Fisheries and Oceans Canada
Pêches et Océans Canada

Ecosystems and Oceans Science
Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Research Document 2017/063

Newfoundland and Labrador Region

Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2016

R.M. Rideout[1], D.W. Ings[1], B.P. Healey[1], J. Brattey[1], M.J. Morgan[1], D. Maddock Parsons[1], and J. Vigneau[2]

[1]Science Branch
Fisheries and Oceans Canada
PO Box 5667
St. John's, NL A1C 5X1

[2]IFREMER
Av. du Général de Gaulle, 14520
Port en Bessin, France

September 2017

Foreword

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

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

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

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

ISSN 1919-5044

Correct citation for this publication:

Rideout, R.M., Ings, D.W., Healey, B.P., Brattey, J., Morgan, M.J., Maddock Parsons, D., and Vigneau, J. 2017. Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2016. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/063 v + 68 p

TABLE OF CONTENTS

ABSTRACT

The status of the cod stock in the Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps was assessed during a Fisheries and Oceans Canada (DFO) Regional Peer Review Process meeting held October 17-19, 2016.

Total landings for the 2015-16 management year (April 1-March 31) were 6,427 t or just 48% of the Total Allowable Catch (TAC). This marks the sixth consecutive season that the TAC has not been fully taken.

Survey abundance estimates from the DFO research vessel (RV) spring survey have been about average in recent years, whereas biomass estimates have generally been below average. Sentinel gillnet catch rates have been very low and stable since 1999. Sentinel linetrawl catch rates have been below average for the past six years and the 2015 catch rate was the lowest in the time series.

Estimates of Spawning Stock Biomass (SSB) derived from a survey-based (SURBA) cohort model increased considerably over 2009-12 but have since declined. Although the stock is currently estimated to be in the Cautious Zone (18% above Blim) as defined by the DFO Precautionary Approach (PA) Framework, the probability that the stock is in the critical zone is 0.22, which is a concern. There are further concerns that the current estimate of spawning stock biomass (SSB) could be biased as the model has overestimated SSB in recent years (i.e. the assessment has been subject to downward retrospective revisions of SSB). The current SSB is very young, composed to a large extent (46%) of 4-5 year old fish. These fish are from the strong 2011 and 2012 year classes that have not yet fully matured. Estimated total mortality for fish in the age range of 5-10 years is currently very high (three year average Z = 0.73), which is a large concern especially considering that reported landings have been only about half of the TACs over this time period.

Short-term projections of the stock were not performed due to concerns related to variability in the survey data, the strong directional retrospective pattern in model estimates, and the unavailability of recent estimates of commercial fish weights-at-age. However, it is generally noted that biomass of the stock is likely to decline sharply in the coming years if the current high mortality rate persists.

Évaluation de l’état du stock de morue (*Gadus morhua*) de la sous-division 3Ps de l’OPANO en 2016

RÉSUMÉ

L'état du stock de morue dans la sous-division 3Ps de l’Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) a fait l'objet d'une évaluation lors d'une réunion du processus régional d'examen par les pairs de Pêches et Océans Canada (MPO) qui s'est tenue du 17 au 19 octobre 2016

Les débarquements de l'année de gestion de 2015-2016 (du 1er avril au 31 mars) ont totalisé 6 427 tonnes, ce qui représente seulement 48 % du total autorisé des captures (TAC). Il s'agit de la sixième saison consécutive où le TAC n'est pas atteint.

Au cours des dernières années, les estimations de l'abondance selon le relevé par navire de recherche mené au printemps par le MPO équivalaient à peu près aux moyennes, tandis que les estimations de la biomasse étaient généralement inférieures à la moyenne. Depuis 1999, les taux de prise des pêches sentinelles au filet maillant sont très faibles et stables. Depuis six ans, les taux de prise des pêches sentinelles à la palangre sont inférieurs à la moyenne. L'année 2015 est celle où le taux de prise a été le plus faible.

Les estimations de la biomasse du stock reproducteur (BSR) calculées à partir d'un modèle de cohorte basé sur les relevés (SURBA) ont augmenté de façon importante au cours de la période 2009-2012, mais ont connu un déclin depuis. Bien que le stock se situe actuellement dans la zone de prudence (18 % au-dessus de la valeur Blim) définie par le cadre de l'approche de précaution du MPO, la probabilité que le stock tombe dans la zone critique est de 0,22, ce qui est préoccupant. D'autres préoccupations existent quant au fait que l'estimation actuelle de la BSR pourrait être biaisée, car le modèle a surestimé la BSR au cours des dernières années (c.-à-d., l'évaluation a fait l'objet de révisions rétrospectives à la baisse de la BSR). La BSR actuelle est très jeune et composée en grande partie (46 %) de poissons de 4 à 5 ans. Ces poissons sont tirés des fortes classes d'âge de 2011 et de 2012 qui n'ont pas encore atteint leur pleine maturité. La mortalité totale estimée des poissons âgés de 5 à 10 ans est actuellement très élevée (moyenne sur trois ans; Z = 0,73), ce qui constitue une grande préoccupation étant donné que les débarquements déclarés représentaient environ la moitié du TAC durant cette période.

Les projections à court terme du stock n'ont pas été effectuées en raison de préoccupations liées à la variabilité dans les données d'enquête, de la forte tendance rétrospective directionnelle dans les estimations modélisées, et de la non-disponibilité de récentes estimations des poids selon l'âge des poissons commerciaux. Il convient toutefois de noter qu'en général, la biomasse du stock est susceptible de diminuer de façon marquée au cours des prochaines années si les taux de mortalité élevés actuels persistent.

INTRODUCTION

This document gives an account of the 2016 assessment of the Atlantic cod (*Gadus morhua*) stock in North Atlantic Fisheries Organization (NAFO) Subdivision (Subdiv.) 3Ps, located off the south coast of Newfoundland, Canada (Figs. 1 and 2). The French overseas territory of St. Pierre et Miquelon also lies within the boundaries of NAFO Subdiv. 3Ps and only Canada and France have fished in this area since the extension of jurisdiction by each country to 200 miles in the late 1970s. The stock is jointly managed by Canada and France through formal agreements.

A Regional Peer Review Process meeting was conducted during October 2016 (DFO 2017) with participation from Fisheries and Oceans Canada (DFO) scientists, IFREMER (France), DFO Fisheries Management, academia, the Canadian fishing industry, and the province of Newfoundland and Labrador (NL).

Various sources of information on 3Ps cod were available to update the status of this stock. Commercial landings through September 2015 were presented. The results of the 2016 DFO research vessel (RV) survey were reviewed in detail and compared to previous survey results. A survey-based assessment model (Cadigan 2010) was used to smooth signals in the RV survey, and provided estimates of biomass, total mortality and recruitment for the stock as covered by the DFO RV survey. Additional sources of information presented included inshore sentinel surveys and exploitation rates estimated from cod tagging. An update of commercial logbook data was not available for the current assessment.

ASSESSMENT

TOTAL ALLOWABLE CATCHES AND COMMERCIAL CATCH

Total Allowable Catch

The cod stock in Subdiv. 3Ps was subject to a moratorium on all fishing from August, 1993 to the end of 1996. Excluding these years, the magnitude of the Total Allowable Catch (TAC) has varied considerably over time, ranging from 70,500 t in 1973, the initial year of TAC regulation, to 10,000 t in 1997 (Fig. 3). Beginning in 2000, TACs have been established for seasons beginning April 1 and ending March 31 of the following year (during January-March 2000, an interim TAC was set to facilitate this change). The TAC was set at 11,500 t for five consecutive management years (2009/10-2013/14) and was subsequently increased to 13,225 t for the 2014/15 management year. In 2015/16 Canada adopted a Conservation Plan and Rebuilding Strategy (CPRS) for 3Ps cod that included a harvest control rule (HCR) for suggesting the TAC level for the upcoming year. In 2015/16 and 2016/17 this rule suggested TACs of 13,490 t and 13,043 t respectively, and Canada and France agreed to accept these TAC values. Under the terms of the 1994 Canada France agreement, the Canadian and French shares of the TAC are 84.4% and 15.6%, respectively.

Commercial Catch

Prior to the moratorium, Canadian landings for vessels < 35 ft (see “Can-NL fixed” in Table 1) were estimated mainly from purchase slip records collected and interpreted by Statistics Division, DFO. Shelton et al. (1996) emphasized that these data may be unreliable. Post moratorium landings for Canadian vessels < 35 ft come mainly from a dock side monitoring program initiated in 1997. Landings for Canadian vessels > 35 ft come from logbooks. Non-Canadian landings (only France since 1977) were compiled from national catch statistics reported by individual countries to NAFO. In recent years, French landings have been provided directly by French government officials.

Cod in the 3Ps management unit were heavily exploited in the 1960s and early 1970s by non-Canadian fleets, mainly from Spain and Portugal, with reported landings peaking at about 87,000 t in 1961 (Fig. 3a). After extension of Canadian jurisdiction in 1977, cod catches averaged between 30,000 t and 40,000 t until the mid-1980s when increased fishing effort by France led to increased total reported landings, with catches increasing to about 59,000 t in 1987. Subsequently, reported catches declined gradually to 36,000 t in 1992. Catches exceeded the TAC throughout the 1980s and into the 1990s. The Canada France boundary dispute at this time led to fluctuations in the French catch during the late 1980s. Under advice from the Fisheries Resource Conservation Council, a moratorium was imposed on all directed cod fishing in August 1993 after only 15,216 t had been landed. Access by French vessels to Canadian waters was restricted in 1993.

Total landings for the 2015-16 management year (April 1–March 31) were 6,427 t, or 48% of the 13,043 t TAC. This marks the seventh consecutive year in which the landings have been less than the TAC. Over the past five years the landings have averaged half the TAC. Industry participants have indicated multiple reasons contributing to this change, including reduced availability of fish, poor marketing conditions/economics, and the closure of a processing facility in St. Pierre. Prior to the 2009-10 season, the TAC had been fully utilized if not exceeded in each year since Canadian jurisdiction was extended in 1977. Furthermore, excluding the moratorium years, current landings are the lowest of the available time series. Preliminary landings data for 2016/17 to September 29 totaled 2,088 t. Although the 2016/17 fishing season is incomplete, these totals to date are again relatively low and it is unlikely that the full TAC will be landed.

Since 1997, most of the TAC has been landed by Canadian inshore fixed gear fishermen (where inshore is typically defined as unit areas 3Psa, 3Psb, and 3Psc; refer to Fig. 1), with remaining catch taken mainly by the mobile gear sector fishing the offshore, i.e., unit areas 3Psd, 3Pse, 3Psf, 3Psg, and 3Psh (Table 1, Figs. 3a, and 3b).

Line trawl (i.e. longline) catches dominated the fixed gear landings over the period 1977-93, reaching a peak of over 20,000 t in 1981 and typically accounting for 40-50% of the annual total for fixed gear (Table 2, Fig. 4). In the post moratorium period, line trawls have accounted for 16-26% of the fixed gear landings. Gillnet landings increased steadily from about 2,300 t in 1978 to a peak of over 9,000 t in 1987, and remained relatively stable until the moratorium. Gillnets have been the dominant gear used for the inshore catch since the fishery reopened in 1997, with gillnet landings exceeding 50% of the TAC for the first time in 1998. Gillnets have typically accounted for 70-80% of the fixed gear landings since 1998. Gillnets accounted for a lower percentage of the fixed gear landings in 2001 (60%), partly due to a temporary management restriction in their use that was removed part way through the fishery following extensive complaints from industry. Gillnets have also been used extensively in offshore areas in the post moratorium period. Cod trap landings from 1975 up until the moratorium varied considerably, ranging from approximately 1,000-7,000 t. Since 1998, trap landings have been reduced to negligible amounts (< 120 t). Hand line catches were a small component of the inshore fixed gear fishery prior to the moratorium (about 10-20%) and accounted for about 5% of landings on average for the post moratorium period. However, hand line catch for 2001 shows a substantial increase (to 17% of total fixed gear) and this may reflect the temporary restriction in use of gillnets described above. Increases in the proportion of hand-line catch in some years (e.g. 2009, 2013) are likely due to buyers paying a higher price for hook-caught fish than for gillnet landings.

The spatial-temporal details of reported landings are reported in (Table 3). Of particular note is the fact that offshore catches in 3Psh were higher from December 2014 through to March 2015 than in other recent years.

Inshore landings are low early in the year (Table 3), arising mostly from by-catch of cod in other fisheries. The vast majority of landings from the inshore areas (3Psa, 3Psb, and 3Psc) are taken in June-November, with highest landings in June and July, particularly in 3Psc. The inshore (3Psa, 3Psb, and 3Psc) has consistently accounted for most of the reported landings. These have typically been highest in Placentia Bay (3Psc), ranging from 1,500 t to almost 11,650 t with 26-55% of the annual 3Ps catch coming from this unit area alone. In 2014 the landings from 3Psc were 1673 t, representing 43% of the 3Ps total. Most of the offshore landings have come from 3Psh and 3Psf (Halibut Channel and the southeastern portion of St. Pierre Bank). Unit areas 3Psd, 3Pse and 3Psg have accounted for a very small portion of the total catch in recent years but totals for these areas were increased in 2014. Catches in these areas thus far in 2015 have again been very low. The breakdown of landings by unit area excludes landings by France from 2009 to present. Resource managers from France have reported that the majority of these landings are taken in either 3Psf or 3Psh, but the exact unit area is unavailable.

The 2013-14 (April 1 to March 31) conservation harvesting plan places various seasonal and gear restrictions on how the 3Ps cod fishery in Canadian waters could be pursued. For example, unit areas 3Psa and 3Psd were closed from November 15-April 15 of the following year to avoid potential capture of migrating cod from the Northern Gulf stock (NAFO Divisions 3Pn4RS) and all of 3Ps was closed from April 1 to May 14, a closure intended to protect spawning aggregations. Full details of these and other measures, which may differ among fleet sectors, are available from the DFO Fisheries and Aquaculture Management (FAM) branch in St. John’s.

CATCH AT AGE

Estimates of the 2014 and 2015 catch numbers-at-age were not available for the 2016 3Ps cod Regional Assessment Process due to a shortage of time/personnel for ageing commercial otoliths. Similar restraints at the French aging facility prevented the availability of age estimates from French catches. At this point the potential to age all future commercial samples is unclear.

Detailed catch-at-age estimates for the three most recent years (i.e. 2011-13) are provided in Table 4 and the complete time series (1959 to 2013) of available catch numbers at age (ages 3-14 shown) for the 3Ps cod fishery is given in Table 5. As noted in recent assessments (e.g. Brattey et al. 2008), there are discrepancies in the ratio of the sum of the product to landings over the 1959-76 period and attempts have been made to clarify these discrepancies by checking for missing catch and by adding plus group catch, but neither of these adequately explained the discrepancies. Until these discrepancies are resolved, it is recommended that catch at age prior to 1977 not be used as estimates of total removals in population analyses.

WEIGHT AT AGE

With no available ageing of commercial samples for 2014 and 2015, weight-at-age could not be updated. The assessment uses approximate beginning of the year weights calculated from weight-at-age via the Rivard geometric mean method. In the absence of 2014 and 2015 weight-at-age data, however, approximate beginning of the year weights at age for 2014 were instead estimated based on the geometric mean of the beginning of the year weights at each age for 2011-13.

The time series of available mean weights-at-age in the 3Ps fishery (including landings from the commercial and food fisheries and the sentinel surveys) are given in Table 6a and Fig. 6, while beginning of the year weights-at-age are given in Table 6b and Fig. 7. Estimates of mean weights-at-age are derived from sampling of the catches stratified by gear type, unit area and month. Seasonal age length keys are applied to length frequency data to age the catch and calculate proportions at age. Weights-at-age are calculated using a length-weight relationship for cod.

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

RESEARCH VESSEL SURVEY

Stratified-random surveys have been conducted in the offshore areas of Subdiv. 3Ps during the winter-spring period by Canada since 1972 and by France over 1978-92. The two surveys were similar with regard to the stratification scheme used, sampling methods and analysis, but differed in the type of fishing gear and the daily timing of trawls (daylight hours only for French surveys). Canadian surveys were conducted using the research vessels A.T. Cameron (1972-82), Alfred Needler (1983-84; 2009-present), and Wilfred Templeman (1985-2008). From the limited amount of comparable fishing data available, it has been concluded that the three vessels had similar fishing power and no adjustments were necessary to achieve comparable catchability factors, even though the A.T. Cameron was a side trawler. The CCGS Teleost has also been used during exceptional events (e.g. severe mechanical issues on regular survey vessel), and any potential vessel effect is unaccounted for. Cadigan et al. (2006) found no significant differences in catchability for several species, including cod, between the Wilfred Templeman and Alfred Needler research vessels. Surveys by France were conducted using the research vessels Cyros (1978-91) and Thalassa (1992) and the results are summarized in Bishop et al. (1994).

The Canadian research vessel surveys from 1983 to 1995 employed an Engel 145 high-rise bottom trawl. In 1996, research surveys began using the Campelen 1800 shrimp trawl. The Engel trawl catches for 1983-95 were converted to Campelen 1800 shrimp trawl-equivalent catches using a length-based conversion formulation derived from comparative fishing experiments (Warren 1996; Warren et al. 1997; Stansbury 1996, 1997).

The stratification scheme used in the DFO RV bottom-trawl survey in 3Ps is shown in Fig. 8. Canadian surveys have covered strata ranging down to 300 fathoms (ftm) in depth (1 fathom = 1.83 meters) since 1980. Five new inshore strata were added to the survey in 1994 (stratum numbered 779-783) and a further eight inshore strata were added in 1997 (numbered 293-300) resulting in a combined 18% increase in the surveyed area. Beginning in the 2007 assessment, new indices using survey results from the augmented survey area were presented for the first time. Two survey time series are constructed from the catch data from Canadian surveys. The index from the expanded surveyed area that includes new inshore strata is referred to as the “All Strata < 300 ftm” index and the time series extends from 1997 onwards. The original smaller surveyed area is referred to as the “Offshore” survey index and the time series that incorporates a random stratified design extends from 1983-present.

The timing of the survey has varied considerably over the period (Table 7). In 1983 and 1984 the mean date of sampling was in April, in 1985 to 1987 it was in March, and from 1988 to 1992 it was in February. Both a February and an April survey were carried out in 1993; subsequently, the survey has generally been carried out in April. The change to April was aimed at reducing the possibility of stock mixing with cod from the adjacent northern Gulf (3Pn4RS) stock in the western portion of 3Ps. The stock mixing issue is described in more detail in previous assessments (e.g., Brattey et al. 2007). Due to extensive mechanical problems with the research vessel, the survey in 2006 was not completed: only 48 of 178 planned sets were completed. Therefore, results for 2006 for the full survey area are not considered comparable to the remainder of the time-series. All subsequent surveys were considered complete. The 2016 survey completed 157 of the intended 178 fishing sets (Fig. 9). Stratum 708 was not completed, since only one successful fishing set was performed.

Abundance, Biomass, and Distribution

Trends in the abundance index and biomass index from the RV survey are shown for the offshore (i.e. index strata only: those strata of depth ≤ 300 ftm, excluding the new inshore strata) and the all strata area (Fig. 10). The trawlable abundance index declined from 88.2 million in 2001 to 38.7 million in 2008, the longest period of consistent decline in the entire time-series. However, the index has generally been higher during 2009-16. The 2013 estimate was particularly high, but was followed by a subsequent large decline for the 2014-16, with the 2016 estimate being below average. The trawlable biomass estimate has been variable for much of the post-moratorium period, but shows a general declining trend over 1998-2016, with the exception of a high value of 83,000 t in 2013.The survey biomass estimate for 2016 was 28,154 t and below the time series average.

The trends and degree of variability in the combined inshore/offshore survey are almost identical to those of the offshore survey (Tables 8 and 9, Fig. 10) in spite of the 18% increase in surveyed area; the only exception is in 2005 when the combined inshore/offshore survey shows higher biomass and abundance due mainly to a large estimate from inshore stratum 294.

Survey indices of cod in 3Ps are at times influenced by “year-effects”, an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. The time series for abundance and biomass from 1983 to 1999 show considerable variability, with strong year effects, for example, the 1995, 1997 and 1998 surveys when compared to those from adjacent years. There are strong indications that the 2013 survey may have been influenced by a year effect. A clear sign of a year-effect is the fact that the 2013 RV survey estimated that the abundance of multiple cohorts increased compared to observations of these same cohorts at one age younger in 2012. The number of fish in a cohort cannot increase as it ages (without immigration) and when analyses suggest that such an increase has occurred it is considered evidence for a year effect. In the 2013 survey, the 2011 year class (age 2 fish) was estimated to be by far the strongest in the times series. The subsequent three assessments have downgraded the estimated strength for this year class but it still appears strong relative to other recent year classes.

Surveys in 3Ps are prone to single large fishing sets that heavily influence the survey indices and are often largely responsible for the year-effects mentioned previously. An extreme example is the 1995 survey, where a single large catch contributed 87% of the total biomass index. In 2013, a large single catch of larger fish on Burgeo Bank (Figs. 11 and 12) resulted in >50% of the overall biomass being located in this particular area (Fig. 13) and causing a large spike in the survey indices for that year. A similar phenomenon occurred in the 2015 and 2016 surveys with a single large set in the Burgeo Bank area accounting for 38% and 60%, respectively, of the biomass index in those years. The fact that single large fishing sets have heavily influenced survey indices throughout the history of this stock, including three out of the last four years, is a concern for the assessment. The recent sporadic appearance of high numbers of fish on Burgeo Bank is not fully understood. Méthot et al. (2005) used otolith microchemistry to investigate the stock affinity of fish collected on Burgeo Bank in 2001 and suggested that approximately half of the fish in this area in April (which also equates to the time of the DFO RV survey) were fish that originated from the Northern Gulf of St. Lawrence. The presence of Northern Gulf fish within the 3Ps stock area at the time of the RV survey could bias the assessment of 3Ps cod.

To further investigate survey trends for different portions of the stock area, the stratification scheme was divided up (Fig. 14) into areas referred to as 'inshore' (strata 293-298, and 779-783), 'Burgeo' (strata 306-309, and 714-716), and 'eastern' (remaining strata) and the trends in biomass and abundance in each of these regions were examined based on the combined inshore/offshore survey data. The proportions were variable, with typically 30-70% observed in the larger eastern area, 15-60% in the Burgeo area, and around 10-25% in the inshore area. Over the last five years the inshore and eastern regions show a decline in both abundance and biomass (Fig. 15), whereas the Burgeo indices have been highly variable. In three of the last four years the survey biomass has been estimated to be higher on Burgeo Bank than the Eastern area due largely to the single large sets mentioned previously.

Age Composition

Survey numbers at age are obtained by applying an ALK to the numbers of fish at length in the samples. The current sampling design for cod in Subdiv. 3Ps requires that an attempt be made to obtain 2 otoliths per centimeter from each of the following locations: Northwest St. Pierre Bank (strata 310-314, 705, 713), Burgeo Bank (strata 306-309, 714-716), Green Bank-Halibut Channel (strata 318 319, 325 326, 707-710), Placentia Bay (strata 779-783) and remaining area (strata 315-317, 320-324, 706, 711-712). This spatial stratification ensures sampling is distributed over the surveyed area. The otoliths are then combined into a single ALK and applied to the survey data. These data can be transformed into trawlable population abundance at age by multiplying the mean numbers per tow at age by the number of trawlable units in the survey area. This is obtained by dividing the area of the survey by the number of trawlable units. For the "offshore" survey in 3Ps, the survey area is 16,732 square nautical miles including strata out to 300 ftms (and excluding the relatively recent inshore strata added in 1997). The swept area for a standard 15 min tow of the Campelen net is 0.00727 square nautical miles. Thus, the number of Campelen trawlable units in the 3Ps survey is $16{,}732 \div 0.00727 = 2.3 \times 10^6$. For the expanded survey area, there are approximately 2.7×10^6 trawlable units.

The mean numbers per tow at age in the DFO RV survey are given in Table 10 and results for ages 1-15 are shown in the form of standardized proportion at age per year (SPAY) "bubble" plots in Fig. 16. Cod up to 20 years old were not uncommon in survey catches during the 1980s, but the age composition became more contracted through the late 1980s and early 1990s. In fact, few cod aged 15 or older have been sampled during surveys in the past two decades and none have been sampled in the last three years.

Over 2007-11, survey results indicated the 2006 year-class was much greater than average (at ages 1 through 5). However, subsequent surveys suggested the numbers at age for the 2006 year-class at older ages to be near or below average. The age 1 survey index for the 2012 survey, representing the 2011 year-class, was much greater than the time-series average. Although the relative strength of this year class has been revised downward to some degree in subsequent surveys it continues to look strong and is now of age to be selected to the fishery. An examination of age-disaggregated spatial plots indicate that this year class was located primarily on Burgeo Bank and in the Halibut Channel area in the 2016 RV survey (Fig. 17).

Size-at-Age (Mean Length and Mean Weight)

The sampling protocol for obtaining lengths-at-age and weights-at-age has varied over time (Lilly 1998), but has consistently involved stratified sampling by length. For this reason, calculation of mean lengths and weights included weighting observations by population abundance at length (Morgan and Hoenig 1997), where the abundance at length (3-cm size groups) was calculated by areal expansion of the stratified arithmetic mean catch at length per tow (Smith and Somerton 1981). Only data from 1983 onward are presented.

For ages older than age 3 there was a general decline in mean length-at-age from the early 1980s to the mid-1990s (Table 11, Fig. 18). For most ages there was an increase in length-at-age from the mid-1990s through the mid-2000s, followed by a period of lower length-at-age in recent years. In 2016 length-at-age decreased compared to 2015 for most of the ages examined. Annual variation in mean length at age was examined using deviation from the average as a proportion over the time series for each age. The average mean length at age from 1983 to 2016 was calculated for each age. Deviation was calculated for each age in each year by subtracting the mean for the age for the time series from the annual observation for that age and then dividing this by the mean for that age. Ages 3 to 9 were included. Mean length at age was greater than average in the mid-1980s. It showed a declining trend until the mid-1990s when it was below average. Mean length-at-age subsequently increased to above average through the early 2000s but has generally declined since, with the last 4 years being among the lowest in the time series (Fig. 18).

Values for mean weight at age were examined in the same manner as length at age (Table 12, Fig. 19). Average deviation from the mean weight (Fig. 19) suggested there was a decrease in weight-at-age throughout the 1980s into the early 1990s, followed by an increase through the mid-2000s. As with mean length-at-age, mean weights-at-age increased after that time to about 2000. Weight-at-age has since declined and the last four years were well below average and among the lowest values in the time series.

Condition

Relative gutted condition (relative K) and relative liver condition (relative LK) were calculated from survey data. It has been shown that the timing of the survey affects estimates of condition for 3Ps cod (Lilly 1998) and so only estimates from April surveys beginning in 1993 were estimated. A length - gutted weight relationship was estimated, and the condition index is then observed weight divided by the weight predicted from the length - weight regression for a fish of that length. Relative liver condition was calculated in a similar fashion using a liver weight-body length regression. However, evaluation of the model fit indicated that a simple linear regression did not provide an adequate fit to the data. In addition, liver weight data for fish under 30 cm and greater than 120 cm were highly variable. Therefore, the analyses were restricted to fish 30-120 cm in length and the regression was log(liver weight) = intercept + b1*log(length) + b2*(log(length)*log(length)). Gutted and liver condition followed similar trends over the time series, increasing to about 1998 and then declining again before increasing to 2005 (Fig. 20). Both condition indices increased again between 2007 and 2013 but the values in the most recent three years have been well below average and among the lowest in the time series.

Maturity

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

Annual estimates of age at 50% maturity (A50) for females from the 3Ps cod stock, collected during annual winter/spring DFO RV surveys, were calculated as described by Morgan and

Hoenig (1997). Trends in age at 50% maturity are shown in Fig. 21a (only cohorts with a significant slope and intercept term are shown); parameter estimates and associated standard errors for the 1954 to 2011 cohorts are given in Table 13, and the model did not adequately fit data for subsequent cohorts as most of these fish remain immature. Age at 50% maturity declined rapidly for cohorts from the 1980s and remained low for cohorts from the 1990s. There was a slight increase in A50 to ~ 5.5 years for cohorts of the early 2000s but values for the most recent cohorts have once again dropped below 5 years (Fig. 21a). Given that the estimation is conducted by cohort, estimates for the most recent cohorts may be revised slightly in future years as additional data are collected. Males show a similar trend in A50 over time (data not shown), but tend to mature about one year earlier than females.

Annual estimates of the proportion mature at age are shown in Table 14; these were obtained from the cohort model parameter estimates in Table 13. The estimates of proportion mature for ages 4-7 show a similar increasing trend (i.e., increasing proportions of mature fish at young ages) through the late 1970s and 1980s, particularly for ages 5, 6, and 7 (Fig. 21b). Due to the low age at 50% maturity, the proportions mature at age are quite high.

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

Cohort Analyses

During the 2006 assessment of this stock, it was agreed that sequential population analyses of 3Ps cod should be discontinued, primarily due to inconsistent trends in the index data available (poor correlations within and between surveys) and poor model fit (strong year-effects and poor precision in estimated parameters) (For additional discussion, refer to DFO (2006, 2007) as well as Brattey et al. (2008)). In addition, the accuracy of the total landings captured by the commercial catch data has been questioned during assessment meetings (e.g., Shelton et al. 1996, DFO 2010). In the 2007 assessment of this stock, Brattey et al. (2008) provided estimates of instantaneous rates of total mortality (Z) for 1997-2007 as computed directly from the combined DFO RV survey. A debate on smoothing these annual estimates of total mortality during the winter 2009 zonal assessment meeting led to the exploration of cohort modeling of the survey data to provide structure to the smoothing. Consequently, a survey-based (SURBA) model based upon the work of Cook (1997) was implemented and it provides estimates of total mortality, relative recruitment strength, and relative estimates of total and spawning biomass from the DFO RV survey (see Cadigan 2010).

Data for ages 1-12 from the DFO RV expanded index were used in the SURBA. However, data for ages 1 and 2 over 1983-95 are zero-weighted in estimation, due to concerns of potential biases in RV data conversion of these age groups (this conversion accounts for a change in the trawl gear after the 1995 survey). An age-specific adjustment is applied to the 1983-96 survey indices to account for the inshore area that was not sampled in these years. The ratio of the average survey index for the expanded area (1997-present) to the average offshore survey index over the same period is computed for each age (see Fig. 22). These adjustment factors are applied to the survey index at age over 1983-96. As younger fish are generally found in greater abundance in the near-shore, this ratio exceeds one at ages 1-3. For fish older than age 3, the adjustment is less than 1 and generally declines with age.

The age-disaggregated cohort model assumes that total mortality experienced by the population can be separated into vectors of age effects s_a and year effects f_y (such that $Z_{a,y} = s_a \times f_y$). Estimation (lognormal likelihood) minimizes the difference between the predicted and observed survey index over all ages and years, with penalties applied to impose a degree of smoothing on the estimated age and year effects. However, the model was speculative in that it could not reliably estimate survey selectivity, and fixed values are applied. Survey selectivity is assumed to be constant for ages 4 +, that is, selectivity is “flat-topped”. The age effects estimated in deriving a recruitment index from the age 1-4 survey data during a previous assessment of this stock (Healey et al. 2013) were used to provide some objectivity in the survey catchabilities supplied to the model for the ages which are not fully-recruited. An alternate assumption assuming “domed” selectivity was explored in a previous assessment (Healey et al. 2011). It has been argued that best-practice is to assume flat-topped selectivity (Northeast Fisheries Science Center 2008) unless there is evidence otherwise.

