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Assessing the status of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in 2018

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Foreword

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

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ABSTRACT

The status of the cod stock in the Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps was assessed during a Fisheries and Oceans Canada (DFO) Regional Peer Review Process meeting held October 16-17, 2018.

Total landings for the 2017-18 management year (April 1-March 31) were 5,031 t or 77% of the Total Allowable Catch (TAC). This marks the eighth consecutive season that the entire TAC has not been taken.

Survey abundance and biomass estimates from the DFO research vessel (RV) spring survey were below average during 2016 to 2018. Sentinel gillnet catch rates have been very low and stable since 1999. Sentinel linetrawl catch rates have been below average for the past eight years and the 2017 catch rate was among the lowest in the time series.

Spawning stock biomass (SSB) has increased since 2015. In 2018, 71% of the SSB is comprised of ages 6 and 7. Recruitment has generally been at or above the time-series average since 2005, with a particularly strong cohort produced in 2011. Estimated total mortality remains high. Over 2015-17, total mortality averaged 0.61 (54% survival per year); however, the relative contributions of natural and fishing mortality to total mortality are unknown.

Projection of the stock to 2021 was conducted assuming mortality rates will be within +/- 20% of current values (2015 to 2017 average). All projections show SSB in 2021 to be lower than SSB in 2018. Where total mortality is assumed to remain at or above current levels, projections indicate that SSB in 2020 and 2021 to be at or below B_{lim}.

INTRODUCTION

This document gives an account of the 2018 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 2018 (DFO 2019) with participation from Fisheries and Oceans Canada (DFO) scientists, IFREMER (France), DFO Fisheries Management, academia, the Canadian fishing industry, a non-governmental organization 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 2018 were presented. The results of the 2018 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 data from the Sentinel survey (1995-2017), science logbooks for vessels less than 35 feet (1997-2017), logbooks from vessels greater than 35 feet (1998-2017) and observer sampling. Results of a telephone survey of inshore Canadian fish harvesters and information from tagging experiments in Placentia Bay (and more recently Fortune Bay), were also available.

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 5,980 t in the ongoing 2018/19 season (Fig. 3a). 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. It was not considered prudent to provide management advice for 2017/18 and subsequent seasons based on the HCR. Canada and France agreed on TACs of 6,500 t for the 2017/18 season and 5,980 t for the 2018/19 season. 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 2017-18 management year (April 1–March 31) were 5,031 t, or 77% of the 6,500 t TAC. This marks the eighth consecutive year in which the landings have been less than the TAC. Industry participants have indicated multiple reasons contributing to the low landings, including reduced availability of fish, poor market conditions/economics, and technical issues with the French vessel. A voluntary suspension of fishing activities by the trawler fleet is the primary reason the 2016/17 TAC wasn’t taken. 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 among the lowest of the available time series. Preliminary landings data for 2018/19 to October 5 totaled 2,252 t. Although the 2018/19 fishing season was incomplete at the time of the assessment, these landings to date are comparable to those from recent years when landings approximated the current TAC of 6,500 t.

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 7-26% 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 6% of landings on average for the post moratorium period. However, hand line catch for 2001 showed 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 and shown in Figure 5. Of particular note is that inshore catches in 3Psa were higher during June-July in 2017 than in other recent years.

Inshore landings were 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) were taken in June-November, with highest landings in June and July, particularly in 3Psc. The inshore (3Psa, 3Psb, and 3Psc) 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 2017 the landings from 3Psc were 2813 t, representing 49% 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; Fig. 2). 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 2017 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 and these restrictions continue to apply to the fishery. 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 numbers-at-age for the Canadian catch during 2017 were available for the 2018 3Ps cod Regional Assessment Process. The amount of landings sampled is highly variable among gear types and years, but generally the otter trawl fleet is sampled well compared to other fleets while inshore and offshore line trawl landings are sampled poorly (Table 4). There was sampling for roughly half of the landings from gillnets and handlines.

During 2017 the landings were composed mostly of age five to eight fish, which is typical of fisheries dominated by gillnet catches (Fig. 6; for detailed catch-at-age estimates for 2017, see Table 5; for the complete time series (1959 to 2017) of available catch numbers at age (ages 3-14 shown) for the 3Ps cod fishery, see Table 6). 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 (e.g. Brattey et al. 2008). 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

The assessment uses approximate beginning of the year weights calculated from weight-at-age via the Rivard geometric mean method (Rivard 1980). 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 7a and Fig. 7, while beginning of the year weights-at-age are given in Table 7b and Fig. 8. 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 that has been applied to all cod stocks in the Newfoundland Region.

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 (Tables 7a, 7b Figs. 7-8). 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 (RV) SURVEYS

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 CCGS A.T. Cameron (1972-82), CCGS Alfred Needler (1983-84; 2009-present), and CCGS 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 CCGJ A.T. Cameron was a side trawler. Cadigan *et al*. (2006) found no significant differences in catchability for several species, including cod, between the Wilfred Templeman and Alfred Needler research vessels. The 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. 9. 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 8). 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 2018 survey completed 167 of the intended 178 fishing sets (Fig. 10). No tows or only one tow was conducted in three strata (707, 708, 715) which did not meet the requisite two tows per strata to be included in index calculation. The average contribution of each of these strata to the annual biomass and abundance totals was less than 2 percent, and the meeting concluded that the impact of the incomplete strata on the index was not a great concern.

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. 11). 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 2009-17. The 2013 estimate was particularly high, but was followed by a subsequent large decline during 2014-17, with the 2017 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 1998-2018, with the exception of a high value of 83,000 t in 2013.The survey biomass estimate for 2018 was 28,905 t, 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 9 and 10, Fig. 11) in spite of the 18% increase in surveyed area. However, the combined inshore/offshore survey showed higher biomass and abundance during two years; in 2005 and 2017, values were comparatively higher for the inshore/offshore index due mainly to large estimates (single large set) from inshore stratum 294 and 295 respectively.

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. 12 and 13) resulted in >50% of the overall biomass being located in this particular area (Fig. 14) 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 six 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 (Fig. 15) 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. For the inshore region in 2018, biomass and abundance decreased from 2017 to low levels similar to those observed in 2015 and 2016. After four years of declines, both abundance and biomass increased in the Eastern region during 2018 (Fig. 16), whereas the Burgeo indices have been declining since 2015.

Age Composition

Survey numbers at age are obtained by applying an age-length key (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 Tables 11a and 11b and results for ages 1-15 are shown in the form of standardized proportion at age per year (SPAY) “bubble” plots in Fig. 17. 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 continued to look strong and is now fully selected to the fishery. More recently, abundance of the 2016 year-class appears higher than average, but it too may be subject to revision with the addition of subsequent survey data. An examination of age-disaggregated spatial plots indicated that this year-class was widely distributed in the 2018 RV survey (Fig. 18).

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

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

Mean lengths-at-age were updated using the 2018 survey data (Fig. 19). For ages older than age 3 there was a general decline in length-at-age from the early 1980s to the mid-1990s (Fig. 19, Table 12). 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 2018 ages 1 to 12 were present. Length-at-age increased for most ages, especially age 9, in 2018 compared to 2017.

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 2018 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. Mean length at age was greater than average in the mid 1980s. It showed a declining trend until the mid 1990’s when it was below average. Mean length-at-age subsequently increased. Generally, length-at-age decreased from 2010 to the lowest in the time-series in 2017, but in 2018 there was a considerable increase to near average values, driven mostly by increases in the age 9 fish (Fig. 19).

Values for mean weight at age were updated with data from the 2018 survey (Fig. 20). There was an increase in weight-at-age from the mid-1990s through the mid-2000s, but data from 2007-2017 surveys suggest that mean weight-at-age was mainly lower than the mid-2000’s. Mean weight-at-age was greater than average in the mid 1980s and generally declined to very low levels in the mid 1990s (Fig. 20). As with mean length-at-age, mean weights-at-age increased after the mid-1990s to about 2000. Weight-at-age since 2005 has been generally lower with 8 of the last 19 years below average. Weight-at-age in 2016 and 2017 were the lowest observations in the time series, but weight-at-age in 2018 increased to near the time-series average. The time series for selected ages (3-9) are shown in Figure 20, along with their average deviation from mean weight. Fish aged three to five showed a slight increase in weight-at-age from about 1986 to 2005 while older age groups (6-9) were variable but stable. Values for most ages were lower during the 2013-2017 period than earlier in the time-series. There were modest increases in weight at age for most ages in 2018 (Table 13; Fig. 20).

Condition

Relative gutted condition (relative K) and relative liver condition (relative LK) were calculated from survey data. It has been shown that the timing of the survey affects estimates of condition for 3Ps cod (Lilly 1998) and so only estimates from April surveys beginning in 1993 were estimated. A length gutted weight relationship was estimated, and the condition index is then observed condition divided by the condition predicted from the length weight regression for a fish of that length. Relative liver condition was calculated in a similar fashion using a liver weight length regression. 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 computed as:

$$\log(\text{liver weight}) = \text{intercept} + b1*\text{lglen} + b2*(\log(\text{length})*\log(\text{length}))$$

Both gutted and liver condition increased to about 1998 and then were lower until 2004 with a spike in 2005 (Figure 21). Gutted condition reached a low in 2008 but increased to reach above average levels in 2013, however it declined again and was below average from 2014-2018, with 2016 being the lowest in the time series. Liver condition had been below average from 2014 to 2017, with 2017 being the lowest in the time series. In 2018, liver condition was slightly above average.

In conclusion, mean length-at-age and mean weight-at-age increased for most ages in 2018 with indices of condition also increasing relative to 2017.

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). Age at 50% maturity was estimated for each cohort and trends are shown in Fig. 22a (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 14, 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 are once again near 5 years (Fig. 22a). 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 15; these were obtained from the cohort model parameter estimates in Table 14. The estimates of proportion mature for ages 4-7 show an 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. 22b). 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. 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. Results indicated that SSB declined by 58% over

2004-09 (Fig. 23a). Median SSB was estimated to be at the LRP in 2008 and below the LRP in 2009. SSB has increased since 2015. The stock is currently estimated to be in the Cautious Zone (49% above B_{lim}) as defined by the DFO Precautionary Approach (PA) Framework; the probability that the stock is in the critical zone (i.e., below B_{lim}) is 0.04. In 2018, 71% of the SSB is comprised of ages 6 and 7. This is an enormous reliance on two cohorts that may experience high mortality rates over the next couple years.

Total mortality rates reflect mortality due to all causes, including fishing. Estimated total mortality increased from 1997 to the time-series maximum in 2015, decreased slightly in 2016 and remained at a similar, high level in 2018 (Fig. 23b). Over 2015-17, total mortality averaged 0.61 (54% survival per year). This is very high considering that landings have been between one half to three quarters of the TACs over this time period. However, the relative contributions of natural and fishing mortality to total mortality are unknown. The total mortality values are weighted by population number at each of ages 5-10.

Recruitment (Fig. 23c) has generally been at or above the time-series (1983-2018) average since 2005, with a particularly strong cohort produced in 2011. Even this strong cohort is 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. 24).

Retrospective revisions are not uncommon in cohort models, which use annual information to predict the abundance of multiple cohorts. In the current assessment, retrospective revision in SSB is also impacted by changes in the predicted values for proportion mature at age from a cohort-based model and the updated stock weight estimates for 2014 and 2015. Strong retrospective patterns in the same direction over multiple years could suggest an issue with the assessment (input data and/or model formulation). In the current assessment, only minor revisions were noted in the terminal year estimates of SSB, biomass and recruitment at age (Fig. 25). The downward revision in terminal year total mortality was the most notable retrospective change (Fig. 25), but it was not large enough to be concerning. Moreover, revisions were not always in the same direction. It was agreed that these differences were not sufficient to suggest an issue with the assessment.

Projection of the stock to 2021 was conducted assuming mortality rates will be within ± 20% of current values (2015-17 average). Recruitment was assumed to be the geometric mean of the age 1 estimates over 2015-17, and weights at age were assumed to equal the average of those over 2015-17. The proportions mature at age were projected forward from the cohort-specific model estimates. Five projection scenarios were conducted, using multipliers of 0.8, 0.9 1.0, 1.1, and 1.2 current Z, with a constant mortality rate assumed for each year projected. All projections show SSB in 2021 to be lower than SSB in 2018. Where total mortality is assumed to remain at or above current levels, projections indicate that SSB in 2020 and 2021 to be at or below B_{lim} (Fig. 26). The risk of being below B_{lim} by 2019 ranges from 0.07 and 0.38, and by 2021 from 0.14 to 0.83 (Table 16).

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 (1995-2017), science logbooks for vessels less than 35 feet (1997-2017), logbooks from vessels greater than 35 feet (1998-2017) and observer sampling. Results of a telephone survey of inshore Canadian fish harvesters and information from tagging experiments in Placentia Bay (and more recently Fortune Bay), were also available. 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.

Science Logbooks (<35 Ft Sector)

A science logbook was introduced to record catch and effort data for vessels < 35 ft in the re-opened fishery in 1997. Return of this logbook at season's end is mandatory (pers. comm., L. Slaney, Resource Management Branch, DFO). Prior to the moratorium, the only data for vessels < 35 ft came from purchase slips, which provided limited information on catch and no information on effort. Since the moratorium, catch information comes from estimated weights and/or measured weights from the dockside monitoring program. Catch rates have the potential to provide a relative index of temporal and spatial patterns of fish density, which may relate to the overall biomass of the stock. Prior to the fall assessment meeting, there were about 171,000 records in the database. As with the analysis of results from the Sentinel program, we consider data to 2017 only, and exclude the current (in-progress) year. The number of annual logbook records has declined over time, even over multi-year periods having common TAC. In addition, the percentage of the total cod catch for the < 35 ft sector represented in the logbooks has decreased over time, from about 70% in 1997 to about 20% in recent years.

We present a catch rate index for data pertaining to the inshore fishery, i.e., unit areas 3Psa, 3Psb, and 3Psc. An initial screening of the data was conducted and observations were not used in the analysis if the amount of gear or location was not reported (or reported as offshore / outside of 3Psa, 3Psb or 3Psc), more than 30 gillnets were used, or < 100 or > 4,000 hooks were used on a line trawl. Upper limits for the amount of gear considered are applied to eliminate outlying records and exclude < 1% of the available data for each gear type. As observed in previous assessments, preliminary examination of the logbook data indicated that soak time for gillnets is most commonly 24 hours with 48 hours the next most common time period. In comparison, line trawls are typically in the water for a much shorter period of time-typically 2 hours with very few sets more than 12 hours.

The screening criteria described above have resulted in a substantial fraction of < 35 ft catch not being available for analysis. For example, in 2017 only 20% of the < 35 ft gillnet catch and 15% of the < 35 ft linetrawl catch is included in the CPUE standardization. These values are lower than usual and reflect both the low reporting rate and an increasing portion of logbooks records with invalid entries for the location fished. This occurs when logbook entries do not record a fishing location as shown on the map included in this logbook. (These are denoted as fishing areas 29-37 and illustrated in Fig. 27). Most of these instances are generated from logbooks which report the location fished as either “10” or “11”-these references correspond to “species fishing areas” (e.g., Lobster Area 10) which are relatively large and include more than one of the fishing locations illustrated in Fig. 27. Therefore it is not possible to resolve these entries to the finer-scale areas indicated in the logbook, and, consequently, a substantial fraction of the catch and effort data from smaller vessels is excluded by our selection criteria.

As in previous assessments, effort was treated as simply the number of gillnets, or hooks for line trawls (1000s), deployed in each set of the gear; soak times were not adjusted as the relationship between soak time, gear saturation and fish density is not known. Catch rates from science logbooks are expressed in terms of weight (whereas those from the sentinel fishery are expressed in terms of numbers); commercial catches are generally landed as head on gutted and recorded in pounds; these were converted to whole weight (in kg) by multiplying by a gutted-to-whole weight conversion factor (1.2) and converting pounds to kilograms (2.203).

The frequency distribution of catches per set is skewed to the right for both gears (not shown). For gillnets, catches per net are typically around 15 kg with a long tail on the distribution extending to about 75-100 kg per net. The distribution of catches for line trawls was similarly skewed, with median catches of about 180kg/1000 hooks; but extending out to 500-600kg/1000 hooks.

The catch from 3Ps was divided into cells defined by gear type (gillnet and line trawl), location (numbered 29-37, as described above) and year (1997-2017). Initially, unstandardized CPUE results were computed and examined; in this preliminary analysis, plots of median annual catch rate for gillnets and line trawl were examined for each year location. Catch rates for gillnets tend to be higher in areas 29-32 (Placentia Bay and south of Burin Peninsula) than elsewhere. Gillnet catch rates in 2017 were quite variable among locations with most values comparatively low in Placentia Bay (Fig. 27). For line trawl, most data come from areas west of the Burin Peninsula and the results in areas 29- 33 are based on low sample sizes and show more annual variability (Fig. 28). In 2017, line trawl catch rates at the Head of Fortune Bay were among the highest in time-series, but for all other locations west of the Burin Peninsula, catch rates were the lowest observed. Catch rates were about average at the Head of Placentia Bay and on the eastern side.

Prior to modeling, the data were aggregated within each gear year month location cell, and the aggregated data were weighted by its associated cell count. Catch per unit effort data were standardized to remove site (fishing area) and seasonal (month, year) effects. A Generalized Linear Model with a log link and Gamma distribution was used to estimate year and month within location and there was no intercept. Effort was used as an offset. Note that sets with effort and no catch are valid entries in the model.

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

Standardized gillnet catch rates declined over 1998-2000 and have subsequently been low but stable at approximately 20kg/net (Fig. 29). For line trawls, temporal patterns differ from those in of gillnets, with much inter-annual variation since 2000. After peaking in 2006, line trawl catch rates generally declined to 2010, and remained near the time-series average in 2014 (Fig. 30). The catch rates estimated for 2016 and 2017 were the lowest in the time-series but it was based on a low number of logbook returns.

The observed trends in commercial catch rate indices for the inshore fishery are influenced by many factors. There have been substantial annual changes in the management plans in the post moratorium period (Brattey *et al*. 2003). In addition, gillnets and line trawls can at times be deployed to target local aggregations. For inshore fisheries, catch rates can also be strongly influenced by annual variability in the extent and timing of inshore as well as long shore cod migration patterns. Similarly, the changes in management regulations, particularly the switch from a competitive fishery to Individual Quotas (IQs) and for some vessels the need to fish cod as bycatch to maximize financial return, can have a strong influence on catch rates that is unrelated to stock size (DFO 2006). Consequently, inshore commercial catch rate data must be interpreted with caution. Despite these issues, the initial declines in gillnet and line trawl catch rates following the re-opening of the fishery in 1997 were cause for concern. The remarkable consistency in gillnet catch rates since 1998 despite the changes in resource abundance and management regulations has not yet been explained. The recent decrease in modeled catch rates for line trawls since 2015 is difficult to explain, but it may be related to the low sample sizes. Also, the age structure of the inshore line trawl catch differed from all the other gears and indicates that the 2011 cohort was not be as well represented in line trawls as in other gear types.

Logbooks (>35 Ft Sector)

Standardized catch rate indices for gillnets and otter trawls were updated for vessels greater than 35 ft based on logbook data. This logbook series is administered with follow up by DFO staff when logbooks are not returned promptly and return rates, calculated as the proportion of landings represented by logbooks to sector landings, have been considerably higher than those for the < 35 ft sector.

For gillnets, data were screened to select deployments between 12 and 24 hours and a minimum of five data entries was arbitrarily set for including cells (year, area, quarter) in models. The number of vessels in the logbook database, which were subsequently used in the catch rate model, decreased by half over the time-series with only 52 vessels reporting in 2017. This decline was due to a reduction in the number of vessels participating in the fishery over time. The amount of gillnet landings covered by the logbooks was more than 50 % over the last decade (Table 17). The model standardizes catch rates to account for spatial and seasonal effects. Results indicated that catch rates were higher in magnitude (Fig. 31) than those from vessels less than 35 ft (Fig. 27), but the pattern over time was similar. Catch rates in the > 35 ft fleet initially (1998 to 2000) declined by about half and remained stable at those levels to 2017.

To develop a standardized index for the otter trawl fleet, data were screened to exclude tows less than 15 minutes and longer than 10 hours. As most of the fishery occurs during fall and winter, only tows conducted between October and March were retained for analyses and a minimum of five entries per cell (year, area, quarter) was included in modeling. Catch per unit effort was calculated as catch weight per hour of towing. The percentage of the otter trawl catch that is accounted for in the standardized index is variable over time (27-94%) but has been 60% or higher since 2010 (Table 18). During this period, the otter trawl fleet was small and generally, logbook data was available from less than ten vessels annually.

Catch rates were standardized to remove spatial, seasonal, and vessel size (categorized as greater or less than 100 feet) effects. The frequency distribution of vessel length was bimodal with a clear gap around 100 feet and preliminary testing indicated that vessel length was an important factor in determining catch rates for otter trawlers. Results indicated that standardized annual catch rates generally declined from 1999 to 2017 with high values during 2006 (Fig. 32) attributed to atypically high fishing effort in 3Psh where catch rates are much higher than other areas. The long term decline in catch rates by otter trawlers is broadly consistent with the declining trend in biomass indices from the RV survey. However, otter trawl effort is variable with respect to timing (little or no autumn tows during some years) and is highly concentrated relative to RV survey coverage.

Attempts to standardize catch rates from line trawls revealed diagnostic issues with the models tested (normality violations) and further exploration would be required to develop a catch rate series for the > 35’ sector. Data screening for line trawls removed deployments longer than 24 hours as sets of longer duration were infrequent and not consistent with the known fishing procedures in the area. Also, only line trawls with a minimum of 150 hooks were retained in the analyses to reduce the potential number of mistakes in effort recordings. Standardization was attempted across years, areas and seasons. However, significant interactions between areas and quarters complicated analyses, indicating that seasonal catch rates differ among unit areas.

Observer Sampling

Information collected at sea by observers on Canadian vessels fishing for cod (1997-2017) were reviewed for the potential to create standardized catch rate indices for gillnets, line trawls and otter trawls. Preliminary analyses of the line trawl effort data in 2017 revealed issues associated with changes in recording protocols over time that have not been resolved. Therefore, no standardized estimates of catch rates by line trawls were developed based on observer data. Also, there was insufficient data to develop a standardized catch rate index for the otter trawl fleet.

To develop a standardized catch rate index for gillnets based on observer sampling, data were screened to remove deployments longer than five days. Data exploration indicated substantial variations in observer coverage over time and among unit areas, and the proportion of the landings observed was low (< 2%) during most years (Table 19). Standardization accounted for area and seasonal effects. Generally, the results of standardizing the gillnet data were broadly consistent with those from both logbook series. Catch rates were observed to decline by about half over 1998 to 2000 and remain relatively stable up to 2017 (Fig. 33).

Tagging Experiments/Exploitation Rate

Tagging of adult (> 45 cm fork length) cod in Subdiv. 3Ps was initiated in 1997 and has continued through 2017. 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 20a). 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 World Wildlife Fund. The number of tags released (Table 20a) 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. During 2014 to 2016, the number of tags released declined to less than 1300 annually. Coverage was again restricted to 3Psb and 3Psc in 2014 and 2015 and restricted further to just 3Psb in 2016. In 2017, 1840 tags were released in 3Psb and 3Psc. A brief synopsis of results from recent tagging is provided below.

Over 2008-10, approximately 300 tags were returned annually (Table 20b). Fewer tags were returned in 2011 and 2012 (130 & 188, respectively), resulting from both reductions in landings and the restricted spatial extent of releases. Returns increased in 2013 (246) and remained at similar levels to 2015 (239). For 2017, there were 294 tag recaptures reported (Table 20b). 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. 34). Reporting rate for the offshore portion of 3Ps in 2017 was 0.62 and for the inshore was 0.65.

