Stock Assessment Review (STAR) Panel for Quillback Rockfish off California
Southwest Fisheries Science Center Auditorium, NOAA
110 McAllister Way | Santa Cruz CA 95060

June 23-27, 2025

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Overview
The Stock Assessment Review (STAR) Panel for quillback rockfish (*Sebastes maliger*) off California was held at the NOAA's SWFSC in Santa Cruz, CA on June 23-27, 2025. The meeting was hosted by the Pacific Fishery Management Council (PFMC) and followed the Terms of Reference for the Groundfish Stock Assessment Review Process for 2025-2026 (TOR) and Accepted Practices Guidelines for Groundfish Stock Assessments in 2025 and 2026. Quillback rockfish off California (simply referred to as quillback rockfish for the remainder of this report) are retained in commercial and recreational fisheries. Commercial catches increased with the establishment of a live fish fishery. Although quillback rockfish are generally not considered highly desirable among recreational fishers, most removals (~ 70%) take place within the recreational fishery.

The 2021 length-based data-moderate assessment estimated that the quillback rockfish stock off California decreased through the 1990s, then increased to 2007 because of above average recruitment, and declined again from the late 2010s to 2020, with a terminal estimate that was below the minimum stock size threshold (MSST; Langseth et al. 2021). As a result, rebuilding analyses were conducted in 2021 (Langseth and Wetzel 2022) and 2023 (Langseth 2024). Growth parameter estimates, variation in recruitment deviations, and especially high catches in some years were cited as major uncertainties for the 2021 assessment.

The 2025 full (benchmark) assessment was conducted by Brian Langseth (NWFSC), Melissa Monk (SWFC), and Julia Coates (CDFW). Considerable efforts were made to identify existing sources of age data and collect new demographic information to resolve uncertainty in key life history parameters (i.e., growth, maturity, and fecundity relationships). The 2025 assessment was informed by fishery-dependent catches and compositions as well as fishery-independent indices of relative abundance. Additional demographic data were used to externally estimate length-based maturity and fecundity and internally estimate growth. Natural mortality and steepness were fixed. Model results showed similar trajectories as the 2021 data-moderate estimate, although absolute estimates of spawning output and fraction unfished were higher throughout the time series. The 2025 assessment suggests that quillback rockfish stock off California have remained above the MSST but dropped below the management target in the late 1990s and early 2020s. Terminal estimates were above the management target.

Many discussions and formal requests during the STAR Panel focused on trying to understand effects of the growth fleet on recruitment (see Appendix I for STAR Panel requests, including rationale, STAT responses, and STAR Panel conclusions). The growth fleet included data from ten different sources with varied sampling schemes and spatiotemporal extents. These data were identified by the Panel as not being representative of the stock and by the STAT as not being representative of an individual fleet. The Panel endorsed two alternative models for use in the assessment: 1) a model that removed the growth fleet and treated age data from CCFRP as conditional age-at-lengths for the CCFRP fleet and 2) a model that included only Abrams (2014) data in the growth fleet and treated age data from CCFRP as conditional age-at-lengths for the CCFRP fleet. Although the Panel continued to have concerns about using unrepresentative samples to inform recruitment dynamics (e.g., modeling Abrams data in a growth fleet), the Panel concluded that either of the alternative models, which resulted in similar recruitment deviations and estimates of productivity, could move forward as the new base. The STAT elected to proceed with the second alternative as the revised base model. The Panel recommends continued investigation into how best to treat ancillary age data for this stock.

Summary of Data and Assessment Models

The 2025 benchmark assessment for quillback rockfish was performed using an integrated age-structured model (single area, sex-aggregated) in Stock Synthesis (SS3 v3.30.23.1).

Input Data

- Two (2) catch data streams: commercial removals and recreational removals (historical estimates based on catch reconstructions; discard data included, where available)
- Three (3) abundance indices: private/rental recreational fleet (CA_Recreational), California Collaborative Fisheries Research Program (CCFRP) hook-and-line survey (CA_CCFRP), CDFW's remote operated vehicle (ROV) survey (CA_ROV)
- Four (4) fleets with length composition data: commercial (CA_commercial), recreational (CA_recreational), CCFRP (CA_CCFRP), and ROV (CA_ROV)
- Two (2) fleets with conditional age-at-length (CAAL) data: commercial (CA_Commercial), growth fleet (CA_growth).
    - The growth fleet for the pre-STAR base model included data from 10 different sources and excluded years with less than 30 age samples.
    - Two alternatives for the growth fleet were identified for the post-STAR base model: 1) a model that removed the growth fleet and added CCFRP ages to the CCFRP fleet (with the minimum sample restriction removed) and 2) a model that included only Abrams (2014) age data in the growth fleet and moved CCFRP ages to the CCFRP fleet (with the minimum sample restriction removed). The STAT elected to proceed with the second alternative model endorsed by the Panel.

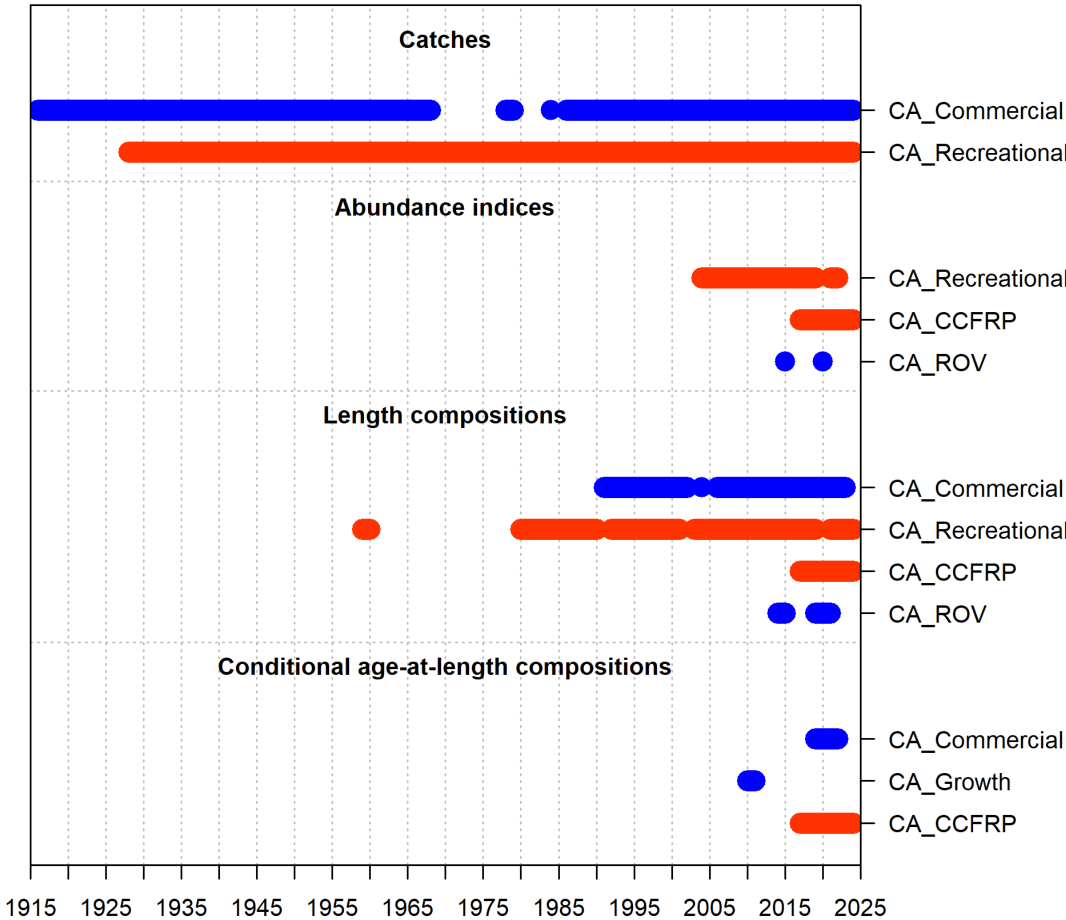

Figure 1. Input data by year and fleet, organized by type (catches, abundance indices, length compositions, and conditional age-at-length compositions).

Model Specifications

- The assessment period began in 1916, when the first catch record was available. The stock was assumed to be unfished and in equilibrium condition at that time.
- The model included ages 0 yr (recruits) to 80 yr (plus group) with a step size of 1 yr and lengths 4 cm (size at birth) to 59 cm (plus group) with a step size of 1 cm. Data were binned in 1 yr increments from 1 to 60 yr and 2 cm increments from 10 to 50 cm.
- Growth was internally estimated using the Schnute parameterization of the von Bertalanffy growth model. Growth was assumed to be sex- and time-invariant.
- Ageing error was estimated externally.
- A lognormal prior for natural mortality (*M*) with a median of 0.068 and a log-standard deviation of 0.31 was based on the Hamel and Cope (2022) prior and A_{max} equal to 80 yr.
- The length-weight relationship was estimated externally as: $W = 1.57769 \times 10^{-5} L^{3.08018}$.
- Length-at-maturity was estimated externally using a logistic curve with $L_{50\%}$ = 28.96 cm and a slope of -0.606.
- The length-fecundity relationship was estimated externally as: $F = 4.216 \times 10^{-8} L^{4.44}$.
- The sex ratio (female to male) was fixed at 0.5.
- Recruitment dynamics were assumed to follow the Beverton-Holt stock-recruit relationship with steepness (*h*) fixed the mean of a beta prior (0.72) with σ = 0.16. Recruitment deviations were estimated from 1940 to 2024, with the main recruitment estimation period being between 1978 and 2021 and σ_R fixed at 0.60. The model used the sum-to-zero constraint for recruitment deviations.

- Selectivities for the commercial and recreational fleets were length-based, included time blocks, and allowed for dome-shaped curves. Selectivities for survey fleets were length-based and assumed to be asymptotic. Selectivity for the growth fleet was fixed at 1.

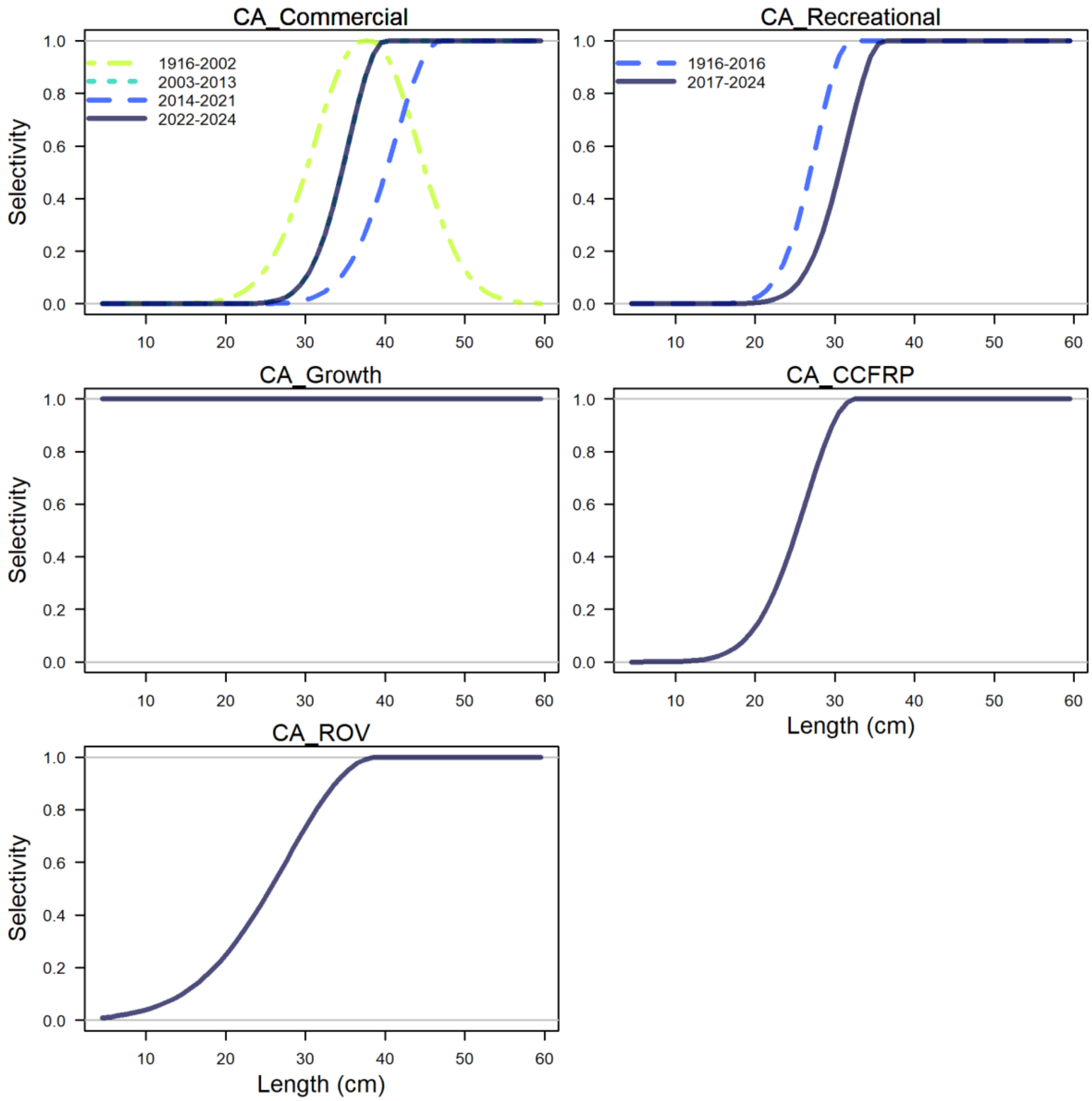

Figure 2. Selectivity curves by length, fleet, and time block.

Description of the Alternative Models used to Bracket Uncertainty in the Decision Table
Prominent sources of structural uncertainty in the base model were natural mortality (*M*, fixed at 0.068) and steepness (*h*, fixed at 0.72). Different values of *M* resulted in a much wider range of estimates for current spawning biomass and stock status, thereby justifying natural mortality as the axis of uncertainty for decision tables. The fixed value of *M* for the base model was based on the median of an *M* prior, where 5.4 is divided by the maximum age (Hamel and Cope 2022).

The maximum age (A_{max}) for this assessment was assumed to be 80 yr. A strong latitudinal trend in observed maximum ages was identified for quillback rockfish throughout their range, where maximum age estimates were 57 yr for CA, 63 yr for OR, 73 yr for WA, 84 yr for BC, and 92 yr for AK (one fish from BC was estimated to be 95 yr in the scientific literature). A maximum age of 57 yr is unlikely for quillback rockfish off California, given the limited sampling of ages used to derive this value.

The predicted OFL for 2025 (lognormally distributed) and a sigma of 0.5 (as used for Category 1 assessments) were used to identify low and high states of nature for *M*. This follows the Accepted Practices Guidelines for Groundfish Stock Assessments in 2025 and 2026. The 12.5th and 87.5th percentiles of this distribution, which corresponded to 6.1 mt and 19.2 mt, were then calculated. The values of *M* that would predict these OFLs are approximately 0.0525 and 0.0800, which correspond to maximum ages of 103 yr and 67.5 yr, respectively. The high state of nature was therefore associated with A_{max} = 67.5, which is older than the maximum age observed for California (i.e., 57 yr). As mentioned previously, A_{max} = 57 yr is highly unlikely given limited sampling in time and space. Thus, a maximum age more similar to what has been observed for OR or WA is more probable. Quillback rockfish off the US West Coast could theoretically reach a maximum age greater than 95 yr (as observed in BC) because fishing took place prior to sampling for ages in the northeast Pacific Ocean.

The Panel was unable to evaluate projections for the decision table, which will be made available in the post-STAR Panel assessment report.

Technical Merits of the Assessment

The Panel found several technical merits:

- This assessment represents a major improvement upon the data-moderate assessment from 2021 (Langseth et al., 2021).
- Considerably more information was incorporated, including a new fishery-dependent index, two new fishery-independent indices (CCFRP and ROV), and additional conditional age-at-length data. Several other data sources were explored for indices of abundance but excluded from the model due to low sample sizes and species identification issues.
- The STAT clearly worked extremely hard to incorporate and extract the most information from available data.
- Model fits were generally good or adequate.
- A wide range of sensitivities were performed to identify sources of uncertainties (e.g., input data, model structure). These included multiple runs with different values for important parameters (e.g., *M*) and removing key datasets (e.g., ages).
- The assessment clearly demonstrates the importance of age data, which supports further efforts to improve the representativeness of various sources prior to the next assessment.
- Bridging analysis clearly showed which data sources were driving different outcomes.

Technical Deficiencies of the Assessment

The Panel found the following technical deficiencies:

- The ROV index was developed as ‘super years’ to address the spatial and temporal aspects of the survey design. This limited estimates from the index to only two years. The Panel recommends a reanalysis of these data using a spatiotemporal model to increase the number of years that can be used in future assessments.
- Despite considerable efforts to increase the amount of age data available for this assessment, CAAL data remain limited.
- The inclusion of age data from multiple sources with different sampling objectives and spatiotemporal coverages as part of a single growth fleet was considered problematic by the Panel because doing so risked undue and/or erroneous effects on the scale and pattern of recruitment. This may become less of an issue as more age data, better spatiotemporal sampling, and/or age data linked to catches become available.
- Natural mortality (*M*) was estimated from the maximum age of fish sampled from the inside waters of British Columbia. Because there appears to be a latitudinal decline in maximum ages from Alaska to California, using a prior based on the maximum age from Canada could underestimate *M*. The Panel recommends reconsidering the most appropriate maximum age for this stock, especially if/when new information becomes available.
- Age and length data were more influential on abundance than the indices of abundance. Ideally, an assessment model should draw on information about abundance from the data sources specifically designed to provide abundance information. Although there are only

two years for the ROV index, its influence was reduced compared to composition data (especially ages). Following Francis (2011), index data should be more influential.

