Rougheye/Blackspotted Rockfishes
Stock Assessment Review (STAR) Panel Report

University of Washington School of Aquatic & Fishery Sciences
Room 203
1122 NE Boat St,
Seattle, WA 98105

July 14-18, 2025

STAR Panel Members

John Field, National Marine Fisheries Service (NMFS) Southwest Fishery Science Center, Pacific Fishery Management Council (PFMC) Scientific and Statistical Committee (SSC) (Chair)
Matt Cieri, Center for Independent Experts (CIE)
Geoff Tingley, Center for Independent Experts (CIE)
Christopher Free, University of California, Santa Barbara, PFMC SSC

Stock Assessment Team (STAT) Members

Jason M. Cope, NMFS Northwest Fisheries Science Center (NWFSC)
Vladlena Gertseva, NMFS Northwest Fisheries Science Center
R. Claire Rosemond, NMFS Northwest Fisheries Science Center
Ali Whitman, Oregon Department of Fish and Wildlife (ODFW)
Fabio P. Caltabellotta, Washington Department of Fish and Wildlife (WDFW)

STAR Panel Advisors

Gerry Richter, B&G Seafoods, Groundfish Advisory Subpanel (GAP) representative
Whitney Roberts, Washington Department of Fish and Wildlife, Groundfish Management Team (GMT) representative
Todd Phillips, PFMC staff/representative

Overview

The Stock Assessment Review (STAR) Panel for rougheye and blackspotted rockfishes, which are managed as a cryptic species complex within the shelf rockfish complexes north and south of 40°10' N, was held at the University of Washington School of Aquatic and Fishery Sciences in Seattle, WA on July 14-18, 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. Rougheye and blackspotted rockfishes are retained primarily in commercial fisheries, including bottom trawl, midwater trawl, hook and line, and midwater trawl for Pacific hake, with most landings off the northern Oregon and Washington coastlines in deeper habitat.

The 2025 full (benchmark) assessment was conducted by Jason M. Cope (NWFSC), Vladlena Gertseva (NWFSC), R. Claire Rosemond (NWFSC), Ali Whitman (ODFW), and Fabio Caltabellotta (WDFW). This is the first assessment since the 2013 benchmark (Hicks et al. 2013), but is considerably better informed by length, age, survey and life history data, including new reproductive biology information. The 2025 model estimates only modest declines in spawning output from the 1980s to the present, and indicates that the stock is well above target levels (e.g., close to unfished levels). These general results diverge fairly substantially from the 2013 assessment.

Discussions during the STAR Panel centered around the challenges associated with estimating the appropriate scale of the resource, as the model is highly sensitive to model assumptions and data treatment. The estimated uncertainty is also very large, and additional challenges are posed by the fact that the model represents a two-species complex, with emerging evidence for fairly substantial differences in both growth and maturity among the two species, although there is robust evidence to demonstrate that both species are extremely long-lived. Ultimately, following additional diagnostic and sensitivity tests, the STAR Panel and STAT agreed that the original draft base model represents the best scientific information available. The Panel identified several key areas for future research.

Summary of Data and Assessment Model

Data

The assessment was conducted using the following data:

1. **Catches:** The assessment uses catch histories for six fleets: (a) bottom trawl; (b) bottom trawl discards; (c) non-trawl; (d) non-trawl discards; (e) mid-water trawl; and (f) at-sea hake. This represents an update from the last assessment, which included trawl discards and mid-water trawl landings with trawl landings.
2. **Indices of relative abundance:** The assessment uses four fishery-independent indices of relative abundance: (a) the West Coast Groundfish Bottom Trawl Survey (WCGBTS; 2003–2024), (b) the Triennial Survey (1980–2004), (c) the AFSC Slope Survey (1997, 1999–2001), and (d) the NWFSC Slope Survey (1999–2002). These indices contributed

to temporal coverage across multiple depth strata and informed both abundance and length structure. The WCGBTS is the only continuing survey.

3. **Length compositions:** The assessment uses length compositions from all six fishery fleets and from three of the four fishery-independent surveys. There are no RE/SB length or age composition data from the NWFSC Slope Survey.
4. **Conditional age-at-length compositions:** The assessment uses conditional age-at-length compositions from the four retention fishery fleets (bottom trawl, non-trawl, mid-water trawl, and at-sea hake) and one fishery-independent survey (WCGBTS). RE/BS conditional age-at-length compositions are not available for the discard fleets or other fishery-independent surveys.

Assessment Model

The reference model was implemented using Stock Synthesis version 3.30.23.1 (Methot and Wetzel 2013), a widely used statistical catch-at-age platform that supports the integration of diverse data types and flexible model specifications. This modeling platform was supported by the Stock Assessment Continuum Tool, which was used to evaluate model performance through likelihood profiling, retrospective diagnostics, and sensitivity plotting. The r4ss R package (v1.51.0) and R version 4.4.3 were used to extract outputs and generate diagnostic plots.

The model is sex-structured and assumes a 1:1 sex ratio at birth. Growth and weight-at-length relationships were estimated separately for females and males, enabling tracking of sex-specific population dynamics. The model start was in 1892, with the population assumed to be in unfished equilibrium prior to that period, consistent with standard assumptions for long-lived rockfish.

Building on this platform, biological processes were parameterized using both estimated and fixed inputs. Growth parameters were freely estimated for each sex and were stable across model scenarios. Natural mortality (M) was estimated for females and fixed at 0.036 for males, based on a likelihood profile that reconciled divergent signals between length and age data. Population length bins were defined from 4 to 84 cm (2-cm intervals), while input data bins ranged from 10 to 80 cm. Conditional age-at-length data were modeled using ages 1 to 100 years.

Other life history functions were fixed, including length-at-maturity, fecundity-weight, and the length–weight relationship. Steepness of the stock–recruit relationship (h) was fixed at 0.72, consistent with the rockfish prior. Recruitment deviations were estimated across the full model time series, and recruitment variability was set at 0.5, consistent with the internal tuning of recruitment variability in the model. Exploratory models with shortened deviation windows produced implausibly high biomass levels and were therefore rejected in favor of the full deviation structure.

To characterize removals, the model included six fleets representing landings and discards from bottom trawl and non-trawl gear, as well as mid-water trawl and at-sea hake bycatch. Discards were modeled as separate fleets to enable independent estimation of selectivity and data weighting, reflecting differences in sampling methodology (port vs. observer data). This structure also avoids the need to estimate retention curves, which can be problematic with sparse discard data. Historical discards were assumed negligible prior to the early 2000s, consistent with observer records and the introduction of rockfish trip limits.

In addition to fishery-dependent data, four fishery-independent surveys were included in the model: the West Coast Groundfish Bottom Trawl Survey (WCGBTS; 2003–2024), the Triennial Survey (1980–2004), the AFSC Slope Survey (1997, 1999–2001), and the NWFSC Slope Survey (1999–2002). These indices contributed to temporal coverage across multiple depth strata and informed both abundance and length structure.

Length-based selectivity functions were applied to all fleets and surveys, consistent with the lack of evidence for age-based selectivity in these fisheries. Both logistic and dome-shaped curves were considered, with time blocks included where changes in fishing behavior, management, or survey design occurred. Selectivity blocks were applied to the bottom trawl (2002, 2011), bottom trawl discard (2011), non-trawl (2011, 2020), and the Triennial Survey (1995). No block was applied to the non-trawl discard fleet, as the length composition data did not indicate a substantive shift in selectivity across time.

A dome-shaped selectivity function was required for the bottom trawl fleet to fit the biological data, marking a notable departure from the 2013 assessment. In contrast, logistic selectivity was retained for the mid-water trawl, at-sea hake, and final block of the non-trawl fleet. Retained and discarded fish in trawl fleets exhibited different length distributions, while non-trawl discards closely mirrored the retained catch. The choice of dome-shaped selectivity for the bottom trawl fleet influenced the scale and status of the stock and was identified as a key source of structural uncertainty.

The model likelihood included five primary components: fits to length composition, conditional age-at-length, survey indices, recruitment deviations, and prior distributions. Catch data were included without error. A crash penalty was also included to prevent biologically implausible outcomes that would imply extinction; however, this term remained inactive under the final model configuration.

To appropriately weight composition data, the Francis (2011) method was applied to both length and age-at-length inputs. This method adjusts effective sample sizes based on agreement between observed and predicted means but applies a constant weighting across all years in each data source. Sensitivity analyses were conducted to evaluate alternative data weighting methods, including the Dirichlet-Multinomial approach, McAllister-Ianelli harmonic mean, and unweighted models.

Additional variance estimation was permitted for survey indices but found unnecessary, as input variances were already large and survey trends exhibited limited contrast. Removal of index data in sensitivity runs confirmed their low leverage on model outcomes. Thus, the reference model was found to be robust to uncertainty in the survey indices and primarily informed by composition and catch data.

Description of the Base Model and Alternative Models used to Bracket Uncertainty

The reference model was constructed with the primary objective of providing a risk-neutral estimate of spawning output and relative stock status for rougheye and blackspotted rockfishes (RE/BS) within U.S. West Coast waters. The STAT sought to develop a structure that reflects a

balance between biological realism and model parsimony, with estimation pursued only where data were sufficiently informative. Where data were limited, the STAT applied simplifying assumptions to avoid overfitting and to ensure numerical stability.

Model development proceeded through a structured sequence of investigative runs designed to evaluate the influence of data inclusion, parameter specification (fixed vs. freely estimated), estimation phasing, and the likelihood surface topology. Initial trials focused on characterizing biological signals using only length and age composition data, omitting catch and recruitment, and assuming constant life history parameters. This phased approach was intended to isolate the information content of each data stream and to inform subsequent model configuration.

Length-dominant models (with fixed *M* and growth parameters) generally produced lower estimates of stock status than the final model, particularly in the absence of selectivity blocks. By contrast, age-only models produced stock status trajectories more consistent with the reference model and were less sensitive to assumptions about time-varying selectivity. Recruitment deviations estimated only for the recent period (1980–present) resulted in reduced biomass estimates, while extending deviations across the full historical period (1892–2023) improved fit. Although all exploratory models fell within the uncertainty envelope of the reference model, the length-only model without selectivity blocks notably underestimated stock status.

A broader suite of exploratory configurations was tested to evaluate model sensitivity to structural assumptions. These included estimating versus fixing natural mortality and growth parameters, exploring alternative steepness priors and recruitment estimation windows, and evaluating variance assumptions in survey indices. Functional forms for selectivity (logistic vs. dome-shaped) were tested in combination with time-blocking structures, and the treatment of key parameters (e.g., *M*, growth) was examined under alternative data-weighting scenarios. These runs informed the configuration of the final model and were used to identify sources of structural uncertainty.

Among the structural assumptions explored, two emerged as dominant drivers of model outcomes: (i) the treatment of sex-specific natural mortality, and (ii) the form and timing of selectivity blocks for the bottom trawl fleet. Together, these structural choices explained the majority of variability in spawning output and stock status across candidate models.

Additional sources of uncertainty related to data treatment were distinguished from model structure per se. These included assumptions regarding ageing error and the choice of data-weighting method for length and age compositions. While these decisions affect the scale and stability of the model's outputs, they reflect broader trade-offs common to integrated assessment frameworks and were addressed through sensitivity analysis rather than within the reference model itself.

The reference model further assumes lognormal observation error for all survey indices, and multinomial error distributions for length and conditional age-at-length compositions, with input sample sizes subject to Francis reweighting to account for overdispersion. Recruitment deviations were modeled as log-normally distributed. These assumptions are consistent with prior assessments of long-lived rockfish and are supported by available diagnostics.

Finally, structural uncertainty was formally evaluated through targeted sensitivity scenarios and likelihood profiling on R_0, steepness, and natural mortality. These evaluations informed the plausibility bounds for spawning output and relative depletion and provided a transparent basis for reference point and status determination.

Technical Merits of the Assessment

- Considerably more age data are available, relative to the previous assessment.
- Increasing age/length data in recent years, but given longevity of species and sensitivity of model to age data, more are required to deliver increased model stability and robustness.
- Includes information on differences in maturity between species.
- Survey samples smaller/younger individuals reasonably well.
- The WCGBTS is providing some information that informs trend, biomass, and recruitment, although the survey tends to sample smaller and younger fish.
- Mixed use of both dome and logistic selectivities is useful for promoting model stability.
- Extensive sensitivity analysis to examine possible alternative states of nature.
- In recent decades, fisheries landings and demographics sampling has improved.
- There are length compositions back into the 1980s.
- There do not appear to be any unusually high sources of tension among data sources in the model.
- Estimated life history parameters were consistent across a wide range of model specifications and data treatments.

Technical Deficiencies of the Assessment

- Catches undifferentiated by the two species (cryptic complex), which means that the overall assessment is on two very different species with potentially substantial life history differences.
- Historical sampling of the fishery has been somewhat limited and not always consistent; in particular, historical catches tend to have greater uncertainty for species that are relatively rare within market categories or landings (e.g., Grunloh et al. 2018).
- The four fishery-independent surveys are generally uninformative, as they were either too short (slope surveys) or too narrow for the depth range (Triennial survey), or have been unable to sample across all habitats used by the fish to adequately index the stock complex (WCGBTS).
- While the WCGBTS is providing some information to suggest a lack of trend in moderately sized and aged individuals, it is not adequately indexing the abundance of the entire population.
- Sufficient age data are still lacking, especially given the longevity of the fish. There is a short timeseries of recent age data relative to the age of the fish, from which detecting significant shifts in demographic structure in response to fishing mortality is difficult. This relates to an overarching need to have more age data and to better inform natural mortality for both species and sexes.
- The model is not resolving the scale of population well, and the scale is highly sensitive to model assumptions and data treatment. The fact that the model is estimating that the current population status is close to the unfished level contributes to greater uncertainty in

stock scale.

- The model is considerably more unstable than most West Coast groundfish assessments that are reasonably well informed by age and length data.
- The use of multiple, short-term selectivity blocks, particularly in the most current years, complicates diagnostics (particularly in the retrospective analysis) and projections.
- The habitat associations of these two species are not well understood – it is not known what life stage is associated with the many habitats in which RE/BS occur and how this variability affects RE/BS vulnerability to the fisheries and surveys.
- Estimated uncertainty is large, hampering usefulness for providing management advice.
- The age data are from a suite of different ageing programs and laboratories, with considerable complexity in the ageing error matrices.

Recommended Sigma Value

The Panel recommends a Category 2 designation for this assessment (default sigma = 1), with the rationale being a combination of a 2d (this assessment is considerably more uncertain than most and has scale issues and unique uncertainties) as well as 2e (the assessment is of a species complex, and the two species demonstrate quite different life history characteristics (particularly growth and maturity). The estimated sigma from the model is also above 0.5 (0.66), even with several key parameters fixed, based on a combination of uncertainty in the biological data and the estimated high relative stock status.

Recommended Next Assessment Type

It would be beneficial to conduct either a full or an updated assessment after additional historical as well as several additional years of age data are collected and analyzed. This should likely occur within six years or so, but in no more than 10 years. The question of whether a full or an update is warranted may depend in part on both catch levels and whether alternative sources of data (not currently in the model) are available.

Areas of Disagreement Regarding STAR Panel Recommendations

There were no disagreements within the Panel.

While there were some robust discussions between the Panel and the STAT about aspects of the assessment, none of these amounted to substantive disagreements.

Management, Data, or Fishery Issues raised by the GMT or GAP Representatives During the STAR Panel Meeting

The GMT recognizes that there is high uncertainty in the scale of the population, particularly on the upper bound of the scale, which results in high uncertainty in the management values projected by the model. The base model projects a threefold increase in the OFLs from 2026 to 2027, and given the high uncertainty in scale, these projections should be viewed with caution. However, there is less uncertainty in the stock status, with very good indication that the stock is above the management target in 2025. The uncertainty in scale appears to be driven in part by

insufficient or uncertain age data for such a long-lived species, so the GMT supports continuing efforts to collect and process more age data to support future assessments.

The GMT advisor expressed interest in the reason for different selectivity time blocks for the retention and discard fleets across the same gear type, as we would expect the timing of changes for retention vs. discard selectivities in the same fleet to be aligned. The STAT explained that there were not sufficient discard data to inform the same time blocks as the respective retention fleets, and the GMT was satisfied with this answer.

There was also discussion amongst the Panel regarding the specific management and fishery behavior changes that occurred in 2020 to support the STAT's choice to include the 2020-2024 selectivity time block in the non-trawl retention fleet. The GMT advisor informed the Panel that the Council took action in 2020 to double the slope rockfish trip limits north of 40° 10′ N. Lat. in response to industry requests for more access to slope species as a new Community Supported Fishery was developing, alongside economic impacts from COVID-19. Additionally, sablefish prices had been declining since around 2019, and COVID-19 exacerbated that decline through impacts to sablefish markets. In response, there was greater incentive for some vessels targeting sablefish to retain incidentally caught rockfish species to supplement exceptionally low sablefish prices and market constraints. These changes combined could explain the observed increase in retention rates starting in 2020 compared to prior years. However, the GMT and GAP advisors did not think those changes would necessarily explain the increase in retention of larger rougheye/blackspotted rockfishes as seen in the commercial non-trawl length data. It is possible that rougheye rockfish in particular is not an entirely incidental species for some vessels, which may seek out areas known to include larger fish, but the potential causes of length differences before and after 2020 should be further explored before the next update or benchmark assessment.

The GMT and GAP are supportive of future research that considers alternative techniques to surveying these species, such as ROV surveys or methods that use non-trawl gears. While the WCGBTS index suggests no trend in the abundance through time, there is some considerable uncertainty about whether that survey adequately samples areas of abundance for these species, which could explain the gap in length data around the 30-40 cm range (also observed in the commercial trawl fleet). The WCGBTS is a valuable source of survey data for all managed groundfish species, but it is relatively less informative for some rockfish species like rougheye/blackspotted rockfishes than the other groundfish species.

