INTERNATIONAL PACIFIC HALIBUT COMMISSION

MSE: Update

Agenda Item 6

IPHC-2022-SRB021-07

A. Hicks & I. Stewart

MSE Program of Work 2021-2023

IPHC-2021-MSE-02

ID	Category	Task	Deliverable
F.1	Framework	Develop migration scenarios	Develop OMs with alternative migration scenarios
F.2	Framework	Implementation variability	Incorporate additional sources of implementation variability in the framework
F.3	Framework	Develop more realistic simulations of estimation error	Improve the estimation model to more adequately mimic the ensemble stock assessment
F.5	Framework	Develop alternative OMs	Code alternative OMs in addition to the one already under evaluation.
M.1	MPs	Size limits	Identification, evaluation of size limits
M.3	MPs	Multi-year assessments	Evaluation of multi-year assessments
E.3	Evaluation	Presentation of results	Develop methods and outputs that are useful for presenting outcomes to stakeholders and Commissioners

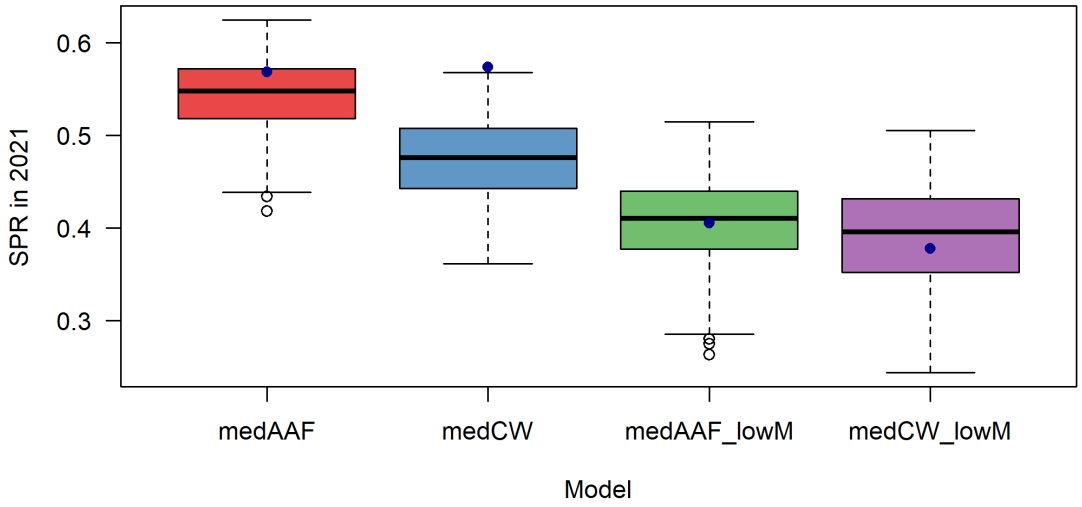
Framework

ID	Category	Task	Deliverable
F.1	Framework	Develop migration scenarios	Develop OMs with alternative migration scenarios
F.5	Framework	Develop alternative OMs	Code alternative OMs in addition to the one already under evaluation.

- Improved OM
  - Four individual models
    - Different natural mortality (high and low)
    - Different resulting migration assumptions
  - Variability in migration rates
  - Incorporates representative uncertainty about the Pacific halibut population

