

Chapter 1: Assessment of the Walleye Pollock Stock in the Eastern Bering Sea

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October 21, 2019

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Figures

Pollock catch estimates (t) from the Eastern Bering Sea by season and region. The A-season is defined as from Jan-May and B-season from June-October.

A-season EBS fleet-wide nominal pollock catch (kg) per hour of fishing recorded by NMFS scientific observers.

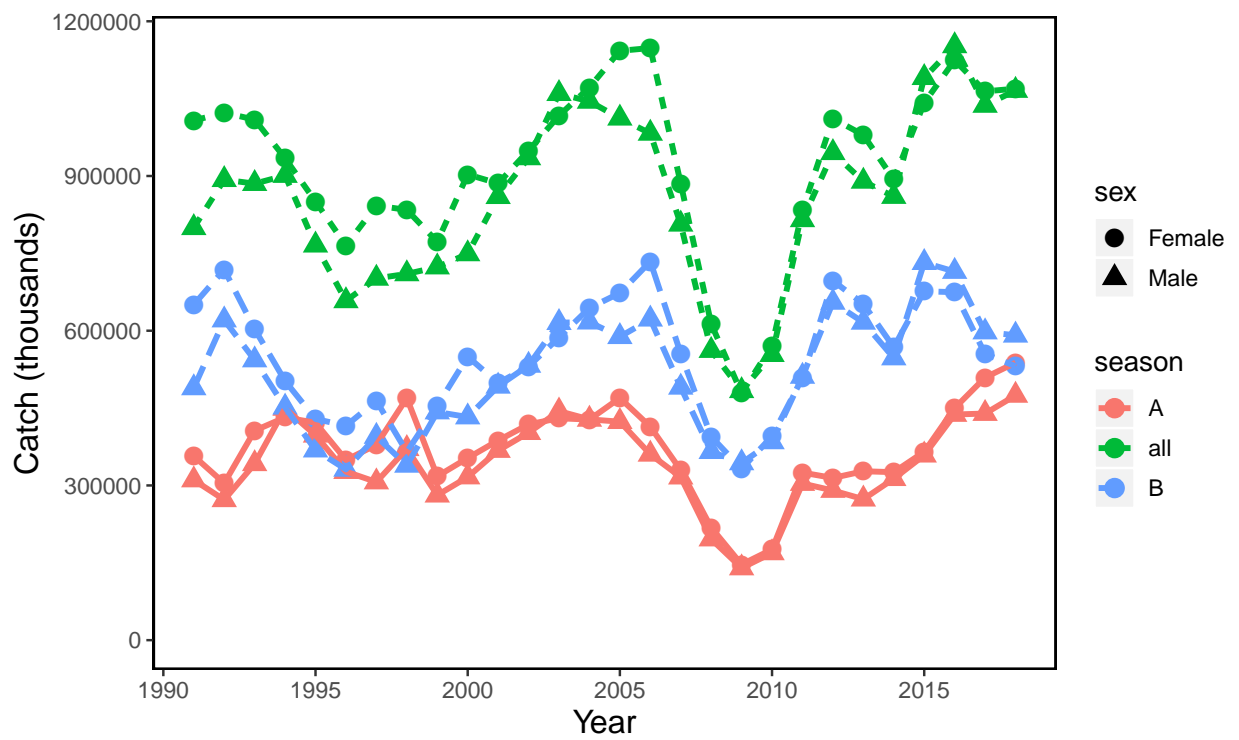


Figure 1: Estimate of EBS pollock catch numbers by sex for the A season (January-May) and B seasons (June-October) and total.

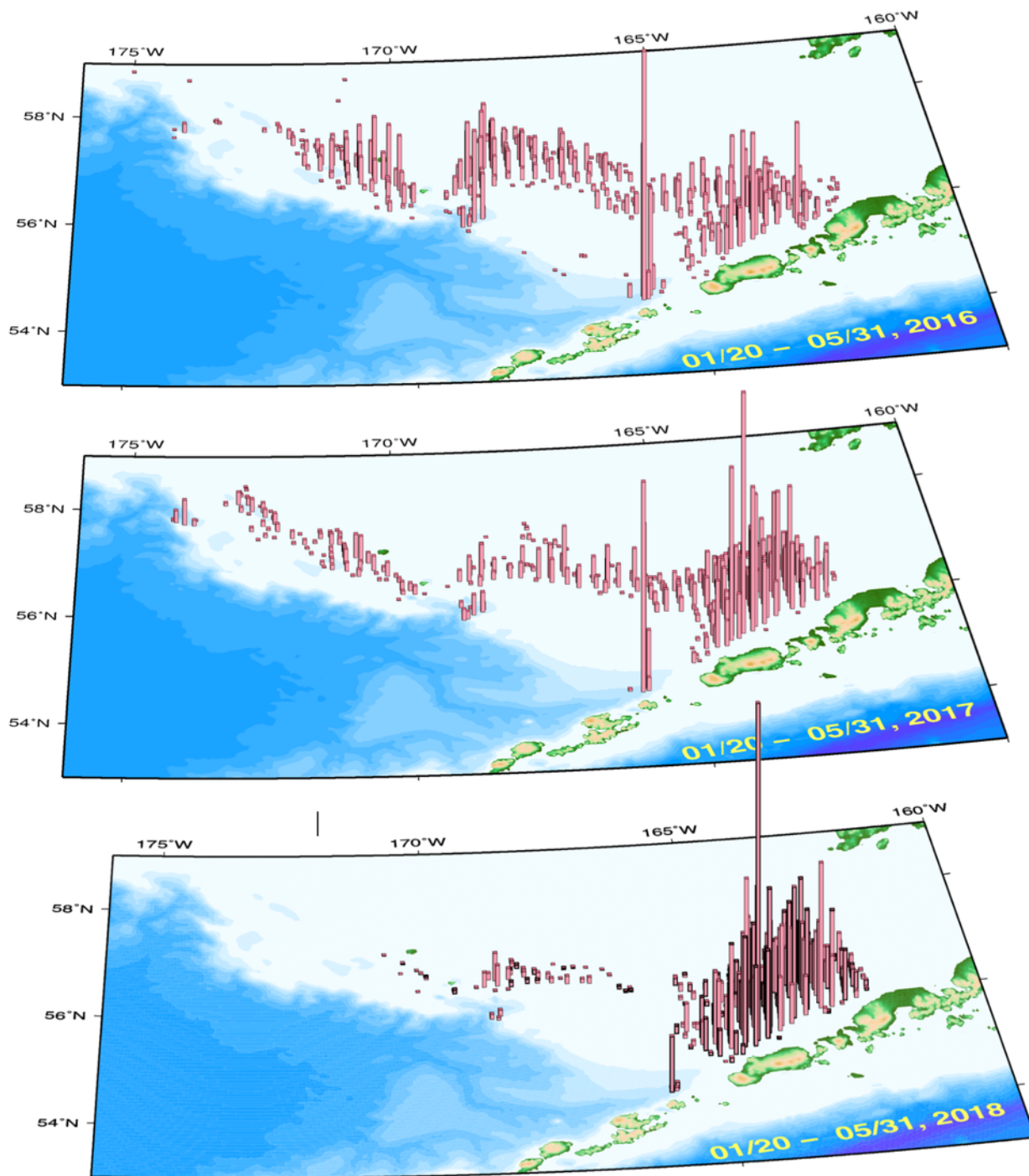


Figure 2: EBS pollock catch distribution during A-season, 2017–2019. Column height is proportional to total catch.

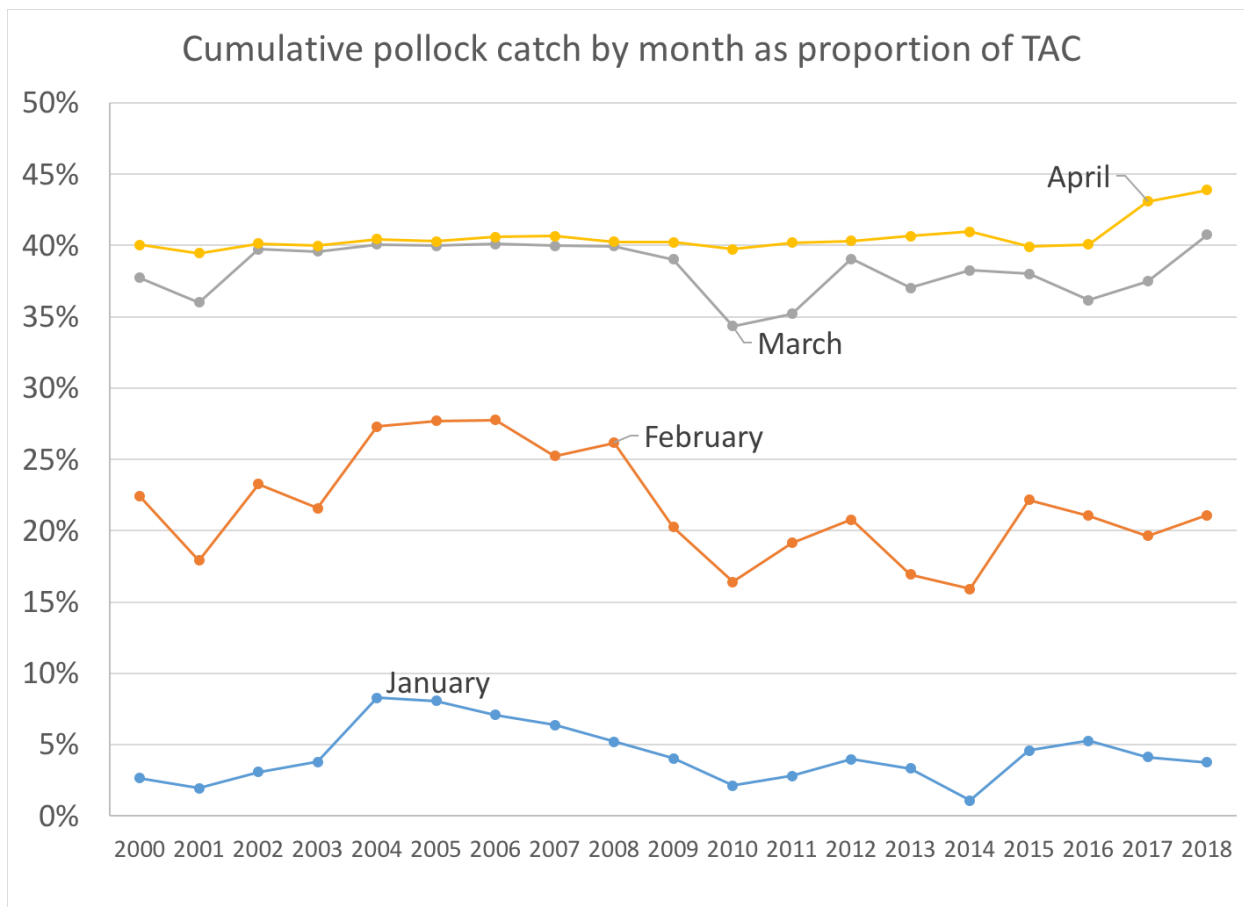


Figure 3: Proportion of the annual EBS pollock TAC by month during the A-season, 2000–2018. The higher value observed since 2017 was due to Amendment 110 of the FMP to allow greater flexibility to avoid Chinook salmon.

