C. POLLOCK – REVIEW PANEL SUMMARY

The panel and workshop participants reviewed a draft report that updated the methods from SAW50 (NEFSC 2010) with fishery data through 2013 and survey data through spring 2014. The panel requested additional sensitivity analyses and projections as well as minor additions to the report and revisions of the draft text, and recommended some topics for the research track.

Terms of Reference

1. Update all fishery-dependent data (landings, discards, catch-at-age, etc.) and all fishery-independent data (research survey information) used as inputs in the baseline model or in the last operational assessment.

The update assessment report documents several revisions from the SAW50 data: recreational catch estimates, precision of recreational discards and commercial discard-at-age estimates for 2001-2008. Estimates of recreational catch for 2004 to 2013 were derived from the newly developed Marine Recreational Information Program (MRIP), replacing the SAW50 estimates for 2004-2009, and previous estimates (1970-2003) were converted to be compatible with the new series using a conversion factor developed by NMFS (2012). The conversion was approximately 10% less landed weight and 5% less discarded weight. The intended method of deriving commercial discards-at-age by SAW50 used combined survey and fishery age-length keys, but fall survey data were unintentionally excluded for estimates from 2001 to 2008 since 2001, so that omission was corrected. Both data changes produced only slight changes in the assessment because both catch components are relatively small. The updated assessment used the average of annual precision estimates from SAW50 for recreational discards (average CV=0.68) and commercial discards (average CV=0.3) because the recreational precision estimates could not be replicated.

The updated catch was approximately 8,000 mt per year, with an increasing proportion of recreational landings and a recent expansion of the age structure. Surveys continued to be noisy because of patchy Pollock catches (e.g., one or two large survey tows in the 2011 spring and fall surveys).

The Panel requested information on weight-at-age data to be included in the report. The information showed a general decrease in weight-at-age for older ages in the most recent five years. A constant maturity schedule was assumed for the entire assessment time series, and maturity-at-age estimates were not revised with recent data for the updated assessment, but the Panel recommends that potential changes in maturity-at-age should be investigated in the next update assessment. Although the age proportions have several periods of adjacent strong year classes and weight-at-age values have abrupt and large decreases for some old ages, quality assurance information from age processing suggests that age determination is not a major source of uncertainty.

2. Estimate fishing mortality and stock size for the current year, and update estimates of these parameters in previous years, if these have been revised.

The panel confirmed that there were no changes to ASAP methodology developed by SAW50 for the updated assessment.

The retrospective pattern of the updated assessment was worse than the SAW50 assessment, with a tendency for SSB to decrease as more data are added and for F to increase as more data are added. The retrospective pattern of the updated assessment was stronger than the SAW52 assessment, with a tendency for SSB to decrease as data are added, and for F to increase as data are added. The retrospective-adjusted estimates of SSB and F are just within the 90% confidence limits of the unadjusted point estimates of SSB and F. Based on the criteria developed by GARM III (NEFSC 2008), , retrospective adjustments should not be applied. However, the panel noted that the retrospective pattern is worth considering as a source of uncertainty (approximately 29% for SSB and 25% for F). The panel noted that retrospective error is a nonrandom error, whereas MCMC-based confidence limits of point estimates quantify random errors. The panel discussed the possibility of estimating MCMC-based confidence limits for retrospective-adjusted F and SSB.

Although several periods of selectivity were assumed for the commercial and recreational fleets by the SAW50 assessment, residual patterns do not suggest recent changes in selectivity, and recent management changes were not expected to cause changes in selectivity. Survey selectivity was assumed to be domed in the SAW50 base ASAP, with 50% selectivity of the oldest age. The assumed dome-shaped selectivity implies that a large portion of the stock is in the oldest age group and is only partly vulnerable to the fishery. A SAW50 sensitivity analysis assuming full selectivity of the oldest age was also updated. The sensitivity run had a greater retrospective pattern, outside the 90% confidence limits. The Panel requested comparison of the ASAP base model results with retrospective-adjusted results from the sensitivity run, and the comparison showed a considerable difference, such that the overfishing status was sensitive to the assumed survey selectivity.

The effective sample sizes for age compositions were assumed to be the same as SAW50, but a sensitivity analysis assumed re-weighted sample sizes, because the model expectation of sample sizes for the spring survey were much lower than the assumed values. The Panel requested comparison of the ASAP base model results with results from the reweighted sensitivity run. Summary plots showed that stock biomass estimates from the reweighted sensitivity run were considerably lower than those from the base run. The lower effective sample size estimated by the model may result from the patchy nature of survey catches. The Panel noted that the absolute stock biomass estimates tended to be sensitive to the model parameterization, but temporal trends of stock biomass tended to be robust with respect to alternative model parameterization. The Panel recommended continued sensitivity analyses in next update assessment and re-consideration of weighting in next benchmark assessment.

3. Identify and quantify data and model uncertainty that can be considered for setting Acceptable Biological Catch limits.

The Panel confirms that the updated assessment includes the information needed to recommend ABC (e.g., stock status and stochastic projections at F40 and 75%F40).

4. If appropriate, update the values of biological reference points (BRPs).

The SAW50 estimate of F40% (0.25) was updated, and the updated estimate was only slightly greater (0.27). The estimate of SSBMSY proxy from SAW50 (90,700 mt) was also updated with long-term stochastic projection at F40%, using randomly selected age-1 recruitment from the series of ASAP estimates (1970-2011), excluding the 2012 and 2013 estimates because the abundance of recent yearclasses are uncertain. The updated estimate of the SSBMSY proxy (76,900 mt) was considerably less than the SAW50 estimate, largely because of the recent decrease in weight-at-age. The estimate of steepness from the updated ASAP model (h=0.56) was lower than the SAW50 estimate (h=0.66), but the two estimates were not significantly different, because neither was precisely estimated. The large difference reflects both the uncertain estimate of steepness (justifying the use of a F40% proxy for FMSY) as well as the recent decrease in weight at age. The Panel concluded that the revised reference point estimates were appropriate because of the observed changes in weight-at-age.

5. Evaluate stock status with respect to updated status determination criteria.

The Panel accepts the stock status determined by updated assessment results (2013 SSB= 126,000 mt and 2013 F=0.1) and the updated estimate of F40% (0.27) and the SSBMSY proxy (76,900 mt). Therefore, the stock is not overfished and not experiencing overfishing. However, the overfishing status is sensitive to the assumed survey selectivity.

6. Perform short-term projections; compare results to rebuilding schedules.

Short-term projections were provided for F40, 75%F40 and status quo F. The Panel requested two sensitivity projections. The Panel discussed the influence that the apparently large 2011 yearclass would have on short-term projections. The Panel confirmed that the 2011 yearclass was not included in random draws for assumed future recruitment, but the yearclass is expected to recruit to the fishery over the next several years. The assessment is expected to be updated again in 2015, providing more information on the strength of the 2011 yearclass. However, a sensitivity projection was requested that reduced the 2011 yearclass by 50% which would decrease it to an approximately average yearclass. The second sensitivity projection requested was from the sensitivity analysis that assumed full selection of the oldest age in surveys.

7. Comment on whether assessment diagnostics—or the availability of new types of assessment input data—indicate that a new assessment approach is warranted (i.e., referral to the research track).

The Panel discussed the convergence problems experienced for some alternative ASAP configurations, and the Panel recommended that reducing the number of estimated parameters may improve model performance. For example, combining fleets should be considered at the next benchmark assessment to investigate if the simplification of selectivity assumptions is worth the reduction in estimated parameters.

8. Should the baseline model fail when applied in the operational assessment, provide guidance on how stock status might be evaluated. Should an alternative assessment approach not be readily available, provide guidance on the type of scientific and management advice that can be.

The panel concluded that the updated assessment is a reliable basis for fishery management and alternative approaches are not necessary at this time.

References

NEFSC. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd Groundfish Assessment Review Meeting (GARM III). NEFSC Ref Doc. 08-15.

NEFSC. 2010. 2010. 50th Northeast Regional Stock Assessment Workshop (50th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 10-17.

NMFS. 2012. MRFSS/MRIP Calibration Workshop Ad-hoc Working Group Report. May 16, 2012. 12 p.

C. POLLOCK (*POLLACHIUS VIRENS*) OPERATIONAL ASSESSMENT UPDATE 2014

1.0 Background

The pollock stock was last assessed as part of the 50th Stock Assessment Review Committee (SARC 50; NEFSC 2010). That assessment was a benchmark, and all methods that were accepted by the SARC 50 review panel were used in this update. Four additional years of catch and index data are incorporated.

2.0 Fishery

Total catches of pollock have increased since the mid-1990s, reaching a peak of around 12,000 mt in 2008 (Table C1; Figure C1). Total catches have remained relatively constant since 2009 at about 8,500 mt. US commercial landings have decreased from around 7,500 mt in 2009 to around 5,000 mt in 2013 but still account for the majority (61%) of total catches in 2013. US commercial discards have remained relatively constant since 2009 at about 170 mt and account for 2% of total catches in 2013. Recreational landings have increased from around 600 mt in 2009 to around 1,600 mt in 2013 and account for 20% of total catches in 2013. Recreational discards have increased from around 400 mt in 2009 to around 1,500 mt in 2013 and account for 17% of total catches in 2013.

Marine Recreational Information Program

The National Marine Fisheries Service (NMFS) Marine Recreational Fishery Statistics Survey (MRFSS) was replaced by the Marine Recreational Information Program (MRIP) in 2012 to provide improved recreational fishing statistics. The MRIP implemented a new statistical method for calculating recreational catch estimates, with many survey elements related to both data collection and analysis updated and refined to address issues such as data gaps, bias, consistency, accuracy, and timeliness. As part of the implementation of the MRIP, recreational fishery catch estimates for 2004 - 2011 have been directly replaced by those using the MRIP estimation methods. For earlier years, a constant “ratio of means” of the MRFSS and MRIP estimates has been used to adjust the recreational catch estimates (Table C2), based on the recommendations of the MRFSS/MRIP Calibration Workshop Ad-hoc Working Group (NMFS 2012).

Over all years (2004 - 2011), the cumulative recreational landings in numbers decreased by about 223,000 fish (-11%), ranging from a decrease of around 160,000 fish in 2010 (-30%) to an increase of around 29,000 fish in 2006 (+17%; Table C3). The average ratio between MRFSS and MRIP for this period was -11%, therefore, for the years 1981 - 2003, recreational landings numbers were decreased by 11% for this assessment. Over all years, the cumulative recreational landings in weight decreased by about 731 mt (-10%), ranging from a decrease of around 566 mt in 2010 (-30%) to an increase of around 122 mt in 2006 (+21%). Therefore, for the years 1981-2003, recreational landings weights were decreased by 10% for this assessment. Over all years, the cumulative recreational discards in numbers decreased by about 57,000 fish (-4%), ranging from a decrease of around 74,000 fish in 2010 (-21%) to an increase of around 60,000 fish in 2004 (+72%). Therefore, for the years 1981-2003, recreational discards numbers were decreased by 4% for this assessment. Over all years, the cumulative recreational discards in weight decreased by about 222 mt (-5%), ranging from a decrease of around 214 mt in 2010 (-21%) to

an increase of around 144 mt in 2004 (+73%). Therefore, for the years 1981 - 2003, recreational discards weights were decreased by 5% for this operational assessment.

Age Structure

Port samples of size and age structure for the commercial catch are summarized in Table C4. Sampling intensity has been good since the early 1980s. Summaries of the Northeast Fisheries Science Center (NEFSC) Age and Growth Program's ongoing QA/QC testing (http://www.nefsc.noaa.gov/fbp/QA-QC/) indicate that age estimation error is not likely an issue for the pollock stock. Landed catch at age shows some relatively strong year-classes in the 1970s and 1980s (Figure C2). The 2014 operational assessment begins in 1970, based on the availability of commercial catch at age data. This assessment models ages 1 to 9+, as was done in the SARC 50 final base model.

An issue was discovered with the 2001-2008 commercial discards at age used in SARC 50. In SARC 50, semi-annual age length keys were applied to discards at length. The age length keys were supposed to be constructed with commercial and survey data, with spring survey data used in the age length keys for the first half of the year and fall survey data used in the age length keys for the second half of the year. In actuality, the second half-year age length keys for 2001-2008 were constructed with only commercial data. Therefore, those age length keys contained no observations less than about 45 cm. For the operational assessment, those second half-year age length keys were reconstructed including fall survey data, and commercial discards at age for 2001-2008 were reestimated (Figure C3). The revised commercial discards at age show increases in the proportions of younger fish compared to the original SARC 50 commercial discards at age (Table C5). The SARC 50 base model was rerun with the revised commercial discards at age, which resulted in little change to the estimates of SSB, average F, and recruitment (Table C6; Figure C4). The lack of difference in model results is due to the small magnitude of the commercial discards relative to the total catch.

The length-frequency of recreational discards was represented by samples of the recreational kept catch (A and B1) as was done in SARC 50. Recreational age samples are not available, so age length keys were constructed from commercial and survey data sources, which were applied to recreational catches at length.

3.0 Research Surveys

The NEFSC spring and fall surveys have large inter-annual variation (Tables C7, C8; Figure C5). The NEFSC fall survey series generally corresponds with the exploitation history. The survey index declines from high abundance in the late 1970s to extremely low abundance in the mid-1990s, consistent with total annual catches exceeding 20,000 mt during the same period. Abundance increased in the late 1990s when catches were less than 6,000 mt. Survey abundance decreased again in the late 2000s as catches approached 10,000 mt. With the exception of a spike in 2011, survey abundance has remained relatively constant since 2010 as catches have remained around 8,500 mt. The spring survey does not correspond as well with the exploitation history.

Pollock NEFSC spring and fall survey spatial distribution plots are shown in Appendix C1.

4.0 Assessment

Model

The final SARC 50 base model for pollock was performed with the NOAA Fisheries Toolbox (NFT) ASAP version 2.0.20. That input file was then run in ASAP version 3.0.17 to confirm that the results were identical. The additional data were then added and run with the same configuration as for SARC 50. Ages 1 through 9 were modeled, with age class nine serving as a plus-group. The first year in the catch at age was 1970.

Maturity

The "hit or miss" nature of the pollock catches in surveys results in highly variable estimates of maturity at age resulting from low sample sizes in many years. When maturity data are pooled across all years, age 3 appears to be an inflection point in the maturity ogive, with most fish younger than 3 immature and most fish older than 3 mature (Figure C6). A time-averaged maturity leads to more reliable estimates of maturity at age. In SARC 50, maturity at age was assumed to be constant over time and was estimated using pooled-year data from the NEFSC fall survey.

Natural Mortality

As in SARC 50, a natural mortality of 0.2 was assumed for all ages (1-9+) and all years. No alternatives were explored.

Indices

The NEFSC spring and fall bottom trawl survey indices (numbers of fish/tow) were used in the operational assessment. Total annual indices and their associated coefficients of variation (CVs), as well as age-specific indices for ages 1-9+ were included as model inputs. As in SARC 50, the NEFSC indices were not calibrated to account for changes in door type and vessel.

ASAP Results

The base model estimates a starting spawning stock biomass (SSB) in 1970 of about 262,000 mt, which is approximately 33% above the deterministic, point estimate of unexploited spawning biomass (~197,000 mt). Spawning biomass decreased to the time series low (56,900 mt) in 1990 (Table C9, Figure C7). Since the 1990 low, spawning biomass increased steadily through 2006, with a decline to the present. The current estimate of spawning biomass is about 126,000 mt.

Two additional biomass measures were calculated from the estimated numbers at age (Table C10). Total population biomass was calculated with January 1 weights at age while exploitable biomass was calculated with mid-year catch weights at age and annual selectivity at age (Tables C11, C12; Figures C8, C9). Total population biomass follows the same trend as SSB (Table C13, Figure C7). Exploitable biomass ranges from 37% to 73% of spawning biomass over the time series (Table C14). Because of the estimated dome-shaped fishery selectivities, exploitable biomass will always be less than spawning biomass.

In any given year, the fishing mortality experienced by an age class depends on the selectivity and amount of catch of each fleet. To provide a consistent metric for expressing F over the whole time series, the unweighted average F for ages 5-7 (F_{5-7}) is reported (Table C15). In 1970, F_{5-7} is estimated at 0.12 and mostly increased to its peak of 0.52 in 1986. Since then, F_{5-}

$_7$ steadily decreased to 2006, when it reached the time series low of 0.04. In the last three years, F_{5-7} was 0.12, 0.10, and 0.10, respectively.

Mean recruitment was around 19 million age 1 recruits. Several abundant year-classes were produced in 1971, 1979, 1997, 1998, 1999, 2001, and 2011, with the estimated number at age ranging from 27 to 53 million (Figure C10). The model estimated steepness at 0.56 with a CV of 0.24 (Figure C11).

As a result of the small CVs assigned to the commercial landings (CV = 0.05), they were well fit (Figure C12). Commercial discards, which used the average of the CVs estimated from the data (CV = 0.30), had larger residuals compared to the landings (Figure C13). The residuals in the commercial age composition did not indicate a need for adding or adjusting selectivity blocks (Figure C14). The final SARC 50 input effective sample size (N = 50) approximately matches most of the model estimated effective sample sizes (Figure C15).

The CV assigned to the recreational landings was five times greater than the commercial landings CV (CV = 0.25), but they still fit well (Figure C16). Recreational discards, which used the average of the CVs estimated from the data (CV = 0.68), had larger residuals compared to the landings (Figure C17). The residuals in the recreational age composition did not indicate a need for adding or adjusting selectivity blocks (Figure C18). The final SARC 50 input effective sample size (N = 35) does a reasonable job of matching most of the model estimated effective sample sizes (Figure C19).

As noted above, the indices show apparently strong year effects, but these years tended to have the largest CVs. Thus, in fitting the indices, the influence of these effects was not strong. The predicted spring index smoothes through the early and late part of the time series, but there is a stretch of positive residuals in the 1980s and 1990s (Figure C20). The residuals in the spring age composition show some persistent trends at age for several year blocks, although the year-age blocks with the trends do not appear to be related (Figure C21). The age composition of the indices was downweighted relative to the landings by having a lower effective sample size (N = 30). As in SARC 50, Figure C22 suggests that the indices could be downweighted further.

The predicted fall index smoothes through the time series until about 1990, when there is a run of positive residuals through 2006 (Figure C23). The residuals in the fall age composition show some persistent trends at age for several year blocks (Figure C24). Unlike for the spring, however, these residual blocks somewhat trace diagonals through the plot and may reflect cohort effects. As in SARC 50, Figure C25 suggests that the fall index could be downweighted further but not to the extent that was seen for the spring index.

MCMC simulation was performed to obtain posterior distributions of spawning stock biomass and F_{5-7} time series. The traces of the MCMC chains were plotted and indicated good mixing (Figure C26). Autocorrelations for F_{5-7} ranged from 0.21 in 1970 to 0.27 in 2013 with a lag of 1 and were less than 0.11 with a lag of 2 or greater. Autocorrelation for SSB ranged from 0.20 to 0.32 with a lag of 1 and were less than 0.20 with a lag of 2 or greater. The decreasing autocorrelation with increasing lag is another good indicator that the MCMC chains have converged. Finally, the Gelman-Rubin potential scale reduction factor (psrf) was calculated for the time series of F_{5-7} and SSB. All psrf were between 1.0 and 1.01, which again suggests convergence of the chains.

As the MCMC simulations appear to have converged, 90% probability intervals were calculated to provide a measure of uncertainty for the model point estimates (Figures C27, C28). Plots of the posterior for SSB_{1970}, SSB_{2013}, $F_{5-7(2007)}$, and $F_{5-7(2013)}$ are shown to characterize the uncertainty in the estimates (Figures C29, C30).

ASAP Retrospective Analysis

The average Mohn's rho was calculated for the seven retrospective relative differences in years 2006-2013 (Figure C31). The values for Mohn's rho were -0.25 for F, 0.29 for SSB, and 0.14 for age 1 recruitment.

ASAP Sensitivity Analysis

A sensitivity model was examined where selectivity in both the NEFSC spring and fall surveys was fixed at 1.0 for ages 6-9+. The effect of this was predictable, in that abundances were scaled lower (Table C6). Specifically, SSB in 1970 was 89,000 mt instead of 262,000 mt. Also, current biomass with flat survey selectivity dropped to 48,000 mt from 126,000 mt in the base model. Compared to the base model, the age composition residuals for both the indices and the fleets barely changed. However, the fits to the indices were worse, with the predicted indices dropping even further below the observed values from the 1990s and later. A retrospective run of the model with flat survey selectivities led to one year where the model did not run to completion (2010). For the remaining six years, the retrospective pattern had relative biases that were greater than the base case (Figure C32). The six year average Mohn's rho was -0.36 for F, 0.66 for SSB, and 0.35 for age 1 recruitment.

A sensitivity model was examined where CVs of both the NEFSC spring and fall surveys were doubled, annual recruitment deviation CVs were increased from 0.5 to 0.6, and input effective sample sizes for the fishery and survey age comps were adjusted to approximately equal the means of the estimated effective sample sizes from the assessment model to produce root mean square errors (RMSEs) closer to 1.0. The effect of the reweighting was that abundances were scaled lower (Table C6). Specifically, SSB in 1970 was 186,000 mt instead of 262,000 mt. Also, current biomass in the reweighted base model dropped to 56,000 mt from 126,000 mt in the base model. The RMSEs for the survey indices decreased from around 2.0 in the base model to 1.3 in the reweighted base model, while the RMSE for the annual recruitment deviations remained around 1.0. A retrospective run of the reweighted base model led to retrospective patterns where predicted F and SSB time series from the peels consistently crossed predicted F and SSB time series from the full model (Figure C33). The seven year average Mohn's rho was -0.26 for F, 0.25 for SSB, and 0.27 for age 1 recruitment.

5.0 Biological Reference Points (BRPs)

The NOAA Toolbox program YPR version 3.3 was used to calculate a deterministic value for the Fmsy proxy of $F_{40\%}$ given average vectors for the most recent 5 years (2009-2013) for SSB weights at age, catch weights at age, maturity at age (which is time invariant), and selectivity at age (Table C16). Expressed as the average F experienced at ages 5-7, the estimate is $F_{40\%(5\text{-}7)} = 0.27$.

As was done for SARC 50, the NMFS Toolbox program AGEPRO was used to determine equilibrium, median values for $SSB_{MSY,}$ and MSY under the $F_{40\%}$ from the YPR analysis. The selectivity ogive and weights used in the determination of $F_{40\%}$ (Table C16) were applied to the population for 100 years and the median, 5th, and 95th percentiles of 1,000 bootstraps are reported for SSB and yield (Table C17). The recruitment option employed was to sample from the empirical cdf (Model 14 in AGEPRO version 4.2). The long-term median recruitment from this projection is 17.6 million age 1 fish, with 90% CI ranging from 8 million to 40 million fish. The estimates of equilibrium SSB_{MSY} and MSY are 76,900 mt and 14,800 mt,

respectively. There is a 90% probability that SSB_{MSY} is between 59,100 and 102,500 mt and that MSY is between 10,700 and 21,400 mt.

Biological Reference Points Sensitivity Analysis

To evaluate the sensitivity of reference points to the model estimated dome-shaped selectivities, results from the flat survey selectivity sensitivity model run were also used to estimate reference points. Following the same methodology, the average $F_{40\%}$ on ages 5 to 7 was 0.24, the proxy for SSB_{MSY} was 51,100 mt, and the proxy MSY was 10,500 mt. Thus, if the survey selectivity at ages 6-9 is fixed at 1.0, rather than having a dome shape, then the biomass reference points would be 29-34% lower.

6.0 Projections

Three projection scenarios were explored with the same AGEPRO configuration used to determine the biomass reference points: $F_{40\%(5\text{-}7)} = 0.27$, $0.75 * F_{40\%(5\text{-}7)} = 0.20$, and status-quo with $F_{2013(5\text{-}7)} = 0.10$. For all three scenarios, total catch in 2014 was assumed to be 6,817 mt, which is the estimate of 2014 total catch provided by the Greater Atlantic Regional Fisheries Office (GARFO) for projections. Following the methods laid out in the 3rd Groundfish Assessment Review Meeting (GARM III; NEFSC 2008), base model projections were not Mohn's rho-adjusted, because the Mohn's rho-adjusted estimates of 2013 SSB and F fell within the 90% probability intervals of the unadjusted estimates of 2013 SSB and F.

Projections are summarized for various percentiles of spawning stock biomass and catch under all three scenarios in Tables C18 and C19. Under the $F_{40\%}$ and $0.75 * F_{40\%}$ scenarios, spawning biomass decreases from SSB_{2013}=126,000 mt to SSB_{2014} = 123,000 mt, increases to SSB_{2015} = 132,000 mt, and then decreases until it reaches equilibrium at the projected F. Projecting at $0.75*F_{40\%}$, the median SSB equilibrates at 92,300 mt, while at $F_{40\%}$ the median SSB equilibrates at 76,900 mt (the proxy for SSB_{MSY}). Under $F_{status\text{-}quo}$, spawning biomass increases from SSB_{2014} = 123,000 mt, and the median SSB equilibrates at 130,000 mt.

Projected catch includes both commercial and recreational landings and discards. Under $F_{status\text{-}quo}$, median projected catch increases from 6,800 mt in 2014 to 11,300 mt in 2018, then decreases until equilibrating around 8,800 mt (Table C19). Projecting at $0.75*F_{40\%}$, the median catch increases to 19,000 mt in 2017, then decreases until equilibrating around 13,300 mt. Projecting at $F_{40\%}$, median catch increases to 22,800 mt in 2017, then decreases until equilibrating around 14,800 mt (the proxy for MSY).

Projections Sensitivity Analysis

Three projection scenarios were explored for the flat survey selectivity sensitivity model with the same AGEPRO configuration used in the base model projections: $F_{40\%(5\text{-}7)} = 0.24$, $0.75 * F_{40\%(5\text{-}7)} = 0.18$, and status-quo with $F_{2013(5\text{-}7)} = 0.20$. Following the methods laid out in GARM III (NEFSC 2008), flat survey selectivity sensitivity model projections were Mohn's rho-adjusted, because the Mohn's rho-adjusted estimates of 2013 SSB and F fell outside the 90% probability intervals of the unadjusted estimates of 2013 SSB and F.

Projections are summarized for various percentiles of spawning stock biomass and catch under all three scenarios in Tables C20 and C21. Under all three scenarios, spawning biomass increases from the Mohn's rho-adjusted SSB_{2013}=29,000 mt until it reaches equilibrium at the projected F. Projecting at $F_{status\text{-}quo}$, the median SSB equilibrates at 58,400 mt. Projecting at

$0.75*F_{40\%}$, the median SSB equilibrates at 60,300 mt, while at $F_{40\%}$ the median SSB equilibrates at 51,100 mt (the proxy for SSB_{MSY}).

Projected catch includes both commercial and recreational landings and discards. Projecting at $F_{status\text{-}quo}$, median projected catch decreases from 6,800 mt in 2014 to 5,200 mt in 2015, then increases until equilibrating around 9,800 mt (Table C21). Projecting at $0.75*F_{40\%}$, the median catch decreases to 5,000 mt in 2015, then increases until equilibrating around 9,600 mt. Projecting at $F_{40\%}$, median catch decreases to 6,400 mt in 2015, then increases until equilibrating around 10,500 mt (the proxy for MSY).

Because of uncertainty in the high estimate of 2012 age 1 recruits (i.e., the 2011 year-class), the sensitivity of short term (i.e., 2015) projections to 2012 recruitment was explored by reducing the 2012 age 1 recruits by 50%, which brought 2012 recruitment more in line with mean recruitment. Three projection scenarios were explored for the reduced 2012 recruitment sensitivity run with the same AGEPRO configuration used in the base model projections: $F_{40\%(5\text{-}7)} = 0.27$, $0.75* F_{40\%(5\text{-}7)} = 0.20$, and status-quo with $F_{2013(5\text{-}7)} = 0.10$.

Projections are summarized for various percentiles of spawning stock biomass and catch under all 3 scenarios in Tables C22 and C23. Under all three scenarios, spawning biomass increases from 121,000 mt in 2014 to 123,000 mt in 2015.

Projected catch includes both commercial and recreational landings and discards. Projecting at $F_{status\text{-}quo}$, median projected catch increases from 6,800 mt in 2014 to 8,000 mt in 2015 (Table C23). Projecting at $0.75*F_{40\%}$, the median catch increases to 15,900 mt in 2015. Projecting at $F_{40\%}$, median catch increases to 20,600 mt in 2015.

7.0 Summary

Stock Status

Following the methods laid out in GARM III (NEFSC 2008), terminal year SSB and F estimates were not Mohn's rho-adjusted for stock status determination, because the Mohn's rho-adjusted estimates of 2013 SSB and F fell within the 90% probability intervals of the unadjusted estimates of 2013 SSB and F (Figure C34). The estimate of SSB_{2013} is 126,000 mt, which is greater than the median estimate of SSB_{MSY} (76,900 mt). Therefore, the pollock stock is not overfished. The estimate of average F on ages 5 to 7 in 2013 is 0.10, which is less than the F_{MSY} proxy (0.27), therefore overfishing is not occurring.

Stock Status Sensitivity Analysis

The sensitivity of stock status to the model estimated dome-shaped selectivities was evaluated by comparing current F and SSB estimates from the sensitivity model with flat survey selectivity for ages 6-9 to their corresponding reference points. Following the methods laid out in GARM III (NEFSC 2008), terminal year SSB and F estimates were Mohn's rho-adjusted for stock status determination because the Mohn's rho-adjusted estimates of 2013 SSB and F fell outside the 90% probability intervals of the unadjusted estimates of 2013 SSB and F. The estimate of SSB_{2013} is 29,000 mt, which is less than the median estimate of SSB_{MSY} (51,100 mt), but greater than $B_{THRESHOLD}$ (25,600 mt). Therefore, the pollock stock is not overfished. The Mohn's rho-adjusted estimate of average F on ages 5 to 7 in 2013 is 0.30, which is greater than the F_{MSY} proxy (0.24), therefore overfishing is occurring. It was therefore concluded that stock status is sensitive to the shape of survey selectivity at older ages.

