

INTERNATIONAL PACIFIC



HALIBUT COMMISSION

Management Procedures and Results

Agenda Item 4.3

IPHC-2022-MSAB017-09

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

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 and produce meaningful outputs of directed commercial discard mortality



MPs: Size limits

- Status quo, default

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	option 1		
Estimation Error	Simulated		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		



MPs: Size limits

- All factors

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



Size Limits

MP name		MP-A0	MP-A26	MP-A32
Decision-making variability		Option 1		
Estimation Error		Sim		
Assessment Frequency		Annual		
Size Limit		0	26	32
SPR		0.43		
Long-term	Biological Sustainability			
	P(any RSB_y<20%)	<0.002	<0.002	<0.002
	Fishery Sustainability			
Short-term	P(all RSB<36%)	0.143	0.143	0.149
	Median average TCEY	60.1	59.8	58.2
	P(any3 change TCEY > 15%)	0.932	0.942	0.958
	Median AAV TCEY	18.0%	18.2%	18.5%

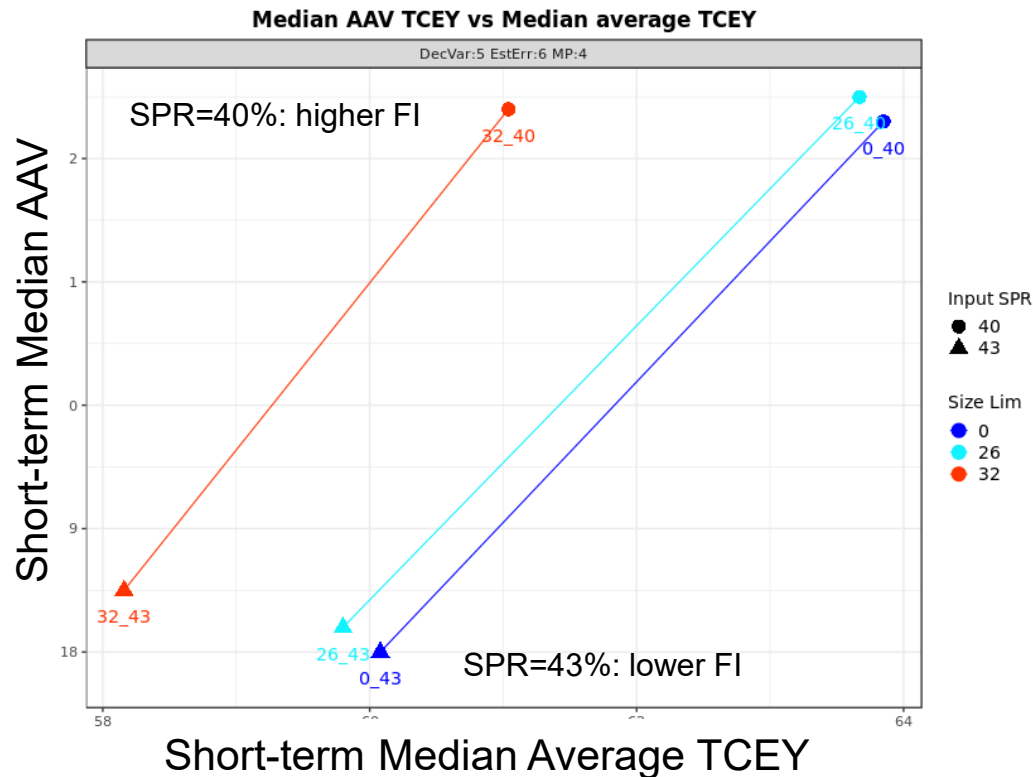
- Long-term sustainability met
- Above target spawning biomass
- A 3.3% short-term increase in TCEY with no size limit
- A slight reduction in TCEY variability
- Annual variability above 15% for all



Size Limits: Higher fishing intensity (short-term)

SPR=40%

- Higher TCEY and variability
- 4.6% increase in TCEY with no size limit (short-term)
- $P(\text{RSB} < 36\%) = 42\%$



Size Limits: Area sustainability objectives

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Biological Sustainability			
$P(p_{SB,2} < 5\%)$	<0.002	<0.002	<0.002
$P(p_{SB,3} < 33\%)$	<0.002	<0.002	<0.002
$P(p_{SB,4} < 10\%)$	<0.002	<0.002	<0.002
$P(p_{SB,4B} < 2\%)$	0.082	0.094	0.124

Long-term

- Long-term sustainability not met in 4B, but unlikely to be met given natural variability in OM
- Less probability of low percentage of SB in 4B with no size limit



Size Limits: Area variability objectives

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
P(AC3 TCEY _{2A} > 15%)	0.262	0.266	0.294
P(AC3 TCEY _{2B} > 15%)	0.690	0.674	0.734
P(AC3 TCEY _{2C} > 15%)	0.748	0.768	0.786
P(AC3 TCEY _{3A} > 15%)	0.758	0.780	0.790
P(AC3 TCEY _{3B} > 15%)	0.758	0.778	0.788
P(AC3 TCEY _{4A} > 15%)	0.854	0.834	0.870
P(AC3 TCEY _{4CDE} > 15%)	0.612	0.624	0.610
P(AC3 TCEY _{4B} > 15%)	0.834	0.826	0.856

- A slight reduction in annual change greater than 15% in 3 or more years without a size limit for most areas
- Areas 2B, 4A, and 4B showed increase from 26" to 0"
- Area 4CDE showed similar probability across size limits



Size Limits: Area variability objectives

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
AAV TCEY 2A	2.3%	2.3%	2.5%
AAV TCEY 2B	16.8%	17.5%	18.0%
AAV TCEY 2C	18.4%	18.7%	19.2%
AAV TCEY 3A	19.9%	20.1%	20.4%
AAV TCEY 3B	20.8%	21.5%	21.5%
AAV TCEY 4A	21.5%	21.6%	22.3%
AAV TCEY 4CDE	15.7%	16.0%	15.8%
AAV TCEY 4B	21.9%	21.8%	22.5%

- Very slight reductions in or similar AAV across all areas

Short-term



Size Limits: Area TCEY objectives

MP name	MP-A0	MP-A26	MP-A32	
Decision-making variability	Option 1			
Estimation Error	Sim			
Assessment Frequency	Annual			
Size Limit	0	26	32	
SPR	0.43			
				% change 32 to 0
Fishery Sustainability				
Median TCEY 2A	1.63	1.63	1.63	0.0%
Median TCEY 2B	9.09	9.03	8.78	3.5%
Median TCEY 2C	6.79	6.77	6.47	4.9%
Median TCEY 3A	24.41	24.14	23.32	4.7%
Median TCEY 3B	7.48	7.45	7.17	4.3%
Median TCEY 4A	3.63	3.60	3.43	5.8%
Median TCEY 4CDE	4.25	4.22	4.04	5.2%
Median TCEY 4B	2.95	2.89	2.79	5.7%

- All areas except 2A show an increase in median average TCEY
- More than 1 Mlbs in 3A
- Greatest % increase in Region 4



Size Limits: Area %TCEY objectives

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Median % TCEY 2A	2.4%	2.4%	2.5%
Median % TCEY 2B	16.6%	16.6%	16.6%
Median % TCEY 2C	11.0%	11.0%	11.0%
Median % TCEY 3A	39.3%	39.2%	39.1%
Median % TCEY 3B	12.2%	12.2%	12.2%
Median % TCEY 4A	5.9%	5.9%	5.9%
Median % TCEY 4CDE	7.7%	7.8%	7.8%
Median % TCEY 4B	4.6%	4.6%	4.6%

