Fisheries and Oceans Canada / Pêches et Océans Canada
Science / Sciences

C S A S / **S C C S**

Canadian Science Advisory Secretariat / **Secrétariat canadien de consultation scientifique**

Research Document 2010/102 / **Document de recherche 2010/102**

Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2009 – results from a Zonal Assessment Process (February/March 2009) and a Regional Assessment Process (September/ October 2009)

Évaluation de l'état du stock de morue (*Gadus morhua*) dans la sous-division 3Ps de l'OPANO en 2009 – résultats d'un processus d'évaluation zonale (février-mars 2009) et d'un processus d'évaluation régionale (septembre-octobre 2009)

B.P. Healey[1], E.F. Murphy[1], J. Brattey[1], N.G. Cadigan[1], M. J. Morgan[1], D. Maddock Parsons[1], D. Power[1], K. Dwyer[1], and J.-C. Mahé[2]

[1]Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's NL A1C 5X1

[2]IFREMER
Station de Lorient
8, rue François Toullec 56100
Lorient, France

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.

La présente série documente les fondements scientifiques des évaluations des ressources et des écosystèmes aquatiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Research documents are produced in the official language in which they are provided to the Secretariat.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au Secrétariat.

This document is available on the Internet at:

Ce document est disponible sur l'Internet à:

http://www.dfo-mpo.gc.ca/csas/

ISSN 1499-3848 (Printed / Imprimé)
ISSN 1919-5044 (Online / En ligne)

Canada

TABLE OF CONTENTS

Correct citation for this publication:

Healey, B.P., Murphy, E.F., Brattey, J., Cadigan, N.G., Morgan, M.J., Maddock Parsons, D., Power, D., Dwyer, K., and Mahé, J-C. 2011. Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2009 – results from a Zonal Assessment Process (February/March 2009) and a Regional Assessment Process (September/October 2009). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/102. viii + 91 p.

ABSTRACT

The status of the cod stock in Subdiv. 3Ps was assessed during two separate meetings held in 2009. A zonal assessment process (ZAP) to review the status of five Atlantic Cod stocks including cod in Subdiv. 3Ps was held during February/March of 2009. A regional assessment process (RAP) was held during September/October of 2009, in which stock status was updated based upon information collected and analyzed during the spring and summer of 2009. Principal sources of information available for the assessments were: reported landings from commercial fisheries, oceanographic data, a time series of abundance and biomass indices from Canadian winter/spring research vessel bottom-trawl surveys, inshore sentinel surveys, science logbooks from vessels < 35ft, industry logbooks for larger (> 35 ft) vessels, and tagging studies. The total allowable catch (TAC) for the 2008/09 fishing season was set at 13,000 t. The TAC was lower for the 2009/10 season, set as 11,500 t. Commercial landings for the 2008/2009 fishery totaled 12,600 t. The 2009/10 fishery was still in progress at the time of the RAP with provisional landings totals of 3,100 t. The removals through recreational fishing is unknown for both 2008 and 2009, but is thought to be a small (~1%) fraction of the commercial landings.

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

Zonal Assessment Process, February/March 2009:

Total biomass from the DFO RV surveys indicates a decline since 2004. The 2008 biomass estimate is less than 50% of the average for 1997-2008. The survey spawning stock biomass (SSB) is in decline and is near the lowest levels observed. Annual total mortality rates (age 5 - 11) inferred from the DFO RV survey increased from an average of 23% in 1997-2004 to an average of 55% in 2005-07. This high value is a concern. Although the trend in natural mortality is unknown, fishing mortality (as inferred from tagging exploitation rates) has increased. Indices from fixed-gear Sentinel surveys conducted shoreward of the DFO RV and industry trawl surveys have been stable in recent years. Recent year-classes supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. Although preliminary indications are that the 2006 cohort is strong, this cohort will not recruit to the fishery until 2011. Cohort modeling of the survey data indicates that survey SSB has been decreasing in recent years and in 2008 was just above the limit reference point ($B_{Recovery}$). If the management goal is to stop the current decline in offshore biomass then a reduction in TAC to 10,000 t is considered the minimum necessary, notwithstanding the uncertainties about survivorship and absolute size of biomass. If the management objective is to ensure growth in offshore biomass, then an even greater reduction is considered necessary.

Regional Assessment Process, September/October 2009:

Cohort analysis of the DFO RV survey data indicated that SSB has declined by 13% per year over 2004-09. It is too early to assess the effect on SSB of the recent reduction in TAC to 11 500 t for the 2009/10 management year. However if the management goal is to ensure growth in SSB, then a further reduction in TAC would increase the probability of growth.

Overall, the findings of the current assessment are consistent with those of previous assessments. However, the current status and recent trends in the stock are somewhat more uncertain due to the nature of the change in the survey index between 2008 and 2009. Several consecutive year-classes (1999-2005) have been relatively weak and are supporting the majority of total landings. This has lead to increased exploitation rates in the offshore, and contributed to an overall reduction in stock size. The 2006 year-class is again estimated to be strong. The probability that the SSB in 2009 is below the LRP varies from 20% to 40% depending on assumptions regarding the catchability of different age fish by the survey.

RÉSUMÉ

L’état du stock de morue dans la sous-division 3Ps a été évalué lors de deux réunions distinctes tenues en 2009. Un processus d’évaluation zonale (PEZ) a été mené en février-mars 2009 dans le but de passer en revue l’état de cinq stocks de morue de l’Atlantique, y compris la morue dans la sous-division 3Ps. Un processus d’évaluation régionale (PER) a été mené en septembre-octobre 2009, au cours duquel l’état du stock a été mis à jour à partir des données recueillies et analysées au printemps et à l’été 2009. Voici les principales sources de données utilisées dans les évaluations : les débarquements signalés des pêches commerciales, les données océanographiques, 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, relevés côtiers de pêches sentinelles, des journaux de bord de navires de recherche scientifique de < 35 pi et des journaux de bord de navires de pêche commerciale de > 35 pi, ainsi que des expériences de marquage. Le total autorisé des captures (TAC) pour la saison de pêche 2008-2009 était fixé à 13 000 t. Le TAC était inférieur pour la saison 2009-2010, soit 11 500 t. Les débarquements de pêches commerciales pour 2008-2009 totalisaient 12 600 t. Au moment du PER, la saison de pêche 2009-2010 était toujours en cours, et les données provisoires sur les débarquements totaux s’établissaient à 3 100 t. On ignore le nombre de prises dans le cadre de la pêche récréative en 2008 et en 2009, mais on croit qu’il représente une faible fraction (~1 %) des débarquements commerciaux.

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

Processus d’évaluation zonale, février-mars 2009 :

La biomasse totale dérivée des relevés par le navire de recherche du MPO indique un déclin depuis 2004. Les estimations de la biomasse de 2008 sont inférieures à 50 % de la moyenne pour 1997-2008. La biomasse du stock reproducteur (BSR) dérivée des relevés est en déclin et s’approche des niveaux les plus bas observés. Les taux de mortalité totale annuelle (de 5 à 11 ans) dérivés des relevés par navire de recherche du MPO sont passés d’une moyenne de 23 % pour 1997-2004 à une moyenne de 55 % pour 2005-2007. Cette valeur élevée soulève des inquiétudes. Même si la tendance relative à la mortalité naturelle demeure inconnue, la mortalité par la pêche s’est accrue (comme l’indiquent les taux d’exploitation établis par marquage). Les indices du relevé de pêche sentinelle à la palangre effectué à proximité des côtes par le navire de recherche du MPO, tout comme ceux du relevé au filet maillant de l’industrie, sont restés stables au cours des dernières années. Les classes d'âge récentes qui alimentent la pêche sont relativement faibles par rapport aux fortes cohortes de 1997 et 1998. Bien que, selon les indications préliminaires, la cohorte de 2006 semble forte, elle ne sera pas recrutée à la pêche avant 2011. La modélisation des données sur la cohorte montre que la BSR de la cohorte dérivée de relevés a diminué au cours des dernières années et, en 2008, était juste au-dessus du point de référence limite ($B_{\text{Rétablissement}}$). Si l’objectif de gestion est d’arrêter le déclin actuel de la biomasse au large, une diminution du TAC à 10 000 t sera le minimum nécessaire, nonobstant les incertitudes concernant la capacité de survie et la taille absolue de la biomasse. Si l’objectif de gestion est d’assurer la croissance de la biomasse au large, il faudra appliquer une réduction encore plus grande du TAC.

Processus d’évaluation régionale, septembre-octobre 2009:

L’analyse des données sur la cohorte dérivées de relevés du navire de recherche du MPO indique que la BSR a diminué de 13 % par année entre 2004 et 2009. Il est trop tôt pour évaluer l’effet sur la BSR de la récente réduction du TAC à 11 500 t pour l’année de référence 2009-2010. Cependant, si l’objectif de gestion est d’assurer la croissance de la BSR, une réduction encore plus grande du TAC améliorerait la possibilité de croissance.

Globalement, les conclusions de cette évaluation confirment celles des évaluations antérieures. Toutefois, l’état actuel et les récentes tendances du stock présentent davantage d’incertitudes en raison de la nature du changement apporté aux indices relevés entre 2008 et 2009. Plusieurs classes d’âge consécutives (1999-2005) ont été relativement faibles et alimentent la majorité des débarquements. Cela a contribué à la hausse des taux d’exploitation au large et à la réduction globale de la taille du stock. La classe d’âge pour l’année 2006 est de nouveau considérée forte. La probabilité qu’en 2009, la BSR soit inférieure au LRP varie de 20 % à 40 %, selon les hypothèses concernant la capturabilité de poissons d’âges différents au cours du relevé.

INTRODUCTION

This document gives an account of the two assessments during 2009 of the Atlantic cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps located off the south coast of Newfoundland (Fig. 1 and 2). A zonal assessment meeting was conducted in St. John's, Newfoundland over February 24 – March 6, 2009 at which five Atlantic cod stocks were assessed. Further, a regional assessment meeting (3Ps cod only) was conducted September 29 – October 2, 2009, returning to more typical assessment timing. The history of the cod fishery in NAFO Subdiv. 3Ps and results from other recent assessments of this stock are described in previous documents (Pinhorn 1969; Bishop et al. 1991, 1992, 1993, 1994, 1995; Shelton et al. 1996; Stansbury et al. 1998; Brattey et al. 1999a, 1999b, 2000, 2001a, 2002a, 2003, 2004, 2005, 2007, 2008).

The two assessments of this stock during 2009 incorporated various sources of information on 3Ps cod. The 2008-09 commercial fishery was mostly complete at the time of the zonal assessment meeting (February/March 2009), and detailed information on catch-at-age was available. In contrast, the 2009-10 commercial fishery was still in progress at the time of the regional assessment meeting (September/October 2009) and hence the complete catch-at-age for 2009 was not available. The results of research vessel surveys during April 2008 and April 2009 were presented during the regional and zonal assessment meetings, respectively, and were compared to previous survey results. Additional sources of information included science logbooks for vessels <35 ft (1997-2008), industry logbooks for vessels >35 ft (1998-2008), an industry trawl survey on St. Pierre Bank from 1997 to 2005 (McClintock 2011) inshore sentinel surveys from 1995 to 2008 (Maddock Parsons and Stead 2009), and recaptures of tagged cod (received up to September 2009) from tagging conducted in 3Ps during 1997-2009 (Brattey and Healey 2006). A survey-based assessment model was used to smooth signals in the research-vessel (RV) survey, and provided estimates of biomass, total mortality and recruitment for that portion of the stock covered by the DFO RV survey.

ENVIRONMENTAL OVERVIEW

Oceanographic data collected during the DFO bottom-trawl multi-species survey in April 2009 indicated that bottom temperatures throughout subdivision 3Ps during spring 2009 were warmer than those during spring 2008. A detailed evaluation of temperatures during the 2009 spring survey was not available. Near-bottom temperatures of 2008 decreased to below normal values in many areas particularly on St. Pierre Bank, where the area of <0°C water increased to near 30%. 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. Spring bottom temperatures were below normal in 2008. Also, the area of bottom habitat covered by <0°C water was above normal in 2007 and 2008. These conditions are less favourable than those of the late 1970's and early 1980's when the stock was more productive.

An examination of oceanographic data collected in NAFO Div. 3P during 1973-2007 are described in detail in Colbourne and Murphy (2008). They stated "Temperature measurements on St. Pierre Bank show anomalous cold periods in the mid-1970s and from the mid-1980s to mid-1990s. Beginning in 1996 however, temperatures moderated, decreased again during the spring of 1997 and returned to normal values during 1998. During 1999 and 2000 temperatures continued to increase, reaching the highest values observed since the late 1970s in some regions. During 2001-2003 however, temperatures cooled significantly to values observed during the mid-1990s with the average temperature during the spring of 2003 the coldest in about 13 years. Temperatures during both 2004 and 2005 warmed considerably over 2003 values to 1°C above normal in some areas. The areal extent of <0°C bottom water during 2003 increased to the highest in about 13 years but decreased during 2004 and 2005 to <10%, the lowest since 1988. On St. Pierre Bank bottom water with temperatures <0°C almost completely disappeared during the warm years of 1999, 2000, 2004 and 2005. During the spring of 2007 however, near-bottom temperatures decreased to below normal values in many areas particularly on St. Pierre Bank, where the area of <0°C water increased to near 30%. 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."

TOTAL ALLOWABLE CATCHES and COMMERCIAL CATCH

TOTAL ALLOWABLE CATCH

A history of the total allowable catch (TAC) for this stock over 1959-2009 is presented in Table 1 (see also Fig. 1). This stock was subject to a moratorium on all fishing from August 1993 to the end of 1996. The TAC was set at 13,000 t for management years 1 April 2006-31 March 2007 through 1 April 2008-31 March 2009. Following the zonal assessment meeting, the TAC for the 1 April 2009-31 March 2010 management year was set at 11,500 t.

COMMERCIAL CATCH

Catches (reported landings) from 3Ps for the period 1959 to 25 September 2009 are summarized by country and separately for fixed and mobile gear in Table 1 and Fig. 3a and 3b. Prior to the moratorium, Canadian landings for vessels <35 ft were estimated mainly from purchase slip records collected and interpreted by Statistics Division, Department of Fisheries and Oceans. Shelton et al. (1996) emphasized that these data may be unreliable. Post-moratorium landings for Canadian vessels <35 ft have come mainly from a dock-side monitoring program initiated in 1997. Landings for Canadian vessels >35 ft come from logbooks. Non-Canadian landings (only France since 1997) are compiled from national catch statistics reported by individual countries to NAFO and there is generally a lag in the submission of final statistics; consequently, the most recent entries in Table 1 are designated as provisional. In some instances, the provisional information is provided by French government officials.

The stock in the 3Ps management unit was heavily exploited in the 1960's and early 1970's by non-Canadian fleets, mainly from Spain and Portugal, with reported landings peaking at about 87,000 t in 1961 (Table 1, Fig. 3a). After extension of jurisdiction (1977), cod catches averaged between 30,000 t and 40,000 t until the mid-1980s when increased fishing effort by France led to increased total reported landings, 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 1980's and into the 1990's. The Canada-France boundary dispute 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, the majority being taken by the Canadian inshore fixed gear fishery (where inshore is typically defined as unit areas 3Psa, b, and c; Fig. 1). Access by French vessels to Canadian waters was restricted in 1993. Under the terms of the 1994 Canada-France agreement, the French share of the TAC is 15.6%.

Since 1997, most of the TAC has been landed by Canadian inshore fixed gear fishermen, with remaining catch taken mainly by the mobile gear sector fishing the offshore, i.e. unit areas 3Psd, e, f, g, h (Table 1, Fig. 1, 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. During the 2007 calendar year, total reported landings were 12,959 t with the Canadian inshore fixed gear sector accounting for 9,303 t (72%) of the total (Table 1). In 2008, reported landings totaled 11,773 t, 74% of which was landed by Canadian inshore fixed gear fishers (Table 1). Preliminary landings data for 2009 to September 25th totaled 6,370 t. Although the 2009/10 fishing season is incomplete, these totals to date are relatively low due to reductions in fishing effort (DFO, 2009b). Further, the offshore mobile gear sector typically fishes in the late fall and early winter and this allocation had yet to be taken; inshore landings are also typically high in late fall (see below).

Line-trawl (=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 to 23% of the fixed gear landings. Gillnet landings increased steadily from about 2,300 t in 1978 to a peak of over 9,000 t in 1987, but declined thereafter until the moratorium. Gillnets have been responsible for the dominant portion of the inshore catch since the fishery reopened in 1997, with gillnet landings exceeding 10,000 t (i.e. 50% of the TAC) for the first time in 1998, and approaching 18,000 t in 1999. Gillnets have typically accounted for 70-80% of the fixed gear landings since 1998. Gillnets accounted for a lower percentage of the fixed gear landings in 2001 (60%), partly due to a 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). Trap catches have varied over the time period, but have not exceeded 8,000 t and have declined from 1,167 t to negligible amounts (<120 t) from 1998 onwards. Hand-line catches were a small component of the inshore fixed gear fishery prior to the moratorium (about 10-20%) and accounted for <5% of landings during most of the post-moratorium period. However, hand-line catch for 2001 shows a substantial increase (to 17% of total fixed gear) compared with the 1998-2000 period and this may reflect the temporary restriction in use of gillnets described above.

A summary of reported landings for 2007, 2008 and 2009 (to September 25th) by month and unit area is provided in Table 3. In general, the spatial-temporal pattern is similar in 2007 and 2008. Inshore landings are low in March and April, mostly arising from by-catch of cod in other fisheries. The vast majority of landings from the inshore areas (3Psa, b, c) are taken in June – November, with highest landings in the summary months, particularly in 3Psb and 3Psc.

In the offshore, monthly landings tended to be more variable among unit areas. Landings from 3Psh show similar patterns over both years, with relatively low effort through the spring and summer, but with considerable landings in the late fall/early winter otter trawl fisheries. Landings from 3Pse and 3Psf were also high (>900 t) in late summer and fall from vessels fishing gillnets.

The distribution of post-moratorium catches among unit areas is illustrated in Fig. 5. The inshore (3Psa, 3Psb, and 3Psc) has consistently accounted for most of the reported landings. These have typically been highest in Placentia Bay (3Psc), ranging from 4,000 t to almost 11,650 t with typically 28-51% of the entire 3Ps catch coming from this unit area alone. This percentage had steadily declined over 1999-2005, but has increased in the most recent three years and is now presently 40% of the 3Ps total landings. Landings from 3Psa and 3Psb have been fairly consistent at about 1,100-3,200 t and generally between 7-12% and 9-18% of the TAC, respectively. Most of the offshore landings have come from 3Psh and 3Pse/f (Halibut Channel and the southeastern portion of St. Pierre Bank). The percentage of total landings from 3Psf has declined considerably in recent years, most particularly 2008. Notably, the landings from 3Pse exceeded those from 3Psf during 2008. Unit area 3Psg continues to have the lowest landings (<4% of the annual total each year since 1997).

The 2007/08 and 2008/09 (1st of April to 31st of March) conservation harvesting plans placed various seasonal and gear restrictions on how the 3Ps cod fishery in Canadian waters could be pursued. Full details of these measures, which differ among gear sectors, are available from DFO Fisheries and Aquaculture Management (FAM) in St. John's.

CATCH-AT-AGE

Samples of length and age composition of catches were obtained from the inshore gillnet, line-trawl and hand-line fisheries and the offshore otter trawl, gillnet, and line-trawl fisheries by port samplers and fishery observers. Additional sampling was obtained from the sentinel fishery. Sampling of the Canadian and French (St. Pierre and Miquelon, SPM) catches in 2007 was undertaken, with 76,535 and 14,259 fish measured for length from Canadian and French catches, respectively; in addition, 6,929 and 665 otoliths were examined for age determination (Table 4). During 2008, 42,182 and 14,082 fish were measured for length from the Canadian and French catches, respectively; with 7,958 and 469 otoliths collected. The changes in Canadian sampling totals resulted from reduced sampling efforts. Sampling in each year was well distributed spatially and temporally across the gear sectors. Substantial landings in summer from inshore fixed gears were sampled intensively, particularly line-trawl and gillnet. The winter offshore otter trawl fishery was also sampled heavily, particularly in the first quarter. Sampling of lengths and ages of the Canadian and French catches during January-March 2009 was also undertaken, but data were not available at the time of the assessment meetings, but will be considered in future assessments.

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

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

Catch-at-age for all gears combined based on sampling of Canadian and French vessels in 2007 and 2008 is summarized in Tables 5a and 5b and also Fig. 6a and 6b. Catch-at-age data for the French catch was provided by colleagues in SPM. During the Feburary/March 2009 Zonal Cod assessment, a research recommendation highlighted a need to further examine discrepancies in age determinations from French and Canadian technical staff. To maintain consistency in the age-class information in the catch-at-age matrix, the Canadian age readings were applied to the length frequencies from the French otter trawl fisheries of 2007 and 2008. The catch-at-age for the French inshore fisheries uses the French age interpretations and this inconsistency will be rectified in future years. This is not a serious issue given that the proportion of the total landings from the French inshore fleet in 2007 and 2008 is less than 5%.
In the 2007 landings from all gears combined, a wide range of ages are represented (4-17 year olds) but most of the catch is comprised of ages 4-10 (Table 5a, Fig. 6a). The age composition of the 2007 catch is consistent with that of the previous five years, with the 1997 and 1998 year classes (ages 10 and 9) strongly represented (Fig. 6b). The most abundant age in 2007 was 6

yr olds with over 1.0 million individuals taken (23% of total by numbers). The proportion of younger cod (ages 3-5) in the catch in 2007 was 23%, similar to that in 2006. The percentage of older ages (>10 yr old) in 2007 (14%) was much higher than that from 2006 (8%), due to the contribution from the 1997 year class noted previously.

In 2008, the catch at age is again comprised of a wide range of ages with a similar age distribution to the 2007 catch. Again, age 6 was the modal age, with more than 1.0 million individuals landed comprising 23% of the total fish caught (Table 5b). Detailed information on the catch from the first three months of 2009 was not available at the time of the assessment; this catch is typically taken mainly by mobile gear in the offshore.

Catch at age for the three main gear types, and for all gears combined for 2007 and 2008, is illustrated in Fig. 7a and Fig. 7b. All gears catch a range of ages, but the dominance of gillnet selectivity on ages 5-9 is evident in the 2007 catch-at-age, whereas line-trawls caught mostly younger fish (ages 4-7). Atypically, the modal age for otter trawl catches in 2007 was age 5; usually otter trawl catches consist of older fish although 48% of the otter trawl catch in 2007 was age 8 or older. Gillnet catches in 2008 were dominated by cod ages 6-8, making up 71% of the number of fish caught by gillnets. The age composition of linetrawl catches in 2008 is quite similar to that of 2007. One notable difference is the contribution of the age 3 cod in 2008 – only 1% of the total numbers, compared to 7% in 2007. Otter trawl catches in 2008 were dominated by young cod which is highly unusual. In fact, 62% of the total numbers caught were age 6 or younger. The switch to younger ages in otter trawl catches with limited changes to the timing or location of most of this effort (localized in the Halibut Channel in unit area 3Psh) highlights that the relatively strong 1997 and 1998 year-classes are no longer contributing substantially to the otter trawl catch. Comparison of catch-at-age from the French otter trawl fishery in both 2007 and 2008 revealed substantial difference between the age interpretations conducted by France and by Canada. As such, a research recommendation to investigate these differences was proposed and accepted during the zonal assessment meeting in February/March 2009. During the regional assessment process of September/October 2009, it was reported that an aging exchange had taken place between technical staff in IFREMER (Boulogne, France) and DFO (both Mont-Joli, QC, and St.John's, NL), with results to be presented at the next assessment of this stock.

A time series of catch numbers-at-age (ages 3-14 shown) for the 3Ps cod fishery from 1959 to 2008 is given in Table 6. As noted in recent assessments (e.g. Brattey et al. (2008)), there are discrepancies in the sum of the product check for the 1959-76 catch-at-age 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. Further investigation is ongoing to check the fixed weights used for the 1959-76 period and to check the sampling protocols to see if either contributed to the discrepancies. Until these discrepancies are resolved, it is recommended that catch at age prior to 1977 not be used in population analyses.

The catch-at-age data indicate that in the pre-moratorium period the landings were dominated by young fish, typically aged 4-6, whereas in the post moratorium period slightly older ages (i.e. ages 5-8) have been more common; this probably reflects the switch in dominant gears from line-trawl and traps to gillnet. During the 2007 fishery, several age groups contributed strongly to the fishery, with ages 6 to 10 providing roughly equal contributions to the total landed weight. This age range includes both the 1997 and 1998 year-classes, which were ages 10 and 9, respectively. In contrast, the landings of the 2008 fishery were more strongly supported by younger fish; 52% of the total weight landed were from ages 6-8, compared to 41% in 2007 (Tables 5a, 5b).

WEIGHT-AT-AGE

Mean weights-at-age in the 3Ps fishery (including landings from the commercial and food fisheries and the sentinel surveys) are given in Table 7a and Fig. 8a. Beginning of the year weights-at-age are given in Table 7b and Fig. 8b. 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. The annual means by gear vary considerably; for example, mean weights-at-age in the 2002 3Ps fishery tended to be least in hand-line and greatest in offshore mobile gear (predominantly otter trawl) (Brattey et al. 2003), with the weight of the 1994 year-class at age 8 in the former being less than half the weight in the latter.

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

SENTINEL SURVEY

The sentinel survey has been conducted in 3Ps since 1995 and there are now fourteen complete years of catch and effort data (see Maddock Parsons and Stead 2009). 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 2008, there were 15 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 5 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 and Stead (2001, 2003a, 2003b, 2004, 2005, 2006, 2007, 2009) have produced a time series of weekly average catch rates and annual relative length frequencies (number of fish at length divided by amount of gear). Catch rates for 5½" gillnets in 2007 and 2008 remained low and similar to those reported for 1999-2006. Line-trawl catch rates in 2007 and 2008 were slightly below the 2006 level, and remain comparable to 1999-2005 levels.

As in previous assessments, an age dis-aggregated index of abundance was produced for the fourteen completed years in gillnet (5½" mesh) and line-trawl sectors of the program; there is insufficient data from the 3¼" gillnets to develop an index for this gear.

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 (1995-2008) 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. Over 2003-2008, there are fewer otoliths available for aging; annual sample sizes range between 248 and 454 otoliths per year from gillnet catches (compared to an average of 1050 otoliths during 1995-2002). From line-trawl there were <700 otoliths per year during 2003 and 2004, but the numbers increased to 1,132 otoliths during 2005 and to 1,160 during 2006. However, less than 1000 cod have been sampled from line-trawl effort in both 2007 and 2008. These variations are generally reflective of annual differences in the numbers of fish caught, although there has been some change in the proportion of sampled fished aged over the duration of the Sentinel program.

Catch-at-age and catch per unit effort (CPUE) data were standardized using a generalized linear model to remove site and seasonal effects. For gillnets, only sets at fixed sites during June to November with a soak time between 12 and 32 hours were used in the analysis. For line-trawl, sets at fixed sites during June to November with a soak time less than or equal to 24 hours were used in the analysis. (During the 2007 assessment of this stock, a re-evaluation of the data screening criteria led to inclusion of additional data in the standardization. The maximum soak time for linetrawls was increased from 12 to 24 hours. In addition, gillnet catches for June, and linetrawl catches during June and July were included in the dataset being modeled, and these revised criteria were applied to the current analysis. This change to the screening criteria was not reported by Brattey et al. (2007).) Prior to modeling, data are aggregated within a gear-division-site-month-year-age cell. Zero catches were generated for ages not observed in a set as sets with effort and no catch are valid entries in the model. Note that catch rates from the sentinel fishery are expressed in terms of numbers of fish, rather than catch weight as was used in the analyses of logbook data. This has important implications when comparing trends in these indices.

A generalized linear model (McCullagh and Nelder, 1989) was applied to the sentinel catch and effort data for each gear type. The 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.

Trends in standardized total (ages 3-10 combined) annual catch rates, expressed in terms of numbers of fish, are shown in Fig. 9a. For gillnets there is no trend over the period 1995-97, but catch rates declined rapidly from 1997 to 1999 then remained stable but low from 1999 to 2008. For line-trawls, catch rates show a decline from 1995, but have been relatively stable with no clear trend from 1997 to 2008.

Two standardized annual catch rate-at-age indices were also produced in the present assessment, one for each gear type. All effects included in the model were significant. The standardized gillnet and line-trawl catch rate-at-age indices for 1995-2008 are given in Table 8 and Fig. 9a and 9b. For gillnets, several year classes were well-represented in catches during 1995-97 but these are replaced by weaker year classes in subsequent years. Observe that the 1997 and 1998 year classes did not yield improvements in the sentinel gillnet catch rates over

2002-06, when these year-classes would have been within the peak selection range of 5½" gillnets.

For line-trawls, catch rates were higher for the 1989 and 1990 year-classes during 1995-96. In 2000-02, sentinel line-trawl catch rates improved for younger fish (3 and 4 year olds) compared to 1995-99, but those for older fish continued to decline. The estimates for age 3 in 2003, age 4 in 2004, and age 5 in 2005 (i.e. the 2000 cohort) are the lowest in the series for those ages. The estimates for ages 5-7 in sentinel line-trawl in recent years have improved slightly and reflect the appearance of the 1997 and 1998 year classes. The 1999 year class also appears reasonably strong at ages 4-5 then below average for age 6 in sentinel line-trawl; this year class is weak in sentinel gillnet and in other (mobile gear) indices. 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.s 9a and 9b).

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

As described in recent 3Ps cod assessments, interpretation of the sentinel catch rate indices is difficult. Sentinel fisheries were free from competitive influences during 1995-96 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, 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. 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. In contrast, the line-trawl catch rates, which mainly incorporate data from areas west of the Burin Peninsula, show less of a decline and rates show some indication of the appearance of the stronger 1997 and 1998 year classes. The cohort signals in the sentinel line-trawl are also reasonably consistent with the DFO RV survey index, the GEAC survey index (see below), and the commercial catch-at-age, all of which show that the 1997 and 1998 year classes were relatively strong.

SCIENCE LOGBOOKS (<35 ft sector)

A new science logbook was introduced to record catch and effort data for vessels <35 ft in the re-opened fishery in 1997. Prior to the moratorium, the only data for vessels <35 ft came from purchase slips, which provided limited information on catch and no information on effort. Since the moratorium, catch information comes from estimated weights and/or measured weights from the dockside monitoring program. Catch rates have the potential to provide a relative index of temporal and spatial patterns of fish density, which may relate to the overall biomass of the stock. Prior to the fall assessment meeting, there were about 134,000 records in the database. The total number of records has declined over time despite multi-year periods with no change in the TAC. (Annual numbers reported by Brattey et al. (2007) were not the total number of logbook records, but appear to reflect the number of records which could be included in the modeling exercise.) In addition, the percentage of the total cod catch for the <35' sector represented in the logbooks has decreased over time, from about 70% in 1997 to about 50% in recent years.

These data pertain 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), more than 30 gillnets were used, or <100 or >4,000 hooks were used on a line-trawl. 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. About 23% of the records were excluded using these criteria and this percentage has been increasing in recent years.

The screening criteria described above have resulted in a substantial fraction of <35 ft catch not being available for analysis. For example, in 2008 only 21% of the <35 ft gillnet catch and 30% of the <35 ft linetrawl catch is included in the CPUE standardization. A major contributor to this loss of information is an increasing portion of logbooks records with invalid entries for the location fished. At present, approximately 26,000 records in the database cannot be assigned a valid fishing location because the 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. 10a). Most of these records 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 Figure. 10a. 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 (1000's), deployed in each set of the gear; soak times were not adjusted as the relationship between soak time, gear saturation and fish density is not known. Catch rates 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 kg by multiplying by 2.2026.

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

The catch from 3Ps was divided into cells defined by gear type (gillnet and line-trawl), location (numbered 29-37, as described above) and year (1997-2008).

Initially, un-standardized CPUE results were computed and examined; in this preliminary analysis plots of median annual catch rate for gillnets and line-trawl were examined for each year-location. Catch rates for gillnets tend to be higher in areas 29-31 (Placentia Bay) than elsewhere. The gillnet catch rates for 2007 and 2008 were not markedly different from recent values and were lower than those in the earliest part of the time series (Fig. 10b). For line-trawl, most data comes from areas west of the Burin Peninsula and the results areas 29-33 are based on fewer data (generally <50 sets per year) and show more annual variability. Line-trawl catch rates in both 2007 and 2008 were generally good across 3Ps, and were higher than those in most previous years.

Prior to modeling, the data were aggregated within each gear-year-month-location cell, and the aggregated data were weighted by its associated cell count. Catch per unit effort (CPUE) data were standardized to remove site (fishing area) and seasonal (month, year) effects. Note that sets with effort and no catch are valid entries in the model.

In the present assessment, the model adequately fitted data from gillnets and line-trawls and two standardized annual catch rate indices were produced, one for each gear type. All effects included in the model were significant.

From model results for gillnets, catch rates have shown a downward trend during 1998-2000 and have subsequently been low but stable (Fig. 10c). The gill-net catch rates have declined from about 37 kg per net in 1997 to 17 kg per net in 2001, but subsequently remained fairly constant at 18-20 kg/net during 2002-08. For line-trawls, catch rates declined from 300 kg/1000 hooks in 1997 to a minimum of about 200 kg/1000 hooks during 2002. Values for 2003 to 2006 were progressively higher and the 2006 value is the largest estimated catch rate at 353 kg/1000 hooks. Catch rates during 2007 and 2008 have declined from this level, but remain relatively high.

