INTERNATIONAL PACIFIC HALIBUT COMMISSION

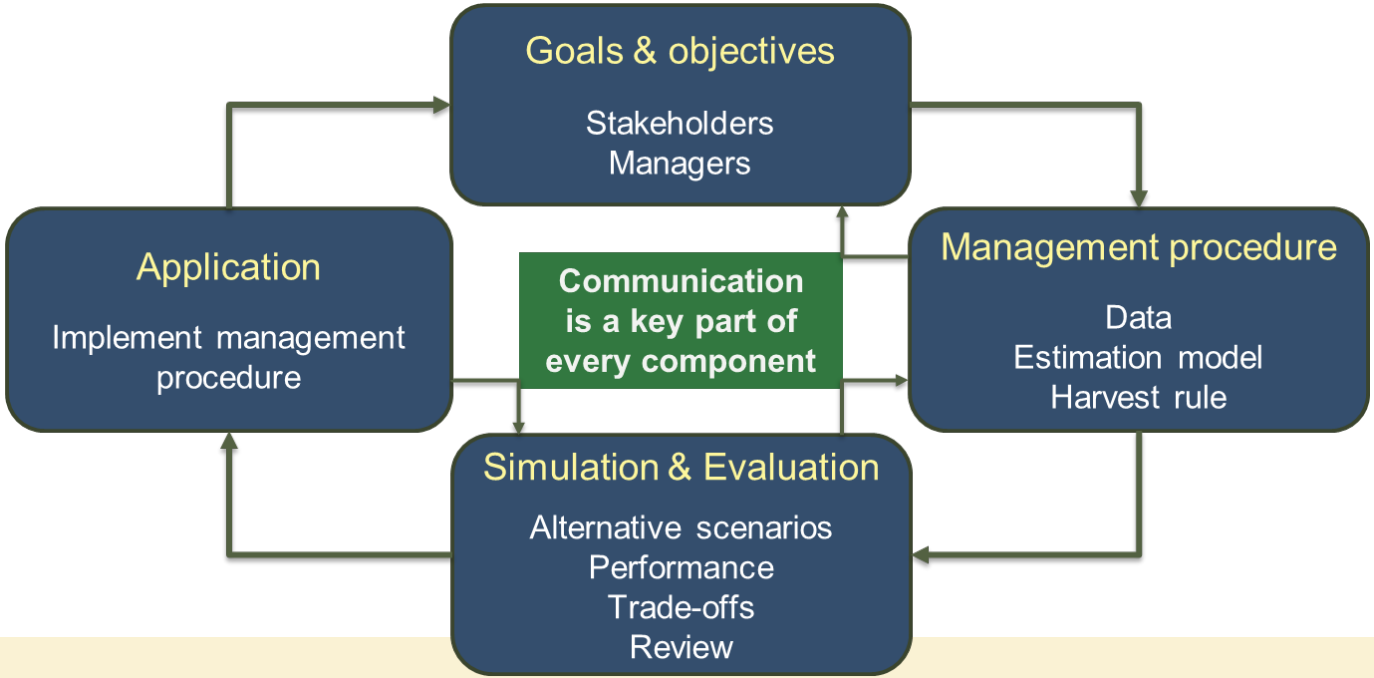
Management Strategy Evaluation: Results

Agenda Item 8.1

IPHC-2020-IM096-11 Rev_1

Management Strategy Evaluation (MSE)

a process to evaluate harvest strategies and develop a management procedure that is robust to uncertainty and meets defined objectives



1.1. Primary biological objectives

Measurable Objective	Performance Metric	Time-frame	Tolerance
Maintain a female spawning stock biomass above a biomass limit reference point at least 95% of the time	$P(SB < 20\%\ B0)$	Long-term	0.05
Maintain a defined minimum proportion of female spawning biomass in each Biological Region	$P(p_{SB,2} < 5\%)$ $P(p_{SB,3} < 33\%)$ $P(p_{SB,4} < 10\%)$ $P(p_{SB,4\mathrm{B}} < 2\%)$	Long-term	0.05

2.1. Primary fishery objective (target SB)

Measurable Objective	Performance Metric	Time-frame	Tolerance
Maintain the coastwide female spawning biomass above a biomass target reference point at least 50% of the time	$P(SB < 36\%\, B0)$	Long-term	0.50

