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2025 Assessment of Yellowtail Flounder in NAFO Divisions 3LNO

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Abstract

Yellowtail flounder in NAFO Div. 3LNO is assessed using a surplus production model in a Bayesian framework. Canadian (Div. 3LNO) and Spanish (Div. 3NO) surveys show the stock size increased from when the moratorium on directed fishing was declared in 1994 until about 1999 or 2000. Estimates remained high until the early 2010, and then showed general declining trends to around 2020. Spanish survey estimates reached the second lowest in its time series in 2022. Declines in the Canadian surveys were of a lower magnitude, remaining well above early-1990s levels. However, Canadian survey gaps in this period complicate interpretation. The Canadian spring and Spanish surveys show increases to 2024, and the Canadian fall has leveled off. Recent landings have been well below the Total Allowable Catch. Relative estimates from the Bayesian production model indicate The stock size remains above B_{msy} with a probability >99%, and has been between 1.3x and 1.5x B_{msy} since 2016. There is very low risk (<1%) of the stock being below $B_{trigger}$ and a very low risk of F being above $F_{lim}=F_{msy}$ or F_{target} (<1%). Recruitment has been generally above average since the late 2010s. Projections were conducted to start of year 2028 and results are presented in the NAFO precautionary approach framework.

I. Fishery and Management

A. TAC Regulation

The stock has been under total allowable catch (TAC) regulation since 1973, when an initial level of 50 000 tonnes (t) was established. In 1976, the TAC was lowered to 9 000 t, following a series of high catches (**Figure 1**; **Table 1**) and a reduction in stock size. From 1977 to 1988, the TAC varied between 12 000 t and 23 000 t and was unchanged at 15 000 t for the last 4 years of that period. The TAC was set at 5 000 t in 1989 and 1990, following sharp declines in stock size after the large catches in 1985 and 1986, then increased to 7 000 t in 1991-94. However, NAFO Fisheries Commission decided that no directed fisheries would be permitted for this stock and some other groundfish fisheries (cod, American plaice and witch flounder) on the Grand Bank during 1994. From 1995 to 1997, the TAC was set at zero and a fishery moratorium was imposed. Following an increase in survey biomass, Scientific Council in 1997 recommended a re-opening of the yellowtail flounder fishery with a precautionary TAC of 4 000 t for the 1998 fishery. With the cessation of the moratorium, other management measures were imposed, such as delaying the re-opening until August of 1998 to allow the majority of yellowtail flounder spawning in that year to be completed, and restricting the fishery to Div. 3N and 3O. For the 1999 fishery, a TAC was set at 6 000 t and again restricted to Div. 3N and 3O, but there were no restrictions on the time period. TAC was set between 10 000 and 15 500 t between 2000 and 2007. In assessments from 2008 through 2021, Scientific Council noted this stock was well above biomass at maximum sustainable yield (B_{msy}), and recommended any TAC option up to 85% F_{msy} for 2009-2021. TAC was been set to 17 000 t for 2009 to 2021 and the TAC increased to 20 000 t for 2022 and 2023. The 2023 assessment indicated the stock had declined to near B_{msy} and Scientific Council recommended fishing mortality up to 75% F_{msy}, corresponding to catches of 15 560 t and 15 810 t in 2024 and 2025, respectively; the TAC was set at these catch levels for 2024 and 2025.

B. Catch Trends

The nominal catch increased from negligible amounts in the early 1960s to a peak of 39 000 t in 1972 (**Table 1**; **Figure 1**). With the exception of 1985 and 1986, when the nominal catch was around 30 000 t, catches were in the range of 10 000 to 18 000 t from 1976 to 1993, the year before the moratorium.

During the moratorium (1994-97), catches decreased from approximately 2 000 t in 1994 to around 300 – 800 t per year, as by-catch in other fisheries. Since the fishery re-opened in 1998, catches have increased from 4 400 t to a high of 14 100 t in 2001. Overall, catches exceeded the TACs during 1985 to 1993 and again from 1998 – 2001, by about 10% in the latter period. Since 2002 the catches have been below the TAC. Corporate restructuring and labour disputes, in 2006, prevented the Canadian fleet from prosecuting the yellowtail flounder fishery, and Canadian catch was only 177 t. The nominal catch in that year was only 930 t, well below the TAC of 15 500 t. In 2007, the participation in the fishery increased by Canadian fleet, but was still low at 3 673 t, and the nominal catch was 4 617 t. Catch increased in 2008 to 11 400 t. Catches from 2009- 2021 were lower than the 17 000 t TAC, ranging from 3 100 to 14 800 t (2020 value). In 2022 only about half of the 20 000 t TAC was taken (10 600 t). Reduction in the effort by the Canadian fleet in from 2006 – 2018 was the result of industry-related factors. In 2022 concerns were raised that yellowtail were more difficult to locate on traditional grounds, perhaps related to increased bottom temperatures that were noted at the time of fishing. Additionally, industry had noted that by-catch rules in place to protect American plaice also hampered commercial catch of yellowtail in 2022 and adjustments were made to bycatch regulations in this fishery starting in 2023 (*COM Doc. 23-01REV)*.

In some years, small catches of yellowtail have been reported from the Flemish Cap, NAFO Div. 3M. STACFIS previously noted that these catches were probably errors in reporting or identification, as the reported distribution of yellowtail flounder does not extend to the Flemish Cap.

Since the fishery reopened in 1998, directed yellowtail catches have been from the Canadian fleet, with Canadian catches fluctuating from less than 200 t to over 14 000 t. With the exception of 1991 – 1993, when Canadian vessels pursued a mixed fishery for plaice and yellowtail flounder in Div. 3O, the majority of catches have been taken in Div. 3N. The primary gear used is otter trawl, and catches by other gears have been less than 10 t annually after 2002. The fishery has operated year-round for the most part.

Since the last assessment, sampling of size composition from commercial catches of yellowtail flounder in the Canadian directed fishery for yellowtail were available for 2023 (Skanes and Simpson 2024) and 2024 (Skanes and Simpson 2025). The mode was about 35cm in both years (**Figure 2**). The Canadian fleet uses a minimum codend mesh size of 145 mm.

Yellowtail flounder catches by Spain were primarily as by-catch in the skate fishery (González-Costas et al. 2024, 2025) in the NRA of Div. 3NO, with length sampling showing a similar mode to the Canadian catches around 35 cm (**Figure 3**). In 2024, a second smaller mode was evident around 25cm in the Spanish samples. Previous years' bycatch by Spain have been from the Greenland halibut and skate fisheries which use a minimum of 130 mm mesh and 280mm mesh, respectively. Length frequencies were also recorded by Russia in 2024 (Fomin and Pochtar 2025) (**Figure 4**).

C. Recent bycatch of American plaice in the Yellowtail flounder directed fishery (Canada)

American plaice is the most common bycatch species in the fishery for Yellowtail flounder, typically followed by Atlantic cod and Atlantic halibut (**Figure 5**). There is a 15% bycatch restriction on American plaice, though since 2023 additional measures have been added to the NAFO CEM indicating that "while conducting a directed fishery for yellowtail in Divisions 3LNO: 15% of American plaice if a vessel is conducting a directed fishery for yellowtail in Divisions 3LNO, and is carrying an observer: (i) this maxima shall be 2 900 kg or 15% of American plaice, whichever the greater; (ii) a vessel may exceed the maxima referred to in Article 6.3(g)(i) for bycatch of American plaice retained on board during the first 9 fishing days in the Regulatory Area provided that American plaice bycatch represents 15% or less by the end of that period or when the vessel leaves the Regulatory Area, whichever occurs first." (COM Doc. 23-01REV). This is currently in effect through December 31, 2025 (COM Doc. 25-01).

Recent bycatch of American plaice is presented here from Canadian catch data for sets reported as directed for Yellowtail flounder (ZIFF, "Main species sought" = yellowtail flounder). American plaice bycatch over the last 5 years (2020 - 2024) has been <5% of the yellowtail flounder catch annually (**Figure 6**), though proportions vary across years and NAFO Divisions and in Div. 3L in 2022 was ~14% (**Figure 7**).

II. Research Survey Data

Three surveys are currently used to monitor this stock: the Canadian spring and fall surveys (Rideout et al 2025a) and the EU-Spain 3NO survey (Garrido et al. 2024, 2025). The Canadian surveys cover the entire stock area, while the EU-Spain only samples the NRA potion of Div. 3NO (about 9% of the area covered by the Canadian surveys). The trends in all surveys are broadly similar, though declines around 2020 were more evident in the spring and EU-Spain surveys, while fall indices have been more stable. Declines in EU-Spain survey to 2022 were of a larger magnitude than that seen in recent Canadian surveys. This may reflect small-scale changes in distribution (e.g. northward and/or contracting) given the EU-Spain survey only covers the outer edge of the distribution in Div. 3NO. However, incomplete Canadian surveys over the same period impede further interpretation.

A. Canadian stratified-random surveys: spring and fall

Stratified-random research vessel surveys have been conducted in the spring in Div. 3L, 3N and 3O since 1984 and in the fall since 1990. Until 1994 the surveys were conducted using an Engel 145' high-rise groundfish trawl whereas since 1995 surveys were carried out with a much more efficient Campelen 1800 shrimp trawl, with small modifications introduced to the Campelen trawl in 2022 and going forward for use with the new Canadian research vessels (Wheeland et al. 2024a).

There have been a number of problems with the survey vessels in recent years, and as a result, surveys in the autumn of 2014 and spring of 2006 and 2015 did not cover the entire stock area and estimates from these surveys are not considered representative of the stock. Due to COVID-19 related restrictions, no survey was conducted in spring of 2020. Descriptions of the history of the Canadian survey and problems with coverage in recent surveys are given in and Rideout et. al. (2025a) and references therein. Canadian surveys in spring and fall were not completed in NAFO Div. 3LNO from 2019-2021 and 2020-2022, respectively. In spring 2022 coverage of 3L was incomplete, however the strata that were sampled across

Div. 3LNO typically account for >95% of the Yellowtail flounder biomass and therefore this index is considered representative. Surveys in 2023 and 2024 were complete in both spring and fall, though at a reduced allocation.

The previous vessels used for the spring survey (usually CCGS Alfred Needler, sometimes CCGS Teleost) have been decommissioned, with new vessels (CCGS John Cabot and CCGS Capt Jacques Cartier) now used for the Canadian surveys, fishing a modified Campelen trawl. Conversion factors have been calculated for these new vessels fishing the modified Campelen trawl, and applied to Canadian survey data from 1984 in spring and 1990 in fall (DFO 2024; Trueman et al. 2025; Wheeland et al. 2024b; Rideout et al. 2025b). Indices previously reported in Campelen units (including those converted from Engel) are now presented in modified Campelen units; this conversion does not impact interpretation of past survey trends for yellowtail flounder (**Figure 8**).

Table 2 and **Table 3**, and **Figure 9** through **Figure 11** show the population abundance and biomass estimates of yellowtail flounder in the Canadian spring and autumn surveys. Detailed descriptions of previous trends in yellowtail flounder from both surveys are contained in Maddock Parsons et al. (2021) and references therein. Survey indices generally show similar trends in both series. Following the declines to the early 1990s, the fall survey indicates that the upward trend in stock size started in 1993 while the spring survey showed the trend starting in 1995. Survey biomass indices remained relatively high from around 2000 to the early 2010s, after which a decrease is evident. This recent decline is more evident in the spring series which showed a marked decline in biomass and abundance from 2012 to 2016 while the fall survey index di showed an overall decreasing trend from 2007 to 2020.

Incomplete spring surveys in 2020 and 2021, and incomplete fall surveys in 2021 and 2022 make it difficult to interpret recent trends, though indices in both surveys are relatively high and both abundance and biomass in spring have increased to 2024.

B. Spanish Stratified-random Spring Surveys in the Regulatory Area, Div. 3NO (SCR Doc. 24/007; 25/006)

Beginning in 1995, Spain has conducted stratified-random surveys for groundfish in the NAFO Regulatory Area (NRA) of Div. 3NO. These surveys cover a depth range of approximately 45 to 1 300 m. In 2003, after extensive comparative fishing between the vessel, C/V Playa de Menduiňa and Pedreira trawl with the replacement vessel, C/V Vizconde de Eza, using a Campelen 1800 shrimp trawl as the new survey trawl, all data have been converted to Campelen units (Paz et al., 2003, 2004). In 2006, an error in the estimation method was corrected and all survey estimates were re-calculated (González-Troncoso et al., 2006). No survey was conducted in 2020 due to COVID-19 related restrictions.

The biomass of yellowtail in the Div. 3NO of the NRA increased sharply up to 1999, and then showed a similar annual fluctuation pattern seen in the Canadian spring surveys of Div. 3LNO until 2016 (Fig. 4 and 9). The survey index rapidly declined after 2016 and in 2022 was near the lowest in the times series. Indices have increased since though remain relatively low to 2024. Abundance shows a similar trend to biomass in this survey.

There has also been a stratified-random trawl survey in the NAFO Regulatory Area (NRA) of Div. 3L since 2003 (Román-Marcote et al. 2024), however yellowtail flounder have never been caught in this survey.

C. Size composition and growth

Age distribution is unavailable for this stock as aging has not occurred since 2001.

Figure 18 shows the length composition of survey catches from Canadian spring and fall surveys by year for Div. 3LNO (combined sexes) and the EU-Spain 3NO Survey. Length frequencies are only shown here from 1996 onwards; the Canadian surveys switched from the Engel trawl to the Campelen trawl beginning in the fall of 1995 onward which had a much higher efficiency. Despite previous application of conversion factors from Engel to Campelen (Walsh et al. 1998) there is considerable uncertainty in interpretation of relative abundance of small fish between the Engel and Campelen series as catchability of small fish with the Engel trawl was extremely low. Earlier length frequencies can be found in Maddock Parsons et al. (2023) and references therein.

In the years when the spring survey indicated that the stock size was very low (1995-1996 for example), length distributions were bimodal, and the smaller size mode (in the range of 20-25cm) can be tracked from year to year, although growth appears slow (the mode is about the same for 2000 and 2001). As the stock size increased, the distribution became dominated by fish in one major mode (30 to 40 cm) made up of a number of different age classes. In the fall surveys, multi-modal peaks are more common and unlike the spring surveys, were evident in many surveys from 2001-2020 (**Figure 18**). After ~30 cm, growth slows and becomes almost negligible between years. This is consistent with the growth curves constructed using ages from thin-sectioned otoliths (Dwyer et al., 2003). Length frequencies in the Spanish survey typically show modes similar to that of the Canadian surveys and showed a similar progression of the peak in the length frequencies from 1996 to 2003.

Smaller peaks of fish less than 20cm are evident in some years, particularly in the fall survey (e.g. 2005, 2019) then merge into the modal peak in following years. Shifts in this size mode from 1996 – 1998, 1999-2002, and 2010 – 2013 seem to track recruitment pulses. A series of peaks of small fish (about 10 cm) in 2016, 2017, 2019, and 2020 have been observed, with peaks tracking through the length frequencies.

Across the three surveys, the main mode is wider than the usual in both 2023 and 2024 suggesting a broader age distribution and possible entrance of one or more relatively strong year classes in the recent period.

D. Recruitment

Survey abundance less than 22 cm for the period 1996-2024 is used as a proxy for recruitment in this stock. At that size, yellowtail flounder are not recruited to any of the regulated fisheries. These lengths are considered to include ~ages ≤3 though this has not been verified since the early 2000s.

However, limited correlation between surveys for this index complicates interpretation of recruitment trends (**Figure 19**). Recruitment indices have previously included the EU-Spain 3NO survey, though given the small footprint recruitment signals from this survey likely reflect more year-over-year changes in the distribution of recruits than total recruitment. As such, this survey is no longer considered appropriate for inclusion in the recruitment index.

In the spring a recent increase in recruitment is evident, reaching a series high in 2023. The fall series has the highest recruitment indices around 2005 and 2019 and declined to below average in 2024. Overall, recruitment appears to have been at or above average since the late-2010s.

Given the consistent detection of a pulse of small fish (~10cm modal length) in the Canadian fall survey (**Figure 18**), a pre-recruit index was proposed, calculated as abundance <12cm. While these lengths are generally consistent with those reported at age 1 in Dwyer et al. 2003, proposed pre-recruit indices showed consistent coupling of years with above average values which may be a reflection of multiple cohorts within the length mode, and/or may signal multi-year consistency in environmental or stock conditions contributing to good recruitment. Further work was recommended to explore cohort identification within these survey length frequencies before a pre-recruit index is defined.

E. Stock Distribution

Yellowtail flounder are mainly found in water depths <183m and are concentrated mainly in Div. 3N, particularly on the Southeast Shoal, and areas immediately to the west and to a lesser extent the border of Div. 3LN. More than 80% of yellowtail flounder in the Canadian surveys are caught shallower than 75m, with >95% caught shallower than 100m. Occasional survey catches occur in deep water, with observations up to 675m, though these are rare and generally small in magnitude. Plots of distributions from recent Canadian spring and autumn surveys are shown in **Figure 12**, **Figure 13**, and **Figure 14**, with previous descriptions found in Maddock Parsons et al. (2021) and references therein.

In 2022 there were concerns expressed by some industry members that yellowtail flounder were more difficult to locate on traditional fishing grounds, perhaps related to increased bottom temperatures that were noted at the time of fishing. To explore recent distribution on a stock level, stock distribution is updated here using Canadian spring and fall survey data to 2024. Indices examined include: Design Weighted Area Occupied (Busby et al. 2007), abundance-weighted mean depth, abundance-weighted mean temperature, and proportion of yellowtail flounder north of 45 degrees. Previously, a steady increase in the abundance of yellowtail flounder was seen to coincide with a northward expansion of the stock from 1995 up to 2005 and also coincided with increasing bottom temperatures (Walsh and Brodie, 2006), with recent analyses confirming past distributional shifts in response to periods of changing ocean conditions (Robertson et al. 2021). Across all indicators, there is no evidence of recent changes in the distribution of this stock (**Figure 15**). However, this does not exclude the possibility that there were localized and/or or short-term changes in yellowtail flounder distribution that could not be detected by these surveys (e.g. due to survey gaps in 2020 – 2022, or movements outside of survey timing).

Seasonal bottom temperature indices for key yellowtail flounder areas (depths <100m, 50-75m in Div. 3LNO) were derived from the CABOTS (Canadian Atlantic Bottom Observations Temperature-Salinity) data product (Coyne and Cyr, *in prep.*) to quantify thermal habitat occupied by the vast majority of this stock (settled juveniles, adults). These indices show annual-to-multiyear variation but lack a clear linear trend, with average temperature near 1-2°C since 1980 (Figure 16). This contrasts deeper slope areas of Div. 3NO where steady warming has been observed in the Canadian surveys since the late-1990s (NAFO 2023).

Broader oceanographic trends in Div. 3LNO are described in Cyr et al. 2024, Bélanger et al. 2024, and Cyr and Belanger 2024. These broader trends (e.g. surface temperatures, spring bloom) have a larger influence on early life stages and trophic dynamics impacting the stock (e.g. Robertson et al 2023).

F. Biological Studies

Information used to estimate maturity, weight at length and to calculate an index of female spawning stock biomass (SSB) comes from biological sampling of yellowtail flounder conducted on the Canadian spring surveys of NAFO Div. 3LNO. In recent years there has been a reduction in both the number of sets conducted and the amount of biological sampling undertaken during the survey, in an attempt to improve survey efficiency and increase survey coverage. This was particularly evident with a notable reduction in sampling of yellowtail flounder in Div. 3L and 3N in 2019. Recent sampling numbers can be found in Rideout et al. 2025a.

Maturity

Maturity-at-size by year was estimated using Canadian spring research vessel data from 1984 – 2024. Estimates were produced using a probit model with a logit link function and a binomial error structure. Length-at-50%-mature (L50) has shown a general decline in males from the beginning of the time series to about 2000 after which it was relatively stable to 2015. It had declined since, with the exception of 2019 (though this year had reduced sampling) and in 2024 was the lowest in the series, with $L50_{2024}$ around 21cm compared to 30 cm in the mid 1980's. Female L50 generally declined from the mid 1990's to the late 2000s and has been relatively stable since. The current female L50 is about 31 cm compared to 34 cm at the beginning of the time series (Figure 20).

Female SSB

Estimates of female proportion mature at length, population numbers at length, and annual length weight relationships were used to produce an index of female SSB from the spring survey. Female SSB declined from 1984 to 1992 (Figure 21). It increased substantially from 1995 to 2009. Since then it declined substantially to 2016 and remained relatively low for a few years, but has increased to 2024.

III. Assessment Results

In 2018, a stock production model using a Bayesian formulation was accepted to assess 3LNO yellowtail flounder, replacing the previous stock production model using ASPIC (Maddock Parsons et al. 2018), and has been used since.

this model uses the Schaefer (1954) form of a surplus production model:

$$P_t=[P_{t-1}+ r\bullet P_{t-1} (1 - P_{t-1})- C_{t-1}/K]\bullet\eta_t$$

Where:

- P_{t-1} is exploitable biomass (as a proportion of carrying capacity) for year t-1
- C_{t-1} is catch for year t-1.
- K is carrying capacity (level of stock biomass at equilibrium prior to commencement of a fishery)
- r is the intrinsic rate of population growth
- η_t is a random variable describing stochasticity in the population dynamics (process error).

The model uses biomass proportional to an estimate of K in order to aid mixing of the Markov Chain Monte Carlo (MCMC) samples and to help minimize autocorrelation between each state and K (Meyer and Millar, 1999a, 1999b).

An observation equation is used to relate the unobserved biomass, P_t, to the research vessel survey indices:

$$I_t=q\bullet P_t \bullet\varepsilon_t$$

Where:

- q is the catchability parameter
- P_t is an estimate of the biomass proportional to K at time t
- ε_t is observation error

Input data are given in **Table 4** and shown in **Figure 22** scaled to each series mean. The model formulation is given in Appendix 1 and uses the same specifications as in 2023, with the exception of the number of iterations and the thinning: examination of the diagnostics of a run with the previous thinning (10) and iterations (500,000) showed evidence of remaining autocorrelation which warranted additional thinning. Thinning was therefore increased to 20 and in turn, iterations increased to 750,000. The priors on r and initial population size were uninformative, with a uniform distribution ranging from 0.01 to 1 and 0.5 to 1, respectively. The prior for K was also intended to be uninformative, with a mean of 150 and very large CV (1000%) .

Priors used in the model were:

Initial population size	Pin~dunif(0.5, 1)	uniform(0.5 to 1)
Intrinsic rate of natural increase	r ~ dunif(0.01,1)	uniform (0.01 to 1)
Carrying capacity	K~dlnorm(2.703,0.2167)	lognormal (mean, precision)
Survey catchability	q ~dgamma(1,1)	gamma(shape, rate)
Process error	sigma ~ dunif(0,5) isigma2= $sigma^{-2}$	uniform(0 to 5)
Observation error	tau~dgamma(1,1)	gamma(shape, rate)

The model fit and convergence diagnostics were similar to those seen in the previous assessment of this stock (Maddock Parsons et al. 2023) for most surveys, with no apparent trend in process error (see **Figure 23** through **Figure 27**, **Table 6** and Appendix 2). With the resumption of the Canadian surveys since 2023 sigma lowered slightly, from 0.15 in the 2023 assessment back to 0.13 (same as the 2021 assessment). The recent and relatively large negative residuals in the Spanish survey noted at the previous assessment were associated with the years of missed Canadian surveys, and residuals for the most recent two years are much smaller in magnitude. Posteriors for r and K are updated from their priors (**Figure 25**) and diagnostics are acceptable for this model formulation (**Table 6**).

The 2025 accepted production model estimated that an MSY of 18 410 t can be taken from a biomass of 86 420 t at a fishing mortality of 0.21. Intrinsic rate of natural increase is estimated to be 0.43 and carrying capacity 172 800 t (**Table 5**). Overall there has been a slight downward adjustment in the scale of estimates attributed to the switch from Campelen to modified Campelen units for the Canadian survey indices.

Biomass (**Figure 28**) showed a continuous decline from the late 1960s to the mid-1970s, stabilized through to the mid-1980s, before declining further until about 1994, when the moratorium was imposed. Relative biomass (B_t /B_{msy}) was below the level at which MSY can be produced from 1973 to 1997, and at its minimum in 1992 the ratio was about 0.4. Since then, the stock increased rapidly to a point where B_t/B_{msy} > 1.5, where it remained for around 15 years. A decline began in the early 2010s, though the stock remained above $B_{msy,}$ with a recent low in 2022, and is estimated to be 1.50 (85% CL = 1.26, 1.86) in 2024.

The relative fishing mortality rate (F_t/F_{msy}) was high during most of the historical fishery (**Figure 28**), in particular during the mid to late 1980s to the early 1990s when landings were often double the TAC (**Figure 1**). Since the fishery re-opened in 1998, the fishing mortality rate gradually increased and since

2001 the F-ratios were lower than half of F_{msy}. The F-ratio has been low over the last two years, at 0.13 (80% CL = 0.11, 0.18) in 2023 and 0.11 (80% CI = 0.09, 0.14) in 2024. Catches since 2014 have been lower than the estimated surplus production (**Figure 29**).

The model results and diagnostics from this Bayesian formulation are similar to those from the 2023 assessment of this stock, though recent trends are more similar to the sensitivity analysis completed in the 2023 assessment which excluded recent Spanish survey indices (Maddock Parsons et al. 2023), suggesting the EU-Spain survey overestimated recent declines.

Precautionary Approach Framework

Under the NAFO Precautionary Framework (NAFO 2024), the limit reference point (B_{lim}) is set at 0.30 B_{msy}, $B_{trigger}$ is set at 0.75 B_{MSY}, F_{lim} is set at F_{MSY}, and F_{target} is set at 0.85 F_{MSY}.

The surplus production model outputs indicate that the stock is presently 1.5 times B_{msy} and F is below F_{target} and F_{lim} (**Figure 30**). At present, the risk of the stock being below B_{lim} and risk of $F>F_{lim}$ is very low (<1%) The stock is in the healthy zone as defined in the NAFO Precautionary Approach Framework.

IV. Projections

Stochastic projections were conducted under two catch scenarios for 2025: (1) $Catch_{2025}$ = average of 2023-2024 = 3 135 t, and (2) $Catch_{2025}$ = TAC_{2025} = 15 810 t. Constant fishing mortality was applied from 2026-2027 at four levels of *F: F*=0, and the three levels defined for stocks in the Healthy zone (75% F_{msy}, and 85% F_{msy}, and F_{msy}). Results were similar for both catch scenarios (**Figure 31**, **Figure 32**). Projected trajectory in the PA in detailed in **Table 7**, with median yield and risk levels within the NAFO PA Framework shown in **Table 8** and **Table 9**.

At 75% F_{msy}, the probability that F > F_{lim} was between 0.11 and 0.12 in the medium term (2026, 2027). Projected at the level of 85% F_{lim}, the probability that F > F_{lim} ranges between 0.24 and 0.25 and for F_{msy} projections, this probability increases to 0.50.

The probability that biomass in 2028 is greater than B_{2025} is 0.70, 0.21, 0.16, and 0.11 for projections of *F=0*, 75% F_{msy}, 85% F_{msy}, and F_{msy} respectively, in the $Catch_{2025}$ = TAC = 15 810 scenario. At 75% F_{msy} to F_{msy} biomass declines towards B_{msy} are expected, with decreases from 2025 to 2028 estimated at 15 to 23%. Through 2028 the risk of biomass being below B_{lim} or $B_{trigger}$ 4% or less in all cases.

Summary

The stock is in the Healthy Zone. The stock size remains above B_{msy} with a probability >99%, and has been between 1.3x and 1.5x B_{msy} since 2016. There is very low risk (<1%) of the stock being below $B_{trigger}$ and a very low risk of F being above F_{lim}=F_{msy} or F_{target} (<1%). Recruitment has been generally above average since the late 2010s.

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Tables and Figures

Table 1. Nominal catches by country and TACs (tonnes) of yellowtail flounder in NAFO Div. 3LNO. Since 2020 catch values used in the assessment have been obtained from CESAG estimates (estimation method is outlined in Annex 1 of COM-SC Doc. 17-08.).

Year	Canada	France	USS/Rus.	S. Korea	Other	Total	TAC
1960	7	.	.	.	.	7	.
1961	100	.	.	.	.	100	.
1962	67	.	.	.	.	67	.
1963	138	.	380	.	.	518	.
1964	126	.	21	.	.	147	.
1965	3075	.	55	.	.	3130	.
1966	4185	.	2834	.	7	7026	.
1967	2122	.	6736	.	20	8878	.
1968	4180	14	9146	.	.	13340	.
1969	10494	1	5207	.	6	15708	.
1970	22814	17	3426	.	169	26426	.
1971	24206	49	13087	.	.	37342	.
1972	26939	358	11929	.	33	39259	.
1973	28492	368	3545	.	410	32815	50000
1974	17053	60	6952	.	248	24313	40000
1975	18458	15	4076	.	345	22894	35000
1976	7910	31	57	.	59	8057	9000
1977	11295	245	97	.	1	11638	12000
1978	15091	375	.	.	.	15466	15000
1979	18116	202	.	.	33	18351	18000
1980	12011	366	.	.	.	12377	18000
1981	14122	558	.	.	.	14680	21000
1982	11479	110	.	1073	657	13319	23000
1983	9085	165	.	1223		10473	19000
1984	12437	89	.	2373	1836[a]	16735	17000
1985	13440	.	.	4278	11245[a]	28963	15000
1986	14168	77	.	2049	13882[a]	30176	15000
1987	13420	51	.	125	2718	16314	15000
1988	10607	.	.	1383	4166[a]	16156	15000
1989	5009	139	.	3508	1551	10207	5000
1990	4966	.	.	5903	3117	13986	5000
1991	6589	.	.	4156	5458	16203	7000
1992	6814	.	.	3825	123	10762	7000
1993	6747	.	.	.	6868	13615	7000
1994	.	.	.	.	2069	2069	7000
1995	2	.	.	.	65	67	0
1996	.	.	.	.	232	232	0
1997	1	.	.	.	657	658	0
1998	3739	.	.	.	647	4386	4000
1999	5746	.	96	.	1052[a]	6894	6000
2000	9463	.	212	.	1486	11161	10000
2001	12238	.	148	.	1759	14145	13000
2002	9959	.	103	.	636	10698	13000
2003	12708	.	184	.	914[b]	13806	14500
2004	12575	.	158	.	621	13354	14500
2005	13140	299	8	.	486	13933	15000
2006	177	.	1	.	752	930	15000
2007	3673	.	76	.	874	4623	15500
2008	10217	384	143	.	659	11403	15500
2009	5416	87	3	.	662	6168	17000
2010	8070	580	101	.	628	9379	17000
2011	3946	338	82	.	863	5229	17000
2012	1795	321	84	.	1483	3683	17000
2013	7999	.	166	.	2597	10762	17000
2014	6750	6	85	.	1095	7936	17000
2015	5581	.	.	.	.	5581	17000
2016	6327	322	81	.	2597	9327	17000
2017	6262	280	85	.	2329	8956	17000
2018	7134	.	83	.	1477	8694	17000
2019	11535	338	82	.	880	12835	17000
2020	13478	329	84	.	913	14804	17000
2021	13755	.	81	.	774	14610	20000
2022	10036	393	95	.	117	10641	20000
2023	2658	394	20	.	142	3214	15560
2024	2522	304	40	.	152	3018	15810

[a] includes catches estimated from Canadian surveillance reports

[b] includes catches averaged from a range of estimates

Table 2. Estimates of Abundance (000s), mean number per tow, biomass (000t) and mean weight (kg) per tow for Canadian Spring surveys of NAFO Divisions 3LNO 1984-2024. Surveys in 2006 and 2015 did not cover the entire stock area and estimates are not considered representative. There were no surveys in 2020-2021. Indices have been converted to Modified Campelen units.