8.0 References Cited

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Table C1. Total catch (mt) of pollock (*Pollachius virens*) in US areas 5 & 6 by commercial and recreational fisheries.

Year	US Landings	US Discards	Canadian Landings	Distant Water Fleet Landings	**Commercial Total mt**	Recreational Landings	Recreational Discards	**Recreational Total mt**	Total Catch (mt)
1960	8190	0	2211	0	10401	0	0	0	10401
1961	7861	0	359	0	8220	0	0	0	8220
1962	5550	0	601	0	6151	0	0	0	6151
1963	4673	0	953	615	6241	0	0	0	6241
1964	4764	0	1942	2298	9004	0	0	0	9004
1965	4903	0	2044	2040	8987	0	0	0	8987
1966	3232	0	4012	2664	9908	0	0	0	9908
1967	2741	0	5287	449	8477	0	0	0	8477
1968	2913	0	1740	499	5152	0	0	0	5152
1969	3521	0	2443	3872	9836	0	0	0	9836
1970	3586	0	853	7116	11555	0	0	0	11555
1971	4734	0	1636	7949	14319	0	0	0	14319
1972	5248	0	1366	6381	12995	0	0	0	12995
1973	5753	0	1727	5600	13080	0	0	0	13080
1974	7720	0	3539	755	12014	0	0	0	12014
1975	8190	0	4736	556	13482	0	0	0	13482
1976	9593	0	2116	1022	12731	0	0	0	12731
1977	11999	0	3413	104	15516	0	0	0	15516
1978	16758	0	4754	0	21512	0	0	0	21512
1979	14613	0	3032	0	17645	0	0	0	17645
1980	16567	0	5634	0	22201	0	0	0	22201
1981	17766	0	4050	0	21816	677	386	1063	22879
1982	13961	0	5373	1	19335	737	715	1452	20787
1983	13842	0	4383	0	18225	523	695	1218	19443
1984	17657	0	3290	0	20947	103	62	165	21112
1985	19192	0	1764	0	20956	233	55	288	21244
1986	24339	0	654	1	24994	129	32	161	25155
1987	20251	0	0	0	20251	104	178	282	20533
1988	14830	0	0	0	14830	150	385	535	15365
1989	10553	473	0	0	11025	233	224	457	11482
1990	9559	107	0	0	9666	140	110	250	9916
1991	7886	223	0	0	8109	90	274	364	8473
1992	7184	196	0	0	7380	45	45	90	7470
1993	5674	100	0	0	5774	47	55	102	5876
1994	3763	154	0	0	3918	228	192	420	4338
1995	3352	192	0	0	3544	222	488	710	4254

1996	2962	230	0	0	3192	305	212	517	3709
1997	4264	124	0	0	4388	177	163	340	4728
1998	5572	68	0	0	5640	116	176	292	5932
1999	4590	141	0	0	4730	80	134	214	4944
2000	4043	117	0	0	4160	219	338	557	4717
2001	4109	73	0	0	4182	424	830	1254	5436
2002	3580	68	0	0	3648	492	581	1073	4721
2003	4794	45	0	0	4839	449	448	897	5736
2004	5070	104	0	0	5174	558	343	901	6075
2005	6509	100	0	0	6609	425	216	641	7250
2006	6067	73	0	0	6140	700	270	970	7110
2007	8372	157	0	0	8529	591	188	779	9308
2008	10040	355	0	0	10395	929	915	1844	12239
2009	7504	279	0	0	7783	583	400	983	8766
2010	5153	97	0	0	5250	1338	805	2143	7393
2011	7211	174	0	0	7385	1450	926	2376	9761
2012	6742	108	0	0	6850	588	855	1443	8293
2013	5058	168	0	0	5226	1623	1455	3078	8304

Table C2. Estimated recreational landings (mt) and discards (mt) of pollock (*Pollachius virens*) from the Marine Recreational Statistics Survey (MRFSS) and the Marine Recreational Information Program (MRIP). MRFSS estimates were converted to MRIP equivalents for 1981-2003.

Year	Recreational Landings MRFSS (mt)	Recreational Landings MRIP (mt)	Recreational Discards MRFSS (mt)	Recreational Discards MRIP (mt)
1981	752	677	407	386
1982	819	737	755	715
1983	581	523	733	695
1984	115	103	65	62
1985	259	233	58	55
1986	143	129	34	32
1987	115	104	187	178
1988	167	150	406	385
1989	259	233	236	224
1990	155	140	116	110
1991	100	90	289	274
1992	50	45	47	45
1993	52	47	58	55
1994	253	228	202	192
1995	247	222	514	488
1996	339	305	223	212
1997	196	177	172	163
1998	128	116	186	176
1999	89	80	141	134
2000	243	219	356	338
2001	471	424	875	830
2002	547	492	613	581
2003	499	449	472	448
2004	661	558	198	343
2005	509	425	266	216
2006	578	700	251	270
2007	537	591	227	188
2008	942	929	923	915
2009	562	583	468	400
2010	1904	1338	1019	805
2011	1613	1450	930	926
2012	---	588	---	855
2013	---	1623	---	1455

Table C3. Estimates of recreational landings (top row) and discards (bottom row) of pollock (*Pollachius virens*) in numbers (left column) and weight (right column) form the Marine Recreational Statistics Survey (MRFSS) and Marine Recreational Information Program (MRIP). Percentage difference between MRSS and MRIP estimates is (MRIP-MRFSS)/MRFSS. Positive % Delta value indicates MRIP estimate is greater than MRFSS estimate.

Landings (numbers of fish)				Landings (kg)			
Year	MRFSS	MRIP	% Delta	Year	MRFSS	MRIP	% Delta
2004	223,697	192,221	-14%	2004	661,003	557,713	-16%
2005	156,804	130,694	-17%	2005	509,185	425,177	-16%
2006	175,068	204,247	17%	2006	577,685	699,949	21%
2007	161,172	178,884	11%	2007	536,774	591,266	10%
2008	241,974	237,055	-2%	2008	941,977	928,900	-1%
2009	144,660	149,794	4%	2009	561,560	582,679	4%
2010	541,332	381,069	-30%	2010	1,904,304	1,338,195	-30%
2011	463,419	411,037	-11%	2011	1,613,170	1,450,284	-10%
Total	2,108,125	1,885,001	-11%	Total	7,305,658	6,574,164	-10%

Discards (numbers of fish)				Discards (kg)			
Year	MRFSS	MRIP	% Delta	Year	MRFSS	MRIP	% Delta
2004	83,932	144,348	72%	2004	198,299	342,606	73%
2005	97,328	79,907	-18%	2005	266,455	215,596	-19%
2006	103,168	111,393	8%	2006	250,954	269,787	8%
2007	77,864	66,042	-15%	2007	227,294	187,550	-17%
2008	256,483	253,565	-1%	2008	923,376	914,542	-1%
2009	142,950	125,798	-12%	2009	467,883	399,979	-15%
2010	350,715	277,109	-21%	2010	1,018,962	804,735	-21%
2011	315,558	312,681	-1%	2011	929,566	926,421	0%
Total	1,427,997	1,370,843	-4%	Total	4,282,788	4,061,216	-5%

Table C4. Port samples (sampling intensity) for pollock (*Pollachius virens*).

Year	Number of Fish Lengths	Number of Aged Fish	Commercial Landings (mt)	Lengths per mt	Ages per mt
1970	396	---	3586	0.11	---
1971	57	---	4734	0.01	---
1972	633	---	5248	0.12	---
1973	965	---	5753	0.17	---
1974	1053	---	7720	0.14	---
1975	548	---	8190	0.07	---
1976	497	60	9593	0.05	0.01
1977	4695	1099	11999	0.39	0.09
1978	2159	451	16758	0.13	0.03
1979	5716	1365	14613	0.39	0.09
1980	2412	548	16567	0.15	0.03
1981	5448	1346	17766	0.31	0.08
1982	5809	1314	13961	0.42	0.09
1983	9616	2415	13842	0.69	0.17
1984	7605	1811	17657	0.43	0.10
1985	7900	2050	19192	0.41	0.11
1986	9515	2438	24339	0.39	0.10
1987	8128	2162	20251	0.40	0.11
1988	9067	2128	14830	0.61	0.14
1989	7954	1853	10553	0.75	0.18
1990	6179	1429	9559	0.65	0.15
1991	6089	1418	7886	0.77	0.18
1992	6071	1405	7184	0.85	0.20
1993	4733	737	5674	0.83	0.13
1994	4466	1121	3763	1.19	0.30
1995	3043	753	3352	0.91	0.22
1996	3879	889	2962	1.31	0.30
1997	6738	1574	4264	1.58	0.37
1998	3198	822	5572	0.57	0.15
1999	4134	1168	4590	0.90	0.25
2000	3617	1006	4043	0.89	0.25
2001	5087	1385	4109	1.24	0.34
2002	3240	1133	3580	0.91	0.32
2003	9719	3360	4794	2.03	0.70
2004	8996	1640	5070	1.77	0.32
2005	7599	1598	6509	1.17	0.25
2006	8396	1985	6067	1.38	0.33
2007	7606	1802	8372	0.91	0.22

2008	7807	1558	10040	0.78	0.16
2009	8204	1612	7504	1.09	0.21
2010	10252	2445	5153	1.99	0.47
2011	9884	2198	7211	1.37	0.30
2012	9241	2081	6742	1.37	0.31
2013	8909	2447	5058	1.76	0.48

Table C5. Ratios of commercial discards at age for pollock (*Pollachius virens*) from the revised SARC 50 base model (i.e., with revised commercial discards at age for 2001-2008) to commercial discards at age from the original SARC 50 base model. Ratios greater than 1.0 (blue shading) indicate a greater proportion at age for the revised SARC 50 base model. Empty cells result from division by zero.

Year	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8	Age9+
1989	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1990	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
1991	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
1992	1.00	1.00	1.00	1.00	1.00				
1993	1.00	1.00	1.00	1.00	1.00				
1994	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1995	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1996	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1998	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
1999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
2001		1.00	1.10	0.75	1.00	1.00	1.00		
2002		0.81	1.19	0.86	0.81	0.81	0.00	0.00	
2003		2.16	0.81	0.68	0.51	0.68	0.68	0.68	
2004	1.59	0.85	1.21	0.54	0.54	0.41	0.82	1.09	
2005	0.42	2.54	0.97	0.95	1.06	0.85	0.85	0.56	
2006	0.45		1.27	0.60	0.91	0.91	1.09	0.91	
2007	1.29	3.88	1.62	0.73	1.13	0.80	0.55	0.40	
2008	6.24	1.69	0.80	0.70	0.63	0.68	0.73	0.75	

Table C6. Age Structured Assessment Program (ASAP) model results for the SARC 50 base model, revised SARC 50 base model (i.e., with revised commercial discards of pollock (*Pollachius virens*) at age for 2001-2008), 2014 base model, 2014 base model with flat survey selectivity patterns, and reweighted 2014 base model. SSB0 is unexploited spawning biomass. The terminal year for the two SARC 50 models is 2009. The terminal year for the three 2014 models is 2013. Only the 2014 base model and 2014 base model with flat survey selectivity patterns use the same data. Therefore, only the likelihood components of those two models are directly comparable.

Model estimate	SARC 50 base	SARC 50 base revised	2014 base	2014 base w/ flat sel	2014 base reweighted
lk.total	4531	4537	**4316**	4349	4454
lk.catch.total	402	402	**453**	456	454
lk.discard.total	648	648	**-31**	-31	-32
lk.index.fit.total	168	168	**187**	240	142
lk.catch.age.comp	878	879	**970**	978	1310
lk.discards.age.comp	539	545	**656**	657	826
lk.index.age.comp	1475	1474	**1623**	1607	1304
lk.Recruit.devs	420	420	**459**	441	449
R0	26431	20573	**19249**	15435	15989
R1970	28663	28731	**26621**	19032	31185
mean.R	21358	21411	**19498**	13029	14831
SSB0	273763	213090	**197398**	158286	163959
SSB1970	297288	298156	**262338**	88937	186172
CV.SSB1970	0.14	0.14	**0.14**	0.11	0.18
SSB1970/SSB0	1.09	1.40	**1.33**	0.56	1.14
SSB2009	196339	196195	**151646**	56456	68210
CV.SSB2009	0.14	0.14	**0.14**	0.13	0.20
SSB2009/SSB0	0.72	0.92	**0.77**	0.36	0.42
SSB2013	--	--	**125879**	48138	55618
CV.SSB2013	--	--	**0.15**	0.16	0.26
SSB2013/SSB0	--	--	**0.64**	0.30	0.34
F1970	0.11	0.11	**0.12**	0.21	0.14
CV.F1970	0.13	0.13	**0.13**	0.11	0.13
F2009	0.07	0.07	**0.09**	0.18	0.18
CV.F2009	0.16	0.16	**0.14**	0.12	0.17
F2013	--	--	**0.10**	0.20	0.19
CV.F2013	--	--	**0.18**	0.19	0.27
steepness	0.66	0.60	**0.56**	0.62	0.53
CV.steepness	0.24	0.28	**0.24**	0.12	0.18
Spring.index.q	2.53E-05	2.53E-05	**2.92E-05**	5.66E-05	4.71E-05
Fall.index.q	1.36E-05	1.35E-05	**1.60E-05**	2.73E-05	2.30E-05

Table C7. Northeast Fisheries Science Center (NEFSC) spring survey age structure for pollock (*Pollachius virens*).

			N/tow at age								
Year	N/tow	CV	1	2	3	4	5	6	7	8	9+
1970	1.09	0.24	0.070	0.035	0.108	0.059	0.033	0.061	0.090	0.163	0.383
1971	0.80	0.18	0.044	0.115	0.164	0.101	0.075	0.079	0.010	0.068	0.345
1972	3.38	0.50	0.157	0.473	0.193	0.008	0.018	0.006	0.016	0.035	0.096
1973	4.56	0.45	0.001	0.722	0.129	0.037	0.027	0.006	0.003	0.020	0.056
1974	1.34	0.25	0.000	0.048	0.424	0.121	0.042	0.107	0.050	0.016	0.192
1975	1.43	0.31	0.000	0.163	0.120	0.235	0.027	0.051	0.061	0.057	0.286
1976	1.69	0.19	0.029	0.059	0.099	0.102	0.151	0.067	0.102	0.103	0.289
1977	1.61	0.32	0.067	0.296	0.136	0.040	0.094	0.171	0.089	0.065	0.042
1978	1.94	0.50	0.000	0.139	0.213	0.265	0.162	0.060	0.045	0.024	0.093
1979	0.95	0.19	0.117	0.054	0.089	0.076	0.143	0.110	0.065	0.146	0.200
1980	1.43	0.32	0.070	0.127	0.065	0.206	0.174	0.108	0.166	0.038	0.047
1981	1.43	0.25	0.004	0.263	0.034	0.051	0.114	0.147	0.049	0.043	0.296
1982	3.96	0.46	0.027	0.382	0.216	0.185	0.031	0.067	0.029	0.029	0.034
1983	0.88	0.33	0.650	0.067	0.022	0.033	0.002	0.000	0.054	0.030	0.141
1984	1.03	0.27	0.167	0.124	0.112	0.119	0.112	0.099	0.044	0.037	0.185
1985	15.20	0.85	0.001	0.022	0.292	0.236	0.299	0.117	0.016	0.001	0.015
1986	1.88	0.42	0.026	0.079	0.036	0.105	0.054	0.222	0.203	0.069	0.207
1987	1.66	0.68	0.092	0.549	0.121	0.015	0.021	0.022	0.045	0.048	0.087
1988	0.78	0.23	0.517	0.031	0.100	0.018	0.000	0.039	0.028	0.072	0.195
1989	1.90	0.50	0.030	0.065	0.055	0.230	0.215	0.149	0.090	0.076	0.091
1990	0.65	0.34	0.000	0.038	0.369	0.143	0.050	0.080	0.064	0.051	0.206
1991	2.05	0.26	0.053	0.037	0.211	0.287	0.151	0.126	0.077	0.005	0.052
1992	1.75	0.30	0.408	0.111	0.083	0.081	0.094	0.047	0.051	0.022	0.104
1993	1.62	0.34	0.363	0.171	0.202	0.121	0.028	0.055	0.030	0.009	0.022
1994	0.58	0.20	0.005	0.079	0.171	0.220	0.128	0.123	0.147	0.082	0.045
1995	3.58	0.83	0.001	0.006	0.242	0.551	0.143	0.035	0.001	0.014	0.007

1996	0.64	0.43	0.372	0.033	0.012	0.110	0.241	0.129	0.070	0.034	0.000
1997	3.54	0.40	0.145	0.135	0.220	0.168	0.202	0.055	0.055	0.010	0.013
1998	2.66	0.37	0.284	0.098	0.367	0.068	0.022	0.065	0.061	0.026	0.011
1999	2.22	0.45	0.294	0.502	0.081	0.058	0.017	0.023	0.019	0.006	0.000
2000	1.40	0.38	0.524	0.076	0.084	0.060	0.110	0.076	0.039	0.020	0.011
2001	1.72	0.31	0.391	0.097	0.069	0.044	0.150	0.143	0.067	0.029	0.010
2002	0.72	0.28	0.055	0.029	0.054	0.303	0.203	0.253	0.079	0.024	0.000
2003	1.44	0.69	0.210	0.597	0.032	0.051	0.026	0.036	0.028	0.011	0.009
2004	0.47	0.40	0.141	0.411	0.097	0.020	0.063	0.133	0.062	0.026	0.048
2005	2.17	0.38	0.003	0.210	0.007	0.014	0.063	0.430	0.173	0.071	0.029
2006	0.94	0.25	0.091	0.020	0.023	0.008	0.058	0.331	0.402	0.054	0.012
2007	2.09	0.24	0.112	0.067	0.097	0.042	0.152	0.204	0.316	0.011	0.000
2008	2.04	0.23	0.049	0.011	0.003	0.030	0.100	0.124	0.360	0.121	0.202
2009	0.97	0.26	0.132	0.226	0.133	0.008	0.093	0.060	0.032	0.192	0.097
2010	1.21	0.43	0.549	0.056	0.173	0.087	0.076	0.026	0.084	0.102	0.057
2011	3.15	0.75	0.014	0.064	0.423	0.555	0.816	0.813	0.179	0.023	0.262
2012	0.82	0.45	0.366	0.037	0.039	0.011	0.034	0.015	0.093	0.021	0.208
2013	0.82	0.25	0.009	0.080	0.214	0.117	0.028	0.101	0.053	0.092	0.124

Table C8. Northeast Fisheries Science Center (NEFSC) fall survey age structure for pollock (*Pollachius virens*).

			N/tow at age								
Year	N/tow	CV	1	2	3	4	5	6	7	8	9+
1970	0.55	0.20	0.129	0.162	0.011	0.191	0.168	0.125	0.081	0.053	0.080
1971	0.95	0.43	0.019	0.372	0.181	0.017	0.045	0.118	0.019	0.071	0.159
1972	1.48	0.26	0.231	0.198	0.142	0.062	0.053	0.063	0.057	0.050	0.143
1973	0.97	0.21	0.013	0.258	0.079	0.051	0.085	0.073	0.078	0.086	0.278
1974	1.01	0.35	0.002	0.077	0.320	0.234	0.096	0.084	0.112	0.000	0.075
1975	0.70	0.38	0.341	0.056	0.048	0.172	0.098	0.068	0.117	0.023	0.077
1976	4.30	0.48	0.009	0.007	0.039	0.135	0.451	0.152	0.081	0.049	0.077
1977	2.34	0.31	0.022	0.097	0.118	0.118	0.215	0.169	0.097	0.035	0.129
1978	1.06	0.21	0.031	0.207	0.042	0.047	0.103	0.077	0.162	0.076	0.257
1979	0.87	0.19	0.014	0.020	0.209	0.167	0.093	0.107	0.082	0.099	0.210
1980	0.49	0.21	0.115	0.013	0.022	0.100	0.194	0.062	0.096	0.099	0.300
1981	1.10	0.68	0.024	0.161	0.469	0.125	0.118	0.029	0.024	0.003	0.050
1982	0.79	0.36	0.104	0.279	0.281	0.067	0.023	0.072	0.060	0.000	0.116
1983	1.00	0.44	0.505	0.015	0.070	0.041	0.070	0.017	0.057	0.078	0.148
1984	0.28	0.36	0.371	0.440	0.059	0.014	0.009	0.071	0.009	0.009	0.019
1985	1.11	0.35	0.606	0.044	0.093	0.071	0.072	0.045	0.021	0.000	0.049
1986	0.42	0.28	0.319	0.194	0.075	0.091	0.099	0.102	0.091	0.018	0.013
1987	0.54	0.30	0.078	0.353	0.104	0.000	0.109	0.029	0.124	0.057	0.149
1988	3.96	0.66	0.024	0.029	0.279	0.341	0.109	0.113	0.020	0.048	0.036
1989	1.64	0.63	0.266	0.413	0.222	0.081	0.000	0.000	0.000	0.000	0.019
1990	0.70	0.33	0.013	0.116	0.318	0.196	0.161	0.012	0.029	0.044	0.113
1991	0.70	0.40	0.198	0.094	0.221	0.328	0.080	0.062	0.018	0.000	0.000
1992	0.91	0.53	0.334	0.221	0.146	0.145	0.125	0.018	0.011	0.000	0.000
1993	1.10	0.49	0.442	0.364	0.084	0.030	0.011	0.056	0.000	0.000	0.014
1994	0.37	0.37	0.000	0.136	0.366	0.263	0.189	0.047	0.000	0.000	0.000
1995	0.86	0.41	0.036	0.182	0.547	0.128	0.080	0.027	0.000	0.000	0.000
1996	1.01	0.40	0.285	0.306	0.045	0.210	0.133	0.015	0.006	0.000	0.000

1997	1.70	0.54	0.322	0.372	0.086	0.100	0.101	0.019	0.000	0.000	0.000
1998	2.06	0.66	0.602	0.159	0.154	0.045	0.013	0.017	0.010	0.000	0.000
1999	2.28	0.32	0.222	0.235	0.089	0.226	0.116	0.087	0.019	0.006	0.000
2000	2.45	0.74	0.143	0.795	0.038	0.007	0.011	0.007	0.000	0.000	0.000
2001	2.11	0.32	0.054	0.286	0.225	0.234	0.127	0.043	0.025	0.006	0.000
2002	3.18	0.43	0.064	0.041	0.290	0.217	0.261	0.103	0.024	0.000	0.000
2003	7.74	0.67	0.039	0.255	0.240	0.390	0.067	0.009	0.000	0.000	0.000
2004	3.11	0.55	0.037	0.084	0.535	0.135	0.116	0.065	0.028	0.000	0.000
2005	5.06	0.41	0.006	0.438	0.080	0.177	0.124	0.150	0.022	0.002	0.000
2006	1.67	0.66	0.168	0.477	0.069	0.031	0.061	0.092	0.100	0.004	0.000
2007	0.33	0.26	0.339	0.037	0.000	0.083	0.046	0.233	0.170	0.042	0.051
2008	1.01	0.58	0.151	0.260	0.229	0.079	0.043	0.025	0.047	0.047	0.119
2009	0.29	0.30	0.082	0.168	0.024	0.009	0.000	0.000	0.000	0.008	0.000
2010	1.88	0.55	0.076	0.664	0.296	0.099	0.211	0.168	0.091	0.115	0.164
2011	4.37	0.66	1.233	2.089	0.528	0.252	0.088	0.052	0.019	0.071	0.037
2012	1.59	0.44	0.482	0.429	0.300	0.078	0.154	0.077	0.043	0.009	0.013
2013	1.32	0.50	0.041	1.115	0.127	0.008	0.000	0.031	0.000	0.000	0.000

Table C9. Estimated spawning biomass (mt) of pollock (*Pollachius virens*)at age per year from the Age Structured Assessment Program (ASAP) base model (reported to 3 significant digits). Spawning weights were calculated as January 1 weights by applying the Rivard method to mid-year catch weights.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+	Total
1970	43	496	1990	5840	12200	10400	17200	31900	182000	262000
1971	30	578	3620	6390	10900	15000	11400	18000	221000	287000
1972	96	654	5250	13600	12500	14800	16400	11700	202000	277000
1973	27	919	4850	15600	19000	13900	13800	15600	140000	224000
1974	29	461	7410	11700	20800	18700	11200	11100	137000	218000
1975	34	488	3530	27800	20200	24200	19800	11000	133000	240000
1976	34	419	3700	9450	41800	22700	22400	17500	121000	239000
1977	32	595	3130	9440	15100	46100	21300	21200	111000	228000
1978	12	520	4380	9570	15100	17800	45000	20100	104000	216000
1979	22	159	3740	10900	14800	17000	16800	41100	112000	217000
1980	68	373	1170	10100	16800	16300	14800	14600	129000	203000
1981	70	565	2770	3610	14900	16800	13200	12400	118000	182000
1982	17	391	3540	7190	5470	14800	13500	10800	113000	169000
1983	53	201	2190	11200	10100	4860	11900	11000	107000	159000
1984	30	444	1370	8190	17100	8100	3660	9340	83300	132000
1985	12	189	2640	3690	12100	16200	6100	2900	82300	126000
1986	35	203	1130	7740	4850	10600	12300	5250	68500	111000
1987	13	284	1470	4110	11700	3860	6490	7160	55800	90900
1988	31	133	1920	3980	5710	9550	2250	3670	44500	71700
1989	20	220	1070	6520	5780	4650	6040	1300	38800	64400
1990	13	102	1520	3780	9610	5400	3380	4150	28900	56900
1991	15	68	693	5930	5860	10000	4320	2430	28600	57900
1992	33	149	521	3000	10300	6630	8760	3540	26000	58900
1993	38	200	838	2400	4750	11900	6200	7490	25000	58800
1994	23	205	908	2410	3770	5500	11100	5480	28800	58200
1995	28	167	1420	3810	5560	4850	5410	10300	35200	66700
1996	40	251	1230	7270	11600	8730	5100	5030	35000	74300
1997	35	319	1440	5020	13800	15700	9430	4920	34400	85100
1998	59	186	1930	4740	8650	17300	15800	8970	33600	91200
1999	86	394	1230	7500	9480	10600	17800	15200	36600	98900
2000	90	402	1910	5620	15400	12100	11000	17200	41800	106000
2001	32	494	1940	7930	10400	19400	13400	10900	54500	119000
2002	35	212	3490	9260	20700	12900	20200	12900	53700	133000
2003	16	295	1240	16100	22600	25800	13900	20300	58500	159000
2004	9	110	2250	5320	27600	28900	26500	13000	70100	174000
2005	15	148	876	9810	11700	34600	30600	25100	67800	181000
2006	19	104	1310	3870	18100	14900	36900	29800	88300	193000

2007	38	278	690	4850	6780	23300	17000	35600	89300	178000
2008	58	359	2130	3100	10800	10300	26600	16100	96000	165000
2009	65	465	2210	6510	6190	13600	10700	21800	90100	152000
2010	22	223	2450	6790	11200	7690	13200	8660	88000	138000
2011	54	258	1030	7480	12300	14200	7830	11500	82700	137000
2012	100	368	1970	4620	14000	15000	13700	6410	72500	129000
2013	18	701	1960	6430	8840	17000	14400	11200	65400	126000

Table C10. Estimated numbers of pollock (*Pollachius virens*) (thousands of fish) at age per year from the Age Structured Assessment Program (ASAP) base model (reported to 3 significant digits).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+	Total
1970	26600	18200	8830	7370	6740	3910	4550	6310	25000	108000
1971	25000	21800	14700	6830	5380	4830	2800	3400	25000	110000
1972	53300	20500	17600	11300	4900	3770	3390	2060	22700	140000
1973	19500	43700	16600	13700	8350	3570	2750	2560	19900	131000
1974	20700	16000	35300	12800	9920	5920	2530	2040	18000	123000
1975	21200	16900	13000	27600	9550	7310	4360	1930	16100	118000
1976	24500	17300	13700	10200	20800	7070	5410	3330	14500	117000
1977	22600	20100	14100	10800	7650	15400	5240	4140	14400	114000
1978	7310	18500	16300	10900	7920	5530	11100	3940	14800	96300
1979	15400	5980	14900	12300	7570	5350	3730	7970	14800	88000
1980	34000	12600	4830	11300	8640	5200	3680	2710	17900	101000
1981	23300	27900	10100	3530	7360	5410	3260	2500	16200	99600
1982	9600	18600	21700	7140	2200	4420	3260	2160	14500	83600
1983	23900	7570	14300	15300	4460	1330	2680	2170	13000	84700
1984	9910	19000	5880	10200	9640	2710	809	1790	11800	71700
1985	10400	8070	15000	4130	6120	5530	1560	518	10500	61800
1986	17600	8390	6330	10400	2430	3420	3090	980	8540	61200
1987	10700	14000	6750	4750	6360	1250	1620	1460	6920	53800
1988	17000	8550	11200	5050	2910	3270	590	764	5960	55300
1989	7560	13400	6790	8400	3130	1540	1590	288	4900	47600
1990	6410	5960	10700	5150	5520	1820	838	871	3930	41200
1991	10400	5110	4780	8220	3520	3400	1060	490	3600	40600
1992	16700	8300	4110	3730	5850	2310	2150	672	3150	47000
1993	19100	13500	6740	3250	2730	4010	1530	1420	2960	55200
1994	11500	15500	11000	5360	2430	1940	2770	1060	3380	54900
1995	12800	9310	12500	8820	4240	1820	1350	1940	3510	56300
1996	20100	10400	7530	10100	6990	3200	1290	961	4280	64900
1997	13300	16300	8430	6100	8070	5390	2350	950	4200	65100
1998	26900	10800	13300	6850	4900	6220	3960	1730	4120	78800
1999	33200	22000	8830	10800	5500	3770	4540	2890	4650	96200
2000	40900	27100	17900	7190	8730	4280	2800	3380	6000	118000
2001	17700	33300	22100	14600	5780	6800	3210	2110	7490	113000
2002	28900	14300	27000	17800	11600	4480	5100	2420	7710	119000
2003	11500	23700	11700	22000	14400	9180	3430	3890	8140	108000
2004	15500	9410	19300	9560	17800	11400	7020	2620	9640	102000
2005	9060	12700	7690	15800	7770	14300	8890	5350	9760	91300
2006	15600	7410	10400	6280	12800	6240	11200	6750	11900	88600
2007	17000	12700	6060	8450	5100	10300	4880	8520	14800	87800