Four models

- Predicted SPR was biased high (lower fishing intensity) compared to assessment

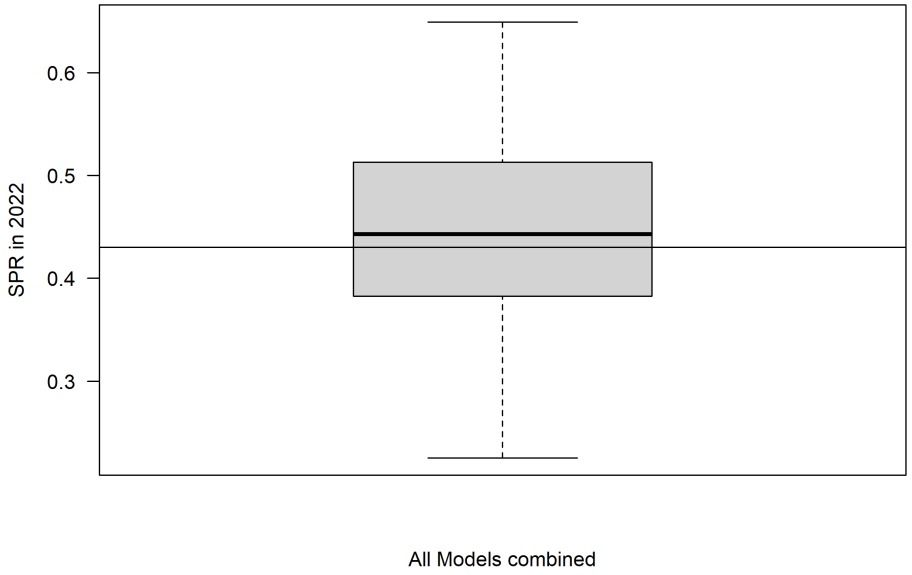


Boxplots are estimated SPR from each OM model

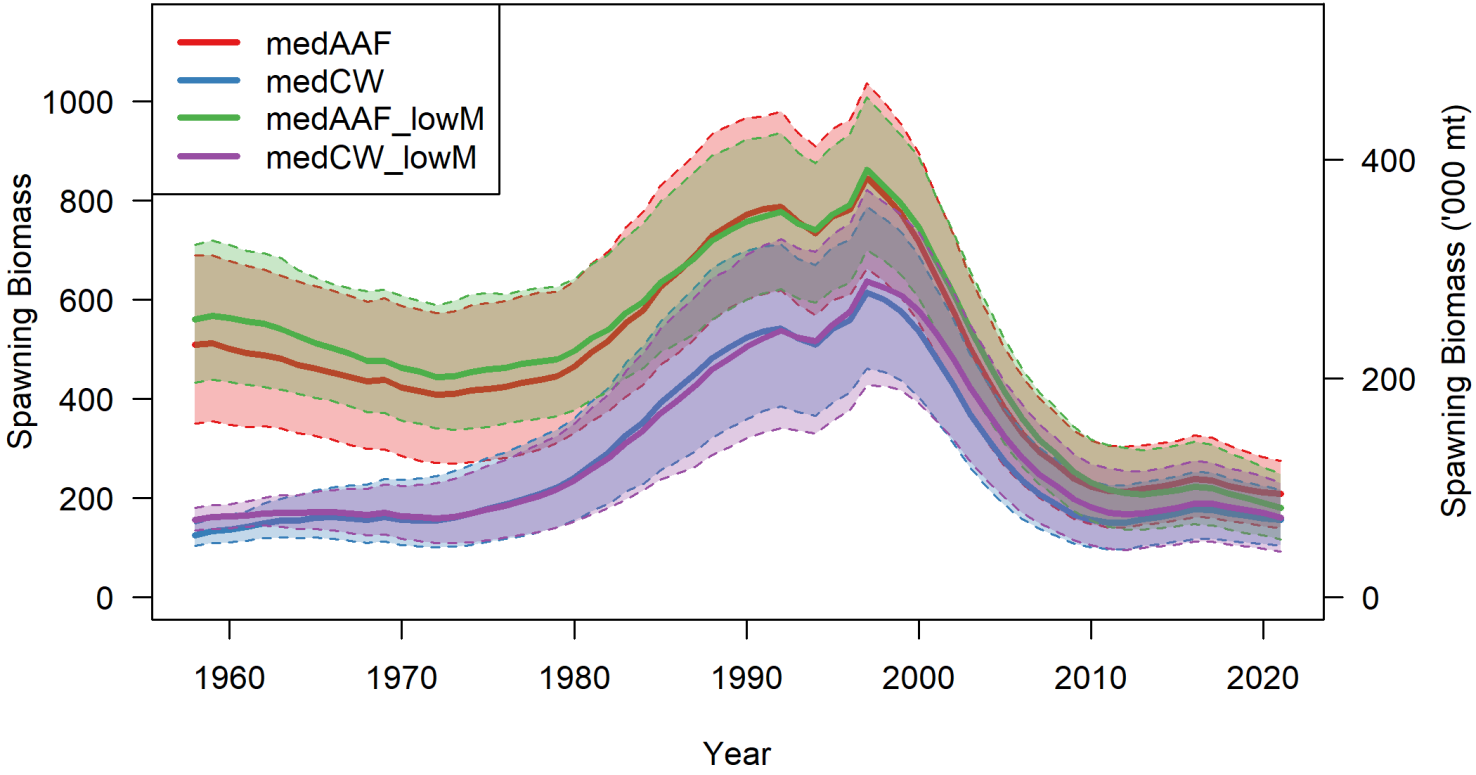
Points are SPR estimates from 2021 stock assessment

