INTERNATIONAL PACIFIC HALIBUT COMMISSION

Development of the 2023 stock assessment

Agenda Item 4.1.1

IPHC-2023-SRB022-08

Outline

- Time-series and software updates
- Response to SRB recommendations and requests
  - MASE use in 2022
  - Frequency of sex-specific fishery age composition
  - *M* estimation in 2022
  - Marine mammal depredation
  - Model weighting
  - Spatial population structure

IPHC stock assessment process

- Full assessment ~ every 3 years
  - 2015, 2019, 2022
- Updated analyses in between
  - **2023**, 2024

Time-series update

- All models are extended by one year with the projected mortality based on the 2023 adopted limits
- No change to parameter estimates or historical time-series, but allows for direct comparison of all changes and new data moving forward

Software update

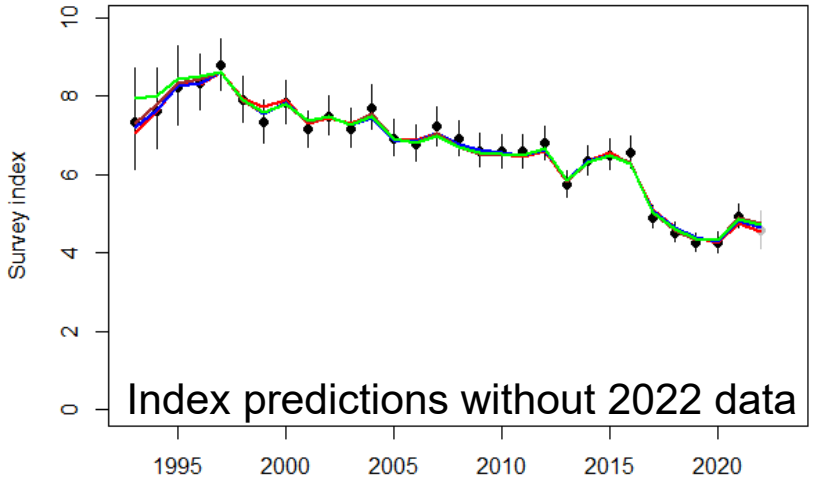
- Stock Synthesis version 3.30.19 to 3.30.21
  - Identical model results
  - Slightly improved run-times and memory usage
- The Secretariat continues to review longer-term software needs and options

SRB recommendation

1) SRB021-Rec.07 (para. 34):

*"The SRB **RECOMMENDED** not implementing MASE weighting for the 2022 stock assessment advice and, instead, continuing to use the equal weighting approach to the ensemble components."*

Done. All four models similarly predicted the observed survey index decrease from 2021 to 2022.



SRB recommendation

2) SRB021-Rec.08 (para. 35):

*"**NOTING** the integration between the stock assessment and biological research in evaluating the impact of genetic sex composition data (and the one-year lag in providing these data) on assessment results along with the resourcing implications, the SRB **RECOMMENDED** continued evaluation of the impact on stock assessment output of analyzing this genetic sex composition data on 1, 2, or 3 year intervals."*

Sex-specific fishery age compositions

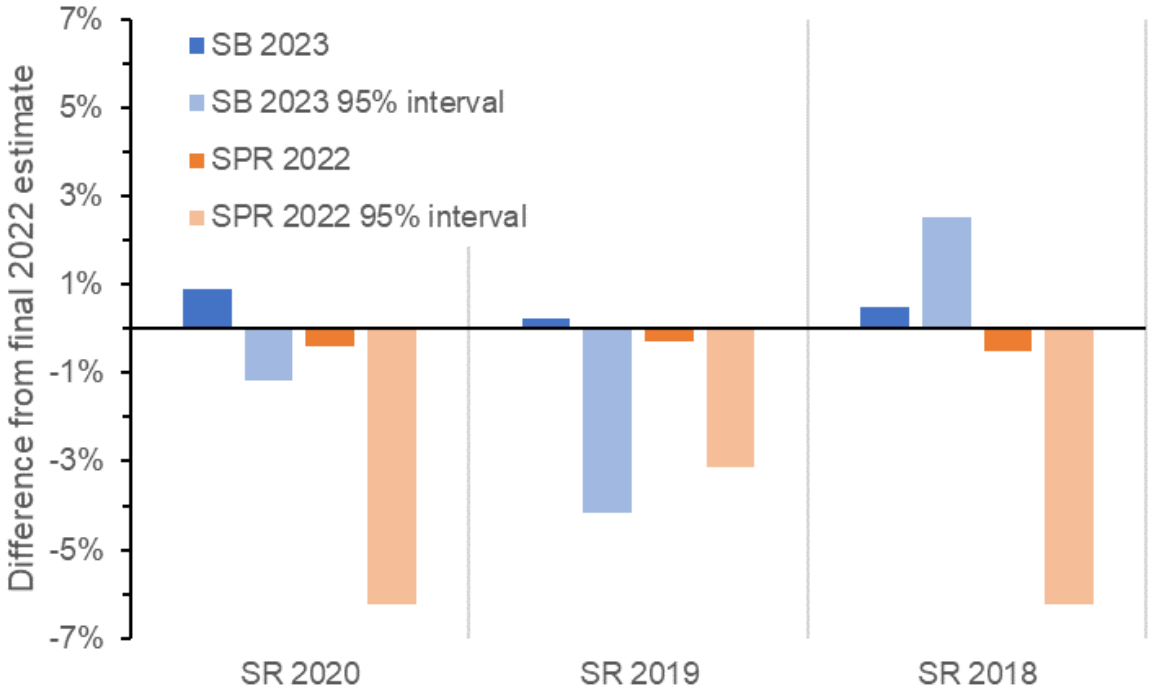
- Data currently available for 2017-2021
- Analysis lags one year: 2022 to be available this summer
- Terminal year of the assessment includes sex-aggregated fishery age data

