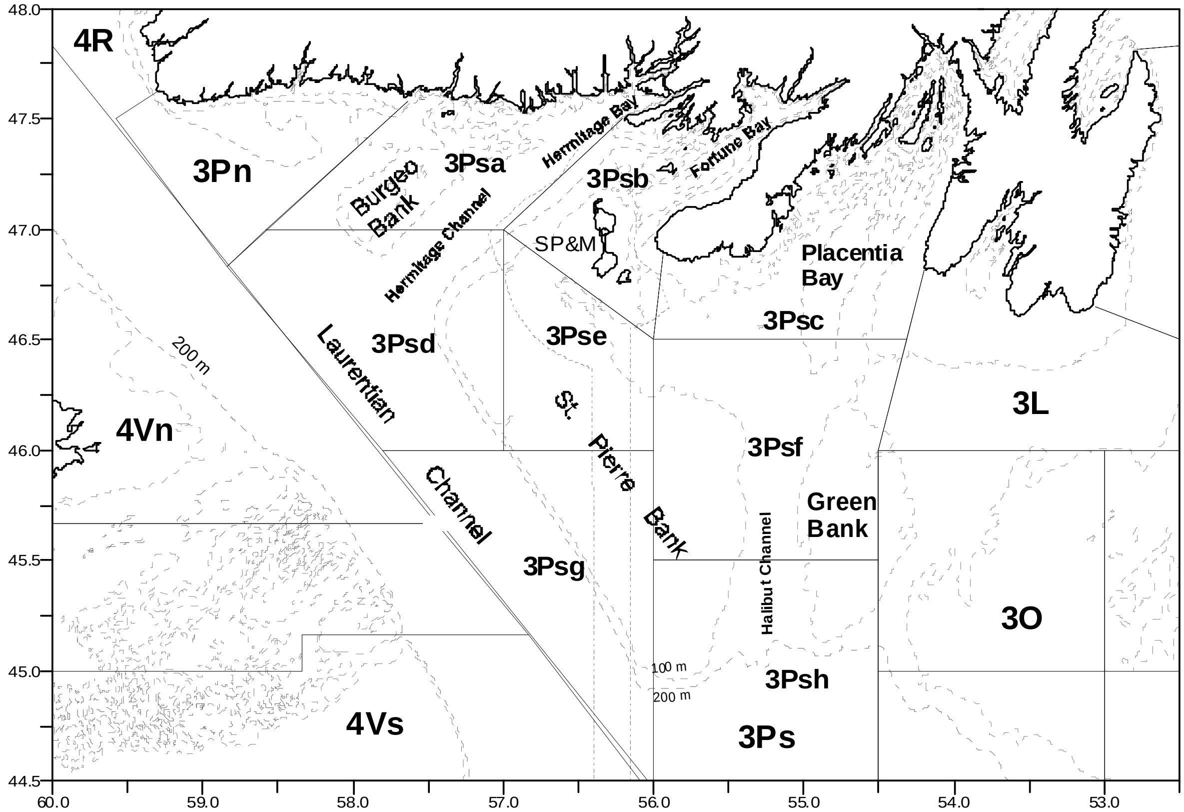


Fig. 1. NAFO Subdivision 3Ps management unit showing French economic zone (fine dashed line), boundaries of statistical unit areas, 100m and 200m depth contours, and main fishing areas.

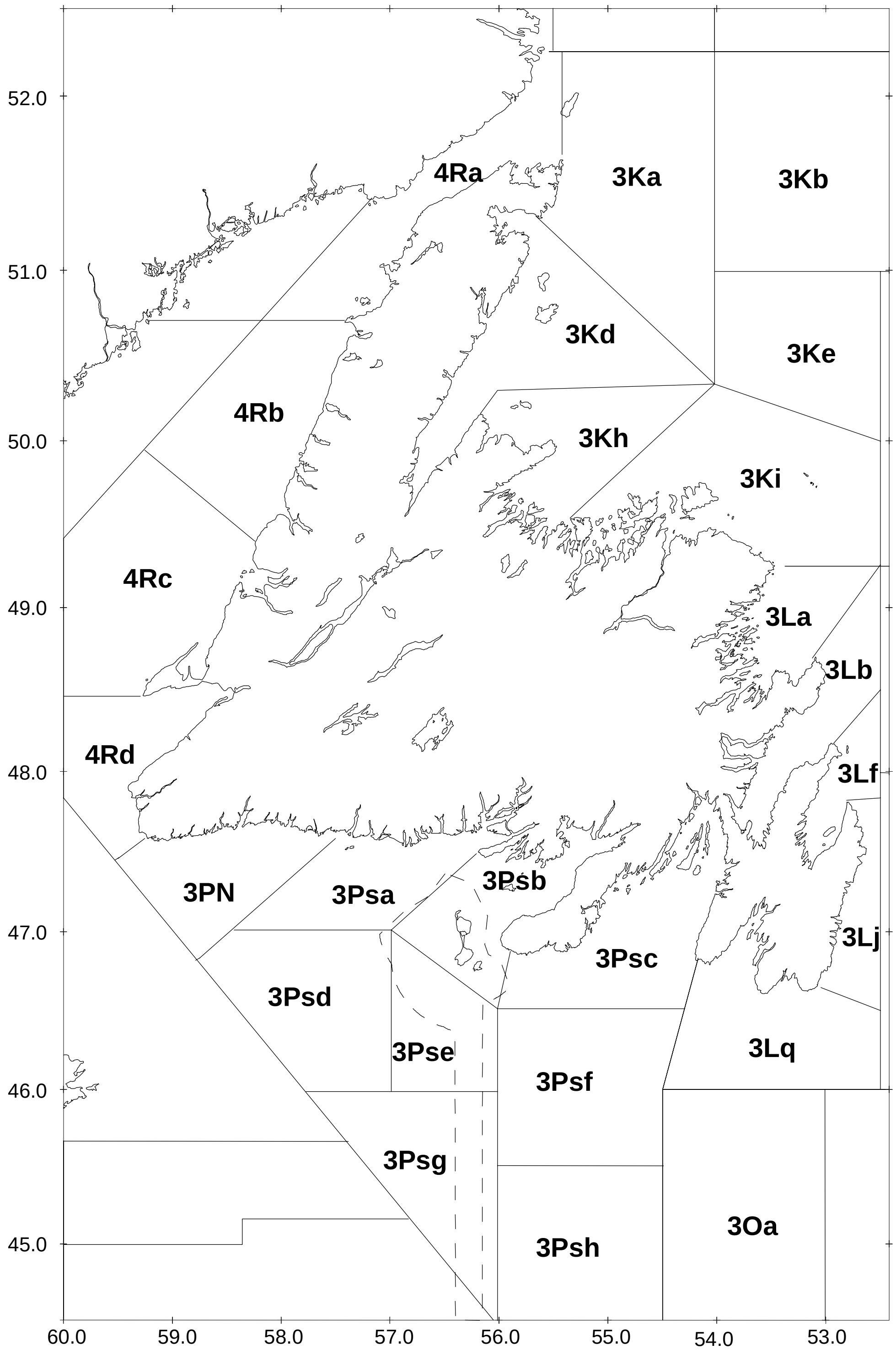


Fig. 2. Names and boundaries of NAFO statistical areas around insular Newfoundland. The dashed line indicates the boundary of the French economic zone.

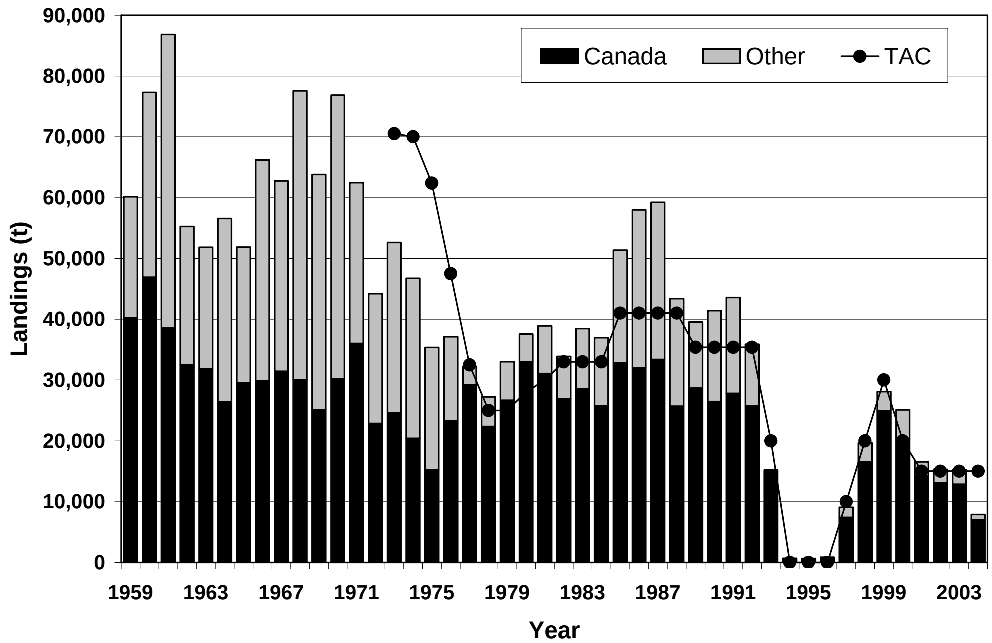


Fig. 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdiv. 3Ps during 1959 - 1 Oct 2004

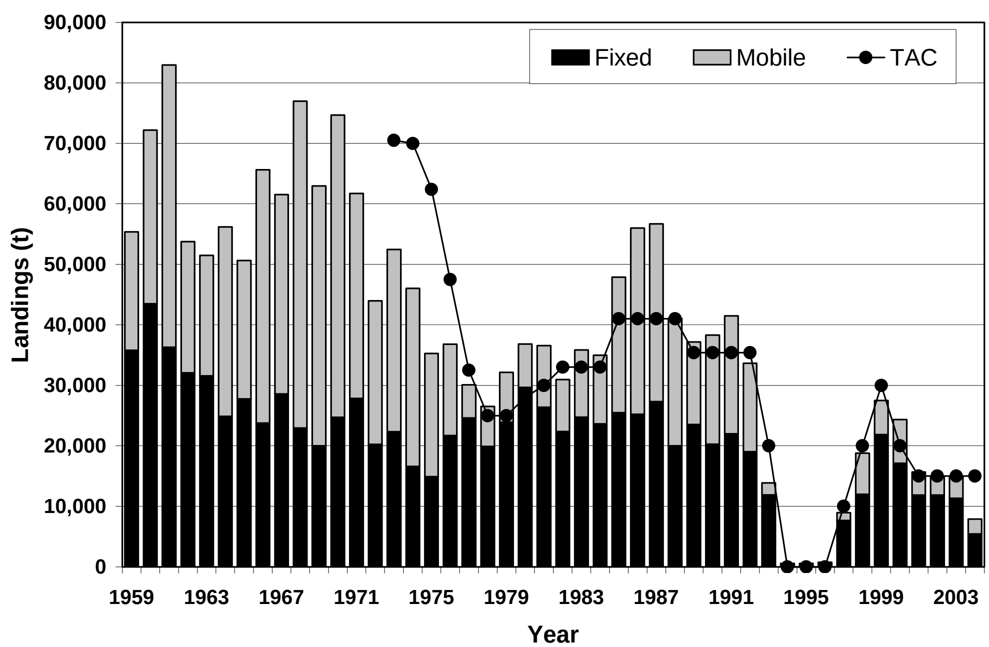


Fig. 3b. Reported landings of cod by fixed and mobile gear vessels in NAFO Subdiv. 3Ps during 1959 - 1 Oct 2004

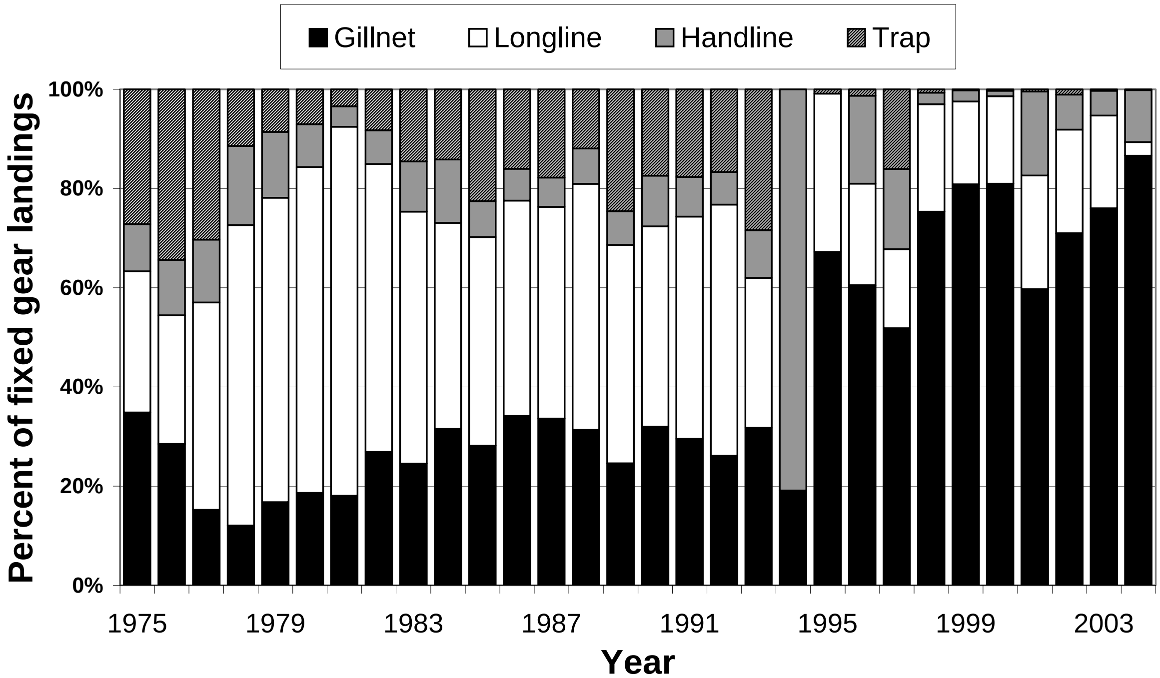


Fig. 4. Percent of fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdiv. 3Ps during 1975 - 1 October 2004. The fishery was under a moratorium during 1994-1996 and values for those years are based on sentinel and by-catch landings of < 800 t. The values for 2004 are based on fixed gear landings to 1 October (about 5,400 t) as the fishery was still in progress.

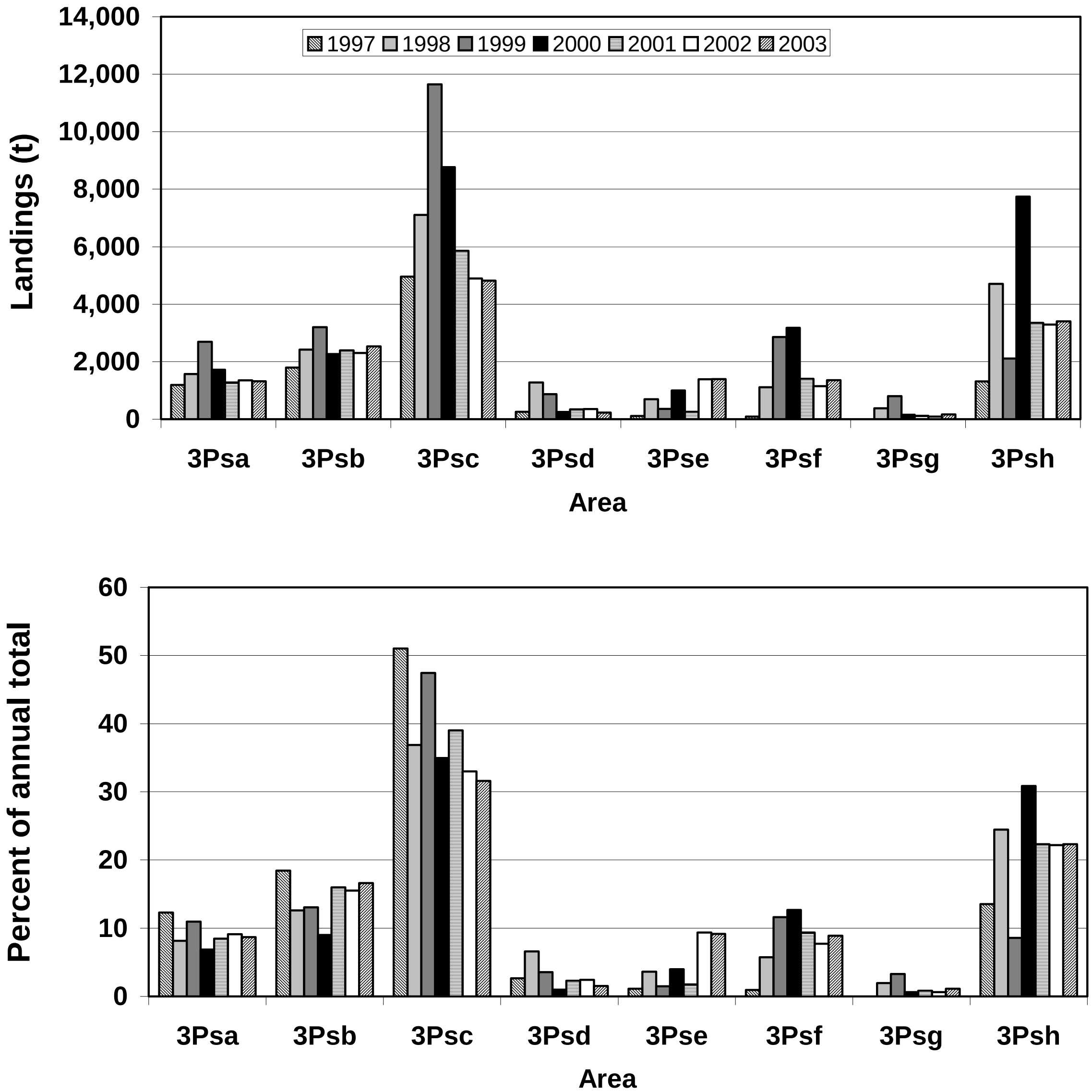


Fig. 5. Annual reported landings of cod by unit area from NAFO Subdiv. 3Ps during 1997-2003.

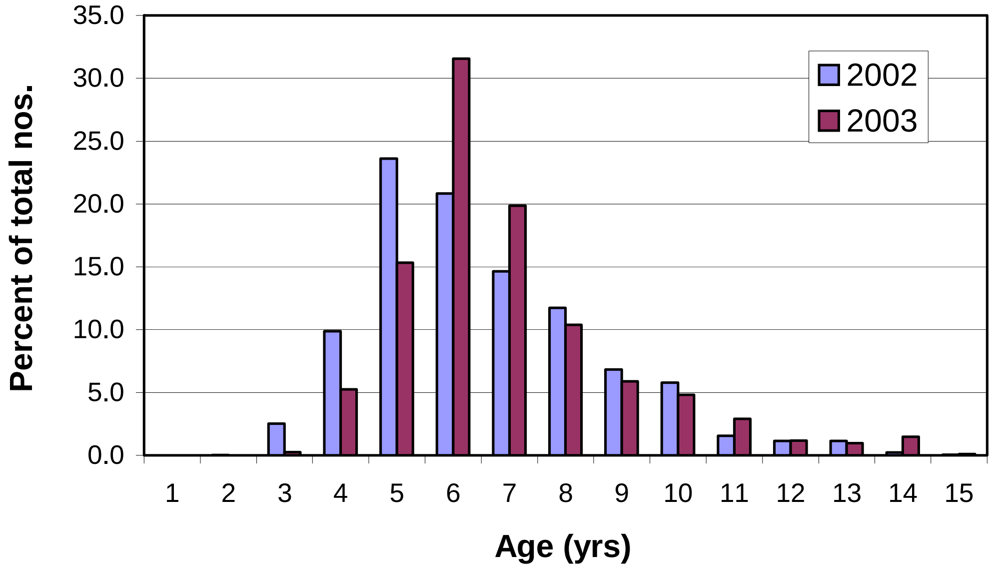


Fig. 6a. Catch numbers-at-age (percents) for the commercial cod fishery in 2002 and 2003.