The observed trends in commercial catch rate indices for the inshore fishery are influenced by many factors. There have been substantial annual changes in the management plans in the post-moratorium period (Brattey et al. 2003). In addition, catch rates from mobile commercial fleets can be related more to changes in the degree of local aggregation of cod and can be a poor reflection of overall trends in stock abundance, particularly for stocks in decline. While this is likely to be a bigger problem with respect to otter-trawl derived catch rates, gillnets and line-trawls can also be deployed to target local aggregations. For inshore fisheries, catch rates can also be strongly influenced by annual variability in the extent and timing of inshore as well as long-shore cod migration patterns. Similarly, the changes in management regulations, particularly the switch from a competitive fishery to IQs 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. Where these data can be dis-aggregated into ages independently of the commercial catch at age data (as is the case with the sentinel survey) the information may be more easily interpreted in terms of stock size. Despite these issues, the initial declines in gillnet and line-trawl catch rates following the re-opening of the fishery in 1997 were cause for concern. The increase in modeled catch rates for line-trawls since 2003 may in part be reflecting the contribution of the 1997 and 1998 year classes in the inshore catch, as the increased growth, larger size, and heavier weight of these year classes result in a larger fraction of the total linetrawl catch. Close inspection of the commercial catch numbers-at-age data has shown that the proportion of cod age 7 and older in the linetrawl catch has consistently increased over 2002-2008. Modeled gillnet catch rates have shown no significant changes in recent years.

INDUSTRY LOGBOOKS (>35 ft sector)

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35' sector) from 1998-2008 were also examined. Catch rates for various vessel length classes and unit areas (refer to Figure 1) with significant catches over this time period are illustrated in Figure 11. Only cells having at least 10 observations (i.e. logbook entries) are plotted. The data for many vessel length classes and gear combinations are too variable for firm conclusions to be drawn. Otter trawl catch rates (particularly for the vessels >100') have declined considerably over 2006-08. The trends remain difficult to interpret in terms of stock size given that the large vessels typically fish a localized area in the vicinity of southern Halibut Channel (see Fig. 2) during the winter months when cod in this area are highly aggregated. Gillnet catch rates were variable over the stock area and the 2008 catch rates are generally lower than those 3-4 years previous. One exception is the catch rates in Placentia Bay (3Psc), which have remained constant at a relatively low level since 2001. Linetrawl catch rates for 65-100' vessels have increased in recent years, but more generally linetrawl catch rates have been stable in the recent period.

TAGGING EXPERIMENTS

A project involving tagging of adult (>45 cm) cod initiated in 1997 has continued through 2009. However, for several reasons, tagging efforts in 3Ps have been much reduced over the 2004-2009 period. 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. Further details are provided below and in Brattey and Healey (2006).

ESTIMATES OF EXPLOITATION (HARVEST) RATE

The methods used to estimate average annual exploitation rates (harvest rates, in percent) for cod tagged in different regions of 3Ps are described in detail previously (Brattey and Cadigan 2004; Brattey and Healey 2003, 2004, 2005, 2006; Cadigan and Brattey 2003, 2006). During 2001-05, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (3Psc, 22-31%) compared to those tagged in Fortune Bay (3Psb, 10-12%), Burgeo Bank/Hermitage Channel (3Psd, 1-8%) or offshore in Halibut Channel (3Psg/h, 2-6%), respectively.

There were insufficient numbers of cod released during the 2004-2006 period to estimate inshore exploitation rates in either 2006 or 2007. Although estimates of inshore exploitation rates from the 2006 fishery were reported by Brattey et al (2007), they noted that due to the lapse in inshore tagging during 2004-2006, these rates were only partial estimates. Cod are normally at least 4 years old when tagged and no inshore tagging was conducted during 2004-06. The 2006 estimates included only cod ages 7+, and as such are not directly comparable to exploitation rates computed in other years. The exploitation of tagged cod aged 4-6 would typically account for much of the annual exploitation estimate. During 2008, estimates of mean exploitation rate for cod tagged in Fortune Bay and Placentia Bay were approximately 10%. The Fortune Bay exploitation estimate for 2008 is comparable to levels estimated for that area during 2000-2005. The Placentia Bay estimate for 2008 is much lower than other values from that area, particularly the estimates of 20-25% during 1999-2005. Tagging was conducted only in the western part of Placentia Bay in 2007, and thus the 2008 exploitation rates for Placentia Bay may not be comparable to those from previous years when tagging was more widespread.

As a result of continued tagging efforts in the offshore (unit area 3Psh), exploitation rates can be estimated – and compared – throughout 1998-2007. Exploitation rates estimated from tagging in Halibut Channel from 2005-07 (none available for 2008) have increased compared to previous estimates. The 2005-2007 exploitation estimates are about 8% per year, compared to estimates of 2-3% over 1997-2004.

As in the previous assessment, mean exploitation was still relatively low among cod tagged offshore (3Psg/h) in spite of substantial offshore landings. These low offshore exploitation rates are consistent with a large offshore biomass in relation to the magnitude of recent offshore catches. However, the offshore estimates of exploitation are considered uncertain because of the limited timing and localization of offshore tagging coverage and restricted distribution of fishing activity in the offshore. There is also greater uncertainty in the reporting rates of tags from the offshore, and in the survival of fish caught and released after tagging offshore in deep (>200 m) water. The estimates of exploitation from offshore tagging experiments reported above assume that 40% of tagged cod succumb post-tagging; this estimate is based on direct estimates from acoustically tagged cod captured with otter trawls at depths of 200m.

The timing of offshore tagging coverage was switched from April to December in 2003-05 to address some of these concerns about offshore tagging and to investigate whether winter catches in the offshore portion of 3Ps includes northern Gulf (3Pn4RS) cod. Both the percentage of tagged cod returned and distribution of recaptures (all within 3Ps) are similar to those of cod tagged in the offshore of 3Ps during April.

Brattey and Healey (2006) emphasized that the 2005 results pertain mostly to the 6+ portion of the 3Ps cod stock because no inshore tagging has been conducted since the fall of 2003 and at that time tagged fish would typically be at least 4 years old. The fishery in the recent past has mostly exploited the relatively strong 1997 and 1998 year classes (Brattey et al. 2005, 2006). Subsequent year classes (2000-05) appear to be weaker (results herein); consequently, Brattey and Healey (2006) cautioned that as the 1997 and 1998 year classes age and grow beyond the main selection size of gillnets, the fishery will switch to these weaker incoming year classes which could result in an increase in fishing mortality if catch levels remain maintained constant. Since 2005, exploitation rates did increase in the offshore, but due to the limited inshore tagging during 2004-2006, it is difficult to infer inshore exploitation patterns in recent years as the 1997 and 1998 year-classes became less important to inshore fisheries. To address this issue inshore tagging was resumed in 2007, with approximately 3,800 cod tagged and released widely across unit areas 3Psa/b/c. In 2008, however, just 400 tagged cod were released near Bar Haven, Placentia Bay. Recaptures from these experiments in the coming years will provide information on harvest rates of more recent year classes.

The tagging results for 2007 and 2008 generally agree with previous findings (Brattey et al. 2001b, 2002b; Brattey and Healey 2004, 2005, 2006), and indicate restricted mixing of cod from different portions of the 3Ps stock area as well as higher exploitation of adult cod tagged inshore, particularly in Placentia Bay. The complex migration patterns and stock structure may have some influence on the various abundance indices that are available for the stock (see Brattey et al. 2005) and add uncertainty to any sequential population analyses of the stock as a whole. The limited mixing of inshore cod in particular make it difficult to determine whether inshore indices are reflecting trends in the stock as a whole or mainly of inshore components of the stock. Trends in the indices differ between inshore and offshore and are difficult to reconcile with the tagging results. Tagging suggests lower exploitation in the offshore than most inshore areas, yet the DFO RV and GEAC offshore abundance indices have shown variability with no clear trend or declining trends. In contrast, inshore indices (sentinel) have been stable for several years (albeit at a lower level than when the fishery opened in 1997), but 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 for the period 1978-92. The two surveys were similar with regard to the stratification scheme used, sampling methods and analysis, but differed in the type of fishing gear and the daily timing of trawls (daylight hours only for French surveys). Canadian surveys were conducted using the research vessels A. T. Cameron (1972-82), Alfred Needler (1983-84), and Wilfred Templeman (1985-2007). 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. The French surveys were conducted using the research vessels Cyros (1978-91) and Thalassa (1992) and the results are summarized in Bishop et al. (1994).

The 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 1983-1995 were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation derived from comparative fishing experiments (Warren 1996; Warren et al. 1997; Stansbury 1996, 1997).

The stratification scheme used in the DFO RV bottom-trawl survey in 3Ps is shown in Fig 12. Canadian surveys have covered strata in depth ranges to 300 fathoms since 1980. Five new inshore strata were added to the survey from 1994 (stratum numbered 779-783) and a further eight inshore strata were added from 1997 (293-300) resulting in a 12% increase in the surveyed area. Beginning in the 2007 assessment, new indices using survey results from the augmented survey area were presented for the first time. Two survey time series can now be constructed from the catch data from Canadian surveys. To avoid confusion, throughout this document as well as the Science Advisory Reports from the two assessment meetings in 2009 (DFO, 2009a, 2009b) the index from the expanded surveyed area that includes new inshore strata is referred to as the “combined” index and the time series extends from 1997-2007, whereas the original smaller surveyed area is referred to as the “offshore” survey and the time series that incorporates a random stratified design extends from 1983-present.

The results (in Campelen or Campelen-equivalent units, see below) for the Canadian “offshore” survey are summarized by stratum in terms of numbers (abundance) (Table 9) and biomass (Table 10), for the period 1983-2009. The timing of the surveys, number of sets fished, and vessel(s) used are also described**.** Figure 13 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. Also, the 2008 and 2009 spring surveys have taken considerably longer to complete than most other years. 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 (Brattey et al. 2006).

ABUNDANCE, BIOMASS, AND DISTRIBUTION

A time series of trawlable abundance and biomass indices from DFO random stratified RV offshore survey is given in Fig.14. The abundance and biomass index estimates for the 2008 survey were 38.7 million fish and 20,535 t. The corresponding values for the 2008 survey were 69.5 million fish and 56,024 t. In the 2008 and 2009 surveys there were no major changes in the distribution of survey catches. The strata with the largest catches in terms of biomass were strata 319 (includes part of the Halibut Channel) and 307 (a portion of Burgeo Bank). Combined, these strata accounted for 50% and 72% of the biomass index during the 2008 and 2009 surveys, respectively. These strata also comprised 51% of the total abundance index for 2008, and 61% of the total abundance index for 2009.

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 combined area (Fig. 14). 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 for biomass from 1983 to 1999 show considerable variability, with strong year effects in the data. Both abundance and biomass are low after 1991 with the exception of 1995, 1998, and 2001. The 1995 estimate is influenced by a single enormous catch contributing 87% of the biomass index and therefore has a very large standard deviation. The 1997 Canadian index was the lowest observed in the time series, which goes back to 1983, being less than half of the 1996 index. The size composition of fish in the 1997 RV survey suggested that this survey did not encounter aggregations of older fish, yet these fish were present in the 1996 survey and in subsequent commercial, sentinel, and survey catches. The minimum trawlable abundance index declined from 88.2 million in 2001 to 38.7 million in 2008. However, in 2009 the index was almost double the 2008 value, at 69.5 million. The minimum trawlable biomass estimate has been variable for much of the post-moratorium period, but as with abundance, the biomass index generally declined over 2001 to 2008. The biomass index also increased considerably between 2008 and 2009, from 20,535 t to 56,024 t – approaching a three-fold increase. The magnitude of the one-year increase in the survey estimates of abundance and biomass is unusual and indicates that one (or possibly both) of the 2008 and 2009 surveys may be influenced by a year-effect. The nature of the difference between the 2008 and 2009 survey results are discussed in detail in the “Age Composition” section below. In general, trends in the abundance and biomass indices are difficult to discern due to high intra-annual variability. Excluding the 1995 and 1997 survey results would suggest the time series can be broadly divided into three periods – highest during 1983-90, lowest during 1991-97, and intermediate to low values during the most recent period 1998-2009. The trends and degree of variability in the combined inshore/offshore survey are almost identical to those of the offshore survey in spite of the 12% increase in surveyed area; the only exception is in 2004 when the combined inshore/offshore survey shows higher biomass and abundance due mainly to a large estimate from inshore stratum 294 (see Tables 9 and 10).

The survey results are also provided in terms of catch rates (i.e. mean numbers per tow) for the offshore (1983-2009) and combined (1997-2009) survey indices (Fig. 15). The trends are identical to the abundance index described above.

To investigate whether there have been annual shifts in the distribution of the stock at the time of the survey, trends in the proportion of the total abundance observed in three different regions of the stock area were compared (Fig. 16); 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, 20-60% in the western area, and around 10% in the inshore area; an exception was 2005 when almost 40% of the total abundance index was observed in the inshore, again due to a large estimate for inshore stratum 294. Much of this variation is resultant from year effects, e.g. 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 2008 and 2009 surveys was examined, for all ages combined (Fig. 17a, includes 2005 and 2007 for comparison) and separately for ages 1-4, and ages 5-8 in both 2008 and 2009 (Fig. 17b to 17e). The age-disaggregated distribution plots for the 2009 survey have been revised from those presented at the fall assessment meeting, to correct for an error discovered in the plotting software after the meeting concluded. Brattey et al. (2007) showed that during 1999-2005 cod were caught over a considerable portion of NAFO Div. 3P with the largest catches typically in the southern Halibut Channel area, on Burgeo Bank and vicinity, in the outer portion of Fortune Bay, and in 3Pn. During these years cod were consistently scarce in the deep water below the mouth of Placentia Bay and in the inner reaches of Hermitage Channel. From 2005 to 2009, the distribution of survey catches shows no major changes. Larger catches were taken mainly on Burgeo Bank, the outer portions of Fortune Bay, northern St. Pierre Bank and Halibut Channel.

Distribution plots of age-disaggregated survey catches from the 2008 survey (Figs. 17b, 17c) indicate that relatively few 1yr old cod were measured in the survey area. Most of the 1yr old cod were found in inshore or nearshore areas. Aside from one “larger” catch of twenty 1yr old cod in the Halibut Channel, very few of this age class were found in offshore areas. Cod aged 2-4yr old were all found through much of the surveyed area, with the largest catches of these age groups taken near Burgeo Bank, within Fortune Bay and within the Halibut Channel. The magnitude of the of catches of cod aged 5-8yr old in 2008 decrease considerably with age, and excluding one relatively large tow in Fortune Bay, very few of these age groups were taken outside of Burgeo Bank or the Halibut Channel.

In the 2009 survey, the distribution plots show that there were limited catches of 1 yr old cod, with the greatest concentration being observed within Fortune Bay (Fig. 17d). The distribution of 2 yr old cod was quite similar to that of the 1 yr olds, but generally there were more 2 yr old caught throughout the survey area. The cod age 3yr old during 2009, i.e. the 2006 year-class, were again detected to be relatively strong, with a widespread distribution across much of the surveyed area, and relatively large abundance – an average of 8.6 3yr olds per tow, the second highest value in the time series (Table 11a). At ages 4 – 8, very few cod were measured outside of Burgeo Bank and the Halibut Channel, though some age 4 cod were found on top of St.Pierre Bank (Fig. 17e). Cod aged 3 – 8 in the 2009 survey were prominent around Burgeo Bank and Halibut Channel despite limited (or no) evidence of these aggregations at age 2 – 7 during the 2008 survey.

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 instructions for Subdiv. 3Ps require that an attempt be made to obtain 2 otoliths per one cm length class from each of the following locations: Northwest St. Pierre Bank (strata 310-314, 705, 713), Burgeo Bank (strata 306-309, 714-716), Green Bank-Halibut Channel (strata 318-319, 325-326, 707-710), Placentia Bay (strata 779-783) and remaining area (strata 315-317, 320-324, 706, 711-712). This is done to spread the sampling over the survey area. The otoliths are then combined into a single ALK and applied to the survey data. The resulting estimates of age-disaggregated mean numbers per tow are given in Table 11a. These data can be transformed into trawlable population abundance at age by multiplying the mean numbers per tow at age by the number of trawlable units in the survey area. This is obtained by dividing the area of the survey by the number of trawlable units. For the "offshore" survey in 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 trawlable units in the 3Ps survey is $16{,}732 \div 0.00727 = 2.3 \times 10^6$.

The mean numbers per tow at age in the DFO RV survey for the "offshore" index is given in Table 11a and results for ages 1-15 are shown the form of "bubble" plots in Fig. 18a. Cod up to 20 years old were not uncommon in survey catches during the 1980's, but the age composition became more contracted through the late 1980s and early 1990s. Survey catches over the post-moratorium period have consistently shown few survivors from year-classes prior to 1989. Recent assessments of this stock (e.g. Brattey et al., 2007) have focused upon the 1997 and 1998 year-classes which were relatively strong and contributed significantly to commercial catches for several years. However, in the most recent three surveys, the 1997 year-class appears to be average, and the 1998 year-class is contributing a lower than average proportion of the survey catches. Several year-classes subsequent to the 1997 and 1998 year-classes - specifically the 1999 through 2005 year-classes - are relatively much poorer. However, the 2006 year-class has been above average in each of the 2007, 2008 and 2009 surveys. A more quantitative analysis of recruitment is given below.

The indication of generally poor incoming recruitment from the survey index is a significant issue as these year classes will supply any commercial catch over the next several years. Overall, the age composition of survey catches has expanded in recent years with ages up to 17 yrs represented; however, the age structure remains somewhat contracted relative to the mid-1980s with presently very few fish older than age 15. The dynamics behind the considerable increases in survey estimates of abundance and biomass from 2008 to 2009 are quite unusual. In the 2009 DFO RV survey the estimated abundance at ages 2-8 *increased* over the estimates of abundance for these same cohorts at ages 1-7 as measured in the 2008 survey. This is biologically impossible, as the numbers of fish in any given cohort must decrease over time owing to natural and anthropogenic removals. Thus, either of the 2008 and 2009 surveys – or possibly both surveys - may be influenced by year-effects. The apparent inconsistency between the survey results in 2008 and 2009 complicates interpretation of the survey data.

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

The sampling protocol for obtaining lengths-at-age (1972-2009) and weights-at-age (1978-2009) 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). Although previous assessments have included estimates of mean length and mean weight from the early 1970's, it was agreed during the Fall Regional Assessment Process that only data from 1983 onward should be presented. This decision was taken as the area surveyed prior to 1977 was less comprehensive (maximum depth surveyed was 200 fathoms, compared to 300 fathoms in current design).

Mean lengths-at-age were updated using the 2008 and 2009 survey data (Table 12; Fig. 19a). Mean lengths have varied over time, and there was a decline in length-at-age from the early 1980s to the late 1980s or the early to mid-1990s, with the duration of the decline increasing with age (Fig. 19a and b). There was an increase in length-at-age from the mid-1990s through the mid-2000s, but data from 2007-2009 surveys suggest a decline for several age groups, particularly for ages 2-4.

Year-to-year variability at older ages has been considerable (as much as 20 cm at age 10) during the past decade or so. There has not yet been a thorough analysis to determine if these differences were caused mainly by environmental factors (e.g. temperature or prey availability), cohort factors (e.g. cohort abundance or distribution) or any of the numerous additional possibilities, such as changes in maturation schedules (Chen and Mello 1999) or size-selective fishing mortality. Variability associated with sampling or processing could also be important.

Much of the high variability in length-at-age at older ages (say 7-10) appears to be caused by cohort effects. For example, the 1989, 1990 and 1992 year-classes were relatively long at age, whereas the 1988, 1991 and particularly the 1987 year-classes were relatively short (Brattey et al. 2003). There has not yet been an investigation of the reasons for such cohort effects.

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

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

Values for mean weight at age were updated with data from the 2008 and 2009 surveys. As expected, the patterns in mean weight-at-age (Table 13; Fig. 20a and b) appear to be very similar to those in length-at-age. The high year-to-year variability at older ages in recent years, noted above for length-at-age, is much more pronounced in weight-at-age, with weights-at-age in some years being more than twice that in others. The weight-at-age estimates may include more sampling variability than the length-at-age estimates in years prior to 1990 because they are based on much smaller sample sizes (Lilly 1998). The weight-at-age data also include variability associated with among-year and within-year variability in weight at length (condition).

CONDITION

Condition of cod (mean somatic condition and liver index) was calculated from research 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 are presented in Figures

21 and 22. Condition and liver index at age indices were not updated during either of the assessments held in 2009.

The somatic (gutted) condition and liver index of each fish were expressed using Fulton's condition factor ((W/L3)*105), where W is gutted weight (kg) or liver weight (kg) and L is length (cm). Since Fulton's condition factor is not independent of length, data are presented by length group. Both somatic and liver condition generally increased until 1998 and was then lower until the early 2000's. The 2008 estimates are among the lowest in the time series (Fig. 21).

Another way to examine condition without an effect of length, is to calculate relative condition (relative K). 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 (relative LK) was calculated in a similar fashion using a liver weight length regression. Relative condition shows the same general trend as Fulton's condition factor for somatic and liver weight, with condition increasing until 1998, followed by a period of lower condition up until 2004 and very low condition in 2008 (Fig. 22). Estimates of relative K and relative LK in 2008 are significantly lower than all other years except 1993 and 1994; in addition the 1995 estimate of LK is significantly lower than that of 2008 (results of generalized linear models with gamma error and identity link).

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 (A50) are shown in Fig. 23a and only cohorts with a significant slope and intercept term are shown; parameter estimates (and SE's) for cohorts from 1954 to 2001 are given in Table 16 and the model did not adequately fit the data from subsequent cohorts (2002 onwards). The estimated A50 was generally between 6.0 and 7.0 for cohorts from the mid-1950s to the early 1980s, but declined dramatically thereafter to 5.1 in the 1988 cohort (Table 16, Fig. 23a). (Although model results were presented during both assessment meetings - using data to 2008 for the zonal assessment, and survey data to 2009 for the regional assessment - differences were limited and only the results from the regional assessment meeting which includes all of the available data available at present are given herein. However, a comparison of the trends in A50 estimated from each dataset is shown in Fig. 23A.)

Estimates for the most recent cohorts (2002-04) have increased but are more uncertain, for two reasons: only younger ages from these cohorts are available to estimate A50, and data for 2006 (incomplete survey) are not available. 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 17; these were obtained from the cohort model parameter estimates in Table 16. 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. 23B). Also, the model estimates for the proportion mature at age 6 in the 1997 and 1998 cohorts are much higher than those of recent cohorts at the same age and this has a substantial effect on the recent estimates of spawner biomass for this stock. In addition, the age composition of the spawning biomass may have important consequences in terms of producing recruits (see Brattey et al., 2008).

The time series of maturities for 3Ps cod shows a long-term trend as well as considerable annual variability. To project the maturities for 3Ps cod forward to 2012, for each age group the average of the last three estimates for the same age group was used (Table 17). To fill in missing age groups in the early part of the time series the average of the first three estimates for the same age was used. There has been considerable debate at recent assessments about the best way to project maturities forward for 3Ps cod and other stocks. The present method can result in large changes in the estimates of proportion mature for incomplete cohorts, and hence considerable variability in the most recent estimates and projections of spawning stock biomass. For the most recent cohorts there are no data for older ages and model fits use data from younger ages. Alternative methods that also use information from older ages in adjacent cohorts are presently being explored as a possible way of providing more reliable estimates of maturity for unfinished cohorts and for projections.

Overall, 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 in recent years has been studied more intensively than elsewhere in 3Ps (Bolon and Schneider 1999; Lawson and Rose 1999; Bradbury et al. 2000).

To address a request from fisheries managers regarding the appropriateness of current spawning closure (dates vary for inshore/offshore fleets), data from the DFO multispecies survey from 1972-2009 were analyzed to determine time of spawning of cod in 3Ps (Morgan and Rideout, 2009). Data for the offshore and inshore strata of the survey were modelled separately. In addition, the proportion of female fish in various maturity stages in April was calculated for inshore and offshore strata separately.

The data from the DFO survey do not show any trends that would indicate a shift in spawning time. The current spawning closure in the offshore appears to encompass most of the spawning period. Spawning time could not be estimated from the inshore but previous studies have found spawning fish from March to August.

COHORT ANALYSES

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. Similar computations were presented and debated during both the zonal and regional assessment meetings. A debate on smoothing these annual estimates of total mortality during the zonal assessment meeting lead to the exploration of cohort modeling of the survey data to provide structure to the smoothing.

The age-disaggregated cohort modeling assumed the total mortality experienced by the population could be separated into vectors of age effects and year effects. Estimation was based on the trends in the DFO RV survey. The estimation procedure was based on the survey-based (SURBA) analyses of Cook (1997), and provided estimates of total mortality, relative recruitment strength, and relative estimates of total and spawning biomass. However, the model was speculative in that it could not reliably estimate survey catchability and this had to be fixed at scenario values. The model specifications, the sensitivities of results to modeling assumptions, and estimation procedures applied during both the zonal and regional assessment meetings are documented in Cadigan (2010). This included examinations into sensitivity of model results to:

- the magnitude of penalty terms (which smooth between-year and between-age variability in the total mortality);
- inclusion/exclusion of age 1 survey data;
- differing assumptions on the survey catchability at age;
- addition of the 1983-1996 RV survey data from the offshore area, but adjusted to account for the inshore area;
- estimating two sets of age effects: one for 1983-1993 and another for 1994-2008.

Main results of the analyses conducted at each of the assessment meetings are described separately below. The results were based on the following assumptions about survey catchability (q): q_a = 1, 2, and 5 for a = age = 1, 2, and 3; q_a = 10 for a > 3. Note that by assuming survey catchability at age one is one (i.e. q_1 = 1) the cohort model estimates of relative recruitment strength have the same scale as the survey estimates of recruitment. Estimates of total and spawning biomass are catchability corrected but are still relative to the assumed survey recruitment scale.

ZONAL ASSESSMENT MEETING (WINTER 2009)

Model estimates indicate increasing total mortality since 1997 (Fig. 24a). The slight decrease in 2008 is the average of the last three years and not a direct estimate from survey data. However, total mortality in 2005 to 2007 was not estimated to be as high as the levels in 1991 to 1993.

A plot of relative spawning stock biomass (SSB) from the SURBA results described in the Science Advisory Report (DFO, 2009a) is presented in Figure 24b. The basis for a limit reference point (LRP) for this stock is $B_{Recovery}$, 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 for this stock (DFO, 2004). The SSB estimates indicate that by 2004, the spawning stock biomass (SSB) had almost tripled compared to the level estimated at the beginning of the moratorium in 1994. However, SSB declined by more than 20% per year over 2004-08. The 2008 estimate of SSB was near the LRP, and there is a high probability (about 50%) that SSB in 2008 was less than the LRP.

REGIONAL ASSESSMENT MEETING (FALL 2009)

Additional SURBA analyses were presented during the regional assessment process, mainly updating analyses provided at the ZAP with results which included the spring 2009 RV survey data. To capture the uncertainty in the survey selectivity, results incorporating two assumed selectivity patterns (i.e. “domed” and “flat-top” selection) were reported in the Science Advisory Report (DFO, 2009b). Under both assumptions, the estimated survey SSB decreased in recent years and in 2009 was above the limit reference point (LRP; see Fig. 25). However, the probability that the SSB in 2009 was below the LRP varied from 20% to 40% depending upon the assumptions regarding the catchability of different age fish by the survey. Despite the large increase in the survey biomass index from 2008 to 2009, it is noteworthy that the estimates of the 2009 biomass from both SURBA models are lower than those for 2008. Cohort model estimates of biomass will only increase through improved recruitment or growth, or reductions in mortality. Given that the 2008 to 2009 trend in the RV abundance index was to have numbers increasing one year *later* for most cohorts, the estimation interprets the 2009 survey as a positive anomaly.

Estimates of total mortality from the cohort model (Fig. 26) over 2004-2008 (ages 4-11) were approximately 0.55 (42% mortality). This value represents the average of the mortality across the two model results evaluated. This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

During the RAP, it was discovered that maturity estimates used in computation of SSB during the ZAP were incorrect (a “cut-and-paste” error). Cadigan (2010) concluded that: “Correcting the error did not lead to a change in inference about the size of 2008 SSB relative to the limit reference point” and provides a comparison of the estimated SSB reported at the ZAP to that using the correct maturity data. (The results illustrated in Figure 24b were presented during the ZAP and include the erroneous maturity data.) Refer to Cadigan (2010) for further detail.

GEAC STRATIFIED RANDOM TRAWL SURVEY

During fall 1997-2005, trawl surveys were conducted by the Groundfish Enterprise Allocation Council (GEAC) using an un-lined commercial trawl. These surveys are carried out in late fall and cover a large portion of offshore 3Ps, but not the Burgeo Bank area. Detailed results of these surveys are reported in McClintock (1999a, 1999b, 2000, 2001, 2002, 2003). In each of these years this survey showed aggregations of cod in the southern Halibut Channel and on or adjacent to St. Pierre Bank. Abundance and biomass indices from this survey were variable, but show a decline over 2001-05. The 1997 and 1998 year classes were strongly represented in the GEAC survey index during 2001 to 2003. However, in both the 2004 and 2005 surveys, catches of several older ages, including the 1997 and 1998 year-classes, were substantially lower. Year-classes produced during 1999-2002 appear weak. During the fall of 2007, a new survey was conducted using a lined shrimp trawl and altered tow protocol from previous surveys and hence the 2007 results are not comparable with previous estimates (see McClintock, 2011). In the 2007 survey, the 2006 year-class (age 1) was detected across most of the surveyed area, consistent with the DFO RV survey.

RECRUITMENT INDEX

A multiplicative model was used to estimate the relative year class strength produced by the 3Ps spawning stock as indicated from trawl survey indices (mean numbers per tow at age). During the 2007 assessment (Brattey et al., 2008), it was decided that it would be inappropriate to include all of the available indices because of the different trends and uncertainty as to whether the available indices were indicative of trends in the stock as a whole or only portions of it. The input data set used during both assessment meetings was restricted to:

i) GEAC mean numbers per tow data,1998-2005 at ages 3 and 4, and

ii) DFO RV combined inshore/offshore survey mean numbers per tow during 1997-2005 and 2007-2009 (2009 data only available for the fall RAP meeting) including ages 1-4 in true Campelen units.

Only year-classes with two or more observations were included in the input.

On a log-scale the model can be written as follows:

$\log(I_{s,a,y}) = \mu + Y_y + (SA)_{s,a} + \varepsilon_{s,a,y}$,

where:

μ = overall mean
s = survey subscript
a = age subscript
y = year class subscript
I = Index (mean nos. per tow)
Y = year class effect
SA = Survey * Age effect, and
ε = error term.

During both the ZAP and RAP meetings, estimation methods were identical. Estimation of model parameters was conducted using PROC MIXED in SAS/STAT software. The input data were equally weighted. Each of the model terms (year-class and survey-age) were significant in all analyses. The estimated least-squares means from the RAP and ZAP are plotted in Fig. 27. The results indicate that year-classes over 1994-2007 can be split into two categories: the 1997, 1998 and 2006 year-classes are all estimated to be about three times stronger than all other cohorts, which appear relatively weaker. A previous analysis that incorporated a longer time-series of data from the DFO RV survey of the offshore showed that recruitment, though variable, was generally higher in the 1980's (Brattey et al. 2007). As noted when describing the commercial catch-at-age, the 1997 and 1998 year-classes strongly contributed to commercial fisheries for several years, but more recent fishing is reliant on the 1999-2005 year-classes, all of which are relatively weaker. Three years of data are now available for the 2006 year-class, each of which suggest this year-class is above average. A comparison of the estimates from the winter 2009 ZAP and fall 2009 RAP indicates a slight downward revision of the relative strength of the 2006 year-class, as the 2009 survey information on this year-class (at age 3), while above average, was not as optimistic as the age 1 and age 2 data from this year-class were compared to other cohorts.

Some information on the relative strength of recent year-classes is also available from the sentinel line-trawl index. This index covers an inshore portion of the stock area shoreward of the trawl surveys. The age-disaggregated sentinel line trawl index (Table 8, Fig. 9b and c) provides evidence that most year classes produced during 2000-02 are weaker than the 1997 and 1998 year classes. Information on the 2006 year-class is not yet available from the sentinel indices.

CONCLUSIONS AND ADVICE - ZONAL ASSESSMENT PROCESS (WINTER 2009)

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. Any aggregations in April within the near-shore 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 evidence that a large fraction of the stock is shore-ward of the DFO RV survey in April.

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

Survey SSB has been decreasing in recent years and in 2008 was just above the LRP. If management is to be consistent with the Precautionary Approach, catches should be reduced compared to recent levels, and greater priority should be given to increasing SSB.

Cohort analysis of the DFO RV survey data indicated that SSB declined by more than 20% per year over 2004-2008. Recruitment will remain low in 2009-2010 so this decline will likely continue through to 2010 with status quo landings. This also suggests that a TAC reduction of at least 20% is necessary to halt this decline. Hence, if the management goal is to stop the current decline in offshore biomass then a reduction in TAC to 10,000 t is considered the minimum necessary, notwithstanding the uncertainties about survivorship and absolute size of biomass. If the management objective is to ensure growth in offshore biomass, then a greater reduction is considered necessary.

Recent year-classes supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. Although preliminary indications are that the 2006 cohort is strong, this cohort will not recruit to the fishery until 2011. Furthermore, these fish will also begin maturing at about this time. If this year-class is as strong as presently indicated, and if total mortality is relatively low, it would be possible to quickly increase the spawning biomass. It would be prudent to consider management measures which would protect this year-class from all sources of fishing mortality (e.g. discarding, high-grading and landings) until it matures, thereby increasing the chance of the stock increasing well above the limit reference point.

