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Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2012

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The status of the cod stock in the Northwest Atlantic Fisheries Organization (NAFO) Subdiv. 3Ps was assessed during a Fisheries and Oceans Canada's (DFO) Regional Assessment Process (RAP) held during October of 2012. Stock status was updated based upon information collected up to spring 2012. Principal sources of information available for the assessments were: a time series of abundance and biomass indices from Canadian winter/spring research vessel (RV) 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 2011-12 management year (April 1-March 31) were 6,025 t or just 52% of the Total Allowable Catch (TAC), and this marks the third consecutive season that the TAC has not been fully taken. The 2012-13 fishery was still in progress at the time of the RAP with provisional landings to date totaling of 2,000 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.

The abundance and biomass indices from the 2012 DFO RV spring survey were both higher than those in 2011. In 2012, the abundance index was above average (average of 1997-2012 as survey area was expanded in 1997) whereas the biomass index was near average. The survey was dominated by young fish which are not yet of commercial size. Sentinel gillnet catch rates have been very low since 1999, and the 2011 gillnet index was the lowest in the time-series. Sentinel linetrawl catch rates from the past three years have also been below average. Gillnet catch rates from logbooks of vessels < 35' have been stable since 1999. Linetrawl catch-rates decreased over 2006-10, but increased in 2011 and are presently at the time-series average.

Over 2009-12, Spawning Stock Biomass (SSB) has increased considerably. The SSB was estimated to be below the Limit Reference Point (LRP) during 2008 and 2009. The 2012 estimate is 64% above the LRP, and the probability of being below the LRP in 2012 is very low (0.01). Three-year projections were conducted assuming future mortality rates were within ± 20% of current values (2009-11 average). Results indicated that SSB will increase if total mortality is reduced, and remain relatively stable if mortality remains at current levels. The Spawning Stock Biomass is projected to decrease if total mortality is above current values. Overall, the probability of being below the LRP in 2013 is very low (0.01 to 0.05). By the end of the projection period (2015) the probability of being below the LRP ranges from 0 to 0.16.

Évaluation de l'état du stock de morue (*Gadus morhua*) dans la sous-division 3Ps de l'OPANO en 2012

RESUME

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 du MPO en octobre 2012. L'état du stock a été mis à jour à partir des données recueillies jusqu'au printemps 2012. 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, les journaux de bord des navires de moins de 35 pi et les débarquements déclarés des pêches commerciales, des données océanographiques, ainsi que des études de marquage.

Les débarquements de l'année de gestion de 2011-2012 (du 1er avril au 31 mars) ont totalisé 6 025 t, soit juste 52 % du total autorisé des captures (TAC). Il s'agit de la troisième saison consécutive où le TAC n'est pas atteint. Au moment du processus d'évaluation régionale, la saison de pêche 2012-2013 était toujours en cours, et les données provisoires sur les débarquements totaux s'établissaient à 2 000 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 (environ 1 %) des débarquements commerciaux.

Les indices d'abondance et de biomasse du relevé du printemps 2012 du navire de recherche du MPO étaient tous les deux supérieurs à ceux de 2011. En 2012, l'indice d'abondance était supérieur à la moyenne (moyenne de 1997 à 2012, car la zone de relevé a été agrandie en 1997) et l'indice de biomasse était près de la moyenne. Lors du relevé, le nombre de jeunes poissons n'ayant pas encore atteint la taille commerciale surpassait les autres classes d'âge. Les taux de prise des pêches sentinelles au filet maillant sont très faibles depuis 1999 et l'indice du filet maillant de 2011 est le plus bas de la série chronologique. Les taux de prise des pêches sentinelles à la palangre des trois dernières années sont aussi inférieurs à la moyenne. Les taux de prise au moyen de filets maillants établis d'après les journaux de bord des navires de moins de 35 pi sont stables depuis 1999. Les taux de prise des pêches à la palangre ont diminué au cours de la période allant de 2006 à 2010, mais ils ont augmenté en 2011, et à l'heure actuelle, ils se trouvent dans la moyenne de la série chronologique.

Sur la période allant de 2009 à 2012, la biomasse du stock reproducteur a considérablement augmenté. On estimait qu'elle était sous le point de référence limite en 2008 et 2009. L'estimation pour 2012 est de 64 % au-dessus du point de référence limite, et la probabilité qu'elle soit en dessous est très faible (0,01 %). On a fait des projections sur trois ans en supposant que les futurs taux de mortalité varieraient d'environ 20 % par rapport aux valeurs actuelles (moyenne de 2009 à 2011). Les résultats ont révélé que la biomasse du stock reproducteur augmenterait si la mortalité totale diminuait et qu'elle demeurerait stable si la mortalité se maintenait aux niveaux actuels. La biomasse du stock reproducteur devrait diminuer si la mortalité totale dépasse les valeurs actuelles. En général, la probabilité que la biomasse du stock reproducteur se situe sous le point de référence limite en 2013 est très faible (de 0,01 à 0,05). D'ici la fin de la période de projection (en 2015), la probabilité qu'elle se situe sous le point de référence limite varie entre 0 et 0,16.

INTRODUCTION

This document gives an account of the 2012 assessment of the Atlantic cod (Gadus morhua) stock in NAFO Subdiv. 3Ps located off the south coast of Newfoundland (Figs. 1 and 2). The history of the cod fishery in NAFO Subdiv. 3Ps and results from other recent assessments of this stock are described in previous documents (e.g. see Brattey et al. 2008; Healey et al. 2013 and references therein). A regional assessment meeting was conducted during October 2012 (DFO 2013). Participants included DFO scientists, a scientist from the French Research Institute for Exploration of the SEA (IFREMER), academia, DFO fisheries managers, government officials from the province of Newfoundland and Labrador, and fishing industry representatives.

Various sources of information on 3Ps cod were available to update the status of this stock. Commercial landings through September 2012 were available, though the 2012 catch at age was not computed. The results of the DFO RV survey during April 2012 was reviewed in detail and compared to previous survey results. Additional sources of information included science logbooks for vessels < 35 ft (1997-2011), inshore sentinel surveys from 1995 to 2012 and exploitation rates estimated from recaptures of tagged cod (received as of October 2012) from tagging conducted in 3Ps during 1997-2011 (Brattey and Healey 2006). A survey-based assessment model (Cadigan 2010) was used to smooth signals in the RV survey, and provided estimates of biomass, total mortality and recruitment for the stock as covered by the DFO RV survey. Short-term projections of these estimates under total mortality levels similar to current levels were also evaluated to advise on the management of this stock.

The French overseas territory of St. Pierre et Miquelon is within the boundaries of NAFO subarea 3Ps. Following extension of jurisdiction by each country to 200 miles in the late 1970s, only Canada and France have fished in this area. This stock (as well as several others) is jointly managed by Canada and France through formal agreements.

ASSESSMENT

TOTAL ALLOWABLE CATCHES AND COMMERCIAL CATCH

Total Allowable Catch

A history of the TAC for this stock over 1959-2012 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. Beginning in 2000, TACs have been established for seasons beginning April 1 and ending March 31 of the following year. (During January-March 2000, an interim TAC was set to facilitate this change.) The TAC for the past four seasons has been unchanged 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 3Ps for the period 1959 to September 30 2012 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 (see “Inshore” in Table 1) were estimated mainly from purchase slip records collected and interpreted by Statistics Division, DFO. Shelton et al. (1996) emphasized that these data may be unreliable. Post moratorium landings for Canadian vessels < 35 ft 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, provisional information for landings by France have been provided directly by French government officials. Recent entries in Table 1 are designated as provisional until final catch statistics from both Canada and France are available.

Cod in the 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 1980's. 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 2011 calendar year, total reported landings were 6,876 t with the Canadian inshore fixed gear sector accounting for 4,046 t (59%) of the total (Table 1). Total landings for the 2011-12 management year (April 1–March 31) were 6,025 t, or 52% of the 11,500 t TAC. This marks the third consecutive season in which the landings have been less than the TAC, and the portion of unutilized TAC has been increasing. Industry participants have indicated multiples reasons contributing to this change, including: reduced profitability, some reductions in availability of fish in the offshore, the closure of a processing facility in St. Pierre, and a reduction in the availability of cod inshore which may be in part due to changes in distribution and abundance of prey species (e.g. capelin). Prior to the 2009-10 season, the TAC had been fully utilized if not exceeded in each year since Canadian jurisdiction was extended in 1977. Furthermore, excluding the moratorium years, current landings are the lowest of the available time series. Preliminary landings data for 2012 to September 30 totaled 2,003 t. Although the 2012-13 fishing season is incomplete, these totals to date are again relatively low in part due to further reductions in fishing effort (DFO 2013) 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, Figs. 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. Over 2009-11, however, some of these patterns differed as effort and landings were reduced.

Line trawl (=longline) catches dominated the fixed gear landings over the period 1977-93, 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 was not sustained in either 2010 or in 2011.

A summary of reported landings for 2011 and for 2012 (to mid-September) by month and unit area is provided in Table 3. In general, the spatial-temporal pattern is similar in to those of recent years.

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-March and from 3Psf over September-November, which combined account for 65% of the offshore catch. Only 5% 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. Inshore landings are limited early in the year, mostly arising from by-catch of cod in other offshore fisheries. The vast majority of landings from the inshore areas (3Psa, b, c) are taken in June-November, with highest landings in June and July, particularly in 3Psc. The inshore (3Psa, 3Psb, and 3Psc) has consistently accounted for most of the reported landings. These have typically been highest in Placentia Bay (3Psc), ranging from 1,500 t to almost 11,650 t with 26-51% of the annual 3Ps catch coming from this unit area alone. In 2011 the landings from 3Psc were 1503 t and the proportion of the 3Ps total this represents was the lowest over the post-moratorium period. This was in part due to poorer catch rates and reductions in effort. The fraction of landings from 3Psa and b increased in 2011, with considerable increases in landings in January and February. Most of the offshore landings have come from 3Psh and 3Psf (Halibut Channel and the southeastern portion of St. Pierre Bank). Unit area 3Psg normally has the lowest landings of any unit area (~4% of the annual total each year since 1997), but in 2010 and 2011 catches in this area, though still low, exceeded those of areas 3Ps d and e combined. This breakdown of landings by unit area excludes landings by France from 2009 to present. Resource managers from France have reported that the majority of these landings are taken in either 3Psf or h, but the exact unit area is unavailable.

The 2012-13 (April 1 to March 31) conservation harvesting plan places various seasonal and gear restrictions on how the 3Ps cod fishery in Canadian waters could be pursued. For example, unit areas 3Ps a,d,g were closed from November 15-May 16 of the following year to avoid potential capture of migrating cod from the Northern Gulf stock (NAFO Divisions 3Pn4RS) and all of 3Ps was closed from March 1 to May 16, a closure intended to protect spawning aggregations. Full details of these and other measures, which may differ among fleet sectors, are available from the DFO Fisheries and Aquaculture Management (FAM) branch in St. John's.

CATCH AT AGE

Estimates of the 2011 catch numbers-at-age were not available during the assessment meeting. At the Northwest Atlantic Fisheries Centre, there are now fewer personnel available for aging cod. Consequently, a decision was made to focus the available expertise on otoliths from the research vessel survey and also from sentinel surveys. Age estimates from French catches in 2011 were also unavailable due to temporary staffing shortages at the French aging facility. At this point it remains unclear if all Canadian commercial samples in subsequent years can be read.

The time series of catch numbers at age (ages 3-14 shown) for the 3Ps cod fishery from 1959 to 2010 is given in Table 4. 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 1959-76 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.

WEIGHT AT AGE

As the commercial ages for 2011 are unavailable, weight-at-age could not be updated. However, since commercial mean weights-at-age are used to generate approximate weights at the start of the year for use in estimating stock size (see COHORT ANALYSIS section), the mean weights at age in the 3Ps fishery (including landings from the commercial and food fisheries and the sentinel surveys) are given in Table 5a and Fig. 6. Beginning of the year weights at age are derived using the Rivard geometric average method and are shown in both Table 5b and Fig. 6. 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 5a, Fig. 7). 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 3Ps since 1995 and there are now seventeen complete years of catch and effort data. Sentinel activity for 2012 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 2011, there were 13 active sites in 3Ps, using predominantly gillnets (5½" mesh) in unit area 3Psc (Placentia Bay) and line trawls in 3Psb and 3Psa (Fortune Bay and west). One 3¼" gillnet was also fished at each of 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 2011 remained low and were similar to those recorded for 1999-2010. Line trawl catch rates have been below the series average for the past 3 years.

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

STANDARDIZED SENTINEL CATCH RATES

The catch from 3Ps was divided into cells defined by gear type (5½" mesh gillnet and line trawl), area (unit areas 3Psa, 3Psb, and 3Psc), year (1995-2011) 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 1050 otoliths during 1995-2002). Sample sizes for linetrawl are more variable, averaging 1100 otoliths from 1996-2002, but were considerably lower in 2003-04 and from 2007 onward. In 2011 only 745 otoliths were available for aging. 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. Only data from fixed sites collected between June-November were included. For gillnets, only sets with a soak time between 12 and 32 hours were included, and for line trawl, soak times 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.

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. 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, as sentinel catches are usually not weighed (unavailability of scales). This complicates direct comparisons of the trends from Sentinel surveys to commercial catch rates.

Trends in standardized total (ages 3-10 combined) annual catch rates, expressed in terms of numbers of fish, are shown in Fig. 8a. Gillnet catch rates declined rapidly from 1997 to 1999 then remained stable but low from 1999 through to 2011, though the 2011 results are the lowest of the time-series. For line trawls, catch rates show a decline from 1995, but have been relatively stable with no clear trend from 1997 to 2011.

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 1995-2011 are given in Table 6 and Fig. 8b. For gillnets, several year classes were well-represented in catches during 1995-97 but these are replaced by mostly weaker year classes. It has been noted that the 1997 and 1998 year-classes contributed significantly to both the fishery and RV index for several years. However, these year classes did not yield improvements in the magnitude of sentinel gillnet catch rates over 2002-06, when these year-classes would have been within the peak selection range of 5½" gillnets, and were a major contributor to inshore fisheries.

For line trawls, catch rates-at-age in the beginning of the time-series were higher due to the strong 1989 and 1990 year classes. In 2000-02, 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 year class, and in particular, the 1998 year class were consistently measured by sentinel linetrawl. 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 2007-09) are higher (Table 6). In 2006, linetrawl catch rates for all ages (3-10) increased, suggesting a year effect in the data rather than a change in stock size (Fig. 8).

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. 8b). Conversely, the 1998 year-class was consistently tracked by linetrawl sampling.

As described in previous 3Ps cod assessments, interpretation of the sentinel catch rate indices is difficult. Sentinel fisheries were free from competitive influences during 1995-96 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 yea--class, though the overall index has not shown increase. The linetrawl index indicates a strong contribution from the 2004 year-class but the 2006 year-class is estimated as one of the weakest over the time-series. This differs from the RV index, in which the 2006 year-class is well above average for ages 3 and 4, but near average for ages 5 and 6.

SCIENCE LOGBOOKS (< 35 FT SECTOR)

A science logbook was introduced to record catch and effort data for vessels < 35 ft in the re-opened fishery in 1997. Return of this logbook at season's end is mandatory (pers. comm., L. Slaney, Resource Management Branch, DFO). 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 165,000 records in the database. As with the analysis of results from the Sentinel program, we consider data to 2011 only, and exclude the current (in-progress) year. The number of annual logbook 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 3Psc), 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 2011 only 13% of the < 35 ft gillnet catch and 19% of the < 35 ft linetrawl catch is included in the CPUE standardization. These values are lower than usual as data entry for logbooks from 2011 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. 9a). 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. 9a. 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 net are typically around 15 kg with a long tail on the distribution extending to about 75-100 kg per net. The distribution of catches for line trawls was similarly skewed, with median catches of about 180kg/1000 hooks; but extending out to 500-600kg/1000 hooks.

The catch from 3Ps was divided into cells defined by gear type (gillnet and line trawl), location (numbered 29-37, as described above) and year (1997-2011).

Initially, unstandardized 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. Gillnet catch rates in 2011 for Fortune Bay and east are amongst the lowest in the time-series (Fig. 9b). 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 2011 were quite variable compared to recent years in those areas. Around the Burin peninsula, catch rates were above average, but further westward were at or below average.

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 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 1998-2000 and have subsequently been low but stable at approximately 20kg/net (Fig. 9c). For linetrawls, temporal patters differ from those in of gillnets, with much inter-annual variation since 2000. After peaking in 2006, linetrawl catch rates generally declined to 2010, and in 2011 show some increase and are 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 remarkable consistency in gillnet catch rates since 1998 despite the changes in resource abundance and management regulations has not yet been explained. 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. Subsequent year-classes generally not been as strong, and catches would be more comprised of younger (and hence lighter) fish.

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. (2011), 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 2012. The purpose of the tagging study is to provide information on movement patterns of 3Ps cod as well as obtain ongoing estimates of exploitation rates on different components of the stock. However, for several reasons, tagging efforts in 3Ps have been much reduced over the past decade with releases in only Placentia Bay over 2008-11. Furthermore, there have been no tagging experiments in the offshore regions of 3Ps since 2005. The number of tags released annually over 2008-12 has been variable, with sample sizes ranging from 395 to 2510. Due to these limitations, 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. Over 2008-10, approximately 300 tags were returned annually. Fewer numbers of tags were returned in 2011 and 2012 (133 & 119, respectively), resulting from both reductions in landings and the restricted spatial extent of releases. The percentage of returns coming from participants in the recreational fishery over this time has ranged from 4-13%. 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). Inter-annual variations are relatively small with no trends over time; the estimated reporting rate for cod having a single tag attached is approximately 0.78.

ESTIMATES OF EXPLOITATION (HARVEST) RATE

The methods and estimates of the average annual exploitation rates (harvest rates, in percent) for cod tagged in different regions of 3Ps are described in detail elsewhere (Brattey and Cadigan 2004; Brattey and Healey 2003, 2004, 2005, 2006; Cadigan and Brattey 2003, 2006, 2008). 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 2004-06, these rates were only partial estimates. Additionally, 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.

Estimated mean exploitation rates for cod tagged in Placentia Bay have all been less than 15% over 2008-2011. This level of exploitation could be considered "reasonable". 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). In the previous assessment, a comparison of exploitation rates across various size groups indicated that despite an overall low exploitation rate, larger cod (> 65 cm) were subject to higher exploitation rates. This trend did not persist in 2011, with low exploitation rates common across all size groups.

With respect to migratory patterns and stock distribution, the tagging results of 2007-11 generally agree with previous findings (Brattey and Healey 2004, 2005, 2006), and indicate restricted mixing of cod from different portions of the 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. Previous tagging results suggested lower exploitation in the offshore than most inshore areas, yet the DFO RV declined for several years over 2001-08. 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 1978-92. The two surveys were similar with regard to the stratification scheme used, sampling methods and analysis, but differed in the type of fishing gear and the daily timing of trawls (daylight hours only for French surveys). Canadian surveys were conducted using the research vessels A.T. Cameron (1972-82), Alfred Needler (1983-84; 2009-present), and Wilfred Templeman (1985-2008). 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 (1978-91) 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 1983-95 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 3Ps is shown in Fig. 10. Canadian surveys have covered strata in depth ranging down to 300 fathoms (1 fathom = 1.83 meters) depth 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 18% 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 are constructed from the catch data from Canadian surveys. To avoid confusion, throughout this document as well as the Science Advisory Report from the 2012 assessment meeting (DFO 2012), 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-present.

The results (in Campelen or Campelen equivalent units) for the entire survey area are summarized by stratum for both abundance (Table 7) and biomass (Table 8), for the period 1983-2012. The timing of the surveys, number of sets fished, and vessels used are provided in the table header. Figure 11 illustrates both the number of days taken to complete the survey of subdivision 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. Therefore, results for 2006 for the full survey area are not considered comparable to the remainder of the time-series. The 2012 survey was fully completed within the planned timeframe. 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 (3Pn4RS) stock in the western portion of 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. 12. In 2012, stratum 319 (in Halibut Channel) accounted for 52% of the total biomass index, which is relatively high but yet not unusual. The remainder of the index was spread across the stock area, with all other strata containing no more than 7% of the total. Likewise, 36% of the total abundance index was observed within stratum 319, and as with biomass, was otherwise well spread over the survey area.

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. 12). Survey indices of cod in 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 when compared to those from adjacent years. The 1995 estimate is influenced by a single large catch contributing 87% of the total 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) are influenced by year-effects. In 2009, survey indices increased for several cohorts, which is impossible (at fully recruited sizes).

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 2012 estimate (74.7 million) is above the 1997-2012 average. The increase from 2011 to 2012 results in part due to small fish and is discussed in detail below. 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. Since 2009, the biomass index has been near the 1997-2012 average. Detailed trends in trawlable abundance and biomass are at times 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 1983-90, lowest during 1991-97, and intermediate to low values during the most recent period 1998-2012. 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 18% increase in surveyed area; the only exception is in 2005 when the combined inshore/offshore survey shows higher biomass and abundance due mainly to a large estimate from inshore stratum 294 (see Tables 7 and 8).

To further 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. 13). 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. In 2012, only 6% of the abundance index came from the Burgeo area, which is unusually low. Part of this variation in the spatial composition of the index is due to 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 (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 3Pn4RS stock.

The spatial distribution of catches of cod during the 2012 survey was examined, for all ages combined (Fig. 14a, also includes 2009 to 2011 survey results for comparison) and separately for ages 1-12 (Fig. 14b to 14d). Previously it has been demonstrated (Healey et al. 2011, Brattey et al. 2007) that during 1999-2011 cod were caught over a considerable portion of

NAFO Subdiv. 3Ps with the largest catches typically in the southern Halibut Channel area, on Burgeo Bank and vicinity, and within 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. The graphic for 2012 illustrates the fact that the proportion of the abundance index was low for the Burgeo area, as catches were much smaller compared to 2009-11. Furthermore, catches across St. Pierre Bank in 2012 were larger than those of the previous three years.

Distribution plots of age-disaggregated survey catches from the 2012 survey (Figs. 14 b-d) indicate that relatively high catches of 1 year old cod were measured across much of the survey area, which is atypical. Further, we note that due to their small size, one-year old cod are not fully selected by the trawl. Cod aged 2 years old were most commonly sampled along the eastern edge of the stock boundary. Cod ages 3 years old were found over most of the surveyed area, with relatively large catches of these age groups taken in Fortune Bay and in and around the Halibut Channel. Distribution of cod aged 4-10 is similar to that of younger ages, though the magnitude of catches decreases considerably with age. Cod aged older than 10 years are encountered less frequently. Catches of these older cod are mainly in the vicinity of the outer Halibut Channel.

Age Composition

Survey numbers at age are obtained by applying an ALK 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 2 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 Fig. 9a. 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 3Ps, the survey area is 16,732 square nautical miles including only strata out to 300 ftms (and excluding the relatively recent inshore strata added in 1997). The swept area for a standard 15 min tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of Campelen trawlable units in the 3Ps survey is 16,732÷0.00727=2.3×106. For the expanded survey area, there are approximately 2.7x106 trawlable units.

The mean numbers per tow at age in the DFO RV survey for the “offshore” index is given in Table 9a and results for ages 1-15 are shown in the form of standardized “bubble” plots in Fig. 15. 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 fact, over 1995-2000, no cod ages 15 or older were sampled during surveys. Although catches of older cod remain quite low, the age composition has expanded to include some cod that are 16-18 years of age. In recent years, much attention has been focused on the 2006 year-class. Over 2007-10, survey results for this year-class were much greater than average (at ages 1 through 4). However, survey values at age 5 from the 2011 survey and at age 6 (2012 survey) are near average. In 2012, survey results for ages 1-5 are all above average. In particular, the age 1 survey index is relatively high-much greater than the time-series average. Though age 1 survey results are not always indicative of year-class strength at older (e.g. recruiting) ages, it is positive that the number of age 1 cod sampled was relatively high and were also well dispersed across the survey area. Examination of the spatial distribution from previous surveys revealed that having relatively large numbers of one year-olds widespread across 3Ps is quite unusual. In most years, one year-olds would be found mainly in nearshore strata. 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 20 years sampled. 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 2012 survey data (Table 10, Fig. 16a). For ages older than age 3 there was a general decline in length-at-age from the early 1980s to the mid-1990s (Fig. 16a). For most ages there was an increase in length-at-age from the mid-1990s through the mid-2000s, followed by a period of lower length-at-age in recent years. For ages 3-5 there has been some increase since 2007 or 2008.

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 2012 was calculated for each age. Deviation was calculated for each age in each year by subtracting the mean for the age for the time series from the annual observation for that age and then dividing this by the mean for that age. 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 inter-annual variation in the deviation from mean length-at-age ($F=3.5$, $df=28,202$, $p<0.0001$, $r2=0.36$) 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 generally been lower than average in the last 5 years (Fig. 16b). Multiple comparisons based on least squares means were used to determine which years were significantly different. Mean length at age was near average in 2012 but significantly lower than in 1983-1985. 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 amongst the lowest in the time series but growth from 2011 to 2012 was about average (Fig. 16c).

Values for mean weight at age were updated with data from the 2012 survey (Table 11, Fig. 17a). There was a general decline in weight-at-age from the early 1980s to the mid-1990s (Fig. 17a). There was an increase in weight-at-age from the mid-1990s through the mid-2000s, but data from 2007-11 surveys suggest that mean weight-at-age was lower than the mid-2000s. Weight-at-age increased for ages 3-6 in 2012 compared to 2011 but declined for ages 7 and 8.

There was significant inter-annual variation in the proportion deviation from mean weight-at-age ($F=3.85$, $df=28,202$, $p<0.0001$, $r2=0.38$) Mean weight-at-age was greater than average in the mid-1980s and generally declined until the mid-1990s (Fig. 17b). The lowest mean weights-at-age were observed in 1994-95 and these were significantly different from 1983-86. As with mean length-at-age, mean weights-at-age increased after that time to about 2000. In recent years, 2007-09 and 2011-12 had lower mean weight-at-age than 1983-84, the highest in the time series period. Weight-at-age in 2012 was significantly higher than the lowest years in the time series (1994-96).

