Fisheries and Oceans Science | Pêches et Océans Sciences

C S A S | **S C É S**

Canadian Stock Assessment Secretariat | **Secrétariat canadien pour l'évaluation des stocks**

Research Document 2000/134 | **Document de recherche 2000/134**

Not to be cited without permission of the authors [1] | Ne pas citer sans autorisation des auteurs [1]

An assessment of the cod stock in NAFO Subdiv. 3Ps in October 2000

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

Science, Oceans and Environment Branch
Department of Fisheries and Oceans
P. O. Box 5667
St. John's NF A1C 5X1

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

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

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

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

This document is available on the Internet at: | Ce document est disponible sur l'Internet à:
http://www.dfo-mpo.gc.ca/csas/

ISSN 1480-4883
Ottawa, 2000

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 during 1 April 2001 and evaluates alternative TAC options for the management year 1 April 2001 – 31 March 2002. Previous assessments provided scientific advice on a calendar year basis, but in 2000 the management year was changed to begin on 1 April and end 31 March the following year. Sources of information for this assessment were: a time series (1973-2000) of abundance and biomass indices from Canadian winter/spring research vessel bottom trawl surveys, reported landings from commercial fisheries including a 6,000 t interim TAC during 1 January-31 March 2000, a third industry trawl survey on St. Pierre Bank, inshore sentinel surveys (1995-1999), science logbooks from vessels <35', and tagging studies. The fishery was still in progress at the time of the assessment and information from the 20,000 t TAC from 1 April 2000 – 31 March 2001 was not available. Sequential population analysis (SPA) was carried out using reported commercial catches, calibrated with Canadian research vessel survey data, and standardized annual catch rate-at-age indices for line-trawl and gillnet from the sentinel survey. The RV surveys were treated as two indices: the first survey index comprised spring (April) surveys conducted in strata in a known mixing area (Burgeo-Bank/Hermitage Channel) during 1993-2000 (thereby excluding surveys from this area during February-March when mixing with 4R-3Pn cod is thought to be more of a problem); the second survey index comprised survey catches from the remaining strata (1972-2000). The population biomass and spawner biomass on 1 April 2000 are estimated to be 76,000 t and 107,000 t, respectively. Spawner biomass on 1 January 1999 is estimated at 106,000 t, approximately 41,000 t lower than estimated for the corresponding time in the previous assessment. This downward revision is attributed to different treatment of the Burgeo Bank/Hermitage Channel portion of the survey index. Spawner biomass is not being sustained by recent recruitment and the present assessment predicts that spawner biomass will decline further in 2000 assuming the 20,000 t TAC is caught. Risk analyses indicates that there is a greater than 50% probability that spawner biomass will decline further in 2001-2002 at catch levels of 10,000 t or higher. The risk of exceeding 0.21 fishing mortality (the reference level used in the last assessment) with a catch of 10,000 t during 2001-2002 is 2% and with a catch of 20,000 t is 58%. The risk of exceeding 0.1 fishing mortality is 54% with a 10,000 t catch, and 99.6% with a 20,000 t catch. These risk analyses, though more comprehensive than those conducted in the past, reflect only the discrepancies between the survey indices and the particular form of the model used in the SPA; they do not take into account uncertainties associated with the stock composition of the commercial catch, misreported catches and assumptions about natural mortality.

Résumé

Ce document est un sommaire des renseignements scientifiques utilisés pour déterminer l'état du stock de morue de la subdivision 3Ps de l'OPANO, au large de la côte sud de Terre-Neuve au 1er avril 2001 et évalue d'autres options de TAC pour l'année de gestion du 1er avril 2001 au 31 mars 2002. Les évaluations précédentes ont fourni des avis scientifiques par année civile, mais en 2000, l'année de gestion a été modifiée et commence dorénavant le 1er avril pour se terminer le 31 mars de l'année suivante. Les sources d'information de cette évaluation ont été : une série chronologique (1973-2000) des indices d'abondance et de biomasse tirés des relevés canadiens effectués au chalut de fond par navire de recherche en hiver et au printemps; les débarquements signalés de la pêche commerciale, comprenant un TAC provisoire de 6000 t du 1er janvier au 31 mars 2000; un troisième relevé au chalut réalisé par l'industrie sur le banc de Saint-Pierre; des relevés côtiers par pêche sentinelle (1995-1999); des registres de bord scientifiques de navires de moins de 35 pieds et des études d'étiquetage. Au moment de l'évaluation, la pêche était encore en cours, et l'information sur le TAC de 20 000 t du 1er avril 2000 au 31 mars 2001 n'était pas disponible. Une analyse séquentielle de la population (ASP) a été effectuée à partir des captures commerciales signalées, qui ont été étalonnées à l'aide des données des relevés canadiens par navire de recherche, et des indices annuels normalisés du taux de captures selon l'âge pour les pêches à la palangre et au filet maillant tirés du relevé par pêche sentinelle. Les relevés par navire de recherche ont été traités comme deux indices distincts : le premier indice comprenait les relevés effectués au printemps (en avril) dans les strates d'une zone connue de mélange (banc Burgeo et chenal Hermitage) de 1993 à 2000 (ce qui exclut de ce fait les relevés effectués dans cette zone en février et en mars, période où l'on considère que le mélange avec la morue de 4R-3Pn est plus problématique); le deuxième indice incluait les prises du relevé effectué dans les autres strates (1972-2000). Au 1er avril 2000, les biomasses de la population et des géniteurs sont estimées respectivement à 76 000 t et à 107 000 t. Au 1er janvier 1999, on estimait la biomasse des géniteurs à 106 000 t, soit environ 41 000 t de moins que ce que l'on avait estimé pour cette période dans l'évaluation précédente. Cette révision à la baisse est imputée au traitement différent de la portion du banc Burgeo et du chenal Hermitage de l'indice de relevé. Le récent recrutement n'assure pas la subsistance de la biomasse des géniteurs qui, selon la présente évaluation, baissera davantage en 2000, en supposant que le TAC de 20 000 t est atteint. Les analyses de risque démontrent que la probabilité que la biomasse des géniteurs baisse encore en 2001-2002 si les niveaux de prises sont de 10 000 t ou plus est de plus de 50 %. La probabilité que le taux de mortalité par pêche soit supérieur à 0,21 (niveau de référence utilisé dans la dernière évaluation) si les captures atteignent 10 000 t en 2001-2002 est de 2 % contre 58 % si ces dernières atteignent 20 000 t pour la même période. La probabilité que le taux de mortalité par pêche dépasse 0,1 si les captures correspondent à 10 000 t est de 54 %, contre 99,6 % si les prises atteignent 20 000 t. Bien que ces analyses de risque soient plus détaillées que celles effectuées par le passé, elles reflètent seulement les divergences entre les indices de relevé et la forme particulière du modèle utilisé dans l'ASP, et ne tiennent pas compte des incertitudes quant à la composition des prises commerciales, des prises mal déclarées et des hypothèses à propos de la mortalité naturelle.

Table of Contents **Page**

1. Introduction

The history of the cod fishery in NAFO Subdivision 3Ps, located off the south coast of Newfoundland (Fig. 1, 2), and results from other recent assessments of this stock are described in detail in previous documents (Pinhorn 1969; Bishop et al. 1991, 1992, 1993, 1994, 1995; Shelton et al. 1996; Stansbury et al. 1998; Brattey et al. 1999a, b,). In the more recent period, following a four year moratorium on cod fishing beginning in August 1993, the directed cod fishery was reopened on 19 May 1997 with a TAC set at 10,000 t; this was subsequently increased to 20,000 t for 1998 and to 30,000 t for 1999. In addition, an interim TAC of 6,000 t was set for the first 3 months of year 2000 to initiate a new management year beginning 1 April 2000 and ending 31 March 2001. The TAC for 1 April 2000 – 31 March 2001 was set at 20,000 t. The present document gives the results of the regional assessment of 3Ps cod for 2000, conducted in St. John’s during 18-22 October 2000. In addition, a workshop on stock mixing was held just prior to the assessment meeting (Chouinard, 2000).

This present assessment incorporates the April 2000 research vessel survey results and a portion of the 2000 catch-at-age from the commercial fishery which was still in progress at the time of the assessment meeting. Detailed information on catch-at-age was available only up to the end of March 2000. Additional sources of information available for the current assessment included oceanographic data, science logbooks for vessels < 35’, an industry trawl survey on St. Pierre Bank, inshore sentinel surveys (to the end of the 1999 fishing season), and information from mark-recapture experiments conducted during 1997-2000.

In the analyses it was assumed that the entire TAC would be taken, as outlined in the original management plan released prior to the start of the 1 April 2000 to 31 March 2001 fishing season. The current assessment provides a revised estimate of the abundance of fish on 1 April 2000 which is updated to 1 April 2001 by accounting for the 1 April 2000 – 31 March 2001 fishery catch and assumed natural mortality. Projections were carried out from 1 April 2000 to 1 April 2001 for a range of TAC options for the current management year. Uncertainty in estimated parameters that relate to stock size in the most recent management year are propagated in the projections. Analyses are performed of the risk of the spawner biomass not increasing and of fishing mortality exceeding two reference levels (0.1 and 0.21 fishing mortality) used in the previous assessment.

2. Environmental overview

Oceanographic data from NAFO subdivisions 3Pn and 3Ps during the spring of 2000 were examined and compared to the long-term (1961-1990) average by Colbourne (2001). The temperature and salinity data were presented as vertical transects across the major banks and channels, horizontal bottom maps, time series of areal extent of bottom water in selected temperature and salinity ranges and as time-series of temperature anomalies at standard depths. Temperature anomalies in the 3Ps St. Pierre Bank area show anomalous cold periods in the mid-1970s and since the mid-1980s, 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 1990s with temperatures as much as 1ºC below average over all depths and as much as 2ºC below the warmer temperatures of the late 1970s and early 1980s in the surface layers. Temperatures in deeper water off the banks show no significant trends. Since 1991, temperatures have moderated in some areas from the lows experienced from the mid-1980s and early 1990s 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. Temperatures during 1999 and 2000 continued to warm and were above normal over most of the water column and near bottom. An analysis of the areal extent of subzero ºC bottom water covering the banks shows a dramatic increase since the mid-1980s, very low values in 1998 and a complete disappearance in 1999 and 2000. The areal extent of bottom water with temperatures above 1ºC on the banks was about 50% of the total area during 1998, the first significant amount since 1984; it increased further to about 70% during 1999 and to 85% during 2000. An examination of the limited salinity data show a clear change in water mass characteristics during 1998 and 1999, from cold-fresh conditions that prevailed during the first half of the 1990's, to warmer fresher conditions during the spring of 2000.

3. Commercial catch

Catches (reported landings) from 3Ps for the period 1959 to 31 December 2000, by country and separated for fixed and mobile gear, are summarized in Table 1 and Fig 3. 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 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-1980's 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. Subsequently catches 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.

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 (Table 1, Fig. 3B). In 1998, approximately 65.5% the 30,000 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. In 1999, over 22,2000 t or approximately 75% of the TAC was taken by the Canadian inshore fixed gear sector, with most of the remainder taken by Canadian and French mobile gear sectors fishing offshore. During the first three months of 2000, there were substantial landings from both the Canadian and French mobile gear sectors fishing the offshore (1,544 t and 2460 t, respectively). The Canadian inshore fixed gear sector reported landings of 3,301 t during this period.

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). In the post-moratorium period, line-trawls have accounted for 15.9 to 21.7% of the fixed gear landings. 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 inshore catch since the fishery reopened in 1997, with gillnet landings exceeding 10,000 t (i.e. 50% of the TAC) for the first time in 1998, and approaching 18,000 t in 1999. Gillnets are also being used in the offshore areas (see below). Trap catches have varied over the time period but have not exceeded 8,000 t and have declined from 1,167 t to negligible mounts in 1999. Hand-line catches have been a minor (<3,000 t) but relatively stable component of the fishery.

The 1999 landings are summarized by month and gear sector in Table 3A. Inshore catches have come mostly from gillnet and line-trawl during May-July and September-December. Lower landings in August reflect an industry-mediated closure of most of the fishery due to poor or unreliable quality. In the offshore, otter trawl fishing by Canadian trawlers and vessels chartered by St. Pierre and Miquelon to fish the French quota was concentrated mainly during the first and last quarters of the year. Overall, 1999 landings were dominated by the directed gillnet fishery with the remaining catch taken by otter trawl, followed by line-trawl and hand-line. As in 1997 and 1998, the gillnet fishery was pursued over a longer period of the year than the traditional gillnet season in this area and more fishers west of the Burin Peninsula were reported to be using gillnets rather than the traditional line-trawl. There was also a substantial offshore gillnet catch totalling over 3,800 t.

The landings for 1999 and the first three months of 2000 are summarized by month and unit area in Tables 3B and 3C. Landings were low during the first three months of 1999 in all unit areas except 3Psh, but increased in 3Psa (west of Fortune Bay) and 3Psb (Fortune Bay) during May, and 3Psc (Placentia Bay) during June and July. There were substantial landings in all inshore unit areas during fall, particularly in Placentia Bay with reported landings of over 5,000 t in November alone. There were also substantial landings (2,500 t) in Placentia Bay during the first three months of 2000 (Table 3C) , although the fishery at the head of Placentia Bay was closed to directed cod fishing during mid-March. Preliminary landings for the 1 April 2000 to 31 March 2001 show similar spatial and temporal trends to those seen in 1999.

The 1999 conservation harvesting plan placed various restrictions on how the 3Ps fishery could be pursued. In addition, unit area 3Psd was closed during directed cod fishing from 15 November to 15 April during 1998-1999 and 1999-2000 as this is an area of stock mixing. As in 1998, fishers with home ports west of the Burin Peninsula fished competitively with quarterly quotas. In contrast, fishers in Placentia Bay operated under an individual quota (IQ) system and could fish up to the end of the year. Many inshore fishers, particularly gill-netters in Placentia Bay, did not intend to fish until late fall when fish were expected to be in better condition. A dockside monitoring system was in place during 1999 and other restrictions included the number of nets that could be fished, where fish could be landed, and a small fish limit. Mesh size of gill nets was also restricted to a maximum of 6.5”.

3.1 Catch-at-age

Samples of length and age composition of catches were obtained from the inshore trap, gillnet, line-trawl and hand-line fisheries and the offshore otter trawl, gillnet, and line-trawl fisheries by port samplers and fishery observers. Maturity information was not collected from commercial catches in 1999. Sampling of the catch in 1999 was intensive, with 9,198 otoliths collected for age determination and over 93,300 fish measured for length (Table 4). The sampling was well distributed spatially and temporally across the gear sectors. Sampling from the first quarter (prior to the opening of the Canadian directed cod fishery) came mainly from sentinel and by-catch fisheries, and the French otter trawl fishery. Substantial landings in July from inshore fixed gears (see Table 3) were sampled intensively, particularly line-trawl and gillnet. The smaller number of samples from hand-line and offshore line-trawl catch reflects the smaller catches from these gears in 1999.

The age composition and mean length-at-age of commercial catches were calculated as described in Gavaris and Gavaris (1983). The average weights were derived from a standard length-weight relationship where log(weight)=3.0879*log(length)-5.2106. Catch-at-age for all gears combined based on sampling of Canadian and French vessels is summarized in Table 5 and Fig. 5 (middle panel). In the 1999 landings from all gears combined, ages 5 to 10 were well represented (1989 to 1994 year classes) with age 7 (1992 year class) the most abundant overall. The provisional age composition of the 1999 catch as used in the previous assessment (Fig. 5, top panel) shows some differences from the final age composition. For example, 6 year olds are more strongly represented and 8 yr olds less strongly represented in the final age composition. The age composition of the catch from the first three months of 2000 showed a similar composition to that of the preceding year, with ages incremented by one year, i.e. ages 6-11 predominating. Ages 10 and 11 were more strongly represented in the first three months of 2000 due to the substantial offshore catch from mobile gear at that time (see Table 1).

A time series of catch numbers-at-age for the 3Ps cod fishery from 1959 to 2000 is given in Table 6. For the 1999 fishery, two age compositions are given; one based on sampling information available up to early October and used in the previous assessment and the other based on sampling for the entire year. The catch in 1999 was dominated by 7 year old cod (1992 year class) although 8, 9 and 10 year olds are also well represented. The 1989 and 1990 year classes followed by the 1992 year class appear to be well represented in the catches throughout the post moratorium period.

Mean annual weights-at-age in the commercial catch in 3Ps (including food fisheries and sentinel survey catches), calculated from mean lengths-at-age, are given in Table 7A and Fig. 6. Beginning of the year weights-at-age calculated from commercial mean annual weights-at-age as described in Lilly (1998) are given in Table 7B. Current 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 3Ps, particularly in 1998 and 1999, could tend to increase the mean weight-at-age of the younger ages, because only the fastest-growing, largest individuals within a cohort would be caught by this gear.

4. Science logbooks

A new science logbook was introduced to record catch and effort data for vessels less than 35 ft in 1997. The purpose of this logbook is for scientific stock assessments and not for quota monitoring or other controls on the fishery. Previously only purchase slip records were available for these size vessels, containing limited information on catch and no information on effort. Catch rates have the potential to provide a relative index of temporal and spatial patterns of fish density, which may relate in some way to the overall biomass of the stock. At this stage, with only three years data available for 3Ps cod, the emphasis is on descriptive studies rather than modeling.

Data were analyzed for 9 fishing (lobster management) areas (numbered 29 to 37) from Placentia Bay to west of Fortune Bay, as illustrated in Fig. 7. They can be grouped into three unit areas – 3Psc (Placentia Bay, areas 29-32), 3Psb (Fortune Bay, areas 33-35) and 3Psa (west of Fortune Bay, areas 36 and 37). Logbook return rates have been reasonably high. There are currently data for more than 15,000 gillnet sets and nearly 7,000 line-trawl sets in the database.

In the present assessment, effort is treated as simply the number of gillnets, or hooks for line-trawls (1000's), deployed in each set of the gear; the relationship between soak time, gear saturation and fish density is not known.

As observed in the October 1999 assessment, preliminary examination of the logbook data collected thus far (not shown) indicated that soak time for gillnets is most commonly 24 hours with 48 hours the next most common time period. In comparison, line-trawls are typically in the water for a much shorter period of time – typically 4 hr with very few sets more than 12 hr. In addition, the distribution of catches per set is typically skewed to the right for most gears (not shown). For gillnets, catches per set are typically 100-200 kg with the tail of the distribution extending to 2 tons. The distribution of catches for line-trawls is somewhat bimodal, the first peak being around 200 to 300 kg per set and the second at about 800 kg per set.

Catch rates for gillnets by unit area for the three years suggest an overall declining trend in 3Psa and 3Psb with a seasonal signal superimposed (Fig. 8). In 3Psc there does not appear to be any trend. Median gillnet catch rates tend to be higher in 3Psc (Placentia Bay) than elsewhere. There is less seasonality in line-trawl catch rates (Fig. 9). There appears to be a decreasing trend for 3Psa, no trend in 3Psb, and no trend but few data in 3Psc.

Spatial patterns in gill net catch rates at the scale of lobster management areas suggest a general decline from Cape St. Mary's westward (Fig. 10, upper panel) with a slight increase in the most westerly area. Also, catch rates in areas 29-31 were highest in 1998, but have shown a progressive decline through 1997-1999 further west. Eastern areas have more data for gillnets or have more fishermen than other areas. For line-trawls (Fig. 10, lower panel) there was a general decrease in median catch rates from Cape St. Mary's westward with lowest values in area 34 and some increase further west. In contrast to the spatial patterns in gillnet fishing, line-trawl fishing effort increases steadily from east to west. Line-trawl catch rates also show a progressive decline through 1997-1999 in western Placentia Bay (areas 31 and 32) and in the most western areas of 3Ps (36 and 37).

Although the time series is too short to obtain an index of stock size from the catch rate data, there are several patterns that appear to be consistent across space and time and which should therefore be interpretable. The apparent decreasing trend in gillnet catch rates in most areas from 32 to 37, and the decreasing trend in line-trawl catch rates in areas 31, 32 and 35-37 is cause for concern. These declines are generally consistent with the declines in standardized sentinel catch rates reported below.

5. Sentinel Survey

The sentinel survey has been conducted in NAFO Subdivision 3Ps since 1995 and there are now five complete years of catch and effort data. During 1999 the sentinel survey continued to produce a time series of catch/effort data and biological information collected by trained fish harvesters at various inshore sites along the south coast of Newfoundland. There were 16 active sites in 3Ps, using predominantly gill nets in unit area 3Psc (Placentia Bay) and line-trawls in 3Psb and 3Psa (Fortune Bay and west). Fishing times were reduced to a maximum of 6 weeks in 1999 as opposed to 12 weeks from 1995-1998. Most fishing takes place in fall/early winter. Catch rates in those locations that fished in 1999 were generally lower than those reported for comparable times in preceding years, and preliminary indications are that these rates are even lower in 2000 although complete data are not yet available.

As in the October 1999 assessment, an attempt is made to produce an age dis-aggregated index of abundance for the five completed years in the gillnet and line-trawl sectors of the program. Sentinel fishers typically fish a control and an experimental site; the location of the control site is fixed whereas the location of the experimental site can change but in general only within the local area.

5.1 Standardized sentinel catch rates

The catch from 3Ps was divided into cells defined by gear type (5½¨ mesh gillnet and line-trawl), area (which corresponds to unit areas 3Psa, 3Psb, 3Psc), year (1995-1999) and quarter. Age-length keys were generated for each cell using fish sampled from both the fixed and experimental sites; however, only fish caught at the fixed sites were used to derive the catch rate indices. Length frequencies and age-length keys were combined within cells. In the previous assessment, non-aged fish were assigned the modal age from the age-length key for that particular cell length combination. However, in the current assessment numbers of fish at length are assigned an age proportional to the number at age for that particular cell length combination. Fish that were not assigned an age because of lack of information within the initial cell were assigned an age by aggregating cells until the data allowed an age to be assigned. For example, if there are no sample data in a quarter then quarters are combined on the half-year, half-years are combined to the year; if an age still cannot be assigned, then areas are combined for the year.

Catch-at-age and catch per unit effort (CPUE) data were standardized to remove site and seasonal effects. For gillnets, only sets at fixed sites during July to November with a soak time between 18 and 24 hours where used in the analysis. For line-trawl, sets at fixed sites during August to November with a soak time less than or equal to 12 hours where used in the analysis. Zero catches were generated for ages not observed in a set. Sets with effort and no catch are valid entries in the model.

The response distribution was specified as Poisson and the link function was chosen to be log. That is, the Poisson mean parameter μ_i is related to the linear predictor by

$$\log(\mu_i) = X_i'\beta$$

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

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

$$\log(\mu_i) = \log(E_i) + month_i(j)\beta_j(site_i(k)\beta_k) + age_i(l)\beta_l(year_i(m)\beta_m),$$

where E_i is and offset parameter for fishing effort and j,k,l,m indicate the level for each of the four factors, for example June for the factor *month*, and where

$$month_i(j) = \begin{cases} 1 \text{ if month} = j \\ 0 \text{ if month} \neq j \end{cases}.$$

In the previous assessment results were provided only for the gillnet analysis. However, in the present assessment the model adequately fitted data from gillnets and line-trawls and two standardized annual catch rate-at-age indices were produced, one for each gear type. All effects included in the model were significant. The standardised gillnet and line-trawl catch rate-at-age indices for 1995 to 1999 are given in Table 8. For gillnets, the catches during 1995-1997 were dominated by the 1989 and 1990 year-classes and for the subsequent period the 1992 year- class is well represented, although catch rates for the latter do not appear to be as strong. For line-trawls a similar trend is evident with higher catch rates for the 1989 and 1990 year-classes during 1995 to 1997 followed by the weaker 1992 year-class in 1998-1999. Thus both indices are consistent, with the relatively strong 1989 and 1990 year classes passing through the fishery and being replaced weaker year classes.

Annual trends in standardized total (ages 3-10 combined) annual catch rates are shown in Fig. 11. For gillnets there is no trend in 1995-1997 and a decline thereafter. For line-trawls there is a consistent decline throughout the time series. As described in a previous assessment (Brattey et al. 1999) there is speculation that commercial fisheries during 1997-1999 may have had some disruptive influence on the execution of the sentinel fishery. Competition with commercial fishers for fishing sites, local depletion, inter-annual changes in the availability of fish to inshore, and shifts in the timing of sentinel fishing to accommodate periods of commercial fishing could all influence mean catch rates between years. The extent to which such effects influence catch rates is not known. Nonetheless, the continuing decline in sentinel catch rates was interpreted as cause for concern.

6. Tagging experiments and genetics

A Strategic Project on the relationship between inshore and offshore cod was continued with further genetic sampling and tagging conducted in 1999. An additional 8,450 and 6,731 tagged fish were released in 3Ps during 1999 and 2000. As in previous years single, double, and high-reward tags were applied, and tagging was conducted on spawning and pre- and post-spawning aggregations in the following areas: Halibut Channel (3Psh), Burgeo Bank-Hermitage Channel (3Psd), Fortune Bay (3Psb), and Placentia Bay (3Psc). Total numbers of cod released and reported as recaptured annually (up to 30 September 2000) from all areas combined are shown below.

		Number reported as recaptured			
Year	**Number tagged**	**1997**	**1998**	**1999**	**2000**
1997	6029	331	362	454	159
1998	9941	.	538	1015	313
1999	8450	.	.	628	417
2000	6731	.	.	.	125

There have been substantial numbers of recoveries in all years since the tagging program was initiated. In most years typically 5-7.4% of the initial releases are reported as recaptured in the same year; however, over 10% of the initial releases in 1998 were reported as recaptured in 1999. Although the 2000 fishery is still in progress there have been substantial numbers of recaptures during 2000 from releases in all years back to 1997. (see Figs. 12-19; also Brattey 1999, 2000; Brattey et al. 1999b).

Cod stock structure within the 3Ps management unit is complex (Lear 1984, 1988; Brattey 1996 and references therein) and results from the tagging and genetics components of the Strategic Project have been used to investigate stock structure and seasonal movement patterns of 3Ps cod during the post-moratorium period (Beacham et al 1999, 2000; Brattey 1999, 2000; Brattey et al. 1999b, c). The tagging data have also been used to provide information on tag loss and reporting rates (Cadigan and Brattey 1999a), growth rates (Cadigan and Brattey 2000a) and to estimate exploitation and migration rates (Cadigan and Brattey 1999b; 2000b). However, estimation of migration rates of cod within 3Ps and between 3Ps and adjacent areas is proving extremely complex and further analyses are required before the model can provide reliable estimates.

Information on the spatial distribution of tagged cod recaptured during 1999 and up to 30 September 2000 is summarized in Figs 12-19. Recaptures from the Halibut Channel (3Psh) releases in the offshore of 3Ps (Figs. 12, 13) consistently show an inshore migration of a portion of this stock component to Placentia Bay and southern 3L.

The 1999 tagging in the Burgeo Bank area gave several inshore recaptures in 3Ps during 1999, but few in 3Pn4RS in spite of landings in the latter of approximately 6,800 t. Preliminary recaptures from 2000 showed a similar pattern. In contrast, tagging in the Burgeo Bank area in 1998 gave several recaptures in 3Ps and in 3Pn4RS in both 1998, 1999, and 2000 (Figs. 14, 15).

Cod tagged in Placentia Bay in 1998, 1999, and 2000 gave many recaptures within Placentia Bay itself as well as several from southern 3L (Figs. 16, 17). However, a notable finding was substantially fewer recaptures in 3L during 2000 compared to the preceding two years, in spite of the 7,000 t quota in 3KL. A possible interpretation is that fewer 3Ps cod migrated into 3KL during 2000 compared to 1998 and 1999.

Cod tagged in Fortune Bay were recaptured mostly within Fortune Bay, but with some recaptures eastward into Placentia Bay and more rarely westward into 3Psa, 3Pn and 4R (Figs. 18, 19).

The recaptures of tagged cod were also examined to test the hypothesis that the decline in standardized sentinel catch rates (Fig. 11) was due to a progressive movement of inshore cod to offshore areas during recent years. However, the results in Figs 12-19 indicated that cod tagged inshore in spring are rarely recaptured offshore, even 2-3 years after release, and in spite of substantial offshore landings. It was concluded that the tagging data did not support the hypothesis of progressive movement of inshore fish to the offshore areas of 3Ps in recent years.

The post-moratorium tagging studies give strong indications of resident inshore stock components in Placentia Bay and Fortune Bay with seasonal movements between these bays as well as into southern 3L. In addition, a portion of the offshore cod in Halibut Channel migrate shoreward during late spring and summer into Placentia Bay and the southern Avalon, but are rarely found inshore west of the Burin Peninsula. In spite of the lack of a directed cod fishery in 3NO there have been a few recaptures from this area in most years indicating a movement of cod between the Halibut Channel and the southern Grand Banks. Tagging on Burgeo Bank in April has also provided important new information, and results in Figs. 14 and 15 suggest that mixing with 3Pn-4RS cod may extend into April in some years, especially 1998. This has important implications for interpretation of research vessel survey catches. However, there has been a notable decline in the availability of adult cod for tagging in the Burgeo area during the period 1998-2000 and in the most recent year no aggregations of cod were encountered. A possible interpretation is that 3Pn-4R cod had left the Burgeo area of 3Ps by April during 2000.

A genetic study 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 was continued (Beacham et al. 1999, 2000). 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 5,050 cod from a total of 19 putative populations. Variation at a class I Mhc locus was surveyed in 2,000 fish from the 19 populations. Ten populations were sampled over two or more years, and variation among populations was on average about 18 times greater than annual variation within populations. Regional structuring of the populations was apparent with inshore and offshore spawning populations forming distinct groups. The Flemish Cap population was the most distinctive of the offshore group, and the Gilbert's Bay population in Labrador was the most distinctive of the inshore group. In Subdiv. 3Ps, genetic differentiation was observed between the inshore Placentia Bay and Fortune Bay samples, and the Placentia Bay sample was distinct from offshore samples of northern cod. In Subdiv. 3Ps, bias of estimated stock compositions was marginal when offshore populations (Burgeo Bank, Halibut Channel) comprised the majority of the sample. However, bias in the estimated stock compositions increased when inshore populations comprised the majority of the sample. Increased baseline population sample sizes or additional discriminating markers are likely needed to increase the degree of precision before this method could be used to reliably estimate sub-stock composition among catches of 3Ps cod.

7. GEAC Stratified Random Trawl Survey

In 1999 the Groundfish Enterprise Allocation Council (GEAC) carried out a third consecutive fall survey directed at cod with the intention of creating a series of annual fall surveys in 3Ps to complement current DFO RV surveys conducted in spring. DFO provided advice on the stratified random design and catch sampling. Results of the previous surveys are reported in McClintock (1999a, b) and for the most recent survey in McClintock 2000. The 1999 survey was carried out from 22 November to 2 December, the 1998 survey from 30 November to 12 December, and the 1997 survey from 8-17 December. The M.V. Pennysmart was used all three surveys. 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 door-spread, wingspread, and net opening was visually monitored and measurements were noted. The gear and configuration were identical in all three surveys. A total of 90 successful stratified random tow sets were completed in the 1999 survey. Four sets were unsuccessful.

The Netmind net monitoring instruments were only partially successful during the 1999 trip: there are no wing-spread values for sets 1 to 18 and there are no measurements for openings for sets 78 onwards. For the monitored sets, door-spread exhibited values varying from 50 to 100 m depending on depth, while wingspread was fairly consistent with a mean value of 18.5 m. This wingspread value is consistent with the estimate assumed for the 1997 and 1998 surveys.

The mean cod catch per tow was 24.9 fish and a mean catch weight of 84.6 kg. The largest catch of 753 cod and weight 2553 kg was from set 75 in the Halibut Channel. A total of 9 sets had catches over 100 kg, four sets with catches over 200 kg. The mean cod weight for all sets was 3.4 kg per cod. The age composition in the 1997 survey was dominated by 5 year olds (1992 year class) and 8-9 year olds (1990 and 1989 year class). In the 1998 survey 9 year olds dominated (1989 year class) and next most abundant were 5 year olds (1994 year). In the 1999 survey, the 1989 and 1990 year classes are well represented along with the 1992, 1993, and 1994 year classes. The 1991 year class is poorly represented relative to adjacent year classes in all three surveys.

Sets in the southern Halibut Channel and south-eastern slopes of St. Pierre Bank had the highest catches in all surveys. The 1997 STRAP estimate was 99,330 t whereas the 1998 and 1999 estimates for a larger survey area were 47,875 t and 44,521 t, respectively. Further details are given in McClintock (2000). There was insufficient time series in the GEAC survey to include the catch at age information from this survey as an index in the sequential population analysis (see Section 9), but the when the results from the 2000 survey become available this should be possible.

8. Research vessel survey

Stratified-random surveys have been conducted in the offshore areas of Subdiv. 3Ps during the winter-spring period by Canada since 1972 and by France for the period 1978-92. The two surveys were similar with regard to the stratification scheme used, sampling methods and analysis, but differed in the type of fishing gear and the daily timing of trawls (daylight hours only for French surveys). Canadian surveys were conducted by the research vessels *A.T. Cameron* (1972-82), *Alfred Needler* (1983-84) and *Wilfred Templeman* (1985-2000). 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 from 1994 (779-783) and a further eight inshore strata were added from 1997 (293-300)(Fig. 20). For surveys from 1983 to 1995 the Engel 145 high-rise bottom trawl was used. The trawl catches for these years were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation derived from comparative fishing experiments (Warren 1997; Warren et al. 1997; Stansbury 1996, 1997).

The Canadian survey results (in Campelen-equivalent units, see below) are summarized by stratum in terms of numbers (abundance) and biomass in Tables 9 and 10, respectively, for the period 1983 to 2000. 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 fell in April, in 1985 to 1987 it fell in March, from 1988 to 1992 it fell 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 change 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. A portion may cross the stock boundary into the Burgeo Bank area (see Fig. 1) and mix with 3Ps cod before they migrate back into the Gulf some time during the following spring. Studies conducted in January 1996 and 1997 suggest that in some years mixing in January may be substantial (Campana et al. 1998, 1999, 2000) and recent tagging studies suggest that mixing may extend into April in some years (see Figs. 14 and 15; also Brattey et al. 1999b); however, the extent, timing, and duration of mixing are variable and have not been quantified on an annual basis.

8.1 Abundance, biomass, and distribution

In the 2000 survey (see Table 9) there were several strata with high biomass estimates (>1,000 t), including three strata located on Burgeo Bank (strata 306, 307, and 308) and two strata north of St. Pierre and Michelon (297 and 298). There were also strata with substantial biomass estimates located in shallow water (< 50 m) on top of St. Pierre Bank (314, 320, and 321), and in Halibut Channel and adjacent areas (315, 319, and 325).

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. 21. The abundance and biomass time series from 1983 to 1999 shows considerable variability, with strong year effects in the data. Both abundance and biomass are low after 1991 with the exception of 1995 and 1998. 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 and in commercial and sentinel catches in subsequent years. The minimum trawlable biomass from the 1999 and 2000 surveys were similar at 48,857 t and 46,111 t, respectively; however, abundance was slightly higher in 2000 (Table 9; 46.5 million versus 39.4 million) indicating that the average size (weight) of fish in 2000 was smaller than in 1999.

Cod appear to have become scarce or absent in shallow strata on St. Pierre Bank in the 1990’s (Tables 9 and 10). Abundance during the early to mid-90’s was 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. However, there is also some indication that cod are becoming more widespread over the survey area in recent years (1997-2000) compared to the early 1990’s, albeit at low abundance. The pattern appears to be continued in 1999 and 2000 with reasonable catches of cod in many of the shallow (<100 m) strata, such as those on St. Pierre Bank (Figs. 22, 23).

8.2 Age composition

Survey numbers at age are obtained by applying an age-length key to the numbers of fish at length in the samples. The current sampling instructions for Subdiv. 3Ps require that an attempt be made to obtain 2 otoliths per one cm length class from each of the following locations - Northwest St. Pierre Bank (strata 310-314, 705, 713), Burgeo Bank (strata 306-309, 714-716), Green Bank-Halibut Channel (strata 318-319, 325-326, 707-710), Placentia Bay (strata 779-783) and remaining area (strata 315-317, 320-324, 706, 711-712). This is done to spread the sampling over the survey area. The otoliths are then combined into a single age-length key and applied to the survey data. The resulting estimates of mean numbers per tow are given in Table 11. It is in this form that the data are used in the calibration of sequential population analysis models. These data can be transformed into trawlable population at age by multiplying the mean numbers per tow at age by the number of trawlable units in the survey area. This is obtained by dividing the area of the survey by the number of trawlable units. For 3Ps, the survey area is 16,732 square nautical miles including only strata out to 300 ftms and excluding the relatively recent strata created in Placentia Bay. The swept area for a standard 15 min tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of trawlable units in the 3Ps survey is $16{,}732/0.00727=2.3\times10^6$.

The mean numbers per tow in the research bottom-trawl survey have been generally low (< 5) since 1992, with the exception of 5 and 6 yr olds in 1995 and 3-5 yr olds in 1998 and 3 yr olds in 2000 (Table 11). 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), 1998 (age 9) and in 2000 where it is the third strongest for 11 yr olds 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 1998 survey at age 8. The 1991 year class has been consistently weak in both the trawl survey and commercial catches up to 1998, but is more strongly represented in the 1999 commercial catch. The 1992 year class is well represented in the commercial fishery catches throughout the post-moratorium period (1997-1999), but has not appeared strongly in the surveys except during 1998. The 1993 and subsequent year classes have not appeared strong in the survey, except during the 1998 survey. Indications from year class strengths in the surveys are that recruitment has not been particularly strong in the mid 1990’s, with only two of the past eight survey years (1998 and to a lesser extent 2000) showing reasonable numbers of young (< 4 yr old) fish, relative to the early to mid-1980’s. The 1997 survey results appear anomalous given that three year classes (1989, 1990 and 1992) that have been well represented in the post-moratorium fishery, the 1998 DFO survey, and the 1997 and 1998 fall industry (GEAC) survey, did not appear to be encountered in the 1997 survey. Although the 1990 and 1989 year classes are still reasonably well represented and have reached ages 10 and 11, respectively, these are among the oldest fish encountered in the survey. The age composition remains somewhat contracted relative to the mid-1980’s when cod aged 12-20 were consistently encountered in surveys of 3Ps (see Table 11).

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

The sampling protocol for obtaining lengths-at-age (1972-2000) and weights-at-age (1978-2000) has varied over time (Lilly 1998), but has consistently involved stratified sampling by length. For this reason, calculation of mean lengths and weights included weighting observations by population abundance of the size groups (Morgan and Hoenig 1997), where the abundance was calculated by areal expansion of the stratified arithmetic mean catch at length per tow (Smith and Somerton 1981).

Mean lengths-at-age (Table 12; Fig. 24A) varied over time. For the period 1972-2000, peak length-at-age occurred in the mid-1970’s for young ages (3-4) and progressively later to 1980 for older ages. From the mid-1980's to the late 1990's, length-at-age varied with no trend (younger ages) or declined (older ages). Mean lengths-at-age in the most recent years appear to be normal,

Growth of the 1989 year-class is of particular interest because that year-class was largely protected from fishing mortality until age 8, by which time it was abundant relative to other year-classes at the same age and contributed to a rapid increase in spawning stock biomass in the late 1990's. As noted in the previous assessment (Brattey et al. 1999b), the length increment for the 1989 year-class was very large (12 cm) in the period 1997-1998. Growth has continued to be strong during 1998-1999, and 1999-2000 (Fig. 24B). As noted previously (Lilly 1996; Chen and Mello 1999), the year-classes born in the 1980's experienced slower growth than those born in the 1970's. Length-at-age of the 1989 year-class was similar to the average of the 1982-1986 year-classes up to age 8, but by ages 9, 10, and 11, the 1989 year-class had surpassed the average of the 1975-1979 year-classes.

As expected, the patterns in mean weight-at-age (Table 13; Fig. 25) 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 1998). The weight-at-age data also include variability associated with among-year and within-year variability in weight at length (condition). Weight-at-age among the most age classes in 2000 appears to be slightly lower than during 1999 but generally appear close to average values.

8.4 Condition

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

Mean somatic (gutted) condition at age (Table 14; Fig. 26A) was variable from 1978 to 1986, relatively constant from 1986 to 1992, and dropped suddenly in 1993 before rising to an intermediate level in 1995-2000. Because condition calculated with Fulton's formula increases with body length, and length-at-age has declined over time, condition at length (Fig. 26B) might be a better indicator of changes in condition over time. 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 (Fig. 26C), there was a gradual decline in condition from the earliest median date (Feb. 7) to approximately mid-April, followed by 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 from sentinel survey catches in the inshore in 1995 (Lilly 1996).