2.2. Primary fishery objectives (stability)

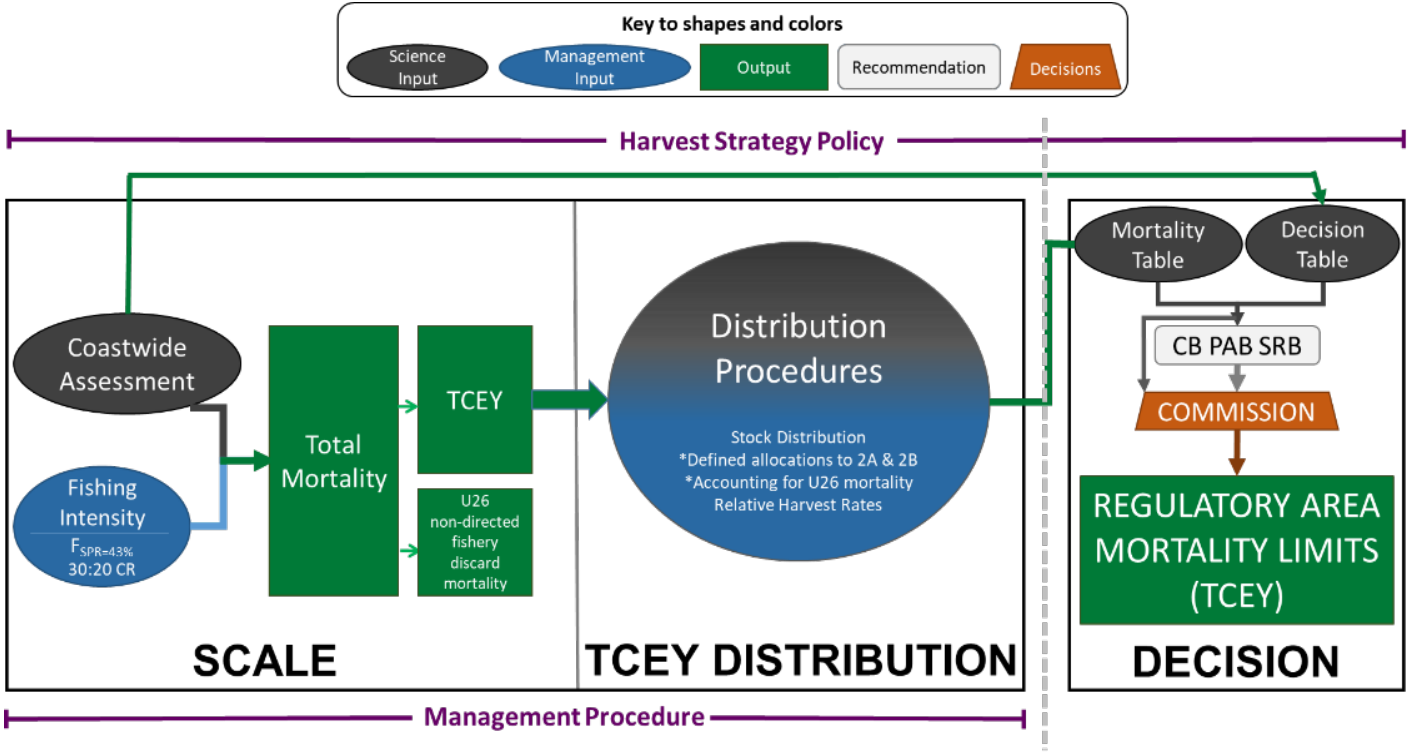
Measurable Objective	Performance Metric	Time-frame	Tolerance
Limit annual changes in the coastwide TCEY	$P(AC > 15\% \text{ in any 3 years of 10})$	Short-term	
	Coastwide Average Annual Variability (AAV)	Short-term	
Limit annual changes in the Regulatory Area TCEY	$P(AC_A > 15\% \text{ in any 3 years of 10})$	Short-term	
	AAV by Regulatory Area (AAV_A)	Short-term	

- AC: actual Annual Change in TCEY from one year to next
- AAV: The average percent variability over a 10-year period

2.3. Primary fishery objectives (yield)

Measurable Objective	Performance Metric	Time-frame	Tolerance
Optimize average coastwide TCEY	Average coastwide TCEY	Short-term	
Optimize TCEY among Regulatory Areas	Average TCEY in each IPHC Regulatory Area	Short-term	
Optimize the percentage of the coastwide TCEY among Regulatory Areas	Average %TCEY in each IPHC Regulatory Area	Short-term	
Maintain a minimum TCEY for each Regulatory Area	Minimum TCEY in each IPHC Regulatory Area	Short-term	
Maintain a percentage of the coastwide TCEY for each Regulatory Area	Minimum %TCEY in each IPHC Regulatory Area	Short-term	

IPHC Harvest Strategy Process



Elements of the Management Procedure

SCALE	TCEY DISTRIBUTION
• Coastwide target fishing intensity – SPR – Control Rule – Constraints	• Regional Stock Distribution • Regulatory Area Allocation – FISS-based distribution – Relative harvest rates – Agreements