	Abundance (millions)				Mean number per tow				Biomass ('000t)				Mean weight per tow			
Survey Year	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO
1984	39.6	348.4	53.7	441.7	19.3	151.8	21.8	64.9	17.9	132.2	22.7	172.8	8.7	57.6	9.2	25.4
1985	41.3	191.8	71.6	304.8	7.8	83.6	29.1	30.2	16.7	69.9	30.6	117.2	3.1	30.4	12.4	11.6
1986	23.6	186.6	59.3	269.4	4.7	81.3	24.1	27.4	10.4	76.0	24.7	111.1	2.1	33.1	10.0	11.3
1987	10.8	234.8	78.2	323.8	2.1	103.3	31.8	33.1	4.8	61.3	33.8	99.9	1.0	27.0	13.7	10.2
1988	7.3	110.2	50.9	168.4	1.4	48.0	20.7	17.2	3.2	42.0	21.0	66.2	0.6	18.3	8.5	6.7
1989	7.2	337.6	40.7	385.6	1.4	147.1	16.5	39.3	3.4	54.9	18.0	76.2	0.7	23.9	7.3	7.8
1990	4.4	222.4	48.8	275.6	0.9	96.9	20.3	28.3	2.0	56.9	20.7	79.6	0.4	24.8	8.6	8.2
1991	2.1	195.7	43.6	241.4	0.4	81.5	17.2	24.5	1.0	50.4	19.9	71.2	0.2	21.0	7.8	7.2
1992	0.3	140.4	24.1	164.8	0.1	58.8	9.5	16.1	0.1	36.9	9.7	46.7	0.0	15.4	3.8	4.6
1993	0.2	111.5	83.0	194.7	0.0	46.4	32.7	19.0	0.1	38.6	33.5	72.2	0.0	16.1	13.2	7.0
1994	0.1	99.6	18.4	118.1	0.0	40.6	7.1	11.2	0.0	36.4	7.7	44.1	0.0	14.8	3.0	4.2
1995	0.0	124.5	24.7	149.2	0.0	51.8	9.7	14.5	0.0	45.5	10.7	56.2	0.0	19.0	4.2	5.5
1996	2.4	381.3	135.7	519.4	0.5	158.8	53.2	50.5	1.0	74.3	52.8	128.0	0.2	30.9	20.7	12.5
1997	1.2	410.2	112.3	523.7	0.2	172.4	44.0	51.0	0.4	90.6	43.1	134.1	0.1	38.1	16.9	13.1
1998	1.4	421.0	122.2	544.6	0.3	175.4	47.9	51.9	0.4	103.5	45.5	149.4	0.1	43.1	17.8	14.2
1999	47.5	729.4	218.8	995.8	8.3	303.8	85.8	93.0	21.8	173.0	83.1	277.9	3.8	72.1	32.6	25.9
2000	33.0	533.2	153.3	719.5	6.2	222.1	60.1	69.9	13.0	150.6	59.7	223.2	2.4	62.7	23.4	21.7
2001	9.6	823.4	154.3	987.3	1.7	342.9	60.5	94.1	3.6	220.0	54.0	277.5	0.6	91.6	21.1	26.4
2002	1.6	389.0	125.3	515.9	0.3	162.0	49.1	49.6	0.5	108.6	40.0	149.1	0.1	45.2	15.7	14.3
2003	71.9	691.8	185.7	949.4	13.2	288.1	72.8	91.3	26.5	211.4	60.2	298.2	4.9	88.0	23.6	28.7
2004	30.8	526.3	182.4	739.5	5.5	219.2	71.5	70.4	11.8	163.6	62.3	237.8	2.1	68.2	24.4	22.6
2005	89.1	626.6	178.5	894.2	16.7	261.0	69.9	86.9	32.2	197.8	67.4	297.4	6.0	82.4	26.4	28.9
2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2007	137.0	712.2	239.8	1088.9	25.7	296.6	94.0	105.8	47.1	220.1	72.3	339.5	8.8	91.7	28.3	33.0
2008	92.6	841.6	194.4	1128.5	18.2	353.0	76.2	112.5	33.0	259.5	66.1	358.6	6.5	108.9	25.9	35.7
2009	37.5	562.9	95.4	695.8	7.0	234.4	37.4	67.6	10.2	162.6	34.9	207.8	1.9	67.7	13.7	20.2
2010	92.6	716.5	210.2	1019.3	17.7	298.4	82.4	100.0	22.3	219.2	73.5	314.9	4.3	91.3	28.8	30.9
2011	124.2	728.4	226.5	1079.1	23.0	303.4	89.2	104.3	42.7	216.2	74.2	333.0	7.9	90.0	29.2	32.2
2012	189.3	874.0	206.5	1269.8	36.8	366.6	80.9	125.9	68.6	251.8	70.7	391.1	13.3	105.6	27.7	38.8
2013	165.9	727.2	149.1	1042.1	31.1	302.9	58.4	101.3	52.4	222.9	46.8	322.1	9.8	92.8	18.3	31.3
2014	99.0	773.6	204.7	1077.2	18.5	322.2	80.2	104.7	33.5	232.4	65.2	331.1	6.3	96.8	25.5	32.2
2015	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2016	11.6	347.9	115.0	474.5	2.2	144.9	45.8	46.3	1.8	101.3	30.4	133.4	0.3	42.2	12.1	13.0
2017	64.6	432.0	90.8	587.4	46.4	181.2	35.6	92.8	15.2	129.7	23.2	168.1	10.9	54.4	9.1	26.6
2018	54.1	588.3	169.2	811.7	11.1	245.0	66.3	82.4	16.6	169.3	53.5	239.4	3.4	70.5	21.0	24.3
2019	75.1	406.5	117.2	598.8	14.1	169.3	46.3	58.3	14.8	107.0	31.1	152.9	2.8	44.6	12.3	14.9
2020	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2021	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2022	NA	508.6	196.3	867.2	NA	215.3	77.9	129.4	NA	121.2	56.4	218.4	NA	51.3	22.4	32.6
2023	131.4	720.8	141.9	994.2	25.7	308.2	60.2	101.3	41.4	144.0	41.3	226.6	8.1	61.6	17.5	23.1
2024	121.5	694.1	278.1	1093.7	23.4	303.3	109.0	109.1	40.1	168.4	83.2	291.8	7.7	73.6	32.6	29.1

Table 3. Estimates of Abundance (000s), mean number, biomass (000t) and mean weight (kg) per tow for Canadian Autumn surveys of NAFO Divisions 3LNO 1990-2024. Survey in 2014 was incomplete and is not considered representative. There were no surveys in 2021 or 2022. Indices have been converted to Modified Campelen units.

	Abundance (millions)				Mean number per tow				Biomass ('000t)				Mean weight per tow (kg)			
survey year	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO
1990	3.9	112.7	34.3	150.9	0.7	50.0	13.9	15.1	1.8	37.1	15.2	54.1	0.3	16.4	6.2	5.4
1991	2.1	158.1	67.1	227.3	0.4	68.6	26.9	22.4	0.9	39.6	25.6	66.1	0.2	17.2	10.3	6.5
1992	1.8	119.6	43.7	165.1	0.3	65.4	17.7	17.2	0.8	34.2	15.5	50.6	0.2	18.7	6.3	5.3
1993	2.3	240.0	35.3	277.5	0.5	100.8	13.9	27.9	0.9	69.7	14.7	85.3	0.2	29.3	5.8	8.6
1994	0.1	205.4	22.8	228.3	0.0	85.5	8.9	22.2	0.0	76.4	8.7	85.2	0.0	31.8	3.4	8.3
1995	3.3	441.3	69.3	513.9	0.6	183.8	27.2	50.0	1.1	75.7	20.8	97.5	0.2	31.5	8.1	9.5
1996	6.0	283.1	5.2	294.2	1.0	123.3	3.6	31.0	1.8	70.0	1.8	73.6	0.3	30.5	1.3	7.8
1997	4.9	513.7	109.2	627.8	1.1	214.0	43.0	67.4	1.0	141.8	43.5	186.3	0.2	59.1	17.1	20.0
1998	11.1	335.0	130.6	476.7	1.9	135.4	49.2	44.0	3.9	99.6	37.3	140.7	0.7	40.2	14.1	13.0
1999	17.4	557.0	143.0	717.4	3.0	234.2	57.9	67.0	7.4	154.2	41.2	202.8	1.3	64.8	16.7	18.9
2000	29.8	649.7	197.7	877.2	6.9	270.6	77.5	94.7	9.6	195.0	58.3	262.9	2.2	81.2	22.8	28.4
2001	57.7	980.8	200.2	1238.8	10.2	408.5	78.4	116.8	20.0	296.8	65.6	382.4	3.5	123.6	25.7	36.0
2002	27.1	727.6	129.8	884.5	4.7	303.0	50.8	82.5	11.1	210.3	42.9	264.3	1.9	87.6	16.8	24.7
2003	45.7	645.9	252.6	944.2	7.9	270.9	99.0	88.2	14.9	193.6	77.0	285.6	2.6	81.2	30.2	26.7
2004	49.3	893.3	162.5	1105.1	10.4	374.3	63.7	114.3	17.3	230.0	48.6	295.9	3.7	96.4	19.0	30.6
2005	30.8	916.2	154.7	1101.8	5.3	381.6	60.6	102.8	11.1	201.5	56.4	269.1	1.9	83.9	22.1	25.1
2006	48.5	622.9	137.7	809.1	8.8	259.4	54.4	77.7	17.3	185.8	43.0	246.2	3.2	77.4	17.0	23.6
2007	70.6	1067.9	194.2	1332.7	14.6	444.8	76.1	136.2	23.6	318.7	63.8	406.0	4.9	132.7	25.0	41.5
2008	64.9	588.3	227.1	880.2	12.2	245.0	89.0	85.5	22.6	175.7	66.2	264.4	4.2	73.2	25.9	25.7
2009	35.7	538.7	112.8	687.2	6.7	224.4	44.5	66.8	13.2	149.5	33.2	195.9	2.5	62.3	13.1	19.0
2010	111.9	1003.8	146.1	1261.8	21.0	424.0	57.2	123.0	30.2	278.1	37.8	346.2	5.7	117.5	14.8	33.7
2011	82.9	580.5	136.3	799.7	18.0	241.8	53.4	83.7	28.3	178.0	48.7	255.0	6.1	74.2	19.1	26.7
2012	73.6	625.1	268.8	967.5	13.8	260.3	105.3	94.0	20.8	184.0	98.8	303.7	3.9	76.6	38.7	29.5
2013	83.8	681.2	141.5	906.5	15.7	283.7	55.4	88.1	30.5	209.8	50.6	290.9	5.7	87.4	19.8	28.3
2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2015	77.0	633.5	110.3	820.8	16.5	263.9	43.2	85.3	25.9	199.6	31.6	257.1	5.6	83.1	12.4	26.7
2016	85.1	639.4	150.8	875.3	15.9	266.3	59.5	85.2	28.8	165.7	47.8	242.3	5.4	69.0	18.9	23.6
2017	81.2	712.1	189.1	982.3	15.2	296.6	74.5	95.6	27.3	176.6	62.0	265.9	5.1	73.5	24.4	25.9
2018	105.5	525.6	161.7	792.9	19.9	218.9	63.4	77.3	32.6	154.2	44.0	230.9	6.1	64.2	17.3	22.5
2019	53.9	667.7	119.4	841.1	10.1	278.1	46.8	81.7	18.7	131.1	35.6	185.4	3.5	54.6	13.9	18.0
2020	66.1	752.4	188.3	1006.7	12.4	314.7	73.8	97.9	18.2	191.4	53.2	262.8	3.4	80.1	20.8	25.6
2021	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2022	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2023	101.2	552.7	127.5	781.4	18.1	230.2	50.0	74.1	22.2	138.9	30.4	191.6	4.0	57.9	11.9	18.2
2024	43.4	413.6	300.3	757.3	8.1	172.3	117.7	73.6	8.6	111.8	86.0	206.5	1.6	46.6	33.7	20.1

Table 4. Nominal catch (000t) and survey series included in the assessment model for yellowtail flounder in 2025. Incomplete and missing surveys are indicated by an x.

Year	Catch	CAN-Spring	CAN-Fall	Yankee	EU-Spain	Russian
1965	3.1	.	.	.	.	.
1966	7.0	.	.	.	.	.
1967	8.9	.	.	.	.	.
1968	13.3	.	.	.	.	.
1969	15.7	.	.	.	.	.
1970	26.4	.	.	.	.	.
1971	37.3	.	.	96.9	.	.
1972	39.3	.	.	79.2	.	.
1973	32.8	.	.	51.7	.	.
1974	24.3	.	.	40.3	.	.
1975	22.9	.	.	37.4	.	.
1976	8.1	.	.	41.7	.	.
1977	11.6	.	.	65.0	.	.
1978	15.5	.	.	44.3	.	.
1979	18.4	.	.	38.5	.	.
1980	12.4	.	.	51.4	.	.
1981	14.7	.	.	45.0	.	.
1982	13.3	.	.	43.1	.	.
1983	10.5	.	.	.	.	.
1984	16.7	172.8	.	.	.	132.0
1985	29.0	117.2	.	.	.	85.0
1986	30.2	111.1	.	.	.	42.0
1987	16.3	99.9	.	.	.	30.0
1988	16.2	66.2	.	.	.	23.0
1989	10.2	76.2	.	.	.	44.0
1990	14.0	79.6	54.1	.	.	27.0
1991	16.2	71.2	66.1	.	.	27.5
1992	10.8	46.7	50.6	.	.	.
1993	13.6	72.2	85.3	.	.	.
1994	2.1	44.1	85.2	.	.	.
1995	0.1	56.2	97.5	.	9.3	.
1996	0.2	128.0	73.6	.	43.3	.
1997	0.7	134.1	186.3	.	38.7	.
1998	4.4	149.4	140.7	.	122.6	.
1999	6.9	277.9	202.8	.	197.0	.
2000	11.2	223.2	262.9	.	144.7	.
2001	14.2	277.5	382.4	.	182.7	.
2002	10.7	149.1	264.3	.	148.5	.
2003	13.8	298.2	285.6	.	136.8	.
2004	13.4	237.8	295.9	.	170.0	.
2005	13.9	297.4	269.1	.	156.5	.
2006	0.9	x	246.2	.	160.1	.
2007	4.6	339.5	406.0	.	160.7	.
2008	11.4	358.6	264.4	.	160.1	.
2009	6.2	207.8	195.9	.	183.4	.
2010	9.4	314.9	346.2	.	189.7	.
2011	5.2	333.0	255.0	.	203.8	.
2012	3.7	391.1	303.7	.	195.6	.
2013	10.7	322.1	290.9	.	188.0	.
2014	8.0	331.1	x	.	136.5	.
2015	6.9	x	257.1	.	140.8	.
2016	9.3	133.4	242.3	.	153.7	.
2017	9.0	168.1	265.9	.	95.9	.
2018	8.7	239.4	230.9	.	107.7	.
2019	12.8	152.9	185.4	.	42.6	.
2020	14.8	x	262.8	.	x	.
2021	14.6	x	x	.	39.1	.
2022	10.6	218.4	x	.	15.1	.
2023	3.3	226.6	191.6	.	69.1	.
2024	3.0	291.8	206.5	.	84.3	.

Table 5. Assessment results for Div. 3LNO yellowtail flounder from the accepted 2025 surplus production model in a Bayesian framework.

	Median	95% credible interval	
B_{MSY}	86.42	63.28	138.40
MSY	18.41	14.79	22.87
F_{MSY}	0.21	0.13	0.31
K	172.80	126.60	276.80
r	0.43	0.25	0.61
q.Spring	1.76	1.11	2.43
q.Fall	1.83	1.15	2.54
q.Russian	0.84	0.48	1.34
q.Yankee	0.65	0.34	1.00
q.Spanish	0.81	0.50	1.20
Pin	0.78	0.52	0.99
deviance	1172	1145	1196
sigma	0.13	0.07	0.20
tau.Spring	0.06	0.03	0.10
tau.Fall	0.05	0.02	0.09
tau.Russian	0.19	0.06	0.76
tau.Spanish	0.34	0.20	0.63
tau.Yankee	0.03	0.01	0.13
B/Bmsy 2024	1.50	1.13	1.93
F/Fmsy 2024	0.11	0.08	0.16

Table 6. Convergence criteria and diagnostics for the 2025 yellowtail flounder Bayesian surplus production model.

		Bin size for calculating Batch SE and (Lag 1) ACF = 50. MinInter 1, MaxInter 35,000									Geweke convergence diagnostics		Brooks, Gelman, and Rubin Convergence Diagnostics. Iterations used = 17501:35000			
	Chain	Mean	SD	Naïve SE	MC error	Batch SE	Batch ACF	0.025	0.5	0.975	z-score	p-score	Potential scale reduction factors (SRF)	Multivariate Potential SRF	Corrected SRF	0.975
k	1	180.3315	40.7888	0.2180	0.7536	0.6936	0.0769	126.9	172.8	278.4	1.059	0.290	1.0008	1.0012	1.0039	1.0061
	2	179.1103	37.6101	0.2010	0.6514	0.6469	-0.0084	126.5	172.5	270.4	0.141	0.888				
	3	181.0381	41.0152	0.2192	0.7629	0.7497	0.1325	126.2	173.3	280.9	-0.405	0.686				
r	1	0.4273	0.0911	0.0005	0.0014	0.0013	0.0781	0.252	0.425	0.613	-1.070	0.285	1.0003	1.0005	1.0004	1.0014
	2	0.4287	0.0895	0.0005	0.0013	0.0012	-0.0048	0.258	0.427	0.612	-0.967	0.333				
	3	0.4260	0.0911	0.0005	0.0013	0.0013	0.0970	0.250	0.424	0.613	-0.048	0.962				
sigma	1	0.1289	0.0339	0.0002	0.0003	0.0003	0.0469	0.071	0.125	0.204	-0.470	0.639	1.0000	1.0001	1.0000	1.0002
	2	0.1286	0.0339	0.0002	0.0002	0.0003	0.0298	0.071	0.126	0.203	0.108	0.914				
	3	0.1287	0.0341	0.0002	0.0003	0.0003	0.0479	0.071	0.126	0.204	-1.877	0.061				
q. Can spring	1	1.7632	0.3359	0.0018	0.0056	0.0049	0.0629	1.102	1.761	2.425	-0.812	0.417	1.0002	1.0003	1.0003	1.0009
	2	1.7700	0.3317	0.0018	0.0050	0.0048	-0.0152	1.133	1.767	2.437	0.063	0.950				
	3	1.7597	0.3382	0.0018	0.0050	0.0051	0.0915	1.101	1.759	2.431	-0.067	0.946				
q. Can fall	1	1.8300	0.3522	0.0019	0.0057	0.0051	0.0580	1.143	1.829	2.530	-0.731	0.464	1.0002	1.0003	1.0003	1.0009
	2	1.8367	0.3479	0.0019	0.0053	0.0050	-0.0115	1.172	1.833	2.546	0.086	0.931				
	3	1.8264	0.3548	0.0019	0.0052	0.0053	0.0813	1.140	1.824	2.537	-0.132	0.895				
q. Russia	1	0.8549	0.2189	0.0012	0.0027	0.0025	0.0497	0.475	0.838	1.335	-0.484	0.628	1.0001	1.0002	1.0003	1.0008
	2	0.8584	0.2156	0.0012	0.0024	0.0024	-0.0201	0.489	0.842	1.333	-0.524	0.600				
	3	0.8531	0.2213	0.0012	0.0024	0.0026	0.0762	0.473	0.836	1.340	0.341	0.733				
q. Yankee	1	0.6540	0.1687	0.0009	0.0029	0.0024	0.1100	0.342	0.647	1.006	-0.329	0.742	1.0005	1.0007	1.0005	1.0018
	2	0.6561	0.1666	0.0009	0.0023	0.0023	0.0242	0.351	0.649	1.002	-0.540	0.589				
	3	0.6526	0.1690	0.0009	0.0024	0.0024	0.0864	0.339	0.647	1.004	0.530	0.596				
q. Spanish	1	0.8219	0.1793	0.0010	0.0025	0.0023	0.0572	0.494	0.813	1.197	-0.765	0.444	1.0001	1.0002	1.0002	1.0006
	2	0.8250	0.1776	0.0009	0.0024	0.0023	-0.0055	0.503	0.816	1.201	0.351	0.725				
	3	0.8208	0.1793	0.0010	0.0023	0.0024	0.0756	0.493	0.812	1.197	-0.183	0.855				

Table 7. Medium-term projections for yellowtail flounder with two catch options in 2025. Estimates for yield and relative biomass (B/Bmsy) with 80% credible intervals are shown for projected F values of F0, 75%Fmsy, 85%Fmsy and Fmsy. Catch in 2025 was assumed at 15 810 t (TAC 2025) or 3 135 t (average catch 2023-2024).

Catch 2025 = 15 810 t			Catch 2025 = 3 135 t		
Year	Yield ('000t) median	Projected Relative Biomass (B/B_{msy}) median (80%CI)	Year	Yield ('000t) median	Projected Relative Biomass (B/B_{msy}) median (80%CI)
F=0			F=0		
2025	15.81	1.62 (1.26, 2.03)	2025	3.125	1.62 (1.26, 2.03)
2026	0	1.55 (1.19, 1.96)	2026	0	1.70 (1.32, 2.13)
2027	0	1.69 (1.31, 2.12)	2027	0	1.80 (1.40, 2.23)
2028	-	1.79 (1.39, 2.22)	2028	-	1.85 (2.29, 1.47)
$F = 0.75F_{msy}$			$F = 0.75F_{msy}$		
2025	15.81	1.62 (1.26, 2.03)	2025	3.125	1.62 (1.26, 2.03)
2026	21.43	1.55 (1.19, 1.96)	2026	23.47	1.70 (1.32, 2.13)
2027	19.88	1.44 (1.09. 1.84)	2027	21.00	1.52 (1.17, 1.91)
2028	-	1.37 (1.02, 1.77)	2028	-	1.42 (1.07, 1.82)
$F = 0.85F_{msy}$			$F = 0.85F_{msy}$		
2025	15.81	1.62 (1.26, 2.03)	2025	3.125	1.62 (1.26, 2.03)
2026	24.29	1.55 (1.19, 1.96)	2026	26.60	1.70 (1.32, 2.13)
2027	22.00	1.41 (1.80, 1.06)	2027	23.23	1.48 (1.14, 1.87)
2028	-	1.32 (0.97, 1.72)	2028	-	1.37 (1.02, 1.76)
$F = F_{msy}$			$F = F_{msy}$		
2025	15.81	1.62 (1.26, 2.03)	2025	3.125	1.62 (1.26, 2.03)
2026	28.58	1.55 (1.19, 1.96)	2026	31.29	1.70 (1.32, 2.13)
2027	24.96	1.36 (1.02, 1.74)	2027	26.31	1.43 (1.09, 1.81)
2028	-	1.24 (0.89, 1.64)	2028	-	1.29 (0.95, 1.68)

Table 8. Yield (000 t) and risk (%) at projected F values of F0, 75% Fmsy, 85% Fmsy and Fmsy for one catch scenario: Catch in 2025 was assumed at 15 810 t (TAC 2025).

		Catch 2025 = 15 810 t			
		F=0	Healthy		
			F = $0.75F_{msy}$	F = $0.85F_{msy}$	F = F_{msy}
Yield ('000t) (50%)	2025	15.81	15.81	15.81	15.81
	2026	0	21.43	24.29	28.58
	2027	0	19.88	22.00	24.96
$P(F>F_{lim})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	11%	24%	50%
	2027	<1%	12%	25%	50%
$P(B<B_{lim})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	<1%	<1%	<1%
	2027	<1%	<1%	<1%	<1%
	2028	<1%	<1%	<1%	<1%
$P(F>F_{target})$	2025	3%	3%	3%	3%
	2026	<1%	29%	50%	78%
	2027	<1%	30%	50%	76%
$P(B<B_{trigger})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	<1%	<1%	<1%
	2027	<1%	<1%	<1%	1%
	2028	<1%	1%	2%	4%
$P(B_{2028}>B_{2025})$		70%	21%	16%	11%
$(B_{2028}-B_{2025})/B_{2025}$		+10.8%	-15.0%	-18.2%	-22.9%

Table 9. Yield (000 t) and risk (%) at projected F values of F0, 75% Fmsy, 85% Fmsy and Fmsy for one catch scenario: Catch in 2025 was assumed at the average of 2023-2024 = 3 135t.

		Catch 2025 = 3 135 t			
		F=0	Healthy		
			F = $0.75F_{msy}$	F = $0.85F_{msy}$	F = F_{msy}
Yield (50%)	2025	3.135	3.135	3.135	3.135
	2026	0	23.47	26.60	31.29
	2027	0	21.0	23.23	26.31
$P(F>F_{lim})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	11%	23%	50%
	2027	<1%	11%	24%	50%
$P(B<B_{lim})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	<1%	<1%	<1%
	2027	<1%	<1%	<1%	<1%
	2028	<1%	<1%	<1%	3%
$P(F>F_{target})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	28%	50%	79%
	2027	<1%	29%	50%	78%
$P(B<B_{trigger})$	2025	<1%	<1%	<1%	<1%
	2026	<1%	<1%	<1%	<1%
	2027	<1%	<1%	<1%	<1%
	2028	<1%	<1%	1%	<1%
$P(B_{2028}>B_{2025})$		76%	26%	21%	15%
$(B_{2028}-B_{2025})/B_{2025}$		+15.4%	-11.9%	-15.2%	-20.2%

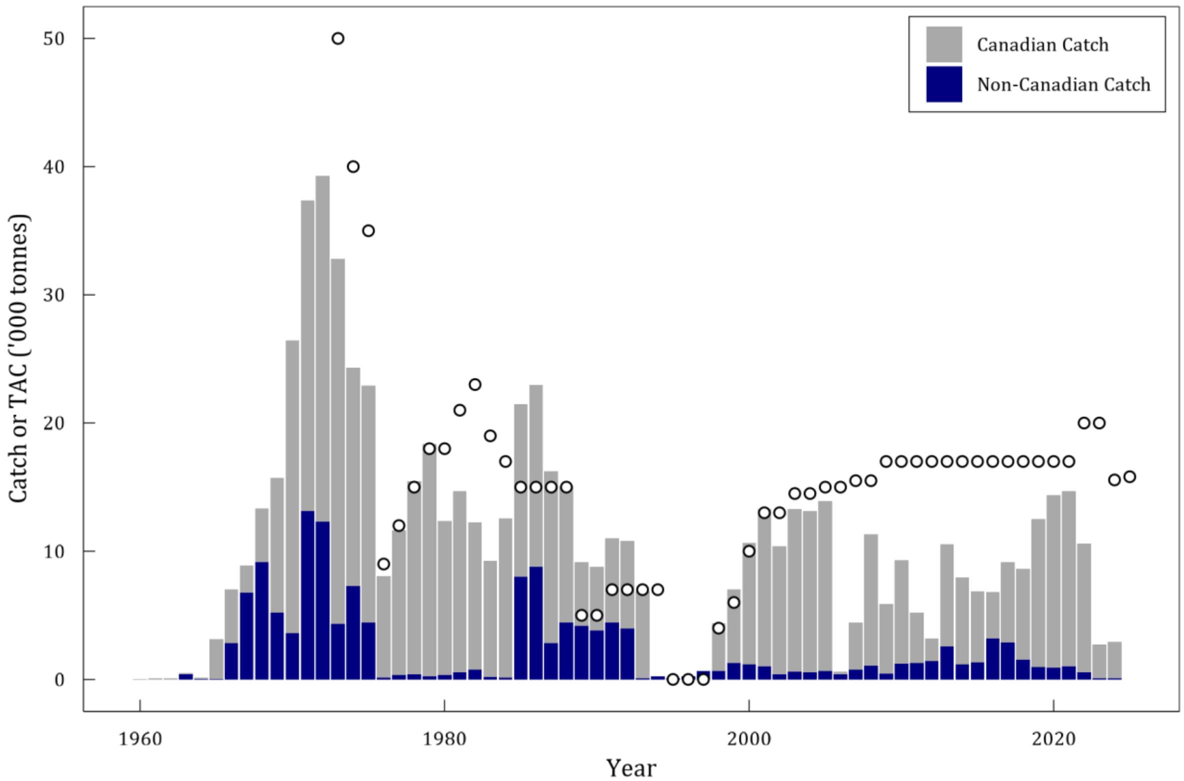


Figure 1. Catch (bars) and TAC (points) of Yellowtail flounder in NAFO Divisions 3LNO. Catch is as reported in NAFO STATLANT21a and may differ from STACFIS/CESAG catches and those used in the production model.