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

An updated run of the previous assessment model formulation was presented. Estimated age-specific patterns in mortality indicate an increasing trend in relative total mortality to age 9, after which relative mortality decreases slightly (Fig. 23). Results indicated that SSB declined by 58% over 2004-09 (Fig. 24a). Median SSB was estimated to be at the LRP in 2008 and below the LRP in 2009. SSB increased considerably over 2009-12 but has since declined by 32%. Although the stock is currently estimated to be in the Cautious Zone (18% above Blim) as defined by the DFO Precautionary Approach (PA) Framework; the probability that the stock is in the critical zone (i.e. below Blim) is 0.22, which is a concern. Very low numbers of old fish in the population combined with the presence of the strong 2011 and 2012 year classes (ages 5 and 4 in 2016) resulted in nearly half (46%) of the 2016 SSB being made up of 4-5 year old fish. This is an enormous reliance on young spawners and may be a concern given that younger fish produce fewer and smaller eggs/larvae that may have reduced survival. Young fish also spawn over a narrower time frame which decreases the probability of overlap between larval emergence and peak plankton abundance and can result in reduced survival.

Total mortality rates reflect mortality due to all causes, including fishing. Estimated total mortality has been increasing since 1997 and the 2015 value is the time-series maximum (Fig. 24b). Over 2013-15, total mortality averaged 0.73 (52% per year). This is very high considering that landings have been about half of the TACs over this time period. The total mortality values are weighted by population number at each of ages 5-10.

Recruitment (Fig. 24c) has improved over the last decade with most cohorts at or above the time series (1983-2014) average. Indications are that the 2011 and 2012 cohorts are among the strongest in the time-series. Even these strong cohorts are expected to decline rapidly in coming years if total mortality rates remain at recent high levels.

Model diagnostics are similar to results obtained during the previous assessment. There is evidence of the year-effects as described in the survey results section, particularly those during the mid-1990s (multiple years of almost all negative residuals) as well as 2013 (almost all positive residuals). Otherwise, there are no indications of systematic model fit issues (Fig. 25).

Recent assessments of 3Ps cod have been subject to retrospective revisions of estimates from previous years with the addition of a new year’s survey data (Fig. 26a). For example, in the 2015 assessment the SSB for 2015 was estimated to be at 1.4 times the level of the LRP. In the current assessment, however, the 2015 SSB has been retrospectively revised downward by 16% to less than 1.2 times the level of the LRP. This is the third year in a row where the assessment has performed a downward revision of the terminal year estimate of SSB from the previous assessment. Likewise upward retrospective revisions of mortality have occurred over the same period. Retrospective revisions are not uncommon in cohort models, which use annual information to predict the abundance of multiple cohorts (It should be noted that the retrospective revision in SSB in the current assessment is also impacted by changes in the predicted values for proportion mature at age from a cohort-based model.) However, strong retrospective patterns in the same direction over multiple years could suggest an issue with the assessment (input data and/or model formulation). Some concern was expressed over the magnitude and direction of the retrospective in recent years. However, it was agreed that these differences were not sufficient to reject model results considering the degree to which confidence intervals of the 2015 and 2016 assessments overlap (Fig. 26b).

Concern over variability in the survey data (particularly in relation to the influence of single large fishing sets in any given year), the strong directional retrospective pattern in SURBA model estimates in recent years, and the unavailability of recent estimates of commercial fish weights-at-age led to the decision to not project the stock forward based on current assessment results. In general, however, it is noted that biomass is likely to decline sharply in the coming years if the current high mortality rate persists.

OTHER DATA SOURCES

Other sources of information were considered in the assessment to provide perspectives on stock status in addition to the DFO survey indices. These sources of information include data from the Sentinel survey (1995-2015), as well as results of a telephone survey of inshore Canadian fish harvesters and exploitation (harvest) rates estimated from tagging experiments in Placentia Bay (and more recently Fortune Bay). Updated logbook data for vessels less than 35 feet and vessels greater than 35 feet were not available for the current assessment. Any differences in trends between these additional data sources and the DFO survey are difficult to reconcile but attributed to differences in survey/project design, seasonal changes in stock distribution, differing selectivity of various gear types, or the degree to which the various data sources track only certain subareas/ components versus the entire distribution of the stock.

SENTINEL SURVEY

The sentinel survey has been conducted in 3Ps since 1995 and there are now twenty complete years of catch and effort data. Sentinel activity for 2016 was ongoing at the time of the assessment; this data will be reviewed in subsequent years. The sentinel survey continues to produce a time series of catch/effort data and biological information collected by trained fish harvesters at various inshore sites along the south coast of Newfoundland. Sentinel fishers typically fish a control and an experimental site; the location of the control site is fixed, whereas the location of the experimental site can change only within the local area. In 2015 (Fig. 27a), there were 11 active sites in 3Ps, using predominantly gillnets (5½" mesh) in unit area 3Psc (Placentia Bay) and line trawls in 3Psb and 3Psa (Fortune Bay and west). One 3¼" gillnet was also fished at each of 3 sites in Placentia Bay one day per week. Fishing effort was less in 1999 (6 weeks), 2003 and 2004 (8 weeks each), than most other years (9-12 weeks), but since 2005 an average of 10 weeks has been maintained. Most fishing takes place in fall/early winter. Catch rates for 5½" gillnets in 2016 remained low and were similar to those recorded since 2003. Line trawl catch rates have declined and have been below the series average for the past 7 years.

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

STANDARDIZED SENTINEL CATCH RATES

The catch from 3Ps was divided into cells defined by gear type (5½" mesh gillnet and line trawl), area (unit areas 3Psa, 3Psb, and 3Psc), year (1995-2015) and quarter. Age length keys (ALKs) were generated for each cell using fish sampled from both the fixed and experimental sites; however, only fish caught at the fixed sites were used to derive the catch rate indices. Length frequencies and ALKs were combined within cells. The numbers of fish at length are assigned an age proportional to the number at age for that particular cell length combination. Fish that were not assigned an age because of lack of information within the initial cell were assigned an age by aggregating cells until the data allowed an age to be assigned. For example, if there are no sample data in a quarter then quarters are combined to half year, half years are combined to year; if an age still cannot be assigned then areas are combined for the year. Since 2002, there are considerably fewer otoliths available for aging; annual sample sizes range between 248 and 464 otoliths per year from gillnet catches (compared to an average of 1,050 otoliths during 1995-2002). Sample sizes for linetrawl are more variable, averaging 1,100 otoliths from 1996-2002, but were considerably lower in 2003-04 and from 2007 onward. These variations are generally reflective of annual differences in the numbers of fish caught and decreased sentinel effort over time. However, there have been some changes in the proportion of sampled fish aged over the duration of the Sentinel program. Reductions in the number of fish being aged has not resulted in major difficulties in aging the catch. Further, the fraction of the catch sampled for age in recent years is comparable to earlier years. Sentinel otoliths for 2015 could not be processed in time for this assessment as a result of focused efforts to provide additional data input for the December 2015 Northern Cod Framework meeting (thereby reducing the available time for age-readings of 3Ps cod). When considering whether data from prior years aging could be used to age-disaggregate the Sentinel results, an evaluation of mean length at age was conducted to determine whether there have been substantial changes in growth. Values for recent years were examined and as no trends were noted, it was agreed that the 2014 sentinel sampling would be applied to the 2015 length sampling.

Catch at age and catch per unit effort (CPUE) data were standardized using a generalized linear model to remove site and seasonal effects. Only data from fixed sites collected between June-November were included. For gillnets, only sets with a soak time between 12 and 32 hours were included, and for line trawl, soak times less than or equal to 24 hours were used in the analysis. Prior to modeling, data are aggregated within a gear/division/site/month/year/age cell. Zero catches were generated for ages not observed in a set as sets with effort and no catch are valid entries in the model.

A generalized linear model (McCullagh and Nelder 1989) was applied to the sentinel catch and effort data for each gear type. The number of fish caught in each set is assumed to have a Poisson distribution. A log link function was chosen, and the factors included in the model were both “nested effects”: month is nested within site and age is nested within year. Fishing effort is included as an offset term in the model. In the present assessment, the model adequately fitted data from gillnets and line trawls, and all effects included in the model were significant. Note that catch rates from the sentinel fishery are expressed in terms of numbers of fish, rather than catch weight, as sentinel catches are usually not weighed (unavailability of scales). This complicates direct comparisons of the trends from Sentinel surveys to commercial catch rates.

Trends in standardized total (ages 3-10 combined) annual catch rates, expressed in terms of numbers of fish, are shown in Fig. 27b. Gillnet catch rates declined rapidly from 1997 to 1999 then remained stable but low from 1999 through to 2015. For line trawls, catch rates declined from 1995-97, remained relatively stable with no clear trend from 1997 to 2008, and have declined since that time with the 2015 value being the lowest in the time series.

Two standardized annual catch rate at age indices were also produced in the present assessment, one for each gear type. The standardized gillnet and line trawl catch rate at age indices for 1995-2014 are given in Table 15 and Fig. 28. For gillnets, several year classes were well-represented in catches during 1995-97 but these are replaced by mostly weaker year classes. It has been noted that the 1997 and 1998 year-classes contributed significantly to both the fishery and RV index for several years. However, these year classes did not yield improvements in the magnitude of sentinel gillnet catch rates over 2002-06, when these year-classes would have been within the peak selection range of 5½" gillnets, and were a major contributor to inshore fisheries.

For line trawls, catch rates-at-age in the beginning of the time-series were higher due to the strong 1989 and 1990 year classes. In 2000-02, sentinel line trawl catch rates improved for younger fish (3 and 4 year olds) as the 1997 and 1998 year classes recruited to this index. Catch rates for older fish continued to decline. Both the 1997 year class, and in particular, the 1998 year class were consistently measured by sentinel linetrawl. As noted previously, these year-classes contributed strongly to commercial catches for several years. In addition, the 1999 year class also appears reasonably strong at ages 4-5 then is generally below average for older ages. This year class is weak in sentinel gillnet and in other (mobile gear) indices. These year-classes were followed by several successive year-classes which were weaker; but catch rates of the 2004 year-class at ages 3-5 (in 2007-09) are higher (Table 7). In 2006, linetrawl catch rates for all ages (3-10) increased, suggesting a year effect in the data rather than a change in stock size (Table 7b). Similarly, the 2013 gillnet index shows catch rates for most ages were also higher than in the previous year.

Although the sentinel indices did not increase in magnitude as the 1997 and 1998 year-classes were available to these gears, the age composition of the standardized estimates indicates that the 1997 year-class was consistently detected as relatively strong in the sentinel gillnets (Fig. 28). Conversely, the 1998 year-class was consistently tracked by linetrawl sampling.

As described in previous 3Ps cod assessments, interpretation of the sentinel catch rate indices is difficult. Sentinel fisheries were free from competitive influences during 1995-96 as the commercial fishery was closed. However, commercial fisheries may have had some disruptive influence on the execution of the sentinel fishery since 1997, particularly in Placentia Bay. The concentration of fishing effort in Placentia Bay during the late-1990s, primarily with gillnets, may have had a negative influence on the sentinel gillnet catch rates. Competition with commercial fishers for fishing sites, local depletion, inter annual changes in the availability of fish to inshore, and shifts in the timing of sentinel fishing to accommodate periods of commercial fishing could all influence mean catch rates between years. The extents to which such effects influence catch rates are not fully understood. These issues also complicate the interpretations of relative year-class strength over the time-series. The decline in sentinel gill net catch rates after the fishery reopened in 1997 are consistent with the inshore catch rate data from science log books and the high estimates of exploitation from tagging in Placentia Bay. More recently, the index is consistently tracking the 2006 year-class, though the overall index has not shown increase. The linetrawl index indicates a strong contribution from the 2004 year-class but the 2006 year-class is estimated as one of the weakest over the time-series. This differs from the RV index, in which the 2006 year-class is well above average for ages 3 and 4, but near average for ages 5 and 6. The 2011 and 2012 year classes, which appear strong in the survey, were not yet of age to be fully selected by either of the gears in the 2015 sentinel survey.

TAGGING EXPERIMENTS/EXPLOITATION RATE

Tagging of adult (> 45 cm fork length) cod in Subdiv. 3Ps was initiated in 1997 and has continued through 2016. The objectives of the tagging study are to provide information on movement patterns of 3Ps cod as well as obtain ongoing estimates of exploitation rates (% harvested) on different components of the stock. Tagging efforts in 3Ps were reduced during 2005-11 with releases only in Placentia Bay (3Psc) during 2008-11 and there has been no tagging in the offshore regions of 3Ps since 2005 (Table 16a). However, during 2012-13 efforts were made to expand the tagging program under the auspices of a Fisheries Improvement Program (FIP) conducted by various levels of Government, Industry, and the WWF. The number of tags released (Table 16a) was increased to 2,340 in 2012 and 3,951 in 2013, with coverage expanded to include a broader portion of the stock area (3Psa, 3Psb, 3Psc). Attempts to tag in the offshore were also made but these proved unsuccessful. In 2014 and 2015, the number of tags released declined to 989 and 1250, respectively, and coverage was again restricted to 3Psb and 3Psc. A brief synopsis of results from recent tagging is provided below.

Over 2008-10, approximately 300 tags were returned annually (Table 16b). Fewer tags were returned in 2011 and 2012 (131 & 189, respectively), resulting from both reductions in landings and the restricted spatial extent of releases. Returns increased in 2013 (244) and 2014 (259) but decreased again slightly in 2015 (216). The percentage of returns coming from participants in the recreational fishery ranged from 4-11% during 2007-15 (Table 16b). Sufficient numbers of tags have been returned to estimate annual tag reporting rates (fraction of captured tags returned) using mixed-effects logistic regression (Cadigan and Brattey 2008). Inter-annual variations are relatively small with no trends over time (Fig. 29). Reporting rate for the offshore portion of 3Ps in 2015 was 0.66 and for the inshore was 0.77.

The methods and estimates of the average annual exploitation rates (harvest rates, in percent) for cod tagged in different regions of 3Ps are described in detail elsewhere (Brattey and Cadigan 2004; Brattey and Healey 2003, 2004, 2005, 2006; Cadigan and Brattey 2003, 2006, 2008). However, results on size-specific exploitation rate from recent releases showed that although exploitation has been low in Placentia Bay, exploitation rate increases considerably with fish length, particularly for those sizes which are fully selected by the predominantly gill-net fishery. Exploitation rates for 2015 were obtained. These incorporated annual estimates of tag reporting rates (~68% during 2015) based on high-reward tagging and a range of assumed values for the annual rate of natural mortality ($M = 0.2$ or 0.4). At $M = 0.4$, in 2015, the harvest rates ranged from 9% to 20% ($F = 0.09$ to 0.23) among cod 50-85 cm at release tagged in Placentia Bay and Fortune Bay. These values would be approximately double if the entire quota had been taken as most of the unharvested TAC was available to the inshore sector.

With respect to migratory patterns and stock distribution, recent tagging suggests exploitation of 3Ps cod in neighbouring stock areas (3KL) is minimal and not a major issue for management. No new data are available to investigate mixing in the western portion of the stock area (3Psa/d). Post-moratorium tagging studies have generally revealed extensive movement of cod tagged inshore between Placentia Bay (3Psc) and Fortune Bay (3Psb), but limited movement from inshore to offshore. In contrast, many cod tagged offshore in Halibut Channel (3Psh) have shown extensive movement shoreward, particularly into Placentia Bay.

CONCLUSIONS AND ADVICE

- Although the stock is currently estimated to be in the Cautious Zone (18% above Blim) as defined by the DFO PA Framework; the probability that the stock is in the critical zone is 0.22, which is a concern.
- There are further concerns that the current estimate of SSB could be biased as the model has overestimated SSB in recent years.
- The SSB has declined since 2012 and there are few older (ages 6+) fish in the population.

- The strong 2011 cohort is now of age to recruit to the fishery. The subsequent cohorts are lower but near the time-series average.
- Estimated total mortality has been increasing and the 2015 value is the time-series maximum. Over 2013-15, total mortality averaged 0.73 (52% per year). This is very high considering that landings have been about half of the TACs over this time period.
- Projection of the stock to 2019 was not conducted. If the current high mortality rate persists, it will result in sharp decline in biomass in the coming years.
- Recent trends in mean size and weight-at-age, fish condition and age-at-maturity are at or near their lowest observed levels. This is consistent with broader ecosystem trends (e.g. warming temperatures, changes in community structure and cod diet composition) which also suggest some aspects of cod productivity may be impaired.
- Catches of approximately half the TAC generated from the Harvest Control Rule (HCR) in recent years have not promoted recovery of the stock toward the healthy zone. It was therefore not considered prudent to provide management advice based on the HCR.
- Given the downward trajectory of the stock in recent years, coupled with the current close proximity of the stock to the LRP, it is recommended that catch be reduced below recent levels.

Sources Of Uncertainty

Although the RV survey of Subdivision 3Ps includes coverage of 45 index strata, the majority of the survey indices for cod are typically attributed primarily to only a small number of those strata. In some years the high estimates in some of these strata are a result of a single large survey tow. For example, in three of the last four years, a large survey tow on Burgeo Bank has had a major influence on survey indices (e.g. 60% of the biomass index in 2016 resulted from a single survey tow in stratum 309). The RV survey uses a stratified-random design which assumes fish density to be uniform within a stratum and hence single large survey tows have the potential to bias survey (and hence assessment) results.

Survey indices are at times influenced by “year-effects”, an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. There are strong indications that the 2013 survey may have been influenced by a year effect that resulted in a large spike in the survey indices for that year. The 2013 RV survey estimated that the abundance of multiple cohorts increased compared to observations of these same cohorts at one age younger in 2012. Since the number of fish in a cohort cannot increase as it ages (without immigration), such results are usually considered clear evidence for a year effect. Year effects in the survey data have the potential to bias results, mask trends in the data and contribute to retrospective patterns.

Recent assessments of 3Ps cod have been subject to retrospective revisions of estimates from previous years with the addition of a new year’s survey data. For example, in the 2015 assessment the SSB for 2015 was estimated to be at 1.4 times the level of the LRP. In the current assessment, however, the 2015 SSB has been retrospectively revised downward to less than 1.2 times the level of the LRP. This is the third year in a row where the assessment has performed a downward revision of the terminal year estimate of SSB from the previous assessment. Likewise upward retrospective revisions of mortality have occurred over the same period. Retrospective revisions are not uncommon in cohort models, which use annual information to predict the abundance of multiple cohorts. However, strong retrospective patterns in the same direction over multiple years could suggest an issue with the assessment (input data and/or model formulation). Some concern was expressed over the magnitude and direction of the retrospective in recent years. However, it was agreed that these differences were not sufficient to reject model results considering the degree to which confidence intervals of the 2015 and 2016 assessments overlap.

This assessment uses fish weights at age from the commercial fishery along with proportions mature at age in order to convert numbers at age into spawning stock biomass. However, the recent need to age a backlog of otoliths for the December 2015 Northern cod framework meeting left insufficient time to fully age otoliths from the 2015 and 2016 3Ps commercial fisheries prior to the current assessment. Therefore the average weights for the three previous years (2012-14) were used. RV survey data suggest that current fish weights are lower than previous years and hence the use of weights from previous years could result in current SSB being overestimated.

Fish sampled on Burgeo Bank have represented a large portion of the survey estimates of cod in Subdivision 3Ps in recent years. However, the origin of fish in this area is not certain, with previous reports suggesting that a large portion of the fish in this area in April (the time of the RV survey) may in fact be fish from the Northern Gulf of St. Lawrence that migrate seasonally into the Burgeo Bank area. If this is true it would suggest an overestimation of recent indices for the 3Ps stock.

The level of total removals is uncertain. It is likely that historical landings have been biased both upwards (e.g. due to misreporting of catch by area and/or species) and downwards (e.g. due to discarding). In addition, commercial catch accounting procedures pre- and post-moratorium are radically different, with current measures likely to provide improved estimates of removals. Estimates of recreational fishery landings have not been available since 2006. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium period. Given these uncertainties and the variability in the reliability of removals estimates, they are not used in the current analytical assessment. Assessment models do exist that are capable of handling uncertainty in the catch estimates but some information would still be needed in order to place reasonable bounds on the landings.

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

ACKNOWLEDGMENTS

This assessment is supported by the extensive efforts by DFO personnel who participate in collection of data during annual research surveys or sampling of the 3Ps commercial cod fishery. Additionally, data processing by D. Pittman and P. Upward and the age reading efforts of G. Cossitt are gratefully acknowledged.

REFERENCES

Bishop, C.A., Murphy, E.F., and Davis, M.B. 1994. An assessment of the cod stock in NAFO Subdivision 3Ps. DFO Atl. Fish. Res. Doc. 1994/033, 33p.

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

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

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

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

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

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

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

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

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

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

Cadigan, N.G., and Brattey, J. 2006. Reporting and shedding rate estimates from tag recovery experiments in Atlantic cod (*Gadus morhua*) in coastal Newfoundland. Can. J. Fish. Aquat. Sci. 63: 1944-1958.

Cadigan, N.G., and Brattey, J. 2008. Reporting rates from cod tagging studies in NAFO Divisions 2J3KL and Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2008/031.

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

Cook, R.M. 1997. Stock trends in six North Sea stocks as revealed by an analysis of research vessel surveys. ICES J. Mar. Sci. 54: 924–933.

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

DFO. 2007. Proceedings of the Newfoundland and Labrador Regional Advisory Process for 3Ps Cod; October 16-20, 2006. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/016.

DFO. 2010. Stock Assessment of Subdivision 3Ps cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/067.

Healey B.P., Murphy, E.F., Brattey, J., Cadigan, N.G., Morgan, M.J., Maddock Parsons, D., and Mahé, J.-C. 2013. Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2011. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/158. iv + 81 p.

Healey B.P., Murphy, E.F., Brattey, J., Cadigan, N.G., Morgan, M.J., Maddock Parsons, D., Power, D., Rideout, R., Colbourne, E., and Mahé, J.-C. 2011. Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/076. vi + 86 p.

Lilly, G.R. 1998. Size-at-age and condition of cod in 3Ps as determined from research bottom-trawl surveys (1972-1997). DFO Can. Stock Assess. Sec. Res. Doc. 98/94. 29p.

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

Méthot, R., Castonguay, M., Lambert, Y., Audet, C., and Campana, S.E. 2005. Spatio-temporal distribution of spawning and stock mixing of Atlantic cod from the Northern Gulf of St. Lawrence and Southern Newfoundland stocks on Burgeo Bank as revealed by maturity and trace elements of otoliths. J. Northw. Atl. Fish. Sci. 36: 1-12.

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

Northeast Fisheries Science Center. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August 4-8, 2008. US Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii.

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

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

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

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, Ser. No. N2907. 10 p.

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

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

TABLES

Table 1. Reported landings of cod (t) from NAFO Subdiv. 3Ps by country and for fixed and mobile gear sectors. Landings are presented by calendar year but note that since 2000 the TAC has been established for April 1-March 31. Catch estimates for 2016 are incomplete since the fishing year was in progress at the time of the assessment. See Healey et al. (2014) for pre-1980 data.

Year	Canada NL (Mobile)	Canada NL (Fixed)[2]	Canada Mainland (All gears)	France SPM (Inshore)	France SPM (Offshore)	France Metro (All gears)	Others (All gears)	Total	TAC
1980	2,809	29,427	715	214	1,722	2,681	-	37,568	28,000
1981	2,696	26,068	2,321	333	3,768	3,706	-	38,892	30,000
1982	2,639	21,351	2,948	1,009	3,771	2,184	-	33,902	33,000
1983	2,100	23,915	2,580	843	4,775	4,238	-	38,451	33,000
1984	895	22,865	1,969	777	6,773	3,671	-	36,950	33,000
1985	4,529	24,854	3,476	642	9,422	8,444	-	51,367	41,000
1986	5,218	24,821	1,963	389	13,653	11,939	7	57,990	41,000
1987	4,133	26,735	2,517	551	15,303	9,965	-	59,204	41,000
1988	3,662	19,742	2,308	282	10,011	7,373	4	43,382	41,000
1989	3,098	23,208	2,361	339	9,642	892	-	39,540	35,400
1990	3,266	20,128	3,082	158	14,771	-	-	41,405	35,400
1991	3,916	21,778	2,106	204	15,585	-	-	43,589	35,400
1992	4,468	19,025	2,238	2	10,162	-	-	35,895	35,400
1993	1,987	11,878	1,351	-	-	-	-	15,216	20,000
1994	82	493	86	-	-	-	-	661	0
1995	26	676	60	59	-	-	-	821	0
1996	60	836	118	43	-	-	-	1,057	0
1997	108	7,594	79	448	1,191	-	-	9,420	10,000
1998	2,543	13,609	885	609	2,511	-	-	20,156	20,000
1999	3,059	21,156	614	621	2,548	-	-	27,997	30,000
2000	3,436	16,247	740	870	3,807	-	-	25,100	20,000
2001	2,152	11,187	856	675	1,675	-	-	16,546	15,000
2002	1,326	11,292	499	579	1,623	-	-	15,319	15,000
2003	1,869	10,600	412	734	1,645	-	-	15,260	15,000
2004	1,595	9,450	790	465	2,113	-	-	14,414	15,000
2005	1,863	9,537	818	617	1,941	-	-	14,776	15,000
2006	1,011	9,590	675	555	1,326	-	-	13,157	13,000
2007	1,339	9,303	294	520	1,503	-	-	12,959	13,000
2008	982	8,654	377	467	1,293	-	-	11,773	13,000
2009	1,733	5,870	193	282	1,684	-	-	9,762	11,500
2010	1,419	5,244	196	76	1,364	-	-	8,299	11,500
2011	1,392	4,046	300	456	682	-	-	6,876	11,500
2012	658	3,596	277	265	291	-	-	5,087	11,500
2013	378	2,680	174	366	768	-	-	4,366	11,500
2014	472	4,199	637	279	1,158	-	-	6,745	13,225
2015[1]	962	3,706	175	440	724	-	-	6,008	13,490
2016[1]	1,602	2,037	222	273	616	-	-	4,751	13,043

[1]Provisional catches

[2]1996-2006 includes recreational and sentinel catch. 2007-16 does not include recreational catch.

Table 2. Reported fixed gear catches of cod (t) from NAFO Subdiv. 3Ps by gear type (includes non-Canadian and recreational catch). See Healey et al. (2014) for pre-1980 data.

Year	Gillnet	Longline	Handline	Trap	Total
1980	5,493	19,331	2,545	2,077	29,446
1981	4,998	20,540	1,142	948	27,628
1982	6,283	13,574	1,597	1,929	23,383
1983	6,144	12,722	2,540	3,643	25,049
1984	7,275	9,580	2,943	3,271	23,069
1985	7,086	10,596	1,832	5,674	25,188
1986	8,668	11,014	1,634	4,073	25,389
1987	9,304	11,807	1,628	4,931	27,670
1988	6,433	10,175	1,469	2,449	20,526
1989	5,997	10,758	1,657	5,996	24,408
1990	6,948	8,792	2,217	3,788	21,745
1991	6,791	10,304	1,832	4,068	22,995
1992	5,314	10,315	1,330	3,397	20,356
1993	3,975	3,783	1,204	3,557	12,519
1994	90	0	381	0	471
1995	383	182	0	5	570
1996	467	158	137	10	772
1997	3,760	1,158	1,172	1,167	7,258
1998	10,116	2,914	308	92	13,430
1999	17,976	3,714	503	45	22,237
2000	14,218	3,100	186	56	17,561
2001	7,377	2,833	2,089	57	12,357
2002	7,827	2,309	775	119	11,030
2003	8,313	2,044	546	35	10,937
2004	7,910	2,167	415	15	10,508
2005	8,112	2,016	626	6	10,760
2006	7,590	2,698	314	2	10,603
2007[2]	7,287	2,374	445	11	10,116
2008[2]	6,636	2,482	341	21	9,480
2009[2]	4,052	1,644	612	36	6,344
2010[2]	4,013	1,182	296	2	5,493
2011[2]	2,910	882	221	19	4,032
2012[1,2]	3,089	670	192	10	3,961
2013[1,2]	1,939	457	270	14	2,680
2014[1,2]	2,760	1,066	331	38	4,195
2015[1,2]	3,065	326	299	9	3,699
2016[1,2,3]	1,621	192	213	10	2,037

[1]provisional

[2]excluding recreational catch

[3]As of September 19, 2016

Table 3. Reported Canadian (NL+Mar) monthly landings (t) of cod per unit area in NAFO Subdiv. 3Ps.

Year	Month	Inshore 3Psa	Inshore 3Psb	Inshore 3Psc	Offshore 3Psd	Offshore 3Pse	Offshore 3Psf	Offshore 3Psg	Offshore 3Psh	Total
2014	Jan	7.4	60.3	46.9	9.9	0.0	0.1	5.8	253.0	383.4
2014	Feb	8.8	35.0	58.1	12.5	0.2	0.0	79.1	177.3	371.1
2014	Mar	5.5	2.0	15.0	1.5	0.0	0.0	109.6	175.4	308.9
2014	Apr	0.1	0.0	0.0	0.7	0.0	0.0	21.5	22.5	44.7
2014	May	35.5	32.8	77.9	0.3	0.0	21.9	5.4	78.8	252.5
2014	Jun	46.5	75.3	600.0	15.6	7.9	69.1	11.7	51.4	877.5
2014	Jul	18.5	67.8	404.4	10.1	5.4	9.3	4.7	12.0	532.2
2014	Aug	5.6	18.0	183.2	0.0	4.9	17.0	0.5	1.6	230.7
2014	Sep	1.6	37.2	118.9	8.5	39.6	145.4	14.6	0.1	365.9
2014	Oct	7.8	67.0	119.9	46.2	18.0	216.3	43.6	6.4	525.2
2014	Nov	27.0	36.3	135.2	29.4	1.5	253.2	0.1	7.2	489.9
2014	Dec	21.5	125.2	258.2	0.0	0.0	11.3	11.8	498.0	926.1
2014	Total	185.8	557.0	2,017.6	134.6	77.5	743.6	308.2	1,283.7	5,307.9
2015	Jan	59.3	99.6	90.6	0.0	0.0	7.2	1.2	429.4	687.3
2015	Feb	58.6	18.3	34.4	4.6	0.0	0.0	15.6	210.2	341.8
2015	Mar	3.2	0.8	14.3	0.4	0.0	1.1	6.5	312.8	339.1
2015	Apr	3.3	0.5	4.3	0.0	0.0	0.0	0.2	4.6	12.8
2015	May	38.4	37.0	59.9	0.0	0.0	0.0	0.1	0.5	135.9
2015	Jun	35.3	51.7	280.4	0.5	0.2	8.2	0.0	0.2	376.5
2015	Jul	20.5	53.2	469.7	27.6	0.3	10.7	0.0	0.1	582.1
2015	Aug	7.4	20.2	232.1	18.8	0.0	68.1	8.1	0.1	354.8
2015	Sep	1.4	33.2	140.4	23.3	15.6	219.2	39.8	0.0	472.9
2015	Oct	4.3	37.9	199.3	2.0	22.5	180.5	45.4	0.0	492.0
2015	Nov	23.7	23.6	294.8	5.1	0.0	202.0	34.1	4.2	587.5
2015	Dec	63.6	160.5	137.6	0.5	12.2	0.0	0.0	86.5	460.9
2015	Total	319.1	536.6	1,957.8	82.9	50.8	697.0	151.1	1,048.5	4,843.8
2016	Jan	18.5	89.7	96.7	0.1	0.0	0.0	1.4	489.3	695.7
2016	Feb	28.9	56.2	36.7	0.7	0.0	4.7	47.7	919.2	1,094.2
2016	Mar	5.9	1.1	5.4	3.0	0.0	0.0	4.3	237.0	256.8
2016	Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	5.1
2016	May	34.1	41.8	51.2	0.0	0.0	9.3	0.0	10.8	147.8
2016	Jun	54.1	93.6	307.2	0.0	0.1	0.0	1.6	12.7	469.3
2016	Jul	29.6	69.1	480.7	1.6	0.5	2.6	0.0	0.8	584.9
2016	Aug	3.7	45.1	212.3	1.3	0.0	10.6	39.8	0.6	313.4
2016	Sep	7.0	50.5	209.5	0.0	0.0	24.4	2.9	0.1	294.3
2016	Oct	-	-	-	-	-	-	-	-	-
2016	Nov	-	-	-	-	-	-	-	-	-
2016	Dec	-	-	-	-	-	-	-	-	-
2016	Total	181.7	447.1	1,399.6	6.8	0.6	51.7	97.8	1,675.7	3,861.5

*French catch (2013 = 1134 t, 2014 = 1437 t, 2015 = 923 t) excluded since unit area not available.