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 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. Inter-annual 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 2008-10 (Fig. 18). Relative K in 2012 was below average and significantly lower than 1996-98 and 2004-07. Estimates of relative K in 2008-10 are significantly lower than estimates from the late 1990s and mid 2000s. Estimates of relative liver condition in 2012 are lower than all but those from 1993-95, 2008 and 2010. Estimates from 2011 were higher than those from 2008 and 2010 but still lower than 9 of the 10 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 1990’s.

In conclusion, length-at-age has been generally lower in the last 5 years, although there has been some increase in length for ages 3-5. Mean length at age was near average in 2012 but significantly lower than in 1983-1985. The amount of annual growth in length (growth increment) from 2010 to 2011 was amongst the lowest in the time series but growth from 2011 to 2012 was about average. In recent years, 2007-09 and 201-12 had lower mean weight-at-age than 1983-84, the highest in the time series period. Weight-at-age in 2012 was significantly higher than the lowest years in the time series (1994-96). Body condition in 2012 was below average and significantly lower than in 1996-98 and 2004-07 while liver condition was lower than all but those from 1993-95, 2008 and 2010.

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 3Ps cod can be found in Brattey et al (2008).

Annual estimates of age at 50% maturity (A50) for females from the 3Ps cod stock, collected during annual winter/spring DFO RV surveys, were calculated as described by Morgan and Hoenig (1997). Trends in age at 50% maturity are shown in Fig. 19a (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 12, and the model did not adequately fit data for subsequent cohorts as most of these fish remain immature. Despite higher estimates of A50 for the 2003-05 cohorts to about 5.5 years, the estimated A50 has declined again, to less than five years of age for both the 2006 and 2007 cohorts (Table 12, Fig. 19a). 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 conducted 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 13; these were obtained from the cohort model parameter estimates in Table 12. 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. 19b). Due to the low age at 50% maturity, the proportions mature at age are quite high. For example, the proportion mature at ages 5 and 6 are both more than 75% greater above the 1983-2012 average.

The time series of maturities for 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 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 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 3Ps cod should be discontinued, primarily due to inconsistent trends in the index data available (poor correlations within and between surveys) and 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, the accuracy of the total landings captured by the commercial catch data has been questioned during assessment meetings (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 1997-2007 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 led 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 it provides estimates of total mortality, relative recruitment strength, and relative estimates of total and spawning biomass from the DFO RV survey (see Cadigan 2010).

Data for ages 1-12 from the DFO RV expanded index were used in the SURBA, including an adjustment for the 1983-96 survey indices to account for the inshore area that was not sampled in these years. However, data for ages 1 and 2 over 1983-95 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.) The age-specific adjustment for the 1983-96 data is the ratio of the average survey index for the expanded area (1997-present) to the average offshore survey index over 1983-96 (see Fig. 20). As younger fish are generally found in greater abundance in the near-shore, this ratio exceeds one at ages 1-3. For fish older than age 3, the adjustment is less than 1 and generally declines with age.

The age-disaggregated cohort model assumes that total mortality experienced by the population can be separated into vectors of age effects sa and year effects fy (such that Za,y=sa x fy). 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 selectivity and fixed values are applied. Survey selectivity is assumed to be constant for ages 4+, that is, selectivity is “flat-topped”. The age effects estimated in deriving a recruitment index from the age 1-4 survey data during a previous assessment of this stock (Healey et al. 2013) were used to provide some objectivity in the survey catchabilities supplied to the model for the ages which are not fully-recruited. An alternate assumption assuming "domed" selectivity was explored in a previous assessment (Healey et al. 2011). It has been argued that best-practice is to assume flat-topped selectivity (Northeast Fisheries Science Center 2008) unless there is evidence otherwise.

Detailed model specification, sensitivities of results to modeling assumptions, and estimation procedures applied in developing this model are documented in Cadigan (2010). PROC NLMIXED in SAS/STAT™ software is used to estimate parameter values and associated uncertainty.

An updated run of the previous assessment model formulation was presented. Estimated age-specific patterns in mortality indicate an increasing trend in relative total mortality to age 8, after which relative mortality decreases (Fig. 21). Estimates of survey SSB relative to Blim from the updated run are consistent with those from the previous assessment, and indicate that survey SSB declined considerably over 2003-09 (Fig. 22a). SSB was estimated to be below the LRP in both 2008 and 2009. However, over 2009-12, SSB increased considerably, and in 2012 is estimated to be 64% above the LRP (Fig. 22a; also see Appendix 1). Much of the current SSB is relatively young with 77% total SSB aged 5, 6 or 7. This is a result of both improved recruitment and the high proportion mature at age.

Estimates of total mortality from the cohort model (Fig. 22b) over 2007-11 (ages 5-10) averaged 0.67 (49% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing. Current estimates of mortality over ages 5-10 vary from 0.33 (28% mortality) at age 5 to 0.85 (58% mortality) at ages 8 and 9. When the age-specific mortality estimates are weighted by the population number at age, total mortality has been decreasing in recent years, with an average value of 0.50 (40% annual mortality). The population-weighted mortality has been decreasing since 2006 as the fraction of older fish in the population has been reduced. Current levels of mortality are relatively high considering that only half of the 2011/12 TAC was taken.

Estimates of recruitment (at age 1; Fig. 22c) from the cohort model indicate that the 2006 cohort is relatively strong, comparable to the 1989 cohort. Several successive cohorts (2004-09) are estimated to be much improved compared to the preceding five estimates. The exceptionally high estimate of the 2011 year-class is based upon only the 2012 age 1 survey data; the degree to which this year-class will recruit to the fishery remains to be confirmed. In general, the relative strength of the most recent year-classes is subject to potential revision as additional data are collected on them in the near future.

Model diagnostics are similar to results obtained during the previous assessment. There is evidence of the year-effects as described in the survey results section, particularly those during the mid-1990s. 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% of average). Recruitment was assumed to be the geometric mean of the age 1 estimates over 2008-10, 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. Results indicated that SSB will increase if total mortality is reduced by either 10% or 20%, and remain relatively stable if mortality remains at current levels. The SSB is projected to decrease if total mortality is above current values (under scenarios of either 10% or 20% increase). The probability of being below the LRP in 2013 is very low, and ranges from

0.01 to 0.05 for each of the projections conducted. The probability that the 2015 SSB will be below the LRP ranges from 0 to 0.16.

CONCLUSIONS AND ADVICE

The assessment concluded from tagging data and ancillary information that the complex of stock components exploited by fisheries in 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 LRP BRecovery 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 2004-09 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 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 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 1982-2010 average.

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

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’ suggest stability. However, linetrawl catch rates from these sources indicate recent decline.

Overall, the findings of the current assessment are consistent with those of previous assessments. The 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 IQs, 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 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 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 NAFO 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 NL shelf. The areal extent of bottom water with temperatures > 3°C has remained relatively constant at about 50% of the total 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 3Ps at various times of the year. Tagging and telemetry experiments show that there is mixing with adjacent stocks (southern 3L and 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 DFO 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 DFO 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 MSY reference points. This reduction in recruitment productivity may be consistent with harvester perspective on the declining abundance of capelin in 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 DFO RV index. A similar phenomenon exists for the 2004 cohort (detected by sentinel linetrawl but not sentinel gillnet or DFO RV index).

The geographical coverage of tagging since 2007 is very limited; during 2008-10 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’ 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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TABLES

Table 1. Reported landings of cod (t) from NAFO Subdivision 3Ps, 1959 – September 30th, 2012 by country and for fixed and mobile gear sectors.

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

-	Can. (Newfoundland)		Can. (Mainland)	France			Spain	Portugal	Others	Total	TAC[3]
-	Offshore	Inshore	-	St. Pierre & Miquelon		Metro	-	-	-	-	-
Year	(Mobile)	(Fixed)	(All gears)	Inshore	Offshore	(All gears)	(All gears)	(All gears)	(All gears)	-	-
2000	3,436	16,247[2]	740	870	3,807	-	-	-	-	25,100	20,000
2001	2,152	11,187[2]	856	675	1,675	-	-	-	-	16,546	15,000
2002	1,326	11,292[2]	499	579	1,623	-	-	-	-	15,319	15,000
2003	1,869	10,600[2]	412	734	1,645	-	-	-	-	15,260	15,000
2004	1,595	9,450[2]	790	465	2,113	-	-	-	-	14,414	15,000
2005	1,863	9,537[2]	818	617	1,941	-	-	-	-	14,776	15,000
2006	1,011	9,590[2]	675	555	1,326	-	-	-	-	13,157	13,000
2007	1,339	9,303[4]	294	520	1,503	-	-	-	-	12,959	13,000
2008	982	8,654[4]	377	467	1,293	-	-	-	-	11,773	13,000
2009	1,733	5,870[4]	193	282	1,684	-	-	-	-	9,762	11,500
2010	1,419	5,244[4]	196	76	1,364	-	-	-	-	8,299	11,500
2011[1]	1,392	4,046[4]	300	456	682	-	-	-	-	6,876	11,500
2012[1]	0	1,911[4]	65	27	0	-	-	-	-	2,003	11,500

[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 Subdivision 3Ps by gear type (includes non-Canadian and recreational catch).

Year	Gillnet	Longline	Handline	Trap	Total
1975	4,995	4,083	1,364	3,902	14,344
1976	5,983	5,439	2,346	7,224	20,992
1977	3,612	9,940	3,008	7,205	23,765
1978	2,374	11,893	3,130	2,245	19,642
1979	3,955	14,462	3,123	2,030	23,570
1980	5,493	19,331	2,545	2,077	29,446
1981	4,998	20,540	1,142	948	27,628
1982	6,283	13,574	1,597	1,929	23,383
1983	6,144	12,722	2,540	3,643	25,049
1984	7,275	9,580	2,943	3,271	23,069
1985	7,086	10,596	1,832	5,674	25,188
1986	8,668	11,014	1,634	4,073	25,389
1987	9,304	11,807	1,628	4,931	27,670
1988	6,433	10,175	1,469	2,449	20,526
1989	5,997	10,758	1,657	5,996	24,408
1990	6,948	8,792	2,217	3,788	21,745
1991	6,791	10,304	1,832	4,068	22,995
1992	5,314	10,315	1,330	3,397	20,356
1993	3,975	3,783	1,204	3,557	12,519
1994	90	0	381	0	471
1995	383	182	0	5	570
1996	467	158	137	10	772
1997	3,760	1,158	1,172	1,167	7,258
1998	10,116	2,914	308	92	13,430
1999	17,976	3,714	503	45	22,237
2000	14,218	3,100	186	56	17,561
2001	7,377	2,833	2,089	57	12,357
2002	7,827	2,309	775	119	11,030
2003	8,313	2,044	546	35	10,937
2004	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]	2,910	882	221	19	4,032
2012[1,2,3]	2,585	34	348	1	2,968

[1]provisional

[2]excluding recreational catches

[3] As of September 30, 2012

Table 3. Reported monthly landings (t) of cod from unit areas in NAFO Subdivision 3Ps during 2011 and 2012 (provisional; to September 15th, 2012).

2011 Month	Inshore					Offshore			
	3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	Totals
Jan	21.3	126.8	46.2	0.4	16.5	4.6	0.0	609.9	825.7
Feb	7.1	86.3	58.5	1.6	0.3	6.8	33.3	345.9	539.9
Mar	0.6	1.4	6.2	22.1	0.0	0.0	31.1	119.4	180.9
Apr	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.3
May	19.1	55.7	68.9	0.0	0.0	0.2	0.0	1.6	145.5
Jun	82.2	180.8	516.1	0.0	0.0	0.1	0.2	0.0	779.4
Jul	99.4	166.5	292.0	18.4	0.9	12.4	1.2	1.2	592.0
Aug	18.3	63.8	62.1	41.3	8.4	27.8	27.1	1.9	250.8
Sep	63.3	57.3	114.1	0.1	29.0	311.2	198.4	8.8	782.2
Oct	108.9	53.9	135.1	6.5	24.7	215.5	15.1	3.9	563.5
Nov	74.4	45.3	135.3	4.0	44.4	224.2	19.3	117.4	664.3
Dec	23.0	68.6	68.1	0.0	0.0	9.1	0.0	252.7	421.5
Totals	517.5	906.4	1,502.6	94.5	124.1	811.7	325.9	1,463.1	5,745.9

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

2012 Month	Inshore					Offshore			
	3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	Totals
Jan	9.0	100.3	26.5	0.0	5.0	3.4	0.0	148.6	292.9
Feb	1.8	39.2	105.3	0.0	0.0	2.0	2.5	218.1	368.9
Mar	0.2	0.0	0.0	2.3	0.0	0.0	0.1	120.9	123.5
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
May	12.9	22.0	73.0	0.0	0.4	0.0	0.0	0.0	108.3
Jun	54.5	161.4	586.8	0.0	0.0	0.0	0.0	0.0	802.7
Jul	35.6	133.9	386.1	0.0	0.1	0.4	0.0	0.0	556.2
Aug	16.6	38.0	51.9	0.0	0.0	0.0	0.0	0.4	107.0
Sep	22.6	118.2	196.0	0.0	0.0	0.5	0.0	0.5	337.8
Oct	-	-	-	-	-	-	-	-	0.0
Nov	-	-	-	-	-	-	-	-	0.0
Dec	-	-	-	-	-	-	-	-	0.0
Totals	153.2	613.1	1,425.6	2.3	5.6	6.3	2.6	488.9	2,697.7

* Excludes 2 t of catch by France through September - Unit Area unavailable.

Table 4. Catch numbers-at-age (000s) for the commercial cod fishery in NAFO Subdivision. 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

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
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 5a. 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 Subdivision 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	0.488	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

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
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	0.556	0.938	1.444	1.962	2.235	2.533	3.732	4.957	5.512	4.861	7.079	8.806
2008	0.628	0.888	1.296	1.907	2.205	2.434	2.588	3.467	4.817	4.978	4.550	7.774
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 5b. 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

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
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	0.455	0.802	1.209	1.640	1.997	2.599	3.159	3.309	3.189	4.633	6.369	6.436
2007	0.469	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	1.757	2.090	2.477	2.613	2.768	4.482	6.753	8.189	8.912
2011	0.468	0.774	1.150	1.665	2.099	2.381	2.565	3.127	4.609	5.907	6.235	7.498

Table 6. 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	4.13	8.96	5.44	2.54	0.39	0.16	21.73
1996	0.02	0.28	2.74	12.58	10.26	2.93	0.87	0.07	29.74
1997	0.01	0.24	5.37	5.35	9.53	7.71	1.14	0.62	29.97
1998	0.00	0.06	1.13	7.82	3.52	2.76	1.70	0.32	17.31
1999	0.05	0.07	0.53	0.91	1.45	0.65	0.29	0.29	4.23
2000	0.01	0.02	0.31	0.73	0.72	0.99	0.33	0.11	3.21
2001	0.03	0.16	0.42	0.88	0.68	0.38	0.37	0.18	3.10
2002	0.00	0.04	0.49	0.81	0.77	0.33	0.15	0.17	2.76
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	0.27	1.07	0.90	0.44	0.22	0.09	3.08
2009	0.02	0.03	0.26	0.65	1.14	0.23	0.18	0.05	2.55
2010	0.01	0.06	0.37	0.80	0.67	0.33	0.12	0.19	2.54
2011	0.01	0.01	0.11	0.35	0.64	0.26	0.20	0.03	1.61

Linetrawl

Year/Age	3	4	5	6	7	8	9	10	Total
1995	7.7	14.6	50.9	73.4	19.4	18.1	4.3	1.5	189.7
1996	8.0	28.9	27.9	44.9	46.4	13.4	7.4	1.8	178.5
1997	5.6	22.6	24.2	15.8	16.7	22.8	2.8	1.7	112.2
1998	7.1	16.3	21.4	16.0	6.2	9.6	11.4	2.4	90.3
1999	5.8	17.1	23.6	13.6	7.7	4.8	4.6	2.0	79.3
2000	12.4	27.5	25.6	17.1	8.1	6.4	2.4	1.0	100.5
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	34.3	39.1	20.1	8.3	3.5	1.3	0.9	110.1
2004	9.1	9.8	36.1	19.0	10.2	3.3	1.6	0.4	89.5
2005	7.1	19.9	13.0	13.1	11.4	4.4	2.0	0.8	71.6
2006	8.7	17.0	26.4	20.0	13.3	12.0	3.6	1.6	102.7
2007	10.8	19.1	16.7	14.0	8.4	5.1	4.5	1.8	80.4
2008	5.2	25.7	22.7	18.7	9.1	5.8	2.8	2.6	92.7
2009	5.2	13.5	27.5	15.7	6.4	3.7	1.7	1.3	75.0
2010	2.3	14.3	11.9	15.1	7.4	2.1	0.9	0.7	54.7
2011	7.8	10.8	17.7	17.7	11.3	4.1	1.8	0.7	71.9

Table 7. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Division 3Ps during 1997-2012. See Fig. 13 for location of strata. For 1983-1997 results see Brattey et al. (2007).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Vessel	WT	WT	WT	Tel; WT	WT	WT	Tel; WT	AnN; WT	WT	WT	WT	AN	AN	AN	AN
Trips	219-220	236-237	313-315	351; 364-365	418-419	476-477	522; 523+546	656; 617-618	688	757-759	824-827	902-904	930-932	401-403	415-417
Sets	176	175	171	173	177	176	177	178	24	178	169	175	177	174	177
Mean Date	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	14-Apr

Depth range (fathoms)	Strata	sq. mi.	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
<30	314	974	57	1729	1531	153	67	19	117	256	-	1570	2144	573	287	328	1223
<30	320	1320	1292	3546	5183	1543	478	1601	396	523	-	333	363	3222	1260	1603	4213
31-50	293[5]	159	292	601	394	219	131	120	375	2850	200	317	252	208	55	284	503
31-50	308	112	4175	2704	1829	1094	285	77	2265	16719	-	1410	2373	486	16893	3058	1167
31-50	312	272	100	461	1235	636	112	150	56	1141	-	370	270	0	112	337	1310
31-50	315	827	5721	2428	1895	1040	228	49	395	1161	-	1268	675	1634	767	1405	3705
31-50	321	1189	49	894	1161	55	98	82	16	229	-	65	189	218	1823	2608	393
31-50	325	944	16	752	2824	1526	65	16	1120	383	-	893	812	1542	7970	8019	519
31-50	326	166	11	52	109	57	0	0	0	0	-	285	11	0	11	627	11
31-50	783[1]	229	16	110	86	142	13	95	16	252	**nf**	126	126	157	515	228	126
51-100	294[5]	135	901	362	170	195	613	455	288	20685	1092	1281	108	4960	713	59	2658
51-100	297[5]	152	209	1892	7000	450	450	42	244	1317	20732	1047	273	1056	4242	2781	3922
51-100	307	395	23490	5879	6991	5665	833	22912	9328	3172	-	2735	4849	18237	7758	4945	3412
51-100	311	317	1652	2169	2864	610	780	349	2733	788	-	1715	2519	3632	9627	1979	3212
51-100	317	193	173	305	1487	637	1049	372	199	1367	-	2522	2881	912	3215	330	7022
51-100	319	984	15600	11839	9327	58696	34398	2149	26117	6064	-	15245	14670	24418	20120	10120	35549
51-100	322	1567	260	713	1529	413	633	263	649	2463	-	2507	1297	1049	820	2546	3162
51-100	323	696	32	158	1001	941	64	19	0	101	-	32	3300	105	15274	8179	3067
51-100	324	494	160	361	442	85	306	391	85	432	-	481	153	359	417	3590	646
51-100	781[1]	446	276	1058	716	1564	261	215	1052	568	491	445	552	548	293	506	813
51-100	782[1]	183	38	38	315	76	227	50	63	221	**nf**	101	227	201	22	566	327
101-150	295[5]	209	465	976	615	978	144	187	72	976	1781	1469	633	396	2441	nf	971
101-150	298[5]	171	1861	46	3450	670	371	5399	976	282	21	7475	3384	73	585	0	6764
101-150	300[5]	217	1579	641	896	791	746	1370	168	657	327	478	90	507	194	917	43
101-150	306	363	771	708	4191	949	246	277	666	1015	-	2175	818	4054	714	1382	706
101-150	309	296	11980	215	142	2056	13172	484	109	582	-	1122	244	49	236	529	308
101-150	310	170	105	131	187	505	485	1391	12	249	-	94	269	30	143	129	35
101-150	313	165	454	91	113	3564	125	567	10	66	-	124	23	111	259	21	11
101-150	316	189	104	23	13	26	117	273	69	117	-	117	13	116	10	12	17
101-150	318	129	53	0	231	44	71	11943	275	683	-	336	16	189	18	9	9
101-150	779[1]	422	39	0	73	26	29	15	19	142	77	671	310	186	0	503	5955
101-150	780[1]	403	18	0	40	0	0	0	0	18	**nf**	400	0	37	0	388	526
151-200	296[5]	71	4	375	107	1924	735	303	2627	35	54	881	273	999	32	3581	2269
151-200	299[5]	212	49	0	13	131	160	214	44	29	44	44	13	13	42	58	39
151-200	705	195	376	24	54	83	241	232	267	64	-	0	76	155	36	29	0
151-200	706	476	327	87	49	49	82	246	120	310	-	31	65	87	258	131	98
151-200	707	74	102	9	0	293	3079	143	121	1263	-	122	257	737	23	16	15
151-200	715	128	5874	484	751	3013	1615	960	102	305	-	132	170	599	63	53	18
151-200	716	539	3089	2428	196	99	1333	952	74	142	-	1368	51	1546	180	130	676
201-300	708	126	1464	947	0	35	151	329	85	1419	-	641	0	4299	26	30	28
201-300	711	593	16	0	783	80	49	96	29	1530	-	505	29	125	44	29	3850
201-300	712	731	201	50	98	117	67	345	60	15	-	106	54	60	15	34	65
201-300	713	851	61	78	176	364	320	372	127	80	-	45	17	99	56	0	134
201-300	714	1074	485	173	151	3781	1346	1678	230	77	-	373	44	819	55	70	79

Depth range (fathoms)	Strata	sq. mi.	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
301-400	709[2]	147	0	0	10	30	0	611	0	0	-	0	13	0	0	0	0
401-500	710[1]	156	nf	0	nf	nf	nf	nf	nf	nf	-	nf	nf	nf	nf	nf	nf
501-600	776[1]	159	nf	nf	nf	nf	nf	nf	nf	nf	-	nf	nf	nf	nf	nf	nf
601-700	777[1]	183	nf	nf	nf	nf	nf	nf	nf	nf	-	nf	nf	nf	nf	nf	nf
701-800	778[1]	166	nf	nf	nf	nf	nf	nf	nf	nf	-	nf	nf	nf	nf	nf	nf

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total[3]	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	74,660
Total[4]	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	99,575
upper	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	102,076
t-value	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	2.23
std[6]	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	12,294

[1]These strata were added to the stratification scheme in 1994 (see Fig. 11 for stratum boundaries).

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

[3]For index strata 0-300 fathoms in the offshore and includes estimates 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

NF – not fished.

Table 8. Cod biomass estimates (t) from DFO research vessel bottom-trawl surveys in NAFO Subdivision 3Ps during 1998-2012. See Fig. 13 for location of strata. For 1983-1997 results see Brattey et al. (2007).

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Vessel	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	AN	AN	AN	AN
Trips	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	415-417
Sets	176	175	171	173	177	176	177	178	24	178	169	175	177	174	177
Mean Date	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	14-Apr

Depth range (fathoms)	Strata	sq. mi.	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
<30	314	974	8	595	829	46	5	0	10	185	nf	53	204	68	43	100	200
<30	320	1320	7766	6287	6761	601	932	2707	395	1890	nf	1274	442	1069	603	500	1695
31-50	293[5]	159	19	27	45	26	9	29	18	1810	34	16	18	7	15	19	46
31-50	308	112	1461	1572	1088	184	48	12	1949	8011	nf	253	789	170	8343	1558	426
31-50	312	272	8	226	640	93	10	9	18	345	nf	60	434	0	37	78	206
31-50	315	827	20072	3771	3092	491	822	17	335	13514	nf	6456	99	1777	235	1295	1585
31-50	321	1189	0	1855	4582	2	5	2	2	40	nf	186	17	54	2054	1639	150
31-50	325	944	0	418	1307	340	10	3	568	84	nf	172	555	447	4194	2831	269
31-50	326	166	0	8	478	25	0	0	0	0	nf	55	1	0	19	140	4
31-50	783[1]	229	0	14	16	6	0	2	1	303	nf	12	18	13	31	25	7
51-100	294[5]	135	40	19	7	26	47	22	14	21147	716	85	27	149	55	7	315
51-100	297[5]	152	22	1697	2339	108	38	5	42	1482	20678	382	122	156	1224	2110	1863
51-100	307	395	16164	3784	5162	1578	197	26828	6055	2423	nf	1471	3059	8114	4100	3258	1563
51-100	311	317	169	3342	1661	26	145	13	182	570	nf	83	219	395	2414	394	348
51-100	317	193	196	36	259	331	88	59	78	218	nf	1118	231	158	2436	31	2849
51-100	319	984	28144	18019	8121	51570	38958	755	67844	5845	nf	14166	8888	33064	20494	10024	28365
51-100	322	1567	13	117	1893	193	32	26	38	1532	nf	79	205	104	439	1395	206
51-100	323	696	112	227	643	305	7	1	0	28	nf	1	2525	4	10070	4602	655
51-100	324	494	8	252	25	7	14	13	8	148	nf	51	39	53	39	653	86
51-100	781[1]	446	16	64	49	36	13	17	61	203	62	23	49	28	33	44	55
51-100	782[1]	183	7	1	7	0	27	1	3	34	nf	5	13	20	1	328	30
101-150	295[5]	209	139	45	61	124	8	26	4	727	253	128	83	20	519	nf	477
101-150	298[5]	171	2608	148	2632	202	75	2735	488	250	30	8445	2881	56	250	0	3903
101-150	300[5]	217	802	650	307	153	124	175	103	391	192	149	25	286	111	480	94
101-150	306	363	618	553	5123	543	67	51	960	812	nf	2142	645	2021	630	932	649
101-150	309	296	9788	320	303	1118	15666	193	56	464	nf	1328	673	10	282	333	210
101-150	310	170	72	145	330	488	209	263	4	410	nf	11	427	7	82	105	17
101-150	313	165	481	162	97	18231	122	807	4	101	nf	352	79	61	213	14	21
101-150	316	189	138	43	21	63	78	146	103	95	nf	120	5	156	7	7	29
101-150	318	129	88	0	592	28	43	12705	506	1672	nf	445	25	189	32	38	15
101-150	779[1]	422	10	0	4	1	1	2	1	47	5	41	38	18	0	168	1246
101-150	780[1]	403	1	0	6	0	0	0	0	2	nf	86	0	2	0	71	21
151-200	296[5]	71	1	102	20	341	118	36	900	54	20	146	76	239	5	2702	1863
151-200	299[5]	212	231	0	1	411	655	315	35	15	30	327	1	2	26	63	29
151-200	705	195	345	25	20	71	244	434	288	96	nf	0	111	122	47	36	0
151-200	706	476	266	68	63	26	40	431	147	301	nf	56	76	51	153	180	126
151-200	707	74	121	21	0	360	3726	187	329	3347	nf	109	243	469	20	24	71
151-200	715	128	6849	1127	1240	5599	2525	1188	114	451	nf	167	296	1793	101	74	16
151-200	716	539	1772	4106	229	92	554	735	75	123	nf	1933	59	961	124	111	1102
201-300	708	126	4389	1455	0	54	139	354	76	1272	nf	940	0	3688	16	30	32
201-300	711	593	11	0	1242	75	35	41	22	1864	nf	1024	52	100	33	25	3546
201-300	712	731	267	25	64	65	25	264	39	6	nf	94	81	52	10	22	55
201-300	713	851	48	143	123	273	235	261	172	63	nf	27	5	59	101	0	124
201-300	714	1074	725	155	123	4113	1212	2306	183	149	nf	514	51	808	55	59	87
301-400	709[2]	147	0	0	5	59	0	383	0	0	nf	0	24	0	0	0	0
401-500	710[1]	156	nf	0	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
501-600	776[1]	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	777[1]	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	778[1]	166	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total[3]	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	44,706
Total[4]	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	54,656
upper	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	70,874
t-value	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	2.26
std[6]	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	11,579

[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 done in 710 prior to 1994 have been recoded to 709.