Mean liver index at age (Table 15; Fig. 27) 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 1980's and there was a more pronounced peak in the late 1980's and early 1990's. When the values for specific size groups were plotted against the median date of sampling, there was a very pronounced decline in liver index during winter and early spring.

Low condition and liver index in recent years (1993-2000) are interpreted to be mainly a consequence of sampling near the low point of the annual cycle and not to be indicative of a large and persistent decline in well-being. It is noted, however, that the surveys in 1993 to 2000 were conducted at approximately the same time of year, so it is possible that the low condition values in 1993 and 1994 reflect anomalously low condition in those years.

8.5 Maturity and spawning

Annual estimates of age at 50% maturity for females from the 3Ps cod stock, collected during annual winter/spring DFO research vessel surveys, were calculated as described by Morgan and Hoenig (1997). The estimated age at 50% maturity dropped dramatically from a high of 7.2 years during 1988 to a low of 4.6 during 1997 with males showing a similar trend over time (Table 16, Fig. 28). An apparent reversal of the declining trend during 1995 and 1996 among females did not continue into 1997. Maturities at age have been highly variable over the past 5 years, but for females have not shown a continuation of the rapid decline seen during 1988 to 1994. The annual estimates of proportion mature for ages 2-8 shows a similar increasing trend through the late 1980s and 1990s, particularly for ages 4, 5, and 6 (Fig. 29). For example, in the late 1970's and 1980's the proportion of mature 5 yr olds was generally less than 0.1, but in recent years (1997-1999) this has increased to over 0.7. The overall age at maturity remains low among 3Ps cod and this has a substantial effect on the estimates of spawner biomass for this 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 2001 and 2002, the estimated proportion mature at age was computed in the standard manner for each of the previous four years (1997-2000 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 2001 and 2002 (Table 17) in projections of mature spawner biomass.

Maturities of cod sampled in three sub-areas of NAFO subdivision 3Ps during winter/spring research vessel bottom-trawl surveys from 1983-2000 are shown in Fig. 30. 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 2000. 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 results from the 2000 survey show no dramatic changes from recent years. 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.

Cod spawning and the distribution of eggs and larvae in Placentia Bay have been studied intensively in recent years (Bolon and Schneider 1999; Lawson and Rose 1999; Robichaud and Rose 1999; Bradbury et al. 2000). 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. In 2000, fishermen reported that cod were densely aggregated and spawning in shallow water at the head of Placentia Bay in the Bar Haven-Sound Island area. The precise duration and timing of spawning in other areas in 3Ps in recent years is not well known.

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

Bradbury et al. (2000) 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. Total larval densities were more than on order of magnitude higher in 1998 compared to 1997. Distribution of egg stages coincided with the predicted circulation, with late stage eggs usually occurring on the western side of Placentia Bay. Based on sampling conducted in only two years these authors speculated that late spawners may be particularly important to successful egg hatching in the coastal waters of Newfoundland.

Robichaud and Rose (1999) surveyed the distribution and abundance of 0 and 1-group cod in the near-shore environment of Placentia Bay with a small beach seine once a month from September to December 1997-1998. In 1997 they caught a total of one hundred and seventeen 0-group cod and three 1-yr olds in 36 fishing sets at 18 sites. In 1998 they caught five hundred and twenty six 0-group and eighty 1-yr old cod and concluded that year-class strengths increased over the period 1996-1998. The 1998 year-class appeared strongest, with a five-fold increase in catch from 1997 to 1998.

9. Sequential population analysis

9.1. Background

The last accepted pre-moratorium SPA analysis of 3Ps cod was in presented during the 1992 assessment (Bishop and Murphy 1992). This was carried out using ADAPT under CAFSAC and there was considerable uncertainty in interpreting the most recent survey results which were lower than expected. Consequently, two estimates of the size of the population on 1 January 1993 were presented - with and without the 1992 survey results. In 1993 an illustrative ADAPT was presented with fully recruited F=0.7 to explore recent stock trends (Bishop et al. 1993). The moratorium in 3Ps was initiated in August 1993 after reported landings of 15,000 t. In 1994 the model fit was considered poor (Bishop et al. 1994) and in 1995 no SPA results were presented

(Bishop et al. 1995) and there was little or no commercial catch in those years. In 1996 an attempt was made to carry out separate quantitative analyses of inshore and offshore sub-components based on perceived differences in their dynamics, but the results were not considered to be reliable (Shelton et al. 1996).

The 1997 assessment was postponed to February 1998 to allow the commercial catch at age data from the reopened fishery to be incorporated into analyses. A new method for SPA estimation (QLSPA, Cadigan 1998) was introduced in the 1998 Regional assessment (St. John's) as an alternative to ADAPT, and this method was applied to the offshore portion of the stock (Stansbury et al. 1998) following the exploration of separate analyses carried out in the 1996 assessment. Offshore catch data only were used and separate *Q*'s were estimated for the winter and spring portions of the Canadian RV index to account for the possibility that different proportions of the stock occurred in the survey area at these times.

In 1999 two assessments of the 3Ps cod stock were carried out, one in March (Zonal, Rimouski, Rivard 1999; Brattey et al. 1999a) and one in October (Regional, Brattey et al. 1999b). The March 1999 assessment accepted a QLSPA run applied to total catch with winter and spring Canadian RV indices having separate *Q*'s to account for possible differences in the proportion of 3Ps cod in the survey area, and with Burgeo Bank strata removed from the winter index to account for suspected mixing with the Northern Gulf cod stock in this area. Self-weighting was applied to the two indices to account for possible differences in the information content of the winter and spring surveys. In this run *F* on age 14 was constrained to equal half the average *F* on ages 11-13.

In the October 1999 assessment an intensive comparison of SPA methodology was carried out on the 3Ps cod stock with the help of fisheries scientists from the UK and France who had considerable experience in ICES assessment methods. Base runs, preferred runs, and sensitivity runs were carried out with XSA, ICA, ADAPT and QLSPA. For the base runs, population biomass estimates from QLSPA, XSA and ADAPT were in very close agreement and spawner biomass estimates were reasonably close. Estimates from QLSPA were higher than those from the other methods for the period from the mid- to late 1990's. XSA and ADAPT estimates of spawner biomass were in very close agreement, while ICA estimates were lowest for the recent period. Recruitment estimates were similar for all four methods. There were no strong reasons provided at the meeting for choosing ADAPT, XSA, or ICA over QLSPA. Furthermore, QLSPA allows greater flexibility than the other methods in using the data to determine the model and error structure. Consequently QLSPA was chosen as the approach for providing scientific advice on the status of the stock. In the formulation of the final model, *F* on age 14 was estimated as an annually constant proportion of the average *F* on ages 11-13. *Q* on age 13 was assumed to be equal to *Q* on age 14. The *Q*'s on ages 13 and 14 were also assumed to be annually equal for the two periods in which different survey gears (Engel and Campelen) were used. This was to account for supposedly different fishing characteristics of the two gears on older fish that have not been completely accounted for in the standardization process (which was based on a limited number of older fish). *Q*'s for all other ages were assumed to be the same across years irrespective of season or survey. The rationale for this was that the need to model *Q*'s separately was removed when the Burgeo strata were removed from the winter index. In addition, a statistical test of the difference in *Q*'s for the winter (minus Burgeo) and spring indices indicated that the *Q*'s were not significantly different. Standardized sentinel gillnet catch rate data were used as an index in the model for the first time in the October 1999 assessment.

The spawner biomass time series from the 1992 and 1993 CAFSAC assessments (ADAPT age 6+), the March 1999 Zonal assessment and the October 1999 Regional assessment are compared in

Fig. 31. The 1992 assessment is clearly at odds with the other assessments, suggesting that spawner biomass increased in the post-extension of jurisdiction period to a peak of 140,000 t in 1986. The other estimates are lower and the more recent assessments indicate that the spawner biomass began to decline after 1984. The 1992 assessment was clearly influence by an increased availability of fish to the winter surveys in 1990 and 1991. Subsequent surveys confirmed a declining trend in stock size, suggesting a minimum spawner biomass of about 40,000 – 55,000 t by the beginning of 1993. The March and October 1999 assessments are similar, although the October assessment gives somewhat higher estimates of the spawner biomass throughout the period. This is primarily a consequence of allowing the model to estimate the proportion of F on age 14 relative to the average on ages 11- 13 in the October assessment, whereas in the March assessment this parameter was set to a value of 0.5. The other difference is that the October 1999 assessment, with the addition of the April 1999 research vessel survey data and additional catch data, indicated that spawner biomass had ceased to grow. The October 1999 assessment predicted that a 25,000 t TAC would be associated with a probability of 50% that the spawner biomass would decline in the year 2000. The TAC was set at 20,000 t which was estimated to be associated with a 33% probability of the spawner biomass declining. Consequently the decline in the spawner biomass which is estimated to have occurred was not unexpected.

9.2 Description of SPA runs carried out

A total of 18 QLSPA formulations were carried out during the current assessment and in the immediate post-assessment period (the later runs have not received any peer review). The large number of runs was partly a consequence of the suggestion that some or all of the fish occurring in the western portion of the stock area in winter and early spring originated from spawning occurring within the southern Gulf stock area. To evaluate the potential effect of thison the assessment different treatments of the survey and catch data were attempted. In addition, runs were carried out to examine the effect of different formulations related to the shape of the partial recruitment vector and the influence of specific survey index values on the model fit. Some runs were also carried out to examine the influence of the inclusion of the Cameron index, the sentinel survey index and the French index. The full list of runs is shown in Table 18. The final run accepted in the stock assessment is first described in detail. The results from this model are then compared with those obtained from last years' assessment and from selected alternative formulations applied to the current data to illustrate the influence of indices and model structure on the estimates. Risk analysis was carried out only on the final model and one alternative model, and these are also described.

9.3 Final run

The final run (Run 10) selected as providing the most reliable estimate of the size of the population on April 1, 2001 and used to evaluate TAC options for the April 1, 2001 to 31 March, 2002 fishery was calibrated with the following indices:

- (i) Cameron RV index for years 1972 to 1982, and ages 2 to 14;
- (ii) Canadian RV index for Burgeo strata for years 1993 to 2000, and ages 2 to 12;
- (iii) Canadian RV index for the Non-Burgeo strata for years 1983 to 2000, and ages 2 to 14;
- (iv) Sentinel gillnet catch rate index for years 1995 to 1999, and ages 3 to 10;
- (v) Sentinel linetrawl catch rate index for years 1995 to 1999, and ages 3 to 10.

A standard cohort model

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

was applied over ages 2-14 for 1959-31 March 2000 using reported catch and sampled age composition. Catch from 1 April 2000 to 31 March 2001 was based on assuming that the 20,000 t TAC set for the period would be harvested according to the average partial recruitment at age vector (PR) estimated for the 1997-1999 period.

Population numbers at age 14 was derived using constraints on the fishing mortalities. For 1959-1993 *F* at age 14 was estimated as an unknown parameter (γ) times the average *F* at ages 11-13. The rationale for this *F* constraint is that the true *F* at age 14 is likely to be more similar to the *F* at ages close to 14 than the *F* at ages far from 14. The parameter is treated as unknown so that the SPA properly reflects uncertainty about the commercial fishery selectivity pattern. This parameter was constrained to be equal in all years between 1959-1993 for simplicity, and because the gear composition was relatively stable prior to the fishing moratorium in 1993. After 1993 the gear composition changed substantially with gillnets becoming the dominant gear. *F* constraints could not be used to derive numbers at age 14 in 1994-97 because the catches at age 14 were zero in these years. This problem was overcome by approximating 1993 population numbers at ages 10-13 using *F* constraints, and then projecting these numbers forward to age 14 in 1994-97. The *F*-constraints were of the form $F_a = \gamma_a \text{ave}(F_{a-1:a-3};)$ that is, *F*'s at ages 10-13 in 1993 were estimated as an unknown parameter times the average *F* at the previous three ages. *F*'s at age 14 in 1998 to 2000 were estimated as three unknown parameters times the average *F* at ages 11-13. Thus, a total of 8γ parameters were estimated to give the population numbers at age 14 throughout 1959-2000.

The Canadian RV indices at age were assumed to be proportional to population numbers at age. The constant of proportionality was assumed to be different for Burgeo and non-Burgeo indices. Age 2 Engel indices were given no weight in estimation because of the low selectivity at this age. Catchability for the Engels and Campelen gears at ages 13-14 were also assumed to be different because of the possibility of differences in the selectivity of the two gears not accounted for in the index conversion process applied to the Engel data (1983-1995). The proportionality of Cameron surveys to population size was assumed to be different from either the Engel or Campelen timeseries because the data were collected with a side-trawl for which no conversion estimates are available. The sentinel gillnet and linetrawl indices at age were assumed to be proportional to population numbers at age with different constants estimated for each index.

In the QLSPA model, the variability of the indices was assumed to be a quadratic function of the mean. The variance was parameterized as a scale parameter times a weighted average of the square and linear components; hence, model variability could range from constant CV to Poisson-like. The weights must sum to one. The quasi-likelihood fit function based on the quadratic variance model was used for estimation (Cadigan 1998). It is

$$\int_{I}^{I'} \frac{I-t}{\phi(\alpha t^2 + (1-\alpha)t)} dt.$$

Where I is the observed index and I' is the predicted index. The variance scale parameter (ϕ) and the weight parameter (α) were estimated separately for each index so that the indices were self-weighted in the estimation.

The following structure was also imposed:

(i) natural mortality was assumed to be 0.2/yr;
(ii) no “plus” age class;
(iii) no error in the catch numbers-at-age.

The inputs, estimates and residuals for the final model are given in Table 19. Beginning of year population biomass and spawner biomass estimates from the final model computed by applying the estimated beginning of year weight at age and maturity at age in Table 7A and Table 17 are plotted in Fig. 32. Estimated recruitment (numbers age 3) from the final model is plotted in Fig. 33.

9.4 Comparison runs

The final model accepted in the current assessment is compared with the final model from the October 1999 assessment and with selected alternative model formulations from Table 18 in Figs. 34 - 41. The comparisons are briefly described below.

October 1999 assessment
The spawner biomass estimates for recent years from the current assessment are substantially lower than those estimated in the October 1999 assessment (Fig. 34). The methods in the current assessment differ from those applied in October 1999. Most importantly, the RV survey was divided into Burgeo and non-Burgeo indices and self-weighting was applied. The Cameron survey index for the period 1972-1982 (Burgeo strata removed) and both the sentinel and gillnet catch rate indices were included with the age structure obtained from the whole age-length key and not just the modal age as was used in October 1999. In the October 1999 assessment a single RV index was applied with the Burgeo strata removed from the winter survey data.

Run 14 which has the same formulation as the October 1999 assessment
Using the same formulation as last year, but applied to the additional RV and sentinel gillnet data (the only difference being that the gillnet index was computed using an age key rather than applying the modal age), gives estimates which are higher than those obtained in the final model run (Fig. 35). The difference is primarily a consequence of the splitting of the RV index into Burgeo and non-Burgeo indices and applying self-weighting. Estimates for the most recent years from Run 14 are similar in magnitude to those obtained from the October 1999 assessment but the trend is different.

Run 16 which excludes the sentinel and linetrawl sentinel gillnet indices
The exclusion of the sentinel gillnet and linetrawl indices from the calibration does not have a substantial effect on the estimates of spawner biomass or the shape of the trend (Fig. 36).

Run 7 which excludes the Burgeo index
Excluding the Burgeo index results in a lowering of the spawner biomass estimates for the 1980’s and 1990’s period (Fig. 37) while the estimates for the earlier period in the time-series are relatively unchanged.

Run 9 which excludes the Burgeo index and 75% of the commercial catch from 3Psa and 3Psd from 1 November to 30 April in each year
The estimates from Run 9 are slightly lower than those for the final run in the most recent years (Fig. 38). Estimates for the late 1980’s and early 1990’s are quite similar, whereas the estimates for Run 9 are substantially lower in the early part of the time-series.

Run 17 which excludes 75% of the commercial catch from 3Psa and 3Psd from 1 November to 30 April in each year
Removing a portion of the Burgeo catch scales down the biomass estimates over the whole time period compared to the final run, as might be expected (Fig. 39).

Run 11 which assumes that fishing mortality on age 14 is equal to the average of ages 11-13
Estimates of spawner biomass are very sensitive to the fishing mortality applied to the oldest age. If the fishing mortality on age 14 is assumed to be equal to the average on ages 11-13 then the spawner biomass estimates are substantially lower over the whole time period (Fig. 40).

Run 13 which excludes Burgeo catch for the whole year and Burgeo survey strata
This run was done to illustrate the possible outcome in terms of risk associated with various TAC options if the western portion of 3Ps were closed to fishing and effort were redirected to the eastern portion. The model estimates are lower over the whole time period (Fig. 41).

9.5 Discussion of final model run (Run 10) and the non-Burgeo run (Run 13)

The final model run was based on the total reported commercial catch, information from the Templeman survey (1983-2000), the Cameron survey (1972-1982), and the sentinel gill net and line-trawl surveys (1995-1999). In the October 1999 assessment, the issue of stock mixing at the time of the survey was addressed by removing Burgeo strata from the winter portion of the survey time series (1983-1992). The Burgeo strata were included as part of the spring series (1993-1999). In the present assessment it was considered more logical to split the Templeman index into two: one for April surveys in the Burgeo Bank/Hermitage Channel area and one for the remaining 3Ps area (winter and spring series combined). For the Burgeo Bank/Hermitage Channel index only April surveys in the recent years (1993-2000) were used in the SPA. The Cameron survey index was also based only on the area of 3Ps excluding the potential mixing area because many of these surveys were conducted during winter.

The SPA estimates the accuracy of each index and hence the weight it receives in determining the final result. The SPA gives the Templeman survey index for the Burgeo Bank/Hermitage Channel area lower weight, as would be expected if this is a poorer index of 3Ps stock abundance. This is consistent with the observation that cod tagged in April in the Burgeo Bank/Hermitage Channel area in 1998 were recaptured mostly in the Gulf, whereas in 1999 they were recaptured mostly in 3Ps.

Population biomass and spawner biomass declined from high values during the late 1950s to the mid-1970s, then increased to a peak in 1985 (Fig. 32). The stock declined from the mid-1980s to the early 1990s, but increased rapidly during 1993-1997 following the declarations of a moratorium on commercial fishing. Population biomass and spawner biomass are estimated to have decreased during 1998 and 1999. The current (1 Jan. 2000) population biomass is estimated to be 123,000 t. and spawner biomass is estimated to be 92,000 t.

Spawner biomass on 1 Jan. 1999 is estimated at 106,000 t in this assessment compared to 147,000 t in the October 1999 assessment (Brattey et al. 1999b). This difference is a consequence of treating the survey data for the Burgeo Bank/Hermitage Channel area and the remainder of the stock area as two separate indices. The current assessment estimates that spawner biomass peaked in 1998 and has subsequently declined, whereas the October 1999 assessment estimated that spawner biomass continued to grow until 1999. The difference is a consequence of data that became available since the October 1999 assessment. The downward trend in 3Ps spawner biomass in recent years was a consistent feature of all SPA formulations considered in the current assessment. Recruitment estimated from the SPA has been variable in 3Ps, but shows a long-term decline (Fig. 33). Recruitment during the mid- to late-1990s does not appear to be strong, but preliminary indications are that it may have increased somewhat in 1999-2000.

Annual exploitation rates, expressed as % of numbers removed by the fishery, varied over time Fig. 42). Exploitation increased from the late 1950's to a peak of over 24% in 1975 and declined to a low of approximately 10% in 1984 then increased rapidly to between 18 and 25% just prior to the moratorium in 1993. With the reopening of the fishery in 1997, exploitation rates were low in 1997 relative to the pre-moratorium period but increased to 13.7% in 1999, the last completed year of the fishery.

If fishery closures in western 3Ps lead to a transfer of effort to the remaining areas of 3Ps, then the exploitation risks for the remaining part of the 3Ps cod stock could change, particularly if there is limited mixing between fish from the closed and open areas. To illustrate the risks of transferring effort to the remainder of the stock, an SPA (Run 13) was performed using information from only that part of the stock area east of Burgeo Bank/Hermitage Channel (i.e. excluding 3Psa and 3Psd). It was conducted using the reported commercial catches outside the mixing region for the entire year, the Templeman survey index excluding the Burgeo Bank/Hermitage Channel area, the Cameron survey index, and the sentinel gill net index. The sentinel line-trawl index was excluded because the results typically came from the western portion of the stock area.. Spawner biomass estimates show similar trends to those from the entire 3Ps region, but fish in this eastern portion are, at present, younger on average. The 1 Jan. 2000 population biomass for this eastern portion is estimated to be 93,000 t. and spawner biomass is estimated to be 68,000 t.

10. Biological reference points and risk analyses

A risk analysis based on the final QLSPA model (Run 10) and a model based on the non-Burgeo RV index and sentinel gillnet index together with the non-Burgo catch (Run 13) were used to propagate the uncertainty in the estimated population size to April 1 2002 after first accounting for expected catches to 1 April 2001 under the 20,000 t TAC. This was done by assuming that 90% of the TAC is caught between April 1 2000 and Dec 31 2000, and 10% of the TAC is caught between Jan 1 2001 and March 31 2001. Catch-at-age in these two periods was computed using the fraction of TAC, commercial weights at age, and the average annual fishery relative selectivity (PR) for 1997-1999 estimated in Run 10. The catch-at-age for these two periods was then used to project stock size from April 1 2000 to April 1 2001. The same procedure was used to evaluate the consequences of TAC options for the 2001-2002 management year on April 1 2002 stock size; that is, the 90-10% split of the TAC was used, along with the same PR, etc. Profile quasi-likelihood methods were used to stochastically evaluate the impact of alternative TAC (see Cadigan 1998 for details of method). The non-Burgeo risk analysis was thought to be of potential use in the context of management options that considered closing the western portion of the stock area to fishing, thus redirecting fishing mortality to the remainder of the stock area.

A number of precautionary reference points have been suggested for this stock (Shelton 2000), and in the previous assessment the following were computed: F_{loss}, F_{high}, F_{med}, $F_{35\%\text{SPR}}$, $F_{0.1}$, SSB at 50%

asymptotic recruitment, Serebryakov's SSB (spawner biomass corresponding to the 90th percentile recruitment value and the fishing mortality replacement line that bisects the stock-recruit scatter such that 90% of the points fall below the line) and 20% virgin SSB. A further reference point, the risk of SSB declining, was also considered. In the current assessment the risk of the average and the fully recruited F falling below 0.1 and 0.21 (the calculated $F_{0.1}$ level in the October 1999 assessment), the risk of the spawner biomass declining from 1 April 2001 to 1 April 2002, and the risk that April 1 2002 spawner biomass is less than the lowest level of January 1 spawner biomass between 1959-2000, were computed for a range of TAC options in the 2001/2002 fishing season from 5,000 to 30,000 t using profile quasi-likelihood methods. The input vectors of weight, maturity and PR at age for the projection are given in Table 20. The results are presented in Table 21 for the final model (Run 10). Cumulative risk plots are presented for both the final model and for Run 13 which includes only non-Burgeo catch and survey data (Figs. 43 - 46).

The risk of exceeding 0.21 fishing mortality in the management year 1 Apr. 2001 to 31 Mar. 2002 with a catch of 10,000 t is 2% and with a catch of 20,000 t is 58% (Fig. 43). The risk of exceeding 0.1 fishing mortality is 54% with a 10,000 t catch, and 99.6% with a 20,000 t catch. The risk of spawning stock biomass declining at the end of the management year for a 10,000 t catch is 50%, and at a 20,000 t catch the risk is 89% (Fig. 44). At 20,000 t the risk of spawning stock biomass declining below the lowest level between 1959-2000 is 2.7%. These risk analyses do not take into account uncertainties associated with the stock composition of the commercial catch, misreported catches and assumptions about natural mortality.

A second risk analysis was conducted using the SPA for the part of the stock excluding the mixing region to illustrate the potential problem of reallocating all the effort to the non-Burgeo portion of the stock area. To run the same 2% risk of exceeding the 0.21 fishing mortality reference level the catch option on this portion of the stock would be 5,000 t. The risk of exceeding 0.1 fishing mortality is 54% with a 6,000 t catch (Fig. 45). A catch of 12,000 t would result in the same 50% risk of spawning stock biomass declining at the end of the management year (Fig. 46).

This document reports risk analyses for the whole of 3Ps and for the eastern portion alone. Note that a risk analysis for the western portion cannot be obtained by simple subtraction, because the age-structures (and therefore relationship between catch and average fishing mortality) are different. The uncertainties are also different.

11. Outlook

An assessment based on all catches taken in 3Ps estimates that the spawning stock biomass was 82,000 on 1 April 2000 and that it will decline to 76,000 on 1 April 2001 if this year's catch is taken; this is comparable to spawning stock biomass in 1992 just before the 1993 moratorium.

Spawning stock biomass increased from 1993 to 1998 due to good growth, early maturation and good survival over the moratorium period by the 1989 and 1990 year-classes. This increase in spawner biomass was not sustained by recent recruitment and spawning stock biomass has declined since 1998. Estimates of year-class strength show a general downward trend over the period 1959 to 1999 with all year-classes from 1991-1996 being particularly low.

There is a greater than 50% risk that spawner biomass will decline further in 2001-2002 at catch levels of 10,000 t or higher.

12. References

Beacham, T. D., J. Brattey, K. M. Miller, K. D. Lee, R. E. Withler. 1999. Population structure of Atlantic cod (*Gadus morhua*) in the Newfoundland and Labrador area based on microsatellite variation. DFO Can. Stock Assess. Sec. Res. Doc. 99/35.

Beacham, T. D., J. Brattey, K. M. Miller, K. D. Lee, K. D. Schulze, and R. E. Withler. 2000. Population structure of Atlantic cod (*Gadus morhua*) in the Newfoundland and Labrador area based on microsatellite variation. DFO Can. Stock Assess. Sec. Res. Doc. 2000/099.

Bishop, C. A., J. W. Baird and E. F. Murphy. 1991. An assessment of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 91/36, 56p.

Bishop, C. A., and E. F. Murphy. 1992. An assessment of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 92/111, 43p.

Bishop, C. A., E. F. Murphy, and M. B. Davis. 1993. An assessment in 1993 of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 93/70, 39p.

Bishop, C. A., E. F. Murphy, and M. B. Davis. 1994. An assessment of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 94/33, 33p.

Bishop, C. A., E. F. Murphy, and D. E. Stansbury. 1995. Status of the cod stock in NAFO Subdivision 3Ps. CAFSAC Res. Doc. 95/31, 21p.

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

Bradbury, I. R., P. V. R. Snelgrove, and S. Fraser. 2000. Transport and development of eggs and larvae of Atlantic cod in relation to spawning time and location in coastal Newfoundland. Can. J. Fish. Aquat. Sci. 57: 1761-1772.

Brattey, J. 1996. Overview of Atlantic cod (*Gadus morhua*) stock structure in NAFO Subdivision 3Ps inferred from tagging studies. DFO Can. Stock Assess. Sec. Res. Doc. 96/93, 19p.

Brattey, J. 1999. Stock structure and seasonal migration patterns of Atlantic cod (*Gadus morhua*) based on inshore tagging experiments in Divs. 3KL during 1995-97. DFO Can. Stock Assess. Sec. Res. Doc. 99/103.

Brattey, J., N. G. Cadigan, G. R. Lilly, E. F. Murphy, P. A. Shelton, and D. E. Stansbury 1999a. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Canadian Stock Assessment Secretariat Res. Doc. 99/36.

Brattey, J., N. G. Cadigan, G. R. Lilly, E. F. Murphy, P. A. Shelton, and D. E. Stansbury. 1999b. An assessment of the cod stock in NAFO Subdivision 3Ps in October 1999. DFO Canadian Stock Assessment Secretariat Res. Doc. 99/161.

Brattey, J., G. A. Lawson, and G. A. Rose. 1999c. Seasonal migration patterns of Atlantic cod (*Gadus morhua*) in Subdivision 3Ps based on tagging experiments during 1997-1998. DFO Can. Stock Assess. Sec. Res. Doc. 99/37.

Brattey, J. 2000. Stock structure and seasonal movements of Atlantic cod (*Gadus morhua*) in NAFO Divs. 3KL inferred from recent tagging experiments. DFO Can. Stock Assess. Sec. Res. Doc. 2000/084.

Cadigan, N. 1998. Semi-parametric inferences about fish stock size using sequential population analysis (SPA) and quasi-likelihood theory. DFO Can. Stock Assess. Sec. Res. Doc. 98/25.

Cadigan, N. and J. Brattey. 1999a. Tag loss and reporting rates for 1997 and 1998 Cod tagging experiments in 3Psc and 3KL. DFO Can. Stock Assess. Sec. Res. Doc. 99/65.

Cadigan, N. and J. Brattey. 1999b. Estimation of coarse exploitation and migration rates of cod in 3Psc and 3KL during 1997 and 1998 based on tagging experiments. DFO Can. Stock Assess. Sec. Res. Doc. 99/38.

Cadigan, N. and J. Brattey. 2000. Lower bounds on the exploitation of cod (*Gadus morhua*) in NAFO Subdiv. 3Ps and Divs 3KL in 1997-1999 from tagging experiments. DFO Can. Stock Assess. Sec. Res. Doc. 2000/073.

Campana, S. E., G. A. Chouinard, M. Hanson, A. Fréchet and J. Brattey. 1998. Stock composition of cod aggregations near the mouth of the Gulf of St. Lawrence in January 1996 based on an analysis of otolith elemental fingerprints. DFO Can. Stock Assess. Sec. Res. Doc. 98/55.

Campana, S. E., G. A. Chouinard, J. M. Hanson, A. Fréchet. 1999. Mixing and migration of overwintering Atlantic cod (*Gadus morhua*) stocks near the mouth of the Gulf of St. Lawrence. Can. J. Fish. Aquat. Sci. 56: 1873-1881.

Campana, S. E., G. A. Chouinard, J. M. Hanson, A. Fréchet, and J. Brattey. 2000. Otolith elemental fingerprints as biological tracers of fish stocks. Fisheries Research 46: 343-357.

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

Chouinard, G. A. 2000. Report of the cod mixing workshop. .DFO Can. Stock Assess. Sec. Res. Doc. 2000/27.

Colbourne, E. 2001. Oceanographic conditions in NAFO Subdivisions 3Pn and 3Ps during 2000 with comparisons to the long-term (1961-1990) average. Canadian Stock Assessment Secretariat Res. Doc. 2001/005.

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

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

Lear, W. H. 1984. Results of tagging of Atlantic cod on St. Pierre Bank during February, 1980. NAFO SCR Doc. 84/IV/25, 4p.

Lear, W. H. 1988. Migrations of Atlantic cod of NAFO Division 3Ps. NAFO SCR Doc. 88/73, 8p.

Lilly, G. R. 1996. Growth and condition of cod in Subdivision 3Ps as determined from trawl surveys (1972-1996) and sentinel surveys (1995). DFO Atl. Fish. Res. Doc. 96/69.

Lilly, G. 1998. Size-at-age and condition of cod in Subdivision 3Ps in 1972-1997. DFO Can. Stock Assess. Sec. Res. Doc. 98/94.

Lilly, G. R., P. A. Shelton, J. Brattey, N. Cadigan, E. F. Murphy, and D. E. Stansbury. 1999. An assessment of the cod stock in NAFO divisions 2J+3KL. DFO Atl. Fish. Res. Doc. 99/42.

Lilly, G. R., P. A. Shelton, J. Brattey, N. Cadigan, E. F. Murphy, and D. E. Stansbury. 2000. An assessment of the cod stock in NAFO divisions 2J+3KL. DFO Atl. Fish. Res. Doc. 2000/063.

McClintock, J. 1999a. Results of Surveys Directed at Cod in NAFO Division 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 99/20.

McClintock, J. 1999b. Second Year Results of Surveys Directed at Cod in NAFO Division 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 99/34.

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

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

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

Murphy, E. F., and P. A. Shelton. 1997. Commercial catch rate data as an index of cod abundance in NAFO Divisions 2J3KL. NAFO SCR Doc. 97/46.

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

Pinhorn, A.T. 1976. Living Marine Resources of Newfoundland-Labrador: Status and Potential. Bull. Fish. Res. Bd. Can. 194, 64p.

Rivard, D. 1999. Proceedings of the zonal cod assessment process, Rimouski, Quebec, 1-12 March 1999. Canadian Assessment Proceedings 99/05.

Robichaud, D., and G. A. Rose. 1999. Distribution of 0 and 1 group cod in nearshore waters of Placentia Bay (NAFO Subdivision 3Ps), 1997-1998. DFO Can. Stock Assess. Sec. Res. Doc. 99/66.

Shelton, P.A. 2000. The development of precautionary and biological reference points for the 3Ps cod stock. DFO Can. Stock Assess. Sec. Res. Doc. 2000/075.

Shelton, P., D. E. Stansbury, E. F. Murphy, G. R. Lilly, and J. Brattey. 1996. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 96/91.

Smith, S. J., and G. D. Somerton. 1981. STRAP: A user-oriented computer analysis system for groundfish research trawl survey data. Can. Tech. Rep. Fish. Aquat. Sci. 1030: iv + 66 p.

Stansbury, D. E. 1996. Conversion factors from comparative fishing trials for Engels 145 otter trawl and the Campelen 1800 shrimp trawl used on research vessels. NAFO SCR. Doc. 96/77 Serial No. N2752. 15p.

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

Stansbury, D. E., P. Shelton, J. Brattey, G. R. Lilly, G. R. Winters, E. F. Murphy, M. B. Davis, and D. W. Kulka. 1998. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Can. Stock Assess. Sec. Res. Doc. 98/19.

Warren, W. G. 1997. Report on the comparative fishing trial between the Gadus Atlantica and Teleost. NAFO Sci. Coun. Studies 2: 81-92.

Warren, W. G., W. Brodie, D. Stansbury, S. Walsh, M. J. Morgan, and D. Orr. 1997. Analysis of the 1996 comparative fishing trial between the Alfred Needler with the Engel 145 trawl and the Wilfred Templeman with the Campelen 1800 trawl. NAFO SCR. Doc. 97/68.

Table 1. Reported landings of cod (t) from NAFO Subdiv. 3Ps, 1959 - Sept 2000 by country and for fixed and mobile gear sectors.

	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	[3] 885	609	-	2,511	-	-	-	-	19,694	20,000
1999 [1]	3,097	21,231	[3] 614	621	-	2,548	-	-	-	-	28,111	30,000
2000 [4]	1,544	3,301	593	-	-	2,460	-	-	-	-	7,897	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.

[4] Catch for Canada and France to 31 March 31 2000.

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

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
1999	17976	3714	503	45	22237
2000 [1]	3186	492	1760	0	5438

[1] provisional catch to end of March

Table 3A. Reported catches of cod (tons) from NAFO Subdivision 3Psby gear type for 1999

Total Catch (Canada + France)								
	Offshore			Inshore				
Month	Otter trawl	Gillnet	Line trawl	Gillnet	Line trawl	Handline	Trap	Total
Jan	317.2	0.0	41.119	23.9	1.64	0.0		383.9
Feb	73.9	0.0	52.232	7.5	0.565	0.0		134.2
Mar	468.3	0.0	32.907	4.0	0.266	0.0		505.4
Apr	137.0	2.1	19.381	210.9	54.677	0.8		424.8
May	3.0	325.5	75.461	877.6	581.748	7.6	0.453	1871.4
Jun	0.4	58.8	2.091	1021.8	55.689	31.5	22.898	1193.2
Jul	11.5	581.3	11.096	2517.0	228.962	100.7	4.875	3455.3
Aug	13.5	60.1	0	487.5	79.248	28.4	13.608	682.4
Sep	304.2	1632.3	11.738	1156.6	602.121	148.3	1.519	3856.7
Oct	1381.7	105.0	22.365	1239.5	294.534	25.5	1.426	3070.1
Nov	2421.0	885.2	128.897	5609.8	1196.289	30.0		10271.2
Dec	702.7	214.1	118.101	957.8	87.408	54.9		2135.0
								0.0
Totals	5834.4	3864.5	515.4	14113.8	3183.1	427.7	44.799	27983.7

Table 3B. Reported landings of cod from Subdiv. 3Ps during 1999 (excluding 602 t fixed gear and 2548 t mobile gear French catch).

Month	3Psa	3Ps	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh
Jan	0.16	4.08	25.22	0.01	0.00	0.00	0.61	28.97
Feb	0.31	2.23	6.32	0.27	0.00	0.00	0.00	104.99
Mar	0.13	3.01	39.13	0.11	0.00	0.00	7.27	107.52
Apr	114.16	149.48	3.91	3.93	0.20	0.06	4.12	10.41
May	412.67	942.77	111.23	141.79	17.29	70.30	102.37	56.43
Jun	73.46	158.02	934.16	91.07	1.66	17.71	6.86	2.56
Jul	288.93	608.41	1853.28	206.27	49.03	64.28	83.53	59.38
Aug	131.91	106.11	315.93	35.37	2.65	41.57	30.52	9.68
Sep	443.35	390.19	953.02	150.28	256.68	872.03	335.53	108.47
Oct	144.61	103.82	1305.26	1.99	0.00	621.72	31.35	205.66
Nov	1061.69	727.35	5053.89	224.91	32.11	1017.16	201.82	1167.04
Dec	25.48	10.46	1052.30	17.26	0.00	151.02	0.01	247.40
Total	2696.85	3205.92	11653.63	873.26	359.62	2855.85	803.98	2108.51

Table 3C. Reported landings to date for cod from Subdiv. 3Ps during 2000. Landings for January-March are shown separately as the management year in 2000 was changed to begin on April 1. Landings for January-March exclude 2460 t mobile gear catch by France.

Month	3Psa	3Ps	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh
Jan	0.02	4.08	977.98	0.00	0.00	0.00	0.00	26.39
Feb	0.74	2.41	1297.47	0.00	0.00	0.00	0.00	79.56
Mar	171.42	667.79	198.04	0.00	0.00	0.00	15.86	141.19
Total	172.18	674.28	2473.49	0.00	0.00	0.00	15.86	247.14
Apr	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00
May	27.14	11.68	4.15	0.00	0.00	0.00	0.00	0.34
Jun	440.16	1104.95	1330.18	0.67	68.79	238.02	8.93	23.26
Jul	126.61	224.00	1183.24	0.00	5.16	89.03	0.00	30.56
Aug	77.24	90.64	370.88	0.00	3.46	12.70	1.84	2.58
Sep	410.74	436.69	519.86	33.54	84.46	143.04	103.98	123.52
Total	1081.89	1868.09	3408.31	34.21	161.87	482.79	114.75	180.26

Table 4. Numbers of cod sampled (commercial fishery and sentinel survey) for length and age and used to estimate the 3Ps commercial catch-at-age for 1999.

	Number Measured						
	Offshore			Inshore			
Month	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Total
Jan	884			3964	414		5262
Feb	843		250	388	188		1669
Mar	1501			0	102		1603
Apr	1250			4410	0		5660
May	182	904		5994	8921	75	16076
Jun	0			3582	2095	171	5848
Jul	0	1955	0	15316	1169	299	18739
Aug	0		0	905	3152	28	4085
Sep	970	1939	312	812	4551		8584
Oct	4498			744	2069		7311
Nov	6053	352		4027	5835	321	16588
Dec	1883						1883
Total	18064	5150	562	40142	28496	894	93308

	Number Aged						
	Offshore			Inshore			
QTR	Ottertrawl	Gillnet	Linetrawl	Gillnet	Linetrawl	Handline	Total
1	602		185	457	128		1372
2	28	272	57	1347	1064	67	2835
3	163	298		911	532		1904
4	633	662	128	877	719	68	3087
Total	1426	1232	370	3592	2443	135	9198

Table 5. Estimated average weight (kg), length (cm), and numbers-at-age (000's) for landings from the commercial cod fishery in 3Ps during 1999 (for all gears combined).

