



INTERNATIONAL PACIFIC



HALIBUT COMMISSION

IPHC MSE Update

Agenda Item 7

IPHC-2019-SRB014-08

14th Meeting of the IPHC Scientific Review Board (SRB014)

Outline

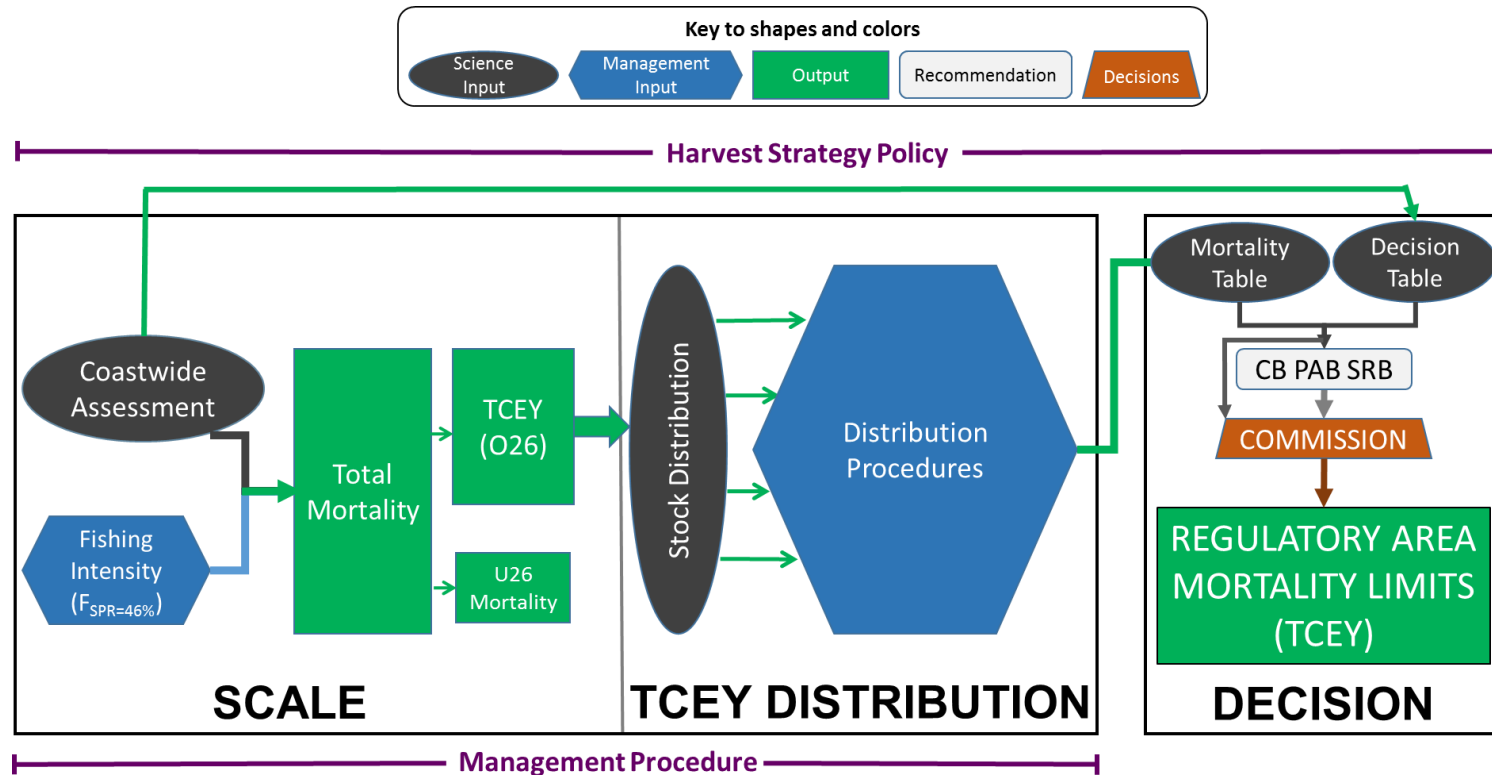
- Brief review
- Update from MSAB013
 - Goals & objectives
 - Coastwide simulation results
 - Distribution framework
- Timeline and SRB deliverables

Management Strategy Evaluation (MSE)

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



Management Procedure



Goals and primary objectives (coastwide)

1. Biological Sustainability (conservation goal)
 - 1.1. Keep biomass above a limit to avoid critical stock sizes
2. Optimise directed fishing opportunities (fishery goal)
 - 2.1. Maintain spawning biomass around a level (i.e., a target biomass reference point) that optimises fishing activities
 - 2.2. Limit catch variability
 - 2.3. Maximize directed fishing yield
3. Minimize discard mortality
4. Minimize bycatch and bycatch mortality

AM095-R (para. 59):
develop a conservation
objective that meets a
spawning biomass
target


Biological Sustainability objectives: update

| GENERAL OBJECTIVE | MEASURABLE OBJECTIVE | MEASURABLE OUTCOME | TIME-FRAME | TOLERANCE |
|--|--|---|-------------------------|-------------|
| 1.1. KEEP BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES Biomass Limit | Maintain a minimum female spawning stock biomass above a biomass limit reference point at least 95% of the time | $SB < \text{Spawning Biomass Limit } (SB_{Lim})$ $SB_{Lim} = 20\%$ unfished SB | Long-term, 10-yr period | 0.05 |