The GMT and GAP are also supportive of research and data collection efforts to improve our understanding of species-specific proportions in this complex and the risk of overexploiting the weaker stock.

Unresolved Problems and Major Uncertainties

There were several important uncertainties associated with the base model. These included:

- That the "stock" for this assessment was composed of two species, each with very different life-history traits.

- The inability of the model to resolve the scale of the population, partially attributed to high stock status estimates (near or above unfished levels).
- The fact that the base model was very sensitive to small changes in parameter estimation.
- The impact of the 2020-2024 selectivity block on diagnostics and projections.

A key uncertainty was the fact that the stock, as assessed, is composed of two distinct species. More importantly, there was some evidence presented that the two species likely had very different stock sizes, availability to the fisheries, and life-history attributes. While species-specific assessment was not possible at this time, it should be recognized that including such distinct species in the assessment as a "complex" risks greater depletion of one species through setting management measures for the complex.

As discussed previously, the base model showed a high degree of uncertainty regarding stock scale. This inability to resolve the stock scale increases the uncertainty for the stock and makes drawing management-relevant conclusions difficult, particularly in estimating OFLs and ABCs.

Related to this, the model was very sensitive to even small parameter changes and data treatments, particularly in retrospective peels. Such seemingly minor changes to the data informing the model often resulted in very large changes in the stock's scale, further increasing uncertainty as to the appropriate level of OFL/ABC.

Additionally, the use of selectivity blocks in the base case was also considered a key uncertainty. Selectivity blocks can be useful tools to allow models to better fit the data, particularly when there have been known changes to management, fish availability, or fishing behavior to warrant such an approach. However, the use of blocks can present challenges. Notably, blocks in selectivity can make the interpretation of some diagnostics, such as retrospectives, more challenging. Further, the implicit assumption when a block is imposed in later years is that the issue that necessitated the block will persist into the foreseeable future: an important consideration when doing projections.

It did not seem possible that these key uncertainties would likely be addressed prior to the finalization of this STAR process. To address these issues in the future, the Panel has a number of research and other recommendations (See "Recommendations for Future Research and Data Collection" below).

The risk table for this species was developed based on a "Category 1" species rubric, and thus may not be as useful as intended for a "Category 2" designation stock. The ratings within that table should not be construed as inferring that the stock should have a Category 1 designation.

Recommendations for Future Research and Data Collection

- Collect more age frequency data representative of the fisheries.
- Plan to read new and any relevant historically collected otoliths to provide informative age data in advance of the next assessment.
- Explore alternative fishery-independent (e.g., demersal longline survey, ROV survey) and fishery-dependent (commercial CPUE) indices of abundance.

- Evaluate the potential for the Pacific halibut longline survey to contribute catch rate information or biological samples.
- Explore the potential for adding habitat layers (e.g., rocky habitat layers from revised habitat areas of particular concern analysis) into survey index models (e.g., sdmTMB) to evaluate whether additional habitat information can improve the indices and/or the understanding of habitat associations.
- Explore speciation of the survey catches for these two species using current methods.
- Explore methods to improve the confidence and accuracy of speciation of the survey and commercial catches for these two species using otoliths, e.g., using DNA, or AI-informed morphology analyses (Harris et al. 2019).
- Convene a workshop to guide practices for using and specifying selectivity blocks, including gear changes and fisher behavior changes. Consider such evaluations prior to either a future full or update assessment.
- Consider providing more advice or guidance regarding best practices for when to start recruitment deviation estimates and whether or not to include the "sum to zero" option within stock synthesis (broad relevance to many assessments).
- More discussion and guidance (and potentially workshops) about how best to develop risk tables, particularly for Category 2 stocks, would be helpful (broad relevance to many assessments)
- Some consideration of alternative approaches to account for ageing error or consolidation of the number of aging error matrices would be beneficial.

Acknowledgements

The STAR panel thanks the public attendees, STAT, GMT, GAP, and Council representatives. The panel also thanks Council staff for providing technical support.

References

Cope, J.M., V. Gertseva, R.C. Rosemond, A.D. Whitman, and F.P. Caltabellotta. (2025) Status of the Rougheye and Blackspotted rockfishes stock off the U.S. West Coast in 2025. Pacific Fishery Management Council. 347 pp.

Grunloh, N., Pearson, D., Dick, E.J., Field, J. and M. Mangel. 2017. Improving Catch Estimation Methods in Sparsely Sampled, Mixed Stock Fisheries. Unpublished report prepared for PFMC. https://www.pcouncil.org/documents/2018/09/agenda-item-i-6-attachment-2.pdf/

Hutchinson, C. and Harris, J. (2019). Use of otolith shape analysis to separate blackspotted (*Sebastes melanostictus)* and rougheye rockfish (*Sebastes aleutianus*). NOAA Poster, 1p. https://apps-afsc.fisheries.noaa.gov/pubs/posters/pdfs/pHutchinson01_otolith-blackspotted-rougheye.pdf

Harris, J. P., Hutchinson, C., and Wildes, S. (2019). Using otolith morphometric analysis to improve species discrimination of blackspotted rockfish (*Sebastes melanostictus*) and rougheye rockfish (*S. aleutianus*). Fish. Bull. 117, 234–244. doi: 10.7755/FB.117.3.10

Hicks, A.C., C. Wetzel and J. Harms. 2013. "The status of rougheye rockfish (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*) as a complex along the U.S. West Coast in 2013." Pacific Fishery Management Council, Portland, OR 97220.

Methot Jr, R.D. and Wetzel, C.R., 2013. Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research, 142, pp.86-99.

ROUGHEYE-BLACKSPOTTED ROCKFISH Requests, Rationale, and Responses

1 - Request

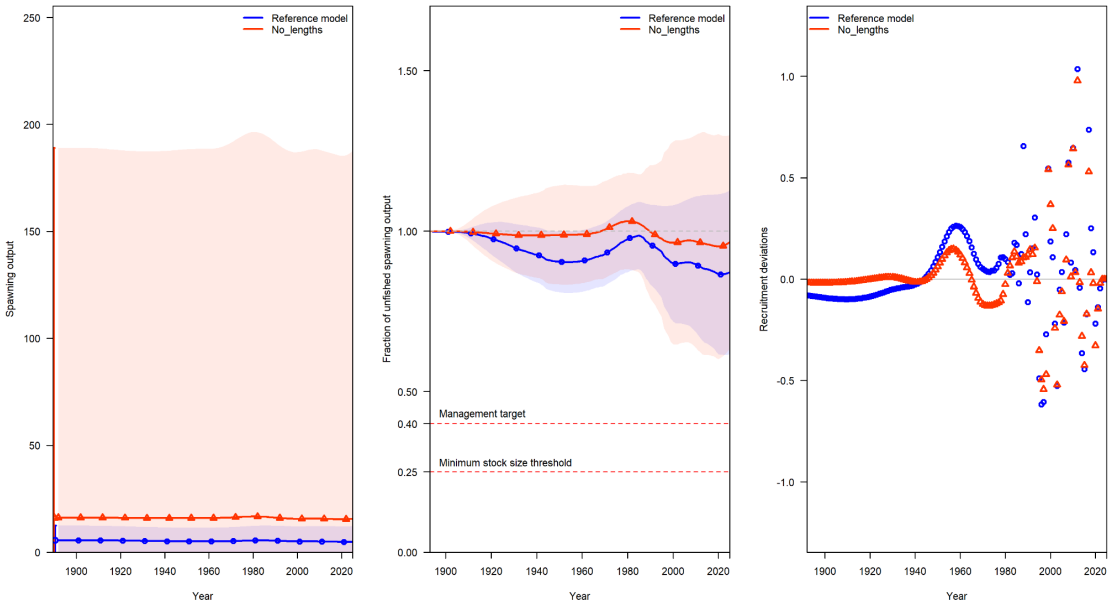
Run a model in which selectivities are estimated using length data, the selectivity curves are then fixed, and the model is run using only CAAL data. If the resulting model seems plausible and time allows, run a five-year retrospective of this model. Plot trajectories of biomass, status, and recruitment deviations; fits to main data.

1 - Rationale

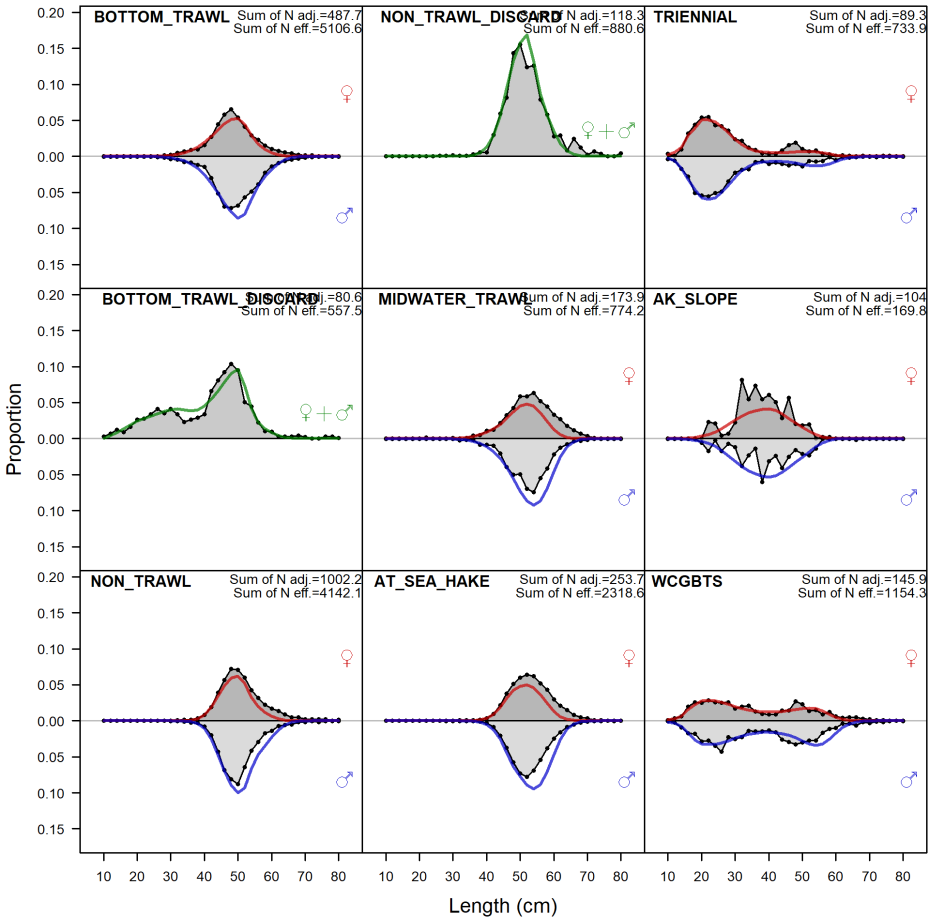
To seek to reduce the influence of length data in the model.

1 - STAT Response

This requested model fixes selectivity, but removes all lengths. This model highlights the importance of the length data that goes beyond the ability to estimate length-based selectivity. Length data also provides insight into recruitment events and stabilizes the model scale estimation. Given sampling of lengths goes back a decade more than the first ages (with many ages samples in the most recent years) and the surveys mostly sample individuals <40 cm (< 20 years of age, when lengths are still informative to ages), it is unsurprising that this data provides important information on recruitments. This is seen both in the information content of recruitments that increase after 1980 (see recruitment deviation variance plot in the reference model) and the lack of information in those recruits when lengths are taken out of the model. Without these lengths, the model scale explodes, the status rests near unfished, and the length data are no longer fit in the model (despite having the same selectivity as the reference model).

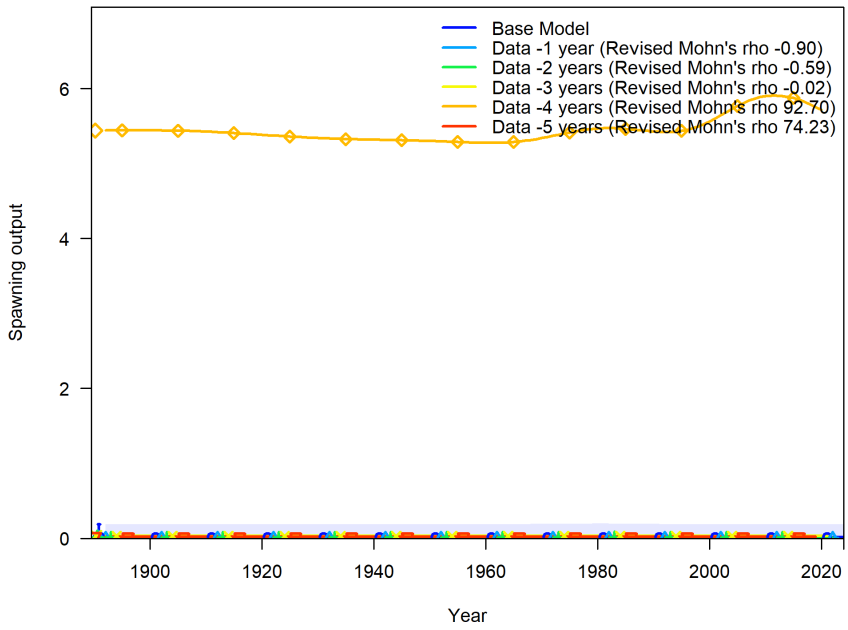

Reference model
No_lengths
Spawning output
Year
Fraction of unfished spawning output
Management target
Minimum stock size threshold
Recruitment deviations

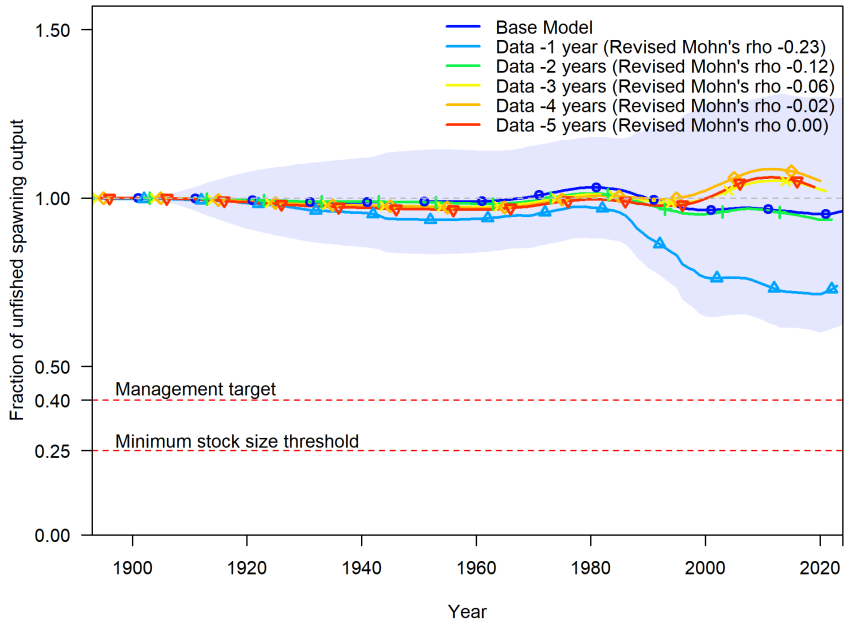
Model fits


BOTTOM_TRAWL
NON_TRAWL_DISCARD
TRIENNIAL
BOTTOM_TRAWL_DISCARD
MIDWATER_TRAWL
AK_SLOPE
NON_TRAWL
AT_SEA_HAKE
WCGBTS
Proportion
Length (cm)

Retrospective analysis

Even though this model is not plausible, here is the retrospective pattern, qualitatively similar to the reference model.





1 - Panel Conclusion
Fixing length-based selectivity and removing the length compositions from the likelihood resulted in increased estimates of scale, increased uncertainty in scale, and poorer fits to the length composition data. This is likely because the length compositions from the surveys contain information on recruitment, particularly the early recruitments, in addition to information on selectivity. Removing this information resulted in uninformed and unrealistic recruitment deviations in the 1980s, which were previously informed. The retrospective analysis still results in large shifts in scale between peels The Panel recommended adding text to the document to explain why age-based selectivity was not appropriate and justifies the use of length-based selectivity.

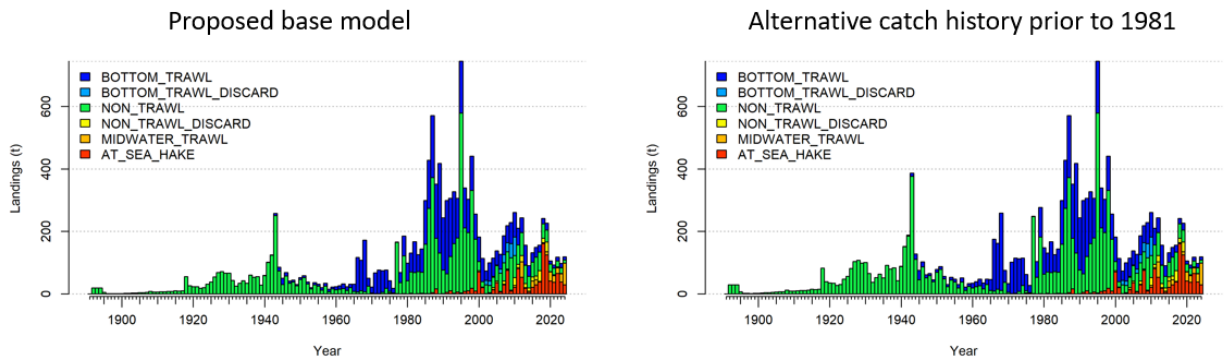
2 - Request
Run a sensitivity with an alternative early catch history (maybe prior to 1977 – STAT to choose and justify choice). Suggest catch +50%. Plot biomass, stock status, and recruitment deviations.

2 - Rationale
To explore catch history uncertainty.