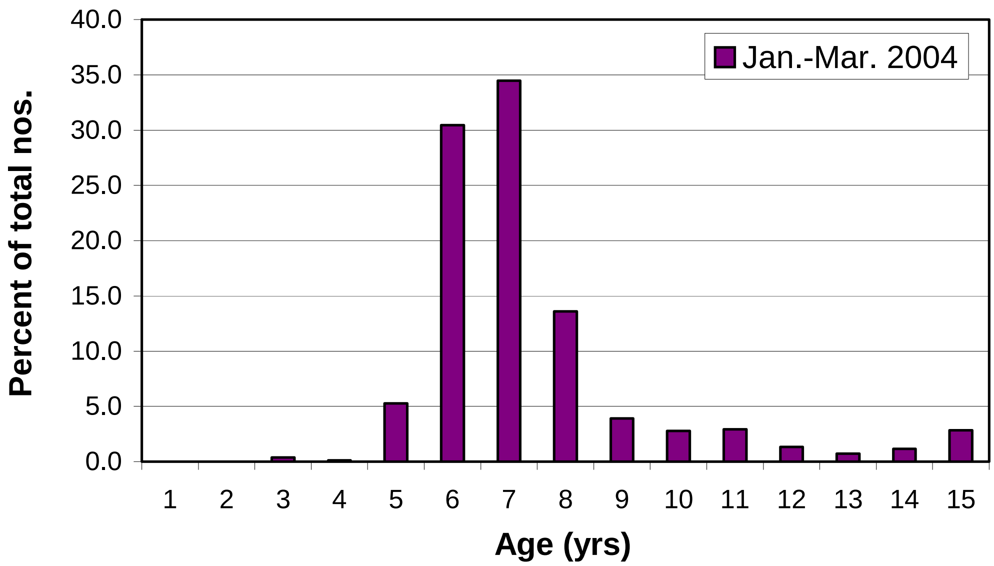
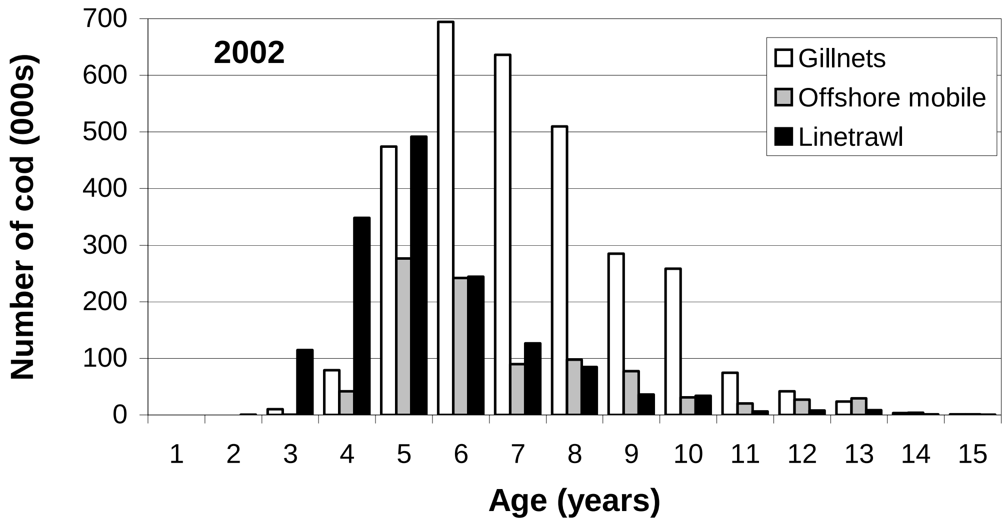


Fig. 6b. Catch numbers-at-age (percents) for the commercial cod fishery in January-March 2004.



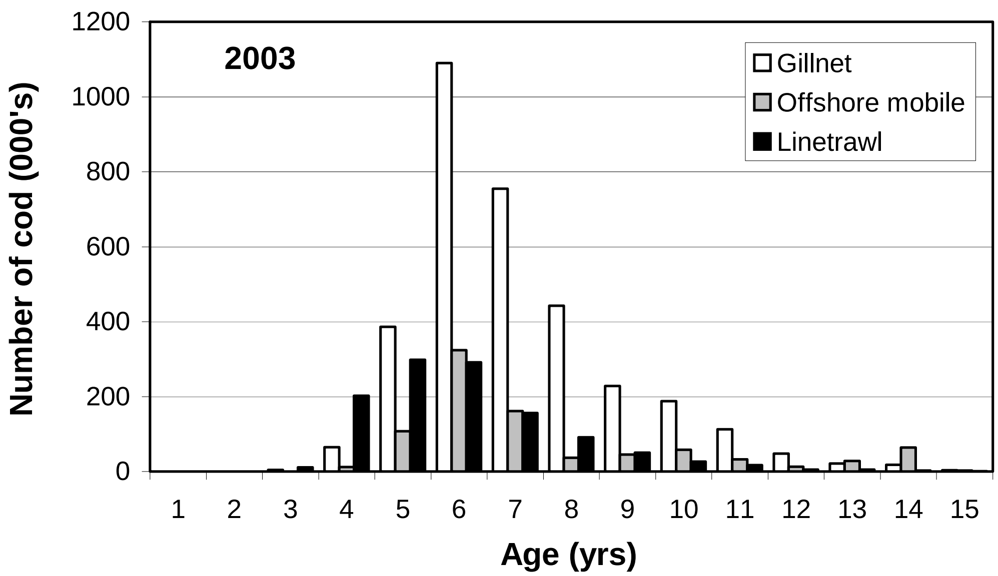


Fig. 7a. Catch numbers-at-age for the main gear types used in the cod fishery in NAFO Subdiv. 3Ps during 2002 and 2003.

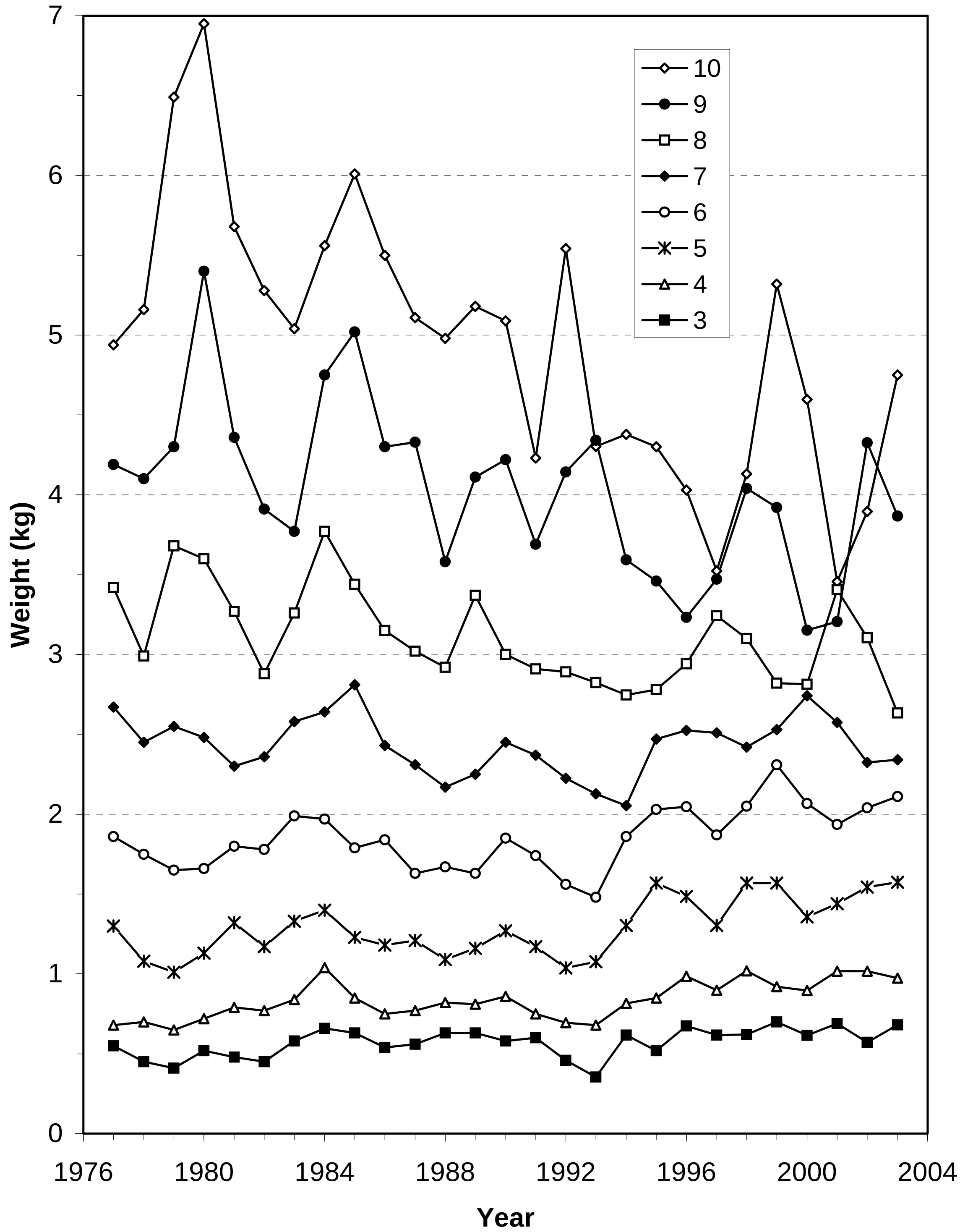


Fig. 8a. Mean weights-at-age calculated from mean lengths-at-age for the commercial catch of cod in NAFO Subdiv. 3Ps during 1977-2003.

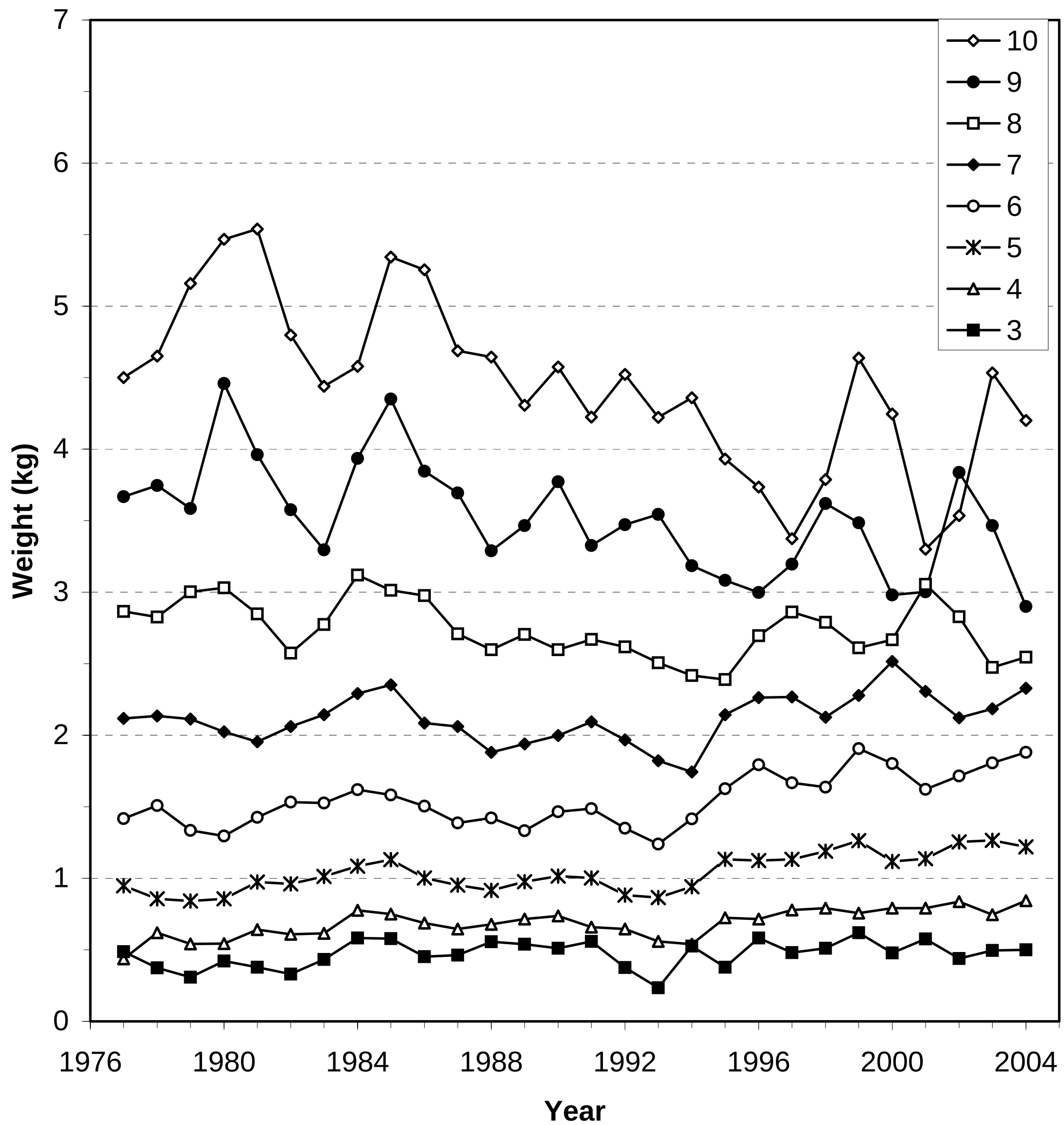


Fig. 8b. Beginning of year mean weights-at-age (3-10) from the commercial catch of cod in NAFO Subdiv. 3Ps during 1977-2004. The values for 2004 are computed using extrapolated values for mid-year weights for 2004, as described in the text.

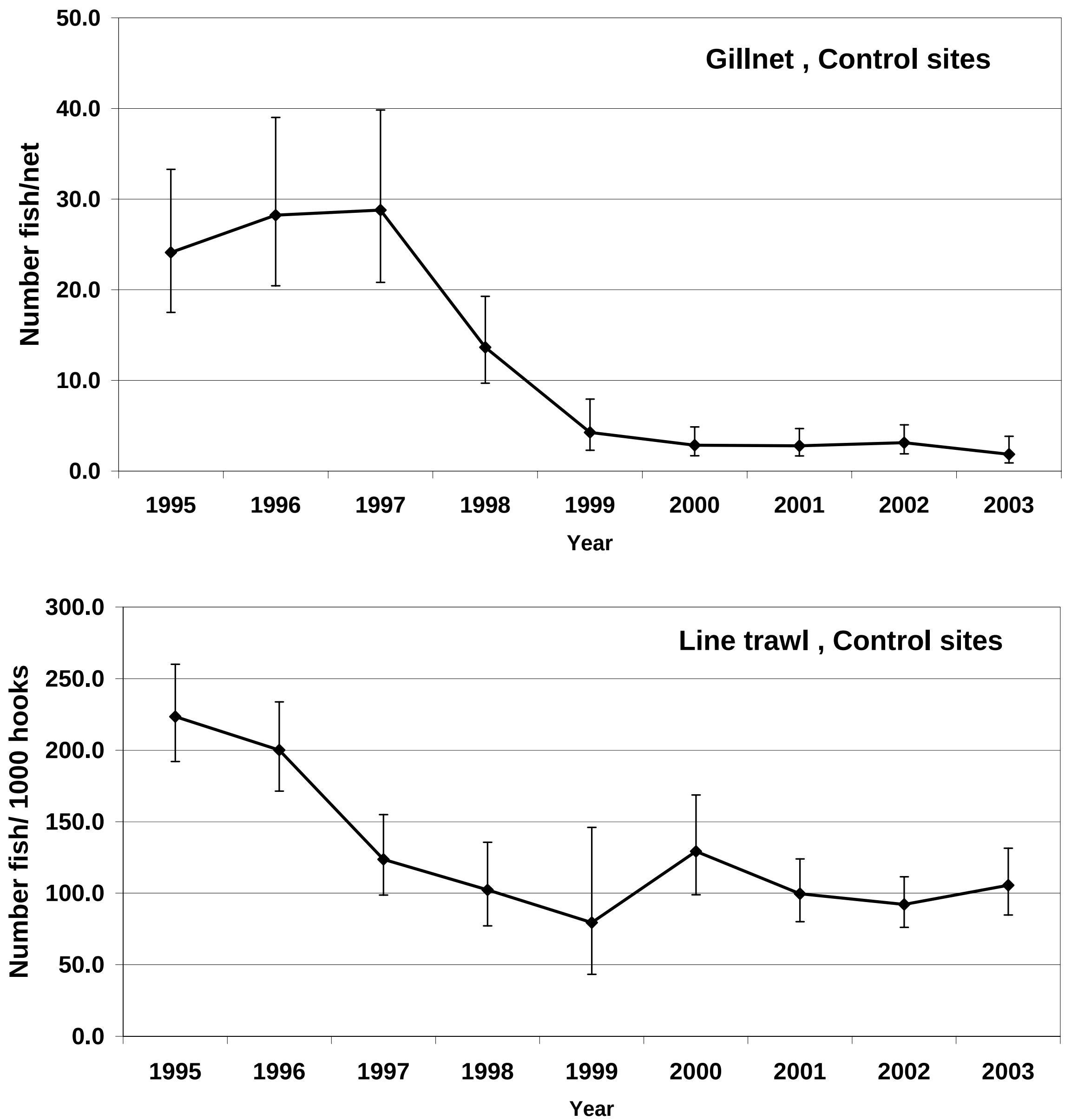
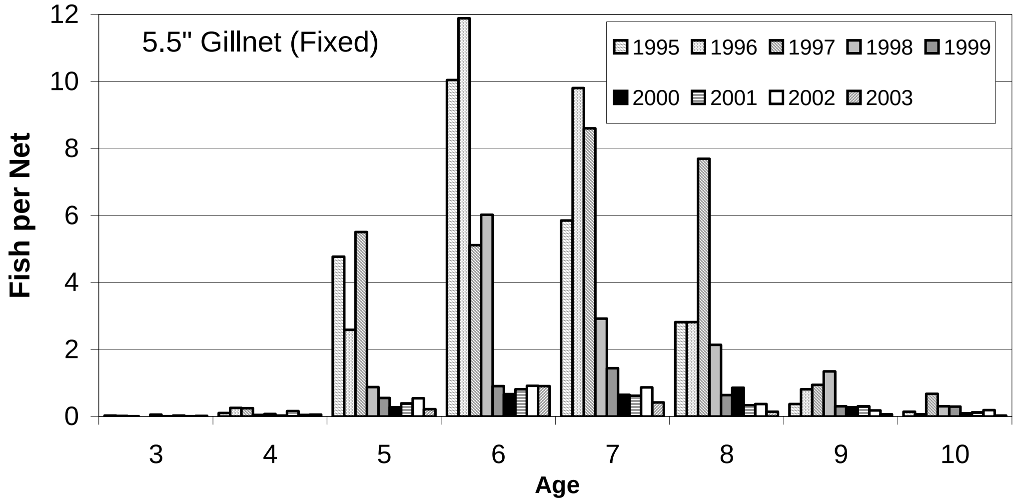


Fig. 9a. Standardized age-aggregated catch rate indices for gill nets (5.5" mesh) and line-trawls (with 95% CL's) estimated using data from sentinel fishery fixed sites. Catch rates are fish per 50 fathom net for gill nets and fish per 1,000 hooks for line trawl.