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 (Fig 35). 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 (see Fig. 36 for 2016 to 2018 data). In contrast, many cod tagged offshore in Halibut Channel (3Psh) have shown extensive movement shoreward, particularly into Placentia Bay.

CONCLUSIONS AND ADVICE

- Consistent with recent assessments, a cohort model (SURBA) based on the spring DFO survey was used to infer overall stock trends.
- The 2018 Spawning Stock Biomass (SSB) is estimated to be in the Cautious Zone (49% above B_{lim}) as defined by the DFO Precautionary Approach (PA) Framework. The probability that the stock is in the critical zone is 0.04.
- SSB has increased since 2015. In 2018, 71% of the SSB is comprised of ages 6 and 7.
- Recruitment has generally been at or above the time-series average since 2005, with a particularly strong cohort produced in 2011.
- Estimated total mortality remains high. Over 2015-17, total mortality averaged 0.61 (54% survival per year), however the relative contributions of natural and fishing mortality to total mortality are unknown.
- Projection of the stock to 2021 was conducted assuming total mortality rates will be within +/- 20% of current values (2015 to 2017 average). All projections show SSB in 2021 to be lower than SSB in 2018. Where total mortality is assumed to remain at or above current levels, projections indicate that SSB in 2020 and 2021 to be at or below B_{lim}.

The ecosystem in Subdivision 3Ps remains under reduced productivity conditions. Spring bloom magnitude and zooplankton biomass have shown very low levels since 2014, which would negatively impact transfer of energy to higher trophic levels. However, there are some improvements in biological indicators for cod in 2018 (e.g. condition and diet).

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 strata were 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.

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 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.

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), though the relative magnitudes of these biases are unknown. 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. A framework project on developing a new population model for 3Ps cod that incorporates uncertainty in catch is ongoing.

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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 2017 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	614	4,199	637	279	1,158	-	-	6,887	13,225
2015	1415	3,706	175	440	724	-	-	6,460	13,490
2016	1,930	3,343	239	324	1,360	-	-	7,196	13,043
2017[1]	1,079	3,010	289	15	551	-	-	4,944	6,500

[1]Provisional catches

[2]1996-2006 includes recreational and sentinel catch. 2007-17 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[2]	3,089	670	192	10	3,961
2013[2]	1,939	457	270	14	2,680
2014[2]	2,760	1,066	331	38	4,195
2015[2]	3,065	326	299	9	3,699
2016[2]	2,779	283	268	10	3,340
2017[2]	3,658	352	359	23	4,392
2018[1,2,3]	1,964	114	115	0	2,193

[1]provisional
[2]excluding recreational catch
[3]As of September 28, 2018

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

Year	Month	Inshore			Offshore					Total
		3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	
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	470.4	496.7
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	280.2	0.5	0.2	8.2	0.0	0.2	376.4
2015	Jul	20.5	53.2	469.7	27.6	0.3	10.7	0.0	0.1	582.1
2015	Aug	7.4	20.1	222.6	18.9	0.0	77.6	8.1	0.1	354.8
2015	Sep	1.4	23.3	129.2	33.2	15.6	230.4	39.8	0.0	472.9
2015	Oct	4.3	37.9	189.0	2.0	31.3	226.9	46.5	24.3	562.2
2015	Nov	23.7	23.6	294.8	5.1	0.0	223.6	34.1	106.3	711.3
2015	Dec	63.6	150.4	127.0	0.5	32.9	0.0	0.0	187.2	561.6
2015	**Total**	**319.1**	**516.4**	**1,916.0**	**93.0**	**80.4**	**785.7**	**152.2**	**1,433.2**	**5,295.9**
2016	Jan	18.5	89.9	93.5	0.1	4.2	0.0	1.4	567.5	775.2
2016	Feb	29.0	56.2	37.0	0.7	0.0	4.7	14.3	941.9	1,083.9
2016	Mar	0.6	1.1	5.4	8.3	0.0	0.0	37.7	255.2	308.4
2016	Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	5.3
2016	May	34.1	41.8	51.2	0.0	0.0	0.0	0.0	19.0	146.2
2016	Jun	54.4	91.5	286.5	2.4	0.3	9.8	3.5	27.9	476.4
2016	Jul	30.8	56.0	456.0	14.4	0.7	10.8	5.8	9.3	583.9
2016	Aug	4.7	22.9	130.5	3.9	7.6	89.1	48.4	2.2	309.5
2016	Sep	7.5	9.1	83.4	40.2	5.2	121.1	41.1	1.5	309.0
2016	Oct	4.3	13.4	135.0	34.9	3.9	100.9	45.0	2.1	339.5
2016	Nov	59.5	115.1	423.2	63.3	28.9	56.5	21.6	74.0	842.2
2016	Dec	19.2	96.3	101.2	0.0	0.0	1.9	0.0	163.5	382.2
2016	**Total**	**262.5**	**593.4**	**1,803.1**	**168.3**	**51.0**	**394.9**	**218.9**	**2,069.4**	**5,561.6**
2017	Jan	128.9	129.6	159.4	0.9	15.2	15.3	20.5	530.1	1,000.0
2017	Feb	41.9	106.0	67.1	4.3	0.0	0.0	110.3	344.8	674.3
2017	Mar	23.7	0.0	1.8	19.5	0.0	0.5	0.4	100.8	146.6
2017	Apr	0.0	0.0	0.1	0.0	0.0	0.0	0.0	5.1	5.2
2017	May	19.4	58.6	47.2	0.5	0.2	0.0	0.3	0.5	126.8
2017	Jun	47.1	123.0	444.5	0.2	1.1	0.0	0.0	0.0	615.9
2017	Jul	8.7	57.5	989.2	0.9	0.0	3.1	0.4	3.9	1,063.6
2017	Aug	9.7	30.2	208.9	0.7	0.3	1.0	0.7	0.0	251.4
2017	Sep	6.6	17.2	139.4	10.3	25.7	131.8	15.8	2.9	349.7
2017	Oct	4.7	26.4	307.6	10.7	143.5	80.4	25.8	1.5	600.6
2017	Nov	4.9	58.8	304.6	4.4	59.0	12.4	1.0	27.5	472.7
2017	Dec	23.0	188.8	143.7	0.0	0.0	24.0	110.9	141.8	632.2
2017	**Total**	**318.7**	**796.0**	**2,813.3**	**52.4**	**245.1**	**268.6**	**286.0**	**1,159.0**	**5,939.0**
2018	Jan	56.5	95.3	75.7	0.0	3.2	55.7	47.9	144.8	479.1
2018	Feb	25.3	67.4	8.1	6.4	0.5	0.0	5.3	56.1	169.1
2018	Mar	13.8	0.0	0.0	24.1	0.0	0.0	5.8	56.6	100.2
2018	Apr	0.0	0.0	0.0	0.7	0.0	0.0	0.5	3.8	5.0
2018	May	19.6	40.7	54.4	0.0	0.0	0.2	0.0	0.1	114.8
2018	Jun	38.8	96.4	430.9	0.0	0.0	0.0	0.0	0.0	566.1
2018	Jul	8.2	86.7	837.1	0.3	2.1	5.1	1.5	0.5	941.5
2018	Aug	1.3	48.9	219.6	2.7	0.0	22.6	0.0	1.7	296.7
2018	Sep	-	-	-	-	-	-	-	-	-
2018	Oct	-	-	-	-	-	-	-	-	-
2018	Nov	-	-	-	-	-	-	-	-	-
2018	Dec	-	-	-	-	-	-	-	-	-
2018	**Total**	**163.5**	**435.3**	**1,625.8**	**34.2**	**5.8**	**83.5**	**61.0**	**263.6**	**2,672.6**

*French catch (2015 = 1,164 t, 2016 = 1,132 t, 2017 = 602 t, 2018 = 118 t) excluded since unit area not available.

Table 4. Summary of sampling conducted on 3Ps cod landings during 2017.

-		Landings		Number of	
Gear	Reported (t)	Sampled (t)	Unsampled (%)	Length frequencies	Otoliths
Inshore	-	-	-	-	-
Handline	359.4	184.3	49	587	294
Gillnet	3111.6	2340.6	25	12085	2799
Line trawl	350.1	56.2	84	7598	1462
Offshore	-	-	-	-	-
Gillnet	546.6	12.4	98	106	0
Line trawl	2.2	0.0	100	364	0
Otter trawl	1371.6	1294.3	6	20780	1705

Table 5. Estimates of average weight, average length and the total numbers and weight of 3Ps cod caught at age from Canadian and french landings during 2014-16 (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)*
2017	1	-	-	-	-	-	-
2017	2	0.25	31.00	4	0.00	0.56	0
2017	3	0.48	38.19	257	0.08	0.30	0
2017	4	0.80	44.61	14,924	2.56	0.17	12
2017	5	1.30	52.37	261,329	25.17	0.10	339
2017	6	1.80	58.27	1,296,988	44.53	0.03	2338
2017	7	1.90	59.24	517,874	41.47	0.08	984
2017	8	2.32	62.83	453,920	37.12	0.08	1051
2017	9	2.50	63.87	197,230	24.56	0.12	494
2017	10	2.45	63.31	60,972	16.02	0.26	150
2017	11	3.97	73.81	42,358	7.65	0.18	168
2017	12	4.78	79.36	4,701	0.9	0.19	22
2017	13	3.83	71.76	15,801	4.78	0.30	60
2017	14	3.15	69.59	1,248	0.59	0.47	4
2017	15	6.99	91.00	2,591	1.38	0.53	18
2017	16	6.9	91.00	228	0.22	0.95	2
2017	17	-	-	-	-	-	-
2017	18	-	-	-	-	-	-
2017	19	-	-	-	-	-	-
2017	20	-	-	-	-	-	-

2017 * Total catch estimate 5644 t , Total landings 6073 t , SOP =0.93.

Table 6. Numbers-at-age (000s) for the commercial cod fishery in NAFO Subdiv. 3Ps from 1959 to 2017 (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

Table 6. 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
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
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
2014	0	6	52	769	806	364	580	215	139	29	36	6
2015	2	211	262	900	653	270	326	75	29	8	5	0
2016	1	63	938	542	728	345	106	133	36	23	9	2
2017	0	15	261	1297	518	454	197	61	42	5	16	1

Table 7a. Mean annual weights-at-age (kg) calculated from lengths-at-age based on samples from commercial fisheries (including food fisheries and sentinel surveys where available) in Subdiv. 3Ps in 1959-2016. 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

Table 7a. 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
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
2014	0.929	1.066	1.844	2.061	2.078	2.704	2.522	3.265	3.913	2.742	4.27	5.022
2015	0.799	1.101	1.559	2.057	2.377	2.676	2.93	3.127	4.299	5.988	5.236	-
2016	0.705	1.179	1.569	1.804	2.348	2.468	2.936	3.691	4.035	4.804	4.522	7.818
2017	0.478	0.800	1.298	1.803	1.901	2.316	2.504	2.453	3.967	4.777	3.825	3.148

Table 7b. 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. Weights at age 3 in 2017, and age 14 in 2016 are the geometric means of the prior three years.

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

Table 7b. 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
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	0.482	0.956	1.208	1.609	2.041	2.031	2.363	2.860	3.176	3.417	2.557	3.236
2014	0.853	0.818	1.478	1.798	1.966	2.404	2.274	2.896	3.412	2.892	3.726	3.518
2015	0.658	1.011	1.289	1.948	2.213	2.358	2.815	2.808	3.746	4.841	3.789	3.836
2016	0.669	0.971	1.314	1.677	2.198	2.422	2.803	3.289	3.552	4.544	5.204	6.398
2017	0.721	0.754	1.239	1.681	1.849	2.335	2.485	2.684	3.827	4.394	4.288	3.773
2018	0.721	0.904	1.280	1.764	2.080	2.371	2.696	2.916	3.707	4.589	4.389	4.524

Table 8. 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
2017	AN 476-478	06-Apr-17	08-May-17	33	179	121	0.68
2018	AN 494-496	28-Apr-18	27-May-18	30	167	115	0.69

*Table 9. Cod abundance estimates (000's of fish) from DFO bottom-trawl research vessel surveys in NAFO Subdiv. 3Ps.**

Strata	Depth (fathoms)	sq. mi.	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
314	<30	974	573	287	328	1,223	563	172	89	395	1,280	1,680
320	<30	1320	3,222	1,260	1,603	4,213	1,189	893	363	715	1,483	3,841
293	31-50	159	208	55	284	503	1,312	186	56	66	93	973
308	31-50	112	486	16,893	3,058	1,167	878	4,437	28,379	131	3,821	1,425
312	31-50	272	0	112	337	1310	854	4,247	75	792	599	1,553
315	31-50	827	1,634	767	1,405	3,705	2,243	11,141	211	2,476	228	2,844
321	31-50	1189	218	1,823	2,608	393	549	307	157	613	474	8,289
325	31-50	944	1,542	7,970	8,019	519	2,194	2,708	1,217	200	114	730
326	31-50	166	0	11	627	11	57	11	23	38	23	0
783	31-50	229	157	515	228	126	110	63	72	142	16	221
294	51-100	135	4,960	713	59	2,658	1,476	845	1,401	716	1,576	2,646
297	51-100	152	1,056	4,242	2,781	3,922	1,547	1,181	1,241	554	1,302	920
307	51-100	395	18,237	7,758	4,945	3,412	1,902	2,010	7,480	1,793	5,868	3,152
311	51-100	317	3,632	9,627	1,979	3,212	17,063	2,847	1,352	2,209	2,965	5,152
317	51-100	193	912	3,215	330	7,022	12,721	0	199	1,739	942	27
319	51-100	984	24,418	20,120	10,120	35,549	40,494	15,851	20,338	13,826	11,624	6,071
322	51-100	1567	1,049	820	2,546	3,162	11,202	8,400	1,376	1,616	1,026	8,969
323	51-100	696	105	15,274	8,179	3,067	1,332	2,489	7,854	3,452	112	394
324	51-100	494	359	417	3,590	646	610	510	680	234	158	731
781	51-100	446	548	293	506	813	5,031	1,166	756	205	622	2,491
782	51-100	183	201	22	566	327	512	1,032	277	138	566	793
295	101-150	209	396	2,441	nf	971	1,639	1,776	2,444	1,495	13,451	1,279
298	101-150	171	73	585	0	6,764	134	125	141	118	3,093	12
300	101-150	217	507	194	917	43	637	254	68	388	968	95
306	101-150	363	4,054	714	1,382	706	877	574	433	136	233	133
309	101-150	296	49	236	529	308	49,273	145	41	22,517	38	0
310	101-150	170	30	143	129	35	1,695	86	386	82	53	35
313	101-150	165	111	259	21	11	164	571	23	227	261	0
316	101-150	189	116	10	12	17	65	0	45	30	23	15
318	101-150	129	189	18	9	9	237	21	35	68	9	0
779	101-150	422	186	0	503	5,955	12,283	7,372	192	348	318	581
780	101-150	403	37	0	388	526	3,587	1,002	127	698	147	249
296	151-200	71	999	32	3,581	2,269	2,338	103	161	347	893	15
299	151-200	212	13	42	58	39	110	188	0	29	33	15
705	151-200	195	155	36	29	0	13	63	13	27	13	0
706	151-200	476	87	258	131	98	16	0	35	147	646	64
707	151-200	74	737	23	16	15	173	12	22	5	9	nf
715	201-300	1074	599	63	53	18	26	0	3,600	117	149	nf
716	151-200	128	1,546	180	130	676	2,330	264	551	148	0	0
708	151-200	539	4,299	26	30	28	199	nf	59	nf	327	nf
711	201-300	126	125	44	29	3,850	16	0	16	41	63	669
712	201-300	593	60	15	34	65	0	20	17	40	0	0
713	201-300	731	99	56	0	134	36	0	0	20	17	0
714	201-300	851	819	55	70	79	0	0	169	92	29	16
Total	Offshore	-	69,462	88,490	52,275	74,660	148,972	57,779	75,237	53,926	32,588	45,788
Total	In/Offshore	-	78,803	97,625	62,146	99,575	179,689	73,072	82,172	59,170	55,667	56,077
std	Offshore	-	15,303	24,153	8,209	12,294	53,762	10,415	29,521	24,399	5,429	9,423

*See Fig. 14 for location of strata. The survey was not completed in 2006. See Brattey et al. (2007) for pre-2005 data.

*Table 10. Cod biomass estimates (t) from DFO bottom-trawl research vessel surveys in NAFO Subdiv. 3Ps.**

Strata	Depth (fathoms)	sq. mi.	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
314	<30	974	68	43	100	200	69	30	52	98	269	230
320	<30	1,320	1,069	603	500	1,695	1,618	759	69	363	1,113	1,444
293	31-50	159	7	15	19	46	52	10	13	5	6	64
308	31-50	112	170	8,343	1,558	426	732	1,408	13,903	49	2,184	692
312	31-50	272	0	37	78	206	234	904	30	125	104	1,081
315	31-50	827	1,777	235	1,295	1,585	544	4,726	180	796	83	1,611
321	31-50	1,189	54	2,054	1,639	150	114	140	56	130	78	7,413
325	31-50	944	447	4,194	2,831	269	547	923	385	18	12	197
326	31-50	166	0	19	140	4	25	3	5	7	3	0
783	31-50	229	13	31	25	7	19	27	1	25	2	31
294	51-100	135	149	55	7	315	73	47	111	45	67	1,185
297	51-100	152	156	1,224	2,110	1,863	528	227	285	138	175	348
307	51-100	395	8,114	4,100	3,258	1,563	650	951	2,185	565	3,137	1,412
311	51-100	317	395	2,414	394	348	1,512	684	108	310	178	4,020
317	51-100	193	158	2,436	31	2,849	970	0	67	325	29	12
319	51-100	984	33,064	20,494	10,024	28,365	20,804	12,559	11,071	4,507	6,151	2,756
322	51-100	1,567	104	439	1,395	206	607	1,439	201	182	77	6,343
323	51-100	696	4	10,070	4,602	655	127	1,220	4,048	1,676	11	135
324	51-100	494	53	39	653	86	175	97	112	21	20	86
781	51-100	446	28	33	44	55	151	70	114	15	44	149
782	51-100	183	20	1	328	30	101	42	51	9	22	32
295	101-150	209	20	519	Nf	477	117	204	453	260	6,718	171
298	101-150	171	56	250	0	3,903	37	79	43	59	1,732	32
300	101-150	217	286	111	480	94	200	74	14	138	510	77
306	101-150	363	2,021	630	932	649	501	268	244	74	120	256
309	101-150	296	10	282	333	210	44,380	25	14	17,005	18	0
310	101-150	170	7	82	105	17	306	74	152	28	39	31
313	101-150	165	61	213	14	21	39	315	12	87	341	0
316	101-150	189	156	7	7	29	23	0	75	30	12	4
318	101-150	129	189	32	38	15	438	51	50	76	7	0
779	101-150	422	18	0	168	1,246	4,719	1,875	34	15	19	54
780	101-150	403	2	0	71	21	284	178	13	80	3	10
296	151-200	71	239	5	2,702	1,863	589	29	33	131	236	1
299	151-200	212	2	26	63	29	9	275	0	21	29	11
705	151-200	195	122	47	36	0	49	141	18	88	8	0
706	151-200	476	51	153	180	126	17	0	53	110	597	107
707	151-200	74	469	20	24	71	154	27	21	6	17	nf
715	151-200	1,074	1,793	101	74	16	45	0	2,033	181	288	nf
716	151-200	128	961	124	111	1,102	1,476	307	311	178	0	0
708	201-300	539	3,688	16	30	32	269	nf	109	nf	334	nf
711	201-300	126	100	33	25	3,546	4	0	7	21	61	1,026
712	201-300	593	52	10	22	55	0	9	9	31	0	0
713	201-300	731	59	101	0	124	16	0	0	7	17	0
714	201-300	851	808	55	59	87	0	0	160	119	48	48
Total	Offshore	-	56,024	57,429	30,487	44,706	76,447	27,057	35,740	27,211	15,356	28,905
Total	In/Offshore	-	57,020	59,698	36,505	54,656	83,327	30,195	36,905	28,154	24,920	31,068
std	Offshore	-	22,078	18,906	5,042	11,579	44,705	6,964	14,899	17,255	3,512	7,956

*See Fig. 14 for location of strata. The survey was not completed in 2006. See Brattey et al. (2007) for pre-2005 data.

Table 11a. 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
2017	1.30	2.42	2.77	2.25	2.42	2.12	0.55	0.32	0.09	0.03	0.05	0.00	0.00	0.00	0.00	14.30
2018	0.89	4.53	4.55	2.77	1.90	2.46	2.58	0.26	0.22	0.20	0.15	0.01	0.00	0.00	0.00	20.52

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

*Table 11b. 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
2017	1.74	3.22	4.34	3.99	3.57	2.62	0.62	0.38	0.09	0.04	0.05	0.00	0.00	0.00	0.00	20.66
2018	1.67	5.40	4.56	2.58	1.73	2.22	2.29	0.23	0.19	0.17	0.13	0.01	0.00	0.00	0.00	21.20

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

Table 12. Mean length-at-age (cm) of cod sampled during research bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983-2018. 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*	-
2017	11.7	19.6	28.2	38.8	44.9	49.1	52.8	53.8	61.7*	85.5*	72.4*	-
2018	12.5	21.8	31.3	38.1	45.3	50.3	57.4	57.0	88.5	60.4*	61.1	96.0

Table 13. Mean round weight-at-age (kg) of cod sampled during DFO bottom-trawl surveys in Subdiv. 3Ps in winter-spring 1983-2018. 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	0.23	0.72	1.30	1.65	1.86	3.55	4.04	4.90	8.85	10.27
1984	-	0.07	0.27	0.63	1.21	1.85	2.79	3.83	4.23	5.03	7.87	9.82
1985	-	-	0.21	0.51	1.04	1.57	2.28	3.21	3.14*	3.76*	-	3.97*
1986	-	0.05	0.17	0.46	0.90	1.33	2.38	3.34	5.02	4.65	6.63*	8.87
1987	-	-	0.25	0.54	0.95	1.27	1.89	2.30	4.48	6.34	6.62	5.94
1988	-	0.06	0.19	0.58	0.92	1.49	2.21	2.42	3.94	4.84	4.26	9.10
1989	-	0.06	0.24	0.61	0.90	1.33	2.36	3.78	4.51	5.82	8.28	9.06
1990	-	0.06	0.21	0.54	0.95	1.35	1.62	2.18	3.05	4.24	4.86	7.35
1991	0.01	0.05	0.22	0.46	0.87	1.32	1.70	2.35	3.09	3.96	4.05	4.91
1992	-	0.06	0.23	0.57	0.87	1.46	2.03	2.26	2.86	3.98*	5.80	5.24
1993	-	-	0.22	0.55	0.89	1.15	1.99	3.00	4.28	4.47	8.67	13.20*
1994	-	0.05	0.25	0.46	0.90	1.04	1.24	1.81	2.89	6.45	4.47*	6.75
1995	-	0.06*	0.21	0.54	1.02	1.51	1.69	1.58	2.21	4.78	5.45	5.54*
1996	0.02	0.07	0.22	0.46	0.67	1.28	2.01	2.08	2.14	4.46	3.90	6.79*
1997	0.02	0.11	0.26	0.55	0.88	1.08	1.90	2.61	2.87	3.08	5.46*	-
1998	0.01	0.09	0.28	0.66	0.94	1.27	1.64	2.79	4.66	4.44	2.53	4.19*
1999	0.01	0.10	0.28	0.65	1.13	1.71	2.00	2.55	4.56	6.57	4.26	12.39*
2000	0.02	0.09	0.27	0.56	0.95	1.33	1.90	2.38	2.90	5.44	8.35	6.78
2001	0.01	0.09	0.29	0.53	0.82	1.17	1.66	3.15	4.32	4.20	6.30	8.96
2002	0.01	0.09	0.26	0.60	1.03	1.37	1.36	2.84	4.03	4.84	3.58*	6.03
2003	0.01	0.11	0.27	0.64	1.13	1.43	1.78	1.72	2.95	3.93	2.47	5.99*
2004	0.02	0.07	0.32	0.48	0.87	1.95	2.48	2.99	2.77	3.32	3.91	4.20*
2005	0.01	0.14	0.34	0.61	0.94	1.42	2.29	3.02	4.00	4.62*	10.75	11.45
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	0.01	0.08	0.23	0.44	0.97	1.43	1.45	2.67	5.91	7.84	7.15	7.63
2008	0.01	0.05	0.16	0.48	0.77	1.22	1.87	1.78	2.63	3.03	7.38	8.58
2009	0.01	0.06	0.25	0.47	0.81	1.39	1.92	2.27	3.53	4.33	6.72	7.09
2010	0.01	0.09	0.23	0.52	0.77	1.35	2.55	3.06	4.14	6.37*	9.02*	11.15
2011	0.02	0.11	0.25	0.51	0.91	1.01	1.59	2.21	3.59	1.23*	-	4.43*
2012	0.01	0.06	0.34	0.58	0.90	1.45	1.32	2.04	3.82	3.62	9.23*	13.34*
2013	0.02	0.07	0.19	0.64	0.94	0.91	1.29	1.31	2.31	1.68	9.88*	10.32*
2014	0.01	0.08	0.22	0.35	0.88	1.24	1.41	2.22	2.48	1.92*	-	4.68*
2015	0.01	0.07	0.22	0.49	0.74	1.35	1.50	1.52	2.51	3.82*	5.67*	-
2016	0.01	0.05	0.20	0.45	0.73	0.92	1.40	2.14	1.30*	3.24	9.68*	-
2017	0.01	0.06	0.18	0.46	0.72	0.93	1.13	1.26	2.23*	5.95*	3.10*	-
2018	0.02	0.09	0.25	0.47	0.77	1.09	1.69	1.57	6.58	2.51*	2.59	9.14*

Table 14. 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 1954-2016.