Consistent with MSC

Updated tolerance

Primary fishery objectives: target biomass

| GENERAL OBJECTIVE | MEASURABLE OBJECTIVE | MEASURABLE OUTCOME | TIME-FRAME | TOLERANCE |
|---|---|--|------------|-----------|
| *2.1 MAINTAIN SPAWNING BIOMASS AROUND A LEVEL THAT OPTIMISES FISHING ACTIVITIES  | 2.1A SPAWNING BIOMASS TRIGGER Maintain the female spawning biomass above a trigger reference point at least 80% of the time | SB < Spawning Biomass Trigger (SB_{Trig}) $SB_{Trig} = SB_{30\%}$ unfished spawning biomass | Long-term | 0.20 |
| | *2.1B SPAWNING BIOMASS TARGET Maintain the female spawning biomass above a biomass target reference point at least 50% of the time | SB < Spawning Biomass Target (SB_{Targ}) $SB_{Targ} = SB_{36-45\%}$ unfished spawning biomass | Long-term | 0.50 |

Primary fishery objectives: target biomass

- B_{MSY}
 - Maximizing the yield in the long-term with minimal risk of being less than SB_{Lim} would naturally result in the stock to fluctuate around a target biomass that would sustainably produce MSY (SB_{MSY})
 - Is likely dynamic, depending on regime
 - We plan to use three methods to investigate B_{MSY}
 1. Simple equilibrium model with life-history parameters
 2. Use the 2019 assessment model
 3. MSE coastwide operating model
- B_{MEY}
 - Proxy of $1.2 \times B_{MSY}$
 - Economist will help understand MEY

Primary fishery objectives: stability

| GENERAL OBJECTIVE | MEASURABLE OBJECTIVE | MEASURABLE OUTCOME | TIME-FRAME | TOLERANCE |
|------------------------------|--|--|-------------------|------------------|
| 2.2. LIMIT CATCH VARIABILITY | Limit annual changes in the coastwide TCEY | Average Annual Variability (AAV) > 15% | Short-term | 0.25 |

Primary fishery objectives: maximize yield

- Maximizing the yield was used instead of maintaining the catch above a specified level.
 - Need to define the minimum catch level (and a tolerance)

| GENERAL OBJECTIVE | MEASURABLE OBJECTIVE | MEASURABLE OUTCOME | TIME-FRAME | TOLERANCE |
|--------------------------------------|---|---|------------|-----------------------|
| 2.3. MAXIMIZE DIRECTED FISHING YIELD | Maintain TCEY above a minimum level coastwide | Coastwide TCEY < $TCEY_{min}$ $TCEY_{min} = ???$ | Short-term | ?? |
| 2.3. MAXIMIZE DIRECTED FISHING YIELD | Maximize average TCEY coastwide | Median coastwide TCEY | Short-term | STATISTIC OF INTEREST |

Define

Additional objectives and performance metrics

- See Appendix I of IPHC-2019-MSAB013-07
- Many of these are *statistics of interest*, which means that they are reported as a metric without a tolerance assigned

Prioritizing coastwide objectives

- No specific prioritization determined with new target objective
- Conservation objective must be met first
- Stability objective is also very important
- Maximizing catch is generally after all objectives have been met

Conservation objectives related to distribution

Conserve spatial population structure

- Relative to biological regions

[IPHC-2018-SRB012-R](#): “the SRB AGREED that the defined Bioregions (i.e. 2,3,4, and 4b described in paper [IPHC-2018-SRB012-08](#)) are presently the best option for implementing a precautionary approach given uncertainty about spatial population structure and dynamics of Pacific halibut.”

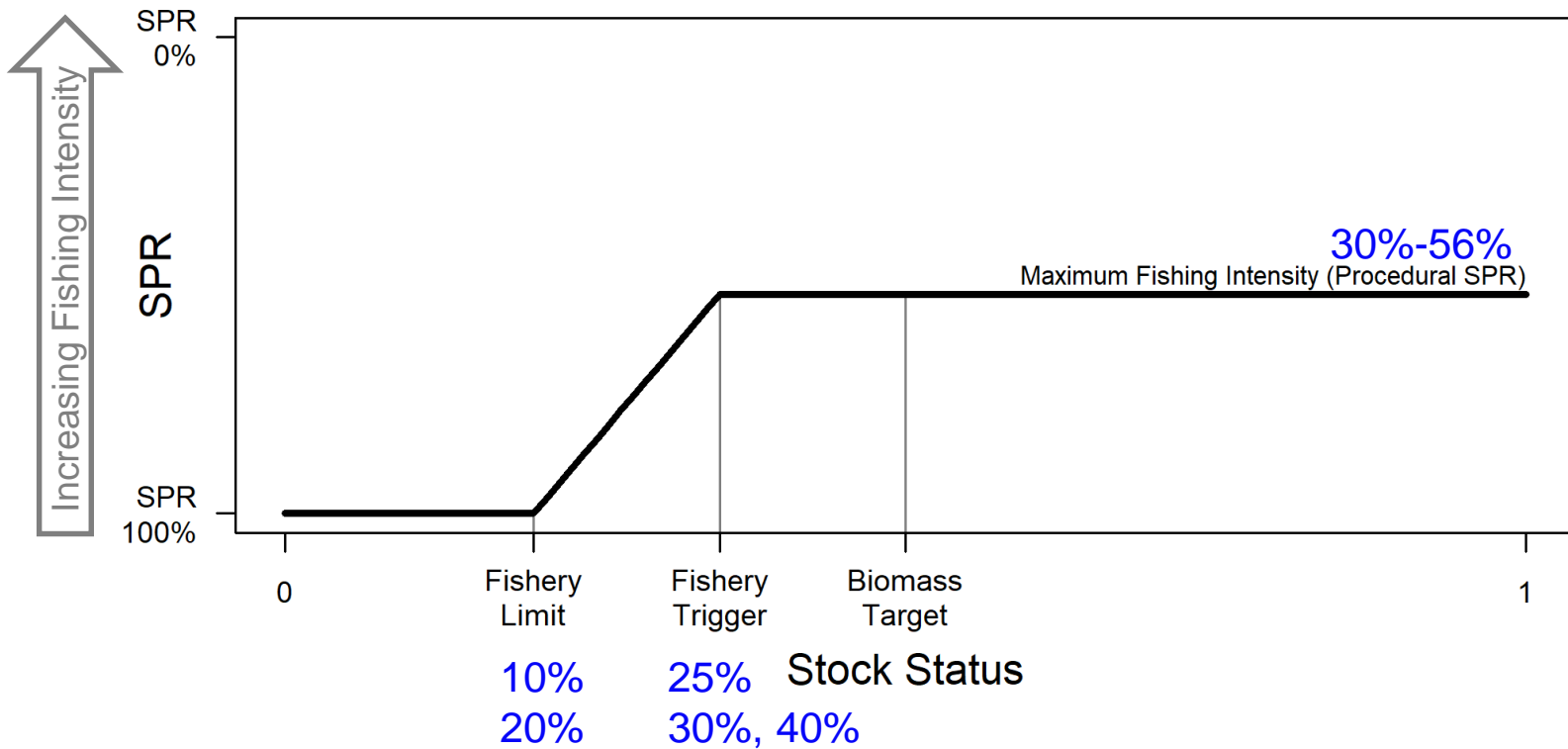
Fishery objectives related to distribution