2 - STAT Response
We ran a sensitivity analysis using an alternative early catch history for fleet 1 (commercial bottom trawl fishery) and fleet 3 (commercial non-trawl fishery) prior to the year 1981 (because after 1980, commercial catch data are better resolved and available in PacFIN). We did not alter the early catch history for the at-sea hake fishery prior to 1981 because the catches are fully observed.

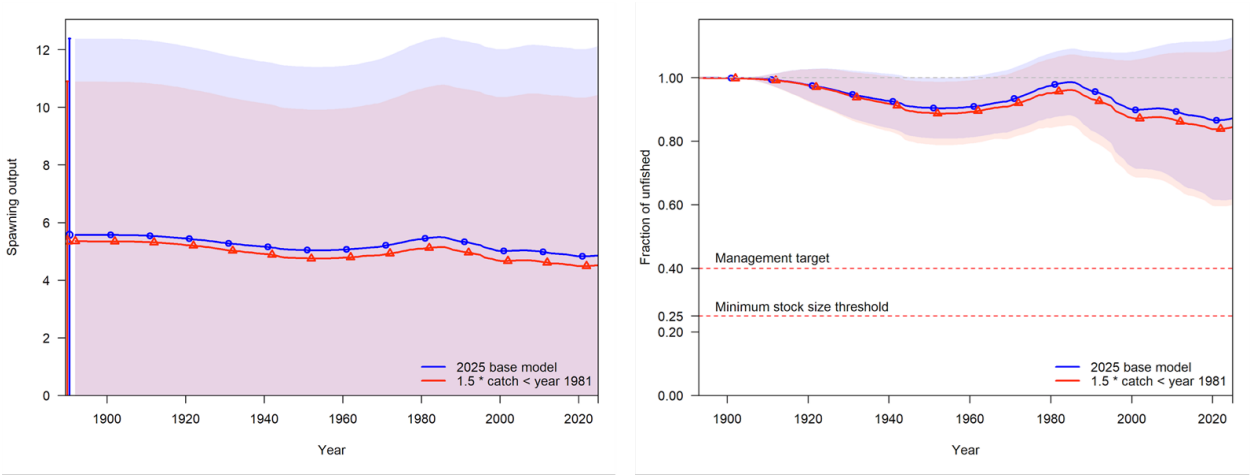
In our sensitivity model, we assumed that the alternative early catch was 50% higher (1.5 x catch) to explore the sensitivity of the model parameter estimates and derived quantities to a higher catch in the earlier period of the catch history.

The plots below compare the catch history used in the proposed base model and the alternative early catch history used in the sensitivity model.



Between the proposed base model and the sensitivity model, we found that the fits to the data and the parameter estimates were similar (base ln(R0) = 6.98 and sensitivity ln(R0) = 6.94). For the sensitivity model with the alternative catch history, the derived quantities of spawning output and relative depletion were slightly lower throughout the time series but remained within the uncertainty of the base model. The estimated recruitment deviations were slightly lower from 1980 to the early 2000s in the sensitivity model.

The plots below compare spawning output, stock status, and recruitment deviations for the proposed base model (blue) and the sensitivity model (red).



2 - Panel Conclusion

The adjustments to the early catch history resulted in slightly lower estimates of scale and status, resulting from slightly lower estimated recruitment in the 2000s. The Panel notes that this is somewhat surprising because increasing early catch history frequently increases in scale and status. Estimated female *M* was not materially different. Overall, the insensitivity of the results to this analysis shows that uncertainty in the early catch history is not a major concern for this assessment.

3 - Request

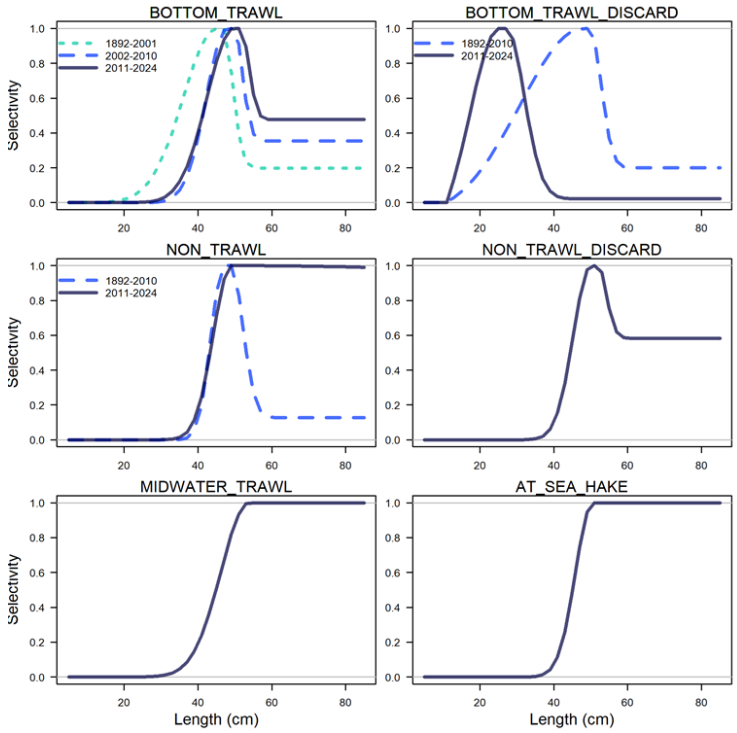
Try removing some of the selectivity blocks (at a minimum the 2019-2024 time block). Use both dome-shaped and asymptotic selectivity for the longer selectivity blocks. Run five-year retrospectives for each.

3 - Rationale

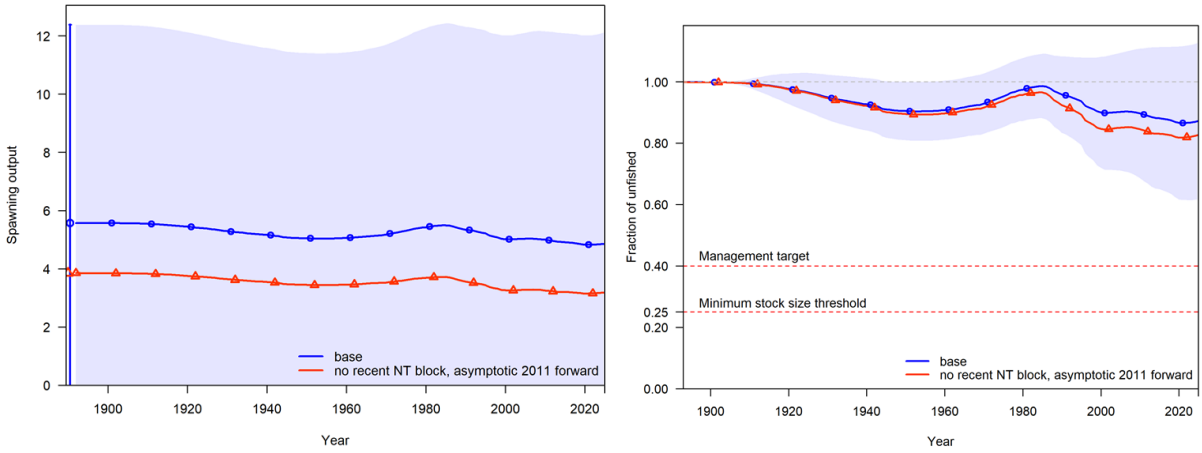
Is the complexity in the selectivity functions contributing to the scaling issues observed in the retrospectives?

3 - STAT Response

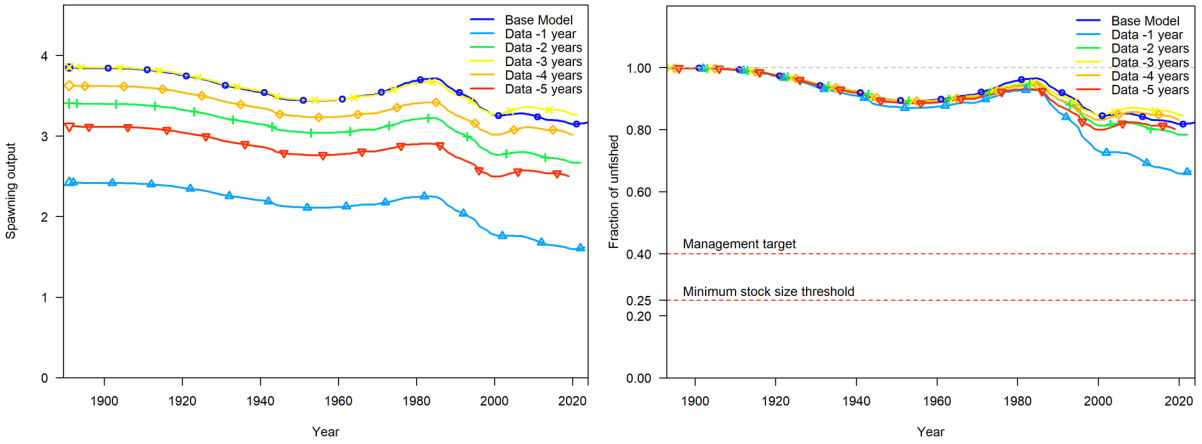
We ran the model removing the 2020-2024 non-trawl selectivity block while assuming 2011 forward to be asymptotic as shown below. In the proposed base model, 2020-2024 non-trawl is fixed asymptotic, and 2011-2019 non-trawl selectivity is estimated to be dome-shaped.



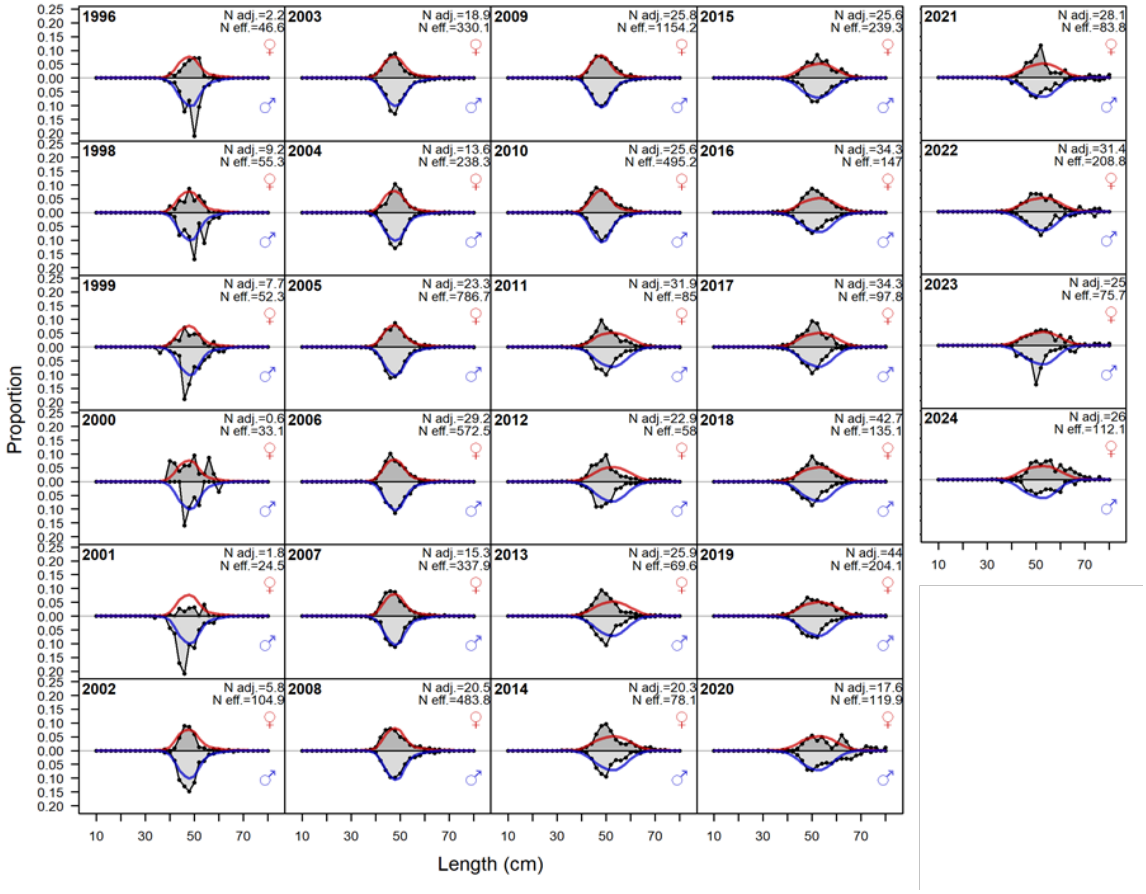
The comparison of this requested run with the proposed base is below. The scale slightly decreased in the requested model run (since the longer period of the non-trawl fleet is assumed asymptotic).



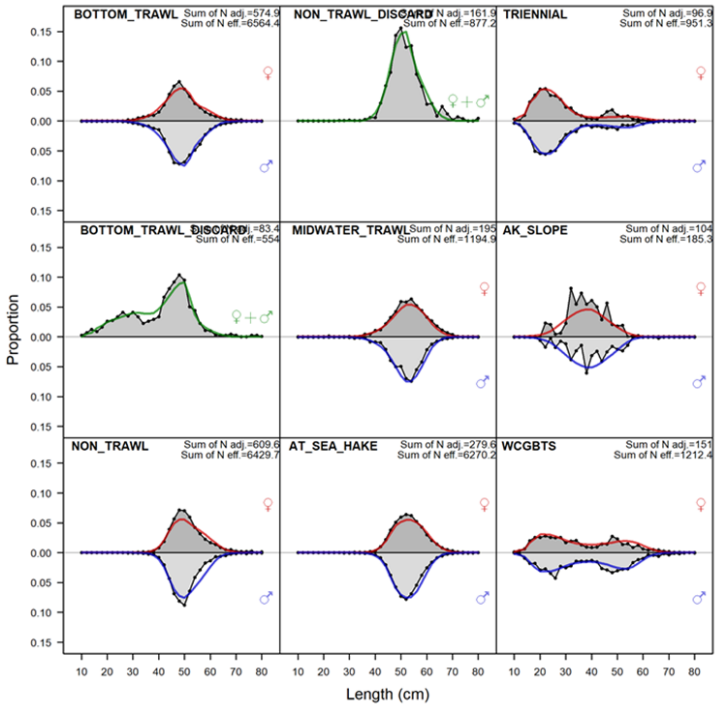
We then ran retrospective analysis on the modified model. Results are below (the modified model is marked on the retrospective plots below as base). The scale does not increase dramatically (as we saw in the proposed base).



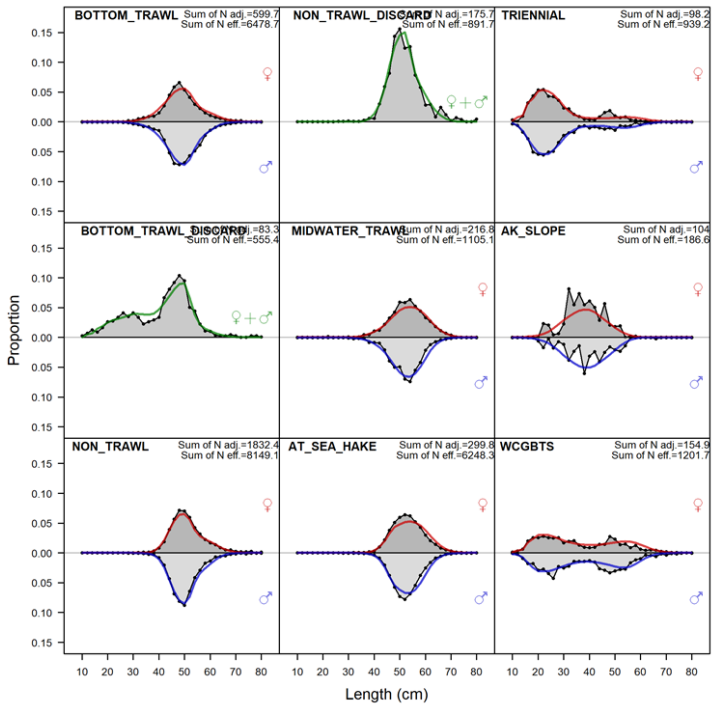
However, the modified model loses fit to the non-trawl lengths composition for the period 2011-2019 (see below):



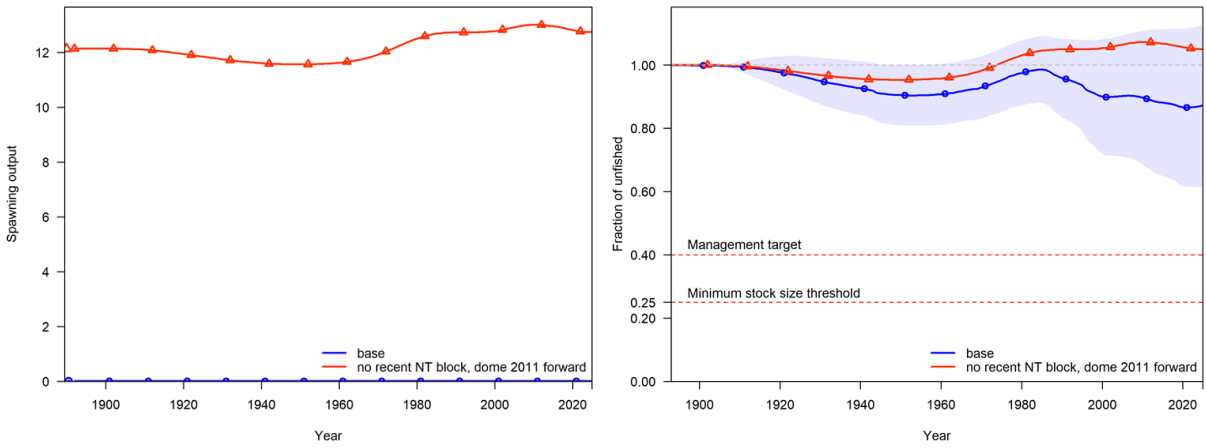
Here is also comparison of fits to length comps for all years combined, for modified model:



And the proposed base:



We also ran the model, removing the 2020-2024 block on non-trawl selectivity, but allowing the period 2011 forward to be dome-shaped. Without asymptotic block, the scale increased substantially as shown below:



Fits to length composition in that model (with 2011-forward non-trawl selectivity dome-shaped) is similar to the proposed base.