Annual total mortality rates (age 5 -11) inferred from the DFO RV survey increased from an average of 23% in 1997-2004 to an average of 55% in 2005-2007. This high value is a concern. Although the trend in natural mortality is unknown, fishing mortality has increased as inferred by the reduction of stock size during a period of constant landings.

The status of inshore components is uncertain. However, both sentinel linetrawl and sentinel gillnet indices are stable.

Overall, the findings of the current assessment are consistent with those of previous assessments. Several consecutive year-classes (1999-2005) have been relatively weak and are now (during 2007 and 2008) supporting the majority of total landings. This has lead to increased exploitation rates in the offshore, and contributed to an overall reduction in stock size.

OTHER CONSIDERATIONS - ZONAL ASSESSMENT PROCESS (WINTER 2009)

Management Considerations

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

If the 2006 year-class recruits strongly to the fishery, it would be prudent to consider management measures which would protect this year-class from all sources of fishing mortality (e.g. discarding, high-grading and landings) until it matures, thereby increasing the chance of the stock increasing well above the limit reference point.

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

Recent management measures (seasonal closures and switch to individual quotas, rather than a competitive fishery in western 3Ps) have reduced the reported winter catches from the mixing area (3Psa/d combined). Results from a telemetry study confirm that the timing of these closures is appropriate and that catches from this area in winter should continue to be minimized to reduce the potential impact on the 3Pn4RS cod stock.

A complex series of area/time closures on directed cod fishing in 3Ps has been introduced to address concerns about stock mixing and disruption of spawning activity. The 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.

Temperature

Oceanographic information collected during the spring 2008 DFO RV survey indicated that near-bottom temperatures decreased to below normal values in many areas particularly on St. Pierre Bank, where the area of <0^{o}C water increased to near 30%. The areal extent of bottom water with temperatures >3^{o}C has remained relatively constant at about 50% of the total 3P area, although actual temperature measurements show considerable inter-annual variability. Spring bottom temperatures were below normal in 2008. Also, the area of bottom habitat covered by <0^{o}C water was above normal in 2007 and 2008. These conditions are less favourable than those of the late 1970's and early 1980's when the stock was more productive.

Sources of Uncertainty

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 from year to year. The assessment is sensitive to mortality on 3Ps cod occurring when fish are outside 3Ps and to incursions of non-3Ps fish into the stock area at the time of the survey and the fishery.

Sentinel catch rates have remained stable at relatively low levels during the recent period while the DFO RV index has been declining. This may be indicative of differing trends within stock components.

Exploitation rates estimated from tagging in Halibut Channel have increased over 2005-07 while those in the inshore are variable. Thus it is uncertain if fishing mortality has increased on inshore components.

There is uncertainty in the survival of fish caught and released after tagging offshore in deep (>200 m) water. Lack of tagging in the inshore during 2004-06 makes estimation of exploitation rates in 2005-07 more uncertain as the catchability and numbers available to be recaptured diminish.

CONCLUSIONS AND ADVICE - REGIONAL ASSESSMENT PROCESS (FALL 2009)

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. Any aggregations in April within the near-shore 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 evidence that a large fraction of the stock is shore-ward of the DFO RV survey in April.

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

Estimated survey SSB from a cohort model decreased in recent years and in 2009 was above the limit reference point (LRP). However, the probability that the SSB in 2009 was below the LRP varied from 20% to 40% depending on assumptions regarding the catchability of different age fish by the survey.

Cohort analysis of the DFO RV survey data indicated that SSB has declined by 13% per year over 2004-09. It is too early to assess the effect on SSB of the recent reduction in TAC to 11 500 t for the 2009/10 management year. However if the management goal is to ensure growth in SSB, then a further reduction in TAC would increase the probability of growth.
Recent year-classes supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. The 2006 cohort is relatively strong, and harvesters indicate this cohort is beginning to recruit to the fishery. These fish could contribute significantly to the SSB by 2011. If this year-class is as strong as presently indicated, and if total mortality is relatively low, it would be possible to quickly increase the spawning biomass well above the LRP. It would be prudent to consider management measures which would protect this year-class until it matures and reproduces.

Estimates of total mortality (ages 4-11) over 2004-08 were approximately 0.55 (40-45% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

Exploitation rates for offshore cod tagged in the Halibut Channel are not high (2-9%) but have increased in 2005-07. Exploitation rates for most inshore components in 2008 were approximately 10% which seems sustainable.

The status of inshore components is uncertain. However, the commercial gillnet catch rates for the <35' fleet, as well as both sentinel (gillnet and linetrawl) indices are stable. The linetrawl catch rates for the <35' fleet have increased in recent years, and remain relatively high.

Overall, the findings of the current assessment are consistent with those of previous assessments. However, the current status and recent trends in the stock are somewhat more uncertain due to the nature of the change in the survey index between 2008 and 2009. Several consecutive year-classes (1999-2005) have been relatively weak and are supporting the majority of total landings. This has lead to increased exploitation rates in the offshore, and contributed to an overall reduction in stock size. The 2006 year-class is again estimated to be strong. The probability that the SSB in 2009 is below the LRP varies from 20% to 40% depending on assumptions regarding the catchability of different age fish by the survey.

OTHER CONSIDERATIONS - REGIONAL ASSESSMENT PROCESS (FALL 2009)

Management Considerations

The implementation of trip limits, price differentials based on size, and individual quotas (IQ's), 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 could improve the understanding of stock productivity. This is an unaccounted source of fishing mortality.

If the 2006 year-class recruits strongly to the fishery, it would be prudent to consider management measures which would protect this year-class until it matures and reproduces. Harvesters noted that this year-class is likely beginning to be captured in fisheries.

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

Various management measures (seasonal closures and switch to individual quotas, rather than a competitive fishery in western 3Ps) have reduced the reported winter catches from the mixing area (3Psa/d combined). Results from a telemetry study confirm that the timing of these closures is appropriate and that catches from this area in winter should continue to be minimized to reduce the potential impact on the 3Pn4RS cod stock.

A complex series of area/time closures on directed cod fishing in 3Ps have been implemented over time to address concerns about stock mixing and disruption of spawning activity. During the current assessment, a review of spawning time found no indication of any shift in the timing of spawning. The 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.

Temperature

Bottom temperatures throughout subdivision 3Ps during the spring 2009 survey were warmer than those during spring 2008.

A detailed evaluation of temperatures during the 2009 spring survey was not available at the time of the current assessment and the following text is from the previous assessment.

Oceanographic information collected during the spring 2008 DFO RV survey indicated that near-bottom temperatures decreased to below normal values in many areas particularly on St. Pierre Bank, where the area of <0°C water increased to near 30%. 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. Spring bottom temperatures were below normal in 2008. Also, the area of bottom habitat covered by <0°C water was above normal in 2007 and 2008. These conditions are less favourable than those of the late 1970's and early 1980's when the stock was more productive.

Ecosystem

A synthesis of research vessel survey trends in indices of abundance and biomass measured across multiple functional groups of fish indicated that overall fish productivity decreased during the 1983-1995 period. Comparisons of results from 1983-1995 and 1996-2008 are complicated by a change in the survey gear used in each period, which was not accounted for in the analysis. Over 1996-2008, no clear trends in productivity are apparent.

Sources of Uncertainty

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. This may contribute to unusual year-to-year variability in survey indices.

Comparison of sentinel catch rates and the DFO RV index show inconsistent trends during the recent period. This may be indicative of differences between stock components.

There is uncertainty in the survival of fish caught and released after tagging offshore in deep (>200 m) water. Lack of tagging in the inshore during 2004-06 makes estimation of exploitation rates in 2005-07 more uncertain as numbers available to be recaptured diminish. Further, the tagged fish begin to grow beyond the main selection range of various commercial gears.

Tagging was conducted only in the western part of Placentia Bay in 2007, and exploitation rates from these experiments may not be comparable to those from previous years when tagging was more widespread.

Trends in the level of natural mortality are difficult to measure and are uncertain.

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. 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.

REFERENCES

Bishop, C.A., Baird, J.W., and Murphy, E.F. 1991. An assessment of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 1991/036, 56p.

Bishop, C.A., and Murphy, E.F. 1992. An assessment of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 1992/111, 43p.

Bishop, C.A., Murphy, E.F., and Davis, M.B. 1993. An assessment in 1993 of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 1993/070, 39p.

1994. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 1994/033, 33p.

Bishop, C.A., Murphy, E.F., and Stansbury, D.E. 1995. Status of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 1995/031, 21p.

Bolon, A.D., and Schneider, D.C. 1999. Temporal trends in condition, gonado somatic index and maturity stages of Atlantic cod (*Gadus morhua*) from northern Placentia Bay (Subdivision 3Ps), Newfoundland, during 1998. DFO Can. Sci. Advis. Sec. Res. Doc. 99/45

Bradbury, I.R., G. L. Lawson, D. Robichaud, G. A. Rose, & P.V.R. Snelgrove. 2000. Success and failure of Atlantic cod, *Gadus morhua*: a case study from coastal Newfoundland. DFO Can. Sci. Advis. Sec. Res. Doc. 2000/022.

Brattey, J., and Cadigan, N.G. 2004. Estimation of short-term tagging mortality of adult Atlantic cod (*Gadus morhua*). Fish. Res. 66: 223-233.

Brattey, J. and Healey, B.P. 2003. Updated estimates of exploitation from tagging of Atlantic *cod (Gadus morhua*) in NAFO Subdiv. 3Ps during 1997-2003. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/091.

2004. Exploitation of Atlantic cod (*Gadus morhua*) in NAFO Subdiv. 3Ps: further updates based on tag returns during 1997-2004. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/084.

2005. Exploitation of Atlantic cod (*Gadus morhua*) in NAFO Subdiv. 3Ps: further updates based on 1997-2005 mark-recapture data. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/071.

2006. Exploitation of Atlantic cod (*Gadus morhua*) in NAFO Subdiv. 3Ps: estimates from mark-recapture experiments for the October 2006 assessment. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/082.

Brattey, J., Cadigan, N.G., Lilly, G.R., Murphy, E.F., Shelton, P.A., and Stansbury, D.E. 1999a. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 1999/036.

1999b. An assessment of the cod stock in NAFO Subdivision 3Ps in October 1999. DFO Can Stock Assess. Sec. Res. Doc. 1999/161.

2000. An assessment of the cod stock in NAFO Subdivision 3Ps in October 2000. DFO Can. Stock Assess. Sec. Res. Doc. 2000/134.

Brattey, J., Cadigan, N.G., Healey, B.P., Lilly, G.R., Murphy, E.F., Shelton, P.A., Stansbury, D.E., Morgan, M.J., and Mahé, J.-C. 2001a. An assessment of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in October 2001. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/099.

2002a. An assessment of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in October 2002. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/096.

Brattey, J., Cadigan, N.G., Healey, B.P., Lilly, G.R., Murphy, E.F., Stansbury, D.E., and Mahé, J.-C. 2003. An assessment of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in October 2003. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/092.

Brattey, J., Cadigan, N.G., Healey, B.P., Lilly, G.R., Murphy, E.F., Shelton, P.A., Mahé, J.-C. 2004. An assessment of the Atlantic cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in October 2004. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/083.

2005. Assessment of the cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps in October 2005. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/070.

Brattey, J., Cadigan, N.G., Healey, B.P., Murphy, E.F., Mahé, J.-C. 2007. Assessment of the cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps in October 2006. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/053.

Brattey, J., Cadigan, N.G., Healey, B.P., Murphy, E.F., M.J.Morgan, D.Parsons, D.Power, Dwyer, K., Mahé, J.-C. 2008. Assessment of the cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps (November 2007). DFO Can. Sci. Advis. Sec. Res. Doc. 2008/029.

Cadigan, N.G. 2010. Trends in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Cod (*Gadus morhua*) stock size based on a separable total mortality model and the Fisheries and Oceans Canada Research Vessel survey index. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/015.

Cadigan, N.G., and Brattey, J. 2003. Semi-parametric estimation of tag loss and reporting rates for tag-recovery experiments using exact time-at-liberty data. Biometrics 59: 869-876.

2006. Reporting and shedding rate estimates from tag-recovery experiments in Atlantic cod (*Gadus morhua*) in coastal Newfoundland. Can. J. Fish. Aquat. Sci. 63: 1944-58.

Cadigan, N.G., Walsh, S.J., W. Brodie. 2006. Relative efficiency of the Wilfred Templeman and Alfred Needler research vessels using a Campelen 1800 shrimp trawl in NAFO Subdivision 3Ps and Divisions 3LN. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/085.

Chen, Y. and G.S. Mello. – 1999. Growth and maturation of cod (*Gadus morhua*) of different year classes in NAFO Subdivision 3Ps in Northwest Atlantic. Fish. Res., 42: 87-101.

Colbourne, E.B., and Murphy, E.F. 2008. Physical oceanographic conditions in NAFO Division 3P during 2007 - possible influences on the distribution and abundance of Atlantic cod (*Gadus morhua*). DFO Can. Sci. Advis. Sec. Res. Doc. 2008/0627.

Cook, R.M. 1997. Stock trends in six North Sea stocks as revealed by an analysis of research vessel surveys. ICES Journal of Marine Science 54, 924–933.

DFO. 2004. Subdivision 3Ps Cod. DFO Can. Sci. Advis. Sec. Stock Status Report. 2004/039.

2006. Stock Assessment on Subdivision 3Ps cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/043.

2009a. Stock Assessment on Subdivision 3Ps cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/008.

2009b. Stock Assessment on Subdivision 3Ps cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/063.

Gavaris, S., and Gavaris, C.A. 1983. Estimation of catch at age and its variance for groundfish stocks in the Newfoundland Region. In “Sampling commercial catches of marine fish and invertebrates”. Edited by W. G. Doubleday and D. Rivard. Can. Spec. Publ. Fish. Aquat. Sci. 66: pp. 178-182.

Lawson, G.L., and Rose, G.A. 1999. Changes in the timing and location of cod spawning in Placentia Bay (NAFO sub-division 3Ps), 1997-1998. DFO Can. Sci. Advis. Sec. Res. Doc. 99/43.

Lilly, G.R. 1998. Size-at-age and condition of cod in Subdivision 3Ps as determined from research bottom-trawl surveys (1972-1997). CSAS Res. Doc. 98/94

Maddock Parsons, D.M., and Stead, P. 2001. Sentinel surveys 1995-2001: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/133.

2003a. Sentinel surveys 1995-2002: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/021.

2003b. Sentinel surveys 1995-2003: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/094.

2004. Sentinel surveys 1995-2004: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/088.

2005. Sentinel surveys 1995-2005: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/073.

2006. Sentinel surveys 1995-2006: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/094.

2007. Sentinel surveys 1995-2007: catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/035.

2009. Overview of Sentinel Surveys in NAFO Divisions 2J3KL and Subdivision 3Ps: 1995-2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/092.

McClintock, J. 1999a. Results of surveys directed at Cod in NAFO Division 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 1999/020.

1999b. Second year results of surveys Directed at Cod in NAFO Division 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 1999/034.

2000. Cod catch results from fall 1999 survey in NAFO Division 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 2000/024.

2001. Cod catch results 2000: year four of the NAFO Division 3Ps fall GEAC surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/012.

2002. Cod catch results 2001: year five of the NAFO Subdivision 3Ps fall GEAC surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/037.

2003. Cod catch results 2002: year six of the NAFO Subdivision 3Ps fall GEAC surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2003/097.

2011. The fall 2007 NAFO Subdivision 3Ps GEAC survey: Catch results for Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides* F.), witch flounder (*Glyptosephalus synoglossus* L.), and haddock (*Melanogrammus aeglefinus).* DFO Can. Sci. Advis. Sec. Res. Doc. 2010/056.

McCullagh, P., and Nelder, J.A. 1989. Generalized linear models. London, Chapman and Hall. 261p.

Morgan, M.J., and Hoenig, J.M.. 1997. Estimating age at maturity from length stratified sampling. J. Northw. Fish. Sci. 21:51-63.

Morgan, M.J. and R.M. Rideout. 2009. Time of spawning in subdivision 3Ps cod (*Gadus morhua*). DFO Can. Sci. Advis. Sec. Res. Doc. 2009/102.

Pinhorn, A.T. 1969. Fishery and biology of Atlantic Cod (*Gadus morhua*) off the southwest coast of Newfoundland. J. Fish. Res. Bd. Can. 26: 3133-3164.

Shelton, P.A., Stansbury, D.E., Murphy, E.F., Lilly, G.R., and Brattey, J. 1996. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 1996/091.

Smith, S.J. and G.D. Somerton. 1981. STRAP: a user-oriented computer analysis system for groundfish research trawl survey data. Canadian technical report of fisheries and aquatic sciences; 1030.

Stansbury, D.E., Shelton, P.A., Brattey, J., Lilly, G.R., Winters, G.R., Murphy, E.F., Davis, M.B., and Kulka, D.W. 1998. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 1998/019.

Stansbury, D.E. 1996. Conversion factors from comparative fishing trials for Engels 145 otter trawl on the FRV Gadus Atlantica and the Campelen 1800 shrimp trawl on the FRV Teleost. NAFO SCR Doc. 96/77, Ser. No. N2752. 15 p.

1997. Conversion factors for cod from comparative fishing trials for Engel 145 otter trawl and the Campelen 1800 shrimp trawl used on research vessels. NAFO SCR Doc. 97/73, Ser. No. N2907. 10 p.

Warren, W.G. 1996. Report on the Comparative Fishing Trial between the Gadus Atlantica and Teleost. NAFO SCR Doc. 96/28, Ser. No. N2701.

Warren, W., Brodie, W., Stansbury, D., Walsh, S., Morgan, J. and Orr, D. 1997. Analysis of the 1996 Comparative Fishing Trial between the Alfred Needler with the Engel 145' Trawl and the Wilfred Templeman with the Campelen 1800 Trawl. NAFO SCR Doc. 97/68, Ser. No. N2902.

Table 1. Reported landings of cod (t) from NAFO Subdivision 3Ps, 1959 – September 25th, 2009 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 [1]	108	7,594 [2]	79	448	1,191	-	-	-	-	9,420	10,000
1998 [1]	2,543	13,609 [2]	885	609	2,511	-	-	-	-	20,156	20,000
1999 [1]	3,059	21,156 [2]	614	621	2,548	-	-	-	-	27,997	30,000
2000 [1]	3,436	16,247 [2]	740	870	3,807	-	-	-	-	25,100	20,000
2001 [1]	2,152	11,187 [2]	856	675	1,675	-	-	-	-	16,546	15,000
2002 [1]	1,326	11,292 [2]	499	579	1,623	-	-	-	-	14,892	15,000
2003 [1]	1,869	10,600 [2]	412	734	1,645	-	-	-	-	15,260	15,000
2004 [1]	1,595	9,450 [2]	790	465	2,113	-	-	-	-	14,414	15,000
2005 [1]	1,863	9,537 [2]	818	617	1,941	-	-	-	-	14,778	15,000
2006 [1]	1,011	9,590 [2]	675	555	1,326	-	-	-	-	13,157	13,000
2007 [1]	1,339	9,303 [4]	294	520	1,503	-	-	-	-	12,959	13,000
2008 [1]	982	8654 [4]	377	467	1293	-	-	-	-	11,773	13,000
2009 [1]	1368	3601 [4]	196	169	1036	-	-	-	-	6,370	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	[1]	3,760	1,158	1,172	1,167	7,258
1998	[1]	10,116	2,914	308	92	13,430
1999	[1]	17,976	3,714	503	45	22,237
2000	[1]	14,218	3,100	186	56	17,561
2001	[1]	7,377	2,833	2,089	57	12,357
2002	[1]	7,827	2,309	775	119	11,030
2003	[1]	8,313	2,044	546	35	10,937
2004	[1]	7,910	2,167	415	15	10,508
2005	[1]	8,112	2,016	626	6	10,760
2006	[1]	7,590	2,698	314	2	10,603
2007	[1,2]	7,287	2,374	445	11	10,116
2008	[1,2]	6,636	2,482	341	21	9,480
2009	[1,2,3]	2,548	829	515	36	3,928

[1]*provisional catch*
[2]*excluding recreational catches*
[3]*catch to September 25th 2009*

Table 3. Reported monthly landings (t) of cod from unit areas in NAFO Subdiv. 3Ps during 2007, 2008 and 2009 (to September 25th).

2007	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	***Totals**
Jan	1.2	201.1	96.9	0.0	0.0	0.0	0.2	782.4	1,081.8
Feb	0.3	35.3	35.5	23.5	0.0	9.5	0.3	1,316.7	1,421.2
Mar	0.1	0.0	0.0	11.3	0.0	0.2	6.6	23.7	42.0
Apr	0.1	0.5	0.0	10.0	0.0	0.0	0.0	7.2	17.8
May	47.0	111.5	45.3	21.1	0.2	2.5	1.3	24.9	253.7
Jun	114.5	236.3	1,458.1	25.4	10.4	110.2	27.3	48.2	2,030.3
Jul	159.3	300.8	1,029.9	143.6	117.0	175.3	113.9	46.5	2,086.4
Aug	205.8	145.3	300.9	35.5	314.3	103.2	72.0	26.5	1,203.3
Sep	130.8	174.6	147.3	43.6	268.8	229.0	33.7	41.9	1,069.7
Oct	199.6	169.6	311.8	42.2	150.0	314.8	62.7	72.1	1,322.9
Nov	43.4	181.5	616.1	0.0	70.1	160.4	16.6	376.8	1,464.9
Dec	7.4	188.4	166.4	0.0	0.0	17.7	0.0	573.3	953.2
Totals	909.5	1,744.8	4,208.1	356.4	930.9	1,122.8	334.7	3,340.2	12,947.3

* Excludes 22 t of catch from unspecified unit area

2008	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**Totals**
Jan	21.9	173.1	123.6	0.0	0.0	9.2	0.0	1,042.4	1,370.2
Feb	6.0	103.0	61.6	0.0	0.0	0.0	15.7	876.7	1,063.1
Mar	0.1	0.0	0.0	2.0	0.0	0.1	3.0	12.2	17.3
Apr	6.6	0.0	0.0	2.1	0.0	0.0	1.0	11.3	20.9
May	54.3	105.8	127.1	8.6	2.0	0.0	0.3	7.6	305.6
Jun	179.0	291.5	1,159.1	11.9	0.0	27.0	0.0	43.7	1,712.2
Jul	167.3	429.8	1,078.4	48.5	80.4	26.5	0.2	19.8	1,850.8
Aug	90.3	121.0	103.8	41.1	171.4	37.3	10.7	6.7	582.4
Sep	156.3	219.3	307.5	46.0	302.1	69.9	3.3	26.0	1,130.5
Oct	163.2	174.1	544.1	128.8	247.4	90.6	14.2	45.8	1,408.1
Nov	75.4	167.5	671.2	158.4	85.3	230.5	26.1	262.9	1,677.3
Dec	22.7	156.7	195.3	0.0	0.0	123.2	0.0	102.0	599.8
Totals	943.2	1,941.7	4,371.7	447.5	888.6	614.2	74.3	2,456.9	11,738.2

* Excludes 36 t of catch from unspecified unit area

2009	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**Totals**
Jan	2.1	214.4	205.1	0.2	0.7			473.1	895.5
Feb	16.3	86.8	137.7			31.3	2.1	885.9	1,160.2
Mar	0.1			5.0			5.3	168.3	178.7
Apr				0.1			8.1	21.0	29.1
May	26.5	33.8	34.1	1.1	0.1	8.8	0.1	14.8	119.3
Jun	99.7	231.4	450.4	3.0	6.7	7.1		3.5	801.8
Jul	152.5	288.6	1,105.0	8.3	38.2	1.5	0.1	6.9	1,601.1
Aug	31.2	46.7	76.4	0.1	31.1	24.2		0.2	209.9
Sep	7.1	81.0	157.1	0.0	93.0	0.0	0.2		338.4
Oct									0.0
Nov									0.0
Dec									0.0
Totals	335.6	982.7	2,165.8	17.7	169.8	73.0	16.0	1,573.6	5,334.2

* Excludes 0.5 t of catch from unspecified unit area

* Excludes 1036 t of catch by France in 1st quarter 2009 - Unit Area breakdown not yet available.

Table 4a. Number of cod sampled for length and age and available to estimate the commercial catch at age for 2007.

	Number Measured (Canada)							
	Offshore			Inshore				
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Other	Total
Jan	1,645			1,080	1,734		37	4,459
Feb	1,560		1,351	56	301		20	3,268
Mar	483				60			543
Apr								0
May			45	370	0			415
Jun				11,712	0	635	112	12,347
Jul	4	998	1,340	4,053	2,325		291	8,720
Aug			87	766	4,909		116	5,762
Sep		306	277	870	3,642	727	16	5,822
Oct	2,086	1,307		962	6,415	200	0	10,970
Nov	9,829	124	21	3,022	2,992	72	53	16,060
Dec	3,546		1,232	1,189	1,434		123	7,401
Total	19,153	2,735	4,353	24,080	23,812	1,634	768	76,535

	Number Aged (Canada)							
	Offshore			Inshore				
Quarter	Ottertrawl	Gillnet	Linetrawl	Gillnets	Linetrawl	Handline	Ottertrawl	Total
1	852		256	208	356		13	1,685
2			13	777		84		874
3		100	192	618	1,339	140		2,389
4	218	283	145	333	910	92		1,981
Total	1,070	383	606	1,936	2,605	316	13	6,929

Sampling by France (SPM)

	Measured		Aged	
Quarter	Ottertrawl	Gillnet	Ottertrawl	Gillnet
1	6,313		265	
3		257		150
4	7,699		250	
Total	14,012	257	515	150

Table 4b. Number of cod sampled for length and age and available to estimate the commercial catch at age for 2008.

	Number Measured (Canada)							
	Offshore			Inshore				
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Other	Total
Jan	2,353			1,521	2,062		18	5,936
Feb	2,382		751					3,133
Mar					32			32
Apr								0
May				108			10	108
Jun		144	76	4,343	1,194		225	5,757
Jul		118		1,709	2,770	118	308	4,715
Aug		536		548	4,749	140	129	5,973
Sep	227	1,149	607	496	2,794		18	5,273
Oct	287	1,308		1,327	1,821			4,743
Nov	1,662	316	284	403	453			3,118
Dec				125	2,561			2,686
Total	6,911	3,571	1,718	10,580	18,436	258	708	42,182

	Number Aged (Canada)							
	Offshore			Inshore				
Quarter	Ottertrawl	Gillnet	Linetrawl	Gillnets	Linetrawl	Handline	Ottertrawl	Total
1	1,170		472	256	190			2,088
2		62	85	449	231			827
3	64	276	228	608	1,360	45		2,581
4	456	292	91	466	1157			2,462
Total	1,690	630	876	1,779	2,938	45	0	7,958

Sampling by France (SPM)

	Measured		Aged	
Quarter	Ottertrawl	Gillnet	Ottertrawl	Gillnet
1	7,282		280	
3		732		189
4	6,068			
Total	13,350	732	280	189

Table 5a. Estimates of average weight (kg), length (cm), and the total numbers (000s) and weight of 3Ps cod caught at age from Canadian and French landings during 2007. The column "Num_Fra" indicates numbers landed-at-age from French Inshore fisheries. The total numbers excludes any recreational catches.

	AVERAGE		CATCH					
	WEIGHT	LENGTH	NUMBER			Num_Fra	Total_Num	Weight (t)
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	CV	(000'S)	(000'S)	
1								
2	0.30	32.55	4.40	1.10	0.25	0.00	4.40	1
3	0.56	39.67	96.94	4.32	0.04	0.00	96.94	54
4	0.94	46.89	310.61	9.38	0.03	0.19	310.81	292
5	1.44	54.02	722.45	22.15	0.03	4.20	726.65	1049
6	1.96	59.79	1062.90	23.77	0.02	8.93	1071.84	2103
7	2.24	62.21	753.56	23.43	0.03	7.04	760.59	1700
8	2.53	64.59	477.46	16.05	0.03	23.58	501.05	1269
9	3.73	72.14	498.44	13.95	0.03	27.76	526.20	1964
10	4.96	79.45	392.48	12.13	0.03	8.15	400.63	1986
11	5.51	82.34	156.98	7.49	0.05	3.04	160.02	882
12	4.86	78.20	42.91	4.11	0.10	1.19	44.10	214
13	7.08	88.34	33.06	3.03	0.09	0.50	33.56	238
14	8.81	96.29	20.50	1.88	0.09	0.00	20.50	181
15	9.00	97.68	6.50	1.30	0.20	0.16	6.66	60
16	9.80	100.41	6.64	1.33	0.20	0.00	6.64	65
17	15.32	117.24	6.15	0.79	0.13	0.00	6.15	94
18	14.71	115.55	4.59	0.68	0.15	0.00	4.59	67
19	15.15	117.14	0.59	0.24	0.41	0.00	0.59	9
20	11.05	106.00	0.03	0.02	0.67	0.37	0.40	4

Table 5b. Estimates of average weight (kg), length (cm), and the total numbers (000s) and weight of 3Ps cod caught at age from Canadian and French landings during 2008. The column "Num_Fra" indicates numbers landed-at-age from French fisheries (inshore and offshore). The total numbers excludes any recreational catches.

	AVERAGE		CATCH					
AGE	WEIGHT (kg.)	LENGTH (cm.)	NUMBER (000'S)	STD ERR.	CV	Num_Fra (000'S)	Total_Num (000'S)	Weight (t)
1								
2	0.21	29.09	0.32	0.30		0.00	0.32	0
3	0.63	40.68	25.96	3.27	0.13	8.65	34.61	22
4	0.89	46.12	317.53	10.37	0.03	104.12	421.65	374
5	1.30	52.08	516.90	16.27	0.03	100.35	617.25	800
6	1.91	59.20	996.30	26.11	0.03	108.46	1104.76	2107
7	2.20	61.99	906.07	25.52	0.03	69.61	975.68	2151
8	2.43	63.73	584.41	21.16	0.04	49.22	633.63	1542
9	2.59	64.94	324.44	15.16	0.05	26.04	350.48	907
10	3.47	70.24	263.43	12.30	0.05	31.15	294.58	1021
11	4.82	78.10	155.66	7.85	0.05	37.60	193.27	931
12	4.98	79.18	80.43	5.95	0.07	10.47	90.90	453
13	4.55	75.55	25.18	5.00	0.20	2.02	27.20	124
14	7.77	89.20	10.51	1.85	0.18	1.31	11.83	92
15	10.49	101.00	6.37	1.15	0.18	3.71	10.09	106
16	8.72	92.14	5.62	1.47	0.26	1.12	6.74	59
17	15.80	118.29	3.72	0.69		1.06	4.78	75
18	16.86	120.92	3.27	0.57	0.17	1.53	4.81	81
19	16.15	119.41	0.47	0.16		0.29	0.76	12
20								

Table 6. Catch numbers-at-age (000s) for the commercial cod fishery in NAFO Subdiv. 3Ps from 1959 to 2008 (only ages 3-14 shown). Recreational catches in 2007 and 2008 are excluded (see text).

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

Table 7a. Mean annual weights-at-age (kg) calculated from lengths-at-age based on samples from commercial fisheries (including food fisheries and sentinel surveys) in Subdivision 3Ps in 1959-2008. 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	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1960	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1961	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1962	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1963	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1964	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1965	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1966	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1967	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1968	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1969	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1970	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1971	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1972	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1973	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1974	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1975	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1976	0.28	0.69	1.08	1.68	2.40	3.21	4.10	5.08	6.03	7.00	8.05	9.16
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.92
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.48	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.51	0.79	1.19	1.63	2.13	2.79	3.62	3.79	4.03	4.89	6.38	9.12
1999	0.62	0.76	1.27	1.90	2.28	2.61	3.49	4.64	4.54	4.93	5.66	6.82
2000	0.48	0.79	1.12	1.80	2.52	2.67	2.98	4.25	5.90	5.53	5.82	6.89
2001	0.57	0.79	1.14	1.62	2.31	3.06	3.00	3.30	5.07	7.50	6.83	7.22
2002	0.44	0.84	1.25	1.71	2.12	2.83	3.84	3.53	3.66	5.82	8.75	7.77
2003	0.57	0.75	1.27	1.81	2.19	2.47	3.46	4.53	4.09	4.54	6.88	9.59
2004	0.46	0.81	1.15	1.79	2.29	2.53	2.74	4.41	5.64	4.75	6.16	8.29
2005	0.51	0.74	1.16	1.59	2.24	2.69	2.94	3.04	4.68	6.42	5.38	7.48
2006	0.44	0.80	1.21	1.64	2.00	2.60	3.16	3.31	3.19	4.63	6.37	6.44
2007	0.56	0.94	1.44	1.96	2.24	2.53	3.73	4.96	5.51	4.86	7.08	8.81
2008	0.63	0.89	1.30	1.91	2.20	2.43	2.59	3.47	4.82	4.98	4.55	7.77

Table 7b. Beginning of the year weights-at-age calculated from commercial annual mean weights-at-age, as described in Lilly (MS 1998). The values for 1976 are extrapolated back to 1959. The values for 2008 are geometric means of the 2005-07 values.