Relative to IPHC Regulatory Areas

- Limit catch variability
- Maximize directed fishery yield
- Minimize potential for no catch limit for directed fishery

Scale Management Procedure

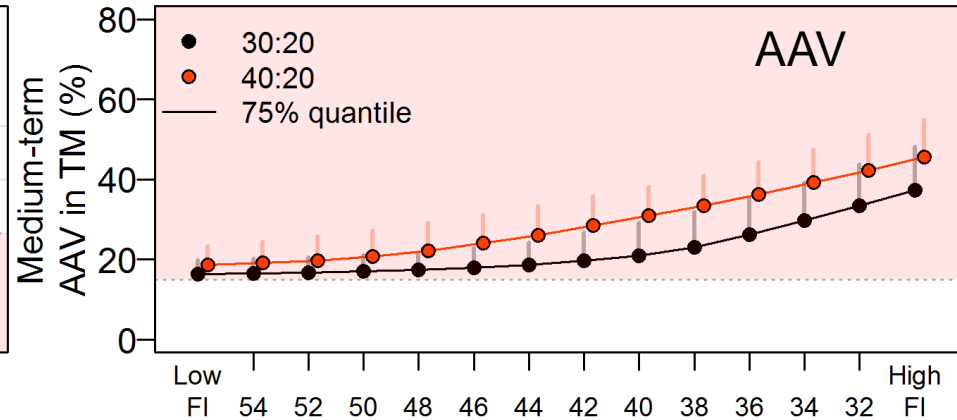
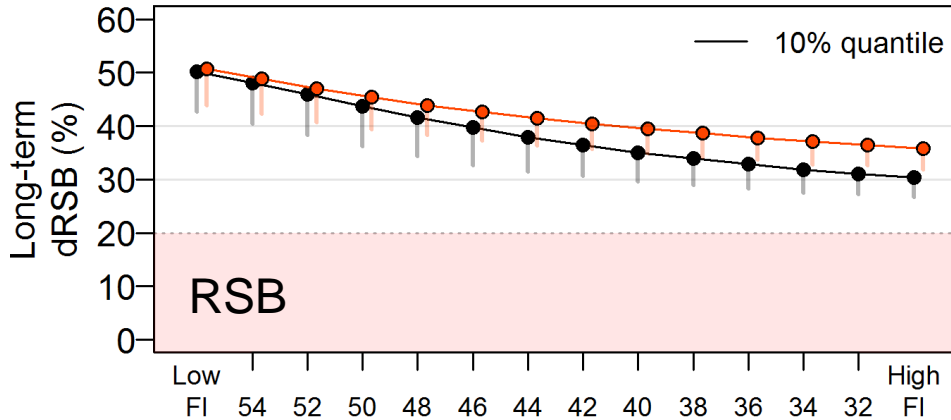
Harvest Control Rule



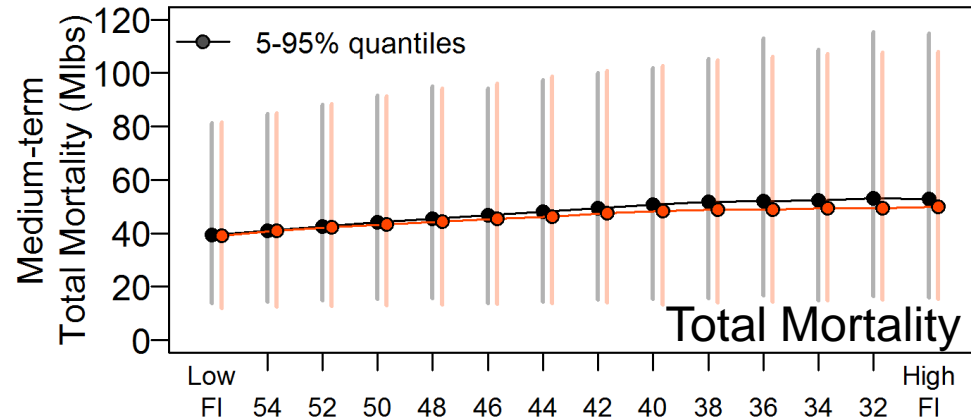
Simulation Results: Performance metrics

- Three performance metrics
 1. RSB: dynamic relative spawning biomass, long-term
 - A measure of stock status
 - Avoid going below 20% more than 10% of the time
 2. AAV: average annual variability, medium-term
 - Average percent change in TM limit from year to year
 - Avoid going above 15% more than 25% of the time
 3. TM: total mortality limit, medium-term
 - Maximize the median value