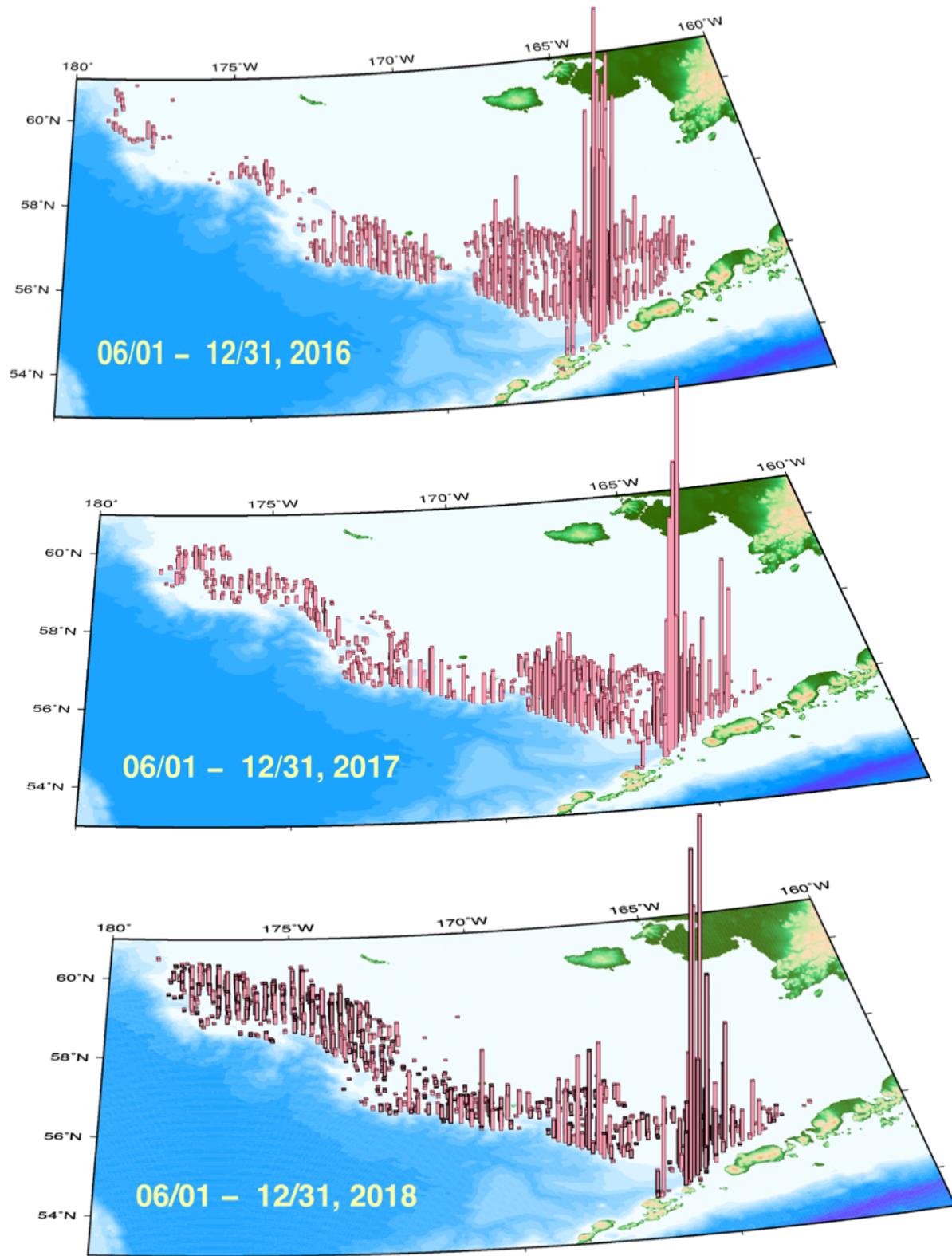


Figure 4: EBS pollock catch distribution during B-season, 2017–2019. Column height is proportional to total catch. Note that directed fishery for pollock generally is finished prior to October; the labels are indicative full-year catches.

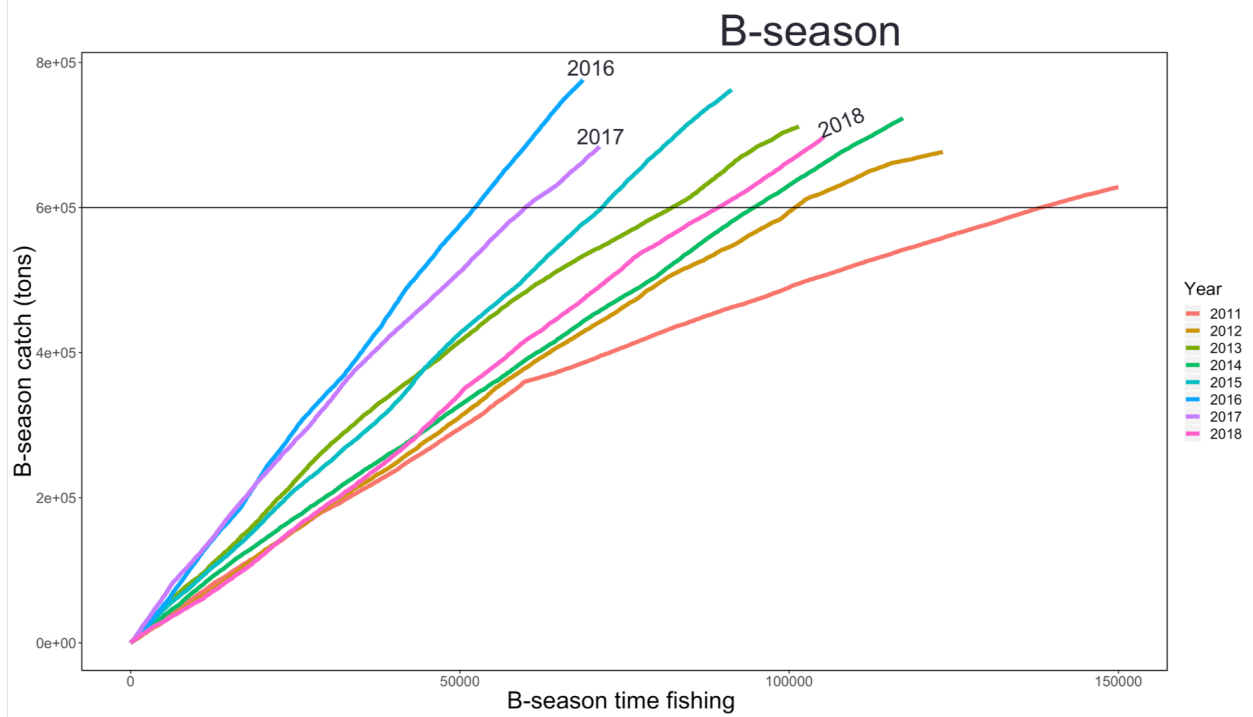


Figure 5: B-season EBS fleet-wide nominal pollock catch (kg) per hour of fishing recorded by NMFS scientific observers.

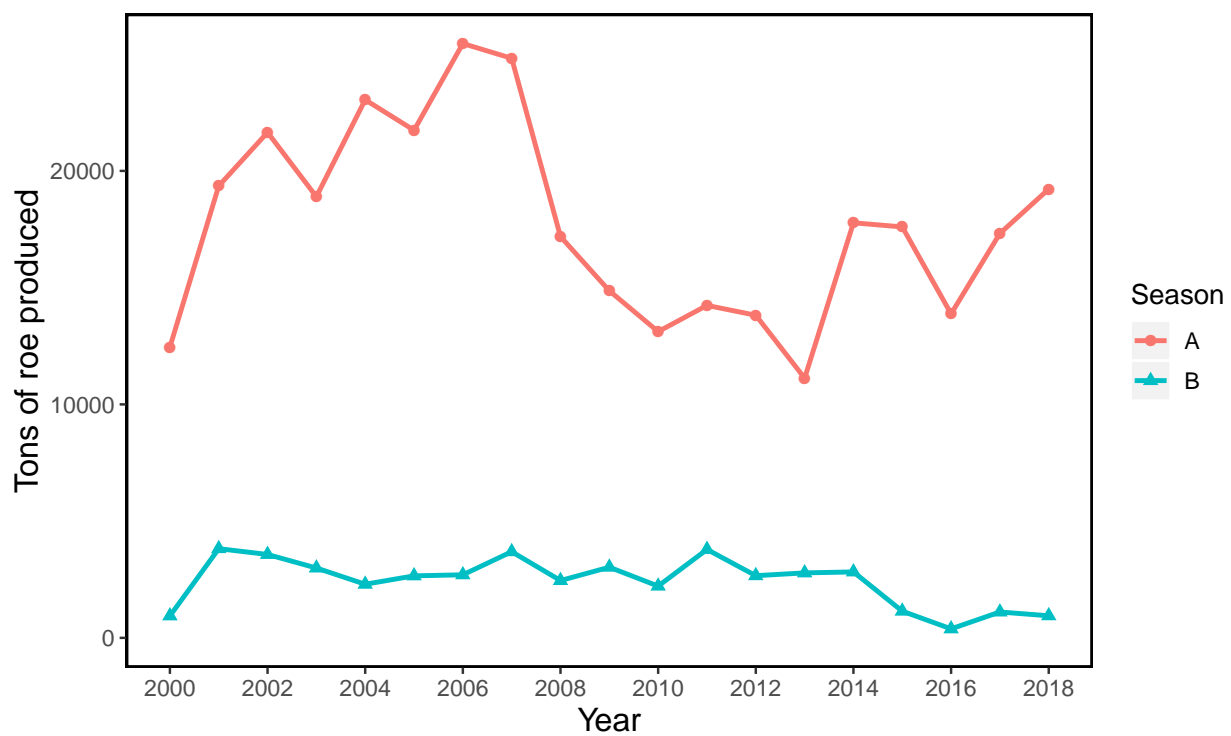


Figure 6: EBS pollock roe production in A and B seasons compared to overall landed catch.

