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Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2011

Évaluation de l'état du stock de morue (*Gadus morhua*) dans la sous-division 3Ps de l'OPANO en 2011

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ABSTRACT

The status of the cod stock in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps was assessed during a regional advisory process (RAP) held during October of 2011. Stock status was updated based upon information collected up to spring 2011. Principal sources of information available for the assessments were: a time series of abundance and biomass indices from Canadian winter/spring research vessel bottom trawl surveys, inshore sentinel surveys, science logbooks from vessels <35 ft, reported landings from commercial fisheries, oceanographic data, and tagging studies. Total landings for the 2010-2011 management year (April 1 to March 31) were 7,800 t or just 68% of the total allowable catch (TAC). Though this is the second consecutive year that the TAC was not fully taken, it is unusual. Industry participants indicated this discrepancy was primarily due to reduced profitability, additional market considerations, and some reduction in fish availability offshore. The 2011-2012 fishery was still in progress at the time of the RAP with provisional landings to date totaling of 2,600 t. The removals through recreational fishing are unknown since 2007, but based on previous estimates are thought to be a small fraction (~1%) of the commercial landings.

A complex of stock components are exploited in Subdiv. 3Ps. Thus the impact of fishing at specific TAC levels on all components cannot be quantified. However, the Fisheries and Oceans Canada (DFO) research vessel (RV) survey covers most of the stock, and it is thought that survey trends broadly reflect overall stock trends.

The abundance and biomass indices from the 2011 DFO RV spring survey were both lower than those in 2010, and both are presently below the time-series (1983 to 2010) average. The 2006 year-class is estimated to be well above average, and survey results for this year-class are comparable to the 1997 and 1998 year-classes, each of which contributed to stock growth and supported commercial fisheries for several years. The gillnet catch rates from inshore sentinel surveys and logbooks for vessels <35 ft suggest stability. However, recent line-trawl catch rates from these sources indicate decline.

Spawning stock biomass (SSB) estimated from a survey based cohort model decreased in recent years and was estimated to be below the limit reference point (LRP) during 2008 and 2009. Thereafter, SSB has increased, and in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08). A one year projection to 2012 using the cohort model indicated that survey SSB will continue to increase if total mortality is similar to current values (i.e., within ± 20%). This increase is due to the recruitment of the relatively strong 2006 year class (YC) to the spawner biomass. The projection also indicated that the probability of being below the LRP in 2012 is low (0.02 to 0.09). A three year projection to 2014 indicates subsequent declines in both total biomass and spawning biomass, and in 2014 the probability of being below the LRP ranges from 0.03 to 0.56, depending upon the assumed mortality.

RÉSUMÉ

L'état du stock de morue dans la sous-division 3Ps de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) a fait l'objet d'une évaluation lors d'un processus d'évaluation régionale (PER) en octobre 2011. L'état du stock a été mis à jour à partir des données recueillies jusqu'au printemps 2011. Voici les principales sources de données utilisées dans les évaluations : une série chronologique d'indices d'abondance et de biomasse obtenus par des relevés au chalut de fond effectués à l'hiver et au printemps au moyen d'un navire de recherche canadien, des relevés par pêches sentinelles côtières, des journaux de bord des navires de recherche scientifique de < 35 pi et les débarquements signalés des pêches commerciales, les données océanographiques, ainsi que des études de marquage. Les débarquements de l'année de gestion de 2010-2011 (du 1er avril au 31 mars) ont totalisé 7 800 tonnes ou juste 68 % du total autorisé des captures (TAC). Même s'il s'agit de la deuxième année consécutive où le TAC n'a pas été atteint, cela reste inhabituel. Les participants de l'industrie ont signalé que cette anomalie était due surtout à une réduction de la rentabilité, à d'autres considérations relatives au marché et à la diminution de la disponibilité des poissons dans les zones extracôtières. Au moment du PER, la saison de pêche 2010-2011 était toujours en cours, et les données provisoires sur les débarquements totaux s'établissaient à 2 600 t. On ignore le nombre de prises dans le cadre de la pêche récréative depuis 2007, mais, d'après les estimations précédentes, on croit qu'il représente une faible fraction (~1 %) des débarquements commerciaux.

Un ensemble de composantes du stock de morue est exploité dans la sous-division 3Ps. En conséquence, l'impact de la pêche à des niveaux de TAC particuliers sur toutes les composantes ne peut pas être quantifié. Cependant, le relevé effectué par le navire de recherche de Pêches et Océans Canada (MPO) couvre presque tout le stock, et l'on croit que les tendances observées reflètent généralement les tendances globales du stock.

Les indices d'abondance et de biomasse du relevé du printemps 2011 du navire de recherche du MPO étaient inférieurs à ceux de 2010 et se situent actuellement en dessous de la moyenne de la série chronologique de 1983 à 2010. On considère que la classe d'âge de 2006 est bien au-dessus de la moyenne et les résultats du relevé pour cette classe sont comparables à ceux des classes des années 1997 et 1998, qui avaient contribué à la croissance du stock et alimenté la pêche commerciale pendant des années. Les taux de prise des relevés sentinelles au filet maillant dans les eaux côtières ainsi que les journaux de bord des navires de < 35 pi indiquent une certaine stabilité. Cependant, les taux de prise récents à la palangre que donnent ces mêmes sources indiquent un déclin.

La biomasse du stock reproducteur (BSR), estimée à partir d'un modèle de cohorte basé sur les relevés, a diminué ces dernières années et se situerait, selon les estimations, en dessous du point de référence limite (PRL) pendant 2008 et 2009. Après, la BSR a augmenté et on estime qu'elle se situe au-dessus du PRL en 2011, avec une faible probabilité (0,08) qu'elle soit en dessous. Une projection d'un an jusqu'en 2012 établie à l'aide du modèle des cohortes a révélé que la BSR dérivée des relevés continuera de s'accroître si la mortalité totale demeure près des valeurs actuelles (c.-à-d. ±20 %). Cette augmentation est causée par le recrutement de la classe d'âge relativement abondante de 2006 dans la biomasse reproductrice. La projection indique également que la probabilité que la BSR soit inférieure au PRL en 2012 est faible (de 0,02 à 0,09). Une projection de trois ans jusqu'en 2014 indique que la biomasse totale et la biomasse reproductrice déclineront par la suite et la probabilité qu'elles se situent en deçà du PRL en 2014 varie entre 0,03 et 0,56, en fonction de la mortalité présumée.

INTRODUCTION

This document gives an account of the 2011 assessment of the Atlantic Cod (*Gadus morhua*) stock in Northwest Atlantic Fisheries Organization (NAFO) Subdiv. 3Ps located off the south coast of Newfoundland (Figs. 1 and 2). The history of the cod fishery in Subdiv. 3Ps and results from other recent assessments of this stock are described in previous documents (see Brattey et al. 2007, 2008; Healey et al. 2011 and references therein). A regional assessment meeting was conducted during October 2011 (DFO 2012). Participants included DFO scientists, a scientist from the French Research Institute for Exploitation of the Sea (IFREMER, France), DFO fisheries managers, government officials from the province of Newfoundland and Labrador, fishing industry representatives, and a representative of World Wildlife Fund (Canada).

Various sources of information on Subdiv. 3Ps cod were available to update the status of this stock. Commercial landings through September 2011 were available, though catch at age was only updated to 2010 as the 2011 fishery and sampling thereof were ongoing. The results of the DFO research vessel survey during April 2011 was reviewed in detail and compared to previous survey results. Additional sources of information included science logbooks for vessels <35 ft (1997 to 2010), inshore sentinel surveys from 1995 to 2010 (Maddock Parsons 2013), and recaptures of tagged cod (received as of October 2010) from tagging conducted in Subdiv. 3Ps during 1997-2010 (Brattey and Healey 2006). A survey-based assessment model (Cadigan 2010) was used to smooth signals in the research vessel (RV) survey, and provided estimates of biomass, total mortality, and recruitment for that portion of the stock covered by the DFO RV survey. Short-term projections of these estimates under mortality similar to recent levels were also evaluated to advise on the management of this stock.

ENVIRONMENTAL OVERVIEW

Oceanographic information collected during the spring DFO RV surveys indicated that near-bottom temperatures throughout Subdiv. 3Ps have warmed during 2009 to 2011 and are presently above average. As an example, the percentage of the survey area with bottom temperatures $<0^{o}$C was near 0% in 2011, compared to almost 30% in 2007 and 2008. Survey catches of cod are generally lower in years when there are relatively large incursions of cold/fresh water from the eastern Newfoundland shelf. Furthermore, a significant positive correlation was found between bottom temperature and the survey abundance of cod in depths of 100 m or less. The areal extent of bottom water with temperatures $>3^{o}$C has remained relatively constant at about 50% of the total Div. 3P area, although actual temperature measurements show considerable inter-annual variability. The current conditions are comparable to those of the late 1970s and early 1980s when the stock was more productive.

TOTAL ALLOWABLE CATCHES AND COMMERCIAL CATCH

TOTAL ALLOWABLE CATCH (TAC)

A history of the total allowable catch (TAC) for this stock over 1959 to 2011 is presented in Table 1 (see also Fig. 3). This stock was subject to a moratorium on all fishing from August 1993 to the end of 1996. Excluding these years, the magnitude of the TAC has varied considerably over time, ranging from 70,500 t in 1973, the initial year of TAC regulation, to 10,000 t in 1997. The TAC for the past three seasons has been constant at 11,500 t. Under the terms of the 1994 Canada-France agreement, the Canadian and French shares of the TAC are 84.4% and 15.6%, respectively.

COMMERCIAL CATCH

Catches (reported landings) from Subdiv. 3Ps for the period 1959 to September 30th, 2011 are summarized by country and separately for fixed and mobile gear in Table 1 and Figs. 3a and 3b. Prior to the moratorium, Canadian landings for vessels <35 ft were estimated mainly from purchase slip records collected and interpreted by Statistics Division, Fisheries and Oceans Canada. Shelton et al.

(1996) emphasized that these data may be unreliable. Post-moratorium landings for Canadian vessels <35 ft have come mainly from a dock-side monitoring program initiated in 1997. Landings for Canadian vessels >35 ft come from logbooks. Non-Canadian landings (only France since 1977) were compiled from national catch statistics reported by individual countries to NAFO. In recent years, the provisional information for landings by France are provided directly by French government officials. Recent entries in Table 1 are designated as provisional until final catch statistics are available.

Cod in the Subdiv. 3Ps management unit was heavily exploited in the 1960s and early 1970s 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 Canadian jurisdiction in 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, with catches increasing to about 59,000 t in 1987. Subsequently, reported catches declined gradually to 36,000 t in 1992. Catches exceeded the TAC throughout the 1980s and into the 1990s. The Canada-France boundary dispute at this time led to fluctuations in the French catch during the late 1980s. Under advice from the Fisheries Resource Conservation Council, a moratorium was imposed on all directed cod fishing in August 1993 after only 15,216 t had been landed. Access by French vessels to Canadian waters was restricted in 1993.

During the 2010 calendar year, total reported landings were 8,299 t with the Canadian inshore fixed gear sector accounting for 5,244 t (63%) of the total (Table 1). Total landings for the 2010-2011 management year (April 1–March 31) were 7,800 t, 68% of the 11,500 t TAC. Though this is the second consecutive season in which the full TAC was not landed (77% of the TAC landed during the previous season), it is uncommon. Prior to the 2009-2010 season, the TAC had been fully utilized if not exceeded in each year since Canadian jurisdiction was extended in 1977 (excluding moratorium). Industry participants at the 2010 and 2011 assessment indicated several reasons contributing to this shortfall, but primarily it was thought to be due to a large reduction in prices, additional market considerations and a reduction in the availability of large fish offshore during winter 2010. Preliminary landings data for 2011 to September 30th totaled 4,248 t. Although the 2011-2012 fishing season is incomplete, these totals to date are again relatively low due to reductions in fishing effort (DFO 2011) and it is unlikely that the full TAC will be landed.

Since 1997, most of the TAC has been landed by Canadian inshore fixed gear fishermen (where inshore is typically defined as Unit areas 3Psa, b, and c; refer to Fig. 1), with remaining catch taken mainly by the mobile gear sector fishing the offshore, i.e., Unit areas 3Psd, e, f, g, and h (Table 1, Fig. 3a, and 3b). This general pattern has continued since the fishery reopened in 1997, but there has been a slight increase in landings from offshore unit areas due to some smaller fixed gear vessels redirecting their effort to offshore fishing areas. However, in both 2009 and 2010, some of these patterns differed as effort and landings were reduced.

Line-trawl (= longline) catches dominated the fixed gear landings over the period 1977-1993, 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 16-26% 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 the dominant gear used for the inshore catch since the fishery reopened in 1997, with gillnet landings exceeding 50% of the TAC for the first time in 1998. 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 temporary 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). Cod trap landings from 1975 up until the moratorium varied considerably, ranging from approximately 1,000 – 7,000 t. Since 1998, trap landings have been reduced to negligible amounts (<120 t). Hand-line catches were a small component of the inshore fixed gear fishery prior to the moratorium (about 10-20%) and accounted for about 5% of landings on average for the post-moratorium period. However, hand-line catch for 2001 shows a substantial increase (to 17% of total fixed gear) and this may reflect the temporary restriction in use of gillnets

described above. In 2009, the proportion of hand-line catch doubled and increased to almost 10% of the fixed gear catch as buyers paid a higher price for hook-caught fish than for gillnet landings. This increase has not been sustained in either 2010 (or in 2011 statistics to date).

A summary of reported landings for 2010 and for 2011 (to date) by month and unit area is provided in Table 3. In general, the spatial-temporal pattern is similar in to those of recent years. Inshore landings are limited in March and April, mostly arising from by-catch of cod in other offshore fisheries. The vast majority of landings from the inshore areas (Unit areas 3Psa,b,c) are taken in June to November, with highest landings in June and July, particularly in Unit area 3Psc.

In the offshore, monthly landings tended to be more variable among unit areas. The majority of the offshore catch is taken in 3Psh during January to March and from 3Psf over September to November, which combined account for >70% of the offshore catch. Less than 10% of offshore landings occurred within April-August resulting from relatively low effort through the spring and summer.

The distribution of total catch (post-moratorium) among unit areas is illustrated in Fig. 5. The inshore (3Psa,b,c) has consistently accounted for most of the reported landings. These have typically been highest in Placentia Bay (3Psc), ranging from 2,700 t to almost 11,650 t with 28-51% of the annual Subdiv. 3Ps catch coming from this unit area alone. This percentage had declined steadily over 1999-2005, but has increased in the most recent five years and is now presently 38% of the Subdiv. 3Ps total landings. Landings from 3Psa and 3Psb have been fairly consistent at about 1,100-3,200 t and generally between 7-12% and 9-18%, respectively, of the annual total. Most of the offshore landings have come from 3Psh and 3Psf (Halibut Channel and the southeastern portion of St. Pierre Bank). The percentage of total landings from 3Psf declined considerably in 2008. Unit area 3Psg normally has the lowest landings of any unit area (<4% of the annual total each year since 1997), but in 2010 catches in this area, though still low, exceeded those of areas 3Psd and 3Pse combined. During the first quarter of 2009, no month or unit-area breakdown of French catch is available though these landings were known to be taken from either unit area 3Psf or 3Psh (L. Yetman, Fisheries and Aquaculture Management Branch, DFO, St. John's; pers. comm.). The 2009 values illustrated in Fig. 5 do not include these catches and hence are not representative of all landings.

The 2011-2012 (1st of April to 31st of March) conservation harvesting plan places various seasonal and gear restrictions on how the Subdiv. 3Ps cod fishery in Canadian waters could be pursued. Full details of these measures, which differ among fleet sectors, are available from the DFO Fisheries and Aquaculture Management (FAM) branch in St. John's.

CATCH-AT-AGE

Samples of length and age composition of Canadian catches were obtained from the inshore gillnet, line-trawl and hand-line fisheries and the offshore otter trawl, gillnet, and line-trawl fisheries by port samplers and fishery observers. Additional sampling was obtained from the sentinel fishery. Length and age sampling of the catches by French fleet (St. Pierre and Miquelon, SPM) are collected by IFREMER. These data are used to age-disaggregate the total landings into numbers of removals by age. During 2010, more than 48,500 length measurements of Canadian and French catches were taken. In addition, 4,800 otoliths from Canadian catches were taken to determine the age composition of the catches (Table 4). All age determinations for 2010 catch-at-age were made by Canadian technical staff. During the February/March 2009 zonal cod assessment, a research recommendation highlighted a need to further examine discrepancies in age determinations from French and Canadian technical staff. This exchange occurred during late 2009 with results reported by Healey et al. (2011b). A workshop to improve consistency between the interpretations by staff in each country is scheduled for the fall of 2012. Following this workshop, it is expected that aging information will again be provided by France.

Canadian sampling totals are lower than in previous years and resulted from both reduced landings and reduced sampling efforts. Despite these reductions, sampling was reasonably well distributed spatially and temporally across the gear sectors. Sampling of lengths and ages of the Canadian and French catches during January to March 2011 was also undertaken, but data were not available at the time of the assessment and will be considered in future years.

The age composition and mean length-at-age of commercial catches were calculated as described in Gavaris and Gavaris (1983). Where possible, monthly landings for each gear type were age dis-aggregated using length and age samples from that quarter of the year (from the same gear type) to yield the age composition of each component of the catch. The average weights were derived from a standard length-weight (wt) relationship where:

$$\log(wt) = 3.0879*\log(length) - 5.2106.$$

Catch-at-age for all gears combined based on sampling of Canadian and French vessels in 2010 is summarized in Table 5 and also Fig. 6. As described previously, these data exclude recreational catches, the magnitude of which has been unknown since 2007. Previous estimates of recreational catches indicated the total was a relatively low compared to commercial landings.

The 2010 landings from all gears combined include a wide range of ages (ages 2-21). In 2010, much of the catch was comprised of younger, smaller fish, with 60% of the numbers caught aged 6 or younger (Table 5, Fig. 6a). The modal age in the 2010 catch was age 6, with approximately 1.3 million individuals taken (34% of total by numbers; Fig. 6b). The 1997 and 1998 year classes, aged 13 and 12 years old in 2010, were the focus of the fishery for many years, and although they are outside of the range of gillnet selectivity (predominantly ages 5-9), they still comprised 9% of the landed weight. Annual contributions to the catch-at-age are illustrated using a standardized proportion at age figure (Fig. 6c). Over the longer time series of catch (1977 to 2010), changes in the age distribution of annual catches (reflecting differences in gear composition of the catch pre and post-moratorium described previously) are evident. In this figure, cohorts which are strongly indicated in the commercial catch are large grey circles, while those which are well represented in the catches are large black circles. Over the past decade, this clearly illustrates the significance of the 1997 and 1998 year-classes to the total catch along with the below average to average contribution from several successive year-classes. Commercial catches of the 2004 cohort thus far indicate the proportional contribution is larger than average (Fig. 6c, lower panel).

Detailed information on the catch from the first three months of 2011 was not available at the time of the assessment; most catches during January-March are typically taken by mobile gear in the offshore.

Catch at age for the three main gear types in 2010 show (Fig. 7) that all gears catch a range of ages, but the dominance of gillnet selectivity on ages 5-8 is evident, whereas line-trawls caught a larger fraction of younger fish (mainly ages 4-7). Otter trawls indicate a relatively wide range of ages captured, though almost 50% of the catch numbers in 2010 were of ages 4 and 6 only.

A time series of catch numbers-at-age (ages 3-14 shown) for the Subdiv. 3Ps cod fishery from 1959 to 2010 is given in Table 6. For 2010, the ratio of the sum-of-products (catch numbers and catch weights) to the total reported landings is 0.97. As noted in recent assessments (e.g. Brattey et al. 2008), there are discrepancies in the ratio of the sum of the product to landings over the 1959 to 1976 period and attempts have been made to clarify these discrepancies by checking for missing catch and by adding plus group catch, but neither of these adequately explained the discrepancies. Until these discrepancies are resolved, it is recommended that catch at age prior to 1977 not be used in population analyses.

The catch-at-age data 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., ages 5-8) have been more common (Fig. 6c) which likely reflects the switch in dominant gears from line-trawl and traps to gillnet. Line-trawl and trap typically select younger fish than gillnets.

WEIGHT-AT-AGE

Mean weights-at-age in the Subdiv. 3Ps fishery (including landings from the commercial and food fisheries and the sentinel surveys) are given in Table 7a and Fig. 8. Beginning of the year weights-at-age are given in Table 7b and Fig. 9. 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; the weights at age may therefore vary with season and gear, and possibly by geographic area.

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. 8). The converse is generally 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. Notwithstanding this limitation, the weight-at-age for ages 11-14 in the past 2 years have increased considerably. 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.

SENTINEL SURVEY

The sentinel survey has been conducted in Subdiv. 3Ps since 1995 and there are now 16 complete years of catch and effort data (see Maddock Parsons 2013). Sentinel activity for 2011 was ongoing at the time of the assessment; this data will be reviewed in subsequent years. The sentinel survey continues 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. 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. In 2010, there were 13 active sites in Subdiv. 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 4 sites in Placentia Bay one day per week. Fishing effort was less in 1999 (6 weeks), 2003 and 2004 (8 weeks each), than most other years (9-12 weeks), but since 2005 an average of 10 weeks has been maintained. Most fishing takes place in fall/early winter. Maddock Parsons (2013) provides 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 2010 remained low and were similar to those recorded for 1999 to 2009. Line-trawl catch rates decreased in both 2009 and 2010; the 2010 result was the lowest in the time-series.

As in previous assessments, an age disaggregated index of abundance was produced for gillnet (5½" mesh) and line-trawl sampling. There are insufficient data from the 3¼" gillnets to develop a standardized index for this gear.

STANDARDIZED SENTINEL CATCH RATES

The catch from Subdiv. 3Ps was divided into cells defined by gear type (5½" mesh gillnet and line-trawl), area (unit areas 3Psa, 3Psb, and 3Psc), year (1995 to 2010) and quarter. Age length keys (ALKs) 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 ALKs 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. Since 2002, there are considerably fewer otoliths available for aging; annual sample sizes range between 248 and 464 otoliths per year from gillnet catches (compared to an average of 1,050 otoliths during 1995 to 2002). Sample sizes for line-trawl are more variable, and in 2010 just 702 otoliths were collected – which is relatively low. For line-trawl there were <700 otoliths per year during 2003 and 2004, but the numbers increased to 1,132

otoliths during 2005 and to 1,160 during 2006. However, less than 1000 cod have been sampled from line-trawl effort in both 2007 and 2008. These variations are generally reflective of annual differences in the numbers of fish caught and decreased sentinel effort over time. However, there have been some changes in the proportion of sampled fished aged over the duration of the Sentinel program. Despite these decreases, there have been no major difficulties in aging the sampled catch. Further, the fraction of the catch sampled for age in recent years is comparable to earlier years.

Catch at age and catch per unit effort (CPUE) data were standardized using a generalized linear model to remove site and seasonal effects. For gillnets, only sets at fixed sites during June to November with a soak time between 12 and 32 hours were used in the analysis. For line-trawl, sets at fixed sites during June to November with a soak time less than or equal to 24 hours were used in the analysis. Prior to modeling, data are aggregated within a gear division site month year age cell. Zero catches were generated for ages not observed in a set as 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 complicates direct comparisons of the trends from Sentinel surveys to commercial catch rates.

A generalized linear model (McCullagh and Nelder 1989) was applied to the sentinel catch and effort data for each gear type. The number of fish caught in each set is assumed to have a Poisson distribution. A log link function was chosen, and the factors included in the model were both “nested effects”: month is nested within site and age is nested within year. Fishing effort is included as an offset term in the model. In the present assessment, the model adequately fitted data from gillnets and line-trawls, and all effects included in the model were significant.

Trends in standardized total (ages 3-10 combined) annual catch rates, expressed in terms of numbers of fish, are shown in Fig. 10a. Gillnet catch rates declined rapidly from 1997 to 1999 then remained stable but low from 1999 through to 2010. For line-trawls, catch rates show a decline from 1995, but have been relatively stable with no clear trend from 1997 to 2010.

Two standardized annual catch rate at age indices were also produced in the present assessment, one for each gear type. The standardized gillnet and line-trawl catch rate at age indices for 1995 to 2010 are given in Table 8 and Fig. 10b. For gillnets, several year classes were well-represented in catches during 1995 to 1997 but these are replaced by weaker year classes in all subsequent years. It has been noted that the 1997 and 1998 year-classes contributed significantly to both the fishery and RV index for several years. However, it is noteworthy that these year classes did not yield improvements in the magnitude of sentinel gillnet catch rates over 2002 to 2006, when these year-classes would have been within the peak selection range of 5½” gillnets.

For line-trawls, catch rates-at-age in the beginning of the time-series were higher due to the 1989 and 1990 year classes. In 2000-2002, sentinel line-trawl catch rates improved for younger fish (3 and 4 year olds) as the 1997 and 1998 recruited to this index. Catch rates for older fish continued to decline. Both the 1997, and in particular, the 1998 year class were consistently measured by sentinel line-trawl. As noted previously, these year-classes contributed strongly to commercial catches for several years. In addition, the 1999 year class also appears reasonably strong at ages 4 5 then is generally below average for older ages. This year class is weak in sentinel gillnet and in other (mobile gear) indices. These year-classes were followed by several successive year-classes which were weaker; but catch rates of the 2004 year-class at ages 3-5 (in 2007-2009) are higher (Table 8). In 2006, line-trawl catch rates for all ages (3-10) increased, suggesting a year effect in the data rather than a change in stock size (Fig. 10).

Although the sentinel indices did not increase in magnitude as the 1997 and 1998 year-classes were available to these gears, the age composition of the standardized estimates indicates that the 1997 year-class was consistently detected in the sentinel gillnets (Fig. 10b). Conversely, the 1998 year-class was consistently tracked by line-trawl sampling.

As described in recent Subdiv. 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 since 1997, particularly in Placentia Bay. The concentration of fishing effort in Placentia Bay during the late-1990s, primarily with gillnets, may have had a negative influence on the sentinel gillnet 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. These issues also complicate the interpretations of relative year-class strength over the time-series. The decline in sentinel gill net catch rates after the fishery reopened in 1997 are consistent with the inshore catch rate data from science log books and the high estimates of exploitation from tagging in Placentia Bay. More recently, the index is consistently tracking the 2006 year-class, though the overall index has not shown increase. The line-trawl index indicates a strong contribution from the 2004 year-class; indications of the 2006 year-class have been less consistent. This is in contrast to the RV index, which has shown the 2006 year-class to be well above average.

SCIENCE LOGBOOKS (<35 FT SECTOR)

A new science logbook was introduced to record catch and effort data for vessels <35 ft in the re-opened fishery in 1997. Prior to the moratorium, the only data for vessels <35 ft came from purchase slips, which provided limited information on catch and no information on effort. Since the moratorium, catch information comes from estimated weights and/or measured weights from the dockside monitoring program. 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. Prior to the fall assessment meeting, there were about 159,000 records in the database. As with the analysis of results from the Sentinel program, we consider data to 2010 only, and exclude the current (in-progress) year. The total number of records has declined over time even over multi-year periods having common TAC. In addition, the percentage of the total cod catch for the <35 ft sector represented in the logbooks has decreased over time, from about 70% in 1997 to about 50% in recent years.

We present a catch rate index for data pertaining to the inshore fishery, i.e., unit areas 3Psa, 3Psb, and 3Psc. An initial screening of the data was conducted and observations were not used in the analysis if the amount of gear or location was not reported (or reported as offshore / outside of 3Psa, 3Psb or 3Psb), more than 30 gillnets were used, or <100 or >4,000 hooks were used on a line-trawl. Upper limits for the amount of gear considered are applied to eliminate outlying records and exclude <1% of the available data for each gear type. 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.

The screening criteria described above have resulted in a substantial fraction of <35 ft catch not being available for analysis. For example, in 2010 only 16% of the <35 ft gillnet catch and 24% of the <35 ft line-trawl catch is included in the CPUE standardization. These values are lower than usual as data entry for 2010 logbooks was ongoing at the time of the assessment. A major contributor to this loss of information is an increasing portion of logbooks records with invalid entries for the location fished. This occurs when logbook entries do not record a fishing location as shown on the map included in this logbook. (These are denoted as fishing areas 29-37 and illustrated in Fig. 11a). Most of these instances are generated from logbooks which report the location fished as either “10” or “11” – these references correspond to “species fishing areas” (e.g., Lobster Area 10) which are relatively large and include more than one of the fishing locations illustrated in Fig. 11a. Therefore it is not possible to resolve these entries to the finer-scale areas indicated in the logbook, and, consequently, a substantial fraction of the catch and effort data from smaller vessels is excluded by our selection criteria.

As in previous assessments, effort was treated as simply the number of gillnets, or hooks for line-trawls (1000s), 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 from science logbooks are expressed in terms of weight (whereas those from the sentinel fishery are expressed in terms of numbers); commercial catches are generally landed as head-on gutted and recorded in pounds; these were converted to whole weight (in kg) by multiplying by a gutted to whole weight conversion factor (1.2) and converting pounds to kilograms (2.203).

The frequency distribution of catches per set is skewed to the right for both gears (not shown). For gillnets, catches per set are typically 100 to 200 kg with a long tail on the distribution extending to about 2 t. The distribution of catches for line-trawls was similarly skewed.

The catch from Subdiv. 3Ps was divided into cells defined by gear type (gillnet and line-trawl), location (numbered 29-37, as described above) and year (1997 to 2010).

Initially, un-standardized CPUE results were computed and examined; in this preliminary analysis plots of median annual catch rate for gillnets and line-trawl were examined for each year-location. Catch rates for gillnets tend to be higher in areas 29-32 (Placentia Bay and south of Burin Peninsula) than elsewhere. The gillnet catch rates for 2010 were not markedly different from recent values (Fig. 11b). For line-trawl, most data come from areas west of the Burin Peninsula and the results in areas 29-33 are based on low sample sizes and show more annual variability. Line-trawl catch rates from areas 34-37 in 2010 were quite variable compared to those of the past few years.

Prior to modeling, the data were aggregated 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 (fishing area) and seasonal (month, year) effects. 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.

Standardized gillnet catch rates declined over 1998 to 2000 and have subsequently been low but stable at approximately 20 kg/net (Fig. 11c). For line-trawls, catch rates declined from 300 kg/1000 hooks in 1997 to a minimum of about 200 kg/1000 hooks during 2002. Values for 2003 to 2006 were progressively higher and the 2006 value is the largest estimated catch rate at 353 kg/1000 hooks. Subsequently, catch rates have declined, and the 2010 value of 247 kg/1000 hooks is near the time-series average.

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, gillnets and line-trawls can at times 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 individual quotas (IQs) and for some vessels the need to fish cod as by-catch to maximize financial return, can have a strong influence on catch rates that is unrelated to stock size (DFO 2006). Consequently, inshore commercial catch rate data must be interpreted with caution. 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 decrease in modeled catch rates for line-trawls since 2006 may in part be reflecting the reduced availability of the 1997 and 1998 year classes in the inshore catch, as the numbers of fish in these cohorts decline. Close inspection of the commercial catch numbers-at-age data has shown that the proportion of cod age 7 and older in the line-trawl catch has increased over 2002 to 2010. Modeled gillnet catch rates have shown no significant changes in recent years.

INDUSTRY LOGBOOKS (>35 FT SECTOR)

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35 ft sector) were not available for this assessment as data analysis could not be completed prior to the assessment meeting. Recent trends were documented by Healey et al. (2011a), and it is expected that this data set will be studied further in future assessments.

TAGGING EXPERIMENTS

A project involving tagging of adult (>45 cm) cod initiated in 1997 has continued through 2010. The purpose of the tagging study is to provide information on movement patterns of Subdiv. 3Ps cod as well as obtain ongoing estimates of exploitation rates on different components of the stock. However, for several reasons, tagging efforts in Subdiv. 3Ps have been much reduced over the 2004 to 2010 period. In particular, tag releases in 2008 to 2010 have been limited to Placentia Bay only, with variable sample sizes (395, 2,510, and 1,022 tagged cod released in 2008, 2009, and 2010, respectively). In contrast to previous years, it is no longer possible to estimate tagging-based exploitation rates across most of the stock area. A brief synopsis of current results and details from previous years are provided below. Approximately 300 tags have been returned annually over 2008 – 2010. The percentage of tag returns from participants in the recreational fishery over this time has ranged from 4-8%. Sufficient numbers of tags have been returned to estimate annual reporting rates (fraction of captured tags returned) using mixed-effects logistic regression (Cadigan and Brattey 2008).

ESTIMATES OF EXPLOITATION (HARVEST) RATE

The methods used to estimate average annual exploitation rates (harvest rates, in percent) for cod tagged in different regions of Subdiv. 3Ps are described in detail previously (Brattey and Cadigan 2004; Brattey and Healey 2003, 2004, 2005, 2006; Cadigan and Brattey 2003, 2006, 2008). During 2001-2005, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (3Psc, 22-31%) compared to those tagged in Fortune Bay (3Psb, 10-12%), Burgeo Bank/Hermitage Channel (3Psd, 1-8%) or offshore in Halibut Channel (3Psg/h, 2-6%), respectively. Estimation of inshore exploitation during 2006 and 2007 was hampered by insufficient numbers of releases. Although estimates of inshore exploitation rates from the 2006 fishery were reported by Brattey et al. (2007), they noted that due to the lapse in inshore tagging during 2004-2006, these rates were only partial estimates.

Estimated mean exploitation rates for cod tagged in Placentia Bay have all been less than 14% over 2008 to 2010. This level of exploitation would usually be considered “reasonable”. However, results on size-specific exploitation rate from recent releases showed that although exploitation has been low in Placentia Bay, exploitation rate increases considerably with fish length, particularly for those sizes which are fully selected by the fishery (approximately 65 cm). Exploitation rates were compared for all fish >45 cm, >55 cm, and for all releases >65 cm. In 2008, exploitation rates corresponding to these size classes were 7%, 9% and 13% respectively. Corresponding results for 2009 were 9%, 15%, 27%, respectively, and in 2010 were 13%, 21% and 22% respectively. Despite the substantial change with size, particularly the results for >65 cm, none of the values appear to be excessively high. It is cautioned that the exploitation rates for 2009 corresponded to tagging activity shortly before the 2009 fishery with limited time for dispersal of tagged fish which likely biases the estimated exploitation. Also noteworthy is that the exploitation rates of 2010 were higher even though only two-thirds of the 2010/2011 TAC was taken.

Tagging in the offshore (unit area 3Psh) was last conducted in 2005, and exploitation rates can be estimated – and compared – throughout 1998 to 2007. Exploitation rates estimated from tagging in Halibut Channel from 2005 to 2007 increased compared to previous estimates. The 2005-2007 exploitation estimates were about 8% per year, compared to estimates of 2-3% over 1997-2004.