MPs for evaluation in 2020

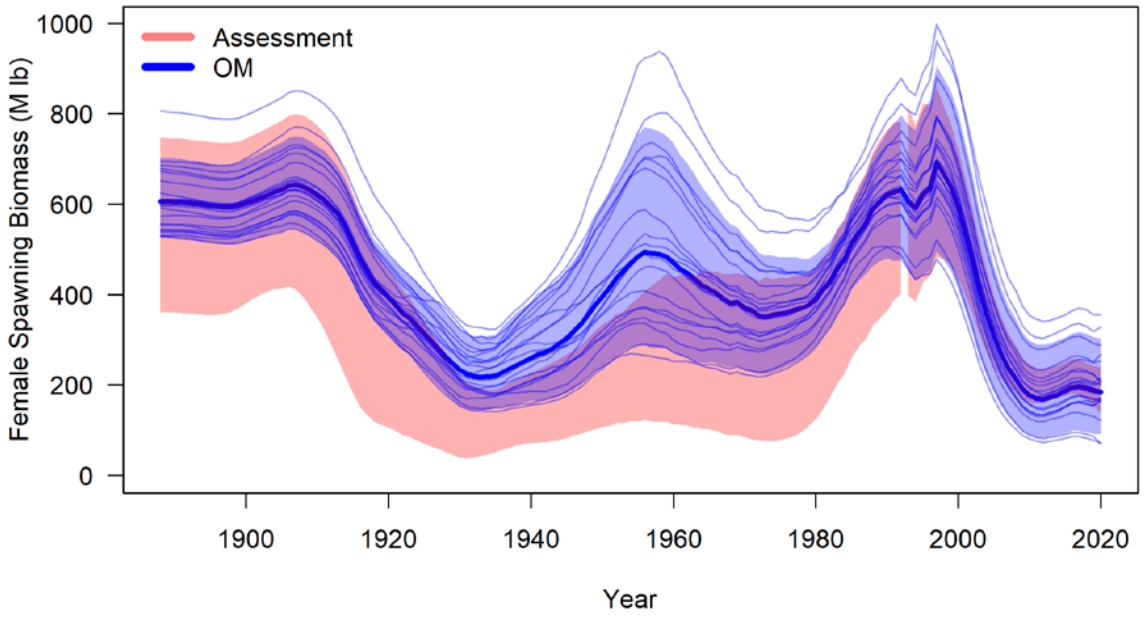
MP	Coastwide	Regional	IPHC Regulatory Area	Priority
MP 15-A	SPR 30:20		• O32 stock distribution • Proportional relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) • 1.65 Mlbs floor in 2A • Formula percentage for 2B	1
MP 15-B	SPR 30:20 MaxChange15 %		• O32 stock distribution • Proportional relative harvest rates (1.0 for 2-3A, 0.75 for 3B-4) • 1.65 Mlbs floor in 2A • Formula percentage for 2B	1
MP 15-C	SPR 30:20 MaxChange15 %	O32 stock distn Rel HRs: R2, R3=1, R4, R4B=0.75,	• O32 stock distribution • Relative harvest rates not applied • 1.65 Mlbs floor in 2A • Formula percentage for 2B	2
… K				

Management Procedures for evaluation

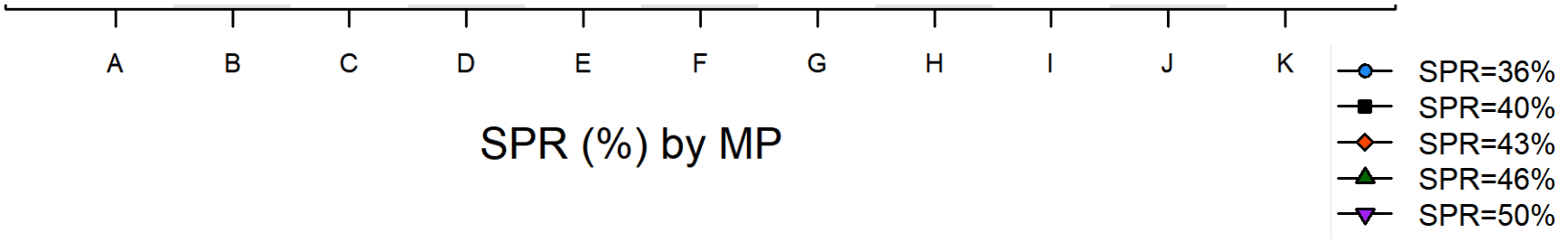
Element	MP-A	MP-B	MP-C	MP-D	MP-E	MP-F	MP-G	MP-H	MP-I	MP-J	MP-K
TCEY constraint of 15%											
Max Fishing Intensity buffer 36%											
O32 stock distribution											
O32 stock distribution (5-year moving average)											
All sizes stock distribution											
Fixed shares updated in 5th year from O32 stock distribution											
Relative harvest rates of 1.0 for 2-3A, and 0.75 for 3B-4											
Relative harvest rates of 1.0 for 2-3, 4A, 4CDE, and 0.75 for 4B											
Relative harvest rates by Region: R2=1, R3=1, R4=0.75, R4B=0.75											
1.65 Mlbs fixed TCEY in 2A											
Formula percentage for 2B											
National Shares (2B=20%)											