- Similar percentage of TCEY for each area across size limits

Short-term



Size Limits: Area minimum TCEY objectives

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Median Min TCEY 2A	1.53	1.52	1.50
Median Min TCEY 2B	6.02	5.92	5.66
Median Min TCEY 2C	4.40	4.40	4.12
Median Min TCEY 3A	15.25	14.93	13.65
Median Min TCEY 3B	4.56	4.37	4.04
Median Min TCEY 4A	2.25	2.22	2.03
Median Min TCEY 4CDE	2.85	2.80	2.70
Median Min TCEY 4B	1.89	1.84	1.69

- Median minimum TCEY greater for all areas

Short-term



Size Limits: Area minimum %TCEY objectives

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Minimum %TCEY 2A	1.8%	1.8%	1.8%
Minimum %TCEY 2B	16.0%	16.0%	15.8%
Minimum %TCEY 2C	9.4%	9.5%	9.3%
Minimum %TCEY 3A	36.3%	36.3%	36.0%
Minimum %TCEY 3B	10.8%	10.9%	10.8%
Minimum %TCEY 4A	5.1%	5.1%	5.0%
Minimum %TCEY 4CDE	6.5%	6.4%	6.4%
Minimum %TCEY 4B	3.9%	3.9%	3.8%

- Similar percentage of minimum TCEY for each area across size limits
- Slightly less than median % percent TCEY

Short-term



Size Limits: Commercial Landings

MP name	MP-A0	MP-A26	MP-A32	
Decision-making variability	Option 1			
Estimation Error	Sim			
Assessment Frequency	Annual			
Size Limit	0	26	32	
SPR	0.43			
Fishery Sustainability				% change 32 to 0
Median CW Landings	42.51	41.72	39.47	7.7%
Median Landings 2A	0.82	0.82	0.81	0.4%
Median Landings 2B	7.09	7.06	6.87	3.2%
Median Landings 2C	4.24	4.19	3.95	7.4%
Median Landings 3A	15.14	15.04	14.74	2.7%
Median Landings 3B	6.58	6.54	6.30	4.4%
Median Landings 4A	3.25	3.25	3.06	6.3%
Median Landings 4CDE	1.90	1.86	1.68	12.7%
Median Landings 4B	2.81	2.74	2.64	6.1%

Short-term

- All areas show an increase in landings
 - ~3Mlb CW
- Greatest % increase in Area 4CDE



Size Limits: Commercial %U32 Landings

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Median CW %U32 Landings	7.3%	6.2%	0.0%
Median %U32 Landings 2A	4.4%	3.8%	0.0%
Median %U32 Landings 2B	5.5%	4.9%	0.0%
Median %U32 Landings 2C	4.7%	4.2%	0.0%
Median %U32 Landings 3A	6.5%	5.5%	0.0%
Median %U32 Landings 3B	10.7%	8.7%	0.0%
Median %U32 Landings 4A	10.0%	8.2%	0.0%
Median %U32 Landings 4CDE	10.3%	8.5%	0.0%
Median %U32 Landings 4B	3.9%	3.3%	0.0%

This is percent U32 in commercial landings within an Area

- Majority of increase in U32 occurs from 32 to 26 inches
- Areas 3B, 4A, and 4CDE with largest percentage of U32

Short-term



Size Limits: Commercial Discards

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Median CW Discards	0.168	0.273	0.855
Median U32 Discards 2A	0.004	0.006	0.012
Median U32 Discards 2B	0.025	0.039	0.105
Median U32 Discards 2C	0.020	0.026	0.061
Median U32 Discards 3A	0.054	0.077	0.213
Median U32 Discards 3B	0.020	0.045	0.176
Median U32 Discards 4A	0.018	0.028	0.098
Median U32 Discards 4CDE	0.007	0.012	0.033
Median U32 Discards 4B	0.014	0.028	0.079

Short-term

- ~80% reduction in coastwide commercial discards
 - 0.687 Mlb reduction
- 67%-89% reduction by Area
- 3B had largest percent reduction
- Majority of reduction occurred with 26 inch size limit



Further understand effect of size limits

[SRB021–Rec.05](#) (para. 26) NOTING the MSE results for size limit scenarios presented, the SRB RECOMMENDED further analysis of the economic implications of harvesting smaller fish (e.g. reduced yield and/or increased processing costs, changes in efficiency, and potential lower value for smaller fish).

- Previous size limit analysis ([IPHC-2021-AM097-09](#)) investigated the value of the fishery dependent on the ratio between U32 and O32 price



Equal Value Price Ratio (EVPR)

- Called 'critical price ratio' in [IPHC-2021-AM097-09](#)
- The ratio between the price of U32 commercial landings and the price of O32 commercial landings that would result in an equal value of the fishery with or without a size limit

$$\text{value} = P_{O32}L_{O32} + P_{U32}L_{U32}$$

Noting that without a size limit L_{U32} would be zero

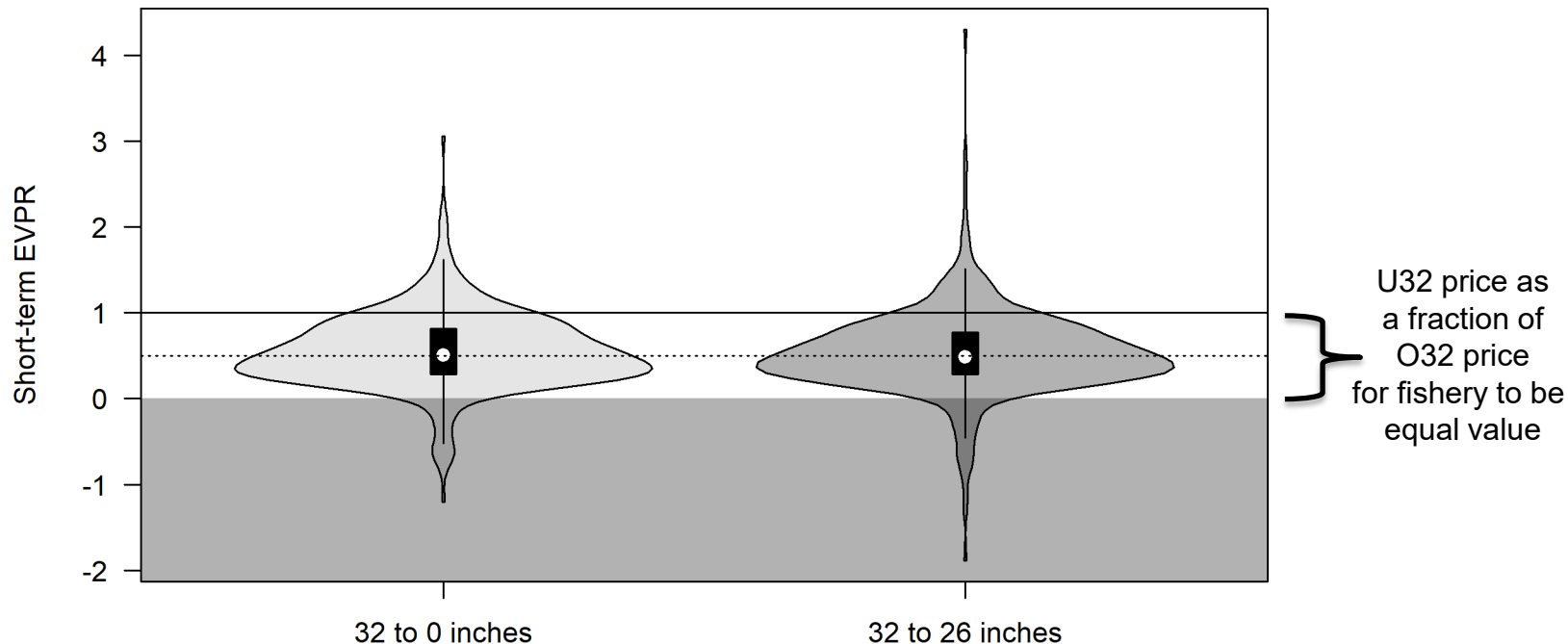
$$R = P_{U32} / P_{O32}$$

$$\text{EVPR} = \frac{L_{O32,SL} - L_{O32,NSL}}{L_{U32,NSL}}$$



Equal Value Price Ratio (EVPR)