Age	Average weight (kg)	Average lenth (cm)	Catch number (000'S)	std err.	cv
1	0.00	0.00	0.0	.	.
2	0.13	25.00	0.0	.	.
3	0.70	42.99	48.8	11.66	0.00
4	0.92	46.87	627.6	32.94	0.05
5	1.57	55.26	1202.5	45.53	0.04
6	2.31	62.95	2156.4	59.41	0.03
7	2.53	65.07	2321.4	59.42	0.03
8	2.82	67.00	1019.7	43.45	0.04
9	3.92	74.24	959.7	31.60	0.04
10	5.32	82.04	873.0	22.64	0.03
11	4.99	80.29	189.1	12.99	0.08
12	5.27	82.19	110.1	9.69	0.09
13	6.14	85.91	20.7	2.75	0.15
14	7.27	91.46	8.4	1.70	
15	3.57	70.98	2.6	1.03	0.43
16	7.33	92.16	0.1	0.08	0.57
17	0.00	0.00	0.0	.	.
18	16.63	121.00	0.0	.	.

Table 6. Catch numbers-at-age (000's) for the commercial fishery in 3Ps, all gears combined, for 1959 to end of March 2000.

Year/age	2	3	4	5	6	7	8	9	10	11	12	13	14
1959	0	1001	13940	7525	7265	4875	942	1252	1260	631	545	44	0
1960	0	567	5496	23704	6714	3476	3484	1020	827	406	407	283	27
1961	0	450	5586	10357	15960	3616	4680	1849	1376	446	265	560	58
1962	0	1245	6749	9003	4533	5715	1367	791	571	187	140	135	241
1963	0	961	4499	7091	5275	2527	3030	898	292	143	99	107	92
1964	0	1906	5785	5635	5179	2945	1881	1891	652	339	329	54	27
1965	0	2314	9636	5799	3609	3254	2055	1218	1033	327	68	122	36
1966	0	949	13662	13065	4621	5119	1586	1833	1039	517	389	32	22
1967	0	2871	10913	12900	6392	2349	1364	604	316	380	95	149	3
1968	0	1143	12602	13135	5853	3572	1308	549	425	222	111	5	107
1969	0	774	7098	11585	7178	4554	1757	792	717	61	120	67	110
1970	0	756	8114	12916	9763	6374	2456	730	214	178	77	121	14
1971	0	2884	6444	8574	7266	8218	3131	1275	541	85	125	62	57
1972	0	731	4944	4591	3552	4603	2636	833	463	205	117	48	45
1973	0	945	4707	11386	4010	4022	2201	2019	515	172	110	14	29
1974	0	1887	6042	9987	6365	2540	1857	1149	538	249	80	32	17
1975	0	1840	7329	5397	4541	5867	723	1196	105	174	52	6	2
1976	0	4110	12139	7923	2875	1305	495	140	53	17	21	4	3
1977	0	935	9156	8326	3209	920	395	265	117	57	43	31	11
1978	0	502	5146	6096	4006	1753	653	235	178	72	27	17	10
1979	0	135	3072	10321	5066	2353	721	233	84	53	24	13	10
1980	0	368	1625	5054	8156	3379	1254	327	114	56	45	21	25
1981	0	1022	2888	3136	4652	5855	1622	539	175	67	35	18	2
1982	0	130	5092	4430	2348	2861	2939	640	243	83	30	11	7
1983	0	760	2682	9174	4080	1752	1150	1041	244	91	37	18	8
1984	0	203	4521	4538	7018	2221	584	542	338	134	35	8	8
1985	0	152	2639	8031	5144	5242	1480	626	545	353	109	21	6
1986	0	306	5103	10253	11228	4283	2167	650	224	171	143	79	23
1987	0	585	2956	11023	9763	5453	1416	1107	341	149	78	135	50
1988	0	935	4951	4971	6471	5046	1793	630	284	123	75	53	31
1989	0	1071	8995	7842	2863	2549	1112	600	223	141	57	29	26
1990	0	2006	8622	8195	3329	1483	1237	692	350	142	104	47	22
1991	0	812	7981	10028	5907	2164	807	620	428	108	76	50	22
1992	0	1422	4159	8424	6538	2266	658	269	192	187	83	34	41
1993	0	278	3712	2035	3156	1334	401	89	38	52	13	14	5
1994	0	9	78	173	74	62	28	12	3	2	0	0	0
1995	0	3	7	56	119	57	37	7	2	0	0	0	0
1996	0	9	43	43	101	125	35	24	8	2	1	0	0
1997	0	66	427	1130	497	937	826	187	93	31	4	1	0
1998	0	91	373	793	1550	948	1314	1217	225	120	56	15	1
1999P	0	72	811	1248	1463	2455	1563	1035	988	383	181	59	33
1999F	0	49	628	1202	2156	2321	1020	960	873	189	110	21	8
2000	0	1	6	80	204	455	380	213	249	320	49	25	12

Note: Provisional and final figures are given for 1999. The 2000 catch-at-age is comprised of 2460 t for France and the remainder mainly for Canadian inshore fixed gear. The French catch is January to March otter trawl; there was no reported fixed or inshore catch by France during this period. The Canadian catch for 2000 is comprised of otter trawl and offshore fixed gear catch for January - March and inshore fixed gear January - March.

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 and 2000.

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
2000	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 and 2001.

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
2001	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. Standardized gill-net (5.5" mesh) and line-trawl catch rate-at-age indices estimated using data from sentinel fixed sites. Gill-net catch rates are expressed as fish per net, line-trawl as fish per 1000 hooks.

Gillnet year/age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1995	0.02	0.08	4.19	8.91	5.17	2.46	0.34	0.12
1996	0.02	0.25	2.51	11.14	9.12	2.60	0.71	0.06
1997	0.01	0.23	4.82	4.46	7.47	7.06	0.83	0.65
1998	0.01	0.04	0.81	5.51	2.65	1.90	1.17	0.25
1999	0.00	0.01	1.24	1.76	2.34	0.79	0.23	0.21

Linetrawl Year/age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1995	10.60	20.30	66.80	88.90	23.60	17.70	3.30	1.40
1996	9.70	35.50	33.80	55.20	54.00	15.50	8.50	1.90
1997	6.80	26.00	29.70	20.90	19.00	28.60	3.00	2.80
1998	9.10	20.40	22.20	26.20	7.40	13.20	12.40	2.40
1999	8.70	19.60	22.90	15.60	15.10	6.30	3.60	1.90

Table 9. Cod abundance estimates (000's) from DFO research vessel bottom trawl surveys in NAFO Subdiv. 3Ps. Shaded cells are model estimates. See Fig. 20 for locations of strata.

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

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

Table 10. Cod biomass estimates (t) from DFO research vessel bottom trawl surveys in NAFO Subdiv. 3Ps. Shaded cells are model estimates. See Fig. 20 for locations of strata.

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

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

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

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

[4] totals are for all strata fished .

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

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

Table 11. Mean numbers per tow at age in Campelen units for the Canadian RV index for the period 1983 to 2000. Data are adjusted for missing strata.There were two surveys in 1993 (January and April). A minor correction has been made to the 1995 index.

Age/Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993.1 (January)	1993.2 (April)	1994	1995	1996	1997	1998	1999	2000
1	6.42	0.30	0.38	0.20	1.09	0.42	0.49	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.90	0.22	0.52	1.24	1.25
2	10.01	5.40	7.74	6.62	8.48	9.13	6.50	1.48	27.69	1.80	0.00	0.00	1.63	0.31	1.08	1.53	0.97	2.54	3.33
3	6.52	2.33	14.88	5.65	5.67	5.93	4.66	9.82	5.03	6.95	1.83	1.99	1.46	1.16	3.67	2.33	6.79	2.55	5.36
4	1.14	1.55	12.57	6.48	4.97	2.96	3.17	14.49	10.00	2.11	4.03	4.04	4.31	1.67	3.62	1.04	8.42	2.38	3.10
5	3.72	0.63	9.96	7.95	13.82	2.84	1.51	10.89	11.24	4.15	0.71	1.49	6.10	13.08	1.32	0.50	5.60	2.58	2.17
6	1.62	2.11	3.28	6.33	8.31	6.50	1.16	5.67	5.75	2.03	2.96	1.35	1.73	19.65	2.69	0.28	3.99	2.34	1.82
7	0.48	0.77	2.66	2.13	3.35	5.84	2.15	3.84	2.84	1.03	0.68	0.47	1.62	4.40	2.91	0.30	1.96	1.72	1.20
8	0.89	0.37	0.79	1.47	1.29	3.65	1.21	3.14	1.58	0.53	0.33	0.10	0.50	5.75	0.54	0.24	2.50	0.44	0.89
9	1.61	0.46	0.48	0.84	0.69	1.49	0.67	1.15	1.19	0.26	0.13	0.04	0.08	2.19	0.46	0.14	2.79	0.79	0.35
10	0.75	0.71	0.42	0.29	0.28	0.84	0.37	0.71	0.74	0.24	0.09	0.03	0.04	0.25	0.09	0.05	0.43	0.60	0.31
11	0.36	0.18	0.42	0.24	0.23	0.74	0.41	0.32	0.56	0.08	0.11	0.04	0.03	0.20	0.09	0.02	0.30	0.09	0.53
12	0.14	0.15	0.49	0.29	0.16	0.35	0.13	0.16	0.22	0.04	0.03	0.01	0.02	0.01	0.02	0.00	0.06	0.02	0.12
13	0.06	0.06	0.21	0.17	0.17	0.16	0.11	0.12	0.11	0.01	0.04	0.00	0.01	0.07	0.00	0.00	0.03	0.02	0.00
14	0.05	0.03	0.12	0.10	0.16	0.15	0.05	0.09	0.07	0.01	0.01	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.01
15	0.04	0.00	0.03	0.06	0.06	0.09	0.09	0.01	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.04	0.04	0.03	0.04	0.04	0.10	0.06	0.05	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.01	0.00	0.05	0.02	0.05	0.01	0.04	0.01	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
18	0.02	0.03	0.02	0.00	0.04	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	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	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	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	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	0.00	0.00

Table 12. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdivision 3Ps in winter-spring 1972-2000. Entries in boxes are based on fewer than 5 aged fish. Some entries are different from those in Table 6 of Lilly (MS 1996) because only data from successful sets in the index strata are included in the present analyses.

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

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1		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	12.0	13.3
2	19.6	22.1	21.0	22.4	22.0	20.2	19.2	17.9	18.7	19.9	19.7	19.2	20.0	19.2	20.7		19.1	21.2	20.6	24.1	22.3	22.2	22.0
3	28.0	32.2	28.1	32.4	33.3	31.2	30.6	29.0	26.8	29.5	29.0	30.1	29.9	29.5	30.5	30.9	32.3	30.1	30.0	31.7	32.5	31.4	31.7
4	35.9	42.6	42.9	44.4	44.9	43.0	42.1	40.3	40.3	39.4	40.8	41.6	40.0	38.5	40.9	41.1	39.2	41.4	38.6	40.8	42.5	42.9	40.7
5	48.0	47.4	50.6	50.6	53.4	52.6	51.8	50.9	48.6	48.1	47.5	47.9	48.0	46.9	47.1	48.0	48.0	50.3	44.0	47.9	48.7	51.2	48.6
6	59.0	56.3	58.2	58.6	59.3	57.8	60.6	60.0	55.5	53.9	56.2	56.0	53.7	53.3	55.1	52.6	50.2	56.4	52.9	51.5	53.2	58.9	54.6
7	65.6	70.5	71.3	63.2	66.4	65.4	66.2	66.3	62.1	61.1	61.9	63.9	56.6	57.4	61.1	62.2	53.6	58.2	60.9	60.6	57.5	61.7	60.3
8	70.1	76.8	84.8	69.9	70.1	71.4	70.6	74.0	72.1	67.3	66.7	71.8	62.2	62.7	62.4	70.3	59.1	57.9	61.1	65.2	67.0	66.2	65.3
9	84.1	85.8	94.9	72.6	75.6	73.3	75.6	74.3	76.4	77.8	74.6	75.9	70.1	68.1	66.6	77.1	68.0	63.0	63.3	66.9	77.2	77.6	67.8
10	86.3	95.3	98.0	83.2	90.6	79.4	78.9	79.3	82.6	85.4	79.7	84.4	76.1	73.7	73.4	80.5	88.0	79.8	76.7	67.3	77.2	86.5	81.1
11	88.3	94.3	97.2	97.6	98.7	89.6	84.1	89.1	93.3	83.1	79.7	88.5	79.4	73.8	83.6	96.0	79.3	81.2	74.7	82.5	64.3	76.9	92.5
12	79.3	116.0	106.6	90.1	104.6	94.1	98.2	93.0	93.8	89.9	87.5	96.5	88.7	77.2	81.8	106.0	90.3	83.6	86.1		78.0	109.0	89.1

Table 13. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1978-2000. Entries in boxes are based on fewer than 5 aged 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	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1		0.011	0.027		0.040	0.010								0.012					0.018	0.016	0.011	0.014	0.018
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	0.095	0.087
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	0.286	0.272
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	0.646	0.562
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	1.130	0.953
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	1.709	1.333
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	1.992	1.902
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	2.549	2.376
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	4.565	2.904
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	6.567	5.437
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	4.265	8.351
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	12.388	6.780

Table 14. Mean gutted condition-at-age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2000. Boxed entries are based on fewer than 5 aged fish.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1																			0.754	0.727	0.898	0.673	0.594
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	0.675	0.666
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	0.704	0.696
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	0.697	0.707
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	0.694	0.688
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	0.688	0.677
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	0.690	0.674
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	0.686	0.674
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	0.722	0.698
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	0.762	0.754
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	0.722	0.784
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	0.737	0.712

Table 15. Mean liver index at age of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2000. Boxed entries are based on fewer than 5 aged fish.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1																							
2	0.018	0.014	0.015	0.012	0.023	0.025	0.012	0.024	0.023	0.030	0.025	0.028	0.029	0.025	0.030		0.030	0.014	0.025	0.024	0.025	0.024	0.024
3	0.022	0.016	0.011	0.015	0.024	0.028	0.017	0.017	0.023	0.023	0.023	0.022	0.021	0.021	0.020	0.011	0.014	0.011	0.016	0.021	0.017	0.020	0.018
4	0.020	0.018	0.014	0.019	0.023	0.032	0.018	0.018	0.020	0.022	0.028	0.027	0.029	0.028	0.024	0.015	0.014	0.013	0.016	0.020	0.021	0.017	0.015
5	0.023	0.019	0.019	0.017	0.023	0.028	0.014	0.018	0.021	0.024	0.028	0.027	0.034	0.029	0.032	0.018	0.020	0.021	0.017	0.020	0.022	0.017	0.019
6	0.025	0.022	0.020	0.019	0.016	0.035	0.014	0.022	0.023	0.024	0.028	0.030	0.036	0.031	0.031	0.019	0.022	0.020	0.020	0.018	0.025	0.017	0.019
7	0.026	0.029	0.026	0.021	0.021	0.028	0.020	0.022	0.024	0.027	0.028	0.030	0.038	0.036	0.026	0.018	0.017	0.021	0.022	0.023	0.023	0.021	0.021
8	0.032	0.036	0.037	0.032	0.020	0.030	0.019	0.023	0.027	0.029	0.031	0.034	0.033	0.034	0.037	0.021	0.021	0.018	0.023	0.024	0.035	0.020	0.022
9	0.028	0.032	0.038	0.042	0.023	0.033	0.019	0.027	0.030	0.036	0.036	0.041	0.035	0.039	0.040	0.028	0.021	0.019	0.019	0.027	0.041	0.029	0.024
10	0.033	0.036	0.033	0.047	0.026	0.033	0.033	0.030	0.038	0.046	0.044	0.043	0.041	0.041	0.038	0.018	0.042	0.026	0.030	0.038	0.042	0.039	0.034
11	0.026	0.028	0.038	0.028	0.036	0.045	0.033	0.041	0.044	0.040	0.050	0.052	0.047	0.042	0.047	0.035	0.023	0.034	0.031	0.040	0.027	0.023	0.038
12	0.038		0.039	0.042	0.054	0.046	0.045	0.044	0.046	0.048	0.055	0.069	0.048	0.037	0.038	0.038	0.033	0.025	0.020		0.028	0.026	0.030

Table 16. Observed proportion mature at age of female Atlantic cod (*Gadus morhua*) in NAFO Subdiv. 3Ps (Jan 1, 1972-2000). 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	1985
1	0	.	0	0	0	.	.	.	0	0	0	0	0	.
2	0	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	0.01	0.01	0	0	0	0	0	0	0.09	0	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	0.05
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	0.34
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	0.80
8	0.92	0.93	1	1	0.95	0.89	0.93	0.92	1	0.92	0.93	1	0.91	1
9	1	1	1	0.83	0.80	1	1	0.85	1	1	0.96	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	0.94	1	1
11	1	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	1
13	1	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	6.32
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	6.12
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	6.52
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	2.30
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	0.30
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	-14.53
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	1.88
n	223	301	94	305	332	307	322	312	337	328	391	410	285	376

AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	.	.	.	0	.	0	.	.	.	.	0	0	0	0	0
2	0	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	0
4	0	0	0	0	0.05	0	0.07	0	0.11	0	0.01	0.23	0.17	0.04	0.11
5	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	0.47	0.63
6	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	0.79	0.81
7	0.71	0.60	0.40	0.79	0.80	0.84	0.97	0.94	0.94	0.97	0.92	1	1	0.97	0.95
8	0.96	0.86	0.85	0.93	0.82	0.88	1	1	1	0.96	1	1	1	1	0.96
9	1	1	0.9	0.97	1	1	1	1	1	1	1	1	1	1	1
10	1	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	1
12	1	1	0.94	1	1	1	1	1	1	1	.	.	.	1	1
13	1	1	1	1	1	1 .		1	1	1	.	.	.		
A50	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	5.21	5.13
L 95%	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	4.99	4.78
U 95%	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	5.44	5.46
Slope	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	2.04	1.59
SE	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	0.27	0.21
Int	-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	-10.64	-8.16
SE	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	1.45	1.17
n	643	548	492	432	317	417	289	476	664	288	415	150	253	321	257

Table 17. Estimated proportions mature at age for female cod from NAFO Subdiv. 3Ps projected to 2002.

	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	0.0002	0.0014	0.0108	0.0774	0.3924	0.8325	0.9745	0.9966	0.9996	0.9999	1.0000	1.0000	1.0000	1.0000
2000	0.0014	0.0069	0.0327	0.1425	0.4492	0.8001	0.9516	0.9897	0.9979	0.9996	0.9999	1.0000	1.0000	1.0000
2001	0.0002	0.0015	0.0153	0.1357	0.6132	0.9412	0.9939	0.9994	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
2002	0.0002	0.0015	0.0153	0.1357	0.6132	0.9412	0.9939	0.9994	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000

Table 18. List of the 18 QLSPA runs applied to the catch and index data in the October 2000 assessment and immediate post-assessment period.

	Survey/Catch Rate Indices								
	Research Vessel			Sentinel		Industry		F Multiplier	
Run	Templeman[1]	Cameron[2]	French	Gill net	Line trawl	GEAC	Catch	Constraints	Rationale
1	X	X	X	X	X		All	Estimate some	Similar structure to last year, but with additional surveys, and a bound on the weight given to sentinel
2	X	X	X	X	X		All	Fix at 1	Diagnostic, to assess the dome PR
3	X[3]	X[4]	X	X	X		All	Estimate some	PR sensitivity check
4	X	X	X	X	X		All	Estimate some	No bound on the weight Sentinel indices get
5	X	X		X	X		All	Estimate some	Sensitivity to the French RV indices
6	X			X	X		All	Estimate some	Sensitivity to the Cameron RV indices
7	X[5]	X	X	X	X		All	Estimate some	Sensitivity (index only) to potential stock mixing in the Burgeo Bank/Hermitage Channel area
8	X[5]	X		X	X		All	Estimate some	Same as Run 7
9	X[5]	X		X	X		Part Burgeo[6]	Estimate some	Sensitivity (index and catch) to potential stock mixing in the Burgeo Bank/Hermitage Channel area
10[7]	X[8]	X		X	X		All	Estimate some	Same as Run 7
11	X[8]	X		X	X		All	Fix at 1	Assess the effect of the domed PR in Run 10
12	X[8]	X		X	X		All	Estimate all	Assess the F constraints in Run 10
13[9]	X[5]	X		X			No Burgeo[10]	Estimate some	Excluding Burgeo Bank/Hermitage Channel area
14	X			X			All	Estimate some	Identical structure to the 1999 assessment final run
15	X	X					All	Estimate some	Similar to Run 5, except no Sentinel
16	X[8]	X					All	Estimate some	Similar to Run 10, except no Sentinel
17	X[8]	X		X	X		Part Burgeo[6]	Estimate some	Similar to Run 10, except using only 25% of Burgeo catch
18	X[8]	X		X	X	X	All	Estimate some	Similar to Run 10, except using only 25% of Burgeo catch

[1] Burgeo strata not included in the mean numbers per tow for the winter surveys (1985-1993).
[2] Burgeo strata not included in the mean numbers per tow.
[3] Age 9 and 11 indices for 1995 appear influential in Run 2, and are given no weight in Run 3 to test the sensitivity of the PR.
[4] Age 11 index for 1972 appears influential in Run 2, and is given no weight in Run 3 to test the sensitivity of the PR.
[5] Canadian RV indices for 3Ps without Burgeo strata (1983-2000).
[6] 75% of 3Psa,d catch removed for 1 Nov-30 Apr.
[7] SSR run for all of 3Ps.
[8] The survey results were split into two indices, one for Burgeo Bank (1993-2000), and one for the rest of the 3Ps index strata (1983-2000). The SPA was allowed to give these two indices different estimation weights.
[9] SSR run for part of 3Ps east of the the Burgeo Bank/Hermitage Channel area.
[10] All catch in 3Psa,d removed for the entire year.

Table 19. Inputs, estimates and residuals for the final QLSPA model (Run 10) used to evaluate TAC options for 2001/2002.

```
11:48 Monday, February 12, 2001  46

Quasi-likelihood SPA for 3Ps cod

Cohort model for years  1959 - 2000 , and ages   2 - 14

Cameron RV                    index for years 1972 to 1982 , and ages  2 to 14. Var =  Quadratic

Can RV Burgeo                 index for years 1993 to 2000 , and ages  2 to 12. Var =  Quadratic

Can RV No Burgeo              index for years 1983 to 2000 , and ages  2 to 14. Var =  Quadratic

Sentinel gillnet              index for years 1995 to 1999 , and ages  3 to 10. Var =  Quadratic

Sentinel linetrawl            index for years 1995 to 1999 , and ages  3 to 10. Var =  Quadratic
```

```
Extended Deviance =  806.73 , df =  461 , #Parms =   80

Penalty =    0.00

Var scale =  Cameron RV                    0.396
             Can RV Burgeo                 0.801
             Can RV No Burgeo              0.542
             Sentinel gillnet              0.300
             Sentinel linetrawl            0.300
```

Quadratic Var Const	Estimate	Std. Err	95% L	95% U
Cameron RV	0.242	0.180	0.170	0.345
Can RV Burgeo	0.357	0.207	0.238	0.536
Can RV No Burgeo	0.312	0.145	0.235	0.415
Sentinel gillnet	0.701	0.609	0.212	2.316
Sentinel linetrawl	0.015	0.345	0.008	0.030

Age	Survivors	CV	95% L	95% U
2	39727.42	0.60	12298.32	128332.0
3	27111.37	0.40	12367.06	59434.20
4	10850.15	0.32	5778.64	20372.57
5	11028.70	0.29	6256.27	19441.66
6	7095.40	0.27	4213.90	11947.30
7	3658.88	0.34	1892.85	7072.64
8	2901.29	0.34	1485.94	5664.75
9	1399.20	0.38	660.87	2962.44
10	3135.26	0.34	1598.02	6151.27
11	4266.00	0.33	2239.86	8124.95
12	1455.11	0.34	747.33	2833.19
13	1638.21	0.34	845.41	3174.47

Year Effect Constraint	Effect	CV	95% L	95% U
.	1.00	.	1.00	1.00

F Constraint	Estimate	CV	95% L	95% U
1959<=F14<=1993	0.441	0.094	0.366	0.530
F10_in_1993	0.268	0.837	0.052	1.383
F11_in_1993	0.242	0.565	0.080	0.733
F12_in_1993	0.176	0.662	0.048	0.643

Table 19. Cont'd

F13_in_1993	0.369	0.672	0.099	1.380
F14=1998	0.102	0.599	0.031	0.330
F14=1999	0.541	0.486	0.209	1.405
F14=2000	0.416	0.308	0.227	0.761

Q_CONST	Estm (x1000)	CV	95% L	95% L
Cameron_a=02	0.0291	0.18	0.0205	0.0413
Cameron_a=03	0.0460	0.18	0.0325	0.0650
Cameron_a=04	0.1070	0.18	0.0756	0.1513
Cameron_a=05	0.1557	0.18	0.1102	0.2199
Cameron_a=06	0.1173	0.20	0.0796	0.1728
Cameron_a=07	0.1226	0.21	0.0806	0.1865
Cameron_a=08	0.1215	0.26	0.0737	0.2005
Cameron_a=09	0.1552	0.31	0.0852	0.2829
Cameron_a=10	0.1364	0.38	0.0651	0.2857
Cameron_a=11	0.1116	0.48	0.0434	0.2869
Cameron_a=12	0.1083	0.58	0.0346	0.3390
Cameron_a=13	0.0813	0.76	0.0182	0.3640
Cameron_a=14	0.0548	1.01	0.0075	0.3991
Can_RV_Burgeo=02	0.0369	0.45	0.0153	0.0887
Can_RV_Burgeo=03	0.4865	0.30	0.2711	0.8730
Can_RV_Burgeo=04	0.7221	0.29	0.4107	1.2696
Can_RV_Burgeo=05	0.9453	0.29	0.5341	1.6729
Can_RV_Burgeo=06	0.8978	0.30	0.5011	1.6085
Can_RV_Burgeo=07	1.0570	0.32	0.5608	1.9924
Can_RV_Burgeo=08	0.5468	0.37	0.2665	1.1219
Can_RV_Burgeo=09	0.3660	0.42	0.1601	0.8371
Can_RV_Burgeo=10	0.0741	0.62	0.0220	0.2493
Can_RV_Burgeo=11	0.2459	0.52	0.0889	0.6806
Can_RV_Burgeo=12	0.0881	0.78	0.0191	0.4053
Can_RV_No_Burgeo=02	0.0858	0.39	0.0399	0.1846
Can_RV_No_Burgeo=03	0.1314	0.17	0.0938	0.1840
Can_RV_No_Burgeo=04	0.1238	0.17	0.0883	0.1737
Can_RV_No_Burgeo=05	0.1909	0.18	0.1343	0.2713
Can_RV_No_Burgeo=06	0.2333	0.19	0.1595	0.3413
Can_RV_No_Burgeo=07	0.1944	0.22	0.1255	0.3009
Can_RV_No_Burgeo=08	0.2431	0.28	0.1414	0.4180
Can_RV_No_Burgeo=09	0.2322	0.32	0.1233	0.4371
Can_RV_No_Burgeo=10	0.1493	0.39	0.0693	0.3217
Can_RV_No_Burgeo=11	0.1266	0.44	0.0532	0.3012
Can_RV_No_Burgeo=12	0.0950	0.51	0.0350	0.2578
Can_RV_No_Burgeo_Campelen_	0.0097	2.34	0.0001	0.9583
Can_RV_No_Burgeo_Campelen_	0.0055	4.02	0.0000	14.3329
Can_RV_No_Burgeo_Engels_a=	0.0890	0.61	0.0270	0.2931
Can_RV_No_Burgeo_Engels_a=	0.0953	0.64	0.0269	0.3372
Sent_gillnet_a=03	0.0007	2.05	0.0000	0.0391
Sent_gillnet_a=04	0.0111	0.61	0.0033	0.0369
Sent_gillnet_a=05	0.2797	0.24	0.1763	0.4436
Sent_gillnet_a=06	0.7039	0.23	0.4501	1.1008
Sent_gillnet_a=07	0.7890	0.25	0.4802	1.2964
Sent_gillnet_a=08	0.5347	0.29	0.3040	0.9406
Sent_gillnet_a=09	0.1646	0.38	0.0782	0.3463
Sent_gillnet_a=10	0.1048	0.51	0.0388	0.2832
Sent_linetrawl_a=03	0.0006	0.43	0.0003	0.0015
Sent_linetrawl_a=04	0.0022	0.34	0.0011	0.0043
Sent_linetrawl_a=05	0.0036	0.33	0.0019	0.0069
Sent_linetrawl_a=06	0.0043	0.33	0.0022	0.0083
Sent_linetrawl_a=07	0.0034	0.38	0.0016	0.0071
Sent_linetrawl_a=08	0.0031	0.41	0.0014	0.0070
Sent_linetrawl_a=09	0.0015	0.52	0.0005	0.0042
Sent_linetrawl_a=10	0.0009	0.76	0.0002	0.0038

Table 19. Cont'd

Population Numbers at age

	2	3	4	5	6	7	8	9	10	11	12	13	14	2+
1959	77468	60650	117E3	44873	24337	16874	6349	4133	4451	6684	1701	411	12	365249
1960	63894	63425	48751	83429	29930	13352	9404	4346	2251	2504	4902	899	297	327383
1961	60696	52312	51415	34941	46857	18429	7786	4547	2635	1095	1683	3645	480	286522
1962	53193	49694	42422	37041	19236	23922	11817	2140	2050	912	493	1138	2477	246535
1963	86783	43551	39559	28626	22180	11647	14415	8438	1036	1162	578	277	810	259061
1964	101E3	71052	34787	28318	17020	13387	7249	9060	6096	584	822	383	130	289638
1965	105E3	82487	56448	23247	18086	9249	8295	4233	5707	4401	172	375	265	318244
1966	122E3	86196	65441	37497	13786	11542	4628	4932	2364	3738	3307	79	197	355508
1967	87849	99723	69713	41216	18878	7105	4818	2354	2380	995	2592	2356	36	340015
1968	69951	71925	79049	47201	22073	9672	3692	2710	1381	1662	471	2036	1794	313617
1969	43902	57271	57853	53317	26760	12776	4687	1839	1722	746	1160	285	1663	263980
1970	75305	35944	46189	40943	33170	15414	6339	2247	789	761	556	841	173	258671
1971	50743	61654	28744	30474	21835	18323	6853	2968	1180	452	462	385	579	224653
1972	42466	41545	47869	17703	17192	11302	7566	2778	1276	476	294	265	259	190991
1973	51933	34768	33353	34718	10340	10862	5088	3809	1520	626	204	134	174	187530
1974	74482	42519	27611	23048	18122	4837	5254	2175	1292	779	357	68	97	200639
1975	83121	60981	33104	17139	9833	9078	1662	2621	741	571	412	220	27	219509
1976	102E3	68054	48262	20472	9149	3942	2124	707	1064	511	310	291	174	257153
1977	60114	83588	51999	28530	9592	4889	2047	1291	452	823	403	235	234	244196
1978	34710	49218	67590	34288	15824	4949	3170	1318	817	264	622	291	164	213227
1979	50371	28418	39842	50682	22557	9331	2466	2005	867	508	151	485	223	207905
1980	88273	41240	23144	29840	32156	13884	5511	1367	1430	634	368	102	385	238334
1981	55160	72272	33432	17479	19858	18947	8310	3377	823	1068	468	260	64	231518
1982	88726	45161	58246	24758	11473	12049	10215	5336	2277	516	814	352	197	260120
1983	81395	72643	36857	43081	16262	7269	7276	5704	3790	1644	347	639	278	277185
1984	69673	66641	58787	27749	26970	9622	4366	4917	3728	2882	1264	251	507	277358
1985	33547	57044	54377	44040	18613	15731	5869	3046	3535	2746	2238	1003	198	241988
1986	44536	27466	46566	42133	28790	10585	8137	3466	1927	2401	1929	1734	802	220471
1987	58447	36463	22210	33508	25218	13412	4791	4701	2249	1375	1811	1450	1348	206982
1988	64541	47852	29324	15509	17460	11813	6047	2641	2847	1533	991	1412	1065	203035
1989	58017	52841	38332	19528	8200	8440	5106	3328	1592	2074	1144	744	1108	200454
1990	26618	47500	42294	23245	8893	4123	4603	3174	2182	1102	1571	885	583	166772
1991	48128	21793	37075	26826	11616	4269	2034	2650	1972	1470	774	1192	682	160479
1992	28333	39404	17108	23133	12889	4165	1537	935	1608	1228	1106	565	930	132940
1993	13597	23197	30974	10244	11317	4637	1360	663	522	1143	836	830	431	99752
1994	22768	11133	18741	22001	6545	6410	2589	751	462	393	889	673	667	94021
1995	17562	18641	9106	15273	17856	5292	5192	2095	604	376	320	728	551	93595
1996	18916	14378	15259	7449	12454	14512	4281	4217	1709	492	308	262	596	94833
1997	21254	15487	11764	12454	6060	10105	11768	3473	3431	1392	401	251	215	98055
1998	16253	17401	12620	9245	9174	4512	7425	8888	2675	2725	1111	325	205	92558
1999	33114	13307	14165	9995	6852	6109	2836	4890	6175	1986	2122	859	253	102663
2000	39727	27111	10850	11029	7095	3659	2901	1399	3135	4266	1455	1638	685	114952
2000.3	37790	25788	10315	10413	6550	3037	2389	1123	2739	3746	1336	1534	639	107400

Table 19. Cont'd

Fishing Mortalities

	2	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.000	0.018	0.141	0.205	0.400	0.385	0.179	0.408	0.375	0.110	0.437	0.126	0.099
1960	0.000	0.010	0.133	0.377	0.285	0.339	0.527	0.300	0.521	0.197	0.096	0.427	0.106
1961	0.000	0.010	0.128	0.397	0.472	0.244	1.091	0.597	0.861	0.598	0.191	0.186	0.143
1962	0.000	0.028	0.193	0.313	0.302	0.307	0.137	0.525	0.368	0.257	0.377	0.141	0.114
1963	0.000	0.025	0.134	0.320	0.305	0.274	0.264	0.125	0.373	0.146	0.210	0.557	0.134
1964	0.000	0.030	0.203	0.248	0.410	0.279	0.338	0.262	0.126	1.025	0.584	0.169	0.261
1965	0.000	0.031	0.209	0.323	0.249	0.492	0.320	0.383	0.223	0.086	0.576	0.445	0.163
1966	0.000	0.012	0.262	0.486	0.463	0.674	0.476	0.529	0.665	0.166	0.139	0.593	0.132
1967	0.000	0.032	0.190	0.424	0.469	0.455	0.375	0.333	0.159	0.548	0.041	0.072	0.097
1968	0.000	0.018	0.194	0.368	0.347	0.524	0.497	0.253	0.416	0.160	0.302	0.003	0.068
1969	0.000	0.015	0.146	0.275	0.352	0.501	0.535	0.646	0.616	0.095	0.121	0.301	0.076
1970	0.000	0.024	0.216	0.429	0.393	0.611	0.559	0.445	0.356	0.299	0.166	0.173	0.094
1971	0.000	0.053	0.285	0.372	0.459	0.685	0.703	0.644	0.707	0.233	0.355	0.196	0.115
1972	0.000	0.020	0.121	0.338	0.259	0.598	0.486	0.403	0.512	0.646	0.581	0.223	0.213
1973	0.000	0.030	0.170	0.450	0.560	0.526	0.650	0.881	0.469	0.362	0.903	0.122	0.204
1974	0.000	0.050	0.277	0.652	0.491	0.868	0.495	0.877	0.617	0.436	0.285	0.737	0.214
1975	0.000	0.034	0.281	0.428	0.714	1.253	0.655	0.702	0.170	0.411	0.150	0.031	0.087
1976	0.000	0.069	0.326	0.558	0.427	0.455	0.298	0.247	0.057	0.037	0.078	0.015	0.019
1977	0.000	0.012	0.216	0.389	0.462	0.233	0.240	0.257	0.337	0.080	0.125	0.158	0.053
1978	0.000	0.011	0.088	0.219	0.328	0.497	0.258	0.219	0.275	0.359	0.049	0.067	0.070
1979	0.000	0.005	0.089	0.255	0.285	0.327	0.390	0.137	0.113	0.123	0.193	0.030	0.051
1980	0.000	0.010	0.081	0.207	0.329	0.313	0.290	0.307	0.092	0.103	0.145	0.258	0.074
1981	0.000	0.016	0.100	0.221	0.300	0.418	0.243	0.194	0.268	0.072	0.086	0.079	0.035
1982	0.000	0.003	0.102	0.220	0.256	0.304	0.383	0.142	0.125	0.196	0.042	0.035	0.040
1983	0.000	0.012	0.084	0.268	0.325	0.310	0.192	0.225	0.074	0.063	0.125	0.032	0.032
1984	0.000	0.003	0.089	0.199	0.339	0.294	0.160	0.130	0.106	0.053	0.031	0.036	0.018
1985	0.000	0.003	0.055	0.225	0.364	0.459	0.327	0.258	0.187	0.153	0.055	0.023	0.034
1986	0.000	0.012	0.129	0.313	0.564	0.593	0.349	0.232	0.137	0.082	0.085	0.052	0.032
1987	0.000	0.018	0.159	0.452	0.558	0.597	0.396	0.301	0.183	0.128	0.049	0.109	0.042
1988	0.000	0.022	0.207	0.437	0.527	0.639	0.397	0.306	0.117	0.093	0.087	0.042	0.033
1989	0.000	0.023	0.300	0.587	0.488	0.406	0.275	0.222	0.168	0.078	0.057	0.044	0.026
1990	0.000	0.048	0.255	0.494	0.534	0.507	0.352	0.276	0.195	0.154	0.076	0.060	0.043
1991	0.000	0.042	0.272	0.533	0.826	0.822	0.577	0.299	0.274	0.085	0.115	0.047	0.036
1992	0.000	0.041	0.313	0.515	0.822	0.919	0.641	0.383	0.141	0.184	0.087	0.069	0.050
1993	0.000	0.013	0.142	0.248	0.368	0.383	0.394	0.161	0.084	0.052	0.017	0.019	0.013
1994	0.000	0.001	0.005	0.009	0.013	0.011	0.012	0.018	0.007	0.006	0.000	0.000	0.000
1995	0.000	0.000	0.001	0.004	0.007	0.012	0.008	0.004	0.004	0.000	0.000	0.000	0.000
1996	0.000	0.001	0.003	0.006	0.009	0.010	0.009	0.006	0.005	0.004	0.004	0.000	0.000
1997	0.000	0.005	0.041	0.106	0.095	0.108	0.081	0.061	0.030	0.025	0.011	0.004	0.000
1998	0.000	0.006	0.033	0.100	0.207	0.264	0.218	0.164	0.098	0.050	0.057	0.052	0.005
1999	0.000	0.004	0.050	0.143	0.427	0.545	0.507	0.245	0.170	0.111	0.059	0.027	0.036
2000	0.000	0.000	0.001	0.007	0.030	0.136	0.144	0.170	0.085	0.080	0.035	0.016	0.018