2008	20800	13900	10400	4940	6850	4070	7890	3600	18200	90700
2009	12500	17000	11400	8460	3970	5350	2980	5460	16800	83900
2010	18400	10200	13900	9250	6820	3120	3980	2110	17200	85000
2011	20600	15100	8300	11300	7430	5350	2330	2830	15100	88300
2012	50000	16900	12300	6720	9010	5750	3860	1570	13700	120000
2013	8990	40800	13700	9960	5400	7050	4240	2690	11900	105000

Table C11. January 1 weights of pollock (*Pollachius virens*) at age (kg), assumed to reflect spawning weights at age, derived by applying the Rivard method to mid-year catch weights at age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1970	0.08	0.35	0.87	1.34	2.11	2.78	3.81	5.07	7.29
1971	0.06	0.34	0.95	1.58	2.37	3.23	4.11	5.29	8.83
1972	0.09	0.41	1.15	2.03	2.97	4.09	4.88	5.70	8.92
1973	0.07	0.27	1.13	1.92	2.65	4.06	5.07	6.10	7.05
1974	0.07	0.37	0.81	1.55	2.45	3.29	4.46	5.43	7.64
1975	0.08	0.37	1.05	1.70	2.47	3.44	4.59	5.72	8.23
1976	0.07	0.31	1.04	1.57	2.35	3.34	4.18	5.25	8.32
1977	0.07	0.38	0.86	1.48	2.30	3.12	4.10	5.12	7.70
1978	0.08	0.36	1.04	1.48	2.23	3.35	4.09	5.12	7.01
1979	0.07	0.34	0.97	1.50	2.29	3.30	4.54	5.17	7.56
1980	0.10	0.38	0.94	1.50	2.27	3.26	4.07	5.42	7.21
1981	0.15	0.26	1.06	1.73	2.36	3.23	4.08	4.96	7.29
1982	0.09	0.27	0.63	1.70	2.90	3.49	4.17	5.03	7.77
1983	0.11	0.34	0.59	1.24	2.64	3.81	4.50	5.06	8.24
1984	0.15	0.30	0.90	1.36	2.07	3.11	4.57	5.23	7.07
1985	0.06	0.30	0.68	1.51	2.31	3.05	3.96	5.61	7.86
1986	0.10	0.31	0.69	1.26	2.33	3.22	4.03	5.37	8.03
1987	0.06	0.26	0.84	1.46	2.14	3.22	4.06	4.91	8.07
1988	0.09	0.20	0.66	1.33	2.29	3.04	3.85	4.82	7.47
1989	0.13	0.21	0.61	1.31	2.15	3.15	3.83	4.51	7.91
1990	0.10	0.22	0.55	1.24	2.03	3.09	4.08	4.77	7.36
1991	0.07	0.17	0.56	1.22	1.94	3.07	4.11	4.96	7.95
1992	0.10	0.23	0.49	1.36	2.05	2.98	4.12	5.28	8.25
1993	0.10	0.19	0.48	1.25	2.03	3.09	4.08	5.27	8.44
1994	0.10	0.17	0.32	0.76	1.81	2.95	4.06	5.17	8.53
1995	0.11	0.23	0.44	0.73	1.53	2.78	4.06	5.33	10.05
1996	0.10	0.31	0.63	1.22	1.94	2.84	4.00	5.25	8.17
1997	0.13	0.25	0.66	1.39	1.99	3.02	4.05	5.19	8.20
1998	0.11	0.22	0.56	1.17	2.06	2.90	4.04	5.19	8.17
1999	0.13	0.23	0.54	1.17	2.01	2.92	3.97	5.25	7.89
2000	0.11	0.19	0.41	1.32	2.06	2.95	3.98	5.10	6.97
2001	0.09	0.19	0.34	0.92	2.10	2.97	4.22	5.19	7.29
2002	0.06	0.19	0.50	0.88	2.08	3.00	4.01	5.33	6.97
2003	0.07	0.16	0.41	1.24	1.83	2.92	4.08	5.22	7.20
2004	0.03	0.15	0.45	0.94	1.81	2.65	3.81	4.97	7.28
2005	0.08	0.15	0.44	1.05	1.76	2.52	3.48	4.70	6.95
2006	0.06	0.18	0.49	1.04	1.65	2.49	3.34	4.42	7.40
2007	0.11	0.28	0.44	0.97	1.55	2.35	3.52	4.19	6.04

2008	0.14	0.33	0.79	1.06	1.84	2.63	3.40	4.47	5.29
2009	0.26	0.35	0.75	1.30	1.82	2.64	3.63	4.00	5.37
2010	0.06	0.28	0.68	1.24	1.92	2.56	3.35	4.12	5.13
2011	0.13	0.22	0.48	1.12	1.93	2.76	3.40	4.09	5.49
2012	0.10	0.28	0.62	1.16	1.81	2.72	3.57	4.08	5.29
2013	0.10	0.22	0.55	1.09	1.91	2.51	3.43	4.16	5.50

Table C12. Catch weights of pollock (*Pollachius virens*) at age (kg), assumed to reflect mid-year weights at age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1970	0.16	0.58	1.17	1.78	2.61	3.38	4.49	5.72	7.28
1971	0.16	0.71	1.56	2.12	3.16	4.00	4.99	6.24	8.83
1972	0.16	1.06	1.86	2.65	4.17	5.29	5.95	6.52	8.92
1973	0.16	0.46	1.21	1.98	2.65	3.96	4.86	6.25	7.05
1974	0.16	0.84	1.42	1.98	3.02	4.09	5.03	6.06	7.64
1975	0.16	0.86	1.31	2.04	3.07	3.92	5.14	6.51	8.23
1976	0.16	0.60	1.25	1.89	2.71	3.64	4.46	5.37	8.32
1977	0.16	0.88	1.22	1.75	2.80	3.58	4.62	5.88	7.70
1978	0.16	0.79	1.23	1.79	2.85	4.01	4.66	5.67	7.01
1979	0.16	0.71	1.20	1.83	2.94	3.82	5.15	5.73	7.56
1980	0.16	0.90	1.24	1.87	2.82	3.61	4.33	5.71	7.21
1981	0.20	0.43	1.24	2.42	2.98	3.70	4.61	5.67	7.28
1982	0.17	0.35	0.92	2.33	3.47	4.09	4.69	5.48	7.77
1983	0.18	0.67	0.99	1.66	2.98	4.19	4.95	5.45	8.24
1984	0.21	0.49	1.20	1.87	2.57	3.25	4.98	5.53	7.07
1985	0.14	0.43	0.94	1.91	2.84	3.61	4.83	6.31	7.86
1986	0.16	0.68	1.11	1.69	2.84	3.65	4.50	5.97	8.03
1987	0.11	0.41	1.03	1.91	2.71	3.66	4.51	5.35	8.07
1988	0.14	0.37	1.07	1.71	2.75	3.41	4.04	5.15	7.47
1989	0.17	0.32	1.01	1.60	2.69	3.61	4.30	5.04	7.91
1990	0.13	0.28	0.93	1.53	2.58	3.54	4.60	5.29	7.36
1991	0.13	0.23	1.12	1.59	2.46	3.64	4.76	5.35	7.94
1992	0.14	0.40	1.04	1.64	2.64	3.61	4.67	5.86	8.25
1993	0.13	0.27	0.57	1.51	2.50	3.61	4.62	5.95	8.44
1994	0.15	0.22	0.37	1.01	2.17	3.49	4.56	5.78	8.53
1995	0.18	0.35	0.89	1.44	2.33	3.57	4.73	6.22	10.05
1996	0.16	0.52	1.15	1.67	2.61	3.47	4.48	5.82	8.17
1997	0.17	0.39	0.83	1.68	2.36	3.50	4.73	6.01	8.20
1998	0.16	0.29	0.80	1.64	2.52	3.55	4.66	5.69	8.17
1999	0.16	0.33	1.00	1.70	2.46	3.38	4.44	5.92	7.89
2000	0.14	0.23	0.50	1.75	2.50	3.53	4.69	5.86	6.97
2001	0.13	0.25	0.51	1.70	2.52	3.53	5.05	5.74	7.29
2002	0.10	0.27	0.99	1.50	2.54	3.57	4.55	5.62	6.97
2003	0.10	0.27	0.61	1.54	2.23	3.35	4.66	5.98	7.20
2004	0.06	0.21	0.75	1.45	2.12	3.14	4.34	5.31	7.28
2005	0.12	0.36	0.91	1.47	2.13	2.99	3.85	5.09	6.95
2006	0.13	0.27	0.66	1.19	1.86	2.92	3.74	5.07	7.40
2007	0.19	0.58	0.73	1.42	2.02	2.96	4.24	4.69	6.04
2008	0.22	0.58	1.08	1.54	2.38	3.43	3.91	4.71	5.29

2009	0.27	0.56	0.96	1.57	2.14	2.92	3.83	4.10	5.37
2010	0.11	0.29	0.83	1.59	2.34	3.06	3.84	4.44	5.13
2011	0.19	0.44	0.79	1.50	2.33	3.25	3.78	4.35	5.49
2012	0.15	0.41	0.86	1.71	2.19	3.17	3.93	4.40	5.29
2013	0.15	0.32	0.73	1.39	2.13	2.88	3.72	4.40	5.50

Table C13. Estimated January 1 total biomass (mt) of pollock (*Pollachius virens*) at age per year from the Age Structured Assessment Program (ASAP) base model (reported to 3 significant digits). January 1 weights are the same as spawning weights and were calculated by applying the Rivard method to mid-year catch weights.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+	Total
1970	2130	6360	7680	9870	14200	10900	17300	32000	182000	282000
1971	1500	7410	14000	10800	12700	15600	11500	18000	221000	313000
1972	4800	8390	20300	22900	14500	15400	16600	11800	203000	318000
1973	1370	11800	18700	26300	22100	14500	14000	15600	140000	264000
1974	1450	5910	28600	19800	24300	19500	11300	11100	137000	259000
1975	1690	6260	13600	47000	23600	25200	20000	11000	133000	281000
1976	1720	5370	14300	16000	48800	23600	22600	17500	121000	271000
1977	1580	7630	12100	16000	17600	48000	21500	21200	111000	257000
1978	585	6660	16900	16200	17700	18500	45500	20200	104000	246000
1979	1080	2030	14500	18400	17300	17600	16900	41200	112000	241000
1980	3400	4790	4540	17000	19600	17000	15000	14700	129000	225000
1981	3490	7240	10700	6100	17400	17500	13300	12400	118000	206000
1982	864	5020	13700	12100	6380	15400	13600	10900	113000	191000
1983	2620	2570	8450	19000	11800	5060	12100	11000	107000	180000
1984	1490	5690	5290	13800	19900	8430	3700	9360	83400	151000
1985	622	2420	10200	6230	14100	16900	6160	2910	82400	142000
1986	1760	2600	4370	13100	5650	11000	12500	5260	68600	125000
1987	644	3640	5670	6940	13600	4020	6560	7180	55800	104000
1988	1530	1710	7420	6720	6670	9940	2270	3680	44500	84400
1989	982	2820	4140	11000	6740	4840	6110	1300	38800	76700
1990	641	1310	5860	6390	11200	5620	3420	4160	28900	67500
1991	726	869	2680	10000	6830	10400	4370	2430	28600	66900
1992	1670	1910	2010	5070	12000	6900	8850	3550	26000	68000
1993	1910	2560	3230	4060	5540	12400	6260	7500	25000	68500
1994	1150	2630	3500	4070	4400	5720	11300	5490	28900	67200
1995	1410	2140	5500	6440	6490	5050	5470	10300	35200	78000
1996	2010	3220	4740	12300	13600	9080	5150	5040	35000	90100
1997	1730	4090	5560	8480	16100	16300	9530	4930	34400	101000
1998	2960	2380	7450	8010	10100	18100	16000	8990	33700	108000
1999	4320	5060	4770	12700	11100	11000	18000	15200	36700	119000
2000	4500	5160	7360	9490	18000	12600	11100	17200	41800	127000
2001	1590	6330	7500	13400	12100	20200	13500	10900	54600	140000
2002	1740	2720	13500	15600	24200	13500	20500	12900	53800	158000
2003	805	3780	4800	27300	26300	26800	14000	20300	58600	183000
2004	464	1410	8700	8990	32200	30100	26700	13000	70200	192000
2005	725	1900	3380	16600	13700	36000	30900	25100	67800	196000
2006	935	1330	5070	6530	21200	15500	37300	29800	88400	206000

2007	1870	3570	2670	8200	7910	24200	17200	35700	89400	191000
2008	2920	4600	8230	5240	12600	10700	26800	16100	96100	183000
2009	3240	5960	8530	11000	7220	14100	10800	21800	90200	173000
2010	1110	2850	9450	11500	13100	8000	13300	8680	88000	156000
2011	2680	3310	3980	12600	14300	14800	7910	11600	82800	154000
2012	5000	4720	7600	7800	16300	15600	13800	6430	72600	150000
2013	899	8980	7560	10900	10300	17700	14500	11200	65400	147000

Table C14. Estimated exploitable biomass of pollock (*Pollachius virens*) at age per year from the Age Structured Assessment Program (ASAP) base model (reported to 3 significant digits). Mid-year catch weights were multiplied by numbers at age, and the exploitable fraction was obtained by further multiplying by selectivity at age by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+	Total
1970	0	905	4400	11300	17600	13200	14100	15000	23400	99900
1971	0	1330	9770	12500	17000	19300	9660	8850	28400	107000
1972	0	1860	13900	25800	20400	20000	13900	5610	26000	127000
1973	0	1730	8540	23500	22100	14100	9240	6680	18000	104000
1974	0	1150	21300	21800	30000	24200	8790	5150	17700	130000
1975	0	1250	7230	48700	29300	28700	15500	5230	17000	153000
1976	0	893	7300	16600	56200	25700	16700	7470	15500	146000
1977	0	1520	7300	16300	21400	55100	16700	10200	14200	143000
1978	0	1260	8520	16900	22600	22200	35800	9320	13300	130000
1979	0	365	7610	19400	22200	20400	13300	19000	14400	117000
1980	0	974	2550	18300	24400	18800	11000	6450	16600	99100
1981	376	1890	5850	7500	21900	19900	10300	5870	15200	88800
1982	203	1280	9800	14800	7630	17900	10400	4880	14700	81600
1983	426	885	6770	22400	13300	5500	9060	4880	13900	77100
1984	29	912	3060	16500	24800	8800	2780	4120	10700	71700
1985	42	388	6210	6850	17400	19900	5170	1360	10600	67900
1986	128	185	1110	9220	5820	12500	13900	4520	11100	58500
1987	61	220	1120	4790	14600	4570	7280	6040	9070	47800
1988	174	183	2100	4630	6790	11200	2380	3030	7260	37700
1989	118	323	1280	7280	7170	5540	6830	1120	6340	36000
1990	65	104	1760	4230	12100	6430	3840	3550	4720	36800
1991	117	83	981	7050	7360	12400	5040	2020	4660	39700
1992	130	139	701	3240	13100	8350	10000	3040	4230	42900
1993	163	185	653	2610	5780	14500	7070	6530	4070	41600
1994	103	251	400	1130	2960	6770	12200	3460	3620	30900
1995	163	284	1270	2840	5640	6480	6100	6700	4360	33800
1996	182	376	814	3420	10200	11100	5580	3160	4400	39200
1997	92	320	501	1860	10300	18900	10900	3290	4410	50600
1998	121	109	576	1840	6570	22100	18200	5750	4380	59600
1999	134	227	442	2950	7170	12700	19900	10000	4780	58300
2000	366	490	934	2690	12300	15100	12600	11100	5220	60800
2001	269	1200	2000	7100	8900	24000	15100	6380	6400	71300
2002	45	98	1390	4360	14900	15200	23200	8680	8660	76500
2003	13	118	296	5170	16200	29700	16000	14500	8900	90900
2004	11	45	635	1530	10200	23100	30500	12300	17700	96000
2005	10	84	255	2330	4290	27400	34200	24200	17100	110000
2006	24	46	299	826	6460	11800	41700	30200	22300	114000

2007	29	136	160	1200	2670	19600	20700	35400	22500	102000
2008	56	194	510	858	4460	9040	30900	14900	24300	85200
2009	34	196	435	1400	2250	10100	11400	19800	22800	68400
2010	38	103	728	2020	4810	6320	15300	8120	22400	59800
2011	65	205	371	2170	5040	11400	8800	10700	21000	59800
2012	95	171	491	1320	5430	11800	15200	6100	18400	59000
2013	31	546	747	2120	3670	13600	15800	10200	16700	63400

Table C15. Estimated total pollock (*Pollachius virens*) fishing mortality at age (both fleets combined), and the unweighted average F for ages 5 to 7 from the Age Structured Assessment Program (ASAP) base model.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+	Ave 5-7
1970	0.00	0.01	0.06	0.11	0.13	0.13	0.09	0.06	0.02	0.12
1971	0.00	0.01	0.07	0.13	0.15	0.15	0.11	0.06	0.02	0.14
1972	0.00	0.01	0.05	0.10	0.12	0.12	0.08	0.05	0.01	0.10
1973	0.00	0.01	0.06	0.12	0.14	0.14	0.10	0.06	0.02	0.13
1974	0.00	0.01	0.04	0.09	0.10	0.10	0.07	0.04	0.01	0.09
1975	0.00	0.01	0.04	0.09	0.10	0.10	0.07	0.04	0.01	0.09
1976	0.00	0.01	0.04	0.09	0.10	0.10	0.07	0.04	0.01	0.09
1977	0.00	0.01	0.05	0.11	0.12	0.12	0.09	0.05	0.02	0.11
1978	0.00	0.02	0.08	0.17	0.19	0.19	0.13	0.08	0.02	0.17
1979	0.00	0.01	0.07	0.15	0.17	0.17	0.12	0.07	0.02	0.16
1980	0.00	0.02	0.11	0.23	0.27	0.27	0.18	0.11	0.03	0.24
1981	0.02	0.05	0.14	0.27	0.31	0.31	0.21	0.13	0.04	0.28
1982	0.04	0.06	0.15	0.27	0.31	0.30	0.21	0.13	0.04	0.27
1983	0.03	0.05	0.14	0.26	0.30	0.29	0.20	0.12	0.04	0.27
1984	0.00	0.03	0.15	0.31	0.36	0.36	0.25	0.15	0.05	0.32
1985	0.01	0.04	0.17	0.33	0.38	0.38	0.26	0.16	0.05	0.34
1986	0.03	0.02	0.09	0.29	0.46	0.55	0.55	0.43	0.09	0.52
1987	0.03	0.02	0.09	0.29	0.46	0.55	0.55	0.42	0.09	0.52
1988	0.04	0.03	0.09	0.28	0.44	0.52	0.52	0.40	0.08	0.49
1989	0.04	0.03	0.08	0.22	0.35	0.41	0.40	0.31	0.07	0.39
1990	0.03	0.02	0.06	0.18	0.29	0.34	0.34	0.26	0.05	0.32
1991	0.02	0.02	0.05	0.14	0.22	0.26	0.26	0.20	0.04	0.25
1992	0.01	0.01	0.03	0.11	0.18	0.21	0.21	0.16	0.03	0.20
1993	0.01	0.01	0.03	0.09	0.14	0.17	0.17	0.13	0.03	0.16
1994	0.01	0.01	0.02	0.03	0.09	0.17	0.16	0.09	0.02	0.14
1995	0.01	0.01	0.02	0.03	0.08	0.14	0.14	0.08	0.02	0.12
1996	0.01	0.01	0.01	0.02	0.06	0.11	0.10	0.06	0.01	0.09
1997	0.00	0.01	0.01	0.02	0.06	0.11	0.11	0.06	0.01	0.09
1998	0.00	0.00	0.01	0.02	0.06	0.12	0.11	0.07	0.01	0.10
1999	0.00	0.00	0.00	0.02	0.05	0.10	0.10	0.06	0.01	0.08
2000	0.01	0.01	0.01	0.02	0.05	0.09	0.09	0.05	0.01	0.07
2001	0.01	0.01	0.02	0.03	0.05	0.09	0.08	0.05	0.01	0.07
2002	0.00	0.00	0.00	0.01	0.04	0.07	0.07	0.05	0.01	0.06
2003	0.00	0.00	0.00	0.01	0.04	0.07	0.07	0.04	0.01	0.06
2004	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.06	0.02	0.05
2005	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.07	0.02	0.05
2006	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.06	0.02	0.04
2007	0.00	0.00	0.00	0.01	0.03	0.07	0.10	0.09	0.03	0.07

2008	0.00	0.00	0.01	0.02	0.05	0.11	0.17	0.15	0.04	0.11
2009	0.00	0.00	0.01	0.02	0.04	0.10	0.15	0.13	0.04	0.09
2010	0.00	0.00	0.01	0.02	0.04	0.09	0.14	0.12	0.04	0.09
2011	0.00	0.01	0.01	0.02	0.06	0.13	0.19	0.17	0.05	0.12
2012	0.00	0.00	0.01	0.02	0.04	0.11	0.16	0.14	0.04	0.10
2013	0.00	0.01	0.01	0.02	0.05	0.10	0.15	0.13	0.04	0.10

Table C16. Input and output for the yield per recruit analysis of pollock (*Pollachius virens*). $F_{40\%}$ expressed as average F on ages 5-7. Weights reported in kg.

2014 Operational Assessment

Age	Selectivity	M	Stock wt	Catch wt	SSB wt	Maturity
1	0.02	0.20	0.13	0.17	0.13	0.02
2	0.03	0.20	0.27	0.40	0.27	0.08
3	0.06	0.20	0.62	0.83	0.62	0.26
4	0.13	0.20	1.18	1.55	1.18	0.59
5	0.29	0.20	1.88	2.23	1.88	0.86
6	0.66	0.20	2.64	3.06	2.64	0.96
7	1.00	0.20	3.48	3.82	3.48	0.99
8	0.87	0.20	4.09	4.34	4.09	1.00
9	0.25	0.20	5.36	5.36	5.36	1.00

	F	YPR	SSB/R
F40%	0.27	0.79	4.07

SARC 50

Age	Selectivity	M	Stock wt	Catch wt	SSB wt	Maturity
1	0.01	0.20	0.06	0.10	0.06	0.02
2	0.02	0.20	0.16	0.28	0.16	0.08
3	0.04	0.20	0.44	0.72	0.44	0.26
4	0.08	0.20	0.95	1.32	0.95	0.59
5	0.20	0.20	1.59	2.03	1.59	0.86
6	0.61	0.20	2.42	2.92	2.42	0.96
7	1.00	0.20	3.36	3.80	3.36	0.99
8	0.85	0.20	4.30	4.73	4.30	1.00
9	0.26	0.20	6.39	6.39	6.39	1.00

	F	YPR	SSB/R
F40%	0.25	0.80	4.41

Table C17. Updated reference points compared to SARC 50 estimates for pollock (*Pollachius virens*). SSB_{MSY} and MSY are in thousands of metric tons. Recruitment is in millions of age 1 fish.

2014 Operational Assessment

	Median	**5th**	**95th**
SSBmsy	76.9	59.1	102.5
MSY	14.8	10.7	21.4
Recruitment	17.6	7.7	39.7

SARC 50

	Median	**5th**	**95th**
SSBmsy	90.7	70.9	118.1
MSY	16.2	11.8	23.3
Recruitment	19.3	8.4	42.2

Table C18. Percentiles of pollock (*Pollachius virens*) spawning stock biomass (000s mt) for projections at $F_{status\text{-}quo}$, 0.75* $F_{40\%}$, and $F_{40\%}$ from the base model.

F-status-quo = 0.10 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	85.9	96.0	100.9	111.0	123.4	135.2	146.3	153.3	165.4
2015	93.9	102.6	109.0	119.2	131.6	144.5	157.0	163.7	179.0
2016	101.2	110.9	116.3	126.7	139.3	152.5	166.0	173.5	188.3
2017	103.1	112.9	118.3	128.8	141.1	153.7	166.9	173.9	190.4
2018	103.0	113.0	118.3	128.4	140.0	151.9	164.1	171.2	186.3
2019	101.5	110.9	116.2	125.4	136.3	148.0	159.2	166.3	180.1
2020	102.4	111.9	117.1	126.2	137.1	149.1	160.9	168.4	182.9
2021	100.3	109.3	114.4	123.3	134.3	146.5	159.0	166.7	182.2

0.75*F40% = 0.20 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	85.9	96.0	100.9	111.0	123.4	135.2	146.3	153.3	165.4
2015	93.9	102.6	109.0	119.2	131.6	144.5	157.0	163.7	179.0
2016	95.4	104.5	109.4	119.4	131.3	143.6	156.3	163.4	178.0
2017	91.7	100.5	105.4	114.8	125.8	136.8	148.6	155.1	169.7
2018	86.2	94.6	99.1	107.6	117.2	127.2	137.3	143.3	155.9
2019	80.3	87.9	92.1	99.5	108.1	117.6	126.8	132.6	143.9
2020	78.0	85.2	89.3	96.4	105.0	114.7	124.7	130.8	143.3
2021	74.7	81.7	85.7	92.8	101.6	111.7	122.3	128.9	142.1

F40% = 0.27 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	85.9	96.0	100.9	111.0	123.4	135.2	146.3	153.3	165.4
2015	93.9	102.6	109.0	119.2	131.6	144.5	157.0	163.7	179.0
2016	91.9	100.6	105.2	115.0	126.5	138.2	150.6	157.4	171.9
2017	85.3	93.6	98.2	107.0	117.2	127.4	138.4	144.5	158.1
2018	77.3	84.9	88.9	96.6	105.2	114.2	123.2	128.7	139.8
2019	69.9	76.5	80.2	86.6	94.3	102.6	110.9	116.1	126.4
2020	66.3	72.6	76.1	82.3	90.0	98.7	107.8	113.6	124.9
2021	62.9	68.9	72.4	78.7	86.5	95.8	105.5	111.6	123.9

Table C19. Percentiles of pollock (*Pollachius virens*) catch (000s mt) for projections at $F_{status\text{-}quo}$, 0.75* $F_{40\%}$, and $F_{40\%}$ from the base model.

F-status-quo = 0.10 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	6.0	6.6	6.9	7.6	8.4	9.2	10.0	10.5	11.3
2016	6.7	7.3	7.7	8.3	9.1	10.0	10.9	11.2	12.2
2017	7.9	8.8	9.2	9.9	10.9	11.9	12.9	13.5	14.9
2018	8.0	9.1	9.5	10.4	11.3	12.4	13.4	14.1	15.5
2019	7.1	7.9	8.3	9.0	9.7	10.6	11.5	12.0	13.1
2020	6.0	6.6	6.9	7.5	8.2	9.0	9.9	10.5	11.6
2021	6.1	6.7	7.1	7.8	8.7	9.8	11.1	12.0	13.5

0.75*F40% = 0.20 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	11.9	13.1	13.8	15.0	16.6	18.2	19.8	20.7	22.3
2016	12.4	13.5	14.1	15.4	16.9	18.4	20.0	20.8	22.6
2017	13.7	15.2	16.0	17.3	19.0	20.7	22.5	23.5	26.1
2018	13.1	14.8	15.6	16.9	18.5	20.1	21.9	23.1	25.2
2019	11.2	12.3	12.9	14.0	15.2	16.6	17.9	18.7	20.4
2020	9.4	10.3	10.9	11.8	13.0	14.3	15.9	17.0	19.1
2021	9.4	10.4	11.0	12.2	13.7	15.5	17.7	19.1	21.6

F40% = 0.27 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	15.5	17.0	17.8	19.5	21.5	23.6	25.7	26.8	29.0
2016	15.4	16.7	17.6	19.1	20.9	22.8	24.9	25.8	28.1
2017	16.3	18.3	19.1	20.8	22.8	24.8	27.0	28.2	31.3
2018	15.1	17.0	17.9	19.5	21.2	23.2	25.1	26.5	29.0
2019	12.6	13.8	14.5	15.7	17.1	18.6	20.1	21.0	22.9
2020	10.7	11.7	12.3	13.4	14.8	16.4	18.2	19.7	22.2
2021	10.5	11.6	12.4	13.7	15.4	17.5	20.1	21.8	24.7

Table C20. Percentiles of pollock (*Pollachius virens*) spawning stock biomass (000s mt) for projections at $F_{status\text{-}quo}$, 0.75* $F_{40\%}$, and $F_{40\%}$ from Mohn's rho-adjusted flat survey selectivity sensitivity run.