SPR in 2022

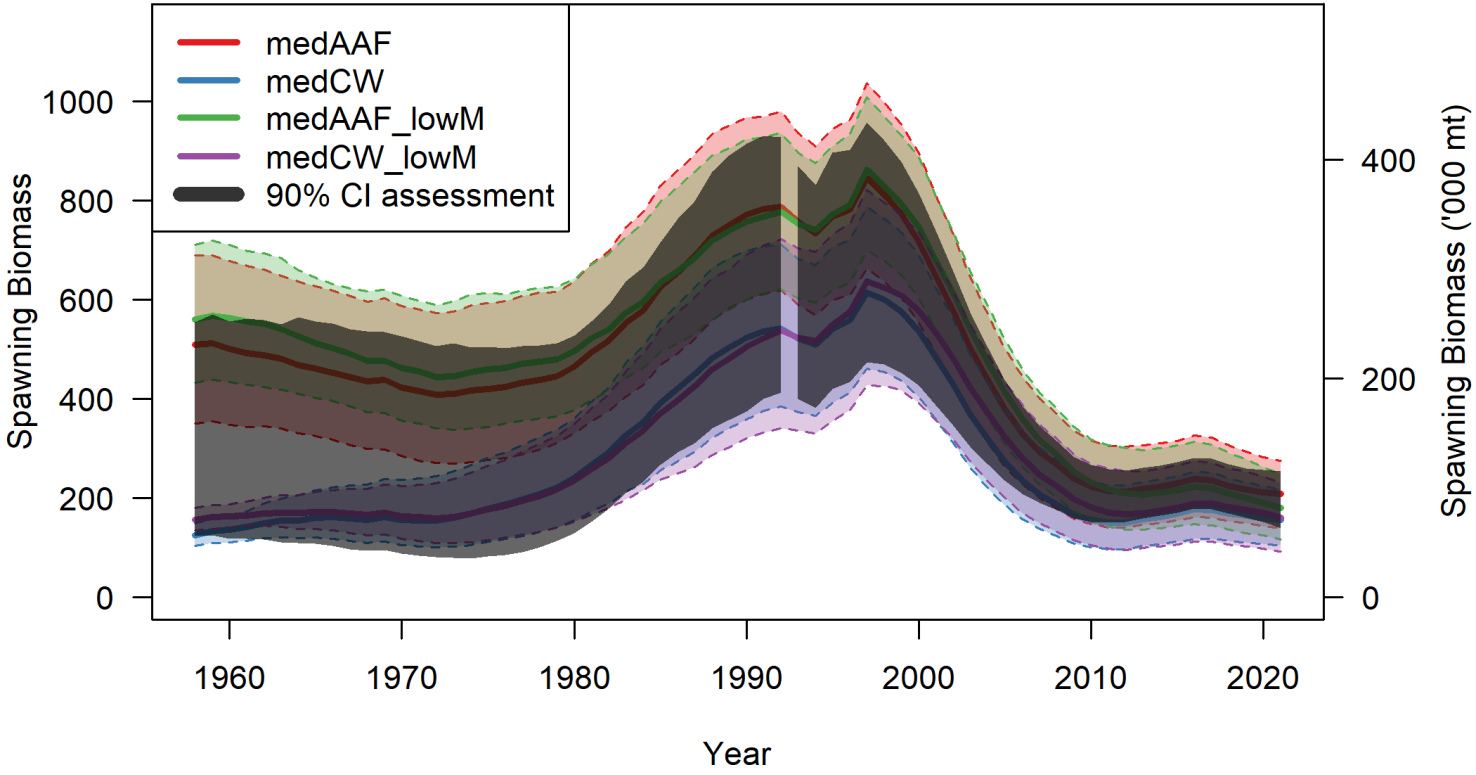
- OM is close to the adopted 43%



Operating Model

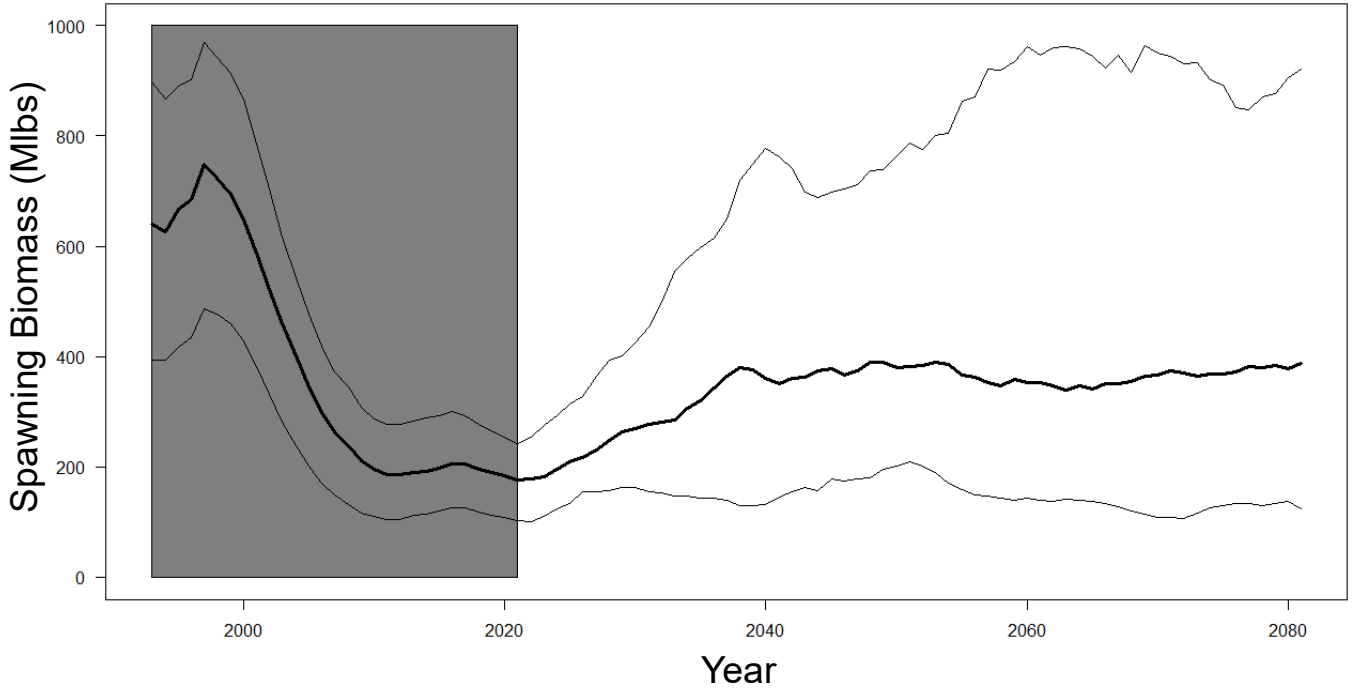


Operating Model



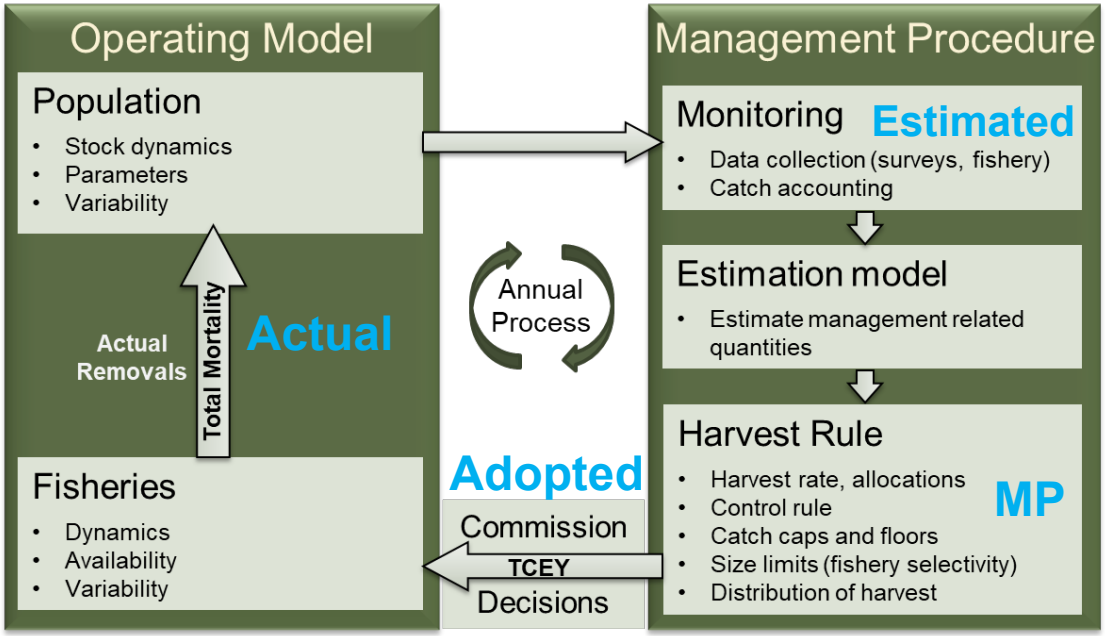
Projected spawning biomass

- SPR=43%
- 5th and 95th percentiles



F.2: Implementation variability & uncertainty

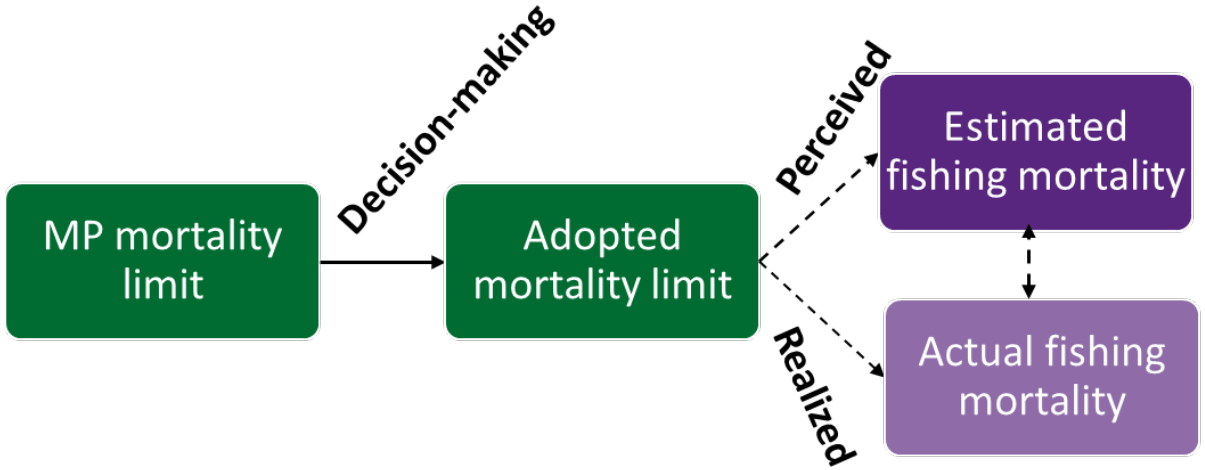
ID	Category	Task	Deliverable
F.2	Framework	Implementation variability	Incorporate additional sources of implementation variability in the framework



Mortality types in blue

Types of implementation variability

1. **Decision-making variability**: difference between MP mortality limits and the adopted mortality limits set by the Commission.
2. **Realized variability**: difference between the adopted mortality limits set by the Commission and the actual mortality resulting from fishing.
3. **Perceived variability**: difference between the actual & estimated fishing mortality