Conditioned Operating Model

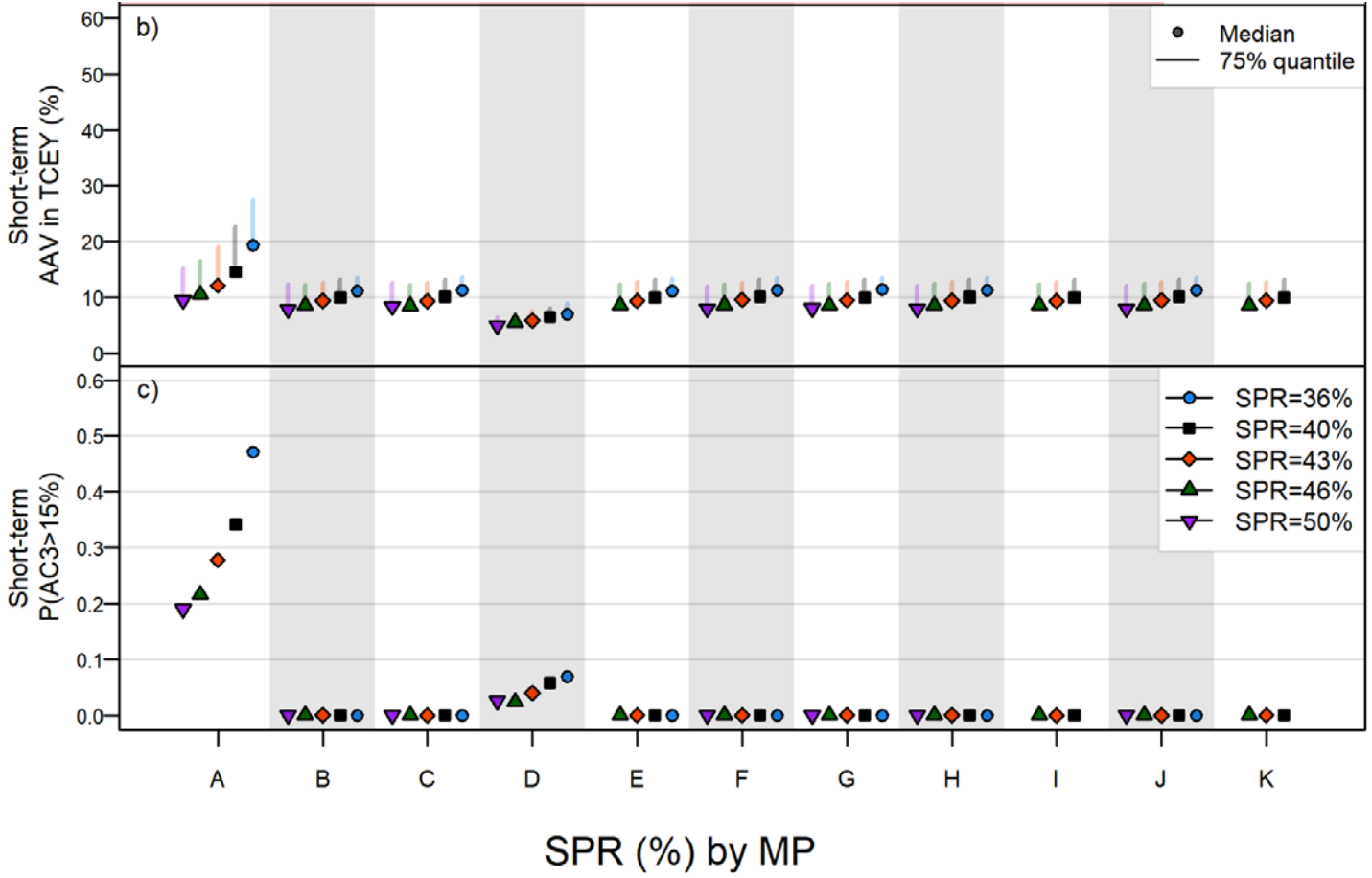
- Four Biological Regions
- 33 fisheries
- Fit to multiple sources of information