With respect to migratory patterns and stock distribution, the tagging results of 2007-2010 generally agree with previous findings (Brattey et al. 2001, 2002; Brattey and Healey 2004, 2005, 2006), and indicate restricted mixing of cod from different portions of the Subdiv. 3Ps stock area. The limited mixing of inshore cod in particular make it difficult to determine whether inshore indices are reflecting trends in the stock as a whole or mainly of inshore components of the stock. Trends in the indices differ between inshore and offshore and are difficult to reconcile with the tagging results. Tagging suggests lower exploitation in the offshore than most inshore areas, yet the DFO RV declined for several years over 2001 to 2008. In contrast, inshore indices (sentinel) have been stable for several years (albeit at a lower level than when the fishery opened in 1997), whereas tagging suggests that in some inshore areas such as Placentia Bay exploitation was relatively high (~25%) for several years. The discrepancy between trends in inshore/offshore abundance indices and tagging estimates of exploitation was previously noted in recent assessments and remains enigmatic and difficult to explain.

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 over 1978 to 1992. 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 to 1982), *Alfred Needler* (1983 to 1984; 2009 to 2010), and *Wilfred Templeman* (1985 to 2008). 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. Cadigan et al. (2006) found no significant differences in catchability for several species, including cod, between the *Wilfred Templeman* and *Alfred Needler* research vessels. Surveys by France were conducted using the research vessels *Cyros* (1978 to 1991) and *Thalassa* (1992) and the results are summarized in Bishop et al. (1994).

The Canadian research vessel surveys from 1983 to 1995 employed an Engel 145 high-rise bottom trawl. In 1996, research surveys began using the Campelen 1800 shrimp trawl. The Engel trawl catches for 1983 to 1995 were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation derived from comparative fishing experiments (Warren 1996; Warren et al. 1997; Stansbury 1996, 1997).

The stratification scheme used in the DFO RV bottom-trawl survey in Subdiv. 3Ps is shown in Fig. 12. Canadian surveys have covered strata in depth ranges to 300 fathoms since 1980. Five new inshore strata were added to the survey from 1994 (stratum numbered 779-783) and a further eight inshore strata were added from 1997 (numbered 293-300) resulting in a combined 12% increase in the surveyed area. Beginning in the 2007 assessment, new indices using survey results from the augmented survey area were presented for the first time. Two survey time series can now be constructed from the catch data from Canadian surveys. To avoid confusion, throughout this document as well as the Science Advisory Report from the 2011 assessment meeting (DFO 2011), the index from the expanded surveyed area that includes new inshore strata is referred to as the “All Strata <300 fms” index and the time series extends from 1997 onwards, whereas the original smaller surveyed area is referred to as the “Offshore” survey index and the time series that incorporates a random stratified design extends from 1983 to present.

The results (in Campelen or Campelen-equivalent units) for the entire survey area are summarized by stratum in terms of numbers (abundance) (Table 9) and biomass (Table 10), for the period 1983 to 2010. The timing of the surveys, number of sets fished, and vessels used are provided in the table header. Fig. 13 illustrates both the number of days taken to complete the survey of Subdiv. 3Ps, and also number of survey sets completed each year. Due to extensive mechanical problems with the research vessel, the survey in 2006 was not completed: only 48 of 178 planned sets were completed.

During 2010, one stratum in Subdiv. 3Ps could not be completed: stratum 295 in Fortune Bay. This is not considered problematic as this stratum comprises just 1% of the surveyed area, and on average, has contributed about 1% to the annual abundance and biomass indices. In the tables of results, strata for which no samples are available were filled in using a multiplicative model (excluding 2006 survey results). The 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 of stock mixing with cod from the adjacent northern Gulf (Div. 3Pn4RS) stock in the western portion of Subdiv. 3Ps. The stock mixing issue is described in more detail in previous assessments (e.g., Brattey et al. 2007).

ABUNDANCE, BIOMASS, AND DISTRIBUTION

A time series of trawlable abundance and biomass indices from DFO random stratified RV offshore survey is given in Fig. 14. The abundance and biomass index estimates from the 2011 survey were 55.3 million fish and 30.5 Kt. In the 2011 survey there was no major change in the distribution of survey catches. The strata with the largest catches in terms of biomass were 319 and 323 (together, these strata cover much of the Halibut Channel) and 308 (a portion of Burgeo Bank). Combined, these strata accounted for 40% of the biomass index and 29% of the abundance index for 2010. Although it is common for results from the Halibut Channel to comprise a significant fraction of the overall survey abundance and biomass results, mostly due to results from stratum 319, it is atypical to have large contributions from stratum 323 (north of stratum 319).

Trends in the abundance index and biomass index from the RV survey are shown for the offshore (i.e., index strata only: those strata of depth less than or equal to 300 fathoms, excluding the new inshore strata) and the all strata area (Fig. 14). Survey indices of cod in Subdiv. 3Ps are at times influenced by “year-effects”, an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. The time series for abundance and biomass from 1983 to 1999 show considerable variability, with strong year effects, for example, the 1995, 1997 and 1998 surveys compared to those from adjacent years. The 1995 estimate is influenced by a single large catch contributing 87% of the biomass index and therefore has a very large standard deviation. The 1997 survey values were 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. It is also likely that either the 2008 or 2009 results (possibly both results) include year-effects.

The trawlable abundance index declined from 88.2 million in 2001 to 38.7 million in 2008, the longest period of consistent decline in the entire time-series. However, the index has increased since 2008 and the 2011 estimate is near the 1997 to 2011 average. The trawlable biomass estimate has been variable for much of the post-moratorium period, but as with abundance, the biomass index generally declined over 2001 to 2008. The biomass index also increased considerably between 2008 and 2009, from 20.5 Kt to 56.0 Kt – approaching a three-fold increase. Although the 2010 index was similar to 2009, the increase has not been sustained, with the 2011 value being 40% lower than the 2010 result. Detailed trends in trawlable abundance and biomass are generally difficult to discern from the survey indices due to high intra-annual variability. Excluding the 1995 and 1997 survey results would suggest the time series of biomass estimates can be broadly divided into three periods – highest during 1983 to 1990, lowest during 1991 to 1997, and intermediate to low values during the most recent period 1998 to 2011. The trends and degree of variability in the combined inshore/offshore survey are almost identical to those of the offshore survey in spite of the 12% increase in surveyed area; the only exception is in 2004 when the combined inshore/offshore survey shows higher biomass and abundance due mainly to a large estimate from inshore stratum 294 (see Tables 9 and 10).

To investigate whether there have been annual shifts in the distribution of the stock at the time of the survey, trends in the proportion of the total abundance observed in three different regions of the stock area were compared (Fig. 15). The areas were: the inshore (strata 293-298, and 779-783), the Burgeo area (Hermitage strata 306-309, and 714-716), and the eastern area (remaining strata). Data from the combined inshore/offshore survey were used and the Campelen trawl was fished in all these surveys. The proportions were variable, with typically 30-70% observed in the larger eastern area, 15-60% in the western area, and around 10-25% in the inshore area; an exception was 2005 when almost 40% of the total abundance index was observed in the inshore, again due to a large estimate for inshore stratum 294. Much of this variation is resultant from year effects, often resulting from a small number of survey sets with very large catches. For example, the value for 1998 is high due to several large catches on Burgeo Bank and vicinity that may have included fish from the neighbouring northern Gulf (Div. 3Pn4RS) cod stock. The age-aggregated surveys in recent years do not give any strong indications of a significant influx of cod from the neighbouring Div. 3Pn4RS stock.

The spatial distribution of catches of cod during the 2011 survey was examined, for all ages combined (Fig. 16a, includes 2008 to 2010 for comparison) and separately for ages 1-12 (Fig. 16b to 16d). Previously it has been demonstrated (Brattey et al. 2007; Healey et al. 2011a) that during 1999 to 2010 cod were caught over a considerable portion of Subdiv. 3Ps with the largest catches typically in the southern Halibut Channel area, on Burgeo Bank and vicinity, and in the outer portion of Fortune Bay. During these years cod were consistently scarce in the deep water below the mouth of Placentia Bay and in the inner reaches of Hermitage Channel.

Distribution plots of age-disaggregated survey catches from the 2011 survey (Figs. 16 b-d) indicate that relatively small catches of 1 year old cod were measured across much of the survey area where cod are typically found. Due to their small size, one-year old cod are not fully selected by the trawl. Cod aged 2 years old were encountered more frequently, especially along the eastern edge of the stock boundary. Cod ages 3 years old were found over most of the surveyed area, with the relatively large catches of these age groups taken on Burgeo Bank and within the Halibut Channel. The magnitude of the of catches of cod aged 4-9 year old in 2011 decrease considerably with age, and only small catches of these age groups were found outside of Burgeo Bank, the Hermitage Channel, or the Halibut Channel. Catches of cod in 2010 aged 10 or older were infrequent and far fewer fish were caught than in the recent past. Catches of these older fish are almost exclusively within the Halibut Channel.

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 design for cod in Subdiv. 3Ps requires that an attempt be made to obtain two otoliths per centimeter 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 spatial stratification ensures sampling is distributed over the surveyed area. The otoliths are then combined into a single ALK and applied to the survey data. The resulting estimates of age-disaggregated mean numbers per tow are given in Table 11a. These data can be transformed into trawlable population abundance 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 the “offshore” survey in Subdiv. 3Ps, the survey area is 16,732 square nautical miles including only strata out to 300 fathoms (and excluding the relatively recent inshore strata added in 1997). The swept area for a standard 15 minute tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of Campelen trawlable units in the Subdiv. 3Ps survey is $16{,}732 \div 0.00727 = 2.3 \times 10^6$. For the expanded survey area, there are approximately 2.7×10^6 trawlable units.

The mean numbers per tow at age in the DFO RV survey for the “offshore” index is given in Table 11a and results for ages 1-15 are shown in the form of standardized “bubble” plots in Fig. 17. Cod up to 20

years old were not uncommon in survey catches during the 1980s, but the age composition became more contracted through the late 1980s and early 1990s. In the 2011 survey, the number of fish age 7 and older is relatively low, consistent with results of recent years. The 2006 year-class, was measured as being much greater than average in each of the 2007 to 2010 surveys, and was primarily responsible for the considerable increase in the abundance index over that time. However, in 2011, the 2006 year-class (age 5) is near the time-series average. A more quantitative analysis of recruitment is given later.

Overall, the age composition of survey catches has expanded slightly in recent years with ages up to 17 years represented; however, the age structure remains somewhat contracted relative to the mid-1980s with presently very few fish older than age 12.

SIZE-AT-AGE (MEAN LENGTH AND MEAN WEIGHT)

The sampling protocol for obtaining lengths-at-age and weights-at-age 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). Only data from 1983 onward are presented.

Mean lengths-at-age were updated using the 2011 survey data (Table 12; Fig. 18). For ages older than age 3 there was a general decline in length-at-age from the early 1980s to the mid-1990s (Fig. 18a). For most ages there was an increase in length-at-age from the mid-1990s through the mid-2000s, but data from 2007 to 2011 surveys suggest that mean length at age for ages 3-8 has been lower in most years than the mid-2000s.

Annual variation in mean length at age was examined by analyzing deviation from the average as a proportion over the time series for each age. The average mean length at age from 1983 to 2011 was calculated. At each age, mean-standardized deviations were calculated by subtracting the time-series mean from the annual observations and dividing this by the mean. These deviations were examined for a significant year effect using year as a class variable in a general linear model. Ages 3 to 9 were included. There was significant interannual variation in the deviation from mean length at age ($F = 3.6$, $df = 27,195$, $P < 0.0001$, $r^2 = 0.37$). Mean length at age was greater than average in the mid-1980s. It showed a declining trend until the mid-1990s when it was below average. Mean length at age subsequently increased. Length at age has been generally lower in the last four years (Fig. 18b). Multiple comparisons based on least squares means were used to determine significant differences among years. Mean length at age was lower in 2011 than all but four years and significantly lower than in 2010. Growth from one year to the next (length increment) was also examined. First the effect of age on length increment was removed using a general linear model. The residuals from this model were then examined for a significant year effect using a generalized linear model with an identity link and a normal distribution. The amount of annual growth in length (growth increment) from 2010 to 2011 was also amongst the lowest in the time series (Fig. 18c).

Values for mean weight at age were updated with data from the 2011 survey (Table 13; Fig. 19a). There was a general decline in weight-at-age from the early 1980s to the mid-1990s (Fig. 19a). There was an increase in weight-at-age from the mid-1990s through the mid-2000s, but data from 2007 to 2011 surveys suggest that mean weight-at-age has been lower than the mid-2000s.

There was significant interannual variation in the proportion deviation from mean weight-at-age ($F = 2.7$, $df = 27,195$, $P < 0.0001$, $r^2 = 0.30$). Mean weight-at-age was greater than average in the mid-1980s and generally declined until the mid-1990s (Fig. 19b). The lowest mean weights-at-age were observed in 1994-1995 and these were significantly different from 1983 to 1986. As with mean length-at-age, mean weights-at-age increased after that time until about 2000. In recent years, 2008 had lower mean weight-at-age than the 1983-1986 period and 2011 was lower than 1984 and 1986, but not lower than 2010.

CONDITION

Relative gutted condition (relative K) and relative liver condition (relative LK) were calculated from survey data. It has been shown that the timing of the survey affects estimates of condition for Subdiv. 3Ps cod (Lilly 1998) and so only estimates from April surveys beginning in 1993 were estimated. A length gutted weight relationship was estimated, and the condition index is then observed condition divided by the condition predicted from the length weight regression for a fish of that length. Relative liver condition was calculated in a similar fashion using a liver weight length regression. Interannual variation in condition was analyzed using a generalized linear model with an identity link with a gamma distribution. Relative K increased until 1998, followed by a period of lower condition up until 2004 and very low condition in 2008 to 2010 (Fig. 20). Relative K in 2011 was about average and significantly lower than only 1998 and 2005. Estimates of relative K in 2008 to 2010 are significantly lower than estimates from the late 1990s and mid 2000s. Estimates of relative liver condition in 2010 are lower than all but those from 1993 to 1994, and estimates from 2008 are lower than all but 1995. Estimates from 2011 are higher than those from 2008 and 2010 but still lower than seven of the 11 years from 1997 to 2007. These results indicate that condition in recent years has been low compared to most of the years since the mid-1990s.

In conclusion, length at age has been generally lower in the last four years. Mean length at age was lower in 2011 than all but four years since 1983 and significantly lower than in 2010. The amount of annual growth in length (growth increment) from 2010 to 2011 was also amongst the lowest in the time series. Mean weights-at-age in 2011 were similar to the 2010 values, and were lower than the highs of the mid-1980s. Body condition in 2011 was about average, while liver condition was below most of the values from 1997 to 2007.

MATURITY AND SPAWNING

The sampling design used to gather biological data to study maturation trends and an overview of recent maturity and fecundity research relating to Subdiv. 3Ps cod can be found in Brattey et al (2008).

Annual estimates of age at 50% maturity (A50) for females from the Subdiv. 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 are shown in Fig. 21a (only cohorts with a significant slope and intercept term are shown); parameter estimates and associated standard errors for the 1954 to 2006 cohorts are given in Table 14 and the model did not adequately fit the data from subsequent cohorts as most of these fish remain immature. The estimated A50 was generally between 6.0 and 7.0 for cohorts from the mid-1950s to the early 1980s, but declined dramatically thereafter to 5.1 in the 1988 cohort (Table 14, Fig. 21a). A50 has remained at this lower level, though the estimates for the 2003 and 2004 cohorts are improved – with A50 greater than 5.5 years. Given that the estimation is by cohort, estimates for the most recent cohorts may be revised slightly in future years as additional data is collected. Males show a similar trend in A50 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 15; these were obtained from the cohort model parameter estimates in Table 14. The estimates of proportion mature for ages 4-7 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. 21b). The current proportion mature at age remains high; however, the effect of increased A50 for the 2003 and 2004 cohorts, which equates to reduced proportion mature at age, is evident.

The time series of maturities for Subdiv. 3Ps cod shows a long-term trend as well as considerable annual variability. Such variations can have substantial effects on estimation of spawner biomass. Further, the age composition of the spawning biomass may have important consequences in terms of producing recruits (see Brattey et al. 2008).

Cod in Subdiv. 3Ps appear to spawn over a significant portion of the year and at many locations within the stock area. 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 has been studied more intensively than elsewhere in Subdiv. 3Ps (Bolon and Schneider 1999; Lawson and Rose 1999; Bradbury et al. 2000).

COHORT ANALYSES

During the 2006 assessment of this stock, it was agreed that sequential population analyses of Subdiv. 3Ps cod should be discontinued, primarily due to inconsistent trends in the index data available (poor correlations within and between surveys), poor model fit (strong year-effects and poor precision in estimated parameters). (For additional discussion, refer to DFO (2006, 2007) as well as Brattey et al. 2007.) In addition, during assessment meetings concerns have been expressed regarding the accuracy of the total landings captured by the commercial catch data (e.g., DFO 2010). In the 2007 assessment of this stock, Brattey et al. (2008) provided estimates of instantaneous rates of total mortality (Z) for 1997 to 2007 as computed directly from the combined DFO RV survey. A debate on smoothing these annual estimates of total mortality during the winter 2009 zonal assessment meeting lead to the exploration of cohort modeling of the survey data to provide structure to the smoothing. Consequently, a survey-based (SURBA) model based upon the work of Cook (1997) was implemented and provides estimates of total mortality, relative recruitment strength, and relative estimates of total and spawning biomass from the DFO RV survey (see Cadigan 2010).

The age-disaggregated cohort model assumes that total mortality experienced by the population can be separated into vectors of age effects s_a and year effects f_y (such that $Z_{a,y} = s_a \times f_y$). Estimation (lognormal) minimizes the difference between the predicted and observed survey index over all ages and years, with penalties applied to impose a degree of smoothing on the estimated age and year effects. However, the model was speculative in that it could not reliably estimate survey catchability and this is fixed at scenario values. Detailed model specification, sensitivities of results to modeling assumptions, and estimation procedures applied during both the zonal and regional assessment meetings of 2009 are documented in Cadigan (2010). PROC NLMIXED in SAS/STAT™software is used to estimate parameter values and associated uncertainty. Data for ages 1-12 from the DFO RV expanded index were used, including an adjustment for the 1983 to 1996 survey indices to account for the inshore area that was not sampled in these years. However, data for ages 1 and 2 over 1983 to 1995 are zero-weighted in estimation, due to concerns of potential biases in RV data conversion of these age groups. (This conversion accounts for a change in the trawl gear after the 1995 survey.)

An updated run of the previous assessment model formulation was presented. Survey selectivity is assumed to be constant for ages 4+, that is, selectivity is “flat-topped”. An alternate assumption about selectivity “domed” was explored in previous years. It has been argued that best-practice is to assume flat-topped selectivity (Northeast Fisheries Science Center 2008) unless there is evidence otherwise. The age effects estimated in deriving a recruitment index from the age 1-4 survey data (details in next section) were used to provide some objectivity in the survey catchabilities supplied to the model. Model diagnostics are similar to results obtained during the previous assessment. Estimated survey spawning stock biomass (SSB) relative to the biomass limit reference point (B_{lim}) from the updated run is consistent with those from the previous assessment, and indicate a considerable decline in survey SSB over 2003 to 2009 (Fig. 22a). The estimate of 2010 and 2011 survey SSB in the update run indicates some increase compared to the 2009 estimate, with the median 2011 SSB estimated to be 1.34 times the limit reference point (LRP; Fig. 22a; also see Appendix 1).

Estimates of total mortality (Fig. 22b) show consistent increase over 1997 to 2011, and mortality over 2006 to 2010 (ages 5-10) averaged 0.68 (49% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing. Estimated recruitment shows that the 2006 year-class is much stronger than several prior year-classes (Fig. 22c) and that the 2007-2009 year-classes all appear to be near the time-series average. Model diagnostics show evidence of the year-effects described in the survey results section, some of which are large in magnitude.

Otherwise, there are no indications of systematic model fit issues (Fig. 23). Detailed output of estimation and model results is provided in Appendix 1.

Survey population estimates were projected to 2014 assuming total mortality rates were similar to current values (i.e., within +/- 20%). Recruitment was assumed to be the geometric mean of the age 1 estimates over 2008 to 2010, and weights at age were assumed to equal the average of those over 2008-10. The proportions mature at age were projected forward from the cohort-specific model estimates. Five projection scenarios were conducted, using multipliers of 0.8, 0.9 1.0, 1.1, and 1.2 current *Z*, with a constant mortality rate assumed for each year projected. The one-year projection results indicated that survey SSB will increase if total mortality rates are similar to current values (i.e., within ±20%), and that the probability of being below the LRP in 2012 is low (0.02 to 0.09). This increase is driven by the continued recruitment of the 2006 year-class into the spawning biomass. By 2014, however, there are projected declines in both total biomass and spawning biomass if total mortality is similar to current values. In 2014 the probability of being below the LRP ranges from 0.03 (if mortality is 20% lower than current) to 0.56 (mortality 20% higher).

CONCLUSIONS AND ADVICE

The assessment concluded from tagging data and ancillary information that the complex of stock components exploited by fisheries in Subdiv. 3Ps does not comprise a single stock for which population biomass and abundance can be estimated from existing information. Therefore the impacts of fishing at specific TAC levels on all stock components could not be quantified. However, the DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Indices based on the RV survey have been used to assess current status of the stock relative to historic observations and to evaluate growth and sustainability of the stock.

A limit reference point ($B_{Recovery}$) was identified for this stock during the 2004 assessment (DFO 2004). It is defined as the lowest observed SSB from which there has been a sustained recovery; the 1994 value of SSB has been identified as the LRP.

SSB decreased over the 2004 to 2009 period. Median SSB was estimated to be below the LRP in 2008 and 2009. The SSB in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08). A one year projection to 2012 using the cohort model indicated that survey SSB will continue to increase if total mortality is similar to current values (i.e., within ± 20%). This increase is due to the recruitment of the relatively strong 2006 year class to the spawner biomass. The projection also indicated that the probability of being below the LRP in 2012 is low (0.02 to 0.09). A three year projection to 2014 indicates subsequent declines in both total biomass and spawning biomass if total mortality is similar to current values (i.e., within ± 20%). In 2014 the probability of being below the LRP ranges from 0.03 to 0.56.

The 2006 cohort is estimated to be relatively strong and is expected to recruit to the 2011 fishery. The 2007 to 2009 cohorts are estimated to be near the 1982 to 2010 average.

Estimates of total mortality (ages 5-10) over 2006 to 2010 averaged 0.68 (49% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

Exploitation rates for 2010 based on tagged cod released in Placentia Bay ranged from 28-33% for large cod (>65 cm) and 10-17% for smaller cod (<65 cm).

Gillnet catch rates from both sentinel surveys and logbooks for vessels <35 ft suggest stability. However, line-trawl catch rates from these sources indicate recent decline.

Overall, the findings of the current assessment are consistent with those of previous assessments. The Subdiv. 3Ps cod SSB at the beginning of 2011 was estimated to be above the LRP.

OTHER CONSIDERATIONS

MANAGEMENT CONSIDERATIONS

The implementation of trip limits, price differentials based on size, and individual quotas, are all potential incentives for discarding and high-grading of catches. Recent investigations into this problem have identified that high-grading has occurred, but the quantity has not been determined. Quantifying discards would improve the understanding of stock productivity. This is an unaccounted source of fishing mortality.

Management should recognize that cod which overwinter in Subdiv. 3Ps are also exploited in adjacent stock areas (Div. 3L and Subdiv. 3Pn). Hence management actions in these stock areas should consider potential impacts on Subdiv. 3Ps cod.

Recent results confirmed that closures to protect spawning or mixed-stock aggregations are appropriate.

Consequences of area/time closures should be carefully considered as these may result in higher exploitation rates on the components of the stock that remain open to fishing. The fishery should be managed such that catches are not concentrated in ways that result in high exploitation rates on any stock components.

Management should be aware of within-year variations in the individual weight of cod. Greatest yield can be gained when fish are in peak condition, typically in late fall/early winter, while minimizing the number of individuals removed from the stock.

The level of total removals is uncertain. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium when commercial catches are more strictly monitored. Accurate estimates of recreational fishery landings are also required.

TEMPERATURE

Oceanographic information collected during the spring DFO RV surveys indicated that near-bottom temperatures throughout Subdiv. 3Ps have warmed in both 2009 and 2010, increasing to above normal values. For example, the area of <0°C water has decreased to about 10% of the survey area, compared to almost 30% in 2007 and 2008. Survey catches of cod are generally lower in years when there are relatively large incursions of cold/fresh water from the eastern Newfoundland shelf. The areal extent of bottom water with temperatures >3°C has remained relatively constant at about 50% of the total Div. 3P area, although actual temperature measurements show considerable inter-annual variability. The current conditions are comparable to those of the late 1970s and early 1980s when the stock was more productive.

SOURCES OF UNCERTAINTY

The level of total removals is uncertain. It is likely that historical landings have been biased both upwards (e.g., due to misreporting of catch by area and/or species) and downwards (e.g., due to discarding). In addition, commercial catch accounting procedures pre- and post-moratorium are radically different, with current measures likely to provide improved estimates of removals. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium. Estimates of recreational fishery landings have not been available since 2006.

There is uncertainty regarding the origins of fish found in Subdiv. 3Ps at various times of the year. Tagging and telemetry experiments show that there is mixing with adjacent stocks (southern Div. 3L and Div. 3Pn4RS) and this may vary over time.

The DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Any near-shore aggregations in April would not be measured by the DFO RV survey. The majority of the area shore-ward of the RV survey lies within inner and western Placentia Bay. There is no recent evidence that a large fraction of the stock is shore-ward of the RV survey in April.

There is evidence that the recruitment productivity of the stock has changed over time, and that the stock has been less productive since 1990 than in earlier periods. The causes for these changes are not well understood. Better understanding of this issue is required and could have important implications for any management targets and maximum sustainable yield (MSY) reference points. This reduction in recruitment productivity may be consistent with harvester perspective on the declining abundance of capelin in Subdiv.3Ps.

Comparison of sentinel catch rates and the DFO RV index at times show inconsistent age-compositions. This may be indicative of differences in cohort strength between stock components. For example, the sentinel gillnet data consistently measured the 1992 cohort as being an above average fraction of the annual catch. This cohort was also important to the commercial gillnet catch, but was not notable in the RV index. A similar phenomenon exists for the 2004 cohort (detected by sentinel line-trawl but not sentinel gillnet or RV index).

The geographical coverage of tagging since 2007 is very limited; during 2008 to 2010 cod have only been tagged in Placentia Bay. The lack of recent tagging in other areas adds uncertainty to our understanding of natural mortality rates, exploitation rates, stock structure, and movement patterns and how these influence survey and commercial catch rates in the recent period.

The relative efficiency of the survey trawl at capturing different age groups is uncertain. Differing patterns of catchability were explored in recent assessments and yielded similar outcome in terms of current status relative to the LRP. If the catchabilities differ from the assumed values, stock dynamics may differ from the results presented above.

Survey indices are at times influenced by “year-effects”, an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. In the 2009 DFO RV survey, the estimated abundance at ages 2-8 increased compared to these cohorts at ages 1-7 as measured in the 2008 survey. This is unusual and indicates that one (or possibly both) of the 2008 and 2009 surveys may be influenced by a year-effect. Year-effects are also evident in the 1995 and 1997 survey results.

The percentage of the catch from the <35 ft sector that is accounted for in the standardized logbook indices has declined over time and now represents only about 30% of the catch as compared to approximately 70% at the start of the time series in 1997. This likely affects the quality and comparability of this index over time.

Age at 50% maturity has been declining in recent years. The proportion of female cod maturing at younger ages has been higher for all cohorts subsequent to the 1986 cohort, resulting in a significant proportion of SSB made up of younger fish. Questions exist as to whether or not these small, young fish are effective spawners. Given the lack of definitive data regarding size and age effects on spawner quality for this stock, the current practice of equally weighting all components of SSB (regardless of size and age) continues to be employed. However, if young spawners contribute disproportionately less to recruitment than older fish, the current reproductive potential of the stock would be lower than expected and would be reduced in comparison to the pre-1986 SSB, which was comprised of older fish.

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Table 1. Reported landings of cod (t) from NAFO Subdiv. 3Ps, 1959 to September 30th, 2011 by country and for fixed and mobile gear sectors.

Year	Can. (Newfoundland) Offshore (Mobile)	Inshore (Fixed)	Can. (Mainland) (All gears)	France St. Pierre & Miquelon Inshore	Offshore	Metro (All gears)	Spain (All gears)	Portugal (All gears)	Others (All gears)	Total	TAC
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	676	60	59	-	-	-	-	-	821	0
1996	60	836 [2]	118	43		-	-	-	-	1,057	0
1997	108	7,594 [2]	79	448	1,191	-	-	-	-	9,420	10,000
1998	2,543	13,609 [2]	885	609	2,511	-	-	-	-	20,156	20,000
1999	3,059	21,156 [2]	614	621	2,548	-	-	-	-	27,997	30,000
2000	3,436	16,247 [2]	740	870	3,807	-	-	-	-	25,100	20,000 [3]
2001	2,152	11,187 [2]	856	675	1,675	-	-	-	-	16,546	15,000 [3]
2002	1,326	11,292 [2]	499	579	1,623	-	-	-	-	15,319	15,000 [3]
2003	1,869	10,600 [2]	412	734	1,645	-	-	-	-	15,260	15,000 [3]
2004	1,595	9,450 [2]	790	465	2,113	-	-	-	-	14,414	15,000 [3]
2005	1,863	9,537 [2]	818	617	1,941	-	-	-	-	14,776	15,000 [3]
2006	1,011	9,590 [2]	675	555	1,326	-	-	-	-	13,157	13,000 [3]
2007	1,339	9,303 [4]	294	520	1,503	-	-	-	-	12,959	13,000 [3]
2008	982	8,654 [4]	377	467	1,293	-	-	-	-	11,773	13,000 [3]
2009	1,733	5,870 [4]	193	282	1,684	-	-	-	-	9,762	11,500 [3]
2010 [1]	1,419	5,244 [4]	196	76	1,364	-	-	-	-	8,299	11,500 [3]
2011 [1]	938	2,711 [4]	272		327	-	-	-	-	4,248	11,500 [3]

[1] Provisional catches

[2] Includes recreational fishery and sentinel fishery.

[3] Since 2000, TAC's have been established for the period 1 April to 31 March rather than by calender year.

[4] Does not include estimates of recreational catch.

Table 2. Reported fixed gear catches of cod (t) from NAFO Subdiv. 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	[1]	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	[1]	7,910	2,167	415	15	10,508
2005	[1]	8,112	2,016	626	6	10,760
2006	[1]	7,590	2,698	314	2	10,603
2007	[1,2]	7,287	2,374	445	11	10,116
2008	[1,2]	6,636	2,482	341	21	9,480
2009	[1,2]	4,052	1,644	612	36	6,344
2010	[1,2]	4,013	1,182	296	2	5,493
2011	[1,2,3]	2,161	509	153	18	2,841

[1]provisional

[2]excluding recreational catches

[3]September 30th 2011

Table 3. Reported monthly landings (t) of cod from unit areas in NAFO Subdiv. 3Ps during 2010 and 2011 (provisional to September 15th, 2011).

2010	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**Totals**
Jan	17.3	69.8	166.1	3.4	0.0	0.0	0.7	531.9	789.1
Feb	4.4	66.5	128.7	11.6	0.0	8.3	138.9	502.4	860.8
Mar	0.4	0.0	0.0	10.3	0.0	0.0	6.9	180.3	197.9
Apr	0.0	0.0	0.0	2.5	0.0	0.0	0.5	8.6	11.6
May	23.9	20.6	17.8	0.0	0.0	0.0	0.0	1.4	63.7
Jun	78.1	157.2	947.6	0.3	0.0	20.1	0.0	14.8	1,218.0
Jul	83.3	192.4	806.3	9.4	0.1	46.5	1.6	24.9	1,164.4
Aug	44.2	52.3	64.5	3.7	73.2	28.3	8.3	6.0	280.4
Sep	24.5	17.2	37.0	1.7	14.6	237.3	0.6	9.9	342.8
Oct	88.6	51.9	149.1	1.5	38.8	234.5	44.3	5.0	613.7
Nov	97.5	87.3	271.4	2.8	46.5	414.1	48.7	55.1	1,023.5
Dec	17.6	88.8	77.4	0.0	0.4	7.5	0.0	177.9	369.6
Totals	479.8	803.8	2,666.0	47.0	173.6	996.5	250.5	1,518.3	6,935.5

* Excludes 1364 t of catch by France in 2010 - Unit Area unavailable.

2011	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**Totals**
Jan	21.3	126.6	45.9	0.4	16.5	4.6	0.0	609.9	825.2
Feb	7.1	86.3	58.5	1.6	0.3	6.8	33.3	345.9	539.9
Mar	0.3	1.4	6.2	21.8	0.0	0.0	31.4	119.4	180.6
Apr	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.3
May	19.1	55.5	67.8	0.0	0.0	0.0	0.0	1.6	144.1
Jun	82.1	180.9	515.5	0.0	0.0	0.0	0.0	0.0	778.4
Jul	102.1	169.6	307.1	6.0	0.0	0.0	0.0	0.0	584.7
Aug	14.9	87.2	124.0	15.5	0.0	0.2	0.0	0.0	241.8
Sep	9.0	244.3	360.0	0.0	0.0	2.9	7.7	0.3	624.2
Oct									0.0
Nov									0.0
Dec									0.0
Totals	255.8	951.7	1,485.0	45.5	16.8	14.4	72.6	1,077.3	3,919.1

* Excludes 330 t of catch by France in 1st quarter of 2011 - Unit Area unavailable.

Table 4. Number of cod sampled for length and age used to estimate the commercial catch at age for 2010.

	Number Measured (Canada)							
	Offshore			Inshore				
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Other	Total
Jan	2,229			1,525	1,710	103	23	5,590
Feb	917		437	1,827	3,281		3	6,465
Mar	260				179			439
Apr								0
May				693			322	1,015
Jun				4,199	897	63	215	5,374
Jul				4,925	3,185	303	269	8,682
Aug				272	1,700		62	2,034
Sep		485		111	720			1,316
Oct		2,055		479	1,462	88		4,084
Nov	394	748		1,857	3,219	59	32	6,309
Dec	1,665			173	1,096		74	3,008
Total	5,465	3,288	437	16,061	17,449	616	1,000	44,316

	Number Aged (Canada)							
	Offshore			Inshore				
Quarter	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Ottertrawl	Total
1	678		228	230	295			1,431
2				432	180	63		675
3		61		329	553	60		1,003
4	158	551		222	704	84		1,719
Total	836	612	228	1,213	1,732	207	0	4,828

Sampling by France (SPM)

	Measured		Aged	
Quarter	Ottertrawl	Gillnet	Ottertrawl	Gillnet
1	2,841			
3	379			
4	1,046	183		
Total	4,266	183	0	0

Table 5. Estimates of average weight (kg), length (cm), and the total numbers (000s) and weight of 3Ps cod caught at age from Canadian and French landings during 2010. Numbers exclude any recreational catches.

