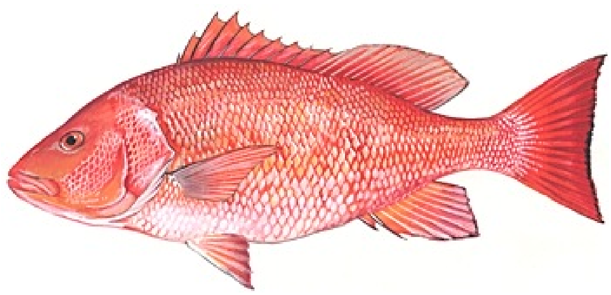
Stock Assessment of Red Snapper off the Southeastern United States

Update of SEDAR73 Assessment



Southeast Fisheries Science Center

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Document History

August 2024 Draft release.

16 September 2024 This release corrects text related to the stock being overfished (i.e., SSB relative to MSST) versus still rebuilding (i.e., SSB relative to SSB_{MSY}). It adds two projection scenarios, one using the current fishing rate and one using recent recruitment, and updates associated text. It adds a new figure for a previous projection scenario ($F = F_{30\%}$) that quantifies the trade-off between landings and dead discards in hypothetical reductions of discards.

18 September 2024 This release adds two projection scenarios, one using the current fishing rate and one the fishing rate that achieves SSB(2028) = $0.86\text{SSB}_{\text{F30\%}}$ with probability of 0.5. Both assume recent average recruitment. For the latter of these two scenarios, this report also adds the figure that quantifies the trade-off between landings and dead discards in hypothetical reductions of discards.

30 September 2024 This release adds three projection scenarios, in which F equals 70%, 80%, or 90% of the current fishing rate. All three assume recent average recruitment. It also adds a table of $\text{SSB}/\text{SSB}_{\text{F30\%}}$ and the figure that quantifies the trade-off between landings and dead discards in hypothetical reductions of discards for these new projections, as well as for $F = F_{30\%}$ and $F = F_{\text{current}}$.

3 December 2024 Document finalized; draft status removed.

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1 Executive Summary

This update assessment evaluated the stock of red snapper (Lutjanus campechanus) in the South Atlantic region of the southeastern United States, a stock currently under a rebuilding plan. This update was undertaken at the request of the Southeast Regional Office under the exceptional circumstance of a Secretarial Amendment. The primary objectives were to update the 2021 SEDAR73 operational assessment of red snapper and to conduct new stock projections. Using data through 2019, SEDAR73 had indicated that the stock was overfished and undergoing overfishing. For this update assessment, data compilation and assessment methods were identical to methodology of SEDAR73. The assessment period is 1950–2023.

Available data on this stock included indices of abundance, landings, discards, and samples of annual length and age compositions from fishery dependent and fishery independent sources. Five indices of abundance were fitted by the model: one from the commercial logbooks, one from the recreational headboat logbooks, one from on-board observers of headboat discards, one from the Southeast Reef Fish Survey (SERFS) chevron trap data, and one from SERFS video data. Sensitivity runs evaluated the effects of reducing estimates of the recreational landings and discards by 20% or 40%. Data on landings and discards were modeled from three distinct fleets: commercial handline, recreational headboats, and general recreational (private and charter modes). For this update assessment, key data sources were updated through 2023, including landings and discards from all three fleets, both fishery independent (SERFS) indices, and age compositions from SERFS chevron traps.

The primary model used in SEDAR73—and the one updated here—was the Beaufort Assessment Model (BAM), an integrated statistical catch-age formulation. A base run of BAM, identical to the configuration of SEDAR73, was implemented to provide point estimates of key management quantities, such as stock and fishery status. Uncertainty in estimates from the base run was evaluated through a mixed Monte Carlo/Bootstrap Ensemble (MCBE) procedure, again with identical configuration to that of SEDAR73. Median values from the uncertainty analysis are also provided. In this assessment, as codified in the Fishery Management Plan, reference points were based on $F_{30\%}$, the F providing 30% SPR, as a proxy for F_{MSY}.

The assessment estimated that spawning stock declined until about 1990, then increased slowly until about 2010, with more rapid increase since. The terminal (2023) base-run estimate of spawning stock was below the rebuilding criterion of $\mathrm{SSB}_{\mathrm{F30\%}}$ ($\mathrm{SSB}_{2023}/\mathrm{SSB}_{\mathrm{F30\%}} = 0.76$), as was the median estimate from the MCBE ($\mathrm{SSB}_{2023}/\mathrm{SSB}_{\mathrm{F30\%}} = 0.89$). The estimated fishing rate has exceeded the maximum fishing mortality threshold (MFMT), represented by $F_{30\%}$, since about 1980. The terminal estimate, which is based on a three-year geometric mean, was above $F_{30\%}$ in the base run ($F_{2021-2023}/F_{30\%} = 1.85$) and in the median of the MCBE ($F_{2021-2023}/F_{30\%} = 1.58$). Thus, this assessment indicated that the stock is not yet rebuilt and is experiencing overfishing.

The MCBE analysis illustrated that the overfishing result is robust. Of all MCBE runs, 96% were in agreement that overfishing is occurring. However, there was a larger degree of uncertainty in stock status, with 62% of MCBE runs in agreement with the base run, and 38% suggesting that the stock is rebuilt.

The estimated trends of this operational assessment were quite similar to those from the SEDAR73 operational assessment. Compared to SEDAR73, this assessment suggested slightly lower levels of overfishing in terminal years and higher values of stock size relative to their benchmarks. The two assessments showed nearly identical stock status through 2019, the terminal year of SEDAR73. Since then, the update assessment indicated continued progress toward rebuilding, as a result of higher-than-expected recruitment during 2014–2021. Estimated recruitment in 2022 and 2023 were lower, closer to the long-term expectation. The primary driver of overfishing remains general recreational discards.

2 Data Review and Update

The input data for this assessment are described below.

2.1 Data Review and Update

In this update assessment, the Beaufort assessment model (BAM) was fitted to data sources developed during the SEDAR73 process. These data are detailed in the SEDAR73 report (SEDAR73 2021). Highlights for this update assessment are described below.

Data sources treated as input by this SEDAR73 update assessment

- Life history: Meristics, population growth, fishery dependent size at age, female maturity, proportion female, number of batches at age, size-dependent batch fecundity, age-dependent natural mortality
- Discard mortality

Data sources fitted by this SEDAR73 update assessment

- Landings and discards: Commercial handline landings and discards, headboat landings and discards, general recreational landings and discards
- Indices of abundance: Commercial handline, headboat, headboat discards, SERFS[1] chevron trap, SERFS video
- Length compositions: Commercial landings, commercial discards, headboat discards
- Age compositions: Commercial landings, headboat landings, general recreational landings, SERFS chevron trap

Data sources updated through 2023 for this SEDAR73 update assessment

- Landings and discards: Landings and discards from commercial, headboat, and recreational fleets
- Indices of abundance: SERFS indices (chevron trap and video)
- SERFS age compositions: SERFS age compositions from chevron trap data

Data fitted by this assessment are summarized in Figure 1. Landings and discards for each fleet were extended to include years 2020–2023. Similarly, the additional years were added for the SERFS age composition data, although SERFS did not sample in 2020 due to the COVID-19 pandemic, and thus no SERFS data are available for that year. SERFS indices (chevron trap and video) were updated using data through 2023, standardized with methods identical to those of SEDAR73. Because these indices represent changes in relative abundance, the entire time series were updated for years 2010–2023 (chevron trap) or 2011–2023 (videos), although with no observations in 2020.

[1] Abbreviations and acronyms used in this report are defined in Appendix A

3 Stock Assessment Methods

The stock assessment methods are detailed in SEDAR73 (2021). In brief, this update assessment applied identical modeling methodology as in SEDAR73 (2021), but with key data sources updated through 2023. Implementation of the model was accomplished using the Beaufort Assessment Model (BAM) software (Williams and Shertzer 2015). The model is similar in structure to Stock Synthesis (Methot and Wetzel 2013) and other stock assessment models used in the United States (Dichmont et al. 2016; Li et al. 2021). Versions of BAM have been used in previous SEDAR assessments of reef fishes in the U.S. South Atlantic, such as Black Sea Bass, Blueline Tilefish, Gag, Greater Amberjack, Red Grouper, Red Porgy, Scamp Grouper, Snowy Grouper, Tilefish, and Vermilion Snapper, as well as in the previous SEDAR assessment of Red Snapper (SEDAR73 2021).

The only methodological difference in this update assessment lies in the treatment of discard mortality. In SEDAR73, four time blocks were used to quantify discard mortality (Table 1). The third time block (2017–2020) included the terminal year (2019) of the SEDAR73 assessment, and thus benchmarks estimated by the assessment were predicated on those block-3 discard mortality values. The fourth time block (post-2020) occurred after the terminal year of the assessment (2019), and was applied to projections. That created an inconsistency between the projections and the benchmarks estimated by the assessment model. To resolve that inconsistency, the assessment-estimated benchmarks were recomputed assuming block-4 discard mortality, such that the recomputed benchmarks would be consistent with projections. In other words, SEDAR73 had two sets of benchmarks: one set for gauging stock status during the assessment period, and another set for gauging stock status during the projection period. In this update assessment, block-4 discard mortality (post-2020) included the terminal three years of the assessment and was assumed to carry forward in the projections. Given the terminal year of 2023 in this update, reference points from the assessment period are predicated on block-4 discard mortality, as are projections, and therefore there is no need to compute a second set of benchmarks for consistency with projections. Benchmarks used to gauge stock status in the assessment period are the same as those used in the projections.

3.1 Sensitivity analyses

Two sensitivity runs were explored, as requested by SERO. These runs were intended to demonstrate directionality of results but are not considered to be equally plausible alternative states of nature. These model runs vary from the base run as follows:

- S1: General recreational landings and discards are assumed to be 20% lower than the base-run values.
- S2: General recreational landings and discards are assumed to be 40% lower than the base-run values.

3.2 Projections

Projections were run to predict stock status and provide catch advice in years after the assessment, 2024–2044. The year 2044 is the last year of the current rebuilding plan. Any new management was assumed to start in 2025. Thus, the year 2024 was treated as an interim year in which the fishing mortality rate was adjusted to match recent (2021–2023) average landings.

The structure of the projection model was the same as that of the assessment model, and parameter estimates were those from the assessment. Any time-varying quantities, such as recreational selectivity, were fixed to the most recent values of the assessment period. A single selectivity curve was applied to calculate landings, averaged across fleets using geometric mean Fs from the last three years of the assessment period, as in the computation of $L_{\mathrm{F30\%}}$ benchmarks. Similarly, a single, average selectivity curve was applied to calculate dead discards.

Expected values of SSB (time of peak spawning), F, recruits, landings, and dead discards were represented by deterministic projections using parameter estimates from the base run. Unless otherwise noted, projections applied the long-term mean recruit with bias correction, and were thus consistent with estimated benchmarks in the sense that long-term fishing at $F_{30\%}$ would yield $L_{\mathrm{F30\%}}$ from a stock size at $\mathrm{SSB}_{\mathrm{F30\%}}$. Uncertainty in future time series was quantified through stochastic projections that extended the ensemble (MCBE) fits of the stock assessment model.

Additional details of the projection methods can be found in SEDAR73 (2021).

Projection scenarios Six projection scenarios were considered.

- Scenario 1: $F = F_{30\%}$ with recruitment at the long-term average value
- Scenario 2: $F = F_{\mathrm{rebuild}}$ with recruitment at the long-term average value
- Scenario 3: $F = F_{\mathrm{current}}$ with recruitment at the long-term average value
- Scenario 4: $F = F_{30\%}$ with recruitment at the recent (last 10 y) average value
- Scenario 5: $F = F_{\mathrm{current}}$ with recruitment at the recent (last 10 y) average value
- Scenario 6: $F = CF_{30\%}$ with recruitment at the recent (last 10 y) average value and $\mathrm{SSB}(2028) \geq 0.86\mathrm{SSB}_{\mathrm{F30\%}}$ with probability of 0.5
- Scenario 7: $F = 70\% F_{\mathrm{current}}$ with recruitment at the recent (last 10 y) average value
- Scenario 8: $F = 80\% F_{\mathrm{current}}$ with recruitment at the recent (last 10 y) average value
- Scenario 9: $F = 90\% F_{\mathrm{current}}$ with recruitment at the recent (last 10 y) average value

The F_{rebuild} is defined as the maximum F that achieves rebuilding in the allowable time frame. The F_{current} is defined as the geometric mean F from the last three assessment years. In Scenario 6, the fishing rate is equal to $F = CF_{30\%}$, where C is a constant multiplier, such that the applied fishing rate is defined relative to $F_{30\%}$. Because $F_{30\%}$ differs across MCBE iterations, $F = CF_{30\%}$ would differ as well. For this Scenario 6, the value of C was solved for iteratively, to achieve $\mathrm{SSB}(2028) \geq 0.86\mathrm{SSB}_{\mathrm{F30\%}}$ with probability of 0.5. That is, across all iterations of the stochastic projections, half achieved $\mathrm{SSB} \geq 0.86\mathrm{SSB}_{\mathrm{F30\%}}$ in the year 2028, and half remained below $0.86\mathrm{SSB}_{\mathrm{F30\%}}$. The criterion of $\mathrm{SSB}(2028) = 0.86\mathrm{SSB}_{\mathrm{F30\%}}$ was chosen because it matches previous projections that were used in the rebuilding plan of Amendment 17A.

Scenarios 1–3 assume long-term average recruitment, for consistency with reference points. Scenarios 4–9 assume recent average recruitment from the last 10 years, and are projected for five years only. Recent-recruitment scenarios may be considered for short-term catch advice (SAFMC SSC Projections Workgroup 2022), noting that this assumption about recruitment is not consistent with that used to compute reference points on which status indicators and rebuilding time frames are based.

For Scenarios 1 and 4–9, the tradeoff between 2025 landings and dead discards was quantified to indicate expected gains in landings that could be obtained by reducing discards. This analysis was conducted with the following assumptions:

- For Scenario 1, recruitment in 2024 was equal to the long-term average, and for Scenarios 4–9, recruitment in 2024 was equal to the recent average (last 10 y).
- Fishing rates were assumed equal to that of the corresponding projection scenario.

- Selectivity of landings and selectivity of discards were based on the average curves from the assessment (Figure 28). These are the same selectivities used to compute $F_{30\%}$ and in the projections.
- The assumed percentage decrease to dead discards decreases the discard selectivity by that amount, and simultaneously increases the landings selectivity by the same amount.
- The N-at-age is that of year 2025 from the relevant scenario (Scenario 1 or 4–9). Thus, relative to the terminal year of the assessment (2023), there is an additional year (2024) of recruitment and overfishing applied.

4 Stock Assessment Results

4.1 Measures of Overall Model Fit

In general, the BAM fit well to the available data. The model was configured to fit observed commercial and recreational removals closely (Figures 2–7). Fits to indices of abundance generally captured the observed trends but not all annual fluctuations (Figures 8–12).Predicted length compositions were reasonably close to observed data in most years, as were predicted age compositions (Figure 13).

4.2 Parameter Estimates

Estimates of all parameters from the catch-age model are shown in Appendix B. Estimates of management quantities and some key parameters are reported in sections below.

4.3 Stock Abundance and Recruitment

In general, estimated abundance at age showed truncation of the older ages through most of the assessment period, but with signs of increased recruitment during the last decade (Figures 14, 15; Table 2). Total estimated abundance was at its lowest value in the early 1990s, but at its highest levels near the end of the time series, above or comparable to estimates in the 1950s and 1960s, but with a more truncated age structure. The MCBE results reflect the same patterns with their associated uncertainties for total abundance and abundance of age 2+ (Figure 16). Annual number of recruits is shown in Table 2 (age-1 column) and in Figure 17. The highest recruitment values were predicted to have occurred in the mid-1980s, 2006–2008, and near the end of the assessment (2014–2021). Recruitment estimates in the terminal two years (2022, 2023) were closer to the long-term average, with the terminal estimate lower than average. This result was consistent in the MCBE analysis (Figure 18). Nonetheless, terminal-year estimates of recruitment can be highly uncertain, as the model-fitting process does not have multiple years of data with which to track year-class strength. It can be instructive to track those strong year-classes through time to understand how they are affected by mortality, e.g., the 2006–2008 recruits were largely depleted during their first five years (Figure 15; Table 2).

4.4 Total and Spawning Biomass

Estimated biomass at age followed a similar pattern as abundance at age (Figure 19; Table 3), but the biomass recovery in recent years occurs to a lesser degree than the abundance recovery, because the age structure has shifted toward younger fish compared to the first several decades of the assessment period. Total biomass and spawning biomass showed similar trends—general decline through to the early-1990s, and relatively stable or increasing patterns since the mid-1990s (Figure 20; Table 4). The increase during 2013–2023 was notably rapid, although that increase in total biomass appears to have subsided in the terminal year because of the decreased recruitment in 2023. Such a terminal-year plateau does not occur in spawning biomass because the 2023 recruits are mostly immature. Plateau or not, terminal year estimates of total and spawning biomass are at levels not seen since around 1980, but with a younger age structure.

4.5 Selectivity

Selectivity of the SERFS indices are shown in Figure 21, and selectivities of landings from commercial and recreational fleets are shown in Figures 22–24. Selectivities of discards from commercial and recreational fleets are shown in Figures 25–27. Selectivities from each time block are tabulated in Tables 5–7. In the most recent selectivity block, full selection of landings or discards occurred near ages 2–6, depending on the fleet.

Average selectivities of landings, dead discards, and the total weighted average of all selectivities were computed from F-weighted selectivities in the most recent three assessment years (Figure 28, Table 8). These average selectivities were used in computation of point estimates of benchmarks, as well as in projections.

4.6 Fishing Mortality and Removals

Estimates of total F by fleet are shown in Figure 29 and Table 9, and estimates of F at age are shown in Table 10. In any given year, the maximum F at age (i.e., apical F) may be less than that year's sum of fully selected Fs across fleets. This inequality is due to the combination of two features of estimated selectivities: full selection occurs at different ages among gears and several sources of mortality have dome-shaped selectivity. Since 2010, general recreational discards have been the dominant source of fishing mortality.

Alternative measures of fishing intensity have implications similar to those of apical F (Figure 30). The value of SPR_{F} has remained below 30% since about 1980, indicating overfishing. Similarly, the exploitation rate has generally remained above that corresponding to $F_{30\%}$ since about 1980. The pattern of exploitation could be thought of as having three general stanzas. Prior to 1992, the exploitation rate was dominated by landings. During 1992–2010, the exploitation rate comprised an approximate even mix of landings and dead discards. Starting in 2010, the exploitation rate has been dominated by dead discards, especially from the general recreational fleet.

Estimated time series of landings and discards are shown in Figures 31–32 and Tables 11–14. Table 15 shows total landings at age in numbers, and Table 16 in weight. Table 17 shows total discards at age in numbers, and Table 18 in weight. The general recreational fleet has been the dominant source of removals, for both landings and dead discards. In recent years, total landings have generally remained near the level at $L_{\mathrm{F30\%}}$ (Figure 33), although the terminal-year (2023) estimate is more than double that of $L_{\mathrm{F30\%}}$ as a result of increased landings from the general recreational fleet. Discard mortalities have far exceeded the $D_{F_{30\%}}$ level for the past ten years (Figure 34).

4.7 Spawner-Recruitment Parameters

The mean recruit relationship and variability around that mean are shown in Figure 35. Values of recruitment-related parameters were as follows: unfished age-1 recruitment $\widehat{R_0} = 417823.2$, and standard deviation of recruitment residuals in log space $\widehat{\sigma}_R = 0.54$ (which resulted in bias correction of $\varsigma = 1.16$). Uncertainty in these quantities was estimated through the MCBE analysis (Figure 36).

4.8 Per Recruit and Equilibrium Analyses

Yield per recruit and spawning potential ratio were computed as functions of F. These computations applied the most recent selectivity patterns averaged across fleets, weighted by the geometric mean F's from the last three years (2021–2023) (Figures 37, 38). The spawning potential ratio (SPR) as a function of F provides the basis for computing the proxy for F_{MSY}, here $F_{30\%}$, the F that provides 30% SPR.

4.9 Benchmarks / Reference Points

As described in SEDAR73 (2021), biological reference points (benchmarks) were derived numerically assuming equilibrium dynamics, corresponding to the mean-unbiased recruitment (Figure 35). Reference points estimated were $F_{30\%}$, $L_{\mathrm{F30\%}}$, $B_{\mathrm{F30\%}}$, $\mathrm{SSB}_{\mathrm{F30\%}}$, and $E_{\mathrm{F30\%}}$. Based on $F_{30\%}$, three possible values of F at optimum yield (OY) were considered—$F_{\mathrm{OY}} = 65\% F_{30\%}$, $F_{\mathrm{OY}} = 75\% F_{30\%}$, and $F_{\mathrm{OY}} = 85\% F_{30\%}$—and for each, the corresponding yield was computed. Standard errors of benchmarks were approximated as those from MCBE analysis.

Maximum likelihood estimates (base run) of benchmarks, as well as median values from MCBE analysis, are summarized in Table 19. Point estimates of $L_{\mathrm{F30\%}}$-related quantities were $F_{30\%} = 0.18$ (y^{-1}), $L_{\mathrm{F30\%}} = 620.72$ (1000 lb), $B_{\mathrm{F30\%}} = 7308.63$ (mt), and $\mathrm{SSB}_{\mathrm{F30\%}} = 702270.7$ (1E8 Eggs). Median estimates were $F_{30\%} = 0.19$ (y^{-1}), $L_{\mathrm{F30\%}} = 616.11$ (1000 lb), $B_{\mathrm{F30\%}} = 7073.66$ (mt), and $\mathrm{SSB}_{\mathrm{F30\%}} = 632894$ (1E8 Eggs). Corresponding dead discards were $D_{\mathrm{F30\%}} = 140.19$ (1000 dead fish) from the base run, with a median value of $D_{\mathrm{F30\%}} = 140.67$. Distributions of these benchmarks from the MCBE analysis are shown in Figure 39.

4.10 Status of the Stock and Fishery

Estimated time series of stock status $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{F30\%}}$ showed general decline throughout the beginning of the assessment period, a leveling off, and then increase since 2010 (Figure 40, Table 4). Base-run estimates of spawning biomass have remained below $\mathrm{SSB}_{\mathrm{F30\%}}$ since 1980. Current stock status was estimated in the base run to be $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{F30\%}} = 0.76$ (Table 19), indicating that, although increasing, the stock has not yet recovered to $\mathrm{SSB}_{\mathrm{F30\%}}$. Median values from the MCBE analysis indicated similar results $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{F30\%}}$ =0.89. The MCBE analysis suggested that the terminal estimate of stock status is somewhat uncertain (Figures 41, 42). Of the MCBE runs, 62% indicated that the stock was below $\mathrm{SSB}_{\mathrm{F30\%}}$ in 2023, in agreement with the base run. However, a non-negligible proportion (38%) of MCBE runs was above $\mathrm{SSB}_{\mathrm{F30\%}}$ in 2023, indicating that the stock may be rebuilt or at least continued progress toward rebuilding. Age structure estimated by the base run showed fewer older fish in the last few decades than the (equilibrium) age structure expected at $F_{30\%}$ (Figure 43). Age structure in the terminal year(2023) shows marked improvement relative to the expected age structure at $F_{30\%}$, particularly for ages 2–10.

The estimated time series of $F/F_{30\%}$ suggests that overfishing has occurred throughout most of the assessment period (Table 4, Figure 40). Current fishery status in the terminal year, with current F represented by the geometric mean from years 2021–2023, was estimated by the base run to be $F_{2021-2023}/F_{30\%} = 1.85$ (Table 19). The estimate of fishery status was robust (Figures 41, 42). Of the MCBE runs, approximately 96% agreed with the base run that the stock is currently experiencing overfishing.

4.11 Comparison to the SEDAR73 Operational Assessment

The results of this update assessment are similar to those from SEDAR73. Estimated average selectivities, as used to compute benchmarks and projections, are nearly identical, but with the update showing increased selectivity of landed fish for most ages (Figure 44). This result is due to the selectivities being F-weighted by values from the terminal three years, where that weighting is affected by both the increase in general recreational landings in the terminal year (Figure 33) and the assumed reduction in discard mortality starting in 2021 (Table 1; block 4).

The two assessments showed similar trends in estimated time series of recruitment, abundance, fishing mortality, and spawning biomass (Figures 45, 46). The primary differences were that the update assessment estimated higher abundance and spawning biomass, and consequently lower fishing rates. These differences were due to the update's higher estimate of unfished recruitment ($R0$), which scales the total abundance (Table 20). In addition, this update estimated $F_{30\%}$ to be slightly lower and $\mathrm{SSB}_{\mathrm{F30\%}}$ slightly higher than in SEDAR73 (Table 20). Consequently, scaling F and SSB by their reference points resulted in status indicators over time that were nearly identical between the update and SEDAR73 (Table 20; Figure 47).

4.12 Sensitivity Analyses

Two sensitivity runs were used to explore the influence of the scale of general recreational removals (landings and discards). In the first, general recreational removals were reduced by 20%, and in the second, by 40%. These reductions affected the perceived scale of the stock, with lower removals resulting in lower stock size, as indicated by the estimate of $R0$ (Table 20). However, these reductions in removals had almost no influence on the estimated status of stock and fishery (Figure 48).

4.13 Projections

Projections based on $F = F_{30\%}$ and long-term average recruitment allowed the spawning stock to continue its upward trend and did allow for rebuilding by the year 2027 (Figures 49, 50; Table 21). However, this rebuilding occurred because of recent high recruitment pulsing through the population, with long-term probabilities showing the stock returning to an overfished condition before the terminal year of the rebuilding plan (2044). Thus, these results suggest that, if $F = F_{30\%}$ were chosen as a short-term management strategy, the F would need to be reduced after recovery, unless recruitment were to remain high. Projected indices of abundance, conditional on $F = F_{30\%}$, are shown in Figure 51. The projected tradeoff between 2025 landings and dead discards shows an inverse linear relationship (Figure 52). The slopes of these lines are ± 1.331, suggesting that for every percentage decrease in dead discards, there would be 1,331 fewer dead discards and 1,331 more landed fish.

Projections based on $F = F_{\mathrm{rebuild}}$ and long-term average recruitment allowed the spawning stock to continue its upward trend and did allow for rebuilding by the year 2028 (Figures 53, 54; Table 22). However, as with the $F = F_{30\%}$ projection scenario, this rebuilding occurred because of recent high recruitment pulsing through the population, with long-term probabilities showing the stock returning to an overfished condition before the terminal year of the rebuilding plan (2044). Thus, these results suggest that, if $F = F_{\mathrm{rebuild}}$ were chosen as a short-term management strategy, the F would need to be reduced after recovery, unless recruitment were to remain high. Projected indices of abundance, conditional on $F = F_{\mathrm{rebuild}}$, are shown in Figure 55. Here, the value of F_{rebuild} exceeded $F_{30\%}$, with $F_{\mathrm{rebuild}} = 1.08 \times F_{30\%}$.

Projections based on $F = F_{\mathrm{current}}$ and long-term average recruitment resulted in stock decline (Figures 56, 57; Table 23). With this continued level of overfishing, rebuilding did not occur within the duration of the rebuilding plan. Projected indices of abundance, conditional on $F = F_{\mathrm{current}}$, are shown in Figure 58.

Projections based on $F = F_{30\%}$ and recent average recruitment allowed the spawning stock to continue its upward trend, rebuilding by the year 2026 (Figures 59, 60; Table 24). Projected indices of abundance, conditional on $F = F_{30\%}$ and recent average recruitment, are shown in Figure 61. In this Scenario 4, projected landings in 2025 are not much higher than they are in Scenario 1 ($F = F_{30\%}$ and long-term average recruitment), however the dead discards in 2025 are substantially higher. This occurs because of the selectivities of landings and discards, where younger are preferentially selected as discards (Figure 28). Thus, it takes a few years until the higher level of recruitment in Scenario 4 is reflected in the landings.

Projections based on $F = F_{\text{current}}$ and recent average recruitment allowed the spawning stock to continue its upward trend in the short-term (Figures 62, 63; Table 25). Despite continued overfishing, higher-than-expected recruitment (average of last 10 y) allowed rebuilding to occur within a few years. Projected indices of abundance, conditional on $F = F_{\text{current}}$ and recent average recruitment, are shown in Figure 64.

Projections based on $F = CF_{30\%}$ and recent average recruitment showed a downward trend in spawning stock (Figures 65, 66; Table 26). This occurred because more than half of MCBE iterations, on which stochastic projections are based, had already achieved spawning biomass greater than $0.86\text{SSB}_{\text{F30\%}}$ by 2023 (median value was $\text{SSB}_{2023}/\text{SSB}_{\text{F30\%}} = 0.89$; Table 19). Thus, the criterion of achieving $\text{SSB}_{2028}/\text{SSB}_{\text{F30\%}} = 0.86$ with probability P=0.5 required decreasing the spawning stock from its current level. The fishing rate that met this criterion was $F = CF_{30\%}$ with $C = 2.18$, moderately higher than the current rate of overfishing (Table 19). Projected indices of abundance, conditional on $F = CF_{30\%}$ and recent average recruitment, are shown in Figure 67. Although spawning stock declined in this scenario, the projected indices increased in the short-term, which reflects transient dynamics in the projected age structure. The projected tradeoff between 2025 landings and dead discards shows an inverse linear relationship (Figure 68). The slopes of these lines are ±4.915, suggesting that for every percentage decrease in dead discards, there would be 4,915 fewer dead discards and 4,915 more landed fish.

Projections based on $F = 70\%F_{\text{current}}$, $F = 80\%F_{\text{current}}$, or $F = 90\%F_{\text{current}}$ and recent average recruitment allowed the spawning stock to continue its upward trend in the short-term (Tables 27–30). The value of $F_{30\%}$ is about 54% of F_{current}, thus the time series of these projections (Scenarios 7–9; plots not shown) fall in between those of projections with $F_{30\%}$ (Scenario 4) and F_{current}(Scenarios 5). The projected tradeoffs between 2025 landings and dead discards for these five scenarios (Scenarios 4, 5, 7, 8, and 9) show inverse linear relationships (Figure 69). The slopes of these lines are ±2.413, ±3.073, ±3.474, ±3.867, and ±4.251 for $F = F_{30\%}$, $F = 70\%F_{\text{current}}$, $F = 80\%F_{\text{current}}$, $F = 90\%F_{\text{current}}$, and $F = F_{\text{current}}$, respectively. These slopes indicate the expected reduction in dead discards (1000s of fish) and increase in landed fish (1000s of fish) for every percentage decrease in dead discards. For example, if $F = F_{\text{current}}$, for every percentage decrease in dead discards, there would be 4,251 fewer dead discards and 4,251 more landed fish.

5 Discussion

The base run of the BAM indicated that the stock is still rebuilding ($\text{SSB}/\text{SSB}_{\text{F30\%}}$ =0.76), and that overfishing is occurring ($F/F_{30\%}$ =1.85), though at a lower rate than in terminal years of previous red snapper assessments (Figure 47; F_{2006}/F_{MSY} =7.51 for SEDAR15, $F_{2007-2009}/F_{\text{MSY}}$ =4.12 for SEDAR24, $F_{2012-2014}/F_{\text{MSY}}$ =2.52 for SEDAR41, and $F_{2017-2019}/F_{\text{MSY}}$ =2.06 for SEDAR73). The primary driver of overfishing in recent years has been recreational discards. In the future, mortality of discards may be mitigated to some degree through increased use of descender devices. This assessment estimated that, since 2010, total abundance and spawning stock have been increasing at a relatively rapid rate, showing substantial progress toward rebuilding. Despite overfishing, this increase in abundance has been stimulated by higher than average recruitment.

The MCBE analysis illustrated that the overfishing result is robust. Of all MCBE runs, 96% were in agreement that overfishing is occurring. However, there was a larger degree of uncertainty in stock status, with 62% of MCBE runs in agreement with the base run, and 38% suggesting that the stock is rebuilt. The results that overfishing is occurring on a rebuilding stock were also in agreement with the two sensitivity run configurations of this assessment, in which general recreational removals (landings and discards) were reduced by 20% or 40%.

To end overfishing, the fishing rate would need to be reduced below its threshold of $F_{30\%}$. The current fishing rate was estimated to be $F_{\text{current}} = 0.34$, above the threshold by $F_{2021-2023}/F_{30\%}$ =1.85. Thus the fishing rate would need to be reduced by about 47% to meet the threshold $(0.34 - 0.34 \times 0.47 = 0.18 = F_{30\%})$. The dominant contributor to overfishing is discarding by the general recreational fleet, followed by landings from the same fleet; all other fleets are minor in comparison (Table 9, Figure 29). The estimates of current landings and discards, based on the arithmetic means from 2021–2023, are $L_{\text{current}} = 948,479$ lb whole weight and $D_{\text{current}} = 544,014$ dead fish. Both exceed the levels associated with $F_{30\%}$: $L_{\text{F30\%}} = 620,720$ lb whole weight and $D_{\text{F30\%}} = 140,190$ dead fish (Table 19). In both cases (landings and discards), the vast majority of overage comes from the general recreational fleet (Tables 11-14, Figures 33-34).

5.1 Comments on the Assessment

Estimated benchmarks played a central role in this assessment. Values of $\text{SSB}_{\text{F30\%}}$ and $F_{30\%}$ were used to gauge the status of the stock and fishery to be consistent with established definitions of MFMT and the existing rebuilding plan. The computation of $F_{30\%}$ is conditional on selectivity, and the computation of $\text{SSB}_{\text{F30\%}}$ is additionally conditional on the assumption about recruitment (here based on long-term average recruitment). Benchmarks would likely be modified, if expected recruitment were based on a different assumption, or if selectivity patterns change in the future, for example as a result of new size limits or different relative catch allocations among sectors.

In general, fishery dependent indices of abundance may not track actual abundance well, because of factors such as hyperdepletion or hyperstability. Furthermore, this issue can be exacerbated by management measures. In this assessment, the commercial handline and headboat indices generated from logbook data, were not extended beyond 2009 because of the moratorium on red snapper. In general, management measures in the southeast U.S. have made the continued utility of fishery dependent indices questionable. This situation amplifies the importance of fishery independent sampling, such as through SERFS, and sampling programs conducted by the states.

Two SERFS indices of abundance were included in this assessment, one developed from chevron trap data and one from video data. Because the video cameras are mounted on top of traps, sampling by these two gears is not independent. In most previous SEDAR assessments, this non-independence was accounted for by combining the two indices into one prior to fitting the assessment model. However, that approach implicitly assumes that selectivities of the two gears are equivalent, which was not found to be the case by the selectivity working group (SEDAR73-WP14 2020). Instead, the working group found that, for red snapper, selectivity of chevron traps is dome-shaped relative to that of video cameras. This assessment fitted the two indices as separate time series to allow for different selectivities, but acknowledged their dependence by multiplying each likelihood by 0.5, such that their sum (rather than each component) would have full weight relative to other data sources. This weighting approach is novel, as the SEDAR73 assessment was the first for which both SERFS indices were fitted separately. Sensitivity to this choice of weights (i.e., [0.5,0.5]) was evaluated in SEDAR73 through model runs that gave full weight to one index or the other (i.e., [1,0] or [0,1]), and results were nearly identical regardless of weights.

Many assessed stocks in the southeast U.S. have shown histories of heavy exploitation. High rates of fishing mortality can lead to changes in life-history characteristics, such as growth and maturity schedules. Indeed, red snapper mature at a very young age relative to their maximum lifespan. This could in theory be explained by a density dependent response, in which more per capita resources available at low biomass allow for greater energetic investment in reproduction at younger ages. It could also be indicative of an adaptive response to exploitation. Such adaptations can affect expected yield and stock recovery, and thus resource managers might wish to consider the potential for rapid evolutionary effects of fishing in their management plans (Dunlop et al. 2009; Enberg et al. 2009; Heino et al. 2013).

Because steepness could not be estimated reliably, this assessment (and SEDAR73) used the null (or, mean) recruitment model (Brooks 2024). SEDAR41 had approximated the mean model by fixing steepness at $h = 0.99$. In either approach, MSY-based management quantities are not appropriate, and a proxy is required. Here, as in SEDAR41 and SEDAR73, $F_{30\%}$ was used as a proxy for F_{MSY}.

Natural mortality plays a driving role in this assessment, as it does in most. The pattern of natural mortality at age affects multiple outputs, including annual fishing rates, benchmarks, and equilibrium age structure expected at MSY (or proxies and related quantities). Although this assessment estimates record-high abundance in recent years, the stock remains below its target (SSB_{MSY}) while the age structure is still rebuilding. Nonetheless, progress on rebuilding the age structure is apparent (Figure 43). Rebuilding to MSY levels can be a lengthy process for a fish that can live 50 years (current maximum observed age is 51), yet projections conducted for this update assessment demonstrate that rebuilding could be achieved within several years, given the higher-than-expected recent recruitment. The natural mortality rate, on which the bar for rebuilding age structure is predicated, was estimated in this assessment using meta-analytical methods that are common in SEDAR. However, natural mortality of red snapper remains a source of uncertainty in the assessment, and the age structure associated with optimum yield may differ from MSY-related levels, depending on management objectives.

5.2 Comments on the Projections

The projections from this update suggest that rebuilding could be achieved, with 0.5 probability, within the next five years if fishing at the threshold $F_{30\%}$ (Projection scenario 1) or slightly higher at F_{rebuild} (Projection scenario 2). However, this short-term rebuilding occurs because recent, higher-than-expected recruitment created large year-classes that still remain in the population. In the longer term, fishing at these rates of $F_{30\%}$ or F_{rebuild} were projected to return the stock to an overfished status (Figures 51, 55) in the probabilistic sense. The projection using F_{current} (Projection scenario 3) resulted in stock decline and did not achieve rebuilding. The projection using $F_{30\%}$ and recent average recruitment allowed for rapid rebuilding (Projection scenario 4). This rate of recovery was dampened in the projection using F_{current} and recent average recruitment, but recovery still occurred within a few years (Projection scenario 5). At a higher rate of fishing ($F = CF_{30\%}$ with $C = 2.18$) and recent average recruitment, spawning stock declined and recovery did not occur (Projection scenario 6). Projections with F in between $F_{30\%}$ and F_{current} and recent average recruitment allowed for rapid rebuilding (Projection scenarios 7–9), with trajectories bracketed by those of scenarios 4 and 5.

The assumption of recent average recruitment may be valid for short-term catch advice (SAFMC SSC Projections Workgroup 2022), but is not consistent with the assumption of long-term average recruitment used to compute $F_{30\%}$ reference points. The question of how many years defines “recent” does not have a scientific one-size-fits-all answer. The SAFMC SSC recommended using 3, 5, or 10 years, depending on the situation (SAFMC SSC Projections Workgroup 2022). For the base case of this assessment, the mean-unbiased average recruitment (1000 age-1 fish) was 784, 1087, and 1248 for 3, 5, and 10 years, respectively, as compared to 481 for the long-term average. If reference points were to be recomputed, which is not necessary for short-term catch advice, the value of $F_{30\%}$ itself would not be affected by the assumed level of recruitment, but the criterion for rebuilding, $\text{SSB}_{\text{F30\%}}$, would be.

In deterministic projections, fishing at $F_{30\%}$ results in a stock size of $\text{SSB}_{\text{F30\%}}$ exactly. However in stochastic projections, lognormal recruitment variability reduces the spawning stock size on average relative to the deterministic case, such that when fishing at $F_{30\%}$, fewer than 50% of the MCBE iterations achieve $\text{SSB}_{\text{F30\%}}$ in the long-term.

Projection scenarios 1-3 are conditional on recruitment being centered on the long-term average, and scenarios 4-9 are conditional on recruitment being centered at the recent (last 10 y) average. Although recent average recruitment was higher than the long-term average, estimated recruitment from the terminal two years (2022, 2023) of this update assessment were closer to the long-term average than were previous years, with the terminal-year estimate being lower-than-expected (Figure 17) and lower than the 5^{th} percentile of recruitment in the recent-average projection (Figure 59). In general, terminal-year estimates of recruitment tend to be more uncertain than recruitment estimates supported by more years of age composition data. In this case, the estimated reduction in recruitment in 2022 and 2023 is consistent with the SERFS chevron trap age compositions (Figure 13; fewer age-1 fish in these two years than in previous years) and with the two SERFS indices, both of which show a plateau of abundance in the terminal two years (Figures 8, 9). It would seem prudent to continue monitoring these data for indications about the level of recruitment in the terminal years of the assessment and into the future.

In general, projections should be interpreted in light of the model assumptions and key aspects of the data. Some standard considerations are the following:

- Projections of fish stocks are highly uncertain, particularly as the time horizon is extended beyond a few years (Van Beveren et al. 2021).
- Although projections included many major sources of uncertainty, they did not include structural (model) uncertainty. That is, projection results are conditional on one set of functional forms used to describe population dynamics, selectivity, recruitment, etc.
- Fisheries were assumed to continue fishing at their estimated current proportions of total effort, using the estimated current selectivity patterns. New management regulations that alter those proportions or selectivities would likely affect projection results. The projections (and benchmarks) did, however, account for the reduction in discard mortality expected to result from increased use of descender devices.
- The projections assumed that the estimated spawner-recruit relationship applies in the future and that past deviations represent future uncertainty in recruitment. If future recruitment is characterized by runs of large or small year classes, possibly due to environmental or ecological conditions, stock projections may be affected.
- Projections apply the Baranov catch equation to relate F and landings using a one-year time step, as in the assessment. The catch equation implicitly assumes that mortality occurs throughout the year. This assumption is violated when seasonal closures or small intensive fishing seasons are in effect, introducing additional and unquantified uncertainty into the projection results.

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7 Tables

Table 1. Discard mortality for commercial handlines (cH), headboat (HB), and general recreational (GR). For cH, Block 1 ends in 2006, and Block 2 is 2007–2016. For HB and GR, Block 1 ends in 2010, and Block 2 is 2011–2017. For all fleets, Block 3 is 2017–2020, and Block 4 is post-2020. Shown in parentheses are the ranges used in uncertainty analyses.

Fleet	Block 1	Block 2	Block 3	Block 4
cH	$0.48(0.38-0.58)$	$0.38(0.28-0.48)$	$0.36(0.26-0.46)$	$0.32(0.22-0.42)$
HB	$0.37(0.27-0.45)$	$0.26(0.18-0.34)$	$0.25(0.17-0.33)$	$0.22(0.14-0.30)$
GR	$0.37(0.27-0.45)$	$0.28(0.20-0.36)$	$0.26(0.18-0.34)$	$0.23(0.15-0.31)$

Table 2. Estimated total abundance at age (1000 fish) at start of year.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1950	482.76	359.36	281.59	228.55	189.45	159.08	134.66	114.79	98.24	84.33	72.61	62.64	54.09	46.76	40.46	35.01	30.33	26.27	22.78	148.52	2672.26
1951	482.76	361.23	287.88	233.78	193.78	162.72	137.74	117.41	100.49	86.26	74.27	64.07	55.33	47.83	41.39	35.81	31.02	26.87	23.30	151.91	2715.86
1952	482.76	360.87	288.17	237.99	197.36	165.73	140.29	119.59	102.35	87.85	75.64	65.26	56.35	48.72	42.15	36.48	31.59	27.37	23.73	154.72	2744.96
1953	482.76	361.22	289.07	239.23	201.76	169.51	143.48	122.31	104.68	89.86	77.36	66.74	57.64	49.82	43.11	37.31	32.31	27.99	24.27	158.25	2778.68
1954	482.76	361.21	289.30	239.93	202.77	173.25	146.73	125.08	107.04	91.89	79.11	68.25	58.94	50.95	44.09	38.15	33.04	28.62	24.82	161.83	2807.78
1955	482.76	360.69	287.54	238.64	202.11	173.05	149.04	127.11	108.79	93.38	80.40	69.36	59.90	51.78	44.81	38.77	33.58	29.09	25.22	164.46	2820.47
1956	482.76	359.79	282.05	232.11	197.12	169.55	146.71	127.57	109.50	94.21	81.28	70.12	60.56	52.35	45.30	39.20	33.95	29.41	25.50	166.26	2805.28
1957	482.76	359.69	280.80	227.15	191.32	165.05	143.51	125.40	109.78	94.76	81.95	70.85	61.18	52.89	45.76	39.60	34.30	29.71	25.76	167.97	2790.20
1958	482.76	358.49	276.55	222.62	184.36	157.78	137.64	120.89	106.38	93.67	81.29	70.45	60.96	52.70	45.60	39.46	34.18	29.60	25.67	167.37	2748.42
1959	482.76	359.03	277.16	220.41	181.68	152.92	132.38	116.69	103.24	91.40	80.94	70.38	61.06	52.89	45.76	39.60	34.30	29.71	25.76	167.97	2726.01
1960	482.76	358.75	276.42	219.88	179.08	150.08	127.81	111.83	99.32	88.43	78.76	69.88	60.83	52.82	45.80	39.63	34.33	29.73	25.78	168.11	2700.03
1961	482.76	358.55	275.32	218.49	178.04	147.47	125.08	107.70	94.97	84.91	76.07	67.88	60.29	52.53	45.66	39.59	34.29	29.70	25.75	167.94	2672.98
1962	482.76	357.95	272.91	215.68	175.39	145.40	121.94	104.61	90.82	80.65	72.57	65.15	58.19	51.74	45.13	39.22	34.04	29.49	25.57	166.72	2635.95
1963	482.76	358.15	272.78	213.92	173.30	143.44	120.45	102.22	88.46	77.36	69.17	62.37	56.04	50.11	44.59	38.90	33.84	29.37	25.47	166.08	2608.79
1964	482.76	358.40	273.42	214.10	172.17	142.02	119.12	101.26	86.72	75.63	66.61	59.68	53.86	48.45	43.36	38.59	33.69	29.32	25.47	166.09	2590.73
1965	482.76	358.04	272.11	213.28	171.30	140.32	117.34	99.68	85.55	73.85	64.89	57.27	51.36	46.40	41.78	37.39	33.31	29.08	25.33	165.52	2566.58
1966	482.76	357.74	270.53	211.09	169.77	138.96	115.45	97.82	83.92	72.64	63.20	55.64	49.16	44.13	39.91	35.93	32.19	28.68	25.06	164.47	2539.06
1967	482.76	357.67	270.00	209.59	167.83	137.56	114.21	96.15	82.29	71.21	62.12	54.16	47.73	42.21	37.93	34.30	30.92	27.70	24.70	163.24	2514.30
1968	482.76	357.02	267.79	207.44	165.27	134.88	112.16	94.37	80.26	69.29	60.44	52.83	46.11	40.67	36.01	32.36	29.29	26.40	23.67	160.64	2479.66
1969	482.76	356.42	265.28	204.11	162.29	131.81	109.15	91.99	78.20	67.10	58.40	51.04	44.66	39.02	34.45	30.50	27.44	24.84	22.41	156.44	2438.30
1970	482.76	357.42	267.92	204.58	161.58	130.98	107.95	90.61	77.17	66.19	57.26	49.93	43.69	38.27	33.46	29.55	26.18	23.55	21.34	153.69	2424.09
1971	482.76	357.45	268.72	206.64	161.98	130.44	107.30	89.65	76.04	65.34	56.51	48.98	42.76	37.45	32.84	28.71	25.38	22.49	20.25	150.49	2412.20
1972	482.76	357.30	267.74	206.27	162.92	130.29	106.55	88.92	75.12	64.34	55.77	48.33	41.94	36.65	32.13	28.17	24.66	21.79	19.33	146.76	2397.73
1973	482.76	357.12	266.51	204.44	161.87	130.53	106.09	88.08	74.38	63.48	54.88	47.68	41.36	35.92	31.42	27.54	24.17	21.16	18.72	142.69	2380.80
1974	482.76	357.15	265.91	202.94	160.09	129.51	106.21	87.71	73.73	62.95	54.27	47.01	40.88	35.49	30.86	26.99	23.69	20.79	18.22	138.95	2366.09
1975	482.76	356.09	261.98	199.19	156.43	126.17	103.89	86.64	72.51	61.67	53.21	45.97	39.86	34.69	30.16	26.22	22.95	20.14	17.70	133.79	2332.03
1976	482.76	355.14	257.57	193.22	151.28	121.59	99.92	83.74	70.84	60.02	51.64	44.65	38.61	33.51	29.20	25.38	22.09	19.34	16.99	127.74	2285.21
1977	482.76	355.00	256.17	189.33	146.29	117.27	96.06	80.38	68.36	58.57	50.22	43.29	37.47	32.43	28.18	24.55	21.36	18.59	16.29	121.94	2244.51
1978	144.20	354.66	254.78	187.24	142.58	112.84	92.22	76.95	65.36	56.32	48.84	41.96	36.21	31.37	27.18	23.61	20.59	17.92	15.61	116.07	1866.52
1979	138.51	105.81	252.75	184.71	139.95	109.22	88.19	73.48	62.28	53.63	46.80	40.66	34.97	30.20	26.19	22.69	19.74	17.21	14.99	110.18	1572.18
1980	345.77	101.41	74.05	179.14	135.29	105.36	84.16	69.48	58.97	50.82	44.42	38.84	33.78	29.08	25.14	21.81	18.91	16.45	14.36	104.41	1551.68
1981	138.11	251.95	68.83	50.62	126.93	98.88	79.10	64.84	54.73	47.38	41.57	36.41	31.87	27.74	23.91	20.67	17.94	15.56	13.55	97.83	1308.43
1982	324.22	91.48	96.84	24.23	19.52	53.88	46.11	40.48	36.19	33.07	30.73	27.02	23.69	20.75	18.09	15.59	13.49	11.71	10.17	72.76	1010.01
1983	998.85	230.20	54.69	57.41	15.08	12.71	36.50	32.49	29.54	27.25	25.62	23.86	21.00	18.43	16.16	14.09	12.15	10.52	9.14	64.71	1710.41
1984	945.22	712.27	138.72	32.63	35.88	9.84	8.62	25.74	23.70	22.23	21.08	19.86	18.51	16.31	14.33	12.56	10.96	9.45	8.19	57.52	2143.64
1985	312.20	617.52	285.35	52.42	13.55	16.30	4.87	4.64	14.98	14.82	14.82	14.08	13.28	12.39	10.92	9.60	8.43	7.35	6.35	44.11	1477.97
1986	271.61	192.60	187.00	78.69	16.37	4.77	6.45	2.16	2.30	8.18	8.83	8.85	8.42	7.94	7.42	6.54	5.75	5.05	4.41	30.28	863.62
1987	513.34	174.86	91.45	90.42	41.65	9.26	2.86	4.08	1.44	1.59	5.91	6.40	6.42	6.11	5.77	5.39	4.76	4.19	3.68	25.26	1004.82
1988	412.42	339.18	88.06	46.55	49.80	24.36	5.71	1.85	2.76	1.01	1.17	4.34	4.71	4.72	4.50	4.25	3.98	3.51	3.09	21.37	1027.36
1989	172.05	273.90	154.19	38.82	22.26	25.62	13.42	3.36	1.16	1.83	0.71	0.81	3.03	3.29	3.30	3.15	2.98	2.78	2.46	17.13	746.22
1990	153.52	109.54	95.81	50.11	13.96	8.83	11.18	6.42	1.75	0.66	1.11	0.43	0.50	1.85	2.01	2.01	1.92	1.82	1.70	11.98	477.11
1991	281.75	104.32	63.11	56.94	31.54	9.14	5.97	7.77	4.58	1.28	0.49	0.83	0.32	0.37	1.38	1.50	1.51	1.44	1.37	10.27	585.89
1992	260.69	190.72	54.43	32.87	31.70	18.55	5.64	3.86	5.25	3.22	0.93	0.36	0.61	0.23	0.27	1.01	1.10	1.11	1.06	8.52	622.12
1993	109.69	185.18	134.03	22.82	10.84	11.99	8.23	2.91	2.28	3.44	2.28	0.66	0.25	0.43	0.17	0.19	0.72	0.78	0.79	6.83	504.51
1994	194.56	65.31	109.87	71.02	11.85	6.12	7.23	5.26	1.96	1.59	2.48	1.65	0.48	0.18	0.31	0.12	0.14	0.52	0.57	5.53	486.77
1995	100.68	119.35	40.12	60.13	38.22	6.94	3.82	4.79	3.66	1.42	1.19	1.85	1.23	0.36	0.14	0.23	0.09	0.10	0.39	4.57	389.29
1996	178.50	62.65	74.85	23.02	34.69	23.84	4.57	2.64	3.43	2.70	1.07	0.90	1.40	0.93	0.27	0.10	0.18	0.07	0.08	3.78	419.67
1997	255.38	122.32	43.74	42.87	12.37	20.21	14.92	3.05	1.86	2.52	2.05	0.81	0.68	1.07	0.71	0.21	0.08	0.14	0.05	2.95	527.99
1998	491.52	183.77	91.64	28.25	26.51	8.11	13.93	10.75	2.28	1.43	1.99	1.62	0.64	0.54	0.85	0.56	0.16	0.06	0.11	2.39	867.13
1999	624.27	342.17	131.41	53.78	15.28	15.45	5.10	9.42	7.73	1.72	1.12	1.56	1.27	0.51	0.43	0.67	0.45	0.13	0.05	1.97	1214.47
2000	735.53	405.33	220.09	60.43	21.26	6.80	7.83	2.93	6.03	5.38	1.28	0.83	1.16	0.95	0.38	0.32	0.50	0.33	0.10	1.51	1478.98
2001	438.33	449.16	241.21	93.97	22.28	8.94	3.30	4.35	1.83	4.13	3.96	0.94	0.62	0.86	0.70	0.28	0.24	0.37	0.25	1.19	1276.89
2002	416.75	257.59	257.53	107.50	37.85	10.11	4.58	1.89	2.75	1.25	3.00	2.88	0.69	0.45	0.63	0.51	0.20	0.17	0.27	1.05	1107.65
2003	590.14	254.47	153.55	112.58	41.35	16.53	5.03	2.58	1.19	1.88	0.91	2.18	2.09	0.50	0.33	0.46	0.37	0.15	0.13	0.96	1187.37
2004	208.12	364.00	159.21	91.56	66.84	26.32	11.18	3.60	1.93	0.92	1.50	0.73	1.74	1.68	0.40	0.26	0.37	0.30	0.12	0.87	941.65
2005	85.52	90.05	146.89	66.85	41.00	34.14	14.95	6.98	2.43	1.39	0.70	1.14	0.55	1.32	1.28	0.30	0.20	0.28	0.23	0.76	496.98
2006	1837.31	49.73	52.25	81.89	37.78	25.24	22.52	10.49	5.16	1.87	1.11	0.55	0.90	0.44	1.06	1.02	0.24	0.16	0.22	0.79	2130.75
2007	1310.62	1232.52	34.01	29.44	42.44	21.23	15.47	15.00	7.50	3.90	1.48	0.87	0.44	0.72	0.35	0.84	0.81	0.19	0.13	0.80	2718.74
2008	1096.39	827.78	789.08	19.43	16.21	25.23	13.59	10.60	10.89	5.70	3.07	1.17	0.69	0.35	0.57	0.28	0.66	0.64	0.15	0.74	2823.21
2009	217.08	606.98	439.73	325.89	7.24	6.91	12.37	7.60	6.64	7.46	4.18	2.26	0.86	0.51	0.26	0.42	0.20	0.49	0.47	0.66	1648.21
2010	179.24	100.10	251.09	123.74	78.30	2.13	2.51	5.46	3.97	3.97	4.93	2.77	1.50	0.57	0.34	0.17	0.28	0.14	0.33	0.75	762.26
2011	283.65	109.23	55.92	135.50	72.81	53.15	1.63	2.06	4.65	3.44	3.47	4.32	2.43	1.31	0.50	0.30	0.15	0.24	0.12	0.95	735.82
2012	252.80	190.79	72.08	36.56	93.36	54.17	42.11	1.34	1.73	3.95	2.94	2.97	3.70	2.08	1.13	0.43	0.25	0.13	0.21	0.92	763.63
2013	483.97	161.72	115.42	41.81	21.95	61.52	39.01	32.08	1.05	1.38	3.16	2.35	2.38	2.97	1.67	0.90	0.34	0.20	0.10	0.91	974.90
2014	1186.62	336.25	113.69	80.73	30.04	16.59	48.66	31.78	26.53	0.88	1.15	2.65	1.98	2.00	2.50	1.41	0.76	0.29	0.17	0.85	1885.53
2015	1313.55	785.57	214.12	68.13	47.69	18.79	11.12	34.13	22.81	19.25	0.64	0.84	1.94	1.45	1.47	1.84	1.03	0.56	0.21	0.76	2545.91
2016	1138.86	857.66	494.03	132.32	44.77	34.66	14.87	9.27	29.18	19.73	16.77	0.56	0.74	1.70	1.27	1.29	1.61	0.91	0.49	0.85	2801.52
2017	1610.07	687.08	468.20	258.46	75.77	29.91	26.40	12.25	7.92	25.38	17.31	14.74	0.49	0.65	1.50	1.12	1.14	1.42	0.80	1.19	3241.80
2018	1046.97	1073.06	447.16	296.77	169.30	53.66	22.78	21.04	9.98	6.53	21.03	14.37	12.25	0.41	0.54	1.25	0.93	0.95	1.19	1.66	3201.82
2019	1866.36	618.50	560.56	215.05	149.75	98.88	36.03	16.66	16.02	7.74	5.11	16.51	11.29	9.64	0.32	0.43	0.98	0.74	0.75	2.24	3633.56
2020	1366.80	1222.89	389.49	336.41	130.23	97.74	69.84	26.77	12.68	12.35	6.01	3.97	12.85	8.80	7.51	0.25	0.33	0.77	0.57	2.34	3708.59
2021	1988.53	817.77	653.19	192.12	172.78	76.61	65.57	50.80	20.24	9.76	9.59	4.68	3.10	10.02	6.87	5.86	0.20	0.26	0.60	2.28	4090.81
2022	762.92	1326.94	533.18	412.61	123.99	119.79	56.99	51.01	40.40	16.27	7.90	7.77	3.79	2.51	8.14	5.58	4.77	0.16	0.21	2.34	3487.27
2023	206.58	495.65	825.11	320.82	259.31	85.77	90.43	45.41	41.71	33.44	13.56	6.59	6.50	3.17	2.11	6.82	4.68	4.00	0.13	2.14	2453.95