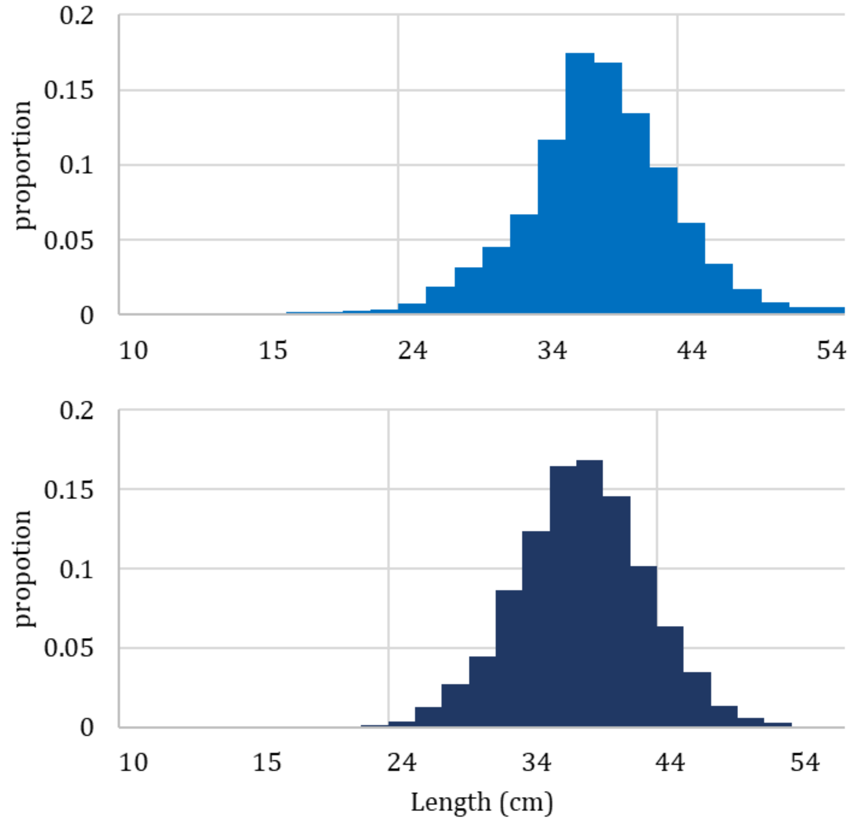


Figure 2. Length frequencies from the Canadian commercial otter trawl fishery on Yellowtail Flounder in NAFO Div. 3LNO from 2023 (top) and 2024 (bottom) (SCS 24/09, 25/11).

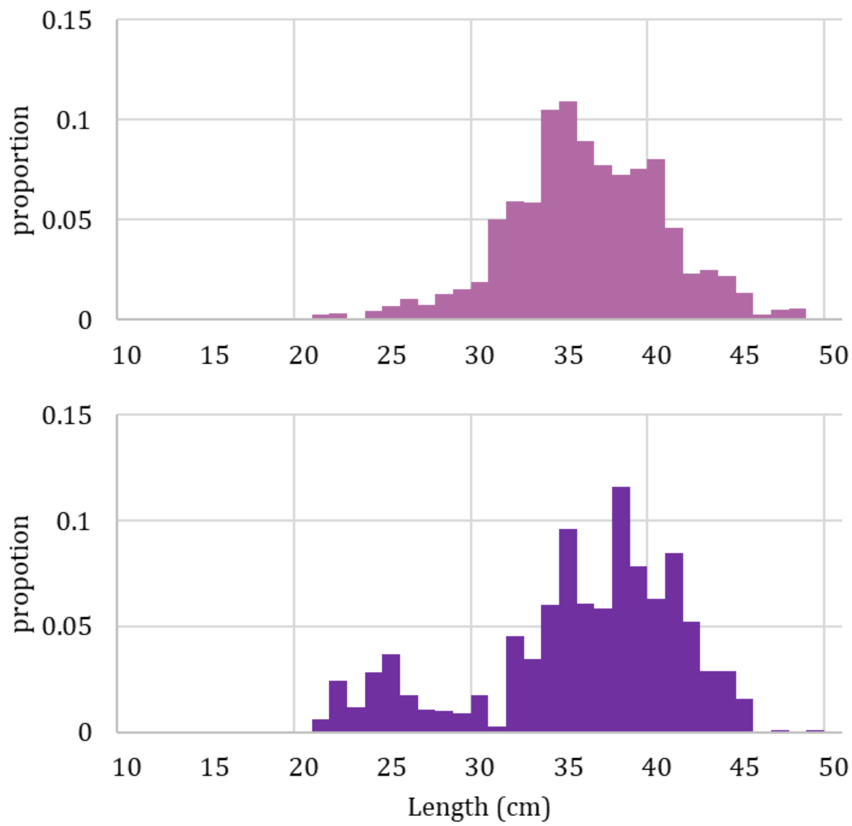


Figure 3. Length frequencies of Yellowtail flounder catch from commercial fisheries in the NRA conducted by Spain (Div 3NO) in 2023 (top) and 2024 (bottom) (SCS 24/08, 25/05REV)

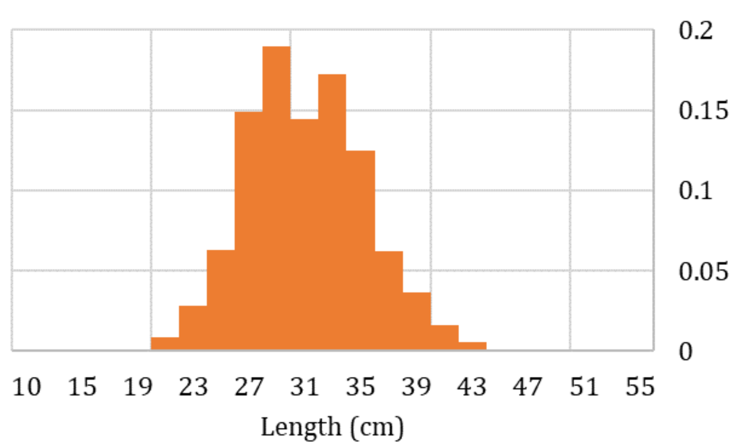


Figure 4. Length frequencies of Yellowtail flounder catch from commercial fisheries in the NRA (3N) conducted by Russia in 2024 (SCS 25/09REV).

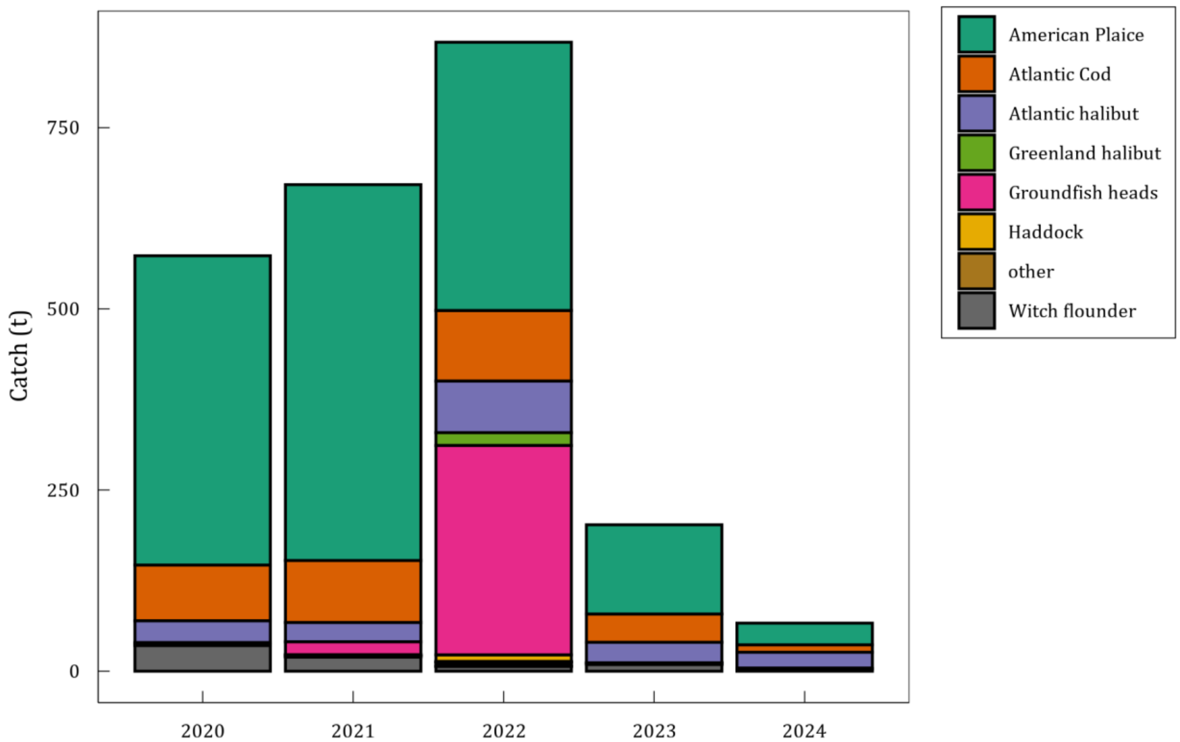


Figure 5. Composition of bycatch in the Canadian directed Yellowtail flounder fishery from 2020-2024. Data are provisional. Reported weight of "groundfish heads" may include catch also reported under other species and/or have a conversion applied to live weight equivalent; the relative weight of this category is likely overrepresented here.

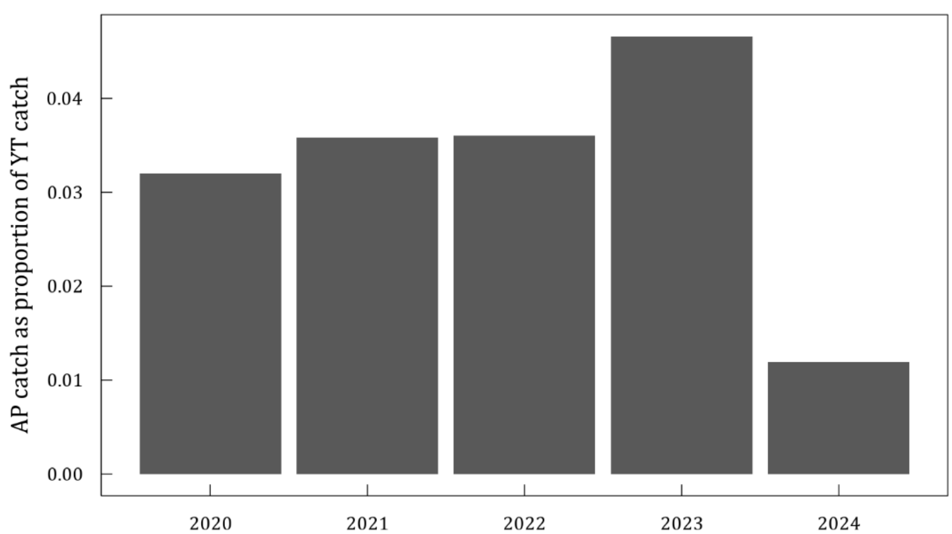


Figure 6. American plaice landings as a proportion of Yellowtail flounder in the Canadian directed Yellowtail fishery in Div. 3LNO from 2020-2024.

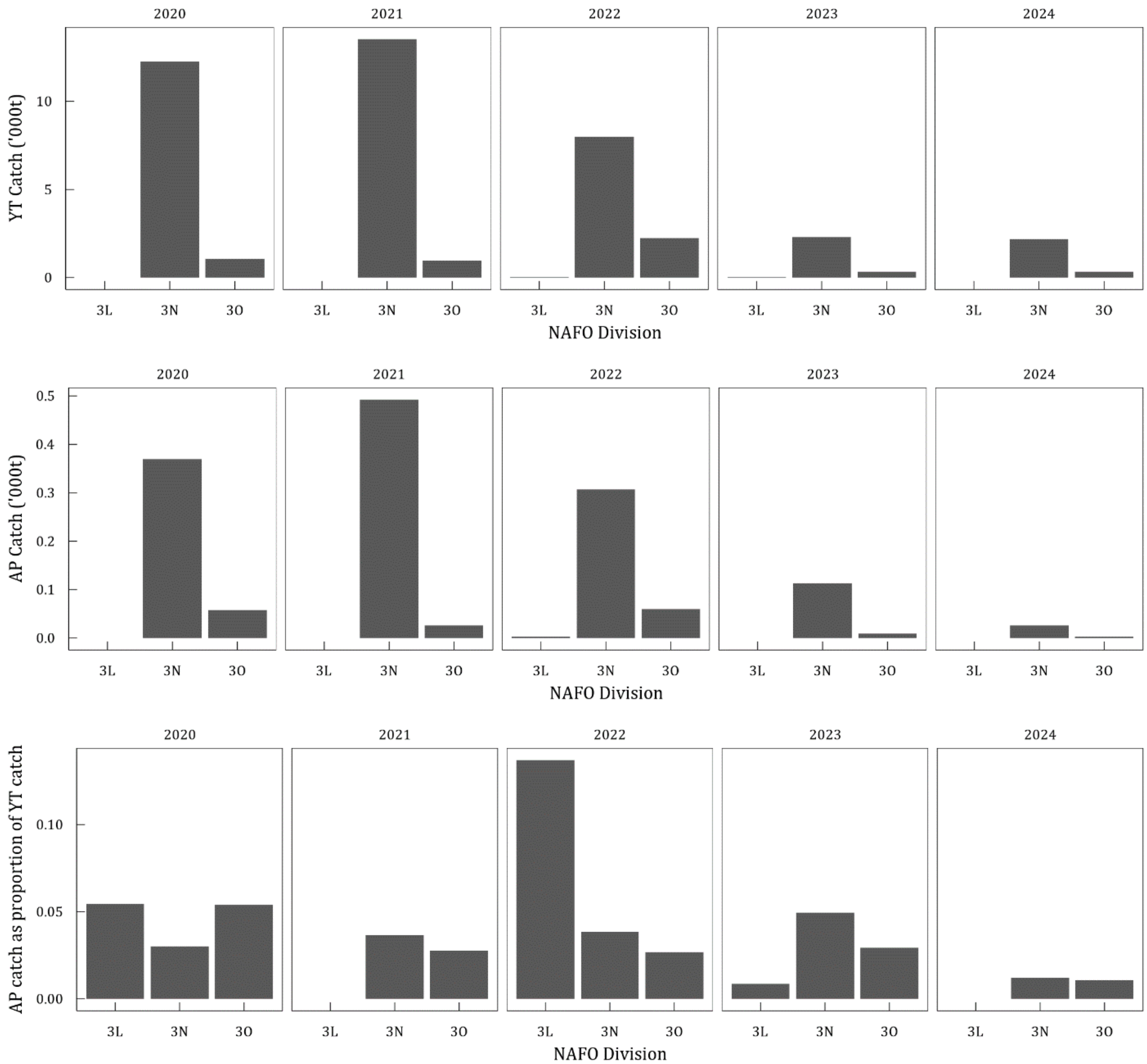


Figure 7. Yellowtail flounder (YT) and American plaice (AP) in the Canadian directed Yellowtail flounder fishery. Top: Yellowtail flounder landings by Division. Middle: American plaice landings by Division from sets reported as directing for yellowtail flounder. bottom: American plaice as a proportion of yellowtail flounder catch.

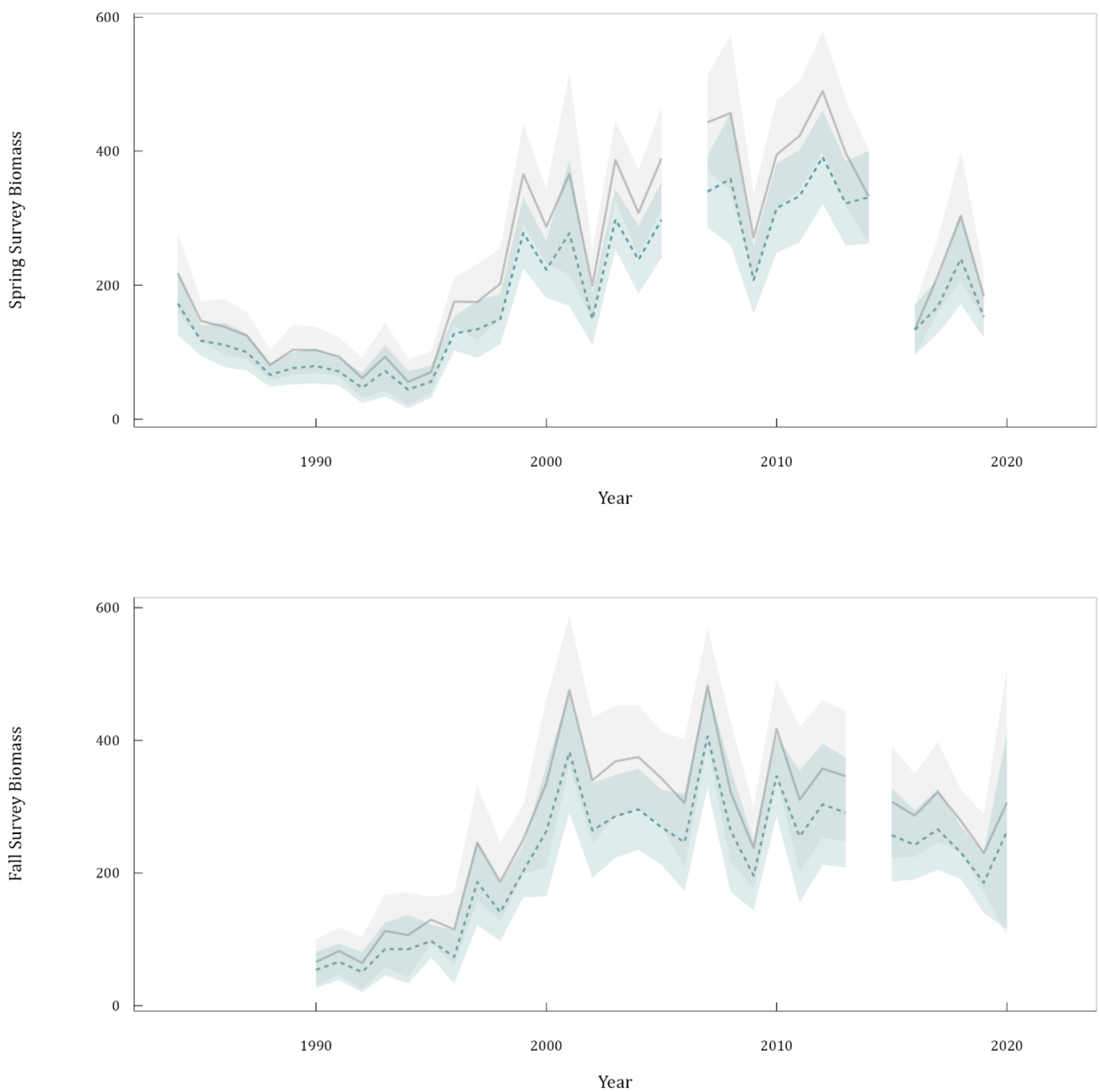
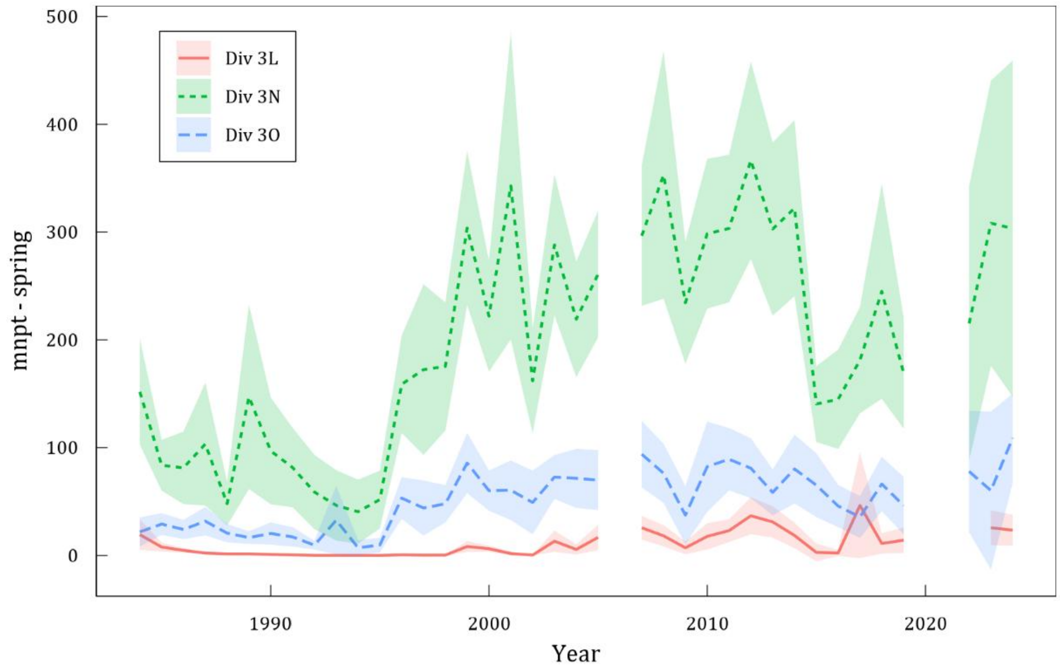


Figure 8. Comparison of previous Campelen unit series for Canadian spring and fall surveys (grey, solid line) and newly converted Modified Campelen series (blue dashed) to 2020 following the application of conversion factors described in Wheeland et al. 2024, Trueman et al. 2025. All subsequent plots for the Canadian surveys are presented in Modified Campelen units.



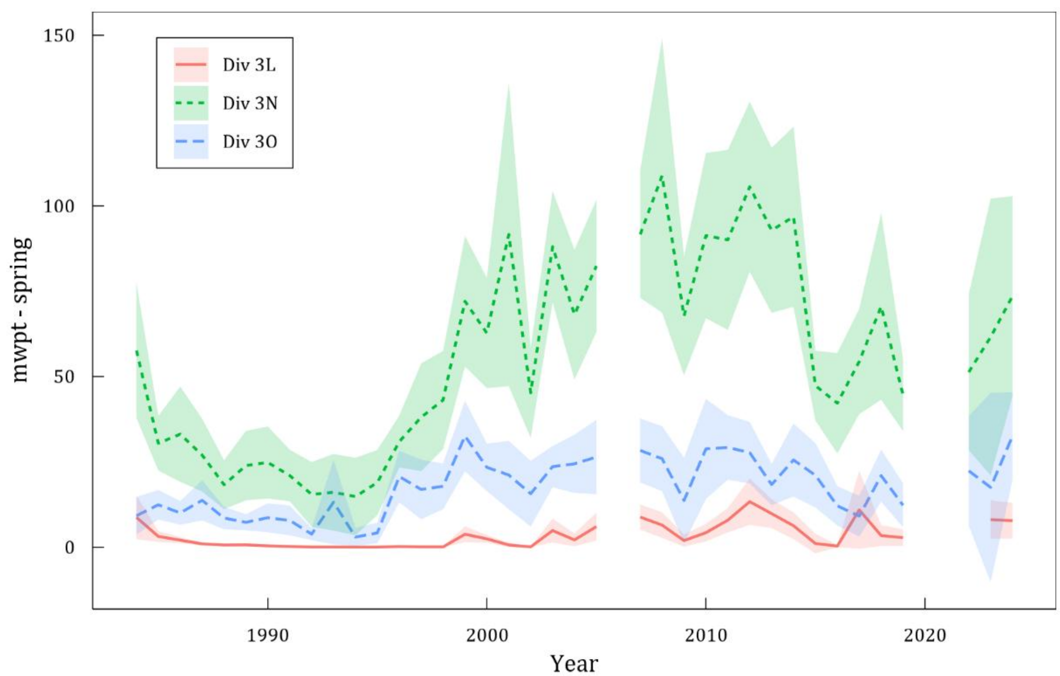
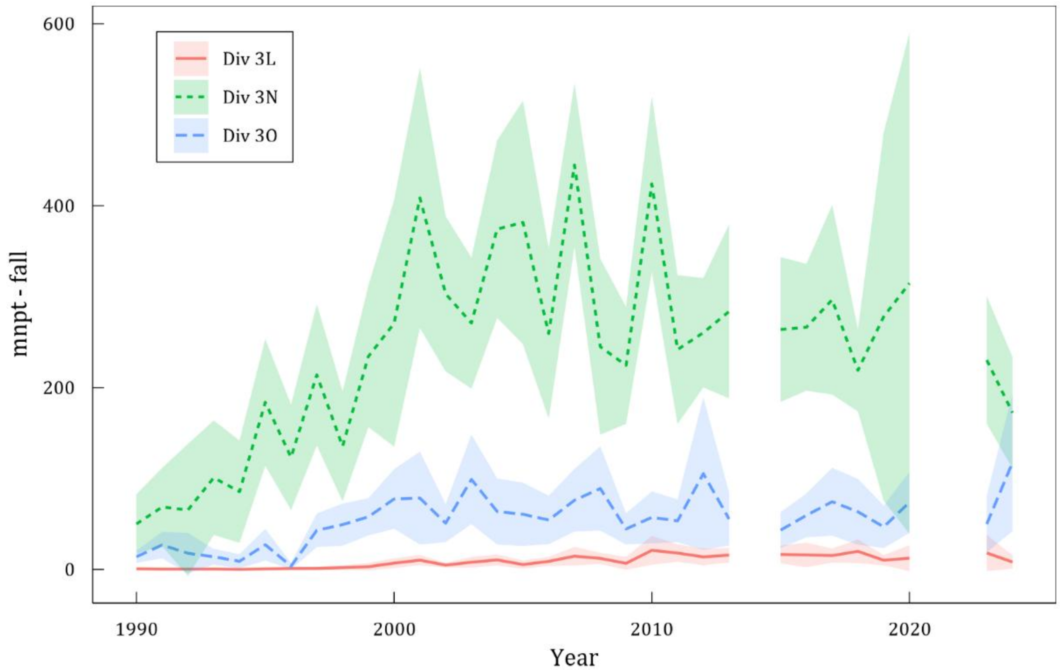


Figure 9. Mean number per tow (mnpt; top) and mean weight per tow (mwpt; bottom) by Division for the Canadian Spring surveys.



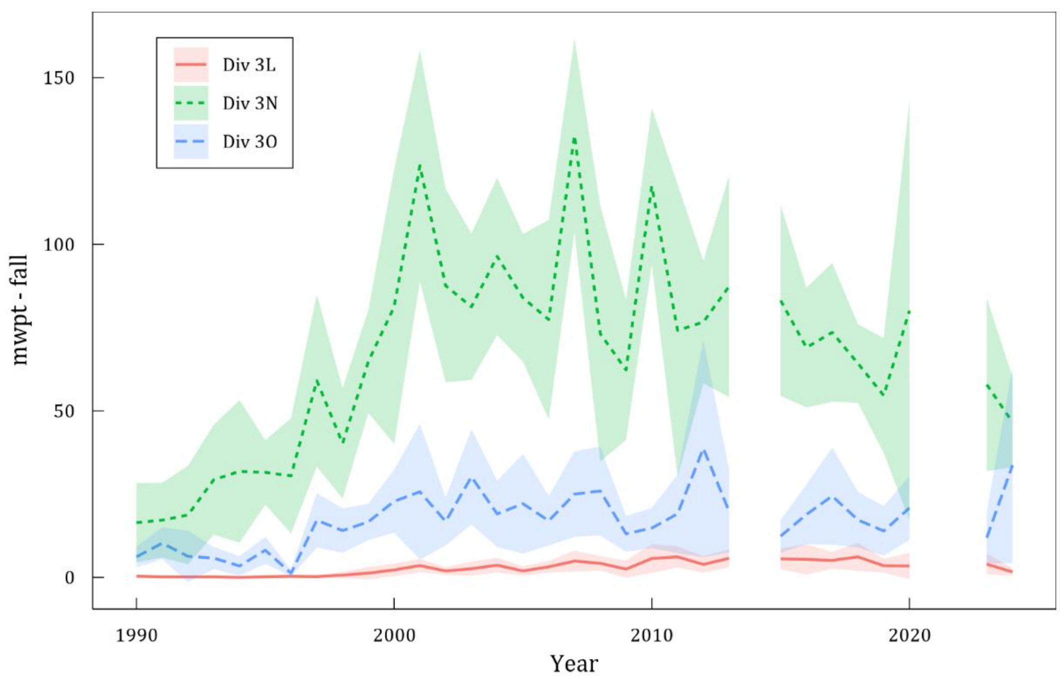


Figure 10. Mean number per tow (mnpt; top) and mean weight per tow (mwpt; bottom) by Division for the Canadian Fall surveys.

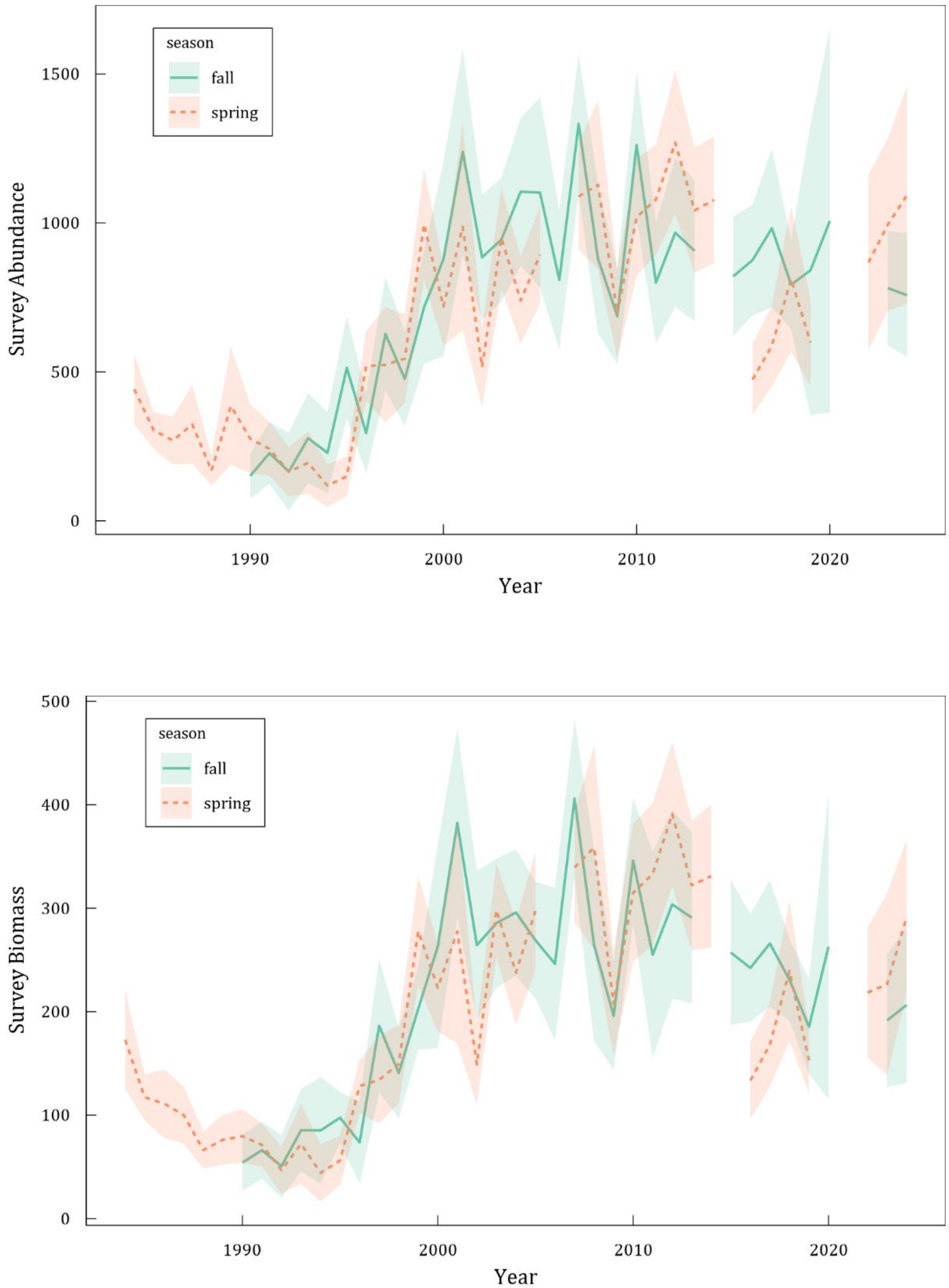


Figure 11. Estimates of survey abundance (top) and biomass (bottom) for the Canadian spring and fall surveys in NAFO Div. 3LNO. Indices have been converted to new Modified Campelen units following Wheeland et al. 2024 and therefore differ from those presented in previous assessments of this stock.

