INTERNATIONAL PACIFIC HALIBUT COMMISSION

Development of the 2024 stock assessment

Agenda item: 4.1.1
IPHC-2024-SRB025-06
(I. Stewart & A. Hicks)

Outline

- Stock assessment and review process
- SRB requests
  - FISS design evaluation simulations
  - Treatment of ageing imprecision and bias
- Preliminary maturity ogive sensitivity
- Topics planned for investigation in 2025

Stock assessment and review process

- Full stock assessments – every ~3 years
  - 2015, 2019, 2022, *2025 (planned)*
  - Includes re-evaluation of all data sources, model structure, etc.
- Updated stock assessments in intervening years
  - 2023, **2024**
  - Only minor/necessary changes as data sets and methods evolve
- June SRB review
  - Research and development
  - Recommendations primarily to the Secretariat
- September SRB review
  - Finalizing the assessment and planning for next June
  - Recommendations to the Secretariat and Commission

SRB requests and recommendations

1) SRB023–Rec.19 (para. 59):

*"The SRB **RECOMMENDED** that the Secretariat continue exploring ways of estimating the impacts of different FISS designs and efficiency decisions on stock assessment outputs and fishery performance objectives. The end goal should be to provide a decision support tool that can frame decisions about FISS design in terms of costs and benefits in comparable currencies."*

2) SRB023–Req.07 (para. 60):

*The SRB **REQUESTED** that the Commission NOTE that some longer-term (2025 and beyond) implications of reduced FISS designs are predictable and potentially consequential. For instance, higher FISS CVs will generally result in higher inter-annual variation in TCEY under the current decision-making process. This would occur for two reasons: (1) biomass estimates and projections from the assessment model will have greater uncertainty and therefore greater variability in outputs and (2) ad hoc management adjustments to the interim harvest policy recommendations would be more frequent and/or more variable for greater input uncertainty. The SRB therefore REQUESTED the following analyses for SRB024:*

a) Assessment of reduced FISS designs (2025-2027) via simulation tests of assessment model outputs (e.g. probability of decline, estimated stock abundance and status, TCEY) under alternative revenue-neutral FISS designs using the existing stock assessment ensemble;

b) Mitigation options of reduced FISS designs (short-term and long-term) via MSE simulations of management procedures that deliberately aim to reduce inter-annual variability in TCEY via multi-year TCEYs and (possibly) fixed stock distribution schemes;

c) Components (a,b) above would be integrated since (a) will need to inform simulations in (b)."

FISS design simulation

- Three FISS designs:
  1) ‘Base block design’ - preferred design given Commission guidance and supplementary funding; unbiased (over the 3-year rotation) and relatively precise
  2) ‘Core design’ - possible under reduced supplementary funding/revenue, similar to 2023; potentially biased and would provide reduced information, larger CVs and gaps in estimates of stock distribution
  3) ‘Reduced core design’ – possible under reduced supplementary funding/revenue, similar to 2024; likely biased with large CVs and no coverage over broad areas of the stock distribution

FISS design simulation: 3 experiments

'True' FISS trend	Estimation models	Inference
No trend	*Unbiased*: No FISS trend, base block design *Unbiased*: No trend, core design *Unbiased*: No trend, reduced core design	Effect of increased CV due to reduced designs
+15% over 3 years	*Unbiased*: +15% FISS trend, base block design *Biased*: No trend, core design *Biased*: No trend, reduced core design	Effect of failing to identify an increasing trend
-15% over 3 years	*Unbiased*: -15% FISS trend, base block design *Biased*: No trend, core design *Biased*: No trend, reduced core	Effect of failing to identify a decreasing trend

FISS design simulation

- Using the same parametric bootstrapping approach from June
  - Fit models to ‘true’ trends: 2025-2027 (stable, decreasing, increasing)
  - Fit models to biased trends: 2025-2027 (stable)
  - Bootstrap 100 new data sets of each combination of design and bias
  - Combine biased and unbiased data as appropriate
    - FISS trend and CV – biased or unbiased
    - Age composition data scaled with FISS design
    - Fishery data - always unbiased
  - Refit 100 models to combined data
  - Compare results across each FISS design
    - Spawning biomass in 2028, fishing intensity (SPR in 2027) probability of stock decline

FISS design simulation

- Experiment 1: How does increased FISS variance during 2025-2027 affect the assessment results?
  - No appreciable bias:
    - Only 1-2 percent difference in estimated spawning biomass
    - Unbiased SPR
    - Unbiased risk of stock decline
  - “Inertia” is already set up by existing year-classes in 2024
  - Fishery data remains unbiased and therefore stabilizes the results

FISS design simulation

- Experiment 2: If the FISS is increasing and we fail to detect it, how much bias occurs in the stock assessment results?
  - -2% bias in spawning biomass core design
  - -3% bias in spawning biomass reduced core design
  - ‘True’ SPR = 47%, both reduced designs estimated 46%
  - ‘True’ risk of stock decline = 40%, both reduced designs estimated 46%