Table 3. Estimated biomass at age (1000 lb) at start of year

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1950	564	1116	1581	1907	2088	2145	2110	2013	1878	1722	1559	1400	1246	1102	972	853	747	655	571	3743	29976
1951	564	1122	1616	1951	2136	2196	2158	2059	1920	1761	1596	1431	1274	1129	994	873	765	668	584	3829	30629
1952	564	1120	1618	1986	2176	2235	2198	2099	1955	1795	1625	1457	1299	1149	1014	891	780	681	595	3900	31134
1953	564	1120	1623	1995	2224	2286	2249	2145	2002	1834	1662	1490	1327	1175	1036	911	798	697	608	3988	31738
1954	564	1120	1625	2002	2235	2337	2299	2194	2046	1876	1700	1526	1358	1202	1060	930	816	712	622	4079	32302
1955	564	1120	1616	1991	2227	2335	2335	2229	2079	1907	1726	1550	1380	1221	1078	946	829	723	633	4145	32635
1956	564	1116	1585	1938	2174	2286	2299	2238	2092	1925	1746	1567	1396	1235	1089	957	838	732	639	4191	32602
1957	564	1116	1576	1896	2110	2227	2249	2200	2099	1936	1761	1583	1409	1248	1100	966	847	739	646	4235	32503
1958	564	1113	1554	1858	2033	2127	2156	2121	2033	1911	1746	1574	1404	1243	1096	963	842	736	644	4220	31941
1959	564	1113	1556	1839	2002	2064	2075	2048	1973	1865	1739	1572	1407	1248	1100	966	847	739	646	4233	31597
1960	564	1113	1552	1834	1973	2024	2004	1962	1898	1806	1691	1561	1402	1246	1100	966	847	741	646	4237	31171
1961	564	1113	1545	1823	1962	1989	1960	1889	1817	1733	1634	1517	1389	1239	1098	966	847	739	646	4233	30702
1962	564	1111	1532	1799	1933	1962	1911	1834	1737	1647	1559	1455	1340	1221	1085	957	840	734	642	4202	30064
1963	564	1111	1532	1786	1909	1936	1887	1792	1691	1579	1486	1393	1292	1182	1071	948	836	732	639	4187	29553
1964	564	1113	1537	1786	1898	1916	1867	1777	1658	1543	1431	1334	1241	1142	1043	941	831	730	639	4187	29174
1965	564	1111	1528	1779	1887	1894	1839	1748	1636	1508	1393	1279	1184	1096	1005	913	822	723	635	4171	28715
1966	564	1111	1519	1761	1872	1874	1810	1715	1605	1484	1358	1243	1133	1041	959	877	794	714	628	4145	28206
1967	564	1109	1517	1748	1850	1856	1790	1687	1574	1453	1334	1210	1100	996	913	838	763	690	619	4114	27723
1968	564	1109	1504	1731	1821	1819	1757	1656	1534	1415	1299	1179	1063	959	866	789	723	657	593	4050	27088
1969	564	1107	1490	1704	1788	1779	1711	1614	1495	1369	1254	1140	1030	922	829	743	677	617	562	3944	26334
1970	564	1109	1506	1706	1781	1766	1691	1590	1475	1351	1230	1116	1008	904	805	721	646	586	536	3874	25962
1971	564	1109	1510	1724	1786	1759	1682	1572	1453	1334	1215	1093	985	884	789	701	626	560	507	3794	25646
1972	564	1109	1504	1722	1797	1757	1669	1561	1435	1314	1197	1080	966	864	772	688	608	542	485	3699	25333
1973	564	1109	1497	1706	1784	1761	1662	1545	1422	1296	1179	1065	952	847	756	672	597	527	470	3596	25005
1974	564	1109	1493	1693	1764	1746	1664	1539	1409	1285	1166	1049	941	838	741	659	584	518	456	3503	24725
1975	564	1105	1470	1662	1724	1702	1629	1519	1387	1259	1142	1027	919	818	725	639	567	500	443	3373	24176
1976	564	1102	1446	1612	1667	1640	1565	1468	1354	1226	1109	999	888	791	701	619	545	481	425	3221	23426
1977	564	1102	1440	1581	1612	1583	1506	1411	1307	1195	1078	968	864	765	677	600	527	463	408	3073	22719
1978	168	1100	1431	1563	1572	1521	1446	1349	1250	1151	1049	937	833	741	653	575	507	445	390	2926	21612
1979	161	328	1420	1541	1543	1473	1382	1290	1190	1096	1005	908	805	712	631	553	487	428	375	2778	20106
1980	403	315	417	1495	1490	1422	1318	1219	1127	1038	955	869	778	686	604	531	467	410	359	2632	18534
1981	161	783	386	423	1400	1334	1239	1138	1047	968	893	814	734	655	575	505	443	388	340	2467	16685
1982	379	284	545	203	216	728	723	710	692	675	659	604	547	489	434	379	333	291	256	1834	10977
1983	1166	714	306	478	165	172	571	571	564	556	551	534	483	434	388	344	300	262	229	1631	10423
1984	1102	2211	778	273	395	132	134	452	454	454	452	443	425	386	344	306	271	236	205	1451	10906
1985	364	1916	1603	437	150	220	77	82	287	302	317	315	306	293	262	234	207	183	159	1111	8827
1986	317	597	1049	657	181	64	101	37	44	168	190	198	194	187	179	159	141	126	110	763	5465
1987	600	542	514	754	459	126	44	71	26	33	128	143	148	143	139	132	117	104	93	637	4954
1988	481	1052	494	388	549	328	90	33	53	20	24	97	108	112	108	104	99	88	77	538	4846
1989	201	851	866	324	245	346	209	60	22	37	15	18	71	77	79	77	73	68	62	432	4134
1990	179	340	538	419	154	119	174	112	33	13	24	9	11	44	49	49	49	46	42	302	2705
1991	328	324	355	476	348	123	93	137	88	26	11	18	7	9	33	37	37	35	35	258	2778
1992	304	591	306	273	348	251	88	68	101	66	20	9	13	7	7	24	26	26	26	214	2773
1993	128	575	752	190	119	161	128	51	44	71	49	15	7	11	4	4	18	20	20	172	2538
1994	227	203	617	593	130	82	112	93	37	33	53	37	11	4	7	2	4	13	13	139	2414
1995	117	370	225	503	421	93	60	84	71	29	26	42	29	9	2	7	2	2	9	115	2216
1996	207	194	421	192	381	322	71	46	66	55	22	20	33	22	7	2	4	2	2	95	2167
1997	298	379	245	357	137	273	234	53	35	51	44	18	15	24	18	4	2	4	2	75	2271
1998	573	571	514	236	293	110	218	190	44	29	42	35	15	13	20	13	4	2	2	60	2985
1999	728	1063	739	450	168	209	79	165	148	35	24	35	29	11	11	15	11	2	2	49	3975
2000	858	1259	1237	505	234	93	123	51	115	110	26	18	26	22	9	9	13	9	2	37	4755
2001	511	1393	1356	785	245	121	51	77	35	84	86	22	13	20	18	7	7	9	7	31	4874
2002	487	800	1446	897	417	137	73	33	53	26	64	64	15	11	15	13	4	4	7	26	4590
2003	688	789	862	939	456	223	79	46	22	37	20	49	49	11	9	11	9	4	2	24	4332
2004	243	1129	895	765	736	355	174	64	37	20	33	15	40	40	9	7	9	7	2	22	4603
2005	99	280	825	558	452	461	234	123	46	29	15	26	13	31	31	7	4	7	7	20	3265
2006	2145	154	293	683	417	340	353	183	99	37	24	13	20	11	26	24	7	4	7	20	4859
2007	1530	3825	192	245	467	287	243	262	143	79	31	20	11	18	9	20	20	4	2	20	7430
2008	1279	2568	4431	163	179	340	214	185	207	117	66	26	15	9	13	7	15	15	4	18	9877
2009	254	1883	2469	2718	79	93	194	132	128	152	90	51	20	11	7	11	4	13	11	18	8340
2010	209	311	1411	1032	862	29	40	95	75	82	106	62	35	13	9	4	7	4	9	20	4411
2011	331	340	313	1131	802	717	26	35	88	71	75	97	55	31	11	7	4	7	2	24	4169
2012	295	593	406	304	1030	730	659	24	33	82	64	66	86	49	26	11	7	2	4	24	4493
2013	564	503	648	348	243	829	611	562	20	29	68	53	55	71	40	22	9	4	2	22	4705
2014	1385	1043	639	675	331	225	763	558	507	18	24	60	46	46	60	35	20	7	4	22	6464
2015	1532	2438	1204	569	525	254	174	600	437	392	13	20	44	35	35	44	26	13	4	20	8380
2016	1329	2661	2776	1105	494	467	234	163	558	403	359	13	18	40	31	31	40	22	13	22	10774
2017	1878	2132	2630	2156	836	403	414	214	152	518	373	328	11	15	35	26	29	35	20	31	12240
2018	1221	3331	2511	2476	1865	723	357	368	192	132	452	322	282	9	13	31	22	24	29	42	14407
2019	2178	1920	3148	1795	1651	1334	564	293	306	159	110	368	260	227	9	11	24	18	18	57	14449
2020	1596	3794	2187	2806	1435	1318	1093	470	243	251	130	88	295	207	181	7	9	20	15	60	16206
2021	2321	2538	3668	1603	1905	1034	1027	891	386	198	205	104	71	236	165	143	4	7	15	57	16583
2022	891	4118	2994	3444	1367	1616	893	895	772	333	170	174	88	60	196	137	117	4	4	60	18329
2023	240	1539	4634	2676	2857	1157	1418	796	798	683	291	148	150	75	51	165	115	99	4	55	17952

Table 4. Estimated time series of status indicators, fishing mortality, and biomass. Fishing mortality rate is apical F. Total biomass (B, mt) is at the start of the year, and spawning biomass (SSB, 1E8 eggs) at the time of peak spawning (mid-year). The $MSST_{\mathrm{F30}}$ is defined by $75\%SSB_{\mathrm{F30}}$. Exploitation rate (E) is based on numbers, and SPR_{F} is equilibrium spawners per recruit conditioned on annual F and associated selectivity patterns.

Year	F	F/F_{30}	B	B/B_{unfished}	SSB	SSB/SSB_{F30}	$SSB/MSST_{\mathrm{F30}}$	E	E/E_{F30}	SPR_{F}
1950	0.013	0.071	13597	0.687	1478810	2.106	2.808	0.010	0.128	0.836
1951	0.017	0.094	13893	0.702	1530932	2.180	2.907	0.014	0.170	0.790
1952	0.013	0.071	14122	0.713	1562757	2.225	2.967	0.010	0.129	0.835
1953	0.013	0.072	14396	0.727	1596108	2.273	3.030	0.011	0.130	0.833
1954	0.020	0.106	14652	0.740	1621615	2.309	3.079	0.016	0.191	0.768
1955	0.041	0.223	14803	0.748	1632845	2.325	3.100	0.026	0.285	0.669
1956	0.043	0.235	14788	0.747	1635012	2.328	3.104	0.027	0.295	0.659
1957	0.059	0.320	14743	0.745	1618348	2.304	3.073	0.038	0.431	0.555
1958	0.054	0.292	14488	0.732	1599180	2.277	3.036	0.033	0.367	0.598
1959	0.059	0.317	14332	0.724	1579243	2.249	2.998	0.036	0.398	0.574
1960	0.062	0.337	14139	0.714	1555117	2.214	2.953	0.038	0.419	0.558
1961	0.071	0.385	13926	0.703	1523395	2.169	2.892	0.044	0.486	0.514
1962	0.071	0.382	13637	0.689	1492228	2.125	2.833	0.042	0.461	0.527
1963	0.069	0.375	13405	0.677	1467350	2.089	2.786	0.040	0.431	0.545
1964	0.075	0.408	13233	0.668	1441857	2.053	2.738	0.044	0.471	0.518
1965	0.081	0.438	13025	0.658	1413165	2.012	2.683	0.047	0.504	0.496
1966	0.082	0.445	12794	0.646	1384177	1.971	2.628	0.047	0.512	0.491
1967	0.091	0.490	12575	0.635	1350002	1.922	2.563	0.053	0.586	0.451
1968	0.099	0.533	12287	0.621	1308717	1.864	2.485	0.059	0.654	0.417
1969	0.087	0.470	11945	0.603	1277952	1.820	2.426	0.050	0.542	0.474
1970	0.087	0.469	11776	0.595	1255689	1.788	2.384	0.050	0.540	0.476
1971	0.092	0.495	11633	0.588	1235332	1.759	2.345	0.051	0.556	0.466
1972	0.097	0.523	11491	0.580	1215523	1.731	2.308	0.054	0.575	0.453
1973	0.099	0.538	11342	0.573	1197787	1.706	2.274	0.054	0.570	0.454
1974	0.116	0.627	11215	0.566	1172383	1.669	2.226	0.064	0.688	0.394
1975	0.131	0.711	10966	0.554	1135658	1.617	2.156	0.073	0.791	0.348
1976	0.135	0.730	10626	0.537	1096075	1.561	2.081	0.074	0.807	0.342
1977	0.140	0.760	10305	0.521	1056103	1.504	2.005	0.077	0.844	0.327
1978	0.149	0.804	9803	0.495	1014361	1.444	1.926	0.092	0.902	0.310
1979	0.171	0.927	9120	0.461	965525	1.375	1.833	0.100	0.971	0.277
1980	0.207	1.122	8407	0.425	894206	1.273	1.698	0.100	1.096	0.224
1981	0.871	4.714	7568	0.382	667689	0.951	1.268	0.360	3.554	0.015
1982	0.350	1.893	4979	0.252	520326	0.741	0.988	0.140	1.615	0.102
1983	0.343	1.859	4728	0.239	440041	0.627	0.835	0.105	1.559	0.105
1984	0.800	4.330	4947	0.250	341043	0.486	0.648	0.285	3.442	0.017
1985	1.115	6.035	4004	0.202	234711	0.334	0.446	0.466	4.908	0.008
1986	0.554	2.996	2479	0.125	182090	0.259	0.346	0.273	2.912	0.039
1987	0.502	2.718	2247	0.113	155790	0.222	0.296	0.207	2.631	0.049
1988	0.646	3.497	2198	0.111	129679	0.185	0.246	0.271	3.403	0.028
1989	0.951	5.146	1875	0.095	95712	0.136	0.182	0.427	4.889	0.011
1990	0.347	1.879	1227	0.062	82868	0.118	0.157	0.195	2.296	0.089
1991	0.479	2.594	1260	0.064	77282	0.110	0.147	0.203	2.775	0.053
1992	0.957	5.177	1258	0.064	63311	0.090	0.120	0.182	3.527	0.028
1993	0.503	2.724	1151	0.058	60380	0.086	0.115	0.263	3.148	0.048
1994	0.468	2.530	1095	0.055	61495	0.088	0.117	0.239	3.071	0.060
1995	0.398	2.155	1005	0.051	61337	0.087	0.116	0.220	2.625	0.077
1996	0.469	2.537	983	0.050	60287	0.086	0.114	0.173	2.635	0.081
1997	0.329	1.779	1030	0.052	61872	0.088	0.117	0.094	1.720	0.151
1998	0.462	2.502	1354	0.068	66395	0.095	0.126	0.119	2.133	0.092
1999	0.776	4.198	1803	0.091	68461	0.097	0.130	0.198	3.275	0.033
2000	0.846	4.578	2157	0.109	71891	0.102	0.136	0.251	3.859	0.025
2001	0.757	4.098	2211	0.112	77312	0.110	0.147	0.292	4.089	0.027
2002	0.803	4.347	2082	0.105	78471	0.112	0.149	0.295	4.404	0.026
2003	0.369	1.999	1965	0.099	88622	0.126	0.168	0.198	2.562	0.096
2004	0.698	3.779	2088	0.105	90579	0.129	0.172	0.425	4.510	0.017
2005	0.419	2.265	1481	0.075	90729	0.129	0.172	0.265	2.915	0.070
2006	0.505	2.734	2204	0.111	89890	0.128	0.171	0.118	2.150	0.076
2007	0.445	2.407	3370	0.170	105250	0.150	0.200	0.170	2.132	0.078
2008	0.835	4.521	4480	0.226	137502	0.196	0.261	0.328	4.488	0.020
2009	1.274	6.894	3783	0.191	113605	0.162	0.216	0.524	6.581	0.007
2010	0.444	2.402	2001	0.101	114026	0.162	0.216	0.255	2.562	0.143
2011	0.252	1.364	1891	0.096	131588	0.187	0.250	0.131	1.387	0.256
2012	0.372	2.011	2038	0.103	140282	0.200	0.266	0.190	2.008	0.108
2013	0.184	0.998	2134	0.108	153233	0.218	0.291	0.092	1.021	0.287
2014	0.374	2.025	2932	0.148	159390	0.227	0.303	0.146	2.012	0.087
2015	0.308	1.668	3801	0.192	187150	0.266	0.355	0.153	1.549	0.237
2016	0.475	2.570	4887	0.247	235368	0.335	0.447	0.243	2.453	0.132
2017	0.283	1.531	5552	0.280	290063	0.413	0.551	0.145	1.701	0.183
2018	0.559	3.025	6535	0.330	321093	0.457	0.610	0.285	3.094	0.051
2019	0.350	1.892	6554	0.331	351949	0.501	0.668	0.168	2.100	0.107
2020	0.534	2.888	7351	0.371	373340	0.532	0.709	0.265	2.903	0.054
2021	0.286	1.550	7522	0.380	421681	0.600	0.801	0.145	1.727	0.157
2022	0.335	1.813	8314	0.420	494397	0.704	0.939	0.192	1.920	0.156
2023	0.417	2.256	8143	0.411	532473	0.758	1.011	0.258	2.575	0.078

Table 5. Selectivity at age in selectivity block 1 (1950–1991) for commercial handlines (cH), headboat (HB), and general recreational (GR) landings (L) and discards (D).

Age	cH.L	HB.L	GR.L	cH.D	HB.D	GR.D
1	0.230	0.131	0.131	0.562	0.842	0.842
2	0.978	0.846	0.846	0.903	1.000	1.000
3	1.000	1.000	1.000	1.000	0.441	0.441
4	1.000	0.920	0.920	0.534	0.102	0.102
5	1.000	0.822	0.822	0.111	0.019	0.019
6	1.000	0.719	0.719	0.016	0.003	0.003
7	1.000	0.617	0.617	0.002	0.001	0.001
8	1.000	0.518	0.518	0.000	0.000	0.000
9	1.000	0.427	0.427	0.000	0.000	0.000
10	1.000	0.346	0.346	0.000	0.000	0.000
11	1.000	0.346	0.346	0.000	0.000	0.000
12	1.000	0.346	0.346	0.000	0.000	0.000
13	1.000	0.346	0.346	0.000	0.000	0.000
14	1.000	0.346	0.346	0.000	0.000	0.000
15	1.000	0.346	0.346	0.000	0.000	0.000
16	1.000	0.346	0.346	0.000	0.000	0.000
17	1.000	0.346	0.346	0.000	0.000	0.000
18	1.000	0.346	0.346	0.000	0.000	0.000
19	1.000	0.346	0.346	0.000	0.000	0.000
20	1.000	0.346	0.346	0.000	0.000	0.000

Table 6. Selectivity at age in selectivity block 2 (1992–2009) for commercial handlines (cH), headboat (HB), and general recreational (GR) landings (L) and discards (D).

Age	cH.L	HB.L	GR.L	cH.D	HB.D	GR.D
1	0.002	0.001	0.005	0.562	0.842	0.842
2	0.056	0.054	0.086	0.903	1.000	1.000
3	0.661	0.805	0.687	1.000	0.441	0.441
4	0.985	1.000	1.000	0.534	0.102	0.102
5	1.000	0.864	0.874	0.111	0.019	0.019
6	1.000	0.707	0.702	0.016	0.003	0.003
7	1.000	0.550	0.533	0.002	0.001	0.001
8	1.000	0.409	0.384	0.000	0.000	0.000
9	1.000	0.291	0.266	0.000	0.000	0.000
10	1.000	0.201	0.178	0.000	0.000	0.000
11	1.000	0.201	0.178	0.000	0.000	0.000
12	1.000	0.201	0.178	0.000	0.000	0.000
13	1.000	0.201	0.178	0.000	0.000	0.000
14	1.000	0.201	0.178	0.000	0.000	0.000
15	1.000	0.201	0.178	0.000	0.000	0.000
16	1.000	0.201	0.178	0.000	0.000	0.000
17	1.000	0.201	0.178	0.000	0.000	0.000
18	1.000	0.201	0.178	0.000	0.000	0.000
19	1.000	0.201	0.178	0.000	0.000	0.000
20	1.000	0.201	0.178	0.000	0.000	0.000

Table 7. Selectivity at age in selectivity block 3 (2010–2023) for SERFS chevron traps (CVT), SERFS video (VID), commercial handlines (cH), headboat (HB), and general recreational (GR) landings (L) and discards (D).

Age	CVT	VID	cH.L	HB.L	GR.L	cH.D	HB.D	GR.D
1	0.126	0.126	0.029	0.040	0.010	0.126	0.718	0.463
2	0.725	0.725	0.218	0.369	0.061	0.611	1.000	0.836
3	1.000	1.000	0.723	0.948	0.297	0.945	0.963	1.000
4	0.957	1.000	0.961	1.000	0.733	0.995	0.725	0.850
5	0.884	1.000	0.996	0.923	0.947	1.000	0.465	0.544
6	0.808	1.000	1.000	0.837	0.992	1.000	0.268	0.277
7	0.734	1.000	1.000	0.752	0.999	1.000	0.145	0.122
8	0.662	1.000	1.000	0.671	1.000	1.000	0.076	0.050
9	0.593	1.000	1.000	0.594	1.000	1.000	0.039	0.020
10	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
11	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
12	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
13	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
14	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
15	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
16	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
17	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
18	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
19	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008
20	0.528	1.000	1.000	0.523	1.000	1.000	0.020	0.008

Table 8. Selectivity of removals averaged (avg) across fleets in the terminal three years of the assessment (2017–2019) for landings (L), discards (D) and total (Tot), as used in computation of benchmarks and projections.

Age	L.avg	D.avg	Tot.avg
1	0.004	0.415	0.419
2	0.024	0.753	0.776
3	0.099	0.901	1.000
4	0.210	0.768	0.978
5	0.261	0.498	0.759
6	0.271	0.263	0.534
7	0.273	0.126	0.399
8	0.273	0.063	0.335
9	0.272	0.036	0.308
10	0.272	0.025	0.297
11	0.272	0.025	0.297
12	0.272	0.025	0.297
13	0.272	0.025	0.297
14	0.272	0.025	0.297
15	0.272	0.025	0.297
16	0.272	0.025	0.297
17	0.272	0.025	0.297
18	0.272	0.025	0.297
19	0.272	0.025	0.297
20	0.272	0.025	0.297

Table 9. Estimated time series of fully selected fishing mortality rates for commercial handlines (F.cH.L), headboat (F.HB.L), recreational (F.GR.L) landings (L) and discards (D). Also shown is Full F, the maximum F at age summed across fleets, which may not equal the sum of fully selected F's because of dome-shaped selectivities.

Year	F.cH.L	F.HB.L	F.GR.L	F.cH.D	F.HB.D	F.GR.D	Full F
1950	0.013	0.000	0.000	0.000	0.000	0.000	0.013
1951	0.017	0.000	0.000	0.000	0.000	0.000	0.017
1952	0.013	0.000	0.000	0.000	0.000	0.000	0.013
1953	0.013	0.000	0.000	0.000	0.000	0.000	0.013
1954	0.020	0.000	0.000	0.000	0.000	0.000	0.020
1955	0.016	0.000	0.025	0.000	0.000	0.000	0.041
1956	0.016	0.000	0.028	0.000	0.000	0.000	0.043
1957	0.029	0.000	0.030	0.000	0.000	0.000	0.059
1958	0.021	0.000	0.033	0.000	0.000	0.000	0.054
1959	0.022	0.000	0.036	0.000	0.000	0.000	0.059
1960	0.023	0.000	0.039	0.000	0.000	0.000	0.062
1961	0.028	0.000	0.043	0.000	0.000	0.000	0.071
1962	0.023	0.000	0.047	0.000	0.000	0.000	0.071
1963	0.018	0.000	0.051	0.000	0.000	0.000	0.069
1964	0.020	0.000	0.056	0.000	0.000	0.000	0.075
1965	0.021	0.000	0.060	0.000	0.000	0.000	0.081
1966	0.021	0.000	0.061	0.000	0.000	0.000	0.082
1967	0.029	0.000	0.062	0.000	0.000	0.000	0.091
1968	0.035	0.000	0.063	0.000	0.000	0.000	0.099
1969	0.022	0.000	0.065	0.000	0.000	0.000	0.087
1970	0.022	0.000	0.065	0.000	0.000	0.000	0.087
1971	0.019	0.000	0.072	0.000	0.000	0.000	0.092
1972	0.018	0.000	0.079	0.000	0.000	0.000	0.097
1973	0.013	0.000	0.087	0.000	0.000	0.000	0.099
1974	0.021	0.000	0.095	0.000	0.000	0.000	0.116
1975	0.028	0.000	0.104	0.000	0.000	0.000	0.131
1976	0.027	0.000	0.108	0.000	0.000	0.000	0.135
1977	0.029	0.000	0.111	0.000	0.000	0.000	0.140
1978	0.030	0.014	0.104	0.000	0.000	0.000	0.149
1979	0.023	0.018	0.130	0.000	0.000	0.000	0.171
1980	0.023	0.022	0.161	0.000	0.000	0.000	0.207
1981	0.029	0.068	0.769	0.000	0.000	0.010	0.871
1982	0.033	0.052	0.261	0.000	0.000	0.008	0.350
1983	0.038	0.063	0.241	0.000	0.000	0.003	0.343
1984	0.032	0.044	0.707	0.000	0.000	0.039	0.800
1985	0.042	0.085	0.963	0.000	0.000	0.058	1.115
1986	0.051	0.044	0.416	0.000	0.000	0.096	0.554
1987	0.051	0.071	0.348	0.000	0.000	0.072	0.502
1988	0.049	0.092	0.487	0.000	0.000	0.041	0.646
1989	0.095	0.073	0.766	0.000	0.000	0.038	0.951
1990	0.104	0.090	0.129	0.000	0.000	0.055	0.347
1991	0.070	0.063	0.328	0.000	0.000	0.042	0.479
1992	0.076	0.057	0.806	0.028	0.003	0.039	0.957
1993	0.156	0.058	0.251	0.027	0.005	0.250	0.503
1994	0.126	0.058	0.242	0.040	0.006	0.205	0.468
1995	0.123	0.078	0.153	0.051	0.009	0.179	0.398
1996	0.100	0.051	0.287	0.048	0.005	0.070	0.469
1997	0.082	0.058	0.168	0.038	0.003	0.020	0.329
1998	0.061	0.039	0.347	0.016	0.002	0.075	0.462
1999	0.058	0.045	0.652	0.010	0.002	0.160	0.776
2000	0.057	0.042	0.720	0.009	0.002	0.233	0.846
2001	0.094	0.051	0.581	0.010	0.003	0.277	0.757
2002	0.084	0.051	0.636	0.021	0.004	0.223	0.803
2003	0.060	0.024	0.260	0.006	0.002	0.226	0.369
2004	0.073	0.048	0.465	0.002	0.017	0.632	0.698
2005	0.058	0.044	0.278	0.020	0.021	0.267	0.419
2006	0.042	0.039	0.410	0.002	0.005	0.124	0.505
2007	0.059	0.044	0.321	0.003	0.014	0.186	0.445
2008	0.065	0.037	0.696	0.003	0.018	0.337	0.835
2009	0.100	0.052	1.062	0.007	0.033	0.535	1.274
2010	0.002	0.001	0.000	0.014	0.031	0.397	0.444
2011	0.000	0.004	0.000	0.039	0.026	0.186	0.252
2012	0.003	0.007	0.081	0.020	0.029	0.292	0.372
2013	0.010	0.005	0.034	0.015	0.021	0.128	0.184
2014	0.019	0.008	0.157	0.018	0.011	0.244	0.374
2015	0.001	0.001	0.007	0.013	0.009	0.284	0.308
2016	0.001	0.000	0.000	0.012	0.010	0.453	0.475
2017	0.013	0.003	0.051	0.006	0.005	0.245	0.283
2018	0.016	0.004	0.104	0.004	0.006	0.503	0.559
2019	0.014	0.004	0.118	0.003	0.005	0.280	0.350
2020	0.015	0.003	0.112	0.006	0.006	0.475	0.534
2021	0.013	0.004	0.077	0.004	0.006	0.240	0.286
2022	0.011	0.001	0.047	0.007	0.004	0.301	0.335
2023	0.010	0.001	0.137	0.008	0.006	0.345	0.417

Table 10. Estimated instantaneous fishing mortality rate (per yr) at age.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1950	0.003	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
1951	0.004	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
1952	0.003	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
1953	0.003	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
1954	0.004	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
1955	0.007	0.037	0.041	0.039	0.037	0.034	0.032	0.029	0.027	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
1956	0.007	0.039	0.043	0.041	0.039	0.036	0.033	0.030	0.028	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
1957	0.011	0.054	0.059	0.057	0.054	0.051	0.048	0.045	0.042	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
1958	0.009	0.048	0.054	0.051	0.048	0.045	0.041	0.038	0.035	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
1959	0.010	0.052	0.059	0.056	0.052	0.048	0.045	0.041	0.038	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
1960	0.010	0.056	0.062	0.059	0.055	0.051	0.047	0.043	0.040	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
1961	0.012	0.064	0.071	0.068	0.063	0.059	0.055	0.050	0.046	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
1962	0.012	0.063	0.071	0.067	0.062	0.057	0.052	0.048	0.043	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
1963	0.011	0.061	0.069	0.065	0.060	0.055	0.050	0.044	0.040	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
1964	0.012	0.066	0.075	0.071	0.066	0.060	0.054	0.049	0.044	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
1965	0.013	0.071	0.081	0.076	0.070	0.064	0.058	0.052	0.047	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
1966	0.013	0.072	0.082	0.077	0.071	0.065	0.059	0.053	0.047	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
1967	0.015	0.080	0.091	0.086	0.080	0.073	0.067	0.061	0.055	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
1968	0.016	0.088	0.099	0.093	0.087	0.081	0.074	0.068	0.062	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
1969	0.014	0.076	0.087	0.082	0.075	0.069	0.062	0.056	0.050	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
1970	0.014	0.076	0.087	0.081	0.075	0.068	0.062	0.055	0.049	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
1971	0.014	0.080	0.092	0.086	0.079	0.071	0.064	0.057	0.050	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
1972	0.014	0.084	0.097	0.090	0.083	0.075	0.066	0.059	0.051	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
1973	0.014	0.086	0.099	0.093	0.084	0.075	0.066	0.058	0.050	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
1974	0.017	0.101	0.116	0.108	0.099	0.089	0.080	0.070	0.062	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
1975	0.020	0.115	0.131	0.123	0.113	0.102	0.092	0.081	0.072	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063
1976	0.020	0.118	0.135	0.126	0.116	0.105	0.094	0.083	0.073	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
1977	0.021	0.123	0.140	0.132	0.121	0.109	0.098	0.087	0.077	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
1978	0.023	0.130	0.149	0.139	0.128	0.115	0.103	0.092	0.081	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071
1979	0.025	0.148	0.171	0.159	0.145	0.130	0.114	0.100	0.086	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074
1980	0.030	0.179	0.207	0.193	0.175	0.156	0.137	0.119	0.102	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
1981	0.125	0.747	0.871	0.801	0.718	0.632	0.546	0.463	0.387	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319
1982	0.055	0.305	0.350	0.322	0.291	0.258	0.226	0.195	0.167	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141	0.141
1983	0.051	0.297	0.343	0.318	0.288	0.257	0.225	0.195	0.168	0.143	0.143	0.143	0.143	0.143	0.143	0.143	0.143	0.143	0.143	0.143
1984	0.139	0.706	0.800	0.727	0.650	0.572	0.495	0.421	0.353	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292
1985	0.196	0.986	1.115	1.012	0.904	0.796	0.688	0.584	0.489	0.404	0.404	0.404	0.404	0.404	0.404	0.404	0.404	0.404	0.404	0.404
1986	0.153	0.536	0.554	0.484	0.431	0.382	0.335	0.290	0.248	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210	0.210
1987	0.127	0.477	0.502	0.444	0.397	0.353	0.310	0.269	0.230	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196
1988	0.122	0.579	0.646	0.586	0.526	0.466	0.406	0.349	0.296	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249
1989	0.165	0.841	0.951	0.871	0.785	0.699	0.612	0.530	0.453	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385
1990	0.099	0.342	0.347	0.311	0.285	0.262	0.239	0.217	0.197	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
1991	0.103	0.442	0.479	0.434	0.392	0.351	0.311	0.272	0.237	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205
1992	0.055	0.144	0.696	0.957	0.833	0.682	0.537	0.409	0.307	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231
1993	0.231	0.313	0.462	0.503	0.434	0.375	0.322	0.277	0.240	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213
1994	0.202	0.278	0.430	0.468	0.397	0.339	0.288	0.243	0.208	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181
1995	0.187	0.258	0.383	0.398	0.333	0.287	0.248	0.214	0.186	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166
1996	0.091	0.150	0.384	0.469	0.401	0.338	0.281	0.231	0.191	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161
1997	0.042	0.080	0.264	0.329	0.283	0.241	0.203	0.170	0.143	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123
1998	0.075	0.126	0.360	0.462	0.401	0.332	0.267	0.210	0.164	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
1999	0.145	0.232	0.604	0.776	0.671	0.548	0.430	0.327	0.245	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183
2000	0.206	0.310	0.678	0.846	0.727	0.592	0.463	0.351	0.260	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193	0.193
2001	0.245	0.347	0.635	0.757	0.651	0.538	0.431	0.338	0.263	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207
2002	0.206	0.308	0.654	0.803	0.690	0.567	0.450	0.349	0.268	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207	0.207
2003	0.196	0.260	0.344	0.369	0.313	0.260	0.212	0.170	0.136	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.111
2004	0.551	0.698	0.695	0.651	0.533	0.435	0.347	0.271	0.210	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
2005	0.255	0.335	0.411	0.419	0.346	0.285	0.230	0.182	0.144	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116
2006	0.112	0.171	0.401	0.505	0.437	0.358	0.282	0.216	0.163	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123
2007	0.173	0.237	0.386	0.445	0.381	0.316	0.254	0.200	0.157	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
2008	0.304	0.424	0.711	0.835	0.713	0.581	0.457	0.348	0.261	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197
2009	0.487	0.674	1.095	1.274	1.085	0.884	0.695	0.530	0.398	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
2010	0.208	0.373	0.444	0.378	0.249	0.136	0.071	0.040	0.027	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
2011	0.110	0.207	0.252	0.221	0.157	0.102	0.069	0.054	0.047	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
2012	0.160	0.294	0.372	0.358	0.278	0.197	0.148	0.125	0.114	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
2013	0.077	0.143	0.184	0.178	0.141	0.104	0.081	0.070	0.065	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063
2014	0.125	0.242	0.339	0.374	0.330	0.269	0.231	0.212	0.204	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2015	0.139	0.255	0.308	0.268	0.180	0.103	0.058	0.037	0.028	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024
2016	0.218	0.396	0.475	0.406	0.264	0.141	0.070	0.036	0.022	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
2017	0.119	0.221	0.283	0.271	0.206	0.142	0.103	0.085	0.077	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074
2018	0.239	0.440	0.559	0.532	0.399	0.267	0.189	0.152	0.137	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
2019	0.136	0.253	0.338	0.350	0.288	0.217	0.173	0.152	0.144	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140	0.140
2020	0.227	0.418	0.534	0.514	0.392	0.268	0.194	0.160	0.145	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139
2021	0.118	0.219	0.286	0.286	0.227	0.165	0.127	0.109	0.101	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098
2022	0.144	0.266	0.335	0.312	0.229	0.150	0.103	0.081	0.072	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
2023	0.166	0.310	0.407	0.417	0.339	0.252	0.199	0.174	0.163	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159

Table 11. Estimated time series of landings in number (1000 fish) for commercial handlines (L.cH), headboat (L.HB), and recreational (L.GR).

Year	L.cH	L.HB	L.GR	Total
1950	27.61	0.00	0.00	27.61
1951	37.33	0.00	0.00	37.33
1952	28.70	0.00	0.00	28.70
1953	29.47	0.00	0.00	29.47
1954	43.67	0.00	0.00	43.67
1955	36.08	0.00	36.57	72.66
1956	35.20	0.00	39.95	75.15
1957	62.95	0.00	43.32	106.28
1958	44.42	0.00	46.70	91.12
1959	47.76	0.00	50.09	97.85
1960	48.84	0.00	53.48	102.32
1961	58.19	0.00	58.35	116.54
1962	47.39	0.00	63.22	110.62
1963	36.02	0.00	68.11	104.13
1964	39.81	0.00	73.02	112.83
1965	41.55	0.00	77.93	119.48
1966	41.51	0.00	78.44	119.95
1967	54.72	0.00	78.94	133.66
1968	65.85	0.00	79.46	145.31
1969	41.20	0.00	79.98	121.18
1970	39.58	0.00	80.51	120.09
1971	35.51	0.00	88.65	124.15
1972	31.72	0.00	96.85	128.57
1973	23.22	0.00	105.12	128.34
1974	37.70	0.00	113.46	151.16
1975	47.71	0.00	121.88	169.59
1976	45.73	0.00	123.47	169.20
1977	48.19	0.00	124.86	173.05
1978	46.75	15.32	110.31	172.37
1979	29.81	15.49	111.61	156.91
1980	26.24	15.66	112.63	154.52
1981	25.54	36.25	407.09	468.88
1982	20.88	19.63	97.97	138.48
1983	29.32	30.81	117.08	177.21
1984	31.83	31.21	504.13	567.17
1985	31.61	50.44	569.83	651.88
1986	24.98	16.63	157.29	198.91
1987	23.94	24.96	121.58	170.47
1988	25.12	36.40	193.64	255.16
1989	37.24	23.40	245.02	305.65
1990	29.51	20.90	29.73	80.14
1991	19.69	13.86	72.57	106.12
1992	8.57	5.30	75.50	89.36
1993	20.81	7.33	29.91	58.05
1994	18.68	8.21	32.41	59.29
1995	15.77	8.81	17.18	41.76
1996	12.27	5.54	29.84	47.65
1997	9.60	5.76	16.68	32.04
1998	8.25	4.74	41.60	54.59
1999	9.27	6.83	97.40	113.50
2000	11.19	8.43	139.14	158.76
2001	21.67	12.02	133.53	167.21
2002	20.54	12.94	153.14	186.61
2003	14.42	5.71	60.79	80.91
2004	17.17	10.84	103.02	131.03
2005	12.44	8.91	53.61	74.96
2006	7.59	5.95	62.85	76.39
2007	11.06	6.89	59.99	77.94
2008	30.14	18.93	323.58	372.65
2009	40.13	21.51	422.44	484.07
2010	0.75	0.48	0.06	1.29
2011	0.06	1.36	0.06	1.47
2012	0.75	2.12	18.01	20.88
2013	2.95	1.52	7.45	11.92
2014	6.69	2.95	37.43	47.07
2015	0.57	0.75	2.03	3.35
2016	0.39	0.33	0.08	0.80
2017	10.84	2.72	25.79	39.35
2018	14.85	4.43	59.94	79.23
2019	13.69	4.05	71.47	89.21
2020	15.14	3.22	72.86	91.22
2021	14.44	5.04	53.56	73.04
2022	13.91	1.59	39.06	54.56
2023	13.08	1.88	120.67	135.63

Table 12. Estimated time series of landings in whole weight (1000 lb) for commercial handlines (L.cH), headboat (L.HB), and recreational (L.GR).

Year	L.cH	L.HB	L.GR	Total
1950	368.83	0.00	0.00	368.83
1951	500.12	0.00	0.00	500.12
1952	386.16	0.00	0.00	386.16
1953	398.55	0.00	0.00	398.55
1954	593.87	0.00	0.00	593.87
1955	493.82	0.00	402.05	895.87
1956	484.44	0.00	441.05	925.49
1957	869.16	0.00	479.02	1348.18
1958	613.53	0.00	515.49	1129.03
1959	659.04	0.00	551.16	1210.20
1960	672.57	0.00	586.28	1258.85
1961	798.70	0.00	637.00	1435.70
1962	647.67	0.00	686.81	1334.48
1963	489.86	0.00	736.11	1225.97
1964	539.02	0.00	785.40	1324.42
1965	559.81	0.00	834.42	1394.23
1966	556.37	0.00	835.44	1391.81
1967	729.03	0.00	836.05	1565.08
1968	871.09	0.00	835.78	1706.88
1969	540.57	0.00	834.59	1375.16
1970	515.43	0.00	834.28	1349.71
1971	459.52	0.00	913.78	1373.31
1972	408.52	0.00	994.35	1402.87
1973	297.66	0.00	1075.50	1373.16
1974	481.52	0.00	1156.91	1638.43
1975	606.28	0.00	1236.65	1842.93
1976	576.86	0.00	1243.15	1820.02
1977	602.33	0.00	1245.04	1847.37
1978	600.32	155.84	1121.77	1877.92
1979	423.74	177.46	1278.40	1879.60
1980	387.69	191.53	1377.85	1957.07
1981	380.94	435.20	4887.34	5703.49
1982	310.19	232.25	1159.11	1701.54
1983	318.53	258.78	983.30	1560.62
1984	254.32	190.46	3076.32	3521.10
1985	251.40	310.40	3506.79	4068.58
1986	219.69	116.14	1098.33	1434.15
1987	191.45	168.46	820.68	1180.59
1988	173.28	215.74	1147.61	1536.63
1989	265.83	143.41	1501.86	1911.10
1990	226.07	139.79	198.80	564.67
1991	143.49	91.79	480.58	715.86
1992	104.21	52.32	725.16	881.68
1993	218.51	63.14	255.67	537.33
1994	194.13	73.25	289.70	557.07
1995	176.55	86.26	166.49	429.31
1996	138.32	53.83	290.43	482.57
1997	110.34	57.10	162.66	330.10
1998	89.41	43.70	377.29	510.40
1999	93.35	59.13	822.69	975.17
2000	103.88	68.90	1116.23	1289.01
2001	195.91	98.26	1077.33	1371.50
2002	187.77	108.32	1278.36	1574.45
2003	138.30	50.45	533.74	722.49
2004	171.98	99.35	938.28	1209.61
2005	129.81	83.56	506.16	719.52
2006	86.47	60.81	626.14	773.43
2007	114.94	61.93	491.97	668.85
2008	251.66	143.83	2426.99	2822.47
2009	362.26	178.80	3492.83	4033.89
2010	6.45	3.67	0.57	10.69
2011	0.57	12.29	0.64	13.50
2012	8.14	19.84	221.72	249.70
2013	31.57	13.70	94.88	140.15
2014	65.33	23.18	458.11	546.62
2015	4.72	4.94	22.66	32.32
2016	3.18	2.20	0.80	6.18
2017	90.22	19.14	265.10	374.46
2018	127.81	32.16	631.37	791.34
2019	120.29	30.40	766.31	917.00
2020	134.77	24.02	795.48	954.27
2021	127.77	37.61	585.61	750.99
2022	125.73	12.11	429.43	567.27
2023	127.27	15.86	1378.14	1521.27

Table 13. Estimated time series of discard mortalities in numbers (1000 fish) for commercial handlines (D.cH), headboat (D.HB), and recreational (D.GR).

Year	D.cH	D.HB	D.GR	Total
1981	.	.	2.70	.
1982	.	.	2.70	.
1983	.	.	2.70	.
1984	.	0.03	44.80	.
1985	.	0.04	37.17	.
1986	.	0.01	37.15	.
1987	.	0.02	37.14	.
1988	.	0.03	22.80	.
1989	.	0.02	12.67	.
1990	.	0.02	12.68	.
1991	.	0.01	12.67	.
1992	8.89	0.93	14.31	24.13
1993	7.71	1.29	65.56	74.56
1994	9.74	1.44	45.72	56.90
1995	9.72	1.55	32.47	43.73
1996	9.55	0.97	14.29	24.81
1997	10.31	1.01	6.25	17.57
1998	7.42	0.83	40.14	48.40
1999	6.26	1.20	119.60	127.06
2000	6.70	1.48	203.87	212.05
2001	6.97	2.11	196.93	206.01
2002	12.39	2.26	125.41	140.07
2003	3.97	1.00	148.78	153.74
2004	0.97	7.14	260.71	268.83
2005	4.78	3.69	48.15	56.62
2006	2.18	6.45	166.86	175.50
2007	5.00	27.14	352.79	384.92
2008	4.74	27.62	520.24	552.60
2009	5.38	21.41	352.07	378.87
2010	6.13	14.37	172.62	193.12
2011	14.68	10.89	69.34	94.91
2012	7.45	12.28	104.85	124.57
2013	6.25	12.15	59.06	77.47
2014	10.10	12.11	205.85	228.06
2015	11.40	14.14	359.64	385.18
2016	13.51	17.28	649.00	679.79
2017	7.56	10.32	411.92	429.79
2018	4.98	11.82	816.79	833.59
2019	4.55	12.14	503.30	519.98
2020	9.11	13.26	868.86	891.23
2021	6.94	15.85	499.06	521.85
2022	12.65	10.01	591.29	613.95
2023	13.03	7.86	475.49	496.37

Table 14. Estimated time series of discard mortalities in whole weight (1000 lb) for commercial handlines (D.cH), headboat (D.HB), and recreational (D.GR).

Year	D.cH	D.HB	D.GR	Total
1981	.	.	7.38	.
1982	.	.	5.59	.
1983	.	.	4.53	.
1984	.	0.05	94.83	.
1985	.	0.11	103.36	.
1986	.	0.04	98.16	.
1987	.	0.04	74.35	.
1988	.	0.07	51.65	.
1989	.	0.05	35.20	.
1990	.	0.05	33.73	.
1991	.	0.02	26.51	.
1992	25.54	2.11	32.44	60.09
1993	29.63	3.90	198.72	232.25
1994	38.05	3.64	115.36	157.05
1995	37.68	4.23	88.78	130.69
1996	32.34	2.23	32.89	67.46
1997	30.46	2.17	13.43	46.06
1998	19.92	1.68	81.33	102.94
1999	17.38	2.59	258.47	278.44
2000	19.61	3.30	455.66	478.57
2001	23.95	5.54	518.21	547.70
2002	44.85	5.82	322.17	372.83
2003	12.75	2.23	331.45	346.42
2004	3.77	20.95	764.84	789.55
2005	22.39	12.46	162.51	197.36
2006	3.71	8.54	220.69	232.94
2007	12.29	60.33	784.37	856.99
2008	16.14	72.11	1358.40	1446.65
2009	23.17	70.47	1158.66	1252.30
2010	45.96	72.25	959.88	1078.09
2011	126.17	48.94	368.45	543.56
2012	65.50	50.99	502.59	619.08
2013	52.72	40.50	229.03	322.25
2014	69.19	30.60	605.99	705.79
2015	66.03	38.75	1113.15	1217.93
2016	82.17	56.71	2400.04	2538.92
2017	48.13	33.34	1548.94	1630.42
2018	33.10	43.72	3425.34	3502.16
2019	31.03	39.70	1934.08	2004.80
2020	61.48	46.44	3468.22	3576.14
2021	47.37	52.22	1907.31	2006.90
2022	90.23	41.20	2691.37	2822.80
2023	110.62	43.25	2777.82	2931.70

Table 15. Estimated total removals (landings and dead discards) at age in numbers (1000 fish)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1950	1.26	4.11	3.35	2.75	2.29	1.93	1.64	1.40	1.20	1.03	0.89	0.77	0.66	0.57	0.50	0.43	0.37	0.32	0.28	1.83
1951	1.67	5.48	4.55	3.73	3.11	2.62	2.23	1.90	1.63	1.40	1.21	1.04	0.90	0.78	0.67	0.58	0.51	0.44	0.38	2.48
1952	1.27	4.16	3.46	2.88	2.41	2.03	1.72	1.47	1.26	1.08	0.93	0.81	0.70	0.60	0.52	0.45	0.39	0.34	0.29	1.92
1953	1.28	4.21	3.51	2.93	2.49	2.10	1.78	1.52	1.31	1.12	0.97	0.84	0.72	0.62	0.54	0.47	0.41	0.35	0.30	1.98
1954	1.88	6.17	5.14	4.31	3.66	3.14	2.67	2.28	1.96	1.68	1.45	1.25	1.08	0.93	0.81	0.70	0.61	0.53	0.46	2.97
1955	2.93	11.81	10.65	8.50	6.80	5.44	4.36	3.44	2.72	2.16	1.86	1.61	1.39	1.20	1.04	0.90	0.78	0.68	0.59	3.82
1956	3.04	12.39	11.02	8.71	6.96	5.58	4.47	3.57	2.82	2.23	1.93	1.67	1.44	1.24	1.08	0.93	0.81	0.70	0.61	3.96
1957	4.43	17.03	14.83	11.63	9.35	7.64	6.27	5.15	4.24	3.45	2.99	2.58	2.23	1.93	1.67	1.45	1.25	1.09	0.94	6.14
1958	3.81	15.27	13.34	10.32	8.07	6.45	5.22	4.23	3.44	2.80	2.43	2.11	1.82	1.58	1.37	1.18	1.02	0.89	0.77	5.02
1959	4.13	16.57	14.48	11.07	8.61	6.77	5.44	4.43	3.62	2.96	2.62	2.28	1.98	1.72	1.49	1.29	1.11	0.97	0.84	5.46
1960	4.37	17.55	15.32	11.71	8.99	7.03	5.55	4.48	3.66	3.01	2.68	2.38	2.07	1.80	1.56	1.35	1.17	1.02	0.88	5.74
1961	5.06	20.06	17.39	13.28	10.23	7.93	6.26	4.99	4.07	3.38	3.03	2.70	2.40	2.09	1.82	1.58	1.37	1.18	1.03	6.70
1962	4.82	19.67	17.08	12.93	9.87	7.59	5.86	4.60	3.64	2.96	2.66	2.39	2.14	1.90	1.66	1.44	1.25	1.09	0.94	6.13
1963	4.53	19.13	16.77	12.52	9.44	7.17	5.48	4.19	3.26	2.56	2.29	2.06	1.86	1.66	1.48	1.29	1.12	0.97	0.84	5.51
1964	4.96	20.82	18.26	13.62	10.21	7.74	5.91	4.54	3.49	2.74	2.42	2.17	1.96	1.76	1.58	1.40	1.23	1.07	0.93	6.04
1965	5.30	22.25	19.45	14.52	10.86	8.17	6.22	4.77	3.68	2.86	2.51	2.22	1.99	1.80	1.62	1.45	1.29	1.13	0.98	6.42
1966	5.38	22.57	19.63	14.59	10.93	8.22	6.21	4.75	3.66	2.85	2.48	2.19	1.93	1.73	1.57	1.41	1.27	1.13	0.99	6.47
1967	6.13	24.97	21.50	15.97	11.99	9.10	6.95	5.34	4.16	3.28	2.87	2.50	2.20	1.95	1.75	1.59	1.43	1.28	1.14	7.55
1968	6.83	27.18	23.11	17.19	12.90	9.81	7.55	5.84	4.57	3.63	3.17	2.77	2.42	2.14	1.89	1.70	1.54	1.39	1.24	8.44
1969	5.67	23.69	20.29	14.86	11.00	8.21	6.18	4.70	3.59	2.77	2.41	2.11	1.84	1.61	1.42	1.26	1.13	1.03	0.93	6.47
1970	5.64	23.70	20.46	14.87	10.93	8.13	6.08	4.60	3.51	2.70	2.34	2.04	1.78	1.56	1.37	1.21	1.07	0.96	0.87	6.28
1971	5.81	24.83	21.61	15.77	11.45	8.42	6.25	4.66	3.52	2.68	2.32	2.01	1.76	1.54	1.35	1.18	1.04	0.93	0.83	6.19
1972	6.02	26.07	22.70	16.56	12.07	8.77	6.44	4.77	3.55	2.67	2.32	2.01	1.74	1.53	1.34	1.17	1.03	0.91	0.81	6.11
1973	5.98	26.57	23.21	16.79	12.20	8.87	6.41	4.66	3.42	2.52	2.18	1.89	1.64	1.43	1.25	1.10	0.96	0.84	0.75	5.68
1974	7.21	30.98	26.77	19.35	14.11	10.39	7.65	5.61	4.16	3.13	2.70	2.34	2.04	1.77	1.54	1.35	1.18	1.04	0.91	6.93
1975	8.31	34.94	29.69	21.44	15.62	11.51	8.56	6.39	4.75	3.59	3.10	2.68	2.32	2.02	1.76	1.53	1.34	1.18	1.03	7.81
1976	8.48	35.65	29.89	21.29	15.45	11.33	8.40	6.28	4.72	3.54	3.05	2.64	2.28	1.98	1.73	1.50	1.31	1.14	1.00	7.56
1977	8.87	37.07	30.88	21.68	15.54	11.39	8.43	6.31	4.77	3.63	3.11	2.68	2.32	2.01	1.75	1.52	1.33	1.15	1.01	7.58
1978	2.79	39.03	32.38	22.60	15.96	11.54	8.52	6.35	4.79	3.66	3.18	2.73	2.36	2.04	1.77	1.54	1.34	1.17	1.02	7.57
1979	2.95	13.17	36.62	25.29	17.65	12.47	8.98	6.59	4.87	3.63	3.17	2.76	2.37	2.05	1.78	1.54	1.34	1.17	1.02	7.49
1980	8.76	15.01	12.77	29.18	20.27	14.26	10.13	7.33	5.40	4.00	3.50	3.06	2.67	2.30	1.99	1.72	1.49	1.30	1.13	8.25
1981	13.23	119.65	37.03	26.11	61.19	43.71	31.47	22.76	16.63	12.26	10.77	9.44	8.26	7.20	6.20	5.36	4.66	4.04	3.52	25.40
1982	13.38	21.27	26.12	6.20	4.61	11.53	8.79	6.78	5.25	4.12	3.83	3.37	2.96	2.59	2.26	1.95	1.68	1.46	1.27	9.09
1983	41.25	53.20	14.62	14.56	3.53	2.70	6.94	5.44	4.31	3.43	3.23	3.01	2.65	2.33	2.04	1.78	1.53	1.33	1.15	8.18
1984	81.67	311.29	69.45	15.69	16.11	4.04	3.18	8.37	6.67	5.33	5.06	4.77	4.45	3.92	3.44	3.02	2.63	2.27	1.97	13.83
1985	36.48	334.33	174.81	31.15	7.60	8.45	2.29	1.95	5.49	4.67	4.67	4.44	4.19	3.91	3.45	3.03	2.66	2.32	2.01	13.95
1986	15.87	59.67	67.94	27.61	5.36	1.43	1.73	0.51	0.48	1.47	1.59	1.59	1.51	1.43	1.34	1.18	1.04	0.91	0.79	5.45
1987	28.12	51.26	31.30	29.76	12.77	2.59	0.72	0.91	0.28	0.27	1.00	1.08	1.08	1.03	0.98	0.91	0.81	0.71	0.62	4.28
1988	29.57	126.21	37.75	19.14	19.09	8.54	1.80	0.52	0.67	0.21	0.24	0.91	0.99	0.99	0.94	0.89	0.83	0.74	0.65	4.48
1989	18.29	136.13	86.49	21.07	11.40	12.16	5.81	1.31	0.40	0.55	0.21	0.25	0.92	1.00	1.00	0.96	0.90	0.85	0.75	5.21
1990	6.71	24.15	24.11	12.25	3.23	1.91	2.24	1.18	0.30	0.10	0.17	0.07	0.08	0.29	0.31	0.31	0.30	0.28	0.27	1.87
1991	15.73	30.60	21.36	18.50	9.57	2.54	1.50	1.75	0.91	0.22	0.09	0.15	0.06	0.07	0.24	0.26	0.27	0.25	0.24	1.81
1992	0.93	12.35	23.63	18.62	16.81	8.65	2.22	1.23	1.31	0.63	0.18	0.07	0.12	0.05	0.05	0.20	0.22	0.22	0.21	1.67
1993	0.14	4.85	32.01	7.75	3.52	3.52	2.14	0.67	0.46	0.62	0.41	0.12	0.05	0.08	0.03	0.04	0.13	0.14	0.14	1.24
1994	0.23	1.61	24.49	22.49	3.56	1.65	1.70	1.07	0.35	0.25	0.39	0.26	0.08	0.03	0.05	0.02	0.02	0.08	0.09	0.87
1995	0.09	2.32	7.67	16.27	9.87	1.62	0.79	0.87	0.59	0.21	0.17	0.27	0.18	0.05	0.02	0.03	0.01	0.02	0.06	0.66
1996	0.25	1.74	17.45	7.47	10.57	6.41	1.05	0.51	0.56	0.38	0.15	0.13	0.20	0.13	0.04	0.01	0.03	0.01	0.01	0.53
1997	0.23	2.36	7.65	10.42	2.81	4.06	2.58	0.45	0.23	0.28	0.23	0.09	0.08	0.12	0.08	0.02	0.01	0.01	0.01	0.33
1998	0.78	5.54	22.03	9.41	8.15	2.15	3.08	1.92	0.33	0.17	0.23	0.19	0.07	0.06	0.10	0.07	0.02	0.01	0.01	0.28
1999	1.72	17.13	47.77	26.43	6.98	6.14	1.69	2.49	1.59	0.27	0.18	0.25	0.20	0.08	0.07	0.11	0.07	0.02	0.01	0.31
2000	2.17	21.35	83.87	31.26	10.27	2.86	2.74	0.82	1.31	0.90	0.21	0.14	0.19	0.16	0.06	0.05	0.08	0.06	0.02	0.25
2001	1.06	20.01	83.00	44.65	9.93	3.50	1.09	1.18	0.40	0.73	0.70	0.17	0.11	0.15	0.12	0.05	0.04	0.07	0.04	0.21
2002	1.11	12.52	93.38	53.23	17.58	4.12	1.57	0.53	0.61	0.22	0.53	0.51	0.12	0.08	0.11	0.09	0.04	0.03	0.05	0.19
2003	0.67	5.50	28.47	30.08	10.24	3.54	0.90	0.38	0.14	0.19	0.09	0.22	0.21	0.05	0.03	0.05	0.04	0.01	0.01	0.10
2004	0.35	11.18	43.20	36.76	25.32	8.70	3.09	0.81	0.35	0.13	0.22	0.10	0.25	0.24	0.06	0.04	0.05	0.04	0.02	0.13
2005	0.10	2.06	29.43	19.30	11.00	7.93	2.89	1.10	0.31	0.14	0.07	0.12	0.06	0.14	0.13	0.03	0.02	0.03	0.02	0.08
2006	3.27	1.65	13.57	29.47	12.48	7.14	5.23	1.93	0.73	0.21	0.12	0.06	0.10	0.05	0.12	0.11	0.03	0.02	0.02	0.09
2007	1.84	33.16	7.68	9.37	12.47	5.39	3.27	2.57	1.03	0.43	0.16	0.10	0.05	0.08	0.04	0.09	0.09	0.02	0.01	0.09
2008	3.00	40.31	288.93	9.85	7.70	10.47	4.70	2.95	2.37	0.96	0.52	0.20	0.12	0.06	0.10	0.05	0.11	0.11	0.03	0.13
2009	0.83	40.33	208.80	210.54	4.48	3.83	5.87	2.96	2.06	1.83	1.03	0.55	0.21	0.13	0.06	0.10	0.05	0.12	0.12	0.16
2010	0.02	0.07	0.54	0.34	0.23	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.04	0.15	0.20	0.54	0.28	0.19	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.24	1.22	1.82	1.98	6.55	4.10	3.27	0.11	0.14	0.31	0.23	0.23	0.29	0.16	0.09	0.03	0.02	0.01	0.02	0.07
2013	0.33	0.82	2.11	1.39	0.89	2.60	1.67	1.37	0.04	0.06	0.13	0.10	0.10	0.13	0.07	0.04	0.01	0.01	0.00	0.04
2014	2.33	4.46	6.01	8.86	4.19	2.48	7.45	4.91	4.10	0.14	0.18	0.41	0.31	0.31	0.39	0.22	0.12	0.05	0.03	0.13
2015	0.16	0.72	0.70	0.42	0.37	0.15	0.09	0.29	0.19	0.16	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.00	0.00	0.01
2016	0.03	0.18	0.31	0.11	0.04	0.03	0.01	0.01	0.03	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	1.32	3.92	10.30	11.20	4.12	1.74	1.57	0.74	0.48	1.53	1.04	0.89	0.03	0.04	0.09	0.07	0.07	0.09	0.05	0.07
2018	1.35	9.02	14.79	20.67	15.54	5.44	2.41	2.27	1.08	0.71	2.29	1.56	1.33	0.04	0.06	0.14	0.10	0.10	0.13	0.18
2019	2.62	5.79	21.50	17.60	15.78	11.23	4.21	1.97	1.90	0.92	0.61	1.96	1.34	1.15	0.04	0.05	0.12	0.09	0.09	0.27
2020	1.77	10.17	13.15	24.55	12.56	10.41	7.76	3.03	1.44	1.41	0.69	0.45	1.47	1.01	0.86	0.03	0.04	0.09	0.07	0.27
2021	2.11	5.98	18.87	11.34	12.94	6.14	5.38	4.20	1.68	0.81	0.80	0.39	0.26	0.83	0.57	0.49	0.02	0.02	0.05	0.19
2022	0.51	6.00	9.62	15.29	5.89	6.14	3.01	2.73	2.17	0.88	0.43	0.42	0.20	0.14	0.44	0.30	0.26	0.01	0.01	0.13
2023	0.28	4.27	30.85	27.29	29.07	10.48	11.43	5.82	5.38	4.33	1.76	0.85	0.84	0.41	0.27	0.88	0.61	0.52	0.02	0.28