Performance metrics (40:20 & 30:20 CRs)



- Bio objective satisfied for all procedures
- AAV objective not satisfied for all procedures
- Median TM increases slightly and range increases with FI



Results table

| Input Control Rule | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 | 30:20 |
|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Input SPR | 56% | 48% | 46% | 44% | 42% | 40% | 38% | 36% | 34% | 32% | 30% | |
| Biological Sustainability (Long-term) | | | | | | | | | | | | |
| P(all RSB<20%) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| P(any RSB_y<20%) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 |
| Fishery Sustainability (medium-term) | | | | | | | | | | | | |
| P(all AAV > 15%) | 0.60 | 0.66 | 0.69 | 0.72 | 0.76 | 0.80 | 0.84 | 0.88 | 0.93 | 0.96 | 0.98 | |
| Median average TM | 39.4 | 45.5 | 46.8 | 48.0 | 49.5 | 50.6 | 51.8 | 52.1 | 52.4 | 53.2 | 52.8 | |
| Rankings (lower is better) over all management procedures without a constraint (Table 3, Table 4, and Table 5) | | | | | | | | | | | | |
| Meet biological objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Meet stability objective? | No | No | No | No | No | No | No | No | No | No | No | No |
| Maximum catch (TM) | 30 | 27 | 24 | 21 | 14 | 11 | 9 | 8 | 7 | 4 | 5 | |
| Overall Ranking | — | — | — | — | — | — | — | — | — | — | — | — |

Ranking results (lower is better)

| CR | Input SPR | 56% | 48% | 46% | 44% | 42% | 40% | 38% | 36% | 34% | 32% | 30% |
|-------|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 30:20 | Meet biological objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | Meet stability objective? | No | No | No | No | No | No | No | No | No | No | No |
| | Maximum catch (TM) rank | 30 | 27 | 24 | 21 | 14 | 11 | 9 | 8 | 7 | 4 | 5 |
| | Overall Ranking | — | — | — | — | — | — | — | — | — | — | — |
| 40:20 | Meet biological objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | Meet stability objective? | No | No | No | No | No | No | No | No | No | No | No |
| | Maximum catch (TM) rank | 32 | 29 | 27 | 25 | 22 | 20 | 18 | 17 | 16 | 14 | 13 |
| | Overall Ranking | — | — | — | — | — | — | — | — | — | — | — |
| 25:10 | Meet biological objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No |
| | Meet stability objective? | No | No | No | No | No | No | No | No | No | No | No |
| | Maximum catch (TM) rank | 30 | 26 | 23 | 19 | 12 | 10 | 6 | 3 | 2 | 1 | — |
| | Overall Ranking | — | — | — | — | — | — | — | — | — | — | — |

Recommendation from MSAB012

MSAB012–Rec.03 (para. 37) The MSAB **RECOMMENDED** that a coastwide fishing intensity SPR should not be lower than 40% nor higher than 46%, with a target SPR of 42%-43% with a 30:20 HCR.

Additional MPs from MSAB012

MSAB012–Req.03 (para. 40) The MSAB **REQUESTED** that additional MPs components be considered to meet the objective of catch stability. The IPHC Secretariat may consider the following MPs, but is **ENCOURAGED** to explore other options to report at SRB014.

- a) 25:10 control rule, and other control rules, as possible, potentially including 30:10 and 30:15 and 30:20;
- b) Multi-year quotas, defined as setting the TCEY in one year and sticking with the same TCEY in one or more following years, noting that AAV may not be an appropriate metric to measure variability
- c) Limiting change in catch limits from the previous year to +/-15% per year, in addition to other relevant percentages, with the goal of finding MPs that meet the main objectives
- d) Limiting change in catch limits from the previous year to a maximum increase of 15% per year with no limit on decreasing the catch limit
- e) Slow up (33% of the change in TCEY), fast down (-50% of the change in TCEY).

Additional MPs: SRB013 foresight

SRB013–Req.02 (para. 29) The SRB **REQUESTED** that in future iterations of the MSE, the IPHC Secretariat and MSAB consider:

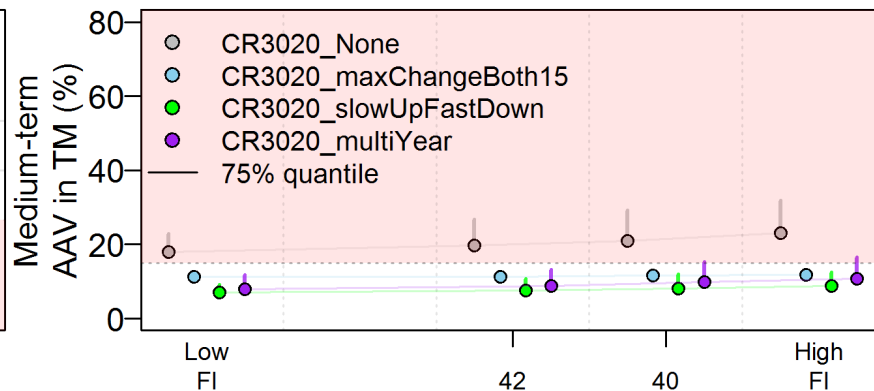
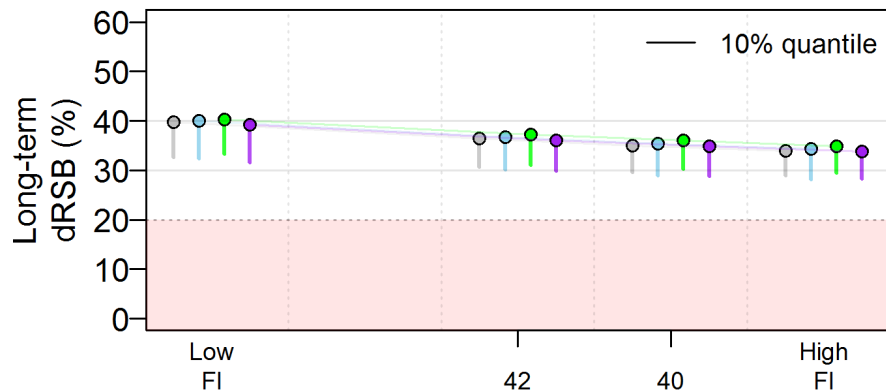
- b) a management procedure include a constraint on the TMq change to be consistent with the maximum change that has happened historically;
- c) the current conditioned operating model be used to simulate a coast-wide survey index and that such data be used to consider an alternative survey-based management procedure (this may provide a more transparent TMq-setting algorithm than the current SPR based control-rule and help with MSAB deliberations).

