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An assessment of the cod stock in NAFO Subdivision 3Ps

by

J. Brattey, N. G. Cadigan, G. R. Lilly, E. F. Murphy, P.A. Shelton, and D. E. Stansbury
Science Branch, Department of Fisheries and Oceans,
P.O. Box 5667, St John's, Newfoundland
Canada, A1C 5X1

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Abstract

This document summarizes scientific information used to determine the status of the cod stock in NAFO Subdivision 3Ps off the south coast of Newfoundland on 1 January 1999 and evaluates alternative TAC options for 1999. Primary sources of information were: a time series of abundance and biomass indices from Canadian (1978-1998) and French (1980-1991) winter/spring research vessel bottom-trawl surveys, reported landings from commercial fisheries including a 20,000 t fishery in 1998, a second fall industry trawl survey on St. Pierre Bank, inshore sentinel surveys (1995-1998), acoustic surveys in Placentia Bay and adjacent areas, data from recent mark-recapture experiments and genetic studies, and information from graduate student research projects. Sequential population analyses were carried out using combined inshore fixed gear and offshore fixed and mobile gear catches calibrated with French and Canadian research vessel survey data. The latter was divided into two time periods (February-March and April) and these treated as two separate indices. Survey catches from a known stock mixing area (Burgeo Bank -Hermitage Channel) were removed from the February-March series. The current population biomass is estimated to be 250,000 t and has increased substantially since the moratorium. Spawner biomass is currently estimated to be 145,000 t. Recent increases are largely due to the high survival and maturation of the strong 1989 and 1990 year classes combined with a reduction in the age at maturity. The 1992 year class also appears to be strong. A risk analyses showed that the probability of the spawner biomass falling below an arbitrary reference point of 100,000 t was 9% with a catch of 20,000 t in 1999. The probability of exceeding an average fishing mortality reference level of 0.25 over ages 7-14 in 1999 at this catch level was estimated to be 5%.

Résumé

Le présent document est un sommaire des renseignements scientifiques utilisés pour déterminer l'état du stock de morue de la sous-division 3Ps de l'OPANO, au large de la côte sud de Terre-Neuve, au premier janvier 1999, et évaluer d'autres options de TPA pour 1999. Les principales sources utilisées ont été : une série chronologique d'indices d'abondance et de biomasse tirés des relevés canadiens (1978-1998) et français (1980-1991) effectués au chalut de fond par navire de recherche en hiver et au printemps, les débarquements signalés de la pêche commerciale dont ceux d'une pêche de 20 000 t effectuée en 1998, un deuxième relevé d'automne au chalut de fond effectué par l'industrie sur le banc Saint-Pierre, des relevés côtiers par pêches sentinelles (1995-1998), des relevés acoustiques réalisés dans la baie Placentia et les zones avoisinantes, des données d'expériences de marquage-recapture et d'études génétiques récentes et des renseignements tirés de projets de recherche d'étudiants diplômés. Des analyses de populations séquentielles ont été effectuées à partir des captures combinées de la pêche côtière aux engins fixes et de la pêche hauturière aux engins fixes et mobiles étalonnées à l'aide des données des relevés canadiens et français par navires de recherche. Ces dernières données ont été réparties selon deux périodes (février-mars et avril) et traitées comme deux indices distincts. Les données relatives aux captures des relevés effectués à partir d'une zone connue de mélange des stocks (banc Burgeo et chenal Hermitage) ont été retirées des séries de février-mars. La biomasse actuelle de la population est estimée à 250 000 t et s'est accrue de façon appréciable depuis l'imposition du moratoire. La biomasse des géniteurs est actuellement estimée à 145 000 t. Les augmentations récentes s'expliquent surtout par un taux élevé de survie et de maturation des classes d'âges fortes de 1989 et 1990 allié à une réduction de l'âge à la maturité. La classe de 1992 semble aussi être importante. L'analyse des risques a montré que la probabilité que la biomasse des géniteurs tombe en deçà d'une valeur de référence arbitraire de 100 000 t, s'élevait à 9 % pour des captures de 20 000 t en 1999. La probabilité de dépasser un niveau de référence moyen de mortalité par pêche de 0,25 pour les âges de 7 à 14 en 1999, à ce niveau de captures a été estimée à 5 %.

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1. Introduction

Cod in NAFO Subdiv. 3Ps (Fig. 1) were traditionally thought to be comprised of cod that inhabited the outer slopes of St. Pierre Bank in winter, migrating onto the top of the bank and to the south coast in summer (Pinhorn 1976). However, tagging studies indicate that the stock structure and migration patters of cod in NAFO Subdiv. 3Ps are extremely complex (Taggart et al. 1995; Brattey 1996, Lawson et al. 1998; Brattey et al. 1999). At least five stocks or stock complexes are thought to contribute to the commercial fishery at various times of year: the northern Gulf stock (3Pn4RS), the Burgeo Bank stock, the southern St. Pierre Bank stock, the Avalon-Burin stock complex and southern Grand Bank (3LNO) fish (Thompson 1943; Templeman and Fleming 1972; Templeman 1974, 1979; Templeman and Fleming 1962; Lear 1984, 1988; Moguedet 1994. Stock mixing between northern Gulf (3Pn4RS) and 3Ps cod in the Burgeo Bank area of 3Ps during winter is known to occur, but the extent of mixing appears to vary annually. Recent studies involving analysis of otolith elemental fingerprints, genetic and meristic data (Campana et al. 1998) from cod sampled near the mouth of the Gulf of St Lawrence in January are aimed at providing more information on the extent of stock mixing in this area. In addition, new tagging experiments and genetic studies are underway (Brattey 1999; Cadigan and Brattey 1999; Beacham et al. 1999) and these could further help elucidate stock affinities in this mixing area as well as quantify the migration patterns of different stock components. Uncertainty regarding stock structure and what constitutes the 3Ps stock has not been formally taken into account in past assessments because accurate methods for assigning catches to the appropriate stock are not available. However, survey timing has been delayed until April since 1993 in an attempt to restrict enumeration to 3Ps fish only in the Burgeo Bank area.

Before 1959, landings data for 3Ps and 3Pn were not recorded separately (Pinhorn 1969), so that population reconstructions cannot go back further than this time. Maximum sustainable yield for this stock was estimated at about 60,000 t (Pinhorn 1976). Landings exceeded this level at various times in the 1960s. In the 1991 assessment of this stock (Bishop et al. 1991), it was estimated that the 3+ biomass reached a low level of about 80,000 t in the mid -1970s, increased to a level of 225,000 t in 1985, declined somewhat in the late 1980s as a result of the weak 1983 and 1984 year classes, and then increased again to the highest estimated level in 1991 as a result of the strong 1986 and 1987 year classes. The TAC equivalent to $F_{0.1}$ for 1992 was estimated to have been about 40,000 t. The actual TAC in 1992 was set below this level at 35,400 t.

The 1992 survey indices for both Canada and France were considerably lower that the 1991 values and the 1992 assessment had difficulty in resolving the status of the stock (Bishop and Murphy 1992). The assessment concluded that if the large decline in the research vessel index in 1991 was a result of fish being temporarily out of the survey area (i.e. a “year effect”) then the 3+ biomass at the beginning of 1992 was estimated to be slightly less than that of 1991. However, if the research vessel index reflected a real decline, then the biomass could be as low as 90,000 t, close to the lowest estimated biomass level for this stock. CAFSAC advised that if the stock size was in fact

this low then the consequences of keeping the current TAC (35,400 t) could be severe and therefore advised a decrease in the TAC to 20,000 t in 1993. The TAC for 1993 was set at 20,000 t but only 15,000 t was caught by the time a moratorium was imposed in August 1993, based on the recommendation of the Fisheries Resource Conservation Council following the 1993 assessment of this stock.

The French survey was discontinued after 1992. The 1993 Canadian survey index was even lower than the 1992 value. Under the assumptions that were made regarding constant natural mortality and survey catchability, the SPA carried out at the 1993 assessment (Bishop et al. 1993) could not reconcile the survey and catch data and the results were considered to be only "illustrative" of what might be taking place. Hence no TAC projection was attempted for 1994. It was estimated that a 20,000 t catch in 1993 would have generated a fishing mortality in excess of $F_{0.1}$.

The 1994 survey was again low. The assessment (Bishop et al. 1994) suggested the apparent decline in the stock size was consistent with the declining length at age, increased total mortality from catch curve analysis and a loss of older age groups of fish. It was concluded that, similar to stocks in adjoining divisions, 3Ps cod appeared to have been declining since the mid-eighties. In contrast to the 1994 survey, the 1995 survey gave the highest index in the time series (1978 to 1995), however this resulted from one large set of about 15 t. Although it was not decided to treat this set as an outlier, the assessment recommended a cautious approach and considered that stock size was probably closer to that estimated for 1994 (Bishop et al. 1995).

In 1996 the survey switched from the Engel 145 otter trawl gear to the Campelen 1800 shrimp trawl. Despite extensive comparative fishing exercises and subsequent length based conversion of the Engels catches to Campelen equivalent catches (Warren 1997; Warren et. al. 1997; Stansbury 1996, 1997) there is still uncertainty regarding whether or not the integrity of the time series has been maintained. The conversion makes a big difference to the appearance of the time series. For example, the 1995 index, which is the highest in the unconverted Engels data, is lower than the 1985, 1990 and 1991 indices in the converted series.

The 1996 assessment of this stock (Shelton et al. 1996) attempted, for the first time, to carry out separate quantitative analyses for inshore and offshore components of the stock. The results of the trawl surveys suggested that the biomass of cod in the survey area had declined to a low level in 1993 and may have increased only modestly since then. This decline and continuing low biomass in the offshore conflicted with trends in inshore catch rates, results of the 1995 and 1996 Sentinel Survey and limited acoustic data. The perception of many fishers was that there has been a good recovery of the stock in the inshore. An acoustic survey in the inner portion of Placentia Bay in November 1995 had found about 23,000 t of cod (Rose 1996). ADAPT formulations carried out separately for inshore catch and fixed gear commercial catch rate data, and offshore catch and research vessel survey data were both considered to be flawed because of large standard errors associated with the parameter estimates and the temporal pattern in the residuals. The Stock Status Report for 1996 (Anon. 1996) reports on an attempt to extrapolate the Placentia Bay acoustic estimate to the area covered by the sentinel survey using the ratio of fish density in the acoustic

survey to the catch rates experienced by sentinel fishermen. The biomass estimated in this manner exceeded 100,000 t. The estimate was reported as being "...considered extremely tenuous." (Anon. 1996).

Based on the available data, it was concluded in the 1996 assessment that a limited reopening of the inshore fixed gear fishery may not compromise the recovery of the stock, but that a re-opening of the offshore bottom trawl fishery in 1997 was not supported by trawl survey data (Anon. 1996). It was pointed out that in 1993, prior to closure, about 10,000 metric tons was taken inshore by fixed gear. Given the uncertainties and risks associated with reopening, as outlined above, it was suggested that there was no basis for recommending catches above this level during the first year of any limited re-opening. The Stock Status Report requested that detailed logbook information accurately reflecting catches and associated effort should be gathered from all vessel sizes involved in the fishery. Previously, vessels less than 35 ft were not required to fill in logbooks. Catch data for these vessels were derived from a number of sources, including purchase slips, and are generally considered to be unreliable. No record of fishing effort is available for these vessels. Although the introduction of logbooks for smaller vessels was not universally popular, it was set as a condition of license for the 1997 3Ps fishery.

There was no assessment in 1997. Instead the assessment was held in February 1998 to allow the commercial catch at age data from the reopened fishery to be included in analyses. A Quasi-likelihood SPA (Cadigan 1998) based on offshore mobile gear commercial catches and research vessel survey data was used to reconstruct the offshore component of the stock. Results indicated that the spawner biomass had increased to 100,000 t to January 1, 1998, largely as a result of the high survival and early maturation of the 1989 and 1990 year classes. A risk analysis indicated that for a 12,500 t offshore TAC in 1998 the probability of fishing mortality exceeding F0.1 was <10%, with an associated 50% probability that the offshore spawning stock biomass would not increase from 1998 to 1999. An attempt was made to extrapolate the biomass from a mark-recapture study in Placentia Bay during 1997 to the entire inshore area of 3Ps using gillnet catch rates reported by commercial fishermen. This extrapolation gave a biomass estimate of 115,000 t. The estimates of the inshore and offshore summed to a spawner biomass of 215,000 t. The associated F0.1 reference level (0.24) was calculated to be about 40,000 t. Because of the uncertainties and concerns associated with the 1998 assessment, it was considered that exploitation not exceeding about 50% of the reference F0.1 level would provide an adequate margin of safety. This translated to a TAC of about 20,000 t. This TAC was implemented for 1998.

A Regional Assessment for 3Ps cod was conducted in February 1999 to allow the commercial catch-at-age data from the reopened fishery, which extended to the end of 1998, to be incorporated into the analyses. A Zonal Assessment of this stock was carried out in March 1999. This document summarizes information for the Regional and Zonal assessments in February and March 1999, incorporating the April 1998 research vessel survey results and the 1998 catch at age from the 20,000 t commercial fishery. The fishery began on June 30th and ended December 31st, 1998. Information from several other sources, including the sentinel survey, acoustic surveys, a fall industry survey, DFO Strategic projects involving genetics and tagging, and graduate student

research projects were also used. The current assessment provides an estimate of the abundance of fish on 1 January 1998, which is updated to 1 January 1999 by accounting for the 1998 catches and assumed natural mortality. Projections are then carried out from 1 January 1999 to 1 January 2000 for a range of TAC options for the current year. Uncertainty in estimates of stock size are propagated in the projections and analyses are performed of the risk of the spawner biomass falling below an arbitrary reference level and of fishing mortality exceeding a reference level.

2. Water temperatures

Water temperatures from NAFO subdivisions 3Pn and 3Ps during 1997 and 1998 were examined and compared to the long-term (1961-1990) average (Colbourne 1999). Time series of temperature anomalies in the 3Ps St. Pierre Bank area show anomalous cold periods in the mid-1970's and since the mid-1980's, similar to conditions on the continental shelf along the east coast of Newfoundland. The most recent cold period, which started around 1984, continued to the early 1990's with temperatures as much as 1.0 C below average over all depths and up to 2.0 ^{o}C below the warmer temperatures of the late 1970's and early 1980's in the surface layers. Temperatures in deeper water off the banks show no significant trends. Since 1991, temperatures have moderated somewhat in some areas from the lows experienced from the mid to late 1980's and early 1990's, but negative temperature anomalies continued over large areas of the banks into the spring of 1995. During 1996 temperatures started to moderate, decreased again during the spring of 1997 and returned to more normal values during 1998. An analysis of the areal extent of cold (-1.8 to 0.0 ^{o}C) bottom water covering the banks shows a dramatic increase since the mid-1980s, very low values in 1996 and 1998 (<10%), while 1997 was at about 60 % of the total area. The areal extent of bottom water above 1.0 ^{o}C (i.e. relatively warm) was about 50 % of the total area of the banks in the 3Ps region during 1998, the first significant amount since 1984.

3. Catch and catch-at-age

Catches (reported landings) from 3Ps for the period 1959 to 1998, by country and separated for fixed and mobile gear, are summarized in Table 1. Canadian landings for vessels <35 ft were estimated mainly from purchase slip records collected and interpreted by Statistics Division, Department of Fisheries and Oceans prior to the moratorium. Shelton et al. (1996) emphasized that these data may be unreliable. Post-moratorium landings for vessels <35 ft have come mainly from a new dock-side monitoring program. Landings for vessels >35 ft come from logbooks. Non-Canadian landings (mainly France) are compiled from national catch statistics reported by individual countries to NAFO and there is generally a two to three year lag in the submission of final statistics; consequently, the last few entries in Table 1 are designated as provisional.

The stock in the 3Ps management unit was heavily exploited in the 1960's and early 1970's by non-Canadian fleets, mainly from Spain and Portugal, with catches (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 landings, reaching a high for the post-extension of jurisdiction period of about 59,000 t in 1987. Catches then declined gradually to 36,000 t in 1992. Catches clearly exceeded the TAC throughout the 1980's and into the 1990's. The Canada-France boundary dispute led to fluctuations in the French catch since the late 1980's. A moratorium was imposed on all directed cod fishing in August 1993 after only 15,216 t had been landed, the majority being taken by the Canadian inshore fixed gear fishery. In this year access by French vessels to Canadian waters was restricted. Under the terms of the Canada-France agreement, France is allocated 15.6% of the TAC of which 70% must be fished by Canadian trawlers, with the remainder fished by small inshore fixed gear vessels.

Although offshore landings have fluctuated, the inshore fixed gear sector consistently reported landings between 20,000 and 25,000 t each year up until the moratorium (Table 2, Fig. 3B). In 1997, 72% of the 10,000 t TAC was landed by Canadian inshore fixed gear fishermen, with most of the remaining catch taken by the French mobile gear sector fishing the offshore. In 1998, approximately 65.5% the 20,000 t TAC was taken by the Canadian inshore fixed gear sector, with 25% taken by the Canadian and French mobile gear sectors fishing the offshore.

Line-trawl catches dominated the fixed gear landings over the period 1977 to 1993, reaching a peak of over 20,000 t in 1981 (Table 2, Fig. 4). Gillnet landings increased steadily from 1978 to a peak of over 9,000 t in 1987 and then declined until the moratorium. However, gillnets have been responsible for the dominant portion of the catch since the fishery reopened in 1997, with gillnet landings in 1998 exceeding 10,000 t (i.e. 50% of the TAC) for the first time. Trap catches have varied over the time period but have not exceeded 8,000 t and were minimal in 1998. Hand-line catches have been a minor (<3,000 t) but relatively stable component of the fishery.

The 1998 Canadian landings by unit area, month and gear type for by-catch, sentinel survey and the directed fishery are summarized in Table 3. In 1998, inshore catches (3Psa, 3Psb and 3Psc; see Fig. 2) came mostly from gillnet and line-trawl during July and October-November. Overall landings in the inshore increased in an easterly direction, ranging from about 1,700 t in the west (3Psa) to 5750 t in the east (3Psc-Placentia Bay). Higher landings in July, September and November compared to August and October reflect seasonal openings and closings of the competitive fishery that was in effect in 3Psa, 3Psb, and 3Psd (see below). In the offshore, otter trawl fishing by Canadian trawlers and vessels chartered by St. Pierre and Miquelon to fish the French quota was concentrated on St. Pierre Bank and in Halibut Channel (see Fig.1) in unit areas 3Psh and 3Psg (Fig. 2) and mainly during the last quarter of the year. Overall, the 1998 landings were dominated by the directed gillnet fishery (10,000 t) with the remaining catch taken by otter trawl (5,000), followed by line-trawl (3,000), and hand-line (300 t) with only small amounts taken by traps in Placentia Bay. As in 1997, the gillnet fishery was pursued over a longer period of the year than the traditional gillnet season in this area.

The 1998 conservation harvesting plan placed various restrictions on how the 3Ps fishery could be pursued. West of the Burin Peninsula a competitive fishery with quarterly quotas was conducted. In

contrast, fishers in Placentia Bay operated under an individual quota (IQ) system and could fish up to the end of the year. Many fishers, particularly gill-netters in Placentia Bay, did not fish until fall when fish were reported to be in better condition and markets were strong. A dockside monitoring system was in place during 1998 and other restrictions included the number of nets that could be fished, where fish could be landed, and a small fish limit.

Samples of length and age compositions of catches were obtained from the inshore trap, gillnet, line-trawl and hand-line fisheries and the offshore otter trawl and gillnet fisheries by port samplers and fishery observers. Maturity information was not collected in 1998 from these sources because of the relatively late opening of the fishery. Detailed description of the information on length frequency distributions and spatial distribution of the fishing effort during 1998 can be found in Kulka et al. (1999). Sampling of the catch in 1998 was intensive, with 11,580 otoliths collected for age determination (Table 4) and over 132,000 fish measured for length (Table 5). The sampling was well distributed spatially and temporally across the gear sectors. Sampling from the first two quarters (prior to the opening of the directed cod fishery) came mainly from sentinel and by-catch fisheries. Substantial landings in July from inshore fixed gears (see Table 3) were sampled intensively, particularly line-trawl in 3Psa and 3Psb, and gillnet in 3Psc. The small number of samples from trap catch reflects the small catch from this gear in 1998. The offshore unit areas (3Psd-h) were fished mainly during the last quarter and were sampled intensively at that time.

The age composition and mean length-at-age were calculated as described in Gavaris and Gavaris (1983). The average weights were derived from a standard length-weight relationship where log(weight)=3.0879*log(length)-5.2106)). Catch-at-age by gear type and for all gears combined based on sampling of Canadian vessels is summarized in Table 6 and Fig. 5. In the 1998 landings from all gears combined ages 6, 8 and 9 were most abundant (1992, 1990 and 1989 year classes). The age composition of fixed gear catches in 1998 comprised a range of ages from 3 to 13, but predominantly ages 6 in almost all fixed gears (Fig. 5). Gill nets and line trawls also caught substantial amounts of 8 and 9 yr old fish, with 5 yr olds well represented in line trawl and hand-line catches. Otter trawl catches consisted mainly of 8 and 9 yr olds. Fish aged 7 were poorly represented in both fixed and mobile gears. The overall age composition for the 1998 catch (Fig. 5) shows the 1992 year class (6 year olds) dominating, followed by the 1990 and 1989 year classes (8 and 9 year olds respectively).

Mean weights-at-age calculated from mean lengths-at-age have varied considerably over the time series (Table 7A, B). Current mean weights of younger fish (3-6) tend to be higher than those reported for the 1970's and early 1980's, whereas for older fish the converse is true. Sample sizes for the oldest age groups (>10) have been low in recent years due to scarcity of old fish in the catch. Furthermore, as Lilly et al. (1999) point out for 2J3KL cod, interpretation of these trends is difficult because of changes in the relative contribution of various gear components and changes in the location and timing of catches. The higher proportion of gill net landings in recent years in 3Ps will tend to increase the mean weight-at-age of the younger ages, because only the largest, faster-growing individuals within a cohort will be caught by this gear.

A time series of catch numbers-at-age for the 3Ps cod fishery from 1959 to 1998 is given in Table 8. The catch in 1998 was dominated by 6, 8 and 9 year old cod and is consistent with the catch numbers-at-age from the preceding year, incremented by one year.

4. Science logbooks

Historically, commercial fixed gear catch rates are available only for the period 1987 until the moratorium in 1993, and only for vessels >35ft. Murphy and Shelton (1997) concluded that the data were extremely sparse and unreliable. A new fixed gear logbook was introduced to collect scientific data from vessels ≤35ft (Murphy logbook) for the reopening of the 3Ps commercial fishery in 1997. The purpose of the logbook was to provide information for stock assessments and not for quota monitoring. This logbook was also used during the 1998 commercial fishery in 3Ps and during the limited commercial inshore fishery in 2J3KL during 1998 (index fishery).

Catch rates for the 1997 and 1998 fisheries in 3Ps have been derived for cod-directed sets from the data provided by fishermen. A sample is considered to be the catch rate for each "set", irrespective of the number of nets or hooks deployed, for either gillnets or line trawls in a specified unit area, month and year. Catch is expressed in kilograms. Gillnet effort was standardized to per net per day and line-trawl effort was standardized to 1,000 hooks per day.

Arithmetic means were considered as a possible statistic for making comparisons; however, the distributions of sample values within area/month/year cells tend to be skewed with long tails representing a small number of high catch rates. To illustrate possible trends in the data from the commercial fishery in 1997 and 1998, the mean, median and 90^{th}, 75^{th} 25^{th} and 10^{th} percentiles are shown to examine how the distributions may have changed over time or space. Emphasis is placed on the median as an indicator of central tendency in the comparisons described below. Some sentinel data have been inadvertantly included in the science logbooks resulting in some catch rates for months outside the directed cod fishing season (typically during January-April) in Figs. 6 and 7.

Median line-trawl catch rates in 1997 to the west of the Burin Peninsula (3Psa and 3Psb) increased gradually from April to December to about 3000 kg per thousand hooks per day at the end of the year (Fig 6A). The 1998 line-trawl fishery catch rates in the same area were somewhat lower than those observed in 1997 from July to September (Fig 6B), but increased during fall to rates comparable to those seen the previous year**.** There was generally less variability in catch rates during 1998 compared to 1997.

In the 1997 commercial gillnet fishery in 3Psc, median catch rates increased from May to July. Catch rates appeared somewhat lower in October but the rate is based on a small sample size (Fig. 7A). Gillnet catch rates appeared generally lower in 3Psc in May-August 1998 compared to 1997, but it should be noted that only for the month of July was the sample size high in both years. The catch rates in 1998 show a marked seasonality and increased quite rapidly during the September to December period, reaching 100 kg per net per day (Fig. 7B)**.** Gillnet catch rates were particularly

low in August and September, averaging less than 25 kg per net per day. Note that in 1997 there was a full competitive fishery with approximately quarterly quotas which opened on May 19th, July 1st, and Oct. 1st, whereas in 1998 an IQ system was in place in 3Psc and fishers could fish any time after June 28th. The influence of changes in the management plan on catch rate between 1997 and 1998 are not well understood, but it is difficult to envisage how IQ's would result in lower catch rates.

5. Sentinel catch rates

A "sentinel survey" program was introduced in 3Ps in 1995 to provide a catch rate series for use in resource assessments and to incorporate the knowledge of inshore fishermen into the resource assessment process, as well as to provide biological and environmental data (Davis and Jarvis 1998). Evaluation of the data for use in a quantitative manner in stock assessments, for example as a potential calibration index in SPA's, required a number of years of data to be available. Now that the program has been running for 4 years the data can be evaluated, particularly in terms of being a potential index of stock size.

The survey design for sentinel comprised selecting fishers from around the coast to fish in a standard manner at consistent times and locations each year. Time and location for fixed sites were chosen to reflect the optimum fishing pattern with respect to each fisher and were expected to remain invariant over the years. There is evidence that both location and time have changed in the case of some fishers over the time period. Timing changes are most evident in 1998 when a TAC of 20,000 t was set for 3Ps cod. In addition to fixed sites, "experimental sites" were also fished providing more flexibility to the program (Davis and Jarvis 1998). Only the fixed site data are considered further below.

From the available data recorded on log sheets and from biological sampling of the catches, catch rates were calculated in one of two ways, depending on the information available. If a catch weight is not reported on the log sheet, the length frequency is often known, and a mean length of the sample may be calculated. Using a standard length – weight relationship, a predicted mean weight can be calculated, and since the sample size is known, a predicated catch weight can be constructed. If the catch weight has not been reported, this predicted catch was used as input to determine the catch rate. If available, the reported catch weight is used in the calculation. If both the catch weight and respective length frequency of a catch are unknown, the catch rate cannot be calculated. In order to standardize the data, catch rates were calculated as kg per net per day for gillnets and as kg per thousand hooks per day for line-trawls.

Four analyses were applied to sentinel catch rates. In the first analysis, the square root of the catch rates for each fishermen were plotted individually for the period 1995 to 1998 to allow visual inspection of the data (Fig. 8). Gillnet catch rate data are available for 12 sites and line-trawl data for 12 sites in 3Ps. Gillnet data for Little Paradise, Red Harbour, Rencontre East, Seal Cove, and Placentia provide series that are either too short or too patchy in time to provide any information on

possible changes in catch rates over the time period. In the remaining sites it is clear that catch rates were much lower in 1995 than in 1996-98. From 1996 to 1998 there is clear evidence at a number of sites of seasonal patterns in catch rates (e.g. Monkstown), but no evidence of any distinct trends across years at most sites. Shifts in the time window in which the sentinel fishery was pursued from one year to the next relative to the seasonal cycle in catch rates, or in inter-annual changes in the seasonal cycle itself, could result in very different mean catch rates between years. There is some evidence that the 20,000 t TAC in 1998 might have had a disruptive influence on the sentinel program in that year. For example, the catch rate data for Fox Harbour and Little Harbour East show a gap during the usual period of peak gillnet catch rates, possibly indicating that these fishers pursued their IQ as part of the commercial fishery.

Line-trawl data for sentinel sites in 3Ps clearly shows low catch rates in both the spring and fall period in 1995 compared with catch rates in subsequent years (Fig. 8). There is less evidence of seasonal cycles in catch rates for line-trawls, although in Rencontre East there is clearly an increasing trend in the fall fishery from the beginning of October to the end of the year.

In the second analysis, the line-trawl and gillnet catch rate data were each grouped within unit areas (3Psc – Placentia Bay, 3Psb – Fortune Bay and 3Psa – west of Fortune Bay) for each month for 1995 to 1998. The 90^{th}, 75^{th} 50^{th}, 25^{th} and 10^{th} percentiles as well as the mean for the distribution in each month were plotted across years (Figs. 9A, 9B, 9C). As a possible reference level, the median historic catch rate for the gear for the period 1987 to 1992 was calculated and plotted. These data come from logbooks completed for vessels greater than 35ft. The data are very sparse and have many missing values, and previously led to the conclusion that the data (for 2J-3KL cod) are unreliable for further analysis (Murphy and Shelton 1997). The 3Ps data are just as poor.

The line-trawl catch rates in 3Psa (Fig 9A) peak earlier in the year than in 3Psb (Fig. 9B) and are more variable, but also suggest a decreasing trend from 1996 to 1998. Line-trawl catch rates in 3Psb were quite variable in 1995, but in the fall fishery in 1996 to 1998 there are well-defined peaks, the heights of which decrease over the three years. Line-trawl catch rate series in both 3Psb and 3Psa show gaps, which probably reflect the disruptive influence of the 20,000 t TAC in 1998 on the execution of the sentinel program.

Line-trawl catch rates for 3Psc are variable with some long tails to the distributions in 1995 and 1996 (Fig. 9C). Median catch rates are generally lower than those reported historically for the area for vessels greater than 35 ft and there is some evidence of decreasing catch rates over the period 1996 to 1998.

For gillnet catch rates in 3Psc there is clear seasonality with a summer and fall fishery, the fall fishery generally giving substantially higher catch rates (Fig. 9D). The monthly data in 1995 and 1998 were close to being normally distributed whereas in 1996 and 1997 the distributions were skewed by some very large catch rates. There is no evidence of a trend in median catch rates over years. Gillnet data in 3Psa and 3Psb are extremely sparse and are not plotted.

Comparison of sentinel gillnet catch rates in 1997 and 1998 (Fig. 9D) with those recorded in the commercial fishery from the science logbooks for vessels less than 35ft (Figs. 7A, 7B) shows that the gillnet fishery in 1997 occurred primarily during the summer and that commercial catch rates were comparable to those that occurred in the sentinel fishery (up to 100 kg per net per day). Commercial gillnet catch rates in the fall of 1997 are based on limited data, but are lower than those observed in the 1997 fall sentinel fishery (latter 300 kg per net per day). In the 1998 commercial fishery, the gillnet catch rates in summer were lower than those observed in 1997 with a median of only 50 kg per net per day. The 1998 commercial fishery catch rates peaked in the fall at over 100 kg per net per day, substantially lower than sentinel catch rates at the same time (median just under 300 kg per net per day).

A comparison of commercial line-trawl catch rates during 1997 and 1998 in 3Psa and 3Psb combined (Figs. 6A, 6B) with sentinel catch rates for these two areas (Figs. 9A, 9B) shows that the strong seasonality in the sentinel data does not occur in the commercial data (for the two areas combined). Median commercial catch rates did not reach above 300 kg per thousand hooks per day in either year, whereas in the sentinel fishery median catch rates above this value were common. The reason why median sentinel catch rates are so much higher than commercial catch rates for both gear types in the two years requires further consideration.

In the third analysis, sentinel catch rates were subject to statistical tests to determine whether or not there has been a significant increase from one year to the next. A non-parametric test for ranked data was applied. A two-tailed Kruskal-Wallis test was used to identify sites for which there has been a shift in location of the distribution of catch rates between the two years being compared. This test only informs as to which sites have observed a statistically significant change in catch rates, and does not provide the direction of the shift between years. To obtain information on the direction of change, a general linear model was fit to ranked CPUE data. Comparison of means for sites observing statistically significant change in catch rates provides an indication whether the central tendency of the distribution of catch rates has increased or decreased over the years under examination. It is important to note that although sites are grouped for the entire inshore 3Ps area, the comparison is done by sentinel fishermen, so that the change in catch rate by individual fishermen is being evaluated. The results of this evaluation are summed to give an outcome for the whole of inshore 3Ps. The outcome of these tests is summarized in Table 9.

For gillnets, at the $\alpha = 0.05$ level, there were significant differences in catch rates for all fishermen for 1995 and all other years, with all other years being significantly higher than 1995. For the remaining year by year comparisons, only 3 out of 8 sentinel fishermen had significantly higher catch rates in 1997 compared to 1996, only 1 out of 8 in 1998 compared to 1996 and only 1 out of 9 in 1998 compared to 1997. For line-trawls, the catch rate of most (but not all) fishermen is statistically higher in 1996, 1997 and 1998 than in 1995. For the remaining year by year comparisons, no fishermen out of 9 had significantly higher catch rates in 1997 compared with 1996, only 1 fisherman out of 9 in 1998 compared to 1996 and no fishermen out of 9 in 1998 compared to 1997.

In the fourth analysis, annual trends in sentinel survey catch rates were explored using an analysis of variance to account for effects associated with month and sentinel enterprise. For each of the two major gears (5.5 inch gillnet and line-trawl) the following model was fit:

Ln(sum of catch/sum of effort) = Year + Month + Enterprise

where the years were 1995-1998, the months were July to November for gillnets and August to November for line-trawls, and the enterprises were all those in Subdiv. 3Ps that fished with that specific gear in any of the above years and months. (Each Enterprise was assigned a unique number) Catch per unit effort was expressed as number of fish caught per net (gillnet) and number caught per 1000 hooks (line-trawl). Catch rates were not standardized for soak time, but only records with soak times between 18 and 24 hours were selected for the gillnet analysis and only those less than or equal to 12 hours were selected for the line-trawl analysis.

In the gillnet analysis, all main effects were significant at the 0.05 level (Table 10A). The standardized gillnet catch rate increased from 1995 to 1997 and then decreased to 1998 (Table 10A; Fig. 10A). In the line-trawl analyses all main effects were also significant (Table 10B). The standardized line-trawl catch rate showed a slight decrease from 1995 to 1996, a larger decrease to 1997 and little further change to 1998 (Table 10B; Fig. 10B). Reasons for the annual changes in catch rates were not explored further at this time. In additional to a possible fish abundance signal in the data, fishermen indicated that fishing activity in the reopened fishery may have influenced sentinel catch rates.