- Similar for reducing size limit to 26" or 0"



Caveats to EVPR analysis

- Does not consider change in price due to change in supply
- Assumes that price ratio is independent of total landings
 - price for O32 and U32 would change in parallel
- Does not consider efficiency and if there may be reduced costs due to less bait and fewer trips
- Some additional work on impact of supply on price would provide value of fishery in addition to EVPR

[IPHC-2021-SRB019-R](#) (para 61): The SRB REQUESTED further information (e.g. inverse demand curves), to be presented at SRB020, on the regional supply-price relationships for commercial landings, as well as localized importance of the Pacific halibut fishery to communities



Size Limits: Recreational limits

MP name	MP-A0	MP-A26	MP-A32	
Decision-making variability	Option 1			
Estimation Error	Sim			
Assessment Frequency	Annual			
Size Limit	0	26	32	
SPR	0.43			
Fishery Sustainability				% change 32 to 0
Median Recreational	11.87	11.80	11.20	6.0%
Median Recreational 2B	1.25	1.25	1.21	3.2%
Median Recreational 2C	2.12	2.11	2.07	2.1%
Median Recreational 3A	7.87	7.81	7.20	*9.2%

- Increase in recreational limits when removing the size limit

Short-term

*There may be an error in the simulation of the catch sharing plan in 3A



Long-term effects of size limits

[IPHC-2021-AM097-R](#), **para 50**: The Commission NOTED that the evaluation provided decision-making information for consideration of the current MinSL and/or a MaxSL. The focus is on short-term yield, fishery and stock performance while retaining all other aspects of the IPHC's interim management procedure. It is not intended to provide a comparison of long-term performance of size limits as one part of a comprehensive management procedure. Such a comprehensive analysis may be done through management strategy evaluation (MSE). Questions regarding **long-term change** in spatial distribution and scale of recruitment and spawning biomass require the full 'closed-loop' approach used in the MSE.

[SS011-Rec.01](#) (**para. 7**) The Commission RECOMMENDED that the IPHC Secretariat:[...] c) continue investigation of size limits (M.1) to understand the **long-term effects** of a change in the size limit, including under different realizations of population dynamics such as size-at-age.



Size Limits: Dstn of Spawning Biomass

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Median %SB in Region 2	18.7%	18.8%	18.8%
Median %SB in Region 3	53.1%	53.2%	53.5%
Median %SB in Region 4	23.2%	23.2%	23.1%
Median %SB in Region 4B	4.2%	4.1%	3.9%

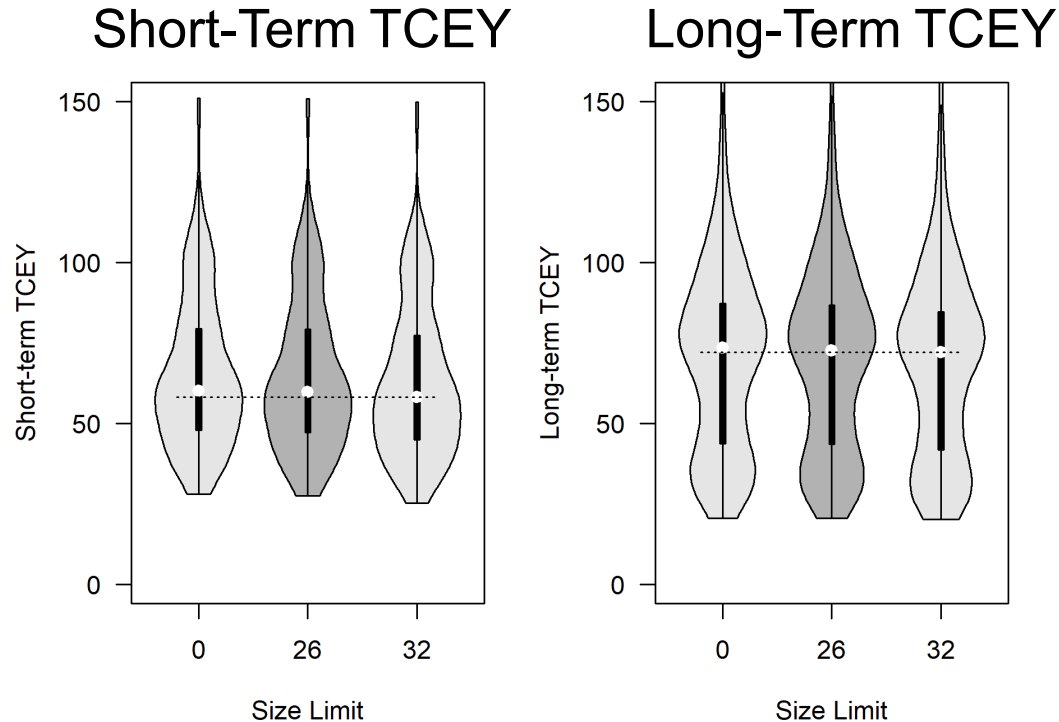
- Very small changes in distribution of spawning biomass