Constrained Management Procedures

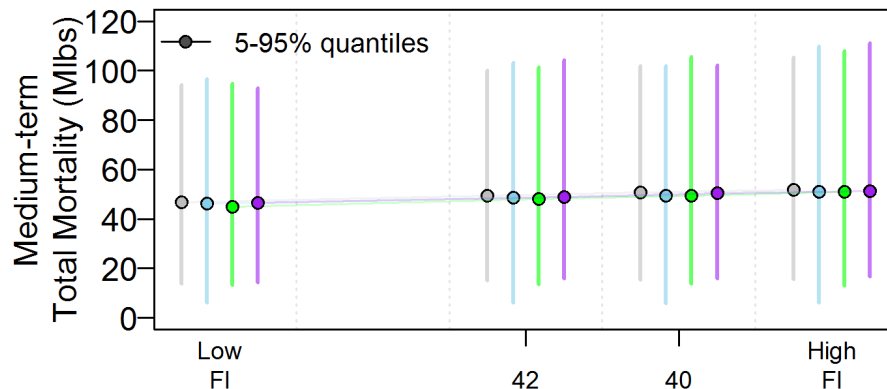
- 1) **MaxChangeBoth15%** & 2) **MaxChangeBoth20%**
 - TM limit constrained to change no more than **15%** or **20%**
- 3) **MaxChangeUp15%**
 - TM limit constrained to increase no more than 15%
- 4) **SlowUpFastDown** & 5) **SlowUpFullDown**
 - TM limit increases by 1/3rd of increase suggested by harvest control rule
 - TM limit decreases by 1/2 or **full** of decrease suggested by harvest control rule
- 6) **Cap60** & 7) **Cap80**
 - TM limit cannot exceed **60** or **80** Mlb
- 8) **Multi-year**
 - Set the TM limit every third year

**All use a
30:20 control rule**

Constrained results



- Bio objective satisfied for all procedures
- AAV objective satisfied for some constraints
- Median TM slightly higher with increasing FI



SPR (%)

SRB014

Slide 24

Ranking constrained results (lower is better)

| Constraint Input SPR | maxChangeBoth15% | | | | slowUp FastDown | | | | multiYear | | | |
|----------------------------|------------------|----------|----------|----------|-----------------|----------|----------|----------|-----------|----------|-----|-----|
| | 46% | 42% | 40% | 38% | 46% | 42% | 40% | 38% | 46% | 42% | 40% | 38% |
| Meet biological objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Meet stability objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No |
| Maximum catch (TM) | 20 | 14 | 9 | 4 | 23 | 15 | 9 | 2 | 17 | 13 | 6 | 1 |
| Overall Ranking | 10 | 6 | 3 | 2 | 11 | 7 | 3 | 1 | 9 | 5 | --- | --- |

| Constraint Input SPR | maxChangeBoth20% | | | | maxChangeUp | | slowUp FullDown | | | Cap80 | | Cap60 | |
|----------------------------|------------------|-----|-----|-----|-------------|-----|-----------------|----------|-----|-------|-----|-------|-----|
| | 46% | 42% | 40% | 38% | 46% | 40% | 46% | 42% | 40% | 46% | 40% | 46% | 40% |
| Meet biological objective? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Meet stability objective? | No | No | No | No | No | No | Yes | Yes | No | No | No | No | No |
| Maximum catch (TM) | 17 | 12 | 8 | 2 | 25 | 22 | 24 | 16 | 11 | 19 | 5 | 20 | 7 |
| Overall Ranking | --- | --- | --- | --- | --- | --- | 12 | 8 | --- | --- | --- | --- | --- |