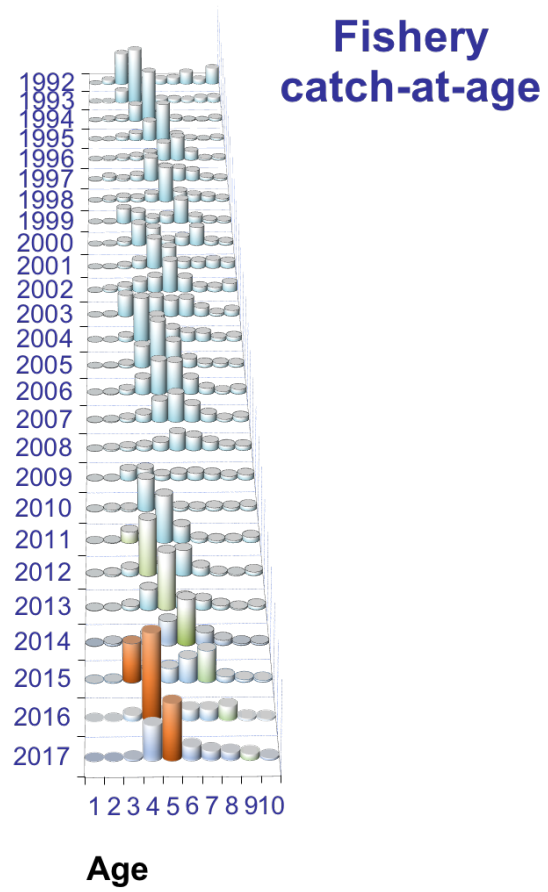


Figure 7: EBS pollock fishery estimated catch-at-age data (in number) for 1992–2018. Age 10 represents pollock age 10 and older. The 2008 year-class is shaded in green.

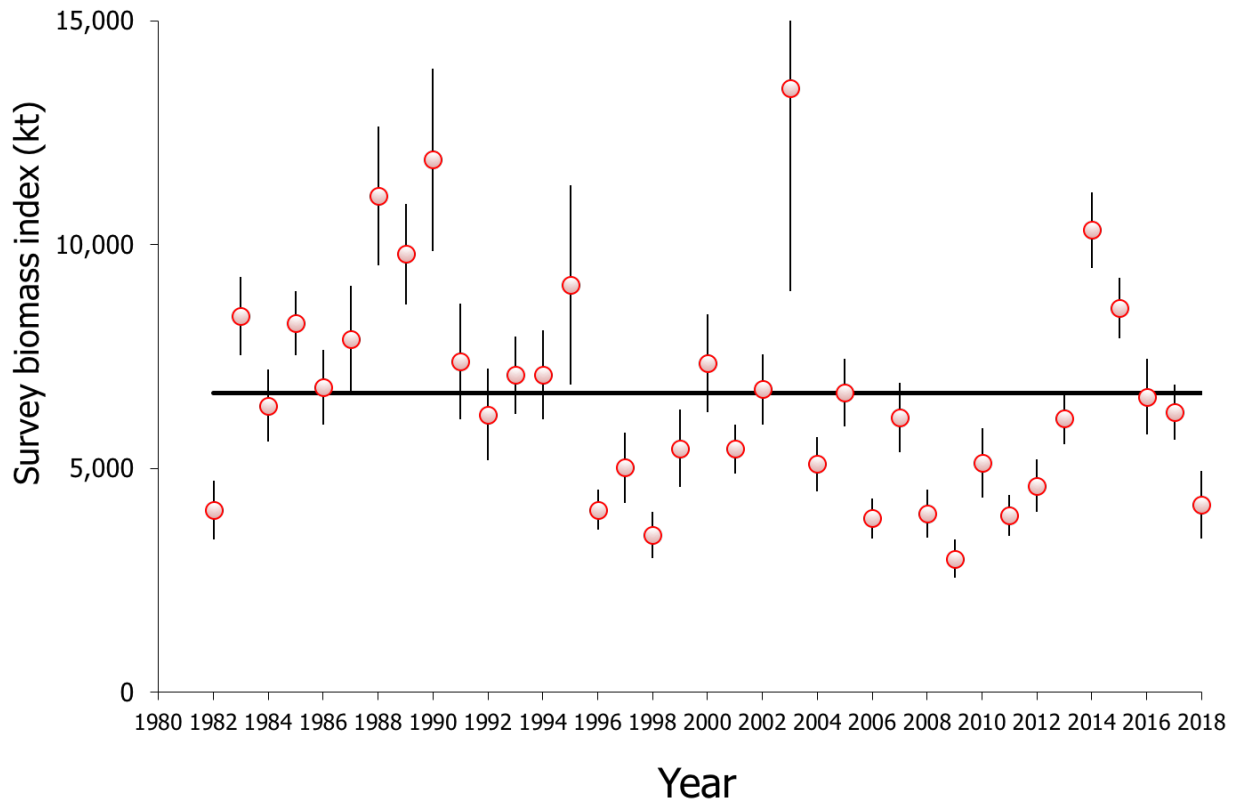


Figure 8: Bottom-trawl survey biomass estimates with error bars representing 1 standard deviation (density-dependent correction method; DDC) for EBS pollock. Horizontal line represents the long-term mean. Note these values differ from the design-based versions in Table ??.

Bottom and surface temperatures for the Bering Sea from the NMFS summer bottom-trawl surveys (1982–2018). Dashed lines represent mean values.

Bottom trawl survey pollock catch in kg per hectare for 2016 - 2018. Height of vertical lines are proportional to station-specific pollock densities by weight (kg per hectare) with constant scales for all years.

Pollock abundance levels by age and year as estimated directly from the NMFS bottom-trawl surveys (1990–2018). The 2006

Pollock abundance at age estimates from the AT survey, 1979–2018; 2018 age estimates are preliminary using primarily BTS age data

EBS pollock ATS transects (superimposed) over bottom-trawl survey stations and density estimates (in both settings contoured in the yellow-red heat map) for 2018.

EBS pollock AVO transects (superimposed) over bottom-trawl survey stations and density estimates (in both settings contoured in the yellow-red heat map) for 2018.

Recent fishery average weight-at-age anomaly (relative to mean) by strata for ages 3–10, 2013–2017. Vertical shape reflects uncertainty in the data (wider shapes being more precise), colors are consistent with cohorts.

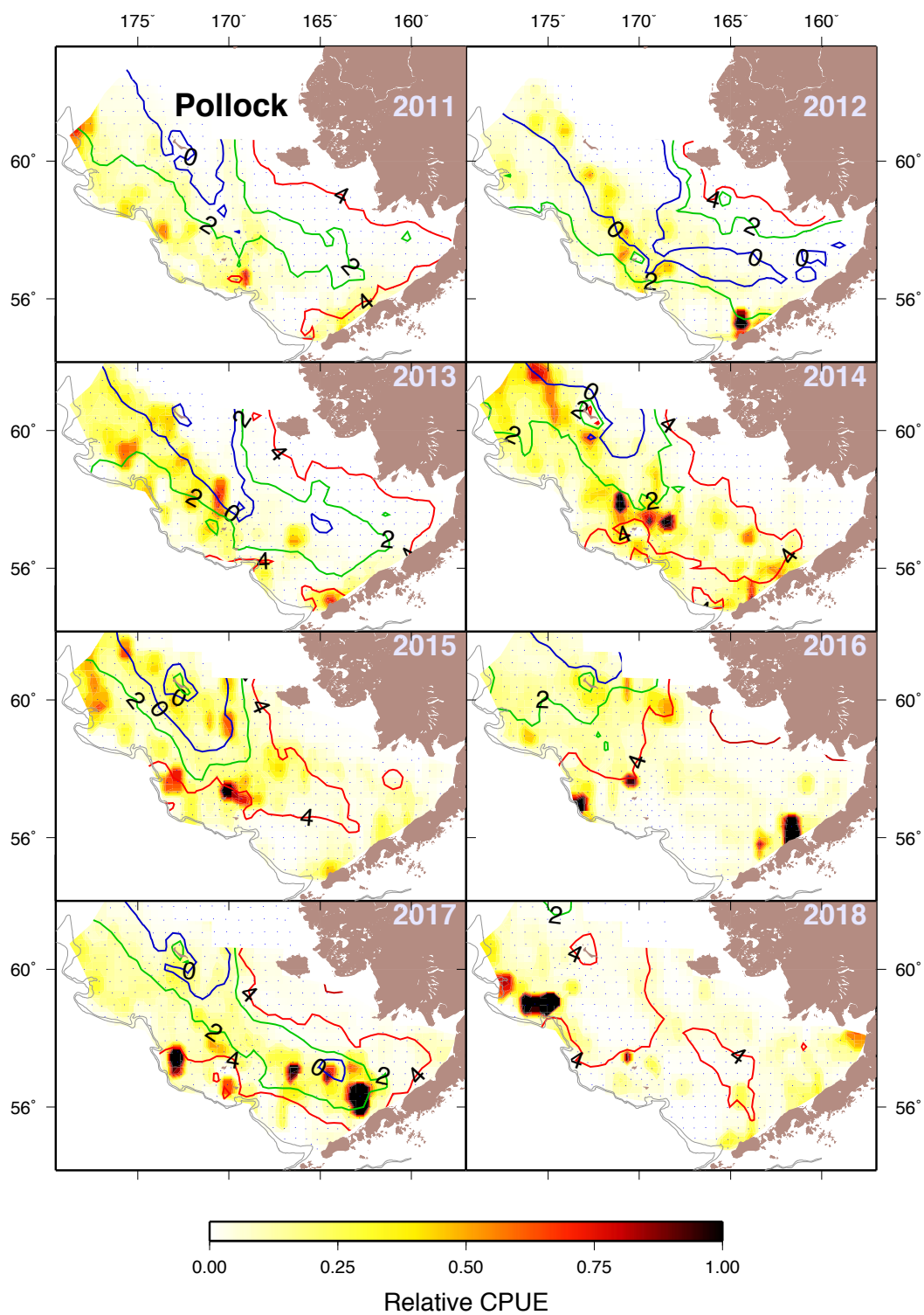


Figure 9: EBS pollock CPUE (shades = relative kg/hectare) and bottom temperature isotherms in degrees C; from the bottom trawl survey data 2011–2018.