	F-status-quo = 0.20 (average F on ages 5-7)								
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	20.7	23.9	25.4	28.2	32.0	36.4	40.8	43.4	49.4
2015	21.2	24.5	26.3	29.8	34.1	39.2	44.9	47.4	53.5
2016	24.8	28.2	30.2	33.9	37.9	43.2	48.6	51.2	57.9
2017	26.9	30.2	32.2	36.0	39.9	44.7	49.9	52.7	58.4
2018	28.7	32.0	34.0	37.5	41.5	46.2	51.0	54.0	59.6
2019	29.8	33.1	35.1	38.6	43.1	48.2	53.7	57.2	64.0
2020	31.7	35.2	37.4	41.5	46.9	53.1	59.9	64.3	72.6
2021	32.7	36.6	39.1	43.8	49.9	57.2	64.8	69.6	78.8

	0.75*F40% = 0.18 (average F on ages 5-7)								
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	20.7	23.9	25.4	28.2	32.0	36.4	40.8	43.4	49.4
2015	21.2	24.5	26.3	29.8	34.1	39.2	44.9	47.4	53.5
2016	24.9	28.4	30.4	34.2	38.2	43.5	49.0	51.6	58.3
2017	27.2	30.6	32.7	36.4	40.5	45.3	50.5	53.5	59.2
2018	29.2	32.6	34.7	38.2	42.3	47.1	52.0	55.1	60.8
2019	30.5	33.9	35.9	39.5	44.0	49.3	54.8	58.3	65.2
2020	32.5	36.2	38.3	42.5	48.0	54.4	61.1	65.6	74.0
2021	33.6	37.5	40.1	44.8	51.0	58.5	66.2	71.0	80.3

	F40% = 0.24 (average F on ages 5-7)								
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	20.7	23.9	25.4	28.2	32.0	36.4	40.8	43.4	49.4
2015	21.2	24.5	26.3	29.8	34.1	39.2	44.9	47.4	53.5
2016	24.1	27.4	29.4	32.9	36.8	41.8	47.1	49.6	56.0
2017	25.5	28.6	30.5	34.1	37.8	42.2	47.1	49.9	55.2
2018	26.6	29.6	31.5	34.7	38.4	42.7	47.2	49.9	55.2
2019	27.0	30.0	31.8	35.0	39.2	44.0	49.2	52.6	59.0
2020	28.3	31.5	33.5	37.3	42.4	48.4	54.9	59.2	67.0
2021	29.0	32.6	34.9	39.3	45.1	52.1	59.4	63.9	72.7

Table C21. Percentiles of pollock (*Pollachius virens*) catch (000s mt) for projections at $F_{status\text{-}quo}$, 0.75* $F_{40\%}$, and $F_{40\%}$ from Mohn's rho-adjusted flat survey selectivity sensitivity run.

F-status-quo = 0.20 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	3.1	3.7	4.0	4.5	5.2	6.1	6.9	7.4	8.4
2016	3.8	4.4	4.7	5.3	5.9	6.7	7.5	8.0	8.9
2017	4.8	5.4	5.7	6.4	7.1	7.9	8.9	9.4	10.5
2018	5.3	5.9	6.3	7.0	7.7	8.6	9.6	10.1	11.3
2019	5.0	5.5	5.9	6.5	7.1	7.9	8.7	9.3	10.2
2020	5.0	5.5	5.8	6.4	7.2	8.1	9.1	9.9	11.2
2021	5.3	5.9	6.3	7.2	8.3	9.7	11.3	12.4	14.3

0.75*F40% = 0.18 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	2.9	3.5	3.8	4.3	5.0	5.7	6.5	7.0	7.9
2016	3.6	4.2	4.5	5.0	5.6	6.4	7.2	7.6	8.5
2017	4.6	5.2	5.5	6.1	6.8	7.6	8.5	9.0	10.1
2018	5.1	5.7	6.1	6.8	7.5	8.3	9.3	9.8	10.9
2019	4.9	5.4	5.7	6.3	6.9	7.7	8.5	9.0	9.9
2020	4.8	5.3	5.6	6.2	7.0	7.8	8.8	9.6	10.8
2021	5.2	5.8	6.2	7.0	8.1	9.4	10.9	12.0	13.8

F40% = 0.24 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	3.8	4.5	4.9	5.5	6.4	7.4	8.4	9.0	10.2
2016	4.5	5.1	5.5	6.2	6.9	7.8	8.8	9.4	10.5
2017	5.5	6.2	6.6	7.3	8.1	9.1	10.2	10.8	12.0
2018	5.9	6.6	7.0	7.8	8.6	9.6	10.7	11.3	12.6
2019	5.5	6.1	6.4	7.1	7.8	8.7	9.6	10.1	11.2
2020	5.4	6.0	6.3	7.0	7.9	9.0	10.1	11.1	12.6
2021	5.7	6.4	6.9	7.8	9.1	10.7	12.5	13.7	15.8

Table C22. Percentiles of pollock (*Pollachius virens*) spawning stock biomass (000s mt) for projections at $F_{status\text{-}quo}$, 0.75* $F_{40\%}$, and $F_{40\%}$ from the reduced 2011 year-class sensitivity run.

F-status-quo = 0.10 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	84.0	94.1	98.8	108.7	120.9	132.6	143.5	150.1	161.7
2015	85.8	95.1	101.0	110.6	122.6	135.1	146.5	152.9	166.7
2016	89.2	96.5	102.3	111.5	122.7	134.7	146.4	151.7	166.0
2017	88.3	95.9	100.7	109.8	120.4	131.3	142.3	148.0	161.5
2018	88.3	96.0	100.6	109.2	119.1	129.5	139.5	145.3	157.5
2019	88.6	96.5	101.1	109.3	118.9	129.3	139.1	145.4	157.8
2020	89.9	98.1	102.8	110.9	120.7	131.6	142.5	149.4	163.0
2021	89.9	98.1	102.7	111.0	121.3	132.9	144.8	152.4	167.3

0.75*F40% = 0.20 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	84.0	94.1	98.8	108.7	120.9	132.6	143.5	150.1	161.7
2015	85.8	95.1	101.0	110.6	122.6	135.1	146.5	152.9	166.7
2016	83.4	90.4	95.9	104.4	114.9	126.2	137.1	142.1	155.8
2017	77.9	84.7	89.0	97.1	106.4	115.9	125.7	130.8	142.9
2018	73.7	80.3	84.2	91.5	99.7	108.4	116.7	121.6	132.0
2019	71.0	77.5	81.3	87.8	95.7	104.3	112.6	117.9	128.4
2020	69.9	76.5	80.2	86.8	94.8	104.0	113.5	119.5	131.4
2021	68.3	74.9	78.6	85.4	93.8	103.7	114.1	120.6	133.6

F40% = 0.27 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	84.0	94.1	98.8	108.7	120.9	132.6	143.5	150.1	161.7
2015	85.8	95.1	101.0	110.6	122.6	135.1	146.5	152.9	166.7
2016	80.0	86.8	92.1	100.3	110.3	121.1	131.5	136.5	149.7
2017	72.1	78.5	82.5	90.0	98.6	107.4	116.5	121.2	132.6
2018	66.1	72.2	75.6	82.2	89.6	97.5	104.9	109.3	118.7
2019	62.3	68.1	71.4	77.2	84.3	91.9	99.6	104.4	114.1
2020	60.3	66.1	69.4	75.2	82.5	90.8	99.7	105.5	116.4
2021	58.2	63.9	67.3	73.3	81.0	90.1	99.7	105.8	117.9

Table C23. Percentiles of pollock (*Pollachius virens*) catch (000s mt) for projections at $F_{status\text{-}quo}$, 0.75* $F_{40\%}$, and $F_{40\%}$ from the reduced 2011 year-class sensitivity run.

F-status-quo = 0.10 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	5.7	6.3	6.6	7.2	8.0	8.8	9.6	10.0	10.8
2016	6.0	6.5	6.9	7.5	8.2	9.0	9.8	10.1	11.0
2017	6.5	7.0	7.4	8.0	8.8	9.5	10.3	10.8	11.8
2018	6.1	6.7	7.1	7.7	8.4	9.1	9.9	10.3	11.4
2019	5.7	6.2	6.5	7.0	7.7	8.4	9.0	9.4	10.3
2020	5.5	6.1	6.4	6.9	7.6	8.4	9.2	9.9	11.0
2021	5.7	6.3	6.7	7.4	8.3	9.3	10.6	11.6	13.1

0.75*F40% = 0.20 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	11.3	12.5	13.1	14.4	15.9	17.4	19.0	19.9	21.3
2016	11.0	11.9	12.6	13.8	15.1	16.4	17.9	18.5	20.1
2017	11.2	12.0	12.7	13.7	15.1	16.4	17.8	18.5	20.3
2018	10.1	11.0	11.6	12.6	13.7	14.9	16.2	16.9	18.6
2019	9.1	10.0	10.5	11.3	12.3	13.4	14.5	15.2	16.6
2020	8.9	9.7	10.2	11.1	12.3	13.6	15.1	16.3	18.3
2021	8.9	9.9	10.5	11.7	13.1	14.9	17.1	18.6	21.0

F40% = 0.27 (average F on ages 5-7)									
YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
2014	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
2015	14.7	16.2	17.0	18.6	20.6	22.6	24.6	25.7	27.6
2016	13.6	14.7	15.6	17.0	18.6	20.3	22.1	22.9	24.8
2017	13.3	14.3	15.1	16.3	17.9	19.4	21.1	22.0	24.1
2018	11.6	12.8	13.4	14.6	15.8	17.2	18.7	19.5	21.5
2019	10.4	11.4	12.0	13.0	14.1	15.4	16.7	17.4	19.1
2020	10.1	11.1	11.7	12.7	14.1	15.6	17.5	19.0	21.4
2021	10.0	11.1	11.9	13.2	14.9	17.0	19.6	21.3	24.2

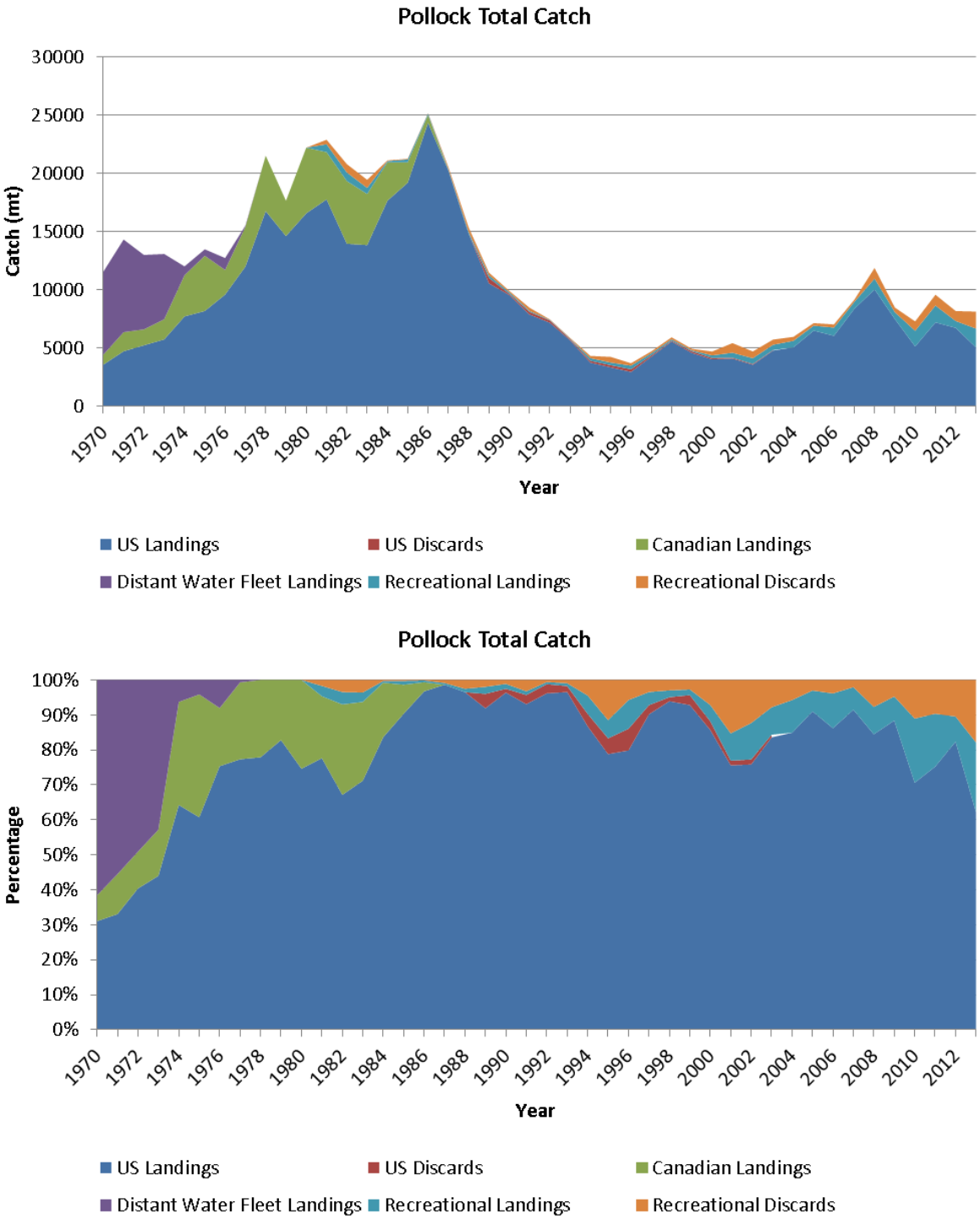


Figure C1. Total catch of pollock (*Pollachius virens*) in US areas 5 & 6 by commercial and recreational fisheries in weight (mt; top panel) and in percentages (bottom panel).

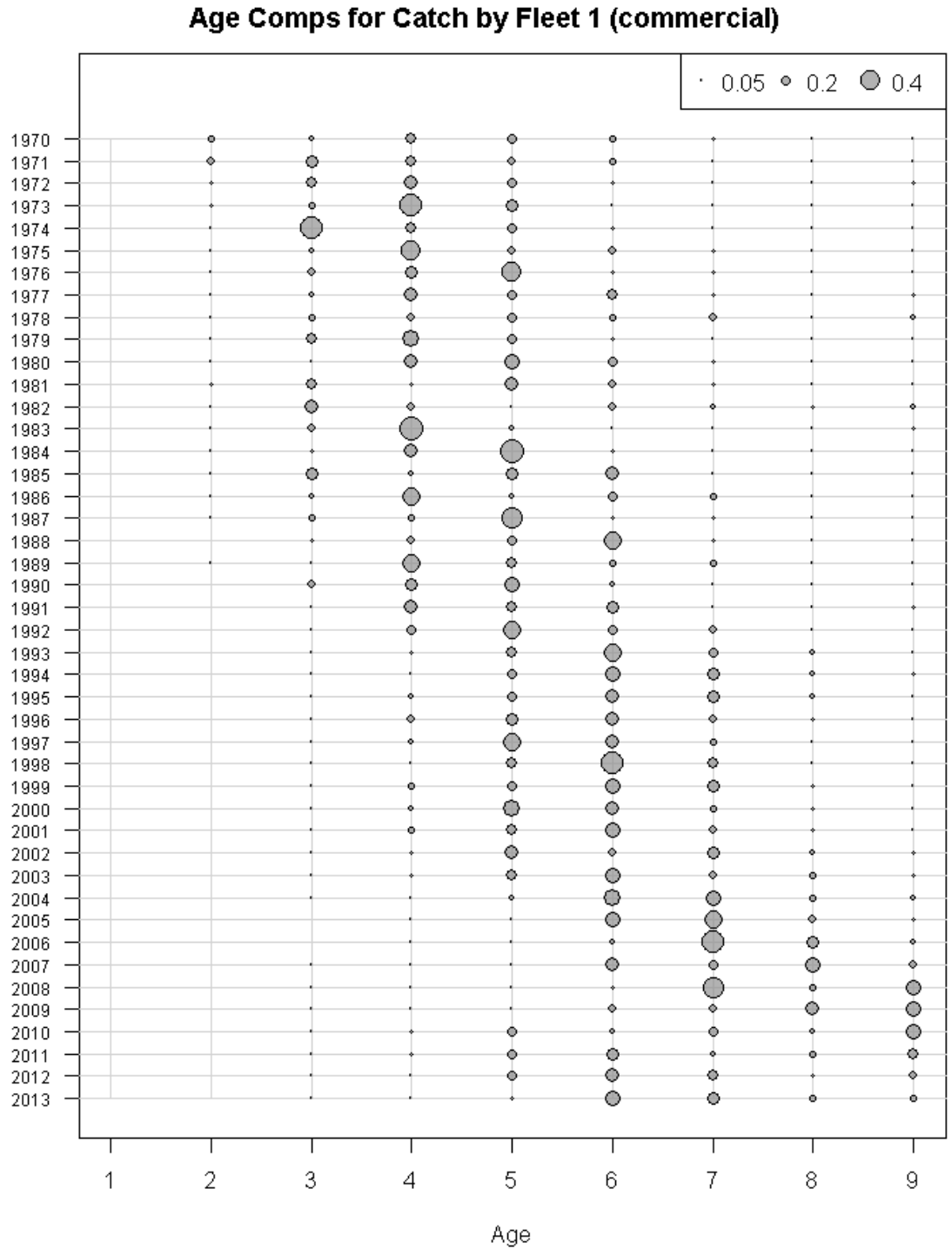


Figure C2. Total commercial landings at age of pollock (*Pollachius virens*) expressed as a proportion of total
annual landings.

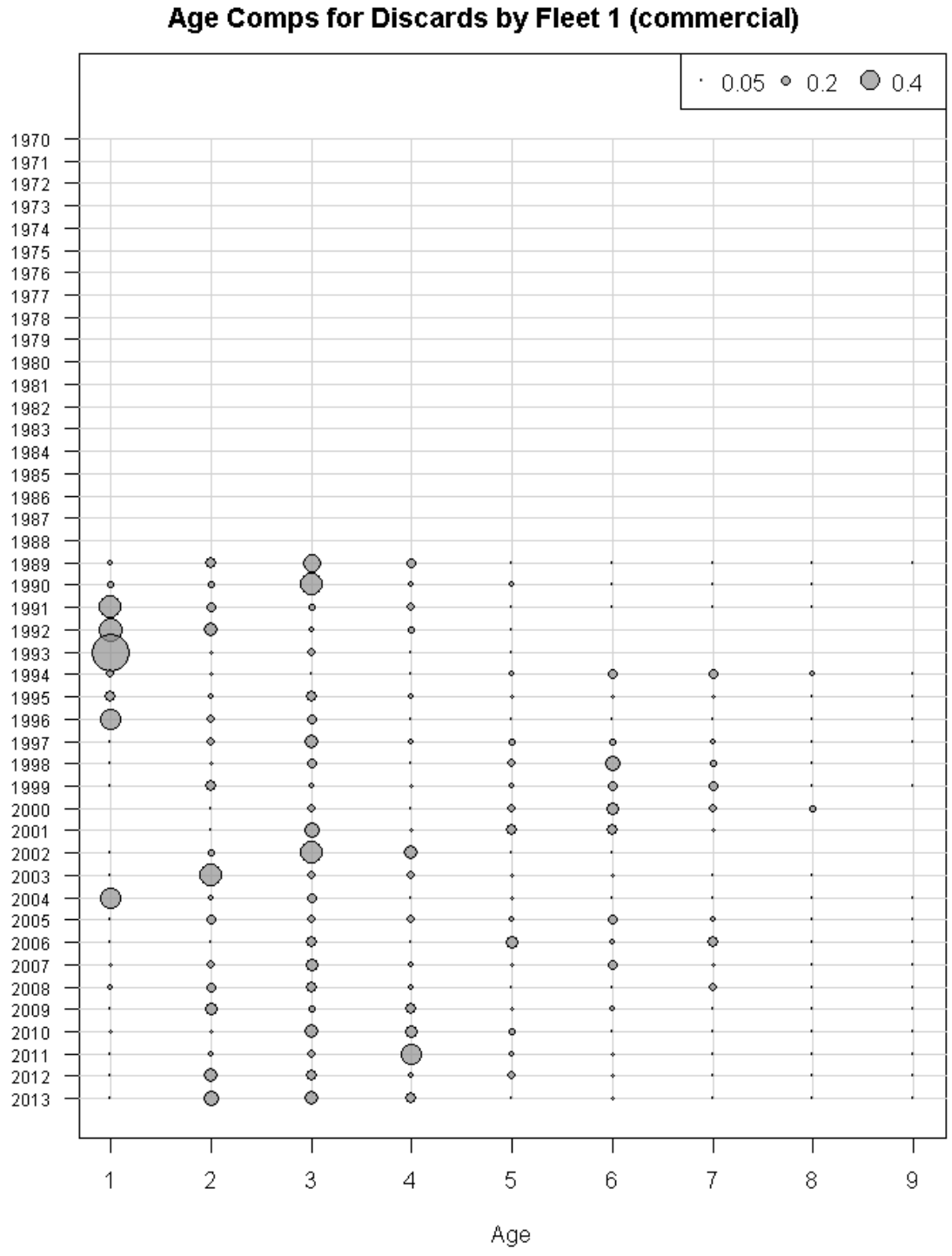


Figure C3. Total commercial discards at age of pollock (*Pollachius virens*) expressed as a proportion of total annual discards.

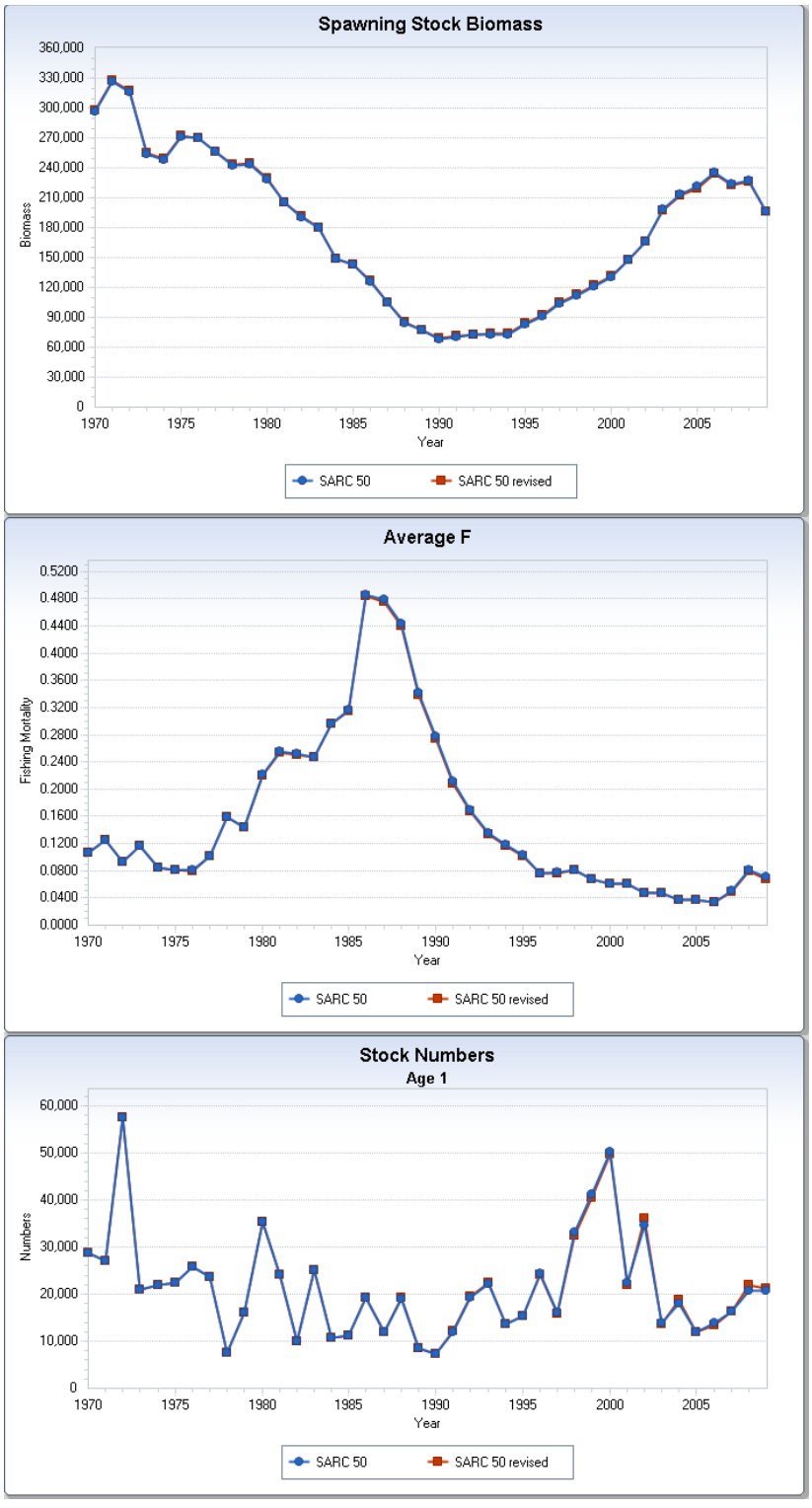


Figure C4. Estimated spawning stock biomass, average F (ages 5-7), and age 1 recruitment of pollock (*Pollachius virens*) from the original SARC 50 base model and revised SARC 50 base model (i.e., with revised commercial discards at age for 2001-2008).

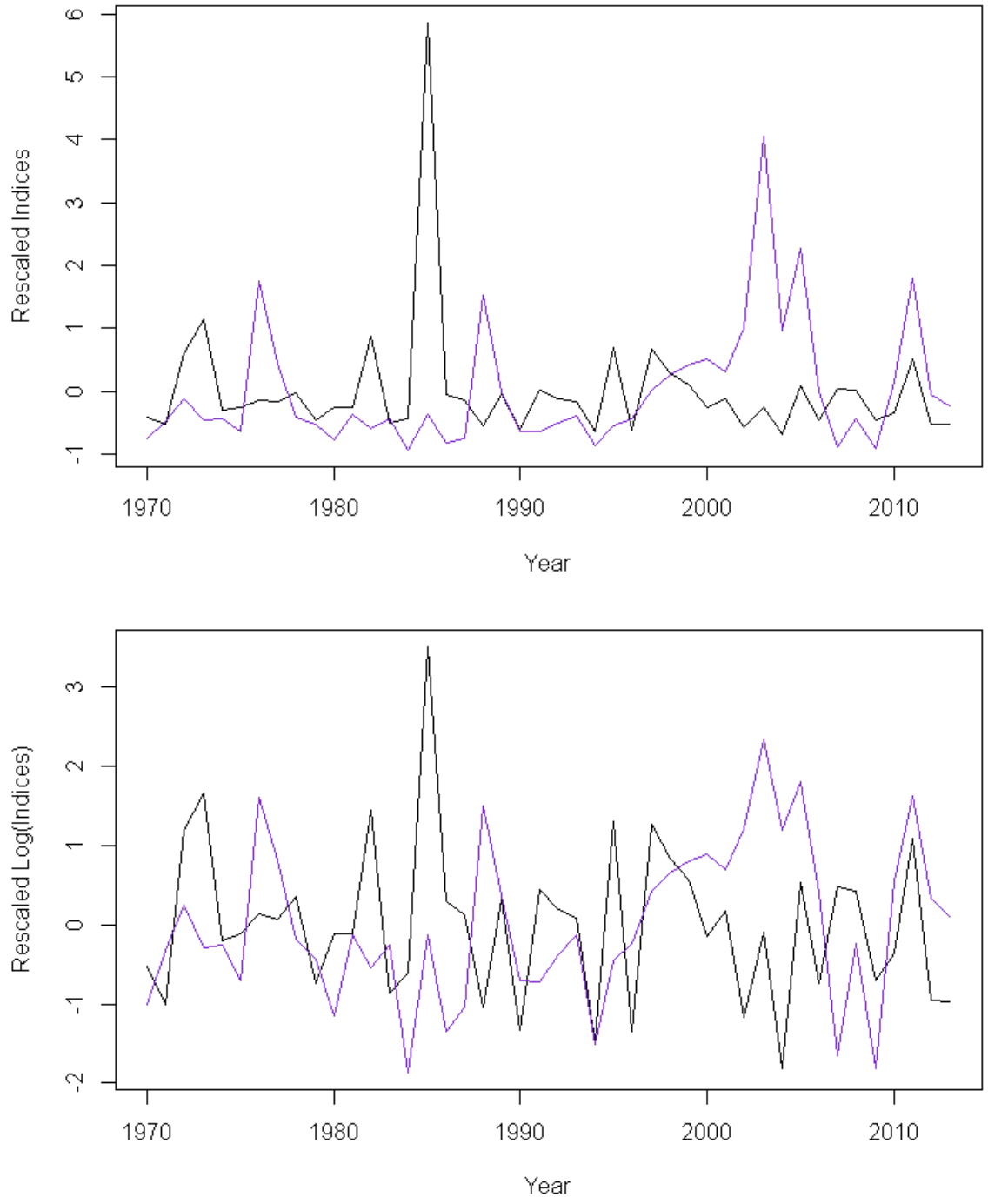


Figure C5. Rescaled Northeast Fisheries Science Center (NEFSC) spring (black line) and fall (purple line) bottom trawl survey indices (top panel). Rescaled NEFSC spring (black line) and fall (purple line) bottom trawl survey log indices (bottom panel). Rescaled indices based on numbers of fish/tow.