MSE Explorer

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

Additional Management Procedures

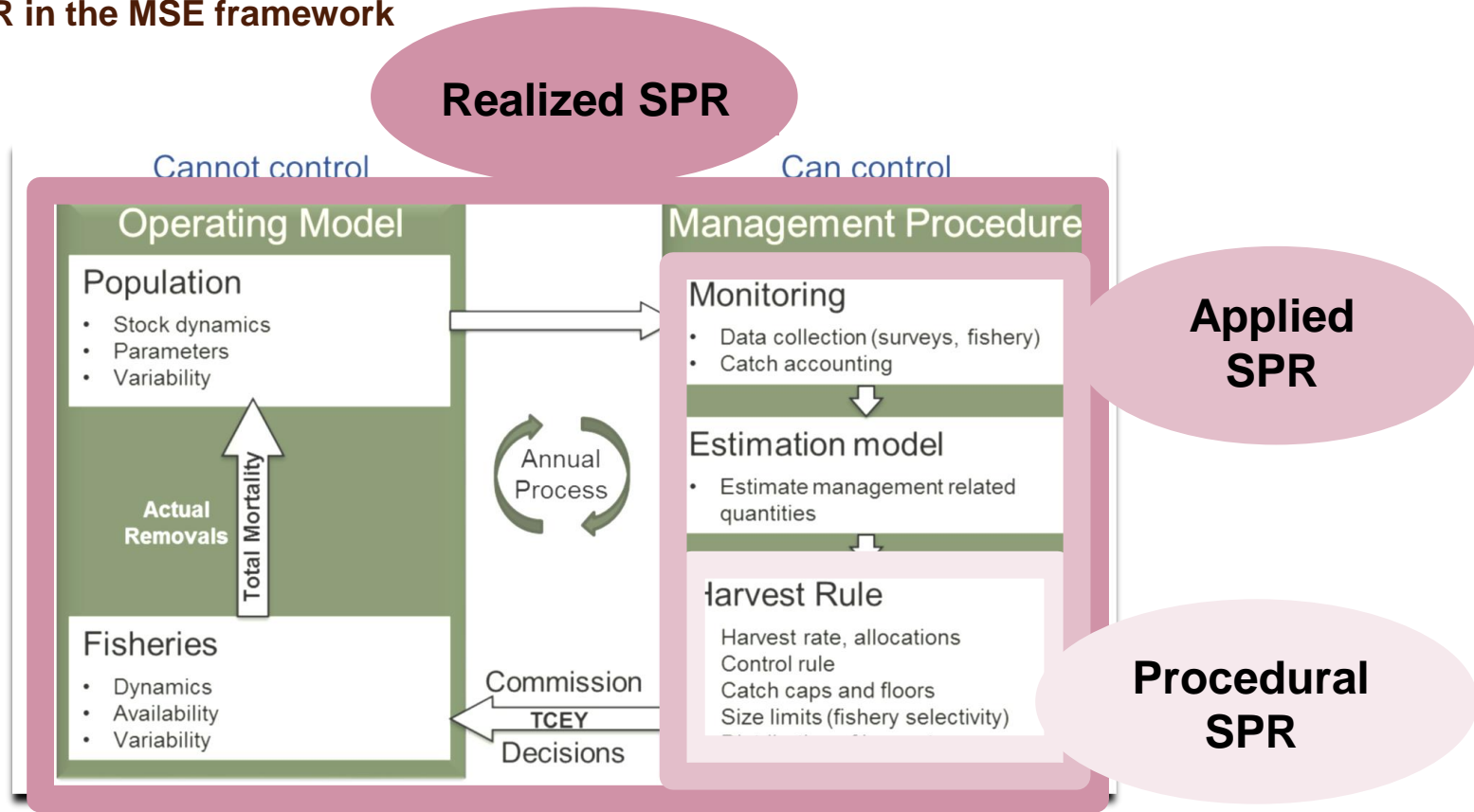
- Other control rules
- MP based on coastwide survey index

AM095-R (para. 52.) The Commission **NOTED** the potential benefits in terms of transparency and simplicity, of a management procedure setting mortality limits directly from modelled survey results, particularly for long-lived species where year-to-year demographic change will be relatively minor.

Meaning of SPR in the MSE framework

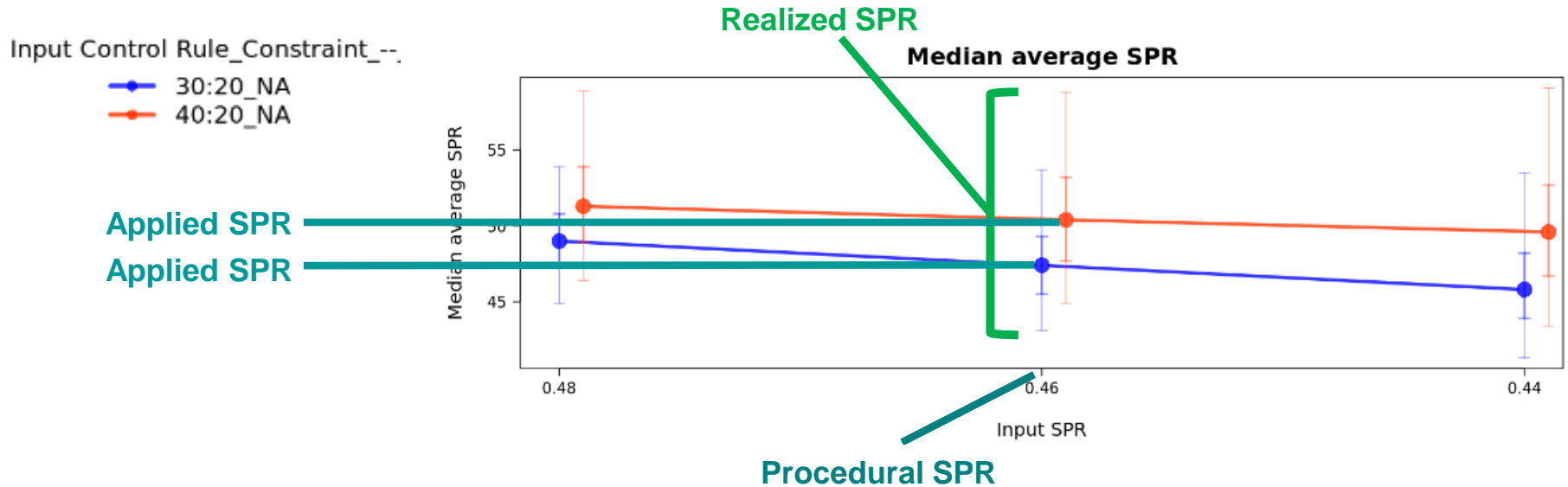
- **Procedural SPR (pSPR):** the biological target of the management strategy.
- **Applied SPR (aSPR):** the SPR generated from the management procedure after the application of the harvest control rule, which includes uncertainty on stock status.
- **Realized SPR (rSPR):** the resulting SPR that includes all the uncertainties (OM + Assessment + application of control rule).