[3]For index strata 0-300 fathoms in the offshore and includes estimates 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

NF – not fished.

Table 9a. Mean numbers per tow at age (1-15 only) in Campelen units for the Canadian research vessel bottom trawl survey of NAFO Subdivision 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
2012	5.32	2.94	8.88	5.82	3.22	3.38	1.75	0.96	0.17	0.26	0.02	0.04	0	0.01	0.02	32.79

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

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
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
2012	5.5	3.99	11.21	6.37	3.34	3.39	1.76	0.94	0.16	0.25	0.01	0.04	0	0.01	0.02	36.99

Table 9b. 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 Subdivision 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
2012	6.27	3.49	11.60	6.45	3.17	3.96	1.10	0.54	0.09	0.10	0.01	0.01	0.00	0.01	0.03	36.83

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

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
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
2012	0.44	0.44	4.91	2.84	1.96	1.96	2.31	0.79	0.12	0.05	0.00	0.00	0.00	0.00	0.00	15.82

Table 10. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdivision 3Ps in winter-spring 1983-2012.

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*	-

*based on fewer than 5 aged fish

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	11.1
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	18.6
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	34.2
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	41.7
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	48.1
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	55.8
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	53.9
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	61
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	72.2
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*	73.8*
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*	-	105*
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*	107*

*based on fewer than 5 aged fish

Table 11. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1983-2012. 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*	-

*based on fewer than 5 aged fish

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	0.01
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	0.05
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	0.33
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	0.60
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	0.89
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	1.45
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	1.35
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	2.20
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	3.82
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*	4.02
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*	-	9.23*
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*	12.61*

*based on fewer than 5 aged fish

Table 12. 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 Subdivision 3Ps based on surveys conducted during 1959-2012.

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

Cohort	slope	slope_SE	intercept	intercept_se
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	1.6768	0.2439	-8.8521	1.2950
2003	1.5865	0.2286	-9.0336	1.2869
2004	1.494	0.1664	-8.3335	0.9211
2005	1.8417	0.2339	-9.9492	1.2618
2006	1.8298	0.1971	-8.9735	0.9914
2007	1.6384	0.2943	-7.7704	1.3637

Table 13. Estimated proportions mature for female cod from NAFO Subdivision 3Ps from DFO surveys from 1978 to 2012, projected forward to 2015. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age (from "combined" survey area).

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	0.0004[1]	0.0015[1]	0.0050[1]	0.0175[1]	0.0607[1]	0.1938[1]	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1955	0.0009	0.0015[1]	0.0050[1]	0.0175[1]	0.0607[1]	0.1938[1]	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1956	0.0002	0.0026	0.0050[1]	0.0175[1]	0.0607[1]	0.1938[1]	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1957	0.0003	0.0007	0.0078	0.0175[1]	0.0607	0.1938[1]	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1958	0.0001	0.0011	0.0032	0.0234	0.0607[1]	0.1938[1]	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1959	0.0000	0.0006	0.0040	0.0142	0.0677	0.1938[1]	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1960	0.0000	0.0000	0.0026	0.0149	0.0610	0.1804	0.4701[1]	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1961	0.0001	0.0002	0.0001	0.0112	0.0535	0.2265	0.4003	0.7573[1]	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1962	0.0001	0.0007	0.0012	0.0010	0.0464	0.1744	0.5691	0.6693	0.9135[1]	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1963	0.0002	0.0004	0.0035	0.0102	0.0111	0.1733	0.4409	0.8562	0.8599	0.9723[1]	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1964	0.0001[2]	0.0008	0.0028	0.0185	0.0785	0.1096	0.4745	0.7465	0.9641	0.9490	0.9914[1]	0.9973[1]	0.9992[1]	0.9997[1]
1965	0.0000	0.0005[2]	0.0046	0.0177	0.0914	0.4129	0.5741	0.7955	0.9166	0.9918	0.9826	0.9973[1]	0.9992[1]	0.9997[1]
1966	0.0000	0.0001	0.0028[2]	0.0252	0.1041	0.3491	0.8531	0.9365	0.9437	0.9762	0.9982	0.9942	0.9992[1]	0.9997[1]
1967	0.0002	0.0000	0.0010	0.0159[2]	0.1255	0.4283	0.7410	0.9796	0.9938	0.9863	0.9935	0.9996	0.9981	0.9997[1]
1968	0.0002	0.0009	0.0001	0.0066	0.0847[2]	0.4435	0.8285	0.9385	0.9975	0.9994	0.9968	0.9983	0.9999	0.9994
1969	0.0000	0.0012	0.0044	0.0012	0.0438	0.3415[2]	0.8157	0.9689	0.9879	0.9997	0.9999	0.9993	0.9995	1.0000
1970	0.0002	0.0001	0.0066	0.0206	0.0130	0.2396	0.7498[2]	0.9609	0.9950	0.9977	1.0000	1.0000	0.9998	0.9999
1971	0.0007	0.0009	0.0012	0.0344	0.0899	0.1292	0.6839	0.9489[2]	0.9927	0.9992	0.9996	1.0000	1.0000	1.0000
1972	0.0015	0.0030	0.0049	0.0099	0.1616	0.3174	0.6250	0.9370	0.9915[2]	0.9987	0.9999	0.9999	1.0000	1.0000
1973	0.0006	0.0054	0.0137	0.0257	0.0784	0.5103	0.6864	0.9493	0.9903	0.9986[2]	0.9998	1.0000	1.0000	1.0000
1974	0.0004	0.0023	0.0198	0.0601	0.1241	0.4196	0.8493	0.9115	0.9953	0.9986	0.9998[2]	1.0000	1.0000	1.0000
1975	0.0000	0.0016	0.0093	0.0697	0.2273	0.4324	0.8600	0.9682	0.9798	0.9996	0.9998	1.0000[2]	1.0000	1.0000
1976	0.0001	0.0001	0.0067	0.0369	0.2176	0.5752	0.8038	0.9812	0.9940	0.9956	1.0000	1.0000	1.0000[2]	1.0000
1977	0.0007	0.0005	0.0008	0.0280	0.1359	0.5081	0.8617	0.9566	0.9978	0.9989	0.9991	1.0000	1.0000	1.0000[2]
1978	0.0000	0.0028	0.0030	0.0058	0.1096	0.3922	0.7933	0.9663	0.9916	0.9997	0.9998	0.9998	1.0000	1.0000
1979	0.0001	0.0000	0.0106	0.0175	0.0418	0.3447	0.7259	0.9344	0.9925	0.9984	1.0000	1.0000	1.0000	1.0000

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
1980	0.0044	0.0008	0.0004	0.0400	0.0961	0.2444	0.6921	0.9157	0.9815	0.9984	0.9997	1.0000	1.0000	1.0000
1981	0.0003	0.0123	0.0047	0.0048	0.1391	0.3878	0.7059	0.9057	0.9781	0.9949	0.9996	0.9999	1.0000	1.0000
1982	0.0000	0.0014	0.0336	0.0275	0.0557	0.3852	0.7905	0.9468	0.9762	0.9946	0.9986	0.9999	1.0000	1.0000
1983	0.0000	0.0002	0.0059	0.0888	0.1452	0.4197	0.7084	0.9574	0.9925	0.9943	0.9987	0.9996	1.0000	1.0000
1984	0.0000	0.0001	0.0012	0.0240	0.2143	0.5049	0.8987	0.9040	0.9926	0.9990	0.9987	0.9997	0.9999	1.0000
1985	0.0000	0.0003	0.0007	0.0066	0.0929	0.4331	0.8595	0.9909	0.9734	0.9987	0.9999	0.9997	0.9999	1.0000
1986	0.0000	0.0001	0.0020	0.0051	0.0366	0.2991	0.6814	0.9735	0.9993	0.9930	0.9998	1.0000	0.9999	1.0000
1987	0.0000	0.0000	0.0012	0.0132	0.0370	0.1783	0.6400	0.8569	0.9955	0.9999	0.9982	1.0000	1.0000	1.0000
1988	0.0001	0.0001	0.0004	0.0111	0.0818	0.2225	0.5536	0.8811	0.9437	0.9992	1.0000	0.9995	1.0000	1.0000
1989	0.0000	0.0006	0.0018	0.0053	0.0946	0.3719	0.6809	0.8764	0.9686	0.9792	0.9999	1.0000	0.9999	1.0000
1990	0.0004	0.0002	0.0057	0.0233	0.0731	0.4931	0.7975	0.9409	0.9759	0.9923	0.9925	1.0000	1.0000	1.0000
1991	0.0006	0.0024	0.0033	0.0515	0.2400	0.5396	0.9006	0.9632	0.9916	0.9957	0.9981	0.9973	1.0000	1.0000
1992	0.0000	0.0036	0.0158	0.0507	0.3408	0.8069	0.9457	0.9883	0.9943	0.9989	0.9992	0.9996	0.9990	1.0000
1993	0.0000	0.0003	0.0210	0.0957	0.4612	0.8310	0.9822	0.9962	0.9987	0.9991	0.9998	0.9999	0.9999	0.9997
1994	0.0003	0.0004	0.0034	0.1136	0.4106	0.9320	0.9791	0.9986	0.9997	0.9999	0.9999	1.0000	1.0000	1.0000
1995	0.0014	0.0023	0.0055	0.0394	0.4339	0.8210	0.9955	0.9978	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
1996	0.0008	0.0071	0.0150	0.0695	0.3302	0.8209	0.9679	0.9997	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
1997	0.0005	0.0042	0.0341	0.0921	0.5017	0.8557	0.9648	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1998	0.0000	0.0028	0.0216	0.1490	0.4030	0.9314	0.9862	0.9939	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
1999	0.0005	0.0002	0.0160	0.1032	0.4649	0.8180	0.9946	0.9988	0.9990	0.9999	1.0000	1.0000	1.0000	1.0000
2000	0.0007	0.0035	0.0037	0.0847	0.3753	0.8117	0.9676	0.9996	0.9999	0.9998	1.0000	1.0000	1.0000	1.0000
2001	0.0006	0.0042	0.0250	0.0740	0.3455	0.7582	0.9553	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2002	0.0014	0.0033	0.0260	0.1591	0.6347	0.7507	0.9424	0.9907	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
2003	0.0008	0.0079	0.0192	0.1443	0.5826	0.9742	0.9450	0.9884	0.9981	0.9999	1.0000	1.0000	1.0000	1.0000
2004	0.0006	0.0041	0.0444	0.1042	0.5155	0.9115	0.9988	0.9899	0.9978	0.9996	1.0000	1.0000	1.0000	1.0000
2005	0.0011	0.0028	0.0214	0.2125	0.4082	0.8704	0.9870	0.9999	0.9982	0.9996	0.9999	1.0000	1.0000	1.0000
2006	0.0003	0.0047	0.0137	0.1048	0.6104	0.8035	0.9769	0.9982	1.0000	0.9997	0.9999	1.0000	1.0000	1.0000
2007	0.0008	0.0019	0.0208	0.0637	0.3851	0.9010	0.9604	0.9963	0.9998	1.0000	0.9999	1.0000	1.0000	1.0000

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
2008	0.0022	0.0049	0.0118	0.0865	0.2495	0.7701	0.9814	0.9931	0.9994	1.0000	1.0000	1.0000	1.0000	1.0000
2009	0.0011[1]	0.0111	0.0298	0.0703	0.2966	0.6190	0.9471	0.9967	0.9988	0.9999	1.0000	1.0000	1.0000	1.0000
2010	0.0011[1]	0.0060[1]	0.0544	0.1605	0.3229	0.6526	0.8881	0.9897	0.9994	0.9998	1.0000	1.0000	1.0000	1.0000
2011	0.0011[1]	0.0060[1]	0.0320[1]	0.2285	0.5438	0.7504	0.8933	0.9749	0.9981	0.9999	1.0000	1.0000	1.0000	1.0000
2012	0.0011[1]	0.0060[1]	0.0320[1]	0.1531[1]	0.6039	0.8814	0.9499	0.9739	0.9948	0.9996	1.0000	1.0000	1.0000	1.0000
2013	0.0011[1]	0.0060[1]	0.0320[1]	0.1531[1]	0.4902[1]	0.8870	0.9789	0.9917	0.9940	0.9989	0.9999	1.0000	1.0000	1.0000
2014	0.0011[1]	0.0060[1]	0.0320[1]	0.1531[1]	0.4902[1]	0.8396[1]	0.9758	0.9965	0.9987	0.9987	0.9998	1.0000	1.0000	1.0000
2015	0.0011[1]	0.0060[1]	0.0320[1]	0.1531[1]	0.4902[1]	0.8396[1]	0.9682	0.9952	0.9994	0.9998	0.9997	1.0000	1.0000	1.0000

[1] Averages of the three closest cohorts
[2] Average of estimates for the adjacent cohorts

FIGURES

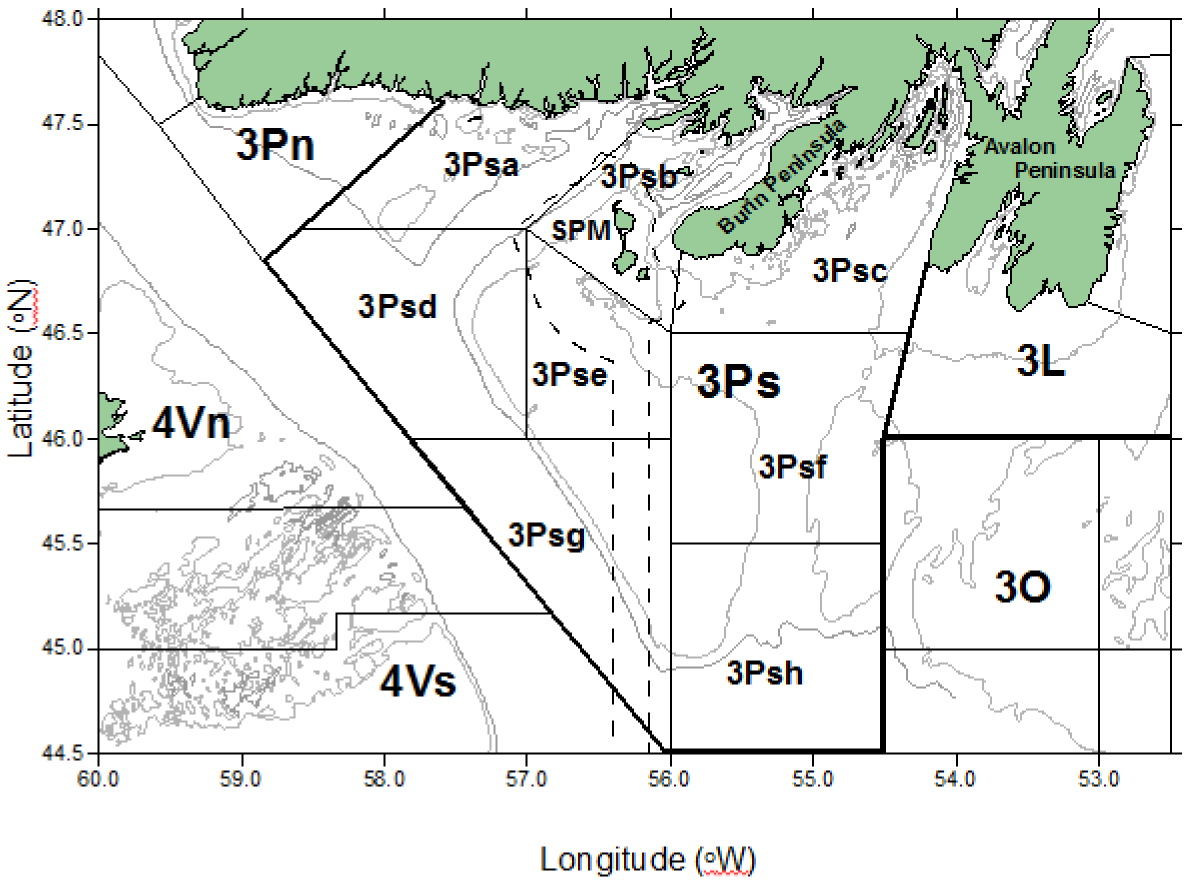


Figure 1. NAFO Subdivision 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).

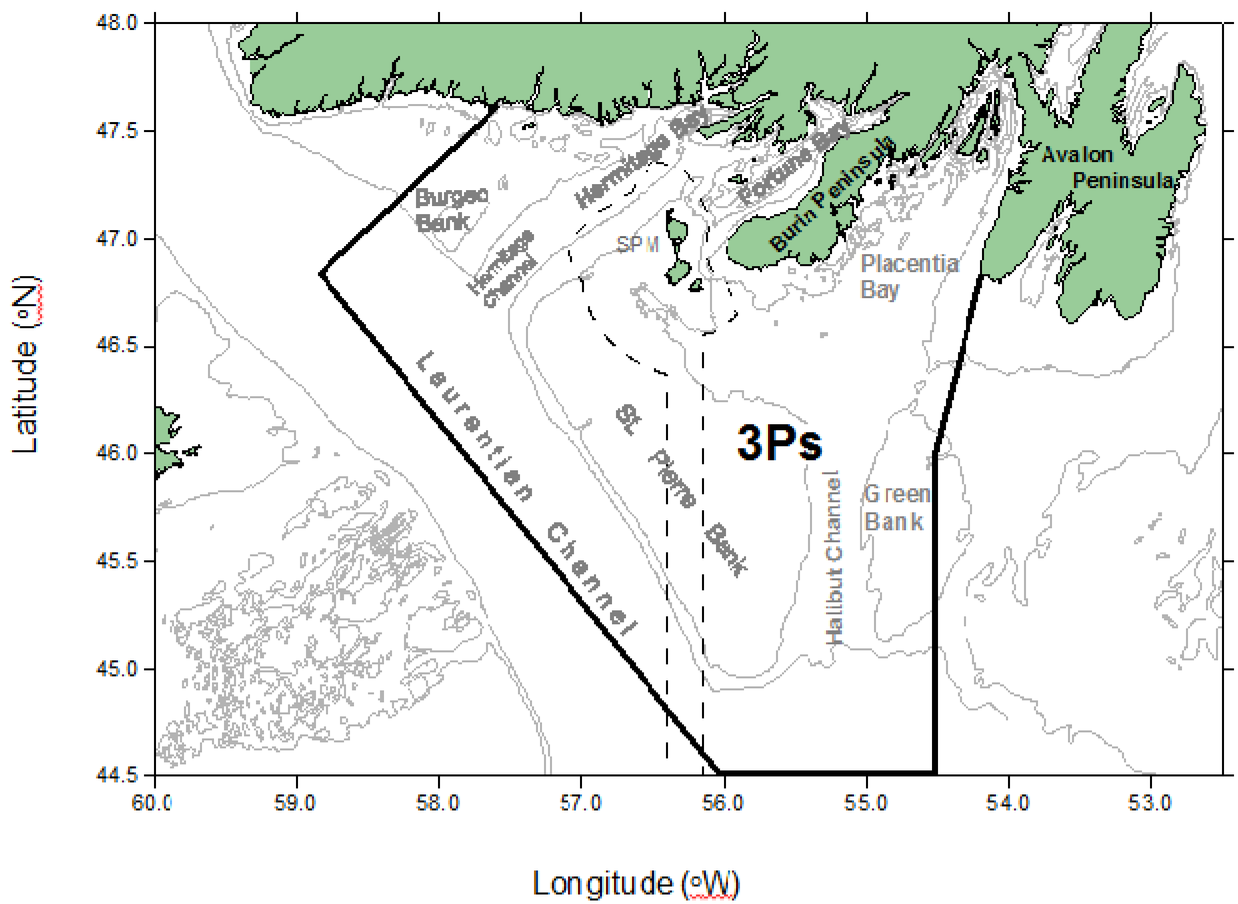


Figure 2. NAFO Subdivision 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the main fishing areas.

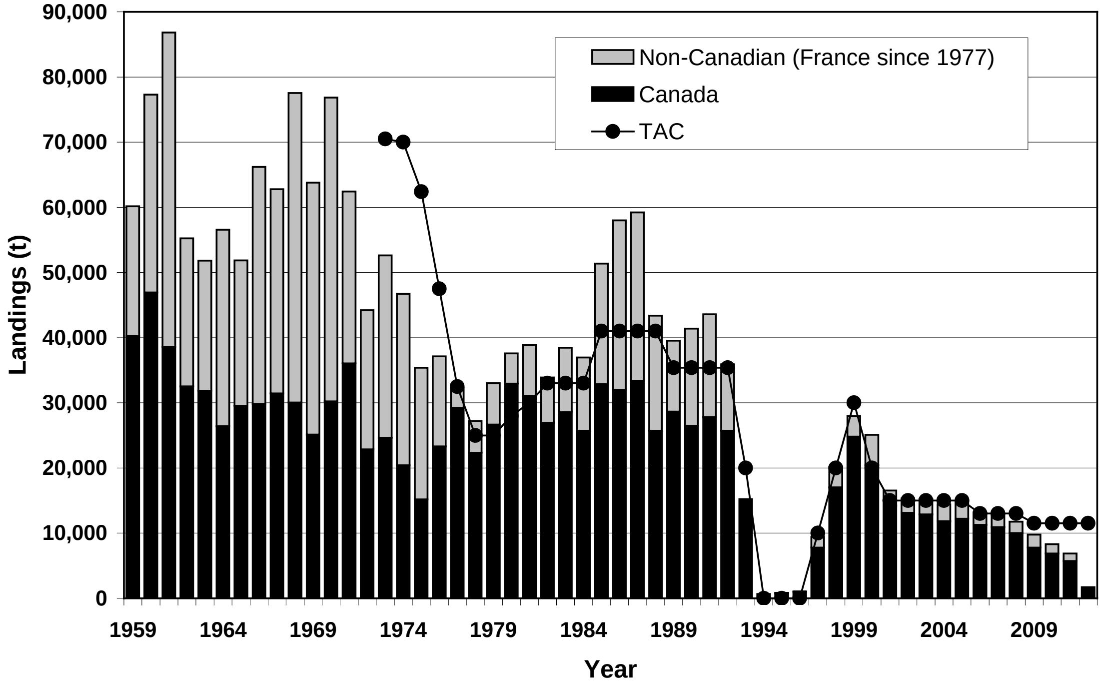


Figure 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdivision 3Ps during 1959-September 2012. The 2012 fishery was still in progress at the time of the October 2012 assessment.

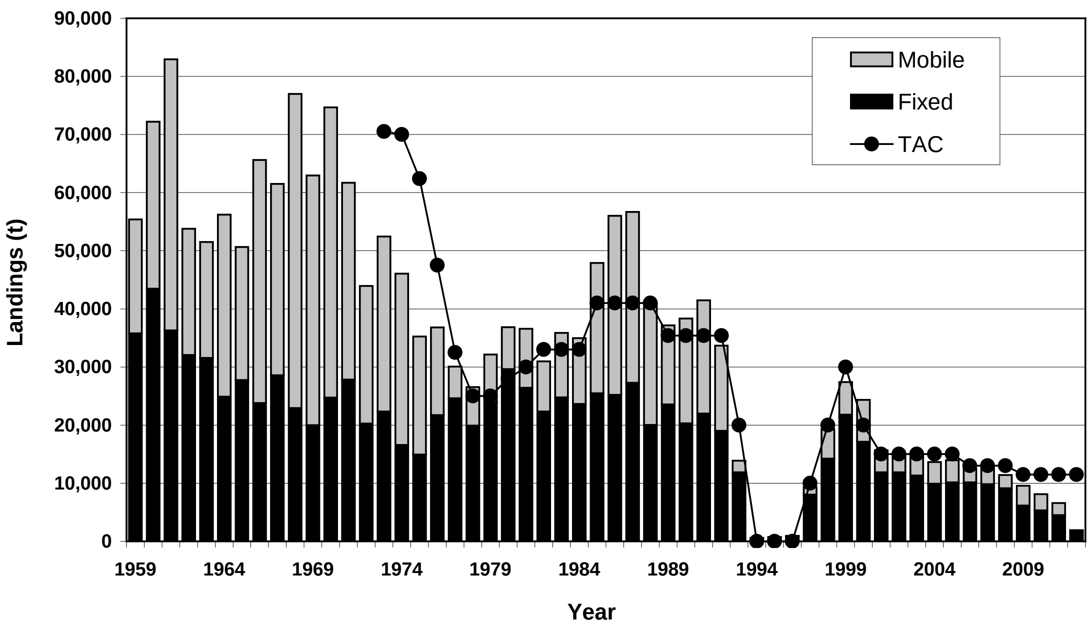


Figure 3b. Reported landings of cod by fixed and mobile gears in NAFO Subdivision 3Ps during 1959-September 2012. The 2012 fishery was still in progress at the time of the October 2012 assessment.