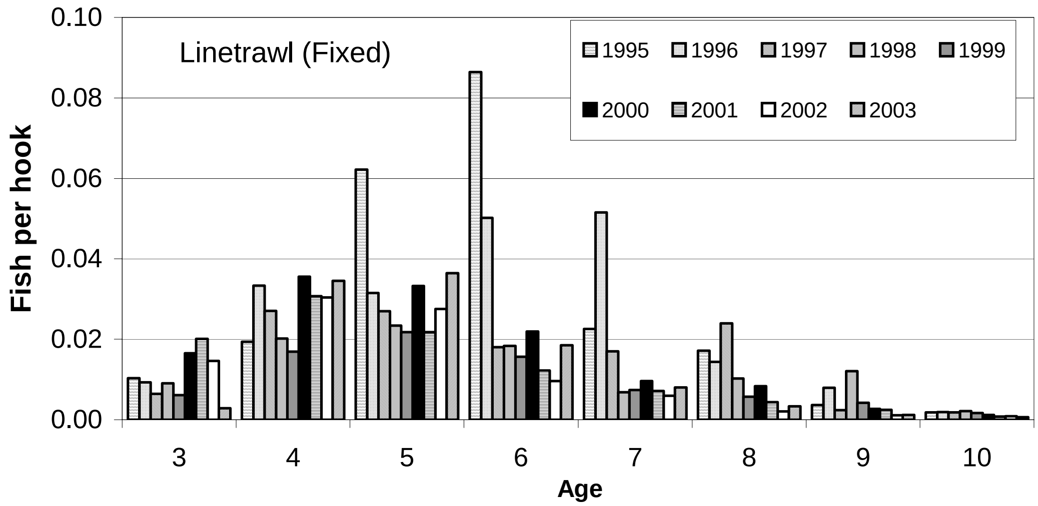
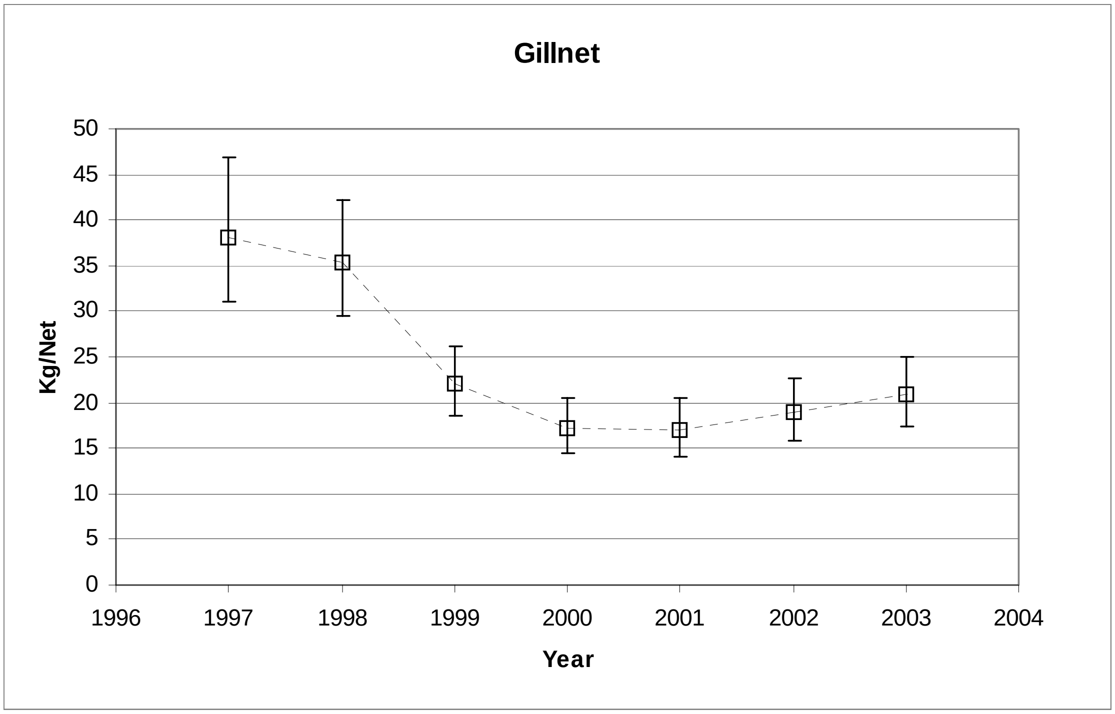


Fig. 9b. Standardized gillnet (5.5") and line-trawl annual catch rate-at-age indices estimated using data from sentinel fishery fixed sites.



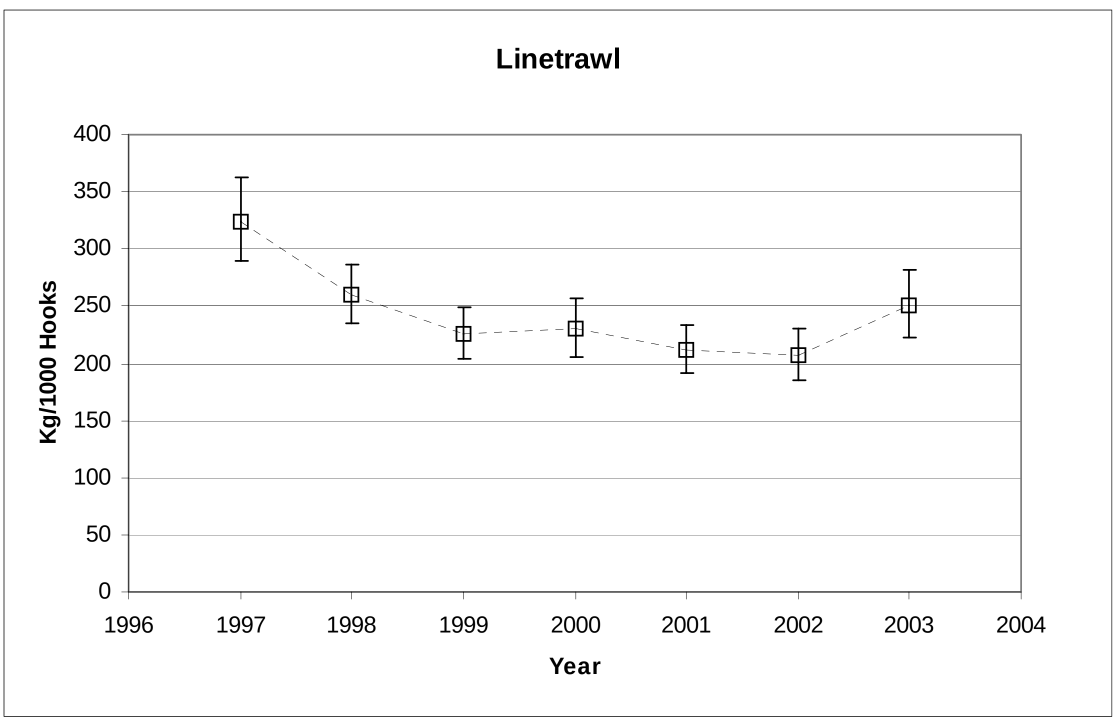


Fig. 10. Standardized annual catch rate indices (with 95% CL's) for gillnets and line-trawls using data from science logbooks for the < 35 ft sector. Catch rate is live weight equivalence (kg).

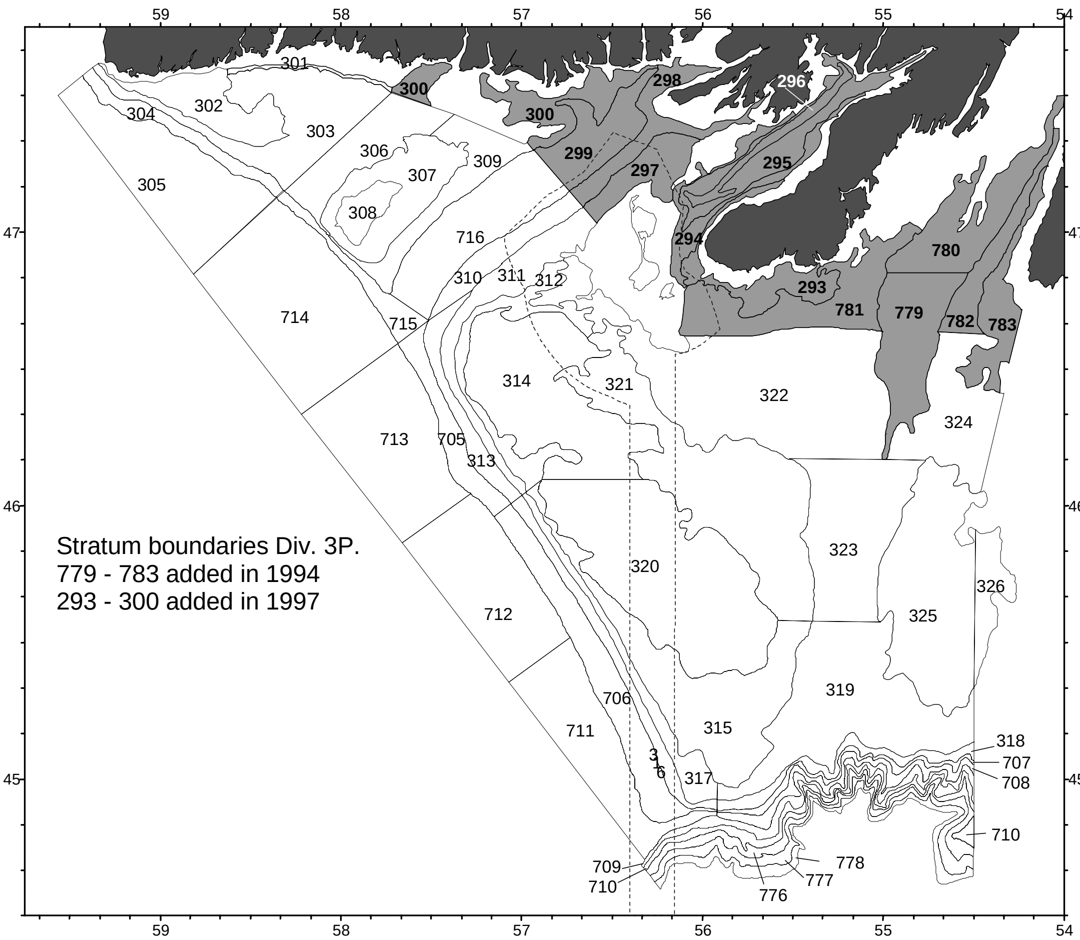


Fig. 11. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdiv. 3Ps. Dashed line is the boundary of the French economic zone which is included in the surveyed area.

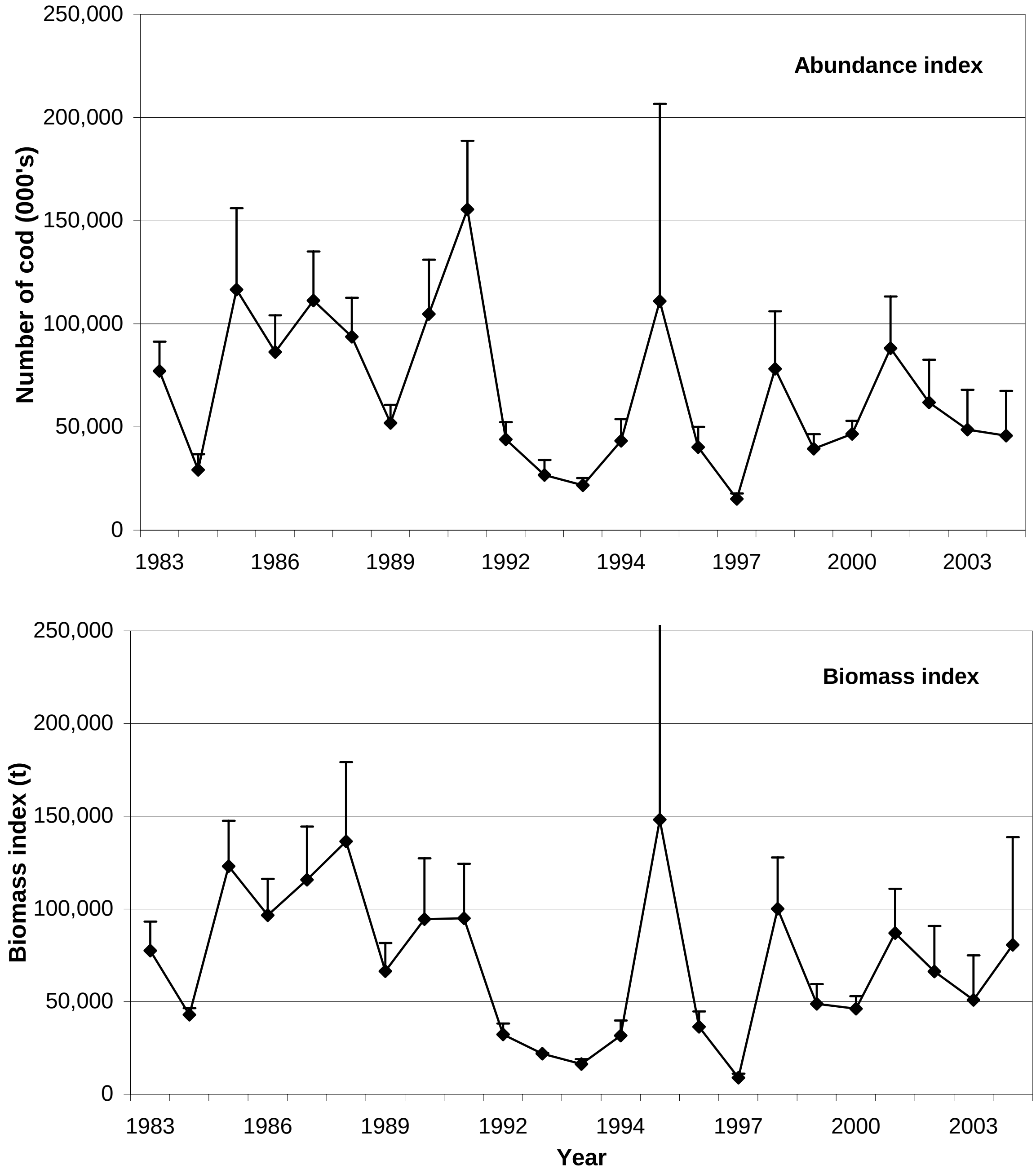


Fig. 12. Abundance and biomass indices for cod in NAFO Subdiv. 3Ps from DFO research vessel bottom trawl surveys during winter/spring from 1983-2004. There were two surveys in 1993. Error bars show plus one standard deviation.

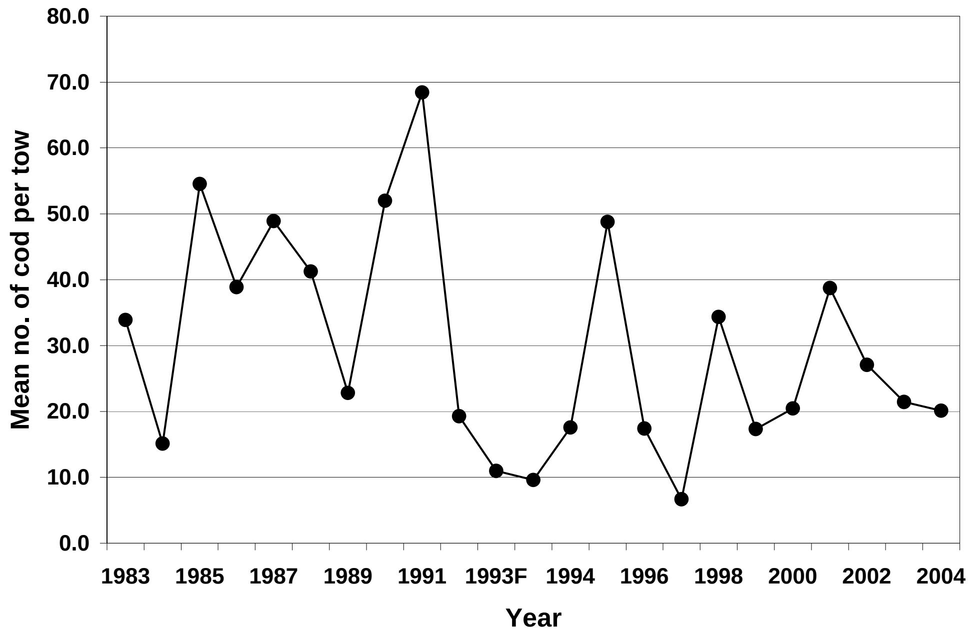


Fig. 13. Age-aggregated catch rate index (mean numbers per tow in Campelen units) from the DFO research vessel bottom trawl survey of NAFO Subdiv. 3Ps conducted during winter/spring (1983-2004). There were two surveys in 1993 (February and April).

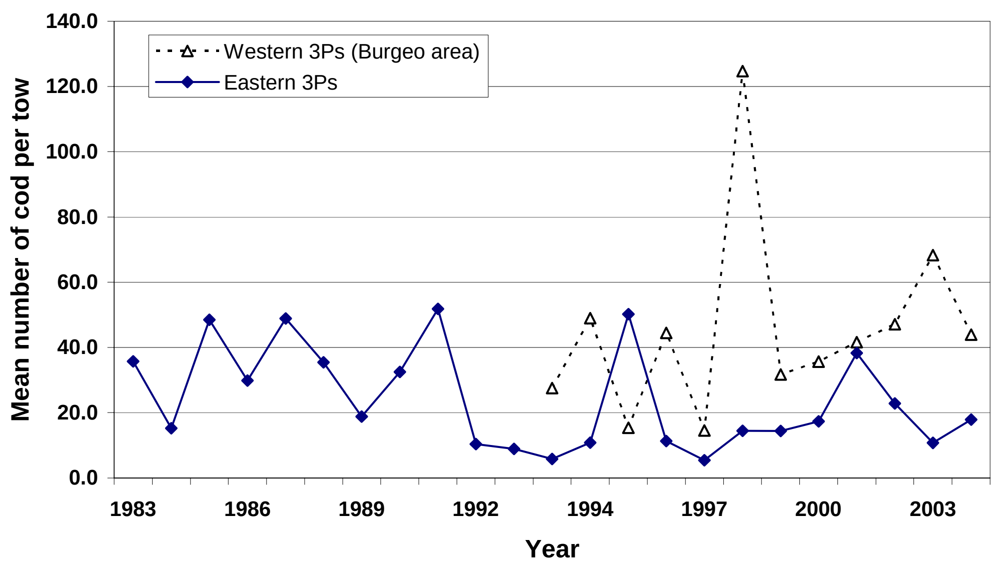


Fig. 14. Age-aggregated catch rate index for the eastern and western (Burgeo area) portions of 3Ps from the DFO research vessel bottom trawl surveys. There were two surveys in 1993.