Table 19. Cont'd

Commercial catch

	2	3	4	5	6	7	8	9	10	11	12	13	14
1959	0.000	1001	13940	7525	7265	4875	942.0	1252	1260	631.0	545.0	44.00	1.000
1960	0.000	567.0	5496	23704	6714	3476	3484	1020	827.0	406.0	407.0	283.0	27.00
1961	0.000	450.0	5586	10357	15960	3616	4680	1849	1376	446.0	265.0	560.0	58.00
1962	0.000	1245	6749	9003	4533	5715	1367	791.0	571.0	187.0	140.0	135.0	241.0
1963	0.000	961.0	4499	7091	5275	2527	3030	898.0	292.0	143.0	99.00	107.0	92.00
1964	0.000	1906	5785	5635	5179	2945	1881	1891	652.0	339.0	329.0	54.00	27.00
1965	0.000	2314	9636	5799	3609	3254	2055	1218	1033	327.0	68.00	122.0	36.00
1966	0.000	949.0	13662	13065	4621	5119	1586	1833	1039	517.0	389.0	32.00	22.00
1967	0.000	2871	10913	12900	6392	2349	1364	604.0	316.0	380.0	95.00	149.0	3.000
1968	0.000	1143	12602	13135	5853	3572	1308	549.0	425.0	222.0	111.0	5.000	107.0
1969	0.000	774.0	7098	11585	7178	4554	1757	792.0	717.0	61.00	120.0	67.00	110.0
1970	0.000	756.0	8114	12916	9763	6374	2456	730.0	214.0	178.0	77.00	121.0	14.00
1971	0.000	2884	6444	8574	7266	8218	3131	1275	541.0	85.00	125.0	62.00	57.00
1972	0.000	731.0	4944	4591	3552	4603	2636	833.0	463.0	205.0	117.0	48.00	45.00
1973	0.000	945.0	4707	11386	4010	4022	2201	2019	515.0	172.0	110.0	14.00	29.00
1974	0.000	1887	6042	9987	6365	2540	1857	1149	538.0	249.0	80.00	32.00	17.00
1975	0.000	1840	7329	5397	4541	5867	723.0	1196	105.0	174.0	52.00	6.000	2.000
1976	0.000	4110	12139	7923	2875	1305	495.0	140.0	53.00	17.00	21.00	4.000	3.000
1977	0.000	935.0	9156	8326	3209	920.0	395.0	265.0	117.0	57.00	43.00	31.00	11.00
1978	0.000	502.0	5146	6096	4006	1753	653.0	235.0	178.0	72.00	27.00	17.00	10.00
1979	0.000	135.0	3072	10321	5066	2353	721.0	233.0	84.00	53.00	24.00	13.00	10.00
1980	0.000	368.0	1625	5054	8156	3379	1254	327.0	114.0	56.00	45.00	21.00	25.00
1981	0.000	1022	2888	3136	4652	5855	1622	539.0	175.0	67.00	35.00	18.00	2.000
1982	0.000	130.0	5092	4430	2348	2861	2939	640.0	243.0	83.00	30.00	11.00	7.000
1983	0.000	760.0	2682	9174	4080	1752	1150	1041	244.0	91.00	37.00	18.00	8.000
1984	0.000	203.0	4521	4538	7018	2221	584.0	542.0	338.0	134.0	35.00	8.000	8.000
1985	0.000	152.0	2639	8031	5144	5242	1480	626.0	545.0	353.0	109.0	21.00	6.000
1986	0.000	306.0	5103	10253	11228	4283	2167	650.0	224.0	171.0	143.0	79.00	23.00
1987	0.000	585.0	2956	11023	9763	5453	1416	1107	341.0	149.0	78.00	135.0	50.00
1988	0.000	935.0	4951	4971	6471	5046	1793	630.0	284.0	123.0	75.00	53.00	31.00
1989	0.000	1071	8995	7842	2863	2549	1112	600.0	223.0	141.0	57.00	29.00	26.00
1990	0.000	2006	8622	8195	3329	1483	1237	692.0	350.0	142.0	104.0	47.00	22.00
1991	0.000	812.0	7981	10028	5907	2164	807.0	620.0	428.0	108.0	76.00	50.00	22.00
1992	0.000	1422	4159	8424	6538	2266	658.0	269.0	192.0	187.0	83.00	34.00	41.00
1993	0.000	278.0	3712	2035	3156	1334	401.0	89.00	38.00	52.00	13.00	14.00	5.000
1994	0.000	9.000	78.00	173.0	74.00	62.00	28.00	12.00	3.000	2.000	0.000	0.000	0.000
1995	0.000	3.000	7.000	56.00	119.0	57.00	37.00	7.000	2.000	0.000	0.000	0.000	0.000
1996	0.000	9.000	43.00	43.00	101.0	125.0	35.00	24.00	8.000	2.000	1.000	0.000	0.000
1997	0.000	66.00	427.0	1130	497.0	937.0	826.0	187.0	93.00	31.00	4.000	1.000	0.000
1998	0.000	91.00	373.0	793.0	1550	948.0	1314	1217	225.0	120.0	56.00	15.00	1.000
1999	0.000	49.00	628.0	1202	2156	2321	1020	960.0	873.0	189.0	110.0	21.00	8.000
2000	0.000	1.000	6.000	80.00	204.0	455.0	380.0	213.0	249.0	320.0	49.00	25.00	12.00

Table 19. Cont'd

Biomass at age

	2	3	4	5	6	7	8	9	10	11	12	13	14	2+
1959	0	10917	51615	38591	32855	33917	17650	15004	20297	36963	11053	3088	101	272051
1960	0	11417	21450	71749	40405	26837	26144	15775	10265	13848	31860	6752	2550	279053
1961	0	9416	22623	30049	63257	37043	21646	16507	12016	6054	10939	27372	4124	261045
1962	0	8945	18666	31855	25968	48084	32851	7769	9348	5046	3203	8547	21280	221561
1963	0	7839	17406	24618	29943	23411	40073	30629	4726	6424	3756	2079	6955	197859
1964	0	12789	15306	24353	22978	26907	20153	32888	27797	3232	5341	2880	1115	195740
1965	0	14848	24837	19992	24416	18591	23061	15367	26023	24337	1116	2817	2277	197681
1966	0	15515	28794	32247	18611	23199	12866	17904	10779	20669	21497	594	1690	204364
1967	0	17950	30674	35446	25485	14282	13393	8545	10851	5503	16850	17692	307	196979
1968	0	12946	34781	40593	29798	19441	10264	9838	6297	9192	3061	15294	15410	206916
1969	0	10309	25455	45853	36126	25679	13029	6676	7853	4125	7541	2141	14283	199071
1970	0	6470	20323	35211	44779	30983	17623	8158	3599	4210	3611	6318	1485	182769
1971	0	11098	12647	26208	29477	36829	19051	10773	5379	2502	3004	2893	4976	164837
1972	0	7478	21062	15224	23210	22717	21033	10083	5819	2633	1908	1992	2227	135387
1973	0	6258	14675	29858	13959	21832	14146	13827	6933	3461	1328	1010	1493	128780
1974	0	7653	12149	19821	24465	9723	14605	7894	5891	4307	2319	509	837	110172
1975	0	10976	14566	14739	13275	18247	4620	9515	3378	3157	2680	1650	228	97031
1976	0	12250	21235	17606	12351	7923	5904	2565	4851	2828	2014	2182	1499	93207
1977	0	40958	22880	27103	13620	10364	5853	4737	2033	4510	2573	1840	2195	138668
1978	0	18210	41906	29488	23895	10542	8972	4930	3799	1333	4063	2109	1436	150685
1979	0	8810	21515	42573	30001	19689	7398	7197	4472	3053	983	4016	2046	151751
1980	0	17321	12498	25662	41481	28046	16697	6095	7825	4359	2862	892	3680	167418
1981	0	27463	21396	16954	28397	36947	23684	13373	4560	7668	3800	2217	608	187068
1982	0	14903	35530	23768	17553	24821	26252	19103	10930	3052	6502	3107	1926	187449
1983	0	31236	22483	43511	24881	15555	20155	18823	16826	9686	2509	5950	2809	214424
1984	0	38652	45854	29969	43692	22035	13621	19371	17074	15851	9733	2438	5186	263478
1985	0	33085	40783	49765	29409	36969	17664	13250	18877	16012	14706	9451	2144	282113
1986	0	12360	32130	42133	43185	22122	24247	13342	10119	14646	14083	13178	8674	250219
1987	0	16773	14214	31832	35053	27629	12982	17346	10549	8032	11899	11398	11041	208748
1988	0	26797	19940	14269	24793	22208	15722	8689	13211	8201	6344	10196	8467	178836
1989	0	28534	27216	19138	10906	16373	13785	11516	6862	11615	7320	5317	8944	167526
1990	0	24225	31297	23477	12983	8246	11968	11966	9972	6324	10852	6893	5220	163425
1991	0	12204	24469	26826	17308	8921	5430	8823	8324	8349	5399	9653	6131	141837
1992	0	14973	11120	20357	17401	8206	4026	3244	7269	6396	7784	5047	9426	115250
1993	0	5335	17346	8809	14033	8440	3414	2346	2203	5818	5801	6077	3991	83613
1994	0	5900	10120	20681	9294	11153	6267	2395	2015	2044	5359	4796	4956	84980
1995	0	7084	6557	17258	29106	11325	12409	6452	2373	1623	1638	4795	4340	104958
1996	0	8339	10987	8343	22292	32797	11559	12652	6373	2241	1375	1438	4438	122835
1997	0	7434	9176	14073	10120	22938	33657	11115	11563	5984	2224	1591	1894	131769
1998	0	8527	9970	11002	15046	9610	20717	32173	10137	10982	5435	2074	1865	137536
1999	0	6520	11332	12693	12333	13623	7771	17312	25257	8679	10400	4958	1987	132866
2000	0	13285	8680	14006	12772	8159	7950	4953	12823	18642	7130	9452	5387	123240
2000.3	0	12636	8252	13224	11791	6772	6546	3976	11205	16369	6548	8851	5032	111203

Table 19. Cont'd

Spawner Biomass at age

	2	3	4	5	6	7	8	9	10	11	12	13	14	2+
1959	0	2	330	2944	11654	25553	16934	14966	20295	36963	11053	3088	101	143884
1960	0	2	137	5474	14332	20219	25083	15736	10264	13848	31860	6752	2550	146258
1961	0	2	145	2293	22437	27908	20767	16465	12015	6054	10939	27372	4124	150521
1962	0	2	119	2431	9211	36226	31517	7749	9347	5046	3203	8547	21280	134678
1963	0	2	111	1878	10621	17638	38446	30553	4726	6424	3756	2079	6955	123188
1964	0	3	98	1858	8150	20272	19335	32806	27794	3232	5341	2880	1115	122883
1965	0	3	159	1525	8660	14006	22125	15328	26020	24337	1116	2817	2277	118374
1966	0	3	184	2460	6601	17478	12344	17859	10778	20669	21497	594	1690	112157
1967	0	4	196	2705	9040	10760	12849	8524	10850	5503	16850	17692	307	95280
1968	0	3	223	3097	10569	14647	9847	9813	6296	9192	3061	15294	15410	97452
1969	0	2	163	3499	12814	19346	12500	6660	7852	4125	7541	2141	14283	90927
1970	0	1	130	2687	15883	23343	16907	8138	3598	4210	3611	6318	1485	86310
1971	0	2	81	2000	10455	27747	18277	10746	5378	2502	3004	2893	4976	88062
1972	0	1	135	1162	8232	17115	20179	10057	5819	2633	1908	1992	2227	71462
1973	0	1	94	2278	4951	16449	13572	13793	6932	3461	1328	1010	1493	65362
1974	0	2	78	1512	8678	7325	14012	7874	5890	4307	2319	509	837	53342
1975	0	2	93	1125	4709	13747	4433	9491	3377	3157	2680	1650	228	44691
1976	0	2	136	1343	4381	5970	5664	2558	4850	2828	2014	2182	1499	33428
1977	0	8	146	2068	4831	7808	5616	4726	2033	4510	2573	1840	2195	38355
1978	0	4	268	2250	8475	7943	8607	4918	3799	1333	4063	2109	1436	45206
1979	0	5	209	3112	8535	12274	6545	7062	4465	3052	983	4016	2046	52304
1980	0	2	47	1473	13083	20505	15972	6080	7825	4359	2862	892	3680	76780
1981	0	22	302	1858	11242	28017	22549	13315	4559	7668	3800	2217	608	96158
1982	0	1	117	1207	5083	17402	24843	19036	10929	3052	6502	3107	1926	93207
1983	0	231	1140	8707	12002	12044	18935	18646	16813	9686	2509	5950	2809	109472
1984	0	263	2595	7253	25044	18895	13275	19327	17073	15851	9733	2438	5186	136934
1985	0	0	65	2354	10228	30052	17398	13246	18877	16012	14706	9451	2144	134531
1986	0	0	67	1968	13539	16810	23549	13329	10119	14646	14083	13178	8674	129962
1987	0	2	47	1350	8181	16737	11645	17140	10543	8032	11899	11398	11041	108014
1988	0	8	92	524	4083	9683	11686	8071	13063	8193	6344	10196	8467	80409
1989	0	34	490	2356	4499	12497	13111	11462	6861	11615	7320	5317	8944	84505
1990	0	182	1483	4261	5723	6016	10951	11770	9953	6323	10852	6893	5220	79629
1991	0	32	727	4426	8221	7155	5218	8789	8322	8349	5399	9653	6131	72422
1992	0	24	558	7512	14530	8114	4026	3244	7269	6396	7784	5047	9426	73930
1993	0	2	526	3278	12484	8416	3414	2346	2203	5818	5801	6077	3991	54355
1994	0	103	1187	10305	8191	10956	6252	2394	2015	2044	5359	4796	4956	58558
1995	0	181	810	7426	23340	10826	12303	6442	2372	1623	1638	4795	4340	76096
1996	0	54	495	2128	15892	31072	11471	12638	6373	2241	1375	1438	4438	89616
1997	0	133	1596	9978	9774	22867	33647	11115	11563	5984	2224	1591	1894	112365
1998	0	96	998	5732	13753	9519	20696	32170	10137	10982	5435	2074	1865	113456
1999	0	70	877	4981	10267	13275	7745	17305	25255	8679	10400	4958	1987	105800
2000	0	435	1237	6292	10219	7764	7868	4943	12818	18641	7130	9452	5387	92186
2000.3	0	414	1176	5940	9434	6444	6479	3968	11200	16368	6548	8851	5032	81854

Table 19. Cont'd

Standardized Cameron RV Residuals; MSE= 1.03

	2	3	4	5	6	7	8	9	10	11	12	13	14
1972.2	0.04	0.10	-0.64	-0.66	-0.93	0.12	0.51	0.45	0.37	1.55	-0.12	-0.21	-0.08
1973.2	0.16	0.34	-0.46	-1.13	-1.42	-1.40	-1.43	-1.38	-0.61	-0.62	0.06	-0.01	-0.30
1974.3	2.13	2.35	-0.60	-0.46	0.37	0.84	-0.54	0.35	-0.04	0.32	0.12	-0.21	1.19
1975.4	-1.23	-0.53	-1.05	-1.21	-0.48	-0.10	0.64	-0.66	-0.35	-0.40	-0.60	0.34	-0.12
1976.4	0.18	-0.38	-0.08	-0.01	0.54	0.79	2.03	0.72	-0.24	0.23	1.06	-0.46	-0.30
1977.3	-1.12	0.53	-0.32	-0.65	-0.08	-0.48	-0.09	1.47	0.49	-0.64	0.01	0.07	-0.35
1978.2	-0.60	-0.79	-0.95	-1.59	-1.34	-0.89	-0.55	-0.13	0.49	0.24	-0.75	-0.47	-0.30
1979.2	-0.86	-0.23	4.70	4.30	0.18	-0.98	-0.56	-0.67	0.14	-0.05	-0.14	-0.44	0.24
1980.2	2.17	-0.34	-0.92	-0.13	-0.23	-1.05	-0.23	0.02	-0.13	0.51	0.37	0.84	-0.44
1981.2	-0.88	-0.21	0.53	2.34	3.61	2.96	-0.27	0.90	1.04	-0.77	0.86	1.33	1.48
1982.4	-0.09	-0.83	-0.23	-0.86	-0.33	0.16	0.85	-0.52	-0.69	0.16	-0.51	-0.31	0.01

Unstandardized Cameron RV Residuals; MSE= 4.05

	2	3	4	5	6	7	8	9	10	11	12	13	14
1972.2	0.03	0.11	-1.72	-0.93	-1.00	0.08	0.26	0.13	0.05	0.11	-0.01	-0.01	-0.00
1973.2	0.14	0.31	-0.86	-3.00	-0.92	-0.99	-0.51	-0.46	-0.10	-0.05	0.00	-0.00	-0.01
1974.3	2.55	2.52	-0.89	-0.73	0.37	0.26	-0.19	0.07	-0.01	0.03	0.01	-0.00	0.03
1975.4	-1.60	-0.78	-1.75	-1.45	-0.24	-0.04	0.09	-0.15	-0.04	-0.03	-0.04	0.01	-0.00
1976.4	0.28	-0.62	-0.20	-0.02	0.29	0.22	0.38	0.08	-0.03	0.02	0.06	-0.02	-0.01
1977.3	-1.11	1.09	-0.90	-1.38	-0.05	-0.17	-0.02	0.24	0.04	-0.06	0.00	0.00	-0.01
1978.2	-0.37	-1.01	-3.70	-4.51	-1.37	-0.34	-0.15	-0.02	0.06	0.01	-0.06	-0.02	-0.01
1979.2	-0.74	-0.18	10.90	17.69	0.25	-0.65	-0.12	-0.16	0.02	-0.00	-0.01	-0.03	0.01
1980.2	3.09	-0.36	-1.24	-0.32	-0.44	-0.95	-0.09	0.00	-0.02	0.04	0.02	0.02	-0.02
1981.2	-0.82	-0.39	1.01	3.39	4.45	3.56	-0.16	0.31	0.12	-0.09	0.06	0.06	0.03
1982.4	-0.13	-0.93	-0.71	-1.59	-0.23	0.12	0.52	-0.25	-0.15	0.01	-0.05	-0.02	0.00

Cameron RV Index

	2	3	4	5	6	7	8	9	10	11	12	13	14
1972.2	1.21	1.92	3.02	1.49	0.81	1.23	1.04	0.50	0.20	0.15	0.02	0.01	0.01
1973.2	1.59	1.83	2.43	1.69	0.11	0.15	0.00	0.01	0.08	0.01	0.02	0.01	0.00
1974.3	4.58	4.33	1.65	2.01	2.08	0.68	0.32	0.31	0.13	0.10	0.04	0.00	0.03
1975.4	0.62	1.76	1.14	0.59	0.54	0.56	0.23	0.13	0.05	0.02	0.00	0.03	0.00
1976.4	3.04	2.21	4.04	2.38	1.14	0.60	0.59	0.17	0.10	0.07	0.09	0.00	0.00
1977.3	0.54	4.69	4.00	2.33	0.87	0.35	0.20	0.41	0.09	0.02	0.04	0.02	0.00
1978.2	0.61	1.18	3.22	0.50	0.34	0.21	0.21	0.17	0.16	0.04	0.00	0.00	0.00
1979.2	0.68	1.09	14.98	25.05	2.71	0.41	0.15	0.14	0.13	0.05	0.01	0.01	0.02
1980.2	5.53	1.44	1.07	3.88	2.87	0.55	0.50	0.19	0.16	0.11	0.06	0.03	0.00
1981.2	0.72	2.79	4.37	5.88	6.55	5.60	0.76	0.79	0.22	0.02	0.11	0.08	0.03
1982.4	2.24	0.97	4.77	1.63	0.88	1.31	1.49	0.47	0.12	0.06	0.03	0.01	0.01

Standardized Can RV Burgeo Residuals; MSE= 0.95

	2	3	4	5	6	7	8	9	10	11	12
1993.3	0.00	-0.93	-0.83	-0.33	-0.27	-0.77	-0.16	-0.03	0.52	-0.34	-0.46
1994.3	0.00	-0.07	-0.32	-0.27	0.74	-0.02	1.37	0.77	1.29	-0.06	-0.09
1995.3	0.00	-0.94	-0.74	-1.14	-1.09	-0.99	-0.29	-0.21	0.33	-0.16	0.26
1996.3	1.12	0.79	0.28	-0.35	-0.60	-0.79	-0.58	0.04	-0.44	0.28	-0.29
1997.3	-0.20	-0.79	-0.54	-1.13	-0.88	-1.21	-1.13	-0.45	-0.41	-0.71	-0.33
1998.3	-0.25	3.19	2.79	3.42	2.07	3.01	0.98	-0.21	0.84	2.41	-0.52
1999.3	-0.01	-0.34	-0.46	0.29	-0.38	-0.31	-0.69	-0.60	-0.46	-0.45	0.82
2000	-0.58	-0.90	-0.16	-0.46	0.44	1.20	0.58	1.19	-0.44	-1.10	0.16

Unstandardized Can RV Burgeo Residuals; MSE= 26.55

	2	3	4	5	6	7	8	9	10	11	12
1993.3	0.00	-7.27	-12.3	-2.12	-1.75	-2.45	-0.10	-0.01	0.05	-0.11	-0.07
1994.3	0.00	-0.27	-3.02	-3.81	3.08	-0.11	1.56	0.25	0.13	-0.01	-0.01

Table 19. Cont'd

	2	3	4	5	6	7	8	9	10	11	12
1995.3	0.00	-5.95	-3.45	-11.3	-12.1	-3.94	-0.60	-0.14	0.04	-0.03	0.02
1996.3	0.71	3.91	2.15	-1.74	-4.64	-8.27	-1.02	0.05	-0.09	0.06	-0.03
1997.3	-0.14	-4.16	-3.19	-8.94	-3.33	-8.74	-5.01	-0.46	-0.13	-0.27	-0.03
1998.3	-0.14	18.80	17.51	20.25	11.19	9.52	2.71	-0.48	0.22	1.48	-0.09
1999.3	-0.01	-1.57	-3.21	1.79	-1.43	-1.20	-0.74	-0.78	-0.21	-0.21	0.21
2000	-0.68	-8.23	-0.89	-3.32	1.93	2.99	0.64	0.54	-0.12	-0.92	0.03

Can RV Burgeo Index

	2	3	4	5	6	7	8	9	10	11	12
1993.3	0.00	3.37	8.04	6.44	6.94	1.73	0.53	0.21	0.09	0.15	0.00
1994.3	0.00	4.84	9.73	15.76	8.60	6.26	2.89	0.51	0.16	0.08	0.06
1995.3	0.49	2.60	2.75	2.26	3.03	1.32	2.07	0.58	0.08	0.06	0.05
1996.3	1.37	10.48	12.50	4.87	5.84	6.11	1.17	1.50	0.03	0.17	0.00
1997.3	0.60	2.94	4.73	1.83	1.66	1.02	0.92	0.72	0.11	0.05	0.00
1998.3	0.42	26.74	25.99	28.22	18.46	13.65	6.28	2.43	0.40	2.10	0.00
1999.3	1.14	4.50	6.24	10.27	3.61	3.90	0.50	0.78	0.20	0.23	0.38
2000	0.71	4.31	6.56	6.52	7.81	6.20	1.95	0.95	0.08	0.00	0.15

Standardized Can RV No Burgeo Residuals; MSE= 1.14

	2	3	4	5	6	7	8	9	10	11	12	13	14
1983.3	0.00	-0.41	-1.15	-0.86	-0.88	-0.90	-0.58	0.76	0.70	1.07	1.65	0.07	0.69
1984.3	0.00	-1.11	-1.21	-1.40	-0.99	-0.98	-0.81	-0.80	0.63	-0.53	0.25	0.65	-0.28
1985.2	0.00	1.47	1.42	0.05	-0.39	-0.51	-0.91	-0.53	-0.65	0.19	0.85	0.88	1.10
1986.2	0.00	1.04	-0.33	-0.23	-0.50	-0.22	-0.67	-0.59	-0.44	-0.31	0.58	-0.04	-0.02
1987.2	0.00	0.45	1.50	2.16	0.98	0.32	0.05	-0.63	-0.51	-0.12	-0.07	0.67	0.54
1988.1	0.00	0.07	-0.57	-0.56	0.21	1.62	1.68	1.38	0.43	1.23	0.50	-0.26	0.57
1989.1	0.00	-0.59	-0.87	-1.21	-1.04	-0.08	-0.13	-0.35	0.30	0.25	0.03	0.32	-0.36
1990.1	0.00	-0.24	1.88	0.98	0.85	1.75	1.57	-0.27	-0.07	0.27	-0.58	-0.38	-0.04
1991.1	0.00	0.88	-0.48	-0.08	0.24	0.86	1.67	0.46	2.46	1.16	1.60	0.11	0.33
1992.1	0.00	0.09	-0.89	-1.12	-1.16	-0.68	-0.69	-0.73	-0.70	-0.63	-0.51	-0.65	
1993	0.00	-0.42	0.40	-1.11	-0.83	-1.15	-0.79	-0.55	-0.54	-0.75	-0.39	-0.53	-0.24
1993.3	0.00	-0.61	-0.39	-0.95	-1.17	-0.83	-0.83	-0.74	-0.61	-0.73	-0.62	-0.60	-0.46
1994.3	0.00	-0.67	0.50	-0.09	-0.78	-0.52	-0.88	-0.79	-0.31	-0.39	-0.55	-0.45	-0.47
1995.3	0.00	-0.90	0.16	7.13	7.47	2.74	2.83	4.59	1.57	2.03	-0.40	0.08	-0.31
1996.3	-0.51	0.15	0.09	-0.76	-0.52	-0.15	-0.87	-1.11	-0.56	0.11	-0.11	-0.12	-0.13
1997.3	0.51	-0.17	-0.92	-1.37	-1.31	-1.35	-1.45	-1.22	-1.12	-0.79	-0.44	-0.12	-0.08
1998.3	-0.53	-0.21	0.58	0.06	-0.63	-0.20	0.83	0.85	-0.28	-0.82	-0.41	-0.13	-0.08
1999.3	0.01	0.27	-0.55	0.08	0.74	0.58	-0.44	-0.21	-0.21	-0.78	-0.79	0.61	-0.09
2000	0.48	0.85	0.87	-0.87	-0.61	-0.15	0.08	-0.00	-0.05	0.41	-0.16	-0.29	0.27

Unstandardized Can RV No Burgeo Residuals; MSE= 3.97

	2	3	4	5	6	7	8	9	10	11	12	13	14
1983.3	0.00	-2.26	-3.07	-3.80	-1.83	-0.77	-0.62	0.63	0.30	0.23	0.12	0.01	0.05
1984.3	0.00	-5.72	-5.10	-4.21	-3.38	-1.10	-0.58	-0.61	0.27	-0.17	0.04	0.04	-0.03
1985.2	0.00	6.65	5.72	0.24	-0.97	-0.91	-0.83	-0.27	-0.27	0.06	0.19	0.11	0.06
1986.2	0.00	2.34	-1.13	-1.05	-1.80	-0.26	-0.81	-0.34	-0.12	-0.09	0.12	-0.01	-0.00
1987.2	0.00	1.34	2.56	7.77	3.20	0.49	0.04	-0.47	-0.15	-0.02	-0.01	0.11	0.09
1988.1	0.00	0.29	-1.29	-1.03	0.52	2.30	1.64	0.66	0.16	0.26	0.07	-0.04	0.08
1989.1	0.00	-2.54	-2.52	-2.68	-1.27	-0.09	-0.11	-0.20	0.07	0.07	0.00	0.04	-0.05
1990.1	0.00	-0.94	5.98	2.59	1.10	1.01	1.21	-0.15	-0.02	0.05	-0.10	-0.05	-0.00
1991.1	0.00	1.61	-1.35	-0.23	0.39	0.50	0.66	0.22	0.68	0.24	0.19	0.02	0.04
1992.1	0.00	0.30	-1.20	-2.90	-2.03	-0.37	-0.22	-0.16	-0.17	-0.14	-0.09	-0.05	-0.09
1993	0.00	-0.83	0.97	-1.44	-1.42	-0.76	-0.24	-0.10	-0.07	-0.13	-0.05	-0.06	-0.02
1993.3	0.00	-1.14	-0.89	-1.13	-1.77	-0.49	-0.23	-0.13	-0.07	-0.13	-0.07	-0.07	-0.04
1994.3	0.00	-0.65	0.73	-0.23	-0.79	-0.44	-0.42	-0.15	-0.03	-0.04	-0.07	-0.05	-0.05
1995.3	0.00	-1.39	0.13	12.90	18.89	1.96	2.41	1.81	0.21	0.19	-0.03	0.01	-0.03
1996.3	-0.55	0.18	0.12	-0.71	-0.93	-0.26	-0.63	-0.76	-0.14	0.01	-0.01	-0.00	-0.00

Table 19. Cont'd

1997.3	0.60	-0.22	-0.88	-2.00	-1.21	-1.66	-2.53	-0.71	-0.46	-0.16	-0.04	-0.00	-0.00
1998.3	-0.49	-0.31	0.59	0.07	-0.81	-0.12	0.91	1.07	-0.09	-0.25	-0.06	-0.00	-0.00
1999.3	0.01	0.30	-0.62	0.10	0.69	0.40	-0.20	-0.16	-0.13	-0.19	-0.17	0.02	-0.00
2000	1.01	1.87	0.79	-1.17	-0.65	-0.07	0.04	-0.00	-0.02	0.17	-0.03	-0.01	0.01

Table 19. Cont'd

Can RV No Burgeo Index

	2	3	4	5	6	7	8	9	10	11	12	13	14
1983.3	11.41	6.63	1.08	3.24	1.36	0.42	0.93	1.78	0.82	0.42	0.15	0.06	0.07
1984.3	5.77	2.53	1.59	0.50	2.00	0.52	0.38	0.43	0.78	0.17	0.15	0.06	0.02
1985.2	7.50	13.83	12.11	7.93	2.89	1.76	0.45	0.37	0.22	0.38	0.39	0.20	0.08
1986.2	5.76	5.79	4.25	6.18	3.93	1.48	0.95	0.40	0.15	0.20	0.29	0.14	0.07
1987.2	9.46	5.94	5.14	13.45	8.32	2.74	1.08	0.53	0.16	0.14	0.15	0.23	0.21
1988.1	10.13	6.44	2.20	1.75	4.31	4.41	3.02	1.24	0.57	0.45	0.16	0.08	0.18
1989.1	6.76	4.24	1.98	0.74	0.51	1.45	1.07	0.54	0.30	0.32	0.11	0.10	0.05
1990.1	1.51	5.14	10.97	6.71	3.02	1.75	2.26	0.55	0.29	0.18	0.04	0.03	0.05
1991.1	30.70	4.40	3.01	4.50	2.82	1.24	1.11	0.80	0.96	0.42	0.26	0.12	0.10
1992.1	1.92	5.32	0.79	1.14	0.62	0.33	0.12	0.04	0.06	0.01	0.01	0.00	0.00
1993	0.00	2.19	4.75	0.48	1.16	0.12	0.08	0.05	0.01	0.01	0.03	0.01	0.02
1993.3	0.00	1.73	2.60	0.60	0.49	0.28	0.05	0.01	0.00	0.01	0.00	0.00	0.00
1994.3	1.81	0.73	2.92	3.72	0.65	0.73	0.17	0.01	0.03	0.01	0.01	0.01	0.01
1995.3	0.24	0.92	1.19	15.65	22.81	2.93	3.60	2.27	0.29	0.23	0.00	0.07	0.02
1996.3	0.98	1.96	1.89	0.62	1.79	2.38	0.35	0.16	0.10	0.07	0.02	0.00	0.00
1997.3	2.32	1.70	0.48	0.17	0.09	0.14	0.11	0.04	0.02	0.01	0.00	0.00	0.00
1998.3	0.82	1.84	2.04	1.68	1.08	0.64	2.50	2.91	0.27	0.07	0.04	0.00	0.00
1999.3	2.68	1.94	1.00	1.81	2.00	1.34	0.35	0.83	0.69	0.04	0.02	0.03	0.00
2000	4.25	5.26	2.07	0.82	0.88	0.52	0.62	0.26	0.39	0.64	0.10	0.00	0.01

Standardized Sentinel gillnet Residuals; MSE= 0.52

	3	4	5	6	7	8	9	10
1995.5	0.11	-0.06	0.23	-0.65	0.99	-0.04	0.10	0.61
1996.5	0.20	0.53	0.75	1.20	-0.35	0.60	0.20	-0.55
1997.5	-0.03	0.73	1.53	0.55	0.27	0.82	0.92	1.21
1998.5	-0.09	-0.50	-1.48	0.13	-0.15	-1.04	-0.08	0.02
1999.5	-0.20	-0.71	-1.12	-1.30	-0.76	-0.48	-1.01	-0.88

Unstandardized Sentinel gillnet Residuals; MSE= 0.93

	3	4	5	6	7	8	9	10
1995.5	0.01	-0.01	0.33	-2.42	1.42	-0.04	0.03	0.07
1996.5	0.01	0.10	0.63	3.24	-1.19	0.54	0.08	-0.10
1997.5	-0.00	0.12	1.83	0.78	0.63	1.59	0.33	0.33
1998.5	-0.00	-0.08	-1.42	0.24	-0.17	-1.32	-0.05	0.00
1999.5	-0.01	-0.12	-1.12	-1.76	-0.98	-0.28	-0.42	-0.33

Sentinel gillnet Index

	3	4	5	6	7	8	9	10
1995.5	0.02	0.08	4.19	8.91	5.17	2.46	0.34	0.12
1996.5	0.02	0.25	2.51	11.14	9.12	2.60	0.71	0.06
1997.5	0.01	0.23	4.82	4.46	7.47	7.06	0.83	0.65
1998.5	0.01	0.04	0.81	5.51	2.65	1.90	1.17	0.25
1999.5	0.00	0.01	1.24	1.76	2.34	0.79	0.23	0.21

Standardized Sentinel linetrawl Residuals; MSE= 0.11

	3	4	5	6	7	8	9	10
1995.5	-0.00	0.18	0.53	0.47	0.60	0.27	0.11	0.63
1996.5	0.20	0.28	0.55	0.22	0.33	0.35	0.45	0.23
1997.5	-0.25	0.21	-0.37	-0.11	-0.54	-0.16	-0.31	0.05
1998.5	-0.09	-0.24	-0.35	-0.29	-0.48	-0.41	0.12	0.13
1999.5	0.16	-0.41	-0.38	-0.39	0.06	0.01	-0.39	-0.50

Table 19. Cont'd

Unstandardized Sentinel linetrawl Residuals; MSE= 0.00

	3	4	5	6	7	8	9	10
1995.5	-0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00
1996.5	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00
1997.5	-0.00	0.00	-0.01	-0.00	-0.01	-0.00	-0.00	0.00
1998.5	-0.00	-0.00	-0.01	-0.01	-0.00	-0.01	0.00	0.00
1999.5	0.00	-0.01	-0.01	-0.01	0.00	0.00	-0.00	-0.00

Sentinel linetrawl Index

	3	4	5	6	7	8	9	10
1995.5	0.01	0.02	0.07	0.09	0.02	0.02	0.00	0.00
1996.5	0.01	0.04	0.03	0.06	0.05	0.02	0.01	0.00
1997.5	0.01	0.03	0.03	0.02	0.02	0.03	0.00	0.00
1998.5	0.01	0.02	0.02	0.03	0.01	0.01	0.01	0.00
1999.5	0.01	0.02	0.02	0.02	0.02	0.01	0.00	0.00

Table 20. The input vectors of weight, maturity and partial recruitment at age used in the projection and risk analysis to evaluate TAC options for the 1April 2001 – 31 March 2002.

Age	PR	Jan1 Wt	Mat	Jul1 Wt
2	0.000	0.000	0.007	0.00
3	0.025	0.490	0.033	0.62
4	0.199	0.800	0.142	1.02
5	0.541	1.270	0.449	1.57
6	0.816	1.800	0.800	2.05
7	1.000	2.230	0.952	2.42
8	0.835	2.740	0.990	3.10
9	0.545	3.540	0.998	4.04
10	0.320	4.090	1.000	4.13
11	0.208	4.370	1.000	4.62
12	0.142	4.900	1.000	5.21
13	0.095	5.770	1.000	6.39
14	0.028	7.870	1.000	9.69

Table 21. Output from the profile likelihood analysis of risk for a range of TAC options for the 2001/2002 fishing season with respect to two fishing mortality reference points and the population declining.

Risk Event	TAC	Prob	Proj event	Ref Event	Prof_Quasi
APR SPB 2002 < APR SPB 2001	30000	0.9778	57891.60	75615.86	4.0436
APR SPB 2002 < APR SPB 2001	25000	0.9513	62219.25	75615.86	2.7492
APR SPB 2002 < APR SPB 2001	20000	0.8906	66586.47	75615.86	1.5120
APR SPB 2002 < APR SPB 2001	17500	0.8362	68783.31	75615.86	0.9583
APR SPB 2002 < APR SPB 2001	15000	0.7576	70988.22	75615.86	0.4878
APR SPB 2002 < APR SPB 2001	12500	0.6495	73200.70	75615.86	0.1474
APR SPB 2002 < APR SPB 2001	10000	0.5127	75420.27	75615.86	0.0010
APR SPB 2002 < APR SPB 2001	7500	0.3604	77646.51	75615.86	0.1277
APR SPB 2002 < APR SPB 2001	5000	0.2183	79879.02	75615.86	0.6050
APR SPB 2002 < APR SPB 2001	2500	0.1124	82117.44	75615.86	1.4730
APR SPB 2002 < MIN JAN SPB	30000	0.0946	57891.60	33427.90	1.7231
APR SPB 2002 < MIN JAN SPB	25000	0.0569	62219.25	33427.90	2.5018
APR SPB 2002 < MIN JAN SPB	20000	0.0314	66586.47	33427.90	3.4623
APR SPB 2002 < MIN JAN SPB	17500	0.0224	68783.31	33427.90	4.0232
APR SPB 2002 < MIN JAN SPB	15000	0.0156	70988.22	33427.90	4.6414
APR SPB 2002 < MIN JAN SPB	12500	0.0105	73200.70	33427.90	5.3278
APR SPB 2002 < MIN JAN SPB	10000	0.0066	75420.27	33427.90	6.1528
APR SPB 2002 < MIN JAN SPB	7500	0.0040	77646.51	33427.90	7.0508
APR SPB 2002 < MIN JAN SPB	5000	0.0022	79879.02	33427.90	8.1024
APR SPB 2002 < MIN JAN SPB	2500	0.0012	82117.44	33427.90	9.2213
Ave F (2001-2002) > 10%	30000	1.0000	0.38	0.10	18.0031
Ave F (2001-2002) > 10%	25000	0.9998	0.30	0.10	12.7478
Ave F (2001-2002) > 10%	20000	0.9969	0.23	0.10	7.4883
Ave F (2001-2002) > 10%	17500	0.9873	0.20	0.10	4.9953
Ave F (2001-2002) > 10%	15000	0.9512	0.16	0.10	2.7455
Ave F (2001-2002) > 10%	12500	0.8361	0.13	0.10	0.9575
Ave F (2001-2002) > 10%	10000	0.5650	0.11	0.10	0.0268
Ave F (2001-2002) > 10%	7500	0.1986	0.08	0.10	0.7168
Ave F (2001-2002) > 10%	5000	0.0151	0.05	0.10	4.7019
Ave F (2001-2002) > 10%	2500	0.0000	0.02	0.10	444.683
Ave F (2001-2002) > 21%	30000	0.9804	0.38	0.21	4.2538
Ave F (2001-2002) > 21%	25000	0.8637	0.30	0.21	1.2039
Ave F (2001-2002) > 21%	20000	0.6089	0.23	0.21	0.0765
Ave F (2001-2002) > 21%	17500	0.4194	0.20	0.21	0.0414
Ave F (2001-2002) > 21%	15000	0.2285	0.16	0.21	0.5532
Ave F (2001-2002) > 21%	12500	0.0867	0.13	0.21	1.8534
Ave F (2001-2002) > 21%	10000	0.0187	0.11	0.21	4.3362
Ave F (2001-2002) > 21%	7500	0.0016	0.08	0.21	8.6787
Ave F (2001-2002) > 21%	5000	0.0000	0.05	0.21	86.3958
Ave F (2001-2002) > 21%	2500	0.0000	0.02	0.21	100.445
Full Rec F (2001-2002) > 10%	30000	1.0000	0.96	0.10	813.973
Full Rec F (2001-2002) > 10%	25000	1.0000	0.76	0.10	44.4575
Full Rec F (2001-2002) > 10%	20000	1.0000	0.58	0.10	35.0131
Full Rec F (2001-2002) > 10%	17500	1.0000	0.50	0.10	29.7493
Full Rec F (2001-2002) > 10%	15000	1.0000	0.42	0.10	24.0915
Full Rec F (2001-2002) > 10%	12500	1.0000	0.34	0.10	18.0502

Table 21. Cont'd.

