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Assessment of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Atlantic Cod in 2024

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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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TABLE OF CONTENTS

ABSTRACT.....	V
INTRODUCTION	1
FISHERY	1
CATCH-AT-AGE	1
LOGBOOKS	2
CANADIAN RESEARCH VESSEL (RV) SURVEYS.....	2
BIOMASS AND ABUNDANCE	3
BIOLOGICAL CHARACTERISTICS	4
DIET	4
EXPLORING THE INTERACTION BETWEEN COD AND SILVER HAKE IN 3PS	4
ABUNDANCE, BIOMASS, AND DISTRIBUTION	4
DIET COMPARISON.....	5
CONCLUSION ON COD AND SILVER HAKE.....	5
STOCK WEIGHTS.....	5
SENTINEL PROGRAM	6
SUMMARY OF SENTINEL SURVEY AND INPUTS	7
STANDARDIZED INDICES FOR SENTINEL GILLNET 5.5 INCH AND SENTINEL LINE TRAWL	7
BIOLOGICAL INFORMATION	8
SENTINEL RECOMMENDATIONS	8
DISCONTINUED SURVEYS OF THIS STOCK.....	9
ERHAPS SURVEYS	9
GROUNDFISH ENTERPRISE ALLOCATION COUNCIL (GEAC) SURVEY	9
HYBRID ASSESSMENT MODEL.....	9
MODEL FITS AND DIAGNOSTICS	10
MODEL OUTPUTS	10
RETROSPECTIVE ANALYSES	12
RECRUITMENT SENSITIVITY EXPLORATIONS	12
PROJECTIONS.....	12
SAM MODEL.....	13
MODEL CONCLUSIONS	13
SOURCES OF UNCERTAINTY	13
ACKNOWLEDGMENTS.....	14
REFERENCES CITED	14
TABLES	17
FIGURES.....	31
APPENDIX A. HYBRID MODEL INPUT	94

APPENDIX B. HYBRID MODEL DIAGNOSTICS	110
APPENDIX C. SAM MODEL UPDATE 2024	120
C.1. SAM MODEL DESCRIPTION	120
C.2. INPUT DATA AND PARAMETRIZATION.....	120
C.3. Sentinel Indices Influence	120
C.4. Surveys Influence	121
C.5. SAM Results	121
C.6. Projection with SAM.....	121

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 28–30, 2024. The stock is assessed through an examination of information from research vessel surveys, tagging, and sentinel and commercial fisheries, with stock status determined using a custom state-space assessment model. This document summarizes the main scientific information presented at this meeting, with analyses used to support the conclusions presented in DFO 2025.

INTRODUCTION

This document gives a detailed account of the information presented at the 2024 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 (Figure 1). 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. Data from commercial and sentinel fisheries and DFO Research Vessel (RV) surveys are integrated with other data in an age-structured state space model for the assessment of this stock (HYBRID; Varkey et al. 2022). A complementary State-Space Assessment Model (SAM; Champagnat et al. 2024) is also examined in this assessment as a consistency check. Stock status is determined from the output of the HYBRID model.

FISHERY

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 1,304 t in the 2023/24 season (Figure 2). Beginning in 2000, TACs have been established for seasons beginning April 1 and ending March 31 of the following. A [Rebuilding Plan](#) for this stock was adopted in 2024 and includes a management procedure (MP) which informs the negotiations which set the TAC for this stock. Under this MP, the maximum level of fishing mortality remains at a fixed level while the 3Ps cod stock is in the Critical zone. In the calculation of the MP, fishing mortality at the fully selected ages (9+) is set at 0.065, and decreases with age according to the average selectivity from 2019–21 estimated for this stock, as tested within the rebuilding simulation framework (DFO 2023). Under the terms of the 1994 Canada France agreement, the Canadian and French shares of the TAC are 84.4% and 15.6%, respectively.

A description of the history of the fishery for this stock can be found in Ings et al. 2023. Table 1 provides annual landings since 1980, with the full series of catch used in the model listed in Appendix A, with breakdowns by area, month, and gear for NL landings in Table 2, Table 3, Table 4. 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 Figure 1), with remaining catch taken mainly by the mobile gear sector fishing the offshore, i.e., unit areas 3Psd, 3Pse, 3Psf, 3Psg, and 3Psh. Most of the recent catches have come from unit area 3Psc (Placentia Bay) (Figure 3).

There are no direct estimates of recreational fishery catches for 3Ps cod. Estimates from tag returns indicate catches between 135 t and 376 t (95% CI) with a geometric mean of 225 t based on values from 2016–22, the period for which the current recreational fishery season has been in place and in 2022 was estimated at 250 t (SD = 82 t) (DFO 2024a; Wheeland et al. 2025).

CATCH-AT-AGE

Sampling (length frequencies, otolith collection for aging) of the commercial fishery occurs through observers and port sampling. Sampling data are applied to catch data by gear, unit area, and quarter to estimate the age distribution of commercial catch. 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 5). Coverage of commercial sampling decreased in 2020–21 given restrictions associated with the COVID-19, and gaps remain.

In 2023 there were no samples taken from the line trawl fishery; in lieu of this, sampling from the sentinel line trawl was used to estimate catch-at-age from this gear as it was the nearest representative sampling based on catchability of gear type, location, and timing of catches. Comparisons of sentinel and commercial line trawl age structure in previous years shows general consistency indicating this is likely an appropriate assumption, however there is year over year variation, and this should not be considered a “perfect” match. While the assumption used here is necessitated by the limited commercial sampling, it adds considerable uncertainty to the calculated catch-at-age, uncertainty which is not propagated into the analytical assessment.

In 2023 (Table 6, Figure 4) catch numbers at age were composed largely of age 6, and ages 6–7, respectively. Similarly to 2022, this continues to show a return to a more typical age distribution within the fishery. The 2011 cohort (age 12 in 2023) that had been prevalent within the fishery since 2017 has largely moved out of the fishery. However, 2023 also has an unusually large number and proportion of age 2 and age 3 cod, attributed to line trawl catch. This may be a reflection of incoming recruitment, or an artifact of limited commercial sampling; the source cannot be identified at this time, but should become more clear in subsequent assessments if signs of a strong cohort do or do not continue. Notably, sizes at age 2 and 3 here are generally below that defined for “small fish” in the commercial fishery, and reports relating to the small fish protocol from conservation and enforcement at DFO do not suggest higher than usual catches of small fish in the 2023 fishery.

Estimates of mean weights-at-age are also derived from this commercial sampling, with weight at age of fish ages 8+ declining since the mid-1980s (Figure 5).

LOGBOOKS

Logbooks are completed by commercial fishers to record fishing effort and catches. Previous assessments of this stock have examined standardized catch indices (see Ings et al. 2023), however, in the 2021 assessment the standardization models showed poor fit and were not considered acceptable for use. Additionally, small sample size for the >35 foot log books was identified as a barrier to interpretation. These issues have not been remedied, and therefore standardized logbook catch rates are not presented in the current assessment.

In lieu of this, unstandardized catch rates by community or unit area are provided for <35 foot vessels (Figure 6). Here, catch rates are shown relative to the time series mean for each area. These continue to highlight differences across space; in any given year some areas may experience relatively high catch rates, while others are low. There is considerable uncertainty in the interpretation of fishery catch rate data and these data are often more reflective of changes in fishery performance or the nature of the fishery than differences in stock size.

CANADIAN RESEARCH VESSEL (RV) SURVEYS

Stratified-random surveys (Figure 7) have been conducted in the offshore areas of subDiv. 3Ps during the winter-spring period by Canada since 1972. Canadian surveys were conducted using the research vessels *CCGS A.T. Cameron* (1972–82), *CCGS Alfred Needler* (1983–84; 2009–19), *CCGS Wilfred Templeman* (1985–2008), *CCGS Teleost* (2016, 2021), and *CCGS John Cabot* (2022, 2024). The current random stratified survey series for 3Ps began in 1983 and covers depths to 731 m in depth.

Surveys from 1983 to 1995 employed an Engel 145 high-rise bottom trawl. In 1996, research surveys began using the Campelen 1800 shrimp trawl, and in 2022 a modified Campelen trawl was introduced with the new research vessels *CCGS John Cabot* and *CCGS Capt Jacques Cartier*. 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). Cadigan et al. (2006) found no significant differences in catchability for several species, including cod, between the *CCGS Wilfred Templeman* and *CCGS Alfred Needler* fishing the Campelen trawl. Additionally, Wheeland and Trueman (2024) showed no significant difference in catchability for Atlantic Cod between the Needler and Teleost fishing the Campelen 1800 trawl and the *CCGS Capt Jacques Cartier* and *CCGS John Cabot* using the modified Campelen.

The timing of the survey has varied considerably over the period (Table 8, Figure 9). 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 (Div. 3Pn4RS) stock in the western portion of 3Ps. The stock mixing issue is described in more detail in previous assessments (e.g., Bratley et al. 2007).

Five 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). Two survey time series are calculated: indices from the expanded surveyed area 1997 (i.e., including all inshore strata) is referred to as “All index strata”. the original surveyed area is referred to as the “Offshore” survey index. The assessment model uses the “offshore” index to 1996, and “all index strata” from 1997 to present.

Due to extensive mechanical problems with the research vessel, the survey in 2006 was not completed. There was no survey of 3Ps in 2020 due to the COVID-19 pandemic. The 2022 survey was completed by the *CCGS John Cabot* at an approximate 80% allocation of the full 178 survey sets. There was no survey in subDiv. 3Ps 2023, primarily due to limited vessel availability. In 2024 the survey in subDiv. 3Ps was completed with the Cabot at a 70% set allocation.

BIOMASS AND ABUNDANCE

Survey indices of abundance and biomass are shown in Figure 10. The biomass index (Table 9) was variable but exhibited a downward trend from the mid-1980s to the early-1990s. Values for most of the post-moratorium period from 1997–2004 were higher than those of the early-1990s, but remained below levels of the 1980s. Biomass indices have been consistently low since the mid-2010s (below the 1997–2021 average since 2014), reaching a time series low in 2022. Biomass in 2024 was slightly higher than in 2022.

Mean weight per tow in the survey catches has been highest in and around Fortune Bay for the last two surveys (2022, 2024) (Figure 16). The 2022 survey had the highest portion of survey biomass in the inshore strata observed since 1997, and it remained around this level in 2024 (Figure 11).

The DFO research survey abundance index (Table 10) is highly variable. A recent peak was observed in 2012 and 2013 associated with the entry of the 2011 year class. Abundance has been at or near the long term average for the last four surveys. Proportion of abundance in the inshore strata in 2024 is the highest in the time series (Figure 11).

BIOLOGICAL CHARACTERISTICS

Length frequencies indicated a pulse of small (<20 cm) fish in 2021, coinciding with an increase in abundance at age 2 (Figure 14) in the survey. Abundance at age 2 in the survey in 2021 was the highest since the emergence of the 2011 year class, but remains well below that level (age 2 survey abundances in 2021 = ~48% of age 2 abundance in 2013). This pulse carried forward into the 2022 index at age 3. Generally, there is a scarcity of older fish in the survey catch, and sample sizes for biological characteristics of fish ages ~8+ are generally low.

Mean cod condition (relative gutted condition) in the RV survey was below the time series (1993–2024) average from 2014–19, but showed improvement in 2021 and has been at or above average in the last three surveys (Figure 19).

Estimates of age at 50% mature (A50) (Figure 20) showed a precipitous decline from the 1981 to 1988 cohorts, changing from an A50 near 7 years to near 5 years. Size at maturity has remained near 5 years since, and decrease from the mid-1980s to the mid-1990s but have been relatively stable since. Currently, Atlantic Cod in subDiv 3Ps start to mature around age 4 or 5, with around 75% of age 6 fish being mature. Decreases in size-at-age combined with relatively stable age-at-maturity result in smaller mature fish. Smaller fish typically have lower fecundity, and this has been demonstrated for Atlantic Cod (e.g. Stares et al. 2007; Rideout and Morgan 2010); therefore these conditions are expected to have resulted in lower overall reproductive potential of the population.

DIET

The composition of diet by of Atlantic Cod of large (≥ 50 cm) and small (<50 cm) are shown in Figure 21. A break at 50 cm is used here as a proxy for age 5 to correspond with the ages for which natural mortality in the assessment model is linked to fish condition. Atlantic Cod diet in 3Ps is highly variable. Smaller cod tend to feed on more sand lance (*Ammodytes spp.*), Capelin (*Mallotus villosus*), and small invertebrates, and in some years also have a relatively high proportion on snow crab. Large fish rely more on crab than smaller fish in recent years while relying on redfish (*Sebastes spp.*) during the 1990s. There was a reduction of snow crab (*Chionoecetes opilio*) in the diets of both small and large cod in 2017. In large cod there was an increase in flatfish coinciding with this drop, while no specific prey item compensated for this crab reduction for the small cod.

EXPLORING THE INTERACTION BETWEEN COD AND SILVER HAKE IN 3PS

The structure of the ecosystem in subDiv. 3Ps has been changing over at least the last decade. Atlantic Cod was the historically dominant species among predatory fishes in this ecosystem, but its dominance has been markedly reduced, coinciding with increases in warm water species such as Silver Hake (*Merluccius bilinearis*).

Questions have been raised on the interaction of Silver Hake and Atlantic Cod in subDiv. 3Ps given this increase. Here we examine available data from the spring RV survey including indices of abundance and biomass, distribution, and diet.

ABUNDANCE, BIOMASS, AND DISTRIBUTION

Stratified biomass and abundance estimates were estimated for Silver Hake using all strata in subDiv. 3Ps (Figure 22). Note that for the analyses presented here, records of offshore hake *Merluccius albidus* within the DFO NL survey trawl database were combined with those of Silver Hake as the vast majority of “offshore hake” records are attributed to miscoding and presumed to be Silver Hake based on at-sea observations and known species’ distribution.

There was a significant increase in abundance and biomass starting in 2010 and 2011, respectively, and these indices remain elevated compared to pre-2010 levels to 2021. Only the Campelen series (1996–21) is shown here for Silver Hake as there are no conversion factors available from Engel to Campelen (pre-1996) or to the new vessels (since 2022) for this species.

Silver Hake are distributed primarily on the shelf edge in the Spring survey, along the Laurentian Channel and in Hermitage Channel (Figure 23), while Atlantic Cod are distributed more broadly across the top of the banks (Figure 24). While there is some overlap in the depth distribution of the two species during the survey, Silver Hake are typically deeper than cod (Figure 25). Abundance-weighted mean temperature also indicates Silver Hake are occupying warmer waters than cod (Figure 26), with increased temperature noted for Silver Hake since around 2010 consistent with broader observations of temperature in slope waters of 3Ps during the survey (Figure 27 to Figure 29).

DIET COMPARISON

Here we examine diet of cod and Silver hake in the spring RV survey based on stomach content sampling. To account for the fact that larger cod might be eating different prey due to their size, diets of cod less than 40 cm were compared to Silver Hake diets here. The frequency of occurrence of prey items of fish samples from 2013–24 throughout 3Ps during the spring survey (Table 11), from 1847 cod and 604 Silver Hake. To visualize these differences, we conducted nMDS based on presence of prey group in a given year. Years with fewer than 25 samples for a single species were excluded. There is limited diet overlap between these two species (nMDS) within these samples, with Atlantic Cod having a higher richness of prey items (annual mean of 18.1) than Silver Hake (annual mean of 6.33), and correspondingly higher mean annual diversity in prey items (cod: Shannon-Weiner diversity 1.88, Silver Hake: 1.25). Cod have a more variable diet composition, and Silver Hake display more pelagic feeding (e.g., euphausiids, myctophids). This is consistent previous reports in subDiv. 3Ps (Rockwood 2016).

CONCLUSION ON COD AND SILVER HAKE

Silver Hake and Atlantic Cod do not appear to be occupying the same environmental niche in this area. Silver Hake are located in deeper, warmer waters and feed more pelagically than cod. While the increase in Silver Hake in 3Ps is reflective of ongoing ecosystem change in the region, and associated with continued ocean warming – particularly on the shelf edge – there does not appear to be a direct impact of Silver Hake on the 3Ps Atlantic Cod stock at this time. We note that these inferences are based on data from the Spring RV survey and would not capture seasonal dynamics within or among these species, though discussion with harvesters during the assessment meeting do not indicate significant overlap of these species at the times or areas of the cod fishery in 3Ps. However, we note that overlap and interaction between these two species may continue to change as this ecosystem warms, similar to that observed on the Scotian Shelf (DFO 2024b).

STOCK WEIGHTS

Stock weights at age are modelled as described in Cadigan 2023, based on bias corrected length-at-age in the RV survey. There have been considerable declines in weight at age across the time series, with weights for all ages at or near time series lows since the late-2010s (Figure 33).

Length-at-age in the survey along with resulting stock weights have been calculated based on offshore strata only in past assessments. With a high (>40%) proportion of survey biomass observed in the inshore strata in 2022 and 2024 the impact of excluding inshore strata from estimations of size at age was examined. Length-at age was recalculated including offshore and all inshore strata since 1997, and stock weights then modelled using both length-at-age from offshore strata and from all index strata (Figure 33).

When inshore strata are included, length-at-age and resulting stock weight estimates are consistently lower since the mid-2000s than those estimated based on samples from offshore strata only. These differences are more pronounced for older fish and for the most recent years; in 2024 there is a 15% increase in model estimated stock weights for age 7, and a 53% increase for ages 14+ when only offshore strata are included (Figure 32). These differences reflect a difference in stock distribution during the survey (higher proportion inshore) and a difference in size of across the stock area (Figure 17; Cadigan et al. 2022).

The stock weight model does not account for spatial differences in sampling (i.e. introduction of inshore strata) or stock distribution over time. Additionally, in the current recalculation of survey length-at-age we are unable to recreate the values of number of otoliths at age per year used in Cadigan 2023. While this does not appear to impact the estimation of length at age – and is therefore suspected to be a difference in data summary output between those previously reported (SAS) and the current estimates (R) – the stock weight model uses numbers of otoliths collected to infer measurement error CV. The recalculation of stock weights here with inshore strata is therefore considered an initial sensitivity test to examine the relative influence of these strata, and further work is recommended.

SENTINEL PROGRAM

Sentinel survey projects were formally announced by the Minister of Fisheries and Oceans Canada in October 1994. The sentinel surveys in the Newfoundland and Labrador Region of the Department of Fisheries and Oceans (DFO) are an extension of the index fishermen's project from the Northern Cod Science Project Program, with modifications to allow for scientific activities achievable only under a fishing moratorium. The primary collectors of data in the sentinel survey are inshore fish harvesters, particularly through involvement of the FFAW for subDiv. 3Ps. The goals of the collaborative project are to develop indices of relative abundance (i.e., catch rates) for resource assessments; to incorporate the knowledge of inshore fish harvesters into the resource assessment process; to evaluate inter-annual variability in resource distribution over inshore areas; and to collect information on key biological parameters used in assessments (e.g., fish length, sex, otoliths to determine fish age, cod stomach contents).

In winter 1995, the pilot project was started in NAFO subdivision 3Ps at 14 sites and ran for 15 weeks. Since 1995, 32 participants have been involved in the program (Figure 37, Figure 38).

Fishing enterprises from St. Bride's to Burgeo participate in the Sentinel fisheries survey in subDiv. 3Ps. Fishing is conducted at one control site and at least one experimental site: control sites are fixed and based on historical fishing areas and gear-use patterns, while experimental sites vary within a designated area. Each day, up to half of the fishing gear is deployed at the control site, with the remaining gear used at the experimental site(s). Surveys typically last 9–12 weeks annually, averaging 10 weeks since 2005. Harvesters using large mesh gillnets (5½ inch) deploy up to six 50-fathom monofilament nets, with a maximum of three fleets per day. Linetrawl harvesters use two tubs of bait hooks daily, each containing about 500 hooks. Additionally, a small-mesh gillnet (3¼ inch mesh size) is deployed at selected sites at least once a week (Mello and Simpson 2022). After each fishing set, data is recorded, including location (latitude and

longitude), start and soak times, bycatch species, and key environmental conditions such as wind direction, speed, cloud cover, tidal conditions, and water salinity and temperature at depth. Catches are sorted by species, with counts and lengths noted by sex. Otoliths are collected using a length-stratified sampling technique. Additionally, up to 100 whole Atlantic Cod are frozen and sent bi-weekly to the DFO in St. John's, NL, for detailed biological measurements, including total length (TL), gutted weight, and liver and gonad weights. The total annual removal of Atlantic Cod during the sentinel program is calculated from data collected at both control and experimental sites (Mello and Simpson 2022).

Methods for sentinel data analysis are described in Kumar et al. (in press). An unstandardized age-aggregated catch rate is calculated as the yearly sum of the total catch—regardless of the time of year of the catches, or community involved—divided by the total amount of gear used. Age-disaggregated standardized indices for all the major gear types used are also calculated, adjusting for the effects of community (seqcode), month, age, and year.

SUMMARY OF SENTINEL SURVEY AND INPUTS

The number of fishing enterprises participating in the Sentinel Program has decreased steadily from the early 2000s (Figure 39), resulting in decreased number of sets in the sentinel fishery across all gear types. The gillnet fishery has remained fairly stable since 2010, however, there has been a decline in activity in the linetrawl fishery in the recent years. In several communities, new participants were able to maintain continuity in the survey, and these new participants were assigned a distinct sequential code (seqcode) (Figure 40). A detailed view of the number of survey deployments across the different communities involved in the program is available in Table 12, Table 13, and Table 14.

This sentinel fishery predominantly occurs between June to November, the months of data used for the standardization purposes (Figure 41). Among all gears, linetrawl gear captures the most number of cod followed by the 5.5" mesh gillnet. Cod total predicted landings (from all gear types combined) experienced a sharp decline from over 200 tonnes in 1995 to below 50 tonnes by 1999, followed by a gradual decrease with minor fluctuations, reaching about 11.6 tonnes in 2023 (Figure 42). The overall trend indicates a long-term reduction in landings, coinciding as well with reduced participation in the sentinel program. Except for a few recent years, landings from linetrawl have generally been higher than those from the 5.5" mesh gillnet.

The unstandardized indices show similar trends between the fixed and experimental sites. In recent years, the indices show an increasing trend in the gillnets but a decreasing trend in the line trawls (Figure 43). Length frequencies are shown in Figure 44. Two modes are clear in the 3.25" gillnets, as is characteristic of small mesh gillnets. The 5.5" gillnet typically catch fish between 50–80 cm, while the linetrawl catches tend to start around 30 cm. The sizes present in each gear are largely consistent year-over-year, while total catches have declined from the start of the time series.

STANDARDIZED INDICES FOR SENTINEL GILLNET 5.5 INCH AND SENTINEL LINE TRAWL

The aged data used for standardization is presented in figures Figure 45 and Figure 46. There is high variability, and in many years there are no age 3 fish in the 5.5" mesh gillnet. The standardized index for age 3 gillnet is therefore not used in the 3Ps cod assessment model due to consistently low catches of this age in this gear.

The residual plots (Figure 47, Figure 48) do not show any concerning patterns for either gillnet or linetrawl standardization models. Catch rate trends are very similar for both the fixed and experimental sites for aggregated index and index-at-age for both gears (Figure 49). Catch rate

for 5.5" gill nets shows comparable annual patterns across ages 4 to 10. Initially, there is an increasing trend, with the highest catch rates observed in the early phase of the sentinel program. Subsequently, the catch rates experienced a sharp decline by the early-2000s and then stabilized at relatively low levels. In recent years, though, there has been an increase in the catch rates, especially for the older ages. For linetrawls, the same decline in catch-rates by early-2000s is noted in ages 6 and above but is not as prominent as observed with the gillnets. A comparison of the aggregate indices (Figure 50) from gillnets and linetrawls is difficult because the sharp decline in the indices for gillnets in the early phase masks the other ups and downs in this index series.

BIOLOGICAL INFORMATION

Condition indices described below are presented in Figure 51 and Figure 52.

Fulton's condition index (K): Fulton's condition index (K) was generally lower between 2010 and 2019 but has improved in the last 2–3 years, although they remain lower than earlier periods. Females generally show slightly higher K values compared to males.

Seasonal variation in health and condition of Atlantic Cod is evident, with highest K values in the of July, August, and September. During the early months of the year (January to June), K values have decreasing trend towards late spring. K is generally consistent across sexes throughout the year.

Gonadosomatic Index (GSI): The overall annual trends for both female (F) and male (M) exhibit some fluctuations but maintain relative stability. The monthly variations in GSI are reflective of the reproductive cycle and influenced by environmental and biological factors. During January and February GSI values tend to be relatively low with notable increases into the spring and early summer. This period signifies heightened reproductive activity, with peak values observed in June; indicative of the spawning season. Monthly GSI patterns suggest peak spawning activity in the spring and early summer.

Hepatosomatic Index (HSI): The HSI values demonstrate a stable pattern across the years, with most values remaining within a narrow range (3–6%). The HSI values for both female and male cod are consistently higher than 3, with females slightly higher, indicating overall healthy liver condition (Dutil et al. 1995). Fluctuations are likely influenced by seasonal and environmental factors, as well as variations in prey availability and feeding patterns. There is an upward trend in monthly HSI observed from June to August, followed by a subsequent decrease.

Mean weight-at-age (Wa): Bias-corrected mean weight-at-age (Morgan and Hoenig 1997) for fish ages 5–10 caught in the sentinel survey is presented in Figure 53 for males and for females. High variability in these estimates year over year is largely attributed to small sample sizes, particularly for the youngest and oldest fish. For ages 7+ there has been a general decrease in size at age over the time series.

SENTINEL RECOMMENDATIONS

For the standardized index calculation, samples from sets deployed between June and November are used. However, many sets are deployed in December. Additionally, trends observed in fixed sites closely mirror those in experimental sites for both the gears. The 2023 assessment identified a recommendation to use both fixed and experimental sites in standardized index calculation, and include sampling from December which is excluded from the current indices. This recommendation was not addressed in time for the current assessment, and is reiterated.

The occurrence of multiple zero values in a Poisson regression model suggests the potential need for considering a zero-inflated regression model. A zero-inflated model may allow for a better fit by accounting for the overabundance of zeros, which standard Poisson regression might not handle effectively. Exploration of this is therefore recommended going forward.

DISCONTINUED SURVEYS OF THIS STOCK

ERHAPS SURVEYS

The assessment model incorporates bottom trawl data from the ERHAPS (Evaluation des Ressources Halieutiques de la région 3PS) surveys by France that were conducted from 1978 to 1992 using the same stratification scheme as the Canadian offshore RV survey. There was a change in vessel in 1992 and there was no comparative fishing to compare the catchabilities of the two vessels. Therefore, the assessment uses only data from 1978 to 1991. The ERHAPS survey was conducted in February–March using a Lofoten trawl in daylight hours only. When strata were missed during the survey, adjustments to the results of the survey were made using a multiplicative model (Champagnat and Vigneau, personal communication).

GROUND FISH ENTERPRISE ALLOCATION COUNCIL (GEAC) SURVEY

GEAC (presently “Atlantic Groundfish Council”) conducted a fall survey (Nov.–Dec.) within 3Ps from 1997–2007 using the same stratification scheme as the Canadian offshore RV survey (McClintock 2010). Twenty four strata were sampled annually. An Engels 96 high lift trawl was used to conduct 30 minute tows. In the eleven year survey period, coverage was incomplete in 1997, the survey was not conducted in 2006, and in 2007 a different vessel was used and several additional strata were included. Eight years of data from this series (1998–2005) are included in the assessment model.

HYBRID ASSESSMENT MODEL

The assessment model, HYBRID, (Varkey et al. 2022) has been used to assess the stock since 2019. The HYBRID model is named as such because it uses a variety of features from SAM (Nielsen and Berg 2014) (mainly the use of random effects for modelling N and F matrices) and the Northern Cod Assessment Model (Cadigan 2015), mainly the inclusion of expert opinion on reliability of landings time series through the use of censored likelihood. Model inputs and diagnostics are detailed in Appendices A and B.

The model starts in 1959, which is the first year for which landings data are available. The censored likelihood fit for landings uses lower and upper bounds for landings data (Figure 55, Table A1) to account for uncertainty in the landings (Cadigan 2015). The upper and lower bounds were determined based on information gathered from interviews with current and retired fish harvesters (Carruthers and Ings, pers. comm.), further refined at the CSAS framework meeting in 2019 (DFO 2024a), and adjusted for 2020 onwards at the 2023 assessment of this stock based on updated estimates of recreational catch (DFO 2024a, Wheeland et al. 2025). The age composition of the fisheries (Table A2) is fit using continuation ratio logits.

The fishery process is modelled using a multivariate normal (MVN) random walk for F allowing time-varying selectivity in the model. This provides an approach to model the changes in fishing gears in the fishing history from 1959 to the present. A discontinuity is added to the MVN random walk at the moratorium to allow for the large change in the fishery. Since age 2 fish are not targeted in the fishery, the F for age 2 is de-coupled from the MVN random walk for F for the older ages in the fishery (ages 3+).

Age in the model spans from 2 to the plus group which includes fish age 14 and older. Recruitment (age 2) is modelled to follow a random walk. Process error on the state equation is normally distributed. The Hybrid uses time-varying natural mortality which is modelled as a function of a scaled fish condition-based mortality index (see Regular et al. 2022 and Varkey et al. 2022). Biological sampling data from both the CAN-RV spring survey and Sentinel gillnet and line-trawl surveys are utilized to generate an index of natural mortality which is derived from the proportion of cod in poor condition. The condition-based index of natural mortality is available from 1978–2024 (Figure 54; Table A3). For the years 1959 to 1977, the average of the first five years (1978–82) of the index is used.

Further, the model includes all the available surveys (bottom trawl RV surveys: Canada, 1983–2024 (Table A4); French ERHAPS survey, 1978–92 (Table A5); industry association trawl survey, 1998–2005 (Table A6) and gillnet (Table A7) and line-trawl (Table A8) Sentinel surveys, 1995–2023) for the stock. The timing of the DFO RV survey shifted in the early 1990s and inshore strata were added in 1997. We use an inshore-offshore adjustment (offset for catchability) which is applied only to fish aged 8 and older. The catchability for fish aged 2 to 7 are estimated independently for the offshore and combined inshore-offshore DFO RV survey data. Maturity (Table A9) and stock weights-at-age (Table A10) are derived from the RV survey data and the catch weights-at-age (Table A11) from the commercial sampling information.

Censored likelihood is also used for fitting to zero catches in the surveys. Unlike, treating the zeros in the survey as missing data, the application of censoring provides information to the model on low abundances for a specific age group in the population. This is mostly applied to indices for the oldest age-classes in the model.

MODEL FITS AND DIAGNOSTICS

The DFO RV survey could not be completed in SubDiv. 3Ps in 2023, and at the assessment in 2023, Canadian survey data were only available to 2022. At this assessment, there is one additional year of CAN-RV survey (2024) and one additional year of sentinel data (2023). Compared to the model fits at the previous assessment, model predictions of recruits (age 2 fish) in the RV survey show improvement in the fit to the observed indices (Figure B.1). While the RV survey indices for age 2 have shown an increasing trend in recent years (except 2024), the indices for age 3 and 4 were similar to levels in 2022. The standardized residual plots for the RV data show that the model does not show any major year, age or cohort effects (Figure B.2). The mean line of the standardized residuals for year are below the zero line for both 2022 and 2024 indicating a tendency to slightly over-predict the survey indices. In contrast, a positive year effect in the RV survey was last seen in 2013. The model generally fits the younger age indices from the Sentinel line-trawl and Sentinel gillnet surveys more closely than it fits the indices in the RV survey (Figure B.3). In 2023, the sentinel line trawl indices for ages 3 and 4 show increase from 2022. The standardized residual plots for the sentinel line-trawl also show a tendency similar to the RV survey fits to over-predict for the terminal year of 2023 (Figure B.5). The error plots for the Sentinel gillnet series display distinct year effects during the initial years of the time series (Figure B.6); aligning with the early phase of the Sentinel program, which began during the fishery moratorium. When the fishery reopened, there was a TAC of 10, 20, and 30 kt in 1997, 1998, and 1999, respectively. Model fits to the French and GEAC surveys are shown in (Figure B.7) and (Figure B.9).

MODEL OUTPUTS

Model results are detailed in Figure 56 through Figure 72, with model diagnostics shown in Figure B1–B10. SSB declined from the beginning of the time series from levels higher than 200 kt in the early-1960s to values near the Limit Reference Point (LRP) by the mid-1970s

(Figure 56). Subsequently, SSB increased and was estimated to be above 100 kt over 1981 to 1988, but this period was followed by a continuous decline to less than 40 kt in 1993. The SSB was below the LRP from 1991 to 1994. The stock was in moratorium from mid 1993 to 1996. During the moratorium, SSB started to increase, but by 1999 had started to decline again. From about 2001–06, SSB was relatively stable at values below the LRP. SSB decreased in the mid-2000s, and has been stable at a low level (under 30 kt) since 2009. The SSB estimated for the beginning of year 2024 was 29.9 kt (95% CI = 24 to 37.3 kt). With a projected catch of 1,550 t for the current year, the SSB in the beginning of year 2025 is expected to be 33.2 kt (95% CI = 26.4 to 41.8 kt). As noted previously, the stock-weights estimation that used sampled fish from both the inshore and the offshore RV survey are lower than the estimation that only uses fish sampling data from the offshore. When using inshore-offshore stock weights, SSB is lower notably in the recent time period from 2020 onwards (Figure 57) and for the beginning of year 2025 SSB is expected to be 26.8 kt (95% CI = 21.2 to 33.8 kt).

Recruitment (Figure 58) peaked in 1965–66 at approximately 200 million age 2 fish, then generally declined until the late 1970s, when there were about 50 million age 2 cod in the population. During most of the 1980s, recruitment was variable between 70 and 150 million fish. From 1993 onward, recruitment was generally low at values around 25 to 40 million fish with particularly low values (~10–11 million) during 2016–17. Recruitment levels have increased since, reaching near 36.6 million (95% CI = 14.3 to 93.3 million) in 2024. The recruits per spawner were the highest observed in the time series (Figure 59). The high recruits per spawner and the large uncertainty in the recruitment estimates raises concerns about contributing factors. A look into survey trends showed mixed signals: the RV index age 2 indices showed a decrease while indices for ages 3 and 4 indices were similar to levels observed in 2022. The sentinel LT survey saw increase in ages 3 and 4 in 2023. Sentinel GN, on the other hand observed a decrease in age 4 index. Further investigation showed that the large numbers of young fish (ages 2 and 3) in the commercial catch-at-age data had an influence on the estimation of recruitment. For 2023, sampling data from the commercial line-trawl was unavailable and sampling from sentinel line-trawls was used to inform the calculation of the commercial catch-at-age. The catch-at-age data for 2023 showed larger than usual proportion of ages 2 to 3 (Figure 60). Large numbers of young fish in the fishery is generally unexpected and is monitored with a small fish protocol – which was reportedly not triggered in 2023. These larger than usual proportions of young fish may therefore be an artifact resulting from limited commercial sampling – this impact is examined below under Recruitment Sensitivity Explorations.

The assessment model provides estimates of both fishing mortality (F) and natural mortality (M). The estimated fishing mortality rate for ages five to eight generally increased from 1959 (F = 0.23) to the mid-1970s (peaked at 0.4 in 1975) leading up to the extension of jurisdiction in 1977, then declined rapidly to approximately 0.28 and remained at similar values until the mid-1980s (Figure 61; Table 12). Fishing mortality estimates generally increased again until the early 1990s, at which time a moratorium was put in place. Average F was near zero (<0.1) during the moratorium (1994–97) when removals were only from bycatch. The estimated fishing mortality rate for ages 5–8 has generally declined from 0.16 in 2017 to 0.04, (95% CI = 0.03 to 0.06) in 2024, as TACs and catches have been reduced. Ages 5–8 are the dominant ages in the fishery, and the presence of the 2011 year class has decreased substantially.

Generally, M was near 0.33 from 1959 to 1980, then declined to near 0.27 through the early 2000s. M subsequently increased and reached a time series high at 0.40 in 2019 (Figure 62). There was a reduction in the M condition based index in the values from 2023–24 and this results in a decrease in M from 0.35 in 2023 to 0.32, (95% CI = 0.31 to 0.34) in 2024.

Process error shows predominance of negative values in the last two years, especially in the older age groups (Figure 63). The presence of negative process error for the older ages in the terminal year of the model was noted at the previous assessment and the additional process errors estimated for this assessment are mostly negative values in the older age groups. These suggest an unknown source of mortality (or emigration) affecting the stock.

RETROSPECTIVE ANALYSES

There is a negative retrospective pattern in SSB (Figure 64). With a downward revision of SSB, there is an upward revision in F estimates (Figure 65). The presence of older age classes in the fishery has decreased and the model estimates a reduced selectivity of the older age classes (Figure 66). The M condition index revised lower for recent years compared to the values used in the previous assessment (Figure 67). In the estimation, the *mpar* parameter revised upwards from 0.16 to 0.18 resulting in very little difference in the final estimates of M between the assessments (Figure 68). There is a positive retrospective pattern in recruitment (Figure 69), however the recruitment estimates remain within the confidence intervals estimated at the previous assessments.

RECRUITMENT SENSITIVITY EXPLORATIONS

As mentioned previously, there was no sampling from the commercial line trawl and the sampling from sentinel line trawls was used to inform the commercial catch-at-age calculation. Compared to previous years, there was considerably larger numbers of age 2 and age 3 fish in the resulting catch-at-age determination. There were concerns about the impact of the high values for young fish on the final year estimates, especially those for recruitment and SSB. So a sensitivity run was made where the age 2 and age 3 values from 2022 catch-at-age were used in the final year catch-at-age; this resulted in a lower proportion of ages 2 and 3 in the catch-at-age (Figure 70). There was a decrease in the estimates of recruitment, 29.7 million compared to 36.6 million under the base case for the year 2024. The SSB estimates were slightly larger in the sensitivity run (30.9 kt versus 29.9 kt for the year 2024).

The recruitment estimates were sensitive to the catch-at-age assumption. Based on the results from the sensitivity analysis, it was concluded to use the catch-at-age as estimated for the assessment but to limit the projection period to one year.

PROJECTIONS

For projection years it was customary at previous assessments, to calculate recruitment as the average of the last three years of recruitment estimates. Given the high uncertainty in the recruitment estimate for the final year, the projections here are based on the average recruitment estimates for years 2020–22. Other quantities such as stock weights-at-age, condition based index of M were the average of respective values from 2022–24. Catch weights at age were the average for years 2021–23. Maturity-at-age was based on projected maturity for years 2025–28 from the cohort-based maturity model. Catch for 2024 was assumed to be equal to the TAC. Process error in projections were simulated from 2025 onwards based on the process error standard deviations estimated in the model. SSB for 2025 is calculated from the abundance, F, and M estimated for 2024 within the model.

Projections are only provided to 2026, primarily due to current uncertainty in abundance of young fish resulting from limited fishery sampling in 2023. Projections consider three catch scenarios:

1. Catch as calculated with the adopted MP;

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2. Catch = TAC 2024/25 = 1 550 t, and;
 3. with no fishing removals (Table 16).

Although the projections predict modest growth for the stock, under all scenarios explored there is a high probability that the stock will remain within the critical zone through at least the start of 2026.

The expectation for growth in the stock in the current projection is mainly a result of an increase in the abundance estimates for younger ages in the terminal year of the assessment and an improvement in fish condition causing a reduction in estimates of natural mortality.

The trajectory of the projections under the adopted MP was compared with the expected progress under the rebuilding plan. The rebuilding plan stipulates a check of whether the median SSB estimates from the assessment model and projections fall within the 75 percent probability envelope from the rebuilding projections under prevailing productivity conditions. This check (Figure 71) showed that although the median SSB for 2024 had fallen slightly below the 75% percent probability envelope, there was expectation for modest growth and the SSB for 2025 and 2026 were within the 75% probability envelope.

The rebuilding plan also requires a check of whether there has been a sustained decline of the stock for three or more years. From 2022–25 (Figure 72), 21% growth was observed in the stock, however note that the SSB estimate for 2025 is an expectation based on the estimates for SSB, M, and F for 2024. Although the assessment shows year over year growth, a small negative retrospective pattern in SSB causing a downward revision of the recent trends and stock size.

SAM MODEL

A complementary model is also examined in this assessment as a consistency check and showed similar trends to the Hybrid assessment model. The stock assessment model (SAM) model for 3Ps cod stock was developed with the [stock assessment package](#) (from Nielsen and Berg 2014; Berg and Nielsen 2016), and has been described extensively in Champagnat et al. (2024). The model formulation follows the description of 'Sentinel run' (run 143) in Champagnat et al. (2024), with one exception: the removal of age 3 from the Sentinel Gillnet survey due to consistently low catches of this age group in this gear (like in HYBRID). Details on the update to 2024 are provided in Appendix C.

MODEL CONCLUSIONS

Improvement in fish condition, resulting in reduction in M and increase in recruitment resulted in modest growth in the stock. The increase in recruitment estimates are also influenced by the presence of young fish in the catch-at-age data for 2023. This was partly a result of having to completely rely on sampling from the sentinel line trawl fishery to inform the catch-at-age from all the commercial line trawl fishery. To acknowledge this concern, the projections used the average of time series from 2020–22 for informing future recruitment. Although retrospective patterns are small overall, they indicate a downward revision of SSB and raise some reservations about the performance of the adopted MP in meeting the expected progress as outlined in the rebuilding plan.

SOURCES OF UNCERTAINTY

There continue to be disagreements between RV and Sentinel indices at age. Although this index covers only a small portion of the stock, it shows good internal consistency and for this

reason, the model is sensitive to this Sentinel series. The model under-estimates the index for the young ages in the DFO-RV survey in the post-2010 period, mainly because the model fits the younger age indices from the Sentinel line-trawl and Sentinel gillnet surveys more closely than it fits the indices in the RV survey for the younger ages. However, the model fits well to all other ages (6–14+) in the DFO-RV survey and all ages in other surveys plus the catch-at-age. This issue is a source of uncertainty that requires further research.

In the last two RV surveys (2022, 2024) there has been a notable increase in the proportion of the stock in the inshore and in 2024, more than 50% of the DFO-RV index was from the inshore area. This is due primarily to decreases in the offshore during the survey, but small increases in inshore survey abundance and biomass are also evident. The assessment uses average indices from the entire stock area and these spatial aspects could not be investigated. At this time we cannot determine whether this is a sign of shifting distribution in the stock, local declines, changes in movement patterns/timing, etc., but this adds uncertainty to our assessment of the stock. Specifically, stock weights are currently calculated based on offshore strata only. Size at age of Atlantic Cod varies across 3Ps (Cadigan et al. 2022; stock weight estimation above). Not accounting properly for increased inshore fish is likely to overestimate stock weights and resulting SSB. Differences in trends of weight-at-age were also observed between the stock weights and catch weights and these too contribute to the uncertainty from the assessment.

The model estimates increased recruitment over the last three years, resulting in estimates of recruit per spawner over the last three years that are the highest observed in the series (Figure 59). However, these estimates are associated with a high degree of uncertainty, and information contributing to estimation of these young cohorts to date is limited. Caution is warranted in interpretation of these values.

The impact of ongoing warming in 3Ps and associated changes in community composition on the productivity of this stock are not well understood. Further work is needed to quantify the impact of these changes on habitat availability, competition, and cod biological processes.

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Authorship note: after the lead authors (Varkey and Wheeland), contributors are listed alphabetically.

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TABLES

Table 1: Reported landings of cod (t) from NAFO Subdiv. 3Ps. Landings are presented by calendar year but note that since 2000 the TAC has been established for April 1-March 31. Catch estimates for 2024 are not provided as the year is in progress at the time of the assessment. See Healey et al. (2013) for pre-1980 data. Note that 1996 through 2006 include recreational and sentinel catch, while 2007 onwards does not include recreational catch.

Year	Total	TAC
1980	37,568	28,000
1981	38,892	30,000
1982	33,902	33,000
1983	38,451	33,000
1984	36,950	33,000
1985	51,367	41,000
1986	57,990	41,000
1987	59,204	41,000
1988	43,382	41,000
1989	39,540	35,400
1990	41,405	35,400
1991	43,589	35,400
1992	35,895	35,400
1993	15,216	20,000
1994	661	0
1995	821	0
1996	1,057	0
1997	9,420	10,000
1998	20,156	20,000
1999	27,997	30,000
2000	25,100	20,000
2001	16,546	15,000
2002	15,319	15,000
2003	15,260	15,000
2004	14,414	15,000
2005	14,776	15,000
2006	13,157	13,000
2007	12,959	13,000
2008	11,773	13,000
2009	9,762	11,500
2010	8,299	11,500
2011	6,876	11,500
2012	5,087	11,500
2013	4,366	11,500
2014	6,887	13,225
2015	6,460	13,490
2016	7,196	13,043
2017	6,641	6,500
2018	4,722	5,980
2019	3,529	5,980
2020¹	2,228	2,691
2021¹	826	1,346
2022¹	909	1,346
2023¹	805	1,304

¹Catches reported for the most recent three years are considered provisional and subject to change.

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. (2013) 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 ²	3,547	254	257	0	4,057
2019 ²	2,299	285	209	0	2,792
2020 ^{1,2}	1,348	267	135	37	1,787
2021 ^{1,2}	515	121	51	0	686
2022 ^{1,2}	595	120	60	0	775
2023 ^{1,2}	494	134	55	0	683

¹provisional

²excluding recreational catch

Table 3: Reported Canadian (NL) monthly landings (t) of cod per unit area in NAFO Subdiv. 3Ps in 2023. Landings are provisional.

Month	3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	Total
Jan	4.7	16.9	9.9	22.6	-	-	-	-	54.2
Feb	0.4	9.6	1.0	3.3	-	-	-	51.5	65.7
Mar	-	-	-	23.2	-	-	-	2.7	25.9
Apr	-	0.2	-	-	-	-	-	-	0.2
May	5.1	9.0	2.6	-	-	-	-	-	16.8
Jun	6.9	40.6	13.4	-	-	-	-	-	60.9
Jul	1.3	22.2	59.3	-	0.1	-	0.3	0.0	83.3
Aug	0.2	19.0	24.1	-	-	-	0.2	-	43.5
Sep	0.3	9.6	72.3	-	-	-	0.1	-	82.3
Oct	2.2	8.8	46.6	-	0.0	-	-	-	57.7
Nov	10.4	7.5	206.2	1.0	-	0.4	-	-	225.6
Dec	1.3	5.6	23.6	0.2	-	11.8	-	-	42.5
Total	32.9	149.0	459.1	50.4	0.1	12.2	0.5	54.2	758.5

Table 4: Reported Canadian (NL) monthly landings (t) of cod per unit area in NAFO Subdiv. 3Ps in 2024, available at the time of the assessment (as of Oct 2, 2024) with cells marked as to be determined (TBD) where the fishery is ongoing. Landings are provisional.

Month	3Psa	3Psb	3Psc	3Psd	3Pse	3Psf	3Psg	3Psh	Total
Jan	0.9	15.7	19.2	-	-	-	-	-	35.8
Feb	21.5	3.9	6.1	17.1	-	-	3.5	62.4	114.5
Mar	3.6	-	-	27.0	-	-	-	0.4	31.0
Apr	-	-	-	-	-	-	-	-	-
May	8.1	12.0	0.2	-	-	-	-	-	20.3
Jun	9.4	34.6	23.7	-	-	-	-	-	67.7
Jul	2.3	32.1	47.3	-	-	0.4	-	-	82.0
Aug	0.1	7.1	18.8	-	-	-	-	-	26.0
Sep	0.7	18.0	35.2	-	-	-	-	-	53.9
Oct	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Nov	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Dec	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Total, year to date	46.4	123.4	150.4	44.2	-	0.4	3.5	62.7	377.2

Table 5: Summary of sampling conducted on 3Ps cod landings during 2023.

Gear	Proportion of landings that were unsampled (%)	Number of Length measurements	Number of Otoliths collected
Inshore Handline	89%	1,099	185
Inshore Gillnet	36%	2,895	303
Inshore Line trawl	100%	0	0
Offshore Gillnet	100%	0	0
Offshore Line trawl	100%	0	0
Offshore Otter trawl	29%	1,980	79

Table 6: Estimates of average weight, average length and the total numbers and weight of 3Ps cod caught at age from Canadian and French landings during 2023 (excludes recreational catch). Sum of products for catch-at-age = 0.93.

Age	Total Catch (numbers)	Average Weight (kg)	Average Length (cm)	Total Catch std error	Total Catch CV	Total Catch Weight (t)*
1	0	-	-	-	-	0
2	1,677	0.62	40.3	0.88	0.52	1.03
3	31,990	0.70	42.7	4.39	0.14	22.42
4	52,898	0.69	42.6	4.33	0.08	36.55
5	66,179	1.33	51.8	5.87	0.09	88.08
6	86,298	1.80	57.4	6.23	0.07	155.08
7	92,049	2.08	60.9	6.63	0.07	191.65
8	60,190	2.18	61.4	5.60	0.09	131.03
9	17,351	2.21	61.1	2.73	0.16	38.31
10	16,244	2.09	60.6	3.79	0.23	33.93
11	6,764	2.00	60.1	1.49	0.22	13.54
12	9,949	2.43	64.0	2.25	0.23	24.20
13	2,620	3.36	70.7	1.08	0.41	8.79
14	0	2.68	67.0	0.00	1.03	0.00
15	262	6.90	91.0	0.17	0.63	1.81
16	905	3.96	76.0	0.56	0.62	3.58
17	271	6.22	88.0	0.20	0.73	1.69
18	0	-	-	-	-	0
19	0	-	-	-	-	0
20	0	-	-	-	-	0

Table 7: 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 since 1974.

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
1974	0.399	0.624	1.064	1.813	2.429	3.349	3.927	4.832	5.438	7.558	9.337	8.466
1975	0.543	0.827	1.281	1.75	2.355	3.182	3.509	5.381	4.971	6.417	10.185	10.185
1976	0.537	1.005	1.455	2.284	3.032	4.267	5.439	7.395	7.426	9.873	11.45	16.628
1977	0.606	0.684	1.367	1.992	2.765	3.703	4.684	5.452	6.701	6.741	9.225	11.753
1978	0.545	0.763	1.111	2.03	2.888	3.929	4.612	6.058	7.233	6.981	9.747	10.954
1979	0.422	0.668	1.056	1.692	2.694	3.776	4.125	5.942	7.65	10.423	10.032	10.987
1980	0.511	0.776	1.147	1.715	2.357	3.561	5.474	7.193	7.219	9.872	9.566	8.527
1981	0.516	0.877	1.366	1.839	2.303	3.359	4.893	6.991	7.52	10.414	8.871	12.302
1982	0.462	0.809	1.171	1.82	2.396	2.819	3.756	4.853	6.814	8.394	8.805	11.688
1983	0.583	0.853	1.472	2.019	2.525	3.099	3.523	4.952	6.486	7.968	10.613	12.076
1984	0.671	1.201	1.485	2.105	2.741	4.26	5.369	6.314	8.081	10.55	7.704	8.682
1985	0.588	0.821	1.2	1.783	2.626	3.373	5.149	5.941	6.74	7.94	11.32	7.876
1986	0.532	0.691	1.15	1.744	2.327	3.075	4.96	6.132	6.293	7.489	9.41	12.003
1987	0.472	0.701	1.251	1.707	2.27	3.248	4.299	5.523	6.867	7.072	7.73	10.514
1988	0.63	0.799	1.016	1.637	2.169	3.122	4.256	5.976	6.885	7.342	8.277	9.126
1989	0.559	0.79	1.166	1.709	2.441	3.531	4.58	6.081	6.529	7.448	7.889	8.98
1990	0.543	0.753	1.346	1.932	2.562	2.958	3.923	3.959	6.185	7.509	7.836	7.231
1991	0.435	0.7	1.135	1.877	2.608	3.234	4.382	5.15	6.894	8.143	8.065	10.071
1992	0.459	0.665	1.023	1.658	2.514	3.251	4.665	7.621	7.861	9.296	11.49	13.43
1993	0.417	0.848	1.344	1.945	2.08	2.652	3.701	4.286	7.307	6.585	7.378	7.435
1994	0.417	0.848	1.344	1.945	2.08	2.652	3.701	4.286	7.307	6.585	7.378	7.435
1995	0.497	0.681	1.966	2.21	2.499	2.434	2.513	-	-	-	-	-
1996	0.576	0.878	1.383	1.879	2.389	2.709	3.862	4.374	8.354	6.57	10.112	13.097
1997	0.519	0.984	1.153	1.417	2.285	3.233	3.903	3.863	4.585	9.272	5.847	12.044
1998	0.598	0.984	1.736	1.982	2.361	3.158	4.087	3.994	4.439	4.458	5.717	5.459
1999	0.789	0.924	1.543	2.263	2.52	2.784	3.822	5.389	4.985	5.333	6.041	7.166
2000	0.442	1.23	1.219	1.949	2.763	2.808	3.337	4.858	6.799	6.719	6.717	8.679
2001	0.722	1.063	1.478	1.964	2.579	3.379	3.347	3.538	5.472	8.75	7.591	8.118
2002	0.586	1.053	1.531	1.972	2.289	3.013	4.023	3.627	3.751	6.198	9.153	7.133
2003	0.673	0.971	1.531	2.067	2.316	2.621	3.836	4.581	4.066	5.251	7.968	10.317
2004	0.619	0.996	1.409	2.091	2.479	2.709	2.901	4.45	6.298	5.331	6.88	8.703
2005	0.681	0.967	1.381	1.832	2.438	2.87	3.165	3.37	4.944	6.296	6.136	8.697
2006	0.643	1.012	1.53	1.898	2.175	2.732	3.405	3.89	3.213	5.147	7.014	7.387
2007	0.642	1.085	1.517	1.991	2.3	2.556	3.535	4.912	5.425	4.765	6.897	8.299
2008	0.912	0.961	1.349	1.949	2.202	2.522	2.717	4.073	5.214	5.041	5.257	8.153
2009	0.722	0.952	1.446	1.933	2.385	2.506	2.423	3.257	5.567	7.026	8.189	8.303
2010	0.805	1.128	1.334	1.966	2.161	2.523	2.605	2.85	5.562	7.751	9.753	10.329
2011	0.845	1.017	1.355	1.574	2.125	2.386	2.745	2.598	2.769	2.864	4.728	7.567
2012	0.836	0.965	1.418	1.982	2.019	2.206	2.82	3.305	3.559	2.665	2.849	2.897
2013	0.819	1.149	1.487	1.732	2.034	2.067	2.56	2.733	2.926	3.104	2.364	2.583
2014	0.93	1.03	1.832	2.046	2.097	2.731	2.49	3.281	3.826	2.644	4.532	4.873
2015	0.766	1.144	1.532	2.067	2.416	2.727	2.991	3.116	3.997	5.79	5.072	-
2016	0.837	1.184	1.506	1.787	2.261	2.385	2.958	3.575	4.038	4.749	4.14	7.625
2017	0.481	0.852	1.338	1.816	1.932	2.361	2.528	2.396	3.937	4.07	3.654	3.158
2018	0.688	1.414	1.549	1.904	2.148	2.336	3.286	3.151	3.624	5.37	5.806	6.422
2019	0.849	1.071	1.432	1.737	2.011	2.294	2.361	3.086	2.902	3.468	7.89	4.388
2020	0.726	1.210	1.731	1.966	2.055	2.134	2.368	2.776	2.666	3.134	4.577	3.206
2021	0.616	0.915	1.302	1.748	2.043	2.409	2.286	2.171	2.591	3.654	4.32	2.672
2022	0.657	1.438	1.750	2.147	2.325	2.414	2.555	2.552	2.703	3.171	2.588	3.955
2023	0.701	0.691	1.331	1.797	2.082	2.177	2.208	2.089	2.002	2.432	3.356	2.680

Table 8: Details of annual DFO research vessel surveys of NAFO Subdivision 3Ps. Further information can be found in Rideout (2022), Wheeland et al. (2023) and references therein.