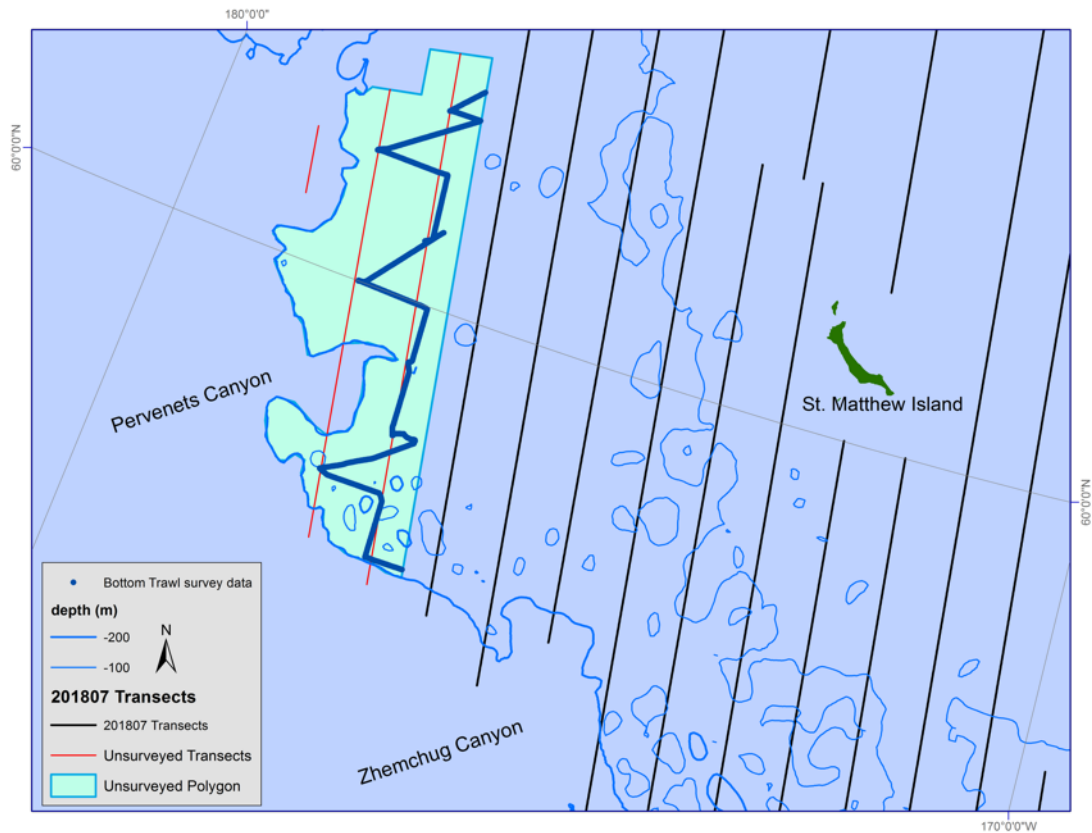


Figure 10: Map of survey area showing completed transects (black lines), unsurveyed transects (red lines), surveyed polygon (green shading), and the tracks of the bottom trawl vessels inside the unsampled area that were used to estimate acoustic backscatter in this area.

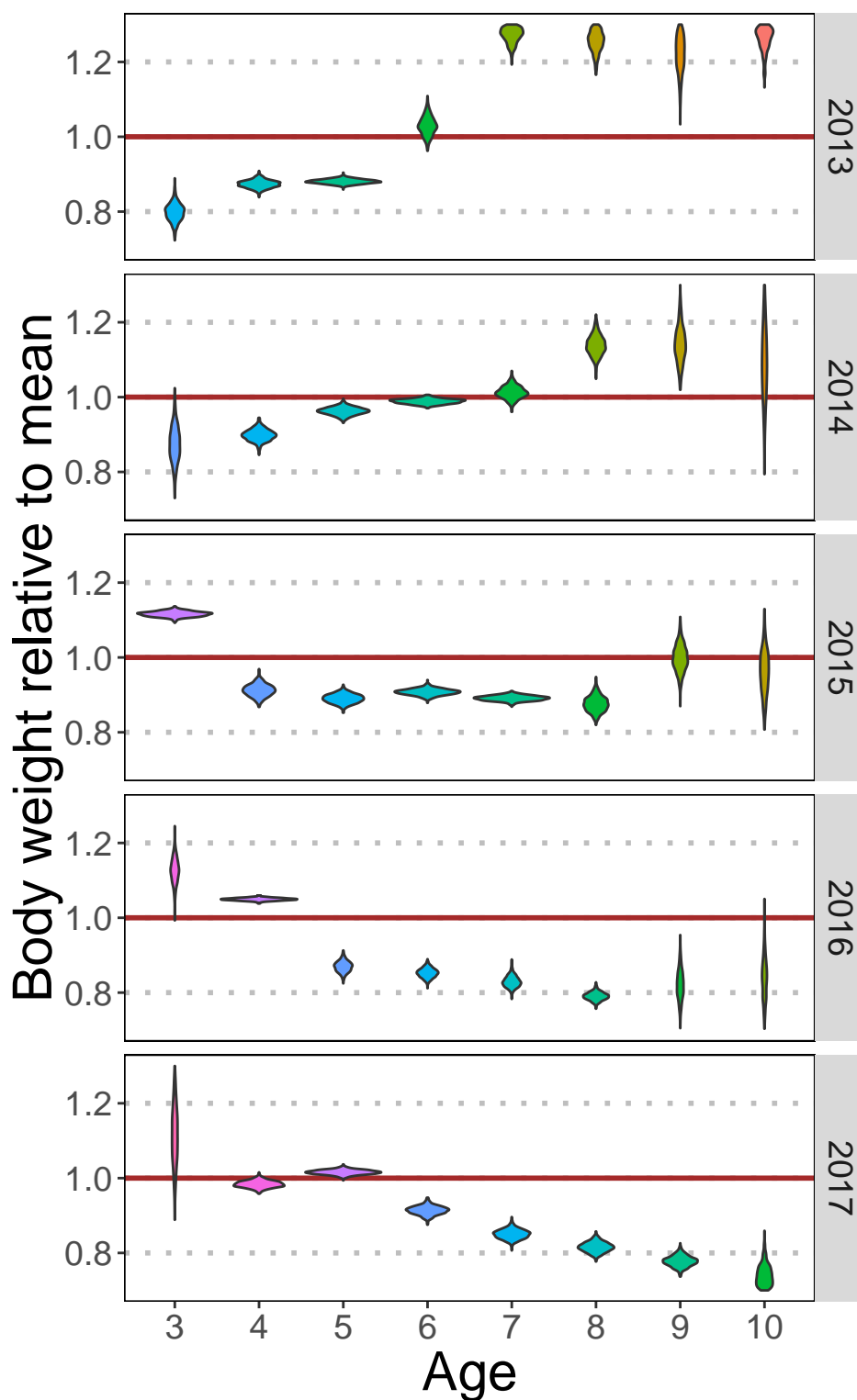


Figure 11: Fishery average weight-at-age anomaly (relative to mean) across strata and combined for all ages (3–10), and available years (1991–2017). Vertical shape reflects uncertainty in the data (wider shapes being more precise), colors are consistent with cohorts.

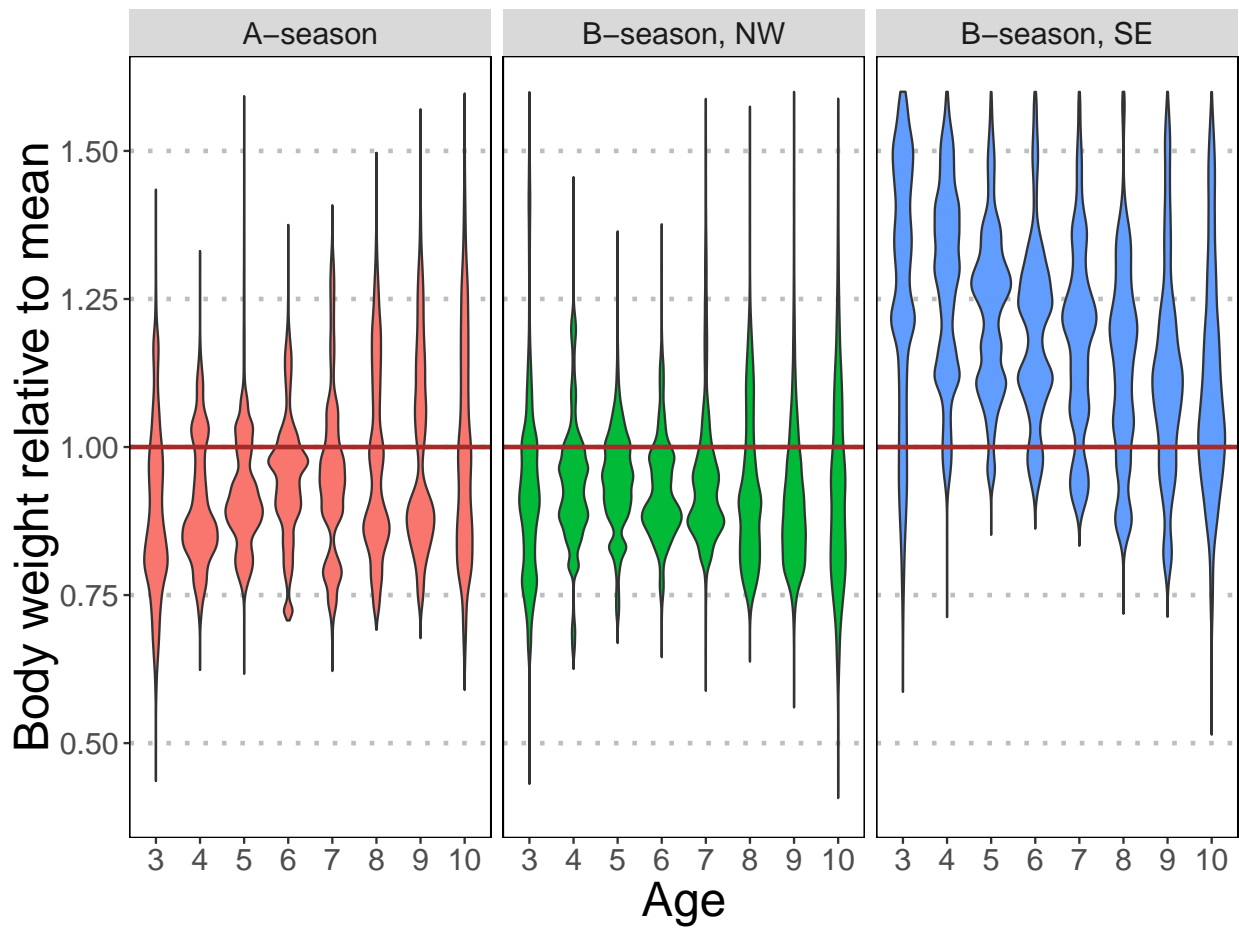


Figure 12: Recent fishery average weight-at-age anomaly (relative to mean) for ages 3–10 by strata (years 1991–2017 combined). Vertical shape reflects uncertainty in the data (wider shapes being more precise).