Year/Age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1960	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1961	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1962	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1963	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1964	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1965	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1966	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1967	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1968	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1969	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1970	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1971	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1972	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1973	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1974	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1975	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1976	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.92
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.48	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.51	0.79	1.19	1.63	2.13	2.79	3.62	3.79	4.03	4.89	6.38	9.12
1999	0.62	0.76	1.27	1.90	2.28	2.61	3.49	4.64	4.54	4.93	5.66	6.82
2000	0.48	0.79	1.12	1.80	2.52	2.67	2.98	4.25	5.90	5.53	5.82	6.89
2001	0.57	0.79	1.14	1.62	2.31	3.06	3.00	3.30	5.07	7.50	6.83	7.22
2002	0.44	0.84	1.25	1.71	2.12	2.83	3.84	3.53	3.66	5.82	8.75	7.77
2003	0.57	0.75	1.27	1.81	2.19	2.47	3.46	4.53	4.09	4.54	6.88	9.59
2004	0.46	0.81	1.15	1.79	2.29	2.53	2.74	4.41	5.64	4.75	6.16	8.29
2005	0.51	0.74	1.16	1.59	2.24	2.69	2.94	3.04	4.68	6.42	5.38	7.48
2006	0.46	0.80	1.21	1.64	2.00	2.60	3.16	3.31	3.19	4.63	6.37	6.44
2007	0.47	0.73	1.21	1.74	2.08	2.34	3.20	4.13	4.37	3.90	5.90	7.62
2008	0.47	0.76	1.19	1.66	2.10	2.54	3.10	3.46	4.03	4.88	5.87	7.16

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

Gillnet (5.5")

Year/Age	3	4	5	6	7	8	9	10	Total
1995	0.02	0.08	3.92	8.51	5.17	2.41	0.37	0.15	20.64
1996	0.01	0.26	2.60	11.91	9.72	2.78	0.83	0.07	28.17
1997	0.01	0.23	5.08	5.06	9.02	7.30	1.08	0.59	28.37
1998	0.00	0.06	1.09	7.56	3.40	2.67	1.65	0.31	16.74
1999	0.05	0.07	0.52	0.90	1.43	0.64	0.29	0.28	4.19
2000	0.01	0.02	0.29	0.69	0.68	0.94	0.31	0.10	3.05
2001	0.02	0.15	0.41	0.86	0.67	0.38	0.36	0.17	3.02
2002	0.00	0.04	0.49	0.79	0.76	0.32	0.15	0.17	2.71
2003	0.01	0.05	0.22	0.96	0.46	0.18	0.09	0.04	2.02
2004	0.00	0.05	0.22	0.82	0.84	0.40	0.14	0.03	2.49
2005	0.00	0.02	0.13	0.58	0.66	0.38	0.29	0.05	2.13
2006	0.00	0.05	0.29	0.57	0.52	0.58	0.24	0.14	2.40
2007	0.00	0.05	0.41	1.05	0.74	0.38	0.28	0.18	3.10
2008	0.00	0.08	0.27	1.06	0.90	0.44	0.22	0.09	3.07

Linetrawl

Year/Age	3	4	5	6	7	8	9	10	Total
1995	7.75	14.74	51.50	74.26	19.68	18.35	4.31	1.48	192.07
1996	7.98	28.98	27.99	45.06	46.51	13.40	7.45	1.78	179.15
1997	5.66	22.82	24.35	15.96	16.81	23.00	2.83	1.73	113.17
1998	7.19	16.47	21.58	16.10	6.23	9.65	11.49	2.43	91.14
1999	5.84	17.30	23.86	13.72	7.75	4.89	4.65	2.03	80.04
2000	12.45	27.59	25.73	17.19	8.11	6.39	2.44	1.00	100.89
2001	17.58	30.50	22.56	13.37	7.30	4.20	2.32	0.69	98.53
2002	13.48	27.88	25.32	8.83	5.46	1.91	1.03	0.81	84.72
2003	2.59	33.92	38.71	19.85	8.22	3.49	1.28	0.86	108.93
2004	8.93	9.64	35.52	18.75	10.04	3.29	1.55	0.44	88.16
2005	7.06	19.75	12.86	12.95	11.25	4.32	1.94	0.84	70.97
2006	8.66	16.78	26.13	19.82	13.21	11.92	3.52	1.58	101.62
2007	10.74	18.99	16.62	13.93	8.41	5.04	4.53	1.82	80.06
2008	5.37	26.02	23.00	19.03	9.28	5.96	2.87	2.73	94.26

Table 9. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Division 3Ps (1997-2009 shown). Shaded cells are model estimates. See Fig. 11 for location of strata. For 1983-1996 results see Brattey et al. (2007).

							Tel 351			Tel 522	AN 656				
		Vessel	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	AN
		Trips	202-203	219-220	236-237	313-315	364-365	418-419	476-477	523+546	617-618	688	757-759	824-827	902-904
Depth		Sets	158	176	175	171	173	177	176	177	178	24	178	169	175
range		Mean Date	12-Apr	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr	27-Apr		18-Apr	2-May	24-Apr
(fathoms)	Strata	sq. mi.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<30	314	974	77	57	1729	1531	153	67	19	117	256		1570	2144	573
	320	1320	303	1292	3546	5183	1543	478	1601	396	523		333	363	3222
31-50	293 [5]	159	107	292	601	394	219	131	120	375	2850	200	317	252	208
	308	112	262	4175	2704	1829	1094	285	77	2265	16719		1410	2373	486
	312	272	19	100	461	1235	636	112	150	56	1141		370	270	0
	315	827	38	5721	2428	1895	1040	228	49	395	1161		1268	675	1634
	321	1189	18	49	894	1161	55	98	82	16	229		65	189	218
	325	944	108	16	752	2824	1526	65	16	1120	383		893	812	1542
	326	166	0	11	52	109	57	0	0	0	0		285	11	0
	783 [1]	229	47	16	110	86	142	13	95	16	252	**nf**	126	126	157
51-100	294 [5]	135	176	901	362	170	195	613	455	288	20685	1092	1281	108	4960
	297 [5]	152	408	209	1892	7000	450	450	42	244	1317	20732	1047	273	1056
	307	395	1123	23490	5879	6991	5665	833	22912	9328	3172		2735	4849	18237
	311	317	371	1652	2169	2864	610	780	349	2733	788		1715	2519	3632
	317	193	451	173	305	1487	637	1049	372	199	1367		2522	2881	912
	319	984	1889	15600	11839	9327	58696	34398	2149	26117	6064		15245	14670	24418
	322	1567	234	260	713	1529	413	633	263	649	2463		2507	1297	1049
	323	696	24	32	158	1001	941	64	19	0	101		32	3300	105
	324	494	272	160	361	442	85	306	391	85	432		481	153	359
	781 [1]	446	195	276	1058	716	1564	261	215	1052	568	491	445	552	548
	782 [1]	183	63	38	38	315	76	227	50	63	221	**nf**	101	227	201
101-150	295 [5]	209	168	465	976	615	978	144	187	72	976	1781	1469	633	396
	298 [5]	171	110	1861	46	3450	670	371	5399	976	282	21	7475	3384	73
	300 [5]	217	584	1579	641	896	791	746	1370	168	657	327	478	90	507
	306	363	816	771	708	4191	949	246	277	666	1015		2175	818	4054
	309	296	260	11980	215	142	2056	13172	484	109	582		1122	244	49
	310	170	1380	105	131	187	505	485	1391	12	249		94	269	30
	313	165	0	454	91	113	3564	125	567	10	66		124	23	111
	316	189	65	104	23	13	26	117	273	69	117		117	13	116
	318	129	1881	53	0	231	44	71	11943	275	683		336	16	189
	779 [1]	422	0	39	0	73	26	29	15	19	142	77	671	310	186
	780 [1]	403	35	18	0	40	0	0	0	0	18	**nf**	400	0	37
151-200	296 [5]	71	632	4	375	107	1924	735	303	2627	35	54	881	273	999
	299 [5]	212	643	49	0	13	131	160	214	44	29	44	44	13	13
	705	195	241	376	24	54	83	241	232	267	64		0	76	155
	706	476	172	327	87	49	49	82	246	120	310		31	65	87
	707	74	353	102	9	0	293	3079	143	121	1263		122	257	737
	715	128	516	5874	484	751	3013	1615	960	102	305		132	170	599
	716	539	91	3089	2428	196	99	1333	952	74	142		1368	51	1546
201-300	708	126	388	1464	947	0	35	151	329	85	1419		641	0	4299
	711	593	44	16	0	783	80	49	96	29	1530		505	29	125
	712	731	60	201	50	98	117	67	345	60	15		106	54	60
	713	851	902	61	78	176	364	320	372	127	80		45	17	99
	714	1074	2765	485	173	151	3781	1346	1678	230	77		373	44	819
301-400	709 [2]	147	nf	0	0	10	30	0	611	0	0		0	13	0
401-500	710 [1]	156	nf	nf	0	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	
601-700	777 [1]	183	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	
	Total [3]		15,123	78,250	39,438	46,543	88,209	61,895	48,737	45,832	42,716		38,722	38,652	69,462
	Total [4]		18,291	83,997	45,537	60,428	95,405	65,775	57,813	51,776	70,748		53,457	44,906	78,803
	upper		21,365	166,891	55,196	60,749	147,318	119,231	109,897	95,755	171,310		48,978	55,629	103,588
	t-value		2.31	3.18	2.23	2.20	2.36	2.78	3.18	2.31	4.30		4.30	2.20	2.23
	std [6]		2,702	27,857	7,066	6,457	25,046	20,624	19,233	21,649	29,906		2,383	7,713	15,303

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

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

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

[4] totals are for all strata fished .

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

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

Table 10. Cod biomass estimates (t) from DFO research vessel bottom-trawl surveys in NAFO Subdivision 3Ps during 1997-2009. Shaded cells are model estimates. See Fig. 11 for location of strata. For 1983-1996 results see Brattey et al. (2007).

							Tel 351			Tel 522	AN 656				
		Vessel	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	AN
		Trips	202-203	219-220	236-237	313-315	364-365	418-419	476-477	523+546	617-618	688	757-759	824-827	902-904
Depth		Sets	158	176	175	171	173	177	176	177	178	24	178	169	175
range		Mean Date	12-Apr	21-Apr	24-Apr	21-Apr	18-Apr	15-Apr	22-Apr	24-Apr	27-Apr	15-Apr	18-Apr	2-May	24-Apr
(fathoms)	Strata	sq. mi.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
<30	314	974	32	8	595	829	46	5	0	10	185	nf	53	204	68
	320	1320	114	7766	6287	6761	601	932	2707	395	1890	nf	1274	442	1069
31-50	293 [5]	159	17	19	27	45	26	9	29	18	1810	34	16	18	7
	308	112	93	1461	1572	1088	184	48	12	1949	8011	nf	253	789	170
	312	272	13	8	226	640	93	10	9	18	345	nf	60	434	0
	315	827	14	20072	3771	3092	491	822	17	335	13514	nf	6456	99	1777
	321	1189	2	0	1855	4582	2	5	2	2	40	nf	186	17	54
	325	944	10	0	418	1307	340	10	3	568	84	nf	172	555	447
	326	166	0	0	8	478	25	0	0	0	0	nf	55	1	0
	783 [1]	229	0	0	14	16	6	0	2	1	303	nf	12	18	13
51-100	294 [5]	135	24	40	19	7	26	47	22	14	21147	716	85	27	149
	297 [5]	152	39	22	1697	2339	108	38	5	42	1482	20678	382	122	156
	307	395	332	16164	3784	5162	1578	197	26828	6055	2423	nf	1471	3059	8114
	311	317	51	169	3342	1661	26	145	13	182	570	nf	83	219	395
	317	193	62	196	36	259	331	88	59	78	218	nf	1118	231	158
	319	984	287	28144	18019	8121	51570	38958	755	67844	5845	nf	14166	8888	33064
	322	1567	118	13	117	1893	193	32	26	38	1532	nf	79	205	104
	323	696	15	112	227	643	305	7	1	0	28	nf	1	2525	4
	324	494	11	8	252	25	7	14	13	8	148	nf	51	39	53
	781 [1]	446	22	16	64	49	36	13	17	61	203	62	23	49	28
	782 [1]	183	2	7	1	7	0	27	1	3	34	nf	5	13	20
101-150	295 [5]	209	24	139	45	61	124	8	26	4	727	253	128	83	20
	298 [5]	171	42	2608	148	2632	202	75	2735	488	250	30	8445	2881	56
	300 [5]	217	147	802	650	307	153	124	175	103	391	192	149	25	286
	306	363	312	618	553	5123	543	67	51	960	812	nf	2142	645	2021
	309	296	87	9788	320	303	1118	15666	193	56	464	nf	1328	673	10
	310	170	206	72	145	330	488	209	263	4	410	nf	11	427	7
	313	165	0	481	162	97	18231	122	807	4	101	nf	352	79	61
	316	189	40	138	43	21	63	78	146	103	95	nf	120	5	156
	318	129	404	88	0	592	28	43	12705	506	1672	nf	445	25	189
	779 [1]	422	0	10	0	4	1	1	2	1	47	5	41	38	18
	780 [1]	403	3	1	0	6	0	0	0	0	2	nf	86	0	2
151-200	296 [5]	71	175	1	102	20	341	118	36	900	54	20	146	76	239
	299 [5]	212	282	231	0	1	411	655	315	35	15	30	327	1	2
	705	195	476	345	25	20	71	244	434	288	96	nf	0	111	122
	706	476	379	266	68	63	26	40	431	147	301	nf	56	76	51
	707	74	72	121	21	0	360	3726	187	329	3347	nf	109	243	469
	715	128	233	6849	1127	1240	5599	2525	1188	114	451	nf	167	296	1793
	716	539	44	1772	4106	229	92	554	735	75	123	nf	1933	59	961
201-300	708	126	629	4389	1455	0	54	139	354	76	1272	nf	940	0	3688
	711	593	43	11	0	1242	75	35	41	22	1864	nf	1024	52	100
	712	731	151	267	25	64	65	25	264	39	6	nf	94	81	52
	713	851	1101	48	143	123	273	235	261	172	63	nf	27	5	59
	714	1074	3471	725	155	123	4113	1212	2306	183	149	nf	514	51	808
301-400	709 [2]	147	nf	0	0	5	59	0	383	0	0	nf	0	24	0
401-500	710 [1]	156	nf	nf	0	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
601-700	777 [1]	183	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
	Total [3]		8,802	100,100	48,857	46,111	86,991	66,193	50,811	80,560	46,059		34,740	20,535	56,024
	Total [4]		9,579	103,996	51,624	51,610	88,484	67,308	54,559	82,230	72,524		44,585	23,910	57,020
	upper		14,193	160,874	71,356	60,876	148,519	134,681	127,771	218,043	146,619		53,944	31,842	107,025
	t-value		2.36	2.201	2.13	2.15	2.57	2.78	3.18	2.365	3.18		2.12	2.31	2.31
	std [6]		2,284	27,612	10,563	6,867	23,941	24,636	24,201	58,132	31,623		9,058	4,895	22,078

Table 11a. 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 (1983-2009)

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

Combined Inshore+Offshore (1997-2009)

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

[1] These strata were added to the stratification scheme in 1994.
[2] Strata 709 was redrawn in 1994 and includes the area covered by strata 710 previously. All sets done in 710 prior to 1994 recoded to 709.
[3] For index strata 0-300 fathoms in the offshore and includes esitmates (shaded cells) for non-sampled strata .
[4] totals are for all strata fished .
[5] These strata were added to the stratification scheme in 1997.
[6] std's are for index strata and do not include estimates from non-sampled strata.

Table 11b. Mean numbers per tow at age in Campelen units for the Canadian research vessel bottom trawl survey of the eastern and western (Burgeo area) portions of NAFO 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 (1993-2009)

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

Western 3Ps (Burgeo Area; 1993-2009)

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

Table 12. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdivision 3Ps in winter-spring 1983-2009. 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	1998
1	10.3	12.0		11.0	10.7	9.2	12.0		9.5					12.6	12.7	10.6
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	22.3
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	32.8
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	42.7
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	49.1
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	53.3
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	57.6
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	67.1
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	77.4
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	77.2
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	64.3
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		78.0

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

Table 13. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1983-2009. 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	1998
1	0.01								0.01					0.02	0.02	0.01
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	0.09
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	0.28
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	0.62
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	0.99
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	1.27
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	1.63
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	2.74
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	4.76
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	5.07
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	2.68
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		5.25

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

Table 14. Mean gutted condition-at-age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2005. Boxed entries are based on fewer than 5 aged fish.

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

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.754	0.727	0.898	0.673	0.594	0.963	0.638	0.876	0.684	0.768
2	0.697	0.674	0.660	0.675	0.666	0.665	0.680	0.671	0.675	0.707
3	0.706	0.717	0.699	0.704	0.696	0.684	0.694	0.700	0.716	0.730
4	0.709	0.725	0.720	0.697	0.707	0.686	0.688	0.702	0.707	0.722
5	0.695	0.702	0.704	0.694	0.688	0.680	0.676	0.703	0.677	0.708
6	0.713	0.683	0.680	0.688	0.677	0.722	0.690	0.697	0.705	0.709
7	0.715	0.693	0.689	0.690	0.674	0.659	0.666	0.701	0.705	0.731
8	0.722	0.714	0.725	0.686	0.674	0.699	0.712	0.674	0.715	0.730
9	0.671	0.713	0.757	0.722	0.698	0.702	0.728	0.674	0.720	0.752
10	0.758	0.751	0.742	0.762	0.754	0.695	0.740	0.649	0.730	0.752
11	0.725	0.785	0.748	0.722	0.784	0.732	0.669	0.669	0.710	0.806
12	0.760		0.784	0.737	0.712	0.773	0.734	0.712	0.734	0.810

Note: this table has not been updated with recent survey information.

Table 15. Mean liver index at age sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2005. Boxed entries are based on fewer than 5 aged fish.

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

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1													
2		0.0304	0.0139	0.0252	0.0244	0.0247	0.0239	0.0241	0.0231	0.0235	0.0242	0.0242	0.0224
3	0.0106	0.0144	0.0111	0.0160	0.0208	0.0165	0.0205	0.0181	0.0150	0.0193	0.0214	0.0188	0.0222
4	0.0154	0.0138	0.0131	0.0161	0.0199	0.0206	0.0170	0.0152	0.0163	0.0155	0.0199	0.0156	0.0223
5	0.0180	0.0197	0.0209	0.0168	0.0201	0.0216	0.0167	0.0193	0.0158	0.0176	0.0210	0.0176	0.0244
6	0.0187	0.0221	0.0201	0.0201	0.0183	0.0249	0.0168	0.0191	0.0209	0.0203	0.0231	0.0259	0.0247
7	0.0184	0.0170	0.0211	0.0219	0.0230	0.0227	0.0210	0.0210	0.0181	0.0172	0.0265	0.0241	0.0272
8	0.0206	0.0211	0.0179	0.0231	0.0240	0.0346	0.0197	0.0222	0.0245	0.0198	0.0197	0.0217	0.0280
9	0.0280	0.0208	0.0189	0.0194	0.0273	0.0407	0.0294	0.0235	0.0270	0.0242	0.0310	0.0204	0.0314
10	$\boxed{0.0182}$	0.0423	0.0265	0.0303	0.0379	0.0424	0.0388	0.0342	0.0258	0.0271	0.0228	0.0222	$\boxed{0.0297}$
11	0.0346	$\boxed{0.0232}$	0.0343	0.0314	$\boxed{0.0396}$	0.0271	0.0234	0.0385	0.0294	$\boxed{0.0110}$	0.0225	0.0261	0.0554
12	$\boxed{0.0379}$	$\boxed{0.0326}$	$\boxed{0.0247}$	$\boxed{0.0202}$		$\boxed{0.0284}$	$\boxed{0.0260}$	0.0298	0.0363	$\boxed{0.0259}$	$\boxed{0.0334}$	$\boxed{0.0208}$	0.0530

Note: this table has not been updated with recent survey information.

Table 16. 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 1959-2009 (nf=no significant model fit).

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			nf	
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

Cohort	slope	slope_SE	intercept	intercept_se
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	-9.3460	1.2620
1997	3.0797	0.4567	-14.8462	2.1742
1998	1.9984	0.2396	-9.6586	1.1567
1999	1.8423	0.2647	-9.1495	1.3103
2000	1.7799	0.3025	-9.2711	1.4888
2001	1.7583	0.2294	-8.3426	0.0340
2002	1.7848	0.2721	-9.3773	1.4367
2003	1.3851	0.2885	-8.0317	1.5286
2004	2.1449	0.5456	-11.4699	2.5863

Table 17. Estimated proportions mature for female cod from NAFO Subdivision 3Ps from DFO surveys from 1978 to 2009 projected forward to 2012. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age (from "combined" survey area). Shaded cells are averages of the three closest cohorts; boxed cells are the average of estimates for the adjacent cohorts.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1954	0.0288	0.0000	0.0328	0.0592	0.1059	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1955	0.0009	0.0515	0.0000	0.0592	0.1059	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1956	0.0002	0.0026	0.0905	0.0000	0.1059	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1957	0.0003	0.0007	0.0078	0.1541	0.0000	0.1866	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1958	0.0001	0.0011	0.0032	0.0234	0.2502	0.0000	0.3097	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1959	0.0000	0.0006	0.0040	0.0142	0.0677	0.3793	0.0006	0.7249	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1960	0.0000	0.0000	0.0026	0.0149	0.0610	0.1804	0.5281	0.8333	0.8832	0.9407	0.9697	0.9842	0.9917	0.9955
1961	0.0001	0.0002	0.0001	0.0112	0.0536	0.2266	0.4003	0.6721	1.0000	0.9407	0.9697	0.9842	0.9917	0.9955
1962	0.0001	0.0007	0.0012	0.0010	0.0464	0.1744	0.5691	0.6693	0.7897	1.0000	0.9697	0.9842	0.9917	0.9955
1963	0.0002	0.0004	0.0035	0.0102	0.0111	0.1733	0.4410	0.8562	0.8599	0.8731	1.0000	0.9842	0.9917	0.9955
1964	0.0001	0.0008	0.0028	0.0185	0.0785	0.1096	0.4745	0.7465	0.9641	0.9490	0.9265	1.0000	0.9917	0.9955
1965	0.0000	0.0005	0.0046	0.0177	0.0914	0.4130	0.5741	0.7955	0.9166	0.9918	0.9826	0.9585	1.0000	0.9955
1966	0.0000	0.0001	0.0028	0.0252	0.1041	0.3491	0.8532	0.9365	0.9437	0.9762	0.9982	0.9942	0.9769	1.0000
1967	0.0002	0.0000	0.0010	0.0159	0.1255	0.4283	0.7410	0.9796	0.9938	0.9863	0.9935	0.9996	0.9981	0.9872
1968	0.0002	0.0009	0.0001	0.0066	0.0847	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	0.8157	0.9689	0.9879	0.9997	0.9999	0.9993	0.9995	1.0000
1970	0.0002	0.0001	0.0066	0.0205	0.0130	0.2395	0.7498	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	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	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	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	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	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	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
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
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	0.7974	0.9409	0.9759	0.9923	0.9925	1.0000	1.0000	1.0000
1991	0.0006	0.0024	0.0033	0.0515	0.2399	0.5395	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	0.4611	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	0.0005	0.0080	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	0.0013	0.0030	0.0445	0.1042	0.5155	0.9115	0.9988	0.9899	0.9978	0.9996	1.0000	1.0000	1.0000	1.0000
2005	0.0001	0.0052	0.0176	0.2126	0.4082	0.8704	0.9870	0.9999	0.9982	0.9996	0.9999	1.0000	1.0000	1.0000
2006	0.0006	0.0008	0.0203	0.0964	0.6104	0.8035	0.9769	0.9982	1.0000	0.9997	0.9999	1.0000	1.0000	1.0000
2007	0.0006	0.0030	0.0065	0.0765	0.3886	0.9009	0.9604	0.9963	0.9998	1.0000	0.9999	1.0000	1.0000	1.0000
2008	0.0006	0.0030	0.0148	0.0526	0.2486	0.7911	0.9814	0.9931	0.9994	1.0000	1.0000	1.0000	1.0000	1.0000
2009	0.0006	0.0030	0.0148	0.0752	0.3218	0.5693	0.9576	0.9967	0.9988	0.9999	1.0000	1.0000	1.0000	1.0000
2010	0.0006	0.0030	0.0148	0.0752	0.3197	0.8021	0.8408	0.9926	0.9994	0.9998	1.0000	1.0000	1.0000	1.0000
2011	0.0006	0.0030	0.0148	0.0752	0.3197	0.7208	0.9719	0.9547	0.9988	0.9999	1.0000	1.0000	1.0000	1.0000
2012	0.0006	0.0030	0.0148	0.0752	0.3197	0.7208	0.9234	0.9966	0.9883	0.9998	1.0000	1.0000	1.0000	1.0000

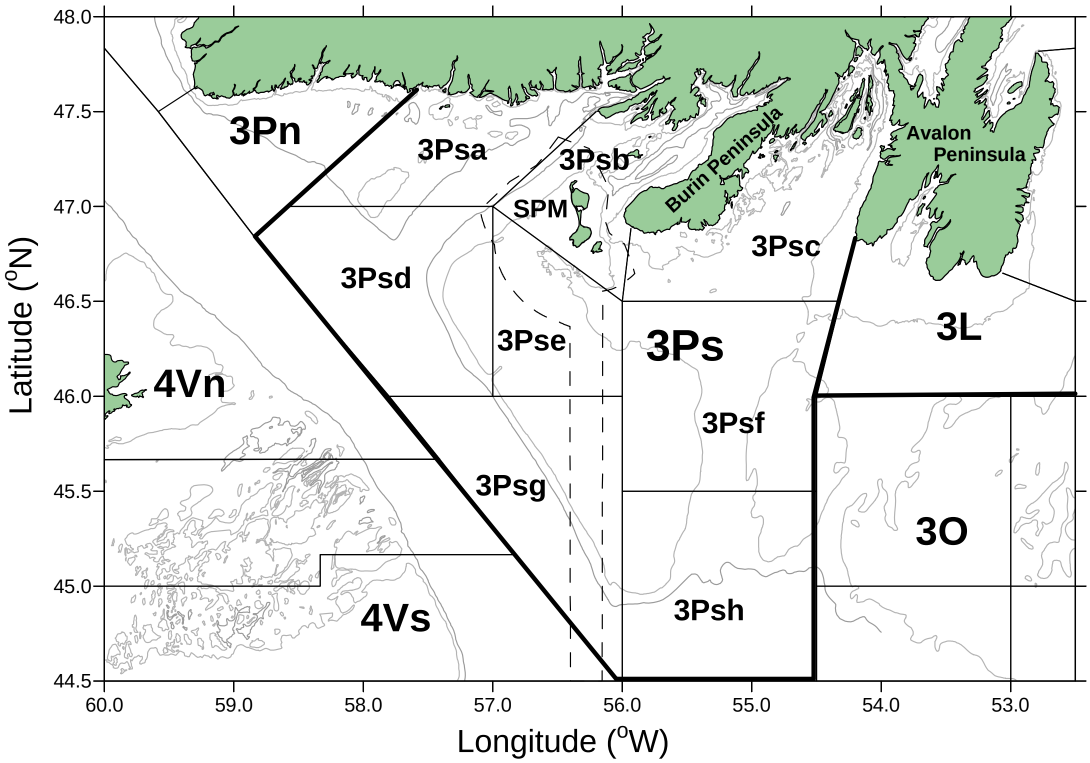


Figure 1. NAFO Subdivision 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).

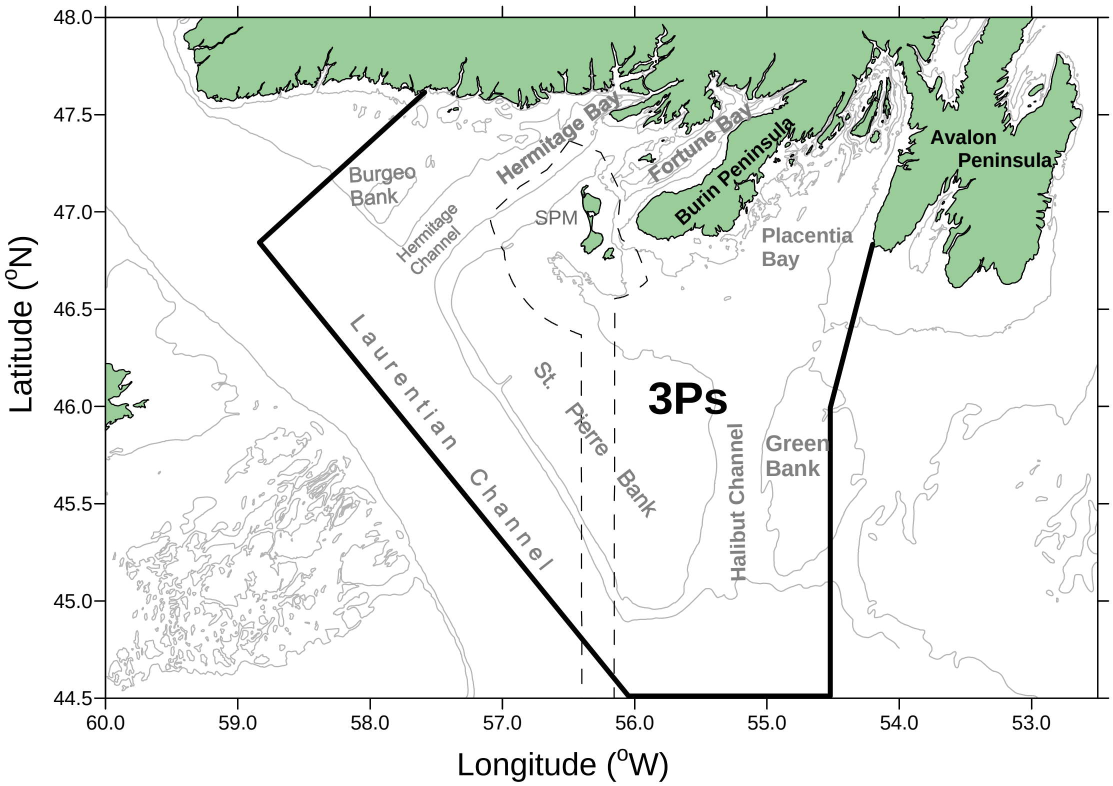


Figure 2. NAFO Subdivision 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the main fishing areas.

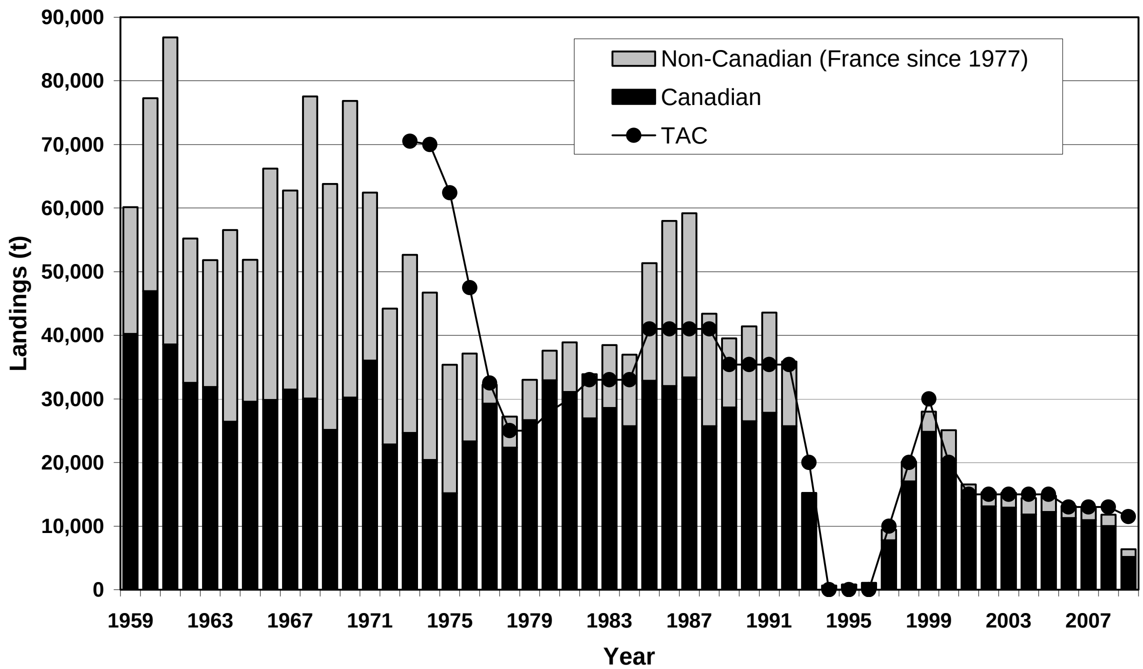


Figure 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdivision 3Ps during 1959-September 2009. The 2009 fishery was still in progress at the time of the October 2009 assessment.

