Responses to requests from the PFMC SSC for the January 2026 additional supplemental review of the widow rockfish stock assessment

Ian G. Taylor[1], Vladlena Gertseva[1]

[1]NOAA Fisheries Northwest Fisheries Science Center,
2725 Montlake Boulevard East,
Seattle, WA, 98112

The Groundfish Subcommittee (GFSC) of the Science and Statistical Committee (SSC) of the Pacific Fishery Management Council (PFMC) conducted a supplemental review for widow rockfish in October 2025. The stock assessment team (STAT) provided all the requested materials for that review, but they and several SSC members who are federal employees were unable to participate in the review meeting due to the United States federal government shutdown that lasted from October 1, 2025 through November 12, 2025 (report available from https://www.pcouncil.org/documents/2025/10/supplemental-review-panel-report-for-widow-rockfish.pdf/). At the subsequent November 2025 PFMC meeting, the SSC requested another review of the widow rockfish assessment to allow for full participation of the STAT and SSC members. The SSC made several additional requests to the STAT (see https://www.pcouncil.org/documents/2025/11/f-2-a-supplemental-ssc-report-1-scientific-and-statistical-committee-report-on-groundfish-management-adopt-stock-assessments.pdf/). This document provides responses to those requests.

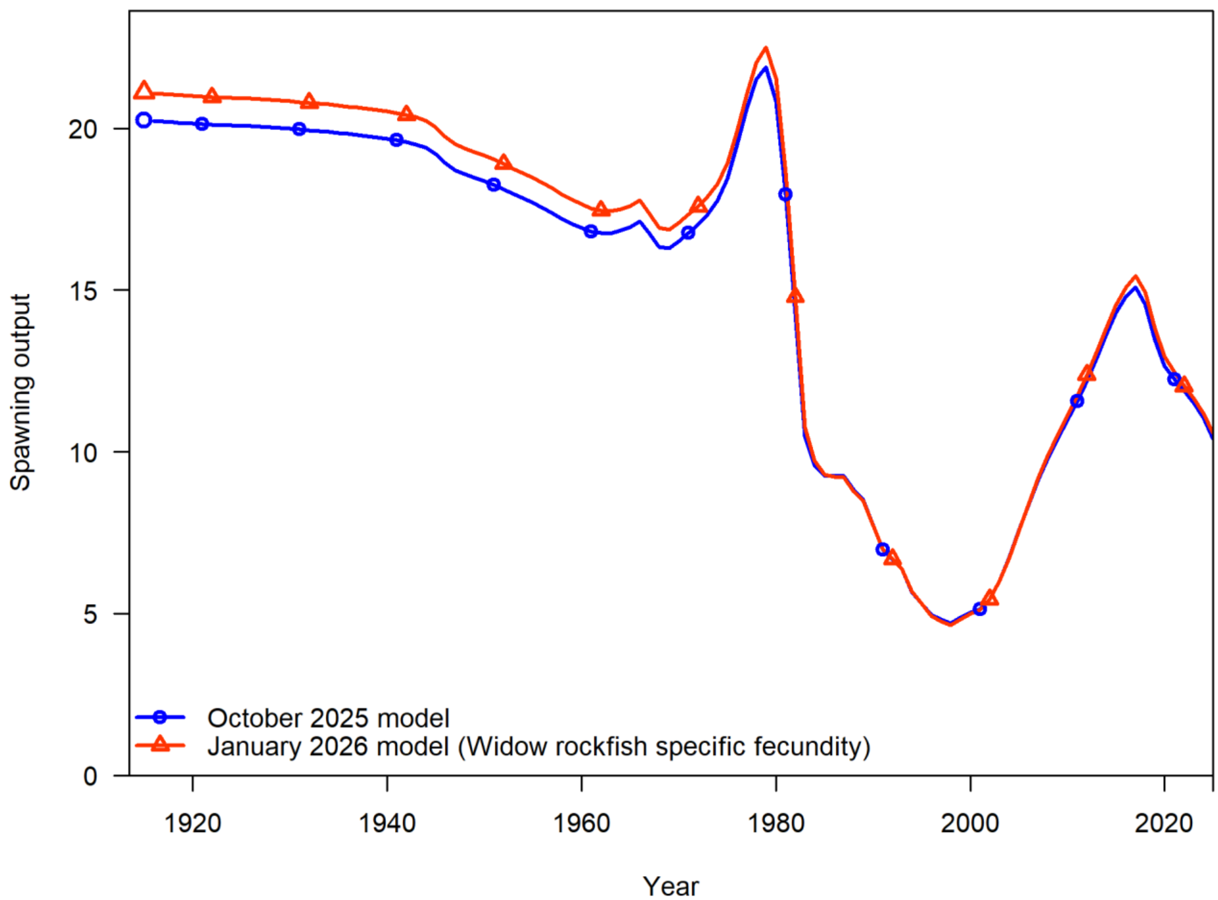
Request 1: Revise the October 2025 model to use the length-fecundity relationship that is specific to *Sebastes entomelas* (Table 6; Dick et al. 2017, however for parameter values in SS3 units, please see github reference in SSC italic notes). [Request 15 from supplemental panel report]

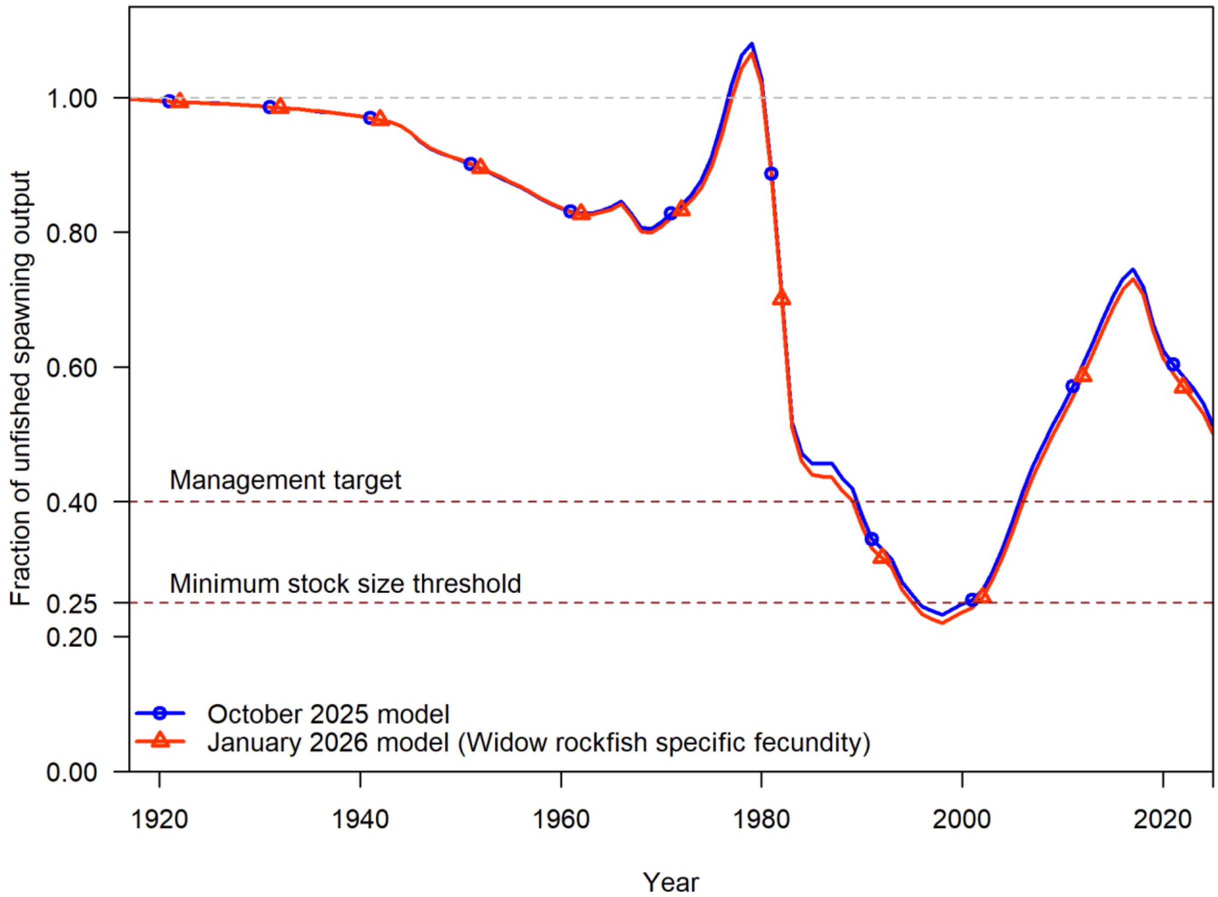
Rationale 1: The length-based fecundity parameters used in the October 2025 model pertained to 'unobserved rockfish'. Species-specific values should be used because they are available.

Response 1: The fecundity parameters ($F = aL^b$) for Widow rockfish, based on meta-analysis, were provided by Dr. E.J. Dick (SWFSC) and reported at https://github.com/EJDick-NOAA/Rockfish-Fecundity as follows:

a = 1.10961E-08, b = 4.545

The comparison between the October 2025 model using the fecundity at length relationships for the unobserved rockfish and the model with Widow rockfish specific fecundity-at-length parameters (January 2026 model thereafter) are below. Spawning output in the plot below is in units of trillions of eggs.





1.00
0.80
0.60
0.40
0.25
0.20
0.00
Fraction of unfished spawning output
Management target
Minimum stock size threshold
October 2025 model
January 2026 model (Widow rockfish specific fecundity)
1920
1940
1960
1980
2000
2020
Year

Comparison of major management quantities in the table below indicates a slight decrease in estimated 2027 OFL for the model with Widow rockfish specific fecundity. This is because the exponent of the fecundity at length relationships for the unobserved rockfish (used in the October 2025 model) is lower than that of the Widow rockfish species-specific fecundity (4.043 versus 4.545 respectively). We provide further details on fecundity at length relationships in our Response to Request 6.

Label	**October 2025 model**	**January 2026 model (Widow rockfish specific fecundity)**
M Female	0.135	0.135
M Male	0.147	0.147
Unfished age 4+ bio 1000 mt	155.7	156.4
B0 trillions of eggs	20.25	21.11
B2025 trillions of eggs	10.4	10.57
Fraction unfished 2025	0.514	0.501
Relative fishing intensity 2024	1.185	1.214
2027 OFL mt	5129	4916
2027 ACL mt	4796	4596
Equil. catch at MSY mt	6829	6746
Equil. catch at SPR targ. mt	6026	5931

Request 2: To the extent practicable, include content tables commonly included in an update assessment, such as retrospectives, jitters, likelihood profiles, and alternative states of nature, to aid recommendations.

Rationale 2: With the additional analyses and review, the assessment has exceeded the detail typically required for an update assessment. While a full benchmark assessment is not feasible at this time, additional sensitivity runs have already been completed and can be included in the report.

Response 2: The standard tables and figures for model output and diagnostics for the January 2026 model are provided in a revised draft assessment report (see section 3.6 Model Diagnostics). The only difference between January 2026 model and October 2025 model is that January 2026 model utilizes Widow rockfish specific fecundity at length parameters.

Request 3: Present a sensitivity analysis that illustrates the sequential changes in fleet structure and handling of discard data that were made for the October 2025 model. Sensitivity runs should include, sequentially, results from the August 2025 model, results from combining catch from fixed gear fleets (hook-and-line and net) with the bottom trawl fleet, results from removing composition data for the hook-and-line fleet, and results after altering the treatment of discard data as done in the October 2025 model.