Table 16. Estimated landings at age in whole weight (1000 lb)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1950	1.86	14.09	19.66	23.35	25.44	26.16	25.82	24.75	23.20	21.39	19.47	17.55	15.70	13.95	12.34	10.87	9.54	8.36	7.31	48.03
1951	2.47	18.79	26.66	31.68	34.53	35.50	35.04	33.59	31.48	29.02	26.42	23.82	21.30	18.93	16.74	14.75	12.95	11.35	9.93	65.18
1952	1.87	14.26	20.27	24.50	26.71	27.46	27.10	25.98	24.35	22.45	20.44	18.42	16.47	14.64	12.95	11.41	10.02	8.78	7.68	50.42
1953	1.90	14.45	20.58	24.92	27.63	28.42	28.06	26.89	25.21	23.24	21.16	19.07	17.05	15.16	13.40	11.81	10.37	9.09	7.95	52.20
1954	2.78	21.14	30.14	36.58	40.65	42.52	41.99	40.25	37.73	34.78	31.67	28.55	25.53	22.69	20.06	17.67	15.52	13.60	11.90	78.12
1955	4.33	40.48	62.42	72.18	75.43	73.64	68.48	60.62	52.43	44.72	40.72	36.71	32.82	29.17	25.80	22.72	19.96	17.49	15.30	100.45
1956	4.50	42.45	64.63	73.94	77.24	75.47	70.21	63.04	54.39	46.23	42.18	38.02	34.00	30.22	26.72	23.54	20.67	18.11	15.84	104.06
1957	6.55	58.38	86.93	98.77	103.77	103.40	98.51	90.81	81.75	71.38	65.29	58.97	52.73	46.87	41.44	36.51	32.06	28.09	24.57	161.38
1958	5.63	52.35	78.20	87.65	89.49	87.23	82.05	74.68	66.29	57.89	53.13	48.11	43.11	38.31	33.88	29.84	26.21	22.96	20.09	131.92
1959	6.11	56.81	84.88	94.00	95.55	91.62	85.55	78.16	69.77	61.28	57.39	52.14	46.83	41.71	36.89	32.49	28.53	25.00	21.87	143.63
1960	6.46	60.15	89.81	99.41	99.75	95.11	87.24	78.98	70.65	62.28	58.66	54.38	49.01	43.76	38.78	34.16	30.00	26.28	22.99	150.99
1961	7.48	68.74	101.93	112.79	113.52	107.33	98.40	88.03	78.54	69.84	66.17	61.69	56.74	50.83	45.15	39.85	35.00	30.67	26.83	176.17
1962	7.13	67.40	100.16	109.78	109.46	102.66	92.08	81.09	70.28	61.20	58.24	54.62	50.52	46.18	41.17	36.43	32.06	28.09	24.57	161.35
1963	6.70	65.55	98.33	106.32	104.73	97.06	86.11	73.93	62.82	52.92	50.04	47.14	43.86	40.32	36.67	32.56	28.73	25.22	22.06	144.89
1964	7.33	71.36	107.08	115.68	113.22	104.70	92.90	80.03	67.42	56.74	52.85	49.47	46.24	42.76	39.11	35.43	31.37	27.61	24.20	158.92
1965	7.84	76.26	114.02	123.28	120.48	110.60	97.79	84.13	70.97	59.08	54.89	50.62	47.01	43.67	40.18	36.61	33.07	29.20	25.66	168.87
1966	7.96	77.35	115.08	123.86	121.21	111.17	97.65	83.79	70.65	58.95	54.24	49.89	45.64	42.13	38.94	35.69	32.42	29.21	25.76	170.23
1967	9.07	85.59	126.05	135.62	133.02	123.18	109.20	94.18	80.27	67.93	62.67	57.09	52.09	47.37	43.50	40.05	36.59	33.17	29.84	198.60
1968	10.10	93.16	135.47	145.96	143.12	132.75	118.69	103.12	88.11	75.10	69.28	63.27	57.18	51.86	46.92	42.92	39.39	35.92	32.50	222.05
1969	8.39	81.21	118.94	126.22	122.08	111.07	97.21	82.92	69.24	57.23	52.67	48.10	43.58	39.15	35.33	31.84	29.03	26.59	24.20	170.16
1970	8.34	81.24	119.97	126.26	121.20	109.93	95.61	81.10	67.70	55.82	51.06	46.53	42.15	37.96	33.92	30.49	27.40	24.93	22.79	165.29
1971	8.60	85.11	126.67	133.88	127.04	113.88	98.25	82.31	67.83	55.46	50.72	45.94	41.53	37.39	33.50	29.83	26.73	23.96	21.77	162.90
1972	8.90	89.34	133.08	140.58	133.94	118.71	101.24	84.13	68.48	55.27	50.67	45.88	41.22	37.03	33.18	29.61	26.28	23.50	21.03	160.79
1973	8.85	91.06	136.08	142.54	135.33	120.01	100.73	82.26	65.94	52.10	47.63	43.23	38.83	34.68	31.00	27.66	24.62	21.80	19.46	149.35
1974	10.67	106.20	156.93	164.34	156.54	140.51	120.32	99.07	80.37	64.75	59.03	53.43	48.11	42.95	38.16	33.98	30.23	26.84	23.73	182.27
1975	12.29	119.77	174.08	182.08	173.28	155.77	134.66	112.71	91.70	74.25	67.75	61.15	54.90	49.13	43.64	38.63	34.29	30.44	26.98	205.42
1976	12.53	122.19	175.26	180.75	171.35	153.31	132.08	110.89	91.00	73.22	66.61	60.18	53.88	48.08	42.81	37.88	33.43	29.61	26.24	198.72
1977	13.11	127.07	181.08	184.13	172.45	154.08	132.53	111.30	92.02	75.05	68.04	61.29	54.92	48.88	43.40	38.49	33.96	29.89	26.43	199.24
1978	4.13	133.79	189.81	191.91	177.10	156.17	133.96	112.12	92.51	75.80	69.51	62.39	55.75	49.66	43.97	38.89	34.39	30.27	26.60	199.21
1979	4.36	45.13	214.68	214.79	195.80	168.68	141.22	116.22	93.90	75.19	69.39	62.99	56.09	49.81	44.15	38.94	34.34	30.29	26.62	197.01
1980	12.95	51.43	74.86	247.76	224.86	192.93	159.32	129.40	104.12	82.82	76.57	69.95	63.00	55.76	49.27	43.49	38.25	33.65	29.64	217.04
1981	19.56	410.10	217.12	221.68	678.80	591.33	494.79	401.54	320.93	253.74	235.39	215.42	195.23	174.76	153.89	135.45	119.22	104.59	91.87	668.08
1982	19.79	72.89	153.11	52.62	51.14	155.94	138.28	119.55	101.25	85.21	83.74	76.91	69.83	62.90	56.02	49.14	43.12	37.87	33.17	239.07
1983	61.00	182.33	85.70	123.60	39.21	36.58	109.18	96.04	83.11	71.03	70.62	68.71	62.60	56.49	50.63	44.92	39.28	34.39	30.15	215.04
1984	120.77	1066.93	407.18	133.28	178.76	54.71	50.05	147.69	128.69	110.24	110.57	108.84	105.05	95.13	85.42	76.25	67.45	58.85	51.44	363.80
1985	53.94	1145.89	1024.89	264.53	84.28	114.36	36.07	34.36	106.01	96.67	102.18	101.47	99.07	95.05	85.64	76.59	68.17	60.16	52.41	366.83
1986	23.47	204.51	398.35	234.49	59.44	19.31	27.25	9.06	9.19	30.38	34.70	36.32	35.78	34.72	33.14	29.75	26.53	23.56	20.75	143.47
1987	41.59	175.69	183.49	252.75	141.62	35.05	11.30	16.01	5.39	5.56	21.82	24.68	25.62	25.09	24.23	23.04	20.61	18.34	16.26	112.45
1988	43.73	432.58	221.30	162.57	211.82	115.54	28.27	9.10	12.94	4.39	5.34	20.75	23.28	24.02	23.40	22.51	21.34	19.05	16.92	117.80
1989	27.05	466.57	507.06	178.89	126.43	164.55	91.41	23.08	7.72	11.47	4.68	5.64	21.74	24.24	24.88	24.15	23.16	21.90	19.52	136.97
1990	9.92	82.79	141.38	103.98	35.83	25.84	35.21	20.91	5.73	2.11	3.78	1.53	1.83	7.00	7.76	7.94	7.68	7.35	6.94	49.18
1991	23.26	104.89	125.21	157.12	106.17	34.42	23.64	30.89	17.63	4.65	1.87	3.33	1.33	1.58	6.04	6.67	6.80	6.57	6.27	47.52
1992	3.00	63.13	169.50	172.96	191.12	115.47	33.63	20.67	24.12	12.38	3.80	1.52	2.70	1.08	1.29	4.91	5.44	5.57	5.39	44.00
1993	0.44	24.79	229.59	72.00	39.96	46.91	32.43	11.21	8.43	12.29	8.64	2.63	1.05	1.84	0.74	0.87	3.32	3.67	3.74	32.78
1994	0.75	8.24	175.67	208.87	40.49	21.98	25.86	18.10	6.38	4.92	8.13	5.67	1.71	0.68	1.19	0.47	0.56	2.12	2.33	22.97
1995	0.28	11.87	54.99	151.13	112.15	21.59	11.99	14.67	10.81	4.04	3.58	5.87	4.07	1.22	0.48	0.84	0.33	0.39	1.48	17.52
1996	0.80	8.91	125.12	69.42	120.14	85.58	16.00	8.65	10.35	7.50	3.15	2.77	4.51	3.11	0.93	0.36	0.63	0.25	0.29	14.08
1997	0.74	12.07	54.90	96.80	31.94	54.16	39.21	7.58	4.30	5.45	4.71	1.96	1.71	2.77	1.90	0.57	0.22	0.38	0.15	8.57
1998	2.51	28.32	157.98	87.43	92.60	28.75	46.74	32.43	6.00	3.26	4.81	4.11	1.70	1.48	2.38	1.62	0.48	0.19	0.33	7.30
1999	5.57	87.57	342.58	245.48	79.39	81.90	25.58	41.89	29.13	5.37	3.71	5.43	4.61	1.90	1.64	2.63	1.79	0.53	0.21	8.25
2000	7.00	109.14	601.49	290.30	116.71	38.19	41.64	13.81	23.98	17.65	4.44	3.04	4.42	3.74	1.53	1.32	2.10	1.43	0.42	6.64
2001	3.42	102.29	595.24	414.66	112.85	46.70	16.55	19.87	7.35	14.43	14.67	3.66	2.49	3.60	3.02	1.23	1.06	1.69	1.14	5.58
2002	3.59	64.02	669.71	494.41	199.79	54.92	23.81	8.89	11.23	4.37	11.09	11.18	2.77	1.87	2.69	2.26	0.92	0.78	1.25	4.91
2003	2.16	28.13	204.19	279.33	116.36	47.30	13.72	6.40	2.61	3.67	1.88	4.74	4.75	1.17	0.79	1.13	0.94	0.38	0.33	2.53
2004	1.14	57.18	309.85	341.38	287.74	116.03	46.89	13.59	6.35	2.61	4.51	2.30	5.74	5.71	1.40	0.94	1.34	1.12	0.45	3.33
2005	0.33	10.51	211.09	179.22	125.02	105.78	43.93	18.52	5.67	2.84	1.51	2.58	1.30	3.24	3.21	0.78	0.52	0.75	0.62	2.08
2006	10.58	8.43	97.34	273.67	141.86	95.30	79.33	32.45	13.46	4.05	2.54	1.34	2.27	1.14	2.82	2.78	0.68	0.45	0.64	2.29
2007	5.95	169.51	55.05	87.01	141.79	71.95	49.62	43.25	18.87	8.51	3.42	2.12	1.11	1.88	0.94	2.31	2.27	0.55	0.37	2.36
2008	9.70	206.09	2072.15	91.50	87.53	139.66	71.41	49.66	43.48	18.98	10.84	4.32	2.66	1.38	2.33	1.16	2.85	2.79	0.68	3.30
2009	2.70	206.17	1497.52	1955.44	50.94	51.12	89.05	49.90	37.90	36.08	21.43	12.14	4.81	2.95	1.52	2.55	1.27	3.10	3.04	4.27
2010	0.02	0.25	3.14	2.91	2.59	0.09	0.12	0.29	0.23	0.24	0.32	0.19	0.10	0.04	0.02	0.01	0.02	0.01	0.03	0.06
2011	0.06	0.51	1.17	4.56	3.12	2.63	0.09	0.11	0.25	0.18	0.19	0.25	0.14	0.08	0.03	0.02	0.01	0.02	0.01	0.06
2012	0.35	4.20	10.67	16.78	72.68	55.47	51.44	1.86	2.62	6.38	5.02	5.30	6.84	3.95	2.19	0.85	0.51	0.26	0.43	1.89
2013	0.49	2.80	12.38	11.83	9.84	35.21	26.23	24.19	0.86	1.21	2.93	2.28	2.39	3.06	1.76	0.97	0.38	0.23	0.11	1.02
2014	3.44	15.30	35.26	75.28	46.54	33.54	117.11	86.57	79.19	2.81	3.90	9.38	7.24	7.54	9.63	5.51	3.03	1.17	0.70	3.49
2015	0.24	2.46	4.11	3.58	4.09	2.10	1.47	5.07	3.69	3.32	0.12	0.16	0.38	0.29	0.30	0.39	0.22	0.12	0.05	0.17
2016	0.05	0.63	1.81	0.94	0.46	0.45	0.23	0.16	0.53	0.37	0.34	0.01	0.02	0.04	0.03	0.03	0.04	0.02	0.01	0.02
2017	1.95	13.44	60.41	95.07	45.75	23.54	24.72	12.98	9.20	31.60	22.80	20.28	0.70	0.95	2.24	1.71	1.75	2.22	1.26	1.88
2018	2.00	30.92	86.72	175.53	172.35	73.63	37.93	40.01	20.89	14.68	50.03	35.73	31.53	1.08	1.46	3.43	2.60	2.67	3.38	4.76
2019	3.88	19.85	126.04	149.44	175.10	151.90	66.14	34.68	36.62	19.00	13.27	44.75	31.70	27.81	0.95	1.28	2.99	2.26	2.32	7.02
2020	2.62	34.87	77.07	208.47	139.39	140.79	121.99	53.40	27.86	29.17	15.01	10.37	34.72	24.45	21.34	0.73	0.97	2.27	1.72	7.04
2021	3.12	20.51	110.63	96.26	143.51	83.01	84.55	74.10	32.35	16.73	17.38	8.85	6.07	20.19	14.15	12.30	0.42	0.56	1.30	4.97
2022	0.76	20.55	56.43	129.88	65.29	83.06	47.32	48.11	41.86	18.11	9.30	9.56	4.83	3.29	10.90	7.60	6.59	0.22	0.30	3.33
2023	0.42	14.63	180.85	231.73	322.50	141.75	179.73	102.71	103.81	89.51	38.38	19.50	19.89	9.99	6.78	22.34	15.54	13.44	0.45	7.32

Table 17. Estimated discards at age in numbers (1000 fish)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1951	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1952	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1953	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1954	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1955	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1956	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1957	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1958	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1959	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1960	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1961	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1981	0.91	1.55	0.18	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1982	1.84	0.57	0.27	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983	2.10	0.53	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1984	25.11	18.09	1.52	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1985	12.06	20.86	4.10	0.18	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	17.83	13.09	5.65	0.57	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	25.42	9.09	2.11	0.50	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988	11.82	9.74	1.10	0.14	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	4.48	6.52	1.57	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	5.95	4.67	1.83	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1991	8.35	3.26	0.87	0.19	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1992	11.22	10.76	1.68	0.38	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1993	19.68	40.30	13.83	0.67	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	30.81	12.78	10.97	2.26	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	14.93	22.25	4.11	2.14	0.28	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1996	13.27	6.17	4.61	0.56	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	8.92	6.12	1.70	0.77	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	30.24	14.20	3.54	0.35	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	71.72	47.13	7.40	0.76	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	117.57	76.69	16.62	1.09	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	82.10	99.62	22.09	2.09	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	66.76	49.49	21.26	2.39	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	91.15	47.30	12.78	2.33	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	77.26	155.92	30.74	4.24	0.62	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	16.74	21.23	16.33	2.03	0.25	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	166.76	5.43	2.36	0.86	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	179.43	202.46	2.39	0.49	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	248.86	219.52	83.65	0.47	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	72.78	231.29	64.08	10.66	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	29.42	28.24	82.64	35.99	15.90	0.25	0.15	0.18	0.09	0.07	0.08	0.05	0.03	0.01	0.01	0.00	0.00	0.00	0.01	0.01
2011	25.61	18.33	11.29	24.41	9.60	4.63	0.10	0.10	0.19	0.13	0.13	0.16	0.09	0.05	0.02	0.01	0.01	0.01	0.00	0.04
2012	32.33	42.80	18.83	8.28	14.67	5.00	2.19	0.04	0.04	0.08	0.06	0.06	0.07	0.04	0.02	0.01	0.01	0.00	0.00	0.02
2013	30.97	18.73	15.79	4.96	1.81	3.08	1.19	0.67	0.02	0.02	0.05	0.04	0.04	0.04	0.03	0.01	0.01	0.00	0.00	0.01
2014	119.65	61.11	24.15	14.63	3.73	1.20	2.00	0.83	0.52	0.01	0.02	0.04	0.03	0.03	0.04	0.02	0.01	0.00	0.00	0.01
2015	148.79	159.46	51.70	14.48	6.99	1.57	0.49	0.87	0.40	0.27	0.01	0.01	0.03	0.02	0.02	0.03	0.01	0.01	0.00	0.01
2016	195.16	254.80	172.36	41.02	9.70	4.25	0.93	0.30	0.58	0.29	0.25	0.01	0.01	0.03	0.02	0.02	0.02	0.01	0.01	0.01
2017	155.85	119.26	96.08	45.93	9.07	1.97	0.86	0.21	0.08	0.18	0.13	0.11	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
2018	193.49	338.53	162.47	93.68	36.68	6.39	1.28	0.54	0.12	0.04	0.14	0.10	0.08	0.00	0.00	0.01	0.01	0.01	0.01	0.01
2019	204.03	119.72	126.70	41.52	19.29	6.87	1.19	0.26	0.13	0.04	0.02	0.08	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.01
2020	240.49	369.65	135.90	101.75	27.00	11.20	3.87	0.70	0.17	0.11	0.05	0.03	0.11	0.08	0.06	0.00	0.00	0.01	0.00	0.02
2021	190.09	139.54	131.11	33.15	19.94	4.80	1.99	0.76	0.17	0.05	0.05	0.03	0.02	0.06	0.04	0.03	0.00	0.00	0.00	0.01
2022	88.90	275.08	130.41	87.84	17.92	9.54	2.25	1.02	0.48	0.14	0.07	0.07	0.03	0.02	0.07	0.05	0.04	0.00	0.00	0.02
2023	27.34	115.56	224.09	74.72	40.87	7.49	3.93	1.01	0.55	0.32	0.13	0.06	0.06	0.03	0.02	0.07	0.04	0.04	0.00	0.02

Table 18. Estimated discards at age in whole weight (1000 lb)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1951	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1952	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1953	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1954	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1955	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1956	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1957	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1958	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1959	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1960	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1961	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1971	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1973	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1974	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1981	1.07	4.83	1.01	0.27	0.17	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1982	2.15	1.77	1.49	0.13	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983	2.45	1.65	0.31	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1984	29.31	56.13	8.51	0.71	0.20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1985	14.08	64.73	23.00	1.52	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	20.80	40.62	31.74	4.77	0.25	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	29.67	28.21	11.84	4.16	0.49	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1988	13.80	30.22	6.18	1.16	0.32	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	5.23	20.25	8.83	0.79	0.12	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1990	6.94	14.50	10.27	1.89	0.13	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1991	9.74	10.12	4.88	1.56	0.22	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1992	13.10	33.38	9.46	3.17	0.87	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1993	22.97	125.08	77.67	5.63	0.71	0.16	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	35.96	39.65	61.60	18.87	0.85	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	17.43	69.05	23.11	17.89	3.10	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1996	15.48	19.14	25.88	4.71	1.97	0.26	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	10.41	18.99	9.57	6.40	0.51	0.15	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	35.29	44.06	19.90	2.89	0.73	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	83.71	146.25	41.56	6.32	0.48	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	137.21	238.00	93.34	9.08	0.85	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2001	95.82	309.18	124.08	17.42	1.10	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2002	77.91	153.57	119.41	19.91	1.90	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2003	106.38	146.80	71.78	19.43	1.86	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	90.17	483.89	172.65	35.34	6.81	0.62	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005	19.53	65.90	91.69	16.94	2.76	0.49	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	194.63	16.86	13.24	7.19	0.86	0.13	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	209.41	628.32	13.43	4.10	1.53	0.17	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2008	290.45	681.28	469.82	3.89	0.86	0.31	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2009	84.94	717.80	359.91	88.94	0.54	0.12	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	34.34	87.64	464.13	300.30	175.24	3.34	2.40	3.22	1.65	1.36	1.78	1.04	0.58	0.23	0.14	0.07	0.12	0.06	0.14	0.32
2011	29.89	56.88	63.40	203.69	105.82	62.42	1.52	1.68	3.60	2.68	2.84	3.68	2.13	1.18	0.46	0.28	0.14	0.23	0.11	0.92
2012	37.73	132.83	105.78	69.10	161.72	67.51	34.37	0.76	0.79	1.63	1.28	1.34	1.73	0.99	0.55	0.21	0.13	0.06	0.11	0.47
2013	36.15	58.14	88.70	41.37	19.95	41.54	18.62	11.78	0.34	0.42	1.02	0.79	0.83	1.06	0.61	0.33	0.13	0.08	0.04	0.35
2014	139.65	189.65	135.61	122.08	41.09	16.24	31.35	14.48	9.88	0.30	0.42	1.00	0.77	0.80	1.02	0.58	0.32	0.12	0.07	0.36
2015	173.65	494.86	290.37	120.85	77.05	21.17	7.75	15.33	7.64	5.60	0.20	0.27	0.64	0.49	0.50	0.64	0.36	0.20	0.08	0.27
2016	227.77	790.77	968.07	342.31	106.86	57.35	14.55	5.33	11.17	5.98	5.35	0.19	0.25	0.60	0.45	0.47	0.59	0.34	0.18	0.32
2017	181.90	370.13	539.64	383.27	100.01	26.53	13.51	3.60	1.51	3.76	2.70	2.39	0.08	0.11	0.26	0.20	0.20	0.26	0.15	0.22
2018	225.83	1050.60	912.52	781.67	404.27	86.24	20.13	9.40	2.32	0.90	3.05	2.17	1.91	0.07	0.09	0.21	0.16	0.16	0.20	0.28
2019	238.12	371.55	711.65	346.46	212.62	92.68	18.63	4.50	2.42	0.77	0.54	1.80	1.27	1.11	0.04	0.05	0.12	0.09	0.09	0.28
2020	280.68	1147.20	763.31	849.08	297.65	151.14	60.58	12.31	3.32	2.17	1.11	0.77	2.55	1.79	1.56	0.05	0.07	0.17	0.12	0.51
2021	221.86	433.07	736.38	276.63	219.80	64.75	31.22	13.25	3.19	1.11	1.15	0.58	0.40	1.32	0.92	0.80	0.03	0.04	0.08	0.32
2022	103.76	853.69	732.49	732.98	197.46	128.71	35.25	17.97	9.12	2.81	1.44	1.47	0.74	0.50	1.66	1.16	1.00	0.03	0.05	0.50
2023	31.91	358.65	1258.63	623.49	450.53	100.98	61.65	17.75	10.54	6.53	2.79	1.41	1.43	0.72	0.49	1.59	1.11	0.96	0.03	0.52

Table 19. Estimated status indicators, benchmarks, and related quantities from the base run of the Beaufort catch-age model, conditional on estimated current selectivities averaged across fleets. Also presented are median values and measures of precision (standard errors, SE) from the Monte Carlo/Bootstrap ensemble analysis. Rate estimates (F) are in units of y^{-1}; exploitation rate (E) and status indicators are dimensionless; biomass estimates are in units of metric tons or pounds, as indicated; and recruits are in number of age-1 fish. Spawning stock biomass (SSB) is measured as population fecundity (number of eggs).

Quantity	Units	Estimate	Median	SE
$F_{30\%}$	y^{-1}	0.18	0.19	0.02
$85\%F_{30\%}$	y^{-1}	0.16	0.16	0.02
$75\%F_{30\%}$	y^{-1}	0.14	0.14	0.02
$65\%F_{30\%}$	y^{-1}	0.12	0.12	0.01
$F_{40\%}$	y^{-1}	0.14	0.14	0.02
$E_{\mathrm{F30\%}}$	—	0.10	0.10	0.01
$B_{\mathrm{F30\%}}$	metric tons	7308.63	7073.66	1507.03
$\mathrm{SSB}_{\mathrm{F30\%}}$	eggs (1E8)	702270.70	632894.00	244880.37
MSST	eggs (1E8)	526703.00	474670.50	183660.28
$L_{\mathrm{F30\%}}$	1000 lb whole	620.72	616.11	145.89
$D_{\mathrm{F30\%}}$	1000 dead fish	140.19	140.67	24.63
$R_{\mathrm{F30\%}}$	number fish	482756.80	496637.30	107658.37
$L_{\mathrm{85\%F30\%}}$	1000 lb whole	618.41	613.28	143.13
$L_{\mathrm{75\%F30\%}}$	1000 lb whole	608.05	602.84	139.56
$L_{\mathrm{65\%F30\%}}$	1000 lb whole	588.41	583.51	134.16
$F_{2021-2023}/F_{30\%}$	—	1.85	1.58	0.44
$E_{2021-2023}/E_{\mathrm{F30\%}}$	—	2.00	1.71	0.49
$\mathrm{SSB}_{2023}/\mathrm{MSST}$	—	1.01	1.19	0.46
$\mathrm{SSB}_{2023}/\mathrm{SSB}_{\mathrm{F30\%}}$	—	0.76	0.89	0.34

Table 20. Results from this update (S73U), SEDAR73 (S73), and sensitivity runs of the Beaufort Assessment Model. Sensitivity runs decreased general recreational landings and discards by 20% (S1) or 40% (S2). Terminal year was 2019 for SEDAR73, 2023 for the other models. Current F represented by geometric mean of last three assessment years. Sensitivity runs should not all be considered equally plausible.

Run	Description	$F_{30\%}$	$\mathrm{SSB}_{\mathrm{F30\%}}$ (1e8 eggs)	$L_{\mathrm{F30\%}}$ (1000 lb)	$D_{\mathrm{F30\%}}$ (1000 fish)	$F_{\mathrm{current}}/F_{30\%}$	$\mathrm{SSB}_{terminal}/\mathrm{SSB}_{\mathrm{F30\%}}$	R0 (1000)
S73U	Update	0.18	702271	621	140.19	1.85	0.76	418
S73	Operational	0.21	635426	405	141.52	2.2	0.44	383
S1	GR 20%	0.18	587218	522	116.24	1.84	0.76	351
S2	GR 40%	0.18	471791	423	92.15	1.82	0.76	283

Table 21. Projection results with fishing mortality rate fixed at $F = F_{30\%}$ starting in 2025 and long-term, average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $\mathrm{SSB} \geq \mathrm{SSB}_{\mathrm{MSY}}$. *The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	482	422	0.33	0.28	544294	583238	78	75	948	915	279	248	1795	1636	0.423
2025	482	426	0.19	0.19	567427	607044	41	46	545	619	133	137	787	849	0.457
2026	482	424	0.19	0.19	595066	627719	38	43	550	618	132	130	700	726	0.490
2027	482	424	0.19	0.19	617706	641530	38	42	557	617	135	131	690	683	0.516
2028	482	420	0.19	0.19	634869	650422	38	41	567	621	138	132	705	684	0.536
2029	482	419	0.19	0.19	648668	654909	39	41	577	622	139	132	719	692	0.547
2030	482	421	0.19	0.19	658846	655634	39	41	584	621	140	133	726	695	0.553
2031	482	419	0.19	0.19	666452	655262	39	40	590	620	140	133	730	699	0.553
2032	482	421	0.19	0.19	672562	653468	39	40	594	618	140	133	732	700	0.547
2033	482	423	0.19	0.19	677109	651355	39	40	598	616	140	133	733	699	0.540
2034	482	418	0.19	0.19	681166	649305	39	40	601	614	140	133	733	700	0.527
2035	482	423	0.19	0.19	684431	647618	39	40	603	613	140	133	733	699	0.514
2036	482	423	0.19	0.19	686799	645013	39	40	605	612	140	134	733	701	0.503
2037	482	423	0.19	0.19	689030	643116	40	40	607	612	140	134	733	702	0.492
2038	482	418	0.19	0.19	690997	643048	40	40	609	610	140	134	733	701	0.485
2039	482	420	0.19	0.19	692342	641285	40	40	610	611	140	134	734	702	0.481
2040	482	421	0.19	0.19	693448	639329	40	40	611	610	140	134	734	702	0.475
2041	482	420	0.19	0.19	694406	638605	40	40	611	609	140	133	734	700	0.470
2042	482	418	0.19	0.19	695246	637151	40	40	612	608	140	133	734	701	0.466
2043	482	416	0.19	0.19	696007	636739	40	40	613	607	140	133	734	700	0.466
2044	482	420	0.19	0.19	696657	636540	40	40	613	607	140	133	734	700	0.465

Table 22. Projection results with fishing mortality rate fixed at $F = F_{\text{rebuild}}$ (P=0.5) starting in 2025 and long-term, average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $\text{SSB} \geq \text{SSB}_{\text{MSY}}$*. The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	482	422	0.33	0.28	544294	583238	78	75	948	915	279	248	1795	1636	0.423
2025	482	426	0.20	0.20	564597	603840	44	50	586	667	143	148	845	912	0.452
2026	482	424	0.20	0.20	587707	619742	41	46	587	659	141	138	744	772	0.479
2027	482	424	0.20	0.20	605720	628964	40	44	590	654	143	139	728	721	0.493
2028	482	420	0.20	0.20	618238	633259	40	43	597	652	146	140	740	718	0.499
2029	482	419	0.20	0.20	627451	633682	40	43	602	650	147	140	752	724	0.496
2030	482	421	0.20	0.20	633257	630487	40	42	606	645	148	141	759	727	0.488
2031	482	419	0.20	0.20	636795	626301	40	42	609	639	148	141	763	730	0.469
2032	482	421	0.20	0.20	639173	620904	40	41	610	634	148	141	764	730	0.444
2033	482	423	0.20	0.20	640377	616270	40	41	611	630	148	141	764	729	0.411
2034	482	418	0.20	0.20	641441	611303	40	41	612	626	148	141	764	729	0.383
2035	482	423	0.20	0.20	642069	607516	40	41	612	622	148	141	764	729	0.354
2036	482	423	0.20	0.20	642160	603551	40	41	613	620	148	141	764	731	0.331
2037	482	423	0.20	0.20	642394	599655	40	41	613	617	148	141	764	731	0.311
2038	482	418	0.20	0.20	642625	598013	40	41	613	615	148	141	764	731	0.294
2039	482	420	0.20	0.20	642498	594911	40	40	613	614	148	141	764	731	0.282
2040	482	421	0.20	0.20	642344	592200	40	40	613	612	148	141	764	731	0.275
2041	482	420	0.20	0.20	642220	590371	40	40	613	610	148	141	764	729	0.269
2042	482	418	0.20	0.20	642134	588194	40	40	612	609	148	141	764	730	0.261
2043	482	416	0.20	0.20	642102	587403	40	40	612	607	148	141	764	729	0.257
2044	482	420	0.20	0.20	642077	586829	40	40	612	606	148	141	764	729	0.253

Table 23. Projection results with fishing mortality rate fixed at $F = F_{\text{current}}$ starting in 2025 and long-term, average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $\text{SSB} \geq \text{SSB}_{\text{MSY}}$. *The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	482	422	0.33	0.28	544294	583238	78	75	948	915	279	248	1795	1636	0.423
2025	482	426	0.34	0.29	537949	585249	72	70	973	951	235	205	1381	1267	0.423
2026	482	424	0.34	0.29	521508	575069	62	61	902	893	215	186	1104	1005	0.406
2027	482	424	0.34	0.29	502333	558332	56	56	844	845	210	181	1004	903	0.379
2028	482	420	0.34	0.29	480348	538560	53	53	797	803	209	179	975	872	0.341
2029	482	419	0.34	0.29	457815	515869	50	50	754	766	209	179	966	861	0.301
2030	482	421	0.34	0.29	435243	492812	47	48	715	730	209	179	963	858	0.262
2031	482	419	0.34	0.29	413890	472382	45	46	680	699	209	179	961	859	0.224
2032	482	421	0.34	0.29	394632	452615	44	44	650	671	209	179	959	858	0.194
2033	482	423	0.34	0.29	377487	434762	43	43	624	647	209	179	956	853	0.167
2034	482	418	0.34	0.29	362899	420138	42	42	602	627	209	179	954	853	0.145
2035	482	423	0.34	0.29	350437	407604	41	42	583	609	208	179	953	852	0.127
2036	482	423	0.34	0.29	339808	396111	40	41	568	596	208	179	951	849	0.113
2037	482	423	0.34	0.29	331061	387256	40	41	555	584	208	179	950	851	0.102
2038	482	418	0.34	0.29	323838	379348	39	40	544	573	208	179	949	850	0.092
2039	482	420	0.34	0.29	317749	373134	39	40	535	565	208	179	948	848	0.087
2040	482	421	0.34	0.29	312740	367101	39	40	528	558	208	179	948	848	0.081
2041	482	420	0.34	0.29	308644	362349	38	39	522	552	208	178	947	845	0.077
2042	482	418	0.34	0.29	305316	358951	38	39	517	547	208	178	947	846	0.074
2043	482	416	0.34	0.29	302624	355984	38	39	513	543	208	178	946	846	0.071
2044	482	420	0.34	0.29	300439	353545	38	39	510	539	208	178	946	844	0.069

Table 24. Projection results with fishing mortality rate fixed at $F = F_{30\%}$ starting in 2025 and recent (last 10 y) average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), pr.reb = proportion of stochastic projection replicates with $\mathrm{SSB} \geq \mathrm{SSB}_{\mathrm{MSY}}$. The extension b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	1248	1077	0.33	0.28	545897	585054	79	75	948	915	363	311	1891	1711	0.426
2025	1248	1075	0.19	0.19	579947	619386	43	48	552	627	241	234	1028	1073	0.476
2026	1248	1092	0.19	0.19	646615	677667	46	51	589	659	293	280	1230	1203	0.572
2027	1248	1082	0.19	0.19	731382	749561	54	58	667	728	329	312	1486	1413	0.685
2028	1248	1083	0.19	0.19	824032	827793	62	65	764	814	348	330	1674	1584	0.793

Table 25. Projection results with fishing mortality rate fixed at $F = F_{\text{current}}$ starting in 2025 and recent (last 10 y) average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), pr.reb = proportion of stochastic projection replicates with $\text{SSB} \geq \text{SSB}_{\text{MSY}}$. The extension b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	1248	1077	0.33	0.28	545897	585054	79	75	948	915	363	311	1891	1711	0.426
2025	1248	1075	0.34	0.29	549546	597182	76	74	985	963	427	354	1806	1597	0.444
2026	1248	1092	0.34	0.29	563558	618414	74	72	963	950	482	403	1951	1685	0.476
2027	1248	1082	0.34	0.29	584833	643888	79	77	994	983	516	435	2174	1883	0.512
2028	1248	1083	0.34	0.29	605361	670759	84	81	1039	1032	531	451	2320	2031	0.549

Table 26. Projection results with fishing mortality rate fixed at $F = CF_{30\%}$ starting in 2025 and recent (last 10 y) average recruitment. The multiplier C is such that the 2028 spawning stock achieves $0.86\mathrm{SSB}_{\mathrm{F30\%}}$ with probability P=0.5. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $\mathrm{SSB} \geq \mathrm{SSB}_{\mathrm{MSY}}$. *The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	1248	1077	0.33	0.28	545897	585054	79	75	948	915	363	311	1891	1711	0.426
2025	1248	1075	0.40	0.41	538625	574730	88	99	1139	1294	492	477	2076	2166	0.399
2026	1248	1092	0.40	0.41	535675	560805	83	91	1078	1206	541	515	2160	2113	0.359
2027	1248	1082	0.40	0.41	538938	553219	85	91	1077	1177	569	538	2339	2229	0.320
2028	1248	1083	0.40	0.41	541330	545294	87	91	1090	1169	581	549	2453	2326	0.276

Table 27. Projection results with fishing mortality rate fixed at $F = 70\% F_{\text{current}}$ *starting in 2025 and recent (last 10 y) average recruitment.* R = *number of age-1 recruits (in 1000s),* F = *fishing mortality rate (per year),* S = *spawning stock (1e8 eggs),* L = *landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), and* D = *dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $\text{SSB} \geq \text{SSB}_{\text{MSY}}$*. The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	1248	1077	0.33	0.28	545897	585054	79	75	948	915	363	311	1891	1711	0.426
2025	1248	1075	0.24	0.21	569073	615363	55	53	708	690	309	255	1310	1153	0.470
2026	1248	1092	0.24	0.21	615969	667142	57	55	732	715	365	303	1513	1288	0.545
2027	1248	1082	0.24	0.21	675598	727504	65	61	802	778	403	336	1775	1504	0.629
2028	1248	1083	0.24	0.21	738322	793733	72	68	889	858	421	353	1960	1678	0.707

Table 28. Projection results with fishing mortality rate fixed at $F = 80\% F_{\text{current}}$ starting in 2025 and recent (last 10 y) average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), pr.reb = proportion of stochastic projection replicates with $\text{SSB} \geq \text{SSB}_{\text{MSY}}$. The extension b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	1248	1077	0.33	0.28	545897	585054	79	75	948	915	363	311	1891	1711	0.426
2025	1248	1075	0.28	0.24	562473	609383	62	60	802	782	349	289	1480	1304	0.461
2026	1248	1092	0.28	0.24	597881	650399	63	61	814	798	406	338	1670	1429	0.520
2027	1248	1082	0.28	0.24	643610	698482	70	67	874	853	443	371	1926	1644	0.590
2028	1248	1083	0.28	0.24	690527	750064	77	73	950	926	461	388	2102	1814	0.653

Table 29. Projection results with fishing mortality rate fixed at $F = 90\% F_{\text{current}}$ starting in 2025 and recent (last 10 y) average recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1e8 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $\text{SSB} \geq \text{SSB}_{\text{MSY}}$. *The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b(1e8)	S.med(1e8)	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2024	1248	1077	0.33	0.28	545897	585054	79	75	948	915	363	311	1891	1711	0.426
2025	1248	1075	0.31	0.26	555964	603314	69	67	894	873	388	322	1645	1452	0.453
2026	1248	1092	0.31	0.26	580419	634096	69	67	891	876	445	371	1816	1562	0.497
2027	1248	1082	0.31	0.26	613391	670254	75	72	938	922	481	404	2058	1770	0.549
2028	1248	1083	0.31	0.26	646306	708846	81	78	999	983	497	421	2221	1930	0.602

Table 30. Projected $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{F30\%}}$ *(SdSF30) for various fishing mortality rates starting in 2025 and recent (last 10 y) average recruitment. Fishing rates are* $F = F_{30\%}$ *(projection scenario 4, S4),* $F = 70\% F_{\mathrm{current}}$ *(projection scenario 7, S7),* $F = 80\% F_{\mathrm{current}}$ *(projection scenario 8, S8),* $F = 90\% F_{\mathrm{current}}$ *(projection scenario 9, S9), and* $F = F_{\mathrm{current}}$ *(projection scenario 5, S5). The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	S4:SdSF30.b	S4:SdSF30.med	S7:SdSF30.b	S7:SdSF30.med	S7:SdSF30.b	S7:SdSF30.med	S7:SdSF30.b	S7:SdSF30.med	S5:SdSF30.b	S5:SdSF30.med
2023	0.76	0.89	0.76	0.89	0.76	0.89	0.76	0.89	0.76	0.89
2024	0.78	0.92	0.78	0.92	0.78	0.92	0.78	0.92	0.78	0.92
2025	0.83	0.97	0.81	0.96	0.80	0.95	0.79	0.94	0.78	0.93
2026	0.92	1.07	0.88	1.05	0.85	1.02	0.83	0.99	0.80	0.97
2027	1.04	1.18	0.96	1.14	0.92	1.10	0.88	1.05	0.84	1.01
2028	1.18	1.30	1.05	1.24	0.99	1.18	0.92	1.11	0.86	1.05

8 Figures

Figure 1. Data availability by source and year, as fitted by the assessment model. cH indicates commercial handlines, HB indicates headboat, GR indicates general recreational, CVT indicates SERFS chevron trap, VID indicates SERFS video data, and the extension D indicates discards for indices or length compositions.

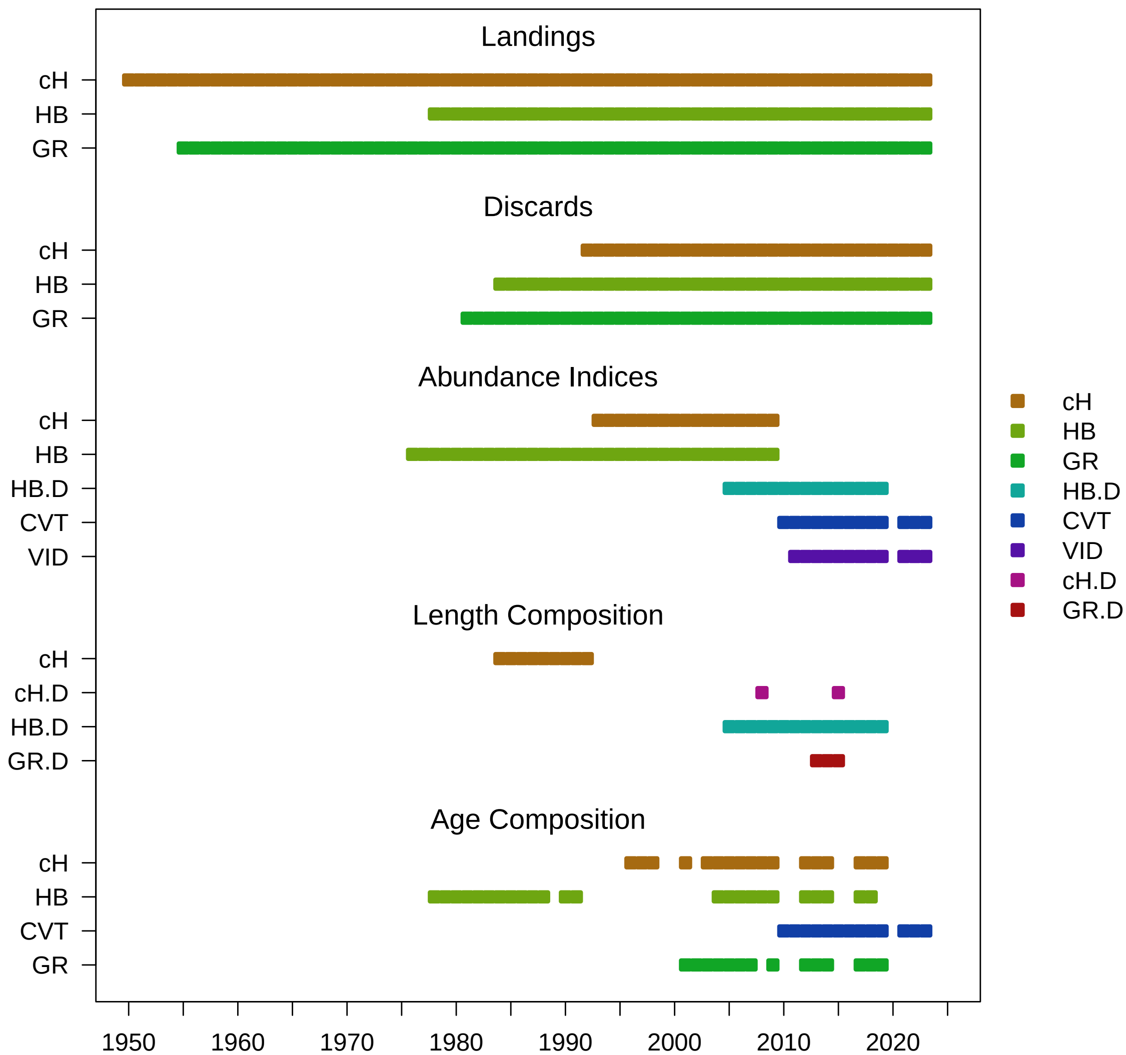


Figure 2. Observed (open circles) and estimated (solid line, circles) commercial handline landings (1000 lb whole weight).

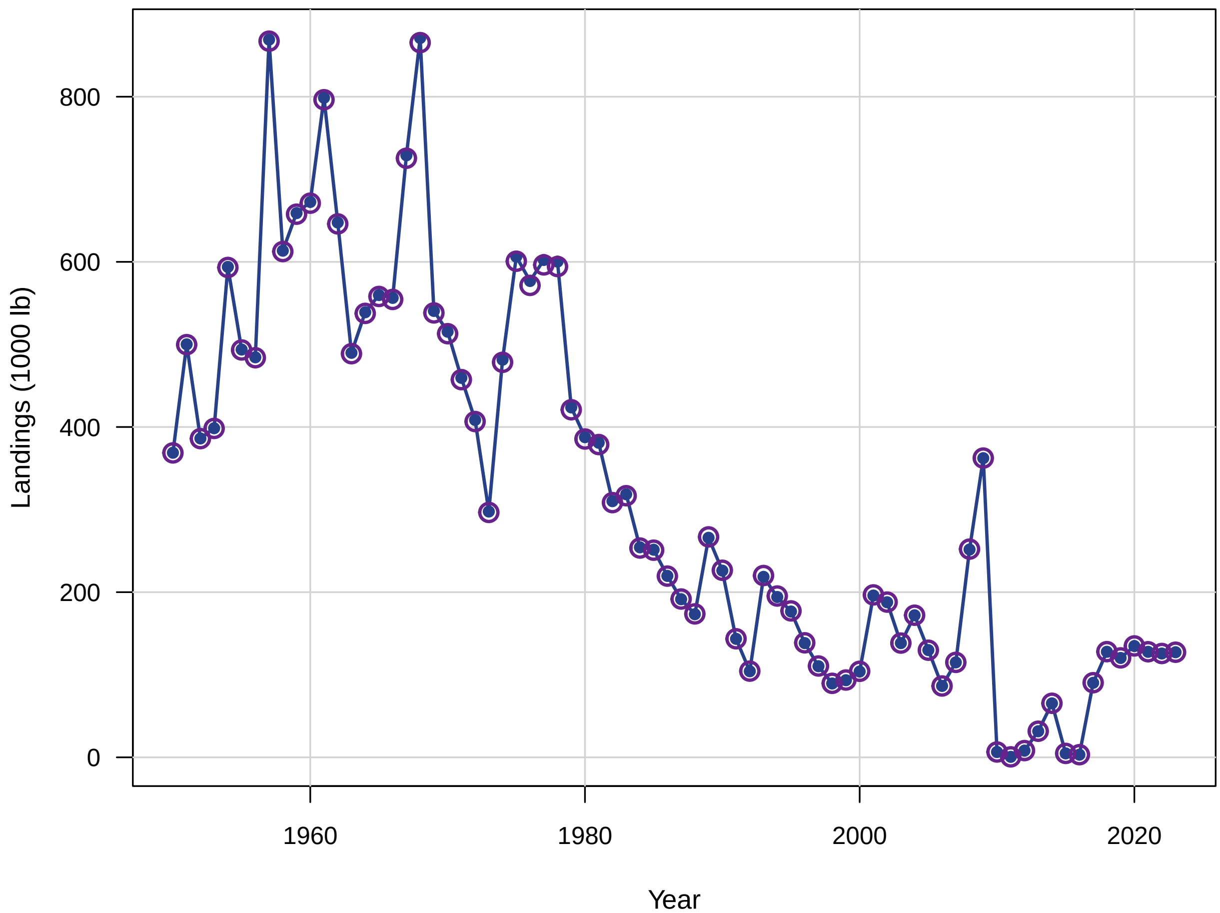


Figure 3. Observed (open circles) and estimated (solid line, circles) headboat landings (1000 fish).

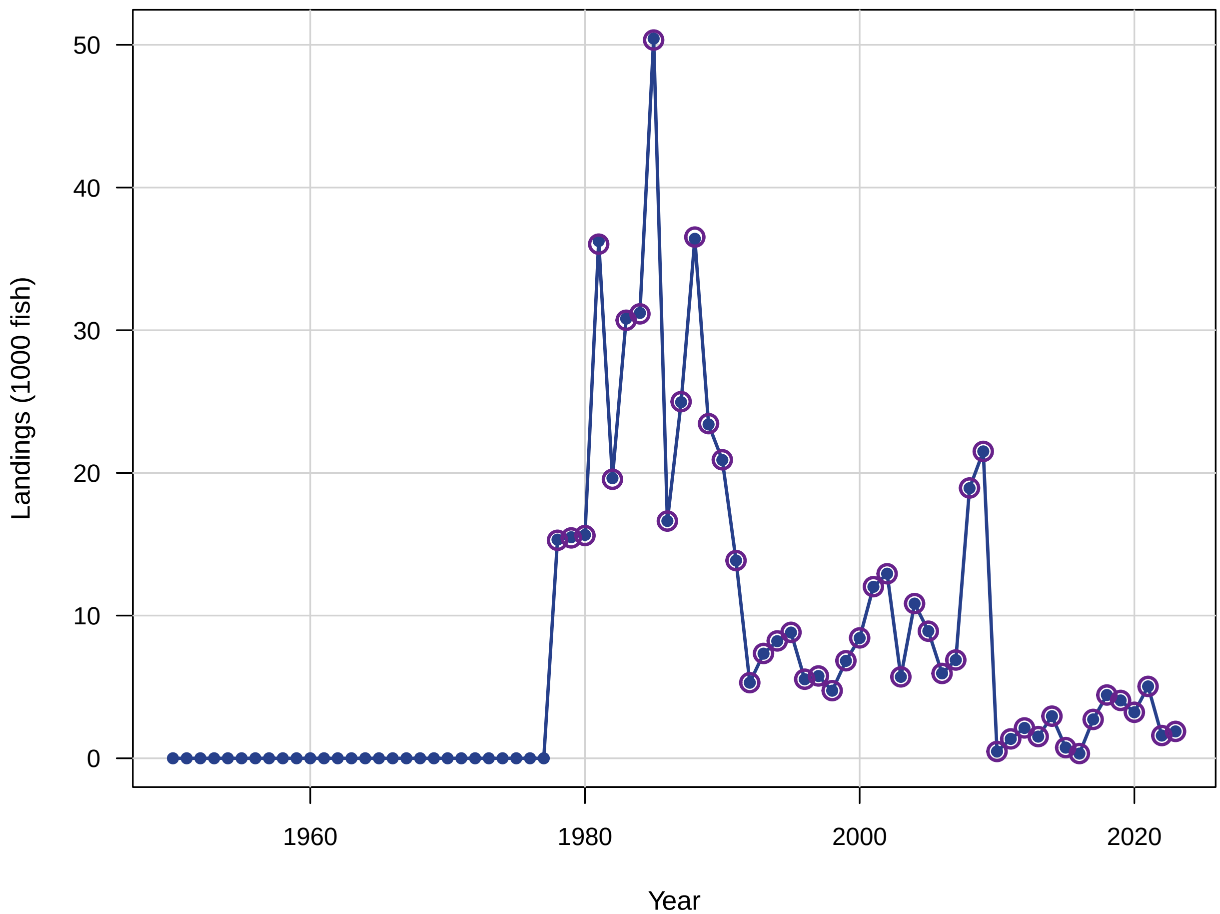


Figure 4. Observed (open circles) and estimated (solid line, circles) general recreational landings (1000 of fish).