Cohort	Slope	Slope SE	Intercept	Intercept SE	Cohort	Slope	Slope SE	Intercept	Intercept SE
1954	1.1094	0.2940	-8.1702	2.4445	**1984**	2.2315	0.2981	-13.4166	1.8044
1955	1.5059	0.2237	-10.2633	1.6124	**1985**	2.6988	0.3728	-16.0342	2.2010
1956	1.3174	0.3208	-9.4592	2.2216	**1986**	2.5829	0.2930	-14.0673	1.5934
1957	1.4604	0.3703	-10.3248	2.3525	**1987**	2.2526	0.2231	-11.9227	1.2350
1958	2.3929	0.5853	-16.4519	3.6202	**1988**	2.7731	0.4110	-14.0212	2.1672
1959	2.1113	0.5358	-13.0196	2.9364	**1989**	1.8846	0.1577	-9.7844	0.8110
1960	1.6741	0.2990	-10.6677	1.7584	**1990**	1.7888	0.1900	-9.2101	0.9575
1961	1.8639	0.3551	-11.4722	2.0669	**1991**	2.4874	0.4971	-13.1443	2.5618
1962	1.7141	0.2898	-10.5115	1.7043	**1992**	2.6015	0.3903	-13.0008	1.9108
1963*	-	-	-	-	**1993**	1.8954	0.2394	-9.8698	1.2957
1964	1.9272	0.2411	-12.7182	1.5667	**1994**	1.6015	0.1969	-8.1481	1.0091
1965	2.4194	0.5982	-16.4244	4.2387	**1995**	1.6523	0.2188	-8.7711	1.1242
1966	1.5492	0.2401	-10.0608	1.6025	**1996**	1.7414	0.2410	-9.3461	1.2620
1967	1.6876	0.3782	-10.0845	2.2543	**1997**	3.0797	0.4567	-14.8462	2.1742
1968	2.1397	0.2885	-13.1625	1.7869	**1998**	1.9984	0.2396	-9.6586	1.1567
1969	1.6825	0.3043	-10.3672	1.8439	**1999**	1.8423	0.2647	-9.1495	1.3103
1970	1.5265	0.2305	-8.8558	1.3136	**2000**	1.7800	0.3025	-9.2716	1.4885
1971	1.3122	0.1401	-7.8405	0.8346	**2001**	1.7588	0.2292	-8.3449	1.0333
1972	1.4117	0.1445	-8.9081	0.8853	**2002**	1.6768	0.2439	-8.8522	1.2949
1973	1.4521	0.1667	-9.3550	1.0320	**2003**	1.5873	0.2283	-9.0376	1.2856
1974	2.0042	0.1969	-13.1541	1.2944	**2004**	1.4999	0.1654	-8.3631	0.9171
1975	1.7846	0.2174	-11.1641	1.3757	**2005**	1.8575	0.2314	-10.0273	1.2522
1976	1.3552	0.2056	-8.5990	1.2510	**2006**	1.7505	0.1777	-8.5990	0.9036
1977	2.5066	0.3505	-15.3640	2.1732	**2007**	1.5891	0.2499	-7.5603	1.1862
1978	1.7920	0.1680	-10.7323	1.0205	**2008**	1.7560	0.2389	-8.6024	1.0569
1979	1.0297	0.1138	-6.4477	0.7670	**2009**	1.4971	0.1611	-7.6958	0.7294
1980	1.4270	0.1415	-9.4134	0.9131	**2010**	1.8573	0.2860	-9.2644	1.3954
1981	1.7431	0.1781	-11.9865	1.1846	**2011**	2.3599	0.3115	-12.2046	1.6167
1982	2.0091	0.2059	-13.3056	1.3496	**2012**	2.2602	0.4056	-12.0903	2.1402
1983	1.8944	0.2608	-11.8903	1.6045	**2013**	2.9760	0.8310	-14.9256	4.0239

*Fit not significant

Table 15. 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 15. 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	0.0020	0.0061	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	0.0006	0.0090	0.0344	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	0.0039	0.0390	0.1710	0.5952	0.8703	0.9514	0.9743	0.9948	0.9996	1.0000	1.0000	1.0000	1.0000
2013	0.0001	0.0006	0.0243	0.1535	0.5443	0.8781	0.9748	0.9921	0.9942	0.9989	0.9999	1.0000	1.0000	1.0000
2014	0.0000	0.0005	0.0059	0.1376	0.4476	0.8736	0.9724	0.9955	0.9988	0.9987	0.9998	1.0000	1.0000	1.0000
2015	0.0000*	0.0001	0.0049	0.0592	0.5055	0.7836	0.9756	0.9942	0.9992	0.9998	0.9997	1.0000	1.0000	1.0000
2016	0.0000*	0.0004*	0.0025	0.0452	0.4001	0.8675	0.9418	0.9957	0.9988	0.9999	1.0000	0.9999	1.0000	1.0000
2017	0.0000*	0.0004*	0.0044*	0.0465	0.3123	0.8760	0.9767	0.9964	0.9993	0.9998	1.0000	1.0000	1.0000	1.0000
2018	0.0000*	0.0004*	0.0044*	0.0503*	0.4886	0.8132	0.9868	0.9963	0.9969	0.9999	1.0000	1.0000	1.0000	1.0000
2019	0.0000*	0.0004*	0.0044*	0.0503*	0.4003*	0.9493	0.9766	0.9987	0.9994	0.9993	1.0000	1.0000	1.0000	1.0000
2020	0.0000*	0.0004*	0.0044*	0.0503*	0.4003*	0.8795*	0.9973	0.9975	0.9999	0.9999	0.9998	1.0000	1.0000	1.0000
2021	0.0000*	0.0004*	0.0044*	0.0503*	0.4003*	0.8795*	0.9869*	0.9999	0.9997	1.0000	1.0000	1.0000	1.0000	1.0000

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
2022	0.0000*	0.0004*	0.0044*	0.0503*	0.4003*	0.8795*	0.9869*	0.9987*	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 16: Risk of projected SSB being below B_{lim} under five scenarios of total mortality (Z at status quo, ±10% status quo and ±20% status quo) over 2018-2021. Status quo Z was estimated as the geometric mean of the last three year.

Year	Mortality (Z) scenario	Relative SSB (median with 95% CI)	P(SSB<B_{lim})
2018	Status quo	1.49 (0.98-2.27)	0.04
2019	-20%	1.38 (0.90-2.12)	0.07
	-10%	1.30 (0.84-2.00)	0.12
	Status quo	1.22 (0.79-1.88)	0.19
	+10%	1.14 (0.74-1.77)	0.28
	+20%	1.08 (0.69-1.67)	0.38
2020	-20%	1.21 (0.78-1.89)	0.19
	-10%	1.08(0.69-1.69)	0.36
	Status quo	0.97 (0.61-1.52)	0.56
	+10%	0.86 (0.55-1.37)	0.73
	+20%	0.78 (0.49-1.24)	0.86
2021	-20%	1.31 (0.80-2.13)	0.14
	-10%	1.14 (0.69-1.88)	0.31
	Status quo	0.99 (0.59-1.67)	0.51
	+10%	0.87 (0.51-1.48)	0.70
	+20%	0.77 (0.44-1.32)	0.83

Table 17. Estimated catch rates for gillnets and summaries of data provided in logbooks for vessels greater than 35 feet.

Quota Year	Estimated CPUE (t/net)	Standard Error	Number of sets	Number of vessels	Landings (t)		
					Logbooks	Reported	% of reported
1998	114	3.57	1048	128	2495	4237	59
1999	86	1.85	2893	168	4966	8213	60
2000	71	1.83	1734	148	2088	4456	47
2001	43	1.12	1701	131	1044	2309	45
2002	53	1.62	1154	115	1085	2600	42
2003	55	1.64	1212	134	1277	2772	46
2004	54	1.51	1367	127	1112	2437	46
2005	40	1.08	1526	133	1230	2446	50
2006	50	1.37	1393	134	1439	2564	56
2007	50	1.27	1642	151	1722	2456	70
2008	48	1.25	1599	137	1598	2278	70
2009	47	1.40	1126	119	1068	1642	65
2010	50	1.75	805	89	902	1469	61
2011	48	1.68	788	92	1114	1412	79
2012	49	2.18	466	69	792	1235	64
2013	56	2.78	364	49	443	681	65
2014	61	2.32	632	63	969	1397	69
2015	51	1.84	718	58	1217	1813	67
2016	43	1.38	943	62	1101	1662	66
2017	55	2.05	710	52	824	1522	54

Table 18. Estimated catch rates for otter trawlers and summaries of data provided in logbooks for vessels greater than 35 feet.

Quota Year	Estimated CPUE (t/net)	Standard Error	Number of sets	Number of vessels	Landings (t)		
					Logbooks	Reported	% of reported
1998	1402	134	396	7	1692	2506	68
1999	2279	226	254	9	1055	2766	38
2000	2024	221	184	12	739	1875	39
2001	1727	191	174	9	582	1122	52
2002	1684	152	317	12	1278	1897	67
2003	2089	210	233	11	1076	1942	55
2004	1436	128	327	9	1159	1857	62
2005	1982	256	136	8	632	978	65
2006	3256	397	152	4	-	-	71
2007	983	147	95	6	280	1030	27
2008	937	97	215	4	-	-	32
2009	966	86	340	8	1048	1514	69
2010	670	64	317	6	1043	1234	85
2011	528	48	348	3	-	-	94
2012	459	46	260	6	307	350	88
2013	768	94	158	4	-	-	81
2014	543	47	412	5	1295	1465	88
2015	573	48	448	7	1780	2061	86
2016	387	34	379	5	1066	1326	80
2017	347	38	210	3	409	668	61

NOTE: Landings not presented for less than 5 vessels.

Table 19. Standardized catch rates for gillnets based on at sea sampling by observers. Number for sets and proportion of landings observed are also provided.

Quota year	CPUE	Standard error	Number of		Observed catch (t)	Landings (t)	% observed
			trips	sets			
1997	71.8	6.8	19	111	59.3	3760	1.58
1998	79.5	4.8	22	350	281.7	10102	2.79
1999	39.0	2.0	32	425	158.5	20469	0.77
2000	31.5	1.8	20	395	131.1	10891	1.20
2001	-	-	0	0	0.0	6159	0.00
2002	62.8	20.8	3	8	-	-	0.03
2003	32.4	1.7	40	432	131.2	8055	1.63
2004	34.6	1.8	34	457	146.7	7353	2.00
2005	22.9	1.3	23	363	50.9	6898	0.74
2006	23.5	1.7	23	217	44.9	6877	0.65
2007	28.6	1.8	19	285	77.9	6678	1.17
2008	31.3	1.8	30	304	58.9	6264	0.94
2009	32.0	2.4	13	179	48.6	3602	1.35
2010	21.6	1.6	10	212	13.9	3709	0.37
2011	23.2	2.3	9	94	23.7	2994	0.79
2012	15.1	2.0	5	49	9.2	2741	0.34
2013	28.0	9.8	1	7	-	-	0.01
2014	50.3	10.3	3	21	-	-	0.67
2015	38.9	5.1	8	53	31.4	3066	1.02
2016	20.8	2.0	7	110	13.2	3047	0.43
2017	16.8	3.9	3	16	-	-	0.09

NOTE: Landings not presented for less than 5 vessels.

Table 20a. Annual number of cod tagged in NAFO Subdiv. 3Ps during 2007-18 by tag type (low or high reward) and by 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
2016	401	101	-	502	-	502
2017	1467	373	100	1136	574	1840
2018	283	76	-	359	-	359

Table 20b. Annual number of cod tags returned from NAFO Subdiv. 3Ps during 2007-17 by tag type (low or high reward).

Recapture Year	Low Reward ($10)	High Reward ($100)	Total Returned
2007	333	67	400
2008	262	58	320
2009	245	70	315
2010	210	74	284
2011	95	35	130
2012	146	42	188
2013	179	67	246
2014	195	73	268
2015	176	63	239
2016	130	64	194
2017	186	71	257

FIGURES

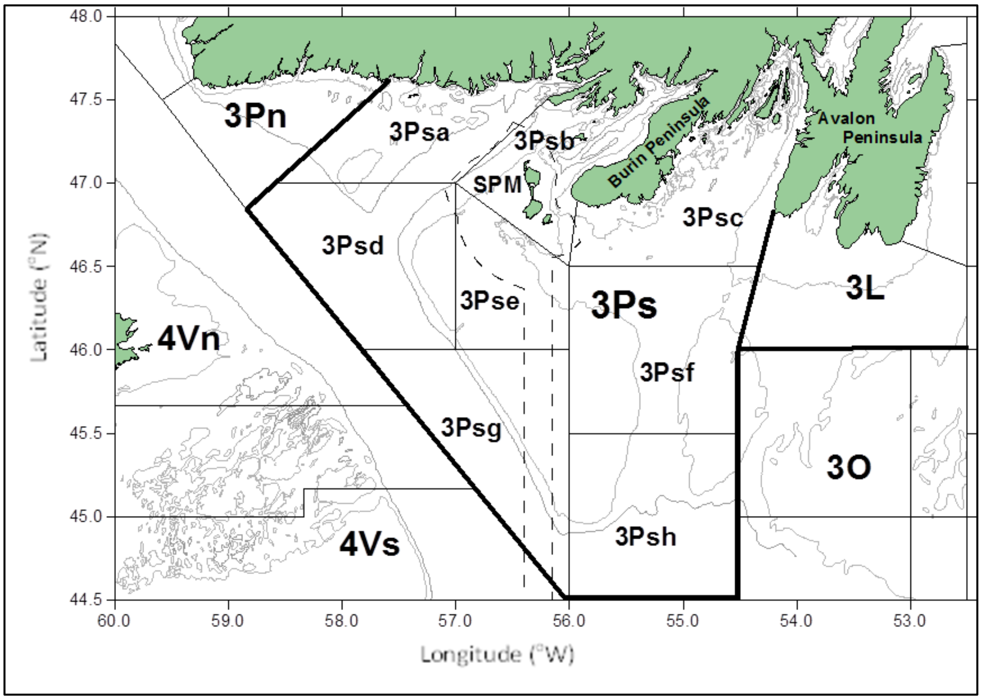


Figure 1. NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre et Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).

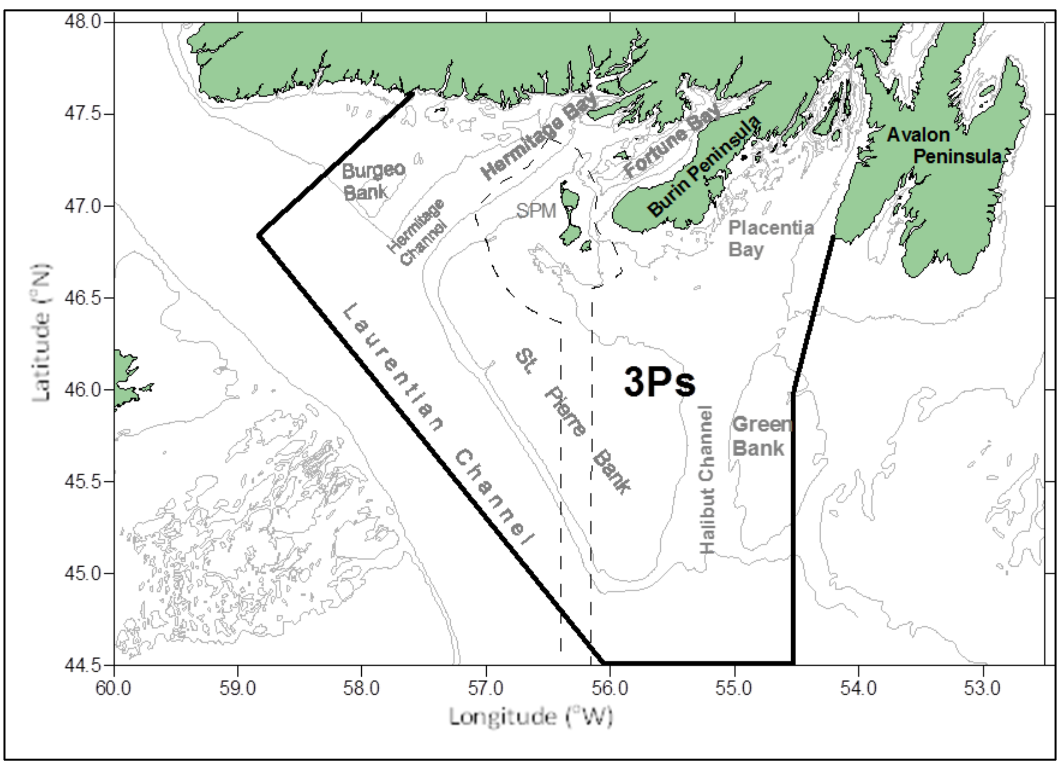


Figure 2. NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre and Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the main fishing areas.

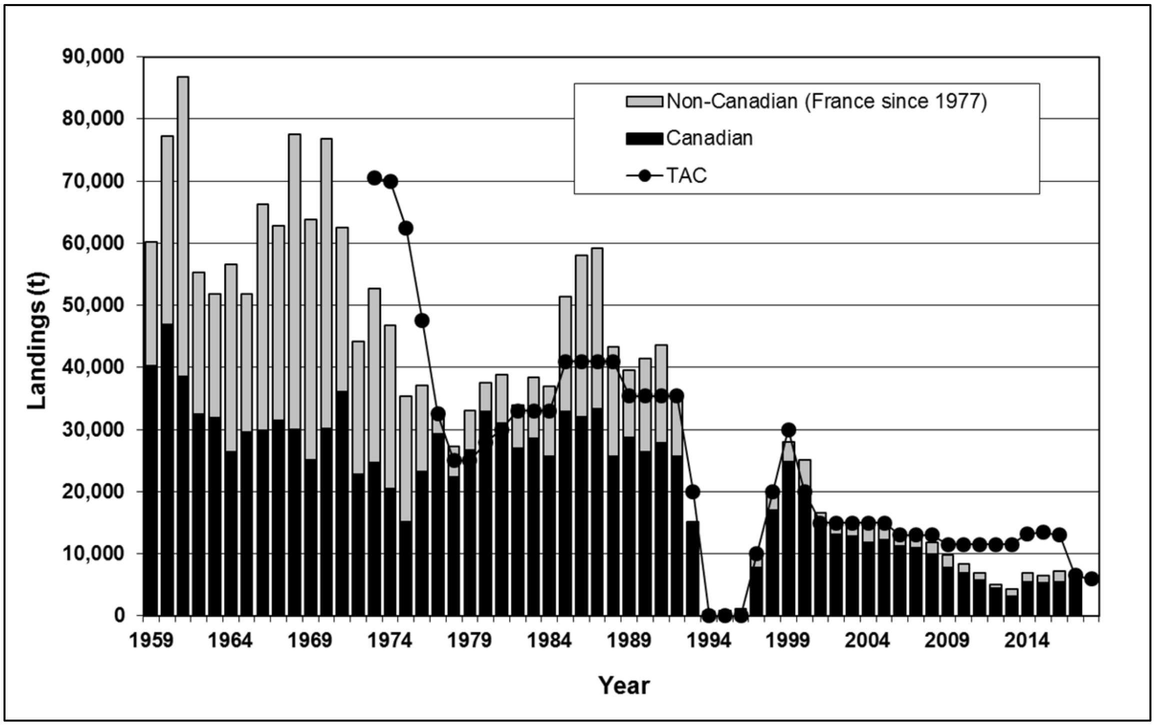


Figure 3a. Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdiv. 3Ps. Note that the 2017 fishery was still in progress at the time of the current assessment.

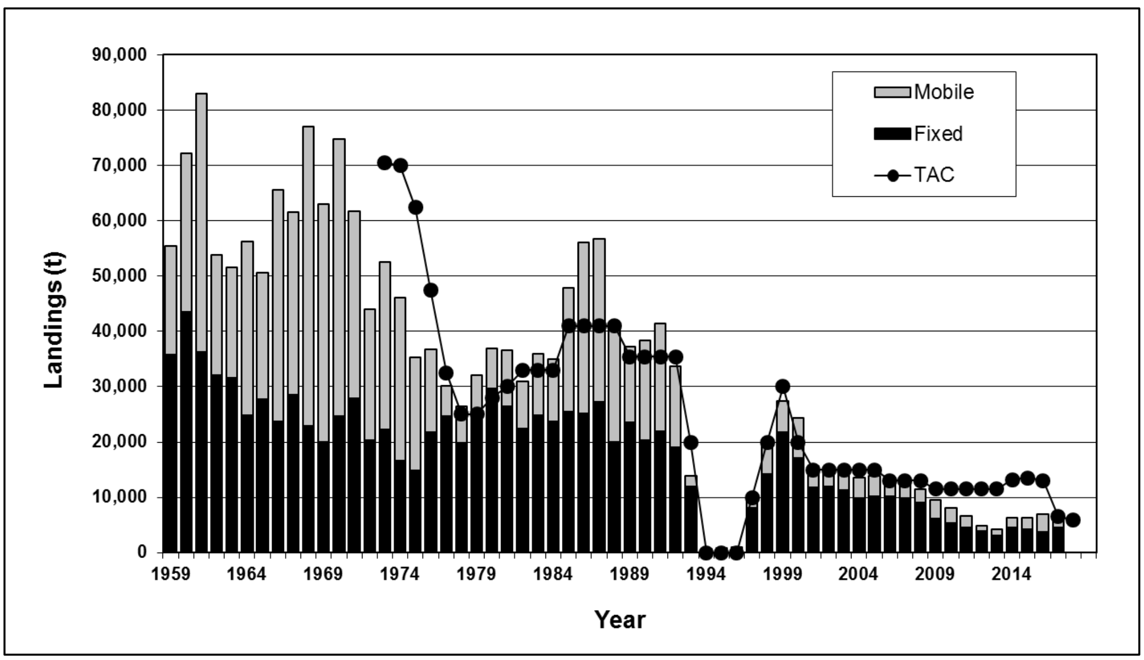


Figure 3b. Reported landings of cod by fixed and mobile gears in NAFO Subdiv. 3Ps. Note that the 2018 fishery was still in progress at the time of the current assessment.