	AVERAGE		CATCH			
AGE	WEIGHT (kg.)	LENGTH (cm.)	NUMBER (000'S)	STD ERR.	CV	Weight (t)
1						
2	0.33	33.55	4.96	0.68	0.14	2
3	0.64	41.08	30.58	2.16	0.07	19
4	1.09	49.45	376.71	14.30	0.04	410
5	1.36	53.15	548.90	23.04	0.04	748
6	2.01	60.06	1239.79	29.79	0.02	2491
7	2.26	62.35	725.79	23.64	0.03	1640
8	2.59	64.97	385.05	18.72	0.05	996
9	2.76	65.93	180.56	11.92	0.07	498
10	2.93	66.73	75.94	7.31	0.10	223
11	5.52	81.20	22.17	2.38	0.11	122
12	7.91	91.42	57.14	3.06	0.05	452
13	9.52	98.92	30.24	1.84	0.06	288
14	9.98	100.85	8.42	0.94	0.11	84
15	10.03	99.96	4.50	0.77	0.17	45
16	13.46	109.08	1.40	0.50	0.36	19
17	14.07	113.92	0.97	0.28	0.29	14
18	15.03	116.67	0.95	0.25	0.26	14
19	16.58	120.47	0.34	0.13	0.39	6
20	17.31	121.39	0.57	0.18	0.32	10
21	18.66	125.13	0.21	0.09	0.46	4

Total (t)	8085
Landings (t)	8300
SOP	0.974

Table 6. Catch numbers-at-age (000s) for the commercial cod fishery in NAFO Subdiv. 3Ps from 1959 to 2010 (only ages 3-14 shown). Recreational catches for 2007 onward are excluded (see text).

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	1001	13940	7525	7265	4875	942	1252	1260	631	545	44	1
1960	567	5496	23704	6714	3476	3484	1020	827	406	407	283	27
1961	450	5586	10357	15960	3616	4680	1849	1376	446	265	560	58
1962	1245	6749	9003	4533	5715	1367	791	571	187	140	135	241
1963	961	4499	7091	5275	2527	3030	898	292	143	99	107	92
1964	1906	5785	5635	5179	2945	1881	1891	652	339	329	54	27
1965	2314	9636	5799	3609	3254	2055	1218	1033	327	68	122	36
1966	949	13662	13065	4621	5119	1586	1833	1039	517	389	32	22
1967	2871	10913	12900	6392	2349	1364	604	316	380	95	149	3
1968	1143	12602	13135	5853	3572	1308	549	425	222	111	5	107
1969	774	7098	11585	7178	4554	1757	792	717	61	120	67	110
1970	756	8114	12916	9763	6374	2456	730	214	178	77	121	14
1971	2884	6444	8574	7266	8218	3131	1275	541	85	125	62	57
1972	731	4944	4591	3552	4603	2636	833	463	205	117	48	45
1973	945	4707	11386	4010	4022	2201	2019	515	172	110	14	29
1974	1887	6042	9987	6365	2540	1857	1149	538	249	80	32	17
1975	1840	7329	5397	4541	5867	723	1196	105	174	52	6	2
1976	4110	12139	7923	2875	1305	495	140	53	17	21	4	3
1977	935	9156	8326	3209	920	395	265	117	57	43	31	11
1978	502	5146	6096	4006	1753	653	235	178	72	27	17	10
1979	135	3072	10321	5066	2353	721	233	84	53	24	13	10
1980	368	1625	5054	8156	3379	1254	327	114	56	45	21	25
1981	1022	2888	3136	4652	5855	1622	539	175	67	35	18	2
1982	130	5092	4430	2348	2861	2939	640	243	83	30	11	7
1983	760	2682	9174	4080	1752	1150	1041	244	91	37	18	8
1984	203	4521	4538	7018	2221	584	542	338	134	35	8	8
1985	152	2639	8031	5144	5242	1480	626	545	353	109	21	6
1986	306	5103	10253	11228	4283	2167	650	224	171	143	79	23
1987	585	2956	11023	9763	5453	1416	1107	341	149	78	135	50
1988	935	4951	4971	6471	5046	1793	630	284	123	75	53	31
1989	1071	8995	7842	2863	2549	1112	600	223	141	57	29	26
1990	2006	8622	8195	3329	1483	1237	692	350	142	104	47	22
1991	812	7981	10028	5907	2164	807	620	428	108	76	50	22
1992	1422	4159	8424	6538	2266	658	269	192	187	83	34	41
1993	278	3712	2035	3156	1334	401	89	38	52	13	14	5
1994	9	78	173	74	62	28	12	3	2	0	0	0
1995	3	7	56	119	57	37	7	2	0	0	0	0
1996	9	43	43	101	125	35	24	8	2	1	0	0
1997	66	427	1130	497	937	826	187	93	31	4	1	0
1998	91	373	793	1550	948	1314	1217	225	120	56	15	1
1999	49	628	1202	2156	2321	1020	960	873	189	110	21	8
2000	76	335	736	1352	1692	1484	610	530	624	92	37	16
2001	80	475	718	1099	1143	796	674	257	202	192	28	13
2002	155	607	1451	1280	900	722	419	355	96	70	71	14
2003	15	301	879	1810	1139	596	337	277	167	67	55	84
2004	62	113	654	1592	1713	649	266	180	104	47	17	24
2005	49	330	515	1007	1628	1087	499	143	95	41	26	12
2006	43	253	866	928	846	1055	632	237	80	36	19	7
2007	97	311	727	1072	761	501	526	401	160	44	34	21
2008	35	422	617	1105	976	634	350	295	193	91	27	12
2009	17	129	813	1000	902	460	205	99	114	86	56	12
2010	31	377	549	1240	726	385	181	76	22	57	30	8

Table 7a. Mean annual weights-at-age (kg) calculated from lengths-at-age based on samples from commercial fisheries (including food fisheries and sentinel surveys where available) in Subdiv. 3Ps in 1959-2010. The weights-at-age from 1976 are extrapolated back to 1959.

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1960	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1961	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1962	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1963	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1964	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1965	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1966	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1967	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1968	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1969	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1970	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1971	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1972	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1973	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1974	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1975	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1976	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1977	0.550	0.680	1.300	1.860	2.670	3.420	4.190	4.940	5.920	6.760	8.780	10.900
1978	0.450	0.700	1.080	1.750	2.450	2.990	4.100	5.160	5.170	7.200	7.750	8.720
1979	0.410	0.650	1.010	1.650	2.550	3.680	4.300	6.490	7.000	8.200	9.530	10.840
1980	0.520	0.720	1.130	1.660	2.480	3.600	5.400	6.950	7.290	8.640	9.330	9.580
1981	0.480	0.790	1.320	1.800	2.300	3.270	4.360	5.680	7.410	9.040	8.390	9.560
1982	0.450	0.770	1.170	1.780	2.360	2.880	3.910	5.280	6.180	8.620	8.640	11.410
1983	0.580	0.840	1.330	1.990	2.580	3.260	3.770	5.040	6.560	8.450	10.060	11.820
1984	0.660	1.040	1.400	1.970	2.640	3.770	4.750	5.560	6.010	9.040	11.200	10.400
1985	0.630	0.850	1.230	1.790	2.810	3.440	5.020	6.010	6.110	7.180	9.810	10.480
1986	0.540	0.750	1.180	1.840	2.430	3.150	4.300	5.500	6.190	8.720	8.050	11.910
1987	0.560	0.770	1.210	1.630	2.310	3.020	4.330	5.110	6.200	6.980	7.080	8.340
1988	0.630	0.820	1.090	1.670	2.170	2.920	3.580	4.980	5.610	6.600	7.460	8.920
1989	0.630	0.810	1.160	1.630	2.250	3.370	4.110	5.180	6.290	7.300	7.750	8.730
1990	0.580	0.860	1.270	1.850	2.450	3.000	4.220	5.090	6.350	7.600	8.310	10.370
1991	0.600	0.750	1.170	1.740	2.370	2.910	3.690	4.230	6.340	7.680	8.640	9.720
1992	0.459	0.694	1.038	1.560	2.226	2.891	4.142	5.542	6.420	7.822	10.397	11.880
1993	0.355	0.680	1.077	1.480	2.127	2.824	4.341	4.302	4.683	7.494	6.845	8.238
1994	0.617	0.816	1.303	1.860	2.054	2.746	3.593	4.377	6.291	7.768	6.784	8.073
1995	0.520	0.850	1.570	2.030	2.470	2.780	3.460	4.300	4.270	4.160	5.590	9.241
1996	0.674	0.985	1.485	2.048	2.525	2.941	3.232	4.031	4.823	4.680	7.257	9.921
1997	0.617	0.898	1.304	1.871	2.510	3.242	3.471	3.524	4.587	6.365	8.579	10.733
1998	0.620	1.020	1.570	2.050	2.420	3.100	4.040	4.130	4.620	5.210	6.390	9.690
1999	0.700	0.920	1.570	2.310	2.530	2.820	3.920	5.320	4.990	5.270	6.140	7.270
2000	0.615	0.896	1.358	2.066	2.741	2.813	3.152	4.597	6.538	6.123	6.423	7.734
2001	0.689	1.018	1.440	1.935	2.575	3.405	3.206	3.456	5.593	8.607	7.609	8.115
2002	0.572	1.017	1.544	2.040	2.324	3.104	4.326	3.896	3.874	6.046	8.895	7.942
2003	0.681	0.974	1.574	2.111	2.342	2.634	3.867	4.750	4.297	5.330	7.819	10.346
2004	0.587	0.963	1.368	2.036	2.495	2.737	2.851	5.021	6.707	5.247	7.128	8.786
2005	0.637	0.943	1.386	1.840	2.458	2.904	3.161	3.246	4.361	6.153	5.525	7.854
2006	0.567	1.010	1.549	1.939	2.167	2.748	3.435	3.465	3.133	4.923	6.593	7.498
2007	0.556	0.938	1.444	1.962	2.235	2.533	3.732	4.957	5.512	4.861	7.079	8.806
2008	0.663	0.981	1.350	1.919	2.223	2.465	2.629	3.804	5.199	5.292	5.003	8.455
2009	0.626	1.019	1.533	1.932	2.375	2.482	2.614	3.671	5.815	7.070	7.973	8.997
2010	0.635	1.089	1.363	2.009	2.260	2.585	2.761	2.932	5.518	7.910	9.520	9.981

Table 7b. Beginning of the year weights-at-age (kg) calculated from commercial annual mean weights-at-age. The values for 1976 are extrapolated back to 1959.

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1960	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1961	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1962	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1963	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1964	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1965	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1966	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1967	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1968	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1969	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1970	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1971	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1972	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1973	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1974	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1975	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1976	0.180	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1977	0.488	0.436	0.947	1.417	2.118	2.865	3.667	4.500	5.484	6.385	7.840	9.367
1978	0.374	0.620	0.857	1.508	2.135	2.825	3.745	4.650	5.054	6.529	7.238	8.750
1979	0.309	0.541	0.841	1.335	2.112	3.003	3.586	5.158	6.010	6.511	8.283	9.166
1980	0.422	0.543	0.857	1.295	2.023	3.030	4.458	5.467	6.878	7.777	8.747	9.555
1981	0.379	0.641	0.975	1.426	1.954	2.848	3.962	5.538	7.176	8.118	8.514	9.444
1982	0.329	0.608	0.961	1.533	2.061	2.574	3.576	4.798	5.925	7.992	8.838	9.784
1983	0.433	0.615	1.012	1.526	2.143	2.774	3.295	4.439	5.885	7.226	9.312	10.106
1984	0.582	0.777	1.084	1.619	2.292	3.119	3.935	4.578	5.504	7.701	9.728	10.229
1985	0.577	0.749	1.131	1.583	2.353	3.014	4.350	5.343	5.829	6.569	9.417	10.834
1986	0.452	0.687	1.001	1.504	2.086	2.975	3.846	5.255	6.099	7.299	7.603	10.809
1987	0.463	0.645	0.953	1.387	2.062	2.709	3.693	4.688	5.840	6.573	7.857	8.194
1988	0.556	0.678	0.916	1.422	1.881	2.597	3.288	4.644	5.354	6.397	7.216	7.947
1989	0.539	0.714	0.975	1.333	1.938	2.704	3.464	4.306	5.597	6.399	7.152	8.070
1990	0.510	0.736	1.014	1.465	1.998	2.598	3.771	4.574	5.735	6.914	7.789	8.965
1991	0.558	0.660	1.003	1.487	2.094	2.670	3.327	4.225	5.681	6.983	8.103	8.987
1992	0.377	0.645	0.882	1.351	1.968	2.618	3.472	4.522	5.211	7.042	8.936	10.131
1993	0.234	0.559	0.865	1.239	1.822	2.507	3.543	4.221	5.095	6.936	7.317	9.255
1994	0.525	0.538	0.941	1.415	1.744	2.417	3.185	4.359	5.202	6.032	7.130	7.434
1995	0.378	0.724	1.132	1.626	2.143	2.390	3.083	3.931	4.323	5.116	6.590	7.918
1996	0.584	0.716	1.123	1.793	2.264	2.695	2.998	3.734	4.554	4.470	5.494	7.447
1997	0.480	0.778	1.133	1.667	2.267	2.861	3.195	3.375	4.300	5.540	6.337	8.825
1998	0.509	0.793	1.187	1.635	2.128	2.789	3.619	3.786	4.035	4.889	6.377	9.118
1999	0.619	0.755	1.265	1.904	2.277	2.612	3.486	4.636	4.540	4.934	5.656	6.816
2000	0.478	0.792	1.118	1.801	2.516	2.668	2.981	4.245	5.898	5.528	5.818	6.891
2001	0.567	0.792	1.136	1.621	2.307	3.055	3.003	3.300	5.071	7.502	6.826	7.220
2002	0.439	0.837	1.254	1.714	2.121	2.827	3.838	3.534	3.659	5.815	8.750	7.774
2003	0.573	0.746	1.265	1.806	2.186	2.474	3.465	4.533	4.092	4.544	6.876	9.593
2004	0.464	0.810	1.154	1.790	2.295	2.532	2.740	4.406	5.644	4.749	6.164	8.288
2005	0.506	0.744	1.155	1.586	2.237	2.692	2.941	3.042	4.679	6.424	5.384	7.482
2006	0.440	0.802	1.209	1.640	1.997	2.599	3.159	3.309	3.189	4.633	6.369	6.436
2007	0.440	0.729	1.207	1.744	2.082	2.343	3.203	4.126	4.370	3.902	5.903	7.620
2008	0.492	0.703	1.103	1.659	2.080	2.333	2.560	3.597	4.887	5.238	4.703	7.418
2009	0.473	0.801	1.168	1.583	2.127	2.335	2.523	3.069	4.471	5.825	6.294	6.378
2010	0.468	0.825	1.180	1.756	2.089	2.476	2.612	2.770	4.489	6.767	8.193	8.917
2011	0.468	0.774	1.150	1.665	2.099	2.380	2.565	3.127	4.612	5.911	6.236	7.500

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 expressed as fish per net for gill nets and fish per 1000 hooks for line-trawl.

Gillnet (5.5")

Year/Age	3	4	5	6	7	8	9	10	Total
1995	0.02	0.08	4.11	8.93	5.43	2.53	0.39	0.16	21.65
1996	0.02	0.27	2.73	12.54	10.23	2.92	0.87	0.07	29.65
1997	0.01	0.24	5.35	5.33	9.50	7.69	1.13	0.62	29.89
1998	0.00	0.06	1.14	7.86	3.54	2.77	1.71	0.32	17.40
1999	0.05	0.07	0.52	0.90	1.44	0.65	0.29	0.28	4.21
2000	0.01	0.02	0.31	0.73	0.72	0.98	0.33	0.11	3.20
2001	0.03	0.16	0.41	0.88	0.68	0.38	0.37	0.18	3.10
2002	0.00	0.04	0.49	0.80	0.77	0.33	0.15	0.17	2.75
2003	0.01	0.05	0.23	0.98	0.47	0.18	0.09	0.04	2.06
2004	0.00	0.05	0.21	0.81	0.82	0.39	0.13	0.03	2.46
2005	0.00	0.02	0.13	0.58	0.66	0.38	0.29	0.05	2.12
2006	0.00	0.05	0.29	0.57	0.51	0.58	0.24	0.14	2.40
2007	0.00	0.05	0.41	1.04	0.73	0.38	0.28	0.18	3.07
2008	0.00	0.08	0.28	1.07	0.90	0.44	0.22	0.09	3.09
2009	0.02	0.03	0.26	0.65	1.15	0.23	0.18	0.05	2.55
2010	0.01	0.06	0.37	0.80	0.67	0.33	0.12	0.18	2.53

Linetrawl

Year/Age	3	4	5	6	7	8	9	10	Total
1995	7.7	14.6	51.0	73.5	19.5	18.2	4.3	1.5	190.1
1996	8.0	29.0	28.0	45.1	46.5	13.4	7.5	1.8	179.2
1997	5.6	22.7	24.2	15.9	16.7	22.9	2.8	1.7	112.5
1998	7.2	16.4	21.5	16.1	6.2	9.6	11.5	2.4	91.0
1999	5.8	17.3	23.8	13.7	7.7	4.9	4.6	2.0	79.9
2000	12.5	27.6	25.8	17.2	8.1	6.4	2.4	1.0	101.0
2001	17.6	30.6	22.6	13.4	7.3	4.2	2.3	0.7	98.7
2002	13.5	28.0	25.4	8.9	5.5	1.9	1.0	0.8	85.0
2003	2.6	34.4	39.2	20.1	8.3	3.5	1.3	0.9	110.4
2004	9.1	9.8	36.1	19.1	10.2	3.3	1.6	0.4	89.6
2005	7.1	20.0	13.0	13.1	11.4	4.4	2.0	0.9	71.7
2006	8.8	17.0	26.4	20.0	13.4	12.1	3.6	1.6	102.8
2007	10.8	19.0	16.6	14.0	8.4	5.0	4.5	1.8	80.2
2008	5.2	25.6	22.6	18.7	9.1	5.8	2.8	2.6	92.4
2009	5.1	13.5	27.5	15.7	6.4	3.7	1.7	1.3	74.8
2010	2.3	14.3	11.9	15.1	7.4	2.1	0.9	0.7	54.8

Table 9. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Subdiv. 3Ps during 1997-2011. Shaded cells are model estimates. See Fig. 13 for location of strata. For 1983 to 1996 results see Brattey et al. (2007).

								Tel 351			Tel 522	AN 656						
		Vessel	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	AN	AN	AN
		Trips	202-203	219-220	236-237	313-315	364-365	418-419	476-477	523+546	617-618	688	757-759	824-827	902-904	930-932	401-403
Depth		Sets	158	176	175	171	173	177	176	177	178	24	178	169	175	177	174
range		Mean Date	12-Apr	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr	27-Apr		18-Apr	02-May	24-Apr	21-Apr	23-Apr
(fathoms)	Strata	sq. mi.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
<30	314	974	77	57	1729	1531	153	67	19	117	256		1570	2144	573	287	328
	320	1320	303	1292	3546	5183	1543	478	1601	396	523		333	363	3222	1260	1603
31-50	293 [5]	159	107	292	601	394	219	131	120	375	2850	200	317	252	208	55	284
	308	112	262	4175	2704	1829	1094	285	77	2265	16719		1410	2373	486	16893	3058
	312	272	19	100	461	1235	636	112	150	56	1141		370	270	0	112	337
	315	827	38	5721	2428	1895	1040	228	49	395	1161		1268	675	1634	767	1405
	321	1189	18	49	894	1161	55	98	82	16	229		65	189	218	1823	2608
	325	944	108	16	752	2824	1526	65	16	1120	383		893	812	1542	7970	8019
	326	166	0	11	52	109	57	0	0	0	0		285	11	0	11	627
	783 [1]	229	47	16	110	86	142	13	95	16	252	**nf**	126	126	157	515	228
51-100	294 [5]	135	176	901	362	170	195	613	455	288	20685	1092	1281	108	4960	713	59
	297 [5]	152	408	209	1892	7000	450	450	42	244	1317	20732	1047	273	1056	4242	2781
	307	395	1123	23490	5879	6991	5665	833	22912	9328	3172		2735	4849	18237	7758	4945
	311	317	371	1652	2169	2864	610	780	349	2733	788		1715	2519	3632	9627	1979
	317	193	451	173	305	1487	637	1049	372	199	1367		2522	2881	912	3215	330
	319	984	1889	15600	11839	9327	58696	34398	2149	26117	6064		15245	14670	24418	20120	10120
	322	1567	234	260	713	1529	413	633	263	649	2463		2507	1297	1049	820	2546
	323	696	24	32	158	1001	941	64	19	0	101		32	3300	105	15274	8179
	324	494	272	160	361	442	85	306	391	85	432		481	153	359	417	3590
	781 [1]	446	195	276	1058	716	1564	261	215	1052	568	491	445	552	548	293	506
	782 [1]	183	63	38	38	315	76	227	50	63	221	**nf**	101	227	201	22	566
101-150	295 [5]	209	168	465	976	615	978	144	187	72	976	1781	1469	633	396	2441	nf
	298 [5]	171	110	1861	46	3450	670	371	5399	976	282	21	7475	3384	73	585	0
	300 [5]	217	584	1579	641	896	791	746	1370	168	657	327	478	90	507	194	917
	306	363	816	771	708	4191	949	246	277	666	1015		2175	818	4054	714	1382
	309	296	260	11980	215	142	2056	13172	484	109	582		1122	244	49	236	529
	310	170	1380	105	131	187	505	485	1391	12	249		94	269	30	143	129
	313	165	0	454	91	113	3564	125	567	10	66		124	23	111	259	21
	316	189	65	104	23	13	26	117	273	69	117		117	13	116	10	12
	318	129	1881	53	0	231	44	71	11943	275	683		336	16	189	18	9
	779 [1]	422	0	39	0	73	26	29	15	19	142	77	671	310	186	0	503
	780 [1]	403	35	18	0	40	0	0	0	0	18	**nf**	400	0	37	0	388
151-200	296 [5]	71	632	4	375	107	1924	735	303	2627	35	54	881	273	999	32	3581
	299 [5]	212	643	49	0	13	131	160	214	44	29	44	44	13	13	42	58
	705	195	241	376	24	54	83	241	232	267	64		0	76	155	36	29
	706	476	172	327	87	49	49	82	246	120	310		31	65	87	258	131
	707	74	353	102	9	0	293	3079	143	121	1263		122	257	737	23	16
	715	128	516	5874	484	751	3013	1615	960	102	305		132	170	599	63	53
	716	539	91	3089	2428	196	99	1333	952	74	142		1368	51	1546	180	130
201-300	708	126	388	1464	947	0	35	151	329	85	1419		641	0	4299	26	30
	711	593	44	16	0	783	80	49	96	29	1530		505	29	125	44	29
	712	731	60	201	50	98	117	67	345	60	15		106	54	60	15	34
	713	851	902	61	78	176	364	320	372	127	80		45	17	99	56	0
	714	1074	2765	485	173	151	3781	1346	1678	230	77		373	44	819	55	70
	Total [3]		15,123	78,250	39,438	46,543	88,209	61,895	48,737	45,832	42,716		38,722	38,652	69,462	88,490	52,275
	Total [4]		18,291	83,997	45,537	60,428	95,405	65,775	57,813	51,776	70,748		53,457	44,906	78,803	97,625	62,146
	upper		21,365	166,891	55,196	60,749	147,318	119,231	109,897	95,755	171,310		48,978	55,629	103,588	139,453	69,678
	t-value		2.31	3.18	2.23	2.20	2.36	2.78	3.18	2.31	4.30		4.30	2.20	2.23	2.11	2.12
	std [6]		2,702	27,857	7,066	6,457	25,046	20,624	19,233	21,649	29,906		2,383	7,713	15,303	24,153	8,209

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

[2] Stratum 709 was redrawn in 1994 and includes stratum 710 from previous surveys. All sets in 710 prior to 1994 were recoded to 709.

[3] For index strata 0-300 fathoms in the offshore and includes estimates (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 1997-2011. Shaded cells are model estimates. See Fig. 13 for location of strata. For 1983 to 1996 results see Brattey et al. (2007).

							Tel 351			Tel 522	AN 656						
		Vessel	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	AN	AN	AN
		Trips	202-203	219-220	236-237	313-315	364-365	418-419	476-477	523+546	617-618	688	757-759	824-827	902-904	930-932	401-403
Depth		Sets	158	176	175	171	173	177	176	177	178	24	178	169	175	177	174
range		Mean Date	12-Apr	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr	27-Apr	15-Apr	18-Apr	02-May	24-Apr	21-Apr	23-Apr
(fathoms)	Strata	sq. mi.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
<30	314	974	32	8	595	829	46	5	0	10	185	nf	53	204	68	43	100
	320	1320	114	7766	6287	6761	601	932	2707	395	1890	nf	1274	442	1069	603	500
31-50	293 [5]	159	17	19	27	45	26	9	29	18	1810	34	16	18	7	15	19
	308	112	93	1461	1572	1088	184	48	12	1949	8011	nf	253	789	170	8343	1558
	312	272	13	8	226	640	93	10	9	18	345	nf	60	434	0	37	78
	315	827	14	20072	3771	3092	491	822	17	335	13514	nf	6456	99	1777	235	1295
	321	1189	2	0	1855	4582	2	5	2	2	40	nf	186	17	54	2054	1639
	325	944	10	0	418	1307	340	10	3	568	84	nf	172	555	447	4194	2831
	326	166	0	0	8	478	25	0	0	0	0	nf	55	1	0	19	140
	783 [1]	229	0	0	14	16	6	0	2	1	303	nf	12	18	13	31	25
51-100	294 [5]	135	24	40	19	7	26	47	22	14	21147	716	85	27	149	55	7
	297 [5]	152	39	22	1697	2339	108	38	5	42	1482	20678	382	122	156	1224	2110
	307	395	332	16164	3784	5162	1578	197	26828	6055	2423	nf	1471	3059	8114	4100	3258
	311	317	51	169	3342	1661	26	145	13	182	570	nf	83	219	395	2414	394
	317	193	62	196	36	259	331	88	59	78	218	nf	1118	231	158	2436	31
	319	984	287	28144	18019	8121	51570	38958	755	67844	5845	nf	14166	8888	33064	20494	10024
	322	1567	118	13	117	1893	193	32	26	38	1532	nf	79	205	104	439	1395
	323	696	15	112	227	643	305	7	1	0	28	nf	1	2525	4	10070	4602
	324	494	11	8	252	25	7	14	13	8	148	nf	51	39	53	39	653
	781 [1]	446	22	16	64	49	36	13	17	61	203	62	23	49	28	33	44
	782 [1]	183	2	7	1	7	0	27	1	3	34	nf	5	13	20	1	328
101-150	295 [5]	209	24	139	45	61	124	8	26	4	727	253	128	83	20	519	nf
	298 [5]	171	42	2608	148	2632	202	75	2735	488	250	30	8445	2881	56	250	0
	300 [5]	217	147	802	650	307	153	124	175	103	391	192	149	25	286	111	480
	306	363	312	618	553	5123	543	67	51	960	812	nf	2142	645	2021	630	932
	309	296	87	9788	320	303	1118	15666	193	56	464	nf	1328	673	10	282	333
	310	170	206	72	145	330	488	209	263	4	410	nf	11	427	7	82	105
	313	165	0	481	162	97	18231	122	807	4	101	nf	352	79	61	213	14
	316	189	40	138	43	21	63	78	146	103	95	nf	120	5	156	7	7
	318	129	404	88	0	592	28	43	12705	506	1672	nf	445	25	189	32	38
	779 [1]	422	0	10	0	4	1	1	2	1	47	5	41	38	18	0	168
	780 [1]	403	3	1	0	6	0	0	0	0	2	nf	86	0	2	0	71
151-200	296 [5]	71	175	1	102	20	341	118	36	900	54	20	146	76	239	5	2702
	299 [5]	212	282	231	0	1	411	655	315	35	15	30	327	1	2	26	63
	705	195	476	345	25	20	71	244	434	288	96	nf	0	111	122	47	36
	706	476	379	266	68	63	26	40	431	147	301	nf	56	76	51	153	180
	707	74	72	121	21	0	360	3726	187	329	3347	nf	109	243	469	20	24
	715	128	233	6849	1127	1240	5599	2525	1188	114	451	nf	167	296	1793	101	74
	716	539	44	1772	4106	229	92	554	735	75	123	nf	1933	59	961	124	111
201-300	708	126	629	4389	1455	0	54	139	354	76	1272	nf	940	0	3688	16	30
	711	593	43	11	0	1242	75	35	41	22	1864	nf	1024	52	100	33	25
	712	731	151	267	25	64	65	25	264	39	6	nf	94	81	52	10	22
	713	851	1101	48	143	123	273	235	261	172	63	nf	27	5	59	101	0
	714	1074	3471	725	155	123	4113	1212	2306	183	149	nf	514	51	808	55	59
	Total [3]		8,802	100,100	48,857	46,111	86,991	66,193	50,811	80,560	46,059		34,740	20,535	56,024	57,429	30,487
	Total [4]		9,579	103,996	51,624	51,610	88,484	67,308	54,559	82,230	72,524		44,585	23,910	57,020	59,698	36,505
	upper		14,193	160,874	71,356	60,876	148,519	134,681	127,771	218,043	146,619		53,944	31,842	107,025	99,022	41,177
	t-value		2.36	2.201	2.13	2.15	2.57	2.78	3.18	2.365	3.18		2.12	2.31	2.31	2.2	2.12
	std [6]		2,284	27,612	10,563	6,867	23,941	24,636	24,201	58,132	31,623		9,058	4,895	22,078	18,906	5,042

[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 previously. All sets done in 710 prior to 1994 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 (1-15 only) in Campelen units for the Canadian research vessel bottom trawl survey of NAFO Subdiv. 3Ps. Data are adjusted for missing strata. Upper table includes all data from offshore index strata; lower table includes data from inshore and offshore strata (area covered since 1997 – refer to text for additional detail). The survey in 2006 was not completed and there were two surveys in 1993 (February and April).

Offshore Only

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1983	6.42	10.01	6.52	1.14	3.72	1.62	0.48	0.89	1.61	0.75	0.36	0.14	0.06	0.05	0.04	33.81
1984	0.30	5.40	2.33	1.55	0.63	2.11	0.77	0.37	0.46	0.71	0.18	0.15	0.06	0.03	0.00	15.03
1985	0.38	7.74	14.88	12.57	9.96	3.28	2.66	0.79	0.48	0.42	0.42	0.49	0.21	0.12	0.03	54.43
1986	0.20	6.62	5.65	6.48	7.95	6.33	2.13	1.47	0.84	0.29	0.24	0.29	0.17	0.10	0.06	38.82
1987	1.09	8.48	5.67	4.97	13.82	8.31	3.35	1.29	0.69	0.28	0.23	0.16	0.17	0.16	0.06	48.73
1988	0.42	9.13	5.93	2.96	2.84	6.50	5.84	3.65	1.49	0.84	0.74	0.35	0.16	0.15	0.09	41.09
1989	0.49	6.50	4.66	3.17	1.51	1.16	2.15	1.21	0.67	0.37	0.41	0.13	0.11	0.05	0.09	22.68
1990	0.00	1.48	9.82	14.49	10.89	5.67	3.84	3.14	1.15	0.71	0.32	0.16	0.12	0.09	0.01	51.88
1991	1.30	27.69	5.03	10.00	11.24	5.75	2.84	1.58	1.19	0.74	0.56	0.22	0.11	0.07	0.04	68.36
1992	0.00	1.80	6.95	2.11	4.15	2.03	1.03	0.53	0.26	0.24	0.08	0.04	0.01	0.01	0.02	19.26
1993 (Feb)	0.00	0.00	1.83	4.03	0.71	2.96	0.68	0.33	0.13	0.09	0.11	0.03	0.04	0.01	0.01	10.96
1993 (Apr)	0.00	0.00	1.99	4.04	1.49	1.35	0.47	0.10	0.04	0.03	0.04	0.01	0.00	0.01	0.01	9.58
1994	0.00	1.63	1.46	4.31	6.10	1.73	1.62	0.50	0.08	0.04	0.03	0.02	0.01	0.01	0.00	17.54
1995	0.00	0.31	1.16	1.67	13.08	19.65	4.40	5.75	2.19	0.25	0.20	0.01	0.07	0.03	0.00	48.77
1996	0.90	1.08	3.67	3.62	1.32	2.69	2.91	0.54	0.46	0.09	0.09	0.02	0.00	0.00	0.00	17.39
1997	0.22	1.53	2.33	1.04	0.50	0.28	0.30	0.24	0.14	0.05	0.02	0.00	0.00	0.00	0.00	6.65
1998	0.52	0.97	6.79	8.42	5.60	3.99	1.96	2.50	2.79	0.43	0.30	0.06	0.03	0.00	0.00	34.36
1999	1.24	2.54	2.55	2.38	2.58	2.34	1.72	0.44	0.79	0.60	0.09	0.02	0.02	0.00	0.00	17.31
2000	1.25	3.33	5.36	3.10	2.17	1.82	1.20	0.89	0.35	0.31	0.53	0.12	0.00	0.01	0.00	20.44
2001	0.57	2.26	12.41	12.29	4.36	2.04	1.26	0.77	0.71	0.38	0.50	0.94	0.12	0.06	0.03	38.70
2002	0.58	1.10	3.90	8.28	5.85	3.04	2.04	0.99	0.53	0.37	0.08	0.12	0.19	0.01	0.00	27.08
2003	0.52	1.46	1.78	4.08	6.55	3.94	1.50	0.72	0.33	0.18	0.19	0.05	0.11	0.01	0.01	21.43
2004	0.20	1.90	2.07	1.71	2.08	4.05	4.24	1.26	0.81	0.67	0.79	0.15	0.10	0.02	0.07	20.12
2005	0.77	1.43	6.73	4.96	1.60	0.89	0.79	0.71	0.28	0.05	0.17	0.08	0.03	0.03	0.09	18.61
2006																
2007	3.18	1.73	4.84	3.11	1.48	0.76	0.44	0.22	0.47	0.42	0.12	0.09	0.08	0.05	0.01	17.00
2008	0.47	4.39	4.51	3.32	1.92	1.12	0.47	0.32	0.12	0.15	0.10	0.04	0.03	0.01	0.00	16.97
2009	0.40	1.43	9.25	6.67	5.70	3.09	1.79	0.99	0.21	0.17	0.21	0.38	0.14	0.02	0.00	30.45
2010	0.60	2.13	7.65	15.71	6.70	4.06	1.47	0.29	0.10	0.04	0.04	0.09	0.01	0.00	0.00	38.89
2011	0.15	4.70	6.55	2.46	5.08	1.92	1.41	0.48	0.10	0.08	0.00	0.02	0.01	0.01	0.00	22.97

Combined Inshore+Offshore (since 1997)

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1997	0.32	1.68	2.44	1.01	0.46	0.25	0.26	0.21	0.12	0.04	0.01	0.00	0.00	0.00	0.00	6.80
1998	0.72	1.28	6.28	7.40	4.91	3.53	1.73	2.19	2.43	0.38	0.26	0.06	0.03	0.00	0.00	31.20
1999	1.31	3.05	2.52	2.26	2.41	2.12	1.54	0.39	0.68	0.52	0.07	0.02	0.02	0.01	0.00	16.92
2000	1.38	3.84	6.66	3.52	2.24	1.75	1.11	0.80	0.31	0.28	0.46	0.11	0.00	0.01	0.00	22.47
2001	0.99	2.88	11.44	10.58	3.71	1.74	1.08	0.66	0.60	0.32	0.43	0.80	0.10	0.05	0.03	35.41
2002	0.79	1.53	3.72	7.08	4.95	2.58	1.73	0.85	0.45	0.31	0.07	0.11	0.16	0.01	0.00	24.34
2003	0.61	2.62	2.24	3.67	5.88	3.51	1.34	0.63	0.28	0.16	0.17	0.04	0.09	0.01	0.01	21.26
2004	0.33	2.24	2.5	1.85	1.93	3.49	3.61	1.08	0.68	0.57	0.67	0.13	0.09	0.02	0.06	19.25
2005	0.8	1.63	7.32	7.27	3.49	2.08	1.52	1.2	0.41	0.09	0.15	0.06	0.03	0.03	0.08	26.16
2006																
2007	3.31	2.34	5.33	3.26	2.11	1.14	0.76	0.35	0.56	0.37	0.12	0.1	0.07	0.04	0.01	19.87
2008	0.55	4.09	4.3	3.27	1.99	1.22	0.5	0.34	0.12	0.14	0.08	0.04	0.02	0.01	0	16.67
2009	1.44	2.47	8.64	5.81	4.91	2.65	1.53	0.84	0.18	0.15	0.18	0.32	0.12	0.01	0	29.25
2010	0.68	2.76	7.75	13.95	5.87	3.53	1.27	0.25	0.08	0.03	0.03	0.07	0.01	0	0	36.28
2011	0.19	4.63	6.37	2.56	5.46	2.04	1.42	0.49	0.09	0.08	0	0.02	0.01	0.01	0	23.37

Table 11b. Mean numbers per tow at age in Campelen units for the Canadian research vessel bottom trawl survey of the eastern and western (Burgeo area) portions of NAFO Subdiv. 3Ps. Data are adjusted for missing strata. There were two surveys in 1993 (February and April) and the 2006 survey was not completed. Only ages 1-14 and data for 1993 onwards are shown.