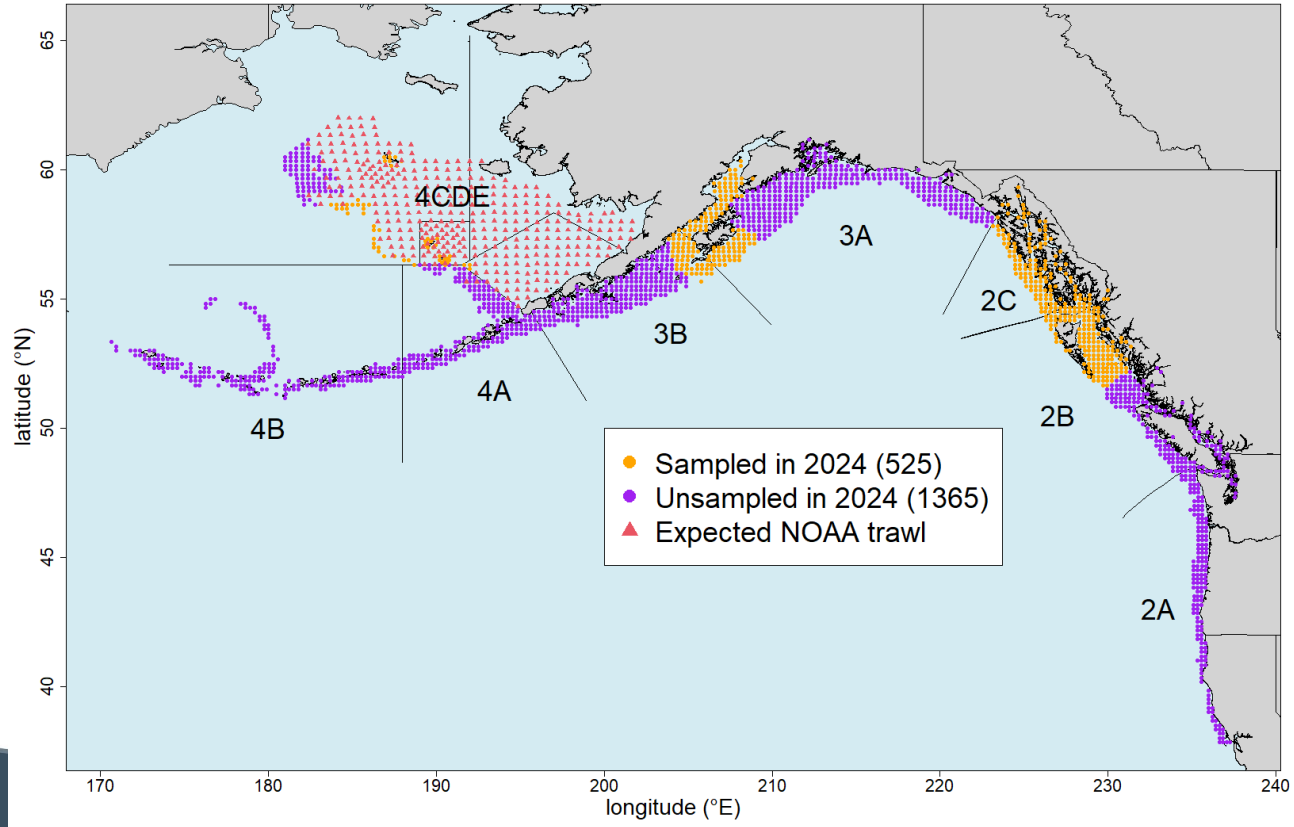
FISS design simulation

- Experiment 3: If the FISS is decreasing and we fail to detect it, how much bias occurs in the stock assessment results?
  - +3% bias in spawning biomass core design
  - +2% bias in spawning biomass reduced core design
  - ‘True’ SPR = 44%, both reduced designs estimated 45%
  - ‘True’ risk of stock decline = 65%, both reduced designs estimated 56%

Slightly lower bias in the reduced core design does not indicate a better outcome. Although less information allows the fishery data to largely dictate the results, the potential for bias with poor FISS coverage is actually higher.

FISS design simulation

- A simulation-based approach does not reflect participant confidence in the FISS data
- Regardless of statistical results, reduced designs do not provide for a stable IPHC management process.



SRB requests and recommendations

1) SRB024 (para. 42):

*The SRB **RECOMMENDED** that the Secretariat investigate:*

a) Fitting a power function to the AI/CNN vs manual age determination to show how bias increases with age;

b) Training the model with more otoliths from older age classes;

c) Alternative objective functions that put more weight on correctly estimating ages of older individuals;

d) The importance of different aspects of aging accuracy/bias on the stock assessment.