- There was a relatively strong retrospective pattern that aligns with the sequential removal of age data. This suggests that the assessment tends to underestimate biomass and stock status in the terminal year.

Recommended Sigma Value

The model estimates sigma at 0.188 (log scale) for the 2025 OFL. This is an underestimate of uncertainty due to structural assumptions such as fixing natural mortality. Thus, the default sigma should be used, depending on the category assigned.

There was considerable discussion about the category designation for this stock, with two potential options: 1b (default sigma = 0.5) or 2d (default sigma = 1.0). Based on the description of categories in the TOR, the STAR Panel identified this stock as Category 1 (OFL determined from an F_{MSY} proxy). When considering the subcategory descriptions, however, the stock could be categorized as 1b or 2d. The distinction would depend on the interpretation of "reliable age composition data". The STAR Panel supports a Category 1b for this stock because the assessment represents a considerable improvement over the previous assessment, which was identified as a Category 2 stock. This assessment integrates the best available length and age data, fishery-independent indices, and estimates the 2025 OFL using an F_{MSY} proxy. Additional uncertainties that may be considered for revising σ are described elsewhere in this document. The Council may also consider information relative to σ based on the risk table (to be provided in the post-STAR panel stock assessment report).

Recommended Next Assessment Type

The base model represents a considerable improvement upon the previous data-moderate assessment. The STAR Panel recognizes the extraordinary efforts of all those involved in compiling additional information for this assessment, particularly those who collected new age data to inform key life history parameters. Several uncertainties were identified in this assessment, some of which were related to the specific uses of these data. When there are sufficient data (historical or recent) to improve model structure and performance, the Panel recommends a benchmark assessment. Otherwise, an update would be appropriate.

Areas of Disagreement

There were no disagreements within the Panel.

There was a single point of disagreement between the STAT and the STAR Panel, which centered around use of a 'growth fleet' in the pre-STAR base model. Principally, the inclusion of a growth fleet was to enable use of age data not associated with a catch or survey fleet to inform internal estimates of growth and other processes.

Disagreement between the STAR Panel and STAT was focused on the apparent influence of age data from the growth fleet on recruitment. The relevant data included in the growth fleet from the pre-STAR base model consisted of a relatively small number of ages (n = 736) collected from ten different sampling schemes between 1985 and 2024. One of the Panel's concerns related to the likelihood that few, if any, of these sampling schemes would provide age data that were representative of the stock or the fishery. The principal area of concern was the effect of including these data on the estimation of peaks in recruitment (timing and scale) and recent productivity (which was elevated). The Panel considered it possible and even likely that the ages from different sampling schemes could produce recruitment signals that were not real, simply due to disparate spatial and/or temporal patterns in sampling effort. This issue was explored through a series of Panel requests. The STAT provided several sensitivity runs that removed different components of the age data from the growth fleet, including a run that excluded the growth fleet entirely. Age data from CCFRP were removed from the growth fleet and used as CAAL for the CCFRP survey fleet because these data were considered more likely to be representative by the STAT.

Disagreements about data used in the growth fleet continued until the Panel indicated that it was unable to endorse the pre-STAR base model as configured. At that point, the meeting focused on two alternative models that could meet perspectives of both the Panel and the STAT. One alternative model removed the growth fleet and treated age data from CCFRP as conditional age-at-lengths for the CCFRP fleet. The other included only Abrams (2014) data in the growth fleet and treated age data from CCFRP as conditional age-at-lengths for the CCFRP fleet. The alternative model that included a reduced growth fleet (using only the Abrams data) was seen as desirable because it would enable that model configuration in an update assessment with a growth fleet. Excluding other data sources in the growth fleet would prevent unwanted interactions among age data from different sampling schemes. Although the reduced growth fleet model retained an effect on recruitment and recent productivity, its influence was much less than that produced by the pre-STAR base model. The discussions around this disagreement were all conducted in a professional, respectful, and appropriate manner. The disagreement was resolved by settling on a reduced growth fleet model (using only the Abrams data) as the revised base model.

It is important to state that the Panel was not intending to make judgments about the statistical validity or appropriateness of the sampling schemes to collect ancillary age data used for internal estimates of growth. The primary concern of the Panel was whether the data were appropriately configured in the pre-STAR base model (i.e., as a unified growth fleet that informs recruitment and stock productivity in addition to growth). The Panel greatly appreciates the considerable effort that went into collecting these data and recognizes their importance external to the assessment model.

Management, Data, or Fishery Issues

The GAP advisor noted that discussions during the review primarily focused on data availability for nearshore stocks. The 2025 quillback rockfish assessment incorporated additional California-specific data that resulted in a notable shift from the 2021 data-moderate assessment outcome. While this new information improved the assessment, the dataset remains less comprehensive than those available for other more established groundfish stocks. Data sources vary in quality and are often inconsistent across time series. The division at Cape Mendocino (40°10` N) remains an important delineation due to different fishing practices and environmental conditions north and south of the boundary. Data collection efforts in both regions are essential for adequately characterizing the stock. Ongoing changes to management measures further complicate the interpretation of trends over time.

The GAP emphasized the value of data collected through CCFRP, which continues to be one of the most complete sources of fishery-independent data for this stock. Following the 2021 assessment, which highlighted the lack of representative California data, many fishermen volunteered to assist with new data collection efforts. Given anticipated constraints in federal funding, community- and industry-based data collection may become increasingly critical. The GAP expressed concern that recent suggestions about the limited utility of newly collected data could discourage future industry participation.

The GAP encourages continued use of CDFW's ROV survey and supports changes to the survey design (and/or development of appropriate spatiotemporal models) that may promote its use as an absolute estimate of abundance. The GAP acknowledged the high-quality work conducted by the STAT, STAR Panel, and Council staff and expressed appreciation for their responsiveness and thorough review process.

The pre-STAR base model included a growth fleet informed by age data from multiple sources; however, based on feedback from the STAR panel, several of these data sources were removed in the post-STAR model due to concerns about their representativeness. In response to GMT inquiries, the STAT clarified that the removed age data were not representative of the recreational fleet's length compositions. While the rationale for exclusion was understood, the GMT noted that the industry, NMFS, and CDFW age data were collected specifically to address data gaps identified in the 2021 quillback rockfish assessment. Although these data were not used directly in the model, they proved valuable in informing biological parameters such as maximum age and fecundity. Moving forward, the GMT recommends that stock assessment scientists work with survey designers and management agencies to revise sampling protocols to ensure future age data collections can be incorporated more directly into assessments.

The GMT also inquired about the selection of maximum age for quillback rockfish off California. The STAT used a value based on fish sampled from British Columbia's inside waters. The GMT expressed concern that this may not reflect conditions in California, which represents the southern extent of the species' range. The oldest quillback rockfish sampled off California was 57 yr, while the model used a maximum age of 80 yr. The STAT provided a summary table indicating a latitudinal trend in maximum age, with lower maximum ages observed at more southern latitudes.

Regarding model structure, the GMT commented on the use of dome-shaped selectivity for commercial removals prior to 2000, which transitioned to asymptotic selectivity in subsequent periods. The GMT found it unexpected that earlier, less-regulated fisheries would exhibit dome-shaped selectivity whereas more regulated periods would reflect an open selectivity pattern. The STAT responded that this configuration was supported by the available data.

The GMT extends its appreciation to the STAT, STAR Panel, and Council staff for their efforts and the opportunity to engage in the review process.

Unresolved Problems and Major Uncertainties

Although the uncertainty around spawning biomass and other estimated or derived parameters was relatively small, there are major uncertainties in this stock assessment. The Panel identified the following remaining uncertainties for this assessment:

- The inclusion of a growth fleet for this stock highlights several uncertainties associated with including multiple data sources (age data in this case) that have different sampling schemes and spatiotemporal coverages. Using conditional age-at-length data in a growth fleet assists with internal estimation of growth parameters, including the variability around length-at-age. The growth fleet also appeared to influence the magnitude and specific year of strong recruitment events.
- The choice of which age data to include in the growth fleet had a large effect on recruitment (see more description above in the "areas of disagreement" section). The way in which these varied sources of data affected recruitment remains an important uncertainty. Different recruitment patterns were most notable for strong year classes in the early to mid 1990s and in recent years. This uncertainty could not be resolved during the STAR Panel meeting.
- The fixed value for natural mortality remains highly uncertain, with *M* selected as the axis of uncertainty for use in decision tables. The fixed value of natural mortality was justified using observed maximum ages. However, a latitudinal trend in *M* was observed, with the lowest maximum age for California. The value of *M* used in the assessment has a large effect on model outcomes, without considering age- or time-varying aspects.
- Historical catch reconstructions for West Coast rockfishes are highly uncertain due to the combination of multiple species into general market categories and small sample sizes to determine proper expansion factors to estimate catch. Historical catch reconstructions can change the scale of the assessment and may result in unusual (large or small) catches that do not match trends.
- Stock structure was a concern for this assessment for several reasons. If there are two different stocks off northern California, one stock with relatively low biomass could result in unnecessary catch restrictions for the other. Data sources tended to come from south or north of Cape Mendocino, making it difficult to estimate relative differences between the two areas. A better understanding about stock structure for quillback rockfish off California would be beneficial for assessment and management.

Recommendations for Future Research and Data Collection

The Panel identified the following research recommendations for this assessment:

- A major unresolved issue was the utility of using a growth fleet in Stock Synthesis, where conditional age-at-length data from multiple sources and sampling designs are used in a single fleet that assumes constant (full) selectivity across all ages and lengths. There are concerns that using age data that are not representative of the stock or a fishery may introduce unrepresentative signals in recruitment and other dynamics. Additionally, the assumption of full selectivity has unknown consequences. Further evaluation of a) the utility of age data external to the assessment model and b) the pitfalls of combining age data from multiple sources across time and space are needed to better understand how the growth fleet may influence multiple aspects of the model (specifically recruitment). This research may include investigating length-based selectivities, identifying how different sampling designs may introduce bias, conducting simulation studies with a range of assumptions about the growth fleet, and exploring whether next generation stock assessment models will be able to resolve these issues in an unbiased and efficient manner. This research would inform best practices for including ancillary age data that may not have been explicitly collected using representative (e.g., randomized, systematic) sampling designs.
- This assessment considerably benefitted from the inclusion of age data that were collected since the previous data-moderate assessment. The quantity and potential uses of these data available are, however, still constraining. Additional data that are more representative of the stock or a particular fishery should be collected and analyzed prior to the next assessment. More ages that are sampled in a representative manner from the commercial fishery would be most beneficial. Secondarily, age data that are representative of the recreational fleet should be sought. One way forward could involve replicating the sampling design from Abrams (2014) to increase the length of that time series. Sufficient fishery-dependent data that are collected in a representative manner should be sufficient to estimate growth within the model (without use of a growth fleet that relies on multiple data sources). Additional age data would assist in a better understanding of maximum age for the California stock and thus improve the approximation of *M*.
- Continued collection of gonads for length- and/or age-based estimates of maturity and fecundity.
- Combining ROV survey data into ‘super years’ reduces the number of estimation years for the index (two at present). Re-analyzing the ROV survey data using a spatiotemporal model may increase the utility of each observation and the index should the spatial design of the survey change.
- Develop a robust prediction grid for index standardization (e.g., CCFRP and ROV). Consider fitting a spatiotemporal model and predicting across a uniform spatial grid with covariate information to create the index of abundance (via summing grid-specific predictions). This would be especially important for habitat variables (e.g., depth, substrate type, temperature) that exhibit spatial heterogeneity.
- Evaluate MRFSS and CRFS catch data for all nearshore demersal rockfishes to better understand the degree of confidence in especially high catches (e.g., recreational in 1983 and 1993, commercial in 1991).
- Evaluate recruitment pulses for other nearshore demersal rockfishes to better understand the degree of confidence in a strong 1994 year class and more recent 2016 and 2017 year classes.
- Collect and/or analyze new information to refine stock structure definitions for quillback rockfish off California, with a focus on the areas north and south of Cape Mendocino.

The Panel identified the following research recommendations for groundfish stock assessments (in general):

- Appropriately weighting length and age compositions remains a challenge but identifying maximum input sample sizes based on expected observation uncertainty and down-weighting accordingly is a practical method. A bootstrapping approach to identifying maximum sample sizes (Hulson et al. 2023; Hulson and Williams 2024) may improve upon existing methods. The Panel recommends exploring different approaches to data weighting for West Coast groundfish assessments.
- Sensitivity analyses should evaluate inclusion and exclusion of the growth fleet to ensure minimal effects on recruitment and stock status.
- Historical catch reconstructions should be accompanied by uncertainty estimates. This will facilitate running sensitivity analyses on catch histories.
- Explore use of nonparametric correlation coefficients within Stock Synthesis to better account for differences in sample size and relax assumptions about normality.
- A paper is in review that describes methods to interpret one-step ahead (OSA) residuals in stock assessments (Stewart and Monnahan, in prep), with applicable code for use in Stock Synthesis. OSA residuals should be considered for future West Coast stock assessments to aid in weighting of different data sources and interpreting potential issues associated with the data weighting procedures used.

STAR Panel Requests, Rationale, and Summary of STAT Responses

1 - Request
Plot comparisons of age-0 recruits and recruitment deviations (separate plots without confidence intervals) for the following sensitivities: a) the pre-STAR base model, b) removal of all ages, c) removal of growth fleet, d) fixed growth at 2021 values with ages, e) fixed growth at 2021 values without ages, f) estimated *M*, and g) no blocks on selectivity. Please separate sensitivities into multiple plots if they are difficult to interpret.

1 - Rationale
There were considerable differences in the magnitude and variability in recruitment deviations between the 2021 and pre-STAR base model. Evaluating changes in time-varying recruitment based on incremental changes in the biological inputs would enhance our understanding about relative effects of new age data, updated growth parameters, estimating M, and time-blocking on recruitment.

1 - STAT Response
Age data contribute to the high peak in 1994, though years for other peaks vary by sensitivity (Fig. 1). The three scenarios removing age data reduced the peak in recruitment deviations and age-0 recruits in 1994. Removing all ages results in a peak in 1995 that is much smaller than the peak in 1994 under the pre-STAR base model. Removing just growth fleet ages results in a smaller peak than the pre-STAR base model, spread across 1994 and 1995. Removing ages while fixing growth results in a peak in 1999 with lesser peaks in 1996 and 1991. Fixing growth with age data results in lesser peaks in 1991 and 1996 along with the 1994 peak.

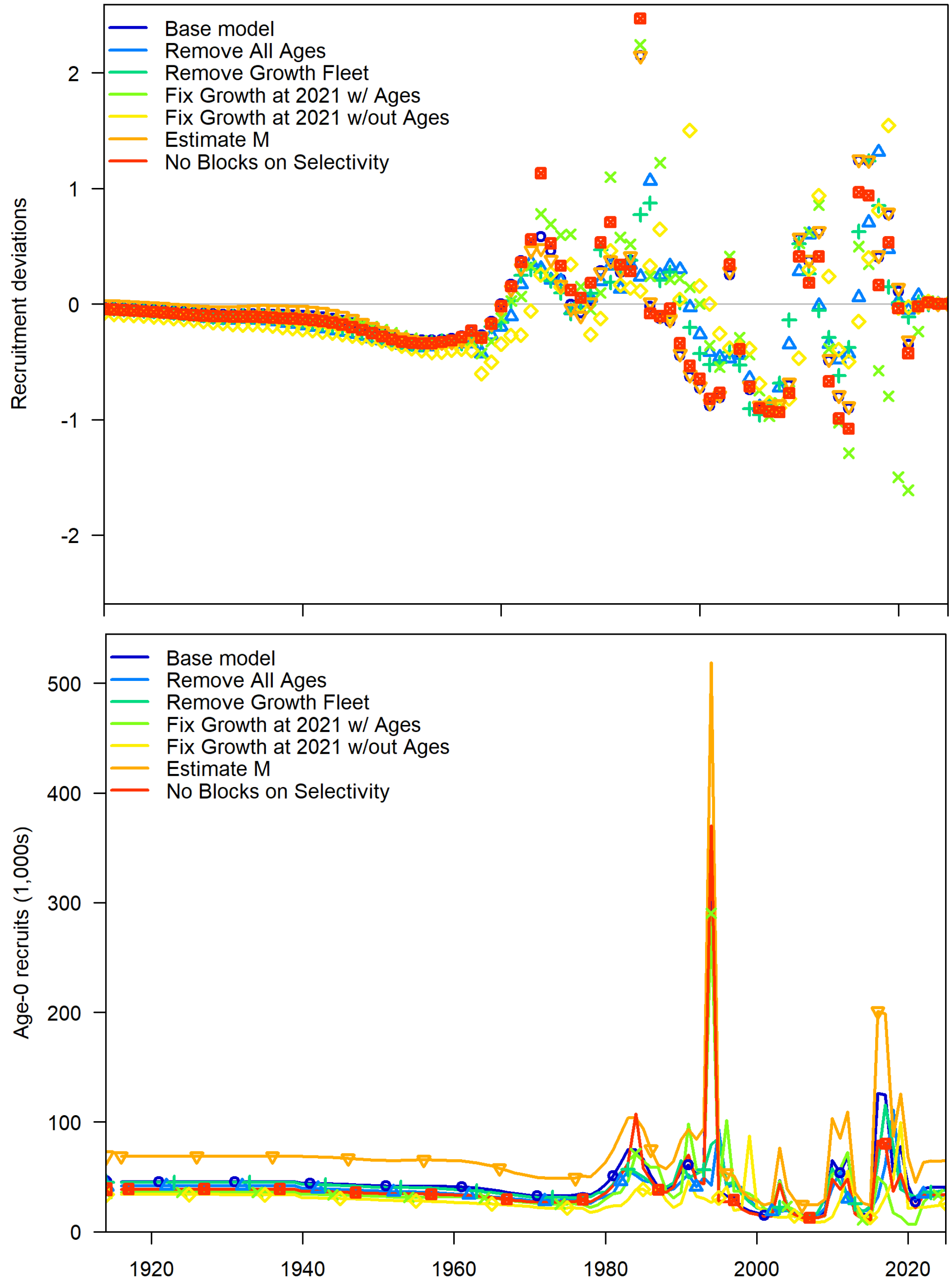

Figure 1. Recruitment deviations (top) and number of age-0 recruits (bottom) from a) the pre-STAR base model and the following sensitivities: b) removal of all ages, c) removal of growth fleet, d) fixed growth at 2021 values with ages, e) fixed growth at 2021 values without ages, f) estimated M, and g) no blocks on selectivity. Runs are independent and not cumulative.