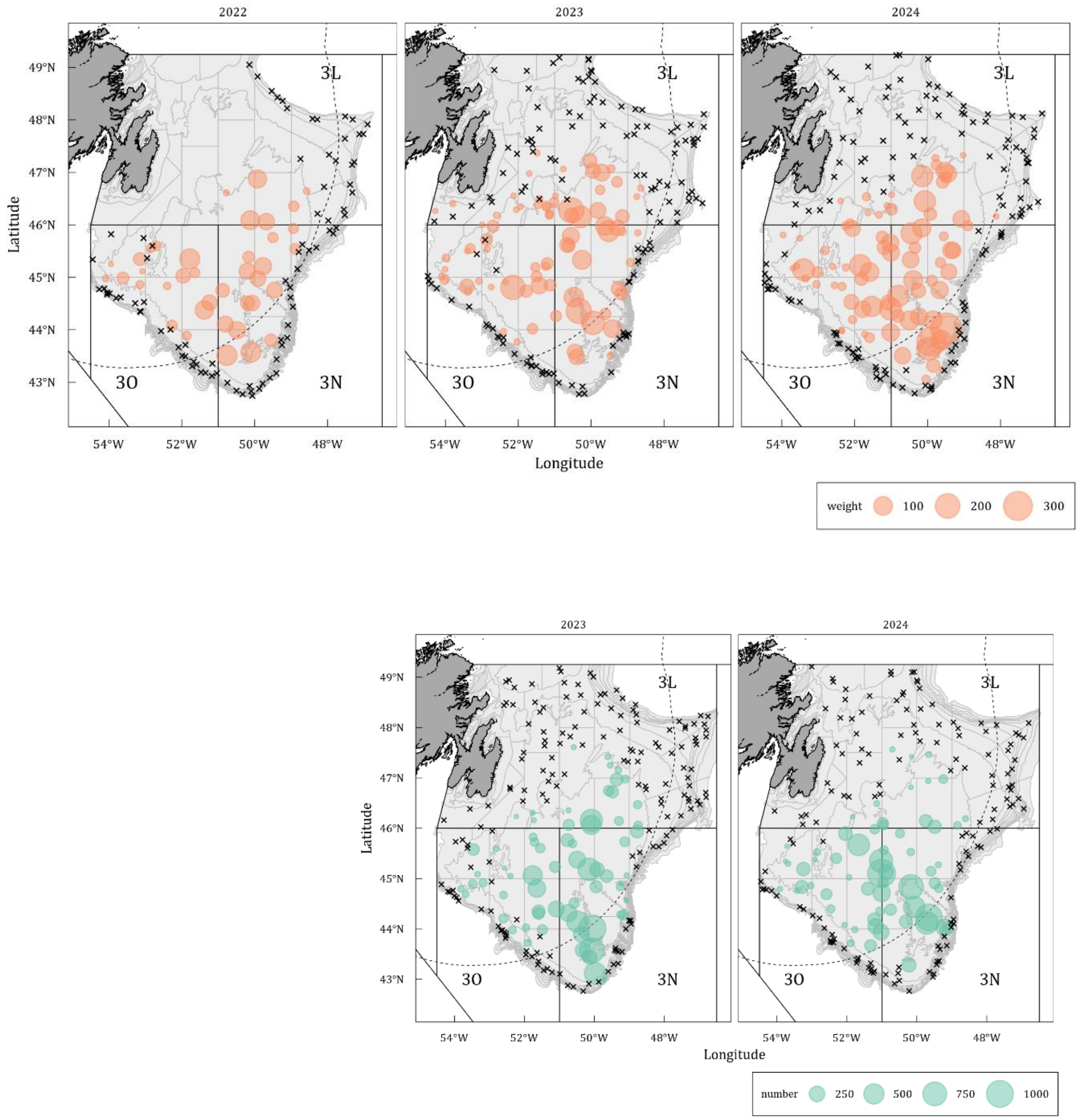


Figure 12. Distribution of Yellowtail Flounder catches (weight per tow) in the Canadian spring surveys from 2022-2024 (top) and fall survey in 2023 and 2024 (bottom). There was no fall survey in 2022. **x** indicates a survey set with no catch of Yellowtail flounder.

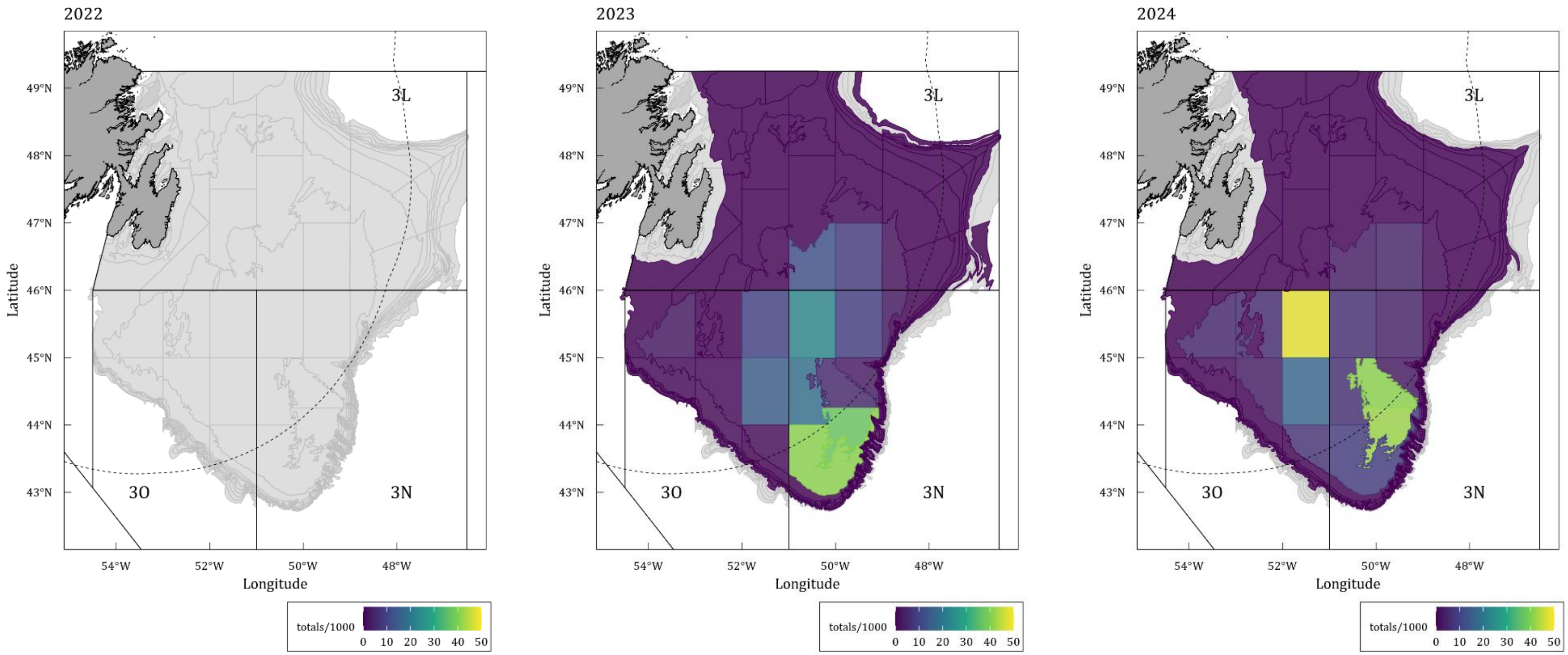


Figure 13. Distribution of biomass by strata in the Canadian fall surveys from 2022-2024. Dashed line shows the 200nm EEZ.

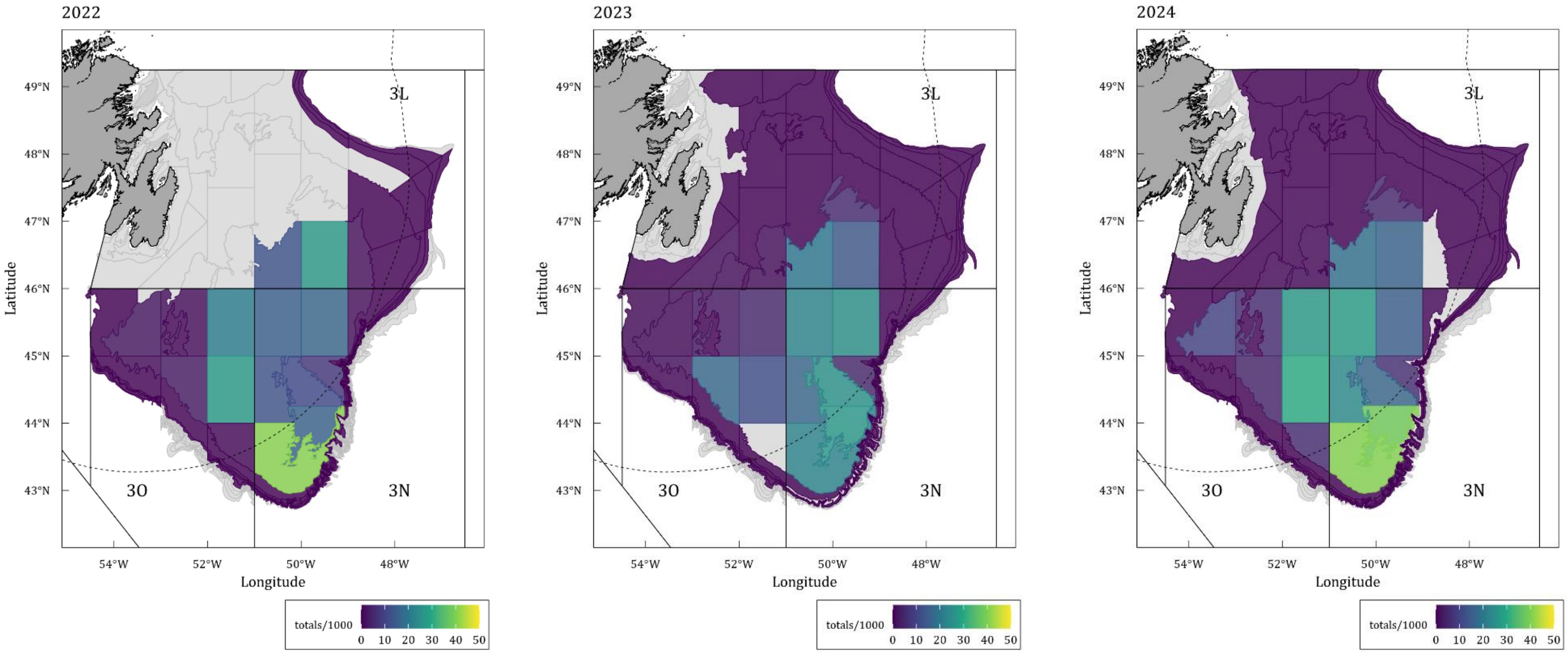


Figure 14. Distribution of biomass by strata in the Canadian spring surveys from 2022-2024. Dashed line shows the 200nm EEZ.

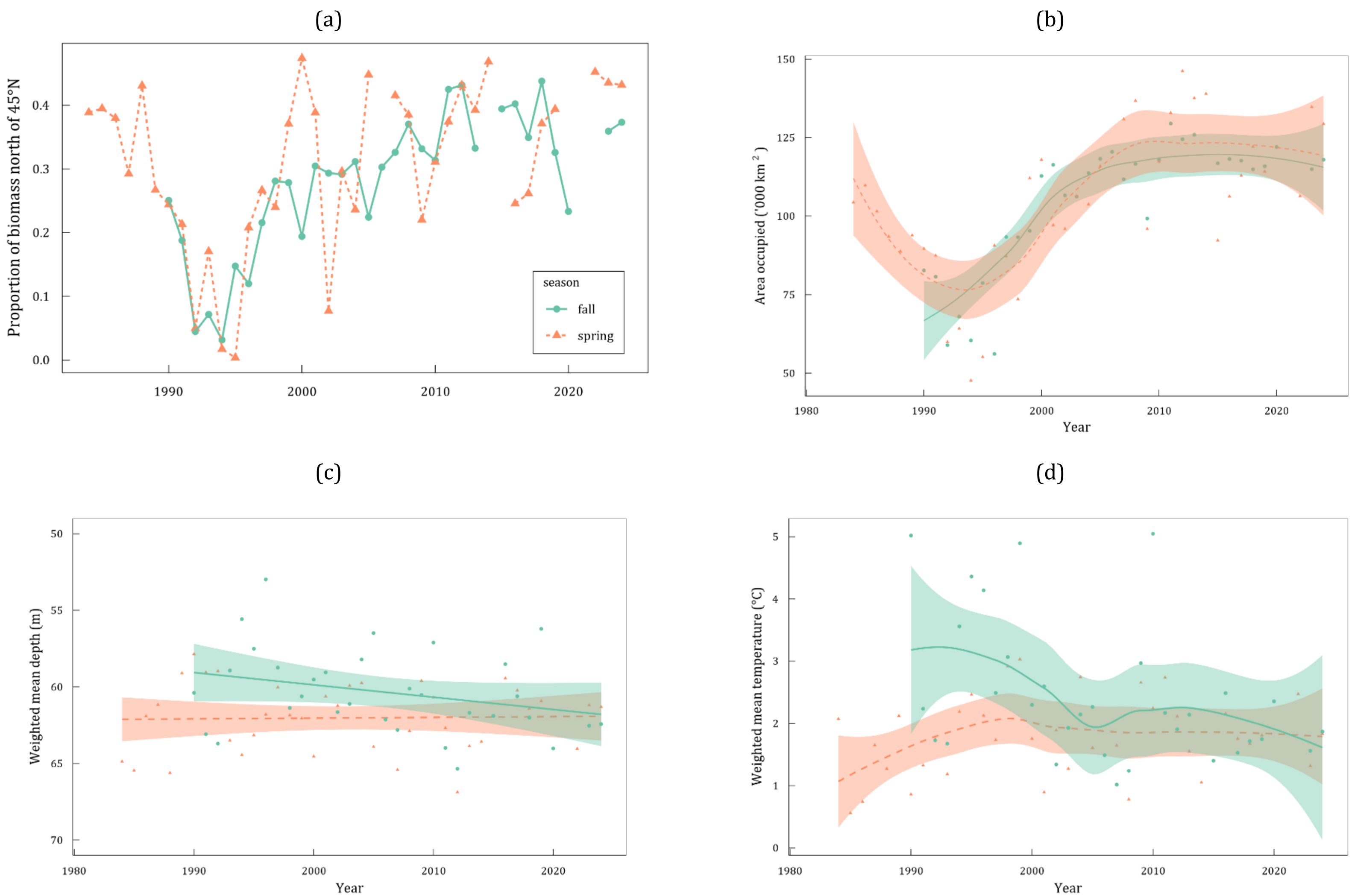


Figure 15. Distribution metrics for Yellowtail flounder in Div. 3LNO in the Canadian spring and fall surveys: (a) biomass north of 45°N; (b) Design-weighted area occupied; (c) abundance-weighted mean depth; (d) abundance weighted mean temperature.

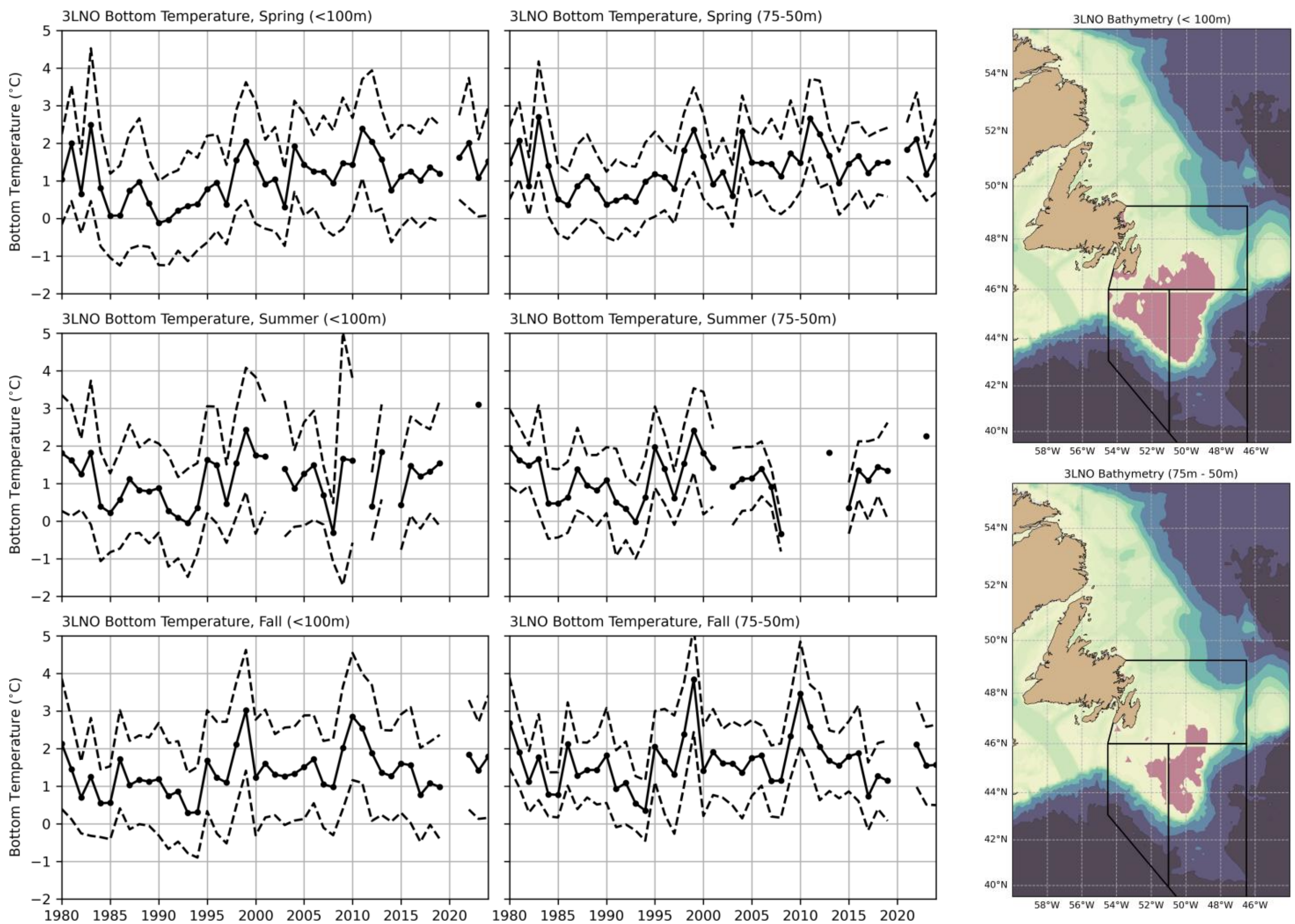


Figure 16. Bottom temperature indices for Yellowtail flounder in Div. 3LNO. Indices here are for the primary areas of distribution of Yellowtail flounder on the Grand Bank, defined here as areas at depths <100m and 50-75m, as shown in the two maps at the right. . In the Canadian surveys, around 80% of Yellowtail flounder are caught between 50-75m, and nearly all are caught shallower than 100m.

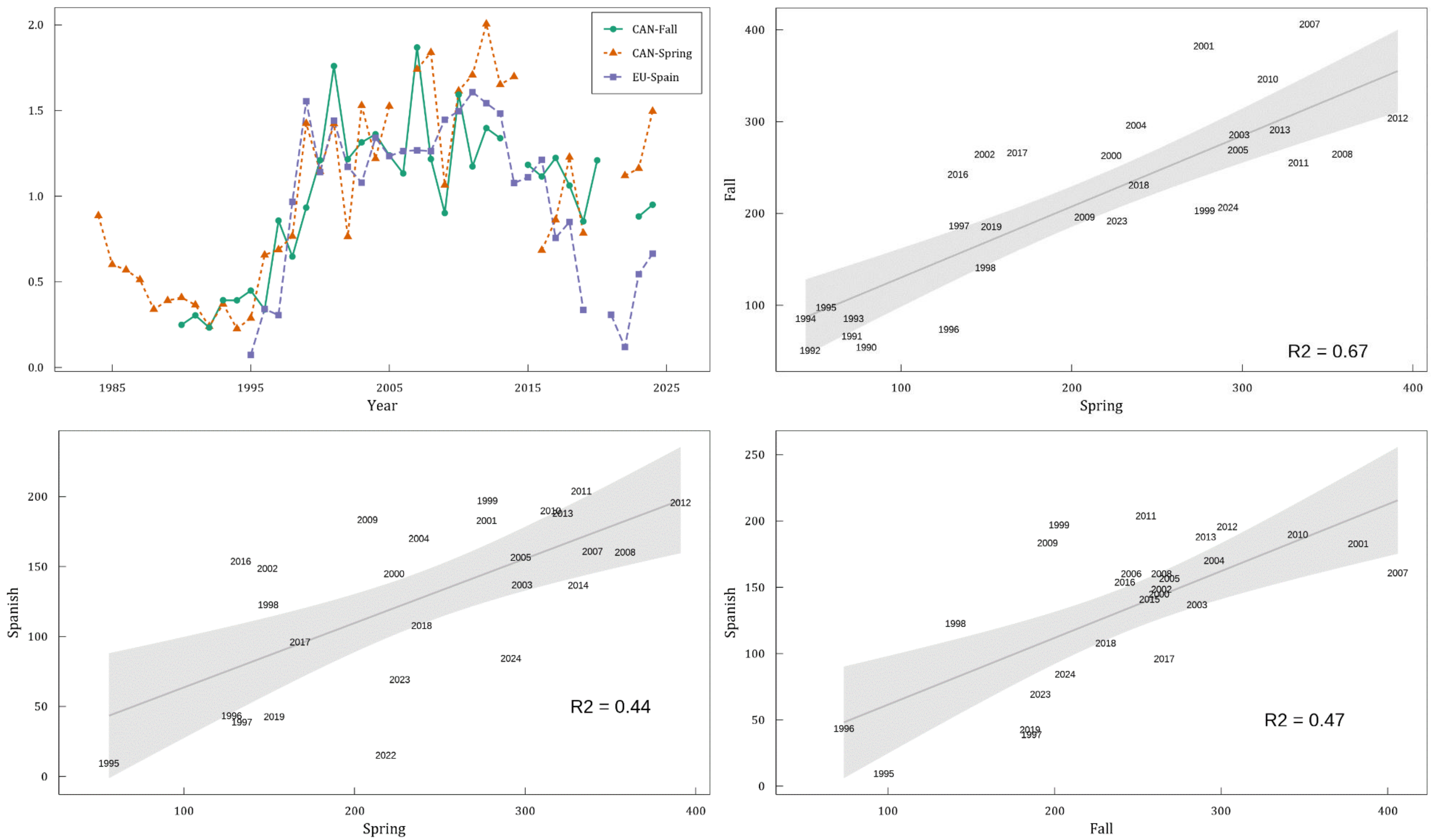


Figure 17. Survey series scaled to series means and regressions of Canadian spring, autumn and Spanish survey estimates of yellowtail flounder biomass in Div. 3LNO, 1990-2024.

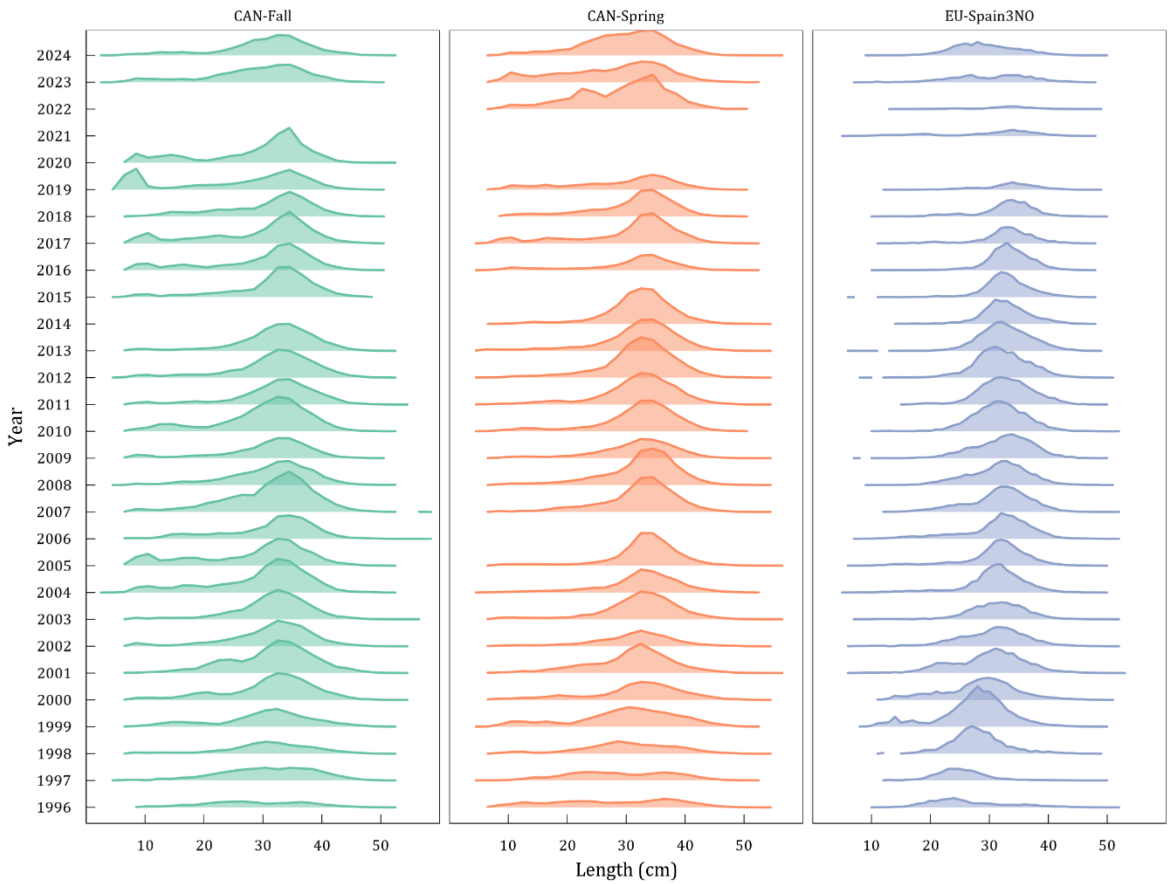


Figure 18. Abundance at length of yellowtail flounder in NAFO Divisions 3LNO from the Canadian spring and fall surveys, and the Spanish survey of 3NO from 1996-2024. Blank years indicate incomplete or missed surveys.

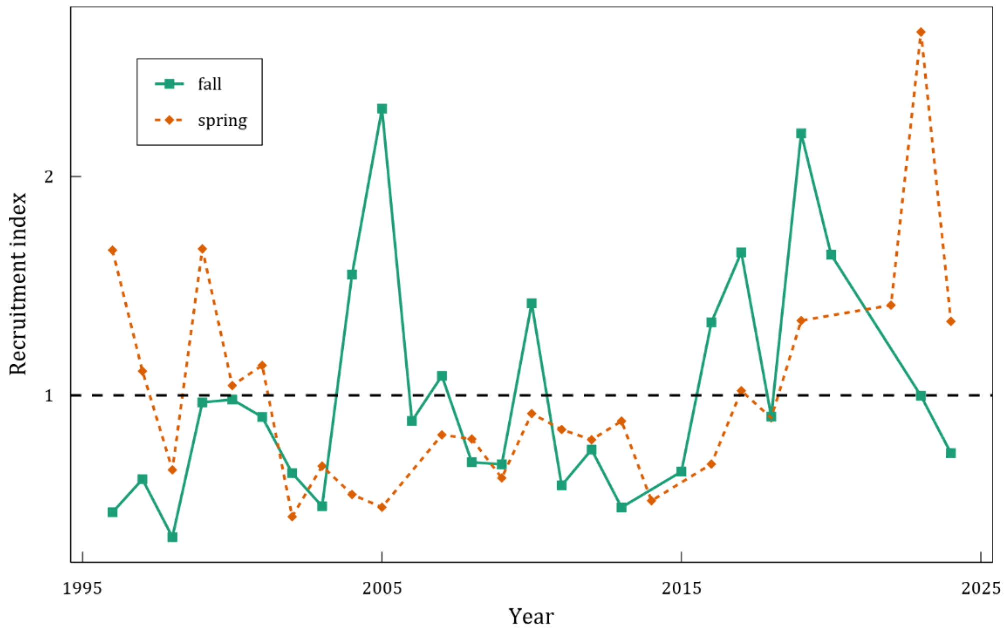


Figure 19. Recruitment index defined as population numbers (scaled to the means of 1995-2024) of yellowtail flounder less than 22cm in the Canadian spring and autumn surveys in NAFO Divisions 3LNO.