The assessment report document should also detail the STAT's mechanistic understanding of why hook-and-line data have a seemingly disproportionate effect on model results, as shown in their responses to Requests 1 and 2 from August 2025.

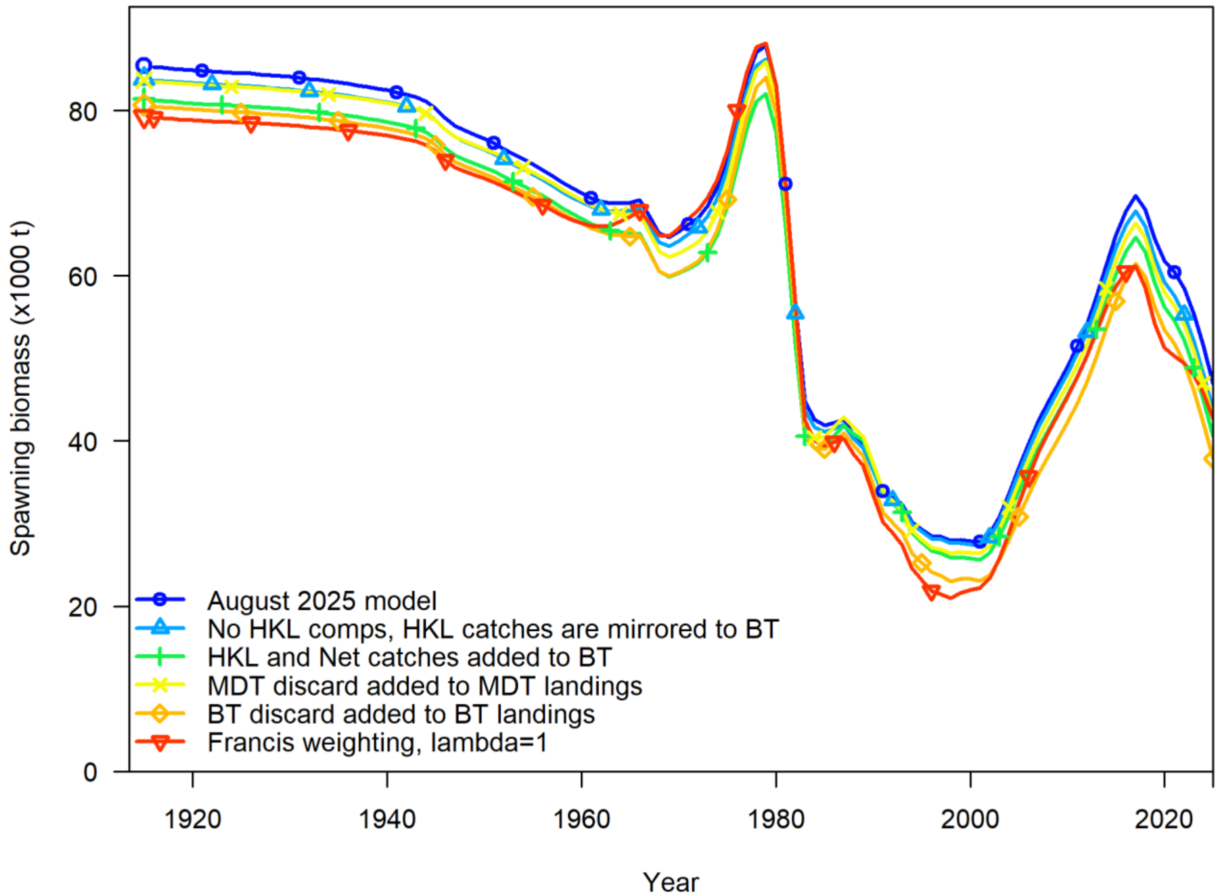
Rationale 3: The sensitivity analysis to hook-and-line data [Requests 1 and 2 from August 2025] continue to show unexpectedly large effects on estimates of stock size. Without the STAT present, it was not possible to understand the reason(s) for this. The review panel had questions about the mechanism for an 11% decrease in 2027 ACL between the August 2025 and October 2025 models [see response to Request 1 from August 2025], given that the scale of the stock does not appear to decrease enough to prompt such a considerable change.

Table 1 in F.2 Attachment 3 reports a substantial change in ACL and other quantities when the fleet structure and discard data treatment change. These two components should be teased apart to identify whether one or both drive the changes.

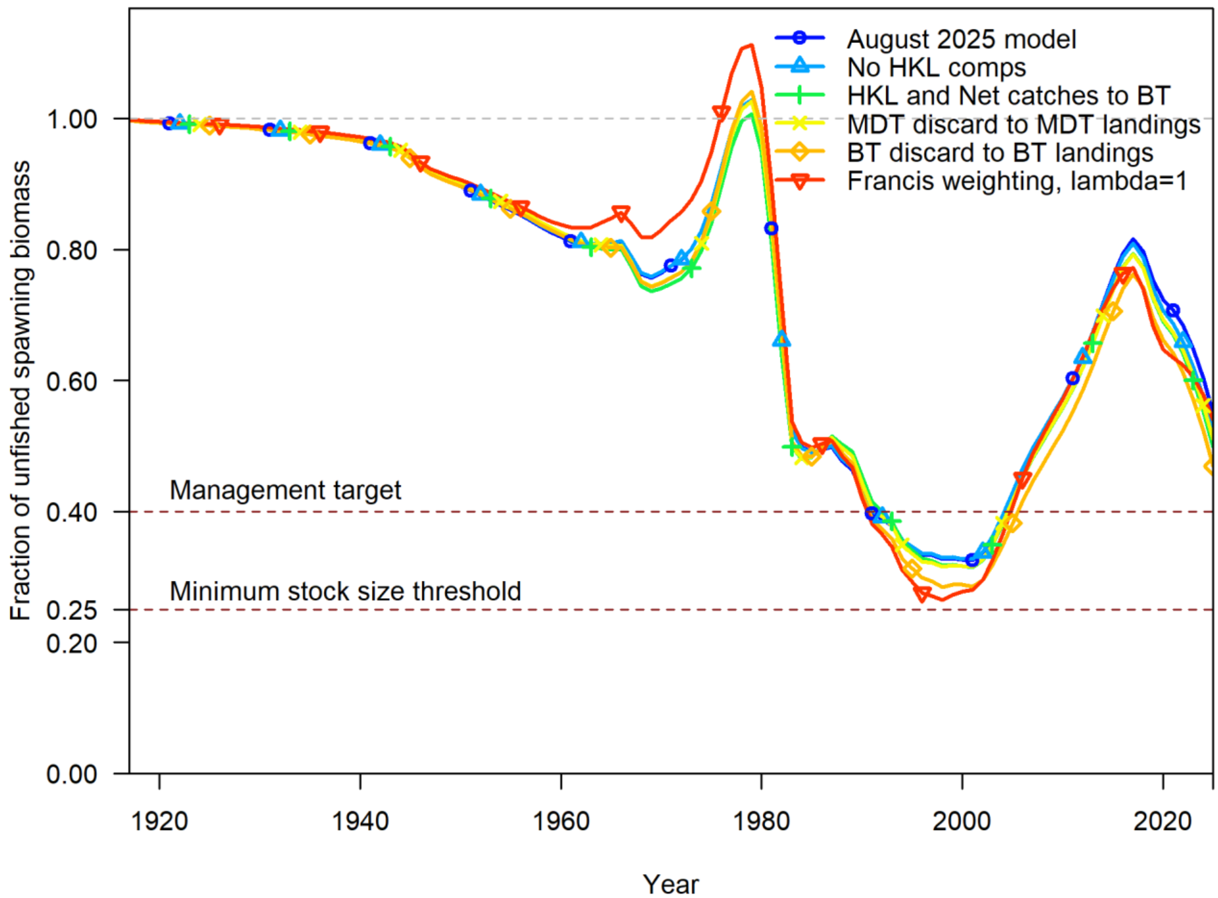
Response 3: The sequential changes in fleet structure included:

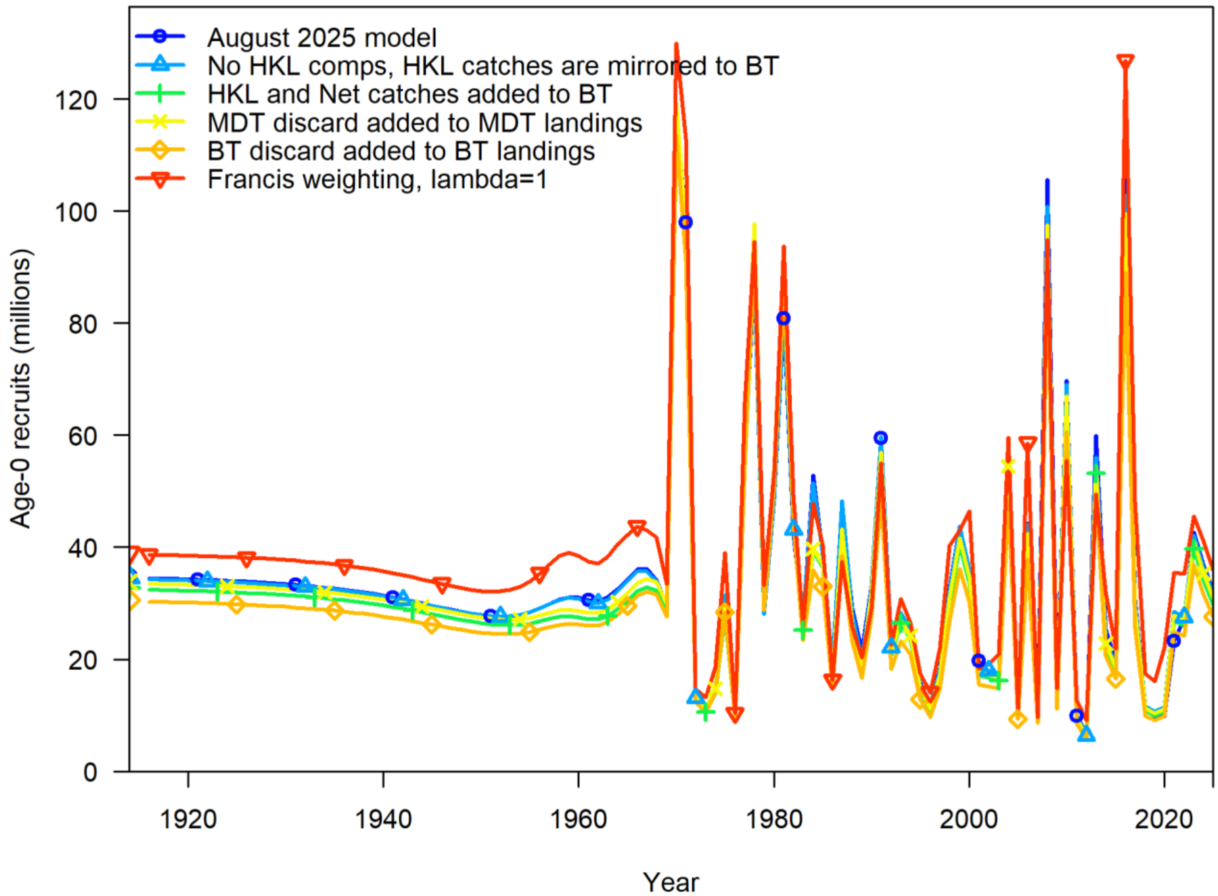
1. Removing hook-and-line (HKL) length and age composition data associated with landed catch and mirroring the HKL catches to the bottom trawl (BT) fleet;
2. Combining catch from fixed gear fleets (HKL and NET) with the bottom trawl (BT) fleet;
3. Midwater trawl (MDT) fleet discard is added to MDT landings;
4. Bottom trawl (BT) discard added to BT landings (arrived to fleet structure of the October 2025 model).
5. Model re-weighted. In the October 2025 and January 2026 models, we used Francis data weighting that is shown to perform better in a simulation analysis (Punt 2017) and has been the preferred approach in most recent stock assessments. Also, we do not use the 50% multiplier on the fishery length and age data weights to account for the potential double use of data since length and age are often observed from the same fish. The sum of the adjusted input sample sizes for length and age data combined are already far lower than the number of sampled fish because they are primarily based on trips or hauls and then further reduced by the data-weighting algorithm. This 50% adjustment is no longer common practice and has not been used in any other recent assessments. In the model, this is implemented via emphasis factors lambdas, which are now all set to 1.