Meaning of SPR in the MSE framework



Example 1

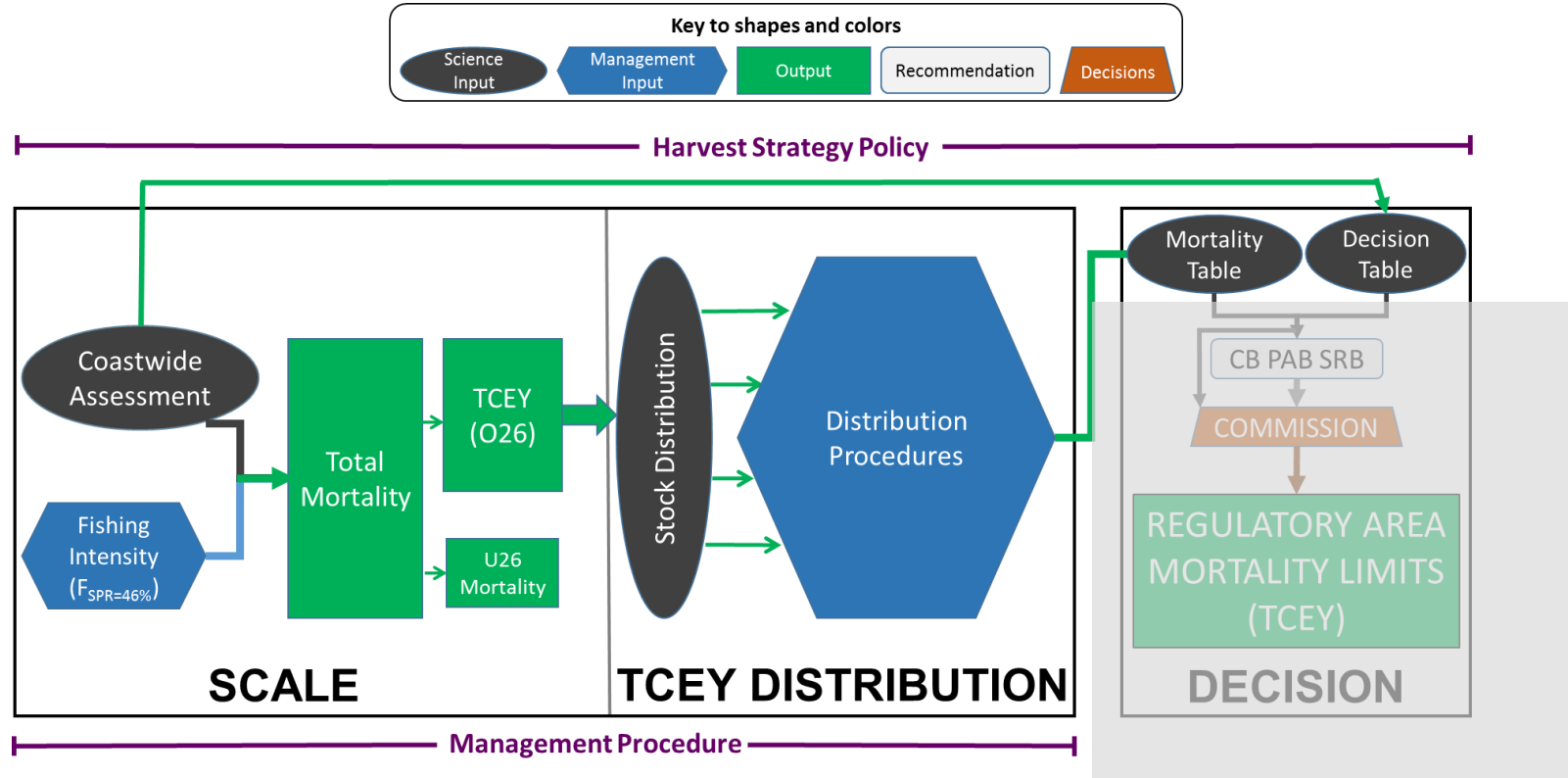
Effect of two different CRs on the aSPR and on the rSPR.



Distribution Framework

*AM095-R (para. 62). The Commission **RECOMMENDED** that the MSAB and IPHC Secretariat continue its program of work on the Management Procedure for the Scale portion of the harvest strategy, **NOTING** that Scale and Distribution components will be evaluated and presented no later than at AM097 in 2021, for potential adoption and subsequent implementation as a harvest strategy*