Ageing imprecision and bias

- Two existing methods:
  - Surface – biased at older ages, less precise
    - Standard until 2001
  - Break-and-bake – unbiased, more precise
    - Standard 2002+
    - Validated with bomb-radiocarbon methods (Piner and Wischnioski 2004)

Ageing imprecision and bias

- Break and bake imprecision from double reads – empirical and estimated (Forsberg and Stewart 2015)

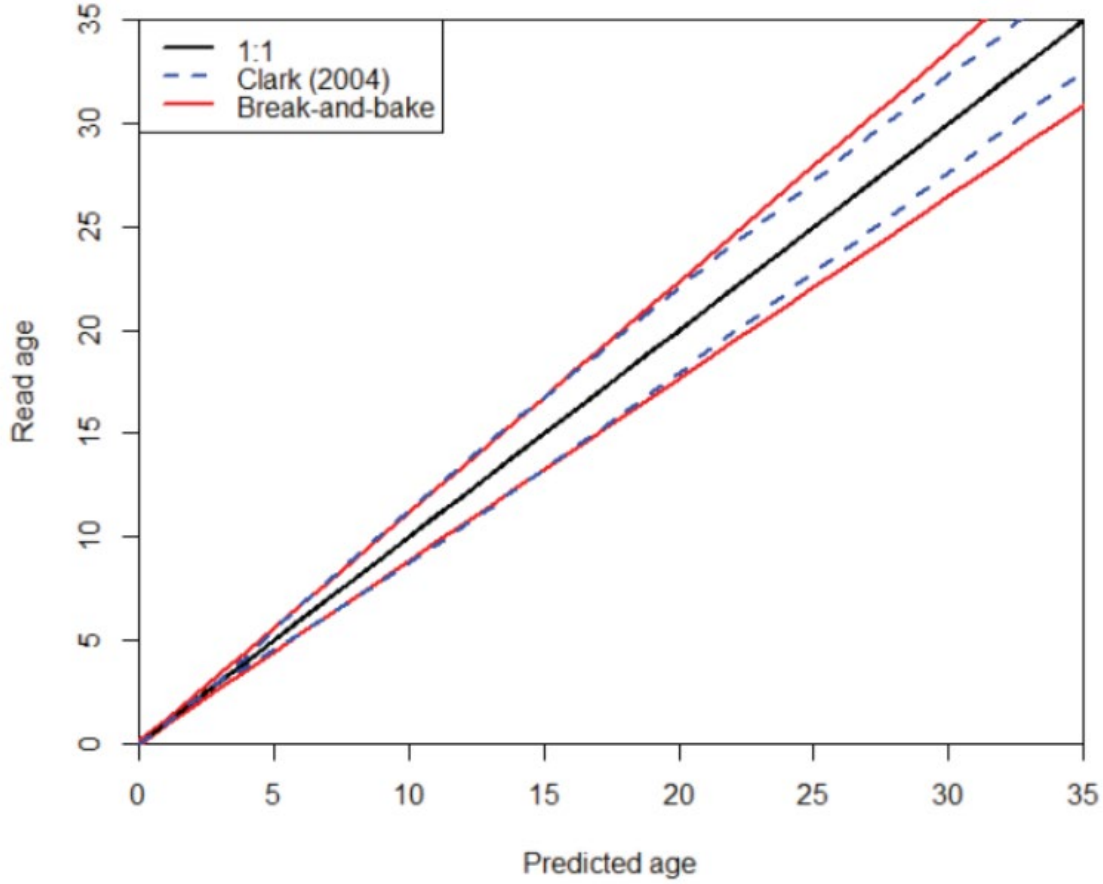
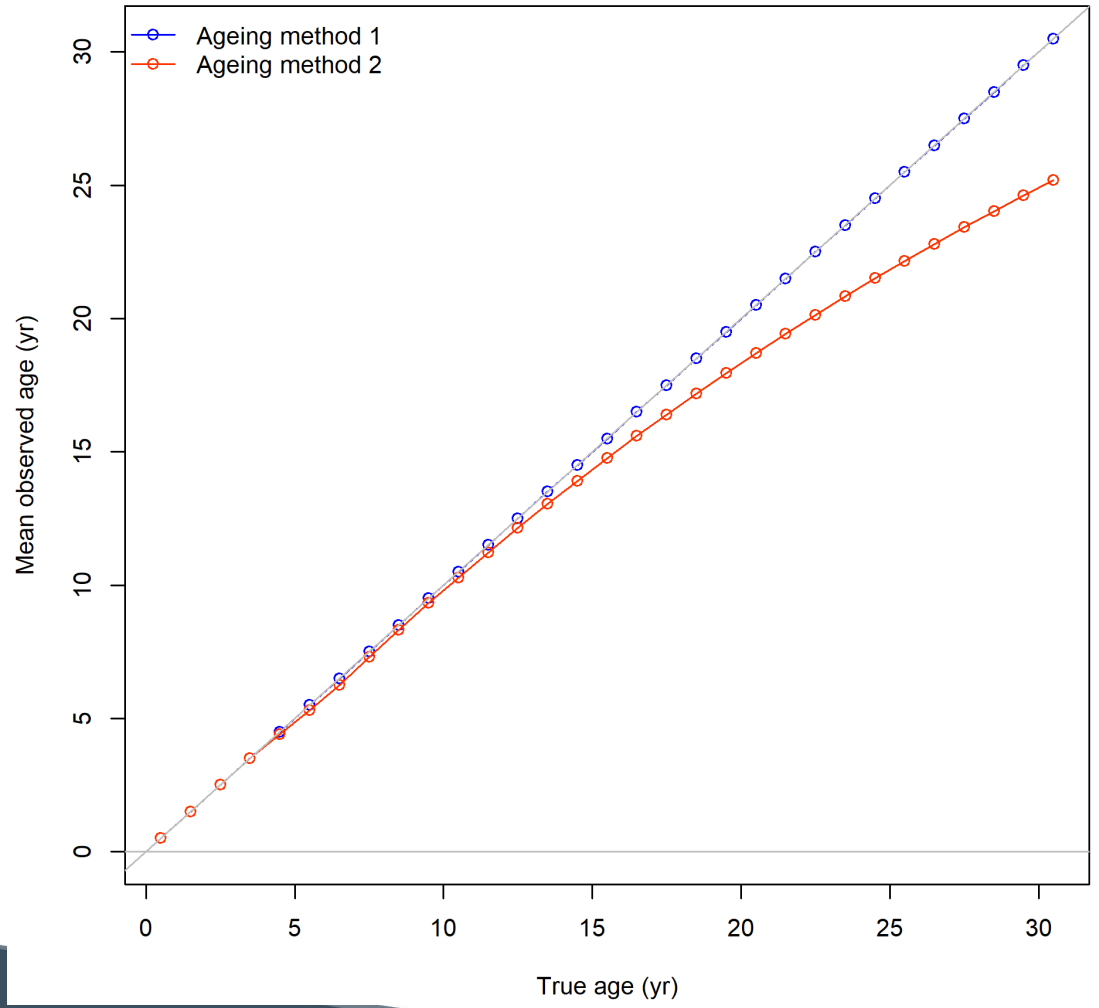