In summary, a number of conclusions can be drawn regarding sentinel catch rates at this stage. Firstly, there is a distinct seasonality in catch rates for many locations for both gear types. Changes in the distribution of sentinel fishing effort from one year to the next could impart a spurious signal into the sentinel catch rate data. Sentinel catch rates are much higher than those obtained in the commercial fishery pursued over the same period in 1997 and 1998. The reason for this is not clear. The commercial fishery with a 20,000 t TAC influenced the execution of the sentinel fishery in 1998, and some sentinel fishers reported that their sentinel fishing sited were occupied by commercial gear. Sentinel catch rates in 3Ps were generally significantly higher after 1995 but there is little evidence to support an interpretation that catch rates continued to increase for the period 1996 to 1998. This latter conclusion may be most important in attempting to interpret sentinel catch rates as an index of overall stock size in 3Ps. When compared with the recent increase in the 3+ and spawner biomass estimated by the SPA over the last 5 years, a sustained increasing trend in sentinel catch rates would have been anticipated if catch rates were reflecting changes in stock size.

6. Acoustic surveys

An acoustic survey conducted in the northwestern portion of Placentia Bay in early May 1998 (D. Porter, Gadoids Section, DFO Newfoundland Region, pers. comm.) did not locate any significant aggregations of cod and a biomass of only 316 t was observed. Sampling revealed a wide range of

age classes from 4 to 12 yr old, with age 6 (1992 yr class) predominating and many fish in spawning condition. A broad-scale acoustic survey conducted in June and extending from Halibut Channel shoreward to the outer portion of Placentia Bay yielded a biomass estimate of 72,000 t , with the major portion of the biomass located on Oderin Bank in the west central portion of Placentia Bay (Rose and Lawson 1999). Samples taken by hand-line indicated that fish aged 6 and 8 predominated along with large numbers of 4 and 5 yr olds (1993 and 1994 yr classes). A higher proportion of younger fish were found on the shelf compared to inside Placentia Bay. An acoustic survey of inner Placentia Bay in June estimated an additional 3,000 t with a similar age structure to the outer bay.

7. Tagging experiments

During 1997, approximately 6,000 commercial sized (>45 cm) cod were tagged and released at various locations in Placentia Bay and adjacent areas prior to and during the 1997 commercial fishery (Brattey and Cadigan, 1998; Lawson et al. 1998). This work was extended in 1998 when an additional 9,800 cod were tagged and released, mostly in spring prior to the start of the commercial fishery. The 1998 tagging experiments included large numbers of releases in the offshore in Halibut Channel and the Burgeo Bank/Hermitage Channel area, as well as inshore in Fortune Bay and Placentia Bay.

Approximately 1,370 of the tagged cod released during 1997 and 1998 were reported as recaptured up to the end of 1998. The data from single, double, and high reward releases was used to estimate tag loss and reporting rates (Cadigan and Brattey 1999a). Estimates of these parameters are essential to allow exploitation rates to be estimated from tagging data. The analyses indicated reporting rates of 61.2% for single and 67.6% for double-tagged cod recaptured during 1997-98. A two-stage model adequately described the data on tag loss with the rate of loss higher (0.006/wk) during the first 15 wk after release, compared to subsequent time periods (0.001/wk). Accurate estimates of tag loss are particularly important when the time at liberty is long, as in the current study, which now extends over 20 months.

Overall exploitation rates for the commercial fisheries in Placentia Bay and 3KL were also estimated from tag-returns. Migration of tagged fish between Placentia Bay and 3KL was evident from the recaptures (Brattey et al. 1999), and this was incorporated into a migration model (see Cadigan and Brattey, 1999b). Estimates of migration rates from this model suggest 8% annual movement of 3Psc (Placentia Bay) cod into southern 3L each year. Exploitation in 1998 was estimated as 10% in Placentia Bay, 10% in southern 3L (Trinity Bay southward), and 7.5% in the northern part of 3L (Bonavista Bay) and 3K combined.

Lawson et al. (1998) addressed movements of cod in 3Ps based on tagging experiments during 1996 and 1997 and these were updated and supplemented with recaptures from the 1998 releases by Brattey et al. (1999). Spawning cod tagged in the inner reaches of Placentia Bay during the early spring of 1998 dispersed outward toward the mouth of Placentia Bay during late spring and

summer. A substantial number of recaptures were obtained from the recreational, index, and sentinel fisheries in southern 3L extending as far north as approximately the eastern side of Trinity Bay. These cod appeared to migrate back to Placentia Bay during late fall. Densities of Placentia Bay tagged cod (expressed as numbers of tagged fish recaptured per 50 t catch) were similar in Placentia Bay and southern 3L, suggesting that a substantial portion of the catch in southern 3L consisted of cod from Placentia Bay. Recaptures from offshore tagging in 1998 indicated that a portion of the offshore stock components migrated shorewards during late spring and contributed to the inshore fishery along the south coast. Cod tagged near Burgeo Bank and in Halibut Channel were recaptured in Placentia Bay during the first few days of the fishery as well as later during summer and fall, indicating that offshore fish were contributing to inshore catches throughout much of the 1998 fishing season. Some cod tagged near Burgeo Bank migrated north and westward and were recaptured in the adjacent management unit (3Pn-4RS) as far north as the Strait of Belle Isle. Determining the stock affinities of cod on Burgeo Bank during winter and early spring remains an important issue; some cod tagged in this region during April were spawning indicating that they belonged to the 3Ps stock. However, many were maturing to spawn later in the spring of 1998 and their stock affinity remains unknown.

8. Genetics

A new genetic study was undertaken to describe population structure and to determine the potential for genetic stock identification of inshore and offshore cod in Newfoundland and Labrador using microsatellite loci and the synaptophysin (SypI) locus (Beacham et al. 1999). Variation at the SypI locus and seven new microsatellite loci (*Gmo*3, *Gmo*8, *Gmo*19, *Gmo*34, *Gmo*35, *Gmo*36, and *Gmo*37) developed at the DFO Pacific Biological Station in Nanaimo, was surveyed in 1251 cod from a total of six putative inshore and offshore populations in subdivision 3Ps. The degree of genetic differentiation was small between inshore and offshore populations. Genetic differentiation was observed between the inshore Placentia Bay and Fortune Bay samples. The Placentia Bay sample was generally distinct from offshore samples of northern cod, but not from inshore populations sampled in 3KL. Within 3Ps, the Burgeo Bank sample may have been a composite of fish from at least two spawning populations. Characters affording greater differentiation among the sampling sites in Subdiv. 3Ps are required to increase the accuracy and precision of the estimated contributions of inshore and offshore cod for practical applications. Preliminary results based on screening of loci that code for major histo-compatibility complex (MHC) antigens suggests that these may provide a greater degree of differentiation; this is currently being investigated.

9. GEAC Stratified Random Trawl Survey

The Groundfish Enterprise Allocation Council (GEAC) has funded surveys during fall 1997 and fall 1998 directed at cod with the intention of creating a series of annual fall surveys covering a portion of 3Ps to complement current DFO RV surveys conducted in spring. DFO provided advice on the

stratified random design and catch sampling. Results of the first survey are reported in McClintock (1999a) and the results of the second survey are presented in McClintock (1999b).

The 1998 survey was carried out from 30 November to 11 December and the 1997 survey from 8-17 December. The M.V. Pennysmart, with the same captain, was used in both surveys. Weather and seas were poor for the first seven days of the 1998 survey limiting the number of sets completed and was a possible factor in gear performance. Tows of 30 minutes duration using an Engels 96 high lift trawl with a 135 mm diamond mesh cod end (not lined) were conducted. The trawl was fitted with rock-hopper foot-gear and Bergen #7 trawl doors. Performance of the trawl was checked onboard using Netmind net sensors: bridge display of doorspread, wingspread, and net opening was visually monitored and measurements were noted. The gear and configuration in 1998 were identical to those used in the 1997 survey. A total of 86 successful stratified random tow sets were completed in the 1998 survey. Three sets were unsuccessful.

The Netmind net monitoring instruments were only partially successful during the 1998 trip: no wing-spread and door-spread were reported after set 25, and no mouth openings reported after set 50. The cause of the problem is unknown although it is suspected that water may have leaked into the instrument housings during use. Door spread exhibited values varying from 60 to 90 m, while wingspread was fairly consistent with a mean value of 17.6 m. This wingspread value is consistent with the 60 foot estimate assumed for the 1997 survey.

The mean cod catch per tow was 25 fish and a mean catch weight of 127 kg. The largest catch of 1239 cod (8035 kg) was from set 59 in the Halibut Channel. A total of 10 sets had catches over 100 kg, and four sets had catches over 200 kg. The mean cod weight for all sets was 1.92 kg per cod.

Sets in the southern Halibut Channel and south-eastern slopes of St. Pierre Bank had the highest catches. The 1997 STRAP estimate for the GEAC survey was 99,330 t whereas the 1998 estimate for a larger survey area was 47,875 t.

The age composition of the GEAC Survey catches, expressed as mean numbers per tow, is shown in Fig. 11. In 1997 the catch was dominated by 5 year olds (1992 yr class) and 8 year olds (1989 yr class). In the 1998 survey 9 year olds dominated (1989 yr class). Next most abundant were 5 year olds and 4 year olds (1993 and 1994 yr classes, respectively).

The strong 1989 and 1992 yr classes seen in the 1997 GEAC survey are visible in the 1998 results, although the 1992 yr class is relatively weaker in 1998 and the 1993 yr class looks relatively strong. The 1991 yr class remains weak in both 1997 and 1998. (Fig. 11).

10. Research vessel trawl 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 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 by the research vessels *A.T. Cameron* (1972-82), *Alfred Needler* (1983-84) and *Wilfred Templeman* (1985-98). From the limited amount of comparable fishing data available, it has been concluded that the three vessels had similar fishing power and no adjustments were necessary to achieve comparable catchability factors, even though the *A.T. Cameron* was a side trawler. The French surveys were conducted by the research vessels *Cyros* (1978-91) and *Thalassa* (1992) and the results are summarised in Bishop et al. (1994). Canadian surveys have covered strata in depth ranges to 300 ftm since 1980. Five new inshore strata were added to the survey and sampled in 1994 (779-783) and a further eight inshore strata were added and sampled in 1997 (293-300)(Fig. 12). For surveys from 1983 to 1995 the Engel 145 high-rise bottom trawl was used. The trawl catches for these years were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation which was derived from comparative fishing experiments (Warren 1997; Warren et al. 1997; Stansbury 1996, 1997).

The Canadian survey results (in Campelen-equivalent units, see below) are summarized by stratum in terms of numbers (abundance) and biomass in Tables 11A and 11B, respectively, for the period 1983 to 1998. Strata for which no samples are available were filled in using a multiplicative model. Timing of the survey has varied considerably over the period. In 1983 and 1984 the mean date of sampling was in April, in 1985 to 1987 it was in March, from 1988 to 1992 it was in February. Both a February and an April survey were carried out in 1993 and subsequently the survey has been carried out in April. The recent change from February to April was aimed at reducing the possibility that cod from adjacent 3Pn-4RS would be erroneously counted as part of the 3Ps stock; these cod migrate out of the Gulf during winter and a portion may cross the stock boundary into the Burgeo Bank area of 3Ps (see Fig. 1) before they migrate back into the Gulf some time during the following spring. In the 1998 survey there were several strata with substantial biomass estimates (>1,000 t), including three strata located on and adjacent to Burgeo Bank (strata 307, 309, and 715) with estimates of 16,164, 9,000, and 6,000 t, respectively. There were three additional strata with substantial biomass estimates located on the southern end of St. Pierre Bank and in Halibut Channel (strata 315, 319, and 320 with estimates of 20,000, 28,144 and 7,766 t, respectively). An acoustic mapping exercise and additional fishing sets conducted at the end of the 1998 research vessel trawl survey confirmed the presence of an extensive school of cod in the southern end of Halibut Channel (D. Porter, Gadoids Section DFO Newfoundland, pers. comm.).

Trends in abundance and biomass from the RV survey of the index strata in 3Ps (depths less than or equal to 300 ftm, excluding the new inshore strata) are shown Fig. 13. The abundance and biomass time series from 1983 to 1998 shows considerable variability, with strong year effects in the data. Both abundance and biomass are low after 1991 with the exception of 1995. 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 research vessel survey suggested that this survey did not encounter aggregations of older fish, yet these fish were present in the 1996 survey, the fall 1997 industry trawl survey, and the commercial and sentinel catches in 1997. The minimum trawlable biomass from the 1998 survey was 100,100 t, i.e. more than ten times the 1997 estimate. Age classes in the 1998 RV survey correspond well to those seen in the 1997 and 1998 commercial catches and industry surveys, with the 1992, 1990 and 1989 year classes predominating.

The spatial distribution of cod (mean numbers per tow, standardized to Campelen equivalent units) is plotted in Fig. 14 for surveys from 1994 to 1997. Cod appear to have become scarce or absent on St. Pierre Bank in the 1990s. Abundances during the early to mid-90's were highest in the southern Halibut Channel area towards the edge of the survey area, and on the slopes in the vicinity of Burgeo Bank and the Hermitage Channel. There was some indication that cod were becoming more widespread over the survey area in 1997 than in previous recent years, albeit at low abundance, but the distribution pattern for 1998 (Fig. 15) is much the same as 1997. Reasonable catches of cod were obtained in the inshore strata in Fortune Bay in both 1997 and 1998, but few cod were encountered at the mouth of Placentia Bay in either of those years.

Survey numbers at age are obtained by applying an age-length key to the numbers of fish at length in the samples. The current sampling instructions for Subdiv. 3Ps require that an attempt be made to obtain 2 otoliths per one cm length class from each of the following locations - Northwest St. Pierre Bank (strata 310-314, 705, 713), Burgeo Bank (strata 306-309, 714-716), Green Bank-Halibut Channel (strata 318-319, 325-326, 707-710), Placentia Bay (strata 779-783) and remaining area (strata 315-317, 320-324, 706, 711-712). This is done to spread the sampling over the survey area. The otoliths are then combined into a single age-length key and applied to the survey data. The resulting estimates of mean numbers per tow is given in Table 12. It is in this form that the data are used in the calibration of sequential population analysis models. These data can be transformed into trawlable population at age by multiplying the mean numbers per tow at age by the number of trawlable units in the survey area. This is obtained by dividing the area of the survey by the number of trawlable units. For 3Ps, the survey area is 16,732 square nautical miles including only strata out to 300 ftms and excluding the relatively recent strata created in Placentia Bay. The swept area for a standard 15 min tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of trawlable units in the 3Ps survey is $16{,}732/0.00727=2.3\times10^6$.

The mean numbers per tow at ages 1-3 in the research bottom-trawl survey have been generally low since 1992, with the exception of 3 yr olds in 1992 and 1998 (Table 12). In recent years, the 1989 year class has appeared strongly in the sentinel and commercial catches, but appeared only intermittently in the surveys; it is strongly represented in 1994 (at age 5), 1995 (age 6), and particularly in 1998 (age 9) where it is the strongest in the time series going back to 1983. The 1990 year class has also appeared reasonably strong in the sentinel and commercial catches, but has not appeared strong in the survey except at age 1 and in the most recent survey at age 8. The 1991 year class has been consistently weak in both the trawl survey and commercial catches. The 1992 year class appeared strongly in the commercial fishery catches in 1997 and 1998, but has not

appeared strongly in the surveys except during the most recent year. The 1993 and subsequent year classes have not appeared strong in the survey, except during the most recent survey. The 1997 survey results appear somewhat anomalous given that three year classes (1989, 1990 and 1992) that have been well represented in fishery, the 1998 DFO survey, and the 1997 and 1998 fall industry (GEAC) survey, did not appear to be encountered in the 1997 survey.

11. Size-at-age of cod sampled in the DFO surveys

The sampling protocol for obtaining lengths-at-age (1972-1998) and weights-at-age (1978-1998) has varied over time (Lilly 1996), but has consistently involved stratified sampling by length. For this reason, calculation of mean lengths and weights included weighting observations by population abundance of the size groups (Morgan and Hoenig 1997), where the abundance were calculated by areal expansion of the stratified arithmetic mean catch at length per tow (Smith and Somerton 1981).

Mean lengths-at-age (Table 13; Fig. 16) have varied over time. For the period 1972-1998, peak length-at-age occurred in the mid-1970s for young ages (3-4) and progressively later to 1980 for older ages. From the mid-1980's to 1998, length-at-age varied with no trend (younger ages) or declined (older ages). The length increment for the 1989 year-class was very large (12 cm) in the period 1997-1998. Mean length-at-age has been extremely variable among the older ages (>5) over the past several years. Older year-classes were poorly sampled in 1997, and the length-at-age estimated in 1997 may have been low. An exploration of the potential effects of environmental factors such as temperature has not been conducted, because there appears to be negative growth for at least 2 cohorts during each of the intervals 1977-1978, 1980-1981, 1989-1990 and 1993-1994 (Lilly 1996). Length-at-age may differ among the various groups of fish occurring in Subdivision 3Ps at the time of the surveys and annual variability in the rate at which these groups were sampled may explain some of the year effects in length-at-age.

As expected, the patterns in mean weight-at-age (Table 14; Fig. 17) appear to be very similar to those in length-at-age. However, the weight-at-age data may include more sampling variability because they are based on smaller sample sizes (Lilly 1996). The weight-at-age data also include variability associated with among-year and within-year variability in weight at length (condition).

12. Condition of cod sampled in the DFO surveys

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

Mean gutted condition-at-age (Table 15; Fig. 18) was variable from 1978 to 1986, relatively constant from 1986 to 1992, and dropped suddenly in 1993 before rising to an intermediate level in

1995-1998. Because condition calculated with Fulton's formula increases with body length and length-at-age has declined over time, condition at length (Fig. 16B) might be a better indicator of changes in condition over time. Condition at length appears to have increased in all three length groups over the past five years. As demonstrated by Lilly (1996), much of the annual variability is related to the timing of the surveys. When mean condition in each of three length groups was plotted against the median date of sampling during the survey, there was a gradual decline in condition from the earliest median date (Feb. 7) to approximately mid-April, after which there was an increase. The time course of changes from late April onward is poorly defined because of the paucity of observations. A decline in condition during the winter and early spring was also observed in cod sampled in the inshore from sentinel survey catches in 1995 (Lilly 1996).

Mean liver index-at-age (Table 16; Fig. 19) had a pattern similar to that seen in condition, except that the 1983 values were more clearly at higher levels than other years in the early 1980s and there was a more pronounced peak in the late 1980's and early 1990's. Liver index appears to have increased over the past four years (Fig. 19A, 19B). When the values for specific size groups were plotted against the median date of sampling, there was a pronounced decline in liver index during winter and early spring (Fig. 19C).

Low condition and liver index in recent years (1993-1998) are probably a consequence of sampling near the bottom of the seasonal cycle and are not indicative of a large and persistent decline in well-being. It is noted, however, that the surveys in 1993 to 1998 were conducted at approximately the same time of year, so it is possible that the low condition values in 1993 and 1994 may well reflect anomalously low condition in those years.

13. Maturity-at-age

Age at 50% maturity for females dropped dramatically from a high of 7.2 years during 1988 to a low of 5 during 1994 (Table 17, Fig. 20) with males showing a similar trend over time. An apparent reversal of the declining trend during 1995 and 1996 among females did not continue into 1997. The 1998 estimate of age at 50% maturity is among the lowest in the time series at 4.97 years. Maturities at age have been highly variable over the past 5yrs, but have not shown a continuation of the rapid decline seen during 1988 to 1994. Nonetheless, the early age at maturity has a substantial effect on spawner biomass production by the 3Ps cod stock.

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 to 1999 and 2000, the estimated proportion mature at age was computed in the standard manner for each of the previous four years (1995-1998 inclusive), then the model was again fitted to these estimates (i.e there would be four estimates for each age class) to get new estimates comparable to average maturation for the recent period. These values were used for both 1999 and 2000 (Table 18) in projections of mature spawner biomass.

14. Spawning and abundance of 0 and 1 group cod

Maturities of cod sampled in three sub-areas of NAFO subdivision 3Ps during winter/spring research vessel bottom-trawl surveys from 1983-1998 are shown in Fig. 21. The areas are defined as Burgeo Bank / Hermitage Channel (Strata 306-310 and 714-716), Southern 3Ps / Halibut Channel (all areas south of 45°34.5' N), and mid-3Ps which includes the remainder of the subdivision (excluding inshore strata 293-300 and 779-783). Note that the timing of the survey varied through the time series, with surveys predominantly in April during 1983-84, March during 1985-1987, February from 1988-1992, and April from 1993 to 1998. There were two surveys (February and April) in 1993; only the April one is shown here. The three sub-areas show a consistent pattern of maturity stages across most of the time series, with maturing fish dominating in most years. The switch in timing from February to April clearly results in an increase in the proportions of spawning fish and a reduction or disappearance of fish that are spent from the previous year. When surveys were conducted in April, spawning and spent fish were found in each area; within any one year the proportion of spawning and spent fish tended to vary among sub-areas, but generally about 15-50% of the mature fish sampled were spawning or recently spent. The March 1987 sample from the most southerly area appears anomalous, with an unusually high proportion of spawning fish compared to other areas in 1987 and compared to adjacent years within the same area. The results also show that a substantial portion of the mature cod sampled in the Burgeo area in the April surveys are spawning and by definition belong to the 3Ps stock; most of the remaining adult fish are maturing to spawn later in the same year and their stock affinities remain unclear.

During the 1997 commercial fishery, the proportions of fish in spawning condition were high during May-July in some inshore areas of 3Ps (Kulka et al. 1998). During 1997, cod in the inner reaches of Placentia Bay (Bar Haven area) showed peak spawning in March and early April, but this was delayed to June in 1998 (Lawson and Rose 1999). Based on a time series of samples from four sites in the inner reaches of Placentia Bay during 1998, Bolon and Schneider (1999) concluded that spawning fish were present from March to August with the highest proportions of spawning females present from May to August. This indicates that the spawning period of cod in the inner reaches of Placentia Bay was extremely protracted during 1998. The precise duration and timing of spawning in other areas in 3Ps in recent years is not well known.

Bradbury et al. (1999) investigated the distribution and abundance of cod eggs and larvae in Placentia Bay in 1997 and 1998. Peak densities of stage 1 eggs were highest in April in both years, but larval density was much lower in all of 1997 and highest in August of 1998. Distribution of egg stages coincided with the predicted circulation, with late stage eggs usually occurring on the western side of Placentia Bay.

In summary, cod in 3Ps appear to spawn over a significant portion of the year and at many locations within the stock area, and there appears to be no distinct peak in the spawning time. Spawning is spatially widespread and is known to occur on Burgeo Bank, St. Pierre Bank, and the Halibut Channel area, as well as inshore in Hermitage Bay (3Psa) Fortune Bay (3Psb) and Placentia Bay (3Psc).

Robichaud and Rose (1999) surveyed the distribution and abundance of 0 and 1-group cod in the near-shore environment of Placentia Bay during 1996-1998 and concluded that year-class strengths increased over the three year period. The 1998 year class appeared strongest, with a five-fold increase in catch from 1997 to 1998.

15. Sequential population analysis

Background: In the 1996 assessment of 3PS cod an attempt was made to carry out separate SPA's for the inshore and the offshore components of the stock (Shelton et al. 1996). The basis for following this approach was:

1. the differences in the dynamics of the two components shown by the converged portions of uncalibrated VPA's constructed from the catch data,
2. reports of high catch rates by sentinel fishermen in the inshore, and
3. an acoustic estimate of 23 000 t of cod in Placentia Bay, in comparison to the scarcity of fish observed in recent years in the research bottom trawl survey taking place further offshore.

Based on large coefficients of variation in the estimates and the presence of strong year effects in the residuals, it was concluded that neither the inshore nor the offshore analysis could be used as a basis for determining stock status in 1997. There was no 1997 assessment of this stock.

In the 1998 assessment a number of analyses were carried out using the standard ADAPT framework (Gavaris 1988), and a new quasi-likelihood approach (QLSPA, Cadigan 1998). QLSPA is similar to ADAPT; however, inferences are based on a semi-parametric stochastic model involving only assumptions about the first two central moments of abundance indices (Cadigan 1998). The final model that was considered for the offshore component of the stock in 3PS was QLSPA applied to the offshore catch and calibrated with the Canadian and French research vessel indices. Note that separate catchabilities were used for Canadian surveys in February-March and in April. This model gave an estimate of January 1 1998 spawner biomass of 95 000 t for the offshore component. Risk analysis indicated that for a 12 500 t offshore quota in 1998 the probability of fishing mortality exceeding $F_{0.1}$ was less than 10%. With this quota it was estimated that there was a 50% probability that the offshore component of spawner biomass would not increase from 1998 to 1999.

An SPA was not attempted for the inshore catch data in the 1998 assessment because of the lack of a suitable index for calibration. Alternatively, the biomass estimated from a tagging study in Placentia Bay was extrapolated to the entire inshore area of 3Ps. The extrapolation was based on

gillnet catch rate data reported by fishermen in the new log-book introduced in 1997, and the ratio of the relative area of Placentia Bay to the entire inshore. This gave an estimate of 82 765 t. It was noted that this kind of extrapolation was extremely tenuous, and was adopted as a last resort. An analysis of the relationship between commercial catch rate data and acoustic estimates had not been carried out. Also, the presumably very large uncertainty associated with spatial extrapolations had not been evaluated. It was felt that this approach should be avoided in future assessments if at all possible.

In the present assessment it was decided that separate analyses of inshore and offshore populations were no longer warranted, based on the relative abundance of cod in the offshore during 1998 from industry and research vessel trawl surveys. Evidence from tagging studies also indicated that a significant portion of cod caught in the inshore originated from the offshore.

Model Formulation: Several different SPA model formulations were run and presented at the Regional and Zonal Assessment meetings (Rivard 1999). The SPA model formulation preferred in the 1999 assessment was based on the Canadian survey indices for 1983-98. The cohort model used was

$$N_{a+1\ y+1} = N_{ay}e^{-m} - C_{ay}e^{-m/2}$$

Estimation was based on minimizing the extended quasi-likelihood function (Cadigan 1998). The variance function used was:

$$Var\ (RV\ ) = f_s E(RV\ )^2,\ for\ ages\ \ 2-8,$$
$$Var\ (RV\ ) = f_s\ E(RV\ ),\ \ for\ ages\ \ 9-12.$$

This is a constant CV variance model for the Canadian survey for ages less than 9, and otherwise is a Poisson-type variance model. This variance model was used because it seems unreasonable that the variance is proportional to the square of the mean for small values of the mean, and such small values are mostly found at the older ages (9-12). For a constant CV variance model even tiny differences in model predictions and survey indices, when the predictions are small, are magnified greatly because the variance for a small prediction is much smaller than the prediction. The above variance model gave a much better fit than did either purely constant CV or Poisson variance models.

The stock size parameters estimated by QLSPA were the survivors ($N_{a,1998}$ a=2,…,14*)* and the population numbers at age 14 for 1994-98. Age 14 numbers prior to 1994 were estimated by using a constraint on their fishing mortality (see below). It was felt this constraint could not be used during 1994-96 because of the lack of commercial catch in these years. The catchability of the Canadian surveys appears different in the winter (1985-93) and spring, and were parameterized as:

Q_{i1}, where i = 3 to 12, for the Canadian winter surveys, and
Q_{i2}, where i = 2 to 12 for the Canadian spring surveys.

The precision of the winter and spring surveys also appears to be different, so f was estimated separately for each time period. In addition, separate f's were used for ages < and ≥ 9; hence, 4 f parameters were estimated. This is sometimes referred to as ``self-weighting''.

The following structure was also imposed:
(i) natural mortality was assumed to be 0.2;
(ii) fishing mortality on the oldest age (14) set equal to ½ the average F for ages 11-13;
(iii) no "plus" age class;
(iv) no error in the catch numbers-at-age.
(v) Age 2 survey indices collected with the Engels net (i.e. prior to 1996) were given zero weight in estimation.

Input data were:
1. Catch numbers-at-age for ages 2 to 14 and for 1959-98. Note that catches at age 2 were taken to be zero, which is approximately true.
2. Canadian Research Vessel survey estimates of mean numbers per tow-at-age (Campelen or Campelen equivalent values) for ages 2-12 and 1983-98. Note that to account for mixing in the Burgeo Bank/Hermitage Channel area, these strata were removed from the February-March (winter; 1985-93) RV series.

For estimation and inference the extended quasi-likelihood function was minimized over all years and ages in the survey indices.

Results: The parameter estimates are given in Table 19 and the historical reconstructions of abundance, biomass, spawner biomass, and fishing mortalities are shown in Tables 20-23 and Fig. 22. The $N_{a,1999}$'s, a > 2, are computed using the above cohort model, and $N_{2,1999}$ is computed as the geometric mean of $N_{2,1996:98}$. The relative error in the parameter estimates of abundance in Table 19 usually varied between 30 and 100 % with a high of 133% at age 2. Therefore, the younger age classes currently in the population are estimated with considerable uncertainty and perceptions as to their strength may change with subsequent surveys. The QLSPA suggests that the total 3Ps biomass of 249 000 t in 1999 is near the highest observed since 1959 (i.e. 263 000 t in 1960). The 2+ abundance in 1999 is estimated at 291 million, which is about the average value observed in the 1960's and early 1870's. Spawner biomass is estimated to be 145 000 t in 1999, which is the highest observed since 1959. The peak fishing mortality in 1998 was 0.23, at age 7. Predicted catchabilities are shown in Fig. 23. The survey catchability tends to be higher in the winter than in the spring. During both winter and spring the surveys have dome-shaped catchabilities, which indicates that the older fish are caught less frequently by the survey than are age 7-9 fish. Predicted indices are compared with observed indices in Tables 24a-d and Fig. 24. The scatter of points in Fig. 24 demonstrates the variability that exists in the survey indices compared to the SPA. This is reflected in the large CV's reported in Table 19, and also in the risk analysis we present below.

The results of a deterministic projection of the change in spawner biomass and absolute fishing mortality resulting from a range of potential TAC's in 1999 are presented in Fig. 25. The exploitation rate in this figure is actually the average fishing mortality on ages 7-14. The TAC was partitioned into catch numbers-at-age using the projected weights-at-age presented in Table 7a, and an assumed partial recruitment vector for the 1999 fishery,

Pr = {0 0.004 0.035 0.178 0.765 1 0.748 0.670 0.739 0.391 0.239 0.774 0.061},

for ages 2-14. The projected beginning of year spawner biomass in year 2000 was computed using the projected beginning of year weights-at-age presented in Table 7b. After partitioning the TAC into catch numbers-at-age the projection is achieved using the common cohort model: $N_{a+1\ y+1} = N_{ay}e^{-m} - C_{ay}e^{-m/2}$. The results in Fig. 25 suggest that even for a 1999 TAC of 50 000 t the spawner biomass will continue to grow by almost 10%. $F_{0.1}$ for this stock is 0.433. The value is this large because of the domed shaped partial recruitment vector. At this value of $F_{0.1}$ the average F for ages 7-14 is 0.25; hence, the $F_{0.1}$ catch for 1999 is near 40 000 t.

A risk analysis of the probability of exceeding $F_{0.1}$ in 1999, or equivalently the probability of 1999 average fishing mortality on ages 7-14 exceeding 0.25, is presented in Fig. 26. These results suggest that the TAC resulting in a 10% probability associated with average fishing mortality exceeding 0.25 is approximately 22 000 t. Another risk analysis that was conducted suggested a 9% probability associated with spawner biomass falling below 100,000 t with a catch of 20,000 t in 1999.

Summary

The current population biomass on January 1, 1999 is estimated to be 250,000 t and the spawner biomass is estimated to be 145,000 t . The increase in spawning stock in recent years is due to the growth, maturation and good survival of the 1989 and 1990 year classes over the moratorium period, a strong 1992 year class, as well as the reduction in the age at maturity.

An intensive tagging study in Placentia Bay gave an estimated exploitation rate of about 10% from a 20,000 t commercial fishery in 1998. This exploitation rate is compatible with the 1998 assessment.

Standardized catch rates from the sentinel survey show a substantial decline for line-trawls in 1997 and 1998 and somewhat lower catch rates for gillnets in 1998. Fishermen suggested that this was attributable to competition for fishing sites and the disruption of high density fish aggregations and thus should not necessarily be interpreted as a decrease in stock biomass.

The fall industry survey gave a biomass estimate of only 50% of the 1997 estimate. This is only the second year of this new time-series and, as in the research vessel surveys for this stock, large year affects are anticipated.

Mixing of northern Gulf (3Pn4RS) cod with 3Ps cod in the Burgeo Bank-Hermitage Channel area of 3Ps during winter continues to present problems. This area was closed to directed cod fishing in

the winter of 1998-1999; significant landings from this area during winter could have detrimental effects on the recovery of the neighbouring 3Pn-4RS cod stock.

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Table 1. Cod catches (t) from NAFO Subdivision 3Ps, 1959 -1998 by country and separated for fixed and mobile gear

	Can (N)		Can (M)	France			Spain	Portugal	Others	Total	TAC
	Offshore	Inshore		St. P & M		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	14,929 14,771	-	-	-	-	41,405	35,400
1991	3,916	21,778	2,106	204	15,789 15,585	-	-	-	-	43,589	35,400
1992	4,468	19,025	2,238	2	10,164 10,162	-	-	-	-	35,895	35,400
1993 [1]	1,987	11,878	1,351	-	-	-	-	-	-	15,216	20,000
1994 [1]	82	493	86	-	-	-	-	-	-	661	0
1995 [1]	26	555	60	-	-	-	-	-	-	641	0
1996 [1]	60	707	118							885	0
1997 [1]	122	7,205 [3]	79	448	1,191					9,045	10,000
1998 [1]	4,320	11,370	885	609	2,511					19,694	20,000

[1] Provisional catches

[2] Includes 137 t from food fishery and 251 t from sentinel fishery.

[3] Includes food fishery and sentinel fishery.

Table 2. Reported fixed gear catches of cod (tons) from NAFO Subdivision 3Ps by gear type.