Sex-specific fishery age compositions

- Sensitivity was evaluated by replacing past years with aggregated data and comparing the affect on 2023 SB and SPR point estimates and variance estimates
- Equivalent to ‘skipping’ one, two, or three recent years of genetic analysis

Sex-specific fishery age compositions

- Generally small changes
- Slight tendency to underestimate variances



If we had skipped: one year two years three years

Sex-specific fishery age compositions

- The 2022 fishery saw a shift from older to younger fish, expected to correspond to a higher fraction female
- Sex-specific data may therefore be relatively more important than any other single year from 2019-2021
- Further evaluation of processing frequency could be made in the near future
- We recommend no change to sample collection

SRB recommendation

3) SRB021-Req.03 (para. 32):

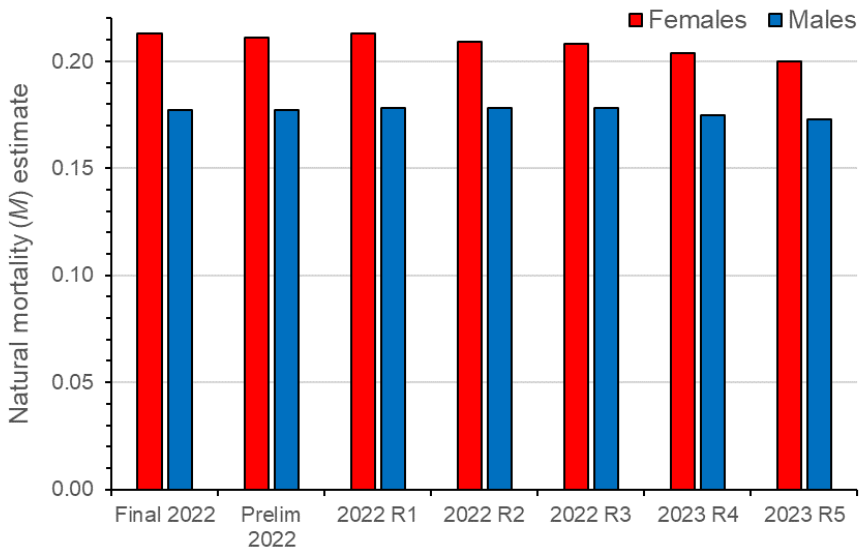
*"The SRB **RECALLED** SRB020–Rec.02 (para. 23) and SRB020-Rec.04 (para. 25) (shown below), and **REQUESTED** an update at SRB022:*

*SRB020–Rec.02 (para. 23) "The SRB **NOTED** that most models within the ensemble produced reasonable and well-constrained estimates of natural mortality (M) and **RECOMMENDED** that estimation of M should be adopted in the short AAF assessment model with consideration in other models as part of the stock assessment research program."*

*SRB020–Rec.04 (para. 25) "The SRB **NOTED** apparent discrepancies in marine mammal prevalence among anecdotal reports, FISS observations, and preliminary evaluation of logbook data, and therefore **RECOMMENDED** further investigation of methods to better estimate marine mammal prevalence and impacts on the fishery."*