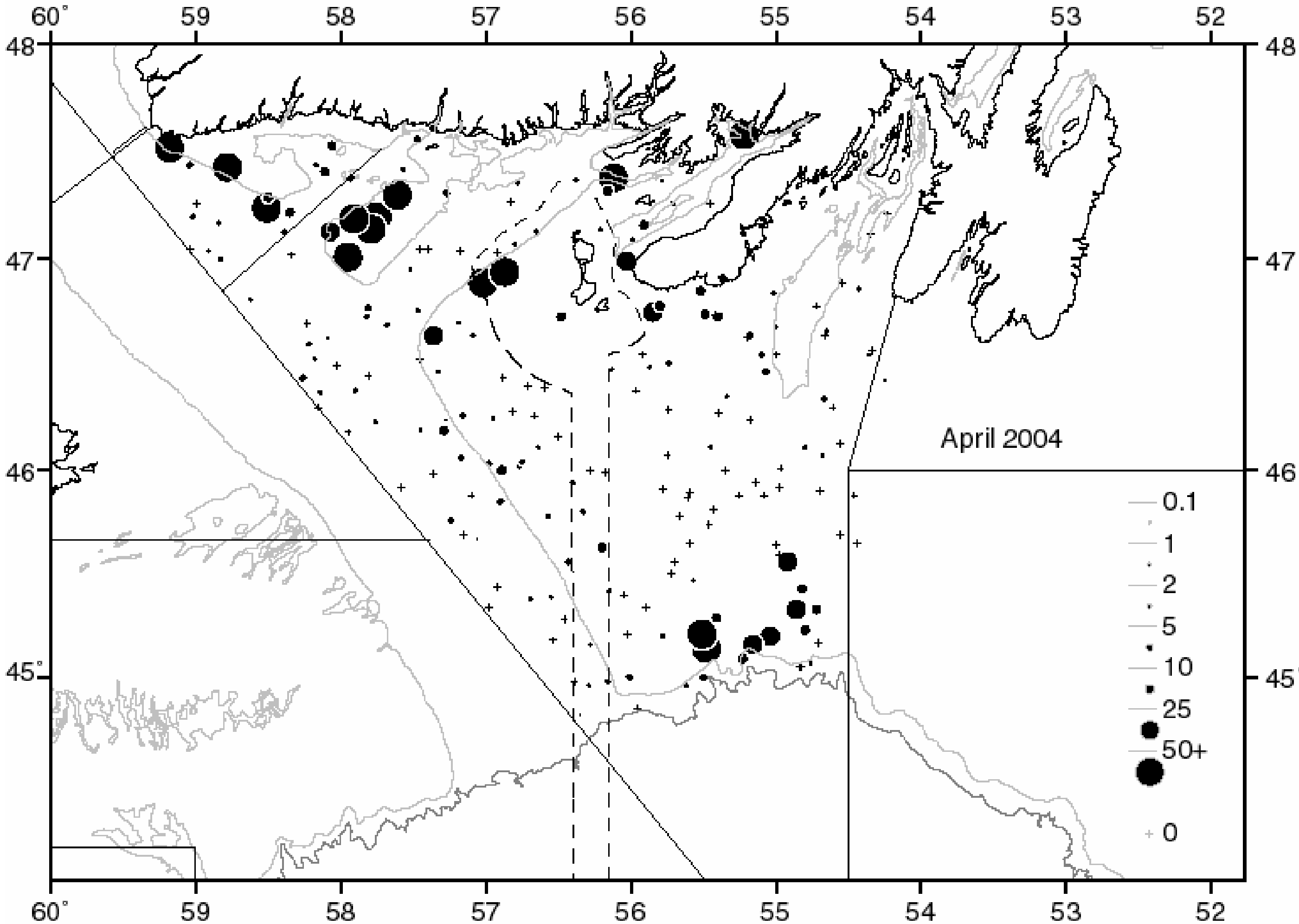


Fig 15. Age-aggregated distribution of cod catches (nos per tow) from the DFO RV survey of 3Pn and 3Ps during April 2004.

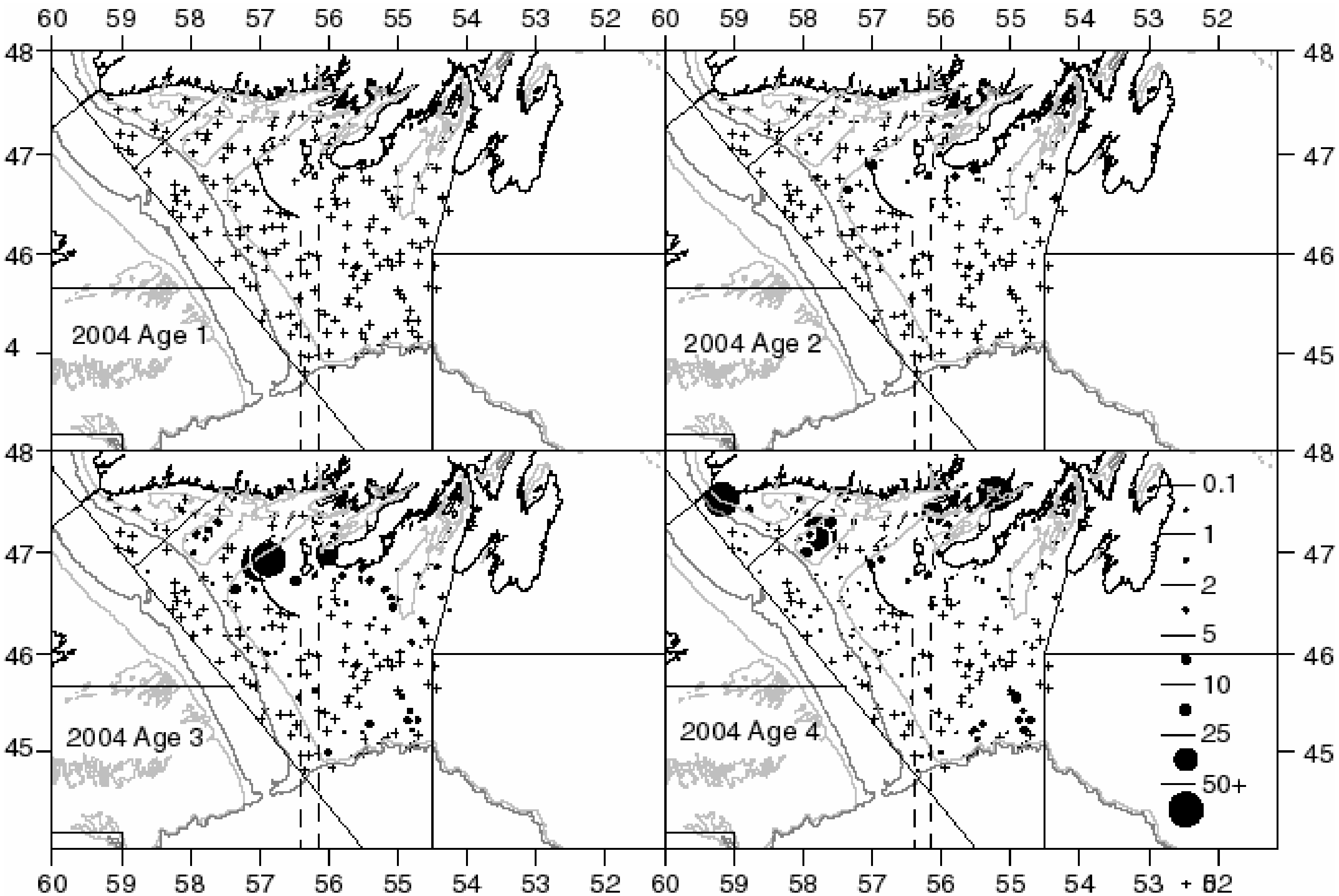


Fig. 16. Age -dis-aggregated distribution of cod (ages 1-4) catches for the DFO RV bottom trawl survey of NAFO Div. 3P during April 2004.

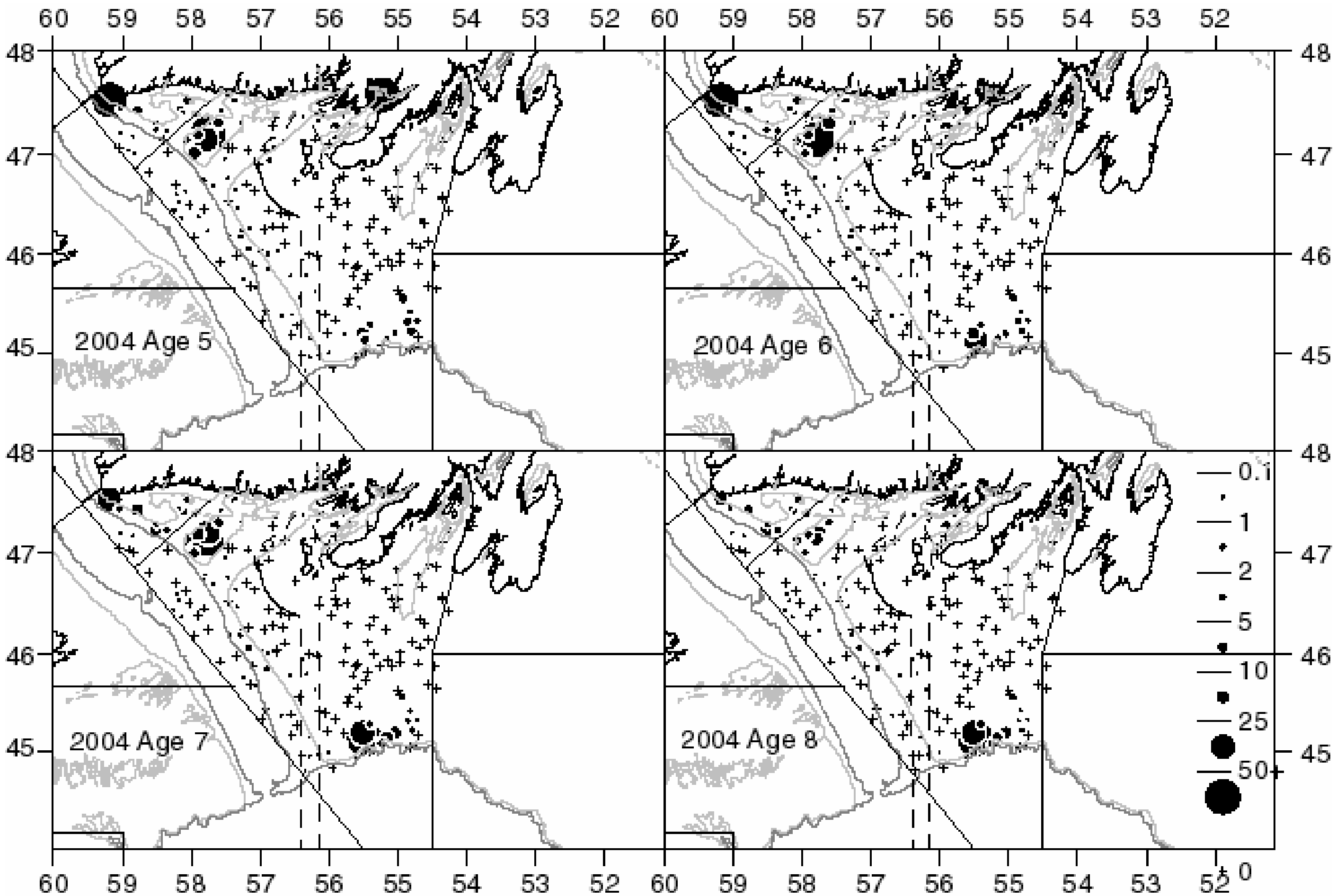


Fig. 17. Age -dis-aggregated distribution of cod (ages 5-8) catches for the DFO RV bottom trawl survey of NAFO Div. 3P during April 2004.

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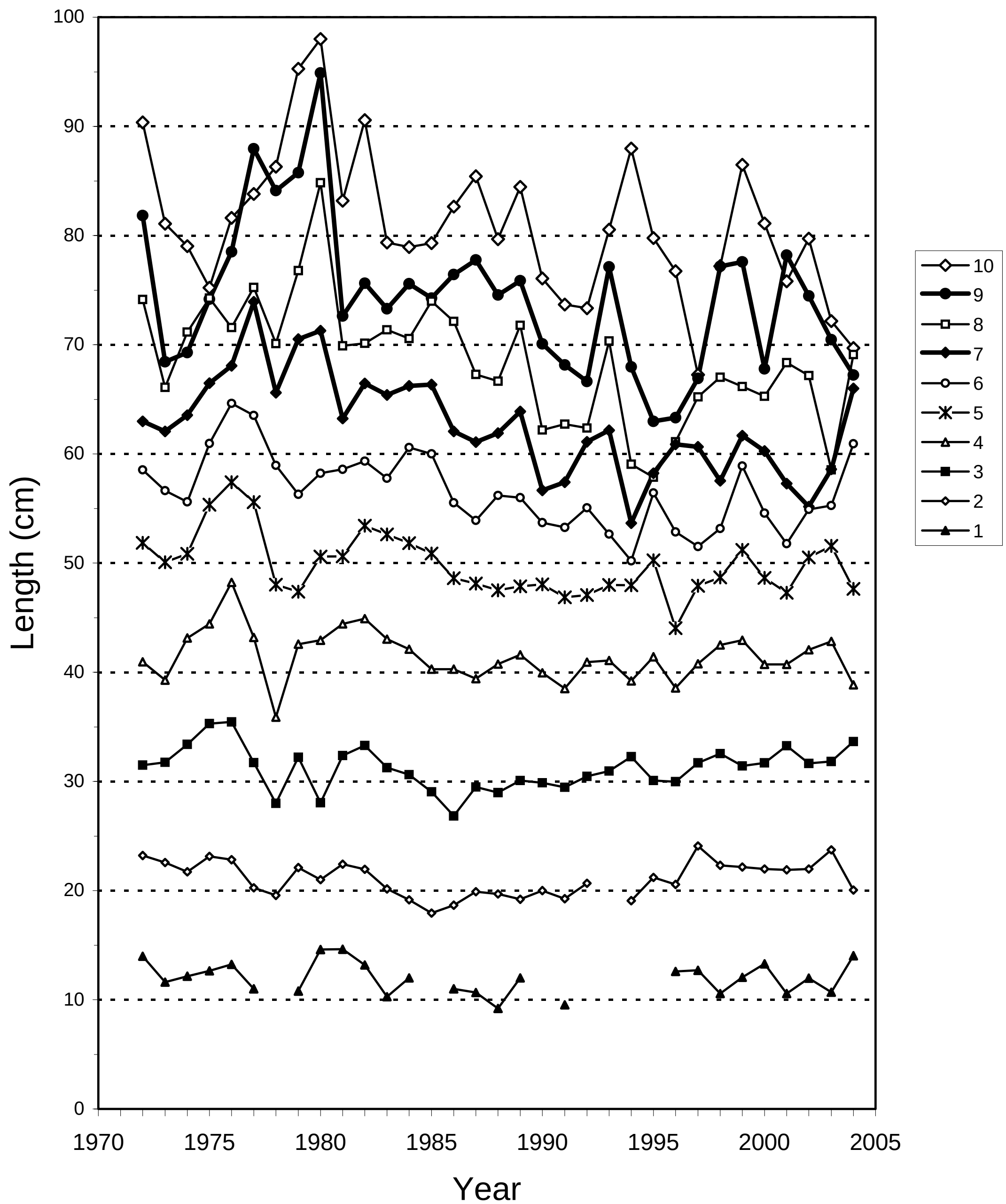


Fig. 18a. Mean length at ages 1-10 of cod in Subdivision 3Ps during 1974-2004, as determined from sampling during DFO bottom-trawl surveys in winter-spring.

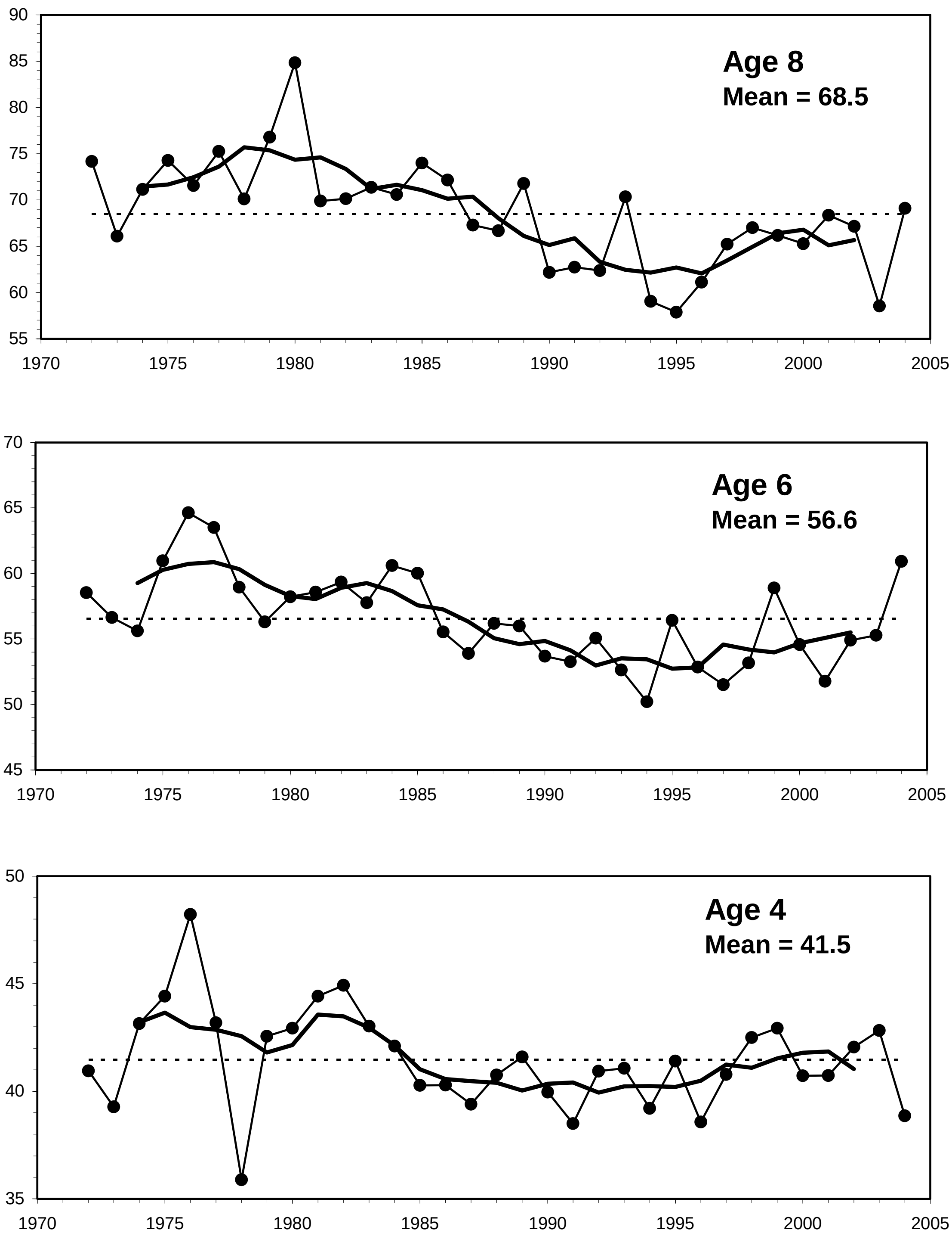


Fig. 18b. Mean lengths (cm) at ages 4, 6 and 8 of cod in Subdivision 3Ps during 1972-2004, as determined from sampling during DFO bottom-trawl surveys in winter-spring. The lines in each panel indicate the annual means (solid line with symbols), a 5-year running mean (heavy solid line) and the mean for the period 1972-2004 (dashed line).