The comparisons of estimated absolute and relative spawning outputs as well as estimated recruitments for the sequential runs are shown below. No unexpected or unreasonable patterns with a disproportionate effect of changes on model results (as it was in case of HKL discard data) have been detected in any of the sequential runs.



Spawning biomass (x1000 t)
0
20
40
60
80
1920
1940
1960
1980
2000
2020
Year
August 2025 model
No HKL comps, HKL catches are mirrored to BT
HKL and Net catches added to BT
MDT discard added to MDT landings
BT discard added to BT landings
Francis weighting, lambda=1


August 2025 model
No HKL comps
HKL and Net catches to BT
MDT discard to MDT landings
BT discard to BT landings
Francis weighting, lambda=1
Management target
Minimum stock size threshold
Fraction of unfished spawning biomass
1.00
0.80
0.60
0.40
0.25
0.20
0.00
1920
1940
1960
1980
2000
2020
Year



Comparison of estimated management quantities are provided in the table below. There were slight fluctuations in estimated values associated with every step, which is primarily related to removal of limited and noisy discard length data used to estimate retention curves.

Data re-weighting resulted in higher estimates of natural mortality (female M =0.135, male M=0.147), equilibrium catch and estimated OFLs. The updated data weighting method upweighted length data from the bottom trawl fleet and age data from all three commercial fleets (bottom trawl, midwater trawl, hake); all other composition data sources were down-weighted. For bottom trawl, in particular, this upweighting is likely in part due to the removal of discard composition data, as Stock Synthesis does not apply separate data weights to discarded and retained composition data from the same fleet. The discard compositions are very noisy and difficult to fit, so their removal allowed for upweighting of the remaining data.

The decrease in the weight of WCGBTS conditional age-at-length data by approximately one-third, paired with upweighting of other data, is likely the major driver of the increased estimate of natural mortality.

Label	August 2025 model	No HKL comps	HKL and Net catches to BT	MDT discard to MDT landings	BT discard to BT landings	Francis weighting, lambda=1
M Female	0.122	0.123	0.122	0.122	0.118	0.135
M Male	0.135	0.134	0.132	0.133	0.129	0.147
Unfished age 4+ bio 1000 mt	159	157.2	152.8	157.2	150.7	151.4
B0 thousand mt	85.46	83.88	81.43	83.7	80.7	79.25
B2025 thousand mt	46.93	43.7	40.55	42.66	37.9	42.771
Fraction unfished 2025	0.549	0.521	0.498	0.51	0.469	0.54
Relative fishing intensity 2024	1.175	1.217	1.266	1.235	1.32	1.12
2027 OFL mt	4533	4369	3923	4211	3504	5598
2027 ACL mt	4238	4085	3624	3937	3146	5235
Equil. catch at MSY mt	6526	6482	6219	6408	5978	6917
Equil. catch at SPR targ. mt	5822	5786	5557	5725	5346	6158

One of the reasons why HKL discard length data had a disproportionate effect on model results lies in how discards were modeled in the 2015 assessment. Explorations in other recent groundfish assessments (e.g., Yellowtail rockfish, Sablefish) have revealed that there are some hard-to-diagnose issues that come from estimating retention parameters (especially with limited amounts of data), and the HKL fleet in previous Widow rockfish assessment is another example of those challenges.

In the 2015 benchmark and subsequent 2019 update assessments, the HKL fleet was modeled with a retention curve and a selectivity curve. The parameter estimates for the selectivity and retention curves were informed by the combination of length composition data collected from the landed catch by the port samplers and data collected by the observer program from the catch discarded at sea.

The amount of discard length data (tens of organisms) in the model was substantially lower than the amount of length data from landings (around a thousand). However, the model calculated a single weighting value for the composition data of the entire fleet and applied that to both landings and discards length data. As a result, the influence of the small amount of HKL discard length data on the data weighting was disproportionately high. Moreover, in the 2015 and 2019 assessments the HKL discard length data consisted of primarily small fish (from nearshore fixed gear added to HKL samples), which the model interpreted as evidence of strong recruitment. The 2019 update assessment estimated the 2013 recruitment was the strongest year class over the duration of the fishery. With the nearshore fixed gear lengths removed (according to current WCGOP practices) and the hook-and-line discards added to landings, the 2025/2026 model estimated lower recruitment in the 2010s, which resulted in lower estimates of spawning biomass and stock productivity in recent years.

We made similar changes in other fleets modeled with retention curves to avoid similar potential issues with data weighting and differences in sample sizes for landed catch and discard lengths. Previously, the BT retention curve was informed by very limited length composition data and the MT fleet had no discard length composition data. In both cases, we have removed the retention curves and added discard amounts to landings.

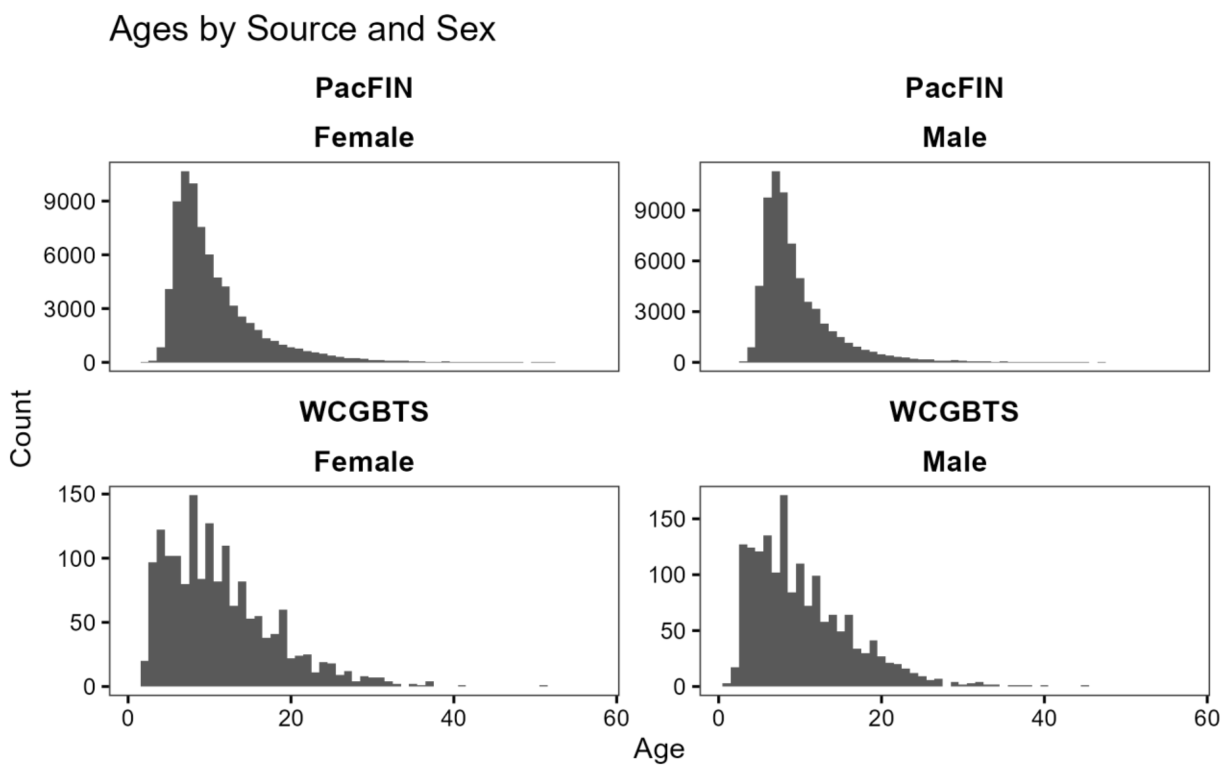
Request 4: Present a sensitivity analysis that prespecifies M using the median of a prior informed by maximum age (sensu Hamel and Cope 2022). Include a justification for the estimate of maximum age that is used for the prior.

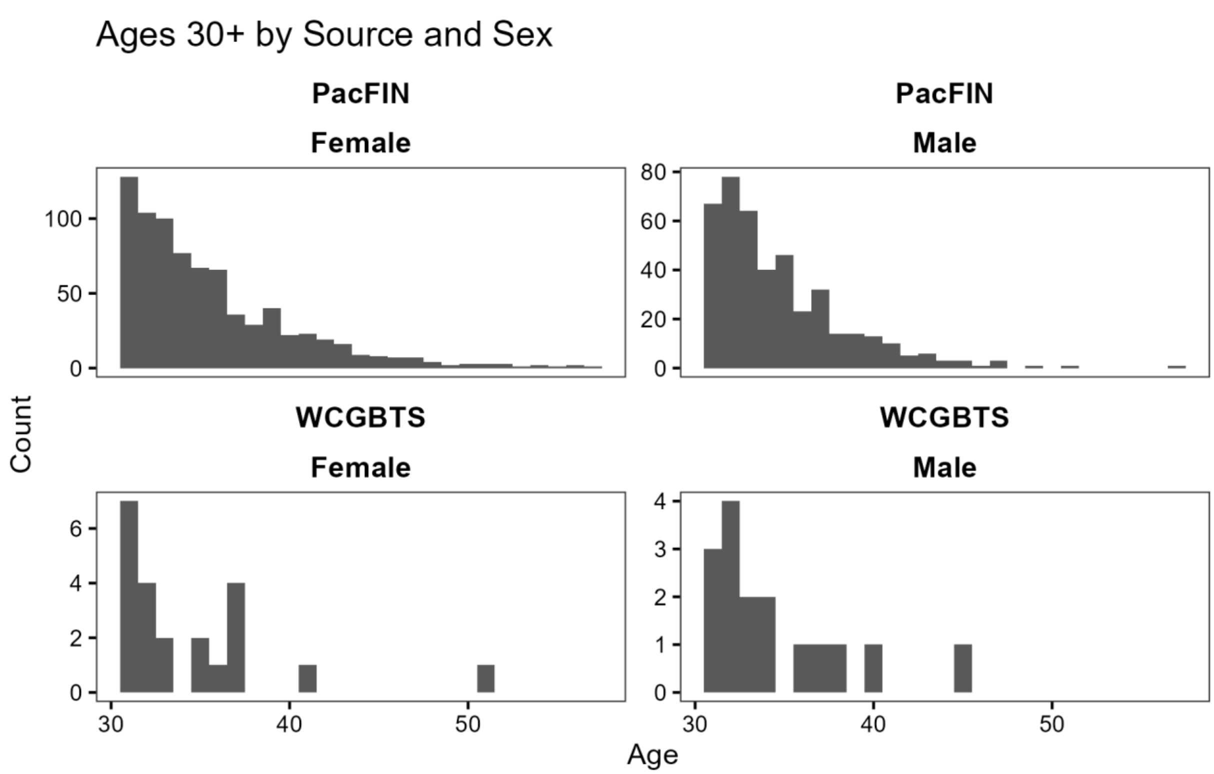
Rationale 4: Older fish identified in the WCGBTS may have an outsized effect on estimates of M. This approach is commonly used for West Coast groundfish assessments and would provide additional estimates of stock biomass to evaluate uncertainty.