Table 4. Estimates of average weight, average length and the total numbers (000s) and weight of 3Ps cod caught at age from Canadian and french landings during 2011-13 (Excludes recreational catch).

Year	Age	Average Weight (kg)	Average Length (cm)	Total Catch (000's)	Total Catch std error	Total Catch CV	Total Catch Weight (t)*
2011	1	0.23	30.01	15	0.01	0.51	0
2011	2	0.58	40.42	872	0.27	0.31	1
2011	3	1.07	48.47	30,602	3.23	0.11	32
2011	4	1.06	48.85	136,030	10.64	0.08	145
2011	5	1.37	53.04	838,616	20.82	0.02	11,52
2011	6	1.63	55.98	808,873	22.38	0.03	1,321
2011	7	2.18	61.44	853,939	21.85	0.03	1,853
2011	8	2.42	63.40	351,441	13.73	0.04	851
2011	9	2.72	65.09	172,333	10.16	0.06	468
2011	10	2.67	64.70	67,828	6.75	0.1	181
2011	11	2.79	66.11	32,978	4.88	0.15	92
2011	12	2.81	65.90	23,441	3.69	0.16	66
2011	13	7.01	86.65	16,763	2.7	0.16	117
2011	14	10.42	102.55	7,807	0.68	0.09	81
2011	15	5.16	80.93	9,443	3.81	0.4	49
2011	16	12.73	108.40	581	0.15	0.26	7
2011	17	15.39	118	68	0.03	0.5	1
2011	18	17.10	121.19	216	0.11	0.49	4
2011	19	-	-	0	-	-	0
2011	20	18.09	124.20	220	0.11	0.51	4
2012	1	0.06	19.00	1	0.00	0.02	0
2012	2	0.18	27.43	30	0.01	0.17	0
2012	3	0.77	44.18	8,056	0.89	0.11	6
2012	4	0.93	46.91	65,563	4.97	0.08	61
2012	5	1.39	52.96	18,3215	11.07	0.06	255
2012	6	1.95	58.98	675,125	26.42	0.04	1,315
2012	7	2.01	59.96	621,312	27.64	0.04	1,250
2012	8	2.17	61.06	396,430	23.55	0.06	862
2012	9	2.75	65.52	146,424	13.85	0.09	403
2012	10	3.31	69.30	62,806	5.73	0.09	208
2012	11	3.59	70.75	22,766	3.46	0.15	82
2012	12	2.65	64.96	30,690	5.35	0.17	81
2012	13	4.33	73.71	6239	1.19	0.19	27
2012	14	3.51	69.32	10,713	1.84	0.17	38
2012	15	7.72	92.65	3,302	0.69	0.21	26
2012	16	7.23	89.33	792	0.38	0.48	6
2012	17	15.18	116.78	120	0.05	0.44	2
2012	18	12.04	109.00	78	0.00	0.02	1
2012	19	20.75	130.00	37	0.06	1.54	1
2013	1	-	-	0	-	-	0
2013	2	0.21	29.17	34	0.01	0.18	0
2013	3	0.63	41.64	6,296	1.33	0.21	4
2013	4	1.18	50.47	153,640	11.60	0.08	182
2013	5	1.57	55.48	430,935	20.69	0.05	676
2013	6	1.86	58.53	331,654	19.51	0.06	617
2013	7	2.14	61.14	488,483	22.31	0.05	1,044
2013	8	2.05	60.18	361,214	19.03	0.05	740
2013	9	2.57	64.13	139,756	11.60	0.08	359

Table 4. Continued.

Year	Age	Average Weight (kg)	Average Length (cm)	Total Catch (000's)	Total Catch std error	Total Catch CV	Total Catch Weight (t)*
2013	10	2.98	67.76	48,664	6.68	0.14	145
2013	11	3.05	67.97	21,621	5.56	0.26	66
2013	12	3.25	69.45	20,534	4.71	0.23	67
2013	13	2.46	64.13	4,990	1.79	0.36	12
2013	14	2.42	64.46	9,231	3.42	0.37	22
2013	15	2.01	61.00	2,061	1.37	0.67	4
2013	16	0.00	0.00	0	0.00	0.00	0
2013	17	0.00	0.00	0	0.00	0.00	0
2013	18	3.96	76.00	164	0.14	0.84	1

2011 * Total catch estimate (t) 6425, Total landings (t) 6877, SOP 0.93

2012 * Total catch estimate (t) 4622, Total landings (t) 5021, SOP 0.92

2013 * Total catch estimate (t) 3939, Total landings (t) 4129, SOP 0.95

Table 5. Numbers-at-age (000s) for the commercial cod fishery in NAFO Subdiv. 3Ps from 1959 to 2013 (ages 3-14 shown). Recreational catches excluded for 2007 onward (see text).

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1959	1001	13,940	7,525	7,265	4,875	942	1,252	1,260	631	545	44	1
1960	567	5,496	23,704	6,714	3,476	3,484	1,020	827	406	407	283	27
1961	450	5,586	10,357	15,960	3,616	4,680	1,849	1,376	446	265	560	58
1962	1245	6,749	9,003	4,533	5,715	1,367	791	571	187	140	135	241
1963	961	4,499	7,091	5,275	2,527	3,030	898	292	143	99	107	92
1964	1906	5,785	5,635	5,179	2,945	1,881	1,891	652	339	329	54	27
1965	2314	9,636	5,799	3,609	3,254	2,055	1,218	1,033	327	68	122	36
1966	949	13,662	13,065	4,621	5,119	1,586	1,833	1,039	517	389	32	22
1967	2871	10,913	12,900	6,392	2,349	1,364	604	316	380	95	149	3
1968	1143	12,602	13,135	5,853	3,572	1,308	549	425	222	111	5	107
1969	774	7,098	11,585	7,178	4,554	1,757	792	717	61	120	67	110
1970	756	8,114	12,916	9,763	6,374	2,456	730	214	178	77	121	14
1971	2884	6,444	8,574	7,266	8,218	3,131	1275	541	85	125	62	57
1972	731	4,944	4,591	3,552	4,603	2,636	833	463	205	117	48	45
1973	945	4,707	11,386	4,010	4,022	2,201	2,019	515	172	110	14	29
1974	1887	6,042	9,987	6,365	2,540	1,857	1,149	538	249	80	32	17
1975	1840	7,329	5,397	4,541	5,867	723	1,196	105	174	52	6	2
1976	4110	12,139	7,923	2,875	1,305	495	140	53	17	21	4	3
1977	935	9,156	8,326	3,209	920	395	265	117	57	43	31	11
1978	502	5,146	6,096	4,006	1,753	653	235	178	72	27	17	10
1979	135	3,072	10,321	5,066	2,353	721	233	84	53	24	13	10
1980	368	1,625	5,054	8,156	3,379	1,254	327	114	56	45	21	25
1981	1022	2,888	3,136	4,652	5,855	1,622	539	175	67	35	18	2
1982	130	5,092	4,430	2,348	2,861	2,939	640	243	83	30	11	7
1983	760	2,682	9,174	4,080	1,752	1,150	1,041	244	91	37	18	8
1984	203	4,521	4,538	7,018	2,221	584	542	338	134	35	8	8
1985	152	2,639	8,031	5,144	5,242	1,480	626	545	353	109	21	6
1986	306	5,103	10,253	11,228	4,283	2,167	650	224	171	143	79	23
1987	585	2,956	11,023	9,763	5,453	1,416	1,107	341	149	78	135	50
1988	935	4,951	4,971	6,471	5,046	1,793	630	284	123	75	53	31
1989	1071	8,995	7,842	2,863	2,549	1,112	600	223	141	57	29	26
1990	2006	8,622	8,195	3,329	1,483	1,237	692	350	142	104	47	22
1991	812	7,981	10,028	5,907	2,164	807	620	428	108	76	50	22
1992	1422	4,159	8,424	6,538	2,266	658	269	192	187	83	34	41
1993	278	3,712	2,035	3,156	1,334	401	89	38	52	13	14	5

Table 5. Continued.

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1994	9	78	173	74	62	28	12	3	2	0	0	0
1995	3	7	56	119	57	37	7	2	0	0	0	0
1996	9	43	43	101	125	35	24	8	2	1	0	0
1997	66	427	1,130	497	937	826	187	93	31	4	1	0
1998	91	373	793	1,550	948	1,314	1,217	225	120	56	15	1
1999	49	628	1,202	2,156	2,321	1,020	960	873	189	110	21	8
2000	76	335	736	1,352	1,692	1,484	610	530	624	92	37	16
2001	80	475	718	1,099	1,143	796	674	257	202	192	28	13
2002	155	607	1,451	1,280	900	722	419	355	96	70	71	14
2003	15	301	879	1,810	1,139	596	337	277	167	67	55	84
2004	62	113	654	1,592	1,713	649	266	180	104	47	17	24
2005	49	330	515	1,007	1,628	1,087	499	143	95	41	26	12
2006	43	253	866	928	846	1,055	632	237	80	36	19	7
2007	97	311	727	1,072	761	501	526	401	160	44	34	21
2008	35	422	617	1,105	976	634	350	295	193	91	27	12
2009	17	129	813	1,000	902	460	205	99	114	86	56	12
2010	31	377	549	1,240	726	385	181	76	22	57	30	8
2011	31	136	839	809	854	351	172	68	33	23	17	8
2012	8	66	183	675	621	396	146	63	23	31	6	11
2013	6	154	431	332	488	361	140	49	22	21	5	9

Table 6a. Mean annual weights-at-age (kg) calculated from lengths-at-age based on samples from commercial fisheries (including food fisheries and sentinel surveys where available) in Subdiv. 3Ps in 1959-2013. The weights-at-age from 1976 are extrapolated back to 1959.

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1959	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1960	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1961	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1962	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1963	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1964	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1965	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1966	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1967	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1968	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1969	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1970	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1971	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1972	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1973	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1974	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1975	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1976	0.280	0.690	1.080	1.680	2.400	3.210	4.100	5.080	6.030	7.000	8.050	9.160
1977	0.550	0.680	1.300	1.860	2.670	3.420	4.190	4.940	5.920	6.760	8.780	10.900
1978	0.450	0.700	1.080	1.750	2.450	2.990	4.100	5.160	5.170	7.200	7.750	8.720
1979	0.410	0.650	1.010	1.650	2.550	3.680	4.300	6.490	7.000	8.200	9.530	10.840
1980	0.520	0.720	1.130	1.660	2.480	3.600	5.400	6.950	7.290	8.640	9.330	9.580
1981	0.480	0.790	1.320	1.800	2.300	3.270	4.360	5.680	7.410	9.040	8.390	9.560
1982	0.450	0.770	1.170	1.780	2.360	2.880	3.910	5.280	6.180	8.620	8.640	11.410
1983	0.580	0.840	1.330	1.990	2.580	3.260	3.770	5.040	6.560	8.450	10.060	11.820
1984	0.660	1.040	1.400	1.970	2.640	3.770	4.750	5.560	6.010	9.040	11.200	10.400
1985	0.630	0.850	1.230	1.790	2.810	3.440	5.020	6.010	6.110	7.180	9.810	10.480
1986	0.540	0.750	1.180	1.840	2.430	3.150	4.300	5.500	6.190	8.720	8.050	11.910
1987	0.560	0.770	1.210	1.630	2.310	3.020	4.330	5.110	6.200	6.980	7.080	8.340
1988	0.630	0.820	1.090	1.670	2.170	2.920	3.580	4.980	5.610	6.600	7.460	8.920
1989	0.630	0.810	1.160	1.630	2.250	3.370	4.110	5.180	6.290	7.300	7.750	8.730
1990	0.580	0.860	1.270	1.850	2.450	3.000	4.220	5.090	6.350	7.600	8.310	10.370
1991	0.600	0.750	1.170	1.740	2.370	2.910	3.690	4.230	6.340	7.680	8.640	9.720
1992	0.459	0.694	1.038	1.560	2.226	2.891	4.142	5.542	6.420	7.822	10.397	11.880
1993	0.355	0.680	1.077	1.480	2.127	2.824	4.341	4.302	4.683	7.494	6.845	8.238
1994	0.617	0.816	1.303	1.860	2.054	2.746	3.593	4.377	6.291	7.768	6.784	8.073
1995	0.520	0.850	1.570	2.030	2.470	2.780	3.460	4.300	4.270	4.160	5.590	9.241
1996	0.674	0.985	1.485	2.048	2.525	2.941	3.232	4.031	4.823	4.680	7.257	9.921
1997	0.617	0.898	1.304	1.871	2.510	3.242	3.471	3.524	4.587	6.365	8.579	10.733
1998	0.620	1.020	1.570	2.050	2.420	3.100	4.040	4.130	4.620	5.210	6.390	9.690
1999	0.700	0.920	1.570	2.310	2.530	2.820	3.920	5.320	4.990	5.270	6.140	7.270
2000	0.615	0.896	1.358	2.066	2.741	2.813	3.152	4.597	6.538	6.123	6.423	7.734
2001	0.689	1.018	1.440	1.935	2.575	3.405	3.206	3.456	5.593	8.607	7.609	8.115
2002	0.572	1.017	1.544	2.040	2.324	3.104	4.326	3.896	3.874	6.046	8.895	7.942
2003	0.681	0.974	1.574	2.111	2.342	2.634	3.867	4.750	4.297	5.330	7.819	10.346
2004	0.587	0.963	1.368	2.036	2.495	2.737	2.851	5.021	6.707	5.247	7.128	8.786
2005	0.637	0.943	1.386	1.840	2.458	2.904	3.161	3.246	4.361	6.153	5.525	7.854
2006	0.567	1.010	1.549	1.939	2.167	2.748	3.435	3.465	3.133	4.923	6.593	7.498
2007	0.556	0.938	1.444	1.962	2.235	2.533	3.732	4.957	5.512	4.861	7.079	8.806
2008	0.663	0.981	1.350	1.919	2.223	2.465	2.629	3.804	5.199	5.292	5.003	8.455
2009	0.626	1.019	1.533	1.932	2.375	2.482	2.614	3.671	5.815	7.070	7.973	8.997
2010	0.635	1.089	1.363	2.009	2.260	2.585	2.761	2.932	5.518	7.910	9.520	9.981
2011	1.060	1.063	1.374	1.633	2.170	2.422	2.717	2.665	2.788	2.806	7.008	10.424
2012	0.772	0.930	1.392	1.948	2.012	2.174	2.749	3.307	3.590	2.654	4.333	3.507
2013	0.628	1.184	1.568	1.860	2.138	2.050	2.569	2.976	3.050	3.252	2.464	2.416

Table 6b. Beginning of the year weights-at-age (kg) calculated from commercial annual mean weights-at-age. The values for 1976 are extrapolated back to 1959.

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1959	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1960	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1961	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1962	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1963	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1964	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1965	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1966	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1967	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1968	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1969	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1970	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1971	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1972	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1973	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1974	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1975	0.178	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1976	0.180	0.440	0.863	1.347	2.008	2.776	3.628	4.564	5.535	6.497	7.507	8.587
1977	0.488	0.436	0.947	1.417	2.118	2.865	3.667	4.500	5.484	6.385	7.840	9.367
1978	0.374	0.620	0.857	1.508	2.135	2.825	3.745	4.650	5.054	6.529	7.238	8.750
1979	0.309	0.541	0.841	1.335	2.112	3.003	3.586	5.158	6.010	6.511	8.283	9.166
1980	0.422	0.543	0.857	1.295	2.023	3.030	4.458	5.467	6.878	7.777	8.747	9.555
1981	0.379	0.641	0.975	1.426	1.954	2.848	3.962	5.538	7.176	8.118	8.514	9.444
1982	0.329	0.608	0.961	1.533	2.061	2.574	3.576	4.798	5.925	7.992	8.838	9.784
1983	0.433	0.615	1.012	1.526	2.143	2.774	3.295	4.439	5.885	7.226	9.312	10.106
1984	0.582	0.777	1.084	1.619	2.292	3.119	3.935	4.578	5.504	7.701	9.728	10.229
1985	0.577	0.749	1.131	1.583	2.353	3.014	4.350	5.343	5.829	6.569	9.417	10.834
1986	0.452	0.687	1.001	1.504	2.086	2.975	3.846	5.255	6.099	7.299	7.603	10.809
1987	0.463	0.645	0.953	1.387	2.062	2.709	3.693	4.688	5.840	6.573	7.857	8.194
1988	0.556	0.678	0.916	1.422	1.881	2.597	3.288	4.644	5.354	6.397	7.216	7.947
1989	0.539	0.714	0.975	1.333	1.938	2.704	3.464	4.306	5.597	6.399	7.152	8.070
1990	0.510	0.736	1.014	1.465	1.998	2.598	3.771	4.574	5.735	6.914	7.789	8.965
1991	0.558	0.660	1.003	1.487	2.094	2.670	3.327	4.225	5.681	6.983	8.103	8.987
1992	0.377	0.645	0.882	1.351	1.968	2.618	3.472	4.522	5.211	7.042	8.936	10.131
1993	0.234	0.559	0.865	1.239	1.822	2.507	3.543	4.221	5.095	6.936	7.317	9.255
1994	0.525	0.538	0.941	1.415	1.744	2.417	3.185	4.359	5.202	6.032	7.130	7.434
1995	0.378	0.724	1.132	1.626	2.143	2.390	3.083	3.931	4.323	5.116	6.590	7.918
1996	0.584	0.716	1.123	1.793	2.264	2.695	2.998	3.734	4.554	4.470	5.494	7.447
1997	0.480	0.778	1.133	1.667	2.267	2.861	3.195	3.375	4.300	5.540	6.337	8.825
1998	0.509	0.793	1.187	1.635	2.128	2.789	3.619	3.786	4.035	4.889	6.377	9.118
1999	0.619	0.755	1.265	1.904	2.277	2.612	3.486	4.636	4.540	4.934	5.656	6.816
2000	0.478	0.792	1.118	1.801	2.516	2.668	2.981	4.245	5.898	5.528	5.818	6.891
2001	0.567	0.792	1.136	1.621	2.307	3.055	3.003	3.300	5.071	7.502	6.826	7.220
2002	0.439	0.837	1.254	1.714	2.121	2.827	3.838	3.534	3.659	5.815	8.750	7.774
2003	0.573	0.746	1.265	1.806	2.186	2.474	3.465	4.533	4.092	4.544	6.876	9.593
2004	0.464	0.810	1.154	1.790	2.295	2.532	2.740	4.406	5.644	4.749	6.164	8.288
2005	0.506	0.744	1.155	1.586	2.237	2.692	2.941	3.042	4.679	6.424	5.384	7.482
2006	0.455	0.802	1.209	1.640	1.997	2.599	3.159	3.309	3.189	4.633	6.369	6.436
2007	0.419	0.729	1.207	1.744	2.082	2.343	3.203	4.126	4.370	3.902	5.903	7.620
2008	0.535	0.738	1.125	1.665	2.089	2.347	2.581	3.768	5.076	5.400	4.931	7.736
2009	0.474	0.822	1.226	1.615	2.135	2.349	2.538	3.107	4.703	6.063	6.495	6.709
2010	0.491	0.825	1.178	1.755	2.089	2.478	2.618	2.768	4.501	6.782	8.204	8.921
2011	1.132	0.822	1.223	1.492	2.088	2.340	2.650	2.712	2.859	3.935	7.445	9.962
2012	0.623	0.993	1.216	1.636	1.813	2.172	2.580	2.998	3.093	2.720	3.487	4.958
2013	0.702	0.956	1.208	1.609	2.041	2.031	2.363	2.860	3.176	3.417	2.557	3.236
2014	0.702	0.921	1.216	1.578	1.977	2.177	2.528	2.854	3.040	3.319	4.049	5.426

Table 7. Details of annual DFO research vessel surveys of 3Ps.

Year	Vessel	Start Date	End Date	Days	Sets	Sets w/ Cod	% w/ cod
1983	AN 9	23-Apr-83	8-May-83	15	164	117	0.71
1984	AN 26	10-Apr-84	17-Apr-84	7	93	59	0.63
1985	WT 26	8-Mar-85	25-Mar-85	17	109	78	0.72
1986	WT 45	6-Mar-86	23-Mar-86	17	136	88	0.65
1987	WT 55-56	13-Feb-87	22-Mar-87	37	130	95	0.73
1988	WT 68	27-Jan-88	14-Feb-88	18	146	106	0.73
1989	WT 81	1-Feb-89	16-Feb-89	15	146	90	0.62
1990	WT 91	1-Feb-90	19-Feb-90	18	108	66	0.61
1991	WT 103	2-Feb-91	20-Feb-91	18	158	104	0.66
1992	WT 118	6-Feb-92	24-Feb-92	18	137	63	0.46
1993.1	WT 133	6-Feb-93	23-Feb-93	17	136	52	0.38
1993.4	WT 135	2-Apr-93	20-Apr-93	18	130	63	0.48
1994	WT 150-151	6-Apr-94	26-Apr-94	20	166	73	0.44
1995	WT 166-167	04-Apr-95	28-Apr-95	24	161	65	0.40
1996	WT 186-187	10-Apr-96	01-May-96	22	148	105	0.71
1997	WT 202-203	02-Apr-97	23-Apr-97	22	158	104	0.66
1998	WT 219-220	10-Apr-98	05-May-98	25	177	113	0.64
1999	WT 236-237	13-Apr-99	06-May-99	23	175	128	0.73
2000	WT 313-315	08-Apr-00	11-May-00	34	171	136	0.80
2001	WT 364-365, Tel 351	07-Apr-01	29-Apr-01	23	173	134	0.77
2002	WT 418-419	05-Apr-02	27-Apr-02	21	177	117	0.66
2003	WT 476-477	05-Apr-03	02-May-03	23	176	117	0.66
2004	WT 523, WT 546, Tel 522	11-Apr-04	11-May-04	30	177	107	0.60
2005	WT 617-618, AN 656	17-Apr-05	09-May-05	22	178	134	0.75
2006	WT 688	13-Apr-06	18-Apr-06	5.1	48	43	-
2007	WT 757-759	04-Apr-07	02-May-07	29	178	135	0.76
2008	WT 824-827	10-Apr-08	23-May-08	44	169	115	0.68
2009	AN 902-904	08-Apr-09	13-May-09	35	175	137	0.78
2010	AN 930-932	08-Apr-10	08-May-10	31	177	132	0.75
2011	AN 401-403	07-Apr-11	08-May-11	32	174	131	0.75
2012	AN 415-417	31-Mar-12	26-Apr-12	27	177	137	0.77
2013	AN 430-432	26-Mar-13	23-Apr-13	29	179	133	0.74
2014	AN 445-446, Tel 130	05-Apr-14	10-May-14	36	156	105	0.67
2015	AN 450-452	11-Apr-15	10-May-15	30	173	116	0.67
2016	Tel 157,158,169	02-Apr-16	01-May-16	30	157	110	0.70

*Table 8. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Subdiv. 3Ps.**

Strata	**Depth (fathoms)**	**sq. mi.**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
314	<30	974	1,570	2,144	573	287	328	1,223	563	172	89	395
320	<30	1320	333	363	3,222	1,260	1,603	4,213	1,189	893	363	715
293	31-50	159	317	252	208	55	284	503	1,312	186	56	66
308	31-50	112	1,410	2,373	486	16,893	3,058	1,167	878	4,437	28,379	131
312	31-50	272	370	270	0	112	337	1310	854	4,247	75	792
315	31-50	827	1,268	675	1,634	767	1,405	3,705	2,243	11,141	211	2,476
321	31-50	1189	65	189	218	1,823	2,608	393	549	307	157	613
325	31-50	944	893	812	1,542	7,970	8,019	519	2,194	2,708	1,217	200
326	31-50	166	285	11	0	11	627	11	57	11	23	38
783	31-50	229	126	126	157	515	228	126	110	63	72	142
294	51-100	135	1,281	108	4,960	713	59	2,658	1,476	845	1,401	716
297	51-100	152	1,047	273	1,056	4,242	2,781	3,922	1,547	1,181	1,241	554
307	51-100	395	2,735	4,849	18,237	7,758	4,945	3,412	1,902	2,010	7,480	1,793
311	51-100	317	1,715	2,519	3,632	9,627	1,979	3,212	17,063	2,847	1,352	2,209
317	51-100	193	2,522	2,881	912	3,215	330	7,022	12,721	0	199	1,739
319	51-100	984	15,245	146,70	24,418	20,120	10,120	35,549	40,494	15,851	20,338	13,826
322	51-100	1567	2,507	1,297	1,049	820	2,546	3,162	11,202	8,400	1,376	1,616
323	51-100	696	32	3,300	105	15,274	8,179	3,067	1,332	2,489	7,854	3,452
324	51-100	494	481	153	359	417	3,590	646	610	510	680	234
781	51-100	446	445	552	548	293	506	813	5,031	1,166	756	205
782	51-100	183	101	227	201	22	566	327	512	1,032	277	138
295	101-150	209	1,469	633	396	2,441	nf	971	1,639	1,776	2,444	1,495
298	101-150	171	7,475	3,384	73	585	0	6,764	134	125	141	118
300	101-150	217	478	90	507	194	917	43	637	254	68	388
306	101-150	363	2,175	818	4,054	714	1,382	706	877	574	433	136
309	101-150	296	1,122	244	49	236	529	308	49,273	145	41	22,517
310	101-150	170	94	269	30	143	129	35	1,695	86	386	82
313	101-150	165	124	23	111	259	21	11	164	571	23	227
316	101-150	189	117	13	116	10	12	17	65	0	45	30
318	101-150	129	336	16	189	18	9	9	237	21	35	68
779	101-150	422	671	310	186	0	503	5,955	12,283	7,372	192	348
780	101-150	403	400	0	37	0	388	526	3,587	1,002	127	698
296	151-200	71	881	273	999	32	3,581	2,269	2,338	103	161	347
299	151-200	212	44	13	13	42	58	39	110	188	0	29
705	151-200	195	0	76	155	36	29	0	13	63	13	27
706	151-200	476	31	65	87	258	131	98	16	0	35	147
707	151-200	74	122	257	737	23	16	15	173	12	22	5
715	201-300	1074	132	170	599	63	53	18	26	0	3,600	117
716	151-200	128	1,368	51	1,546	180	130	676	2,330	264	551	148
708	151-200	539	641	0	4,299	26	30	28	199	Nf	59	nf
711	201-300	126	505	29	125	44	29	3,850	16	0	16	41
712	201-300	593	106	54	60	15	34	65	0	20	17	40
713	201-300	731	45	17	99	56	0	134	36	0	0	20
714	201-300	851	373	44	819	55	70	79	0	0	169	92
Total	Offshore	-	387,22	38,652	69,462	88,490	52,275	74,660	148,972	57,779	75,237	53,926
Total	In/Offshore	-	534,57	44,906	78,803	97,625	62,146	99,575	1796,89	73,072	82,172	59,170
std	Offshore	-	2,383	7,713	15,303	24,153	8,209	12,294	53,762	10,415	29,521	24,399

*See Fig. 12 for location of strata. The survey was not completed in 2006. See Brattey et al. (2007) for pre-2005 data.

*Table 9. Cod biomass estimates (t) from DFO bottom-trawl research vessel surveys in NAFO Subdiv. 3Ps.**

Strata	Depth (fathoms)	sq. mi.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
314	<30	974	53	204	68	43	100	200	69	30	52	98
320	<30	1,320	1,274	442	1,069	603	500	1,695	1,618	759	69	363
293	31-50	159	16	18	7	15	19	46	52	10	13	5
308	31-50	112	253	789	170	8,343	1,558	426	732	1,408	13,903	49
312	31-50	272	60	434	0	37	78	206	234	904	30	125
315	31-50	827	6,456	99	1,777	235	1,295	1,585	544	4,726	180	796
321	31-50	1,189	186	17	54	2,054	1,639	150	114	140	56	130
325	31-50	944	172	555	447	4,194	2,831	269	547	923	385	18
326	31-50	166	55	1	0	19	140	4	25	3	5	7
783	31-50	229	12	18	13	31	25	7	19	27	1	25
294	51-100	135	85	27	149	55	7	315	73	47	111	45
297	51-100	152	382	122	156	1,224	2,110	1,863	528	227	285	138
307	51-100	395	1,471	3,059	8,114	4,100	3,258	1,563	650	951	2,185	565
311	51-100	317	83	219	395	2,414	394	348	1,512	684	108	310
317	51-100	193	1,118	231	158	2,436	31	2,849	970	0	67	325
319	51-100	984	14,166	8,888	33,064	20,494	10,024	28,365	20,804	12,559	11,071	4,507
322	51-100	1,567	79	205	104	439	1,395	206	607	1,439	201	182
323	51-100	696	1	2,525	4	10,070	4,602	655	127	1,220	4,048	1,676
324	51-100	494	51	39	53	39	653	86	175	97	112	21
781	51-100	446	23	49	28	33	44	55	151	70	114	15
782	51-100	183	5	13	20	1	328	30	101	42	51	9
295	101-150	209	128	83	20	519	Nf	477	117	204	453	260
298	101-150	171	8,445	2881	56	250	0	3,903	37	79	43	59
300	101-150	217	149	25	286	111	480	94	200	74	14	138
306	101-150	363	2,142	645	2,021	630	932	649	501	268	244	74
309	101-150	296	1,328	673	10	282	333	210	44,380	25	14	17,005
310	101-150	170	11	427	7	82	105	17	306	74	152	28
313	101-150	165	352	79	61	213	14	21	39	315	12	87
316	101-150	189	120	5	156	7	7	29	23	0	75	30
318	101-150	129	445	25	189	32	38	15	438	51	50	76
779	101-150	422	41	38	18	0	168	1,246	4,719	1,875	34	15
780	101-150	403	86	0	2	0	71	21	284	178	13	80
296	151-200	71	146	76	239	5	2,702	1,863	589	29	33	131
299	151-200	212	327	1	2	26	63	29	9	275	0	21
705	151-200	195	0	111	122	47	36	0	49	141	18	88
706	151-200	476	56	76	51	153	180	126	17	0	53	110
707	151-200	74	109	243	469	20	24	71	154	27	21	6
715	151-200	1,074	167	296	1,793	101	74	16	45	0	2,033	181
716	151-200	128	1,933	59	961	124	111	1,102	1,476	307	311	178
708	201-300	539	940	0	3,688	16	30	32	269	nf	109	nf
711	201-300	126	1,024	52	100	33	25	3,546	4	0	7	21
712	201-300	593	94	81	52	10	22	55	0	9	9	31
713	201-300	731	27	5	59	101	0	124	16	0	0	7
714	201-300	851	514	51	808	55	59	87	0	0	160	119
Total	Offshore	-	34,740	20,535	56,024	57,429	30,487	44,706	76,447	27,057	35,740	27,211
Total	In/Offshore	-	44,585	23,910	57,020	59,698	36,505	54,656	83,327	30,195	36,905	28,154
std	Offshore	-	9,058	4,895	22,078	18,906	5,042	11,579	44,705	6,964	14,899	17,255

*See Fig. 12 for location of strata. The survey was not completed in 2006. See Brattey et al. (2007) for pre-2005 data.