Year	Vessel	Start Date	End Date	Days	Sets	Sets with Cod	Proportion of sets with 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
2019	AN 506-508	30-Mar-19	4-May-19	35	169	106	0.63
2020	No Survey	-	-	-	-	-	-
2021	TEL 218, 219	24-Apr-21	17-May-21	24	141	92	0.65
2022	CAB 21, 22, 23, 24	8-Apr-22	27-May-23	49	129	83	0.64
2023	No Survey	-	-	-	-	-	-
2024	CAB 48, 49, 50	14-Apr-24	7-May-24	21	125	93	0.74

Table 9: Survey biomass estimates for Atlantic Cod from DFO research vessel surveys in NAFO Subdiv. 3Ps. NF = strata not fished. There was no survey in 2020 or 2023. See Brattey et al. 2007 and Ings et al. 2023 for previous years.

Stratum	Depth (m)	sq. nm	2019	2020	2021	2022	2023	2024
314	<55	974	8	NF	222	465	NF	2,081
320	<55	1,320	1,580	NF	1,216	363	NF	1,961
293	56-91	159	23	NF	NF	81	NF	186
308	56-91	112	56	NF	1,011	1,231	NF	367
312	56-91	272	71	NF	93	1,520	NF	237
315	56-91	827	452	NF	3,216	687	NF	600
321	56-91	1,189	257	NF	6,066	99	NF	579
325	56-91	944	31	NF	124	337	NF	34
326	56-91	166	0	NF	21	1	NF	1
783	56-91	229	2	NF	71	67	NF	4
294	92-183	135	85	NF	2,050	3,056	NF	1,826
297	92-183	152	1,668	NF	835	4,636	NF	3,150
307	92-183	395	3,345	NF	832	1,735	NF	5,073
311	92-183	317	274	NF	1,663	471	NF	567
317	92-183	193	862	NF	0	0	NF	29
319	92-183	984	8,662	NF	1,157	923	NF	1,573
322	92-183	1,567	217	NF	2,055	1,384	NF	817
323	92-183	696	33	NF	42	2,015	NF	133
324	92-183	494	34	NF	350	691	NF	5
781	92-183	446	94	NF	517	139	NF	251
782	92-183	183	23	NF	37	127	NF	20
295	184-274	209	124	NF	1,063	339	NF	692
298	184-274	171	0	NF	126	245	NF	5,830
300	184-274	217	37	NF	64	61	NF	23
306	184-274	363	231	NF	85	0	NF	31
309	184-274	296	3,591	NF	37	44	NF	69
310	184-274	170	103	NF	0	25	NF	41
313	184-274	165	15	NF	0	0	NF	0
316	184-274	189	0	NF	0	0	NF	15
318	184-274	129	59	NF	0	0	NF	0
779	184-274	422	54	NF	8	492	NF	141
780	184-274	403	138	NF	33	528	NF	11
296	275-366	71	69	NF	39	168	NF	37
299	275-366	212	0	NF	0	17	NF	7
705	275-366	195	1	NF	5	3	NF	18
706	275-366	476	19	NF	0	0	NF	166
707	275-366	74	47	NF	11	0	NF	2
715	275-366	128	39	NF	0	42	NF	140
716	275-366	539	0	NF	0	190	NF	0
708	367-549	126	13	NF	0	0	NF	390
711	367-549	593	135	NF	0	0	NF	30
712	367-549	731	5	NF	0	13	NF	28
713	367-549	851	31	NF	0	0	NF	0
714	367-549	1,074	0	NF	0	0	NF	42
Total	Offshore	-	20,173	-	18,205	12,238	-	15,027
Total	In/Offshore	-	22,491	-	23,048	22,194	-	27,204
Std	In/Offshore	-	5,939	-	5,925	3,149	-	6,922

Table 10: Survey abundance estimates for Atlantic Cod from DFO vessel surveys in NAFO Subdiv. 3Ps. NF = strata not fished. There was no survey in 2020 or 2023. See Bratley et al. 2007 and Ings et al. 2023 for previous years.

Stratum	Depth (m)	sq. nm	2019	2020	2021	2022	2023	2024
314	<55	974	22	NF	1,644	2,970	NF	3,725
320	<55	1,320	838	NF	2,651	1,253	NF	3,969
293	56-91	159	197	NF	NF	580	NF	1,629
308	56-91	112	169	NF	2,773	2,550	NF	1,114
312	56-91	272	206	NF	1,029	3,367	NF	1,278
315	56-91	827	861	NF	3,104	4,238	NF	2,247
321	56-91	1,189	1,276	NF	7,900	537	NF	1,554
325	56-91	944	487	NF	1,336	1,436	NF	108
326	56-91	166	0	NF	91	13	NF	11
783	56-91	229	44	NF	621	221	NF	16
294	92-183	135	1,367	NF	4,330	9,946	NF	8,183
297	92-183	152	5,499	NF	3,251	5,876	NF	6,200
307	92-183	395	6,466	NF	1,386	3,559	NF	6,874
311	92-183	317	2,384	NF	3,336	1,112	NF	1,573
317	92-183	193	5,031	NF	0	0	NF	226
319	92-183	984	22,102	NF	5,631	4,250	NF	5,008
322	92-183	1,567	2,867	NF	5,266	4,742	NF	6,143
323	92-183	696	447	NF	432	14,060	NF	662
324	92-183	494	702	NF	8,931	8,053	NF	210
781	92-183	446	1,242	NF	2,851	1,135	NF	2,485
782	92-183	183	712	NF	730	1,661	NF	239
295	184-274	209	1,624	NF	6,411	1,877	NF	2,602
298	184-274	171	12	NF	24	247	NF	5,918
300	184-274	217	90	NF	119	119	NF	149
306	184-274	363	316	NF	125	0	NF	54
309	184-274	296	5,366	NF	48	41	NF	224
310	184-274	170	160	NF	0	12	NF	35
313	184-274	165	20	NF	0	0	NF	0
316	184-274	189	0	NF	0	0	NF	13
318	184-274	129	27	NF	0	0	NF	0
779	184-274	422	916	NF	264	2,922	NF	1,509
780	184-274	403	1,285	NF	83	5,802	NF	416
296	275-366	71	587	NF	91	200	NF	68
299	275-366	212	0	NF	0	58	NF	58
705	275-366	195	13	NF	13	13	NF	13
706	275-366	476	15	NF	0	0	NF	131
707	275-366	74	31	NF	14	0	NF	5
715	275-366	128	23	NF	0	44	NF	62
716	275-366	539	0	NF	0	99	NF	0
708	367-549	126	8	NF	0	0	NF	612
711	367-549	593	87	NF	0	0	NF	31
712	367-549	731	17	NF	0	29	NF	23
713	367-549	851	50	NF	0	0	NF	0
714	367-549	1,074	0	NF	0	0	NF	42
Total	Offshore	-	49,991	-	45,709	52,378	-	35,947
Total	In/Offshore	-	63,565	-	64,486	83,022	-	65,419
Std	In/Offshore	-	13,133	-	11,629	15,032	-	10,125

Table 11: Frequency of occurrence (proportion) of prey items in Atlantic Cod <40 cm and Silver Hake in 3Ps.

Prey Group	Prey Item	Atlantic Cod	Silver Hake
Fish	Capelin	0.07	<0.01
Fish	Sandlance	0.12	0.01
Fish	Redfishes	<0.01	0.01
Fish	Lanternfish	-	0.02
Fish	Sculpins	0.01	<0.01
Fish	Blennies	0.01	-
Fish	Other Fishes	<0.01	<0.01
Fish	Unidentified Fishes	0.02	-
Invertebrates	Amphipods	0.37	0.11
Invertebrates	Brittle/Basket Stars	0.02	-
Invertebrates	Copepods	<0.01	-
Invertebrates	Euphausiids	0.03	0.30
Invertebrates	Pandalus shrimp	0.04	<0.01
Invertebrates	Polychaetes	0.08	<0.01
Invertebrates	Snow Crab	0.08	-
Invertebrates	Toad Crab	0.04	-
Invertebrates	Bivalves	0.01	-
Invertebrates	Other Invertebrates	0.01	-
Invertebrates	Other Shrimp	0.11	0.05
Other	Other	0.03	0.01
Other	Empty	0.17	0.53

Table 12: Annual count of sentinel survey deployments by community for 3.5" gillnets. The value is for the number of fixed sets with the number of experimental sets in parentheses. (-) indicates unsampled sites.

Year	Little Harbour East	North Harbour	Lawn	St. Bride's	Little Paradise	Fair Haven	Lord's Cove	Red Harbour	Garden Cove
1995	1 (0)	1 (0)	-	-	-	-	-	-	-
1996	0 (5)	0 (5)	-	-	-	-	-	-	-
1997	0 (7)	0 (7)	0 (7)	0 (1)	-	-	-	-	-
1998	0 (8)	0 (4)	0 (6)	0 (11)	-	-	-	-	-
1999	0 (1)	1 (0)	0 (4)	-	-	-	-	-	-
2000	3 (16)	8 (10)	0 (4)	0 (7)	-	-	-	-	-
2001	0 (15)	8 (5)	0 (19)	0 (9)	6 (0)	-	-	-	-
2002	-	4 (4)	0 (20)	0 (20)	2 (4)	0 (8)	1 (19)	0 (6)	-
2003	-	0 (8)	0 (10)	0 (9)	0 (6)	-	0 (12)	0 (2)	-
2004	-	0 (5)	0 (18)	0 (11)	0 (6)	-	0 (16)	0 (4)	-
2005	-	0 (11)	0 (16)	0 (11)	0 (6)	-	0 (16)	-	-
2006	-	0 (8)	0 (18)	0 (10)	0 (8)	-	0 (15)	-	-
2007	-	0 (8)	0 (11)	0 (10)	0 (10)	-	0 (20)	0 (1)	-
2008	-	0 (9)	0 (10)	0 (9)	0 (6)	-	0 (20)	-	-
2009	-	0 (9)	-	0 (7)	0 (10)	-	0 (20)	-	-
2010	-	0 (12)	-	-	0 (12)	-	0 (20)	0 (8)	-
2011	-	0 (10)	-	-	0 (14)	-	0 (20)	0 (5)	-
2012	-	0 (10)	-	-	0 (10)	-	0 (20)	0 (2)	-
2013	-	0 (2)	-	-	0 (14)	-	0 (20)	-	0 (7)
2014	-	-	-	-	0 (14)	-	0 (20)	-	0 (9)
2015	-	-	-	-	0 (15)	-	0 (20)	0 (2)	0 (11)
2016	-	-	-	-	0 (11)	-	0 (20)	-	0 (9)
2017	-	-	-	-	-	-	0 (20)	-	0 (10)
2018	-	-	-	-	0 (12)	-	0 (2)	-	0 (9)
2019	-	-	-	-	0 (12)	-	-	-	0 (12)
2020	-	-	-	-	0 (14)	-	-	-	0 (11)
2021	-	-	-	-	0 (7)	-	-	-	0 (8)
2022	-	-	-	-	0 (14)	-	-	-	0 (9)
2023	-	-	-	-	0 (14)	-	-	-	0 (8)

Table 13: Annual count of sentinel survey deployments by community for 5.5" gillnets. The value is for the number of fixed sets with the number of experimental sets in parentheses. (-) indicates unsampled sites.

Year	Arnolds Cove	Fox Harbour	Grand Bank	Little Harbour East	Lord' s Cove	Monkstown	North Harbour	St. Briide' s	Lawn	Little Paradise	Red Harbour	Rencontre East	Seal Cove fb	Harbour Breton	Fair Haven	Francois	Garden Cove
1995	2(2)	67(78)	-	74(82)	20(19)	73(72)	55(56)	81(79)	-	-	-	-	-	-	-	-	-
1996	-	32(56)	-	15(16)	16(23)	23(46)	24(39)	29(55)	16(16)	2(4)	-	-	-	-	-	-	-
1997	4(4)	24(47)	-	20(24)	16(24)	24(48)	23(36)	25(44)	22(40)	6(11)	0(12)	0(2)	0(3)	-	-	-	-
1998	9(12)	24(47)	-	15(25)	16(32)	24(48)	15(29)	23(46)	23(42)	9(20)	8(16)	6(12)	6(18)	-	-	-	-
1999	0(2)	12(24)	-	5(4)	12(24)	12(24)	6(12)	2(0)	11(21)	8(16)	5(10)	-	4(18)	0(1)	-	-	-
2000	8(12)	16(32)	-	17(20)	16(32)	19(38)	19(36)	15(27)	20(40)	10(20)	3(18)	-	3(3)	-	-	-	-
2001	-	20(40)	8(16)	11(41)	20(40)	20(40)	15(27)	18(36)	20(39)	10(20)	4(12)	-	12(28)	-	-	-	-
2002	-	20(40)	8(15)	-	20(38)	20(40)	16(18)	20(39)	20(39)	8(16)	8(15)	-	13(14)	-	28(35)	2(6)	-
2003	-	16(32)	6(12)	-	12(23)	-	18(19)	31(19)	10(16)	6(12)	2(4)	-	4(4)	-	-	-	-
2004	-	18(36)	8(16)	-	18(36)	-	14(11)	13(25)	18(36)	12(24)	6(12)	-	-	-	-	-	-
2005	-	18(36)	8(15)	-	18(35)	-	20(24)	16(34)	18(34)	10(20)	8(16)	-	-	-	-	-	-
2006	-	18(36)	6(12)	-	18(35)	-	15(18)	18(36)	18(36)	12(24)	6(12)	-	-	-	-	-	-
2007	-	20(40)	6(12)	-	20(40)	-	16(16)	20(40)	19(29)	16(32)	8(15)	-	-	-	-	-	-
2008	-	20(40)	6(12)	-	20(40)	-	17(17)	18(36)	22(22)	12(24)	6(5)	-	-	-	-	-	-
2009	-	20(40)	6(12)	-	20(39)	-	18(19)	14(28)	20(20)	13(28)	8(8)	-	-	-	-	-	-
2010	-	20(40)	10(20)	-	20(40)	-	24(25)	10(20)	18(18)	12(24)	8(8)	-	-	-	-	-	-
2011	-	20(40)	4(8)	-	18(39)	-	22(20)	16(16)	3(3)	14(28)	7(7)	-	-	-	-	-	-
2012	-	19(38)	11(20)	-	20(40)	-	20(19)	18(18)	-	10(20)	5(5)	-	-	-	-	-	-
2013	-	20(40)	6(10)	-	20(39)	-	4(4)	17(18)	-	14(28)	2(2)	-	-	-	-	-	18(36)
2014	-	19(39)	6(8)	-	20(40)	-	-	18(18)	-	14(28)	4(4)	-	-	-	-	-	19(38)
2015	-	20(40)	10(16)	-	20(20)	-	-	16(16)	-	16(32)	4(4)	-	-	-	-	-	21(42)
2016	-	19(40)	10(4)	-	20(20)	-	-	18(18)	-	14(28)	2(2)	-	-	-	-	-	17(36)
2017	-	20(39)	-	-	20(20)	-	-	16(16)	-	-	8(16)	-	-	-	-	-	20(40)
2018	-	20(40)	8(8)	-	2(2)	-	-	14(14)	-	14(28)	10(10)	-	-	-	-	-	18(36)
2019	-	20(40)	8(4)	-	20(19)	-	-	16(16)	-	12(24)	10(10)	-	-	-	-	-	24(48)
2020	-	18(36)	6(6)	-	20(20)	-	-	20(20)	-	14(28)	10(10)	-	-	-	-	-	22(44)
2021	-	20(22)	12(12)	-	20(20)	-	-	16(16)	-	14(28)	10(10)	-	-	-	-	-	16(32)
2022	-	20(20)	6(6)	-	19(19)	-	-	16(16)	-	14(28)	10(10)	-	-	-	-	-	18(36)
2023	-	20(20)	-	-	20(20)	-	-	14(14)	-	14(28)	10(10)	-	-	-	-	-	16(32)

Table 14: Annual count of sentinel survey deployments by community for linetrawl. The value is for the number of fixed sets with the number of experimental sets in parentheses. (-) indicates unsampled sites.

Year	Arnold's Cove	Burgoe	Francois	Grand Bank	Harbour Breton	Lawn	Little Paradise	Lord's Cove	Placentia	Ramea	Red Harbour	Rencontre East	Seal Cove fb
1995	72(75)	-	77(104)	-	64(90)	-	27(25)	4(4)	-	92(109)	14(17)	87(87)	90(109)
1996	30(33)	9(37)	12(54)	-	9(30)	12(13)	12(20)	-	21(20)	9(37)	7(23)	25(71)	16(55)
1997	29(32)	12(48)	12(62)	-	7(20)	-	8(19)	-	-	17(79)	4(13)	15(49)	12(29)
1998	3(3)	12(50)	12(56)	-	7(21)	-	4(6)	-	-	10(50)	2(5)	11(45)	4(14)
1999	4(1)	6(22)	4(26)	-	10(21)	-	2(9)	-	-	6(32)	2(3)	7(29)	4(6)
2000	16(6)	8(28)	8(44)	-	10(35)	-	5(9)	-	-	15(73)	4(4)	15(75)	23(29)
2001	-	13(51)	16(19)	18(18)	8(23)	-	11(16)	-	-	37(55)	3(11)	28(43)	3(3)
2002	-	21(24)	11(11)	18(18)	19(34)	-	17(17)	2(2)	-	29(53)	12(16)	24(36)	6(15)
2003	-	17(19)	15(10)	10(10)	16(18)	-	8(10)	-	-	13(33)	7(7)	10(10)	0(1)
2004	-	12(12)	5(5)	10(10)	15(15)	-	6(10)	-	-	12(24)	11(0)	16(16)	-
2005	-	14(14)	21(21)	10(10)	16(17)	-	8(8)	-	-	18(26)	10(2)	20(20)	-
2006	-	22(22)	19(19)	12(12)	14(14)	-	6(6)	-	-	17(27)	11(5)	16(16)	-
2007	-	20(20)	14(14)	12(12)	14(14)	-	4(4)	-	-	21(28)	12(5)	18(18)	-
2008	-	18(18)	16(16)	14(14)	15(16)	-	8(8)	-	-	21(29)	13(10)	17(17)	-
2009	-	19(22)	11(11)	14(14)	17(17)	-	5(7)	-	-	20(28)	11(5)	18(18)	-
2010	-	20(20)	13(14)	7(9)	18(19)	-	-	-	-	20(28)	11(5)	18(18)	-
2011	-	20(20)	-	7(8)	18(18)	-	6(6)	-	-	20(28)	12(6)	18(18)	-
2012	-	12(12)	-	8(8)	18(18)	-	-	-	-	20(28)	14(4)	20(20)	-
2013	-	17(17)	-	14(11)	16(16)	-	-	-	-	20(26)	18(10)	20(20)	-
2014	-	16(16)	-	14(10)	20(20)	-	6(6)	-	-	20(28)	15(2)	20(20)	-
2015	-	16(16)	-	10(6)	19(19)	-	6(6)	-	-	22(26)	16(14)	20(20)	-
2016	-	18(18)	-	10(7)	16(15)	-	4(4)	-	-	-	4(4)	20(20)	-
2017	-	20(20)	-	19(17)	22(22)	-	-	-	-	-	12(12)	20(20)	-
2018	-	17(17)	-	12(12)	20(20)	-	8(8)	-	-	-	10(10)	20(20)	-
2019	-	13(13)	-	12(10)	21(22)	-	8(7)	-	-	-	10(10)	20(19)	-
2020	-	18(18)	-	14(14)	21(22)	-	6(6)	-	-	-	10(10)	18(18)	-
2021	-	13(13)	-	8(7)	6(6)	-	6(6)	-	-	-	8(8)	20(20)	-
2022	-	-	-	14(14)	-	-	6(6)	-	-	-	10(10)	16(16)	-
2023	-	-	-	22(22)	13(13)	-	6(6)	-	-	-	10(10)	20(20)	-

Table 15: Parameter estimates from the assessment model.

Parameter names	age	Value	Parameter names	Age	Value
mpar	2 to 5	0	q_Sentinel_LT	3	0.033
mpar	6 plus	0.1835	q_Sentinel_LT	4	0.1398
q_DFO_RV_IO	2	0.1699	q_Sentinel_LT	5	0.2588
q_DFO_RV_IO	3	0.38	q_Sentinel_LT	6	0.3279
q_DFO_RV_IO	4	0.3758	q_Sentinel_LT	7	0.3612
q_DFO_RV_IO	5	0.3188	q_Sentinel_LT	8	0.3818
q_DFO_RV_IO	6	0.3008	q_Sentinel_LT	9	0.3401
q_DFO_RV_IO	7	0.2848	q_Sentinel_LT	10	0.3069
q_DFO_RV_IO	8 plus	0.2675	rhoF_postmoratorium	all	0.9552
q_DFO_RV_OFF	2	0.043	rhoF_premoratorium	all	0.954
q_DFO_RV_OFF	3	0.0738	std_CRL	2	2.5914
q_DFO_RV_OFF	4	0.0923	std_CRL	3	0.5819
q_DFO_RV_OFF	5	0.1537	std_CRL	5 to 8	0.1812
q_DFO_RV_OFF	6	0.2069	std_CRL	9 plus	0.6695
q_DFO_RV_OFF	7	0.2395	std_f_pre_moratorium	2	0.7336
q_DFO_RV_OFF	8	0.3024	std_f_pre_moratorium	3	0.1461
q_DFO_RV_OFF	9	0.3068	std_f_pre_moratorium	4	0.0826
q_DFO_RV_OFF	10	0.3031	std_f_pre_moratorium	5	0.0495
q_DFO_RV_OFF	11	0.3121	std_f_pre_moratorium	6	0.1184
q_DFO_RV_OFF	12	0.2918	std_f_pre_moratorium	7	0.2154
q_DFO_RV_OFF	13	0.2972	std_f_pre_moratorium	8	0.2233
q_DFO_RV_OFF	14	0.2917	std_f_pre_moratorium	9	0.3542
q_ERHAPS	2	0.0462	std_f_pre_moratorium	2	0.4651
q_ERHAPS	3	0.0689	std_f_pre_moratorium	3	1.0589
q_ERHAPS	4	0.0993	std_f_pre_moratorium	4	1.1287
q_ERHAPS	5	0.1665	std_f_pre_moratorium	5	0.64
q_ERHAPS	6	0.2353	std_f_pre_moratorium	6	0.5569
q_ERHAPS	7 plus	0.2679	std_f_pre_moratorium	7	0.5613
q_GEAC	2	0.0066	std_f_pre_moratorium	8	0.5538
q_GEAC	3	0.0832	std_f_pre_moratorium	9	0.672
q_GEAC	4	0.253	std_index_DFO_RV_IO	all	0.8487
q_GEAC	5	0.3574	std_index_DFO_RV_OFF	all	0.6918
q_GEAC	6	0.4693	std_index_ERHAPS	all	0.7339
q_GEAC	7 plus	0.6565	std_index_GEAC	all	1.1815
q_Sentinel_GN	4	0.0038	std_index_Sentinel_GN	all	0.6878
q_Sentinel_GN	5	0.0497	std_index_Sentinel_LT		0.418
q_Sentinel_GN	6	0.1925	std_process_error	all	0.2194
q_Sentinel_GN	7	0.3184	std_recruitment	all	0.3697
q_Sentinel_GN	8	0.373	-	-	-
q_Sentinel_GN	9	0.3588	-	-	-
q_Sentinel_GN	10	0.2954	-	-	-

Table 16: Short term (2025–26) projections of SSB and catch under the adopted MP, catch = TAC 2024/25 = 1,550 t, and catch at F = 0, including the probability of stock growth relative to current levels $P(SSB_y > SSB_{2025})$ and the probability of projected SSB being above the LRP. “SSB Low” and “SSB High” indicate the lower and upper limits of the 95 percentile projection envelope.

Scenario	Year	SSB/ B_{LIM}	SSB ('000 t)	SSB Low ('000 t)	SSB High ('000 t)	Catch (t)	$P(SSB_y > SSB_{2025})$	$P(SSB_y > LRP)$
MP	2025	0.50	33.2	26.4	41.8	1,251	NA	<0.1%
MP	2026	0.63	41.3	33.5	51.8	1,536	98%	<0.1%
TAC = 1,550t	2025	0.50	33.2	26.4	41.8	1,550	NA	<0.1%
TAC = 1,550t	2026	0.62	41.0	33.1	51.5	1,550	97%	<0.1%
F=0	2025	0.50	33.2	26.4	41.8	0	NA	<0.1%
F=0	2026	0.64	42.3	34.1	53.2	0	99%	<0.1%

FIGURES

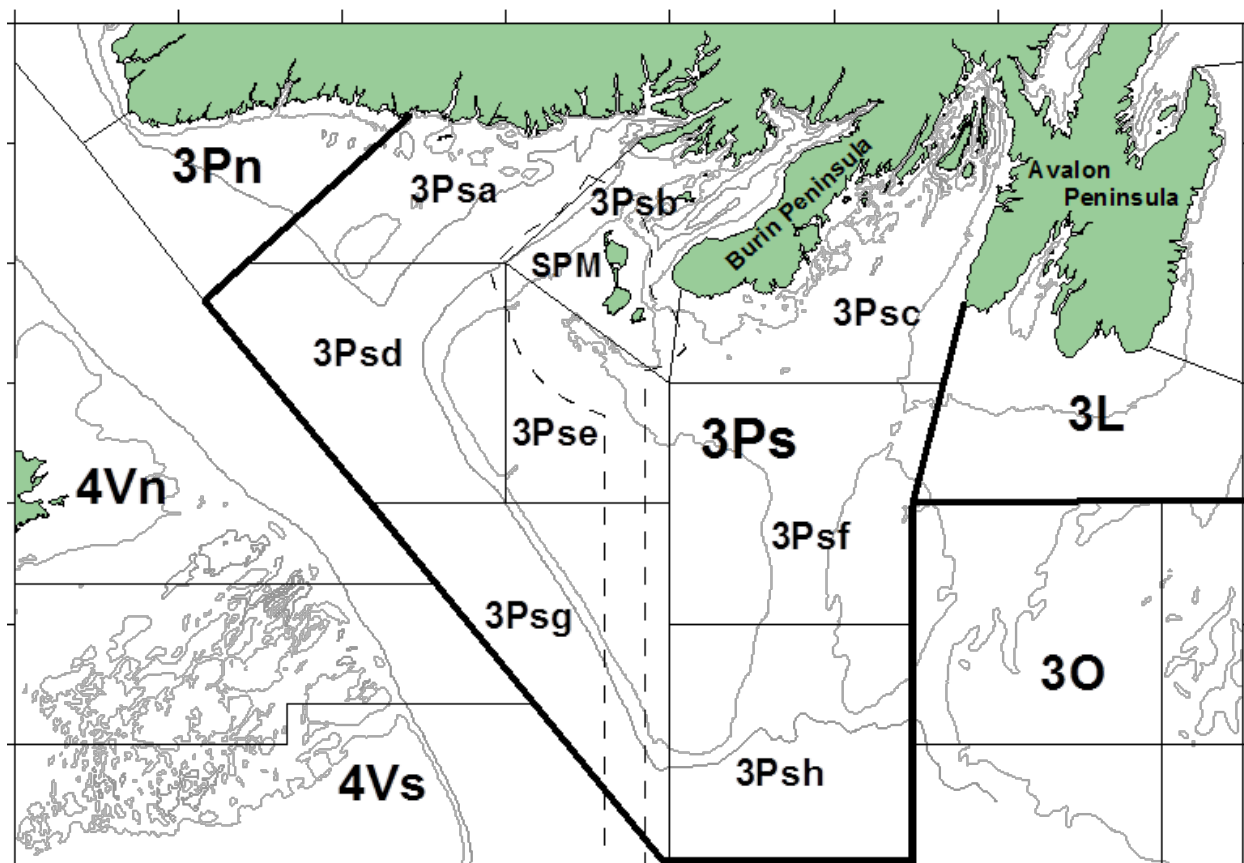


Figure 1: NAFO Subdiv. 3Ps management zone showing the economic zone around the French islands of St. Pierre et Miquelon (SPM, dashed line), the 100 m and 250 m depth contours (grey lines) and the boundaries of the statistical unit areas (solid lines).

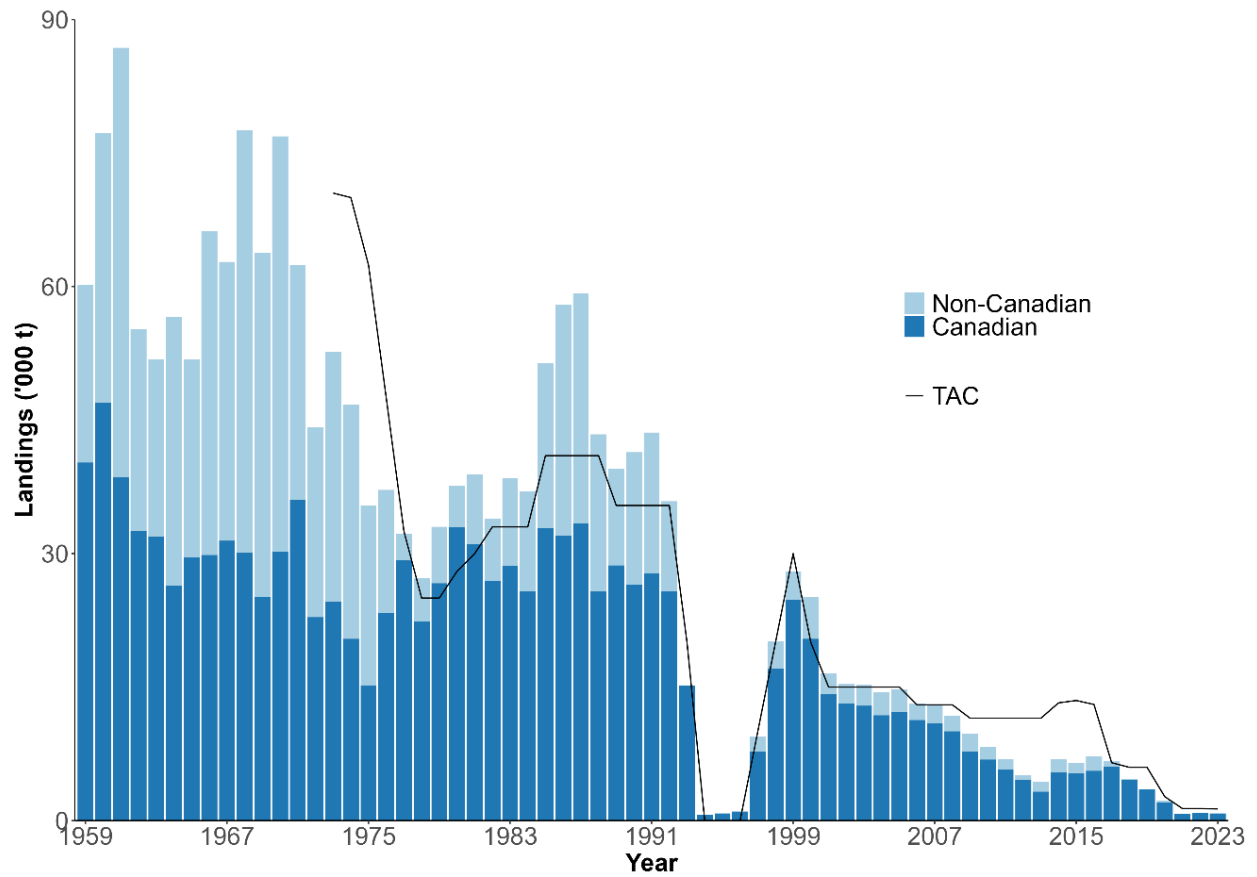


Figure 2: Reported landings of cod by Canadian and non-Canadian vessels in NAFO Subdiv. 3Ps.

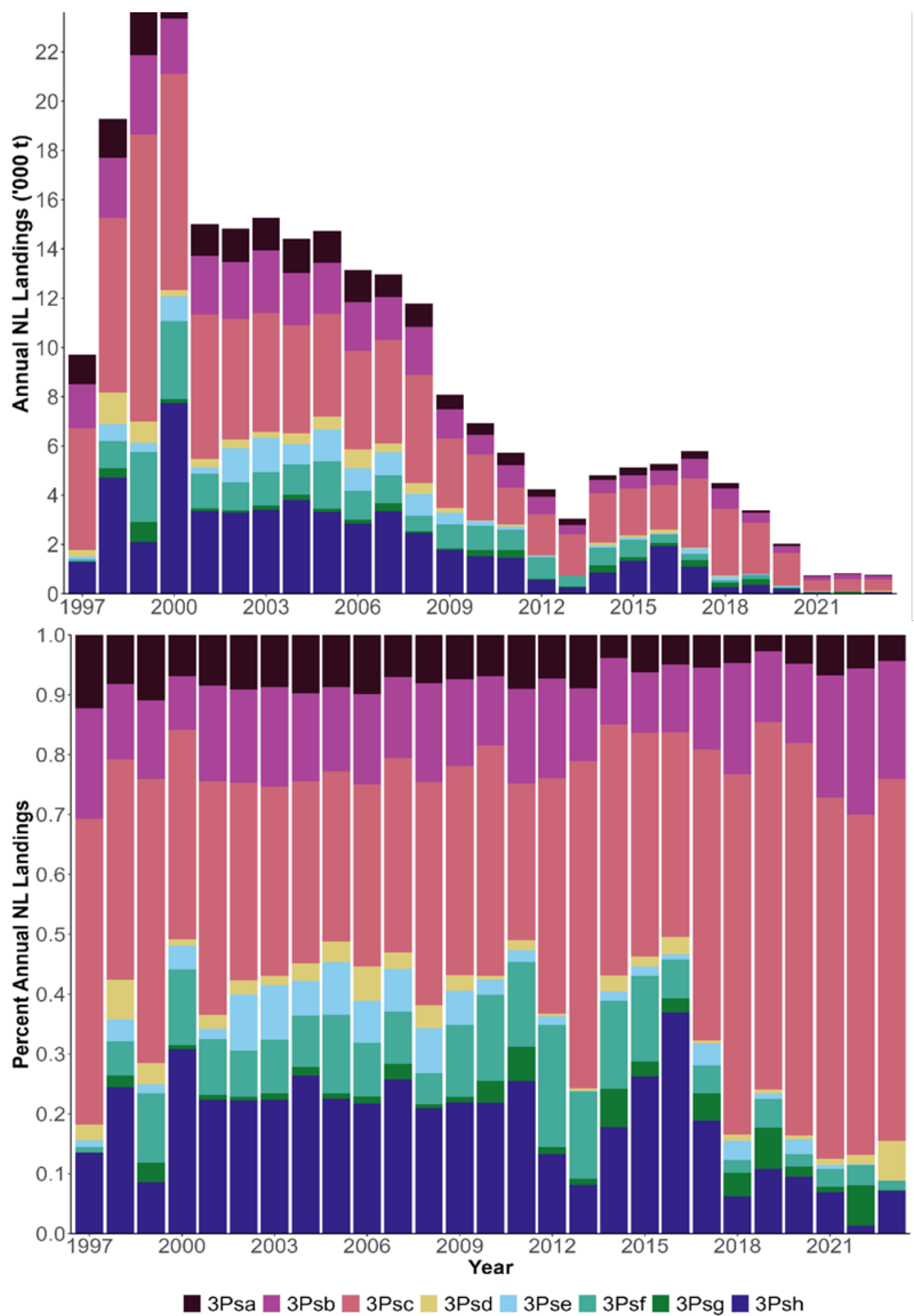


Figure 3: Breakdown of recent Canadian annual landings of 3Ps cod by statistical unit areas. Both landings (upper panel) and percent of total landings (lower panel) are presented. Refer to Figure 1 for locations of unit areas.

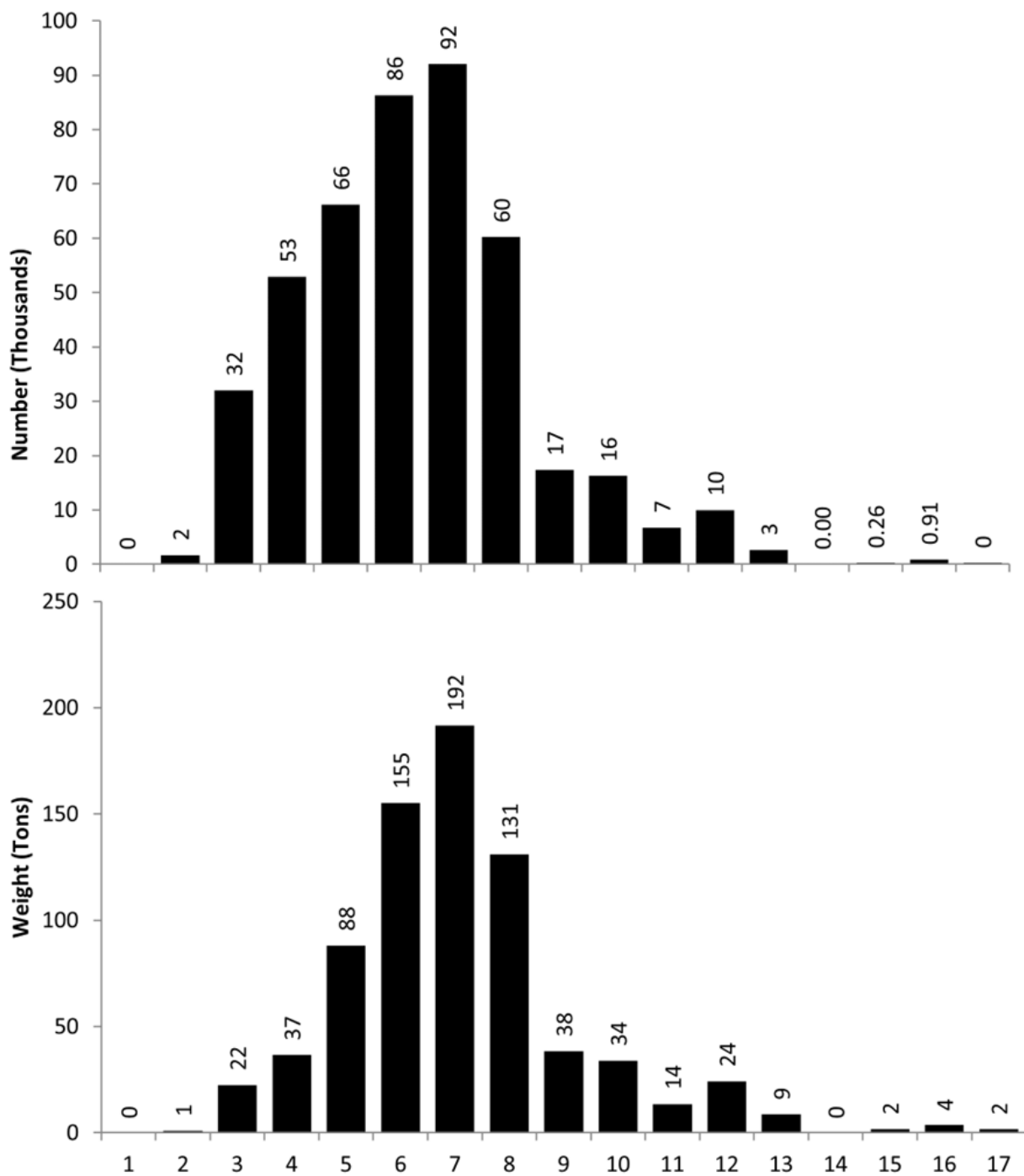


Figure 4: Catch numbers (top) and weight (bottom) at age from commercial and sentinel fisheries in 2023.

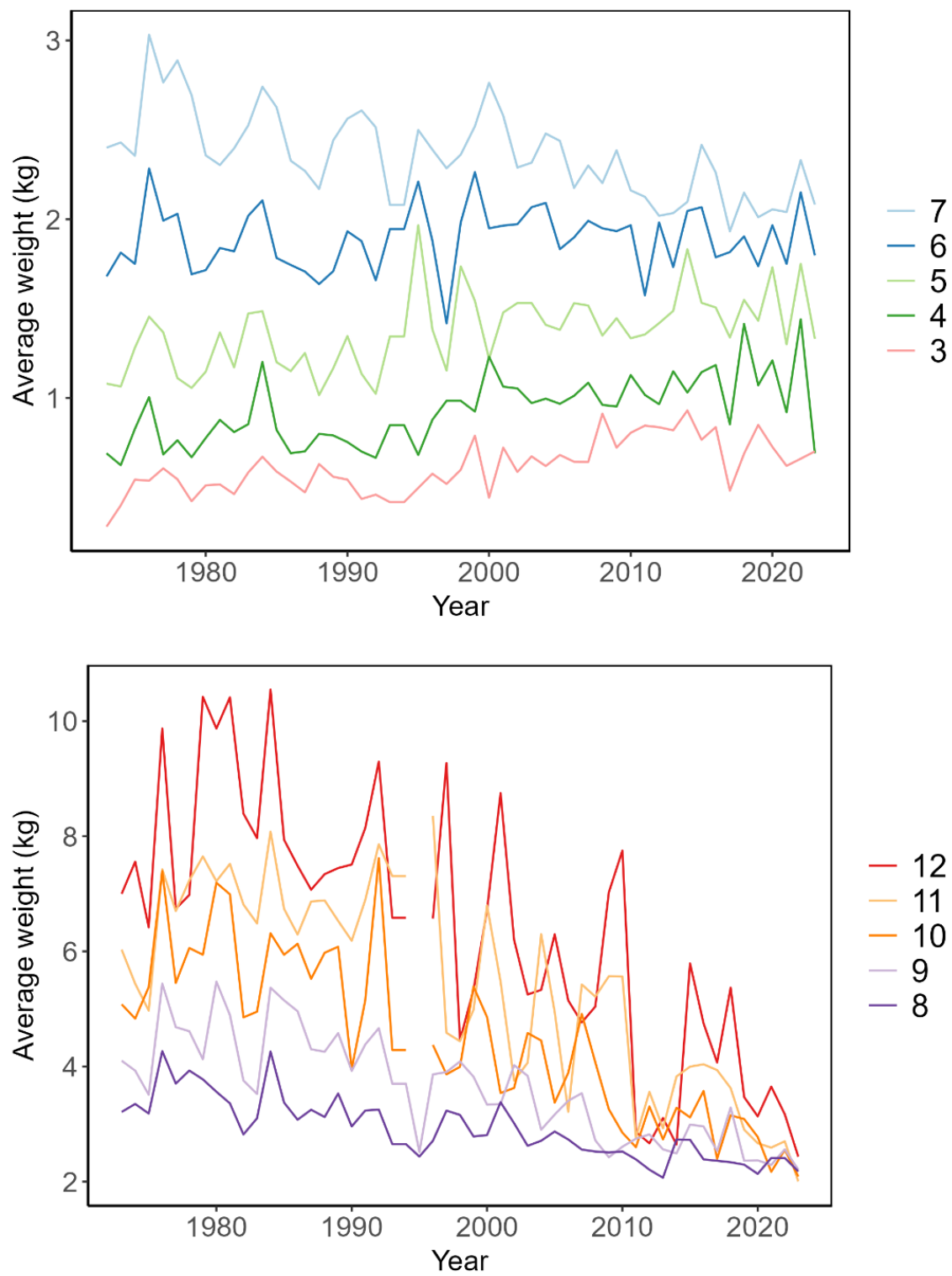


Figure 5: Mean weights-at-age calculated from mean lengths-at-age (upper panel: ages 3–7; upper panel: ages 8–12, colours show different ages) from the commercial catch of cod in Subdiv. 3Ps during 1973–2023.

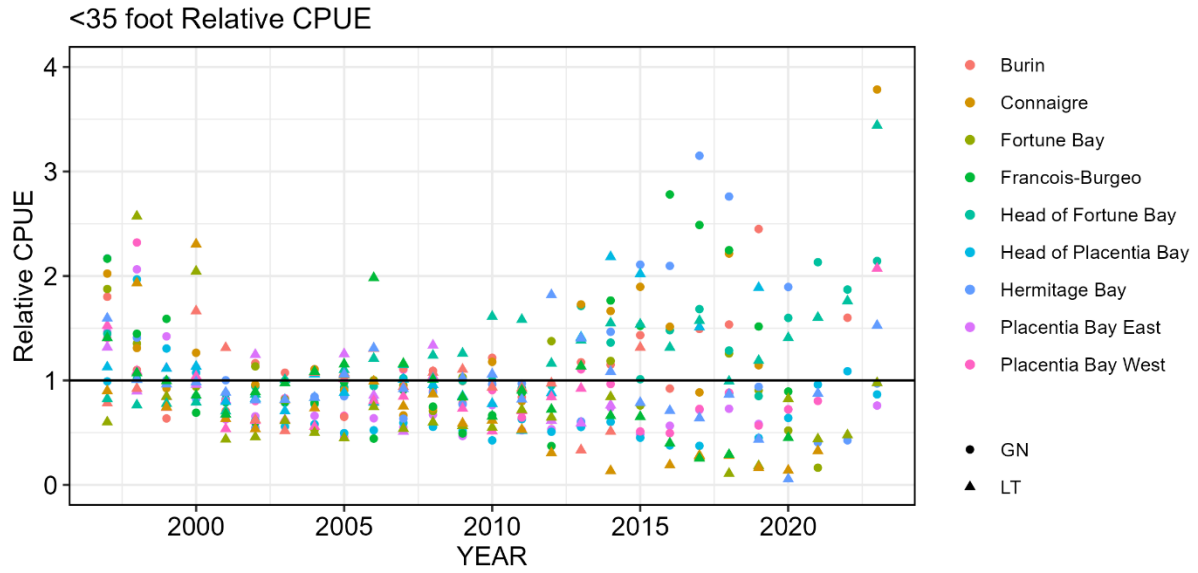


Figure 6: Unstandardized CPUE for <35 foot vessels in 3Ps by year and community. CPUE is presented as relative to each community's series mean (>1 indicated higher than average catch rate for that area, <1 lower). Community-year combinations with <3 reported sets are not included here.

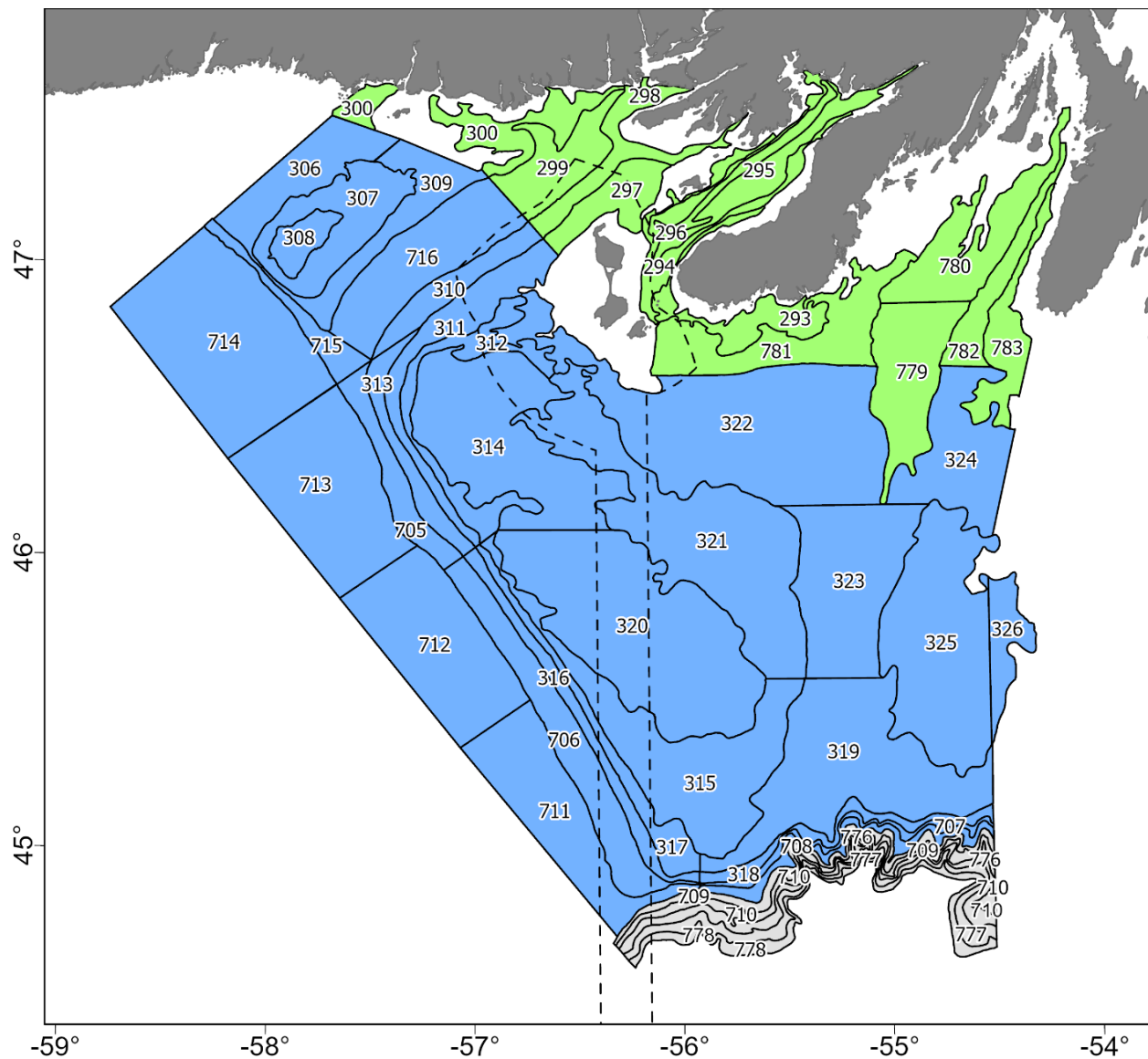


Figure 7: Stratum area boundaries and area surveyed during the DFO research vessel bottom-trawl survey of NAFO subDiv. 3Ps. Offshore strata are shaded blue, inshore strata were added in 1994 (strata 779–783) and 1997 (strata 293–300) and are shaded green, grey strata are not included in the index strata for 3Ps cod. The dashed line shows the boundary of the French economic zone.

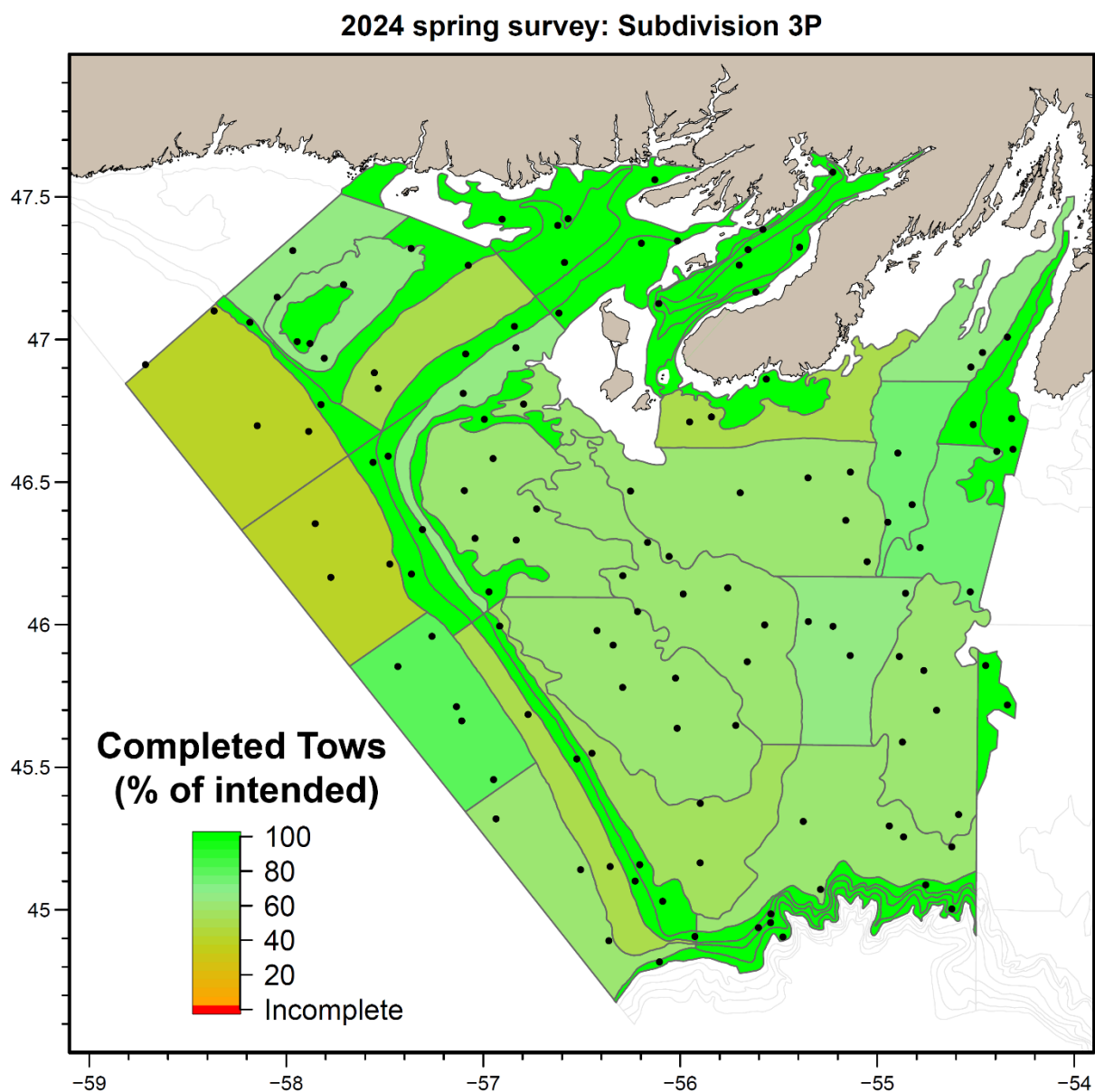


Figure 8: Coverage of the 2024 RV Survey in subDiv. 3Ps. Points indicate set locations, strata are coloured based on percent of intended tows completed.