Long-term

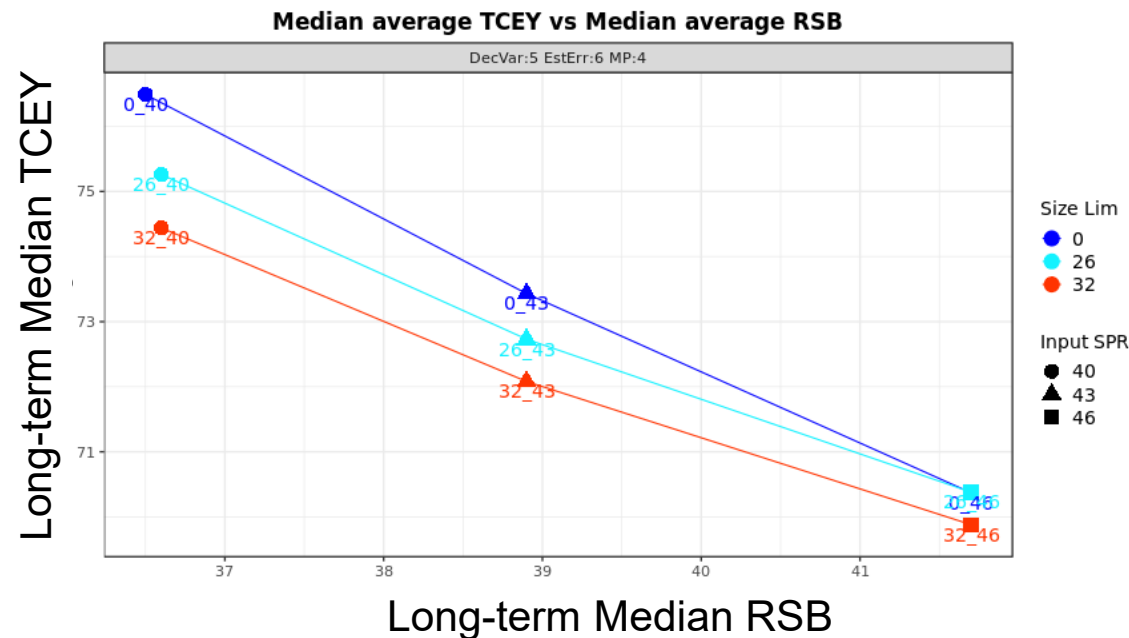


Size limits: long-term effects on TCEY

- Increase in long-term TCEY was 1.9% (~1.3 Mlbs) without a size limit



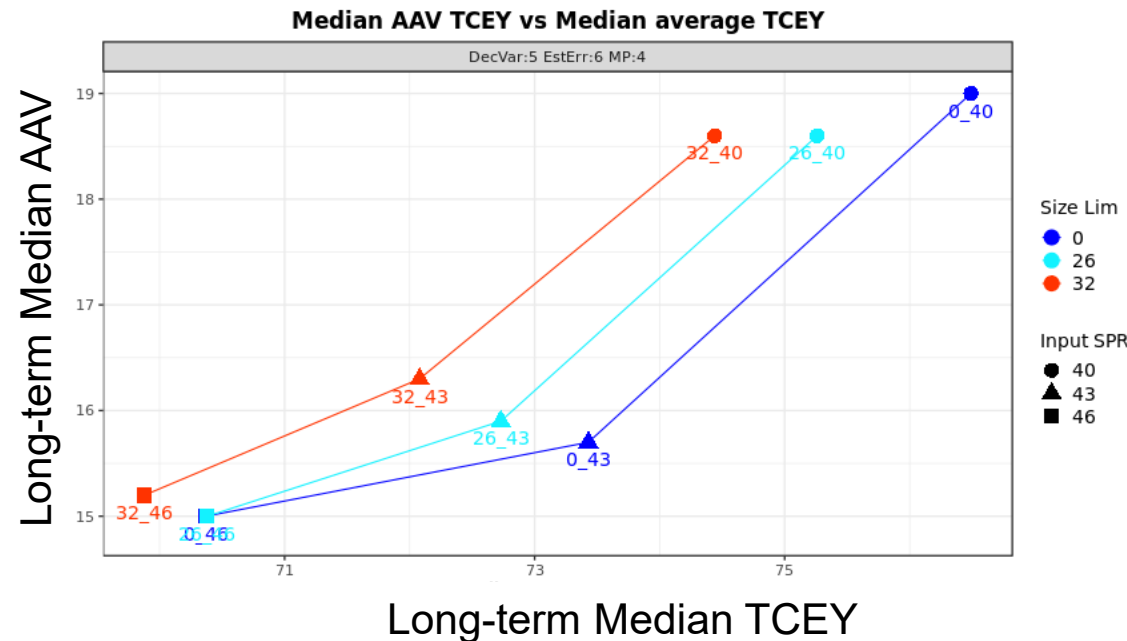
Size Limits: Long-term fishing intensity



- For a specific SPR, each size limit results in a similar RSB but different TCEY
- Higher SPR results in lower RSB but greater difference between TCEYs for size limits
- Have not surpassed the peak of the yield vs RSB curve
 - SPR 40% is near target



Size Limits: Long-term fishing intensity



- SPR=46% as decrease size limit
 - Smaller gains
 - 0 and 26 inch size limits very similar
- SPR=43% as decrease size limit
 - Increase TCEY
 - Decrease AAV
- SPR=40% as decrease size limit
 - Increase TCEY
 - Increase AAV

“No estimation error” has a different pattern



Size Limits: Area long-term TCEY

MP name	MP-A0	MP-A26	MP-A32	
Decision-making variability	Option 1			
Estimation Error	Sim			
Assessment Frequency	Annual			
Size Limit	0	26	32	
SPR	0.43			
				% change 32 to 0
Fishery Sustainability				
Median TCEY 2A	1.64	1.63	1.63	0.6%
Median TCEY 2B	10.10	9.94	9.78	3.3%
Median TCEY 2C	7.66	7.64	7.51	2.0%
Median TCEY 3A	30.43	30.47	30.16	0.9%
Median TCEY 3B	9.02	9.16	8.99	0.3%
Median TCEY 4A	3.50	3.48	3.37	3.9%
Median TCEY 4CDE	3.75	3.69	3.61	3.9%
Median TCEY 4B	3.03	3.00	2.91	4.1%

- Percent increase in median average TCEY less than short-term
- Region 3 max yield at 26"
- Greatest % increase in Region 4/4B then 2B



Size Limits: Long-term Comm %U32 Landings

MP name	MP-A0	MP-A26	MP-A32
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual		
Size Limit	0	26	32
SPR	0.43		
Fishery Sustainability			
Median CW %U32 Landings	3.5%	3.0%	0.0%
Median %U32 Landings 2A	4.2%	3.6%	0.0%
Median %U32 Landings 2B	3.3%	2.7%	0.0%
Median %U32 Landings 2C	2.7%	2.3%	0.0%
Median %U32 Landings 3A	4.8%	3.6%	0.0%
Median %U32 Landings 3B	7.6%	6.4%	0.0%
Median %U32 Landings 4A	9.6%	7.9%	0.0%
Median %U32 Landings 4CDE	2.6%	2.2%	0.0%
Median %U32 Landings 4B	3.5%	3.0%	0.0%

This is percent U32 in commercial landings within an Area

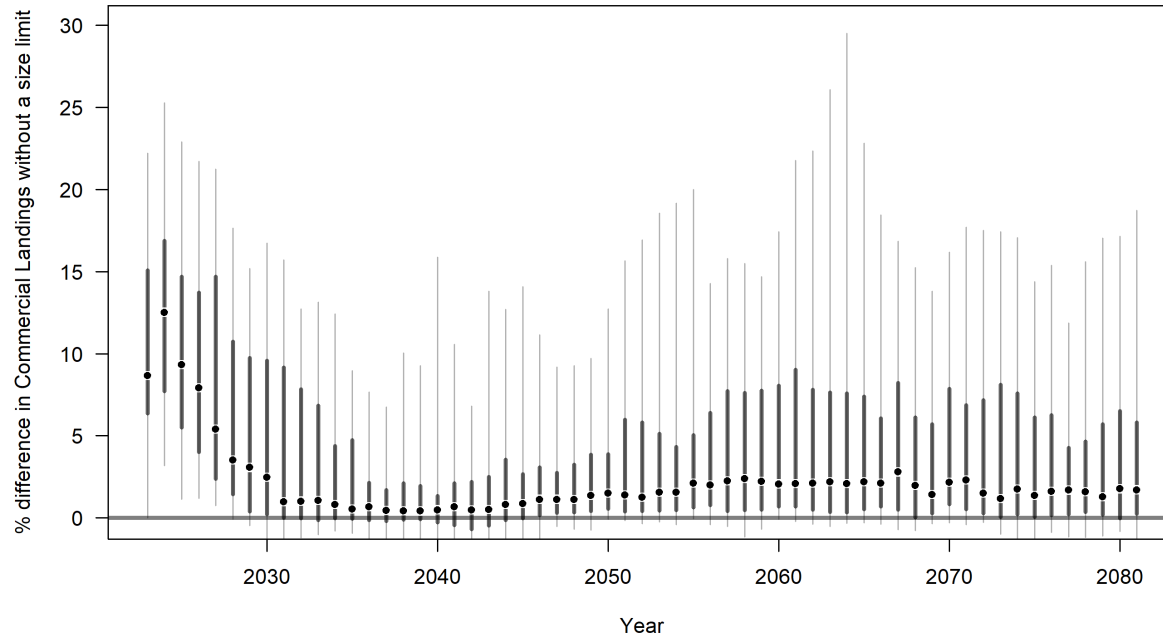
- Majority of increase in U32 occurs from 32 to 26 inches
- Lower percentages than short-term