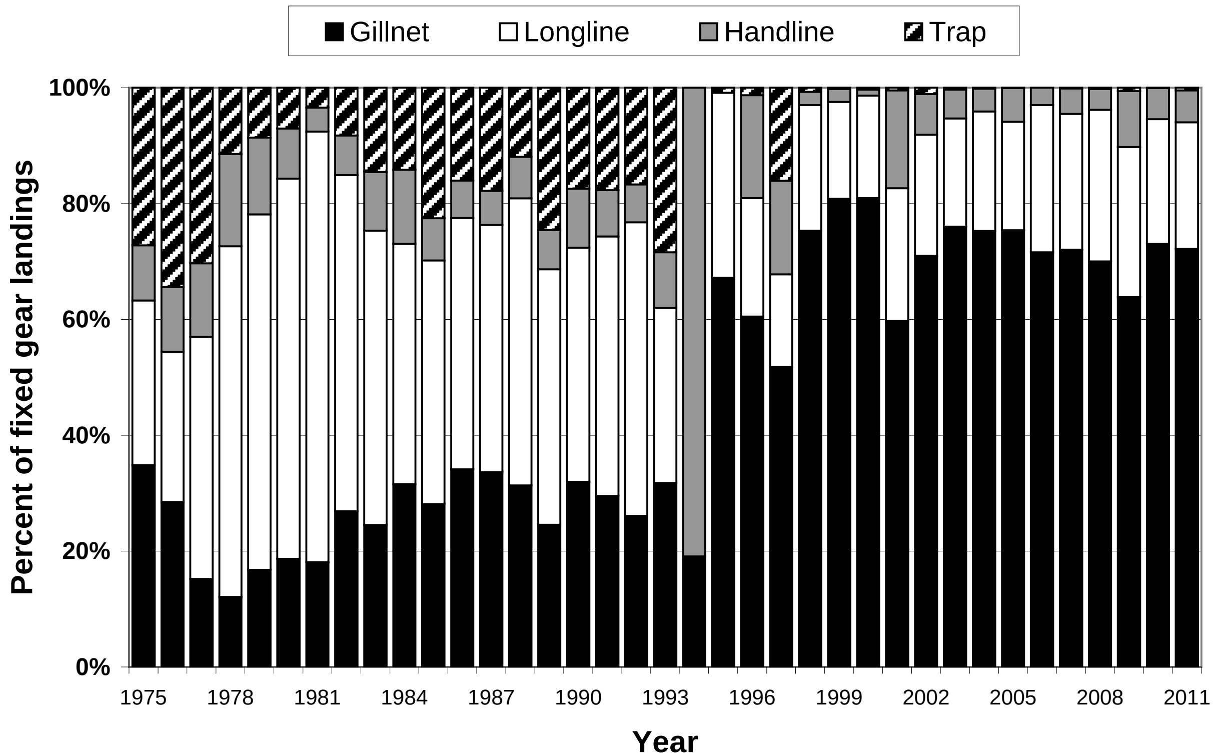


Figure 4. Percent of total fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdivision 3Ps during 1975-2011. The fishery was under a moratorium during 1994-96 and values for those years are based on sentinel and by-catch landings of <800 t.

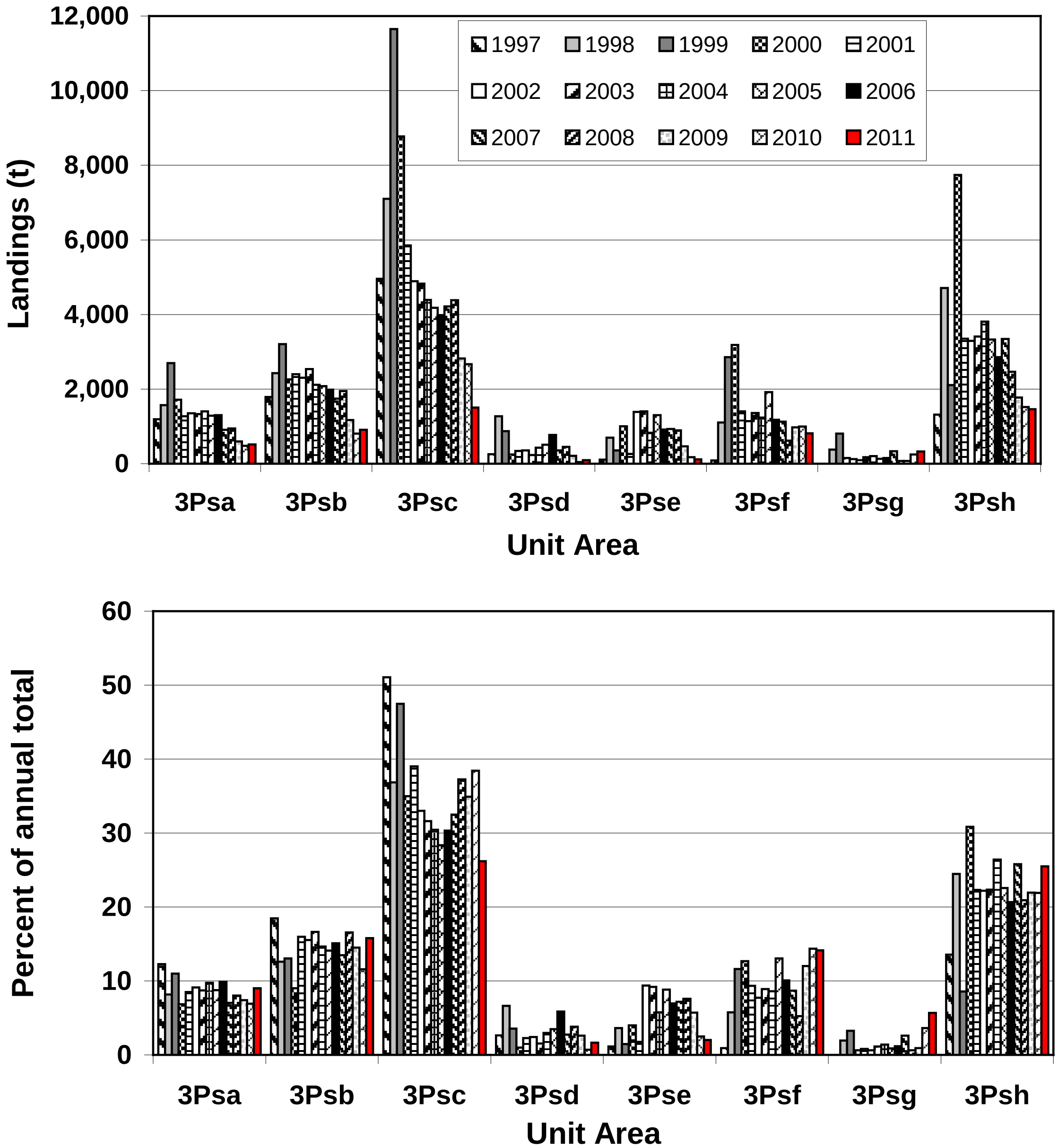


Figure 5. Annual reported landings of cod (upper panel) and percent of annual total (lower panel) by unit area from NAFO Subdivision 3Ps during 1997-2011. Refer to Figure 1 for locations of unit areas.

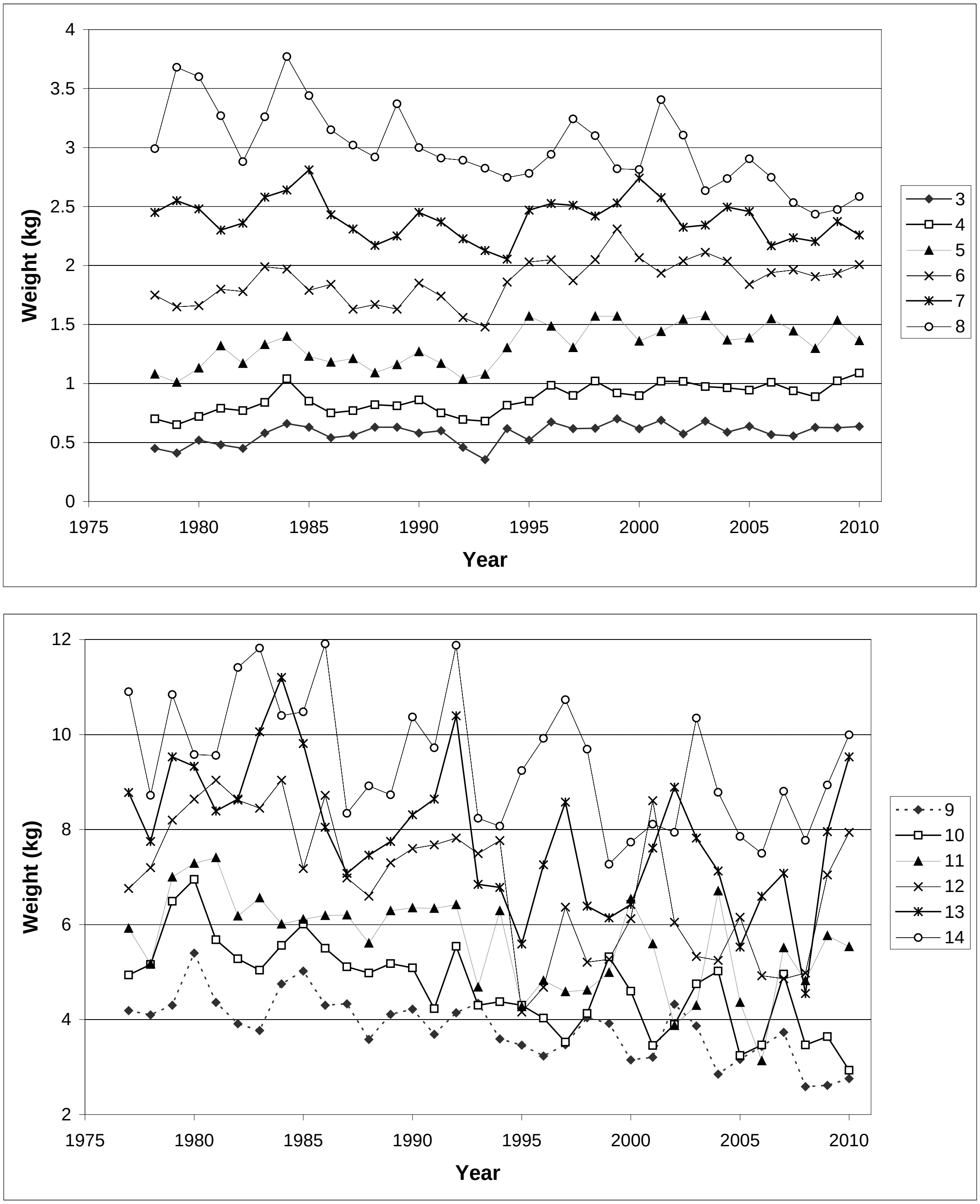


Figure 6. Mean weights-at-age calculated from mean lengths-at-age (upper panel: ages 3-8; lower panel: ages 9-14) for the commercial catch of cod in NAFO Subdivision 3Ps during 1977-2010.

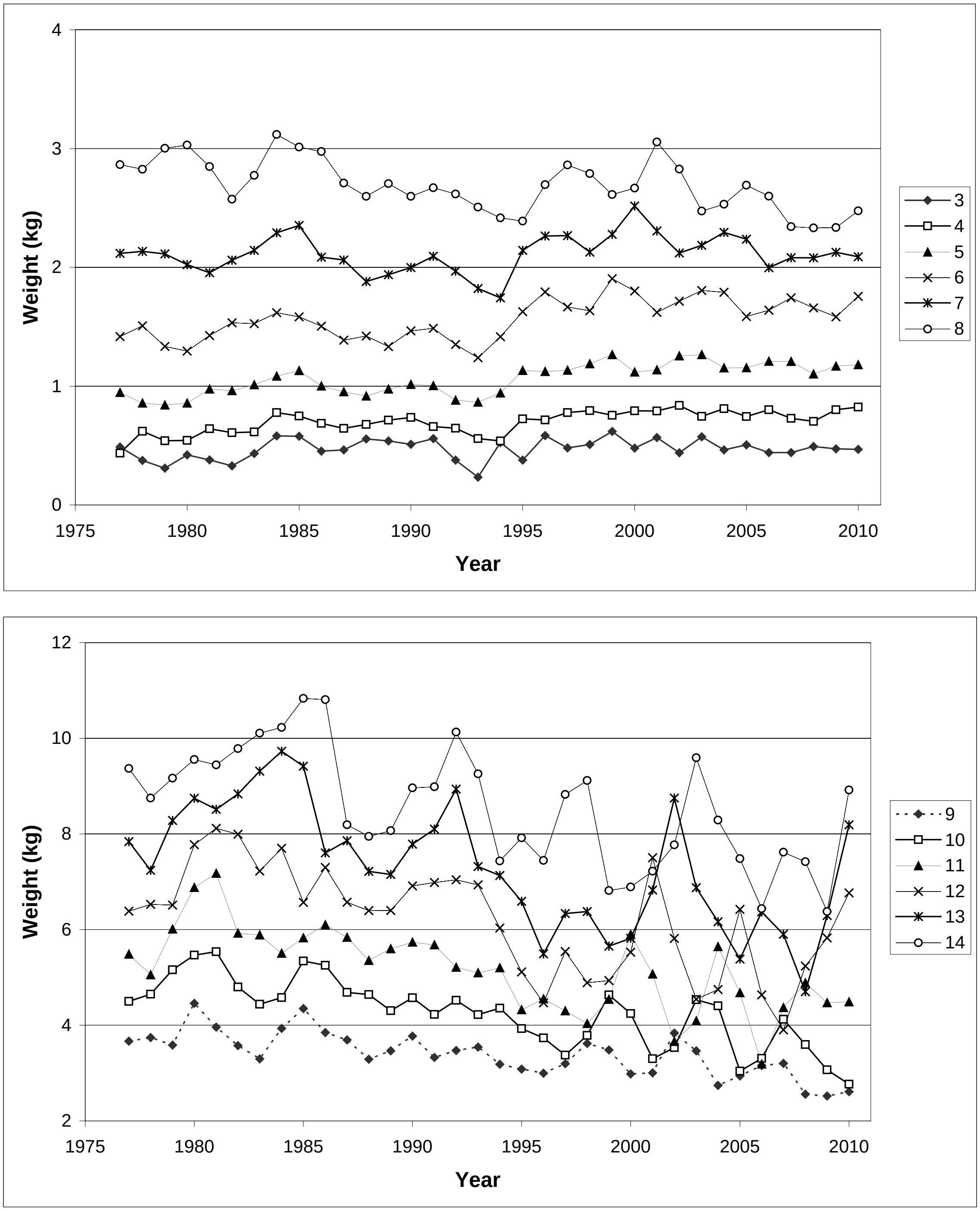


Figure 7. Beginning of year mean weights-at-age (upper panel: ages 3-8; lower panel: ages 9-14) from the commercial catch of cod in NAFO Subdivision 3Ps during 1977-2010.

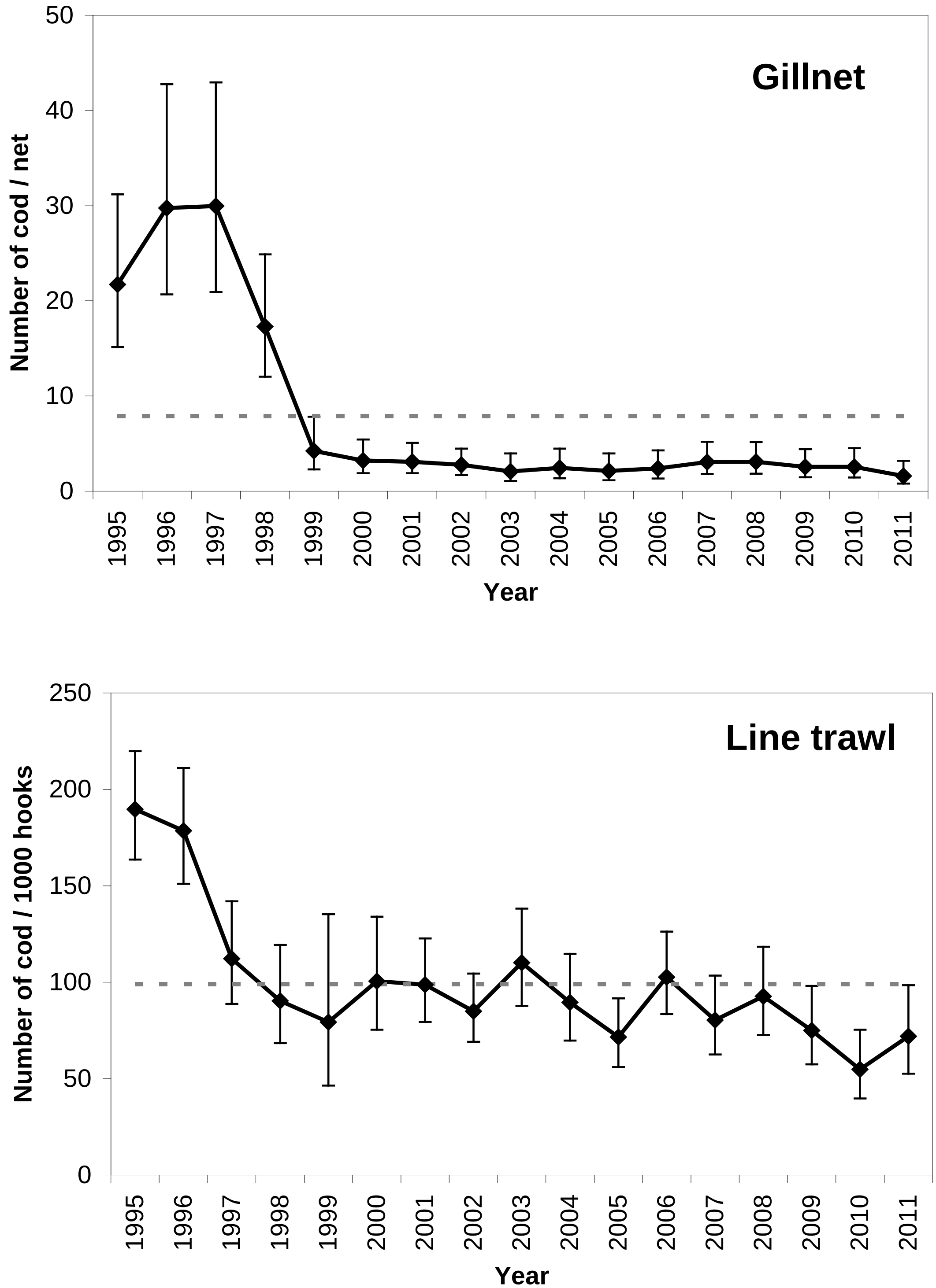
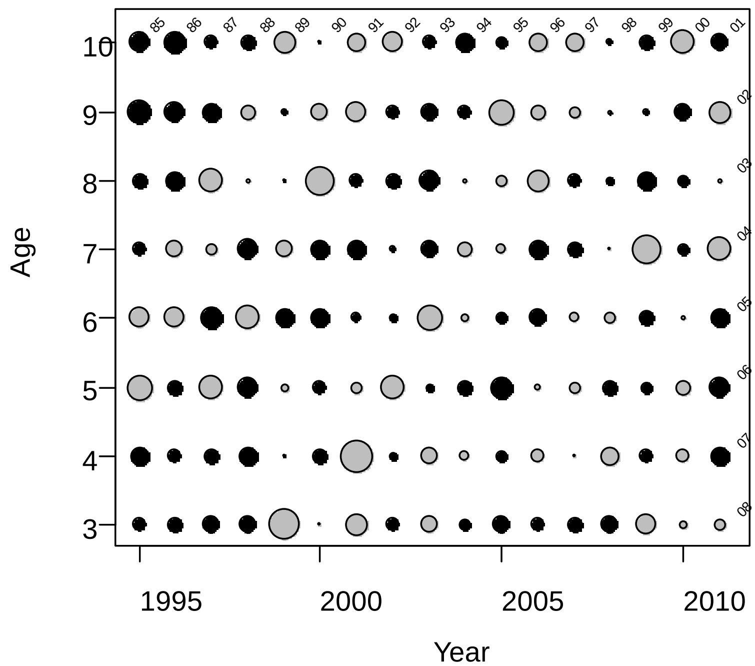


Figure 8a. Standardized age-aggregated catch rate indices for gillnets (5.5" mesh) and line-trawls (with 95% CL's) estimated using data from sentinel fishery fixed sites. Dashed horizontal lines indicate time-series average.

Gillnet



Linetrawl

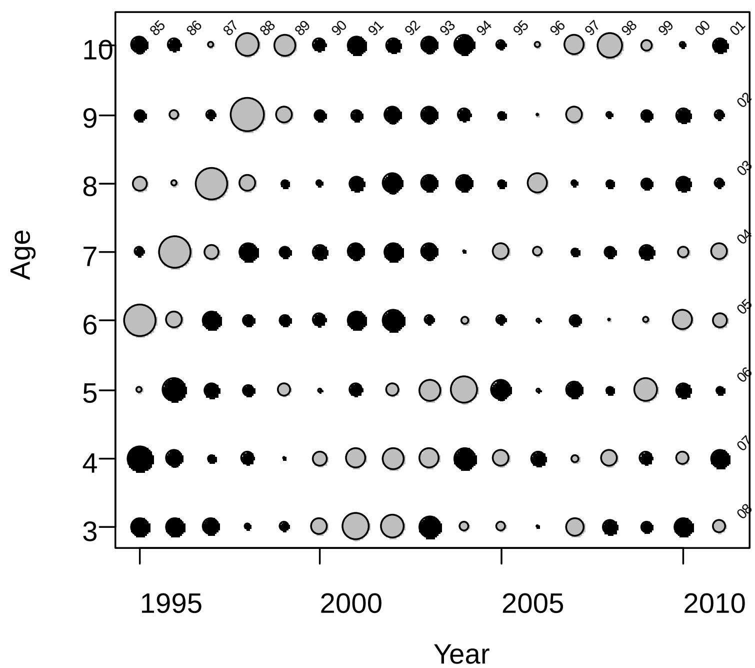


Figure 8b. Standardized proportions at age of sentinel catch rates at age in Subdivision 3Ps. Annual proportions were computed, and then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions across years. Symbol sizes are scaled and values greater than 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.

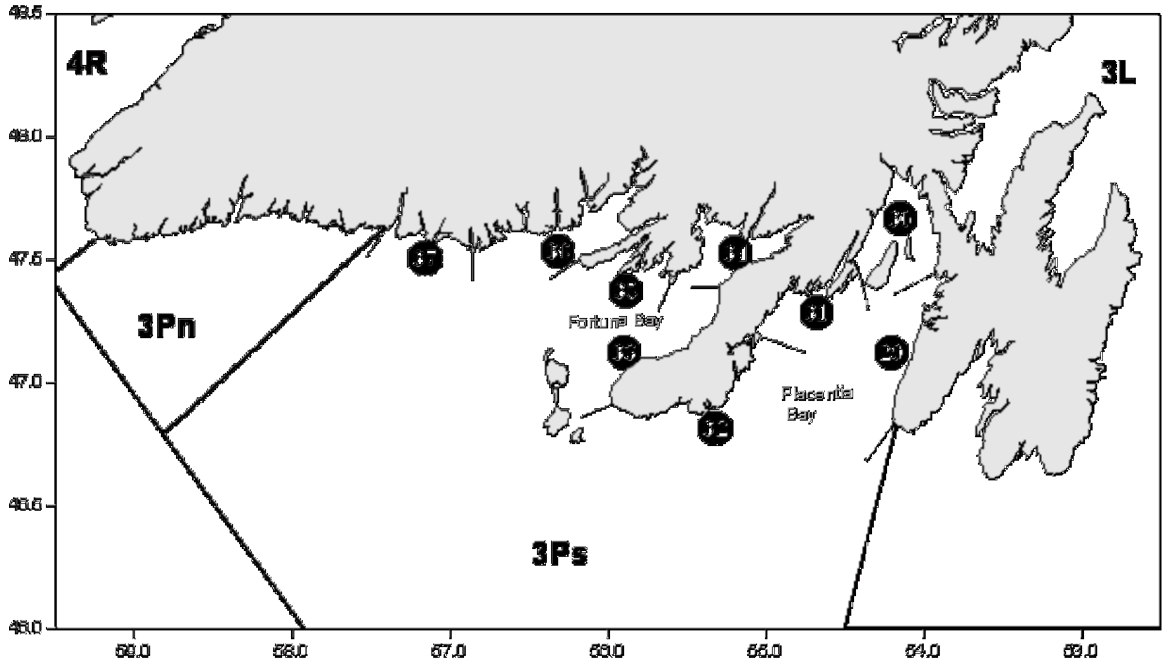


Figure 9a. Location and boundaries of numbered management areas along the inshore of the south coast of Newfoundland (NAFO Subdivision 3Ps) (29=Placentia Bay East, 30=Head of Placentia Bay, 31=Placentia Bay West, 32=The Boot, 33=Fortune Bay, 34=Head of Fortune Bay, 35=Connaigre, 36=Hermitage Bay, 37=Francois-Burgeo).