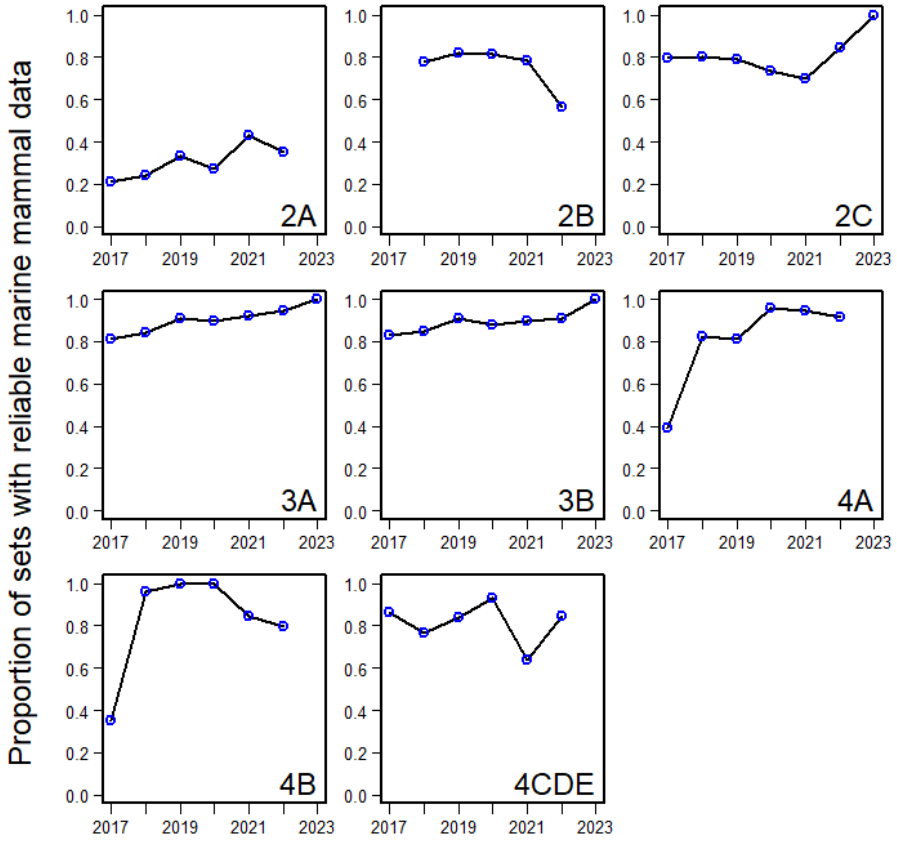
M estimation in the AAF short model

- Little change in the final 2022 model
- Slight decrease over 5-year retrospective
  - But this represents a very large change in sex-specific fishery information



Marine mammal depredation

- Observer data (Alaska) and directly reported information (DFO) has been requested
- Reassessment of data collection and database coding
- Substantially more data can now be included, analysis is also separated by trip target