Response 4 (part 1, exploration of age data):

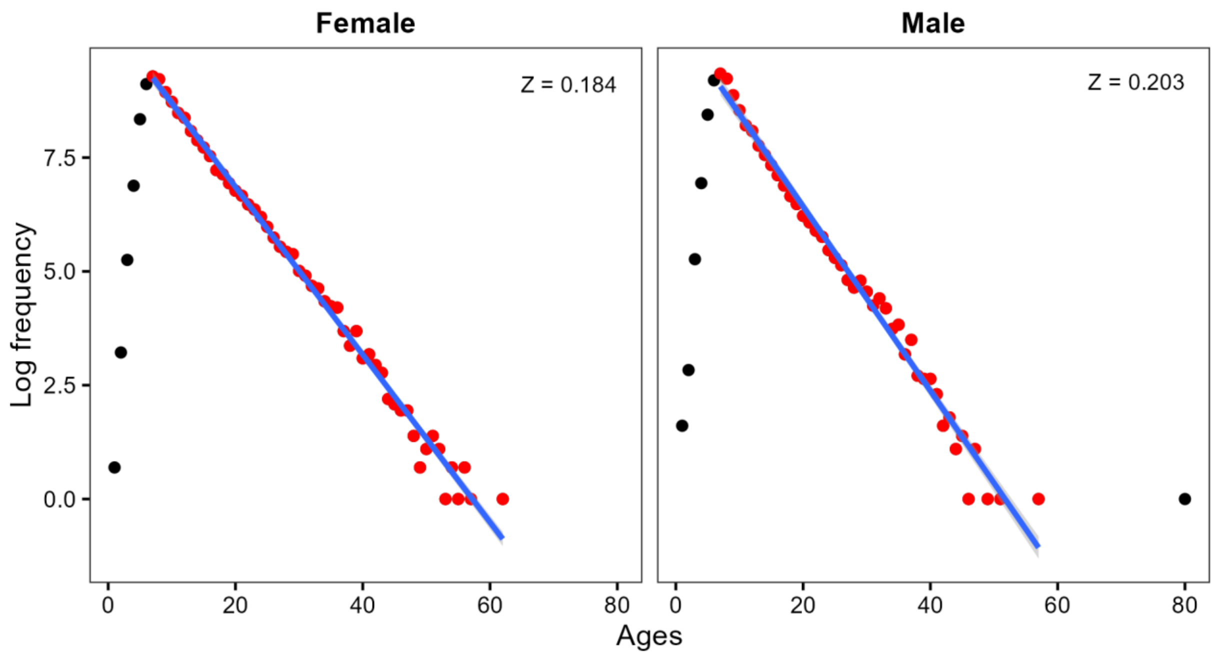
The 2025 assessment estimates natural mortality while using the Hamel and Cope (2022) prior. In selecting a maximum age for a prior, the 2025 assessment and 2019 update maintained the 2015 assessment assumption of a maximum age of 54 years, which corresponds to the median value of the prior for M of 0.1.

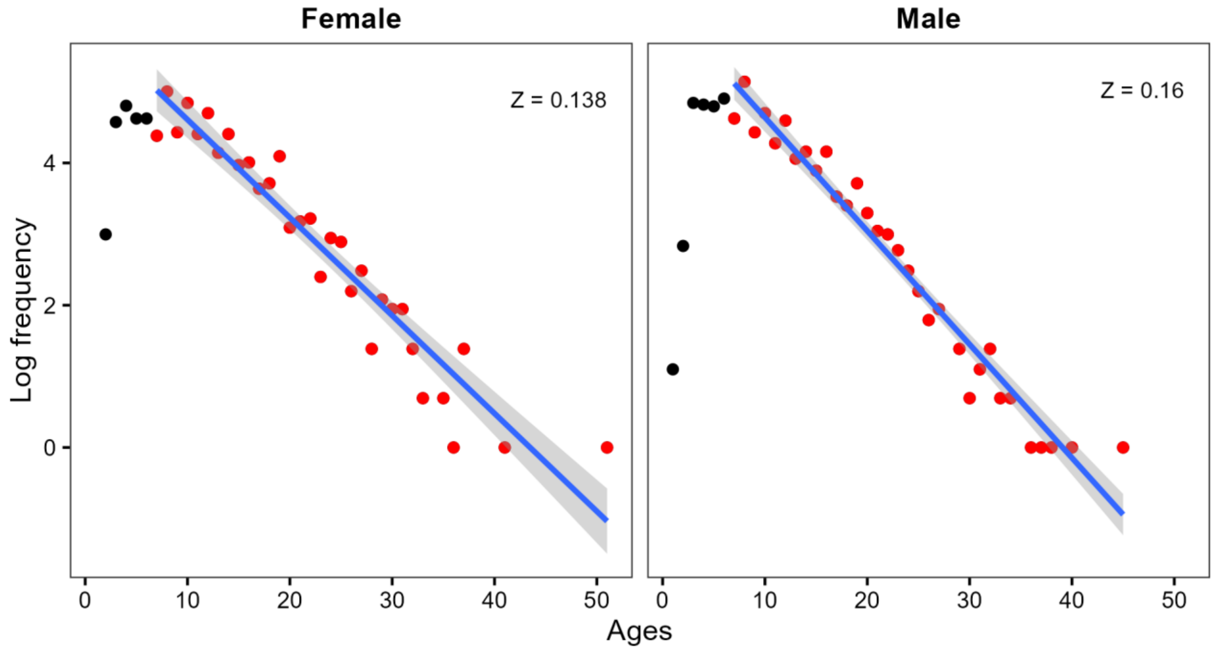
Age data by source and sex from commercial fisheries (PacFIN) and the WCGBT Survey (WCGBTS) is provided in the figures below (all ages, followed by the distribution of ages 30 and above). The estimated natural mortality in the January 2026 model corresponds to a maximum age of 40 years for females (M=0.135), and 37 years for males (M=0.147), ages consistently seen in the data. Ageing uncertainty can spread out this distribution beyond the true maximum age, while fishing pressure can truncate the age distribution below the true maximum age. The figures below exclude a sample at age 62 and another at age 80.


Ages by Source and Sex
PacFIN
Female
PacFIN
Male
WCGBTS
Female
WCGBTS
Male
Count
Age
9000
6000
3000
0
150
100
50
0
20
40
60


Ages 30+ by Source and Sex
PacFIN
Female
PacFIN
Male
WCGBTS
Female
WCGBTS
Male
Count
Age
100
50
0
80
60
40
20
6
4
2
3
1
30
40
50

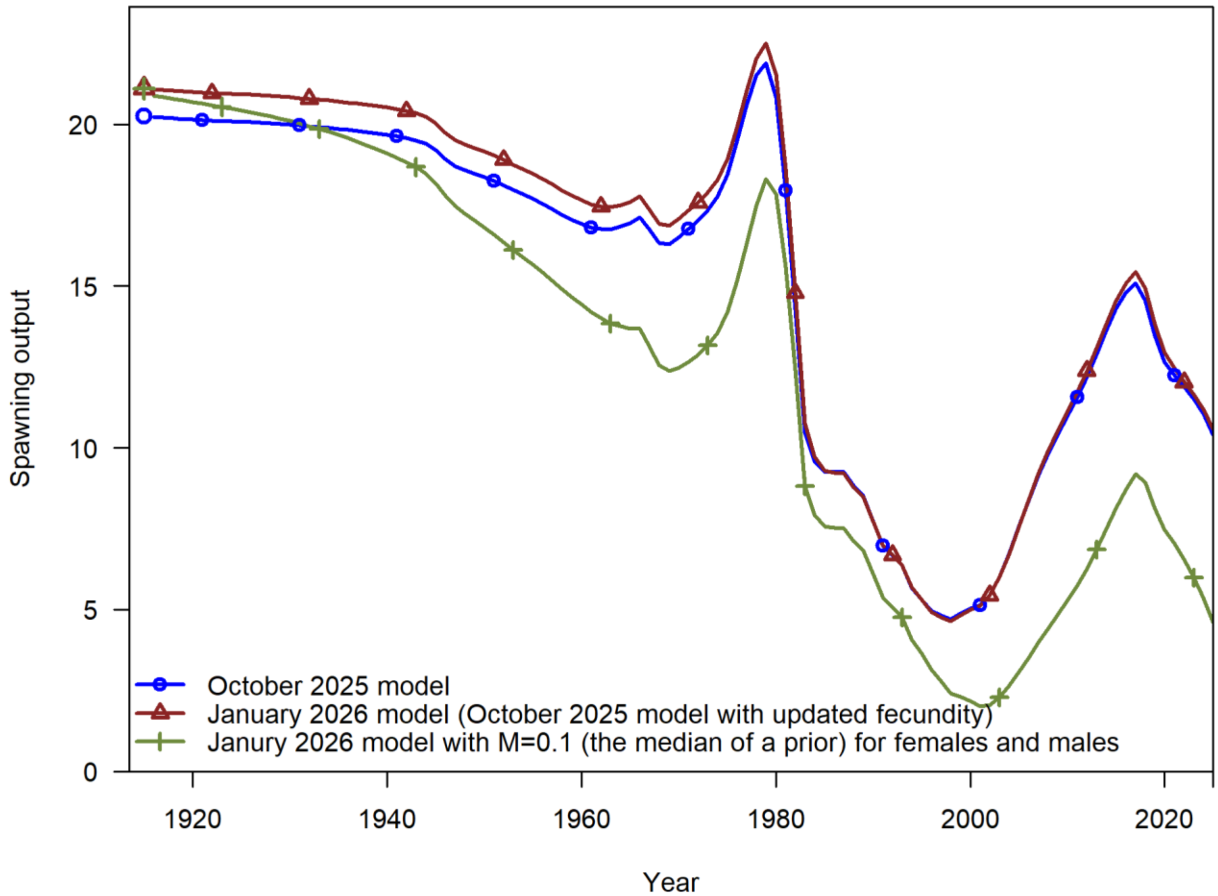
To further explore the raw age distribution, a catch-curve analysis was conducted following the approach used for the 2025 Rougheye/Blackspotted Rockfish stock assessment (e.g. Figure 48 in the Cope et al. 2025 pre-review draft report: https://pam.pcouncil.org/documents/rougheye_and_blackspotted_rockfishes_sar_2025-2-pdf/). This involves taking the log of the abundance of numbers of samples in available age classes and fitting a regression to the observations after the peak frequency where the resulting slope is an approximation to the total mortality (Z), which is the combination of natural mortality (M) and fishing mortality (F). The resulting estimate of total mortality (Z = F + M) when all ages are included is 0.184 for females and 0.203 for males. The samples span the years 1978 to 2024, and from PacFIN and WCGBTS ages 6 to 62 were included in the regression. When only the WCGBTS ages are included in the analysis (second plot below), the estimates are significantly lower, at 0.138 for females and 0.160 for males. The WCGBTS-only catch-curve analysis estimates of Z are similar to the model estimates of M, which highlights the contrasting signals from the commercial and survey age compositions.