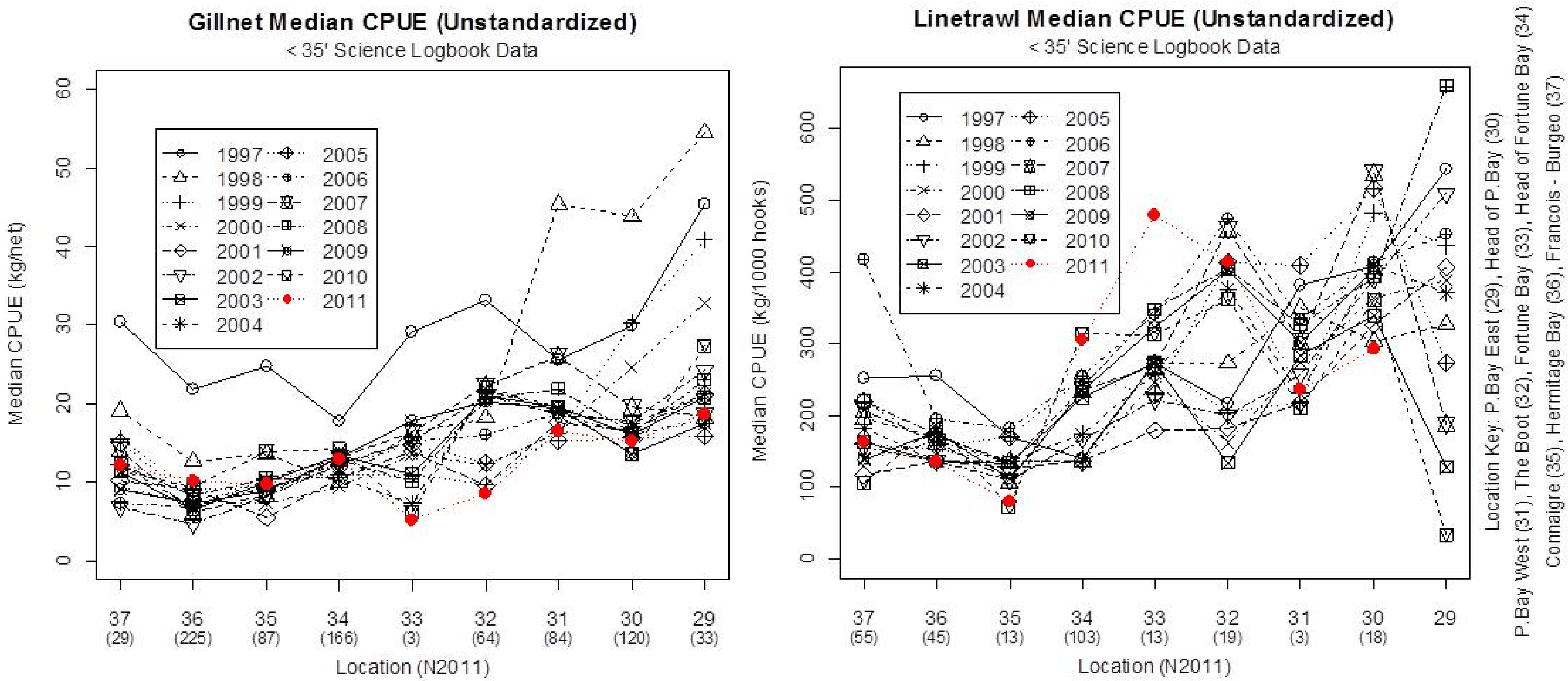
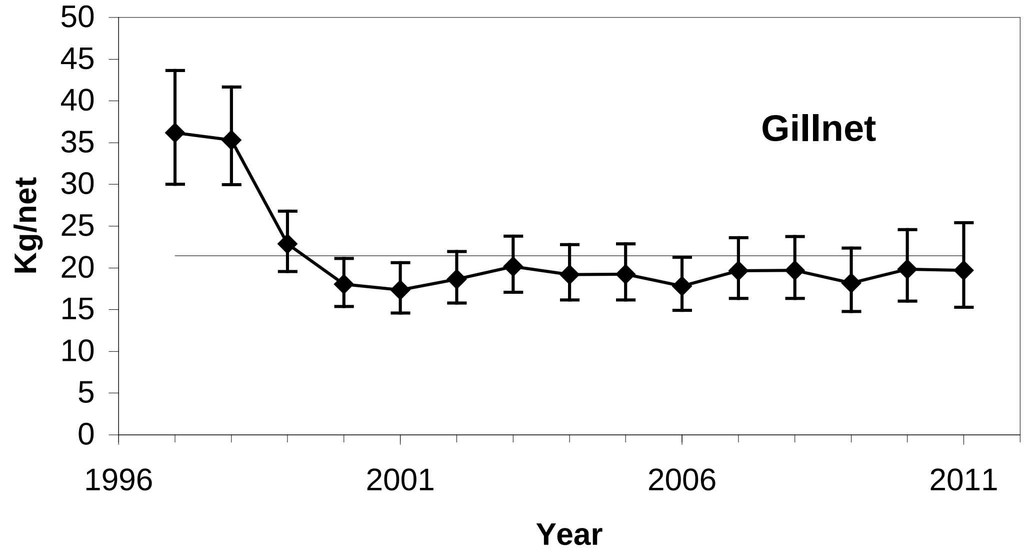


Figure 9b. Area-specific median annual catch rates of cod from gillnets (left panel, kg per net) and line-trawls (right panel, kg per 1,000 hooks) from science log-books for vessels <35 ft. Labels on x-axis are lobster fishing areas ordered from west to east (see key on far right). Values in parenthesis on x-axis are number of valid sets per site during the 2011 fishery.



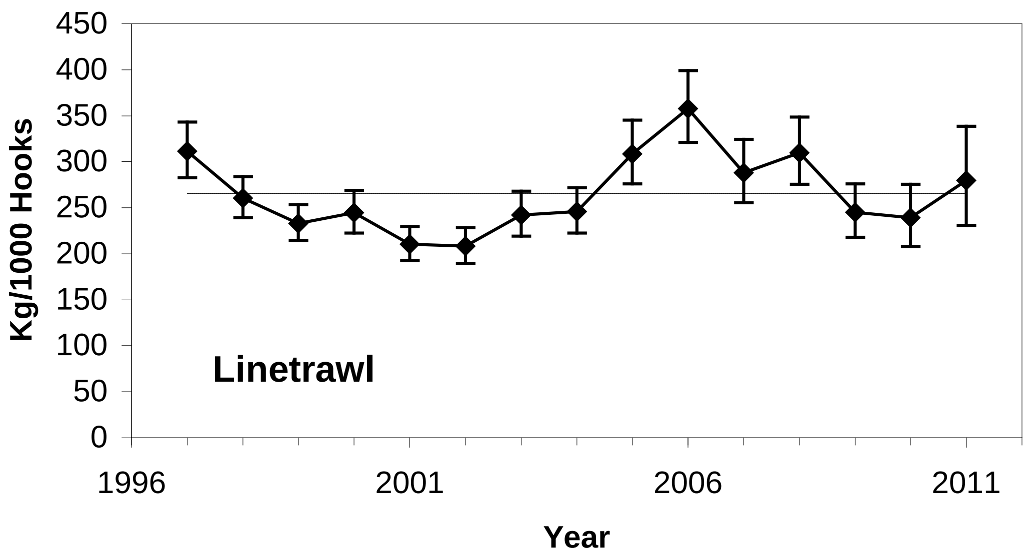


Figure 9c. Standardized catch rates for gillnets and line-trawls from science log-books for vessels <35 ft. Horizontal dashed lines are time-series average; error bars are 95 % confidence intervals of the means. Catch rates are expressed in terms of weight (kg per net or kg per 1000 hooks).

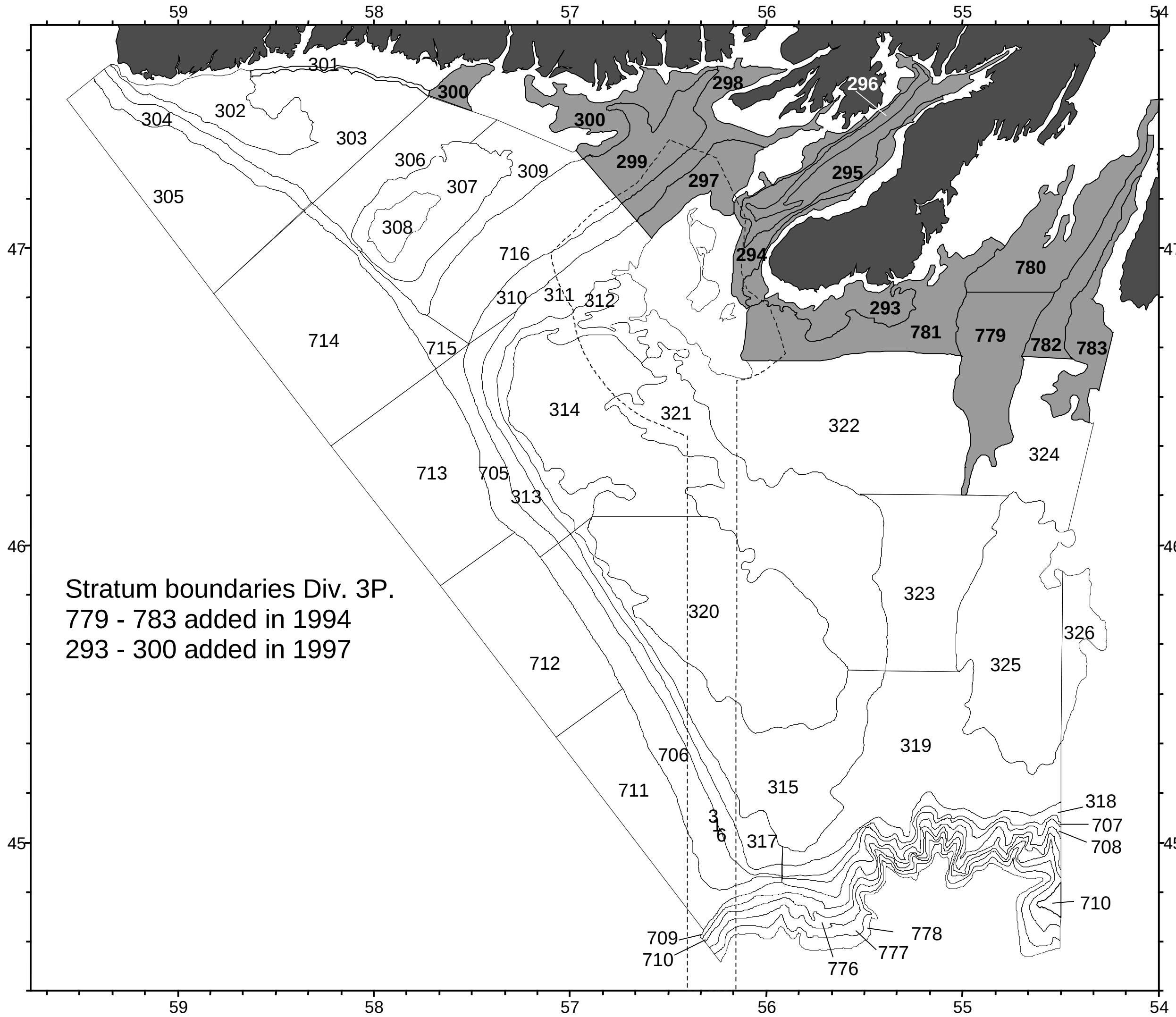


Figure 10. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdivision 3Ps. Dashed line is the boundary of the French economic zone which is included in the surveyed area.

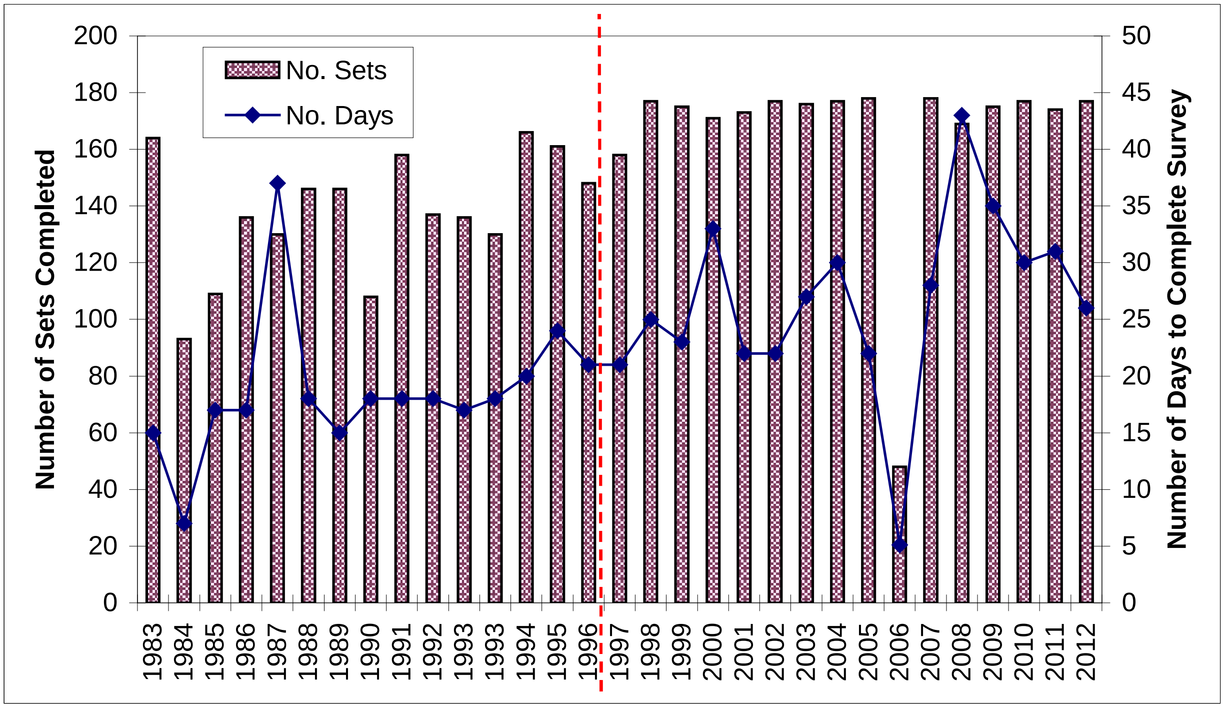


Figure 11. Number of research vessel survey sets completed during surveys of NAFO Subdivision 3Ps, and the number of days required to complete these sets over 1983-2012. Survey coverage was expanded to present levels after 1997 (dashed vertical line).

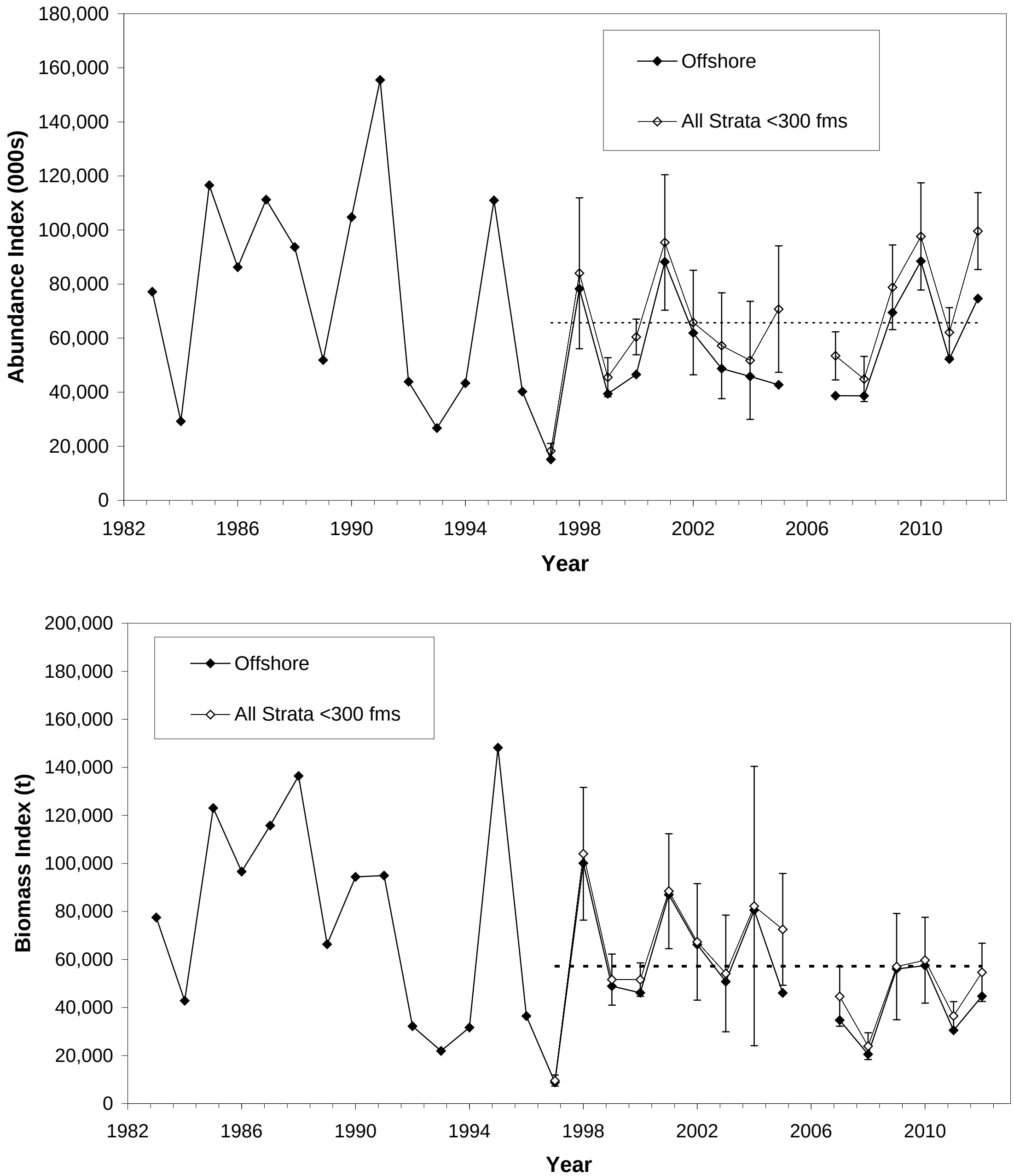


Figure 12. Abundance (upper panel) and biomass (lower panel) indices for cod in NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys of index strata during winter/spring from 1983 to 2012. Error bars show plus/minus one standard deviation. Open symbols show values for the augmented survey 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.

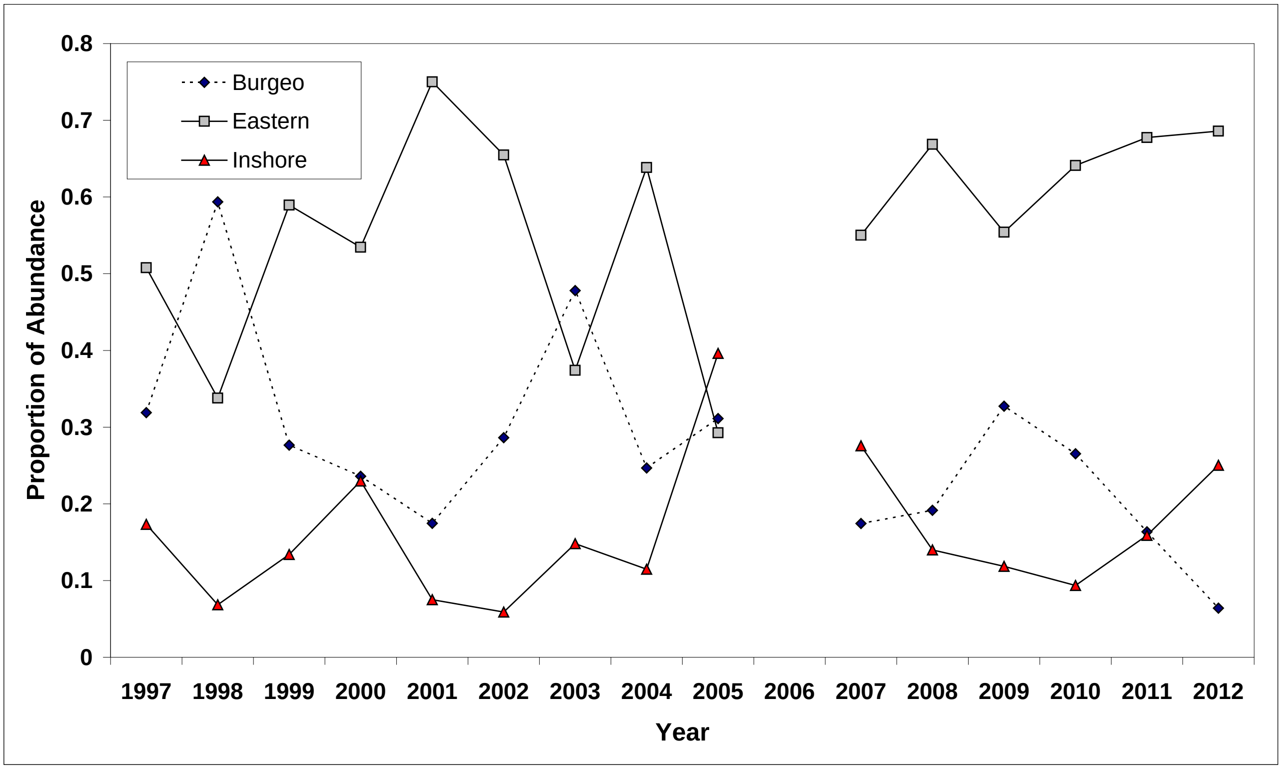


Figure 13. Total abundance index for cod in various regions of NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys during winter/spring from 1997 to 2012. The 2006 survey was not completed. The Campelen trawl was used in all surveys.

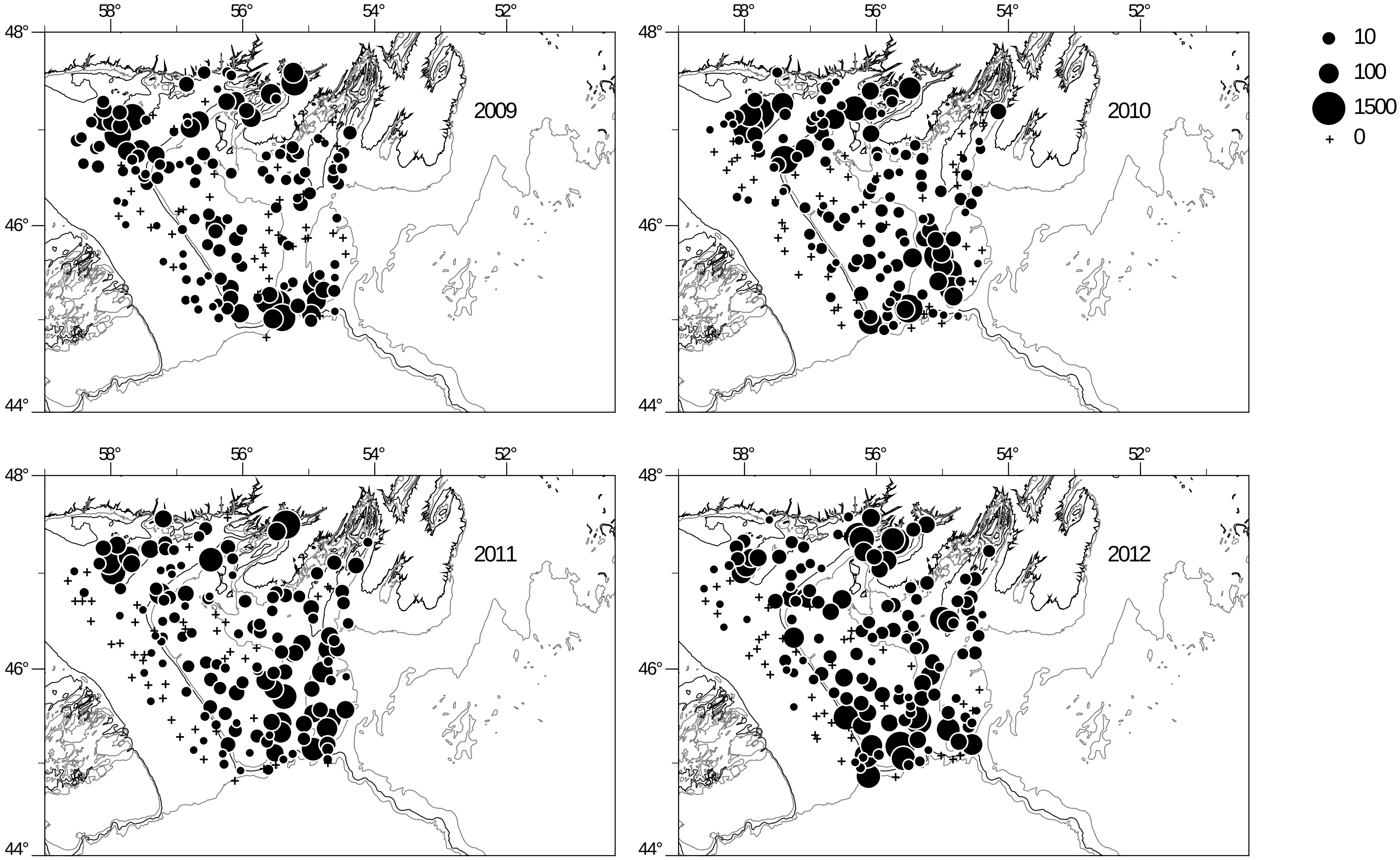


Figure 14a. Age aggregated distribution of cod catches (nos. per tow) from the April DFO research vessel surveys of NAFO Subdivision 3Ps over 2009-12. Bubble size is proportional to numbers caught.