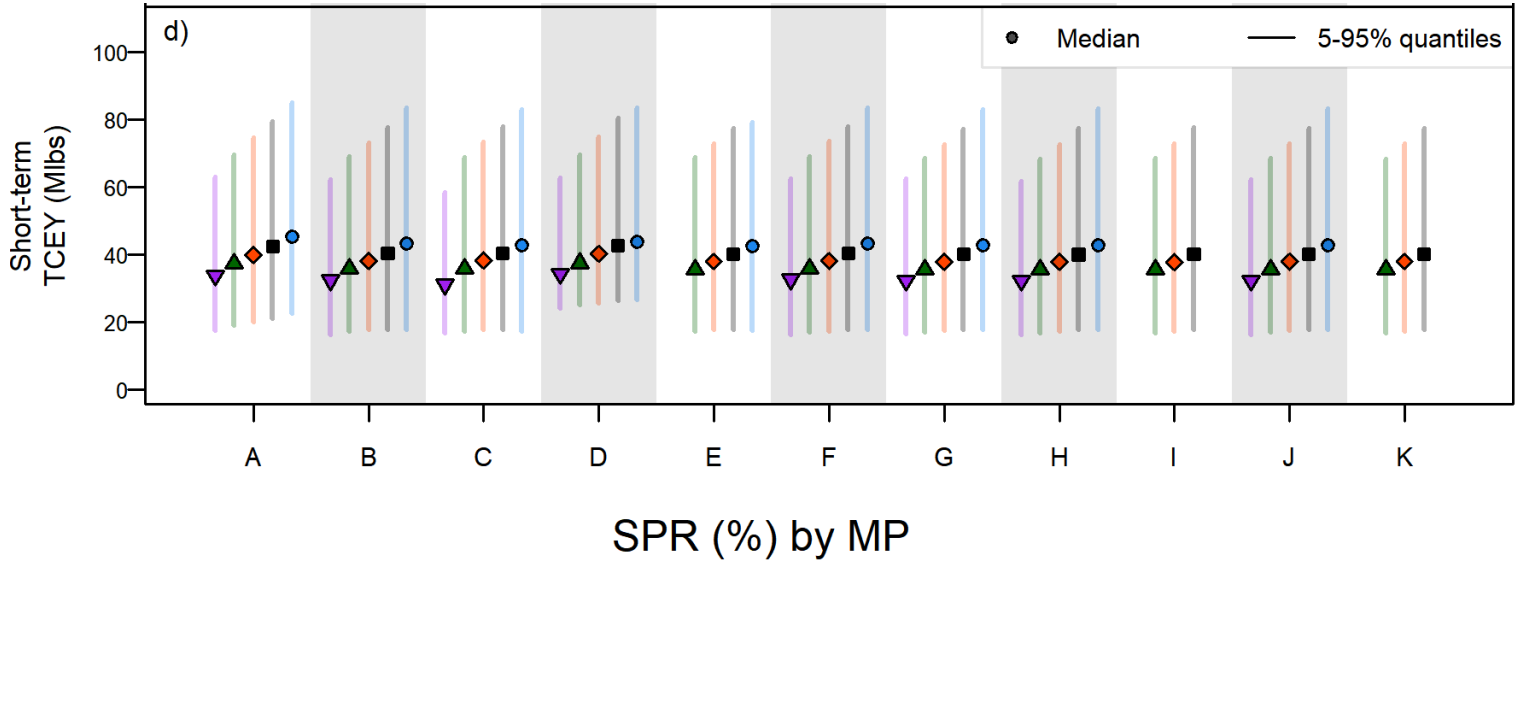
Coastwide sustainability metrics



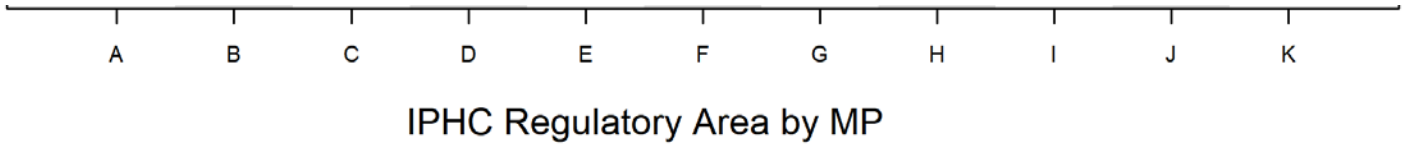
Coastwide stability performance metrics



Coastwide Yield performance metrics



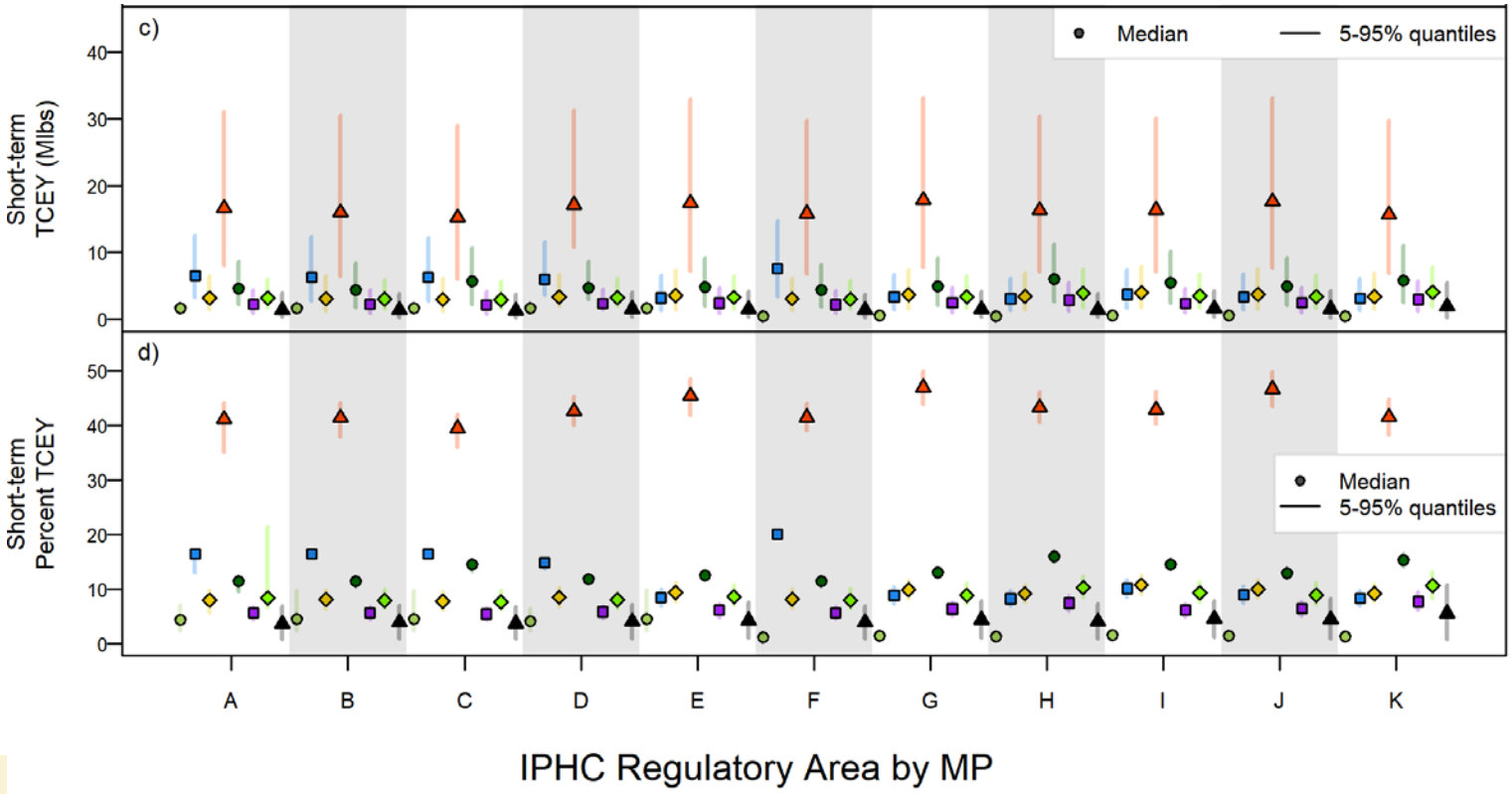
Stability metrics by IPHC Regulatory Area