Full Rec F (2001-2002) > 10%	10000	0.9997	0.26	0.10	11.7309
Full Rec F (2001-2002) > 10%	7500	0.9906	0.19	0.10	5.5167
Full Rec F (2001-2002) > 10%	5000	0.7990	0.13	0.10	0.7024
Full Rec F (2001-2002) > 10%	2500	0.0576	0.06	0.10	2.4812
Full Rec F (2001-2002) > 21%	30000	1.0000	0.96	0.21	23.5963
Full Rec F (2001-2002) > 21%	25000	1.0000	0.76	0.21	17.6091
Full Rec F (2001-2002) > 21%	20000	0.9996	0.58	0.21	11.3653
Full Rec F (2001-2002) > 21%	17500	0.9980	0.50	0.21	8.2487
Full Rec F (2001-2002) > 21%	15000	0.9891	0.42	0.21	5.2604
Full Rec F (2001-2002) > 21%	12500	0.9463	0.34	0.21	2.5926
Full Rec F (2001-2002) > 21%	10000	0.7830	0.26	0.21	0.6119
Full Rec F (2001-2002) > 21%	7500	0.3990	0.19	0.21	0.0655
Full Rec F (2001-2002) > 21%	5000	0.0517	0.13	0.21	2.6529
Full Rec F (2001-2002) > 21%	2500	0.0001	0.06	0.21	13.3071

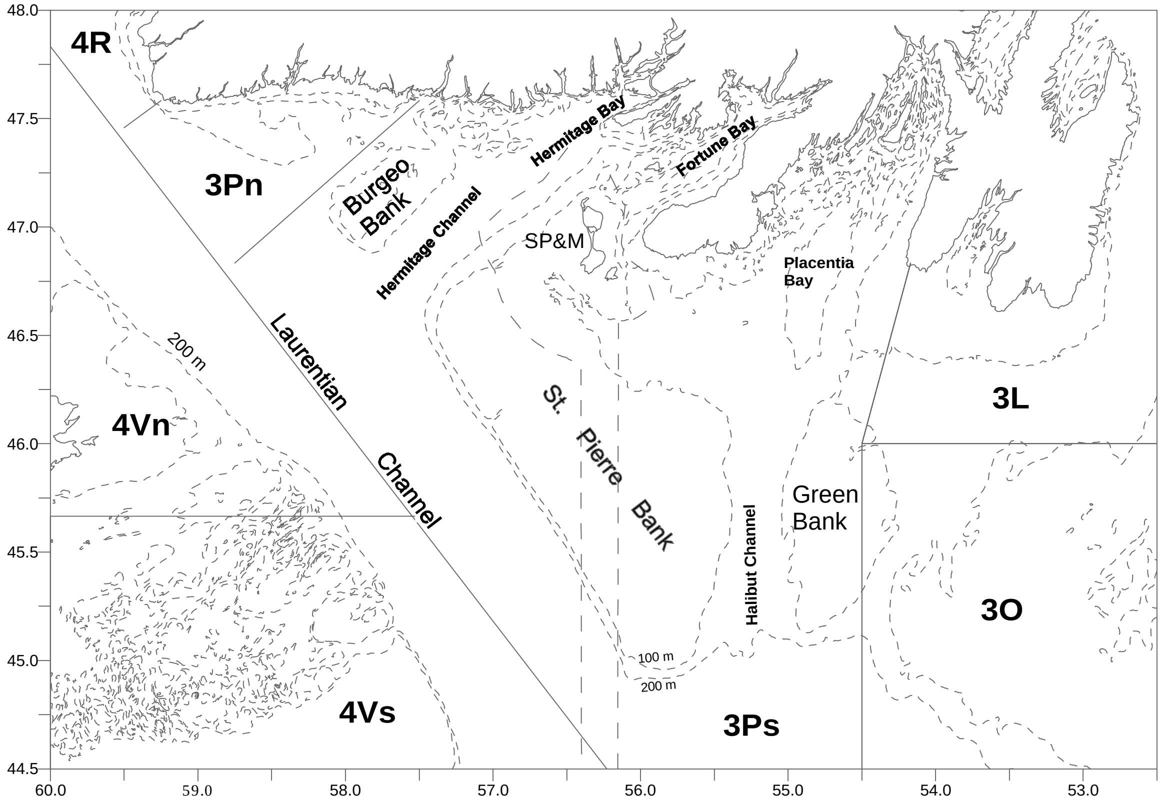


Fig. 1. Southern Newfoundland showing boundaries of NAFO Subdivision 3Ps management unit, French economic zone (dashed line), 100 m and 200 m depth contours, and main fishing areas.

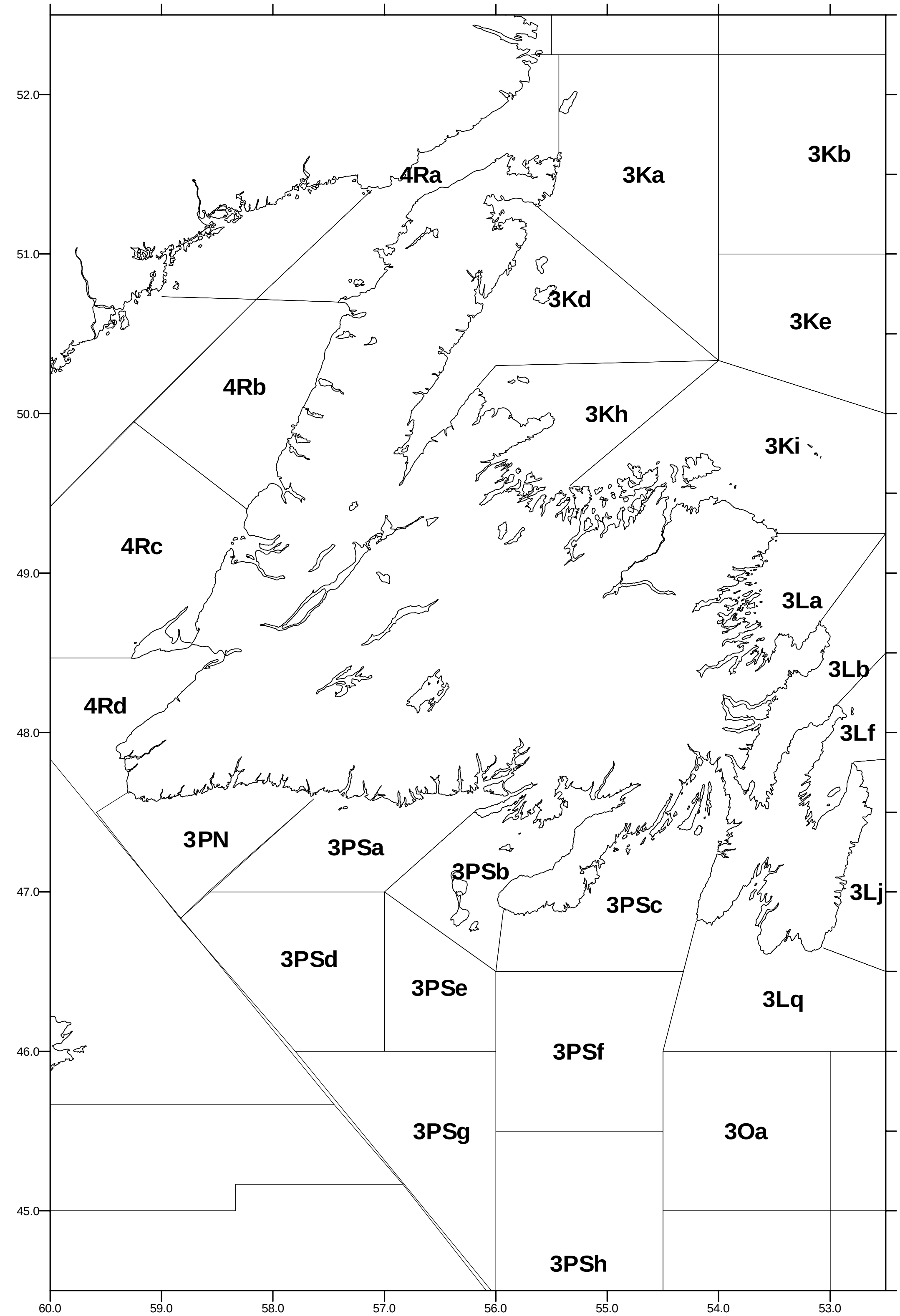


Fig. 2. Names and boundaries of NAFO statistical areas around insular Newfoundland.

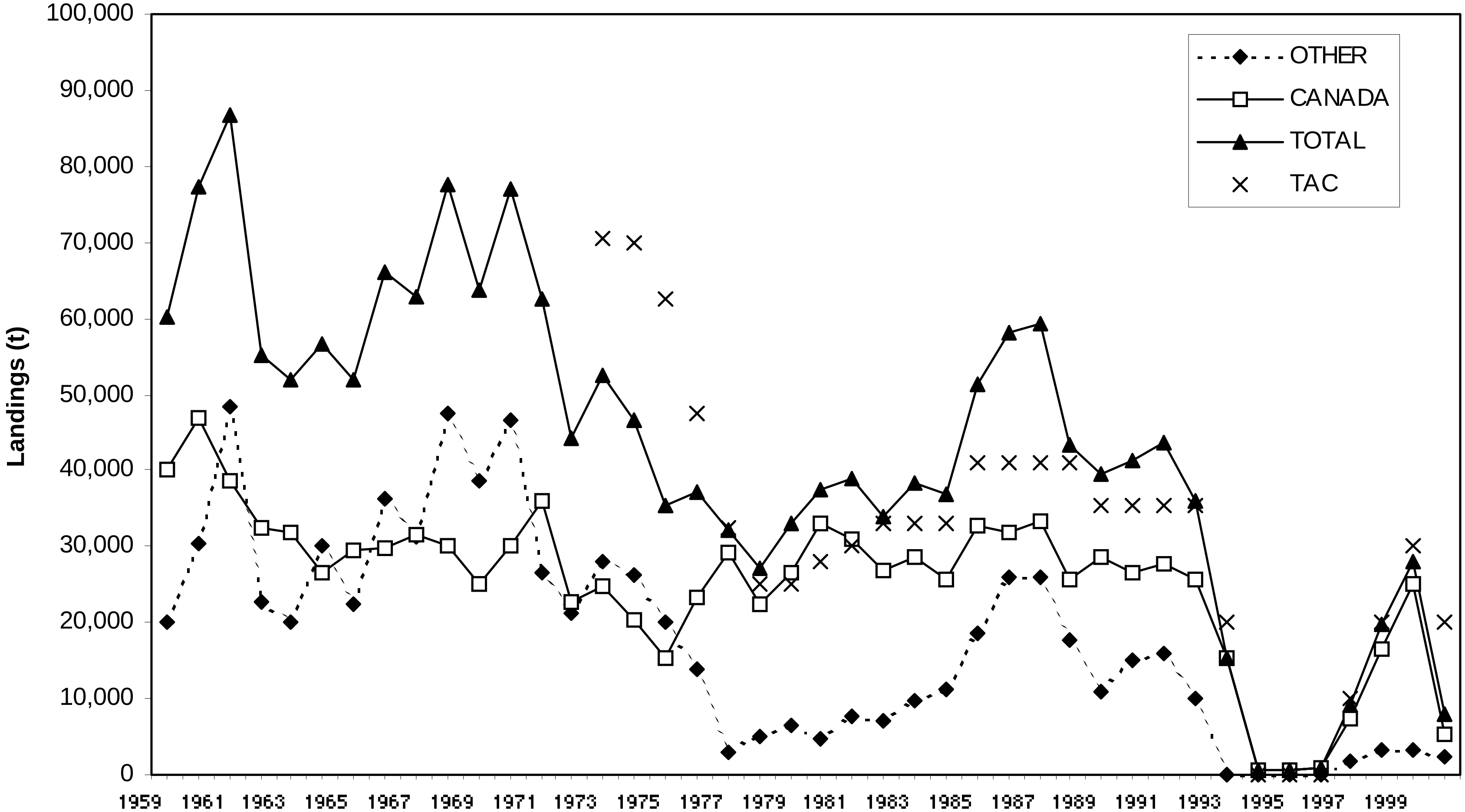


Fig. 3A. TAC and reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdiv. 3Ps during 1959 to Sept 2000.

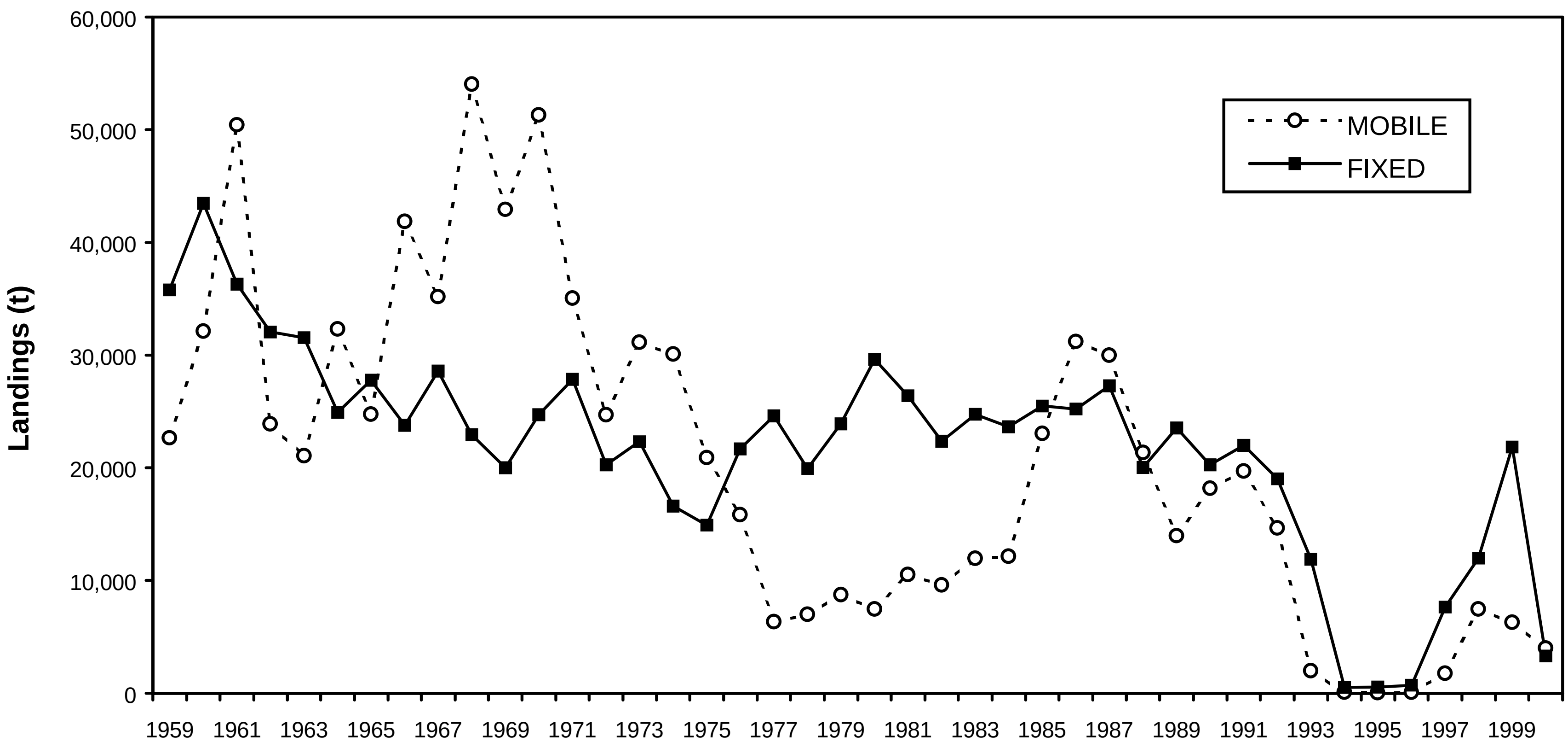


Fig. 3B. Reported landings of cod by fixed and mobile gear in NAFO Subdiv 3Ps from 1959 to Sept 2000

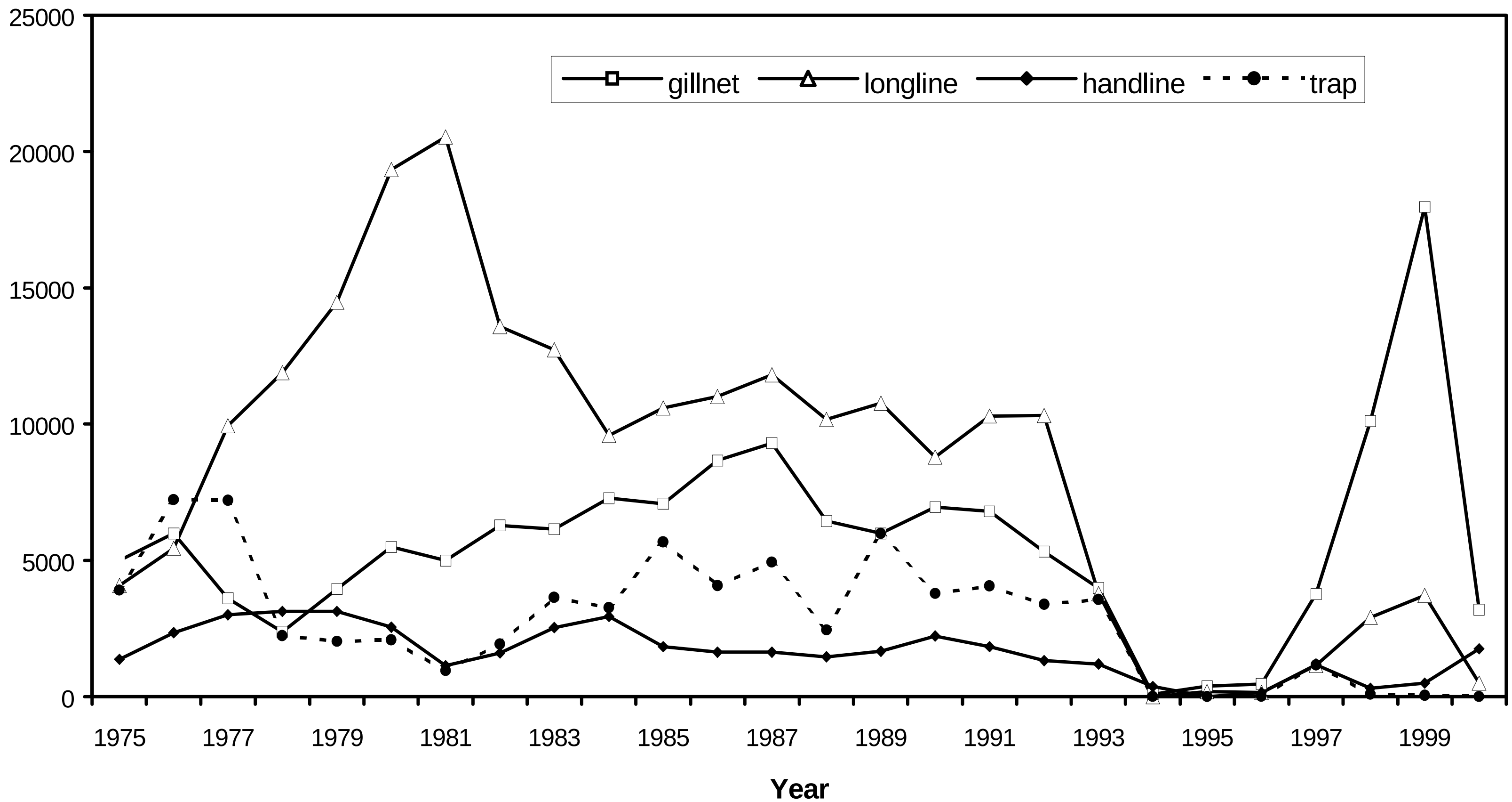


Fig. 4. Reported landings of cod by various fixed gears in NAFO Subdiv. 3Ps during 1975 to Sept 2000

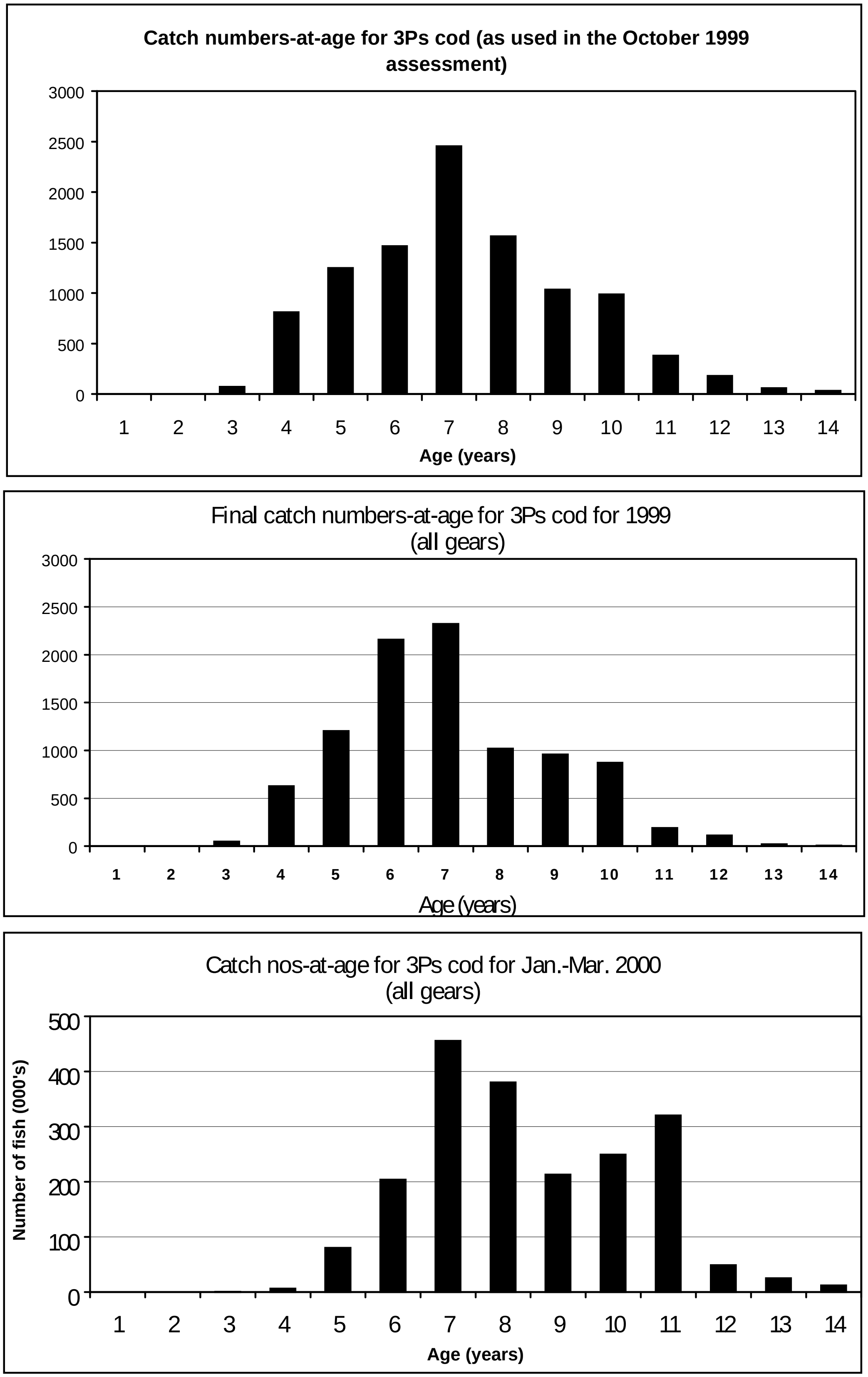


Fig. 5. Catch numbers-at-age for the commercial fishery in 3Ps during 1999 and January-March 2000.

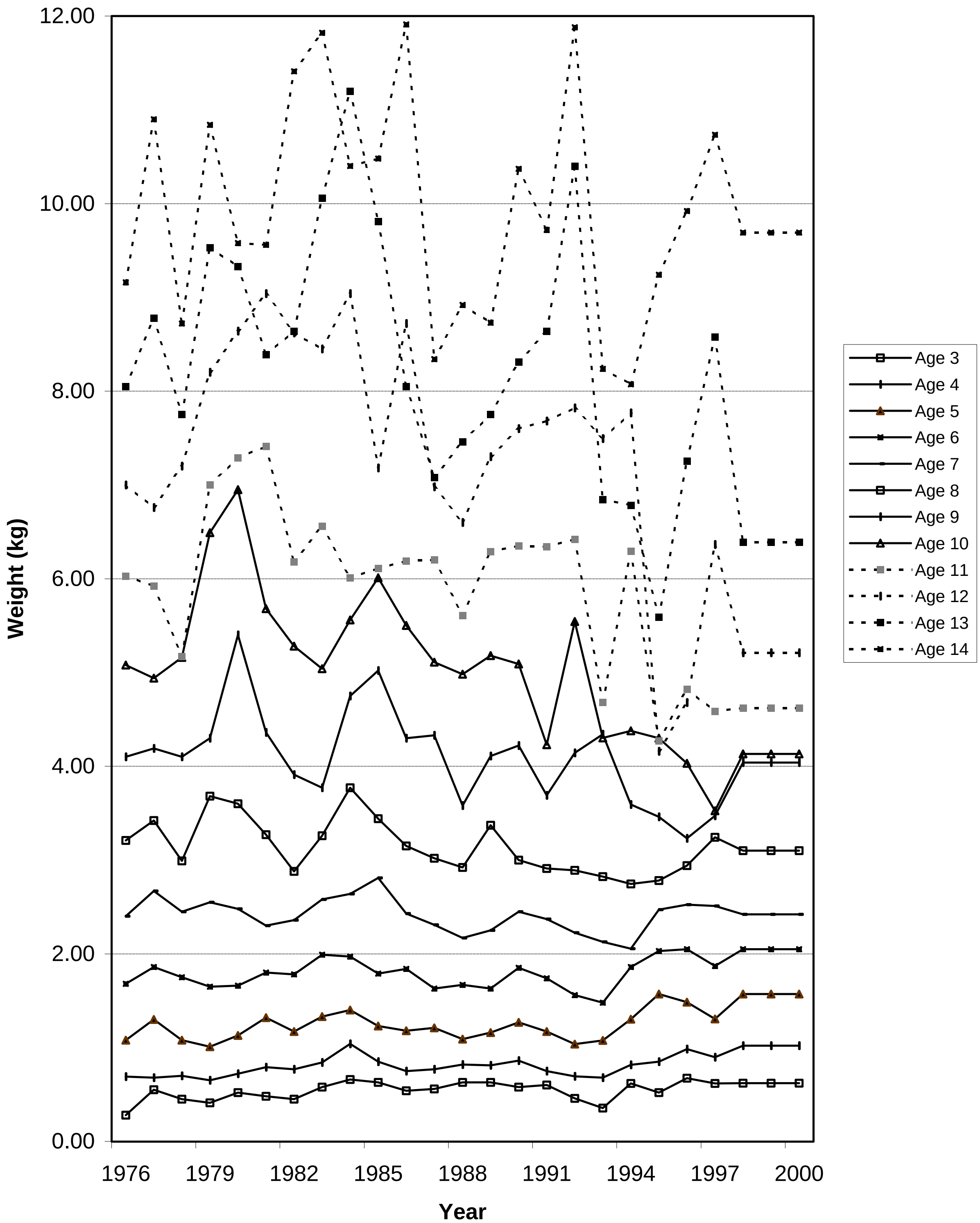


Fig. 6. Mean weights-at-age (3-14) from the commercial catch in 3Ps during 1976-2000 (1998 values are extrapolated to 2000)

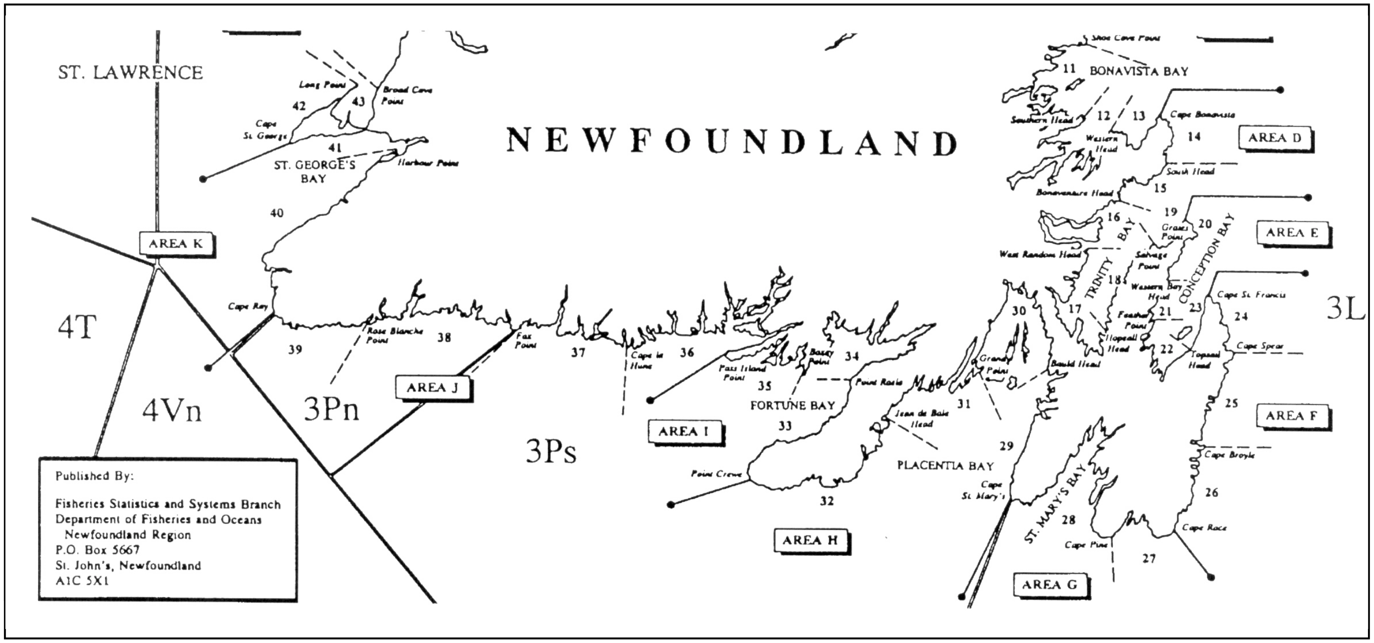
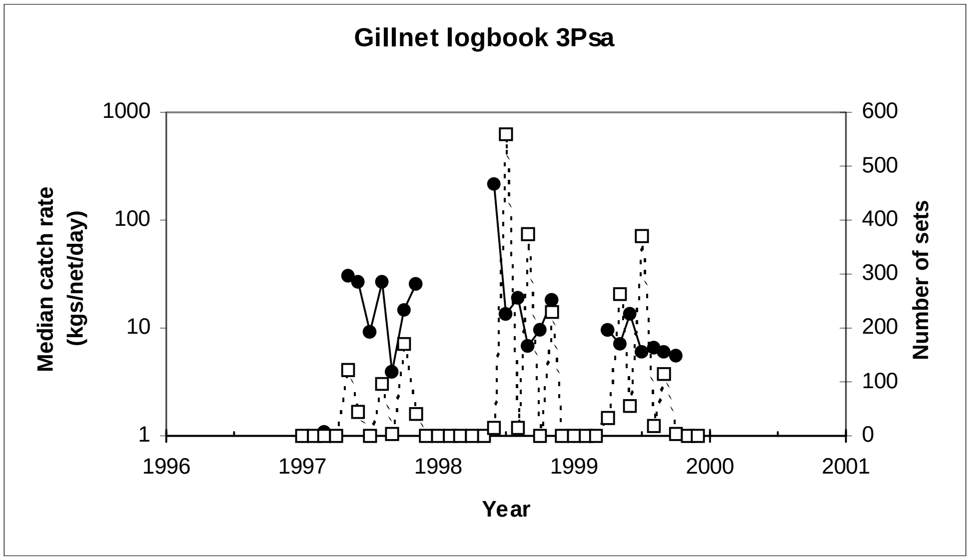
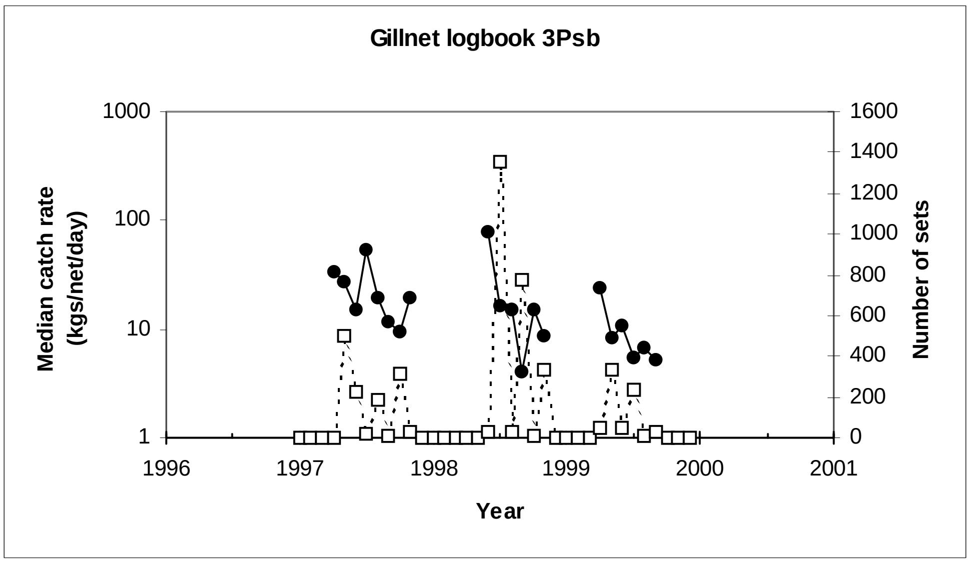


Fig. 7. Southern Newfoundland showing inshore portion of NAFO Subdivision 3Ps and boundaries of lobster management areas H, I, J (solid lines with terminal dot) and fishing areas 29-37 (dashed lines). Areas 29-32 are in unit area 3Psc, 33-35 in 3Psb, and 36-37 in 3Psa.





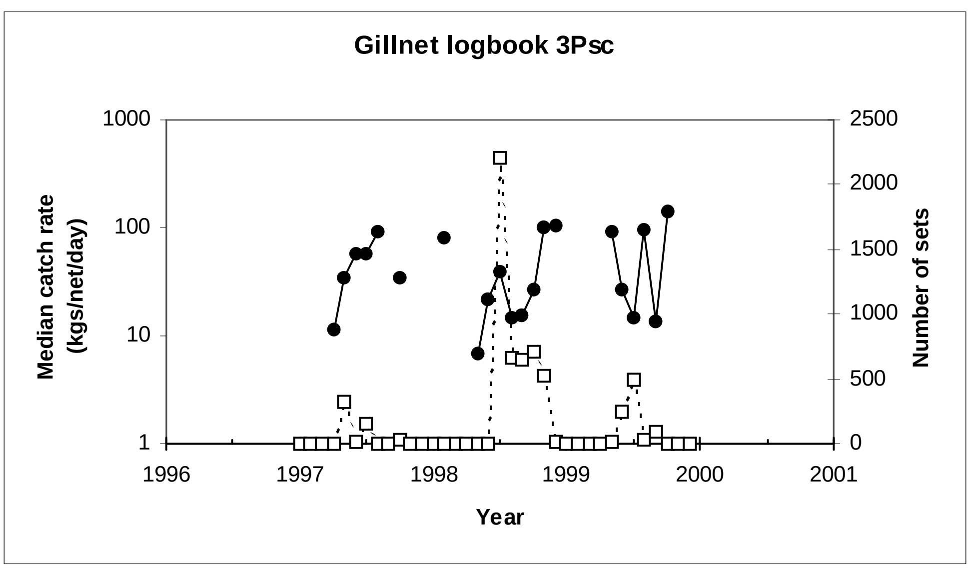


Fig. 8. Temporal trends in catch rates of cod in gillnets in various regions of NAFO Subdiv. 3Ps, based on data from science logbooks. Closed circles are medians, open squares are the number of sets.

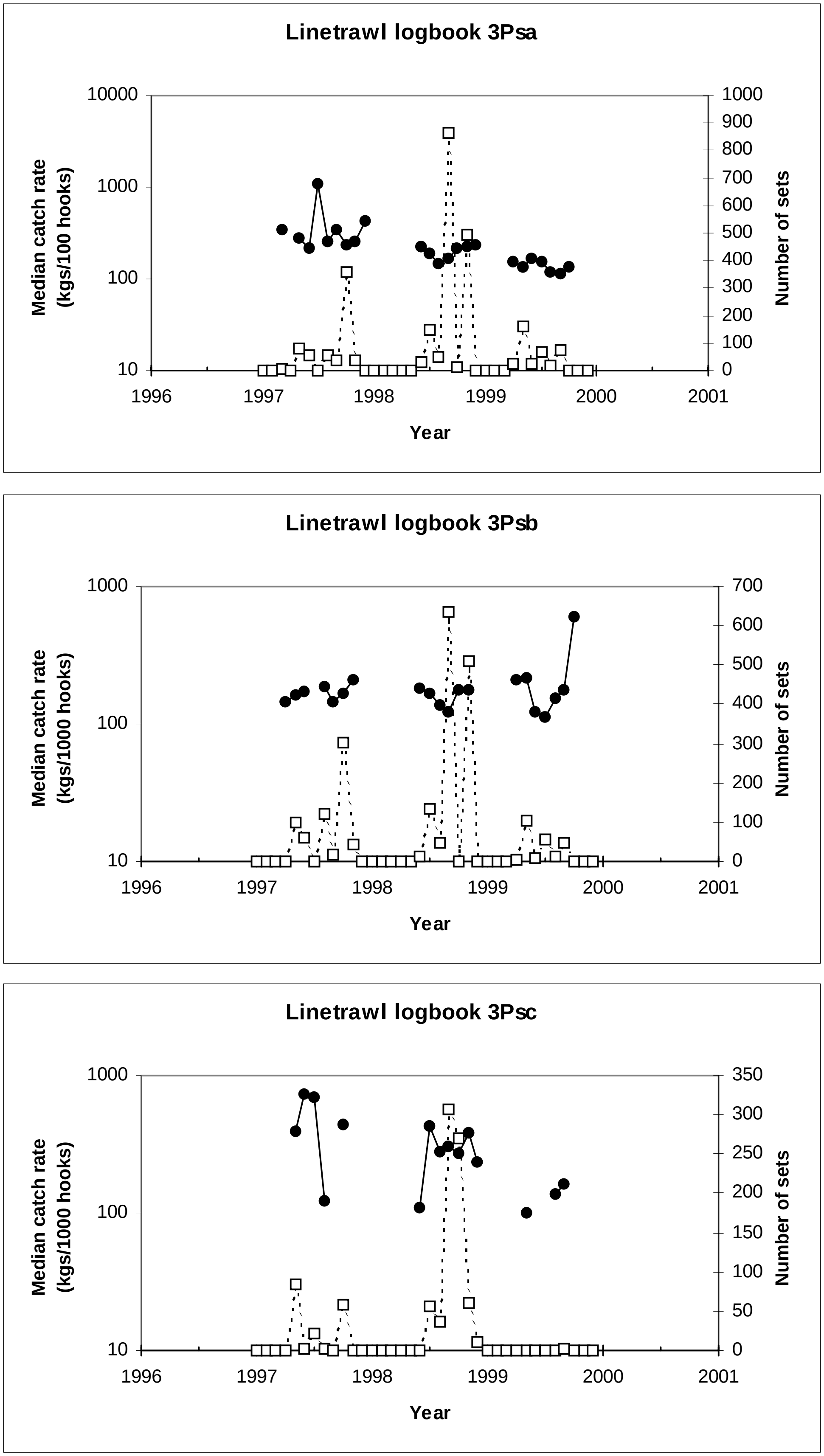
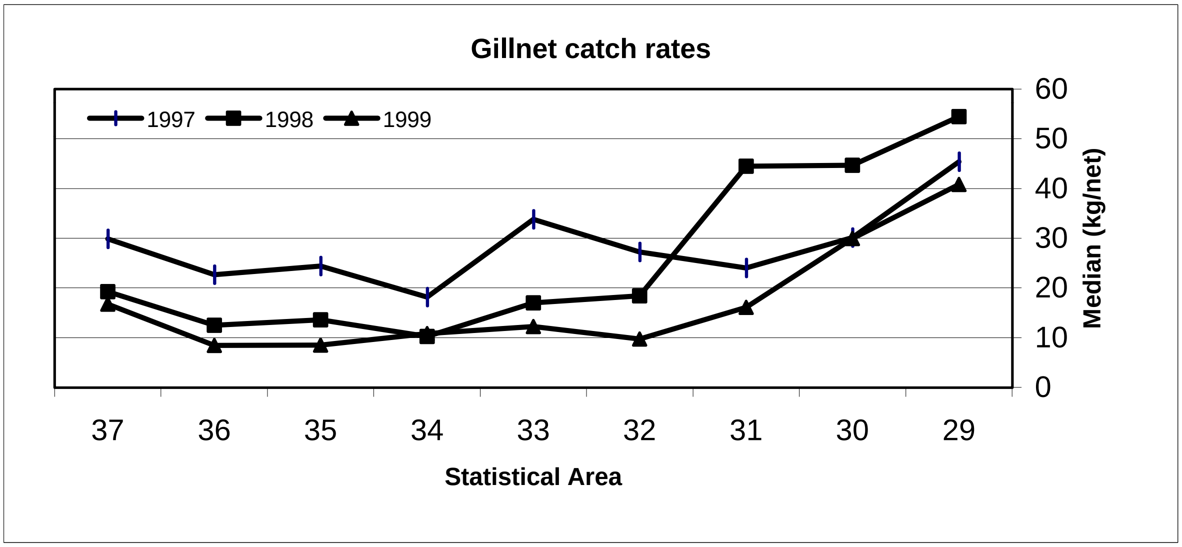


Fig. 9. Temporal trends in catch rates of cod in linetrawls in various regions of NAFO Subdiv. 3Ps based on data from science logbooks. Closed circles are medians, open squares are the number of sets.