Table 10a. Mean numbers per tow at age (1-15 only) in Campelen units for the Canadian research vessel bottom trawl survey of NAFO Subdiv. 3Ps (offshore index strata only).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15	Total
1983	6.42	10.01	6.52	1.14	3.72	1.62	0.48	0.89	1.61	0.75	0.36	0.14	0.06	0.05	0.04	33.81
1984	0.30	5.40	2.33	1.55	0.63	2.11	0.77	0.37	0.46	0.71	0.18	0.15	0.06	0.03	0.00	15.03
1985	0.38	7.74	14.88	12.57	9.96	3.28	2.66	0.79	0.48	0.42	0.42	0.49	0.21	0.12	0.03	54.43
1986	0.20	6.62	5.65	6.48	7.95	6.33	2.13	1.47	0.84	0.29	0.24	0.29	0.17	0.10	0.06	38.82
1987	1.09	8.48	5.67	4.97	13.82	8.31	3.35	1.29	0.69	0.28	0.23	0.16	0.17	0.16	0.06	48.73
1988	0.42	9.13	5.93	2.96	2.84	6.50	5.84	3.65	1.49	0.84	0.74	0.35	0.16	0.15	0.09	41.09
1989	0.49	6.50	4.66	3.17	1.51	1.16	2.15	1.21	0.67	0.37	0.41	0.13	0.11	0.05	0.09	22.68
1990	0.00	1.48	9.82	14.49	10.89	5.67	3.84	3.14	1.15	0.71	0.32	0.16	0.12	0.09	0.01	51.88
1991	1.30	27.69	5.03	10.00	11.24	5.75	2.84	1.58	1.19	0.74	0.56	0.22	0.11	0.07	0.04	68.36
1992	0.00	1.80	6.95	2.11	4.15	2.03	1.03	0.53	0.26	0.24	0.08	0.04	0.01	0.01	0.02	19.26
1993(Feb)	0.00	0.00	1.83	4.03	0.71	2.96	0.68	0.33	0.13	0.09	0.11	0.03	0.04	0.01	0.01	10.96
1993(Apr)	0.00	0.00	1.99	4.04	1.49	1.35	0.47	0.10	0.04	0.03	0.04	0.01	0.00	0.01	0.01	9.58
1994	0.00	1.63	1.46	4.31	6.10	1.73	1.62	0.50	0.08	0.04	0.03	0.02	0.01	0.01	0.00	17.54
1995	0.00	0.31	1.16	1.67	13.08	19.65	4.40	5.75	2.19	0.25	0.20	0.01	0.07	0.03	0.00	48.77
1996	0.90	1.08	3.67	3.62	1.32	2.69	2.91	0.54	0.46	0.09	0.09	0.02	0.00	0.00	0.00	17.39
1997	0.22	1.53	2.33	1.04	0.50	0.28	0.30	0.24	0.14	0.05	0.02	0.00	0.00	0.00	0.00	6.65
1998	0.52	0.97	6.79	8.42	5.60	3.99	1.96	2.50	2.79	0.43	0.30	0.06	0.03	0.00	0.00	34.36
1999	1.24	2.54	2.55	2.38	2.58	2.34	1.72	0.44	0.79	0.60	0.09	0.02	0.02	0.00	0.00	17.31
2000	1.25	3.33	5.36	3.10	2.17	1.82	1.20	0.89	0.35	0.31	0.53	0.12	0.00	0.01	0.00	20.44
2001	0.57	2.26	12.41	12.29	4.36	2.04	1.26	0.77	0.71	0.38	0.50	0.94	0.12	0.06	0.03	38.70
2002	0.58	1.10	3.90	8.28	5.85	3.04	2.04	0.99	0.53	0.37	0.08	0.12	0.19	0.01	0.00	27.08
2003	0.52	1.46	1.78	4.08	6.55	3.94	1.50	0.72	0.33	0.18	0.19	0.05	0.11	0.01	0.01	21.43
2004	0.20	1.90	2.07	1.71	2.08	4.05	4.24	1.26	0.81	0.67	0.79	0.15	0.10	0.02	0.07	20.12
2005	0.77	1.43	6.73	4.96	1.60	0.89	0.79	0.71	0.28	0.05	0.17	0.08	0.03	0.03	0.09	18.61
2007	3.18	1.73	4.84	3.11	1.48	0.76	0.44	0.22	0.47	0.42	0.12	0.09	0.08	0.05	0.01	17.00
2008	0.47	4.39	4.51	3.32	1.92	1.12	0.47	0.32	0.12	0.15	0.10	0.04	0.03	0.01	0.00	16.97
2009	0.40	1.43	9.25	6.67	5.70	3.09	1.79	0.99	0.21	0.17	0.21	0.38	0.14	0.02	0.00	30.45
2010	0.60	2.13	7.65	15.71	6.70	4.06	1.47	0.29	0.10	0.04	0.04	0.09	0.01	0.00	0.00	38.89
2011	0.15	4.70	6.55	2.46	5.08	1.92	1.41	0.48	0.10	0.08	0.00	0.02	0.01	0.01	0.00	22.97
2012	5.32	2.94	8.88	5.82	3.22	3.38	1.75	0.96	0.17	0.26	0.02	0.04	0.00	0.01	0.02	32.79
2013	1.58	18.42	11.49	16.61	6.43	4.50	3.09	2.36	0.56	0.28	0.07	0.01	0.00	0.01	0.00	65.41
2014	0.85	3.33	11.33	4.74	2.22	1.15	0.43	0.94	0.48	0.07	0.00	0.01	0.00	0.01	0.00	25.56
2015	0.11	4.55	9.11	12.60	3.32	1.36	1.07	0.36	0.50	0.06	0.01	0.00	0.00	0.00	0.00	33.05
2016	0.98	2.40	6.10	5.27	5.45	2.31	0.81	0.25	0.14	0.16	0.01	0.00	0.00	0.00	0.00	23.87

*Data are adjusted for missing strata. The survey in 2006 was not completed and there were two surveys in 1993 (February and April).

Table 10b. Mean numbers per tow at age (1-15 only) in Campelen units for the Canadian research vessel bottom trawl survey of NAFO Subdiv. 3Ps (inshore and offshore strata).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15	Total
1997	0.32	1.68	2.44	1.01	0.46	0.25	0.26	0.21	0.12	0.04	0.01	0.00	0.00	0.00	0.00	6.80
1998	0.72	1.28	6.28	7.40	4.91	3.53	1.73	2.19	2.43	0.38	0.26	0.06	0.03	0.00	0.00	31.20
1999	1.31	3.05	2.52	2.26	2.41	2.12	1.54	0.39	0.68	0.52	0.07	0.02	0.02	0.01	0.00	16.92
2000	1.38	3.84	6.66	3.52	2.24	1.75	1.11	0.80	0.31	0.28	0.46	0.11	0.00	0.01	0.00	22.47
2001	0.99	2.88	11.44	10.58	3.71	1.74	1.08	0.66	0.60	0.32	0.43	0.80	0.10	0.05	0.03	35.41
2002	0.79	1.53	3.72	7.08	4.95	2.58	1.73	0.85	0.45	0.31	0.07	0.11	0.16	0.01	0.00	24.34
2003	0.61	2.62	2.24	3.67	5.88	3.51	1.34	0.63	0.28	0.16	0.17	0.04	0.09	0.01	0.01	21.26
2004	0.33	2.24	2.50	1.85	1.93	3.49	3.61	1.08	0.68	0.57	0.67	0.13	0.09	0.02	0.06	19.25
2005	0.80	1.63	7.32	7.27	3.49	2.08	1.52	1.20	0.41	0.09	0.15	0.06	0.03	0.03	0.08	26.16
2007	3.31	2.34	5.33	3.26	2.11	1.14	0.76	0.35	0.56	0.37	0.12	0.10	0.07	0.04	0.01	19.87
2008	0.55	4.09	4.30	3.27	1.99	1.22	0.50	0.34	0.12	0.14	0.08	0.04	0.02	0.01	0.00	16.67
2009	1.44	2.47	8.64	5.81	4.91	2.65	1.53	0.84	0.18	0.15	0.18	0.32	0.12	0.01	0.00	29.25
2010	0.68	2.76	7.75	13.95	5.87	3.53	1.27	0.25	0.08	0.03	0.03	0.07	0.01	0.00	0.00	36.28
2011	0.19	4.63	6.37	2.56	5.46	2.04	1.42	0.49	0.09	0.08	0.00	0.02	0.01	0.01	0.00	23.37
2012	5.50	3.99	11.21	6.37	3.34	3.39	1.76	0.94	0.16	0.25	0.01	0.04	0.00	0.01	0.02	36.99
2013	3.14	19.94	12.11	16.14	5.83	4.04	2.72	2.06	0.48	0.24	0.06	0.01	0.00	0.01	0.00	66.78
2014	1.44	5.21	11.03	4.54	2.23	1.11	0.41	0.83	0.42	0.06	0.00	0.01	0.00	0.01	0.00	27.32
2015	0.41	4.90	8.47	10.97	2.87	1.17	0.92	0.31	0.43	0.06	0.01	0.00	0.00	0.00	0.00	30.51
2016	1.07	2.58	5.98	4.62	4.71	2.00	0.69	0.22	0.12	0.14	0.01	0.00	0.00	0.00	0.00	22.13

*Data are adjusted for missing strata. The survey in 2006 was not completed.

Table 11. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983-2016. Shaded entries (*) are based on fewer than 5 aged fish.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1983	10.3	20.2	31.2	43.1	52.9	57.8	65.6	71.5	73.4	79.4	89.6	93.7
1984	12.0*	19.2	30.7	42.1	52.2	60.7	66.2	70.6	75.5	79.1	84.2	98.1
1985	-	17.9	29.1	40.3	51.2	60.2	66.4	74.2	73.9	79.4	88.9	93.0
1986	11.0*	18.8	27.1	40.3	49.0	55.7	62.1	72.2	76.4	82.8	93.3	93.9
1987	10.7	19.9	29.5	39.5	48.4	54.1	61.2	67.3	77.8	85.4	83.2	89.9
1988	9.2*	19.7	29.0	40.7	47.8	56.2	62.2	66.7	74.6	79.7	79.7	87.5
1989	12.0*	19.2	30.2	41.7	48.2	56.3	64.0	71.8	75.9	84.6	88.5	96.6
1990	-	19.9	29.9	40.1	48.3	53.7	56.6	62.3	70.1	76.2	79.1	88.7
1991	9.5	19.2	29.8	39.0	47.0	53.5	57.4	62.8	68.2	73.7	73.8	77.1
1992	-	20.7	30.4	40.9	47.4	55.3	61.2	62.4	66.7	73.3	83.9	81.8
1993	-	-	30.9	41.3	48.0	52.7	62.3	70.6	77.1	80.2*	96.0	106.0*
1994	-	19.1	32.2	39.4	48.2	50.2	53.7	59.1	68.0	87.7	79.7*	90.5
1995	-	21.2*	29.9	42.0	50.4	56.5	58.2	57.9	63.0	79.6	81.3	83.6*
1996	12.6	20.8	30.0	38.7	44.2	52.9	60.9	61.2	63.3	76.8	74.7	86.1*
1997	12.7	24.1	31.8	40.9	48.2	51.6	60.7	65.4	67.3	67.3	82.5*	-
1998	10.6	22.3	32.8	42.7	49.1	53.3	57.6	67.1	77.4	77.2	64.3	78.0*
1999	12.0	22.4	31.4	43.2	51.4	58.9	61.7	66.2	77.6	86.8	76.9	109.0*
2000	13.3	22.0	31.7	40.8	48.8	54.7	60.5	65.3	67.9	81.2	92.7	89.1
2001	10.6	21.9	33.2	40.6	47.6	51.4	57.4	68.8	77.5	75.0	85.5	96.8
2002	12.0	22.0	31.8	42.0	50.8	55.1	55.2	67.2	74.6	79.8	73.4*	86.0
2003	10.7	23.7	31.9	43.0	51.8	55.4	58.6	58.7	70.5	72.0	65.5	86.6*
2004	14.0	20.2	33.7	38.9	47.6	60.8	66.3	69.2	67.3	69.6	73.2	73.5*
2005	12.1	25.5	34.2	41.9	48.6	54.5	63.5	67.6	72.3	72.6*	99.2	103.4
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	11.1	21.2	30.7	38.1	48.9	54.9	55.8	64.9	81.7	91.6	86.9	86.6
2008	11.7	18.4	26.6	38.5	45.9	53.0	60.2	59.4	66.9	68.2	90.0	94.1
2009	12.3	19.1	31.3	38.7	46.7	55.0	60.5	63.5	72.3	76.0	83.3	87.2
2010	11.8	22.7	30.5	40.4	45.6	55.0	65.8	70.9	75.2	81.1*	92.6*	103.1
2011	14.0	23.5	30.2	40.1	47.1	49.5	56.1	61.7	73.8	53.2*	-	75.5*
2012	11.1	18.6	34.2	41.7	48.1	55.8	53.9	61.0	72.2	73.8*	105.0*	107.0*
2013	12.3	20.4	27.9	41.9	47.7	47.8	53.4	54.0	63.7	55.4	97.0*	95.9*
2014	10.6	20.9	30.2	35.0	47.8	53.4	54.5	63.2	65.0	59.3*	-	80.0*
2015	11.9	20.9	30.5	39.8	45.0	53.8	56.5	56.0	64.5	72.4*	87.0*	-
2016	12.2	19.4	29.7	38.6	45.3	48.8	55.7	61.4	57.0*	72.4	96.0*	-

Table 12. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983-2016. Shaded entries (*) are based on fewer than 5 aged fish.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12
1983	0.01	0.07	0.22	0.66	1.29	1.59	2.15	3.44	3.87	5.22	8.81	10.34
1984	-	0.07	0.25	0.63	1.13	1.84	2.74	3.84	4.26	5.06	8.09	10.03
1985	-	-	0.21	0.49	1.05	1.60	2.30	3.19	3.31*	3.76*	-	3.97*
1986	-	0.05	0.17	0.45	0.87	1.36	2.39	3.25	5.42	4.41	6.42*	9.16
1987	-	-	0.23	0.52	0.92	1.32	1.88	2.41	4.33	6.35	6.74	6.11
1988	-	0.06	0.19	0.56	0.88	1.42	2.17	2.51	4.08	4.77	4.21	9.43
1989	-	0.06	0.24	0.58	0.91	1.28	2.25	3.74	4.57	5.95	8.78	8.88
1990	-	0.06	0.20	0.52	0.96	1.36	1.62	2.19	3.21	4.33	5.09	7.46
1991	0.01	0.05	0.20	0.45	0.84	1.33	1.74	2.37	3.09	4.08	4.10	5.09
1992	-	0.06	0.22	0.54	0.89	1.44	2.06	2.32	2.91	4.15	5.90	5.81
1993	-	-	0.21	0.54	0.86	1.20	2.05	3.13	4.48	4.47*	8.53	13.20*
1994	-	0.05	0.23	0.44	0.87	1.08	1.33	1.87	3.03	6.35	5.21*	7.47
1995	-	0.06*	0.20	0.52	0.93	1.50	1.75	1.75	2.28	4.88	5.50	6.49*
1996	0.02	0.07	0.22	0.46	0.71	1.21	2.04	2.19	2.41	4.46	3.99	7.01*
1997	0.02	0.11	0.26	0.54	0.88	1.15	1.87	2.64	3.06	3.22	5.46*	-
1998	0.01	0.09	0.28	0.62	0.99	1.27	1.63	2.74	4.76	5.07	2.68	5.25*
1999	0.01	0.10	0.28	0.64	1.10	1.72	2.08	2.57	4.39	6.87	5.12	13.16*
2000	0.02	0.08	0.27	0.57	0.92	1.35	1.90	2.51	2.91	5.19	8.34	8.13
2001	0.01	0.08	0.28	0.55	0.87	1.16	1.67	2.96	4.39	4.35	6.09	9.05
2002	0.01	0.09	0.24	0.56	1.01	1.39	1.45	2.75	4.00	5.11	4.20*	6.24
2003	0.01	0.10	0.27	0.61	1.10	1.46	1.83	1.74	3.15	3.76	2.64	6.56*
2004	0.02	0.07	0.31	0.50	0.86	1.81	2.47	3.15	2.95	3.34	4.25	4.71*
2005	0.01	0.14	0.34	0.62	1.00	1.37	2.24	3.12	4.06	4.47*	10.31	11.30
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	0.01	0.08	0.23	0.46	0.95	1.44	1.57	2.54	5.34	8.17	7.66	7.82
2008	0.01	0.05	0.16	0.47	0.80	1.18	1.85	1.88	2.78	3.29	7.21	9.11
2009	0.01	0.05	0.24	0.47	0.79	1.39	1.96	2.42	3.68	4.27	6.26	7.07
2010	0.01	0.09	0.22	0.52	0.79	1.40	2.51	3.24	4.24	6.96*	9.05*	11.31
2011	0.02	0.11	0.24	0.50	0.87	1.09	1.67	2.35	3.80	1.30*	-	4.43*
2012	0.01	0.05	0.33	0.60	0.89	1.45	1.35	2.20	3.82	4.02	9.23*	12.61*
2013	0.02	0.07	0.19	0.60	0.89	0.98	1.42	1.43	2.44	1.76	9.88	10.32*
2014	0.01	0.08	0.21	0.35	0.86	1.28	1.36	2.24	2.65*	2.20*	-	4.68
2015	0.01	0.07	0.22	0.49	0.77	1.34	1.58	1.56	2.65	4.02*	5.67*	-
2016	0.01	0.05	0.19	0.45	0.73	1.02	1.45	2.17	1.30*	3.28	9.68*	-

Table 13. Parameter estimates and SE's for a probit model fitted to observed proportions mature at age (from "combined" survey area) for female cod from NAFO Subdiv. 3Ps based on surveys conducted during 1959-2016.

Cohort	Slope	Slope SE	Intercept	Intercept SE	Cohort	Slope	Slope SE	Intercept	Intercept SE
1954	1.1094	0.2940	-8.1702	2.4445	**1983**	1.8944	0.2608	-11.8903	1.6045
1955	1.5059	0.2237	-10.2633	1.6124	**1984**	2.2315	0.2981	-13.4166	1.8044
1956	1.3174	0.3208	-9.4592	2.2216	**1985**	2.6988	0.3728	-16.0342	2.2010
1957	1.4604	0.3703	-10.3248	2.3525	**1986**	2.5829	0.2930	-14.0673	1.5934
1958	2.3929	0.5853	-16.4519	3.6202	**1987**	2.2526	0.2231	-11.9227	1.2350
1959	2.1113	0.5358	-13.0196	2.9364	**1988**	2.7731	0.4110	-14.0212	2.1672
1960	1.6741	0.2990	-10.6677	1.7584	**1989**	1.8846	0.1577	-9.7844	0.8110
1961	1.8639	0.3551	-11.4722	2.0669	**1990**	1.7888	0.1900	-9.2101	0.9575
1962	1.7141	0.2898	-10.5115	1.7043	**1991**	2.4874	0.4971	-13.1443	2.5618
1963*	-	-	-	-	**1992**	2.6015	0.3903	-13.0008	1.9108
1964	1.9272	0.2411	-12.7182	1.5667	**1993**	1.8954	0.2394	-9.8698	1.2957
1965	2.4194	0.5982	-16.4244	4.2387	**1994**	1.6015	0.1969	-8.1481	1.0091
1966	1.5492	0.2401	-10.0608	1.6025	**1995**	1.6523	0.2188	-8.7711	1.1242
1967	1.6876	0.3782	-10.0845	2.2543	**1996**	1.7414	0.2410	-9.3461	1.2620
1968	2.1397	0.2885	-13.1625	1.7869	**1997**	3.0797	0.4567	-14.8462	2.1742
1969	1.6825	0.3043	-10.3672	1.8439	**1998**	1.9984	0.2396	-9.6586	1.1567
1970	1.5265	0.2305	-8.8558	1.3136	**1999**	1.8423	0.2647	-9.1495	1.3103
1971	1.3122	0.1401	-7.8405	0.8346	**2000**	1.7800	0.3025	-9.2716	1.4885
1972	1.4117	0.1445	-8.9081	0.8853	**2001**	1.7588	0.2292	-8.3449	1.0333
1973	1.4521	0.1667	-9.3550	1.0320	**2002**	1.6768	0.2439	-8.8522	1.2949
1974	2.0042	0.1969	-13.1541	1.2944	**2003**	1.5873	0.2283	-9.0376	1.2856
1975	1.7846	0.2174	-11.1641	1.3757	**2004**	1.4999	0.1654	-8.3631	0.9171
1976	1.3552	0.2056	-8.5990	1.2510	**2005**	1.8575	0.2314	-10.0273	1.2522
1977	2.5066	0.3505	-15.3640	2.1732	**2006**	1.7505	0.1777	-8.5990	0.9036
1978	1.7920	0.1680	-10.7323	1.0205	**2007**	1.5890	0.2500	-7.5598	1.1865
1979	1.0297	0.1138	-6.4477	0.7670	**2008**	1.7494	0.2409	-8.5749	1.0643
1980	1.4270	0.1415	-9.4134	0.9131	**2009**	2.1752	0.2508	-10.4787	1.1117
1981	1.7431	0.1781	-11.9865	1.1846	**2010**	1.7920	0.2948	-8.9887	1.4146
1982	2.0091	0.2059	-13.3056	1.3496	**2011**	2.3129	0.5715	-11.9988	2.7316

*Fit not significant

Table 14. Estimated proportions mature for female cod from NAFO Subdiv. 3Ps from DFO surveys from 1978 to 2016, projected forward to 2019. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age (from “combined” survey area). Black shaded cells(*) are averages of the three closest cohorts; grey shaded cells (†) are the average of estimates for the adjacent cohorts.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1954	0.0004*	0.0015*	0.0050*	0.0175*	0.0607*	0.1938*	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1955	0.0009	0.0015*	0.0050*	0.0175*	0.0607*	0.1938*	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1956	0.0002	0.0026	0.0050*	0.0175*	0.0607*	0.1938*	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1957	0.0003	0.0007	0.0078	0.0175*	0.0607*	0.1938*	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1958	0.0001	0.0011	0.0032	0.0234	0.0607*	0.1938*	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1959	0.0000	0.0006	0.0040	0.0142	0.0677	0.1938*	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1960	0.0000	0.0000	0.0026	0.0149	0.0610	0.1804	0.4701*	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1961	0.0001	0.0002	0.0001	0.0112	0.0535	0.2265	0.4003	0.7573*	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1962	0.0001	0.0007	0.0012	0.0010	0.0464	0.1744	0.5691	0.6693	0.9135*	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1963	0.0002	0.0004	0.0035	0.0102	0.0111	0.1733	0.4409	0.8562	0.8599	0.9723*	0.9914*	0.9973*	0.9992*	0.9997*
1964	0.0001†	0.0008	0.0028	0.0185	0.0785	0.1096	0.4745	0.7465	0.9641	0.9490	0.9914*	0.9973*	0.9992*	0.9997*
1965	0.0000	0.0005†	0.0046	0.0177	0.0914	0.4129	0.5741	0.7955	0.9166	0.9918	0.9826	0.9973*	0.9992*	0.9997*
1966	0.0000	0.0001	0.0028†	0.0252	0.1041	0.3491	0.8531	0.9365	0.9437	0.9762	0.9982	0.9942	0.9992*	0.9997*
1967	0.0002	0.0000	0.0010	0.0159†	0.1255	0.4283	0.7410	0.9796	0.9938	0.9863	0.9935	0.9996	0.9981	0.9997*
1968	0.0002	0.0009	0.0001	0.0066	0.0847†	0.4435	0.8285	0.9385	0.9975	0.9994	0.9968	0.9983	0.9999	0.9994
1969	0.0000	0.0012	0.0044	0.0012	0.0438	0.3415†	0.8157	0.9689	0.9879	0.9997	0.9999	0.9993	0.9995	1.0000
1970	0.0002	0.0001	0.0066	0.0206	0.0130	0.2396	0.7498†	0.9609	0.9950	0.9977	1.0000	1.0000	0.9998	0.9999
1971	0.0007	0.0009	0.0012	0.0344	0.0899	0.1292	0.6840	0.9489†	0.9927	0.9992	0.9996	1.0000	1.0000	1.0000
1972	0.0015	0.0030	0.0049	0.0099	0.1616	0.3174	0.6251	0.9370	0.9915†	0.9987	0.9999	0.9999	1.0000	1.0000
1973	0.0006	0.0054	0.0137	0.0257	0.0784	0.5103	0.6865	0.9493	0.9903	0.9986†	0.9998	1.0000	1.0000	1.0000
1974	0.0004	0.0023	0.0198	0.0601	0.1240	0.4196	0.8492	0.9116	0.9953	0.9986	0.9998†	1.0000	1.0000	1.0000
1975	0.0000	0.0016	0.0093	0.0697	0.2274	0.4324	0.8600	0.9682	0.9798	0.9996	0.9998	1.0000†	1.0000	1.0000
1976	0.0001	0.0001	0.0067	0.0369	0.2176	0.5752	0.8038	0.9812	0.9940	0.9956	1.0000	1.0000	1.0000†	1.0000
1977	0.0007	0.0005	0.0008	0.0280	0.1359	0.5082	0.8617	0.9566	0.9978	0.9989	0.9991	1.0000	1.0000	1.0000†
1978	0.0000	0.0028	0.0030	0.0058	0.1096	0.3922	0.7933	0.9663	0.9916	0.9997	0.9998	0.9998	1.0000	1.0000
1979	0.0001	0.0000	0.0106	0.0175	0.0418	0.3447	0.7259	0.9344	0.9925	0.9984	1.0000	1.0000	1.0000	1.0000
1980	0.0044	0.0008	0.0004	0.0400	0.0961	0.2444	0.6920	0.9157	0.9815	0.9984	0.9997	1.0000	1.0000	1.0000
1981	0.0003	0.0123	0.0047	0.0048	0.1391	0.3878	0.7058	0.9057	0.9781	0.9949	0.9996	0.9999	1.0000	1.0000
1982	0.0000	0.0014	0.0336	0.0275	0.0557	0.3851	0.7905	0.9468	0.9762	0.9946	0.9986	0.9999	1.0000	1.0000
1983	0.0000	0.0002	0.0059	0.0888	0.1453	0.4196	0.7084	0.9574	0.9925	0.9943	0.9987	0.9996	1.0000	1.0000
1984	0.0000	0.0001	0.0012	0.0240	0.2143	0.5049	0.8986	0.9040	0.9926	0.9990	0.9987	0.9997	0.9999	1.0000
1985	0.0000	0.0003	0.0007	0.0066	0.0929	0.4330	0.8596	0.9909	0.9733	0.9987	0.9999	0.9997	0.9999	1.0000

Table 14. Continued.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14
1986	0.0000	0.0001	0.0020	0.0051	0.0366	0.2991	0.6814	0.9735	0.9993	0.9930	0.9998	1.0000	0.9999	1.0000
1987	0.0000	0.0000	0.0012	0.0132	0.0370	0.1783	0.6401	0.8569	0.9955	0.9999	0.9982	1.0000	1.0000	1.0000
1988	0.0001	0.0001	0.0004	0.0111	0.0818	0.2225	0.5536	0.8811	0.9437	0.9992	1.0000	0.9995	1.0000	1.0000
1989	0.0000	0.0006	0.0018	0.0053	0.0946	0.3719	0.6809	0.8763	0.9686	0.9791	0.9999	1.0000	0.9999	1.0000
1990	0.0004	0.0002	0.0057	0.0233	0.0731	0.4931	0.7975	0.9409	0.9759	0.9923	0.9925	1.0000	1.0000	1.0000
1991	0.0006	0.0024	0.0033	0.0515	0.2400	0.5396	0.9006	0.9632	0.9916	0.9957	0.9981	0.9973	1.0000	1.0000
1992	0.0000	0.0036	0.0158	0.0507	0.3408	0.8069	0.9457	0.9883	0.9943	0.9989	0.9992	0.9996	0.9990	1.0000
1993	0.0000	0.0003	0.0210	0.0957	0.4612	0.8310	0.9822	0.9962	0.9987	0.9991	0.9998	0.9999	0.9999	0.9997
1994	0.0003	0.0004	0.0034	0.1136	0.4106	0.9320	0.9791	0.9986	0.9997	0.9999	0.9999	1.0000	1.0000	1.0000
1995	0.0014	0.0023	0.0055	0.0394	0.4339	0.8210	0.9955	0.9978	0.9999	1.0000	1.0000	1.0000	1.0000	1.0000
1996	0.0008	0.0071	0.0150	0.0695	0.3302	0.8209	0.9679	0.9997	0.9998	1.0000	1.0000	1.0000	1.0000	1.0000
1997	0.0005	0.0042	0.0341	0.0921	0.5017	0.8557	0.9648	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1998	0.0000	0.0028	0.0216	0.1490	0.4030	0.9314	0.9862	0.9939	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
1999	0.0005	0.0002	0.0160	0.1032	0.4649	0.8180	0.9946	0.9988	0.9990	0.9999	1.0000	1.0000	1.0000	1.0000
2000	0.0007	0.0035	0.0037	0.0847	0.3753	0.8117	0.9676	0.9996	0.9999	0.9998	1.0000	1.0000	1.0000	1.0000
2001	0.0006	0.0042	0.0250	0.0740	0.3455	0.7582	0.9553	0.9950	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2002	0.0014	0.0033	0.0260	0.1591	0.6347	0.7507	0.9424	0.9907	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000
2003	0.0008	0.0079	0.0192	0.1443	0.5826	0.9742	0.9450	0.9884	0.9981	0.9999	1.0000	1.0000	1.0000	1.0000
2004	0.0006	0.0041	0.0444	0.1042	0.5155	0.9115	0.9988	0.9899	0.9978	0.9996	1.0000	1.0000	1.0000	1.0000
2005	0.0010	0.0028	0.0214	0.2125	0.4082	0.8704	0.9870	0.9999	0.9982	0.9996	0.9999	1.0000	1.0000	1.0000
2006	0.0003	0.0047	0.0137	0.1048	0.6104	0.8035	0.9769	0.9982	1.0000	0.9997	0.9999	1.0000	1.0000	1.0000
2007	0.0011	0.0018	0.0206	0.0637	0.3850	0.9010	0.9604	0.9963	0.9998	1.0000	0.9999	1.0000	1.0000	1.0000
2008	0.0025	0.0061	0.0115	0.0860	0.2495	0.7701	0.9814	0.9931	0.9994	1.0000	1.0000	1.0000	1.0000	1.0000
2009	0.0011	0.0123	0.0340	0.0693	0.2966	0.6192	0.9471	0.9967	0.9988	0.9999	1.0000	1.0000	1.0000	1.0000
2010	0.0002	0.0062	0.0577	0.1684	0.3230	0.6539	0.8883	0.9897	0.9994	0.9998	1.0000	1.0000	1.0000	1.0000
2011	0.0007	0.0022	0.0347	0.2308	0.5383	0.7536	0.8944	0.9749	0.9981	0.9999	1.0000	1.0000	1.0000	1.0000
2012	0.0001	0.0045	0.0188	0.1712	0.5951	0.8703	0.9514	0.9743	0.9948	0.9996	1.0000	1.0000	1.0000	1.0000
2013	0.0004	0.0006	0.0263	0.1446	0.5429	0.8781	0.9748	0.9921	0.9942	0.9989	0.9999	1.0000	1.0000	1.0000
2014	0.0004	0.0024	0.0063	0.1393	0.5980	0.8723	0.9724	0.9955	0.9988	0.9987	0.9998	1.0000	1.0000	1.0000
2015	0.0004	0.0024	0.0171	0.0602	0.4928	0.9291	0.9752	0.9942	0.9992	0.9998	0.9997	1.0000	1.0000	1.0000
2016	0.0004	0.0024	0.0171	0.1147	0.3931	0.8536	0.9914	0.9956	0.9988	0.9999	1.0000	0.9999	1.0000	1.0000
2017	0.0004	0.0024	0.0171	0.1147	0.4947	0.8675	0.9722	0.9990	0.9992	0.9998	1.0000	1.0000	1.0000	1.0000
2018	0.0004	0.0024	0.0171	0.1147	0.4947	0.8834	0.9851	0.9953	0.9999	0.9999	1.0000	1.0000	1.0000	1.0000
2019	0.0004	0.0024	0.0171	0.1147	0.4947	0.8834	0.9829	0.9985	0.9992	1.0000	1.0000	1.0000	1.0000	1.0000

Table 15a. *Standardized gillnet (5.5 in mesh) annual catch rate-at-age indices estimated using data from sentinel fishery fixed sites. Catch rates are expressed as fish per net.*

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Total
1995	0.02	0.07	4.00	8.69	5.28	2.46	0.37	0.15	21.04
1996	0.01	0.26	2.65	12.16	9.92	2.83	0.84	0.07	28.74
1997	0.01	0.21	5.14	5.16	9.20	7.45	1.10	0.59	28.86
1998	0.00	0.06	1.08	7.49	3.36	2.63	1.62	0.31	16.57
1999	0.05	0.07	0.43	0.81	1.26	0.59	0.25	0.24	3.70
2000	0.01	0.02	0.29	0.70	0.69	0.94	0.31	0.10	3.06
2001	0.01	0.11	0.39	0.87	0.69	0.39	0.37	0.17	3.00
2002	0.00	0.03	0.49	0.77	0.75	0.33	0.17	0.18	2.72
2003	0.01	0.05	0.22	0.96	0.46	0.17	0.09	0.04	2.00
2004	0.00	0.05	0.21	0.79	0.80	0.38	0.13	0.03	2.39
2005	0.00	0.02	0.13	0.56	0.64	0.37	0.28	0.05	2.04
2006	0.00	0.05	0.28	0.54	0.48	0.55	0.23	0.12	2.24
2007	0.00	0.05	0.39	1.01	0.71	0.37	0.26	0.17	2.97
2008	0.00	0.08	0.26	1.02	0.86	0.43	0.21	0.09	2.94
2009	0.02	0.02	0.24	0.61	1.10	0.21	0.16	0.05	2.40
2010	0.01	0.05	0.36	0.78	0.65	0.32	0.11	0.18	2.46
2011	0.01	0.01	0.10	0.31	0.57	0.22	0.16	0.02	1.40
2012	0.00	0.03	0.13	0.47	0.49	0.38	0.12	0.06	1.69
2013	0.12	0.06	0.46	1.04	0.43	0.47	0.26	0.03	2.86
2014	0.01	0.03	0.42	0.45	0.29	0.47	0.22	0.11	1.99
2015	0.01	0.08	0.28	0.31	0.26	0.32	0.16	0.07	1.50

Table 15b. Standardized line-trawl annual catch rate-at-age indices estimated using data from sentinel fishery fixed sites. Catch rates are expressed as fish per 1,000 hooks.