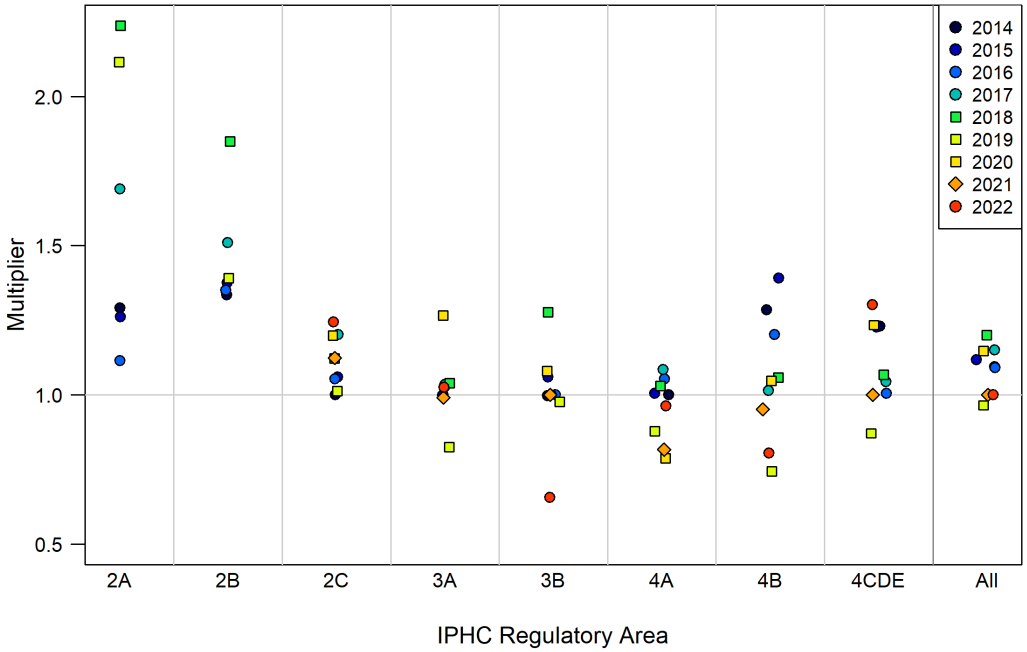
Decision-making variability

- Historically, the adopted TCEY has differed from the MP TCEY
- Can model this as a multiplier to the MP mortality limit

$$\widetilde{TCEY}_t = TCEY_t \times \varepsilon_I$$

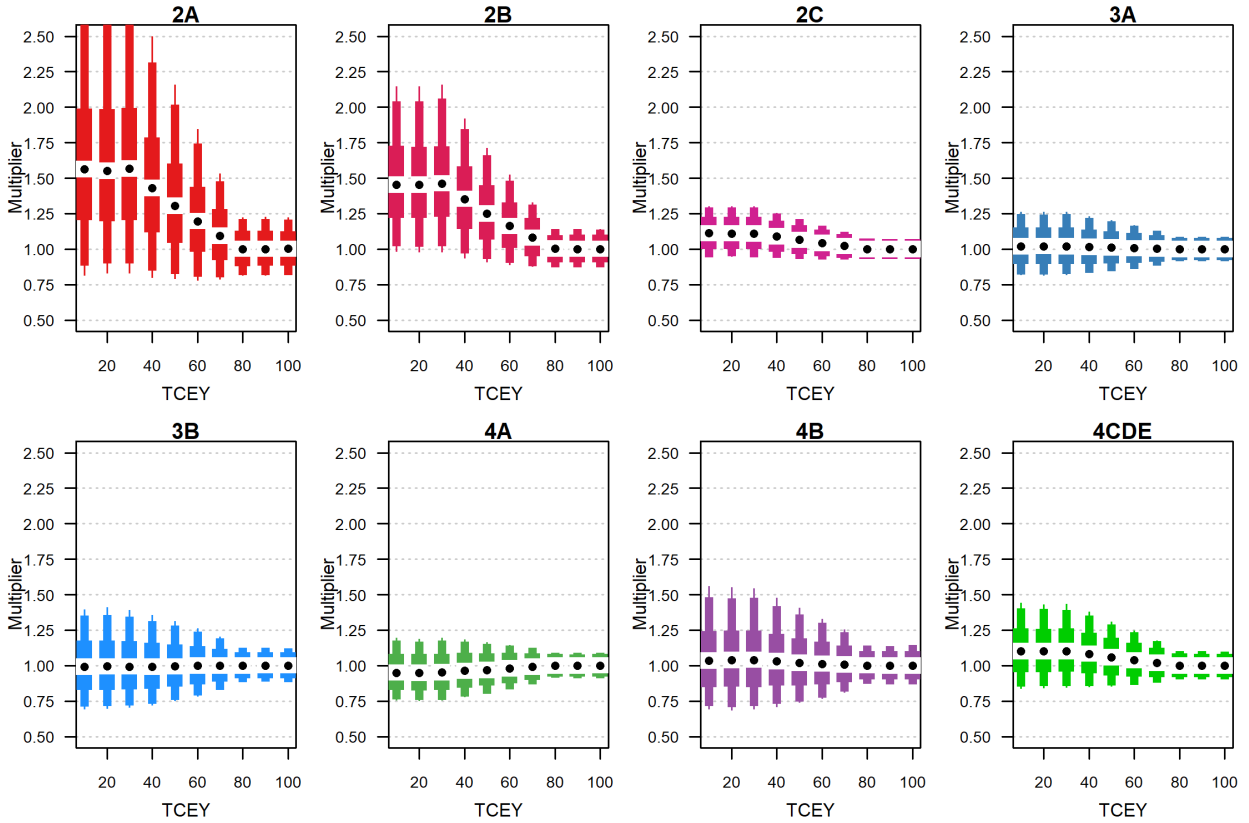
Adopted MP Multiplier

Multipliers for years/areas without agreement



Decision-making variability:No agreements

- 2 out of 5 distribution procedures
- Use 2014-2019 observations in 2A and 2B, and 2014-2022 for other areas to parameterize
- Higher adopted TCEYs result in multiplier at 1 and reduced variability