1 - Panel Conclusion

The Panel appreciates the work done by the STAT. From this response, the “growth fleet” was identified as having a strong impact on recruitment, which the Panel understood to be unintentional and should probably be avoided. The effect on recruitment seems to be somewhat unavoidable given that the growth fleet is a major source of the age data for California quillback rockfish.

2 - Request
Plot recruitment deviations from a 15-year retrospective analysis using the pre-STAR base model.

2 - Rationale
Iteratively removing data from the pre-STAR base model will help identify how influential recent data are on estimation of the 1994 and other year classes.

2 - STAT Response
The estimation of the 1994 year class is robust to removals of the recent years of data. When removing 6 to 13 of the most recent years of data, the largest year class moves back one year to 1993 and is of comparable magnitude to the pre-STAR base model 1994 year class (Fig. 2A). Only when 14 and 15 years of recent data are removed does the peak in 1993/1994 recruitment deviations decrease to lower levels. The terminal year (when removing 14 years of data) is 2010, which is the first year that age data are included in the model. A histogram of birth years for all available age data shows peaks in 1993 and 1994 (Fig. 2B). The quillback rockfish born in 1993 and 1994 were caught from multiple years among all of the data sources, and as recently as 2025.

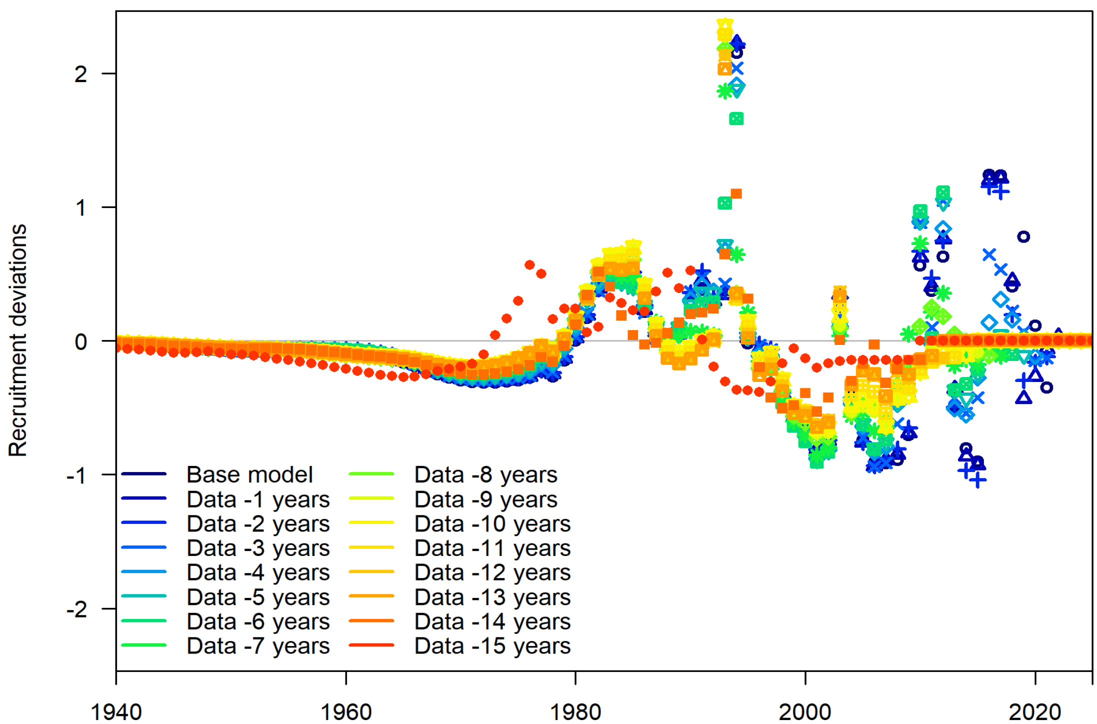

Figure 2A. Recruitment deviations for a 15-year retrospective analysis for the pre-STAR base model.

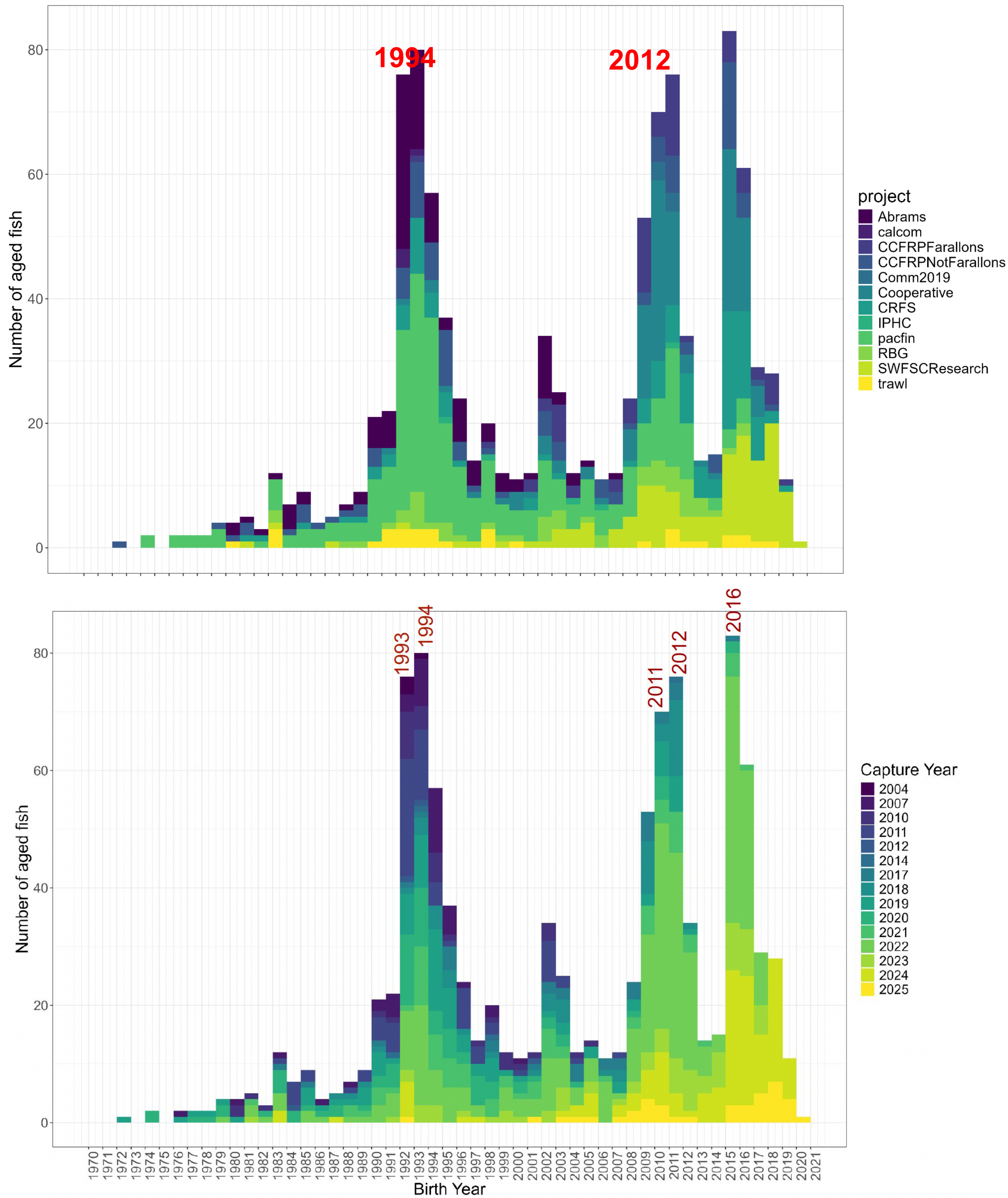

Figure 2B. Number of aged fish by birth year by data sources (top) and capture year (bottom). Notable years are identified with red labels.

2 - Panel Conclusion
It was beneficial to compare the relative contribution of each data source and identify birth year to the aged fish included in the growth fleet. This confirms that the source of age data (from different projects at different time periods) is important. It also shows that the varied sources contain similar information about prominent age classes. There remains a need to find an appropriate way to use these age data in the model and understand how they contribute to recruitment strength. Figure 2B is a really clear way to show these data, thank you.

3 - Request
Conduct a sensitivity with no age data and no time blocks on selectivity (i.e., all selectivities being asymptotic) and compare this to the pre-STAR base model and a sensitivity without age data but including time blocks on sensitivity. Plot spawning output, fraction unfished, and recruitment deviations.

3 - Rationale
This sensitivity will increase our understanding about the effects of selectivity and age data on model results.

3 - STAT Response
No blocks with ages increases the size of the recruitment peak in 1994 and no blocks without ages decreases the recruitment peak in 1994 (though the peak is still 1994), relative to the pre-STAR base model (Fig. 3A). The scenario with no blocks and no ages decreases recent spawning output and fraction unfished (Fig. 3B). The scenario with no blocks but with ages decreases spawning output across the time series, such that the fraction unfished varies around the pre-STAR base model value since 2000. Retaining blocks and removing ages increases early spawning output but decreases it in recent years, resulting in low fraction unfinished in recent years.

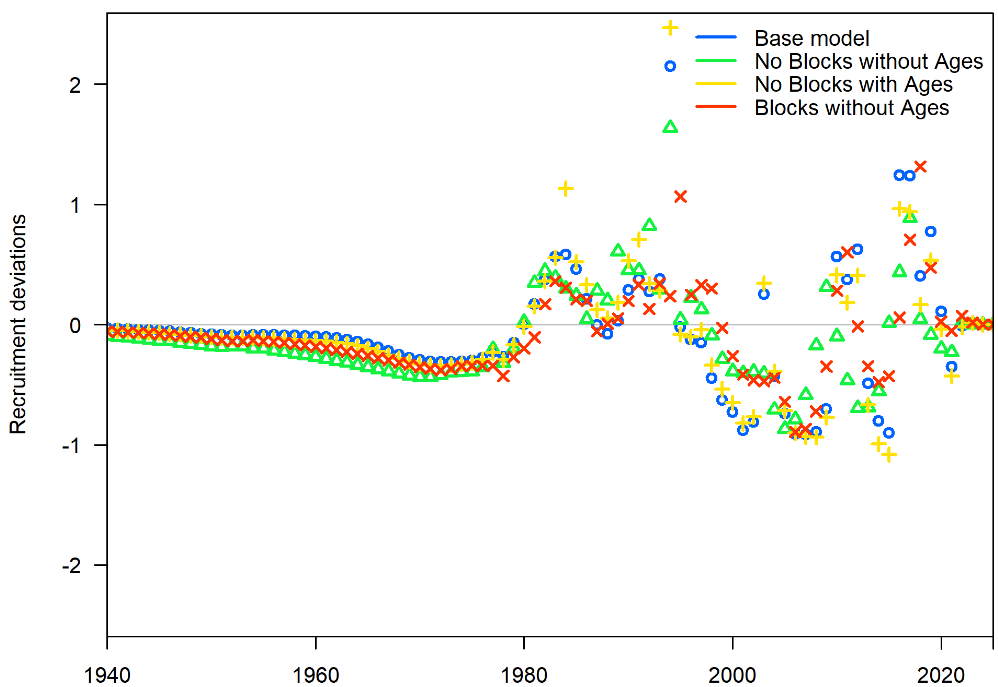

Figure 3A. Recruitment deviations across a range of sensitivities related to time blocking and the inclusion of age data.

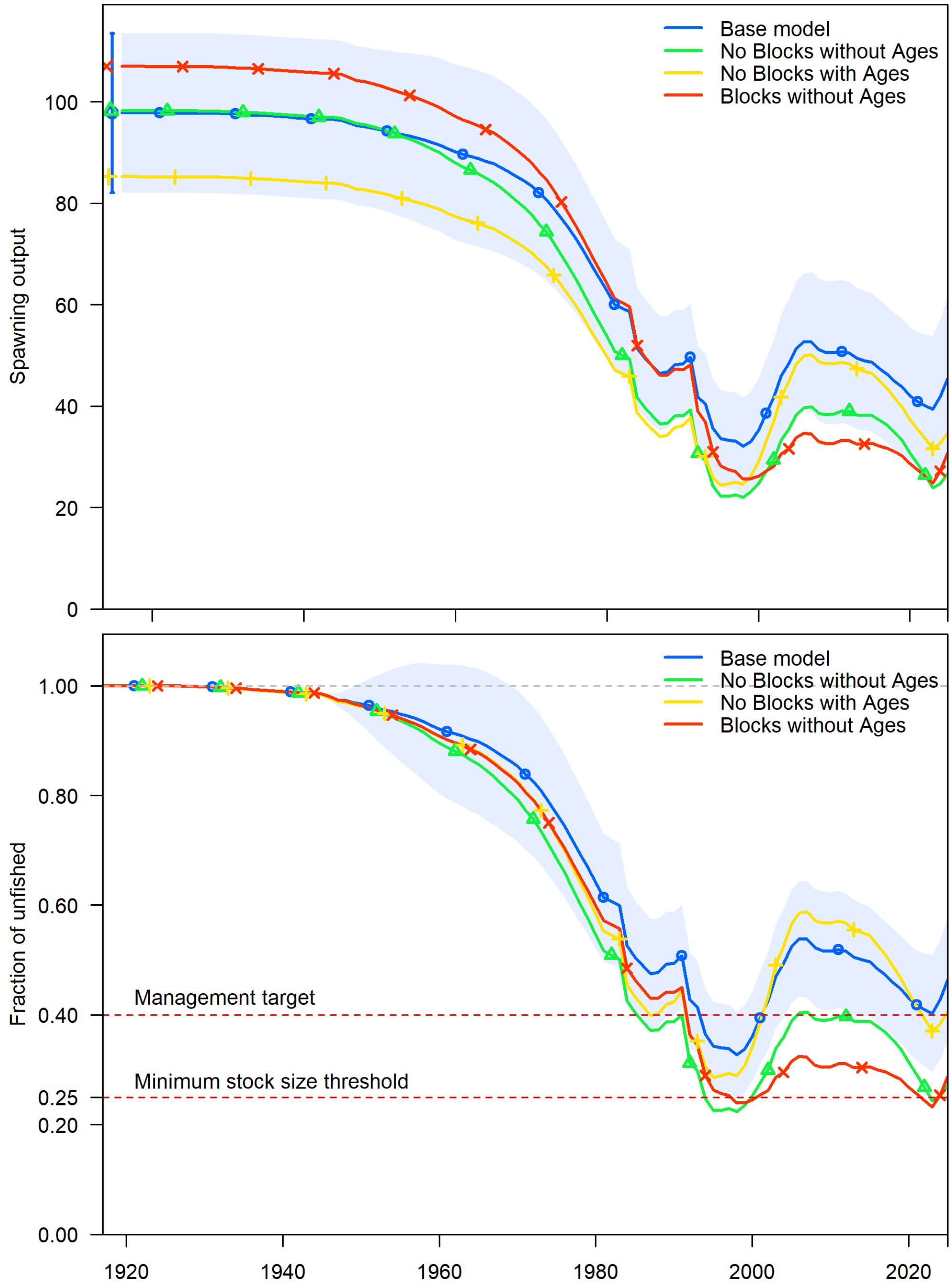

Figure 3B. Spawning output (billions of eggs; top) and fraction unfished (bottom) for a range of sensitivities related to time blocking and the inclusion of age data.

3 - Panel Conclusion

The peak in recruitment in 1994 was most affected by the combination of time blocking and including or excluding age data (as were recruitment patterns in recent years). Incorporating age data resulted in smaller recruitments in the late 1990s and early 2000s. The time blocks for selectivity are important and well justified in the pre-STAR base model. The age data are informing estimates of growth and recruitment.

4 - Request
Recalculate the effective sample sizes for commercial length composition data using only the number of trips and compare those numbers to the effective sample sizes used in the pre-STAR base model. If materially different, present spawning output, fraction unfished, and recruitment deviations plots for both input sample sizes.

4 - Rationale
The Francis method for data weighting typically uses the number of trips as input to the iterative reweighting process. The approach used in the pre-STAR base model used a combination of number of trips and number of samples (lengths and ages), which may result in overweighting composition data.

4 - STAT Response
The STAT does not think that the commercial length composition data are over-weighted. Weighting values and input sample sizes inform the relative contribution of a data set to model fit and decreases in one are offset by increases in another.

Input sample sizes used in the pre-STAR base model included a component for numbers of fish sampled, which are on average twice as high as the total number of trips. Francis weighting in the pre-STAR base model is approximately 60% lower compared to the tuned weighting value when using only the number of trips (Table 4). This offsetting is shown by similar adjusted sample sizes between the pre-STAR base model and the requested run. Whereas weighting values are applied across all years, input sample sizes are entered for each year. Thus, there is some variability in the difference of adjusted sample sizes by year, especially in the early years where more fish were sampled (Fig. 4A). All other fleets have similar weighting values, which are minimally affected by changes in commercial length sample sizes (Fig. 4B and Fig. 4C). The approach used in the pre-STAR base model to calculate input N is commonly used in West Coast assessments.

Table 4. Francis weighting values for fleet-specific composition data using methods in the pre-STAR base model and effective sample sizes based only on the number of trips. CAAL: conditional age-at-length.