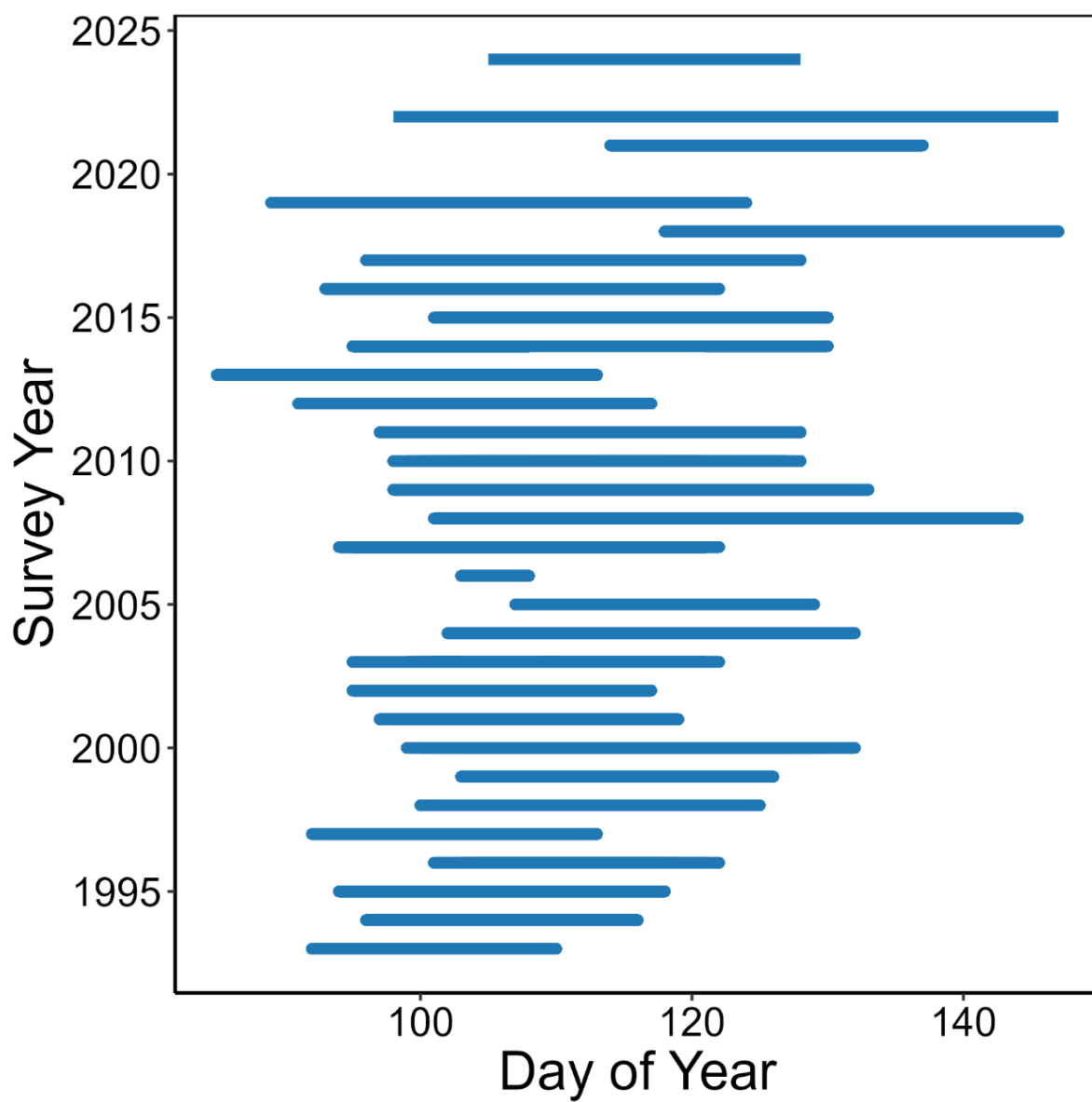


Figure 9: Timing of the survey in subDiv. 3Ps by day of the year. The survey was incomplete in 2006 and there was no survey in 2020 or 2023.

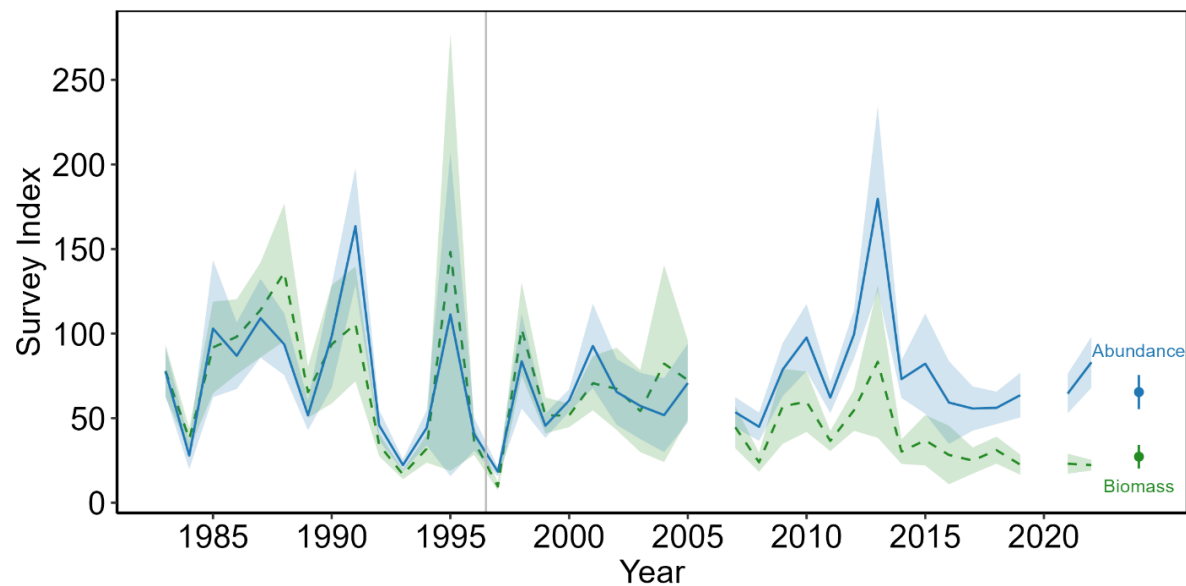


Figure 10: Campelen-equivalent survey indices of abundance (solid blue) and biomass (dashed green) from the annual 3Ps RV survey. Surveys prior to 1994 did not cover inshore areas, from 1994–1997 have varying inshore coverage, and include inshore and offshore areas since 1997 (vertical grey line). Indices are relative values and are therefore presented here without units. The survey was incomplete in 2006 and there was no survey in 2020 or 2023.

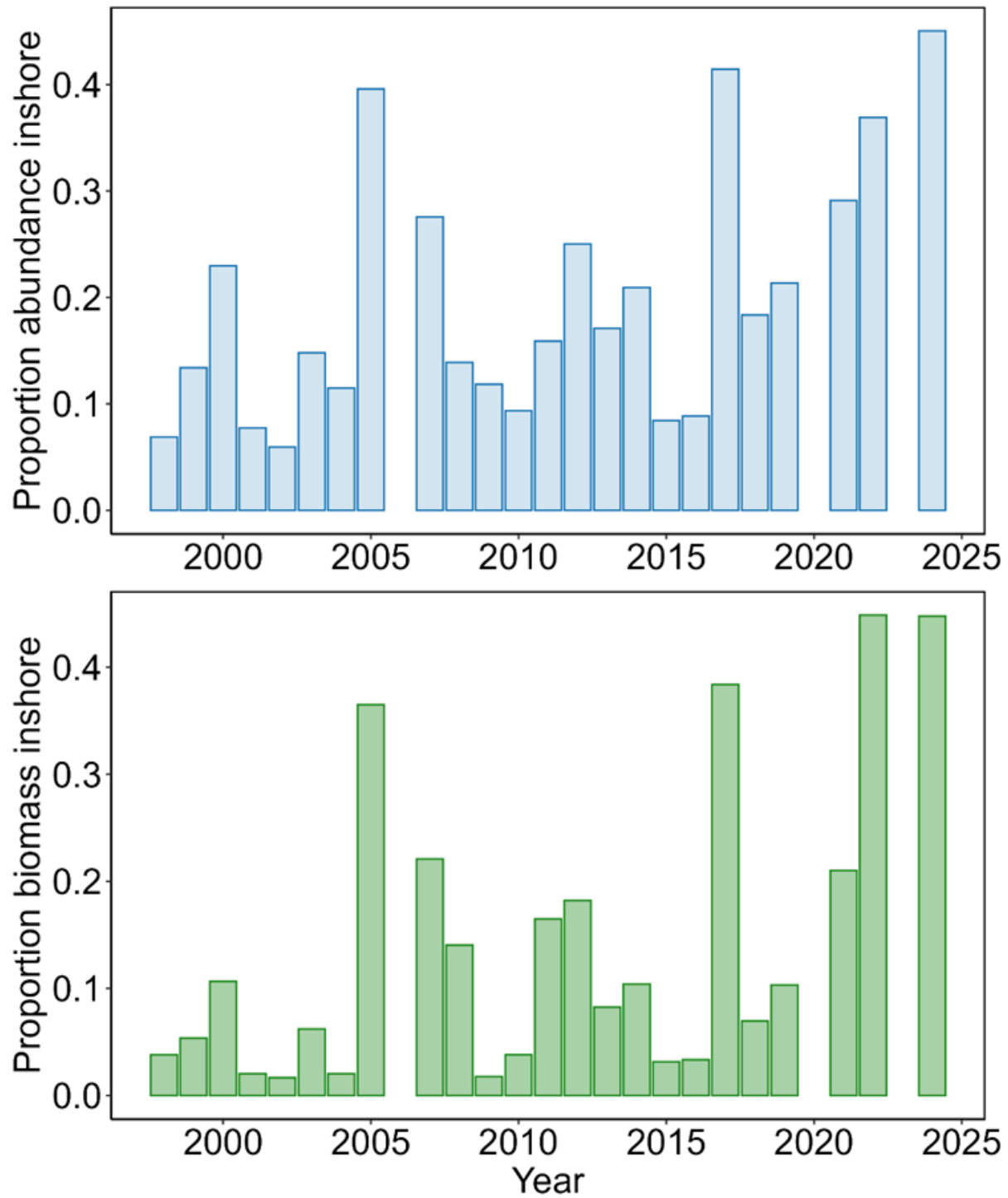


Figure 11: Proportion of survey abundance (top) and biomass (bottom) caught in the inshore strata of subDiv. 3Ps since 1997. The survey was incomplete in 2006 and there was no survey in 2020 or 2023.

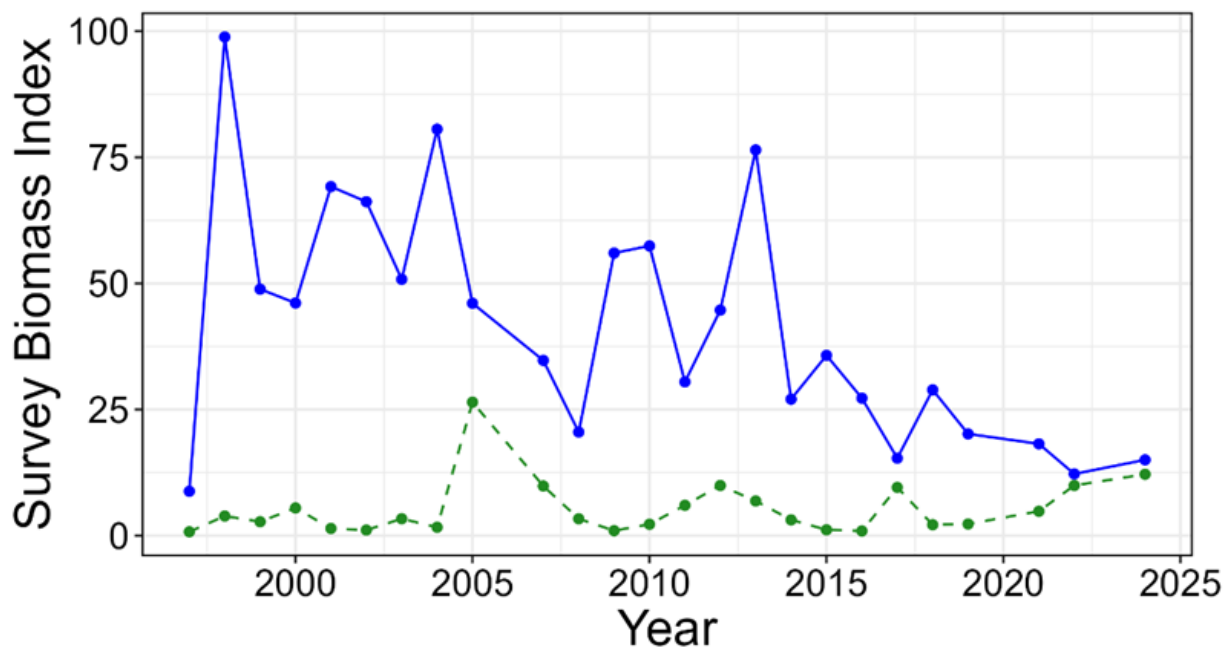
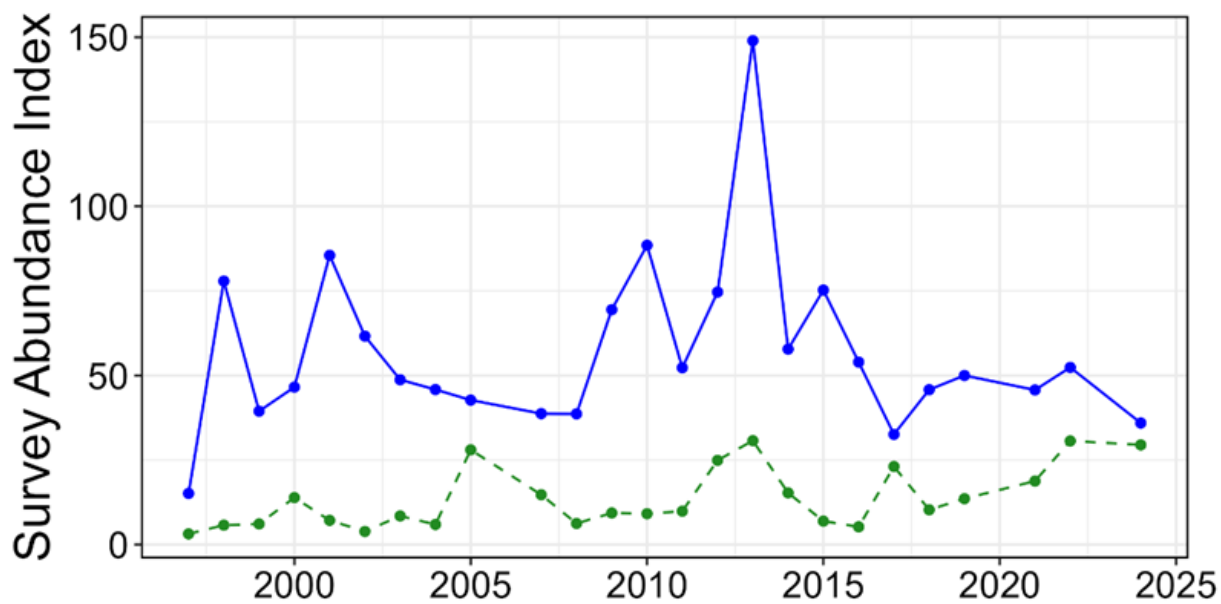


Figure 12: Comparison of abundance (upper panel) and biomass (lower panel) indices for cod in NAFO Subdiv. 3Ps in offshore strata (blue solid line) and in inshore strata only (green dashed line).

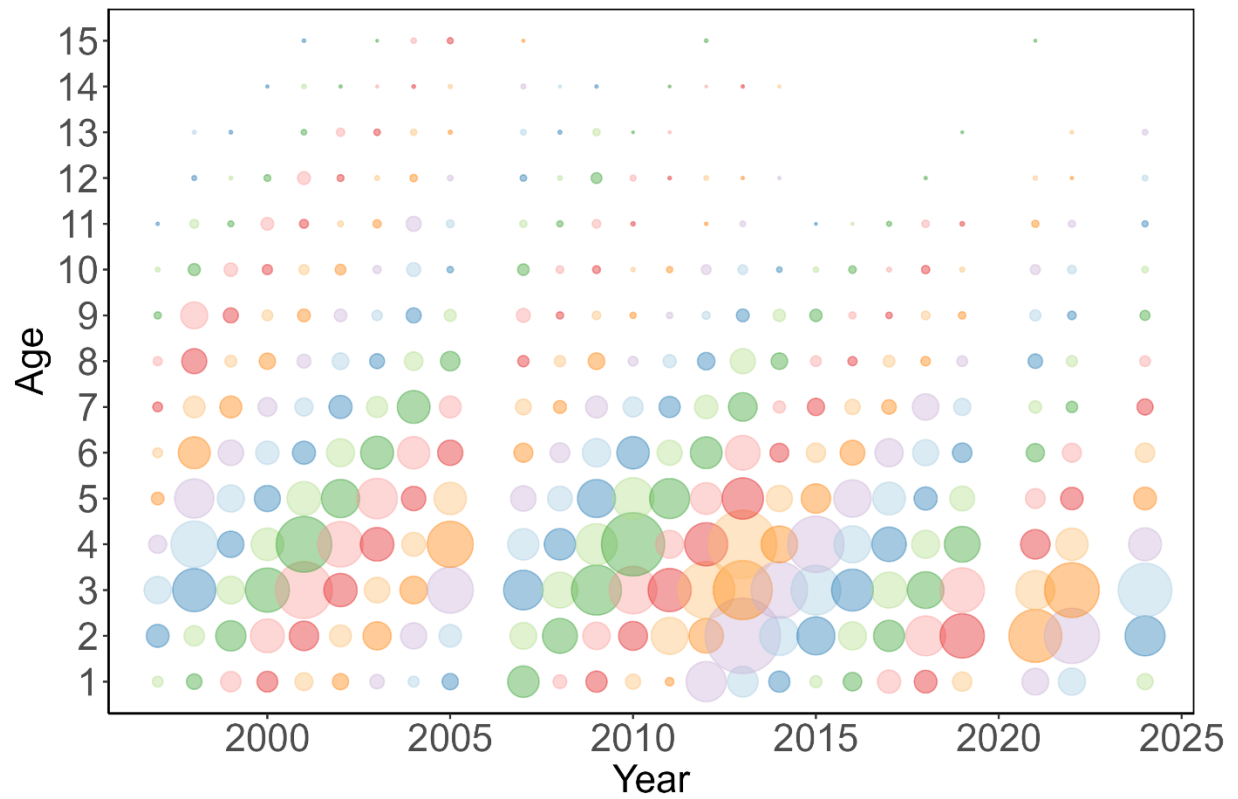


Figure 13: Bubble plot of survey mean number per tow (mnpt) at age from 1997–2024. Bubble area is proportional to the mnpt, and colours coincide with cohorts. The survey was incomplete in 2006 and there was no survey in 2020 or 2023.

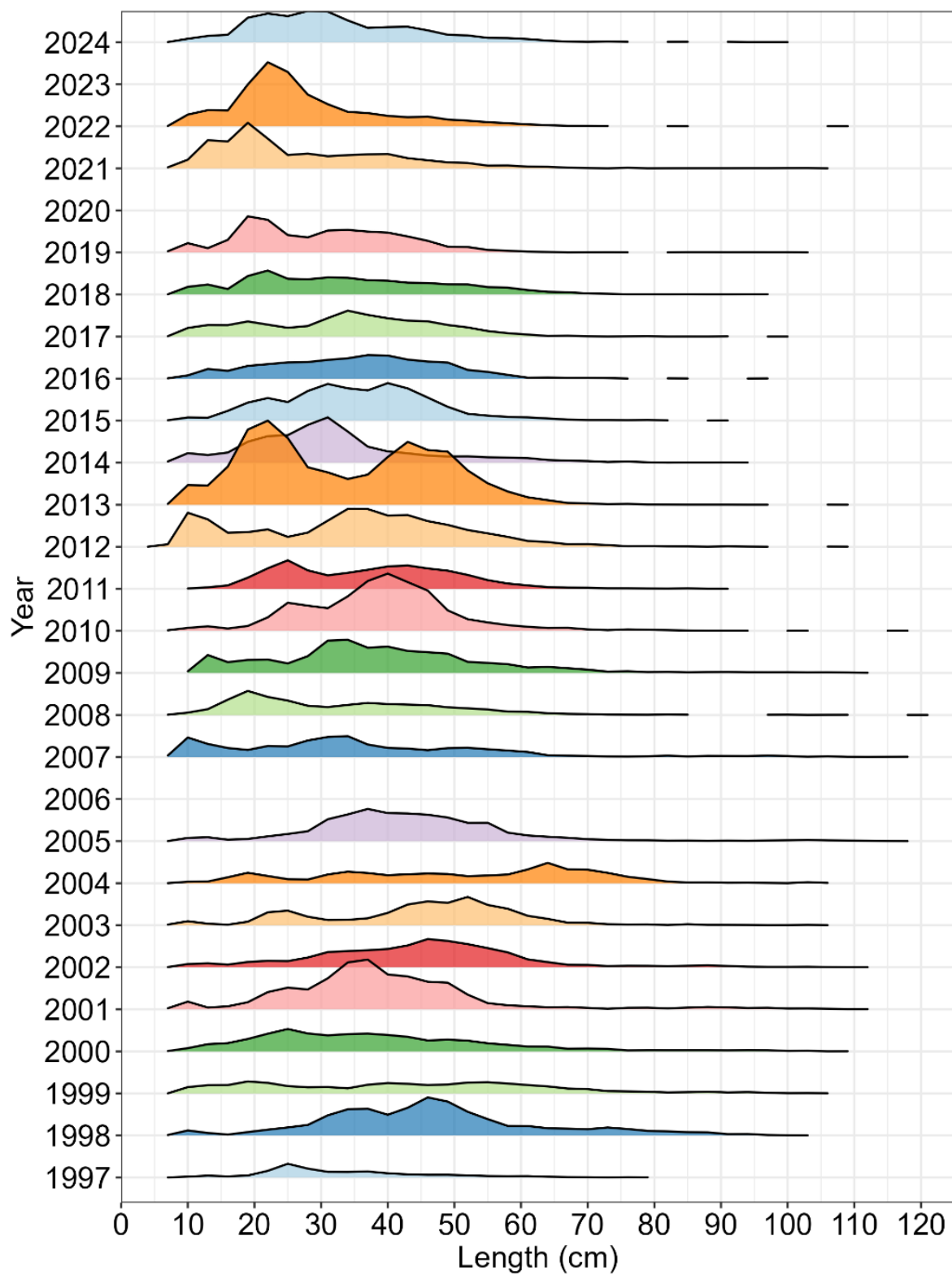


Figure 14: Length frequencies from the spring RV survey in NAFO Subdivision 3Ps from 1997–2024. The survey was incomplete in 2006 and there was no survey in 2020 or 2023.

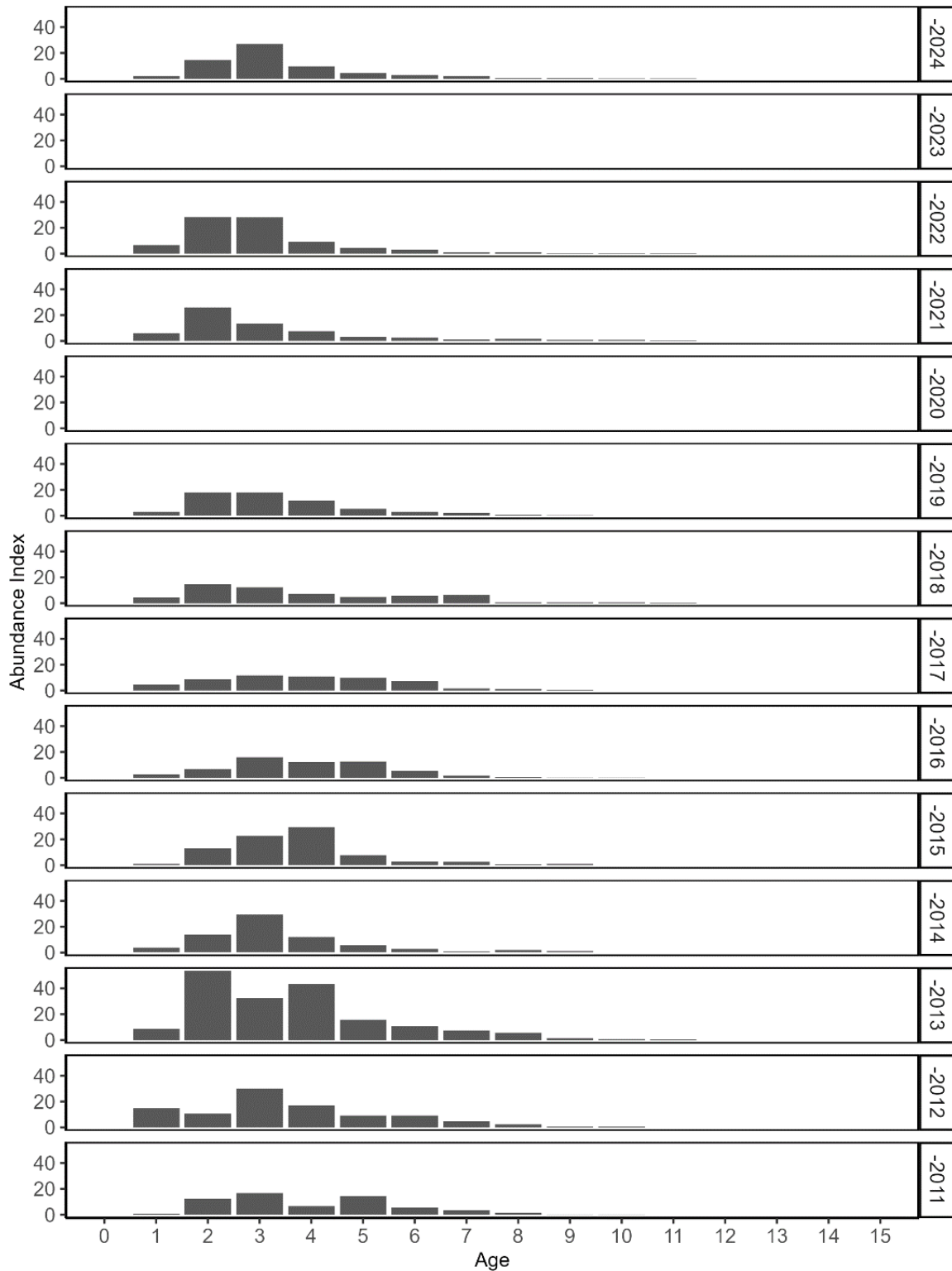


Figure 15: Survey abundance at age from 2011–24. The survey was incomplete in 2006 and there was no survey in 2020 or 2023.

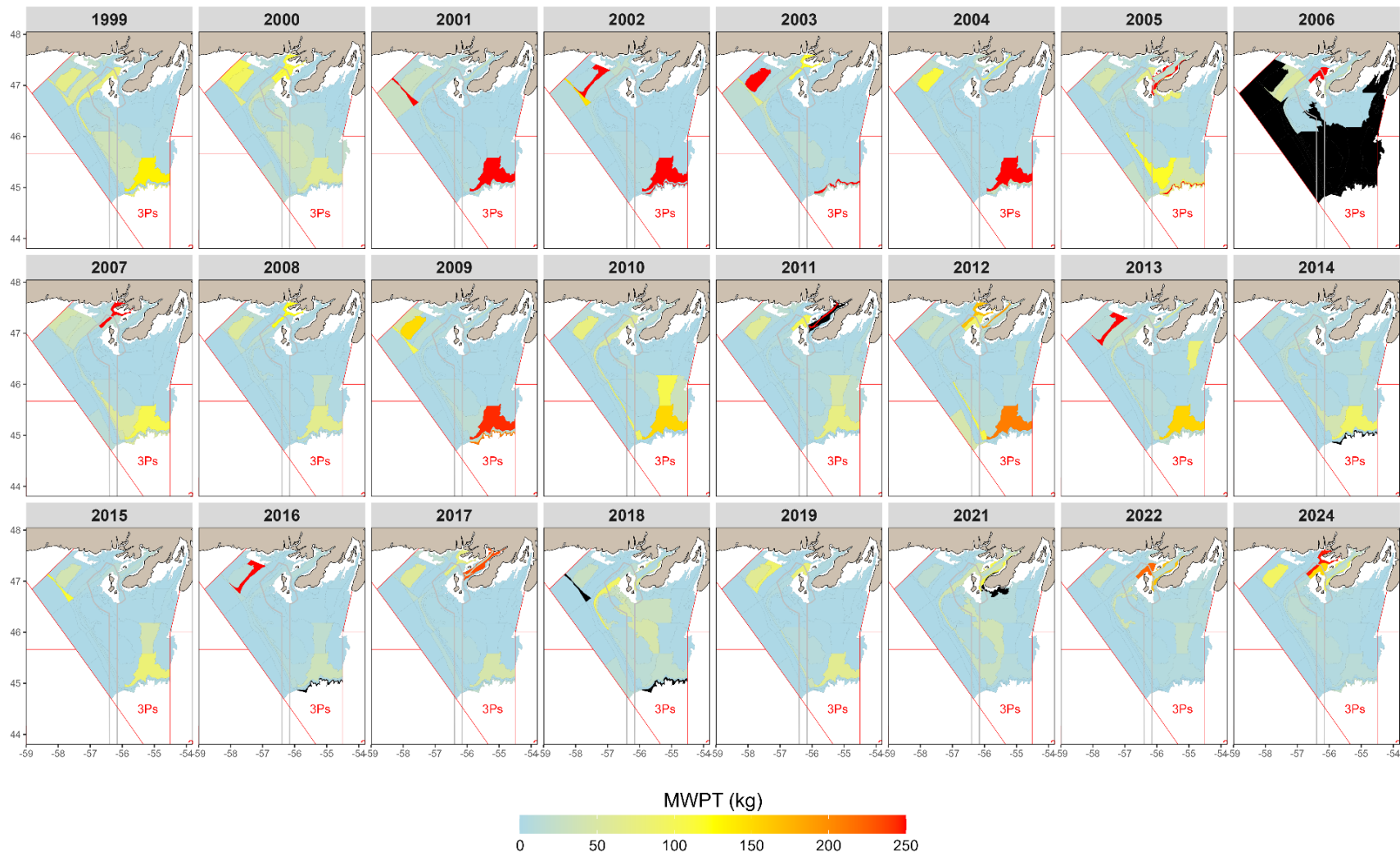


Figure 16: Distribution of survey biomass (mwpt = mean weight per tow) from 1999–2024 by strata. Black shading indicates the strata was incomplete.

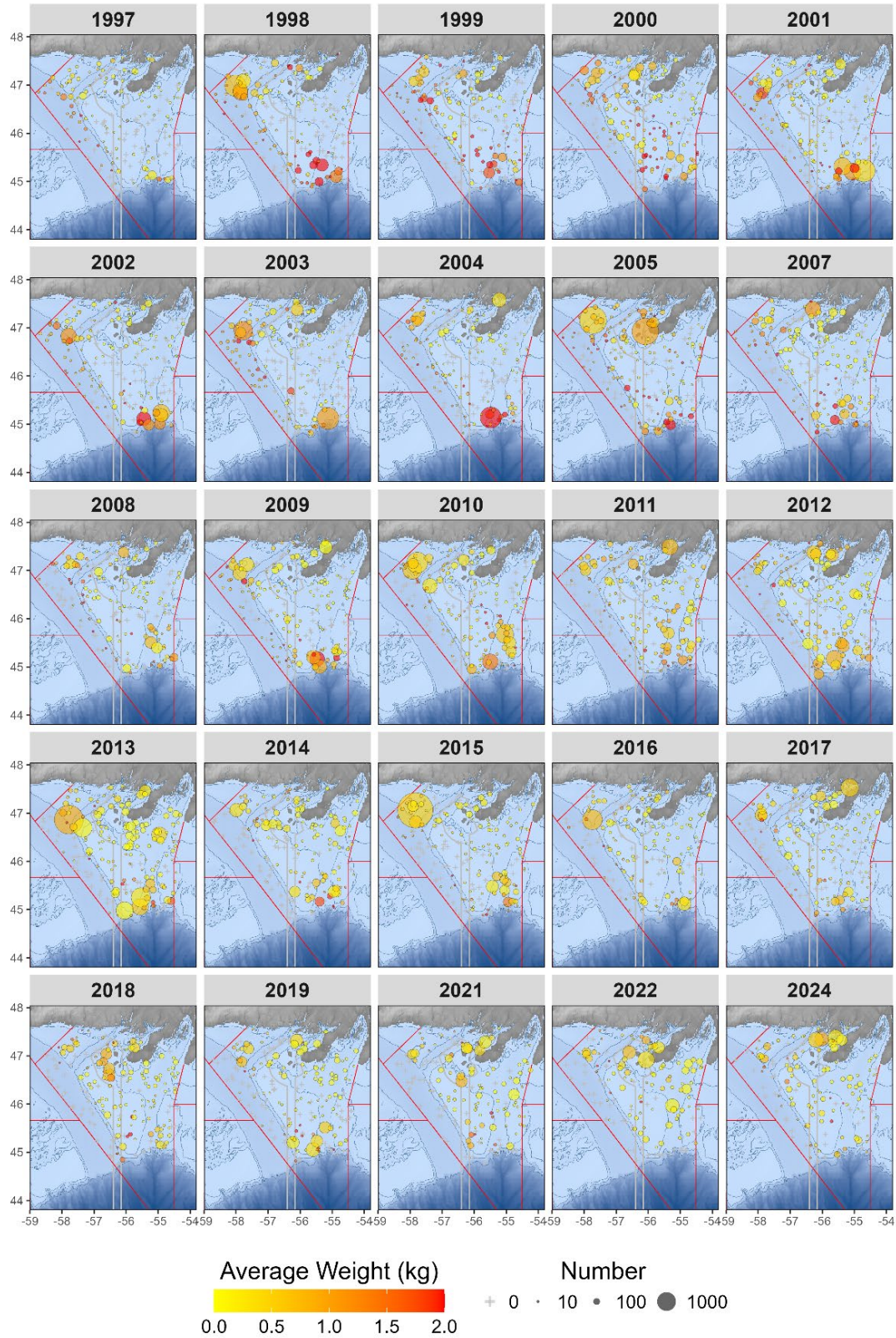


Figure 17: Number of fish (shown by bubble size) per 15 min tow from since 1997. Bubbles are coloured to indicate average individual fish weight (kg) within each set. Note there was no survey in the spring of 2020 or 2023.

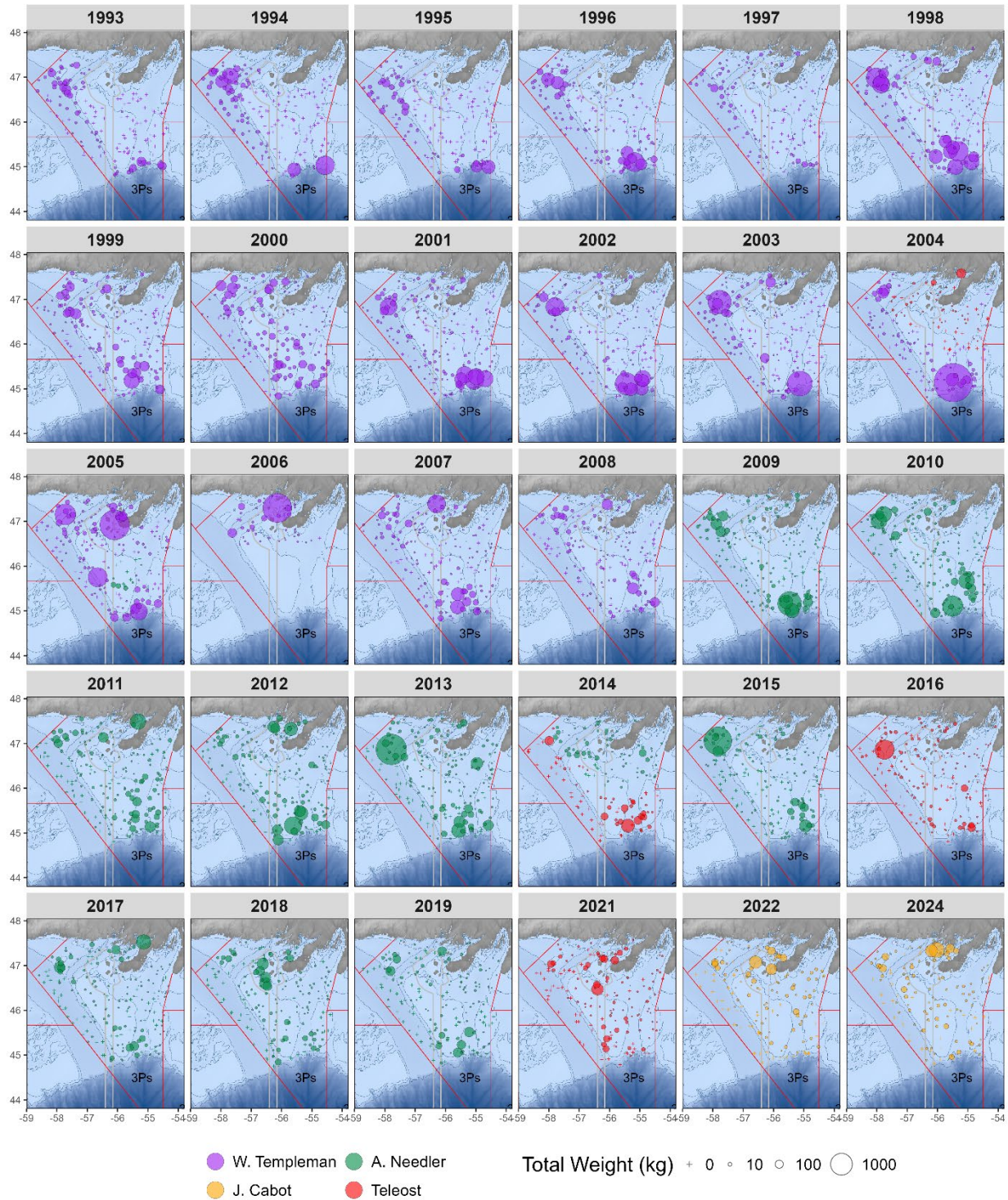


Figure 18: Weight of fish (shown by bubble size) per 15 min tow from since 1993. Bubbles are coloured to indicate which survey vessels was used.

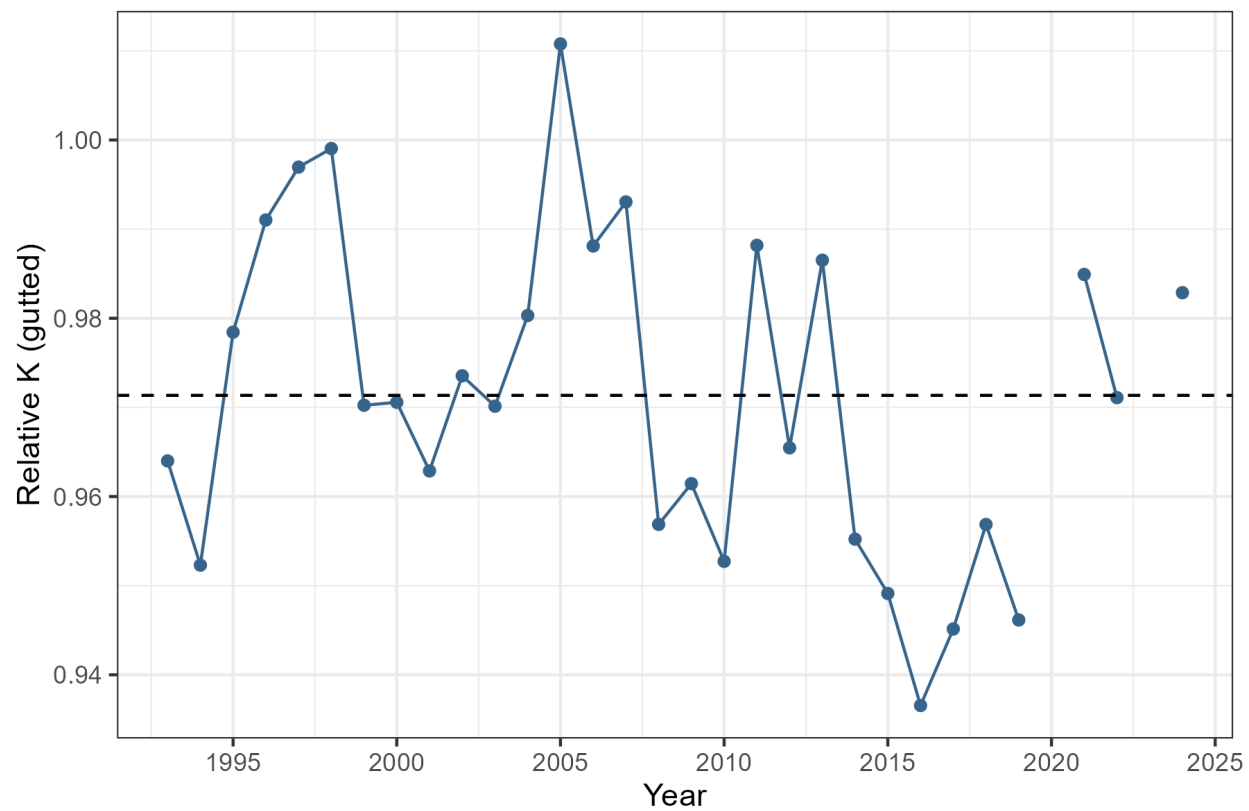


Figure 19: Relative gutted condition (relative K) calculated from RV survey data.

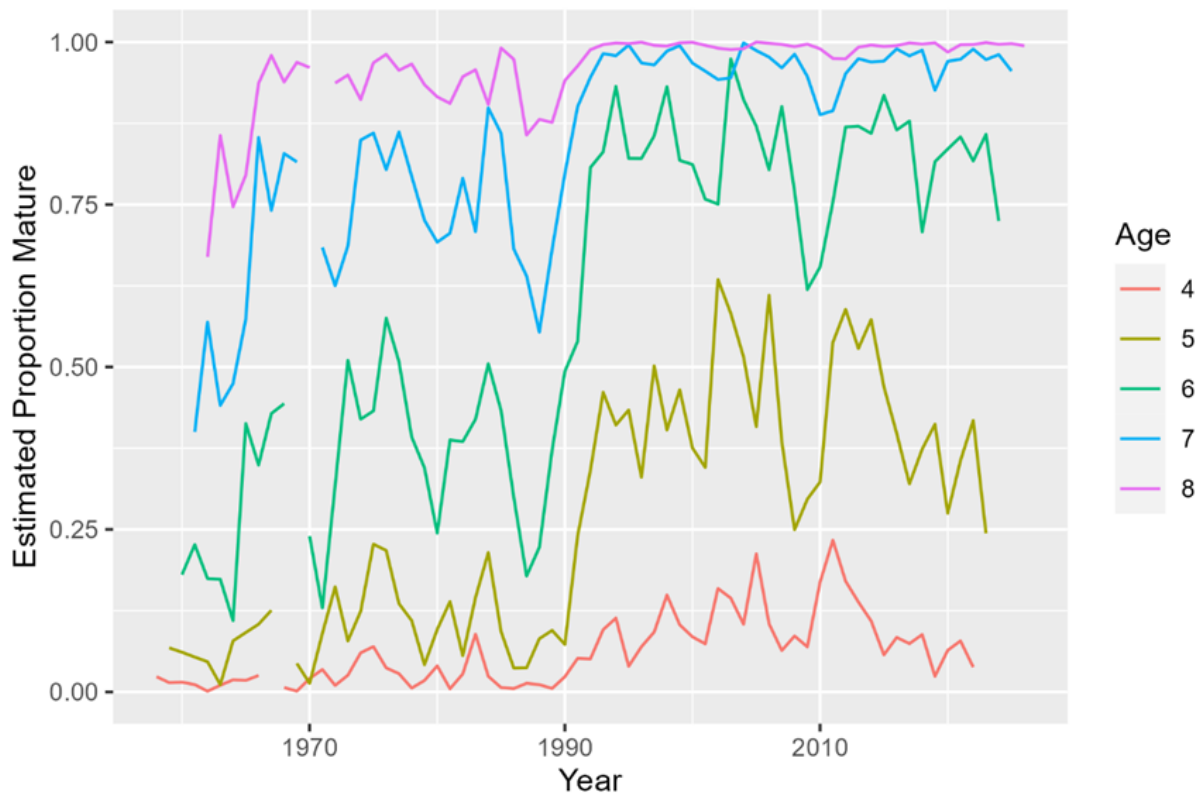
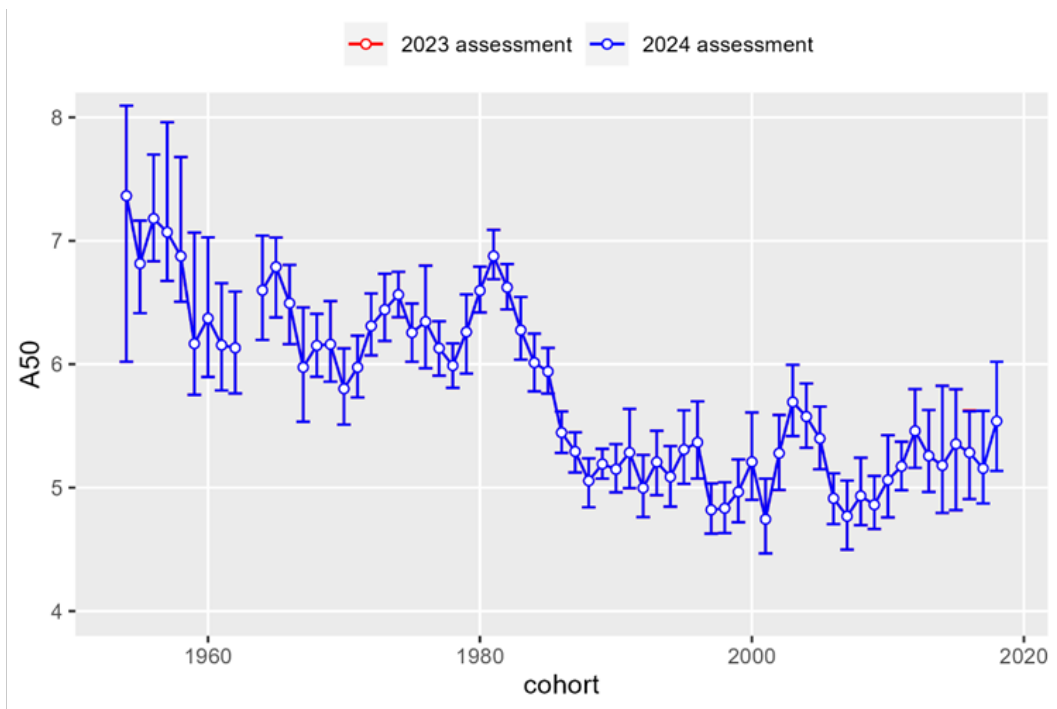


Figure 20: Estimated age at 50% mature by cohort (top; red points show estimates from the previous assessment – given limited change, red points are minimally visible), and proportion mature by age (bottom) for Atlantic Cod in 3Ps.

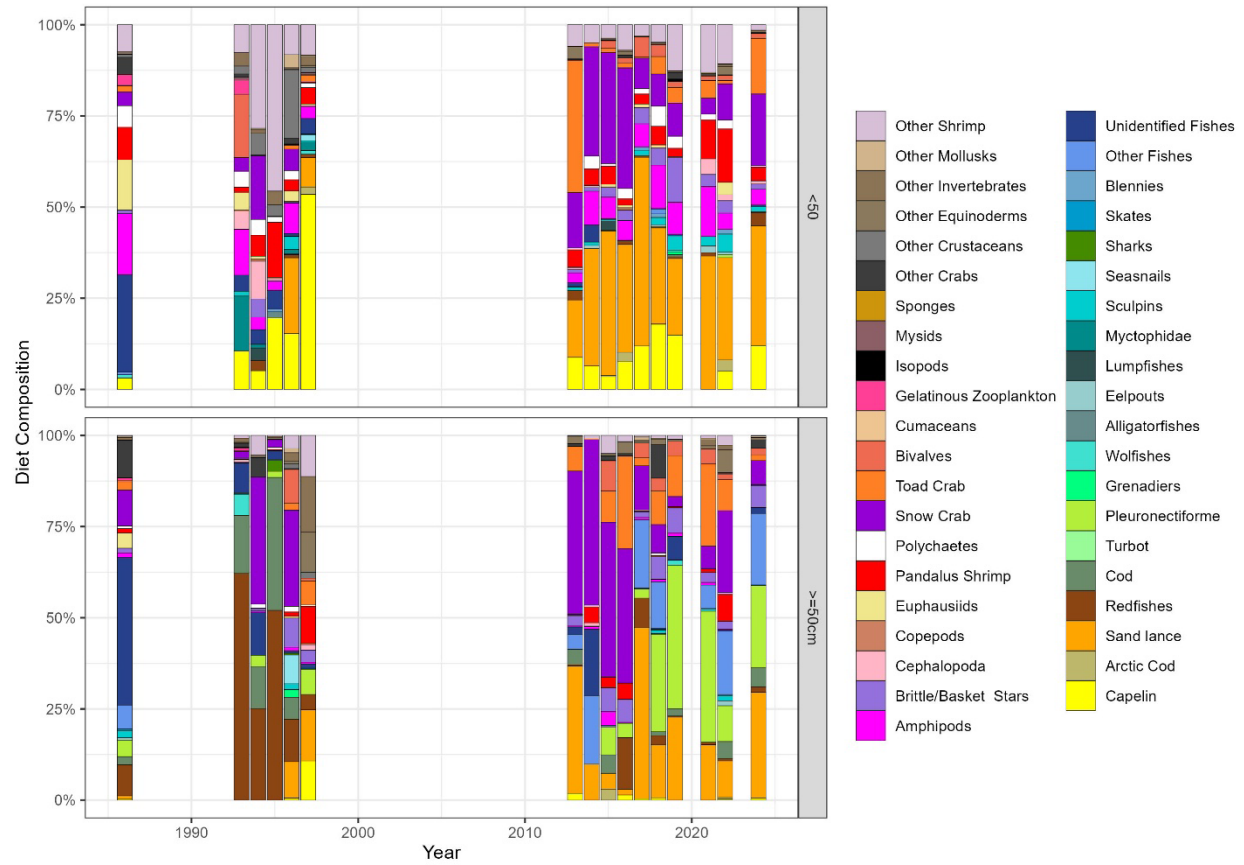


Figure 21: Diet composition of Atlantic Cod smaller than 50 cm (top) and greater than 50 cm (bottom) in 3Ps.

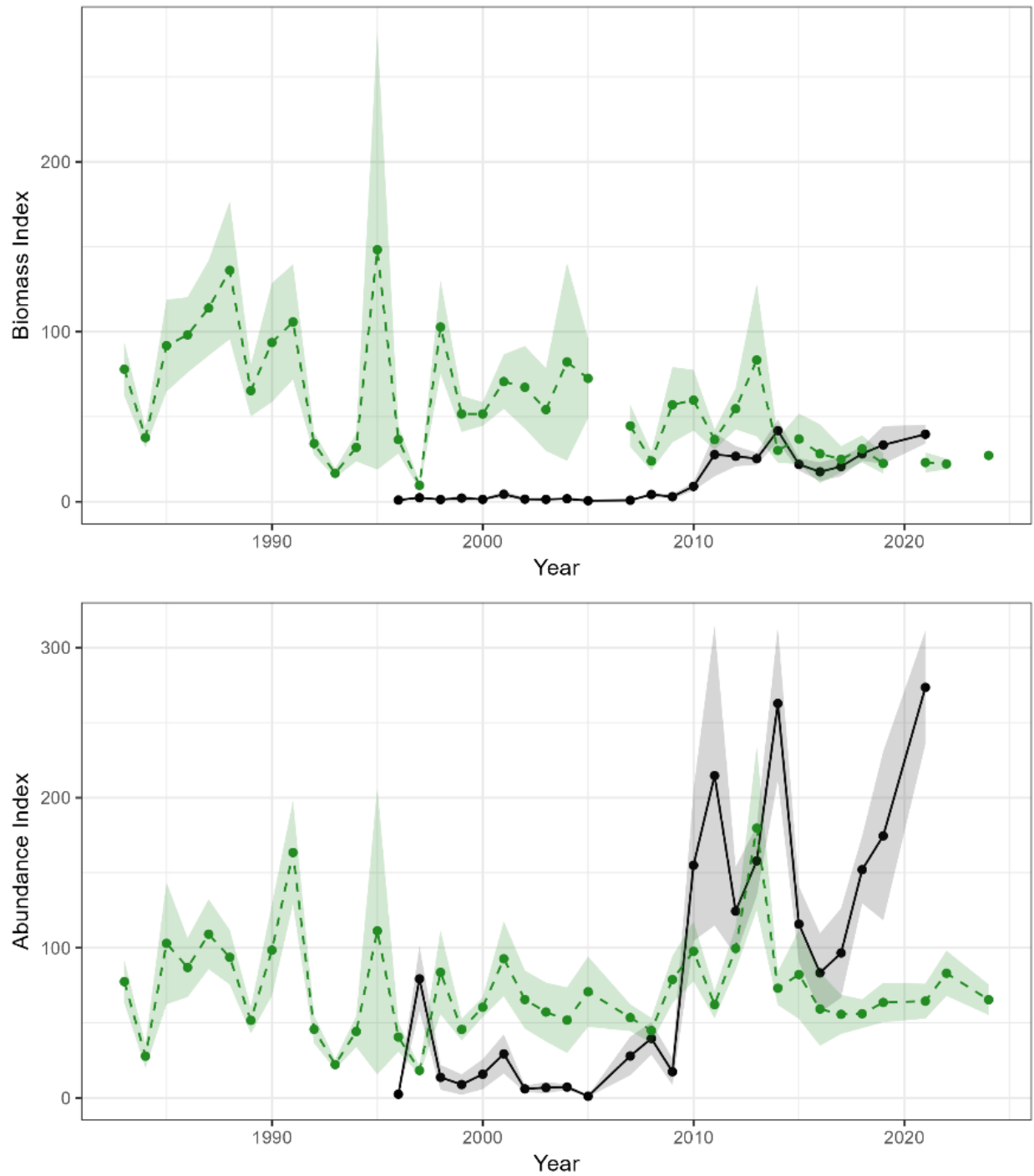


Figure 22: Stratified estimates of cod (green dashed) and Silver Hake (black solid) in 3Ps. Campelen years only for Silver Hake, pre-1996 values for cod are converted Engel. Cod estimates here are the all-Index strata estimates used within the assessment.