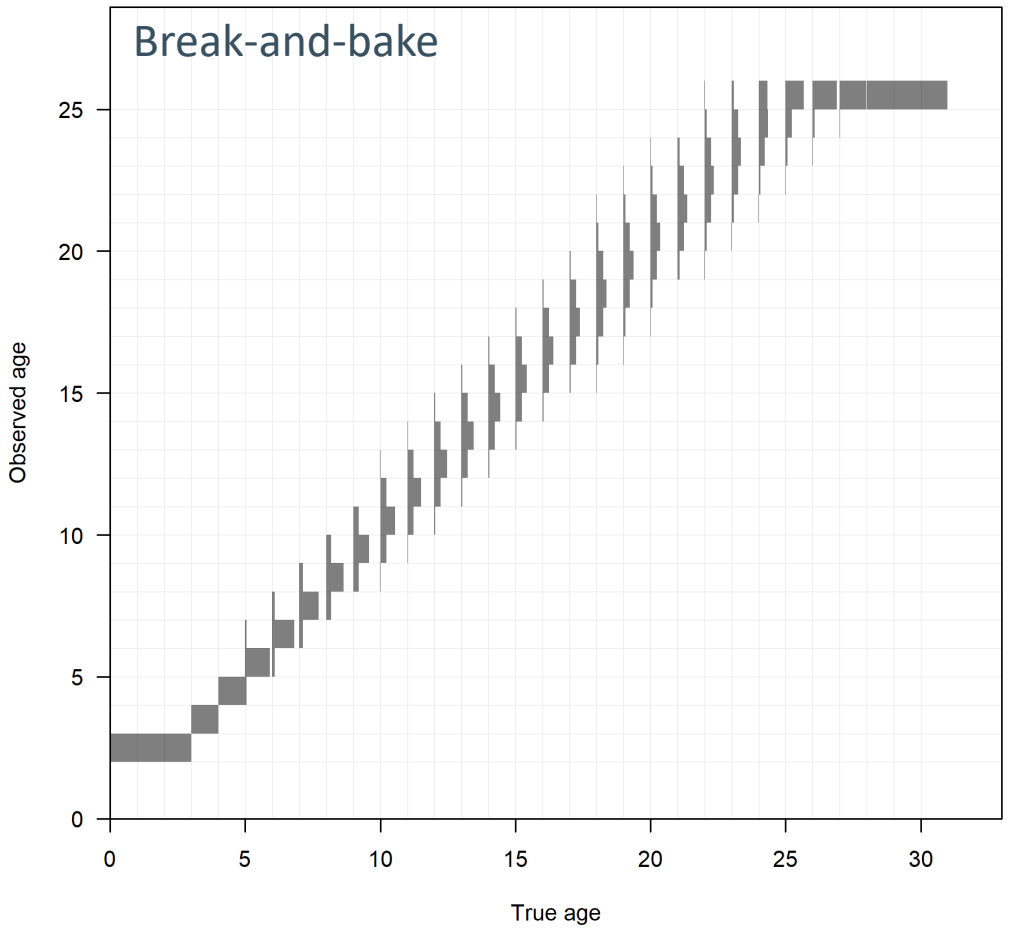
Figure 11. Comparison of imprecision (95% confidence intervals) in the break-and-bake ageing method estimated by Clark (2004; dashed lines) and re-estimated simultaeously.