EBS pollock fishery body mass (given length) anomaly (standardized by overall mean body mass at each length) by month based on some over 700 thousand fish measurements from 1991–2018.

EBS pollock body mass (given length) anomaly (standardized by overall mean body mass at each length) by year and season/area strata, 1991–2018, aggregated by strata.

EBS pollock body mass (given length) anomaly (standardized by overall mean body mass at each length) by year and season/area strata shown as mean values with a fitted loess smooth trend, 1991–2018.

EBS pollock model evaluation results of three model fits to different treatment of bottom trawl survey sampling.

EBS pollock model evaluation results of female spawning biomass comparing model (and data) alternatives. Note that the ‘with NBS’ model is almost identical to model 16.1.

EBS pollock model evaluation results comparing model 16.1 (which assumes a Ricker stock-recruitment relationship) with that where a prior mean steepness of 0.67 and CV of 15% applied to a Beverton-Holt stock recruit relationship.

EBS pollock model fits to the Japanese fishery CPUE.

Model results of predicted and observed AVO index. Error bars represent assumed 95% confidence bounds of the input series.

EBS pollock model fit to the BTS biomass data (density dependence corrected estimates), 1982–2018.

EBS pollock model fit to the ATS biomass data, 1994–2018.

Selectivity at age estimates for the EBS pollock fishery.

Model estimates of bottom-trawl survey selectivity, 1982–2018.

Pairwise plot of selected EBS pollock parameters and output from 3 million MCMC iterations thinned such that 5 thousand draws were saved as an approximation to the multivariate posterior distribution. Note that the figures on the diagonal represent the marginal posterior distributions. Key: $\ln R_0$ is the parameter that scales the stock-recruit relationship, B_{Bmsy} is estimated B_{2017}/B_{MSY} , $DynB_0$ is the ratio of spawning biomass estimated for in 2018 over the value estimated that would occur if there had been no fishing, B_{18} is the spawning biomass in 2018, and B_Bmean is B_{2018}/\bar{B} .

Estimated spawning exploitation rate (defined as the percent removal of egg production in a given spawning year).

Estimated instantaneous age-specific fishing mortality rates for EBS pollock.

Estimated spawning biomass relative to annually estimated F_{MSY} values and fishing mortality rates for EBS pollock.

Recruitment estimates (age-1 recruits) for EBS pollock for all years since 1964 (1963–2017 year classes) for Model 16.1. Error bars reflect 90% credible intervals based on model estimates of uncertainty.

EBS pollock productivity as measured by logged recruits per spawning biomass, $\log(R/S)$, as a function of spawning biomass with a linear fit (bottom) and over time, 1964–2018 (top).

Retrospective patterns for EBS pollock spawning biomass showing the point estimates relative to the terminal year (top panel) and approximate confidence bounds on absolute scale (+2 standard

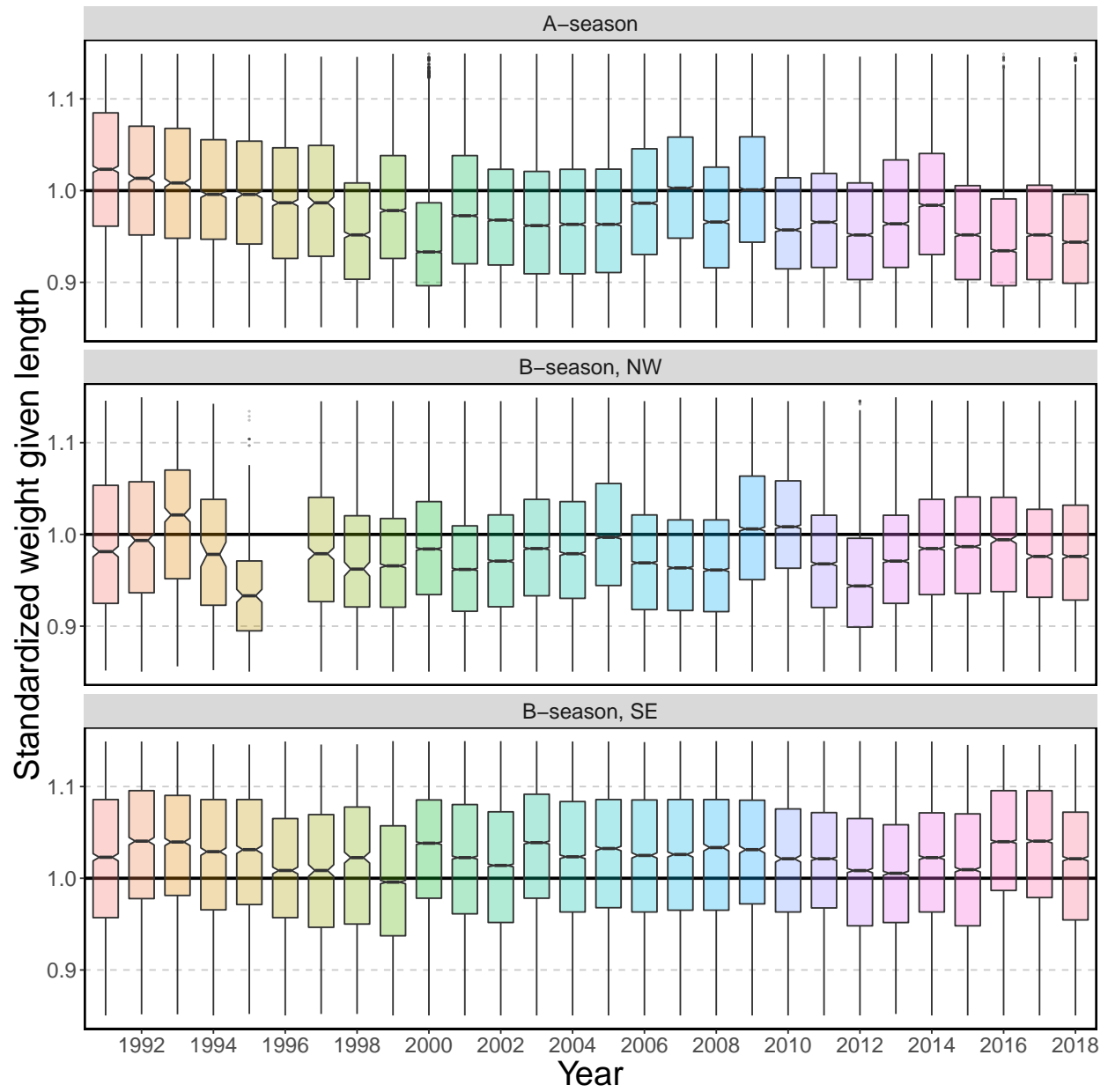


Figure 13: EBS pollock fishery body mass (given length) anomaly (standardized by overall mean body mass at each length) by year and season/area strata, 1991–2018.

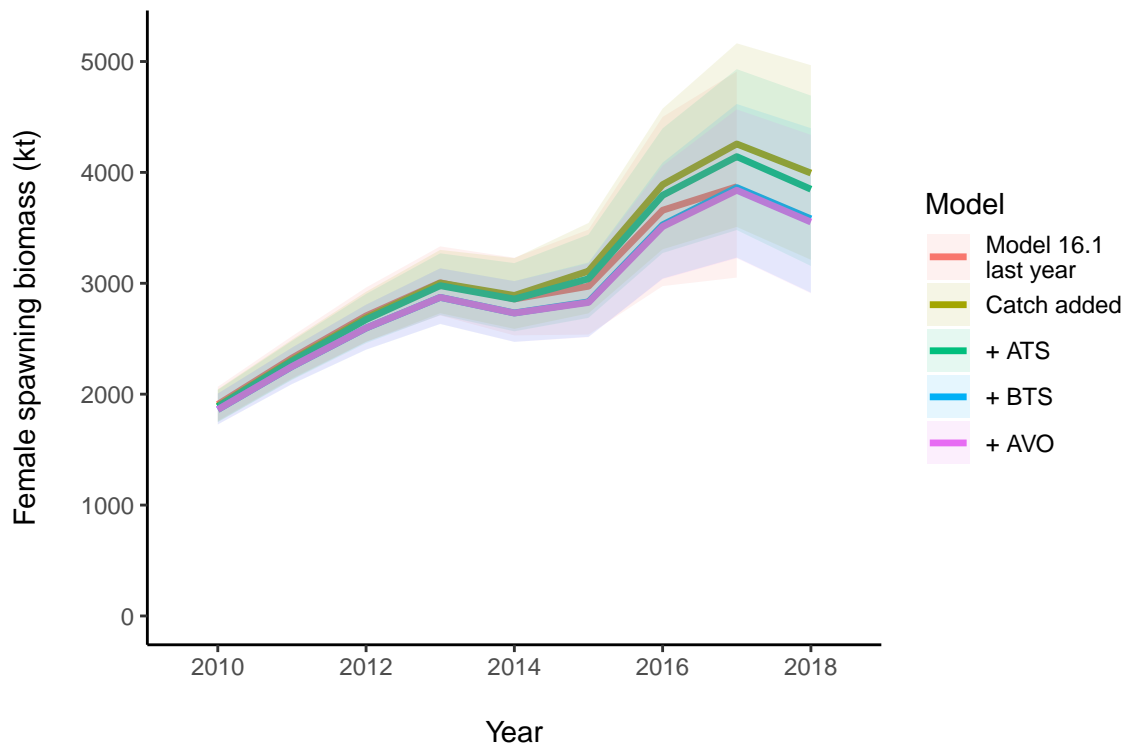


Figure 14: Model runs comparing last year's assessment with the impact of sequentially addint new data (first 2018 catch and 2017 fishery catch-at-age, then the acoustic trawl survey (ATS), bottom trawl survey (BTS) and the acoustic AVO data for model 16.1.