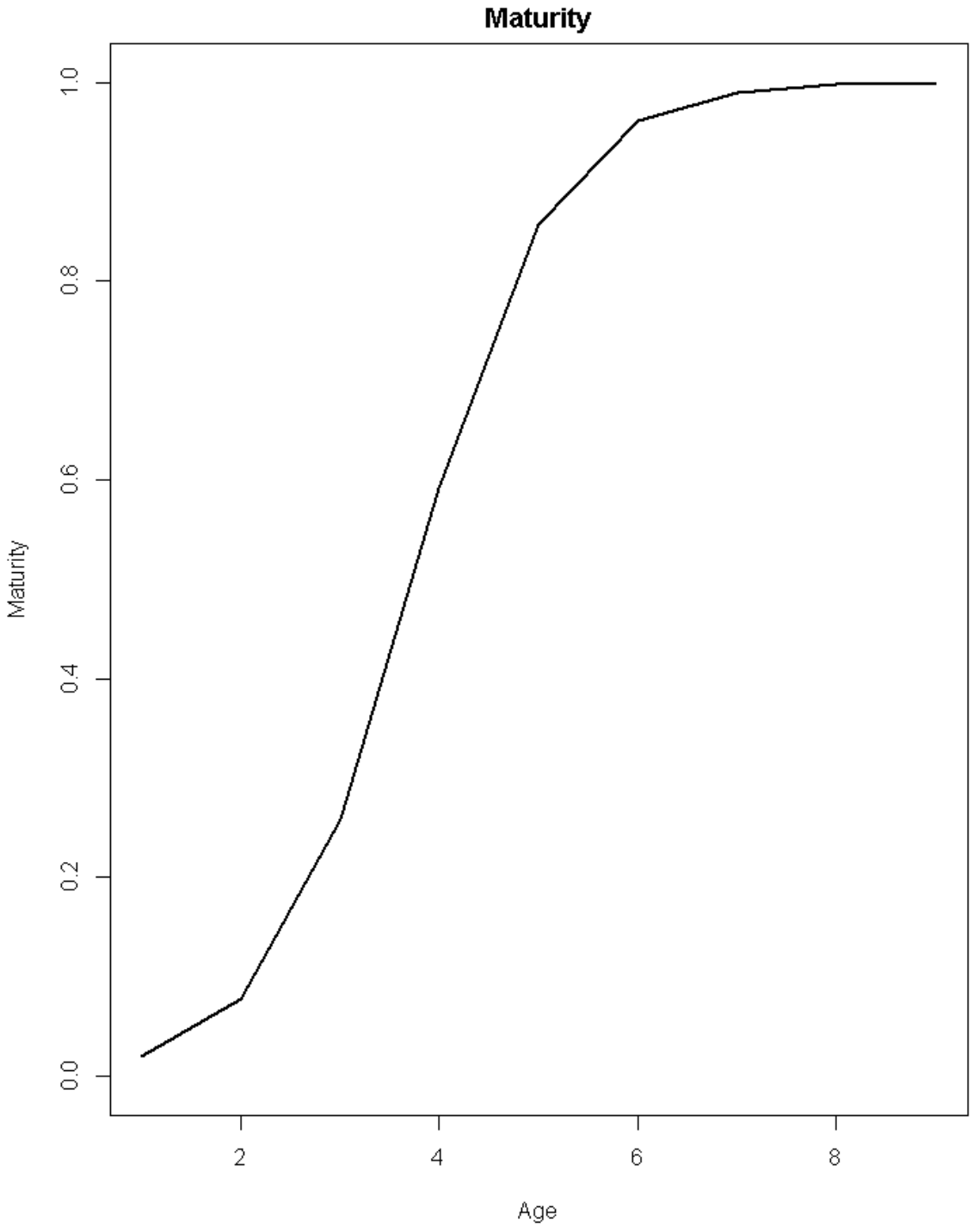


Figure C6. Pollock (*Pollachius virens*) maturity at age, pooled across all years, from samples in the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey.

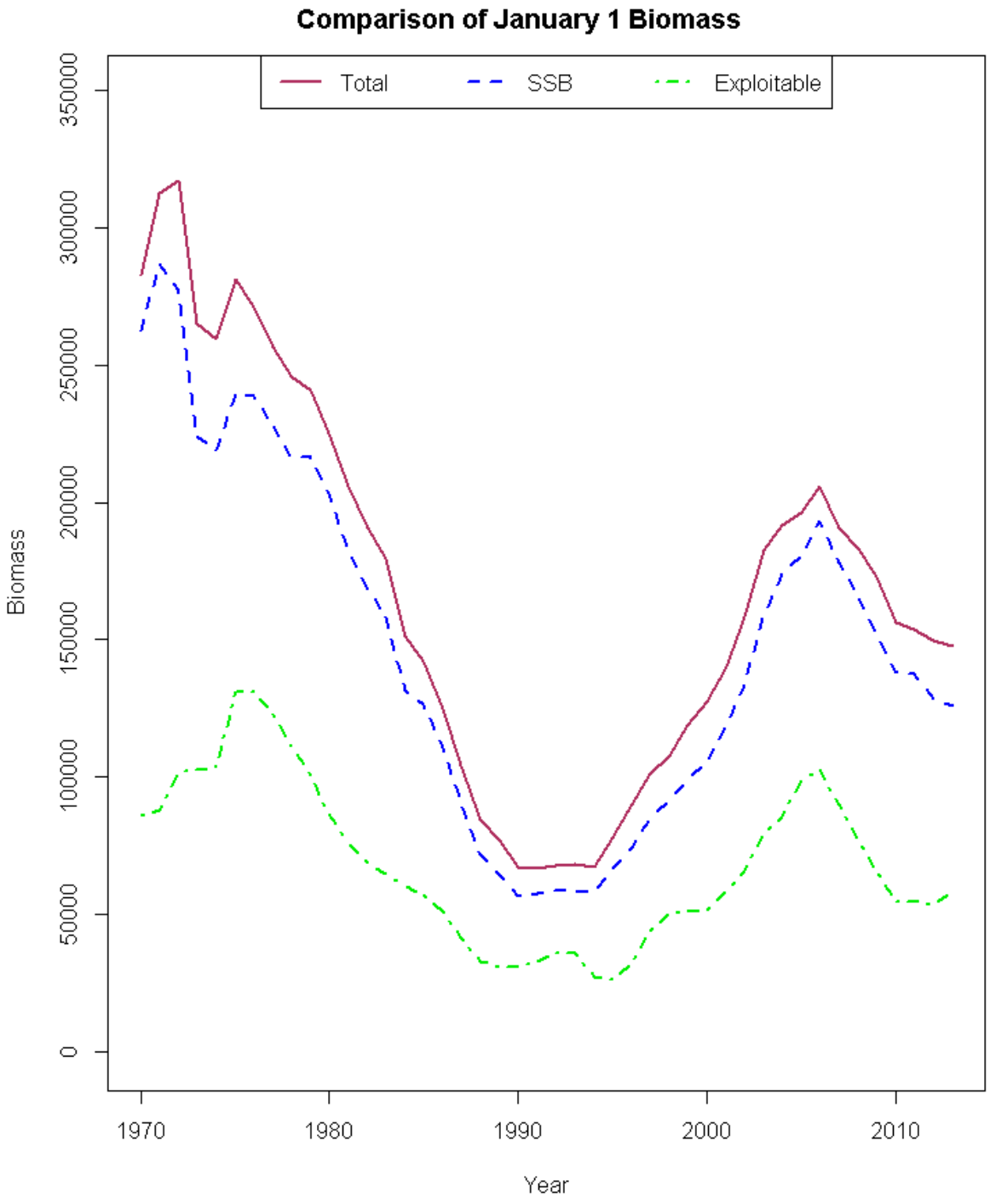


Figure C7. Annual estimates of biomass (mt) of pollock (*Pollachius virens*) from the Age Structured Assessment Program (ASAP) base model.

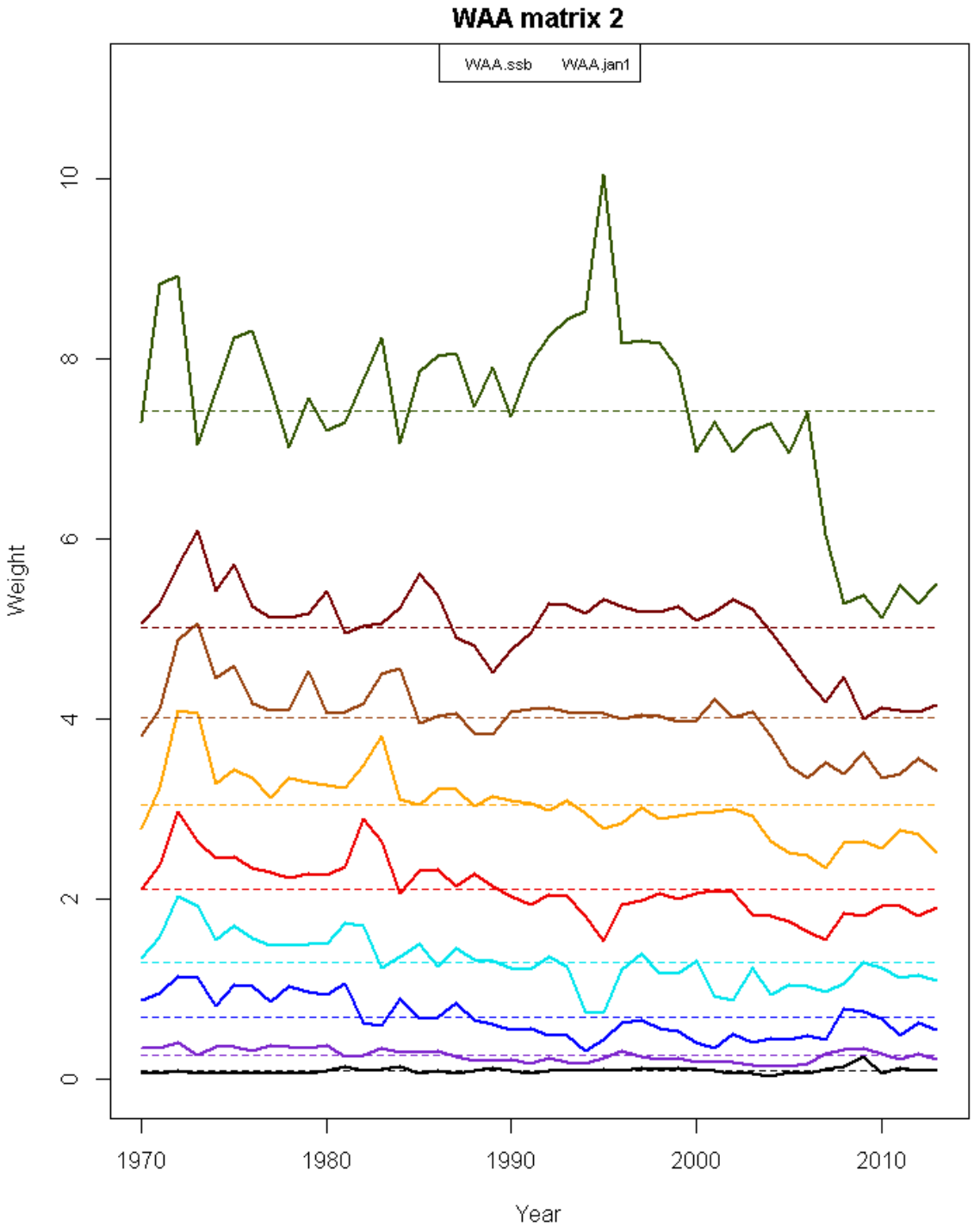


Figure C8. January 1 weights of pollock (*Pollachius virens*) at age (kg), assumed to reflect spawning weights at age, derived by applying the Rivard method to mid-year catch weights at age.

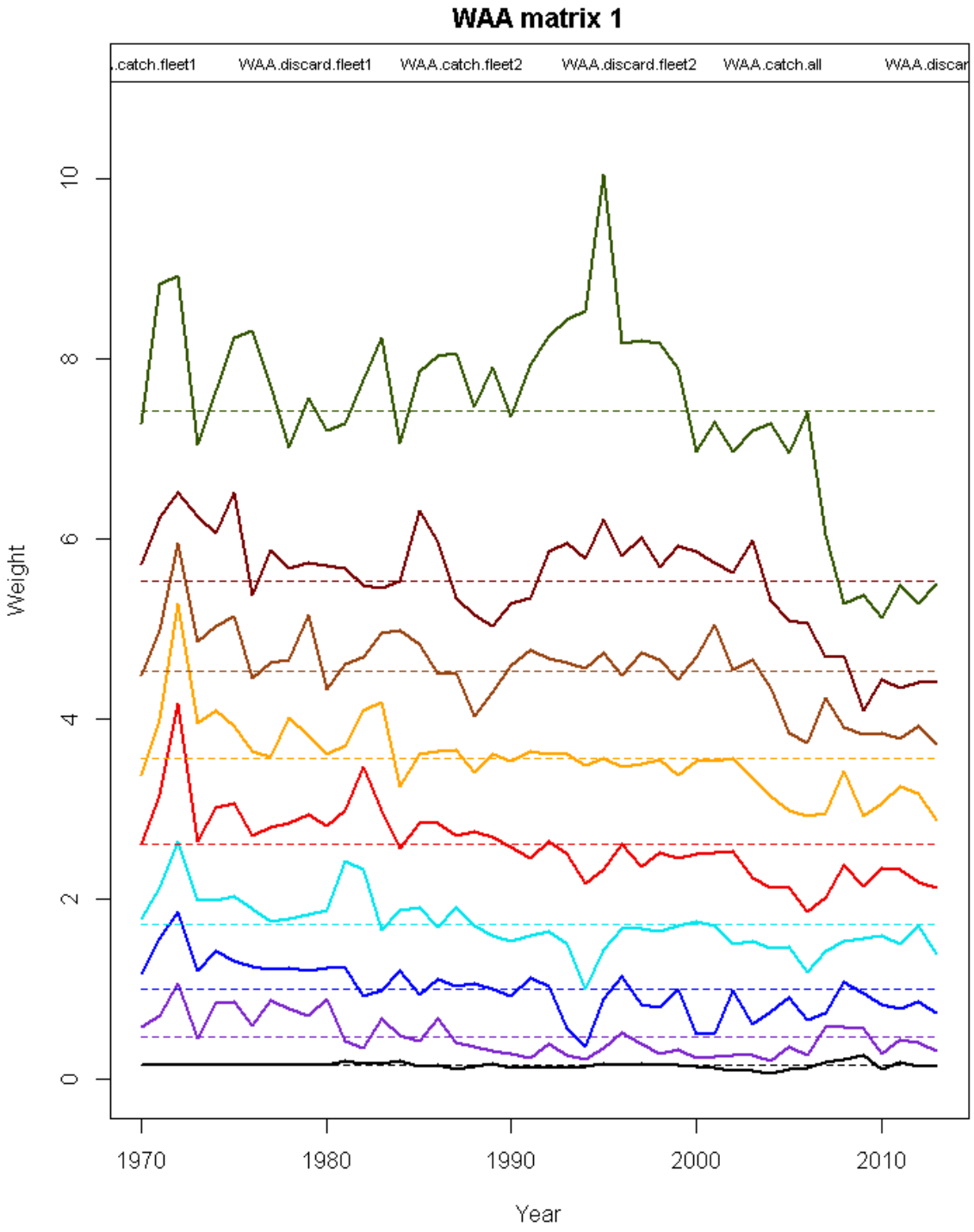


Figure C9. Catch weights of pollock (*Pollachius virens*) at age (kg), assumed to reflect mid-year weights at age.

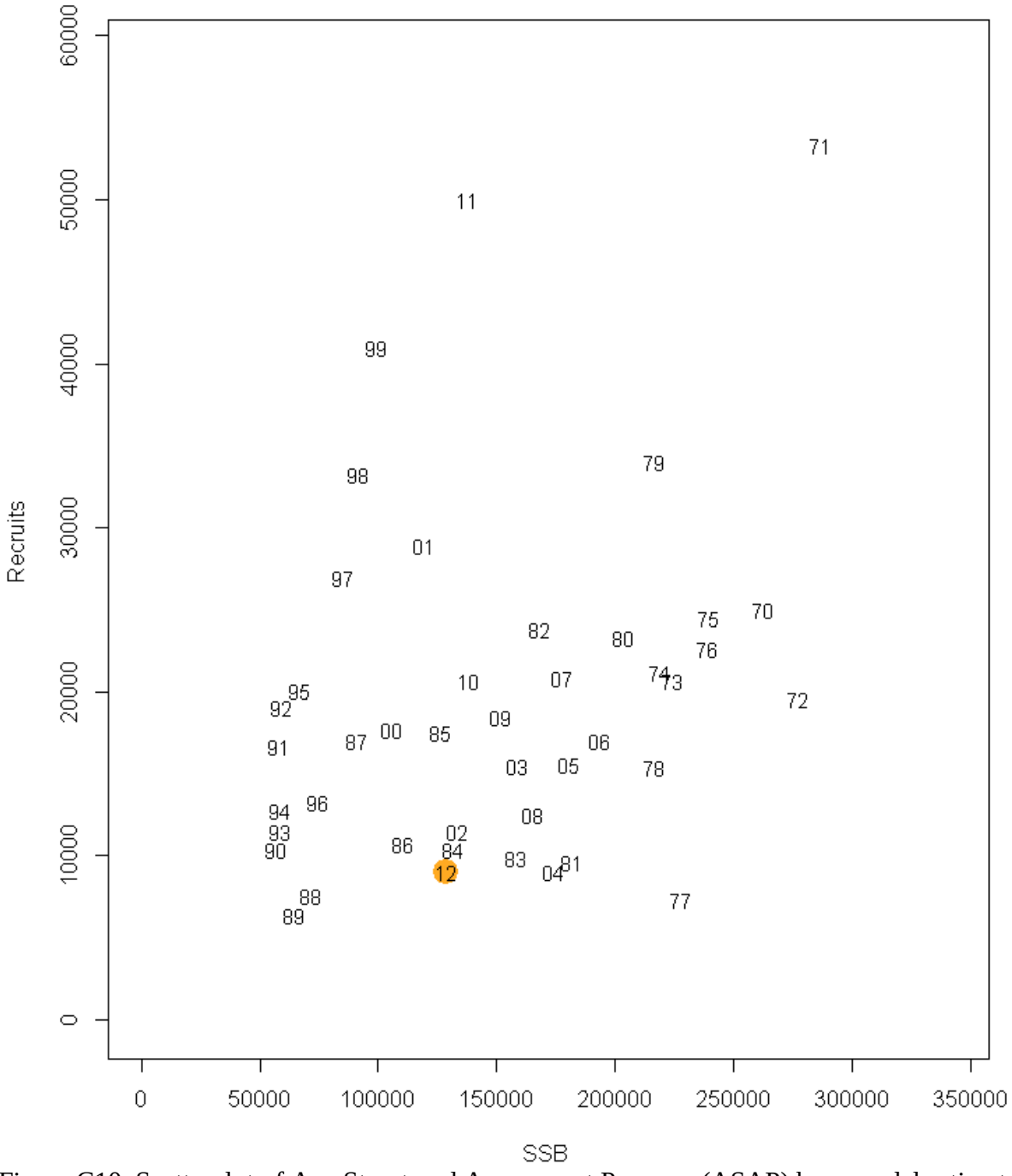


Figure C10. Scatterplot of Age Structured Assessment Program (ASAP) base model estimates of spawning stock biomass of pollock (*Pollachius virens*) (SSB, mt) versus recruitment at age 1 (thousands of fish). The symbol for each observation is the last two digits of the year-class (e.g., "70" is the model estimate of age 1 recruitment in year 1971). The most recent age 1 recruitment estimate for 2013 (i.e., "12") is highlighted by a filled orange circle.

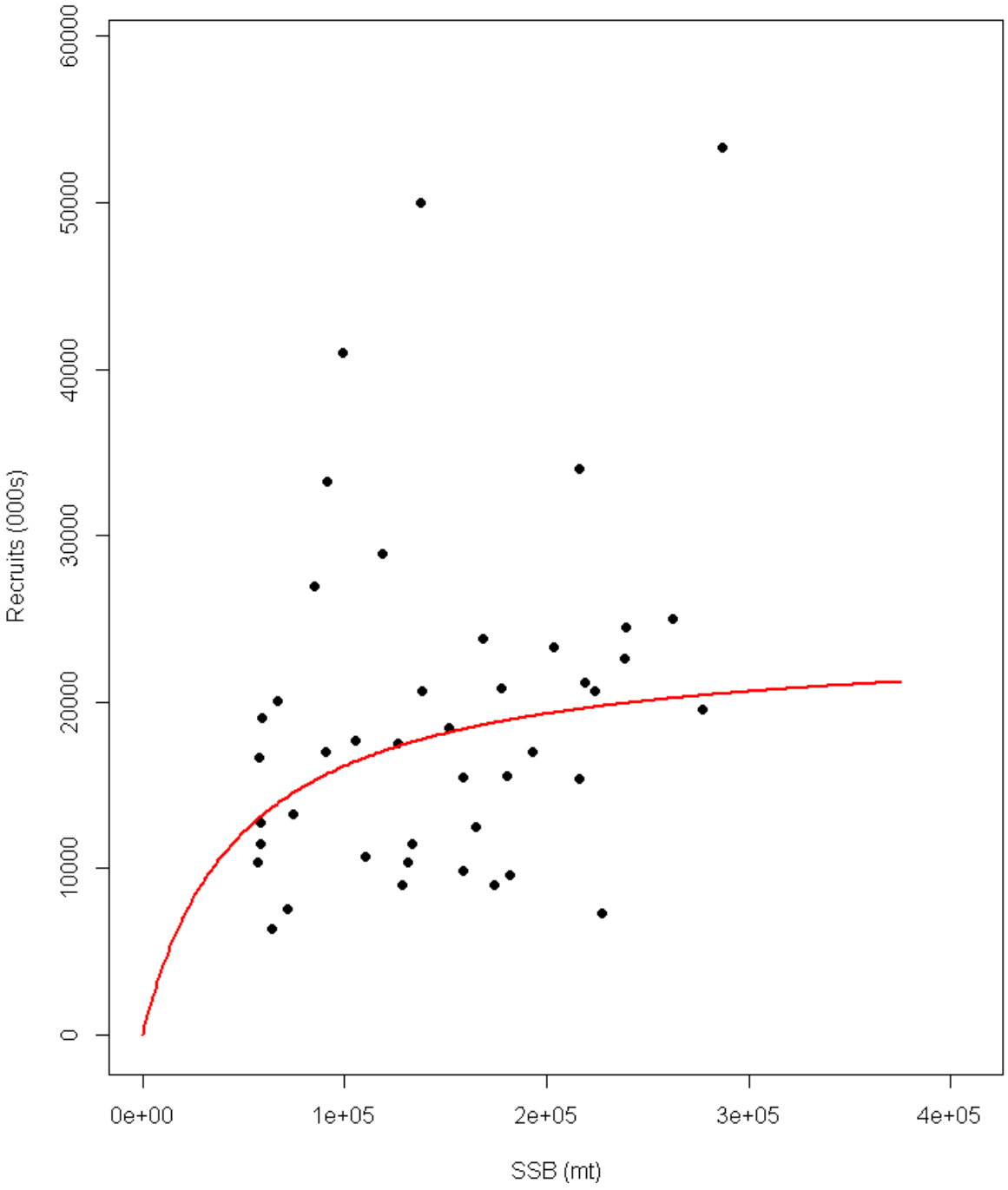


Figure C11. Age Structured Assessment Program (ASAP) base model estimates of the predicted stock recruit relationship (solid red line) and the estimated spawning stock biomass (SSB mt) and age 1 recruits (in thousands of fish).

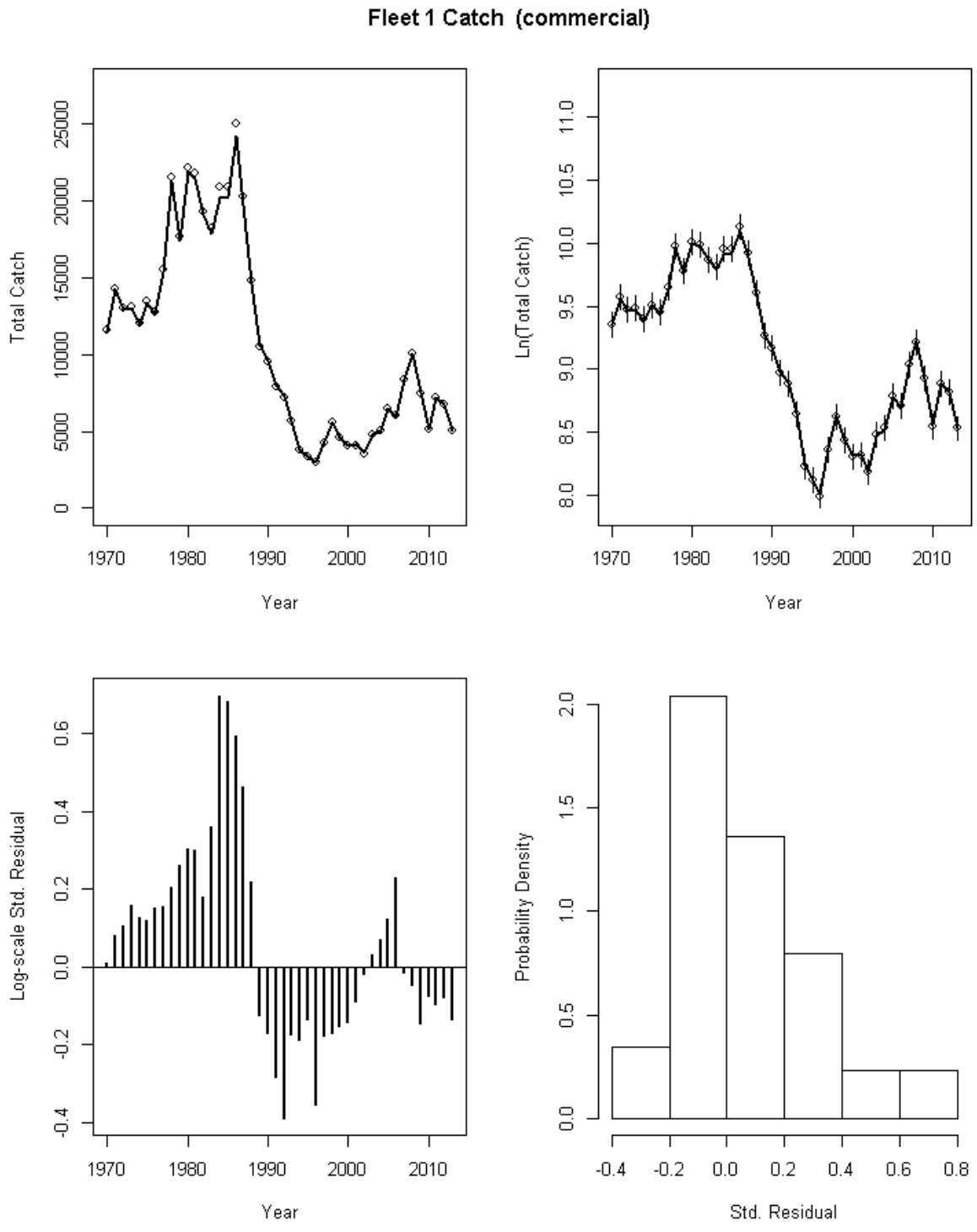


Figure C12. Age Structured Assessment Program (ASAP) base model fit to commercial landings of pollock (*Pollachius virens*).

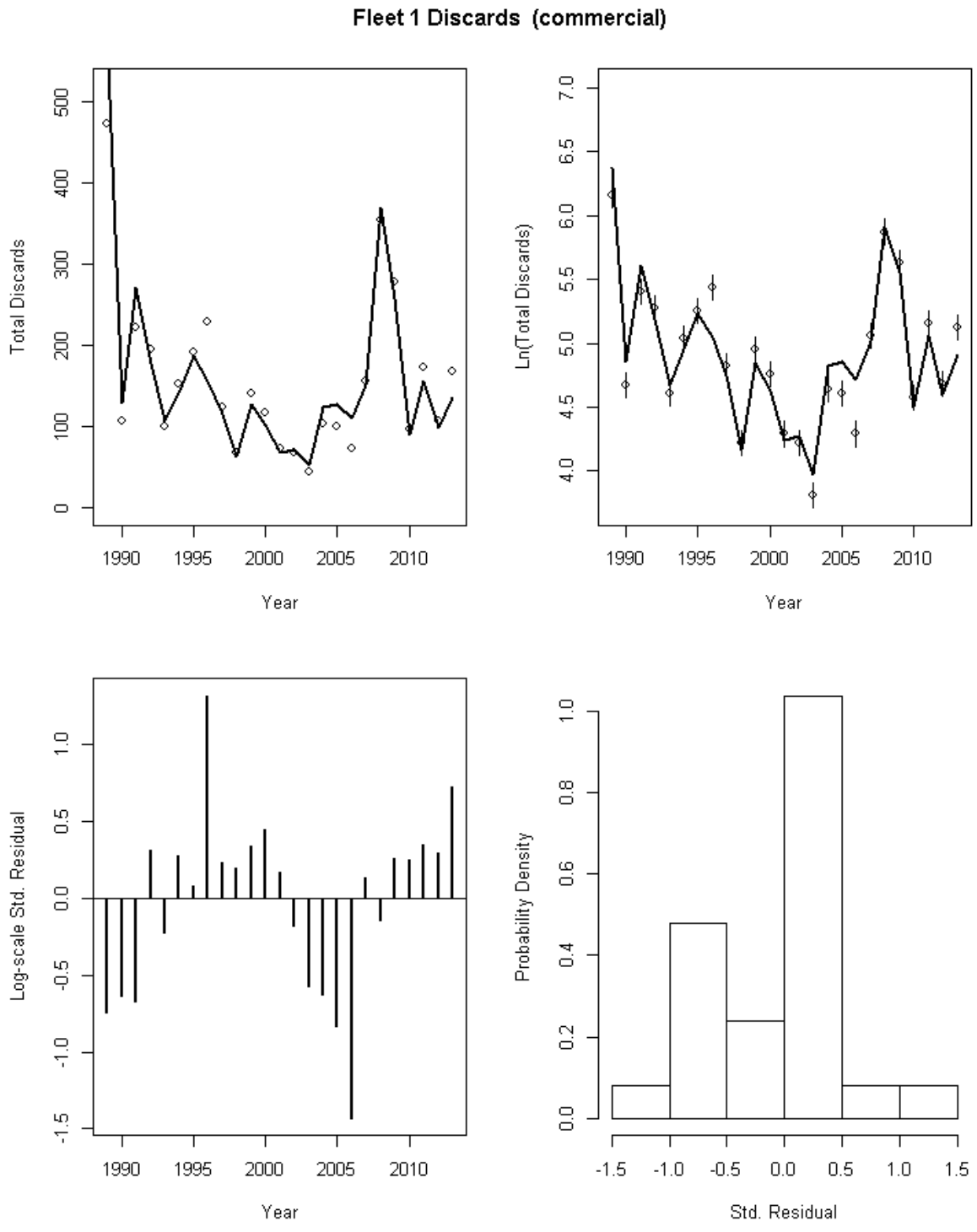


Figure C13. Age Structured Assessment Program (ASAP)base model fit to commercial discards of pollock (*Pollachius virens*).