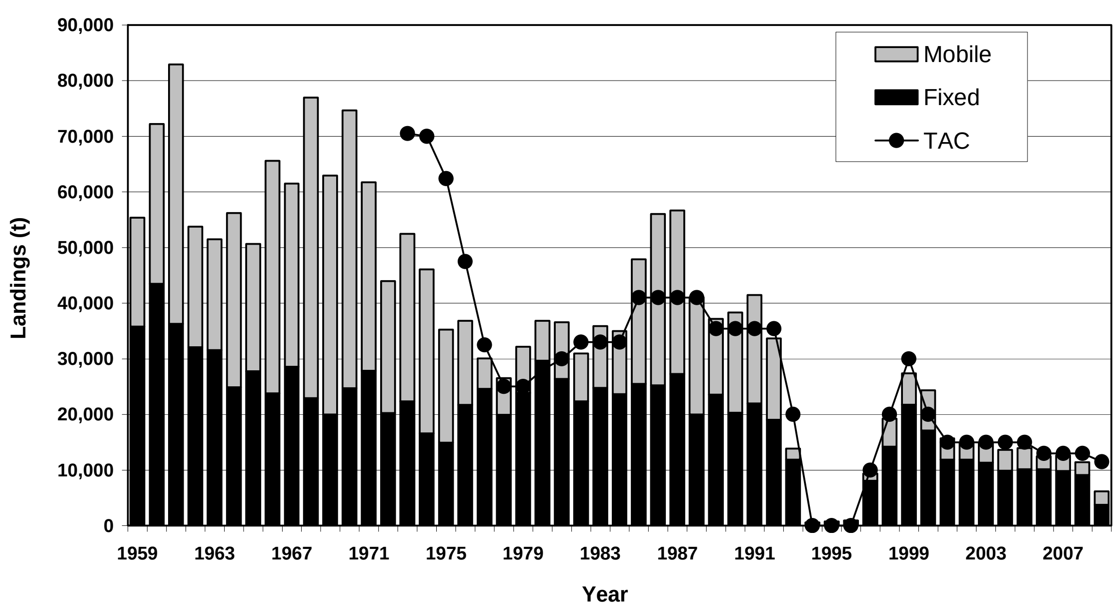


Figure 3b. Reported landings of cod by fixed and mobile gears in NAFO Subdivision 3Ps during 1959-September 2009. The 2009 fishery was still in progress at the time of the October 2009 assessment.

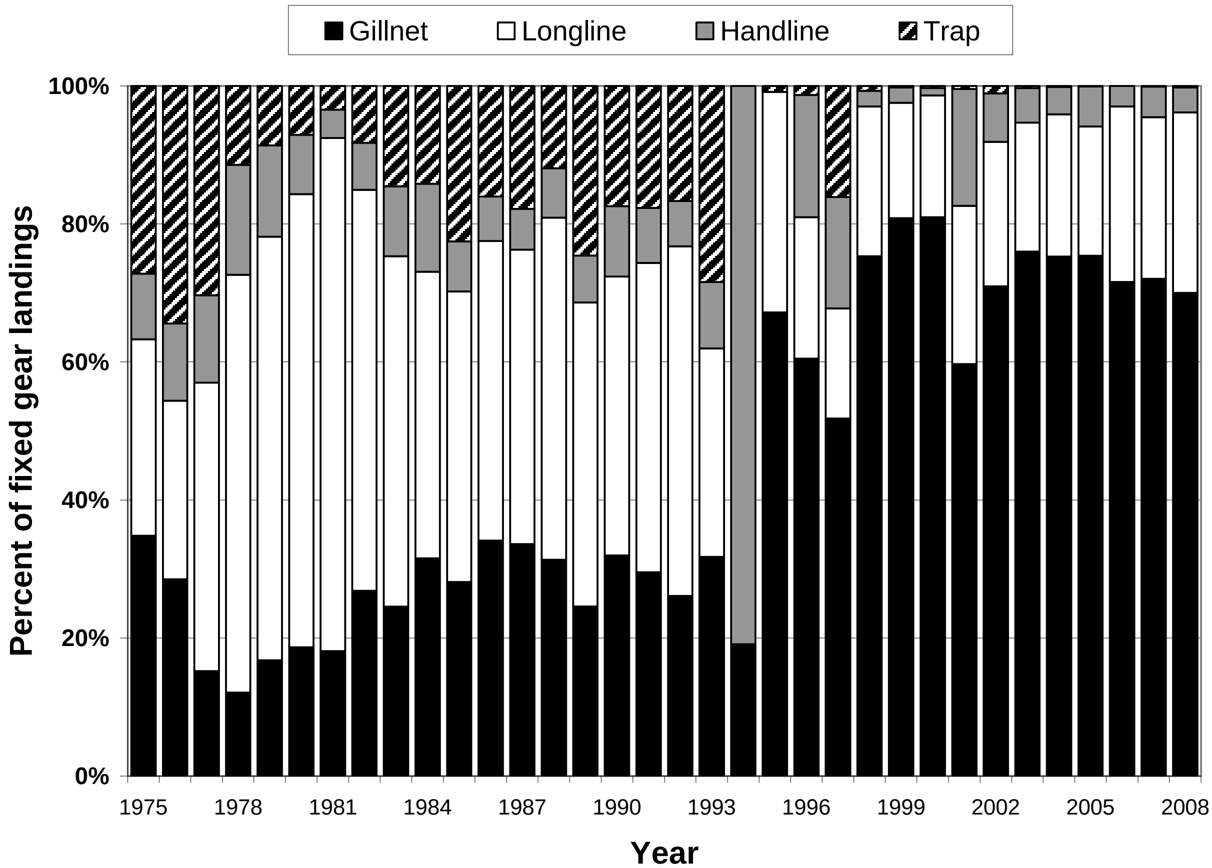


Figure 4. Percent of total fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdivision 3Ps during 1975-2008. (Excludes values for 2009 as the fishery was still in progress.) The fishery was under a moratorium during 1994-96 and values for those years are based on sentinel and by-catch landings of <800 t.

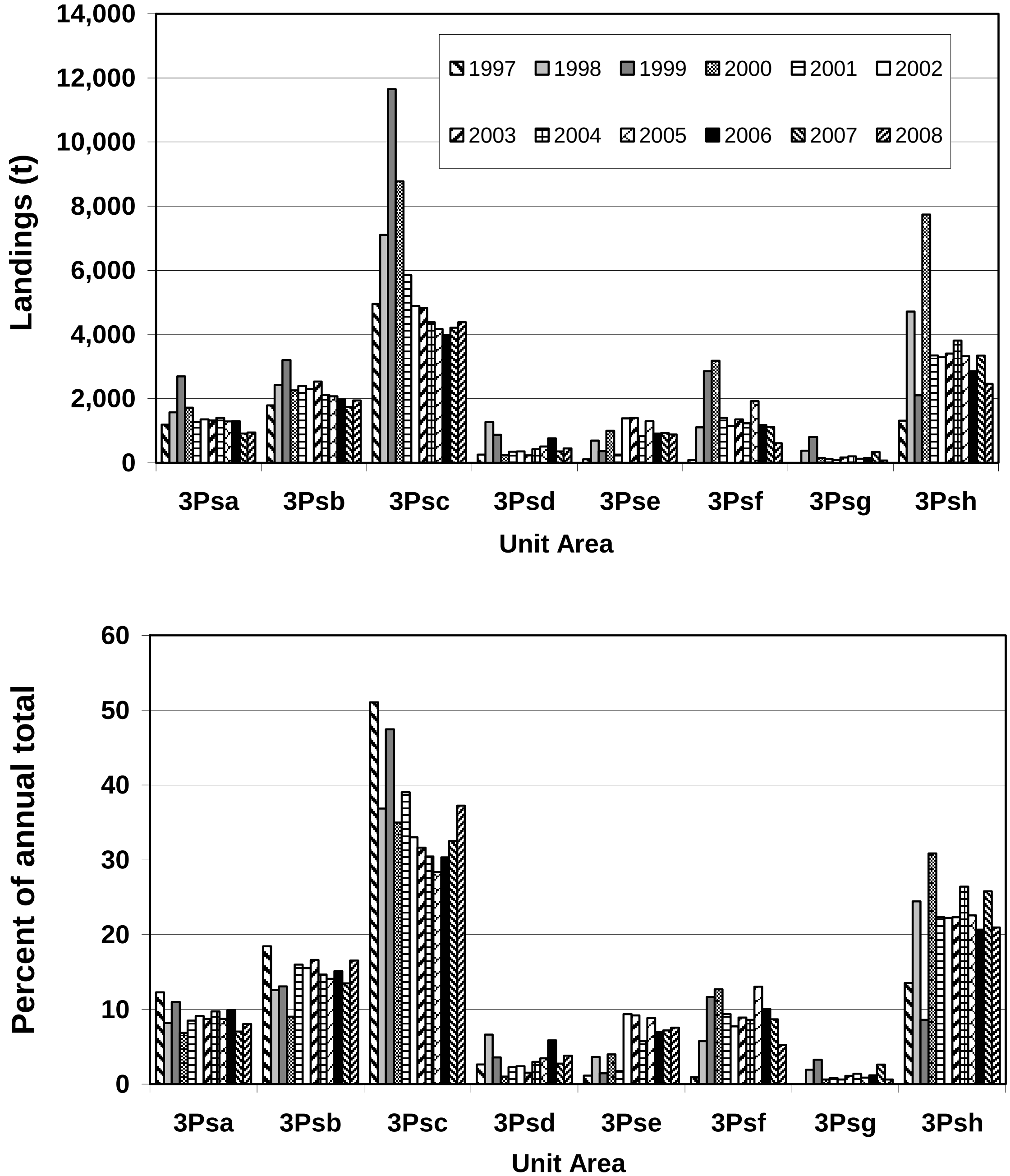


Figure 5. Annual reported landings of cod (upper panel) and percent of annual total (lower panel) by unit area from NAFO Subdivision 3Ps during 1997-2008. Refer to Figure 1 for locations of unit areas.

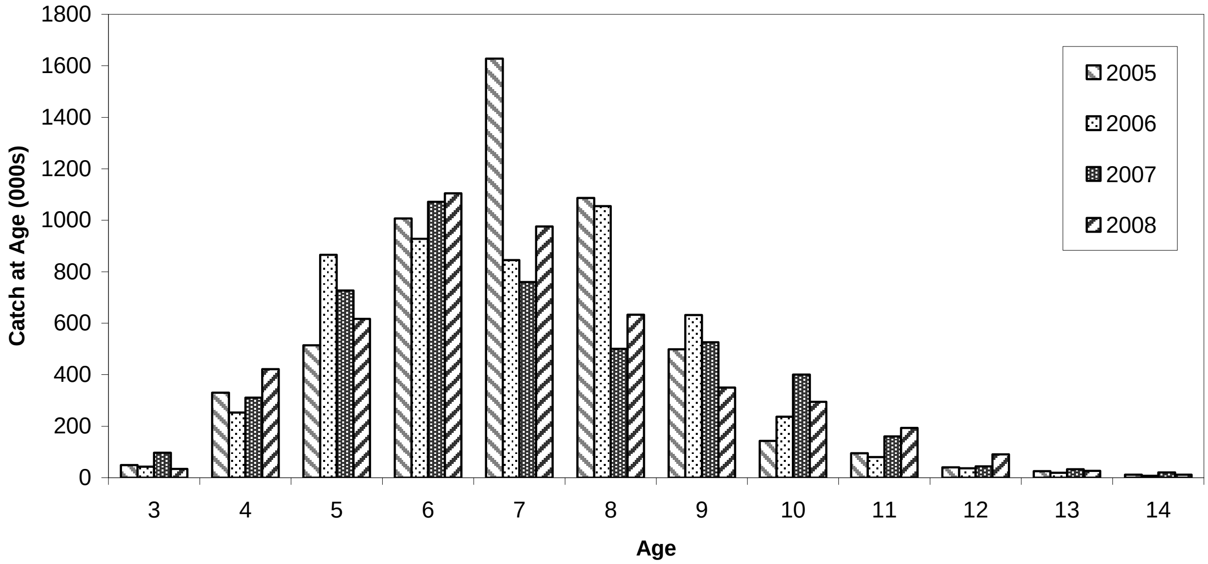


Figure 6a. Catch at age (numbers of fish; in thousands) for the cod fishery in 3Ps during 2005 - 2008. Does not include recreational catches from 2007 or 2008 (see text).

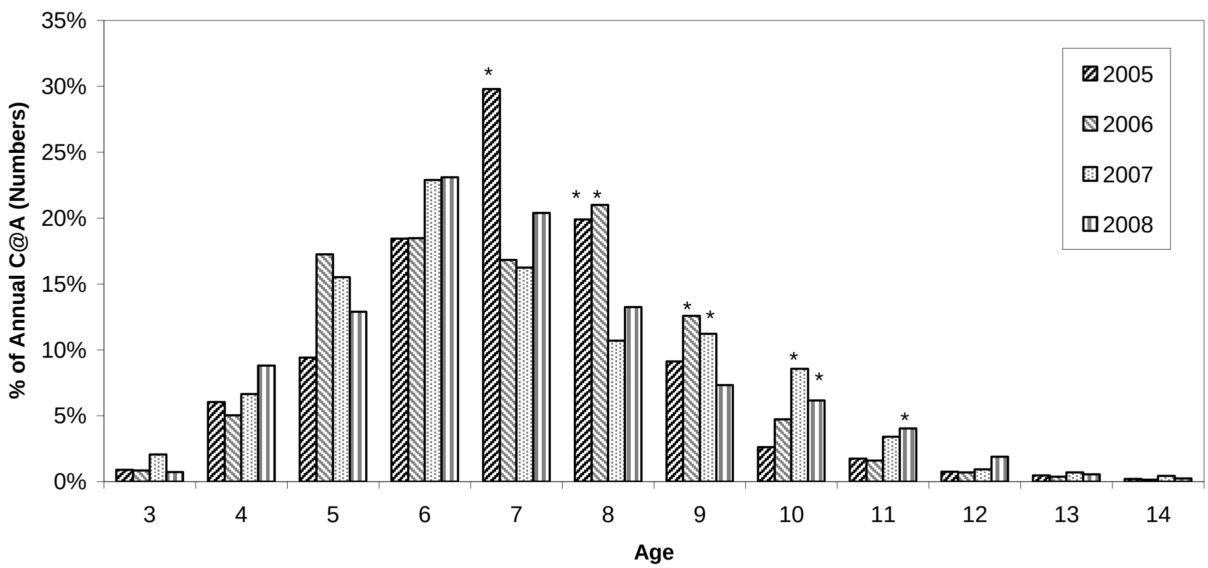


Figure 6b. Trends in catch at age (percents) for 3Ps cod from 2005 to 2008. Catches of the 1997 and 1998 year-classes are highlighted (*).

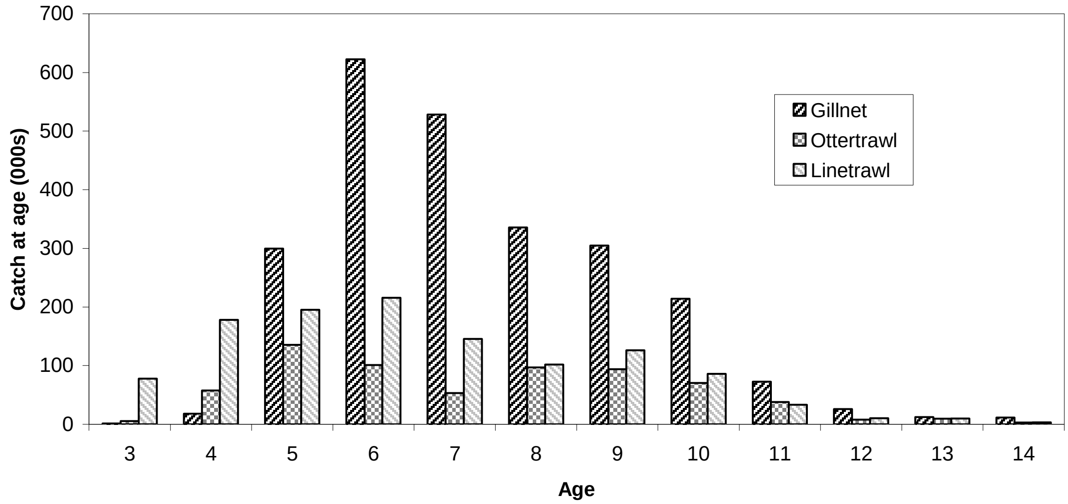


Figure 7a. Catch numbers-at-age for the main gear types used in the 3Ps cod fishery during 2007.

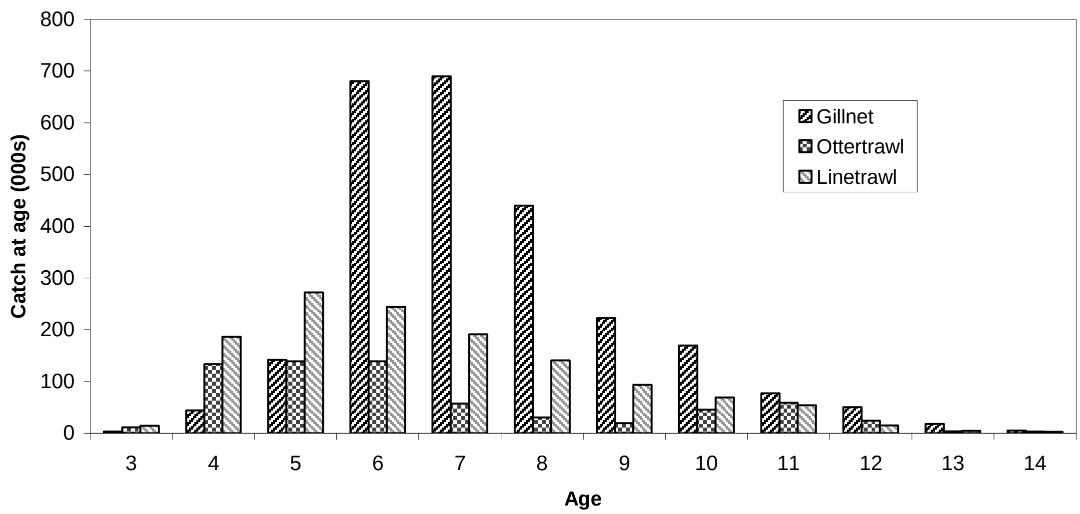


Figure 7b. Catch numbers-at-age for the main gear types used in the 3Ps cod fishery during 2008.

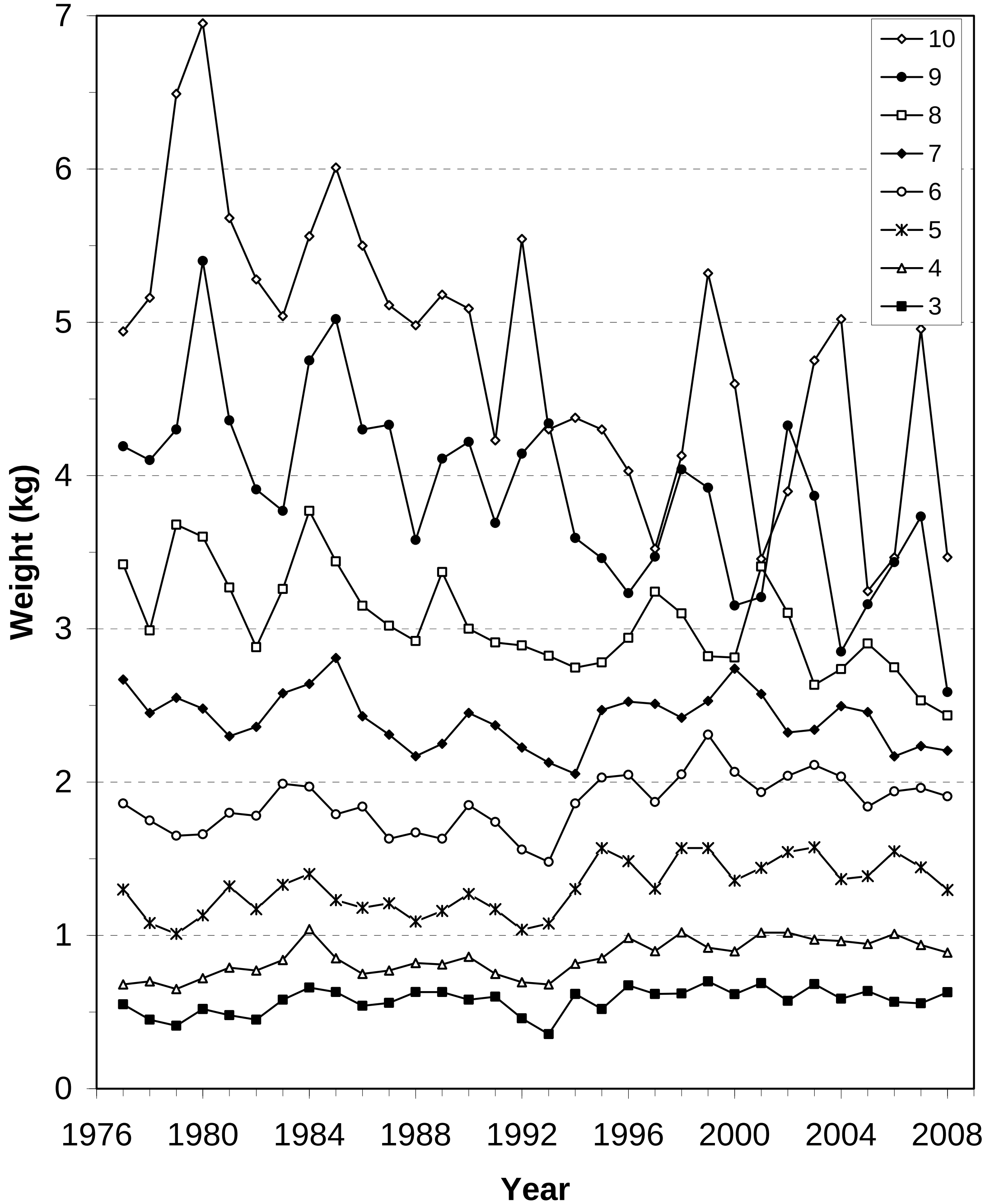


Figure 8a. Mean weights-at-age calculated from mean lengths-at-age for the commercial catch of cod in NAFO Subdivision 3Ps during 1977-2008.

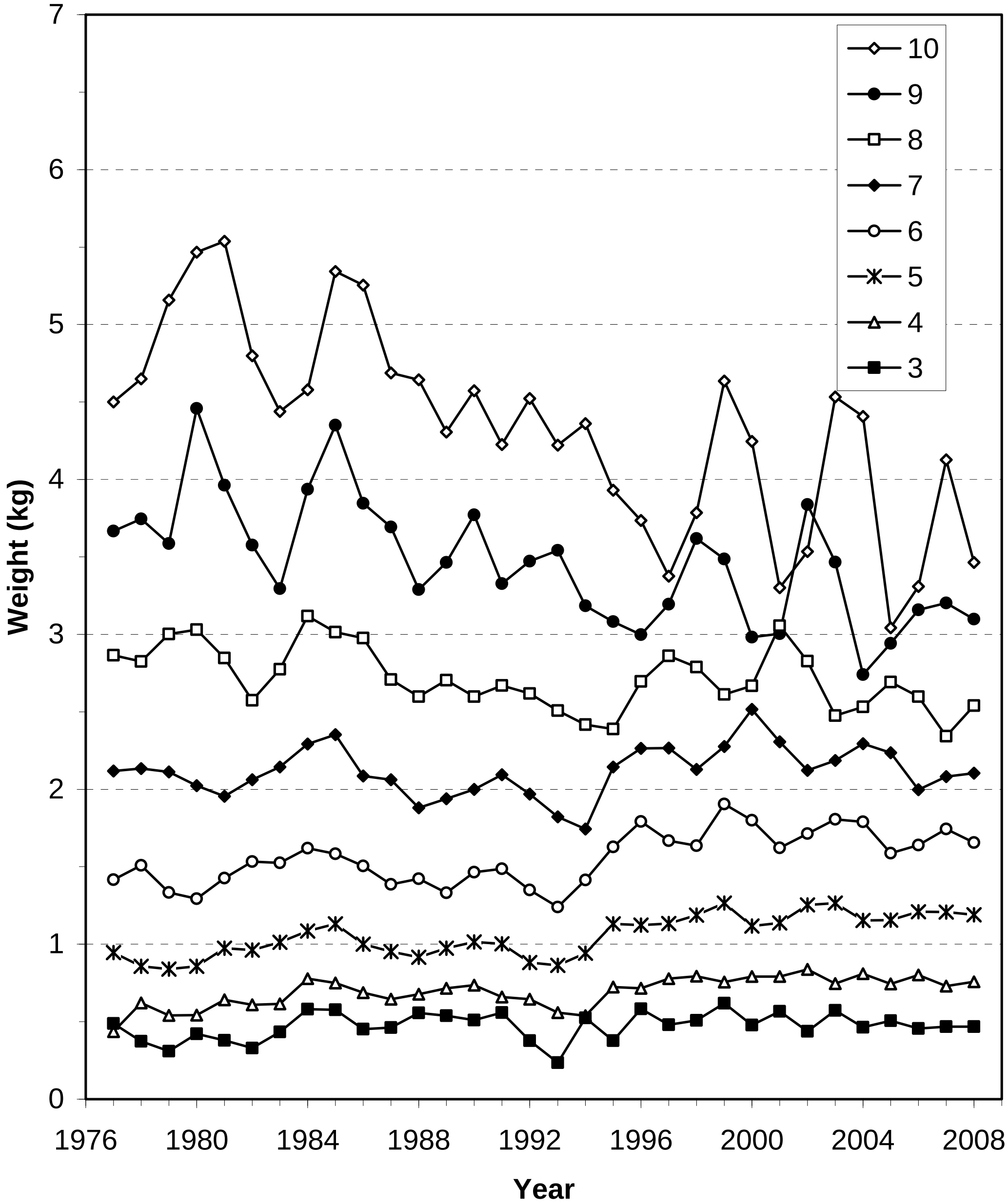


Figure 8b. Beginning of year mean weights-at-age (3-10) from the commercial catch of cod in NAFO Subdivision 3Ps during 1977-2008.

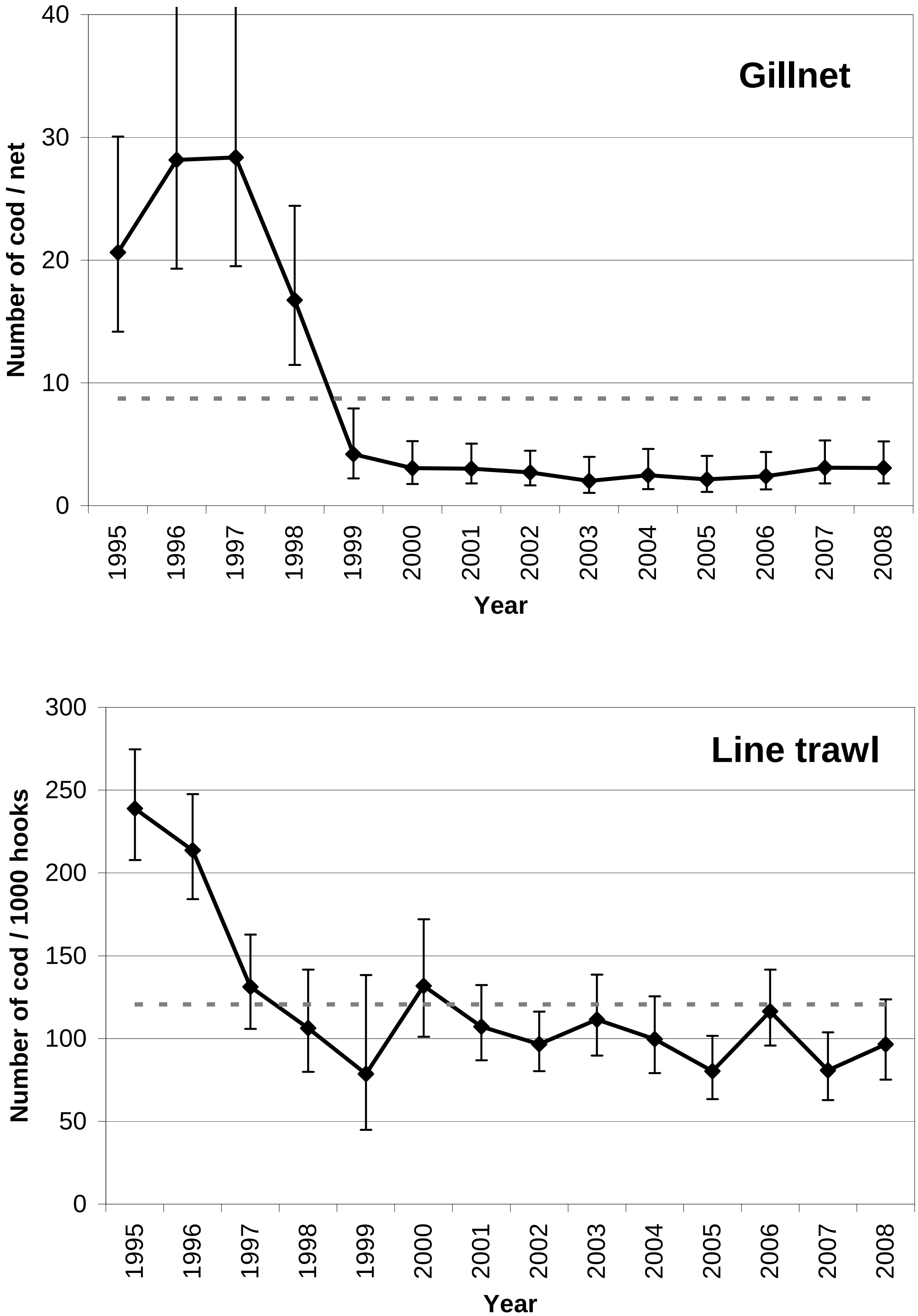
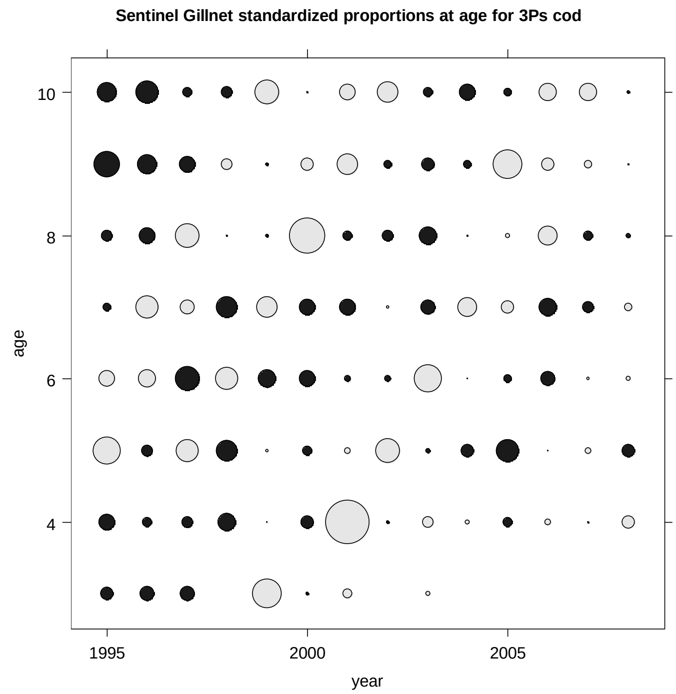


Figure 9a. Standardized age-aggregated catch rate indices for gillnets (5.5" mesh) and line-trawls (with 95% CL's) estimated using data from sentinel fishery fixed sites. Dashed horizontal lines indicate time-series average.



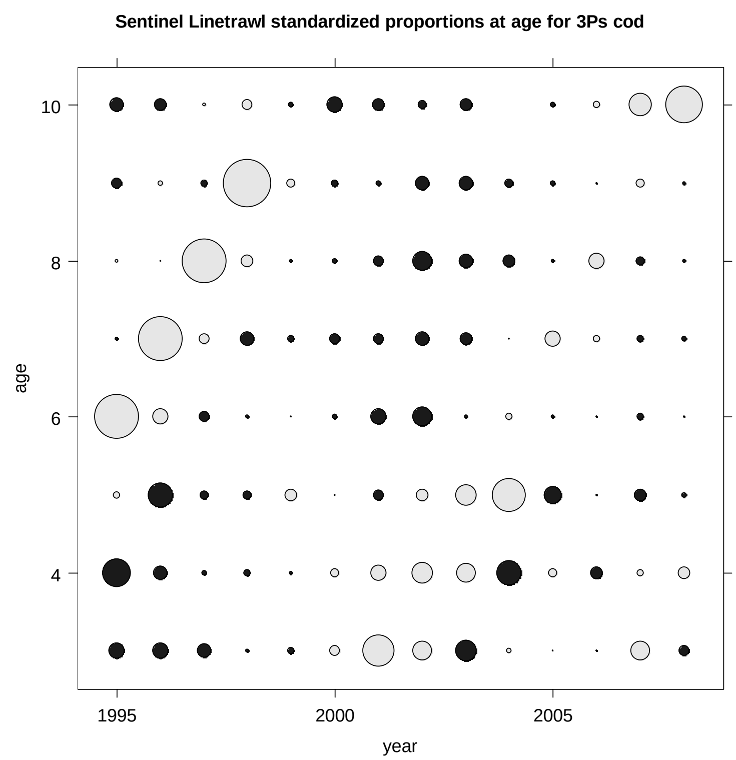


Figure 9b. Standardized age-disaggregated catch rates from Sentinel surveys in subdivision 3Ps. Catch rates (mean nos per set) were converted to proportions within each year (right panel). Values were then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions 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.