Data Type	Fleet	pre-STAR Base Model	Using Ntrips for Commercial Lengths
Length	Commercial	0.377	0.638
Length	Recreational	0.180	0.180
Length	CCFRP	0.236	0.235
Length	ROV	0.170	0.171
CAAL	Commercial	0.081	0.080
CAAL	Growth	0.612	0.610

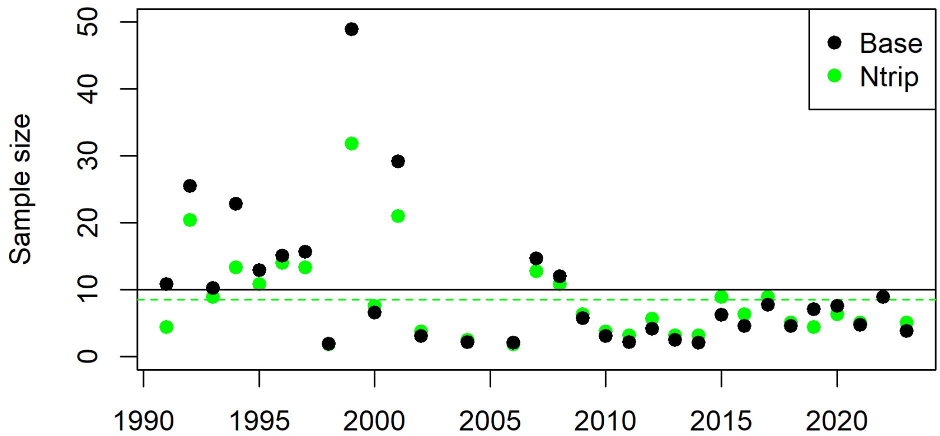

Figure 4A. Effective sample sizes for commercial lengths using a formula that included numbers of fish and numbers of trips (as in the pre-STAR base model) and using only numbers of trips. Lines illustrate medians of adjusted sample sizes.

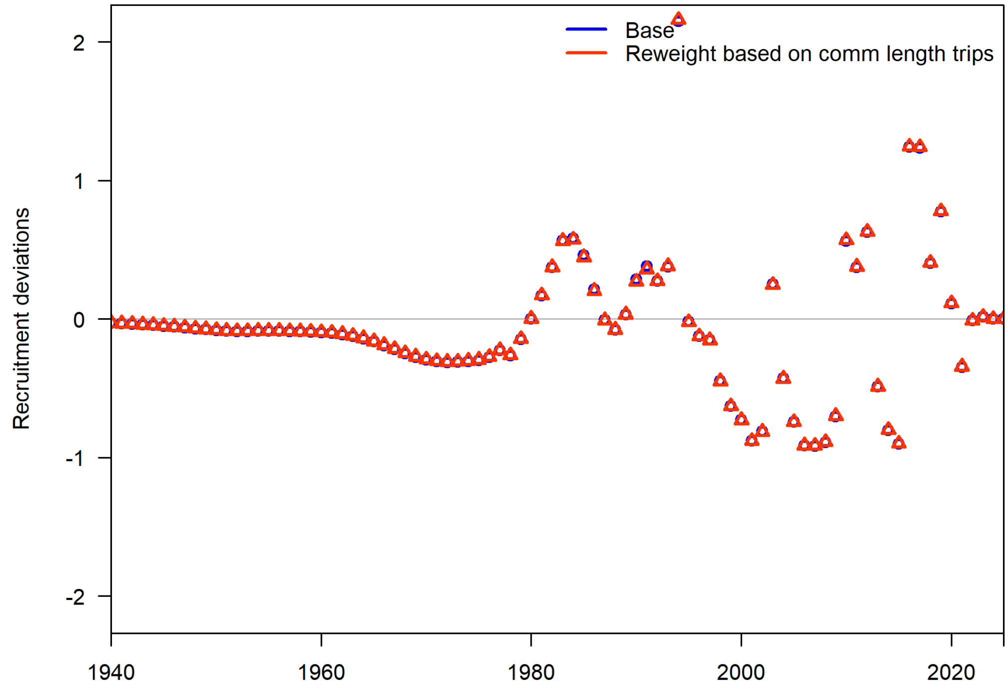

Figure 4B. Recruitment deviations for the pre-STAR base model and a sensitivity using alternative input sample sizes for length composition data from the commercial fleet.

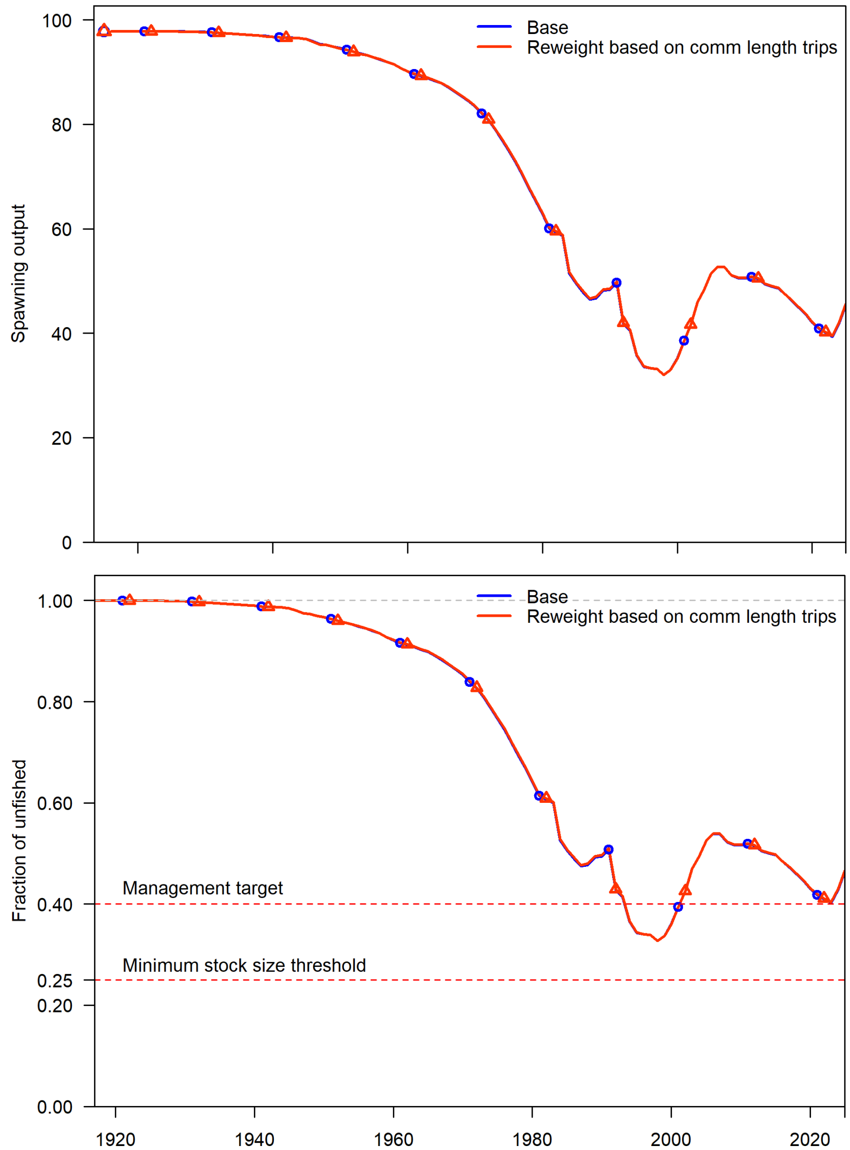

Figure 4C. Spawning output (top) and fraction unfished (bottom) for the sensitivity analysis related to input sample sizes for length compositions data from the commercial fleet.

4 - Panel Conclusion

There were no substantive differences in effective sample sizes. The Panel recommends retaining the approach used in the pre-STAR base model.

5 - Request
Plot the growth curve and associated variability from the pre-STAR base model with fleet-specific (i.e., commercial and growth) observations of length-at-age.

5 - Rationale
These plots will assist in understanding how well the growth model fits to length-at-age data.

5 - STAT Response
The model-estimated growth curve encompasses the available length-at-age data (Fig. 5). The growth fleet contains most of the available ages but both fleets encompass a range of lengths at a given age.

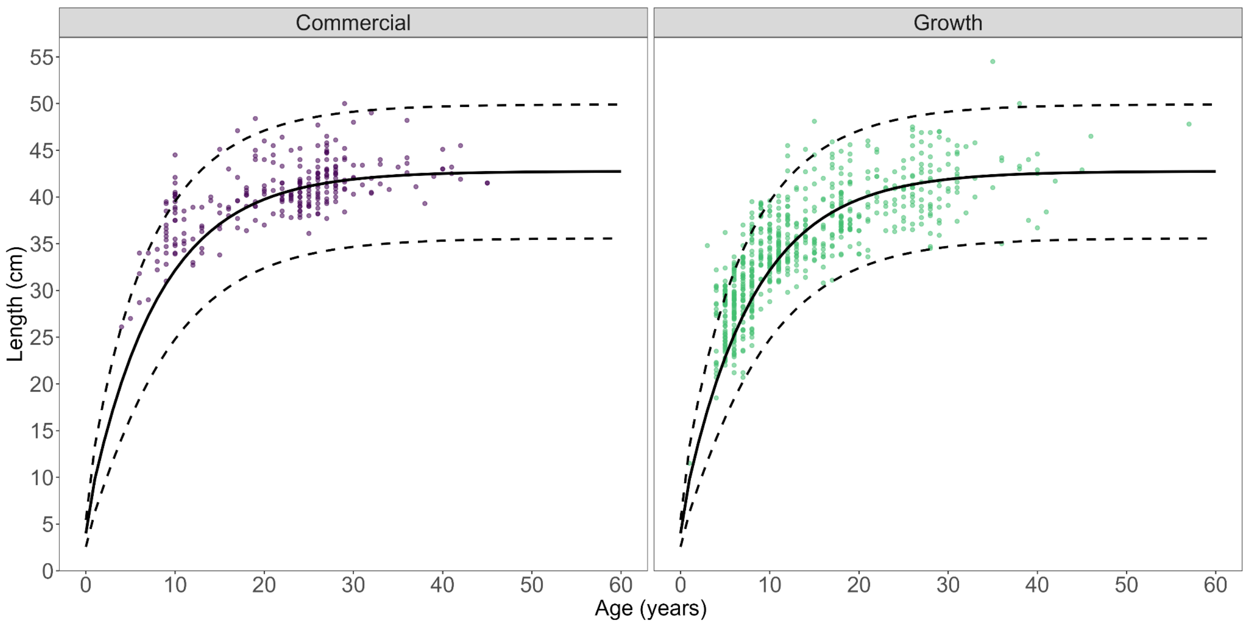

Figure 5. Model-estimated growth curves and coefficients of variation with length-at-age data for commercial (left) and growth (right) fleets.

5 - Panel Conclusion
The Panel appreciated being able to see how well the model-estimated growth curve fit to different data sources. No further action is required.

6 - Request
Tune sigmaR using the built-in approach in r4ss (i.e., looking at asymptotic variance and between standard errors of estimated recruitment deviations; Equation 23 in the SS manual). Run the model twice (at most). Plot spawning output, fraction unfished, and recruitment deviations. Present the method of tuning sigmaR, the resulting sigmaR value, and the recruitment deviations plot.

6 - Rationale
There is a process for tuning sigmaR in Stock Synthesis and early recruitment deviations show an estimated standard error greater than 0.6. Furthermore, the 1994 recruitment is more than three standard deviations outside of the expected recruitment deviation.

6 - STAT Response

Tuning sigmaR using the procedure available in r4ss, which is based on a simulation study by Taylor and Methot (2011), indicates progressively higher alternative values for sigmaR. Running this procedure once gives an alternative sigmaR value of 0.85 and running the procedure on this new model gives an alternative sigmaR value of 1.12 (Table 6). Higher sigmaR values do not result in different recruitment deviations for 1994 but do result in greater deviations in years prior to 1978 (Fig. 6A and Fig. 6B). This includes greater uncertainty in the early 1980s deviations, which are less informed by data, and greater variability in recruitment deviations after 2000. Note that higher values for sigmaR as suggested by the procedure are not uncommon for West Coast assessments but are species-specific.

Table 6. Initial value of sigmaR from the pre-STAR base model and the first and second values of sigmaR from tuning.

Model Run	sigmaR
pre-STAR base model	0.60
First suggested value	0.85
Second suggested value	1.12

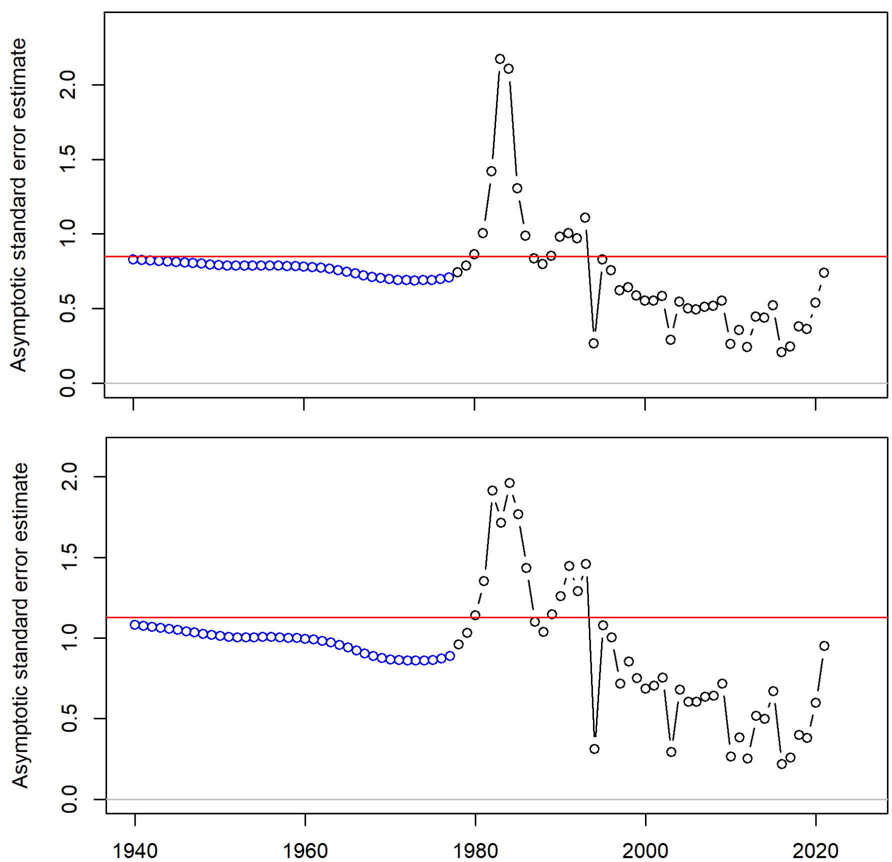

Figure 6A. Recruitment deviation variance for sigmaR values of 0.85 (top) and 1.12 (bottom).

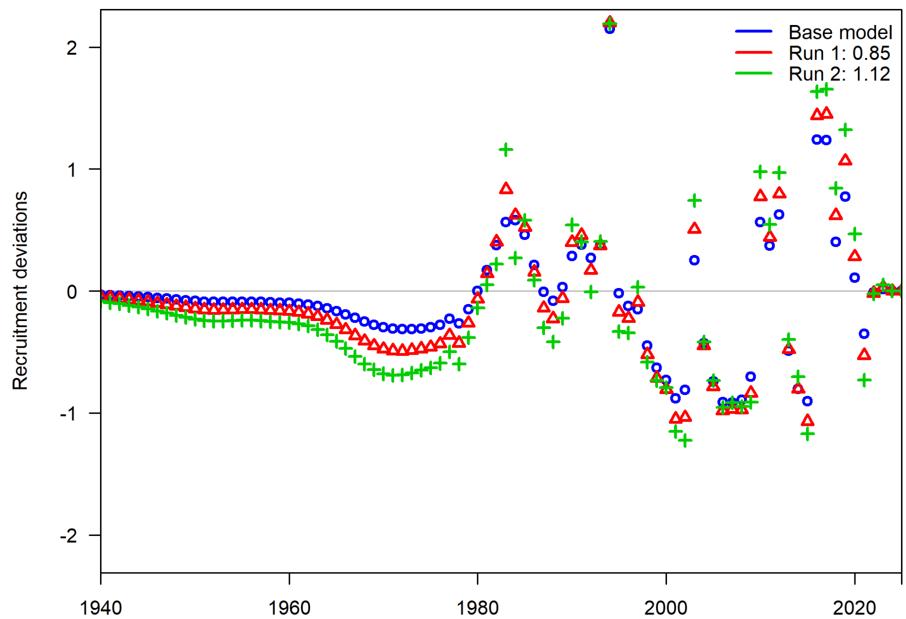

Figure 6B. Recruitment deviations for different values of sigmaR.

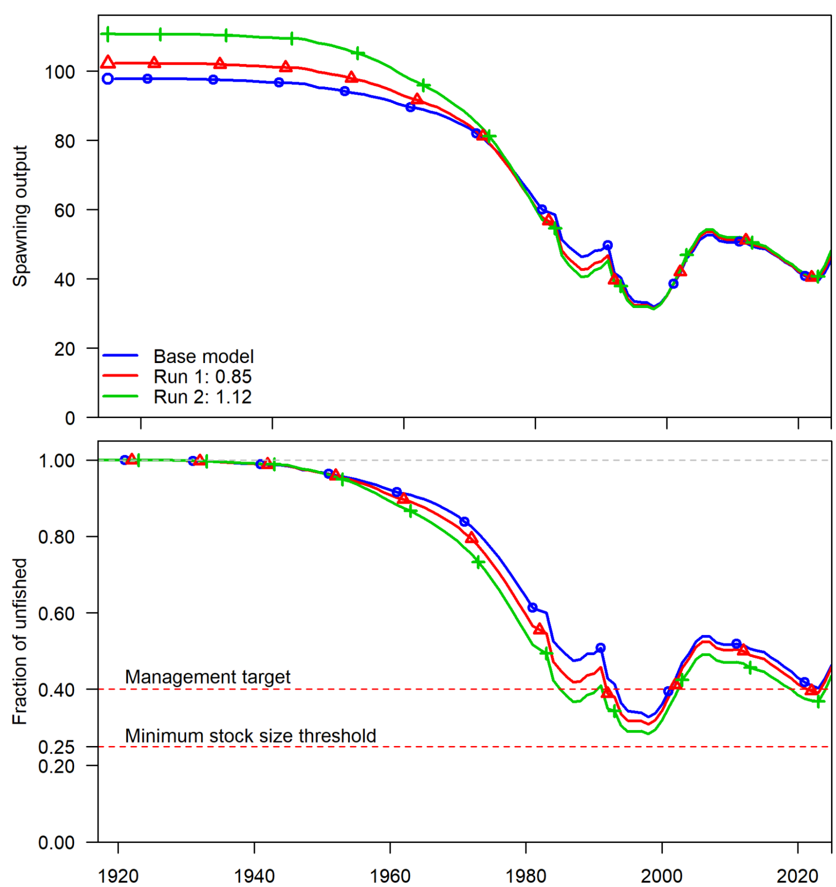

Figure 6C. Spawning output (top) and fraction unfished (bottom) for different values of sigmaR.