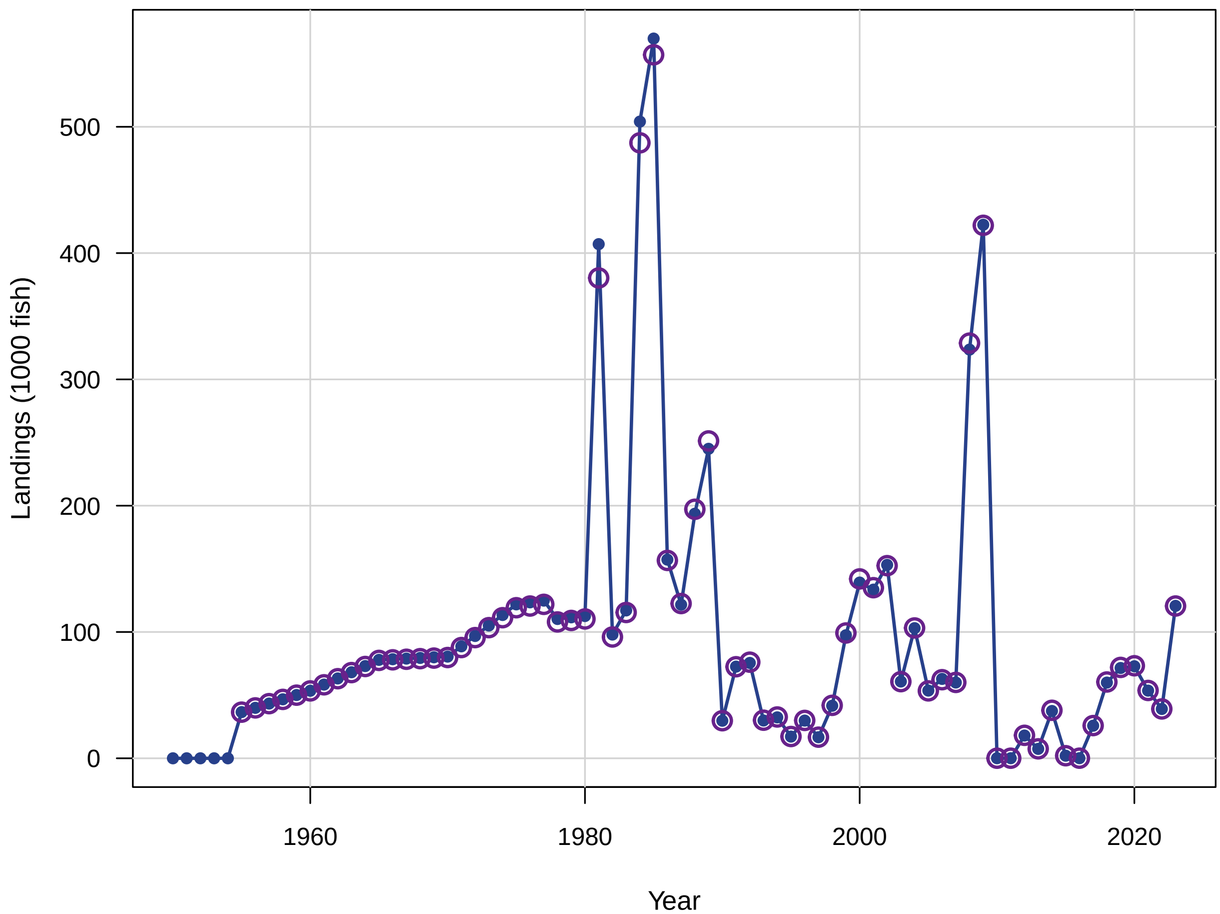


Figure 5. Observed (open circles) and estimated (solid line, circles) commercial handline dead discards (1000 fish).

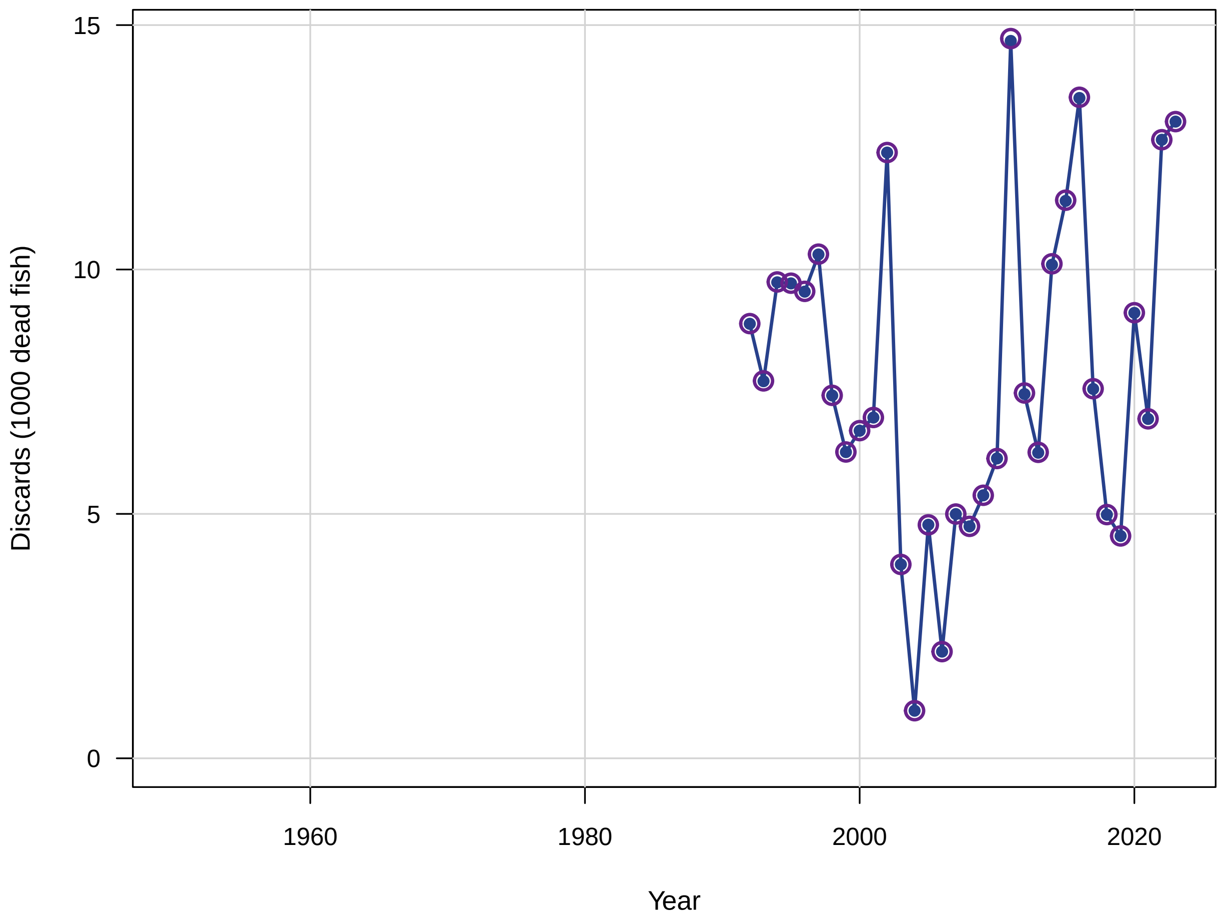


Figure 6. Observed (open circles) and estimated (solid line, circles) headboat dead discards (1000 fish).

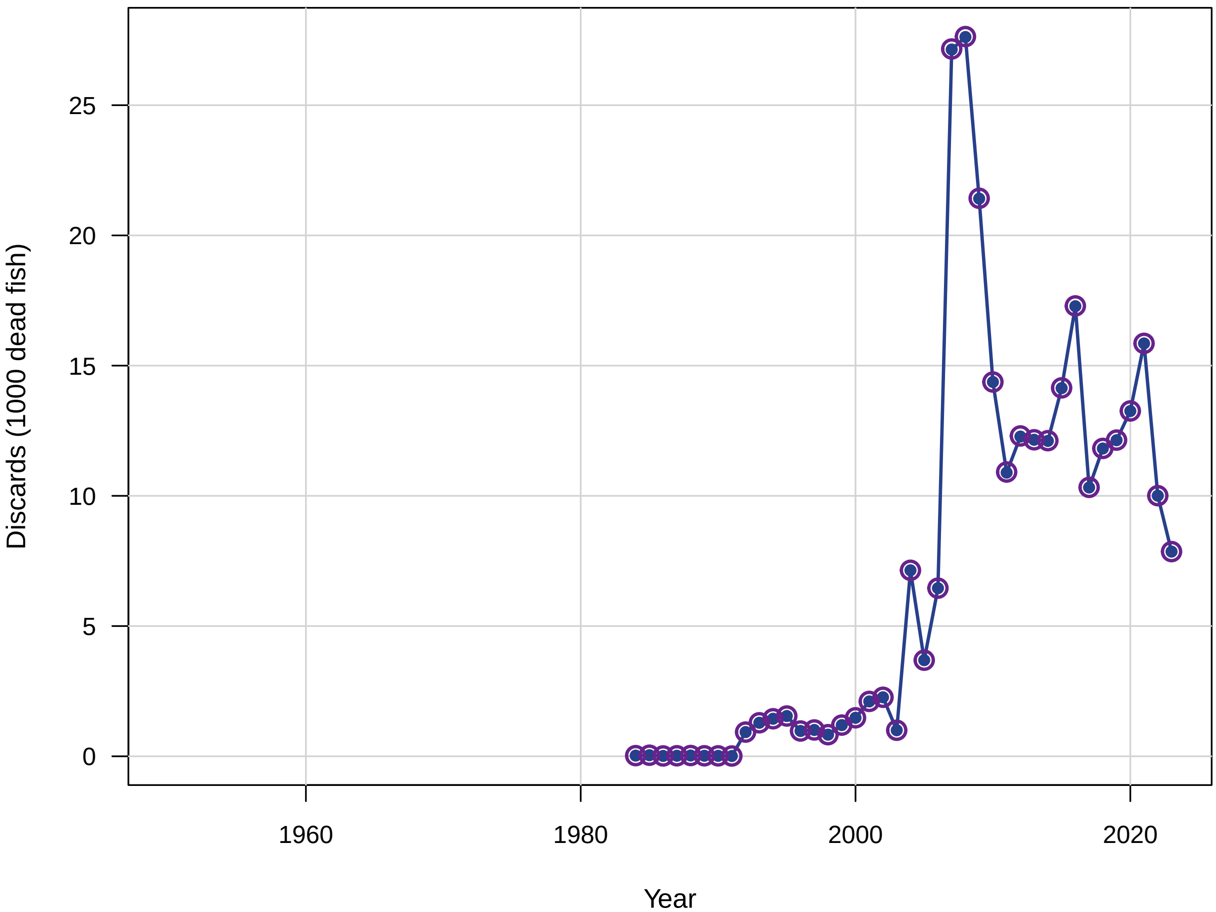


Figure 7. Observed (open circles) and estimated (solid line, circles) general recreational dead discards (1000 fish).

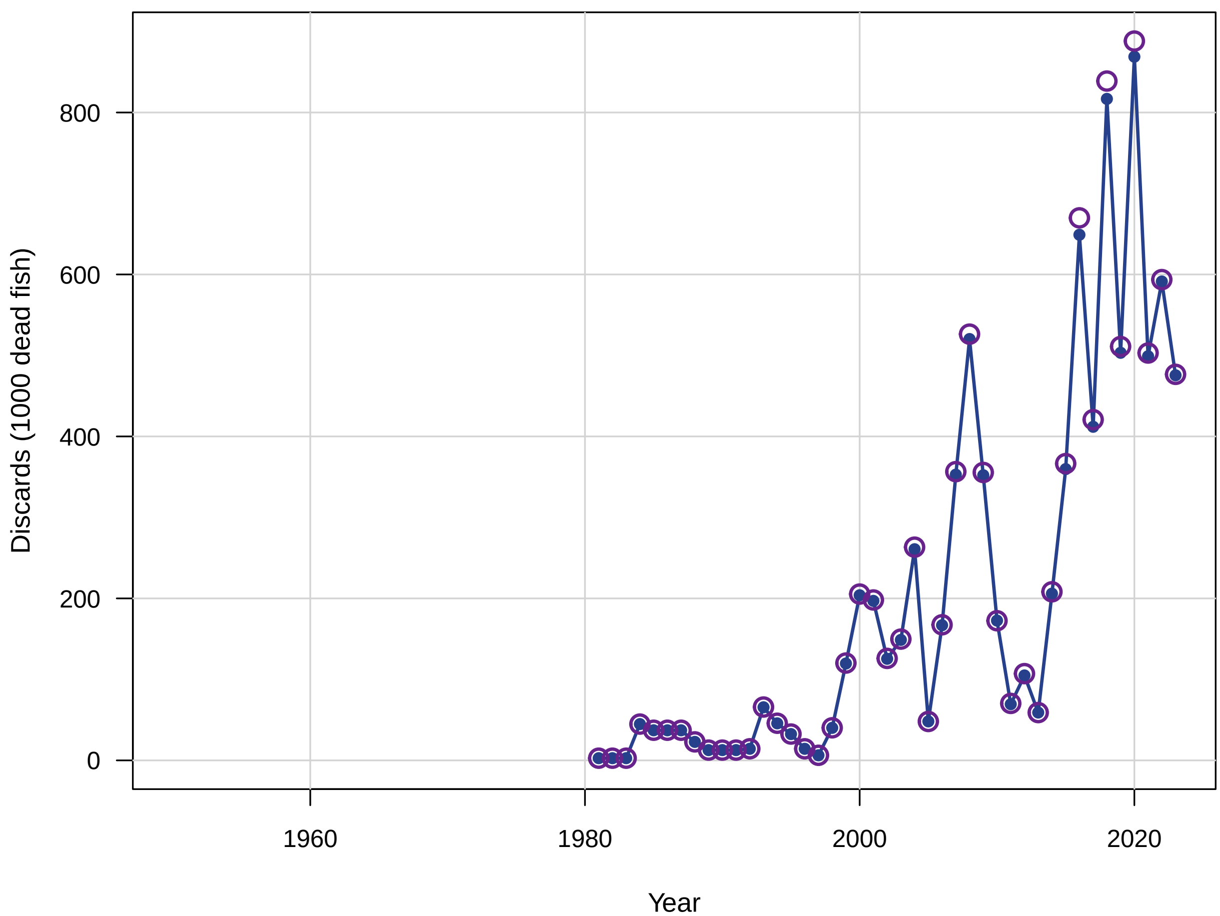


Figure 8. Observed (open circles) and estimated (solid line, circles) index of abundance from the SERFS chevron trap. The error bars represent plus/minus two standard errors, based on the annual CVs. Residuals are observed minus predicted values, then scaled by the mean residual for plotting.

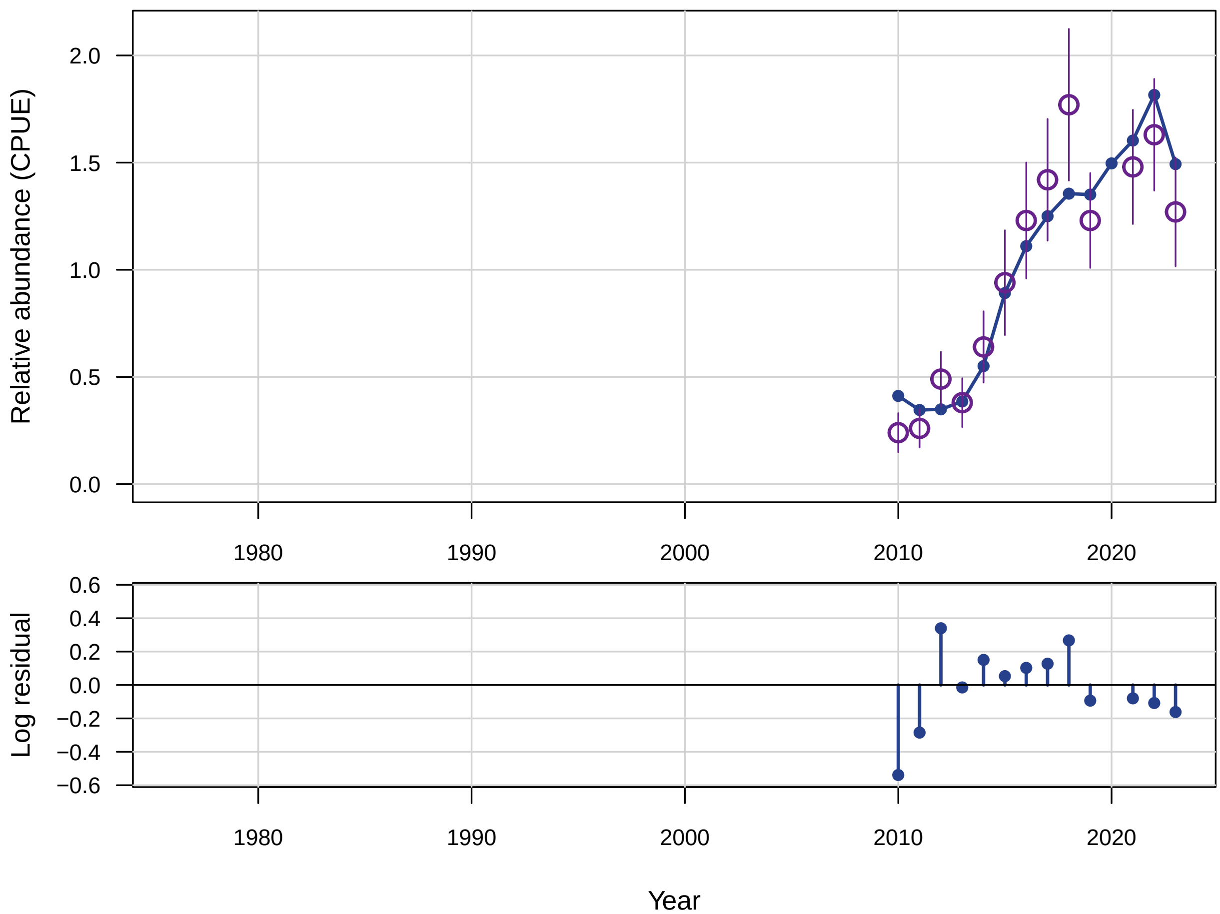


Figure 9. Observed (open circles) and estimated (solid line, circles) index of abundance from the SERFS video. The error bars represent plus/minus two standard errors, based on the annual CVs divided by the likelihood weight on the index. Residuals are observed minus predicted values, then scaled by the mean residual for plotting.

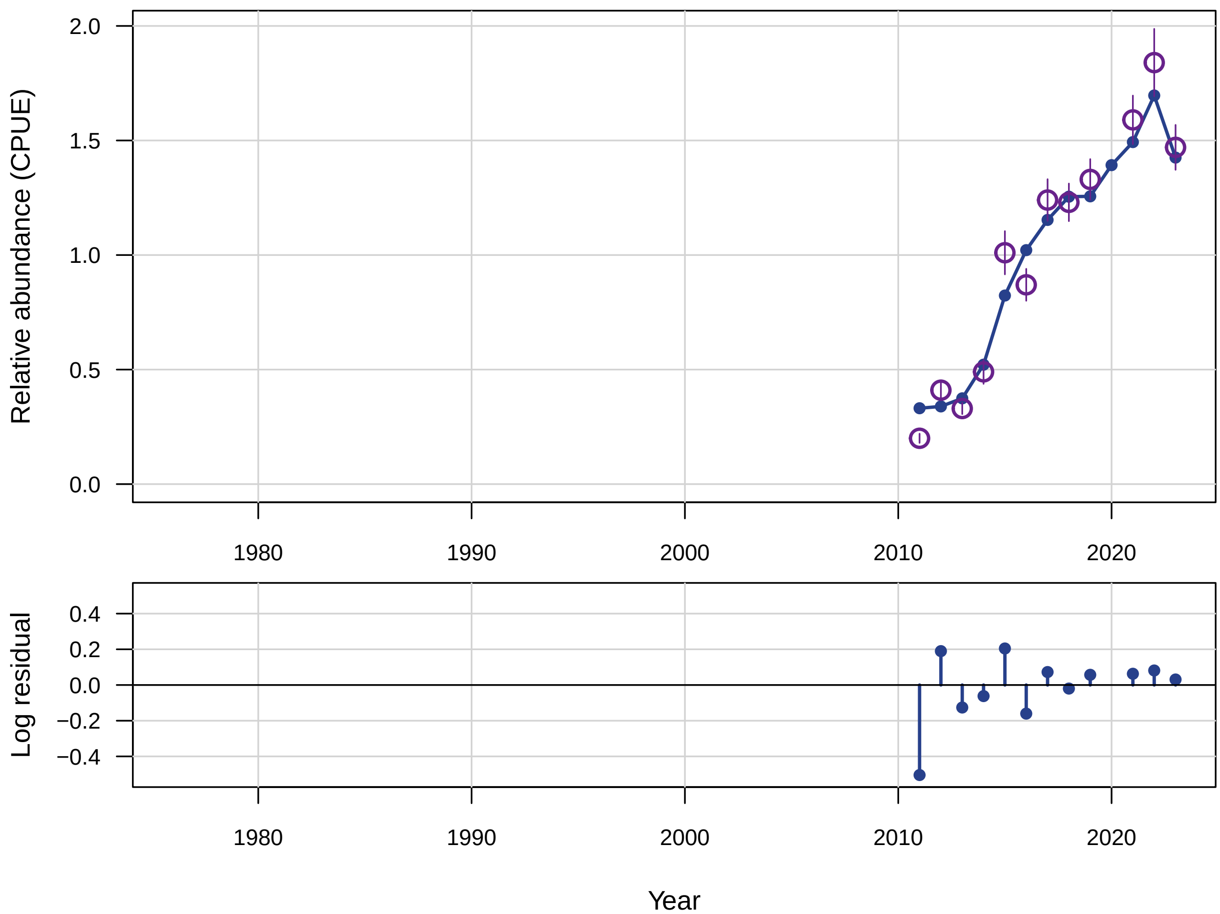


Figure 10. Observed (open circles) and estimated (solid line, circles) index of abundance from the commercial handline fleet. The error bars represent plus/minus two standard errors, based on the annual CVs. Residuals are observed minus predicted values, then scaled by the mean residual for plotting.

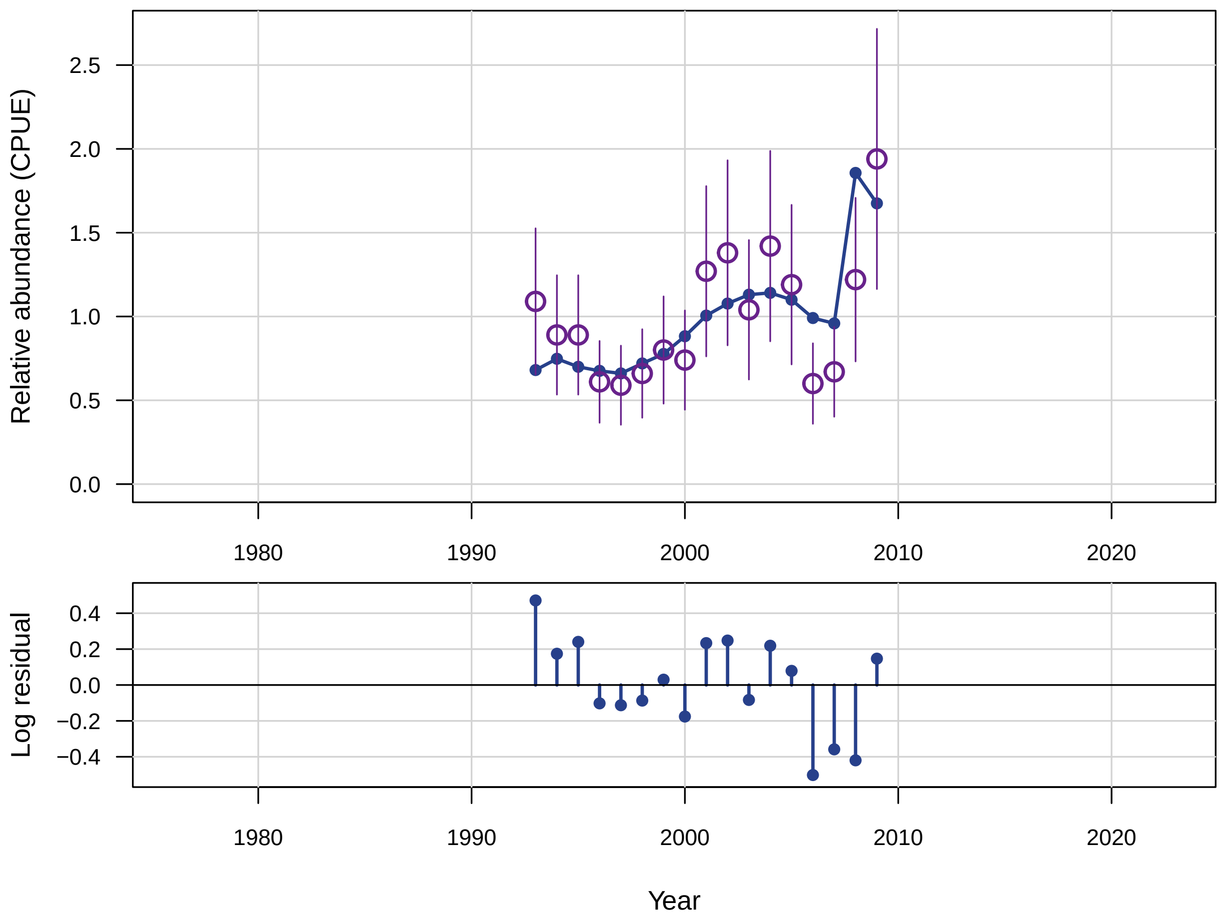


Figure 11. Observed (open circles) and estimated (solid line, circles) abundance from the headboat fleet. The error bars represent plus/minus two standard errors, based on the annual CVs. Residuals are observed minus predicted values, then scaled by the mean residual for plotting.

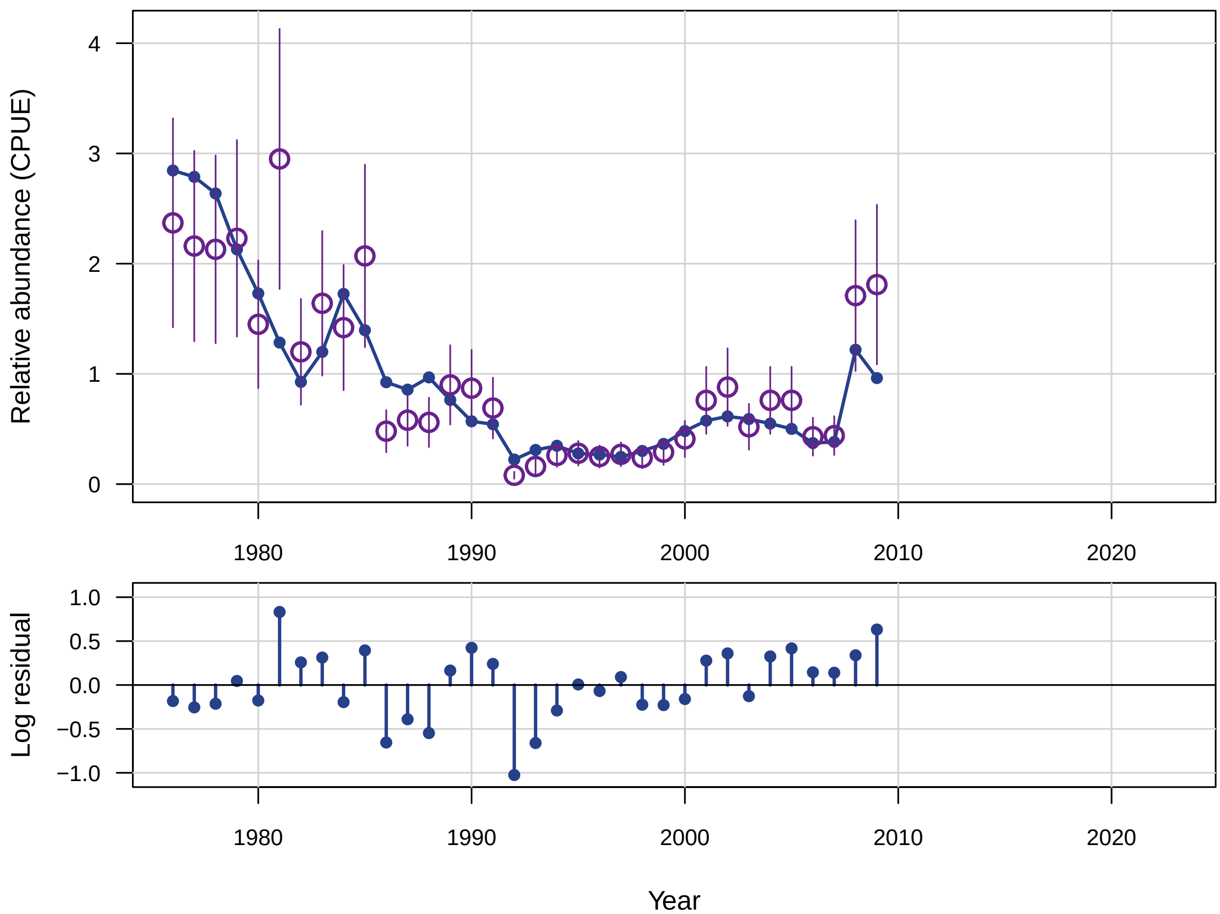


Figure 12. Observed (open circles) and estimated (solid line, circles) abundance from the headboat fleet discards. The error bars represent plus/minus two standard errors, based on the annual CVs. Residuals are observed minus predicted values, then scaled by the mean residual for plotting.

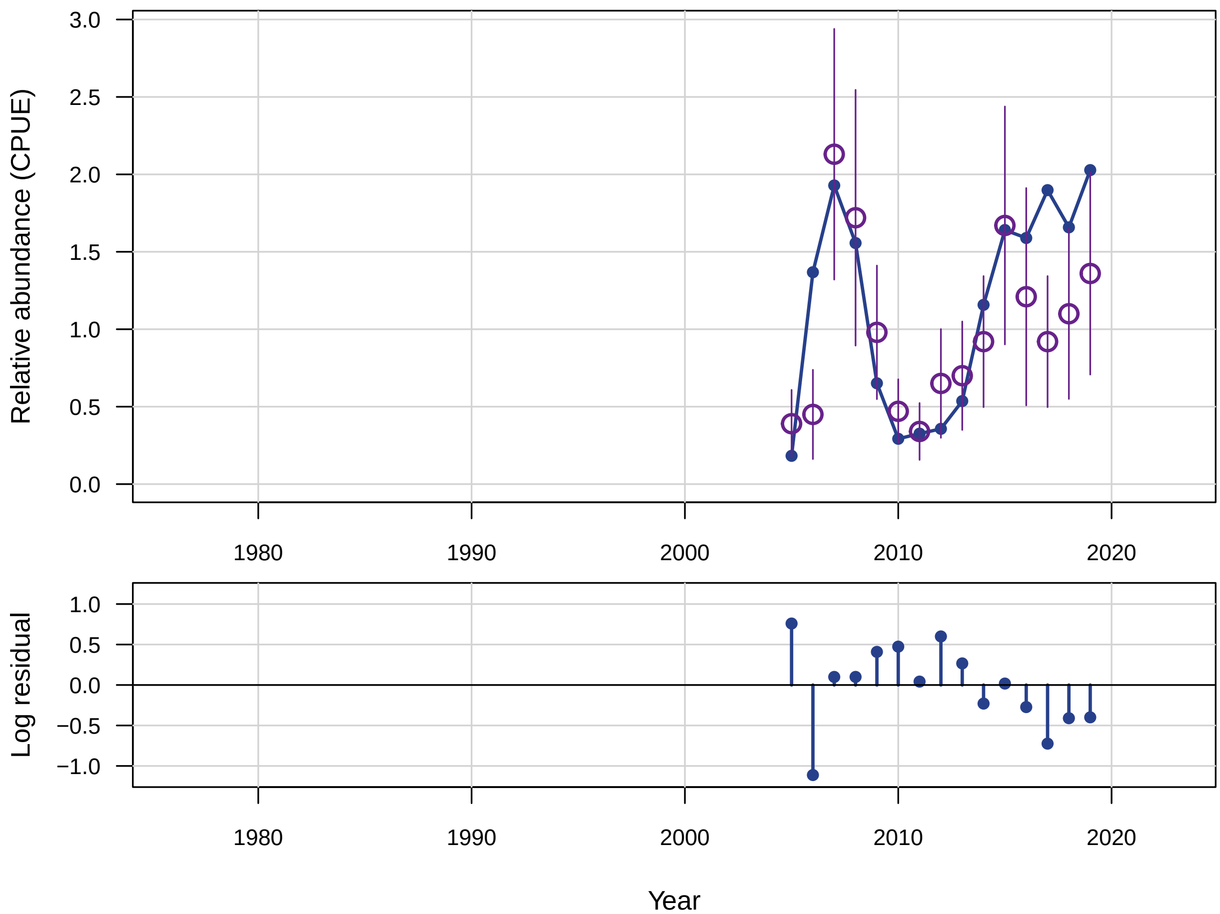


Figure 13. Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey. In panels indicating the data set, lcomp refers to length compositions, acomp to age compositions, CVT to SERFS chevron trap, cH to commercial handline, HB to headboat, and GR to general recreational.

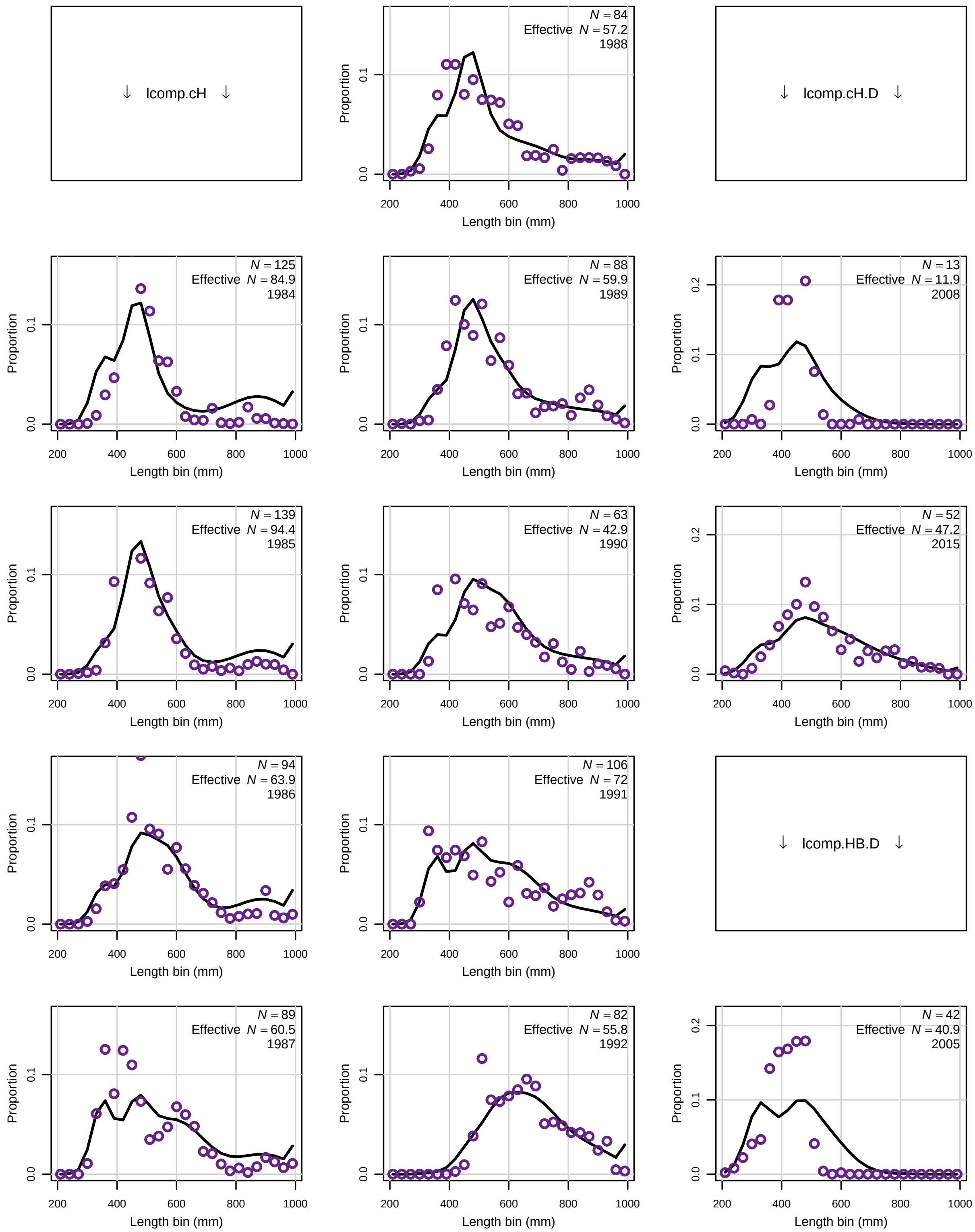


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

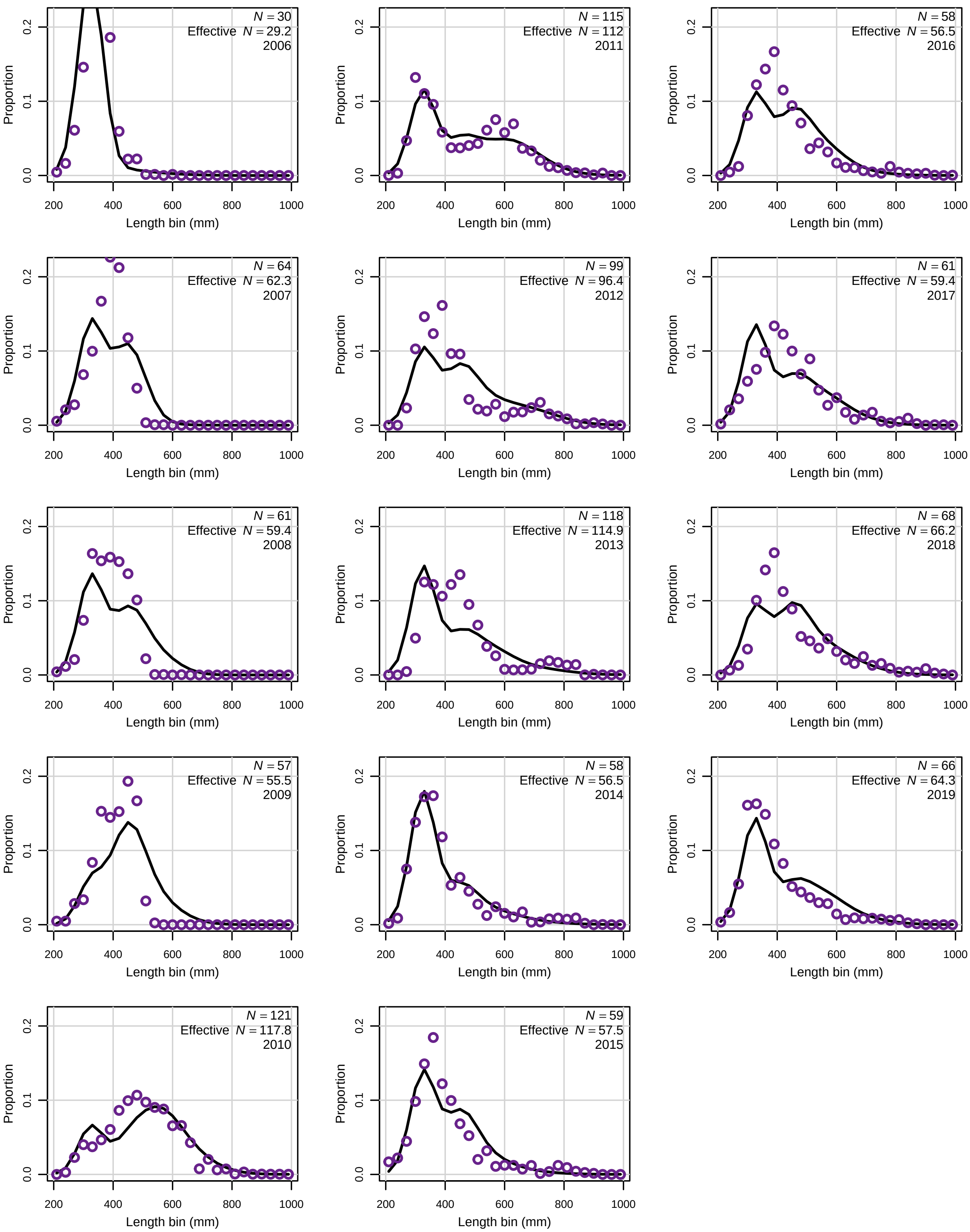


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

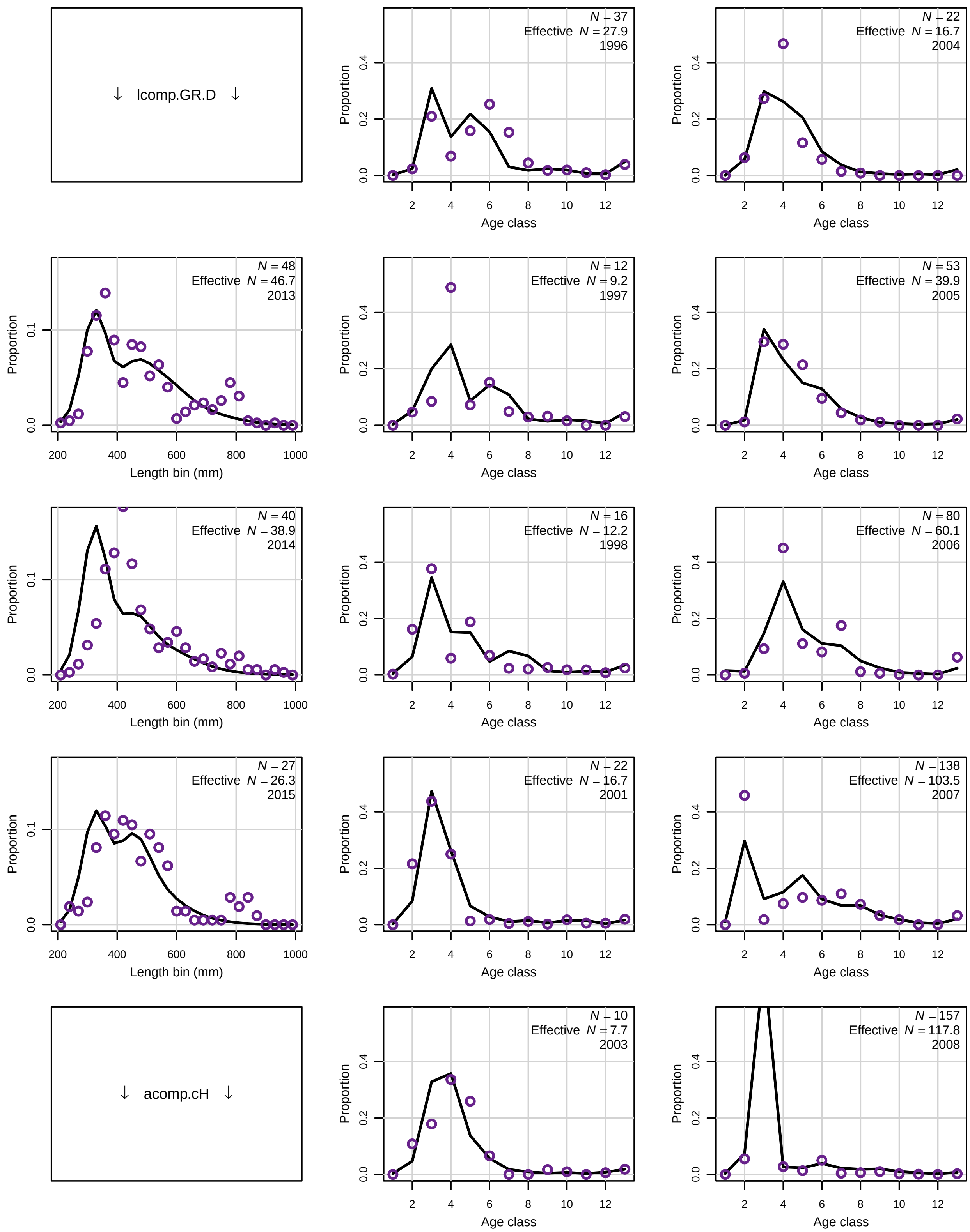


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

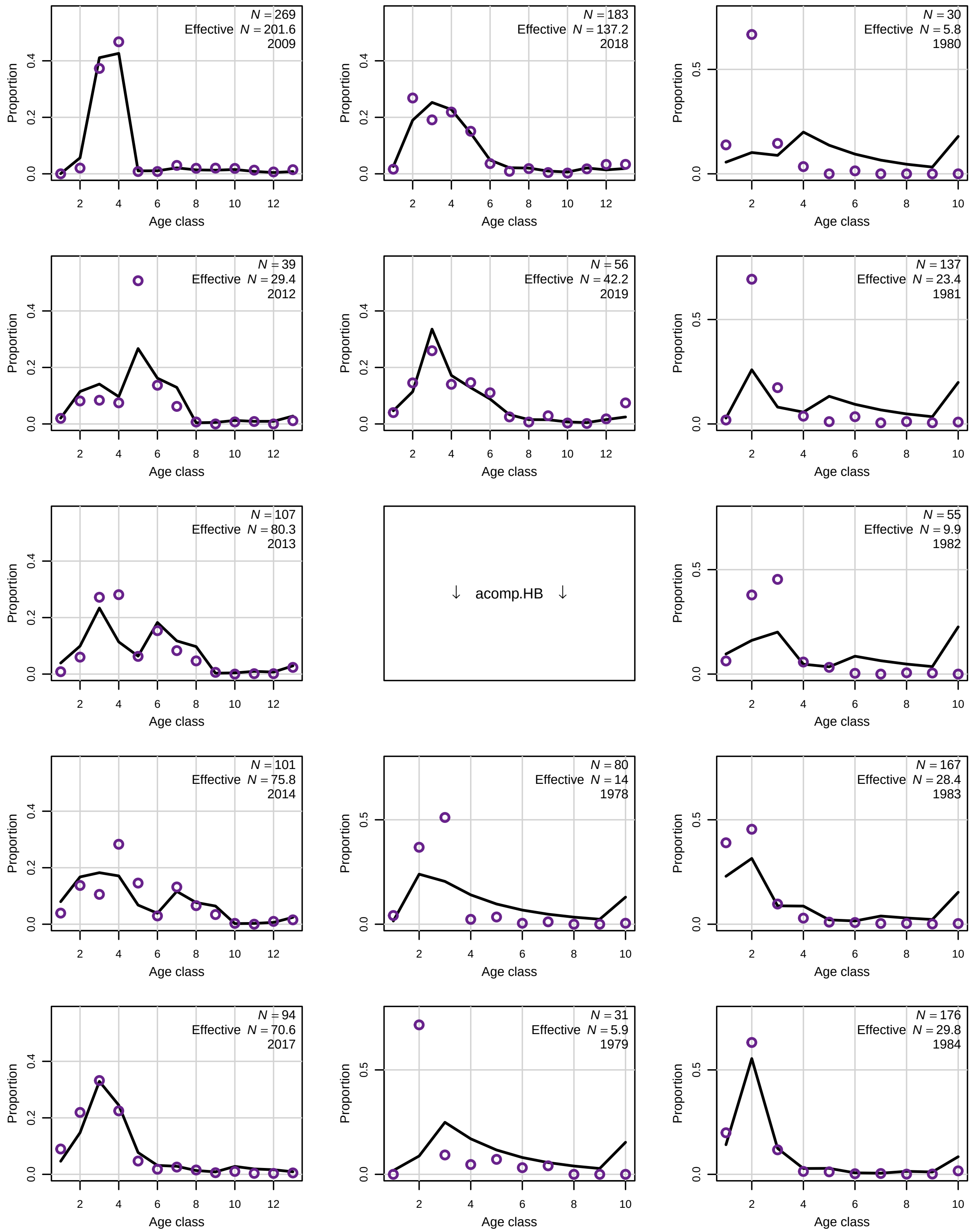


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

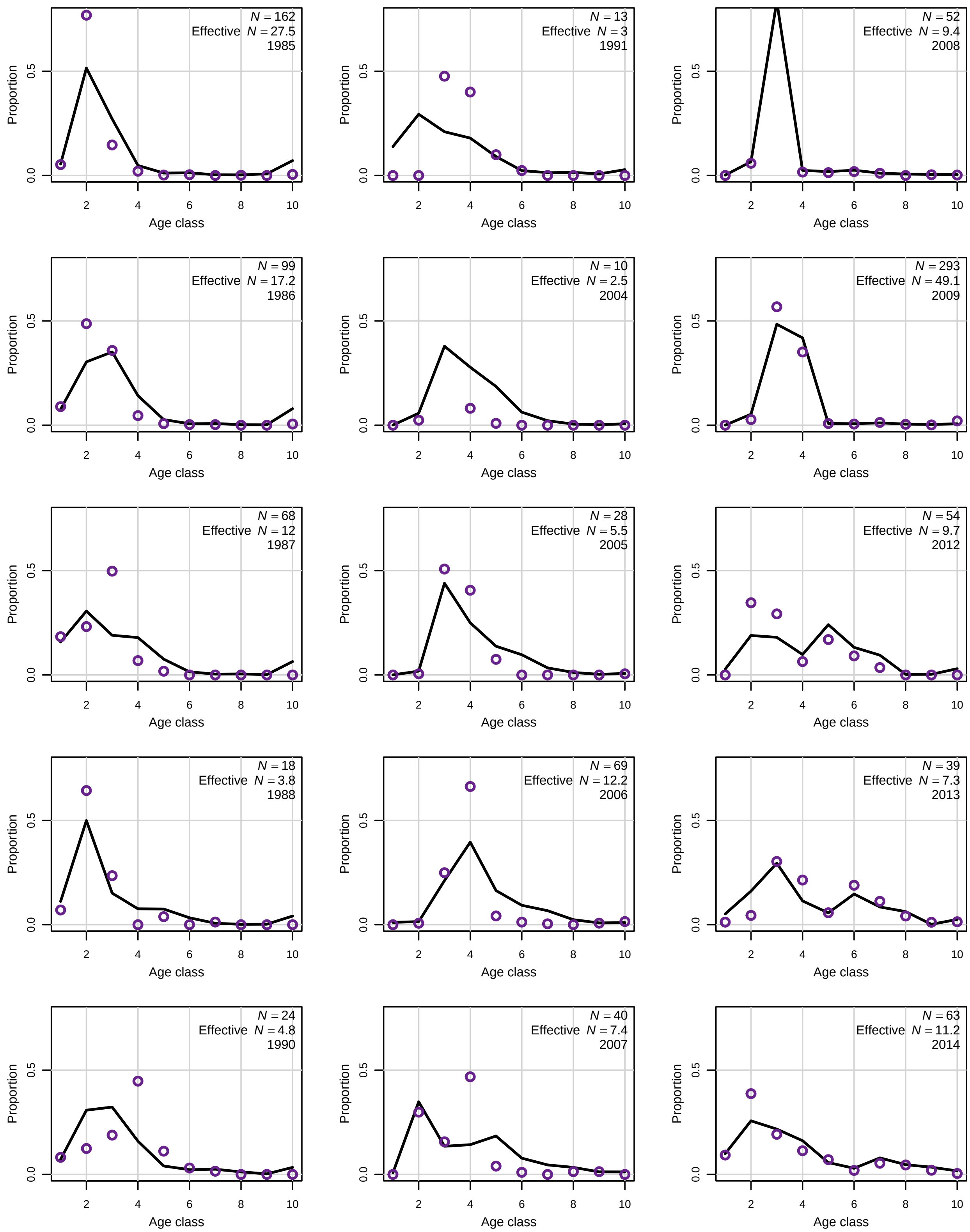


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

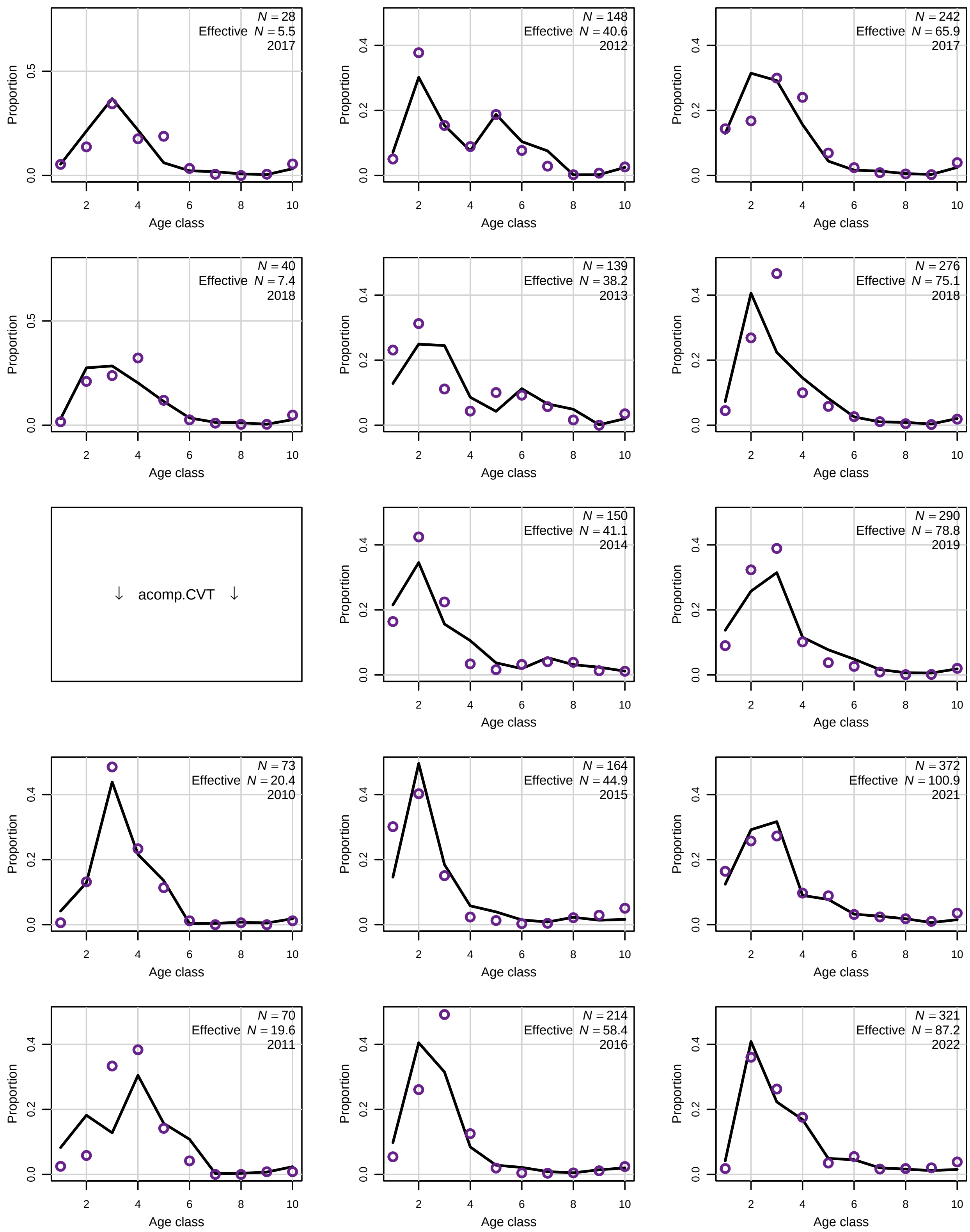


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

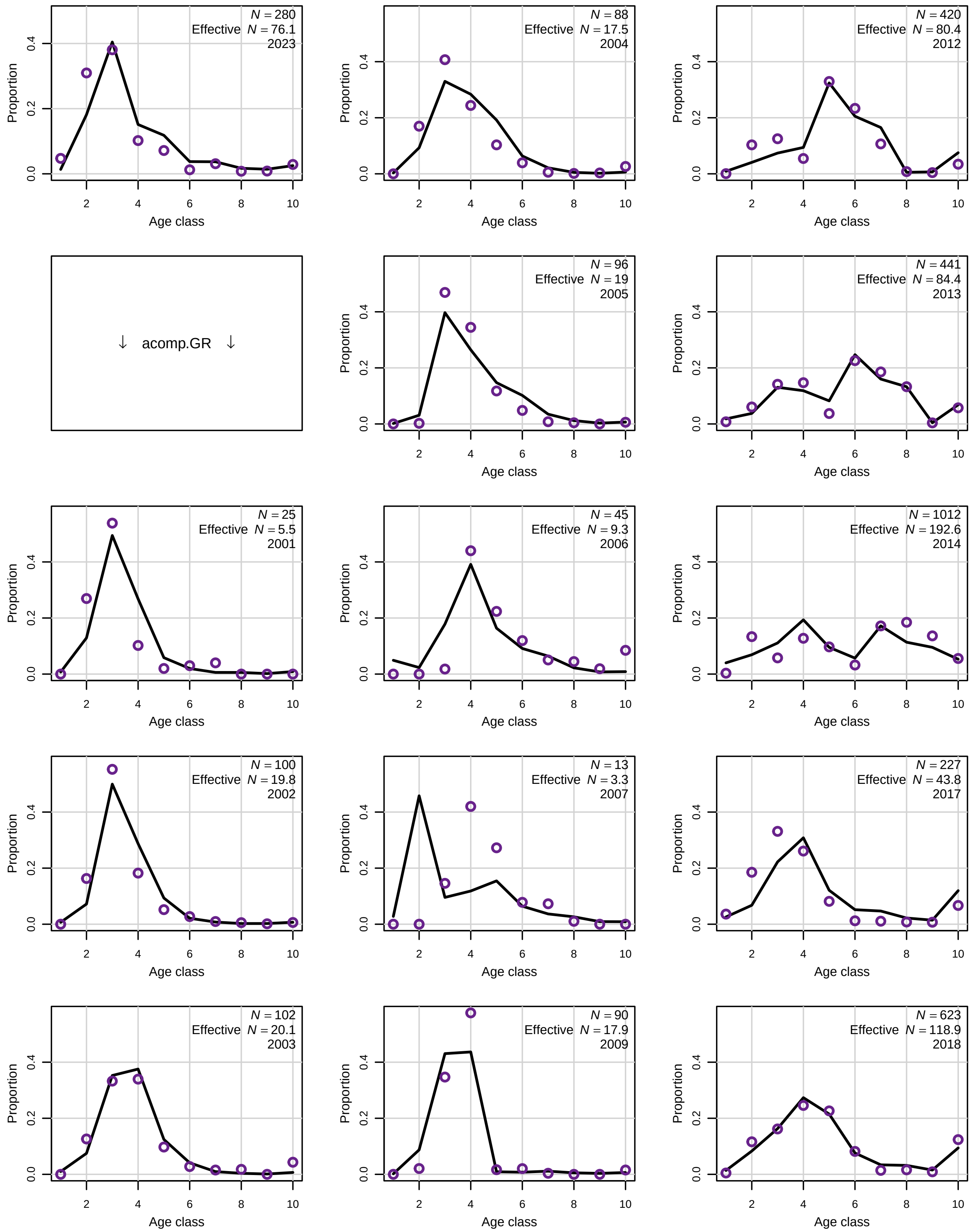


Figure 13. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

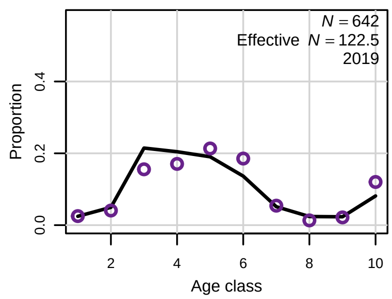


Figure 14. Estimated abundance at age at start of year.