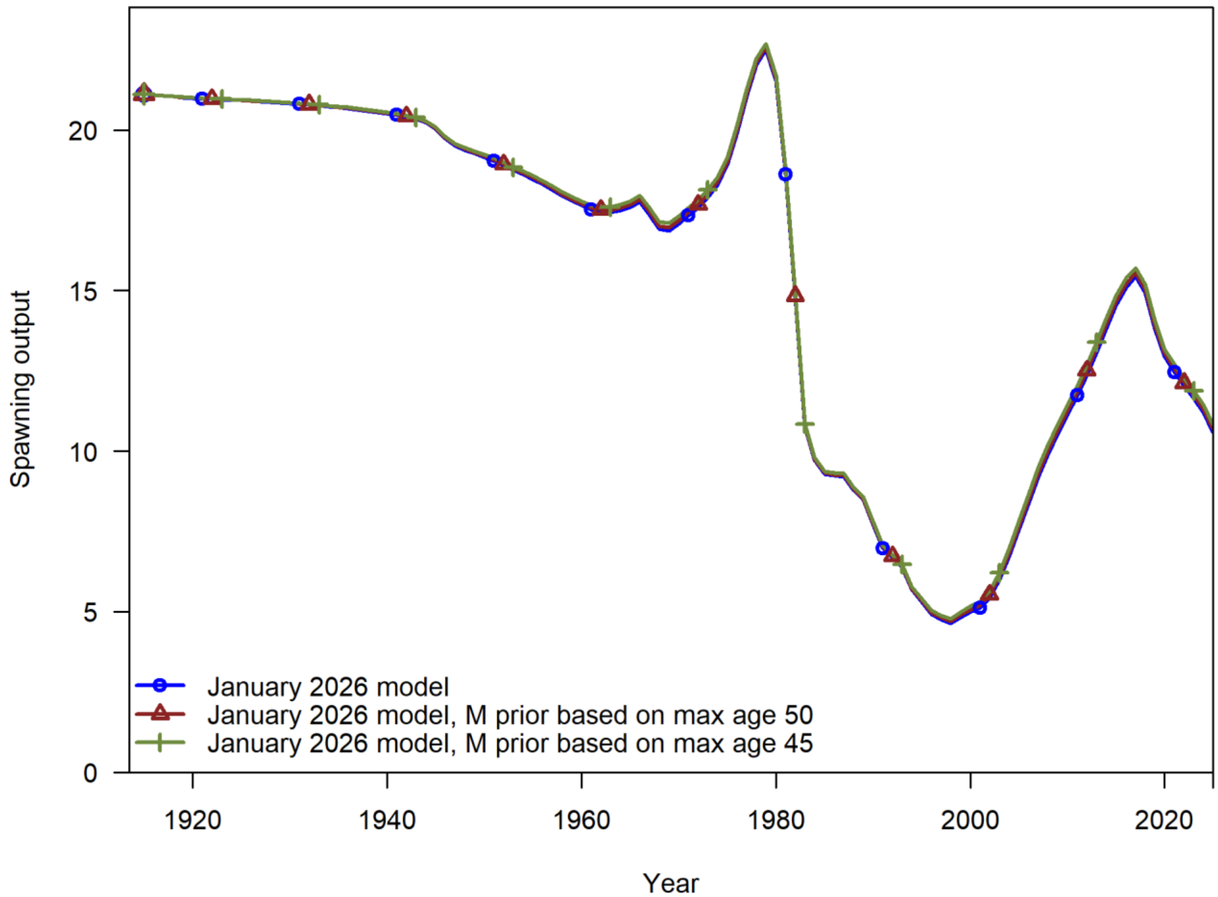
Response 4 (part 2, sensitivity analyses to alternative treatments of M):

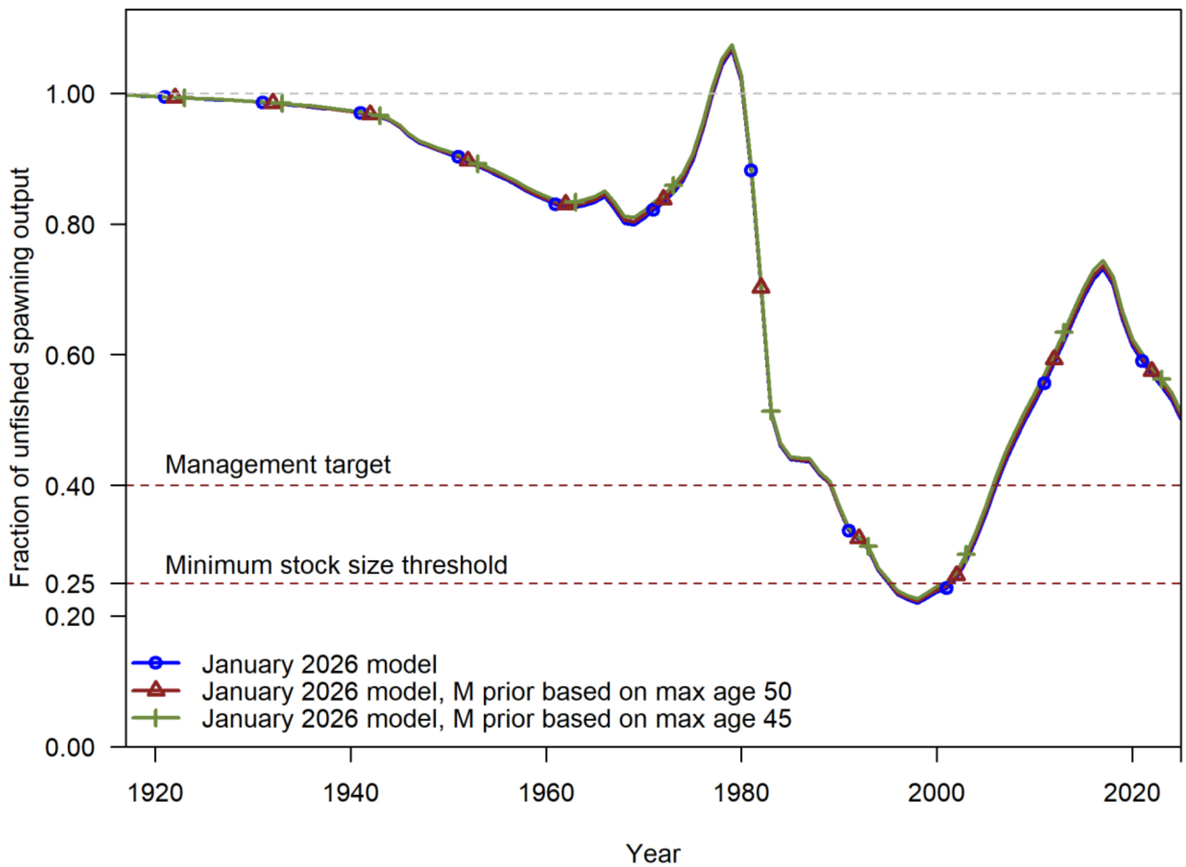
Comparison of estimated absolute and relative spawning output for the sensitivity run with M fixed at 0.1 for females and males with those from the October 2025 model and January 2026 model is shown below. A table summarizing estimated management quantities is also below. The model with M=0.1 further reduces the estimated OFLs, as the productivity of the stock is also decreasing with lower M.



Label	October 2025 model	January 2026 model	January 2026 model, M=0.1
M Female	0.135	0.135	0.1
M Male	0.147	0.147	0.1
Unfished age 4+ bio 1000 mt	155.7	156.4	153.1
B0 trillions of eggs	20.3	21.1	21.1
B2025 trillions of eggs	10.4	10.6	4.6
Fraction unfished 2025	0.514	0.501	0.218
Relative fishing intensity 2024	1.185	1.214	1.719
2027 OFL mt	5129	4916	1307
2027 ACL mt	4796	4596	351
Equil. catch at MSY mt	6829	6746	5073
Equil. catch at SPR targ. mt	6026	5931	4548

We also explored models with alternative assumptions about maximum age for the natural mortality prior. We ran the model with natural mortality estimated using the prior based on the maximum age of 50 and 45 years old. The model results were not sensitive to the alternative values of the median of the M prior, and estimated M values were similar in all runs. This is an indication that the data provide a stronger signal about M than the prior. As a result, the stock trajectories, estimated 2027 OFLs and MSY values were also very close in all the runs.





Label	**January 2026 model**	**January 2026 model with M prior based on age 50**	**January 2026 model with M prior based on age 45**
M Female	0.135	0.136	0.137
M Male	0.147	0.148	0.149
Unfished age 4+ bio 1000 mt	156.4	156.7	157.1
B0 trillions of eggs	21.11	21.1	21.1
B2025 trillions of eggs	10.57	10.7	10.8
Fraction unfished 2025	0.501	0.506	0.512
Relative fishing intensity 2024	1.214	1.205	1.193
2027 OFL mt	4916	4995	5108
2027 ACL mt	4596	4671	4776
Equil. catch at MSY mt	6746	6789	6851
Equil. catch at SPR targ. mt	5931	5967	6020

Request 5: Provide a table of equilibrium MSY from the October 2025 model, the revised model that updates the length-fecundity relationship, and the model that prespecifies M using a life history informed prior.

Rationale 5: In the event that a BSIA determination is not made, these values will help the SSC set OFLs (e.g., using a Category 3 approach). The table of equilibrium MSY values can be compared to estimates from a corrected 2019 update assessment to illustrate effects of the data error that was identified in August 2025.

Response 5: The table below provides a comparison of MSY (along with other management quantities) among the October 2025 model, the January 2026 model, the January 2026 model with M fixed at 0.1 (the median of a prior) and the 2019 model with adjusted HKL discard data, as done in the August 2025 model.

Label	October 2025 model	January 2026 model	January 2026 model, M=0.1	2019 model, HKL data corrected
M Female	0.135	0.135	0.1	0.142
M Male	0.147	0.147	0.1	0.153
Unfished age 4+ bio 1000 mt	155.7	156.4	153.1	166.4
B0 trillions of eggs/thousand mt	20.3	21.1	21.1	86.3
B2025 trillions of eggs/thousand mt	10.4	10.6	4.6	54.8
Fraction unfished 2025	0.514	0.501	0.218	0.635
Relative fishing intensity 2024	1.185	1.214	1.719	1
2027 OFL mt	5129	4916	1307	8290
2027 ACL mt	4796	4596	351	8290
Equil. catch at MSY mt	6829	6746	5073	7824
Equil. catch at SPR targ. mt	6026	5931	4548	6947

Request 6: Expand on the justification for using a length-fecundity relationship and provide a comparison of model estimates with and without the application of this relationship.

Rationale 6: This approach leads to a substantial shift in management advice, so using it should be well justified in the text.