6 - Panel Conclusion

The algorithm to tune sigmaR increased the value to greater than 1 in two iterations. This may be a result of the main recruitment estimation period including years before 1993 because the recruitment deviations are not well informed. Redefining the main recruitment estimation period to start in 1993 may resolve this issue and result in a more robust tuning of sigmaR. The Panel will revisit this issue in a later request, after other aspects of the model are more resolved.

7 - Request

Conduct a new sensitivity that a) treats age data from CCFRP as CAAL for the CCFRP fleet, b) releases the sample size constraints on the CCFRP ages, and c) removes the growth fleet. Plot spawning output, fraction unfished, and recruitment deviations. If possible, please also plot the growth curve. Report the suggested sigmaR from r4ss. Conduct further analyses for any other age data that were sourced from a fleet already represented in the pre-STAR base model and include justifications for inclusion or exclusion of data.

7 - Rationale

The growth fleet represents an aggregation of age data from multiple sampling programs, has an assumed selectivity of 1 across all lengths, and is influential on estimates of recruitment. The intent of this sensitivity analysis is to maximize use of available age data while understanding potential effects on recruitment.

7 - STAT Response

The more age data that are retained, the more results are to the pre-STAR base model. Moving only CCFRP age data from the growth fleet to the CCFRP fleet results in higher initial spawning output, lower recent spawning output, and lower fraction unfished. Moving CCFRP and some sources of ages that are most similar to the recreational fishery (see below for data included) to their respective fleets results in similar spawning output and fraction unfished to the pre-STAR base model (Fig. 7A). Peak recruitment is reduced and occurs in 1995 when using only CCFRP ages, whereas peak recruitment is similar to the pre-STAR base model when using CCFRP and some recreationally attributed sources (Fig. 7B). Internally estimated growth curves were very similar among these scenarios, as were the alternative sigmaR values (Fig. 7C).

The STAT selected three additional sources of age data from the growth fleet to potentially include as CAAL for the recreational fleet: Abrams research ages, private/rental ages collected by the CDFW groundfish team, and SWFSC cooperative research ages. These sources were included as the recreationally attributed sources in the run for CCFRP.

Abrams: Jeff Abrams (2014) conducted a research study aboard recreational charter boats from Crescent City Harbor, Trinidad Bay, and the Noyo River Harbor. Fishing gear was selected to mimic the recreational fleet.

CDFW groundfish: The CDFW groundfish team began sampling the private/rental fleet dockside in 2021 using a sampling design similar to but not as part of the CRFS sampling program.

SWFSC cooperative: The SWFSC Groundfish Cooperative Data Collection (GCDC) collects age and length data from paid passengers aboard party/charter vessels. Quillback rockfish were primarily collected during the pilot year and represent fish from the San Francisco CRFS district.

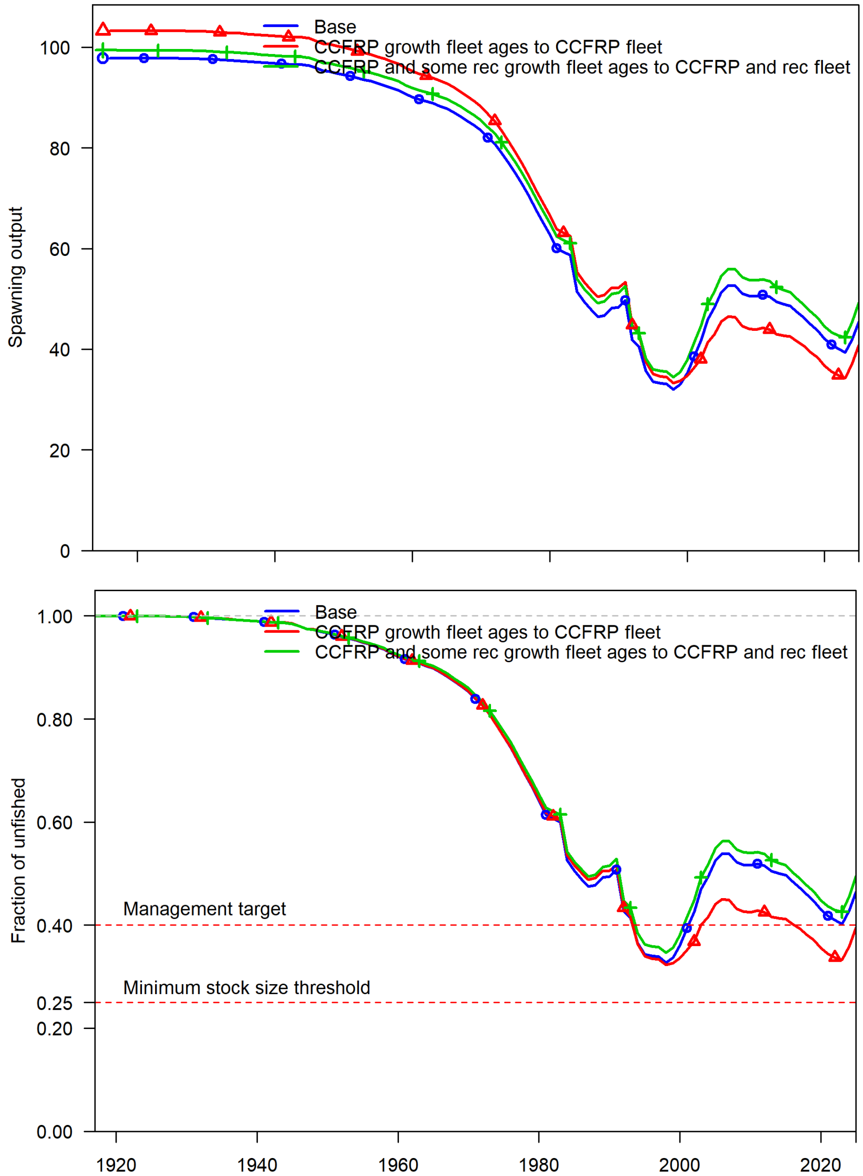

Figure 7A. Spawning output (top) and fraction unfished (bottom) for sensitivities incorporating age data from the growth fleet into CCFRP and recreational fleets in different ways.

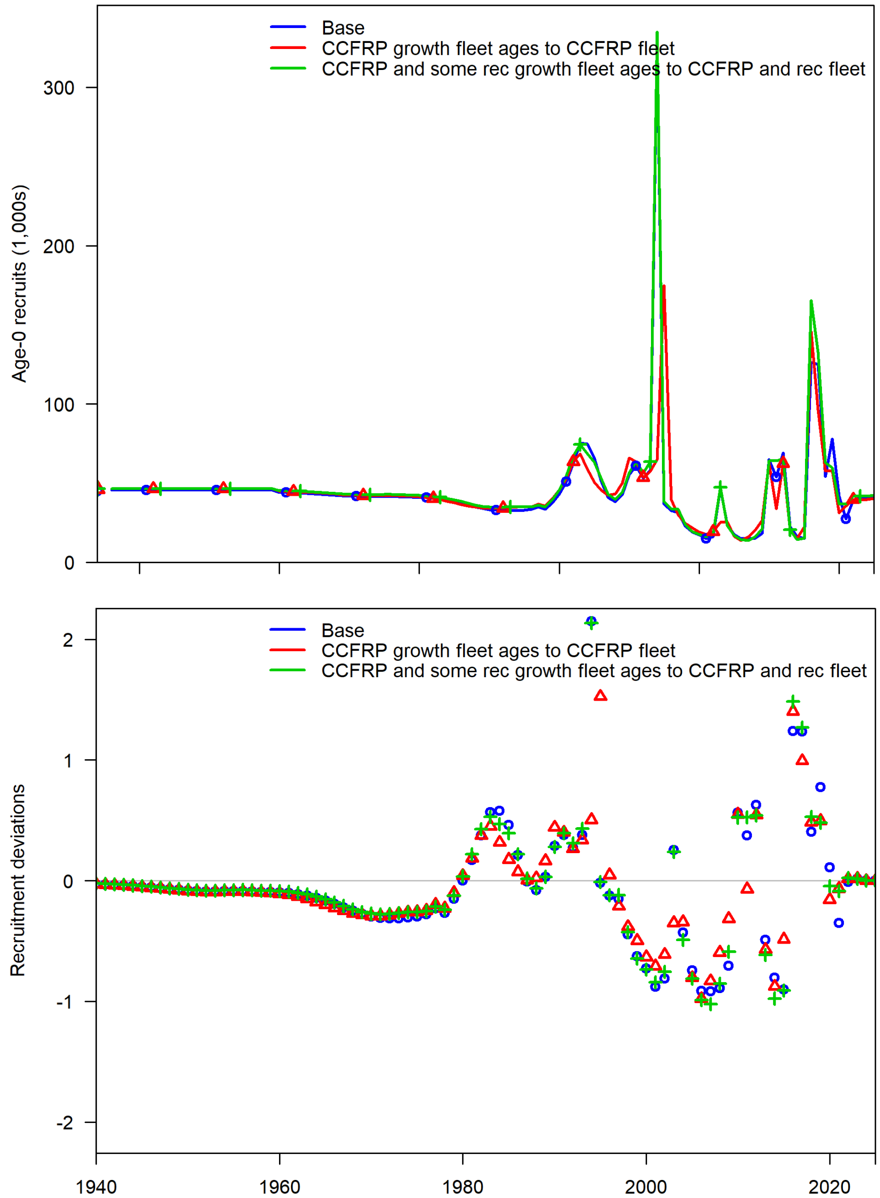

Figure 7B. Age-0 recruits (top) and recruitment deviations (bottom) for the pre-STAR base model and sensitivities incorporating age data from the growth fleet into CCFRP and recreational fleets in different ways. Suggested sigmaR values for these runs were 0.85, 0.8, and 0.87.

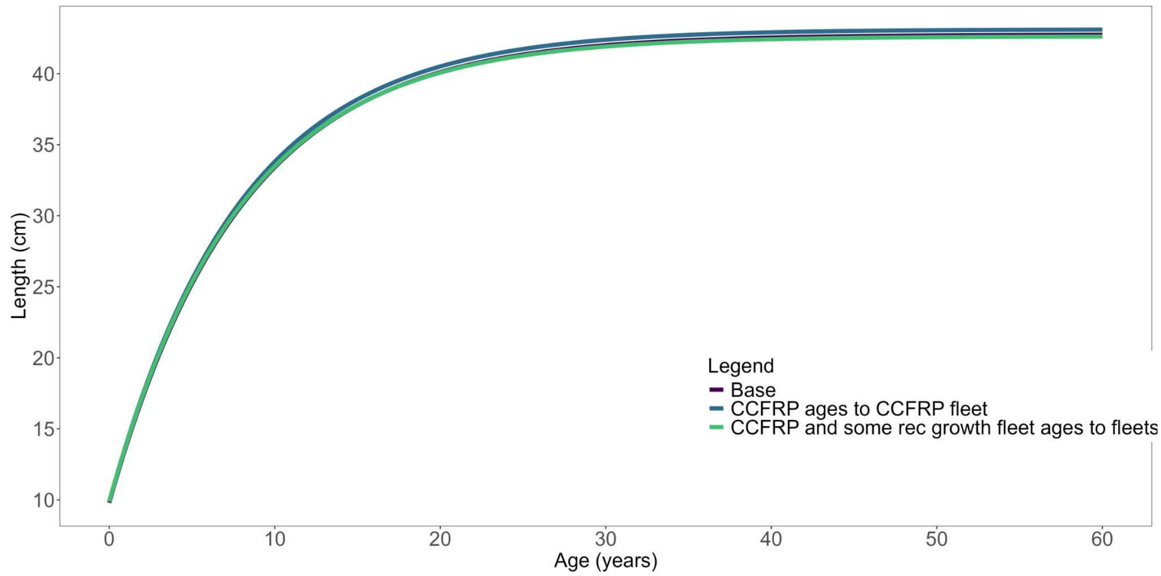

Figure 7C. Model estimated growth curves for the pre-STAR base model, and sensitivities incorporating age data from the growth fleet into the CCFRP and recreational fleets in different ways.

7 - Panel Conclusion

The Panel appreciates the STAT identifying subsets of data that may be more representative of the recreational fleet to conduct this sensitivity analysis. Using only CCFRP samples showed a lower predicted recent spawning output, a lower 1994 year class, a higher 1995 year class, and differences in recent recruitment. This is part of the reason for a slower increase in spawning output in recent years. Including the Abrams, CDFW GFish, and SWFSC Coop data as CAAL for the recreational fleet resulted in very similar results to the pre-STAR base model (i.e., a single strong year class in 1994 and a faster increase in spawning output in recent years). This indicates that these age data are informing recruitment when the original goal was to use these age data to estimate growth. It was noted, however, that these data may also affect recruitment. If age samples were not collected in a manner representative of the fishery or stock, this may result in biased model results. Additional investigations are necessary in order to fully understand the implications of incorporating age data as part of the growth fleet.

8 - Request

Conduct a new sensitivity that estimates selectivity for the growth fleet. Plot spawning output, fraction unfished, and recruitment deviations. If possible, please also plot the growth curve. Please report the suggested sigmaR from r4ss.

8 - Rationale

This request will help identify the effect of an assumed selectivity of 1 for the growth fleet.

8 - STAT Response

When allowed to take a dome shape, the growth fleet is effectively asymptotic (Fig. 8A). The STAT moved forward with a comparison of asymptotic selectivity for the growth fleet (Fig. 8B). There were no changes in recruitment deviations, spawning output, or fraction unfished (Fig. 8C and Fig. 8D). The r4ss suggested sigmaR is 0.85, which was the same as suggested sigmaR from the pre-STAR base model.

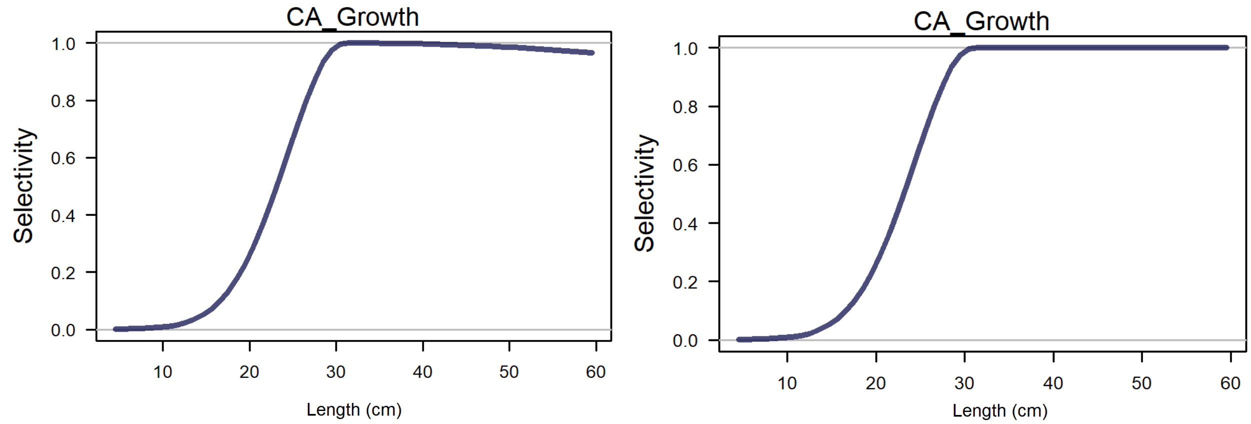

Figure 8A. Selectivity curves for the growth fleet when using parameters that permit a dome shape (left) and asymptotic shape (right).

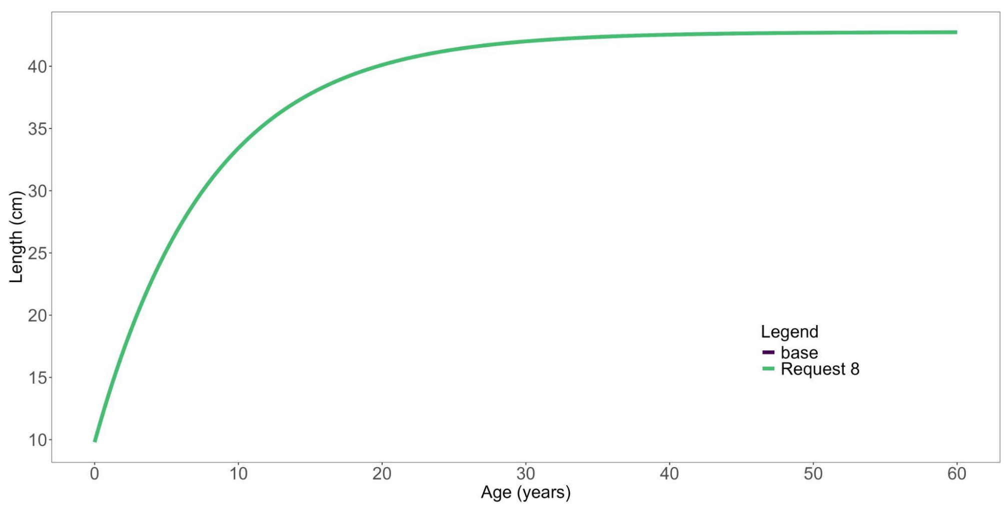

Figure 8B. Growth curves using the pre-STAR base model configuration (i.e., growth fleet selectivity equal to 1 at all sizes) and estimated asymptotic selectivity.