STAT Conclusion: This run illustrated that a substantial increase in retro runs (while removing 3, 4, and years of data) may indeed be driven by the recent (relatively short) block on non-trawl

selectivity. Given this result, we would not expect a sudden jump in scale (as seen in retrospective), since the length of the block will only grow. On the contrary, we should expect increased stability with accumulation of each successive year of data in the block.

Also, keeping the block limited to 2020-2024, when length composition data for non-trawl fleet shows an increase in mean length of fish (which also corresponds to a decrease in discard amount), allows for balancing the estimated scale and model fit. With the asymptotic block on 2020-2024, the scale is being estimated at a reasonable level with $\ln(R_0) = 6.98$, and the model fits the length composition data for years prior to 2020 very well (unlike the model with block extended back to 2011).

3 - Panel Conclusion

The removal of the 2020-2024 selectivity block and replacement with a 2011-2024 block, estimated assuming asymptotic selectivity, resulted in a slight decrease in scale and status and the elimination of a retrospective pattern that jumps orders of magnitude in scale. However, this results in poorer fits to the non-trawl length compositions but better fits to the at-sea hake length compositions. The removal of the 2020-2024 selectivity block and replacement with a 2011-2024 block estimated assuming dome-shaped selectivity, resulted in unrealistically large increases in scale and moderate increases in status. This confirms that some of the jumpy retrospective behaviour results from peeling back into this short, most recent time block. The Panel finds the version of the model with asymptotic selectivity over 2011-2024 to be more stable and show better retrospective behaviour relative to the base model. If the STAT opts to retain the 2020-2024 time block, the Panel recommends the addition of text to the document to justify the use of the 2020-2024 selectivity time block.

4 - Request

Run a sensitivity removing all fishery-independent indices except the WCGBTS. Plot trajectories of biomass, status, and recruitment deviations; fits to main data

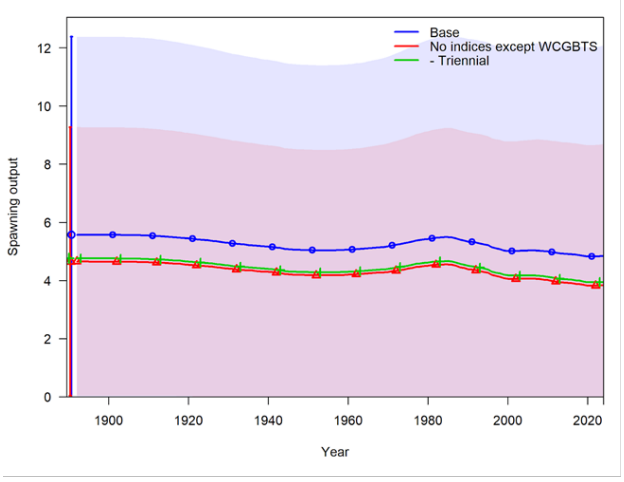
4 - Rationale

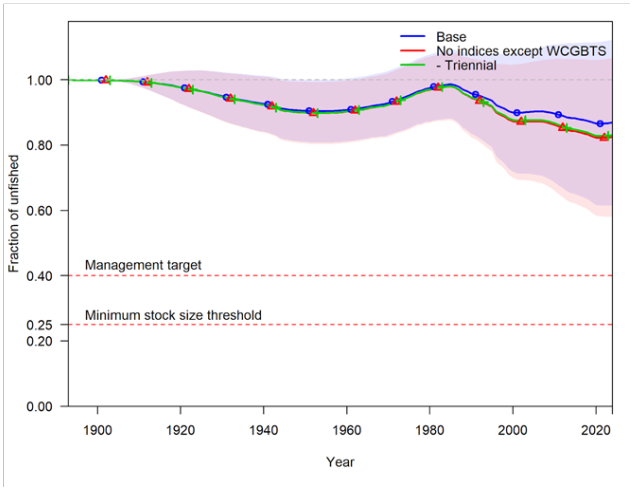
As these indices are not very influential, explore simplifying the model structure for parsimony.

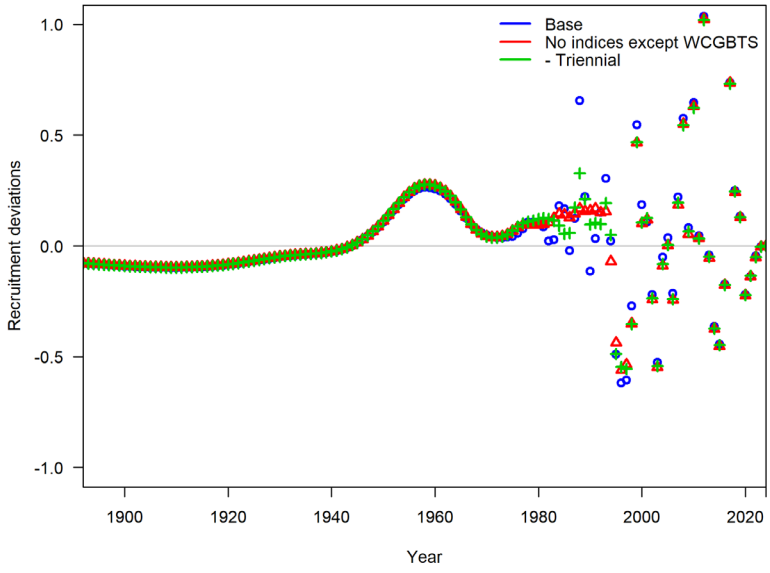
4 - STAT Response

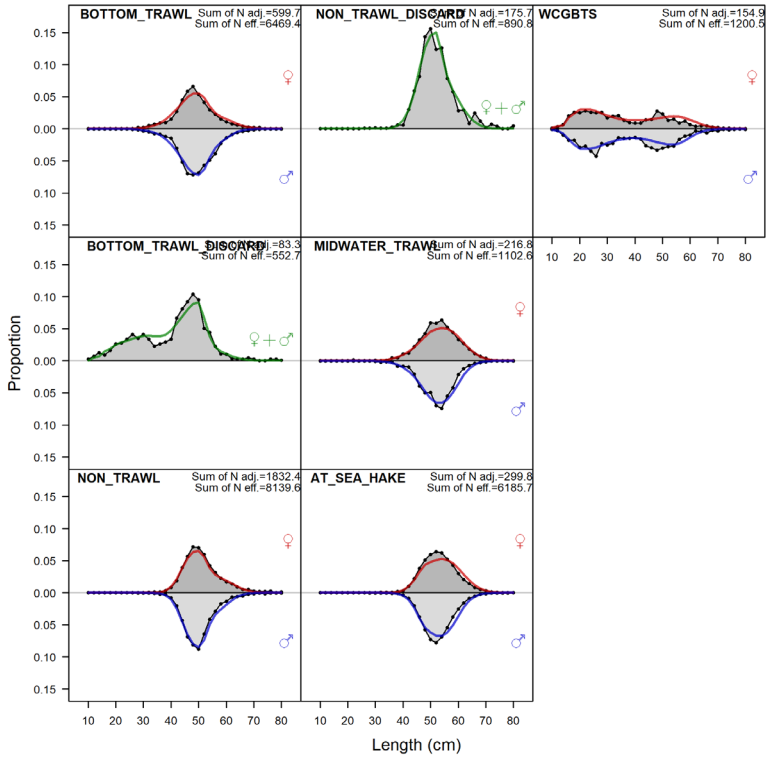
When retaining the WCGBTS as the only index of abundance, the scale and status of the population decrease, as expected, but are still well within the base model uncertainty for both population scale and status. Removing these older indices reduces the available length compositions from this time period, which does appear to impact recdevs in the 1980s, as compared to the base model. This supports the STAT original conclusion that these surveys' biological compositions are particularly useful even if the indices themselves do not offer contrast or highly informative abundance trends. The comparison below includes the Base model

(blue), the model with only the WCGBTS (red), and the Base model sensitivity that removes the Triennial survey. This comparison seems to indicate that among the three indices removed, the Triennial survey seems to be contributing the greatest information, with the two slope surveys (only one of which has biological data) contributing very little information to the model. While it is justifiable to exclude the two slope surveys, we think this is worth noting for the next iteration of the stock assessment, and not necessary for the current model. Model fits are visually similar to the proposed base model.



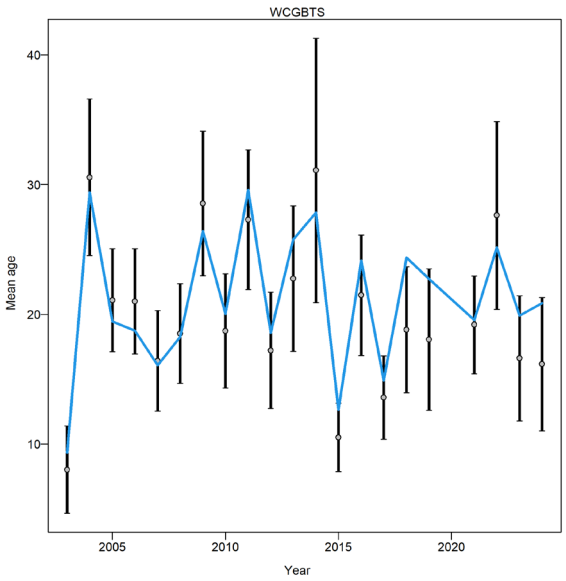




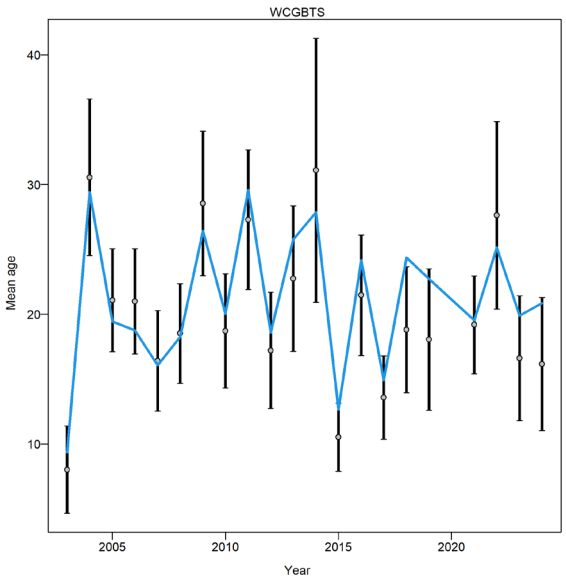


As an example, model fits to mean age for WCGBTS for base and model with only WCGBTS:

Base:



Model with only WCGBTS:

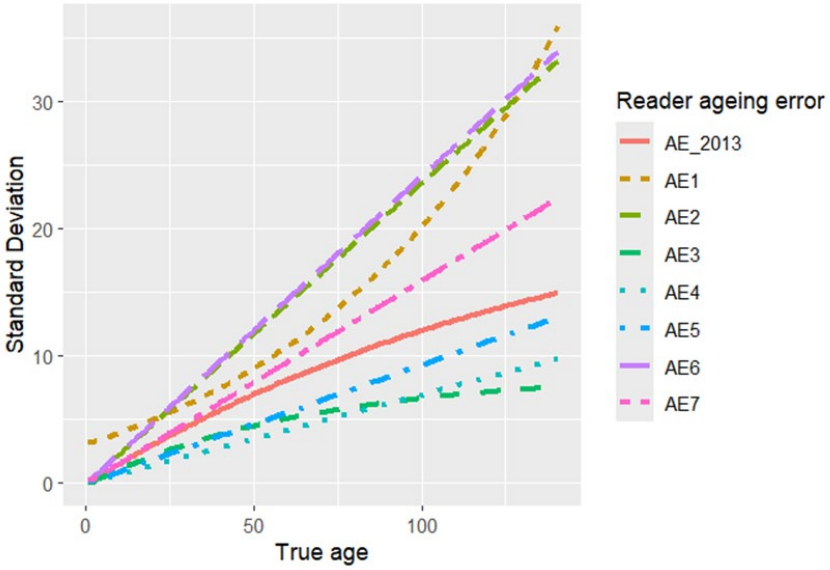


4 - Panel Conclusion

The removal of the three earlier surveys and fitting the model to only the WCGBTS resulted in slight decreases in scale and status. This also results in the removal of the length compositions from these surveys, which results in less-informed recruitment deviations during the period of the early surveys. Although the indices are not very influential on the model results, the length compositions are influential in estimating early recruitment. However, the Panel also notes that the inclusion of the uninformative survey indices increases the uncertainty of the base model.

5 - Request

Select a single aging error matrix to represent all aging errors for two separate runs. Try ageing error matrix 2 and 4 (represent the bounds). Run five-year retrospectives for each. *We switched matrix 4 to 3 as matrix 4 was a) only in one year and b) was the only one with significant bias. Matrix 3 had some of the lowest variance in ageing, so a good representative of the low variance end (matrix 2 was the high variance end).*



5 - Rationale

Is the complexity in the how that ageing error matrices relate to age data contributing to the uncertainty in scale (as this seems driven by nuances in recent year age data).

5 - STAT Response

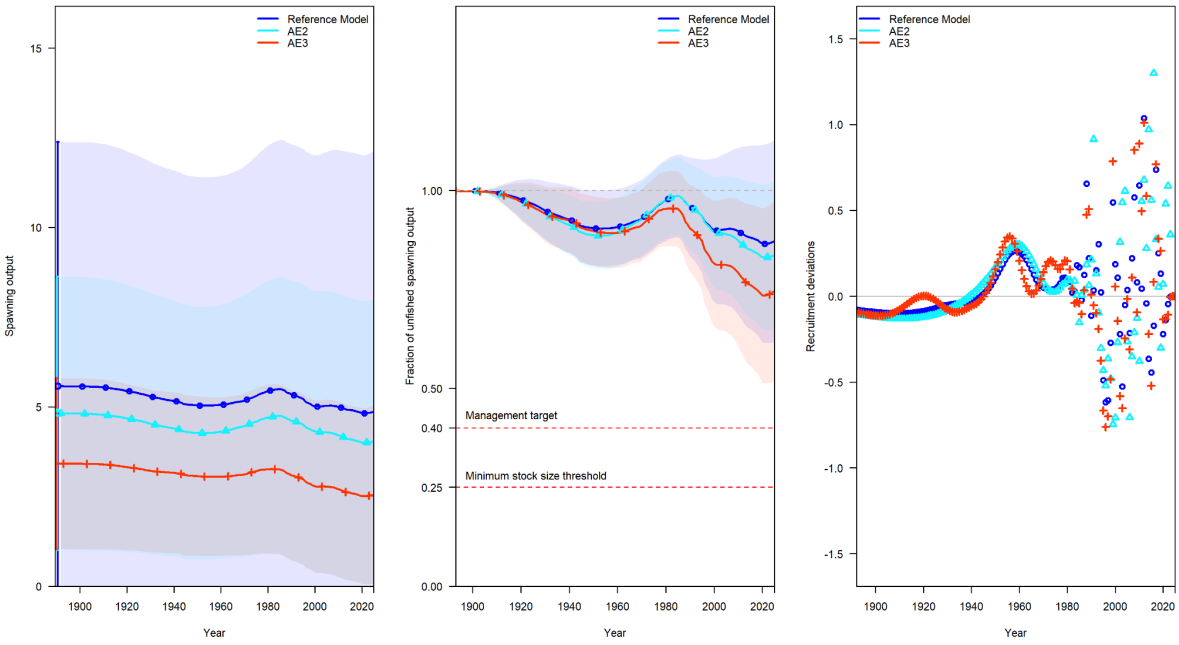
We note that the matrices with the most coverage in years and ages (6, which is very similar to 2, and 7) have notably higher variance than the lower variance matrices. We also note that the sensitivities already done on assuming higher precision via the systematic elimination of bias and imprecision from each age source results in lower stock scale and status. It is important to observe that each ageing error matrix was constructed for the specific age samples, using double reads of average sizes, to construct these matrices. They also searched over 36 possible model bias and imprecision combinations, for the most part finding that simpler explanations for bias

(typical, little to no bias) and precision (varying degrees of imprecision). It is also important to note that these ageing matrices are all associated with fleets or surveys, and thus the sampling can be seen in the fleet selectivities. The ageing error matrix will be more relevant to the smaller, younger ages (WCGBTS) and some to older individuals (at-sea hake samples).

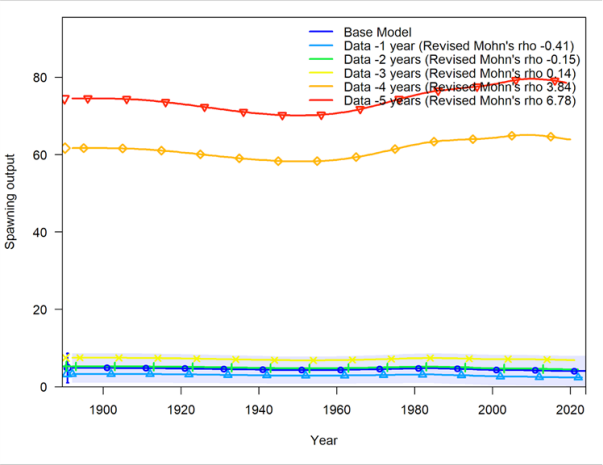
AE2, the less precise ageing error matrix, is more like the reference model. Assuming more precision did what we saw before (AE3), which was to drop both scale and stock status. Both are well within the uncertainty of the reference model.