Year	Gillnet	Longline	Handline	Trap	Total
1975	4995	4083	1364	3902	14344
1976	5983	5439	2346	7224	20992
1977	3612	9940	3008	7205	23765
1978	2374	11893	3130	2245	19642
1979	3955	14462	3123	2030	23570
1980	5493	19331	2545	2077	29446
1981	4998	20540	1142	948	27628
1982	6283	13574	1597	1929	23383
1983	6144	12722	2540	3643	25049
1984	7275	9580	2943	3271	23069
1985	7086	10596	1832	5674	25188
1986	8668	11014	1634	4073	25389
1987	9304	11807	1628	4931	27670
1988	6433	10175	1469	2449	20526
1989	5997	10758	1657	5996	24408
1990	6948	8792	2217	3788	21745
1991	6791	10304	1832	4068	22995
1992	5314	10315	1330	3397	20356
1993	3975	3783	1204	3557	12519
1994	90	0	381	0	471
1995	383	182	0	5	570
1996	467	158	137	10	772
1997	3760	1158	1172	1167	7258
1998	10116	2914	308	92	13430

Table 3. Canadian catch of cod (tons) by gear, unit area, and month during 1998 in NAFO Subdivision 3Ps (ot=otter trawl, ds=danish seine gn=gill net, hl=hand-line, lt=line trawl, tr=cod trap, mwt=mid-water trawl).

3Psa*

	ot	mwt	ds	gn	lt	hl	tr	total
Jan	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.17
Feb	0.00	0.72	0.00	0.00	0.10	0.00	0.00	0.81
Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr	0.10	0.00	0.00	6.36	0.00	0.00	0.00	6.46
May	0.17	0.00	0.05	2.32	1.36	0.01	0.00	3.90
Jun	0.00	0.00	0.00	5.49	10.73	3.49	0.00	19.71
Jul	1.00	0.00	0.45	172.07	84.30	0.30	0.03	258.14
Aug	1.63	0.00	0.17	35.69	17.57	46.39	0.00	101.44
Sep	0.03	0.00	0.05	201.95	449.99	3.78	0.00	655.79
Oct	3.96	0.00	0.53	0.00	1.69	0.00	0.00	6.18
Nov	6.97	0.00	1.13	174.55	420.65	0.54	0.00	603.83
Dec	28.65	0.00	0.00	14.02	0.00	0.00	0.00	42.67
tot	42.52	0.72	2.38	612.43	986.55	54.50	0.03	1699.12

3Psb*

	ot	ds	gn	lt	hl	tr	total
Jan	0.00	0.00	0.00	4.08	0.00	0.00	4.08
Feb	0.00	0.00	0.00	2.23	0.00	0.00	2.23
Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apr	0.00	0.00	64.24	0.00	0.00	0.00	64.24
May	0.00	0.03	4.43	5.50	0.55	0.00	10.51
Jun	0.00	0.00	44.56	19.27	2.16	1.42	67.41
Jul	0.00	0.00	1007.30	64.16	3.85	10.73	1086.04
Aug	0.00	0.00	18.60	21.35	46.29	0.00	86.24
Sep	0.00	1.05	303.74	402.40	6.17	0.00	713.36
Oct	0.00	0.14	1.99	0.31	0.00	0.00	2.44
Nov	0.00	0.00	238.24	442.74	24.57	0.00	705.55
Dec	0.00	0.00	0.00	5.42	0.00	0.00	5.42
tot	0.00	1.22	1683.09	967.45	83.59	12.15	2747.51

3Psc*

	ot	ds	gn	lt	hl	tr	total
Jan	0.00	0.00	17.04	0.00	0.00	0.00	17.04
Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar	5.98	0.00	2.32	0.00	0.00	0.00	8.29
Apr	0.07	0.00	0.27	0.00	0.00	0.00	0.34
May	0.00	0.00	9.04	0.00	0.00	0.00	9.04
Jun	0.00	0.00	36.68	1.63	0.00	0.94	39.25
Jul	0.77	0.17	2026.80	105.87	10.70	75.13	2219.44
Aug	0.76	0.00	405.00	43.57	108.05	3.73	561.10
Sep	70.75	0.00	667.43	337.80	23.46	0.00	1099.44
Oct	34.13	0.00	1240.55	287.15	9.61	0.00	1571.44
Nov	0.00	0.00	1165.52	95.03	17.87	0.00	1278.41
Dec	0.00	0.00	179.65	6.97	0.37	0.00	186.99
tot	112.45	0.17	5750.30	878.02	170.06	79.80	6990.80

3Psd

	ot	mwt	gn	lt	total
Jan	5.71	0.01	0.00	0.00	5.72
Feb	6.68	17.84	0.00	0.00	24.52
Mar	0.00	0.20	0.00	0.00	0.20
Apr	11.51	0.82	0.17	0.00	12.50
May	2.11	0.00	0.00	0.00	2.11
Jun	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	220.78	0.00	220.78
Aug	0.00	0.00	43.29	0.00	43.29
Sep	0.00	0.00	409.78	17.03	426.81
Oct	0.54	0.00	0.00	0.00	0.54
Nov	6.45	0.00	183.95	0.87	191.28
Dec	18.71	0.00	0.00	0.00	18.71
tot	51.71	18.86	857.97	17.91	946.45

3Pse

	ot	ds	gn	lt	total
Jan	0.00	0.00	0.00	0.00	0.00
Feb	0.00	0.00	0.00	0.00	0.00
Mar	0.03	0.00	0.00	0.00	0.03
Apr	0.00	0.00	0.17	0.00	0.17
May	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.02	0.00	0.02
Aug	0.00	0.00	0.03	0.00	0.03
Sep	0.00	0.00	86.97	34.48	121.46
Oct	4.74	1.03	5.23	0.07	11.06
Nov	43.56	0.00	28.18	0.00	71.73
Dec	0.56	0.00	0.00	0.00	0.56
tot	48.88	1.03	120.60	34.548	205.06

3Psf

	ot	mwt	ds	gn	ll	total
Jan	0.00	0.00	0.00	0.00	0.00	0.00
Feb	0.00	0.25	0.00	0.00	0.00	0.25
Mar	0.00	0.47	0.00	0.00	0.00	0.47
Apr	0.00	0.29	0.00	0.00	0.00	0.29
May	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.00	0.00	0.00	0.00	0.00
Aug	0.00	0.00	0.00	0.00	0.58	0.58
Sep	57.64	0.00	0.00	177.35	8.57	243.57
Oct	315.26	0.00	63.17	75.05	20.15	473.63
Nov	30.97	0.00	0.00	99.73	0.00	130.71
Dec	0.42	0.00	0.00	14.10	0.00	14.52
tot	404.30	1.01	63.17	366.23	29.30	864.01

3Psg

	ot	mwt	gn	total
Jan	0.00	0.01	2.18	2.19
Feb	0.00	1.89	0.00	1.89
Mar	3.08	0.56	0.00	3.64
Apr	9.36	0.01	0.38	9.75
May	1.47	0.00	11.20	12.68
Jun	0.00	0.00	0.00	0.00
Jul	0.00	0.00	59.11	59.11
Aug	56.34	0.00	2.87	59.20
Sep	0.43	0.00	44.57	44.99
Oct	1.37	0.00	44.11	45.48
Nov	2.62	0.00	64.44	67.06
Dec	0.19	0.00	0.14	0.33
tot	74.85	2.47	229.00	306.31

3Psh

	ot	mwt	gn	total
Jan	0.00	0.00	5.61	5.61
Feb	0.00	0.90	2.21	3.11
Mar	66.05	0.00	6.57	72.62
Apr	143.22	0.00	2.06	145.29
May	2.98	0.00	44.93	47.91
Jun	0.00	0.00	1.57	1.57
Jul	4.29	0.00	8.22	12.51
Aug	0.00	0.00	46.29	46.29
Sep	121.69	0.00	259.12	380.81
Oct	493.22	0.00	32.10	525.32
Nov	1180.17	0.00	36.72	1216.90
Dec	299.63	0.00	51.05	350.68
tot	2311.27	0.90	496.43	2808.60

* includes sentinel survey and foodfishery catch.

Table 4. Numbers of cod sampled for age and used to estimate the 3Ps commercial catch-at-age during 1998.

NUMBERS AGED - ALL SOURCES COMBINED

GEAR	QT1	QT2	QT3	QT4	TOTAL
OT	446	113	304	1321	2184
TRAP			166		166
GN	49	580	2212	1709	4550
LT	129		802	1211	2142
HL			607	229	836
PS				46	46
MWT	238				238
GN/OFF			462	554	1016
LT/OF		43			43
OT<65		184		175	359
TOTAL	862	920	4553	5245	11580

3PSA

GEAR	QT1	QT2	QT3	QT4	TOTAL
OT				30	30
GN		165	251	429	845
LT	76		378	445	899
HL			111		111
TOTAL	76	165	740	904	1885

3PSB

GEAR	QT1	QT2	QT3	QT4	TOTAL
GN			501	151	652
LT	53		424	378	855
HL			180	128	308
TOTAL	53	0	1105	657	1815

3PSC

GEAR	QT1	QT2	QT3	QT4	TOTAL
TRAP			166		166
GN	49	415	1432	977	2873
LT				388	388
HL			316	101	417
TOTAL	49	415	1914	1466	3844

3PSD

GEAR	QT1	QT2	QT3	QT4	TOTAL
OT			304	266	570
MWT	238				238
OT<65		49			49
GN/OFF			410	336	746
TOTAL	238	49	714	602	1603

3PSF

GEAR	QT1	QT2	QT3	QT4	TOTAL
OT				28	28
GN/OFF			80	191	
TOTAL	0	0	80	219	299

3PSG

GEAR	QT1	QT2	QT3	QT4	TOTAL
OT<65		55			55
GN/OFF				130	130
TOTAL	0	55	0	130	185

3PSH

GEAR	QT1	QT2	QT3	QT4	TOTAL
OT	446	113		775	1334
LT/OFF		43			43
OT<65		80		175	255
GN/OFF				49	49
TOTAL	446	236	0	999	1681

Table 5. Numbers of cod measured for length and used to estimate the 3Ps commercial catch-at-age during 1998,

TOTAL NUMBERS MEASURED - ALL MONTHS AND UNIT AREAS COMBINED

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OT	101	86	1893	1320			1620		1778	7442	4803	1758	20801
TRAP						537	2585						3122
GN	4833		57	262		11282	18923	4259	6858	4364	13183		64021
LT	1940	945				2924	2895	5483	5668	7883	10073		37811
HL							275	3405	319	104	106		4209
SS										207			207
MWT		879	134										1013
LL/GN											209		209
64										6			6
GN/OFF							506		124				630
TOTAL	6874	1910	2084	1582	0	14743	26804	13147	14747	20006	28374	1758	132029

* the total number measured by unit area is less as some freq had unit area missing.

3PSA

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
GN				262			503		778		987		2530
LT	102	55				2592	2355	4140	2536	1332	4447		17559
HL								1121					1121
LL/GN											209		209
TOTAL	102	55	0	262	0	2592	2858	5261	3314	1332	5643	0	21419

3PSB

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
GN			57			1085	6913	47		509	312		8923
LT	1838	890				332	540	1343	1329	180	5391		11843
HL								1006	186		106		1298
TOTAL	1838	890	57	0	0	1417	7453	2396	1515	689	5809	0	22064

3PSC

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
TRAP						537	2585						3122
GN	4833					10197	11345	2510	1923	3644	9893		44345
LL									1803	6371	235		8409
HL							275	1133	133	104			1645
TOTAL	4833	0	0	0	0	10734	14205	3643	3859	10119	10128	0	57521

3PSD

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OT	101	63		344									508
GN								1702	2288	211	1176		5377
HL								145					145
MWT		879											879
GN/OFF							506		124				630
TOTAL	101	942	0	344	0	0	506	1847	2412	211	1176	0	7539

3PSE

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
GN									182				182
TOTAL	0	0	0	0	0	0	0	0	182	0	0	0	182

3PSF

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OT							1620		1778	2880	86		6364
GN									620		226		846
64										5			5
TOTAL	0	0	0	0	0	0	1620	0	2398	2885	312	0	7215

3PSG

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OT		23	171	144									338
GN							162				589		751
MWT			134										134
TOTAL	0	23	305	144	0	0	162	0	0	0	589	0	1223

3PSH

GEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
OT			1722	832						3817	4717	1758	12846
GN									1067				1067
TOTAL	0	0	1722	832	0	0	0	0	1067	3817	4717	1758	13913

Table 6. Estimated average weight (kg), length (cm) and numbers-at-age (000's) by gear type for landings from the commercial cod fishery in 3Ps during 1998

ALL GEARS COMBINED

	AVERAGE		CATCH		
	WEIGHT	LENGTH	NUMBER		CV
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	
1	0	0	0	0	.
2	0.31	33.33	0.47	0.29	0.62
3	0.62	41.29	90.70	6.92	0.08
4	1.02	48.40	329.47	16.36	0.05
5	1.57	55.67	678.89	24.60	0.04
6	2.05	60.88	1417.38	32.63	0.02
7	2.42	64.11	826.03	27.34	0.03
8	3.10	69.17	1092.31	27.88	0.03
9	4.04	75.08	1066.72	24.18	0.02
10	4.13	75.45	214.75	12.73	0.06
11	4.62	78.33	118.96	8.30	0.07
12	5.21	81.04	56.18	5.62	0.10
13	6.39	87.41	15.35	2.18	0.14
14	9.69	100.21	1.39	0.36	0.26
15	6.99	89.73	1.31	0.73	0.56
16	9.02	94.44	0.75	0.42	0.56
17	14.57	115.77	0.42	0.05	0.11
18	0	0	0	0	.
19	0	0	0	0	.

Hand line

	AVERAGE		CATCH		
	WEIGHT	LENGTH	NUMBER		CV
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	
1	0	0	0	0	.
2	0	0	0	0	.
3	0.68	42.71	2.94	0.61	0.21
4	1.00	48.25	18.75	1.71	0.09
5	1.33	52.98	43.94	2.78	0.06
6	1.72	57.54	50.06	2.91	0.06
7	1.98	60.16	27.26	2.30	0.08
8	2.70	66.02	11.62	1.44	0.12
9	3.37	70.89	14.05	1.31	0.09
10	4.01	74.89	2.50	0.61	0.25
11	4.37	77.50	0.92	0.34	0.37
12	4.46	79.00	0.04	0.04	1.06
13	0.00	0.00	0.00	0.00	0.00
14	5.00	82.00	0.13	0.13	1.01
15	0	0	0	0	.
16	0	0	0	0	.
17	0	0	0	0	.
18	0	0	0	0	.
19	0	0	0	0	.

Otter trawl

	AVERAGE		CATCH		
	WEIGHT	LENGTH	NUMBER		CV
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	
1	0	0	0	0	.
2	0	0	0	0	.
3	0.60	40.97	0.14	0.00	0.00
4	1.31	52.61	19.75	1.32	0.07
5	2.19	62.31	93.78	5.43	0.06
6	2.50	65.12	69.67	5.87	0.08
7	3.15	70.05	51.41	5.80	0.11
8	3.76	74.02	225.47	10.14	0.04
9	4.81	80.13	289.58	9.83	0.03
10	5.31	81.97	23.32	3.05	0.13
11	5.36	82.55	8.12	1.85	0.23
12	6.85	89.84	5.76	1.19	0.21
13	7.26	91.76	1.50	0.62	0.42
14	6.99	90.78	0.12	0.06	
15	10.09	102.42	0.39	0.17	0.42
16	15.91	119.00	0.04	0.02	0.41
17	14.21	115.00	0.00	0.00	.
18	0	0	0	0	.
19	0	0	0	0	.

Gill net

	AVERAGE		CATCH		
	WEIGHT	LENGTH	NUMBER		CV
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	
1	0	0	0	0	.
2	0	0	0	0	.
3	0.53	38.94	2.61	0.46	0.18
4	1.23	51.36	26.71	3.12	0.12
5	1.81	58.44	178.13	10.54	0.06
6	2.19	62.33	963.38	24.37	0.03
7	2.50	64.95	612.17	22.50	0.04
8	3.07	69.06	697.00	22.64	0.03
9	3.90	74.21	625.44	19.83	0.03
10	4.12	75.64	150.93	11.00	0.07
11	4.62	78.42	88.62	7.33	0.08
12	5.33	81.92	35.62	4.39	0.12
13	6.25	86.66	11.59	2.02	0.17
14	11.04	105.84	0.31	0.13	0.42
15	4.48	79.13	0.69	0.67	0.98
16	5.00	82.00	0.55	0.42	0.77
17	0	0	0	0	.
18	0	0	0	0	.
19	0	0	0	0	.

Line trawl

	AVERAGE		CATCH		
	WEIGHT	LENGTH	NUMBER		CV
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	
1	0	0	0	0	.
2	0.31	33.33	0.47	0.29	0.62
3	0.62	41.31	84.61	6.88	0.08
4	0.98	47.81	255.75	15.88	0.06
5	1.33	52.94	351.22	21.31	0.06
6	1.60	56.23	310.81	20.60	0.07
7	1.86	58.80	130.06	14.18	0.11
8	2.31	62.94	156.01	12.62	0.08
9	3.13	68.82	136.74	9.65	0.07
10	3.45	70.62	37.77	5.59	0.15
11	4.34	76.42	21.29	3.40	0.16
12	4.27	75.49	14.76	3.31	0.22
13	6.49	88.27	2.22	0.52	0.23
14	10.31	102.32	0.83	0.30	0.37
15	9.23	100.00	0.23	0.24	1.07
16	20.75	130.00	0.16	0.00	0.01
17	14.61	115.86	0.38	0.00	0.01
18	0	0	0	0	.
19	0	0	0	0	.

Trap

	AVERAGE		CATCH		
	WEIGHT	LENGTH	NUMBER		CV
AGE	(kg.)	(cm.)	(000'S)	STD ERR.	
1	0	0	0	0	.
2	0	0	0	0	.
3	0.71	43.29	0.40	0.21	0.53
4	0.95	47.50	8.50	1.10	0.13
5	1.28	52.37	11.83	1.60	0.14
6	1.75	57.97	23.46	1.78	0.08
7	1.92	59.67	5.12	1.12	0.22
8	2.64	66.26	2.21	0.60	0.27
9	3.84	75.07	0.92	0.23	0.25
10	5.99	86.07	0.23	0.02	0.09
11	0.00	0.00	0.00	0.00	0.00
12	10.14	103.00	0.00	0.00	0.00
13	7.23	92.39	0.04	0.02	0.50
14	0	0	0	0	.
15	0	0	0	0	.
16	0	0	0	0	.
17	0	0	0	0	.
18	0	0	0	0	.
19	0	0	0	0	.

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 Subdividion 3Ps in 1950-1998. The weights-at-age from 1976 are extrapolated back to 1959. The 1998 data are extrapolated to 1999.

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

Table.7B. Beginning of the year weights-at-age calculated from commercial mean annual weights-at-age, as described in Lilly (MS 1998). The 1999 data are extrapolated to 2000

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1960	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1961	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1962	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1963	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1964	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1965	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1966	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1967	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1968	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1969	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1970	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1971	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1972	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1973	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1974	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1975	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1976	0.18	0.44	0.86	1.35	2.01	2.78	3.63	4.56	5.53	6.50	7.51	8.59
1977	0.49	0.44	0.95	1.42	2.12	2.86	3.67	4.50	5.48	6.38	7.84	9.37
1978	0.37	0.62	0.86	1.51	2.13	2.83	3.74	4.65	5.05	6.53	7.24	8.75
1979	0.31	0.54	0.84	1.33	2.11	3.00	3.59	5.16	6.01	6.51	8.28	9.17
1980	0.42	0.54	0.86	1.29	2.02	3.03	4.46	5.47	6.88	7.78	8.75	9.55
1981	0.38	0.64	0.97	1.43	1.95	2.85	3.96	5.54	7.18	8.12	8.51	9.44
1982	0.33	0.61	0.96	1.53	2.06	2.57	3.58	4.80	5.92	7.99	8.84	9.78
1983	0.43	0.61	1.01	1.53	2.14	2.77	3.30	4.44	5.89	7.23	9.31	10.11
1984	0.58	0.78	1.08	1.62	2.29	3.12	3.94	4.58	5.50	7.70	9.73	10.23
1985	0.58	0.75	1.13	1.58	2.35	3.01	4.35	5.34	5.83	6.57	9.42	10.83
1986	0.45	0.69	1.00	1.50	2.09	2.98	3.85	5.25	6.10	7.30	7.60	10.81
1987	0.46	0.64	0.95	1.39	2.06	2.71	3.69	4.69	5.84	6.57	7.86	8.19
1988	0.56	0.68	0.92	1.42	1.88	2.60	3.29	4.64	5.35	6.40	7.22	7.95
1989	0.54	0.71	0.98	1.33	1.94	2.70	3.46	4.31	5.60	6.40	7.15	8.07
1990	0.51	0.74	1.01	1.46	2.00	2.60	3.77	4.57	5.74	6.91	7.79	8.96
1991	0.56	0.66	1.00	1.49	2.09	2.67	3.33	4.22	5.68	6.98	8.10	8.99
1992	0.38	0.65	0.88	1.35	1.97	2.62	3.47	4.52	5.21	7.04	8.94	10.13
1993	0.23	0.56	0.86	1.24	1.82	2.51	3.54	4.22	5.09	6.94	7.32	9.25
1994	0.53	0.54	0.94	1.42	1.74	2.42	3.19	4.36	5.20	6.03	7.13	7.43
1995	0.38	0.72	1.13	1.63	2.14	2.39	3.08	3.93	4.32	5.12	6.59	7.88
1996	0.58	0.72	1.12	1.79	2.26	2.70	3.00	3.73	4.55	4.47	5.49	7.45
1997	0.48	0.78	1.13	1.67	2.27	2.86	3.20	3.37	4.30	5.54	6.34	8.83
1998	0.49	0.79	1.19	1.64	2.13	2.79	3.62	3.79	4.03	4.89	6.38	9.12
1999	0.49	0.80	1.27	1.80	2.23	2.74	3.54	4.09	4.37	4.90	5.77	7.87
2000	0.49	0.80	1.27	1.80	2.23	2.74	3.54	4.09	4.37	4.90	5.77	7.87

Table 8. Catch numbers-at-age (000's) for the 3Ps cod fishery from 1959-1998. The 1998 catch includes sentinel and French catches.

	Age											
YEAR	3	4	5	6	7	8	9	10	11	12	13	14
1959	1001	13940	7525	7265	4875	942	1252	1260	631	545	44	0
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

Table 9. Analysis of sentinel catch rate data for 1995 to 1998. Year-by-year comparison carried out using a two-tailed Kruskal-Wallis test to determine significant differences in catch rates. Cell entries have form a (b) / c where c =total number of sentinel sites reporting catch for the two years being compared; a = number of sentinel sites which have a significantly different sentinel catch rate for the two years being compared; and b = number of sentinel sites at which the significant change represents an increase in catch rates (i.e. column year greater than row year).

NAFO Div. 3Ps – Gillnet

	1995	1996	1997	1998
1995	---	6 (6) / 6	6 (6) / 7	6 (6) / 7
1996		---	3 (3) / 8	4 (1) / 8
1997			---	5 (1) / 9
1998				---

NAFO Div. 3Ps – Line-trawl

	1995	1996	1997	1998
1995	---	7 (7) / 8	5 (5) / 8	5 (5) / 8
1996		---	4 (0) / 9	7 (1) / 9
1997			---	1 (0) / 9
1998				---

Table 10A. Standardized catch rate (number per net) for gillnets in the sentinel survey in NAFO Subdiv. 3Ps in 1995-1998. Results of the GLM model in which year month and trip (= sentinel enterprise) effcets were fitted to the log transformed mean catch rates; i.e. ln(sum of catch/sum of effort)=year month trip.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	4	1995 1996 1997 1998
MONTH	5	7 8 9 10 11
TRIP	9	1 5 6 8 10 12 30 34 82

Dependent Variable: LN_MEAN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	15	50.01372312	3.33424821	6.41	0.0001
Error	57	29.63393092	0.51989352		
Corrected Total	72	79.64765404			

R-Square	C.V.	Root MSE	LN_MEAN Mean
0.627937	23.15348	0.72103642	3.11416053

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	3	7.51861660	2.50620553	4.82	0.0046
MONTH	4	7.68223671	1.92055918	3.69	0.0096
TRIP	8	13.21511059	1.65188882	3.18	0.0048

YEAR	LN_MEAN LSMEAN	Std Err LSMEAN	Pr > |T| HO:LSMEAN=0
1995	3.15896665	0.18894869	0.0001
1996	3.29270625	0.17998625	0.0001
1997	3.42153379	0.19467036	0.0001
1998	2.52329559	0.17739322	0.0001

Table 10B. Standardized catch rate (number per 1000 hooks) for line-trawl in the sentinel survey in NAFO Subdiv. 3Ps in 1995-1998. Results of the GLM model in which year month and trip (= sentinel enterprise) effcets were fitted to the log transformed mean catch rates; i.e. ln(sum of catch/sum of effort)=year month trip.

General Linear Models Procedure
Class Level Information

Class	Levels	Values
YEAR	4	1995 1996 1997 1998
MONTH	4	8 9 10 11
TRIP	12	2 3 4 7 9 11 12 30 34 47 82 83

General Linear Models Procedure

Dependent Variable: LN_MEAN

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	15.18073603	0.89298447	5.39	0.0001
Error	67	11.10018547	0.16567441		
Corrected Total	84	26.28092150			

R-Square	C.V.	Root MSE	LN_MEAN Mean
0.577633	-24.43525	0.40703121	-1.66575418

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	3	5.04840863	1.68280288	10.16	0.0001
MONTH	3	1.41265657	0.47088552	2.84	0.0443
TRIP	11	10.56913521	0.96083047	5.80	0.0001

YEAR	LN_MEAN LSMEAN	Std Err LSMEAN	Pr > |T| HO:LSMEAN=0
1995	-1.49881946	0.09596122	0.0001
1996	-1.57117975	0.08568192	0.0001
1997	-2.05652262	0.11268709	0.0001
1998	-2.10024876	0.12932389	0.0001

Table 11A. Cod abundance estimates (thousands of fish) from research vessel surveys in NAFO Division 3Ps . Shaded cells are model estimates.

Depth range (fathoms)	Strata		Vessel Trips / Sets / Mean Da / sq. mi.	AN 9 30-Apr 1983	AN 26 13-Apr 1984	WT 26 13-Mar 1985	WT 45 15-Mar 1986	WT 55+56 7-Mar 1987	WT 68 5-Feb 1988	WT 81 9-Feb 1989	WT 91 9-Feb 1990	WT 103 10-Feb 1991	WT 118 14-Feb 1992	WT 133 13-Feb 1993	WT 135 11-Apr 1993	WT 150-151 15-Apr 1994	WT 166-167 16-Apr 1995	WT 186-187 22-Apr 1996	WT 202-203 12-Apr 1997	WT 219-220 21-Apr 1998
<30	314		974	2527	134	96	0	0	211	30	45	0	0	0	0	74	0	0	77	57
	320		1320	3424	3473	1089	262	248	363	853	0	620	20	0	0	0	0	545	303	1292
31-50	293	5	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	107	292
	308		112	627	801	1741	0	169	247	15	77	31	62	39	308	701	223	177	262	4175
	312		272	6086	374	8026	56	318	580	62	0	56	0	37	0	0	87	37	19	100
	315		827	1536	1183	1983	2920	483	190	228	57	439	33	0	0	0	0	1387	38	5721
	321		1189	2355	954	210	82	867	238	36	102	535	0	0	20	0	0	345	18	49
	325		944	666	312	0	81	152	43	146	130	1068	455	14	0	0	0	103	108	16
	326		166	99	0	50	0	69	80	0	34	69	0	46	0	0	194	11	0	11
	783	1	229	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf	nf	47	16
51-100	294	5	135	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	176	901
	297	5	152	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	408	209
	307		395	1943	380	4347	15450	3586	8803	5524	2717	797	869	353	2826	12769	1087	1645	1123	23490
	311		317	7907	1090	14968	3183	16905	17236	1599	2369	1134	218	145	392	2562	116	654	371	1652
	317		193	8266	27	8190	4898	3487	2695	2363	226	1978	531	0	159	0	465	1195	451	173
	319		984	16321	4828	338	9526	25403	17258	5888	8144	25764	2883	647	3023	150	575	11477	1889	15600
	322		1567	8936	2694	10297	11946	9140	5030	7760	3745	5758	81	0	0	431	0	554	234	260
	323		696	3606	3878	6830	8866	10627	4040	2134	120	2011	16	0	0	0	0	82	24	32
	324		494	8885	7203	38157	720	1087	2395	0	353	2633	163	0	0	544	85	91	272	160
	781	1	446	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	307	280	195	276
	782	1	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	302	0	nf	63	38
101-150	295	5	209	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	168	465
	298	5	171	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	110	1861
	300	5	217	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	584	1579
	306		363	2110	75	574	1971	3845	2422	1265	8273	982	1116	389	2659	1273	350	1106	816	771
	309		296	937	122	2484	4622	2443	3461	1771	3766	3122	244	95	1853	244	421	8190	260	11980
	310		170	133	94	203	351	304	896	6443	3414	13423	175	82	748	405	386	421	1380	105
	313		165	68	23	238	0	409	136	2054	908	6866	2962	11	238	68	1124	182	0	454
	316		189	240	117	78	26	78	87	1586	20669	3081	104		147	182	182	26	65	104
	318		129	6	0	974	27	710	18	4924	946	8855	5900	5051	2103	0	95656	630	1881	53
	779	1	422	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	248	0	0	0	39
	780	1	403	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	0	nf	35	18
151-200	296	5	71	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	632	4
	299	5	212	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	643	49
	705		195	9	0	563	791	255	644	94	107	134	161	80	939	528	1113	418	241	376
	706		476	13	0	1097	557	9835	851	49	98	49	445	109	327	327	442	393	172	327
	707		74	3	0	836	560	753	1919	122	657	2682	1323	1817	494	219	448	2912	353	102
	715		128	158	44	3216	1638	643	3724	167	2509	20768	2386	309	1748	2249	414	4117	516	5874
	716		539	167	25	371	7656	2768	3470	704	593	1216	3979	463	204	519	578	1764	91	3089
201-300	708		126	0	0	2119	451	14317	14490	113	1410	537	1300	813	1621	15842	2808	208	388	1464
	711		593	20	0	33	8227	392	387	218	544	9395	503	176	0	41	20	77	44	16
	712		731	0	117	620	419	67	536	141	1931	1730	716	1098	302	369	322	101	60	201
	713		851	33	286	117	117	1463	368	843	20233	6951	1806	2819	234	1405	893	652	901	61
	714		1074	43	980	6701	835	396	905	4753	20966	32838	15431	12120	1440	2428	2996	750	2765	485
301-400	709	2	147	0	0	0	0	nf	30	10	nf	40	nf	4556	1087	nf	101	0	nf	0
401-500	710	1	156	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	32	nf	nf	nf	nf
501-600	776	1	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	777	1	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	778	1	166	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	Total	3		77,124	29,213	116,546	86,238	111,219	93,723	51,885	104,745	155,522	43,882	26,713	21,785	43,330	110,985	40,250	15,122	78,250
	Total	4		77,124	29,213	116,546	86,238	111,219	93,753	51,895	104,745	155,562	43,882	31,269	22,872	43,912	111,393	40,530	18,290	83,997
	std	3		14,180	7,515	39,466	17,801	23,767	18,831	8,746	26,286	33,139	8,487	7,273	3,377	10,464	95,558	9,771	2,703	27,857

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

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

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

[4] totals are for all strata fished .

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

Table 11B. Cod biomass estimates (t) from research vessel surveys in NAFO Subdiv. 3Ps. Shaded cells are model estimates.

Depth range (fathoms)	Strata		Vessel Trips	AN 9	AN 26	WT 26	WT 45	WT 55+56	WT 68	WT 81	WT 91	WT 103	WT 118	WT 133	WT 135	WT 150-151	WT 166-167	WT 186-187	WT 202-203	WT 219-220
			Sets	164	93	109	136	130	146	146	108	158	137	136	130	166	161	148	158	176
			Mean Dat	30-Apr	13-Apr	13-Mar	15-Mar	7-Mar	5-Feb	9-Feb	9-Feb	10-Feb	14-Feb	13-Feb	11-Apr	15-Apr	16-Apr	22-Apr	12-Apr	21-Apr
			sq. mi.	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1993	1994	1995	1996	1997	1998
<30	314		974	15936	733	59	0	0	104	20	240	0	0	0	0	212	0	0	32	8
	320		1320	8914	8700	6971	464	700	2299	1883	0	267	52	0	0	0	0	155	114	7766
31-50	293	5	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	17	19
	308		112	1371	1157	1809	0	27	17	8	18	10	18	8	96	235	41	35	93	1461
	312		272	1179	1080	3691	110	102	25	14	0	23	0	28	0	0	13	4	13	8
	315		827	4143	2686	661	4606	1211	1992	2453	129	614	38	0	0	0	0	869	14	20072
	321		1189	4121	1941	173	516	410	2201	506	24	146	0	0	37	0	0	8	2	0
	325		944	671	915	0	68	255	53	36	84	246	42	194	0	0	0	173	10	0
	326		166	497	0	83	0	36	59	0	14	45	0	13	0	0	14	0	0	0
	783	1	229	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf	nf	0	0
51-100	294	5	135	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	24	40
	297	5	152	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	39	22
	307		395	2017	1441	8454	19930	4938	21706	6118	1033	171	126	70	1677	8984	250	633	332	16164
	311		317	5706	1711	10086	703	8576	2484	755	265	112	25	15	100	593	35	64	51	169
	317		193	7095	62	15799	3571	1867	352	496	18	756	73	0	244	0	40	73	62	196
	319		984	6983	6989	1861	16211	18530	23773	14172	2702	2436	382	82	507	32	208	12785	287	28144
	322		1567	9141	3904	2597	4571	3226	875	492	347	426	32	0	0	38	0	177	118	13
	323		696	1730	3935	2862	5790	21015	514	562	28	160	41	0	0	0	0	89	15	112
	324		494	1790	787	24660	521	384	455	0	38	217	33	0	0	7	18	3	11	8
	781	1	446	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	113	40	22	16
	782	1	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	8	0	nf	2	7
101-150	295	5	209	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	24	139
	298	5	171	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	42	2608
	300	5	217	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	147	802
	306		363	2167	448	974	2479	3315	4713	605	2786	149	464	114	1820	950	191	194	312	618
	309		296	1690	292	3305	5739	4513	5255	3154	3062	1166	50	15	2021	359	272	4922	87	9788
	310		170	283	209	503	604	383	862	812	938	880	40	13	378	374	228	124	206	72
	313		165	158	242	481	0	563	155	1390	305	472	280	12	152	43	1279	259	0	481
	316		189	492	262	151	113	144	59	3838	13956	294	43		144	270	42	38	40	138
	318		129	25	0	2436	146	1359	196	17756	668	2339	1600	1709	1616	0	129689	1075	404	88
	779	1	422	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	16	0	0	0	10
	780	1	403	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	0	nf	3	1
151-200	296	5	71	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	175	1
	299	5	212	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	282	231
	705		195	55	0	904	1063	273	1053	52	235	16	67	47	1143	652	1927	663	476	345
	706		476	72	0	3010	907	15334	1927	189	153	182	435	76	251	277	385	575	379	266
	707		74	11	0	1672	2779	1821	6883	411	459	1365	767	914	648	24	591	5408	72	121
	715		128	589	99	6482	2738	1315	7420	345	1061	17037	1928	347	1743	2802	575	3807	233	6849
	716		539	311	24	710	7731	3291	4722	779	1112	386	952	64	226	676	777	1457	44	1772
201-300	708		126	0	0	4446	690	18385	42342	123	1220	1072	2419	368	1081	10036	5511	247	629	4389
	711		593	26	0	62	10625	569	841	745	496	23174	360	290	0	30	27	82	43	11
	712		731	0	410	1267	644	262	1042	207	1419	1523	1020	1305	243	819	372	118	151	267
	713		851	61	1023	154	544	2469	567	1096	30722	6295	2025	3263	374	1700	1545	1481	1101	48
	714		1074	265	3788	16731	2748	473	1476	7310	30866	32946	18902	12987	1739	2528	4161	924	3471	725
301-400	709	2	147	0	0	0	0	nf	118	52	nf	27	nf	2457	736	nf	121	0	nf	0
401-500	710	1	156	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	19	nf	nf	nf	nf
501-600	776	1	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	777	1	183	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	778	1	166	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	Total	3		77,499	42,838	123,054	96,611	115,746	136,422	66,327	94,398	94,925	32,214	21,934	16,240	31,641	148,191	36,442	8,802	100,100
	Total	4		77,499	42,838	123,054	96,611	115,746	136,540	66,379	94,398	94,952	32,214	24,391	16,976	31,684	148,425	36,482	9,579	103,996
	std	3		15,678	3,599	24,492	19,608	28,630	42,762	15,259	32,943	33,403	5,909	170	2,622	8,168	129,320	8,143	2,284	27,612

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

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

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

[4] totals are for all strata fished .