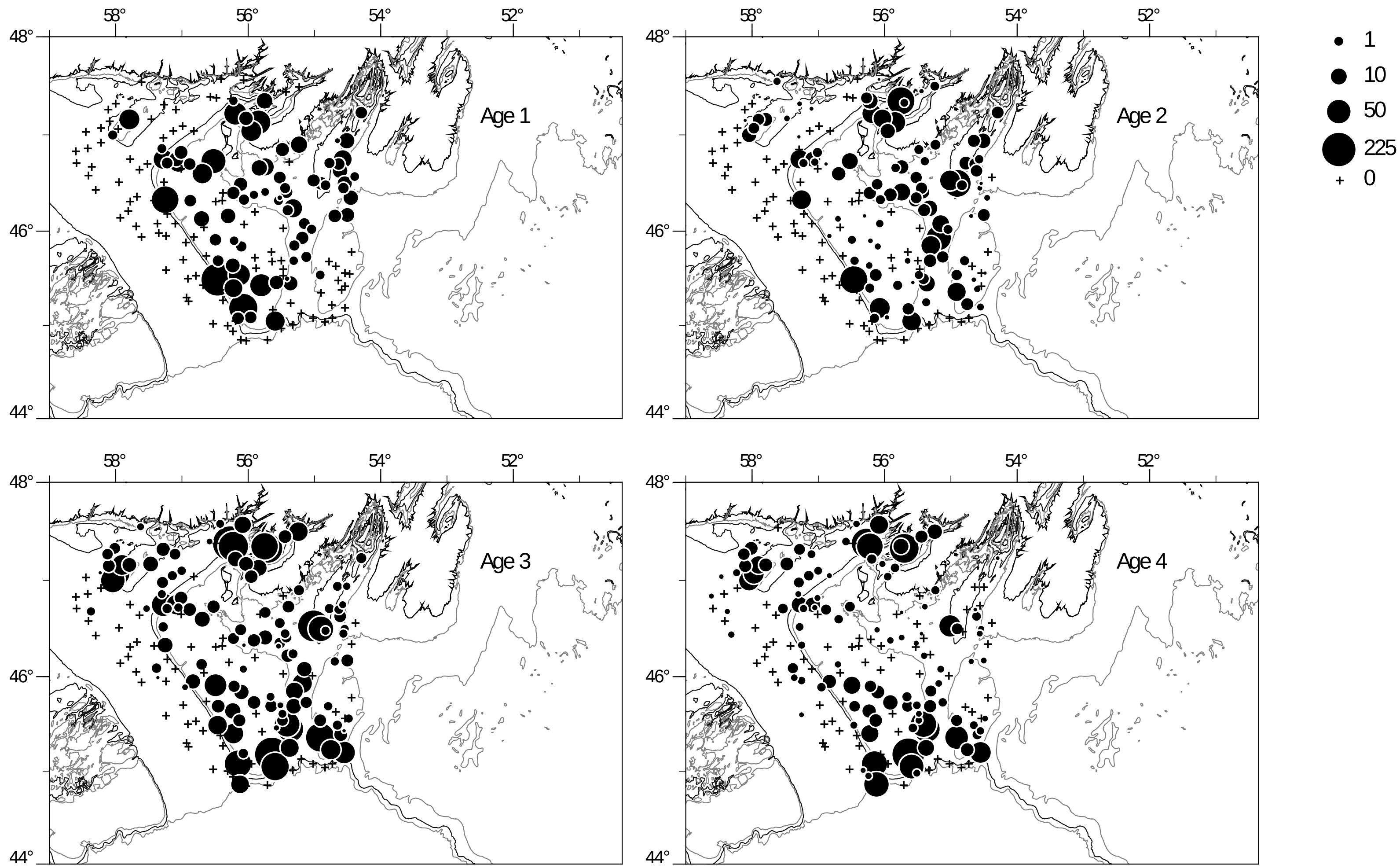


Figure 14b. Age dis-aggregated distribution of cod catches (nos. per tow, ages 1-4) from the April 2012 DFO research vessel survey of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.

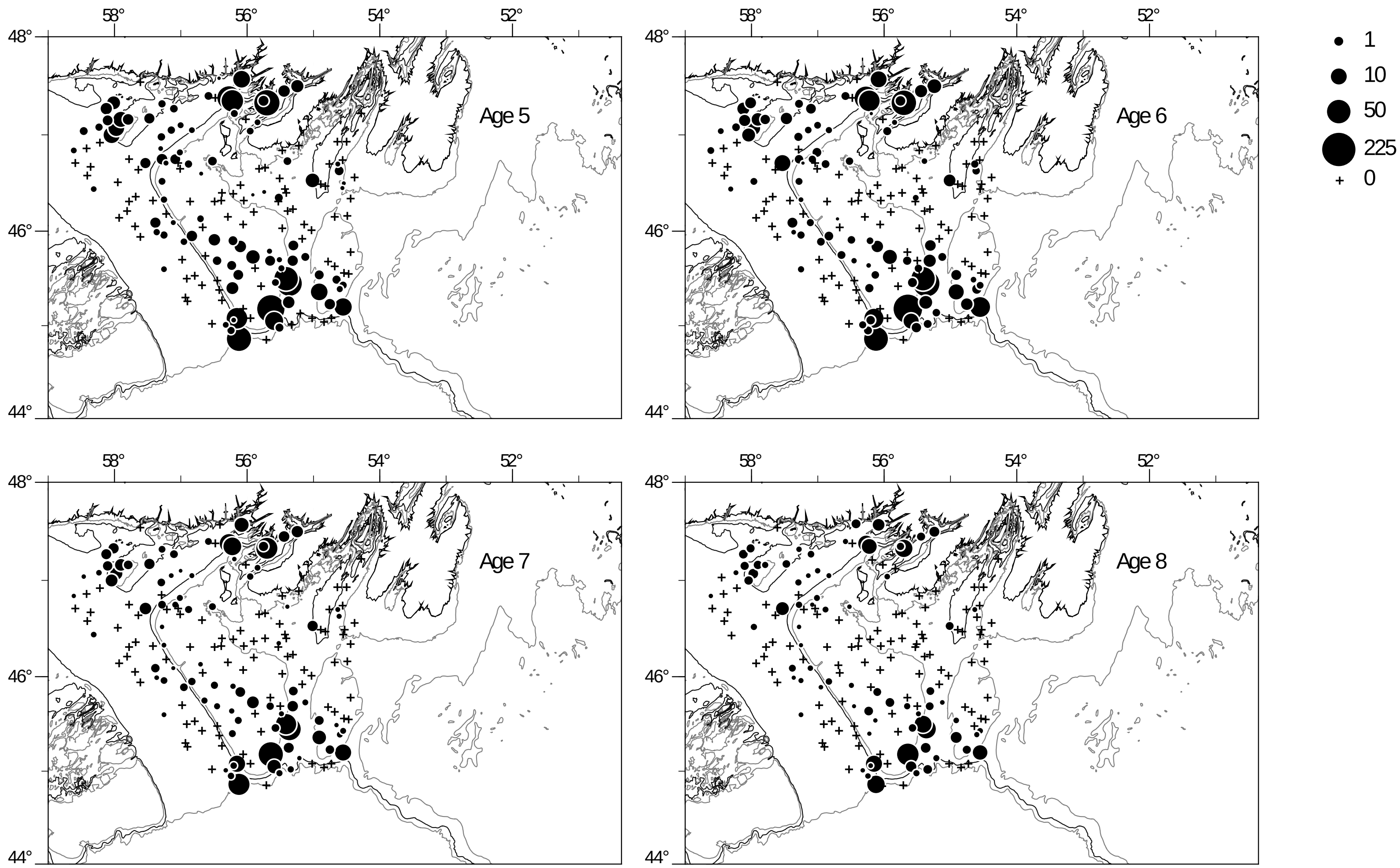


Figure 14c. Age dis-aggregated distribution of cod catches (nos. per tow, ages 5-8) from the April 2012 DFO research vessel surveys of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.

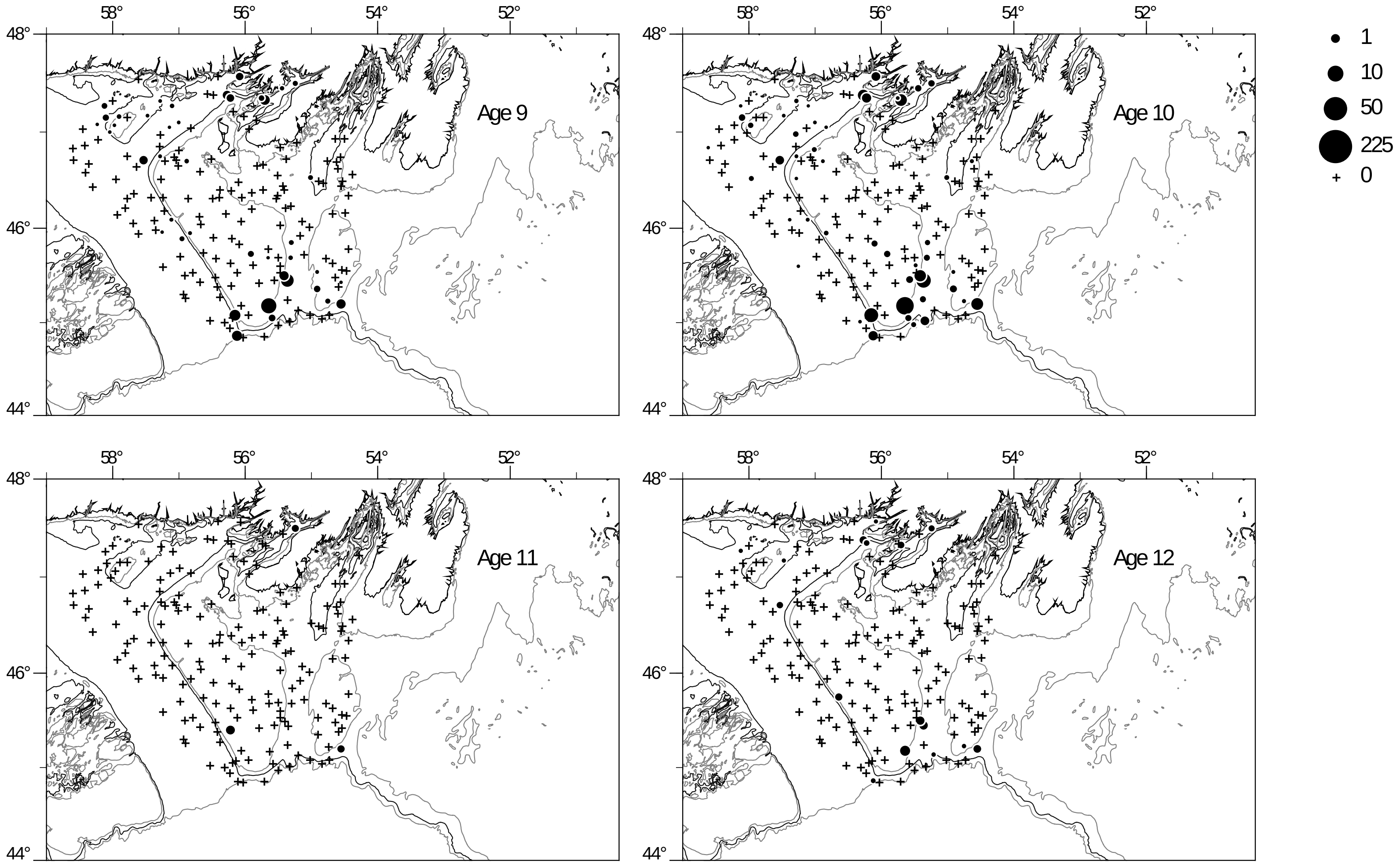


Figure 14d. Age dis-aggregated distribution of cod catches (nos. per tow, ages 5-8) from the April 2012 DFO research vessel surveys of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.

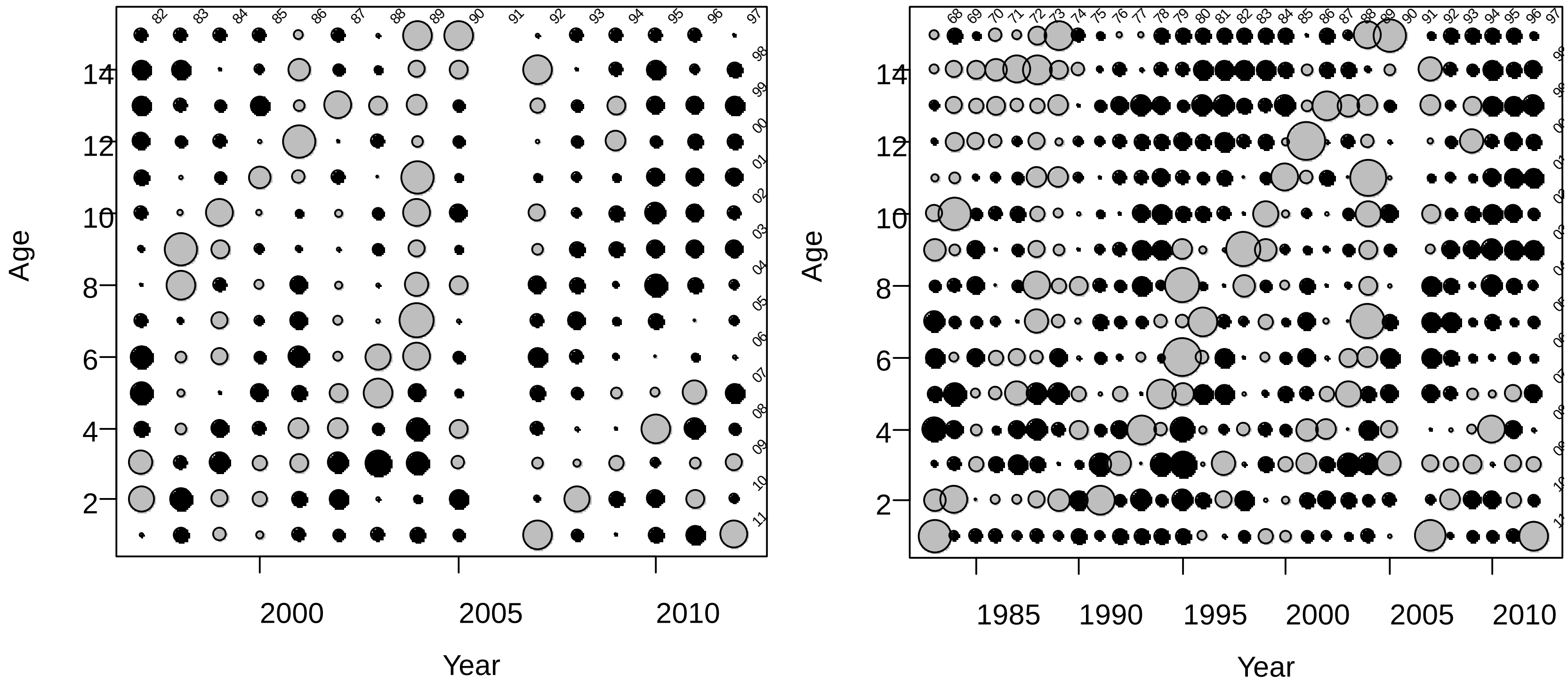


Figure 15. Standardized age-disaggregated catch rates from the spring bottom trawl survey of Subdivision 3Ps. Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions 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 1997-2012 "All Strata <300fm" data, and panel at right includes data which comprise the "Offshore" index (1983-2012).

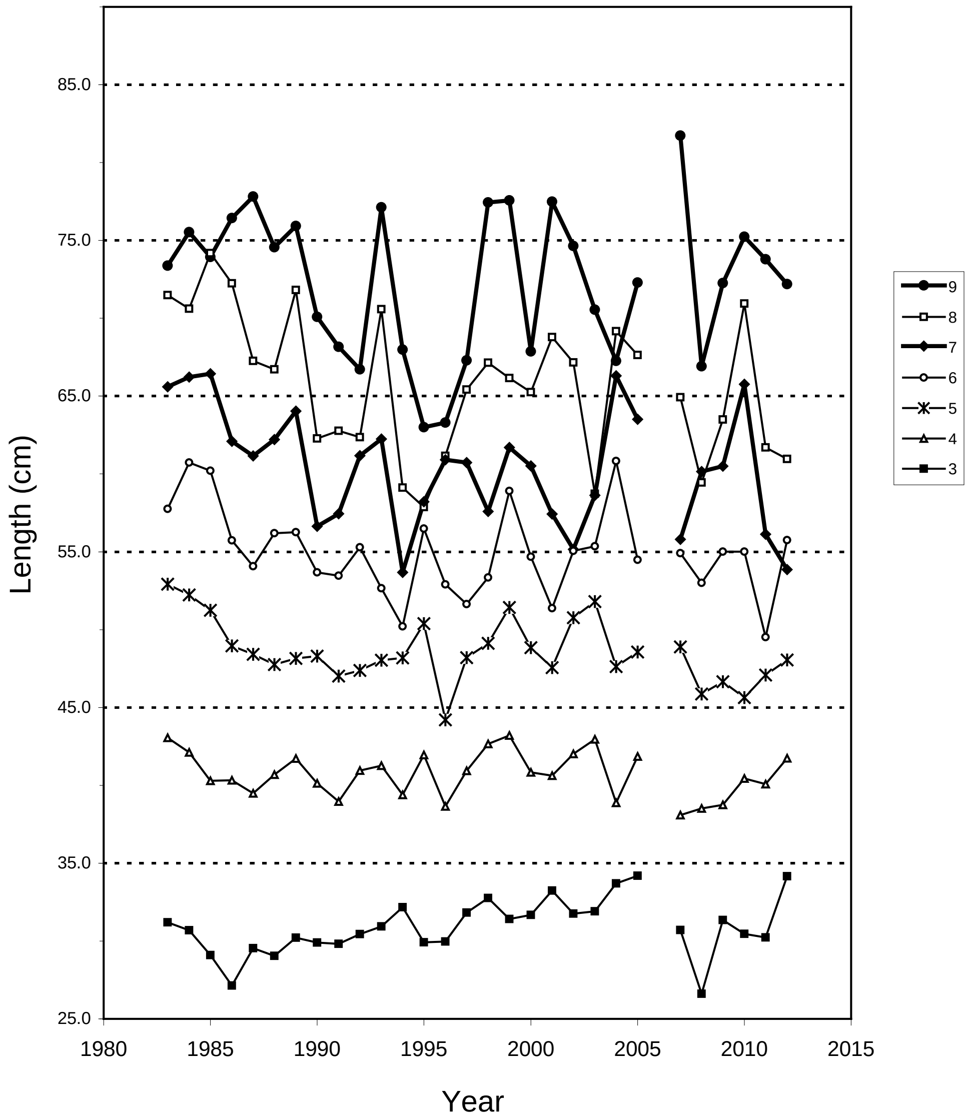


Figure 16a. Mean length at ages 3-9 of cod in Subdivision 3Ps during 1983-2012 from sampling during DFO bottom-trawl surveys in winter-spring.

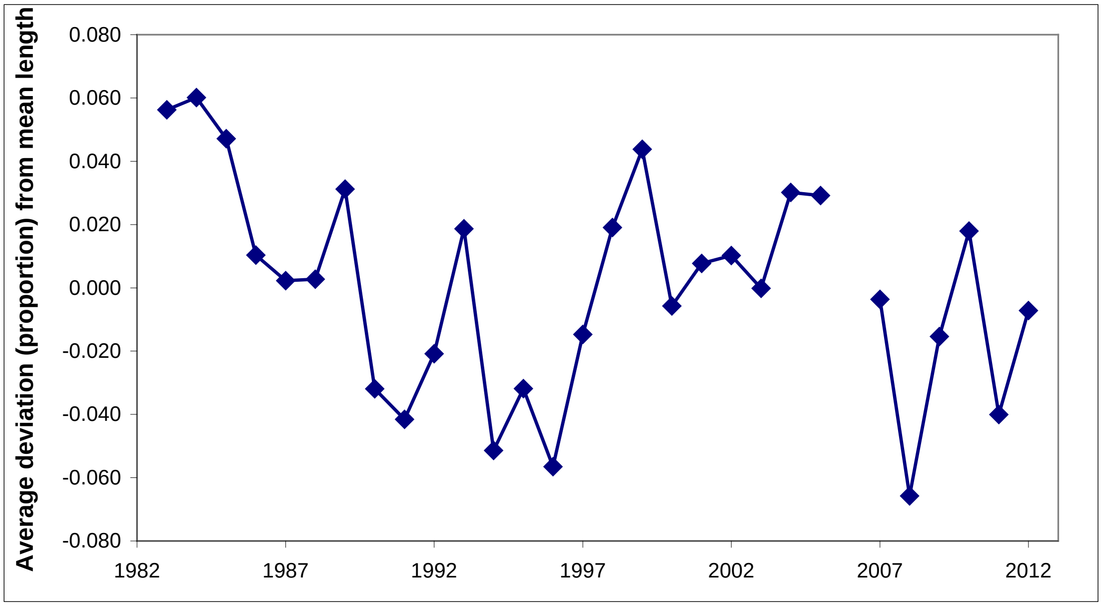


Figure 16b. Average proportion deviation from mean length at age for ages 3-9 from DFO bottom-trawl surveys from 1983-2012.

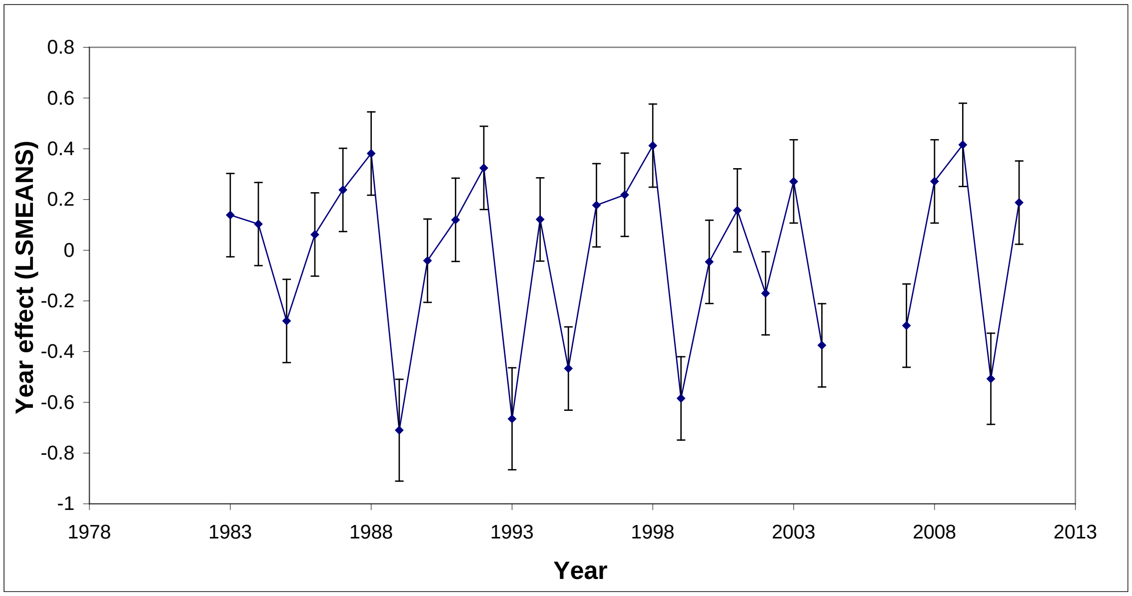


Figure 16c. Least squares means (+ S.E.) of the effect of year on the residuals from a model of the age effect on length increment for ages 3-9 from DFO bottom-trawl surveys from 1983-2012.

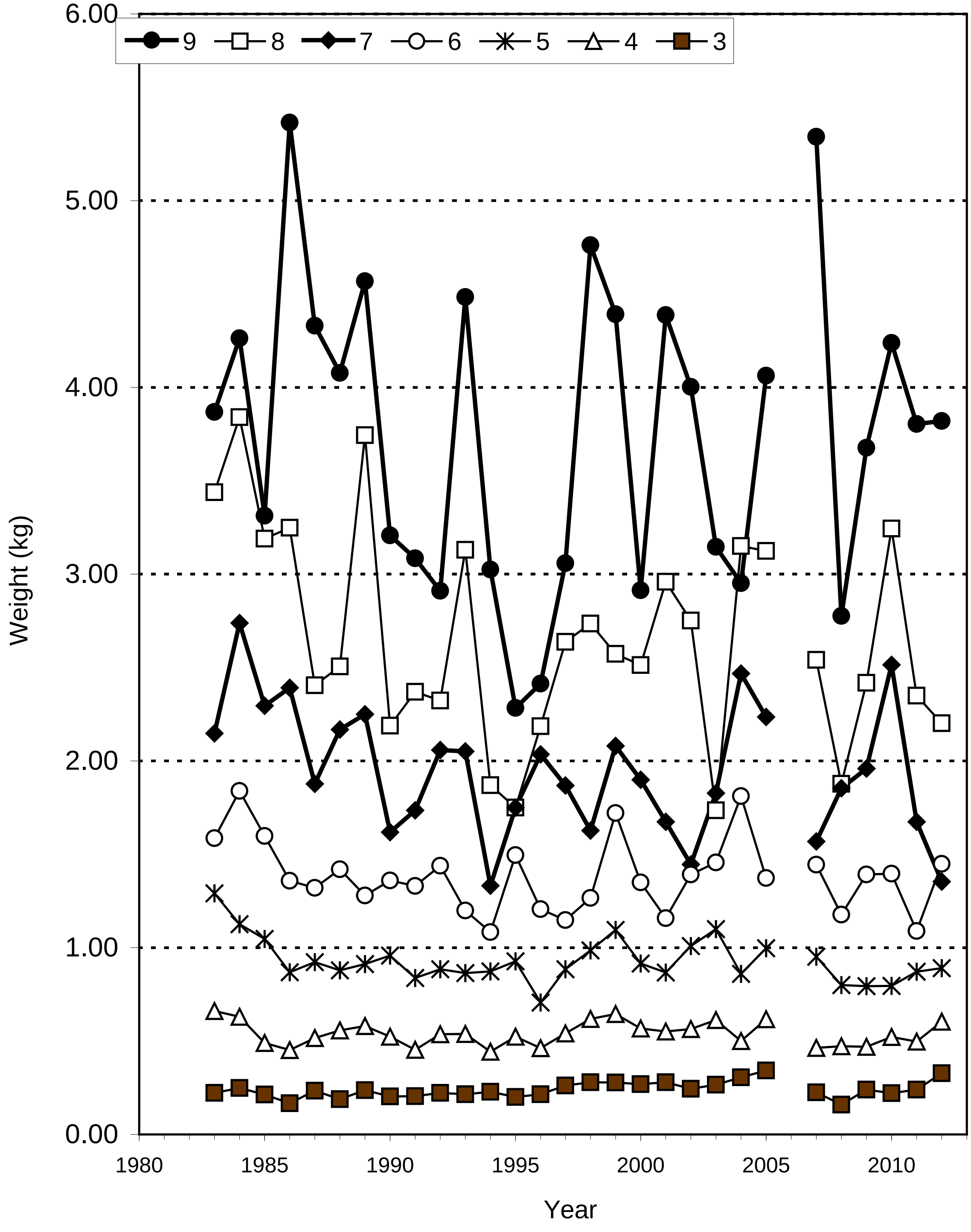


Figure 17a. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in NAFO Subdivision 3Ps in winter-spring 1983-2011.