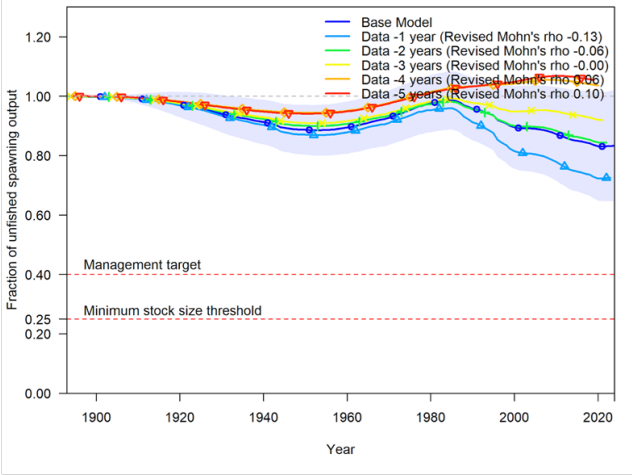
The retrospective patterns show the same behavior as the reference model, just with increasing wacky scales for the final years of the retrospective. We see no support for assuming any one ageing error matrix is good for all age sample sources, and do not see any gain in model stability using just one ageing error matrix.

<u>Comparing ageing error matrices 2 and 3 to the reference model</u>

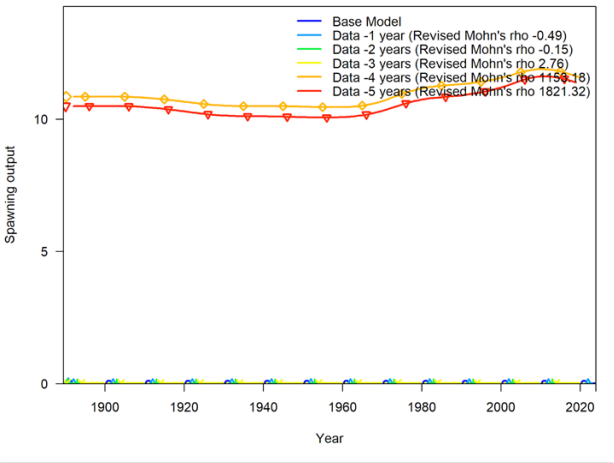


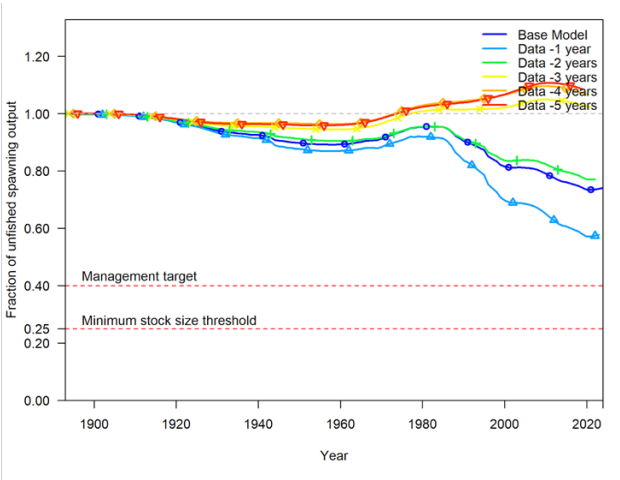
AE Matrix 2 (higher ageing error variance) Retrospective





AE Matrix 3 (lower ageing error variance) Retrospective





5 - Panel Conclusion

The simplification of the ageing error specification to use a single, less precise ageing error vector (AE2) resulted in slight reductions in scale and status and slightly reduced the jumpy retrospective behavior seen in the base model. The use of a more precise ageing error vector (AE3) resulted in larger reductions in scale and status and exacerbated the jumpy retrospective behavior seen in the base model.

6 - Request

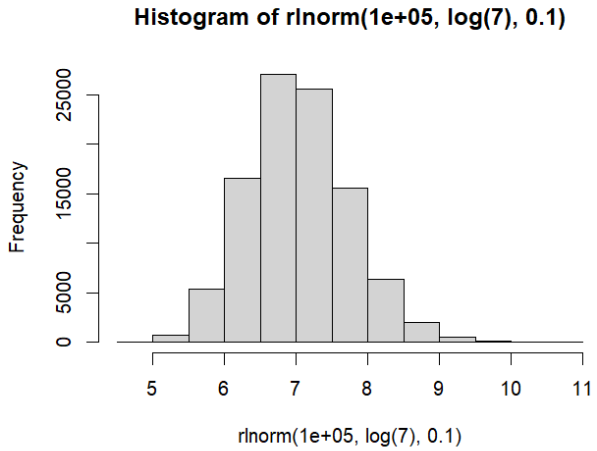
Run a sensitivity with a lognormal prior for R0 specified at the STAT's discretion. Plot trajectories of biomass, status, and recruitment deviations; fits to main data. Run five-year retrospectives.

6 - Rationale

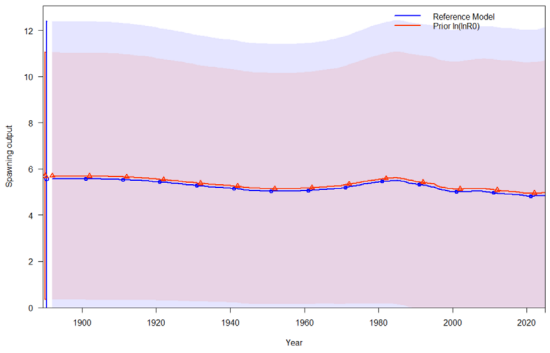
We are interpreting model realism using an implicit R0 prior, and explicitly specifying this prior may constrain scale and remove retrospective pattern.

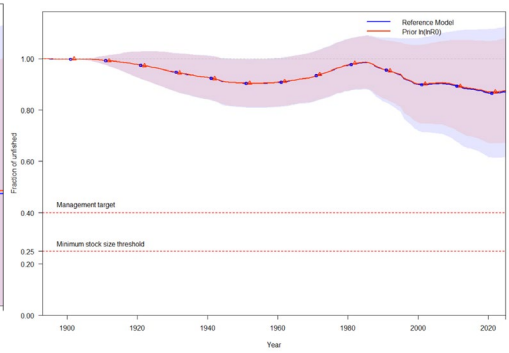
6 - STAT Response

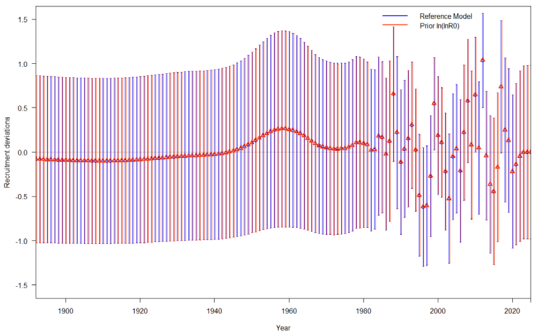
We assumed a lognormal distribution on $\ln(\ln R_0) \sim N(7,0.1)$.



We ran the model, while applying this prior. The model with the prior above resulted in virtually identical results as the proposed base model. The comparison between the proposed base model and the run with ln(R0) estimated with the prior is provided below:

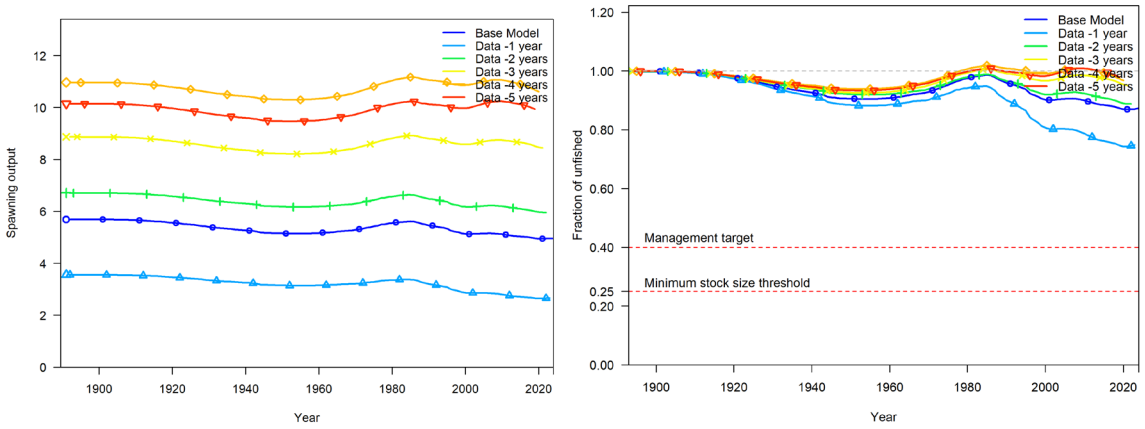




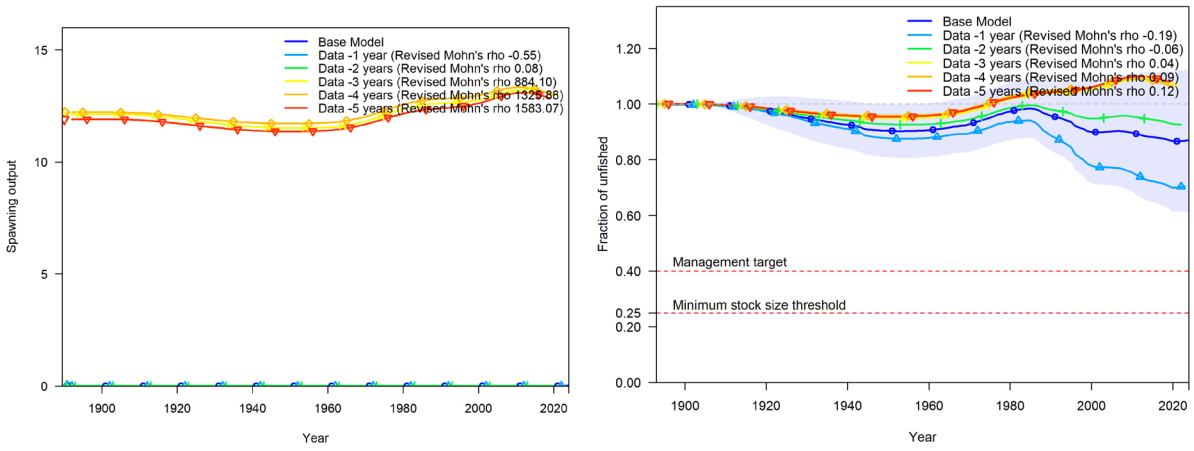


We then ran the retrospective analysis for a model with the prior on ln(R0). The retrospective runs were much closer to the starting point (base model with the prior) than the retro runs in the proposed base. They followed the same pattern (a decrease in scale in retro-1, an increase in retro-2 and -3) informed by the signal in age and length data, but were on the comparable scale. See below:

Base model with prior



Retro runs in proposed base model



The ln(R0) values for the proposed base, modified base, and the retro on modified base are provided below:

	SR_LN(R0)
Base, no prior	6.98226
Base, with prior	7.00278
retro -1	6.5721
retro -2	7.18354
retro -3	7.46143
retro -4	7.64707
retro -5	7.58887

6 - Panel Conclusion

The estimation of the model using a lognormal prior on R_0 resulted in nearly identical results to the base model and removed the large jumps in scale observed in the retrospective behaviour of the base model and reduced uncertainty. The shifts up and down with each retrospective peel match those seen in the base model, supporting that the direction of these shifts are driven by the age/length data. Research into the use of priors for R_0 could be helpful for future assessments, for this and other stocks.

7 - Request

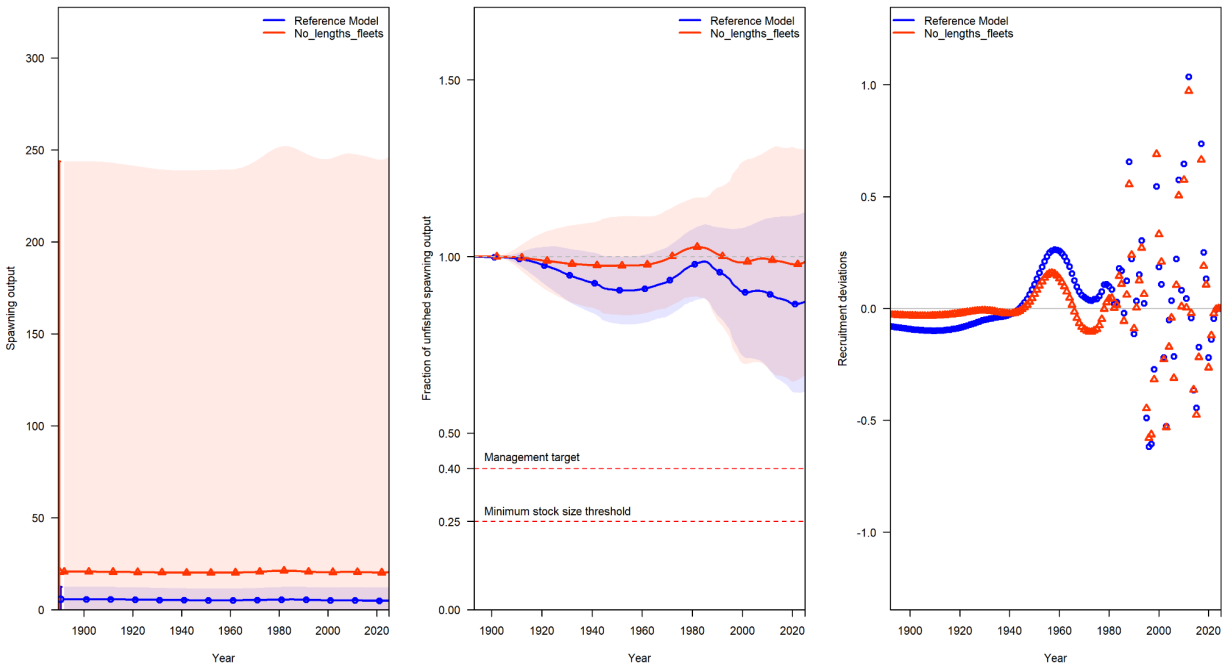
A sensitivity run taking the model developed for request 1, rerun this model but turning on the selectivities for the surveys, retaining the fixed selectivities for the commercial fleets.

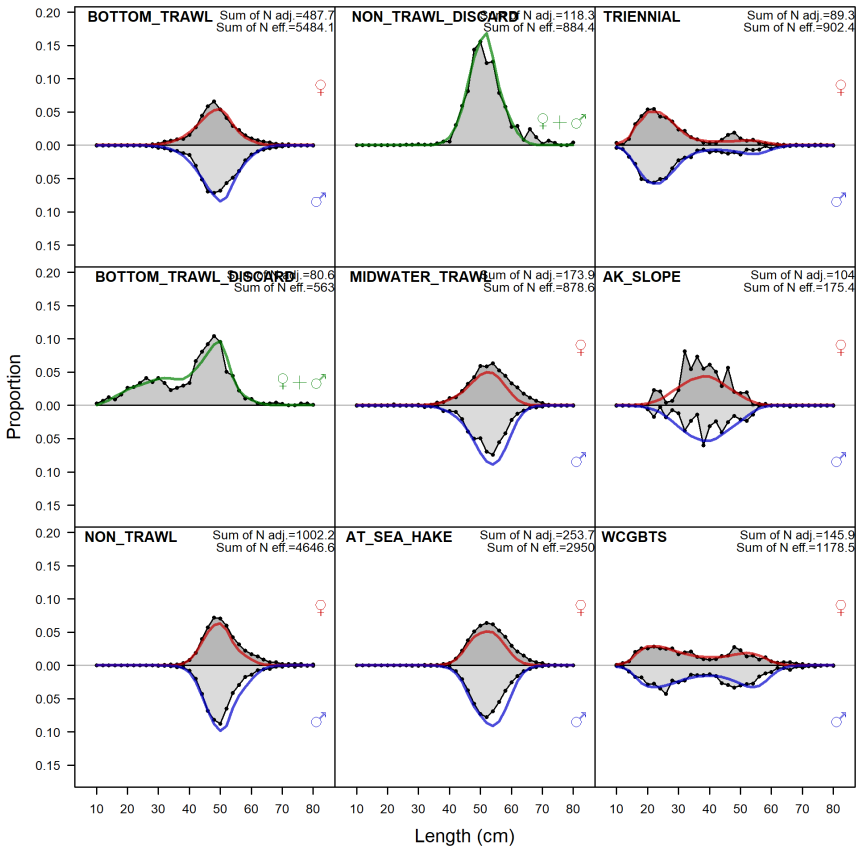
7 - Rationale

To further tease out the contributions of the age and length data to the model results.

7 - STAT Response

The removal of the fleet length data, while retaining the length data from the survey data, had a large impact on the scale and status, moving both upward and into extremely unreasonable territory. This clearly shows the importance of the fleet length data to the model. You can also see that there are informed recruitments back to the early 1980s, again with the inclusion of the survey data.





7 - Panel Conclusion

The removal of the commercial fishery length data led to an unreasonably large increase in scale and a smaller increase in status, concomitant with poorer fits to the survey length data. The influence of the survey length data on the early period recruitments can also be clearly seen.

8 - Request

Provide a model run in which the recruitment deviations start in 1960. Compare this to the base model, and to the sensitivity runs shown in the document in which recruitment deviations started in 1940 and 1980. Provide diagnostic figures (spawning output, depletion, and recruitment) as well as a table that shows the change in fit (likelihood values) by major components to each of the four models. If time allows, include a retrospective for the model that starts recruitments in 1960.