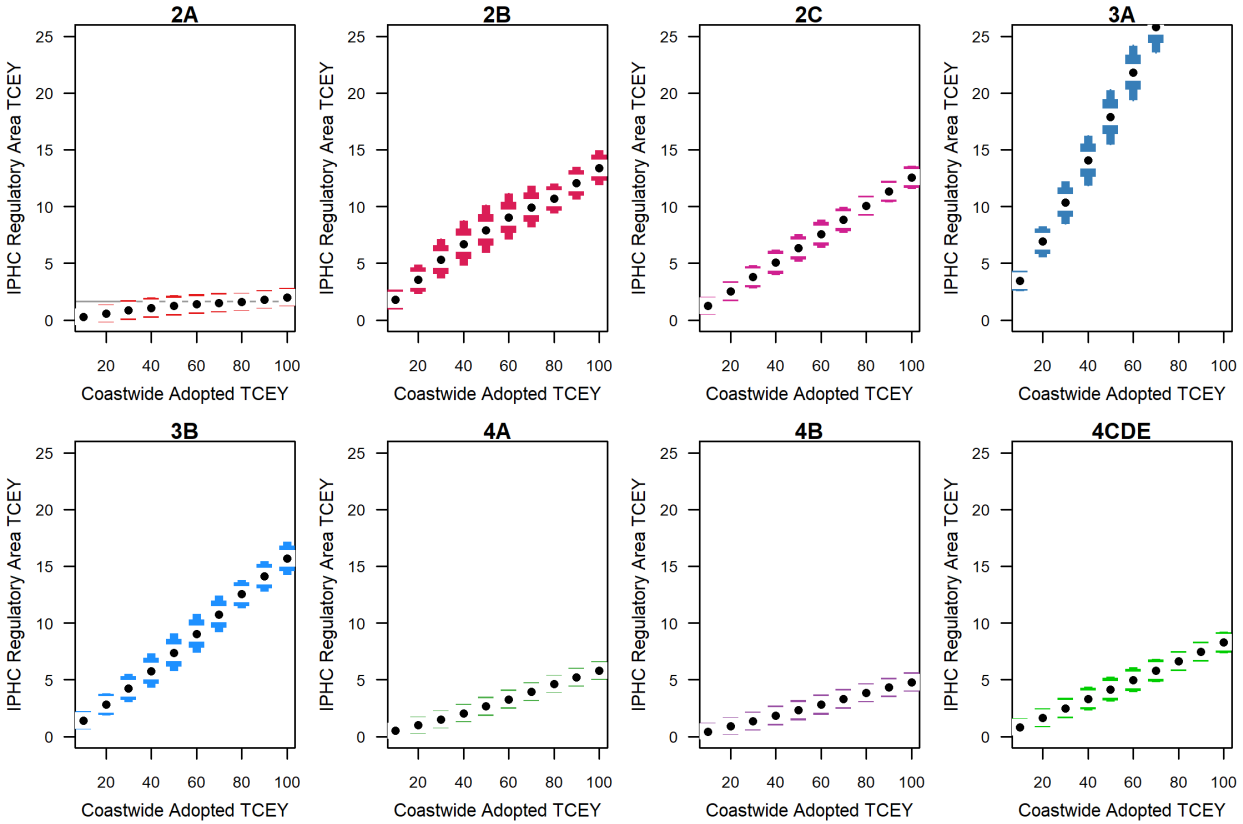
Decision-making variability: With agreements

- 2A and 2B
- 3 out of 5 distribution procedures
- 2C-4B as before
- 2A and 2B have multiplier at 1 and no variability

Decision-making variability: TCEYs

Using 2022 baseline stock distribution

Without agreements



Runs with Decision-making variability

IPHC-2022-SRB020-R, para 19. *The SRB REQUESTED that the ramped implementation bias scenario (Fig. 17 in paper IPHC-2022- SRB020-06 Rev_1) be run under the most aggressive fishing intensity targets to determine the scale of performance sensitivity to that source of implementation variability*.

Three options

0. No decision-making variability
1. Coastwide TCEY is set at MP, distribution of TCEY subject to variability
2. Coastwide TCEY and distribution of TCEY subject to variability

- Runs with SPR=40%, 43%, and 46%
  - SPR 40% and 43% for all three options
- With and without estimation error

F.3: Estimation Error

ID	Category	Task	Deliverable
F.3	Framework	Develop more realistic simulations of estimation error	Improve the estimation model to more adequately mimic the ensemble stock assessment

SRB017-R, **para. 57**. *The SRB … RECOMMENDED continuing work to incorporate actual estimation models, as in the third option, because that method would best mimic the current assessment process.*

SRB020-R, **para. 20**. *The SRB REQUESTED that the MSE not attempt to implement a Stock Synthesis estimation procedure as part of the management procedure and, instead, to integrate a simpler assessment modelling approach into the management procedure via tuning.*

F.3: Estimation Error

- Three methods implemented
  1. No estimation error
  2. Simulated estimation error
     - TM and stock status (correlated and autocorrelated)
  3. Use stock assessment model(s)
     - Stock synthesis (one model)

Size limits

ID	Category	Task	Deliverable
M.1	MPs	Size limits	Identification, evaluation of size limits

IPHC-2022-AM098-R, para 61: *The Commission RECALLED SS011-Rec.01 and REQUESTED that the current size limit (32 inches), a 26 inch size limit, and no size limit be investigated. to understand the long-term effects of a change in the size limit*

- Investigate various size limits
  - **32 inch (current) size limit (81.3 cm)**
  - **26 inch size limit (66.0 cm)**
  - **No size limit**
  - MSE framework updated to accommodate any size limit

MPs: Size limits

- Annual stock assessment

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	None, option 1, option 2		
Estimation Error	None, Simulated, *SS*		
Assessment Frequency	Annual	Annual	Annual
Size Limit	0	26	32
SPR	0.40, 0.43, 0.46		

Size Limits: No Estimation Error

	MP name	MP-A0	MP-A26	MP-A32
	Decision-making variability	**None**	**None**	**None**
	Estimation Error	**None**	**None**	**None**
	Assessment Frequency	**Annual**	**Annual**	**Annual**
	Size Limit	**0**	**26**	**32**
	SPR	**0.43**	**0.43**	**0.43**
	Median average SPR	43.0%	43.0%	43.0%
	Biological Sustainability			
Long-term	Median average RSB	39.3%	39.3%	39.3%
Long-term	P(any RSB_y<20%)	0	0	0
Long-term	P(all RSB<36%)	0.17	0.17	0.18
	Fishery Sustainability			
Short-term	Median average TCEY	62.3	62.1	58.9
Short-term	P(any3 change TCEY > 15%)	0.06	0.06	0.07
Short-term	Median AAV TCEY	5.2%	5.3%	5.7%

- Insignificant difference in long-term sustainability
- A 5.8% short-term increase in TCEY with no size limit
- A slight reduction in TCEY variability