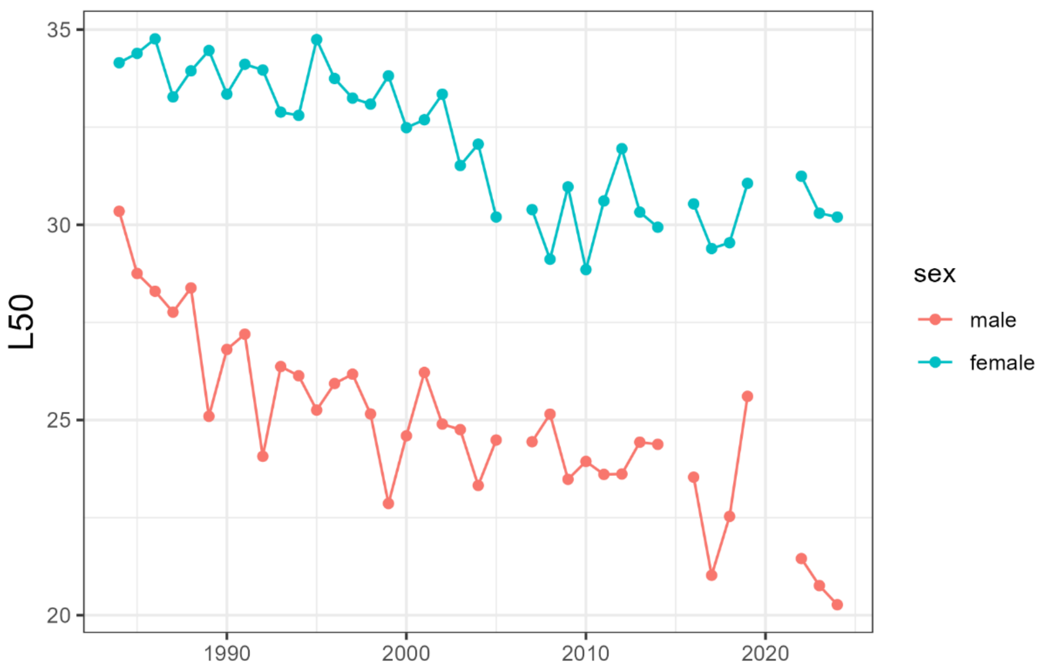


Figure 20. Length at 50% maturity of male and female yellowtail flounder from annual Canadian research vessel surveys of Div. 3LNO from 1984 to 2024.

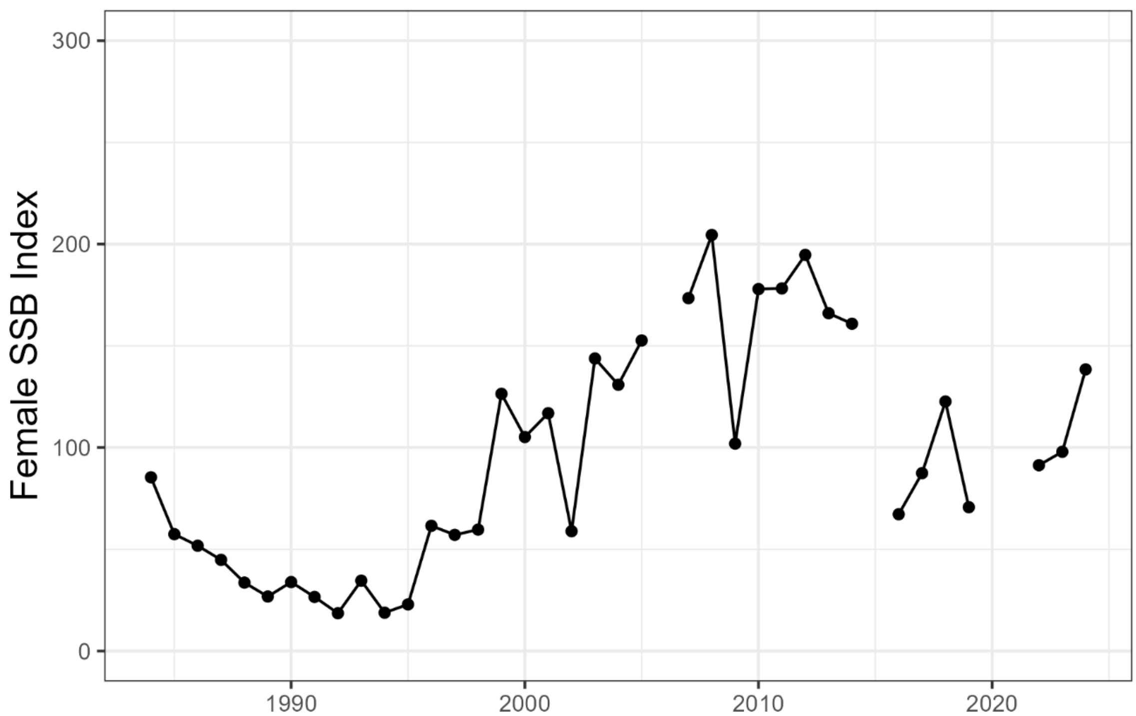


Figure 21. Index of female spawning stock biomass ('000t) for Div. 3LNO yellowtail flounder as calculated from Canadian spring research vessel surveys from 1984-2024.

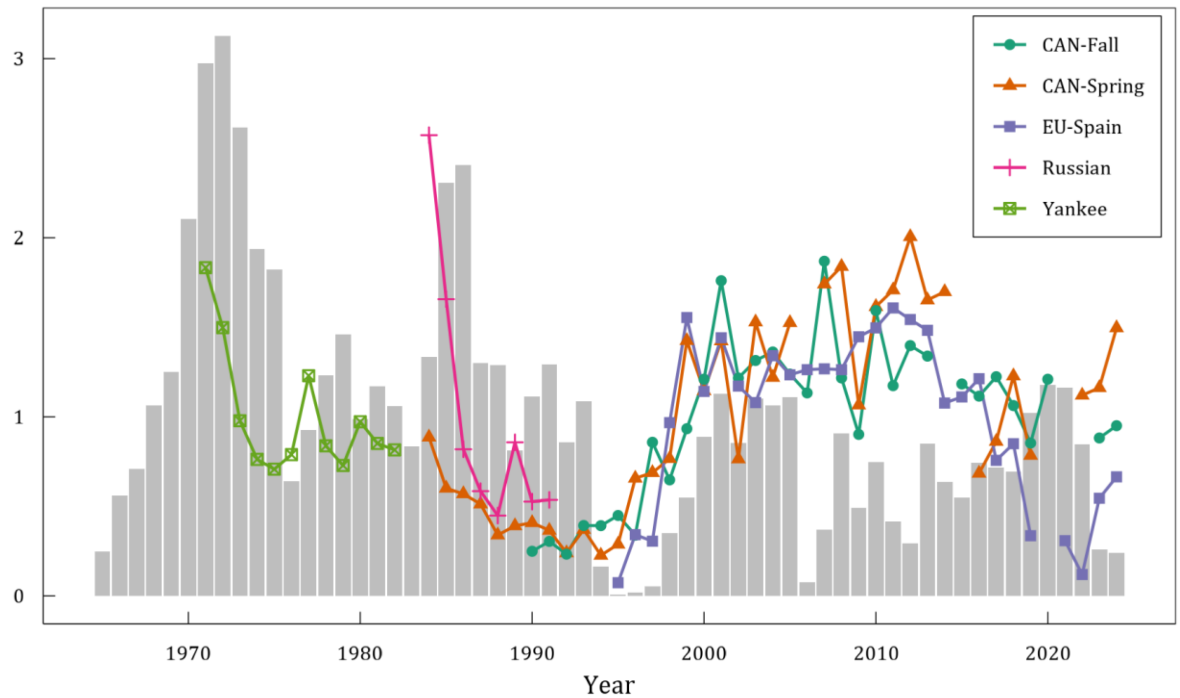


Figure 22. Nominal catch (bars) and survey series scaled to the mean for each of the indices used in the 2025 assessment of yellowtail flounder.

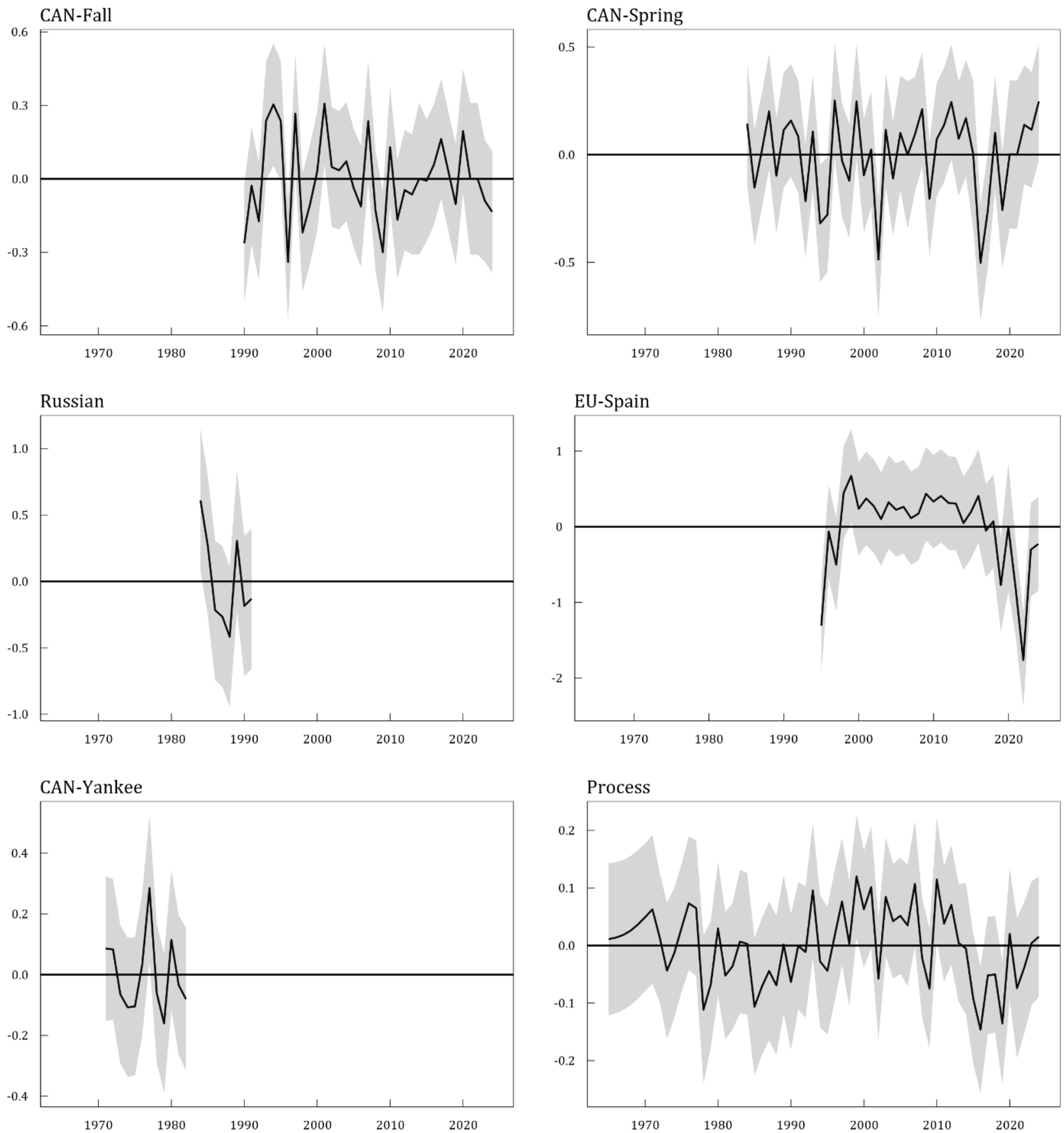


Figure 23. Residual plots (mean +/- sd) for the survey indices from the surplus production model in a Bayesian framework for the 2025 assessment of yellowtail flounder in NAFO Div. 3LNO

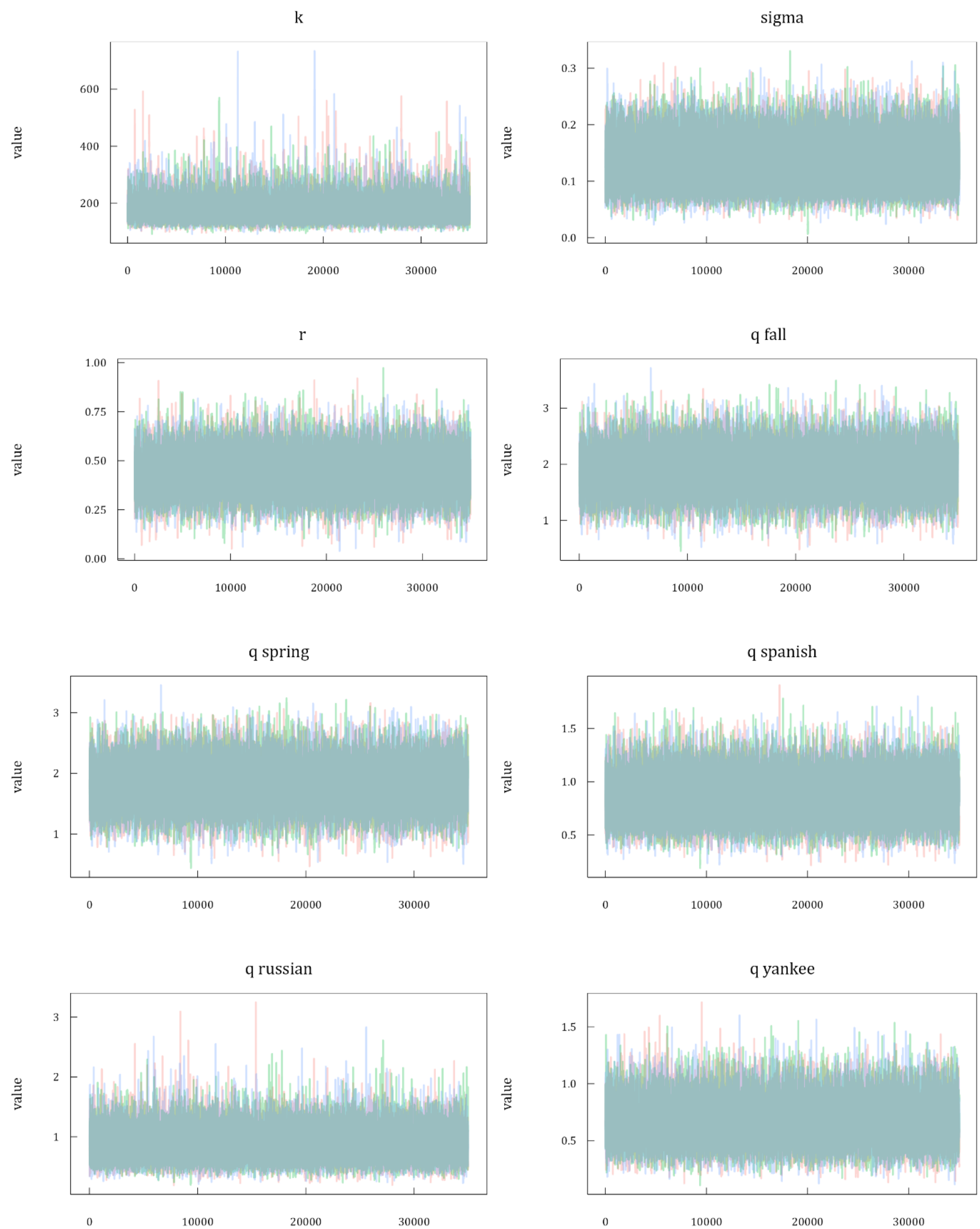


Figure 24. Trace plots for k, sigma, r, and survey qs for the three chains of the Bayesian surplus production model. Additional diagnostics are presented in Appendix 2.

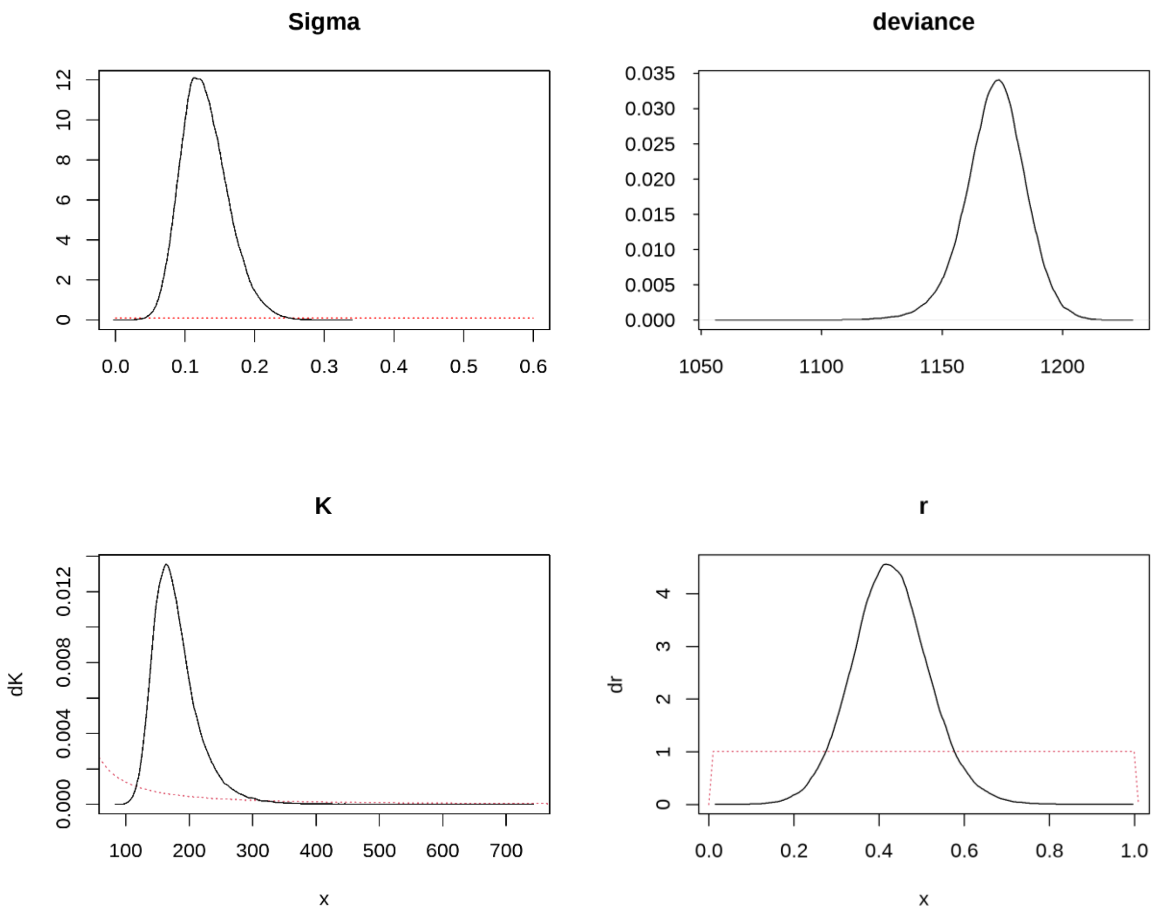


Figure 25. Priors (red line) and posteriors (black line) for sigma (process error), deviance, carrying capacity (K) and intrinsic rate of growth (r).

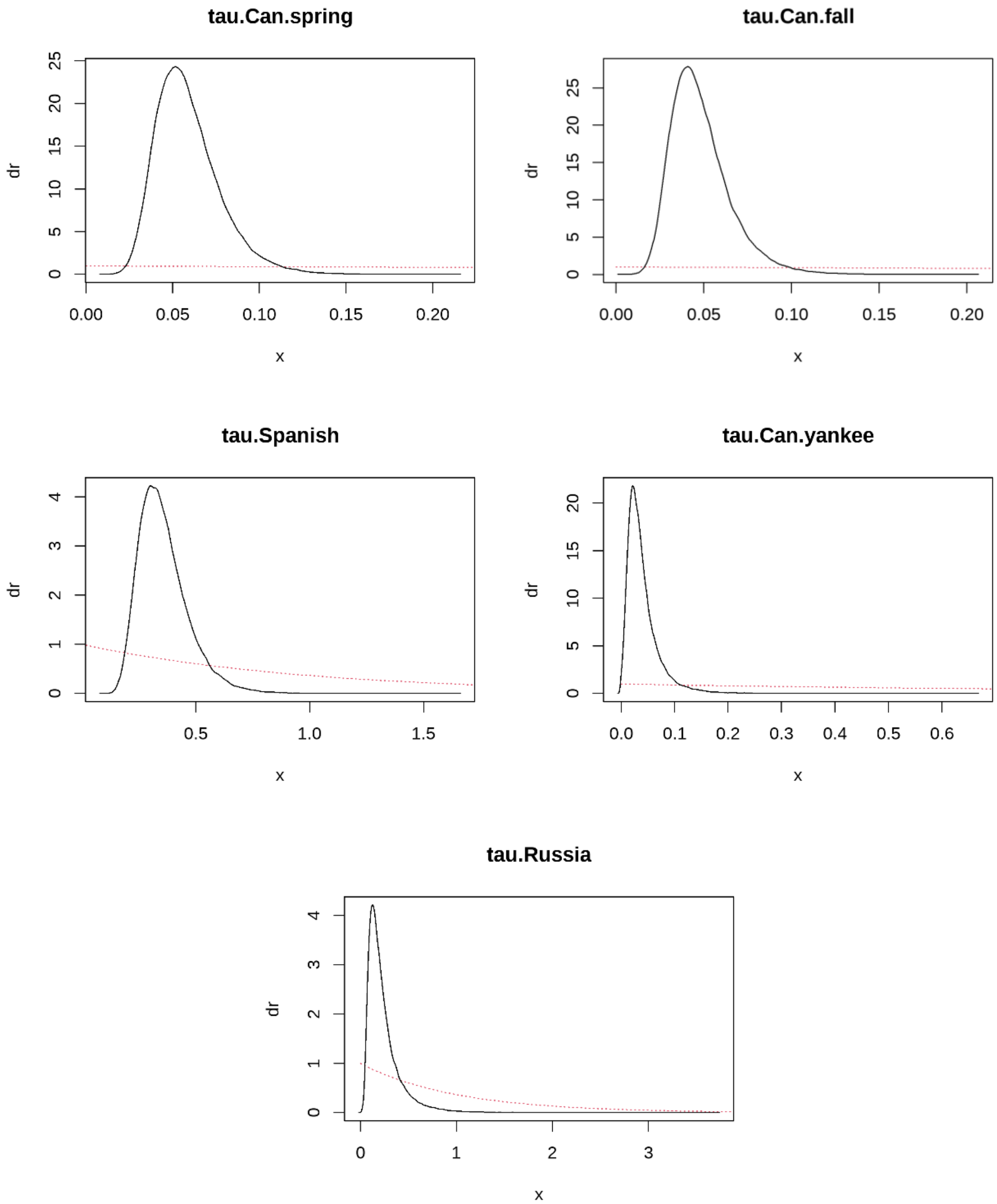


Figure 26. Priors (red line) and posteriors (black line) fop observation error of surveys used in the 2025 Yellowtail flounder Bayesian surplus production assessment model.

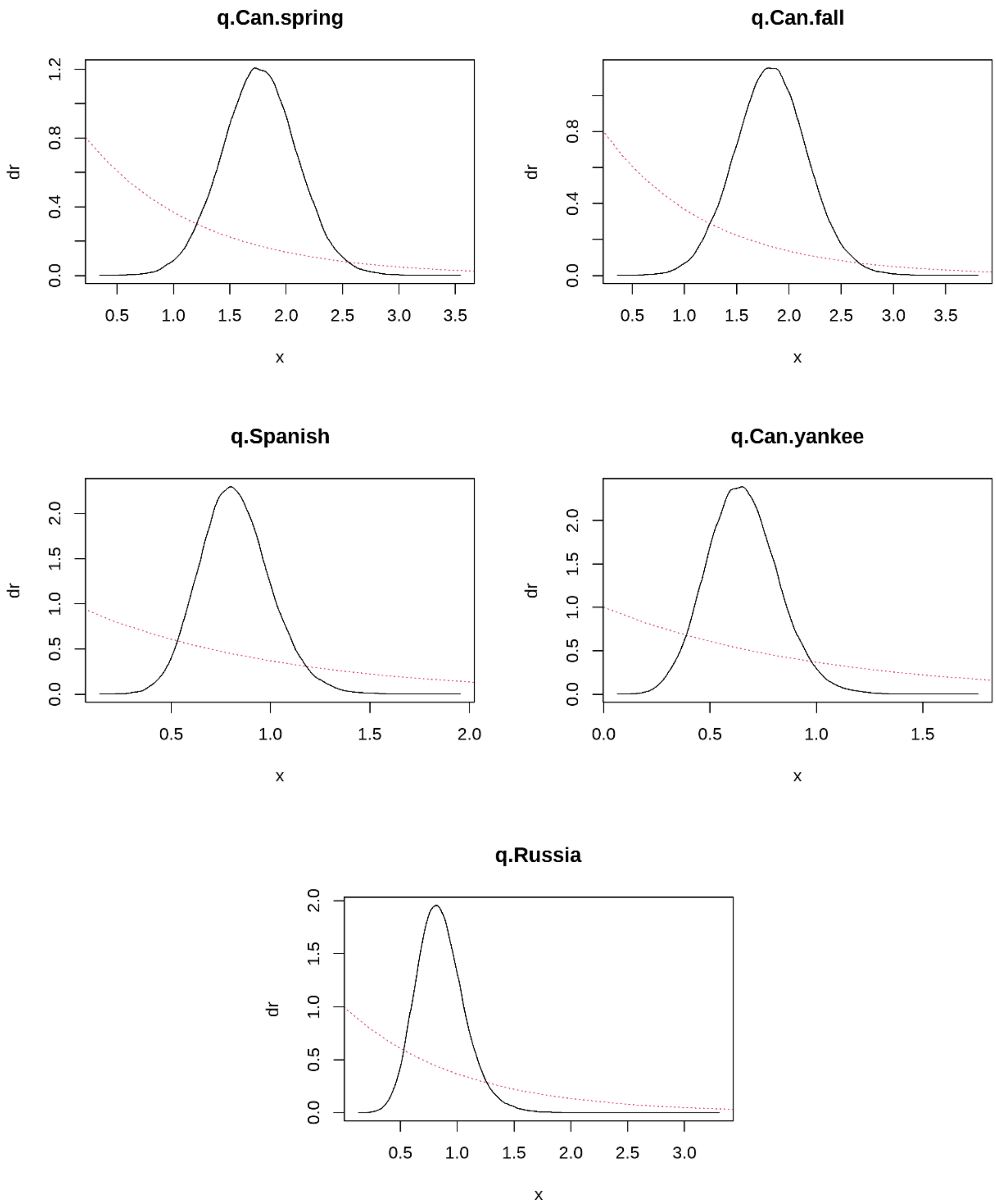


Figure 27. Priors (red line) and posteriors (black line) for the q estimated for each survey used in the 2025 yellowtail flounder Bayesian surplus production model.

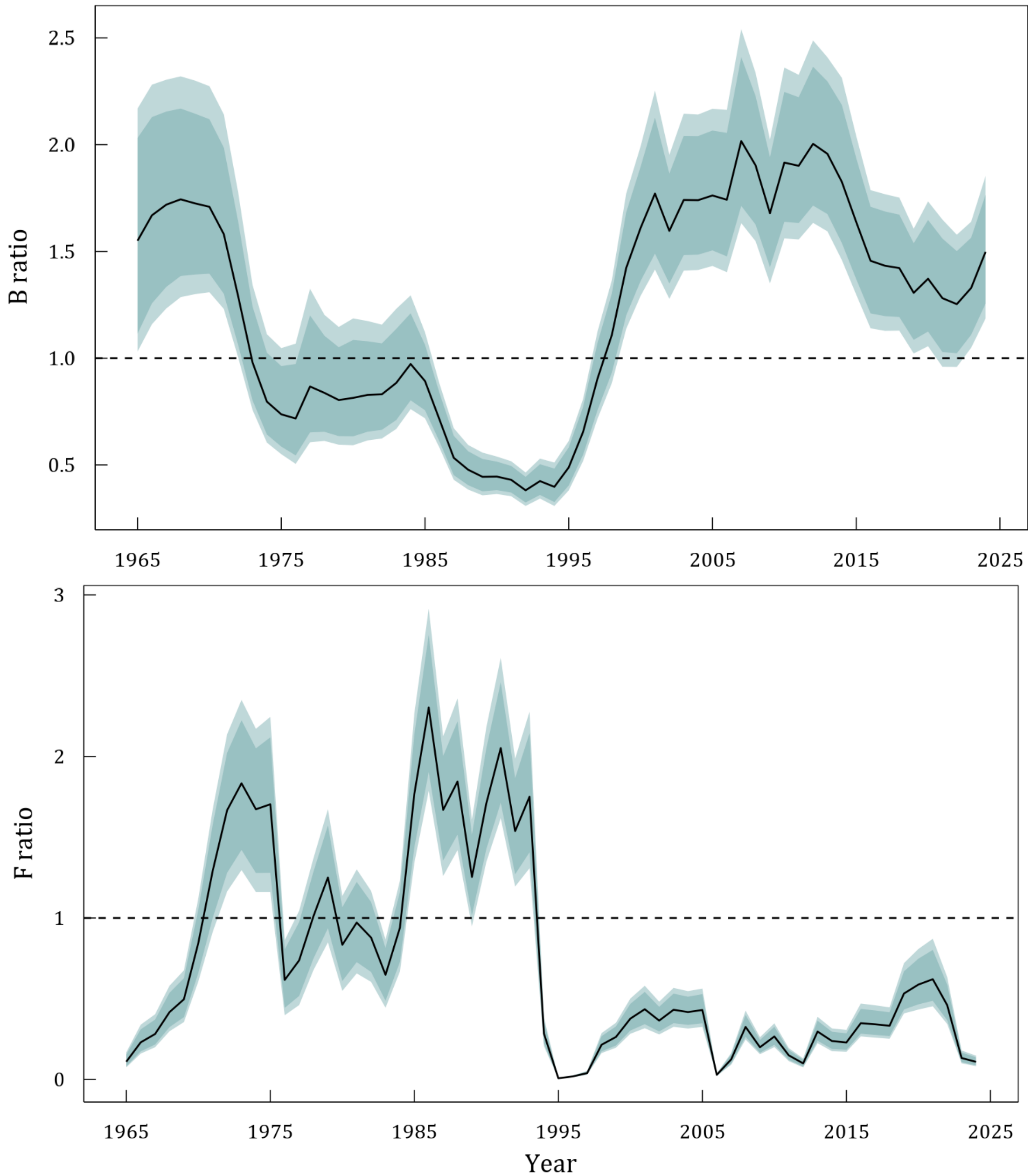


Figure 28. Yellowtail flounder in NAFO Divisions 3LNO: Relative biomass (Bratio = B/Bmsy) and relative fishing mortality (F ratio = F/Fmsy) estimates from a surplus production model in a Bayesian framework. 80% and 95% credible intervals are shown.