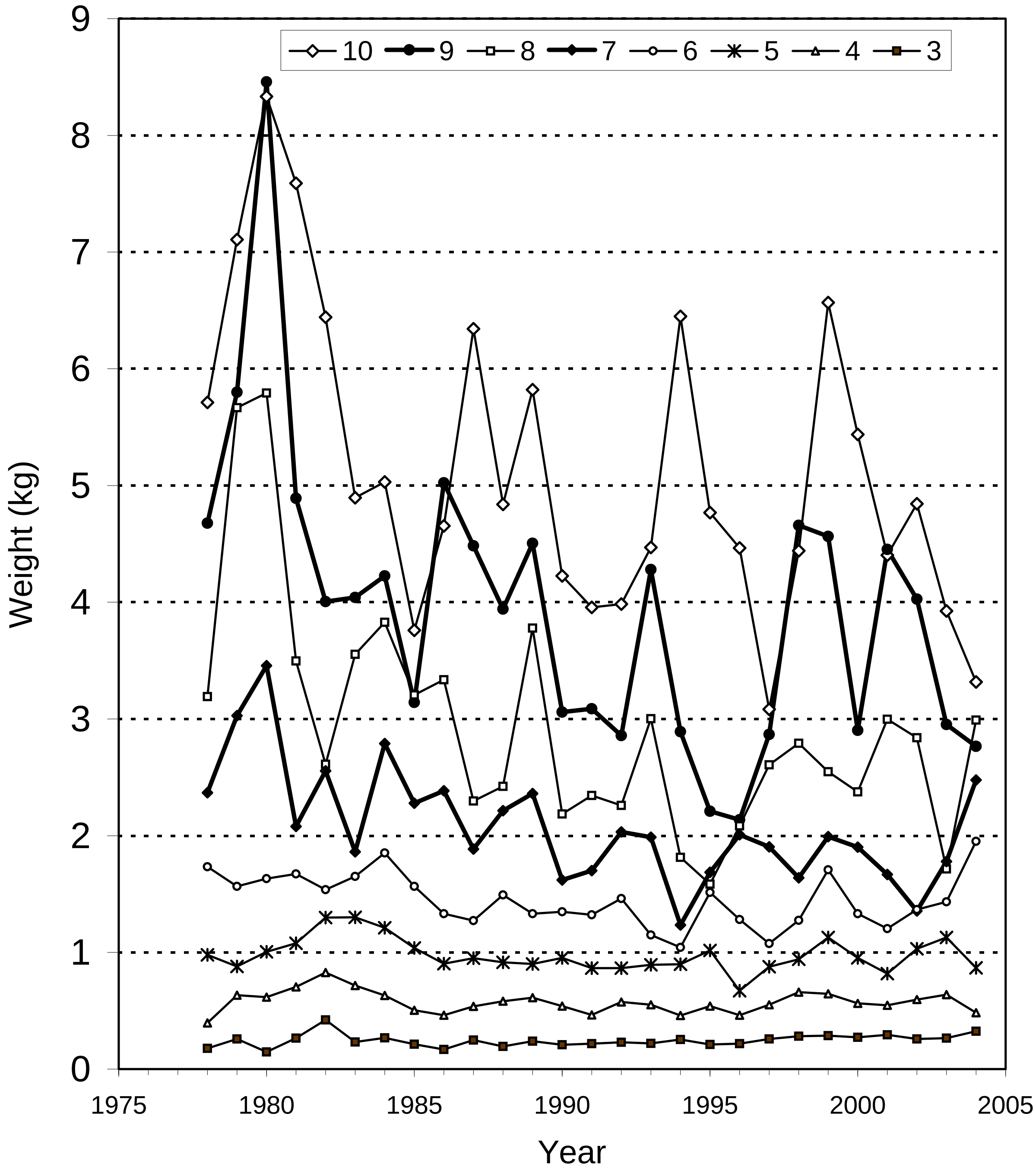


Fig. 19a. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in NAFO Subdivision 3Ps in winter-spring 1978-2004.

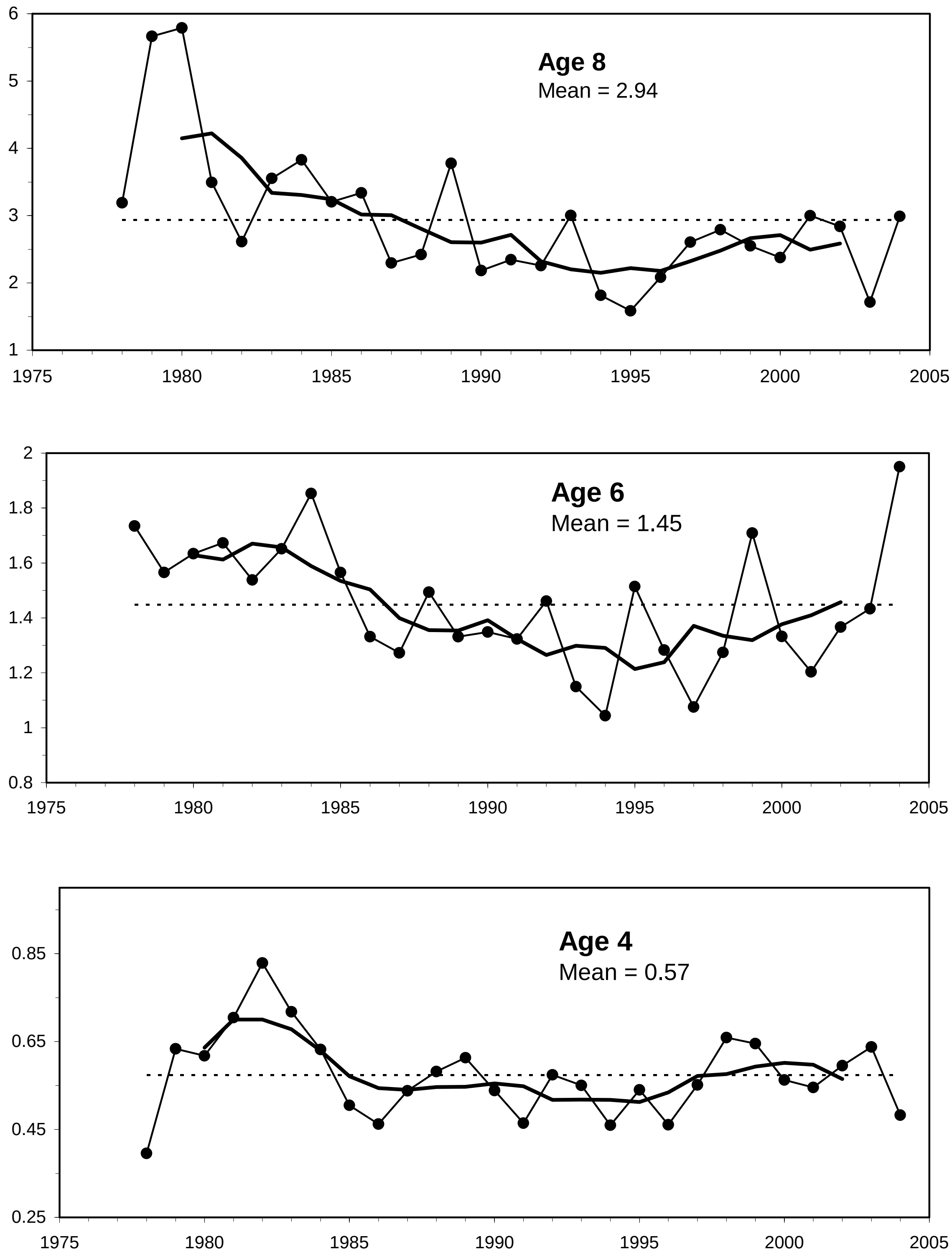


Fig. 19b. Mean weights (kg) at ages 4, 6 and 8 of cod in Subdivision 3Ps during 1972-2004, as determined from sampling during DFO bottom-trawl surveys in winter-spring. The lines in each panel indicate the annual means (solid line with symbols), a 5-year running mean (heavy solid line) and the mean for the period 1978-2004 (dashed line).

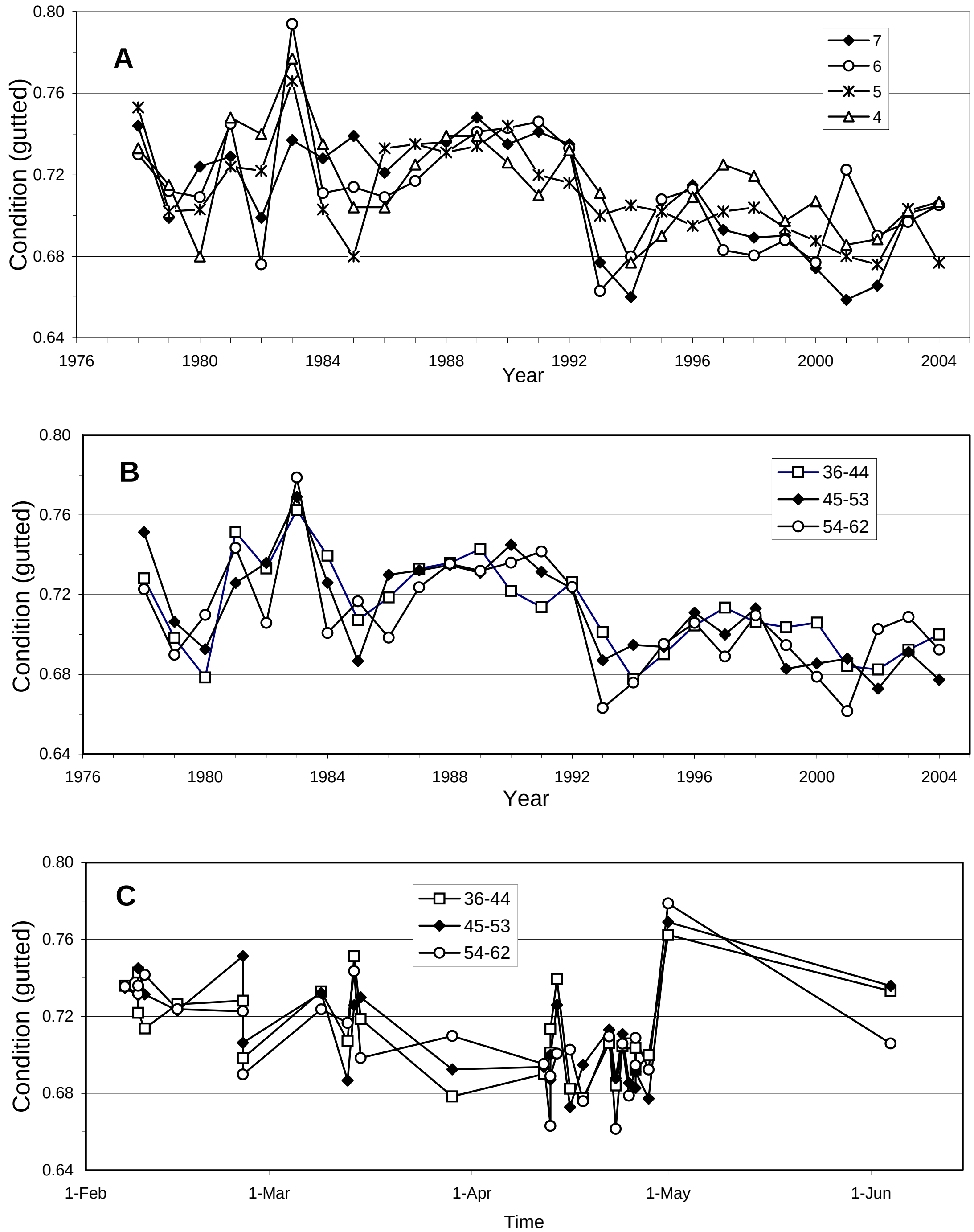
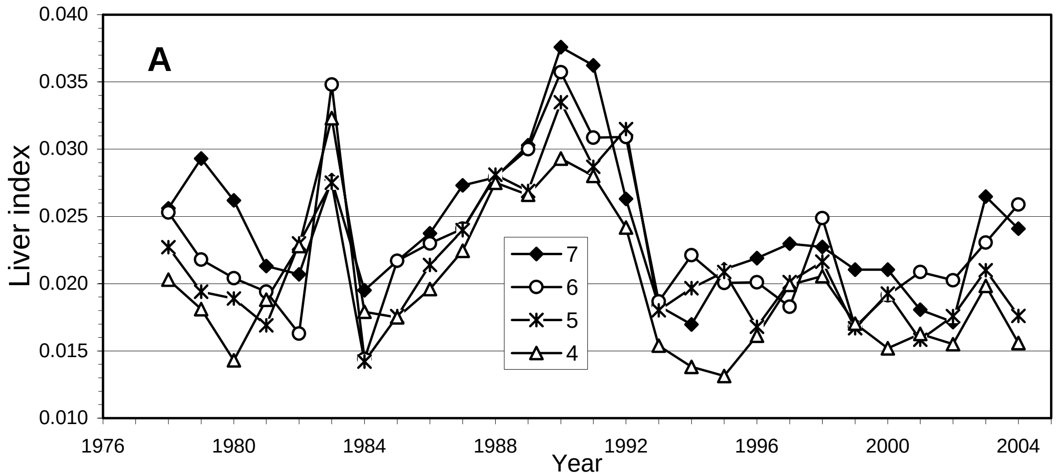
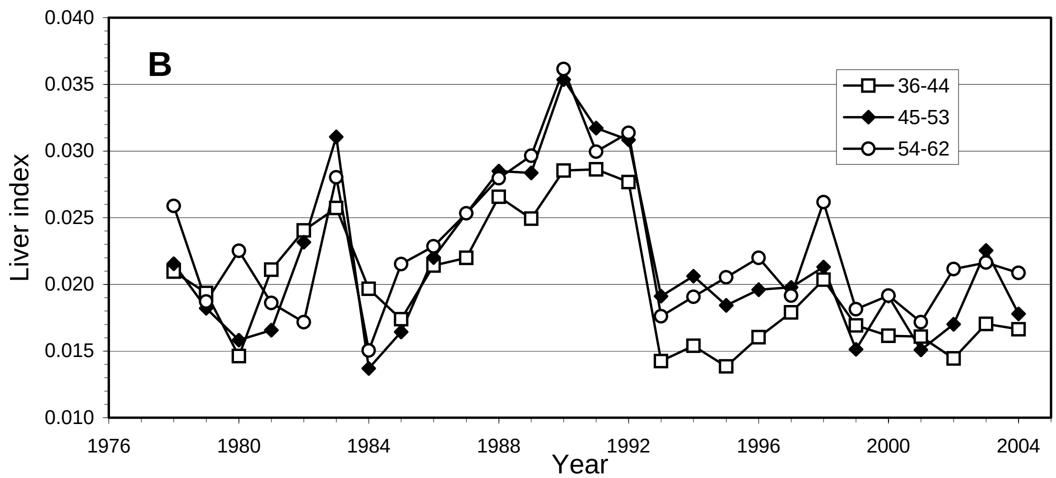


Fig. 20. Mean gutted condition of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in 1978-2004; (A) by age and year, (B) by length-group and year, and (C) by length-group and median date of collection.





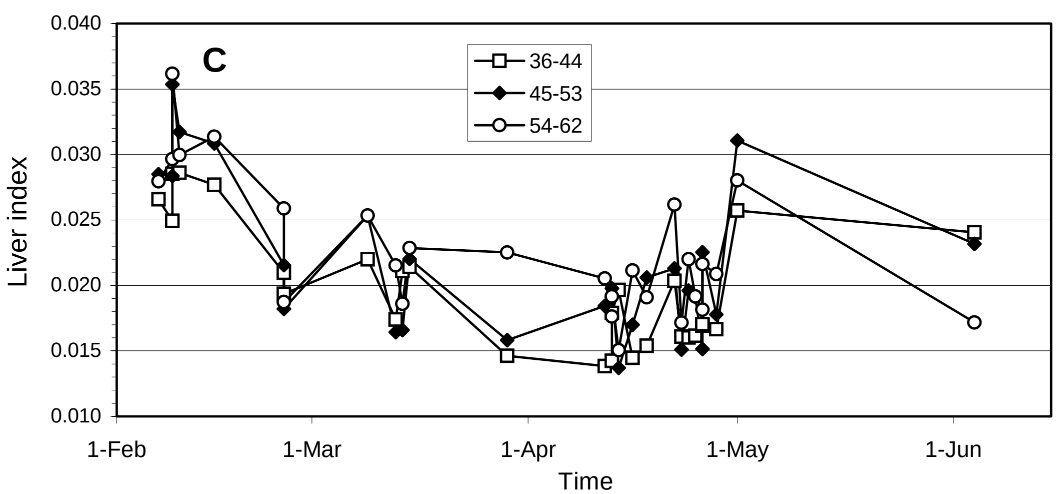


Fig. 21. Mean liver index of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in 1978-2004; (A) by age and year, (B) by length-group and year, and (C) by length-group and median date of collection.

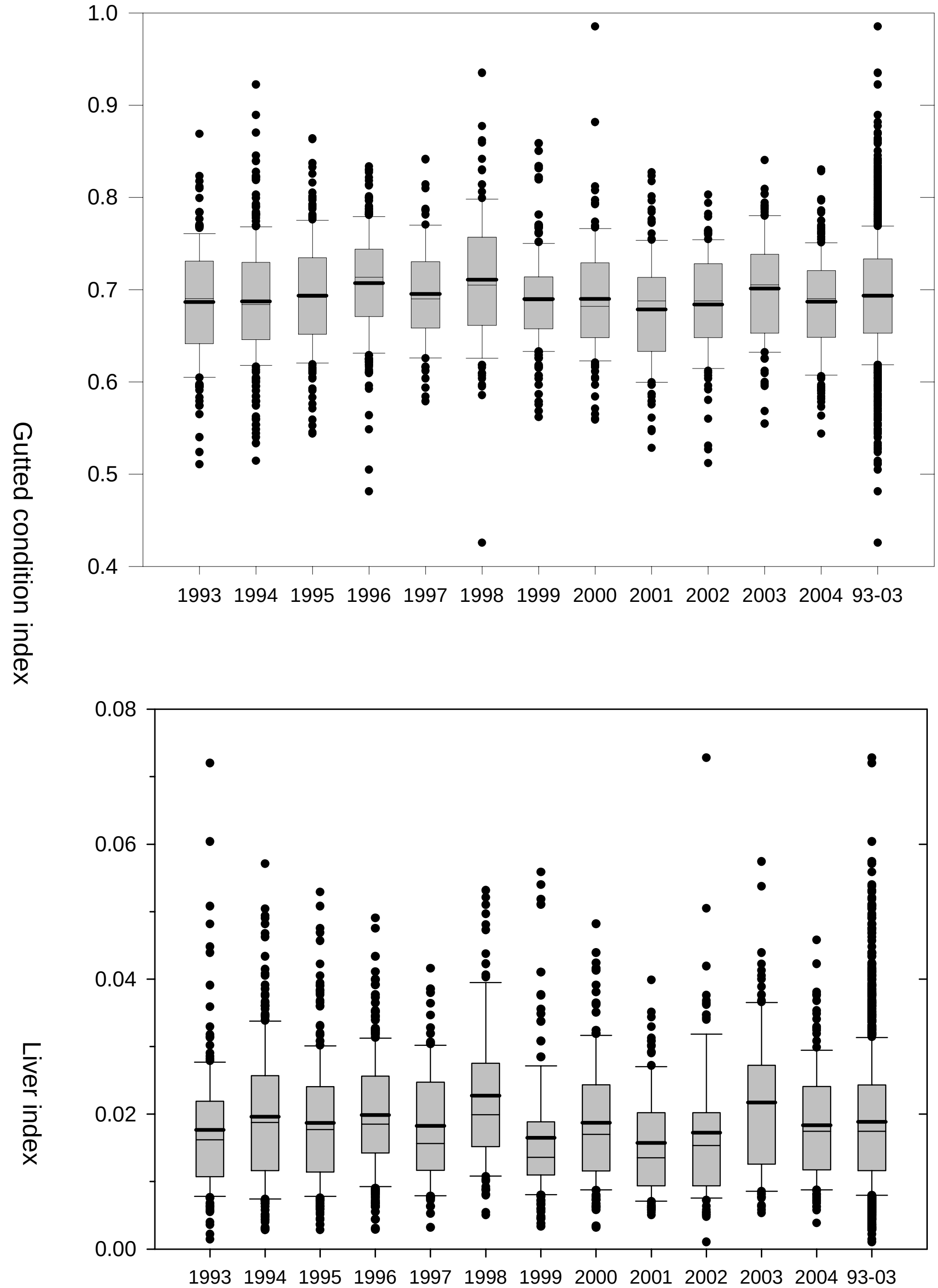


Fig. 22. Gutted condition (above) and liver index (below) of cod (40-59 cm only) caught during DFO research surveys during April-May in 1993-2004. The box furthest to the right in each panel represents all data from 1993 to 2003 combined. Each box plot illustrates the median (light line), mean (dark line), 25th and 75th percentiles (box), 10th and 90th percentiles (whisker caps) and all data beyond the 10th and 90th percentiles.