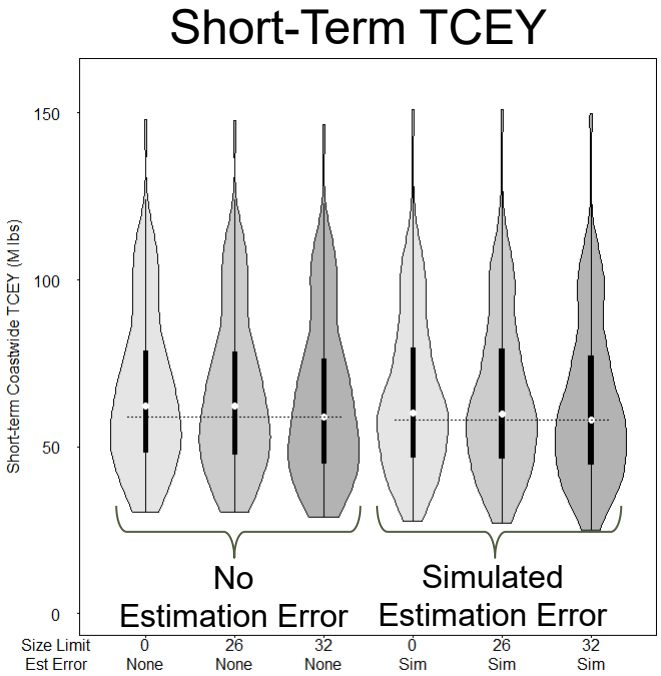
Size Limits: Simulated Estimation Error

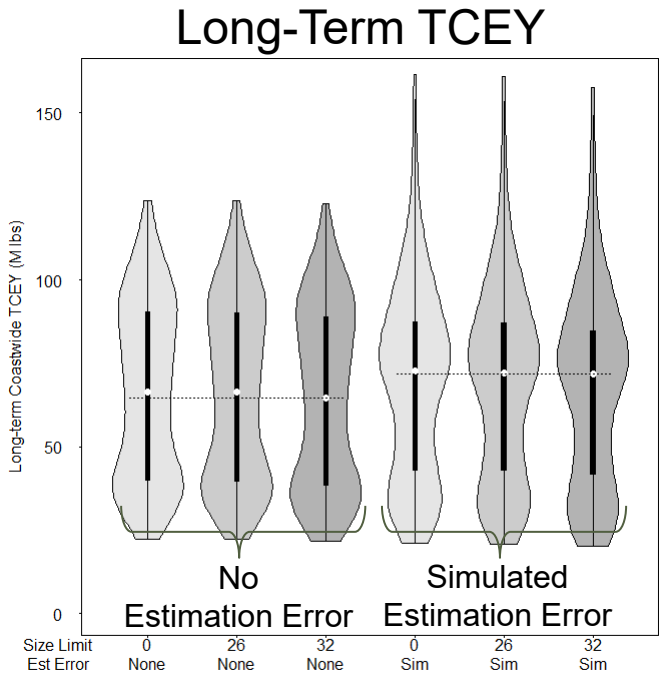
	MP name	MP-A0	MP-A26	MP-A32
	Decision-making variability	**None**	**None**	**None**
	Estimation Error	**Sim**	**Sim**	**Sim**
	Assessment Frequency	**Annual**	**Annual**	**Annual**
	Size Limit	**0**	**26**	**32**
	SPR	**0.43**	**0.43**	**0.43**
	Median average SPR	43.9%	43.9%	44.0%
	Biological Sustainability			
Long-term	Median average RSB	39.0%	39.0%	39.0%
Long-term	P(any RSB_y<20%)	0	0	0
Long-term	P(all RSB<36%)	0.14	0.14	0.14
	Fishery Sustainability			
Short-term	Median average TCEY	60.2	59.7	58.1
Short-term	P(any3 change TCEY > 15%)	0.93	0.95	0.97
Short-term	Median AAV TCEY	18.2%	18.3%	18.7%

- Insignificant difference in long-term sustainability
- A 3.6% short-term increase in TCEY with no size limit
- A slight reduction in TCEY variability
- Much more annual variability compared to no estimation error

Size limits: long-term effects

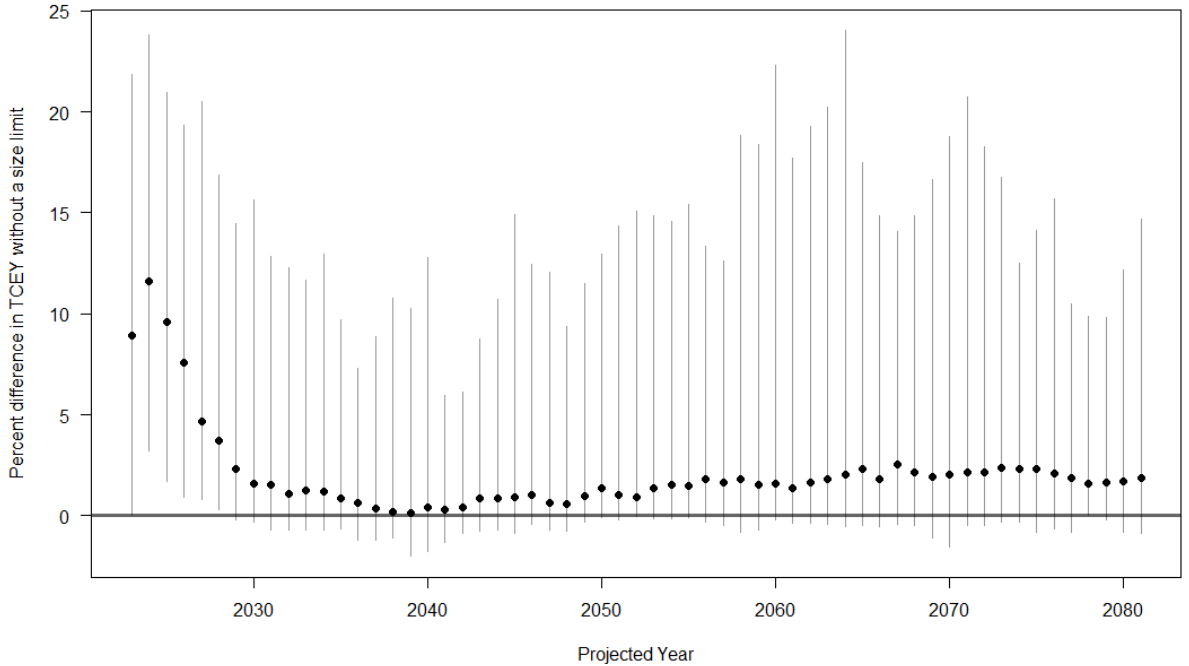
- Increase in long-term yield was 1.0% without a size limit