Short-term



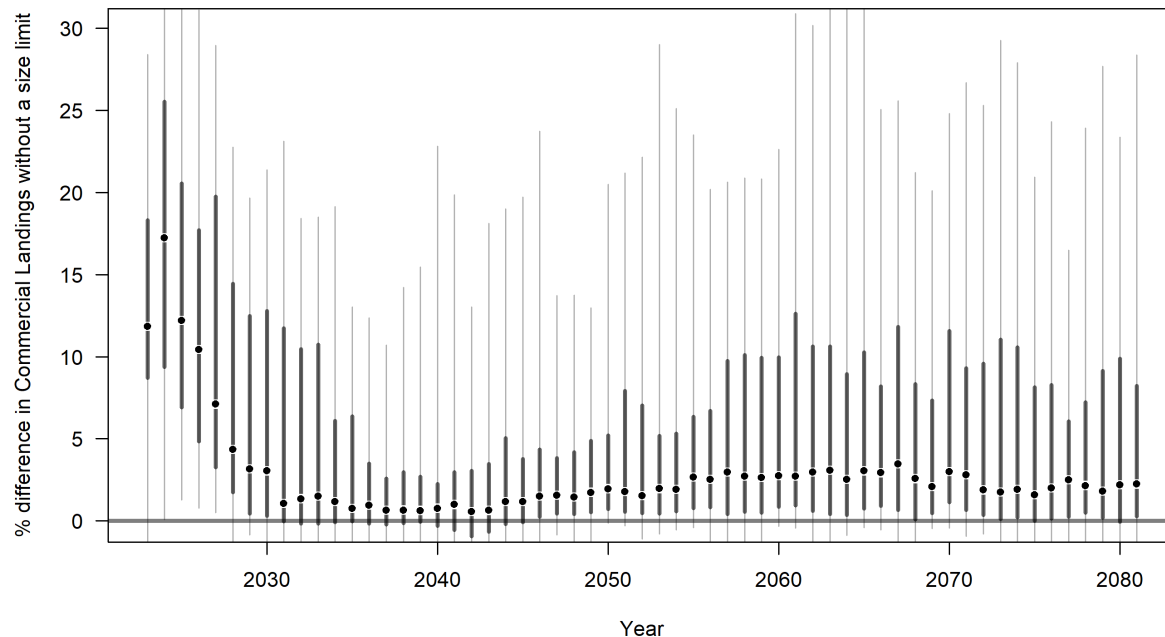
Percent difference in TCEY without a size limit

- 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

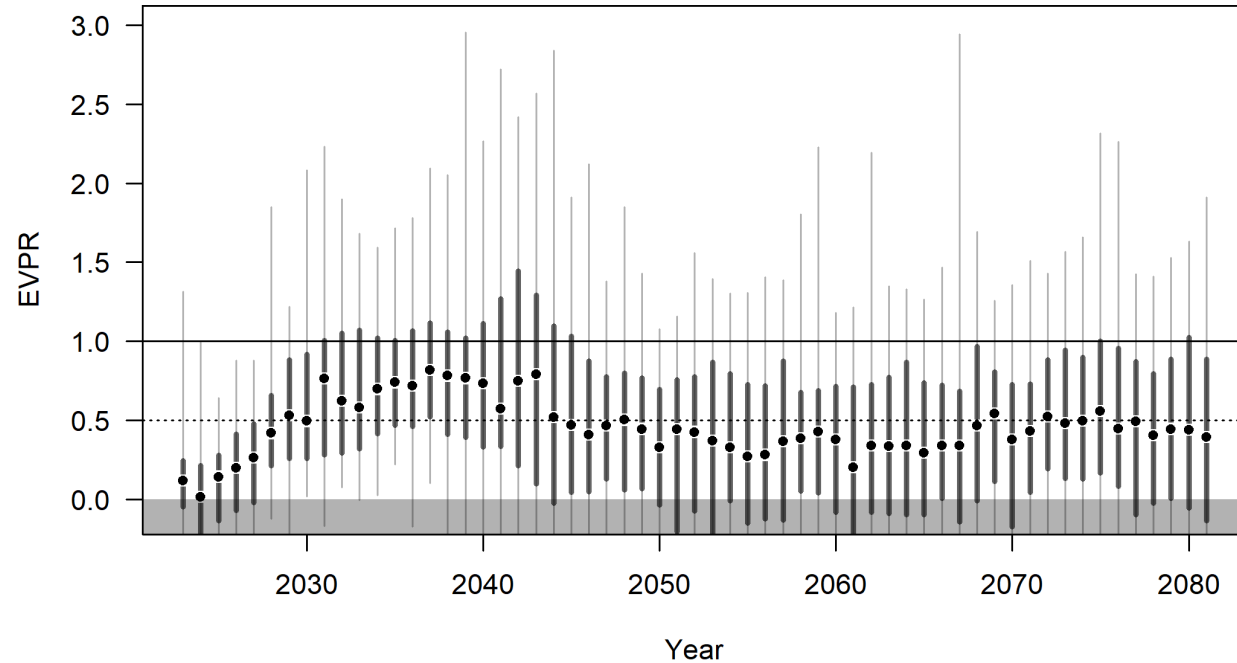


Percent difference in Commercial Landings without a size limit

- Similar to TCEY but different magnitudes



EVPR in Commercial Landings without a size limit



- Dependent on population conditions
- Mostly between 0 and 1
- Current ratio from FISS sales is about 88%
 - Above 80% in past years ([Table 4](#))
- Development of markets and processing may bring the actual price ratio closer to 1

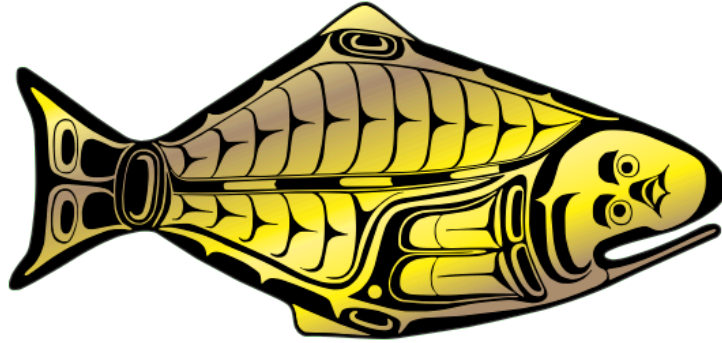


Summary of size limits

- A 4.6% gain (~ 2.8 Mlbs) in short-term TCEY and a 1.9% gain (~1.3 Mlbs) in long-term TCEY
 - All areas show increase (except 2A due to agreement)
 - More than 10% of commercial landings in some areas in near-term could be U26
 - Region 3 had little gain in Commercial landings the long-term
 - Recreational gain in mortality limit also reduced in long-term
- Large reduction in commercial discard mortality
- Possibly a reduction in annual variability of TCEY
- Results change slightly depending on SPR
- Very little, if any, long-term change to distribution of spawning biomass or TCEY
- EVPR mostly between 0 and 1 and around 0.5 in the long-term
- Gains and EVPR are dependent on stock conditions
- Efficiency and cost may be useful to consider



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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*