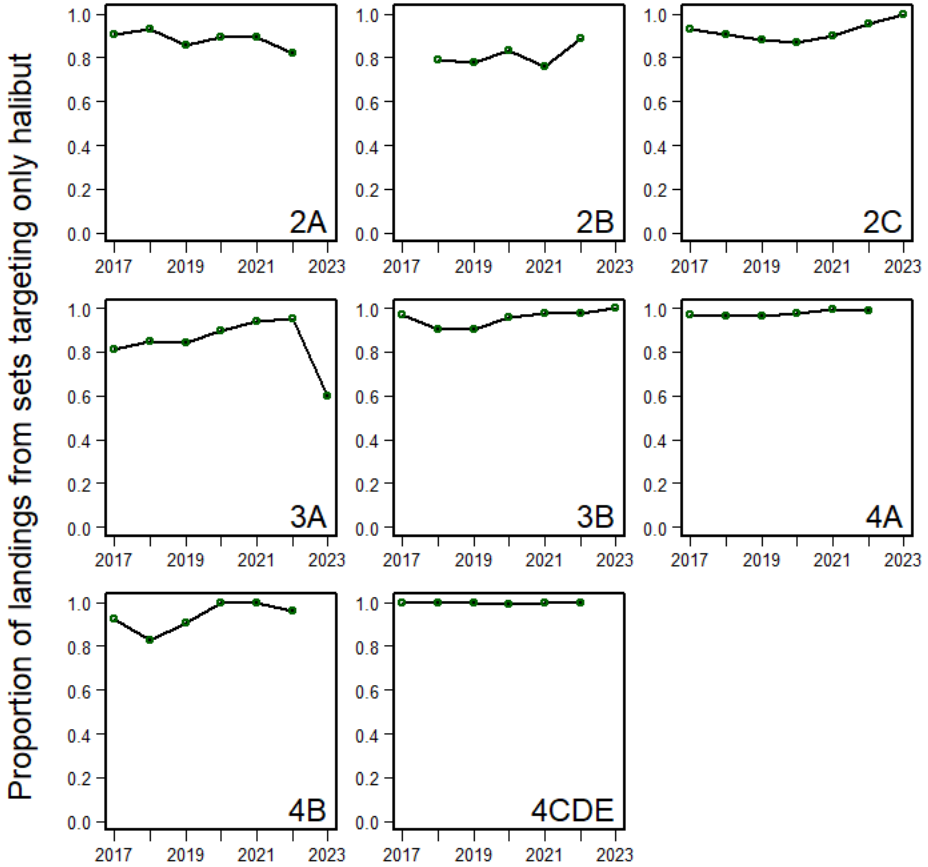


Marine mammal depredation

- Revised criteria (more of a ‘worst case’ approach):
  - Any observation of sperm or orca whales during the set
  - Did not require gear damage reported (this may be subtle for most fishing operations)