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Total
1995	6.81	13.87	49.03	70.71	18.71	17.05	3.57	1.35	181.11
1996	7.68	27.94	26.92	43.09	44.65	12.86	7.11	1.67	171.92
1997	5.29	22.50	24.53	15.90	16.20	20.07	2.78	1.60	108.88
1998	6.38	15.81	19.37	15.47	5.97	8.87	10.87	2.41	85.17
1999	4.91	16.46	22.86	13.14	7.43	4.69	4.34	1.83	75.67
2000	11.82	26.58	24.78	16.49	7.60	5.98	2.11	0.97	96.33
2001	17.15	30.42	22.50	13.34	7.28	4.16	2.24	0.69	97.79
2002	13.42	27.80	24.95	8.70	5.34	1.84	1.00	0.74	83.79
2003	2.47	33.67	38.79	19.89	7.94	3.43	1.16	0.86	108.23
2004	8.99	9.93	36.68	19.42	10.11	3.36	1.59	0.39	90.48
2005	6.26	19.51	13.19	13.39	11.41	4.32	1.86	0.81	70.75
2006	8.61	16.71	26.02	19.74	13.15	11.80	3.51	1.57	101.12
2007	10.56	18.78	16.44	13.78	8.32	4.98	4.40	1.80	79.07
2008	4.91	25.27	22.36	18.38	8.84	5.49	2.73	2.50	90.48
2009	5.09	13.32	27.11	15.49	6.26	3.68	1.58	1.28	73.81
2010	2.10	14.33	11.81	14.92	7.43	2.00	0.78	0.73	54.10
2011	7.55	10.52	17.13	16.94	10.87	3.92	1.75	0.66	69.34
2012	6.67	13.11	12.92	13.27	12.80	4.44	2.43	0.67	66.31
2013	2.11	11.78	12.39	8.03	5.61	5.52	1.51	0.73	47.69
2014	3.93	3.74	12.55	10.84	5.58	4.60	3.17	0.73	45.14
2015	3.05	2.84	11.04	10.29	5.15	4.87	3.18	0.51	40.93

Table 16a. Annual number of cod tagged in NAFO Subdiv. 3Ps during 2007-15 by tag type (low or high reward) and by unit statistical unit area.

Release Year	Low Reward ($10)	High Reward ($100)	Total Tagged in 3Psa	Total Tagged in 3Psb	Total Tagged in 3Psc	Total Tagged in 3Ps
2007	3410	480	840	1019	2031	3890
2008	315	80	-	-	395	395
2009	2006	504	-	-	2510	2510
2010	817	205	-	-	1022	1022
2011	767	196	-	-	963	963
2012	1869	471	-	743	1597	2340
2013	3153	798	554	557	2840	3951
2014	789	200	-	416	573	989
2015	994	256	-	514	736	1250

Table 16b. Annual number of cod tags returned from NAFO Subdiv. 3Ps during 2007-15 by harvester type (commercial or recreational, unknowns excluded).

Recapture Year	Commercial Fishery	Recreational Fishery
2007	353 (93.9)	23 (6.1)
2008	289 (95.8)	13 (4.2)
2009	282 (925)	23 (7.5)
2010	269 (94.7)	15 (5.3)
2011	116 (88.6)	15 (11.4)
2012	180 (95.2)	9 (4.8)
2013	223 (91.1)	21 (8.6)
2014	248 (95.7)	11 (4.3)
2015	193 (89.4)	23 (10.6)

Table 16c. Fishing mortality rates based on tagging for two size groups of cod tagged in three inshore areas of NAFO Subdiv. 3Ps.

Unit Area	Year	50-85 cm	>60 cm	50-85 cm	>60 cm
-	-	m=0.2	m=0.2	m=0.4	m=0.4
3Psa (Hermitage Bay)	2009	0.21	0.25	0.41	0.46
3Psa (Hermitage Bay)	2010	-	-	-	-
3Psa (Hermitage Bay)	2011	-	-	-	-
3Psa (Hermitage Bay)	2012	-	-	-	-
3Psa (Hermitage Bay)	2013	-	-	-	-
3Psa (Hermitage Bay)	2014	0.15	0.18	0.19	0.23
3Psa (Hermitage Bay)	2015	0.13	0.13	0.09	0.22
3Psb (Fortune Bay)	2009	0.13	0.14	0.21	0.23
3Psb (Fortune Bay)	2010	-	-	-	-
3Psb (Fortune Bay)	2011	-	-	-	-
3Psb (Fortune Bay)	2012	-	-	-	-
3Psb (Fortune Bay)	2013	0.10	0.15	0.11	0.16
3Psb (Fortune Bay)	2014	0.14	0.26	0.19	0.34
3Psb (Fortune Bay)	2015	0.17	0.13	0.23	0.19
3Psc (Placentia Bay)	2009	0.13	0.20	0.20	0.30
3Psc (Placentia Bay)	2010	0.22	0.43	0.26	0.56
3Psc (Placentia Bay)	2011	0.11	0.22	0.14	0.30
3Psc (Placentia Bay)	2012	0.15	0.26	0.18	0.29
3Psc (Placentia Bay)	2013	0.13	0.22	0.16	0.27
3Psc (Placentia Bay)	2014	0.12	0.19	0.16	0.25
3Psc (Placentia Bay)	2015	0.15	0.18	0.22	0.25

FIGURES

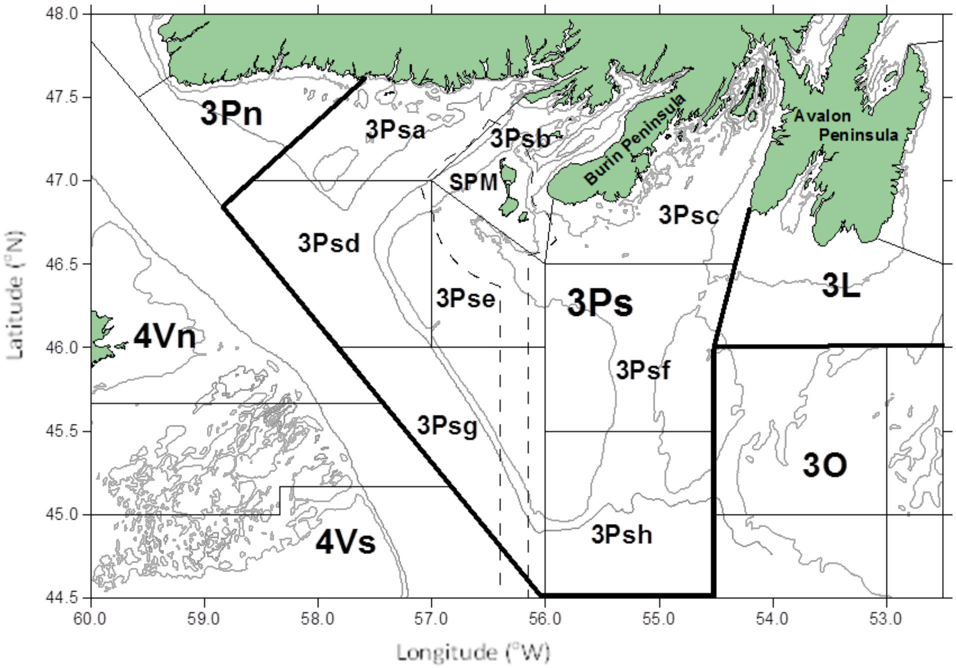

Figure 1. NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre et Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).

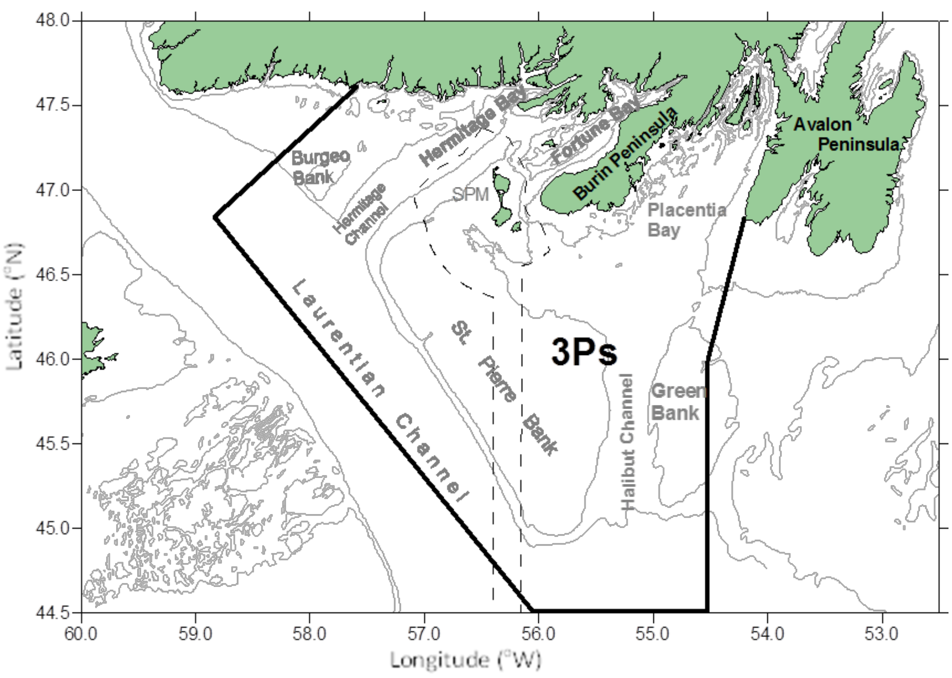

Figure 2. NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the main fishing areas.

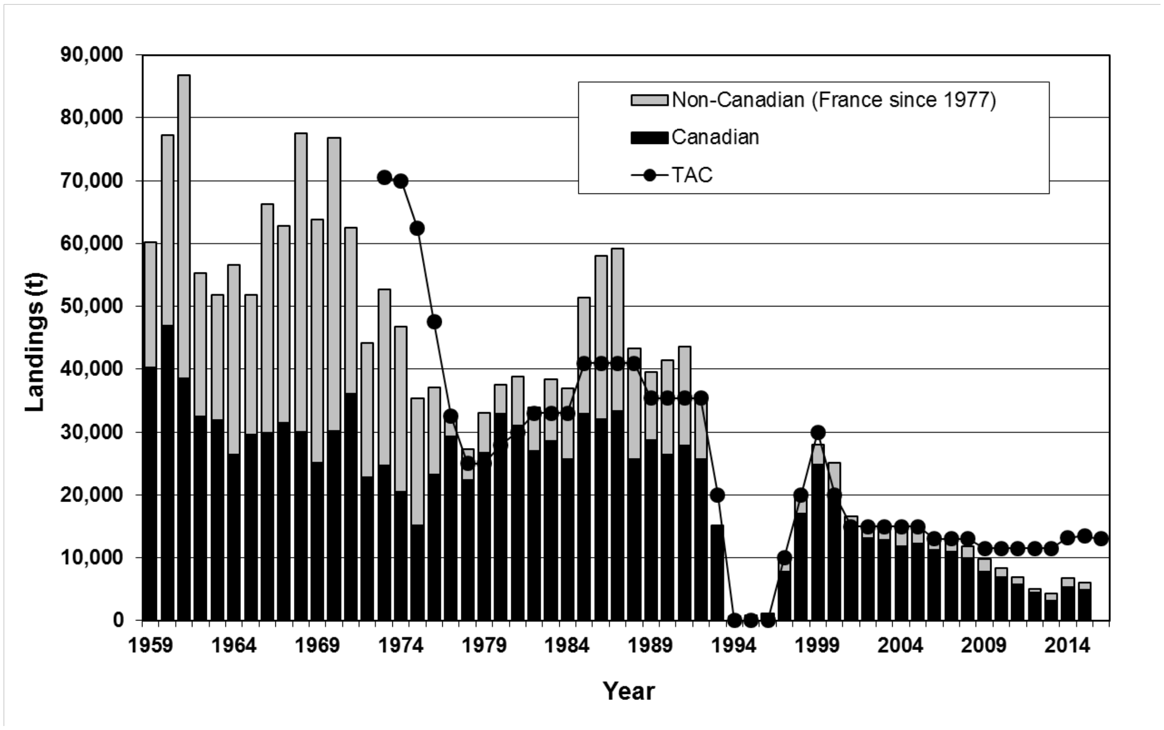

Figure 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdiv. 3Ps. Note that the 2016 fishery was still in progress at the time of the current assessment.

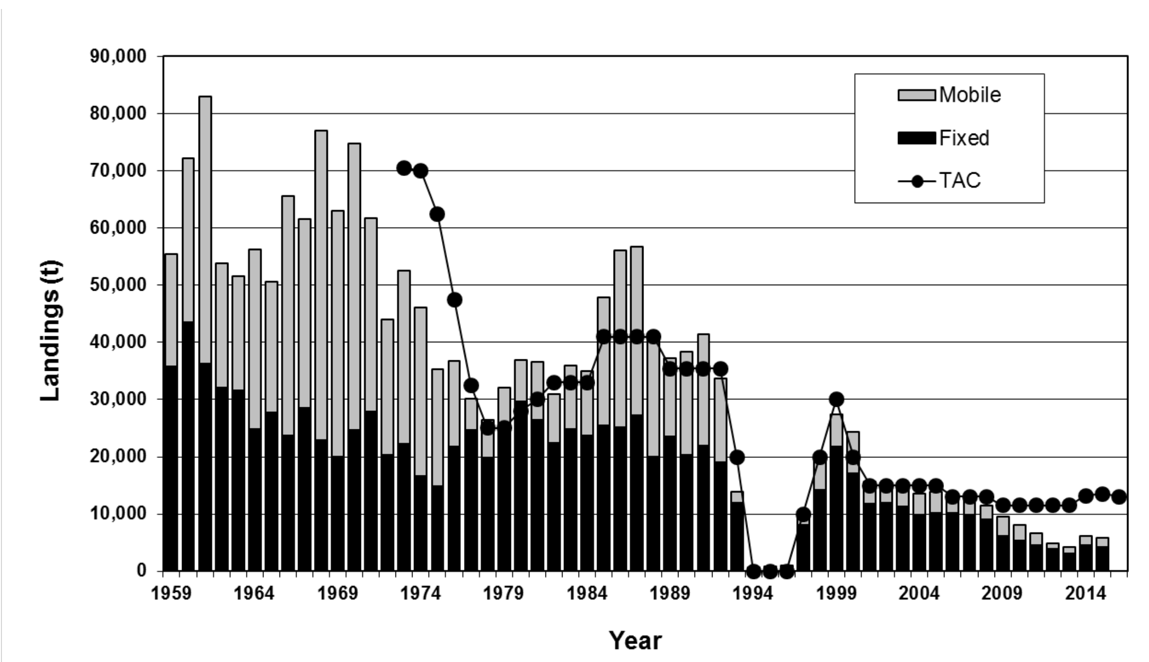

Figure 3b. Reported landings of cod by fixed and mobile gears in NAFO Subdiv. 3Ps. Note that the 2016 fishery was still in progress at the time of the current assessment.

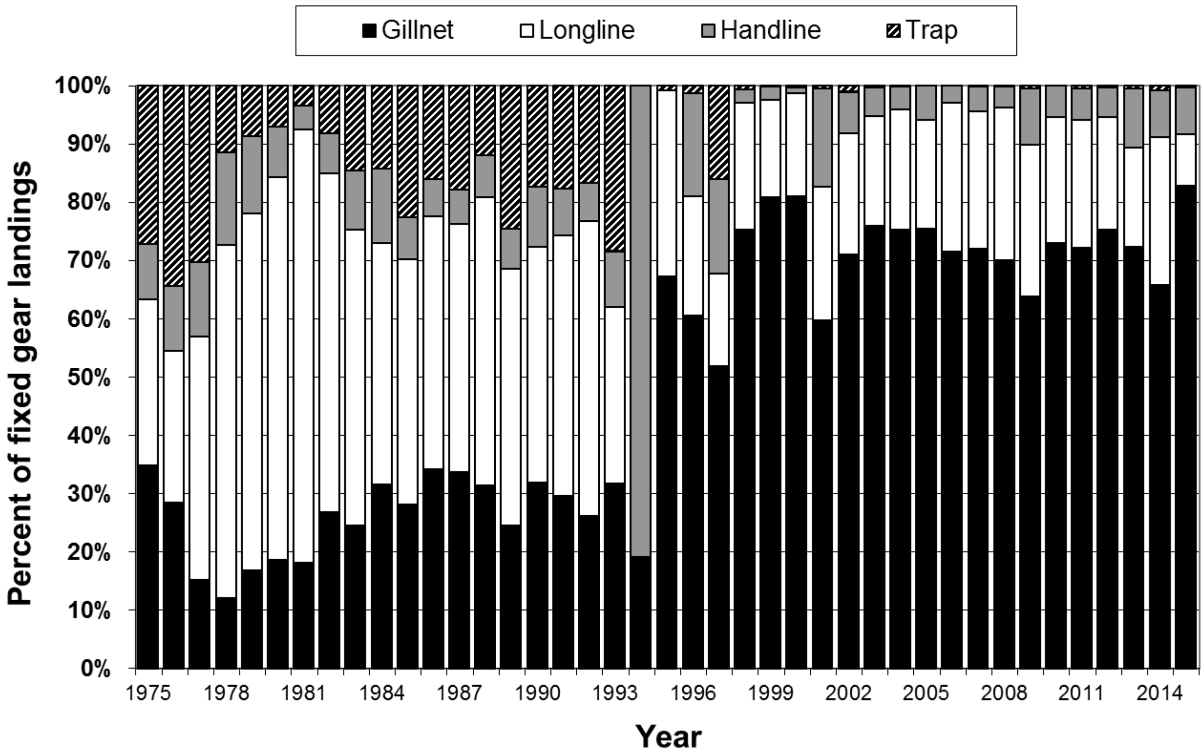

Figure 4. Percent of total fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdiv. 3Ps. The fishery was under a moratorium during 1994-96 and values for those years are based on sentinel and by-catch landings of < 800 t.

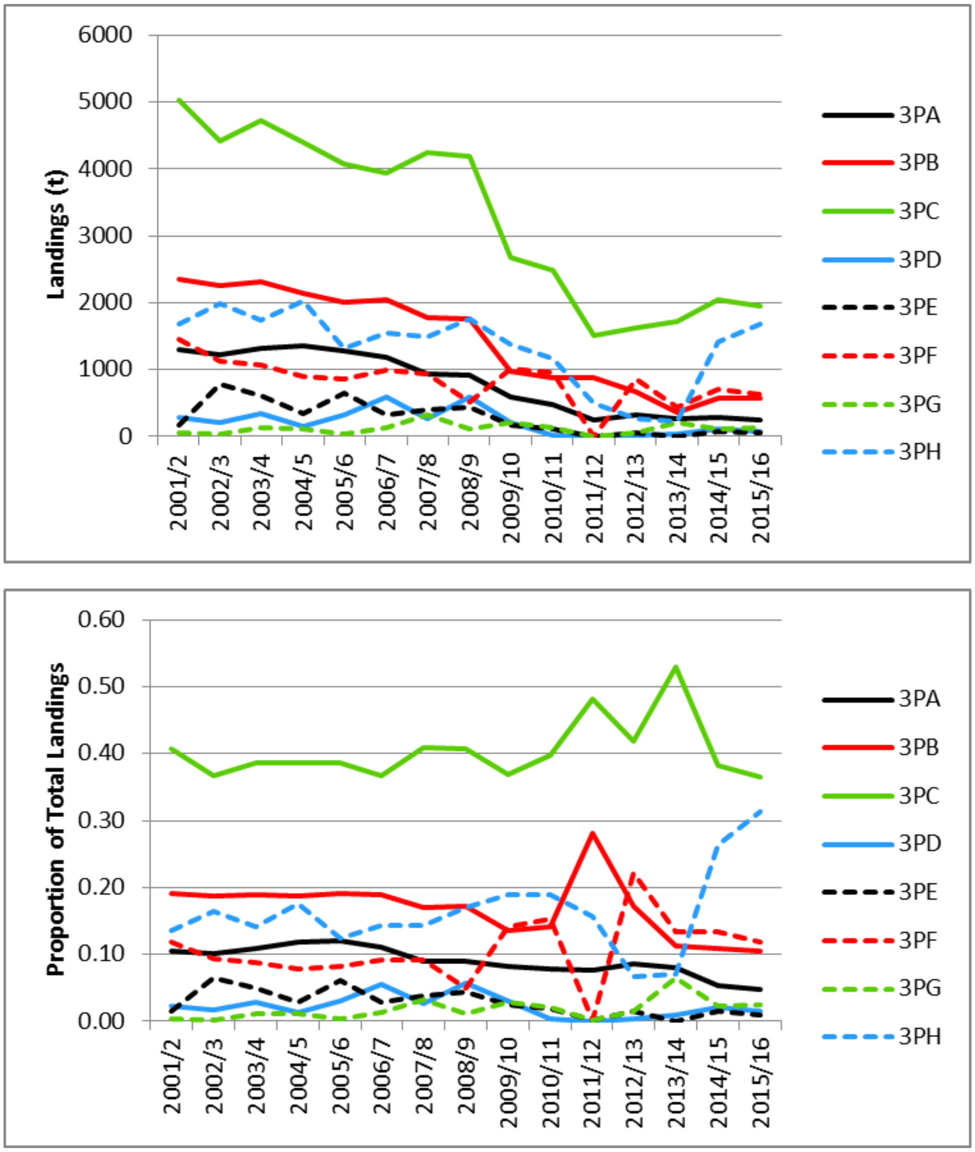

Figure 5. Breakdown of recent Canadian annual landings of 3Ps cod by statistical unit areas. Both landings (upper panel) and percent of total landings (lower panel) are presented. Unit area is not available for SPM landings. Refer to Figure 1 for locations of unit areas.

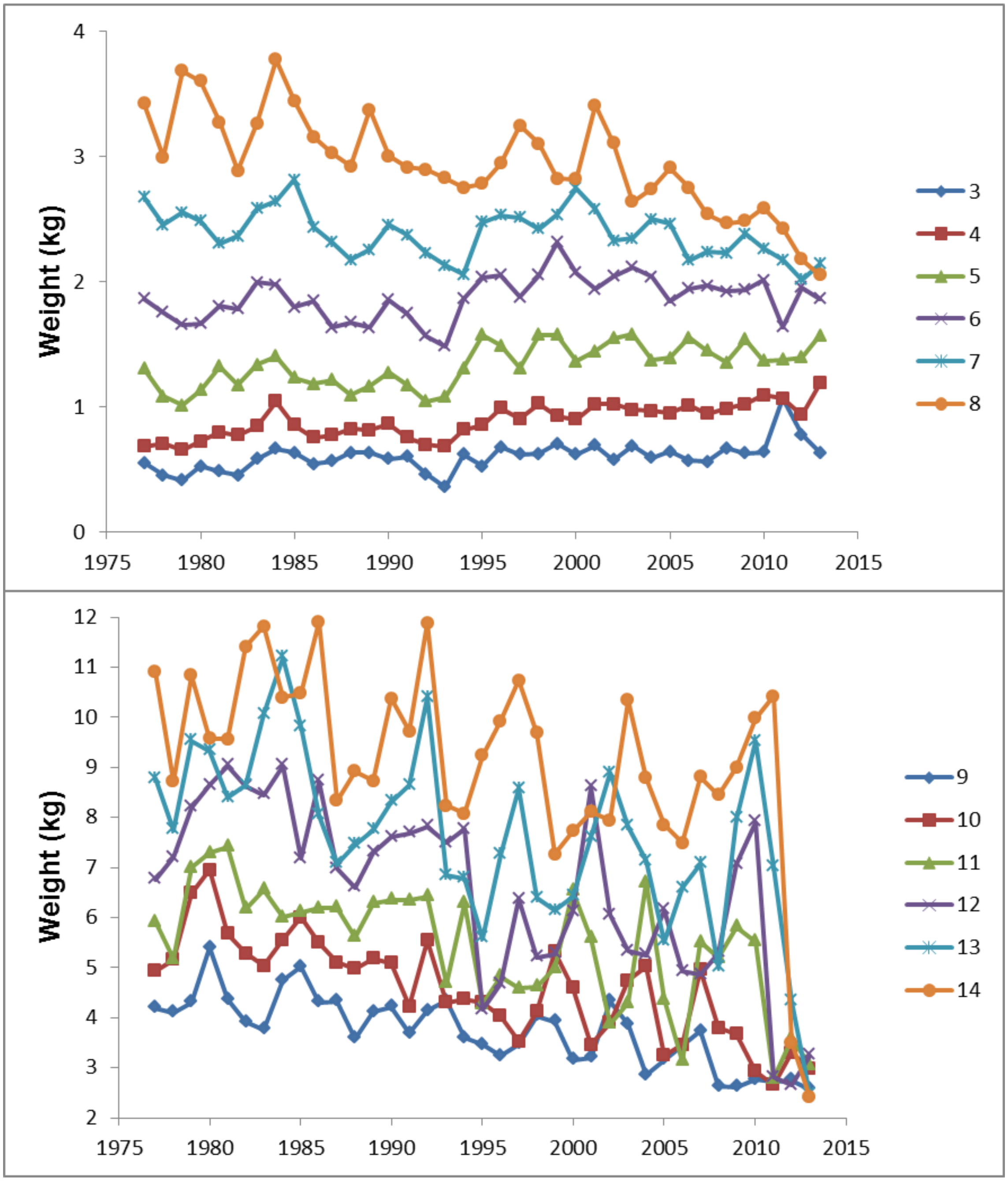

Figure 6. Mean weights-at-age calculated from mean lengths-at-age (upper panel: ages 3-8; lower panel: ages 9-14) from the commercial catch of cod in Subdiv. 3Ps during 1977 to 2013.

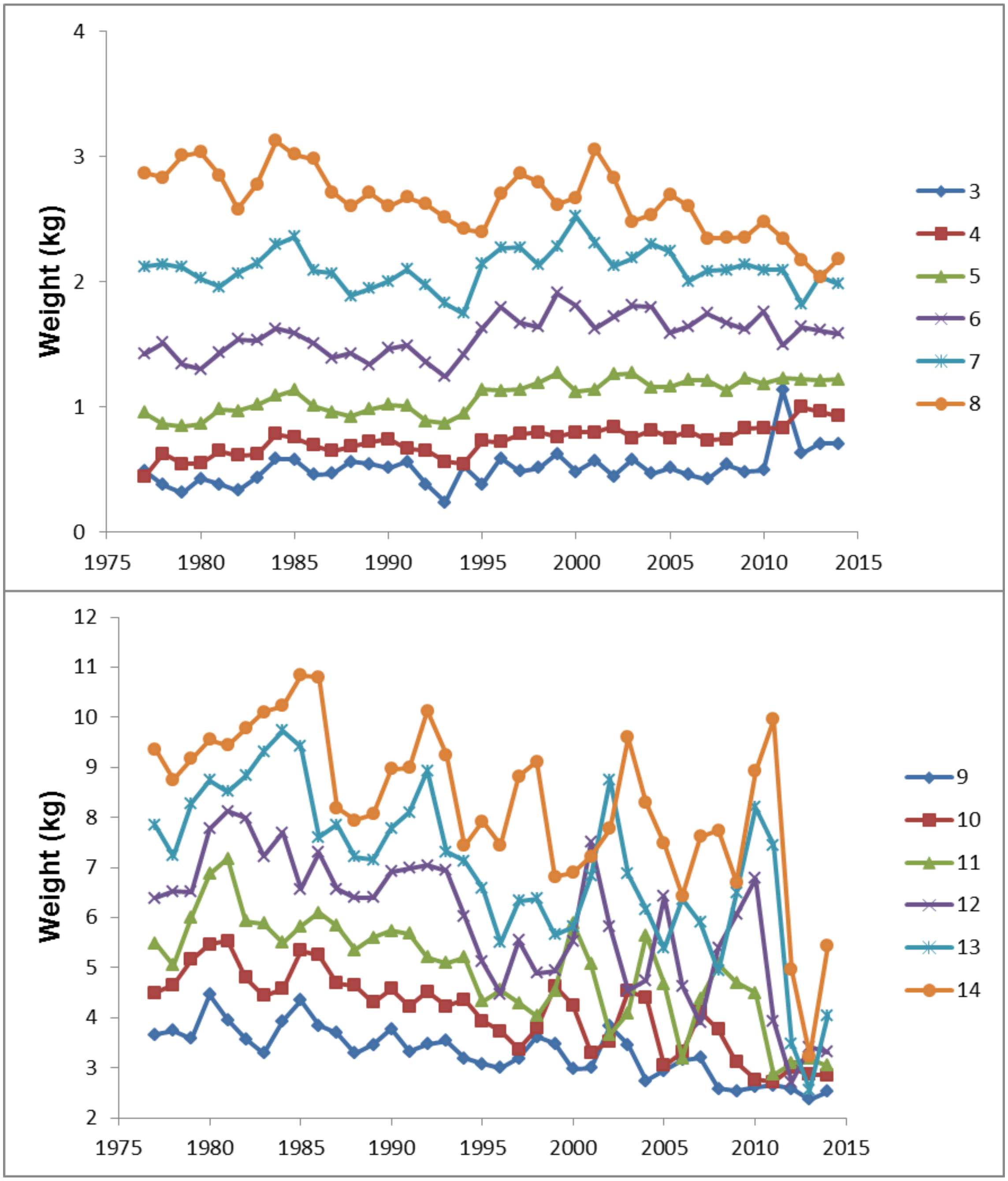

Figure 7. Beginning of year mean weights-at-age (upper panel: ages 3-8; lower panel: ages 9-14) from the commercial catch of cod in Subdiv. 3Ps during 1997 to 2014. Weights at age in 2014 are the geometric means of the prior three years.