FISS remains an annual survey



MPs: Multi-year stock assessment

MP name	MP-A32	MP-Bb32	MP-Tb32
Decision-making variability	option 1		
Estimation Error	Simulated		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32 inches		
SPR	0.43		

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



MPs: Multi-year stock assessment, all factors

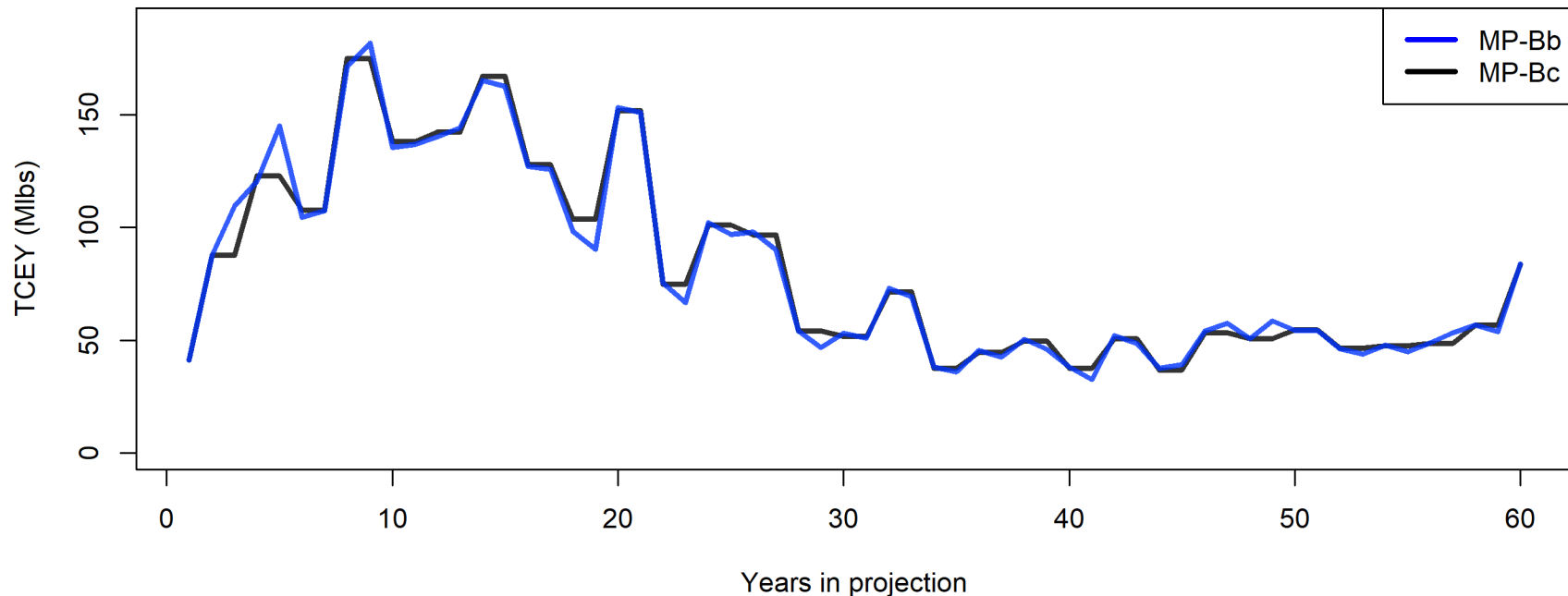
MP name	MP-A32	MP-Ba32	MP-Bb32	MP-Bc32
Decision-making variability	None, option 1, option 2			
Estimation Error	None, Simulated, SS			
Assessment Frequency	Annual	Biennial	Biennial	Biennial
Size Limit	32 inches			
SPR	0.40, 0.43, 0.46			

- 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



What is a multi-year stock assessment?

- Not conducting a stock assessment every year
 - Use empirical method to set mortality limits



Multi-year: option b

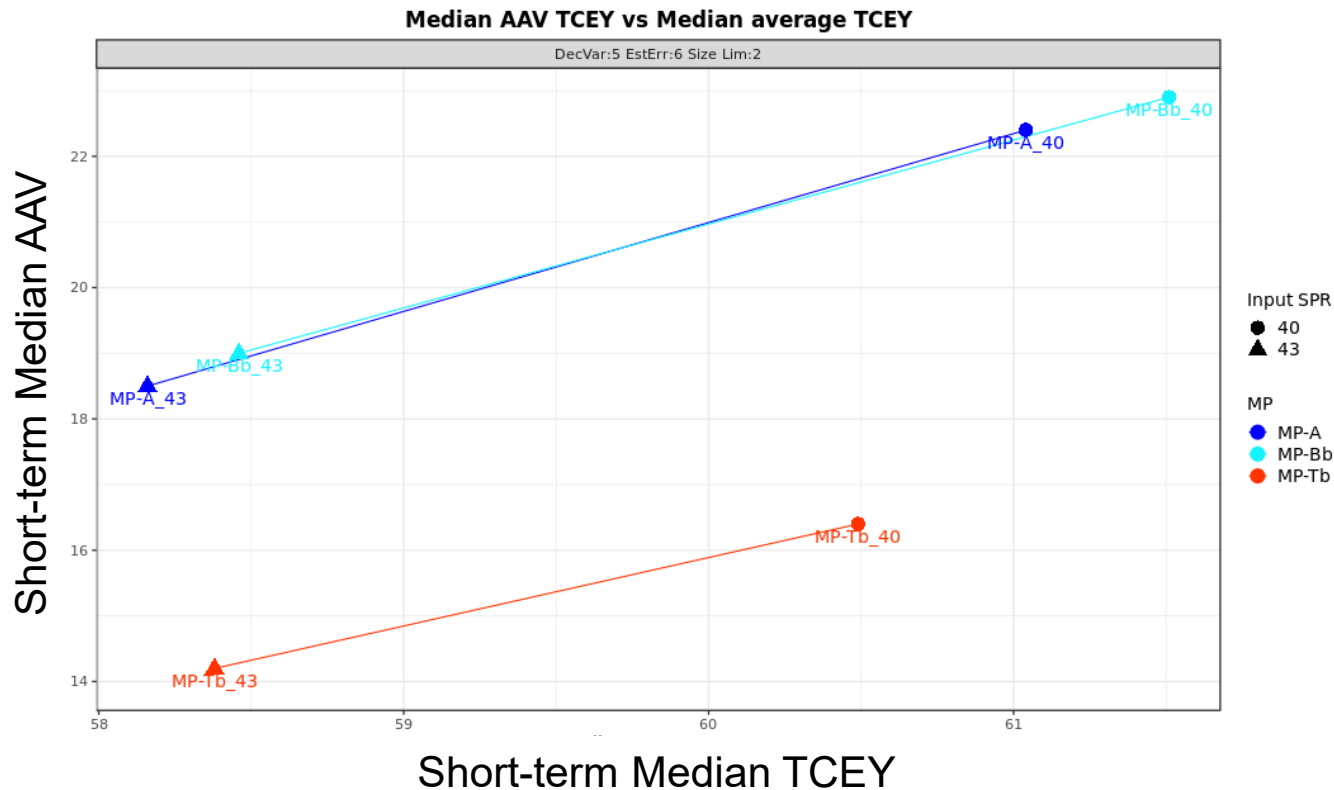
MP name		MP-A32	MP-Bb	MP-Tb
Decision-making variability		Option 1		
Estimation Error		Sim		
Assessment Frequency		Annual	Biennial	Triennial
Size Limit		32		
SPR		0.43		
Long-term	Biological Sustainability			
	P(any RSB_y<20%)	<0.002	<0.002	<0.002
	Fishery Sustainability			
Short-term	P(all RSB<36%)	0.149	0.156	0.225
	Median average TCEY	58.16	58.46	58.38
	P(any3 change TCEY > 15%)	0.958	0.894	0.694
	Median AAV TCEY	18.5%	19.0%	14.2%