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

Table 12. Mean number per tow at age adjusted for missing strata for cod in Subdiv. 3Ps for the years 1983-1998. All means are for Campelen or Campelen equivalent data. Note that there were two surveys in 1993.

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993 (January)	1993 (April)	1994	1995	1996	1997	1998
1	6.42	0.30	0.38	0.19	1.09	0.42	0.49	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.90	0.22	0.52
2	10.01	5.40	7.74	6.62	8.48	9.13	6.50	1.48	27.69	1.80	0.00	0.00	1.63	0.29	1.08	1.53	0.97
3	6.52	2.33	14.88	5.65	5.67	5.93	4.66	9.82	5.03	6.95	1.83	1.99	1.46	1.19	3.67	2.33	6.79
4	1.14	1.55	12.57	6.48	4.97	2.96	3.17	14.49	10.00	2.11	4.03	4.04	4.31	1.54	3.62	1.04	8.42
5	3.72	0.63	9.96	7.95	13.82	2.84	1.51	10.89	11.24	4.15	0.71	1.49	6.10	12.04	1.32	0.50	5.60
6	1.62	2.11	3.28	6.33	8.31	6.50	1.16	5.67	5.75	2.03	2.96	1.35	1.73	18.08	2.69	0.28	3.99
7	0.48	0.77	2.66	2.13	3.35	5.84	2.15	3.84	2.84	1.03	0.68	0.47	1.62	4.05	2.91	0.30	1.96
8	0.89	0.37	0.79	1.47	1.29	3.65	1.21	3.14	1.58	0.53	0.33	0.10	0.50	5.29	0.54	0.24	2.50
9	1.61	0.46	0.48	0.84	0.69	1.49	0.67	1.15	1.19	0.26	0.13	0.04	0.08	2.01	0.46	0.14	2.79
10	0.75	0.71	0.42	0.29	0.28	0.84	0.37	0.71	0.74	0.24	0.09	0.03	0.04	0.23	0.09	0.05	0.43
11	0.36	0.18	0.42	0.24	0.23	0.74	0.41	0.32	0.56	0.08	0.11	0.04	0.03	0.18	0.09	0.02	0.30
12	0.14	0.15	0.49	0.29	0.16	0.35	0.13	0.16	0.22	0.04	0.03	0.01	0.02	0.01	0.02	0.00	0.06
13	0.06	0.06	0.21	0.17	0.17	0.16	0.11	0.12	0.11	0.01	0.04	0.00	0.01	0.07	0.00	0.00	0.03
14	0.05	0.03	0.12	0.10	0.16	0.15	0.05	0.09	0.07	0.01	0.01	0.01	0.01	0.03	0.00	0.00	0.00
15	0.04	0.00	0.03	0.06	0.06	0.09	0.09	0.01	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
16	0.04	0.04	0.03	0.04	0.04	0.10	0.06	0.05	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.01	0.00	0.05	0.02	0.05	0.01	0.04	0.01	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
18	0.02	0.03	0.02	0.00	0.04	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
21	0.01	0.01	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1+	33.92	15.11	54.57	38.90	48.93	41.23	22.83	51.96	68.43	19.27	10.97	9.58	17.55	45.01	17.39	6.65	34.36
3+	17.49	9.41	46.45	32.08	39.36	31.68	15.84	50.48	39.44	17.47	10.97	9.58	15.92	44.72	15.41	4.90	32.87
6+	6.11	4.91	9.05	11.99	14.90	19.95	6.50	15.28	13.17	4.26	4.40	2.06	4.05	29.95	6.80	1.03	12.06

Table 13. Mean length-at-age of cod caught during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps during 1971-1998.

	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
1		14.0	11.6	12.2	12.7	13.2	11.0		10.8	14.6	14.6	13.2	10.3	12.0		11.0	10.7	9.2	12.0		9.5					12.6	12.7	10.6
2		23.2	22.6	21.7	23.1	22.8	20.3	19.6	22.1	21.0	22.4	22.0	20.2	19.2	17.9	18.7	19.9	19.7	19.2	20.0	19.2	20.7		19.1	21.2	20.6	24.1	22.3
3		31.5	31.7	33.4	35.3	35.4	31.7	28.0	32.2	28.1	32.4	33.3	31.2	30.6	29.0	26.8	29.5	29.0	30.1	29.9	29.5	30.5	30.9	32.3	30.1	30.0	31.7	32.5
4		41.0	39.3	43.1	44.4	48.2	43.2	35.9	42.6	42.9	44.4	44.9	43.0	42.1	40.3	40.3	39.4	40.8	41.6	40.0	38.5	40.9	41.1	39.2	41.4	38.6	40.8	42.5
5		51.9	50.1	50.8	55.4	57.4	55.6	48.0	47.4	50.6	50.6	53.4	52.6	51.8	50.9	48.6	48.1	47.5	47.9	48.0	46.9	47.1	48.0	48.0	50.3	44.0	47.9	48.7
6		58.5	56.6	55.6	61.0	64.6	63.5	59.0	56.3	58.2	58.6	59.3	57.8	60.6	60.0	55.5	53.9	56.2	56.0	53.7	53.3	55.1	52.6	50.2	56.4	52.9	51.5	53.2
7		63.0	62.1	63.6	66.5	68.1	73.9	65.6	70.5	71.3	63.2	66.4	65.4	66.2	66.3	62.1	61.1	61.9	63.9	56.6	57.4	61.1	62.2	53.6	58.2	60.9	60.6	57.5
8		74.1	66.1	71.2	74.3	71.6	75.2	70.1	76.8	84.8	69.9	70.1	71.4	70.6	74.0	72.1	67.3	66.7	71.8	62.2	62.7	62.4	70.3	59.1	57.9	61.1	65.2	67.0
9		81.8	68.4	69.3	74.2	78.5	88.0	84.1	85.8	94.9	72.6	75.6	73.3	75.6	74.3	76.4	77.8	74.6	75.9	70.1	68.1	66.6	77.1	68.0	63.0	63.3	66.9	77.2
10		90.4	81.1	79.0	75.2	81.6	83.8	86.3	95.3	98.0	83.2	90.6	79.4	78.9	79.3	82.6	85.4	79.7	84.4	76.1	73.7	73.4	80.5	88.0	79.8	76.7	67.3	77.2
11		95.0	88.2	93.3	76.2	94.8	77.6	88.3	94.3	97.2	97.6	98.7	89.6	84.1	89.1	93.3	83.1	79.7	88.5	79.4	73.8	83.6	96.0	79.3	81.2	74.7	82.5	64.3
12		88.3	87.1	95.6	107.2	110.5	87.9	79.3	116.0	106.6	90.1	104.6	94.1	98.2	93.0	93.8	89.9	87.5	96.5	88.7	77.2	81.8	106.0	90.3	83.6	86.1		78.0

Table 14. Mean round weight-at-age (kg) of cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps in winter-spring 1978-1998. Entries in boxes are based on fewer than 5 fish. Some entries are different from those in Table 7 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

Age	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
1		0.011	0.027		0.040	0.010								0.012					0.018	0.016	0.011
2	0.057	0.070	0.068	0.060	0.103	0.068	0.073		0.045		0.057	0.060	0.062	0.054	0.064		0.053	0.062	0.072	0.108	0.091
3	0.177	0.258	0.147	0.265	0.420	0.232	0.268	0.214	0.168	0.248	0.193	0.239	0.208	0.217	0.230	0.220	0.254	0.212	0.218	0.257	0.282
4	0.396	0.633	0.618	0.704	0.829	0.718	0.632	0.505	0.462	0.538	0.582	0.613	0.538	0.465	0.574	0.550	0.460	0.540	0.461	0.552	0.659
5	0.979	0.879	1.005	1.079	1.299	1.301	1.212	1.039	0.905	0.950	0.915	0.901	0.954	0.865	0.865	0.894	0.898	1.017	0.673	0.878	0.941
6	1.735	1.565	1.634	1.673	1.539	1.652	1.853	1.566	1.332	1.273	1.494	1.331	1.348	1.324	1.461	1.150	1.044	1.514	1.283	1.076	1.274
7	2.368	3.029	3.457	2.081	2.555	1.861	2.790	2.279	2.384	1.885	2.214	2.361	1.621	1.702	2.032	1.987	1.236	1.687	2.009	1.904	1.640
8	3.192	5.666	5.791	3.496	2.612	3.555	3.828	3.206	3.337	2.297	2.423	3.778	2.185	2.346	2.258	3.003	1.814	1.585	2.084	2.608	2.791
9	4.676	5.798	8.459	4.890	4.007	4.042	4.225	3.143	5.023	4.483	3.943	4.505	3.060	3.087	2.859	4.281	2.891	2.209	2.136	2.867	4.660
10	5.711	7.108	8.333	7.591	6.441	4.896	5.029	3.760	4.654	6.344	4.839	5.820	4.225	3.956	3.983	4.470	6.450	4.767	4.464	3.083	4.441
11	4.901	9.030	9.085	8.374	8.885	8.848	7.866		6.633	6.616	4.262	8.285	4.934	4.050	5.796	8.673	4.470	5.446	3.897	5.456	2.528
12	5.760		10.158	11.463	13.068	10.270	9.818	3.970	8.867	5.945	9.103	9.061	7.365	4.906	5.240	13.200	6.748	5.544	6.793		4.190

Table 15. Mean gutted condition at age of cod sampled during DFO research vessel bottom-trawl surveys in Subdiv. 3Ps during winter-spring 1978-1998
Boxed entries are based on fewer than 5 fish.

Age	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
1																			0.754	0.727	0.898
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	0.697	0.674	0.660
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	0.706	0.717	0.699
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	0.709	0.725	0.720
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	0.695	0.702	0.704
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	0.713	0.683	0.680
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	0.715	0.693	0.689
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	0.722	0.714	0.725
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	0.671	0.713	0.757
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	0.758	0.751	0.742
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	0.725	0.785	0.748
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	0.760		0.784

Table 16. Mean liver index-at-age of cod sampled during DFO research vessel bottom-trawl surveys in subdivision 3Ps during winter/spring 1978-1998. Boxed entries are based on fewer than five fish.

	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
1																						
2		0.0175	0.0142	0.0150	0.0118	0.0229	0.0247	0.0120	0.0236	0.0230	0.0304	0.0250	0.0279	0.0292	0.0250	0.0301		0.0304	0.0139	0.0252	0.0244	0.0247
3		0.0223	0.0160	0.0114	0.0146	0.0244	0.0280	0.0167	0.0168	0.0233	0.0233	0.0227	0.0216	0.0213	0.0213	0.0200	0.0106	0.0144	0.0111	0.0160	0.0208	0.0165
4		0.0203	0.0181	0.0143	0.0188	0.0228	0.0323	0.0179	0.0175	0.0196	0.0225	0.0275	0.0266	0.0293	0.0280	0.0242	0.0154	0.0138	0.0131	0.0161	0.0199	0.0206
5		0.0227	0.0194	0.0189	0.0169	0.0230	0.0275	0.0142	0.0176	0.0214	0.0240	0.0281	0.0269	0.0335	0.0287	0.0315	0.0180	0.0197	0.0209	0.0168	0.0201	0.0216
6		0.0253	0.0218	0.0204	0.0194	0.0163	0.0348	0.0144	0.0217	0.0230	0.0241	0.0280	0.0300	0.0357	0.0309	0.0309	0.0187	0.0221	0.0201	0.0201	0.0183	0.0249
7		0.0256	0.0293	0.0262	0.0213	0.0207	0.0277	0.0195	0.0217	0.0237	0.0273	0.0279	0.0303	0.0376	0.0362	0.0263	0.0184	0.0170	0.0211	0.0219	0.0230	0.0227
8		0.0323	0.0359	0.0370	0.0322	0.0203	0.0303	0.0191	0.0233	0.0268	0.0291	0.0312	0.0341	0.0334	0.0337	0.0368	0.0206	0.0211	0.0179	0.0231	0.0240	0.0346
9		0.0284	0.0319	0.0381	0.0418	0.0225	0.0326	0.0188	0.0268	0.0303	0.0362	0.0357	0.0412	0.0349	0.0386	0.0400	0.0280	0.0208	0.0189	0.0194	0.0273	0.0407
10		0.0326	0.0362	0.0328	0.0470	0.0258	0.0327	0.0328	0.0301	0.0383	0.0462	0.0439	0.0432	0.0411	0.0410	0.0379	0.0182	0.0423	0.0265	0.0303	0.0379	0.0424
11		0.0256	0.0276	0.0381	0.0277	0.0356	0.0445	0.0330	0.0405	0.0435	0.0404	0.0495	0.0519	0.0471	0.0419	0.0473	0.0346	0.0232	0.0343	0.0314	0.0396	0.0271
12		0.0379		0.0385	0.0415	0.0539	0.0462	0.0451	0.0435	0.0463	0.0482	0.0545	0.0689	0.0477	0.0373	0.0376	0.0379	0.0326	0.0247	0.0202		0.0284

Table 17. Observed proportion mature at age of female Atlantic cod (Gadus morhua) sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps during 1972-1998. A50=median age at maturity (years); L95% and U95%=lower and upper 95% confidence intervals. Parameter estimates of the logit model are also shown: Int=intercept, SE=standard error, n=number of fish aged, dot=no fish sampled.

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0	.	0	0	0	.	.	.	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0.01	0.01	0	0	0	0	0	0	0.09	0
5	0.10	0.08	0.08	0.20	0.33	0.25	0.11	0.06	0.10	0.10	0.03	0.14	0.41
6	0.43	0.58	0.44	0.54	0.71	0.47	0.33	0.34	0.21	0.49	0.44	0.53	0.59
7	0.64	0.68	1	0.87	0.69	0.96	0.77	0.61	0.87	0.72	0.69	0.91	0.85
8	0.92	0.93	1	1	0.95	0.89	0.93	0.92	1	0.92	0.93	1	0.91
9	1	1	1	0.83	0.80	1	1	0.85	1	1	0.96	1	1
10	1	1	1	1	1	1	1	1	1	1	1	0.94	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	.	1	1	1	1	.	1	1	1	1	1
13	1	1	.	.	.	1	1	.	1	1	.	1	.
A50	6.49	6.41	6.02	5.93	5.81	5.88	6.36	6.62	6.37	6.30	6.51	5.99	5.78
L 95%	6.16	6.14	5.69	5.71	5.54	5.66	6.14	6.40	6.18	6.06	6.26	5.70	5.52
U 95%	6.77	6.66	6.48	6.18	6.17	6.15	6.58	6.88	6.59	6.55	6.75	6.30	6.01
Slope	1.60	1.68	2.92	1.72	1.45	1.80	1.81	1.51	2.37	1.68	1.83	1.47	1.53
SE	0.23	0.20	0.88	0.20	0.18	0.24	0.22	0.17	0.34	0.20	0.21	0.16	0.22
Int	-10.39	-10.77	-17.56	-10.20	-8.43	-10.59	-11.53	-9.99	-15.09	-10.62	-11.91	-8.81	-8.86
SE	1.57	1.32	5.22	1.16	0.95	1.33	1.39	1.10	2.13	1.31	1.41	0.97	1.29
n	223	301	94	305	332	307	322	312	337	328	391	410	285

AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	.	.	.	.	0	.	0	.	.	.	.	0	0	0
2	0	0	0	0	0	0	0	0	.	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0.05	0	0.07	0	0.11	0	0.01	0.23	0.17
5	0.05	0.03	0.04	0.02	0.08	0.11	0.18	0.35	0.46	0.50	0.51	0.39	0.73	0.36
6	0.34	0.35	0.25	0.17	0.49	0.62	0.48	0.87	0.93	0.96	0.79	0.74	0.89	1
7	0.80	0.71	0.60	0.40	0.79	0.80	0.84	0.97	0.94	0.94	0.97	0.92	1	1
8	1	0.96	0.86	0.85	0.93	0.82	0.88	1	1	1	0.96	1	1	1
9	1	1	1	0.9	0.97	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	0.94	1	1	1	1	1	1	1	.	.	.
13	1	1	1	1	1	1	1	.	1	1	1	.	.	.
A50	6.32	6.41	6.74	7.20	6.24	6.20	6.08	5.25	5.24	5.00	5.17	5.54	4.64	4.97
L 95%	6.12	6.28	6.57	6.96	6.02	5.91	5.86	5.06	5.08	4.89	4.92	5.32	4.29	4.67
U 95%	6.52	6.55	6.92	7.45	6.45	6.52	6.32	5.44	5.39	5.12	5.37	5.74	5.05	5.27
Slope	2.30	2.04	1.74	1.43	1.74	1.36	1.63	2.35	2.70	2.01	1.68	1.98	2.45	2.60
SE	0.30	0.18	0.16	0.15	0.19	0.15	0.18	0.33	0.26	0.18	0.23	0.21	0.52	0.51
Int	-14.53	-13.06	-11.73	-10.31	-10.88	-8.40	-9.94	-12.36	-14.12	-10.06	-8.68	-10.98	-11.35	-12.91
SE	1.88	1.14	1.07	1.07	1.19	0.90	1.07	1.75	1.40	0.91	1.26	1.21	2.35	2.52
n	376	643	548	492	432	317	417	289	476	664	288	415	150	253

Table 18. Estimated proportions mature at age for female cod from NAFO Subdiv. 3Ps projected to 2000.

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1978	0.0000	0.0000	0.0002	0.0064	0.0763	0.3547	0.7534	0.9594	0.9975	0.9999	1.0000	1.0000	1.0000	1.0000
1979	0.0000	0.0000	0.0006	0.0097	0.0731	0.2845	0.6234	0.8846	0.9813	0.9985	0.9999	1.0000	1.0000	1.0000
1980	0.0000	0.0000	0.0001	0.0038	0.0574	0.3154	0.7311	0.9566	0.9975	1.0000	1.0000	1.0000	1.0000	1.0000
1981	0.0000	0.0000	0.0008	0.0141	0.1096	0.3959	0.7583	0.9521	0.9957	0.9998	1.0000	1.0000	1.0000	1.0000
1982	0.0000	0.0000	0.0001	0.0033	0.0508	0.2896	0.7011	0.9463	0.9965	0.9999	1.0000	1.0000	1.0000	1.0000
1983	0.0000	0.0006	0.0074	0.0507	0.2001	0.4824	0.7743	0.9395	0.9906	0.9992	1.0000	1.0000	1.0000	1.0000
1984	0.0000	0.0004	0.0068	0.0566	0.2420	0.5732	0.8575	0.9746	0.9977	0.9999	1.0000	1.0000	1.0000	1.0000
1985	0.0000	0.0000	0.0000	0.0016	0.0473	0.3478	0.8129	0.9849	0.9997	1.0000	1.0000	1.0000	1.0000	1.0000
1986	0.0000	0.0000	0.0000	0.0021	0.0467	0.3135	0.7599	0.9712	0.9990	1.0000	1.0000	1.0000	1.0000	1.0000
1987	0.0000	0.0000	0.0001	0.0033	0.0424	0.2334	0.6058	0.8970	0.9881	0.9994	1.0000	1.0000	1.0000	1.0000
1988	0.0000	0.0000	0.0003	0.0046	0.0367	0.1647	0.4360	0.7433	0.9289	0.9888	0.9990	1.0000	1.0000	1.0000
1989	0.0000	0.0000	0.0012	0.0180	0.1231	0.4125	0.7633	0.9511	0.9953	0.9998	1.0000	1.0000	1.0000	1.0000
1990	0.0000	0.0007	0.0075	0.0474	0.1815	0.4408	0.7296	0.9150	0.9836	0.9981	0.9999	1.0000	1.0000	1.0000
1991	0.0000	0.0001	0.0026	0.0297	0.1650	0.4750	0.8020	0.9608	0.9962	0.9998	1.0000	1.0000	1.0000	1.0000
1992	0.0000	0.0000	0.0016	0.0502	0.3690	0.8350	0.9888	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1993	0.0000	0.0000	0.0003	0.0303	0.3721	0.8896	0.9972	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1994	0.0000	0.0024	0.0175	0.1173	0.4983	0.8813	0.9823	0.9976	0.9997	1.0000	1.0000	1.0000	1.0000	1.0000
1995	0.0000	0.0049	0.0256	0.1235	0.4303	0.8019	0.9560	0.9915	0.9984	0.9997	0.9999	1.0000	1.0000	1.0000
1996	0.0001	0.0009	0.0065	0.0451	0.2551	0.7129	0.9474	0.9924	0.9989	0.9999	1.0000	1.0000	1.0000	1.0000
1997	0.0001	0.0016	0.0179	0.1739	0.7090	0.9658	0.9969	0.9997	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1998	0.0001	0.0012	0.0113	0.1001	0.5210	0.9141	0.9905	0.9990	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
1999	0.0004	0.0028	0.0187	0.1133	0.4617	0.8520	0.9748	0.9962	0.9994	0.9999	1.0000	1.0000	1.0000	1.0000
2000	0.0004	0.0028	0.0187	0.1133	0.4617	0.8520	0.9748	0.9962	0.9994	0.9999	1.0000	1.0000	1.0000	1.0000

Table 19. Parameter estimates, CV's, and confidence intervals (CI's).

Year	Age	Survivors	CV	95%L	95%U
1998	2	67020.95	1.33	4982.95	901435.50
1998	3	88343.82	0.88	15772.41	494828.10
1998	4	48809.28	0.69	12649.80	188330.70
1998	5	21895.44	0.61	6646.42	72130.62
1998	6	10627.19	0.54	3656.87	30883.54
1998	7	5102.39	0.49	1948.63	13360.34
1998	8	9198.88	0.39	4276.50	19787.07
1998	9	9422.92	0.26	5653.18	15706.47
1998	10	1588.15	0.36	790.04	3192.54
1998	11	1535.39	0.34	787.46	2993.69
1998	12	1155.83	0.36	565.54	2362.25
1998	13	101.57	0.90	17.30	596.41
1994	14	288.26	0.72	70.43	1179.90
1995	14	250.81	0.70	64.01	982.84
1996	14	309.51	0.59	98.16	975.92
1997	14	78.69	1.09	9.28	667.32
1998	14	81.52	0.96	12.41	535.41

Catchability	Estimate (x 1000)	Std. Err.
Can_Spr02	0.015394	0.008364
Can_Spr03	0.079895	0.026585
Can_Spr04	0.126284	0.042020
Can_Spr05	0.228546	0.076047
Can_Spr06	0.320982	0.106805
Can_Spr07	0.344321	0.114571
Can_Spr08	0.388240	0.129185
Can_Spr09	0.350488	0.059436
Can_Spr10	0.241251	0.073888
Can_Spr11	0.200129	0.085478
Can_Spr12	0.136732	0.100358
an_Wnt03	0.16598	0.03804
an_Wnt04	0.147284	0.033755
an_Wnt05	0.185708	0.042561
an_Wnt06	0.225414	0.051661
an_Wnt07	0.259225	0.059410
an_Wnt08	0.358754	0.082221
an_Wnt09	0.284998	0.050233
an_Wnt10	0.256069	0.058182
an_Wnt11	0.262942	0.067832
an_Wnt12	0.236813	0.073950

Table 20. QLSPA estimates of beginning-of-year numbers-at-age

Year\Age	2	3	4	5	6	7	8	9	10	11	12	13	14	2+
1959	75816	60250	114000	42059	24296	16655	6139	4071	4044	5691	1557	322	9	354659
1960	63224	62073	48423	80517	27626	13318	9225	4174	2200	2171	4089	781	224	318044
1961	60212	51763	50308	34672	44474	16543	7759	4400	2494	1053	1410	2979	384	278452
1962	52821	49297	41973	36134	19016	21971	10273	2118	1930	797	459	914	1932	239635
1963	86672	43246	39235	28258	21438	11467	12817	7174	1018	1063	483	249	627	253746
1964	99926	70961	34537	28052	16719	12779	7102	7752	5061	569	741	306	107	284612
1965	104000	81813	56373	23042	17868	9003	7798	4113	4636	3553	159	309	202	312972
1966	121000	85233	64889	37435	13618	11364	4426	4525	2265	2861	2613	69	143	350518
1967	86748	99130	68924	40764	18828	6968	4672	2189	2046	914	1874	1788	28	334873
1968	67823	71023	78563	46556	21703	9631	3580	2591	1246	1389	405	1449	1329	307286
1969	43520	55529	57114	52919	26231	12473	4653	1747	1624	635	937	231	1182	258796
1970	74239	35632	44763	40339	32844	14982	6091	2220	714	681	465	658	128	253756
1971	49110	60782	28489	29307	21340	18056	6498	2765	1157	391	397	311	429	219031
1972	39424	40207	47154	17494	16236	10897	7347	2487	1110	458	243	212	198	183469
1973	50832	32278	32258	34133	10169	10079	4757	3630	1283	490	189	93	130	180321
1974	69735	41618	25572	22151	17643	4697	4613	1903	1145	584	245	55	64	190026
1975	75221	57094	32366	15469	9099	8686	1547	2096	518	451	253	128	16	202947
1976	95741	61586	45080	19868	7782	3341	1803	613	634	329	212	160	100	237248
1977	53422	78386	46704	25924	9097	3770	1555	1028	375	471	254	154	128	221268
1978	31310	43738	63331	29953	13691	4545	2254	915	602	201	334	169	98	191142
1979	46219	25634	35355	47195	19008	7585	2135	1255	537	332	99	249	123	185725
1980	82564	37841	20865	26167	29301	10978	4081	1095	816	363	224	60	192	214548
1981	52491	67598	30648	15613	16851	16610	5931	2206	601	565	247	142	30	209533
1982	84551	42976	54420	22480	9945	9587	8301	3388	1319	334	402	171	100	237973
1983	78090	69225	35068	39948	14396	6018	5260	4137	2195	860	198	302	130	255826
1984	66518	63934	55989	26285	24405	8095	3342	3266	2445	1576	622	129	231	256837
1985	32050	54460	52161	41749	17414	13631	4618	2207	2184	1696	1169	477	98	223915
1986	43180	26240	44451	40318	26914	9603	6417	2442	1241	1295	1069	859	372	204400
1987	56430	35353	21207	31776	23733	11876	3987	3293	1411	813	905	746	631	192161
1988	64869	46201	28415	14688	16042	10597	4789	1983	1695	847	531	671	489	191815
1989	50820	53110	36980	18784	7527	7279	4110	2299	1053	1130	582	367	501	184543
1990	21237	41608	42514	22138	8284	3572	3653	2359	1339	661	798	425	274	148861
1991	50299	17387	32250	27006	10710	3770	1583	1871	1305	780	412	559	305	148238
1992	34221	41181	13501	19183	13037	3424	1128	566	971	681	541	269	413	129115
1993	15202	28018	32430	7290	8083	4758	753	328	220	621	389	368	189	98649
1994	26002	12447	22688	23192	4128	3762	2688	253	188	146	462	306	288	96550
1995	40612	21288	10182	18505	18832	3312	3024	2176	197	152	117	378	251	119026
1996	72904	33250	17427	8330	15100	15310	2660	2443	1775	159	124	96	310	169888
1997	108000	59689	27215	14229	6781	12271	12422	2146	1978	1446	128	101	79	246389
1998	67021	88344	48809	21895	10627	5102	9199	9423	1588	1535	1156	102	82	264883
1999	80785	54872	72247	39624	17209	7298	3320	6342	6614	1097	1148	896	70	291522

Table 21. QLSPA estimates of fishing mortalities-at-age

Year\Age	2	3	4	5	6	7	8	9	10	11	12	13	14
1959	0	0.019	0.146	0.220	0.401	0.391	0.186	0.415	0.422	0.131	0.489	0.164	0.131
1960	0	0.010	0.134	0.394	0.313	0.340	0.540	0.315	0.537	0.232	0.117	0.511	0.143
1961	0	0.010	0.131	0.401	0.505	0.277	1.098	0.624	0.941	0.631	0.233	0.233	0.183
1962	0	0.028	0.196	0.322	0.306	0.339	0.159	0.532	0.396	0.300	0.412	0.178	0.148
1963	0	0.025	0.136	0.325	0.317	0.279	0.303	0.149	0.381	0.161	0.257	0.645	0.177
1964	0	0.030	0.205	0.251	0.419	0.294	0.346	0.314	0.154	1.073	0.674	0.217	0.327
1965	0	0.032	0.209	0.326	0.253	0.510	0.344	0.396	0.283	0.107	0.637	0.573	0.220
1966	0	0.012	0.265	0.487	0.470	0.689	0.504	0.594	0.707	0.223	0.180	0.718	0.187
1967	0	0.033	0.192	0.430	0.470	0.466	0.390	0.364	0.187	0.615	0.058	0.097	0.128
1968	0	0.018	0.195	0.374	0.354	0.527	0.517	0.267	0.473	0.194	0.361	0.004	0.093
1969	0	0.016	0.148	0.277	0.360	0.517	0.540	0.695	0.669	0.112	0.153	0.387	0.109
1970	0	0.024	0.224	0.437	0.398	0.635	0.590	0.452	0.402	0.341	0.202	0.227	0.128
1971	0	0.054	0.288	0.391	0.472	0.699	0.760	0.713	0.727	0.275	0.428	0.249	0.159
1972	0	0.020	0.123	0.343	0.277	0.629	0.505	0.462	0.618	0.683	0.759	0.289	0.288
1973	0	0.033	0.176	0.460	0.572	0.582	0.716	0.954	0.586	0.491	1.028	0.182	0.283
1974	0	0.051	0.303	0.690	0.509	0.910	0.589	1.101	0.732	0.637	0.447	1.016	0.350
1975	0	0.036	0.288	0.487	0.802	1.372	0.727	0.996	0.253	0.556	0.258	0.053	0.144
1976	0	0.077	0.353	0.581	0.525	0.565	0.362	0.291	0.097	0.059	0.116	0.028	0.034
1977	0	0.013	0.244	0.438	0.494	0.314	0.330	0.335	0.423	0.143	0.207	0.251	0.100
1978	0	0.013	0.094	0.255	0.391	0.556	0.386	0.334	0.396	0.504	0.093	0.118	0.119
1979	0	0.006	0.101	0.277	0.349	0.420	0.467	0.230	0.190	0.194	0.310	0.059	0.094
1980	0	0.011	0.090	0.240	0.368	0.416	0.415	0.400	0.168	0.187	0.251	0.492	0.155
1981	0	0.017	0.110	0.251	0.364	0.494	0.360	0.315	0.388	0.140	0.170	0.150	0.077
1982	0	0.003	0.109	0.246	0.302	0.400	0.496	0.234	0.228	0.322	0.086	0.074	0.080
1983	0	0.012	0.088	0.293	0.376	0.388	0.277	0.326	0.131	0.124	0.231	0.068	0.071
1984	0	0.004	0.093	0.212	0.382	0.361	0.215	0.203	0.166	0.099	0.064	0.071	0.039
1985	0	0.003	0.058	0.239	0.395	0.553	0.437	0.376	0.323	0.261	0.109	0.050	0.070
1986	0	0.013	0.136	0.330	0.618	0.679	0.467	0.348	0.223	0.158	0.160	0.107	0.071
1987	0	0.018	0.167	0.484	0.606	0.708	0.498	0.464	0.311	0.226	0.100	0.223	0.092
1988	0	0.023	0.214	0.468	0.590	0.747	0.534	0.433	0.205	0.175	0.170	0.091	0.073
1989	0	0.023	0.313	0.619	0.545	0.489	0.355	0.340	0.267	0.148	0.115	0.091	0.059
1990	0	0.055	0.254	0.526	0.587	0.614	0.469	0.392	0.341	0.271	0.156	0.130	0.093
1991	0	0.053	0.320	0.528	0.940	1.006	0.829	0.456	0.450	0.166	0.228	0.104	0.083
1992	0	0.039	0.416	0.664	0.808	1.315	1.034	0.745	0.247	0.362	0.186	0.151	0.116
1993	0	0.011	0.135	0.369	0.565	0.371	0.889	0.356	0.212	0.097	0.038	0.043	0.030
1994	0	0.001	0.004	0.008	0.020	0.018	0.012	0.054	0.018	0.015	0.000	0.000	0.000
1995	0	0.000	0.001	0.003	0.007	0.019	0.014	0.004	0.011	0.000	0.000	0.000	0.000
1996	0	0.000	0.003	0.006	0.007	0.009	0.015	0.011	0.005	0.014	0.009	0.000	0.000
1997	0	0.001	0.017	0.092	0.084	0.088	0.076	0.101	0.053	0.024	0.035	0.011	0.000
1998	0	0.001	0.008	0.041	0.176	0.230	0.172	0.154	0.170	0.090	0.055	0.178	0.014