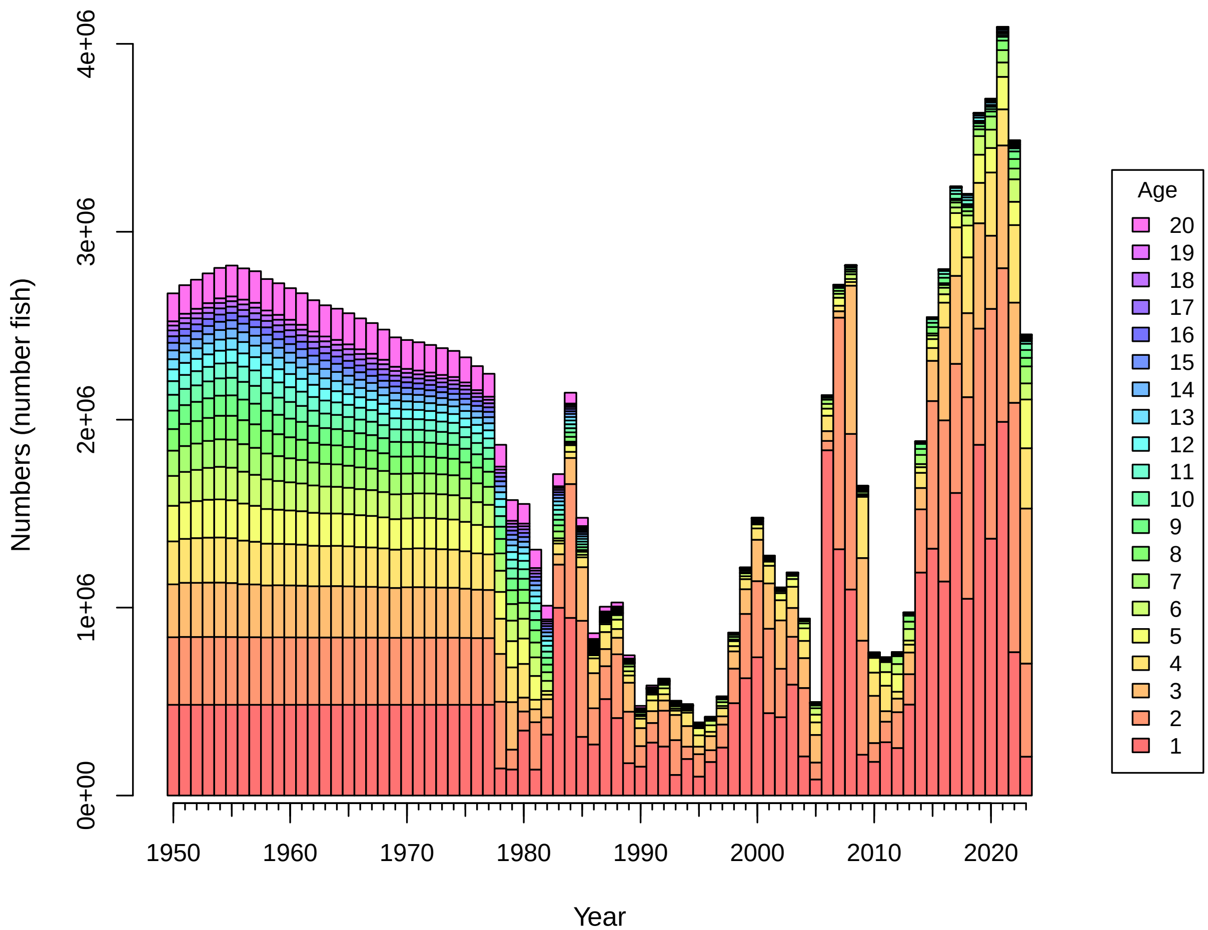


Figure 15. Estimated relative abundance at age at start of year. Solid line represents average age in the population.

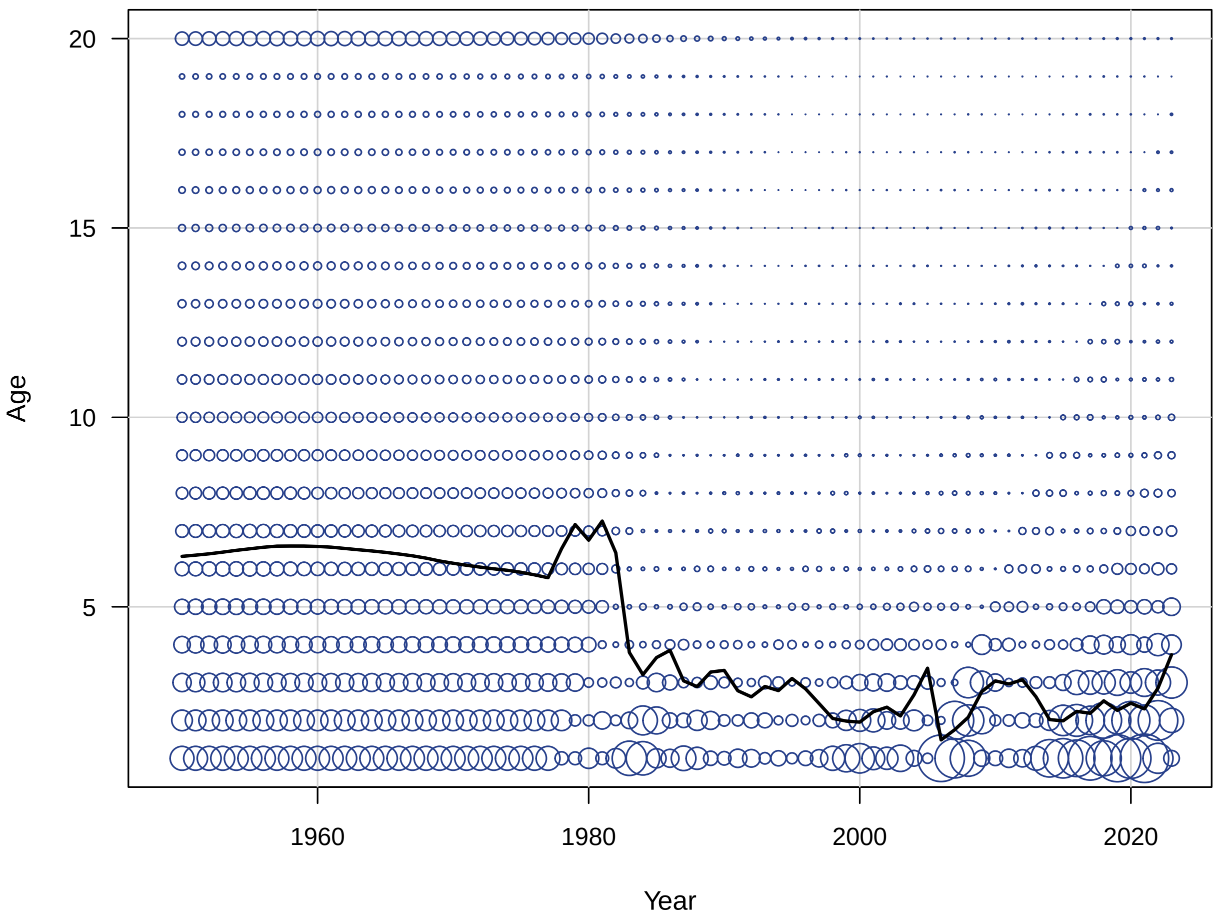


Figure 16. MCBE estimates of population abundance. Gray indicates the range between the 5^{th} and 95^{th} percentiles; dotted line indicates the base-run estimates; and dashed line indicates the median (may be covered by the dotted line). Top panel shows all ages 1+, and the bottom panel shows ages 2+.

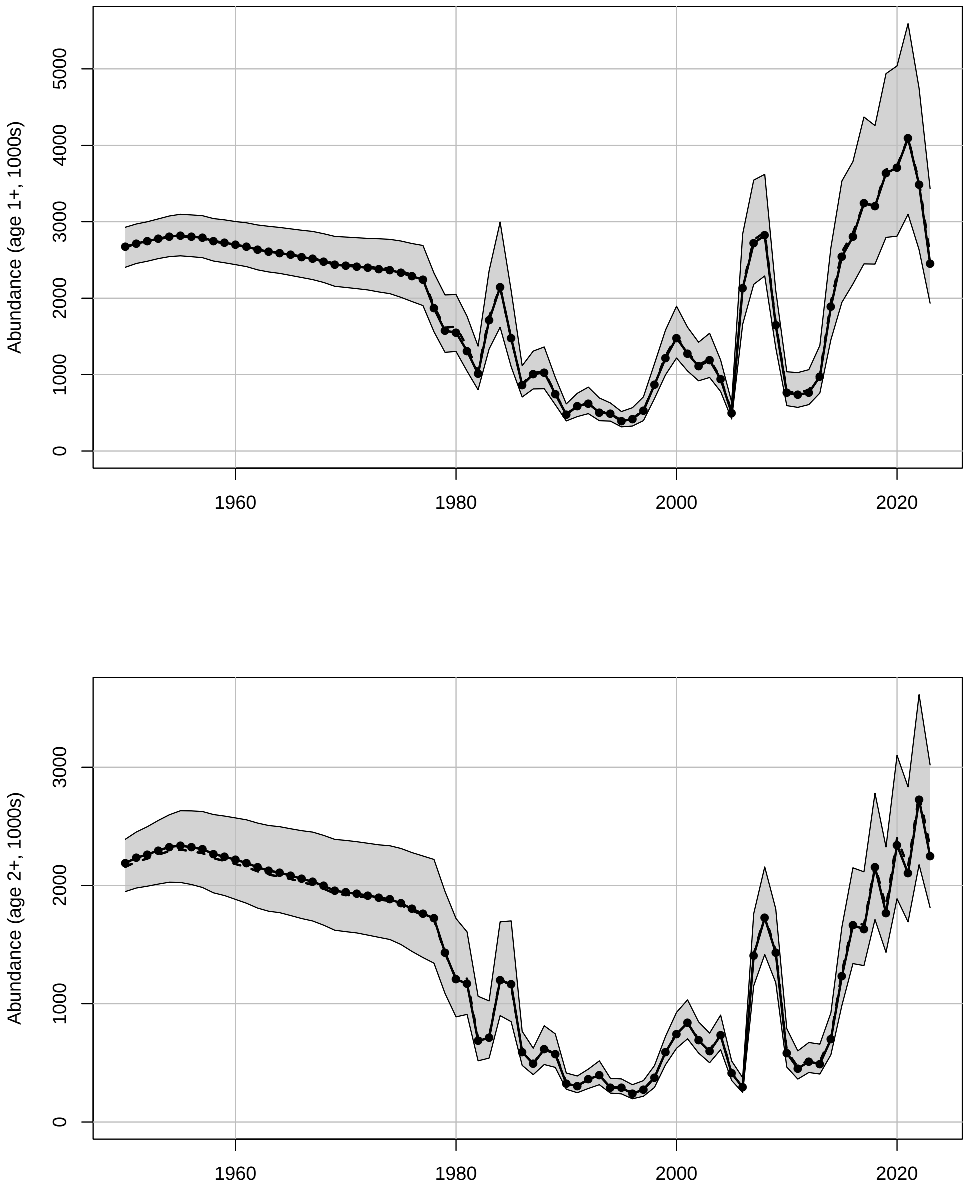


Figure 17. Top panel: Estimated recruitment of age-1 fish. Horizontal dashed line indicates $R_{F30\%}$. Bottom panel: log recruitment residuals.

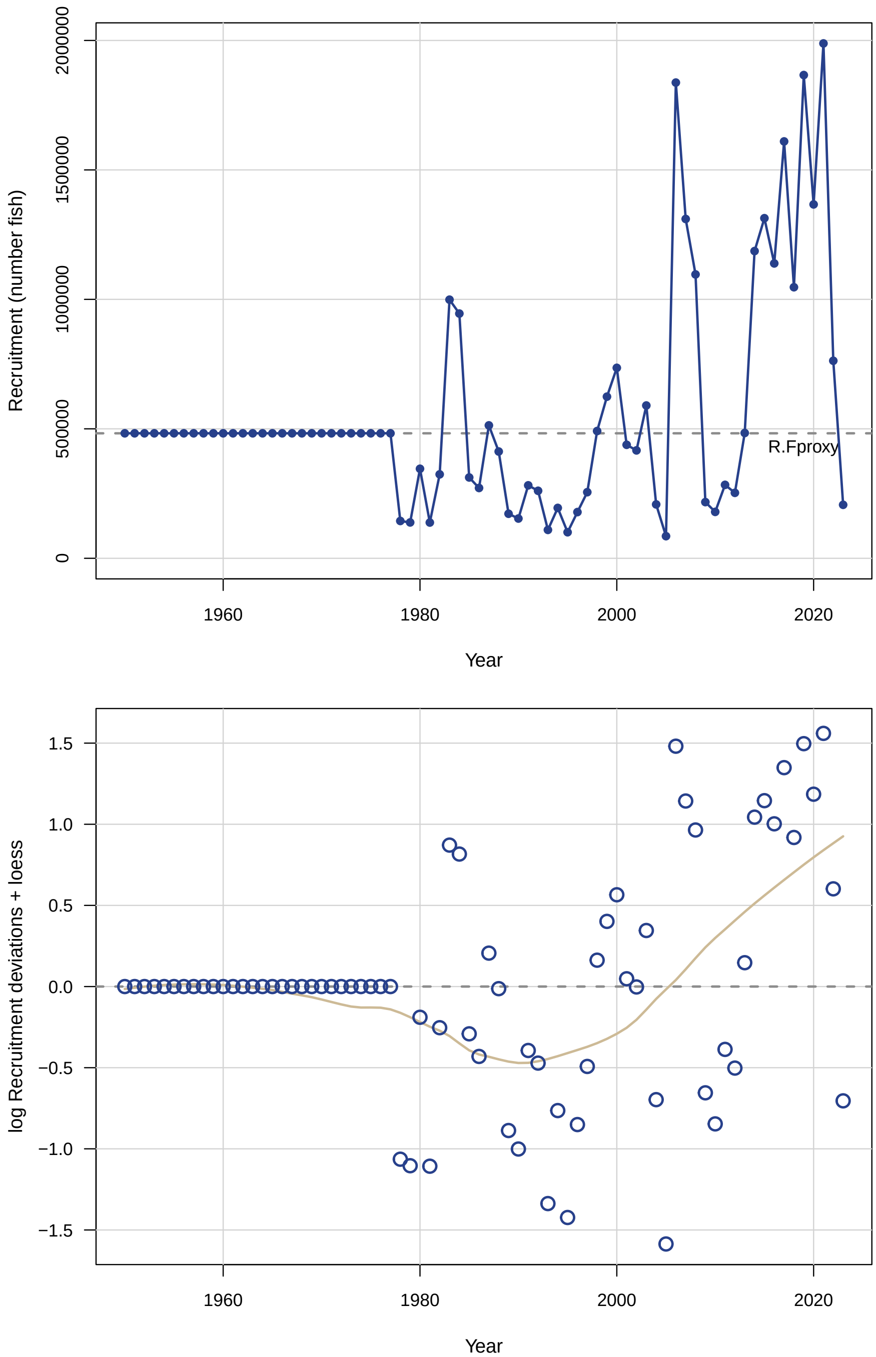


Figure 18. Top panel: MCBE estimates of recruitment (age-1 fish). Gray indicates the range between the 5^{th} and 95^{th} percentiles; dotted line indicates the base-run estimates; and dashed line indicates the median (may be covered by the dotted line). Bottom panel: Distribution of 2023 log recruitment residuals from MCBE iterations.

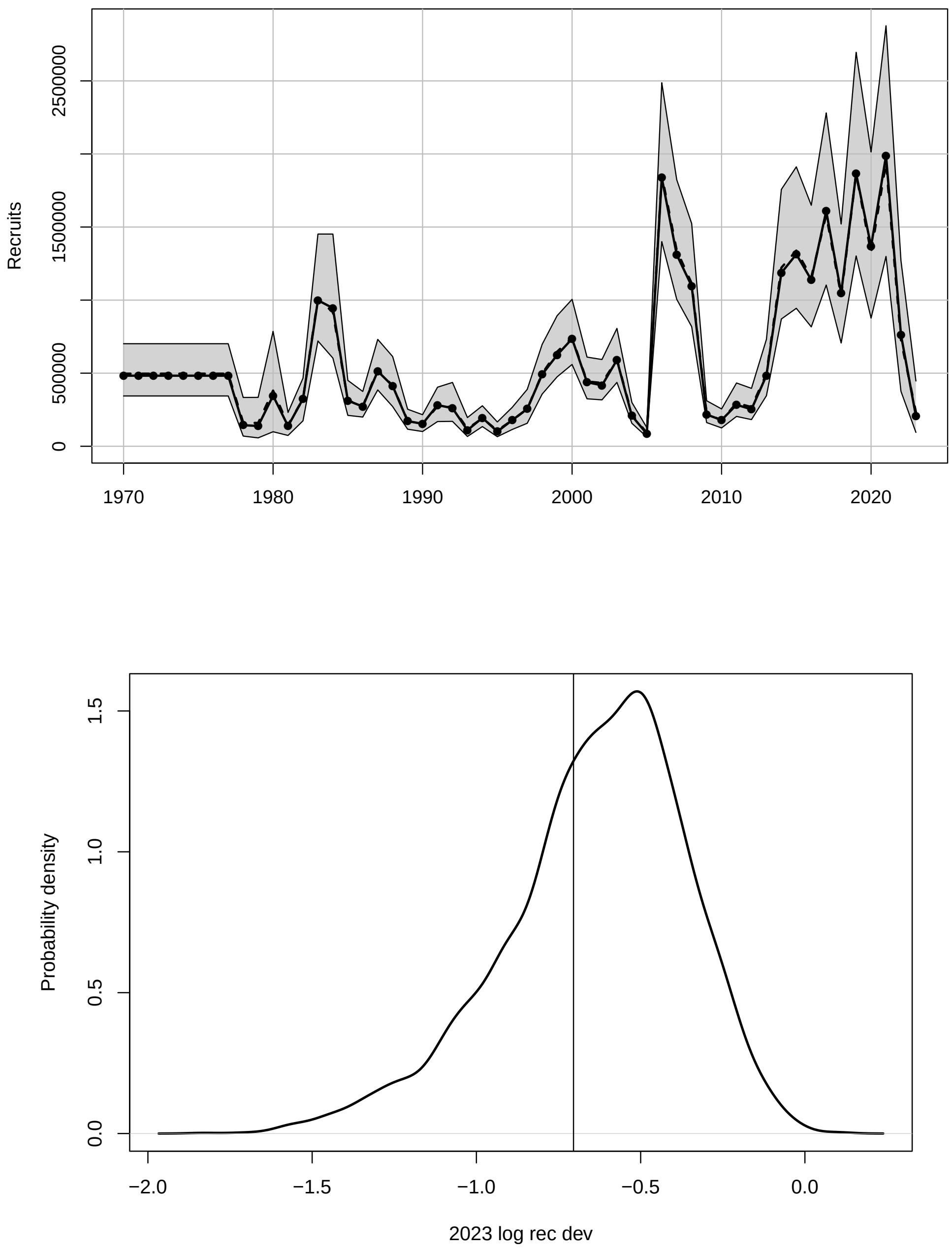


Figure 19. Estimated biomass at age at start of year.

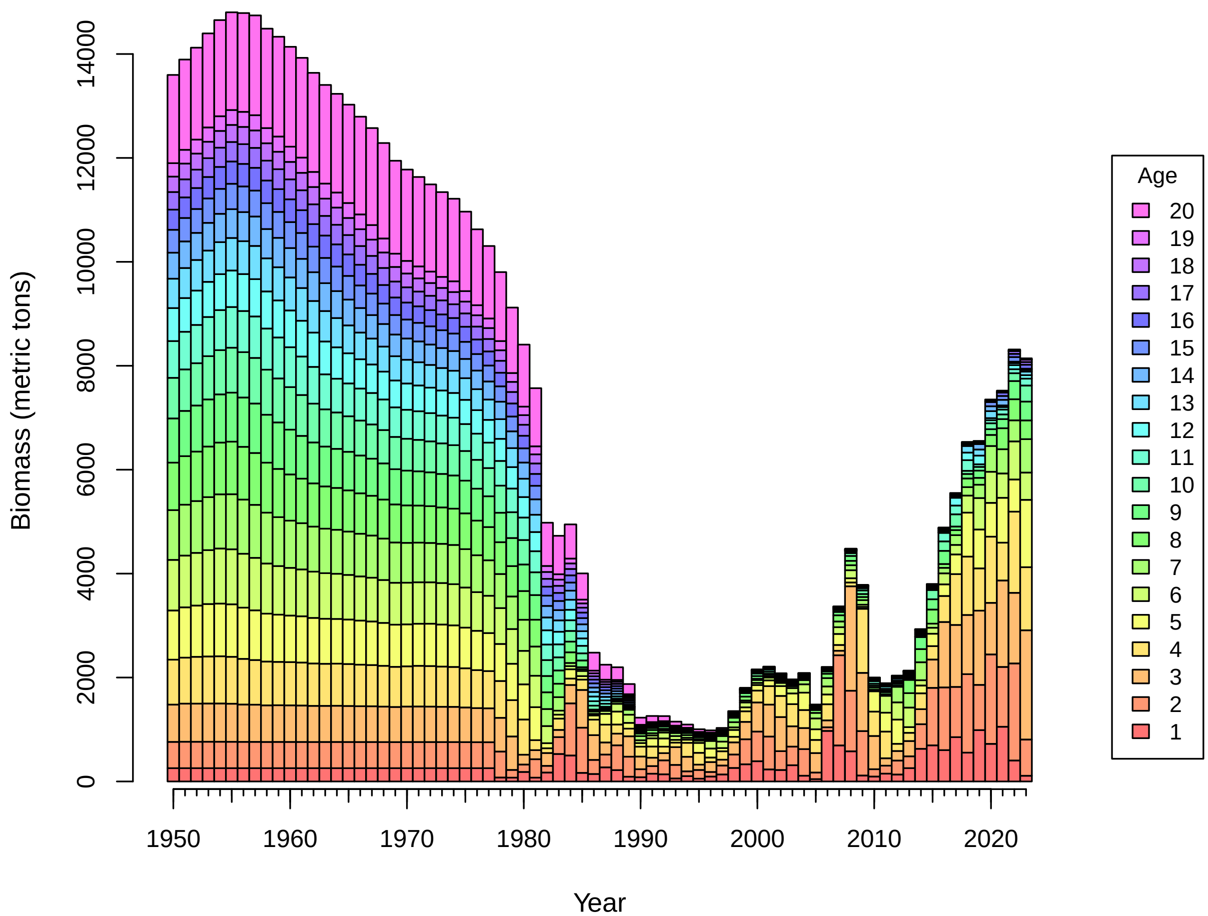


Figure 20. Top panel: Estimated total biomass (metric tons) at start of year. Bottom panel: Estimated spawning stock (population fecundity) at time of peak spawning. Horizontal dashed lines indicate $F_{30\%}$ reference points.

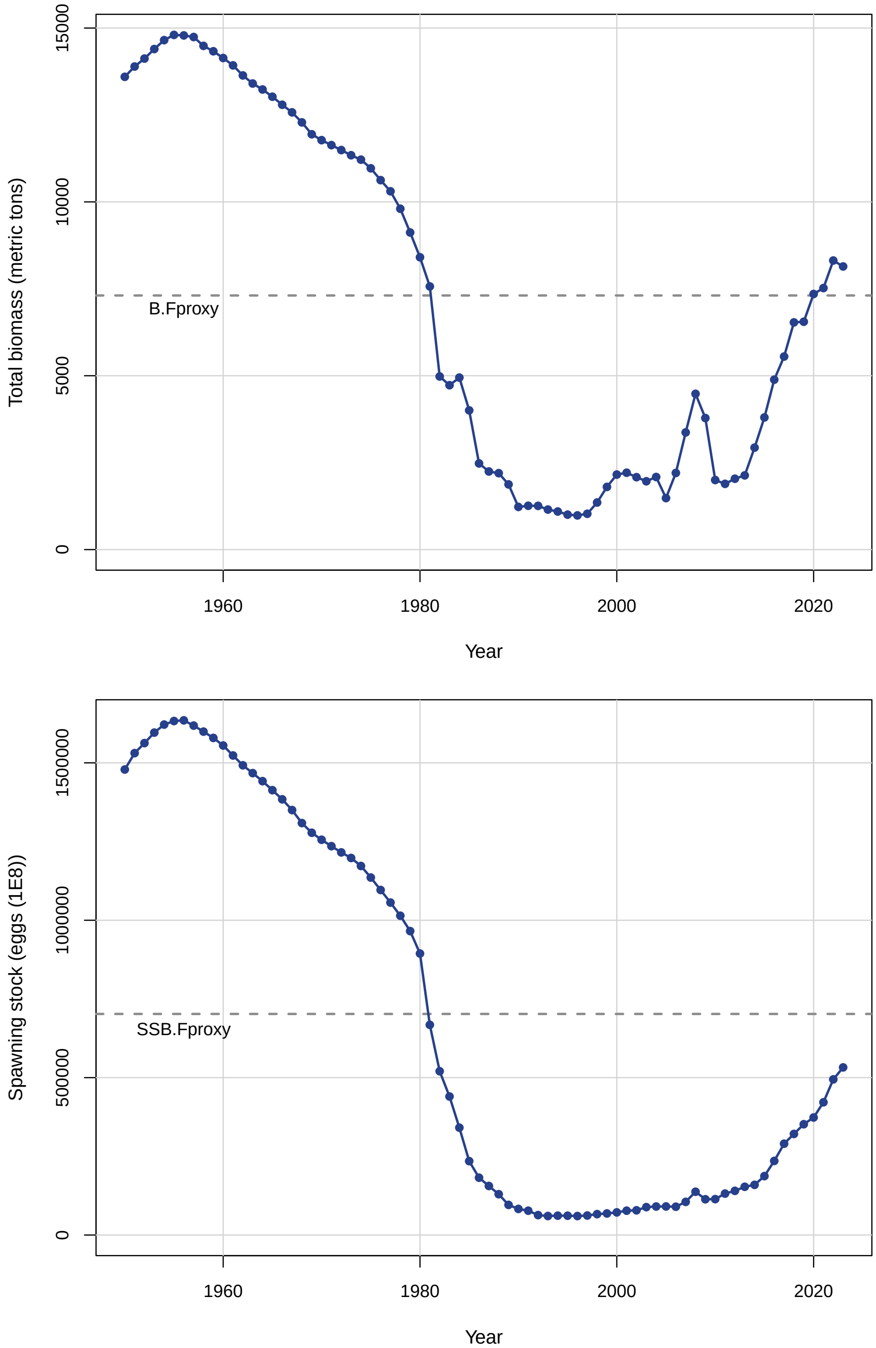


Figure 21. Selectivities of SERFS chevron trap index (top) and video index (bottom).

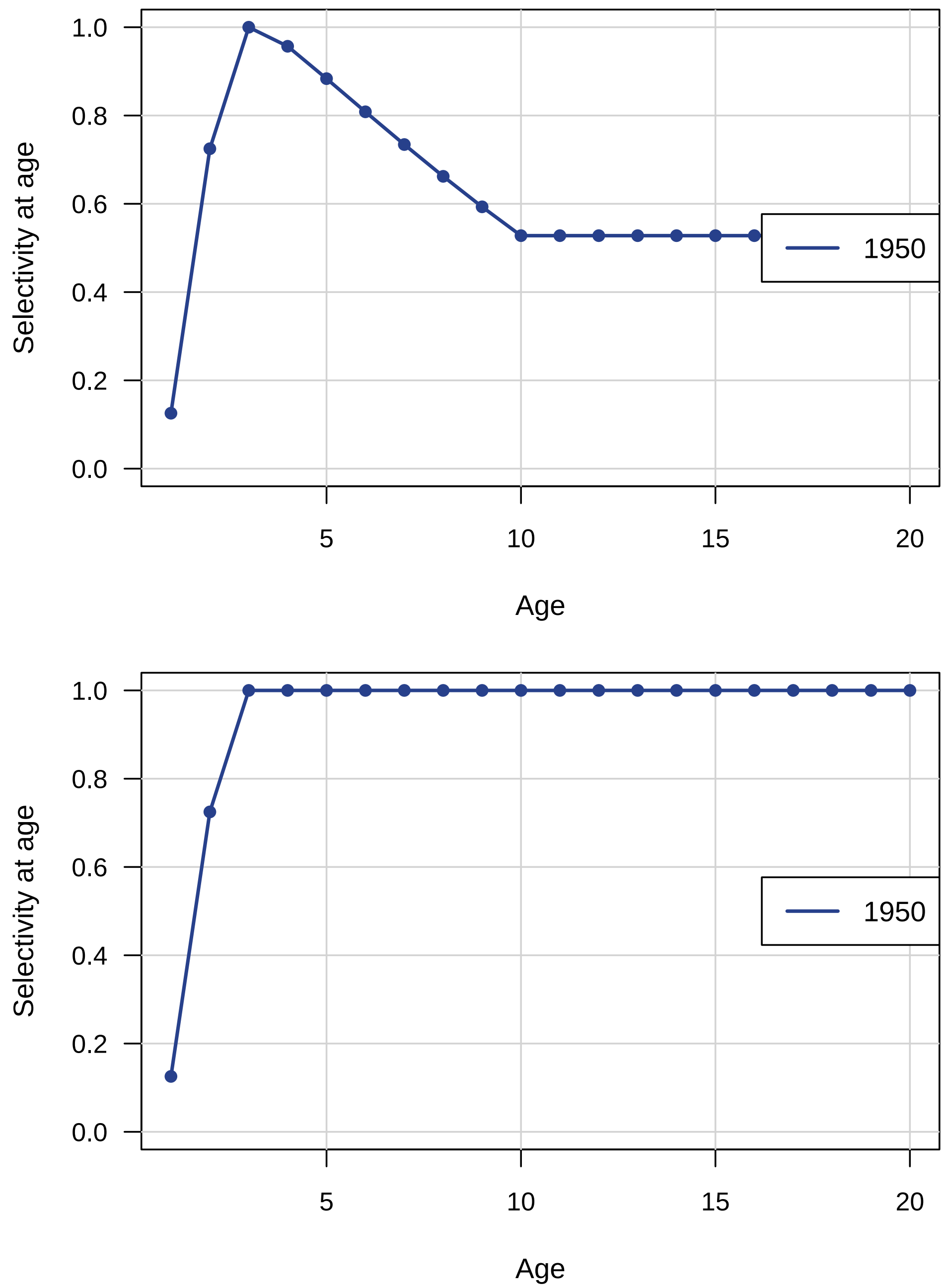


Figure 22. Selectivities of commercial handline landings. The legend indicates the first year of each selectivity block.

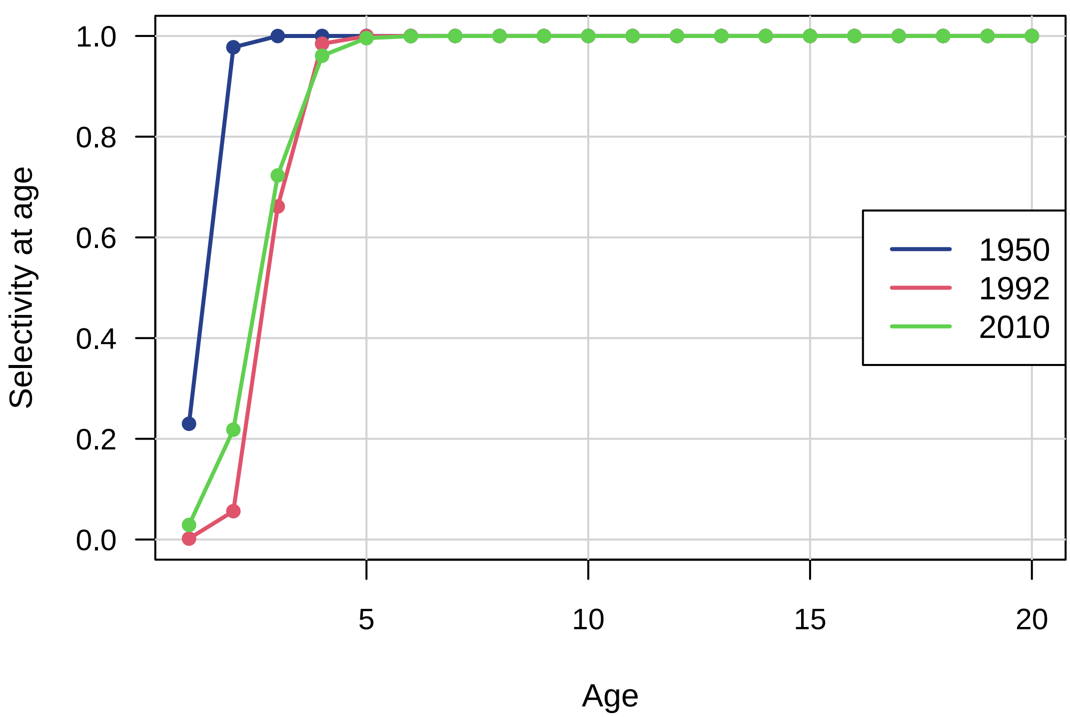


Figure 23. Selectivities of headboat landings. The legend indicates the first year of each selectivity block.

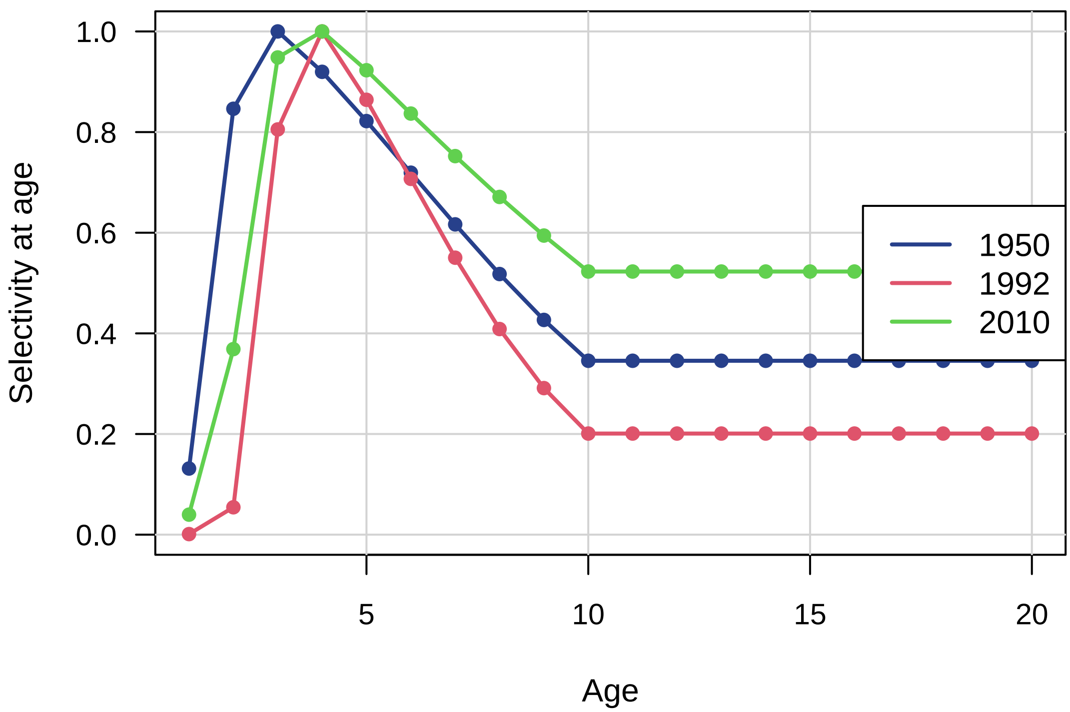


Figure 24. Selectivities of general recreational landings. The legend indicates the first year of each selectivity block.

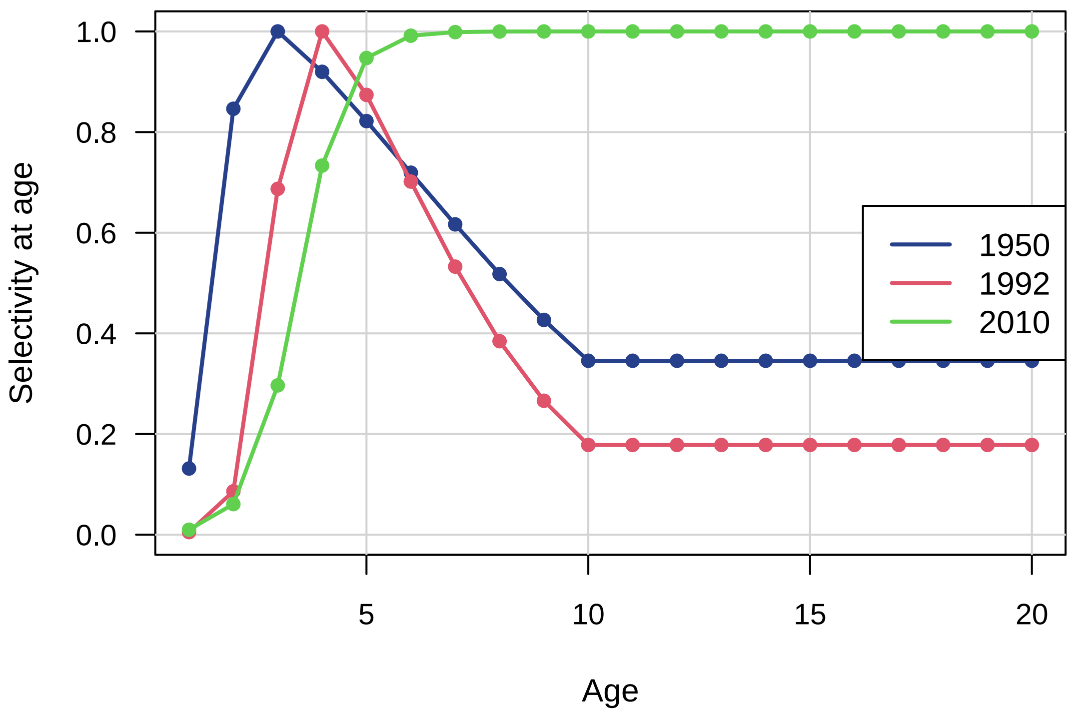


Figure 25. Selectivities of commercial handline discards. The legend indicates the first year of each selectivity block.

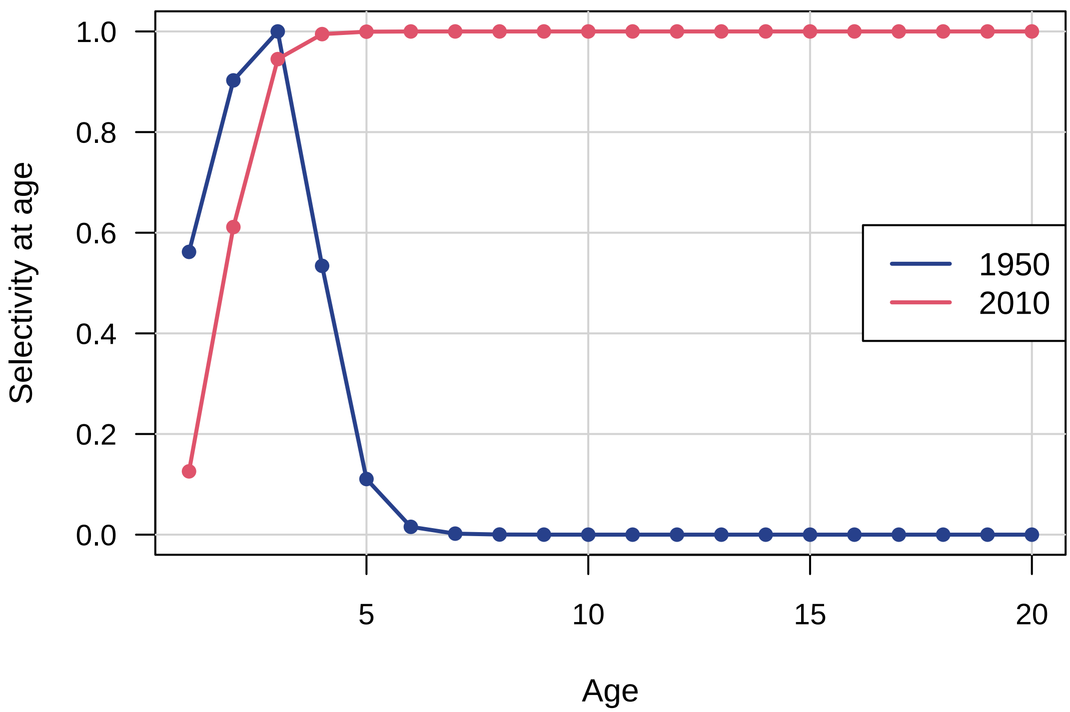


Figure 26. Selectivities of headboat discards. The legend indicates the first year each of selectivity block.

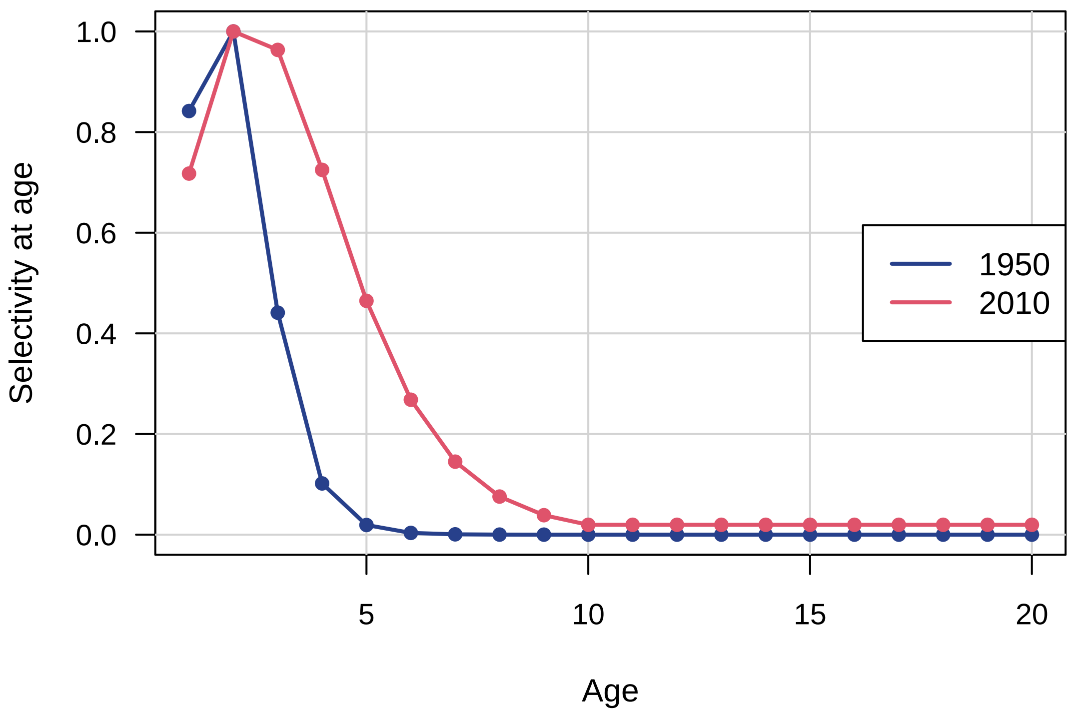


Figure 27. Selectivities of general recreational discards. The legend indicates the first year of each selectivity block.

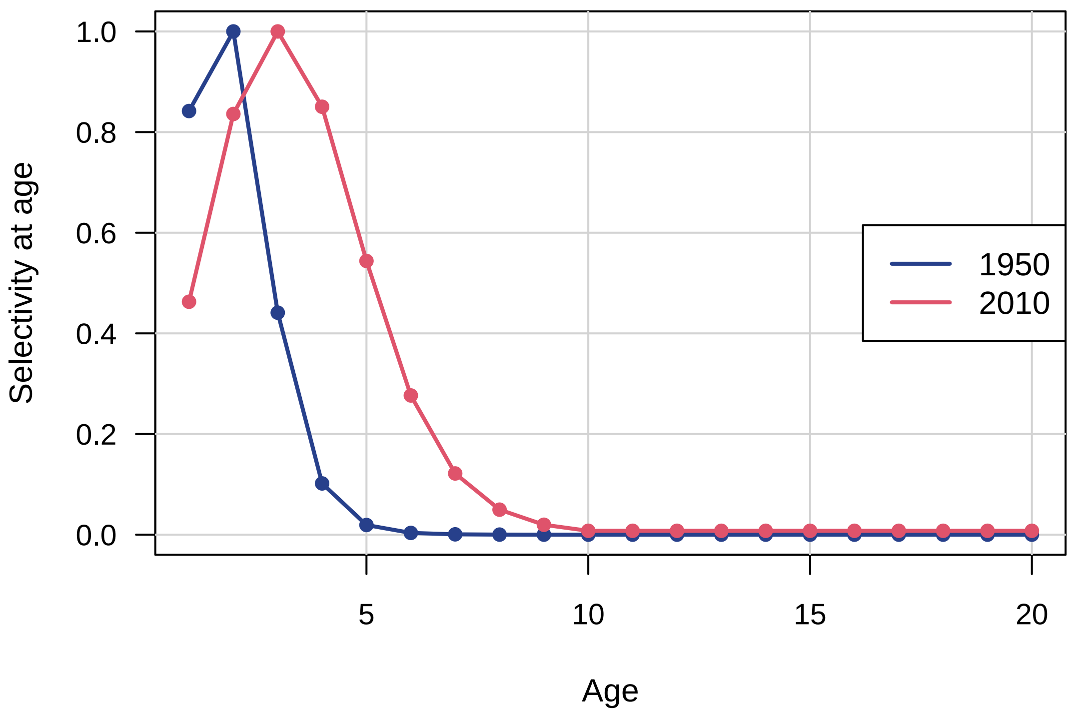


Figure 28. Average selectivity of discards (top), landings (middle), and total weighted average (bottom) from the terminal assessment years, weighted by geometric mean Fs from the last three assessment years, and used in computation of benchmarks and projections.

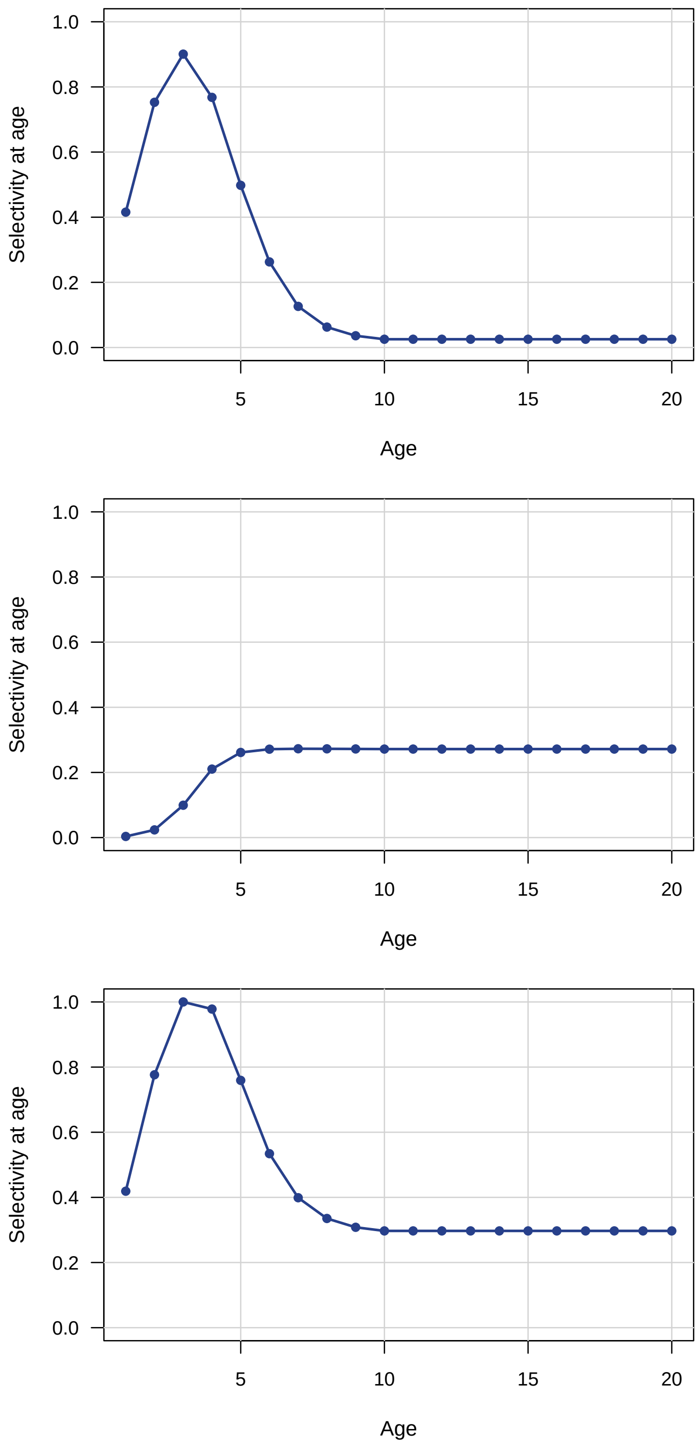


Figure 29. Estimated fully selected fishing mortality rate (per year) by fleet. cH refers to commercial handlines, HB to headboat, GR to general recreational, and D refers to discard mortality.

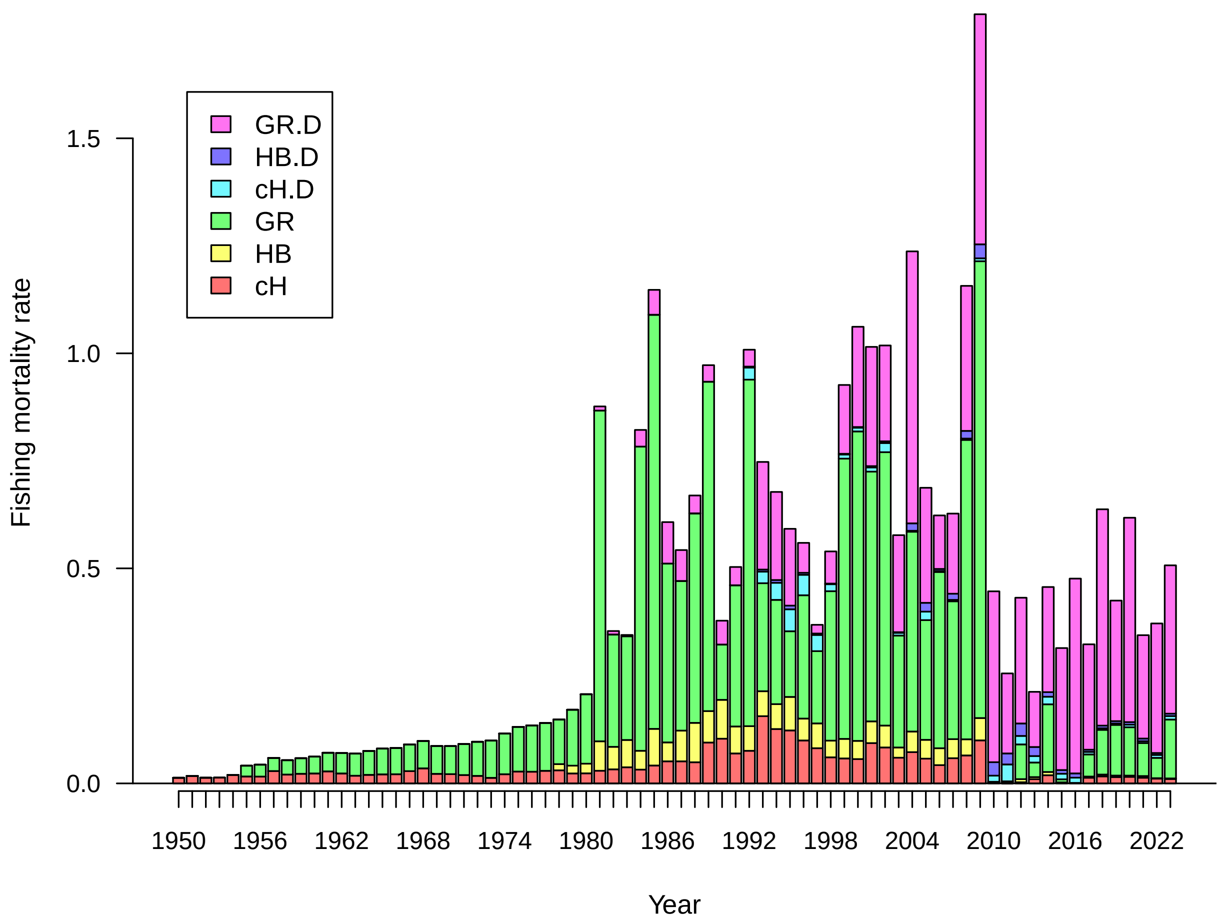


Figure 30. Alternative measures of fishing intensity. Top panel shows equilibrium SPR conditional on annual F, with a reference line at 0.3 (or, 30%). Bottom panel shows exploitation rate (E) computed as number killed divided total abundance (thick black curve), which can be divided into its components of landings (thin green curve) and dead discards (thin blue curve).