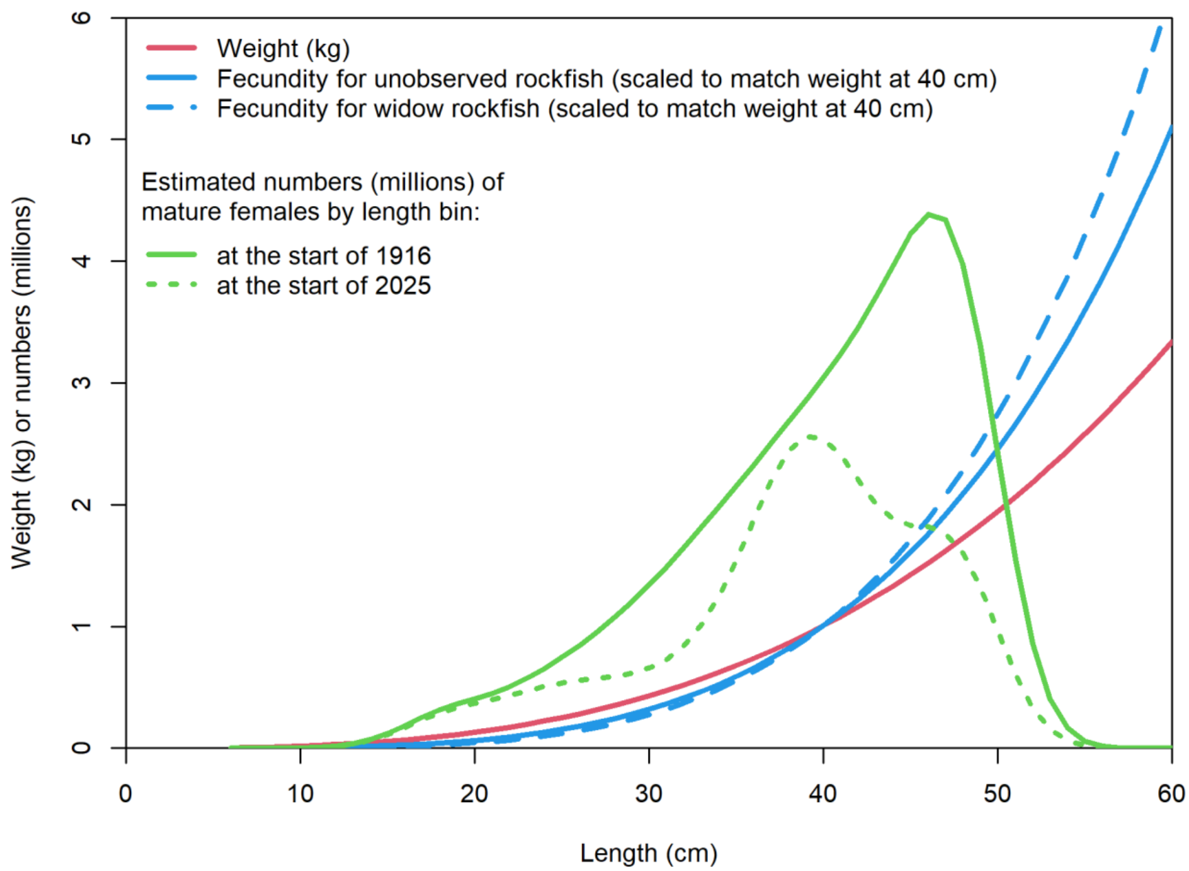
Response 6: The SSC's Accepted Practices Guidelines for Groundfish Stock Assessments in 2025 and 2026 supports the use of fecundity relationships as follows:

> The relationships between body weight or length and fecundity for rockfish should reflect the best available science. Rockfish stock assessments should consider relationships from

the meta-analysis in Dick et al. (2017), at the appropriate taxonomic scale, if better species-specific relationships are unavailable.

Fecundity relationships were not commonly used in west coast groundfish stock assessments in 2015, and the estimates from Dick et al. (2017) were not considered in the 2019 update assessment. The danger of assuming that spawning output is proportional to body weight instead of fecundity is that it could lead to an underestimation of the importance of older and larger individuals on the reproductive potential of the population.

The impact on reference points of using a fecundity relationship is illustrated in the figure below where the two fecundity-at-length relationships (blue) are contrasted with weight-at-length for females (red), along with the mature numbers at length at the start and end of the model (green). The exponent of the weight-at-length curve is 2.987 compared to 4.043 for the unobserved rockfish fecundity (used in the October 2025 model) and 4.545 for the Widow rockfish-specific fecundity (used in the January 2026 model). Comparing these relationships to the number of mature fish in each length bin in 1916 and 2025 shows that when the fecundity relationships are used, the spawning output is more dependent on the larger fish (over 40 cm) which are disproportionately removed from the population due to selective fishing on larger sizes. This combination of factors leads to lower estimates of fraction of unfished when one of the fecundity relationships is used.



Request 7: Clarify how M affects recent changes in stock size.

Rationale 7: Requests 6 and 8 from the August 2025 GFSC review included a "leave one out" analysis where different data sources were excluded from the assessment, and a 10-year retrospective analysis. Both analyses highlighted a sensitivity of model results to some sources of age data, which were important in estimating M. The panel was unable to evaluate how changes in estimates of M corresponded to changes in stock biomass.

Response 7: The change in estimated natural mortality, and related change in understanding of stock productivity by the Widow rockfish assessment model, is caused by the combination of at least two factors, including 1) signals in the age data (that show increasing proportion of older fish), and 2) how the data are weighted.

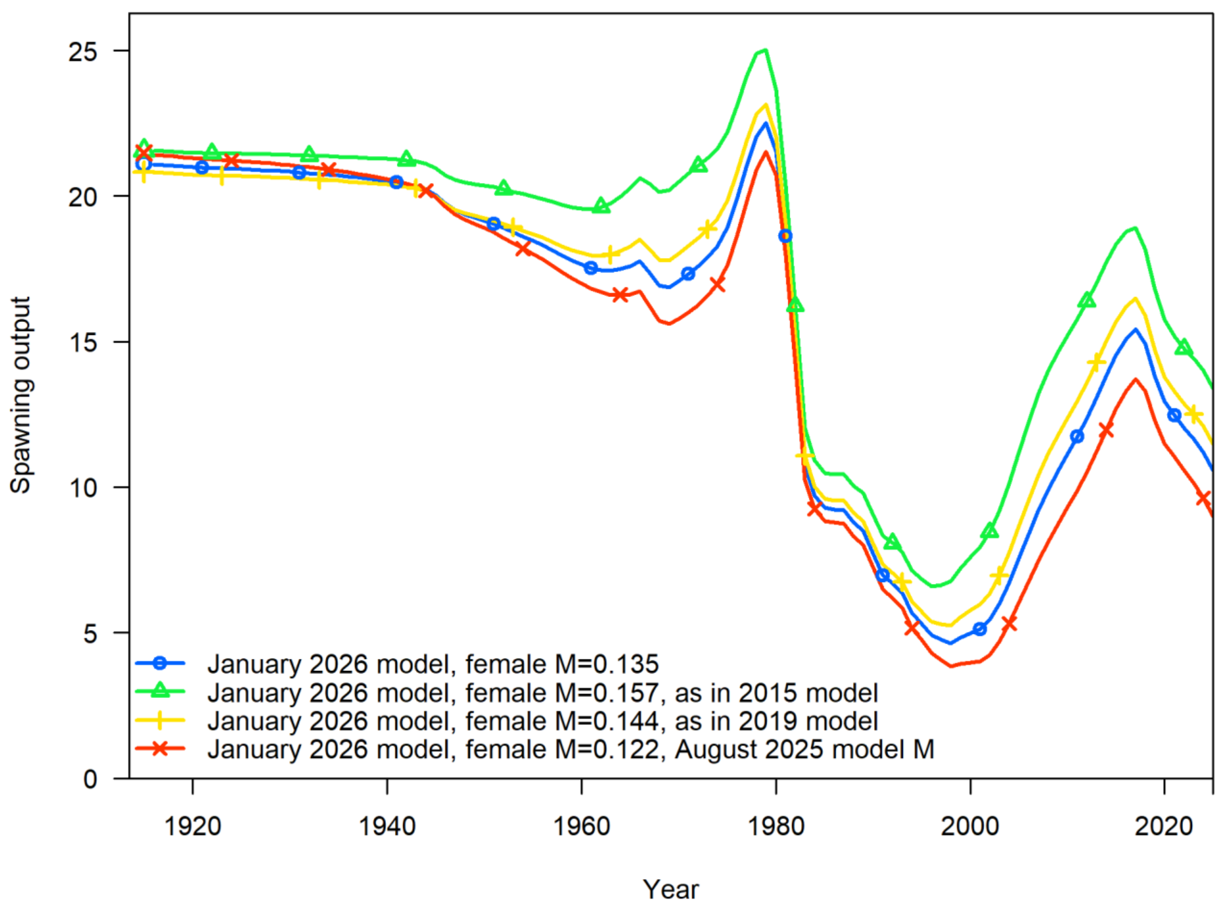
The majority of recent age data in the model comes from the midwater rockfish trawl fishery, and the West Coast Groundfish Bottom Trawl Survey (WCGBTS). There are age data from the At-Sea Hake fishery, but these data represent a much smaller amount of catch than the midwater rockfish trawl fishery, and thus have less influence on estimated management quantities, as shown in the "leave one out" analysis cited in the Request.