Table 22. QLSPA estimates of beginning-of-year biomass-at-age

Year\Age	2	3	4	5	6	7	8	9	10	11	12	13	14	2+
1959	0	10845	50050	36171	32800	33477	17066	14778	18439	31472	10118	2416	78	257709
1960	0	11173	21306	69245	37295	26770	25646	15151	10033	12003	26576	5868	1921	262986
1961	0	9317	22136	29818	60040	33252	21570	15974	11374	5823	9163	22373	3295	244135
1962	0	8874	18468	31076	25671	44161	28558	7688	8800	4408	2981	6867	16599	204150
1963	0	7784	17263	24302	28941	23049	35631	26040	4643	5880	3142	1869	5382	183926
1964	0	12773	15196	24125	22571	25686	19744	28140	23076	3149	4818	2299	918	182495
1965	0	14726	24804	19816	24122	18095	21678	14929	21139	19650	1036	2322	1733	184051
1966	0	15342	28551	32194	18385	22841	12305	16425	10329	15820	16987	518	1226	190923
1967	0	17843	30327	35057	25417	14006	12988	7946	9330	5056	12184	13425	237	183817
1968	0	12784	34568	40038	29299	19359	9952	9405	5680	7683	2631	10879	11414	193690
1969	0	9995	25130	45510	35413	25070	12936	6343	7407	3513	6088	1734	10149	189289
1970	0	6414	19696	34691	44339	30113	16933	8058	3256	3767	3022	4943	1103	176336
1971	0	10941	12535	25204	28809	36293	18066	10036	5276	2162	2578	2335	3689	157923
1972	0	7237	20748	15045	21919	21903	20426	9029	5061	2531	1580	1590	1705	128775
1973	0	5810	14193	29355	13728	20259	13224	13178	5850	2708	1230	700	1115	121351
1974	0	7491	11252	19050	23819	9441	12824	6908	5223	3231	1595	416	547	101796
1975	0	10277	14241	13304	12284	17459	4301	7610	2364	2494	1645	965	141	87085
1976	0	11086	19835	17086	10505	6715	5012	2224	2892	1821	1377	1203	857	80613
1977	0	38409	20550	24628	12918	7992	4446	3773	1687	2583	1622	1211	1195	121014
1978	0	16183	39265	25760	20674	9680	6379	3424	2799	1015	2183	1226	861	129448
1979	0	7947	19092	39644	25280	16004	6404	4504	2770	1994	647	2064	1130	127479
1980	0	15893	11267	22504	37798	22176	12365	4885	4465	2501	1740	522	1837	137953
1981	0	25687	19615	15144	24096	32389	16902	8737	3329	4058	2005	1212	282	153458
1982	0	14182	33196	21580	15216	19749	21334	12129	6330	1975	3213	1507	981	151392
1983	0	29767	21392	40347	22026	12878	14571	13652	9745	5064	1432	2812	1311	174997
1984	0	37082	43671	28387	39537	18537	10426	12869	11199	8669	4787	1252	2364	218779
1985	0	31587	39121	47176	27514	32034	13900	9602	11661	9889	7682	4496	1062	235724
1986	0	11808	30671	40318	40372	20070	19123	9400	6515	7898	7806	6526	4019	204525
1987	0	16262	13572	30187	32988	24465	10804	12152	6617	4750	5948	5864	5172	168781
1988	0	25873	19322	13513	22779	19922	12452	6523	7863	4529	3399	4842	3885	144902
1989	0	28680	26256	18409	10011	14121	11097	7954	4540	6331	3724	2623	4044	137788
1990	0	21220	31460	22359	12094	7145	9498	8893	6120	3792	5514	3309	2456	133860
1991	0	9737	21285	27006	15958	7879	4226	6232	5507	4429	2878	4530	2744	112412
1992	0	15649	8776	16881	17600	6744	2956	1963	4390	3549	3806	2403	4180	88898
1993	0	6444	18161	6270	10023	8659	1889	1163	928	3163	2696	2691	1751	63838
1994	0	6597	12251	21801	5861	6547	6506	808	821	757	2784	2184	2142	69059
1995	0	8090	7331	20910	30696	7088	7228	6701	773	655	601	2491	1976	94540
1996	0	19285	12547	9330	27028	34602	7183	7328	6621	724	555	528	2306	128036
1997	0	28651	21228	16079	11325	27855	35527	6869	6666	6218	712	638	695	162462
1998	0	43288	38559	26056	17429	10868	25665	34111	6019	6188	5652	648	743	215226
1999	0	26887	57075	47153	28223	15545	9262	22960	25066	4420	5616	5714	635	248556

Table 23. QLSPA estimates of beginning-of-year spawner biomass-at-age

Year\Age	2	3	4	5	6	7	8	9	10	11	12	13	14	2+
1959	0	2	320	2760	11634	25222	16373	14741	18437	31472	10118	2416	78	133573
1960	0	2	136	5283	13229	20168	24605	15113	10032	12003	26576	5868	1921	134936
1961	0	2	142	2275	21296	25052	20694	15934	11372	5823	9163	22373	3295	137423
1962	0	2	118	2371	9106	33271	27398	7668	8799	4408	2981	6867	16599	119589
1963	0	2	110	1854	10266	17365	34185	25975	4642	5880	3142	1869	5382	110671
1964	0	3	97	1841	8006	19352	18942	28070	23074	3149	4818	2299	918	110568
1965	0	3	159	1512	8556	13633	20798	14891	21137	19650	1036	2322	1733	105430
1966	0	3	183	2456	6521	17208	11806	16384	10328	15820	16987	518	1226	99440
1967	0	4	194	2675	9016	10552	12461	7926	9329	5056	12184	13425	237	83058
1968	0	3	221	3055	10392	14585	9548	9381	5679	7683	2631	10879	11414	85471
1969	0	2	161	3472	12561	18888	12411	6327	7407	3513	6088	1734	10149	82713
1970	0	1	126	2647	15727	22687	16246	8038	3255	3767	3022	4943	1103	81564
1971	0	2	80	1923	10218	27343	17332	10011	5275	2162	2578	2335	3689	82950
1972	0	1	133	1148	7775	16502	19596	9007	5061	2531	1580	1590	1705	66629
1973	0	1	91	2240	4869	15263	12687	13145	5849	2708	1230	700	1115	59900
1974	0	1	72	1454	8448	7113	12303	6890	5223	3231	1595	416	547	47294
1975	0	2	91	1015	4357	13153	4127	7591	2363	2494	1645	965	141	37945
1976	0	2	127	1304	3726	5059	4808	2218	2892	1821	1377	1203	857	25395
1977	0	8	132	1879	4582	6021	4266	3764	1687	2583	1622	1211	1195	28948
1978	0	3	251	1965	7333	7293	6120	3415	2799	1015	2183	1226	861	34464
1979	0	5	185	2898	7192	9977	5665	4420	2766	1994	647	2064	1130	38942
1980	0	2	43	1292	11922	16213	11828	4873	4465	2501	1740	522	1837	57237
1981	0	21	277	1660	9540	24561	16093	8700	3328	4058	2005	1212	282	71735
1982	0	1	110	1096	4407	13846	20188	12087	6329	1975	3213	1507	981	65740
1983	0	220	1085	8073	10625	9971	13689	13524	9737	5064	1432	2812	1311	77545
1984	0	252	2472	6870	22663	15896	10161	12839	11198	8669	4787	1252	2364	99421
1985	0	0	63	2231	9569	26040	13690	9600	11661	9889	7682	4496	1062	95983
1986	0	0	64	1883	12657	15251	18573	9391	6515	7898	7806	6526	4019	90581
1987	0	2	45	1280	7699	14821	9691	12007	6613	4750	5948	5864	5172	73892
1988	0	8	89	496	3752	8686	9256	6059	7775	4525	3399	4842	3885	52771
1989	0	34	473	2266	4130	10778	10554	7916	4539	6331	3724	2623	4044	57412
1990	0	159	1491	4058	5331	5213	8690	8747	6108	3791	5514	3309	2456	54869
1991	0	25	632	4456	7580	6319	4061	6208	5506	4429	2878	4530	2744	49369
1992	0	25	441	6229	14696	6669	2956	1963	4390	3549	3806	2403	4180	51307
1993	0	2	550	2333	8917	8635	1889	1163	928	3163	2696	2691	1751	34718
1994	0	115	1437	10863	5165	6431	6490	808	821	757	2784	2184	2142	39999
1995	0	207	905	8998	24615	6777	7167	6690	772	655	601	2491	1976	61854
1996	0	125	566	2380	19268	32782	7128	7320	6620	724	555	528	2306	80302
1997	0	513	3692	11400	10938	27769	35516	6869	6666	6218	712	638	695	111625
1998	0	489	3860	13575	15931	10765	25639	34108	6019	6188	5652	648	743	123617
1999	0	304	5713	24567	25798	15398	9253	22957	25066	4420	5616	5714	635	145440

Table 24a. Spring RV survey index, and QLSPA residuals, ϕ = 0.886.

	Year/Age	2	3	4	5	6	7	8
	1983	10.01	6.52	1.14	3.72	1.62	0.48	0.89
	1984	5.40	2.33	1.55	0.63	2.11	0.77	0.37
	1993	0.00	1.99	4.04	1.49	1.35	0.47	0.10
Index	1994	1.63	1.46	4.31	6.10	1.73	1.62	0.50
	1995	0.29	1.19	1.54	12.04	18.08	4.05	5.29
	1996	1.08	3.67	3.62	1.32	2.69	2.91	0.54
	1997	1.53	2.33	1.04	0.50	0.28	0.30	0.24
	1998	0.97	6.79	8.42	5.60	3.99	1.96	2.50
	1983	0.00	1.37	-2.88	-4.03	-2.19	-1.22	-0.85
	1984	0.00	-2.49	-4.94	-4.69	-4.50	-1.60	-0.78
Unstandardized	1993	0.00	-0.12	0.31	0.07	-0.75	-0.93	-0.12
Residuals	1994	0.00	0.52	1.61	1.11	0.49	0.40	-0.48
	1995	0.00	-0.41	0.33	8.05	12.39	2.98	4.19
MSE=7.70	1996	0.02	1.17	1.55	-0.47	-1.86	-2.03	-0.43
	1997	-0.04	-2.17	-2.19	-2.49	-1.72	-3.58	-4.21
	1998	0.00	0.16	2.64	0.95	0.95	0.42	-0.68
	1983	0.00	0.28	-0.76	-0.55	-0.61	-0.76	-0.52
	1984	0.00	-0.55	-0.81	-0.94	-0.72	-0.72	-0.72
Standardized	1993	0.00	-0.06	0.09	0.05	-0.38	-0.71	-0.57
Residuals	1994	0.00	0.59	0.63	0.24	0.42	0.35	-0.52
	1995	0.00	-0.27	0.29	2.15	2.31	2.96	4.03
MSE=0.88	1996	0.03	0.50	0.80	-0.28	-0.43	-0.44	-0.47
	1997	-0.03	-0.51	-0.72	-0.88	-0.91	-0.98	-1.01
	1998	0.00	0.03	0.49	0.22	0.33	0.29	-0.23

Table 24b. Spring RV survey index, and QLSPA residuals, ϕ = 0.218.

	Year/Age	9	10	11	12
	1983	1.61	0.75	0.36	0.14
	1984	0.46	0.71	0.18	0.15
	1993	0.04	0.03	0.04	0.01
Index	1994	0.08	0.04	0.03	0.02
	1995	2.01	0.23	0.18	0.01
	1996	0.46	0.09	0.09	0.02
	1997	0.14	0.05	0.02	0.00
	1998	2.79	0.43	0.30	0.06
	1983	0.39	0.28	0.21	0.12
	1984	-0.56	0.18	-0.11	0.07
Unstandardized	1993	-0.06	-0.02	-0.07	-0.04
Residuals	1994	0.00	0.00	0.00	-0.04
	1995	1.29	0.19	0.15	-0.01
MSE=0.10	1996	-0.34	-0.31	0.06	0.00
	1997	-0.55	-0.39	-0.25	-0.02
	1998	-0.17	0.09	0.02	-0.09
	1983	0.76	0.86	1.12	1.63
	1984	-1.19	0.52	-0.45	0.51
Standardized	1993	-0.40	-0.17	-0.47	-0.38
Residuals	1994	-0.02	-0.03	0.03	-0.35
	1995	3.26	1.88	1.92	-0.09
MSE=1.04	1996	-0.82	-1.05	0.75	0.07
	1997	-1.42	-1.26	-1.03	-0.27
	1998	-0.21	0.32	0.08	-0.48

Table 24c. Winter RV survey index, and QLSPA residuals, $\phi = 0.473$.

	Year/Age	2	3	4	5	6	7	8
	1985	7.50	13.83	12.11	7.93	2.89	1.76	0.45
	1986	5.76	5.79	4.25	6.18	3.93	1.48	0.95
	1987	9.46	5.94	5.14	13.45	8.32	2.74	1.08
Index	1988	10.13	6.44	2.20	1.75	4.31	4.41	3.02
	1989	6.76	4.24	1.98	0.74	0.51	1.45	1.07
	1990	1.51	5.14	10.97	6.71	3.02	1.75	2.26
	1991	30.70	4.40	3.01	4.50	2.82	1.24	1.11
	1992	1.92	5.32	0.79	1.14	0.62	0.33	0.12
	1993	0.00	2.19	4.75	0.48	1.16	0.12	0.08
	1985	0.00	5.17	4.83	0.85	-0.58	-1.26	-1.00
	1986	0.00	1.62	-1.85	-0.52	-1.19	-0.59	-1.05
Unstandardized	1987	0.00	0.30	2.22	8.24	3.71	0.13	-0.18
Residuals	1988	0.00	-1.06	-1.82	-0.80	0.97	1.91	1.42
	1989	0.00	-4.37	-3.17	-2.45	-1.06	-0.30	-0.32
MSE=4.17	1990	0.00	-1.58	5.01	2.91	1.31	0.90	1.04
	1991	0.00	1.59	-1.48	-0.13	0.69	0.38	0.60
	1992	0.00	-1.31	-1.05	-2.06	-1.97	-0.40	-0.23
	1993	0.00	-2.42	0.04	-0.84	-0.60	-1.08	-0.18
	1985	0.00	0.87	0.96	0.18	-0.24	-0.61	-1.00
	1986	0.00	0.57	-0.44	-0.11	-0.34	-0.42	-0.76
Standardized	1987	0.00	0.08	1.11	2.30	1.17	0.07	-0.21
Residuals	1988	0.00	-0.21	-0.66	-0.46	0.42	1.11	1.30
	1989	0.00	-0.74	-0.90	-1.12	-0.98	-0.25	-0.33
MSE=0.66	1990	0.00	-0.34	1.22	1.11	1.11	1.55	1.24
	1991	0.00	0.82	-0.48	-0.04	0.47	0.65	1.72
	1992	0.00	-0.29	-0.83	-0.94	-1.11	-0.80	-0.95
	1993	0.00	-0.76	0.01	-0.93	-0.50	-1.31	-1.00

Table 24d. Winter RV survey index, and QLSPA residuals, $\phi = 0.140$.

	Year/Age	9	10	11	12
	1985	0.37	0.22	0.38	0.39
	1986	0.40	0.15	0.20	0.29
	1987	0.53	0.16	0.14	0.15
Index	1988	1.24	0.57	0.45	0.16
	1989	0.54	0.30	0.32	0.11
	1990	0.55	0.29	0.18	0.04
	1991	0.80	0.96	0.42	0.26
	1992	0.04	0.06	0.01	0.01
	1993	0.05	0.01	0.01	0.03
	1985	-0.19	-0.28	-0.03	0.13
	1986	-0.22	-0.14	-0.12	0.06
Unstandardized	1987	-0.30	-0.17	-0.06	-0.05
Residuals	1988	0.71	0.15	0.24	0.04
	1989	-0.08	0.04	0.03	-0.02
	1990	-0.08	-0.03	0.01	-0.14
MSE=0.05	1991	0.30	0.65	0.22	0.17
	1992	-0.10	-0.18	-0.16	-0.11
	1993	-0.04	-0.05	-0.15	-0.06
	1985	-0.67	-1.06	-0.11	0.68
	1986	-0.75	-0.70	-0.55	0.30
Standardized	1987	-0.88	-0.79	-0.35	-0.31
Residuals	1988	2.60	0.63	1.36	0.30
	1989	-0.26	0.23	0.17	-0.17
	1990	-0.27	-0.16	0.10	-0.89
MSE=0.97	1991	1.15	3.10	1.34	1.46
	1992	-0.73	-0.96	-1.03	-0.86
	1993	-0.37	-0.51	-1.01	-0.54

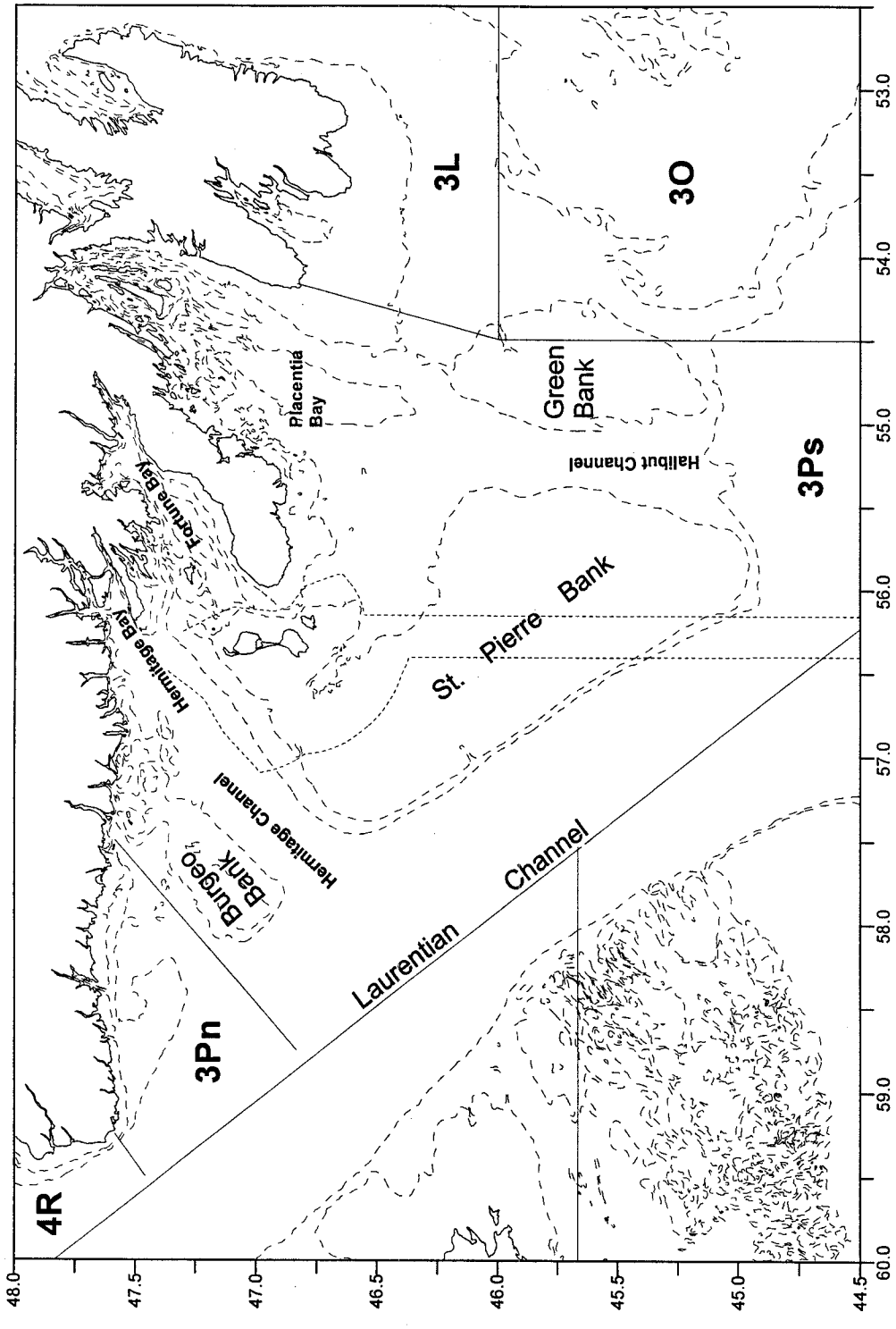


Fig. 1. NAFO Subdivision 3Ps management unit, boundaries of French economic zone (fine dashed line) and main fishing areas ,

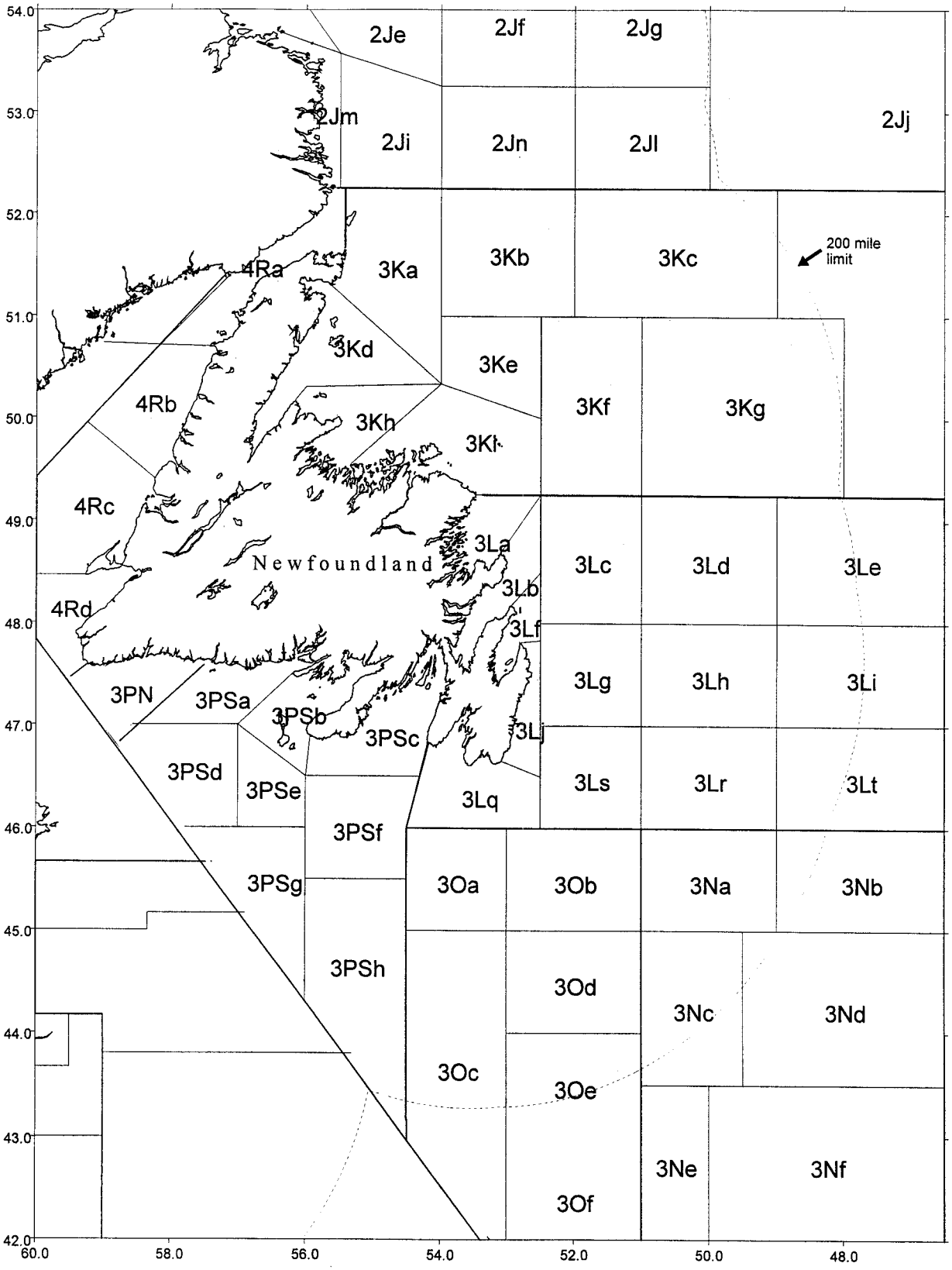


Fig. 2. NAFO statistical area boundaries.

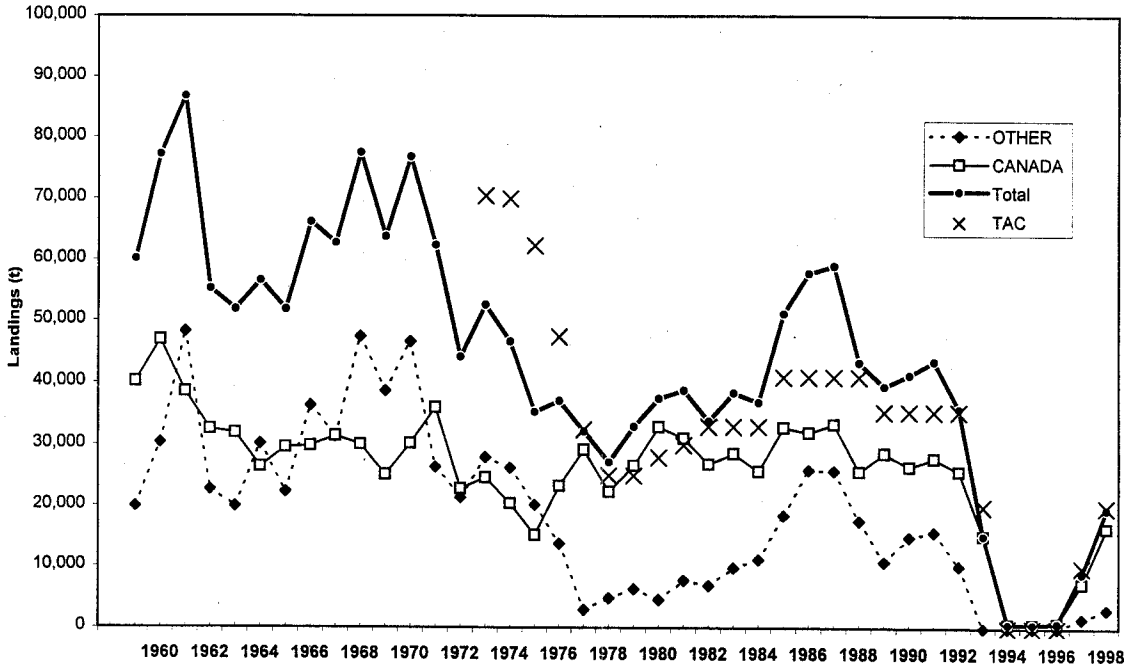


Fig. 3A. TAC and reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdivision 3Ps during 1959-1998

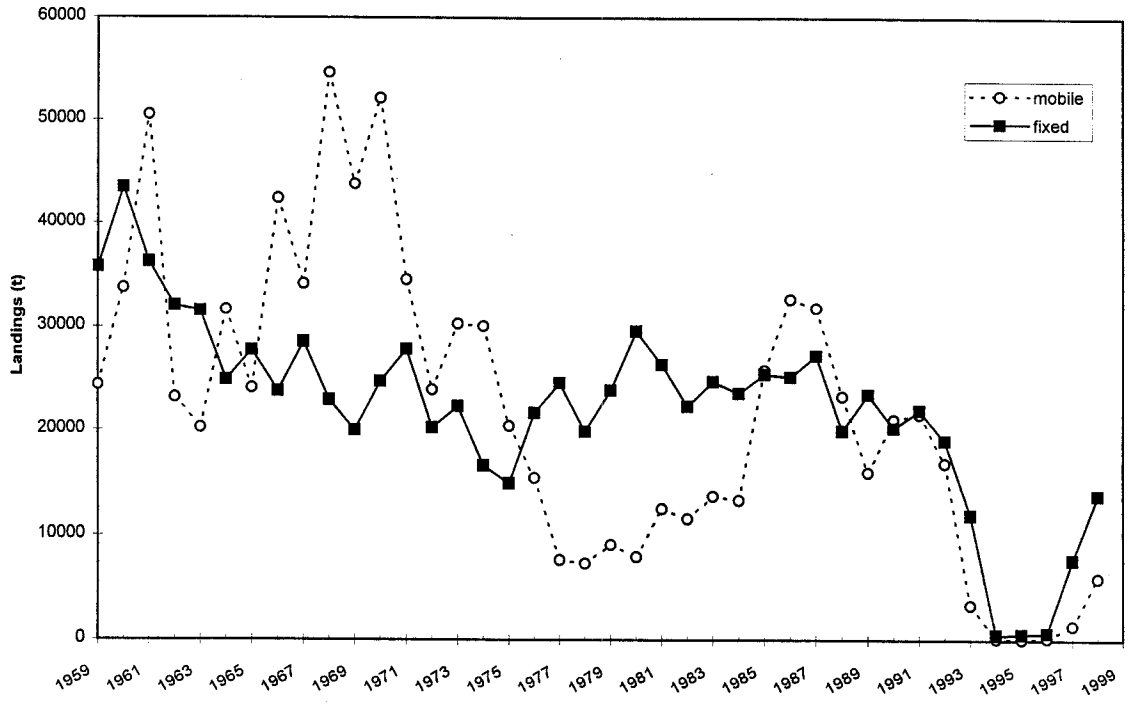


Fig. 3B. Reported landings of cod by fixed and mobile gear in NAFO Subdivision 3Ps during 1959-1998

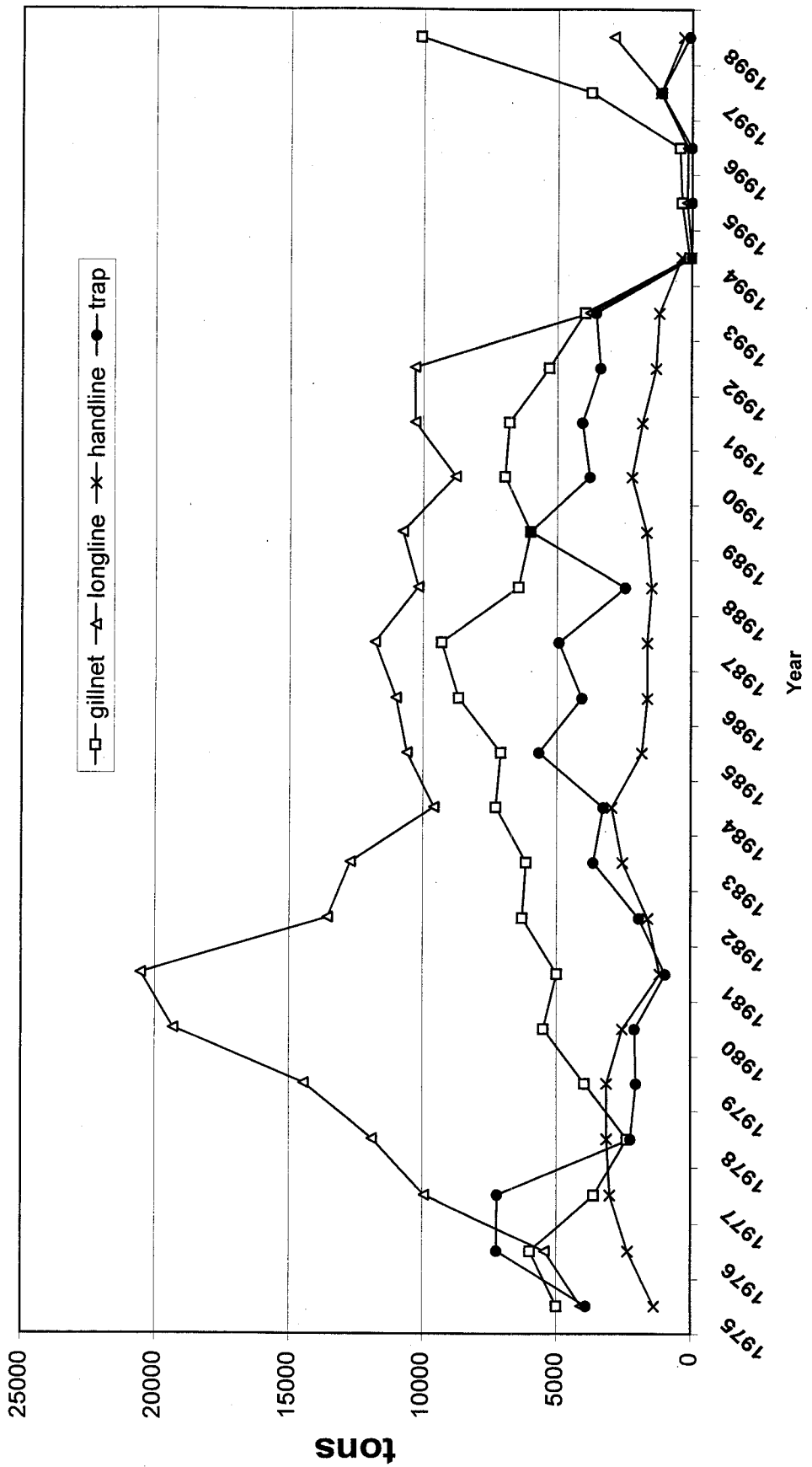


Fig. 4. Reported landings of cod by various fixed gears in NAFO Subdiv. 3Ps during 1975-1998