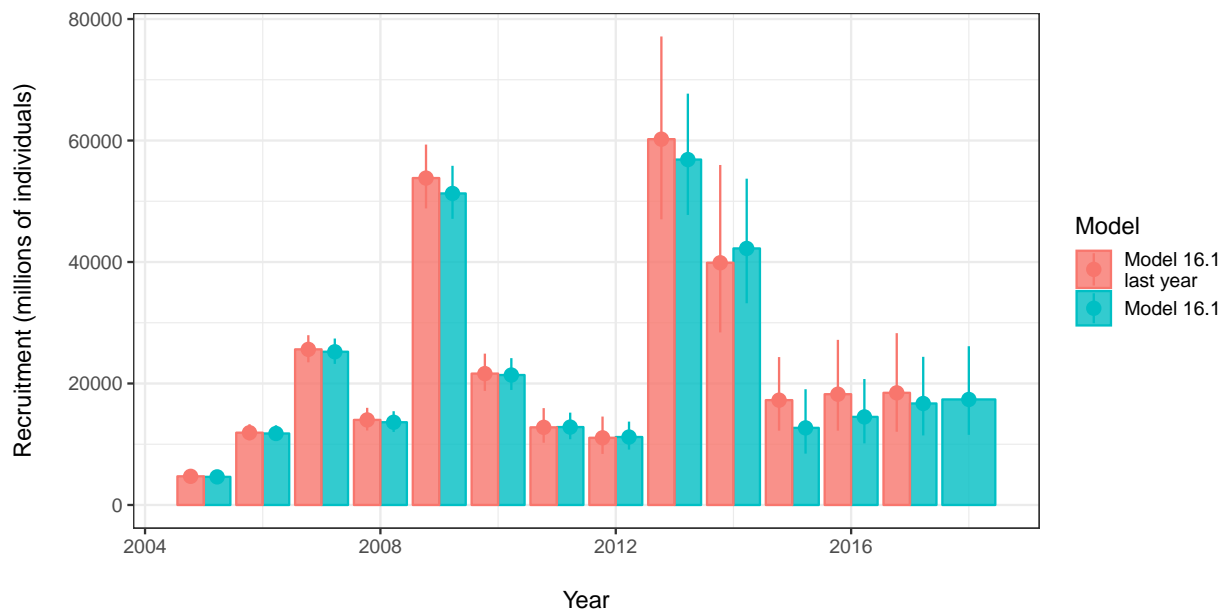


Figure 15: EBS pollock model evaluation results of recruitment comparing last year's model with this year.

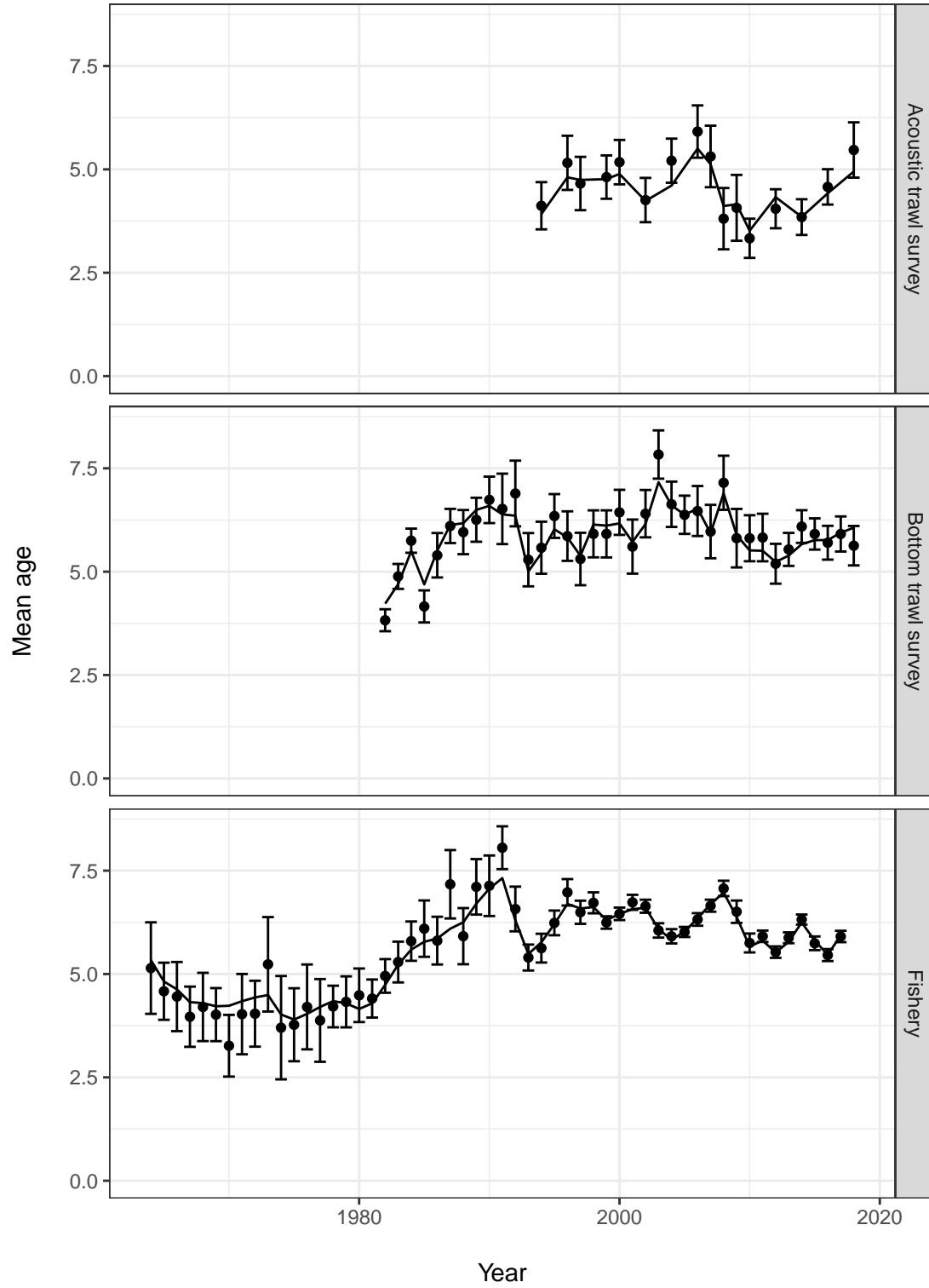


Figure 16: EBS pollock model fits to observed mean age for the Acoustic trawl survey (top)

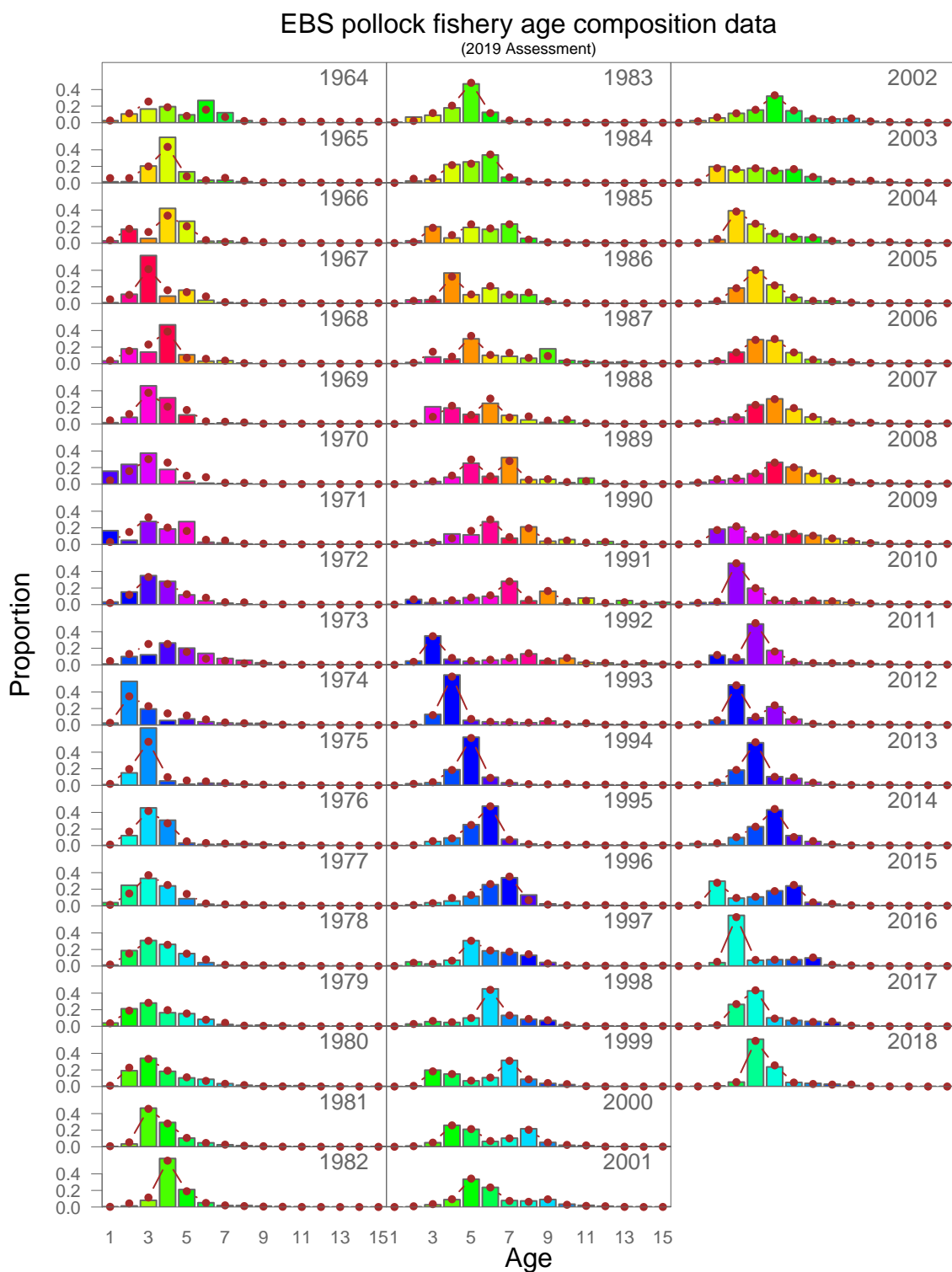


Figure 17: Model fit (dots) to the EBS pollock fishery proportion-at-age data (columns; 1964–2017). The 2017 data are new to this year’s assessment. Colors coincide with cohorts progressing through time.