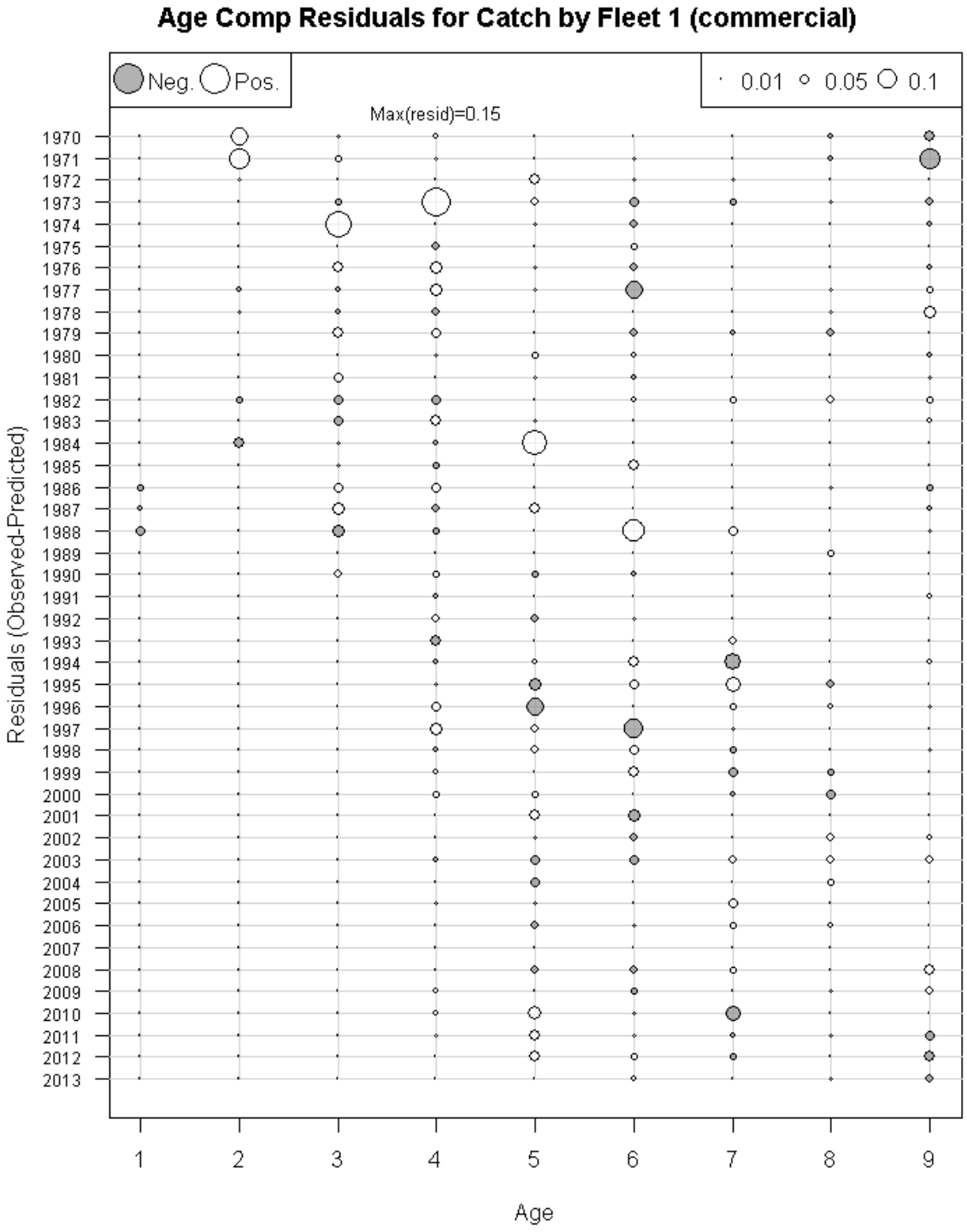


Figure C14. Age Structured Assessment Program (ASAP) base model residuals for commercial catch age composition. Open circles are positive residuals, filled circles are negative residuals, calculated as (Observed-Predicted).

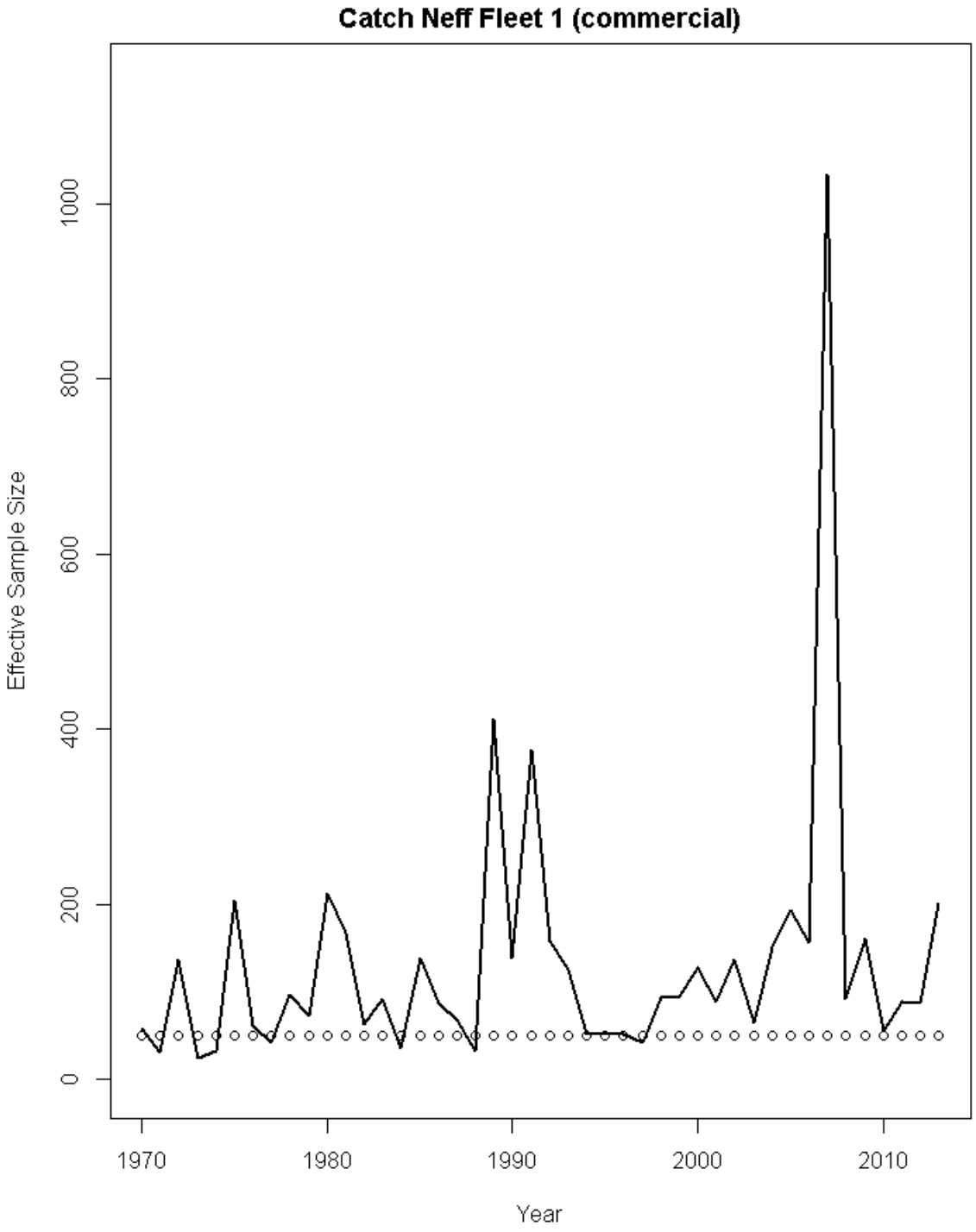


Figure C15. Age Structured Assessment Program (ASAP) base model comparison of input effective sample size (circles) versus the model estimated effective sample size (line) of pollock (*Pollachius virens*) for the commercial fleet.

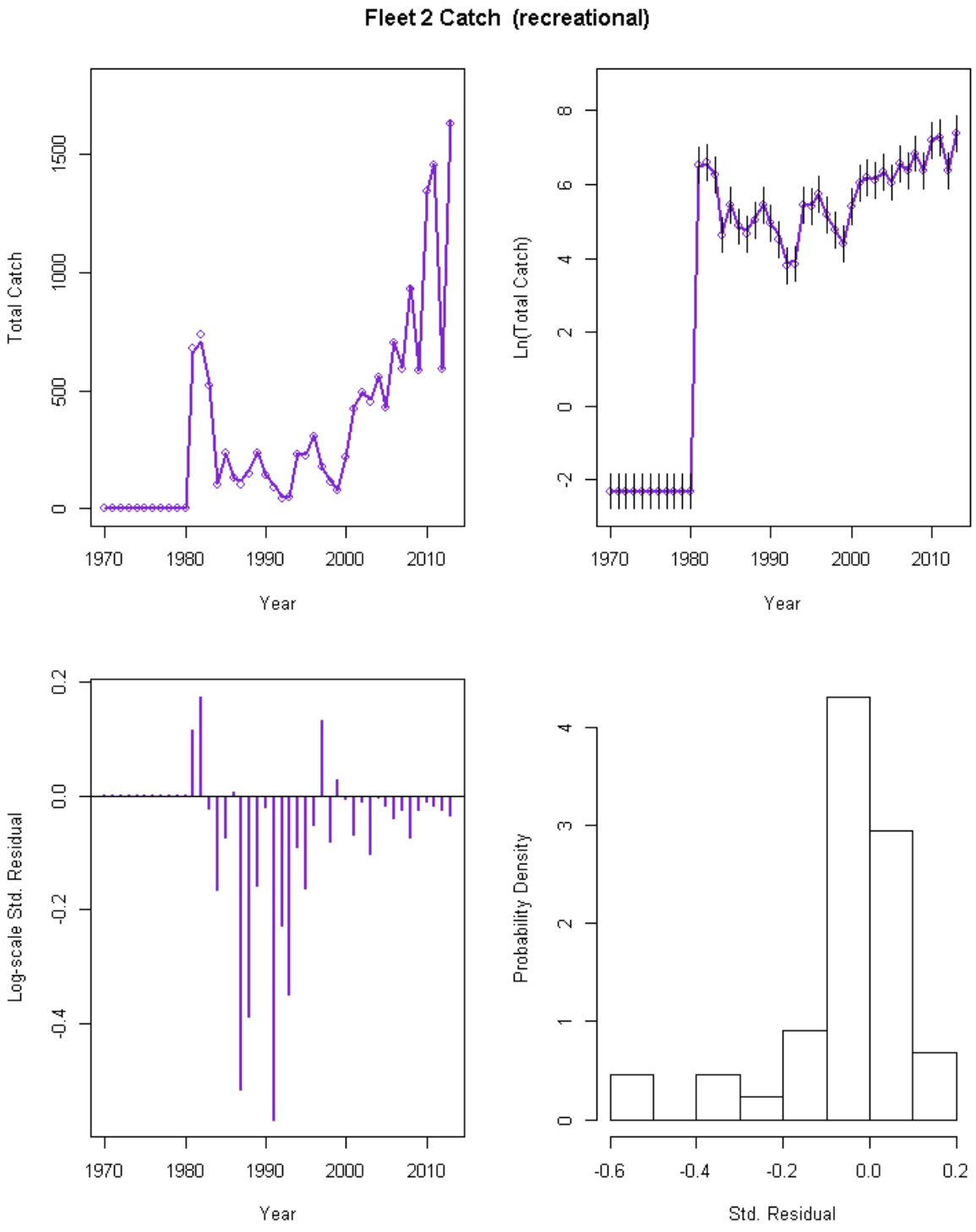


Figure C16. Age Structured Assessment Program (ASAP) base model fit to recreational landings of pollock (*Pollachius virens*).

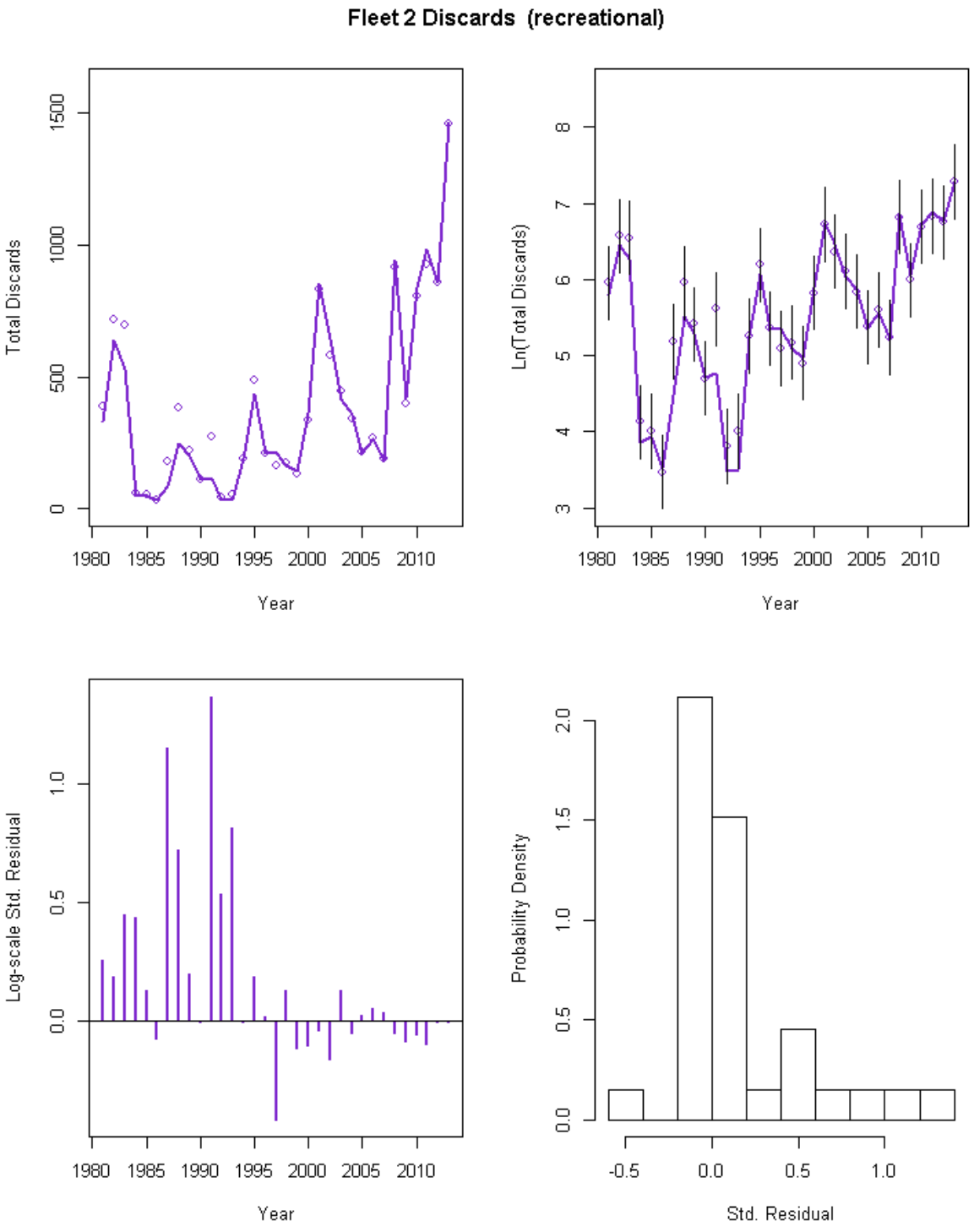


Figure C17. Age Structured Assessment Program (ASAP) base model fit to recreational discards.

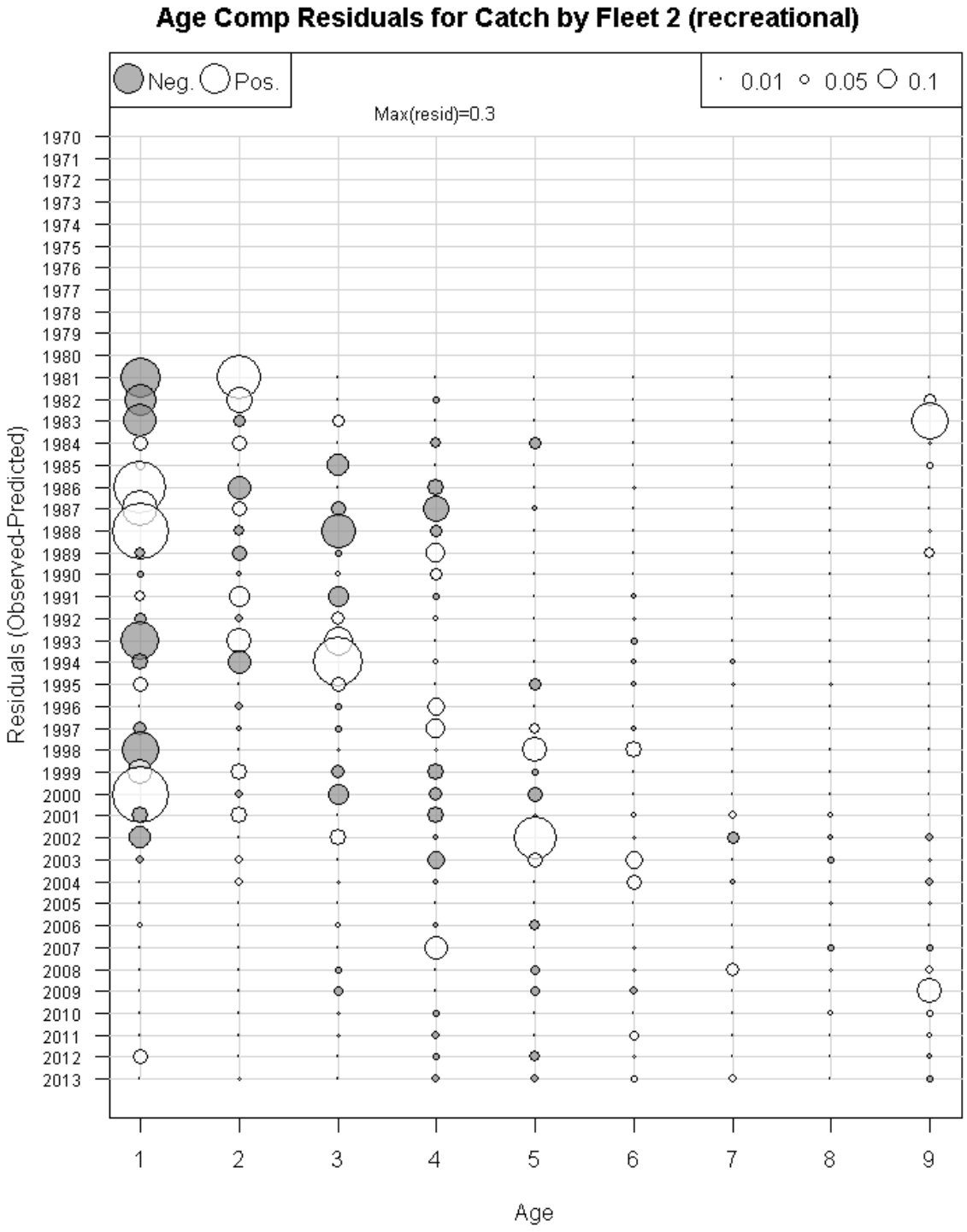


Figure C18. Age Structured Assessment Program (ASAP) base model residuals for recreational catch age composition of pollock (*Pollachius virens*). Open circles are positive residuals, filled circles are negative residuals, calculated as (Observed-Predicted).

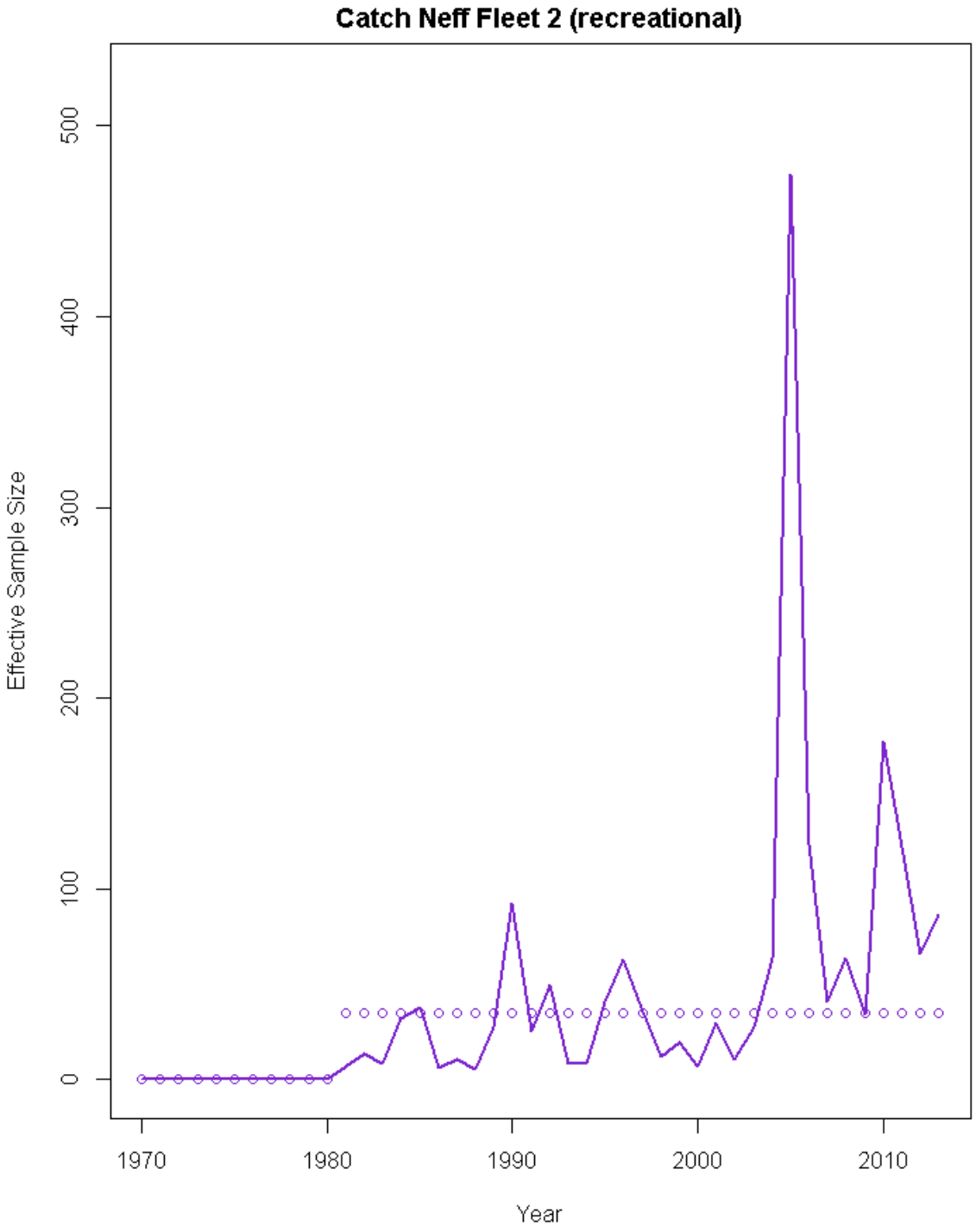


Figure C19. Age Structured Assessment Program (ASAP) base model comparison of input effective sample size (circles) versus the model estimated effective sample size (line) for the recreational fleet.

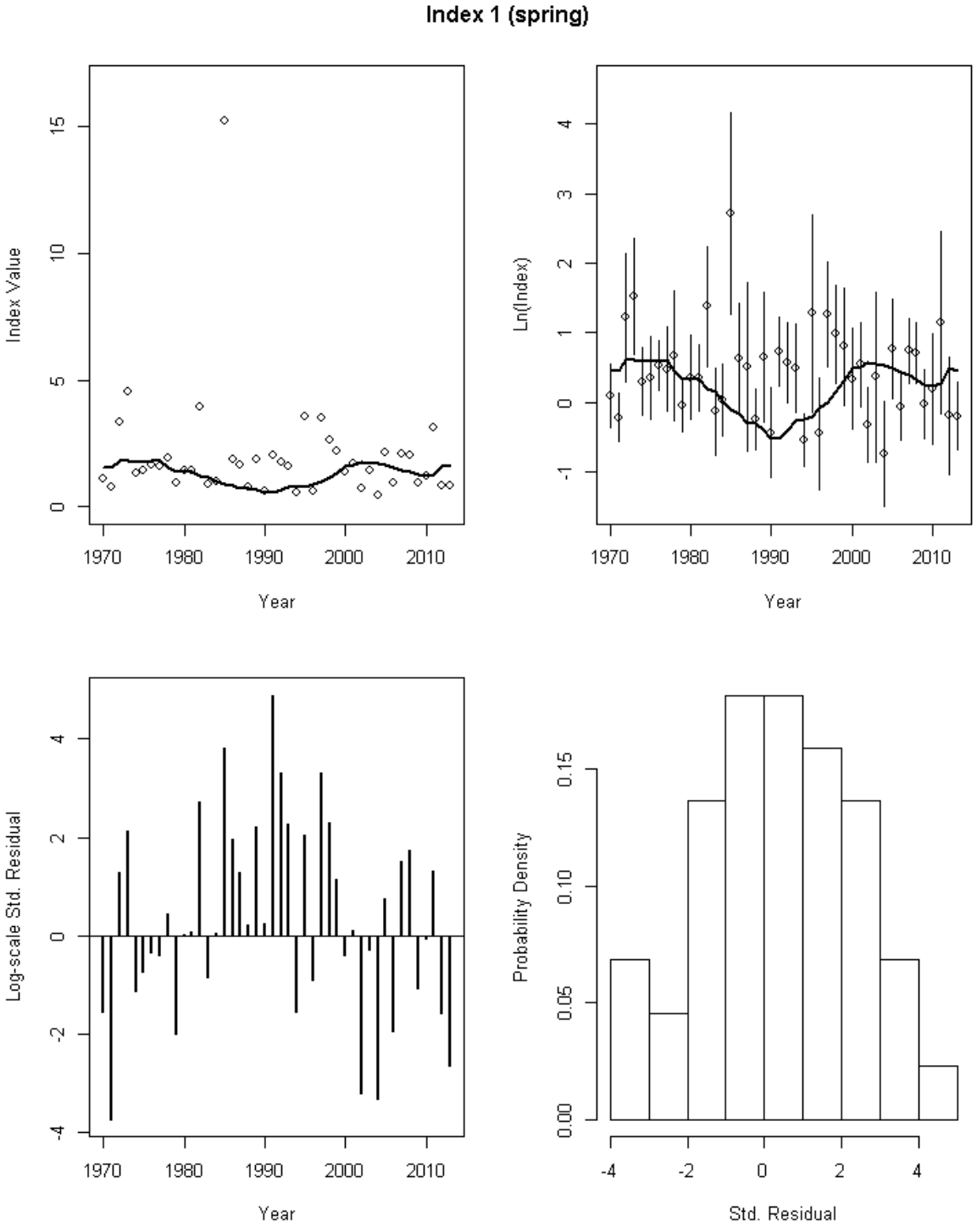


Figure C20. Age Structured Assessment Program (ASAP) base model fit to the Northeast Fisheries Science Center (NEFSC) spring index.