Eastern 3Ps

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1993 (Apr)	0.00	0.00	1.73	2.60	0.60	0.49	0.28	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.01	5.78
1994	0.00	1.81	0.73	2.92	3.72	0.65	0.73	0.17	0.01	0.03	0.01	0.01	0.01	0.01	0.00	10.81
1995	0.00	0.24	0.92	1.19	15.65	22.81	2.93	3.60	2.27	0.29	0.23	0.00	0.07	0.02	0.01	50.23
1996	0.98	0.98	1.96	1.89	0.62	1.79	2.38	0.35	0.16	0.10	0.07	0.02	0.00	0.00	0.00	11.30
1997	0.35	2.32	1.70	0.48	0.17	0.09	0.14	0.11	0.04	0.02	0.01	0.00	0.00	0.00	0.00	5.43
1998	0.60	0.82	1.84	2.04	1.68	1.08	0.64	2.50	2.91	0.27	0.07	0.04	0.00	0.00	0.00	14.49
1999	1.67	2.68	1.94	1.00	1.81	2.00	1.34	0.35	0.83	0.69	0.04	0.02	0.03	0.00	0.00	14.40
2000	1.50	4.25	5.26	2.07	0.82	0.88	0.52	0.62	0.26	0.39	0.64	0.10	0.00	0.01	0.00	17.32
2001	0.68	1.78	14.31	12.75	3.71	1.23	0.63	0.52	0.59	0.13	0.54	1.21	0.09	0.06	0.04	38.27
2002	0.69	1.25	3.04	7.93	5.30	2.00	1.13	0.61	0.35	0.26	0.01	0.10	0.16	0.02	0.00	22.85
2003	0.55	1.12	0.72	1.86	4.47	1.66	0.20	0.05	0.09	0.01	0.00	0.01	0.02	0.01	0.01	10.78
2004	0.26	2.04	1.03	0.66	0.80	4.56	5.87	1.67	0.17	0.39	0.23	0.03	0.00	0.03	0.09	17.83
2005	0.93	1.18	3.09	2.28	0.83	0.47	0.80	0.57	0.22	0.03	0.19	0.09	0.04	0.04	0.11	10.87
2006																
2007	4.02	1.74	4.55	2.94	0.96	0.28	0.09	0.11	0.33	0.45	0.10	0.06	0.10	0.06	0.01	15.80
2008	0.59	5.07	4.16	3.32	1.39	0.68	0.47	0.13	0.06	0.07	0.10	0.05	0.02	0.00	0.00	16.11
2009	0.42	1.76	6.66	3.81	4.73	3.09	1.56	0.73	0.04	0.02	0.11	0.37	0.18	0.02	0.00	23.50
2010	0.71	2.38	7.53	14.46	4.69	2.40	0.92	0.37	0.03	0.05	0.05	0.11	0.01	0.00	0.00	33.71
2011	0.21	5.51	7.16	1.95	4.86	1.71	0.82	0.28	0.13	0.00	0.00	0.01	0.00	0.01	0.00	22.65

Western 3Ps (Burgeo Area)

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1993 (Apr)	0.00	0.00	3.37	8.04	6.44	6.94	1.73	0.53	0.21	0.09	0.15	0.00	0.01	0.01	0.03	27.55
1994	0.00	0.00	4.84	9.73	15.76	8.60	6.26	2.89	0.51	0.16	0.08	0.06	0.02	0.03	0.00	48.94
1995	0.00	0.49	2.60	2.75	2.26	3.03	1.32	2.07	0.58	0.08	0.06	0.05	0.04	0.03	0.00	15.36
1996	0.42	1.37	10.48	12.50	4.87	5.84	6.11	1.17	1.50	0.03	0.17	0.00	0.00	0.00	0.00	44.46
1997	0.00	0.60	2.94	4.73	1.83	1.66	1.02	0.92	0.72	0.11	0.05	0.00	0.00	0.00	0.00	14.58
1998	0.00	0.42	26.74	25.99	28.22	18.46	13.65	6.28	2.43	0.40	2.10	0.00	0.00	0.00	0.00	124.69
1999	0.00	1.14	4.50	6.24	10.27	3.61	3.90	0.50	0.78	0.20	0.23	0.38	0.00	0.00	0.00	31.75
2000	0.41	0.71	4.31	6.56	6.52	7.81	6.20	1.95	0.95	0.08	0.00	0.15	0.00	0.00	0.00	35.65
2001	0.04	6.05	12.35	6.32	4.07	4.35	4.20	1.73	1.22	0.96	0.21	0.10	0.03	0.02	0.00	41.65
2002	0.16	0.83	6.61	9.91	7.77	8.86	6.97	3.09	1.37	0.92	0.32	0.15	0.11	0.00	0.00	47.07
2003	0.08	1.94	4.25	16.66	15.90	14.88	5.65	3.06	1.95	1.23	1.89	0.26	0.58	0.00	0.00	68.33
2004	0.00	1.68	6.22	6.14	8.89	3.75	2.59	0.73	0.66	0.46	0.48	0.15	0.03	0.15	0.00	31.93
2005	0.00	2.74	21.17	20.84	5.41	2.42	1.02	1.06	0.30	0.08	0.00	0.00	0.00	0.00	0.00	55.04
2006																
2007	0.00	0.27	0.50	7.85	3.77	3.90	2.17	2.41	0.90	0.38	0.19	0.48	0.00	0.00	0.00	22.82
2008	0.00	0.86	6.49	6.67	4.04	1.35	0.46	0.69	0.15	0.40	0.07	0.00	0.08	0.05	0.00	21.31
2009	0.00	0.99	29.13	15.73	11.91	2.25	2.44	1.00	0.31	0.19	0.19	0.28	0.04	0.00	0.00	64.46
2010	0.21	0.94	5.58	34.51	18.73	4.38	0.17	0.06	0.18	0.00	0.00	0.00	0.00	0.00	0.00	64.76
2011	0.00	1.51	4.04	2.90	7.89	5.30	2.86	0.37	0.00	0.48	0.00	0.04	0.05	0.00	0.00	25.44

Table 12. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983 to 2011. Shaded entries are based on fewer than 5 aged fish.

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	10.3	12.0		11.0	10.7	9.2	12.0		9.5					12.6	12.7
2	20.2	19.2	17.9	18.8	19.9	19.7	19.2	19.9	19.2	20.7		19.1	21.2	20.8	24.1
3	31.2	30.7	29.1	27.1	29.5	29.0	30.2	29.9	29.8	30.4	30.9	32.2	29.9	30.0	31.8
4	43.1	42.1	40.3	40.3	39.5	40.7	41.7	40.1	39.0	40.9	41.3	39.4	42.0	38.7	40.9
5	52.9	52.2	51.2	49.0	48.4	47.8	48.2	48.3	47.0	47.4	48.0	48.2	50.4	44.2	48.2
6	57.8	60.7	60.2	55.7	54.1	56.2	56.3	53.7	53.5	55.3	52.7	50.2	56.5	52.9	51.6
7	65.6	66.2	66.4	62.1	61.2	62.2	64.0	56.6	57.4	61.2	62.3	53.7	58.2	60.9	60.7
8	71.5	70.6	74.2	72.2	67.3	66.7	71.8	62.3	62.8	62.4	70.6	59.1	57.9	61.2	65.4
9	73.4	75.5	73.9	76.4	77.8	74.6	75.9	70.1	68.2	66.7	77.1	68.0	63.0	63.3	67.3
10	79.4	79.1	79.4	82.8	85.4	79.7	84.6	76.2	73.7	73.3	80.2	87.7	79.6	76.8	67.3
11	89.6	84.2	88.9	93.3	83.2	79.7	88.5	79.1	73.8	83.9	96.0	79.7	81.3	74.7	82.5
12	93.7	98.1	93.0	93.9	89.9	87.5	96.6	88.7	77.1	81.8	106.0	90.5	83.6	86.1	

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	10.6	12.0	13.3	10.6	12.0	10.7	14.0	12.1		11.1	11.7	12.3	11.8	14.0
2	22.3	22.4	22.0	21.9	22.0	23.7	20.2	25.5		21.2	18.4	19.1	22.7	23.5
3	32.8	31.4	31.7	33.2	31.8	31.9	33.7	34.2		30.7	26.6	31.3	30.5	30.2
4	42.7	43.2	40.8	40.6	42.0	43.0	38.9	41.9		38.1	38.5	38.7	40.4	40.1
5	49.1	51.4	48.8	47.6	50.8	51.8	47.6	48.6		48.9	45.9	46.7	45.6	47.1
6	53.3	58.9	54.7	51.4	55.1	55.4	60.8	54.5		54.9	53.0	55.0	55.0	49.5
7	57.6	61.7	60.5	57.4	55.2	58.6	66.3	63.5		55.8	60.2	60.5	65.8	56.1
8	67.1	66.2	65.3	68.8	67.2	58.7	69.2	67.6		64.9	59.4	63.5	70.9	61.7
9	77.4	77.6	67.9	77.5	74.6	70.5	67.3	72.3		81.7	66.9	72.3	75.2	73.8
10	77.2	86.8	81.2	75.0	79.8	72.0	69.6	72.6		91.6	68.2	76.0	81.1	53.2
11	64.3	76.9	92.7	85.5	73.4	65.5	73.2	99.2		86.9	90.0	83.3	92.6	
12	78.0	109.0	89.1	96.8	86.0	86.6	73.5	103.4		86.6	94.1	87.2	103.1	75.5

Table 13. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983 to 2011. Shaded entries are based on fewer than 5 aged fish.

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.01								0.01					0.02	0.02
2	0.07	0.07		0.05		0.06	0.06	0.06	0.05	0.06		0.05	0.06	0.07	0.11
3	0.22	0.25	0.21	0.17	0.23	0.19	0.24	0.20	0.20	0.22	0.21	0.23	0.20	0.22	0.26
4	0.66	0.63	0.49	0.45	0.52	0.56	0.58	0.52	0.45	0.54	0.54	0.44	0.52	0.46	0.54
5	1.29	1.13	1.05	0.87	0.92	0.88	0.91	0.96	0.84	0.89	0.86	0.87	0.93	0.71	0.88
6	1.59	1.84	1.60	1.36	1.32	1.42	1.28	1.36	1.33	1.44	1.20	1.08	1.50	1.21	1.15
7	2.15	2.74	2.30	2.39	1.88	2.17	2.25	1.62	1.74	2.06	2.05	1.33	1.75	2.04	1.87
8	3.44	3.84	3.19	3.25	2.41	2.51	3.74	2.19	2.37	2.32	3.13	1.87	1.75	2.19	2.64
9	3.87	4.26	3.31	5.42	4.33	4.08	4.57	3.21	3.09	2.91	4.48	3.03	2.28	2.41	3.06
10	5.22	5.06	3.76	4.41	6.35	4.77	5.95	4.33	4.08	4.15	4.47	6.35	4.88	4.46	3.22
11	8.81	8.09		6.42	6.74	4.21	8.78	5.09	4.10	5.90	8.53	5.21	5.50	3.99	5.46
12	10.34	10.03	3.97	9.16	6.11	9.43	8.88	7.46	5.09	5.81	13.20	7.47	6.49	7.01	

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01		0.01	0.01	0.01	0.01	0.02
2	0.09	0.10	0.08	0.08	0.09	0.10	0.07	0.14		0.08	0.05	0.05	0.09	0.11
3	0.28	0.28	0.27	0.28	0.24	0.27	0.31	0.34		0.23	0.16	0.24	0.22	0.24
4	0.62	0.64	0.57	0.55	0.56	0.61	0.50	0.62		0.46	0.47	0.47	0.52	0.50
5	0.99	1.10	0.92	0.87	1.01	1.10	0.86	1.00		0.95	0.80	0.79	0.79	0.87
6	1.27	1.72	1.35	1.16	1.39	1.46	1.81	1.37		1.44	1.18	1.39	1.40	1.09
7	1.63	2.08	1.90	1.67	1.45	1.83	2.47	2.24		1.57	1.85	1.96	2.51	1.67
8	2.74	2.57	2.51	2.96	2.75	1.74	3.15	3.12		2.54	1.88	2.42	3.24	2.35
9	4.76	4.39	2.91	4.39	4.00	3.15	2.95	4.06		5.34	2.78	3.68	4.24	3.80
10	5.07	6.87	5.19	4.35	5.11	3.76	3.34	4.47		8.17	3.29	4.27	6.96	1.30
11	2.68	5.12	8.34	6.09	4.20	2.64	4.25	10.31		7.66	7.21	6.26	9.05	
12	5.25	13.16	8.13	9.05	6.24	6.56	4.71	11.30		7.82	9.11	7.07	11.31	4.43

Table 14. Parameter estimates and SE's for a probit model fitted to observed proportions mature at age (from "combined" survey area) for female cod from NAFO Subdiv. 3Ps based on surveys conducted during 1959-2011.

Cohort	slope	slope_SE	intercept	intercept_se
1954	1.1094	0.2940	-8.1702	2.4445
1955	1.5059	0.2237	-10.2633	1.6124
1956	1.3174	0.3208	-9.4592	2.2216
1957	1.4604	0.3703	-10.3248	2.3525
1958	2.3929	0.5853	-16.4519	3.6202
1959	2.1113	0.5358	-13.0196	2.9364
1960	1.6741	0.2990	-10.6677	1.7584
1961	1.8639	0.3551	-11.4722	2.0669
1962	1.7141	0.2898	-10.5115	1.7043
1963		Fit not significant		
1964	1.9272	0.2411	-12.7182	1.5667
1965	2.4194	0.5982	-16.4244	4.2387
1966	1.5492	0.2401	-10.0608	1.6025
1967	1.6876	0.3782	-10.0845	2.2543
1968	2.1397	0.2885	-13.1625	1.7869
1969	1.6825	0.3043	-10.3672	1.8439
1970	1.5265	0.2305	-8.8558	1.3136
1971	1.3122	0.1401	-7.8405	0.8346
1972	1.4117	0.1445	-8.9081	0.8853
1973	1.4521	0.1667	-9.3550	1.0320
1974	2.0042	0.1969	-13.1541	1.2944
1975	1.7846	0.2174	-11.1641	1.3757
1976	1.3552	0.2056	-8.5990	1.2510
1977	2.5066	0.3505	-15.3640	2.1732
1978	1.7920	0.1680	-10.7323	1.0205
1979	1.0297	0.1138	-6.4477	0.7670
1980	1.4270	0.1415	-9.4134	0.9131
1981	1.7431	0.1781	-11.9865	1.1846
1982	2.0091	0.2059	-13.3056	1.3496
1983	1.8944	0.2608	-11.8903	1.6045
1984	2.2315	0.2981	-13.4166	1.8044
1985	2.6988	0.3728	-16.0342	2.2010
1986	2.5829	0.2930	-14.0673	1.5934
1987	2.2526	0.2231	-11.9227	1.2350
1988	2.7731	0.4110	-14.0212	2.1672
1989	1.8846	0.1577	-9.7844	0.8110
1990	1.7888	0.1900	-9.2101	0.9575
1991	2.4874	0.4971	-13.1443	2.5618
1992	2.6015	0.3903	-13.0008	1.9108
1993	1.8954	0.2394	-9.8698	1.2957
1994	1.6015	0.1969	-8.1481	1.0091
1995	1.6523	0.2188	-8.7711	1.1242
1996	1.7414	0.2410	-9.3461	1.2620
1997	3.0797	0.4567	-14.8462	2.1742
1998	1.9984	0.2396	-9.6586	1.1567
1999	1.8423	0.2647	-9.1495	1.3103
2000	1.7800	0.3025	-9.2716	1.4885
2001	1.7588	0.2292	-8.3449	1.0333
2002	1.6762	0.2441	-8.8495	1.2959
2003	1.5778	0.2306	-8.9875	1.2964
2004	1.6544	0.2018	-9.1221	1.0927
2005	1.8388	0.2968	-9.9354	1.5282
2006	1.969	1.463	-9.5485	4.3182

Table 15. Estimated proportions mature for female cod from NAFO Subdiv. 3Ps from DFO surveys from 1978 to 2011, projected forward to 2014. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age (from "combined" survey area). Shaded cells are averages of the three closest cohorts; boxed cells are the average of estimates for the adjacent cohorts.

Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1954	0.000	0.001	0.005	0.018	0.061	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1955	0.001	0.001	0.005	0.018	0.061	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1956	0.000	0.003	0.005	0.018	0.061	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1957	0.000	0.001	0.008	0.018	0.061	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1958	0.000	0.001	0.003	0.023	0.061	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1959	0.000	0.001	0.004	0.014	0.068	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1960	0.000	0.000	0.003	0.015	0.061	0.180	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1961	0.000	0.000	0.000	0.011	0.054	0.227	0.400	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1962	0.000	0.001	0.001	0.001	0.046	0.174	0.569	0.669	0.914	0.972	0.991	0.997	0.999	1.000
1963	0.000	0.000	0.004	0.010	0.011	0.173	0.441	0.856	0.860	0.972	0.991	0.997	0.999	1.000
1964	0.000	0.001	0.003	0.019	0.078	0.110	0.475	0.746	0.964	0.949	0.991	0.997	0.999	1.000
1965	0.000	0.000	0.005	0.018	0.091	0.413	0.574	0.795	0.917	0.992	0.983	0.997	0.999	1.000
1966	0.000	0.000	0.003	0.025	0.104	0.349	0.853	0.937	0.944	0.976	0.998	0.994	0.999	1.000
1967	0.000	0.000	0.001	0.016	0.126	0.428	0.741	0.980	0.994	0.986	0.994	1.000	0.998	1.000
1968	0.000	0.001	0.000	0.007	0.085	0.444	0.829	0.938	0.997	0.999	0.997	0.998	1.000	0.999
1969	0.000	0.001	0.004	0.001	0.044	0.342	0.816	0.969	0.988	1.000	1.000	0.999	1.000	1.000
1970	0.000	0.000	0.007	0.021	0.013	0.240	0.750	0.961	0.995	0.998	1.000	1.000	1.000	1.000
1971	0.001	0.001	0.001	0.034	0.090	0.129	0.684	0.949	0.993	0.999	1.000	1.000	1.000	1.000
1972	0.001	0.003	0.005	0.010	0.162	0.317	0.625	0.937	0.992	0.999	1.000	1.000	1.000	1.000
1973	0.001	0.005	0.014	0.026	0.078	0.510	0.686	0.949	0.990	0.999	1.000	1.000	1.000	1.000
1974	0.000	0.002	0.020	0.060	0.124	0.420	0.849	0.912	0.995	0.999	1.000	1.000	1.000	1.000
1975	0.000	0.002	0.009	0.070	0.227	0.432	0.860	0.968	0.980	1.000	1.000	1.000	1.000	1.000
1976	0.000	0.000	0.007	0.037	0.218	0.575	0.804	0.981	0.994	0.996	1.000	1.000	1.000	1.000
1977	0.001	0.001	0.001	0.028	0.136	0.508	0.862	0.957	0.998	0.999	0.999	1.000	1.000	1.000
1978	0.000	0.003	0.003	0.006	0.110	0.392	0.793	0.966	0.992	1.000	1.000	1.000	1.000	1.000
1979	0.000	0.000	0.011	0.018	0.042	0.345	0.726	0.934	0.992	0.998	1.000	1.000	1.000	1.000
1980	0.004	0.001	0.000	0.040	0.096	0.244	0.692	0.916	0.981	0.998	1.000	1.000	1.000	1.000
1981	0.000	0.012	0.005	0.005	0.139	0.388	0.706	0.906	0.978	0.995	1.000	1.000	1.000	1.000
1982	0.000	0.001	0.034	0.028	0.056	0.385	0.791	0.947	0.976	0.995	0.999	1.000	1.000	1.000
1983	0.000	0.000	0.006	0.089	0.145	0.420	0.708	0.957	0.992	0.994	0.999	1.000	1.000	1.000
1984	0.000	0.000	0.001	0.024	0.214	0.505	0.899	0.904	0.993	0.999	0.999	1.000	1.000	1.000
1985	0.000	0.000	0.001	0.007	0.093	0.433	0.860	0.991	0.973	0.999	1.000	1.000	1.000	1.000
1986	0.000	0.000	0.002	0.005	0.037	0.299	0.681	0.973	0.999	0.993	1.000	1.000	1.000	1.000
1987	0.000	0.000	0.001	0.013	0.037	0.178	0.640	0.857	0.995	1.000	0.998	1.000	1.000	1.000
1988	0.000	0.000	0.000	0.011	0.082	0.223	0.554	0.881	0.944	0.999	1.000	1.000	1.000	1.000
1989	0.000	0.001	0.002	0.005	0.095	0.372	0.681	0.876	0.969	0.979	1.000	1.000	1.000	1.000
1990	0.000	0.000	0.006	0.023	0.073	0.493	0.797	0.941	0.976	0.992	0.992	1.000	1.000	1.000
1991	0.001	0.002	0.003	0.052	0.240	0.540	0.901	0.963	0.992	0.996	0.998	0.997	1.000	1.000
1992	0.000	0.004	0.016	0.051	0.341	0.807	0.946	0.988	0.994	0.999	0.999	1.000	0.999	1.000
1993	0.000	0.000	0.021	0.096	0.461	0.831	0.982	0.996	0.999	0.999	1.000	1.000	1.000	1.000
1994	0.000	0.000	0.003	0.114	0.411	0.932	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000
1995	0.001	0.002	0.006	0.039	0.434	0.821	0.995	0.998	1.000	1.000	1.000	1.000	1.000	1.000
1996	0.001	0.007	0.015	0.069	0.330	0.821	0.968	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	0.000	0.004	0.034	0.092	0.502	0.856	0.965	0.995	1.000	1.000	1.000	1.000	1.000	1.000
1998	0.000	0.003	0.022	0.149	0.403	0.931	0.986	0.994	0.999	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.000	0.016	0.103	0.465	0.818	0.995	0.999	0.999	1.000	1.000	1.000	1.000	1.000
2000	0.001	0.003	0.004	0.085	0.375	0.812	0.968	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.001	0.004	0.025	0.074	0.345	0.758	0.955	0.995	1.000	1.000	1.000	1.000	1.000	1.000
2002	0.001	0.003	0.026	0.159	0.635	0.751	0.942	0.991	0.999	1.000	1.000	1.000	1.000	1.000
2003	0.001	0.008	0.019	0.144	0.583	0.974	0.945	0.988	0.998	1.000	1.000	1.000	1.000	1.000
2004	0.001	0.004	0.044	0.104	0.515	0.911	0.999	0.990	0.998	1.000	1.000	1.000	1.000	1.000
2005	0.001	0.003	0.021	0.213	0.408	0.870	0.987	1.000	0.998	1.000	1.000	1.000	1.000	1.000
2006	0.000	0.003	0.014	0.105	0.610	0.804	0.977	0.998	1.000	1.000	1.000	1.000	1.000	1.000
2007	0.001	0.002	0.015	0.064	0.385	0.901	0.960	0.996	1.000	1.000	1.000	1.000	1.000	1.000
2008	0.000	0.004	0.012	0.076	0.250	0.770	0.981	0.993	0.999	1.000	1.000	1.000	1.000	1.000
2009	0.000	0.003	0.026	0.070	0.299	0.618	0.947	0.997	0.999	1.000	1.000	1.000	1.000	1.000
2010	0.000	0.003	0.018	0.158	0.323	0.691	0.887	0.990	0.999	1.000	1.000	1.000	1.000	1.000
2011	0.000	0.003	0.018	0.101	0.574	0.750	0.921	0.974	0.998	1.000	1.000	1.000	1.000	1.000
2012	0.000	0.003	0.018	0.101	0.399	0.906	0.950	0.984	0.995	1.000	1.000	1.000	1.000	1.000
2013	0.000	0.003	0.018	0.101	0.399	0.782	0.986	0.992	0.997	0.999	1.000	1.000	1.000	1.000
2014	0.000	0.003	0.018	0.101	0.399	0.782	0.952	0.998	0.999	0.999	1.000	1.000	1.000	1.000

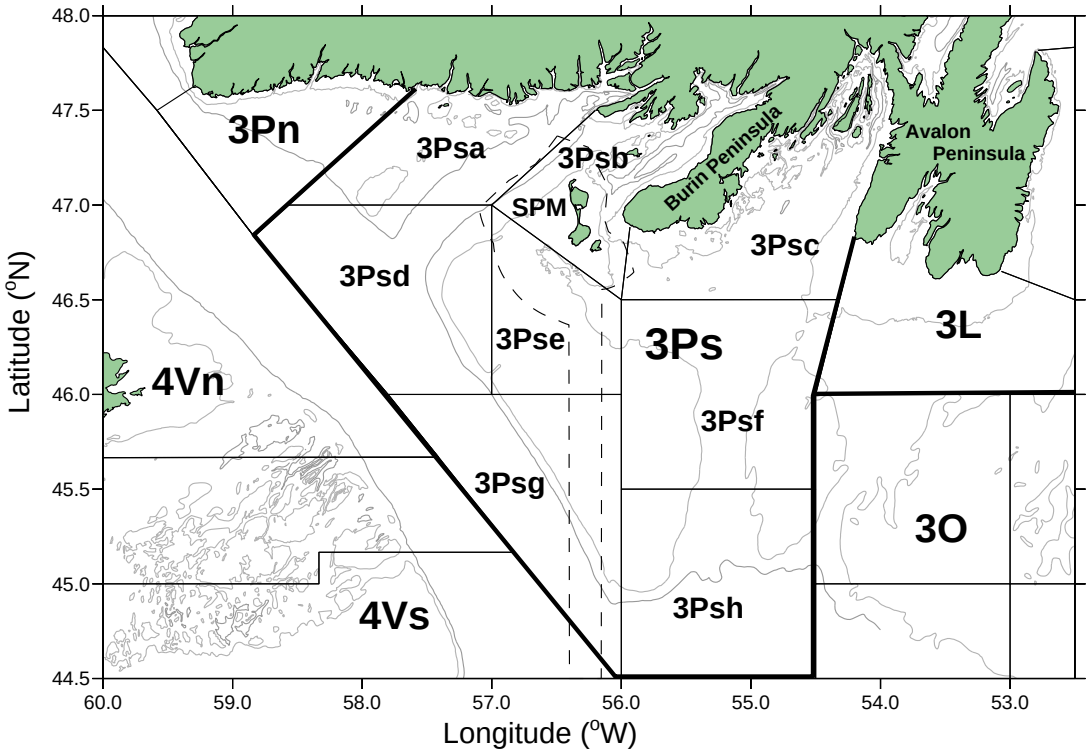


Figure 1. NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).

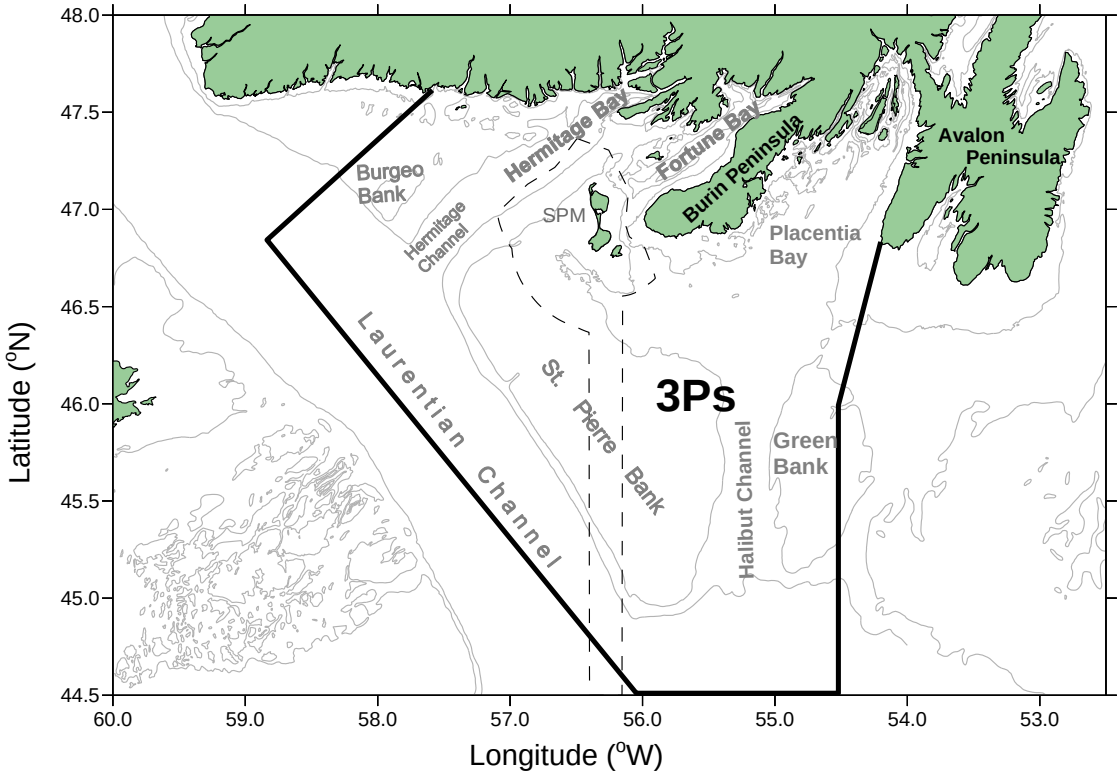


Figure 2. NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the main fishing areas.

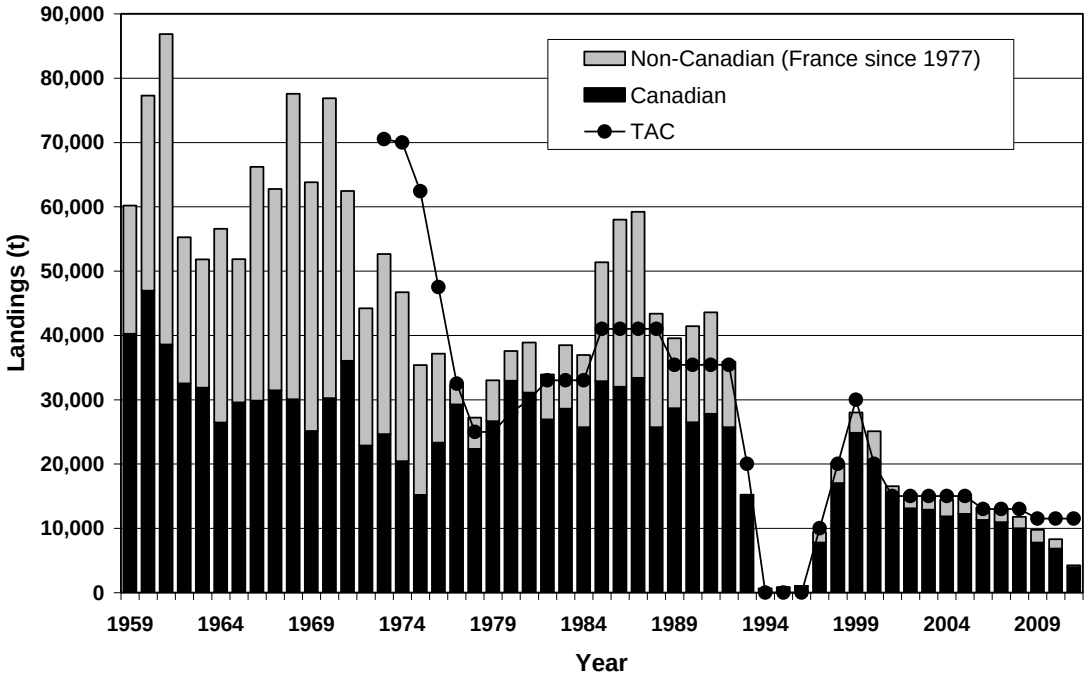


Figure 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdiv. 3Ps during 1959 to October 2011. The 2011 fishery was still in progress at the time of the October 2011 assessment.