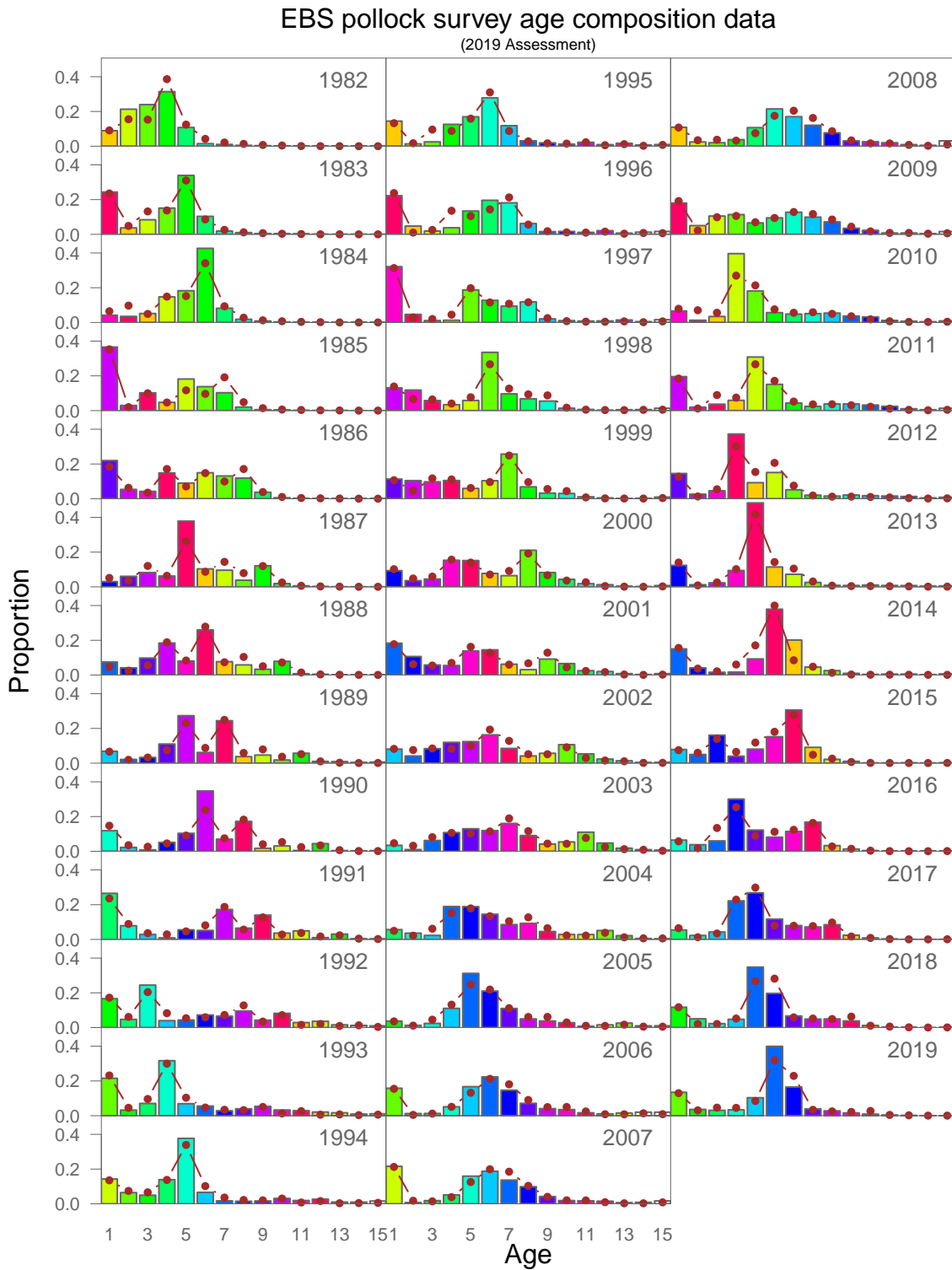


Figure 18: Model fit (dots) to the bottom trawl survey proportion-at-age composition data (columns) for EBS pollock. Colors correspond to cohorts over time. Data new to this assessment are from 2018.

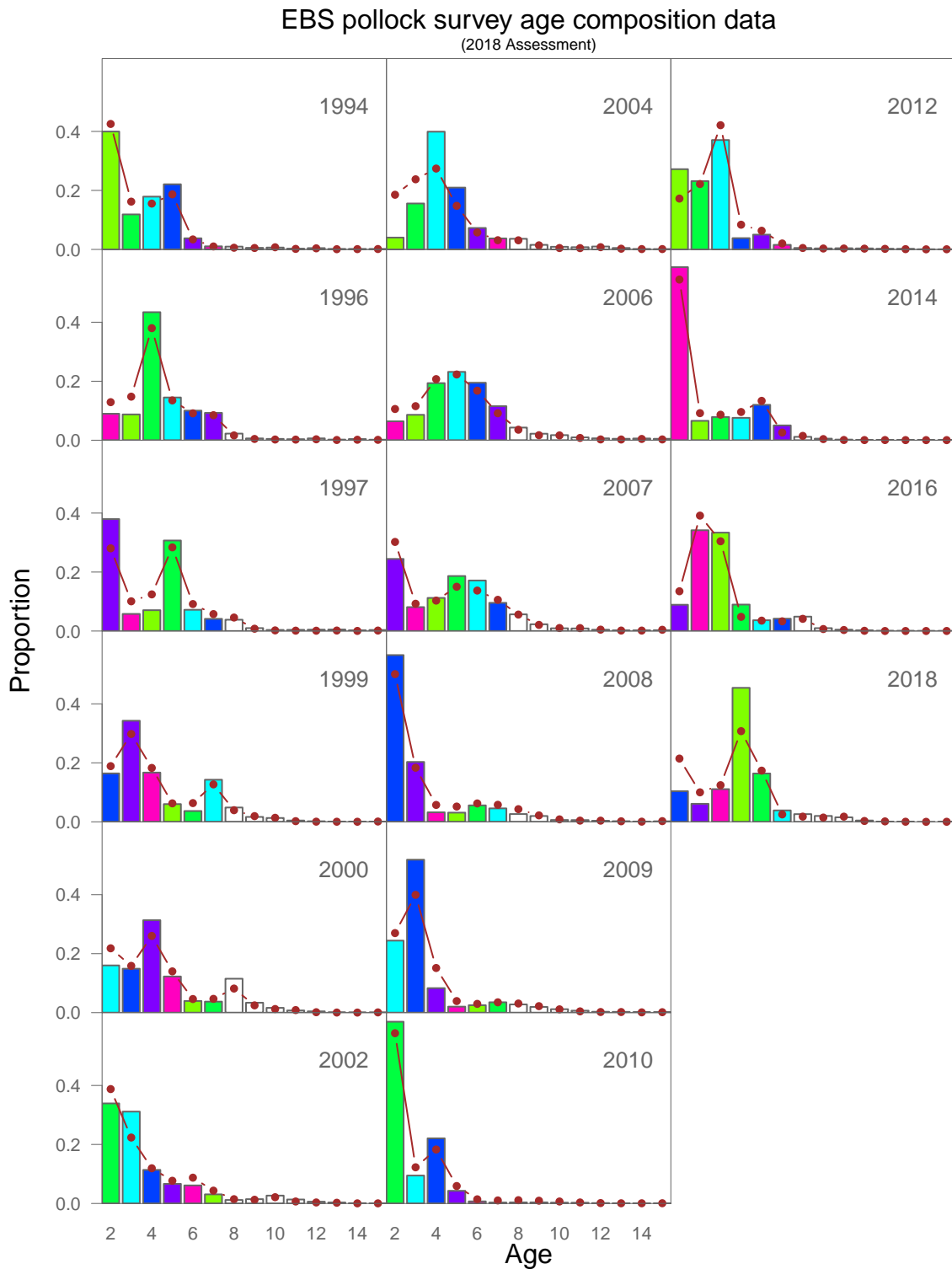


Figure 19: Model fit (dots) to the acoustic-trawl survey proportion-at-age composition data (columns) for EBS pollock. Colors correspond to cohorts over time (for years with consecutive surveys).

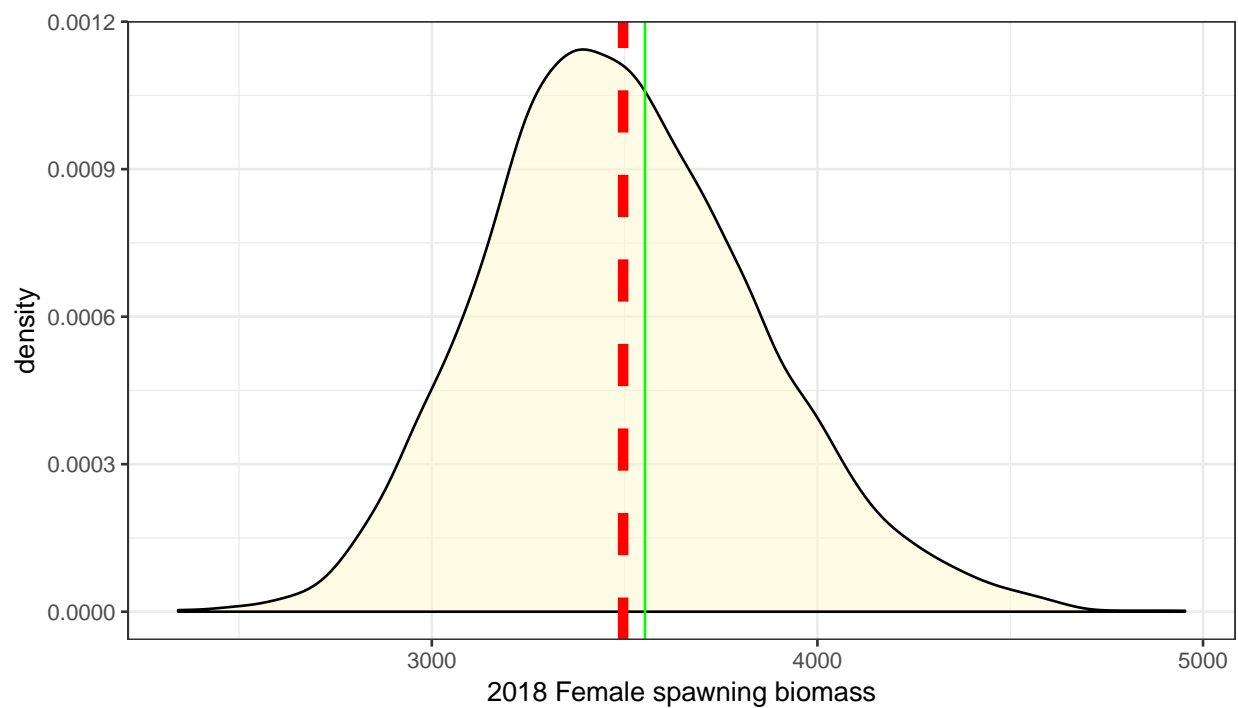


Figure 20: Integrated marginal posterior density (based on MCMC results) for the 2018 EBS pollock female spawning biomass compared to the point estimate (dashed red line). The mean of the posterior is shown in green (under the dashed line).