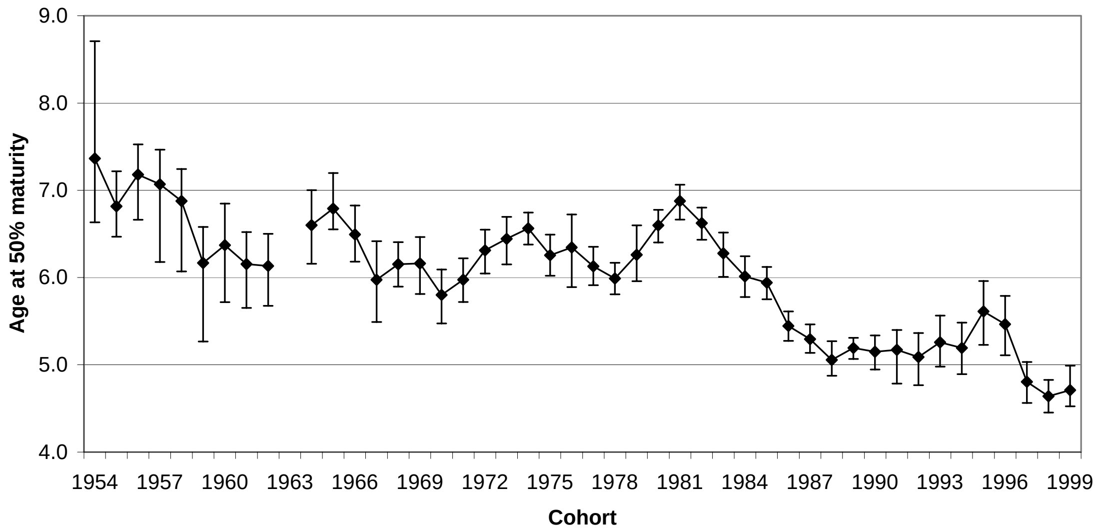


Fig. 23A. Age at 50% maturity by cohort (1954-1999) for female cod sampled during DFO research vessel bottom-trawl surveys of NAFO Subdiv. 3Ps. Error bars are 95% fiducial limits.

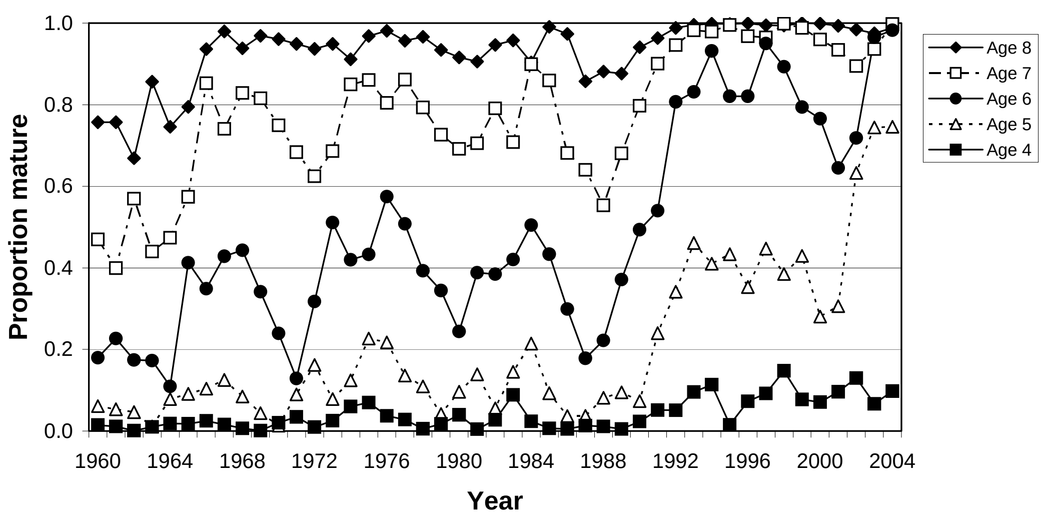


Fig. 23B. Estimated proportions mature at ages 4-8 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps.

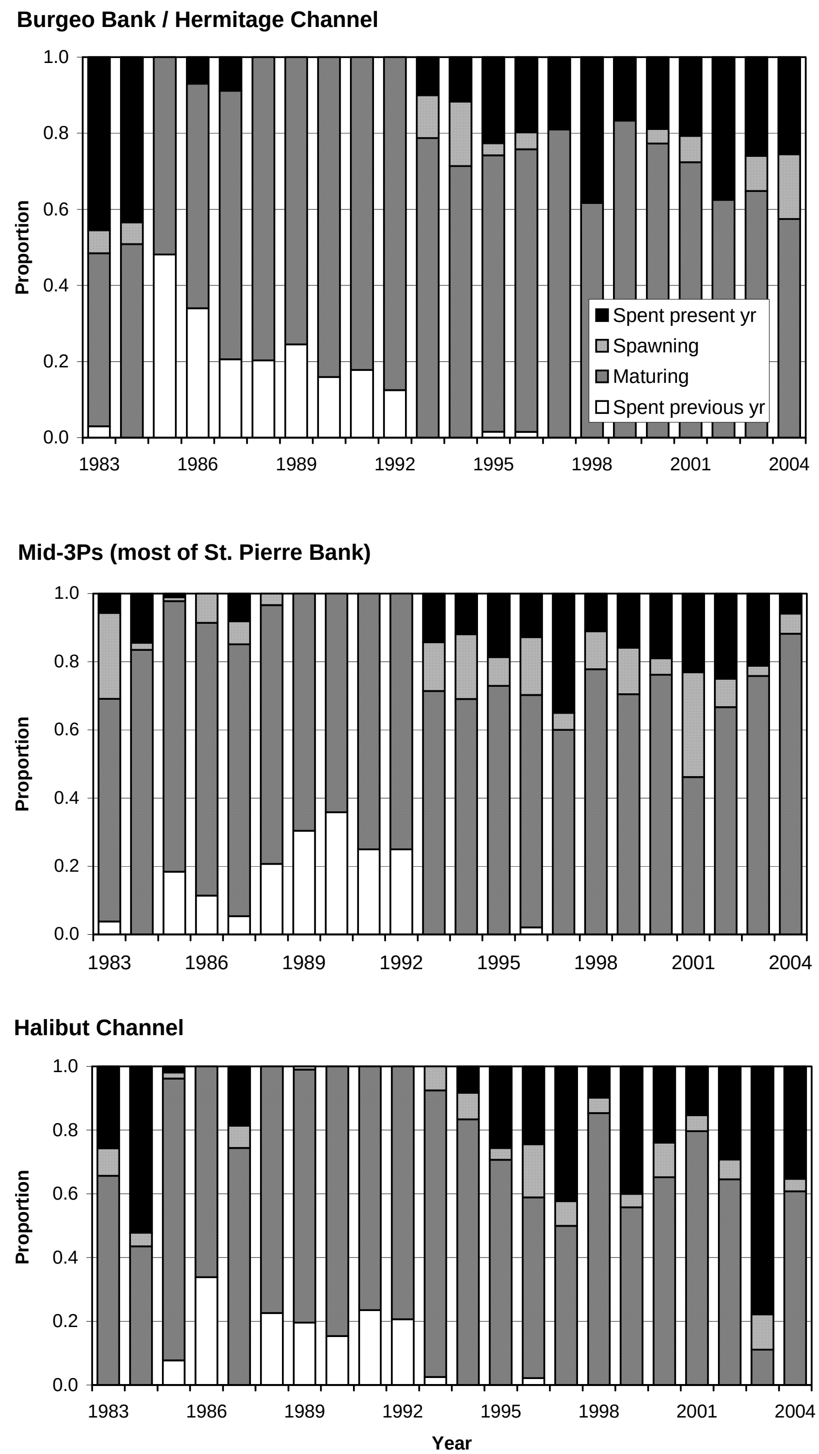


Fig. 24. Maturity stages of adult female cod sampled during DFO research vessel bottom-trawl surveys in three areas of 3Ps during winter/spring 1983-2004. There were two surveys in 1993 (Feb. and April); only the April one is shown here. Surveys were conducted in April in 1983, 1984 and 1993-2004 and in February-March in intervening years.

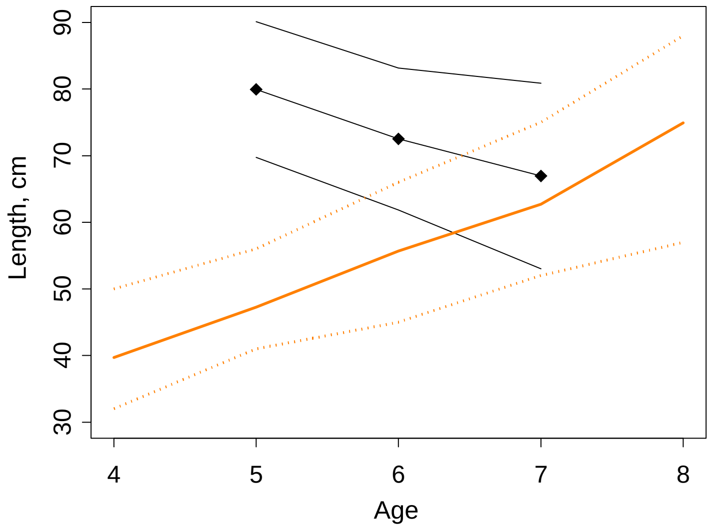


Fig. 25a. Maturation reaction norms of female cod of the 1981 cohort from NAFO Subdivision 3Ps, shown in terms of body lengths at which the probability of maturing equals 25%, 50% (reaction norm midpoint), and 75% (black continuous lines). Growth rates are depicted as arithmetic mean length at age (grey continuous lines) together with 5% and 95% percentiles (grey dotted lines).

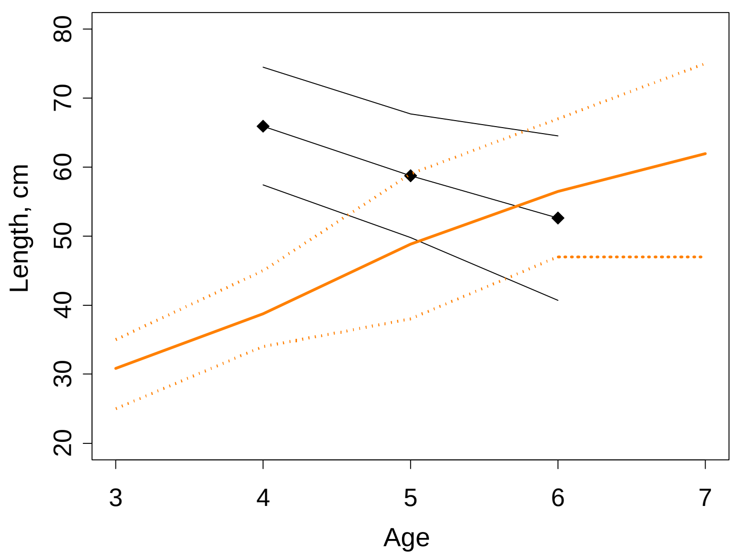


Fig. 25b. Maturation reaction norms of males of the 1981 cohort from NAFO Subdivision 3Ps, shown in terms of body lengths at which the probability of maturing equals 25%, 50% (reaction norm midpoint), and 75% (black continuous lines). Growth rates are depicted as arithmetic mean length at age (grey continuous lines) together with 5% and 95% percentiles (grey dotted lines).

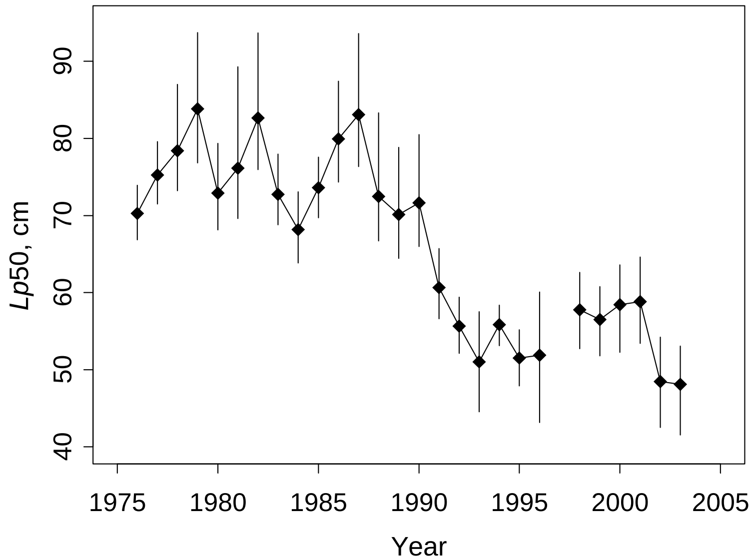


Fig. 26. Temporal trends in maturation reaction norm midpoints L_{p50} (the body length at which the probability of maturing reach 50%) of 5 year old females from the 3Ps cod stock.

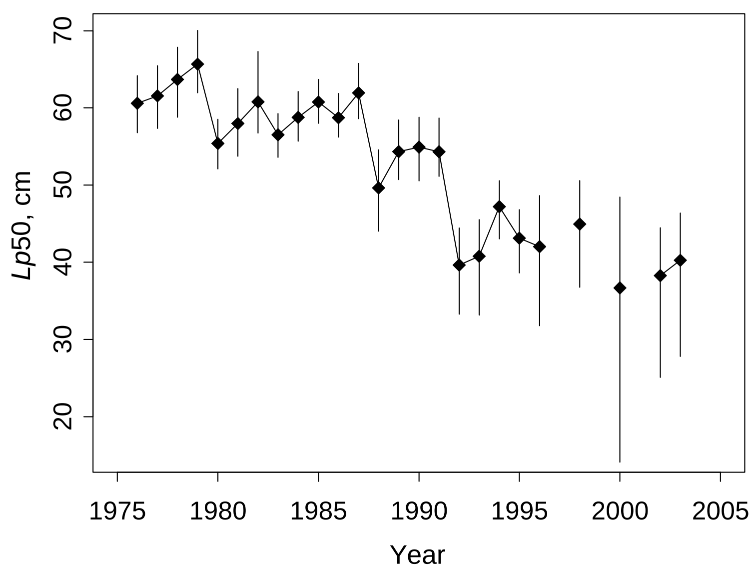


Fig. 27. Temporal trends in maturation reaction norm midpoints L_{p50} (the body length at which the probability of maturing reach 50%) of 5 year old males from the 3Ps cod stock.

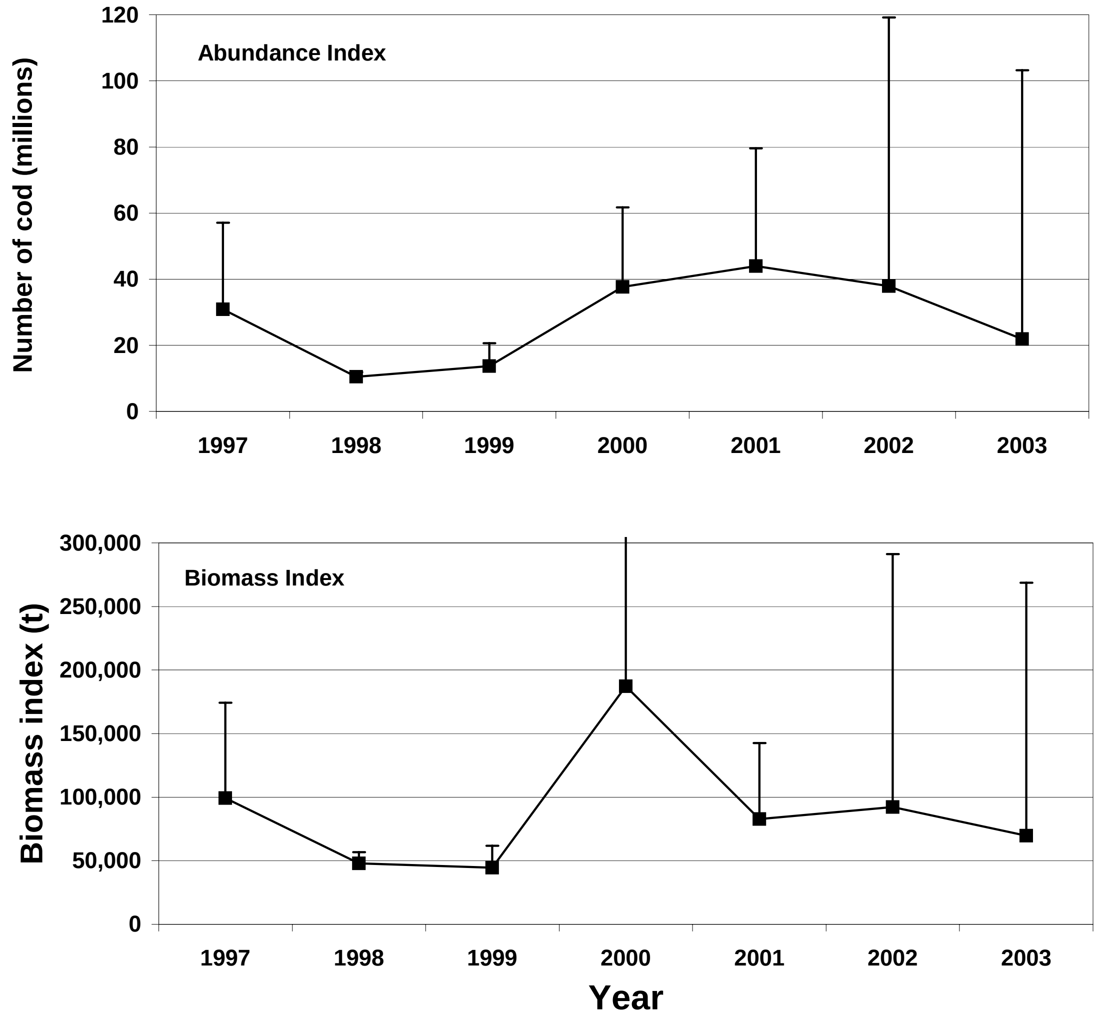


Fig. 28. Cod abundance and biomass indices (+ 1SD) for the fall industry (GEAC) bottom trawl survey of the offshore portion of NAFO Subdiv. 3Ps.