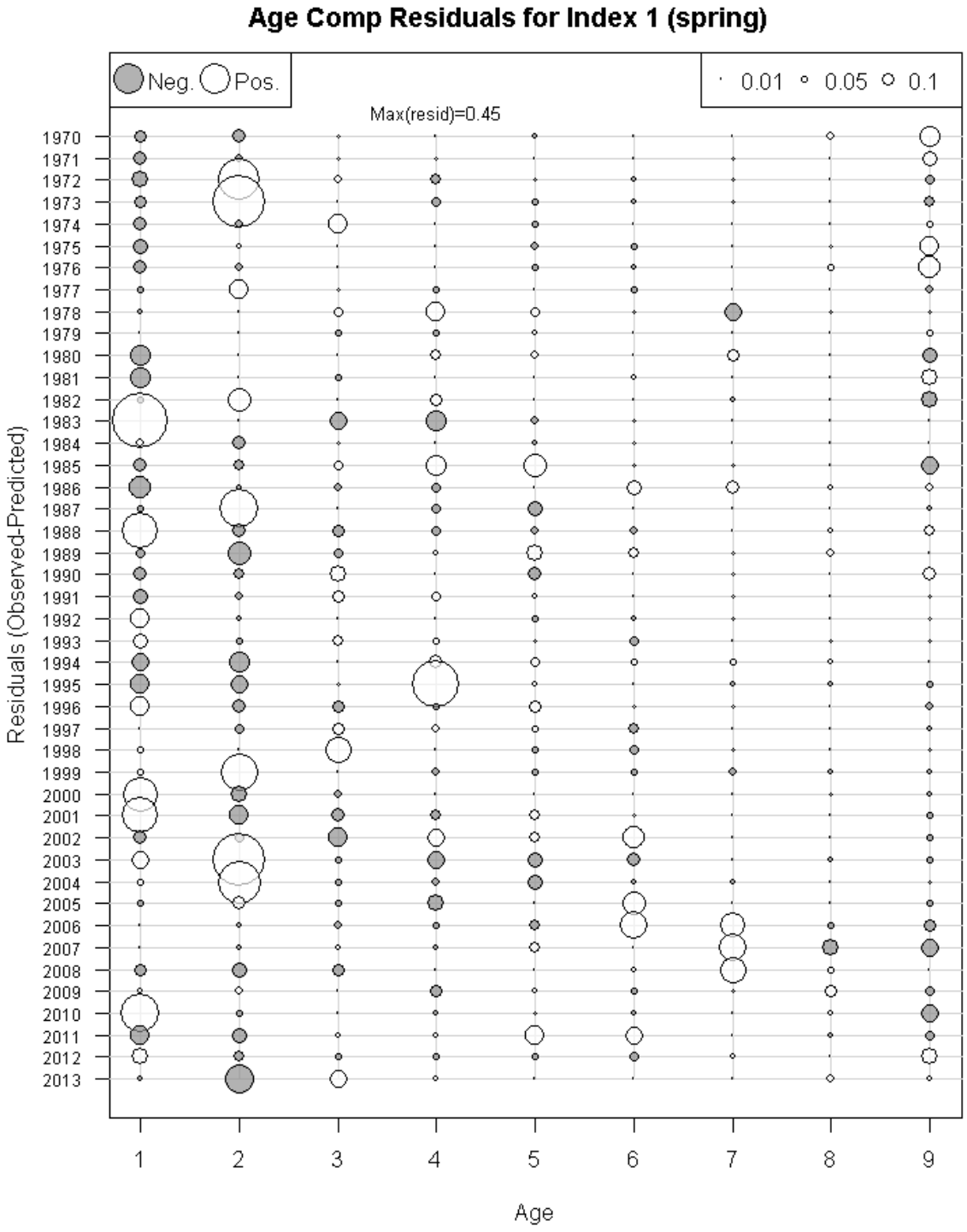


Figure C21. Age Structured Assessment Program (ASAP) base model residuals for Northeast Fisheries Science Center (NEFSC) spring index age composition of pollock (*Pollachius virens*). Open circles are positive residuals, filled circles are negative residuals, calculated as (Observed-Predicted).

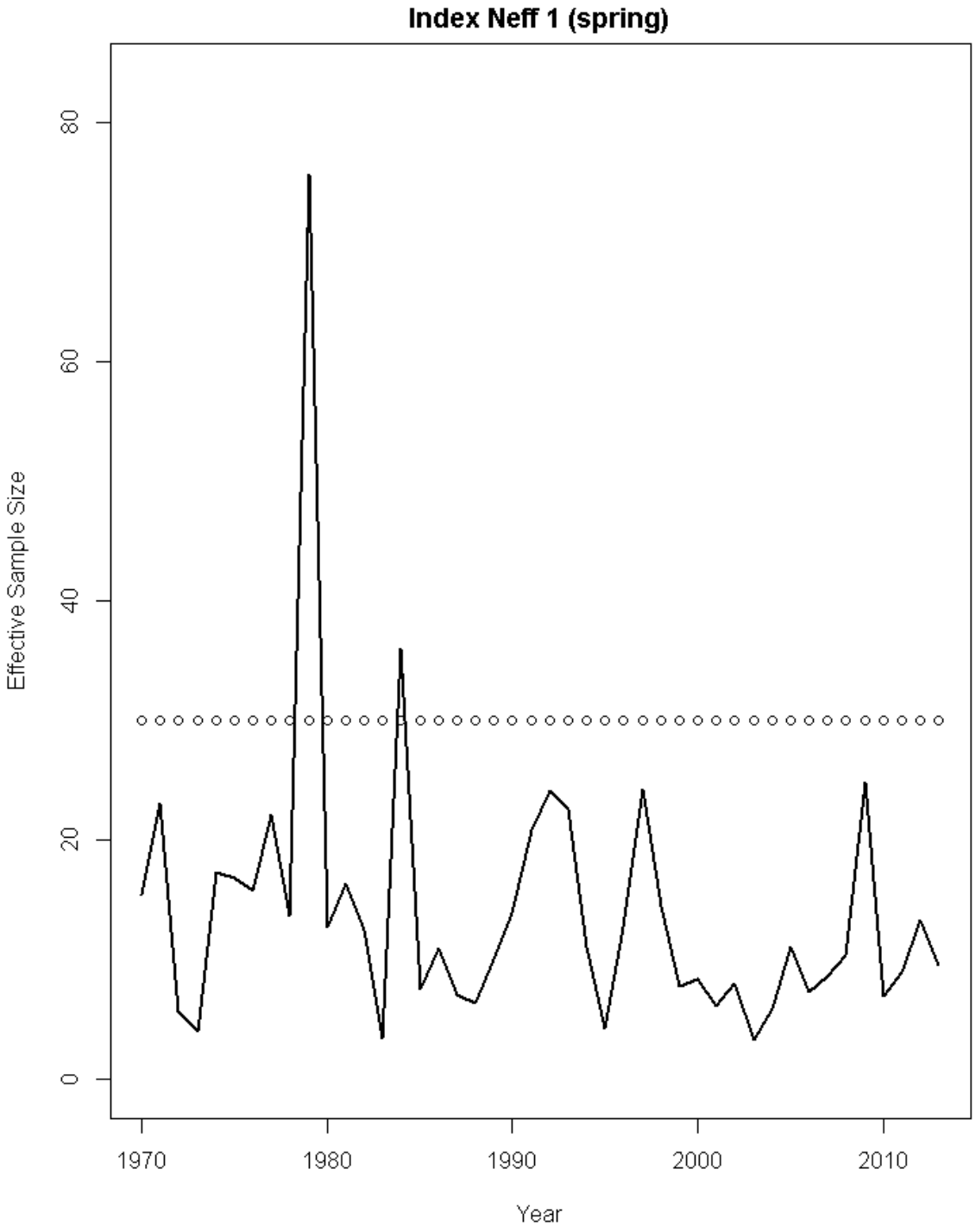


Figure C22. Age Structured Assessment Program (ASAP) base model comparison of input effective sample size (circles) of pollock (*Pollachius virens*) versus the model estimated effective sample size (line) for the Northeast Fisheries Science Center (NEFSC) spring index.

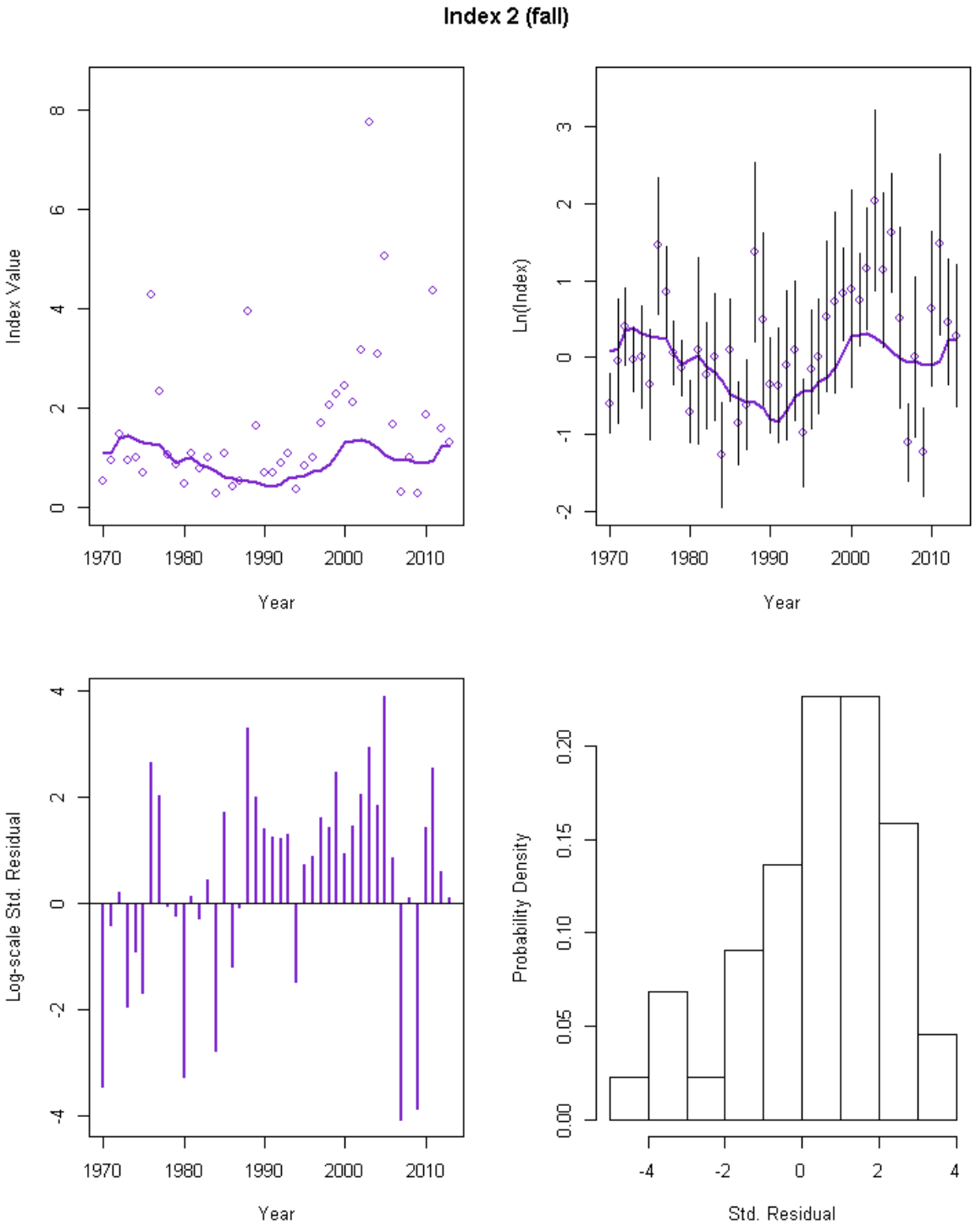


Figure C23. Age Structured Assessment Program (ASAP) base model fit to the Northeast Fisheries Science Center (NEFSC) fall index.

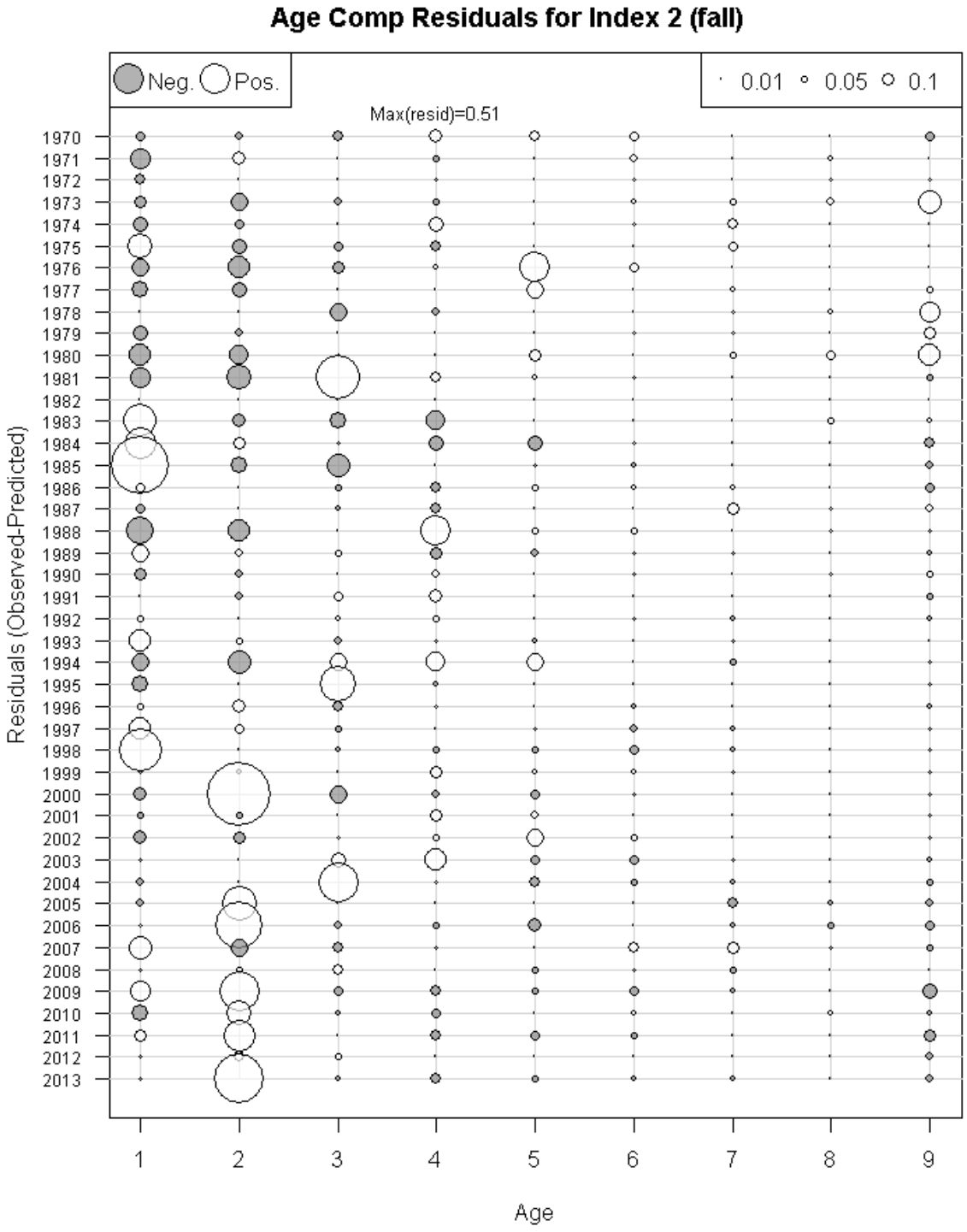


Figure C24. Age Structured Assessment Program (ASAP) base model residuals for Northeast Fisheries Science Center (NEFSC) fall index age composition of pollock (*Pollachius virens*). Open circles are positive residuals, filled circles are negative residuals, calculated as (Predicted-Observed).

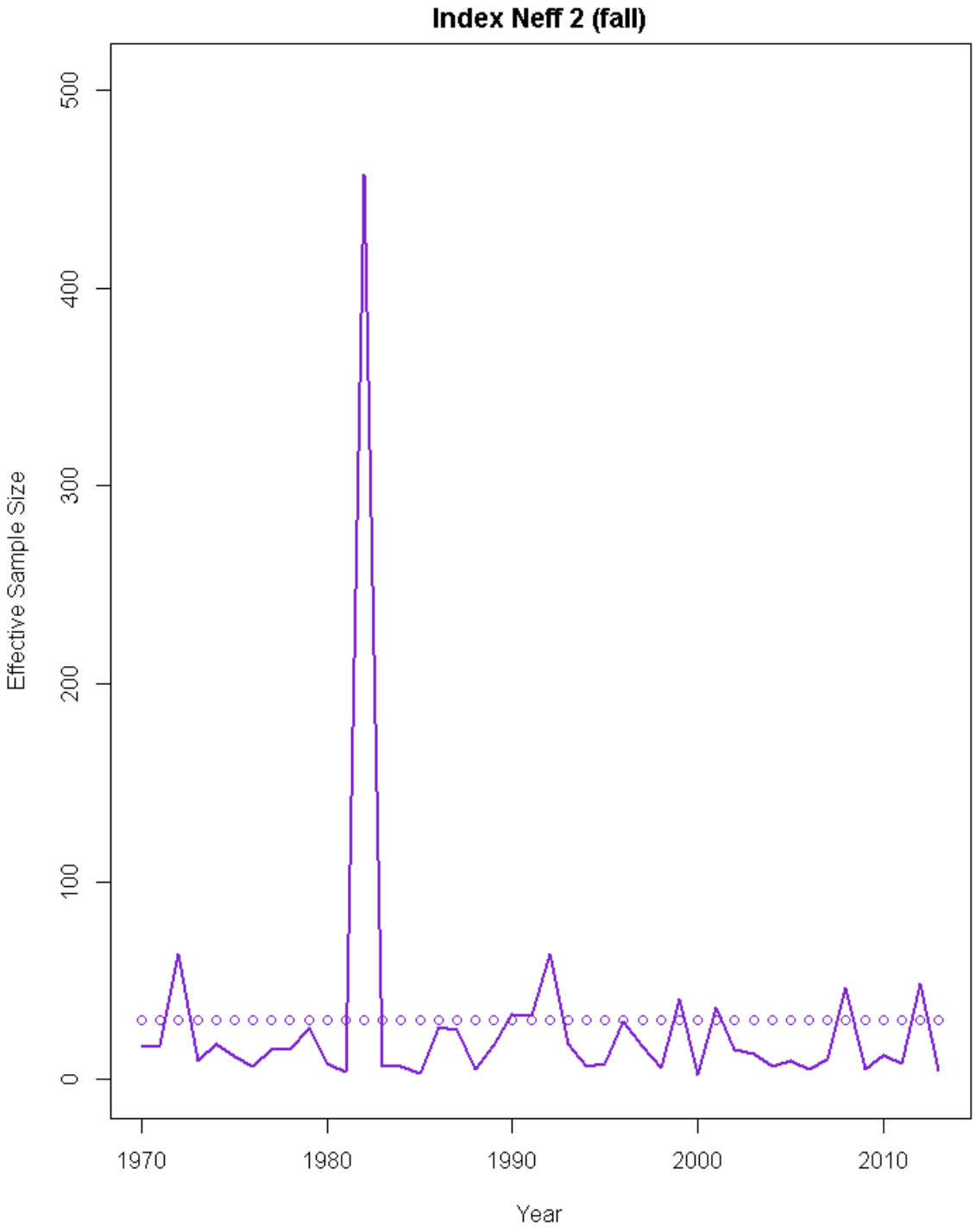


Figure C25. Age Structured Assessment Program (ASAP) base model comparison of input effective sample size (circles) of pollock (*Pollachius virens*) versus the model estimated effective sample size (line) for the Northeast Fisheries Science Center (NEFSC) fall index.

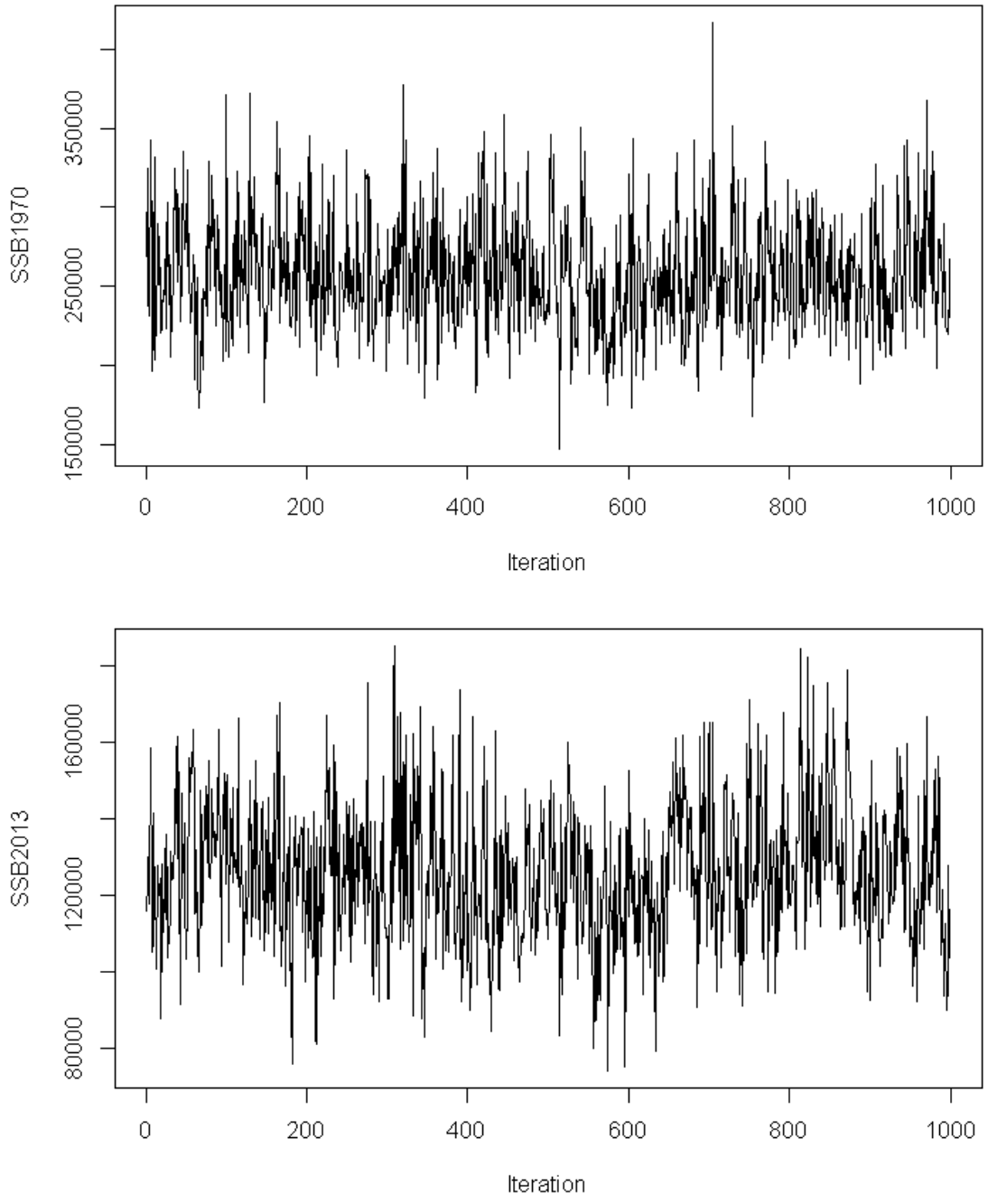


Figure C26. Trace of MCMC chains for SSB1970 (top panel) and SSB2013 (bottom panel), showing good mixing (Age Structured Assessment Program [ASAP] base model). Each chain had initial length of 10 million; the first 5 million were dropped for burn-in, and the remaining 5 million were thinned at a rate of one out of every 5,000th. The final chain length was 1000 saved draws.

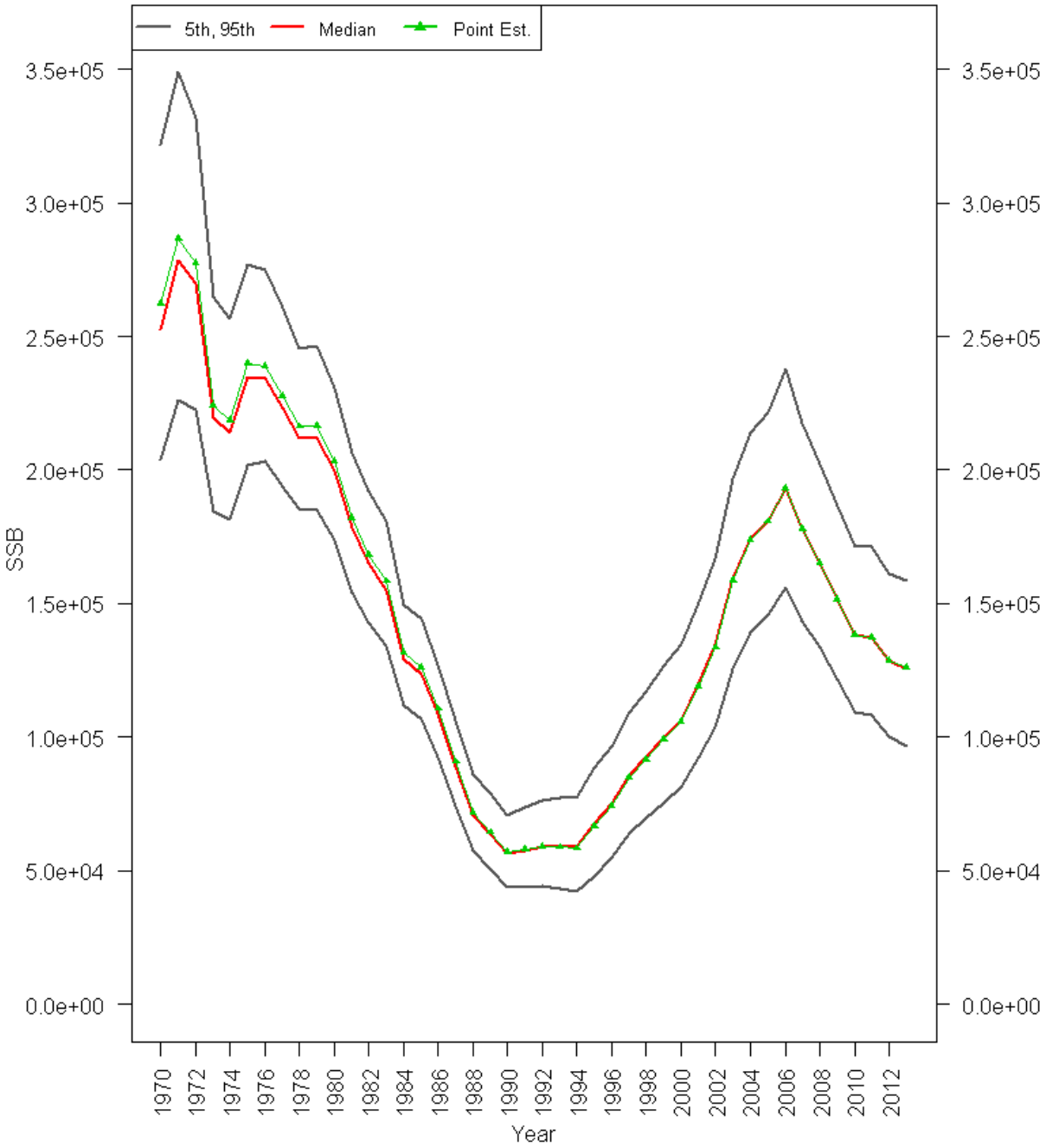


Figure C27. A 90% probability interval for pollock (*Pollachius virens*) spawning stock biomass (SSB) in thousands of mt is plotted for the entire time series. The median value is in red, while the 5th and 95th percentiles are in dark grey. The point estimate from the base model (joint posterior modes) is shown in the thin green line with filled triangles. (Age Structured Assessment Program [ASAP] base model)

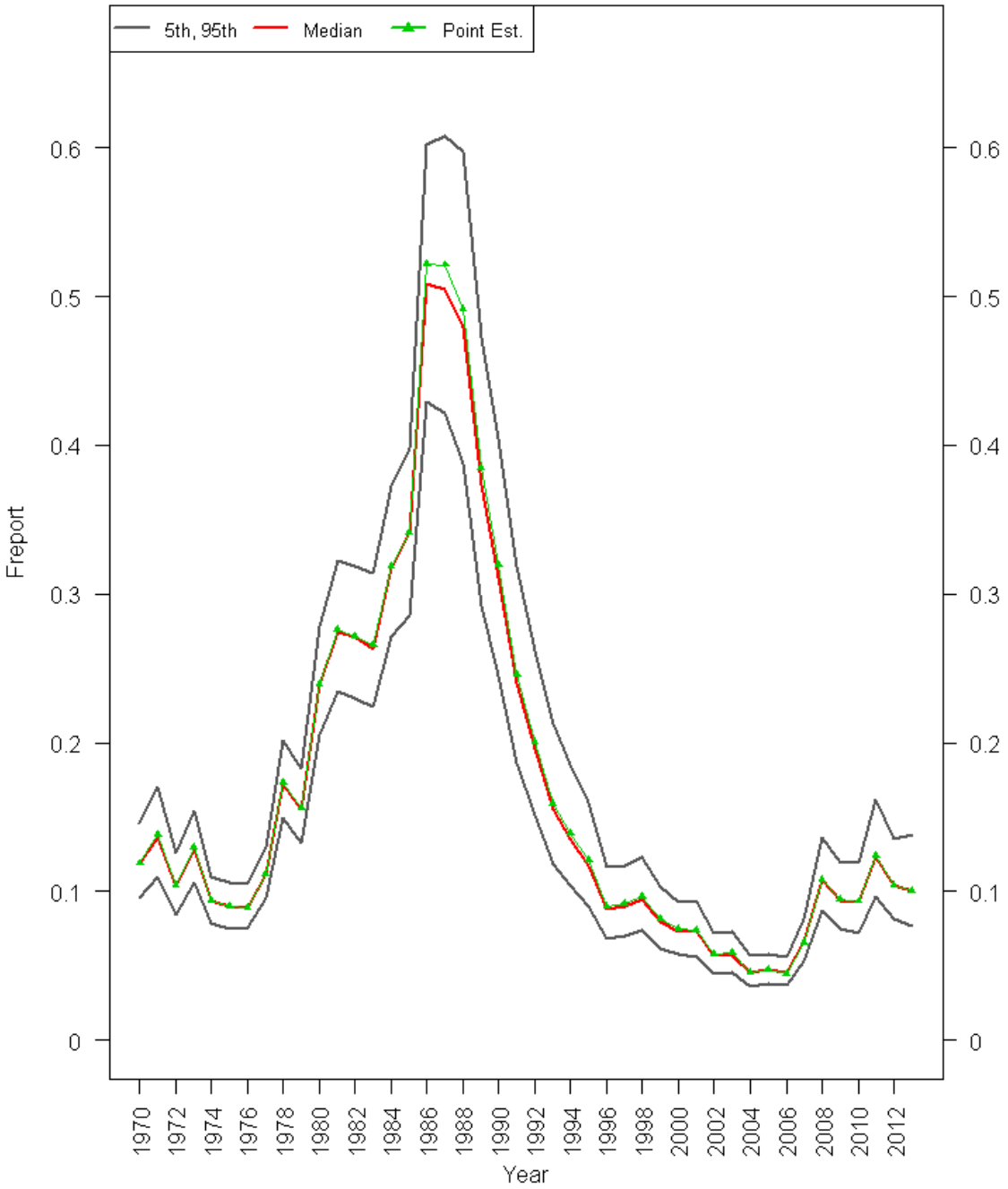


Figure C28. A 90% probability interval for the average F on ages 5-7 (F_{5-7}) for pollock (*Pollachius virens*) is plotted for the entire time series. The median value is in red, while the 5th and 95th percentiles are in dark grey. The point estimate from the base model (joint posterior modes) is shown in the thin green lined with filled triangles. (Age Structured Assessment Program [ASAP] base model)