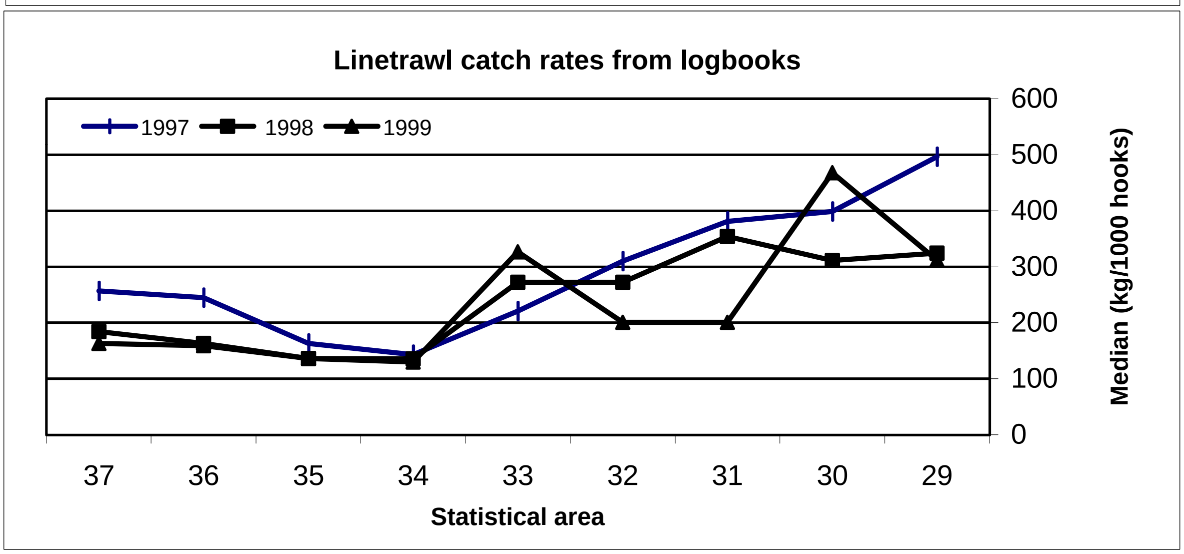


Fig. 10. Spatial and temporal trends in catch rates of cod in gillnets and linetawls in various regions of NAFO Subdiv. 3Ps, based on data collected from science logbooks for vessels <35'. Numbers on x-axis are management areas numbered from west to east (see Fig. 7).

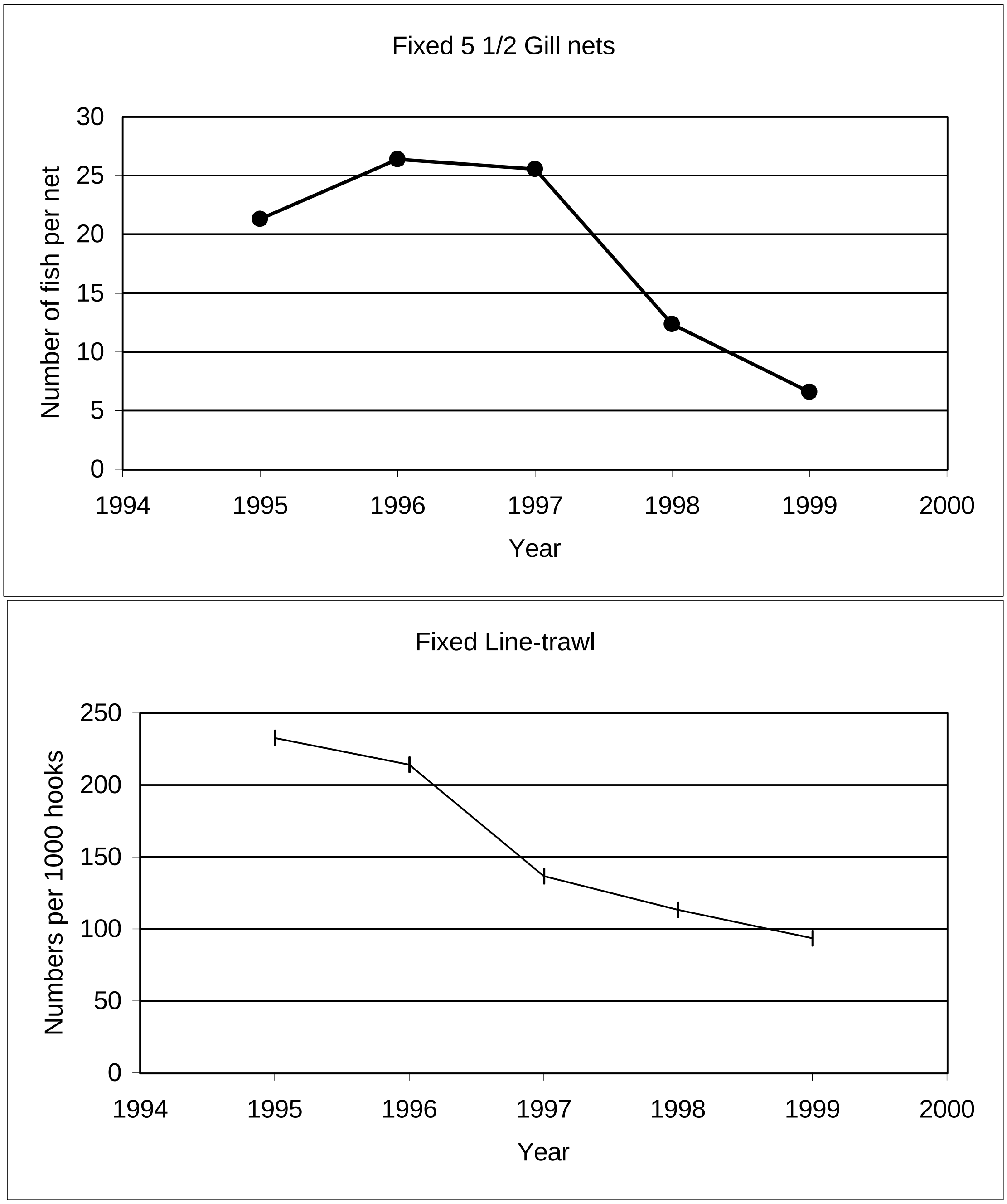


Fig. 11. Standardized gill-net (5.5" mesh) and line-trawl total annual catch rates from sentinel survey

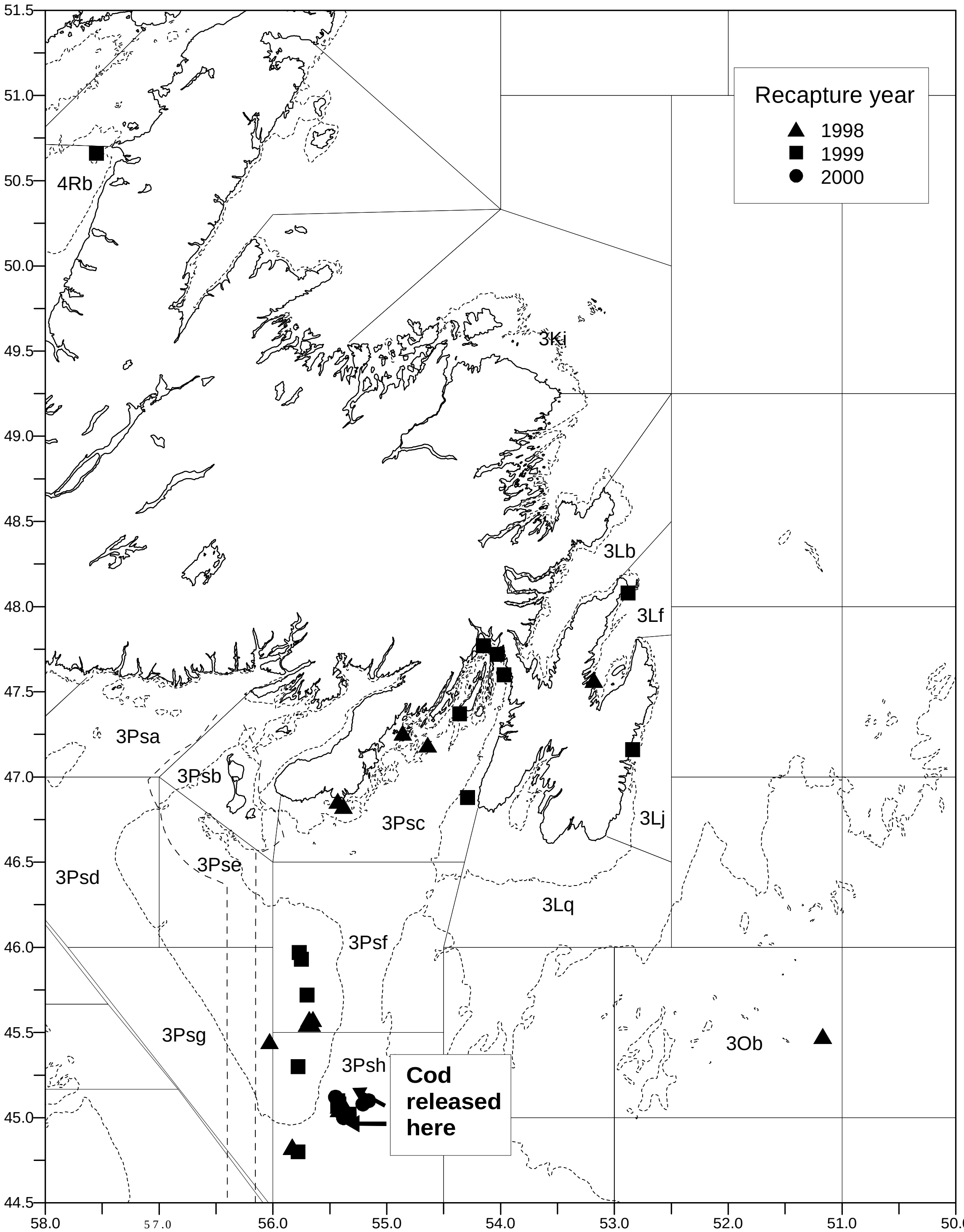


Fig. 12. Reported recapture positions for cod tagged and released in Halibut Channel during 3-5 April 1998 (N=1842).

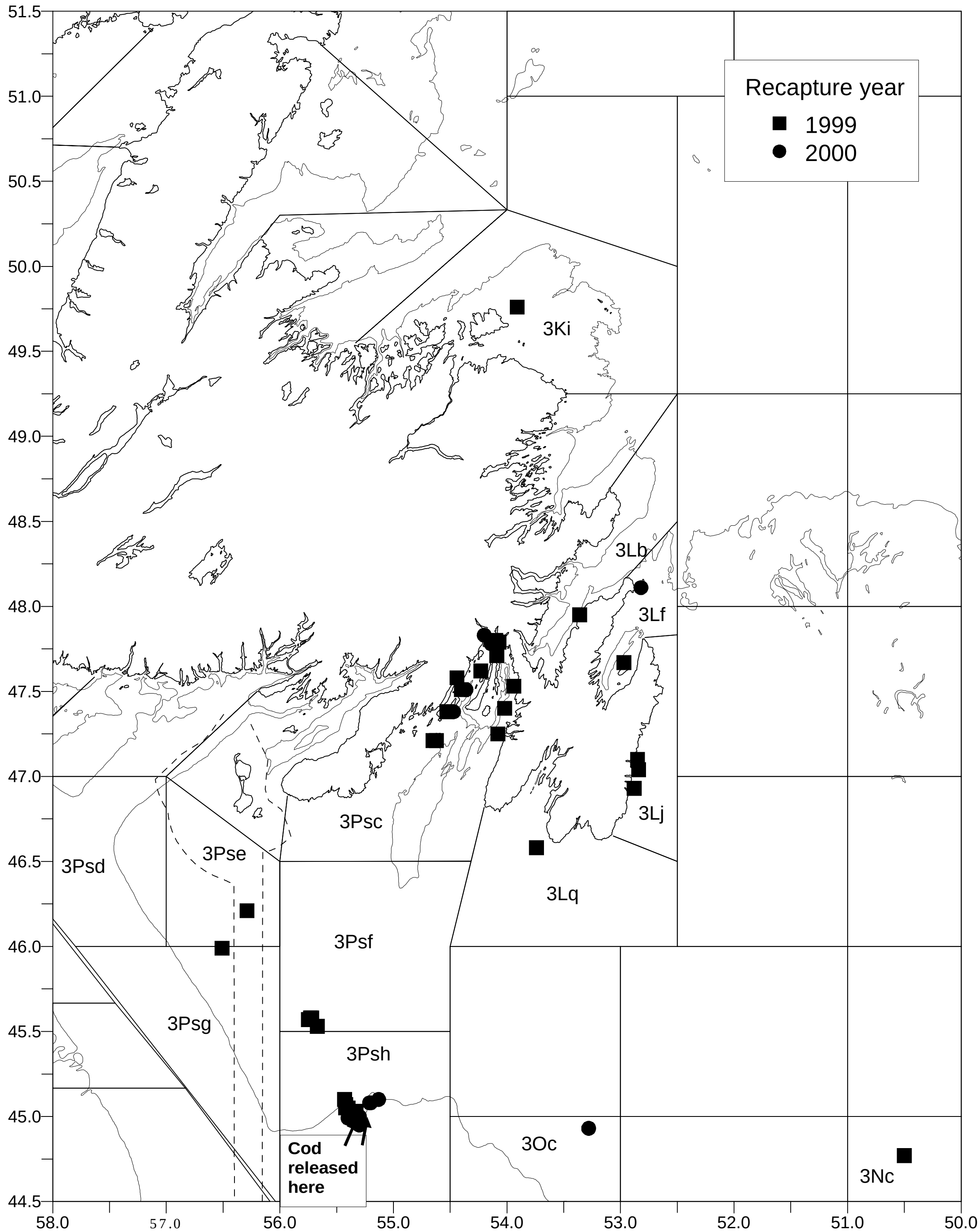


Fig. 13. Reported recapture positions of cod tagged and released in Halibut Channel during 1-3 April 1999 (N=1808).

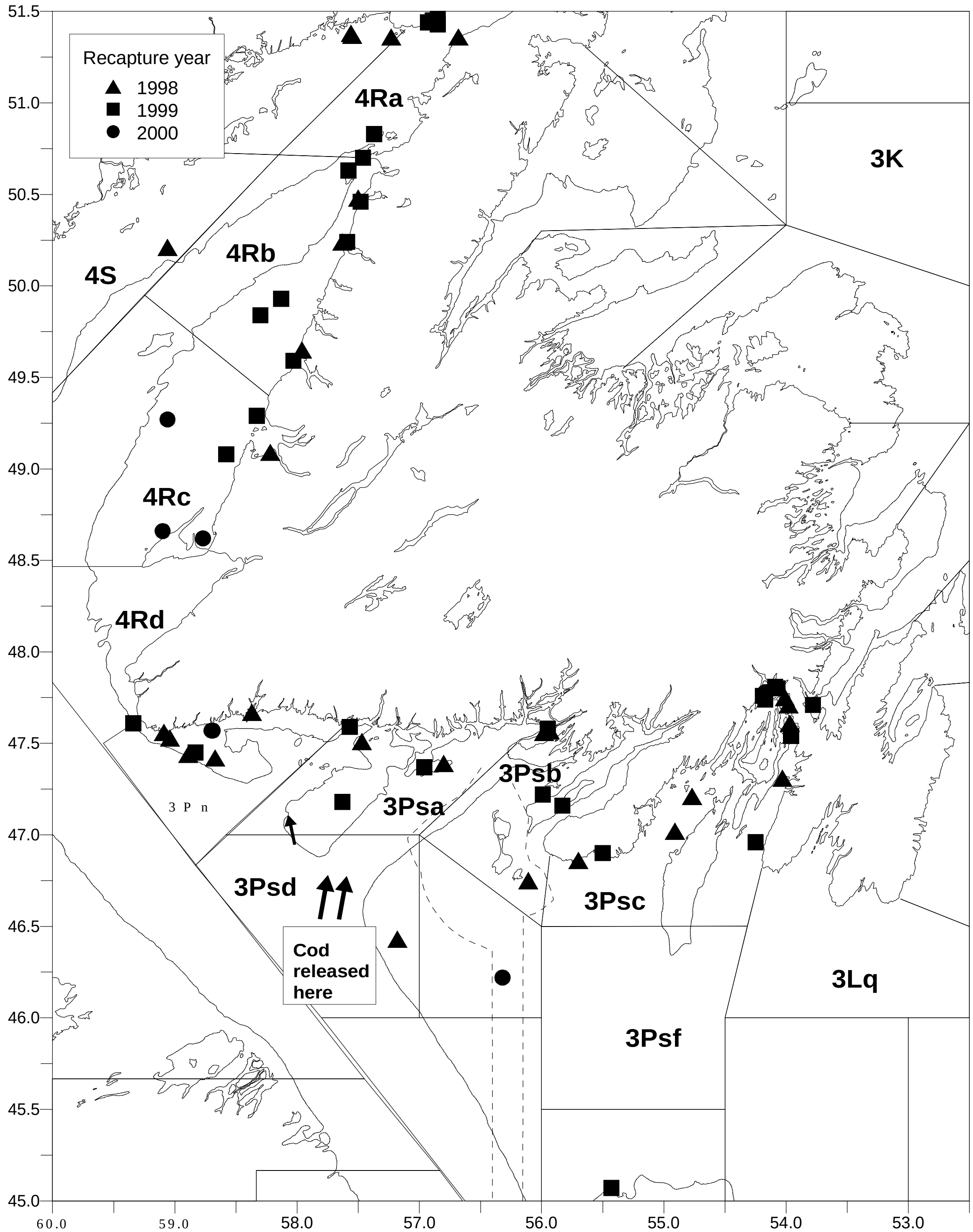


Fig. 14. Reported recapture positions for cod tagged and released in the Burgeo Bank /Hermitage Channel are during 5-7 April 1998 (N=1352).

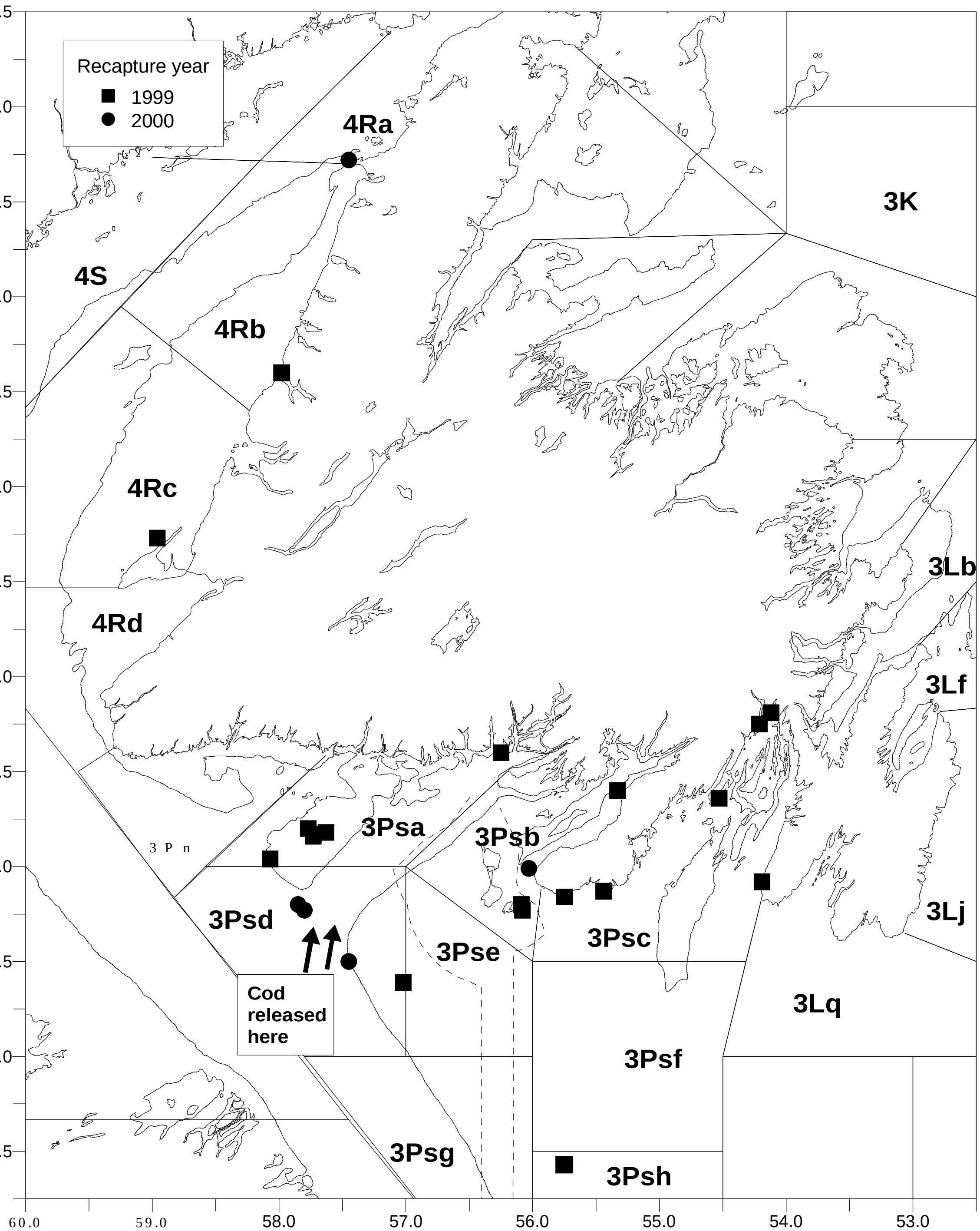


Fig. 15. Reported recapture positions for cod tagged and released in the Burgeo Bank /Hermitage Channel area during 4-7 April 1999 (N=465).

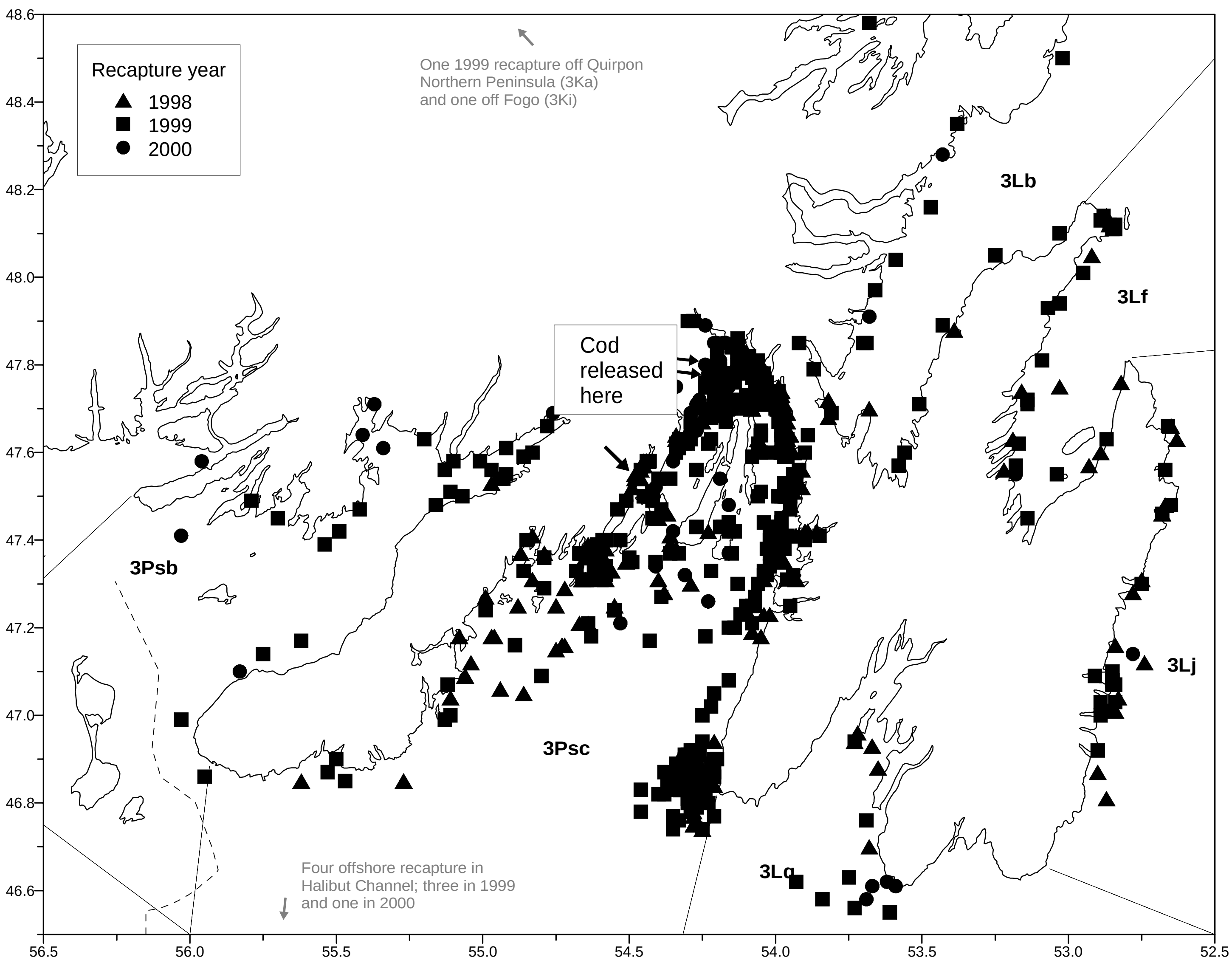


Fig. 16. Reported recapture positions for cod tagged at the head of Placentia Bay during April-May 1998 (N=4322).

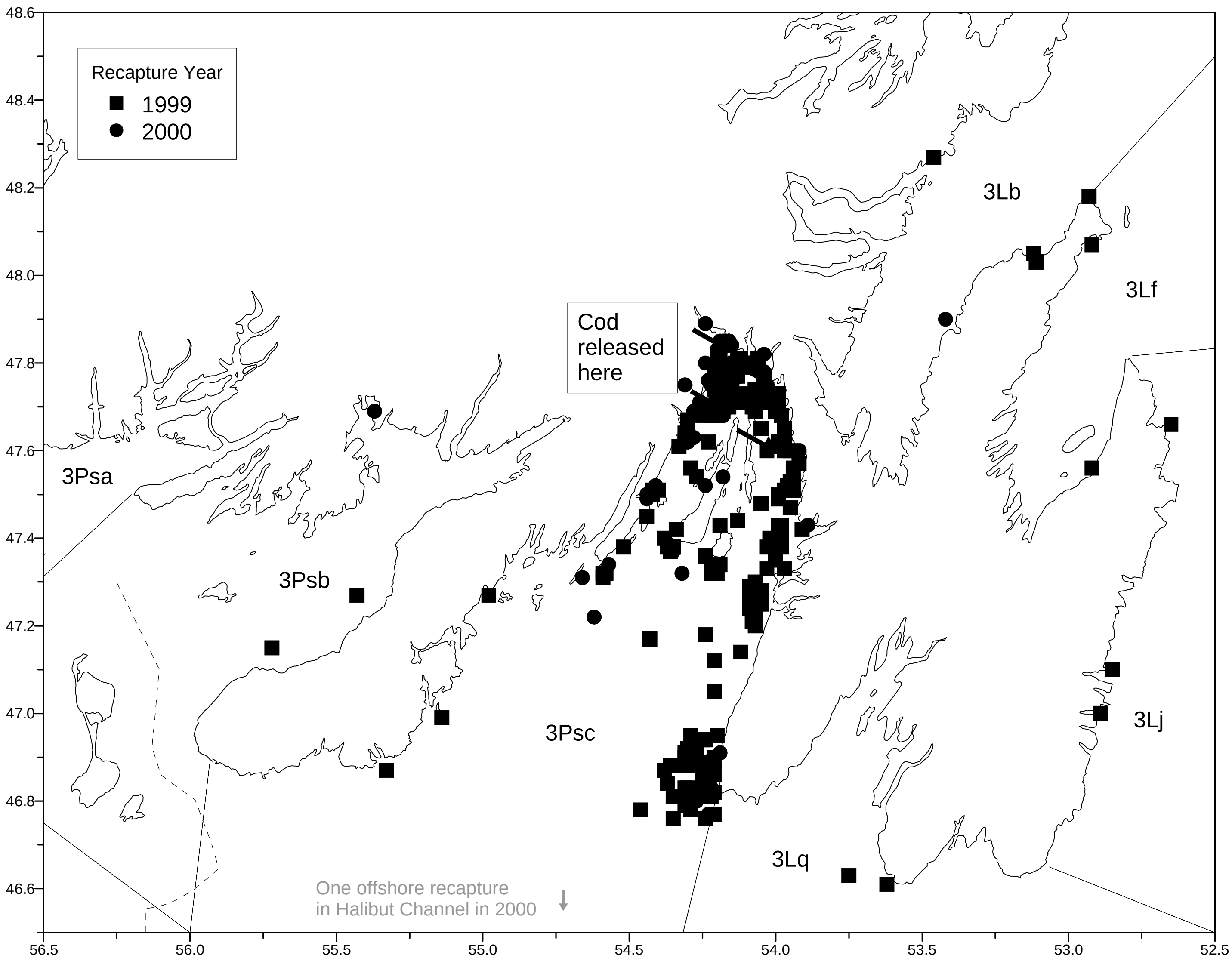


Fig. 17. Reported recapture positions for cod tagged at the head of Placentia Bay during 29 April – 7 May 1999 (N=2422).

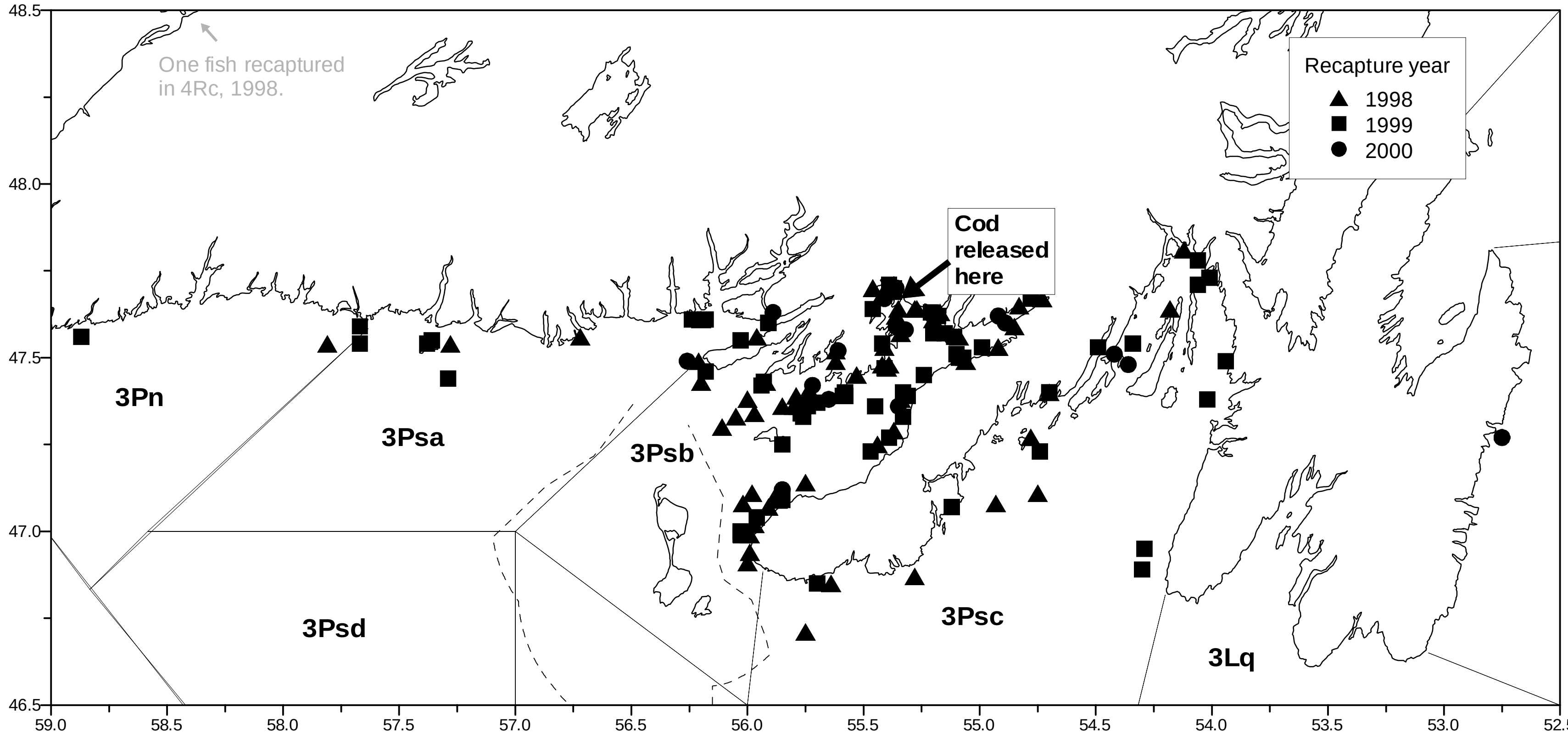


Fig. 18. Reported recapture positions for cod tagged at Poole's Cove, Fortune Bay during 20-25 May 1998 (N=938).

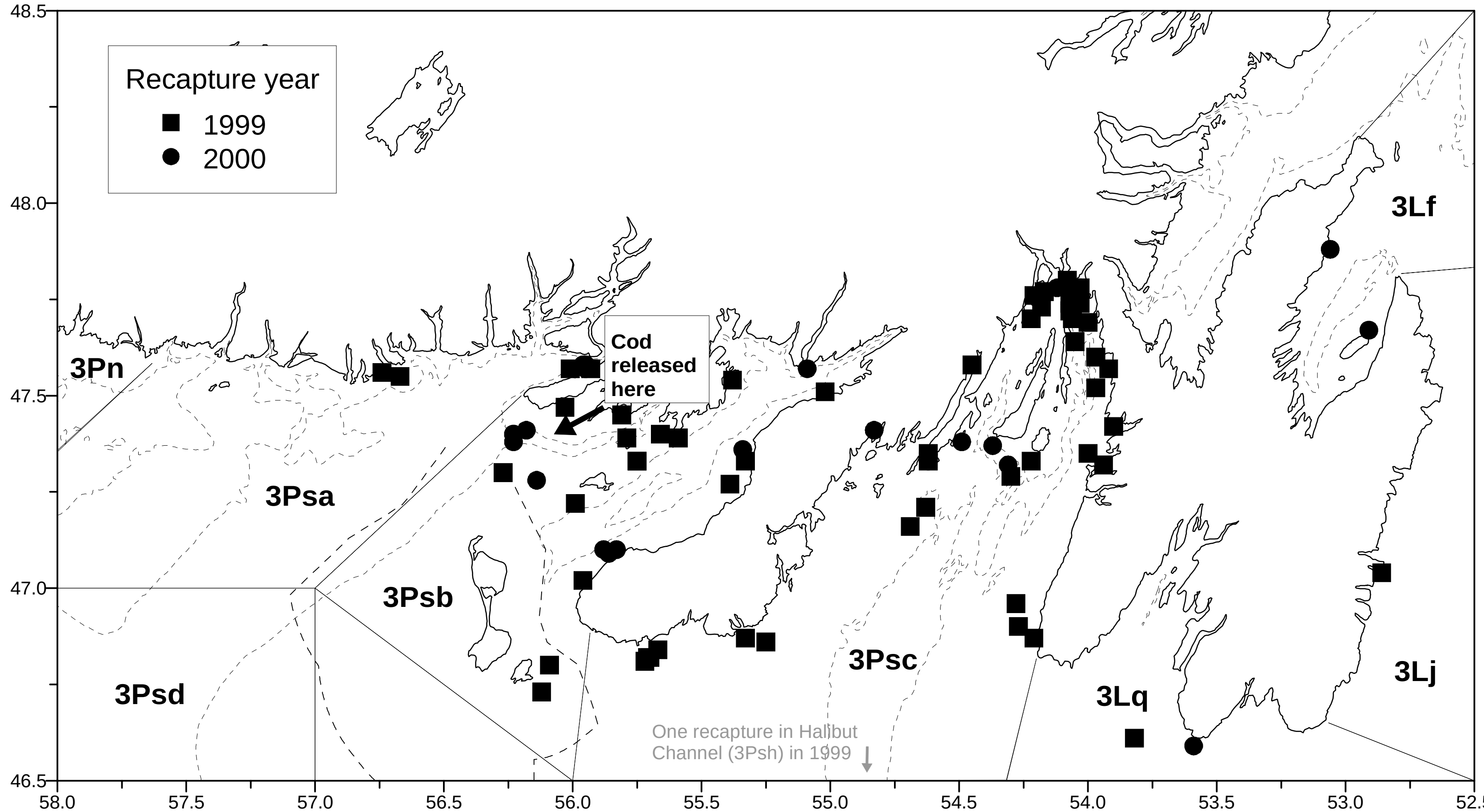


Fig. 19. Reported recapture positions for cod tagged south of Pass Island during 8 April 1999 (N=1293).

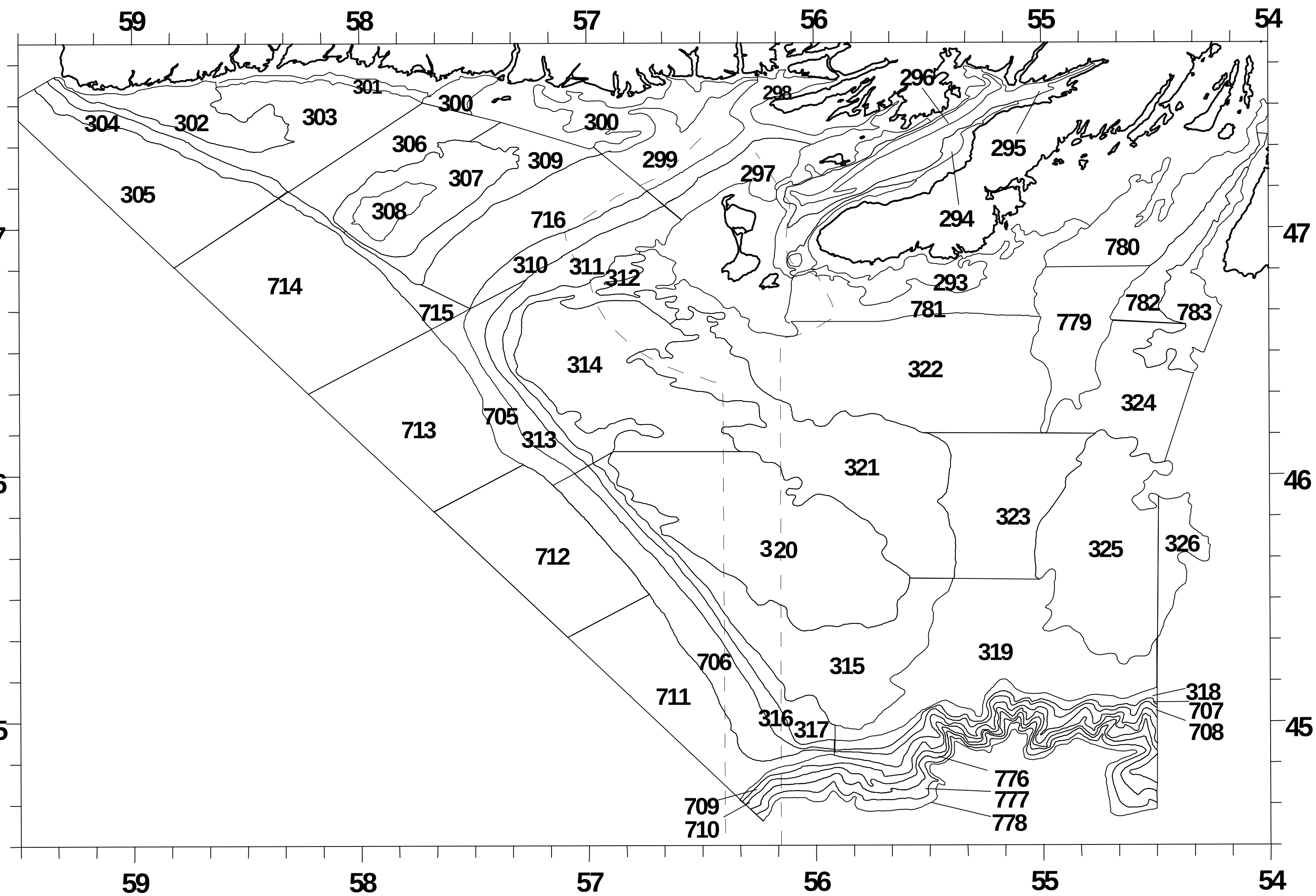


Fig. 20. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdiv. 3Ps (revised March 1999).