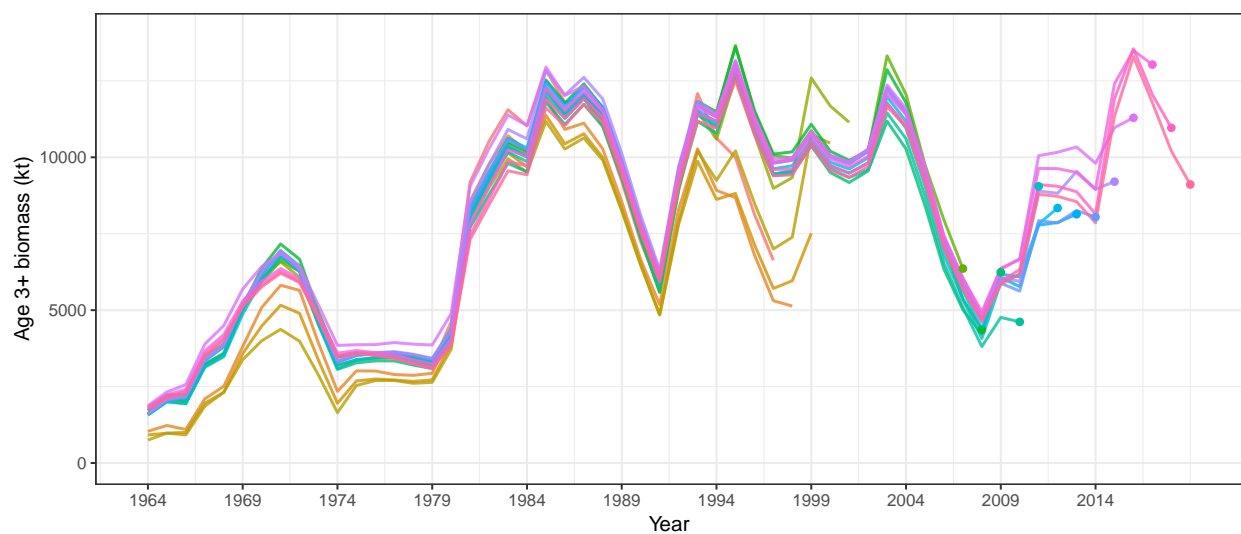


Figure 21: Comparison of the current assessment results with past assessments of begin-year EBS age-3+ pollock biomass.

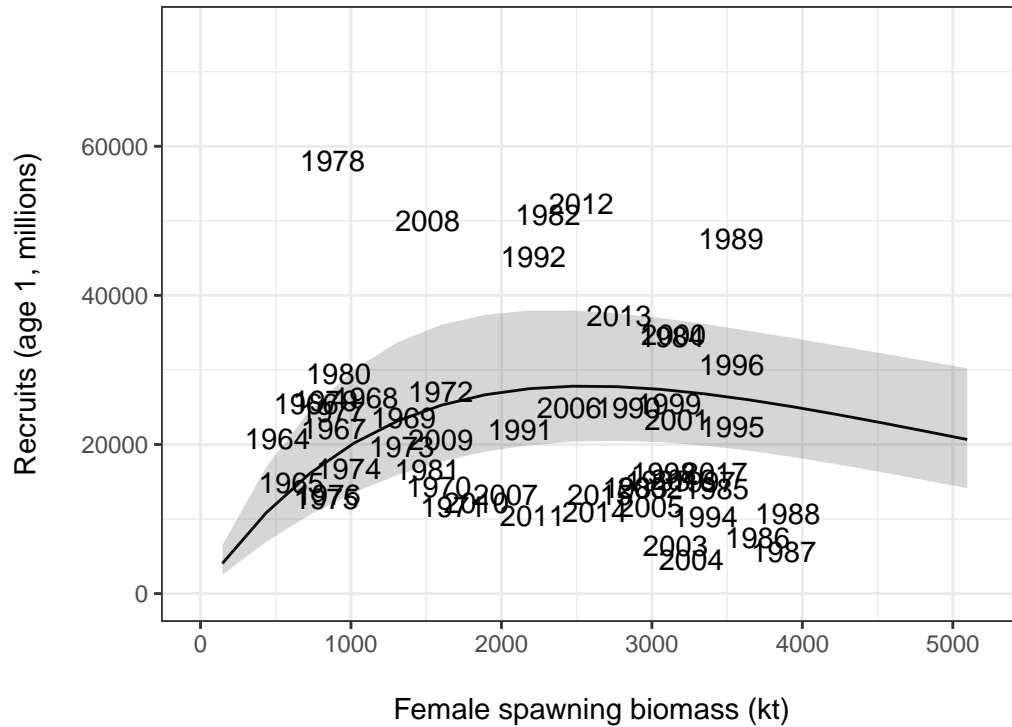


Figure 22: Stock-recruitment estimates (shaded represents structural uncertainty) and age-1 EBS pollock estimates labeled by year-classes

deviations).

Projected fishing mortality and spawning biomass relative to 2018 values under constant catch of 1.35 million t, 2019–2023.

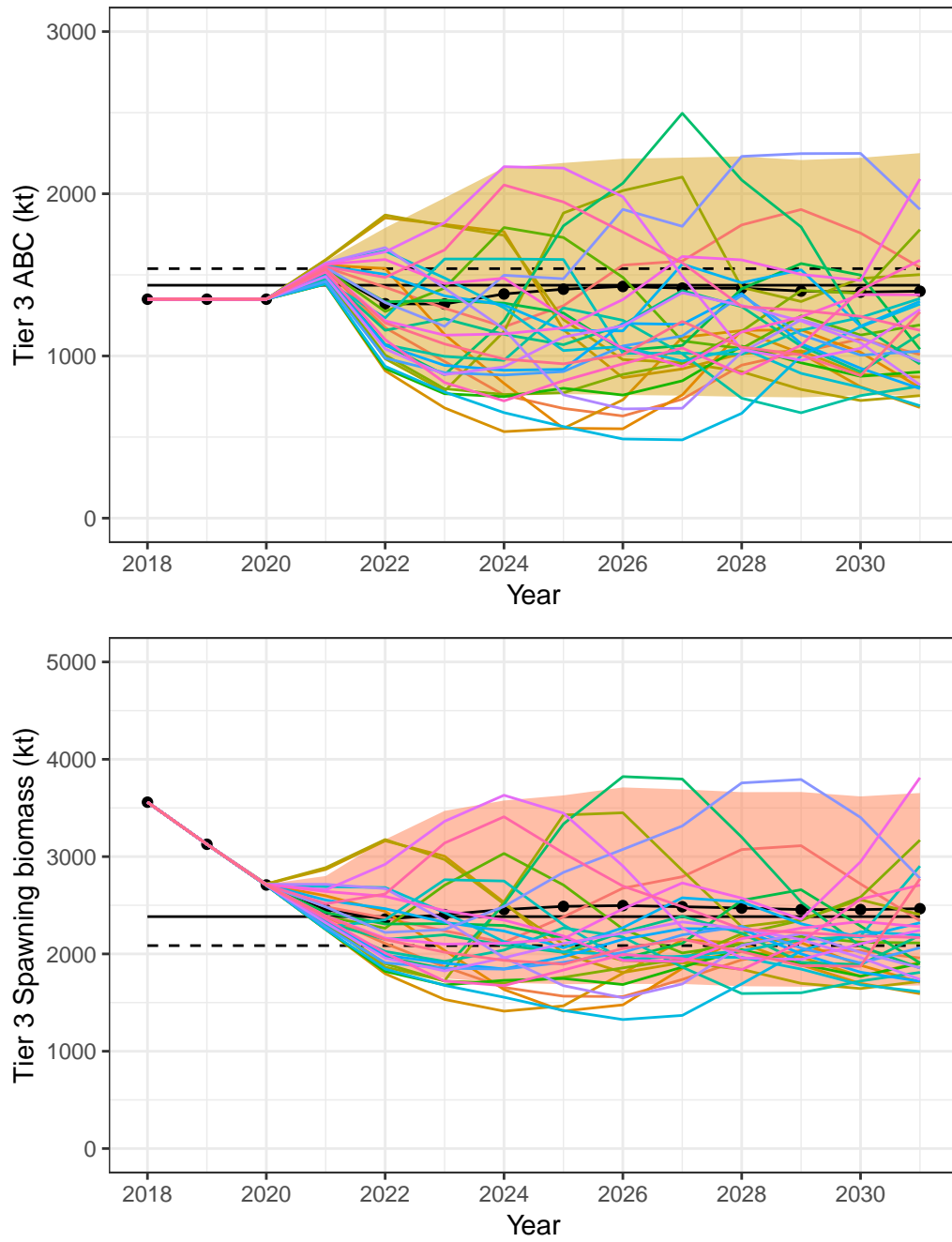


Figure 23: Projected EBS Tier 3 pollock yield (top) and female spawning biomass (bottom) relative to the long-term expected values under $F_{35\%}$ and $F_{40\%}$ (horizontal lines). $B_{40\%}$ is computed from average recruitment from 1978–2015. Future harvest rates follow the guidelines specified under Tier 3 Scenario 1.

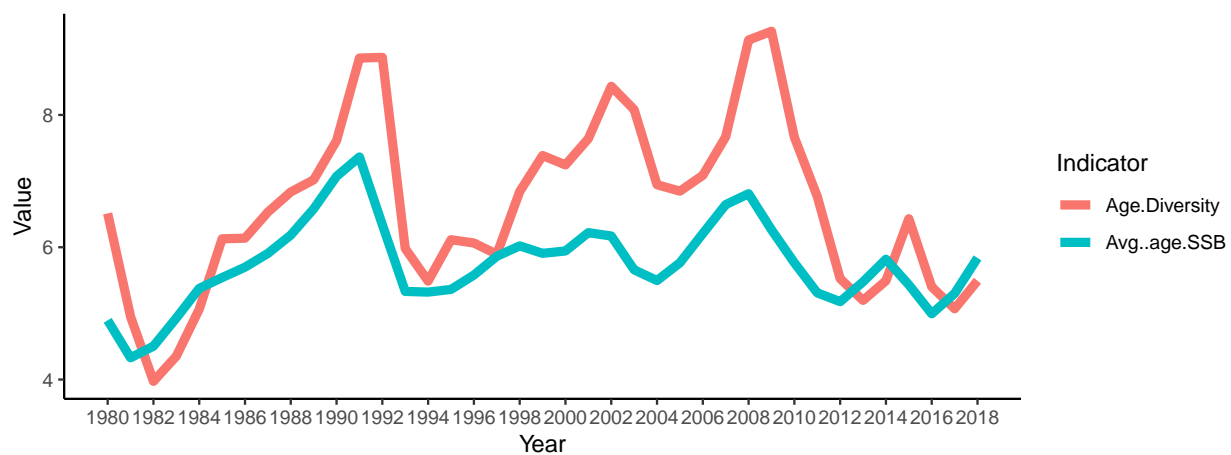


Figure 24: For the mature component of the EBS pollock stock, time series of estimated average age and diversity of ages (using the Shannon-Wiener H statistic), 1980–2018.


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