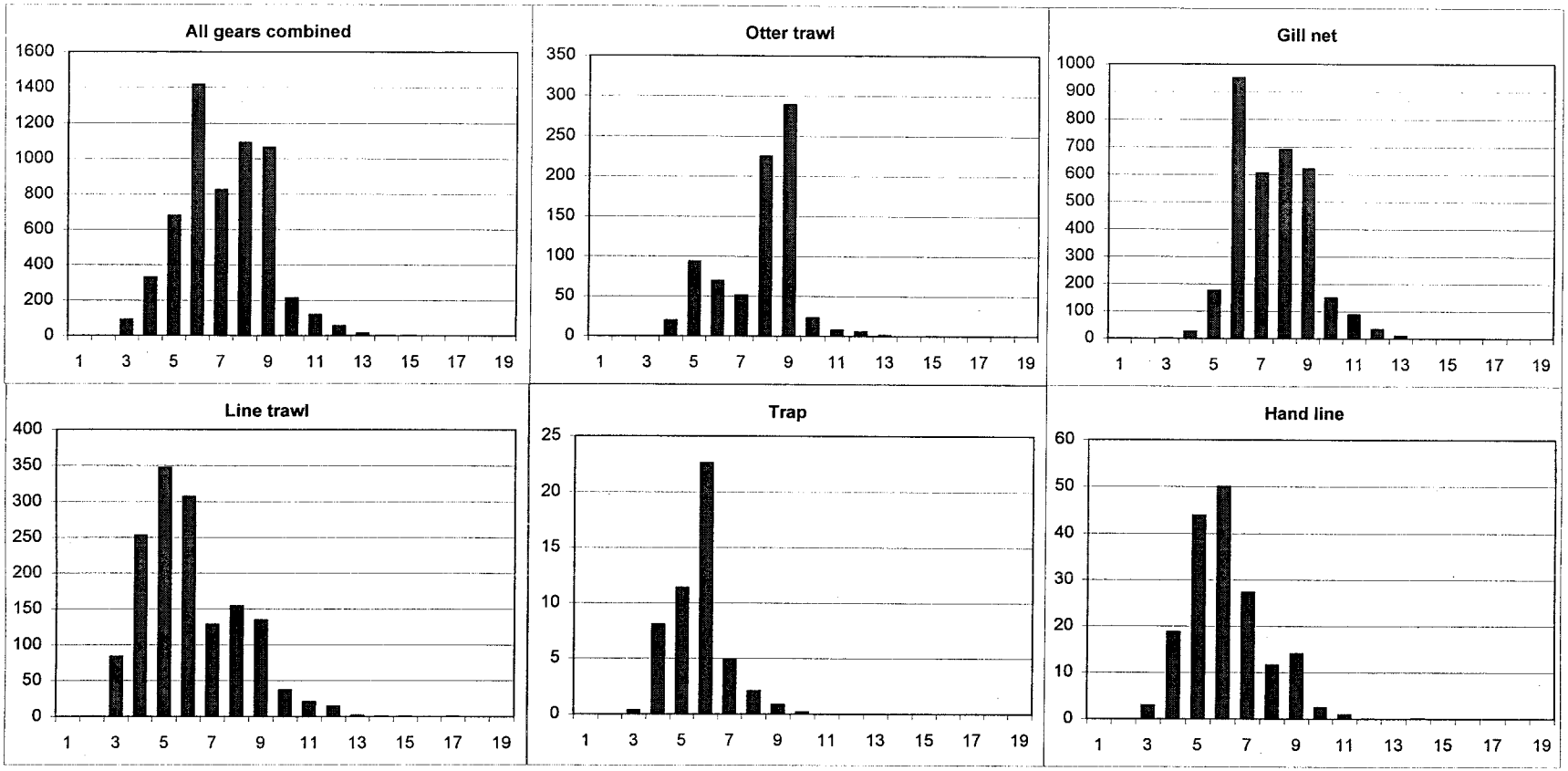
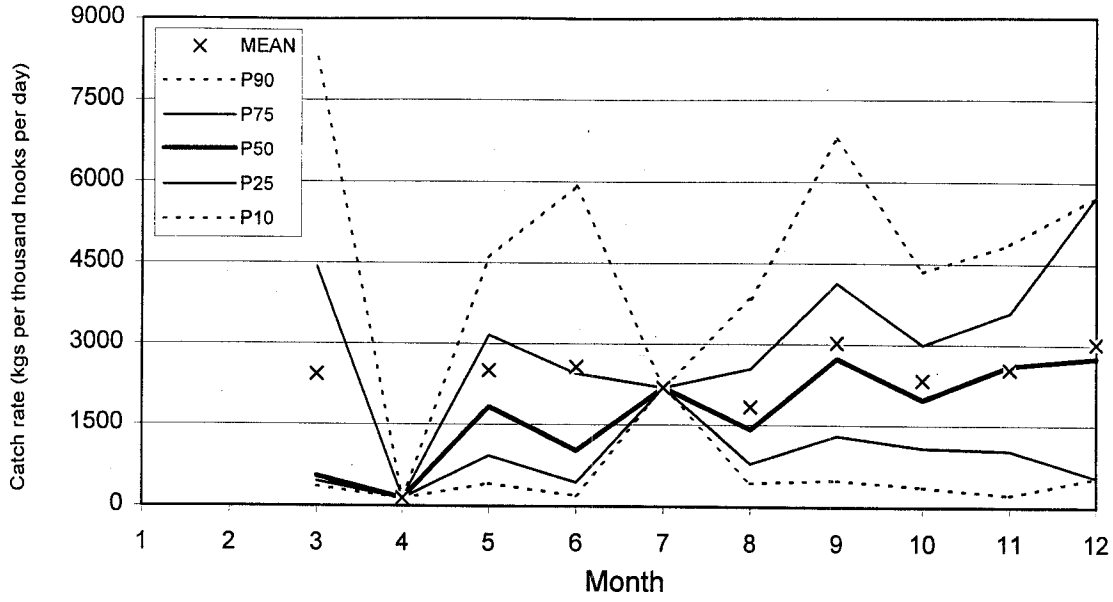
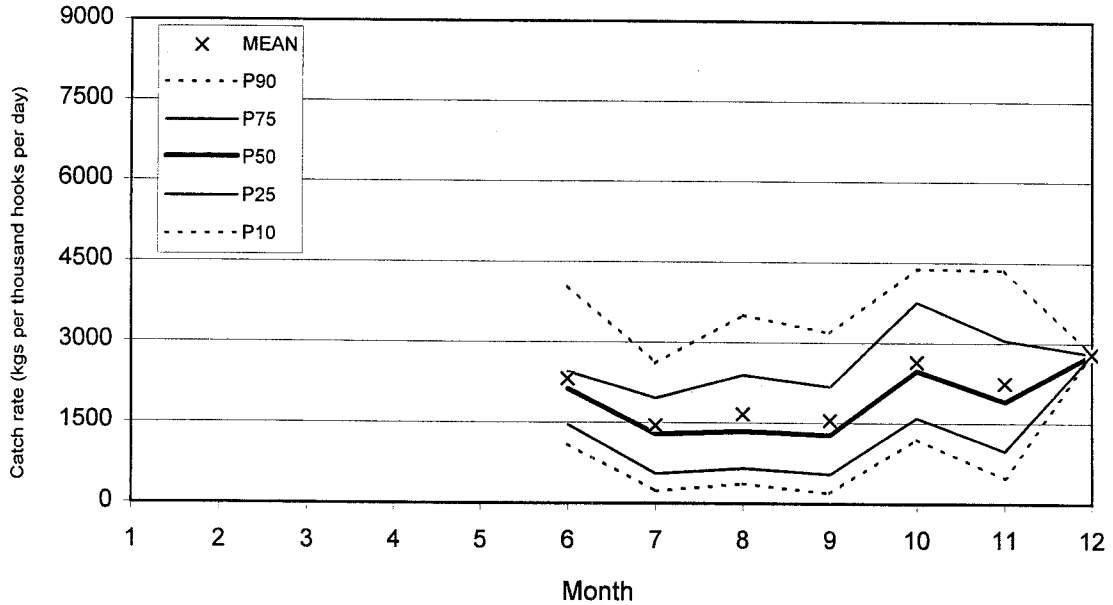


Fig. 5. Canadian commercial catch-at-age (000's) by gear type for the cod fishery in NAFO Subdiv. 3Ps during 1998



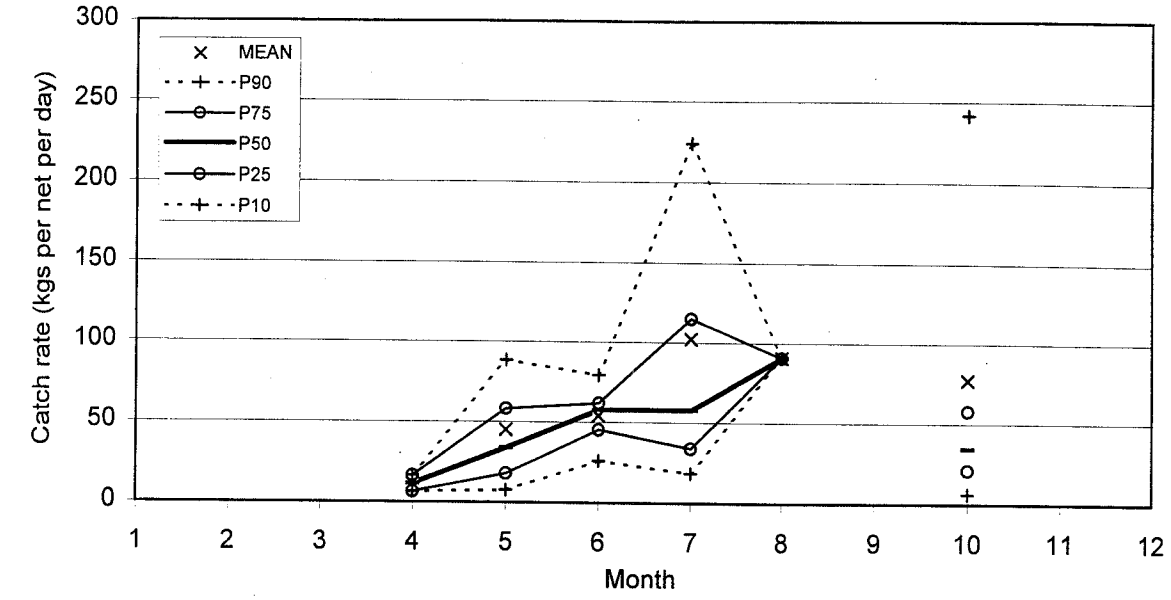
MONTH	1	2	3	4	5	6	7	8	9	10	11	12
N	0	0	4	1	133	98	1	155	49	525	57	3

Fig. 6A. Line-trawl catch rates for 3Psa and 3Psb for 1997 from science logbooks



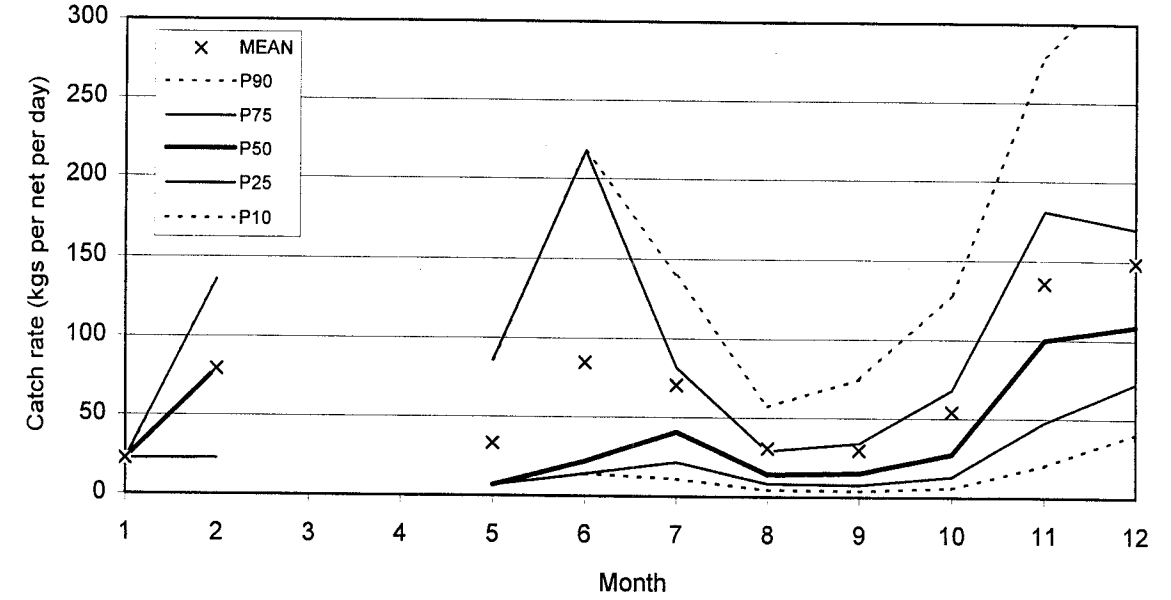
MONTH	1	2	3	4	5	6	7	8	9	10	11	12
N	0	0	0	0	0	38	272	86	1394	10	913	1

Fig 6B. Line-trawl catch rates in 3Psa and 3Psb for 1998 from science logbooks



MONTH	1	2	3	4	5	6	7	8	9	10	11	12
N	0	0	0	2	312	10	153	1	0	26	0	0

Fig. 7A. Gillnet catch rate for 3Psc for 1997 from science logbooks



MONTH	1	2	3	4	5	6	7	8	9	10	11	12
N	1	2	0	0	3	3	2131	617	634	702	476	18

Fig 7B. Gillnet catch rates for 3Psc for 1998 from science logbooks

Fig. 8. Sentinel fishery cpue in NAFO Subdiv. 3Ps, 1995-1998.

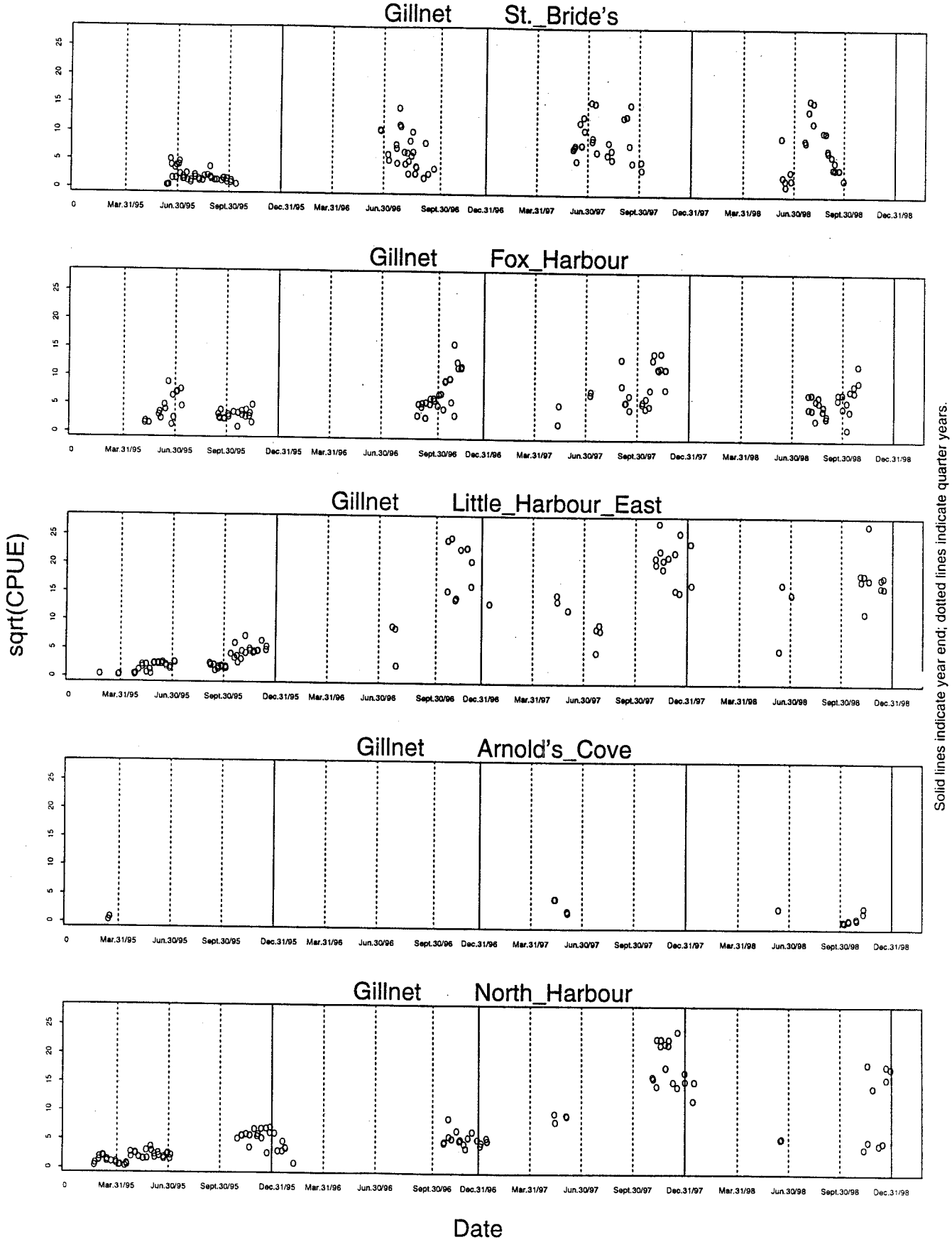


Fig. 8. Cont'd. (Sentinel fishery cpue in NAFO Subdiv. 3Ps, 1995-1998).

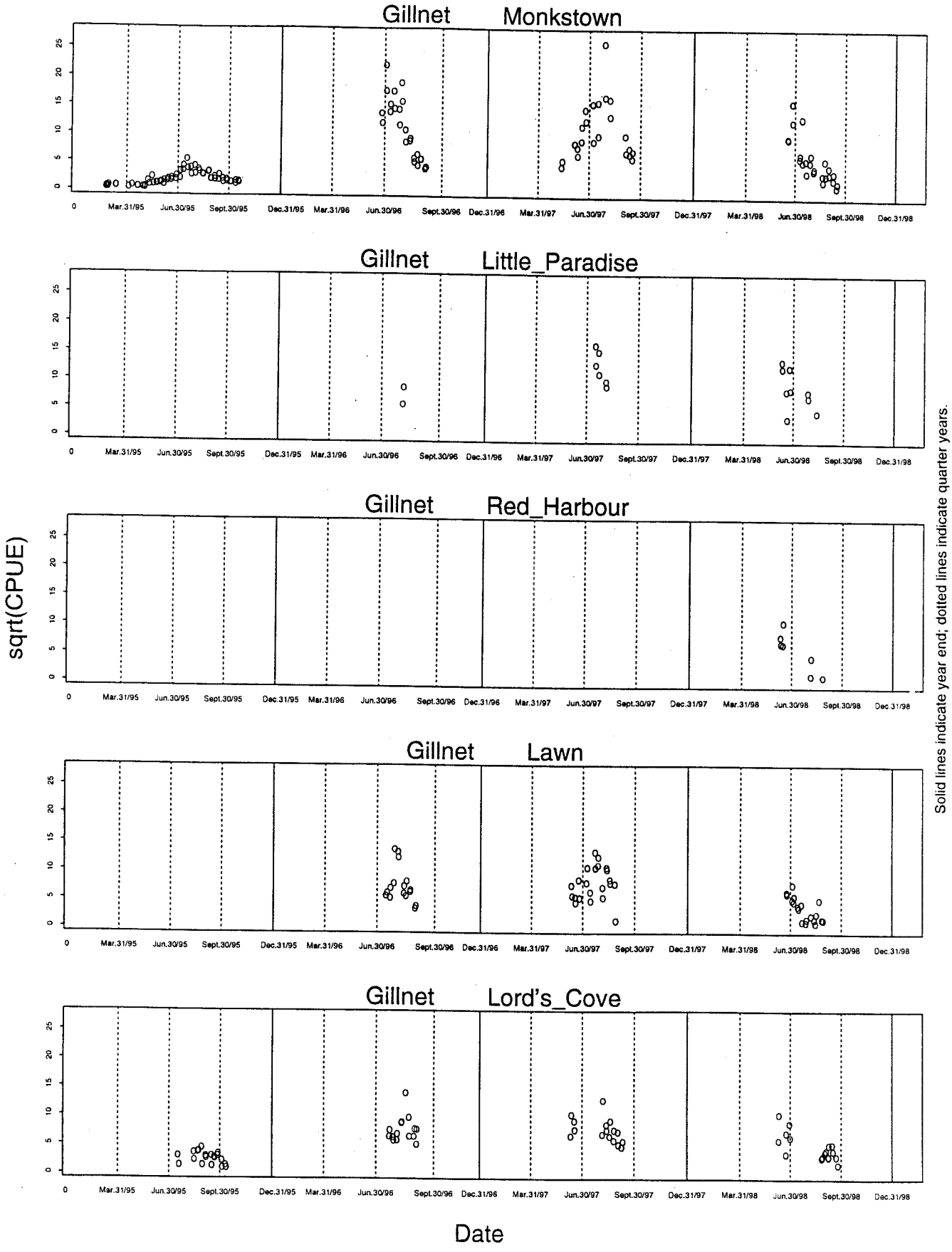


Fig. 8. Cont'd. (Sentinel fishery cpue in NAFO Subdiv. 3Ps, 1995-1998).

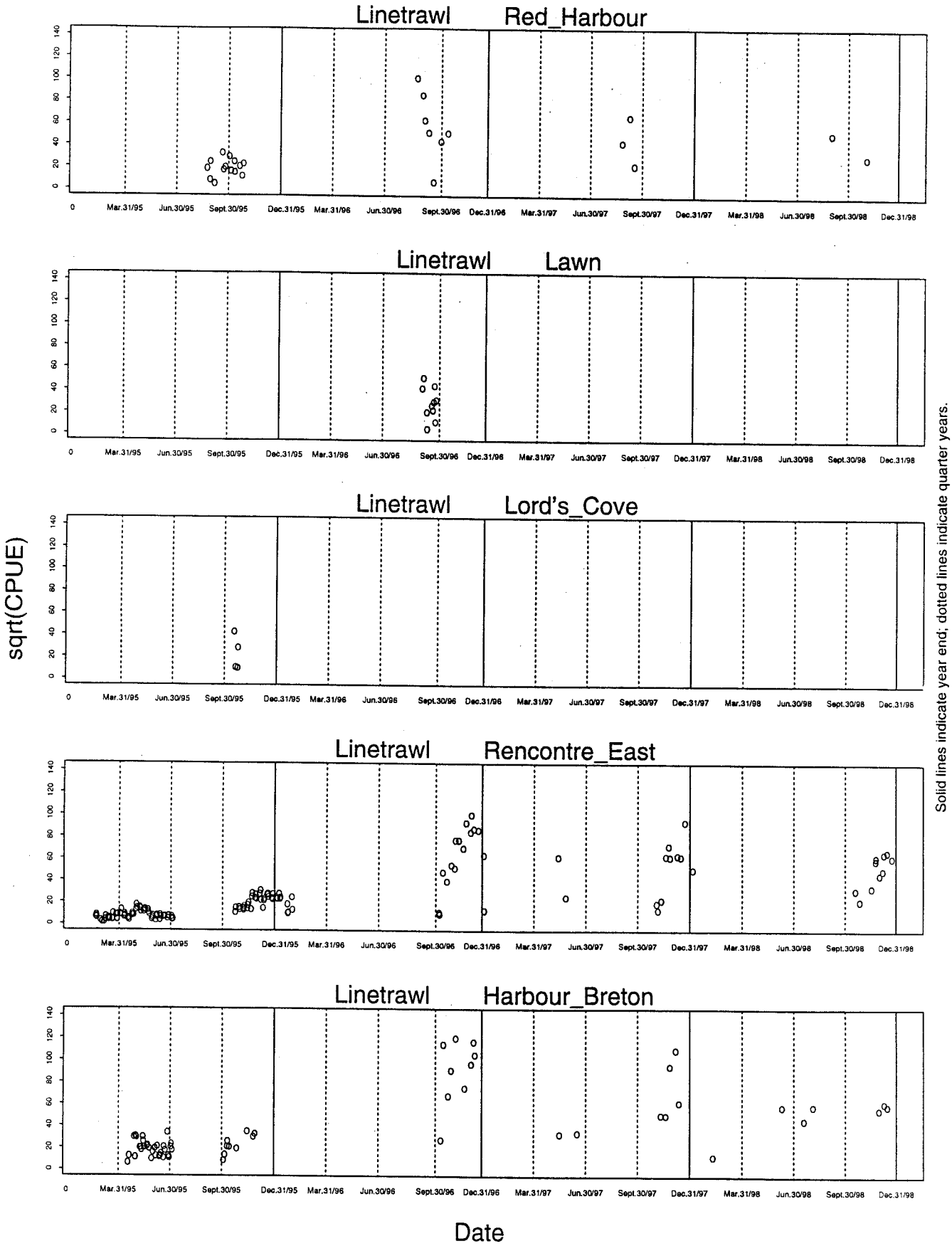


Fig. 8. Cont'd. (Sentinel fishery cpue in NAFO Subdiv. 3Ps, 1995-1998).

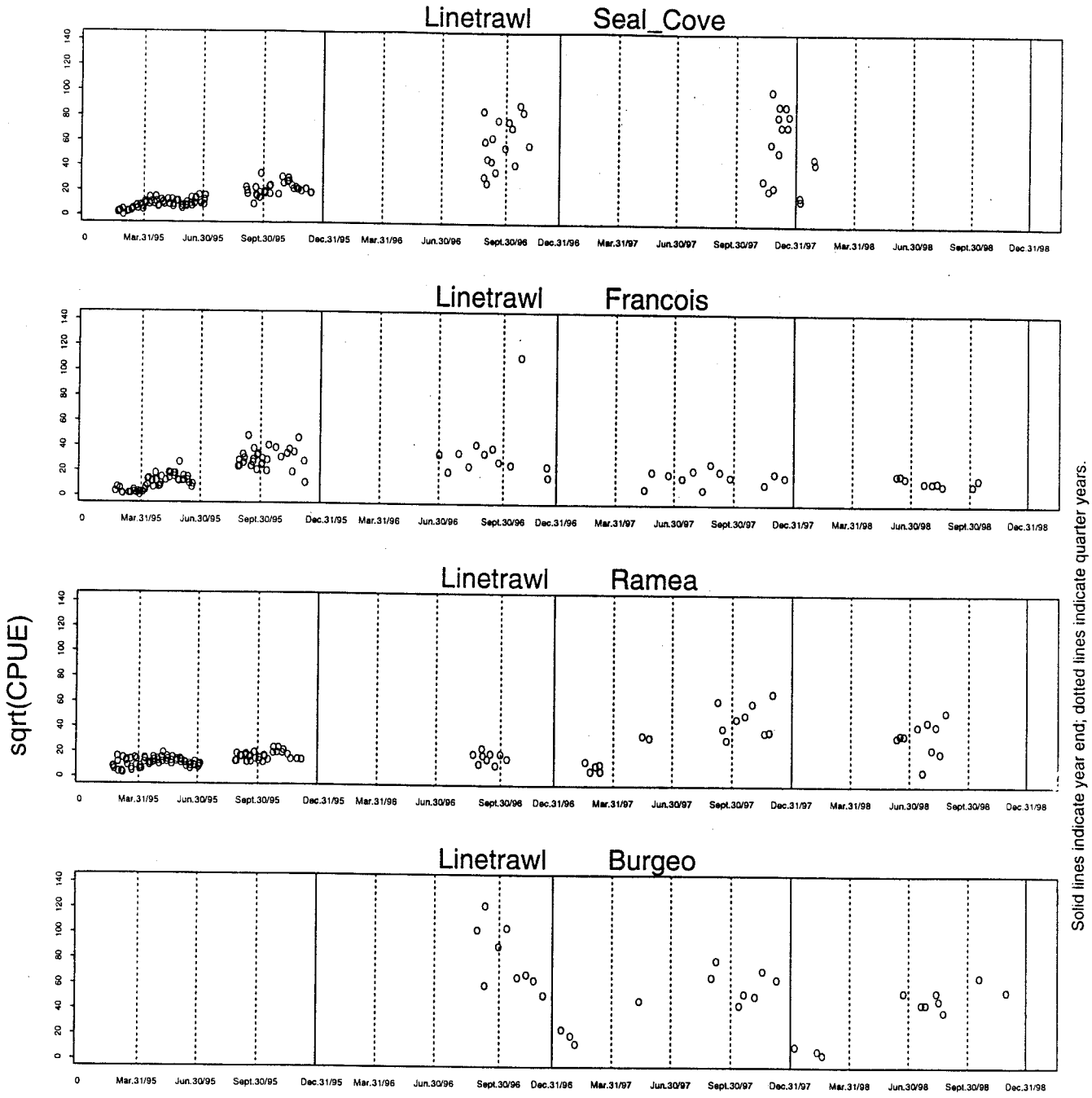
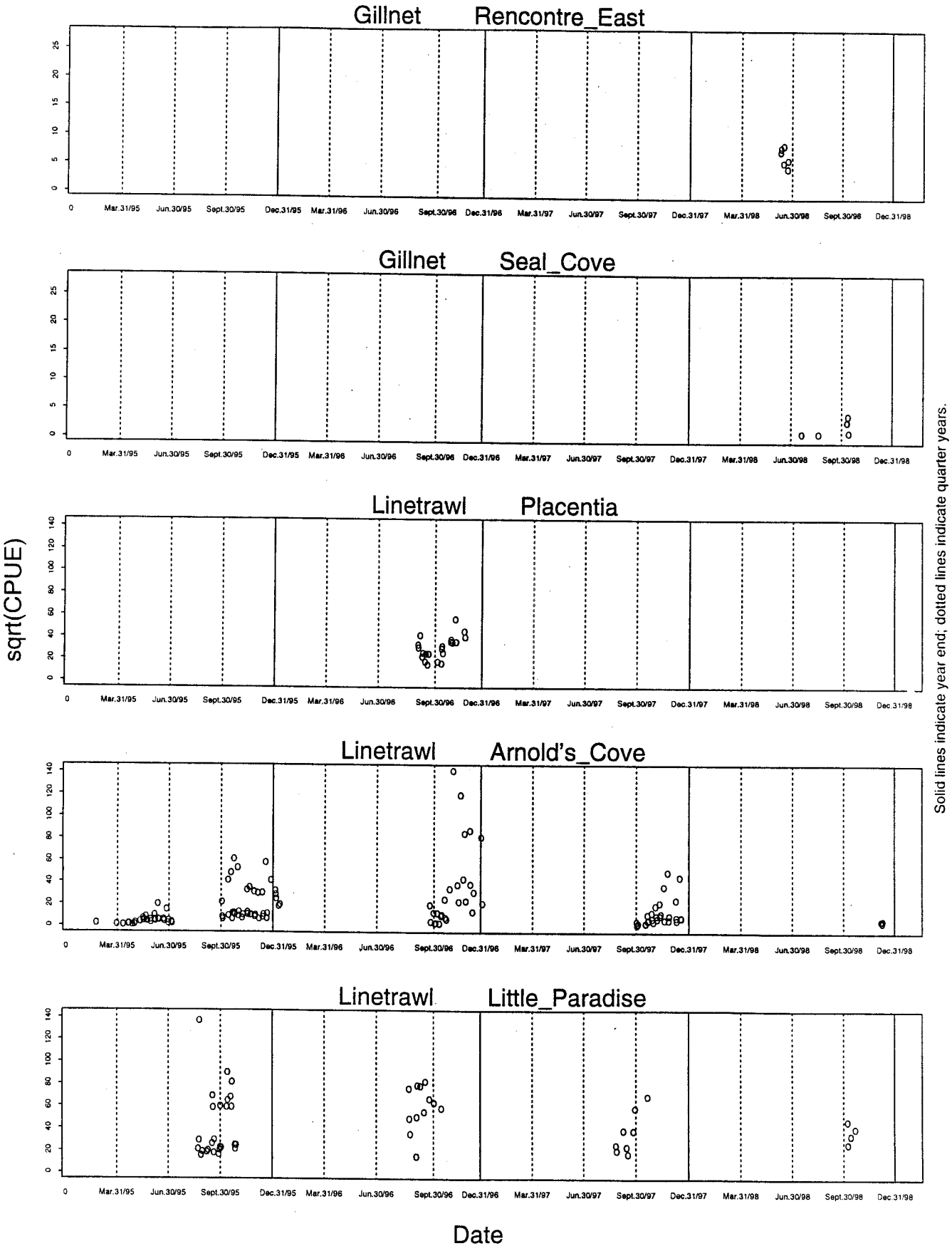


Fig. 8. Cont'd. (Sentinel fishery cpue in NAFO Subdiv. 3Ps, 1995-1998).



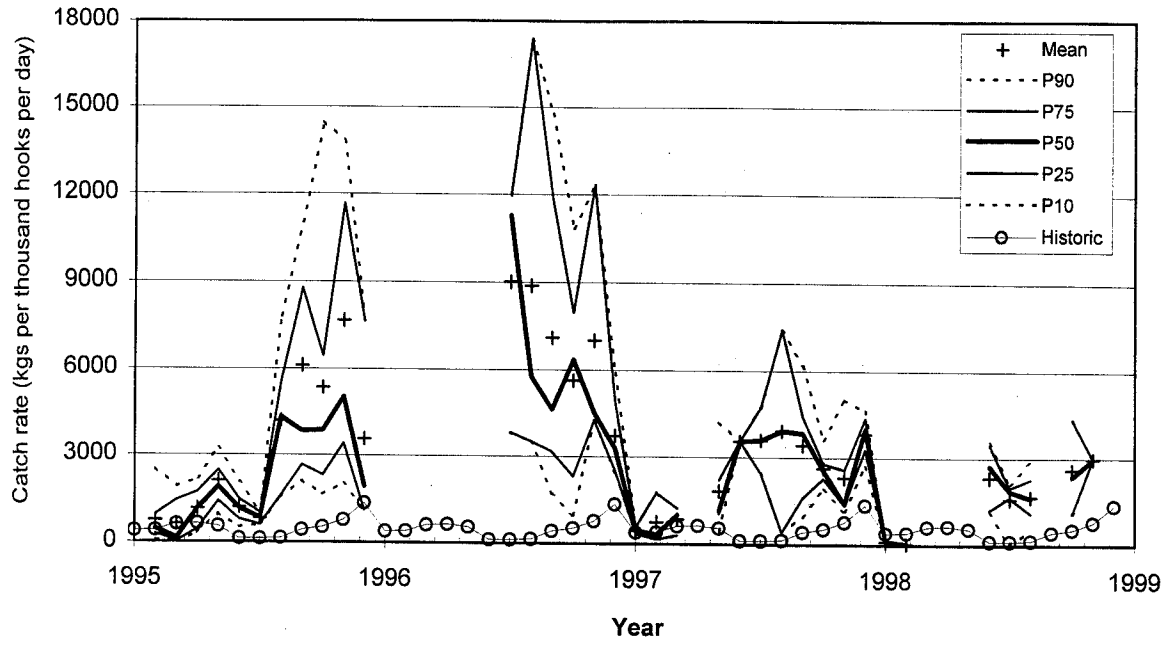


Fig. 9A. Sentinel line-trawl catch rates in 3Psa (west of Fortune Bay).