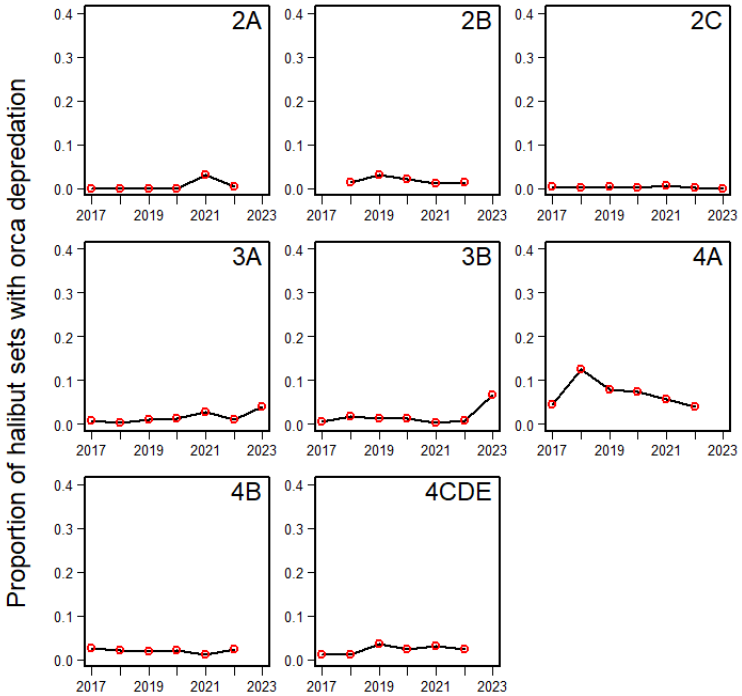
Marine mammal depredation

- Most sets with complete data are halibut target

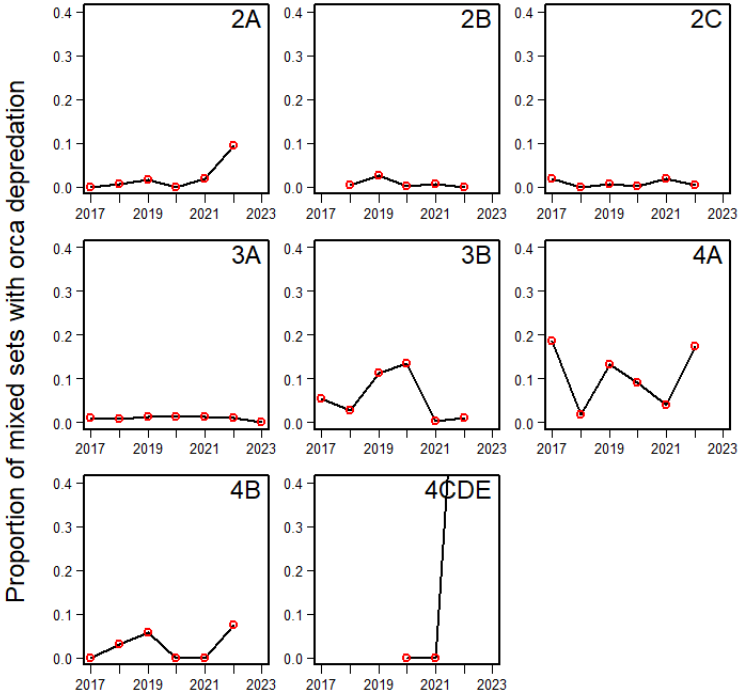


Marine mammal depredation - orca

Halibut sets

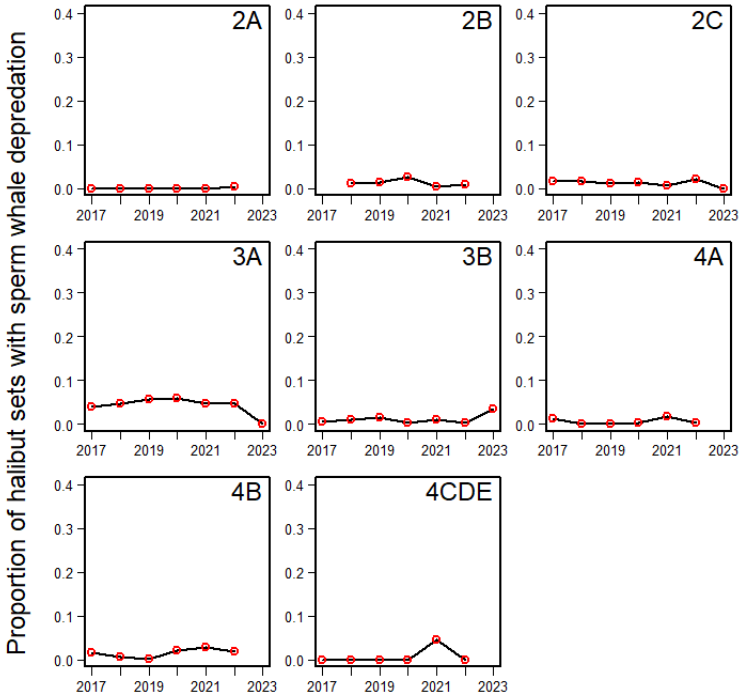


Mixed-target sets

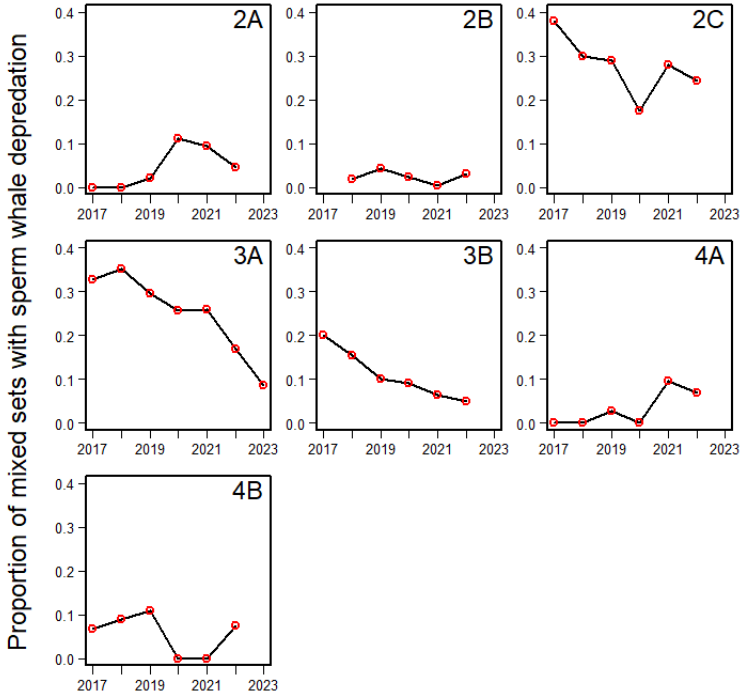


Marine mammal depredation – sperm whales

Halibut sets



Mixed-target sets

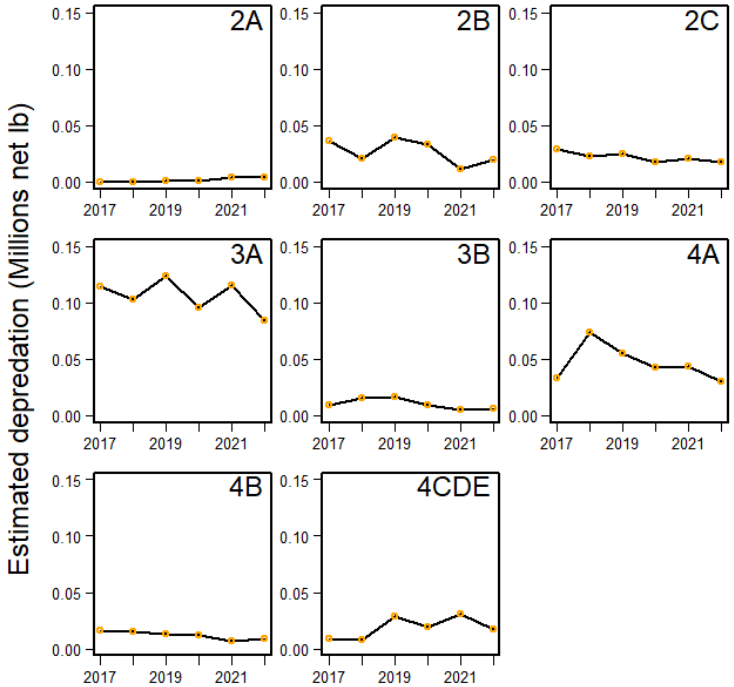


Marine mammal depredation

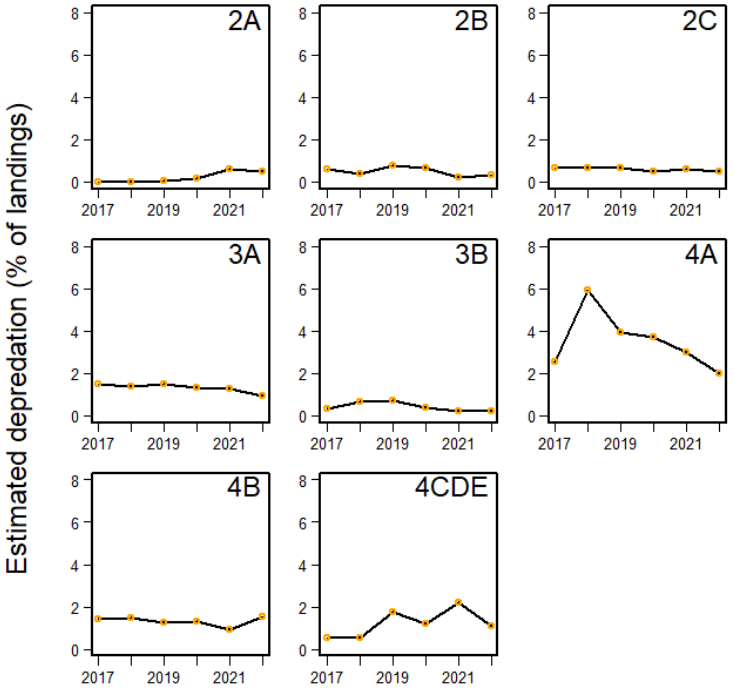
- Depredation rates (percent non-depredated catch per set) from FISS modelling:
  - Orca whales in IPHC Regulatory Area 3A: 84% (68-104% CI)
  - Orca whales in IPHC Regulatory Area 4A: 51% (43-60%)
  - Sperm whales in IPHC Regulatory Area 3A: 86% (75-99%)

Marine mammal depredation

Aggregate estimates



% of landings



Marine mammal depredation

- Potential next steps:
  - Compare with observer data and direct reports (DFO)
  - Propogate uncertainty (for the known components)
  - Consider how to extrapolate 2017+ to 1995-2016
- Should we consider directly adding these estimates as a ‘fleet’ in the stock assessment?

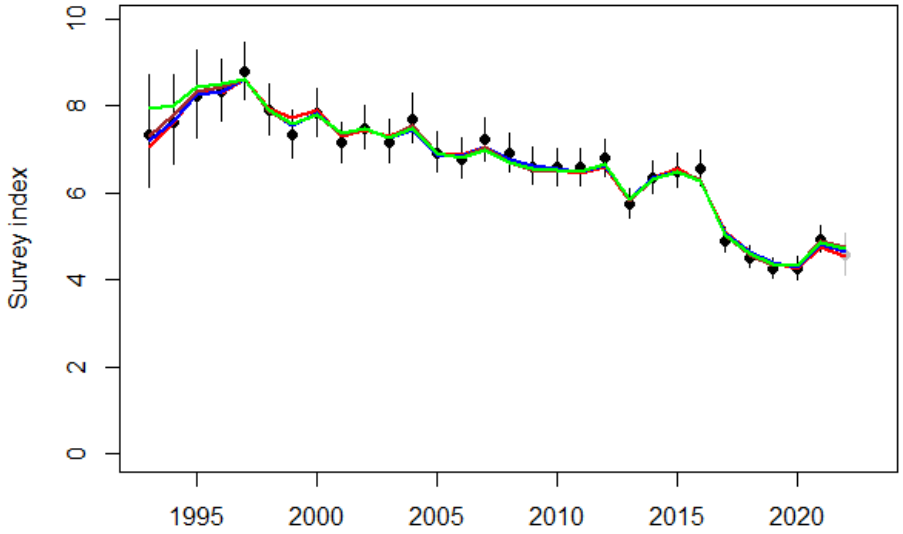
SRB request

4) SRB021-Req.04 (para. 33):