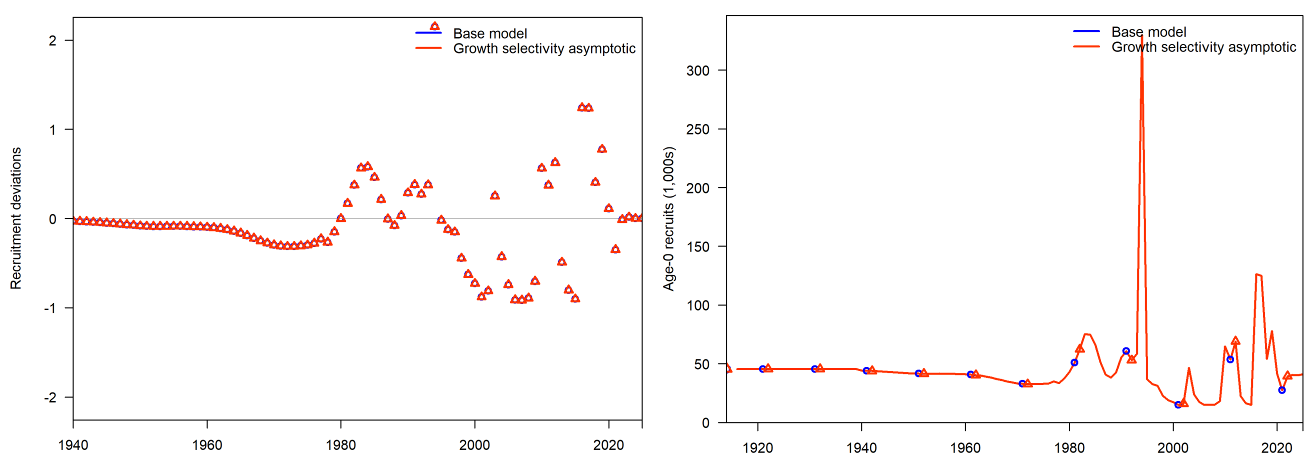

Figure 8C. Recruitment deviations (left) and age-0 recruits (right) using the pre-STAR base model configuration (i.e., growth fleet selectivity equal to 1 at all sizes) and estimated asymptotic selectivity.

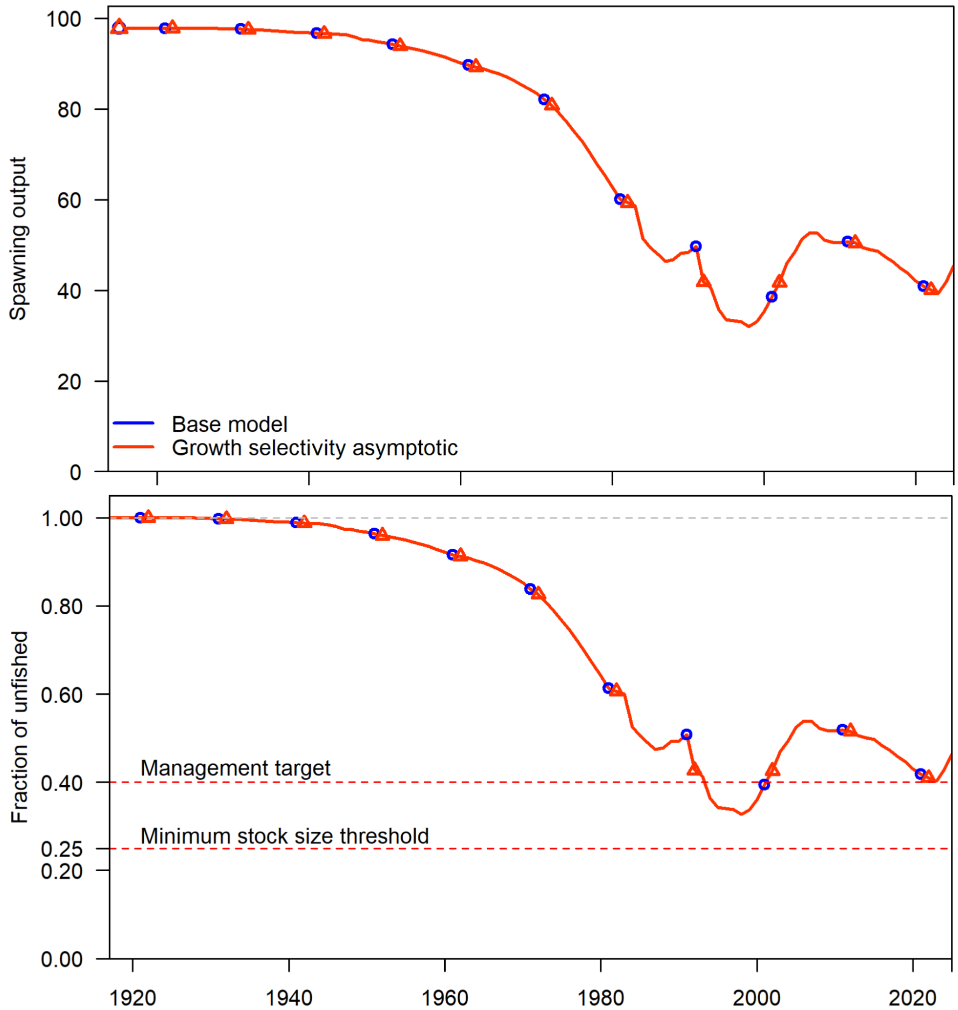

Figure 8D. Spawning output (top) and fraction unfished (bottom) with the pre-STAR base model configuration (i.e., growth fleet selectivity equal to 1 at all sizes) and estimated asymptotic selectivity.

8 - Panel Conclusion
These plots are informative and suggest that estimating selectivity for the growth fleet is inconsequential to model results.

9 - Request
Estimate the prior for *M* using the maximum age sampled in California.

9 - Rationale
This will enable the reader to evaluate sensitivity analyses and subsequent assessment outputs using the prior for *M* that is based on the maximum age for quillback rockfish sampled off California.

9 - STAT Response
The estimate of *M* that corresponds to the maximum age of fish sampled off California (57 yr) is 0.095. This would correspond to the profile run with M = 0.095.

9 - Panel Conclusion
The Panel appreciates the explicit estimate of the prior for *M* given the maximum age for fish collected off California.

10- Request [initially part of Request 1]
Plot comparisons of age-0 recruits and recruitment deviations for the biology and data portions of the bridging analysis (without confidence intervals).

10 - Rationale
These plots will provide an understanding about how estimates of recruitment iteratively change with the addition of new data and modified assumptions.

10 - STAT Response
Large recruitment deviations were estimated in the 2021 and 2025 quillback rockfish assessments and are common in other nearshore assessments. Recruitment deviations from the biology bridging steps show that high deviations were present before age data were added to the model, though in other years during the mid-1990s (Fig. 10A). Recruitment deviations from the data bridging steps show that high deviations were present before age data were added to the model (Fig. 10B), indicating that other sources of information support high deviations.

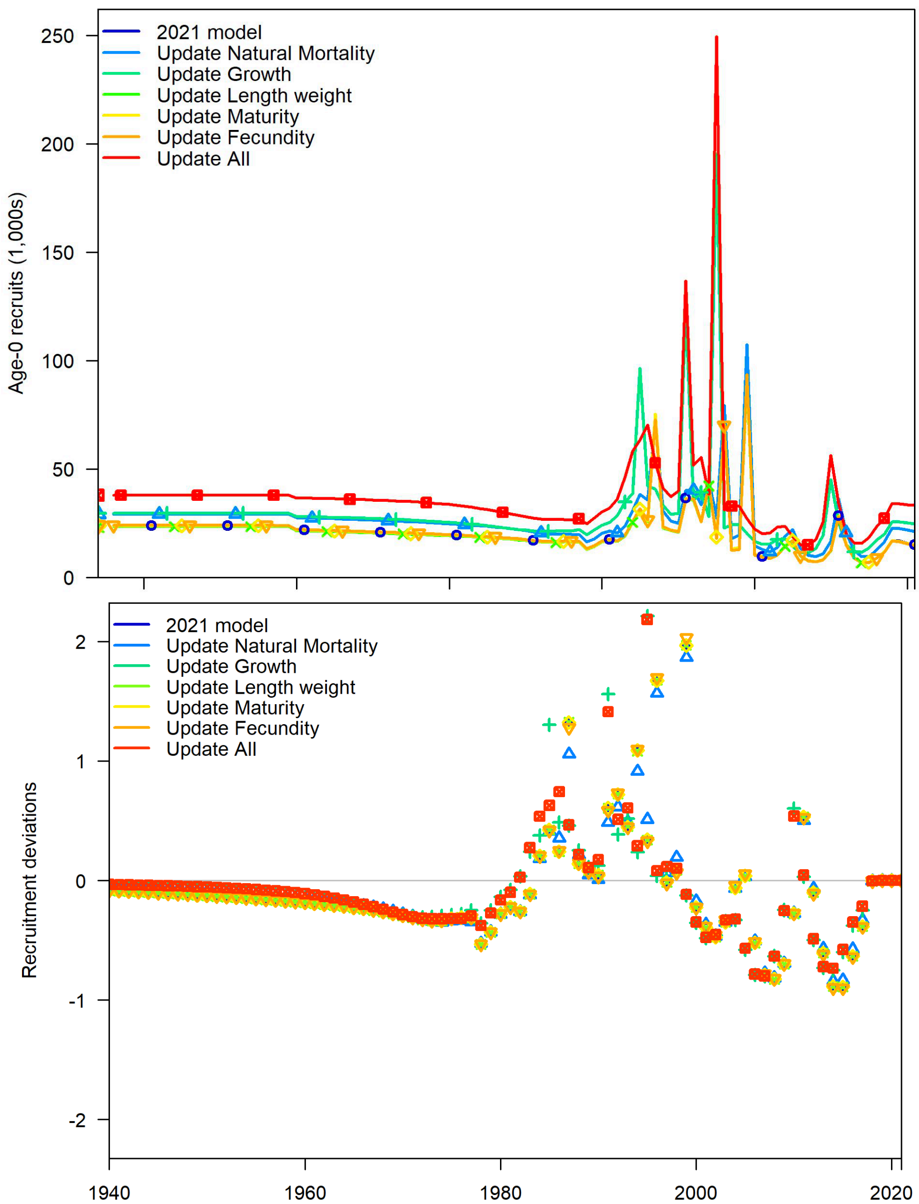

Figure 10A. Age-0 recruits (top) and recruitment deviations (bottom) for the biology bridging steps.

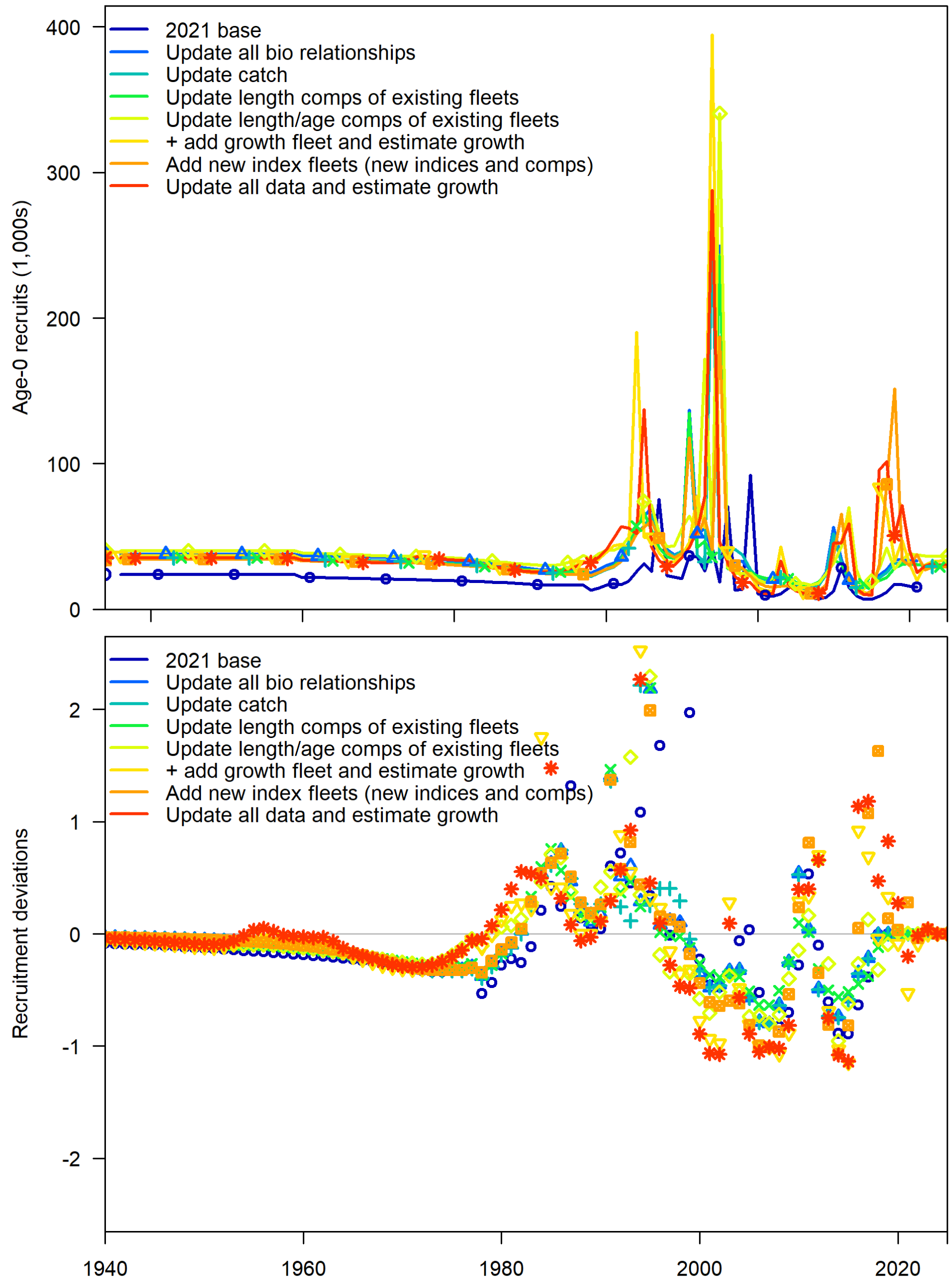

Figure 10B. Age-0 recruits (top) and recruitment deviations (bottom) for the data bridging steps.

10 - Panel Conclusion

Updating biological parameters since the 2021 stock assessment appears to have the greatest effect on estimated recruitment and spawning output in the bio bridging analysis. The 2021 assessment indicated a pattern for recruitment that is not inconsistent with the pre-STAR base model, though deviations are shifted in time and lower in magnitude. The addition of new age data are informative about the pattern in estimated recruitment and identify specific strong cohorts.

11 - Request
Instead of treating age data from CCFRP, Abrams (2014), the CDFW groundfish, and the SWFSC Cooperative as conditional age-at-length (CAAL) for the CCFRP and recreational fleets (as in Request 7), treat those data as marginal ages. Retain length-based selectivity and use the same effective sample sizes to enable comparability with earlier results (as in Request 7).

11- Rationale
Using marginal age data requires that age data are representative of the fleet. Given small sample sizes and limited spatiotemporal coverage, age data in the growth fleet for the pre-STAR base model are unlikely to be representative. This request is intended to improve the Panel's understanding about how CAAL data are informing recruitment.

11 - STAT Response
The STAT does not consider the age samples collected by Abrams (2014), CDFW (surrendered and groundfish staff collections), or the SWFSC Cooperative to be representative of the lengths and other data used to estimate total catch. The STAT does not consider the models explored as part of Requests 7 and 11 more viable base models than the pre-STAR base model. Additional rationale for preferring the pre-STAR base model include:

I. There was little difference in recruitment deviations or stock trajectory between the pre-STAR base model and the model from Request 7 that included CCFRP and recreational conditional ages assigned to their respective fleets (Fig. 11A and Fig. 11B).
II. Selectivity choices for the growth fleet are inconsequential to model results.
III. Conditional age-at-length data are appropriate to model within a growth fleet as described in the accepted best practices guidelines, as referenced on the PAM site, speaks to this in the section on Growth (page 7). This practice has been followed in many assessments for nearshore rockfish species.
IV. Large recruitment deviations have been observed in other adopted West Coast groundfish assessments.

The STAR Panel requested that the STAT explore a number of processes, including treatment of age data, growth, recruitment deviations, sigmaR, and selectivity. All of these are useful to explore and aid to better understand the model. The language of these requests and their rationale, however, indicate these are explorations or sensitivities.

The STAT does not consider the explorations up to this request as viable options for a base model. The practice of utilizing a growth fleet when age data from surveys is limited is an accepted practice and many nearshore and deeper nearshore West Coast groundfish species have fixed sigmaR and high recruitment deviations.