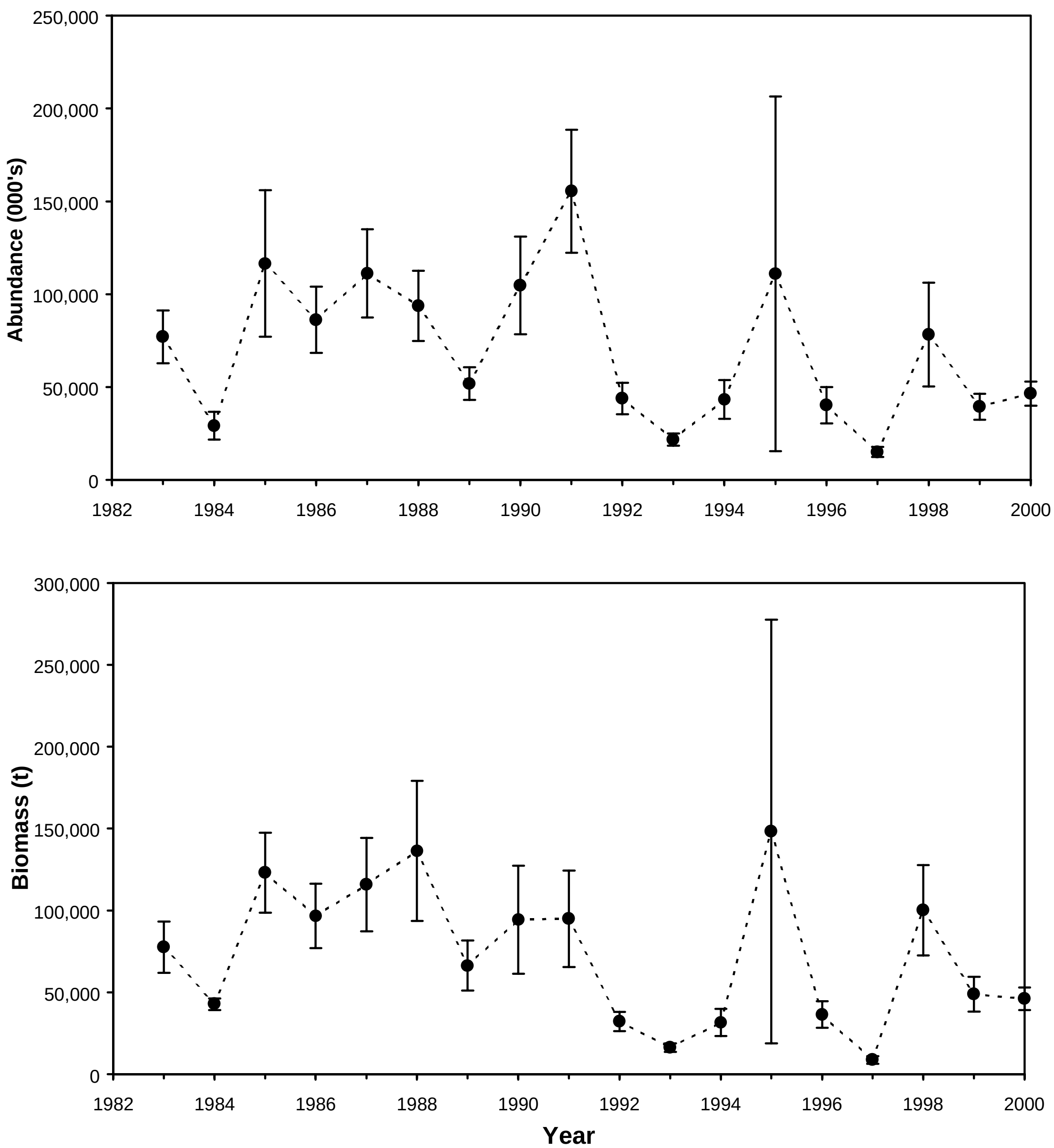


Fig. 21. Abundance and biomass estimates of cod in NAFO Subdiv. 3Ps from DFO research vessel bottom-trawl surveys during winter/spring from 1983 to 2000. Error bars show plus and minus one standard deviation.

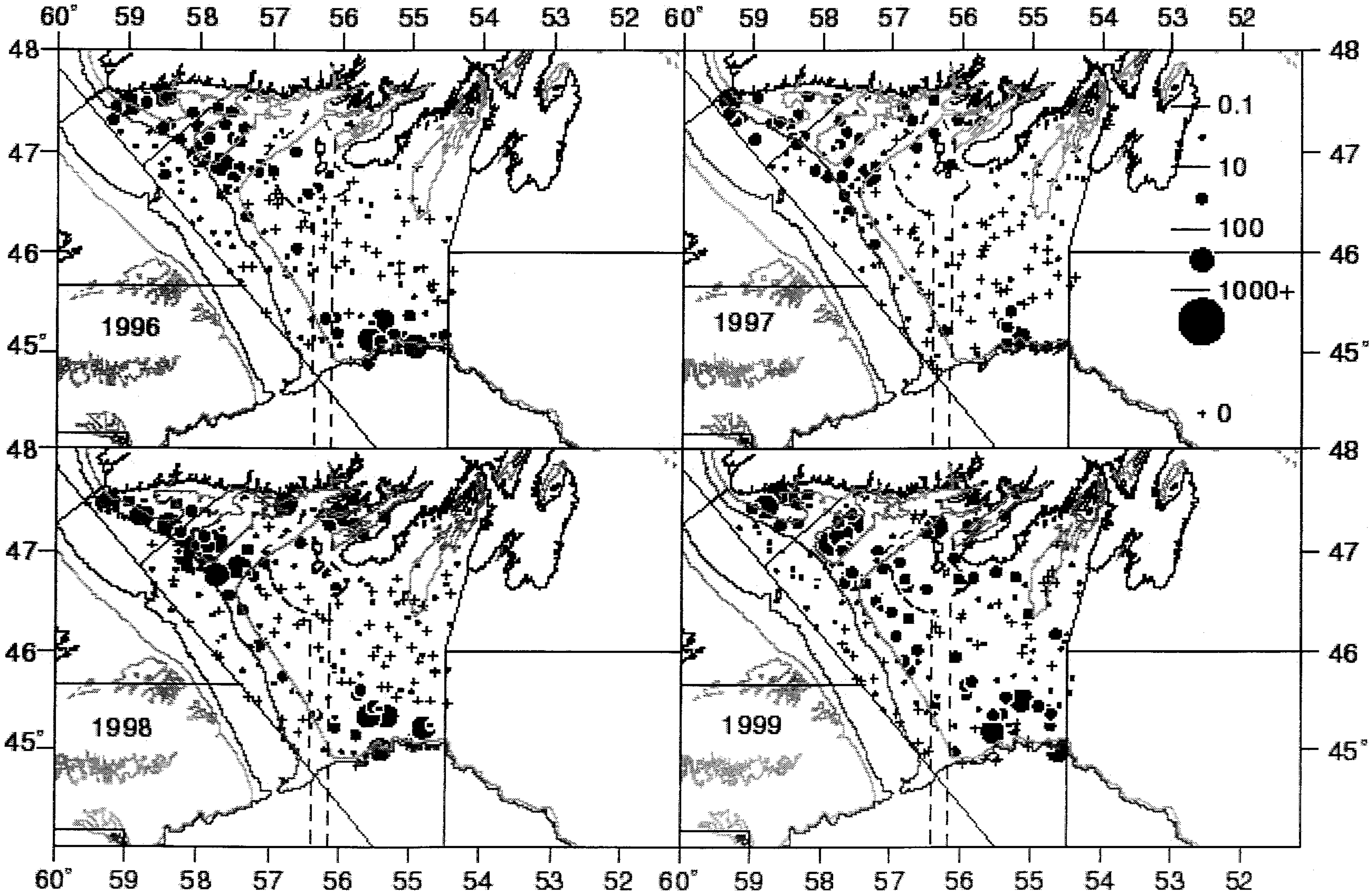


Fig. 22. Distribution of cod catches (number per tow) during Canadian research vessel trawl surveys in NAFO Subdiv. 3Ps during April 1996-1999.

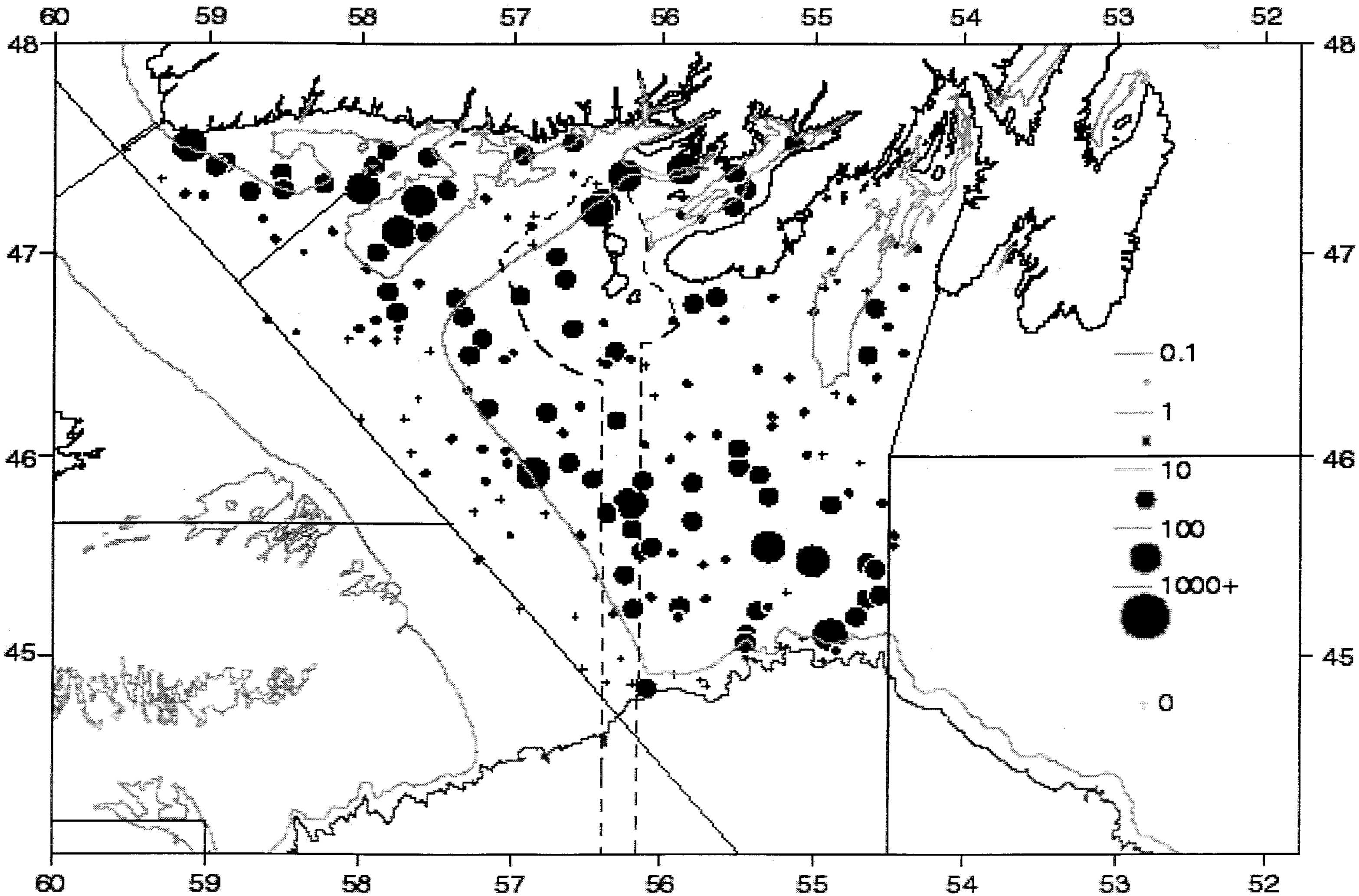


Fig. 23. Distribution of cod catches (number per tow) during Canadian research vessel trawl surveys in NAFO Subdiv. 3Ps during April 2000

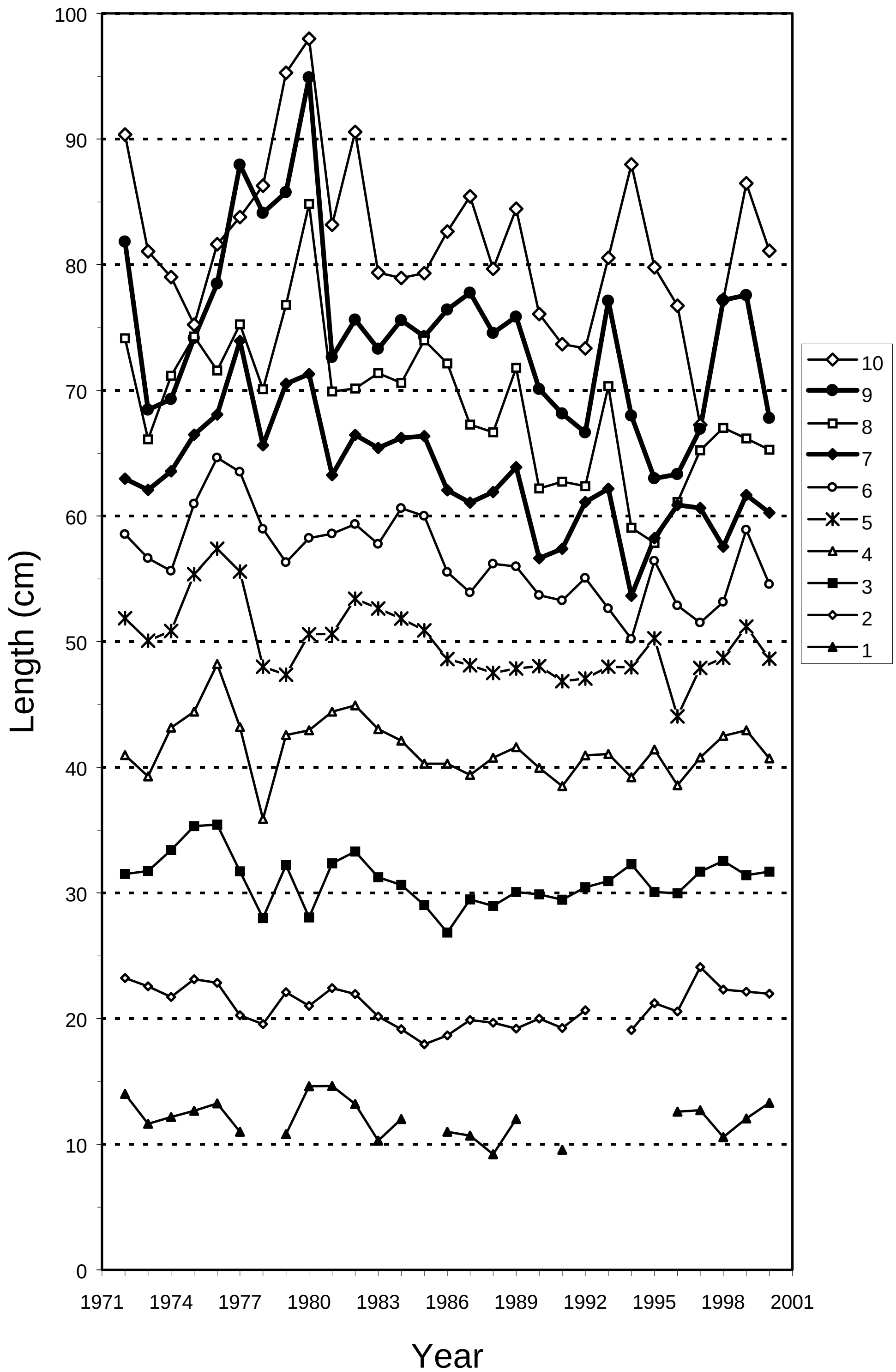


Fig. 24A. Mean length at ages 1-10 of cod in Subdivision 3Ps in 1972-2000, as determined from sampling during DFO bottom-trawl surveys in winter-spring.

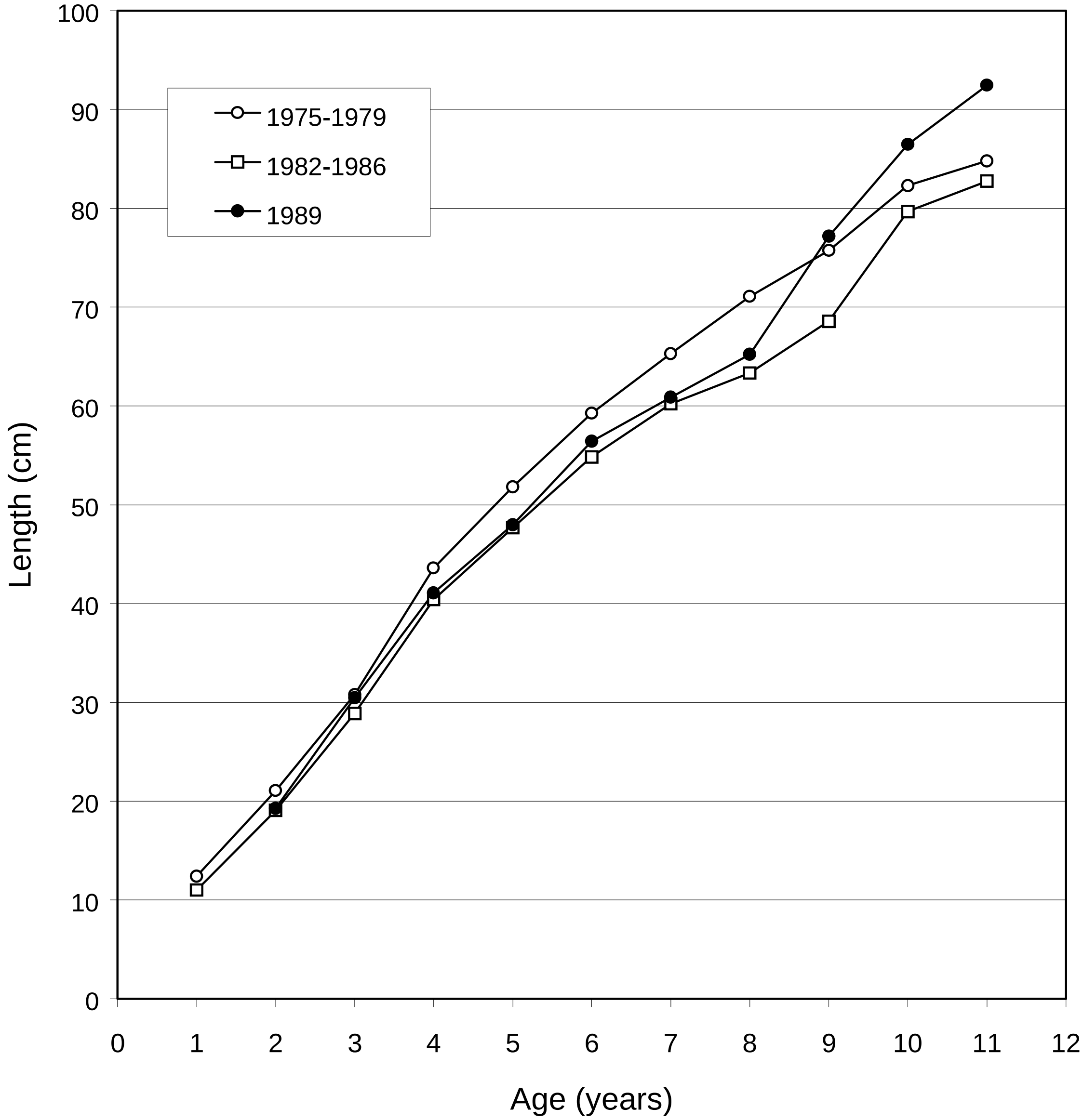


Fig. 24B . Length-at-age of the 1989 year-class, as determined from sampling during winter-spring surveys in Subdivision 3Ps. Mean lengths-at-age of the 1975-1979 and the 1982-1986 year-classes are shown for comparison.

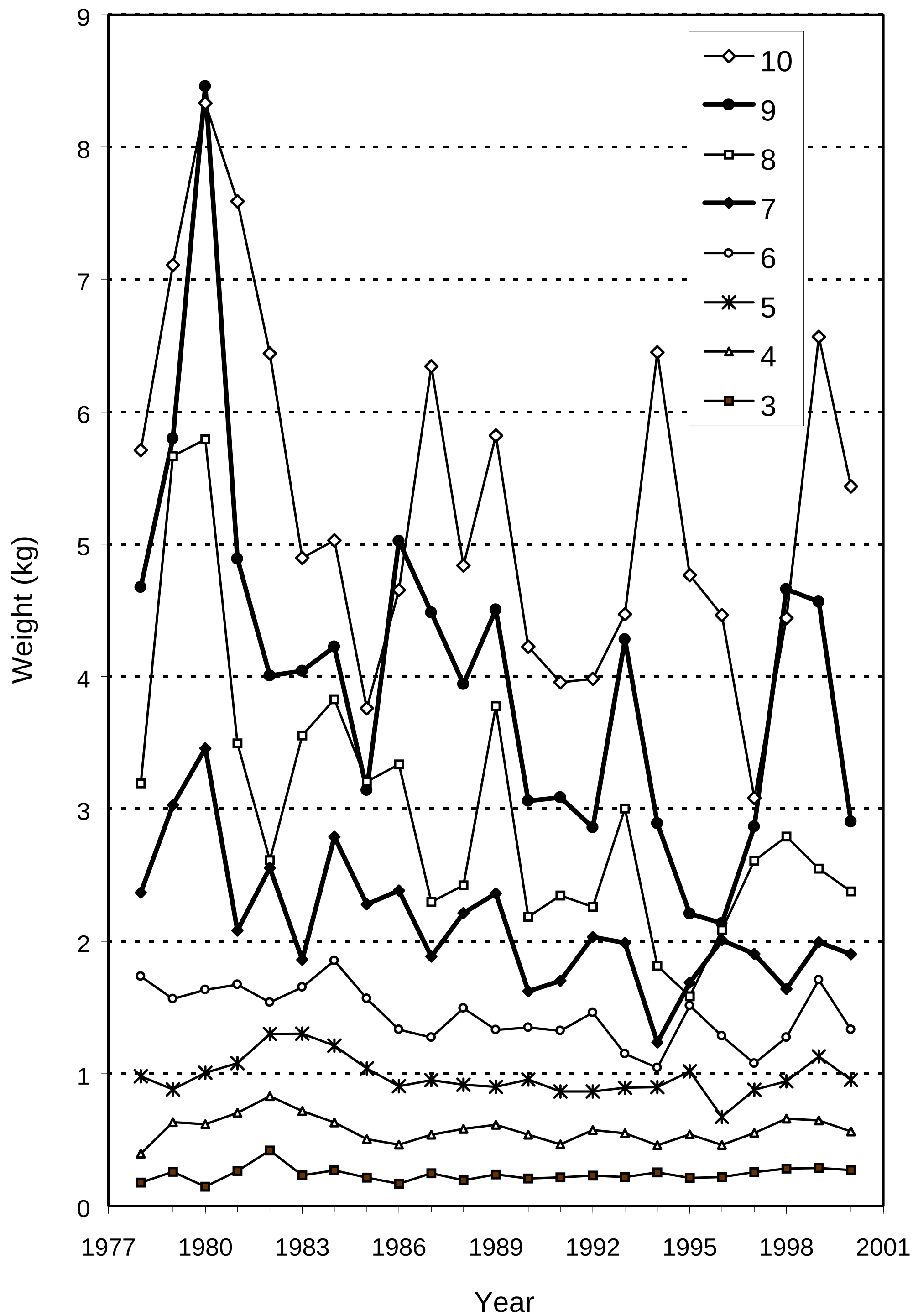


Fig. 25. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in winter-spring 1978-2000.

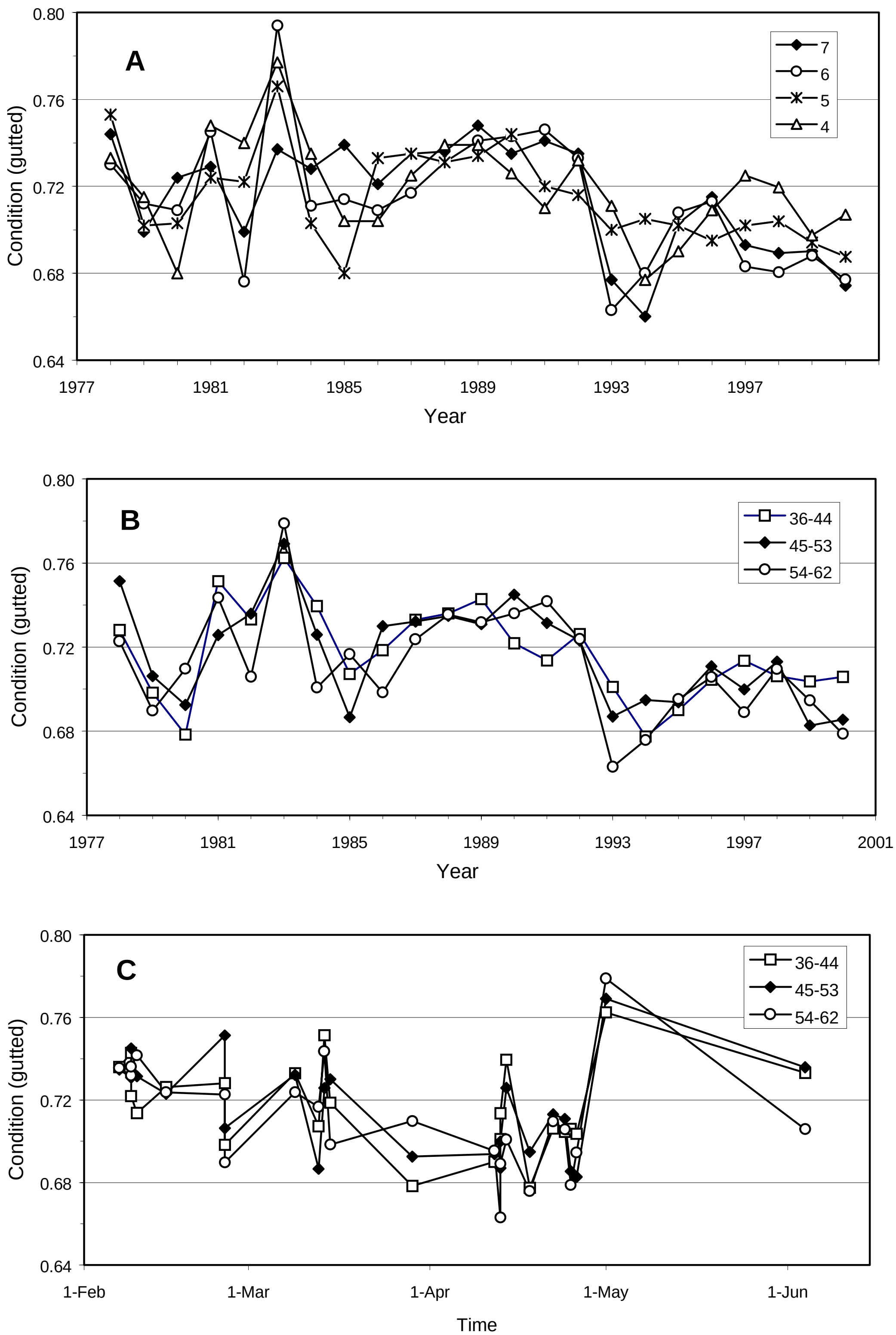


Fig. 26. Mean gutted condition of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in 1978-1999; (A) by age and year, (B) by length-group and year, and (C) by length-group and median date of collection.

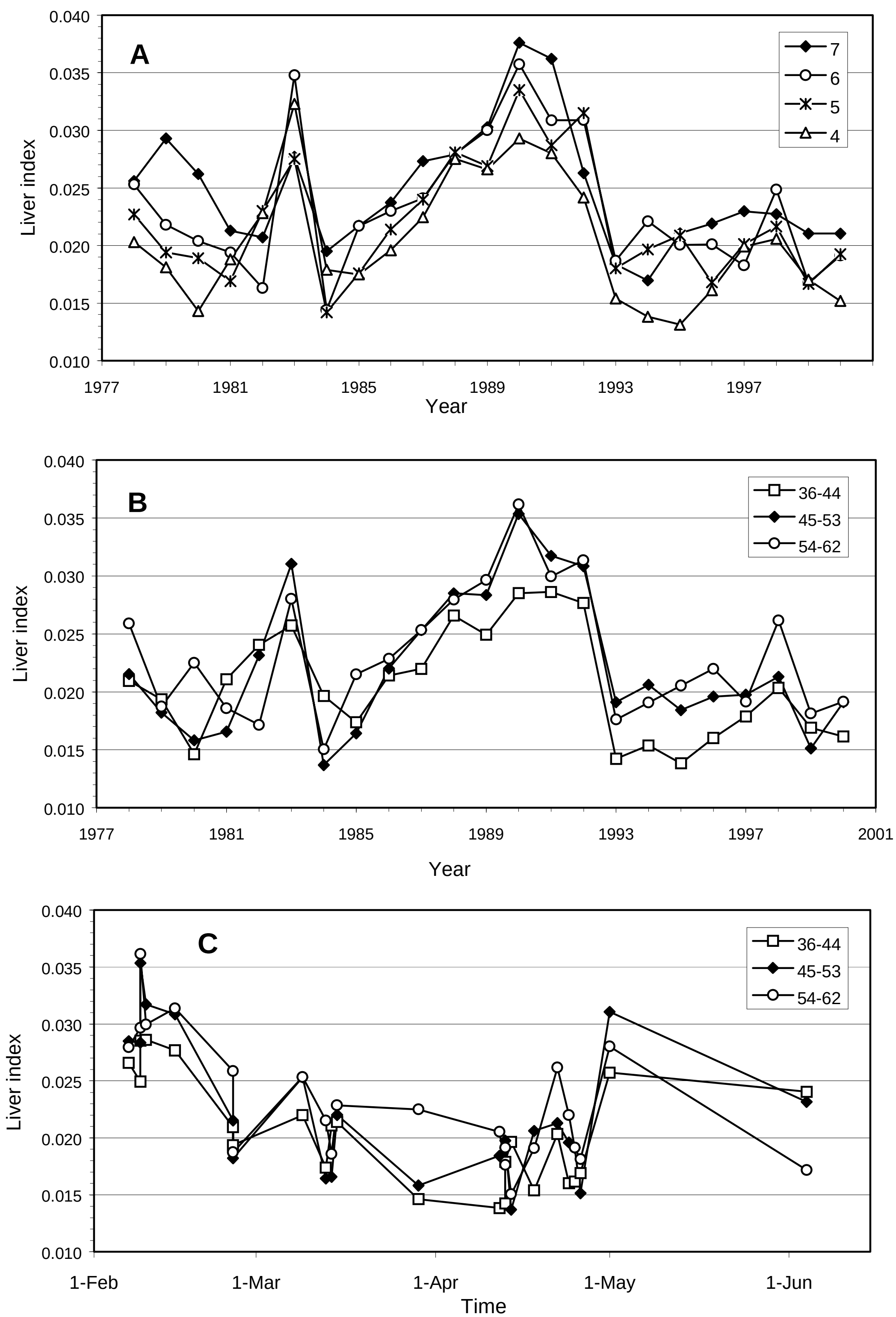
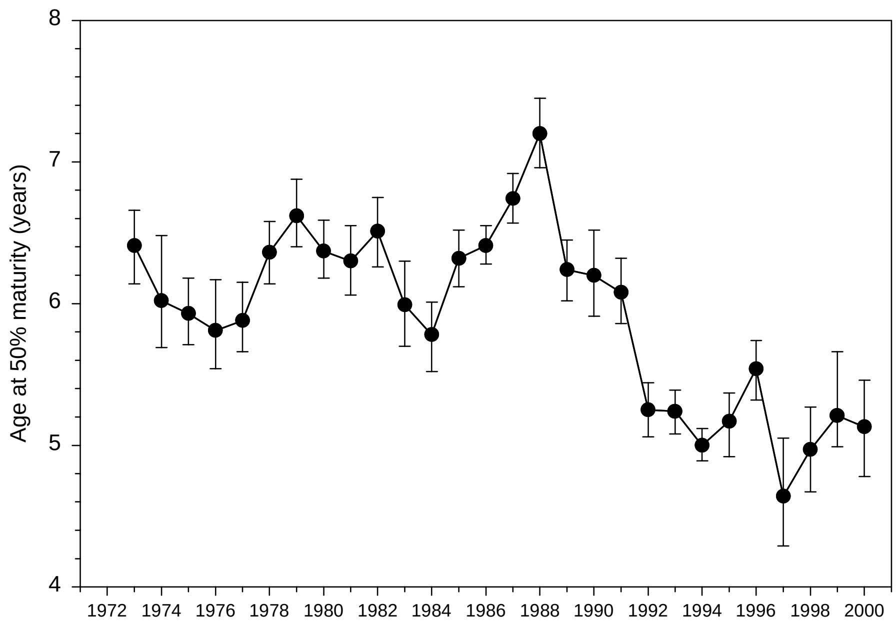


Fig. 27. Mean liver index of cod sampled during DFO bottom-trawl surveys in Subdivision 3Ps in 1978-2000; (A) by age and year, (B) by length-group and year, and (C) by length-group and median date of collection.



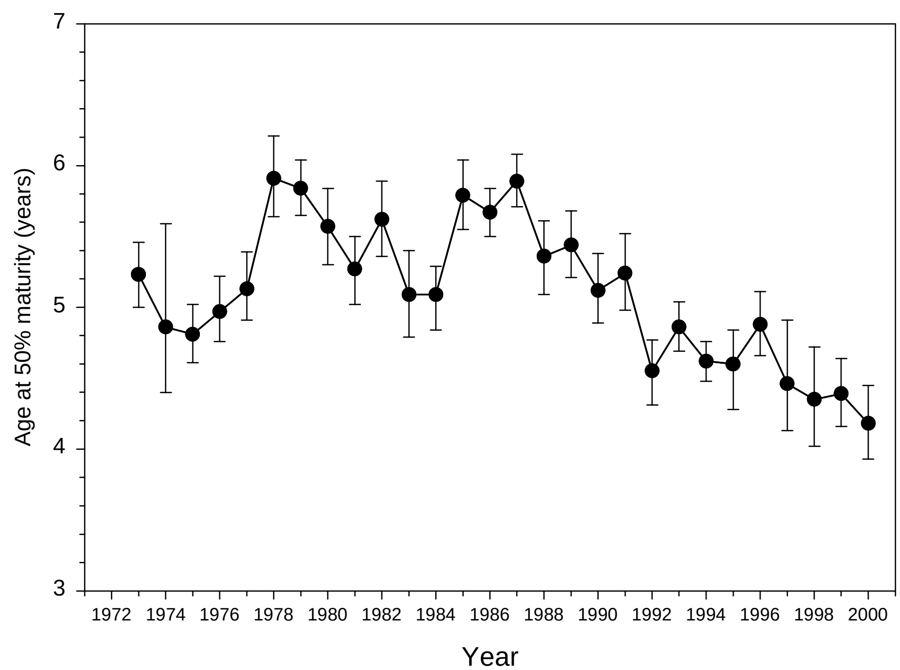


Fig. 28. Age at 50% maturity of cod sampled during DFO research vessel bottom trawl surveys of NAFO Subdiv. 3Ps from 1972-2000. Error bars are 95% confidence intervals.

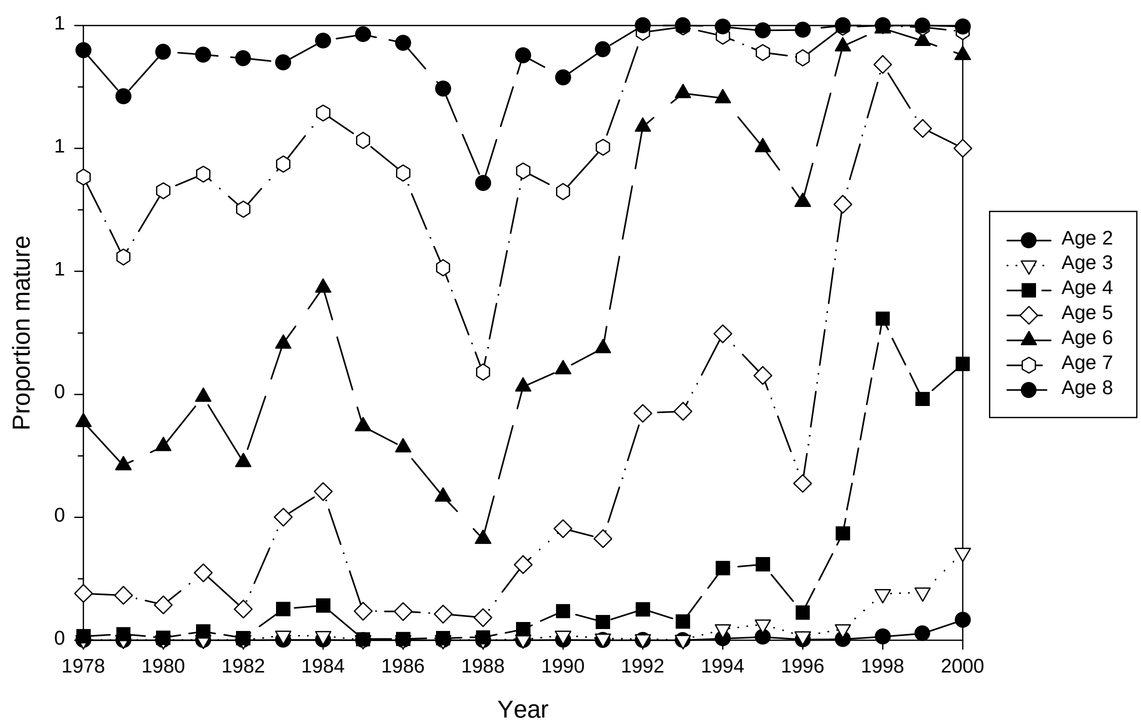


Fig. 29. Estimated proportion mature at ages 2-8 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps from 1978-2000.