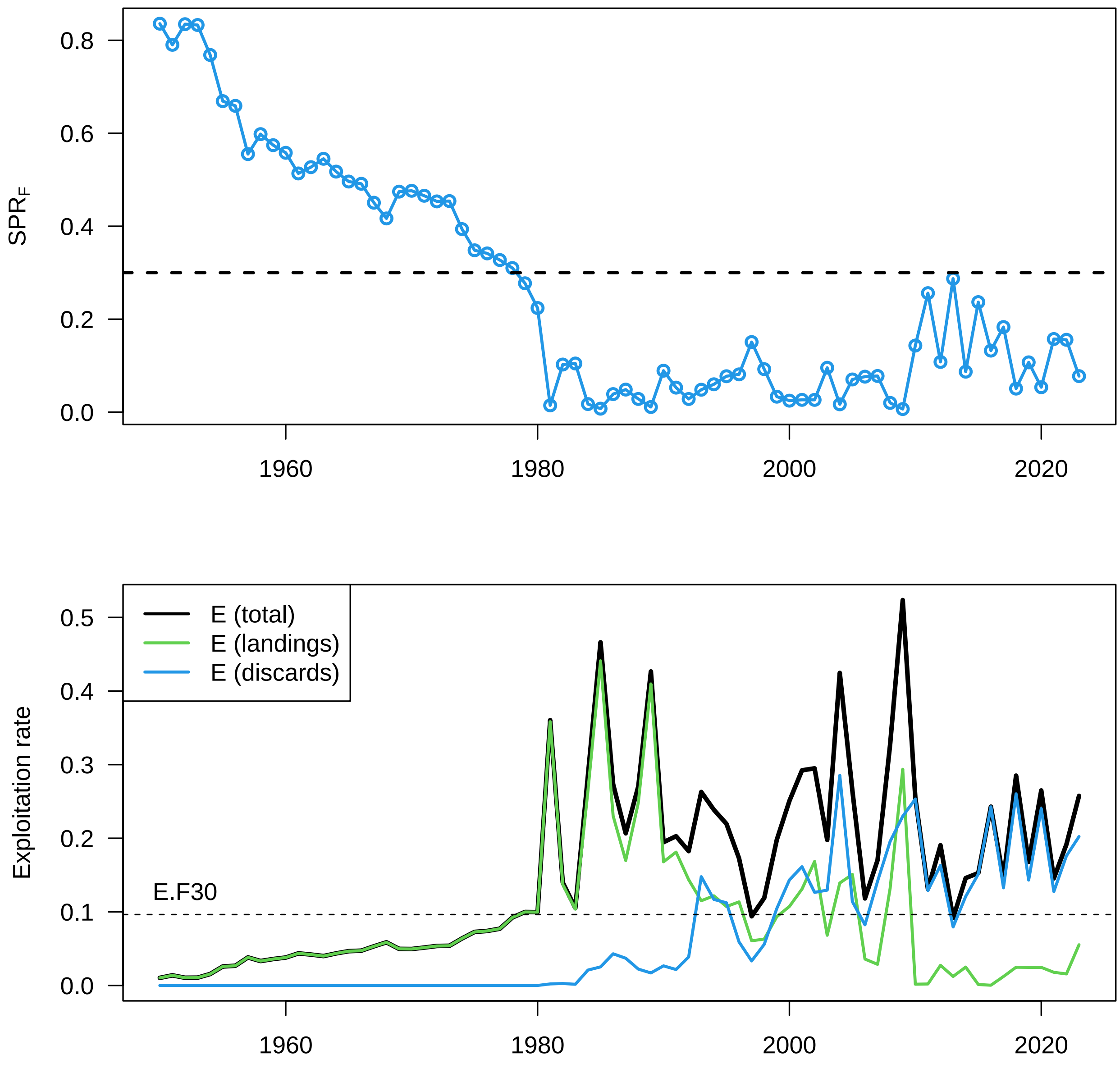


Figure 31. Estimated landings and discards in numbers by fleet from the catch-age model. cH refers to commercial handlines, HB to headboat, GR to general recreational, and L or D indicates landings or discards. Top panel shows absolute values; Bottom panel shows proportions of the total by fleet.

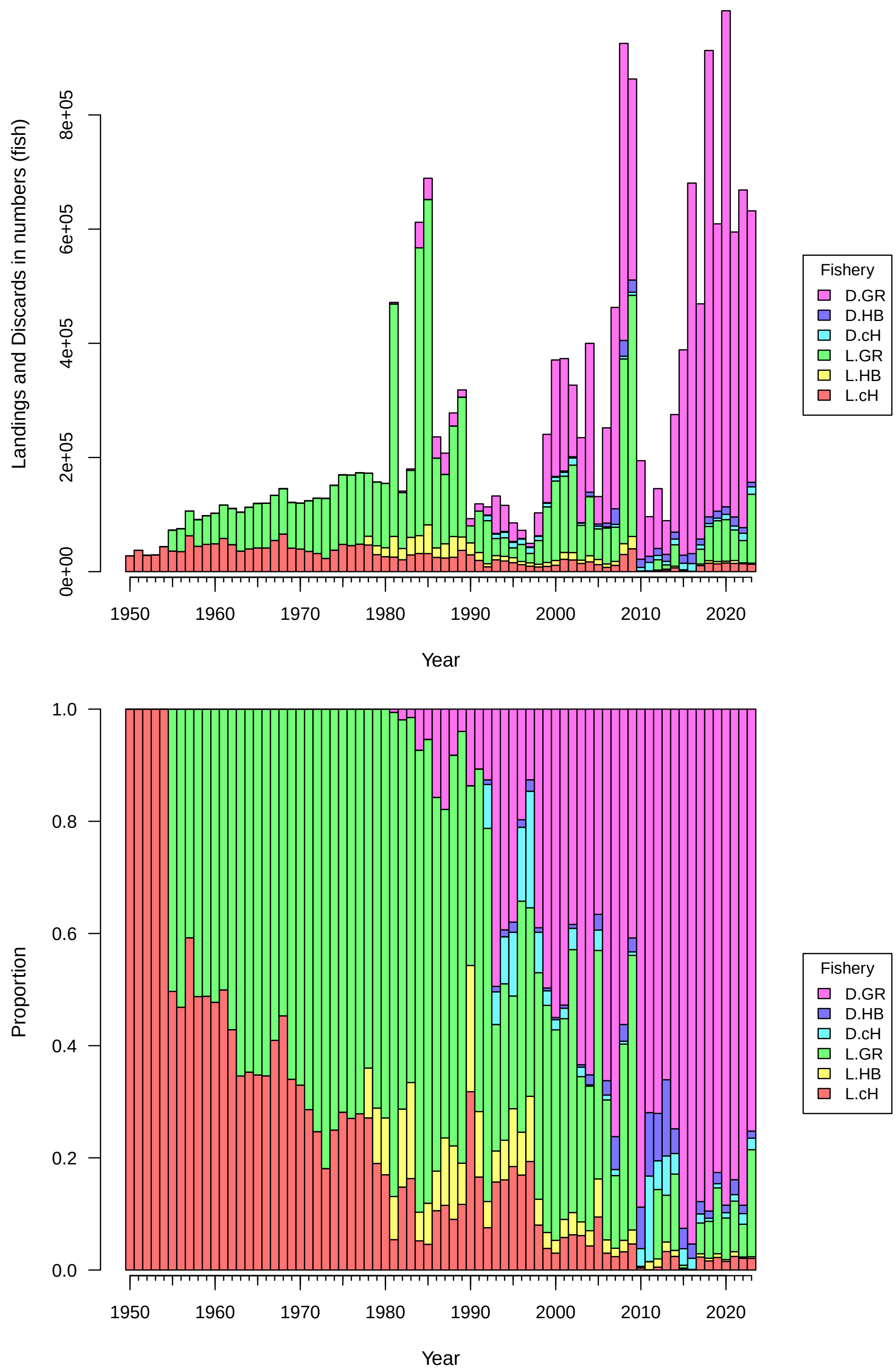
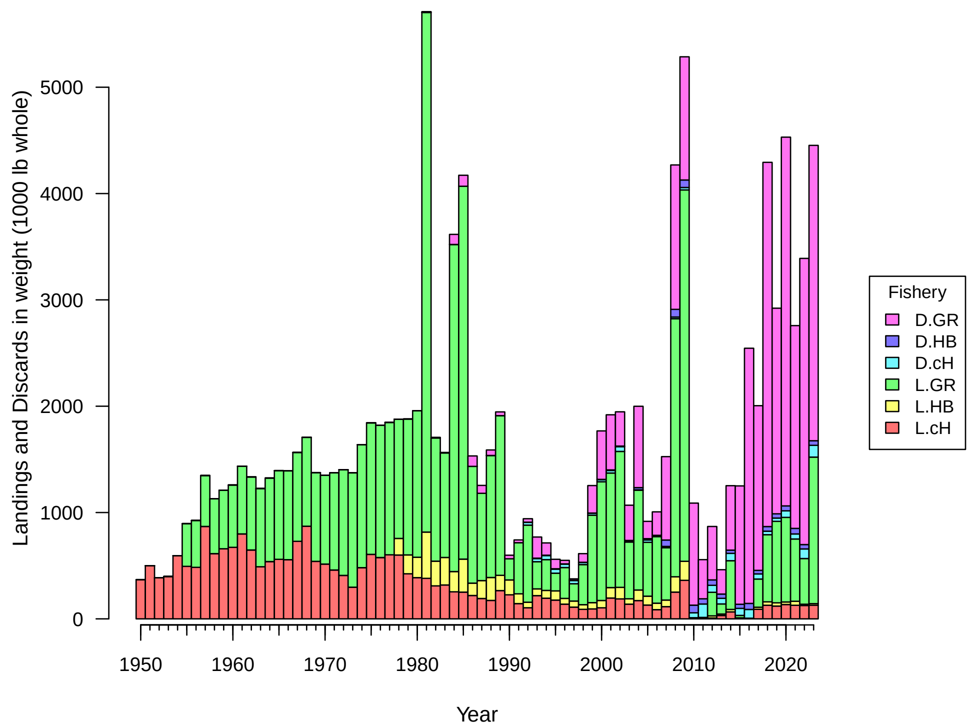


Figure 32. Estimated landings and discards in weight by fleet from the catch-age model. cH refers to commercial handlines, HB to headboat, GR to general recreational, and L or D indicates landings or discards. Top panel shows absolute values; Bottom panel shows proportions of the total by fleet.



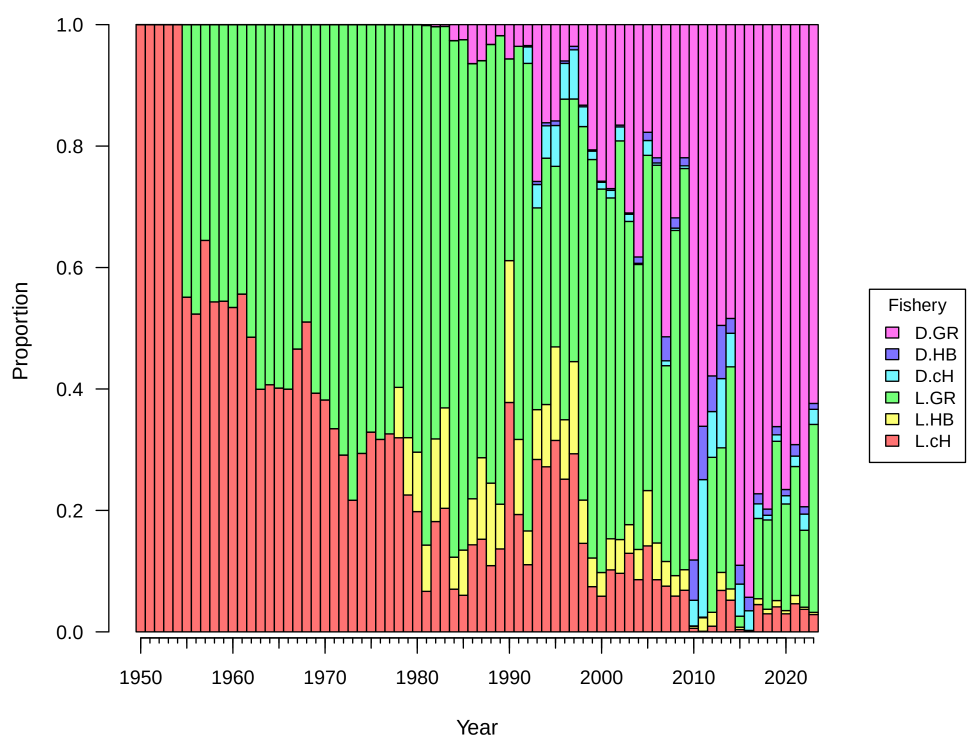


Figure 33. Estimated landings in whole weight by fleet from the catch-age model. cH refers to commercial handlines, HB to headboat, and GR to general recreational. Top panel shows absolute values; Bottom panel shows proportions of the total by fleet. Horizontal dashed line in the top panel corresponds to the point estimate of $L_{\mathrm{F}30\%}$ in weight.

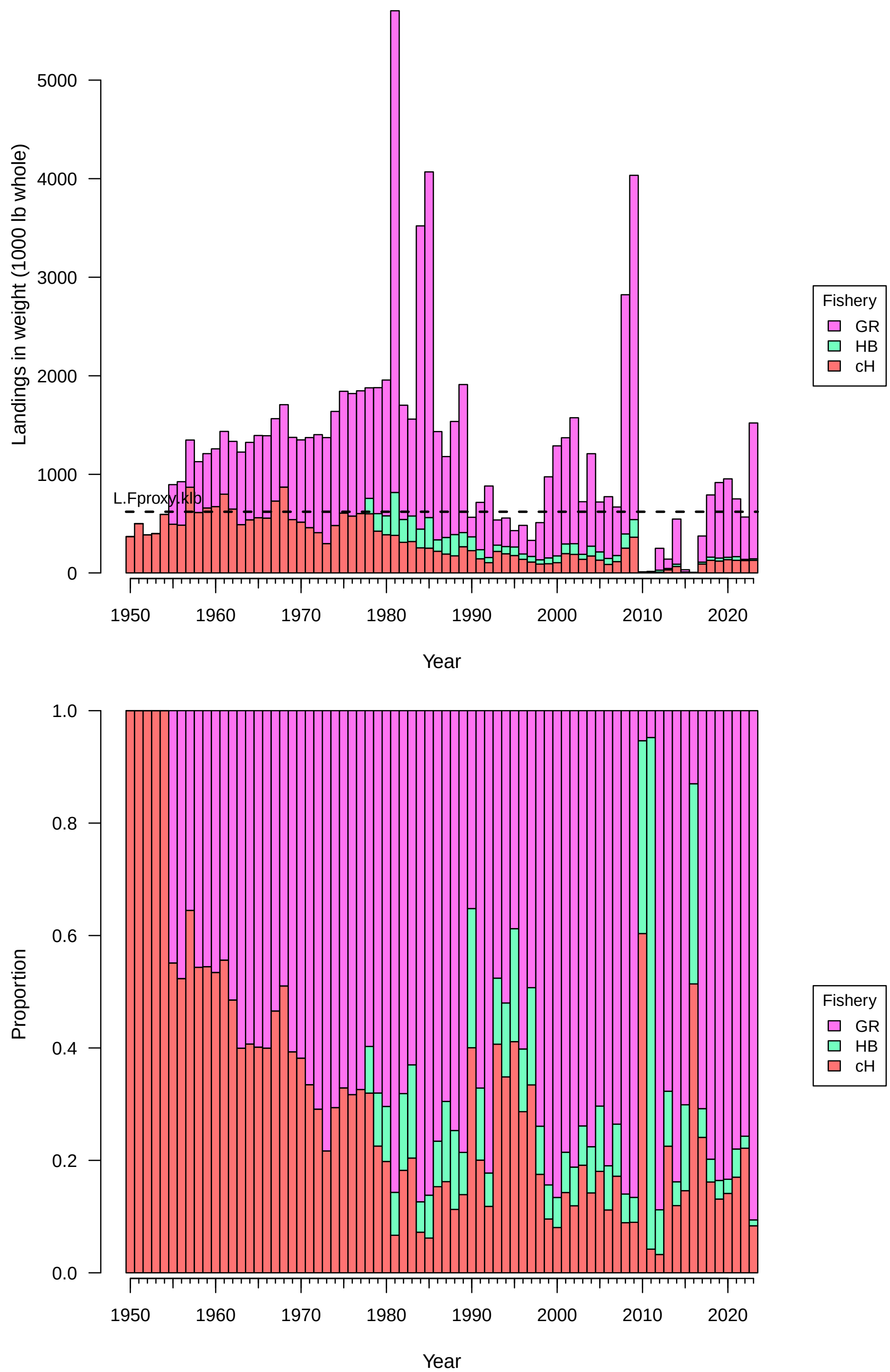


Figure 34. Estimated discard mortalities by fleet from the catch-age model. cH refers to commercial lines, hb to headboat, rec to general recreational. Top panel shows absolute values; Bottom panel shows proportions of the total by fleet. Horizontal dashed line in the top panel corresponds to the point estimate of $D_{F_{30\%}}$ *in numbers.*

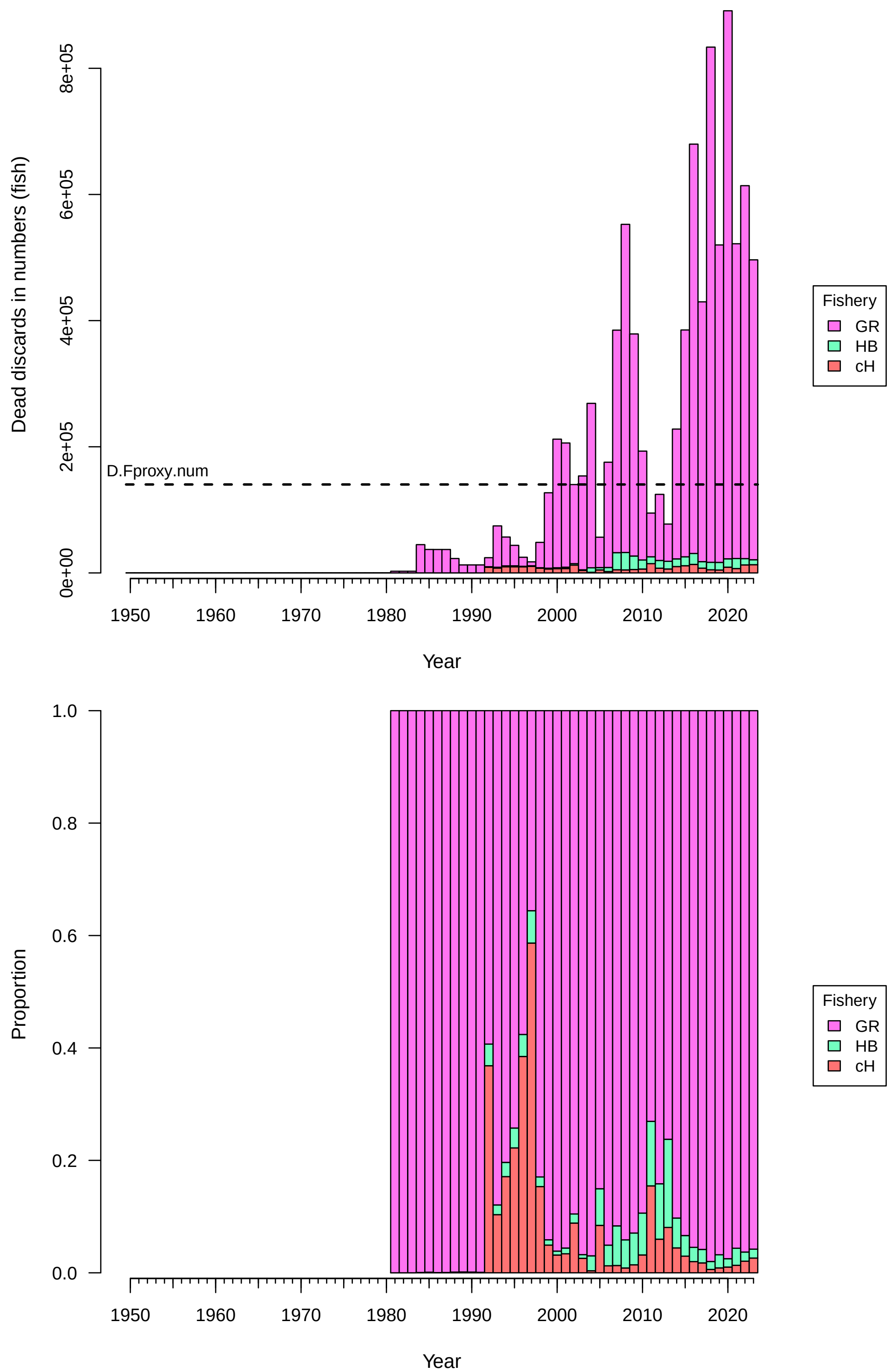


Figure 35. Top panel: Spawner-recruit relationship, with and without lognormal bias correction. The expected (mean-unbiased) curve was used for computing management benchmarks. Bottom panel: log of recruits (number age-1 fish) per spawner as a function of spawners.

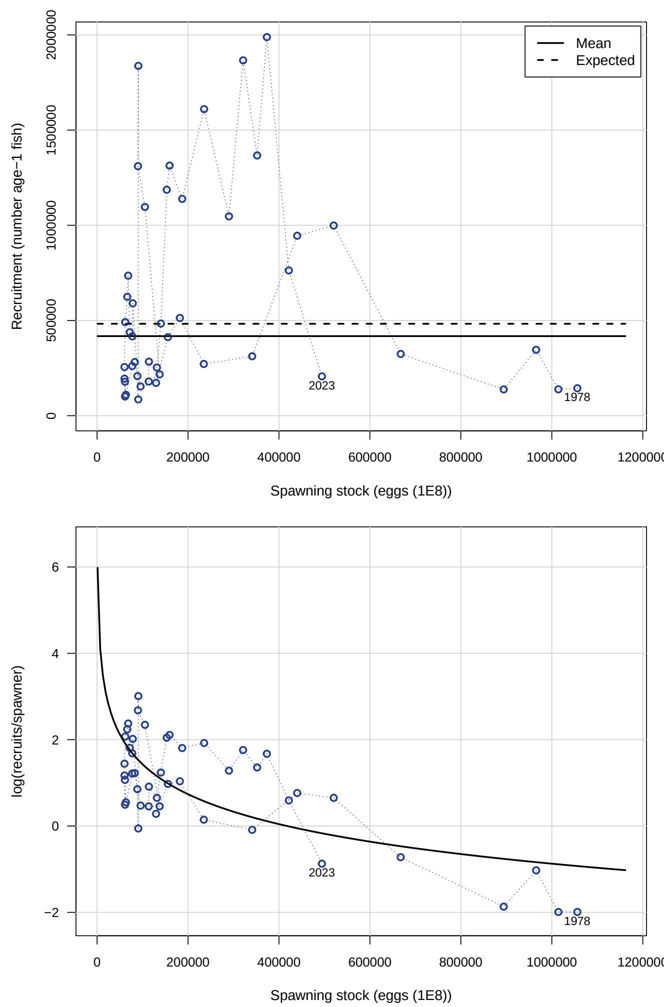


Figure 36. Probability densities of spawner-recruit quantities: Mean recruits (R0, age-1 fish), median recruits, unfished spawners per recruit, and standard deviation of recruitment residuals in log space. Solid vertical lines represent point estimates or values from the base run of the Beaufort Assessment Model; dashed vertical lines represent medians from the MCBE runs.

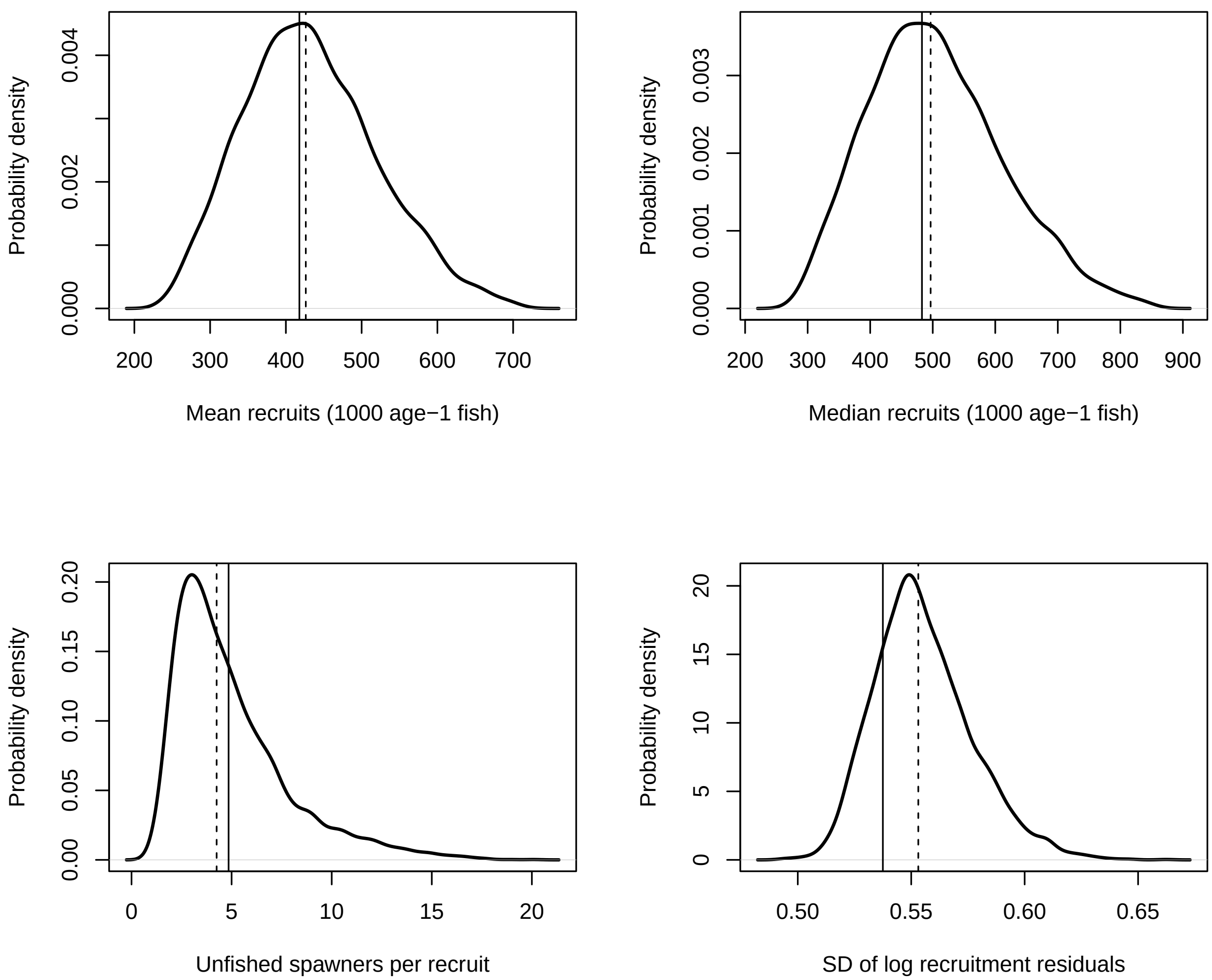


Figure 37. Yield (lb whole weight) per recruit based on average selectivity from the end of the assessment period.

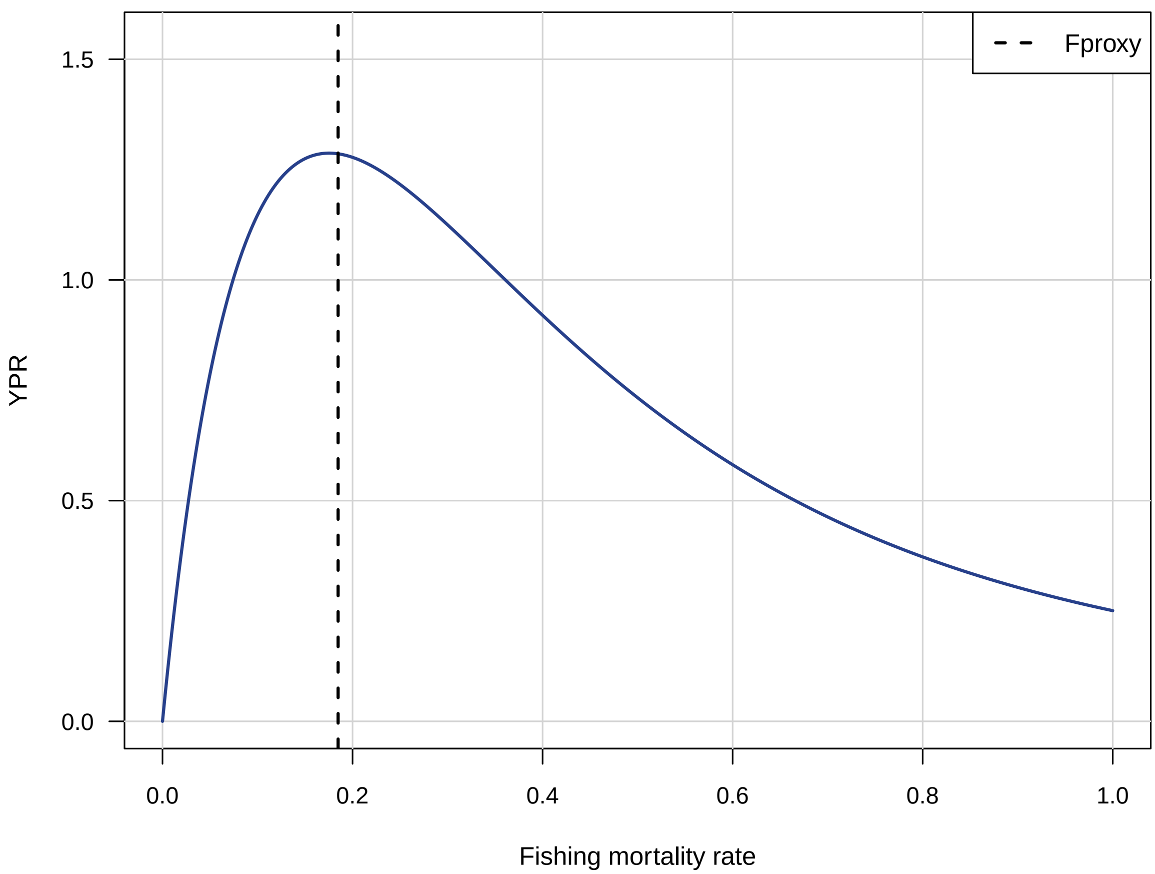


Figure 38. Spawning potential ratio (spawning biomass per recruit relative to that at the unfished level), from which the X% level of SPR provides $F_{X\%}$. SPR is based on average selectivity from the end of the assessment period.

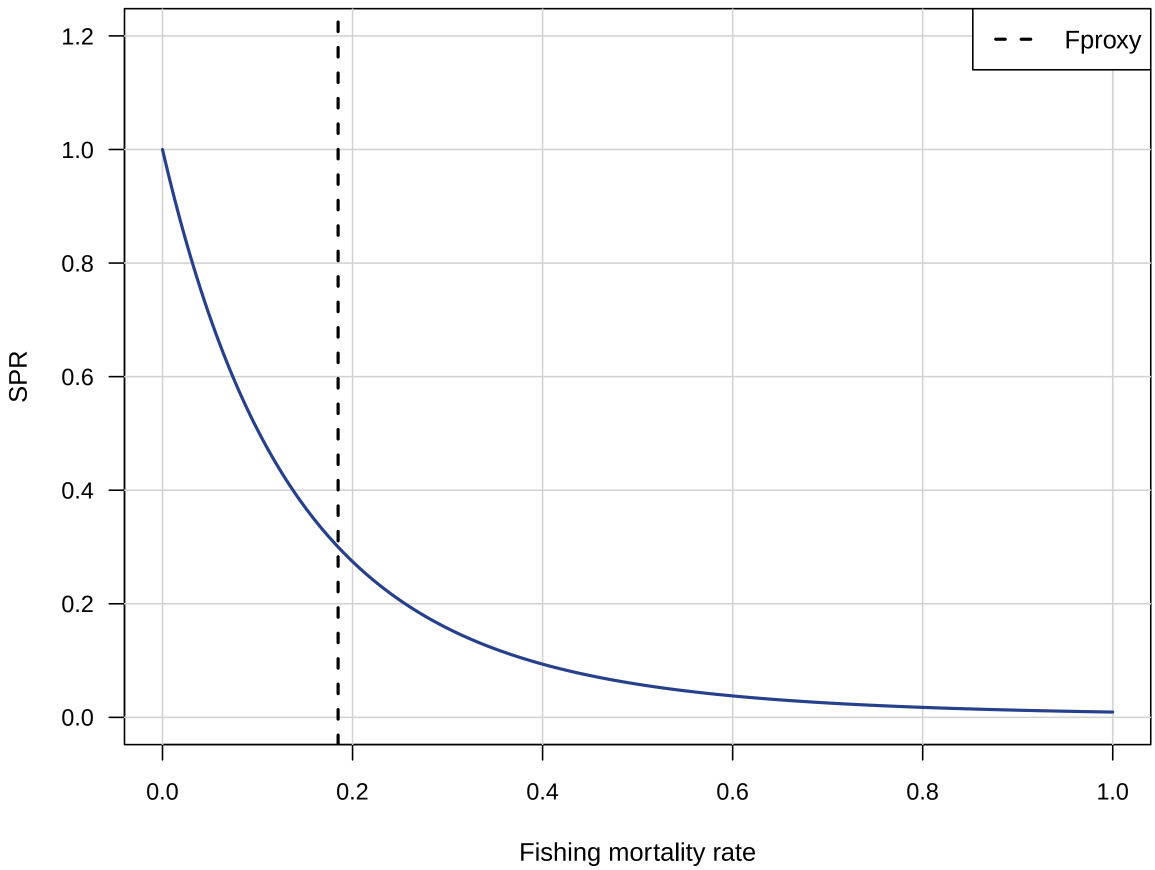


Figure 39. Probability densities of $F_{30\%}$-related benchmarks from MCBE analysis. Solid vertical lines represent point estimates from the base run; dashed vertical lines represent median values.

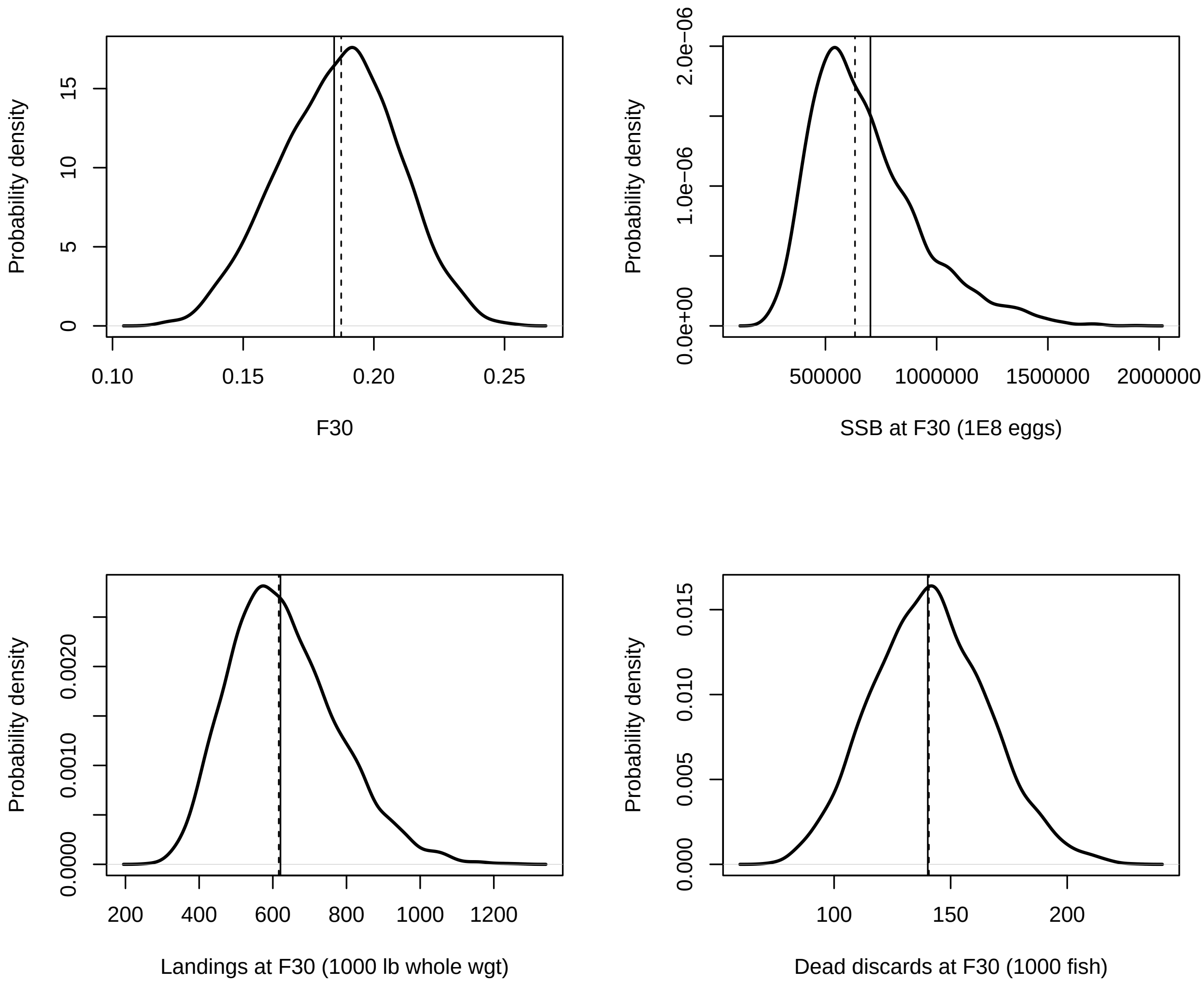


Figure 40. Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; dashed lines represent median values; gray error bands indicate 5^{th} *and* 95^{th} *percentiles of the MCBE. Top panel: spawning biomass relative to* $\mathrm{SSB}_{\mathrm{F30\%}}$*. Bottom panel: F relative to* $F_{30\%}$*.*

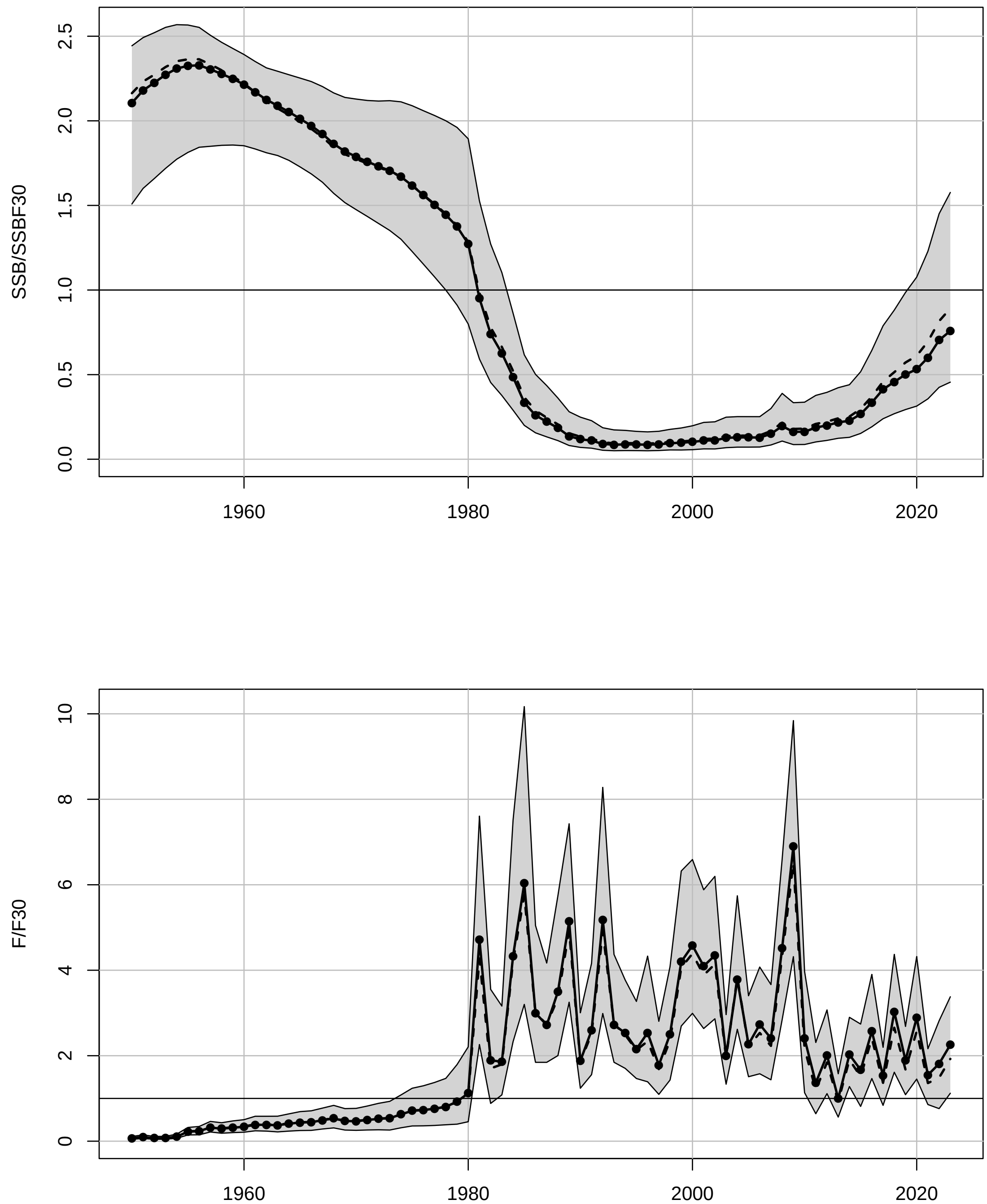


Figure 41. Probability densities of terminal status estimates from MCBE analysis. Solid vertical lines represent point estimates from the base run; dashed vertical lines represent median values.

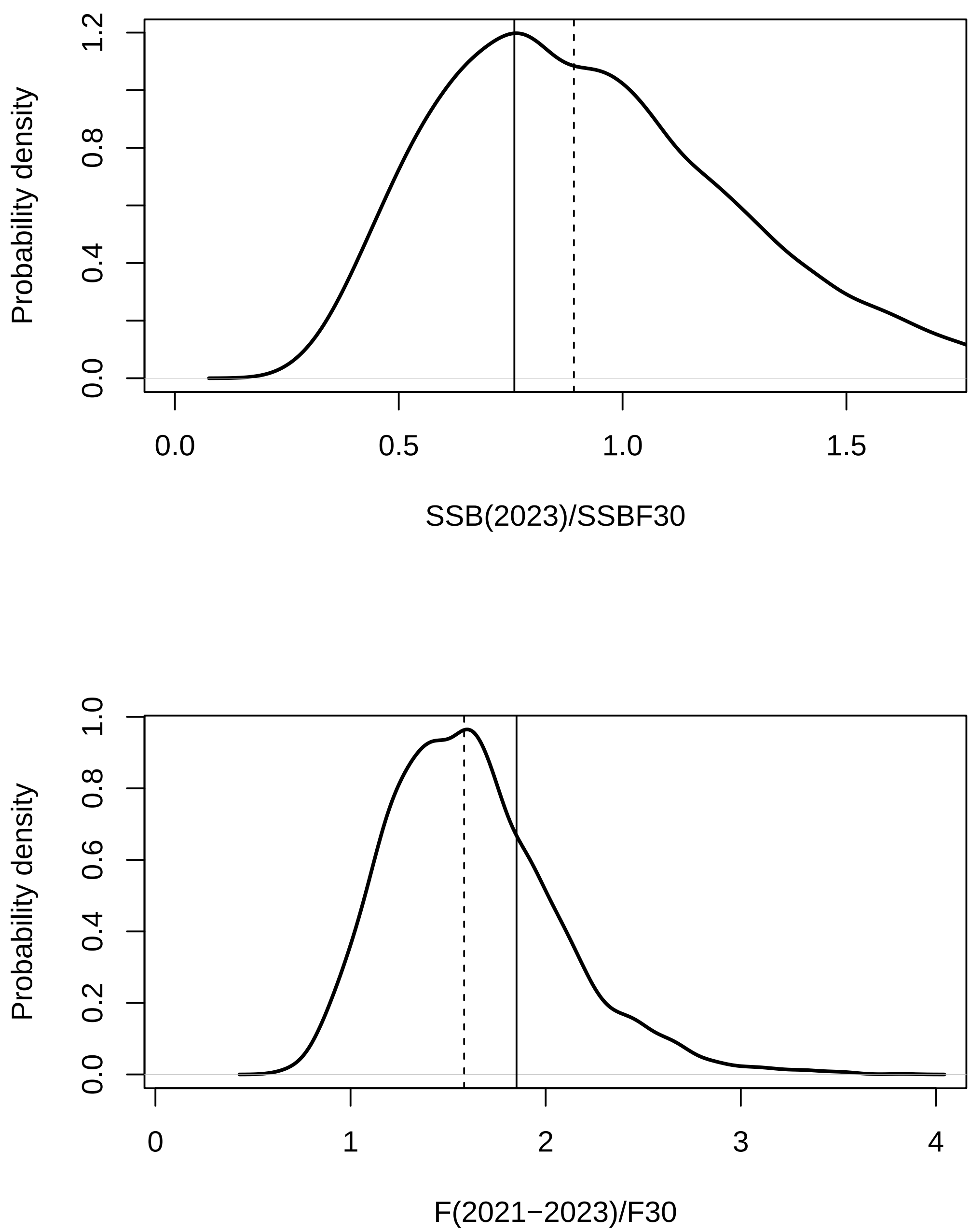


Figure 42. Phase plots of terminal status estimates from MCBE analysis. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5^{th} and 95^{th} percentiles. Proportion of runs falling in each quadrant indicated.

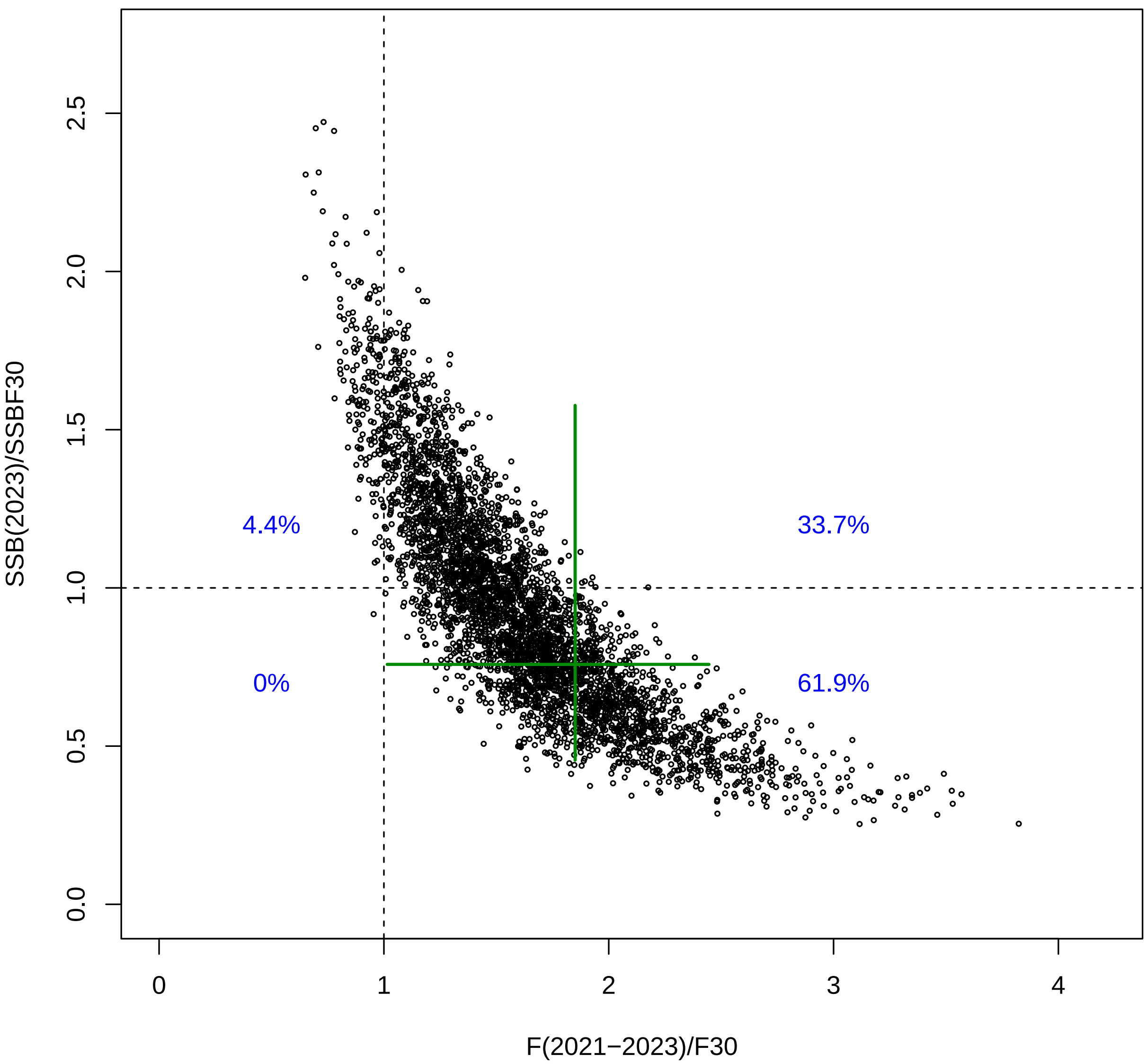


Figure 43. Age structure relative to the equilibrium expected at $F_{30\%}$*. Top panel: log of abundance. Bottom panel: percent of total population in each age bin.*

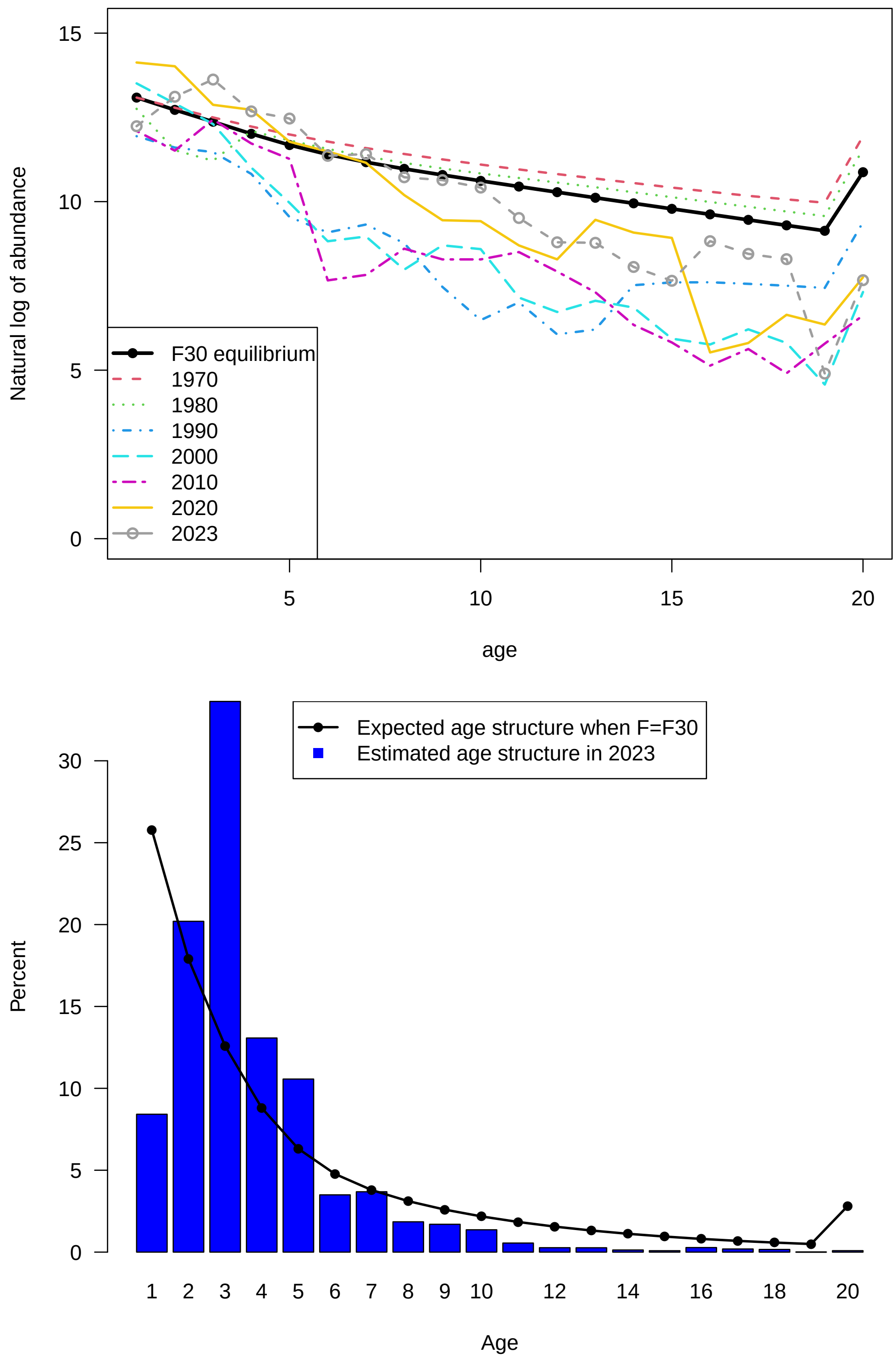


Figure 44. Estimated average selectivities, as used for benchmarks and projections, from SEDAR73 (S73) and this update (S73U).

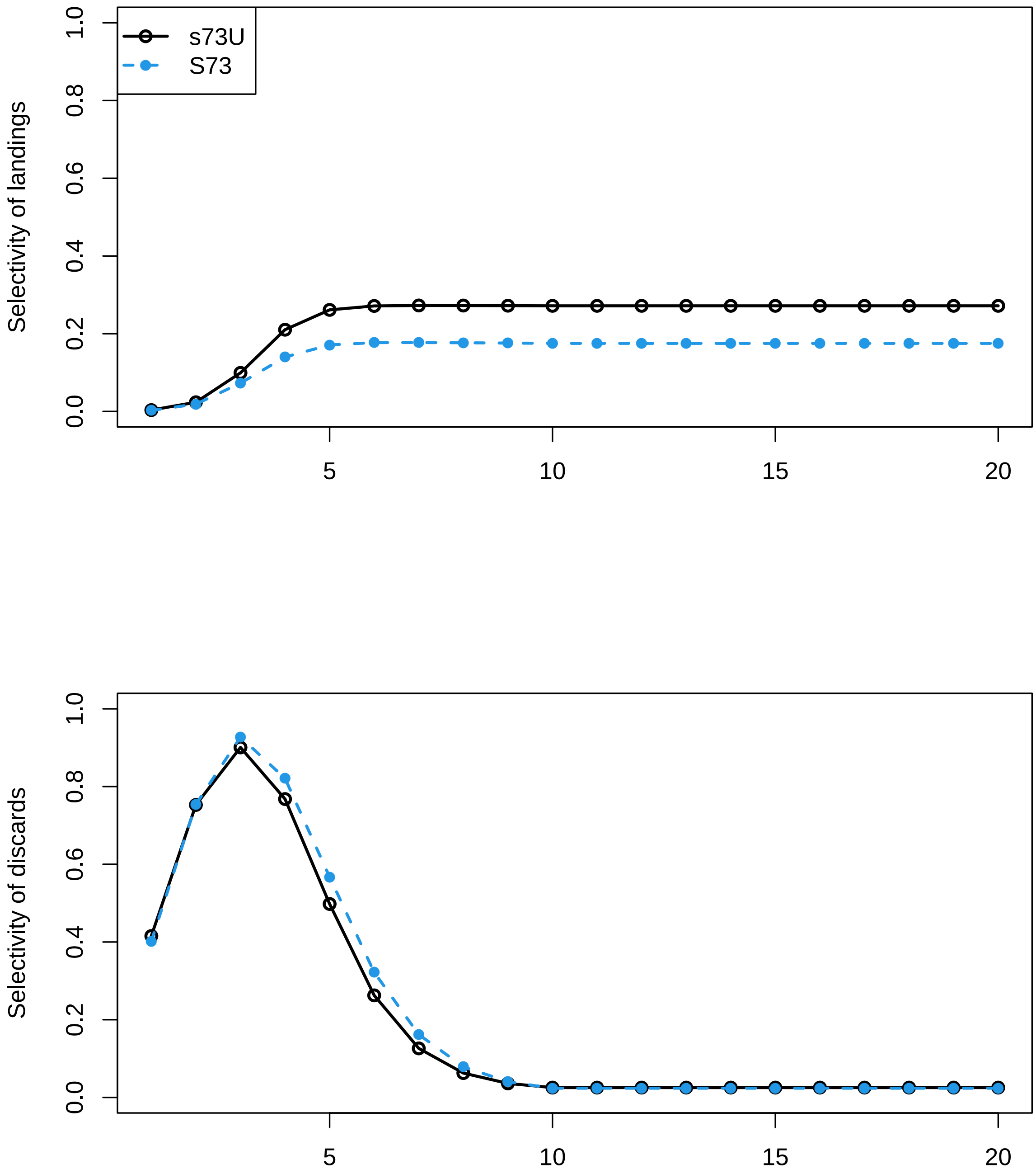


Figure 45. Estimated time series of recruits and abundance (1000 fish) from SEDAR73 (S73) and this update (S73U).