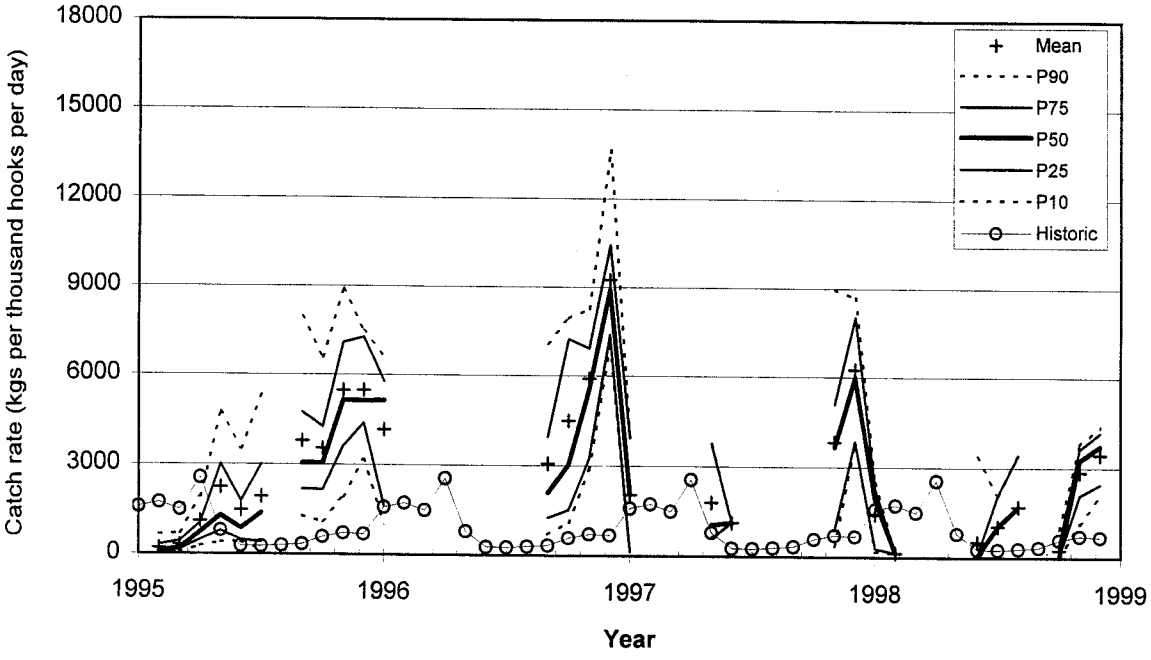


Fig. 9B. Sentinel line-trawl catch rates in 3Psb (Fortune Bay).

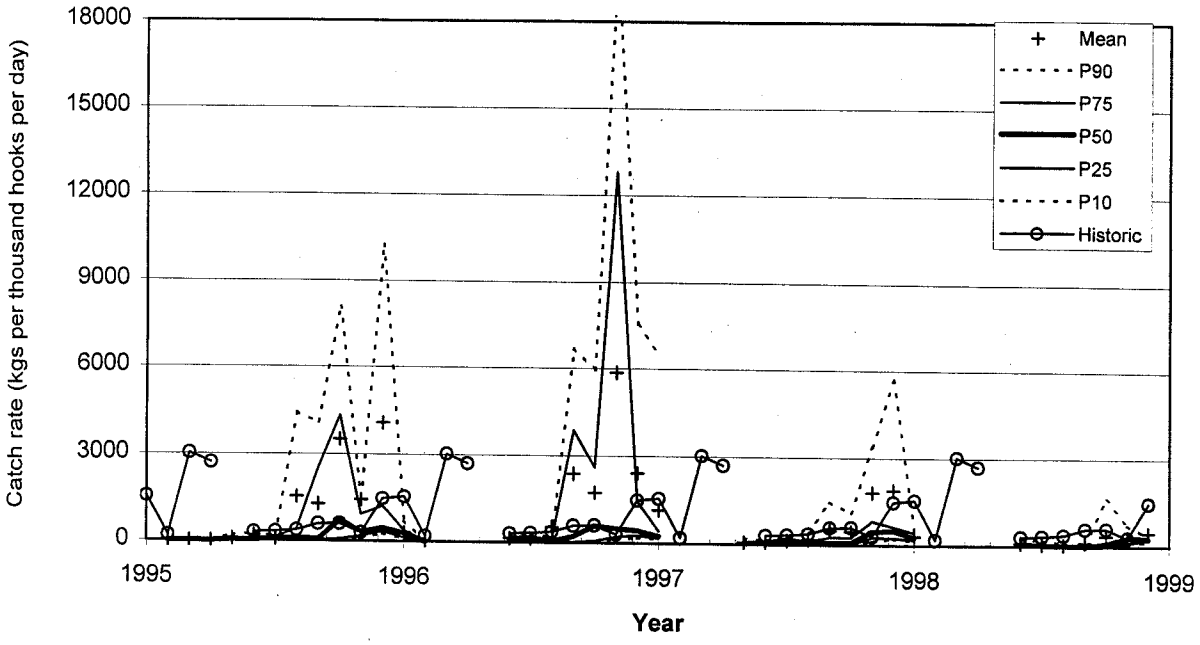


Fig. 9C. Sentinel line-trawl catch rates in 3Psc (Placentia Bay).

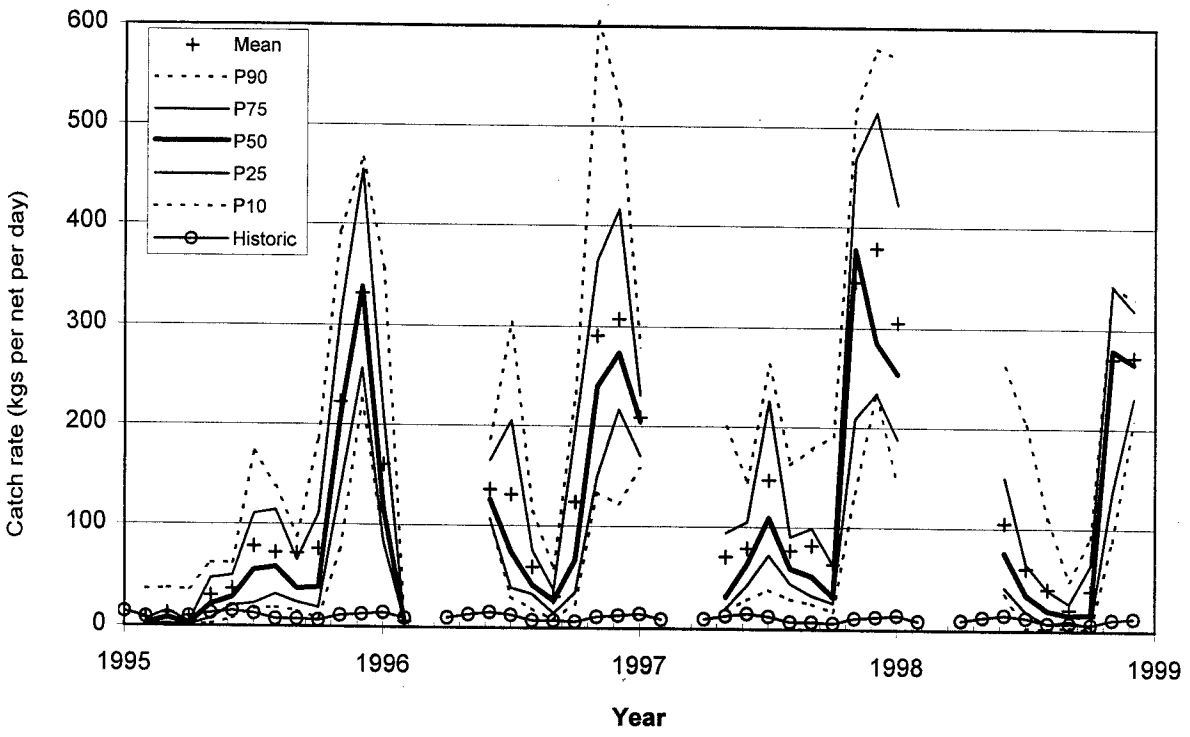


Fig. 9D. Sentinel gillnet catch rates in 3Psc (Placentia Bay).

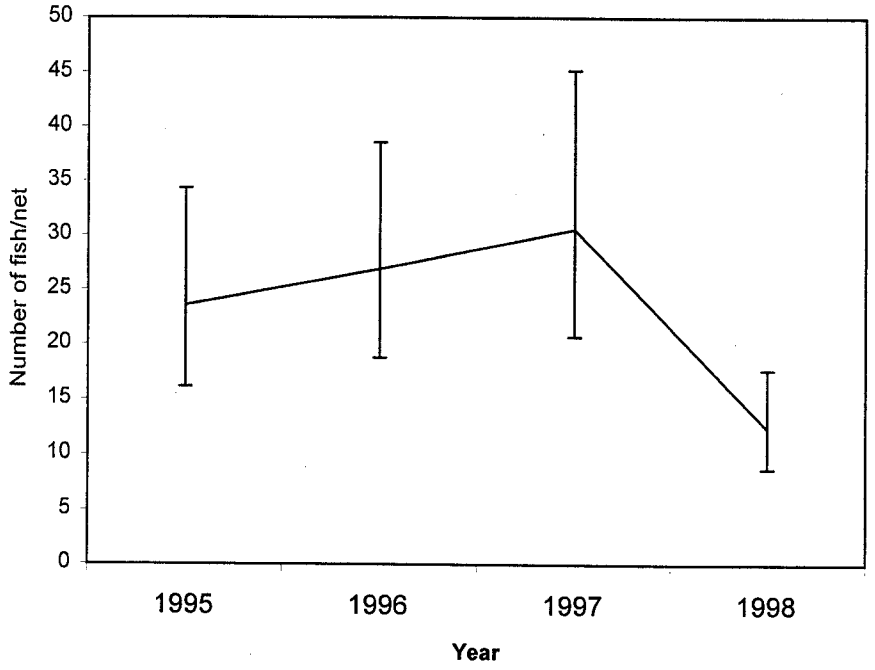


Fig. 10A. Standardized gillnet catch rate from sentinel fishery in NAFO Subdiv. 3Ps.

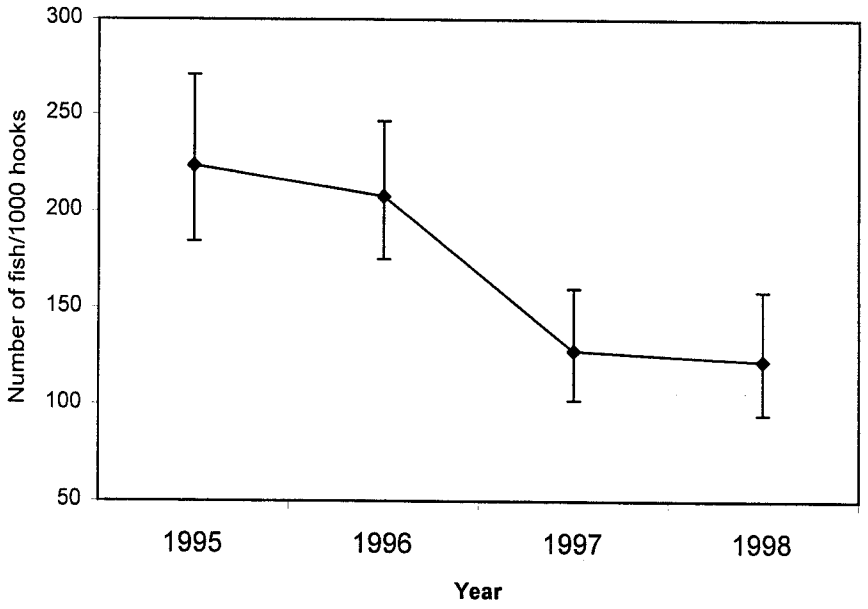


Fig. 10B. Standardized line-trawl catch rate from sentinel fishery in NAFO Subdiv. 3Ps.

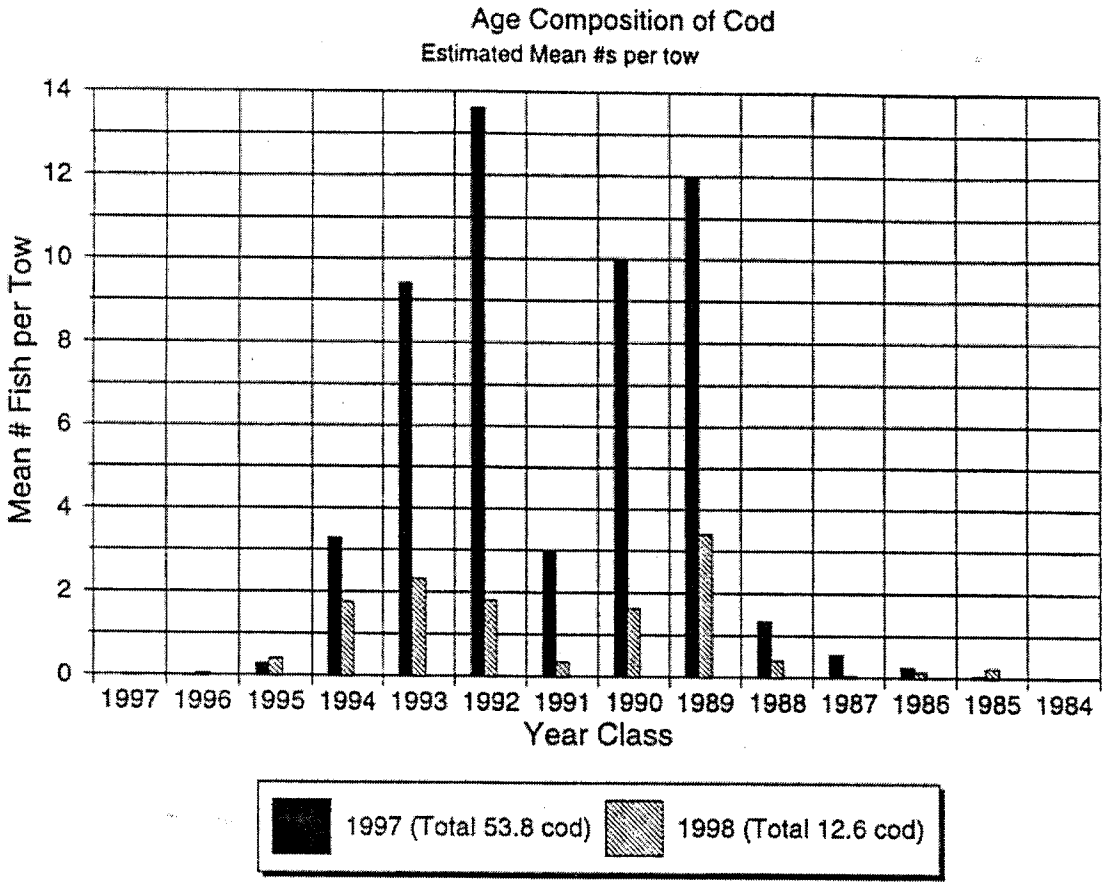


Fig. 11. Age composition (mean numbers per tow) of catch from GEAC trawl surveys conducted in NAFO Subdiv. 3Ps during fall 1997 and fall 1998.

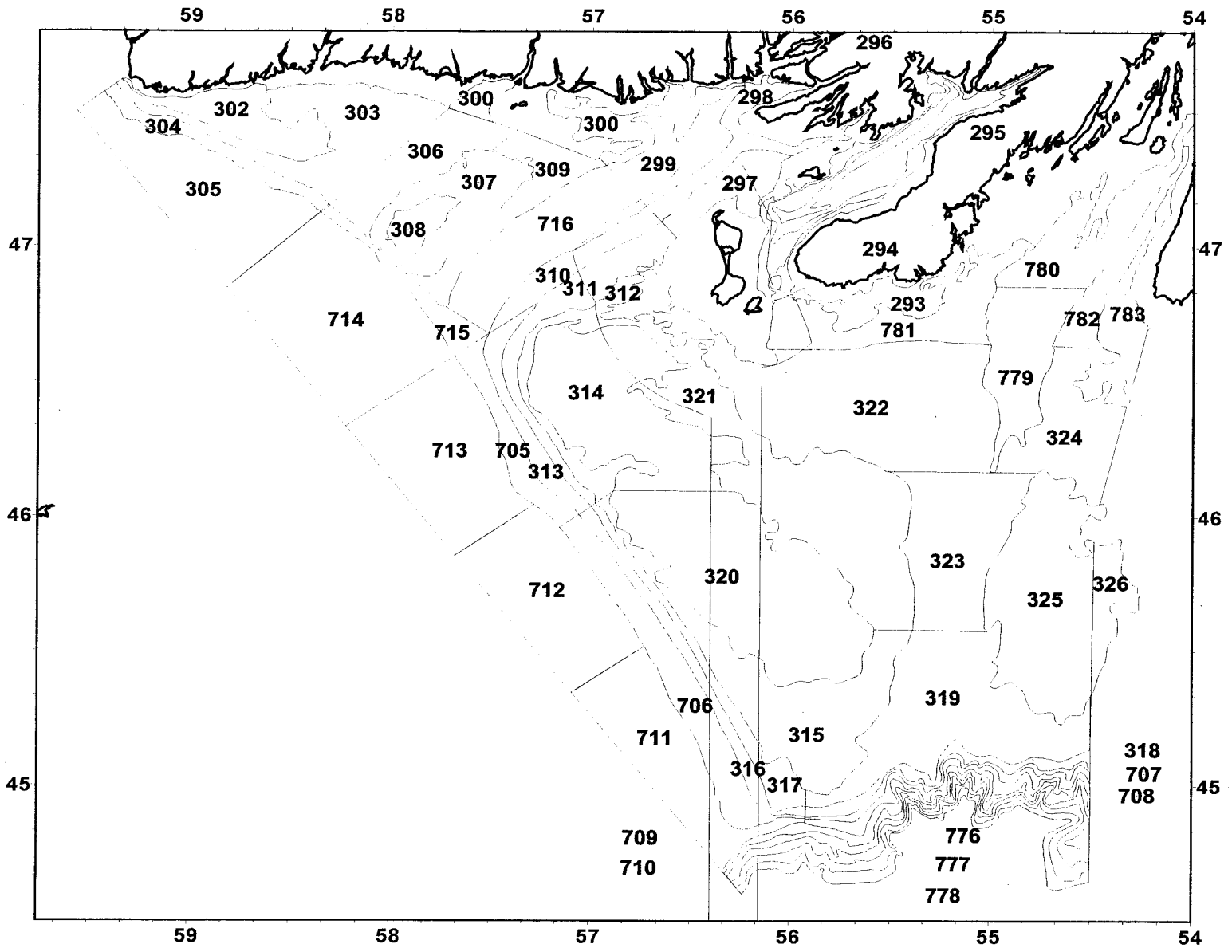
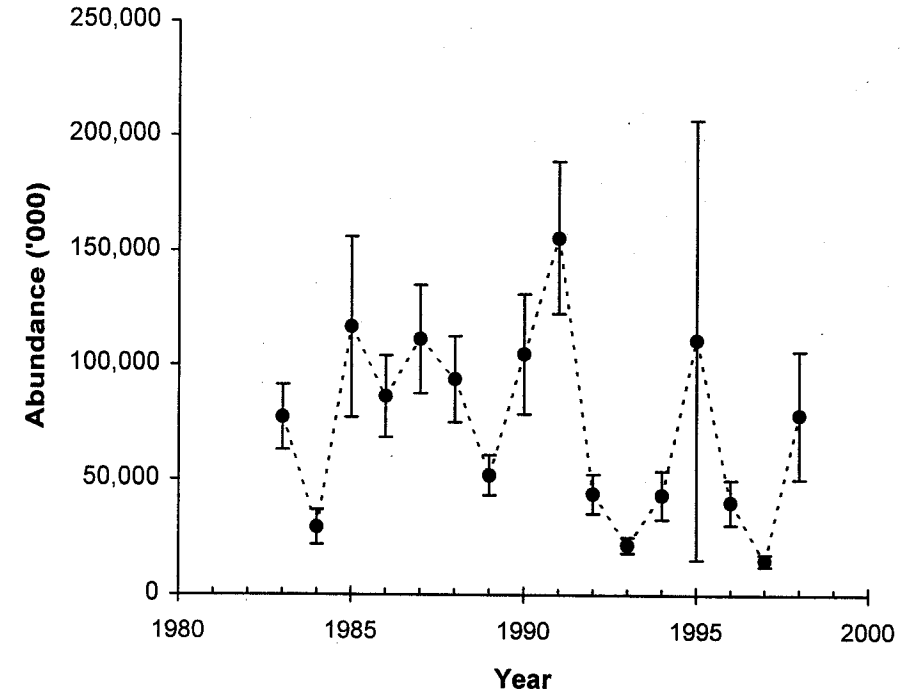


Fig. 12. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdiv. 3Ps (revised March 1999).



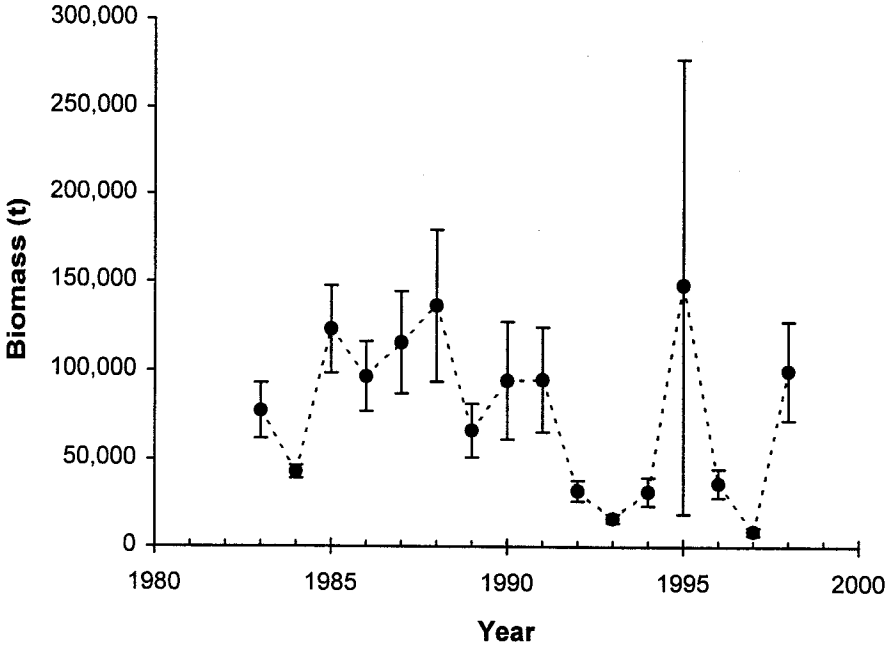


Fig. 13. Abundance and biomass estimates of cod in NAFO Subdiv. 3Ps from DFO research vessel bottom-trawl surveys during winter/spring from 1983 to 1998. Error bars show plus and minus one standard deviation.

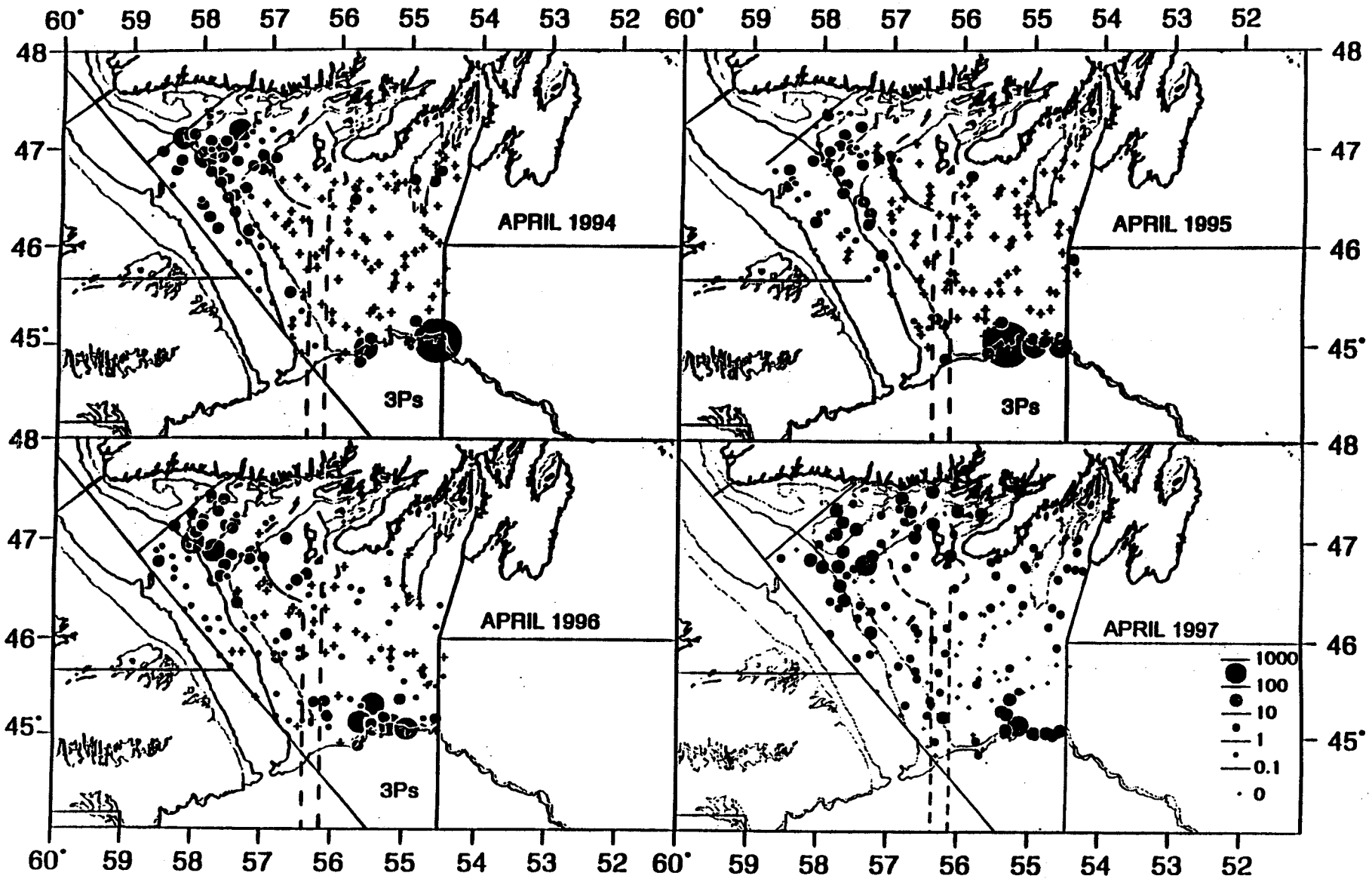


Figure 14. Distribution of cod catches (number per tow) during the Canadian Research Vessel Survey in NAFO Subdivision 3Ps

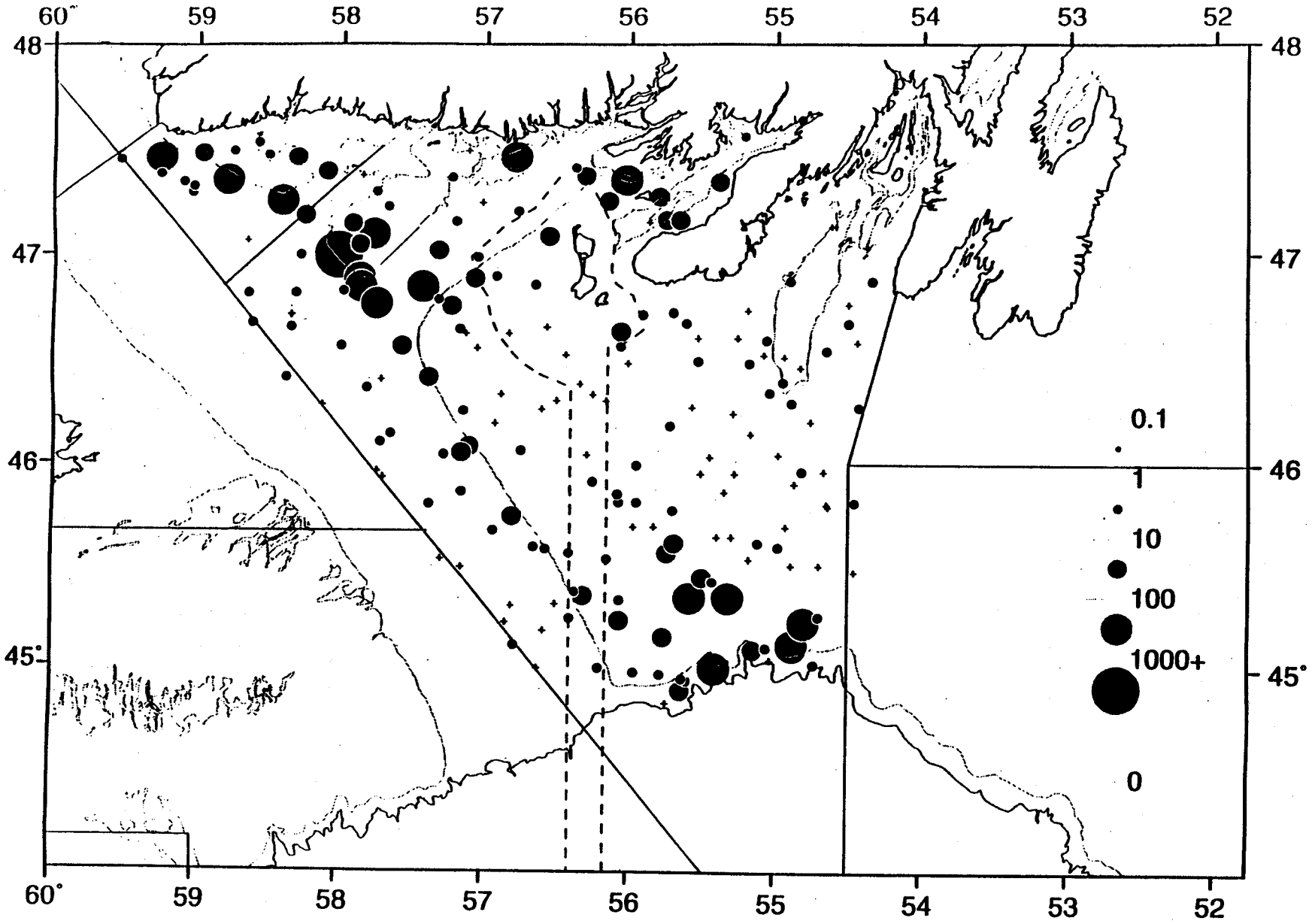


Figure 15. Distribution of cod catches (number per tow) during the Canadian Research Vessel Survey in NAFO Subdivision 3Ps during 1998

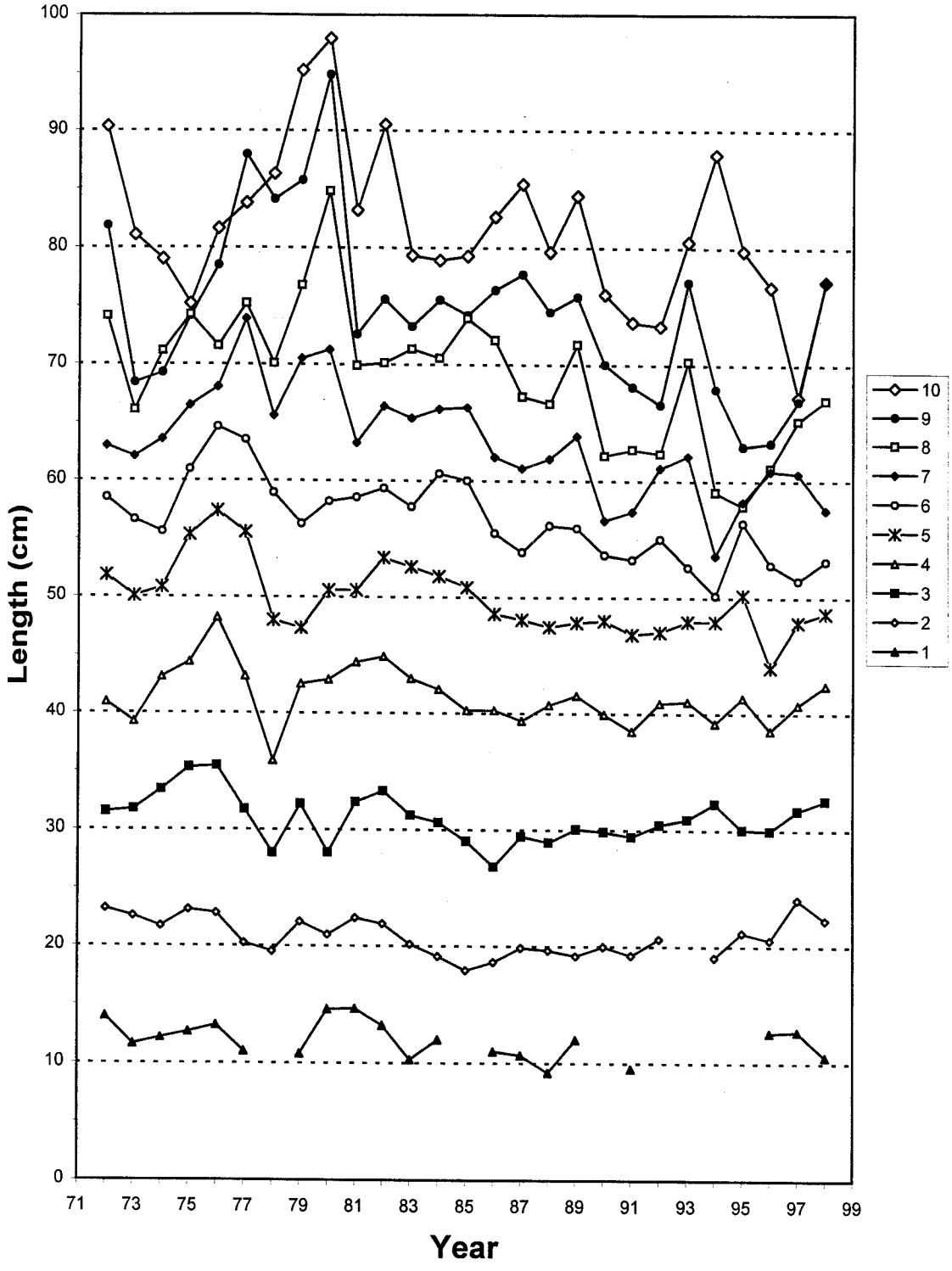


Fig. 16. Mean length-at-age of cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps during winter/spring from 1972-1998.