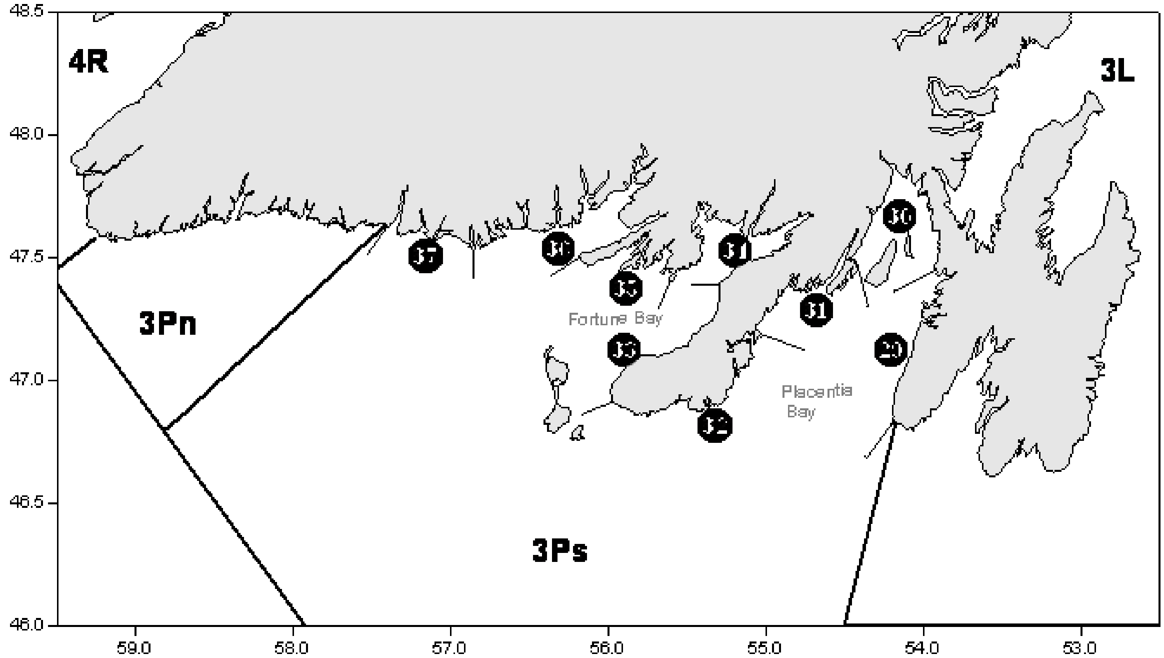
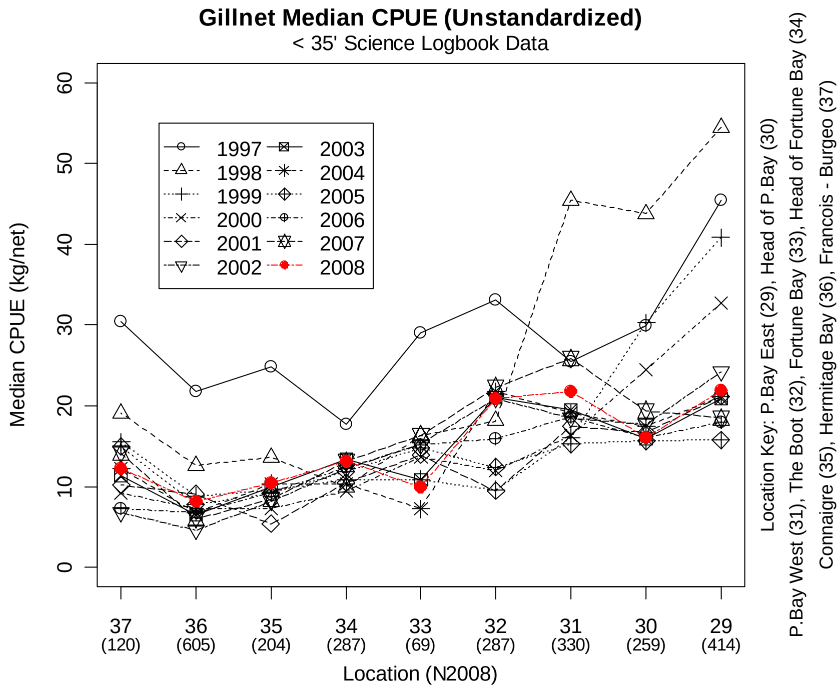


Figure 10a. Location and boundaries of numbered management areas along the inshore of the south coast of Newfoundland (NAFO Subdivision 3Ps) (29=Placentia Bay East, 30=Head of Placentia Bay, 31=Placentia Bay West, 32=The Boot, 33=Fortune Bay, 34=Head of Fortune Bay, 35=Connaigre, 36=Hermitage Bay, 37=Francois-Burgeo).



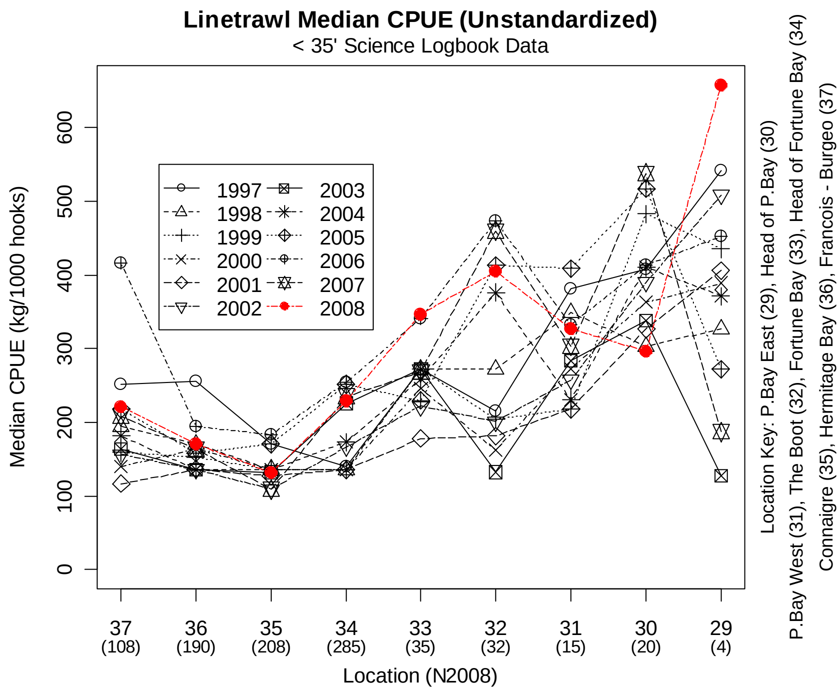


Figure 10b. Area-specific median annual catch rates of cod from gillnets (upper panel, kg per net) and line-trawls (lower panel, kg per 1,000 hooks) from science log-books for vessels <35 ft. Labels on x-axis are lobster fishing areas ordered from west to east (see key on right hand y-axis). Values in parenthesis on x-axis are number of valid sets per site during the 2008 fishery.

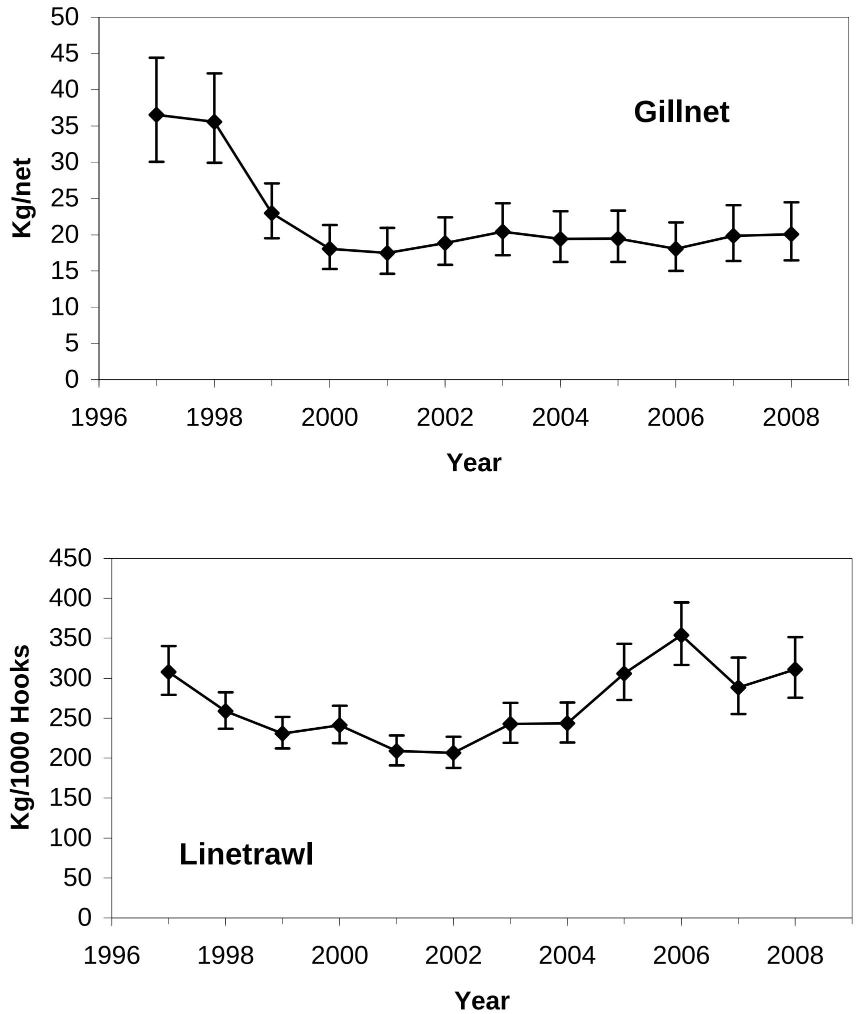
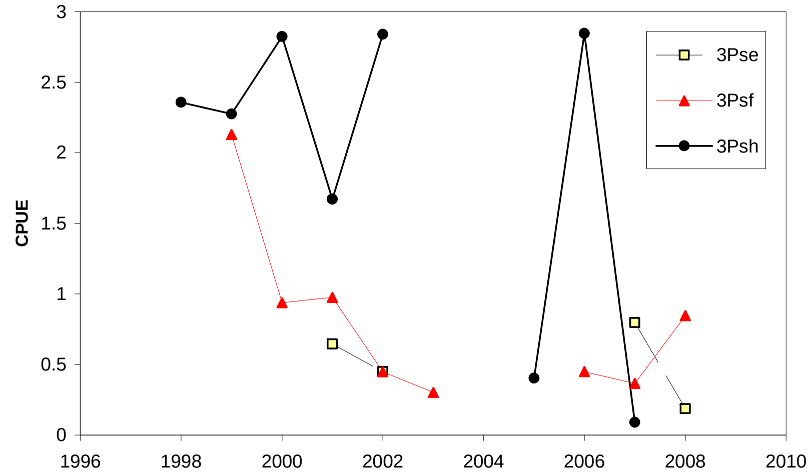
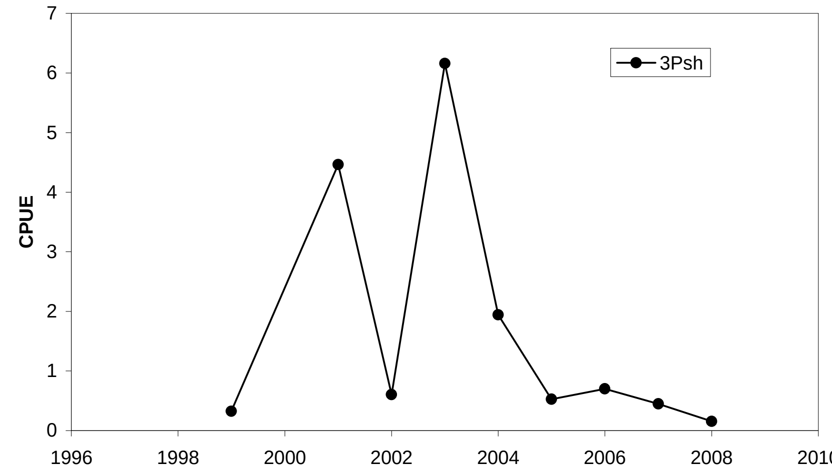


Figure 10c. Standardized catch rates for gillnets and line-trawls from science log-books for vessels <35 ft. Error bars are 95% confidence intervals of the means. Catch rates are expressed in terms of weight (kg per net or kg per 1000 hooks).

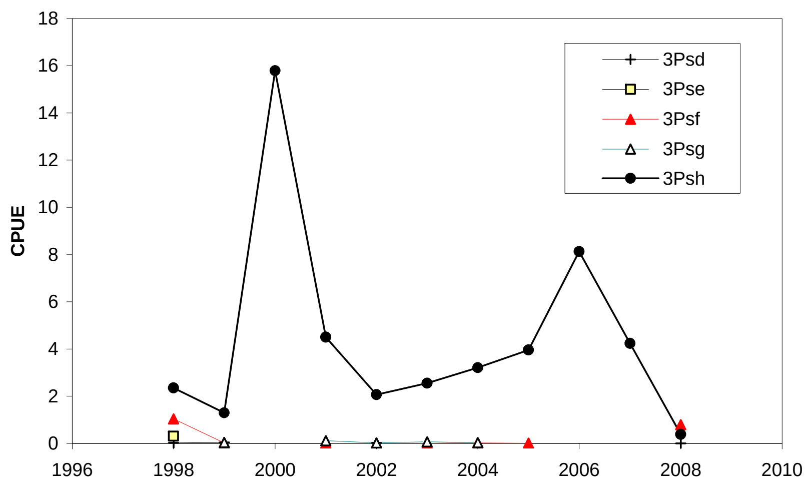
Otter Trawl, Vessel length 35-65'



Otter Trawl, Vessel length 65-100'



Otter Trawl, Vessel length >100' Gillnet, Vessel Length 35-65'



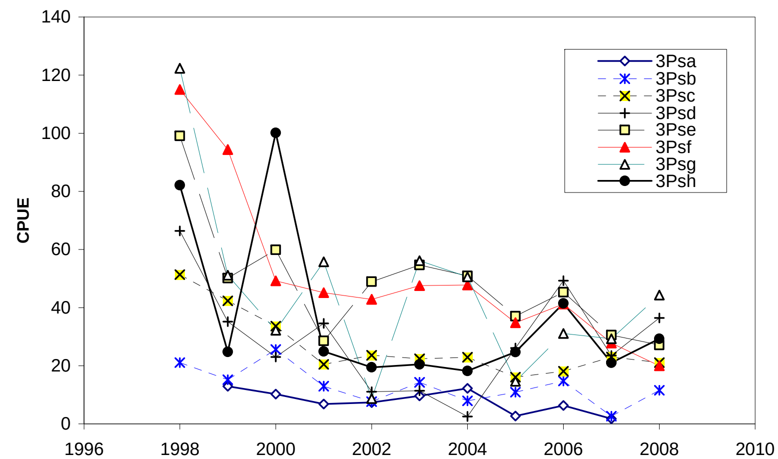
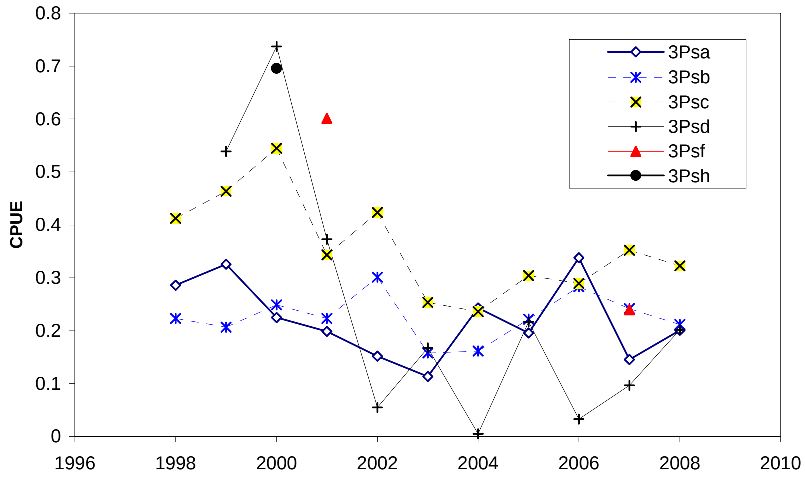


Figure 11. Median annual catch rates of cod by unit area, gear type and vessel length class during 1998-2008 from vessels >35 '. CPUE units are: tons/hours towed for otter trawl, kg per net for gillnet, and kg per hook for linetrawl.

Linetrawl, Vessel length 35-65'



Linetrawl, Vessel length 65-100'

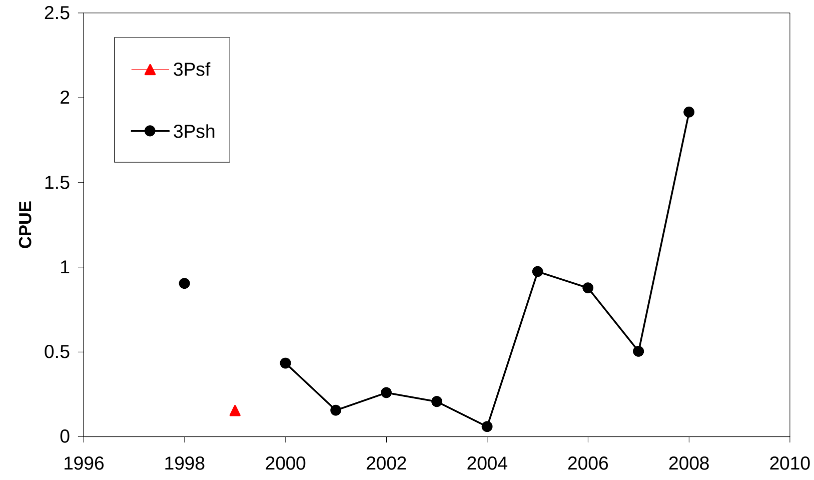


Figure 11 (cont.). CPUE units are: tons/hours towed for otter trawl, kg per net for gillnet, and kg per hook for linetrawl.

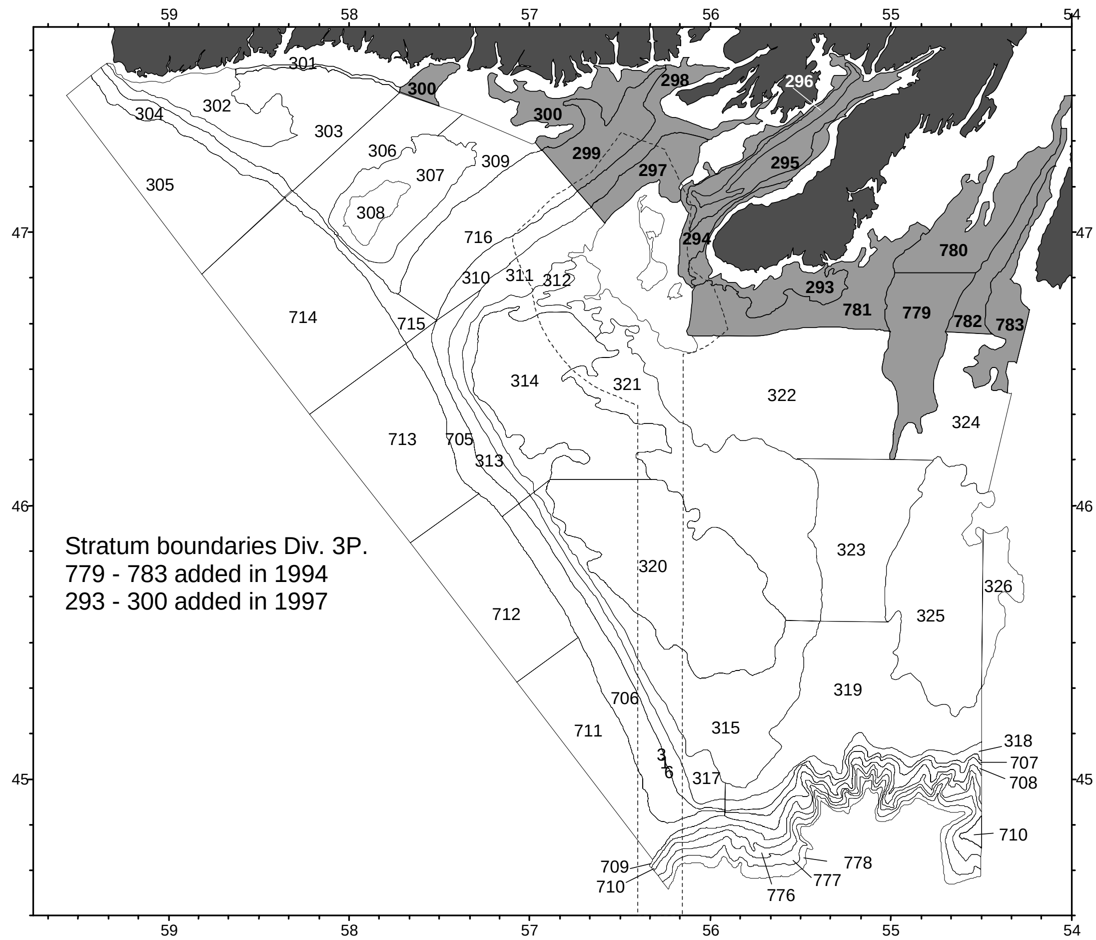


Figure 12. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdivision 3Ps. Dashed line is the boundary of the French economic zone which is included in the surveyed area.

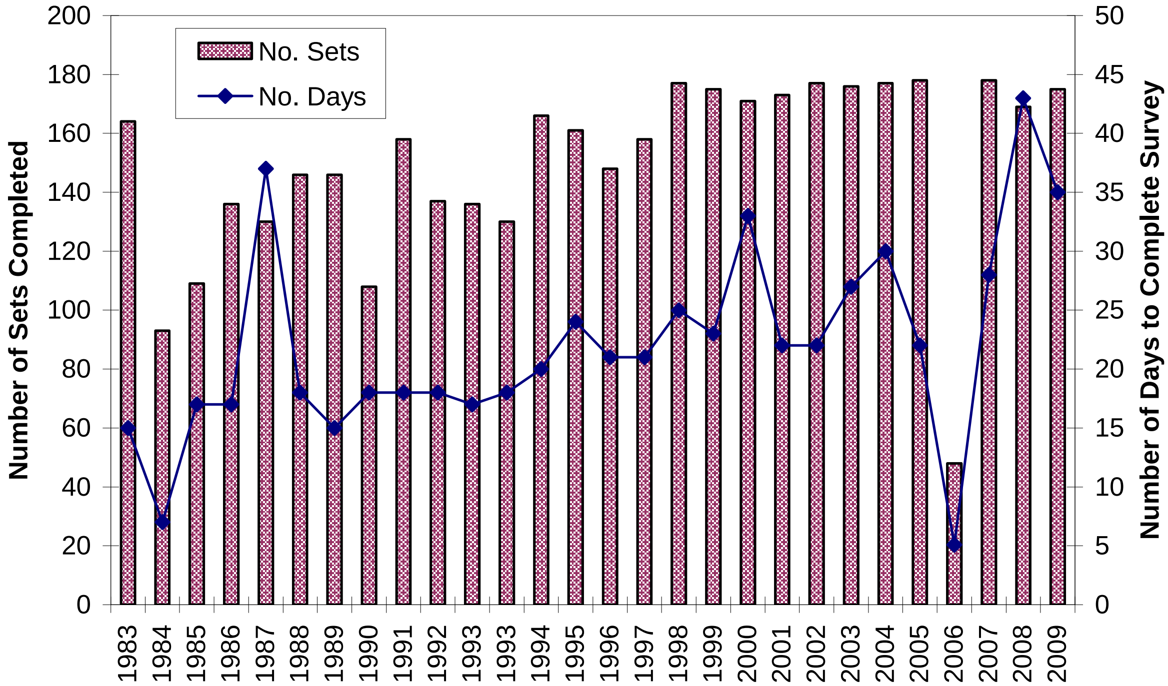
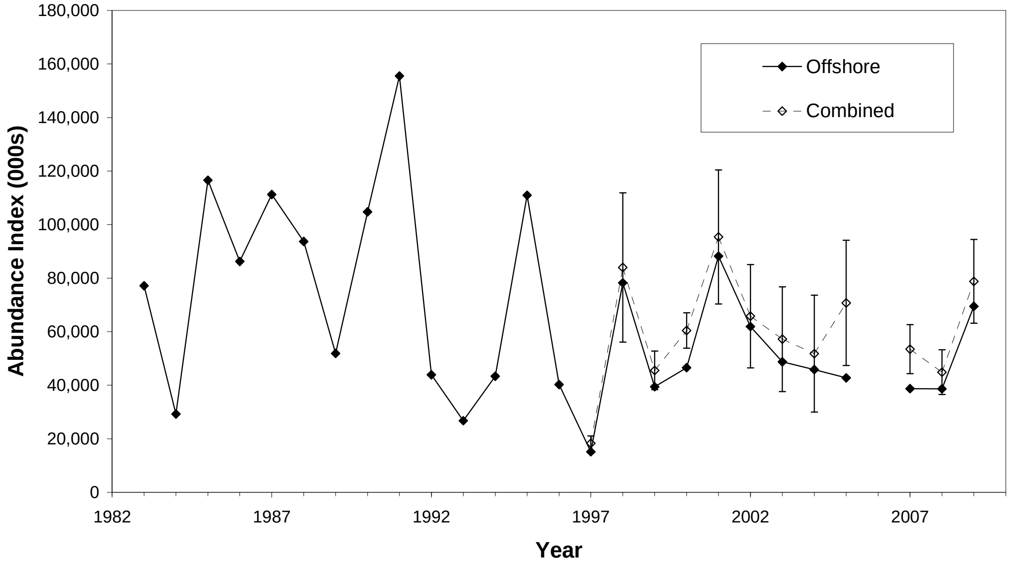


Figure 13. Number of research vessel survey sets completed during surveys of NAFO subdivision 3Ps, and the number of days required to complete these sets over 1983-2009.



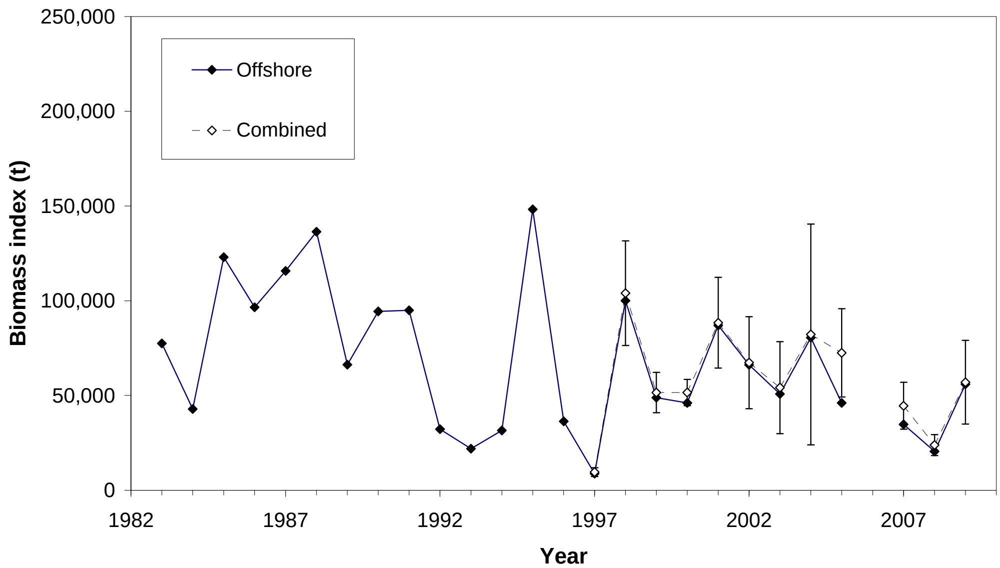


Figure 14. Abundance (upper panel) and biomass (lower panel) indices for cod in NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys of index strata during winter/spring from 1983 to 2009. There were two surveys in 1993 and the 2006 survey was not completed. Error bars show plus one standard deviation. Open symbols show values for augmented survey area that includes additional inshore strata added to the survey area since 1997.

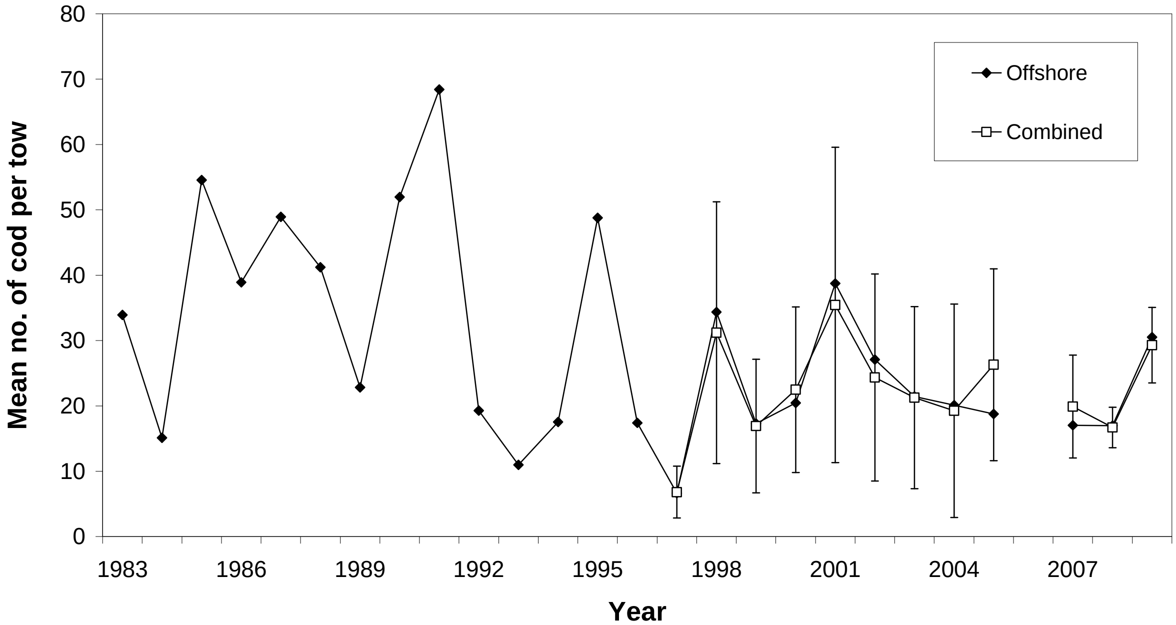


Figure 15. Age-aggregated catch rate index (mean nos. per tow) for cod in NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys of offshore (index) strata during winter/spring from 1983 to 2009. There were two surveys in 1993 and the 2006 survey was not completed. Error bars indicate one standard deviation.

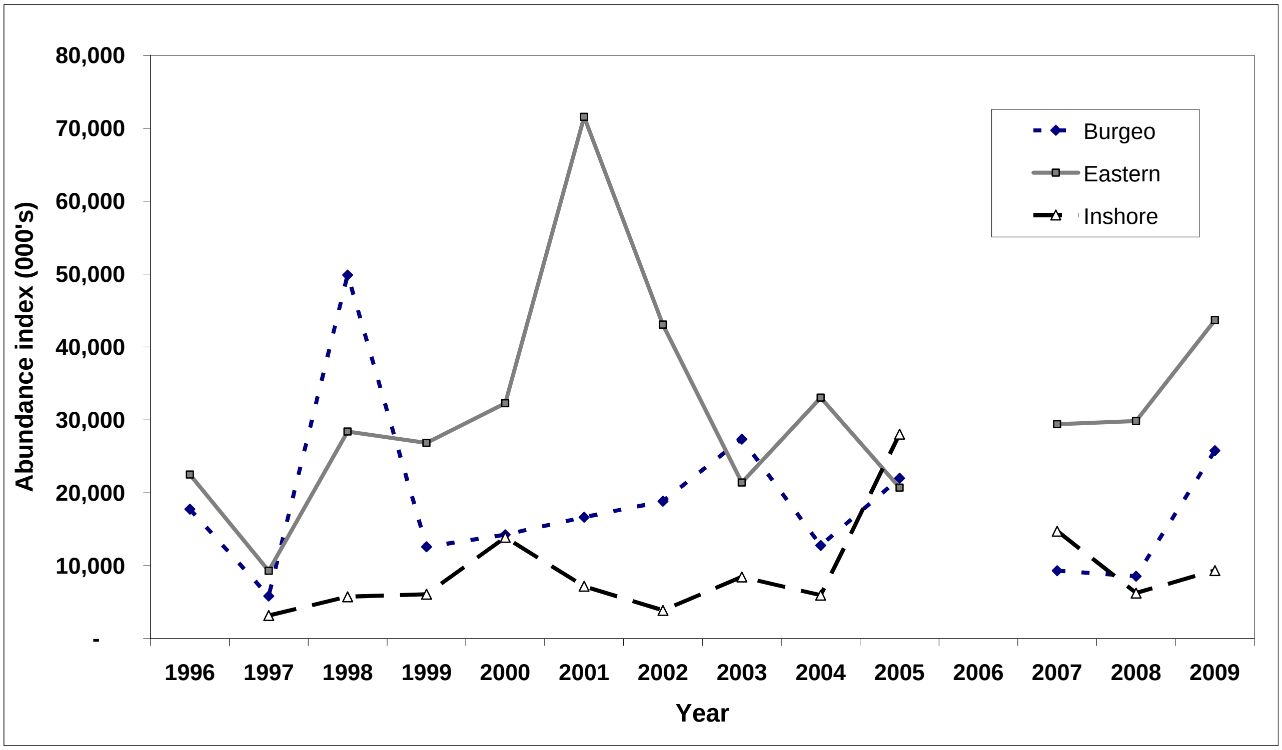


Figure 16. Total abundance index for cod in various regions of NAFO Subdivision 3Ps from DFO research vessel bottom trawl surveys during winter/spring from 1997 to 2009. The 2006 survey was not completed. The Campelen trawl was used in all surveys.