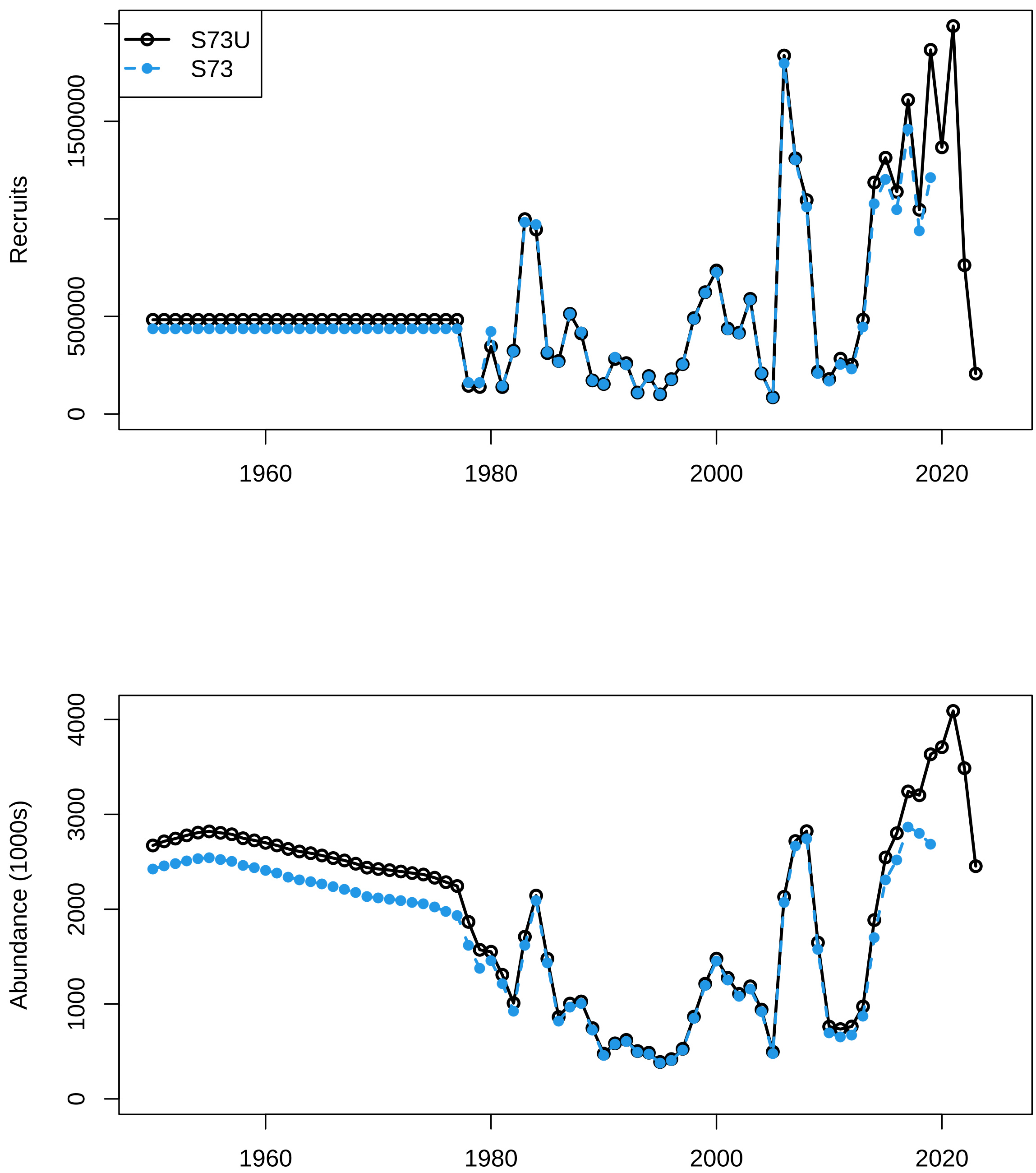
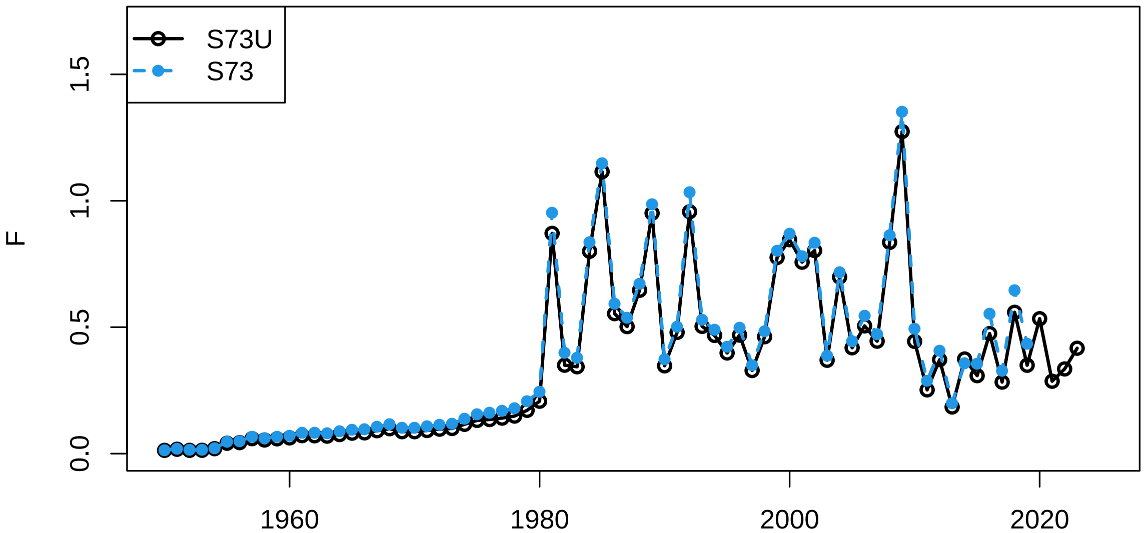


Figure 46. Estimated time series of F and SSB (1e8 eggs) from SEDAR73 (S73) and this update (S73U).



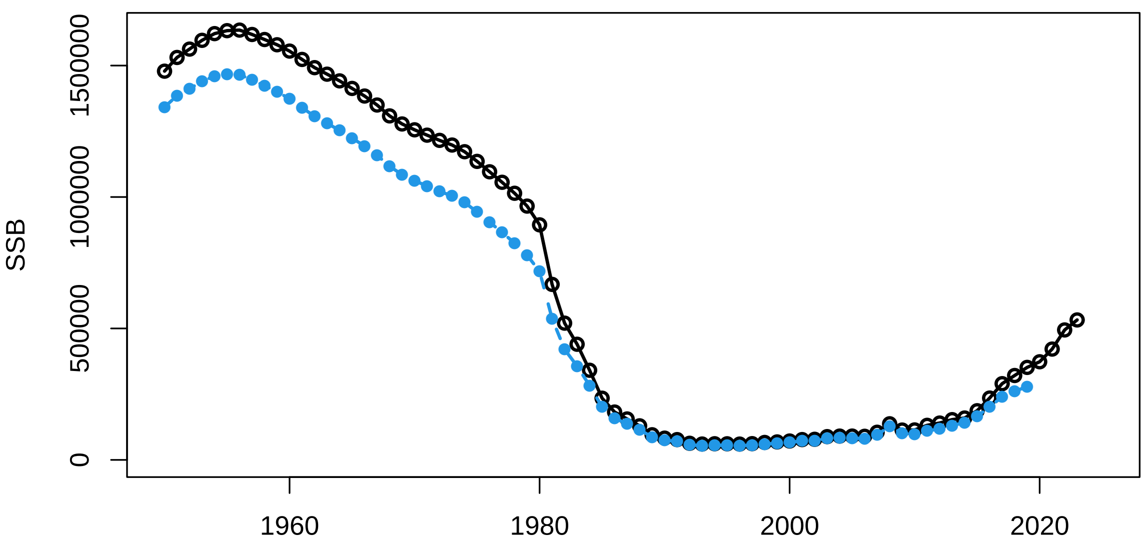


Figure 47. Status indicators from SEDAR73 (S73) and this update (S73U). Top panel: F relative to $F_{30\%}$*. Bottom panel: spawning biomass relative to* $\mathrm{SSB}_{\mathrm{F30\%}}$*.*

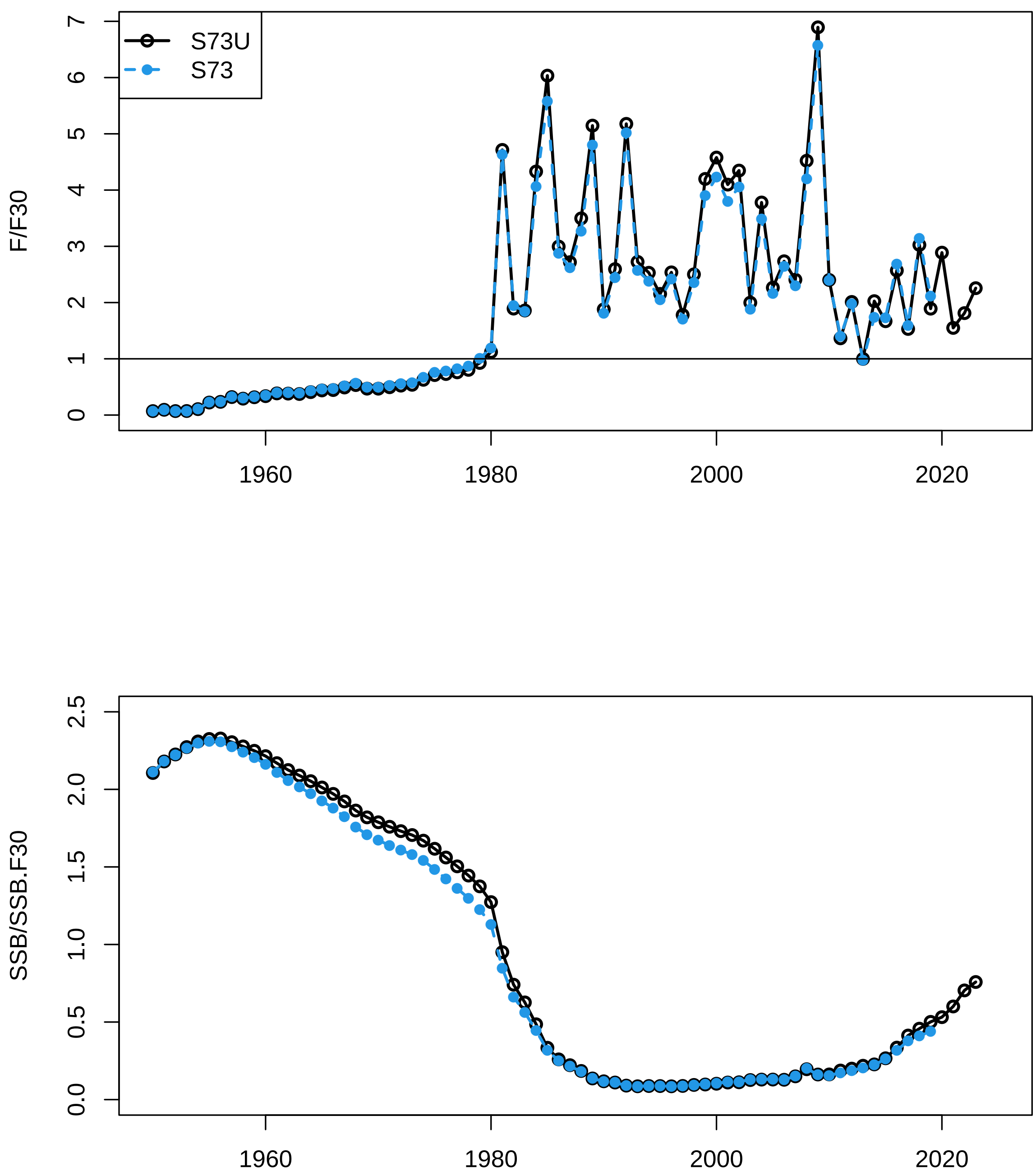


Figure 48. Sensitivity to reductions in general recreational landings and discards. In S1, general recreational landings and discards were reduced by 20%. In S2, general recreational landings and discards were reduced by 40%. Top panel: Ratio of F to $F_{30\%}$*. Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{F30\%}}$*.*

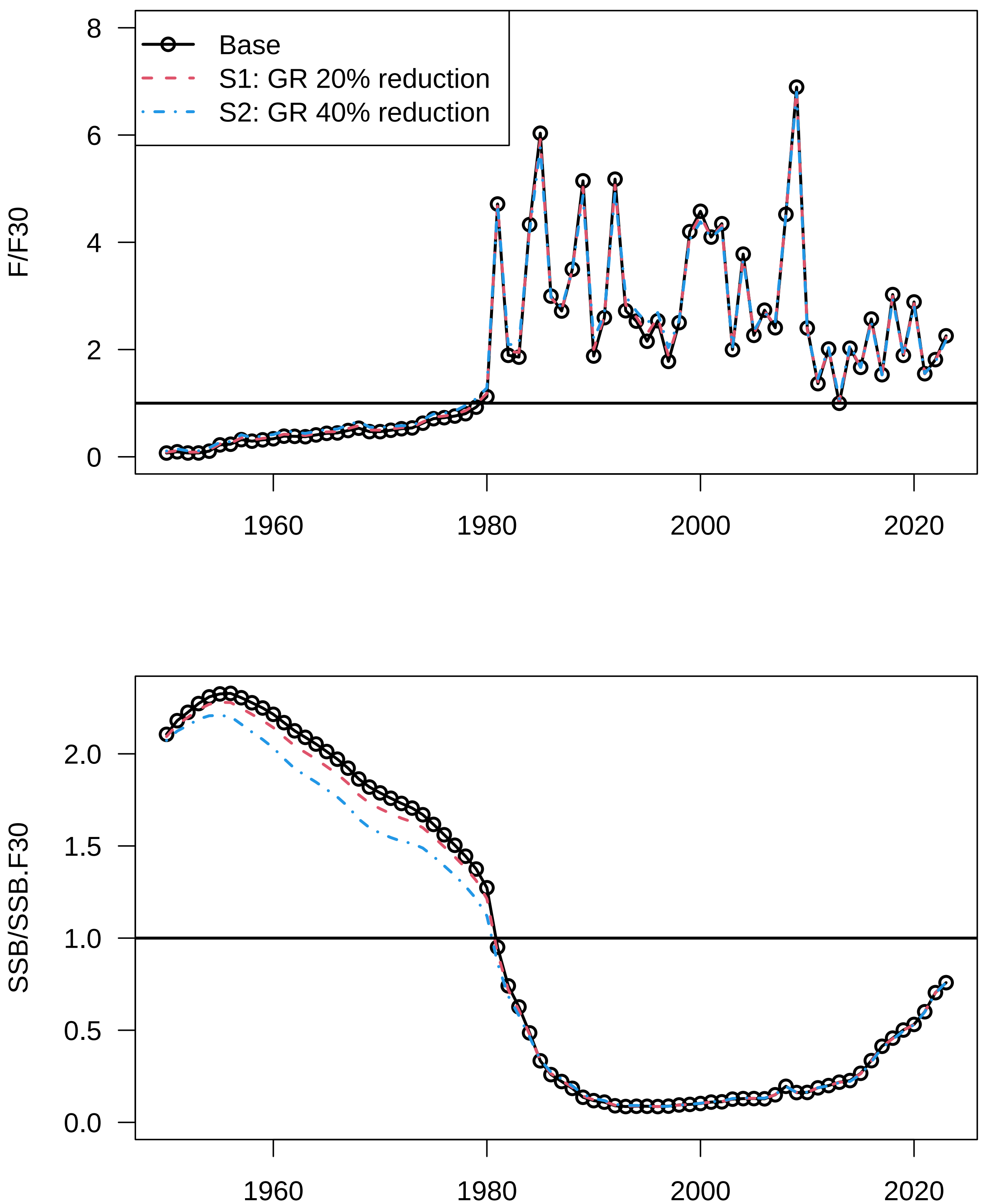


Figure 49. Projected time series under scenario 1—fishing mortality rate at $F = F_{30\%}$ and long-term average recruitment. Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Solid horizontal lines mark $F_{30\%}$-related reference points (benchmarks); dashed horizontal lines represent corresponding medians. Spawning stock (SSB) is at time of peak spawning.

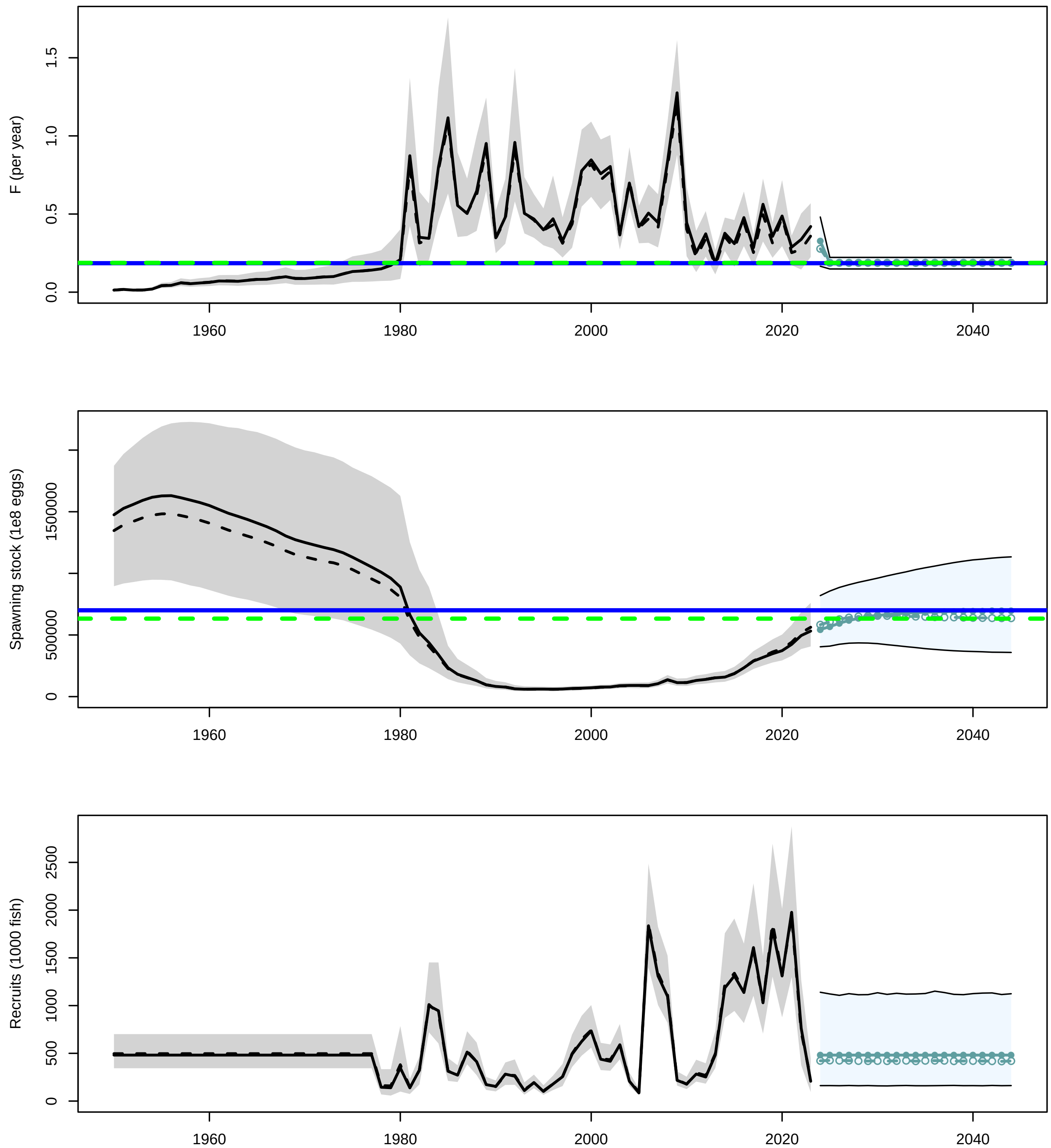


Figure 50. Projected probability of rebuilding under scenario 1—fishing mortality rate at $F = F_{30\%}$ and long-term average recruitment. The curve represents the proportion of projection replicates for which SSB *has reached the replicate-specific* $\mathrm{SSB}_{\mathrm{F30\%}}$*, with reference line at 0.5.*

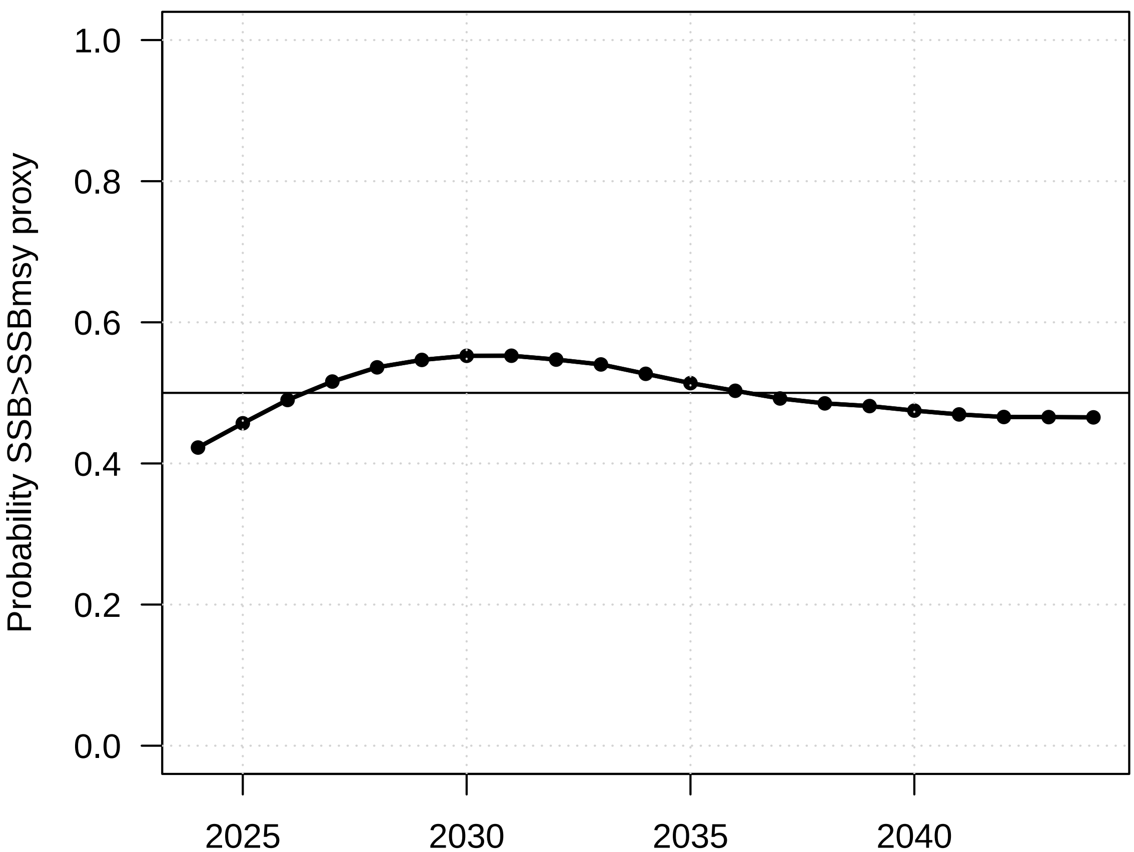
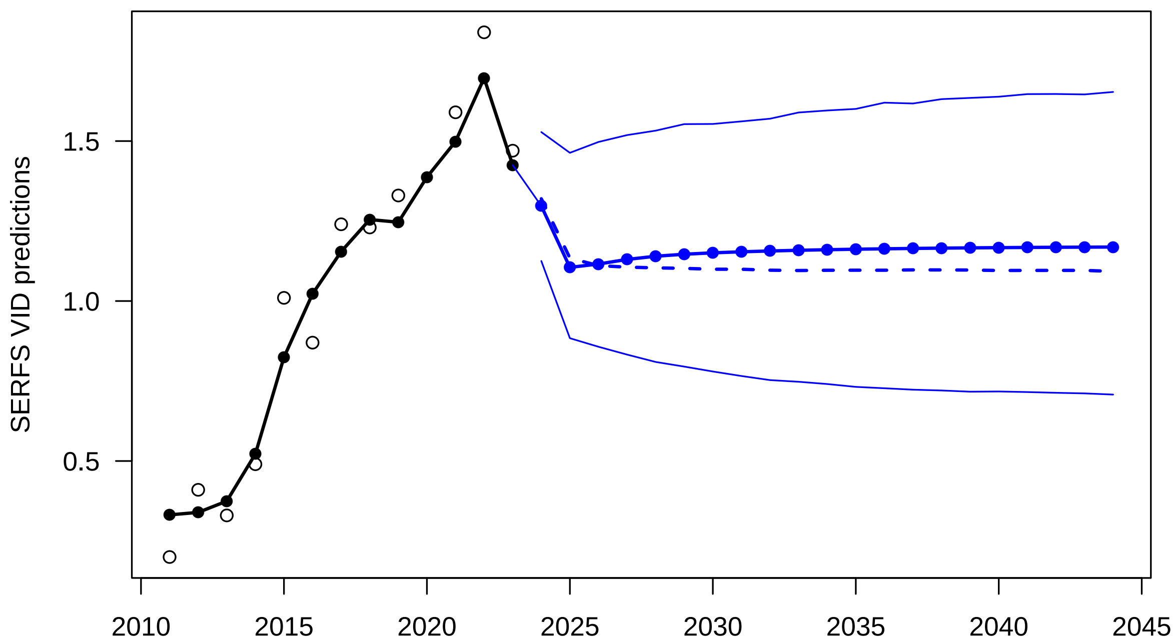


Figure 51. Projected indices of abundance under scenario 1—fishing mortality rate at $F = F_{30\%}$ *and long-term average recruitment. Top panel: SERFS video index. Bottom panel: SERFS chevron trap index.*



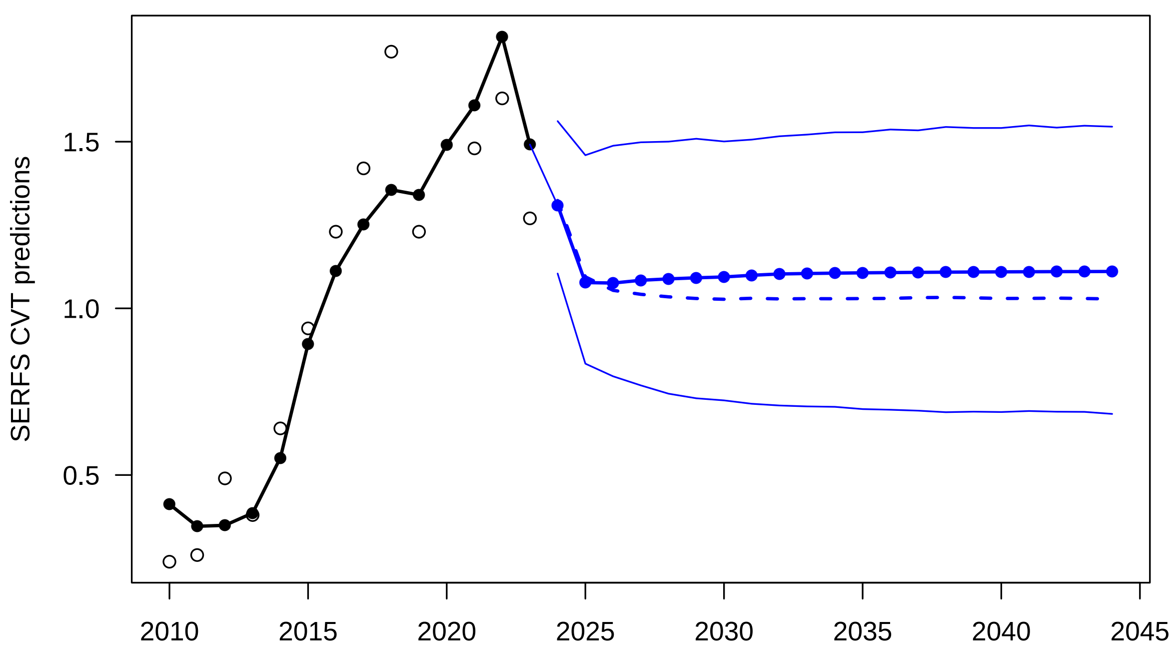


Figure 52. Projected trade-off between 2025 landings and dead discards under scenario 1—fishing mortality rate at $F = F_{30\%}$ *and long-term average recruitment.*

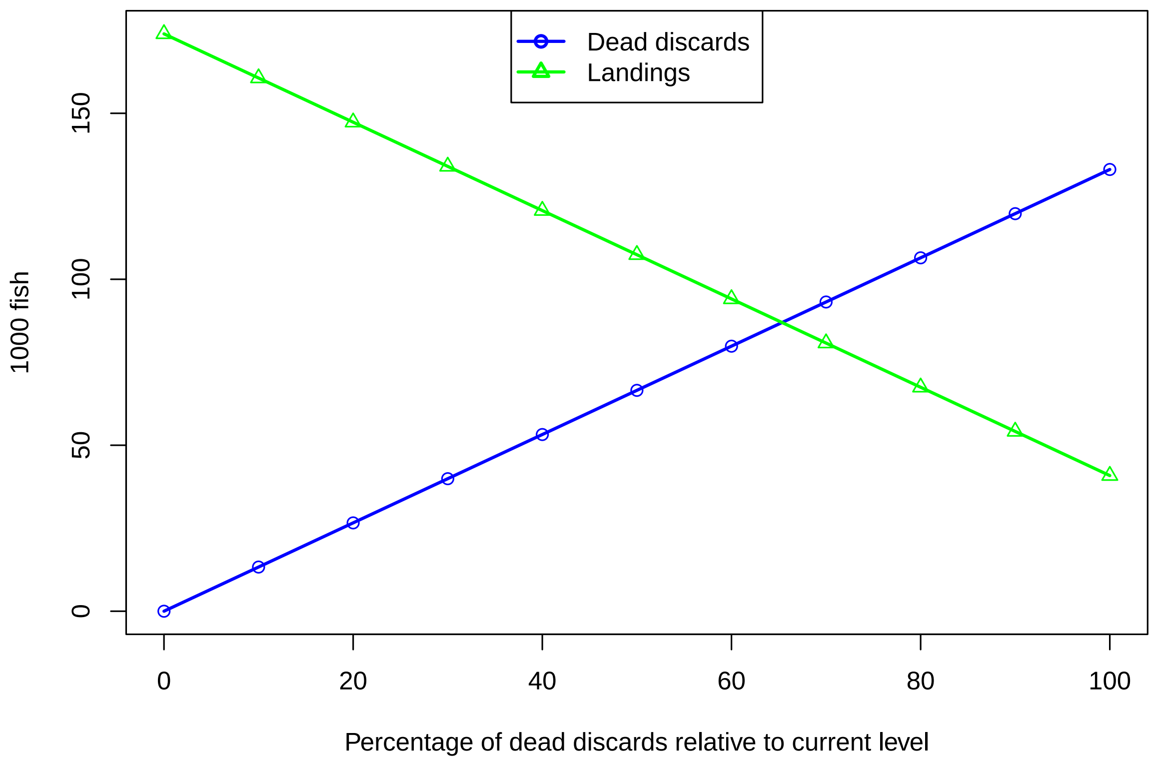


Figure 53. Projected time series under scenario 2—fishing mortality rate at $F = F_{\text{rebuild}}$ with 0.5 probability and long-term average recruitment. Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Solid horizontal lines mark $F_{30\%}$-related quantities (benchmarks); dashed horizontal lines represent corresponding medians. Spawning stock (SSB) is at time of peak spawning.

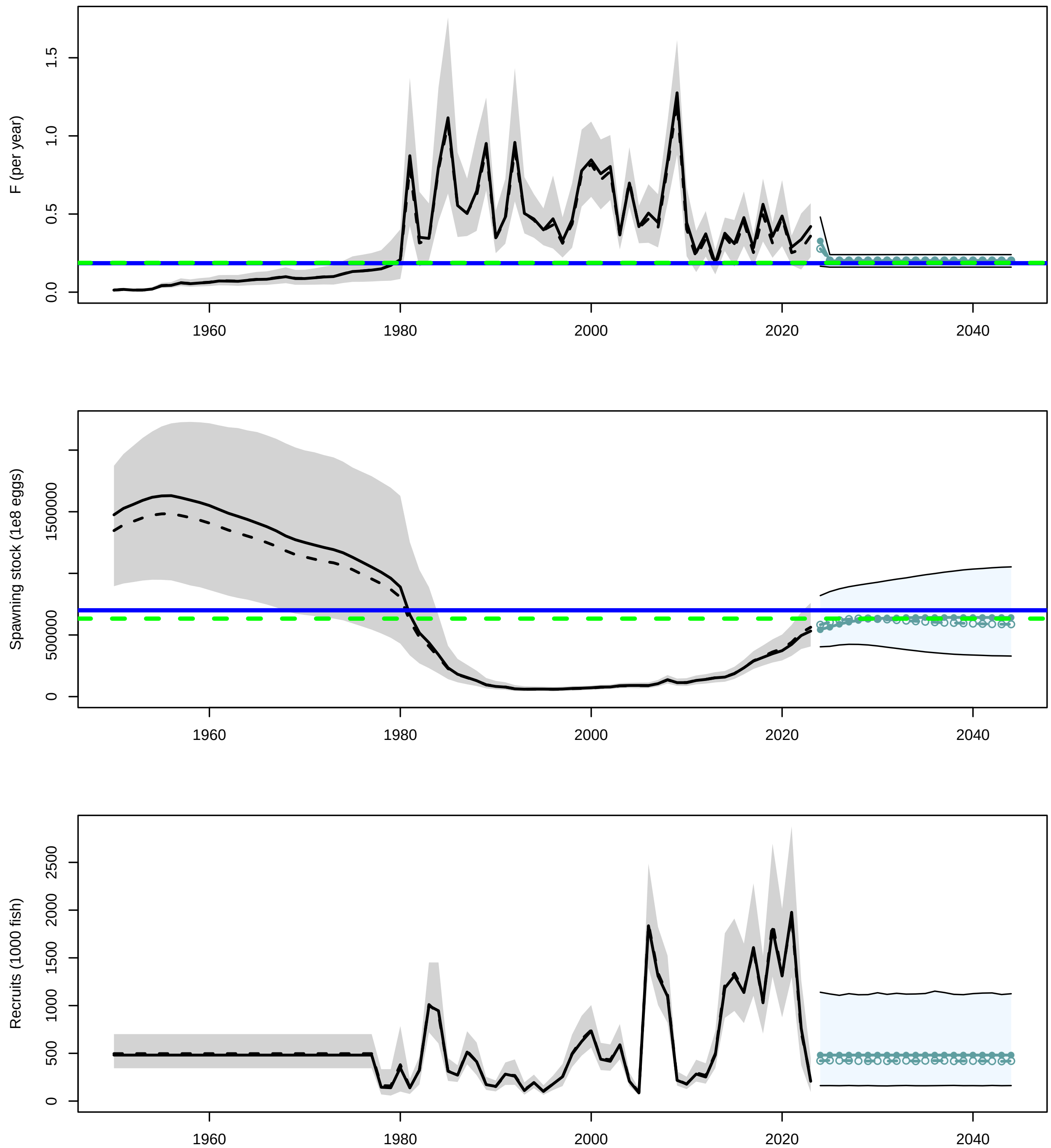


Figure 54. Projected probability of rebuilding under scenario 2—fishing mortality rate at $F = F_{\mathrm{rebuild}}$ with 0.5 probability and long-term average recruitment. The curve represents the proportion of projection replicates for which SSB *has reached the replicate-specific* $\mathrm{SSB}_{\mathrm{F30\%}}$*, with reference line at 0.5.*

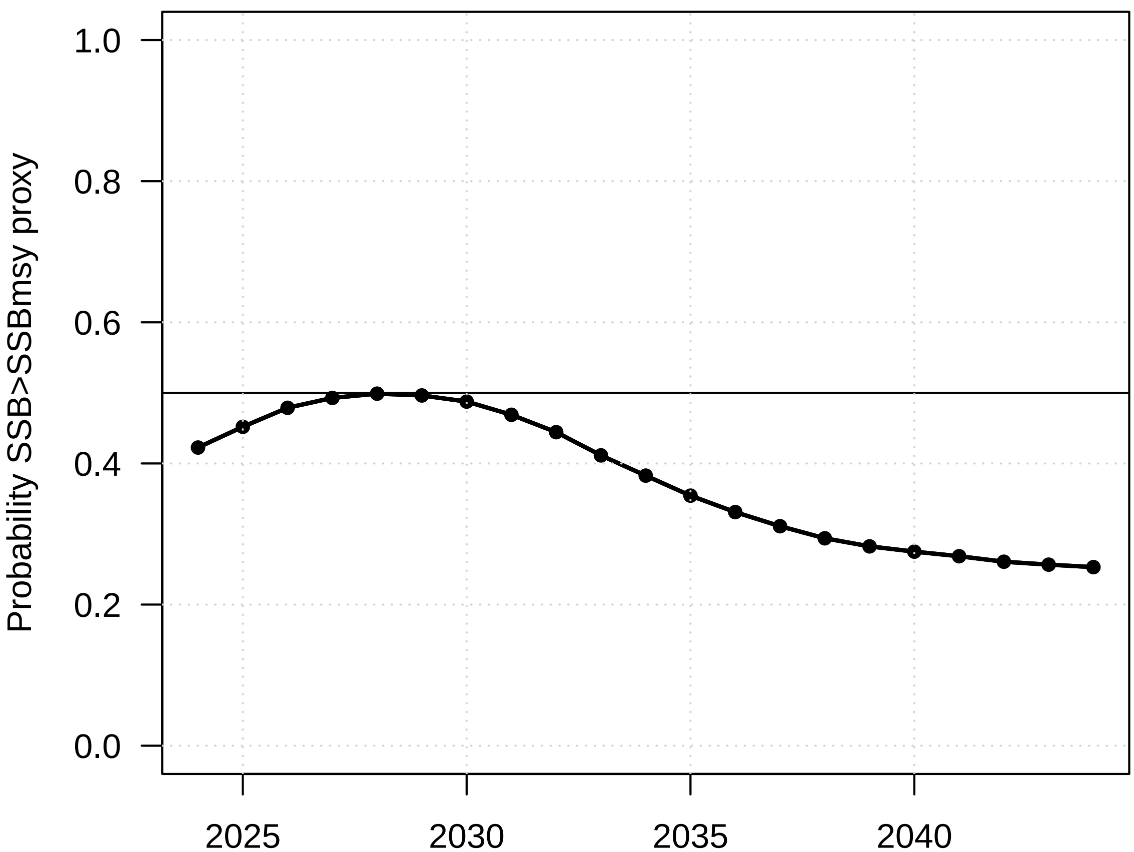


Figure 55. Projected indices of abundance under scenario 2—fishing mortality rate at $F = F_{\text{rebuild}}$ *with 0.5 probability and long-term average recruitment. Top panel: SERFS video index. Bottom panel: SERFS chevron trap index.*

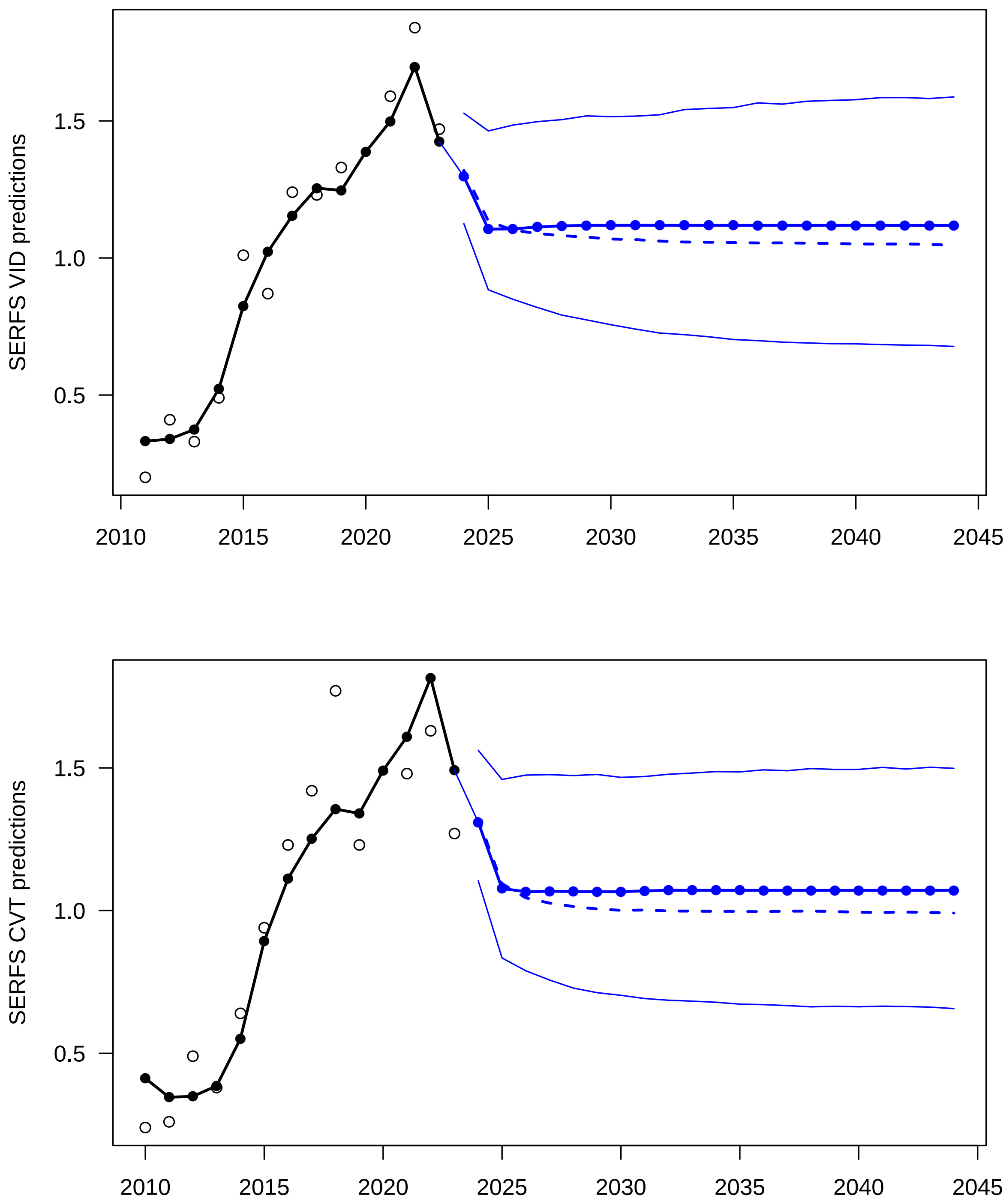


Figure 56. Projected time series under scenario 3—fishing mortality rate at $F = F_{\text{current}}$ *and long-term average recruitment. Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to* 5^{th} *and* 95^{th} *percentiles of replicate projections. Solid horizontal lines mark* $F_{30\%}$*-related quantities (benchmarks); dashed horizontal lines represent corresponding medians. Spawning stock (*SSB*) is at time of peak spawning.*

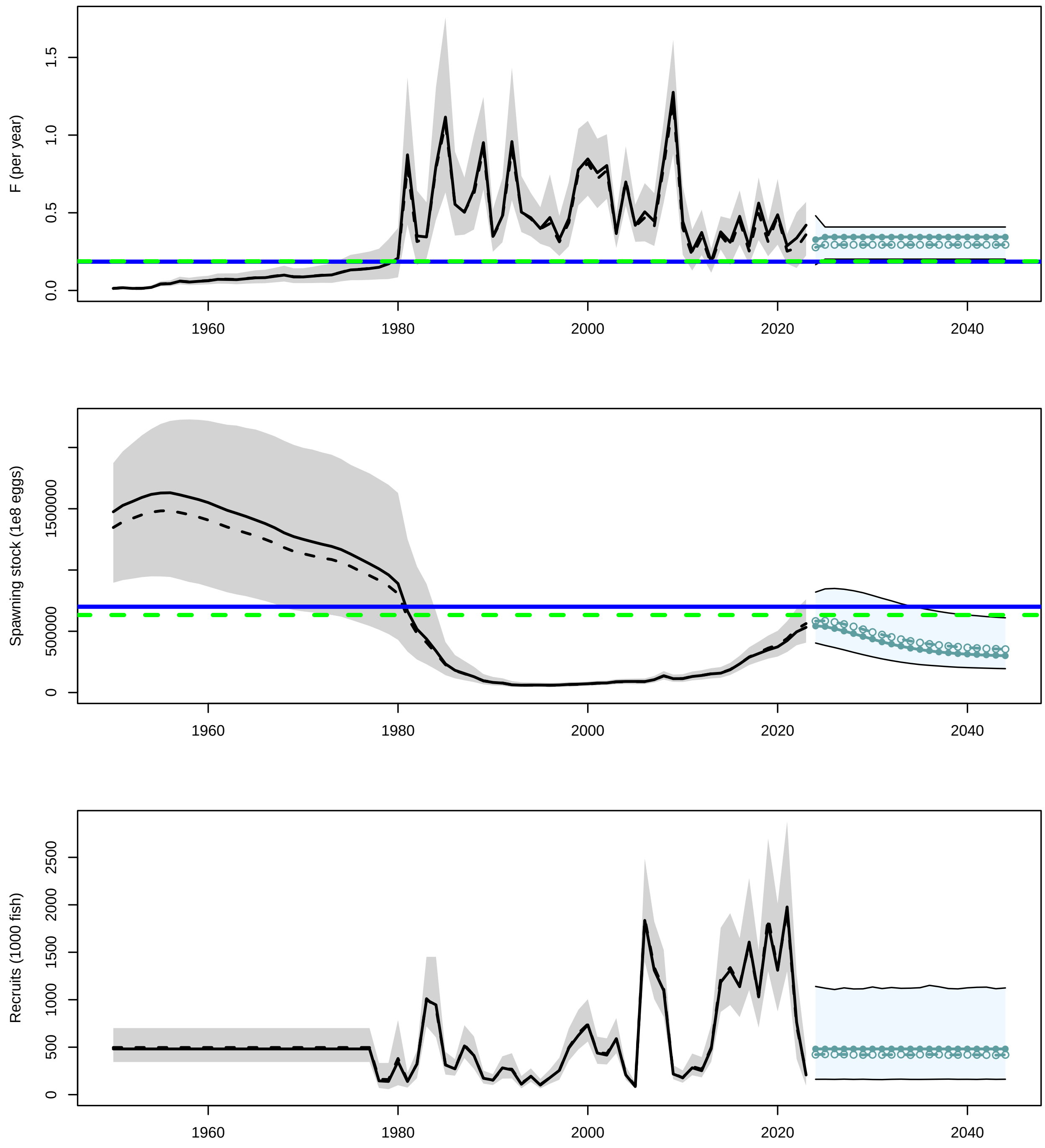


Figure 57. Projected probability of rebuilding under scenario 3—fishing mortality rate at $F = F_{\text{current}}$ and long-term average recruitment. The curve represents the proportion of projection replicates for which SSB *has reached the replicate-specific* $\text{SSB}_{\text{F30\%}}$*, with reference line at 0.5.*

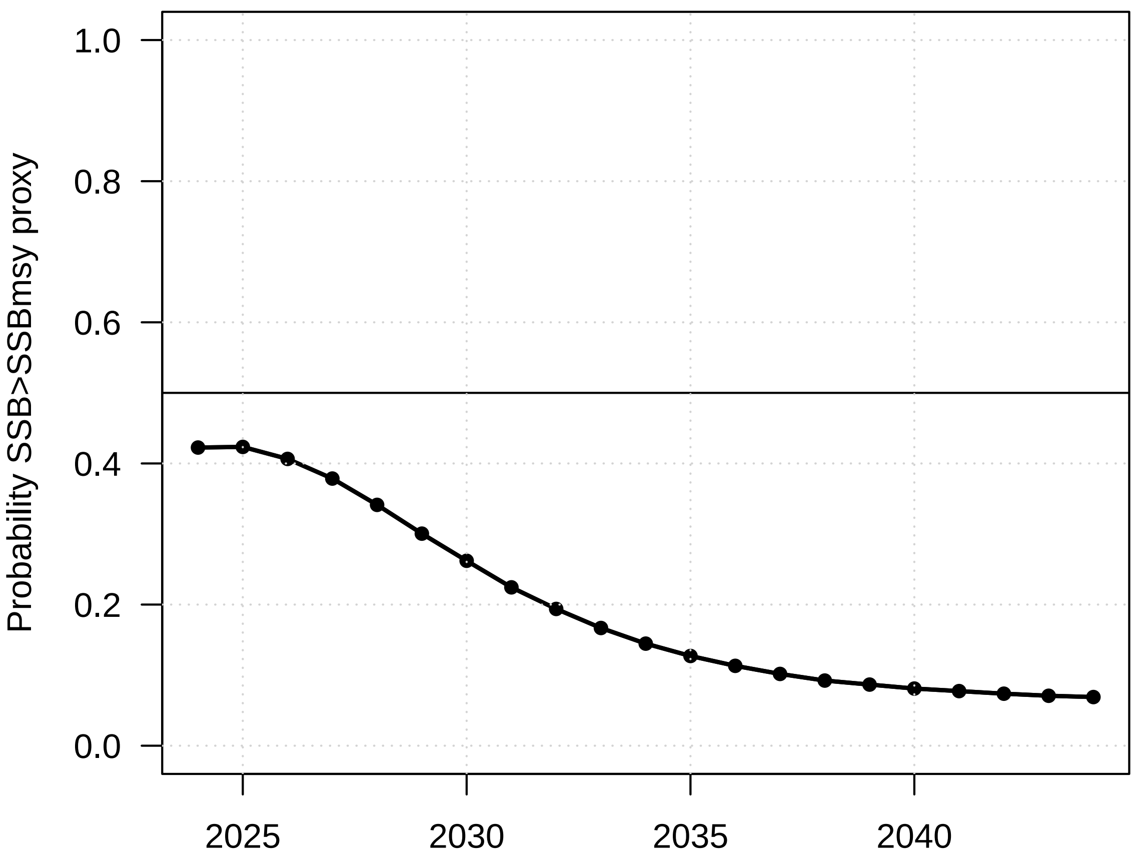
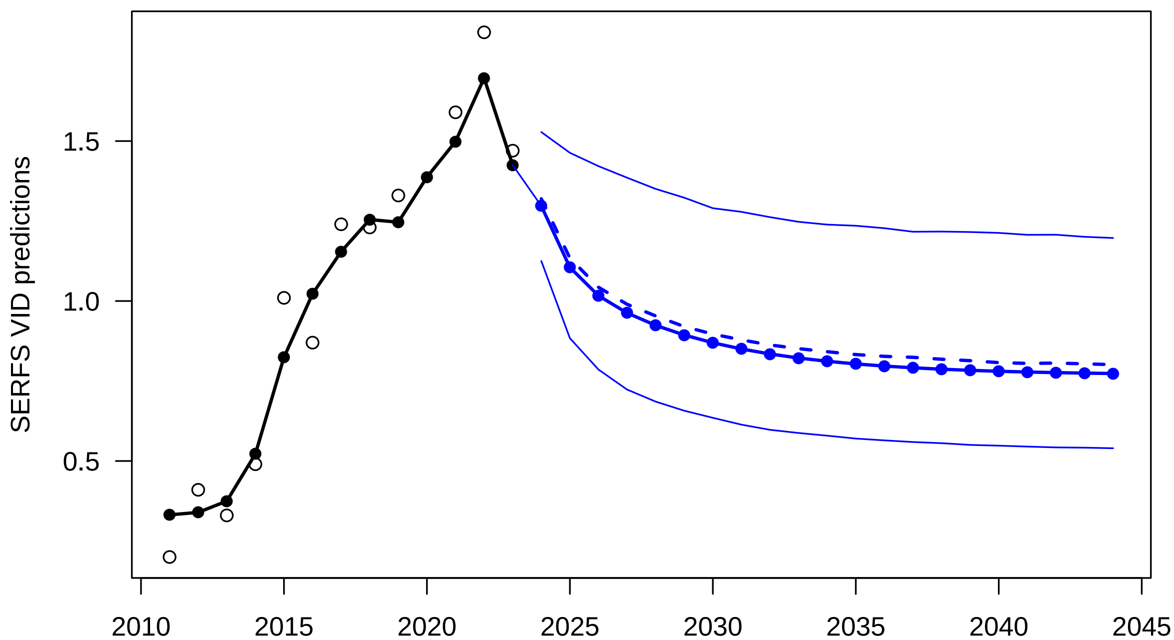


Figure 58. Projected indices of abundance under scenario 3—fishing mortality rate at $F = F_{\text{current}}$ *and long-term average recruitment. Top panel: SERFS video index. Bottom panel: SERFS chevron trap index.*



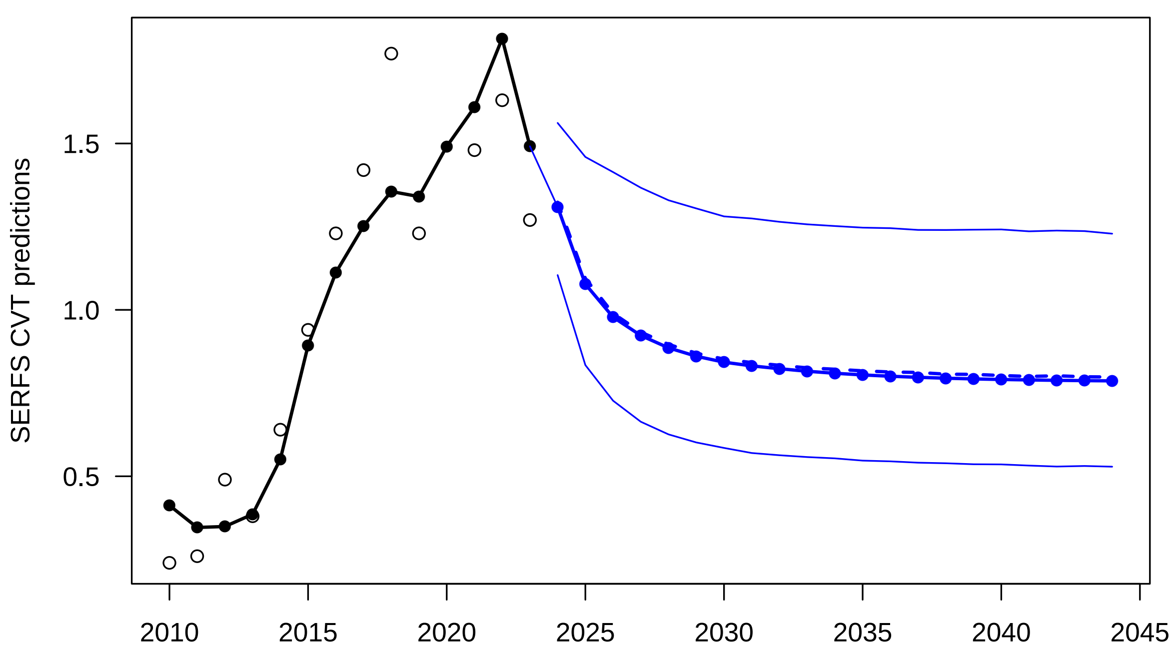


*Figure 59. Projected time series under scenario 4—fishing mortality rate at $F = F_{30\%}$ and recent (last 10 y) average recruitment. Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Solid horizontal lines mark $F_{30\%}$-related reference points (benchmarks); dashed horizontal lines represent corresponding medians. Spawning stock (*SSB*) is at time of peak spawning.*