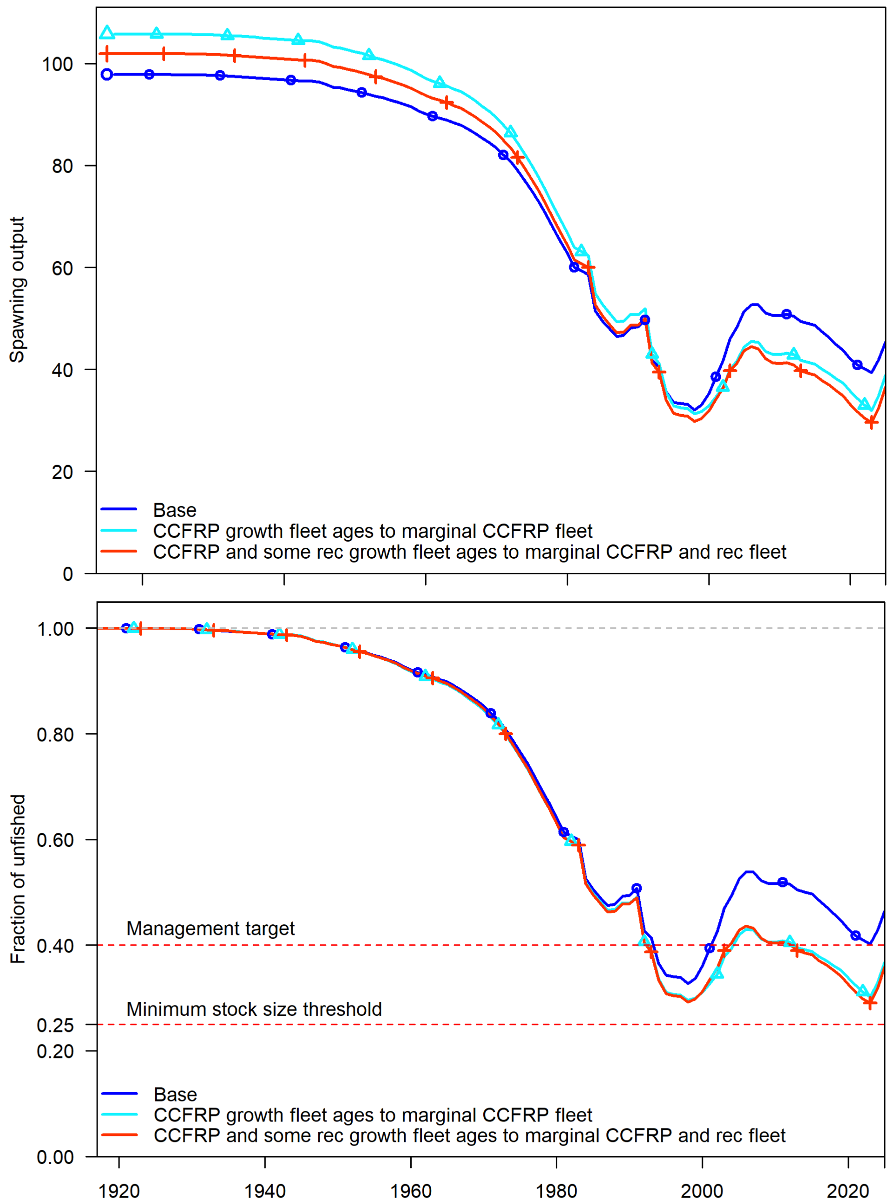

Figure 11A. Spawning output (top) and fraction unfished (bottom) for the pre-STAR base model, a model with CCFRP ages treated as marginals for the CCFRP fleet and no growth, and a model with CCFRP ages treated as marginals for the CCFRP fleet and some recreational ages treated as marginals for their respective catch fleets and no growth fleet. Growth parameter L_1 and $CV(L_1)$ are very low for the CCFRP run.

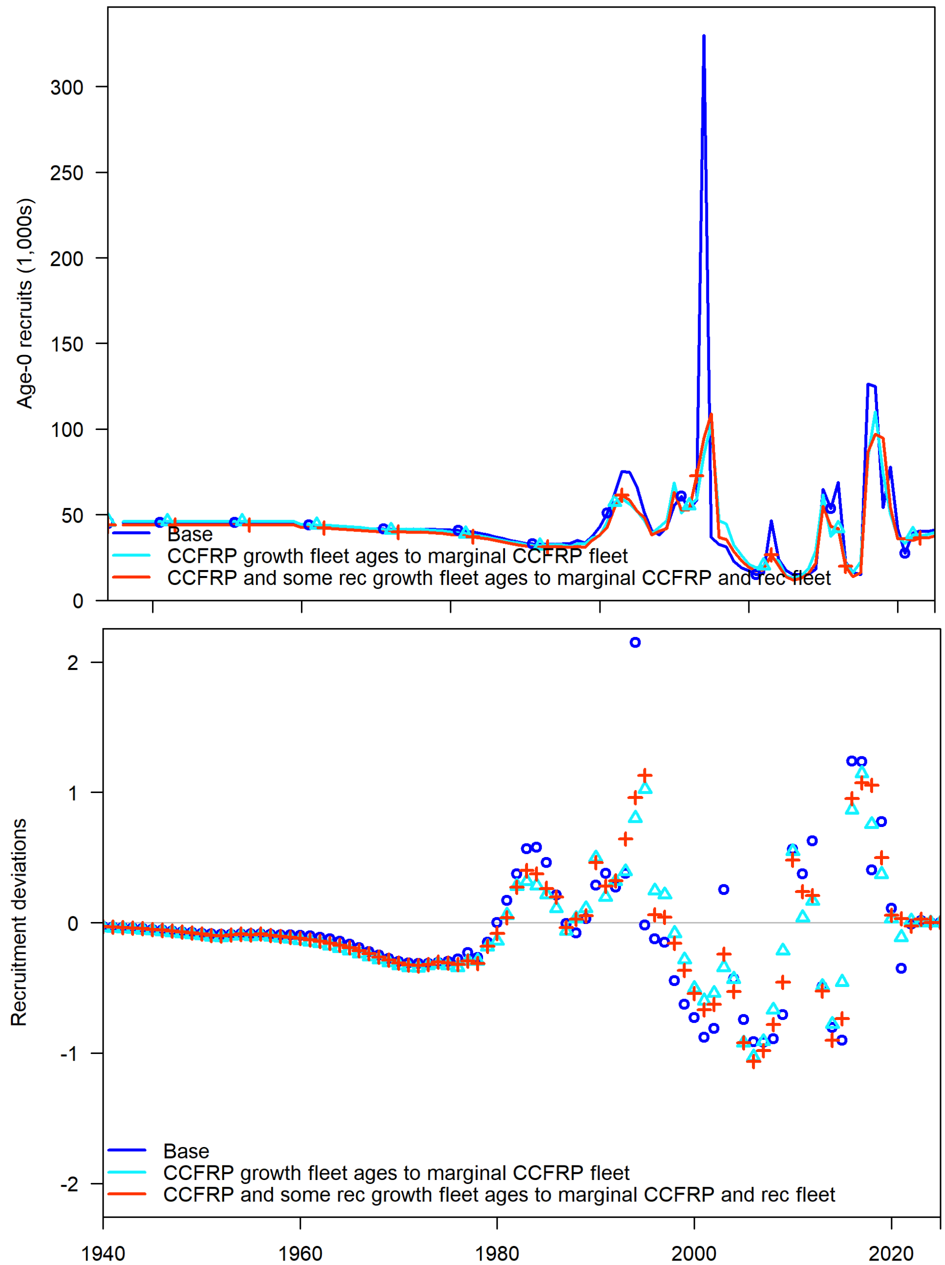

Figure 11B. Age-0 recruits (top) and recruitment deviations (bottom) for the pre-STAR base model, a model with CCFRP ages treated as marginals for the CCFRP fleet and no growth, and a model with CCFRP ages treated as marginals for the CCFRP fleet and some recreational ages treated as marginals for their respective catch fleets and no growth fleet. Recommended sigmaR values for these runs were 0.85, 0.73, and 0.78 respectively.

Conditional age-at-length data within a growth fleet have been used in other assessments. These include: CA and OR black rockfish (Cope et al. 2015), China rockfish (Dick et al. 2016), OR kelp greenling (Berger et al. 2015), OR blue/deacon rockfish (Dick et al. 2017), CA/OR Cabezon (Cope et al. 2019), gopher and black-and-yellow rockfish (Monk and He 2019), Lingcod north (Taylor et al. 2021), Lingcod south (Johnson et al. 2021), copper rockfish north of Pt. Conception (Monk et al. 2023), and copper rockfish south of Pt. Conception (Wetzel et al. 2023). Other assessments have also had large recruitment deviations (Table 11).

Table 11. SigmaR values of recent nearshore assessments.

Assessment	sigmaR	Recruitment deviations
2015 CA black rockfish	Fixed 0.50	Figure 67
2015 OR kelp greenling	Fixed 0.65	Figure 59 (age-0 recruits)
2019 Gopher/black-and-yellow	Fixed 0.50	Figure 61
2021 lingcod	Fixed 0.60	Figure v (north model)
2021 OR vermillion rockfish	Fixed 0.60	Figure v
2021 CA north vermilion	Fixed 0.50	Figure 103
2021 CA south vermilion	Fixed 0.50	Figure 105
2023 CA black rockfish	Fixed 0.60	Figure ES7

11 - Panel Conclusion

Although large recruitment deviations may be common among nearshore groundfish stocks, the various requests for sensitivity analyses were intended to better understand changes in the magnitude and/or placement of those deviations for this particular stock.

The shift from treating age data as conditional to marginal allowed the Panel to better understand the effects of basic assumptions related to representativeness of those data. Somehow, the use of the growth fleet suggests much stronger recruitment in 1994. The magnitude of age-0 recruits is nearly three times higher for the pre-STAR base model compared to the alternative models that exclude some data from the original growth fleet and treat others as marginal. The stock trajectories are similar, but with non-trivial differences in magnitude. Combining observations from this request with others led to Request 13.

The accepted practices guidelines for groundfish stock assessments in 2025 and 2026 identify the utility of integrating length or age data from special projects to “more completely inform growth curves” when these data are limited. There is, however, no explicit discussion about the utility of using auxiliary composition data to inform recruitment, implying that use of a “growth fleet” should be restricted to internal estimates of growth. The Panel has identified a potential unintended consequence of combining multiple data sources with different sampling schemes and spatiotemporal extents in a single growth fleet and recommends that the SSC revisit that section of the document for future assessments. Although growth fleets have been used in several recent stock assessments, there are a myriad of factors that may have affected their impact or lack thereof on recruitment. Thus, precedence is an insufficient justification for their inclusion or exclusion across stocks.

12 - Request
Redefine the main recruitment estimation period to begin in 1994 and tune sigmaR. Conduct two iterations of the tuning method and report the suggested sigmaR for each, including the final iteration (i.e., report three suggested sigmaR values). Use the pre-STAR base model to begin this process and compare to the adjusted main recruitment estimation period and final tuned sigmaR models. Plot spawning output, fraction unfished, and recruitment deviations. Please also present the resulting value for sigmaR and the recruitment variance check plot from r4ss.

12 - Rationale
Estimated recruitment before 1994 is not well informed in the pre-STAR base model. The tuning of sigmaR with the main recruitment estimation period beginning in 1994 should use the most informed recruitments and may stabilize the tuning of sigmaR.

12 - STAT Response
The recommended sigmaR continues to increase when the main recruitment estimation period is adjusted to 1994 (Table 12). Adjusting the main recruitment estimation period to start in 1994 results in a recruitment deviation time series that is very similar to the pre-STAR base model (Fig. 12A). Increasing sigmaR increases the magnitude of deviations across the time series. All scenarios estimate comparable deviations in 1994. Adjusting the main recruitment estimation period to 1994 decreases initial spawning output and increases final fraction unfished in the first iteration (Fig. 12B). Continuing to increase sigmaR results in a trajectory similar to the pre-STAR base model except for some differences in the 1980s.

Table 12. SigmaR values used in the pre-STAR base model and alternative runs that adjust the main recruitment estimation period to begin in 1994.

Run	sigmaR	sigmaR Recommended
pre-STAR Base Model	0.60	0.85
Alternative from Main RecDevs Start 1994	0.60	0.88
2nd Alternative from Main RecDevs Start 1994	0.88	1.05
3rd Alternative from Main RecDevs Start 1994	1.05	1.14

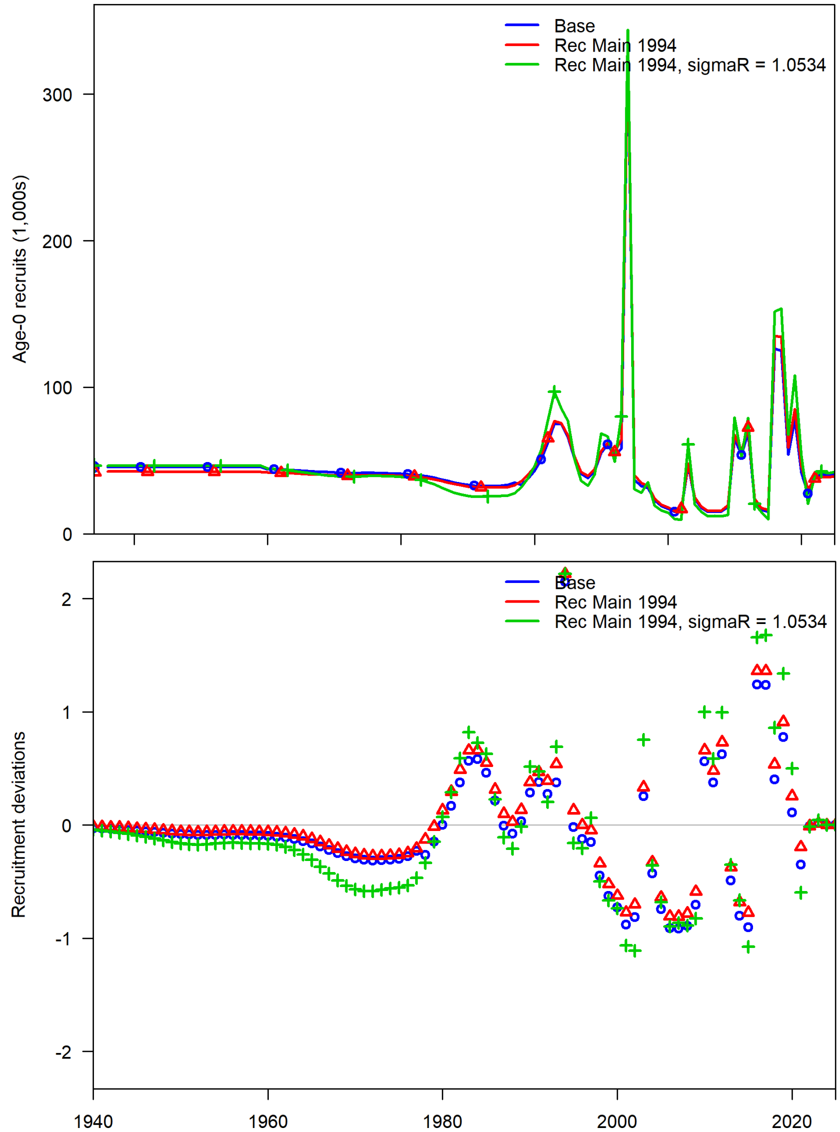

Figure 12A. Age-0 recruits (top) and recruitment deviations (bottom) for the pre-STAR base model and a model that adjusts the start of the main recruitment estimation period to 1994 using a) the pre-STAR base sigmaR value and b) a sigmaR value of 1.05 derived from two iterations of tuning.

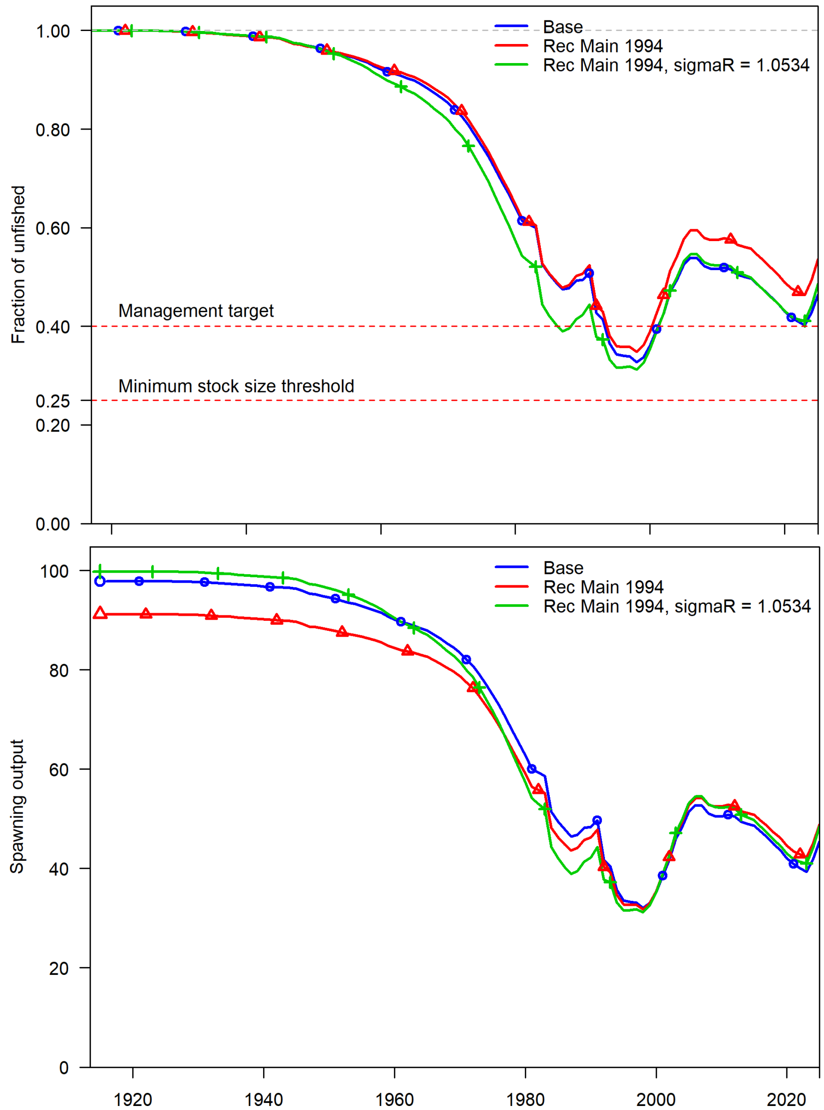

Figure 12B. Spawning output (left) and fraction unfished (right) for the pre-STAR base model and a model that adjusts the start of the main recruitment estimation period to 1994 using a) the pre-STAR base sigmaR value and b) a sigmaR value of 1.05 derived from two iterations of tuning.