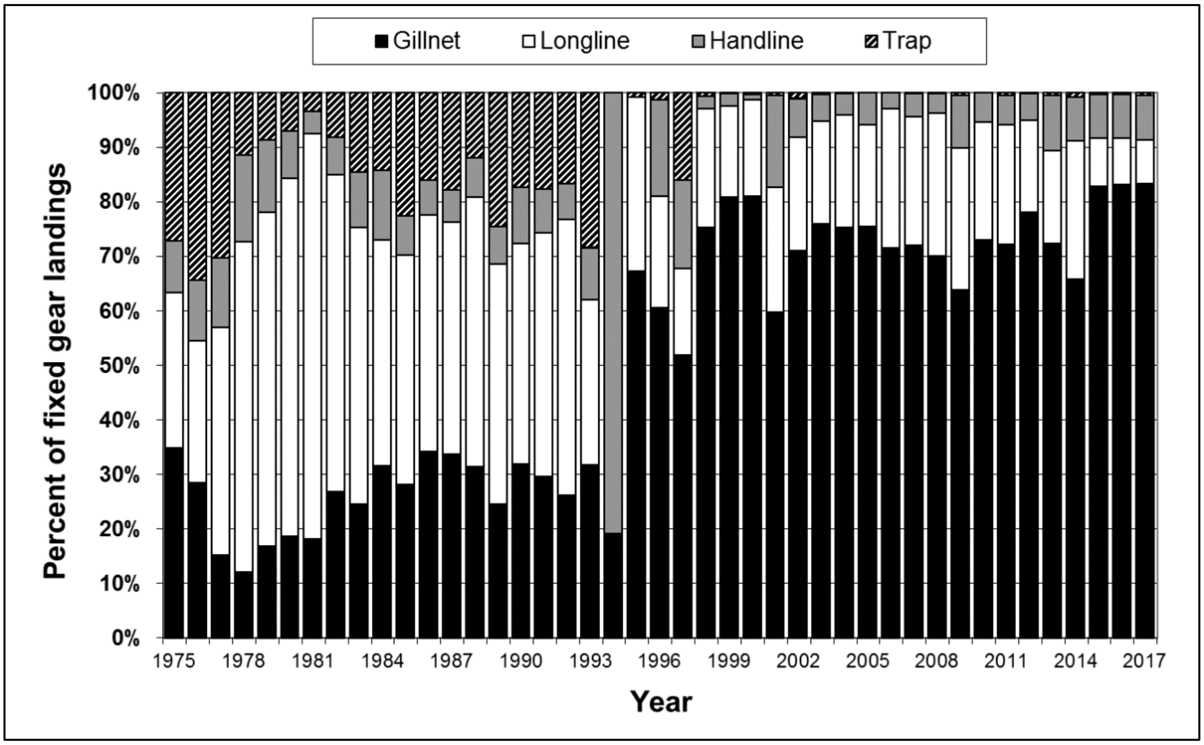


Figure 4. Percent of total fixed gear landings by the four main fixed gears used in the cod fishery in NAFO Subdiv. 3Ps. The fishery was under a moratorium during 1994-96 and values for those years are based on sentinel and by-catch landings of < 800 t.

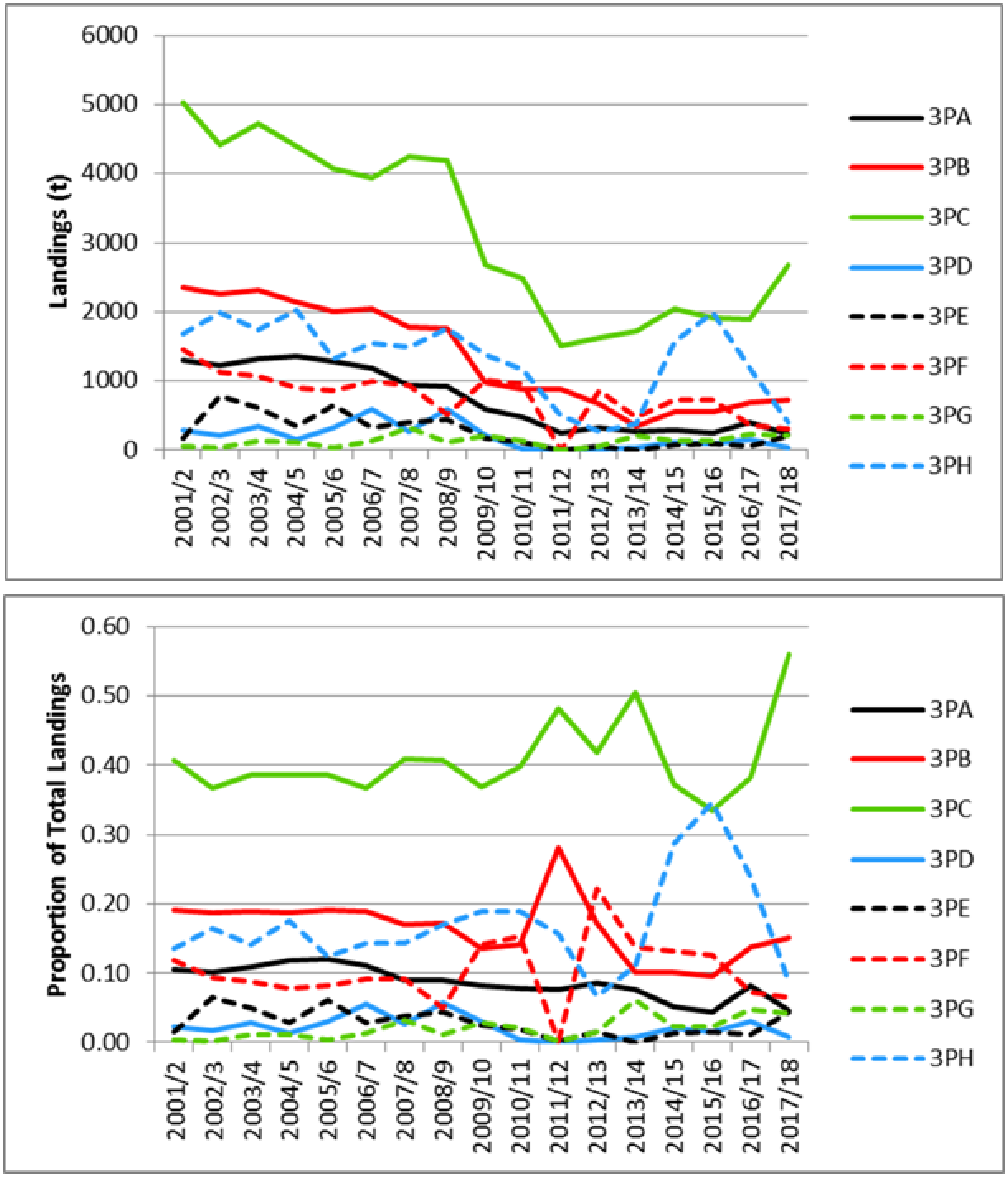


Figure 5. Breakdown of recent Canadian annual landings of 3Ps cod by statistical unit areas. Both landings (upper panel) and percent of total landings (lower panel) are presented. Unit area is not available for SPM landings. Refer to Figure 1 for locations of unit areas.

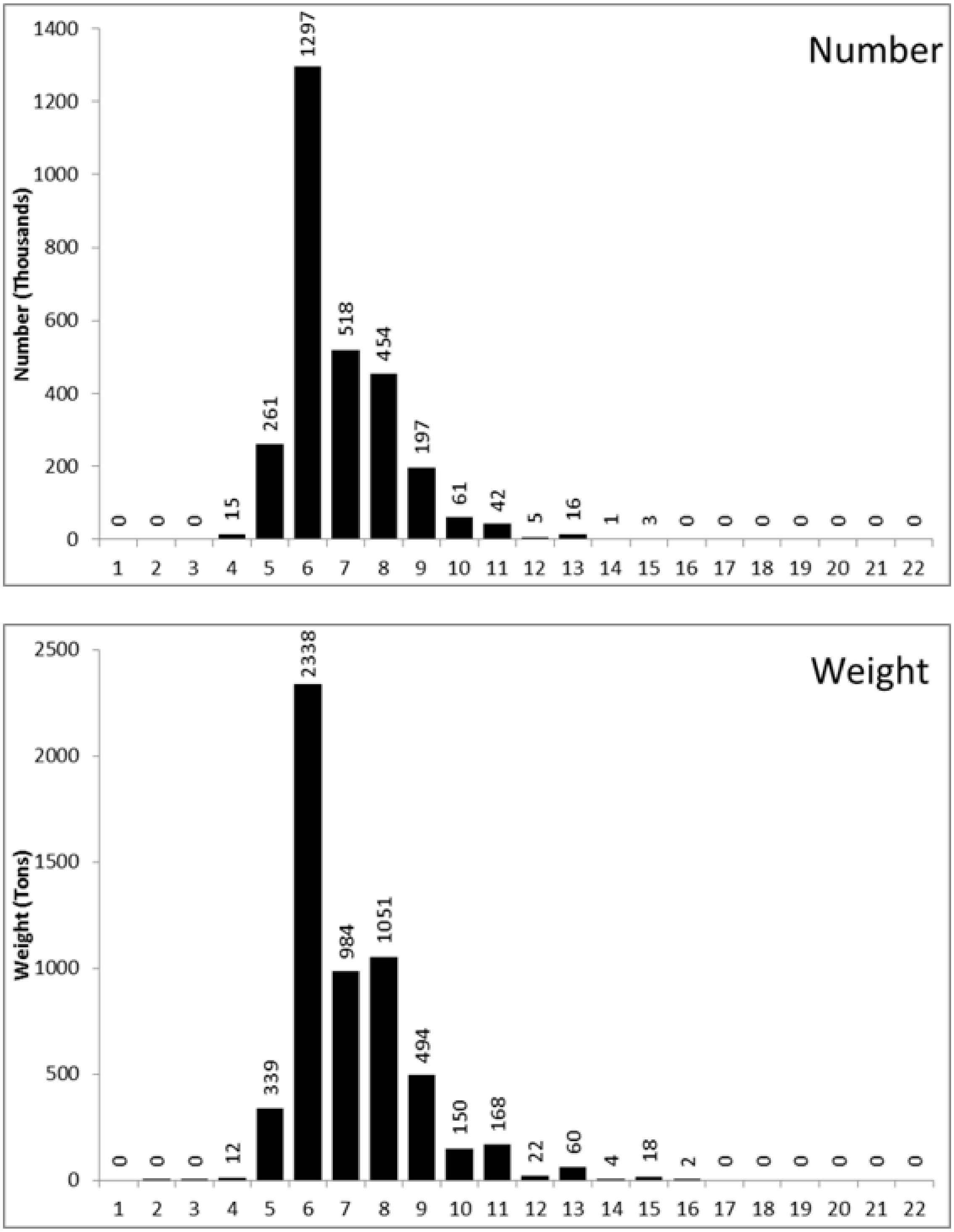


Figure 6. Catch numbers and weight at age from commercial fisheries and sentinel sampling in 2017.

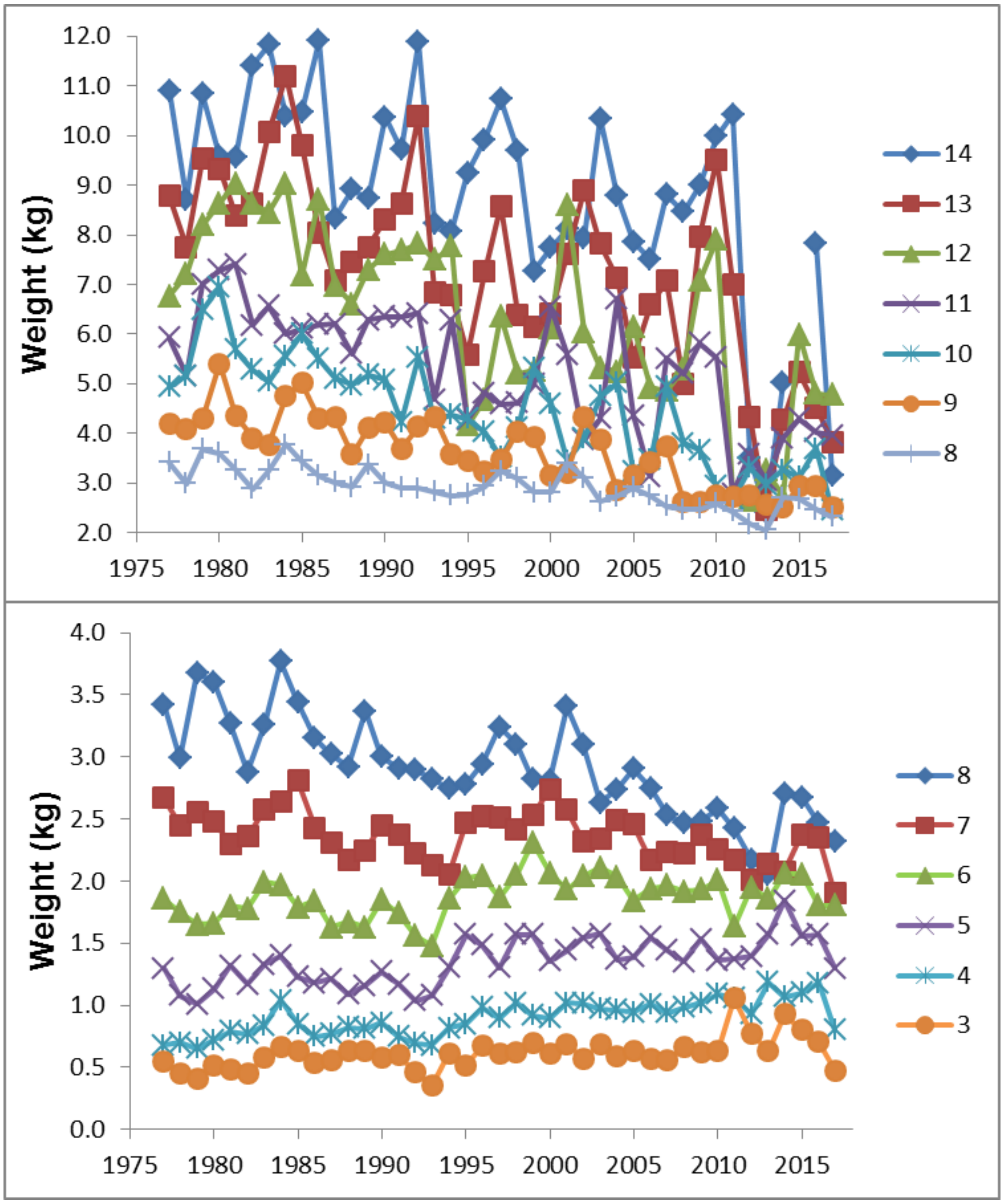


Figure 7. Mean weights-at-age calculated from mean lengths-at-age (lower panel: ages 3-8; upper panel: ages 9-14) from the commercial catch of cod in Subdiv. 3Ps during 1977 to 2017.

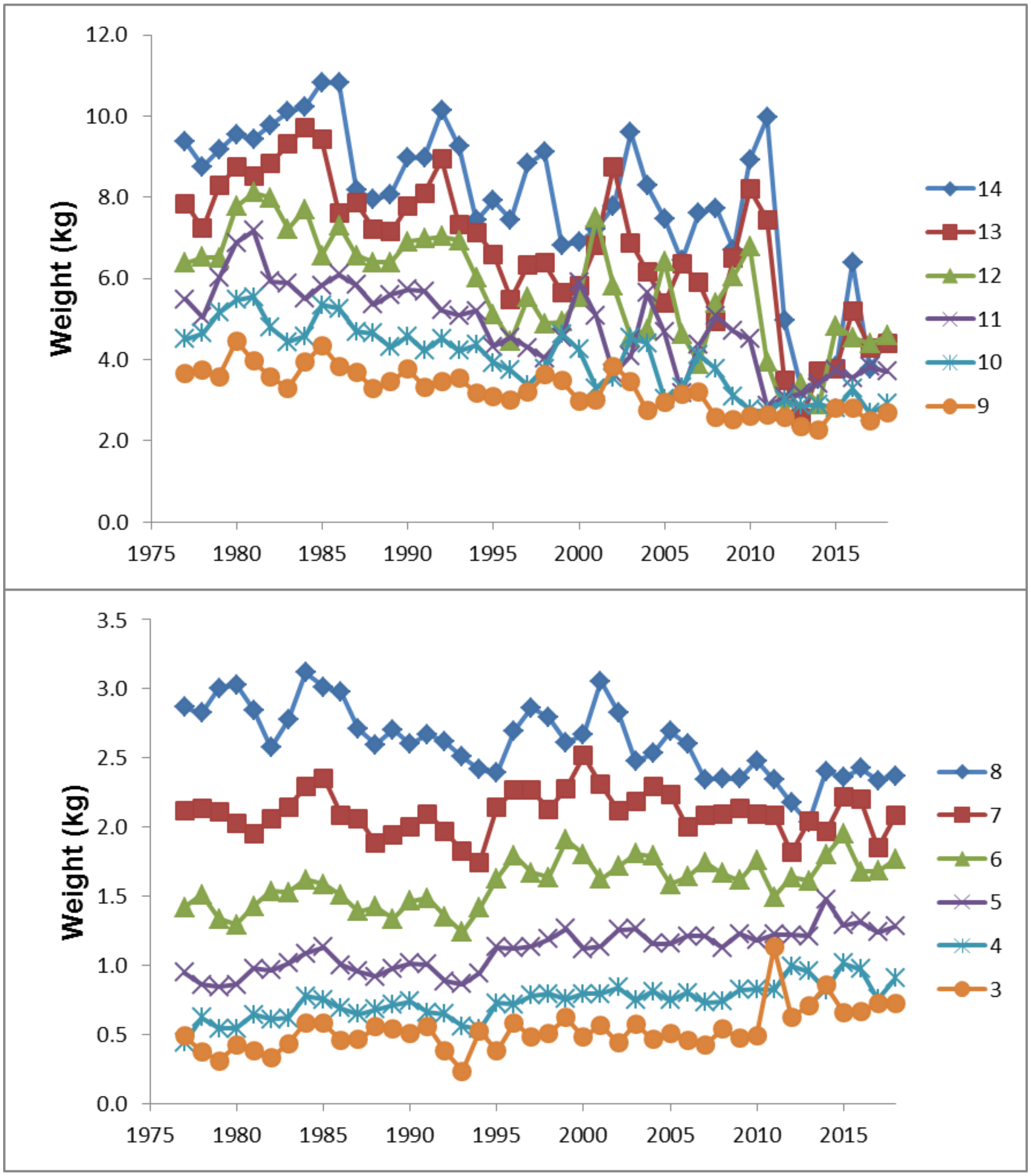


Figure 8. Beginning of year mean weights-at-age (lower panel: ages 3-8; upper panel: ages 9-14) from the commercial catch of cod in Subdiv. 3Ps during 1977 to 2017. Weights at age 3 in 2017, and age 14 in 2016 are the geometric means of the prior three years.

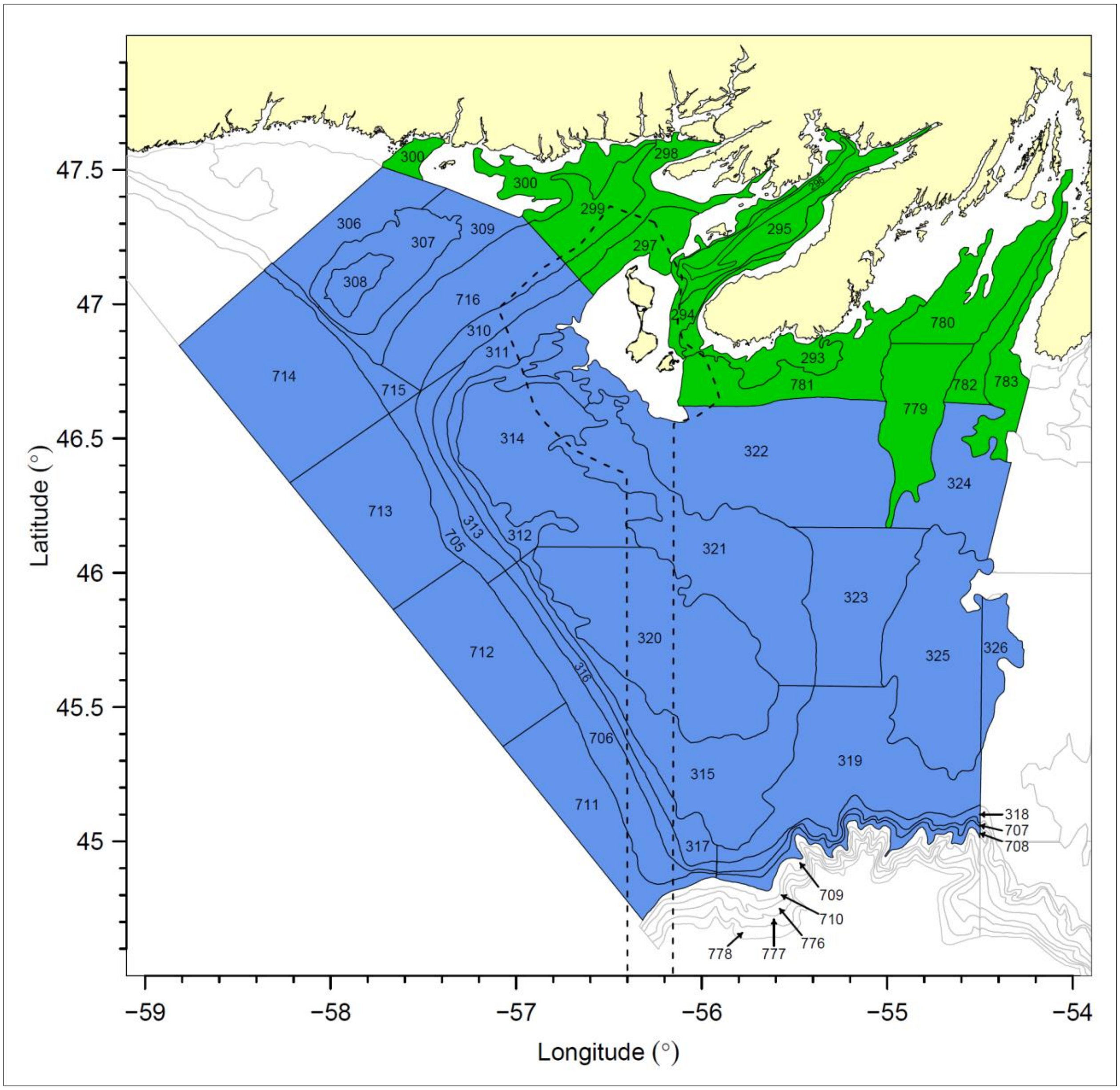


Figure 9. Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO Subdiv. 3Ps. Offshore strata are shaded blue. Inshore strata were added in 1994 (strata 779-783) and 1997 (strata 293-300) and are shaded green. The dashed line represents the boundary of the French economic zone.