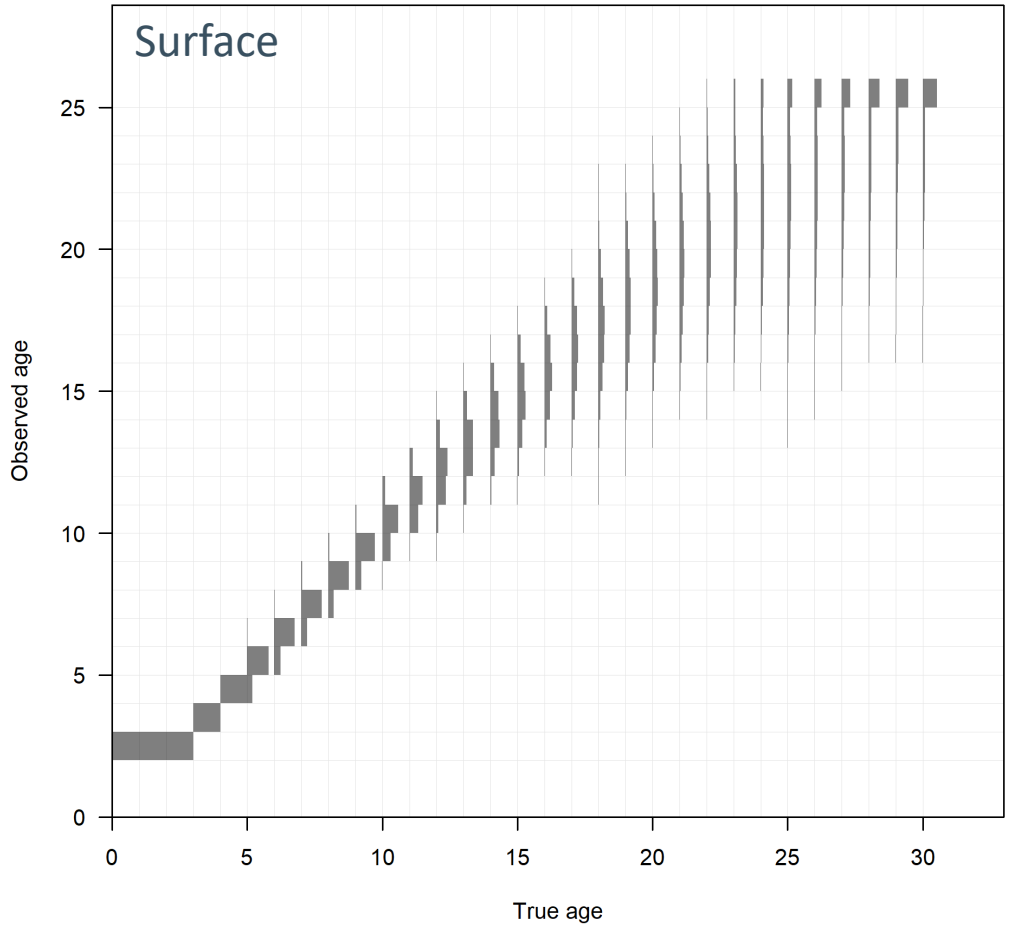
Ageing imprecision and bias

- Increasing bias in surface ages (method 2) after about age 15



Ageing imprecision and bias



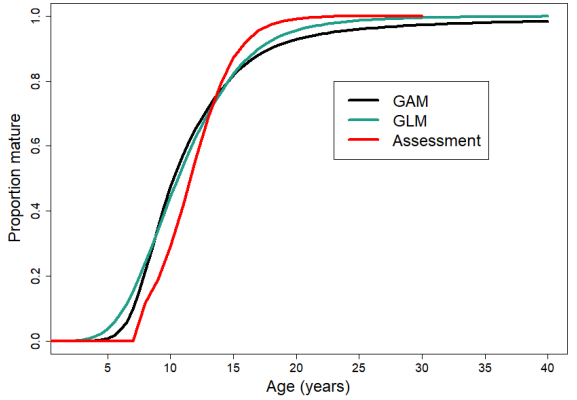


Ageing imprecision and bias

- No limit on the number of ageing methods that can be included in the assessment
- "Quality" of a method is a trade-off between sample size, precision and bias
  - Imprecision reduces the information to track year classes
  - Bias reduces the information on the older fish and therefore on mortality rates (*F*, *M* and *Z*)
  - Faster methods may produce more ages (or the same number at a lower cost), but only as many as can be sampled in the field
- The most critical aspect of any method is that it is reproducible
- Duplicate data sets can be tested for their affect on the assessment, but this will not indicate long-term performance