12 - Panel Conclusion

This request was a follow-up to Request 6. With a continued increase in sigmaR from alternative runs using an adjusted main recruitment estimation period that starts in 1994, the Panel recommends moving forward with the fixed value for sigmaR used in the pre-STAR base model. The Panel notes, however, that when the peak in recruitment in 1994 decreases (e.g., when removing some data sources in the growth fleet; Request 11), the tuning algorithm suggests a smaller sigmaR (i.e., 0.73) than the pre-STAR base model.

13 - Request
Compare the pre-STAR base model to a model that a) removes the growth fleet and b) collapses the growth fleet CAAL data into a single year in 1920. Please tune these models using the Francis method and report the suggested sigmaR. Plot spawning output, fraction unfished, and recruitment deviations. If possible, please show the model-estimated growth curve with variability and all length-age data that were included in the pre-STAR base model (similar to Request 5; replicated for each run). Please make the r4ss plots available for further evaluation (e.g., fits to data). The STAT may choose to perform additional runs that include other data sources in the growth fleet from the pre-STAR base model for further evaluation.

13 - Rationale
The inclusion of length-age data in the growth fleet appears to influence recent productivity. Given that these data were collected from multiple studies with different objectives and varied spatiotemporal coverage, they are unlikely to be representative of fleet catch or population dynamics (i.e., recruitment signals). Thus, it is worthwhile to examine these effects to the fullest extent possible. These runs should at least provide an indication of uncertainty and may be useful for deciding how to proceed with this assessment.

13 - STAT Response
The run that compresses the growth fleet ages to 1920 results in trajectories similar to the run without the growth fleet entirely. Both runs are very near to the uncertainty intervals of the pre-STAR base model. Recruitment deviations for each run peak in 1995, at a value lower than the 1994 value from the pre-STAR base model. However, the compress-to-1920 run also results in a large peak in the mid-2010s. The plot of variability in recruitment deviations for the run with growth fleet ages compressed to 1920 shows that the spike in 1995 is uncertain. Thus, the model produces a recruitment signal in 1995, but that signal is poorly informed given reduced data from compressing the growth curve to 1920. Patterns from increasing sigmaR are similar to those previously identified.

The STAT notes that excluding growth ages results in similar patterns observed from runs with varying degrees of age data removed. Runs with progressively more ages removed become less and less similar to the pre-STAR base model. This progression of runs requested by the Panel would be valuable to include in the final assessment report as a sensitivity group.

13 - Panel Conclusion
The Panel greatly appreciates the quick turnaround for this request. The age composition data are useful for estimating the growth curve and, in particular, the variability around it. Placing age data from the growth fleet in 1920 (prior to the main recruitment estimation period) reduced its effect on estimated recruitment in a manner similar to removing the growth fleet, but variability around the growth curve was more appropriate by compressing those data to 1920. A potential way forward is to consider which age data from the growth fleet are most likely to be representative of the stock and recruitment deviations and include those in the growth fleet.

14 - Request

Compare the following runs: a) pre-STAR base model, b) a model with age data from CCFRP included in the CCFRP fleet and no growth fleet (as in Request 7), and c) a model with age data from CCFRP included in the CCFRP fleet (as in Request 7) and a growth fleet that includes only the Abrams data. Please tune these models using the Francis method and report the suggested sigmaR. Plot spawning output, fraction unfished, and recruitment deviations. If possible, please show the model-estimated growth curve with variability and all length-age data that were included in the pre-STAR base model (similar to Request 5; replicated for each run). Please make the r4ss plots available for further evaluation (e.g., fits to data).

14 - Rationale

The inclusion of length-age data in the growth fleet appears to influence recent productivity. Given that these data were collected from multiple studies with different objectives and varied spatiotemporal coverage, they are unlikely to be representative of fleet catch or population dynamics (i.e., recruitment signals). Thus, it is worthwhile to examine these effects to the fullest extent possible. These runs should at least provide an indication of uncertainty and may be useful for deciding how to proceed with this assessment.

14 - STAT Response

The trajectories and estimated growth for the two requested additional runs are similar (Fig. 14A and Fig. 14C). The recruitment deviations are also dampened without the remaining available age data (Fig. 14B). The STAT continues to support the pre-STAR base model, but recognizes the Panel’s concerns and uncertainty in the model. Given that this is a nearshore species with limited standardized sampling, the proposed base model with the CCFRP and Abrams data, which are the data from the growth fleet viewed by the STAT as most representative, is a reasonable alternative. The first alternative model (CCFRP ages moved from the growth fleet to the CCFRP fleet) was rerun with a bias ramp adjustment following current practice. This change was relatively small and did not change model results in any appreciable manner. The second alternative model (CCFRP ages moved from the growth fleet to the CCFRP fleet and only Abrams ages remaining in the growth fleet) was set up. The model was weighted using the current procedure and then rerun with a bias ramp adjustment. Note that in both of these models, the STAT did not use a minimum sample size threshold.

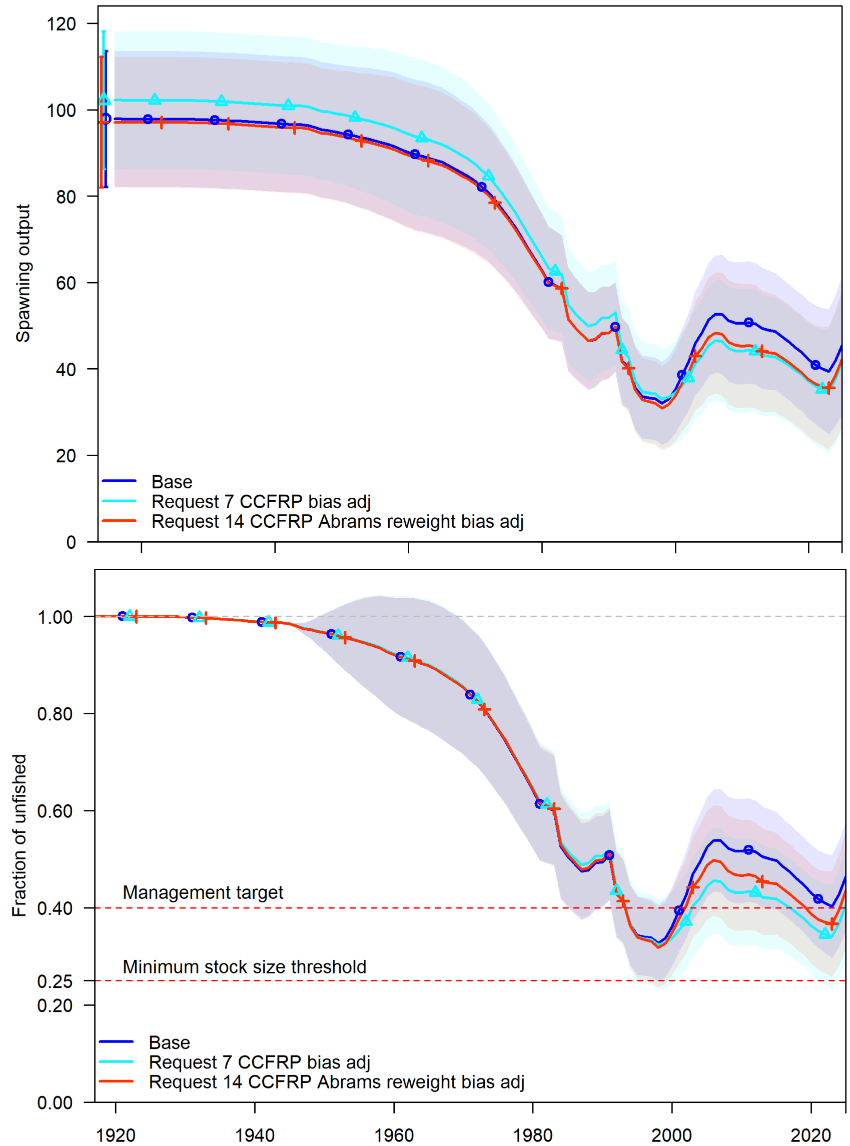

Figure 14A. Spawning output (top) and fraction unfished (bottom) for a) the pre-STAR base model, b) an alternative model that includes CCFRP ages as CAAL for the CCFRP fleet and no growth fleet, and c) an alternative model includes CCFRP ages as CAAL for the CCFRP fleet and retains a growth fleet with only Abrams data.

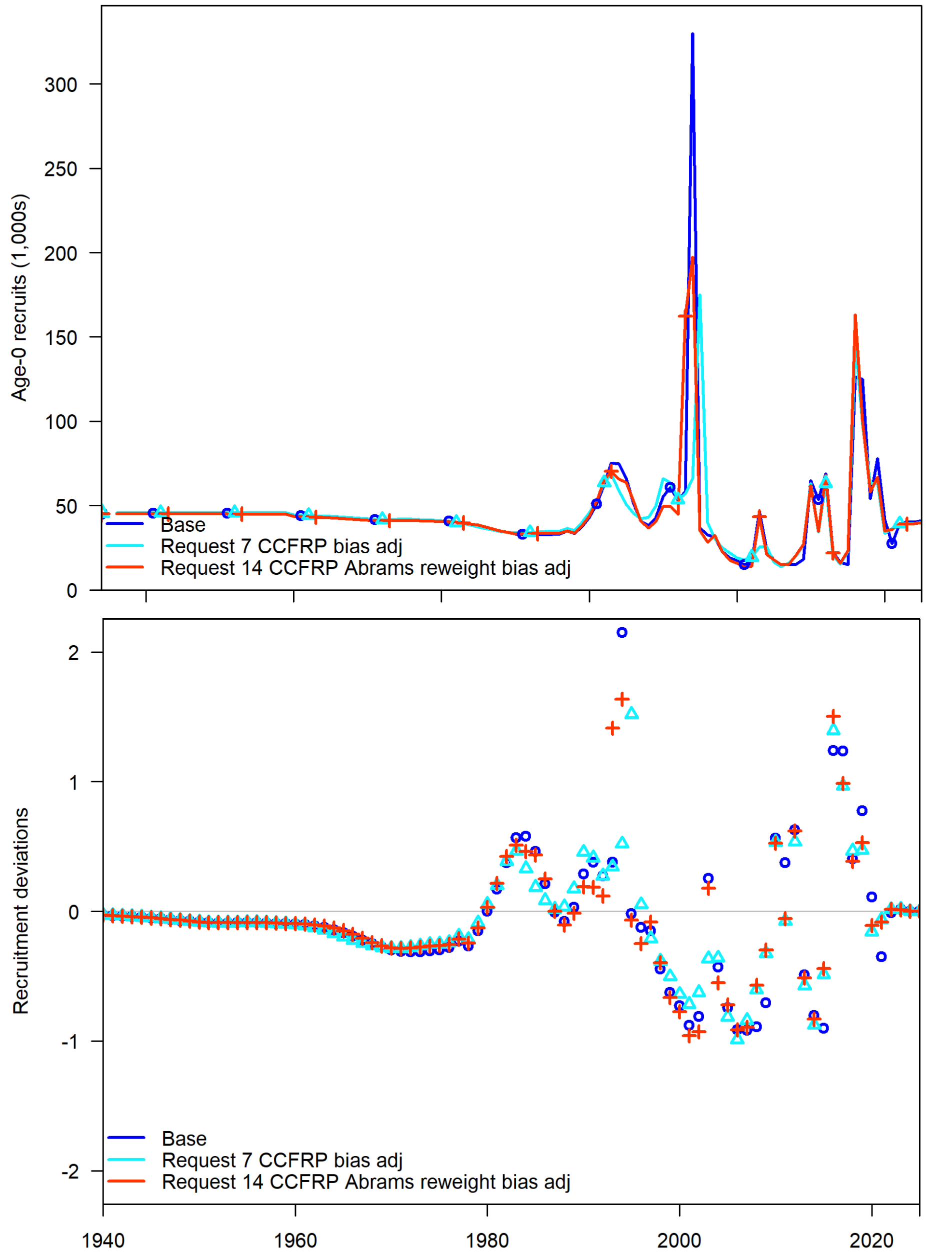

Figure 14B. Age-0 recruits (top) and recruitment deviations (bottom) for a) the pre-STAR base model, b) an alternative model that includes CCFRP ages as CAAL for the CCFRP fleet and no growth fleet, and c) an alternative model includes CCFRP ages as CAAL for the CCFRP fleet and retains a growth fleet with only Abrams data.

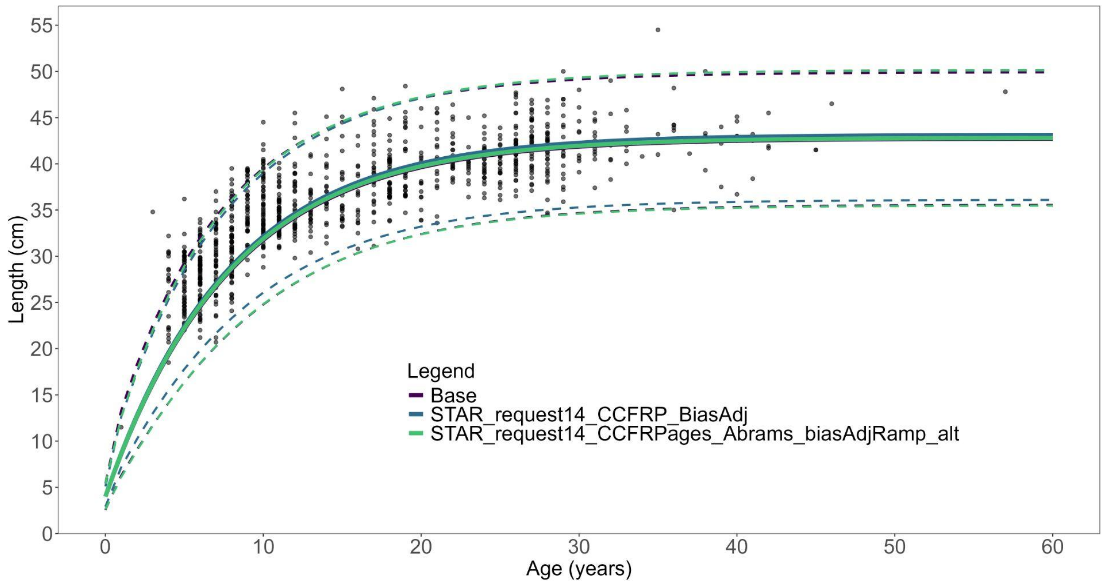

Figure 14C. Growth curves for a) the pre-STAR base model, b) an alternative model that includes CCFRP ages as CAAL for the CCFRP fleet and no growth fleet, and c) an alternative model includes CCFRP ages as CAAL for the CCFRP fleet and retains a growth fleet with only Abrams data. Points represent all available data.

14 - Panel Conclusion

There are remaining uncertainties about how the growth fleet is driving recruitment, especially when combining data from multiple studies that have different sampling schemes and spatiotemporal extents into a single growth fleet. Thus, the Panel will not endorse the pre-STAR base model and recommends continued evaluation into how best to treat ancillary age data for this stock. The alternative models, which retain one or two of the ten data sources that were modeled as part of a growth fleet in the pre-STAR base model (i.e., those that were deemed to be most representative of the stock and/or a fleet), result in similar recruitment deviations and estimates of productivity. Although the Panel continued to have concerns about using unrepresentative samples to inform recruitment dynamics (e.g., modeling Abrams data in a growth fleet), the Panel concluded that either of the alternative models could move forward as the new base.

15 - Request
Please provide a decision table using the new tuned base model that includes CAAL data from CCFRP for the CCFRP fleet and Abrams data in a growth fleet (as in Request 14) with *M* as the primary axis of uncertainty (low *M* = 0.0525, high *M* = 0.08). The decision table should be based on the time series of catch that reflects full attainment (i.e., ACL) from 2027 onwards, as required by the TOR. Please provide this decision table in the post-STAR assessment document and, if possible, to the STAR Panel for inclusion in the STAR Panel report.

15 - Rationale
The low and high values for natural mortality (*M*) were identified using the distribution of the predicted 2025 OFL (10.826), a sigma of 0.5 (default standard error for Category 1 assessments), and the range of maximum ages observed along the West Coast, British Columbia, and Alaska. The low value of *M* (0.0525) is approximately associated with the 12.5% quantile of the 2025 OFL distribution (6.1) and would imply a maximum age of 103 yr, which is slightly greater than the maximum age of 95 yr observed in Alaska. The high value of M (0.08) is approximately associated with the 87.5% quantile of the 2025 OFL (19.2) and implies a maximum age of 67.5 yr, which is greater than the maximum age observed in California (57 yr). The Panel considers a maximum age of 57 yr as an extreme estimate that is highly unlikely, resulting in an overestimate of *M*. As such, the high value of *M* is associated with a slightly higher maximum age.

These outputs are necessary to satisfy the Terms of Reference.

15 - STAT Response
The STAT did not produce results for the decision table in time for inclusion in the STAR Panel report.

15 - Panel Conclusion
The STAT did not produce results for the decision table for inclusion in the STAR Panel report, preventing any sort of conclusion by the STAR Panel.

Acknowledgments
The STAR Panel acknowledges the exceptional time and energy that went into providing additional data for quillback rockfish from various agencies and stakeholders. These data have been used in various ways external and internal to the stock assessment and were important to providing the best possible management advice for quillback rockfish off California.

The Panel would like to thank the STAT for their attention to detail, scientific rigor, and commitment to transparency throughout the development and review of this stock assessment. Their collaborative efforts, in conjunction with actively engaged GMT and GAP advisors, provides a sound foundation for sustainable fisheries management. The Panel was also appreciative of the public feedback that was communicated throughout the review. The Panel thanks Council staff for their technical support and ongoing guidance on the administrative aspects of this process.

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