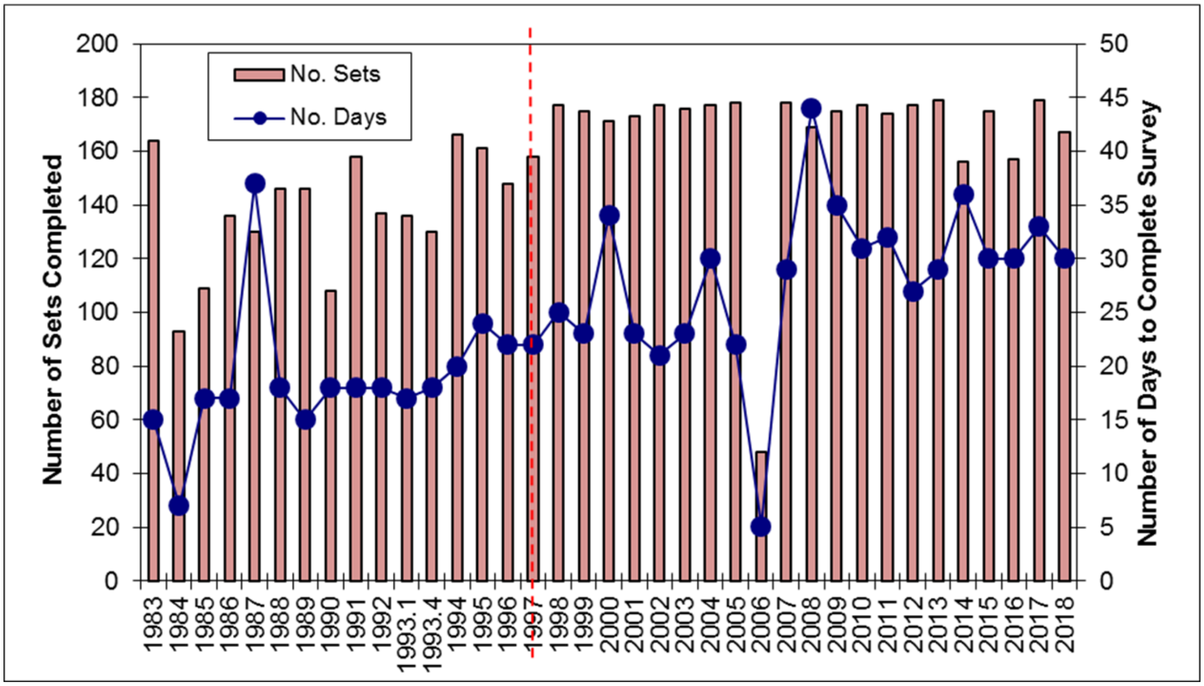


Figure 10. Number of research vessel survey sets completed during surveys of NAFO Subdiv. 3Ps, and the number of days required to complete these set. Survey coverage was expanded to present levels (i.e. covering all inshore and offshore index strata) in 1997 (dashed vertical line).

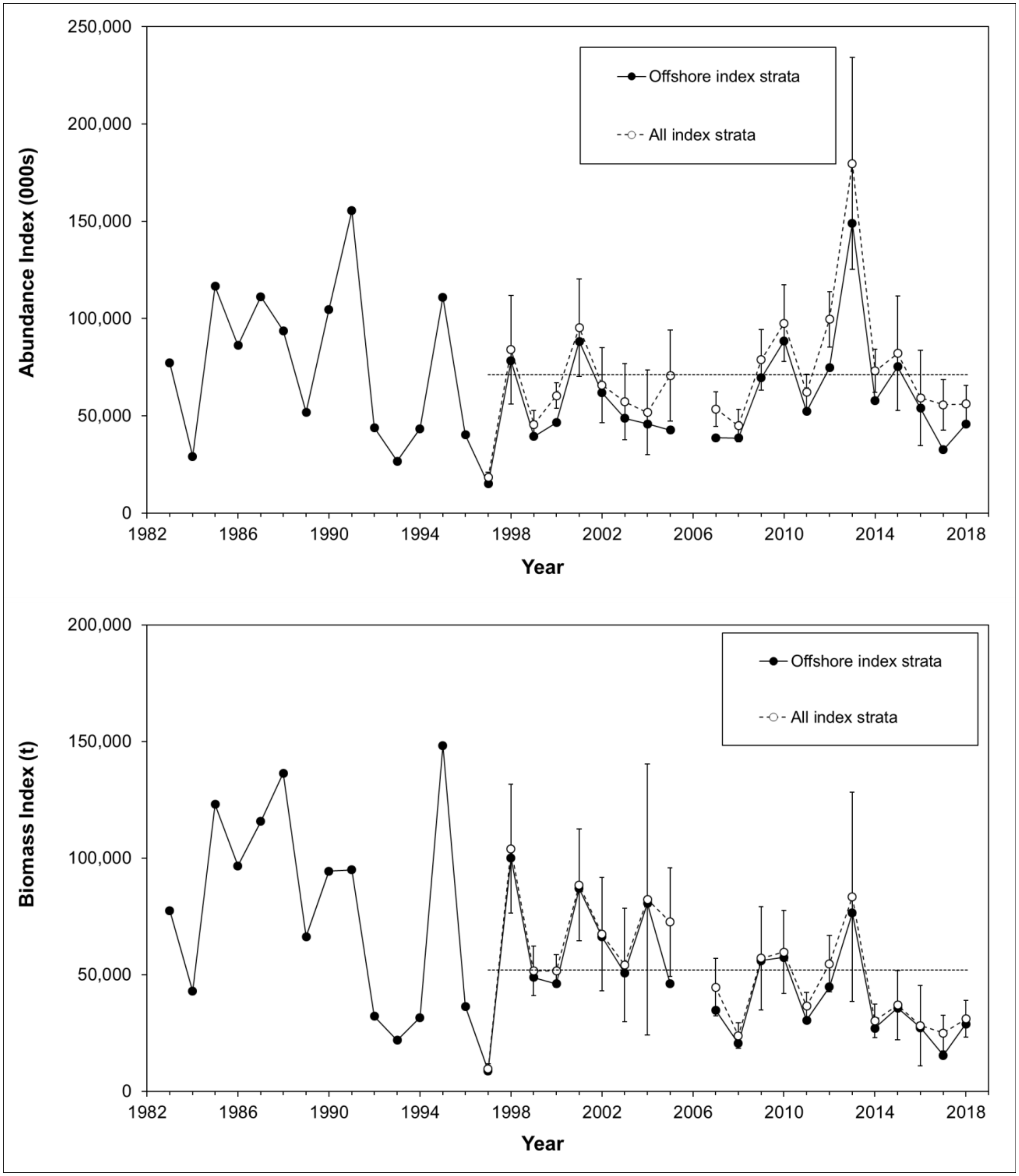


Figure 11. Abundance (upper panel) and biomass (lower panel) indices for cod in NAFO Subdiv. 3Ps from DFO research vessel bottom trawl surveys of index strata during winter/spring from 1983 to 2018. Error bars show plus/minus one standard deviation. Open symbols show values for the augmented survey area that includes additional inshore strata added to the survey in 1997. Dashed horizontal lines are means of the time-series for all index strata.

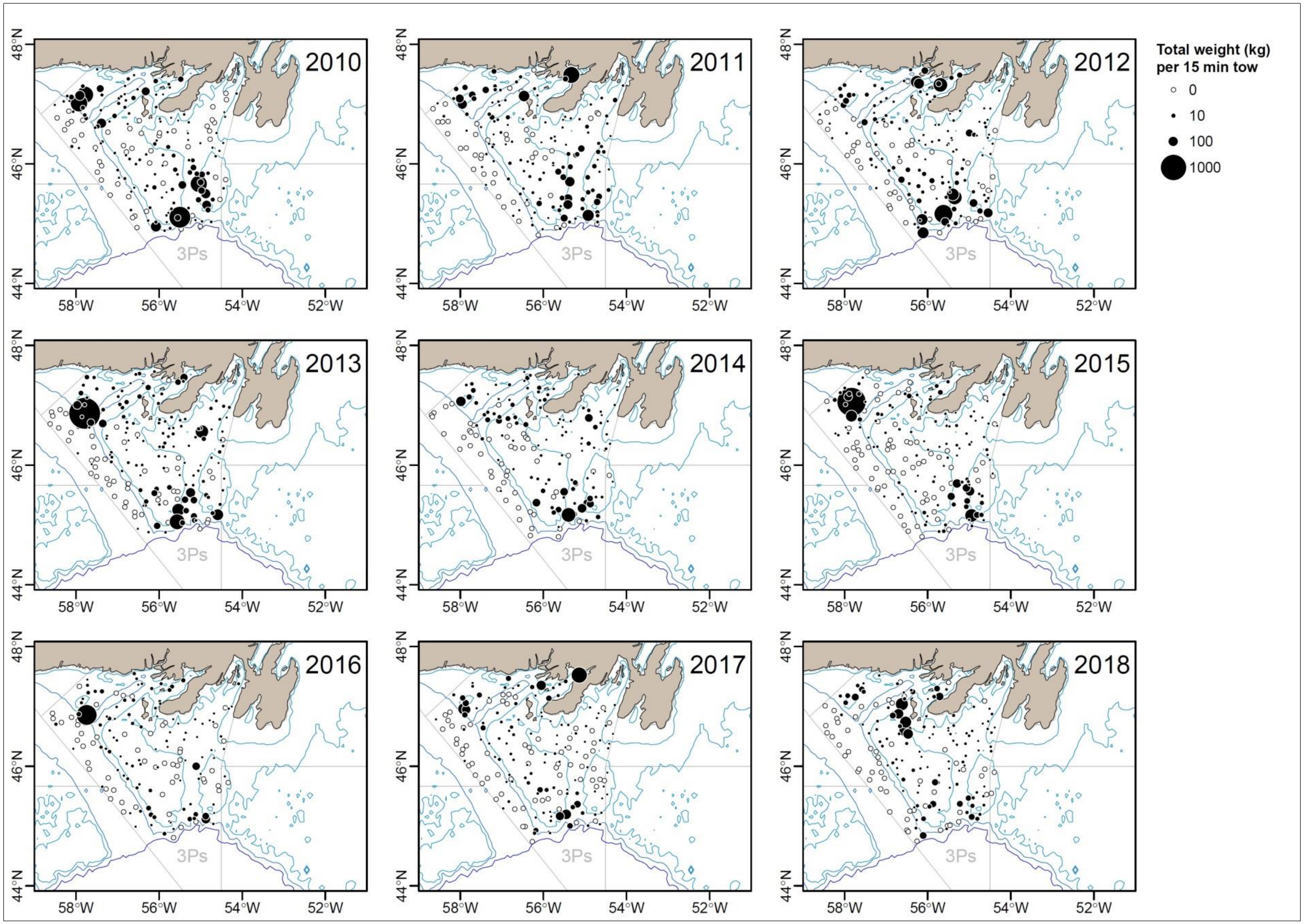


Figure 12. Age aggregated distribution of cod catches (weight per tow) from the April DFO research vessel surveys of NAFO Subdiv. 3Ps over 2010-18. Bubble size is proportional to total weight caught.

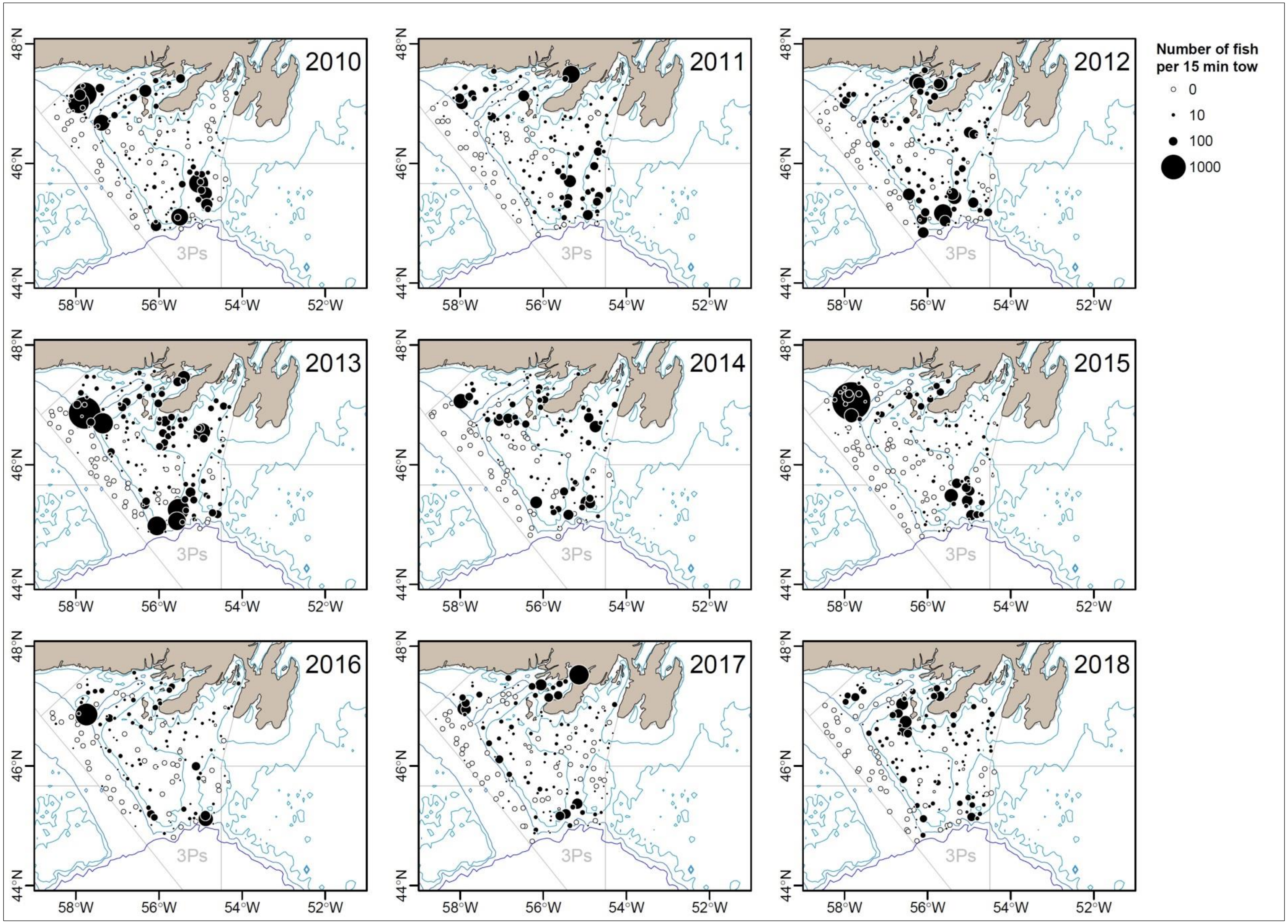


Figure 13. Age aggregated distribution of cod catches (nos. per tow) from the April DFO research vessel surveys of NAFO Subdiv. 3Ps over 2010-18. Bubble size is proportional to numbers caught.

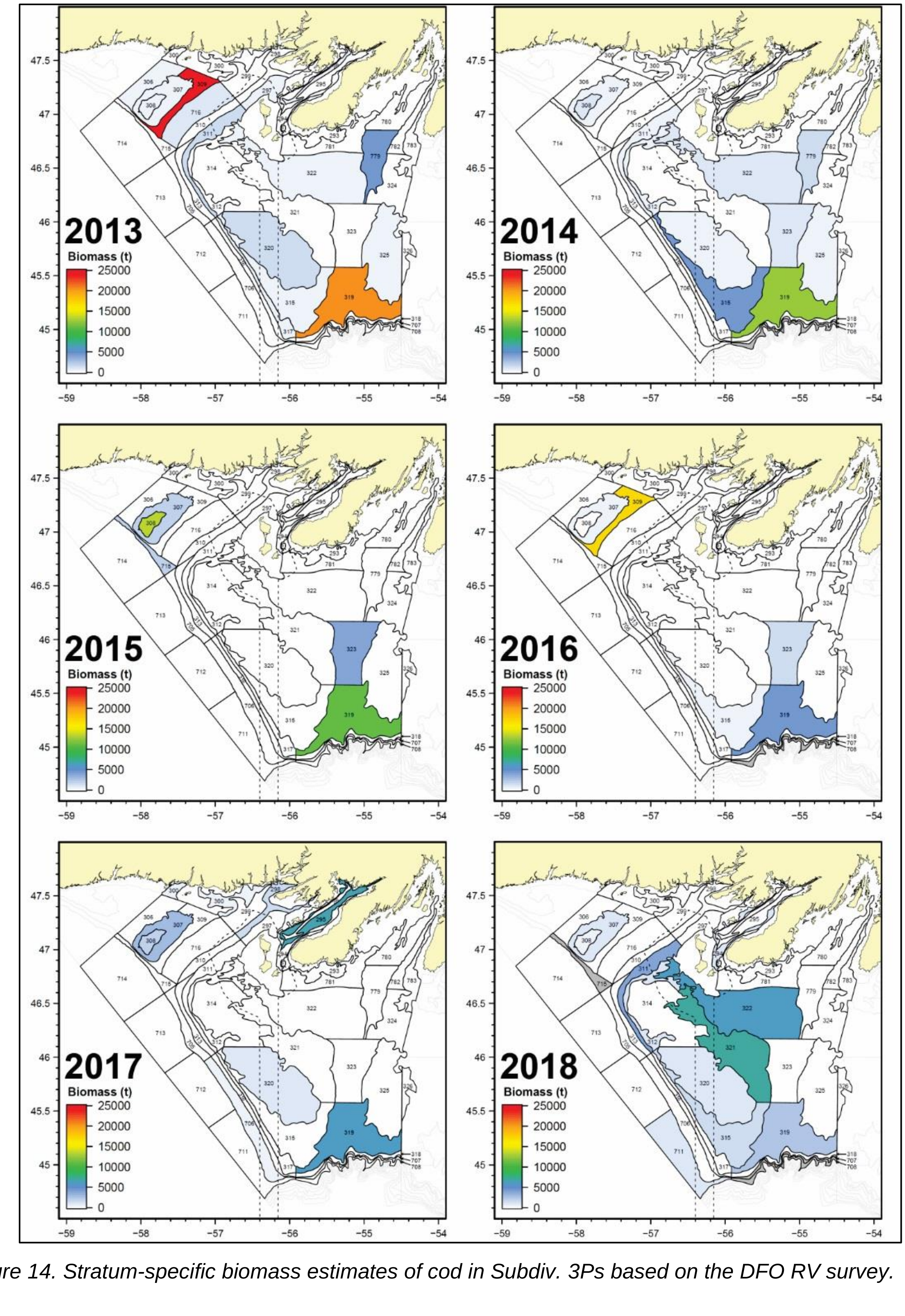


Figure 14. Stratum-specific biomass estimates of cod in Subdiv. 3Ps based on the DFO RV survey.

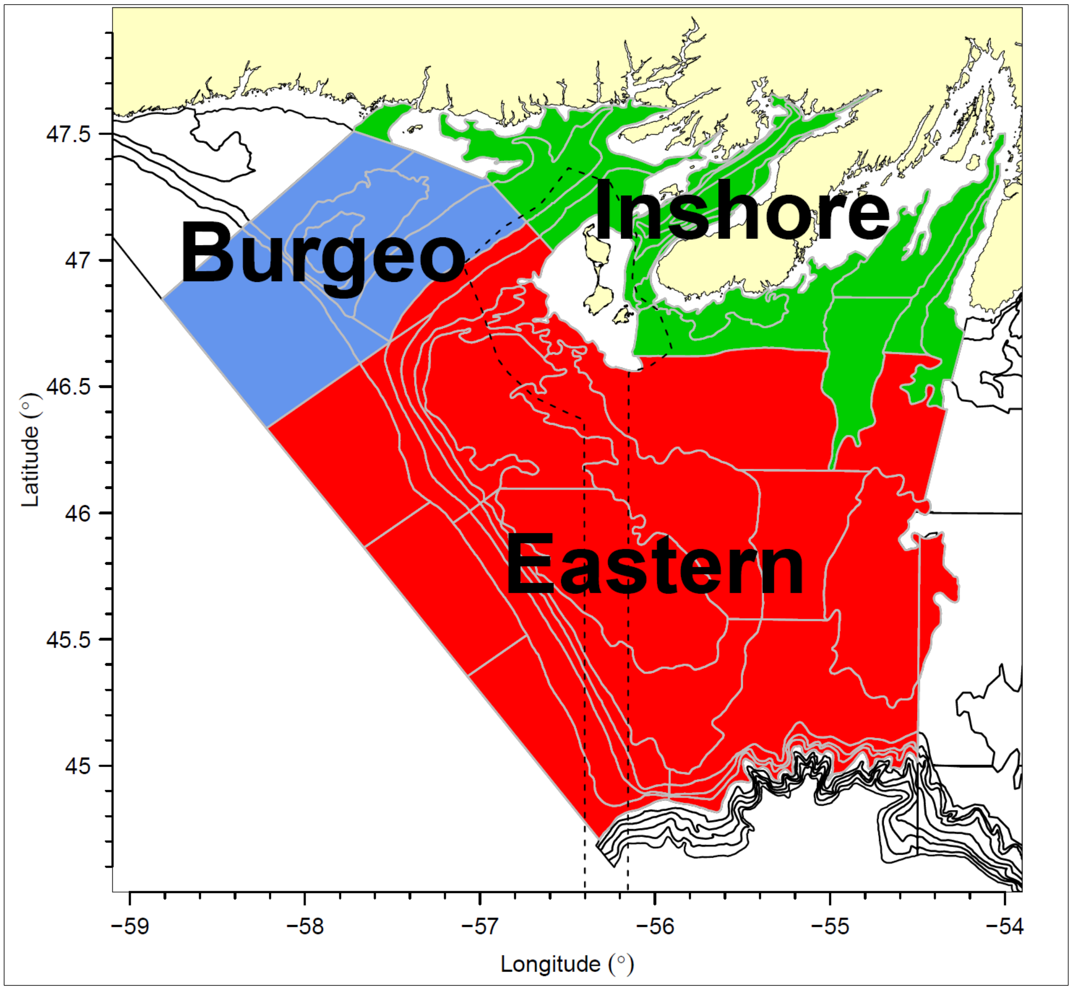


Figure 15. NAFO Subdiv. 3Ps management zone illustrating the allocation of survey strata into 'Inshore', 'Burgeo', and 'Eastern' regions. Survey trends for the three regions are depicted in Fig. 16.

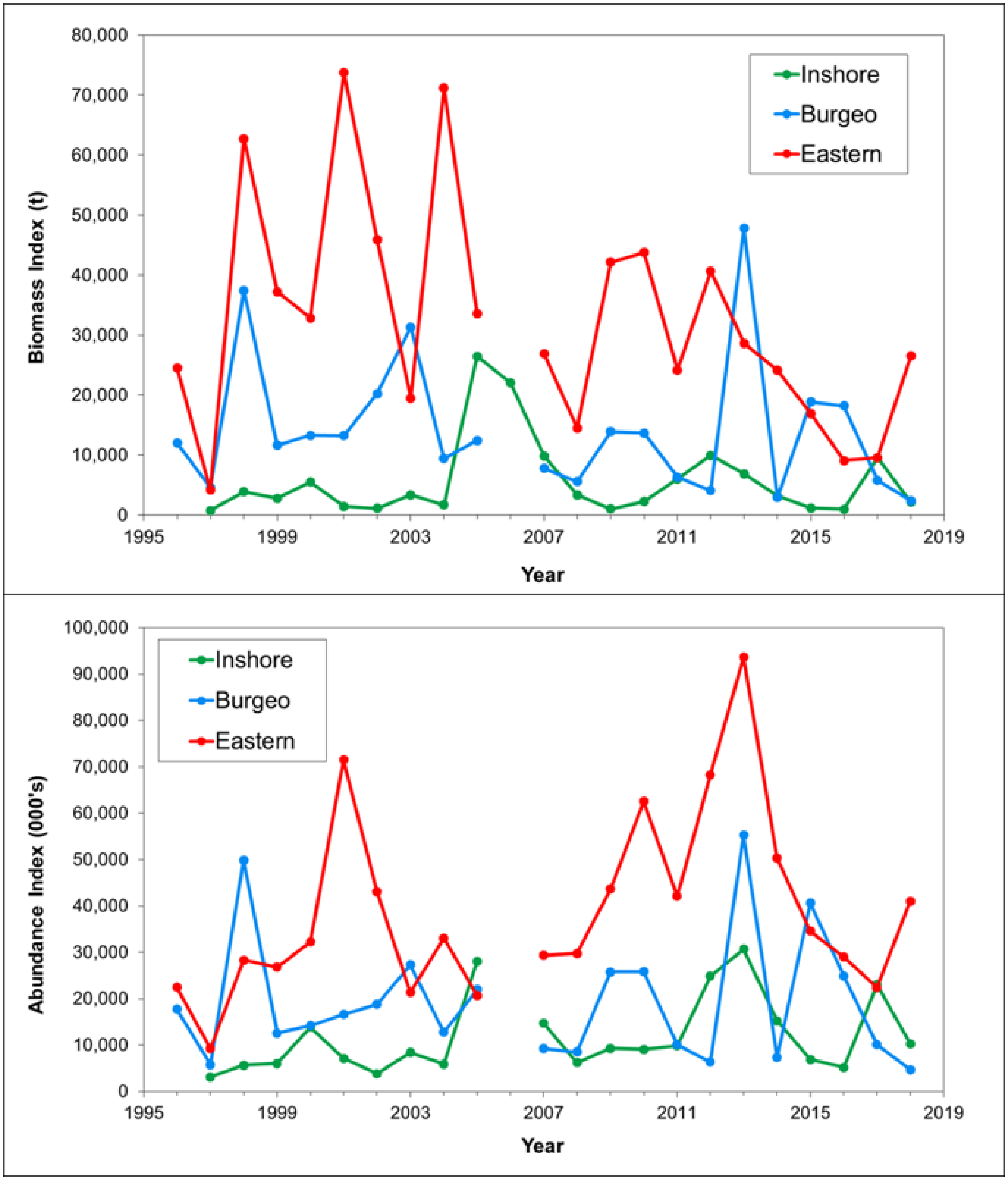


Figure 16. Total biomass (above) and abundance (below) index for cod in various regions of NAFO Subdiv. 3Ps from DFO research vessel bottom trawl surveys during winter/spring from 1997 to 2018. The 2006 survey was not completed. The Campelen trawl was used in all surveys.