IPHC Regulatory Area by MP

SPR=43%

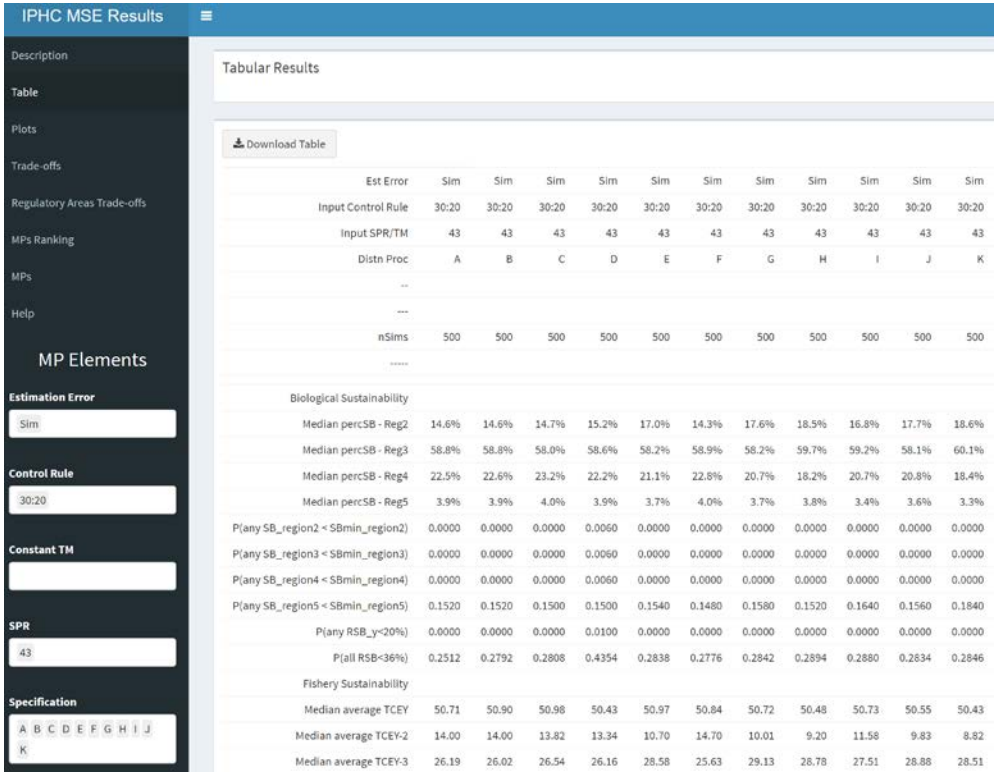
Yield metrics by IPHC Regulatory Area



SPR=43%

MSE Explorer

- Interactive tool
- All results
- Additional MPs
- Additional Metrics
- Table, plots, ranks



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

Are Sustainability objectives met?

Objectives	PMs	Sim 30:2043 MPA	Sim 30:2043 MPB	Sim 30:2043 MPC	Sim 30:2043 MPD	Sim 30:2043 MPE	Sim 30:2043 MPF	Sim 30:2043 MPG	Sim 30:2043 MPH	Sim 30:2043 MPI	Sim 30:2043 MPJ	Sim 30:2043 MPK
Maintain a min prop of female SB	$P(p_{sb,r=2} > 5\%)$	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maintain a min prop of female SB	$P(p_{sb,r=3} > 33\%)$	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maintain a min prop of female SB	$P(p_{sb,r=4} > 10\%)$	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maintain a min prop of female SB	$P(p_{sb,r=4B} > 2\%)$	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.15	0.16	0.16	0.18
Maintain a female SB above a biomass limit reference point 95% of the time	$P(SB < SB_{Lim})$	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Ranking Management Procedures

- Fishery objectives can be ranked using metrics
- Provides a quick evaluation of many MPs

	A	B	C	D	E	F	G	H	I	J	K
Median TCEY	39.9	38.2	38.3	40.2	38.0	38.2	37.9	37.9	37.9	37.9	38.0
Rank	2	4	3	1	6	4	8	8	8	8	6