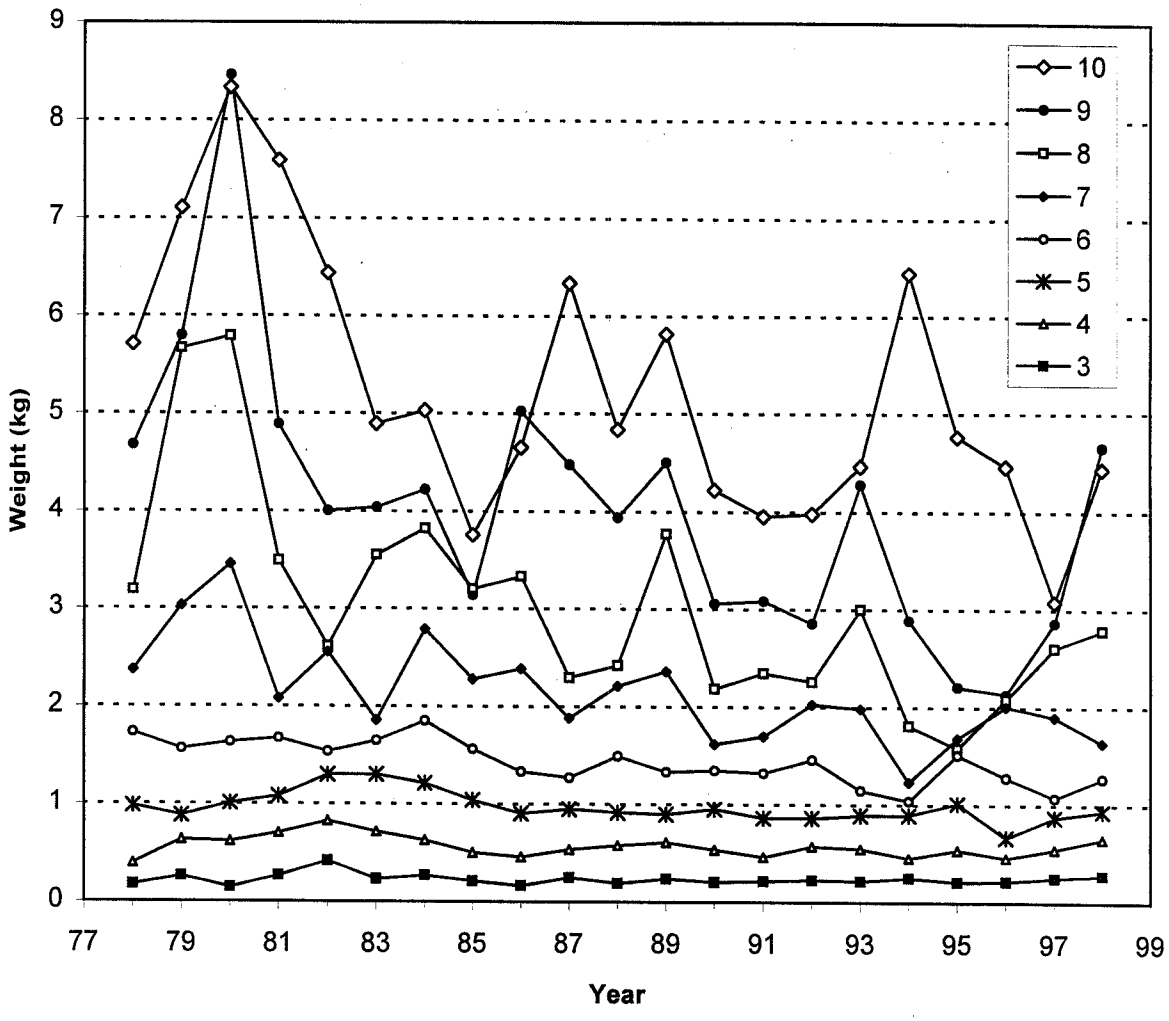


Fig. 17. Mean round weight-at-age (kg) of cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps in winter-spring during 1978-1998.

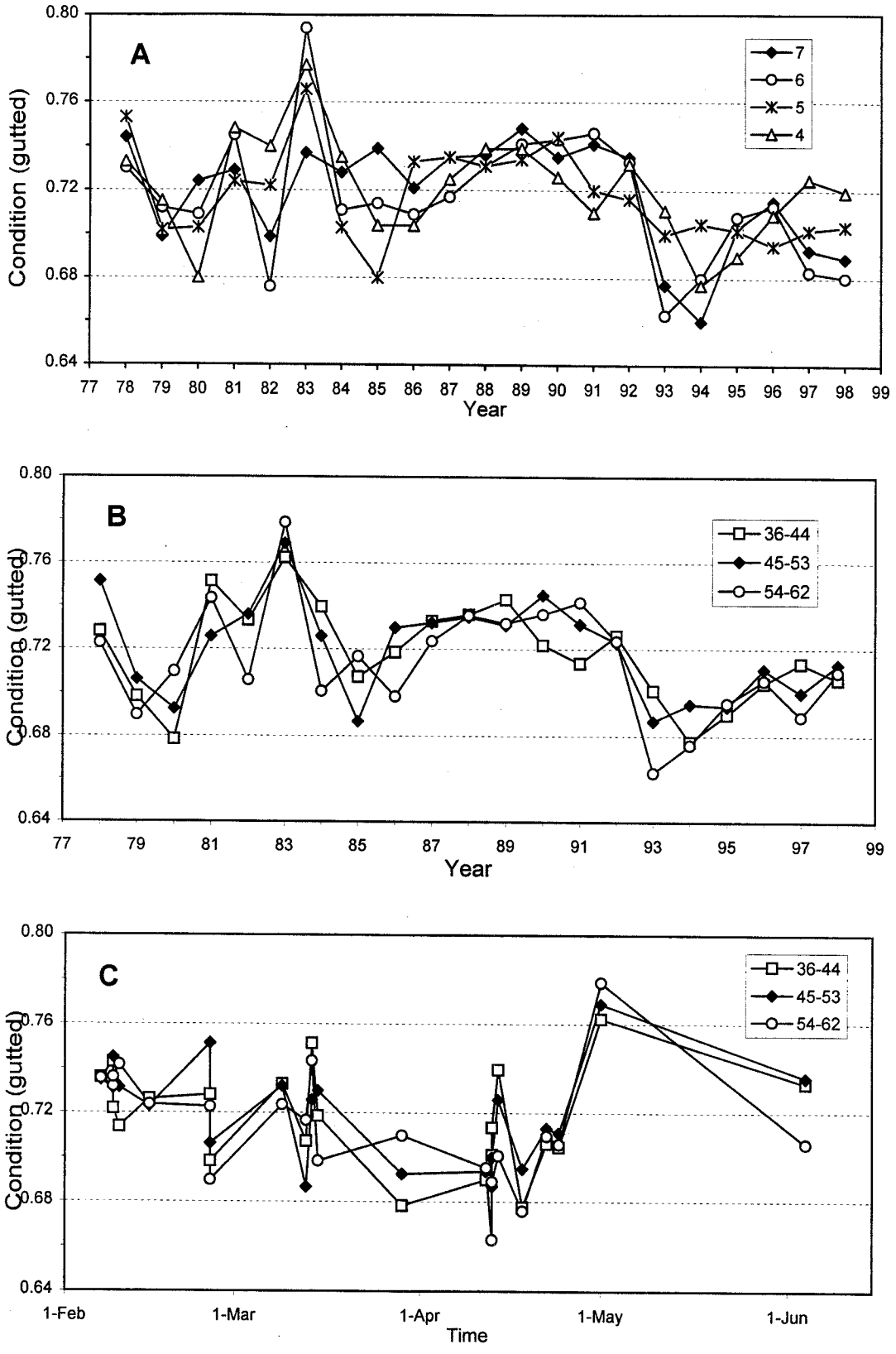


Fig. 18. Mean gutted condition of cod sampled during DFO bottom-trawl surveys in NAFO Subdiv. 3Ps during winter/spring from 1978-1998, by age and year (A), by length-group and year (B), and by length-group and median date of collection (C).

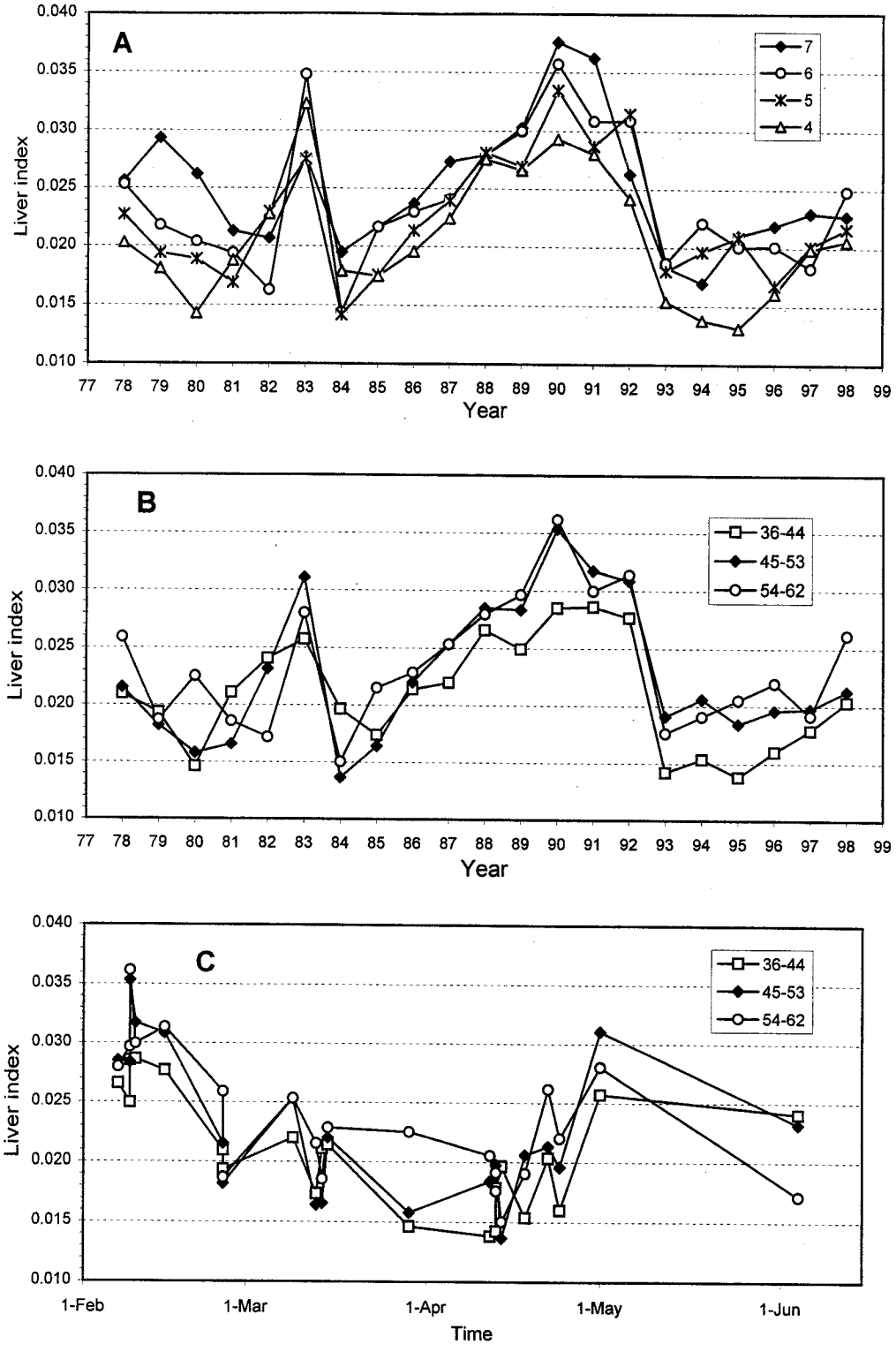


Fig. 19. Mean liver index of cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps during winter/spring from 1978-1998, by age and year (A), by length-group and year (B), and by length-group and median date of collection (C).

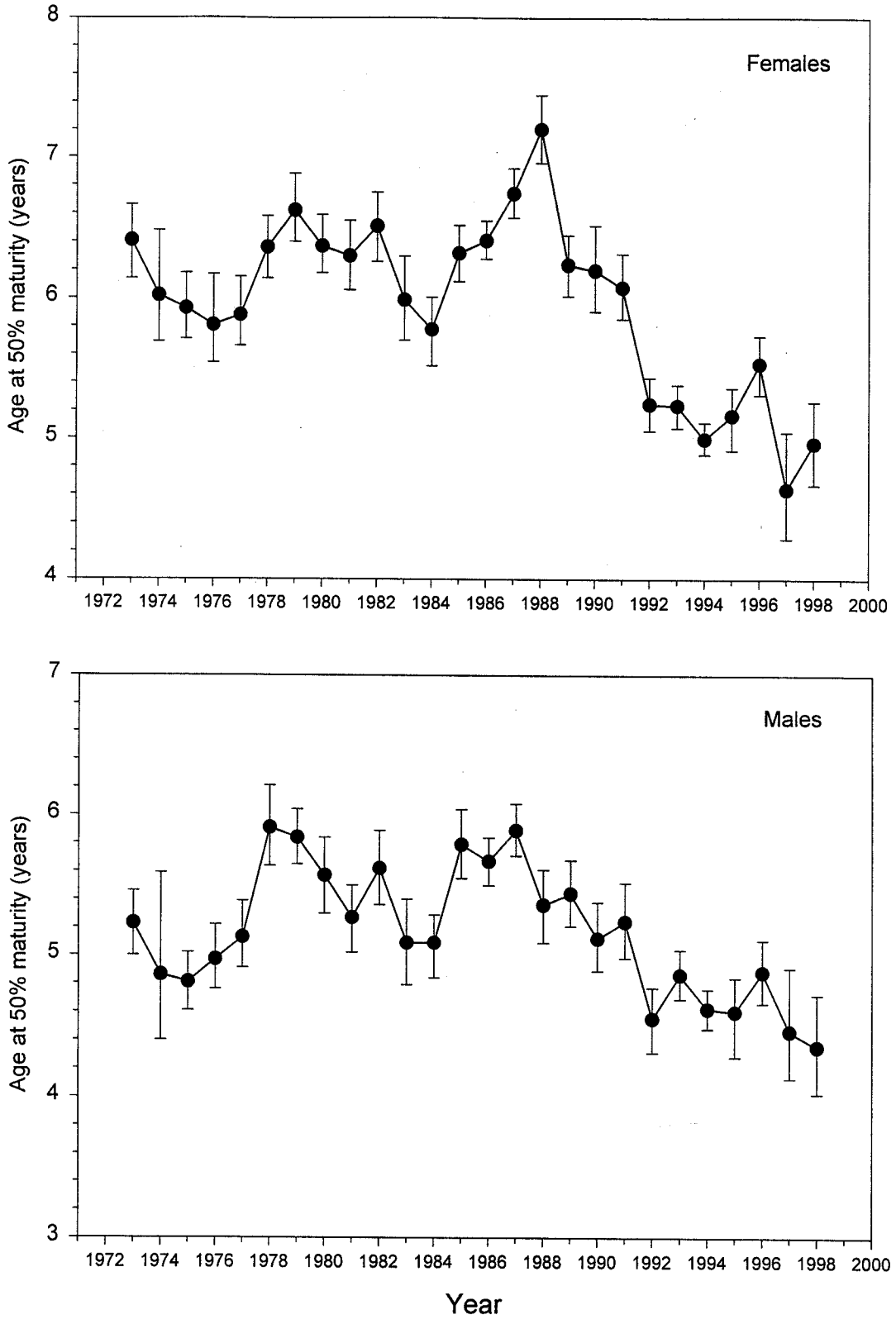


Fig. 20. Age at 50% maturity for cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps from 1972-1998. Error bars are upper and lower 95% confidence intervals.

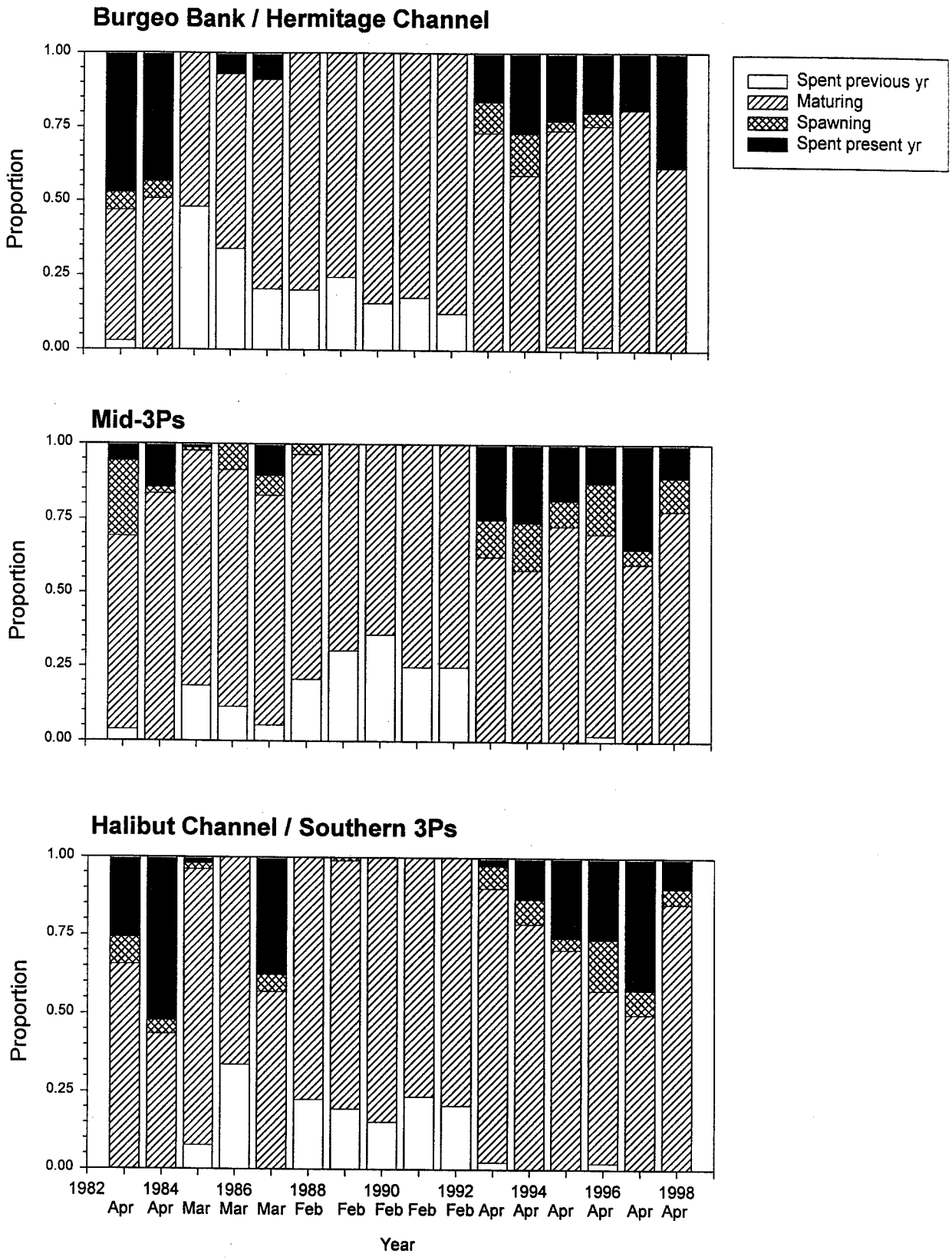


Fig. 21. Maturity stages of cod sampled during DFO research vessel bottom-trawl surveys in three areas of 3Ps during winter/spring 1983-98. Lower x-axis scale is midpoint month of survey. There were two surveys in 1993; only the April one is shown here.

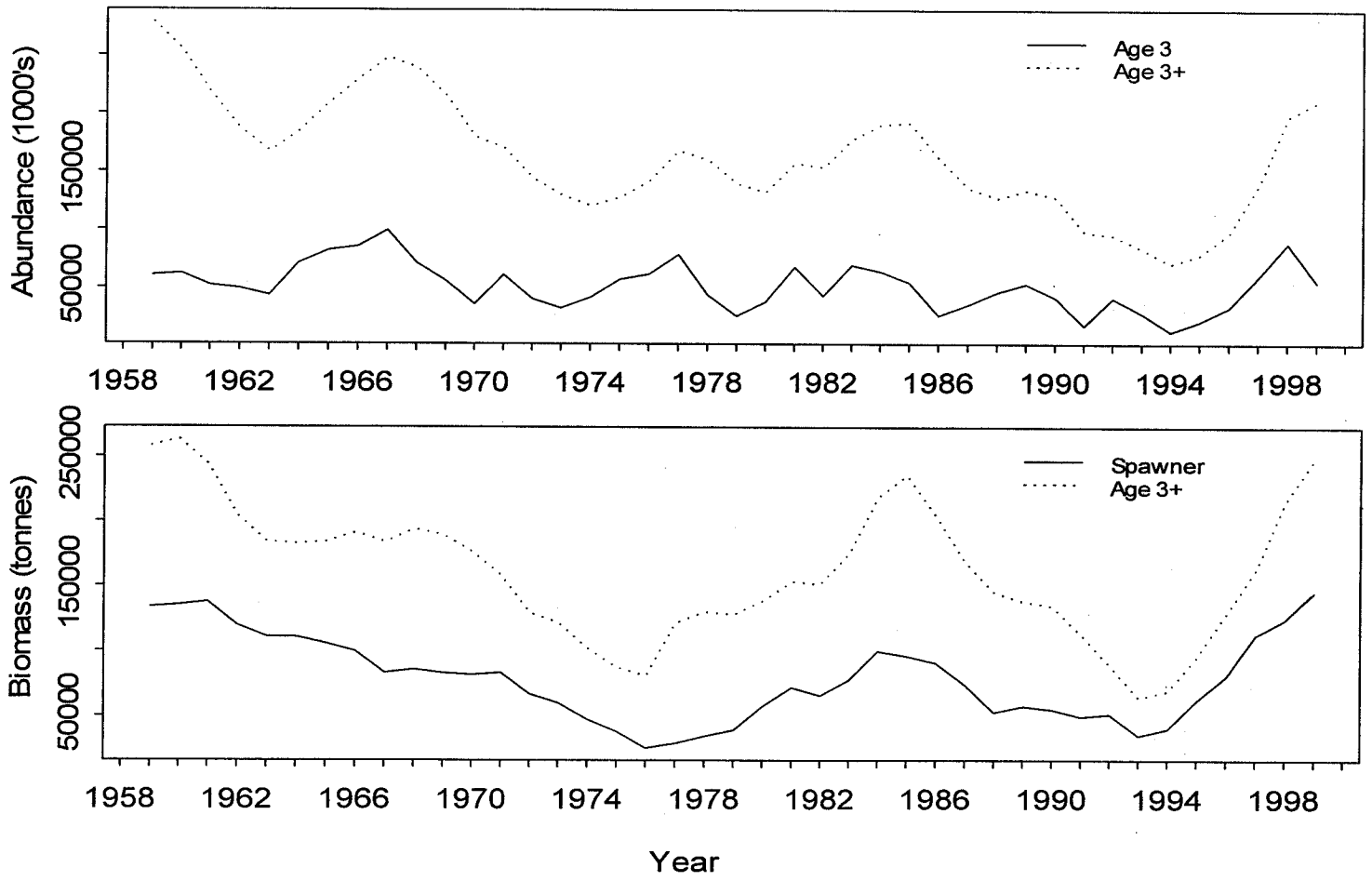


Figure 22. Annual QLSPA estimates of population abundance, recruitment, biomass, and spawner biomass.

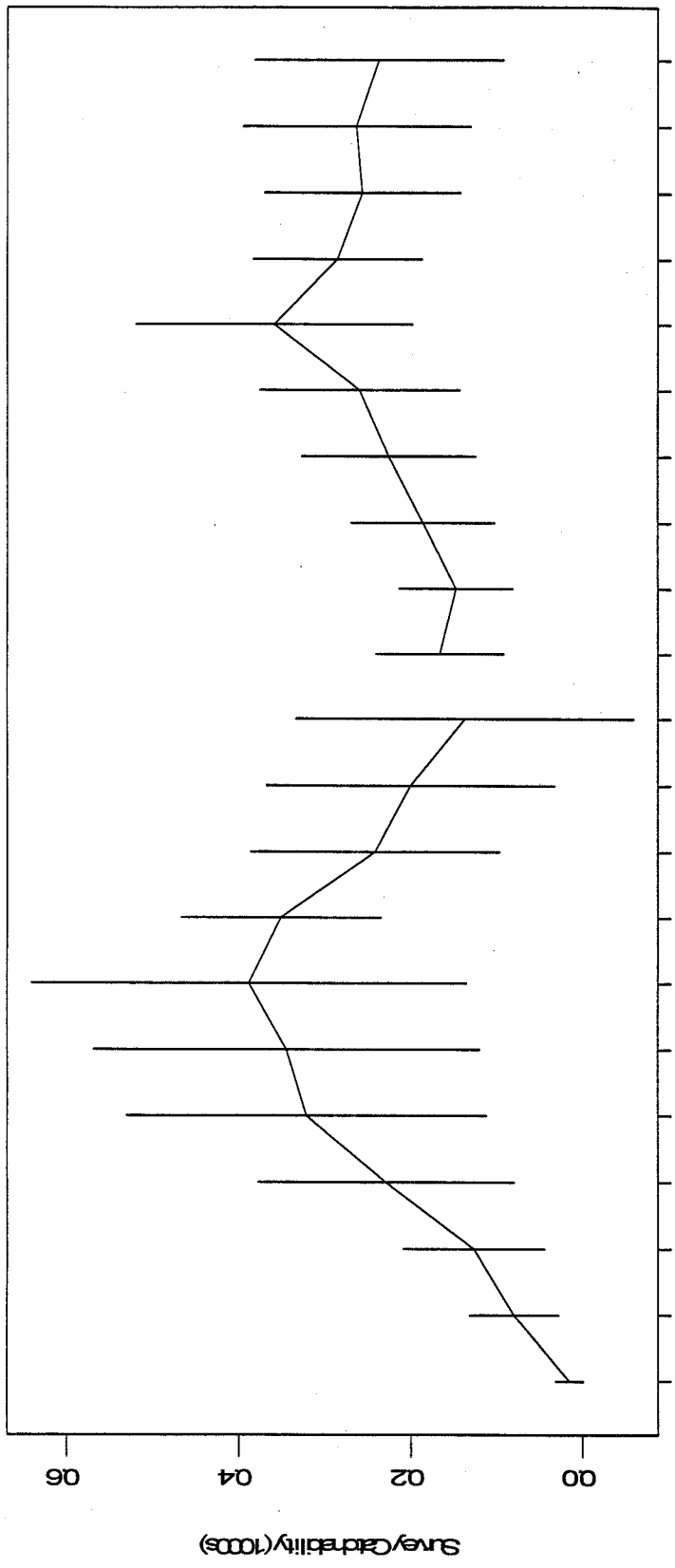


Figure 23. Estimated survey catchabilities-at-age, for winter and spring surveys. Vertical lines mark 95% confidence intervals.

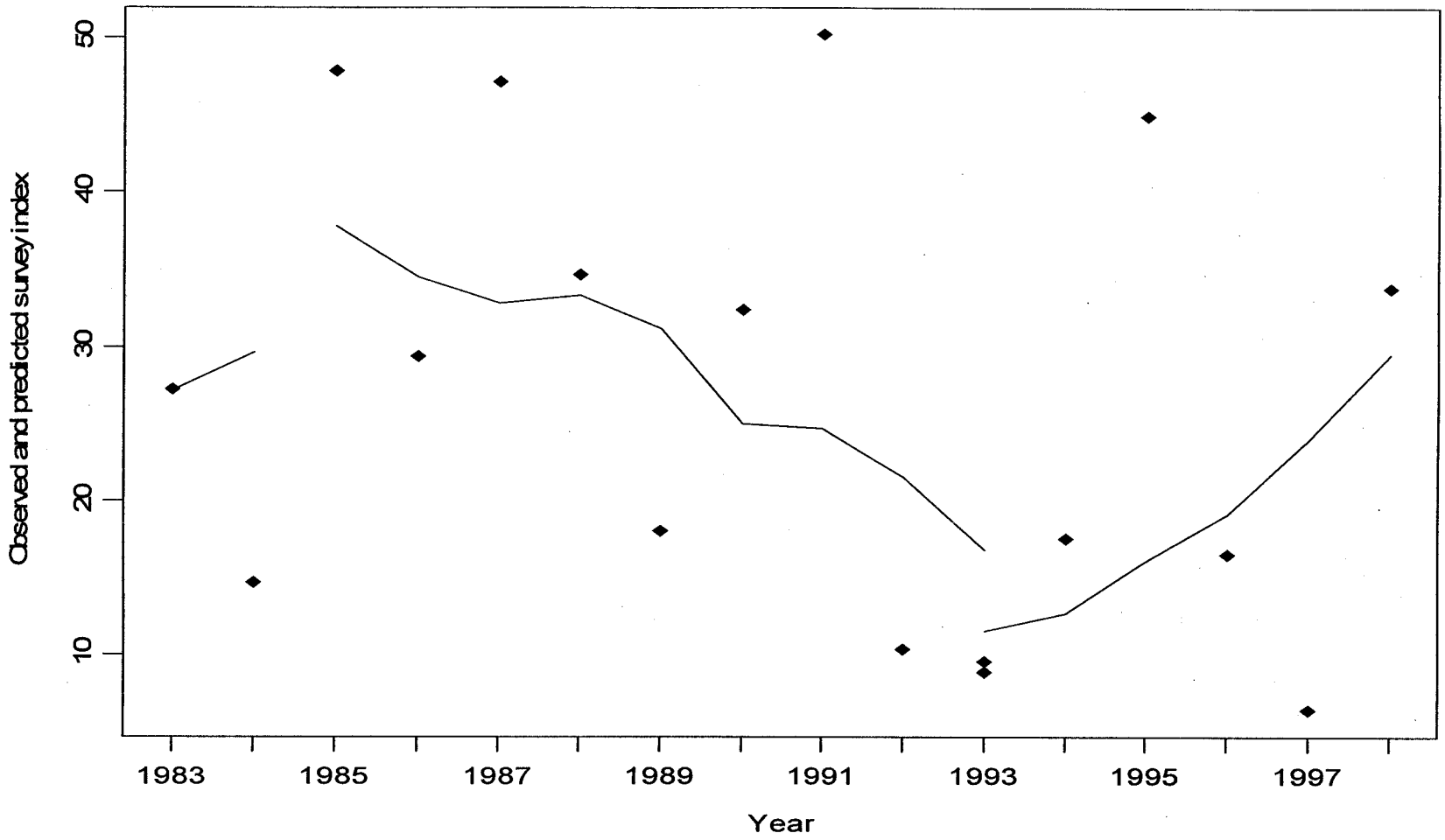


Figure 24. Observed (points) and SPA predicted (lines) 3+ abundance indices. The lines are broken because of estimated changes in survey catchabilities.

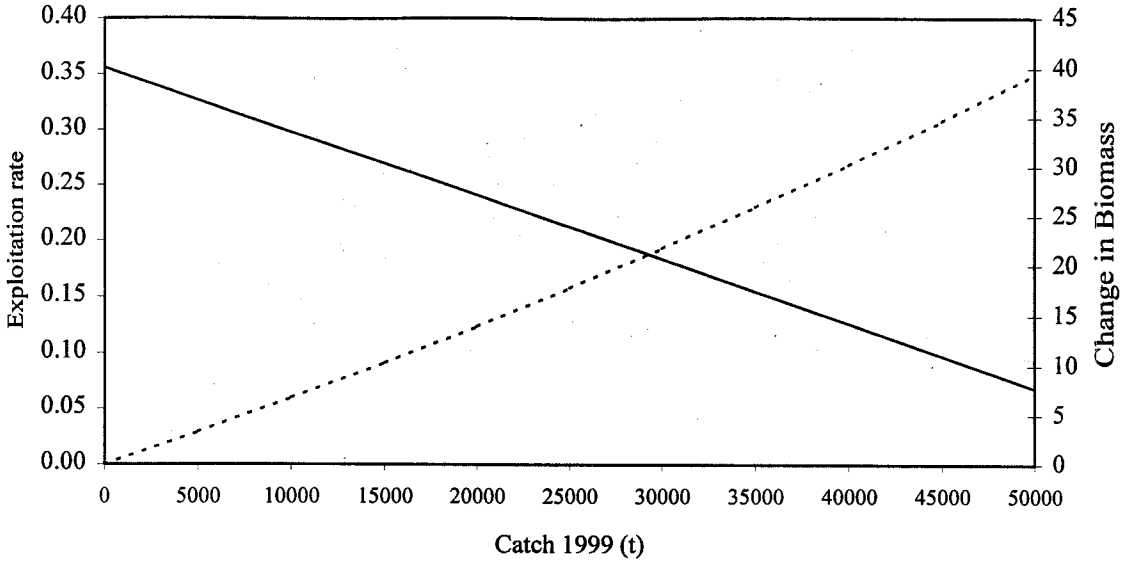


Figure 25. Exploitation rates and percentage change in spawner biomass at different catch rates during 1999.

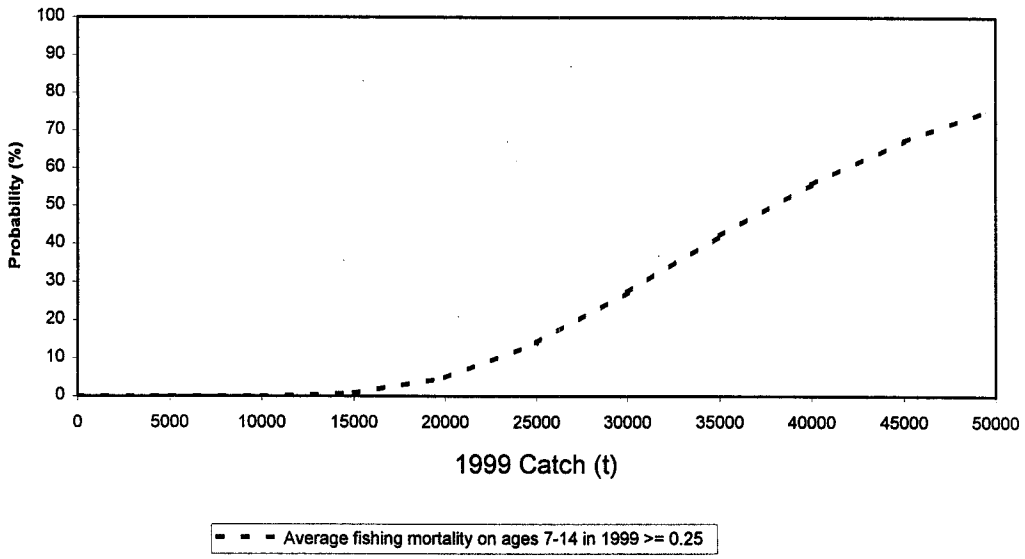


Figure 26. Probability of average fishing mortality (ages 7-14) exceeding 0.25 at different catch levels in 1999.