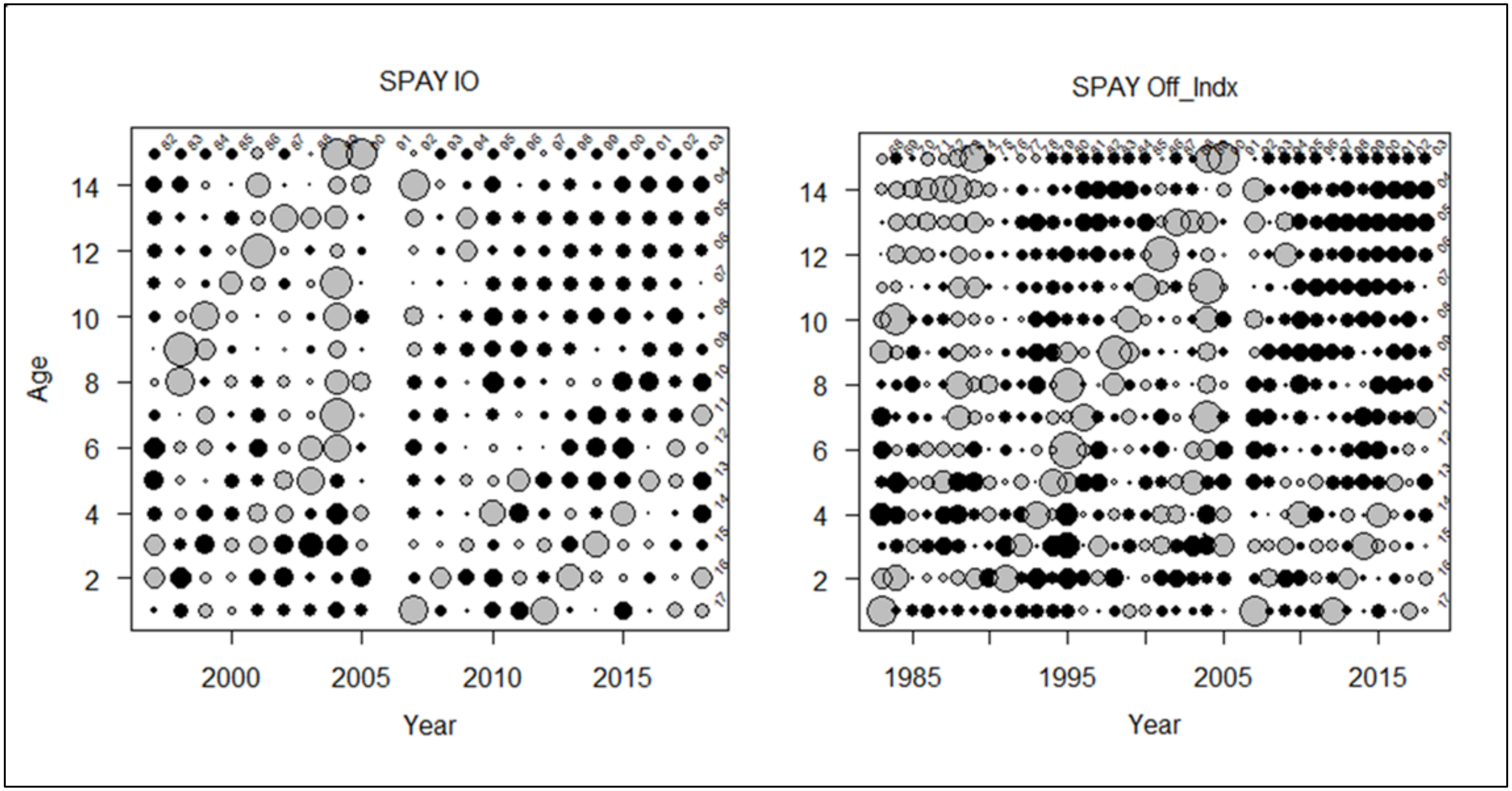


Figure 17. Standardized age-disaggregated catch rates from the spring bottom trawl survey of Subdiv. 3Ps. Catch rates (mean nos per tow) were converted to proportions within each year. Values were standardized by subtracting the mean proportion and dividing by the standard deviation of the proportions 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 1997-2018 "All Strata < 300 fm" data, and panel at right includes data which comprise the "Offshore" index (1983-2018).

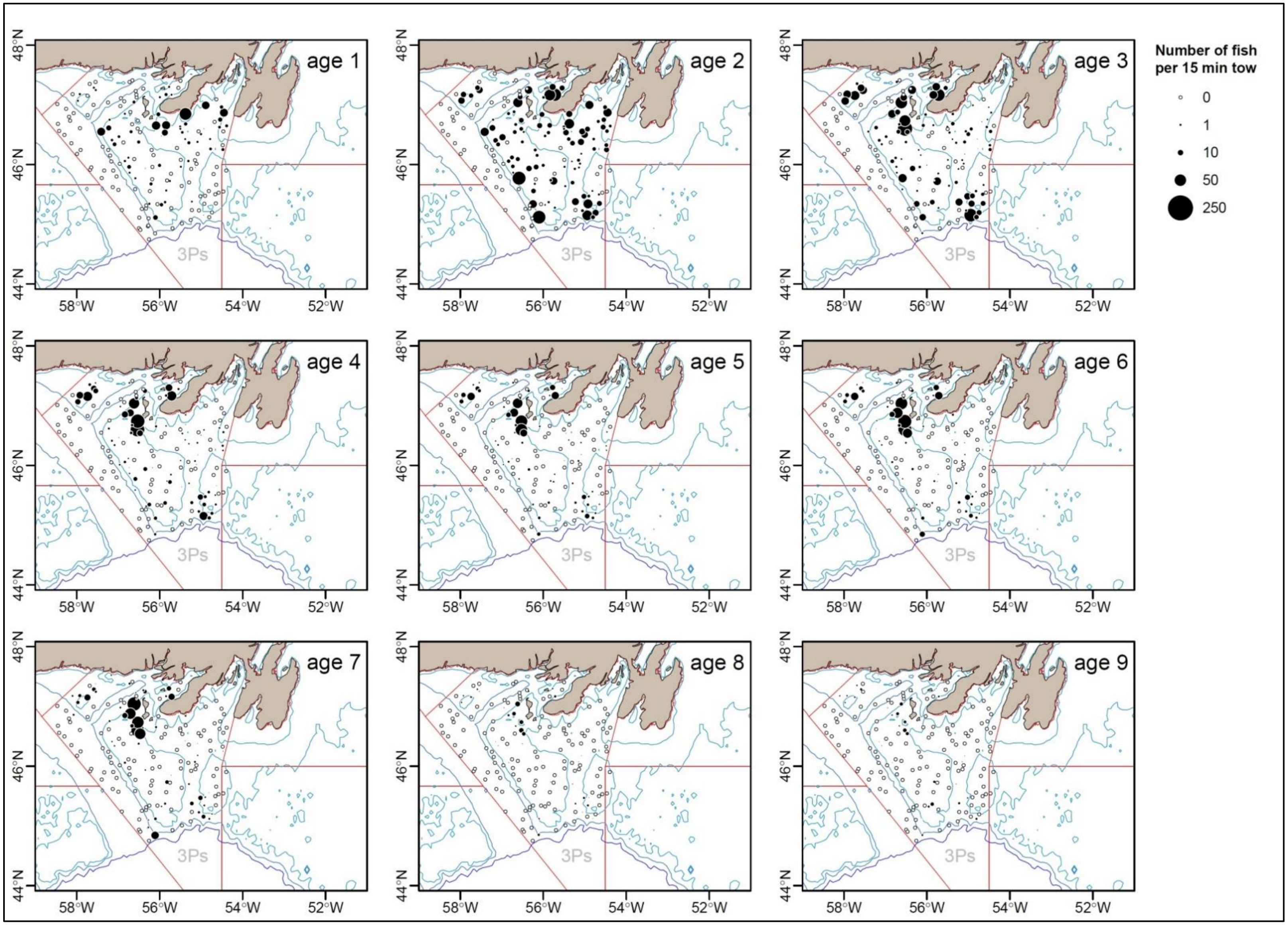
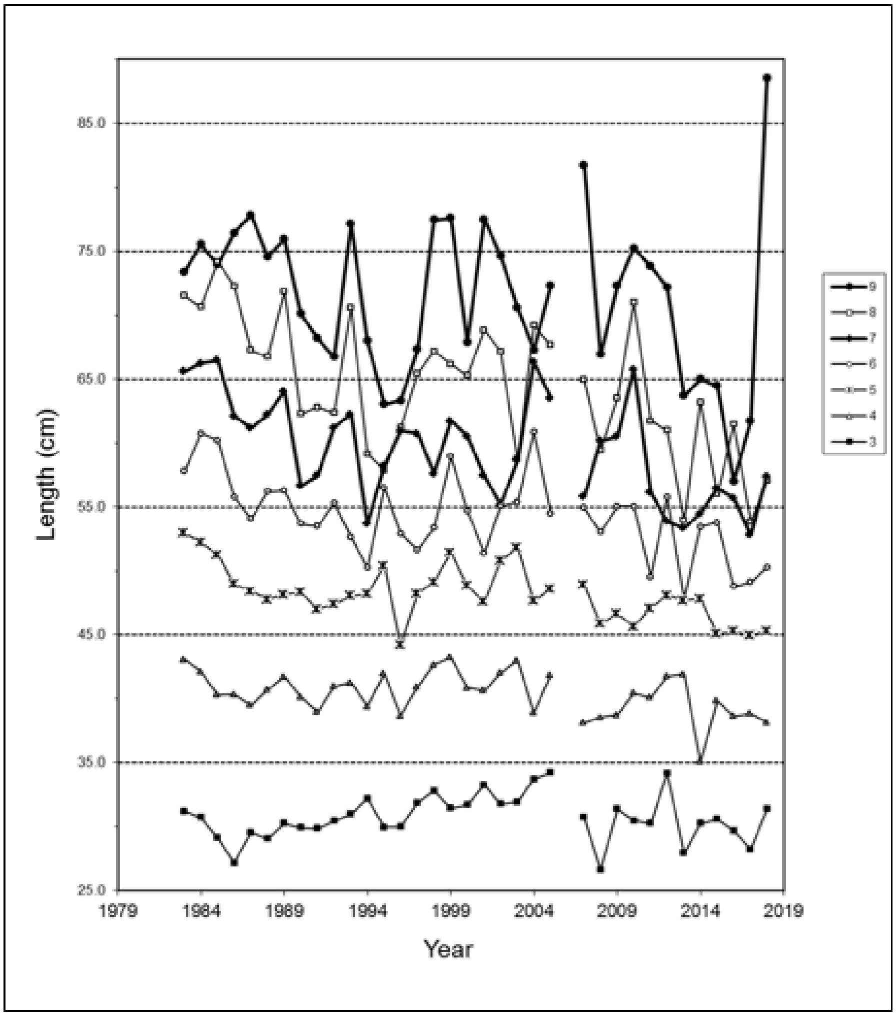


Figure 18. Age dis-aggregated distribution of cod catches (nos. per tow at age) from the Spring 2018 DFO research vessel survey of NAFO Subdiv. 3Ps. Bubble size is proportional to numbers caught.



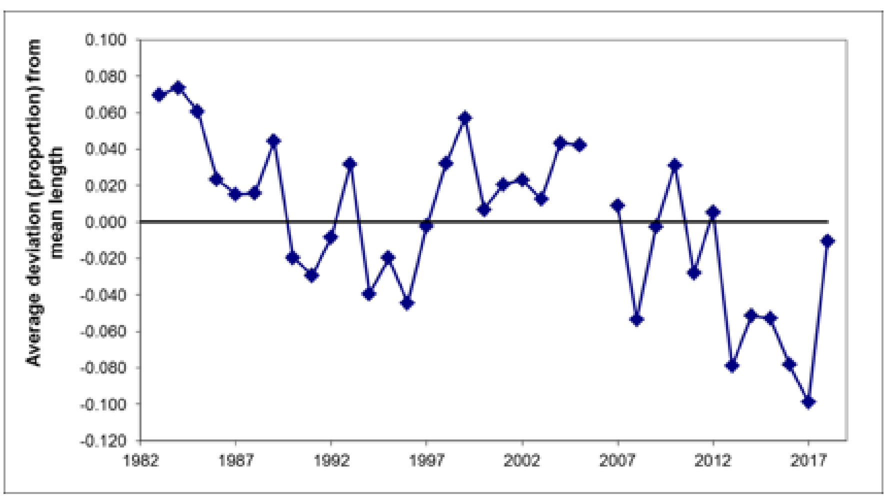


Figure 19. Mean length at ages 3-9 (above) and average proportion deviation from mean length at age for ages 3-9 combined (below) of cod in Subdiv. 3Ps during 1983-2018 from sampling during DFO bottom-trawl surveys in winter-spring.

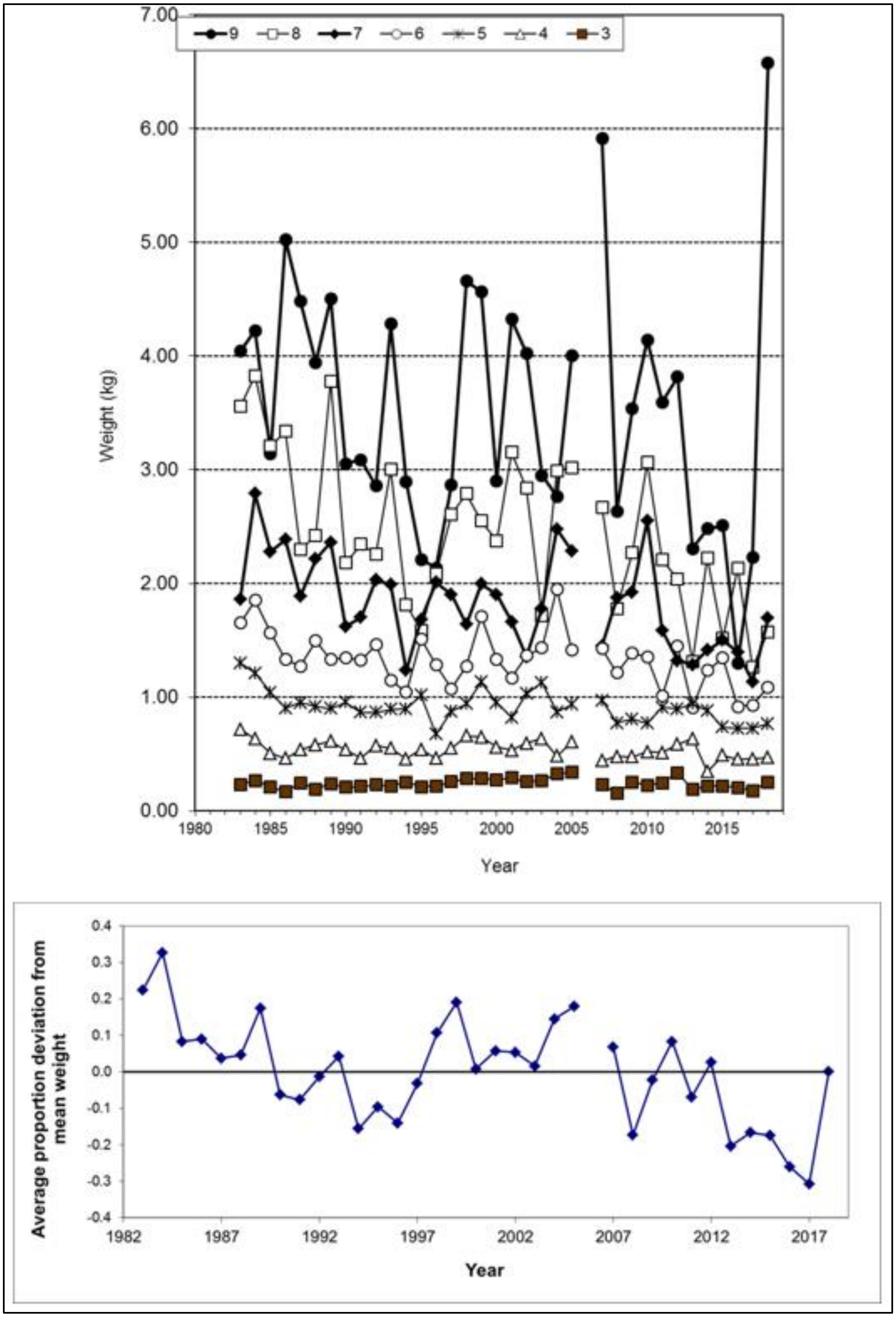


Figure 20. Mean round weight-at-age (kg) (above) and average proportion deviation from mean weight at age for ages 3-9 (below) of cod sampled during DFO bottom-trawl surveys in NAFO Subdiv. 3Ps in winter-spring 1983—2018.

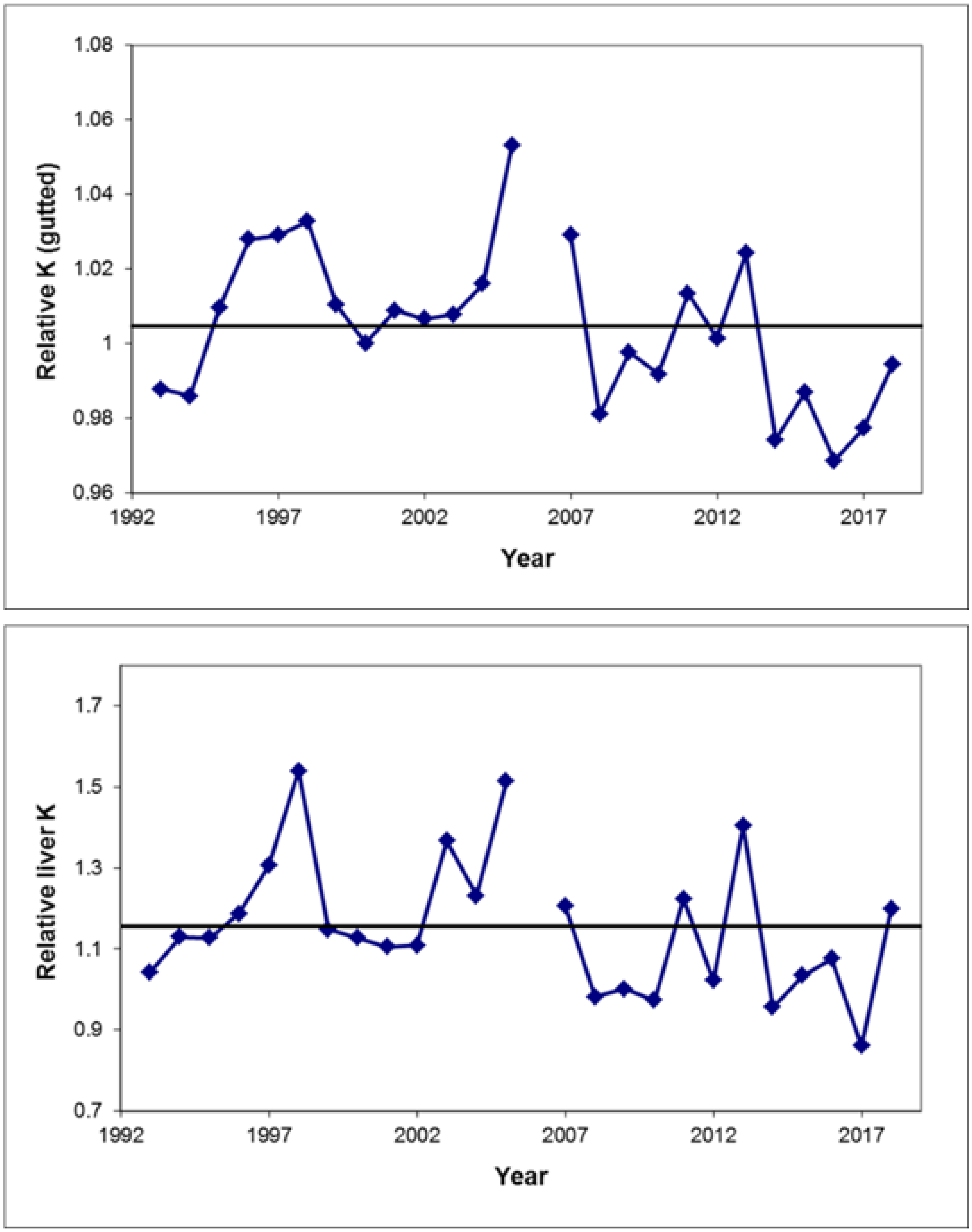


Figure 21. Relative condition indices for 3Ps cod from spring surveys over 1993-2018. Upper panel is relative gutted condition index; lower panel relative liver condition index. Horizontal line represents time-series average.