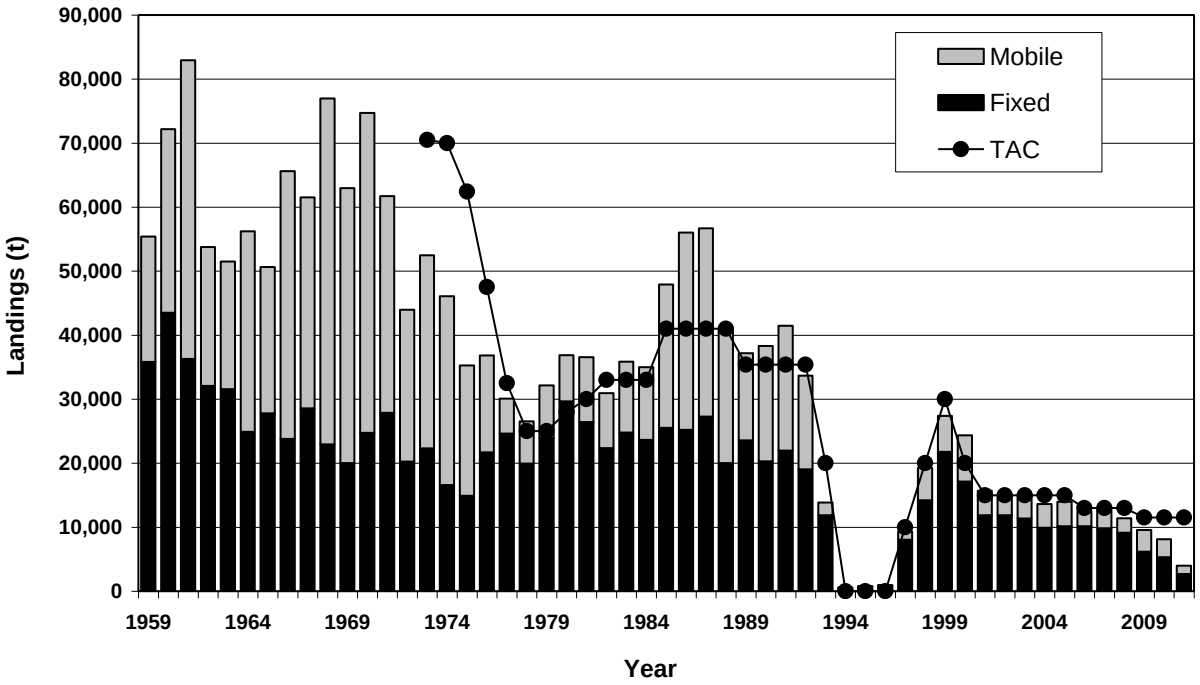


Figure 3b. Reported landings of cod by fixed and mobile gears in NAFO Subdiv. 3Ps during 1959-October 2011. The 2011 fishery was still in progress at the time of the October 2011 assessment.

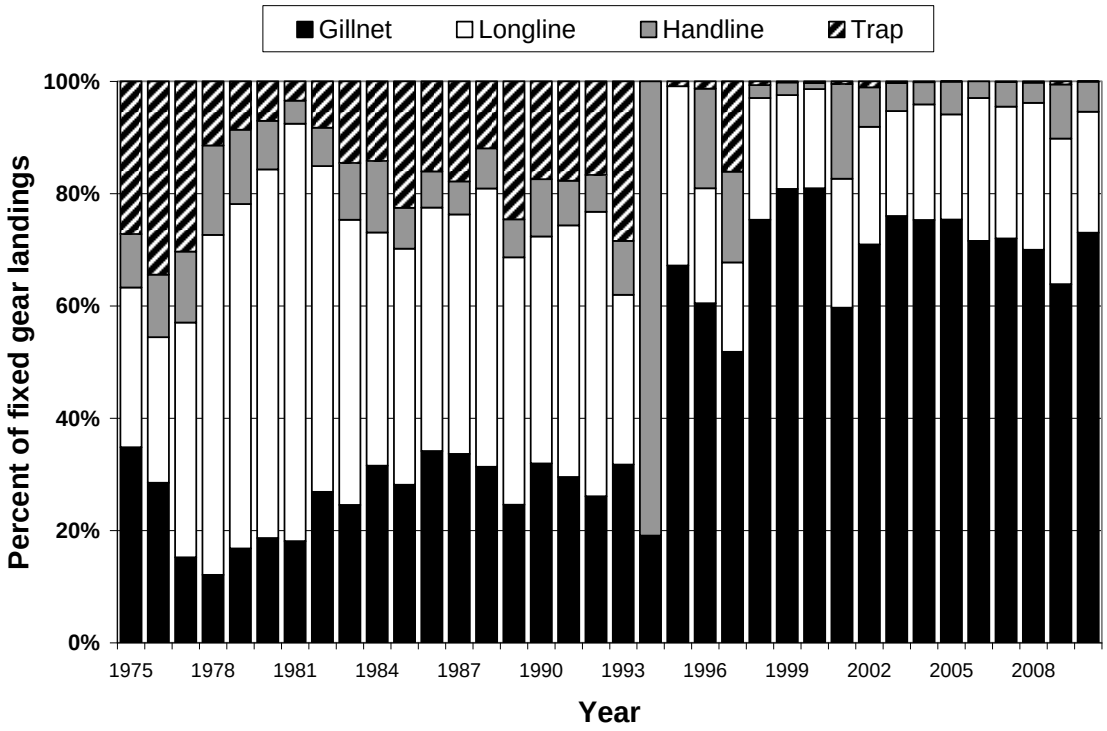


Figure 4. Percent of total fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdiv. 3Ps during 1975 to 2010. The fishery was under a moratorium during 1994-96 and values for those years are based on sentinel and by-catch landings of <800 t.

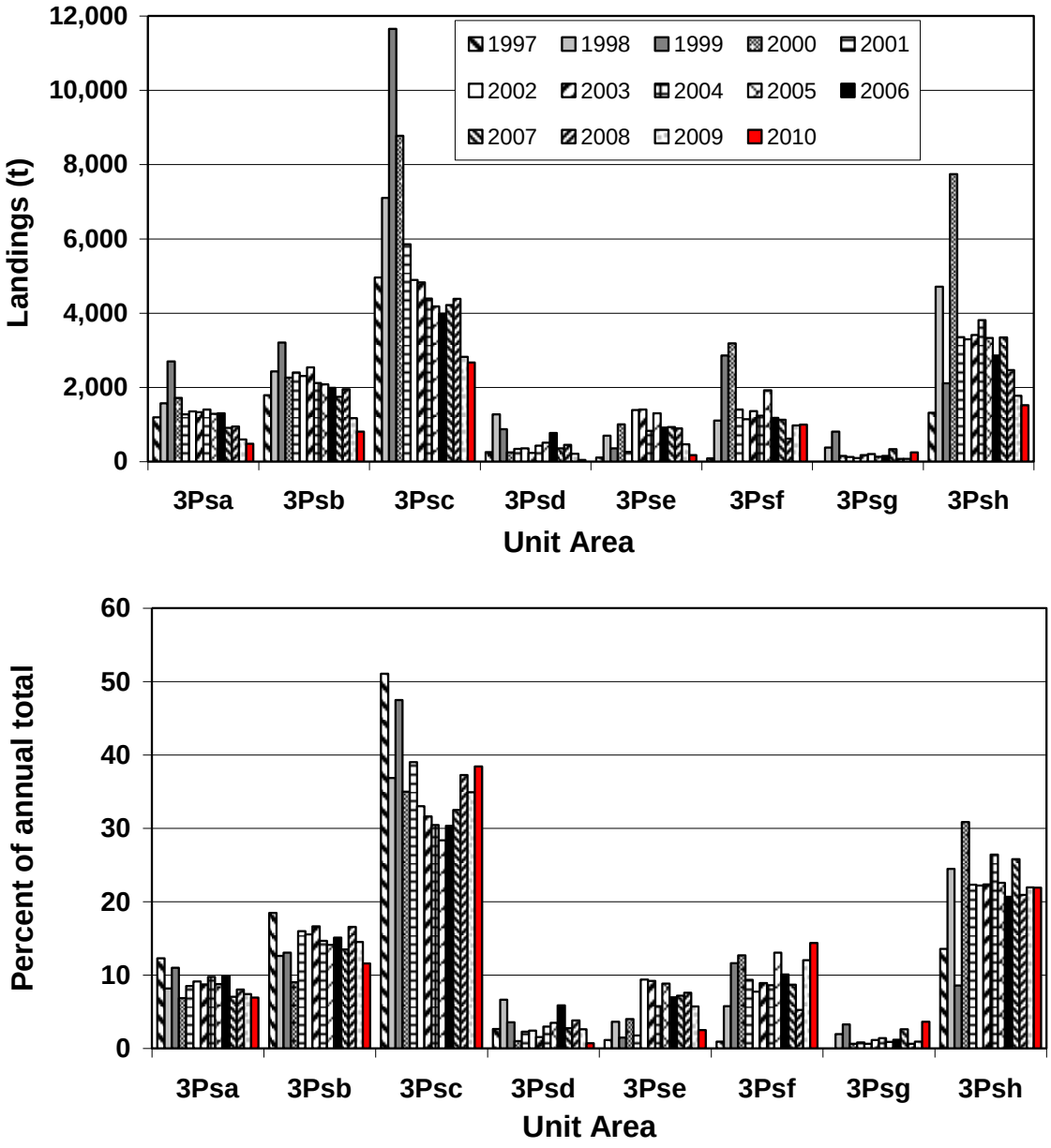


Figure 5. Annual reported landings of cod (upper panel) and percent of annual total (lower panel) by unit area from NAFO Subdiv. 3Ps during 1997-2010. Refer to Figure 1 for locations of unit areas.

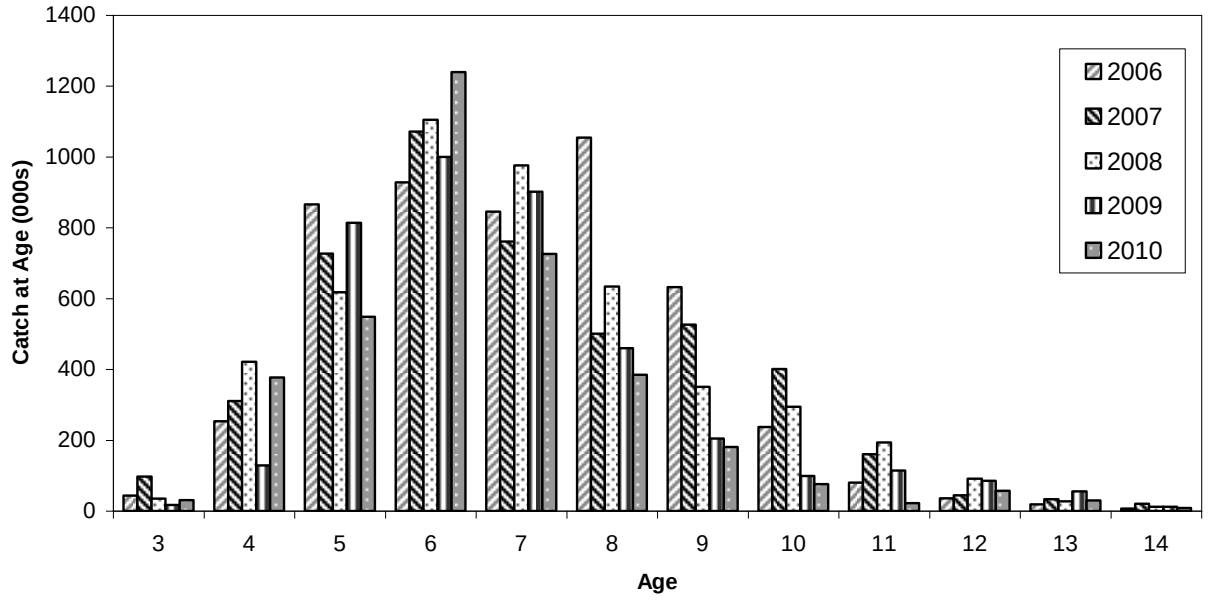


Figure 6a. Catch at age (numbers of fish; in thousands) for the cod fishery in Subdiv. 3Ps during 2006 to 2010. Does not include recreational catches from 2007 onward (see text).

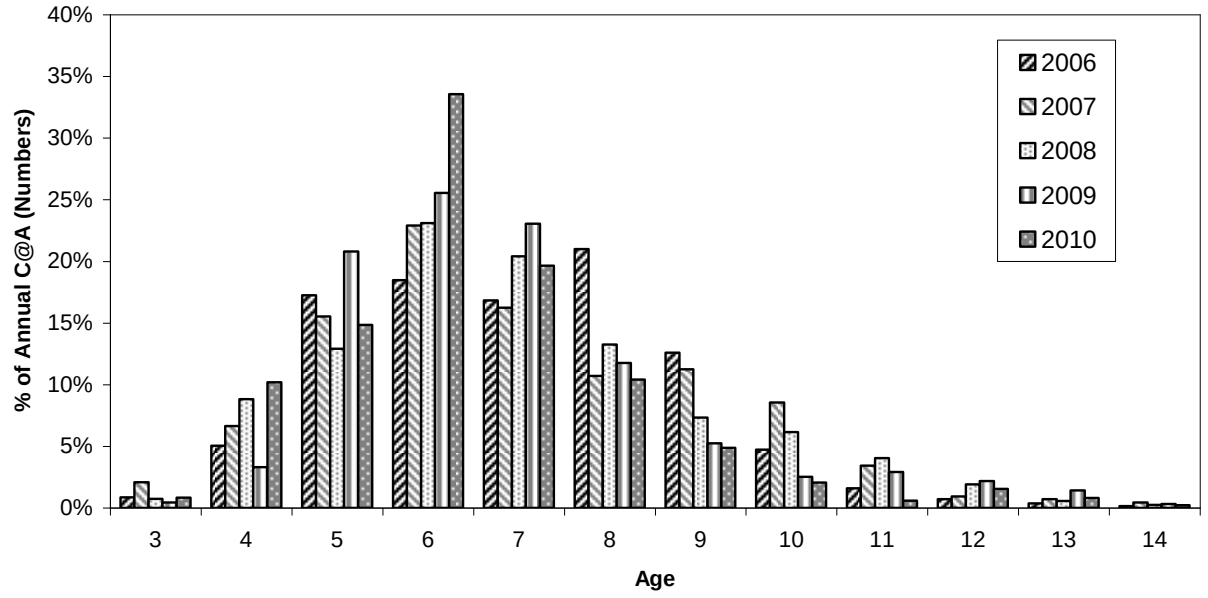


Figure 6b. Percent catch at age for Subdiv. 3Ps cod from 2006 to 2010.

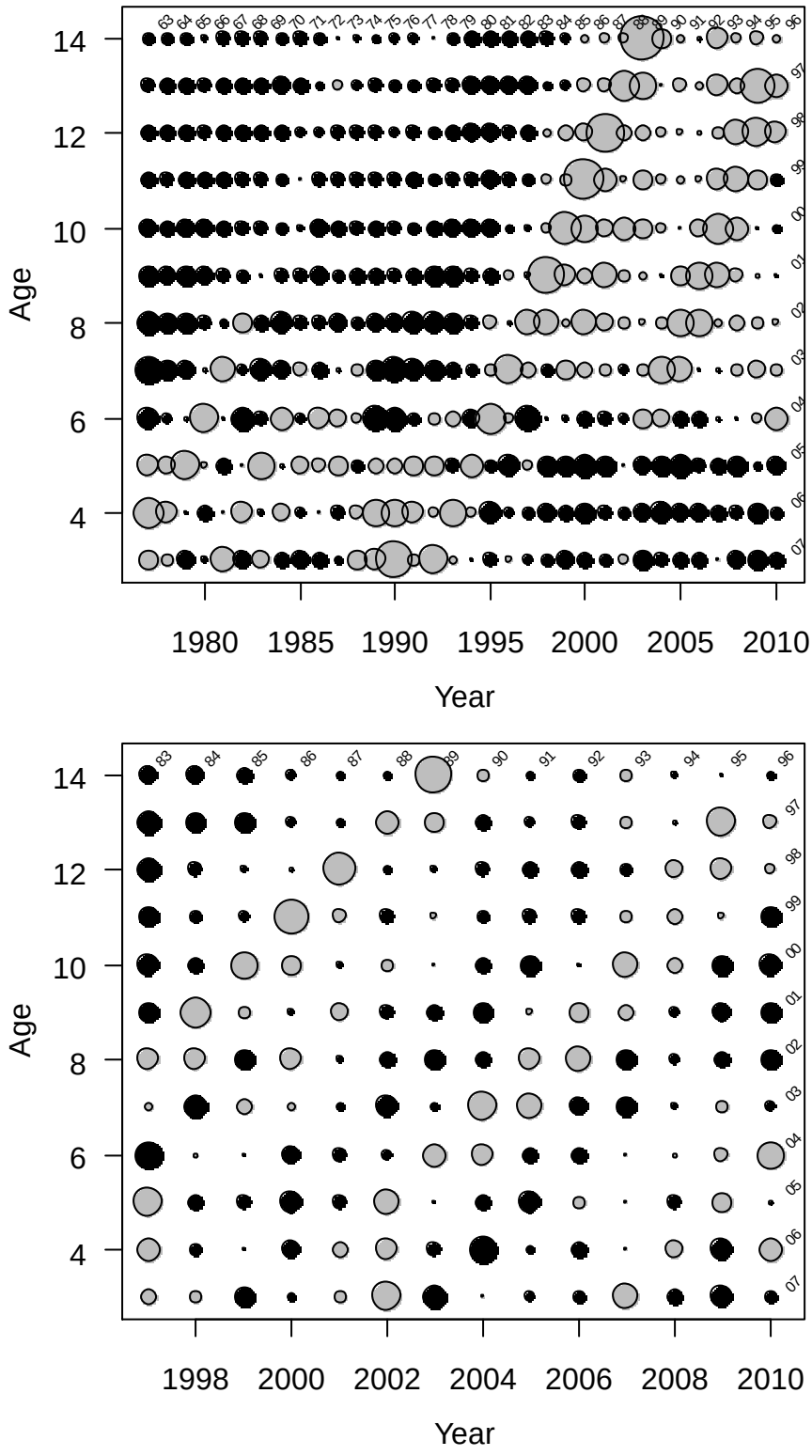


Figure 6c. Standardized proportions at age of commercial catch at age in Subdiv. 3Ps. Catch proportions within each year were computed, and then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts. Upper panel shows catches from 1977 to 2010; lower panel includes catch from post-moratorium period (1997-2010).

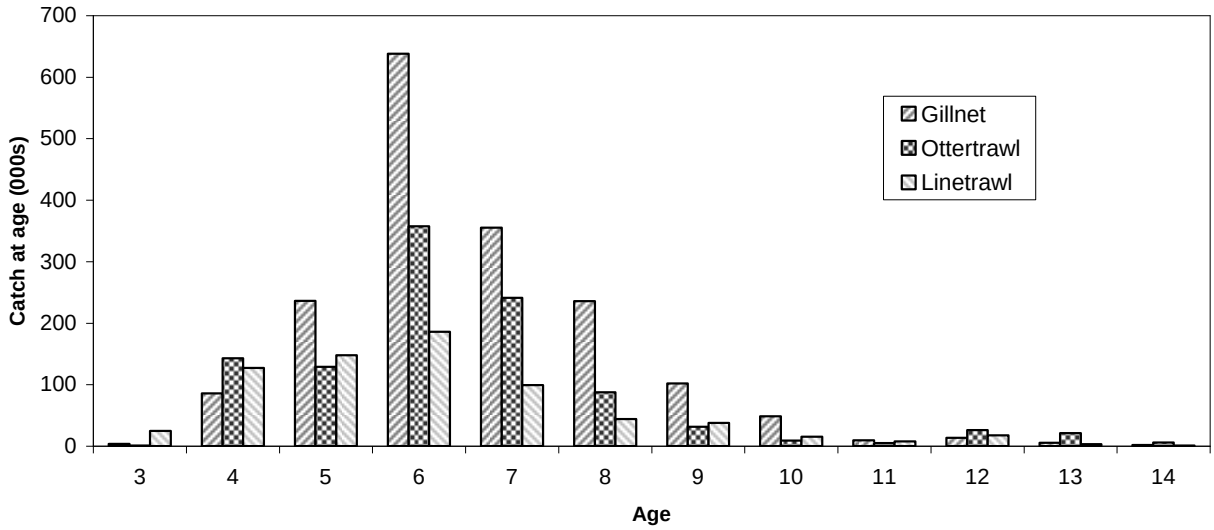
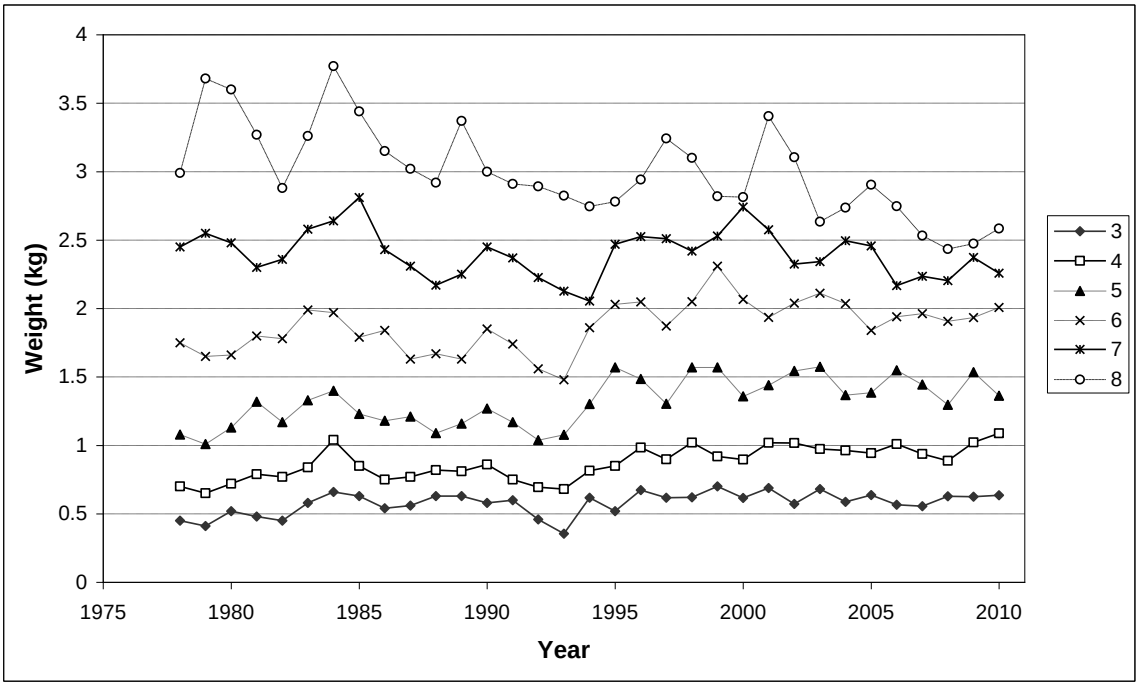


Figure 7. Catch numbers-at-age for the main gear types used in the Subdiv. 3Ps cod fishery during 2010.



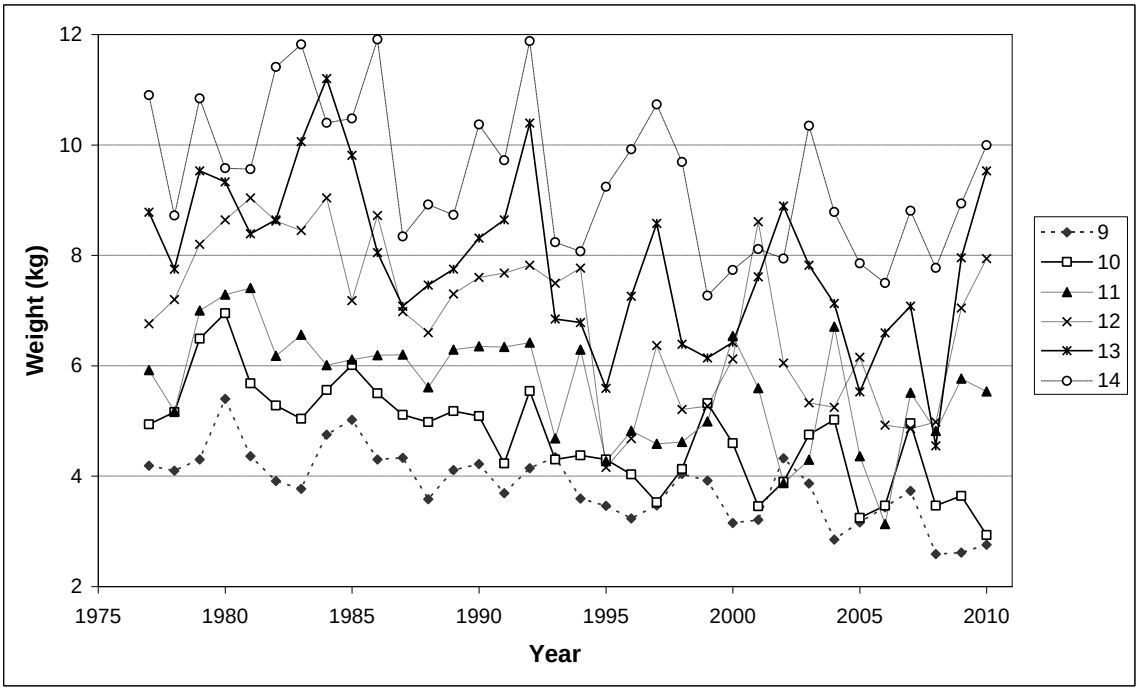


Figure 8. Mean weights-at-age calculated from mean lengths-at-age (upper panel: ages 3-8; lower panel: ages 9-14) for the commercial catch of cod in Subdiv. 3Ps during 1977 to 2010.

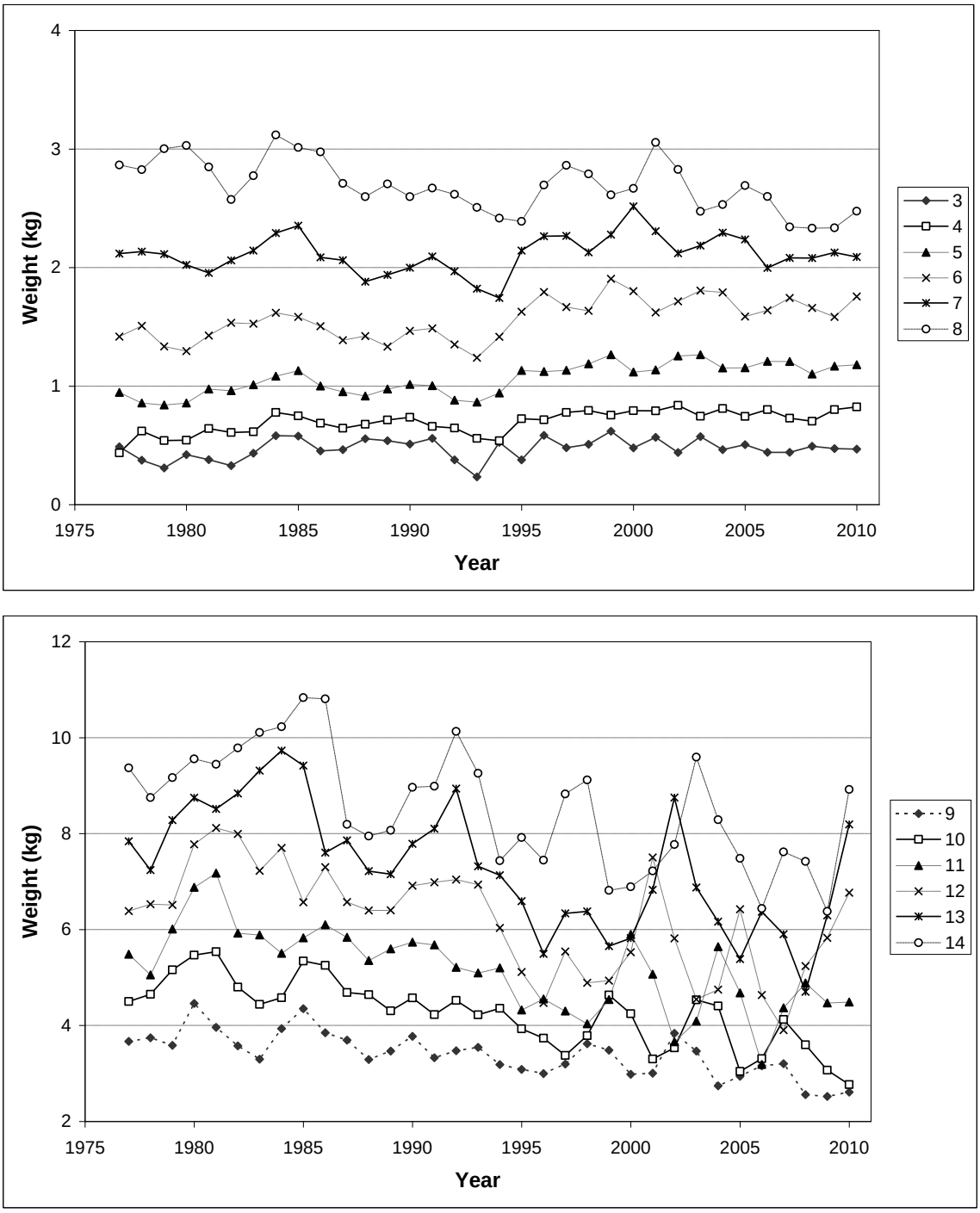


Figure 9. Beginning of year mean weights-at-age (upper panel: ages 3-8; lower panel: ages 9-14) from the commercial catch of cod in Subdiv. 3Ps during 1977 to 2010.

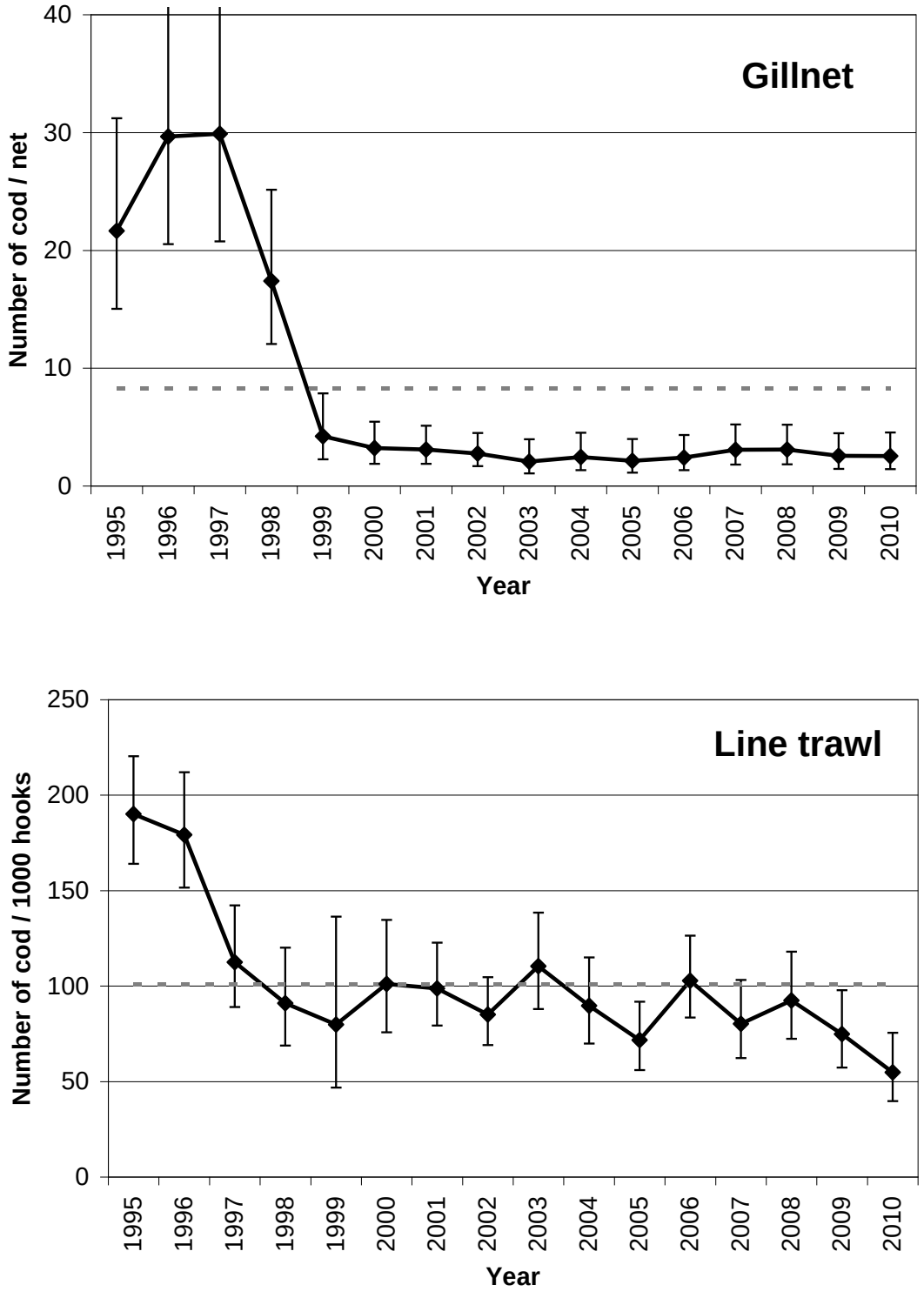


Figure 10a. Standardized age-aggregated catch rate indices for gillnets (5.5" mesh) and line-trawls (with 95% CL) estimated using data from sentinel fishery fixed sites. Dashed horizontal lines indicate time-series average.