Percent difference in TCEY without a size limit

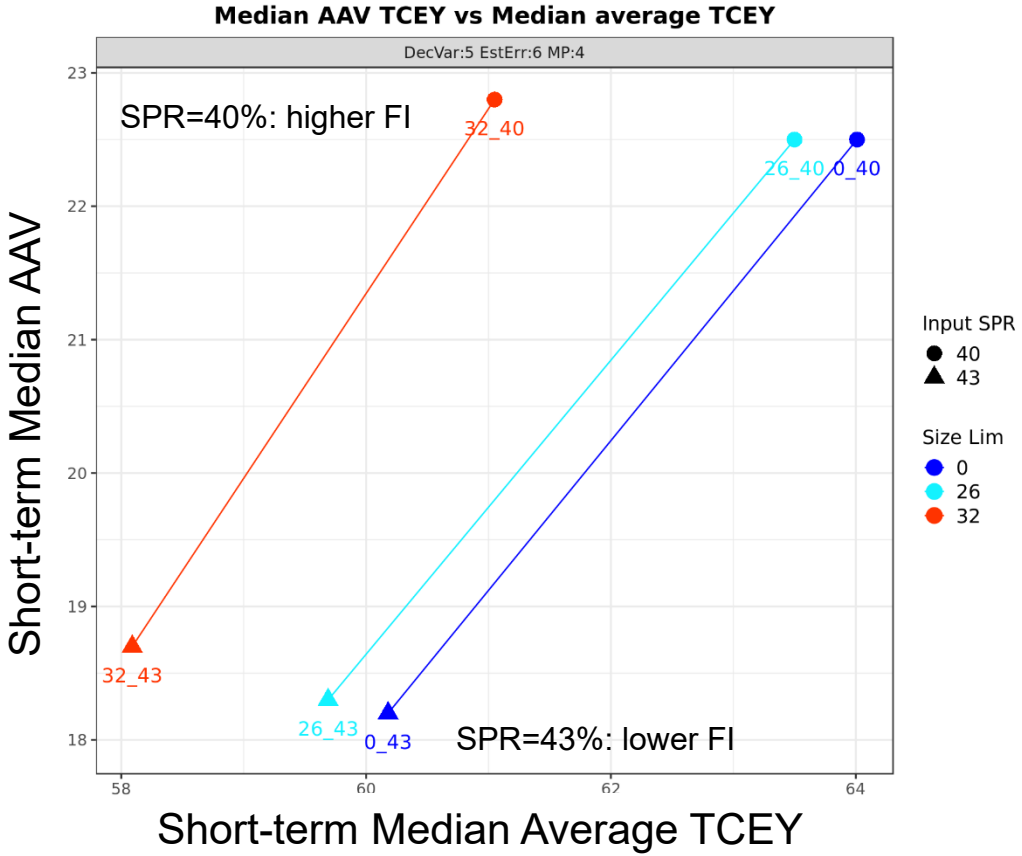
- Benefit of a size limit is dependent on stock conditions
  - Weight-at-age, environmental regime
  - Less often did ‘No size limit’ have a negative effect on yield



Size Limits: Higher fishing intensity

SPR=40%

- Higher TCEY and variability
- 4.8% increase in TCEY with no size limit (short-term)
- 1.0% increase in TCEY with no size limit (long-term)
- P(RSB<36%) = 56%



Evaluation of size limits

- Primary biological sustainability and yield metrics
- Other metrics and tradeoffs
  - Size distribution of landings
    - Proportion of U32
  - Amount of discards
  - Economic metrics
    - For example, value of fishery given differential price of U32
      - See IPHC-2021-AM097-09

Multi-year stock assessment

ID	Category	Task	Deliverable
M.3	MPs	Multi-year assessments	Evaluation of multi-year assessments

IPHC-2022-AM098-R, para 64: *The Commission REQUESTED that multi-year management procedures include the following concepts:*

a) The stock assessment occurs biennially (and possibly triennial if time in 2022 allows) and no changes would occur to the FISS (i.e. remains annual);

b) The TCEY within IPHC Regulatory Areas for non-assessment years:

i. remains the same as defined in the previous assessment year, or

ii. changes within IPHC Regulatory Areas using simple empirical rules, to be developed by the IPHC Secretariat, that incorporate FISS data

- MPs
  a) Biennial stock assessment with constant TCEY for IPHC Regulatory Areas
  b) Biennial stock assessment with coastwide TCEY updated proportionally to coastwide FISS index and distribution of TCEY updated via distribution procedure
  c) Biennial stock assessment with coastwide TCEY constant and distribution of TCEY updated via distribution procedure

FISS remains an annual survey

MPs: Multi-year stock assessment

MP name	MP-A32	MP-Ba32	MP-Bb32	MP-Bc32
Decision-making variability	None, option 1, option 2			
Estimation Error	None, Simulated, *SS*			
Assessment Frequency	Annual	Biennial	Biennial	Biennial
Size Limit	32 inches			
SPR	0.40, 0.43, 0.46			

a) Biennial stock assessment with constant TCEY for IPHC Regulatory Areas

b) Biennial stock assessment with coastwide TCEY updated proportionally to coastwide FISS index and distribution of TCEY updated via distribution procedure

c) Biennial stock assessment with coastwide TCEY constant and distribution of TCEY updated via distribution procedure

Multi-year: all-areas constant TCEY

MP name	MP-A32	MP-Ba32	MP-A32	MP-Ba32
Decision-making variability	**None**	**None**	**None**	**None**
Estimation Error	**None**	**None**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Biennial**	**Annual**	**Biennial**
Size Limit	**32**	**32**	**32**	**32**
SPR	**0.43**	**0.43**	**0.43**	**0.43**
Median average SPR	43.0%	42.9%	44.0%	43.3%
Biological Sustainability				
Median average RSB	39.3%	39.0%	39.0%	38.9%
P(any RSB_y<20%)	0	0	0	0
P(all RSB<36%)	0.18	0.20	0.14	0.17
Fishery Sustainability				
Median average TCEY	58.9	60.1	58.1	57.5
P(any3 change TCEY > 15%)	0.07	0.19	0.97	0.78
Median AAV TCEY	5.7%	5.8%	18.7%	14.7%

- Slightly higher chance of being below 36% RSB
- Effects on TCEY
  - Estimation error resulted in opposite effects
  - Reduced variability with lower yield with estimation error
  - Long-term TCEY about 2% higher in biennial

If we knew the management quantities without error, we would likely want to use them every year
With estimation error, biennial assessment with a constant TCEY provides some stability

Evaluation of multi-year assessments

- Primary biological sustainability and yield metrics
- Other metrics and tradeoffs
  - Measures of TCEY variability
    - Change in assessment years only
  - Economic metrics
    - Example from Hutniczak et al 2019 (summer flounder)
      - Transformed biomass-based metrics to net economic benefits for commercial and recreational fisheries
      - An economic analysis can be complex to create, but once “economic models have been parameterized, the capacity to examine a wide range of scenarios is greatly enhanced”

Multi-year: a look at TCEY variability

MP name	MP-A32	MP-Ba32	MP-Bb32	MP-Bc32
Decision-making variability	**None**	**None**	**None**	**None**
Estimation Error	**Sim**	**Sim**	**Sim**	**Sim**
Assessment Frequency	**Annual**	**Biennial**	**Biennial**	**Biennial**
Size Limit	**32**	**32**	**32**	**32**
SPR	**0.43**	**0.43**	**0.43**	**0.43**
Median average SPR	44.0%	43.3%	43.9%	43.3%
Biological Sustainability				
Median average RSB	39.0%	38.9%	38.6%	38.9%
P(any RSB_y<20%)	0	0	0	0
P(all RSB<36%)	0.14	0.17	0.17	0.17
Fishery Sustainability				
Median average TCEY	58.1	57.5	58.6	57.5
P(any1 change TCEY > 15%)	1.00	0.99	1.00	0.99
P(any2 change TCEY > 15%)	1.00	0.97	0.98	0.97
P(any3 change TCEY > 15%)	0.97	0.78	0.92	0.78
P(any4 change TCEY > 15%)	0.76	0.52	0.71	0.52
P(any5 change TCEY > 15%)	0.59	0.16	0.41	0.17
Median AAV TCEY	18.7%	14.7%	19.5%	14.7%