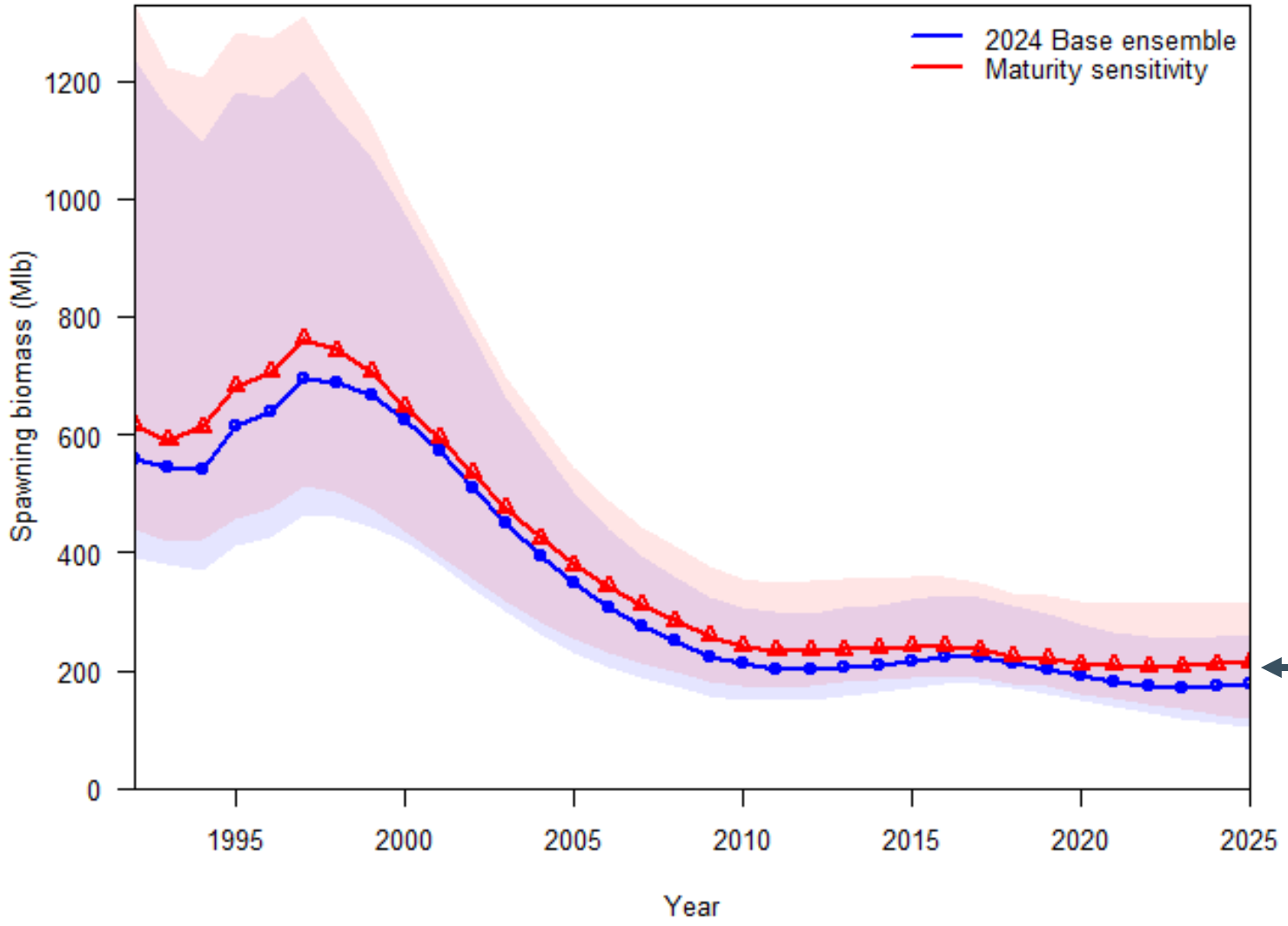
Preliminary maturity sensitivity

- Combined 2022 and 2023 maturity data (GAM)
  - More rapid maturation at younger ages
  - Lower proportion of older fish mature
  - Ages <7 set to 0.0 (no mature fish observed)



- *Simple exploration*: replace the existing curve with the histology-based estimate
  - Does not account for historical differences in stock distribution or potential changes in the relationship over time
    - Could 'correct' historical macroscopic observations
    - Could account for variable stock distribution across Biological Regions (1993+)
    - Could be time-varying instead of a single curve

Preliminary maturity sensitivity (ensemble)