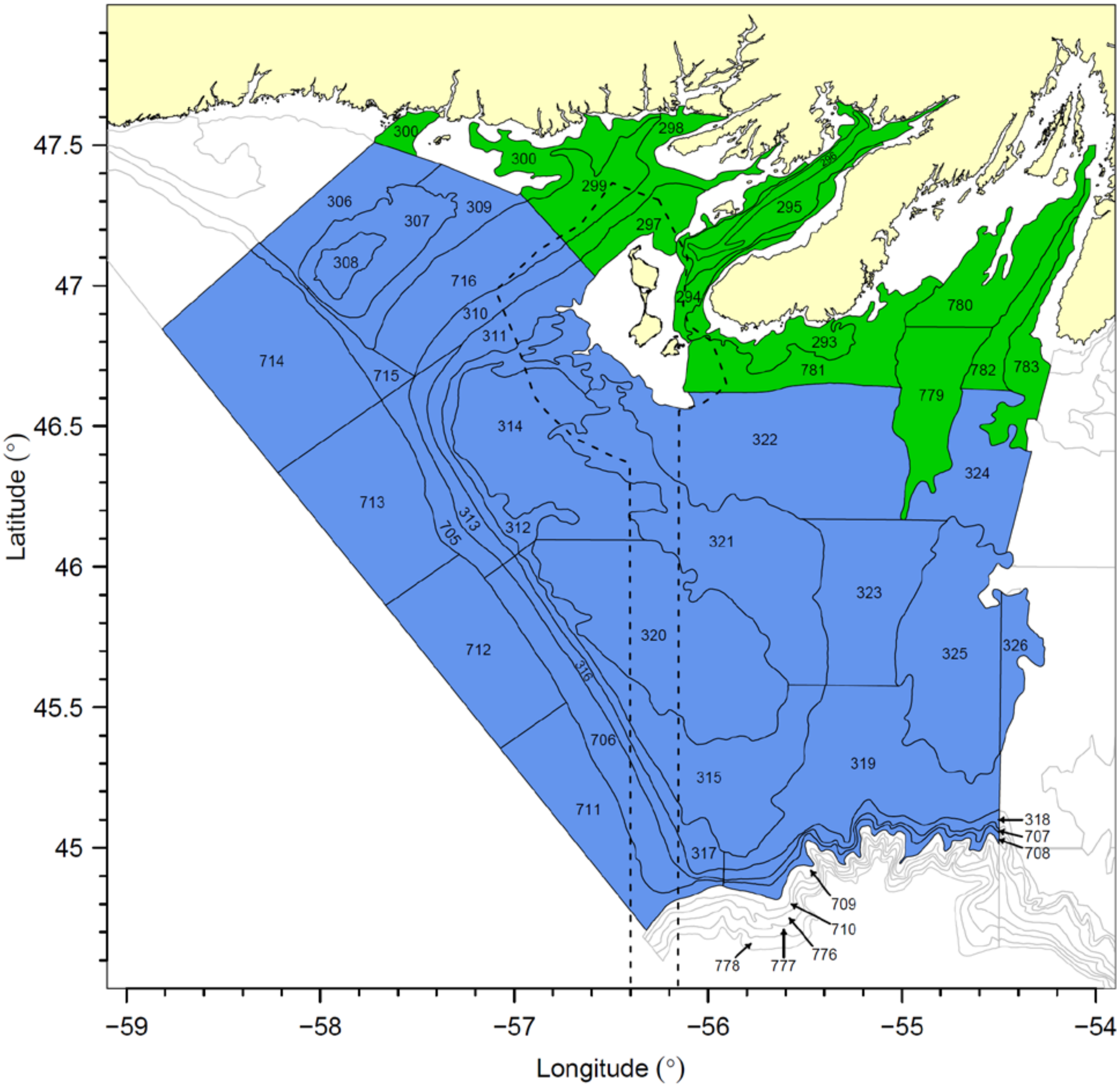

Figure 8. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdiv. 3Ps. Offshore strata are shaded blue. Inshore strata were added in 1994 (strata 779-783) and 1997 (strata 293-300) and are shaded green. The dashed line represents the boundary of the French economic zone.

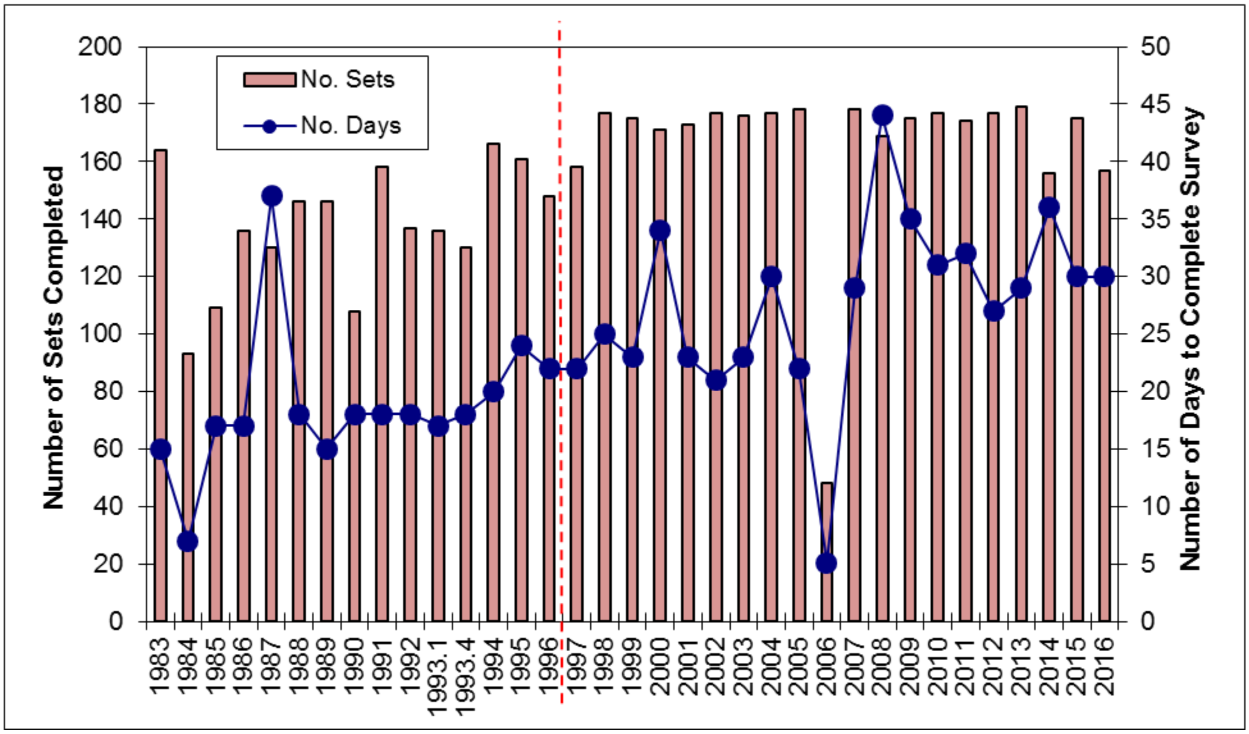

Figure 9. Number of research vessel survey sets completed during surveys of NAFO Subdiv. 3Ps, and the number of days required to complete these set. Survey coverage was expanded to present levels (i.e. covering all inshore and offshore index strata) in 1997 (dashed vertical line).

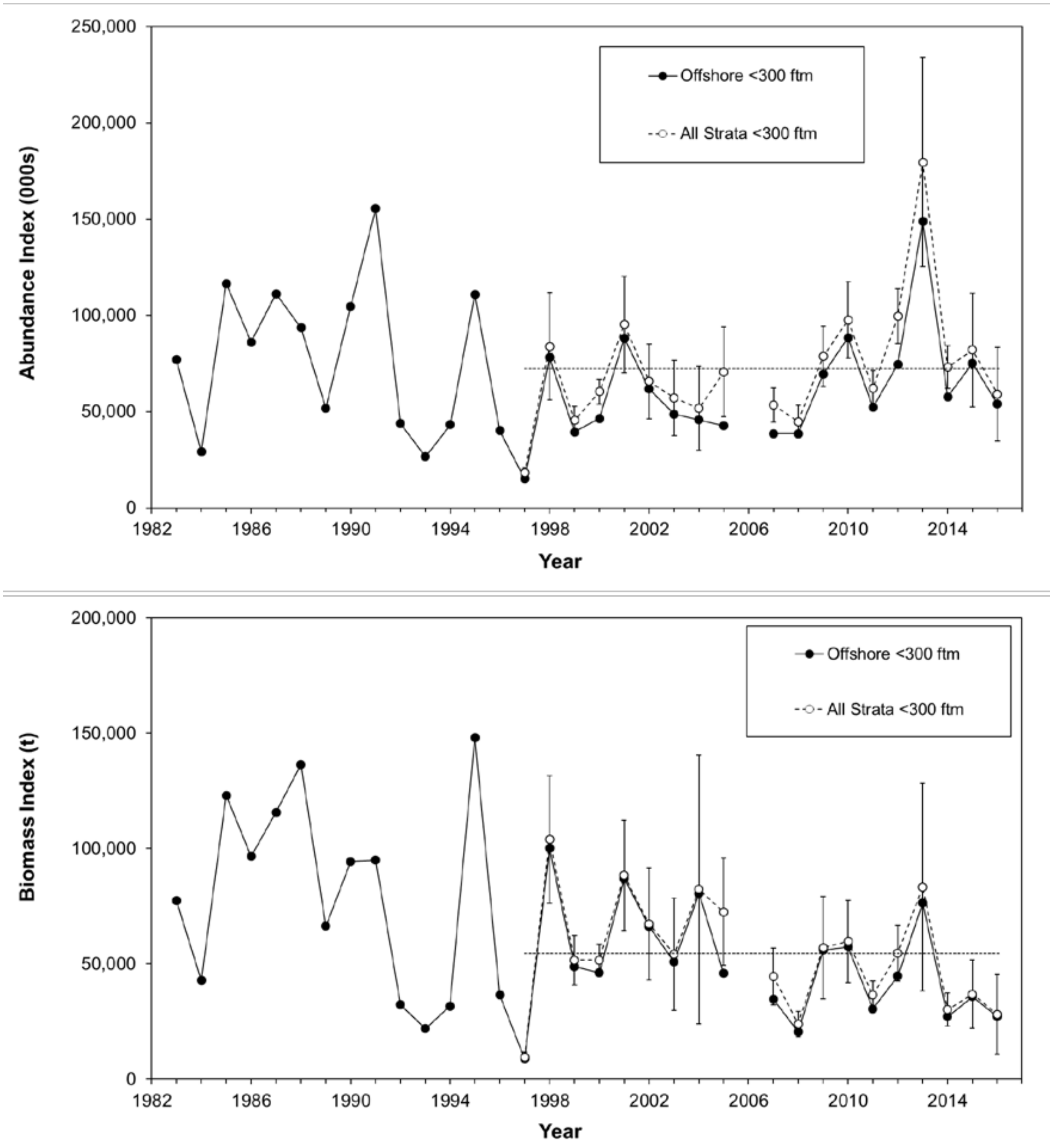

Figure 10. Abundance (upper panel) and biomass (lower panel) indices for cod in NAFO Subdiv. 3Ps from DFO research vessel bottom trawl surveys of index strata during winter/spring from 1983 to 2016. Error bars show plus/minus one standard deviation. Open symbols show values for the augmented survey area that includes additional inshore strata added to the survey in 1997. Dashed horizontal lines are means of the time-series for all index strata.

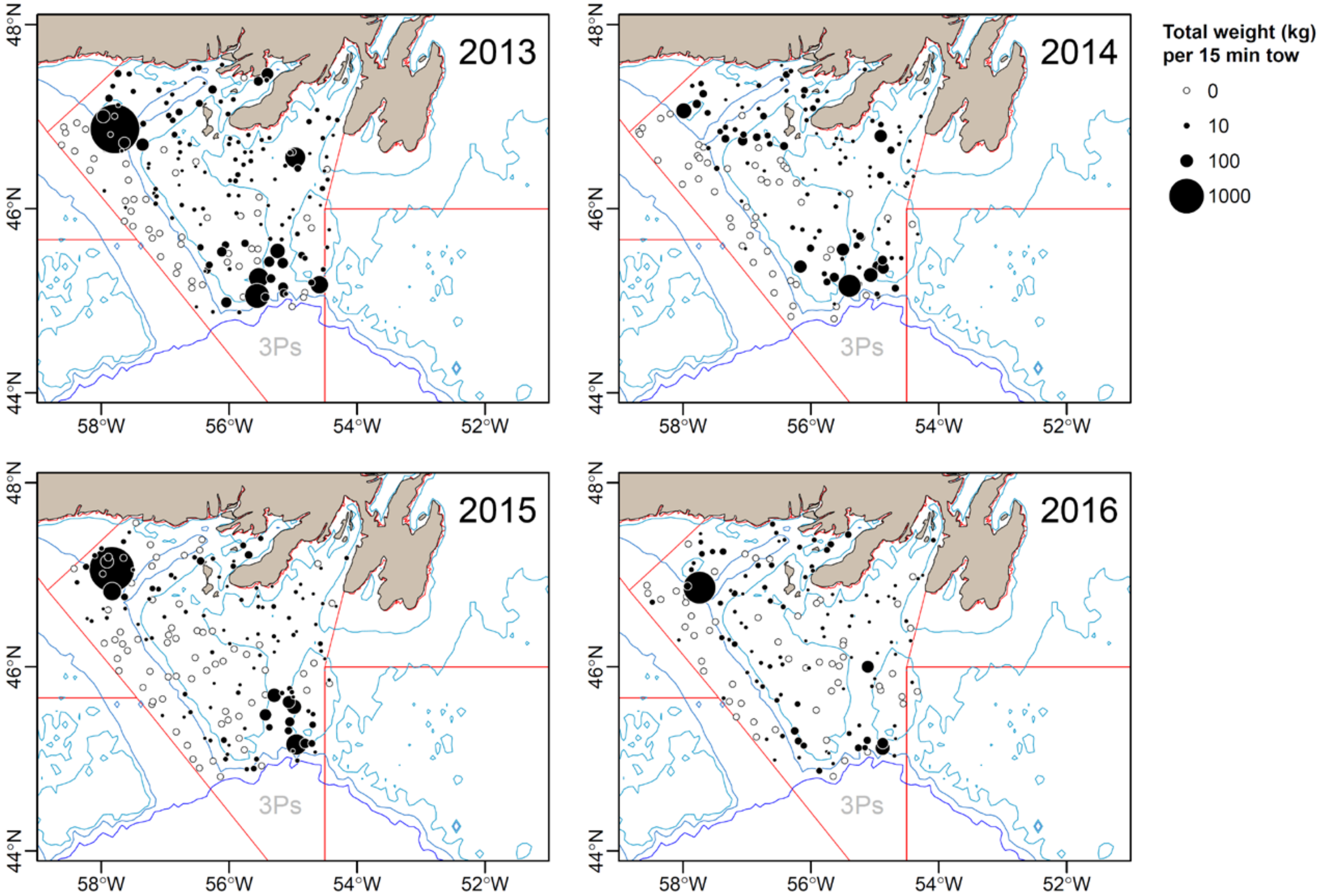

Figure 11. Age aggregated distribution of cod catches (weight per tow) from the April DFO research vessel surveys of NAFO Subdiv. 3Ps over 2013-16. Bubble size is proportional to total weight caught.

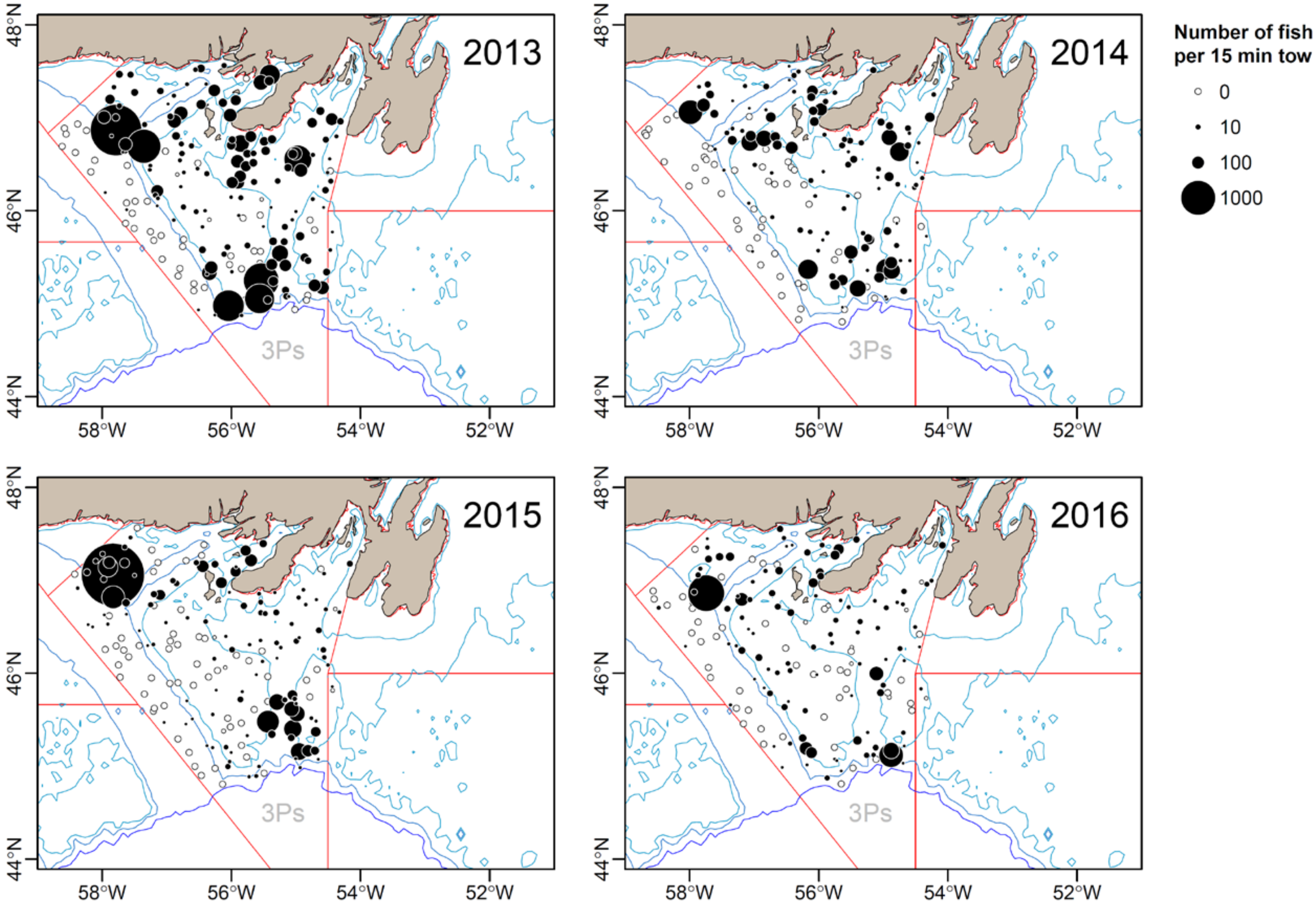

Figure 12. Age aggregated distribution of cod catches (nos. per tow) from the April DFO research vessel surveys of NAFO Subdiv. over 2013-16. Bubble size is proportional to numbers caught.

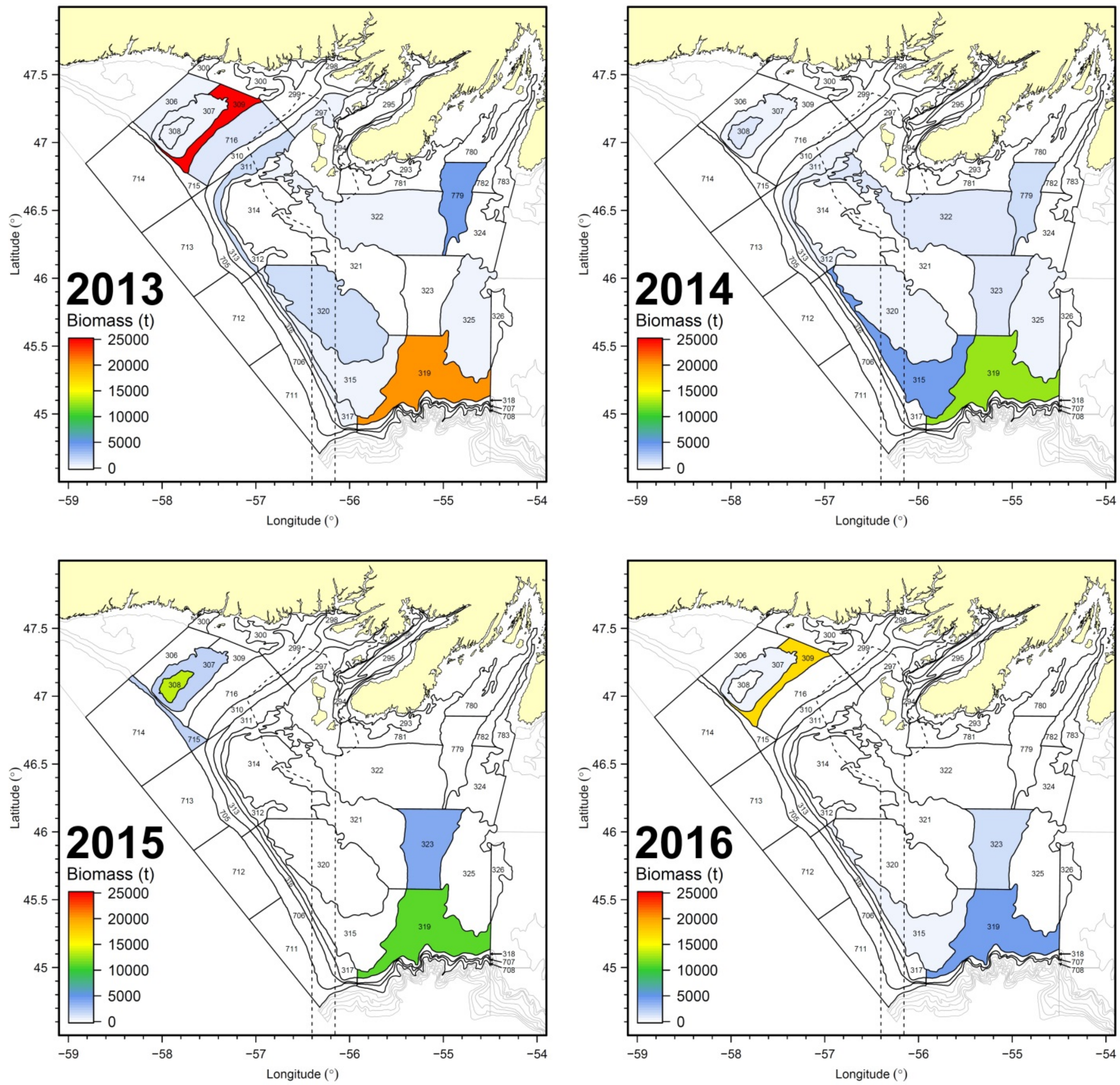

Figure 13. Stratum-specific biomass estimates of cod in Subdiv. 3Ps based on the DFO RV survey.

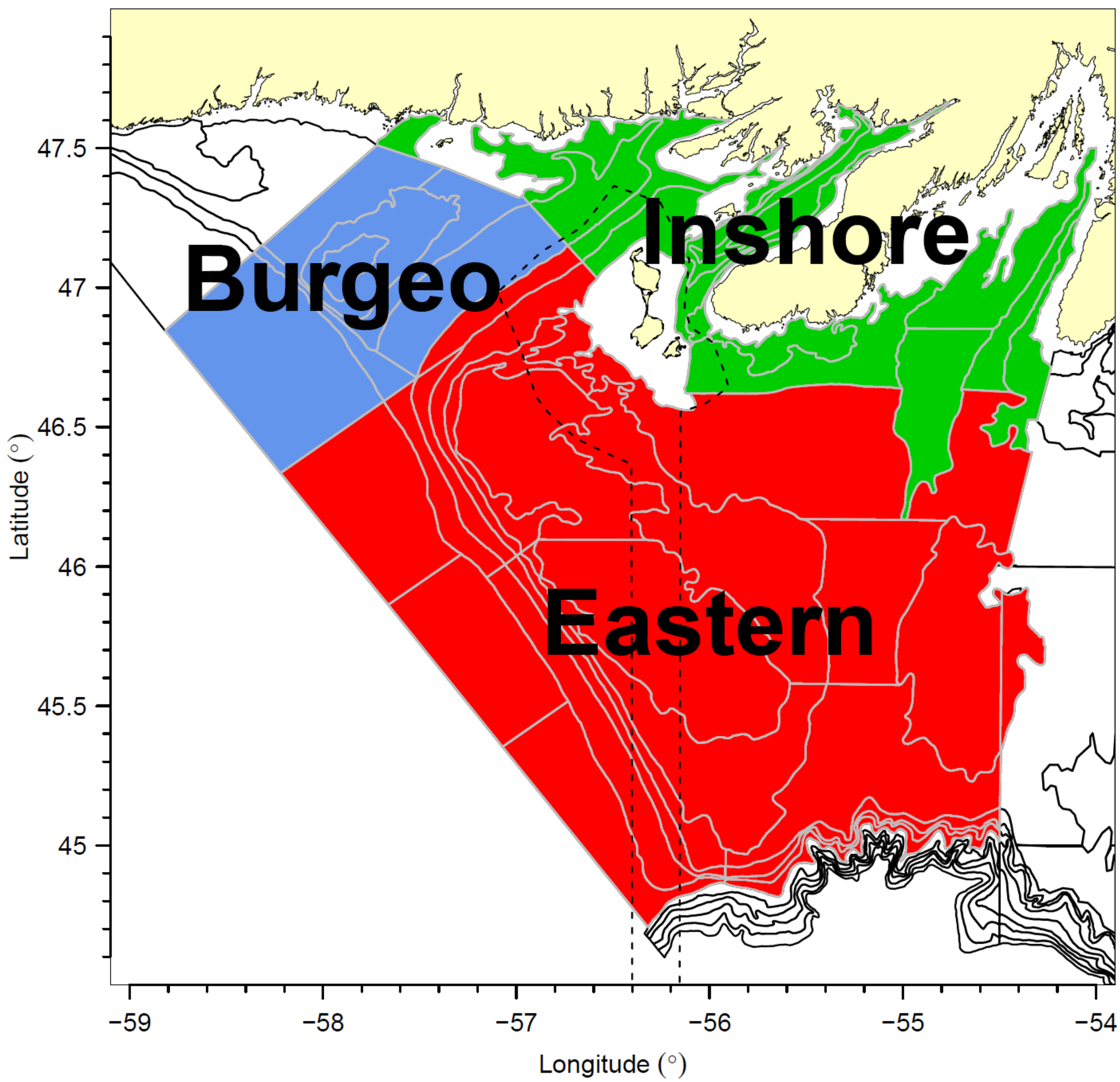

Figure 14. NAFO Subdiv. 3Ps management zone illustrating the allocation of survey strata into 'Inshore', 'Burgeo', and 'Eastern' regions. Survey trends for the three regions are depicted in Fig. 17

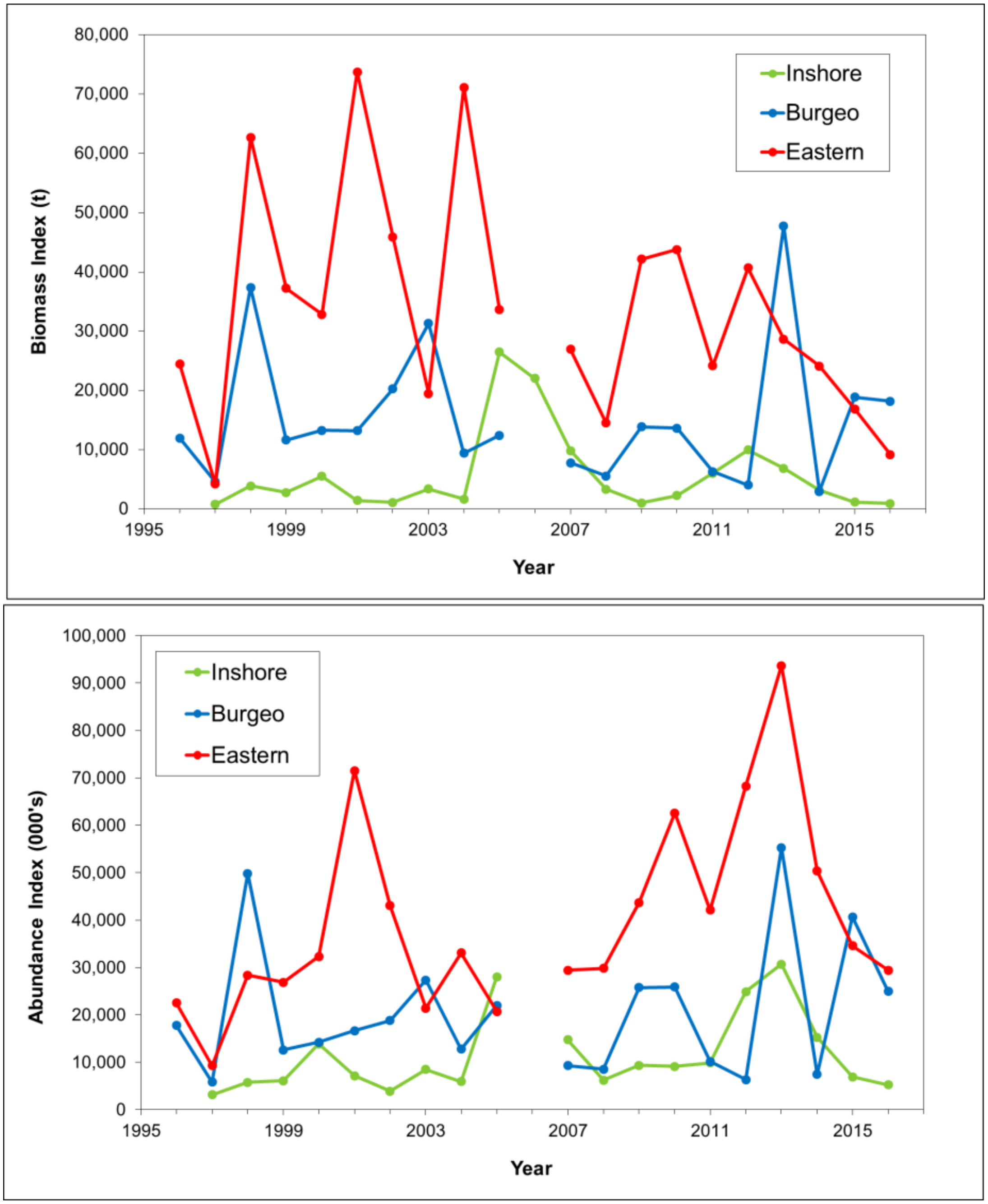

Figure 15. Total biomass (above) and abundance (below) index for cod in various regions of NAFO Subdiv. 3Ps from DFO research vessel bottom trawl surveys during winter/spring from 1997 to 2016. The 2006 survey was not completed. The Campelen trawl was used in all surveys.