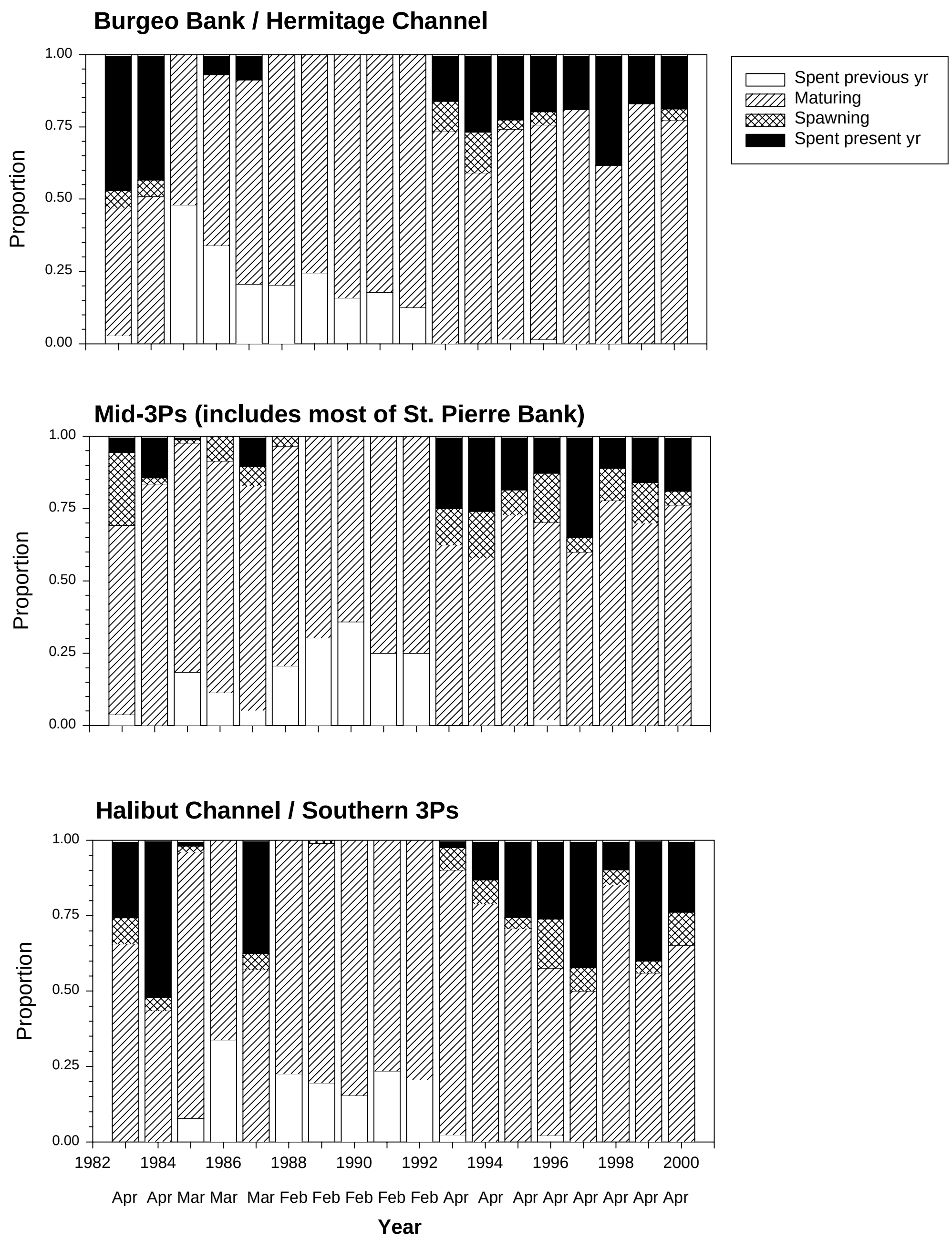


Fig. 30. Maturity stages of cod sampled during DFO research vessel bottom-trawl surveys in three areas of 3Ps during winter/spring 1983-2000. Lower *x*-axis scale is midpoint month of survey. There were two surveys in 1993; only the April one is shown here.

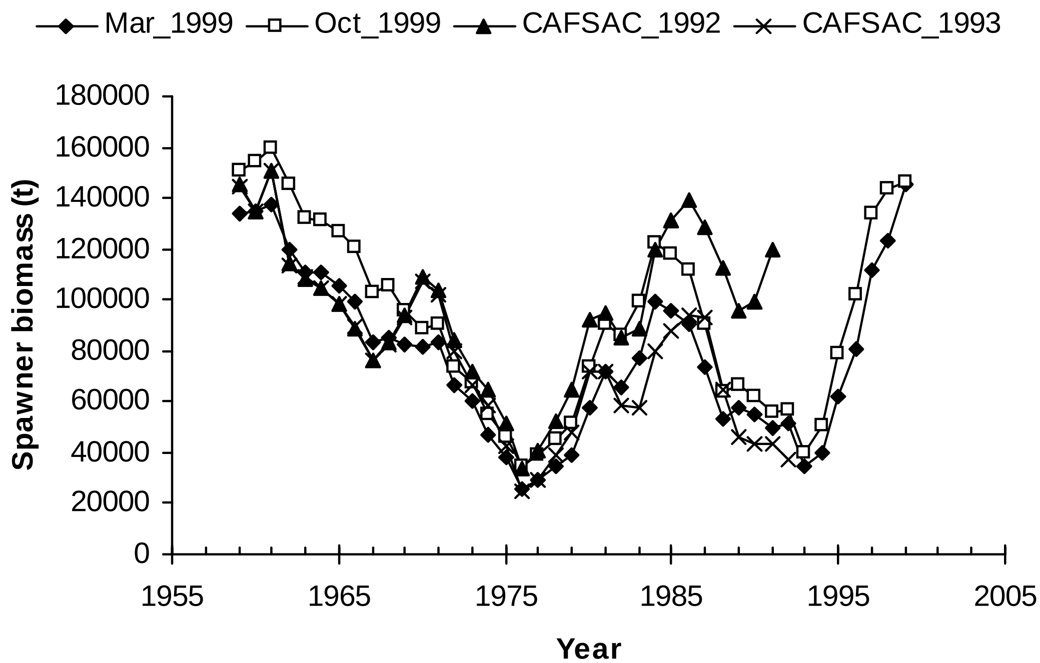


Fig. 31. The spawner biomass time series from the 1992 and 1993 CAFSAC assessments (ADAPT age 6+), the March 1999 Zonal assessment and the October 1999 Regional assessment.

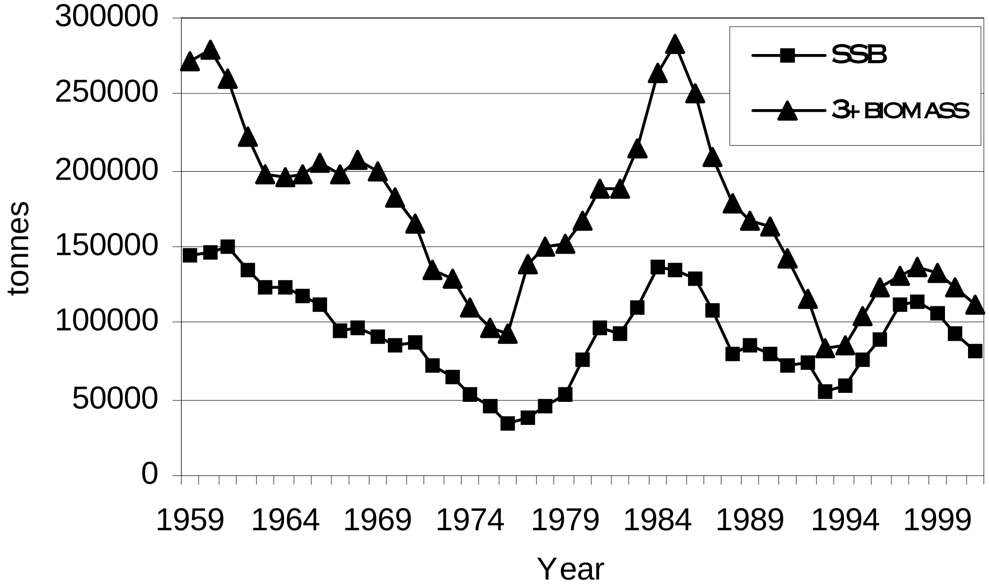


Fig. 32. Estimates of beginning of year population biomass and spawner biomass from the final model fit (Run 10).

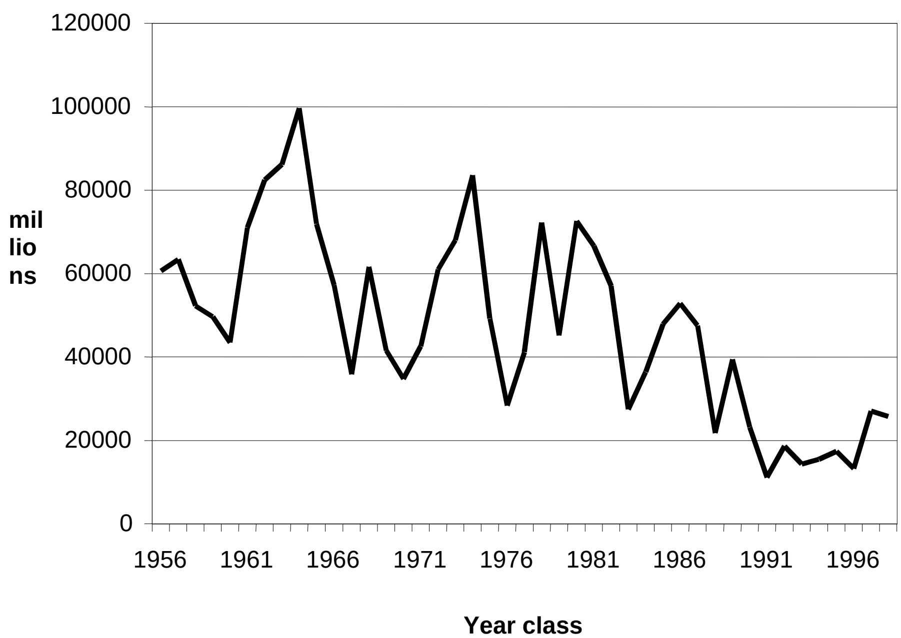


Fig. 33. Estimates for recruitment (numbers of fish age 3) from the final model fit (Run 10).

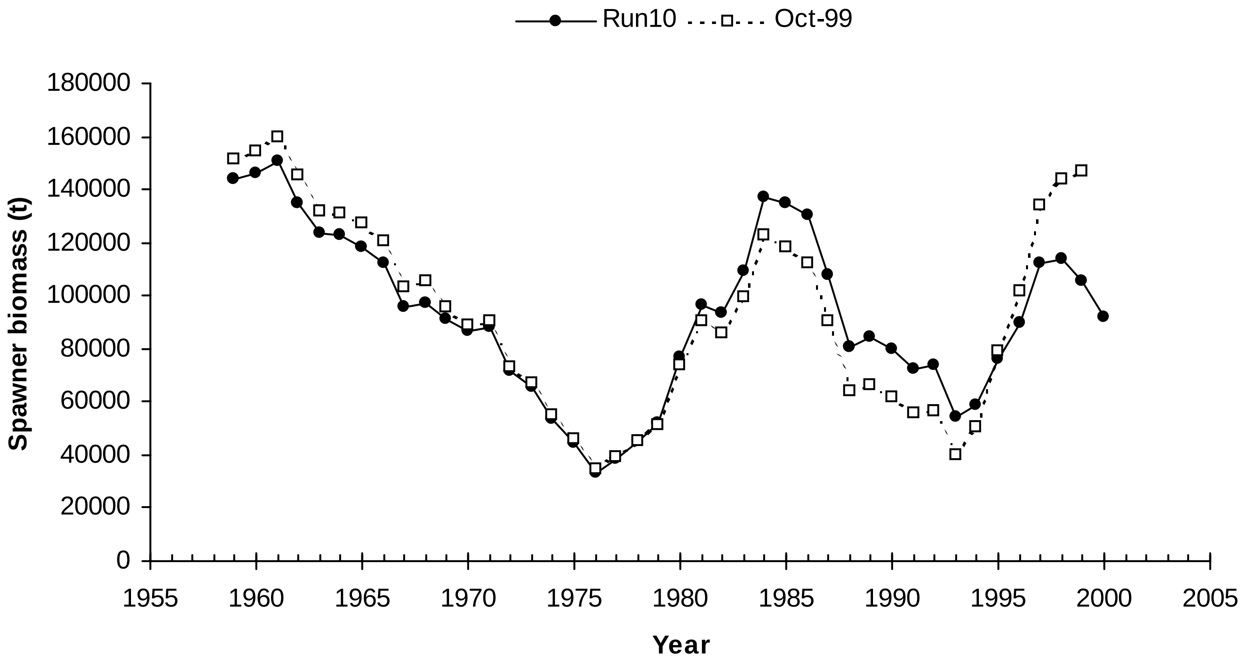


Fig. 34. Comparison of the final model (Run 10) in the October 2000 assessment with the final model in the October 1999 assessment.

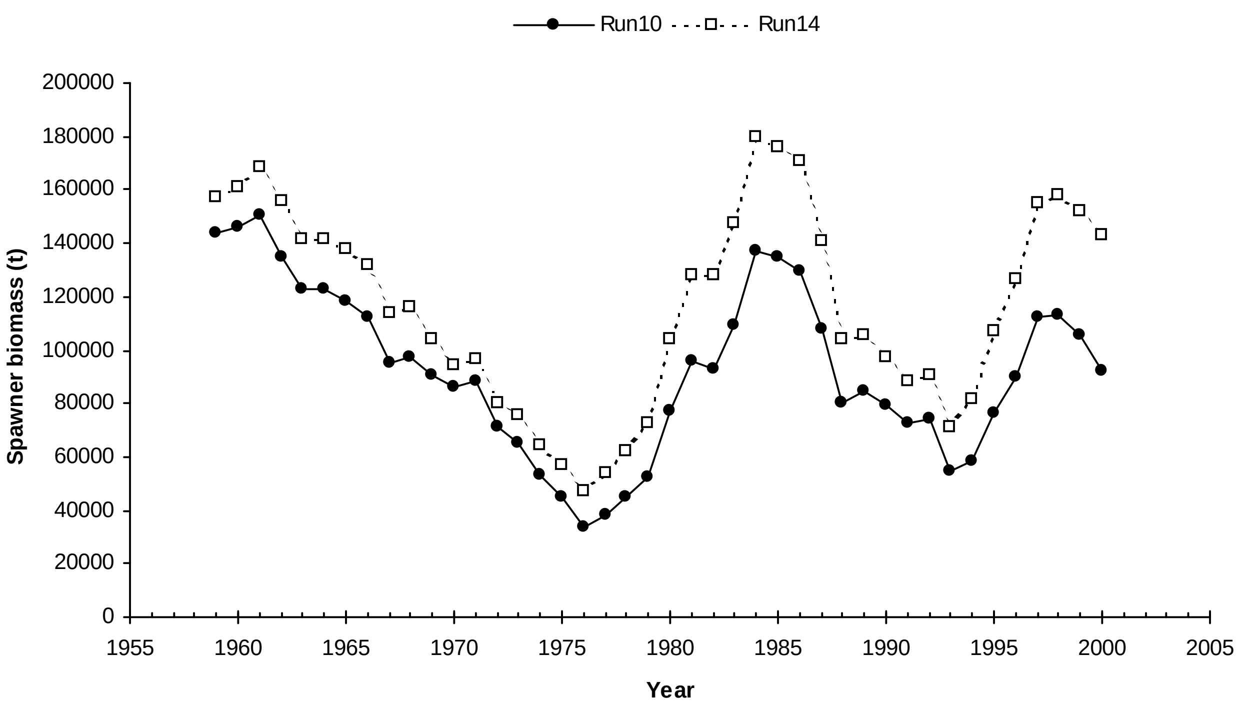


Fig. 35. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 14 which applies the same formulation as the final run in the October 1999 assessment to the additional catch and index data.

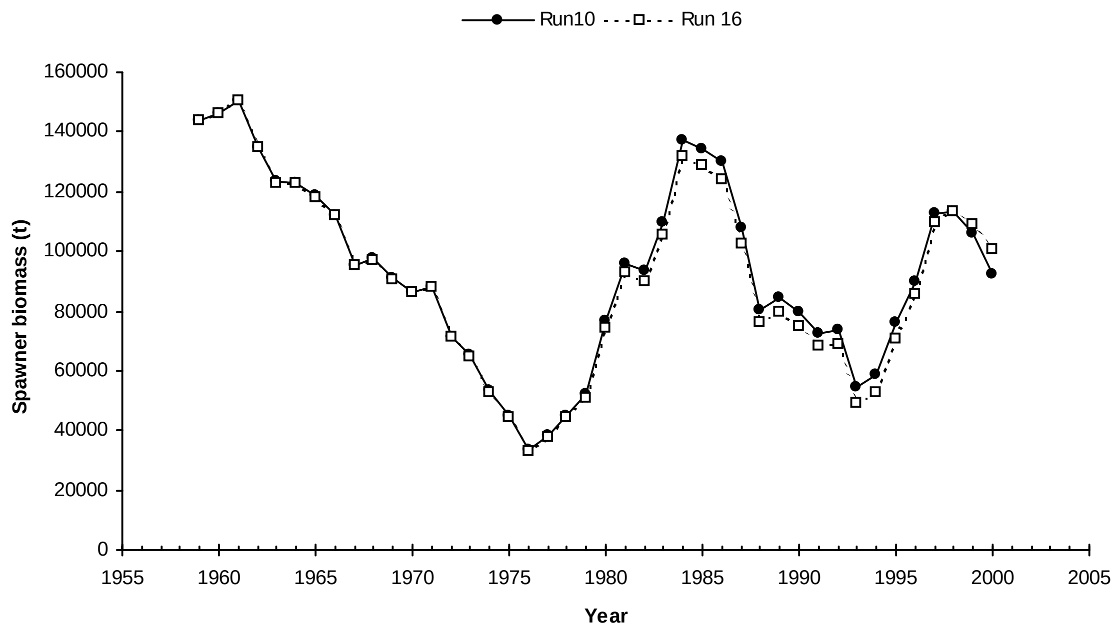


Fig. 36. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 16 which excludes the sentinel gillnet and line-trawl data as tuning indices.

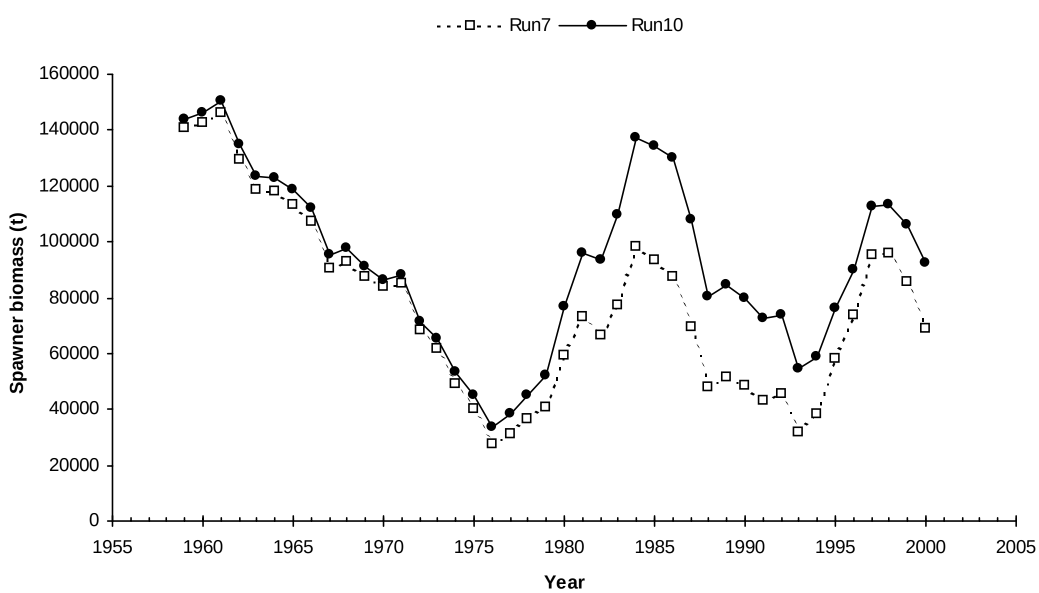


Fig. 37. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 7 which excludes the Burgeo index in the calibration.

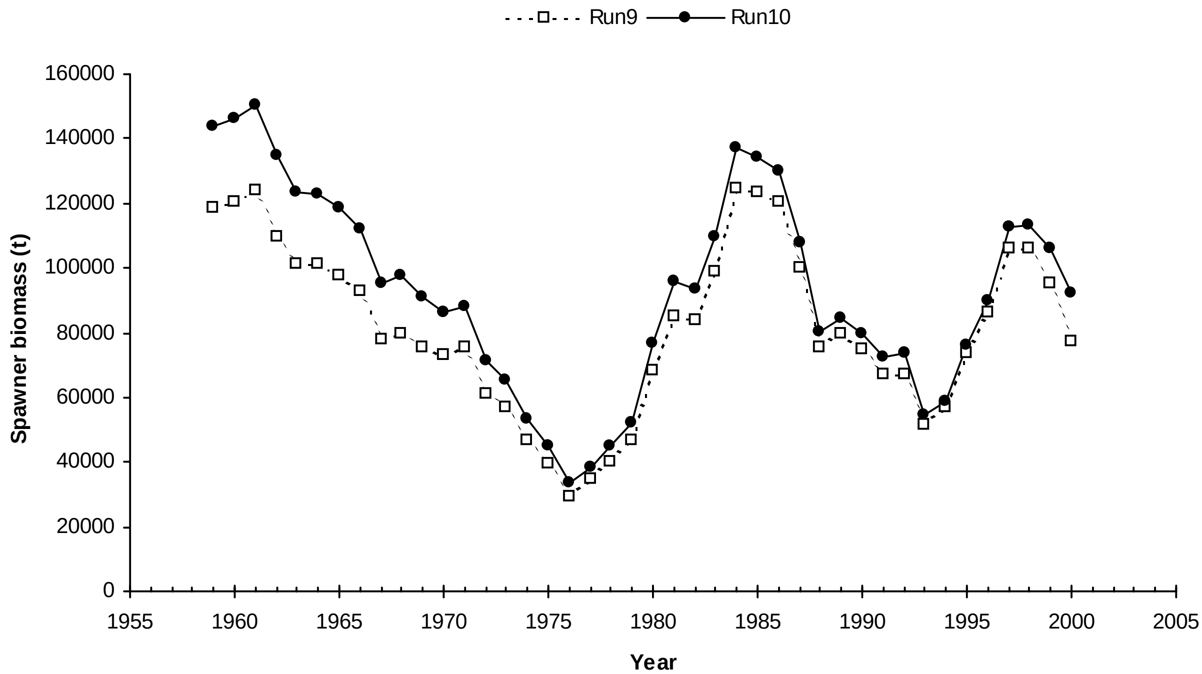


Fig. 38. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 9 which excludes the Burgeo index from the calibration and also excludes 75% of the commercial catch from 3Psa and 3Psd from 1 November to 30 April.

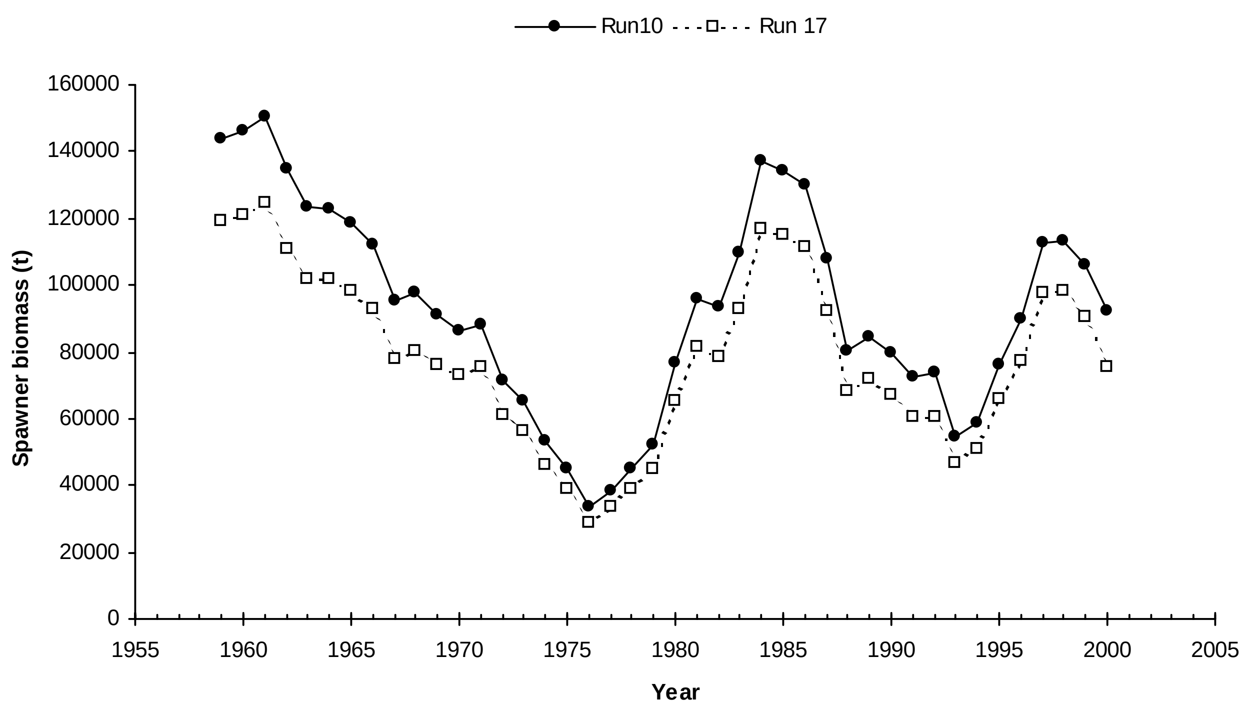


Fig. 39. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 17 which excludes 75% of the commercial catch from 3Psa and 3Psd from 1 November to 30 April.

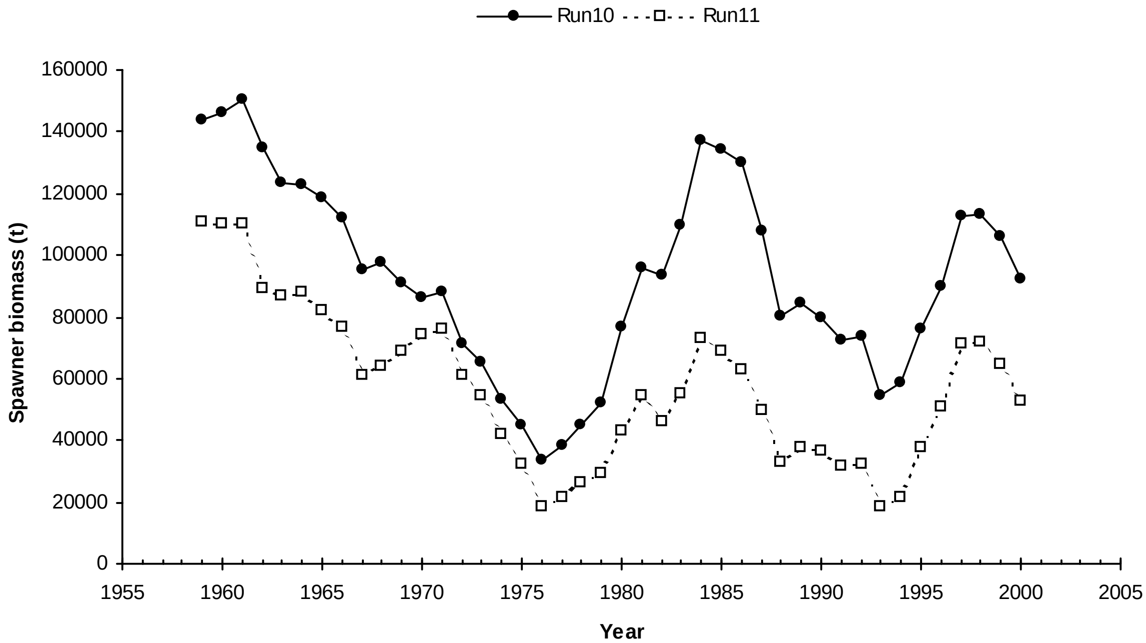


Fig. 40. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 11 which assumes that the fishing mortality on age 14 is equal to the average on ages 11-13.

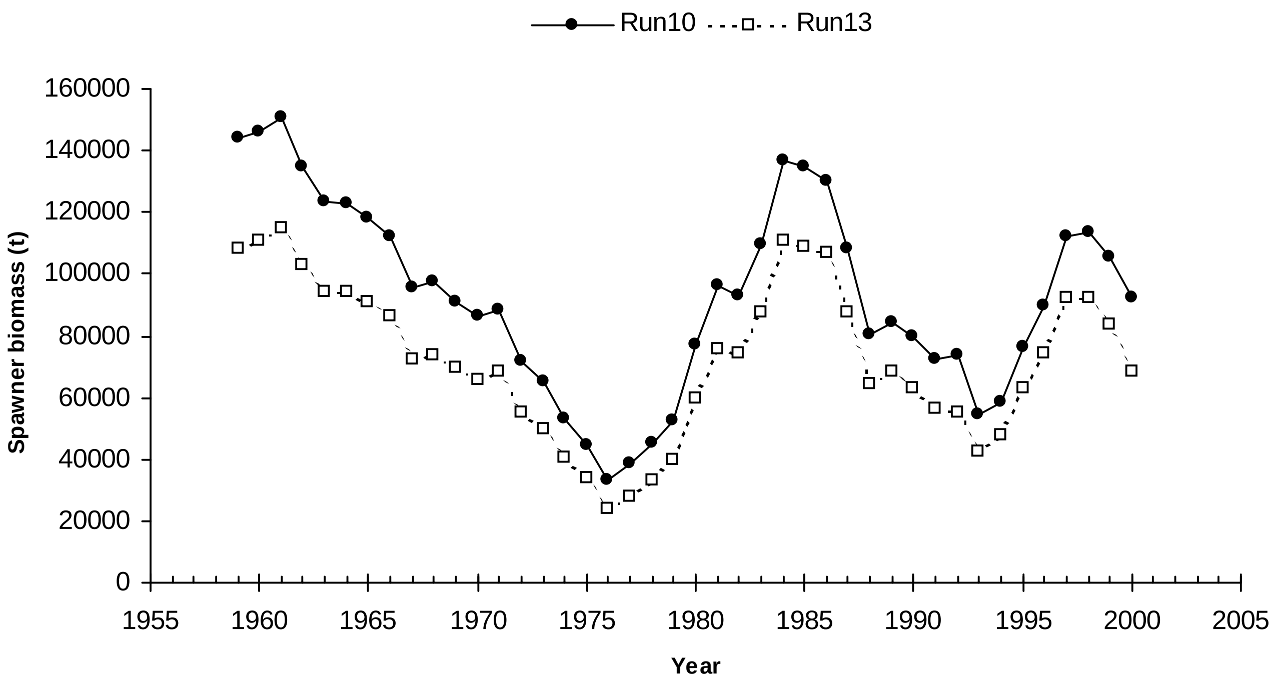


Fig. 41. Comparison of the final model run (Run 10) in the October 2000 assessment with Run 11 which excludes all of the Burgeo catch as well as all Burgeo survey data.

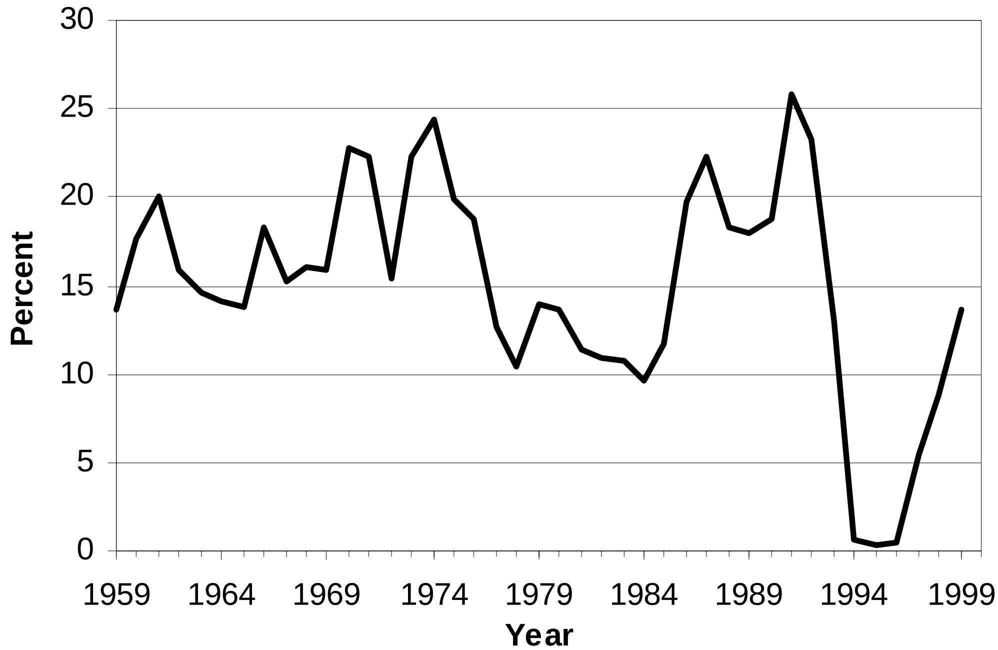


Fig. 42. Annual exploitation rates expressed as % of numbers removed by the fishery.

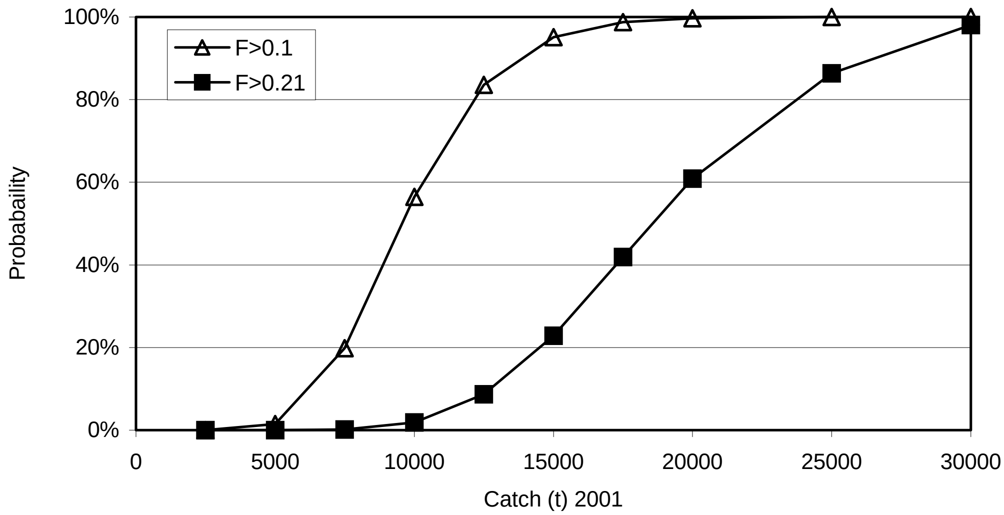


Fig. 43. The risk of exceeding 0.21 and 0.1 fishing mortality in the management year 1 April 2001 to 31 March 2002 for a range of TAC options, based on the final model estimates (Run 10).

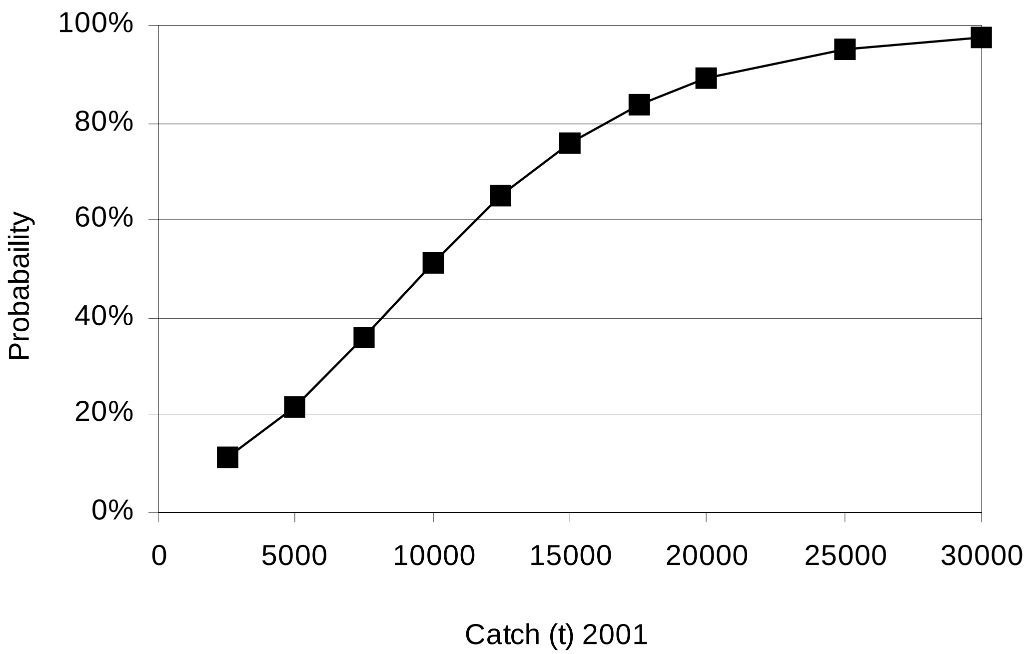


Fig. 44. The risk of spawning stock biomass declining at the end of the management year 1 April 2001 to 31 March 2002 for a range of TAC options, based on the estimates from the final model (Run 10).

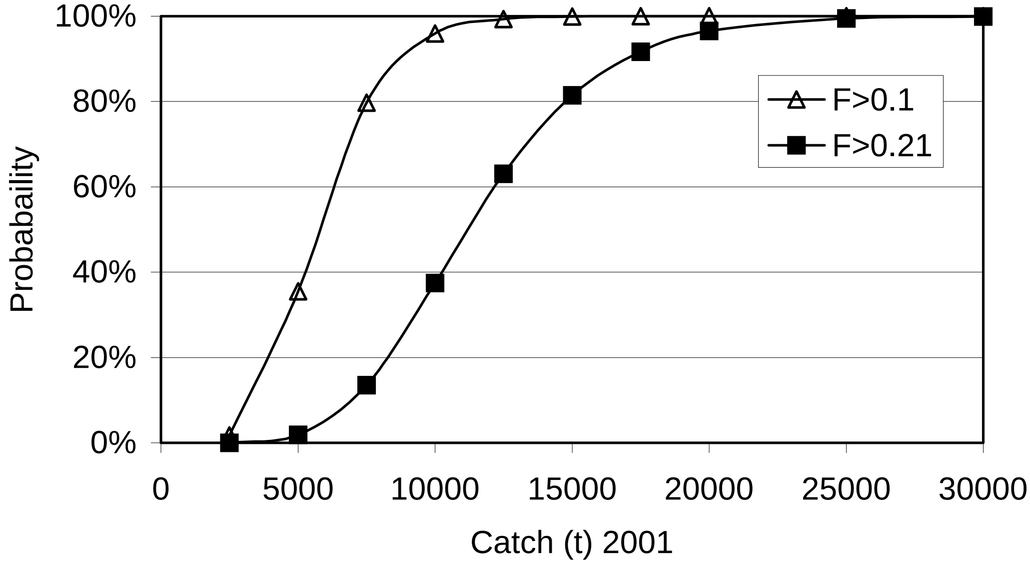


Fig. 45. The risk of exceeding 0.21 and 0.1 fishing mortality in the management year 1 April 2001 to 31 March 2002 for a range of TAC options, based on model for the eastern portion of the stock area (Run 13).

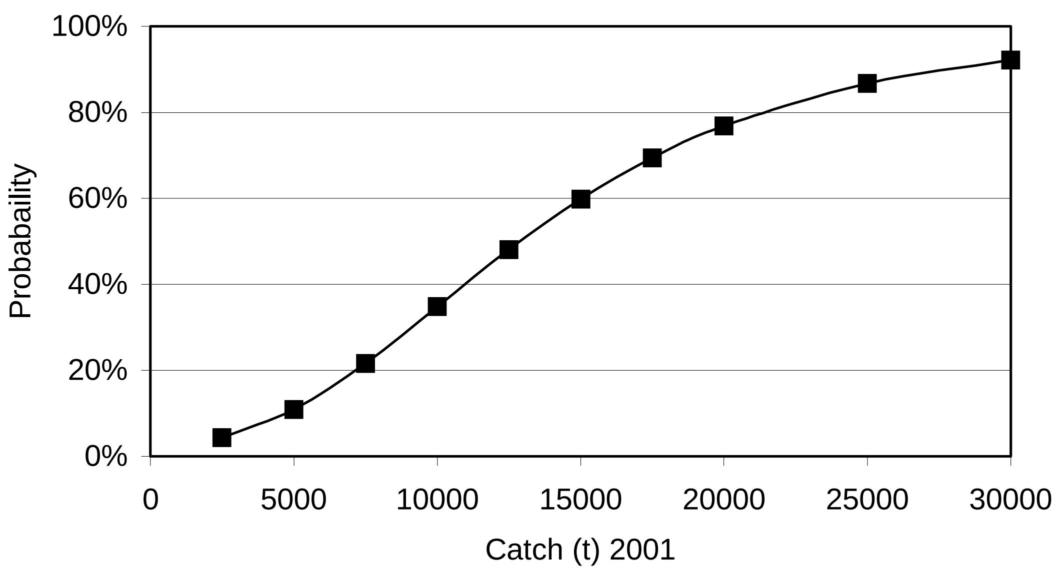


Fig. 46. The risk of spawning stock biomass declining at the end of the management year 1 April 2001 to 31 March 2002 for a range of TAC options, based on the based on model for the eastern portion of the stock area (Run 13).