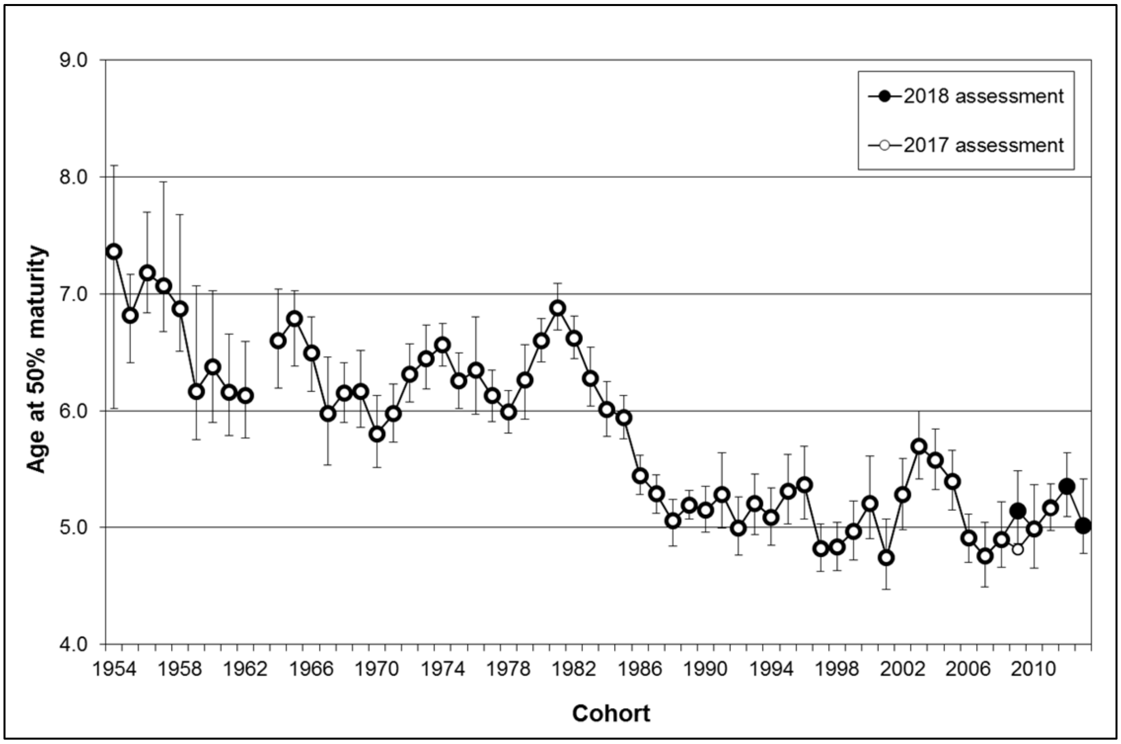


Figure 22a. Age at 50% maturity by cohort for female cod sampled during DFO research vessel bottom-trawl surveys of NAFO Subdiv. 3Ps. Error bars are 95% fiducial limits.

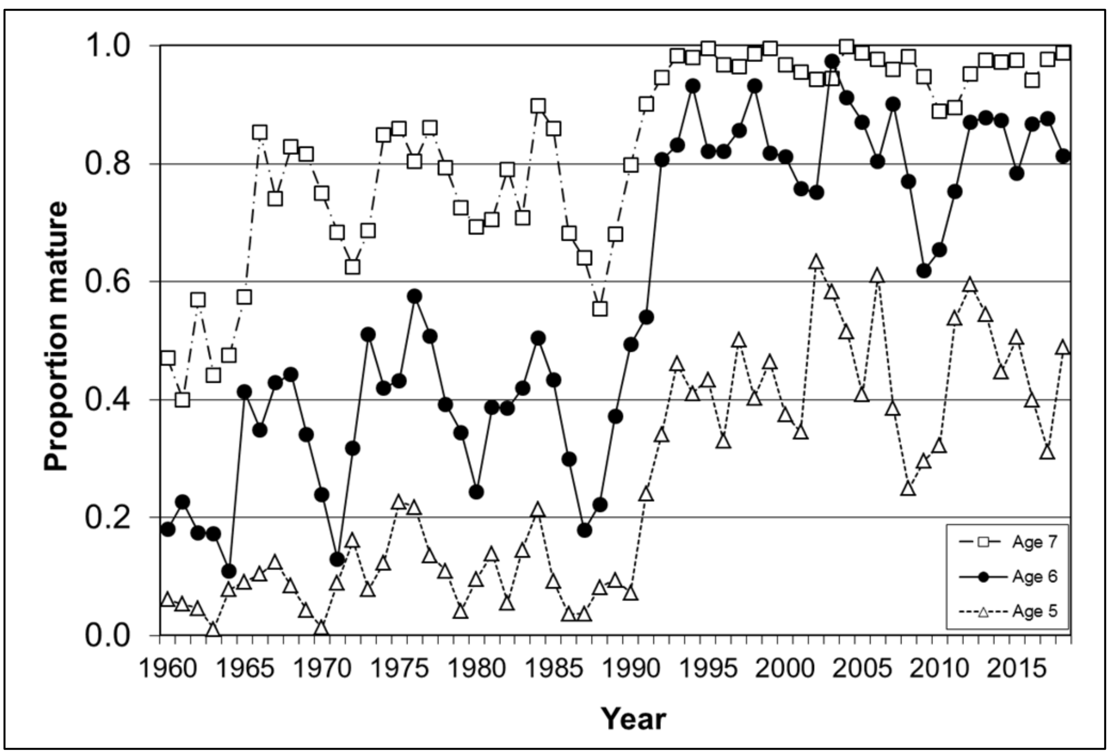


Figure 22b. Estimated proportions mature at ages 5-7 for female cod sampled during DFO research vessel bottom-trawl surveys in NAFO Subdiv. 3Ps (data from all strata surveyed).

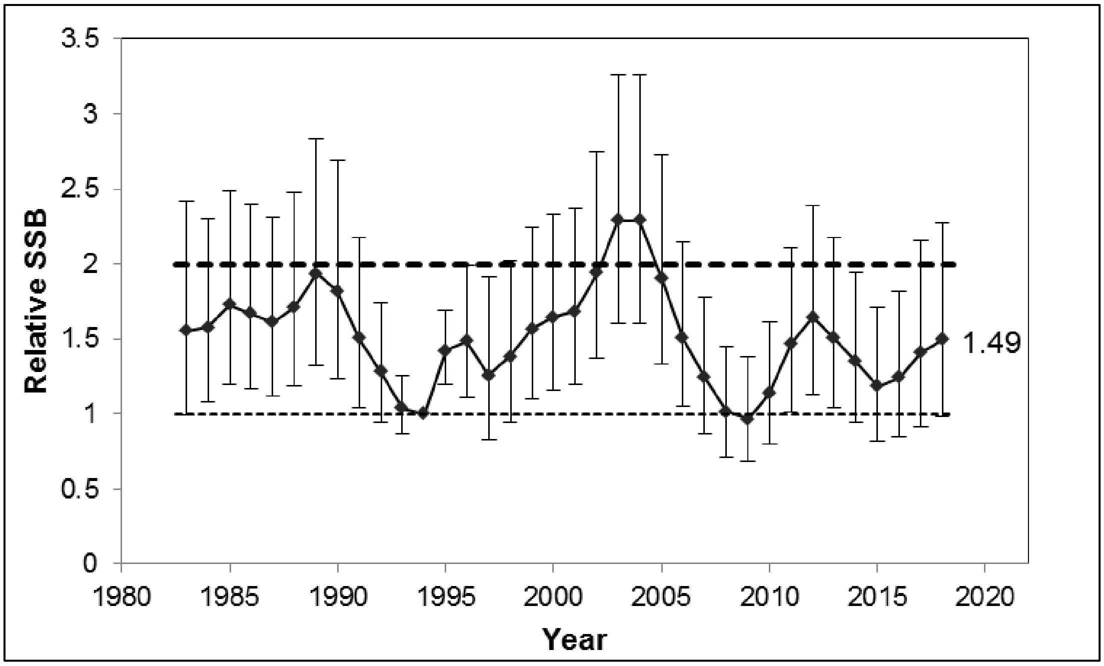


Figure 23a. Cohort analysis estimates of SSB, relative to the 1994 value (median estimate with 95% confidence interval). The lower dashed line at one (reference level) represents the SSB Limit Reference Point and the upper horizontal dashed line at two represents the Upper Stock Reference (i.e., 2 x 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.

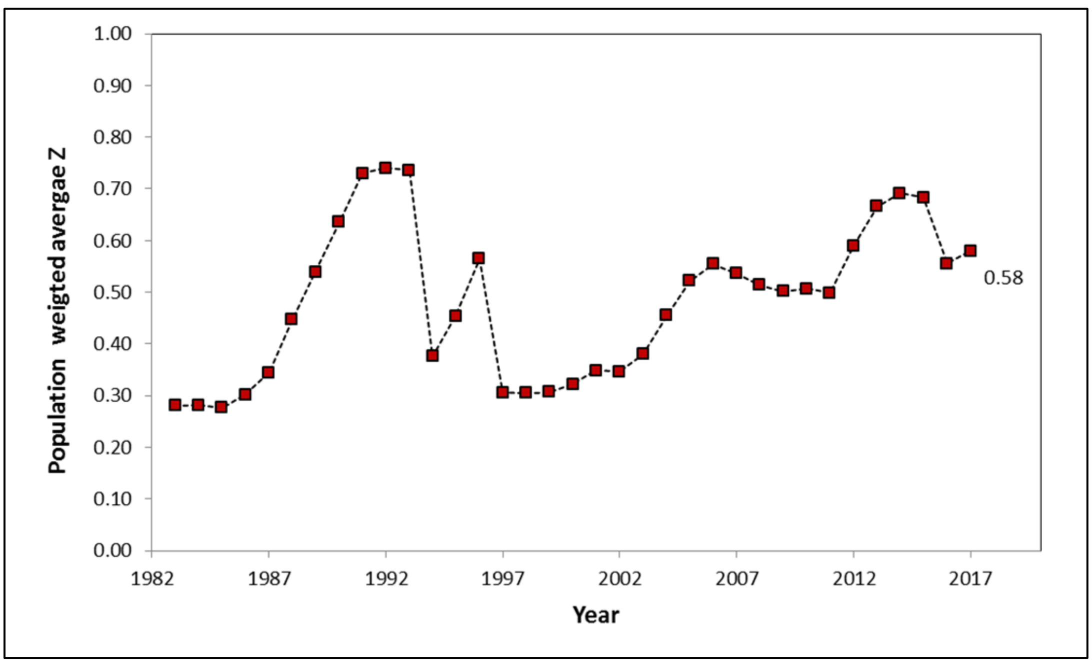


Figure 23b. Cohort analysis estimates of population weighted average annual mortality (ages 5-10). Text label indicates the estimated total mortality for 2017.

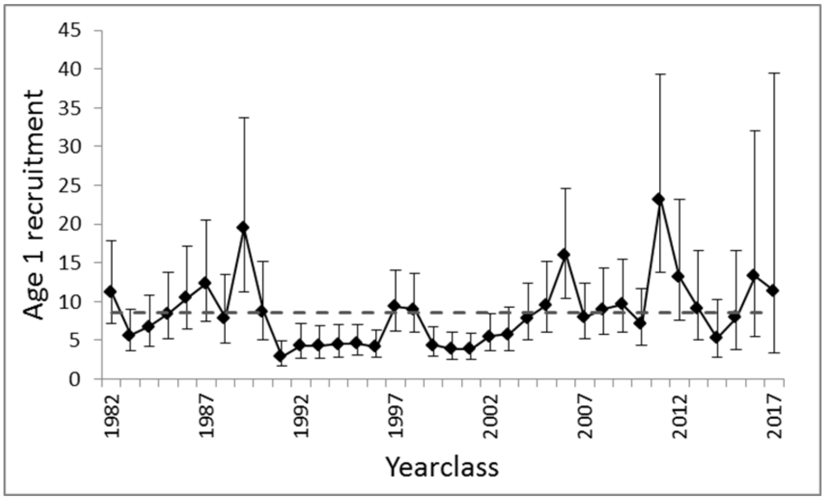


Figure 23c. Estimates of age 1 recruitment from SURBA cohort analysis model.

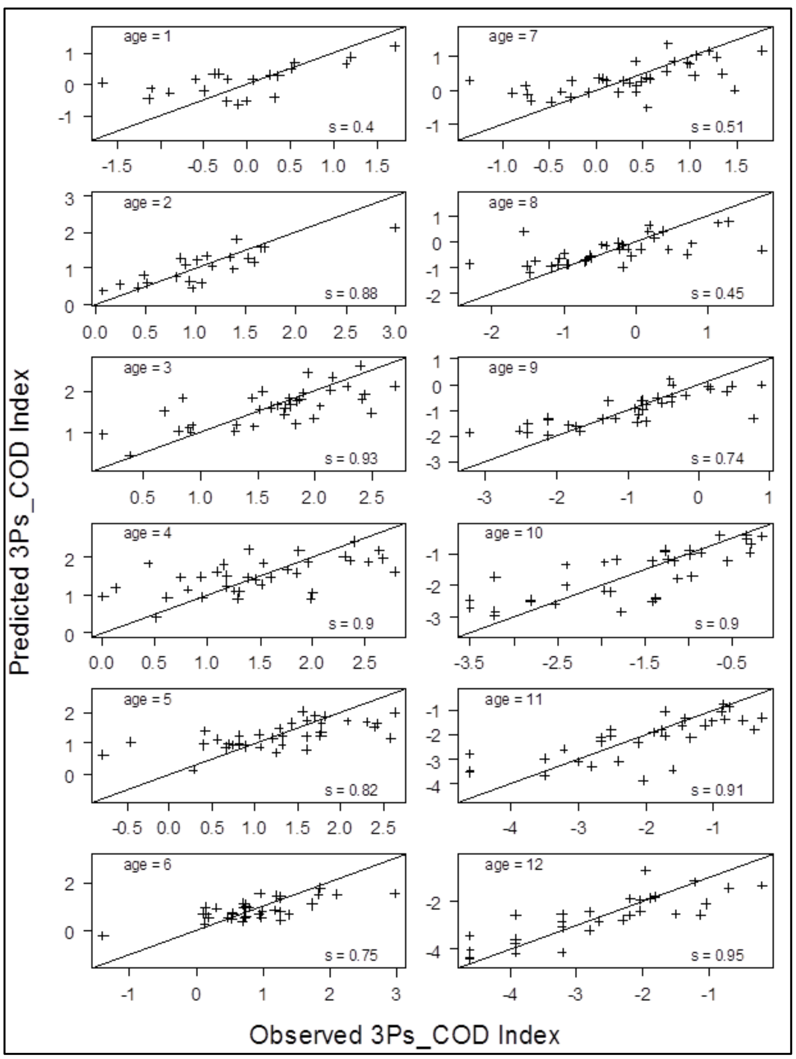


Figure 24. Standardized residuals from SURBA cohort analysis. Panels show residuals plotted year, cohort, age, and expected value, respectively.

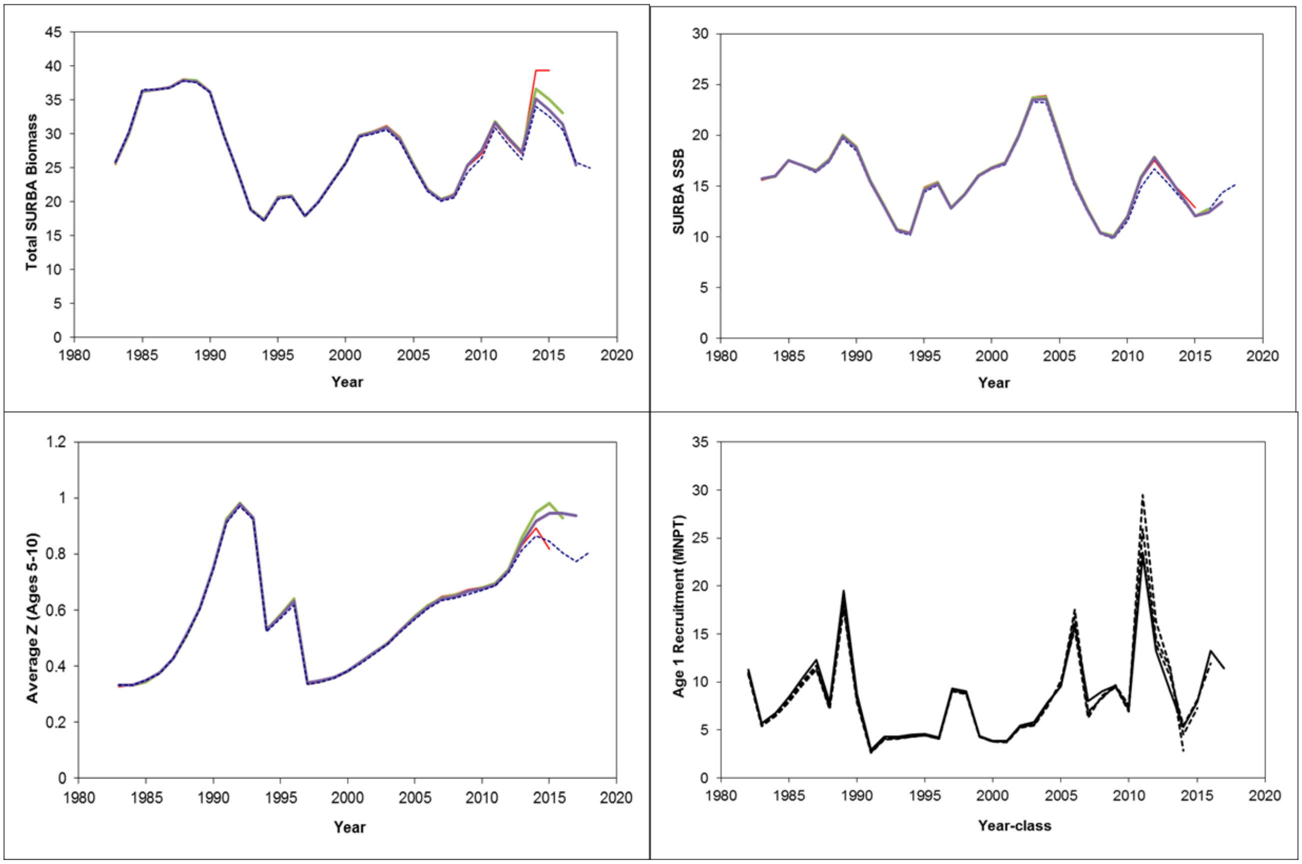


Figure 25. Retrospective patterns comparing the four most recent assessments for 3Ps cod based on a SURBA cohort analysis model.

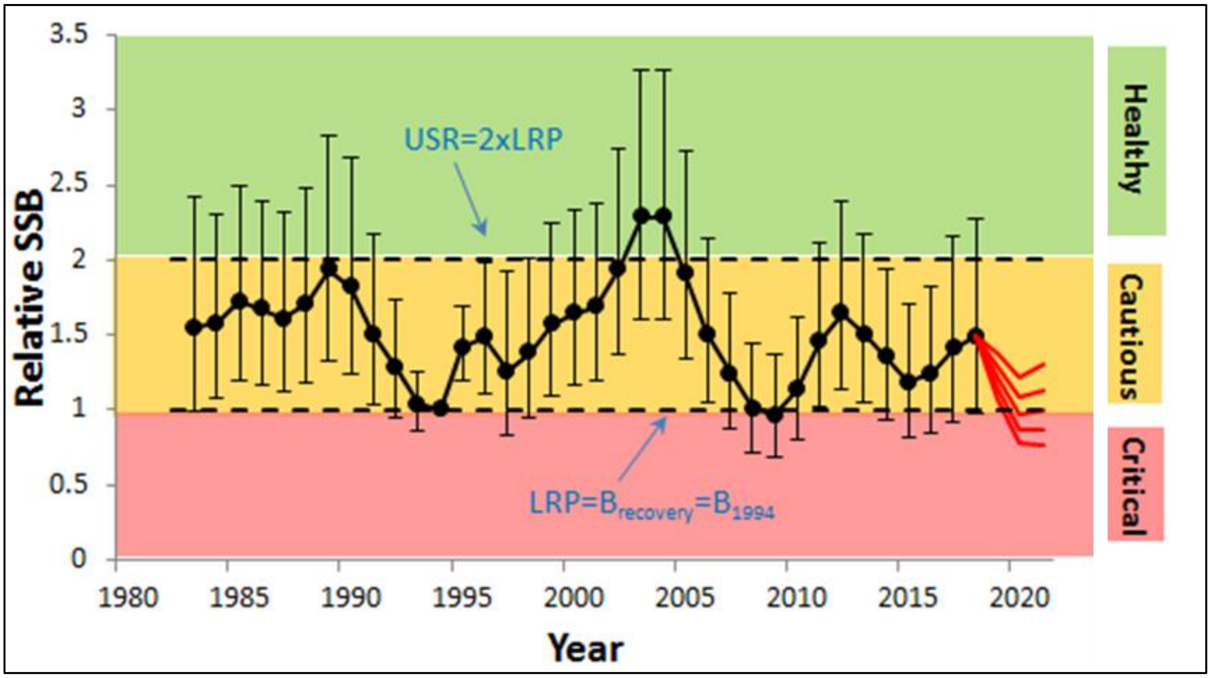
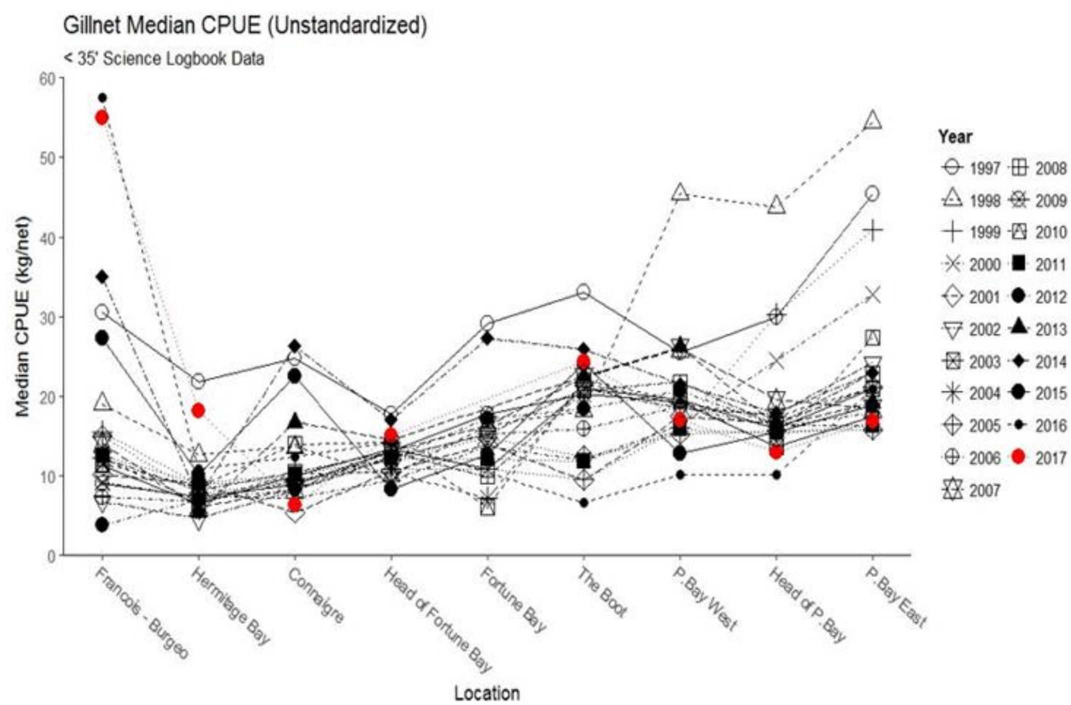


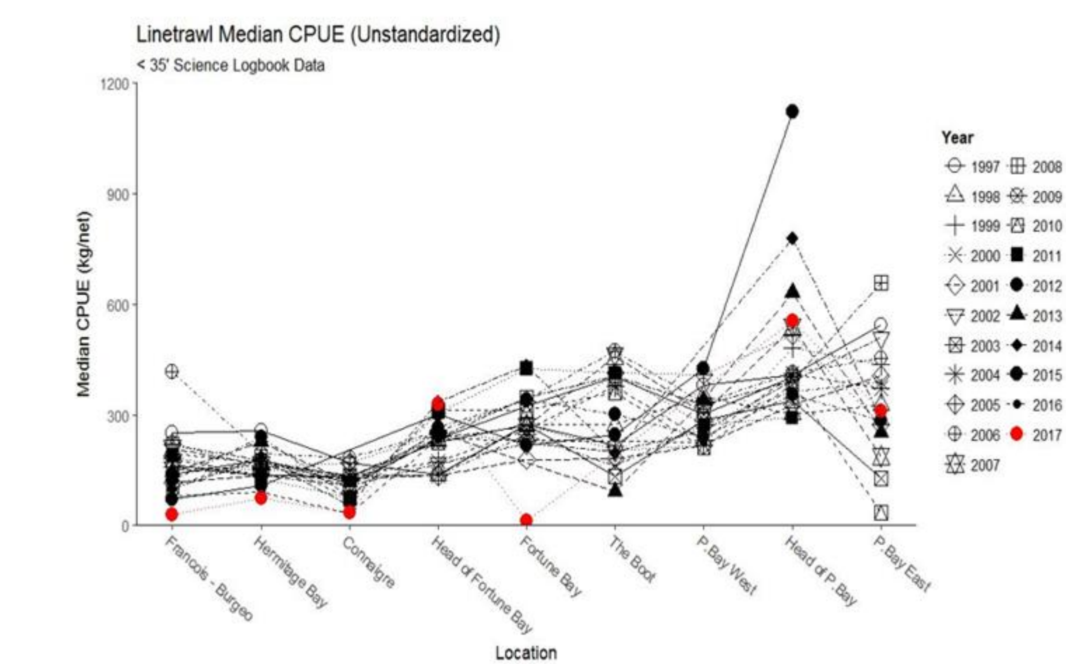
Figure 26. Estimates of SSB, relative to the 1994 value (median estimate with 95% confidence interval) and projected SSB to 2021 (shown in red) under five mortality multipliers (0.8, 0.9, 1.0, 1.1 and 1.2). The lower dashed line at one (reference level) represents the SSB Limit Reference Point and the 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.