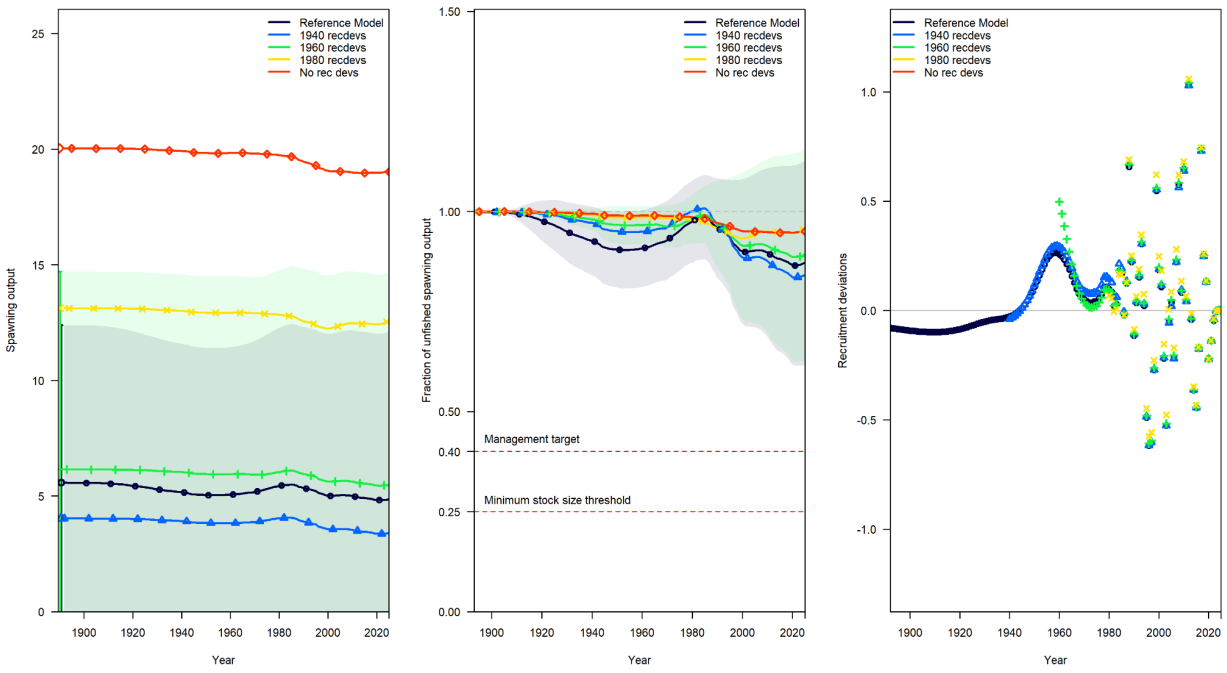
8 - Rationale

The STAT suggests that part of the problem with scale relates to the population increasing above the unfished level in some of the sensitivities, which is largely due to the pulse of strong recruitments estimated around the 1940s. It will be interesting to see how much these early recruitments are improving the fits to data as well as to see if shifting the timing of recruitment estimations helps to resolve the unusual retrospective patterns.

8 - STAT Response

Starting estimation of recruitment deviations in 1960 increases the estimate of both stock scale and status relative to the reference model. The uncertainty is no less than the reference model.

An additional model run started estimation of the recruitment deviations in 1920 as an additional exploration. The stock scale was slightly lower, but status was slightly higher during the historical period in the model with the estimated recruitment deviations starting in 1920 relative to the reference model. The estimated recruitment deviations were nearly identical. Total likelihood of the model with estimation of recruitment deviations starting in 1920: 7334.51.

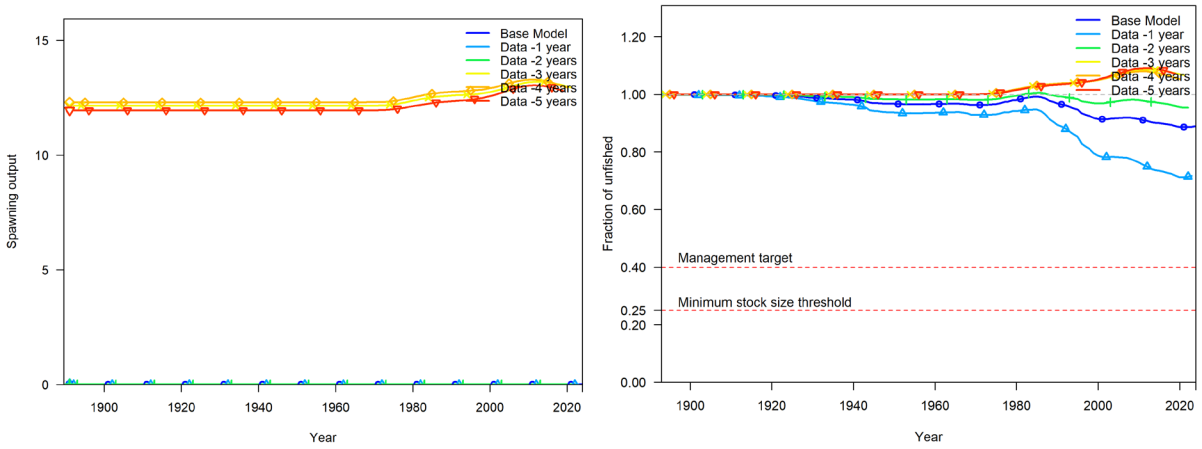


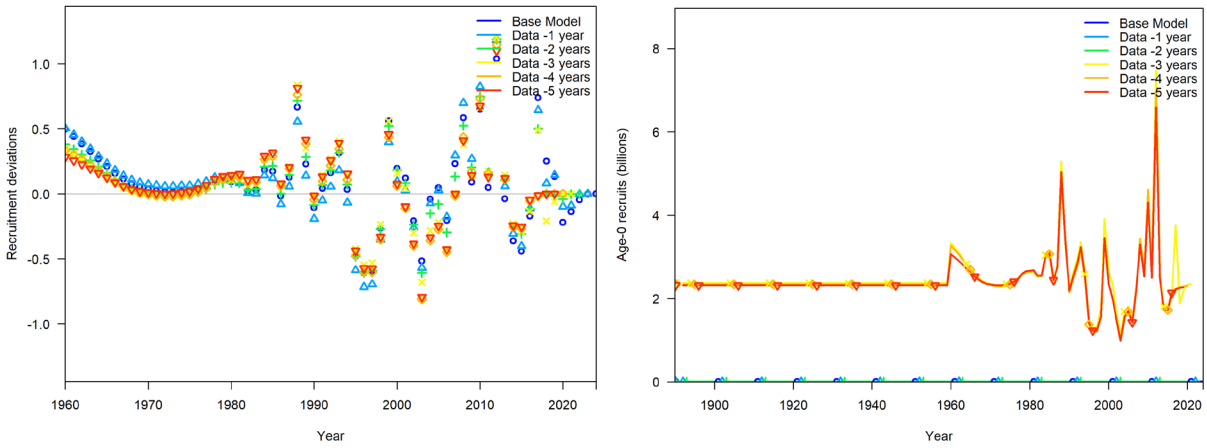
Comparison of likelihood between proposed base model and the model with recruitment deviations estimated from 1960 forward.

LIKELIHOOD	Base	rec devs 1960 forward
TOTAL	7333.93	7336.26
Survey	-26.8077	-26.8841
Length_comp	574.802	575.336
BT landings	79.1078	78.9942
BT discard	27.148	27.1432
NT landings	179.644	180.085
NT discard	46.6251	46.6414
Mid-water	58.9418	59.0621
Ashop	25.4152	25.4996
Triennial	22.4251	22.4141
AK slope	52.3052	52.3296
WCGBTS	83.1902	83.167
Age_comp	6783.5	6785.82
BT landings	464.257	464.338
NT landings	331.374	331.706
Mid-water	182.473	182.299
Ashop	3847.5	3849.67
WCGBTS	1957.89	1957.8

Limiting the period of estimating recruitment deviations to the period from 1960 forward (versus estimating recruitment deviations the entire modeling period in the proposed base) does not impact the behavior in retrospective the runs (when scale increased after 3, 4, and 5 years of data being removed sequentially), which we still observe with this modified model. This result confirms that the change in scale in the retrospective runs is driven by the recent period.

The modified run highlights the presence of the signal in the data by estimating positive recruitment deviations as soon as it has freedom to do so, and consistent with the base model.





8 - Panel Conclusion

The requested run (recruitment deviations from 1960) outcomes were similar in scale and status to the base model. The requested run also produced a similar retrospective pattern to the base. The tabulated likelihoods show only small changes between models.

9 - Request

Provide comparative diagnostic information on the base case and the model from Request 3 without the short terminal block (removal of the 2020-2024 selectivity block and replacement with a 2011-2024 block estimated assuming asymptotic selectivity), including fits to major data components and a table that shows the change in fit (likelihood values) by major components for each model.

9 - Rationale

To provide additional reporting and diagnostics for Request 3.

9 - STAT Response

Comparison of likelihood between proposed base model and the model with non-trawl selectivity fixed asymptotic from 2011 forward is below. The model with asymptotic selectivity assumed from 2011 forward for Non-trawl landings fleet (in contrast with the 2020 forward as in the proposed base model) has worse overall fit (615.569 vs 574.8 likelihood units in proposed base), which is mostly coming from lengths (221.516 vs. 179.644 likelihood points) and specifically non-trawl landings fleet, but also ages.

This is consistent with the fits shown as part of response to Request 3 (above), where the period 2011-2019 in non-trawl landings fleet length compositions exhibit degraded fit.

LIKELIHOOD	Base	2011 forward NT asymptotic
TOTAL	7333.93	7385.4
Survey	-26.8077	-26.6545
Length_comp	574.802	615.569
BT landings	79.1078	81.4011
BT discard	27.148	27.3648
NT landings	179.644	221.516
NT discard	46.6251	47.9632
Mid-water	58.9418	58.1478
Ashop	25.4152	22.7115
Triennial	22.4251	21.8072
AK slope	52.3052	52.3482
NW slope	0	0
WCGBTS	83.1902	82.3086
Age_comp	6783.5	6795.29
BT landings	464.257	461.617
NT landings	331.374	331.639
Mid-water	182.473	181.304
Ashop	3847.5	3862.82
WCGBTS	1957.89	1957.91

9 - Panel Conclusion

Informative table. Removing the 2020-2024 selectivity block for the non-trawl landings fleet significantly degraded the likelihood fits to elements of the length composition and age composition datasets.

10 - Request

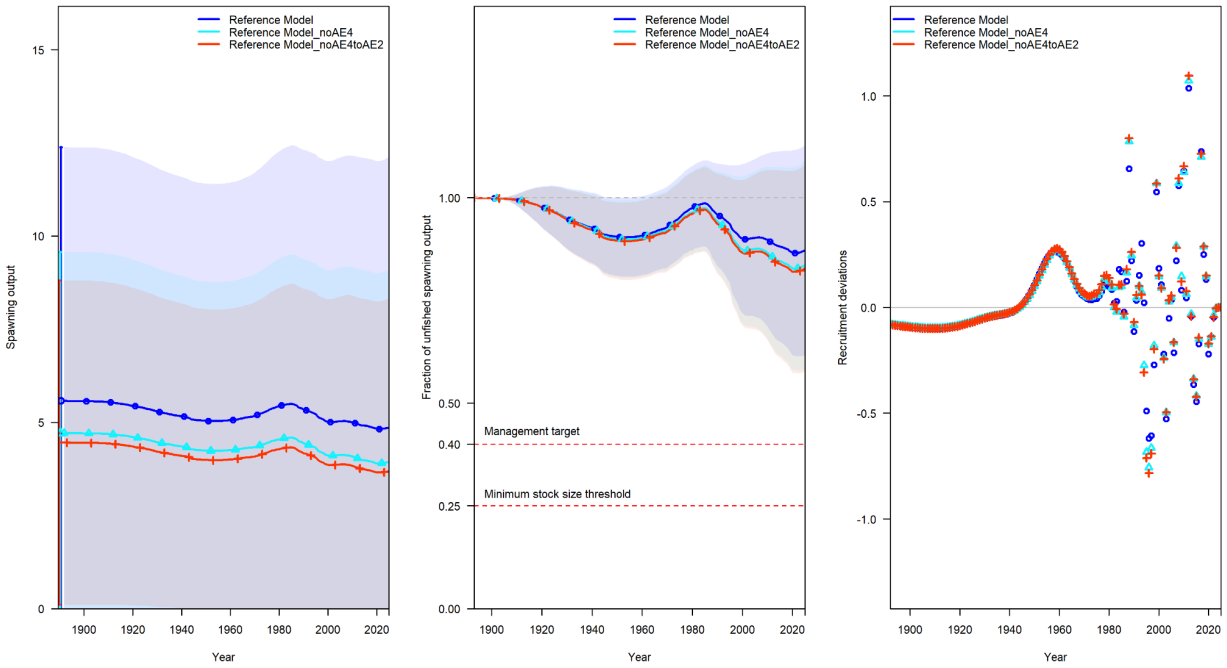
This is a follow-up request to request 5. Given the unusual nature of the aging error matrix #4 (very low standard deviation but very high bias, as per STAT report), develop model sensitivities that 1) remove the ages associated with this matrix from the model, and 2) replace the ageing error matrix from these ages with ageing error matrix #2 (the matrix with the most error, but without as much bias).

10 - Rationale

To explore the influence of specific ages and associated error matrix #4 on model outputs.

10 - STAT Response

Removing or altering the ageing error for the 2010 and 2012 data caused a slight drop in the scale and status, but well within the uncertainty of the reference model. It reduced overall uncertainty in scale, but not to any significant amount.



10 - Panel Conclusion

Both runs reduced the scale outcomes. That these were well within the uncertainty of the reference model signifies little, as the base model uncertainty bounds are very wide. Stock status is slightly reduced for both runs. Uncertainty in scale is reduced. Changes in recruitment deviations are consistent with the other reported changes.

11 - Request

Conduct additional necessary modelling to add information to the likelihood table generated from Request 8 for recruitment deviations starting in 1940. Then retune the 1940 model, report key model outputs in the table (and provide graphical diagnostics), and conduct jitters to evaluate whether this model is reasonably well behaved.

11 - Rationale

This is a potential alternative base model.

11 - STAT Response

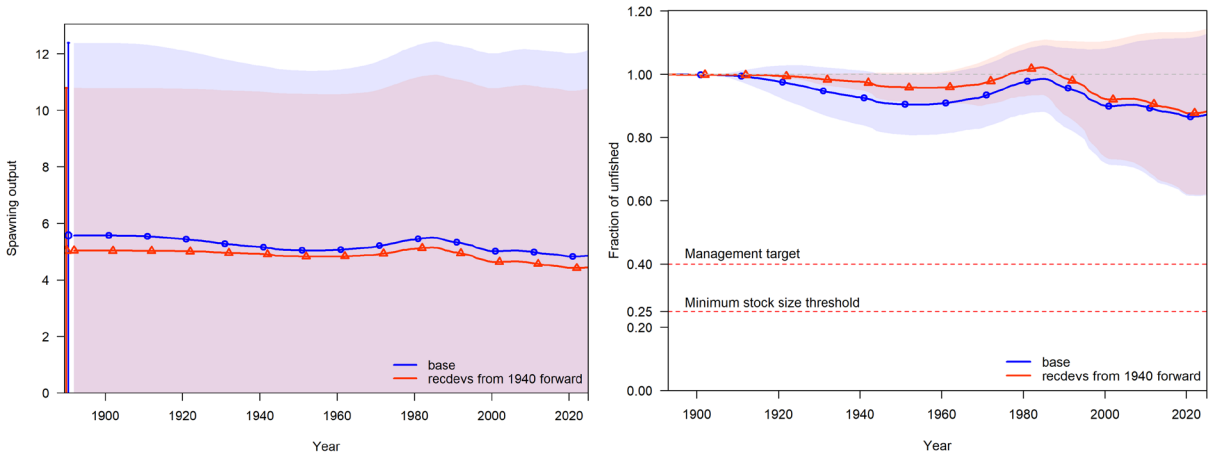
The STAT noticed the recruitment deviation model from 1940 was using an older formulation of the fecundity relationship, thus distorting the amount of scale difference between the reference model and that run, something that had precipitated this request. The STAT has updated the recruitment deviation start year 1940 model and uses it in the runs below.

The requested run produced similar results to the proposed base model, but with decreased uncertainty in the scale and much reduced uncertainty in the early part of the time series of

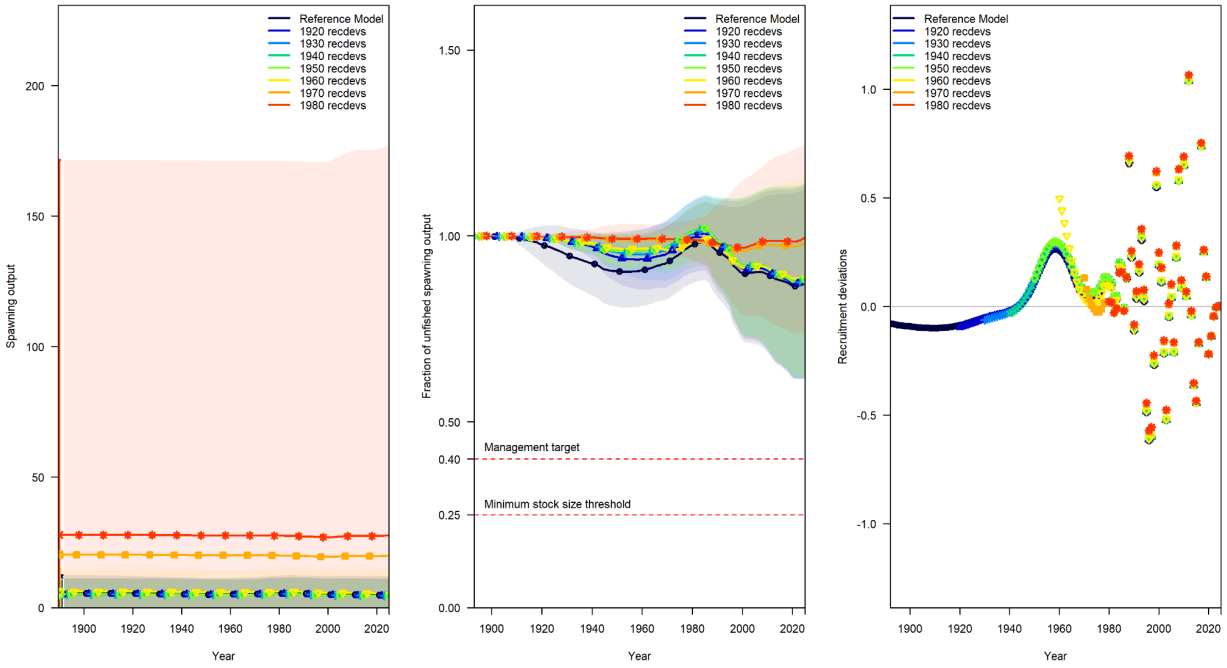
stock's status (up to 2000), and similar amounts in the end year, where stock status is very similar to the reference model. The theory behind estimating recdevs through the early time period (back to the start of the model) is to better communicate the uncertainty through this early time period. The base model provides more uncertainty during this period of unknown recruitment. The modified run with no recruitment deviations estimated from 1940 forward produces possible underestimation of uncertainty.