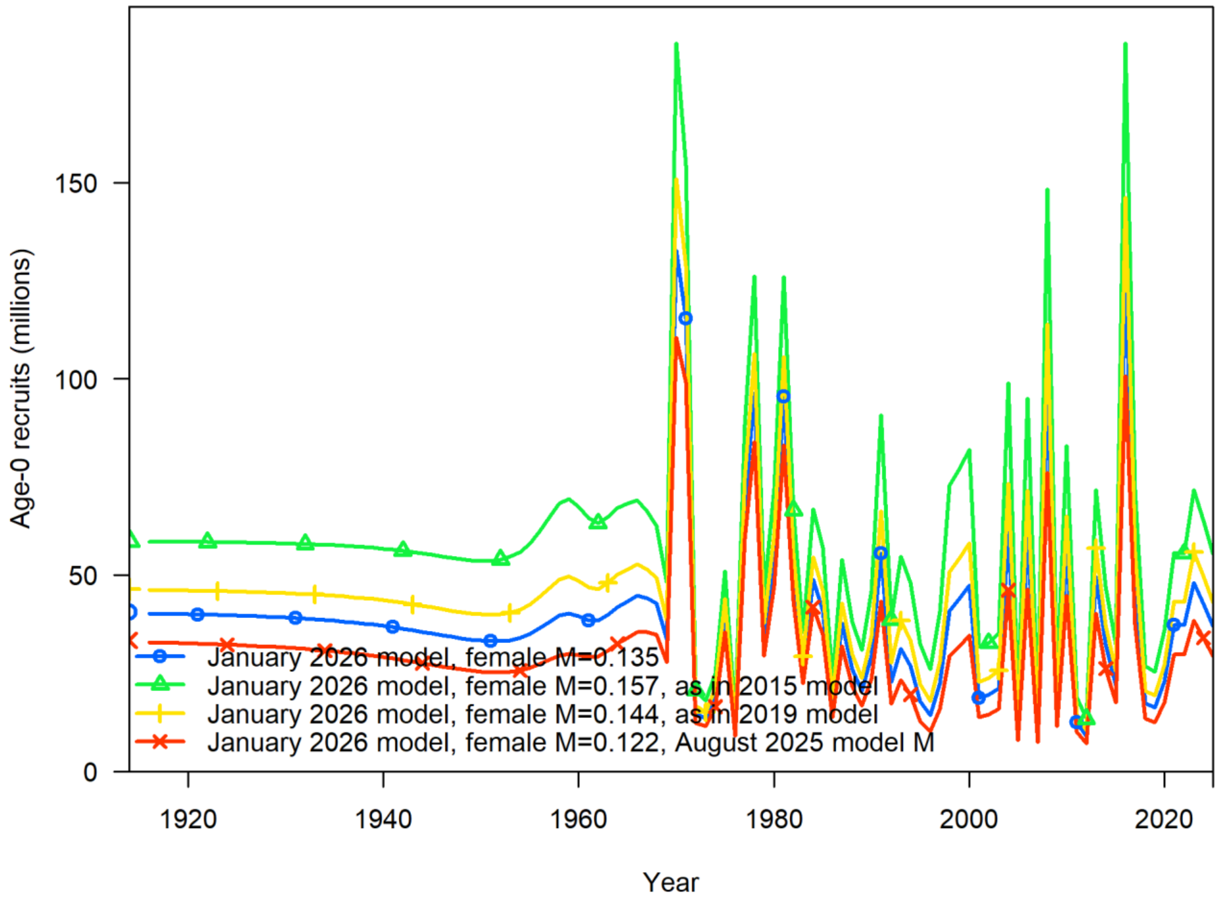
Widow rockfish was the subject of an intense fishery in the 1980s and 1990s, which selectively removed larger/older fish from the population. Thus, information on longevity as well as average natural mortality throughout their natural lifespan was limited for this population, as the age structure no longer represented the natural lifespan, and it is difficult, if not impossible, to fully disentangle fishing and natural mortality with information from a "one way trip" where the stock is declining in size over time. There was, therefore, an expectation that the number and proportion of older fish would increase throughout the rebuilding period, before fishery catches substantially increased in 2017 and that the proportion of old fish (e.g. over age 30) might continue to increase even after that point. However, there remained uncertainty about exactly what those numbers and proportions would look like, with that information expected to refine estimates of natural mortality. This information could have resulted in increasing or decreasing estimates of the natural mortality rate. In fact, the proportions of older fish were greater than expected from previous assessment models and projections, resulting in a decrease of the estimated natural mortality rate (M) in the assessment models. Thus, the estimated female M in the 2015 and 2019 assessments were 0.157 and 0.144, respectively. Using the McAllister-Ianelli data weighting approach and applying an additional 50% multiplier on the data weights to the fishery composition data (as was done in the 2015 and 2019 assessments), the August 2025 update assessment model showed a further decrease in the estimate of natural mortality, with female M estimated as 0.122, reflecting increased proportion of older organisms in the WCGBTS data.

In the October 2025 and January 2026 models, the data weighting approach was updated to match current practices, including the use of the Francis (rather than McAllister-Ianelli) method, and no longer applying a 50% additional reduction in weights for fishery data.

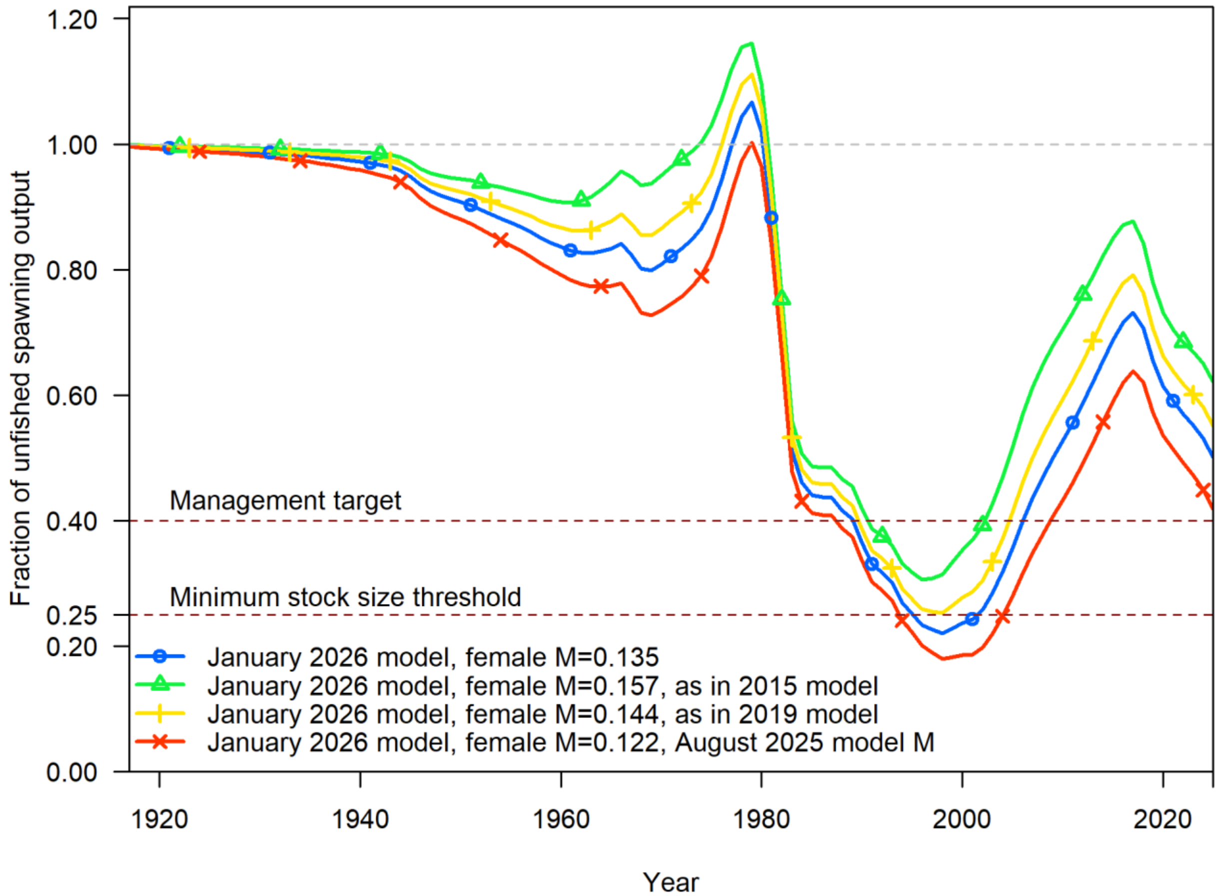
The change in data weighting approach resulted in the estimates of natural mortality to go up (female M =0.135), which translated into increases in equilibrium catch and estimated OFLs. The decrease in the weight of WCGBTS conditional age-at-length data by approximately one-third, paired with upweighting of other data, is likely the major driver of the increased estimate of natural mortality.

The comparisons of absolute and relative stock trajectories with natural mortality fixed at the values from the 2015, 2019 and August 2025 models are shown below. The unfished spawning output (informed by fishery removals and age composition data) is very similar among these runs. However, the lower the natural mortality is, the lower the final assessment year spawning output, since the less productive stock is impacted more by fishery removals. The models with higher natural mortality need to scale up estimated recruitments, in order to provide for a sufficient amount of fish to sustain the catches over time, while having the same recruitment deviations.





Age-0 recruits (millions)
0
50
100
150
1920
1940
1960
1980
2000
2020
Year
January 2026 model, female M=0.135
January 2026 model, female M=0.157, as in 2015 model
January 2026 model, female M=0.144, as in 2019 model
January 2026 model, female M=0.122, August 2025 model M



Fraction of unfished spawning output
1.20
1.00
0.80
0.60
0.40
0.25
0.20
0.00
Management target
Minimum stock size threshold
January 2026 model, female M=0.135
January 2026 model, female M=0.157, as in 2015 model
January 2026 model, female M=0.144, as in 2019 model
January 2026 model, female M=0.122, August 2025 model M
1920
1940
1960
1980
2000
2020
Year

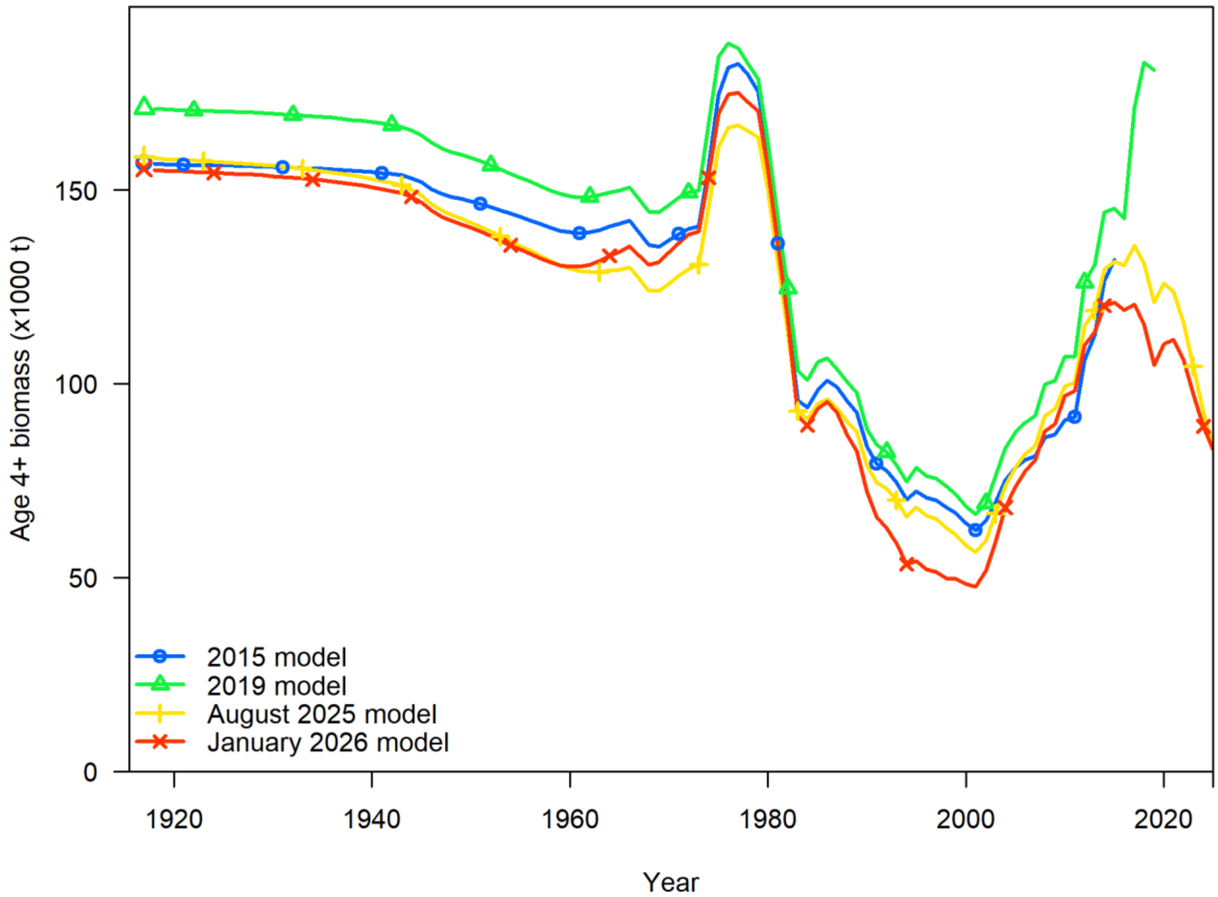
The estimated management quantities associated with each run are provided in the table below. The less productive stocks (those with lower natural mortality) have lower estimated OFLs and MSY values.