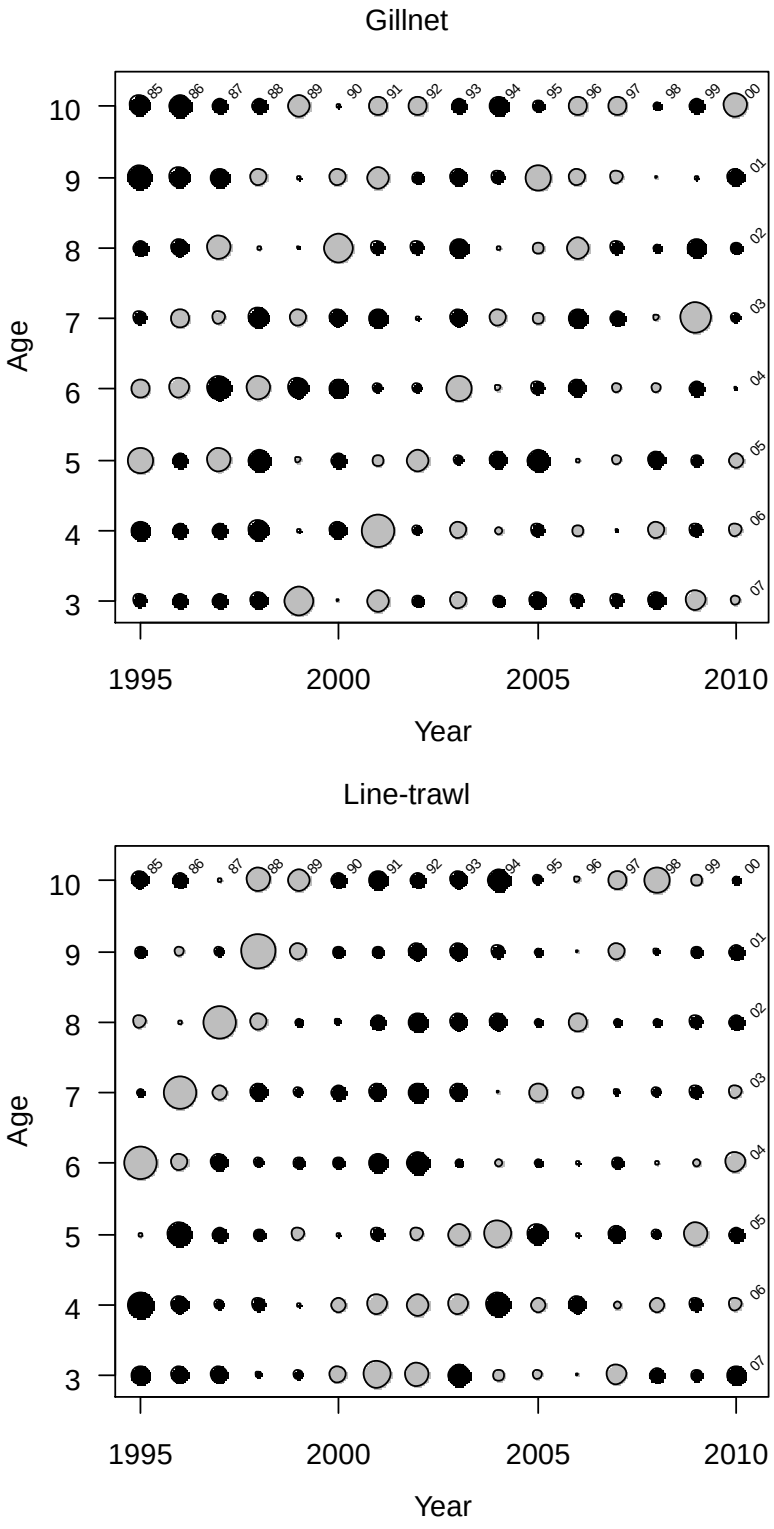


Figure 10b. Standardized proportions at age of sentinel catch rates at age in Subdiv. 3Ps. Annual proportions were computed, and then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts.

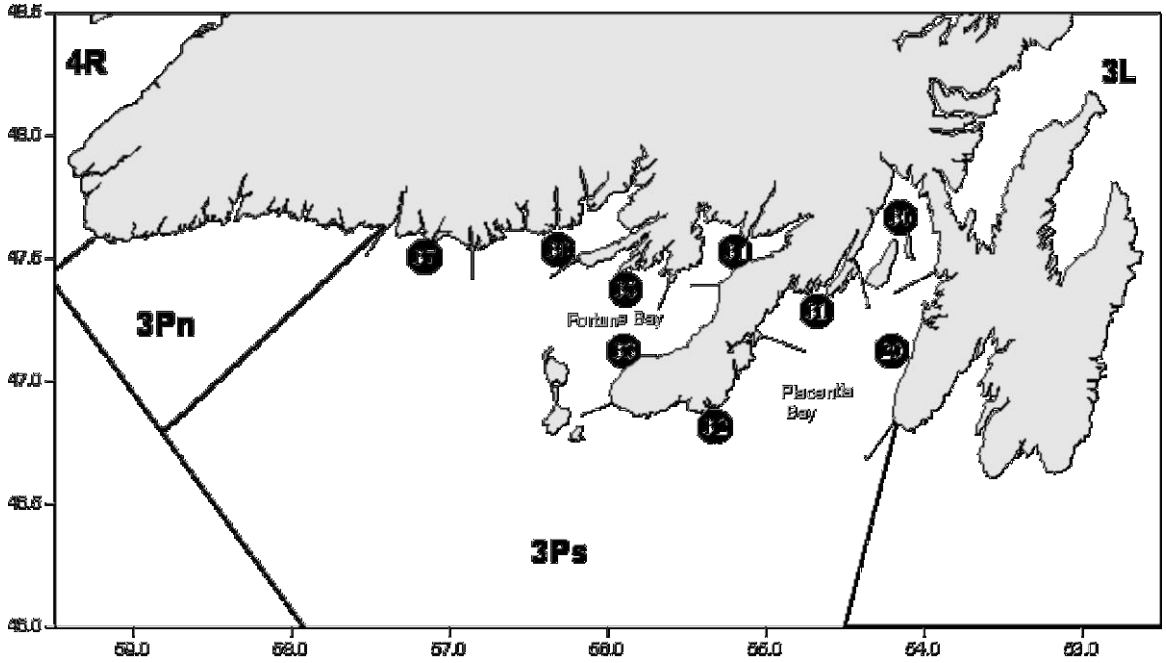


Figure 11a. Location and boundaries of numbered management areas along the inshore of the south coast of Newfoundland (Subdiv. 3Ps) (29 = Placentia Bay East, 30 = Head of Placentia Bay, 31 = Placentia Bay West, 32 = The Boot, 33 = Fortune Bay, 34 = Head of Fortune Bay, 35 = Connaigre, 36 = Hermitage Bay, 37 = Francois-Burgeo).

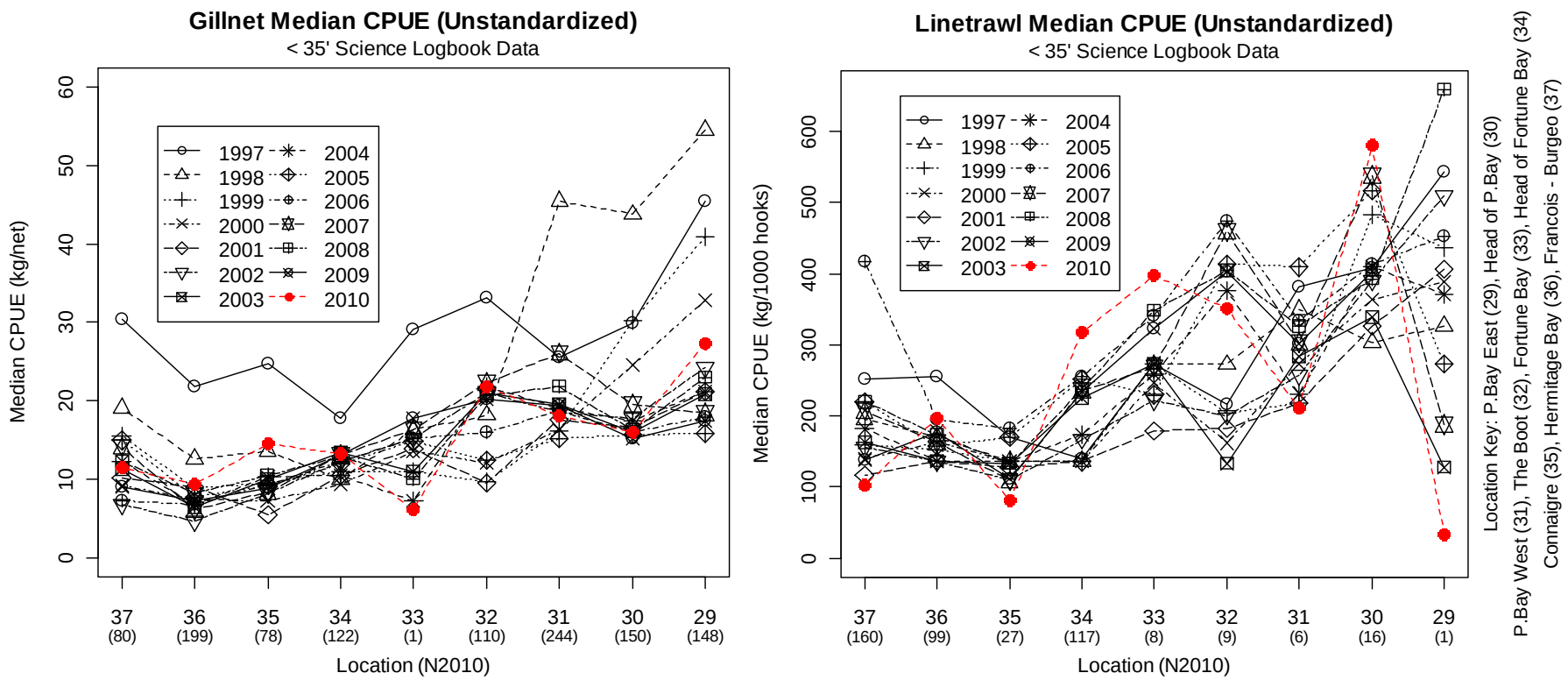


Figure 11b. Area-specific median annual catch rates of cod from gillnets (left panel, kg per net) and line-trawls (right panel, kg per 1,000 hooks) from science log-books for vessels <35 ft. Labels on x-axis are lobster fishing areas ordered from west to east (see key on far right). Values in parenthesis on x-axis are number of valid sets per site during the 2010 fishery.

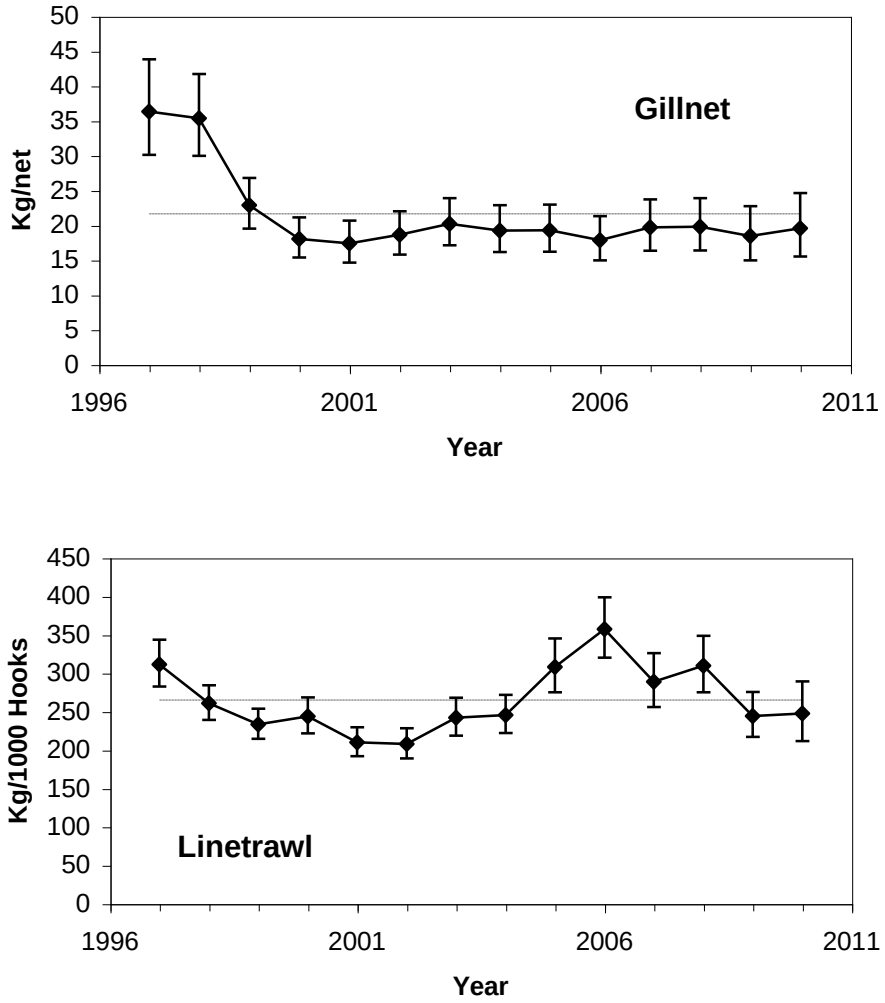


Figure 11c. Standardized catch rates for gillnets and line-trawls from science log-books for vessels <35 ft. Horizontal dashed lines are time-series average; error bars are 95% confidence intervals of the means. Catch rates are expressed in terms of weight (kg per net or kg per 1000 hooks).

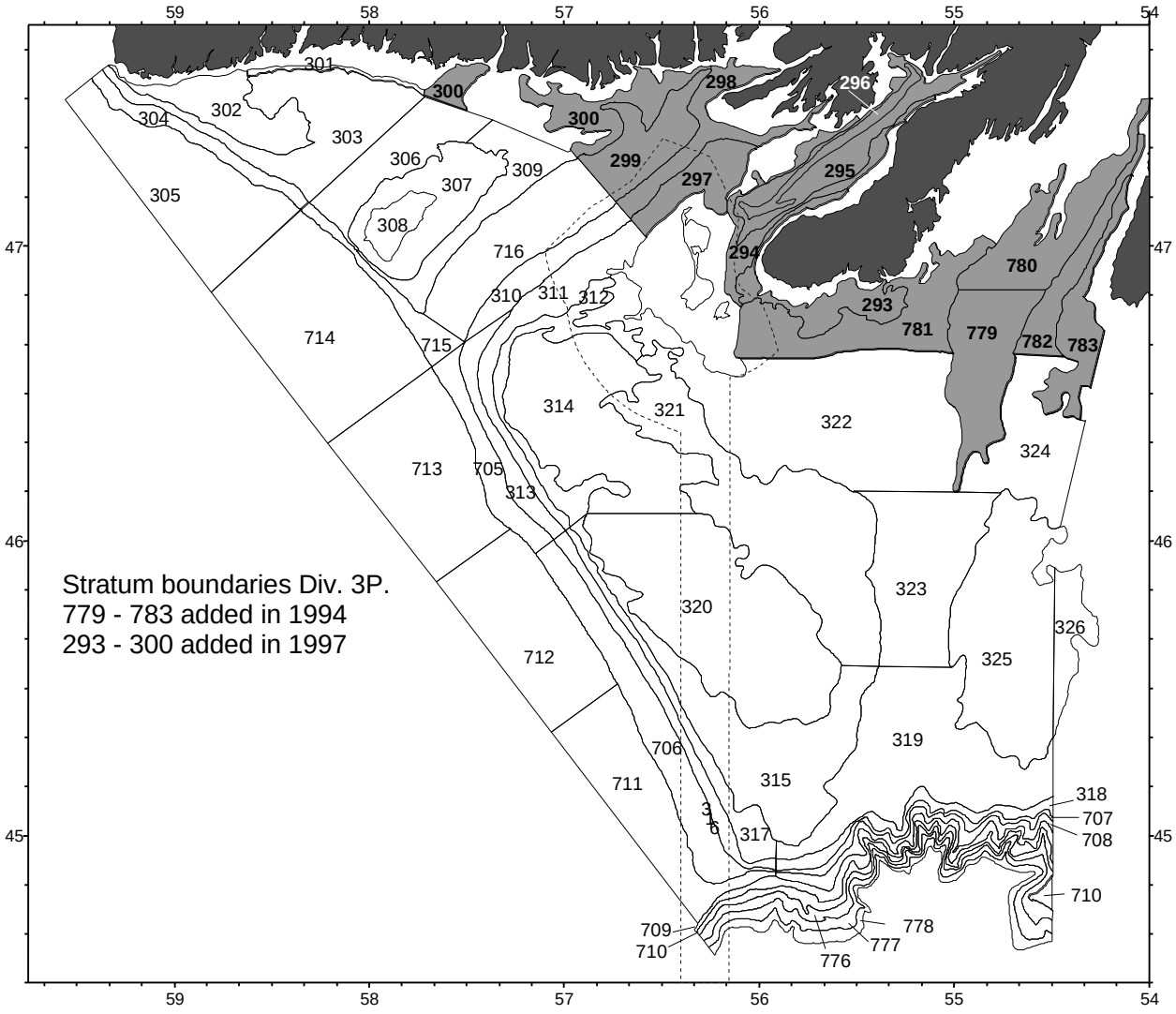


Figure 12. Stratum area boundaries and area surveyed during the DFO research vessel (RV) bottom-trawl survey of Subdiv. 3Ps. Dashed line is the boundary of the French economic zone which is included in the surveyed area.

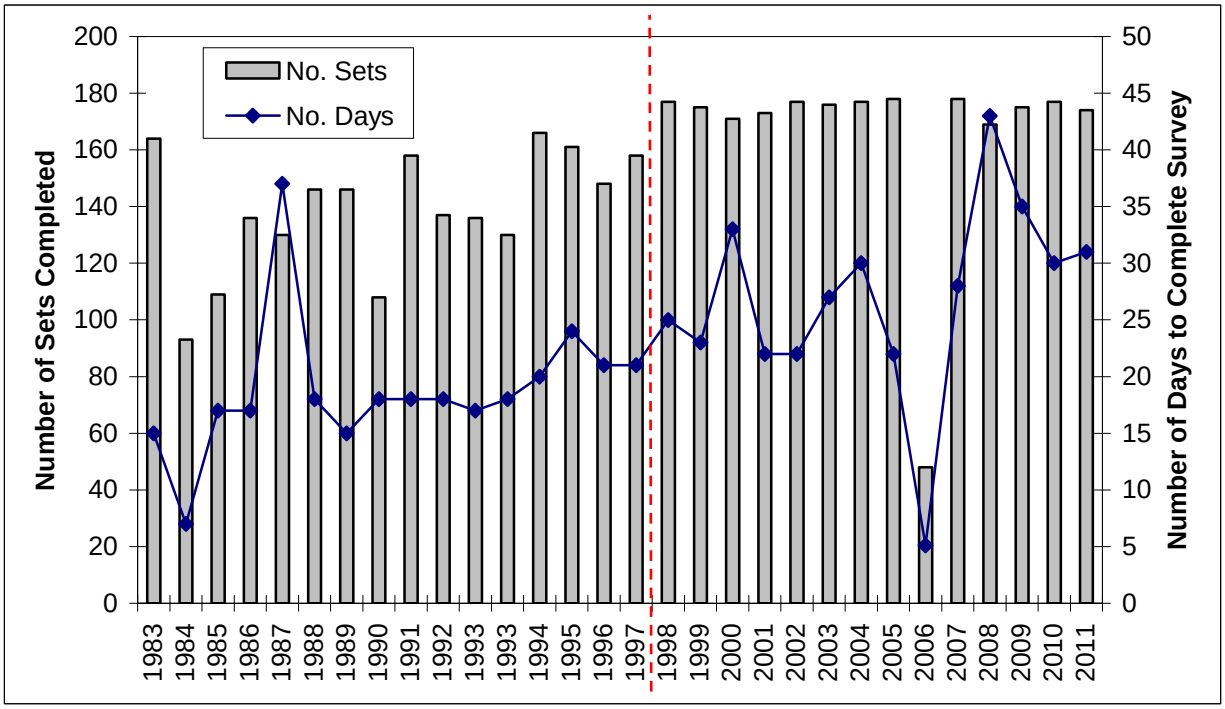
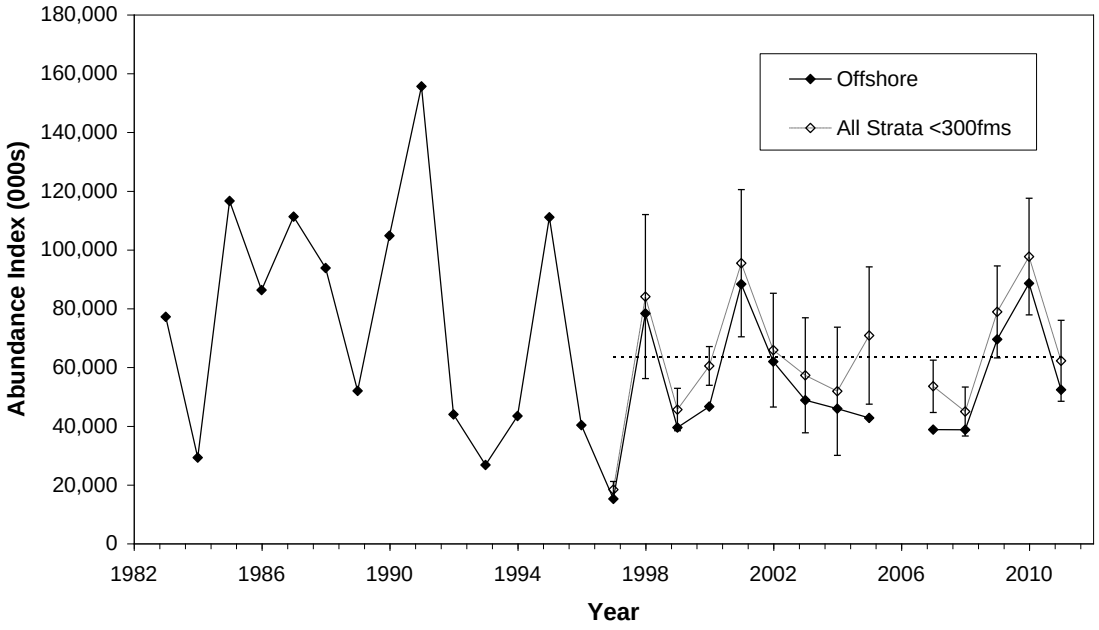


Figure 13. Number of research vessel survey sets completed during surveys of Subdiv. 3Ps, and the number of days required to complete these sets over 1983 to 2011. Survey coverage was expanded to present levels after 1997 (dashed vertical line).



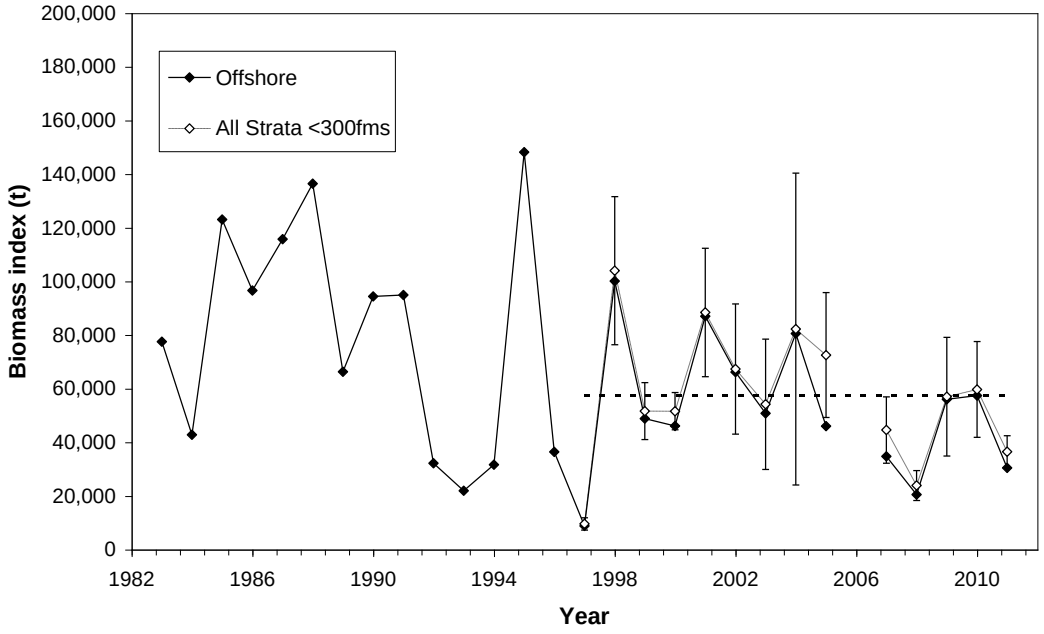


Figure 14. Abundance (upper panel) and biomass (lower panel) indices for cod in Subdiv. 3Ps from DFO research vessel (RV) bottom trawl surveys of index strata during winter/spring from 1983 to 2011. Error bars show plus/minus one standard deviation. Open symbols show values for the augmented survey area that includes additional inshore strata added to the survey in 1997. Dashed horizontal lines are mean of the time-series for all index strata.

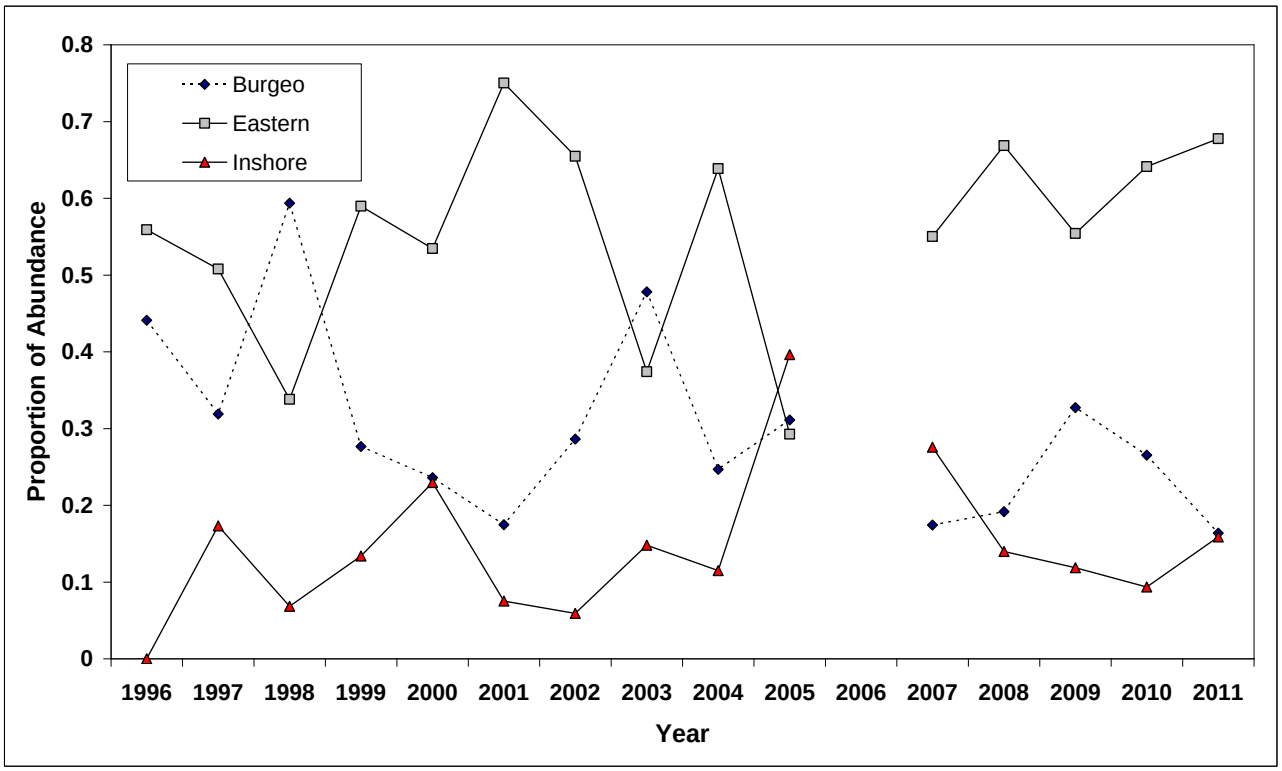


Figure 15. Total abundance index for cod in various regions of Subdiv. 3Ps from DFO research vessel (RV) bottom trawl surveys during winter/spring from 1997 to 2011. The 2006 survey was not completed. The Campelen trawl was used in all surveys.

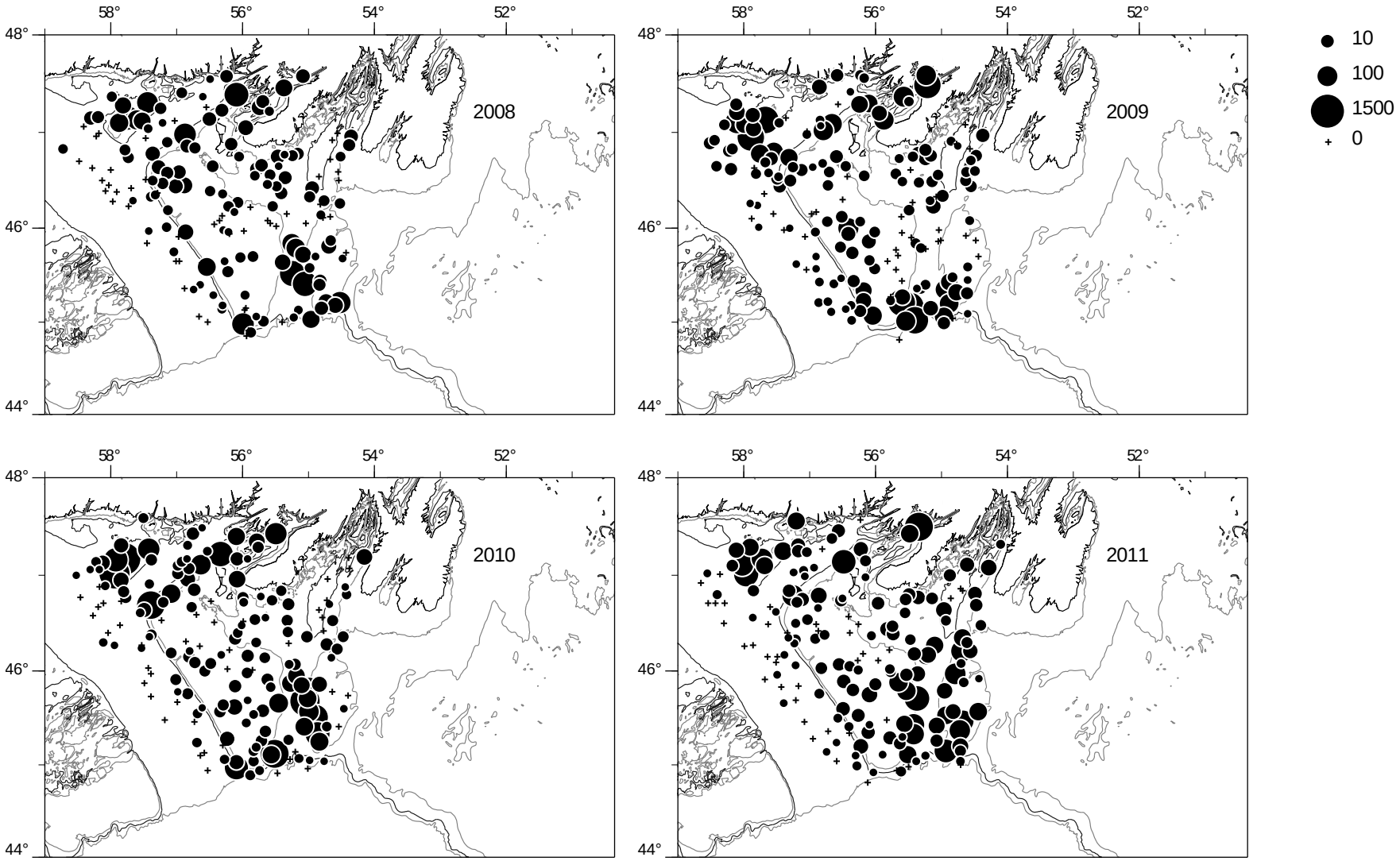


Figure 16a. Age aggregated distribution of cod catches (nos. per tow) from the April DFO research vessel surveys of Subdiv. 3Ps over 2008 to 2011. Bubble size is proportional to numbers caught.

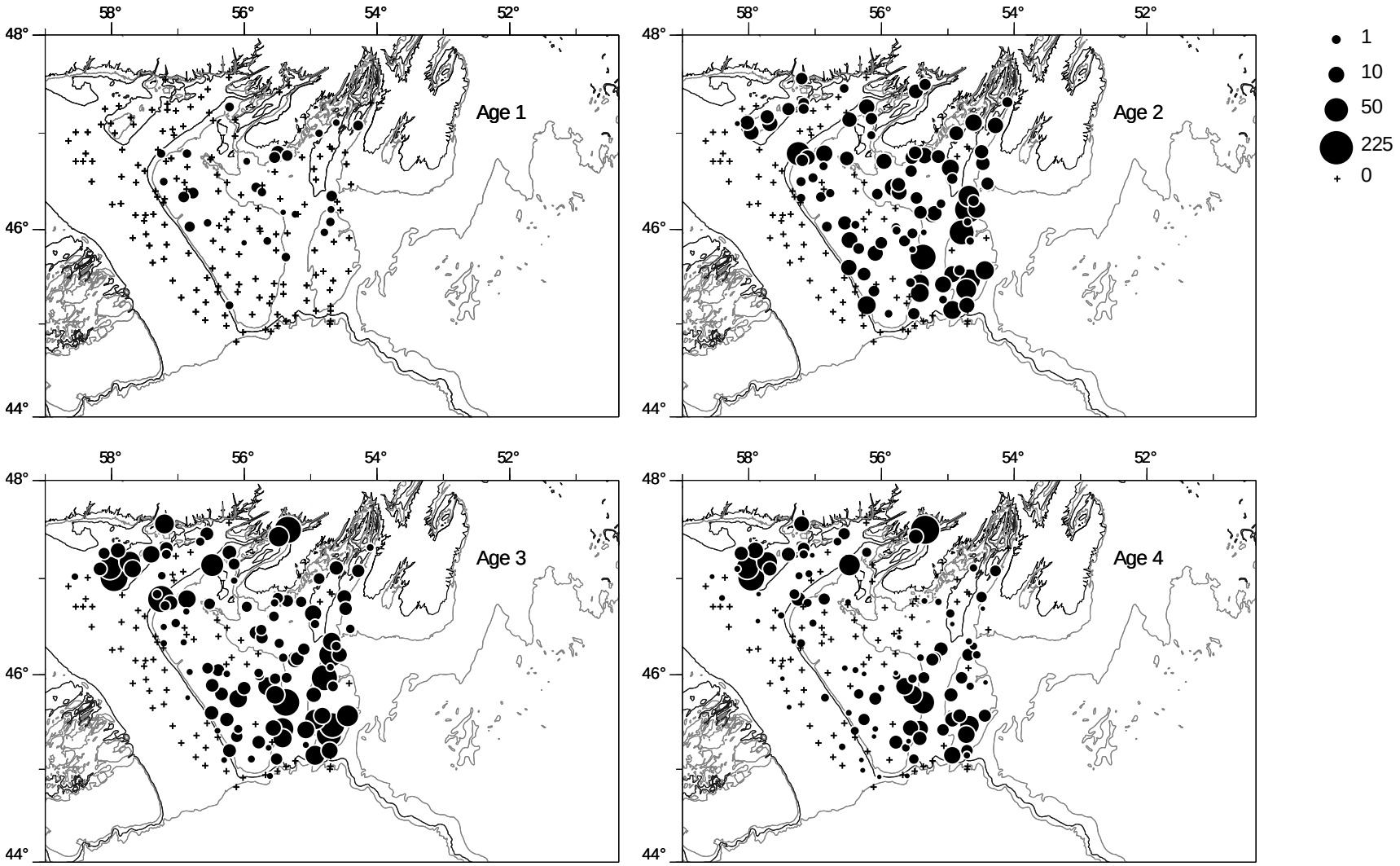


Figure 16b. Age dis-aggregated distribution of cod catches (nos. per tow, ages 1-4) from the April 2011 DFO research vessel (RV) survey of Subdiv. 3Ps. Bubble size is proportional to numbers caught.