Comparing the two models to a profile of recruitment deviation start periods by decade, one can see that the AIC value continues to go down with less recruitments estimated. If AIC is used as a model selection criterion for choosing start time of recruitment deviations, the table below indicates 1970 is the best model. This model also has an outrageous jump in scale. It is not obvious that AIC is the appropriate criterion to determine when recruitment deviations should start. The model is working up toward the start of the data fits and significant catch events. Choosing any start time for the recruitments is setting the model up to figure out how to work into the data, thus not really having any real effect on the ultimate data fits. This is why the total likelihoods change very little regardless of how many recruitment deviations are estimated (data weighting also does not need updating). Only in the most extreme examples of 1970 to 1980 does the model have to make some really big differences in scale to work into the data period, but still show some of the lowest AIC values given so many fewer parameters.

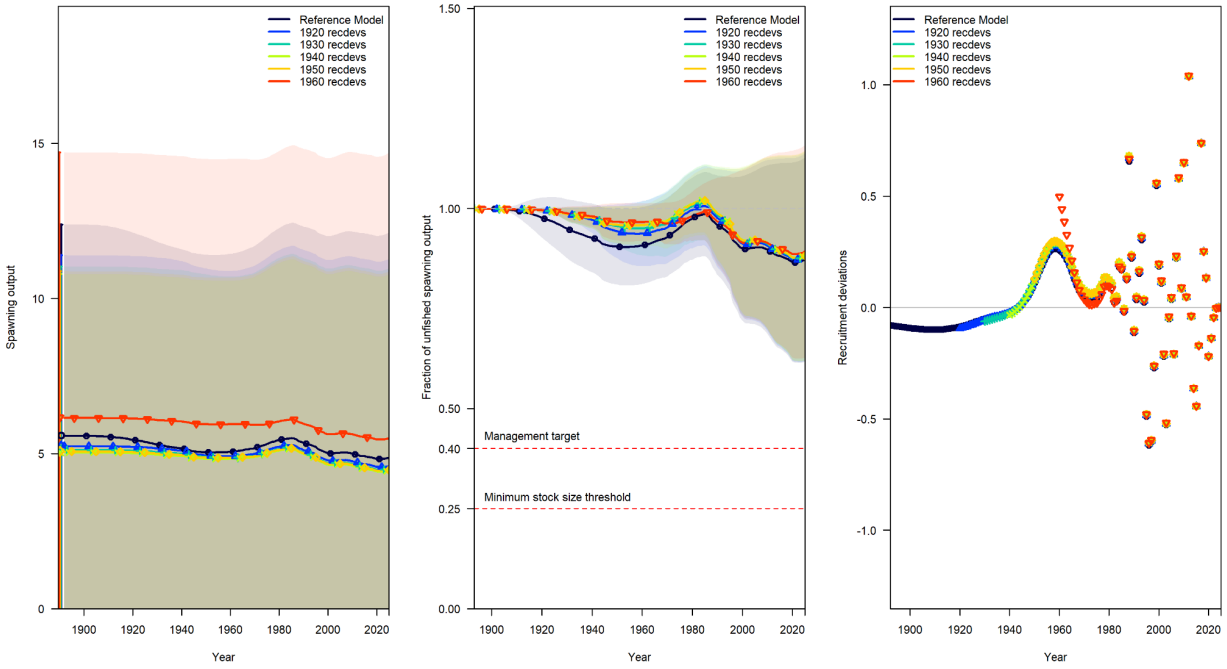
The STAT argues for a complete estimation of the recruitment deviations as it provides the most inclusive measure of uncertainty and does not differ much from the most reasonable scale estimates (1920-1950). It also allows for avoiding making somewhat arbitrary decisions for the alternative recruitment deviation estimation start year.



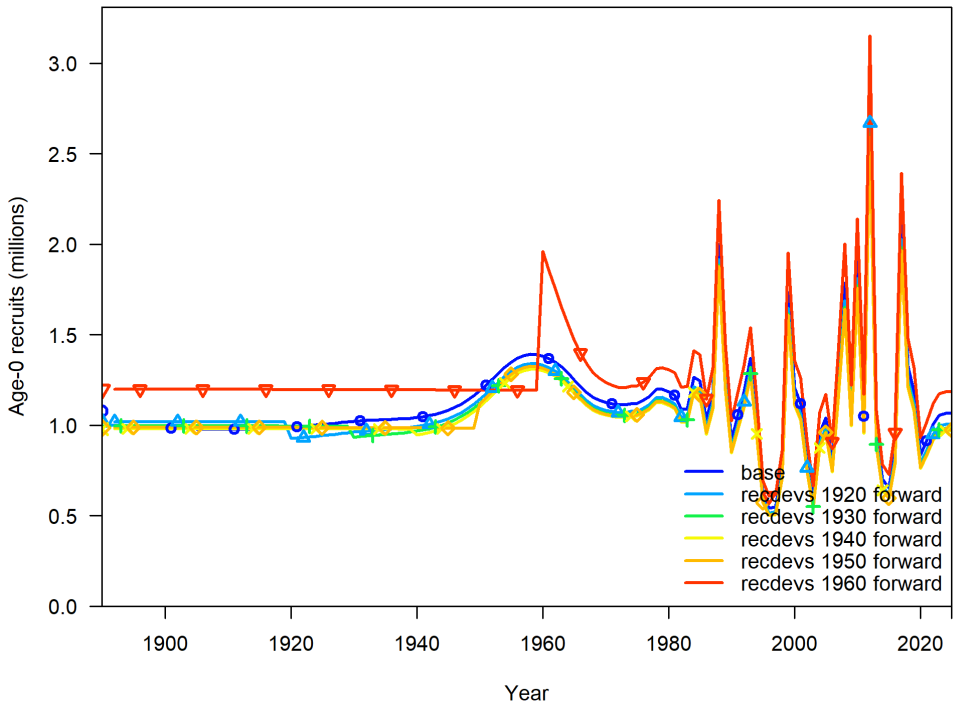
All recruitment deviation comparisons



Recruitment deviations comparisons up through 1960 (for better resolution)



Model	Total Likelihood	AIC	lnR0
Reference	7333.93	15093.86	6.98
1920	7334.51	15039.02	6.92
1930	7334.66	15019.32	6.9
1940	7334.71	14999.42	6.89
1950	7334.76	14979.52	6.89
1960	7336.26	14962.52	7.09
1970	7338.63	14947.26	8.28
1980	7338.69	14927.38	8.59



11 - Panel Conclusion

There was an error in the original sensitivity that provided the model estimates for the run that began in the 1940s (related to the units of spawning output related to the fecundity parameterization). When this error was corrected, the differences among the models that began recruitment deviations in different time periods were considerably less. This greatly reduced the differences in model results and scale among the different recruitment deviation scenarios. The Panel, both individually and collectively, continues to have some reservations about how the recruitment deviations are estimated (related to the length of the time period) but agrees that the STAT preferred model is not unreasonable.

12 - Request

Low state of nature selected based on bottom trawl and non-trawl fishery selectivities, forced to be logistic. Explore options for a high state of nature by adjusting the fixed male *M* and the estimated female *M*.

12 - Rationale

To explore options for the decision table.

12 - STAT Response

1) Use *M* as a high state of nature
   The rationale is that there is a lot of uncertainty in this parameter, and adjusting it upward is shown to increase the scale and status, both behaviors we want to reflect in the high

state of nature. Three additional values of pre-specifying the male M while estimating female M are considered: (0.038, 0.039, 0.04). These correspond to maximum ages for males (i.e., 0.05% of the population left at this age) of 143, 140, 135. Given several samples above 140 and a maximum sampled age of 169, we also consider the M corresponding to 169 (0.032) and 200 (0.027), which is close to the maximum age ever recorded. These can also be seen in the likelihood profile and are not statistically different from the reference model value (0.036). Regarding the high state of nature treatment when natural mortality is estimated for both sexes, males are estimated at 0.041 and females at 0.043 (the average of two, essentially the value used in the 2013 model).

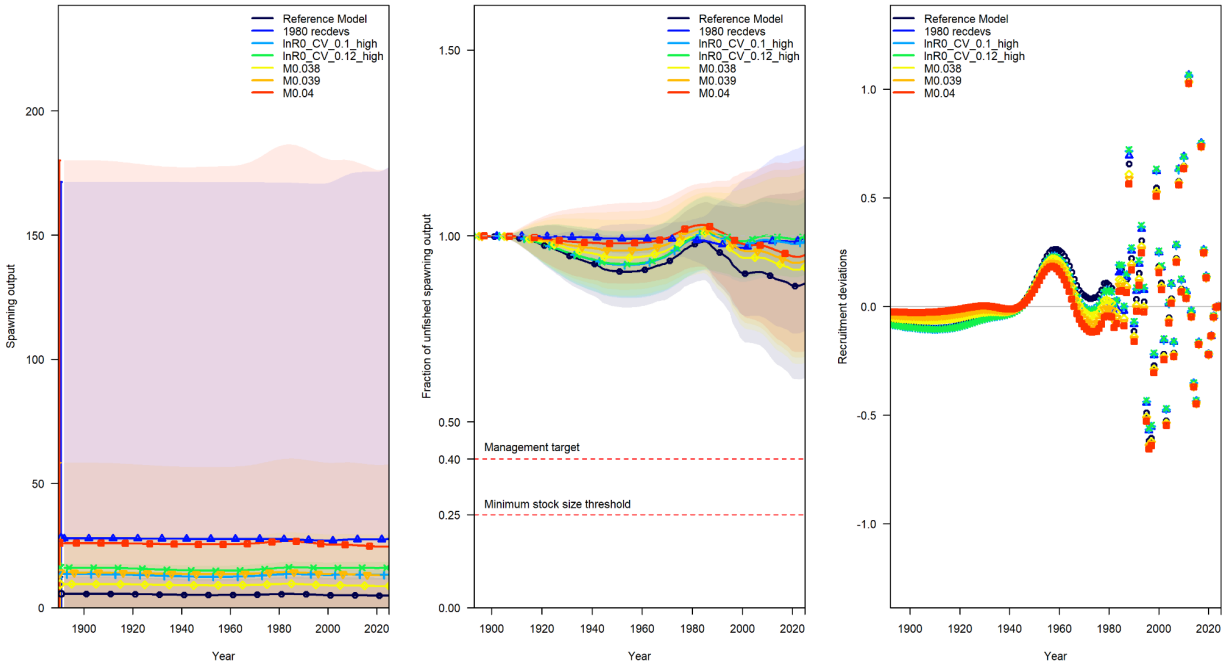
2) $\ln R_0$

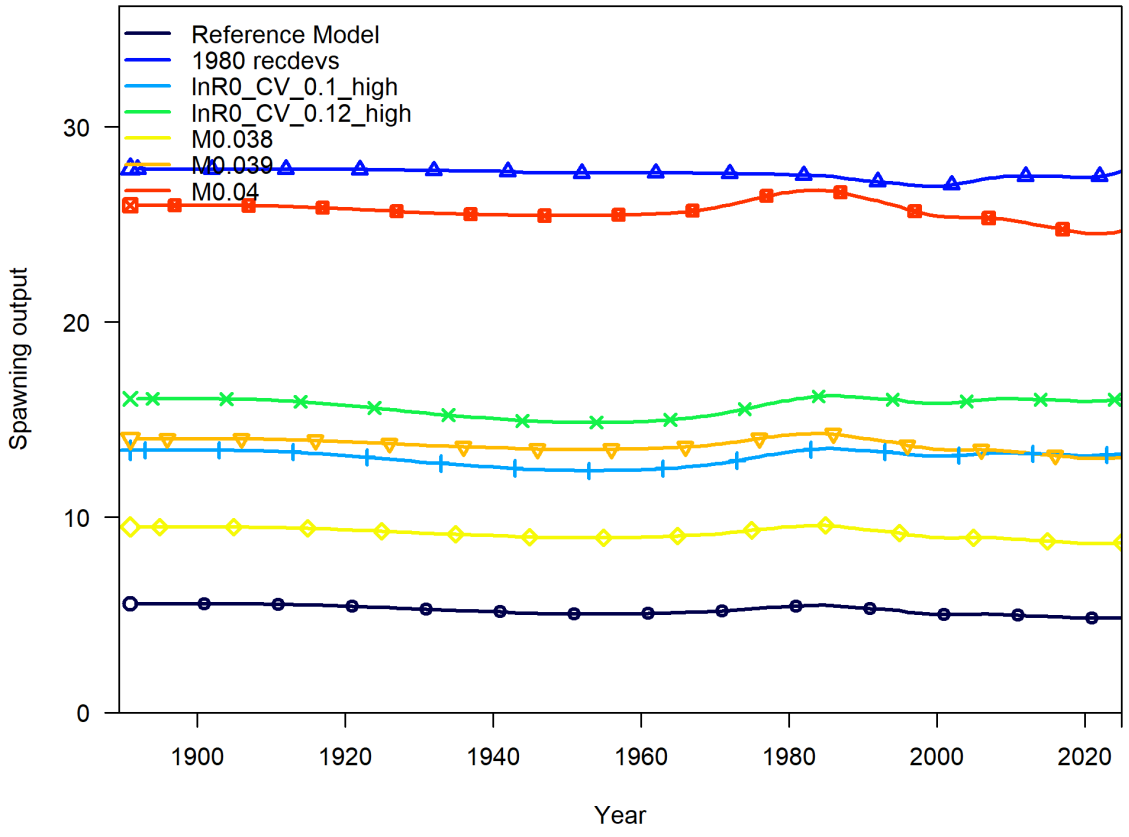
   The parameter directly controls the scale of the population. There is also a clear relationship between it and stock status. It would be straightforward to define a lower bound for this, and thus a lower state of nature. The higher state of nature is completely uninformed, so it would be, as is in most instances of the high state of nature, an arbitrary choice of what a high $\ln R_0$ should be, but this is a basic and direct way to bound states of nature. We chose to use a lognormal distribution on $\ln R_0$ with a mean equal to our estimated $\ln R_0$ from the reference model and a log standard deviation of 0.12. This resulted in $\ln R_0$ values of 6.09 and 8.03 for the low and high states of nature.

3) First year of estimated recruitment deviations

   The rationale is that the selection of the first year of estimated recruitment deviations results in a range of stock scale and status. For a selected year prior to 1960, the scale of the population is lower relative to the results from the proposed base model, and for a selected year of 1960 and later, the scale of the population is higher relative to the results from the proposed base model. We considered a model with 1980 as the first year of estimated recruitment deviations as a potential high state of nature. This model estimated ln(R0) as 8.59 with a resulting scale that is five times larger than that resulting from the base model. The relative depletion (status) remains just below 1.00 throughout the time series. Models with the selection of a year prior to 1960 result in a scale of the population that is lower than the result from the proposed base model, but the scale and status are similar and within the uncertainty of the base model and so the alternative models do not offer an option for a low state of nature that is much different from the proposed base model.