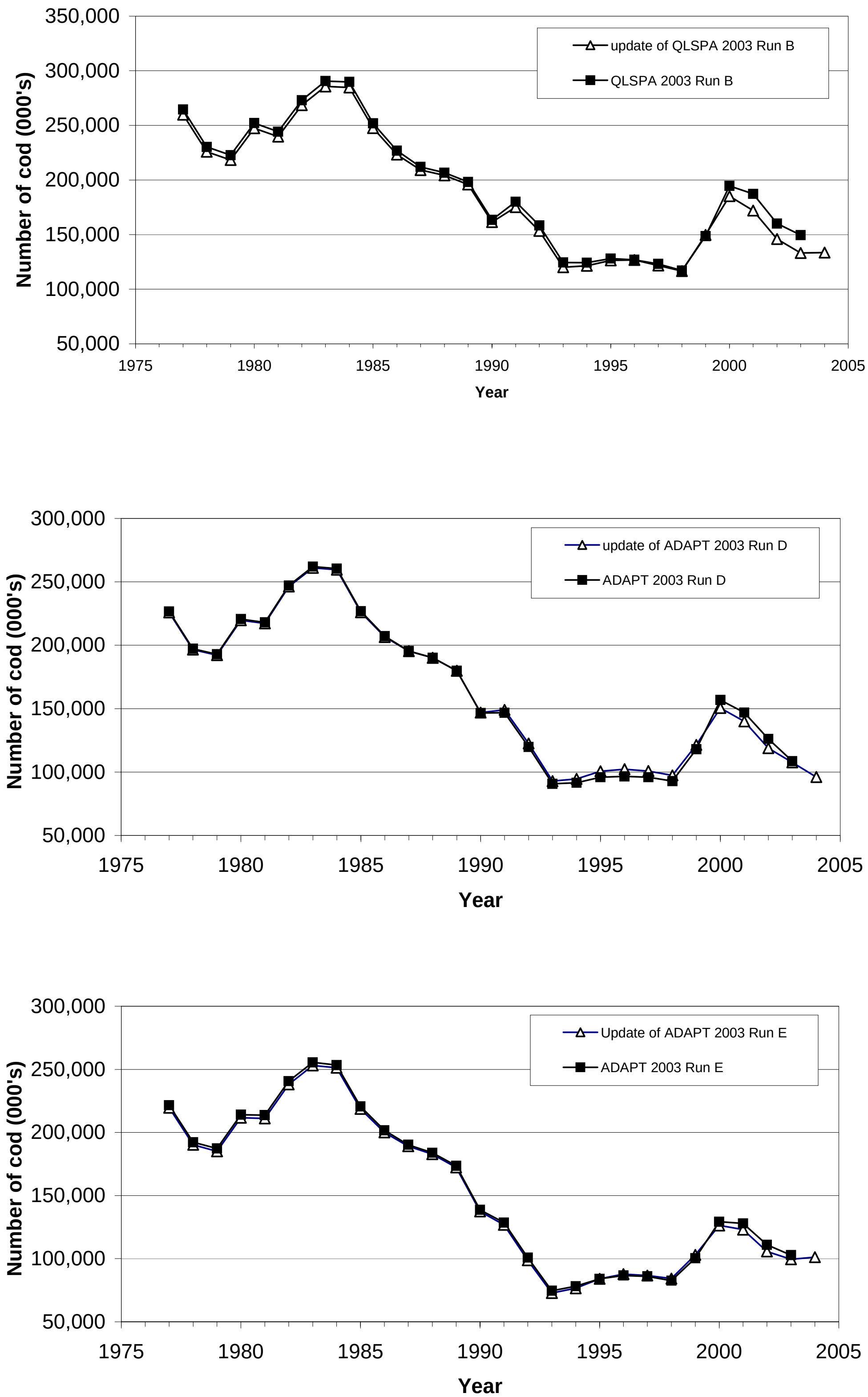
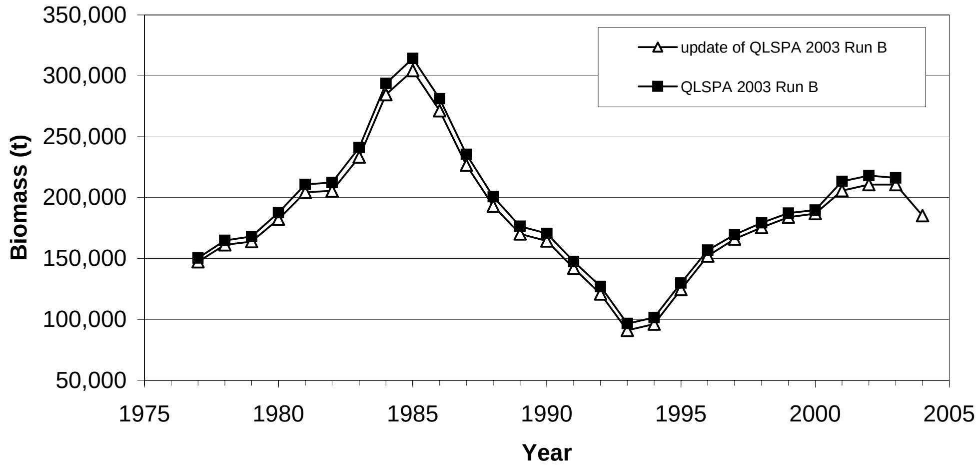
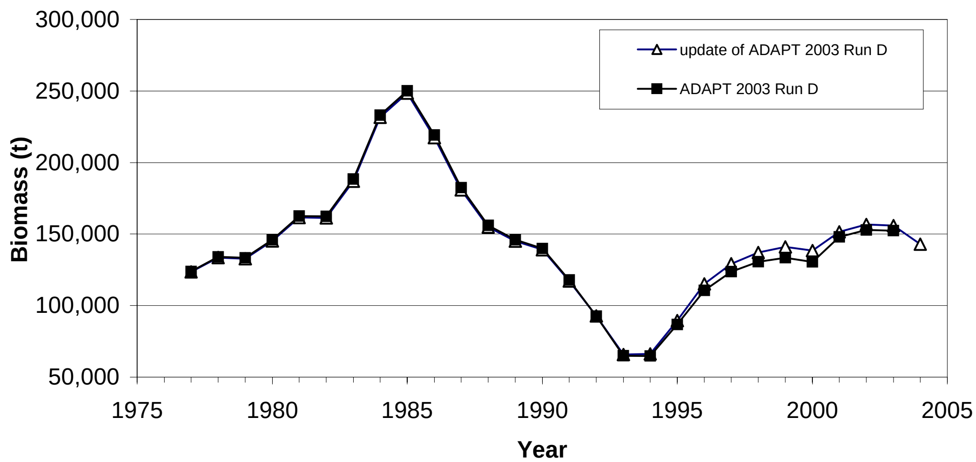


Fig. 29a. Comparison of trends in 3+ population numbers from three SPA formulations used during the 2003 assessment and updated with one more year of data during the 2004 assessment.





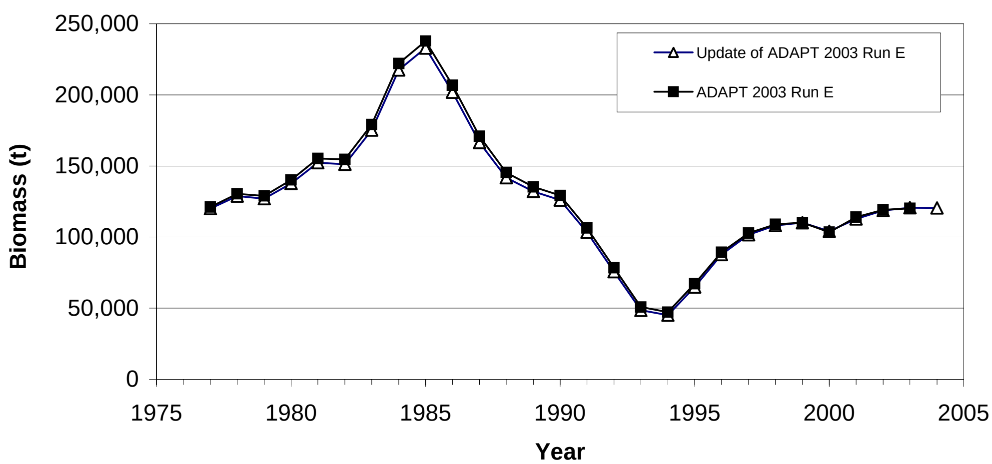


Fig. 29b. Comparison of trends in 3+ population biomass from three SPA formulations used during the 2003 assessment and updated with one more year of data during the 2004 assessment.

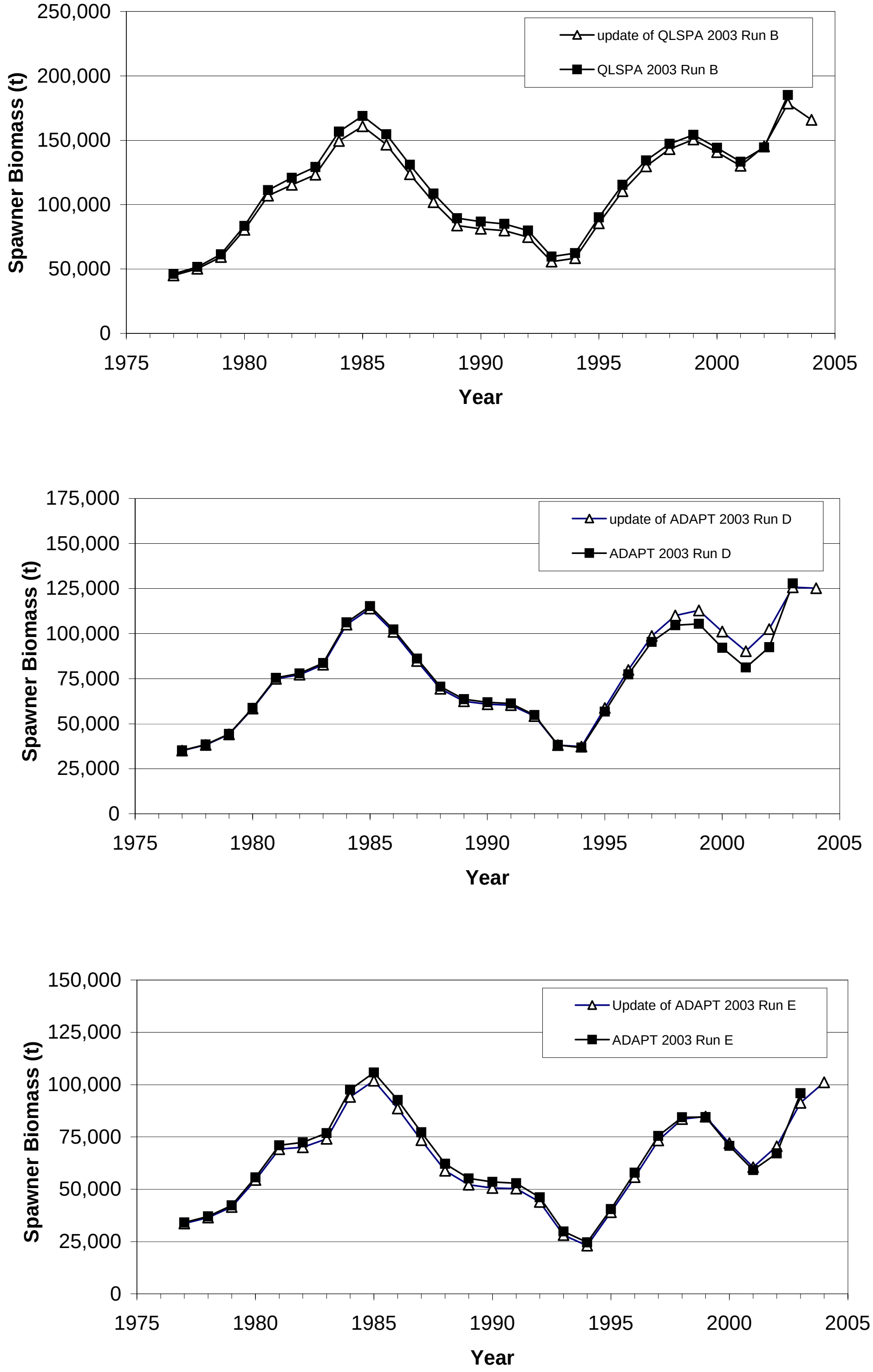


Fig. 29c. Comparison of trends in spawner biomass from three SPA formulations used during the 2003 assessment and updated with one more year of data during the 2004 assessment.

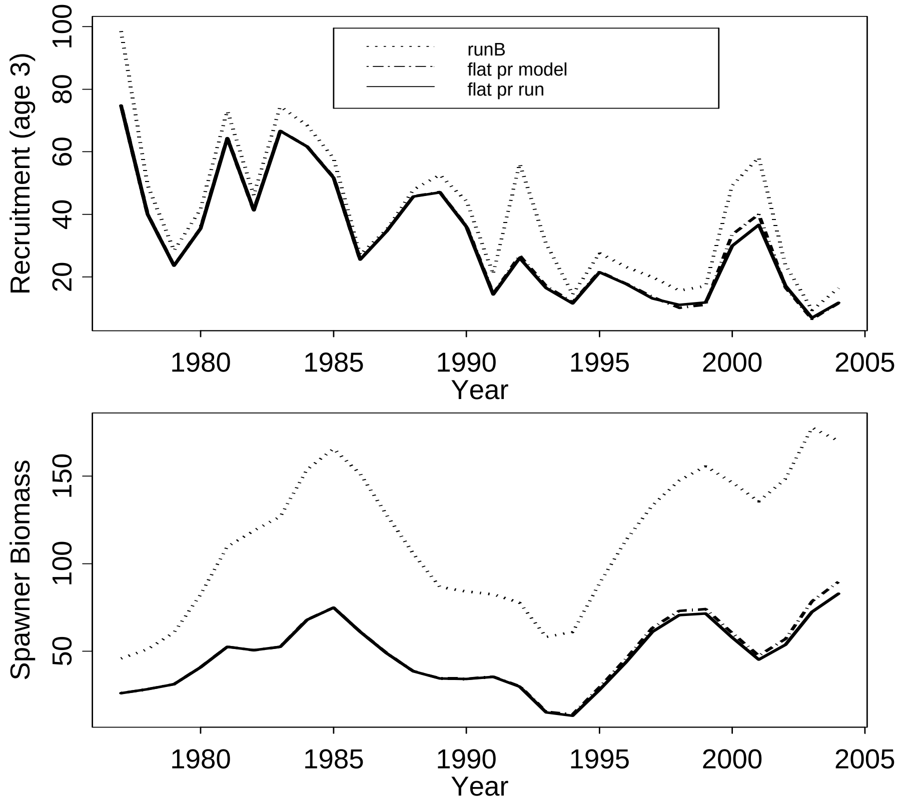


Fig. 30a. Comparison of trends in recruitment (upper panel) and spawner biomass (lower panel) estimated from three QLSPA runs conducted during the October 2004 assessment of 3Ps cod. See text for details.

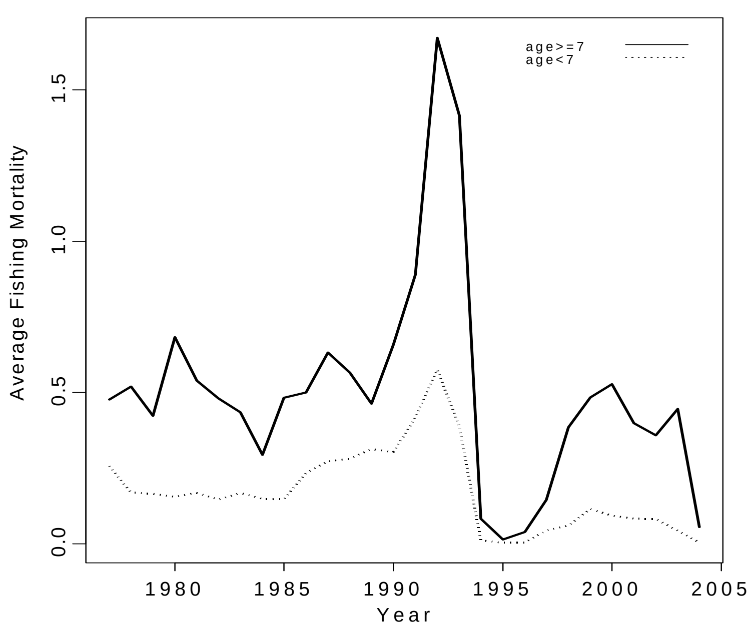


Fig. 30b. Comparison of trends in fishing mortality between two age groups of cod estimated from QLSPA-2004 Run B.

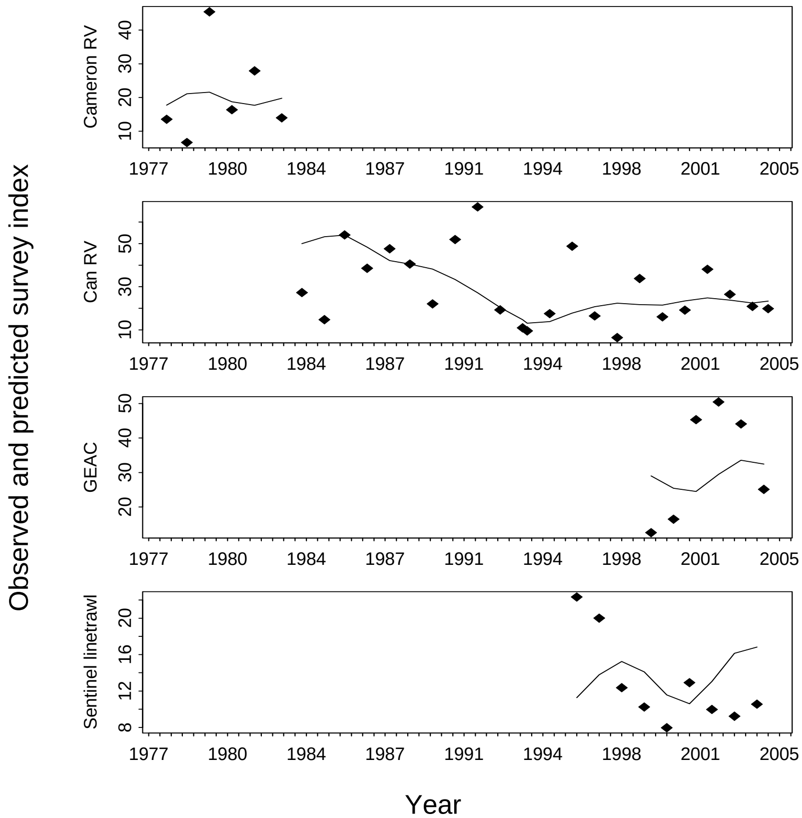


Fig. 30c. Age-aggregated residual plots showing fits to survey indices of QLSPA-2004 Run B from the October 2004 assessment of NAFO Subdiv. 3Ps cod. Symbols are observed values; lines are model predicted values.

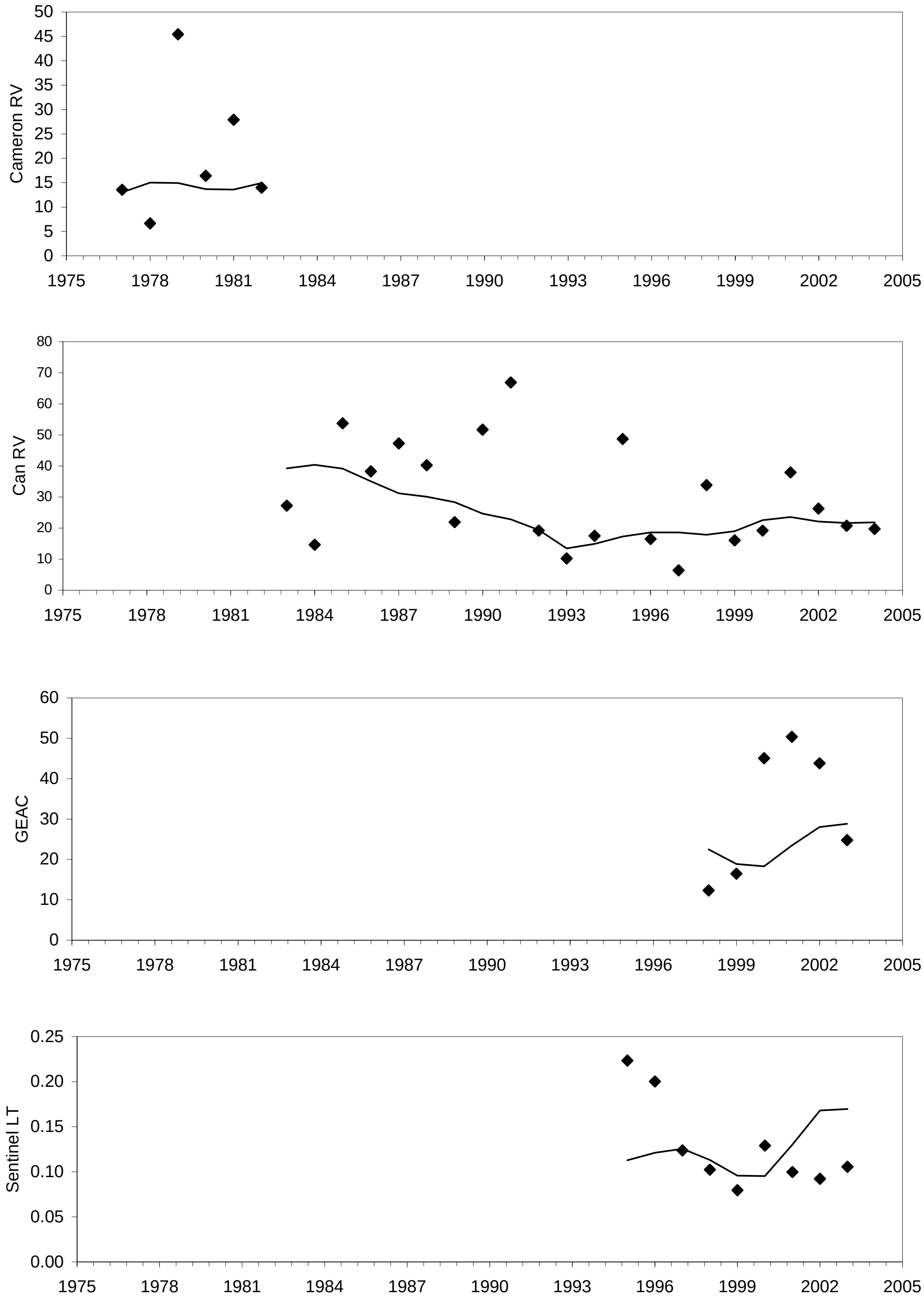


Fig. 31. Age aggregated residual plots for survey indices from ADAPT SPA Run D from the October 2004 assessment of NAFO Subdiv. 3Ps cod. Symbols are observed values, lines are model predicted values.