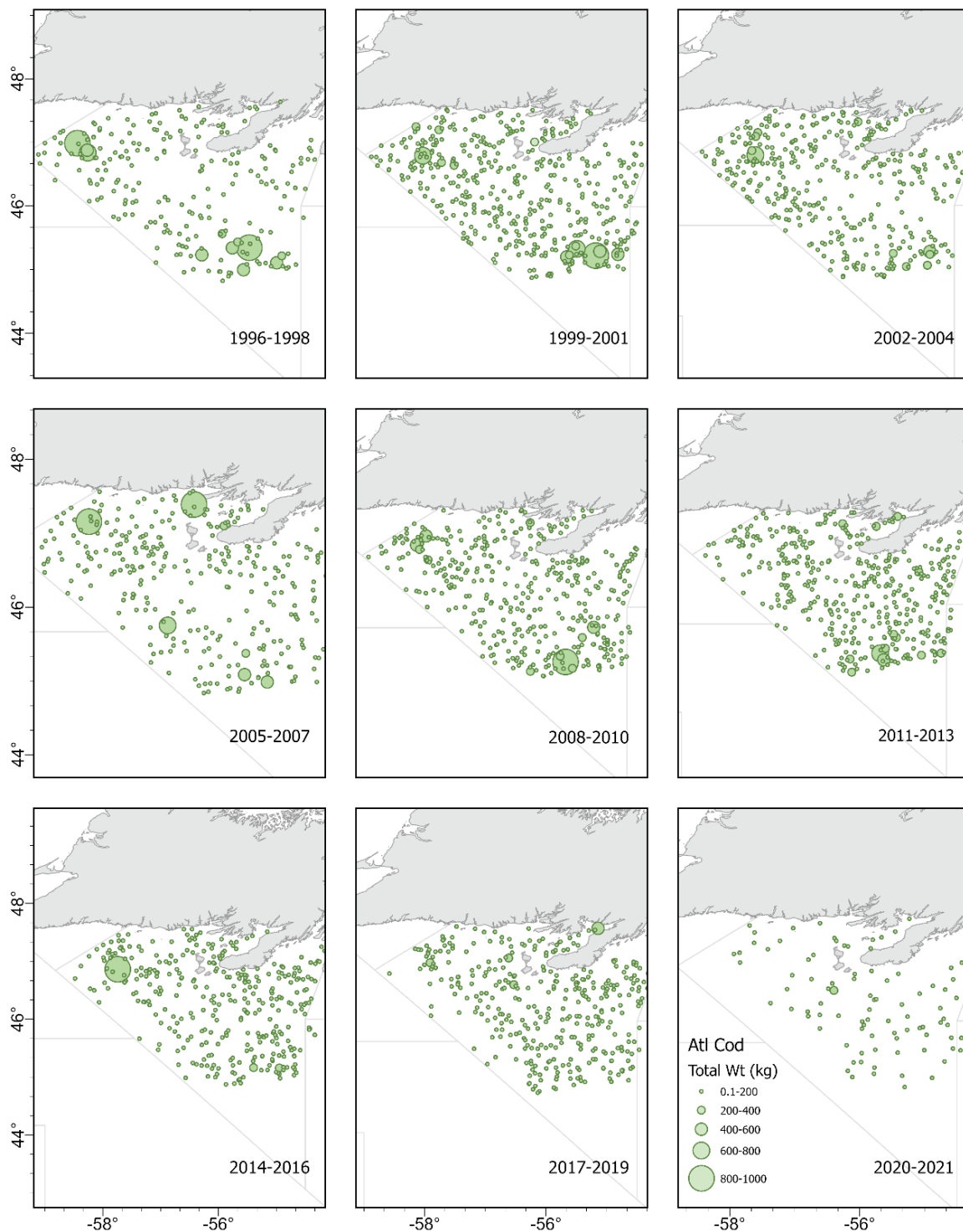


Figure 24: Distribution of Silver Hake in the spring RV survey, 1996–2021. Points are scaled to set by set catch weight. Sets with zero catches are not plotted.

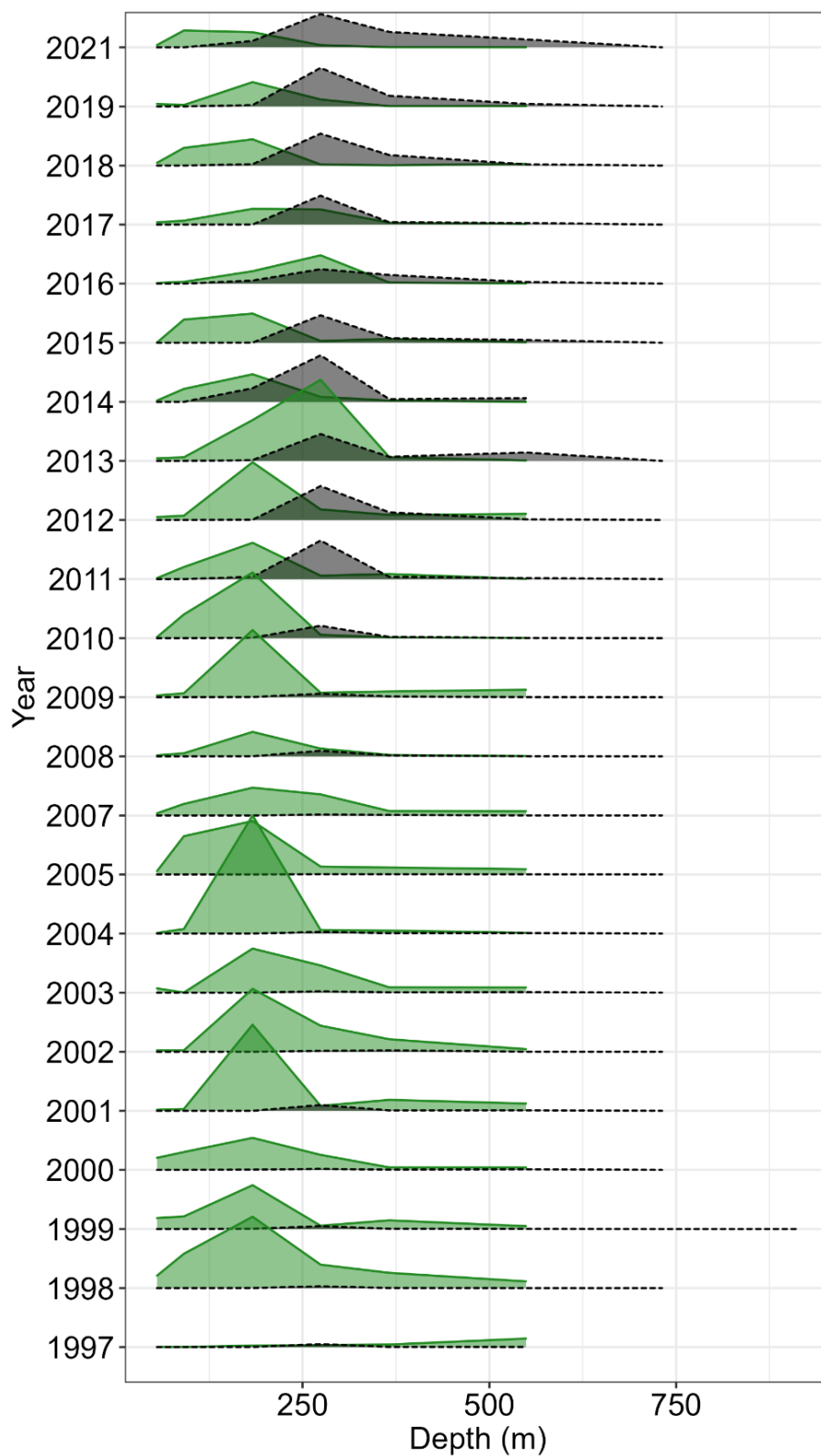


Figure 25: Distribution of Silver Hake (grey) and Atlantic Cod (green) biomass by strata depth in the spring RV survey.



Figure 26: Abundance weighted mean temperature of Silver Hake (black dashed) and Atlantic Cod (green solid) in the RV Survey, 1996–2021.

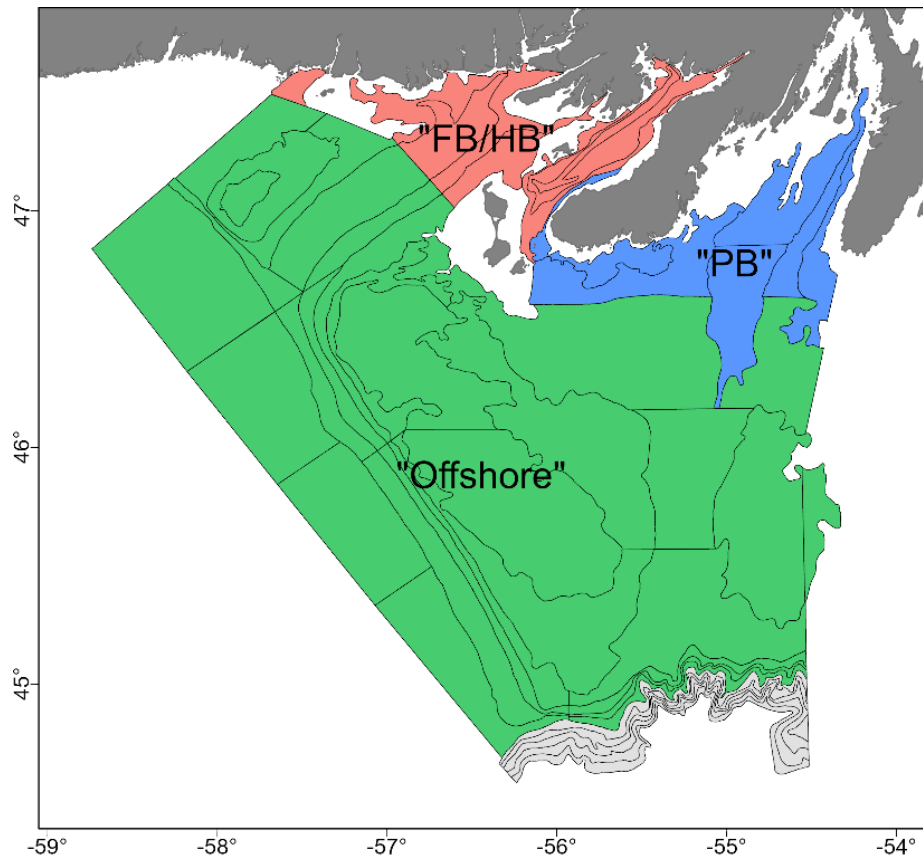


Figure 27: Map of areas used for temperature summaries. 3Ps was split into "offshore" strata, Fortune Bay/Hermitage Bay ("FB/HB"), and Placentia Bay "PB".

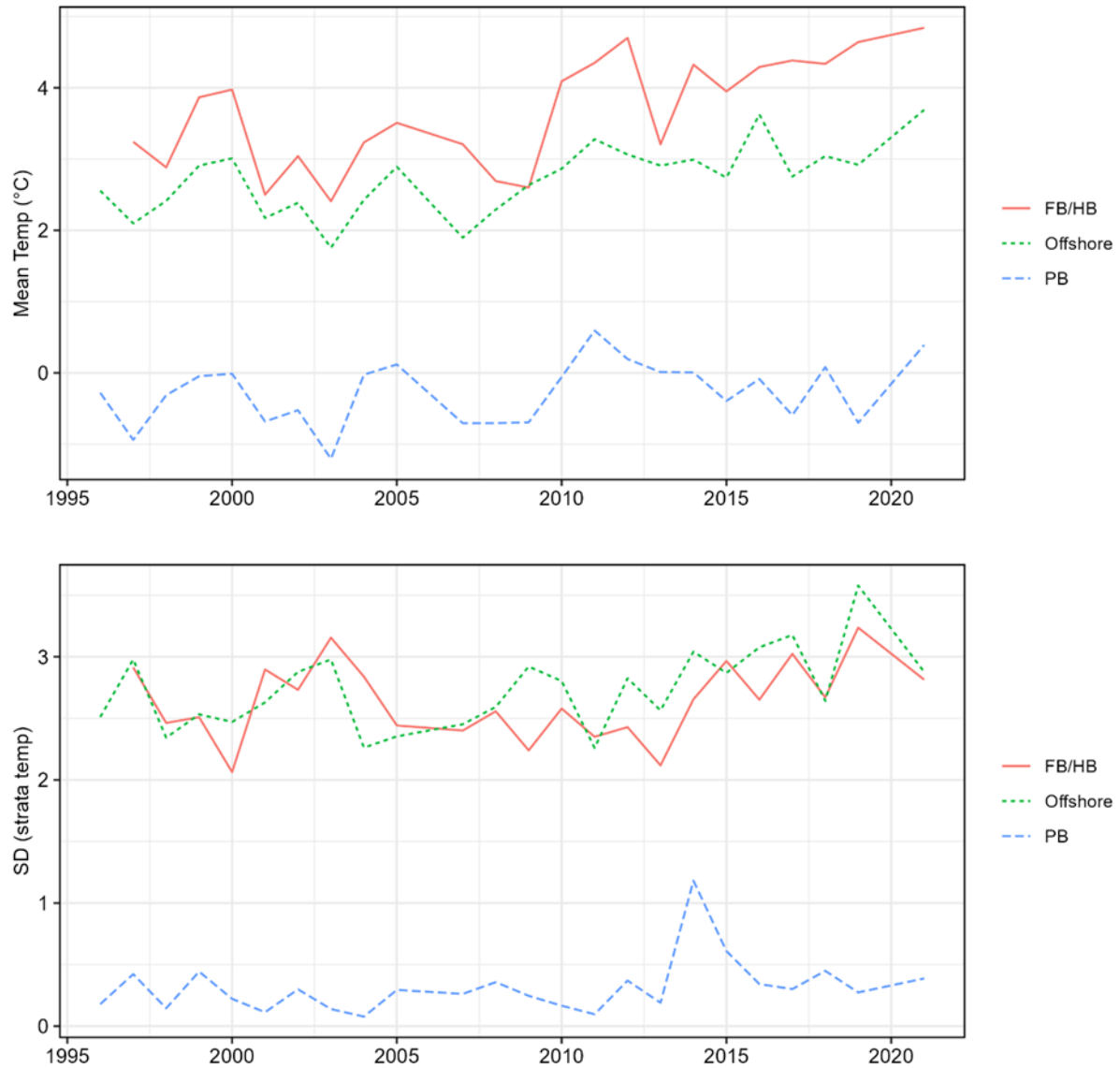


Figure 28: Bottom temperature in the RV survey sets 1996-2022 in 3Ps. Increases in mean temperature and in temperature variability (measured here as SD) have been increasing in the offshore and in Fortune Bay/Hermitage Bay (see Figure 27) since around 2010, while Placentia Bay remains notably colder.

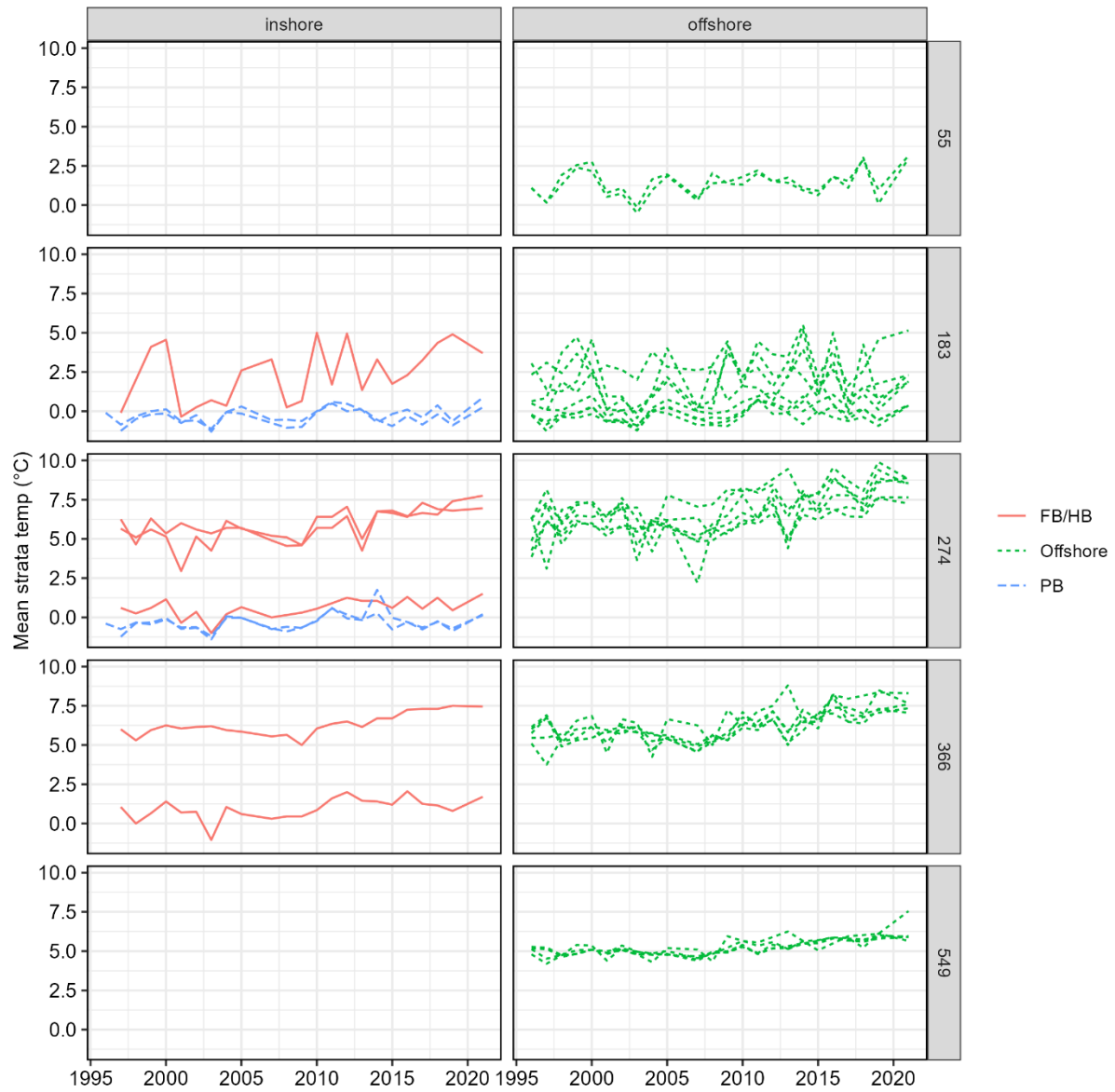


Figure 29: Mean survey temperature by depth (panels down, maximum strata depth in meters) in inshore (left) and offshore (right) areas of 3Ps. Each line shows mean temperature in an individual strata, colours and linetype correspond to areas outlined in Figure 27.

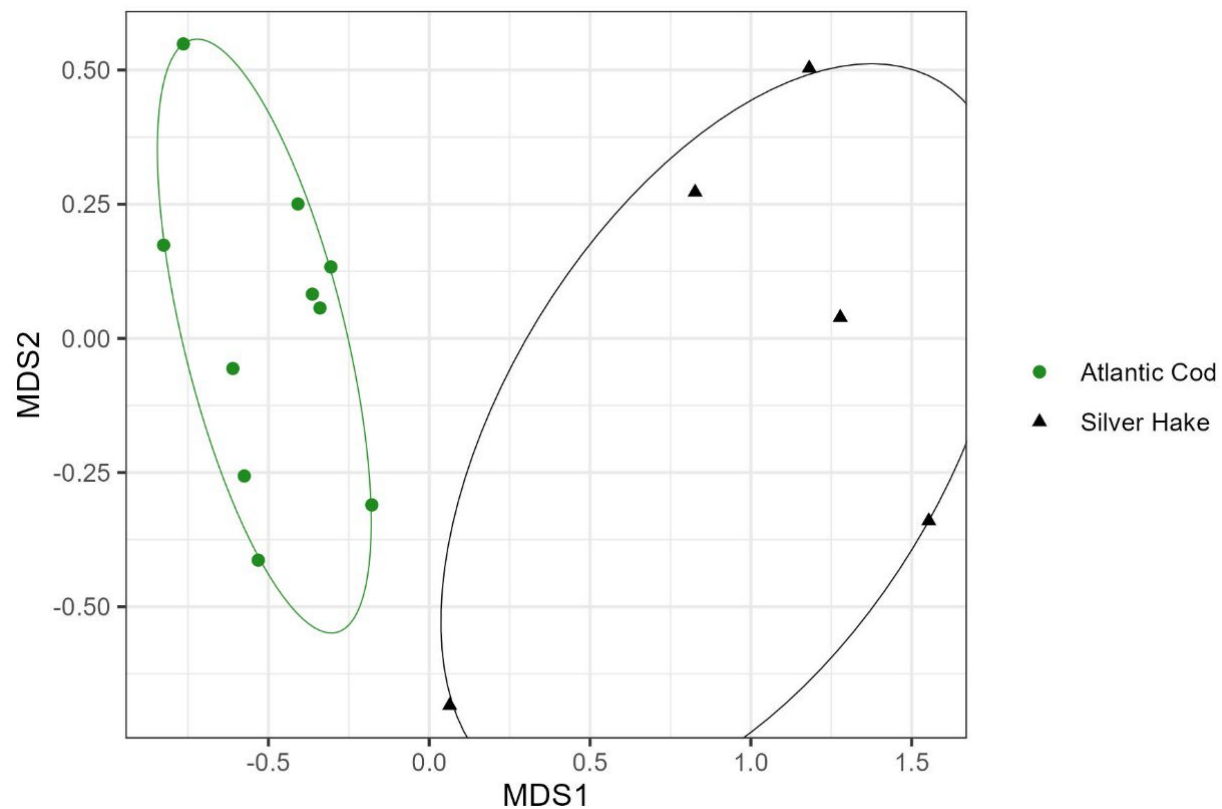


Figure 30: Nonmetric multidimensional scaling (MDS) of annual diet of Atlantic Cod and Silver Hake in years with 50 or more samples. nMDS was conducted with proportion prey weight, using Bray-Curtis distance, and two dimensions. Ellipses include all points of given species.

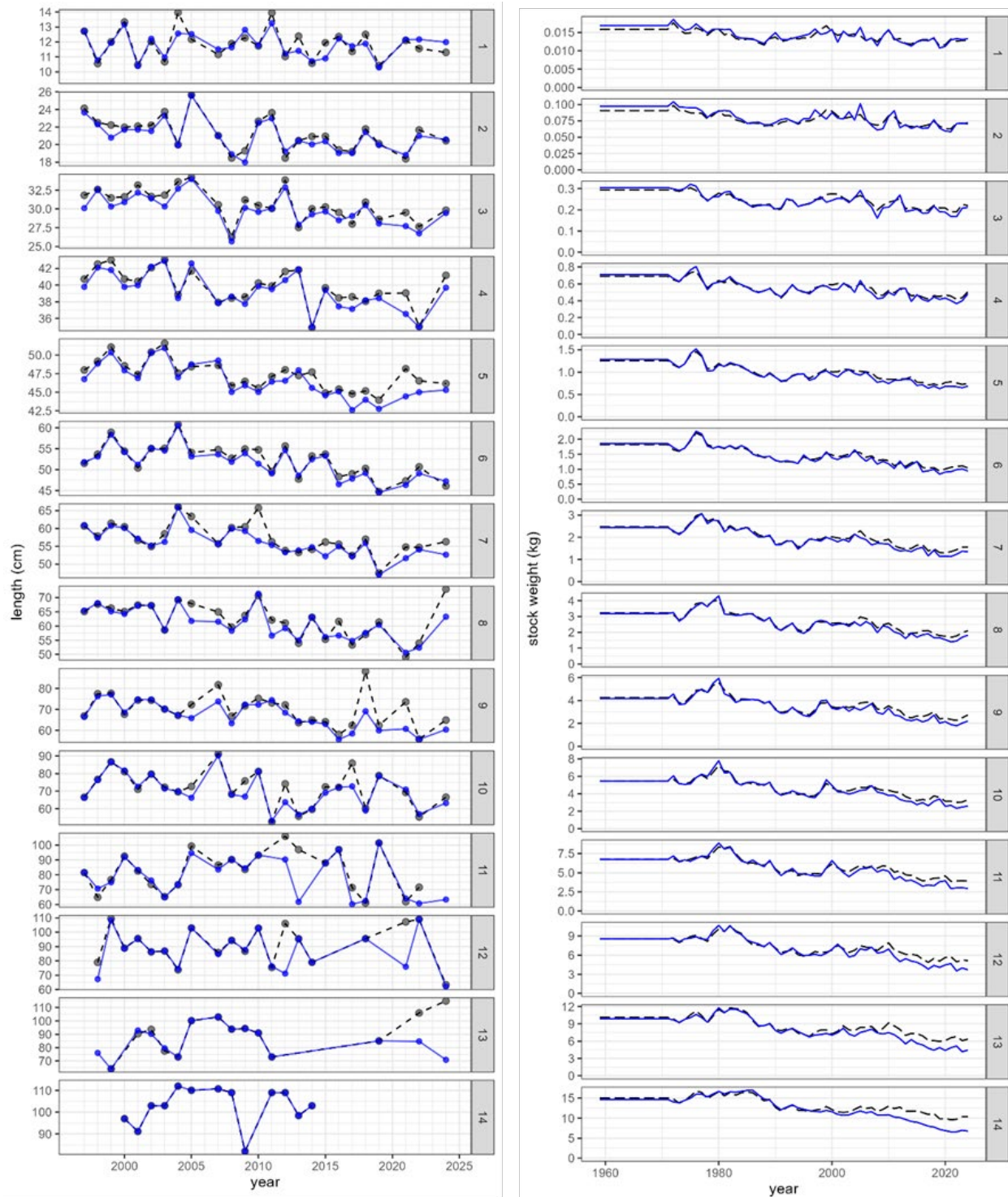


Figure 31: Comparison of survey length at age (left) and modelled stock weights (right) using all index strata (blue solid) and offshore strata only (black dashed).

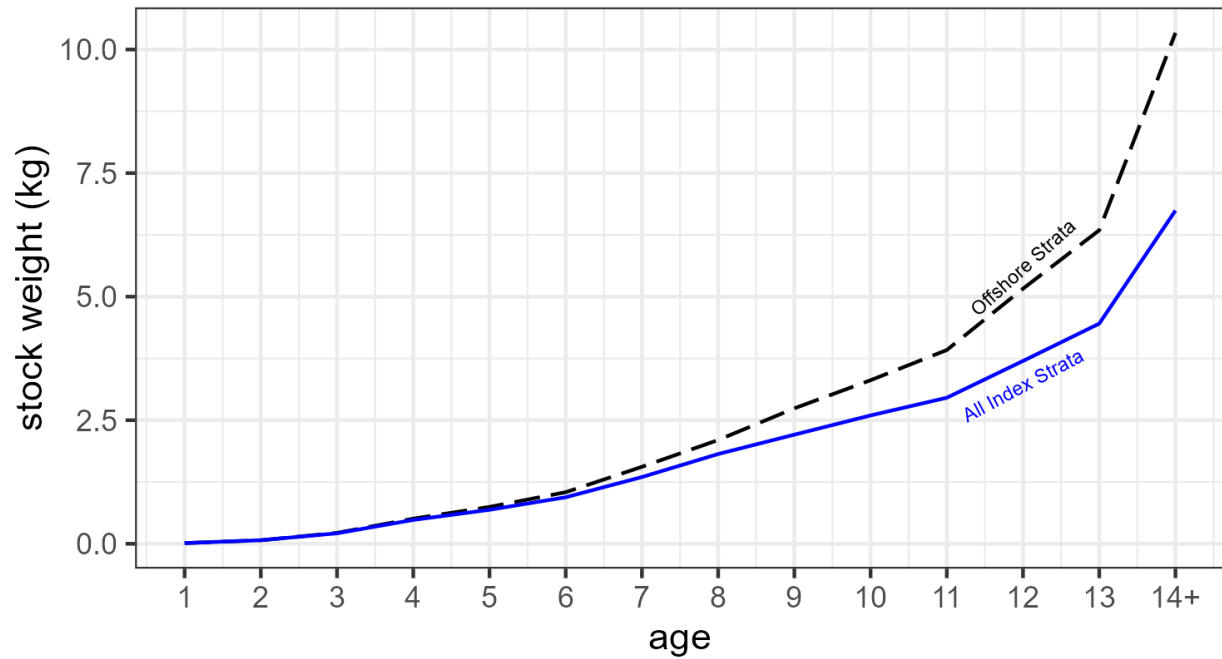


Figure 32: Stock weights at age in 2024 based on survey length-at-age estimated from offshore strata only (black dashed line) and all index strata (blue line).

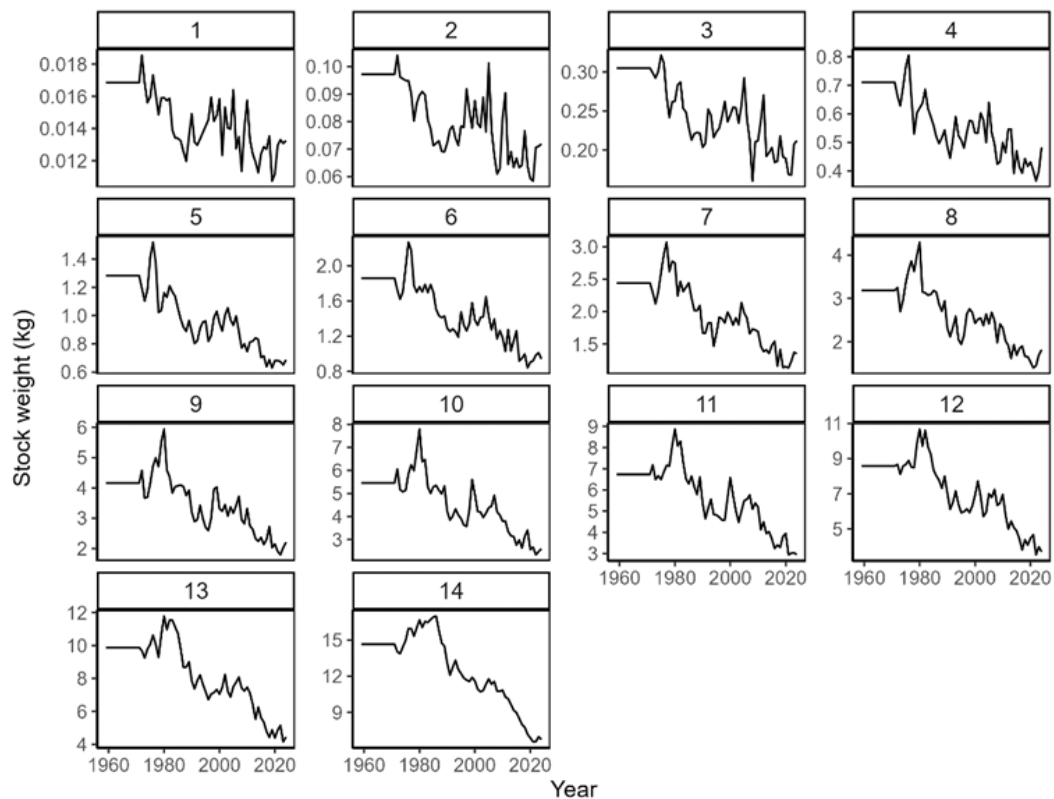
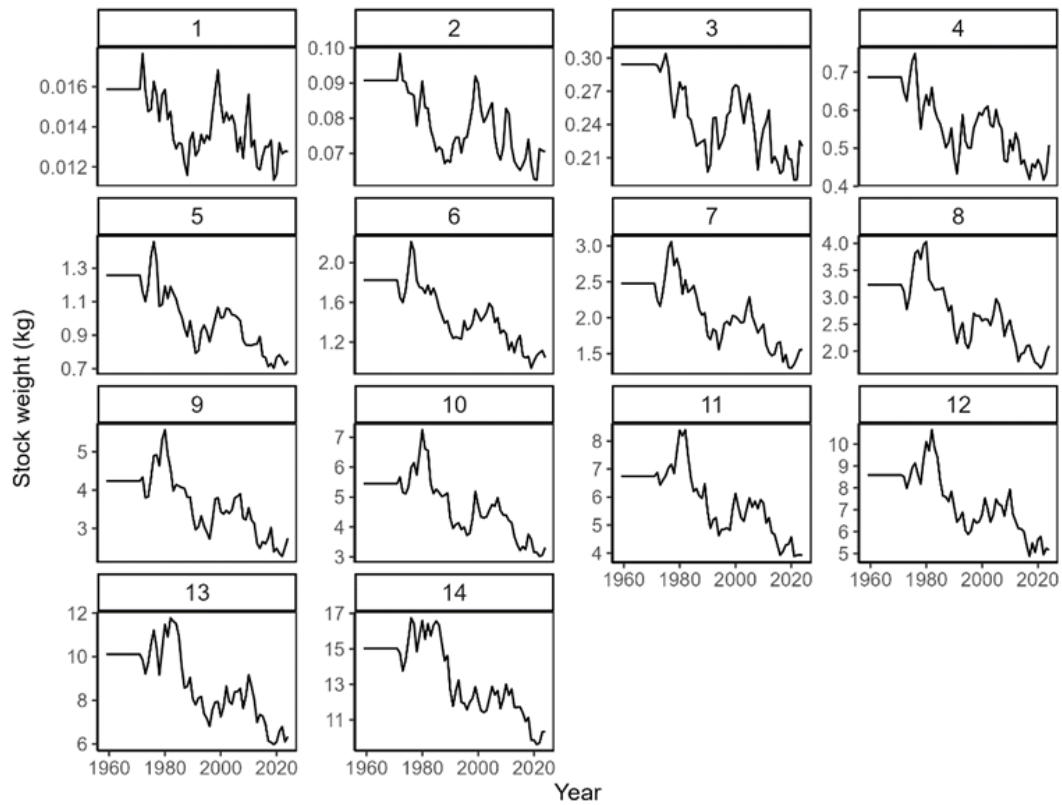


Figure 33: Stock weight at age modelled from RV survey data using offshore strata (top) and all index strata since 1997 (bottom).

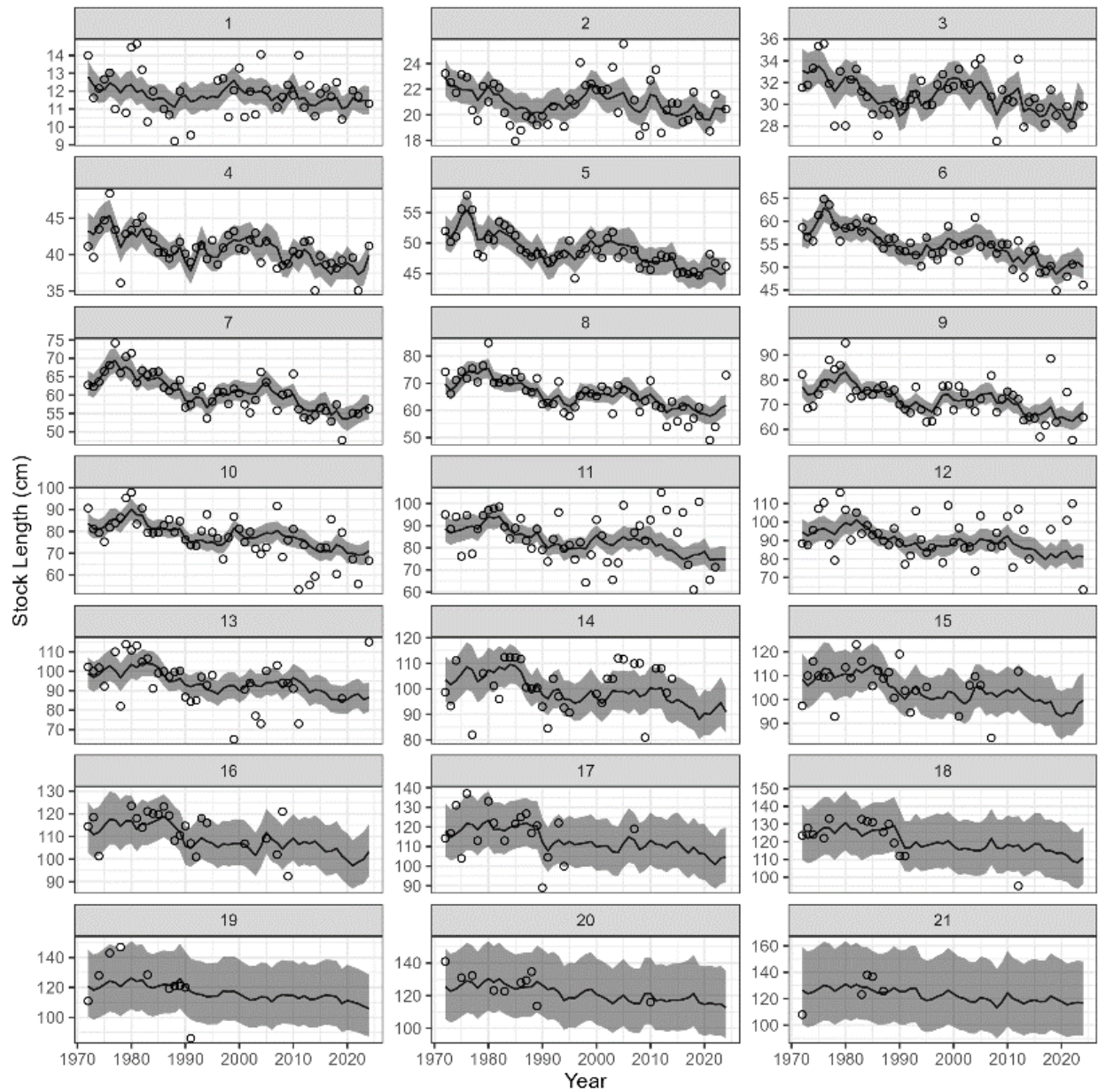


Figure 34: Observed (points) and model-predicted (lines) weight-at-age using offshore strata. Ages are listed at the top of each panel. Shaded regions indicate 95% confidence intervals.

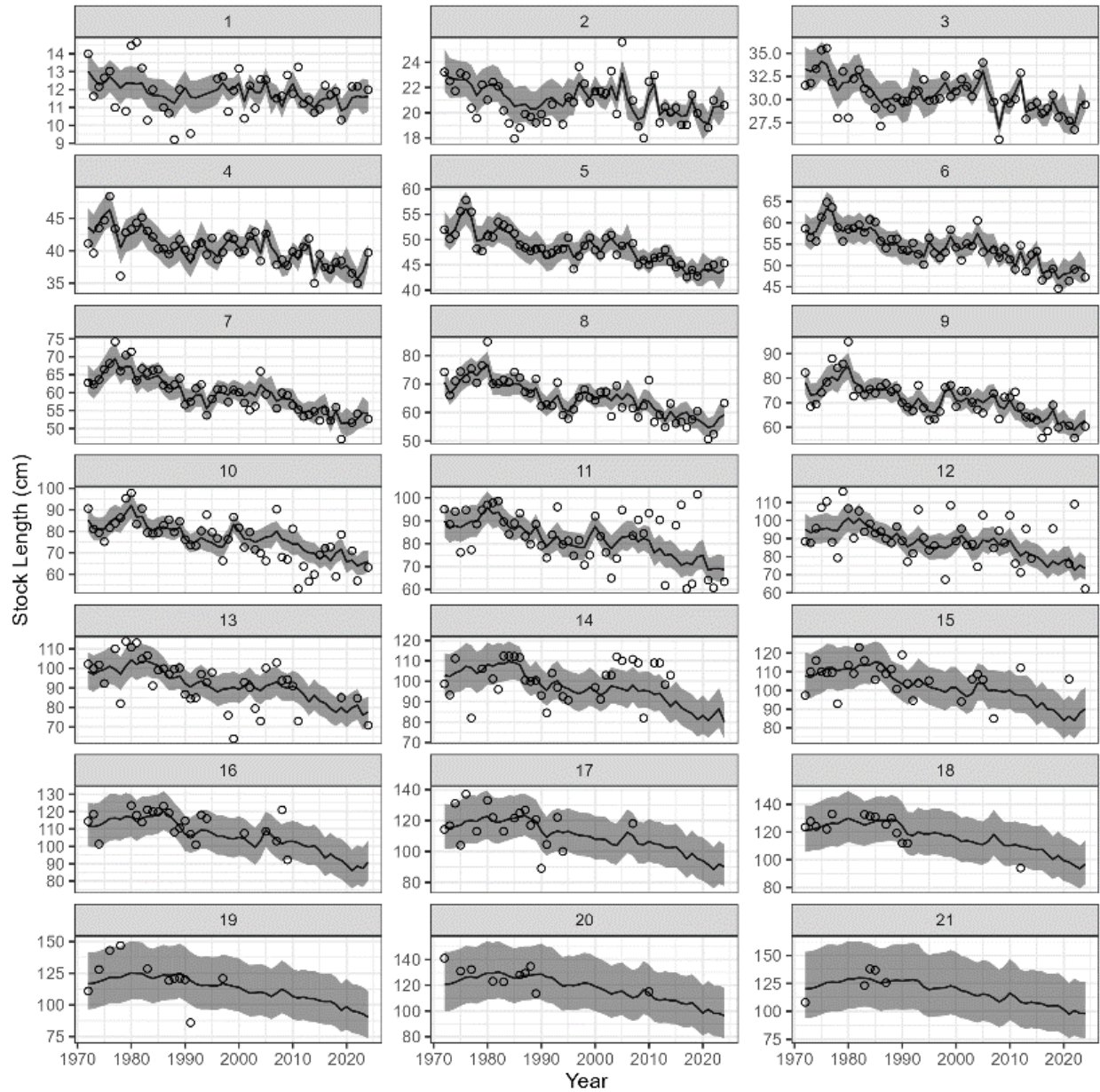


Figure 35: Observed (points) and model-predicted (lines) weight-at-age using all index strata since 1997. Ages are listed at the top of each panel. Shaded regions indicate 95% confidence intervals.

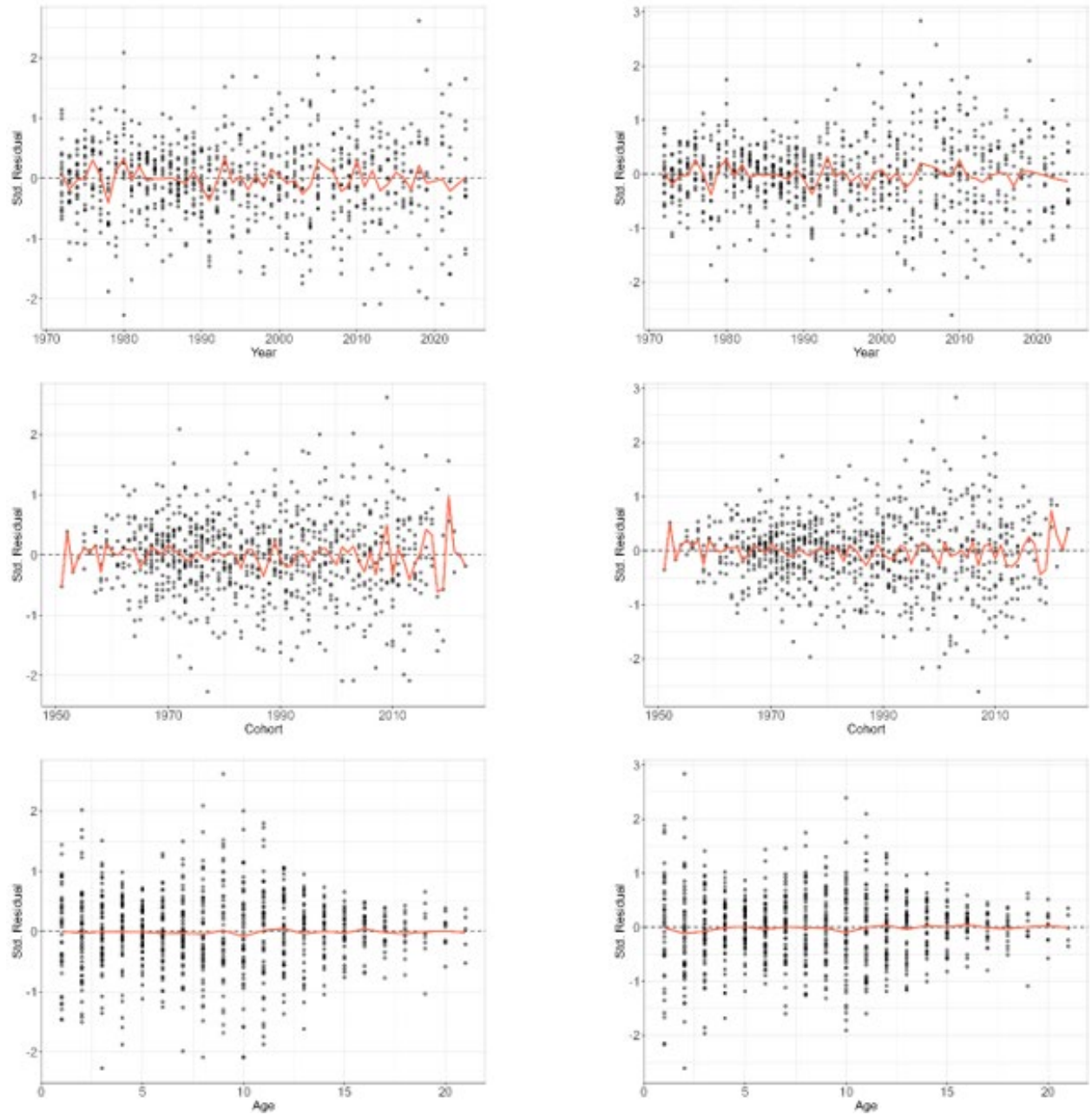


Figure 36: Standardized weight-at-age (offshore strata) residuals versus year (top), cohort (middle) and age (bottom) for models using offshore strata (left) and all index strata since 1997 (right). Red lines indicate the average residual by year or cohort.

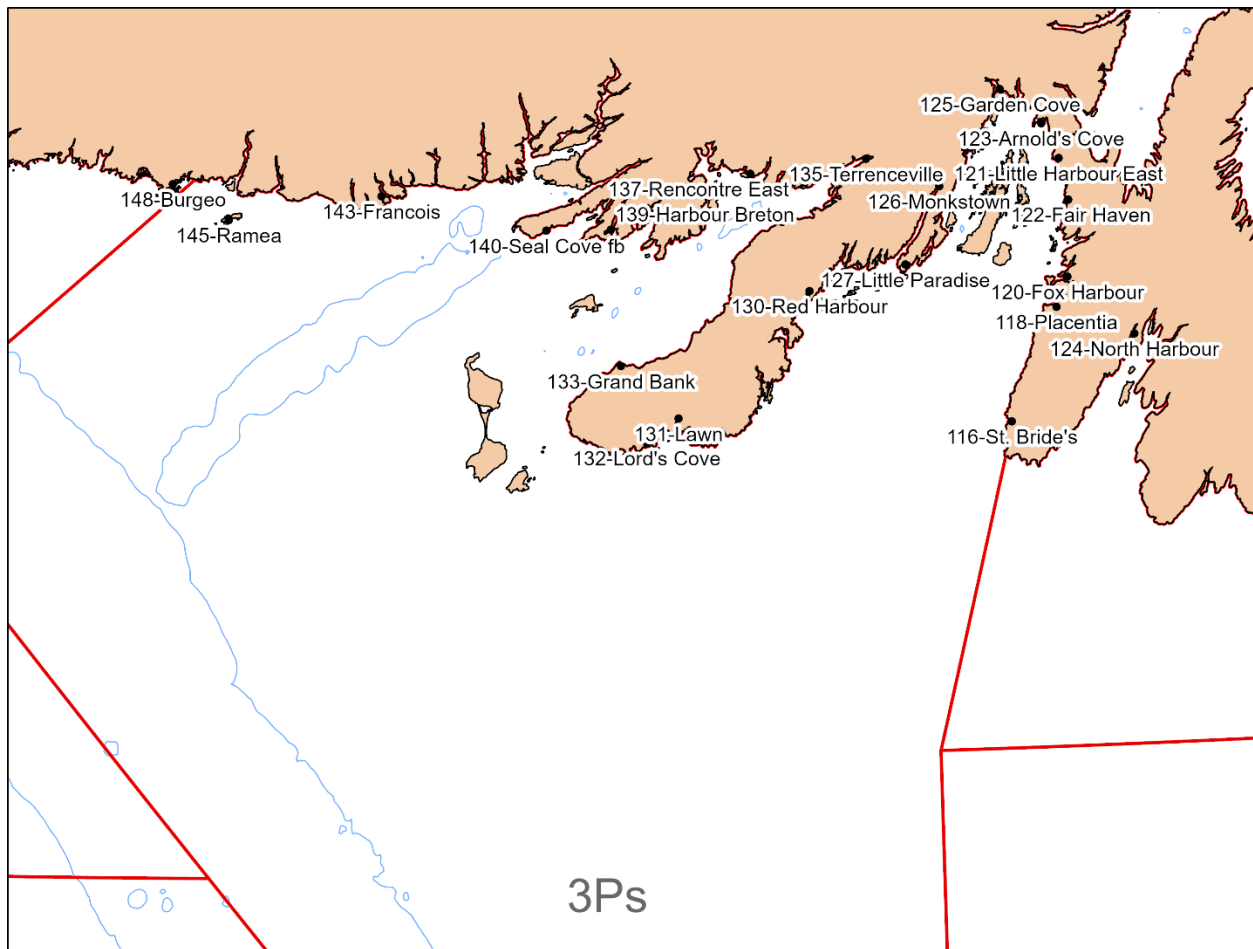


Figure 37: Locations of sentinel sites in NAFO Subdivision 3Ps.

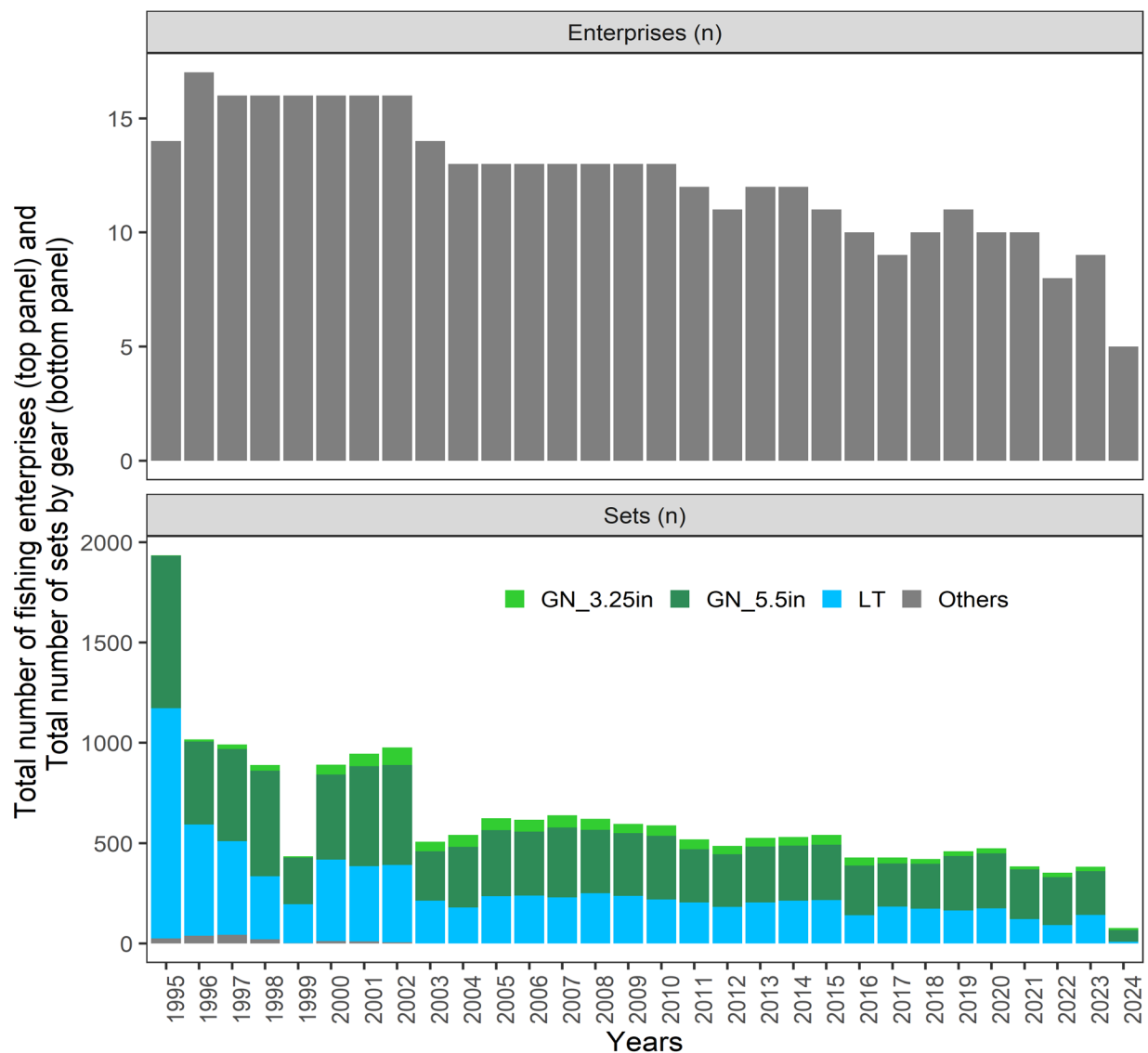


Figure 38: The number of annual participation of fishing enterprises in the Sentinel survey from 1995–2023. The colors in bottom panel represent the number of different types of gear used in total sets for each year. Note that data for the terminal year are incomplete as the sentinel program is ongoing for 2024.