*"**NOTING** the substantial interannual variation in MASE weightings of the four assessment models, the SRB **AGREED** that one-step-ahead predictive skill is a potentially promising basis for model weighting, and **REQUESTED** continued research into MASE weightings averaged over longer time periods as well as comparing these to alternative weighting metrics, for example, via cross-validation."*

MASE recap

- ‘Hindcast’ predictions: one year ahead without that year’s data



MASE recap

- We use these models to project management quantities one year in advance
- The ‘leap’: forecast skill for the change in next year’s survey index may be a reasonable proxy for other management quantities (stock biomass and therefore catch)

- However, a model with high prediction skill may not always perform well for management
  - e.g., Boettiger, C. 2022. The forecast trap. Ecology Letters. 25:1655-1664. DOI: 10.1111/ele.14024

MASE recap

$$MASE = \frac{\frac{1}{n}\sum_{t=1}^{n}\left|\frac{O_t - E_t}{\sigma_t}\right|}{\frac{1}{n}\sum_{t=1}^{n}\left|\frac{O_t - O_{t-1}}{\sigma_t}\right|}$$

O_t = Observation at time t
E_t = Prediction at time t
σ_t = standard deviation of O_t

>1: Model skill is worse than the naïve prediction (last year's observation)
1: Equal to the naïve prediction
<1: Better than naïve prediction
0: Perfect prediction

MASE recap – scaled deviations

$$\left| \frac{O_t - E_t}{\sigma_t} \right|$$

	Prediction				
Year	Naive	CW short	CW long	AAF short	AAF long
2018	3.08	0.52	0.39	1.10	1.00
2019	2.02	1.17	0.16	0.80	0.80
2020	0.07	2.19	0.45	0.14	0.15
2021	4.25	3.86	1.12	1.76	0.72
2022	1.53	0.06	0.33	0.60	0.76

Sets the ‘baseline’ for model skill

MASE weights

- For models with a MASE of <=1:

$$MASE\ weight_m = \frac{1 - MASE_m}{\sum_{m=1}^{M} 1 - MASE_m}$$

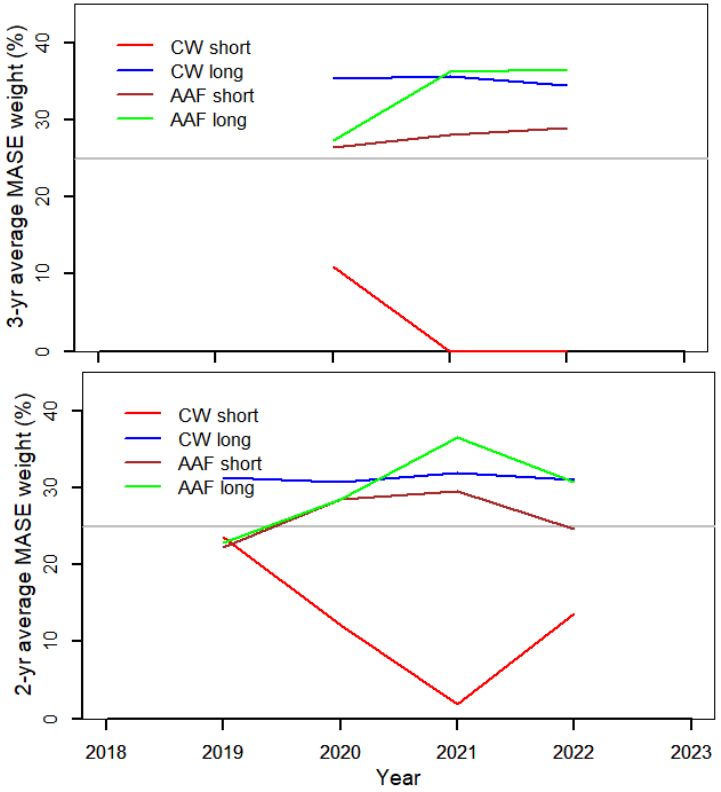
- A model with MASE of 1 gets zero weight
- A model with MASE of 0 gets maximum weight