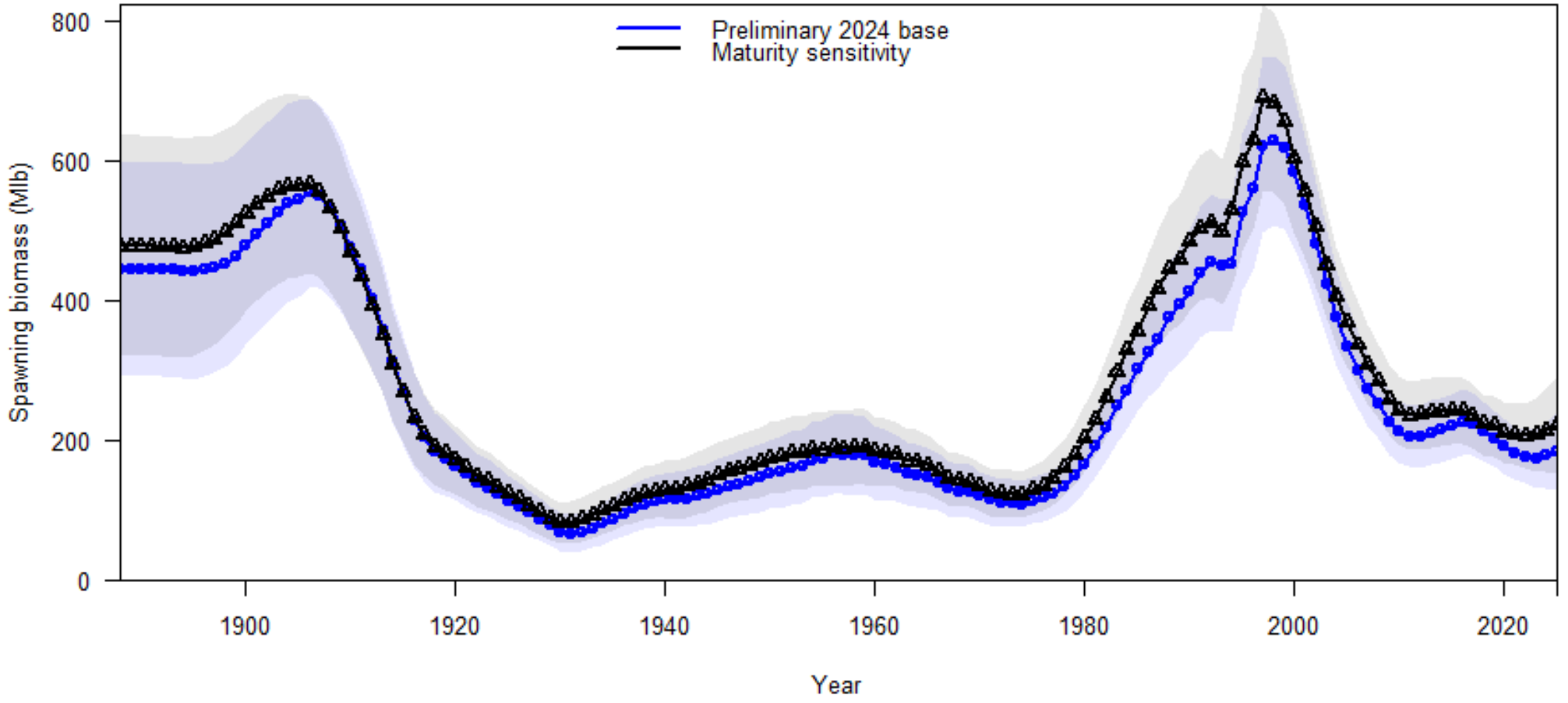


Results in a slightly larger, more productive stock, suggesting a lower fishing intensity.

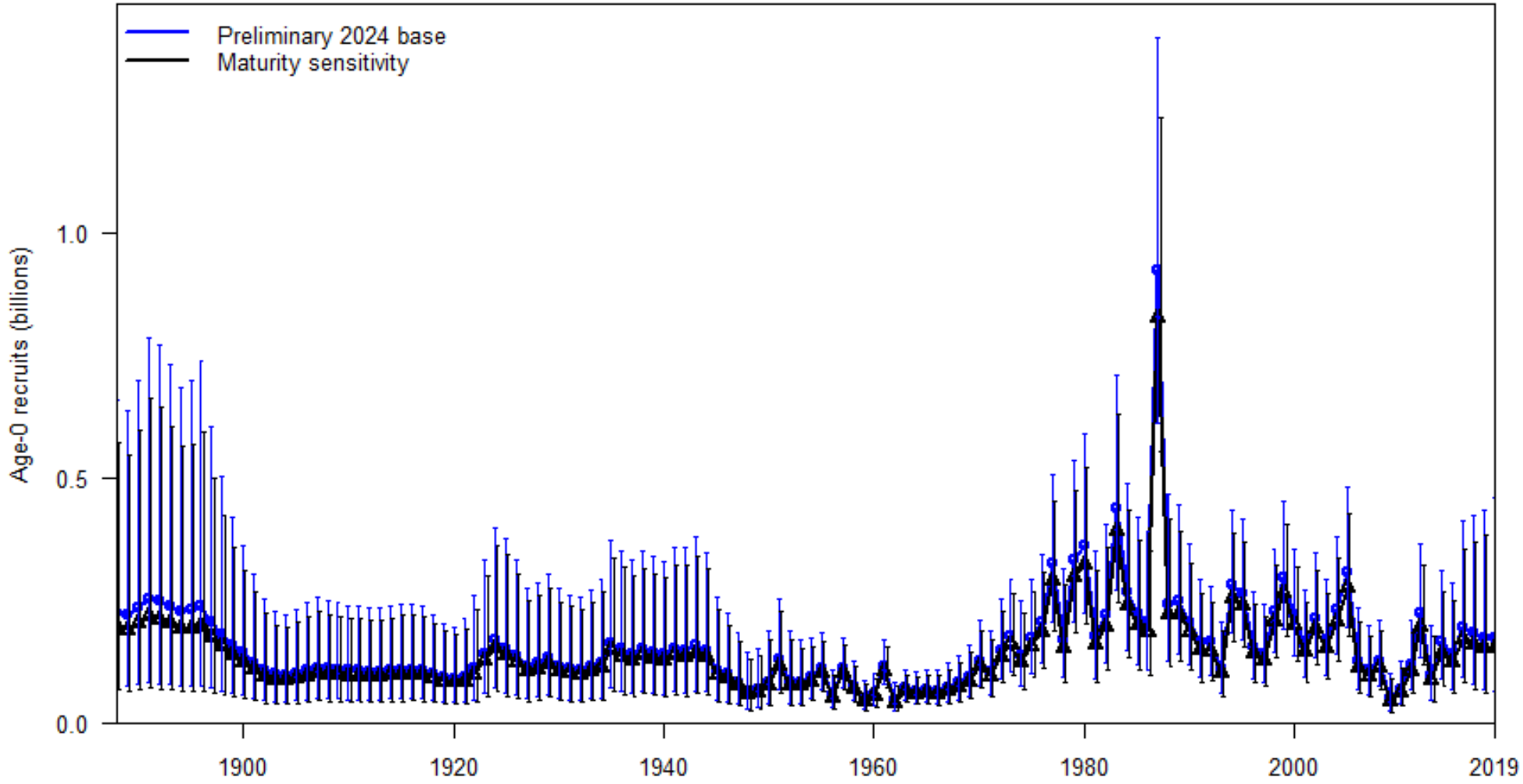
	2024 Base	Sensitivity
SPR_{2024}	**52%**	**56%**
$SB_{2025}/SB_{unfished}$	**42%**	**47%**