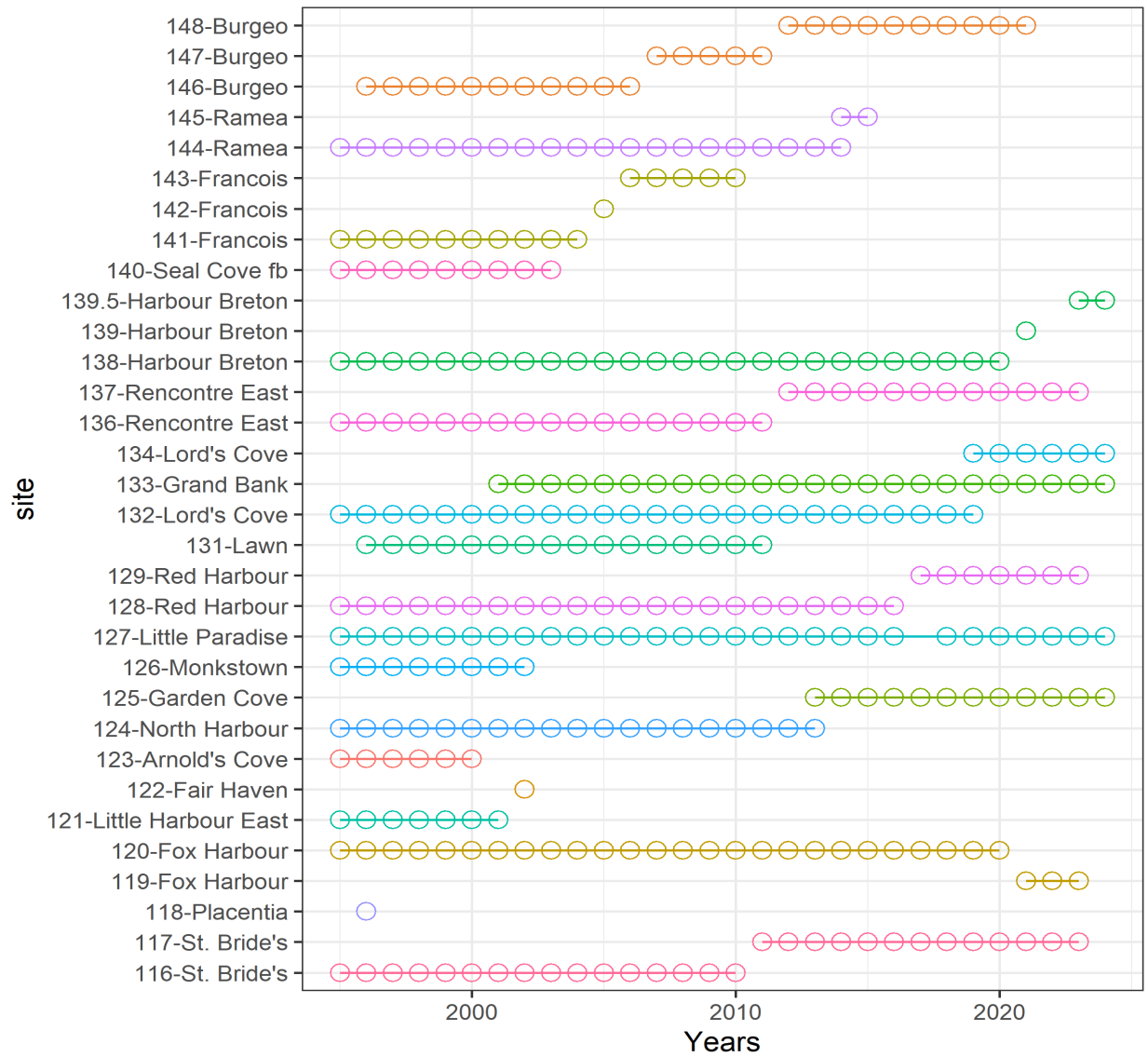


Figure 39: Fishing enterprises' commencement and conclusion years of participation in the Sentinel survey, regardless of the gear types employed, spanning from 1995–2023.

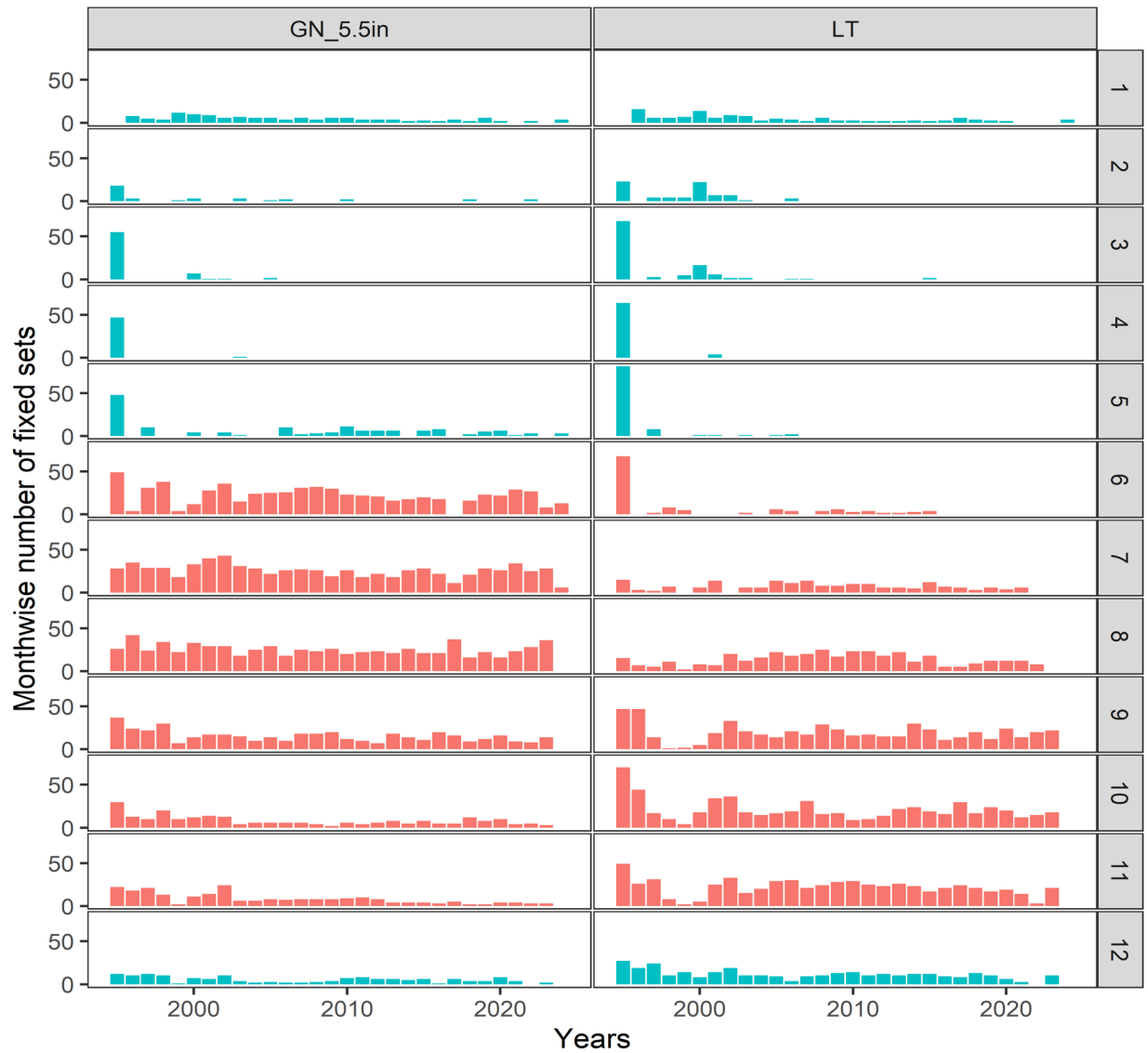


Figure 40: Number of sets by month for fixed gears spanning from 1995–2023. The data used for the standardization of catch rates is from June to November (months 8–11 in pink).

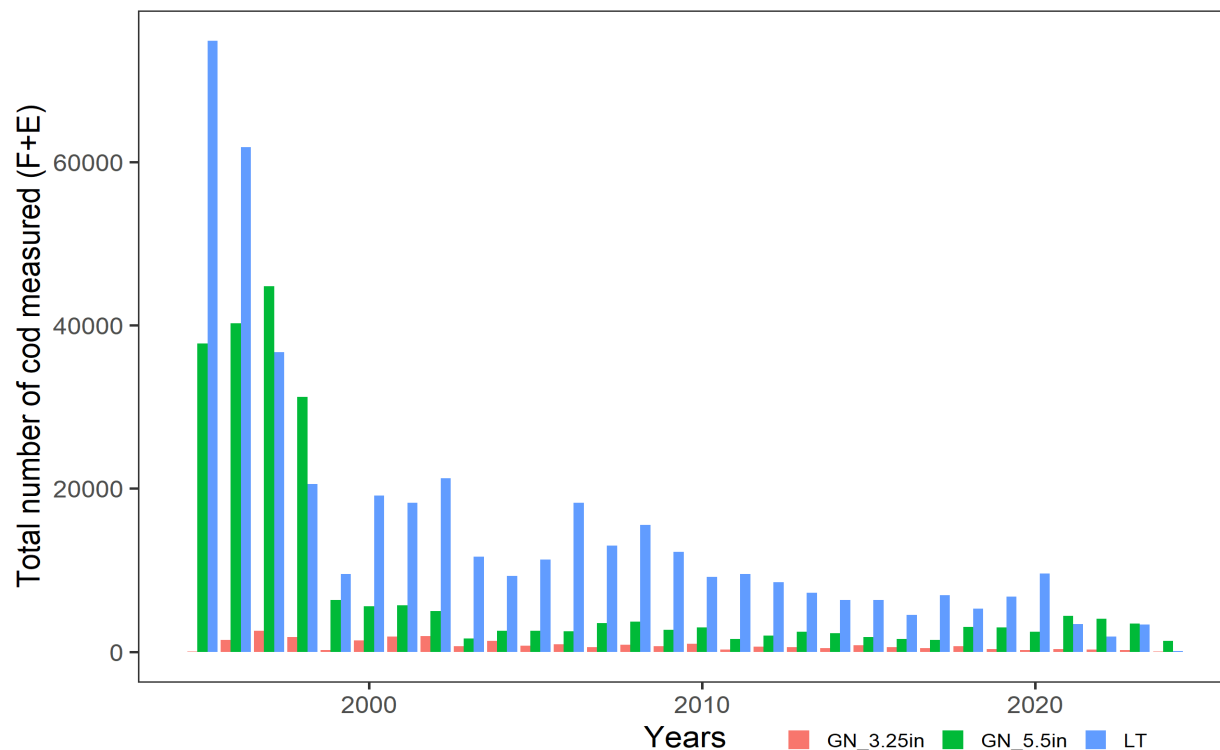


Figure 41: Yearly count of the number of Atlantic Cod caught, encompassing both fixed and experimental sets, categorized by gear. Note that data for the terminal year (2024) are incomplete.

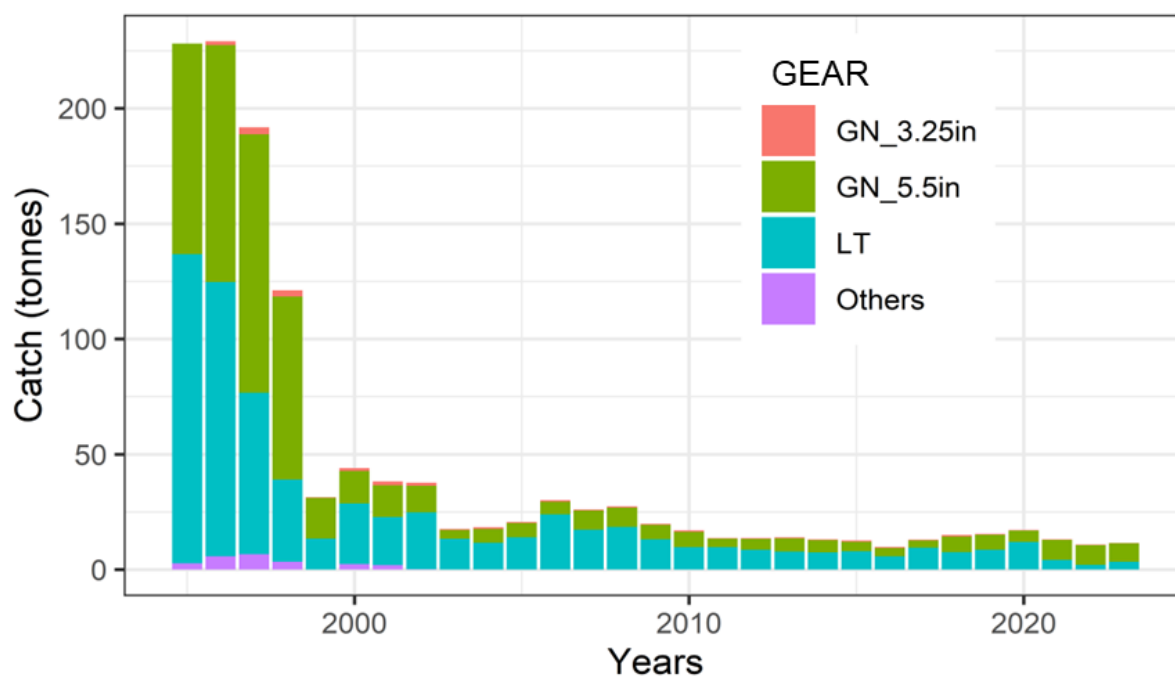


Figure 42: Total Atlantic Cod predicted landings, encompassing both fixed and experimental sets, categorized by gears. Note that data for the terminal year (2024) are incomplete.

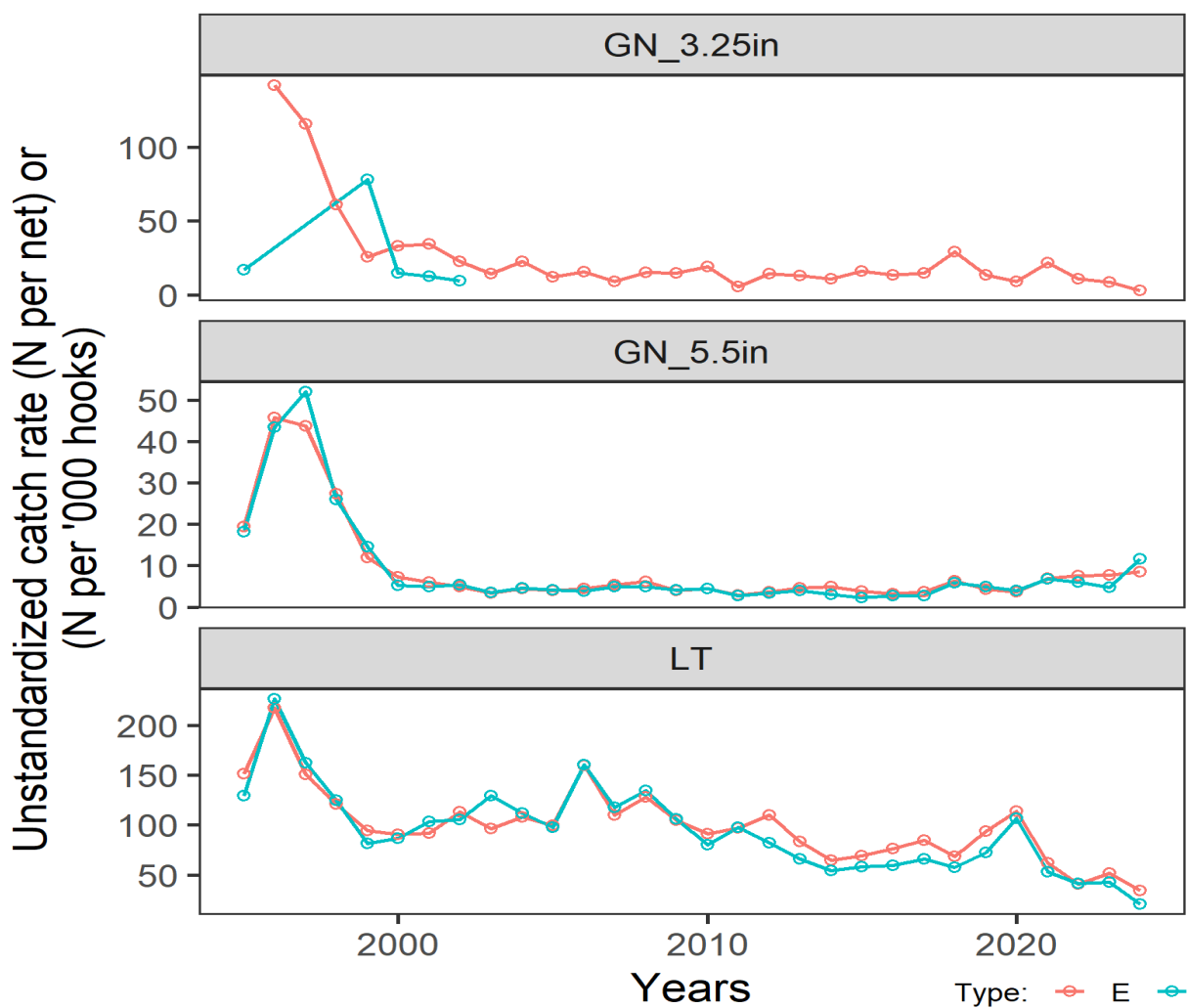


Figure 43: Annual unstandardized catch rates categorized by gear type: Fixed (F) or Experimental (E). Catch rates are measured per tow for gill nets and per 1000 hooks for line trawl. Note that data for the terminal year (2024) are incomplete.

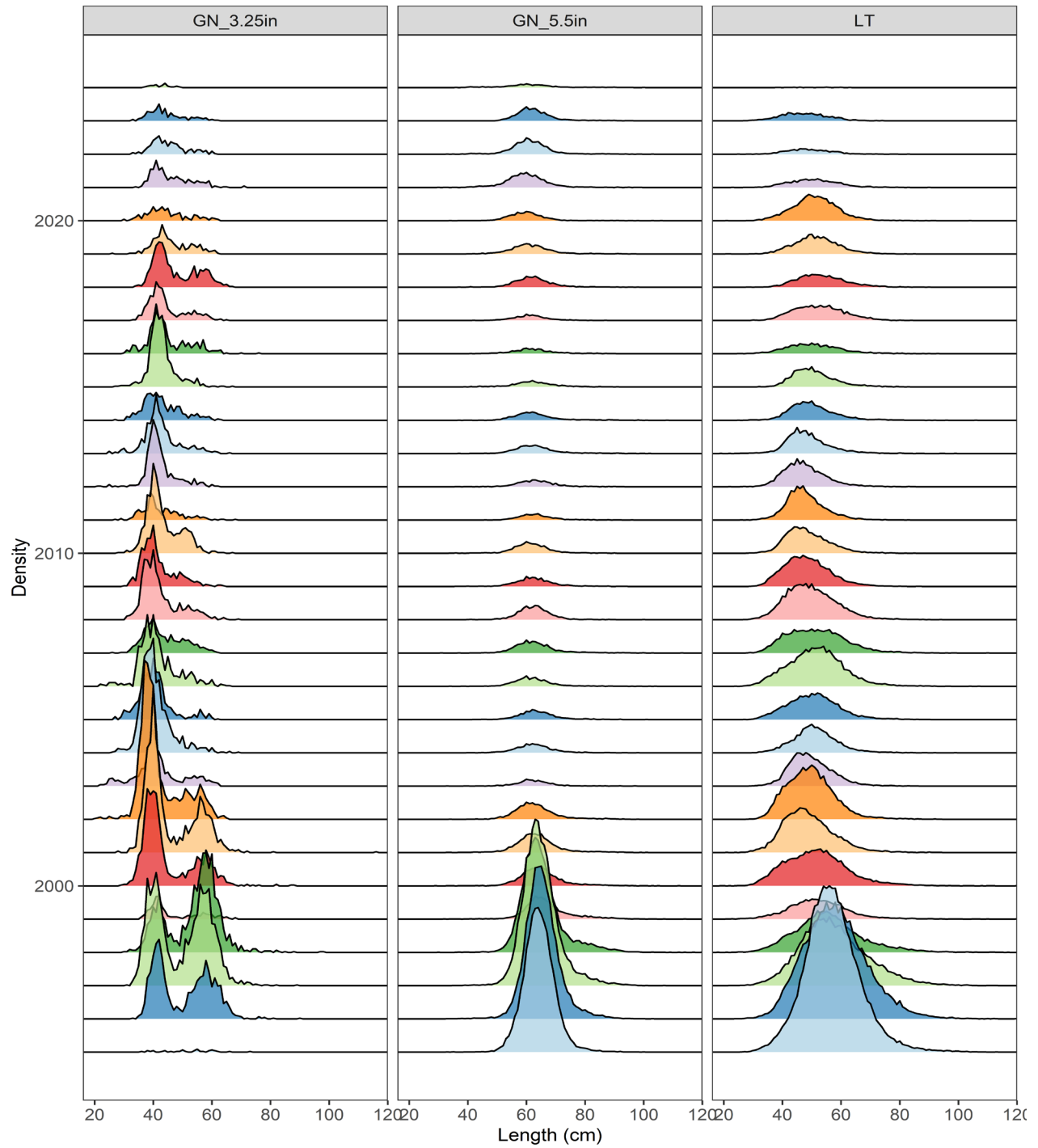


Figure 44: Density plot for number of fish caught in each length bin for gears. The total count represents the cumulative number of fish caught using both gear types (Fixed and Experimental). Note that the scale is relative within each gear category. Note that the scale is relative within each gear category, and data for the terminal year (2024) are incomplete.

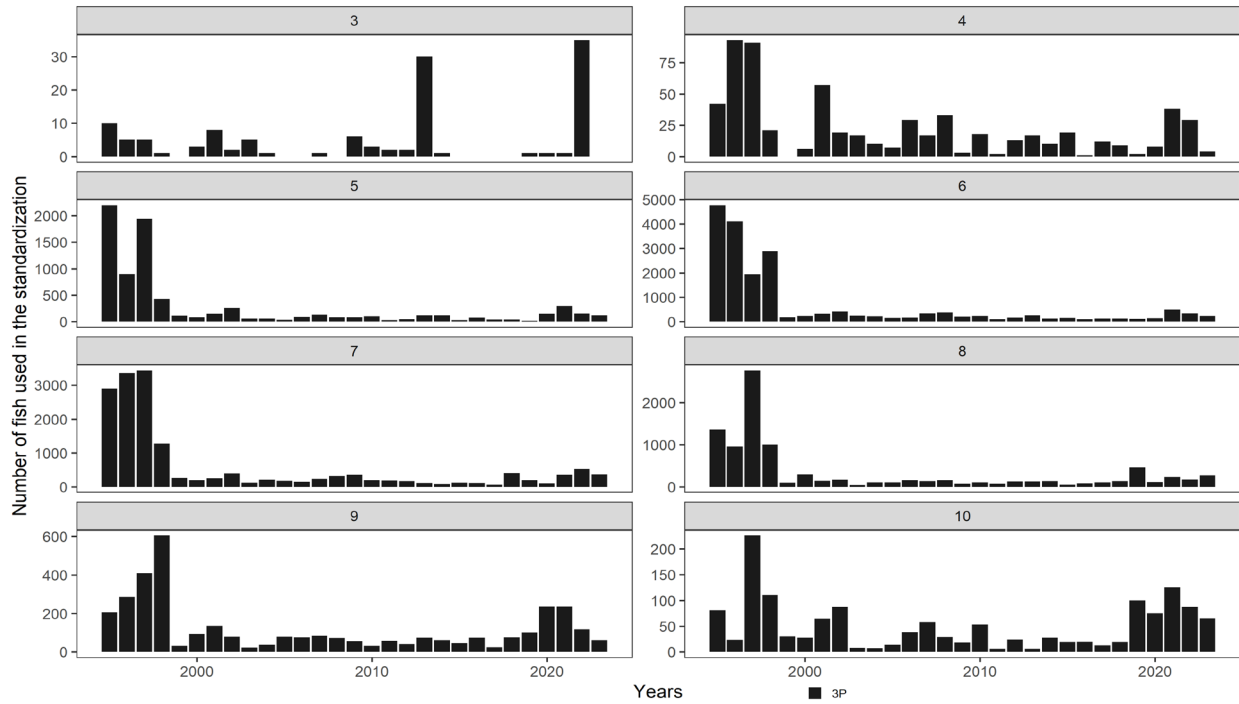


Figure 45: Total number of fish in 5.5 inch gillnet used for generating standardized indices. Panels show fish ages.

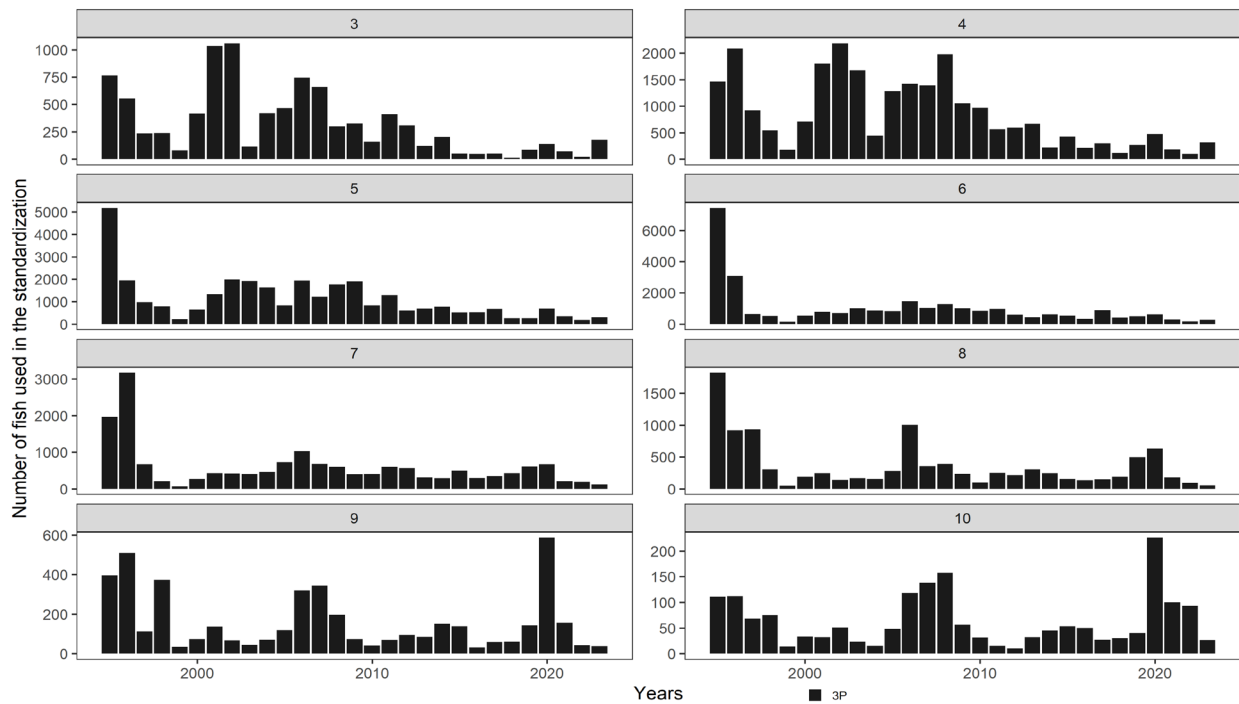


Figure 46: Total number of fish in linetrawl used for generating standardized indices. Panels show fish ages.

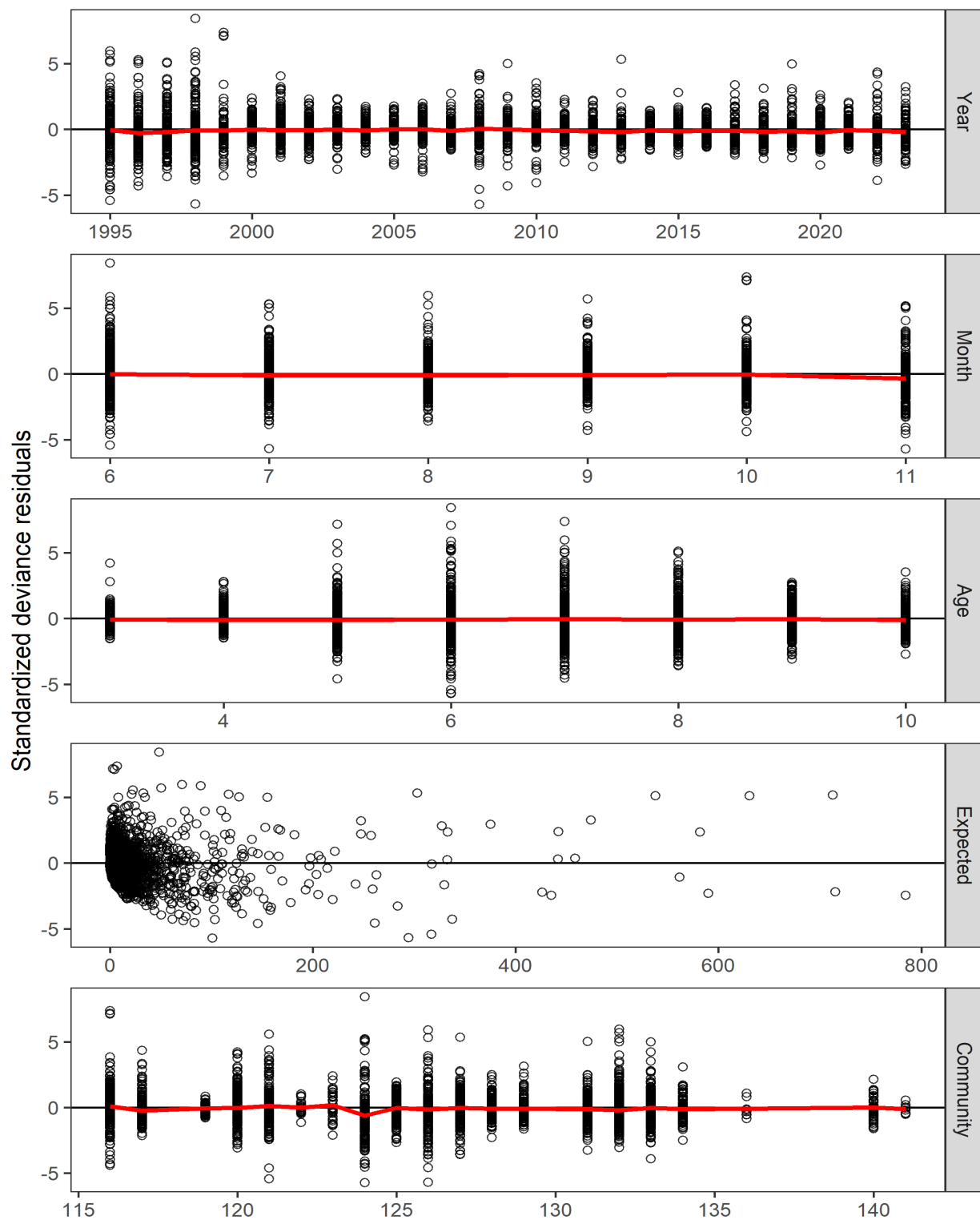


Figure 47: Standardized deviance residuals against years, months, ages, expected values, and community (seqcode) for 5.5 inch fixed gillnet.

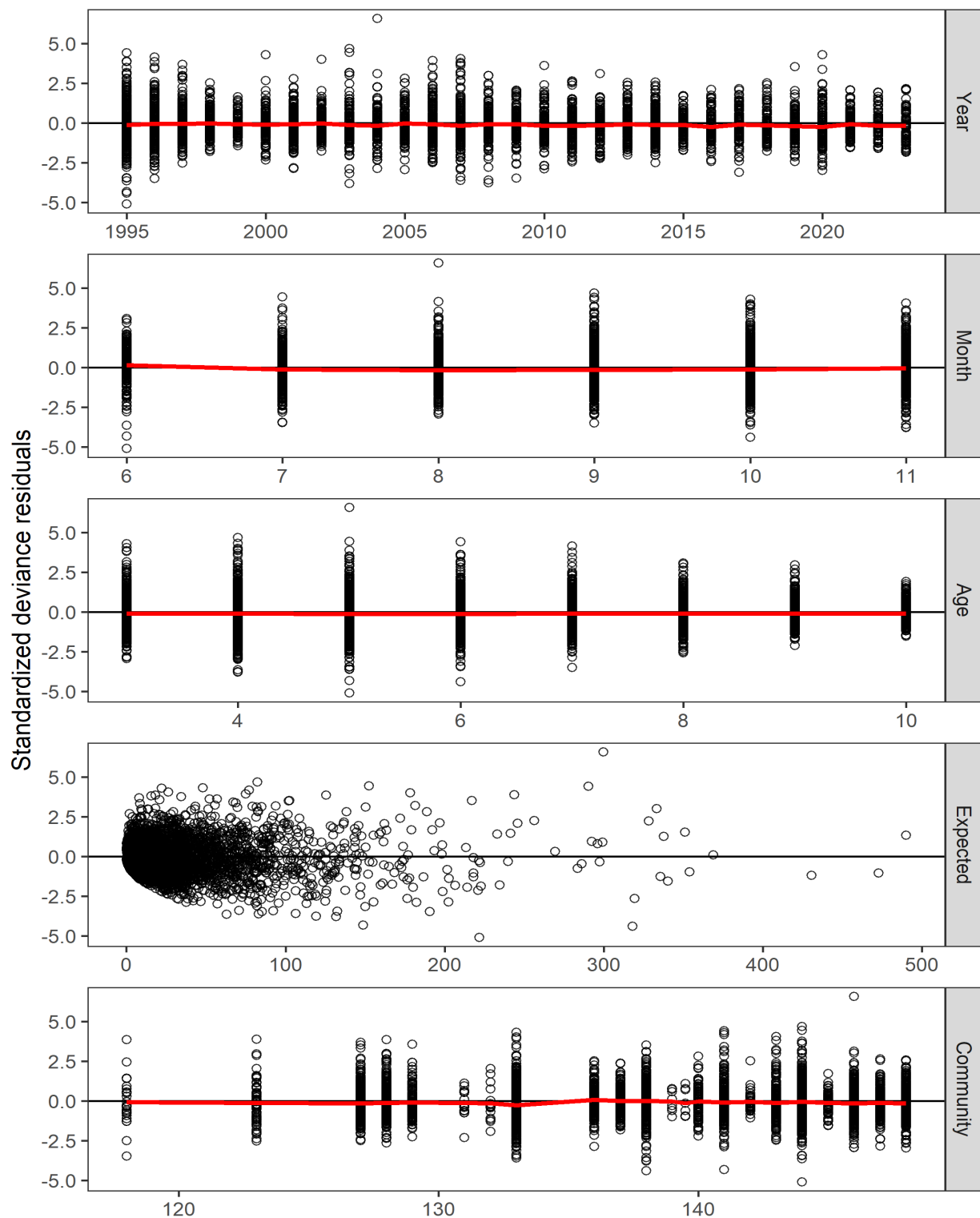


Figure 48: Standardized deviance residuals against years, months, ages, expected values, and community (seqcode) for linetrawl.

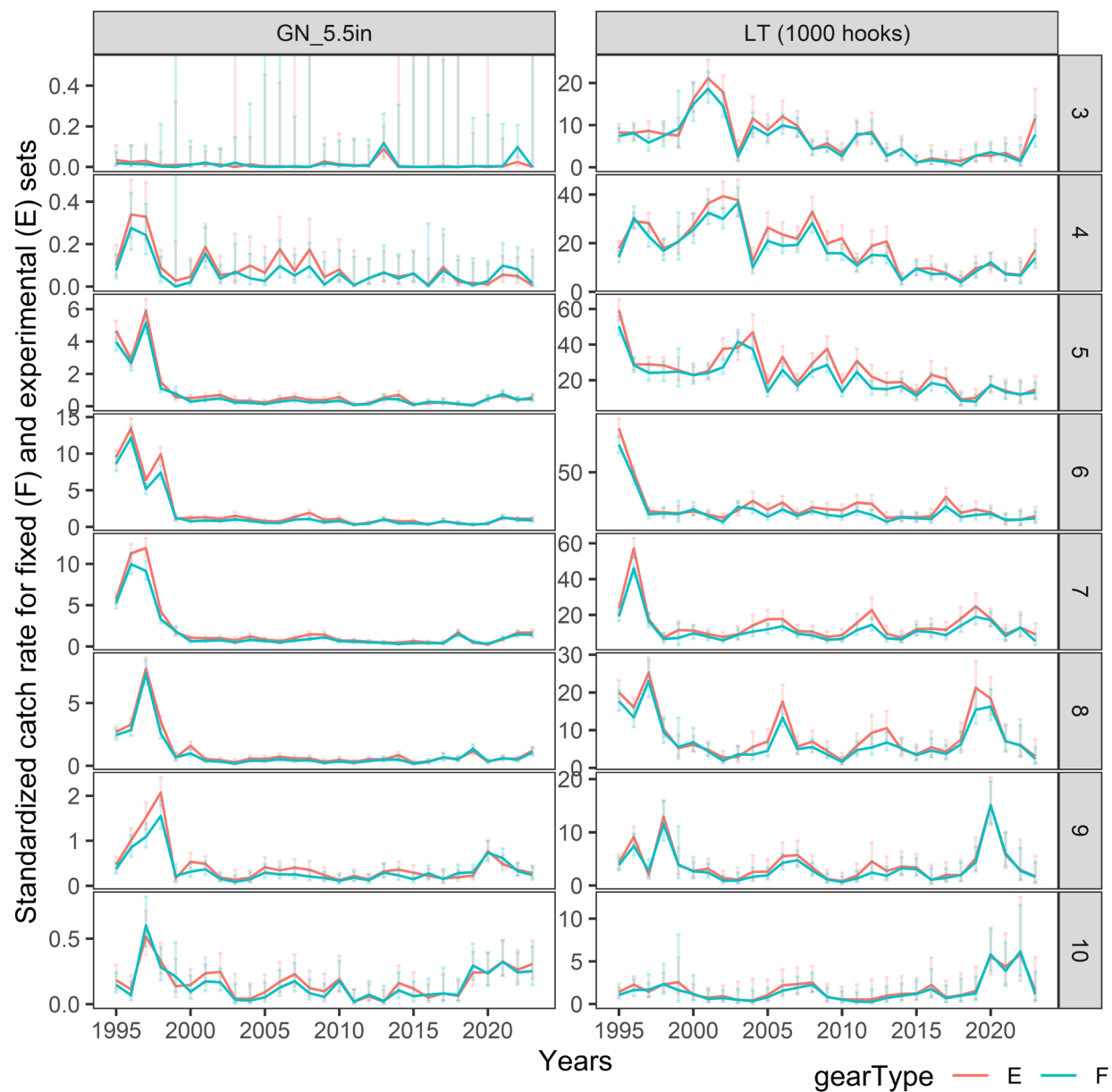


Figure 49: Standardized catch rate for 5.5 inch gillnet (left) and linetrawl (right) for experimental (E) and fixed (F) sites from 1995–2023.

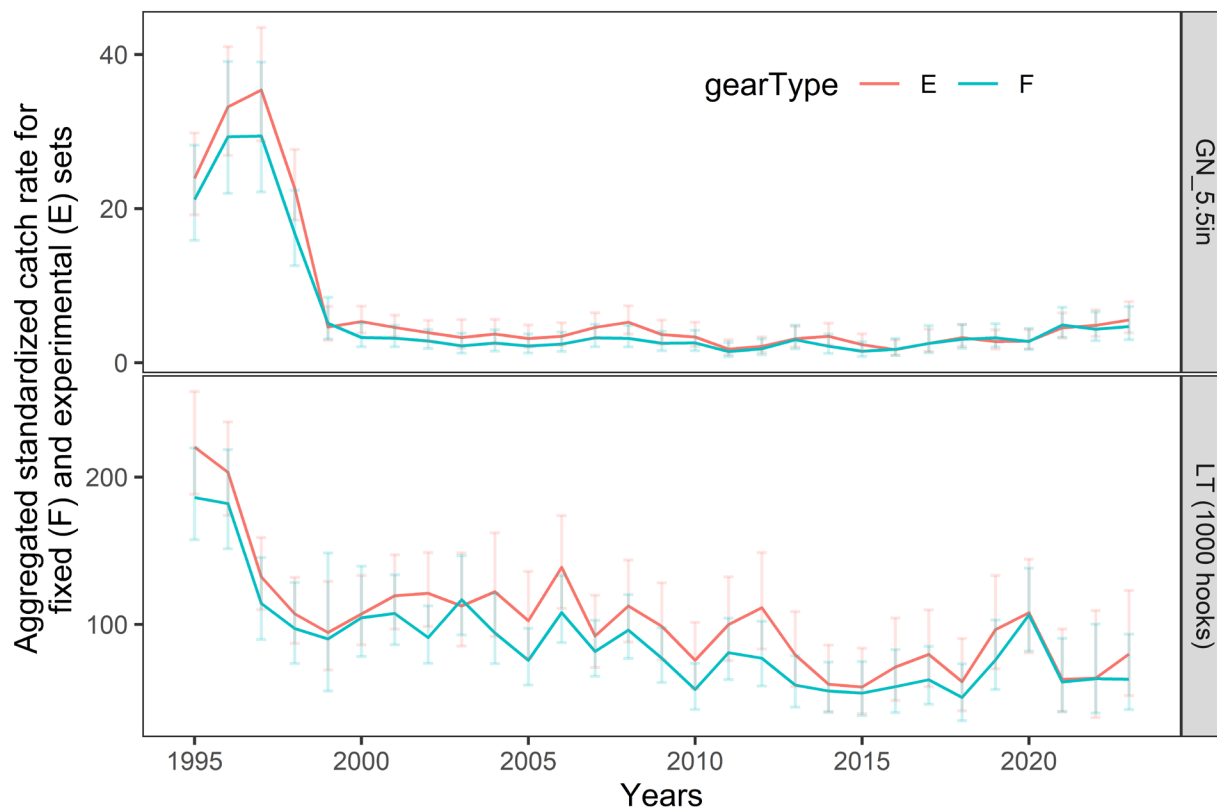


Figure 50: Aggregated standardized catch rate for 5.5 inch gillnet and linetrawl (per 1000 hooks) for experimental (E) and fixed (F) sets.

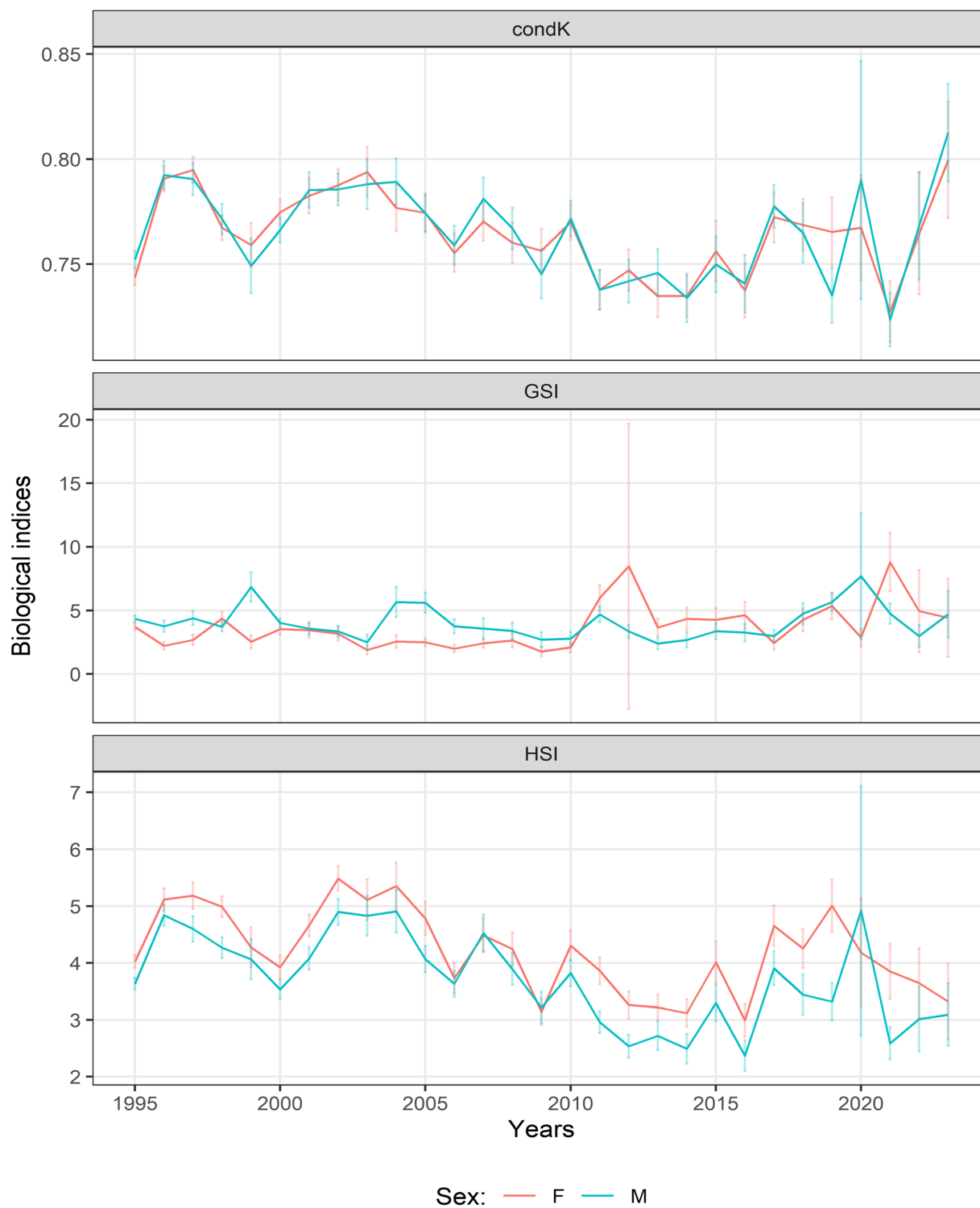


Figure 51: Yearly trends in Mean Fulton's K Condition Factor, Hepatosomatic Index (HSI), and Gonadosomatic Index (GSI) by Sex in Atlantic Cod from Sentinel Surveys in 3Ps. GSI and HSI are in percentage.

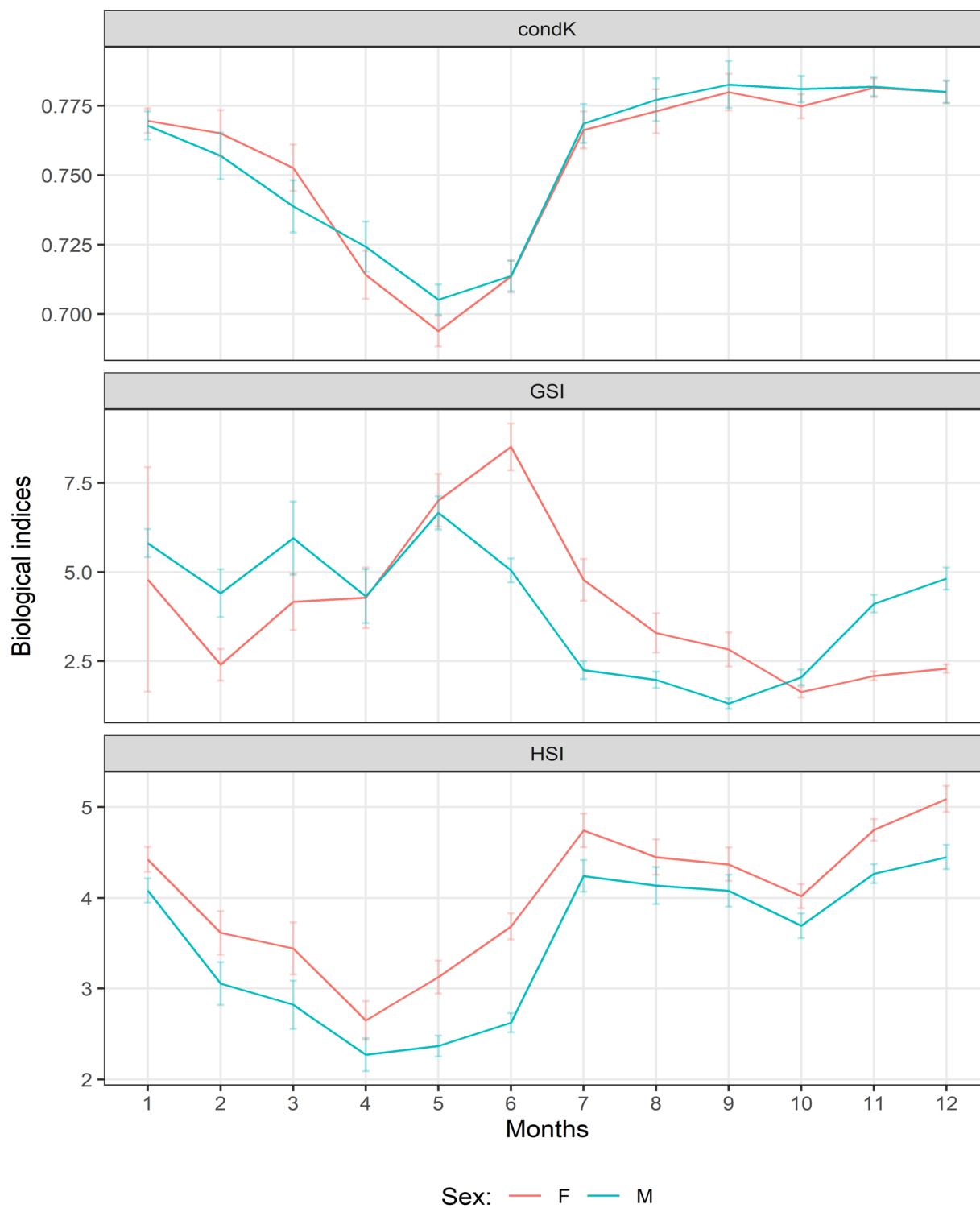


Figure 52: Monthly trends in Mean Fulton's K Condition Factor (condK), Hepatosomatic Index (HSI), and Gonadosomatic Index (GSI) by Sex in Atlantic Cod from Sentinel Surveys in 3Ps. GSI and HSI are in percentage.

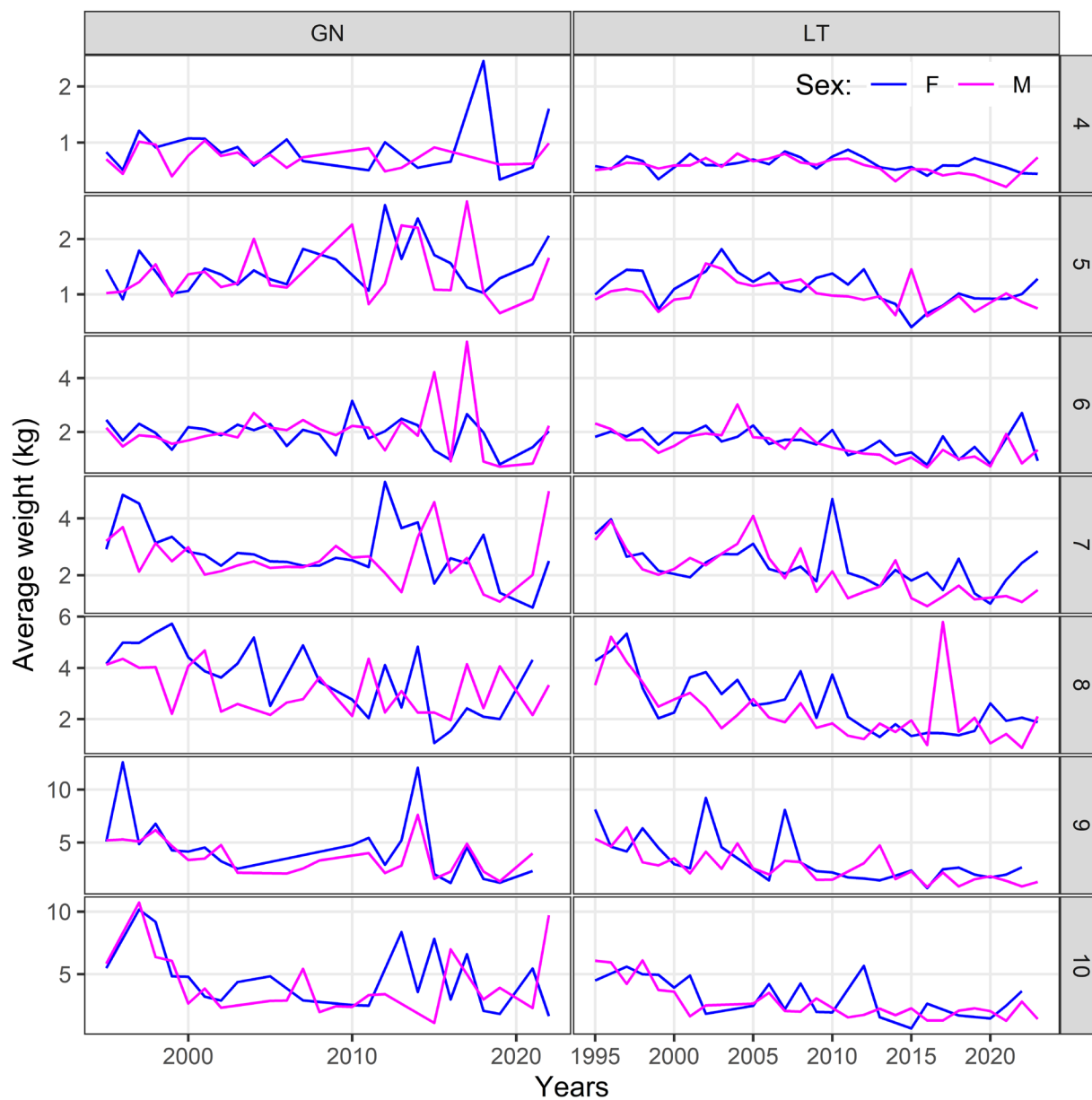


Figure 53: Mean weight-at-age (kg) by sex for fish sampled during Sentinel surveys in 5.5" gillnet (left) and linetrawl (right).

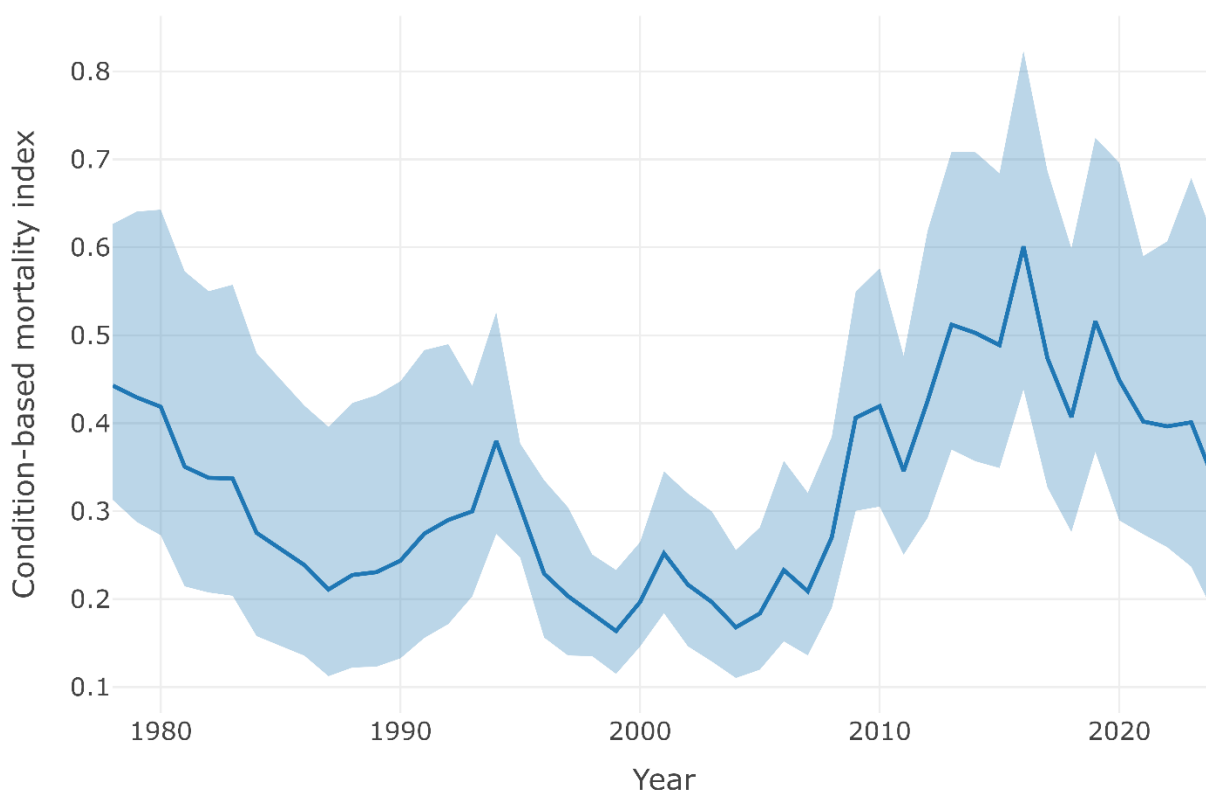


Figure 54: Condition-based mortality index estimated following Regular et al. 2022.