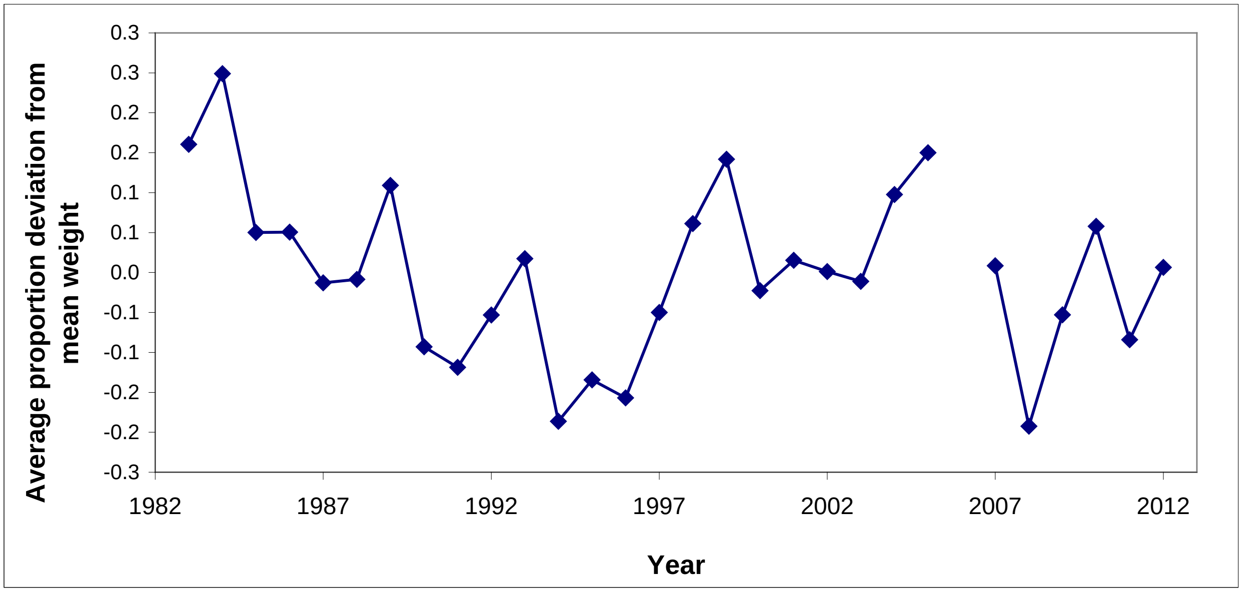


Figure 17b. Average proportion deviation from mean weight at age for ages 3-9 from DFO bottom-trawl surveys from 1983-2012.

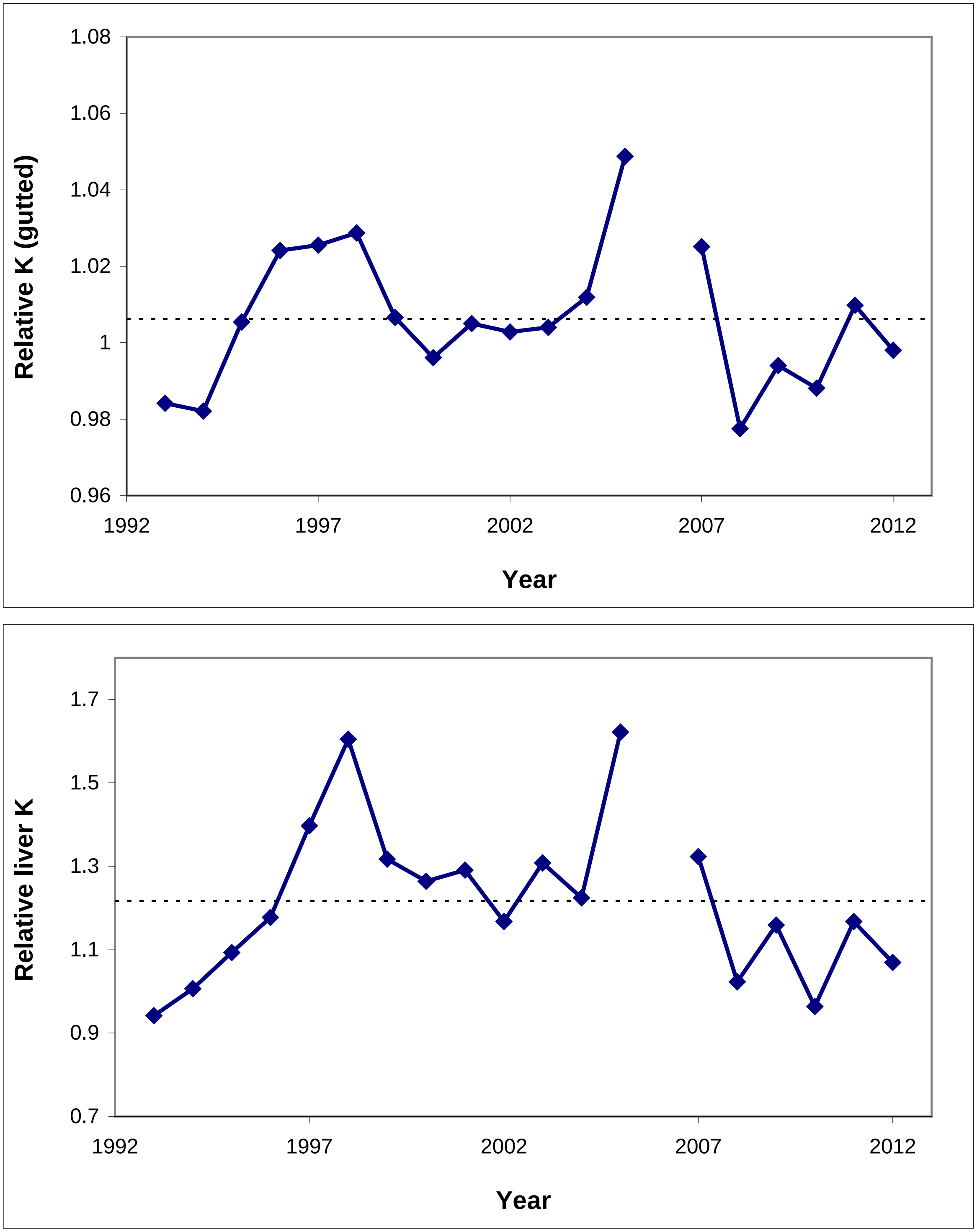


Figure 18. Relative condition indices for 3Ps cod from spring surveys over 1993-2012. Upper panel is relative gutted condition index; lower panel relative liver condition index. Dashed horizontal line represents time-series average.

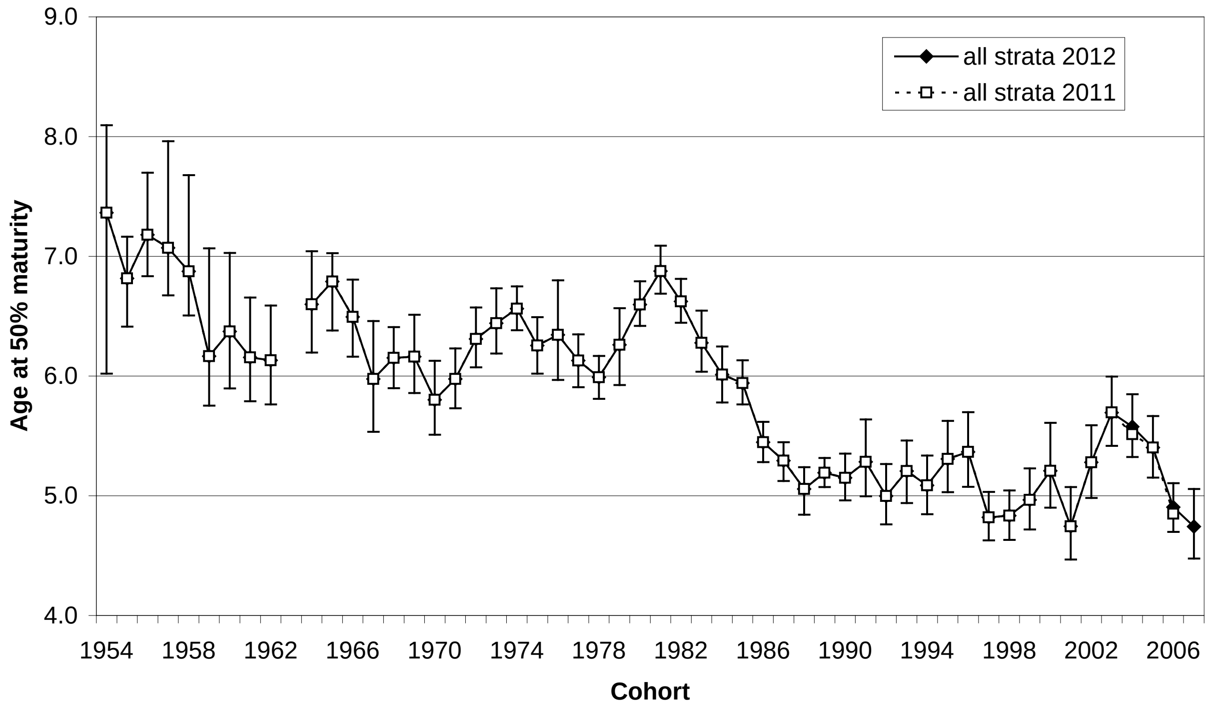


Figure 19a. Age at 50% maturity by cohort (1954-2007, excluding 1963) for female cod sampled during DFO research vessel bottom-trawl surveys of NAFO Subdivision 3Ps. Error bars are 95 % fiducial limits.

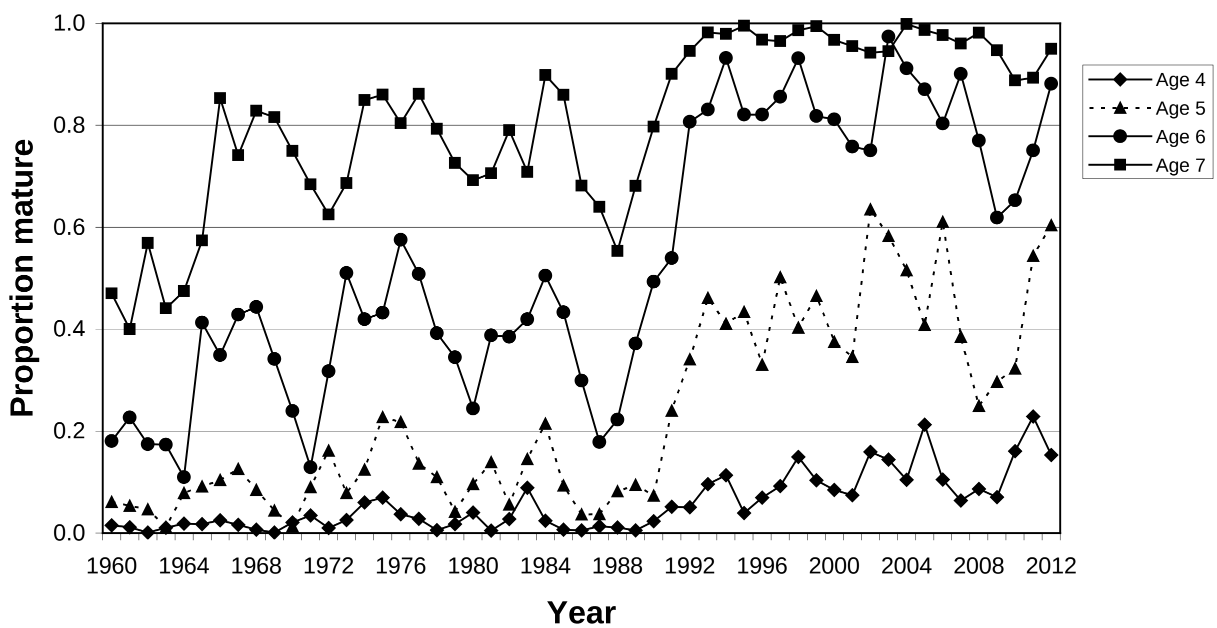


Figure 19b. Estimated proportions mature at ages 4-7 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdivision 3Ps (data from all strata surveyed).

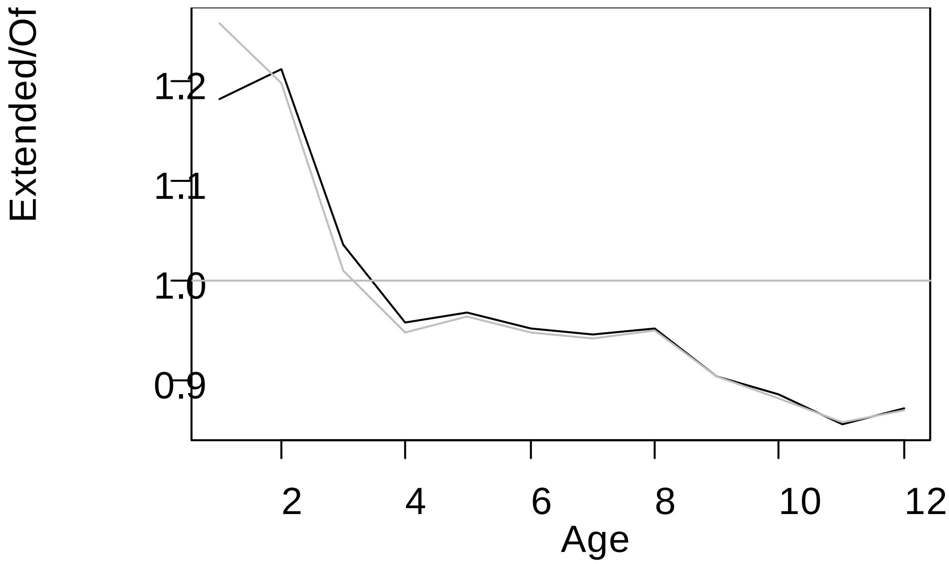


Figure 20. Age-specific ratio of the extended survey indices to the offshore survey indices (each index averaged over 1997-2012). Grey line indicates ratios from previous assessment, where averages were computed over 1997-2011

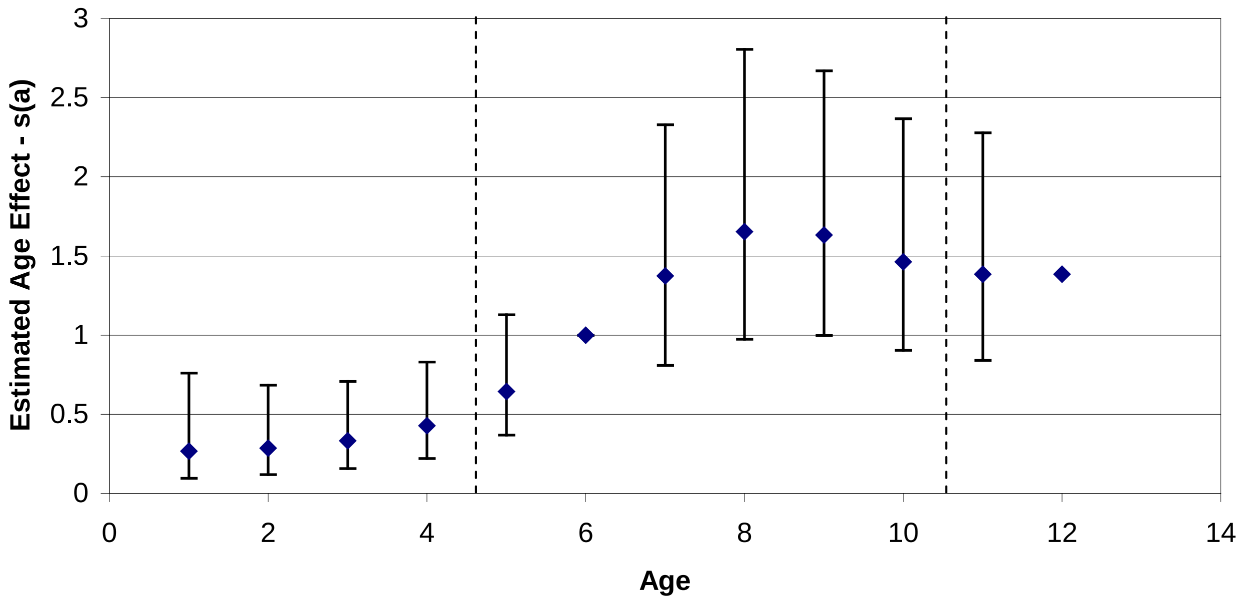


Figure 21. Estimated age-effects from SURBA cohort analysis, with 95% confidence interval. Age 6 is arbitrarily chosen as a reference age (and set to a value of 1), and the effect at age 12 is fixed at the level estimated for age 11.

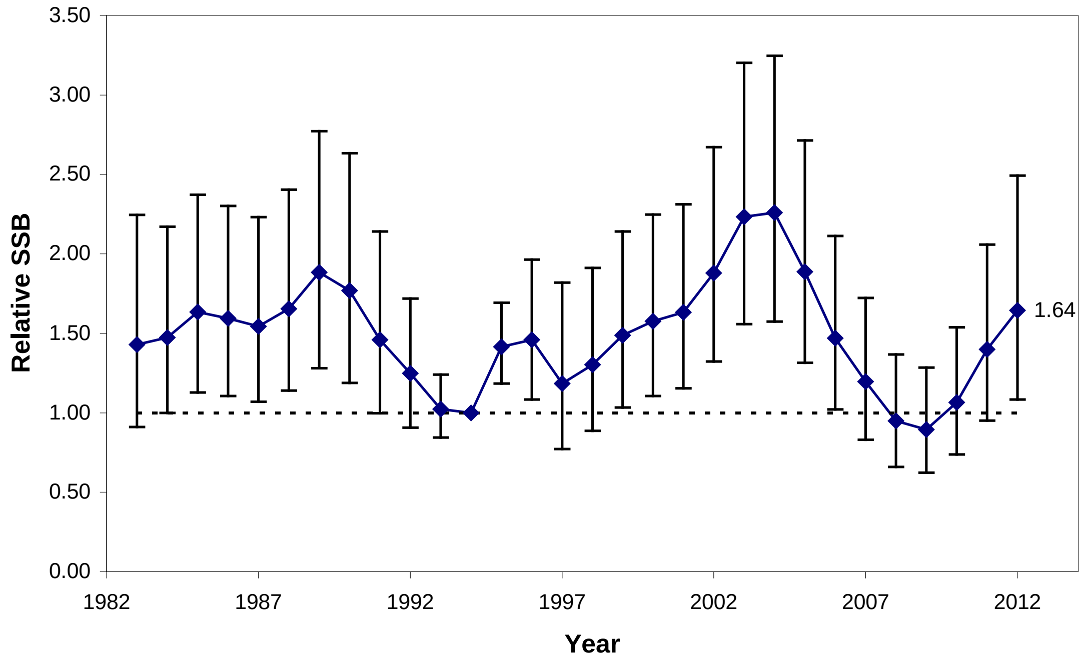


Figure 22a. Estimates of spawning stock biomass (SSB) relative to Blim from SURBA cohort analysis model (i.e., estimates are divided by 1994 SSB), with 95% confidence interval.

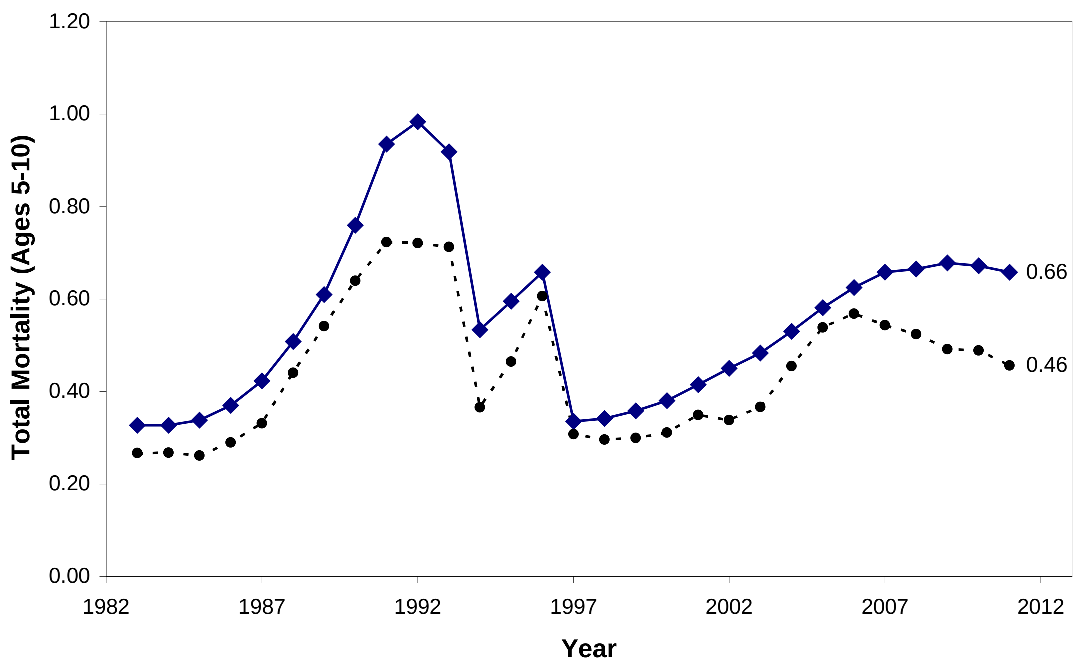


Figure 22b. Estimates of total mortality (Z) from a SURBA cohort analysis model, averaged over ages 5-10. Solid line: average annual mortality; dashed line: average annual mortality weighted by population size at ages 5-10. Text label indicates the estimated total mortality for 2012.

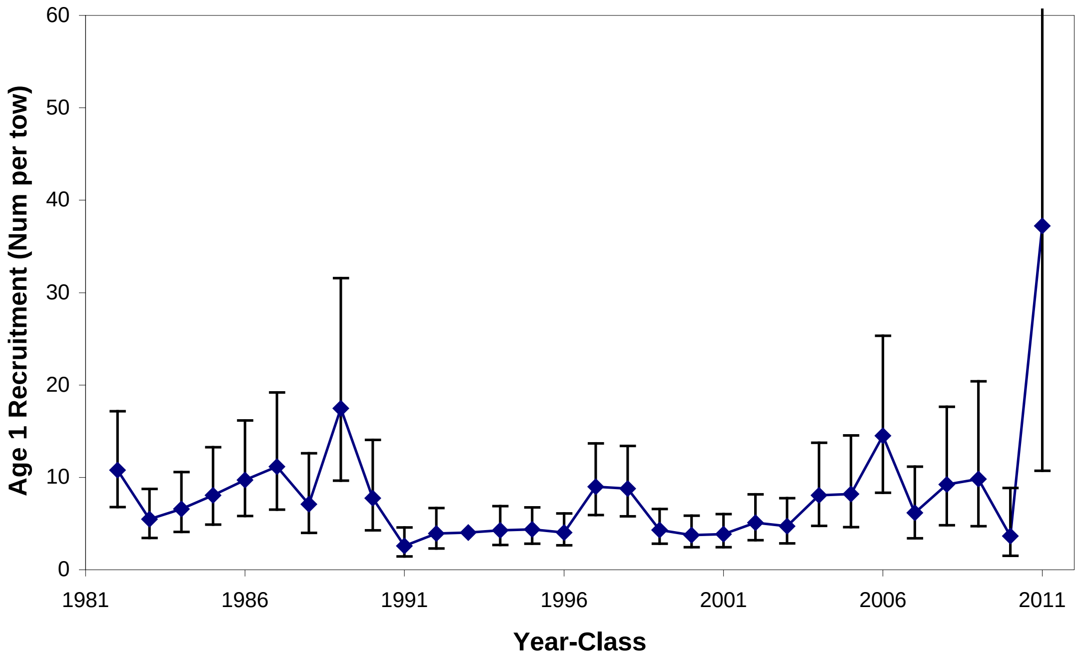


Figure 22c. Estimates of age 1 recruitment from SURBA cohort analysis model.