- Long-term sustainability met
- Above target spawning biomass but increase in probability being below with multi-year
- Possibly a very slight short-term increase in TCEY with multi-year
- A reduction in TCEY variability although AAV greater for biennial
- Annual variability below 15% for Triennial



Multi-year option b: higher fishing intensity

- Smaller increase in yield with triennial assessment
- Close to target SB at SPR=40%



Size Limits: Area sustainability objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Biological Sustainability			
$P(p_{SB,2} < 5\%)$	<0.002	<0.002	<0.002
$P(p_{SB,3} < 33\%)$	<0.002	<0.002	<0.002
$P(p_{SB,4} < 10\%)$	<0.002	<0.002	<0.002
$P(p_{SB,4B} < 2\%)$	0.124	0.108	0.106

Long-term

- Long-term sustainability not met in 4B, but can never be met given natural variability in OM
- Less probability of low percentage of SB in 4B with no size limit



Size Limits: Area variability objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Fishery Sustainability			
P(AC3 TCEY _{2A} > 15%)	0.294	0.368	0.276
P(AC3 TCEY _{2B} > 15%)	0.734	0.714	0.462
P(AC3 TCEY _{2C} > 15%)	0.786	0.740	0.432
P(AC3 TCEY _{3A} > 15%)	0.790	0.752	0.502
P(AC3 TCEY _{3B} > 15%)	0.788	0.802	0.534
P(AC3 TCEY _{4A} > 15%)	0.870	0.742	0.538
P(AC3 TCEY _{4CDE} > 15%)	0.610	0.514	0.288
P(AC3 TCEY _{4B} > 15%)	0.294	0.368	0.276

- Mixed variability with biennial
- Reduced variability with triennial
 - Some areas show a large reduction

Short-term



Size Limits: Area variability objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Fishery Sustainability			
AAV TCEY 2A	2.5%	3.1%	1.6%
AAV TCEY 2B	18.0%	20.9%	15.3%
AAV TCEY 2C	19.2%	20.2%	14.9%
AAV TCEY 3A	20.4%	21.3%	15.1%
AAV TCEY 3B	21.5%	23.4%	15.7%
AAV TCEY 4A	22.3%	22.9%	16.3%
AAV TCEY 4CDE	15.8%	15.6%	12.7%
AAV TCEY 4B	22.5%	23.0%	16.2%

- Slight increase in variability with biennial
 - 4B about same
- Reduced average variability with triennial



Size Limits: Area TCEY objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Fishery Sustainability			
Median TCEY 2A	1.63	1.61	1.61
Median TCEY 2B	8.78	8.59	8.74
Median TCEY 2C	6.47	6.42	6.47
Median TCEY 3A	23.32	23.19	23.48
Median TCEY 3B	7.17	7.09	7.38
Median TCEY 4A	3.43	3.49	3.59
Median TCEY 4CDE	4.04	4.04	4.02
Median TCEY 4B	2.79	2.73	2.78

- Mixed results
- Small differences

Short-term



Size Limits: Area %TCEY objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Fishery Sustainability			
Median % TCEY 2A	2.5%	2.3%	2.3%
Median % TCEY 2B	16.6%	16.6%	16.6%
Median % TCEY 2C	11.0%	10.9%	10.9%
Median % TCEY 3A	39.1%	39.2%	39.3%
Median % TCEY 3B	12.2%	12.1%	12.2%
Median % TCEY 4A	5.9%	6.0%	6.0%
Median % TCEY 4CDE	7.8%	7.9%	7.8%
Median % TCEY 4B	4.6%	4.6%	4.6%

- Similar percentage of TCEY for each area across multi-area MPs

Short-term



Size Limits: Area minimum TCEY objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Fishery Sustainability			
Median Min TCEY 2A	1.50	1.40	1.51
Median Min TCEY 2B	5.66	5.00	5.65
Median Min TCEY 2C	4.12	3.91	4.29
Median Min TCEY 3A	13.65	13.24	15.16
Median Min TCEY 3B	4.04	4.07	4.56
Median Min TCEY 4A	2.03	2.06	2.28
Median Min TCEY 4CDE	2.70	2.67	2.84
Median Min TCEY 4B	1.69	1.71	1.85

- Median minimum TCEY lower for all areas except 4B with biennial
- Median minimum TCEY greater for all areas except 2A and 2B with triennial

Short-term



Size Limits: Area minimum %TCEY objectives

MP name	MP-A32	MP-Bb	MP-Tb
Decision-making variability	Option 1		
Estimation Error	Sim		
Assessment Frequency	Annual	Biennial	Triennial
Size Limit	32		
SPR	0.43		
Fishery Sustainability			
Minimum %TCEY 2A	1.8%	1.7%	1.7%
Minimum %TCEY 2B	15.8%	14.9%	16.1%
Minimum %TCEY 2C	9.3%	9.2%	9.5%
Minimum %TCEY 3A	36.0%	35.4%	36.2%
Minimum %TCEY 3B	10.8%	10.5%	10.7%
Minimum %TCEY 4A	5.0%	5.0%	5.1%
Minimum %TCEY 4CDE	6.4%	6.4%	6.4%
Minimum %TCEY 4B	3.8%	3.7%	3.7%

- Similar percentage of minimum TCEY for each area across size limits except 2B is slightly greater with triennial
- Slightly less than median % percent TCEY

Short-term



Multi-year: a look at short-term TCEY variability

MP name	MP-A32	MP-Ba32	MP-Bb32	MP-Bc32	MP-Tb32
Decision-making variability	Option 1				
Estimation Error	Sim				
Assessment Frequency	Annual	Biennial	Biennial	Biennial	Triennial
Size Limit	32				
SPR	0.43				
P(all RSB<36%)	0.149		0.156	0.169	0.2250
Median average TCEY	58.16		58.46	57.74	58.38
Median Annual Change	16.5%		13.3%	4.6%	9.9%
P(any1 change TCEY > 15%)	1.000		1.000	0.988	0.952
P(any2 change TCEY > 15%)	1.000		0.990	0.974	0.914
P(any3 change TCEY > 15%)	0.958		0.894	0.764	0.694
P(any4 change TCEY > 15%)	0.748		0.656	0.516	0.368
P(any5 change TCEY > 15%)	0.592		0.382	0.170	0.074
Median AAV TCEY	18.5%		19.0%	14.7%	14.2%
95 th AAV percentile	40.4%		37.2%	31.4%	24.3%