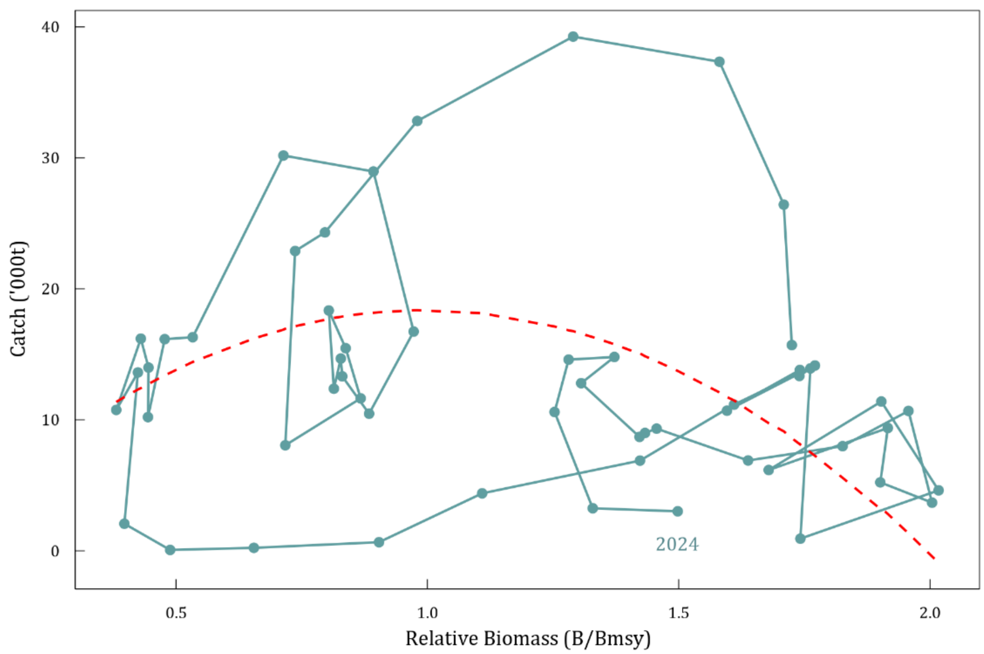


Figure 29. Catch and estimated surplus production ('000 t; dashed red line) plotted against relative biomass (B/Bmsy) of yellowtail flounder in NAFO Div. 3LNO.

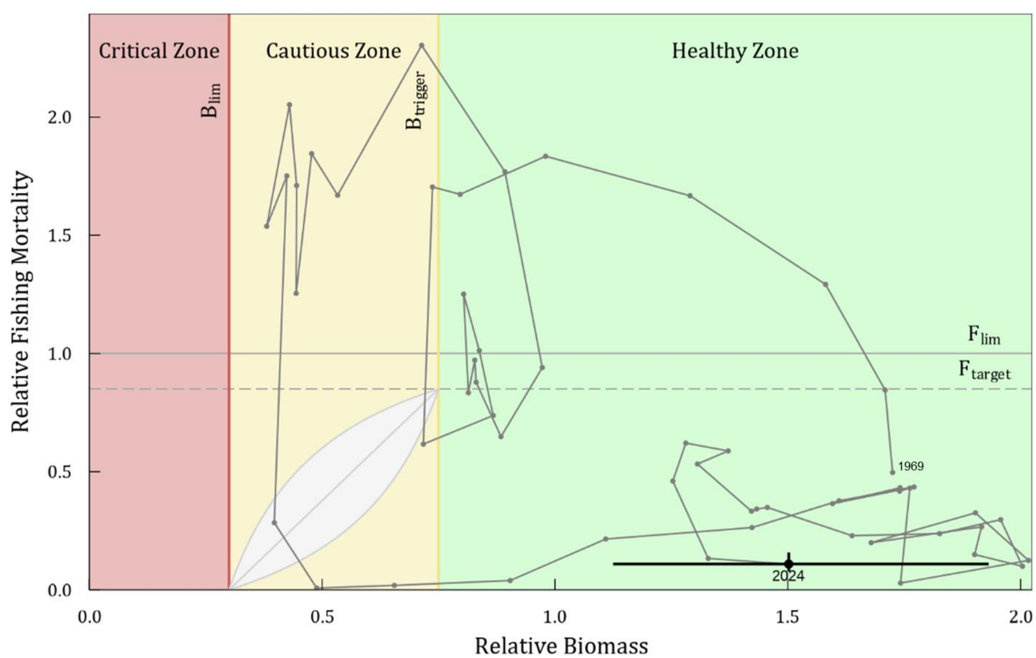


Figure 30. Yellowtail flounder in Div. 3LNO: stock trajectory estimated in the surplus production analysis, under the NAFO precautionary approach framework. Error bars on estimate in final year are 80% credible intervals.

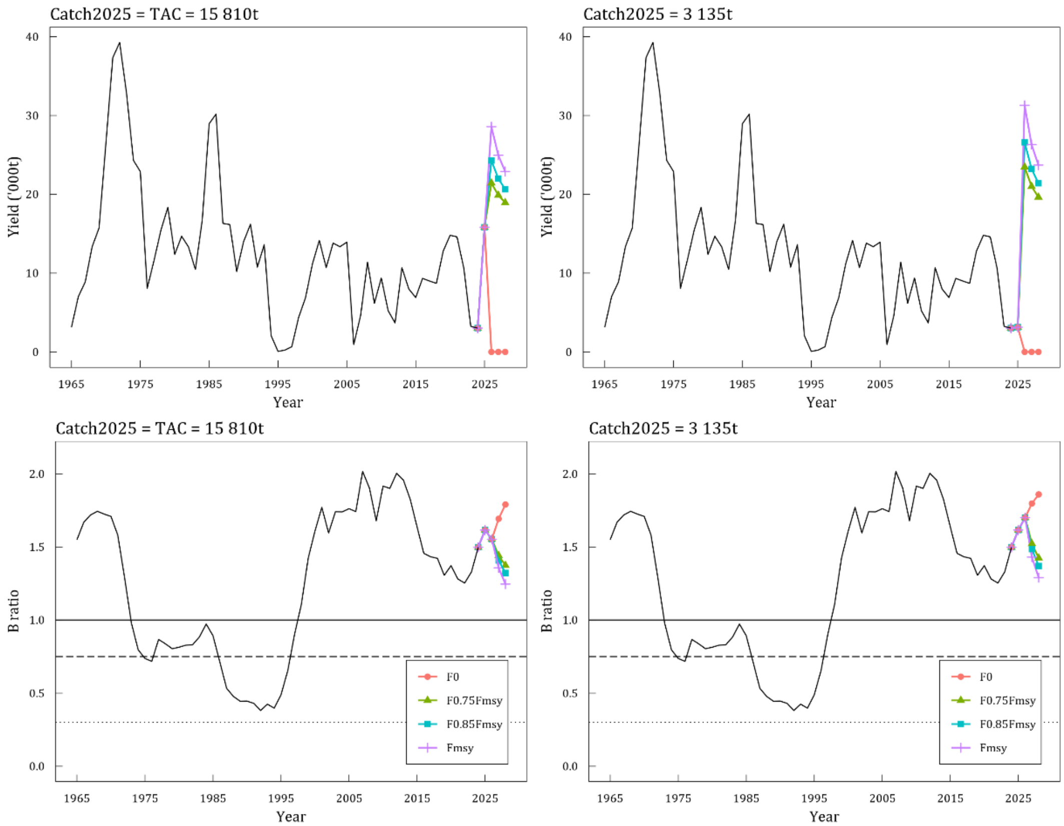


Figure 31. Yellowtail flounder in Div. 3LNO: stochastic projections from 2026-2028 at four levels of F (F=0, 75% Fmsy, 85% Fmsy and Fmsy) for two Catch2025 scenarios (Catch2025 = TAC2025 = 15 810 t and Catch2025 = average of 2023-2024 = 3 135 t). Top panels shows projected yield and lower panels are projected relative biomass ratios (B/Bmsy).

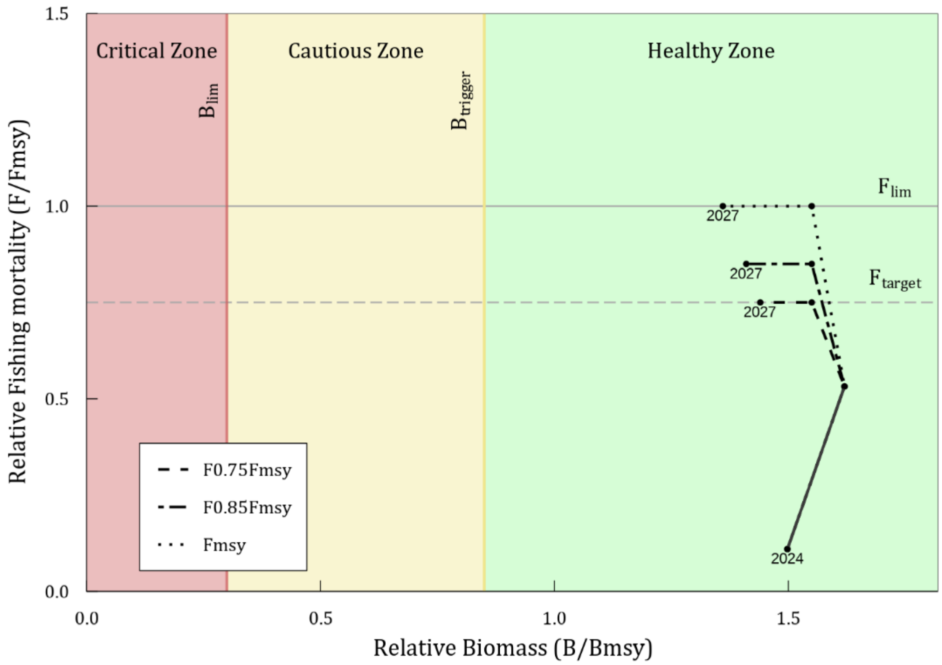


Figure 32. Yellowtail flounder in Div. 3LNO: stochastic projections in the NAFO Precautionary Approach Framework from 2026-2028 at three levels of F (75% Fmsy, 85% Fmsy and Fmsy) assuming Catch2025 = 15 810 t.

APPENDIX 1

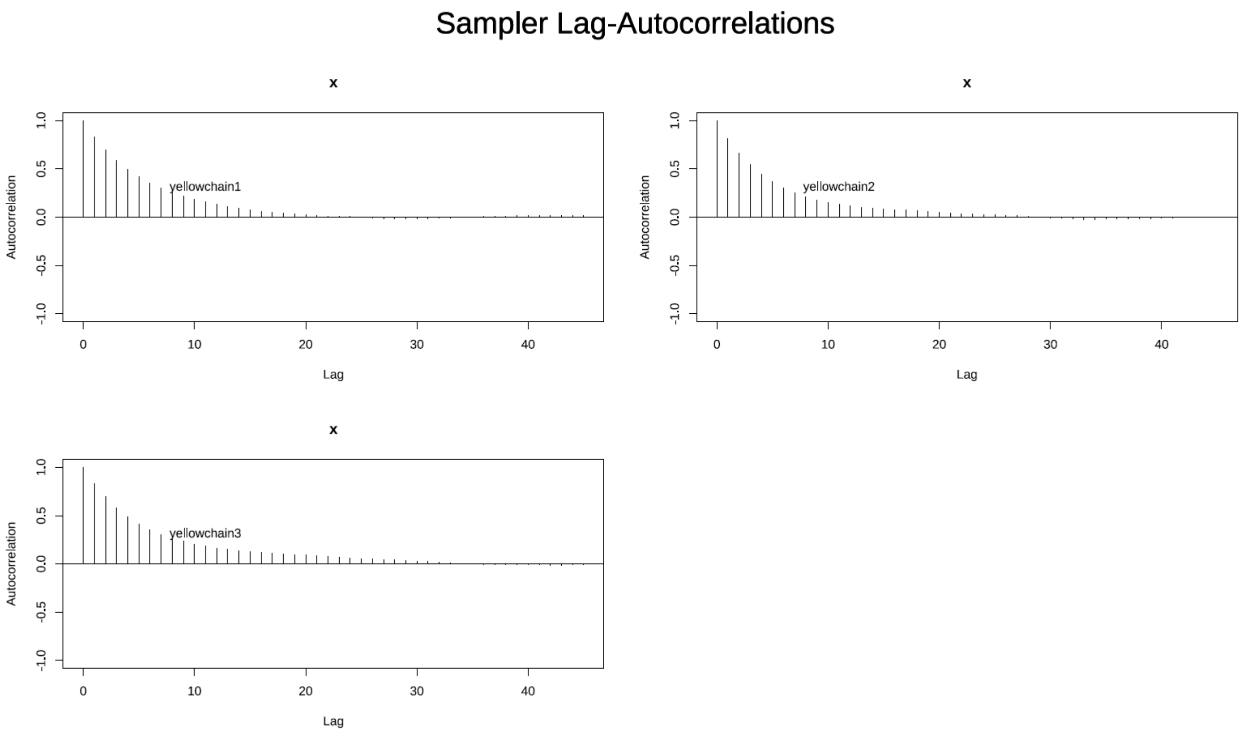
Script for 2025 yellowtail surplus production model in Bayesian framework (original coding J. Bailey)

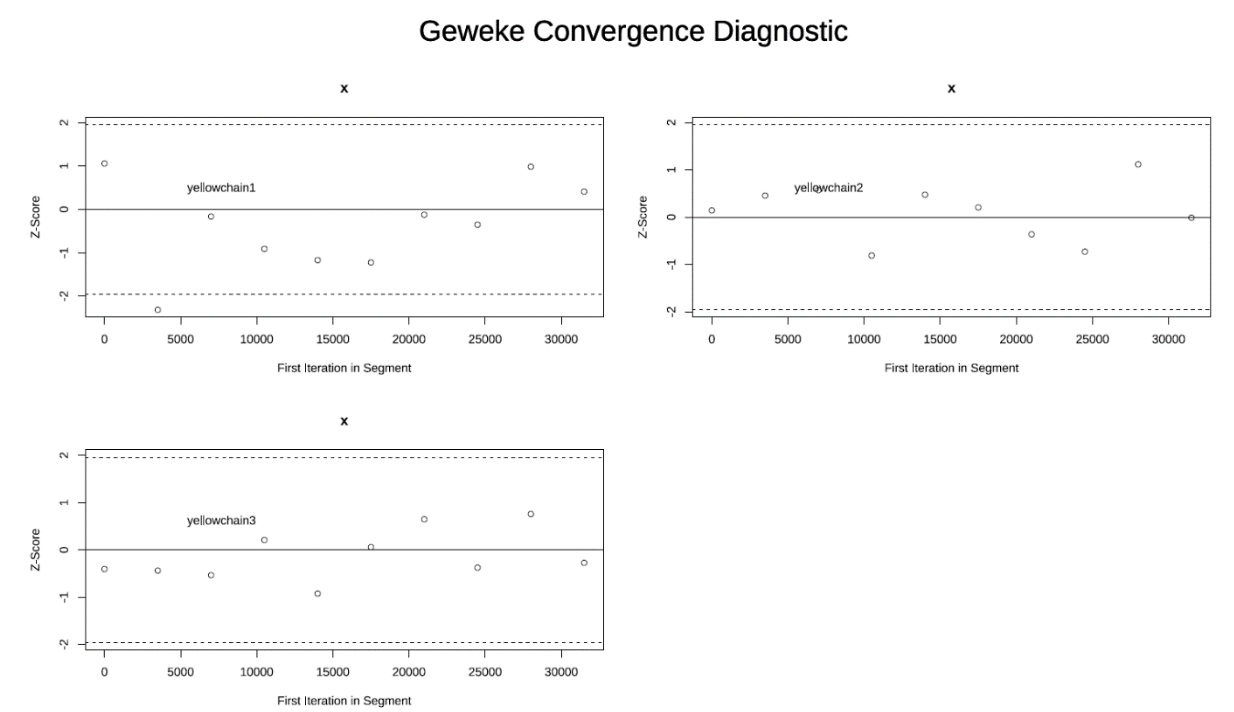
```
Model
{
#prior for r mean 0.3 std 0.1
r ~ dunif(0.01,1)
# prior distribution of K
#mean 150,sd 25 run1 cv was 42% in normal scale
#this run mean of 150 and sd of 1500 CV 1000%
K~dlnorm(2.703,0.2167)
# prior distribution of q's
q.Spring~dgamma(1,1)
q.Fall~dgamma(1,1)
q.Russian~dgamma(1,1)
q.Spanish~dgamma(1,1)
q.Yankee~dgamma(1,1)

# Prior for process noise, sigma
sigma ~ dunif(0,5)
isigma2 <- pow(sigma, -2)

# Prior for observation errors, tau.
tau.Spring~dgamma(1,1)
itau2.Spring <- 1/tau.Spring
tau.Fall~dgamma(1,1)
itau2.Fall <- 1/tau.Fall
tau.Russian~dgamma(1,1)
itau2.Russian<- 1/tau.Russian
tau.Spanish~dgamma(1,1)
itau2.Spanish <- 1/tau.Spanish
tau.Yankee~dgamma(1,1)
itau2.Yankee <- 1/tau.Yankee

# Prior for initial population size as proportion of K, P[1].
Pin~dunif(0.5, 1)
Pm[1] <- log(Pin)
P[1] ~ dlnorm(Pm[1], isigma2)I(0.001,5)
P.res[1]<-log(P[1])-Pm[1]

# State equation - SP Model.
for (t in 2:(56))  {
Pm[t] <- log(max(P[t-1] + r*P[t-1]*(1-P[t-1]) - L[t-1]/K, 0.0001))
P[t] ~ dlnorm(Pm[t], isigma2)I(0.001,5)
P.res[t]<-log(P[t])-Pm[t]
}
# Observation equations
for (t in 20:(N)) {
Springm[t] <- log(q.Spring* K * P[t])
Spring[t] ~ dlnorm(Springm[t], itau2.Spring)
}
for (t in 26:(N)) {
Fallm[t] <- log(q.Fall* K * P[t])
Fall[t] ~ dlnorm(Fallm[t], itau2.Fall)
}
for (t in 31:(N)) {
Spanishm[t] <- log(q.Spanish* K * P[t])
Spanish[t] ~ dlnorm(Spanishm[t], itau2.Spanish)
}
for (t in 7:(18)) {
Yankeem[t] <- log(q.Yankee* K * P[t])
Yankee[t] ~ dlnorm(Yankeem[t], itau2.Yankee)
}
for (t in 20:(27)) {
Russianm[t] <- log(q.Russian* K * P[t])
Russian[t] ~ dlnorm(Russianm[t], itau2.Russian)
}
# Output. Using the proportion and K to estimate biomass, B.
for(t in 1:N) {
B[t] <- P[t] * K
F[t]<-L[t]/B[t]
}
#Biomass Ratio: Showing what percent the stock would be at if fished at
MSY for a given year, t
for(t in 1:N) {
Bratio[t] <- B[t]/BMSY
}
#F Ratio: indicates the ratio of fishing mortality to that estimated for
FMSY.
#e.g. 1.65=65% higher than that estimated for FMSY
for(t in 1:N) {
Fratio[t] <- F[t]/FMSY
}
# further management parameters and predictions:
MSY <- r*K/4;
FMSY<-r/2
BMSY<-K/2
BLIM<-0.75*FMSY
#Replicate data sets code below here
#generate replicate data sets
for (i in 7:18){
        Yankee.rep[i] ~ dlnorm(Yankeem[i],itau2.Yankee)
        p.smaller.Yankee[i] <- step(log(Yankee[i])-log(Yankee.rep[i]))
#residuals of log values of replicate data
        res.Yankee.rep[i] <- log(Yankee[i])-log(Yankee.rep[i])
}
#generate replicate data sets
for (i in 20:N){
        Spring.rep[i] ~ dlnorm(Springm[i],itau2.Spring)
        p.smaller.Spring[i] <- step(log(Spring[i])-log(Spring.rep[i]))
#residuals of log values of replicate data
        res.Spring.rep[i] <- log(Spring[i])-log(Spring.rep[i])
}
#generate replicate data sets
for (i in 26:N){
        Fall.rep[i] ~ dlnorm(Fallm[i],itau2.Fall)
        p.smaller.Fall[i] <- step(log(Fall[i])-log(Fall.rep[i]))
#residuals of log values of replicate data
        res.Fall.rep[i] <- log(Fall[i])-log(Fall.rep[i])
}
#generate replicate data sets
for (i in 31:N){
        Spanish.rep[i] ~ dlnorm(Spanishm[i],itau2.Spanish)
        p.smaller.Spanish[i] <- step(log(Spanish[i])-
log(Spanish.rep[i]))
#residuals of log values of replicate data
        res.Spanish.rep[i] <- log(Spanish[i])-log(Spanish.rep[i])
                                }
#generate replicate data sets
for (i in 20:27){
        Russian.rep[i] ~ dlnorm(Russianm[i],itau2.Russian)
        p.smaller.Russian[i] <- step(log(Russian[i])-
log(Russian.rep[i]))
#residuals of log values of replicate data
        res.Russian.rep[i] <- log(Russian[i])-log(Russian.rep[i])
                                }
} ## END
```

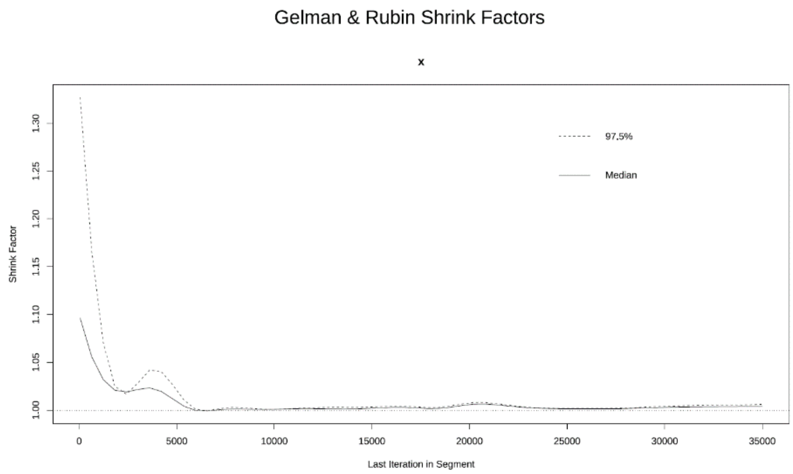
APPENDIX 2

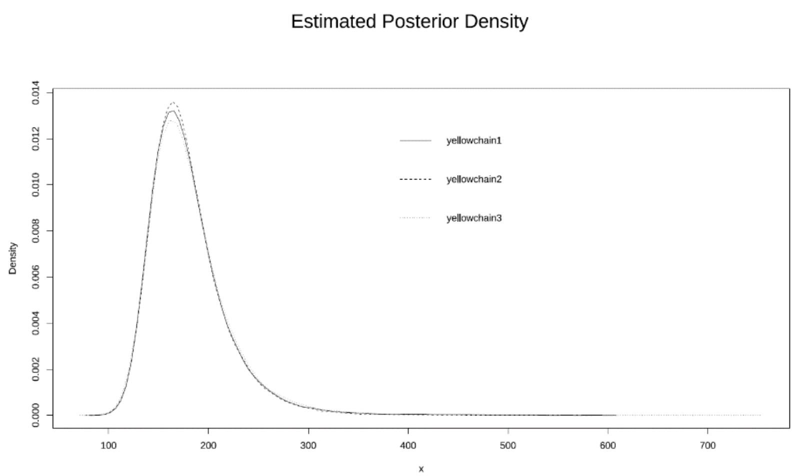
Diagnostics and fit criteria by factor for the 2025 assessment model

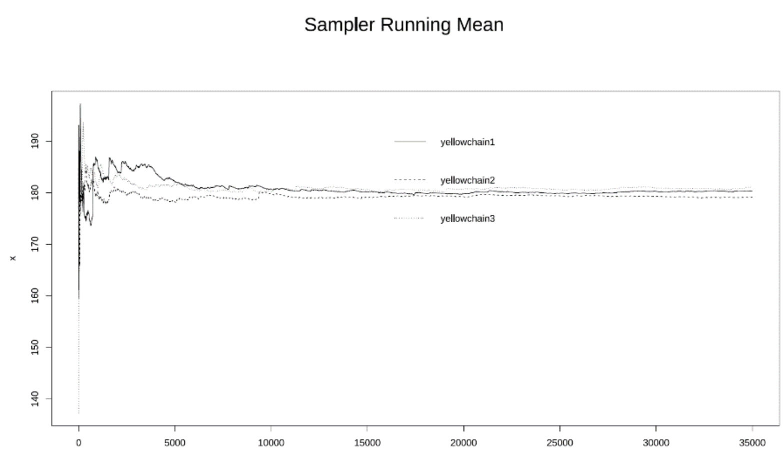
k: carrying capacity



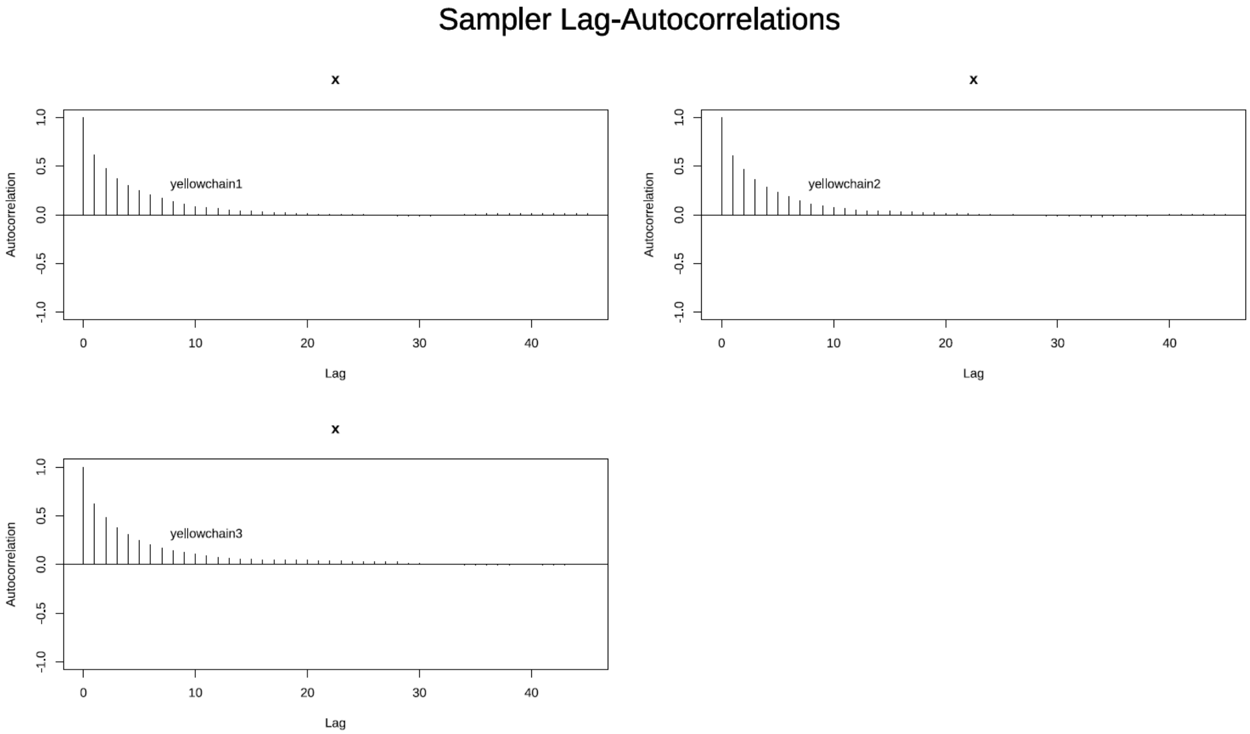


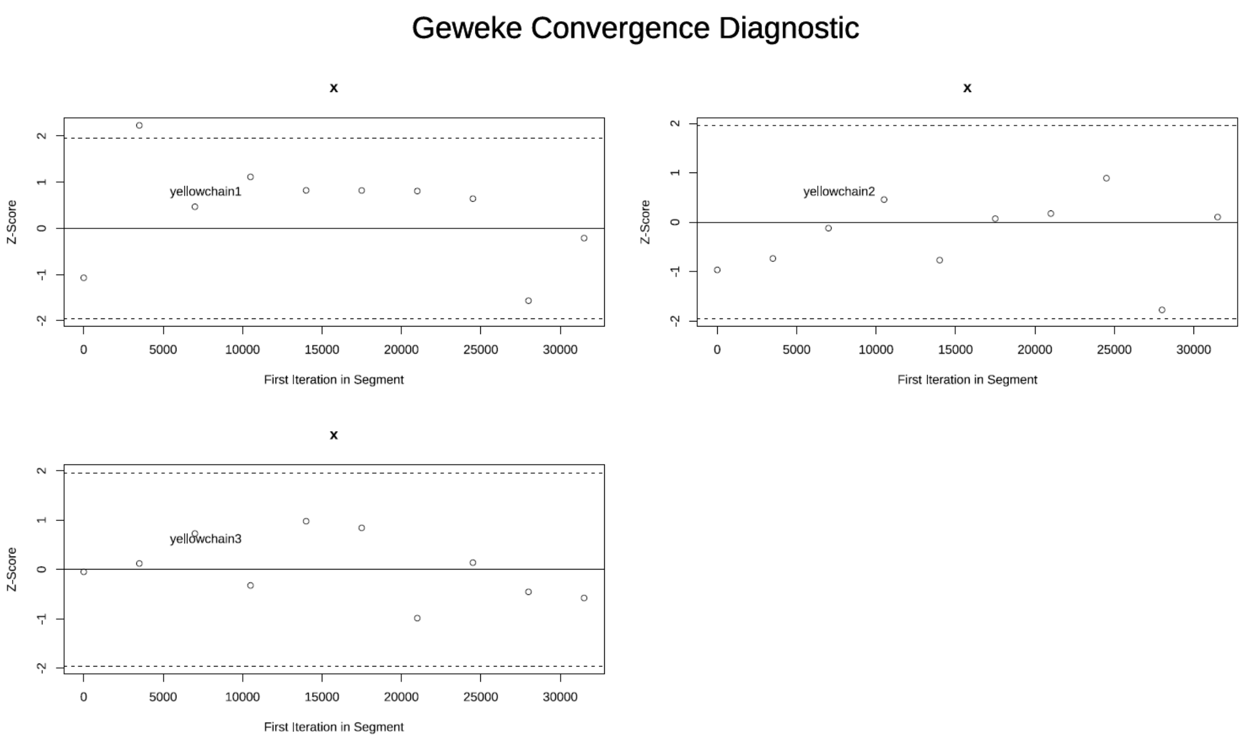

Gelman & Rubin Shrink Factors
x
97.5%
Median
Shrink Factor
Last Iteration in Segment