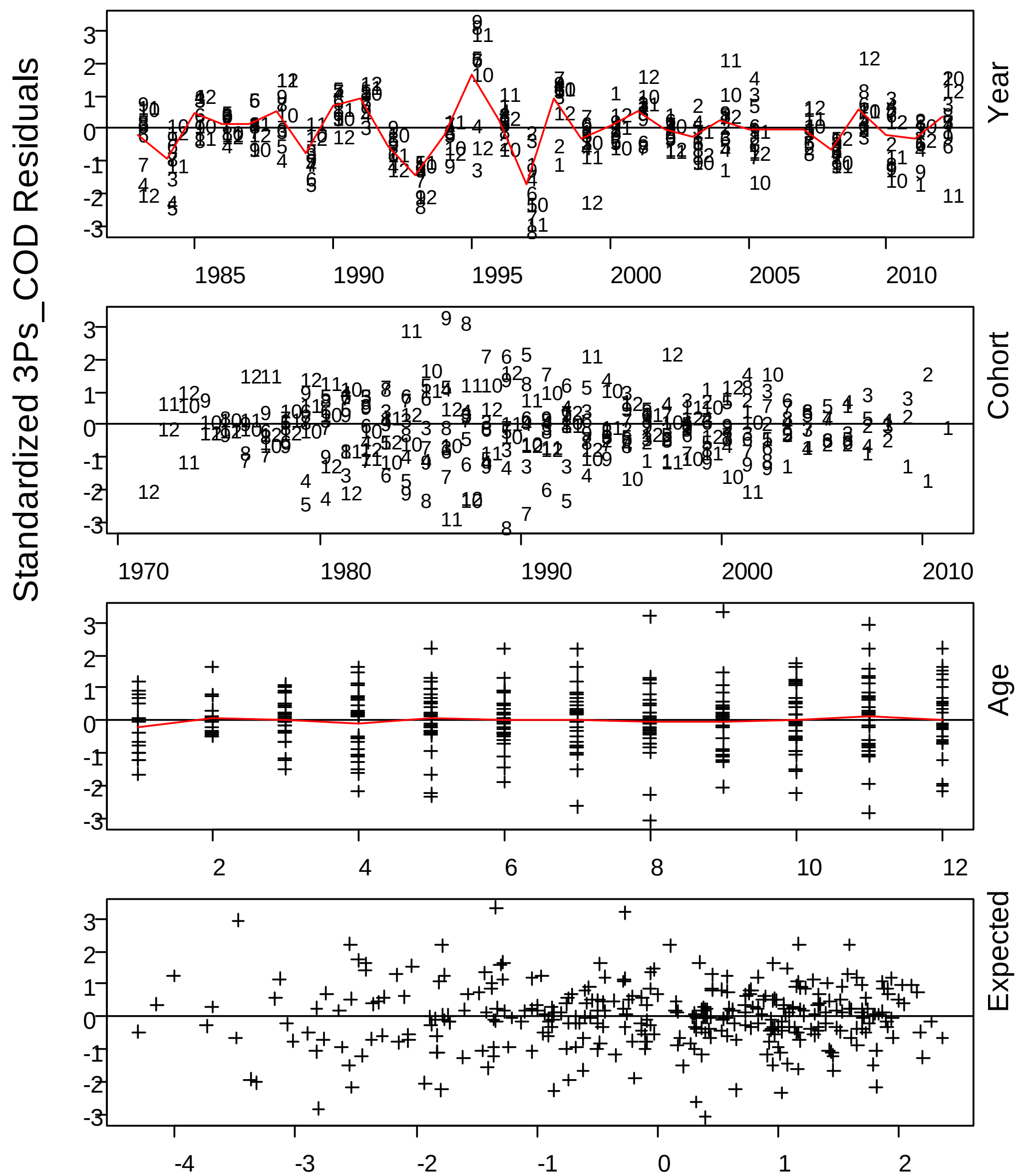


Figure 23. Standardized residuals from SURBA cohort analysis. Panels show residuals plotted year, cohort, age, and expected value, respectively.

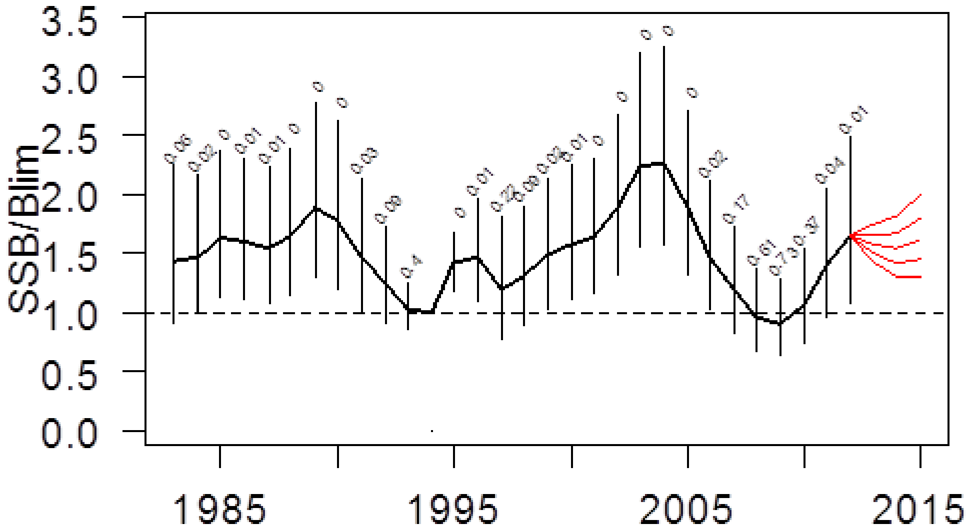


Figure 24. Projections of spawning stock biomass from SURBA cohort analysis (refer to text for details). Values above annual confidence limits indicate $P(SSB_y<B_{lim})$.

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

SAS Standard SURBA for 3Ps_COD

22:27 Friday, September 28, 2012

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	360
Observations Not Used	0
Total Observations	360
Parameters	80

Parameters

Initial Values									
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	logR2011
1	1	1	1	1	1	1	1	1	1
f1983	f1984	f1985	f1986	f1987	f1988	f1989	f1990	f1991	f1992
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
f1993	f1994	f1995	f1996	f1997	f1998	f1999	f2000	f2001	f2002
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
f2003	f2004	f2005	f2006	f2007	f2008	f2009	f2010	f2011	s1
-1	-1	-1	-1	-1	-1	-1	-1	-1	0
s2	s3	s4	s5	s7	s8	s9	s10	s11	S_std
0	0	0	0	0	0	0	0	0	0.1

NegLogLike

36784.6726

Iteration History

Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
1	17	2571.93255	34212.74	12854.34	-5.502E9
2	25	961.976549	1609.956	2455.155	-81.4152
3	27	598.952402	363.0241	679.0951	-171.134
4	29	480.642717	118.3097	115.3945	-74.86
5	31	454.94733	25.69539	45.54982	-17.3809
6	33	449.336193	5.611137	100.1939	-3.3773
7	35	437.37777	11.95842	139.5926	-2.41145
8	37	426.810737	10.56703	58.50415	-9.01302
9	38	424.839948	1.97079	102.4928	-5.80917
10	40	420.732222	4.107726	59.92214	-1.39933
11	42	403.190413	17.54181	310.7154	-6.3266
12	43	368.475182	34.71523	33.47305	-114.602
13	44	361.453235	7.021947	67.11263	-42.2003
14	46	358.54029	2.912945	10.10891	-6.67867
15	48	357.634219	0.90607	12.2235	-1.56674
16	50	354.770917	2.863302	13.92834	-0.95682
17	52	349.011417	5.7595	131.7948	-3.11246
18	53	342.411633	6.599784	40.21288	-9.7424
19	55	339.383173	3.02846	13.60694	-4.81597
20	57	338.550461	0.832711	10.88054	-0.79721
21	59	335.60354	2.946921	44.53136	-1.1705
22	61	332.736923	2.866617	17.79099	-2.31011
23	63	331.639375	1.097548	9.758186	-0.67563
24	65	327.481991	4.157385	37.77367	-1.39989
25	66	326.643662	0.838329	10.07943	-1.58818
26	68	325.112784	1.530879	17.80879	-0.4746
27	70	322.399025	2.713758	9.852554	-2.06128
28	72	321.217926	1.181099	11.23702	-1.15649
29	74	319.887379	1.330548	41.33303	-0.43559
30	76	317.982278	1.9051	6.692301	1.59895
31	78	317.485918	0.496361	7.413805	-0.42465
32	80	315.914423	1.571495	21.01306	-0.46839
33	81	315.112777	0.801646	10.43961	-1.1356
34	83	314.818579	0.294198	6.550336	-0.52923
35	86	314.107219	0.711359	5.759028	-0.12722
36	87	313.629221	0.477998	4.098997	-0.71873
37	89	313.442879	0.186342	8.218349	-0.24759
38	91	312.765682	0.677197	3.297791	-0.1341
39	92	312.463378	0.302304	4.86902	-0.50502
40	94	312.286723	0.176655	11.05144	-0.10561
41	96	311.186109	1.100614	5.889354	-0.23363
42	98	310.982122	0.203987	5.639411	-0.17745
43	100	310.397097	0.585025	15.4541	-0.15383
44	101	310.191784	0.205313	7.015468	-0.30954
45	103	310.098027	0.093758	4.276652	-0.10814
46	105	309.691778	0.406249	2.246293	-0.08503
47	106	309.637471	0.054307	2.631914	-0.08706
48	108	309.530396	0.107074	4.148214	-0.05067
49	110	309.194294	0.336102	2.62	-0.13212
50	112	309.136708	0.057586	7.418696	-0.05247
51	114	308.784901	0.351807	3.08692	-0.0642
52	115	308.701725	0.083177	2.688279	-0.12939
53	117	308.650694	0.051031	2.338696	-0.04254
54	119	308.480678	0.170015	1.729385	-0.04997
55	121	308.452788	0.02789	3.163093	-0.0221
56	123	308.301812	0.150976	2.020734	-0.03144
57	125	308.270178	0.031634	1.76059	-0.02912
58	127	308.13409	0.136088	1.847726	-0.02807
59	128	308.113163	0.020926	2.039987	-0.03218
60	130	308.080093	0.03307	1.94436	-0.01899
61	132	307.939599	0.140495	2.050734	-0.04119
62	134	307.916281	0.023318	1.372354	-0.01384

Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
63	136	307.841727	0.074554	1.527798	-0.03201
64	137	307.82871	0.013017	0.892226	-0.02197
65	139	307.816653	0.012057	1.113121	-0.00701
66	141	307.767418	0.049235	1.371809	-0.01436
67	143	307.74417	0.023247	1.343331	-0.00826
68	145	307.694712	0.049458	1.109505	-0.02656
69	147	307.689201	0.005512	0.779033	-0.0043
70	149	307.666753	0.022447	0.848628	-0.00566
71	151	307.66236	0.004393	0.880807	-0.00486
72	153	307.645736	0.016624	1.138914	-0.00322
73	155	307.635911	0.009825	0.622503	-0.01145
74	157	307.632335	0.003576	0.374637	-0.00198
75	159	307.617861	0.014474	0.69128	-0.00443
76	161	307.611994	0.005867	0.997234	-0.00189
77	163	307.601879	0.010115	0.315243	-0.00714
78	165	307.599642	0.002237	0.60777	-0.00058
79	167	307.592041	0.007601	0.428961	-0.00311
80	169	307.590493	0.001548	0.400773	-0.00081
81	171	307.585476	0.005017	0.387616	-0.00181
82	173	307.584246	0.001231	0.344414	-0.00067
83	175	307.5787	0.005546	0.337091	-0.00151
84	177	307.577825	0.000875	0.24589	-0.00042
85	179	307.573795	0.00403	0.180963	-0.00114
86	181	307.573445	0.00035	0.207096	-0.00039
87	183	307.571134	0.002311	0.217313	-0.00034
88	184	307.569303	0.001831	0.223568	-0.00274
89	186	307.568664	0.000639	0.305757	-0.00088
90	189	307.565596	0.003068	0.191135	-0.00034
91	190	307.564717	0.000879	0.188941	-0.00126
92	192	307.56432	0.000396	0.215388	-0.00051
93	195	307.560836	0.003484	0.188148	-0.00027
94	197	307.56002	0.000816	0.311651	-0.00017
95	199	307.559411	0.00061	0.184131	-0.00068
96	201	307.559204	0.000207	0.142288	-0.0001
97	203	307.558352	0.000852	0.099882	-0.00027
98	205	307.558163	0.000189	0.367162	-0.00005
99	207	307.557089	0.001073	0.055645	-0.00029
100	209	307.557063	0.000027	0.06704	-0.00003
101	212	307.556834	0.000229	0.10845	-0.00002
102	214	307.556385	0.000449	0.079622	-0.00029
103	216	307.556328	0.000057	0.08069	-0.00002
104	218	307.555754	0.000574	0.039184	-0.00009
105	219	307.55568	0.000075	0.046242	-0.00013
106	221	307.555606	0.000074	0.059038	-0.00002
107	223	307.555277	0.000329	0.075303	-0.00015
108	225	307.554956	0.000321	0.075593	-0.00028
109	228	307.554039	0.000917	0.072262	-0.00002
110	229	307.554007	0.000032	0.07202	-0.00005
111	231	307.553942	0.000065	0.143299	-0.00004
112	234	307.55312	0.000822	0.058615	-0.00009
113	236	307.553097	0.000023	0.048371	-0.00001
114	239	307.552383	0.000715	0.034491	-0.00003
115	241	307.552375	7.692E-6	0.030817	-6.07E-6
116	244	307.552148	0.000227	0.045776	-9.4E-6
117	245	307.552137	0.000011	0.017969	-0.00002
118	247	307.552131	6.02E-6	0.020997	-1.93E-6

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	615.1
AIC (smaller is better)	775.1
AICC (smaller is better)	821.6
BIC (smaller is better)	1086.0

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
logR1972	-1.5283	0.4407	360	-3.47	0.0006	0.05	-2.3949	-0.6617	0.015408
logR1973	-0.7230	0.3687	360	-1.96	0.0507	0.05	-1.4481	0.002069	-0.01063
logR1974	-0.04336	0.3312	360	-0.13	0.8959	0.05	-0.6946	0.6079	0.005409
logR1975	-0.2061	0.3138	360	-0.66	0.5117	0.05	-0.8232	0.4110	-0.01331
logR1976	-0.05521	0.2951	360	-0.19	0.8517	0.05	-0.6355	0.5251	-0.01503
logR1977	0.5689	0.2755	360	2.06	0.0397	0.05	0.02705	1.1107	0.000408
logR1978	1.2249	0.2554	360	4.80	<.0001	0.05	0.7227	1.7271	-0.00111
logR1979	1.1464	0.2379	360	4.82	<.0001	0.05	0.6785	1.6142	-0.01022
logR1980	1.8842	0.2246	360	8.39	<.0001	0.05	1.4425	2.3259	-0.00184
logR1981	1.9955	0.2282	360	8.75	<.0001	0.05	1.5468	2.4442	-0.0026
logR1982	2.3786	0.2359	360	10.08	<.0001	0.05	1.9147	2.8425	0.001972
logR1983	1.7017	0.2375	360	7.16	<.0001	0.05	1.2346	2.1687	-0.00016
logR1984	1.8850	0.2415	360	7.81	<.0001	0.05	1.4102	2.3599	0.002768
logR1985	2.0857	0.2545	360	8.20	<.0001	0.05	1.5852	2.5861	0.006791
logR1986	2.2740	0.2586	360	8.79	<.0001	0.05	1.7655	2.7825	-0.00363
logR1987	2.4135	0.2750	360	8.78	<.0001	0.05	1.8727	2.9542	0.009187
logR1988	1.9617	0.2911	360	6.74	<.0001	0.05	1.3892	2.5343	-0.00291
logR1989	2.8597	0.3011	360	9.50	<.0001	0.05	2.2677	3.4518	-0.00043
logR1990	2.0478	0.3031	360	6.76	<.0001	0.05	1.4517	2.6440	0.006539
logR1991	0.9522	0.2905	360	3.28	0.0011	0.05	0.3810	1.5234	-0.00519
logR1992	1.3701	0.2699	360	5.08	<.0001	0.05	0.8393	1.9008	-0.00338
logR1993	1.3947	0.2515	360	5.54	<.0001	0.05	0.9000	1.8894	-0.00187
logR1994	1.4571	0.2404	360	6.06	<.0001	0.05	0.9843	1.9300	-0.0035
logR1995	1.4752	0.2201	360	6.70	<.0001	0.05	1.0423	1.9080	0.000112
logR1996	1.3917	0.2123	360	6.56	<.0001	0.05	0.9743	1.8091	0.000943
logR1997	2.1973	0.2126	360	10.34	<.0001	0.05	1.7793	2.6153	-0.00495
logR1998	2.1742	0.2138	360	10.17	<.0001	0.05	1.7539	2.5946	-0.00154
logR1999	1.4593	0.2157	360	6.77	<.0001	0.05	1.0351	1.8835	0.010612
logR2000	1.3265	0.2240	360	5.92	<.0001	0.05	0.8858	1.7671	-0.00551
logR2001	1.3488	0.2284	360	5.91	<.0001	0.05	0.8997	1.7979	-0.00753
logR2002	1.6309	0.2396	360	6.81	<.0001	0.05	1.1596	2.1021	0.002105
logR2003	1.5521	0.2535	360	6.12	<.0001	0.05	1.0535	2.0508	-0.00803
logR2004	2.0886	0.2706	360	7.72	<.0001	0.05	1.5565	2.6207	0.001228
logR2005	2.1050	0.2915	360	7.22	<.0001	0.05	1.5318	2.6783	0.004076
logR2006	2.6758	0.2825	360	9.47	<.0001	0.05	2.1202	3.2314	-0.00706
logR2007	1.8180	0.3021	360	6.02	<.0001	0.05	1.2240	2.4121	0.003865
logR2008	2.2230	0.3296	360	6.74	<.0001	0.05	1.5748	2.8712	-0.01183
logR2009	2.2832	0.3726	360	6.13	<.0001	0.05	1.5504	3.0159	0.003072
logR2010	1.2945	0.4501	360	2.88	0.0043	0.05	0.4094	2.1797	0.000138
logR2011	3.6168	0.6330	360	5.71	<.0001	0.05	2.3721	4.8616	-0.00306
f1983	-1.3813	0.2662	360	-5.19	<.0001	0.05	-1.9047	-0.8578	0.006647
f1984	-1.3772	0.2450	360	-5.62	<.0001	0.05	-1.8591	-0.8953	-0.00227
f1985	-1.3381	0.2294	360	-5.83	<.0001	0.05	-1.7892	-0.8869	0.001086
f1986	-1.2530	0.2215	360	-5.66	<.0001	0.05	-1.6887	-0.8174	0.002413
f1987	-1.1205	0.2171	360	-5.16	<.0001	0.05	-1.5474	-0.6936	-0.00269
f1988	-0.9333	0.2130	360	-4.38	<.0001	0.05	-1.3522	-0.5144	0.002285
f1989	-0.7517	0.2065	360	-3.64	0.0003	0.05	-1.1577	-0.3457	-0.00168
f1990	-0.5349	0.2029	360	-2.64	0.0087	0.05	-0.9339	-0.1360	-0.00118
f1991	-0.3255	0.2049	360	-1.59	0.1131	0.05	-0.7285	0.07752	0.006458
f1992	-0.2753	0.2088	360	-1.32	0.1883	0.05	-0.6860	0.1354	-0.00051
f1993	-0.3433	0.2196	360	-1.56	0.1189	0.05	-0.7753	0.08864	0.006621
f1994	-0.8866	0.2247	360	-3.95	<.0001	0.05	-1.3286	-0.4447	0.000062
f1995	-0.7790	0.2199	360	-3.54	0.0004	0.05	-1.2115	-0.3466	0.007758
f1996	-0.6806	0.2353	360	-2.89	0.0041	0.05	-1.1433	-0.2178	0.002555
f1997	-1.3580	0.2508	360	-5.41	<.0001	0.05	-1.8512	-0.8648	-0.00688
f1998	-1.3323	0.2327	360	-5.72	<.0001	0.05	-1.7900	-0.8746	-0.00818
f1999	-1.2855	0.2224	360	-5.78	<.0001	0.05	-1.7229	-0.8480	-0.00246
f2000	-1.2236	0.2167	360	-5.65	<.0001	0.05	-1.6498	-0.7973	-0.00073
f2001	-1.1406	0.2136	360	-5.34	<.0001	0.05	-1.5607	-0.7205	0.000707
f2002	-1.0590	0.2108	360	-5.02	<.0001	0.05	-1.4736	-0.6444	0.008097
f2003	-0.9837	0.2097	360	-4.69	<.0001	0.05	-1.3962	-0.5713	0.003022
f2004	-0.8890	0.2115	360	-4.20	<.0001	0.05	-1.3048	-0.4731	0.004754
f2005	-0.8030	0.2112	360	-3.80	0.0002	0.05	-1.2184	-0.3876	0.00632
f2006	-0.7292	0.2077	360	-3.51	0.0005	0.05	-1.1377	-0.3206	0.006489
f2007	-0.6763	0.2066	360	-3.27	0.0012	0.05	-1.0826	-0.2699	0.003642

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
f2008	-0.6650	0.2033	360	-3.27	0.0012	0.05	-1.0648	-0.2652	0.004096
f2009	-0.6474	0.2022	360	-3.20	0.0015	0.05	-1.0450	-0.2497	-0.00027
f2010	-0.6554	0.2080	360	-3.15	0.0018	0.05	-1.0643	-0.2464	0.000697
f2011	-0.6774	0.2235	360	-3.03	0.0026	0.05	-1.1170	-0.2379	0.001454
s1	-1.3178	0.5302	360	-2.49	0.0134	0.05	-2.3605	-0.2751	0.002282
s2	-1.2548	0.4443	360	-2.82	0.0050	0.05	-2.1286	-0.3811	0.014216
s3	-1.1015	0.3834	360	-2.87	0.0043	0.05	-1.8554	-0.3476	-0.00963
s4	-0.8497	0.3372	360	-2.52	0.0122	0.05	-1.5128	-0.1867	0.007754
s5	-0.4400	0.2853	360	-1.54	0.1239	0.05	-1.0011	0.1210	0.003737
s7	0.3171	0.2688	360	1.18	0.2390	0.05	-0.2116	0.8457	0.018
s8	0.5026	0.2690	360	1.87	0.0625	0.05	-0.02640	1.0315	0.008223
s9	0.4897	0.2503	360	1.96	0.0512	0.05	-0.00255	0.9819	-0.01078
s10	0.3803	0.2446	360	1.55	0.1209	0.05	-0.1007	0.8613	0.019468
s11	0.3248	0.2536	360	1.28	0.2011	0.05	-0.1739	0.8234	0.004201
S_std	0.6326	0.02501	360	25.30	<.0001	0.05	0.5835	0.6818	-0.021

Total Error Sum of Squares = 186.3440234

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_5	recruit_U95
1	1983	10.79	6.78	17.16
2	1984	5.48	3.44	8.75
3	1985	6.59	4.10	10.59
4	1986	8.05	4.88	13.28
5	1987	9.72	5.84	16.16
6	1988	11.17	6.51	19.19
7	1989	7.11	4.01	12.61
8	1990	17.46	9.66	31.56
9	1991	7.75	4.27	14.07
10	1992	2.59	1.46	4.59
11	1993	3.94	2.31	6.69
12	1994	4.03	2.46	6.62
13	1995	4.29	2.68	6.89
14	1996	4.37	2.84	6.74
15	1997	4.02	2.65	6.10
16	1998	9.00	5.93	13.67
17	1999	8.80	5.78	13.39
18	2000	4.30	2.82	6.58
19	2001	3.77	2.43	5.85
20	2002	3.85	2.46	6.04
21	2003	5.11	3.19	8.18
22	2004	4.72	2.87	7.77
23	2005	8.07	4.74	13.74
24	2006	8.21	4.63	14.56
25	2007	14.52	8.33	25.32
26	2008	6.16	3.40	11.16
27	2009	9.24	4.83	17.66
28	2010	9.81	4.71	20.41
29	2011	3.65	1.51	8.84
30	2012	37.22	10.72	129.23

Population Estimates

Obs	year	rssb_ Brec	rssb_ tvalue	rssb_ Brec_L	rssb_ Brec_U	rbms_ Brec	rbms_ tvalue	rbms_ Brec_L	rbms_ Brec_U
1	1983	1.42906	1.55474	0.90976	2.24478	1.42053	1.75573	0.95872	2.10480
2	1984	1.47316	1.96411	0.99951	2.17125	1.67872	2.87431	1.17774	2.39281
3	1985	1.63538	2.59798	1.12698	2.37312	2.04652	4.07242	1.44819	2.89204
4	1986	1.59477	2.50156	1.10497	2.30170	2.07587	4.16948	1.47092	2.92962
5	1987	1.54457	2.32164	1.06875	2.23224	2.10626	4.19784	1.48578	2.98587
6	1988	1.65489	2.65420	1.13940	2.40359	2.18368	4.34594	1.53357	3.10938
7	1989	1.88383	3.22482	1.28031	2.77184	2.16713	4.36077	1.52901	3.07157
8	1990	1.76934	2.82131	1.18871	2.63359	2.06048	4.24755	1.47436	2.87961
9	1991	1.46031	1.94747	0.99629	2.14043	1.69364	3.33750	1.24163	2.31021
10	1992	1.24817	1.36299	0.90650	1.71862	1.38829	2.81150	1.10362	1.74639
11	1993	1.02395	0.24220	0.84492	1.24091	1.07736	1.08130	0.94082	1.23370
12	1994	1.00000	.	0.00000	0.00000	1.00000	.	0.00000	0.00000
13	1995	1.41566	3.83166	1.18435	1.69214	1.19153	2.82635	1.05475	1.34604
14	1996	1.45866	2.49958	1.08383	1.96312	1.19248	1.49181	0.94552	1.50396
15	1997	1.18453	0.77585	0.77113	1.81955	0.99840	-0.00890	0.70027	1.42345
16	1998	1.30234	1.35216	0.88689	1.91240	1.11479	0.65628	0.80496	1.54388
17	1999	1.48740	2.14110	1.03289	2.14192	1.29109	1.57230	0.93794	1.77720
18	2000	1.57650	2.52272	1.10556	2.24806	1.45937	2.33633	1.06165	2.00609
19	2001	1.63261	2.77373	1.15332	2.31109	1.69397	3.23422	1.22947	2.33396
20	2002	1.87969	3.53113	1.32264	2.67136	1.72568	3.21284	1.23571	2.40992
21	2003	2.23333	4.38094	1.55708	3.20329	1.77449	3.32442	1.26396	2.49124
22	2004	2.26021	4.42691	1.57335	3.24693	1.69366	3.04144	1.20467	2.38113
23	2005	1.88857	3.44928	1.31431	2.71373	1.46991	2.23365	1.04714	2.06338
24	2006	1.46899	2.07837	1.02090	2.11375	1.22595	1.18105	0.87328	1.72105
25	2007	1.19614	0.96444	0.83019	1.72341	1.15155	0.81489	0.81920	1.61875
26	2008	0.94897	-0.28229	0.65883	1.36687	1.10465	0.56713	0.78224	1.55995
27	2009	0.89494	-0.60360	0.62337	1.28484	1.31269	1.51484	0.92207	1.86878
28	2010	1.06511	0.33713	0.73721	1.53885	1.43244	1.95088	0.99711	2.05782
29	2011	1.39886	1.71008	0.95090	2.05786	1.47334	2.07822	1.02104	2.12601
30	2012	1.64427	2.34877	1.08428	2.49346	1.55989	2.28933	1.06469	2.28543