Prob less than target is higher than annual

AC reduced with multi-year

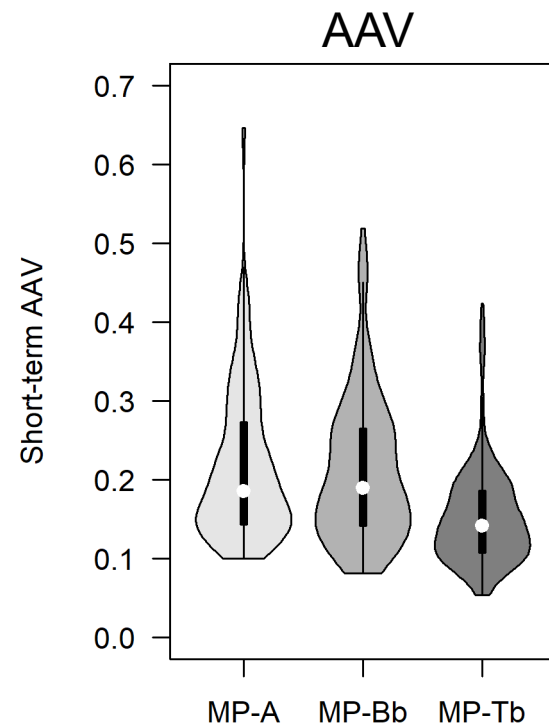
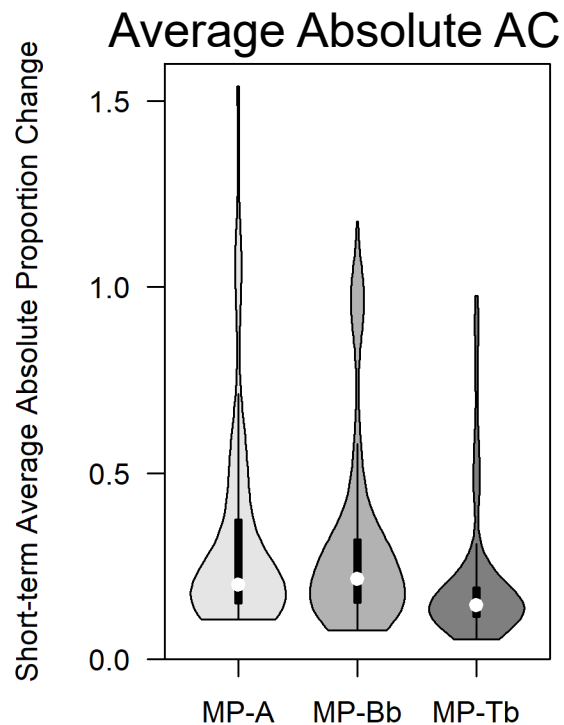
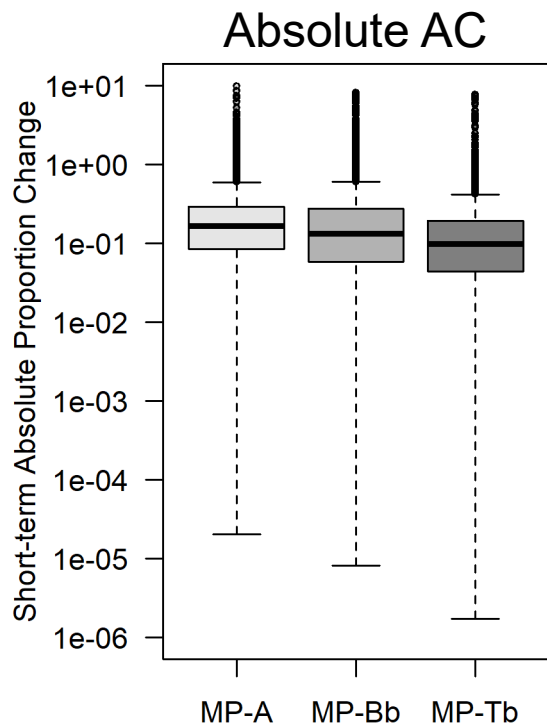
MP-Bb ≈ MP-A

- Difference in Annual Change

Long-term TCEY higher for biennial MPs but lower for triennial



Multi-year: Distributions of variability



Multi-year: Summary

- Met biological sustainability
 - Except 4B; unlikely any MP can meet
- Biennial and Triennial MPs were closer to target but still mostly above target
 - Slightly higher chance of lower stock sizes with multi-year
- TCEY showed minor differences
 - Possibly difference between short-term and long-term
- Increasing fishing intensity showed different results with triennial
 - Should look at specific fishing intensity and not assume patterns
- Details in variability is most important



Multi-year: Variability in the TCEY

- Median AAV was similar for annual and biennial, much reduced for triennial
- Triennial showed lowest variability
- More contrast seen in annual change (AC) metric
 - Prob of AC in more years was reduced
 - Median and distribution of AC were reduced with biennial and more with triennial
- MP-Bc with a constant biennial coastwide TCEY showed similar results as triennial, but with loss in yield



Multi-year: Overall

- Using the FISS results in years without an assessment produced similar results as an annual assessment, potentially with less variability in the TCEY
 - Uses available observations and responds annually to changes in the size and distribution of the stock
 - Would maintain area-specific agreements, if any
- Maintaining a constant coastwide TCEY for non-assessment years may result in loss of yield
 - Adjusting SPR to match the multi-year $P(RSB < 36\%)$ to the annual MP (risk) would likely show additional loss in yield
 - There may be other ways to set a constant multi-year TCEY that may produce similar results as an annual assessment
- Net economic benefits are not known



Costs and benefits of multi-year assessments

[AM098-R](#), para 63. The Commission REQUESTED that the IPHC Secretariat work with the SRB and others as necessary to identify potential costs and benefits of not conducting an annual stock assessment. This will include a prioritized list of work items that could be accomplished in its place.



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.*

SRB021–Req.02 (para. 30) The SRB REQUESTED that the Secretariat examine MPs based on a three-year assessment cycle with annual TCEY changes proportional to changes in the FISS index because (i) this approach would be simpler and more transparent than a model, which has not yet been developed); (ii) the high benefit to cost ratio for multi-year TCEYs; (iii) it matches the current three-year full assessment cycle; and (iv) the general approach has precedents in other fishery commissions (e.g. Southern Bluefin Tuna).



Costs and benefits of multi-year assessments

Costs of multi-year assessment	Benefits of multi-year assessment
Detailed harvest advice not available every year Not following stock trends (Ba, partially Bc)	Reduced inter-annual variability in the TCEY
Potentially a loss in yield	Multi-year stability, short-term predictability, transparent process
Higher chance of smaller stock size, although likely still above target even at SPR 40%	FISS is a reasonable proxy to coastwide and area changes in abundance (Bb, partially Bc)
	More focused assessment research
	Additional collaboration with other IPHC branches
	Triennial would be consistent with current update/full assessment cycle
	Multi-year approach has precedent at other fisheries commissions

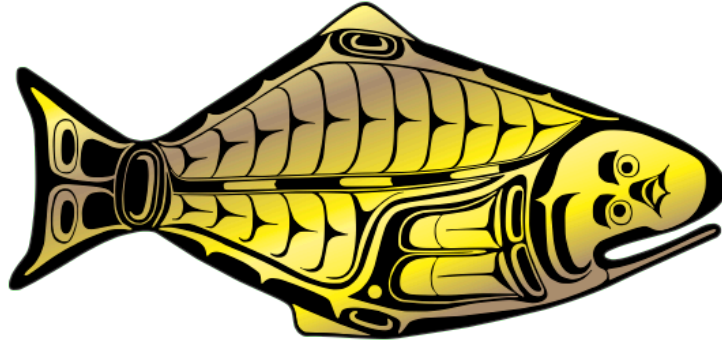


Recommendations

- **NOTE** paper IPHC-2022-MSAB017-09 and additional results in the presentation
- **RECOMMEND** focusing evaluation on option 1 decision-making variability, simulated estimation error, and an SPR of 43%
- **RECOMMEND** additional runs to assist with the evaluation of size limits and multi-year assessments
- **NOTE** short-term and long-term gains, losses, and tradeoffs with different size limits
- **NOTE** costs and benefits from implementing a multi-year assessment management procedure



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Additional Exploration

MSE Explorer

<http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/>



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(any 3 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