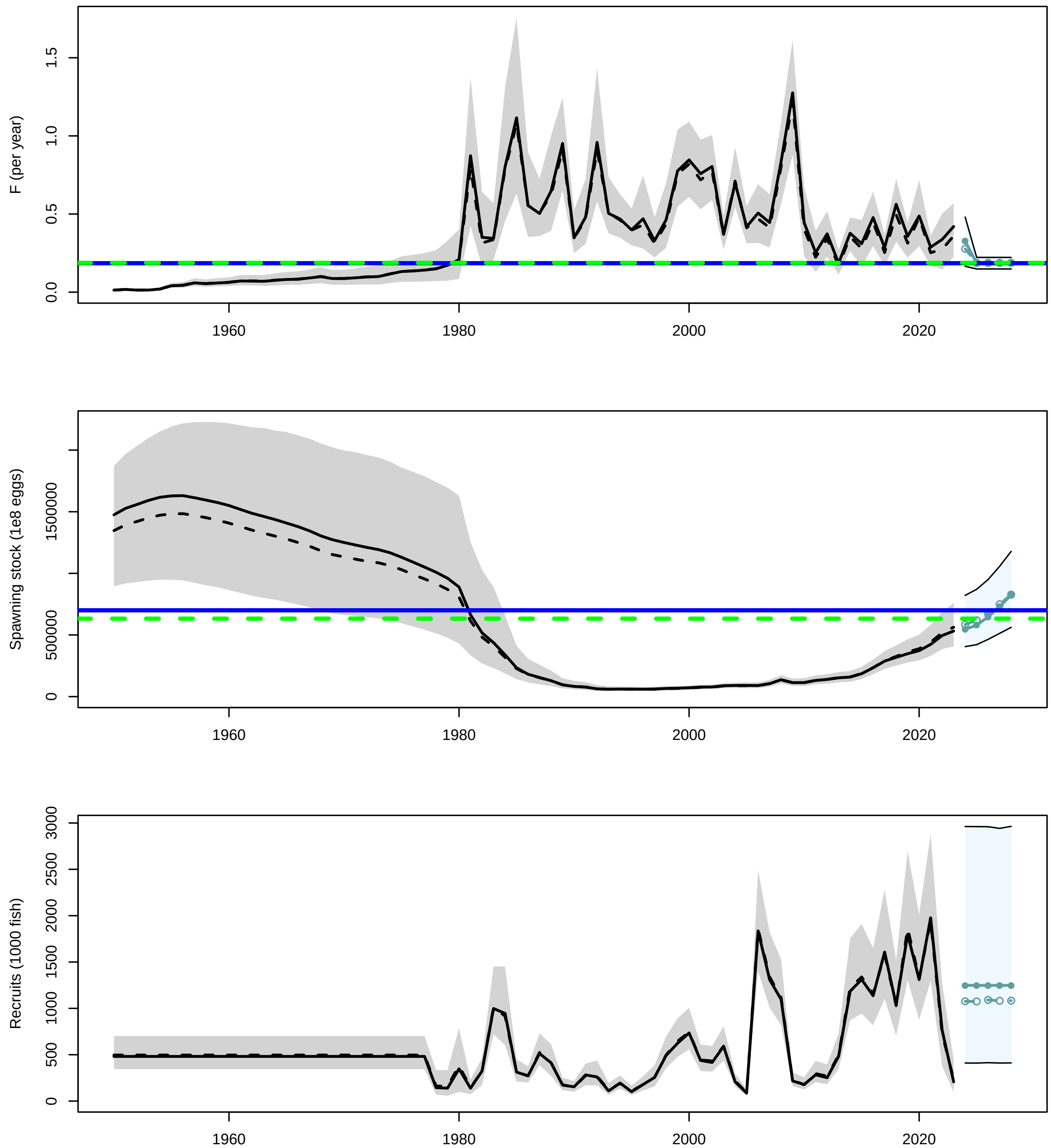


Figure 60. Projected probability of rebuilding under scenario 4—fishing mortality rate at $F = F_{30\%}$ *and recent (last 10 y) average recruitment. The curve represents the proportion of projection replicates for which* SSB *has reached the replicate-specific* $\mathrm{SSB}_{\mathrm{F30\%}}$*, with reference line at 0.5.*

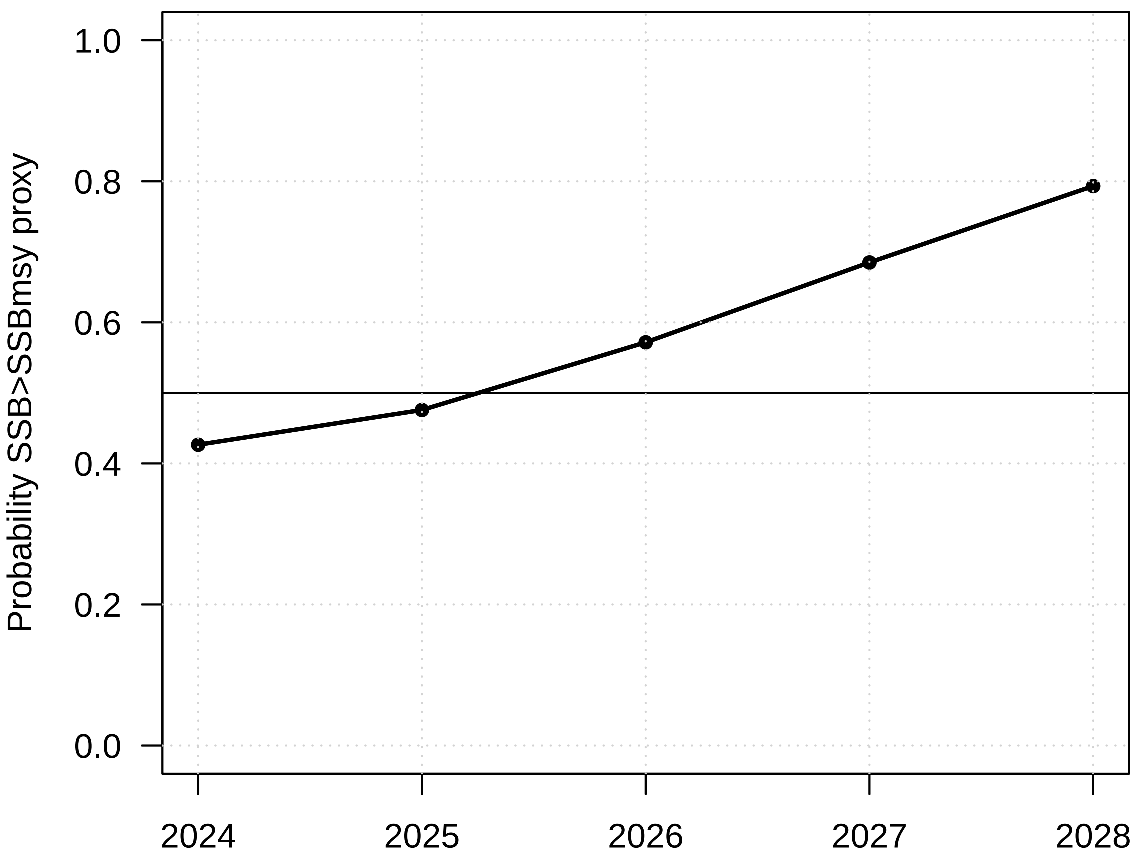
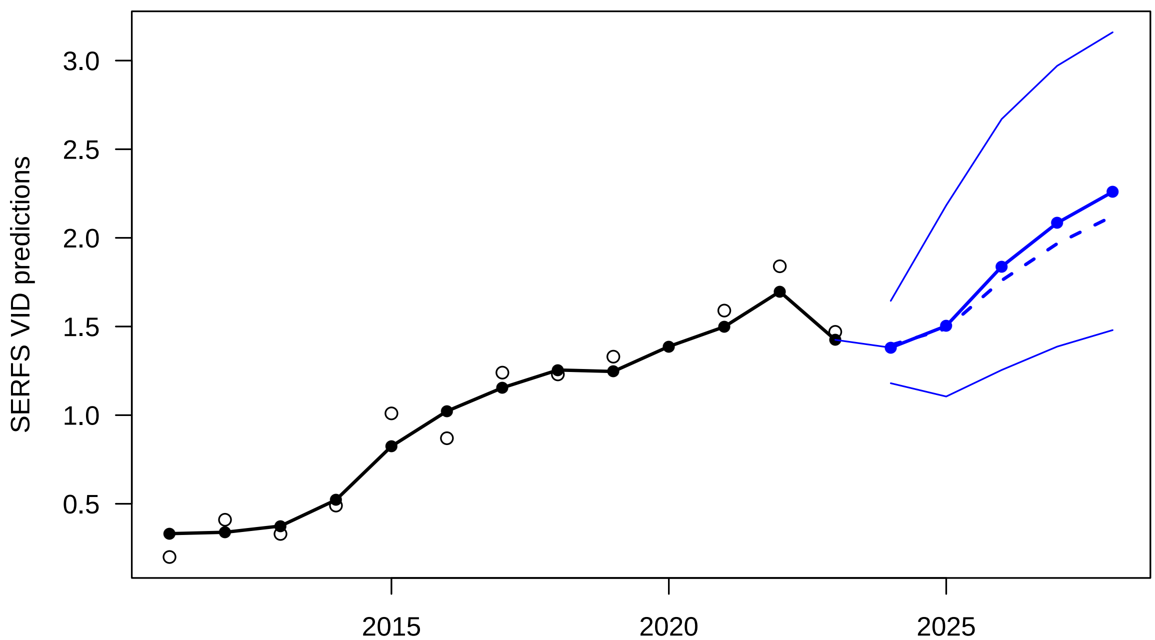


Figure 61. Projected indices of abundance under scenario 4—fishing mortality rate at $F = F_{30\%}$ and recent (last 10 y) average recruitment. Top panel: SERFS video index. Bottom panel: SERFS chevron trap index.



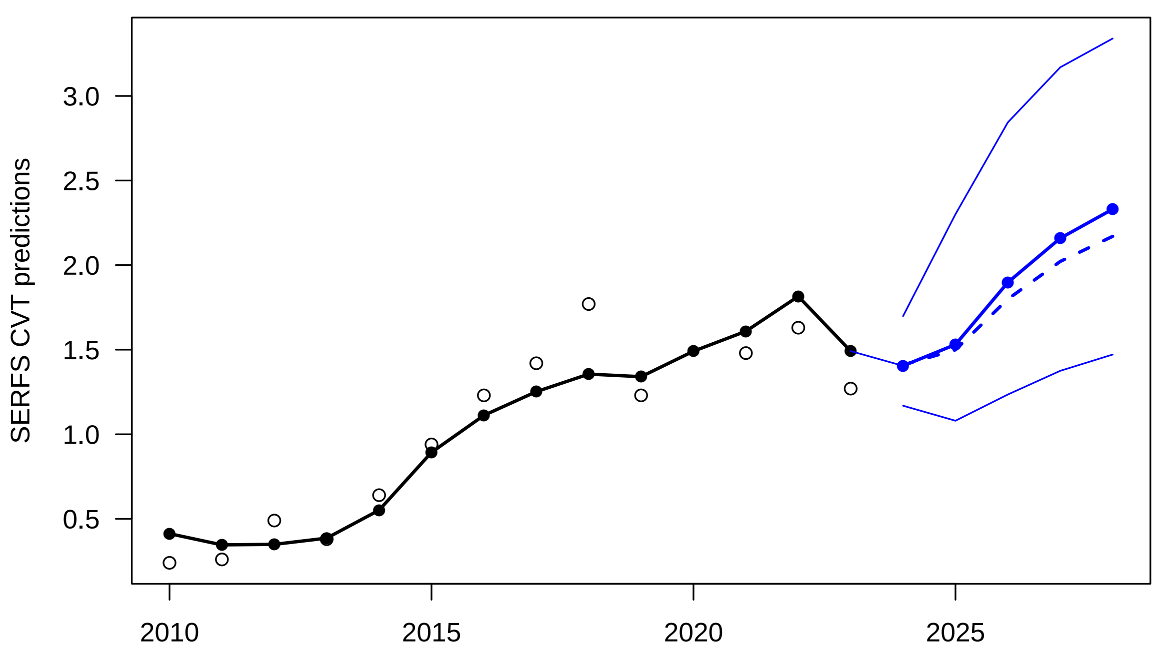


Figure 62. Projected time series under scenario 5—fishing mortality rate at $F = F_{\text{current}}$ and recent (last 10 y) average recruitment. Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Solid horizontal lines mark $F_{30\%}$-related reference points (benchmarks); dashed horizontal lines represent corresponding medians. Spawning stock (SSB) is at time of peak spawning.

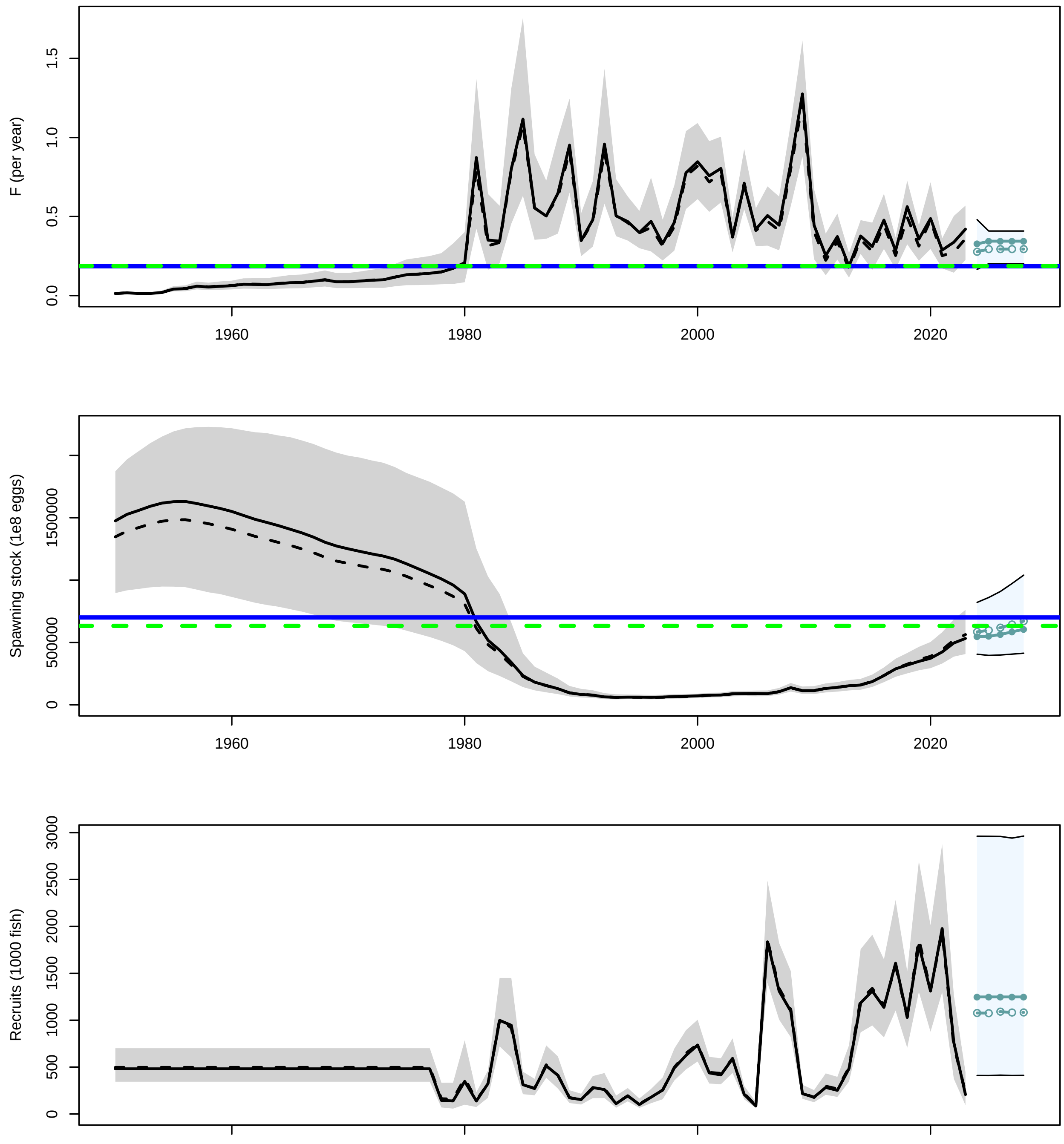


Figure 63. Projected probability of rebuilding under scenario 5—fishing mortality rate at $F = F_{\text{current}}$ and recent (last 10 y) average recruitment. The curve represents the proportion of projection replicates for which SSB *has reached the replicate-specific* $\text{SSB}_{\text{F30\%}}$*, with reference line at 0.5.*

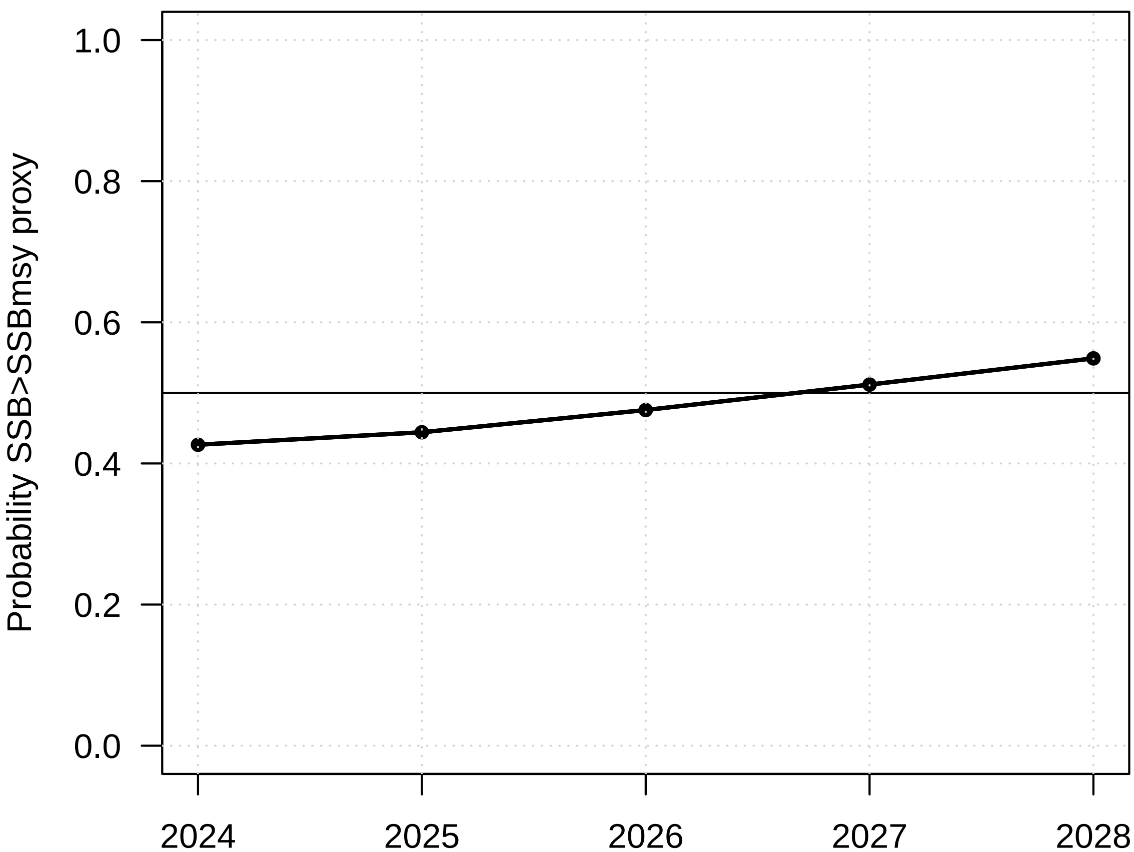


Figure 64. Projected indices of abundance under scenario 5—fishing mortality rate at $F = F_{\text{current}}$ and recent (last 10 y) average recruitment. Top panel: SERFS video index. Bottom panel: SERFS chevron trap index.

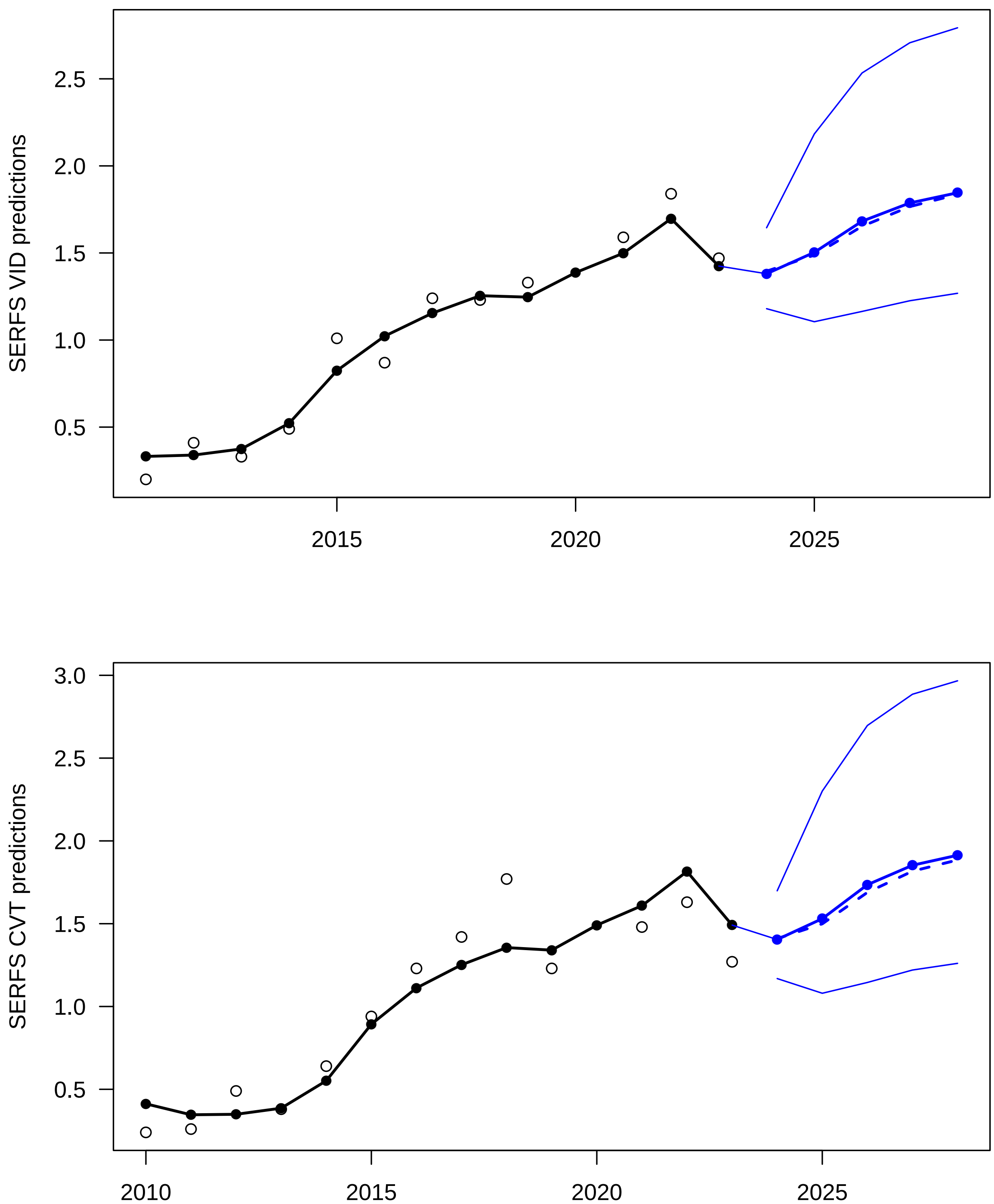


Figure 65. Projected time series under scenario 6—fishing mortality rate at $F = CF_{30\%}$ and recent (last 10 y) average recruitment. The multiplier C is such that the 2028 spawning stock achieves $0.86\mathrm{SSB}_{\mathrm{F30\%}}$ with probability P=0.5. Expected values (base run) represented by solid lines with solid circles, medians represented by dashed lines with open circles, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Solid horizontal lines mark $F_{30\%}$-related reference points (benchmarks); dashed horizontal lines represent corresponding medians. Spawning stock (SSB) is at time of peak spawning.

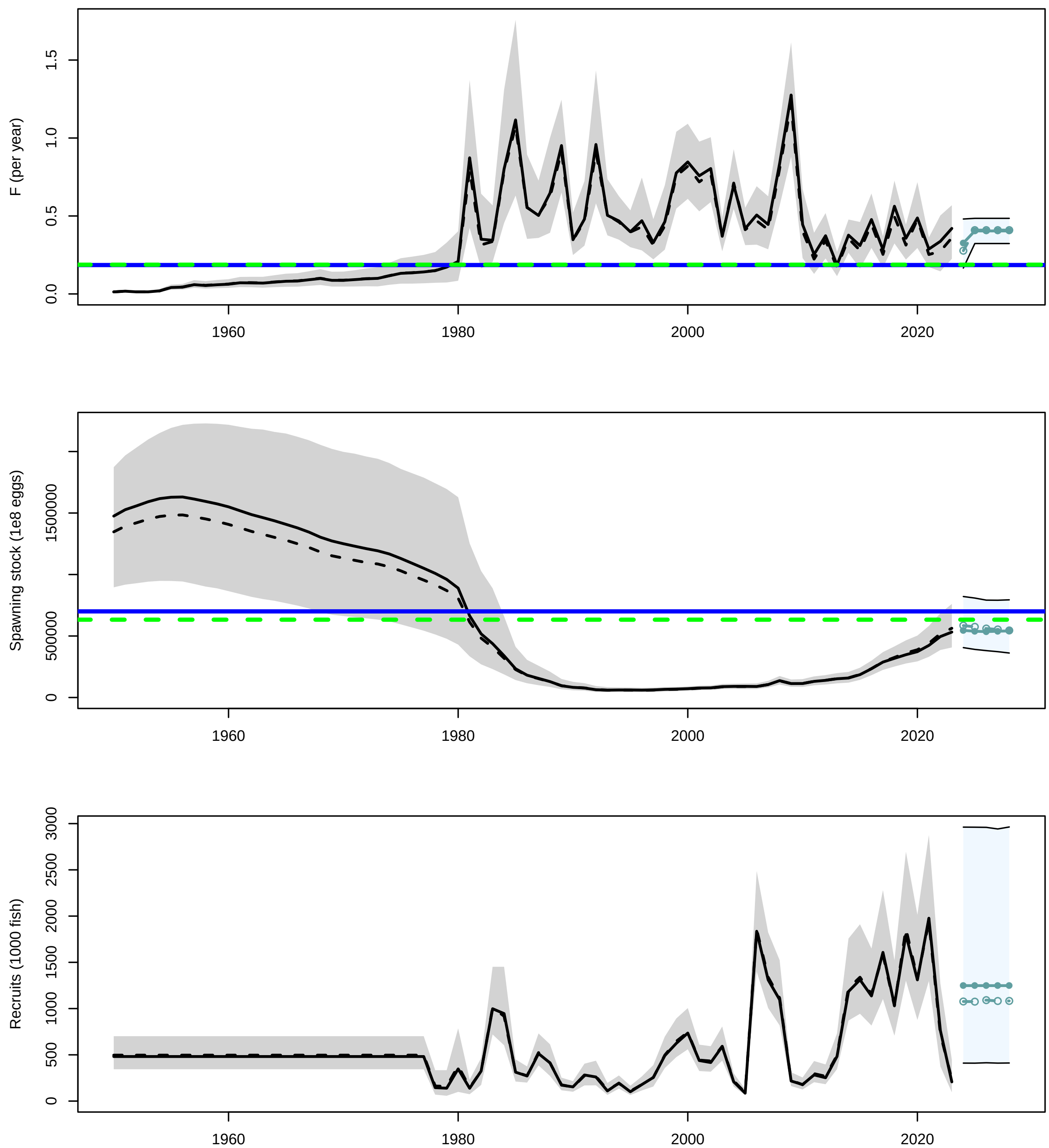


Figure 66. Projected probability of rebuilding under scenario 6—fishing mortality rate at $F = CF_{30\%}$ and recent (last 10 y) average recruitment. The multiplier C is such that the 2028 spawning stock achieves $0.86\mathrm{SSB}_{\mathrm{F30\%}}$ *with probability P=0.5. The curve represents the proportion of projection replicates for which* SSB *has reached the replicate-specific* $\mathrm{SSB}_{\mathrm{F30\%}}$*, with reference line at 0.5.*

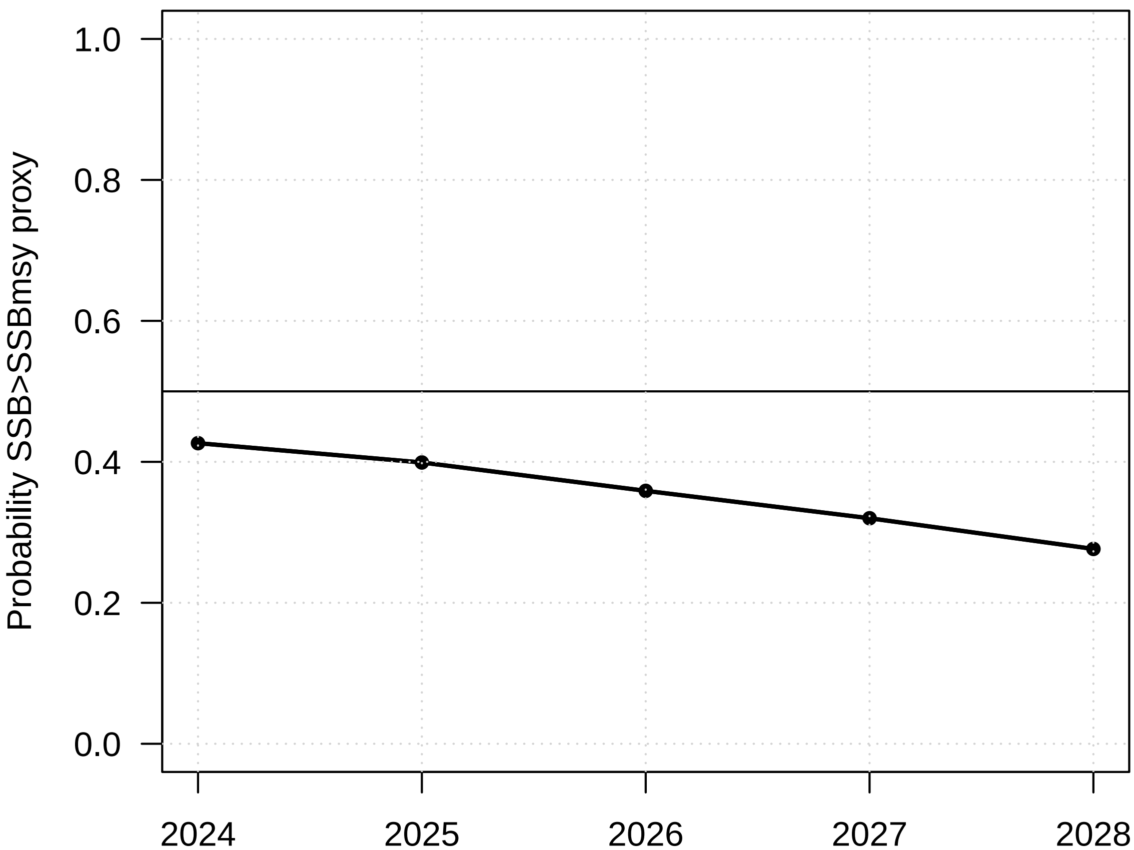


Figure 67. Projected indices of abundance under scenario 6—fishing mortality rate at $F = F_{30\%}$ *and recent (last 10 y) average recruitment. The multiplier C is such that the 2028 spawning stock achieves* $0.86\mathrm{SSB}_{\mathrm{F30\%}}$ *with probability P=0.5. Top panel: SERFS video index. Bottom panel: SERFS chevron trap index.*

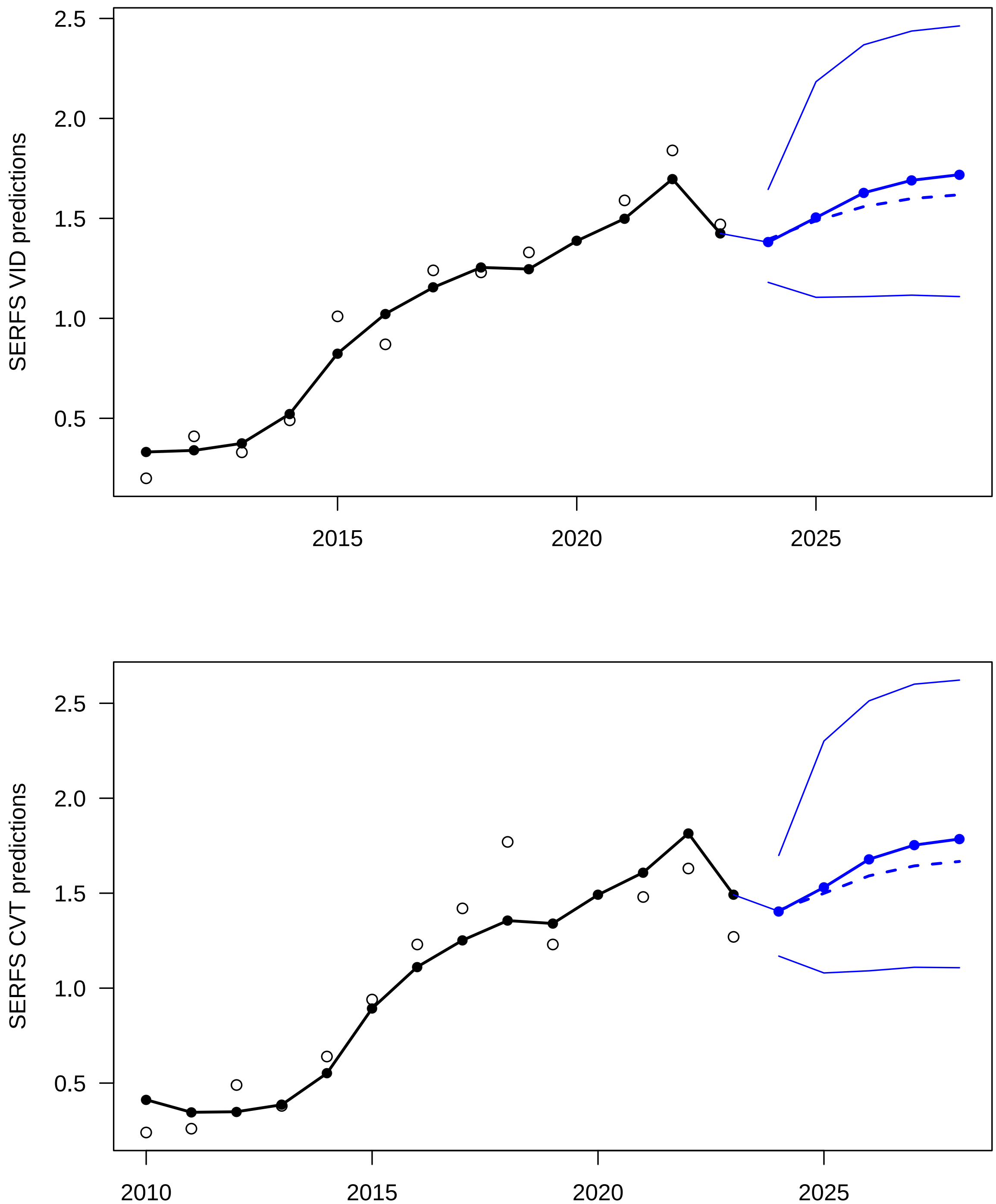


Figure 68. Projected trade-off between 2025 landings and dead discards under scenario 6—fishing mortality rate at $F = CF_{30\%}$ *and recent (last 10 y) average recruitment.*

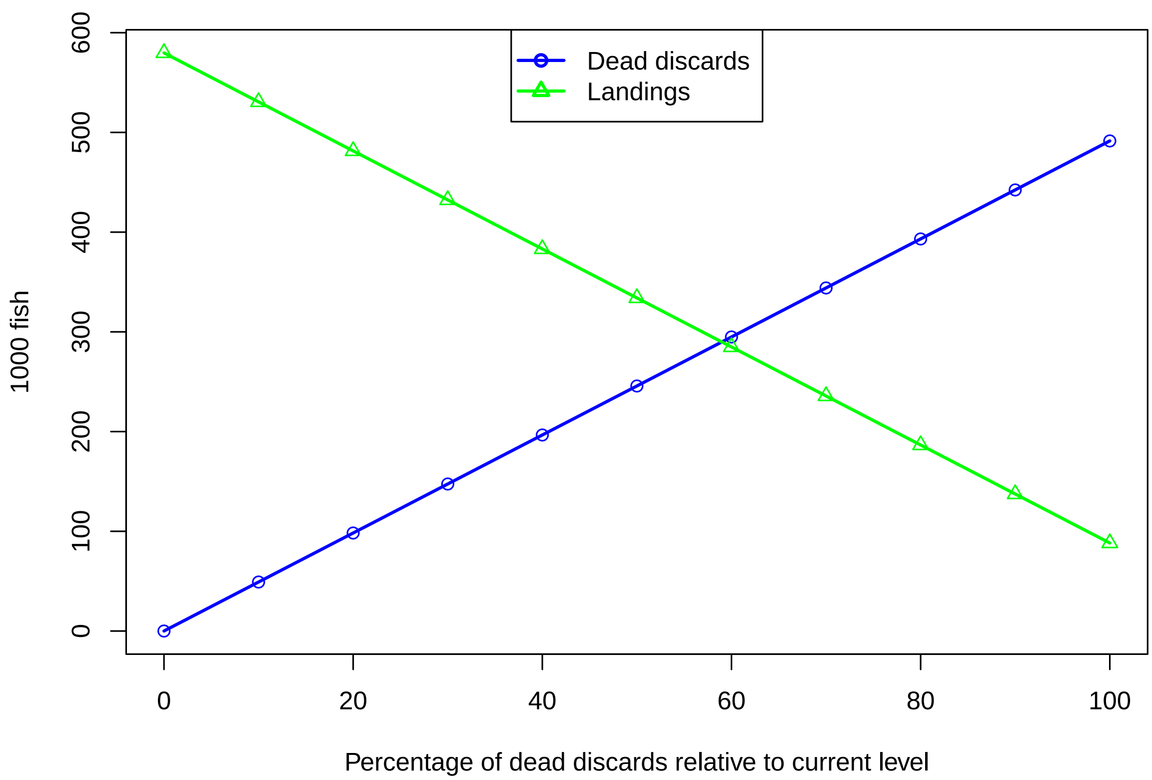
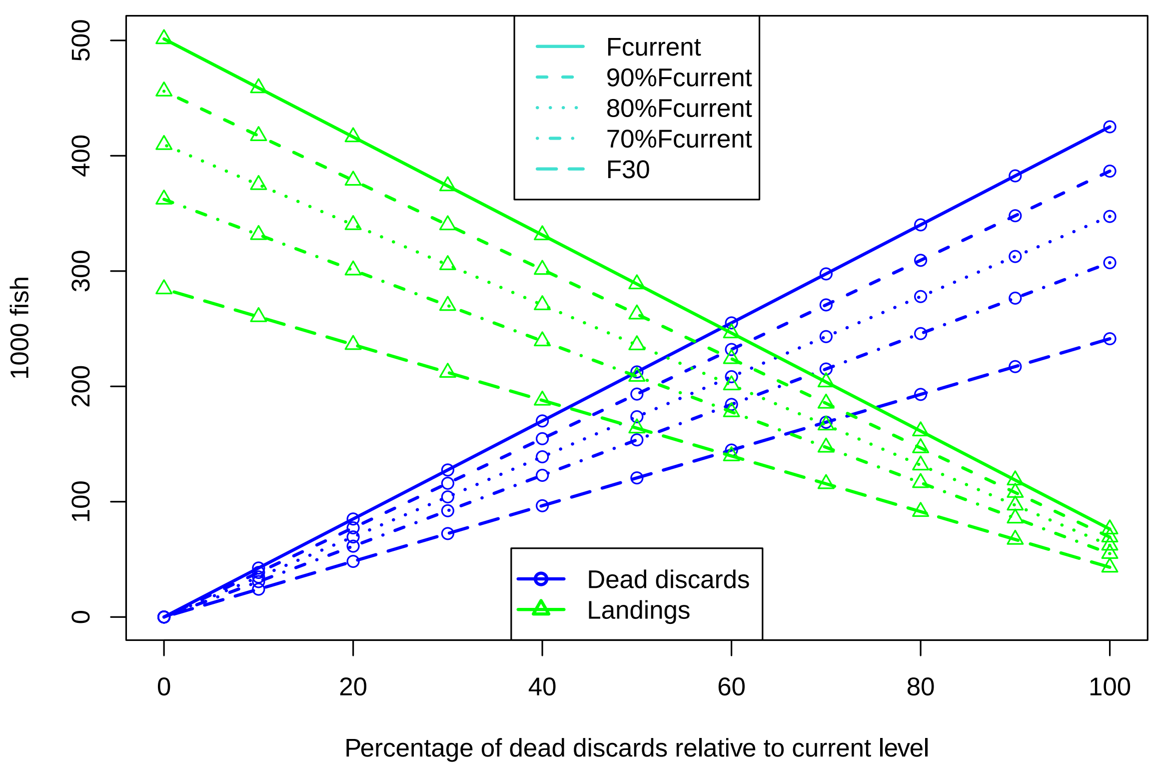


Figure 69. Projected trade-off between 2025 landings and dead discards under scenarios 4, 5, 7, 8, 9—fishing mortality rate at the level indicated and recent (last 10 y) average recruitment.



Appendix A Abbreviations and symbols

Table 31. Acronyms and abbreviations used in this report

Symbol	Meaning
ABC	Acceptable Biological Catch
AW	Assessment Workshop (here, for red snapper)
ASY	Average Sustainable Yield
B	Total biomass of stock
BAM	Beaufort Assessment Model (an integrated, statistical catch-age formulation)
CPUE	Catch per unit effort; used after adjustment as an index of abundance
CV	Coefficient of variation
CVT	SERFS chevron trap gear
DW	Data Workshop (here, for red snapper)
F	Instantaneous rate of fishing mortality
$F_{30\%}$	Fishing mortality rate at which $F_{30\%}$ can be attained
F_{MSY}	Fishing mortality rate at which MSY can be attained
FHWAR	The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey
FL	State of Florida
FWRI	Fish and Wildlife Research Institute (Florida)
GA	State of Georgia
GLM	Generalized linear model
GW	Gutted weight of a fish
K	Average size of stock when not exploited by man (carrying capacity); or, Brody growth coefficient of the von Bertalanffy equation
kg	Kilogram(s); 1 kg is about 2.2 lb.
klb	Thousand pounds; thousands of pounds
lb	Pound(s); 1 lb is about 0.454 kg
m	Meter(s); 1 m is about 3.28 feet.
M	Instantaneous rate of natural (non-fishing) mortality
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program, a fishery-independent data collection program of SCDNR
MCB	Monte Carlo/Bootstrap, an approach to quantifying uncertainty in model results
MCBE	Monte Carlo/Bootstrap Ensemble approach, another name for MCB
MFMT	Maximum fishing-mortality threshold; a limit reference point used in U.S. fishery management; typically based on F_{MSY} or its proxy
mm	Millimeter(s); 1 inch = 25.4 mm
MRFSS	Marine Recreational Fisheries Statistics Survey, a data-collection program of NMFS, predecessor of MRIP
MRIP	Marine Recreational Information Program, a data-collection program of NMFS, descended from MRFSS
MSST	Minimum stock-size threshold; a limit reference point used in U.S. fishery management.
MSY	Maximum sustainable yield (per year)
mt	Metric ton(s). One mt is 1000 kg, or about 2205 lb.
N	Number of fish in a stock
NC	State of North Carolina
NMFS	National Marine Fisheries Service, same as "NOAA Fisheries Service"
NOAA	National Oceanic and Atmospheric Administration; parent agency of NMFS
OY	Optimum yield; SFA specifies that OY $\leq$ MSY.
PSE	Proportional standard error
R	Recruitment
SAFMC	South Atlantic Fishery Management Council (also, Council)
SC	State of South Carolina
SCDNR	Department of Natural Resources of SC
SDNR	Standard deviation of normalized residuals
SEDAR	SouthEast Data Assessment and Review process
SERFS	SouthEast Reef Fish Survey
SFA	Sustainable Fisheries Act; the Magnuson–Stevens Act, as amended
SL	Standard length (of a fish)
SRHS	Southeast Region Headboat Survey, conducted by NMFS-Beaufort laboratory
SPR	Spawning potential ratio
SSB	Spawning stock biomass; mature biomass of males and females
$\mathrm{SSB}_{\mathrm{MSY}}$	Level of SSB at which MSY can be attained
$\mathrm{SSB}_{\mathrm{F30\%}}$	Level of SSB at which $F_{30\%}$ can be attained
TIP	Trip Interview Program, a fishery-dependent biodata collection program of NMFS
TL	Total length (of a fish), as opposed to FL (fork length) or SL (standard length)
VID	SERFS video gear
VPA	Virtual population analysis, an age-structured assessment
WW	Whole weight, as opposed to GW (gutted weight)
yr	Year(s)

Appendix B Parameter estimates from the Beaufort Assessment Model

```
# Number of parameters = 421 Objective function value = 22944.7654220538  Maximum gradient component = 0.00161281400228124
# Linf: (FIXED)
911.360000000
# K: (FIXED)
0.240000000000
# t0: (FIXED)
-0.330000000000
# len_cv_val:
0.128074990283
# Linf_L: (FIXED)
927.000000000
# K_L: (FIXED)
0.220000000000
# t0_L: (FIXED)
-0.660000000000
# len_cv_val_L:
0.0958399729390
# Linf_20: (FIXED)
938.000000000
# K_20: (FIXED)
0.170000000000
# t0_20: (FIXED)
-2.41000000000
# len_cv_val_20:
0.100000030308
# log_Nage_dev: (FIXED)
 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000
 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000
 0.00000000000 0.00000000000 0.00000000000
# log_R0:
12.9428135382
# steep: (FIXED, NOT IMPLEMENTED IN NULL RECRUITMENT MODEL)
0.990000000000
# rec_sigma:
0.537503204655
# R_autocorr: (FIXED)
0.00000000000
# log_rec_dev:
 -1.06386622702 -1.10411944380 -0.189272079048 -1.10703494327 -0.253638929028 0.871542374772 0.816359336284 -0.291412881061
 -0.430681102889 0.205873372738 -0.0130043471852 -0.887268591440 -1.00119815993 -0.394042897114 -0.471722023911 -1.33735777850
 -0.764300788740 -1.42311535936 -0.850481873998 -0.492316553192 0.162451997203 0.401526016053 0.565539496692 0.0479153995955
 -0.00257553688205 0.345303429712 -0.696954697852 -1.58630461977 1.48100022041 1.14319324572 0.964722322998 -0.654805469228
 -0.846320770815 -0.387322049072 -0.502469672620 0.146955794597 1.04380686471 1.14542895142 1.00272574793 1.34897275182
 0.918595854463 1.49668581263 1.18516954602 1.56009427317 0.602094831031 -0.704370844245
# log_dm_cH_lc:
0.738166397745
# log_dm_cH_D_lc:
2.26109642321
# log_dm_HB_D_lc:
3.60385985986
# log_dm_GR_D_lc:
3.54657498700
# log_dm_cH_ac:
1.09045831318
# log_dm_HB_ac:
-1.62271106476
# log_dm_CVT_ac:
-0.998012481082
# log_dm_GR_ac:
-1.45309138403
# selpar_A50_cH1:
1.24269977921
# selpar_slope_cH1:
4.98171533510
# selpar_A50_cH2:
2.80808704354
# selpar_slope_cH2:
3.48828357337
# selpar_A50_cH3:
2.57091965952
# selpar_slope_cH3:
2.23617251946
# selpar_A50_HB1:
1.62390291091
# selpar_slope_HB1:
3.29805350380
# selpar_A502_HB1:
4.41033954798
# selpar_slope2_HB1:
0.288743711732
# selpar_A50_HB2:
2.76933929090
# selpar_slope_HB2:
3.98180224853
# selpar_A502_HB2:
3.19586034406
# selpar_slope2_HB2:
0.447902748983
# selpar_A50_HB3:
```

```
2.30094505461
# selpar_slope_HB3:
2.63582156224
# selpar_A502_HB3:
2.06560650858
# selpar_slope2_HB3:
0.179268736699
# selpar_A50_GR2:
2.88118483803
# selpar_slope_GR2:
2.97541780696
# selpar_A502_GR2:
2.86871000828
# selpar_slope2_GR2:
0.469859214762
# selpar_A50_GR3:
3.46043884560
# selpar_slope_GR3:
1.87548311426
# selpar_A50_HB2_D:
1.25986727769
# selpar_slope_HB2_D:
1.33942203770
# selpar_A502_HB2_D:
0.983354744239
# selpar_slope2_HB2_D:
1.72673351313
# selpar_A50_HB3_D:
1.13223245128
# selpar_slope_HB3_D:
1.21090354020
# selpar_A502_HB3_D:
2.30817204113
# selpar_slope2_HB3_D:
0.691657778724
# selpar_A50_GR3_D:
1.59018901891
# selpar_slope_GR3_D:
1.22784262745
# selpar_A502_GR3_D:
2.87228674562
# selpar_slope2_GR3_D:
0.948033541659
# selpar_A50_cH2_D:
1.37994807957
# selpar_slope_cH2_D:
1.05550841765
# selpar_A502_cH2_D:
2.43012834052
# selpar_slope2_cH2_D:
2.04838962978
# selpar_A50_cH3_D:
1.81077096137
# selpar_slope_cH3_D:
2.39141606979
# selpar_A50_CVT:
1.76683007977
# selpar_slope_CVT:
2.76741347561
# selpar_A502_CVT:
3.24710160878
# selpar_slope2_CVT:
0.170858036611
# log_q_cH:
-7.61593507568
# log_q_HB:
-12.9034520305
# log_q_HB_D:
-13.7886500145
# log_q_CVT:
-13.8373335508
# log_q_VID:
-13.9658315284
# M_constant: (FIXED)
0.110000000000
# log_avg_F_cH:
-3.68422278123
# log_F_dev_cH:
 -0.654736899037 -0.369962882813 -0.647161441556 -0.634996684798 -0.251058025423 -0.441232966714 -0.459124170167
 0.135205277208 -0.198928823182 -0.115103951552 -0.0800945077468 0.110378255115 -0.0793282125354 -0.342764228097
 -0.231987073520 -0.176333536925 -0.163852155237 0.127856192493 0.333083934709 -0.121120751005 -0.154197338736
 -0.255595947644 -0.359545128185 -0.663006175150 -0.164225266902 0.0945082771991 0.0777191594592 0.154226146074
 0.190859306383 -0.0807824134357 -0.0709489807781 0.157430738184 0.263981557078 0.400972916905 0.242348981894
 0.504651025966 0.715210050286 0.714621427311 0.671872275571 1.33041111168 1.41999552864 1.02007956100 1.10459471595
 1.82835005244 1.61594041795 1.58977987868 1.37999404751 1.18064799364 0.881210696689 0.837568472376 0.811876734367
 1.31646815941 1.20228185423 0.866166264732 1.06289362329 0.829291832506 0.525908811520 0.846477780254 0.951230617112
 1.38217388162 -2.42803437838 -4.89891853224 -2.24979778010 -0.939464426722 -0.280632865717 -3.08539546597 -3.78040378288
 -0.649726406522 -0.427794548686 -0.551499726483 -0.498079784323 -0.648976157712 -0.825080829791 -0.898375310769
# log_avg_F_HB:
-3.92098586581
# log_F_dev_HB:
 -0.318301844136 -0.0936773358698 0.124195494064 1.23983815802 0.971064493363 1.16397863374 0.792712898132
 1.45853239233 0.796830154185 1.28183468782 1.53044867100 1.30547870520 1.51736006958 1.15176910028 1.06091820869
 1.07373199494 1.07238841988 1.36921919677 0.942590054121 1.06911796115 0.671678397566 0.830657198912 0.758963251024
 0.936710290976 0.943217924206 0.183424277909 0.882543935672 0.791934921762 0.683623877682 0.805580231658 0.637386526604
```

```
  0.962340878705 -2.76938822242 -1.50820850059 -1.00224190638 -1.40406382385 -0.958481108622 -2.76190624200
  -3.90978902404 -1.95217743534 -1.55353148950 -1.66244013825 -1.94880518848 -1.60228135689 -2.88815038970 -2.67662699989
# log_avg_F_GR:
-2.21878970590
# log_F_dev_GR:
 -1.47095948653 -1.37120856547 -1.27379136680 -1.18269956860 -1.10179950659 -1.02524209068 -0.924817534764
 -0.831702711134 -0.749217446194 -0.672164701050 -0.596715554872 -0.579854142323 -0.561103646522 -0.538018014056
 -0.520902255258 -0.511507465732 -0.411562181147 -0.316974683487 -0.228171374757 -0.139385555157 -0.0459367199498
 -0.00971633173567 0.0218668270472 -0.0466461873825 0.178732858777 0.395237645922 1.95623248377 0.876472006543
 0.796719800375 1.87256451210 2.18094645938 1.34140315686 1.16308923365 1.49960659223 1.95202978686 0.167331972607
 1.10509041356 2.00275520073 0.837046499482 0.801653331388 0.339160068750 0.969636010488 0.434864572194 1.16165242289
 1.79049638772 1.88962492958 1.67507547289 1.76567414984 0.872412873662 1.45212937322 0.939911776959 1.32678202021
 1.08106231671 1.85666726558 2.27913541255 -6.02710551725 -6.08612326339 -0.297770490739 -1.16684292189 0.369500399792
 -2.72760910577 -6.30470897433 -0.748953251431 -0.0449733106523 0.0801786538621 0.0337085060296 -0.348856399825
 -0.833197088879 0.229786020138
# log_avg_F_cH_D:
-4.51965535996
# log_F_dev_cH_D:
 0.940606479324 0.901362088945 1.29409621914 1.54583143100 1.47327616907 1.24220408170 0.398638531596
 -0.116303246754 -0.239804038919 -0.0929364455983 0.671028082544 -0.527588816667 -1.59571843503 0.593332542097
 -1.57088229629 -1.20473516683 -1.26984753142 -0.471465876084 0.271558872592 1.28243704011 0.595320750240
 0.322083126985 0.477279206179 0.169951053783 0.110998508922 -0.600830409681 -1.09995340121 -1.20399771511
 -0.599316934180 -0.946596737497 -0.461749337078 -0.288277795882
# log_avg_F_HB_D:
-5.97853100929
# log_F_dev_HB_D:
 -4.74259972303 -3.68001987633 -4.26728289319 -4.16466536310 -3.85175591017 -3.77061063877 -3.52719769740
 -4.22075750466 0.00440413152053 0.662358036200 0.935327404452 1.21136436216 0.623919750329 0.256572715316
 -0.493816432383 -0.458224981156 -0.404702131989 0.157924262418 0.463014767979 -0.513818923522 1.92255243708
 2.09124605342 0.642186333325 1.73326363661 1.95557834066 2.55313818853 2.51421336434 2.31188133166 2.43595632499
 2.11671637884 1.44840677840 1.23168317532 1.36729721601 0.679464005355 0.891671749880 0.769935478344
 0.865491019800 0.896083296888 0.570784972884 0.783016562973
# log_avg_F_GR_D:
-2.04497316033
# log_F_dev_GR_D:
 -2.60263911446 -2.78625815868 -3.78422199151 -1.20615866802 -0.805533512177 -0.294894200855 -0.588830833096
 -1.13852660977 -1.21423012949 -0.847638810007 -1.11390421071 -1.19408327205 0.659672839061 0.459229912831
 0.322506982269 -0.620452670984 -1.85445717264 -0.548896772049 0.212309406089 0.588722877205 0.762138074098
 0.543509598902 0.555758106394 1.58672329148 0.726275936986 -0.0389797846426 0.364702542738 0.957890461044
 1.41944779509 1.12197818336 0.363195301619 0.815146158324 -0.00859588501978 0.636011128463 0.784905459345
 1.25297544571 0.638779739728 1.35786398742 0.772972858326 1.30089077793 0.619377067670 0.844843199617 0.980474664456
# F_init:
0.0356729213015
# logit_earlyrec_mult: (FIXED)
0.00000000000
```