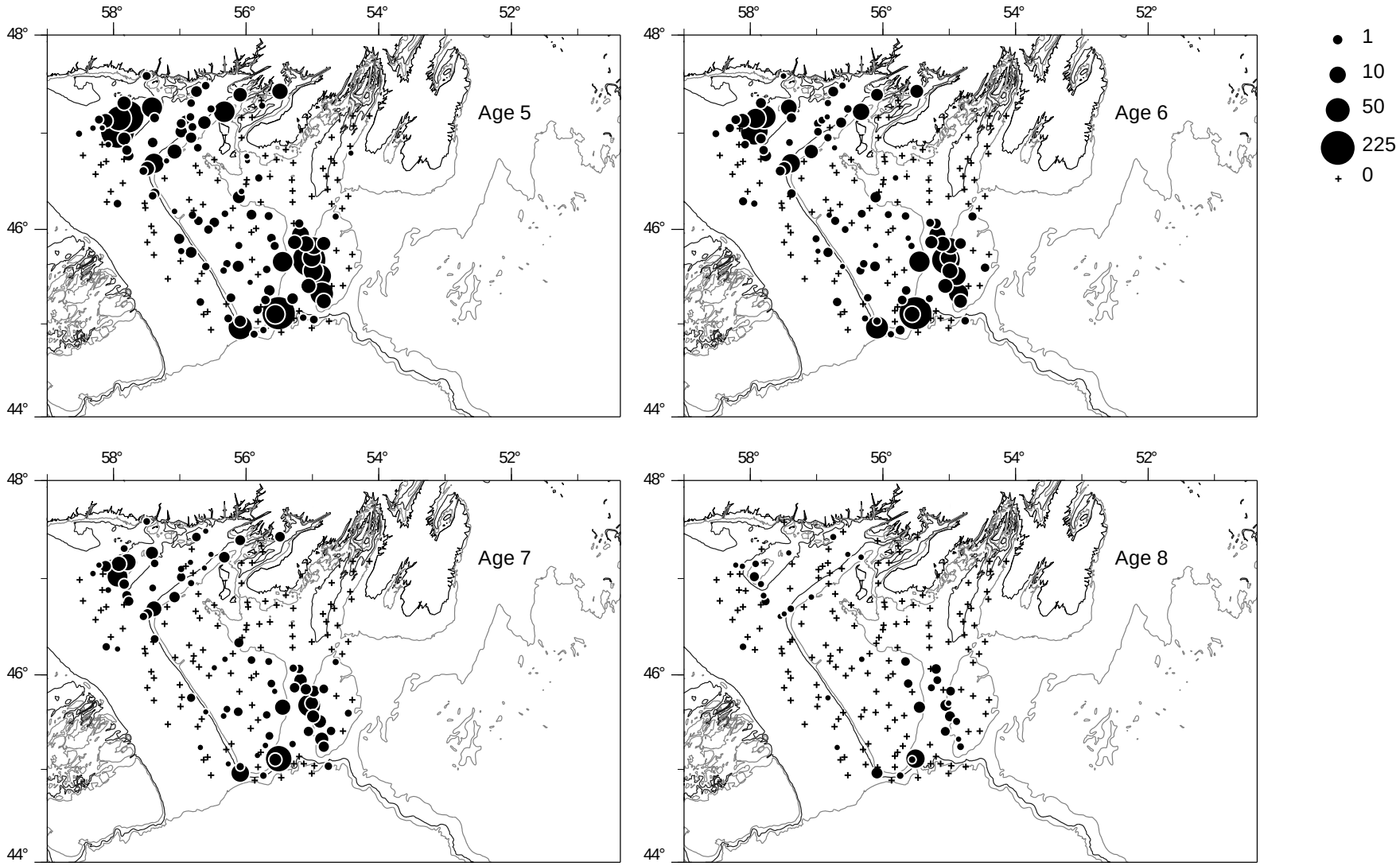


Figure 16c. Age dis-aggregated distribution of cod catches (nos. per tow, ages 5-8) from the April 2011 DFO research vessel (RV) surveys of Subdiv. 3Ps. Bubble size is proportional to numbers caught.

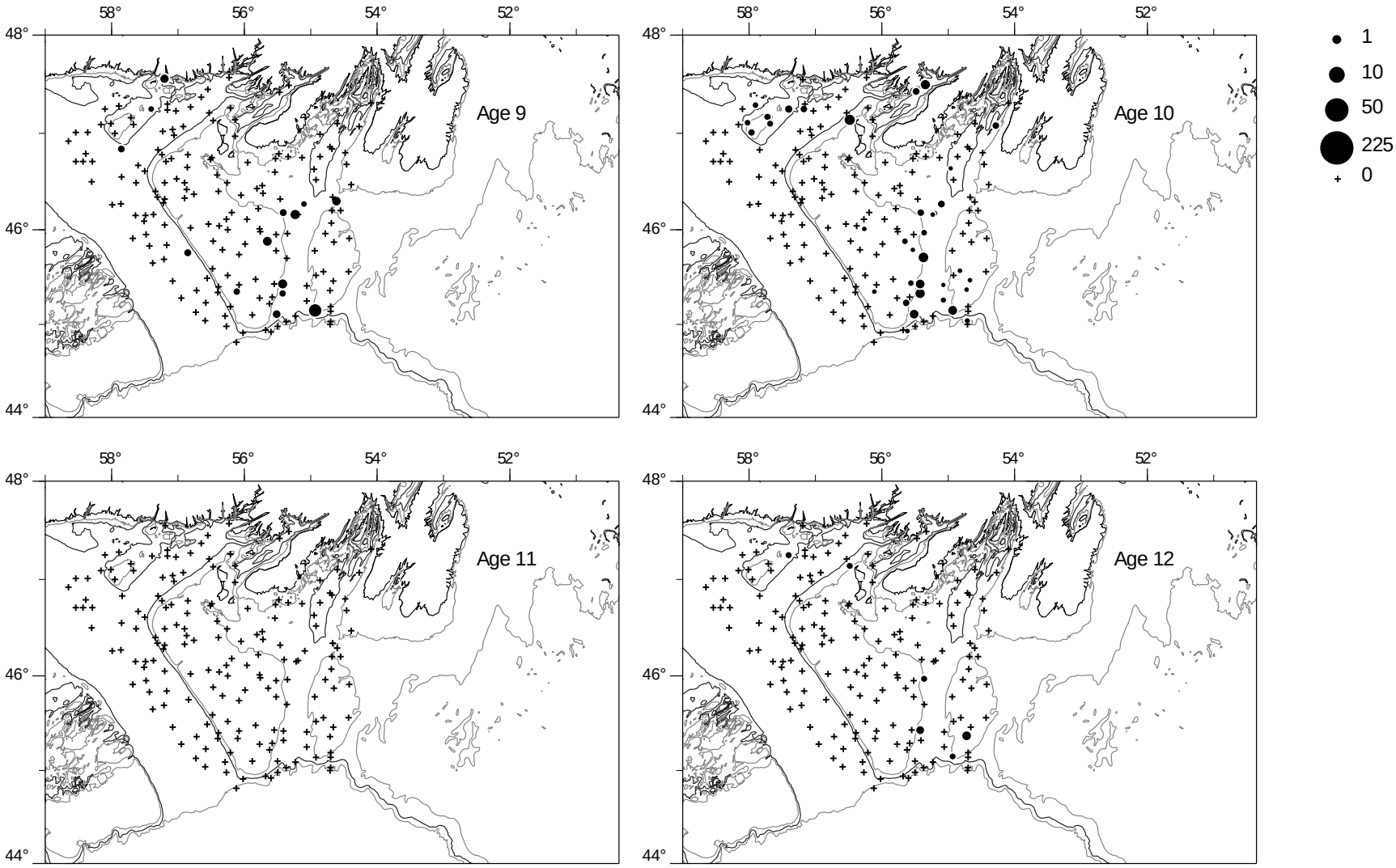


Figure 16d. Age disaggregated distribution of cod catches (nos. per tow, ages 9-12) from the DFO research vessel (RV) survey of Subdiv. 3Ps during April 2011. Bubble size is proportional to numbers caught.

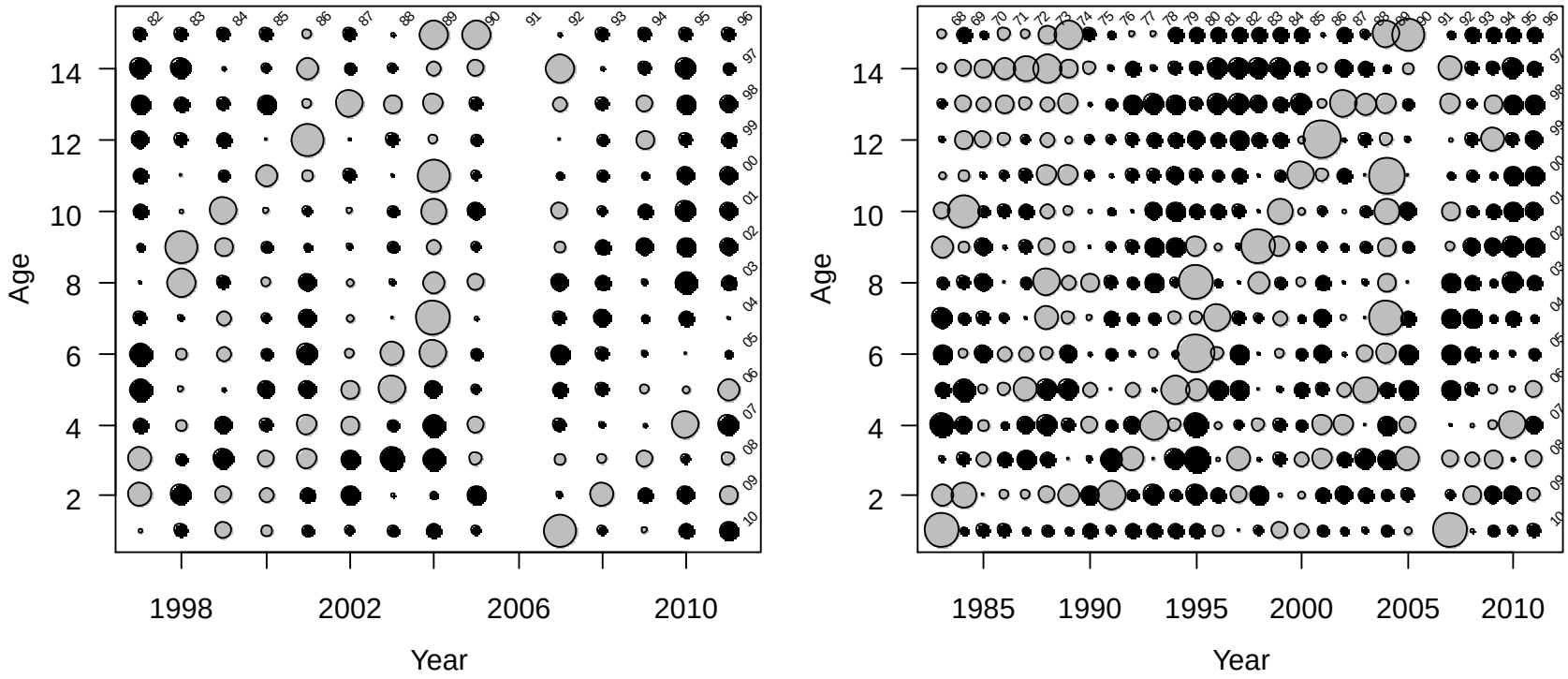


Figure 17. Standardized age-disaggregated catch rates from the spring bottom trawl survey of Subdiv. 3Ps. Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions computed across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts. Left panel includes the 1997-2011 "All Strata <300 fm" data, and panel at right includes data which comprise the "Offshore" index (1983-2011).

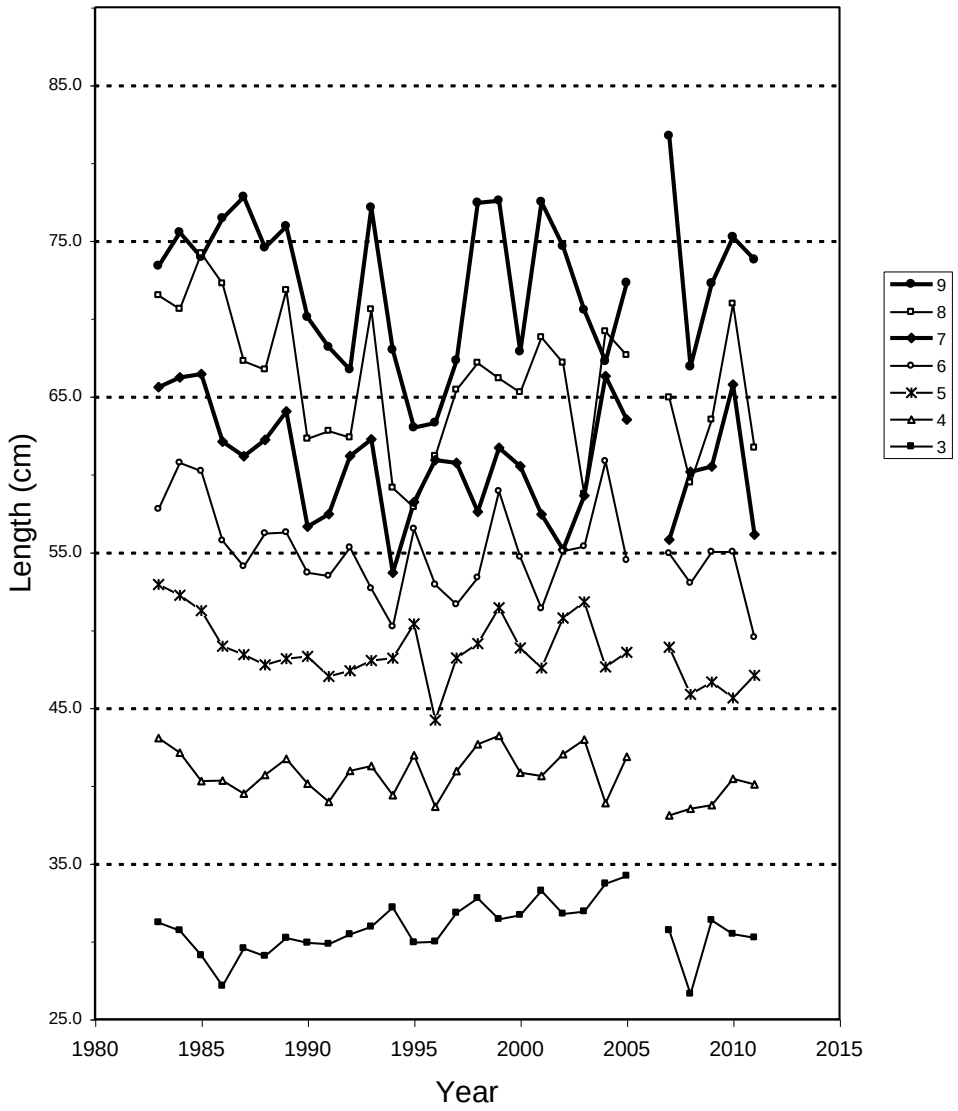


Figure 18a. Mean length at ages 3-9 of cod in Subdiv. 3Ps during 1983 to 2011 from sampling during DFO bottom-trawl surveys in winter-spring.

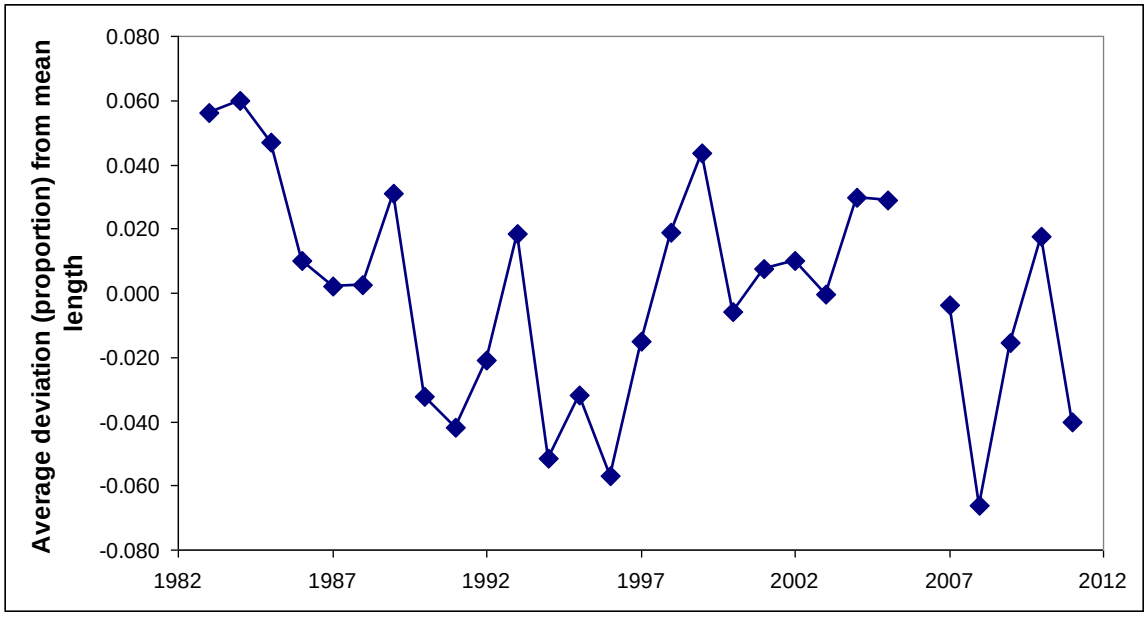


Figure 18b. Average proportion deviation from mean length at age for ages 3-9 from DFO bottom-trawl surveys from 1983-2011.

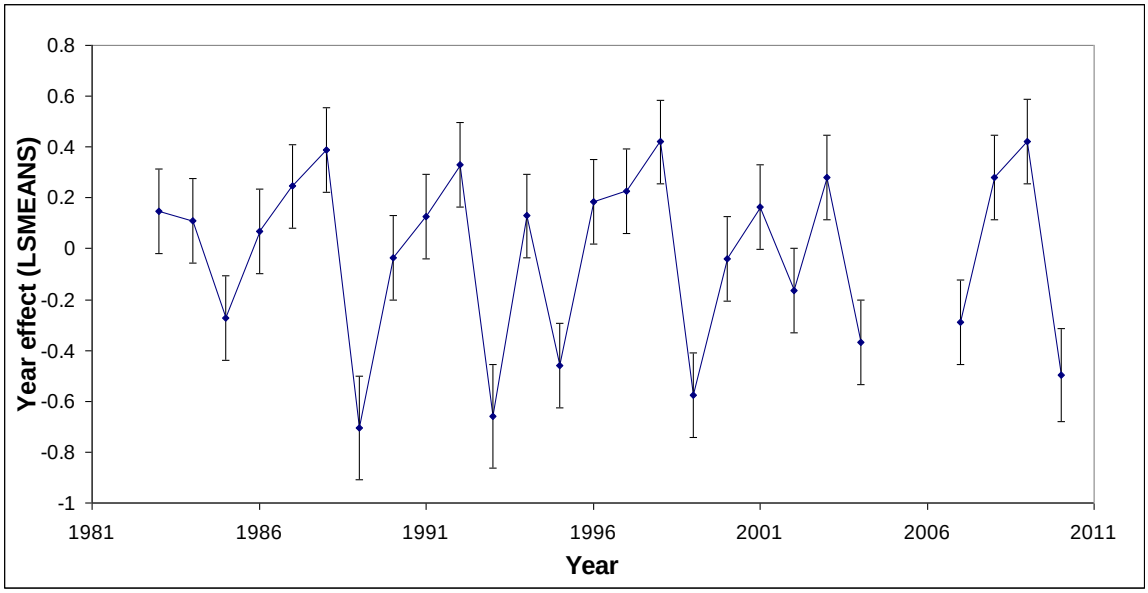


Figure 18c. Least squares means (+ SE) of the effect of year on the residuals from a model of the age effect on length increment for ages 3-9 from DFO bottom-trawl surveys from 1983 to 2011.

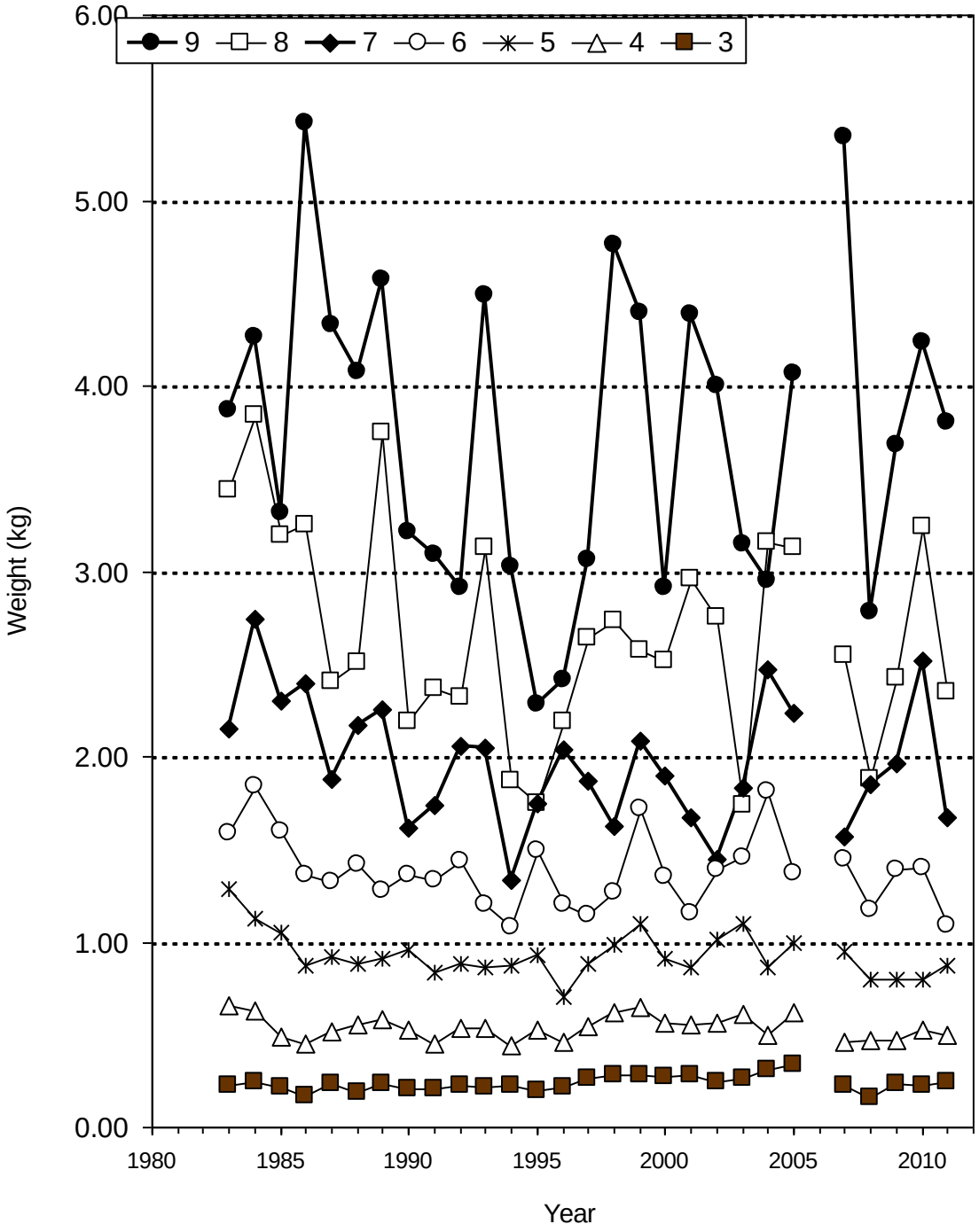


Figure 19a. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983-2011.

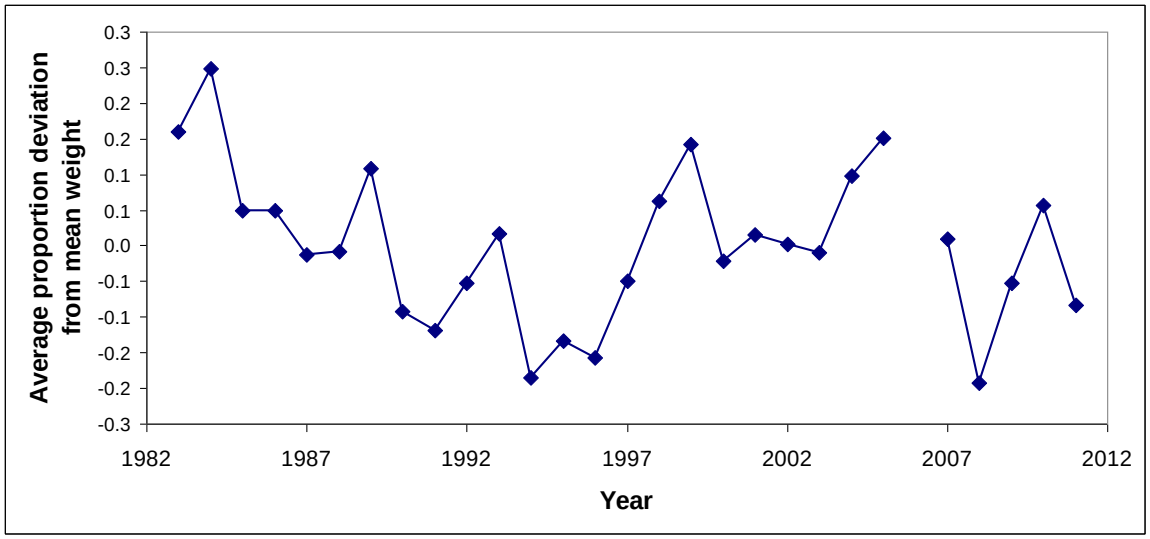


Figure 19b. Average proportion deviation from mean weight at age for ages 3-9 from DFO RV bottom-trawl surveys from 1983 to 2011.

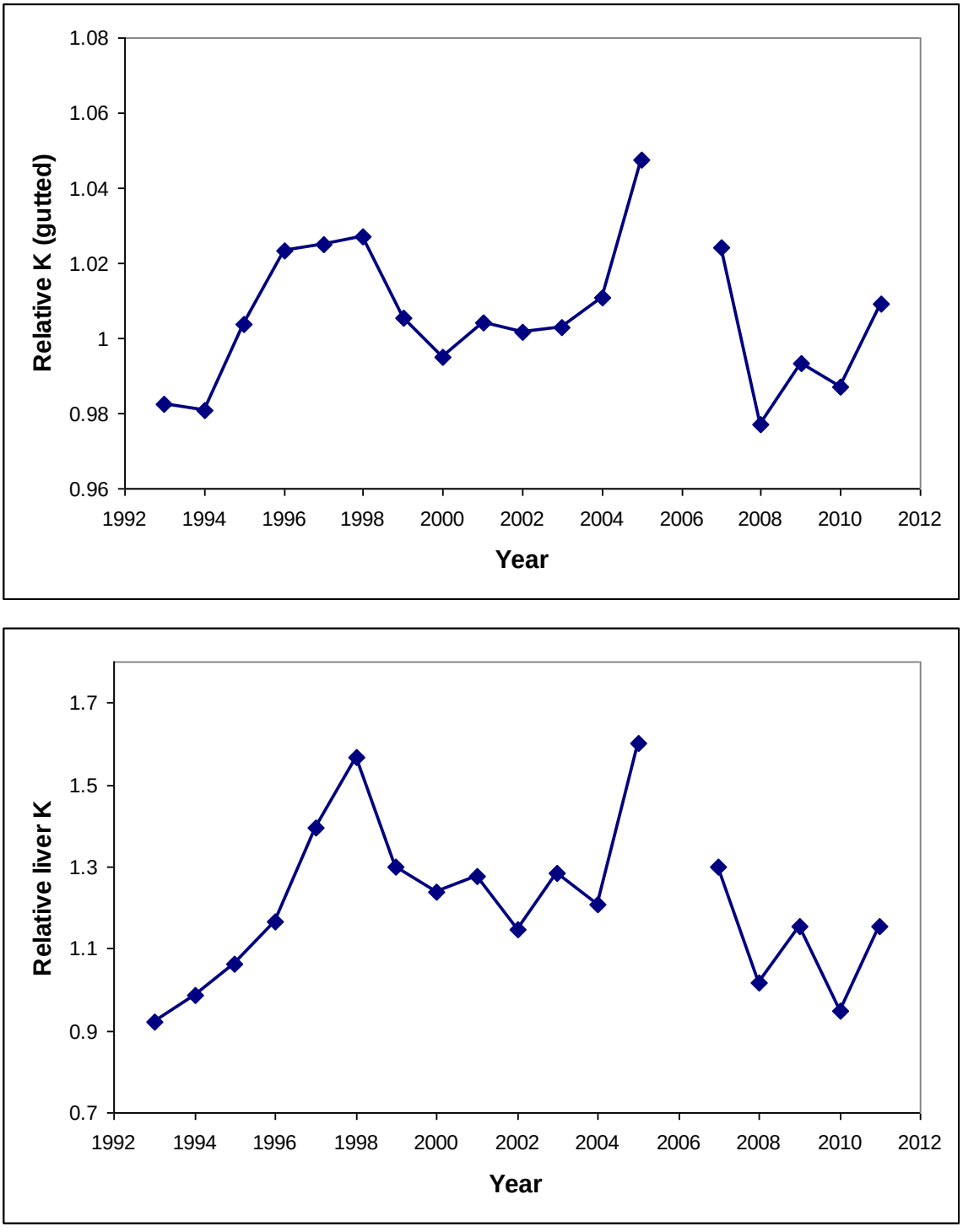


Figure 20. Relative condition indices for Subdiv. 3Ps cod from spring surveys over 1993 to 2011. Upper panel is relative gutted condition index; lower panel relative liver condition index.

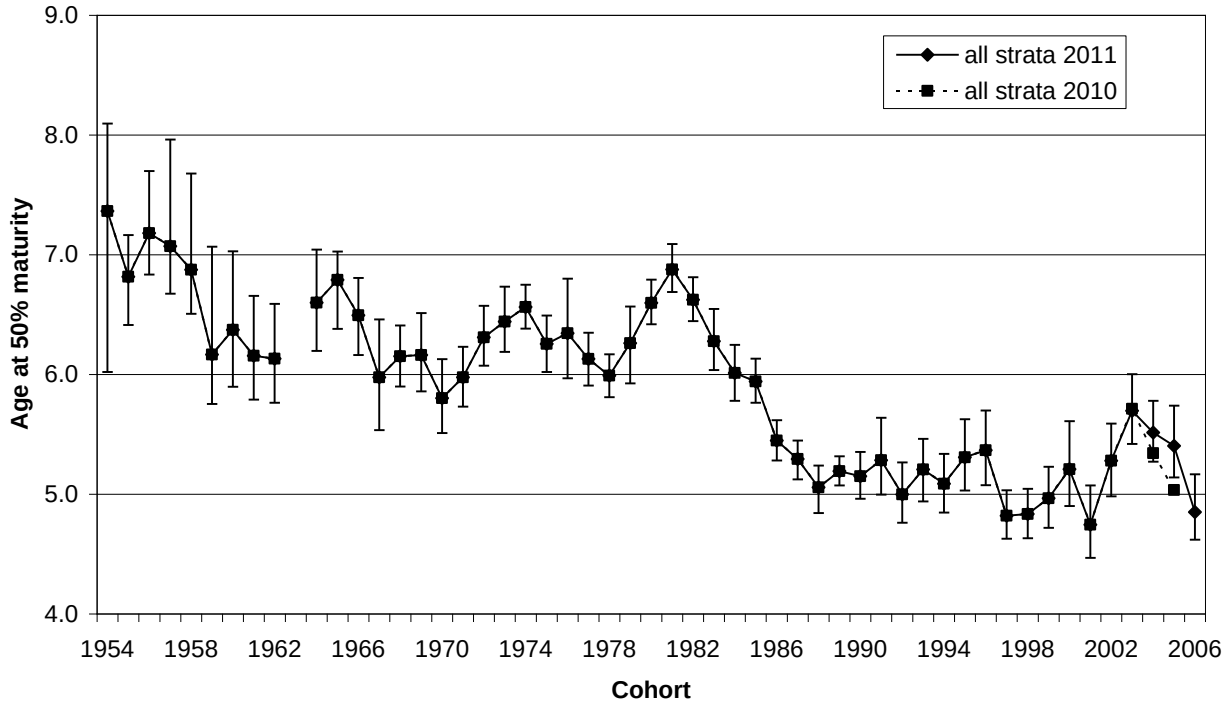


Figure 21a. Age at 50% maturity by cohort (1954 to 2006, excluding 1963) for female cod sampled during DFO research vessel bottom-trawl surveys of Subdiv. 3Ps. Error bars are 95% fiducial limits.