Location

# CFV_{2015}	4	15	1	8	1	3	9	11	7
# CFV_{2016}	2	12	4	6	0	4	7	4	8
# CFV_{2017}	2	9	6	3	2	4	7	6	8

Figure 27. Unstandardized catch rates in gillnets based on data reported in logbooks for vessels < 35 feet.



Location

# CFV_{2015}	5	10	0	5	1	2	1	5	0
# CFV_{2016}	5	7	5	5	0	0	1	0	0
# CFV_{2017}	3	14	7	2	5	0	0	5	1

Figure 28. Unstandardized catch rates in linetrawls based on data reported in logbooks for vessels < 35 feet.

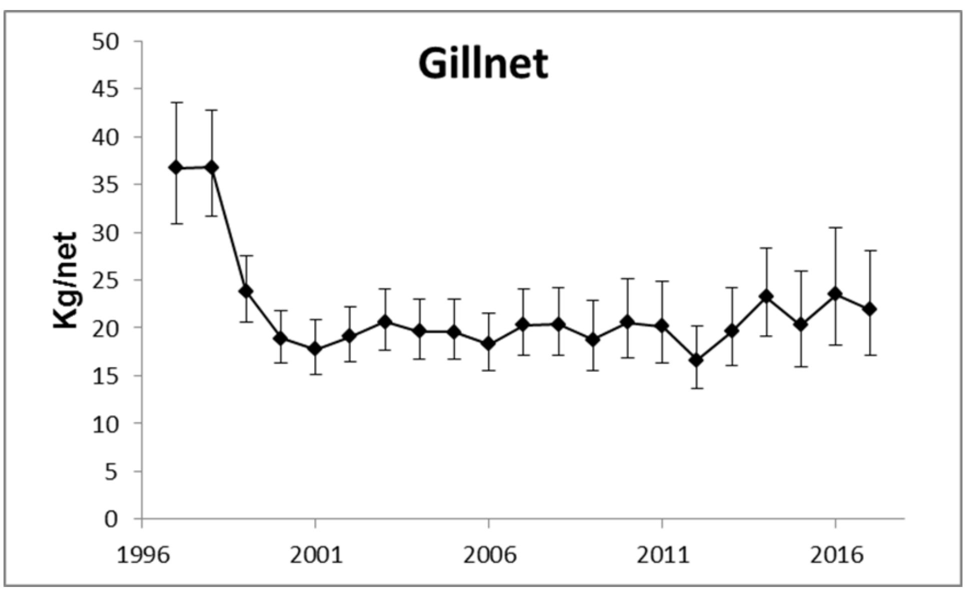


Figure 29. Standardized catch rates plus 95 % confidence intervals for gillnets based on data reported in logbooks for vessels less than 35 feet. Horizontal line represents the time-series average.

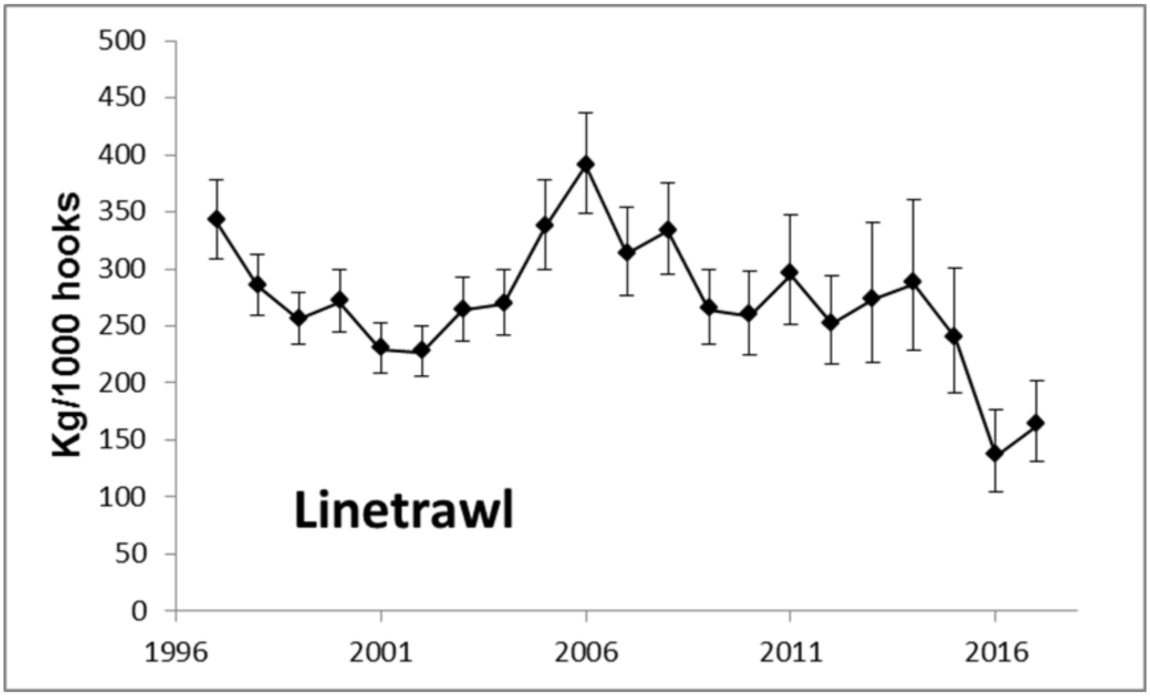


Figure 30. Standardized catch rates plus 95 % confidence intervals for linetrawls as reported in logbooks for vessels less than 35 feet. Horizontal line represents the time-series average.

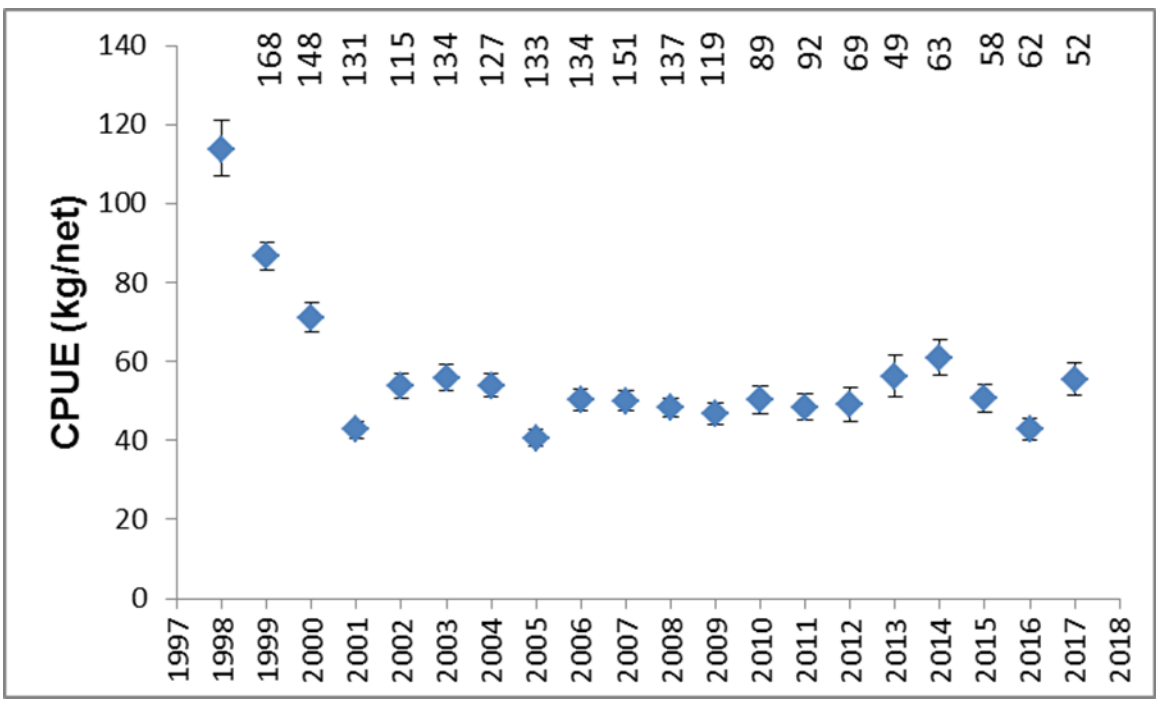


Figure 31. Standardized catch rates with 95% confidence intervals for gillnets based on data from logbooks from vessels greater than 35 feet. Number of sets annually shown at top of graph.

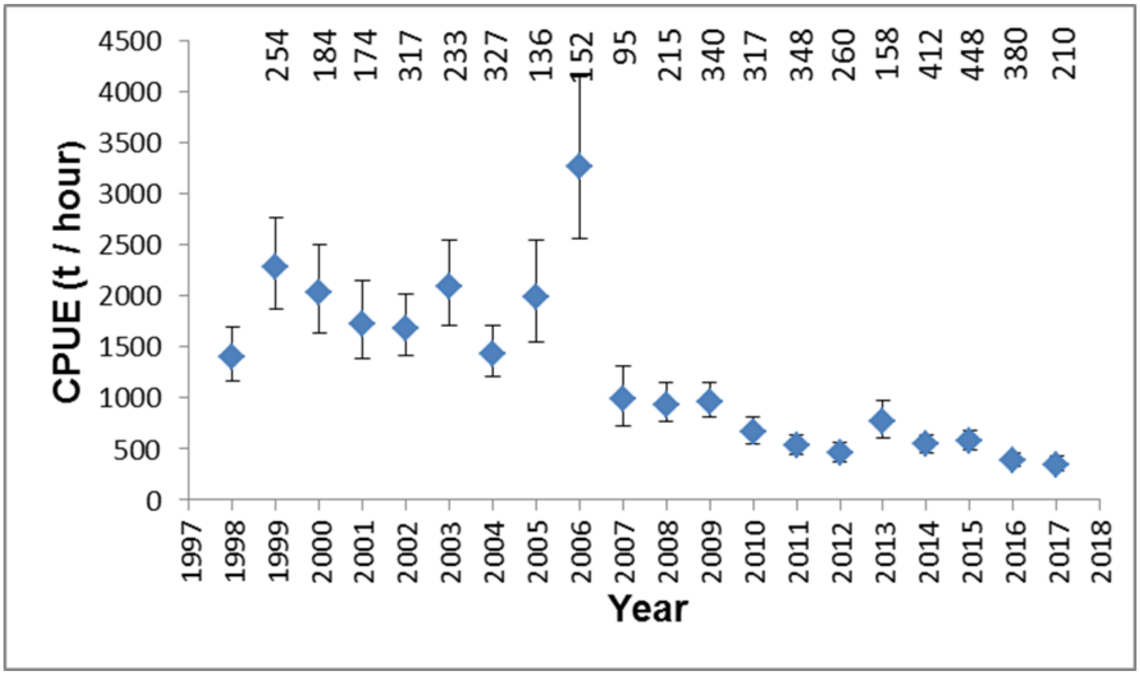


Figure 32. Standardized catch rates with 95% confidence intervals for otter trawlers based on data from logbooks from vessels greater than 35 feet. Number of sets annually shown at top of graph.

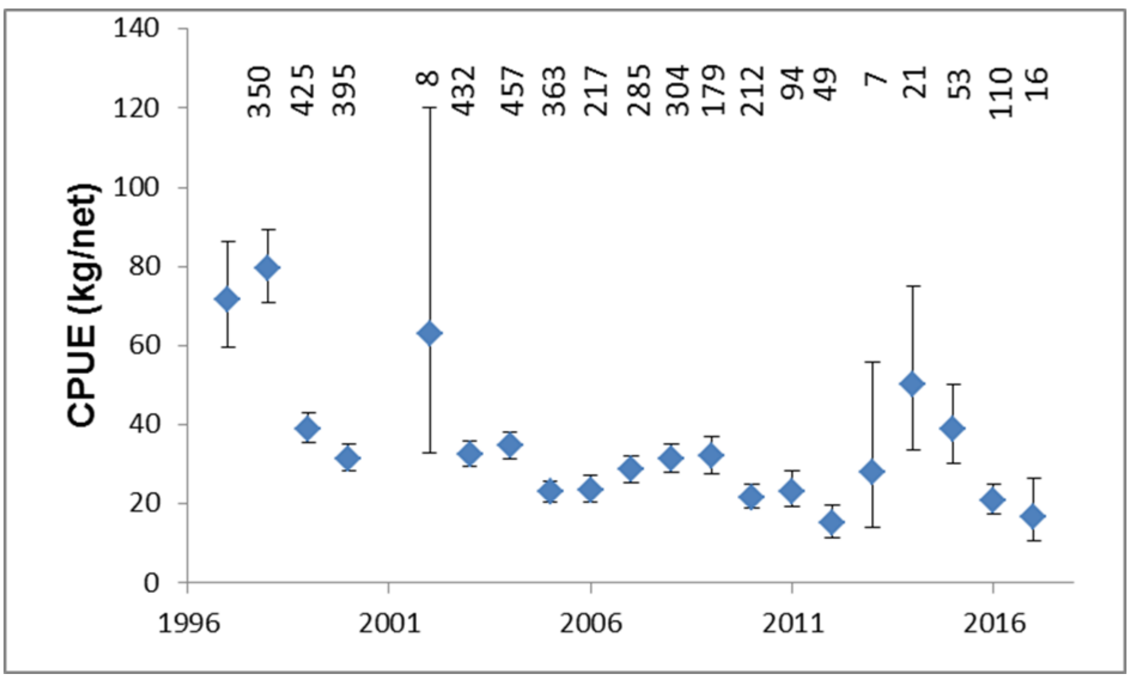


Figure 33. Standardized catch rates for gillnets plus 95 % confidence intervals based on at sea sampling by observers during 1996 to 2016. Number of sets annually shown at top of graph.

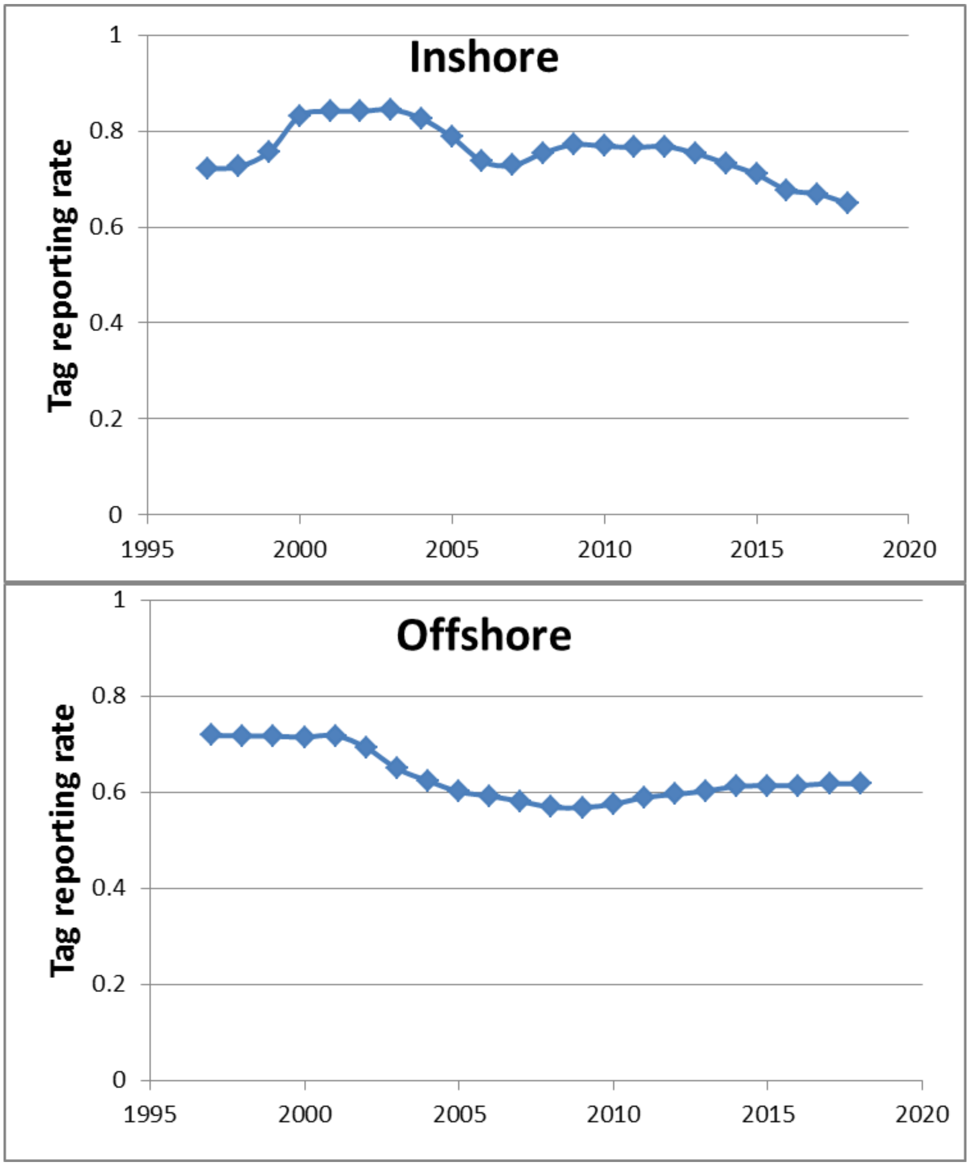


Figure 34. Trends in annual tag reporting rates for low reward ($10) tags based on a mixed effects logistic regression model.

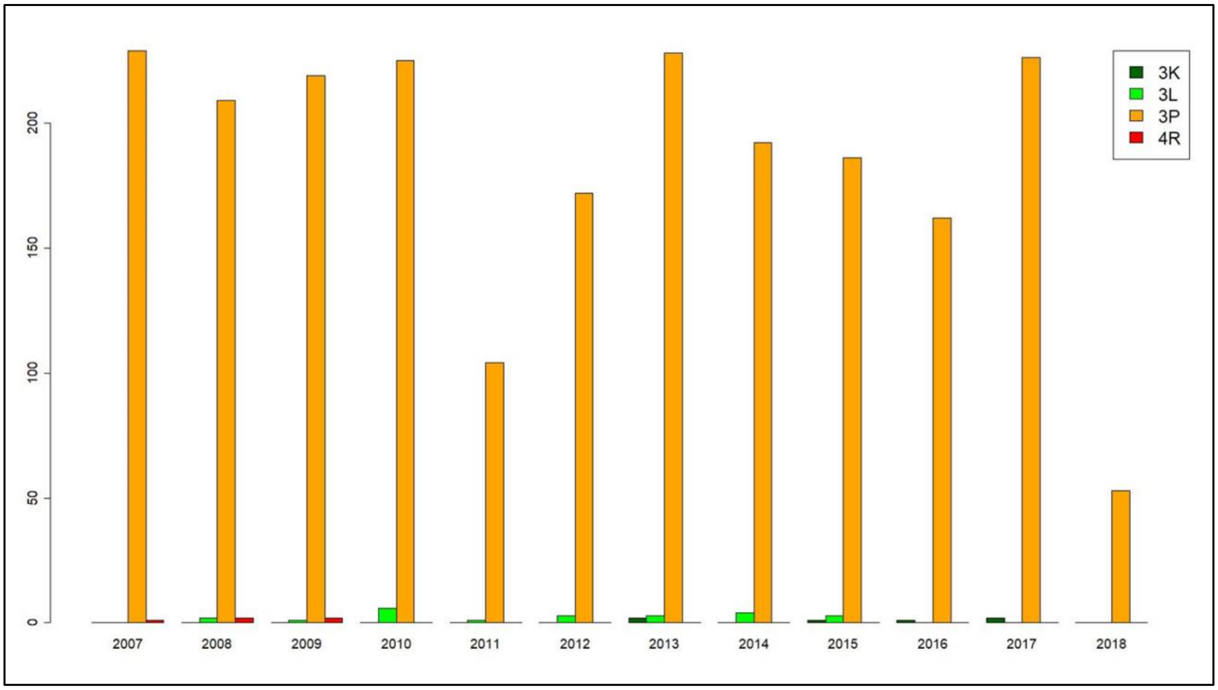


Figure 35. NAFO divisions where tags were recovered during 2007 to 2018, from cod tagged in 3Ps.

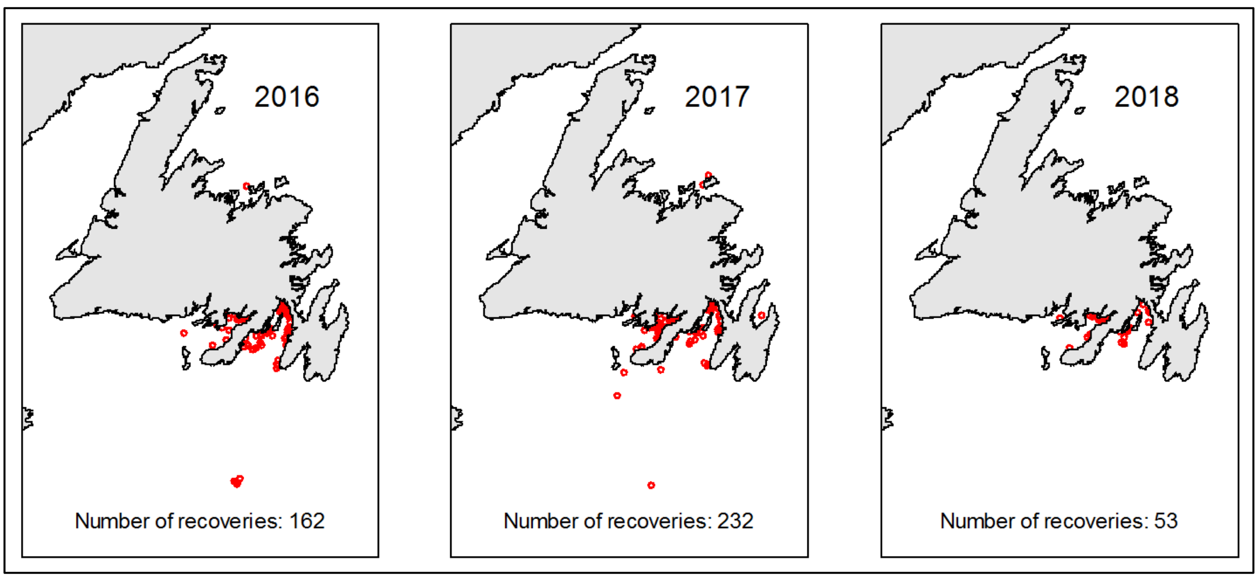


Figure 36. Locations within 3Ps where tags were recovered during 2016 to 2018 from cod tagged in 3Ps.