Summary Ranks over Regulatory Areas

Objective	Performance Metric	A	B	C	D	E	F	G	H	I	J	K
Maintain the coastwide female SB above a target	$P(SB < SB_{36\%})$	11	4	4	1	4	4	4	2	2	4	4
Limit AC in coastwide TCEY	$P(AC_3 > 15\%)$	11	1	1	10	1	1	1	1	1	1	1
Limit AAV in coastwide TCEY	Median AAV TCEY	11	3	2	1	3	8	8	3	3	8	3
Optimize average coastwide TCEY	Median TCEY	9.75	7.25	6.75	1.75	7	5.62	6	5.88	5.75	2.5	3.5
Limit AC in Reg Areas TCEY	$P(AC_3 > 15\%)$ Reg Areas	8.62	7	7.12	1.75	7.38	6.38	6	5.12	6.25	3.5	4
Limit AAV in Reg Areas TCEY	Median AAV TCEY Reg Areas	1	3	3	1	3	3	3	3	3	3	3
Optimize Reg Areas TCEY	Median TCEY Reg Areas	8.5	6.62	7.5	6.12	5.25	7.62	4.88	5.38	4.25	3.62	4.12
Optimize TCEY % among Reg Areas	Median % TCEY Reg Areas	6.38	4	3.75	1.75	2.62	4.5	3.25	3	2.88	2.5	3.12
Maintain minimum TCEY by Reg Areas	Median Min(TCEY) Reg Areas	3.62	4.75	4.25	3.12	3.75	5.5	3.5	4.5	3.12	3.5	3.88
Maintain minimum % TCEY by Reg Areas	Median Min(% TCEY) Reg Areas	8.25	6.75	7.62	6.5	5	7.5	4.38	4.88	4	4.25	4.5

Summary ranks by general objective

Objective	Performance Metric	A	B	C	D	E	F	G	H	I	J	K
2.1 Maintain the coastwide female SB above a target	$P(SB < SB_{Targ})$	11	4	4	1	4	4	4	2	2	4	4
2.2 Limit catch variability	Limit annual change	10.1	4.56	4.22	3.62	4.59	5.25	5.25	3.75	4	3.75	2.88
2.3 Provide directed fishing yield	Optimize TCEY and maintain minimum TCEY in Reg Areas	5.55	5.02	5.22	3.7	3.92	5.62	3.8	4.15	3.45	3.37	3.72

MP elements: Fishing Intensity

- SPR
  - Large effect on coastwide and population metrics
  - Therefore, affects all IPHC Regulatory Areas
- Constraints
  - Reduces variability in TCEY
  - Different constraints have slightly different effects

MP elements: Stock distribution

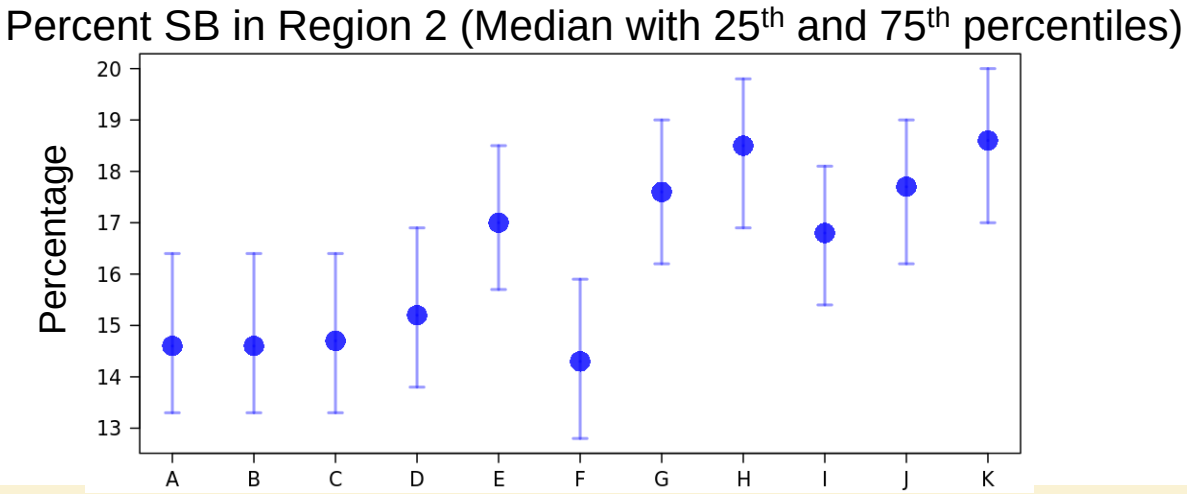
- O32
  - Averaging reduces variability (especially 4B)
- All sizes
  - Small differences for each Regulatory Area
- Regional distribution
  - Small differences for each Regulatory Area
  - Many possibilities for distribution within a Region

MP elements: Relative harvest rates

- Relative harvest rates (0.75 or 1 in 3B, 4A, 4CDE)
  - Slight reduction in coastwide TCEY and AAV
  - Increased TCEY in Regulatory Areas with increased relative HR
  - Decrease TCEY in Regulatory Areas with decreased relative HR
- Effect of migration assumptions
  - Would be worth examining alternative assumptions

MP elements: 2A & 2B agreements

- Overall
  - Tradeoffs between these regulatory areas and others
  - Affects percentage of Spawning Biomass in Region 2



MP with SPR=46%

General Conclusions: coastwide

- Coastwide TCEY was mainly affected by SPR
  - SPR=43% performs well
  - SPR=40% drops below target more than 50% of sims
- 30:20 control rule keeps SB above limit of 20%
- Constraints maintain stability in TCEY