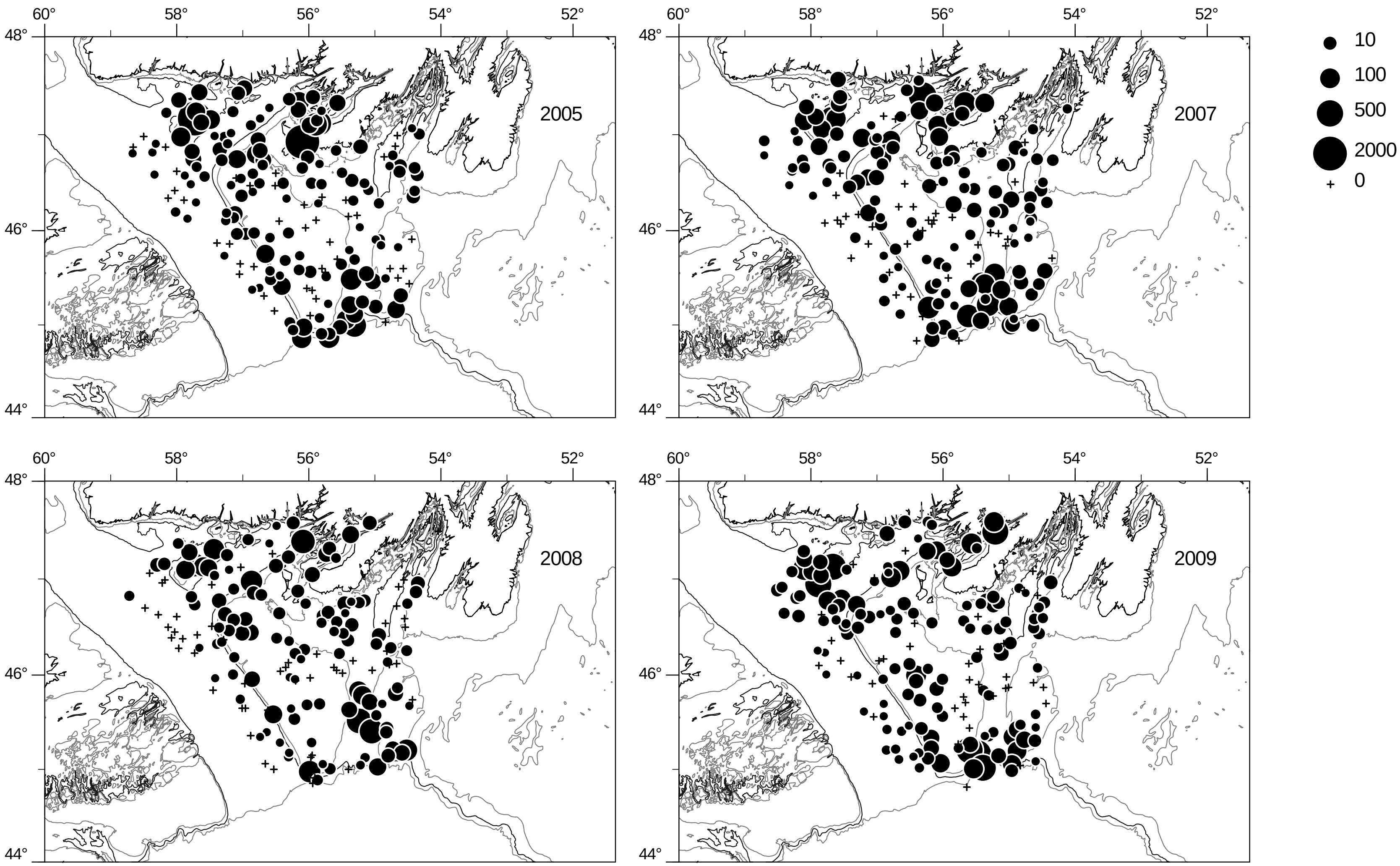


Figure 17a. Age aggregated distribution of cod catches (nos. per tow) from the April DFO research vessel surveys of NAFO subdivision 3Ps in 2005 and 2007-2009 (2006 survey not completed). Bubble size is proportional to numbers caught.

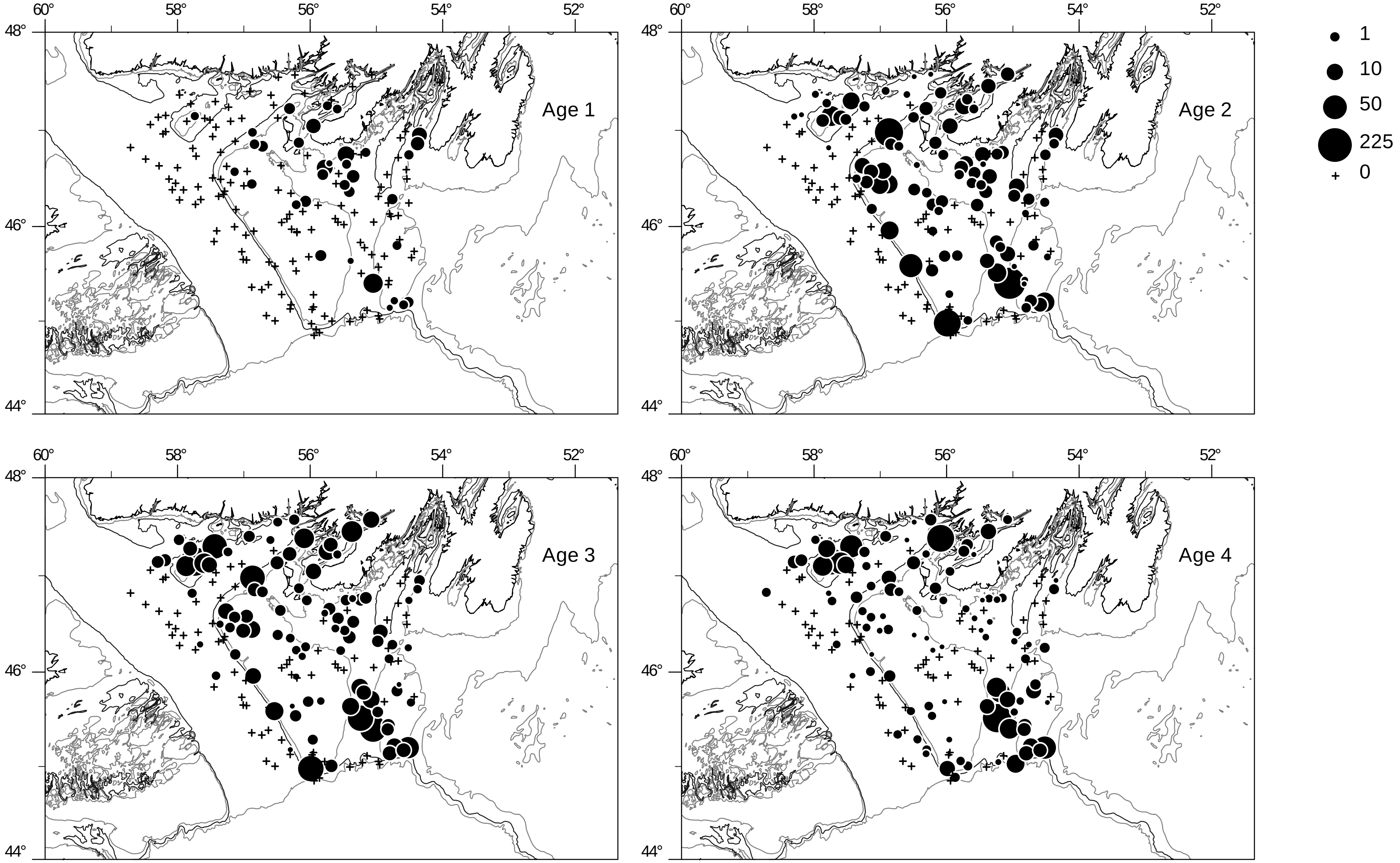


Figure 17b. Age dis-aggregated distribution of cod catches (nos. per tow, ages 1-4) from the April 2008 DFO research vessel surveys of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.

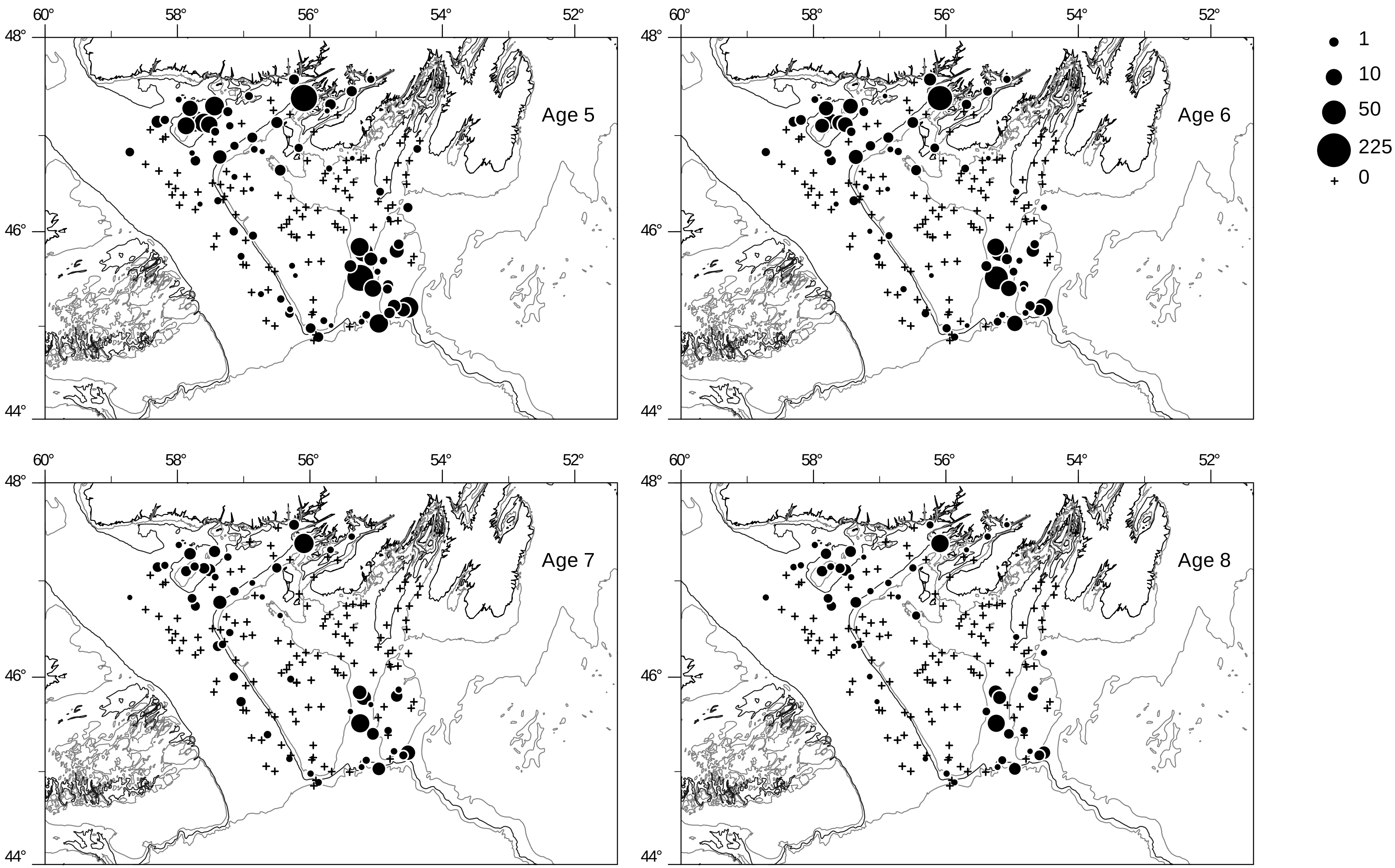


Figure 17c. Age dis-aggregated distribution of cod catches (nos. per tow, ages 5-8) from the April 2008 DFO research vessel surveys of NAFO Subdivision 3Ps. Bubble size is proportional to numbers caught.

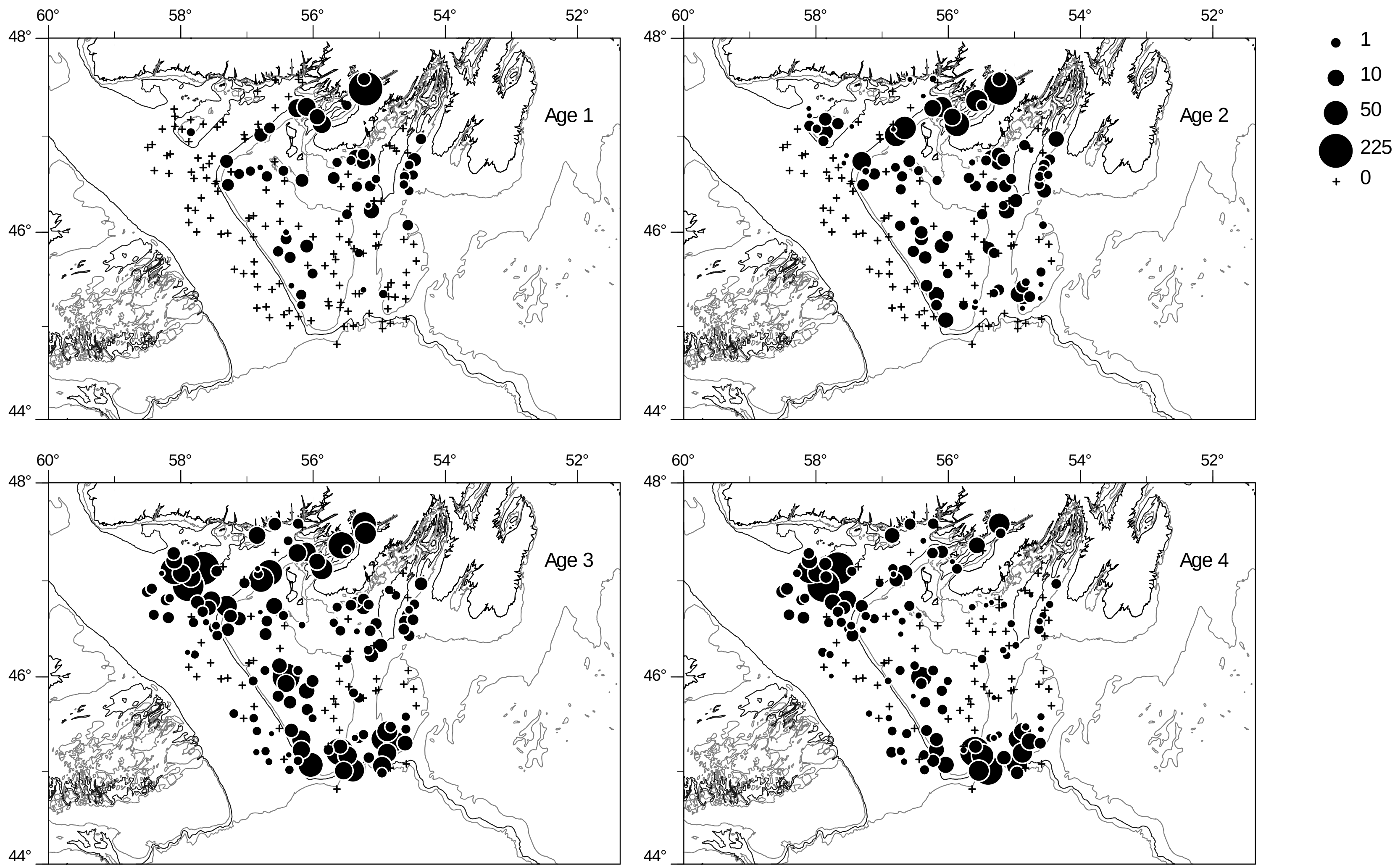


Figure 17d. Age disaggregated distribution of cod catches (nos. per tow, ages 1-4) from the DFO research vessel survey of 3Ps during April 2009. Bubble size is proportional to numbers caught.

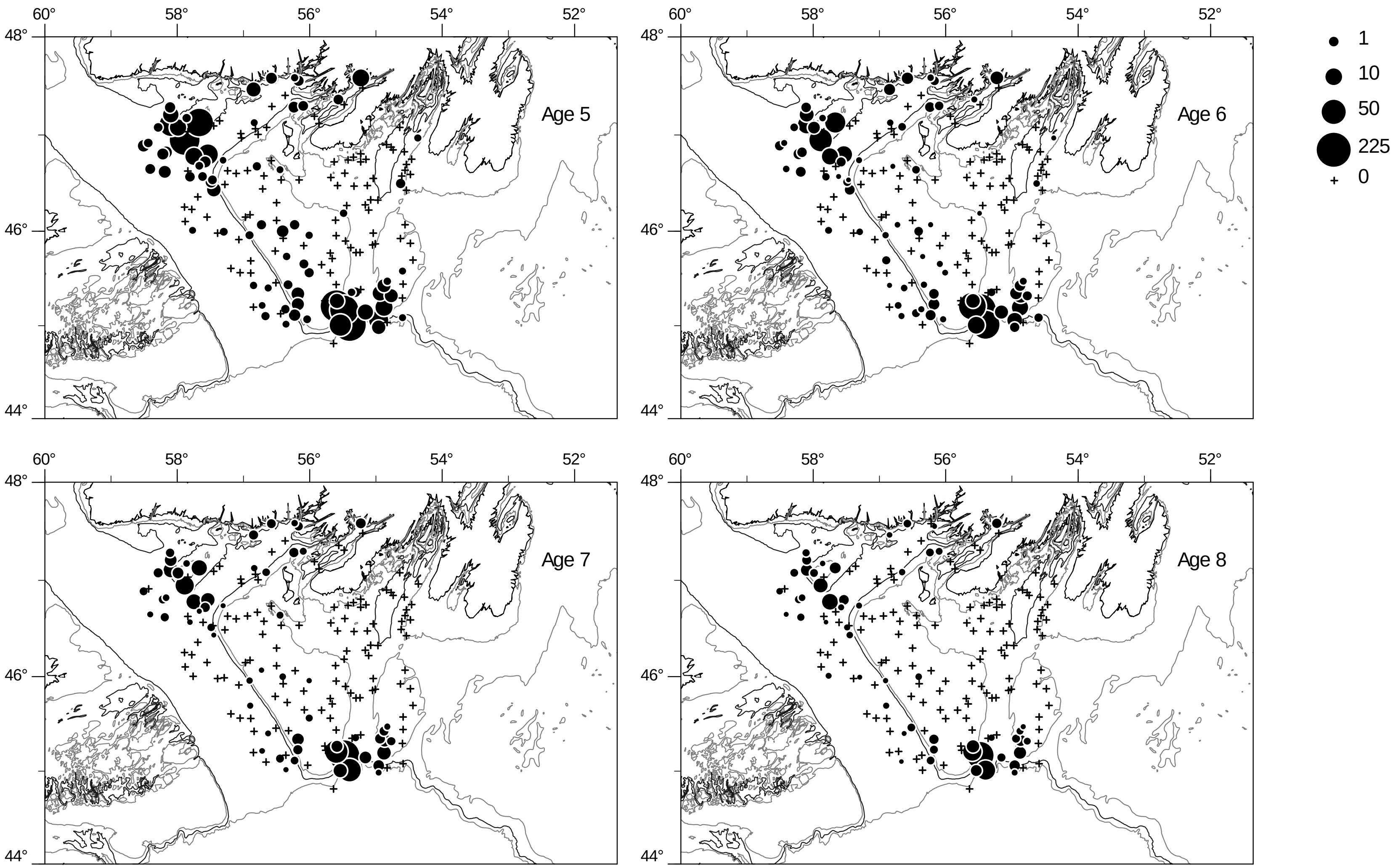


Figure 17e. Age disaggregated distribution of cod catches (nos. per tow, ages 5-8) from the DFO research vessel survey of 3Ps during April 2009. Bubble size is proportional to numbers caught.

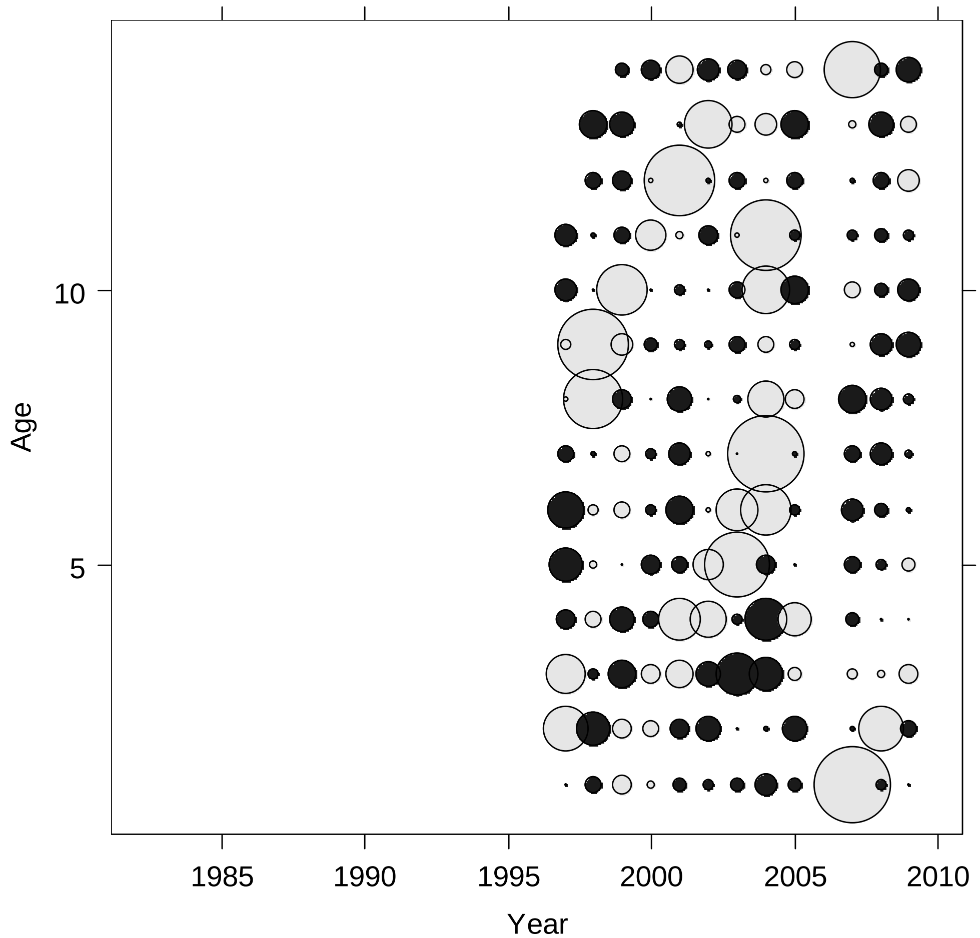


Figure 18a. Standardized age-disaggregated catch rates from the spring bottom trawl survey of subdivision 3Ps (combined area; surveyed beginning in 1997). Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion and dividing 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. The 2006 survey was not completed.

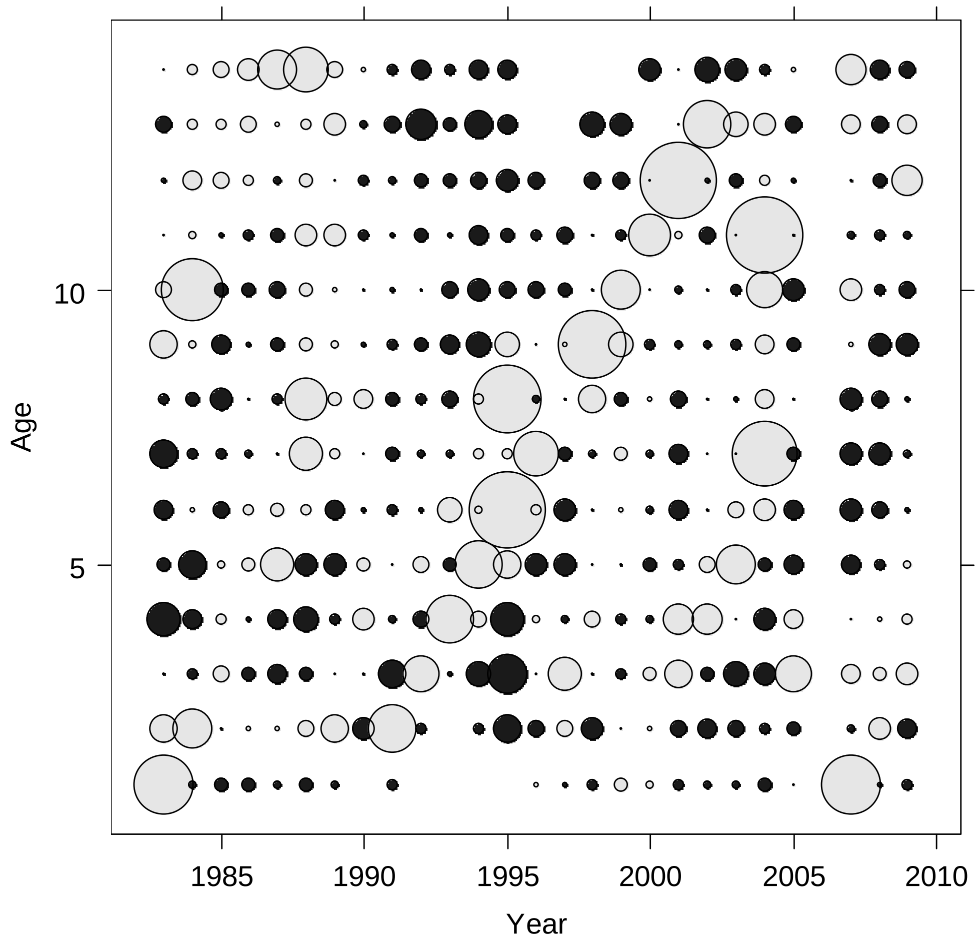


Figure 18b. Standardized age-disaggregated catch rates from the spring bottom trawl survey of subdivision 3Ps (offshore strata only; surveyed beginning in 1983). Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion 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. There were two surveys conducted during 1993; (average values at each age used in producing this figure) and the 2006 survey was not completed.

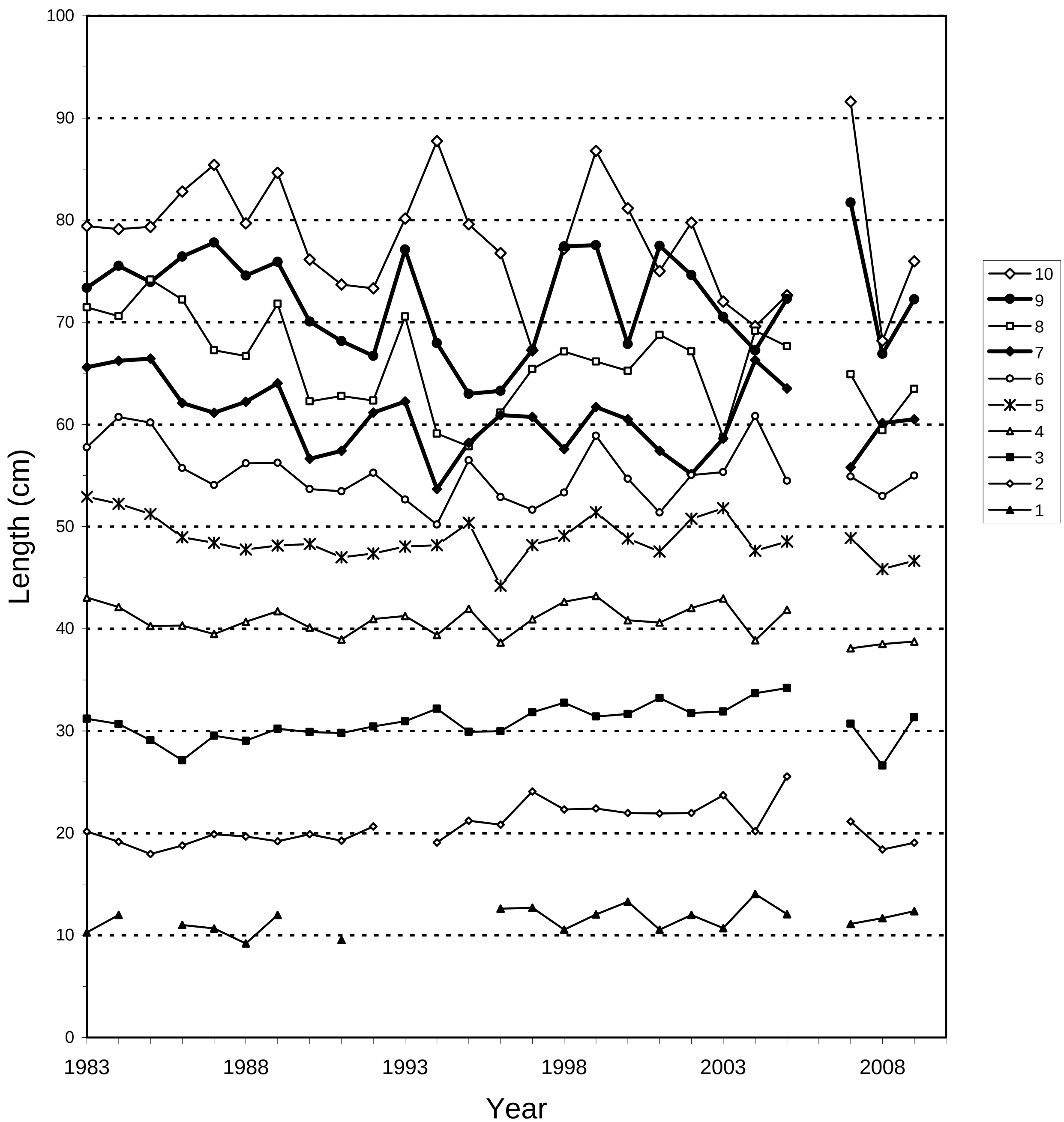


Figure 19a. Mean length at ages 1-10 of cod in Subdivision 3Ps during 1983-2009 from sampling during DFO bottom-trawl surveys in winter-spring.

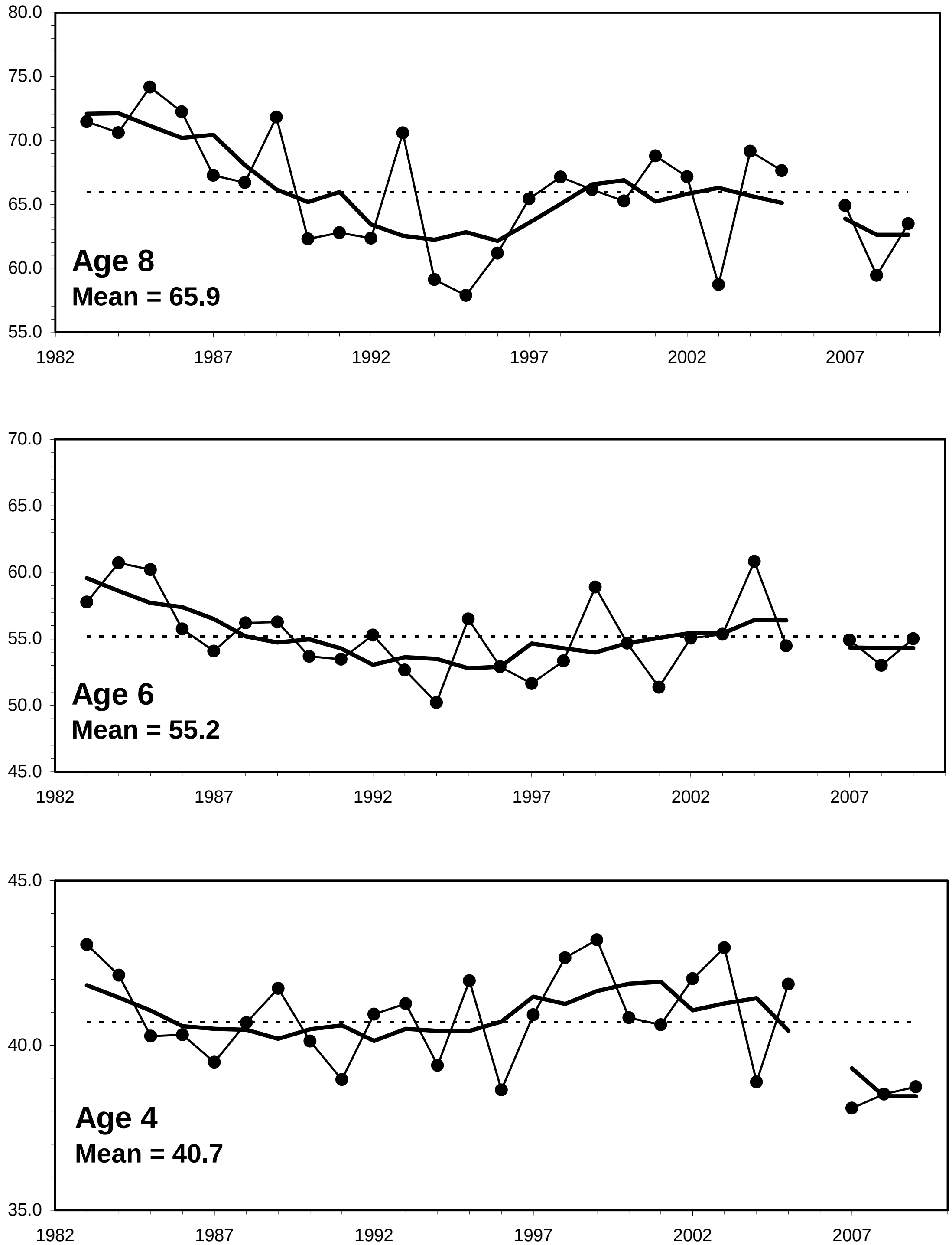


Figure 19b. Mean lengths (cm) at ages 4, 6 and 8 of cod in Subdivision 3Ps during 1983-2009, as determined from sampling during DFO bottom-trawl surveys in winter-spring. The lines in each panel indicate the annual means (solid line with symbols), a 5-year running mean (heavy solid line) and the mean for the period 1983-2009 (dashed line).