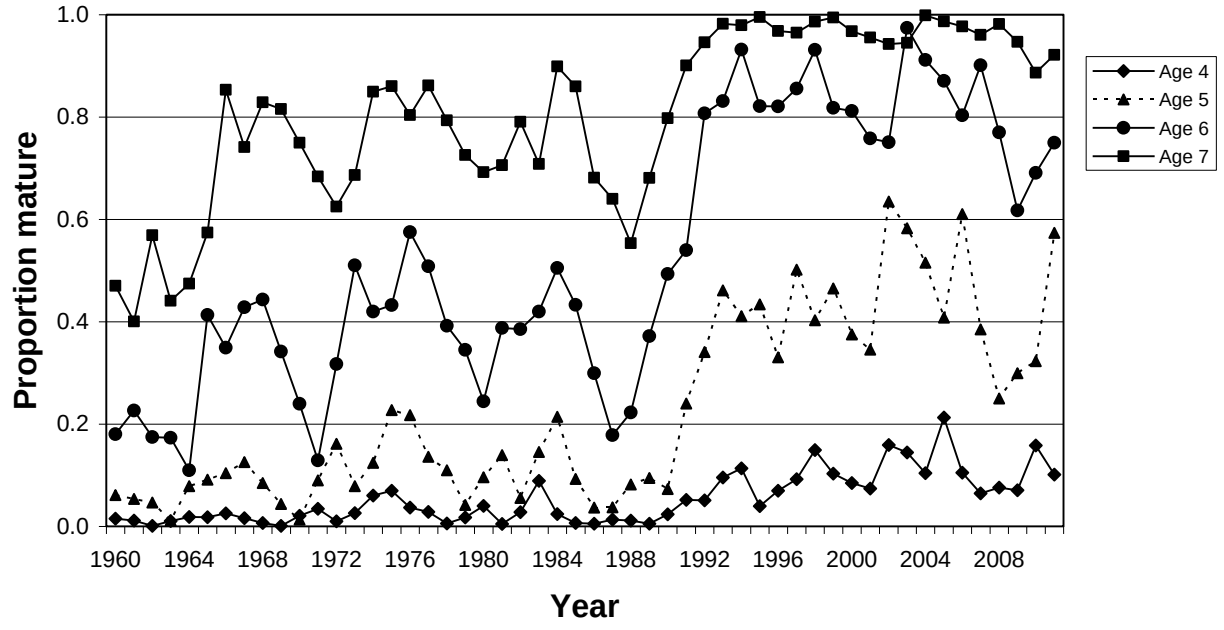


Figure 21b. Estimated proportions mature at ages 4-7 for female cod sampled during DFO research vessel bottom-trawl surveys in Subdiv. 3Ps (data from all strata surveyed).

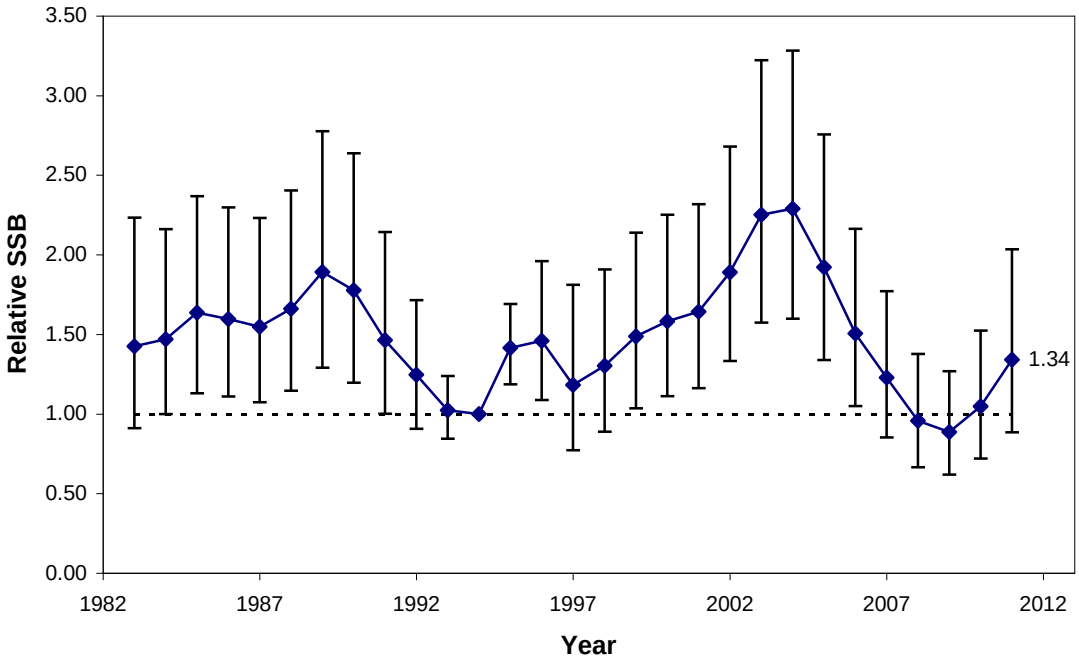


Figure 22a. Estimates of spawning stock biomass (SSB) relative to Blim from SURBA cohort analysis model (i.e., estimates are divided by 1994 SSB).

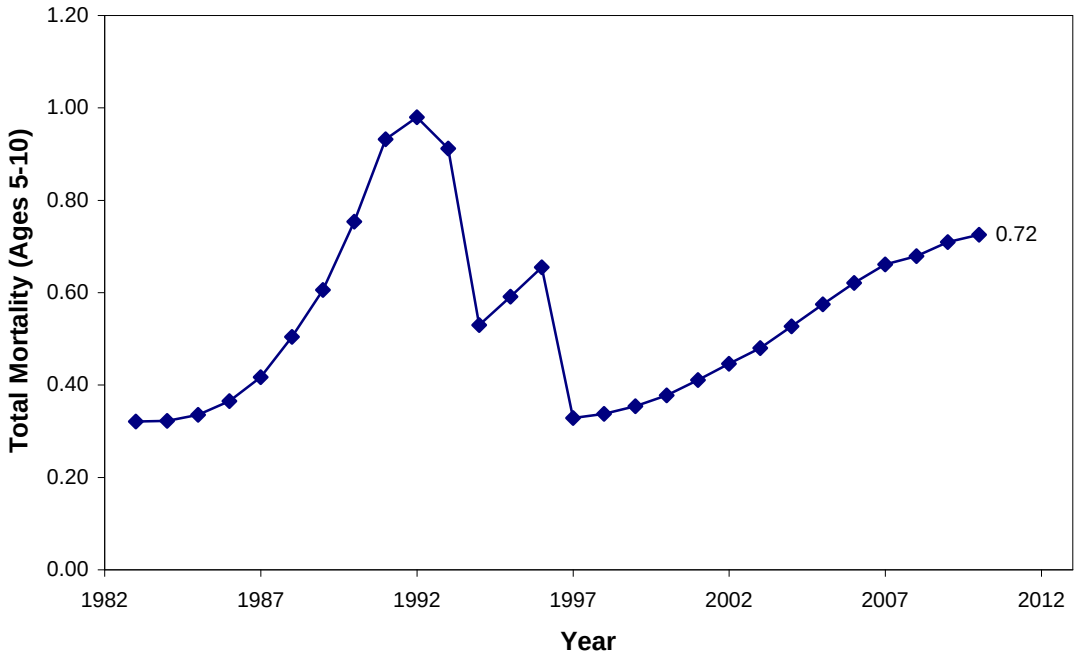


Figure 22b. Estimates of total mortality (Z) from a SURBA cohort analysis model, averaged over ages 5-10.

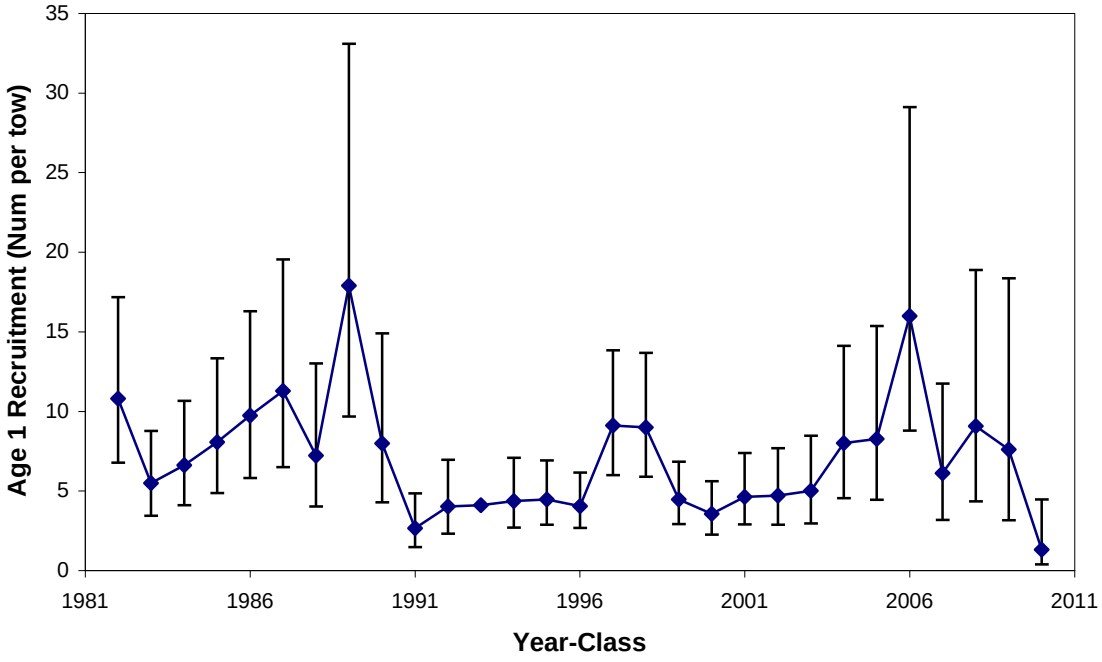


Figure 22c. Estimates of age 1 recruitment from SURBA cohort analysis model.

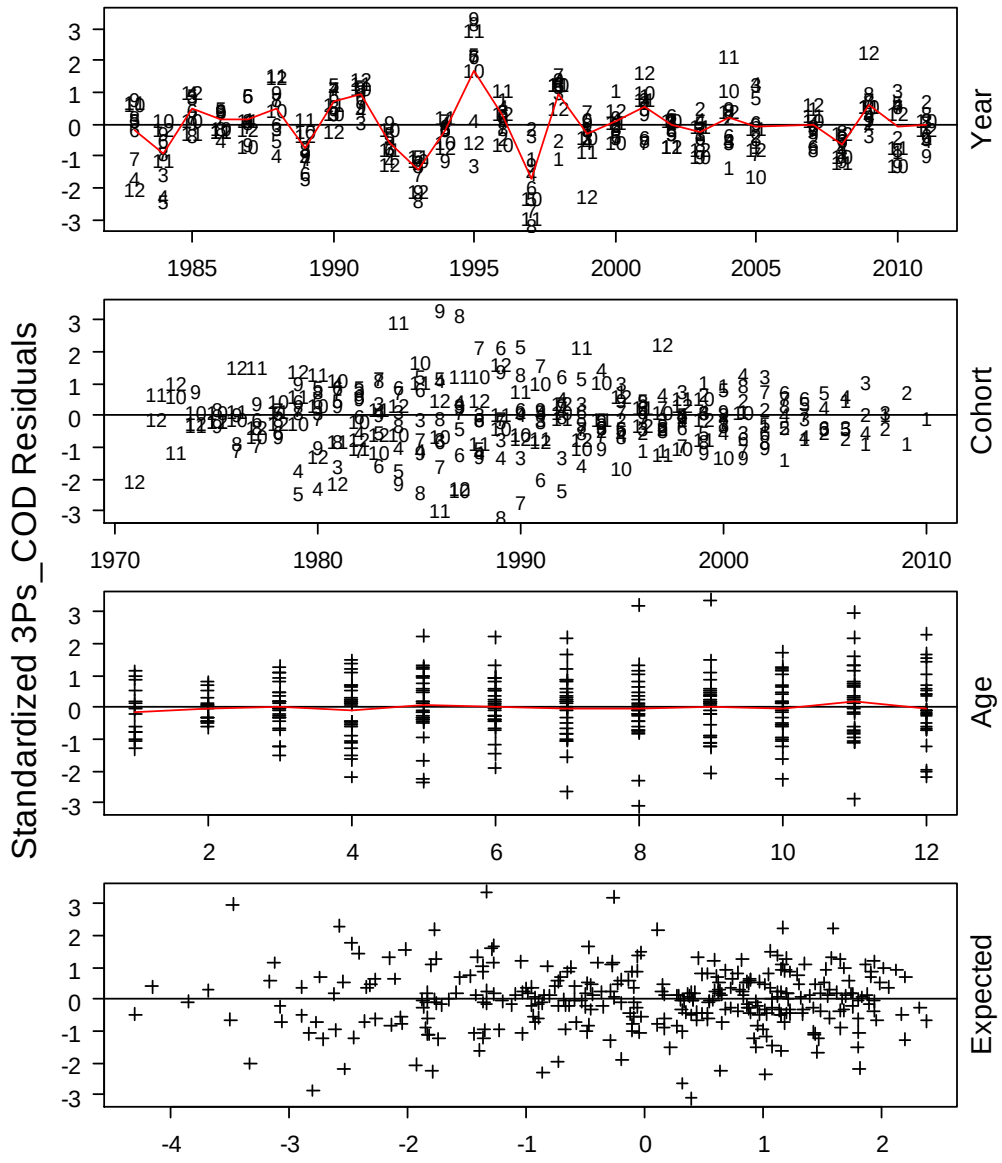


Figure 23. Standardized residuals from SURBA cohort analysis. Panels show residuals plotted year, cohort, age, and expected value, respectively.

APPENDIX 1. SURBA ESTIMATES, OUTPUT, AND ONE-YEAR PROJECTION RESULTS

SAS Standard SURBA for 3Ps_COD

11:25 Monday, October 17, 2011

The NLMIXED Procedure

Specifications

Data Set	WORK.INPUT
Dependent Variable	log_index
Distribution for Dependent Variable	General
Optimization Technique	Dual Quasi-Newton
Integration Method	None

Dimensions

Observations Used	348
Observations Not Used	0
Total Observations	348
Parameters	78

Parameters

logR1972	logR1973	logR1974	logR1975	logR1976	logR1977	logR1978	logR1979	logR1980	logR1981
1	1	1	1	1	1	1	1	1	1

logR1982	logR1983	logR1984	logR1985	logR1986	logR1987	logR1988	logR1989	logR1990	logR1991
1	1	1	1	1	1	1	1	1	1

logR1992	logR1993	logR1994	logR1995	logR1996	logR1997	logR1998	logR1999	logR2000	logR2001
1	1	1	1	1	1	1	1	1	1

logR2002	logR2003	logR2004	logR2005	logR2006	logR2007	logR2008	logR2009	logR2010	f1983
1	1	1	1	1	1	1	1	1	-1

f1984	f1985	f1986	f1987	f1988	f1989	f1990	f1991	f1992	f1993
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

f1994	f1995	f1996	f1997	f1998	f1999	f2000	f2001	f2002	f2003
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

f2004	f2005	f2006	f2007	f2008	f2009	f2010	s1	s2	s3
-1	-1	-1	-1	-1	-1	-1	0	0	0

s4	s5	s7	s8	s9	s10	s11	S_std	NegLogLike
0	0	0	0	0	0	0	0.1	34800.1958

Iteration History

Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
1	16	1154.78797	33645.41	3063.859	-4.926E9
2	24	626.092011	528.696	713.5921	-10.2793
3	26	483.209865	142.8821	137.3822	-83.2311
4	28	446.426965	36.7829	39.29951	-23.6811
5	30	434.98636	11.4406	108.1144	-6.17108
6	32	424.969661	10.0167	142.985	-4.39116
7	34	412.880729	12.08893	107.4178	-13.6542
8	36	398.740018	14.14071	37.76179	-13.8349
9	37	392.27104	6.468979	89.95268	-12.076
10	39	355.222058	37.04898	41.02332	-10.0404
11	42	338.452999	16.76906	11.77157	-73.7861
12	45	335.702602	2.750397	38.59837	-1.41508
13	47	323.81746	11.88514	39.25595	-7.68456
14	48	322.797366	1.020094	41.93373	-3.99523
15	50	320.952397	1.844969	9.380265	-2.53757
16	52	318.434231	2.518166	25.13468	-2.16883
17	54	313.351751	5.08248	14.6707	-3.67278
18	56	311.674293	1.677458	29.06275	-1.48174
19	58	308.764524	2.909769	9.334268	-2.00728
20	60	306.304373	2.460151	10.26957	-0.9326
21	62	303.238146	3.066227	8.32231	-2.39887
22	64	302.345363	0.892784	8.068988	-0.83734
23	66	300.913634	1.431729	5.53902	-0.98634
24	68	300.009364	0.90427	6.056198	-0.37703
25	70	299.133298	0.876065	4.587164	-0.73948
26	72	298.692761	0.440537	5.312401	-0.27903
27	74	297.884773	0.807988	8.063441	-0.48101
28	76	297.58603	0.298743	14.6991	-0.23679
29	78	297.07454	0.51149	4.045298	-0.30307
30	80	296.766554	0.307987	3.912099	-0.26432
31	82	296.118617	0.647937	4.57006	-0.30505
32	83	295.885407	0.233209	2.98839	-0.35017
33	85	295.663953	0.221454	5.852904	-0.20393
34	87	295.353325	0.310628	2.922522	-0.17306
35	89	295.216342	0.136983	3.185082	-0.08359
36	91	295.05992	0.156422	3.260018	-0.1052
37	93	294.906709	0.15321	3.269732	-0.09343
38	95	294.600384	0.306325	8.613143	-0.10548
39	97	294.451496	0.148888	2.729205	-0.16692
40	99	294.331084	0.120412	1.321255	-0.07107
41	101	294.245714	0.08537	2.205547	-0.08084
42	103	294.104664	0.14105	5.937278	-0.03482
43	105	293.938058	0.166606	1.937046	-0.13633
44	107	293.862451	0.075607	1.670939	-0.04952
45	109	293.784578	0.077873	1.390844	-0.05987
46	111	293.720327	0.064251	1.350327	-0.05055
47	113	293.632074	0.088253	1.360059	-0.04957
48	115	293.595416	0.036658	1.081558	-0.03516
49	117	293.544522	0.050895	1.208988	-0.0178
50	119	293.497958	0.046563	1.380916	-0.04112
51	121	293.461458	0.0365	1.171028	-0.02446
52	123	293.433059	0.028399	0.8418	-0.02598
53	125	293.414455	0.018604	1.252948	-0.00917
54	127	293.38403	0.030426	0.702197	-0.0183
55	129	293.373816	0.010214	0.655137	-0.00725
56	131	293.358319	0.015497	0.687755	-0.00834
57	133	293.350859	0.00746	0.605306	-0.00434
58	135	293.34069	0.010169	0.4815	-0.00697
59	137	293.33595	0.00474	0.416821	-0.00244
60	139	293.332945	0.003006	0.332446	-0.0029
61	141	293.32813	0.004815	0.387605	-0.00112

62	143	293.326695	0.001435	0.297327	-0.00138
63	145	293.324496	0.002199	0.252282	-0.00094
64	147	293.323604	0.000892	0.148938	-0.00047
65	149	293.322673	0.000931	0.211118	-0.00071
66	151	293.321462	0.001212	0.19793	-0.00033
67	153	293.320961	0.0005	0.138162	-0.00058
68	155	293.320351	0.000611	0.123581	-0.00023
69	157	293.319791	0.00056	0.121733	-0.00047
70	159	293.31895	0.000841	0.141416	-0.0002
71	161	293.318439	0.000511	0.137996	-0.00022
72	163	293.317919	0.00052	0.076899	-0.00045
73	165	293.317297	0.000622	0.072188	-0.00009
74	166	293.317072	0.000225	0.046386	-0.0004
75	168	293.316948	0.000124	0.103961	-0.00005
76	170	293.31647	0.000478	0.074195	-0.00016
77	172	293.316277	0.000193	0.064047	-0.00006
78	174	293.316158	0.000119	0.071265	-0.00011
79	176	293.316003	0.000156	0.038233	-0.00005
80	178	293.315974	0.000029	0.035378	-0.00002
81	180	293.315769	0.000205	0.026456	-0.00003
82	181	293.315729	0.00004	0.032002	-0.00006
83	183	293.315693	0.000037	0.032993	-0.00002
84	185	293.31564	0.000052	0.032986	-0.00003
85	188	293.315455	0.000185	0.030962	-0.00001
86	190	293.315409	0.000047	0.045978	-8.1E-6
87	192	293.315272	0.000136	0.032661	-0.00007
88	193	293.315255	0.000017	0.019108	-0.00003
89	195	293.315237	0.000019	0.038082	-0.00001
90	197	293.315122	0.000114	0.02766	-0.00002
91	199	293.315073	0.000049	0.041803	-8.83E-6
92	201	293.314918	0.000155	0.026633	-0.00007
93	202	293.314905	0.000013	0.021165	-0.00002
94	204	293.314889	0.000016	0.020555	-9.91E-6
95	206	293.314761	0.000128	0.011951	-0.00002
96	207	293.314752	8.941E-6	0.014389	-0.00002
97	209	293.314743	8.746E-6	0.017133	-2.7E-6

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	586.6
AIC (smaller is better)	742.6
AICC (smaller is better)	788.4
BIC (smaller is better)	1043.1

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
logR1972	-1.5263	0.4370	348	-3.49	0.0005	0.05	-2.3858	-0.6667	0.007124
logR1973	-0.7317	0.3654	348	-2.00	0.0460	0.05	-1.4504	-0.01298	-0.00685
logR1974	-0.04985	0.3286	348	-0.15	0.8795	0.05	-0.6962	0.5965	0.005846
logR1975	-0.2138	0.3115	348	-0.69	0.4930	0.05	-0.8266	0.3989	-0.00951
logR1976	-0.06424	0.2930	348	-0.22	0.8266	0.05	-0.6406	0.5121	-0.00523
logR1977	0.5561	0.2734	348	2.03	0.0427	0.05	0.01847	1.0938	0.007428
logR1978	1.2088	0.2531	348	4.78	<.0001	0.05	0.7109	1.7066	-0.00029
logR1979	1.1300	0.2358	348	4.79	<.0001	0.05	0.6663	1.5938	-0.00325
logR1980	1.8693	0.2228	348	8.39	<.0001	0.05	1.4311	2.3075	0.000999
logR1981	1.9869	0.2271	348	8.75	<.0001	0.05	1.5402	2.4335	-0.00093
logR1982	2.3782	0.2366	348	10.05	<.0001	0.05	1.9129	2.8436	-0.0007
logR1983	1.7013	0.2381	348	7.14	<.0001	0.05	1.2329	2.1697	-0.00394
logR1984	1.8883	0.2424	348	7.79	<.0001	0.05	1.4115	2.3651	0.000474
logR1985	2.0864	0.2561	348	8.15	<.0001	0.05	1.5828	2.5900	0.004972
logR1986	2.2755	0.2615	348	8.70	<.0001	0.05	1.7613	2.7898	-0.00572
logR1987	2.4220	0.2801	348	8.65	<.0001	0.05	1.8711	2.9729	0.007986
logR1988	1.9776	0.2991	348	6.61	<.0001	0.05	1.3893	2.5658	0.002667
logR1989	2.8846	0.3126	348	9.23	<.0001	0.05	2.2697	3.4994	-0.00101
logR1990	2.0766	0.3174	348	6.54	<.0001	0.05	1.4524	2.7009	0.002639
logR1991	0.9787	0.3036	348	3.22	0.0014	0.05	0.3815	1.5759	-0.00258
logR1992	1.3909	0.2789	348	4.99	<.0001	0.05	0.8423	1.9395	-0.00342
logR1993	1.4105	0.2567	348	5.49	<.0001	0.05	0.9056	1.9153	0.001285
logR1994	1.4745	0.2456	348	6.00	<.0001	0.05	0.9914	1.9576	-0.00096
logR1995	1.4952	0.2231	348	6.70	<.0001	0.05	1.0564	1.9340	0.000289
logR1996	1.3985	0.2124	348	6.59	<.0001	0.05	0.9808	1.8162	0.000884
logR1997	2.2083	0.2125	348	10.39	<.0001	0.05	1.7903	2.6262	-0.00015
logR1998	2.1948	0.2138	348	10.27	<.0001	0.05	1.7743	2.6152	0.003711
logR1999	1.4952	0.2169	348	6.89	<.0001	0.05	1.0686	1.9219	0.009023
logR2000	1.2668	0.2327	348	5.44	<.0001	0.05	0.8092	1.7243	0.000683
logR2001	1.5304	0.2374	348	6.45	<.0001	0.05	1.0636	1.9972	-0.00213
logR2002	1.5468	0.2506	348	6.17	<.0001	0.05	1.0540	2.0397	0.00346
logR2003	1.6107	0.2673	348	6.02	<.0001	0.05	1.0849	2.1365	-0.00256
logR2004	2.0791	0.2886	348	7.20	<.0001	0.05	1.5116	2.6467	0.003438
logR2005	2.1107	0.3159	348	6.68	<.0001	0.05	1.4894	2.7320	-0.00274
logR2006	2.7714	0.3048	348	9.09	<.0001	0.05	2.1720	3.3708	-0.00229
logR2007	1.8104	0.3315	348	5.46	<.0001	0.05	1.1584	2.4625	-0.01132
logR2008	2.2043	0.3731	348	5.91	<.0001	0.05	1.4706	2.9380	-0.00486
logR2009	2.0293	0.4479	348	4.53	<.0001	0.05	1.1485	2.9102	-0.00397
logR2010	0.2609	0.6276	348	0.42	0.6779	0.05	-0.9734	1.4953	0.002542
f1983	-1.4000	0.2691	348	-5.20	<.0001	0.05	-1.9294	-0.8707	-0.00651
f1984	-1.3961	0.2478	348	-5.63	<.0001	0.05	-1.8835	-0.9087	-0.00405
f1985	-1.3567	0.2320	348	-5.85	<.0001	0.05	-1.8131	-0.9003	0.001201
f1986	-1.2708	0.2242	348	-5.67	<.0001	0.05	-1.7117	-0.8298	0.002006
f1987	-1.1372	0.2198	348	-5.17	<.0001	0.05	-1.5694	-0.7049	0.001856
f1988	-0.9477	0.2157	348	-4.39	<.0001	0.05	-1.3719	-0.5236	0.002823
f1989	-0.7642	0.2090	348	-3.66	0.0003	0.05	-1.1753	-0.3532	-0.00058
f1990	-0.5455	0.2054	348	-2.66	0.0083	0.05	-0.9494	-0.1415	-0.00169
f1991	-0.3333	0.2076	348	-1.61	0.1092	0.05	-0.7416	0.07489	-0.00142
f1992	-0.2838	0.2114	348	-1.34	0.1804	0.05	-0.6997	0.1321	0.000704
f1993	-0.3555	0.2221	348	-1.60	0.1104	0.05	-0.7923	0.08134	0.002148
f1994	-0.8990	0.2261	348	-3.98	<.0001	0.05	-1.3437	-0.4543	0.000196
f1995	-0.7882	0.2211	348	-3.56	0.0004	0.05	-1.2231	-0.3532	0.002102
f1996	-0.6866	0.2368	348	-2.90	0.0040	0.05	-1.1523	-0.2210	0.00326
f1997	-1.3760	0.2533	348	-5.43	<.0001	0.05	-1.8742	-0.8778	-0.01128
f1998	-1.3493	0.2352	348	-5.74	<.0001	0.05	-1.8118	-0.8867	-0.008
f1999	-1.3010	0.2249	348	-5.78	<.0001	0.05	-1.7434	-0.8586	-0.00285
f2000	-1.2378	0.2193	348	-5.64	<.0001	0.05	-1.6692	-0.8065	0.001572
f2001	-1.1532	0.2162	348	-5.33	<.0001	0.05	-1.5785	-0.7279	0.003106
f2002	-1.0712	0.2134	348	-5.02	<.0001	0.05	-1.4910	-0.6514	0.002191
f2003	-0.9972	0.2124	348	-4.69	<.0001	0.05	-1.4149	-0.5794	-0.00058

f2004	-0.9034	0.2143	348	-4.22	<.0001	0.05	-1.3248	-0.4820	-0.00215
f2005	-0.8170	0.2141	348	-3.82	0.0002	0.05	-1.2381	-0.3959	0.000494
f2006	-0.7392	0.2105	348	-3.51	0.0005	0.05	-1.1532	-0.3251	0.001195
f2007	-0.6767	0.2081	348	-3.25	0.0013	0.05	-1.0860	-0.2675	0.003125
f2008	-0.6498	0.2062	348	-3.15	0.0018	0.05	-1.0553	-0.2443	0.001372
f2009	-0.6062	0.2089	348	-2.90	0.0039	0.05	-1.0171	-0.1954	0.000314
f2010	-0.5845	0.2248	348	-2.60	0.0097	0.05	-1.0266	-0.1424	-0.00073
s1	-1.2018	0.5474	348	-2.20	0.0288	0.05	-2.2784	-0.1252	-0.00109
s2	-1.1692	0.4543	348	-2.57	0.0105	0.05	-2.0627	-0.2757	0.005216
s3	-1.0641	0.3869	348	-2.75	0.0063	0.05	-1.8251	-0.3031	-0.00439
s4	-0.8504	0.3396	348	-2.50	0.0127	0.05	-1.5183	-0.1826	0.007333
s5	-0.4532	0.2878	348	-1.57	0.1162	0.05	-1.0193	0.1128	-0.00209
s7	0.3292	0.2718	348	1.21	0.2267	0.05	-0.2054	0.8638	0.00161
s8	0.5146	0.2717	348	1.89	0.0591	0.05	-0.01986	1.0491	-0.00641
s9	0.5103	0.2531	348	2.02	0.0445	0.05	0.01250	1.0081	-0.01713
s10	0.3640	0.2483	348	1.47	0.1435	0.05	-0.1243	0.8524	0.015224
s11	0.3553	0.2549	348	1.39	0.1642	0.05	-0.1460	0.8567	0.003023
S_std	0.6271	0.02527	348	24.82	<.0001	0.05	0.5774	0.6768	0.00103

Total Error Sum of Squares = 180.7748760

Index Catchabilities – User Supplied

Obs	survey	age	logq	Lower	Upper	Q	Q_L95	Q_U95
1	3Ps_COD	1	-1.87180	-1.87180	-1.87180	0.15385	0.15385	0.15385
2	3Ps_COD	2	-0.77319	-0.77319	-0.77319	0.46154	0.46154	0.46154
3	3Ps_COD	3	-0.08004	-0.08004	-0.08004	0.92308	0.92308	0.92308
4	3Ps_COD	4	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
5	3Ps_COD	5	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
6	3Ps_COD	6	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
7	3Ps_COD	7	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
8	3Ps_COD	8	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
9	3Ps_COD	9	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
10	3Ps_COD	10	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
11	3Ps_COD	11	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000
12	3Ps_COD	12	0.00000	0.00000	0.00000	1.00000	1.00000	1.00000

Recruitments at age 1

Obs	year	recruit	recruit_ L95	recruit_ U95
1	1983	10.79	6.77	17.18
2	1984	5.48	3.43	8.76
3	1985	6.61	4.10	10.65
4	1986	8.06	4.87	13.33
5	1987	9.73	5.82	16.28
6	1988	11.27	6.50	19.55
7	1989	7.23	4.01	13.01
8	1990	17.90	9.68	33.10
9	1991	7.98	4.27	14.89
10	1992	2.66	1.46	4.83
11	1993	4.02	2.32	6.96
12	1994	4.10	2.47	6.79
13	1995	4.37	2.70	7.08
14	1996	4.46	2.88	6.92
15	1997	4.05	2.67	6.15
16	1998	9.10	5.99	13.82
17	1999	8.98	5.90	13.67
18	2000	4.46	2.91	6.83
19	2001	3.55	2.25	5.61
20	2002	4.62	2.90	7.37
21	2003	4.70	2.87	7.69
22	2004	5.01	2.96	8.47
23	2005	8.00	4.53	14.11
24	2006	8.25	4.43	15.36
25	2007	15.98	8.78	29.10
26	2008	6.11	3.18	11.73
27	2009	9.06	4.35	18.88
28	2010	7.61	3.15	18.36
29	2011	1.30	0.38	4.46

Spawning stock biomass (ssb) and Age 3+ biomass (bms) trends relative to 1994 level

(1994 SSB is LRP for this stock; B_Recovery)

Obs	year	rssb_ Brec	rssb_ tvalue	rssb_ Brec_L	rssb_ Brec_U	rbms_ Brec	rbms_ tvalue	rbms_ Brec_L	rbms_ Brec_U
1	1983	1.42513	1.55210	0.90969	2.23262	1.41747	1.75860	0.95954	2.09394
2	1984	1.47014	1.96672	0.99998	2.16135	1.67529	2.88948	1.17912	2.38026
3	1985	1.63542	2.61559	1.12977	2.36738	2.04472	4.10701	1.45169	2.88001
4	1986	1.59656	2.52524	1.10900	2.29846	2.07625	4.21300	1.47625	2.92012
5	1987	1.54763	2.34957	1.07374	2.23066	2.10955	4.24946	1.49329	2.98013
6	1988	1.65973	2.69028	1.14597	2.40383	2.18961	4.40440	1.54303	3.10712
7	1989	1.89231	3.27335	1.28991	2.77602	2.17387	4.41920	1.53867	3.07130
8	1990	1.77643	2.86042	1.19663	2.63717	2.06383	4.29364	1.48092	2.87620
9	1991	1.46423	1.97021	1.00066	2.14256	1.69458	3.36618	1.24516	2.30622
10	1992	1.24677	1.36075	0.90644	1.71487	1.38707	2.81647	1.10374	1.74312
11	1993	1.02281	0.23193	0.84474	1.23843	1.07590	1.06508	0.93994	1.23152
12	1994	1.00000	.	0.00000	0.00000	1.00000	.	0.00000	0.00000
13	1995	1.41599	3.85391	1.18568	1.69104	1.19366	2.87952	1.05771	1.34707
14	1996	1.45963	2.52162	1.08677	1.96043	1.19566	1.53100	0.95040	1.50420
15	1997	1.18185	0.77060	0.77155	1.81033	0.99863	-0.00765	0.70258	1.41944
16	1998	1.30199	1.36018	0.88897	1.90692	1.11768	0.67810	0.80942	1.54335
17	1999	1.48862	2.15957	1.03615	2.13867	1.29608	1.60990	0.94413	1.77923
18	2000	1.58298	2.56201	1.11261	2.25221	1.46905	2.39814	1.07163	2.01386
19	2001	1.64178	2.82419	1.16243	2.31881	1.70847	3.31568	1.24345	2.34740
20	2002	1.89005	3.58667	1.33311	2.67967	1.74324	3.30133	1.25189	2.42743
21	2003	2.25141	4.45393	1.57331	3.22177	1.78954	3.40033	1.27806	2.50570
22	2004	2.28968	4.52510	1.59735	3.28208	1.72678	3.18082	1.23182	2.42063
23	2005	1.92145	3.56255	1.33981	2.75559	1.49531	2.34809	1.06751	2.09453
24	2006	1.50642	2.22582	1.04884	2.16363	1.25218	1.31086	0.89357	1.75472
25	2007	1.22916	1.11152	0.85319	1.77081	1.16894	0.90522	0.83272	1.64091
26	2008	0.95722	-0.23615	0.66505	1.37773	1.10690	0.58151	0.78509	1.56063
27	2009	0.88590	-0.66232	0.61821	1.26950	1.32013	1.53504	0.92486	1.88433
28	2010	1.04750	0.24381	0.72040	1.52311	1.42224	1.85912	0.97981	2.06447
29	2011	1.34141	1.38573	0.88412	2.03523	1.42896	1.78829	0.96500	2.11600