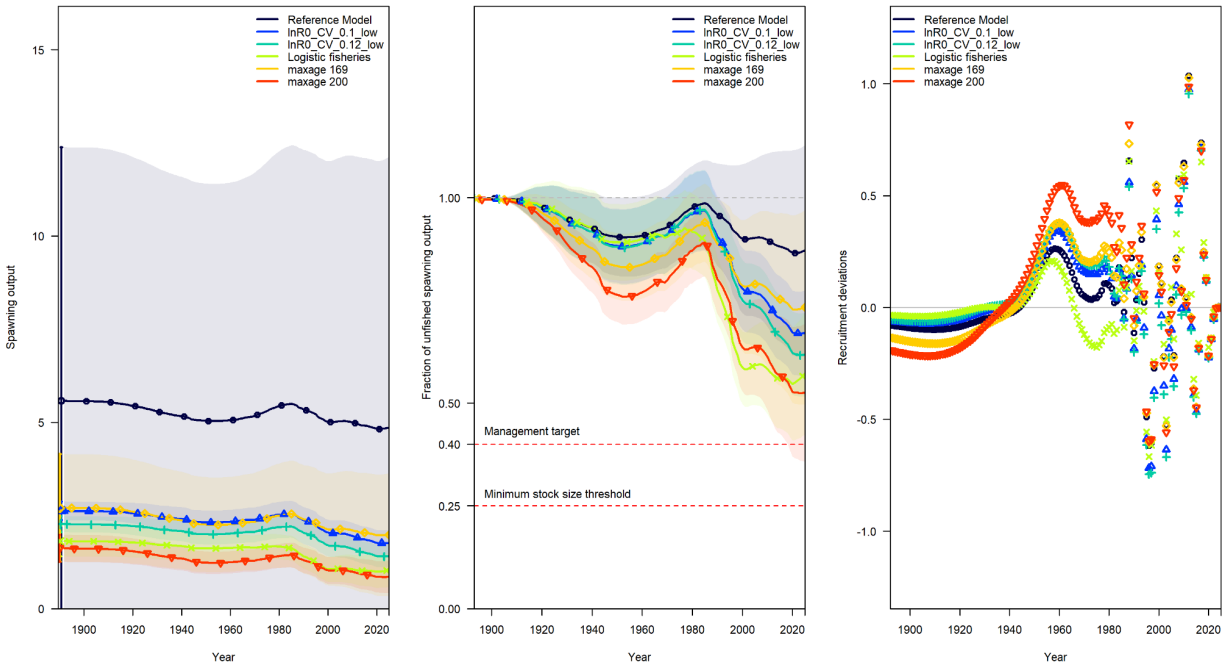
High States of Nature

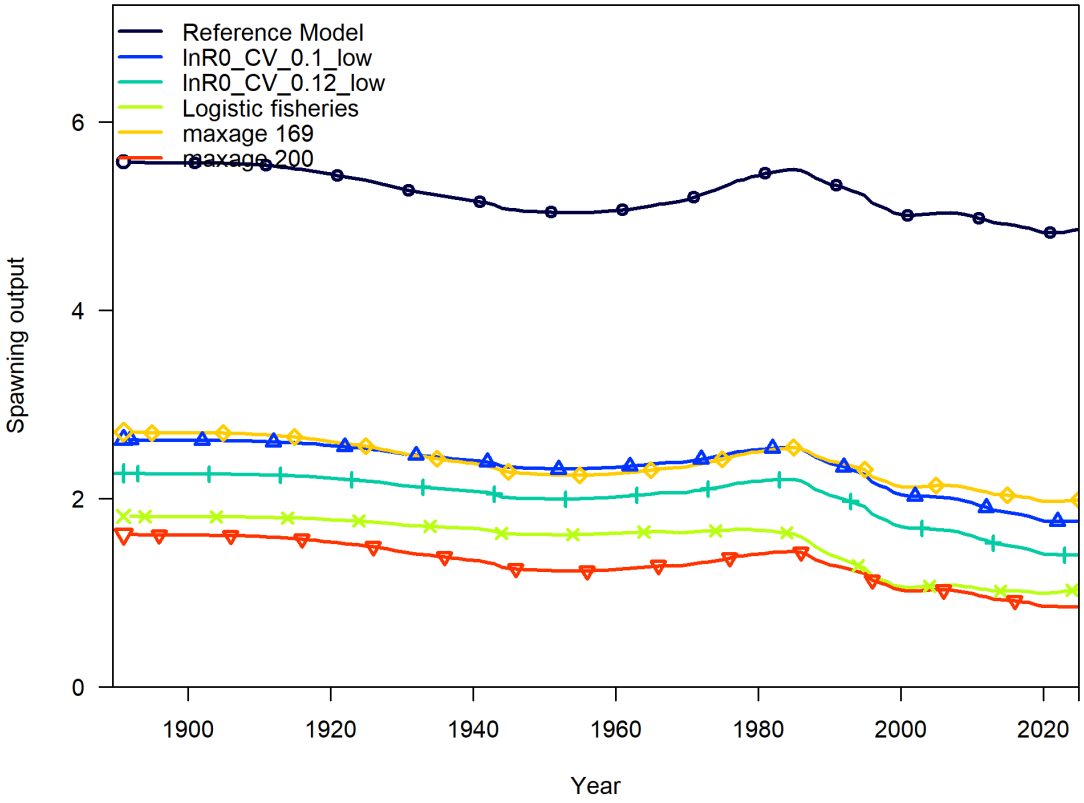




Model	lnR0	SO_0	Status
M=0.040	8.68	25.98	0.95
1980 rec devs	8.59	27.84	1.00
lnR0 CV 0.12 high	8.03	16.07	1.00
M=0.039	8.02	14.03	0.93
lnR0 CV 0.10 hi	7.85	13.44	0.99
M= 0.038	7.60	9.50	0.92
Reference	6.98	5.57	0.87

Low States of Nature

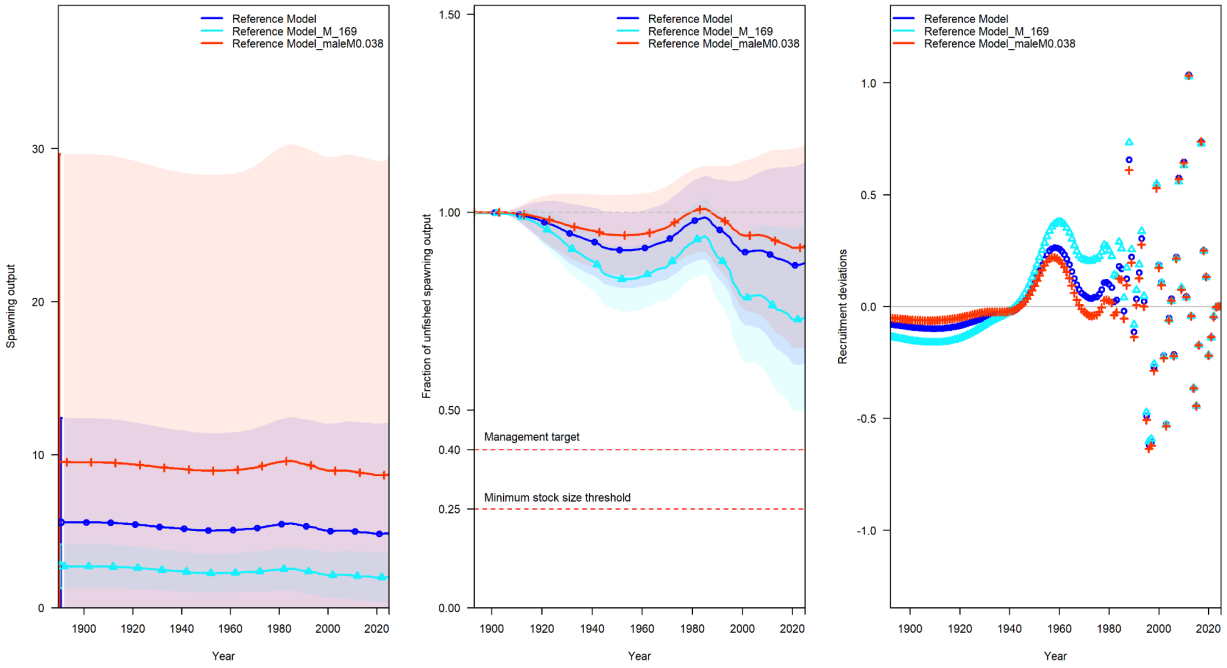




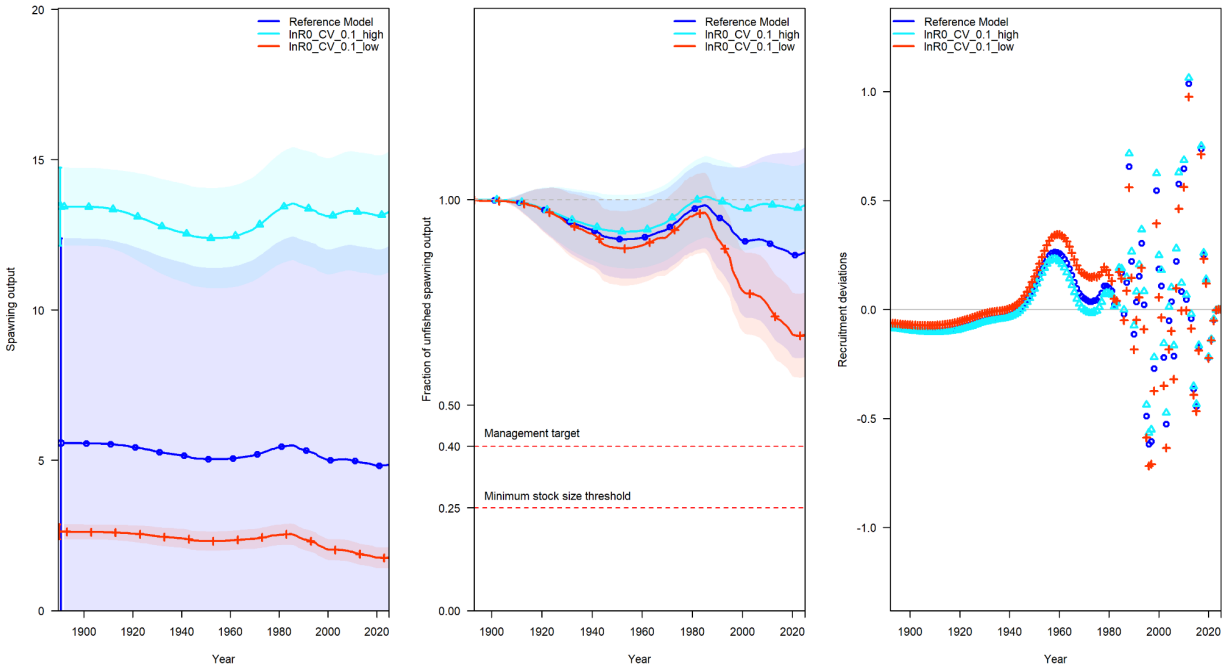
Model	lnR0	SO_0	Status
Reference	6.98	5.57	0.87
lnR0 CV 0.10 low	6.24	2.62	0.67
max age 169	6.10	2.71	0.73
lnR0 CV 0.12 low	6.09	2.27	0.62
Logistic fisheries	6.07	1.81	0.57
max age 200	5.37	1.62	0.52

Possible States of Nature

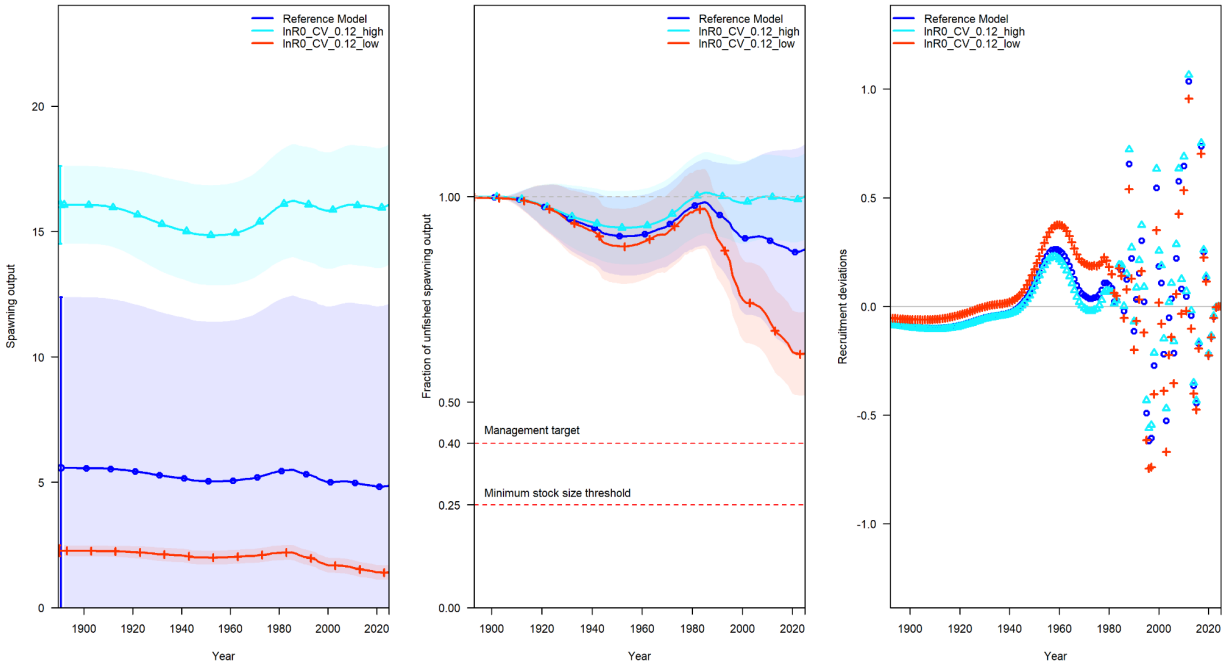
M



lnR0, CV 0.1



lnR0, CV 0.12



12 - Panel Conclusion

RISK TABLE

Ecosystem and environmental conditions	Assessment data inputs	Assessment model fits and structural uncertainty
Recruitment: Moderate abundance of fish less than 6.5 years old. Slightly lower abundance in 2024, but slightly more biomass than in 2010. High uncertainty in estimate [Neutral]. Habitat: No obvious changes in spatial distribution. Juvenile distributions have been fairly stable through time but with interannual fluctuations [Neutral]. Prey: Stable or slightly increasing forage (euphausiid and pink shrimp) [Neutral].	Catch, indices of abundance, lengths and ages are available [Neutral]. Catch data are not disaggregated by species. Combined species catch reconstruction is based on reviewed sources and methods, with uncertainty in historical years when rockfish were not always sorted to species. Additional uncertainty in catches may be due to the fact that this complex is a minor portion of the catch. There is also uncertainty in rougheye	The model expresses a large amount of uncertainty and sensitivity in both scale and status [Unfavorable]. The model captures the appropriate amount of uncertainty [Favorable]. Scale uncertainty is high primarily on the upper end. No evidence the stock is being below or close to the target relative spawning output [Neutral]. Model scale is sensitive to retrospective peels, indicating

Predators: Predation by skates, fur seals, and California sea lions is unlikely to have changed much in recent years. Potential increase in predation by sablefish, but very uncertain [Neutral]. Competitors: Some potential for hake competition for krill and pandalid shrimp but highly uncertain [Neutral].	versus blackspotted contribution to the catch history of the complex [Unfavorable]. Indices of abundance are generally uninformative [Unfavorable]. Many samples and years of sex-specific length data are available from the surveys and commercial fisheries [Favorable]. Some age data are available, but substantial gaps do exist [Unfavorable]. Species specific growth and maturity estimates for both species and species combined available. No species-specific information on fecundity, the unobserved genus Sebastes values are used [Neutral].	a lack of stability and a dependence on recent age data [Unfavorable]. The model fits data generally well with realistic selectivity assumptions [Favorable]. The parameter estimates are robust across a variety of model specifications [Favorable]. Natural mortality is fixed for males, while being estimated for females [Neutral]. The assessed area covers the lower end of the species complex distribution range. Stock structure is not well understood. Dispersal patterns and connectivity beyond the assessment area are also not well understood [Unfavorable].
Level 2: Neutral	Level 2: Neutral	Level 2: Neutral

13 - Request

Provide elements of a decision table in which the low state of nature assumes a natural mortality rate of 0.032 (associated with a max age of 169), and for the high state, a natural mortality rate of 0.039 (associated with a maximum age of 139). Provide catch streams for the base run (from 2027 onward), assuming a P* of 0.45 and a sigma of 1 (category 2 assessment) to estimate the buffers. Run those catch streams in both the low and the high states of nature.

For the low state of nature, also run a scenario assuming a constant catch of 281 tonnes from 2027 onward (based on the highest observed mortality reported in the GEMM since 2002).

13 - Rationale

To arrive at a plan for the final decision table, as well as to help inform the Panel with respect to recommendations for future assessments (e.g., timing, and update versus benchmark).

13 - STAT Response

Decision Table using the Reference model projected catch for the low and high states of nature

	Low state: male M=0.032			Base model: male M=0.036			High state: male M=0.039		
Year	Catch (mt)	Spawning output (trillions of eggs)	Fraction unfished	Catch (mt)	Spawning output (trillions of eggs)	Fraction unfished	Catch (mt)	Spawning output (trillions of eggs)	Fraction unfished
2025	155.1	1.98	0.73	155.1	4.86	0.87	155.1	13.08	0.93
2026	186.7	1.99	0.73	186.7	4.87	0.87	186.7	13.13	0.94
2027	881.5	1.99	0.73	881.5	4.89	0.88	881.5	13.18	0.94
2028	865.9	1.90	0.70	865.9	4.82	0.86	865.9	13.14	0.94
2029	849.6	1.82	0.67	849.6	4.75	0.85	849.6	13.12	0.94
2030	833.5	1.74	0.64	833.5	4.68	0.84	833.5	13.09	0.93
2031	817.8	1.67	0.62	817.8	4.62	0.83	817.8	13.07	0.93
2032	803.3	1.59	0.59	803.3	4.56	0.82	803.3	13.05	0.93
2033	788.0	1.52	0.56	788.0	4.50	0.81	788.0	13.03	0.93
2034	773.6	1.45	0.54	773.6	4.45	0.80	773.6	13.00	0.93
2035	758.4	1.38	0.51	758.4	4.39	0.79	758.4	12.98	0.93
2036	744.3	1.32	0.49	744.3	4.33	0.78	744.3	12.95	0.92

We provided a full decision table for the constant catch of 281 mt scenario.

		Low state: male M=0.032		Base model: male M=0.036		High state: male M=0.039	
Year	Catch (mt)	Spawning output (trillions of eggs)	Fraction unfished	Spawning output (trillions of eggs)	Fraction unfished	Spawning output (trillions of eggs)	Fraction unfished
2025	155.1	1.984	0.73	4.860	0.87	13.085	0.93
2026	186.7	1.987	0.73	4.875	0.87	13.129	0.94
2027	281	1.987	0.73	4.888	0.88	13.178	0.94
2028	281	1.977	0.73	4.892	0.88	13.219	0.94
2029	281	1.968	0.73	4.897	0.88	13.263	0.95
2030	281	1.958	0.72	4.902	0.88	13.309	0.95
2031	281	1.949	0.72	4.907	0.88	13.355	0.95
2032	281	1.940	0.72	4.912	0.88	13.399	0.96
2033	281	1.930	0.71	4.915	0.88	13.441	0.96
2034	281	1.920	0.71	4.917	0.88	13.479	0.96
2035	281	1.910	0.71	4.918	0.88	13.511	0.96
2036	281	1.898	0.70	4.916	0.88	13.537	0.97

13 - Panel Conclusion

The Panel agreed that natural mortality as specified in these elements of the decision table represented an appropriate axis of uncertainty. The GAP and GMT representatives were satisfied with the two catch scenarios used for the draft table, but suggested that additional catch stream scenarios may be requested at a later date.