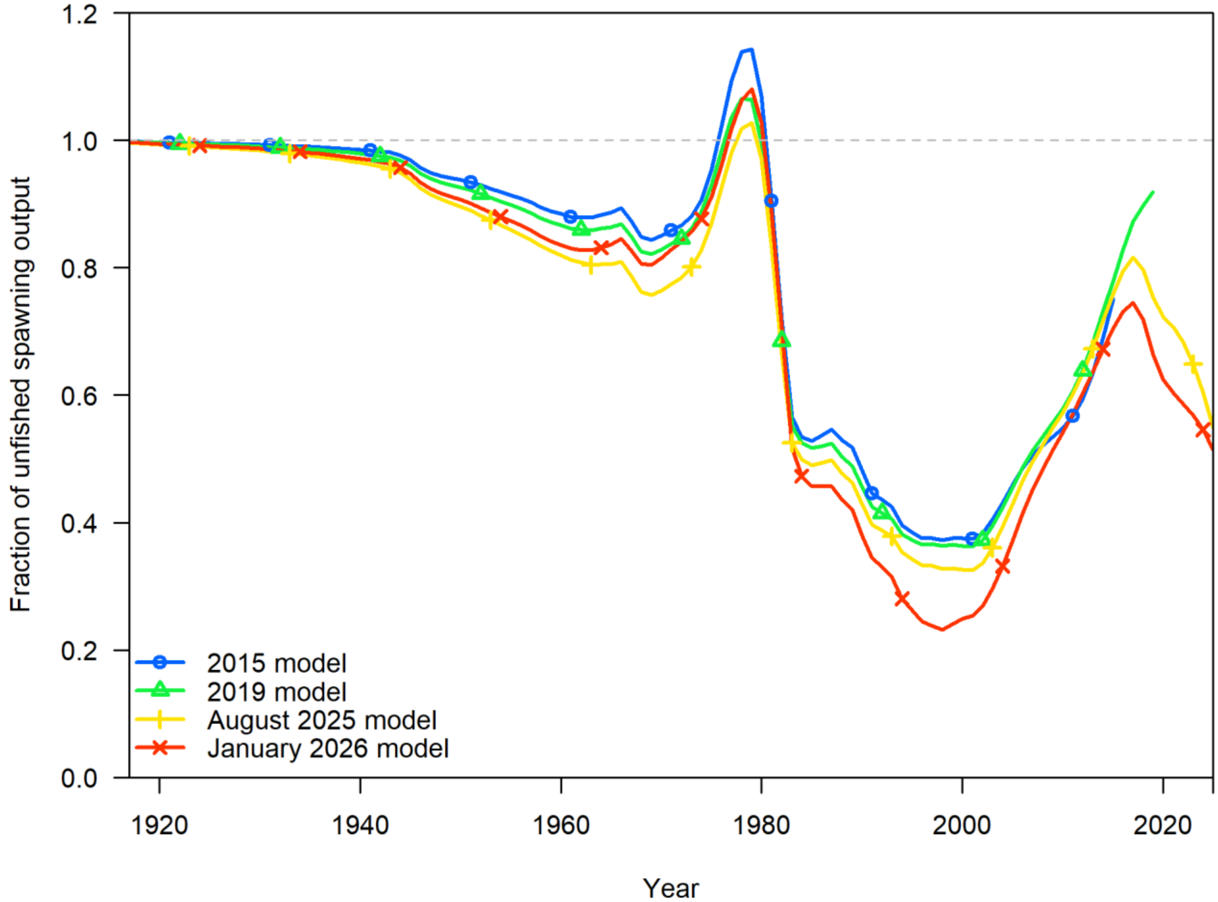
Label	**January 2026 model**	**January 2026 model, M fixed at 2015 assessment estimate**	**January 2026 model, M fixed at 2019 assessment estimate**	**January 2026 model, M fixed at August 2025 model estimate**
M Female	0.135	0.157	0.144	0.122
M Male	0.147	0.17	0.155	0.135
Unfished age 4+ bio 1000 mt	156.4	168.3	159.2	153.5
B0 trillions of eggs	21.11	21.6	20.8	21.5
B2025 trillions of eggs	10.57	13.4	11.5	9
Fraction unfished 2025	0.501	0.621	0.55	0.418
Relative fishing intensity 2024	1.214	0.989	1.122	1.364
2027 OFL mt	4916	7400	5809	3686
2027 ACL mt	4596	6919	5431	3219
Equil. catch at MSY mt	6746	8244	7249	6107
Equil. catch at SPR targ. mt	5931	7193	6360	5388

Request 8: Clarify how changes in model parameters affect changes in management advice.

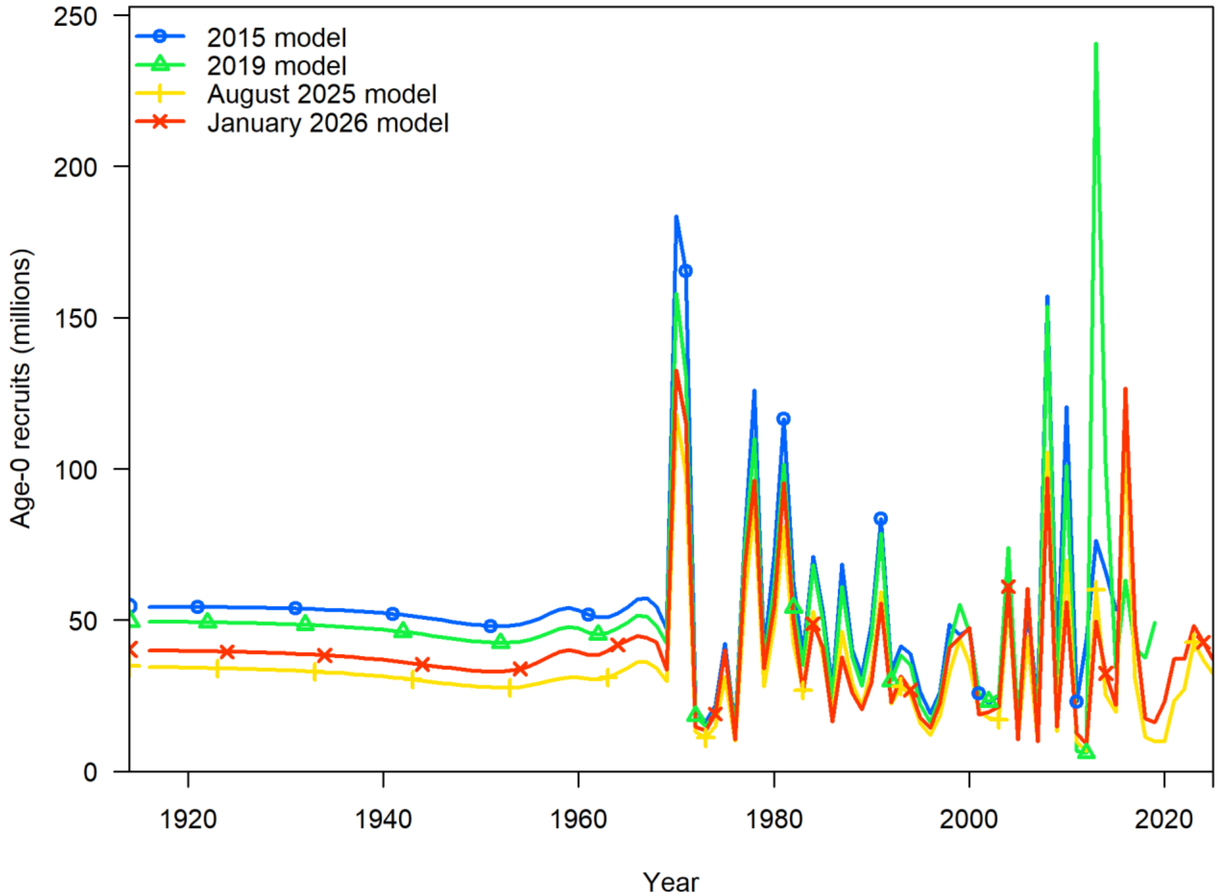
Rationale 8: Some of the changes to the OFLs seem disproportionate relative to associated changes to model parameter estimates. For example, there is a considerable decrease in the 2027 OFL when a length-fecundity relationship is used, but estimates of stock size were fairly similar to the model that relied on different assumptions about fecundity. How this relates to a change in "currency" for reproductive output and other potential drivers should be explicitly stated. It would be helpful to clearly articulate how models with similar biomass trajectories can produce very different OFL projections.

Response 8: Comparison of trajectories in summary (Age 4+ biomass), fraction of unfished and recruitments among models (2015 assessment, 2019 assessment, August 2025 model and January 2026 model) are shown below.


Age 4+ biomass (x1000 t)
0
50
100
150
1920
1940
1960
1980
2000
2020
Year
2015 model
2019 model
August 2025 model
January 2026 model



Fraction of unfished spawning output
Year
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1920
1940
1960
1980
2000
2020
2015 model
2019 model
August 2025 model
January 2026 model



Multiple parameters contribute to decrease in OFL projections.

Natural mortality: As discussed in our Response 7, lower estimates of natural mortality result in less productive stocks and thus decreased estimates of the spawning stock output in final assessment years and estimated OFLs.

Fecundity: As discussed in our Response 6, in a model with fecundity-at-length relationship (January 2026 model), the spawning output is more dependent on the larger fish (over 40 cm) which are less abundant in the current population, which leads to lower estimates of fraction of unfished spawning output and estimated OFLs.

Recruitment: The perception of recent recruitment has changed substantially. The 2019 assessment had a very high estimate of 2013 recruitment and above average 2014 recruitment, leading to a strong increase in the age 4+ biomass at the end of the time series which would continue to contribute significantly to the fishery catch in recent years as well in projections beyond 2025. The projections from the 2019 assessment beyond the range of observed data all assumed recruitment following the stock-recruit curve. In contrast, the recent data indicate an above average but not exceptional 2013 recruitment, a below average 2014 recruitment, a good recruitment in 2016, and a period of below-average recruitment in recent years (especially 2018-2020). When the SPR-based default harvest control rule is applied to the projected age structure, under the model estimated selectivity, the resulting catch limits are well below MSY in 2027 and 2028 in spite of the projected healthy stock status (above 40% of the unfished equilibrium). The impact of recent below-average recruitments can also be seen in the figure under request 6 above illustrating the fecundity relationships, where the low numbers of fish from 20cm to near 35cm have experienced very low fishery selectivity and thus overall exploitation so the reduced numbers relative to unfished equilibrium is due to low recruitment. Many of these fish will grow into lengths closer to peak selectivity by 2027 and 2028, resulting in fewer fish to harvest at those lengths, and thus potentially lower OFLs relative to equilibrium conditions at the same stock size.

The 2013 year class in the 2019 assessment was primarily informed by small fish from nearshore fixed gear added to HKL discard length data, and the model exhibited substantial sensitivity in recruitment estimates to even slight changes in HKL discard amounts. However, it is worth pointing out that the 10-year retrospective analysis showed that with seven years of data removed, the model estimates a higher 2013 year class, which gets smaller with every year of data added. This indicates that other sources inform the model about the potential of a high 2013 year class, and indicates caution should be taken when large recent year classes are estimated in stock assessments.