- MP-Bb ≈ MP-A
  - Slightly lower risk
  - Higher AAV: changes in non-assessment year larger
- Effects on TCEY (MP-Ba, MP-Bc)
  - Slightly lower TCEY
  - Less variability because of the 5/10 stable years
  - Similar risk with increased fishing intensity would increase TCEY
    - Would increase variability metrics
- Long-term TCEY higher for all biennial MPs

Costs and benefits of multi-year assessments

SRB020-R, para. 27: *The SRB NOTED that assessment research activities (e.g. paras. 23-26) are examples of work that could be done more extensively in non-assessment years within a multi-year assessment schedule. Other work could include investigating optimal sub-sampling designs for ages, sex-ratio, annual assessment methods to use within the MPs, and well as any of the several topics listed under Stock Assessment Research. The quantifiable costs of multi-year assessments could be estimated within the MSE, for example, of potentially lower average yield for longer assessment cycles to achieve the same levels of risk associated with annual assessments.*

Costs	Benefits
Possibly more variability in non-assessment years	Biennial stability, short-term predictability, transparent process
Detailed harvest advice no available every year No following stock trends (Ba, partially Bc)	FISS is a reasonable proxy to coastwide and area changes in abundance (Bb, partially Bc)
	More focused assessment research
	Assist with other research

Evaluation

- MSE-Explorer
- Specific look at trade-offs
- Keep size limits and multi-year assessments as independent evaluations
- Distribution integrated

Evaluation

SRB020-R, para. 21. The SRB REQUESTED evaluating whether the relative ranking of MPs – defined only by multi-year assessment cycle and size limits - remains similar across the set of proposed distribution scenarios using objectives identified as priorities by the Commission.

- Will have a closer look before MSAB
  - 100 simulations per distribution procedure

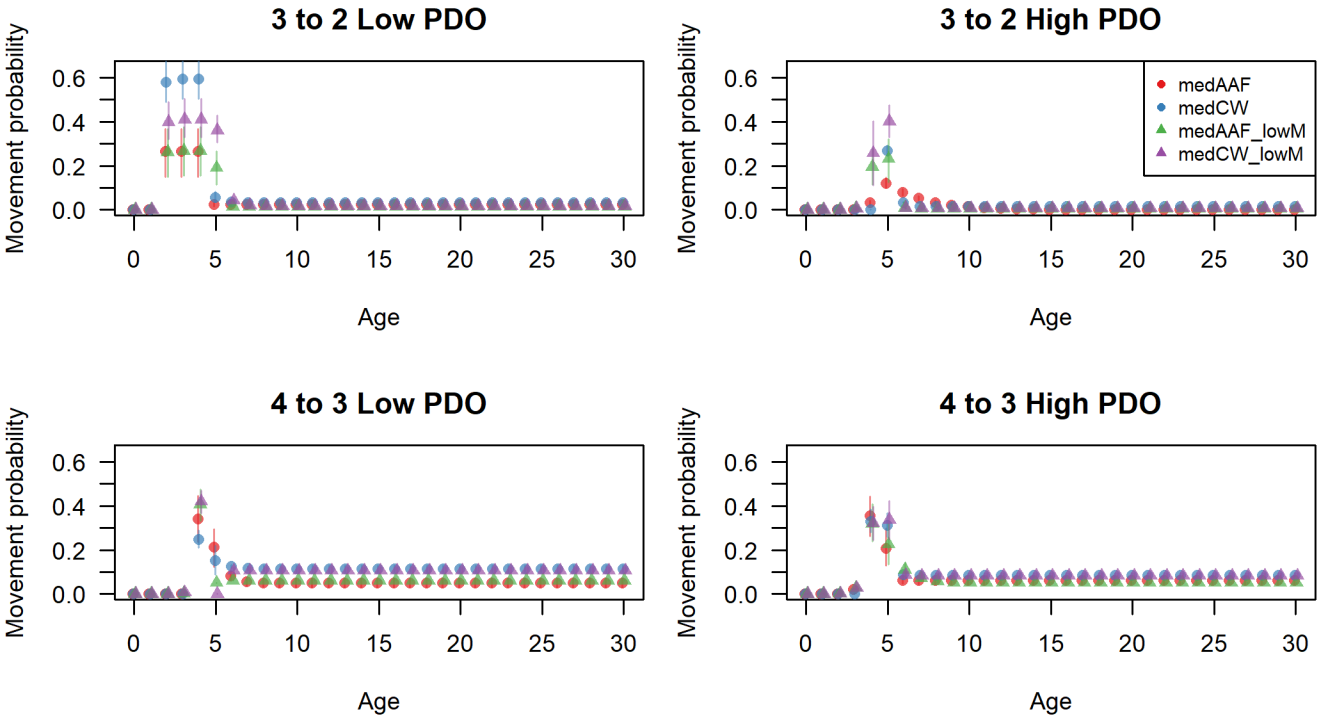
Potential OM Scenarios

- Targeting small Pacific halibut
- Avoiding small Pacific halibut
- Low or high weight-at-age
- Low or high recruitment

> IPHC-2022-SRB020-R, **para 18.** *The SRB NOTED the Secretariat's plan to further explore migration scenarios in the MSE and therefore REQUESTED that the set of migrations scenarios remain within bounds of plausible values identified via the OM development/fitting and previous tagging studies.*

- No migration-specific scenarios

Migration Variability



More to come…

- More results being produced
  - Decision-making variability
  - SPRs of 40%, 43%, and 46%
    - Tuning to SPR
  - Scenarios
  - Closer look at MP elements (e.g. averaging FISS distribution)

Recommendations

- **NOTE** paper IPHC-2022-SRB021-07 and additional results in the presentation
- **RECOMMEND** use of the updated OM with four individual models for MSE simulations
- **RECOMMEND** incorporating the decision-making variability framework described in the presentation
- **RECOMMEND** additional runs to assist with the evaluation of size limits and multi-year assessments
- **RECOMMEND** additional performance metrics to assist with the evaluation of size limits and multi-year assessments
- **NOTE** costs and benefits from implementing a multi-year assessment management procedure
- **RECOMMEND** additional MSE development to be completed in 2023 and beyond
- **NOTE** that future agreements of the Commission related to harvest policy can be tested using the MSE framework and used to focus further evaluations

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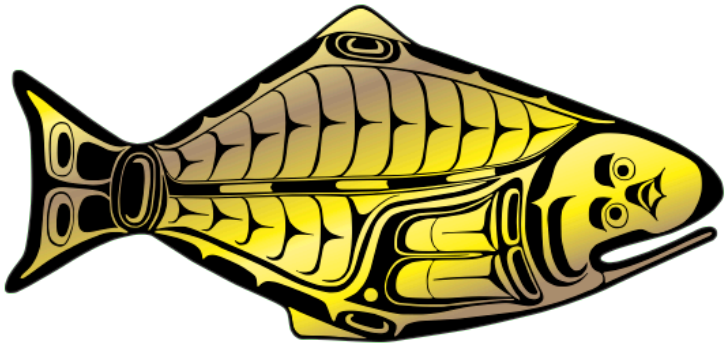

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