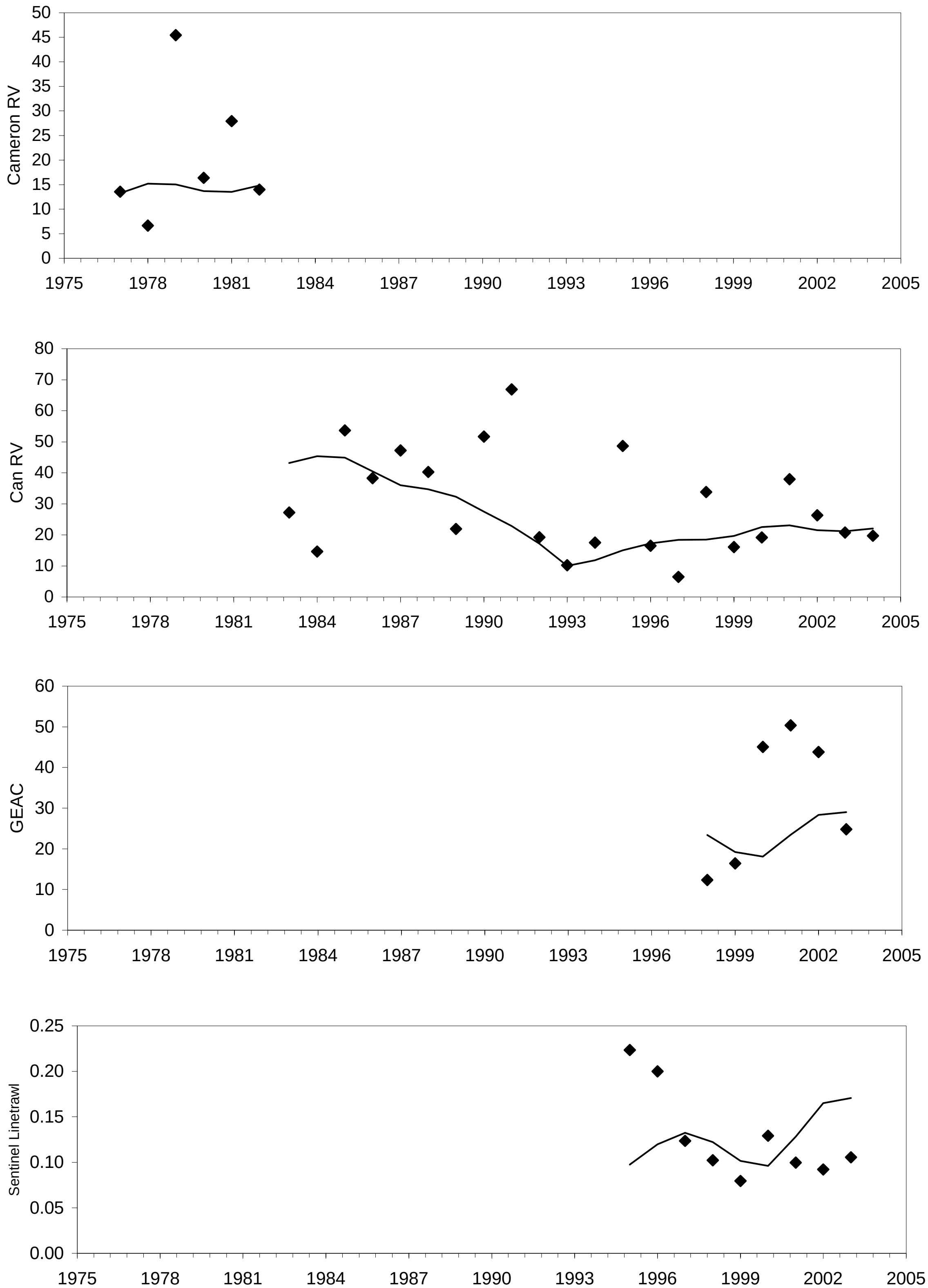


Fig. 32. Age aggregated residual plots for survey indices from ADAPT SPA Run E from the October 2004 assessment of NAFO Subdiv. 3Ps cod. Symbols are observed values, lines are model predicted values.

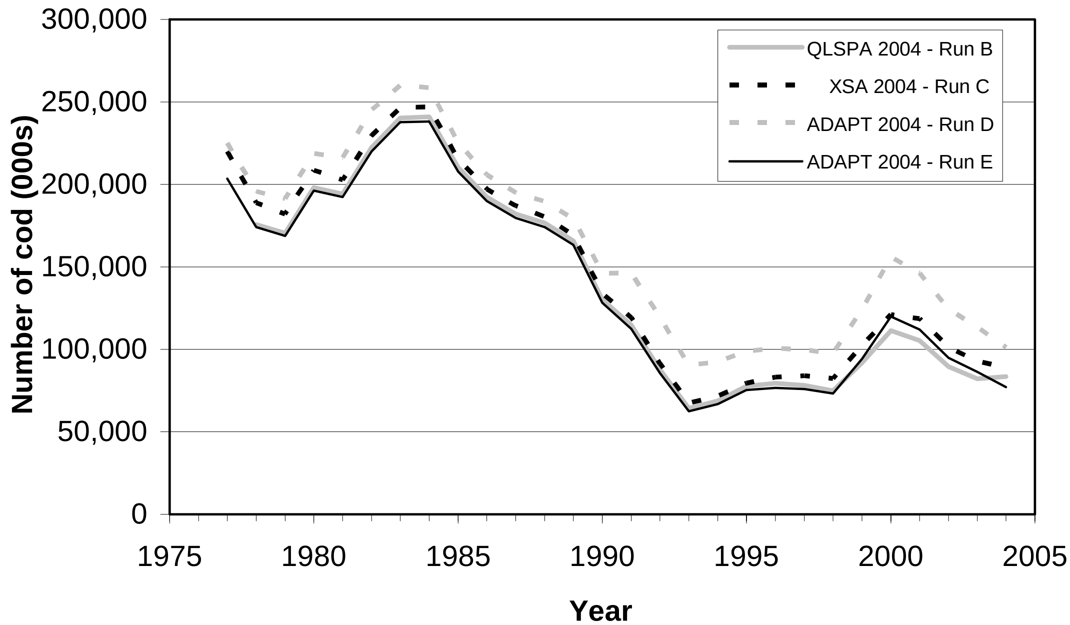


Fig. 33a. Comparison of trends in 3+ population numbers estimated from four SPA models/formulations at the October 2004 assessment of NAFO Subdiv. 3Ps cod.

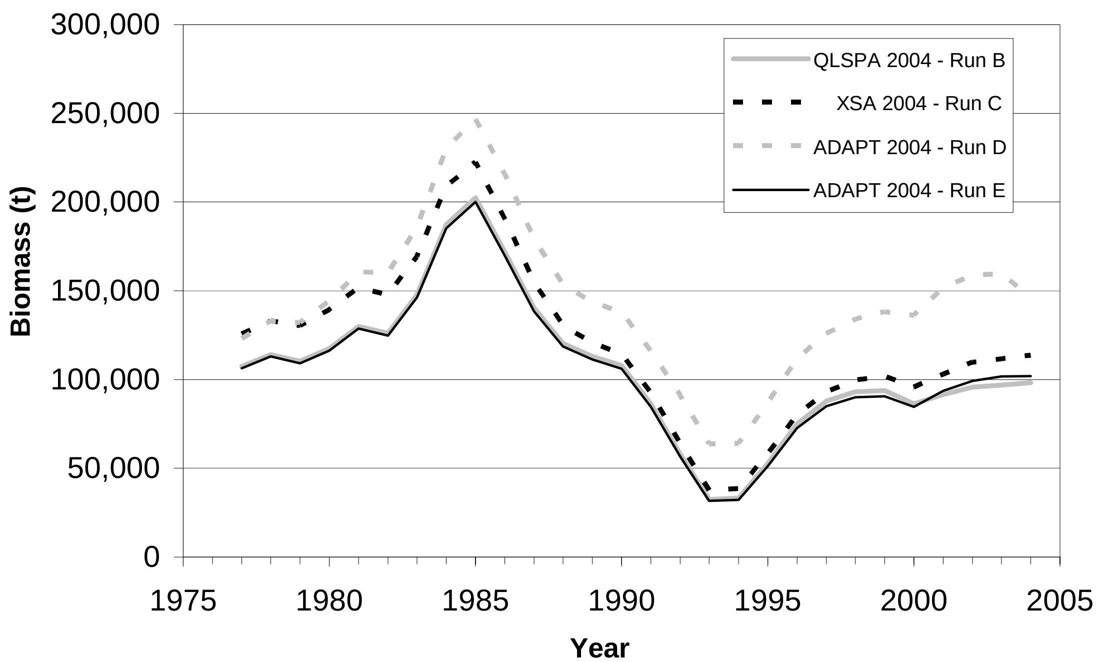


Fig. 33b. Comparison of trends in 3+ biomass (t) estimated from four SPA models/formulations at the October 2004 assessment of NAFO Subdiv. 3Ps cod.

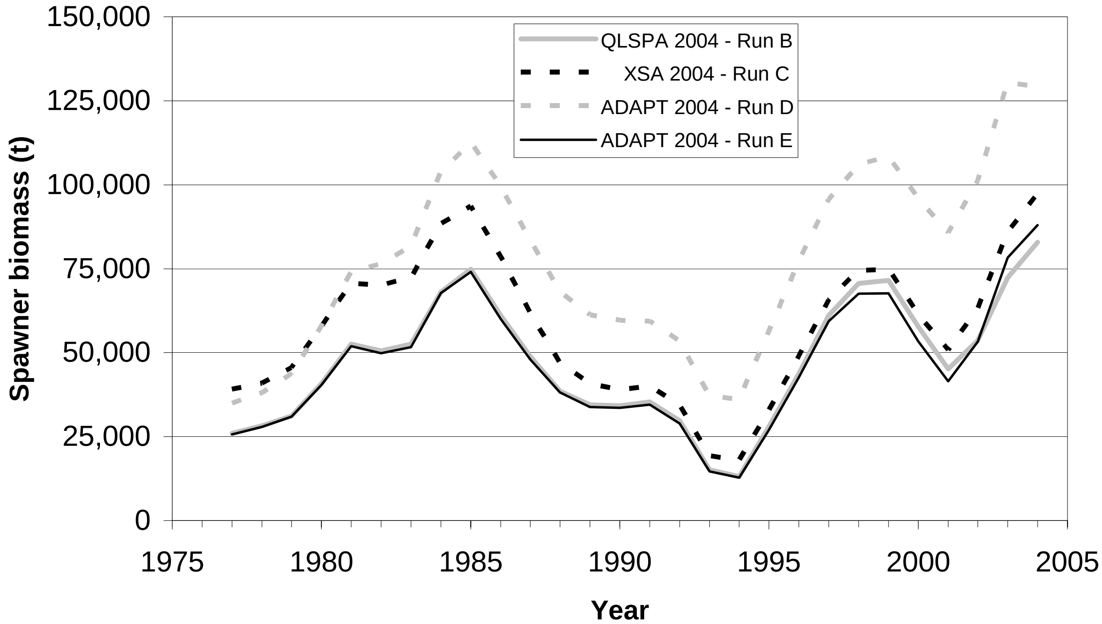


Fig. 33c. Comparison of trends in spawner biomass (t) estimated from four SPA models/formulations at the October 2004 assessment of NAFO Subdiv. 3Ps cod.

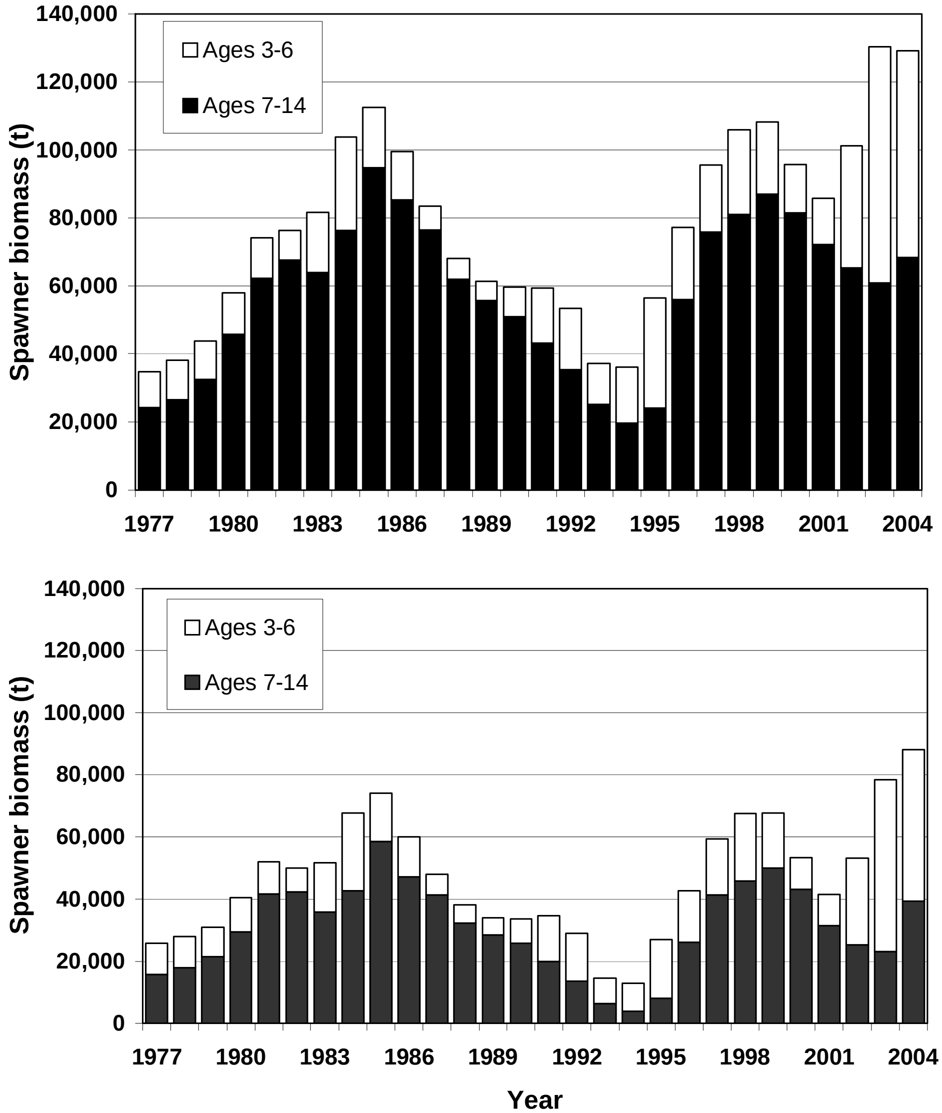


Fig. 33d. Trends in the age composition of the spawner biomass. Upper panel ADAPT-2004 Run D, lower panel ADAPT-2004 Run E.

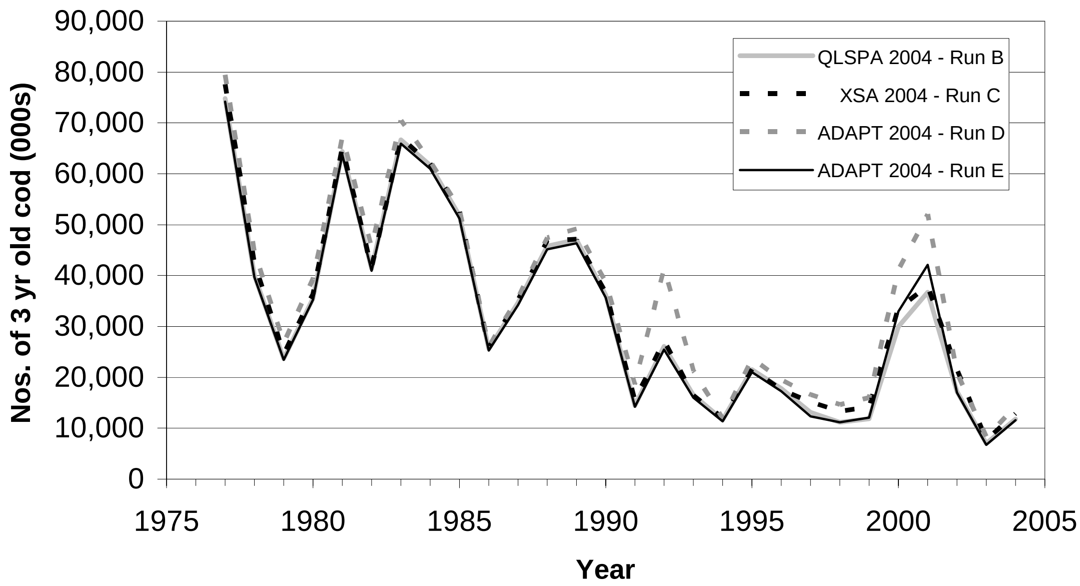


Fig. 33e. Comparison of trends in recruitment (nos. of 3 yr olds) from four SPA models/formulations at the October 2004 assessment of NAFO Subdiv. 3Ps cod.

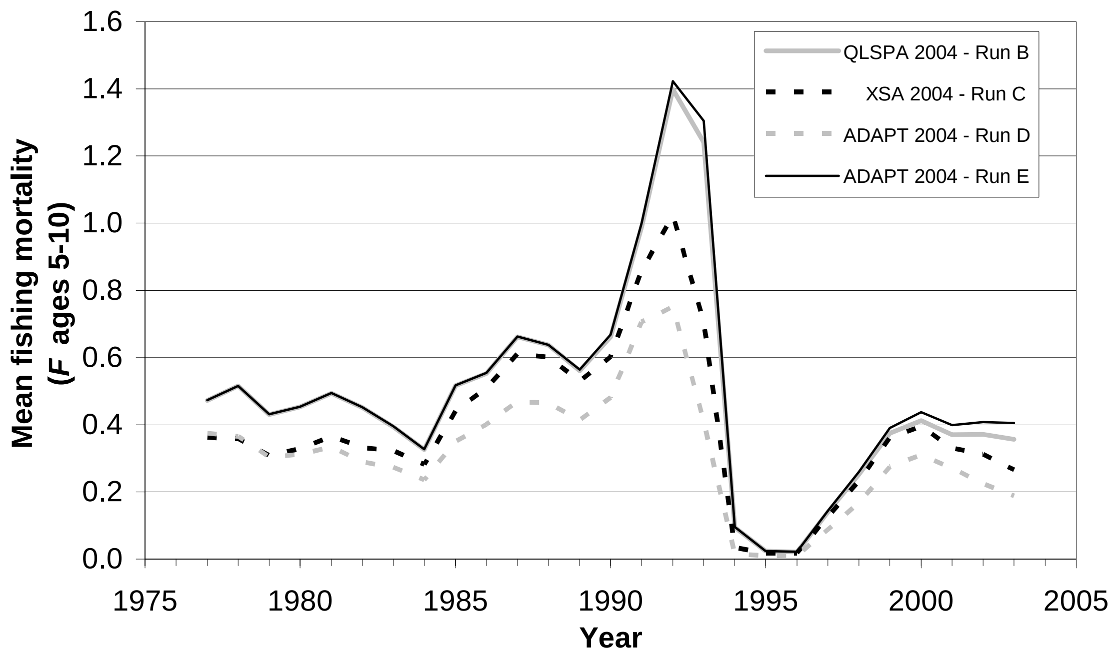


Fig. 33f. Comparison of trends in fishing mortality (average *F* ages 5-10) estimated from four SPA models/formulations at the October 2004 assessment of NAFO Subdiv. 3Ps cod.