General Conclusions: Areas

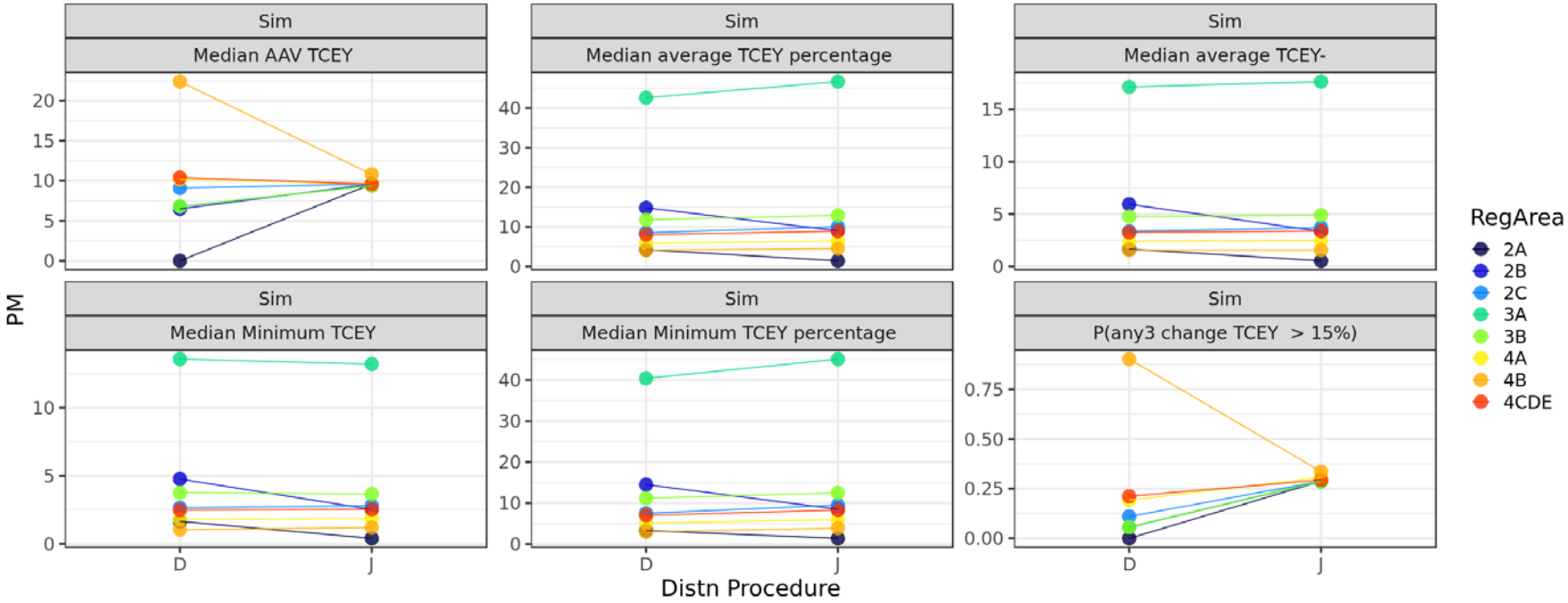
- There are many trade-offs between areas
- MPs without the agreements tended to perform better when considering all IPHC Regulatory Areas
- **MP-D** performed well because it allowed the coastwide TCEY to increase to accommodate agreements
  - A trade-off between coastwide and area stability,
  - A higher fishing intensity that is variable
- Variability in stock distribution has a large effect on stability
- Different metrics would be useful for MP elements that are fixed for a period of years

Best performing MPs

- **MP-D** and **MP-J** were overall ranked best

MP-D	MP-J
• More variability in coastwide TCEY – Flexibility for agreements • SPR is variable and not known exactly – Rarely lower than 40%	• More stable coastwide TCEY • Higher TCEY in areas other than 2A and 2B • Could use lower SPR for slightly more yield without exceeding target tolerance

Compare MP-D and MP-J short-term



- Medium-term shows improved stability for MP-J

Elements

MP-D	MP-J
• *SPR-buffer* allows the TCEY to increase by increasing the fishing intensity • Agreements for 2A and 2B	• 5-year average for stock distribution

- Smoothing stock distribution improved stability in yield
- SPR-buffer allowed for agreements, but with increased risk to stock
- SPR could possibly be reduced slightly for MP-J
  - increase coastwide fishing intensity

Possible work between IM096 and AM097

1) IPHC Secretariat to further improve the operating model, and test the two ‘optimal’ MPs **D** and **J**, based on direction from IM096.

2) IPHC Secretariat to create a new MP for evaluation from best performing elements and directives at IM096.

Recommendations

a) **NOTE** paper IPHC-2020-IM096-11 Rev_1 which provides a description of the IPHC MSE framework and simulations of management procedures for distributing the TCEY.

b) **RECOMMEND** the use of the MSE framework to evaluate management procedures incorporating scale and distribution elements.

c) **RECOMMEND** a management procedure that best meets Commission objectives and accounts for trade-offs between yield and yield stability, in IPHC Regulatory Areas.

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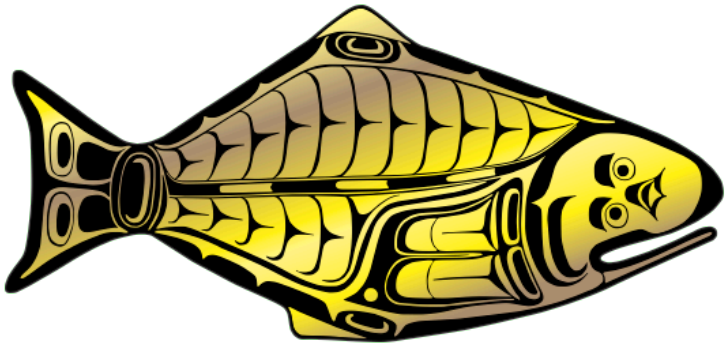

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