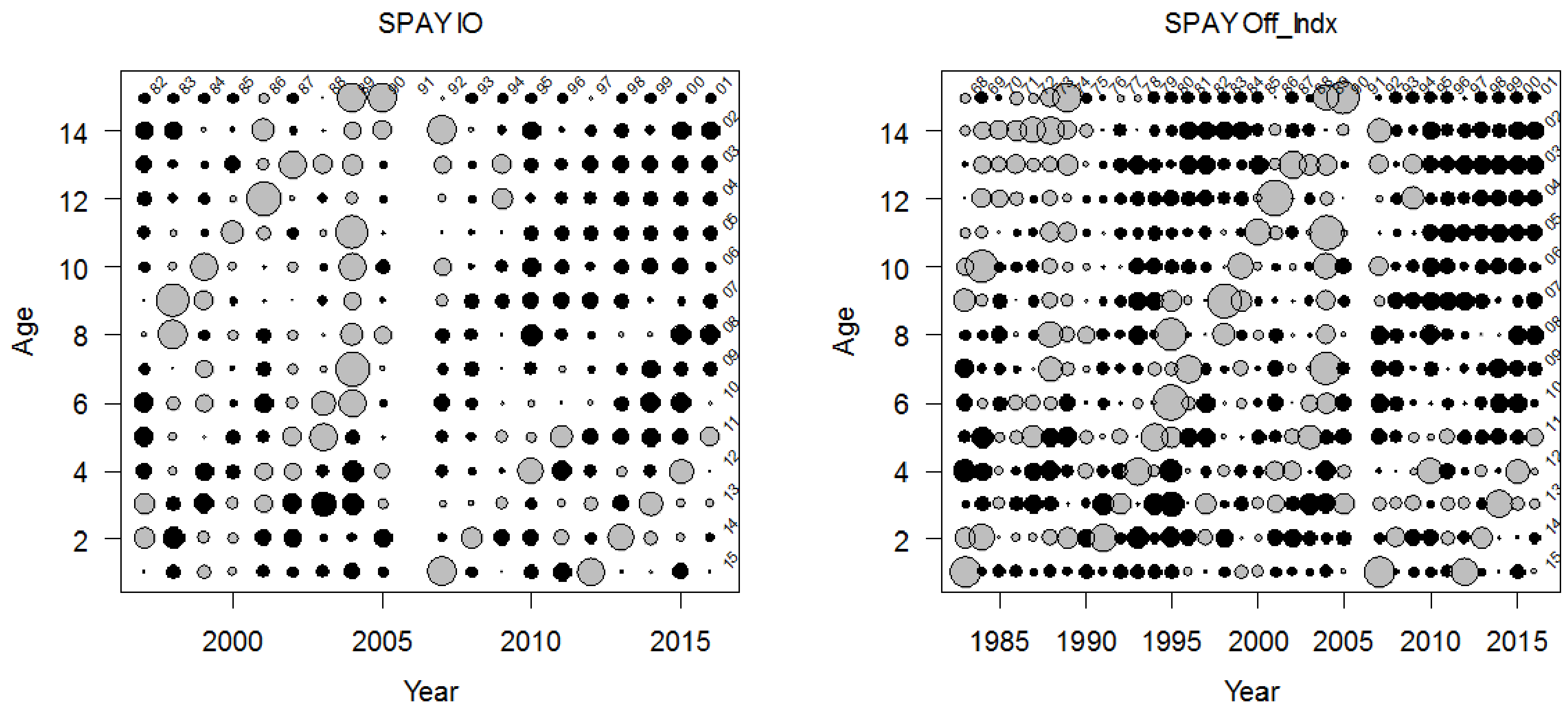

Figure 16. Standardized age-disaggregated catch rates from the spring bottom trawl survey of Subdiv. 3Ps. Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions computed across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts. Left panel includes the 1997-2016 "All Strata < 300 fm" data, and panel at right includes data which comprise the "Offshore" index (1983-2016).

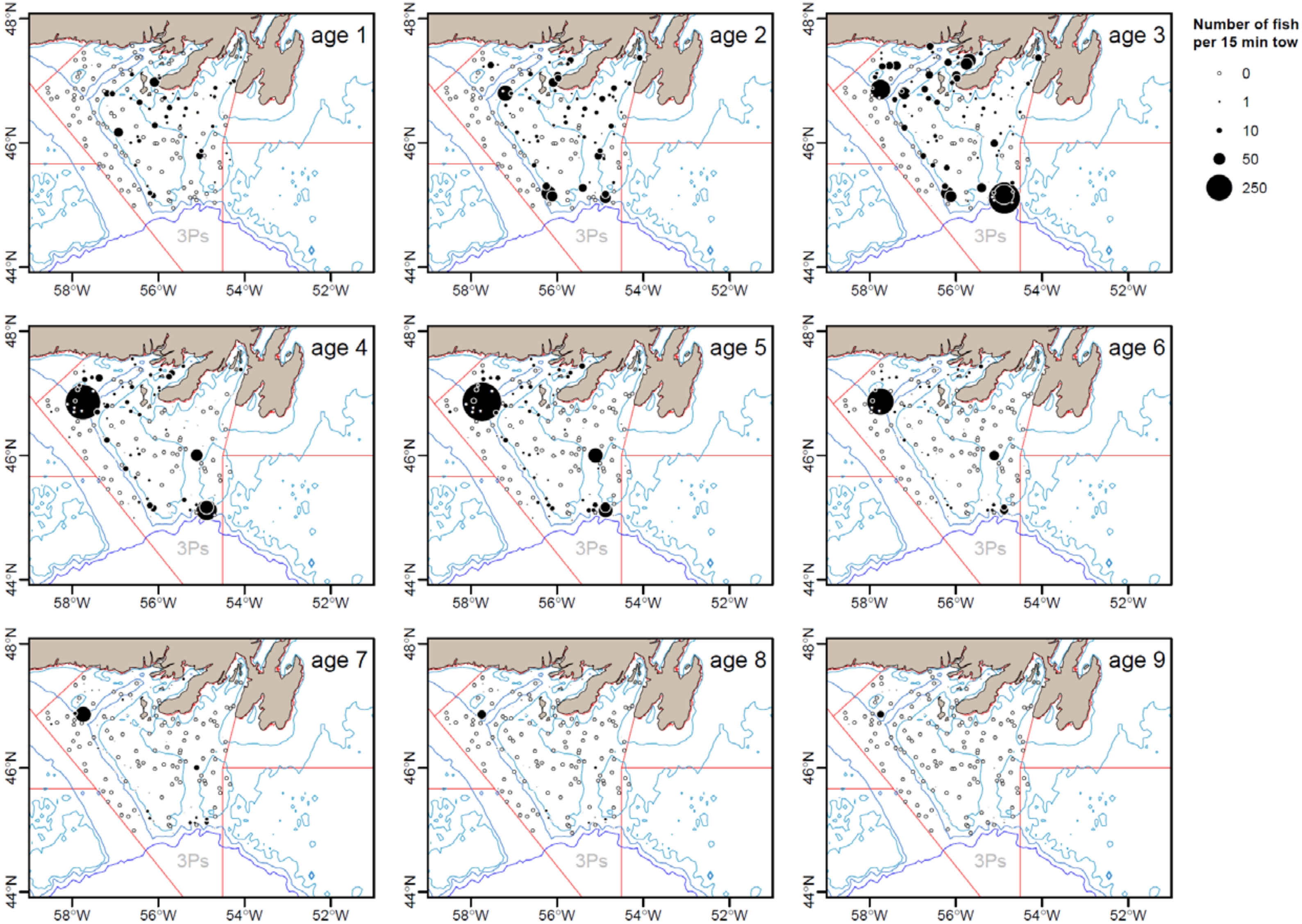

Figure 17. Age dis-aggregated distribution of cod catches (nos. per tow at age) from the April 2016 DFO research vessel survey of NAFO Subdiv. 3Ps. Bubble size is proportional to numbers caught.

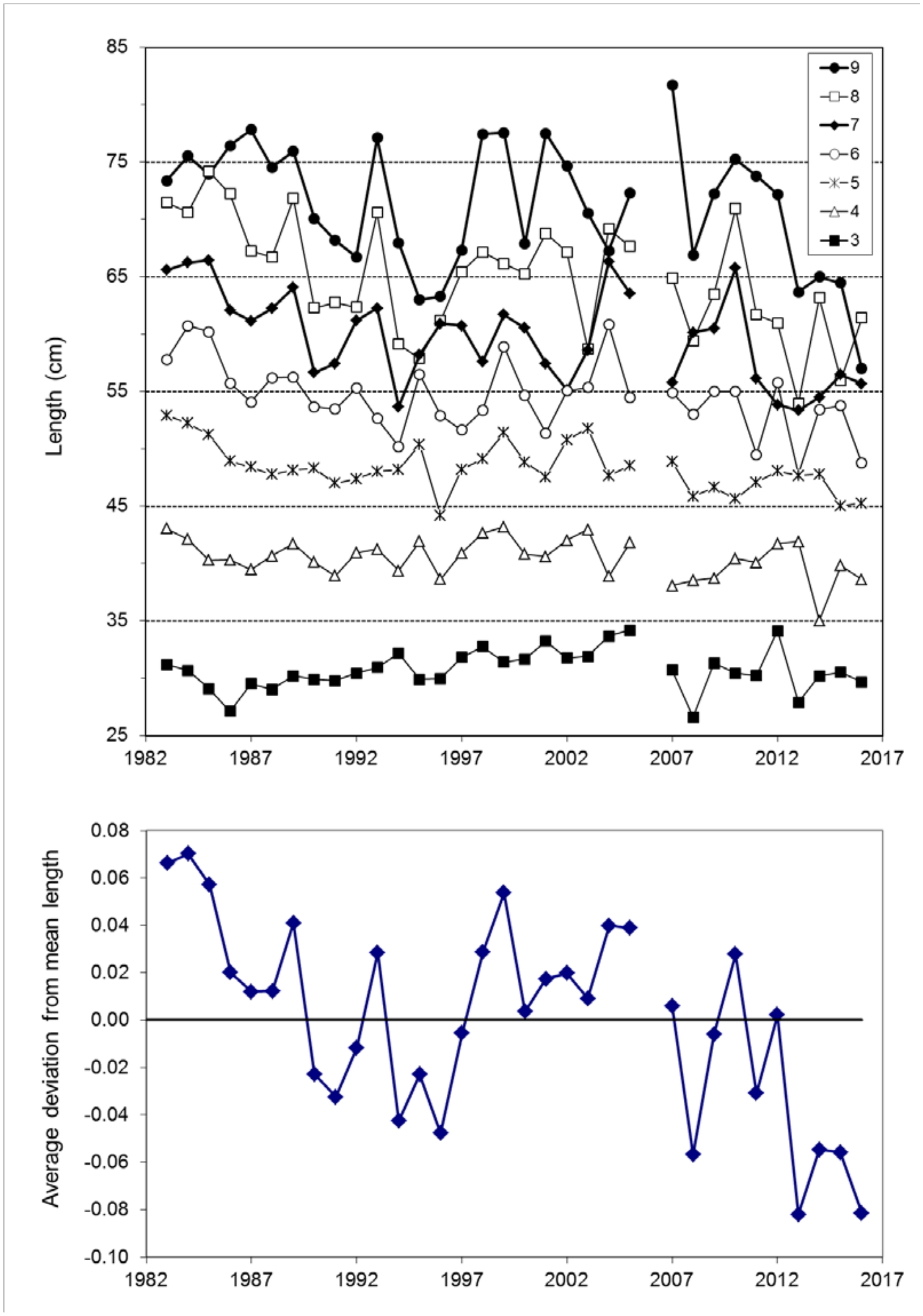

Figure 18. Mean length at ages 3-9 (above) and average proportion deviation from mean length at age for ages 3-9 combined (below) of cod in Subdiv. 3Ps during 1983-2016 from sampling during DFO bottom-trawl surveys in winter-spring.

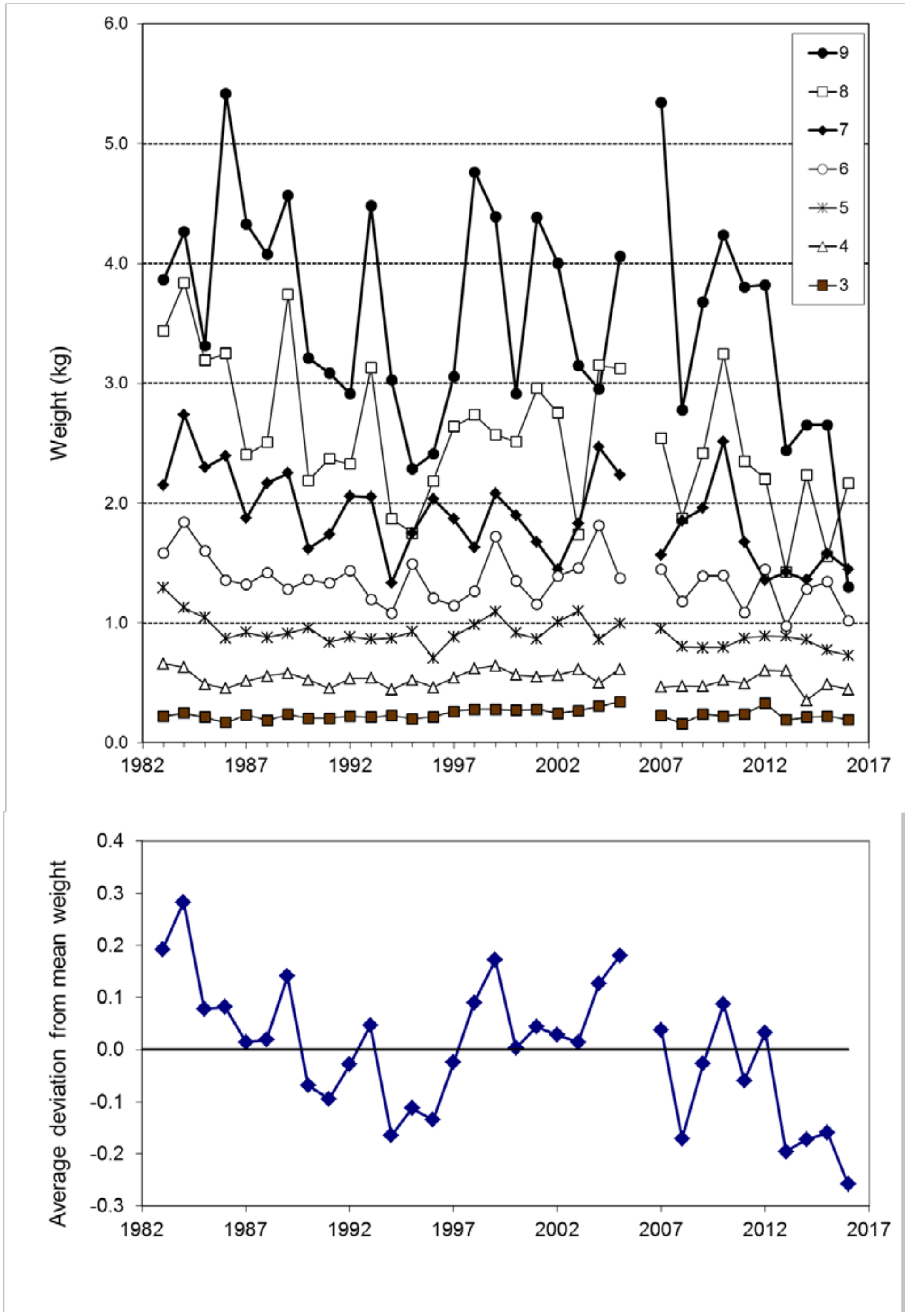

Figure 19. Mean round weight-at-age (kg) (above) and average proportion deviation from mean weight at age for ages 3-9 (below) of cod sampled during DFO bottom-trawl surveys in NAFO Subdiv. 3Ps in winter-spring 1983--2016.

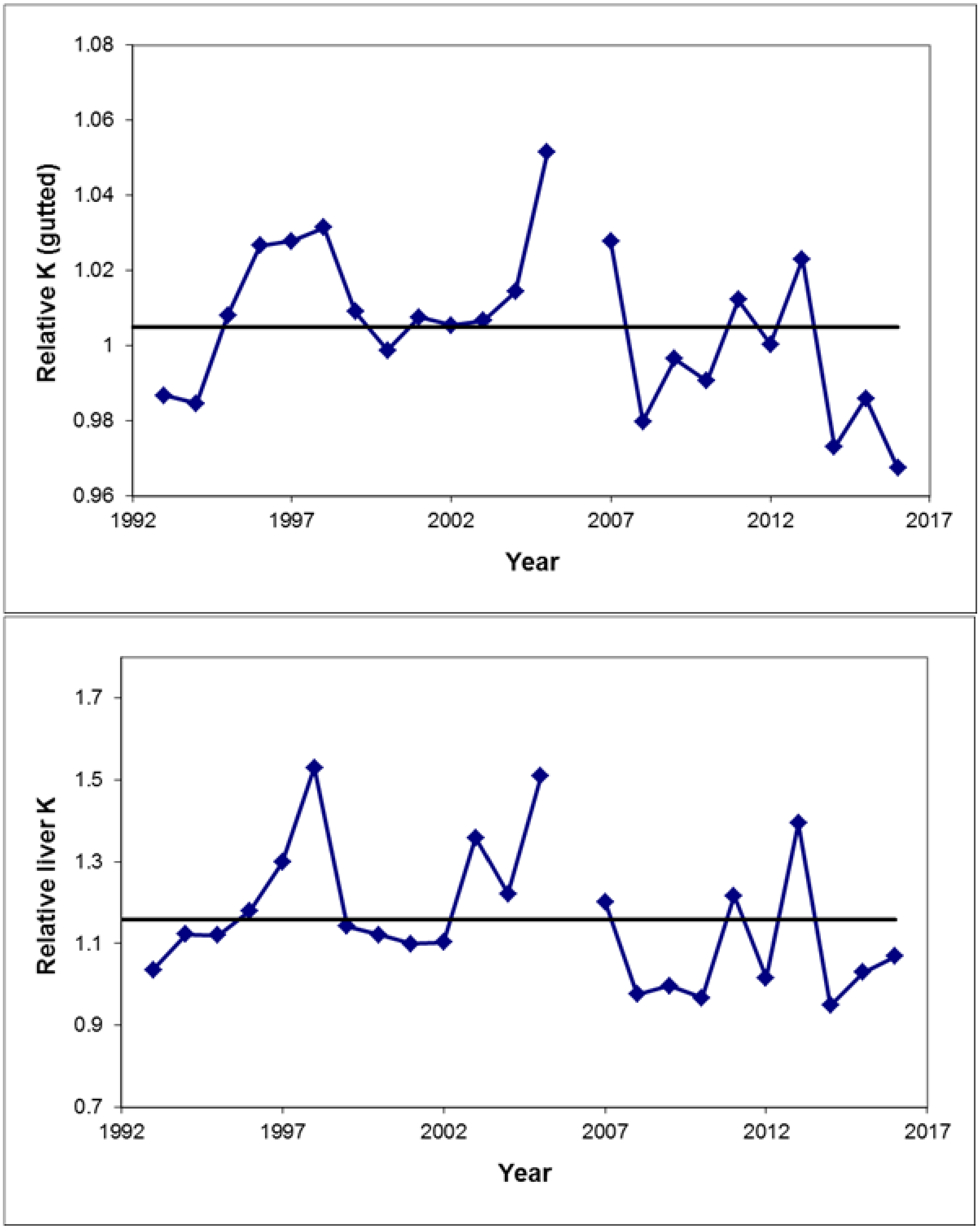

Figure 20. Relative condition indices for 3Ps cod from spring surveys over 1993-2016. Upper panel is relative gutted condition index; lower panel relative liver condition index. Horizontal line represents time-series average.

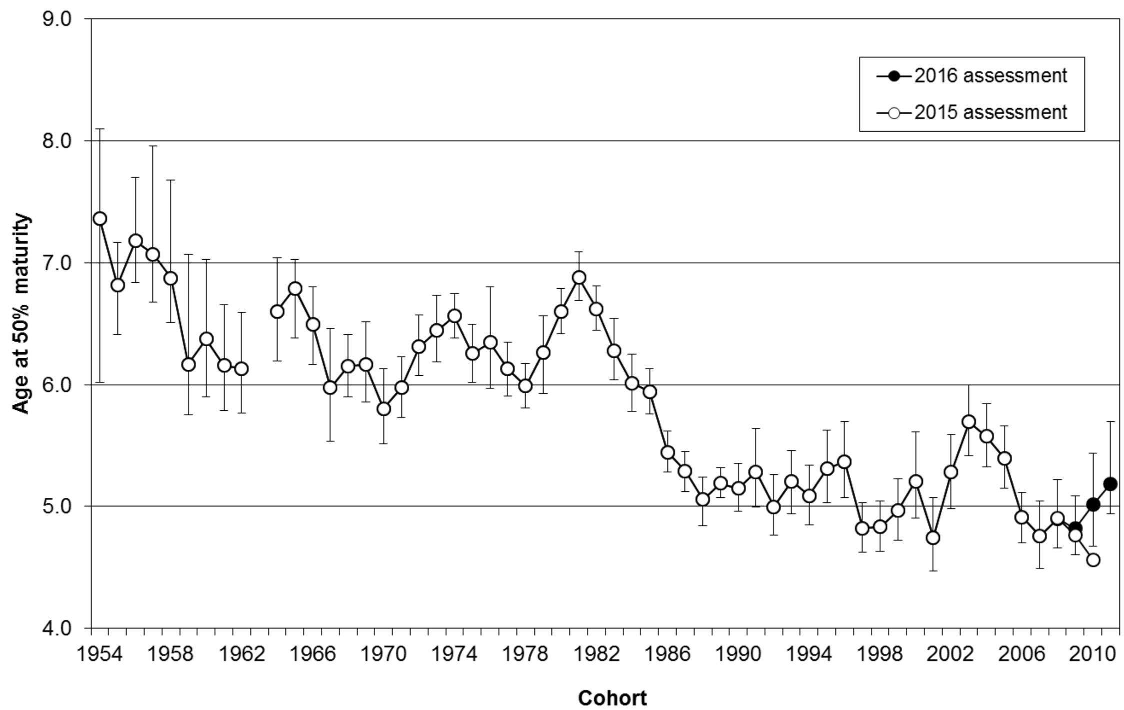

Figure 21a. Age at 50% maturity by cohort for female cod sampled during DFO research vessel bottom-trawl surveys of NAFO Subdiv. 3Ps. Error bars are 95% fiducial limits.

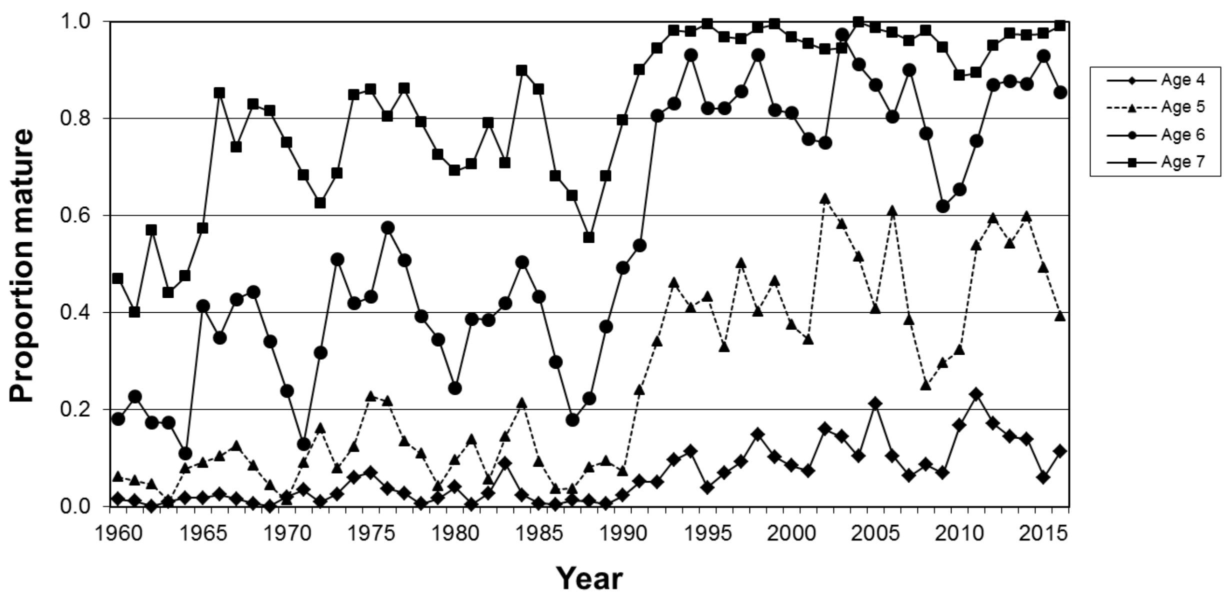

Figure 21b. Estimated proportions mature at ages 4-7 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps (data from all strata surveyed).

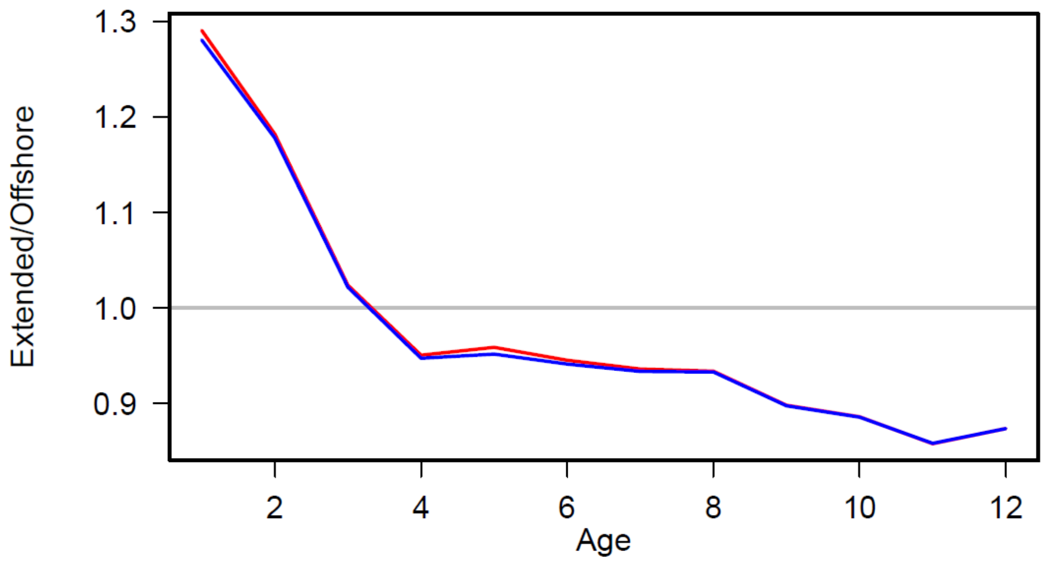

Figure 22. Age-specific ratio of the extended survey indices to the offshore survey indices (each index averaged over 1997-2016). Red line indicates ratios from previous assessment, where averages were computed over 1997-2015.

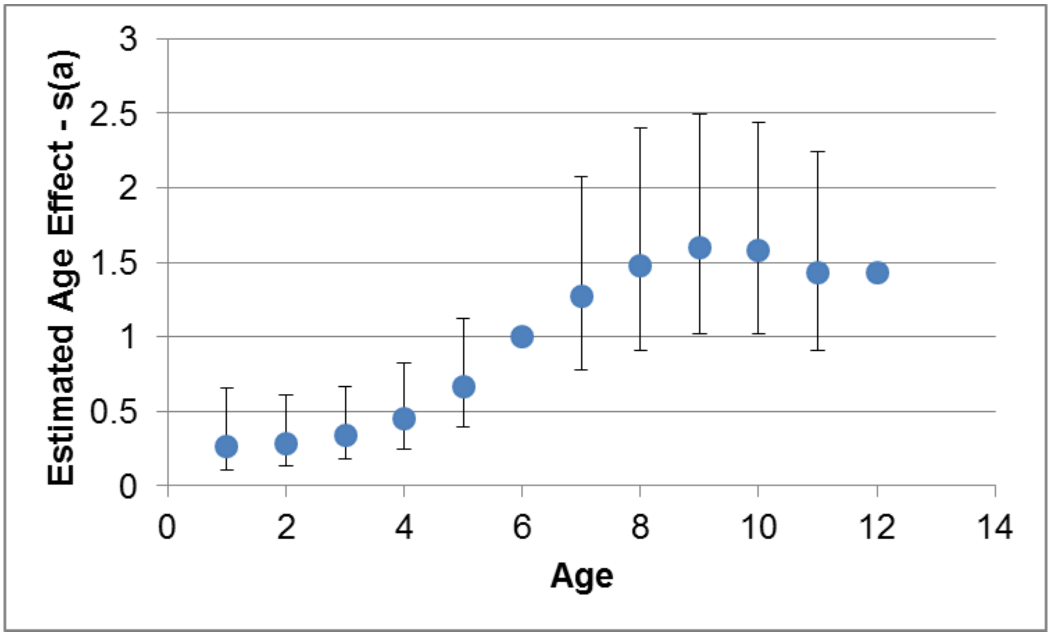

Figure 23. Estimated age-effects from SURBA cohort analysis, with 95% confidence interval. Age 6 is arbitrarily chosen as a reference age (and set to a value of 1), and the effect at age 12 is fixed at the level estimated for age 11.