21% higher 2025 SB

Preliminary maturity sensitivity (Coastwide long model)



Preliminary maturity sensitivity (Coastwide long model)



Planned development for 2025

- Include a revised maturity ogive using data from 2022-2024
- Further explore the PDO as a covariate to recruitment
- Improve the data-weighting approach by:
  - Extending the bootstrapping procedure for input sample sizes by year to include ageing imprecision (Hulson and Williams 2024)
  - Evaluate new diagnostics including One-Step-Ahead (OSA) residuals (Trijoulet et al. 2023)
- Continue to explore estimation performance of natural mortality in all four models, and especially the short coastwide model
- Continued refinement of pre-model data processing and analysis
- Other topics as they arise

Remaining stock assessment development for 2024

- Final data sets available 1 November
  - No structural changes to the models or data
- Data to be updated for the final stock assessment:

1) Trend, age, length, individual weight, and average weight-at-age estimates from the 2024 FISS.
2) Directed commercial fishery logbook trend information from 2024 (and any earlier logs that were not available for the 2024 assessment) for all IPHC Regulatory Areas.
3) Directed commercial fishery biological sampling from 2024 (age, length, individual weight, and average weight-at-age) from all IPHC Regulatory Areas. Sex-ratio at age from the 2023 commercial fishery.
4) Biological information (lengths and/or ages) from non-directed discards (all IPHC Regulatory Areas) and the recreational fishery (IPHC Regulatory Area 3A only) from 2023. These data routinely lag one year.
5) Updated weight-at-age for younger Pacific halibut captured in NOAA Fisheries trawl surveys in the Gulf of Alaska and Bering Sea in 2023. These data also routinely lag one year.
6) Updated mortality estimates from all sources for 2023 (where preliminary values were used) and estimates for all sources for 2024.

Recommendations

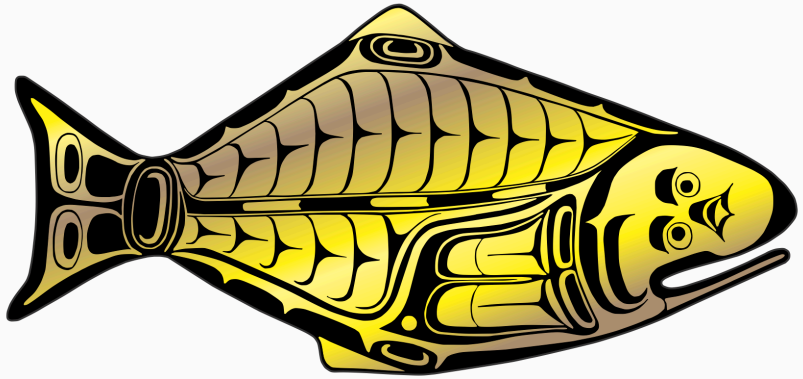
That the SRB:

a) **NOTE** paper IPHC-2024-SRB025-06 which provides a response to requests from SRB023 and SRB024, and an update on model development for 2024.

b) **REQUEST** any modifications to the 2024 stock assessment.

c) **REQUEST** any analyses to be provided at SRB026 as part of the development of the full 2025 stock assessment.

INTERNATIONAL PACIFIC



HALIBUT COMMISSION

https://www.iphc.int/