Estimated Posterior Density
yellowchain1
yellowchain2
yellowchain3
Density
x

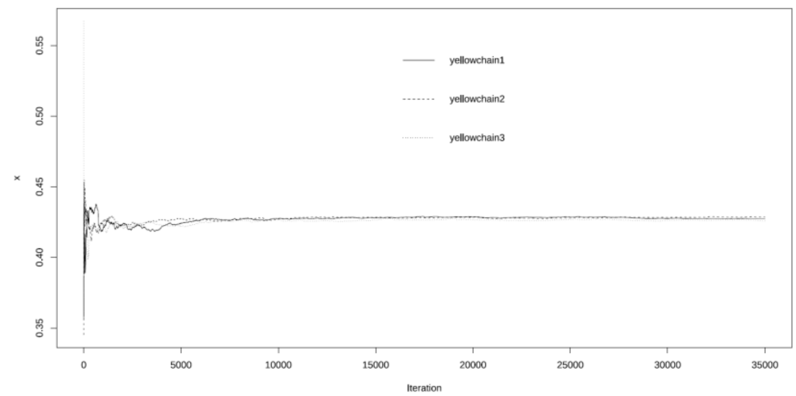

Sampler Running Mean
yellowchain1
yellowchain2
yellowchain3
x
Iteration

r: intrinsic rate of growth

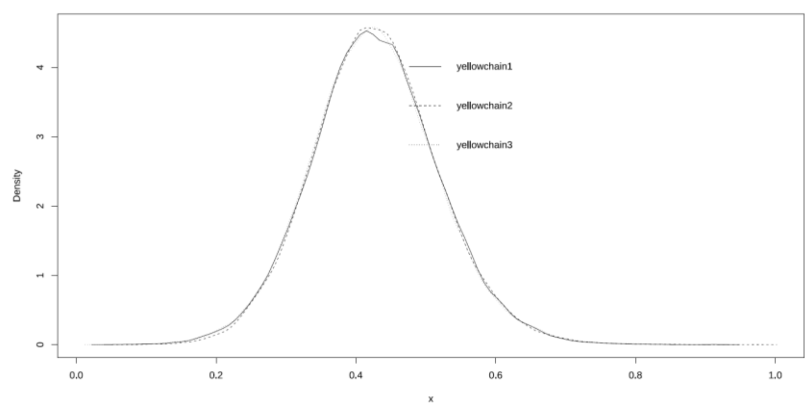




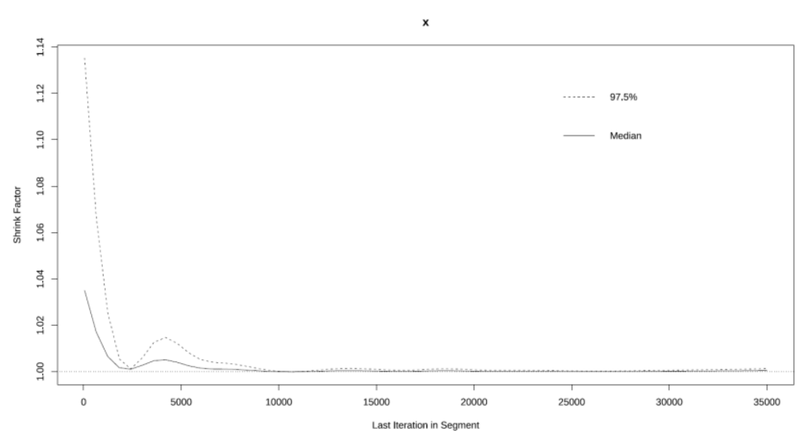
Sampler Running Mean



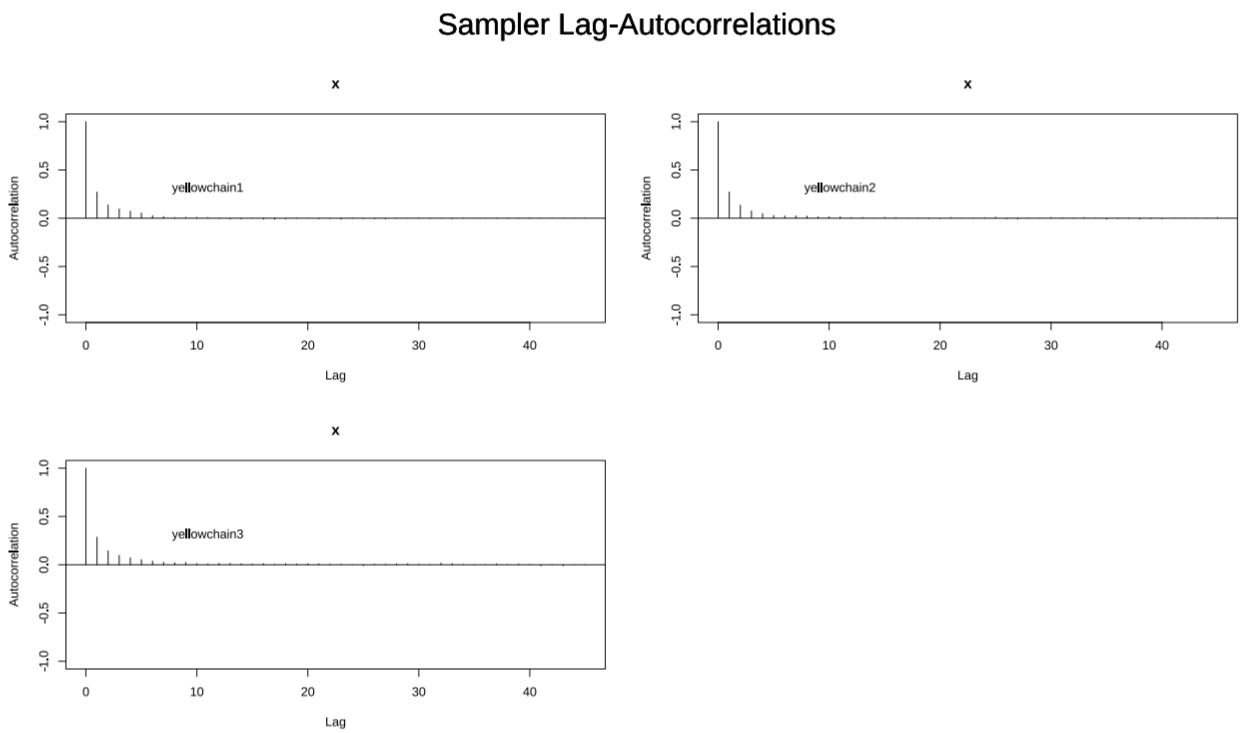
Estimated Posterior Density

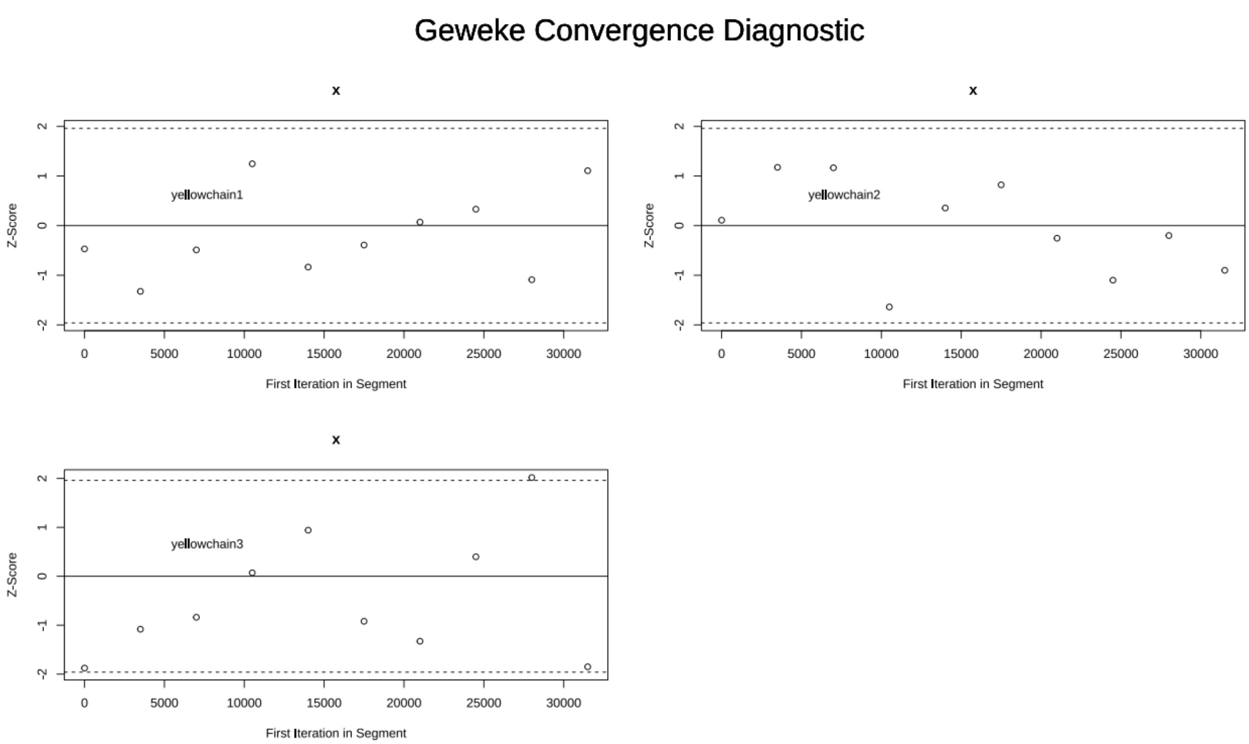


Gelman & Rubin Shrink Factors

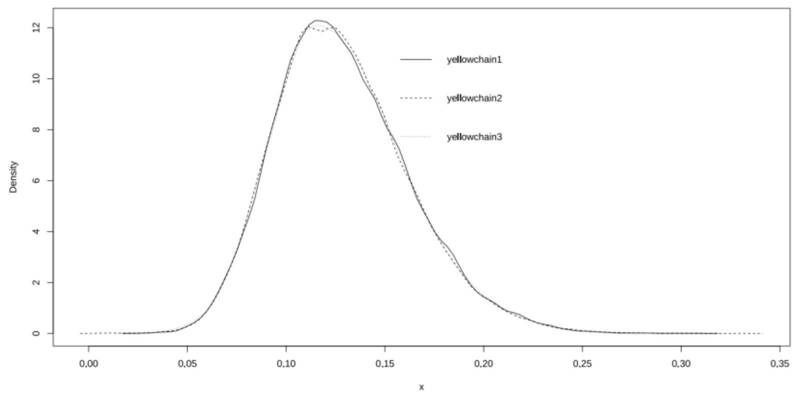


sigma: process error

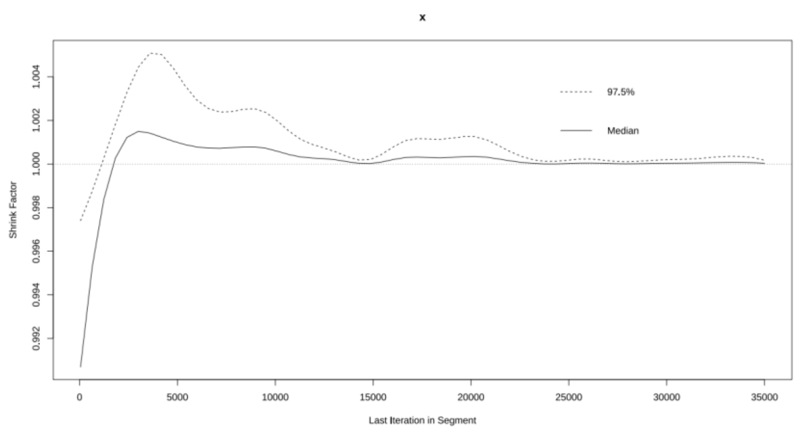




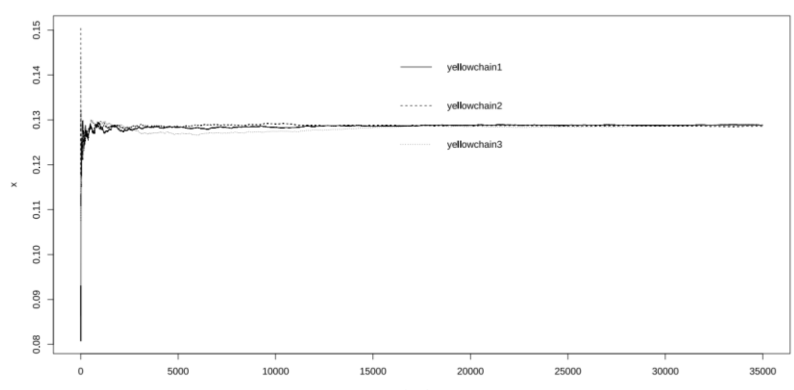
Estimated Posterior Density



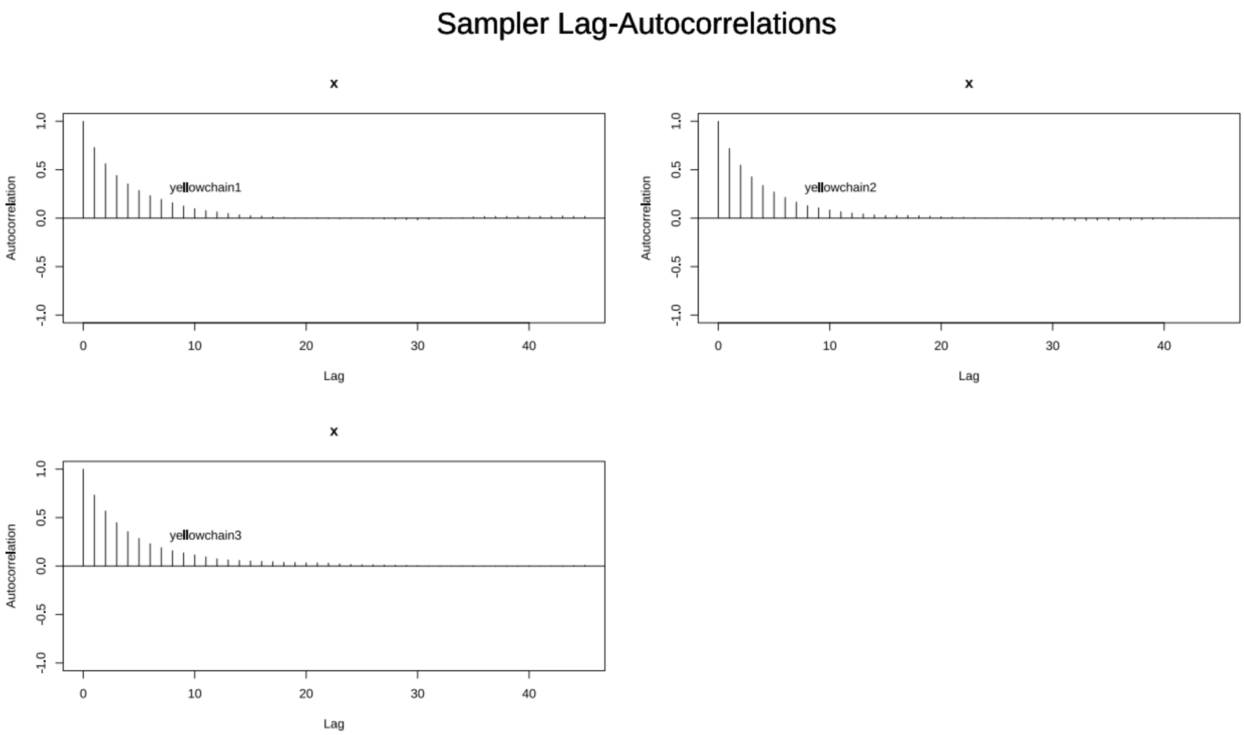
Gelman & Rubin Shrink Factors

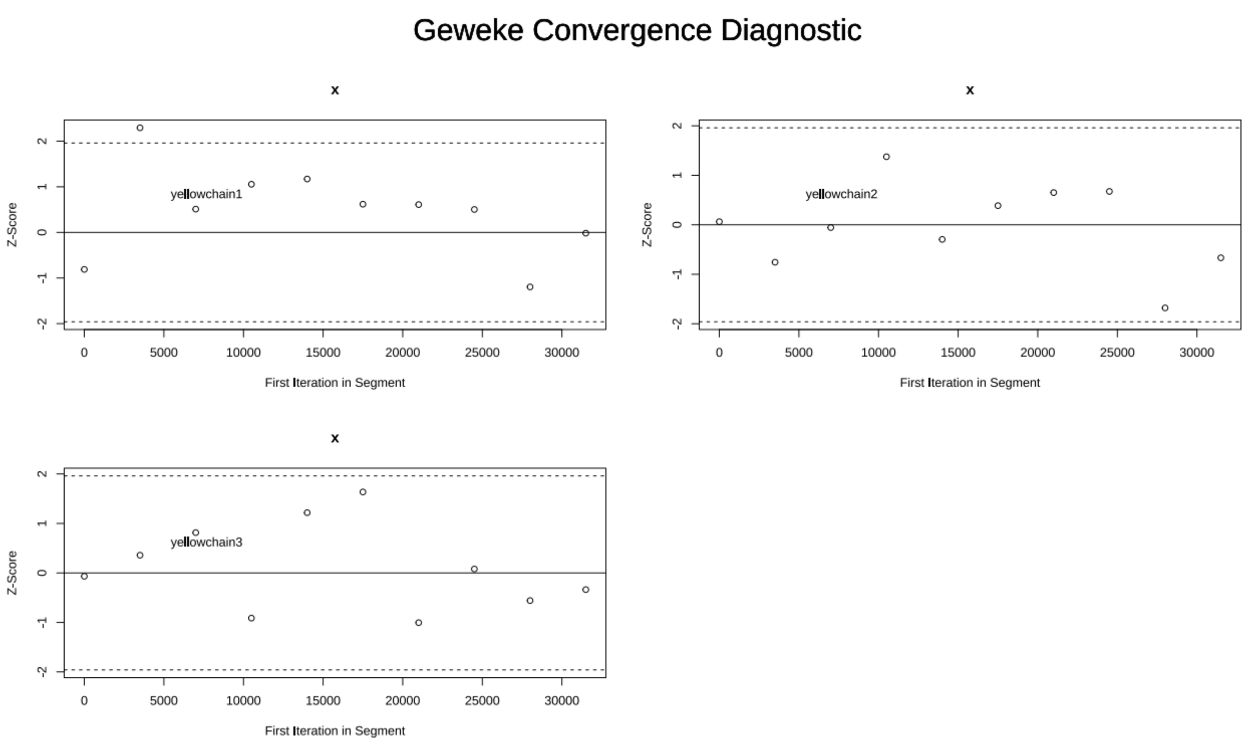


Sampler Running Mean

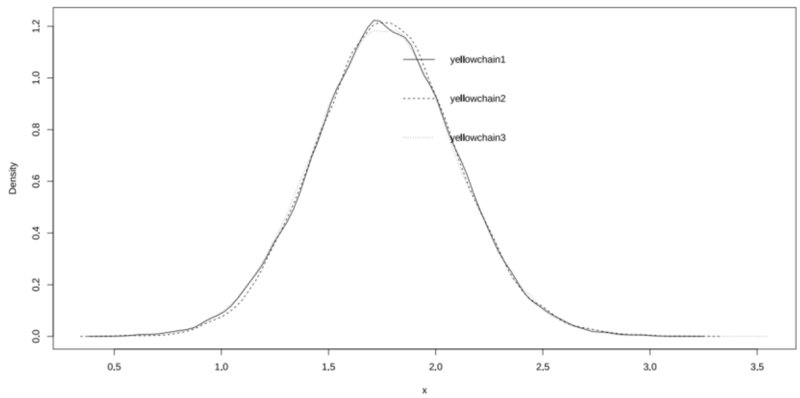


q: Canadian spring

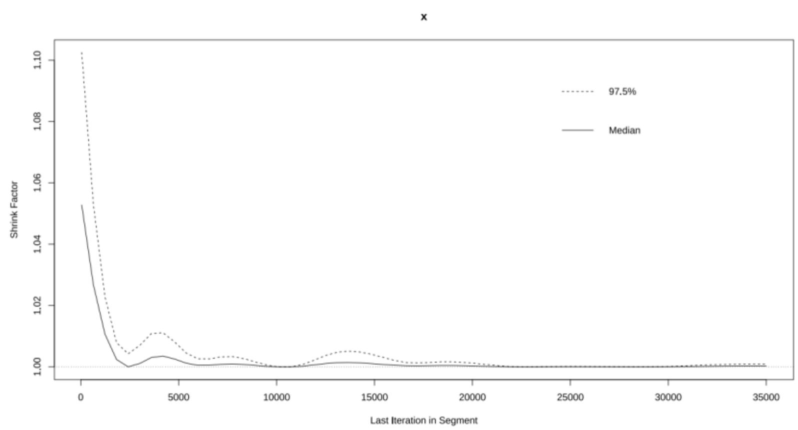




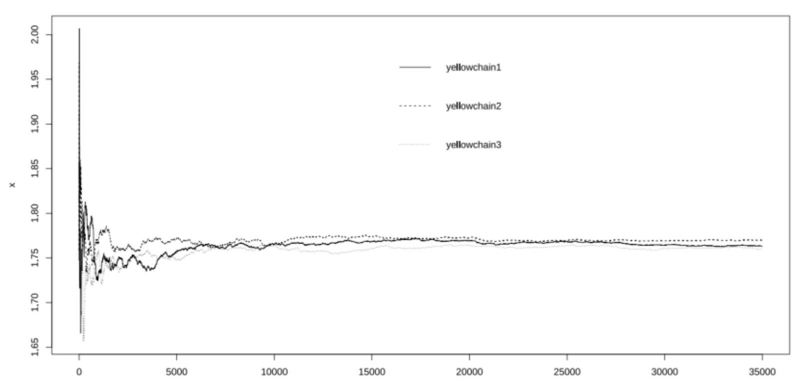
Estimated Posterior Density



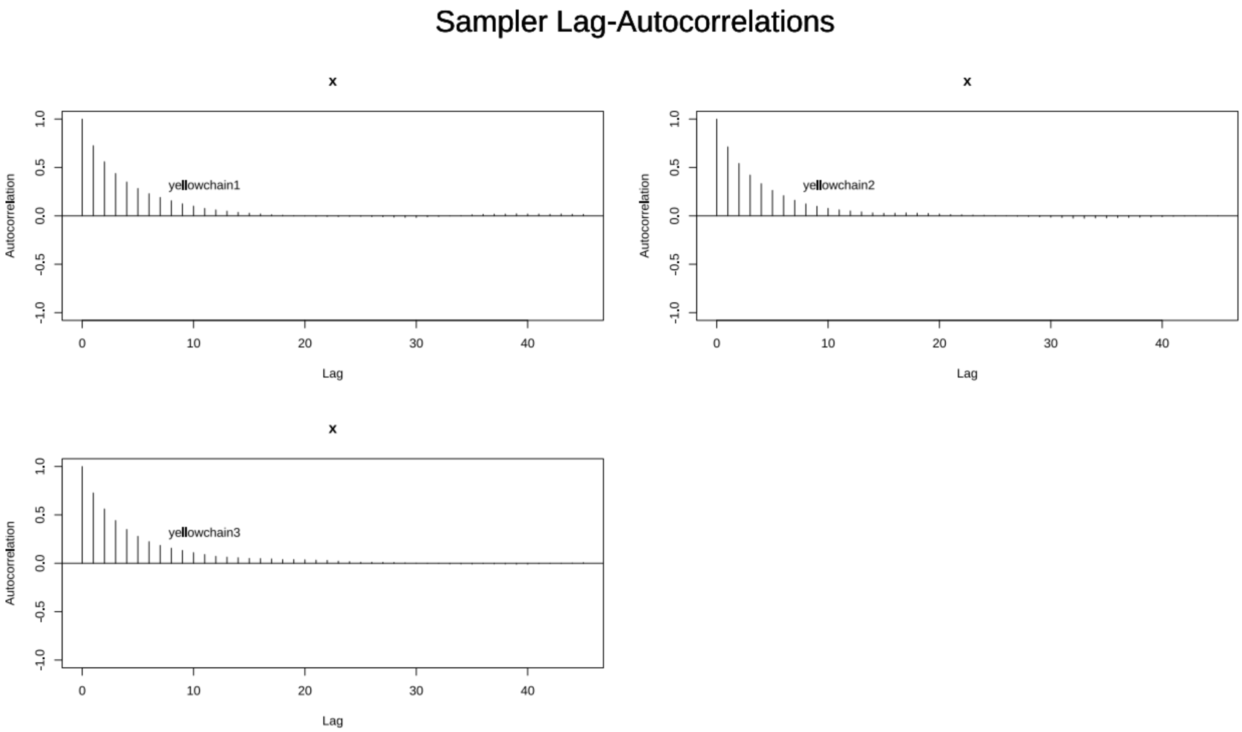
Gelman & Rubin Shrink Factors

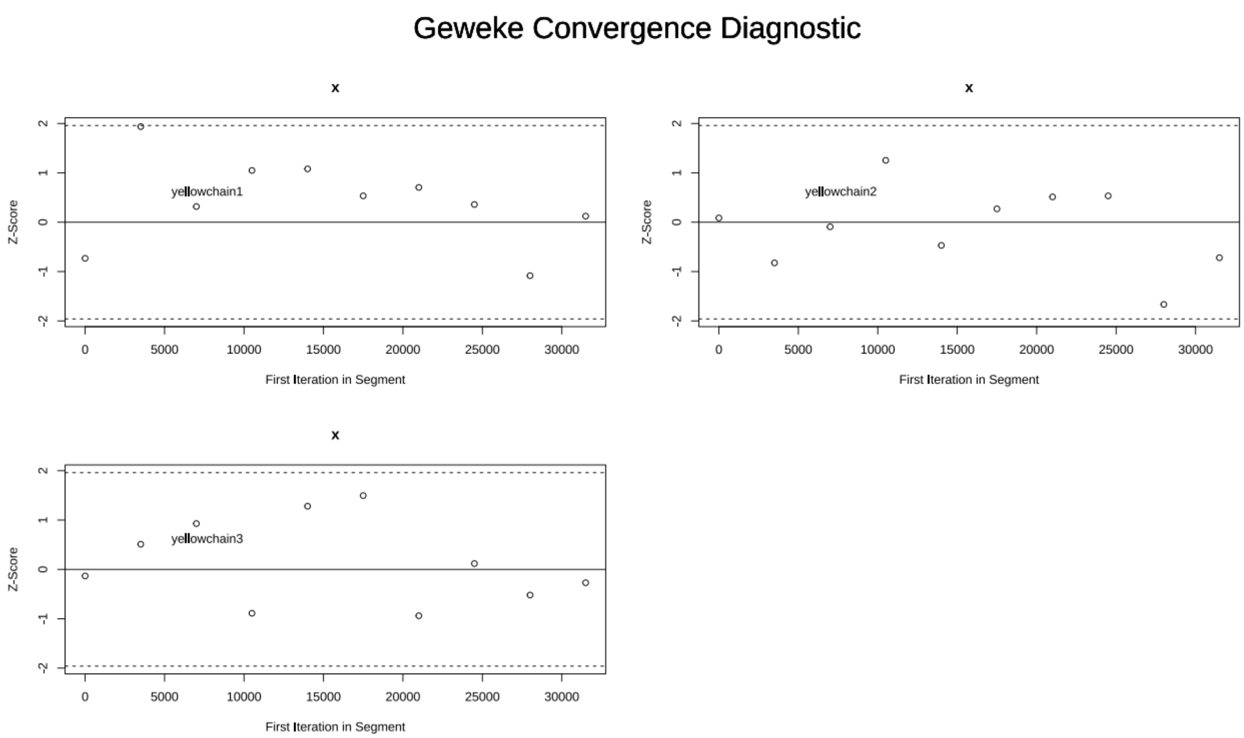


Sampler Running Mean

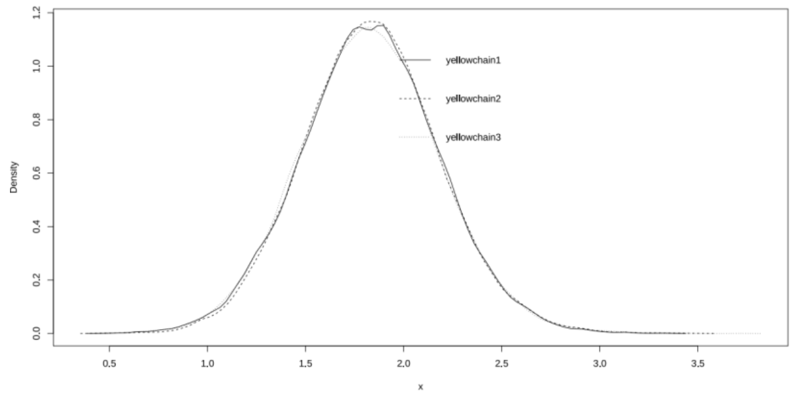


q: Canadian fall

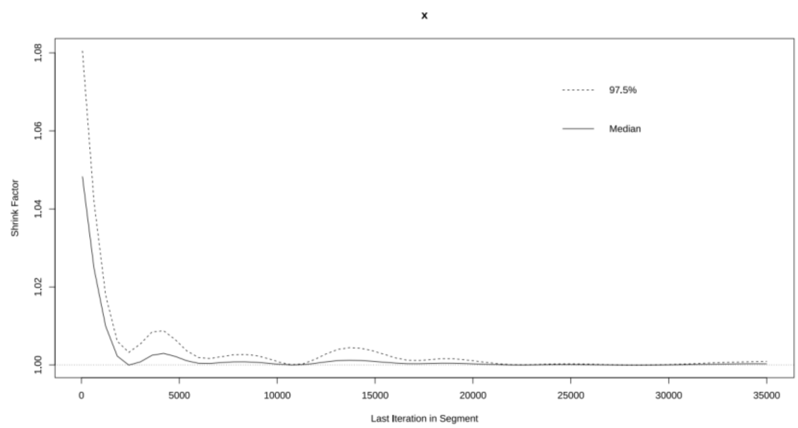




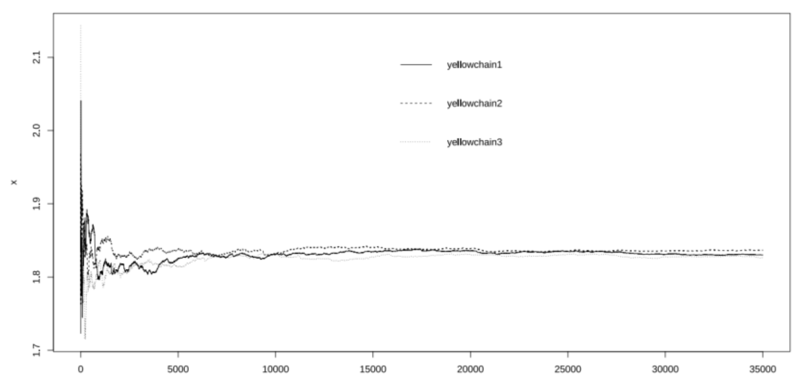
Estimated Posterior Density



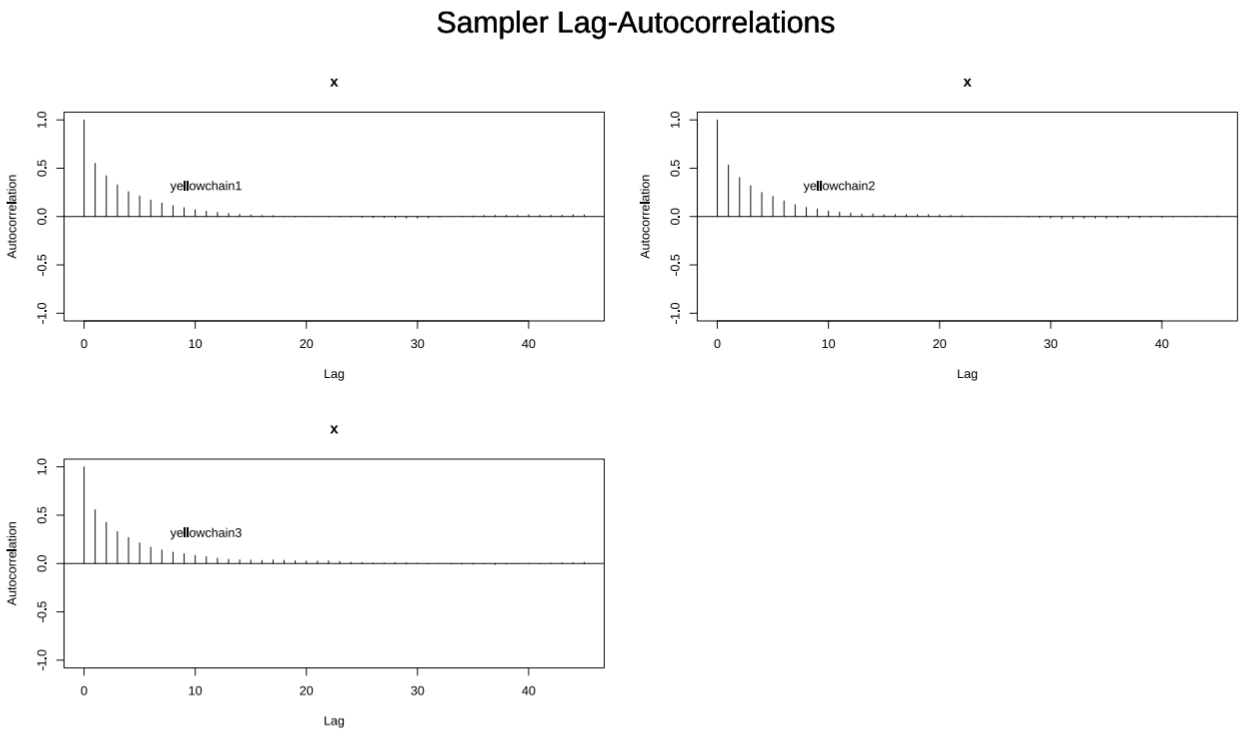
Gelman & Rubin Shrink Factors

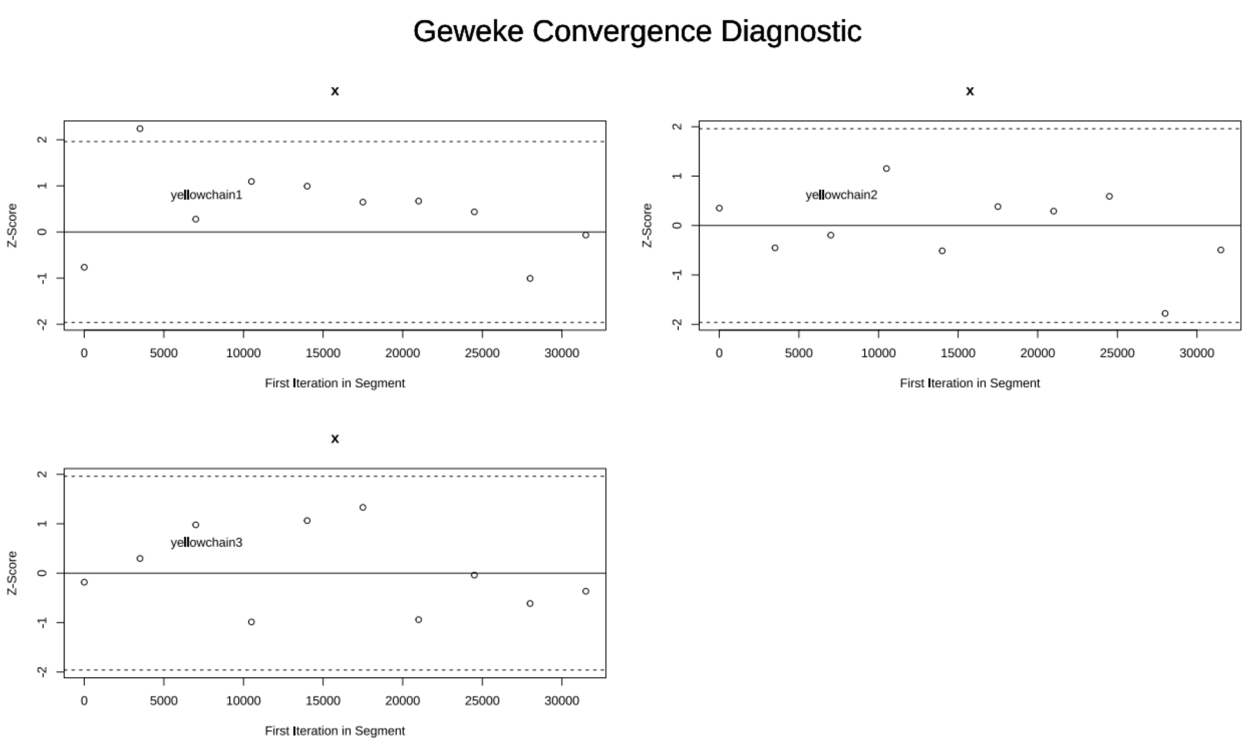


Sampler Running Mean

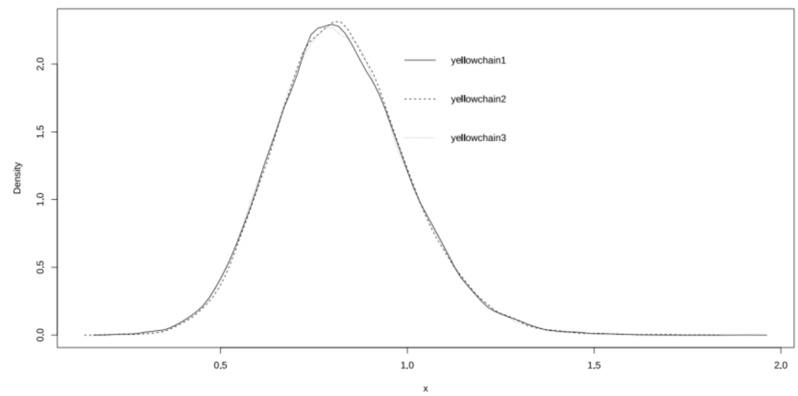


q: EU-Spain

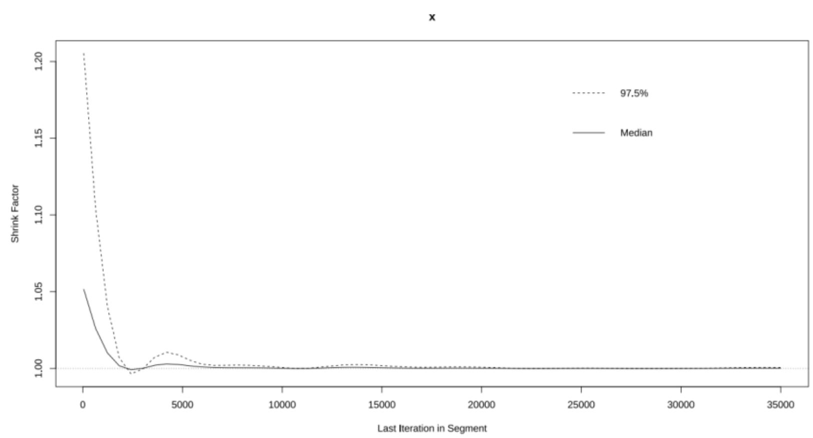

Sampler Lag-Autocorrelations