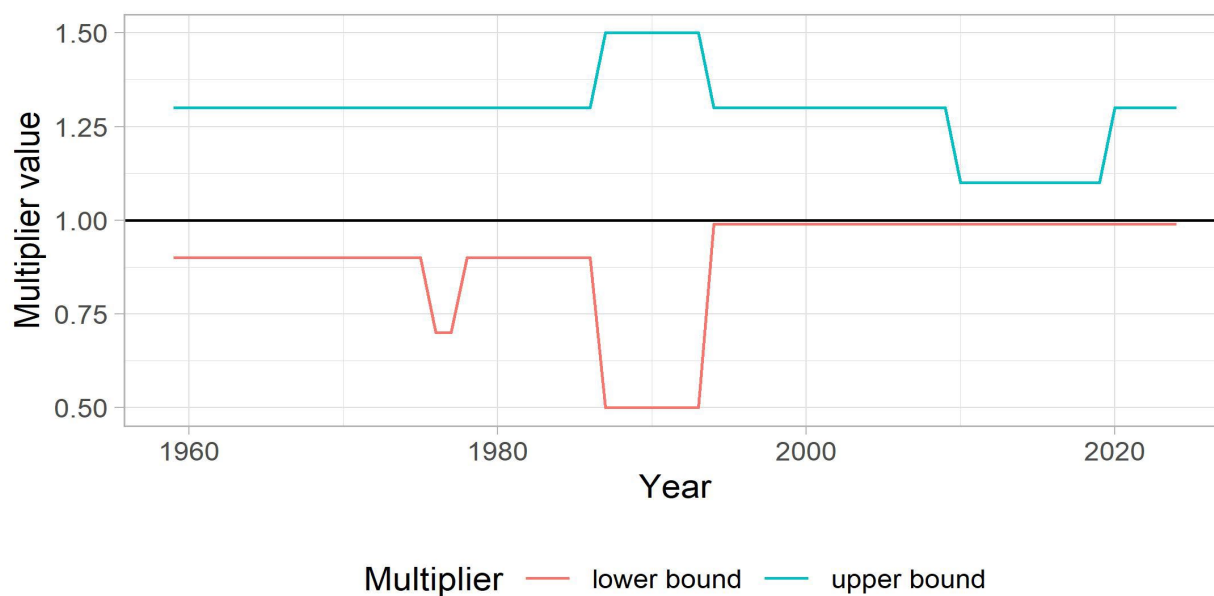


Figure 55: Lower and upper bounds for the landings data decided at the Framework meeting for 3Ps cod in October 2019, and subsequently updated for 2020 onwards at the 2024 Assessment.

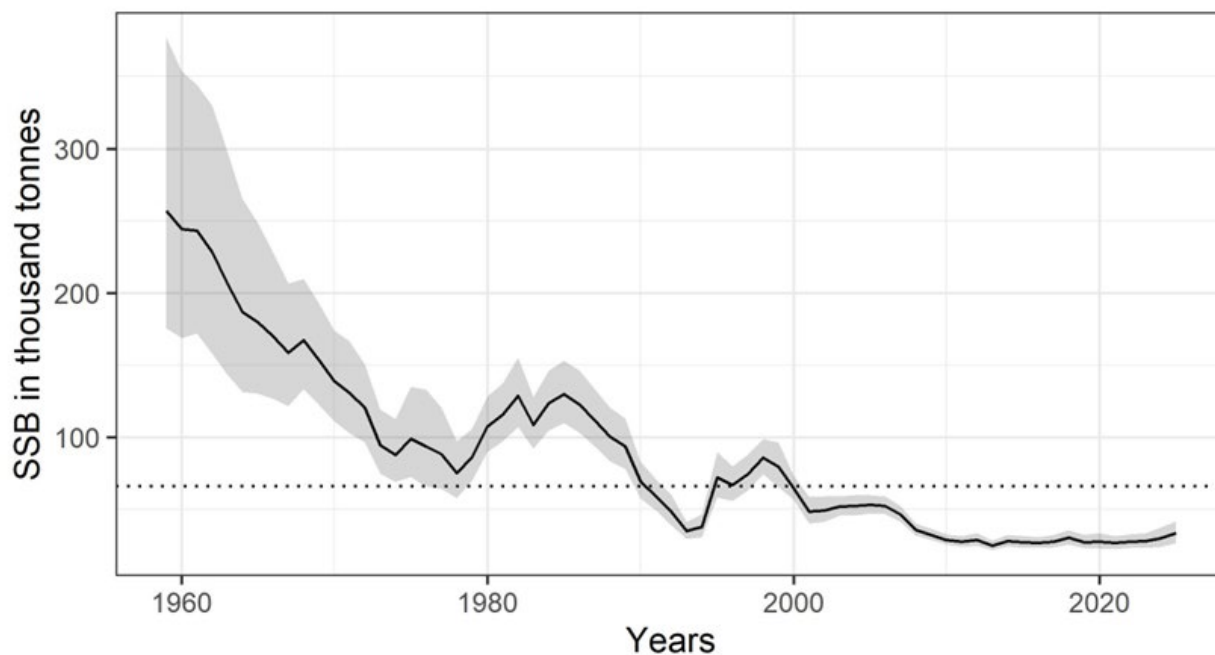


Figure 56: Estimates of SSB (median estimate with 95% confidence interval) for the period 1959–2025. Dashed line indicates *Blim*. This reference point represents the boundary between the Critical and Cautious Zones of DFO's Precautionary Approach framework.

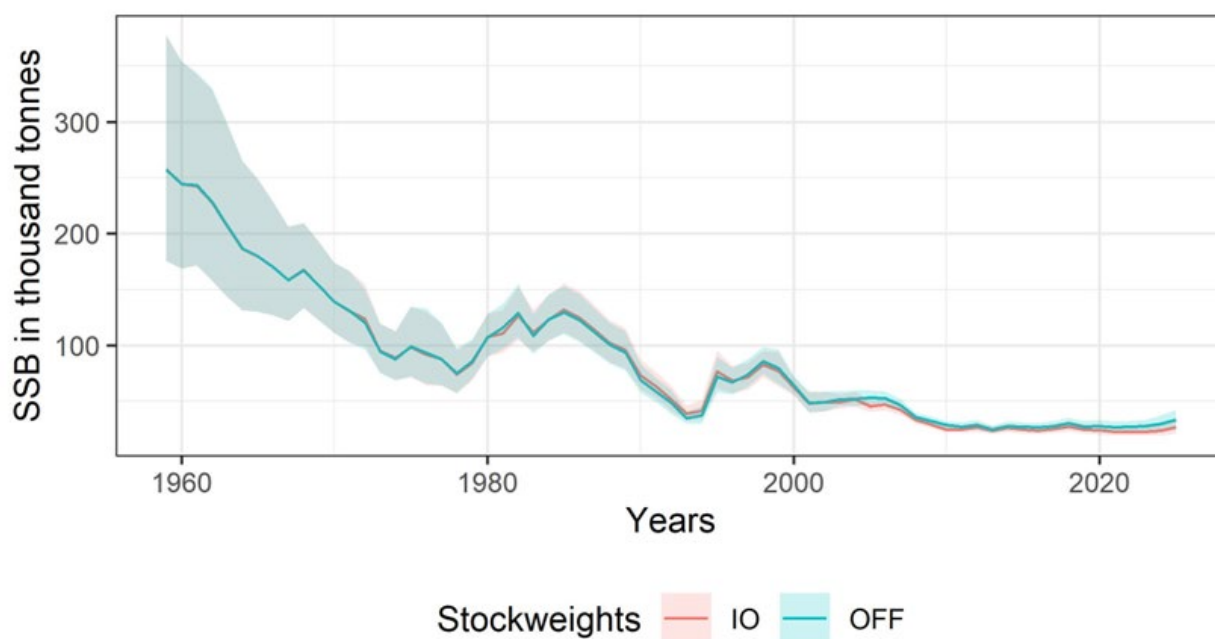


Figure 57: Comparison of estimates of SSB when the model is run with stock weights based on offshore strata only (OFF) and when samples from all index strata (IO) are included in stock weight estimation.

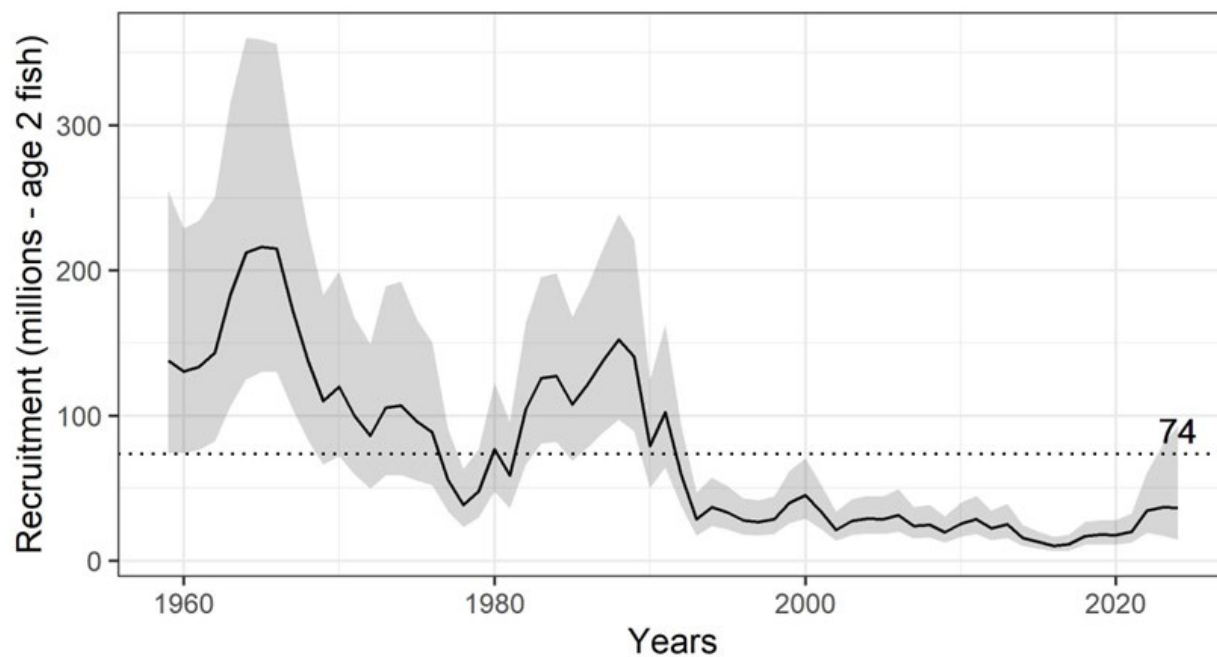


Figure 58: Estimates of recruitment for the period 1959–2024. The dotted line represents the time-series average of 74 million fish.

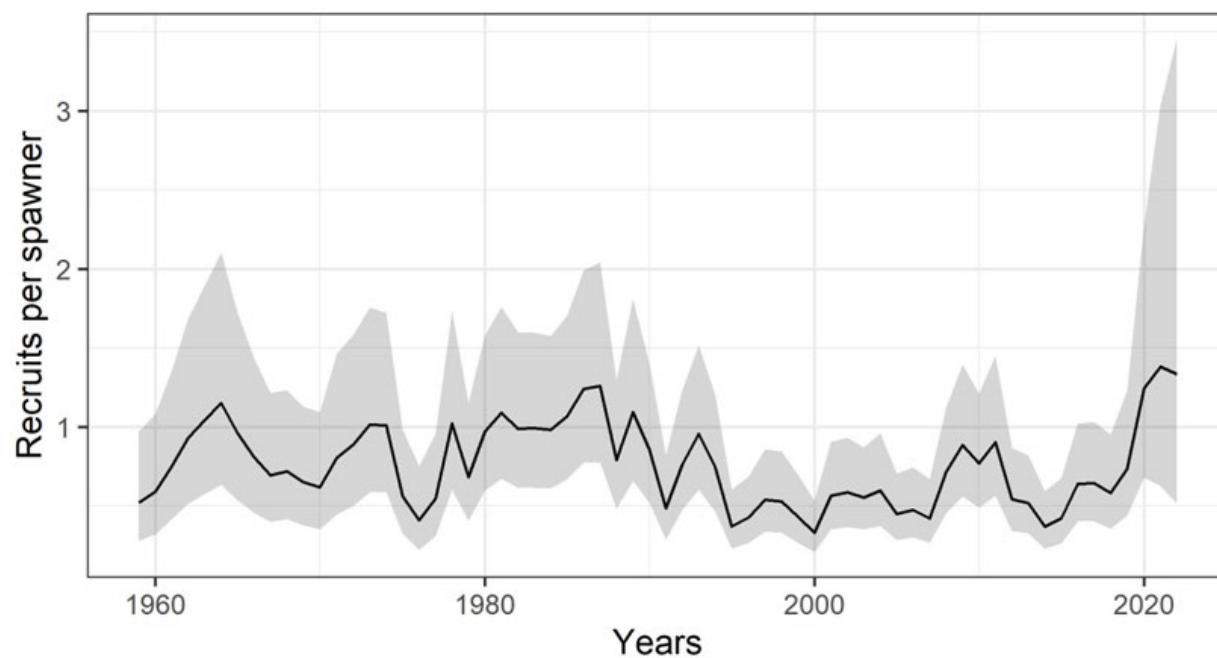


Figure 59: Estimates of recruits per spawner for the period 1959–2021.

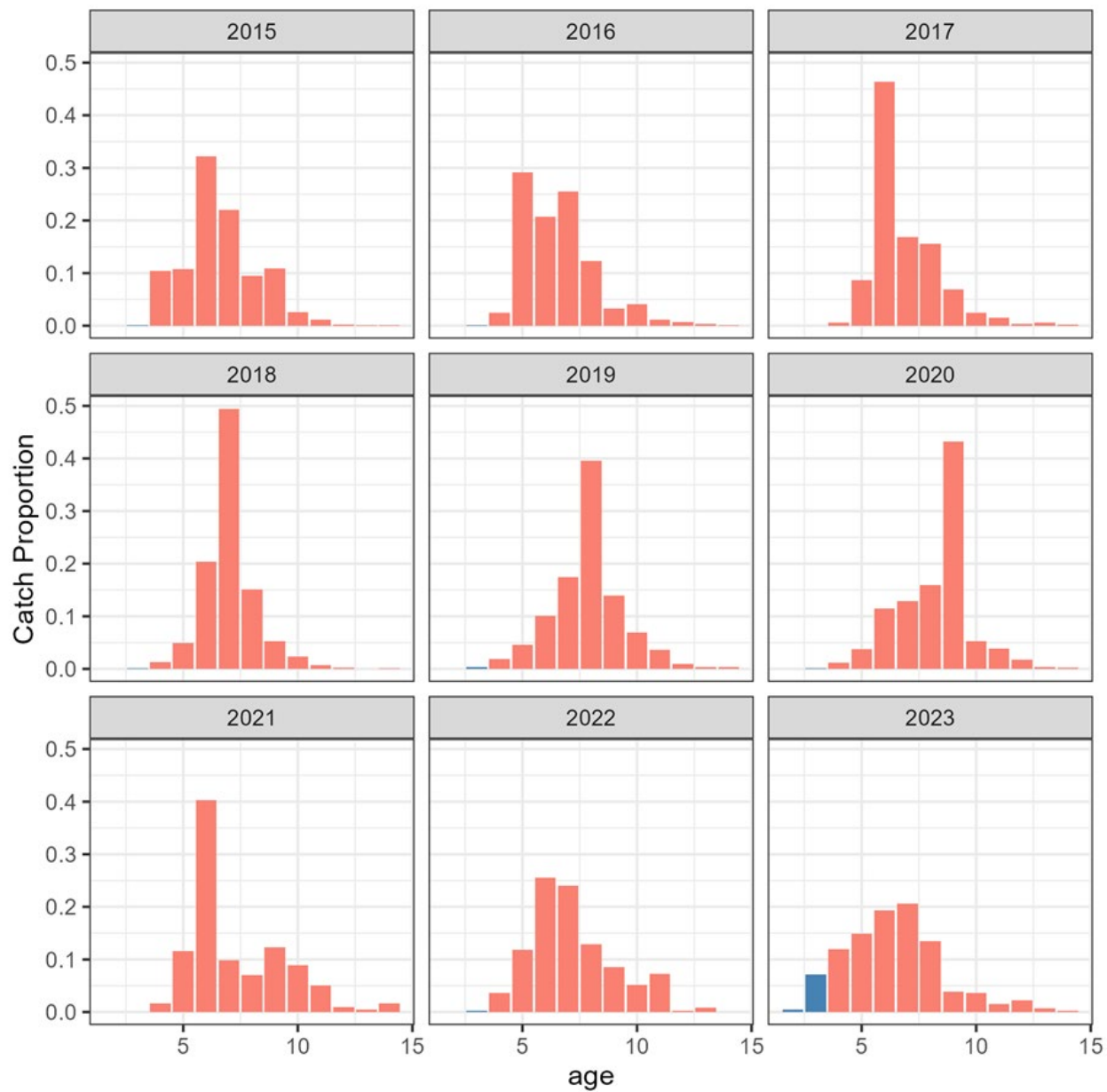


Figure 60: Proportion in Commercial catch-at-age by numbers. Blue bars highlight the proportion fish ages 2 and 3 in the estimated catch-at-age.

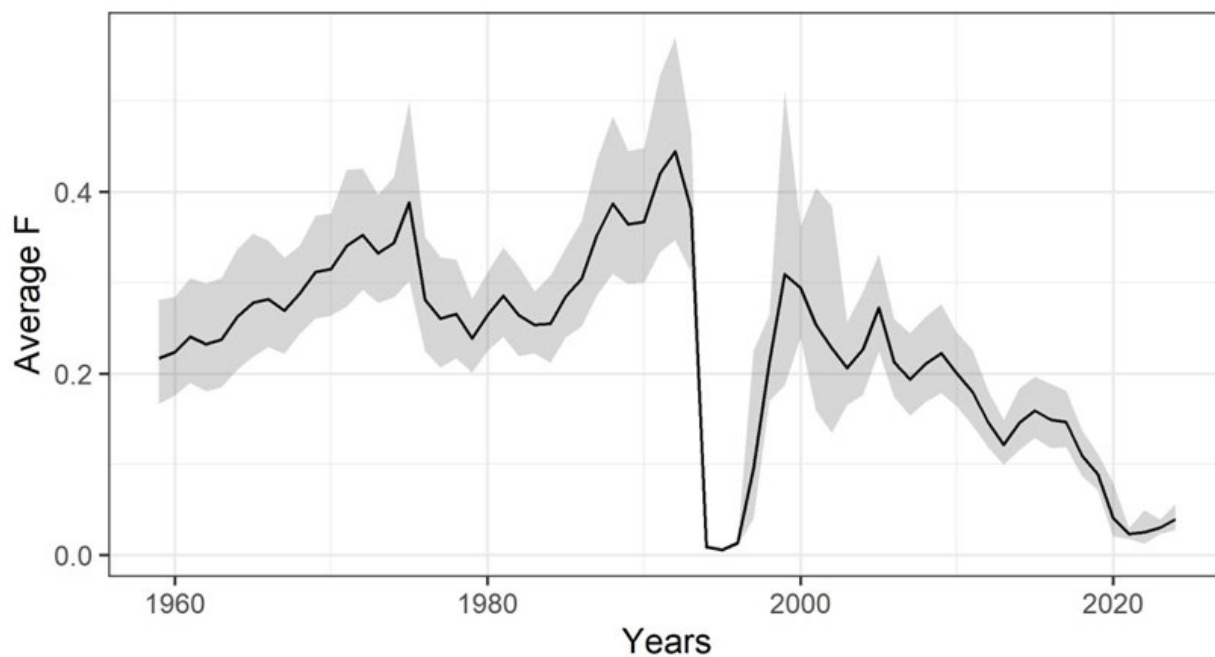


Figure 61: Average fishing mortality (F , ages 5 to 9) estimates for 3Ps cod between 1959 and 2024.

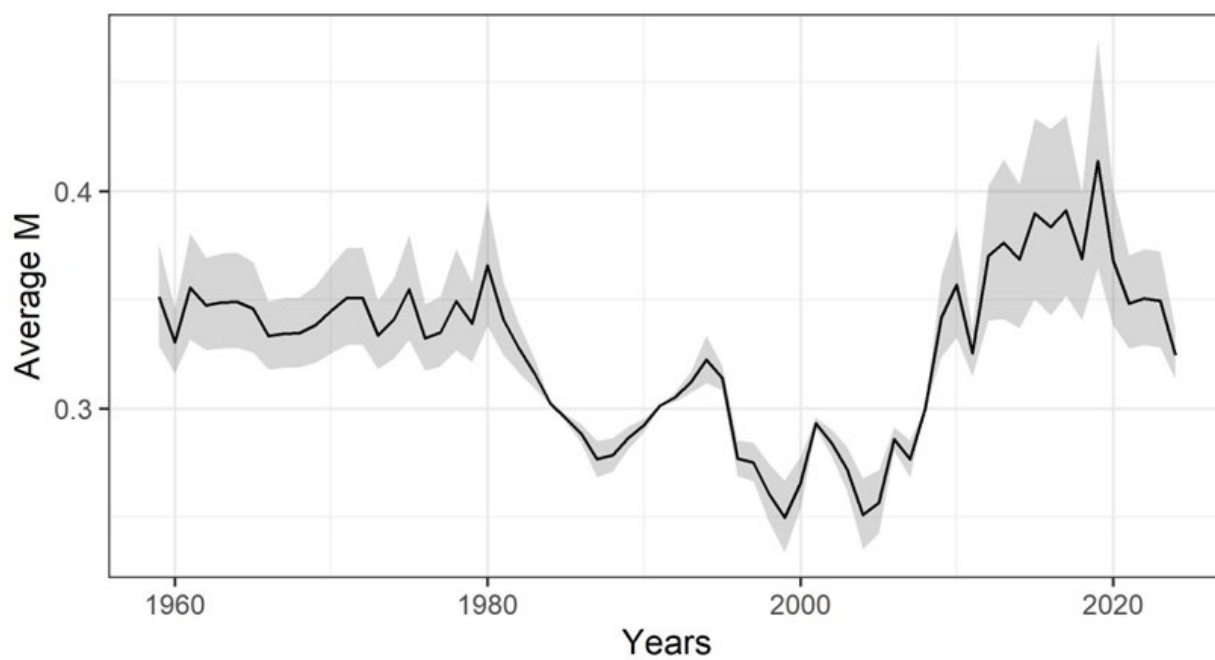


Figure 62: Natural mortality (Average M , ages 5 to 9) of 3Ps cod between 1959 and 2024. M is set at a base level of $M=0.3$ and scaled within the model based on the index of condition.



Figure 63: HYBRID model process error. Larger points indicate a greater magnitude of estimated process error either negatively (red) or positively (blue).

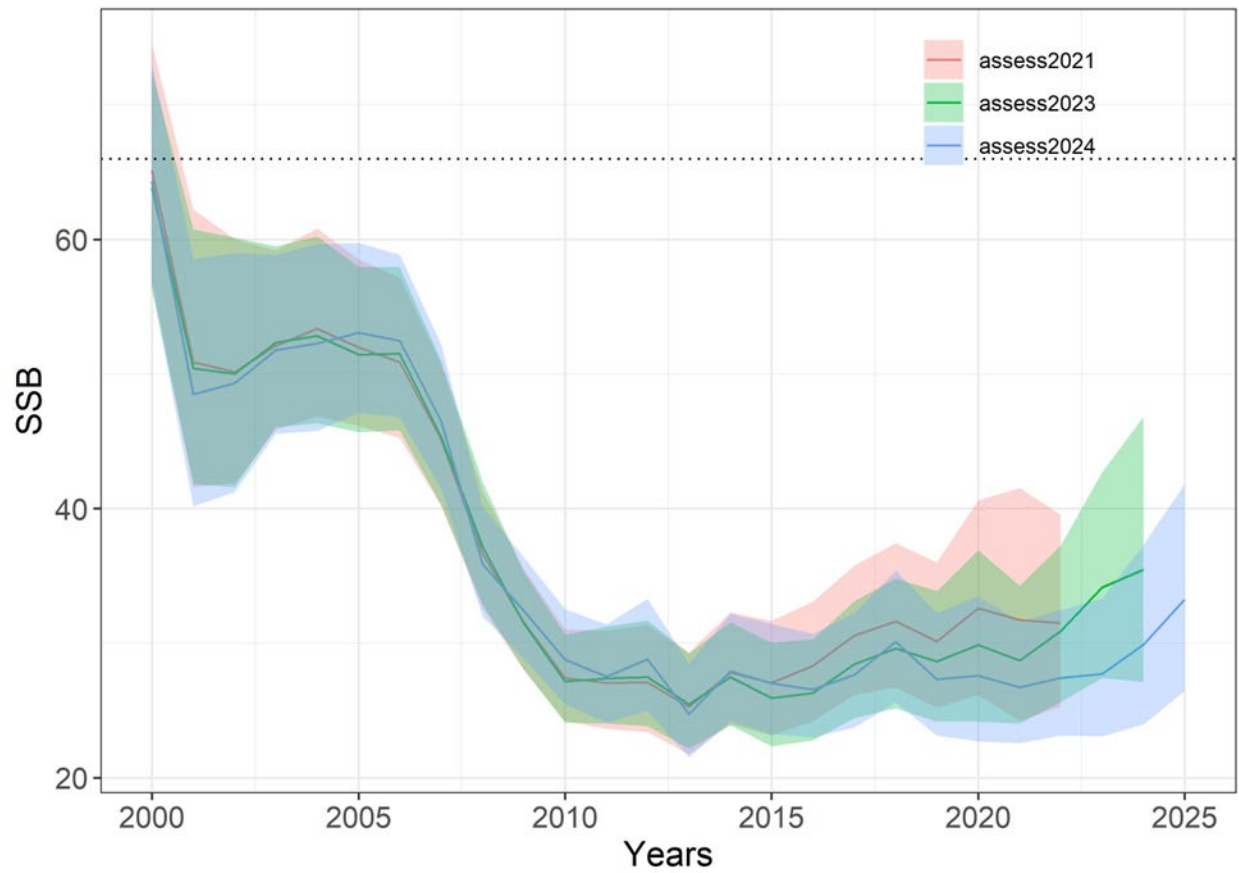


Figure 64: Assessment retro for Spawning Stock Biomass (SSB in thousand tonnes).

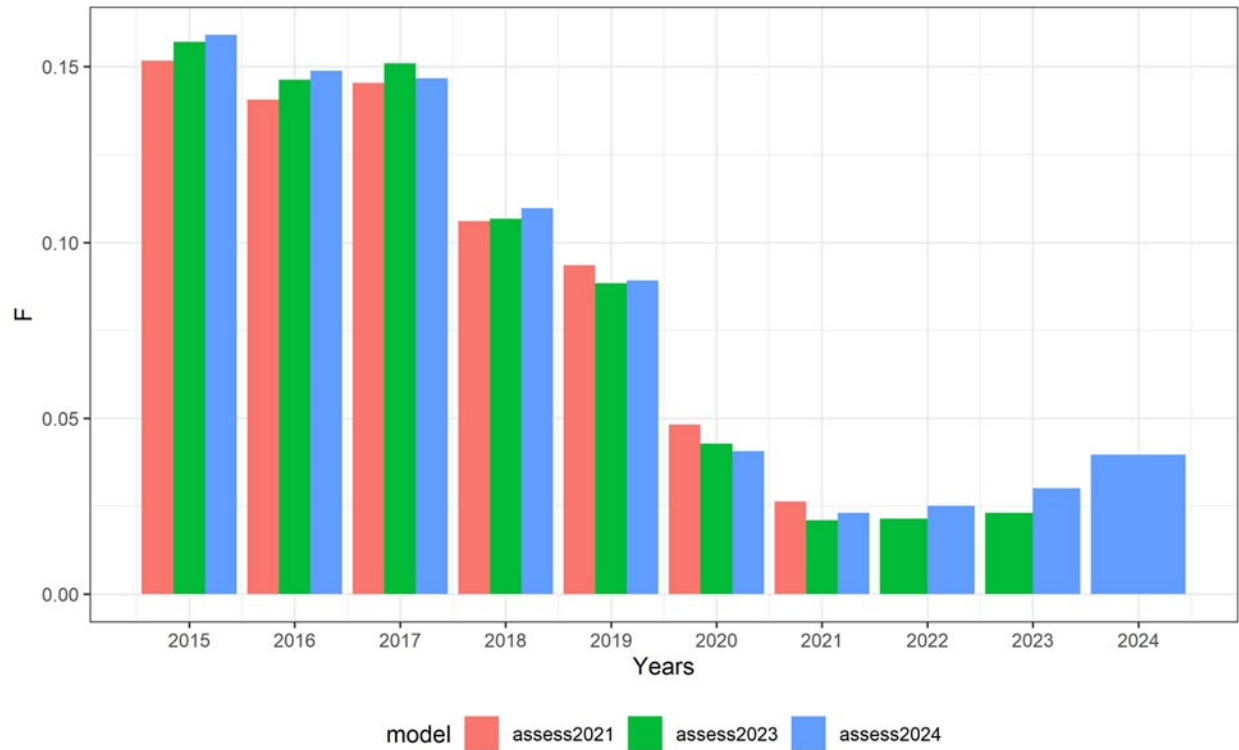


Figure 65: Assessment retro for average F (ages 5 to 8).

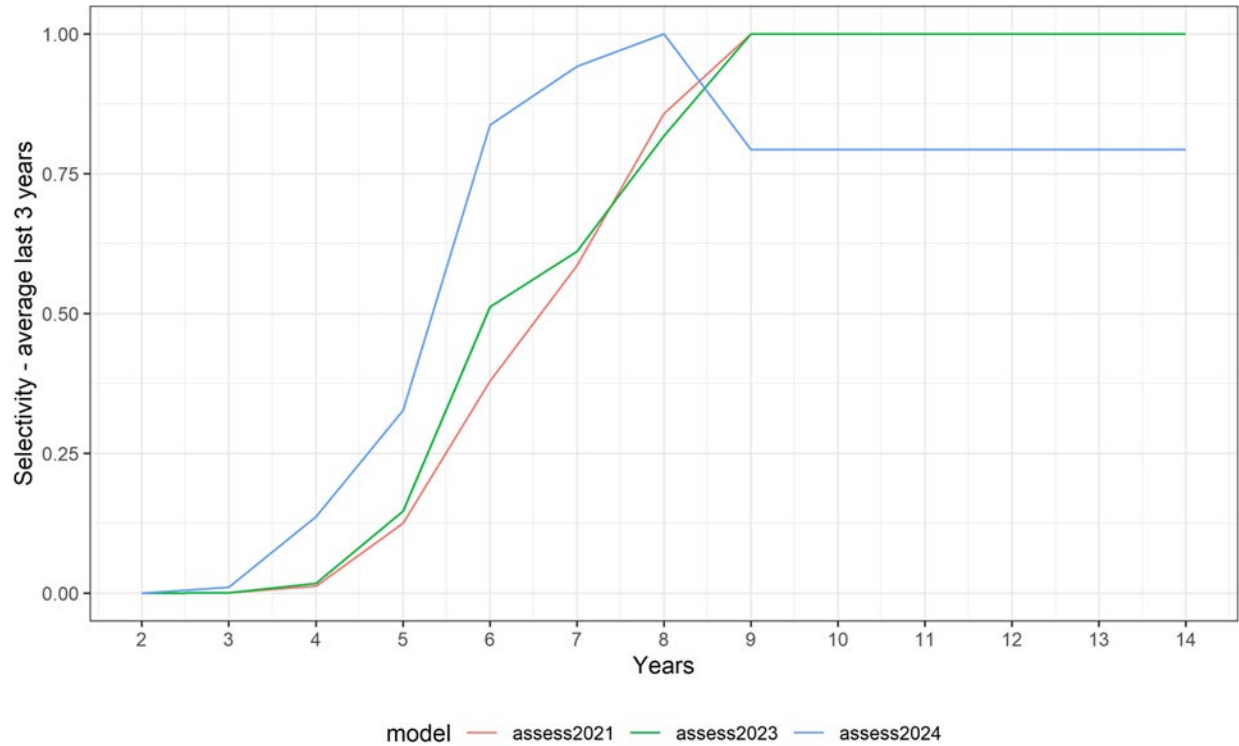


Figure 66: Retrospective pattern in selectivity. The figure shows the selectivity based on F in the last three years of the assessment.

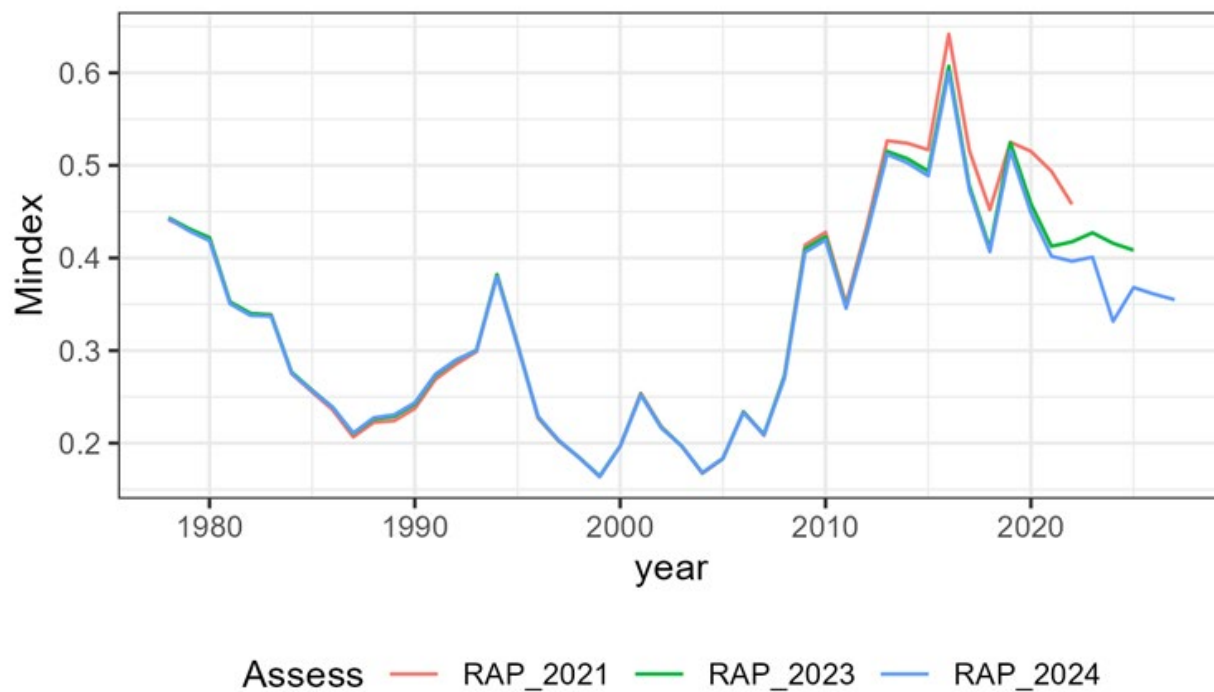


Figure 67: Retro in M condition-based index.

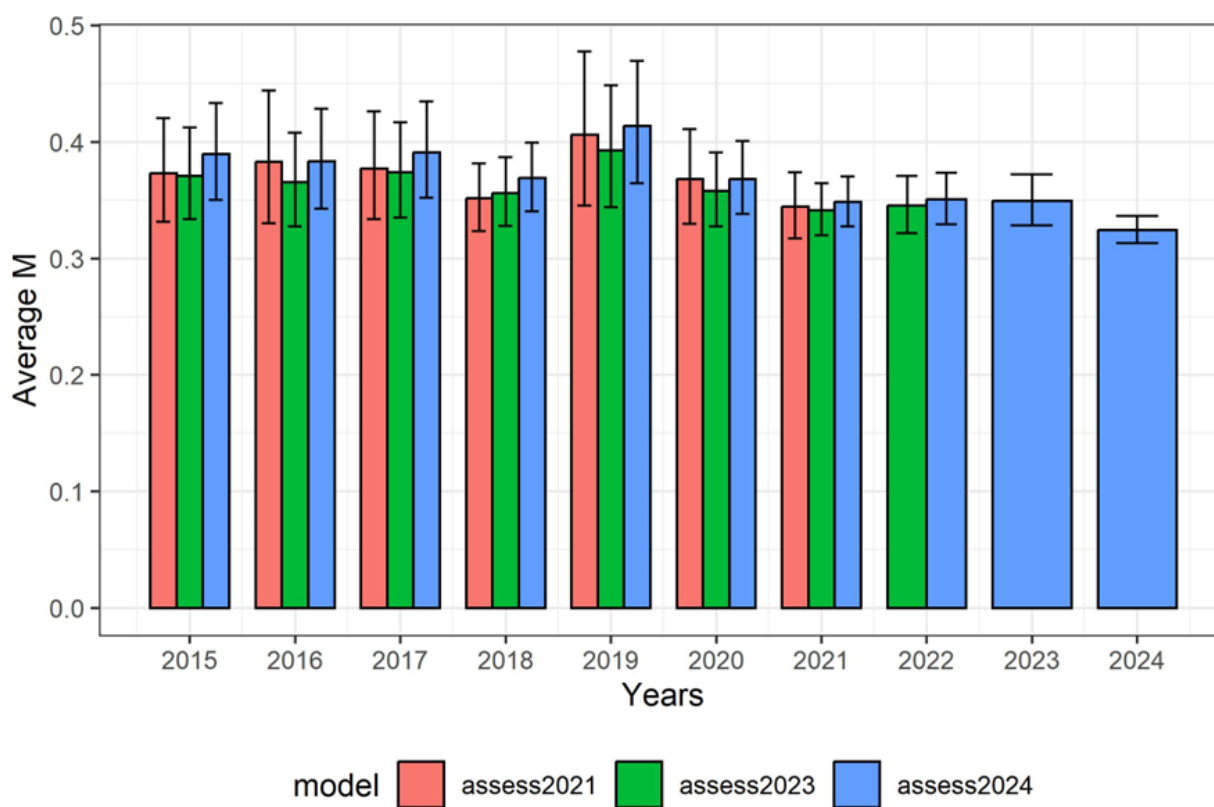


Figure 68: Assessment retro for average M (ages 5 to 8).

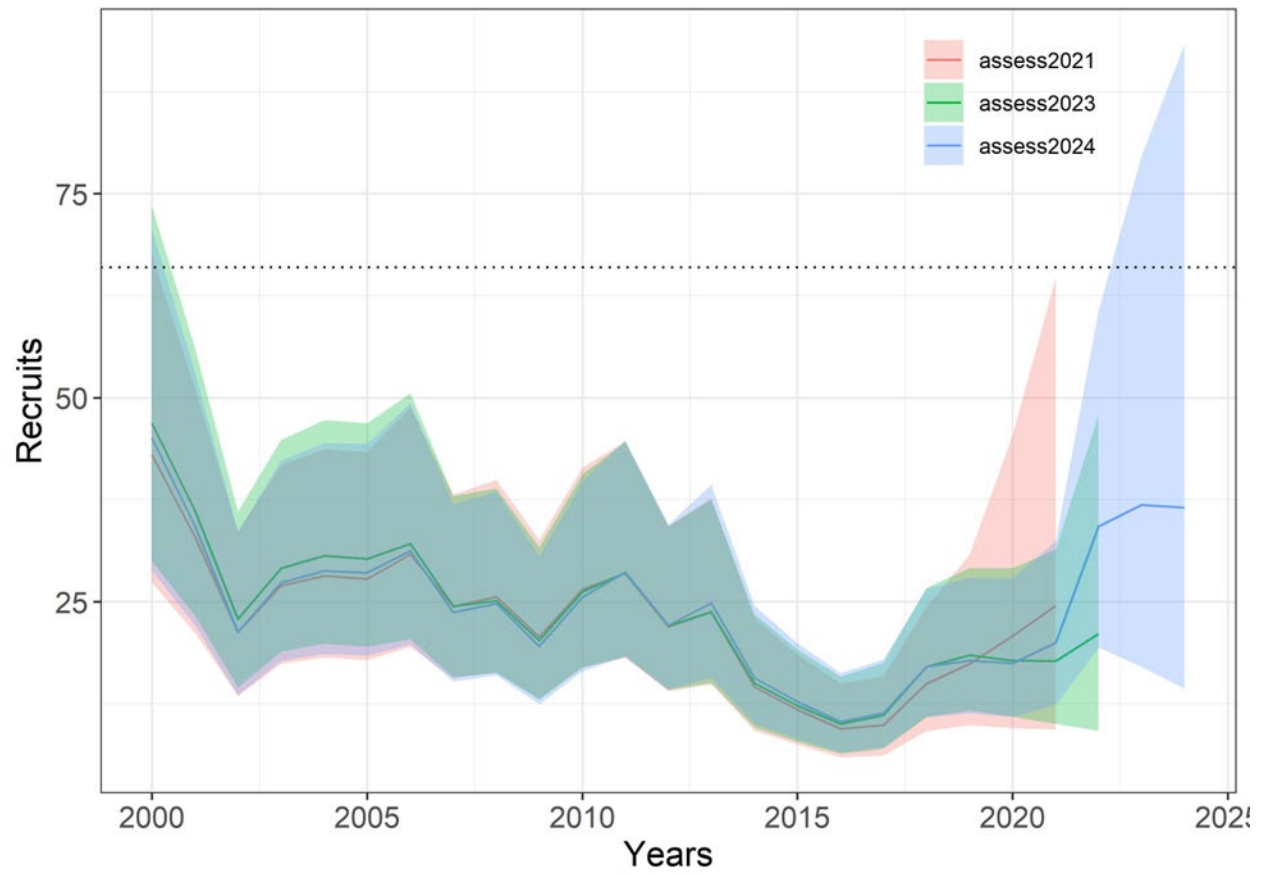


Figure 69: Assessment retro in recruitment (age 2).

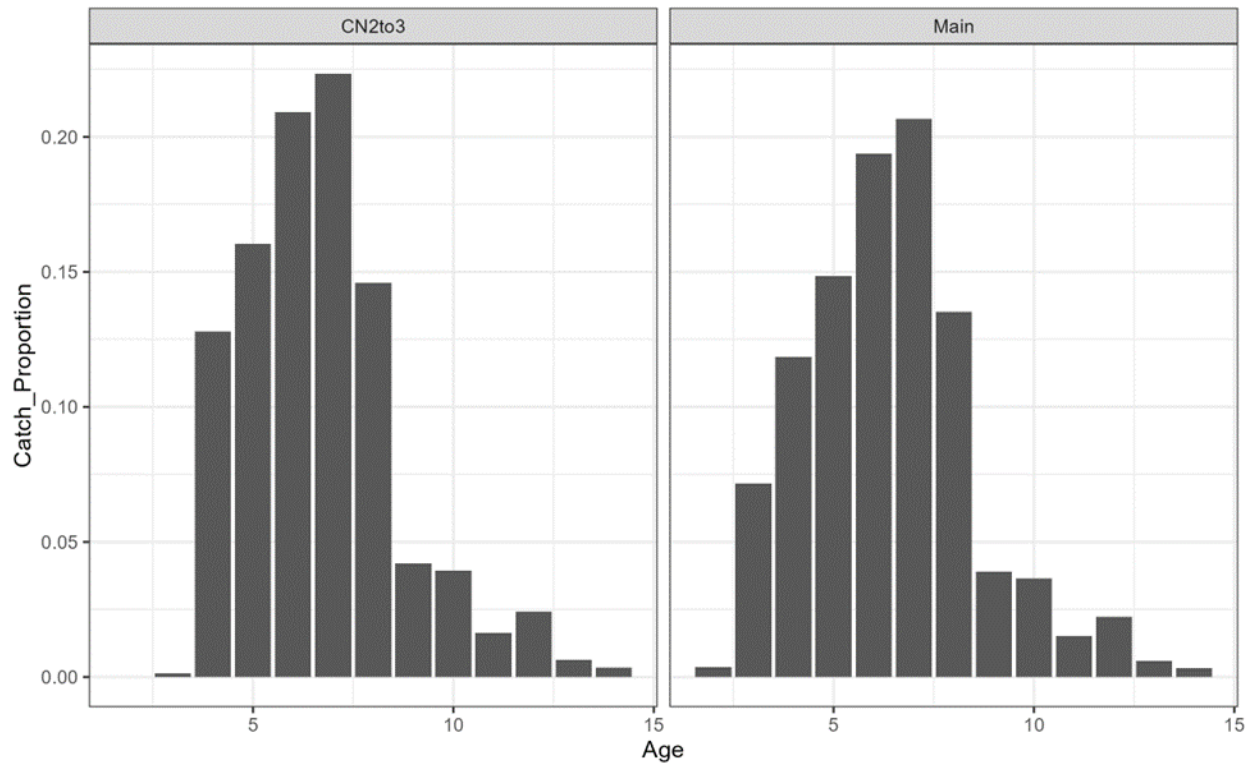


Figure 70: Catch-at-age proportion in sensitivity analysis. The left panel shows the catch-at-age proportions in the sensitivity run. The right panel shows the catch-at-age proportions for the main assessment model run.

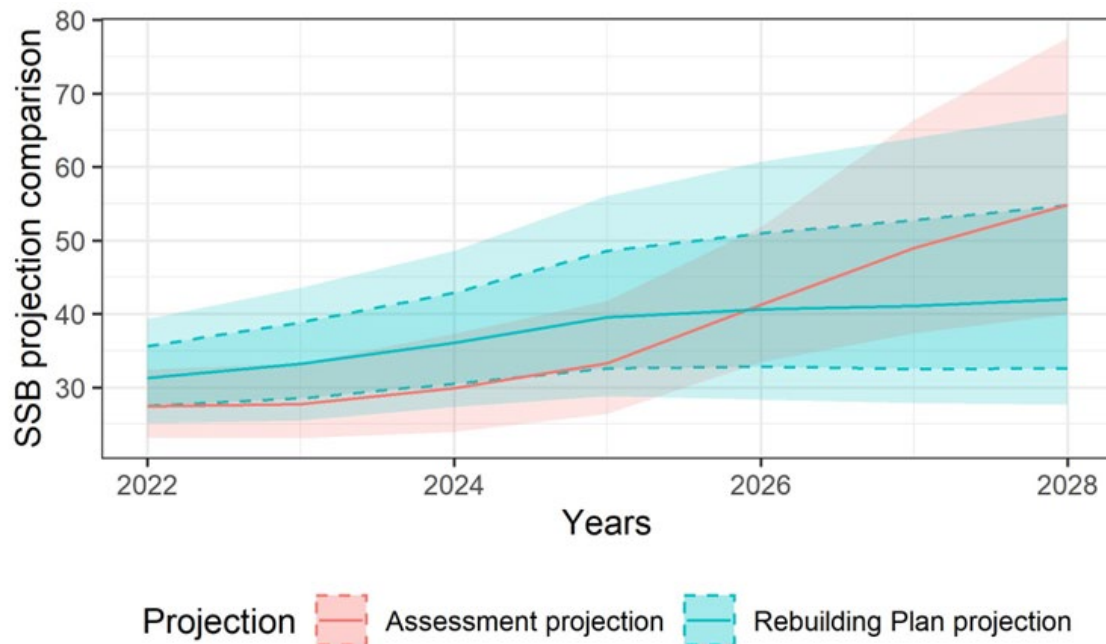


Figure 71: Comparison of projections from the current assessment (solid red line with 95% confidence intervals) with expected growth under the rebuilding plan (solid blue line with 75% and 95% confidence intervals shown). Note that given considerable uncertainty in current estimates of recruitment, only projections to 2026 were considered appropriate for providing advice.

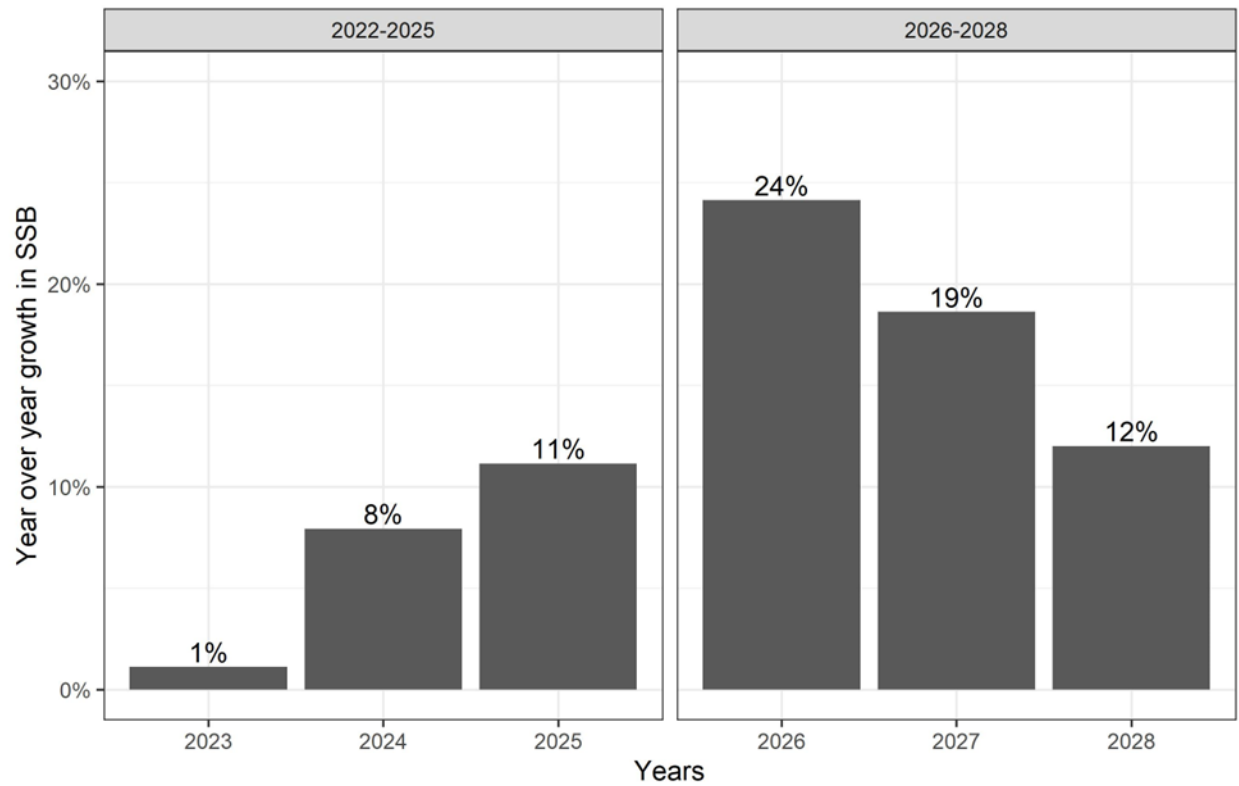


Figure 72: Year over year growth in SSB. Years 2026–28 show expected growth in projection period. Note that given considerable uncertainty in current estimates of recruitment, only projections to 2026 were considered appropriate for providing advice.

APPENDIX A. HYBRID MODEL INPUT

Table A-1: Landings (t) per calendar year, with lower and upper bounds (see Figure 55), 1959–2023. Landings in 2024 are assumed to equal the 2024/25 management year TAC.

Year	Landings	Lower bound	Upper bound
1959	60,170	54.153	78,221
1960	77,285	69.556	100,470
1961	86,824	78.142	112,871
1962	55,239	49.715	71,811
1963	51,821	46.639	67,367
1964	56,567	50.910	73,537
1965	51,853	46.668	67,409
1966	66,207	59.586	86,069
1967	62,774	56.497	81,606
1968	77,556	69.800	100,823
1969	63,799	57.419	82,939
1970	76,858	69.172	99,915
1971	62,448	56.203	81,182
1972	44,213	39.792	57,477
1973	52,641	47.377	68,433
1974	46,712	42.041	60,726
1975	35,373	31.836	45,985
1976	37,133	25.993	48,273
1977	32,245	22.572	41,918
1978	27,221	24.499	35,387
1979	33,006	29.705	42,908
1980	37,568	33.811	48,838
1981	38,892	35.003	50,560
1982	33,902	30.512	44,073
1983	38,451	34.606	49,986
1984	36,950	33.255	48,035
1985	51,367	46.230	66,777
1986	57,990	52.191	75,387
1987	59,204	29.602	88,806
1988	43,382	21.691	65,073
1989	39,540	19.770	59,310
1990	41,405	20.702	62,108
1991	43,589	21.794	65,384
1992	35,895	17.948	53,842
1993	15,216	7.608	22,824
1994	661	654	859
1995	821	813	1,067
1996	1,057	1,046	1,374
1997	9,420	9,326	12,246
1998	20,156	19,955	26,203
1999	27,997	27,717	36,397
2000	25,100	24,849	32,630
2001	16,546	16,380	21,509
2002	15,319	15,166	19,915
2003	15,260	15,108	19,838
2004	14,414	14,270	18,738
2005	14,776	14,628	19,208

Year	Landings	Lower bound	Upper bound
2006	13,157	13,026	17,105
2007	12,959	12,829	16,847
2008	11,773	11,655	15,305
2009	9,762	9,664	12,691
2010	8,299	8,216	9,129
2011	6,876	6,807	7,563
2012	5,087	5,036	5,596
2013	4,366	4,322	4,803
2014	6,887	6,818	7,576
2015	6,460	6,395	7,106
2016	7,246	7,173	7,970
2017	6,641	6,574	7,305
2018	4,737	4,690	5,211
2019	3,528	3,493	3,881
2020	2,228	2,206	2,896
2021	826	818	1,074
2022	909	900	1,182
2023	805	797	1,046
2024	1,550	1,534	2,015

Table A-2: Catch numbers at age.