MASE weights

- Updated weights for 2-, 3-, 4- and 5-year moving average
- Trade-off between relevance and stability
- Currently we can only hindcast for 5 years due to the major change associated with sex-specific fishery data starting in 2017

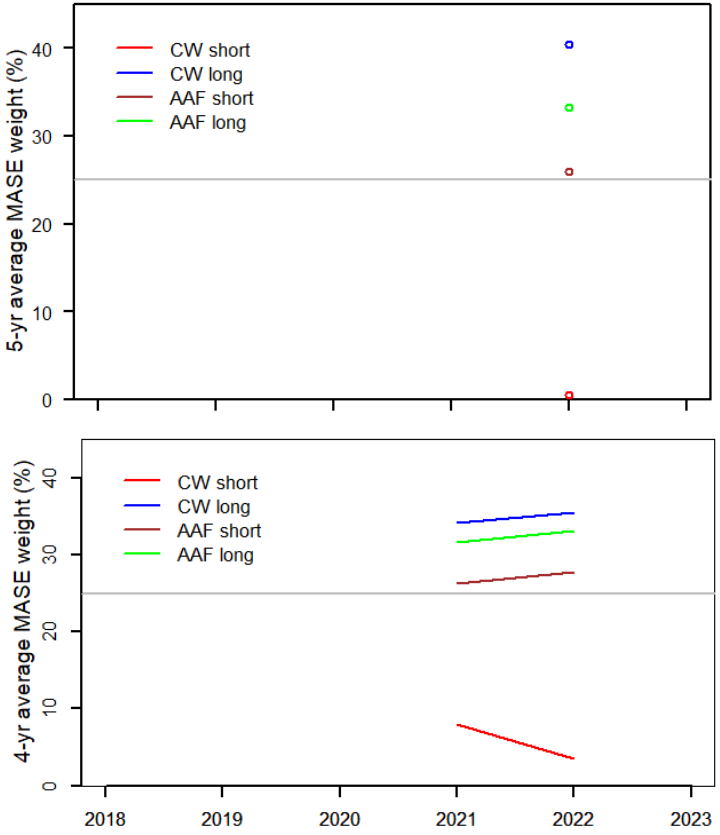
MASE weights

- Shorter (2- 3-yr) weights more variable



MASE weights

- 4- and 5-yr averages suggest down-weighting the coastwide short model
- That model tends to make more pessimistic trends (lower M) in all projections



SRB request

5) SRB021-Req.09 (para. 45):

*"**NOTING** the Secretariat's interest in identification of evidence for spatial population structure, and given the IPHC manages stocks on the basis of biological reporting regions, the SRB **REQUESTED** clarification on how the Secretariat may alter assessments if 'functionally isolated components of the population are found'."*

Stock structure

- Two primary considerations:
  - Maintenance of biological/genetic diversity
  - Optimizing yield
- 4B has shown the highest potential for stock structure
  - Represents ~5% of the coastwide biomass
  - If warranted, a separate assessment could be conducted for this area

2023 Assessment timeline

- August/September: 2022 sex-specific fishery age composition data available
- September SRB: Response to June requests
- Post-September SRB
  - No further model changes other than SRB recommendations
- November 1: data sets close for 2023

Recommendations

a) **NOTE** paper IPHC-2023-SRB022-08 which provides a response to requests from SRB021, and an update on model development for 2023.

b) **REQUEST** any further analyses to be provided at SRB023, 19-21 September 2023.

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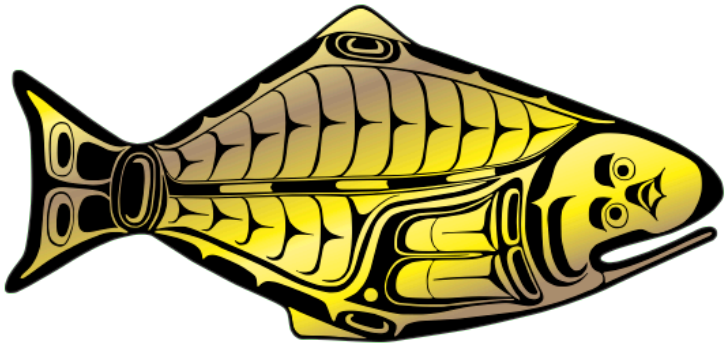

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