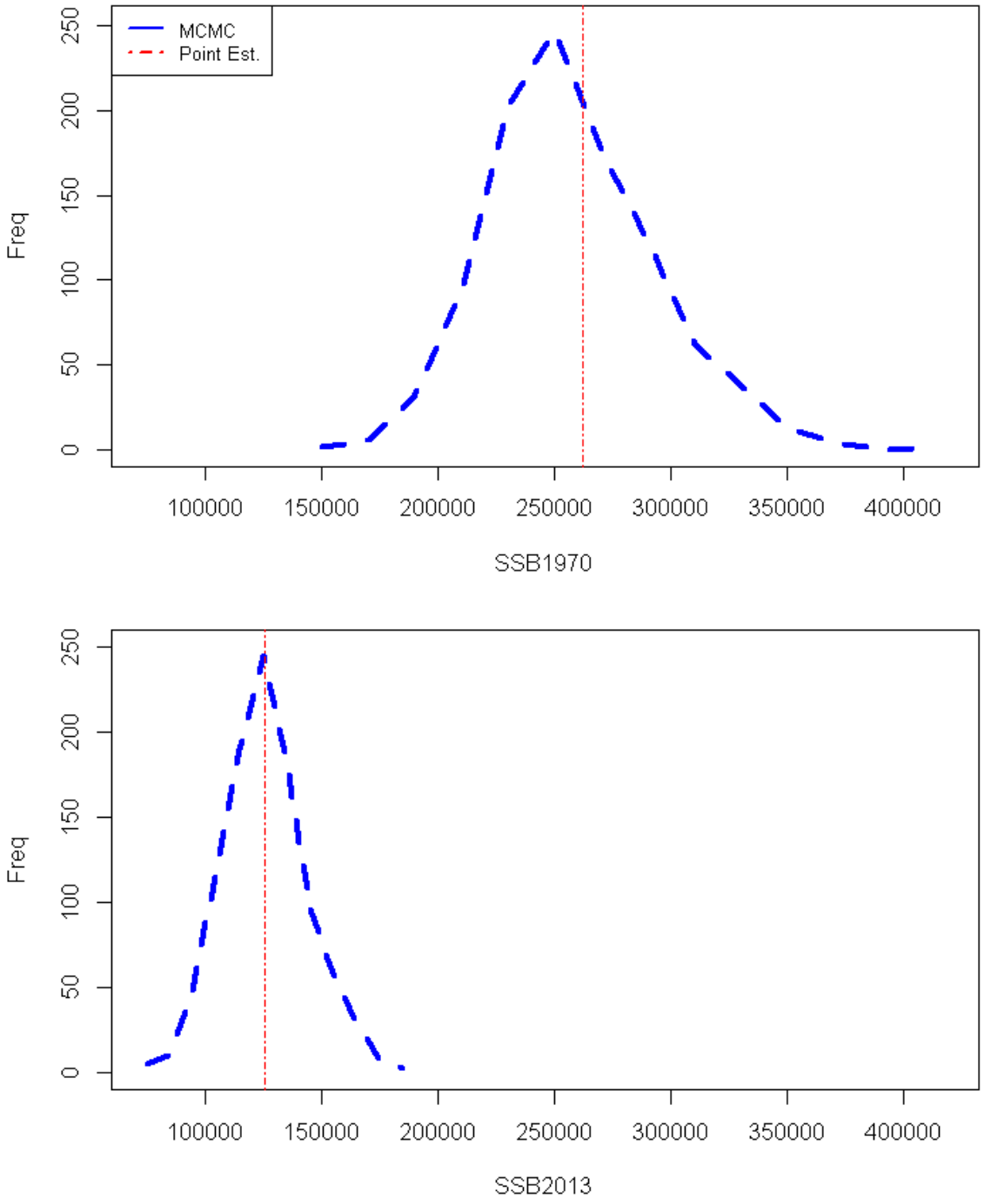


Figure C29. Posterior distribution for spawning stock biomass (SSB) of pollock (*Pollachius virens*) in 1970 (top panel) and in 2013 (bottom panel). The vertical dashed red line indicates the point estimate. (Age Structured Assessment Program [ASAP] base model)

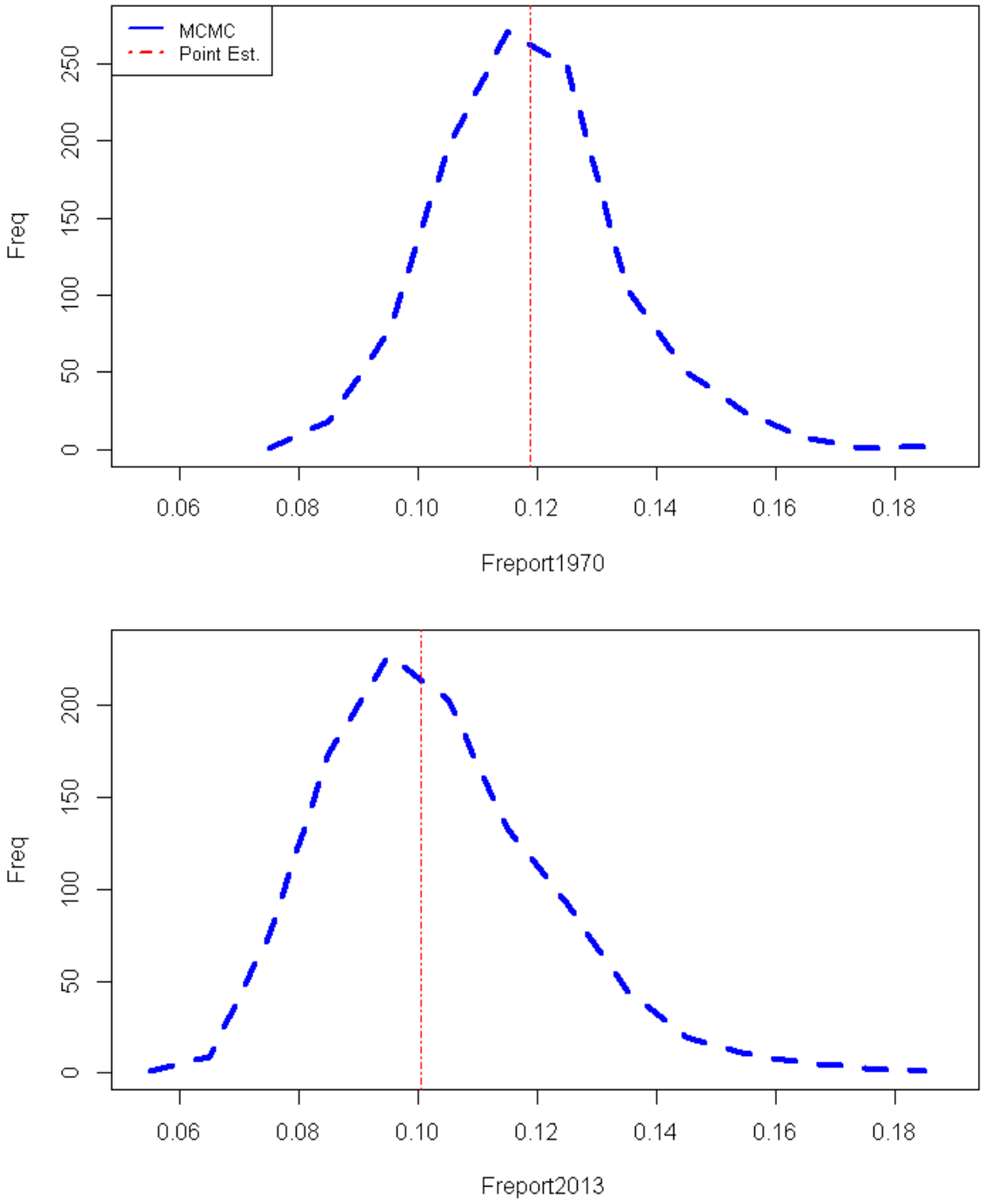


Figure C30. Posterior distribution of pollock (*Pollachius virens*) for average F on ages 5-7 (F_{5-7}) in 1970 (top panel) and in 2013 (bottom panel). The vertical dashed red line indicates the point estimate. (Age Structured Assessment Program [ASAP] base model)

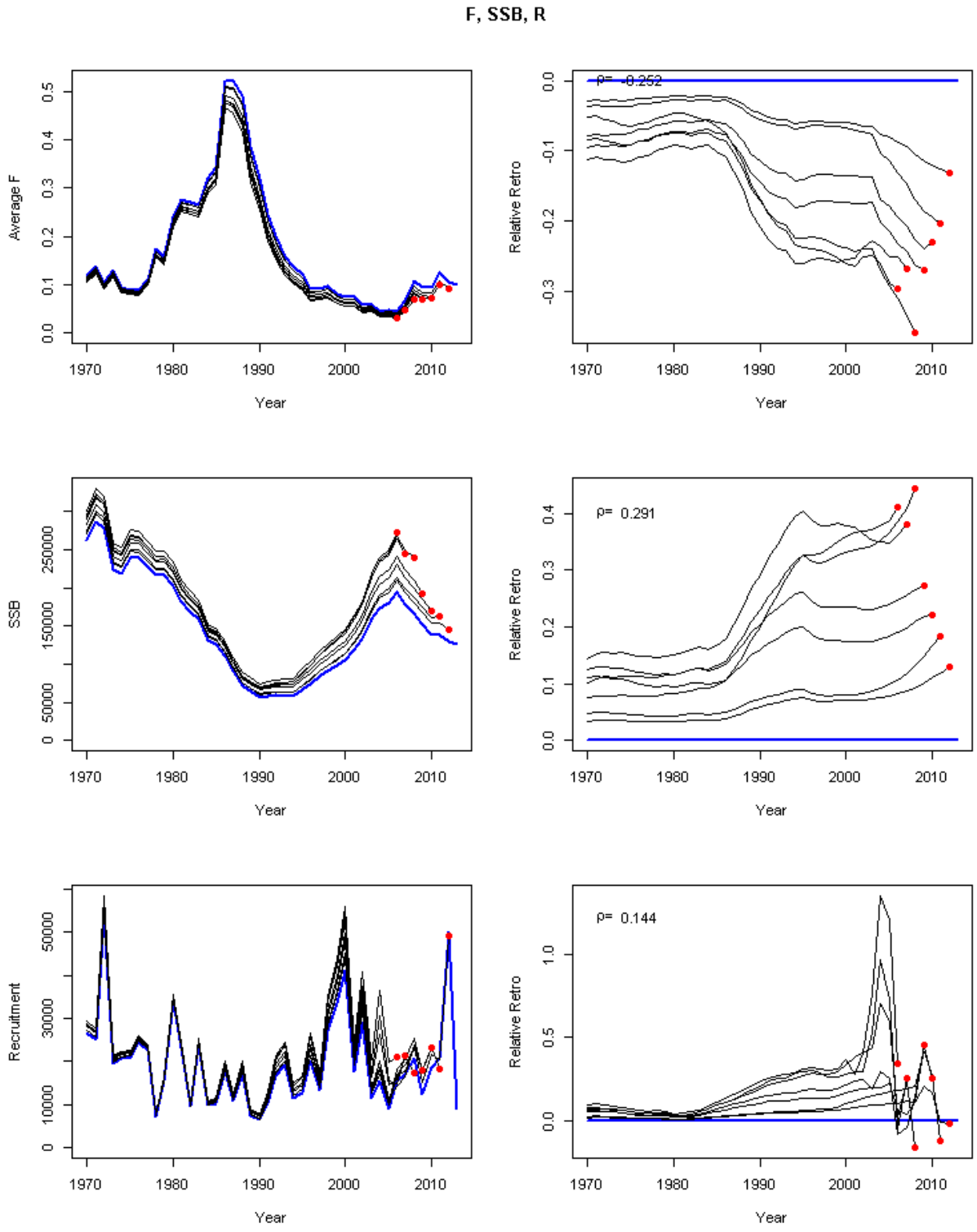


Figure C31. Retrospective analysis for the Age Structured Assessment Program (ASAP) base model for years 2006-2012.

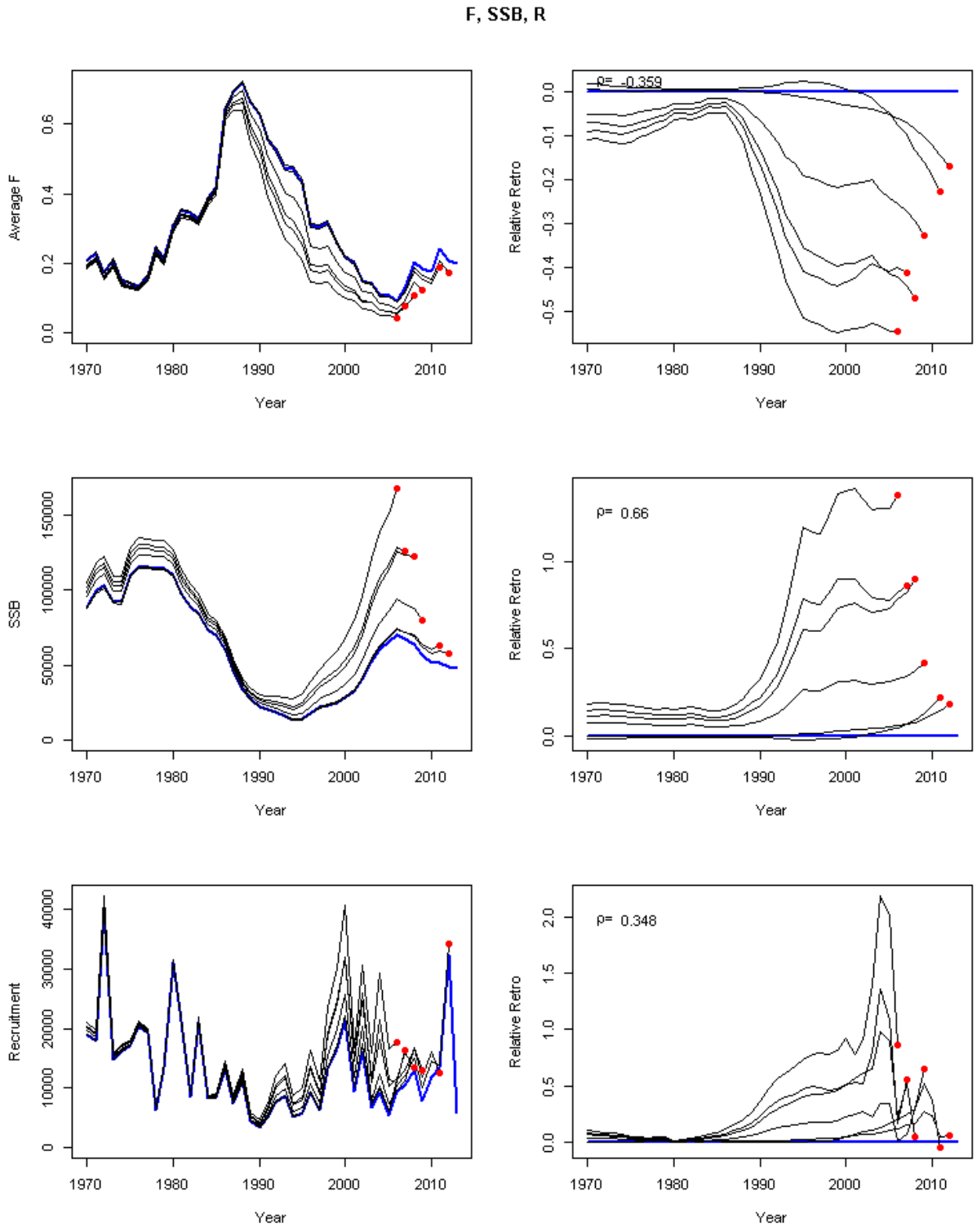


Figure C32. Retrospective analysis for years 2006-2012 for the Age Structured Assessment Program (ASAP) sensitivity model with survey selectivity at ages 6-9+ fixed at 1.0. Relative biases are displayed for 2006-2009 and 2011-2012; the model did not successfully run for year 2010.

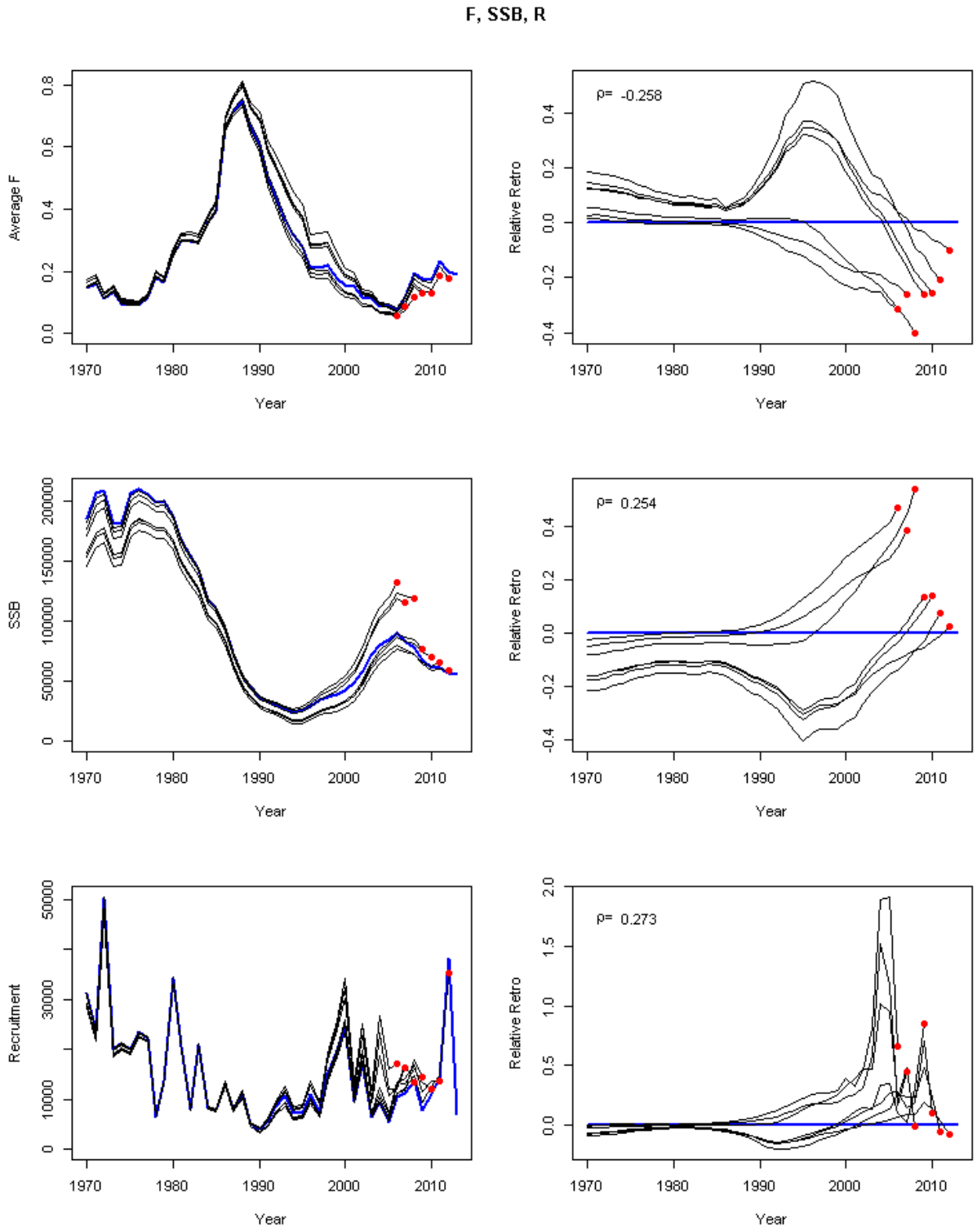


Figure C33. Retrospective analysis for the reweighted Age Structured Assessment Program (ASAP)base model for years 2006-2012.

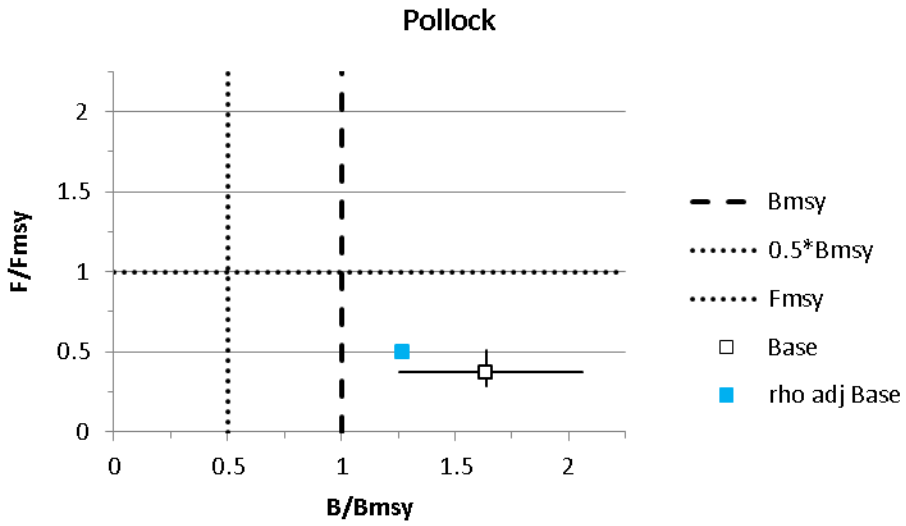
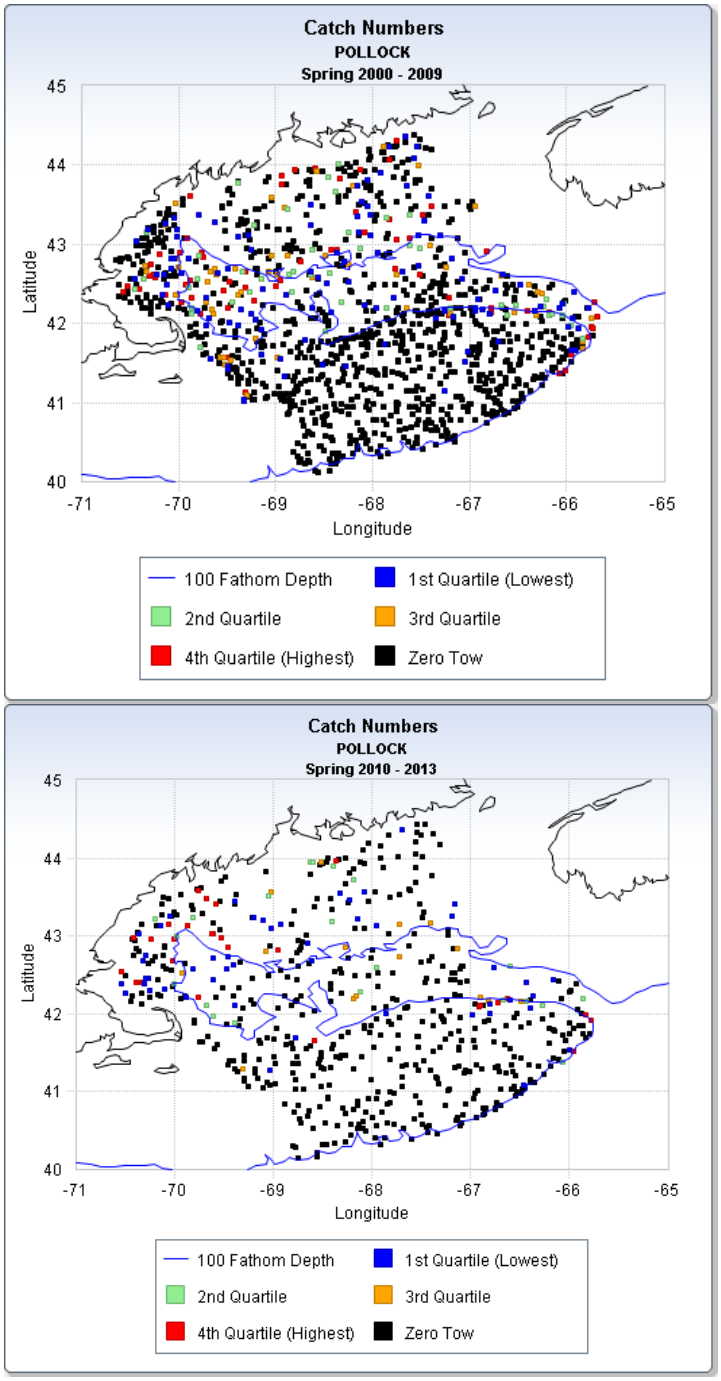
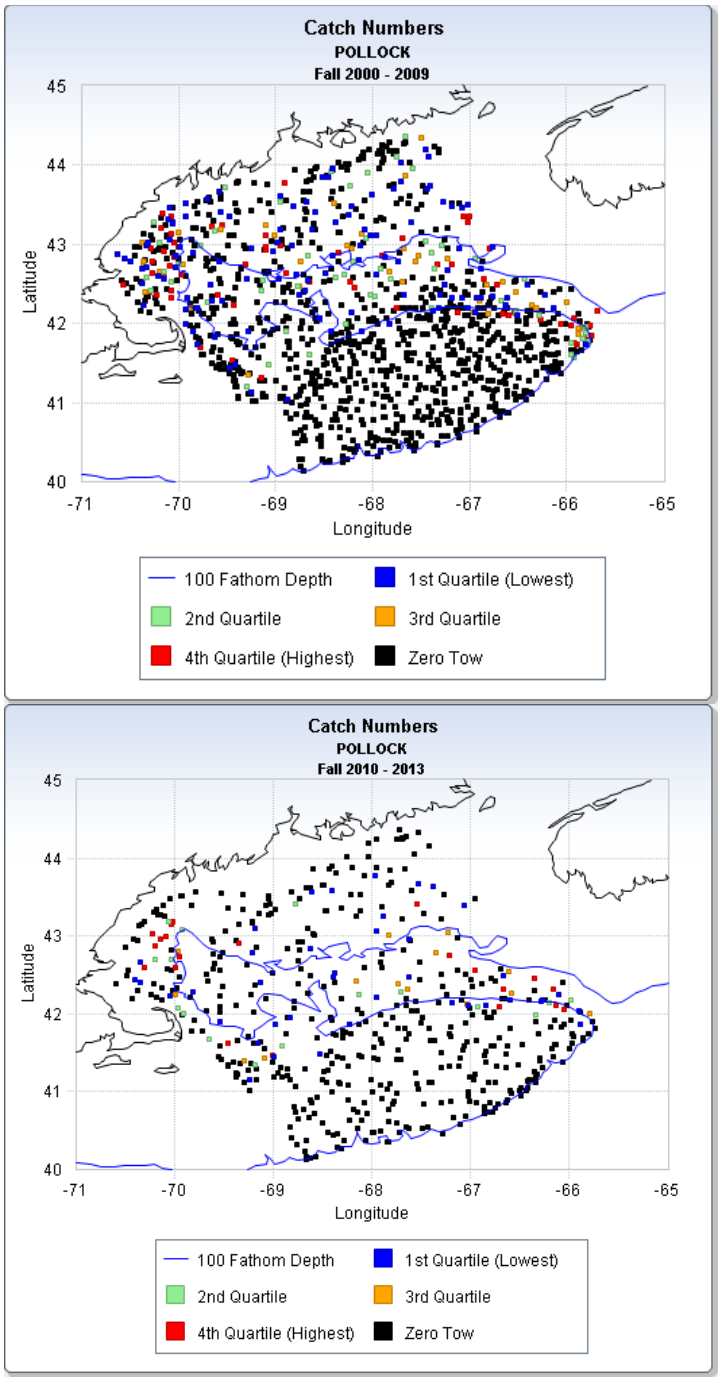


Figure C34. Stock status for pollock (*Pollachius virens*). The base model with 90% probability intervals and Mohn's rho-adjusted base model are plotted.

APPENDIX C1. POLLOCK (*POLLACHIUS VIRENS*) 2014 OPERATIONAL ASSESSMENT SURVEY DISTRIBUTION PLOTS.



Appendix C1 Figure C1. Pollock (*Pollachius virens*) Northeast Fisheries Science Center (NEFSC) spring bottom trawl survey catch (numbers) distributions. Top panel includes total survey catches by tow from 2000-2009. Bottom panel includes total survey catches by tow from 2010-2013.



Appendix C1 Figure C2. Pollock (*Pollachius virens*) Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey catch (numbers) distributions. Top panel includes total survey catches by tow from 2000-2009. Bottom panel includes total survey catches by tow from 2010-2013.