Year	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+
1959	0	1,001	13,940	7,525	7,265	4,875	942	1,252	1,260	631	545	44	1
1960	0	567	5,496	23,704	6,714	3,476	3,484	1,020	827	406	407	283	110
1961	0	450	5,586	10,357	15,960	3,616	4,680	1,849	1,376	446	265	560	91
1962	0	1,245	6,749	9,003	4,533	5,715	1,367	791	571	187	140	135	389
1963	0	961	4,499	7,091	5,275	2,527	3,030	898	292	143	99	107	284
1964	0	1,906	5,785	5,635	5,179	2,945	1,881	1,891	652	339	329	54	233
1965	12	2,314	9,636	5,799	3,609	3,254	2,055	1,218	1,033	327	68	122	165
1966	0	949	13,662	13,065	4,621	5,119	1,586	1,833	1,039	517	389	32	75
1967	0	2,871	10,913	12,900	6,392	2,349	1,364	604	316	380	95	149	55
1968	55	1,143	12,602	13,135	5,853	3,572	1,308	549	425	222	111	5	506
1969	0	774	7,098	11,585	7,178	4,554	1,757	792	717	61	120	67	220
1970	0	756	8,114	12,916	9,763	6,374	2,456	730	214	178	77	121	181
1971	0	2,884	6,444	8,574	7,266	8,218	3,131	1,275	541	85	125	62	57
1972	0	731	4,944	4,591	3,552	4,603	2,636	833	463	205	117	48	45
1973	0	945	4,707	11,386	4,010	4,022	2,201	2,019	515	172	110	14	29
1974	56	3,025	8,265	7,080	4,780	2,457	1,625	1,053	490	241	63	42	79
1975	0	675	3,301	2,557	4,655	5,357	874	778	233	169	51	20	26
1976	0	443	4,161	7,601	3,178	2,251	796	222	84	47	29	13	20
1977	0	552	7,718	7,976	4,409	1,008	308	276	108	48	57	26	30
1978	1	216	4,474	5,347	3,004	1,509	513	253	318	77	58	35	58
1979	1	130	1,669	12,064	4,567	1,839	720	252	49	36	4	3	9
1980	0	188	1,597	4,846	7,864	3,447	1,080	366	107	77	43	13	69
1981	0	1,074	3,616	2,745	3,914	5,210	1,663	576	190	142	127	22	56
1982	8	190	4,447	4,337	1,757	3,063	3,560	672	208	54	16	7	14
1983	9	754	2,733	9,536	3,008	1,471	1,050	1,256	293	109	49	21	20
1984	5	359	4,241	4,984	4,852	1,695	533	436	354	47	25	6	11
1985	0	160	2,839	7,950	5,406	4,994	1,624	606	654	267	98	18	26
1986	55	1,442	8,677	8,914	9,077	3,822	2,204	832	306	198	78	46	54
1987	0	636	2,517	7,779	7,902	6,605	1,823	1,298	466	141	131	144	136
1988	3	375	3,474	3,455	7,380	4,912	1,448	619	423	229	119	79	100
1989	23	1,104	6,967	4,991	2,056	2,393	1,606	960	528	314	110	57	67
1990	0	1,241	5,902	6,370	3,463	1,843	1,705	1,239	749	129	109	34	110
1991	4	425	7,592	5,925	3,873	1,615	756	875	784	333	181	197	221
1992	7	1,370	3,087	6,052	4,004	1,339	449	206	251	211	177	119	438
1993	0	278	3,712	2,035	3,156	1,334	401	89	38	52	13	14	5
1994	0	1	30	152	72	79	41	19	2	2	0	0	0
1995	0	0	0	39	102	34	26	5	0	0	0	0	0
1996	0	2	16	19	77	117	38	13	8	1	0	0	0
1997	1	14	455	1,345	602	769	922	254	113	124	7	13	1
1998	0	83	298	964	1,605	946	1,512	1,371	233	110	55	16	3
1999	0	49	677	1,333	2,139	2,479	1,155	901	849	203	127	23	14
2000	0	23	408	828	1,539	1,573	1,696	589	507	977	133	45	45
2001	1	76	576	844	1,162	1,172	796	720	269	186	199	25	17
2002	1	112	591	1,416	1,283	1,009	788	451	372	112	79	81	11

Year	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+
2003	1	18	363	1,051	2,063	1,278	644	353	277	156	58	46	84
2004	4	66	144	714	1,826	1,855	665	281	165	82	44	14	39
2005	0	70	427	634	1,106	1,653	1,236	598	157	114	45	25	39
2006	0	47	279	927	992	911	1,155	727	324	95	40	24	29
2007	3	63	279	756	1,122	875	540	575	485	178	54	42	42
2008	0	9	212	642	1,314	1,069	653	351	329	208	110	27	38
2009	0	20	131	914	1,037	841	469	223	102	93	66	45	28
2010	0	8	404	590	1,301	741	399	208	80	24	68	34	20
2011	1	28	152	922	912	893	362	169	64	27	21	8	15
2012	0	10	80	202	723	646	398	143	64	22	32	4	11
2013	0	10	166	458	393	495	361	149	56	22	16	4	8
2014	0	6	59	785	796	367	564	218	132	28	32	5	3
2015	0	2	289	298	893	610	262	303	72	32	7	3	4
2016	0	2	78	912	649	797	385	102	128	38	21	10	3
2017	0	0	18	262	1,408	512	472	211	74	46	11	18	7
2018	0	2	27	102	425	1,033	316	111	49	15	5	1	2
2019	0	6	28	69	151	262	595	209	103	54	14	6	6
2020	0	1	9	29	89	100	124	337	41	30	14	3	2
2021	0	0	7	48	167	41	29	51	37	21	4	2	7
2022	0	1	14	46	99	93	50	33	20	28	1	3	0
2023	2	32	53	66	86	92	60	17	16	7	10	3	1

Table A-3: Condition index for M.

Year	Ages 2-14+
1959	-0.927
1960	-0.927
1961	-0.927
1962	-0.927
1963	-0.927
1964	-0.927
1965	-0.927
1966	-0.927
1967	-0.927
1968	-0.927
1969	-0.927
1970	-0.927
1971	-0.927
1972	-0.927
1973	-0.927
1974	-0.927
1975	-0.927
1976	-0.927
1977	-0.927
1978	-0.815
1979	-0.846
1980	-0.871
1981	-1.049
1982	-1.085
1983	-1.087
1984	-1.29
1985	-1.361
1986	-1.433
1987	-1.556
1988	-1.481
1989	-1.467
1990	-1.412
1991	-1.293
1992	-1.238
1993	-1.205
1994	-0.968
1995	-1.187
1996	-1.475
1997	-1.593
1998	-1.692
1999	-1.81
2000	-1.626
2001	-1.378
2002	-1.531
2003	-1.627
2004	-1.784
2005	-1.695
2006	-1.457
2007	-1.566
2008	-1.309
2009	-0.901
2010	-0.869
2011	-1.063
2012	-0.855
2013	-0.669
2014	-0.688
2015	-0.716

Year	Ages 2-14+
2016	-0.509
2017	-0.747
2018	-0.9
2019	-0.662
2020	-0.801
2021	-0.912
2022	-0.925
2023	-0.914
2024	-1.104

Table A-4: Canadian RV Survey.

Year	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+
1983	10.01	6.52	1.14	3.72	1.62	0.48	0.89	1.61	0.75	0.36	0.14	0.06	0.20
1984	5.40	2.33	1.55	0.63	2.11	0.77	0.37	0.46	0.71	0.18	0.14	0.06	0.11
1985	7.74	14.88	12.56	9.96	3.28	2.66	0.79	0.48	0.42	0.42	0.49	0.21	0.29
1986	6.62	5.65	6.48	7.95	6.33	2.13	1.47	0.84	0.29	0.24	0.29	0.17	0.24
1987	8.48	5.67	4.97	13.82	8.31	3.35	1.29	0.69	0.28	0.23	0.16	0.17	0.42
1988	9.13	5.93	2.96	2.84	6.50	5.84	3.65	1.49	0.84	0.74	0.35	0.16	0.38
1989	6.50	4.66	3.17	1.51	1.16	2.15	1.21	0.67	0.37	0.41	0.13	0.11	0.29
1990	1.48	9.82	14.49	10.89	5.67	3.84	3.13	1.15	0.71	0.32	0.16	0.12	0.19
1991	27.69	5.03	10.00	11.24	5.75	2.84	1.58	1.19	0.74	0.56	0.22	0.11	0.18
1992	1.80	6.95	2.11	4.15	2.03	1.03	0.53	0.26	0.24	0.08	0.04	0.01	0.04
1993	0.00	1.99	4.04	1.49	1.35	0.47	0.10	0.04	0.03	0.04	0.01	0.00	0.02
1994	1.63	1.46	4.31	6.10	1.73	1.62	0.50	0.08	0.04	0.03	0.02	0.01	0.02
1995	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
1996	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
1997	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
1998	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
1999	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
2000	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
2001	2.88	11.44	10.58	3.71	1.74	1.08	0.66	0.60	0.32	0.43	0.80	0.10	0.11
2002	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
2003	2.62	2.24	3.67	5.88	3.51	1.34	0.63	0.28	0.16	0.17	0.04	0.09	0.02
2004	2.24	2.50	1.85	1.93	3.49	3.61	1.08	0.68	0.57	0.67	0.13	0.09	0.08
2005	1.63	7.32	7.27	3.49	2.08	1.52	1.20	0.41	0.09	0.15	0.06	0.03	0.24
2007	2.34	5.33	3.26	2.11	1.14	0.76	0.35	0.56	0.37	0.12	0.10	0.07	0.07
2008	4.09	4.30	3.27	1.99	1.22	0.50	0.34	0.12	0.14	0.08	0.04	0.02	0.02
2009	2.47	8.64	5.81	4.91	2.65	1.53	0.84	0.18	0.15	0.18	0.32	0.12	0.04
2010	2.76	7.75	13.95	5.87	3.53	1.27	0.25	0.08	0.03	0.03	0.07	0.01	0.01
2011	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
2012	3.99	11.21	6.37	3.34	3.39	1.76	0.94	0.16	0.25	0.01	0.04	0.00	0.04
2013	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
2014	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
2015	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
2016	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
2017	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
2018	5.40	4.56	2.59	1.73	2.22	2.29	0.23	0.19	0.17	0.13	0.01	0.00	0.00
2019	6.73	6.77	4.32	2.00	1.20	0.90	0.31	0.13	0.04	0.04	0.00	0.01	0.00
2021	9.69	5.15	2.88	1.23	1.04	0.45	0.63	0.34	0.26	0.12	0.03	0.00	0.01
2022	10.56	10.37	3.50	1.62	1.12	0.37	0.33	0.18	0.19	0.11	0.01	0.02	0.00
2024	5.45	9.96	3.62	1.66	1.18	0.79	0.31	0.27	0.09	0.08	0.07	0.06	0.00

Table A-5: Erhaps survey by IFREMER.

Year	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+
1978	0.62	1.32	2.60	1.73	1.01	0.75	0.44	0.25	0.19	0.02	0.03	0.01	0.03
1979	0.46	0.41	2.21	7.73	3.47	1.93	1.02	0.40	0.23	0.31	0.10	0.11	0.23
1980	5.47	1.27	0.37	1.98	3.35	1.23	0.50	0.21	0.16	0.13	0.08	0.08	0.13
1981	0.14	3.78	3.81	3.96	5.74	4.35	1.23	0.92	0.36	0.12	0.11	0.05	0.10
1982	9.21	1.50	6.38	6.12	4.65	3.49	4.07	1.21	0.67	0.32	0.12	0.16	0.08
1983	8.31	4.16	2.29	5.55	4.70	3.50	2.13	1.60	0.58	0.19	0.15	0.06	0.05
1984	9.43	6.22	12.27	7.12	15.45	4.55	1.73	2.52	1.80	0.50	0.13	0.11	0.10
1985	4.38	11.56	5.96	3.14	0.85	1.56	0.91	0.62	0.69	0.87	1.05	0.10	0.18
1986	6.93	4.03	14.55	25.35	20.74	8.73	6.67	3.69	0.76	0.56	0.69	0.21	0.31
1987	16.29	9.09	2.24	6.56	9.87	6.57	2.33	1.53	0.75	0.16	0.28	0.12	0.23
1988	11.69	11.71	7.25	2.85	5.14	3.69	1.26	0.61	0.28	0.28	0.13	0.12	0.26
1989	18.89	12.25	6.27	4.44	2.66	3.39	1.55	0.77	0.21	0.10	0.05	0.05	0.06
1990	2.39	18.26	20.11	7.66	2.46	0.73	1.00	0.44	0.26	0.11	0.09	0.03	0.06
1991	12.14	7.08	12.96	12.68	7.56	2.42	1.07	0.91	0.62	0.06	0.15	0.03	0.03

Table A-6: GEAC survey.

Year	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+
1998	0.06	0.40	1.76	2.32	1.81	0.35	1.64	3.40	0.40	0.04	0.13	0.22	0.04
1999	0.34	1.14	1.71	2.83	3.58	3.27	0.51	1.43	1.36	0.17	0.10	0.02	0.00
2000	1.64	7.24	2.86	3.35	5.18	5.89	3.99	1.14	5.83	7.14	0.79	0.11	0.17
2001	0.21	12.47	26.74	3.75	2.14	1.62	1.34	0.96	0.10	0.44	0.58	0.08	0.10
2002	0.00	1.26	16.88	18.47	2.90	1.39	1.18	0.91	0.46	0.09	0.27	0.30	0.00
2003	0.22	0.41	2.46	8.34	9.28	1.32	0.73	1.32	0.48	0.24	0.00	0.16	0.18
2004	0.08	0.68	0.80	1.07	2.98	1.18	0.15	0.12	0.18	0.13	0.05	0.00	0.20
2005	0.05	1.74	1.15	0.43	0.31	0.74	0.50	0.08	0.04	0.09	0.04	0.00	0.00

Table A-7: Sentinel Gillnet standardized catch rates.

Year	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1995	0.0760	3.9723	8.6248	5.2476	2.4529	0.3726	0.1465
1996	0.2759	2.6555	12.1885	9.9514	2.8454	0.8486	0.0682
1997	0.2422	5.1588	5.1535	9.1490	7.3522	1.0861	0.6016
1998	0.0539	1.1008	7.4000	3.2740	2.5633	1.5498	0.2822
1999	0.0025	0.7787	1.2487	1.8520	0.6665	0.2175	0.2105
2000	0.0202	0.2897	0.7680	0.6332	0.9835	0.3133	0.0943
2001	0.1550	0.3996	0.8618	0.6742	0.3806	0.3670	0.1740
2002	0.0365	0.4933	0.7947	0.7582	0.3263	0.1516	0.1670
2003	0.0691	0.2317	1.0039	0.4837	0.1707	0.0894	0.0325
2004	0.0381	0.2211	0.8195	0.8081	0.3926	0.1410	0.0267
2005	0.0257	0.1357	0.5574	0.6490	0.3814	0.2897	0.0513
2006	0.0965	0.2961	0.5289	0.4857	0.5123	0.2528	0.1264
2007	0.0513	0.3861	1.0194	0.7148	0.4042	0.2503	0.1749
2008	0.0949	0.2445	1.0788	0.8918	0.4315	0.2042	0.0834
2009	0.0092	0.2546	0.6227	1.1073	0.2178	0.1718	0.0552
2010	0.0607	0.3507	0.7991	0.6507	0.3405	0.1079	0.1787
2011	0.0062	0.0935	0.3053	0.5576	0.2243	0.1776	0.0187
2012	0.0390	0.1349	0.4677	0.5007	0.3837	0.1229	0.0720
2013	0.0663	0.4680	1.0179	0.4251	0.4758	0.2925	0.0234
2014	0.0375	0.4346	0.4721	0.2997	0.4871	0.2285	0.1049
2015	0.0619	0.0912	0.4919	0.4072	0.1629	0.1466	0.0619
2016	0.0036	0.2722	0.3593	0.4101	0.3085	0.2722	0.0726
2017	0.0757	0.2396	0.7818	0.3909	0.6683	0.1513	0.0820
2018	0.0331	0.1510	0.4640	1.4878	0.4861	0.2799	0.0700
2019	0.0059	0.0559	0.3265	0.5648	1.3561	0.2971	0.2942
2020	0.0250	0.4529	0.4404	0.3217	0.3373	0.7308	0.2342
2021	0.0987	0.7556	1.2931	0.9322	0.6076	0.6102	0.3246
2022	0.0806	0.4198	0.9675	1.4596	0.4754	0.3253	0.2419
2023	0.0155	0.4568	0.8982	1.4015	1.0608	0.2362	0.2516

Table A-8: Sentinel line-trawl standardized catch rates.

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1995	0.7437	1.4252	5.0320	7.2446	1.9152	1.7674	0.3850	0.1079
1996	0.8075	3.0364	2.8458	4.5161	4.6106	1.3371	0.7420	0.1630
1997	0.5829	2.2771	2.4179	1.5732	1.6547	2.3043	0.2766	0.1679
1998	0.7416	1.6786	2.4388	1.6320	0.6578	0.9432	1.1573	0.2327
1999	0.9149	2.0730	2.4899	1.5866	0.7064	0.5559	0.3938	0.1621
2000	1.4922	2.5467	2.2885	1.9656	0.9649	0.6815	0.2654	0.1184
2001	1.8622	3.2485	2.4084	1.4296	0.7734	0.4399	0.2470	0.0577
2002	1.4513	2.9972	2.7272	0.9470	0.5742	0.1891	0.0904	0.0699
2003	0.2503	3.6537	4.1650	2.1652	0.8835	0.3591	0.0957	0.0501
2004	0.9662	1.0120	3.7453	1.9989	1.0625	0.3511	0.1629	0.0344
2005	0.7602	2.0881	1.3491	1.3589	1.1876	0.4519	0.1941	0.0783
2006	0.9935	1.8898	2.5743	1.9497	1.3637	1.3344	0.4262	0.1571
2007	0.9157	1.9299	1.6788	1.4290	0.9407	0.4981	0.4759	0.1915
2008	0.4320	2.8335	2.5289	1.8337	0.8511	0.5550	0.2818	0.2260
2009	0.4897	1.5822	2.8615	1.5083	0.5997	0.3586	0.1115	0.0844
2010	0.2606	1.5882	1.3473	1.3834	0.6556	0.1606	0.0672	0.0508
2011	0.7886	1.0827	2.4689	1.8426	1.1399	0.4735	0.1318	0.0286
2012	0.7943	1.5142	1.5373	1.5194	1.4425	0.5432	0.2434	0.0256
2013	0.2694	1.4749	1.4925	0.9649	0.6867	0.6734	0.1855	0.0707
2014	0.4333	0.4632	1.6649	1.3063	0.6276	0.5251	0.3245	0.0961
2015	0.1138	0.9458	1.1332	1.2224	1.0953	0.3391	0.3078	0.1182
2016	0.1705	0.7341	1.8405	1.1794	1.0368	0.4592	0.1113	0.1740
2017	0.1293	0.7338	1.6740	2.2014	0.8606	0.3681	0.1443	0.0672
2018	0.0425	0.3827	0.8636	1.3445	1.4034	0.6248	0.1963	0.0981
2019	0.2721	0.8287	0.8071	1.5028	1.8831	1.5399	0.4391	0.1237
2020	0.3572	1.2180	1.7421	1.5931	1.7139	1.6265	1.5083	0.5807
2021	0.2801	0.7236	1.3306	1.1321	0.8170	0.7081	0.6069	0.3891
2022	0.1389	0.6681	1.2172	1.1312	1.2899	0.5954	0.2778	0.6152
2023	0.7742	1.3813	1.3153	1.2229	0.5367	0.2419	0.1628	0.1144

Table A-9: Proportion mature at age.

Year	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+
1959	0.001	0.004	0.014	0.068	0.194	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1960	0.000	0.003	0.015	0.061	0.180	0.470	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1961	0.000	0.000	0.011	0.054	0.227	0.400	0.757	0.914	0.972	0.991	0.997	0.999	1.000
1962	0.001	0.001	0.001	0.046	0.174	0.569	0.669	0.914	0.972	0.991	0.997	0.999	1.000
1963	0.000	0.004	0.010	0.011	0.173	0.441	0.856	0.860	0.972	0.991	0.997	0.999	1.000
1964	0.001	0.003	0.018	0.078	0.110	0.474	0.747	0.964	0.949	0.991	0.997	0.999	1.000
1965	0.000	0.005	0.018	0.091	0.413	0.574	0.795	0.917	0.992	0.983	0.997	0.999	1.000
1966	0.000	0.003	0.025	0.104	0.349	0.853	0.937	0.944	0.976	0.998	0.994	0.999	1.000
1967	0.000	0.001	0.016	0.126	0.428	0.741	0.980	0.994	0.986	0.994	1.000	0.998	1.000
1968	0.001	0.000	0.007	0.085	0.444	0.829	0.938	0.997	0.999	0.997	0.998	1.000	0.999
1969	0.001	0.004	0.001	0.044	0.342	0.816	0.969	0.988	1.000	1.000	0.999	1.000	1.000
1970	0.000	0.007	0.021	0.013	0.240	0.750	0.961	0.995	0.998	1.000	1.000	1.000	1.000
1971	0.001	0.001	0.034	0.090	0.129	0.684	0.949	0.993	0.999	1.000	1.000	1.000	1.000
1972	0.003	0.005	0.010	0.162	0.317	0.625	0.937	0.992	0.999	1.000	1.000	1.000	1.000
1973	0.005	0.014	0.026	0.078	0.510	0.686	0.949	0.990	0.999	1.000	1.000	1.000	1.000
1974	0.002	0.020	0.060	0.124	0.420	0.849	0.912	0.995	0.999	1.000	1.000	1.000	1.000
1975	0.002	0.009	0.070	0.227	0.432	0.860	0.968	0.980	1.000	1.000	1.000	1.000	1.000
1976	0.000	0.007	0.037	0.218	0.575	0.804	0.981	0.994	0.996	1.000	1.000	1.000	1.000
1977	0.000	0.001	0.028	0.136	0.508	0.862	0.957	0.998	0.999	0.999	1.000	1.000	1.000
1978	0.003	0.003	0.006	0.110	0.392	0.793	0.966	0.992	1.000	1.000	1.000	1.000	1.000
1979	0.000	0.011	0.018	0.042	0.345	0.726	0.934	0.992	0.998	1.000	1.000	1.000	1.000
1980	0.001	0.000	0.040	0.096	0.244	0.692	0.916	0.981	0.998	1.000	1.000	1.000	1.000
1981	0.012	0.005	0.005	0.139	0.388	0.706	0.906	0.978	0.995	1.000	1.000	1.000	1.000
1982	0.001	0.034	0.028	0.056	0.385	0.790	0.947	0.976	0.995	0.999	1.000	1.000	1.000
1983	0.000	0.006	0.089	0.145	0.420	0.708	0.957	0.992	0.994	0.999	1.000	1.000	1.000
1984	0.000	0.001	0.024	0.214	0.505	0.899	0.904	0.993	0.999	0.999	1.000	1.000	1.000
1985	0.000	0.001	0.007	0.093	0.433	0.860	0.991	0.973	0.999	1.000	1.000	1.000	1.000
1986	0.000	0.002	0.005	0.037	0.299	0.681	0.973	0.999	0.993	1.000	1.000	1.000	1.000
1987	0.000	0.001	0.013	0.037	0.178	0.640	0.857	0.995	1.000	0.998	1.000	1.000	1.000
1988	0.000	0.000	0.011	0.082	0.223	0.554	0.881	0.944	0.999	1.000	1.000	1.000	1.000
1989	0.001	0.002	0.005	0.095	0.372	0.681	0.876	0.969	0.979	1.000	1.000	1.000	1.000
1990	0.000	0.006	0.023	0.073	0.493	0.797	0.941	0.976	0.992	0.992	1.000	1.000	1.000
1991	0.002	0.003	0.052	0.240	0.540	0.901	0.963	0.992	0.996	0.998	0.997	1.000	1.000
1992	0.004	0.016	0.051	0.341	0.807	0.946	0.988	0.994	0.999	0.999	1.000	0.999	1.000
1993	0.000	0.021	0.096	0.461	0.831	0.982	0.996	0.999	0.999	1.000	1.000	1.000	1.000
1994	0.000	0.003	0.114	0.411	0.932	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000
1995	0.002	0.006	0.039	0.434	0.821	0.995	0.998	1.000	1.000	1.000	1.000	1.000	1.000
1996	0.007	0.015	0.069	0.330	0.821	0.968	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	0.004	0.034	0.092	0.502	0.856	0.965	0.995	1.000	1.000	1.000	1.000	1.000	1.000
1998	0.003	0.022	0.149	0.403	0.931	0.986	0.994	0.999	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.016	0.103	0.465	0.818	0.995	0.999	0.999	1.000	1.000	1.000	1.000	1.000
2000	0.003	0.004	0.085	0.375	0.812	0.968	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2001	0.004	0.025	0.074	0.345	0.758	0.955	0.995	1.000	1.000	1.000	1.000	1.000	1.000
2002	0.003	0.026	0.159	0.635	0.751	0.942	0.991	0.999	1.000	1.000	1.000	1.000	1.000

Year	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+
2003	0.008	0.019	0.144	0.583	0.974	0.945	0.988	0.998	1.000	1.000	1.000	1.000	1.000
2004	0.004	0.044	0.104	0.516	0.911	0.999	0.990	0.998	1.000	1.000	1.000	1.000	1.000
2005	0.003	0.021	0.213	0.408	0.870	0.987	1.000	0.998	1.000	1.000	1.000	1.000	1.000
2006	0.005	0.014	0.105	0.610	0.804	0.977	0.998	1.000	1.000	1.000	1.000	1.000	1.000
2007	0.002	0.021	0.064	0.385	0.901	0.960	0.996	1.000	1.000	1.000	1.000	1.000	1.000
2008	0.006	0.011	0.086	0.250	0.770	0.981	0.993	0.999	1.000	1.000	1.000	1.000	1.000
2009	0.014	0.034	0.069	0.297	0.619	0.947	0.997	0.999	1.000	1.000	1.000	1.000	1.000
2010	0.007	0.061	0.169	0.323	0.654	0.888	0.990	0.999	1.000	1.000	1.000	1.000	1.000
2011	0.002	0.036	0.233	0.538	0.754	0.894	0.975	0.998	1.000	1.000	1.000	1.000	1.000
2012	0.002	0.019	0.170	0.589	0.869	0.951	0.974	0.995	1.000	1.000	1.000	1.000	1.000
2013	0.001	0.017	0.138	0.528	0.871	0.974	0.992	0.994	0.999	1.000	1.000	1.000	1.000
2014	0.003	0.005	0.109	0.573	0.859	0.969	0.995	0.999	0.999	1.000	1.000	1.000	1.000
2015	0.001	0.017	0.057	0.469	0.918	0.971	0.993	0.999	1.000	1.000	1.000	1.000	1.000
2016	0.002	0.011	0.084	0.398	0.865	0.989	0.995	0.999	1.000	1.000	1.000	1.000	1.000
2017	0.000	0.013	0.074	0.320	0.878	0.979	0.999	0.999	1.000	1.000	1.000	1.000	1.000
2018	0.001	0.002	0.088	0.374	0.708	0.988	0.997	1.000	1.000	1.000	1.000	1.000	1.000
2019	0.001	0.008	0.024	0.412	0.816	0.926	0.999	1.000	1.000	1.000	1.000	1.000	1.000
2020	0.001	0.010	0.064	0.275	0.835	0.971	0.985	1.000	1.000	1.000	1.000	1.000	1.000
2021	0.001	0.005	0.078	0.356	0.854	0.974	0.996	0.997	1.000	1.000	1.000	1.000	1.000
2022	0.001	0.008	0.038	0.418	0.817	0.989	0.996	0.999	0.999	1.000	1.000	1.000	1.000
2023	0.001	0.008	0.060	0.244	0.858	0.973	0.999	0.999	1.000	1.000	1.000	1.000	1.000
2024	0.001	0.008	0.060	0.339	0.725	0.981	0.997	1.000	1.000	1.000	1.000	1.000	1.000

Table A-10: Stock weights (kg) at age.

Year	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+
1959	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1960	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1961	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1962	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1963	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1964	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1965	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1966	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1967	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1968	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1969	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1970	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1971	0.09	0.29	0.69	1.26	1.82	2.48	3.23	4.24	5.45	6.74	8.59	10.11	15.02
1972	0.10	0.29	0.65	1.16	1.65	2.24	3.11	4.34	5.67	6.88	8.51	9.85	14.76
1973	0.09	0.29	0.62	1.10	1.60	2.16	2.77	3.80	5.16	6.43	7.98	9.21	13.76
1974	0.09	0.30	0.68	1.20	1.72	2.37	3.02	3.83	5.11	6.61	8.41	9.71	14.36
1975	0.09	0.30	0.73	1.37	1.94	2.65	3.43	4.32	5.33	6.76	8.93	10.57	15.48
1976	0.09	0.29	0.75	1.46	2.21	2.97	3.81	4.90	5.99	7.04	9.13	11.21	16.74
1977	0.09	0.26	0.65	1.35	2.12	3.06	3.87	4.92	6.15	7.17	8.62	10.41	16.43
1978	0.08	0.25	0.55	1.07	1.82	2.73	3.70	4.64	5.74	6.84	8.18	9.16	14.85
1979	0.08	0.26	0.61	1.08	1.75	2.83	3.97	5.32	6.47	7.63	9.30	10.35	15.77
1980	0.09	0.28	0.64	1.19	1.74	2.68	4.03	5.58	7.25	8.39	10.11	11.48	16.59
1981	0.08	0.27	0.61	1.12	1.69	2.33	3.33	4.92	6.61	8.18	9.70	10.91	15.55
1982	0.08	0.27	0.66	1.19	1.77	2.53	3.24	4.56	6.56	8.40	10.65	11.77	16.42
1983	0.08	0.25	0.60	1.15	1.68	2.36	3.14	3.98	5.45	7.48	9.81	11.62	15.73
1984	0.07	0.24	0.58	1.12	1.74	2.39	3.14	4.14	5.11	6.68	9.41	11.52	16.33
1985	0.07	0.23	0.56	1.05	1.66	2.45	3.15	4.10	5.26	6.20	8.32	10.92	16.57
1986	0.07	0.22	0.53	1.01	1.55	2.30	3.18	4.07	5.15	6.31	7.62	9.54	16.34
1987	0.07	0.22	0.50	0.94	1.47	2.11	2.95	4.04	5.02	6.04	7.59	8.57	15.30
1988	0.07	0.22	0.52	0.89	1.39	2.04	2.74	3.81	5.06	5.96	7.38	8.64	14.33
1989	0.07	0.23	0.55	0.99	1.41	2.07	2.84	3.82	5.14	6.47	7.84	9.04	14.63
1990	0.07	0.20	0.48	0.89	1.30	1.75	2.40	3.30	4.30	5.49	7.13	8.06	12.71
1991	0.07	0.20	0.43	0.79	1.24	1.70	2.15	2.96	3.96	4.89	6.44	7.80	11.77
1992	0.07	0.25	0.50	0.81	1.25	1.84	2.38	3.05	4.08	5.19	6.61	8.11	12.64
1993	0.07	0.25	0.59	0.92	1.24	1.81	2.53	3.32	4.13	5.27	6.89	8.17	13.24
1994	0.07	0.22	0.52	0.96	1.23	1.56	2.15	3.06	3.91	4.62	6.07	7.39	11.98
1995	0.07	0.22	0.50	0.92	1.41	1.71	2.05	2.90	4.00	4.84	5.88	7.17	11.94
1996	0.07	0.23	0.50	0.86	1.32	1.92	2.21	2.72	3.72	4.85	6.04	6.81	11.58
1997	0.08	0.25	0.55	0.93	1.34	1.95	2.70	3.19	3.79	4.90	6.56	7.56	12.00
1998	0.08	0.25	0.57	1.00	1.39	1.90	2.65	3.77	4.28	4.82	6.40	7.92	12.21
1999	0.09	0.27	0.59	1.07	1.53	2.03	2.66	3.80	5.19	5.60	6.47	7.93	12.87
2000	0.09	0.28	0.59	1.00	1.48	2.01	2.56	3.44	4.72	6.13	6.79	7.24	12.14
2001	0.08	0.27	0.60	1.01	1.41	1.98	2.59	3.38	4.34	5.66	7.53	7.71	11.53
2002	0.08	0.26	0.61	1.06	1.45	1.93	2.59	3.47	4.31	5.26	7.04	8.65	11.42

Year	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+
2003	0.08	0.24	0.56	1.06	1.50	1.94	2.48	3.39	4.34	5.13	6.44	7.95	11.53
2004	0.08	0.26	0.56	1.02	1.59	2.14	2.66	3.48	4.56	5.57	6.77	7.83	12.19
2005	0.08	0.27	0.60	1.02	1.55	2.29	2.97	3.80	4.75	5.97	7.49	8.39	12.88
2006	0.07	0.25	0.57	1.01	1.40	2.02	2.87	3.84	4.69	5.64	7.26	8.40	12.40
2007	0.07	0.23	0.55	0.99	1.45	1.91	2.66	3.90	4.98	5.85	7.19	8.54	12.65
2008	0.07	0.20	0.47	0.87	1.29	1.79	2.28	3.26	4.55	5.59	6.72	7.63	11.64
2009	0.07	0.22	0.46	0.84	1.32	1.85	2.47	3.23	4.40	5.91	7.40	8.20	12.18
2010	0.08	0.24	0.52	0.84	1.28	1.91	2.57	3.54	4.40	5.78	7.93	9.17	13.00
2011	0.08	0.24	0.49	0.84	1.12	1.62	2.32	3.22	4.22	5.07	6.82	8.64	12.39
2012	0.07	0.25	0.54	0.85	1.20	1.52	2.12	3.13	4.15	5.26	6.47	8.04	12.73
2013	0.07	0.21	0.52	0.85	1.09	1.47	1.81	2.61	3.68	4.73	6.14	6.98	11.71
2014	0.07	0.21	0.46	0.89	1.21	1.49	1.95	2.48	3.41	4.66	6.13	7.35	11.70
2015	0.07	0.21	0.47	0.78	1.27	1.64	1.97	2.65	3.22	4.29	6.00	7.27	11.74
2016	0.07	0.20	0.44	0.77	1.06	1.66	2.10	2.59	3.35	3.93	5.36	6.92	11.39
2017	0.07	0.20	0.42	0.71	1.04	1.38	2.11	2.75	3.25	4.05	4.87	6.14	10.91
2018	0.07	0.22	0.46	0.73	1.06	1.49	1.92	3.02	3.75	4.29	5.48	6.08	11.13
2019	0.07	0.21	0.45	0.70	0.94	1.31	1.79	2.39	3.58	4.32	5.06	5.97	9.86
2020	0.06	0.21	0.47	0.77	1.01	1.30	1.76	2.47	3.15	4.57	5.64	6.10	9.86
2021	0.06	0.19	0.45	0.78	1.06	1.35	1.68	2.35	3.15	3.88	5.78	6.58	9.61
2022	0.07	0.19	0.42	0.76	1.09	1.44	1.77	2.27	3.02	3.92	4.95	6.80	9.71
2023	0.07	0.23	0.43	0.72	1.11	1.55	1.98	2.50	3.06	3.94	5.24	6.10	10.32
2024	0.07	0.22	0.51	0.75	1.04	1.56	2.10	2.74	3.31	3.92	5.16	6.34	10.34

Table A-11: Catch weights (kg) at age.

Year	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
1959	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1960	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1961	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1962	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1963	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1964	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1965	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1966	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1967	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1968	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1969	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1970	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1971	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1972	0.1	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1973	0.09	0.28	0.69	1.08	1.68	2.4	3.21	4.1	5.08	6.03	7	8.05	9.16
1974	0.21	0.4	0.62	1.06	1.81	2.43	3.35	3.93	4.83	5.44	7.56	9.34	10.91
1975	0.09	0.54	0.83	1.28	1.75	2.36	3.18	3.51	5.38	4.97	6.42	10.19	12.86
1976	0.09	0.54	1	1.46	2.28	3.03	4.27	5.44	7.39	7.43	9.87	11.45	13.99
1977	0.09	0.61	0.68	1.37	1.99	2.77	3.7	4.68	5.45	6.7	6.74	9.22	14.33
1978	0.32	0.54	0.76	1.11	2.03	2.89	3.93	4.61	6.06	7.23	6.98	9.75	13.2
1979	0.3	0.42	0.67	1.06	1.69	2.69	3.78	4.12	5.94	7.65	10.42	10.03	13.72
1980	0.06	0.51	0.78	1.15	1.72	2.36	3.56	5.47	7.19	7.22	9.87	9.57	10.03
1981	0.25	0.52	0.88	1.37	1.84	2.3	3.36	4.89	6.99	7.52	10.41	8.87	13.78
1982	0.41	0.46	0.81	1.17	1.82	2.4	2.82	3.76	4.85	6.81	8.39	8.8	13.33
1983	0.3	0.58	0.85	1.47	2.02	2.52	3.1	3.52	4.95	6.49	7.97	10.61	14.54
1984	0.54	0.67	1.2	1.49	2.1	2.74	4.26	5.37	6.31	8.08	10.55	7.7	12.1
1985	0.07	0.59	0.82	1.2	1.78	2.63	3.37	5.15	5.94	6.74	7.94	11.32	13.28
1986	0.36	0.53	0.69	1.15	1.74	2.33	3.08	4.96	6.13	6.29	7.49	9.41	13.8
1987	0.33	0.47	0.7	1.25	1.71	2.27	3.25	4.3	5.52	6.87	7.07	7.73	11.83
1988	0.29	0.63	0.8	1.02	1.64	2.17	3.12	4.26	5.98	6.88	7.34	8.28	10.54
1989	0.31	0.56	0.79	1.17	1.71	2.44	3.53	4.58	6.08	6.53	7.45	7.89	12
1990	0.18	0.54	0.75	1.35	1.93	2.56	2.96	3.92	3.96	6.18	7.51	7.84	8.52
1991	0.29	0.44	0.7	1.14	1.88	2.61	3.23	4.38	5.15	6.89	8.14	8.06	11.44
1992	0.29	0.46	0.66	1.02	1.66	2.51	3.25	4.66	7.62	7.86	9.3	11.49	14.48
1993	0.07	0.42	0.85	1.34	1.95	2.08	2.65	3.7	4.29	7.31	6.58	7.38	7.43
1994	0.07	0.42	0.85	1.34	1.95	2.08	2.65	3.7	4.29	7.31	6.58	7.38	8.93
1995	0.07	0.5	0.68	1.97	2.21	2.5	2.43	2.51	4	4.84	5.88	7.17	8.93
1996	0.27	0.58	0.88	1.38	1.88	2.39	2.71	3.86	4.37	8.35	6.57	10.11	10.24
1997	0.29	0.52	0.98	1.15	1.42	2.29	3.23	3.9	3.86	4.58	9.27	5.85	8.52
1998	0.31	0.6	0.98	1.74	1.98	2.36	3.16	4.09	3.99	4.44	4.46	5.72	5.61
1999	0.13	0.79	0.92	1.54	2.26	2.52	2.78	3.82	5.39	4.98	5.33	6.04	6.97

Year	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
2000	0.19	0.44	1.23	1.22	1.95	2.76	2.81	3.34	4.86	6.8	6.72	6.72	9.43
2001	0.33	0.72	1.06	1.48	1.96	2.58	3.38	3.35	3.54	5.47	8.75	7.59	8.36
2002	0.35	0.59	1.05	1.53	1.97	2.29	3.01	4.02	3.63	3.75	6.2	9.15	7.55
2003	0.36	0.67	0.97	1.53	2.07	2.32	2.62	3.84	4.58	4.07	5.25	7.97	10.3
2004	0.28	0.62	1	1.41	2.09	2.48	2.71	2.9	4.45	6.3	5.33	6.88	10.3
2005	0.37	0.68	0.97	1.38	1.83	2.44	2.87	3.16	3.37	4.94	6.3	6.14	12.32
2006	0.32	0.64	1.01	1.53	1.9	2.17	2.73	3.4	3.89	3.21	5.15	7.01	10.79
2007	0.3	0.64	1.08	1.52	1.99	2.3	2.56	3.54	4.91	5.42	4.76	6.9	10.14
2008	0.37	0.91	0.96	1.35	1.95	2.2	2.52	2.72	4.07	5.21	5.04	5.26	10.3
2009	0.16	0.72	0.95	1.45	1.93	2.38	2.51	2.42	3.26	5.57	7.03	8.19	11.48
2010	0.34	0.8	1.13	1.33	1.97	2.16	2.52	2.6	2.85	5.56	7.75	9.75	11.6
2011	0.59	0.84	1.02	1.35	1.57	2.12	2.39	2.74	2.6	2.77	2.86	4.73	5.52
2012	0.18	0.84	0.96	1.42	1.98	2.02	2.21	2.82	3.31	3.56	2.66	2.85	3.62
2013	0.21	0.82	1.15	1.49	1.73	2.03	2.07	2.56	2.73	2.93	3.1	2.36	2.53
2014	0.29	0.93	1.03	1.83	2.05	2.1	2.73	2.49	3.28	3.83	2.64	4.53	7.22
2015	0.09	0.77	1.14	1.53	2.07	2.42	2.73	2.99	3.12	4	5.79	5.07	7.16
2016	0.13	0.84	1.18	1.51	1.79	2.26	2.38	2.96	3.58	4.04	4.75	4.14	9.51
2017	0.25	0.48	0.85	1.34	1.82	1.93	2.36	2.53	2.4	3.94	4.07	3.65	5.28
2018	0.31	0.69	1.41	1.55	1.9	2.15	2.34	3.29	3.15	3.62	5.37	5.81	7.91
2019	0.09	0.85	1.07	1.43	1.74	2.01	2.29	2.36	3.09	2.9	3.47	7.89	5.41
2020	0.24	0.73	1.21	1.73	1.97	2.06	2.13	2.37	2.78	2.67	3.13	4.58	3.87
2021	0.25	0.62	0.92	1.3	1.75	2.04	2.41	2.29	2.17	2.59	3.65	4.32	2.68
2022	0.33	0.66	1.44	1.75	2.15	2.33	2.41	2.56	2.55	2.7	3.17	2.59	3.96
2023	0.62	0.7	0.69	1.33	1.8	2.08	2.18	2.21	2.09	2	2.43	3.36	4.91
2024	0.4	0.66	1.01	1.46	1.9	2.15	2.33	2.35	2.27	2.43	3.09	3.42	3.85

APPENDIX B. HYBRID MODEL DIAGNOSTICS

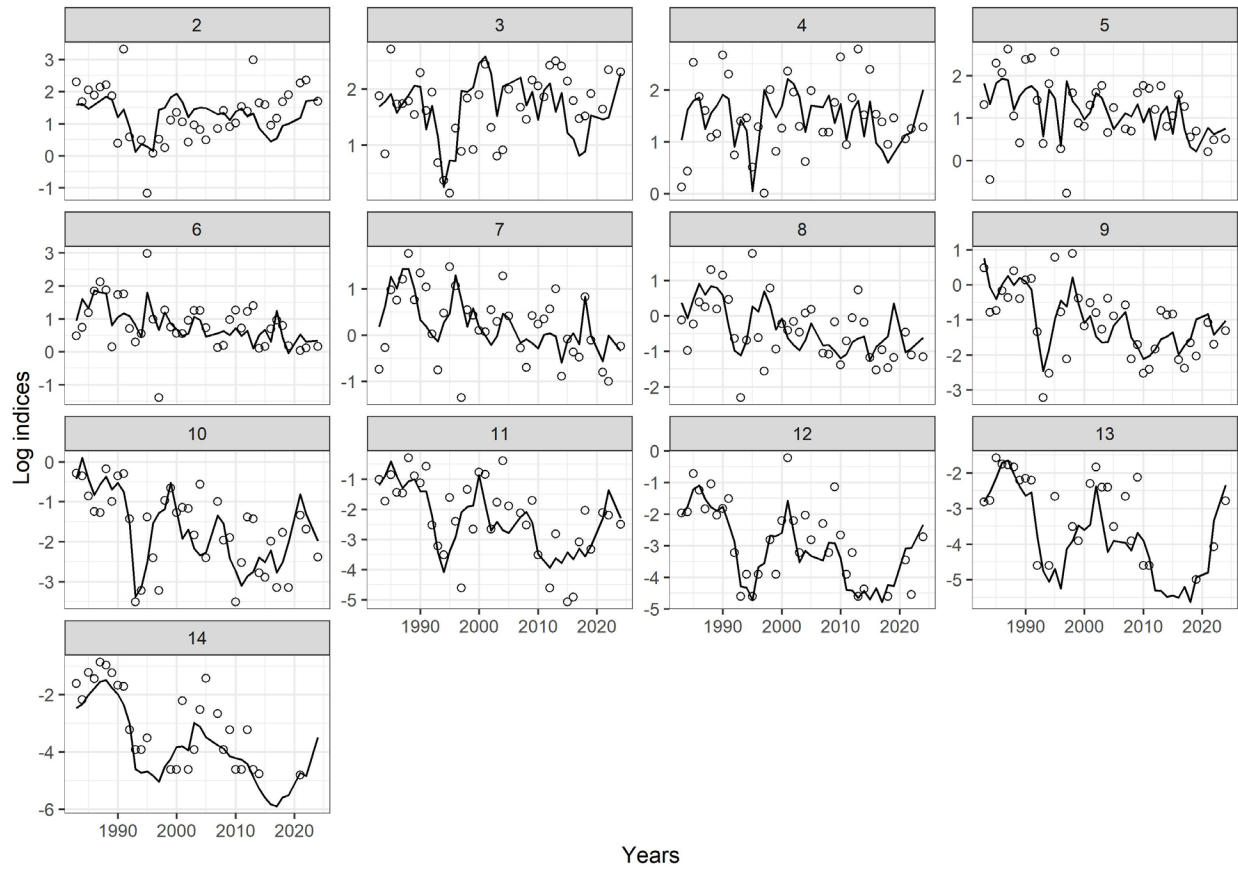


Figure B-1. Model fits at age to the DFO Spring RV survey in NAFO Subdiv. 3Ps.

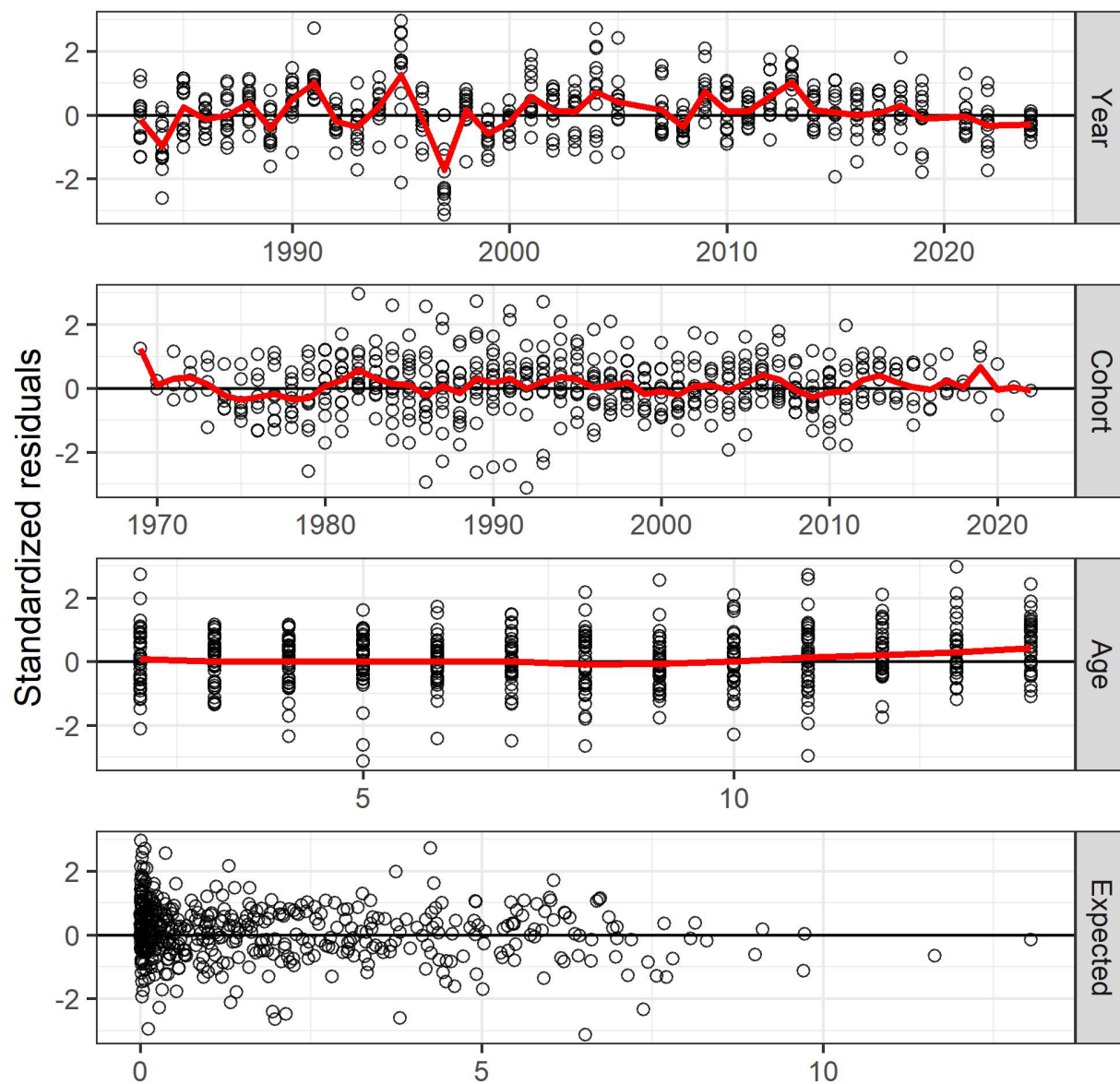


Figure B-2. Standardized residuals of indices obtained from the DFO RV survey are plotted against year, cohort, age, and predicted log-index for the three divisions. A solid line representing the mean is drawn on each plot.

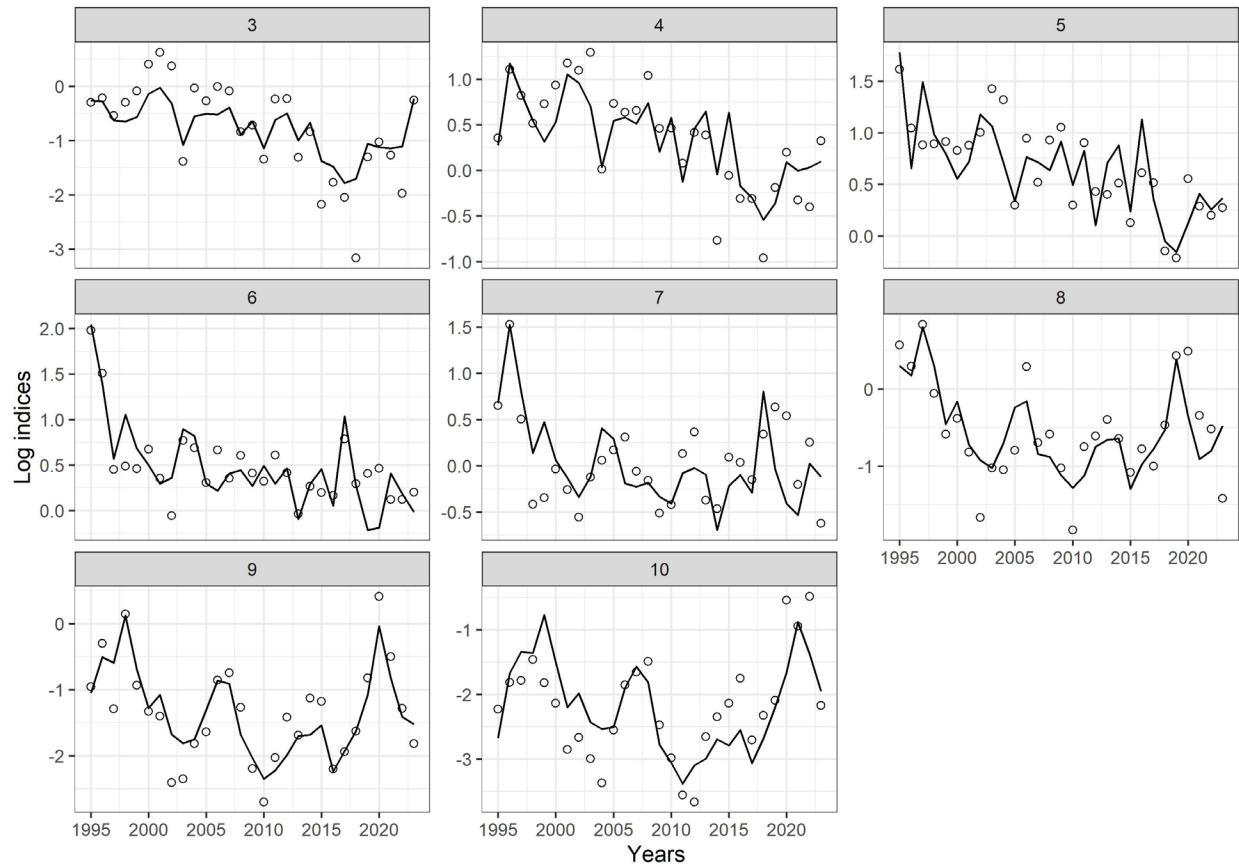


Figure B-3. Model fits at age to the Sentinel line-trawl index.

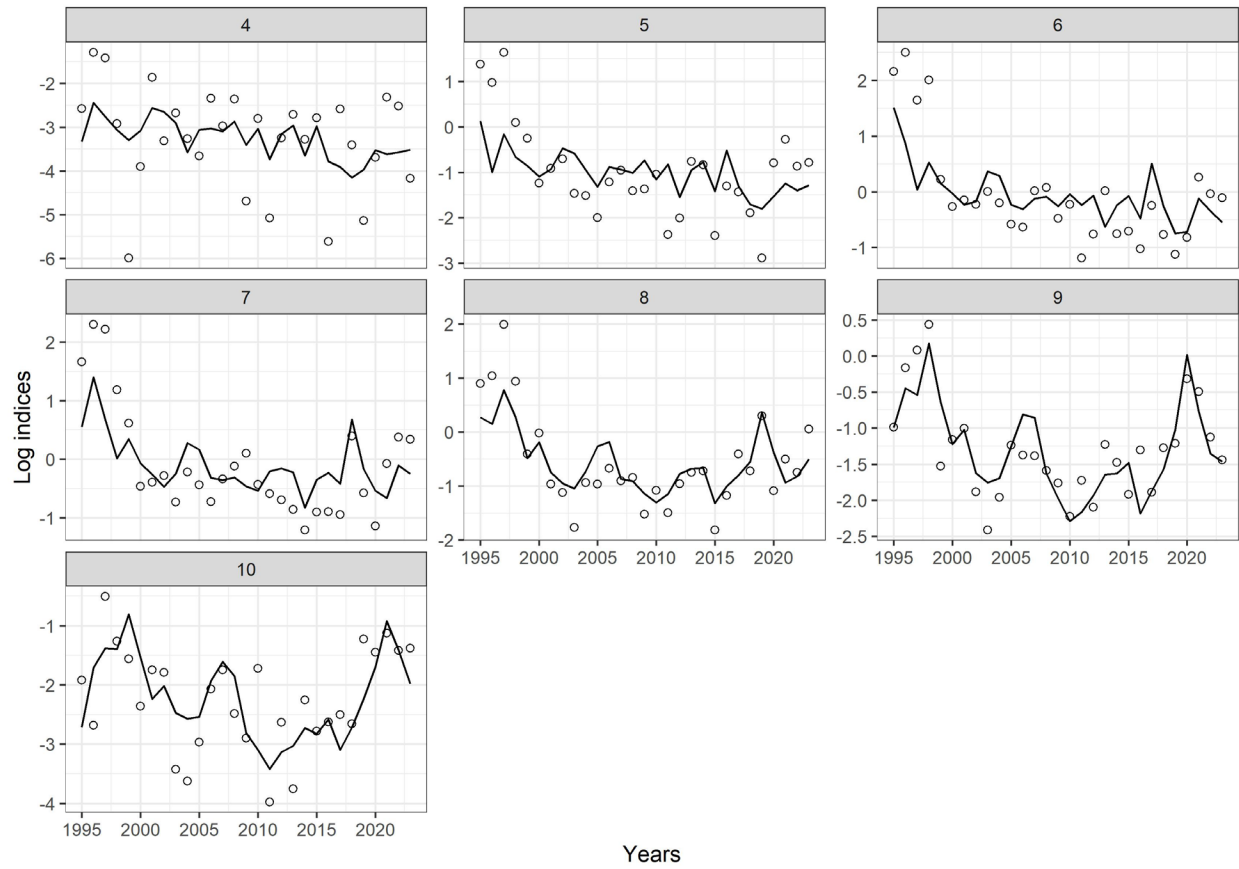


Figure B-4. Model fits at age to the Sentinel GN index.