x
yellowchain1
yellowchain2
yellowchain3
Autocorrelation
Lag


Geweke Convergence Diagnostic
x
yellowchain1
yellowchain2
yellowchain3
Z-Score
First Iteration in Segment

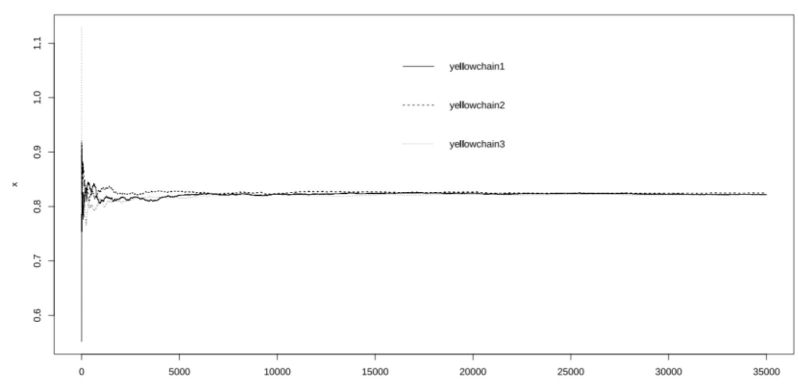
Estimated Posterior Density



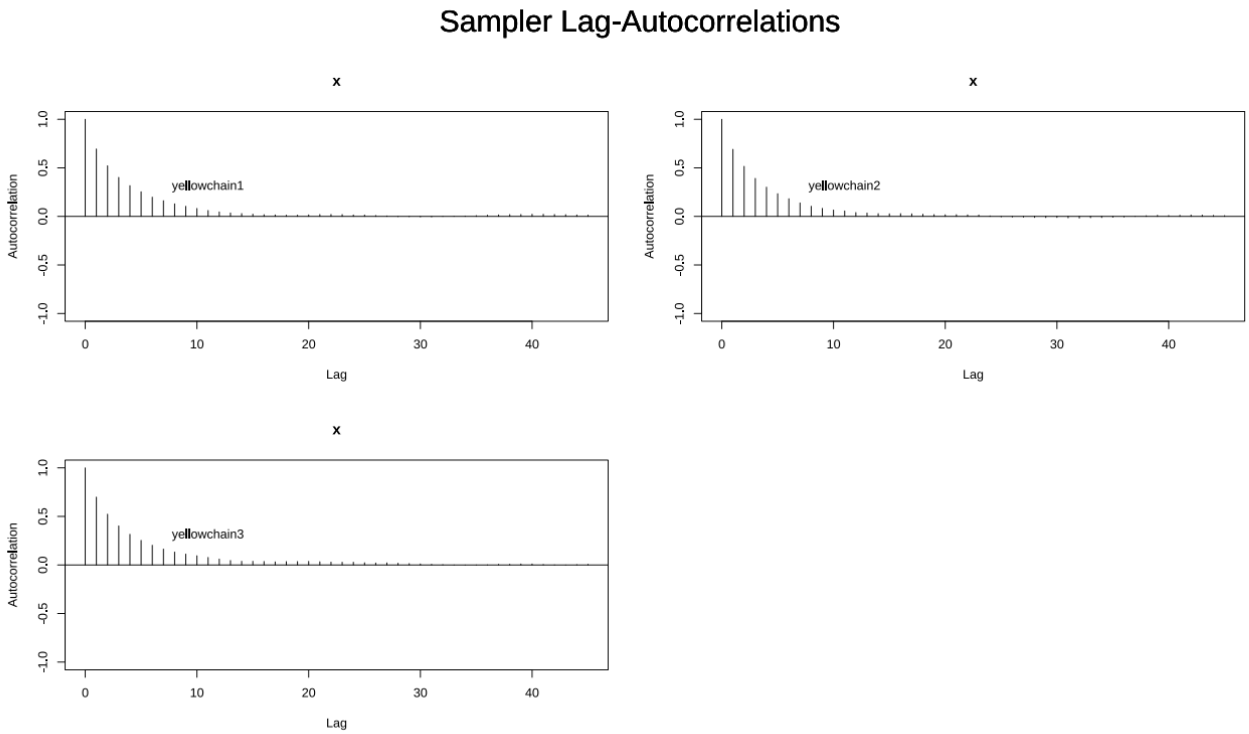
Gelman & Rubin Shrink Factors

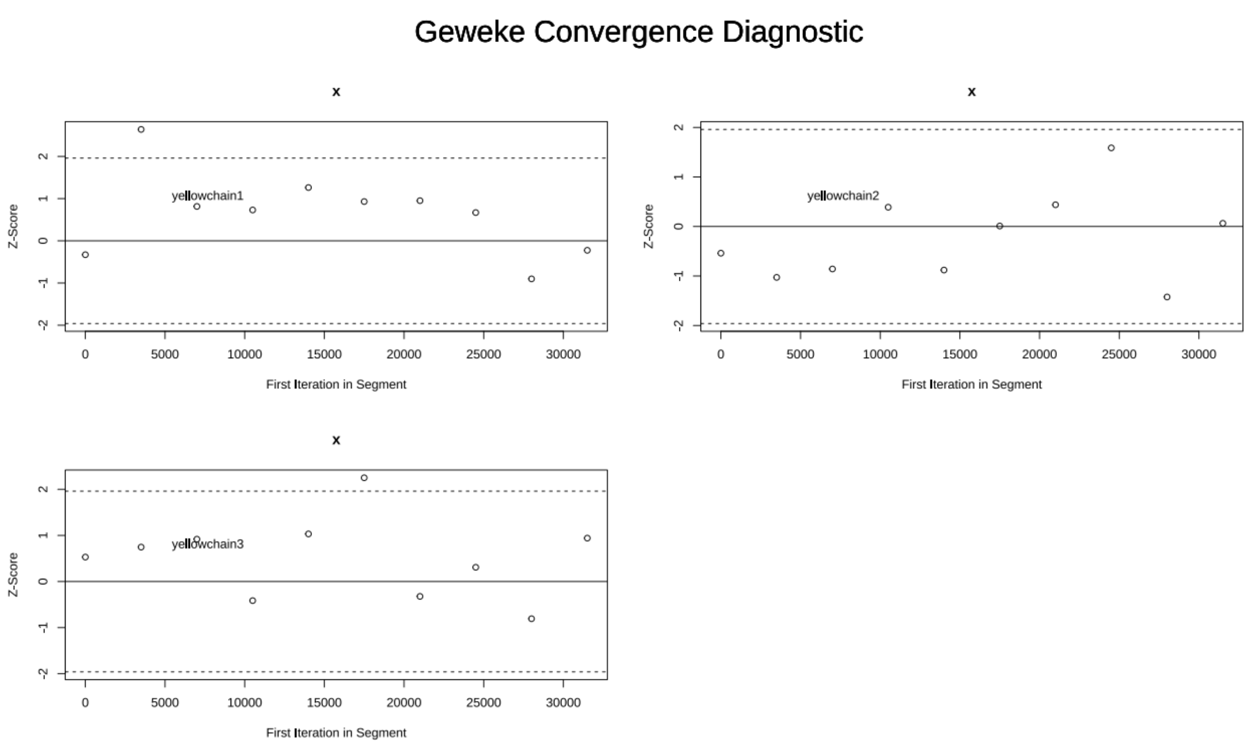


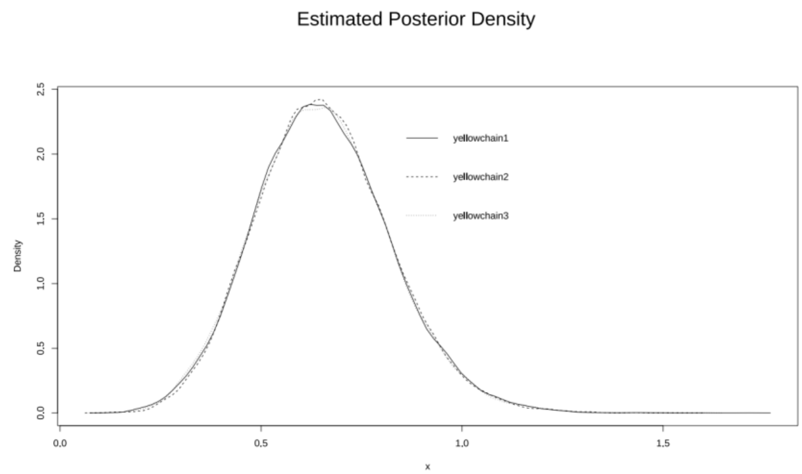
Sampler Running Mean

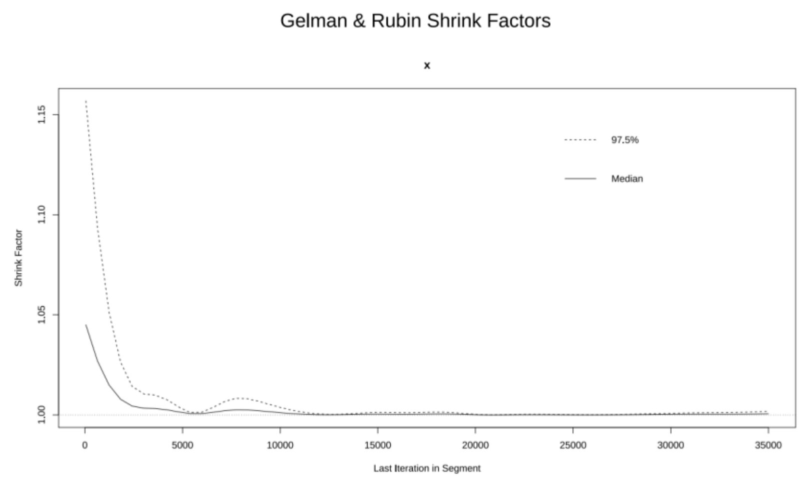


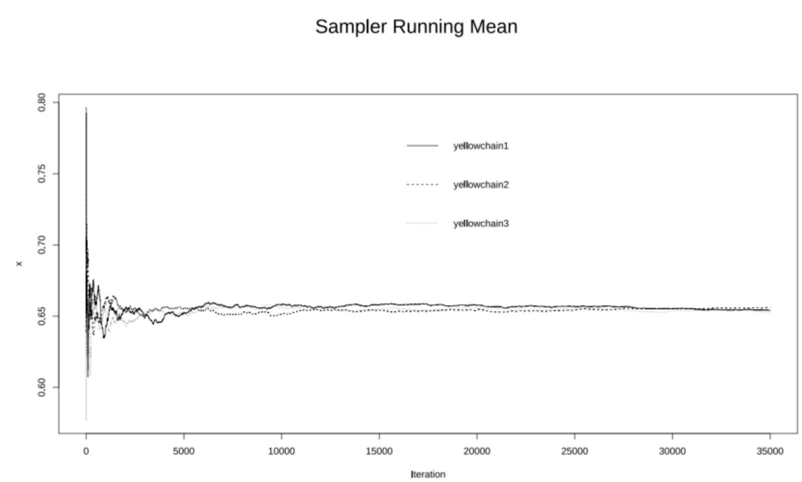
q: Yankee


Sampler Lag-Autocorrelations
x
yellowchain1
yellowchain2
yellowchain3
Autocorrelation
Lag

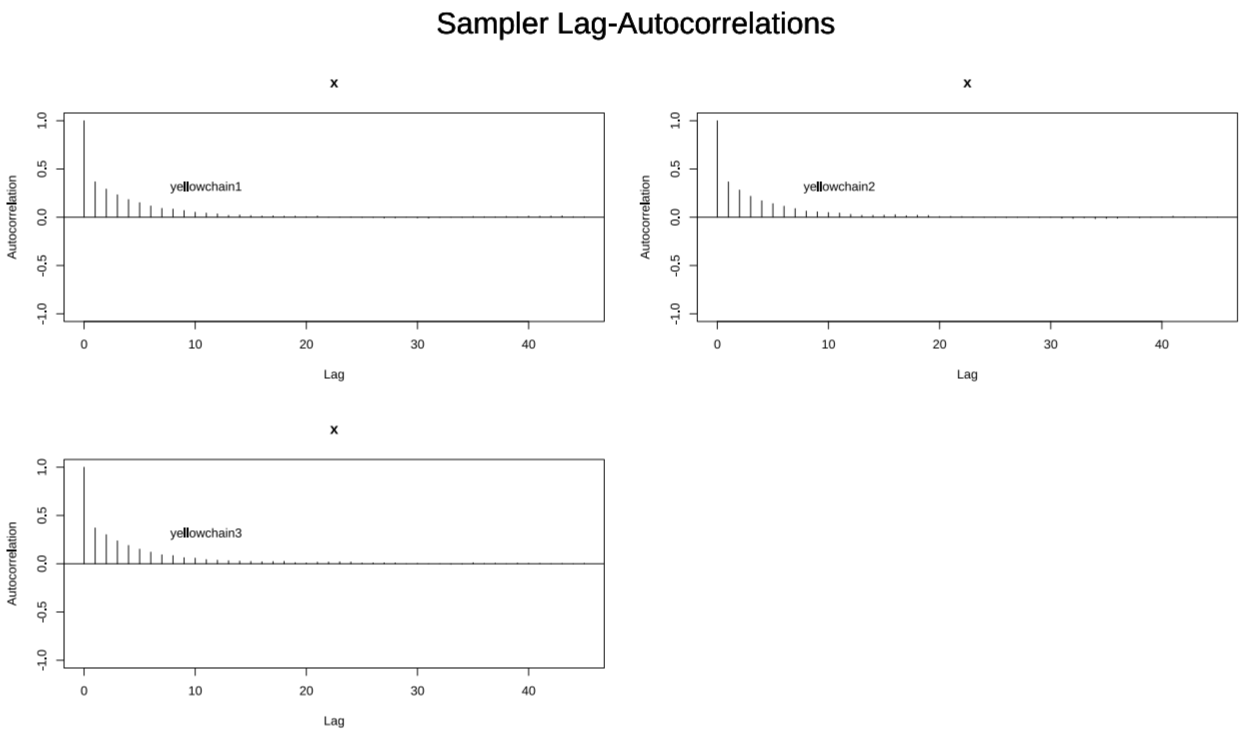

Geweke Convergence Diagnostic
x
yellowchain1
yellowchain2
yellowchain3
Z-Score
First Iteration in Segment

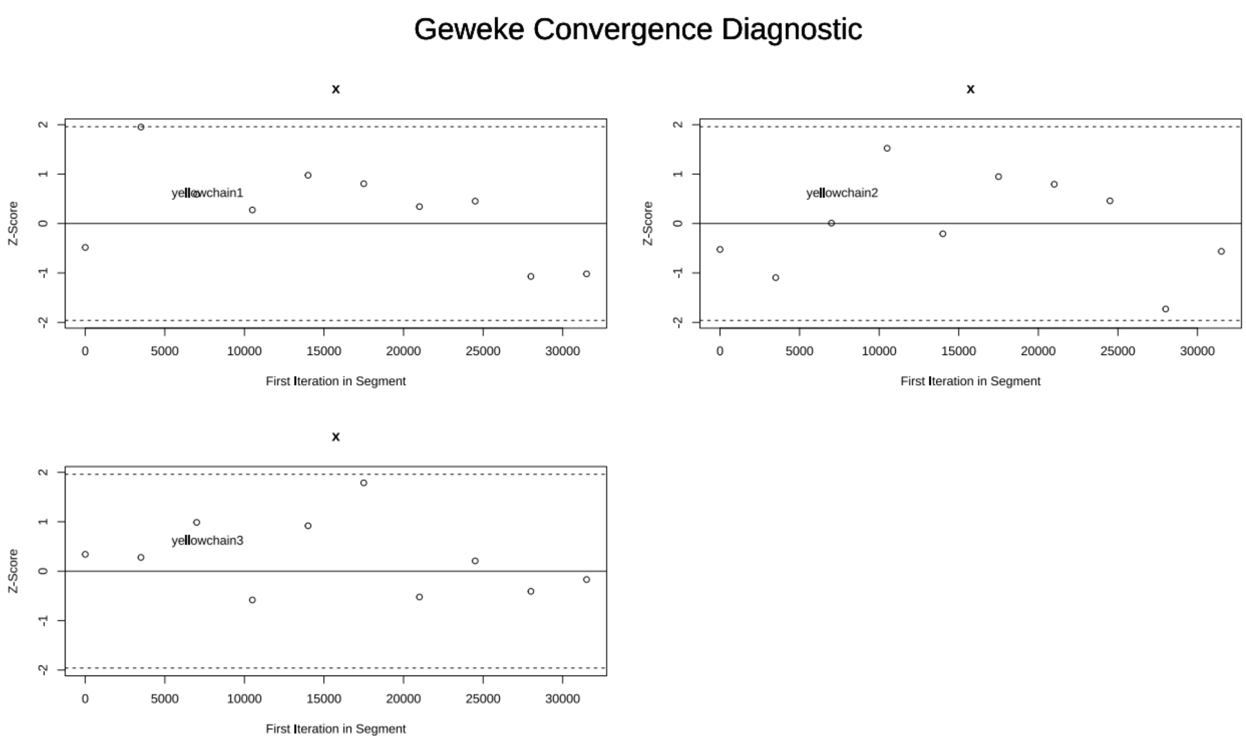

Estimated Posterior Density
Density
x
yellowchain1
yellowchain2
yellowchain3


Gelman & Rubin Shrink Factors
x
Shrink Factor
Last Iteration in Segment
97,5%
Median

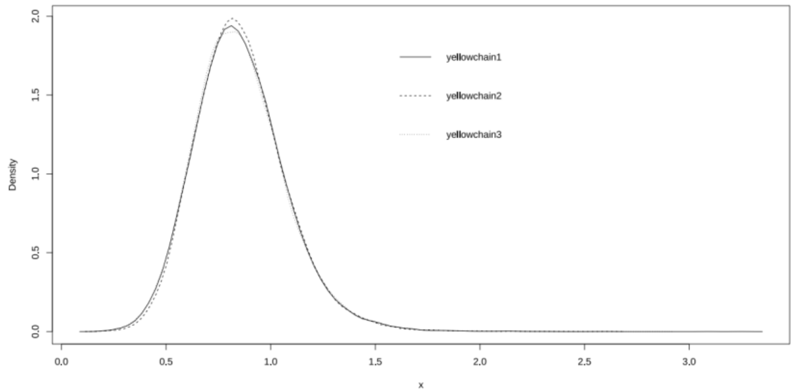

Sampler Running Mean
x
Iteration
yellowchain1
yellowchain2
yellowchain3

q: Russia

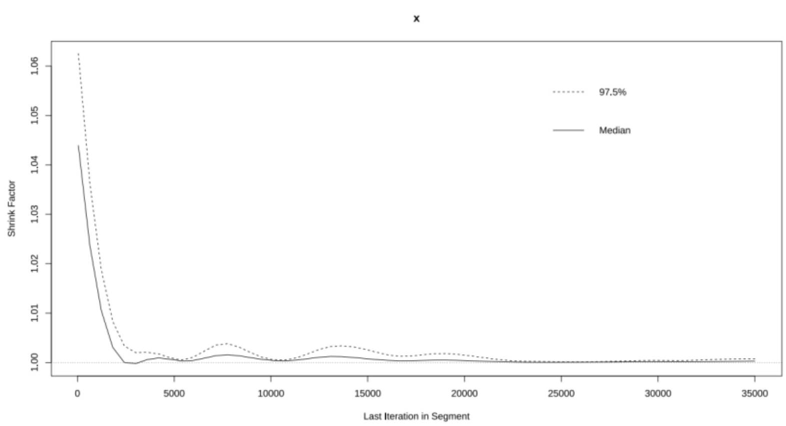

Sampler Lag-Autocorrelations
x
yellowchain1
Autocorrelation
Lag
x
yellowchain2
Autocorrelation
Lag
x
yellowchain3
Autocorrelation
Lag


Geweke Convergence Diagnostic
x
yellowchain1
Z-Score
First Iteration in Segment
x
yellowchain2
Z-Score
First Iteration in Segment
x
yellowchain3
Z-Score
First Iteration in Segment

Estimated Posterior Density



Gelman & Rubin Shrink Factors



Sampler Running Mean