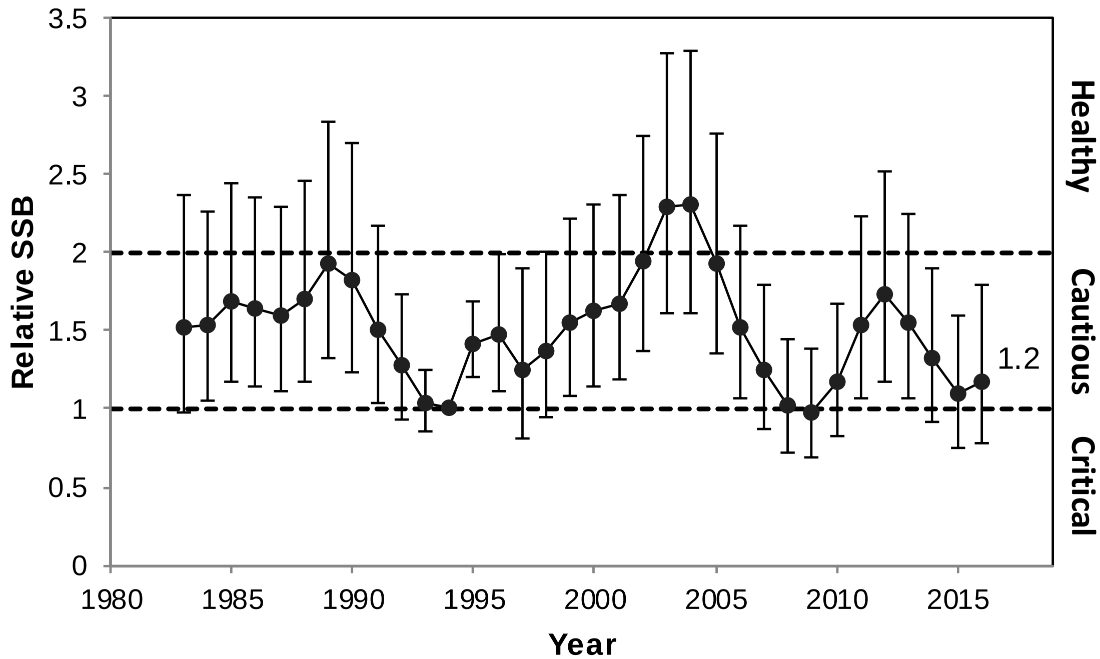

Figure 24a. Cohort analysis estimates of SSB, relative to the 1994 value (median estimate with 95% confidence interval). The lower dashed line at one (reference level) represents the SSB Limit Reference Point and the upper horizontal dashed line at two represents the Upper Stock Reference (i.e., 2 x LRP). These reference points represent the boundaries between the zones of DFO's precautionary approach framework, as indicated on the right axis. Text label indicates the current SSB relative to the LRP.

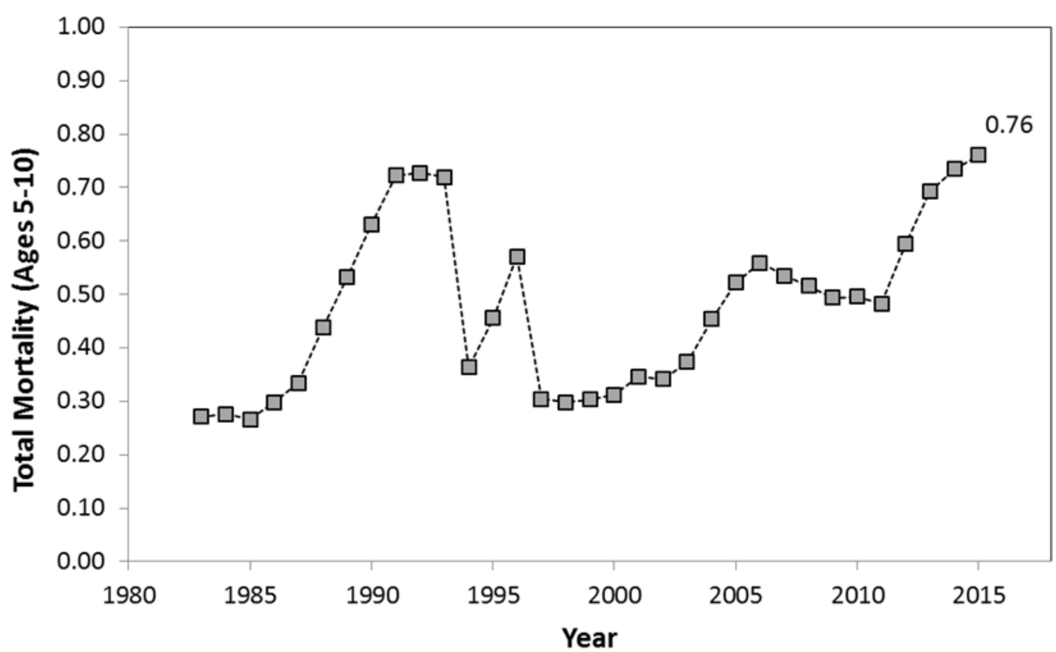

Figure 24b. Cohort analysis estimates of population weighted average annual mortality (ages 5-10). Text label indicates the estimated total mortality for 2015.

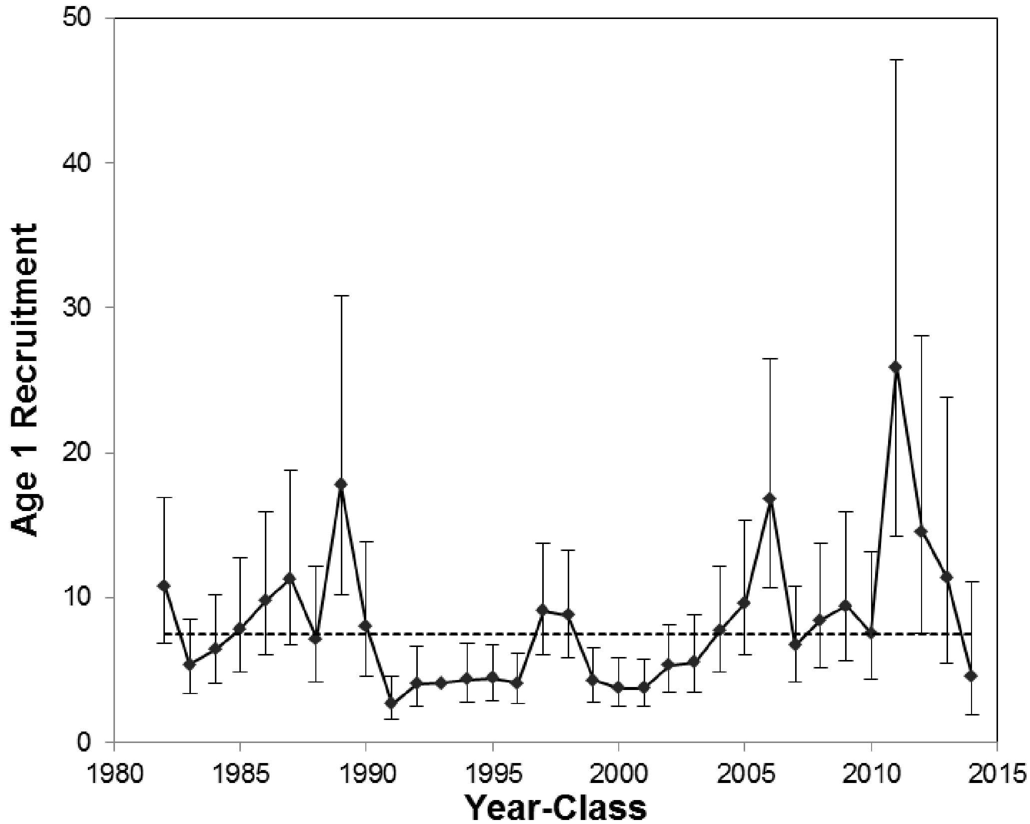

Figure 24c. Estimates of age 1 recruitment from SURBA cohort analysis model.

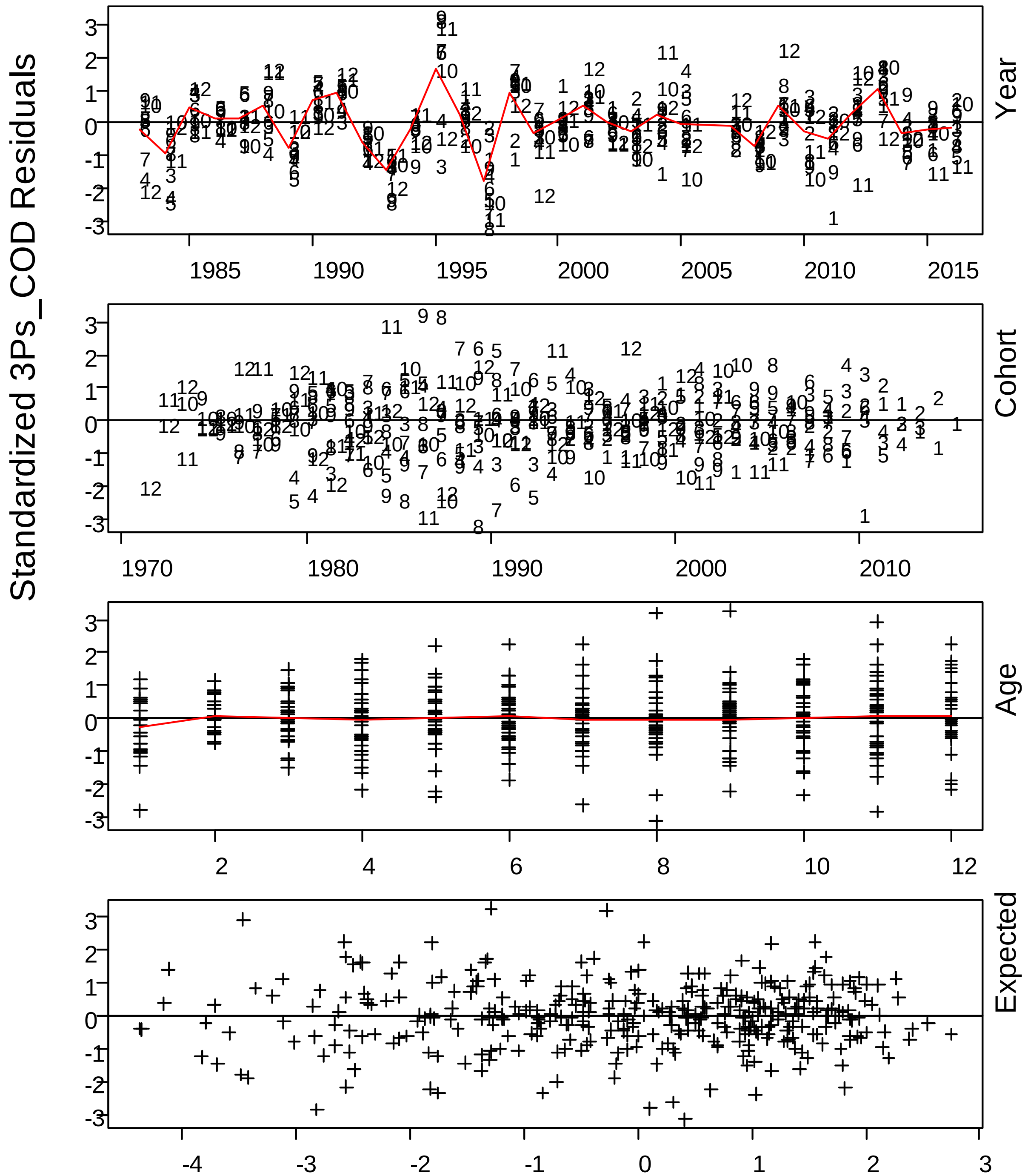

Figure 25. Standardized residuals from SURBA cohort analysis. Panels show residuals plotted year, cohort, age, and expected value, respectively.

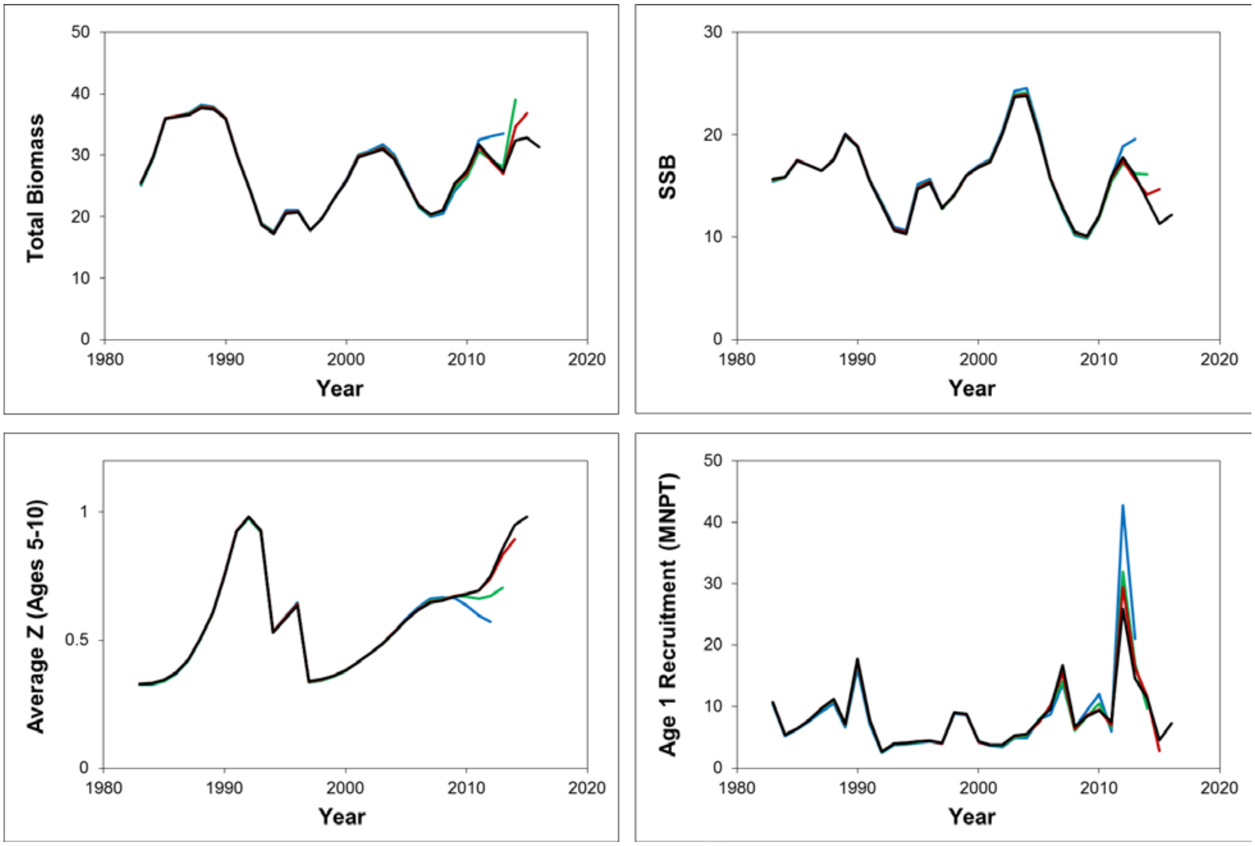

Figure 26a. Retrospective patterns comparing the four most recent assessments for 3Ps cod based on a SURBA cohort analysis model.

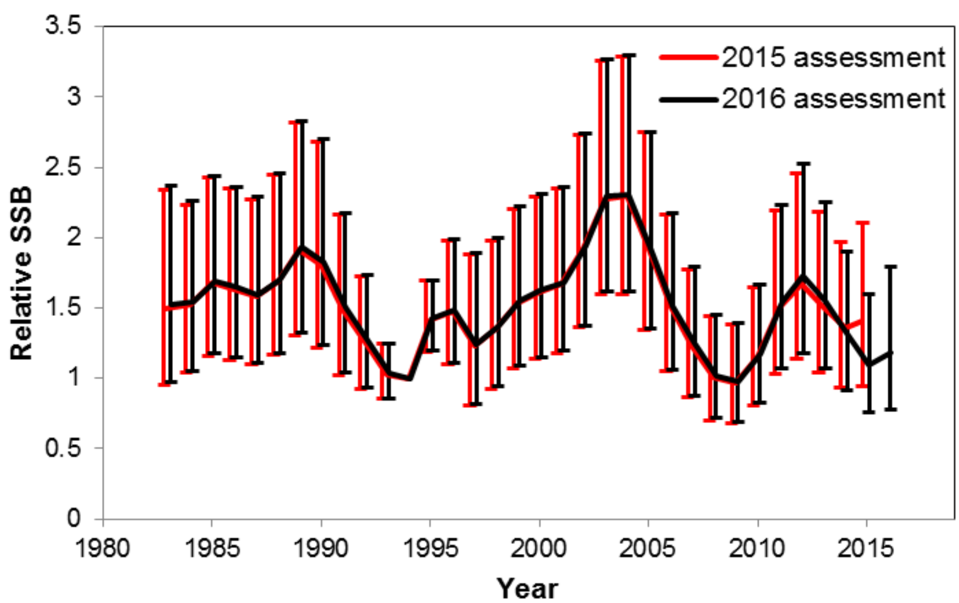

Figure 26b. Retrospective pattern comparing estimates of spawning stock biomass and 95% CI's from the two most recent assessments for 3Ps cod based on a SURBA cohort analysis model.

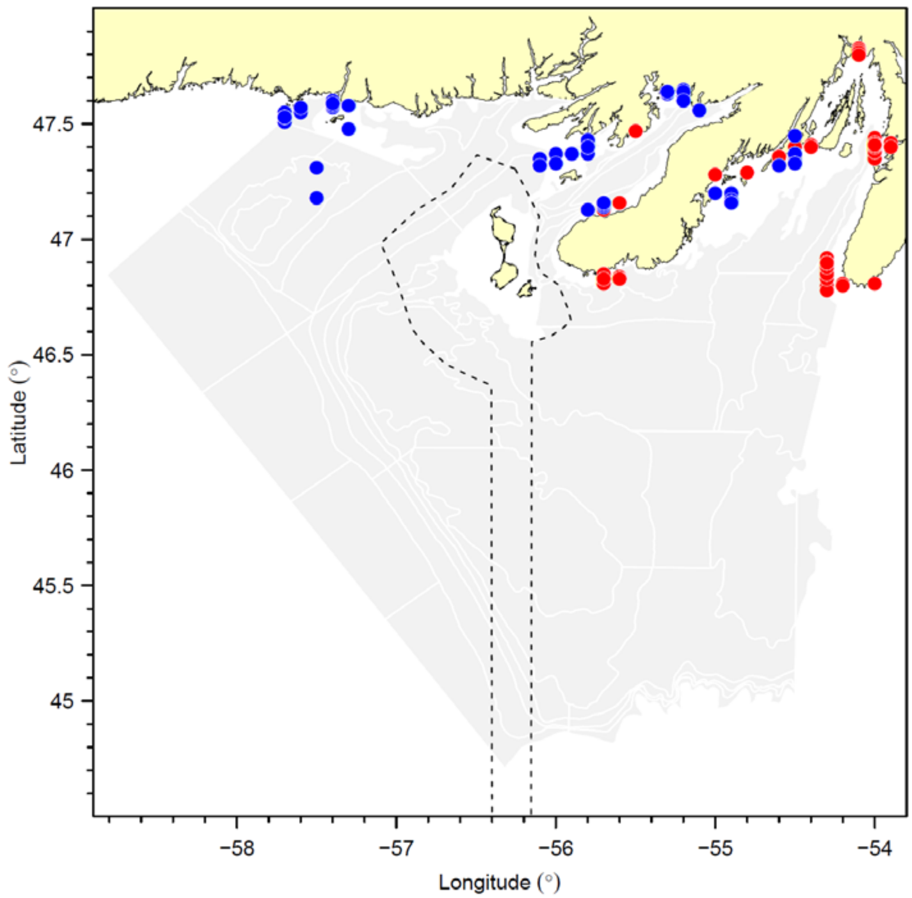

Figure 27a. Sentinel fishery sites in 2015. Gillnet (red) and line trawl (blue) sites are demonstrated in relation to the area covered by the DFO RV survey (shaded grey). The dotted line represents the French EEZ around St. Pierre et Miquelon.

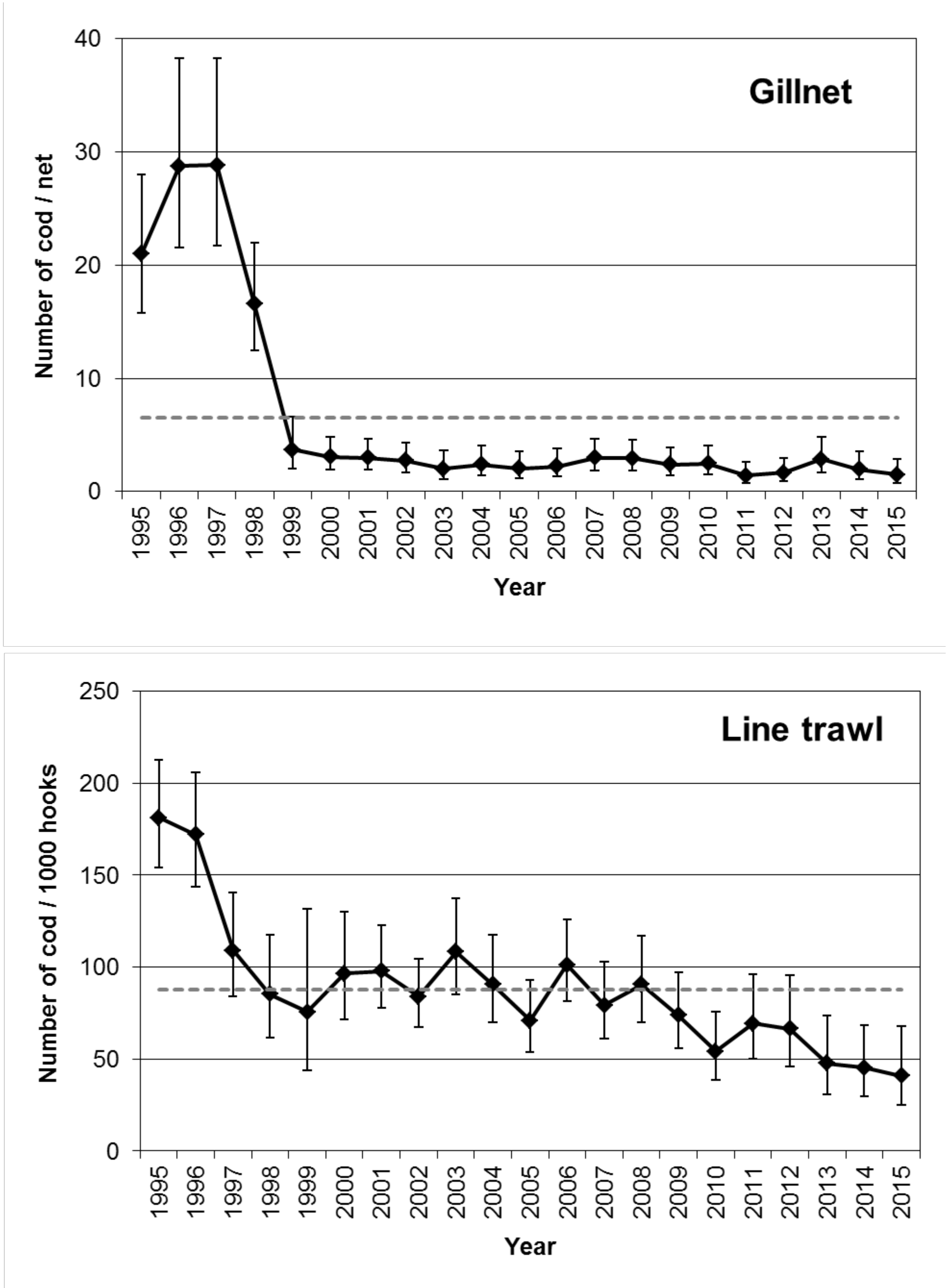

Figure 27b. Standardized age-aggregated catch rate indices for gillnets (5.5" mesh) and line-trawls (with 95% CL's) estimated using data from sentinel fishery fixed sites. Dashed horizontal lines indicate time-series average.

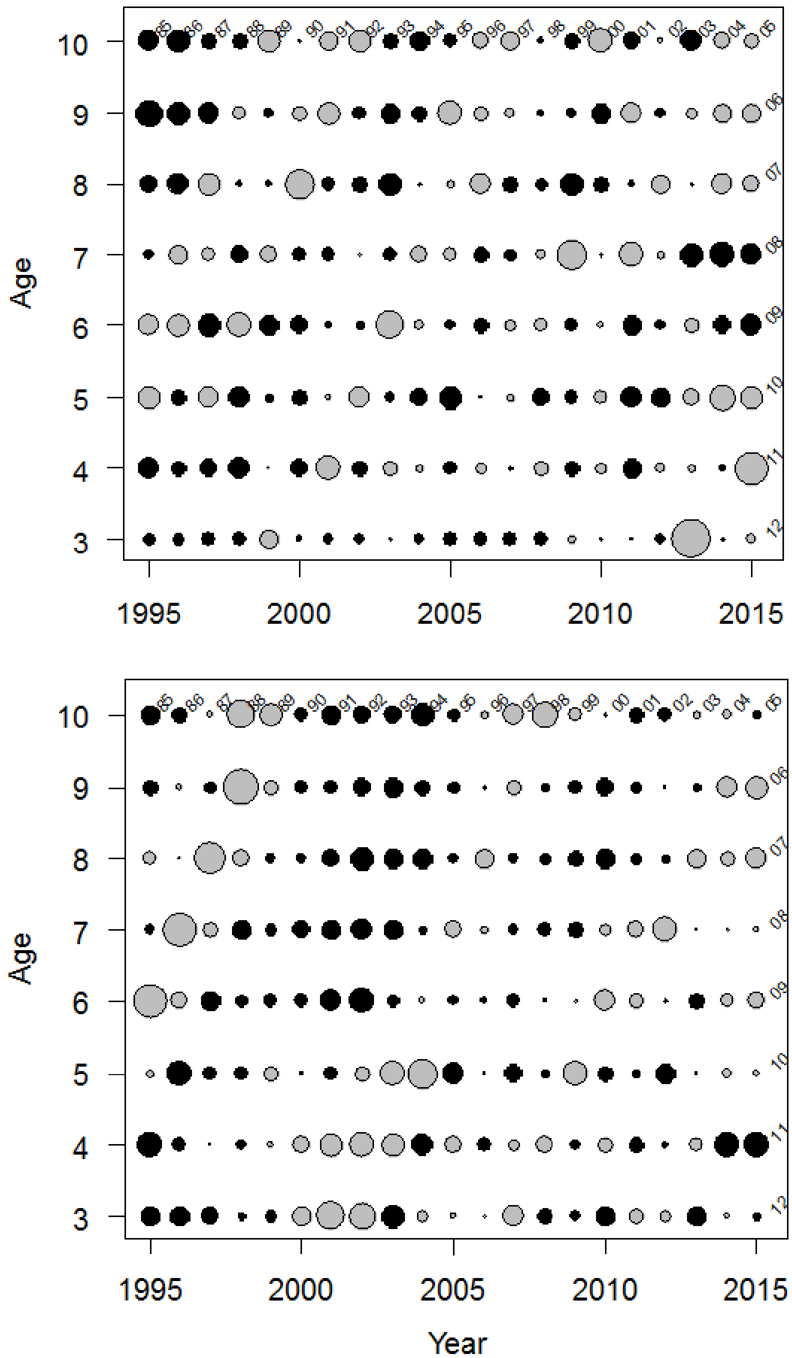

Figure 28. Standardized proportions at age of sentinel catch rates at age for gillnet (top) and linetrawl (bottom) in Subdiv. 3Ps. Annual proportions were computed, and then standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions across years. Symbol sizes are scaled and values greater than average are shown as grey circles, average values are shown as small dots, and less than average values are shown as black circles. Labels in the upper and right margins identify cohorts.

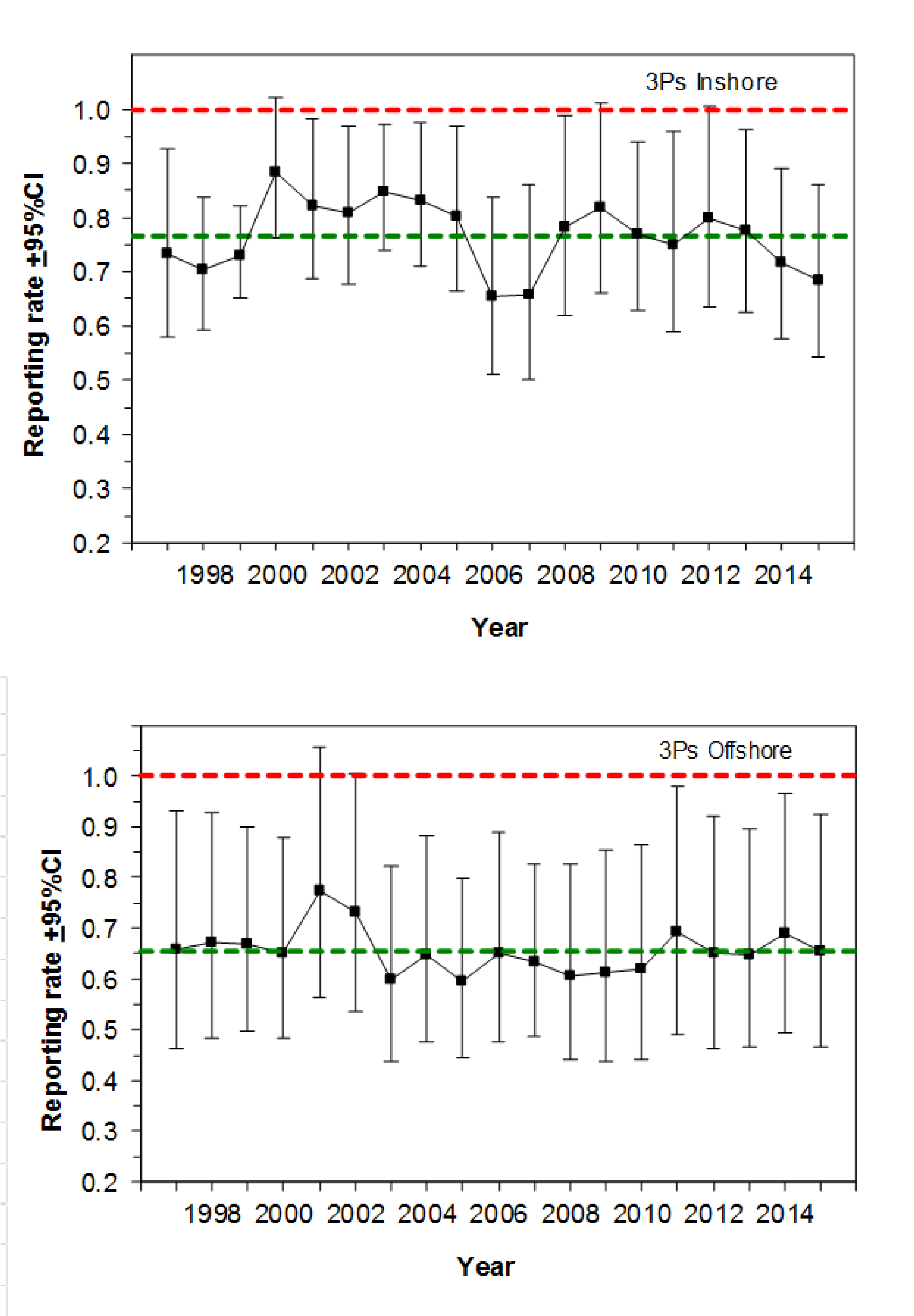

Figure 29. Trends in annual tag reporting rates (± CI's) for low reward ($10) tags based on a mixed effects logistic regression model. Horizontal dashed green line is time series average.