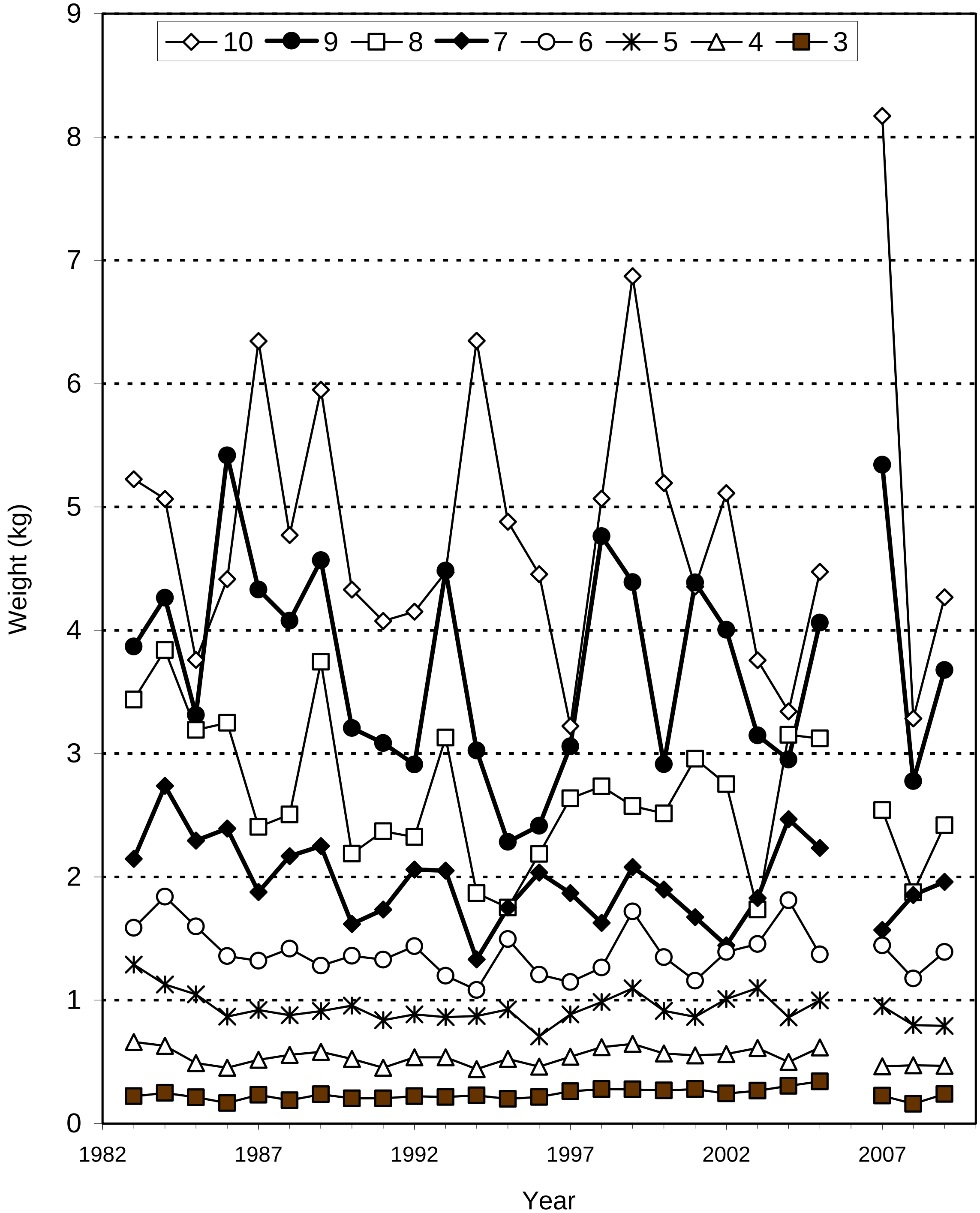


Figure 20a. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in NAFO Subdivision 3Ps in winter-spring 1983-2009.

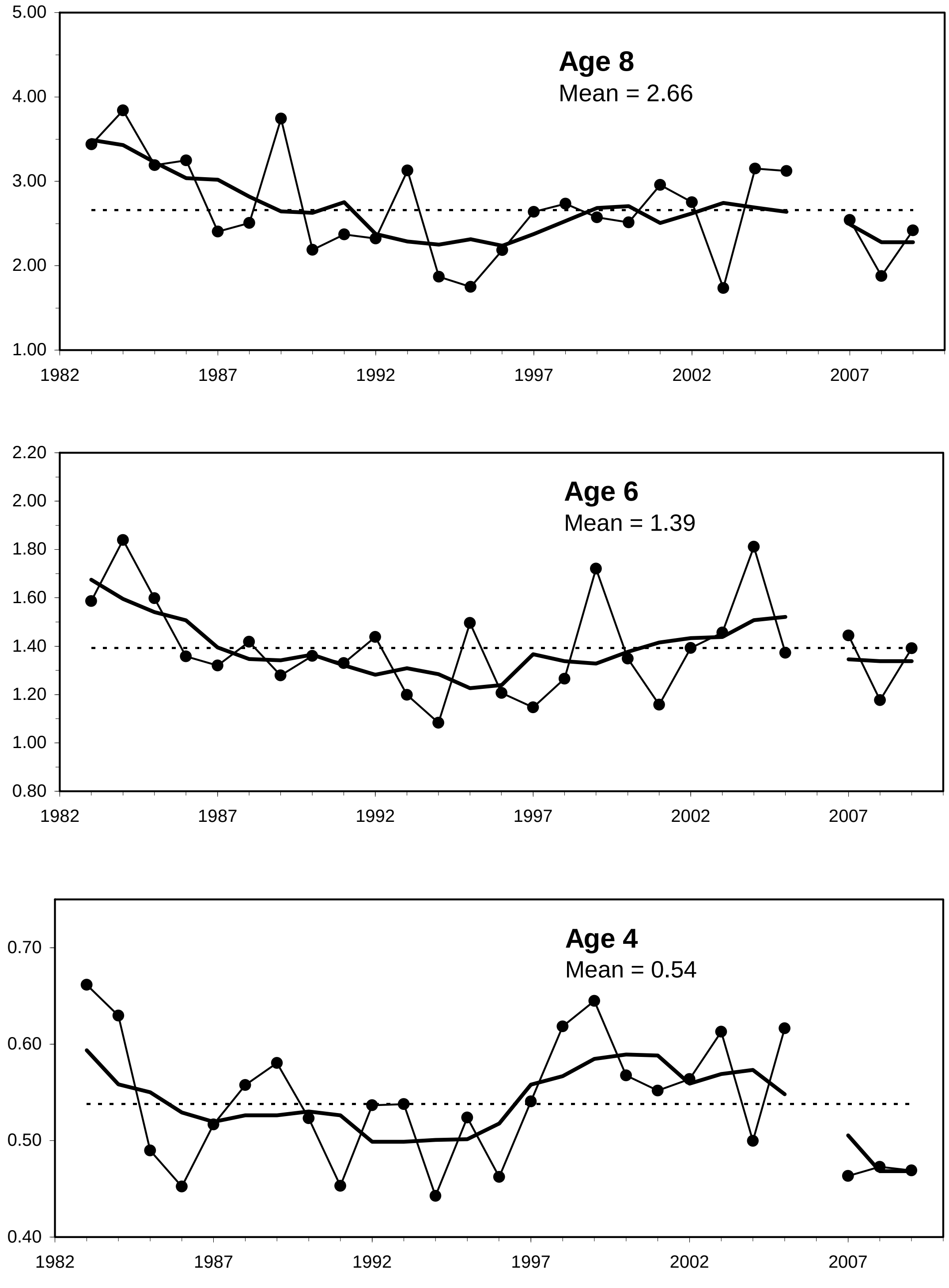


Figure 20b. Mean weights (kg) at ages 4, 6 and 8 of cod in Subdivision 3Ps during 1983-2009, as determined from sampling during DFO bottom-trawl surveys in winter-spring. The lines in each panel indicate the annual means (solid line with symbols), a 5-year running mean (heavy solid line), and the mean for the period 1983-2009 (dashed line).

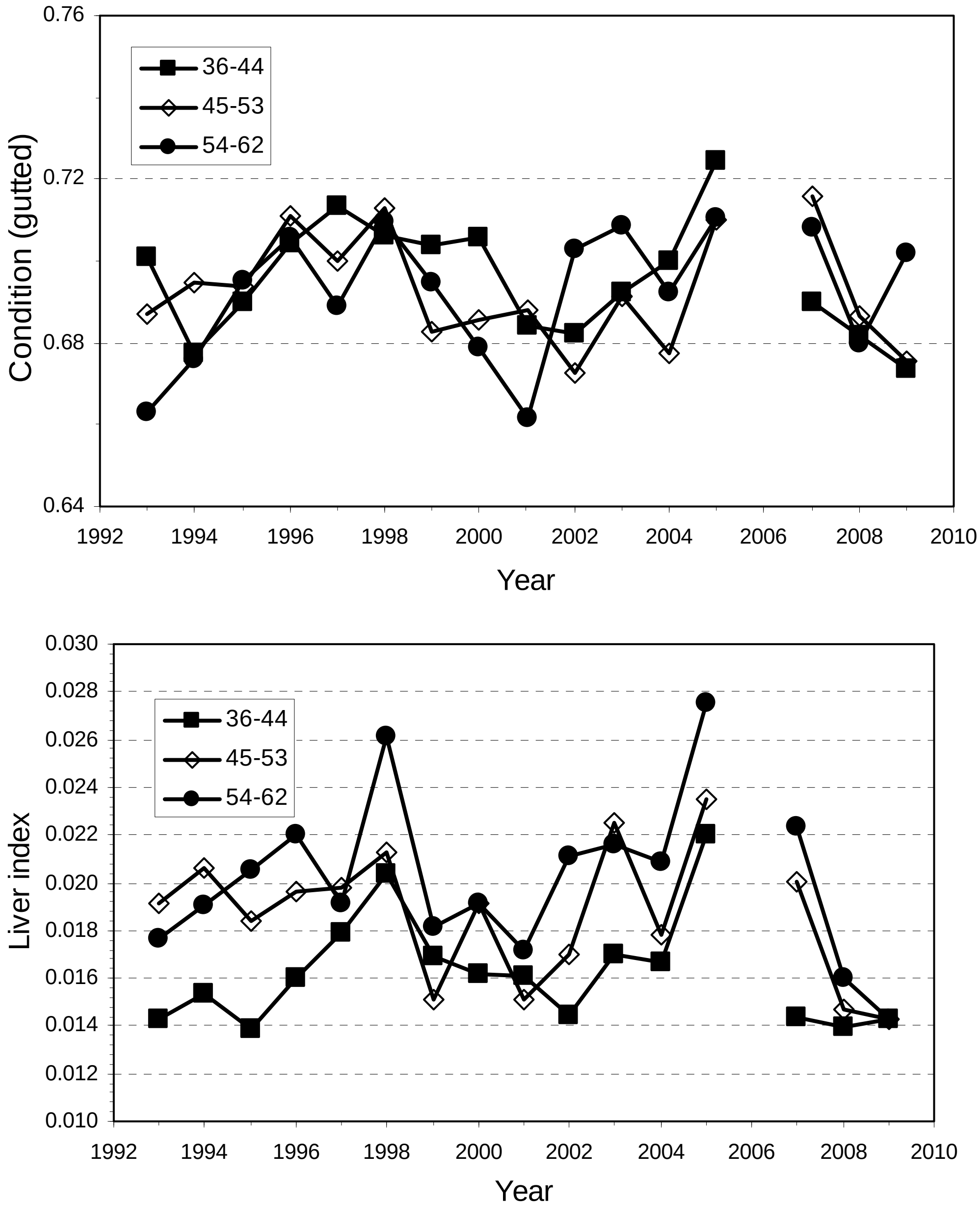


Figure 21. Fultons condition factor (top panel: gutted condition and bottom panel: liver condition) for 3 selected length groups for cod in 3Ps from RV surveys during 1993-2009.

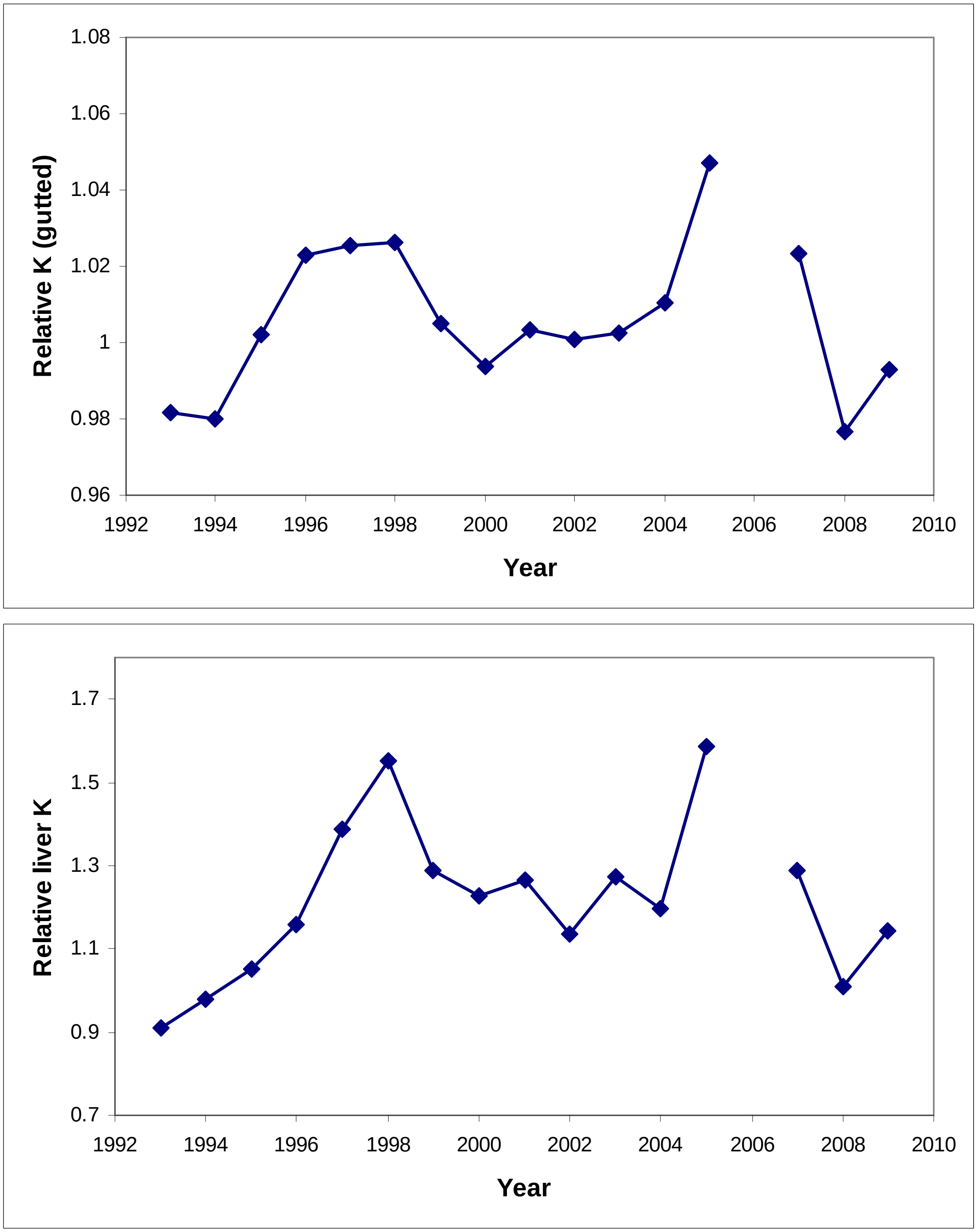


Figure 22. Relative condition indices for 3Ps cod from spring surveys over 1993-2009. Upper panel is relative gutted condition index; lower panel relative liver condition index.

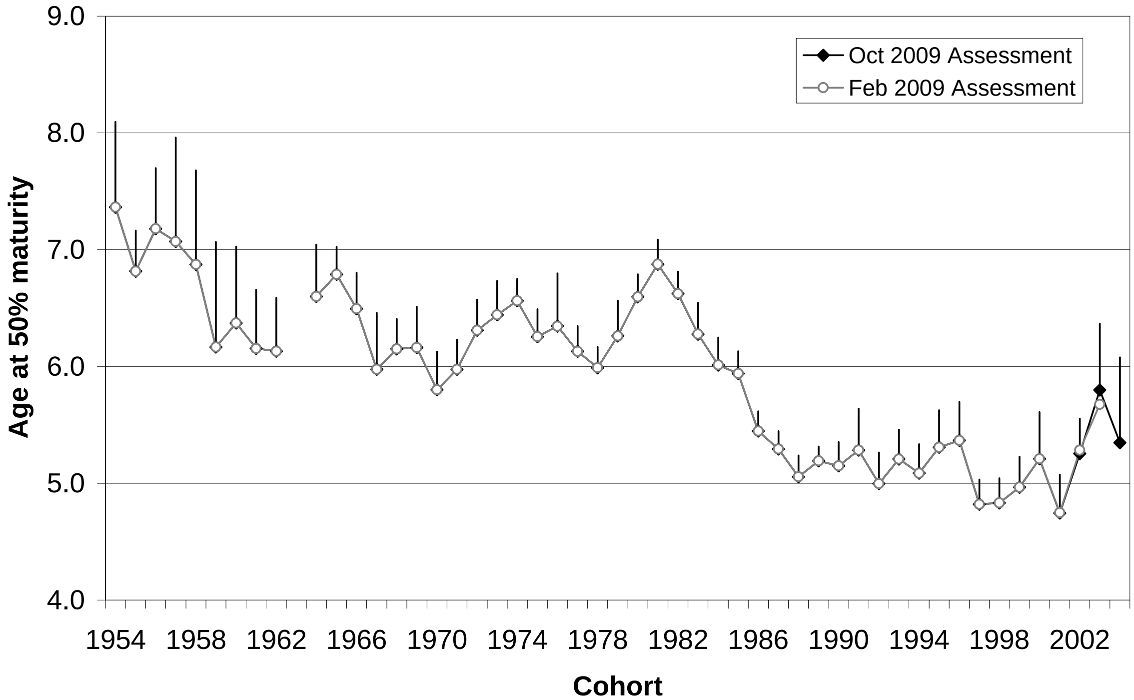


Figure 23a. Age at 50% maturity by cohort (1954-2004, excluding 1963) for female cod sampled during DFO research vessel bottom-trawl surveys of NAFO Subdivision 3Ps. Error bars are 95% fiducial limits.

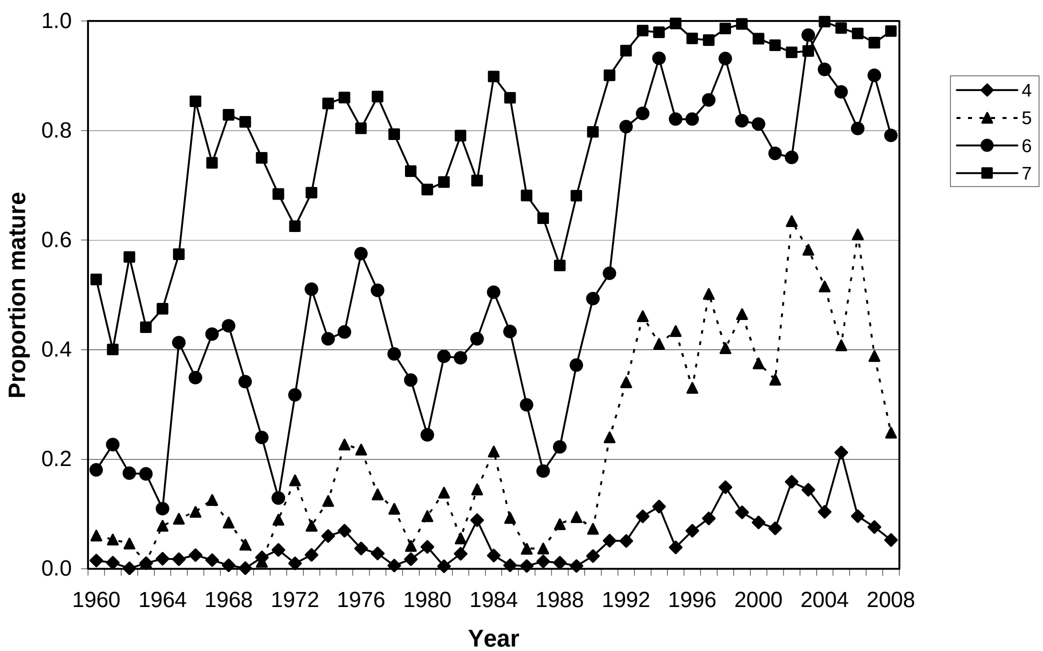


Figure 23b. Estimated proportions mature at ages 4-7 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdivision 3Ps (data from all strata surveyed).

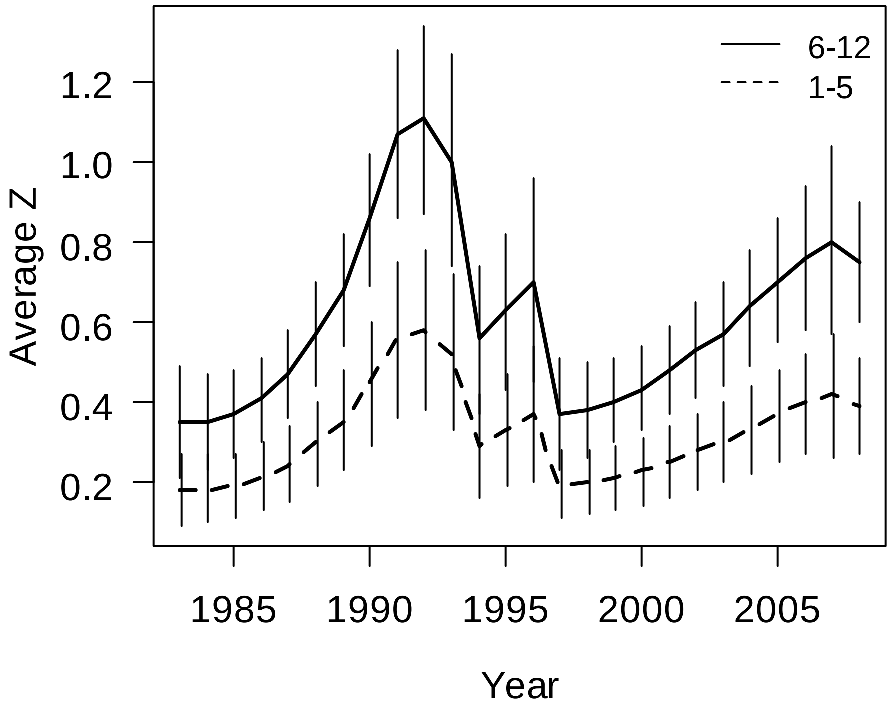


Figure 24a. Estimates of total mortality (Z) from a SURBA cohort analysis model (presented during ZAP meeting). Z's were averaged for ages 1-5 (dashed line) and ages 6-12 (solid line). Vertical lines indicate 95% confidence intervals.

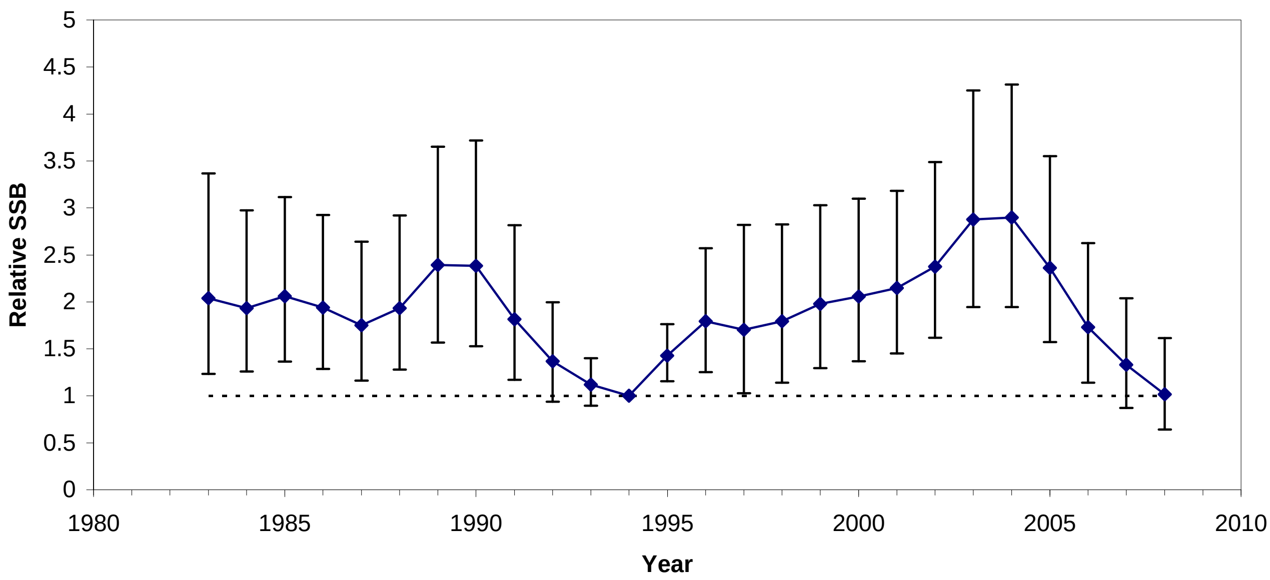


Figure 24b. Estimates of relative spawning stock biomass (SSB) from SURBA cohort analysis model (presented during ZAP meeting). Dashed horizontal line indicates the SSB limit reference point.

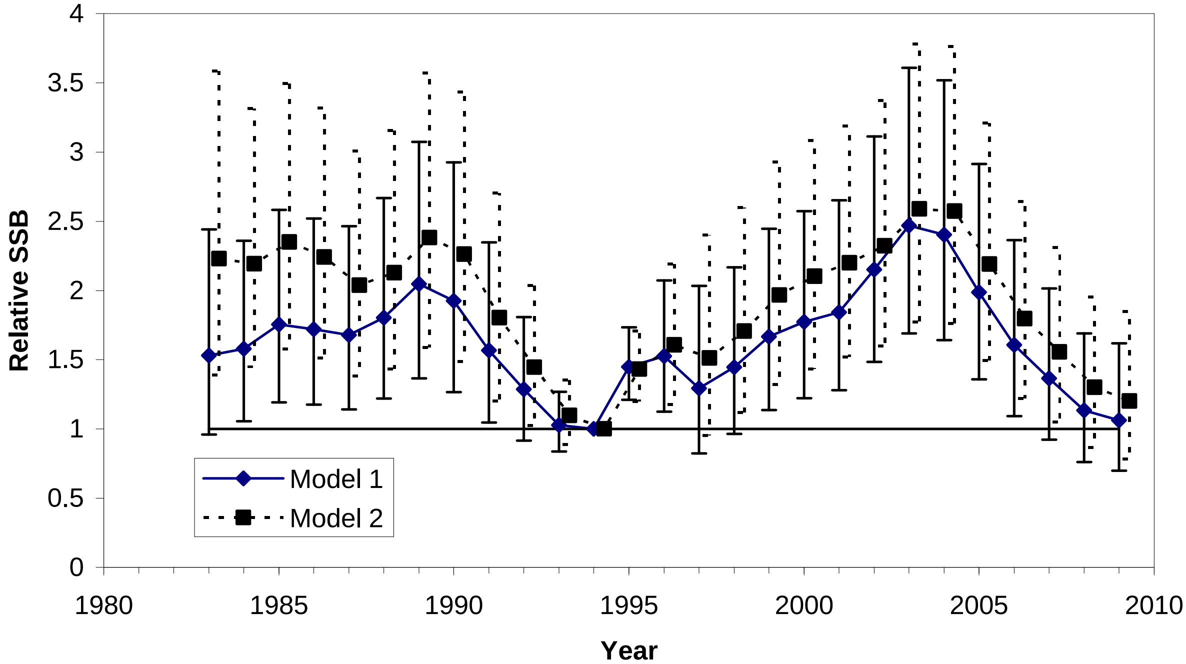


Figure 25. Estimates of relative SSB from SURBA cohort analysis model under two model assumptions regarding survey catchability. (Presented during RAP meeting.) Horizontal reference line indicates SSB limit reference point.

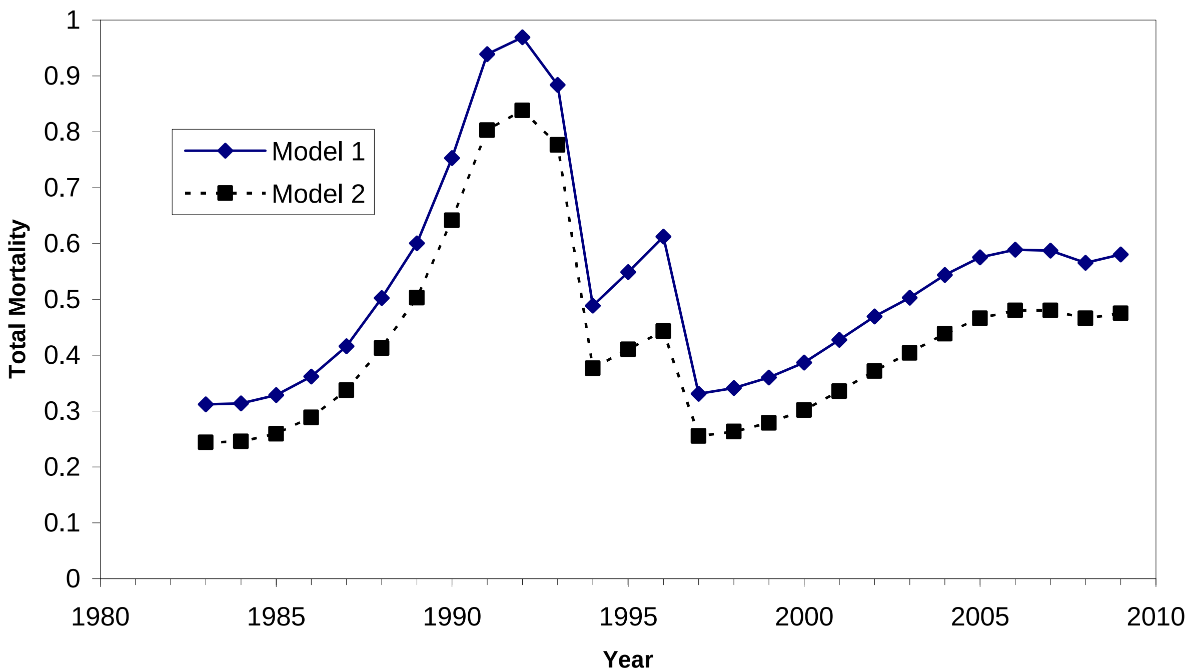


Figure 26. Estimates of total mortality (average over ages 4 to 11) from SURBA cohort analysis model under two model assumptions regarding survey catchability. (Presented during RAP meeting.)

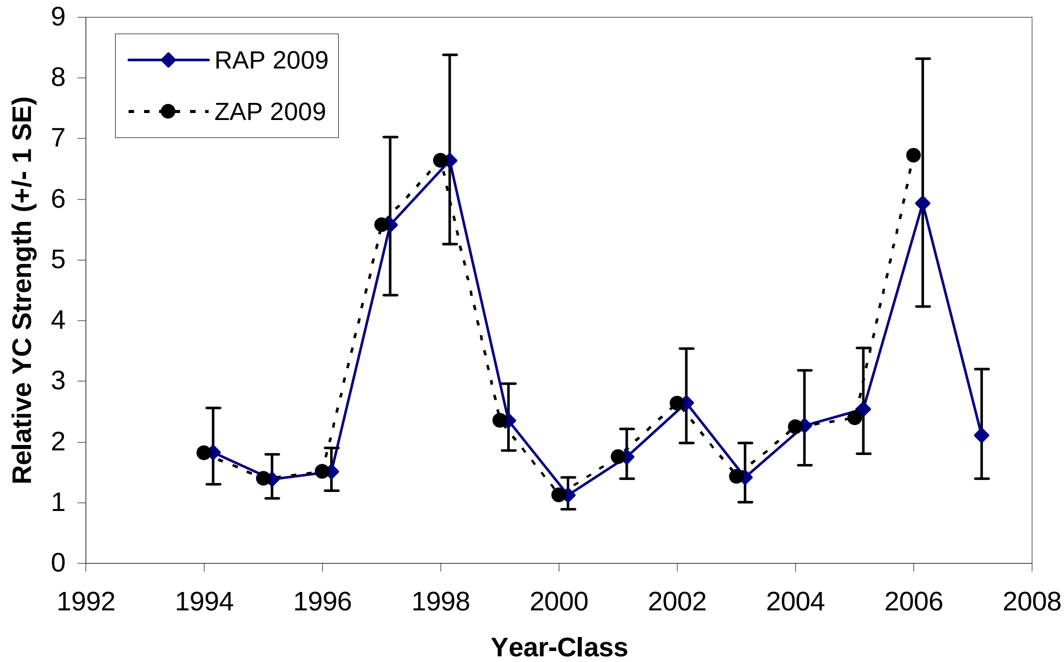


Figure 27. Standardized year-class strength estimated from catches of juvenile cod in combined inshore/offshore DFO RV survey and the GEAC survey. Dashed line indicates estimates from data available during the ZAP; solid line (with error bars) are estimates produced from data available during the RAP.