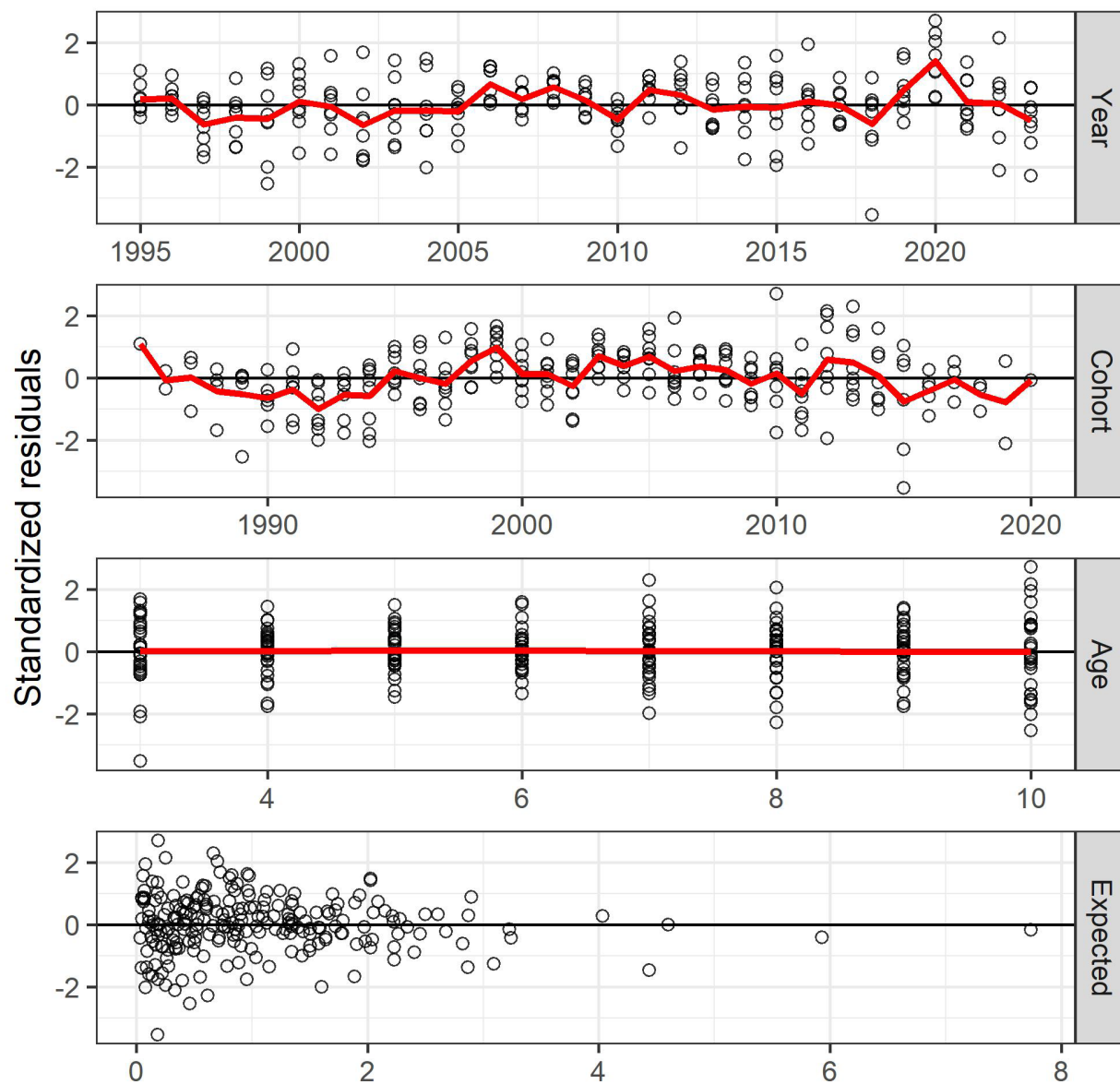


Figure B-5. Standardized residuals of indices obtained from the Sentinel line-trawl survey are plotted against year, cohort, age, and predicted log-index for the three divisions. A solid line representing the mean is drawn on each plot.

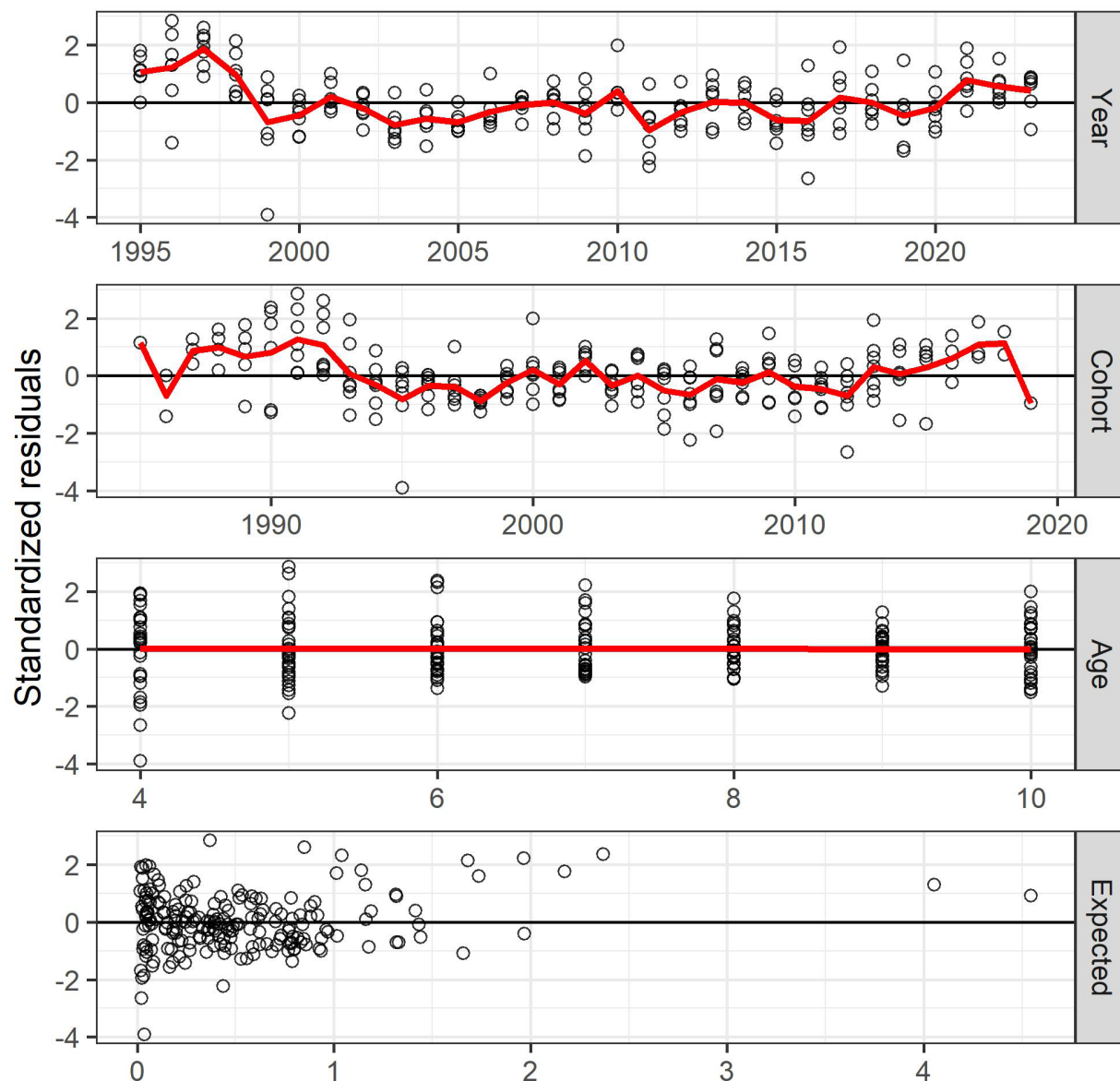


Figure B-6. Standardized residuals of indices obtained from the Sentinel gillnet survey are plotted against year, cohort, age, and predicted log-index for the three divisions. A solid line representing the mean is drawn on each plot.

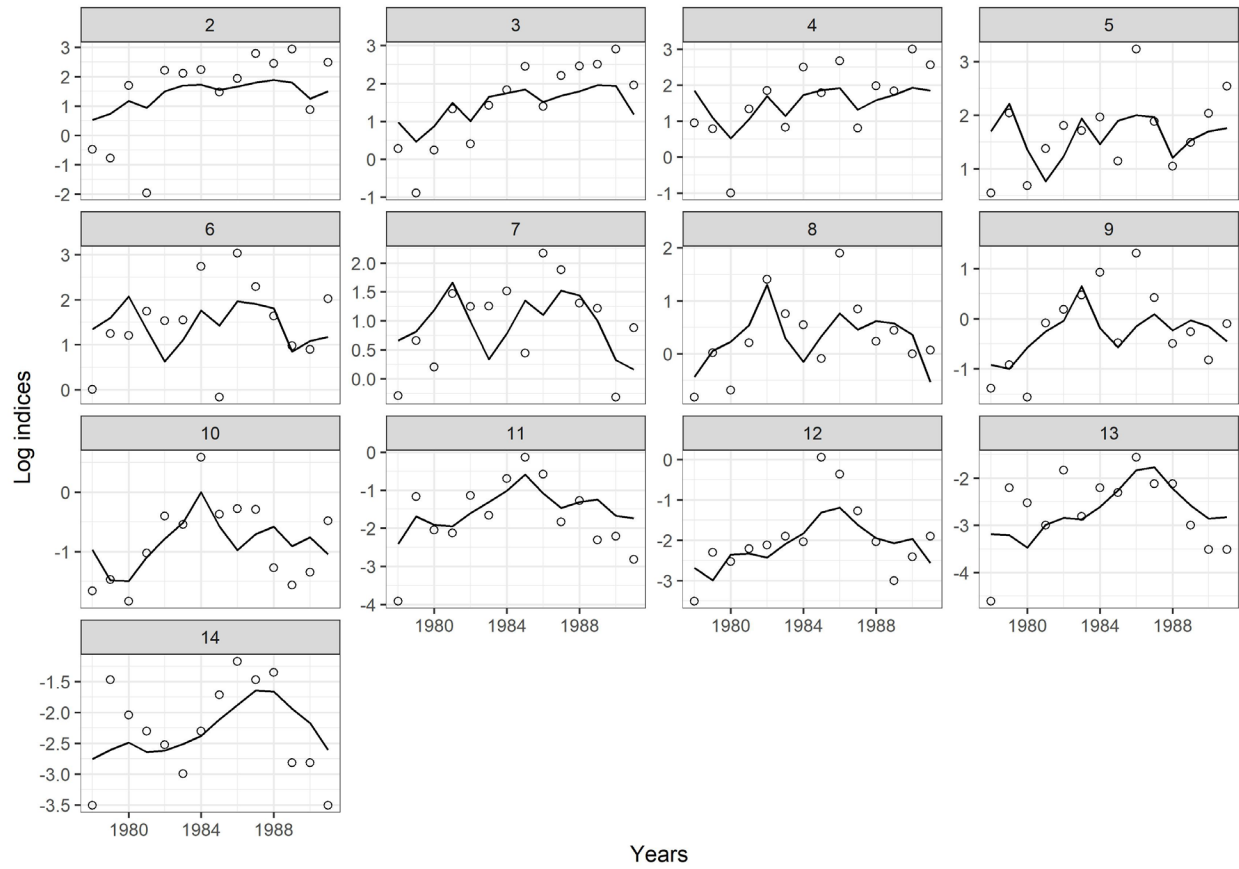


Figure B-7. Model fits at age to the French EHRAPS survey.

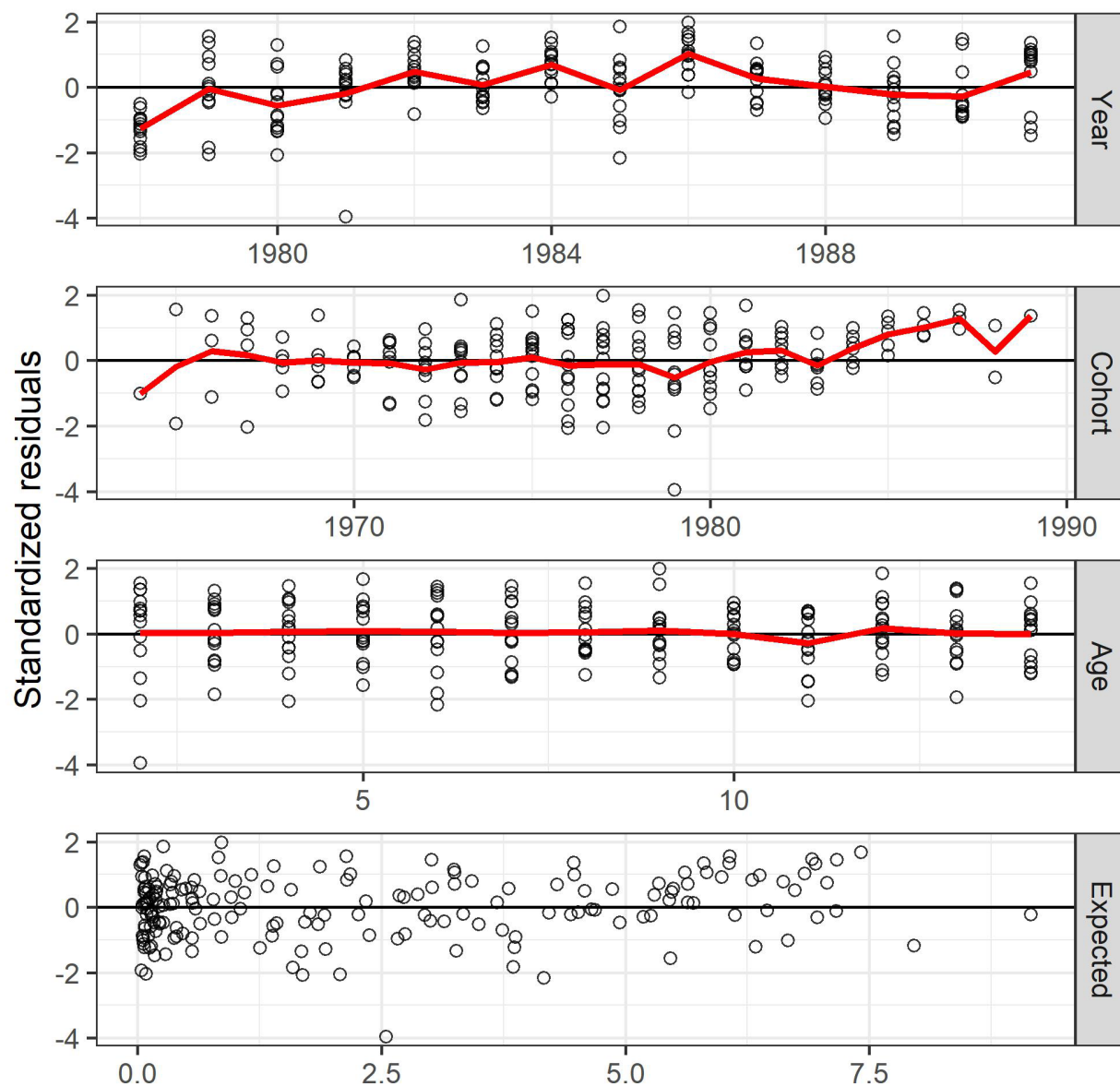


Figure B-8. Standardized residuals of indices obtained from the ERHAPS survey are plotted against year, cohort, age, and predicted log-index for the three divisions. A solid line representing the mean is drawn on each plot.

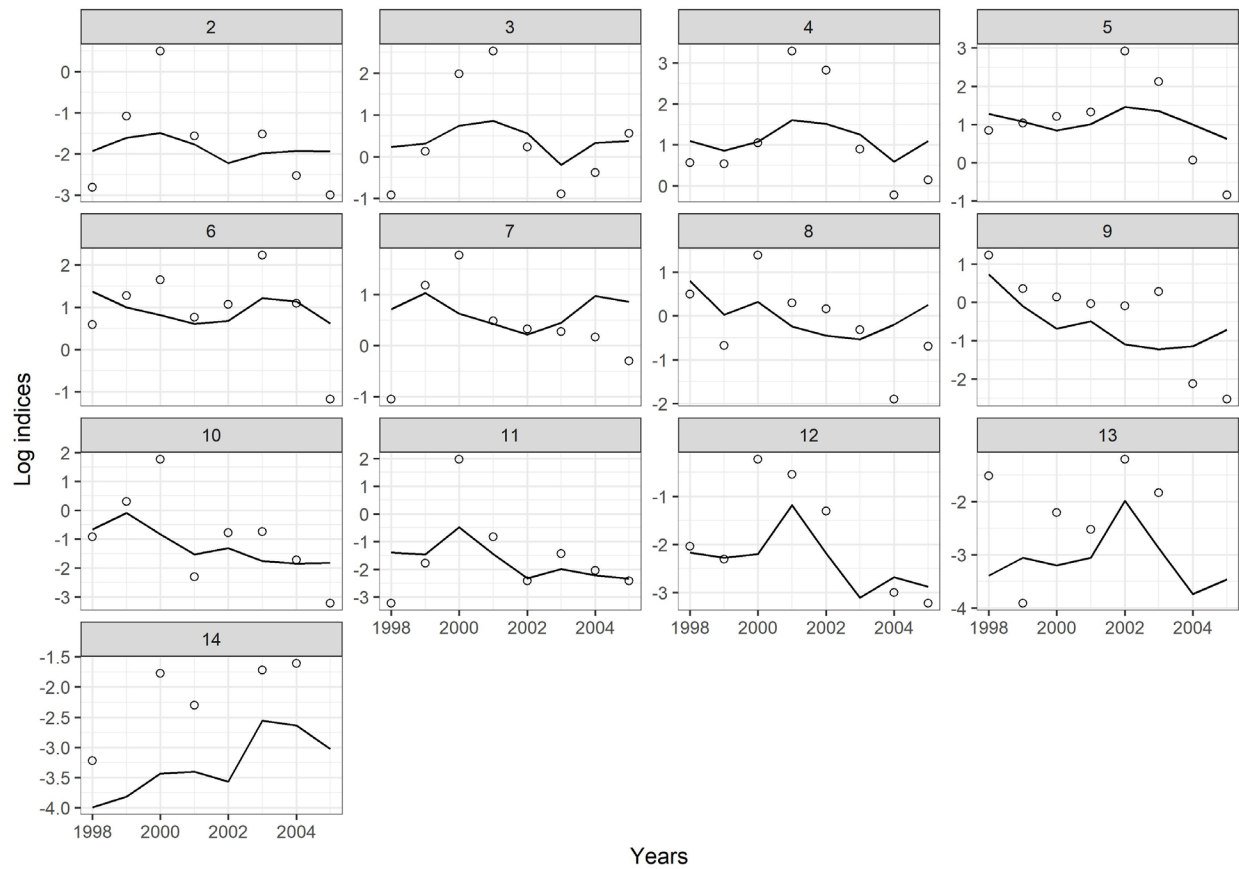


Figure B-9. Model fits at age to the GEAC survey.

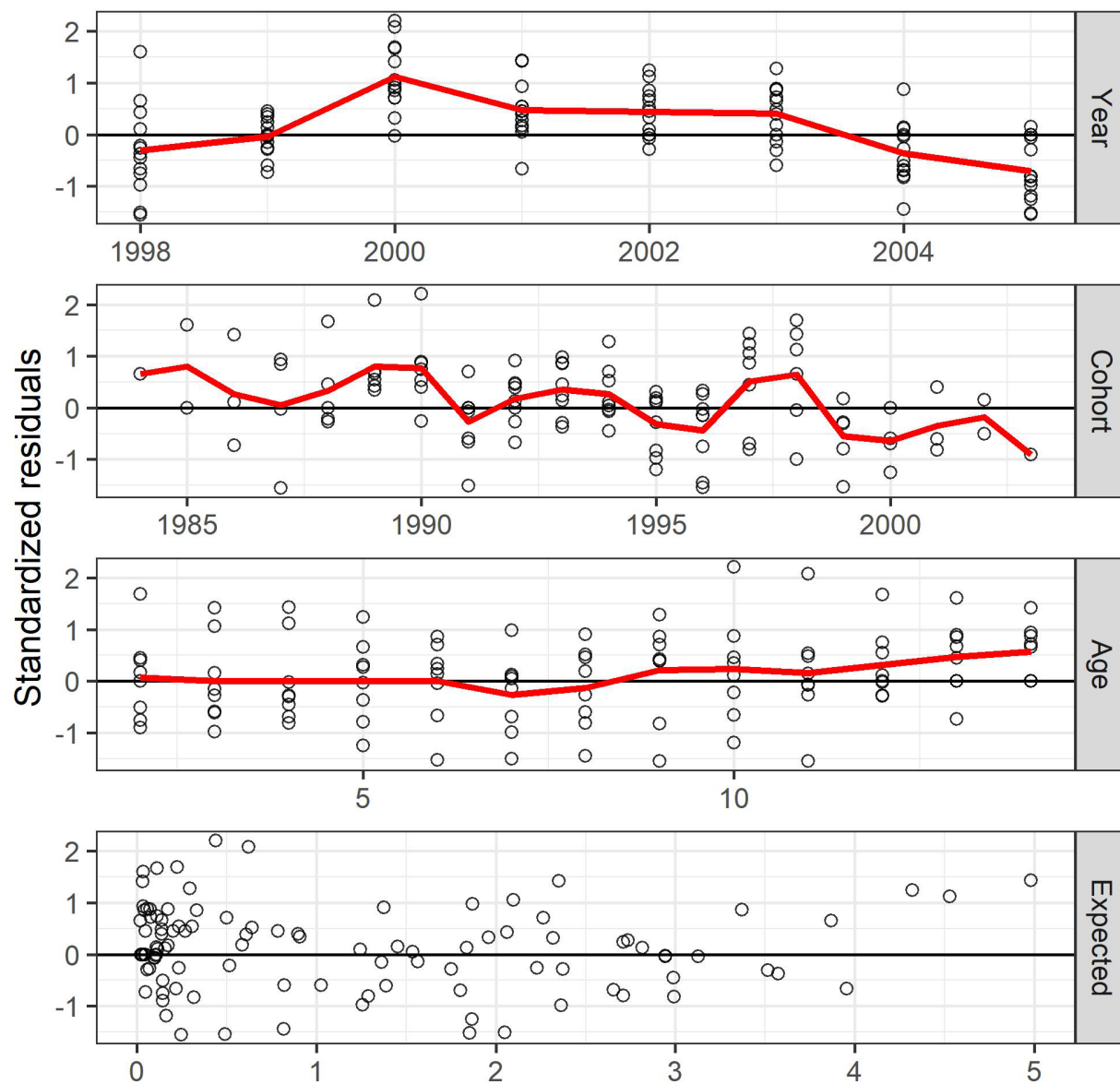


Figure B-10. Standardized residuals of indices obtained from the GEAC survey are plotted against year, cohort, age, and predicted log-index for the three divisions. A solid line representing the mean is drawn on each plot.

APPENDIX C. SAM MODEL UPDATE 2024

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C.1. SAM MODEL DESCRIPTION

The stock assessment model (SAM) model for 3Ps cod stock was developed with the [stock assessment package](#) (from Nielsen and Berg 2014; Berg and Nielsen 2016), and has been described extensively in Champagnat et al. (2024). The model formulation follows the description of 'Sentinel run' (run 143) in Champagnat et al. (2024), with one exception: the removal of age 3 from the Sentinel Gillnet survey due to consistently low catches of this age group in this gear (like in HYBRID).

C.2. INPUT DATA AND PARAMETRIZATION

The input data used in 2024 cod 3Ps assessment are the same as for the HYBRID model with regard to fisheries landings (1959–2023), catch, catch weight and maturity-at-age (1959–2023), stock weight-at-age (1959–2024), Research surveys (CAN-RV Spring Survey, ERHAPS Trawl Survey), GEAC Trawl Survey and Sentinel gillnet and line-trawl (1995–2023). In the HYBRID model, the plus group is set at 14 while for SAM, the plus group is set at 12 and the model differs in the parametrization of the Natural Mortalities and some other elements of the State-Space Assessment Model (SAM) as follows:

Table C-1. Comparison of SAM and HYBRID models.

	SAM	HYBRID
Fit	Catch-at-age directly	To landings and proportion at age using continued ratio logit
Treatment of 0's	Changed into NA and estimated	Censored likelihood to inform on 0 +epsilon
Random effect	F and N	F and N. Break to the MVN for F at the beginning of the moratorium.
IO & OFF	Q > 7 equally in the 2 scientific surveys	Q for ages 8 and older adjusted in the 2 scientific surveys
Catches	No uncertainty (although possible to introduce a proxy)	Uncertainty treated with censored likelihood
M	Set at 0.3 all years and all ages	Condition-based M
Plus group	12	14

C.3. Sentinel Indices Influence

Sentinel line-trawl index has a very low standard deviation estimate (Table C1), which points that the model is fitting substantially to this index. To assess the influence of that series, leave out fleet runs were performed (i.e., running the same model but with one survey out). The run without Sentinel line-trawl index displays similar SSB but larger R (Figure C1) than the main run, which figures out that this index is driving the recruitment estimates downward. The Sentinel gillnet index has the highest standard deviation estimate from the 6 reference fleets. This survey has thus a low influence on the final estimate and leaving it out of the final run displays SSB, F and Recruitment lines confounded with those of the final run (Figure C1).

C.4. Surveys Influence

The standard deviation estimates (Table C2) of the two Spring DFO-RV surveys (Inshore/Offshore [1997 to present], Offshore [pre-1997]) and French ERHAPS survey show a remarkable similarity (0.73–0.77) which means they are contributing equally to the final estimates. The leave out exercise (Figure C1) shows that the DFO-RV survey is the most influential for the last decade SSB and drives the stock estimates downward.

C.5. SAM Results

The final run presented at the 3Ps cod assessment 2024 meeting was parametrized as described in the first section.

The stock spawning biomass shows a slight increase in 2024/2025 (Figure C5). The final estimate for 2021 is 27.6 kt (Table C3), which is 42% of the LRP as defined in 2019.

Population-weighted fishing mortality has overall decreased since 2000, with the 2024 estimate at 0.05. Although fishing mortality remains low, it has been increasing since 2022 (Figure A6; Table C3).

Recruitment estimates (abundance of age-2 fish) have been low since 2002. After hitting a minimum in 2022, recruitment showed an increasing trend until 2022. Since then, recruitment has remained constant at 26.6 million (Figure C7).

Model diagnostics are similar to those discussed at the framework meeting, with some evidence of a year-effect in the survey fit and some conflict between DFO RV survey and Sentinel line-trawl indices.

Process residuals for the population are well described (Figure C2) and those for fishing mortality display some large residuals in the mid-1990's, probably as a side effect of the moratorium.

Regarding the retrospective patterns, two different analyses were carried out. One uses the last two assessments fit compared to the fit for 2024 (method used for HYBRID, Figure C3) and another by successively removing a year (hereafter "yearly based" method, Figure C4).

Based on the former method, there is a negative retrospective pattern in SSB (Figure C3). This is consistent with the outputs of HYBRID with uncertainties identified in the 2023 assessment that indicated a possible overestimation of stock size (lack of 2023 RV survey and recent diverging trends between sentinel and RV indices). The "yearly based" retrospective analysis reveals a very different pattern with no major pattern for SSB but a significant positive deviation in 2023 for the recruitment.

C.6. Projection with SAM

Due to uncertainty in the current abundance of young fish, which likely results in overestimates of stock growth, projections are only provided until 2025/2026. The projections consider three catch scenarios: (1) Catch as calculated with the adopted management procedure (MP); (2) Catch at the Total Allowable Catch (TAC) for 2024/25, which is 1,550 t; and (3) No fishing removals (Table C4). All projections show a very high probability (>95%) of stock growth, though the stock remains below the Limit Reference Point (LRP) through at least early 2026. The stock is projected to be at 29.7 kt in 2025/2026 under the adopted management procedure and remains well below the LRP (Table C4).

Table C-2. Standard deviation parameters estimated for SAM run.

Standard deviation parameters	Standard run 2021	Standard run 2024
Recruitment	0.32	0.32
Survival/population	0.18	0.23
Age2 F	0.69	0.59
Age3–4 F	0.96	0.92
Age5+ F	0.64	0.65
Age2 catch	1.67	1.70
Age3–4 catch	0.67	0.72
Age5+ catch	0.28	0.29
OFF	0.75	0.73
IO	0.79	0.77
GEAC	0.97	0.97
ERHAPS	0.77	0.74
Sentinel GN	2.74	1.20
Sentinel LT	0.45	0.41

Table C-3. Estimates, upper and lower bounds of SSB, F and R from SAM.

Variable	Year	Estimate	Lower – Upper bound
SSB	2022	23.6	18.9–29.4
SSB	2023	23.9	18.8–30.1
SSB	2024	27.6	21.3–35.8
F	2022	0.02	0.02–0.03
F	2023	0.03	0.02–0.04
F	2024	0.05	0.04–0.07
Recruitment	2022	26.6	15.5–45.9
Recruitment	2023	26.9	13.8–52.8
Recruitment	2024	26.6	11.8–60.1

Table C-4. Estimates, upper and lower bound of SSB and fishing mortality in 2025/2026 from SAM projection.

Variable	Catch scenario	SAM Estimate	SAM Lower bound	SAM Upper bound
SSB	no_fishing	29.4	21.7	40.1
SSB	fishing_under_MP	29.7	21.8	40.6
SSB	status_quo_3yr	29.3	21.5	40.5
F	no_fishing	0.000	0.000	0.000
F	fishing_under_MP	0.027	0.007	0.099
F	status_quo_3yr	0.044	0.012	0.159

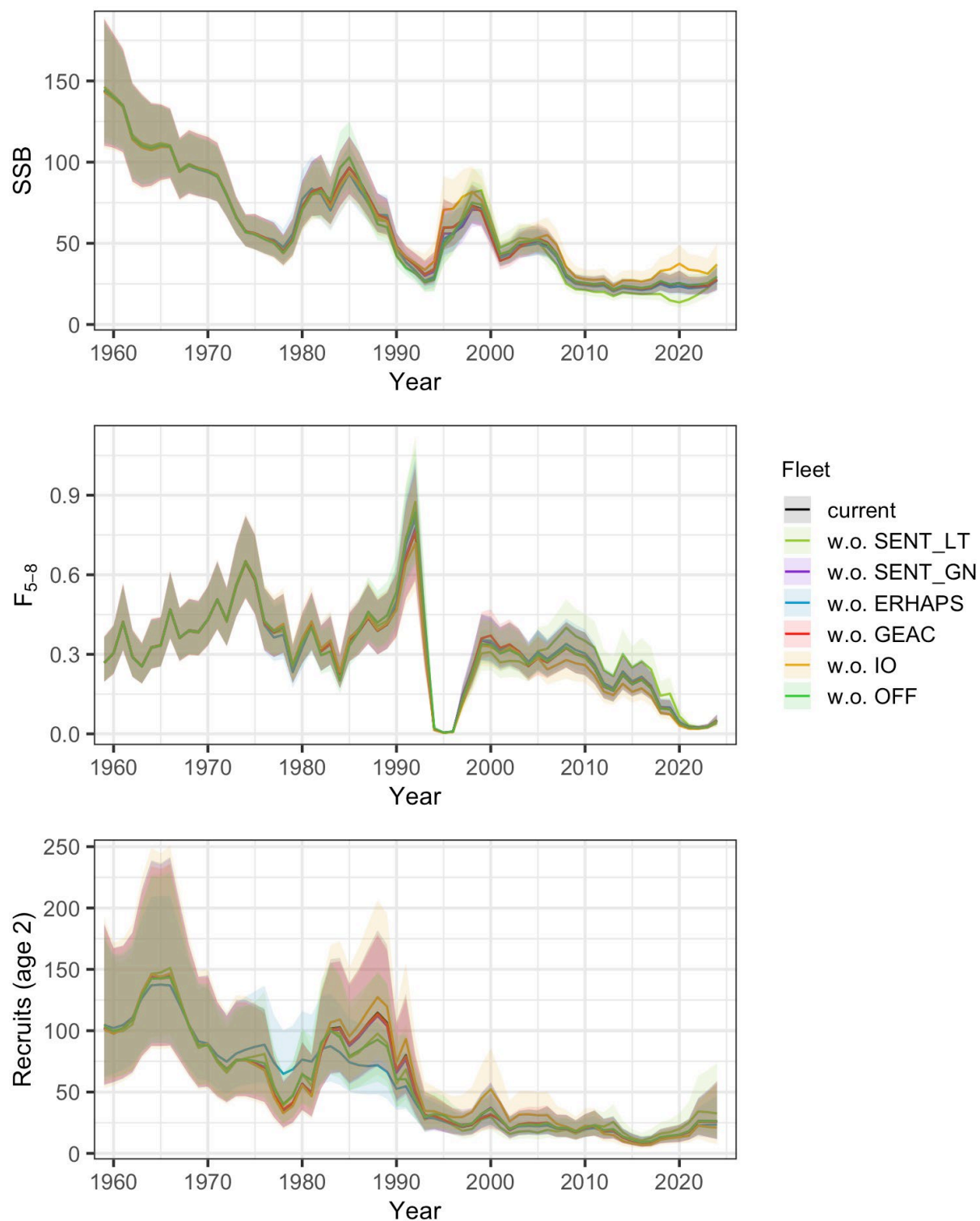


Figure C-1. Trends in SSB, average fishing mortality and recruitment (age-2) estimated by SAM for current run and leave out fleet runs.

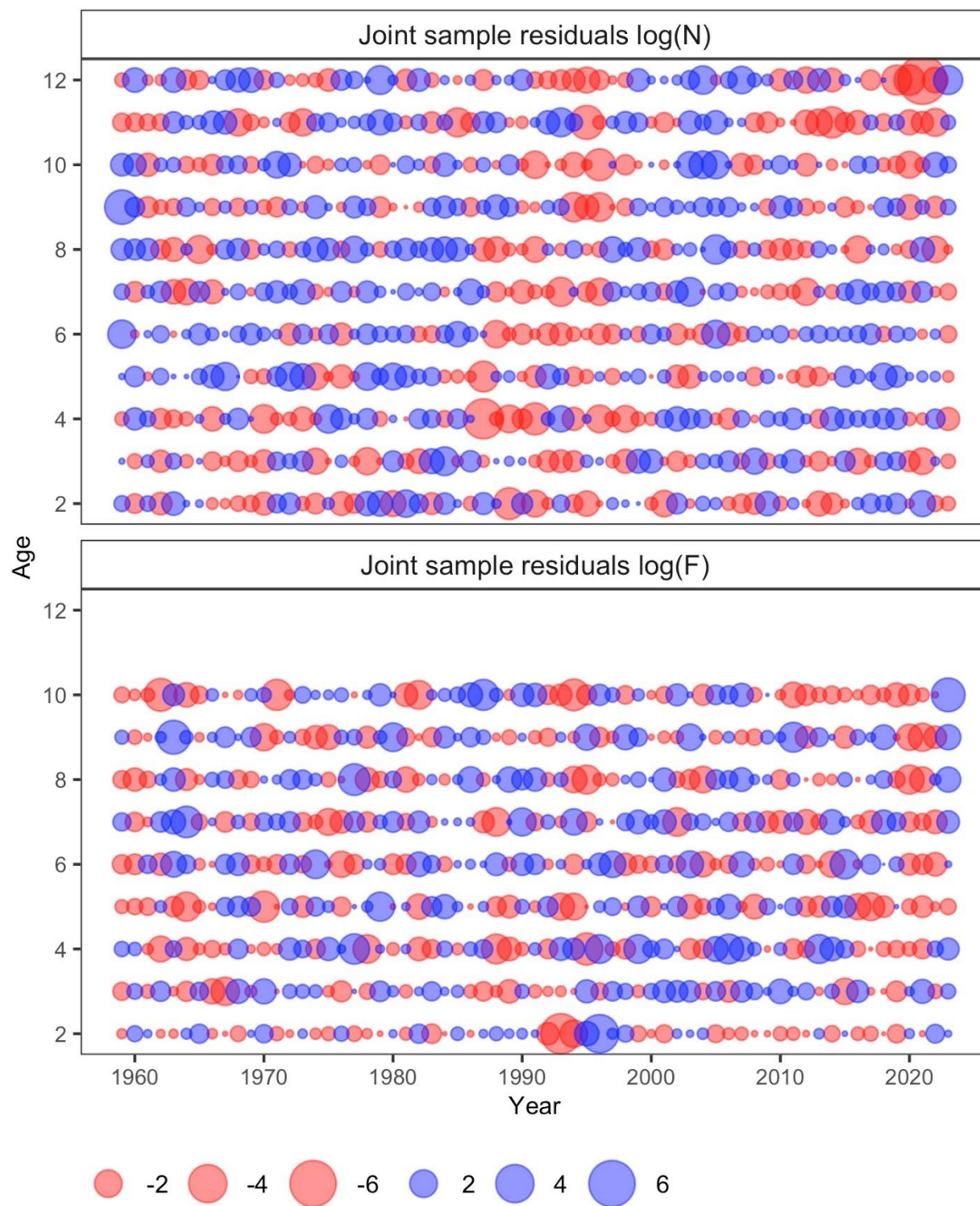


Figure C-2. Process residuals for population (top) and fishing mortality (down).

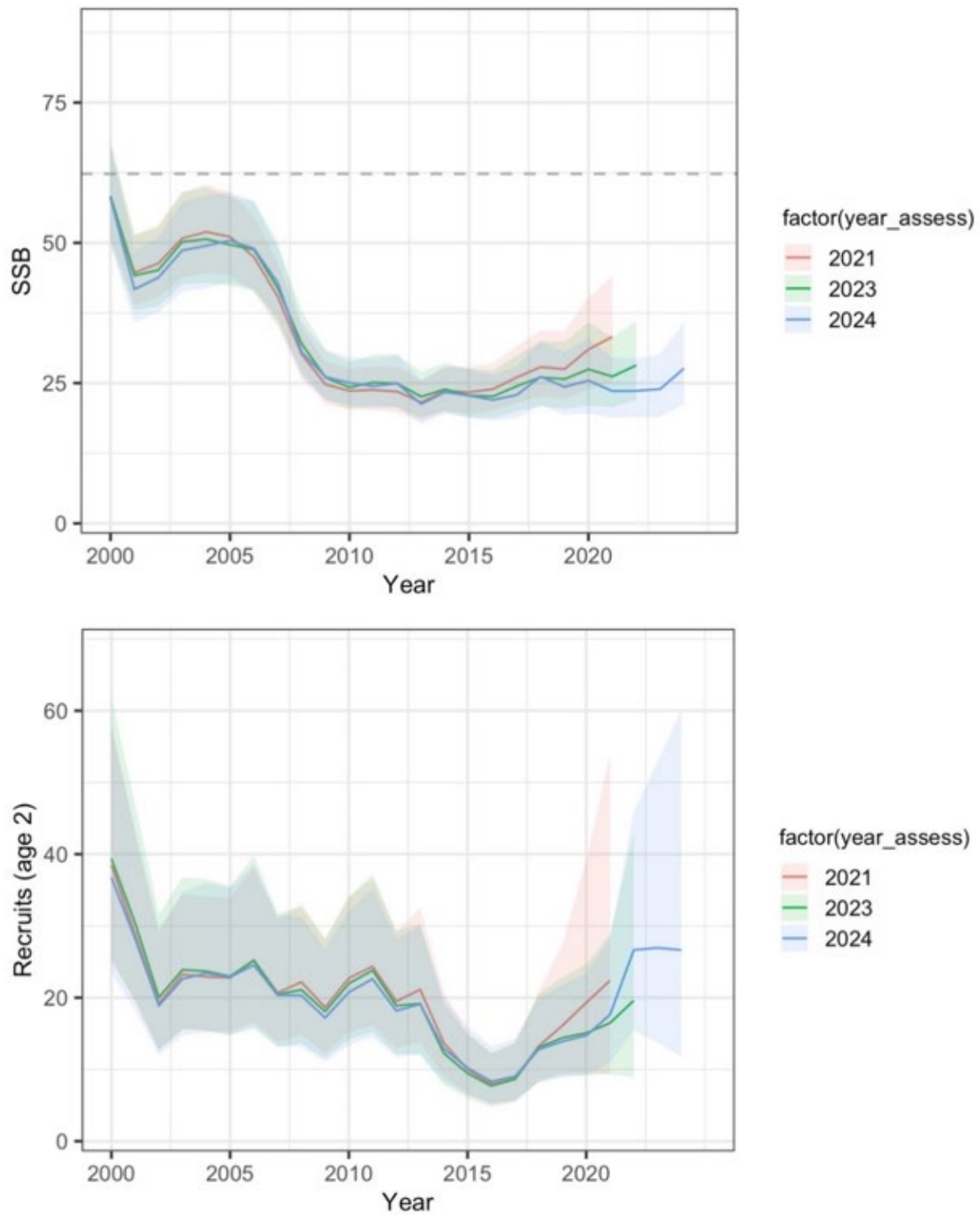


Figure C-3. Plots of retrospective analysis for SSB and recruitment (age-2) estimated by SAM using the assessment based method.

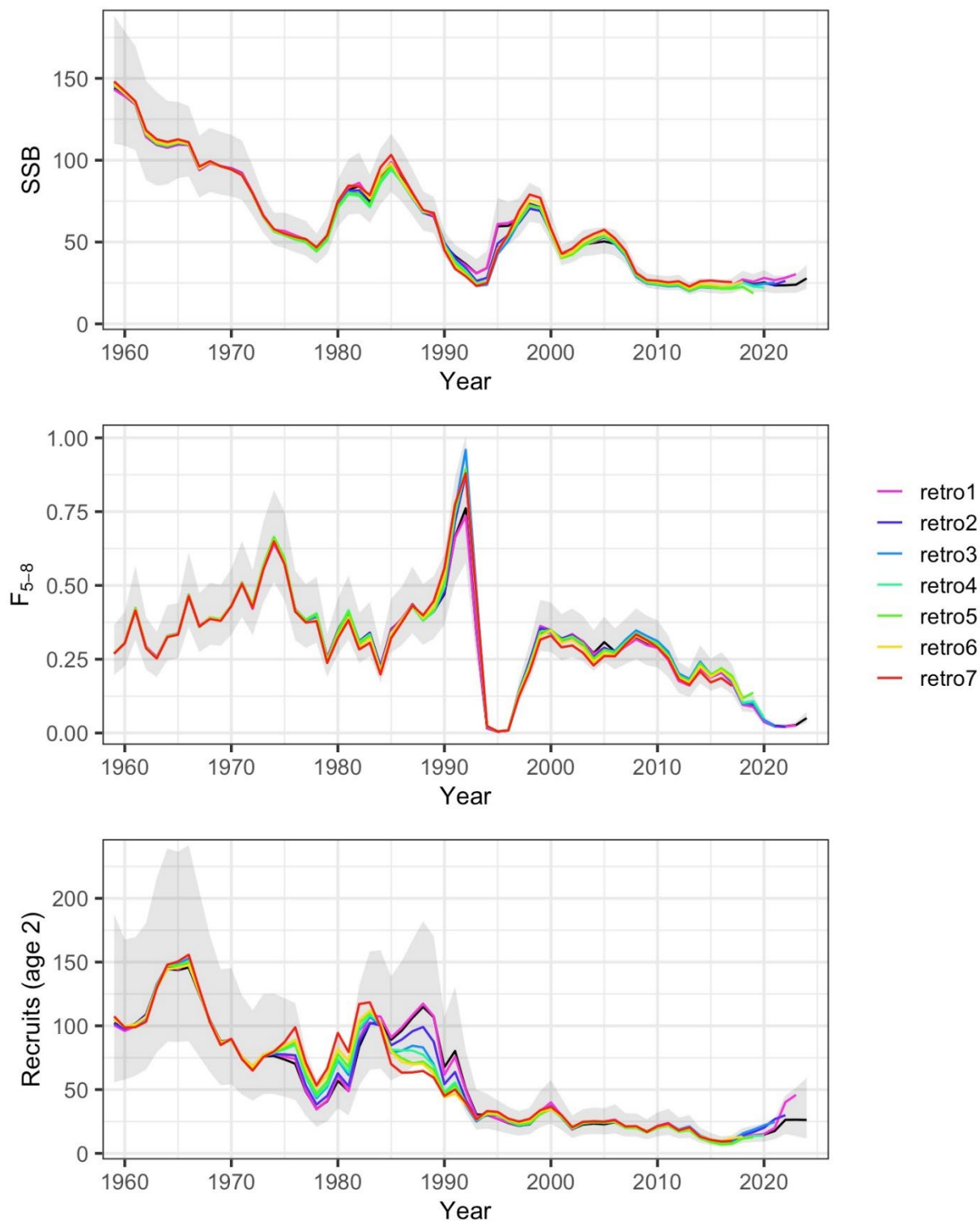


Figure C-4. Plots of retrospective runs for SSB, average fishing mortality and recruitment (age-2) estimated by SAM using the yearly-based method.

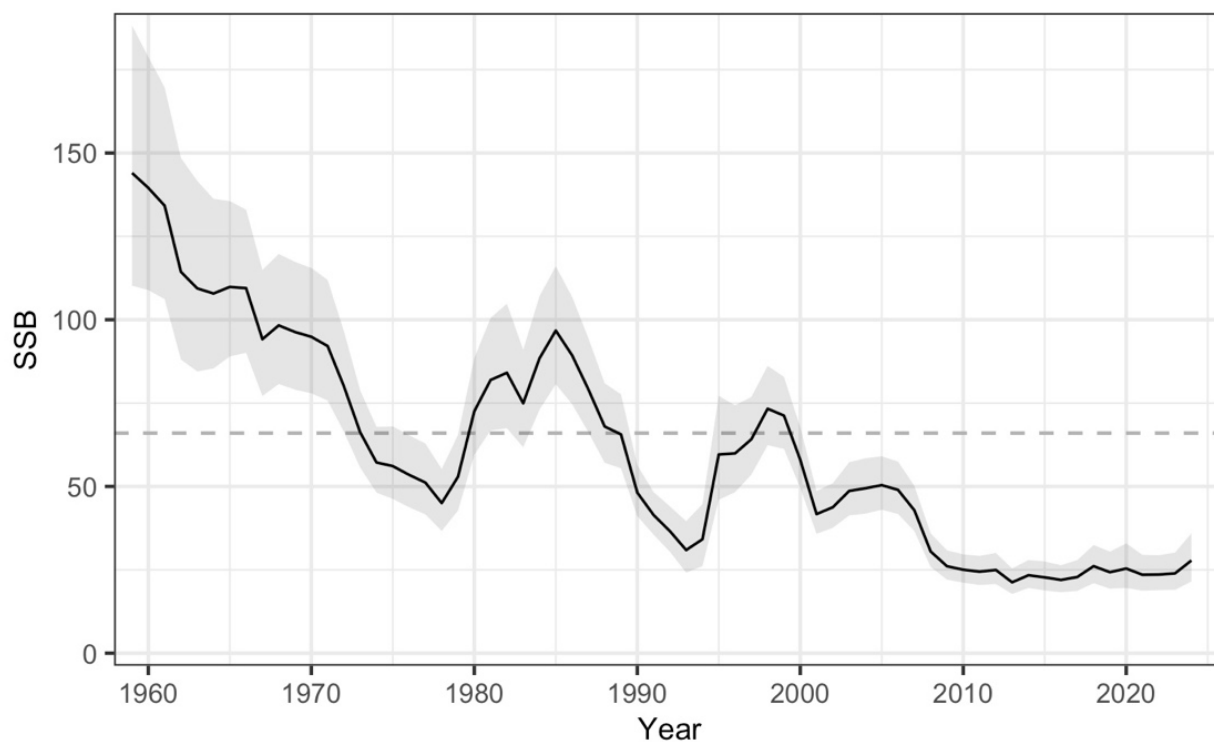


Figure C-5. Estimates and confidence intervals for SSB from SAM run.

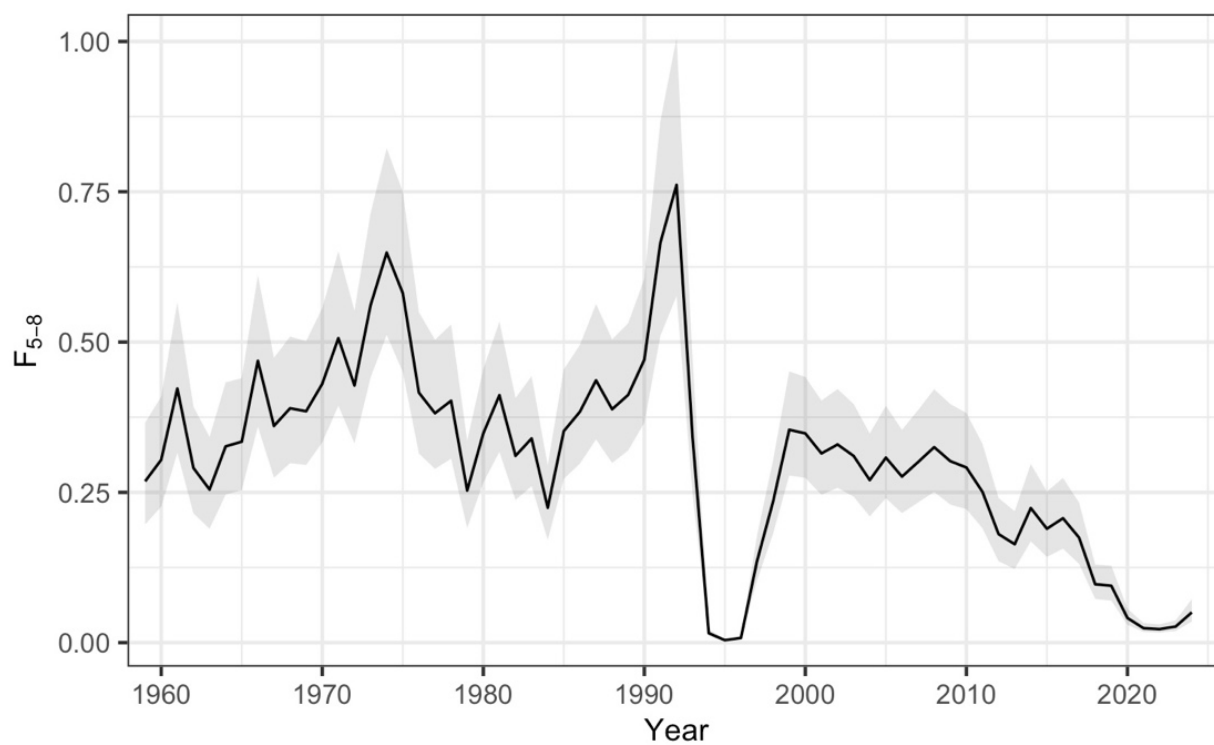


Figure C-6. Estimates and confidence intervals of average fishing mortality from SAM run.

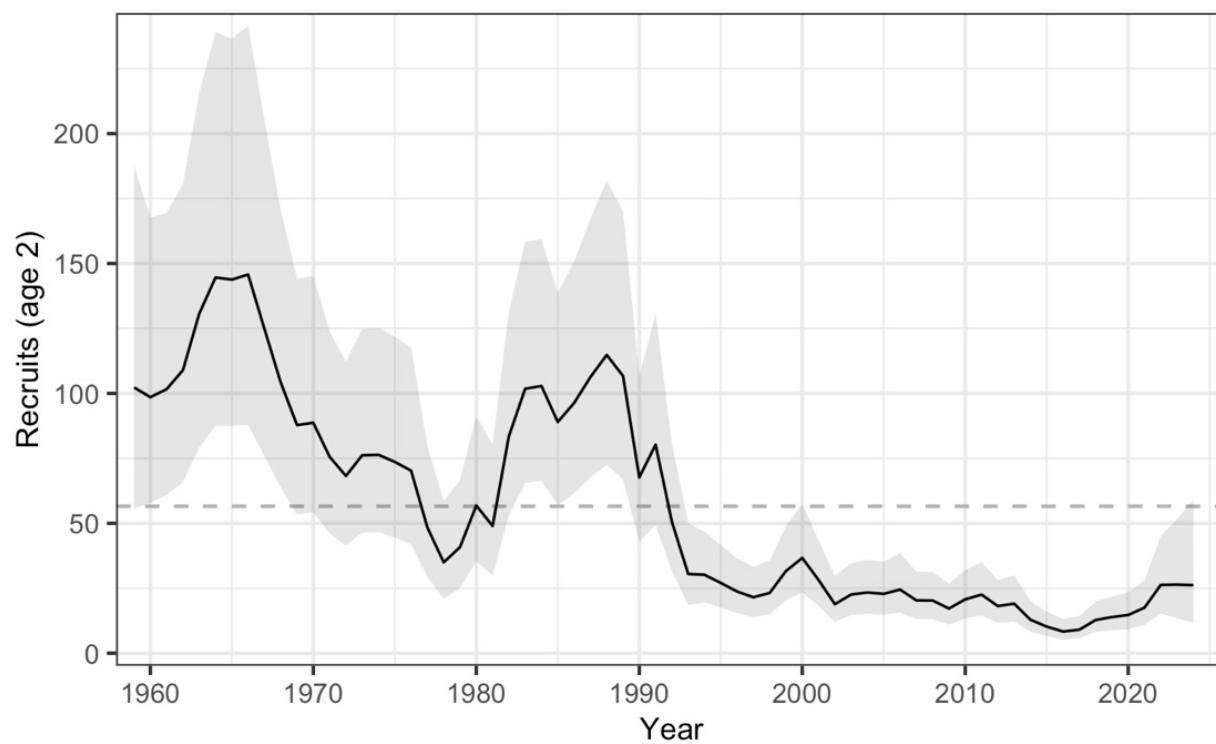


Figure C-7. Estimates and confidence intervals of recruitment (age-2) from SAM run.