Management Procedure



Foundations for distributing the TCEY

There are two foundations for the elements in the TCEY distribution procedure

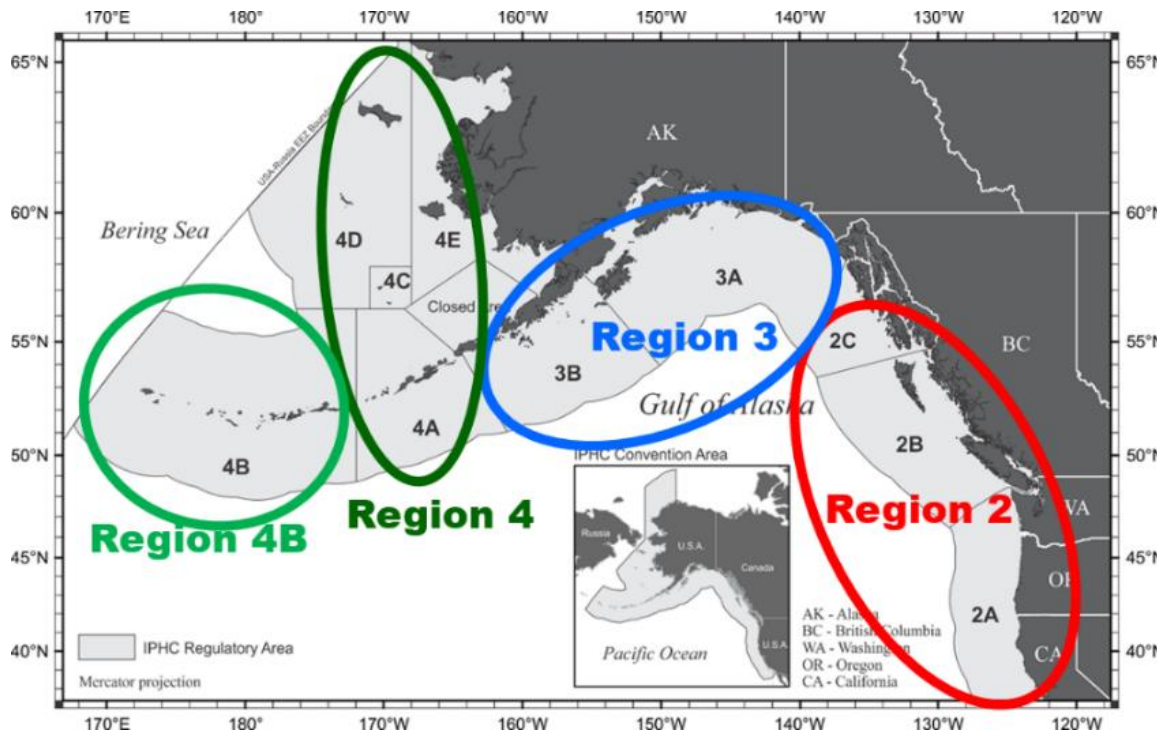
- 1. Science-based:** understanding of biology, based on analysis of observations and data from the stock to meet biological objectives
- 2. Management-derived:** procedure to distribute TCEY, based on any method, to meet biological and fishery objectives

Recent Interim MP

- **Stock Distribution** (science-based foundation)
 - The proportion of the stock in IPHC Regulatory Areas
 - Estimated from the space-time model mean WPUE indices for each IPHC Regulatory Area
 - Uses O32 WPUE index
 - Linked to Biological Sustainability objectives
- **Relative Harvest Rates** (both foundations)
 - Shift stock distribution to account for additional factors
 - Lower productivity in western areas (3B, 4A, 4B, and 4CDE)
 - Quantity and quality of data (e.g., uncertainty)
 - $\frac{3}{4}$ relative harvest rate in western areas

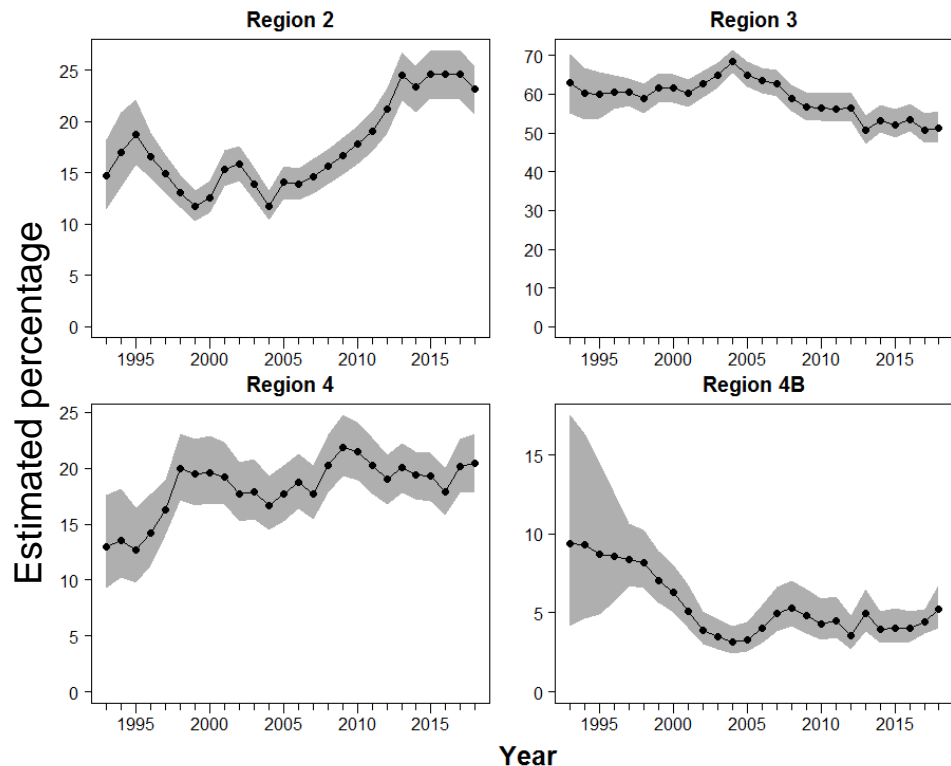
Changes to Stock Distribution

- Use Biological Regions
 - Best option for biologically-based areas to meet management needs



Changes to Stock Distribution

- All-sizes WPUE is more similar to TCEY
 - TCEY is over 26 inches (O26)
 - “All-sizes” is predominately O26



Changes to Relative Harvest Rates

- Apply by Biological Region
- Conduct research on productivity in each Region
- Enumerate uncertainty of data in each Region
- Consider other factors

Future elements for distributing the TCEY to IPHC Regulatory Areas

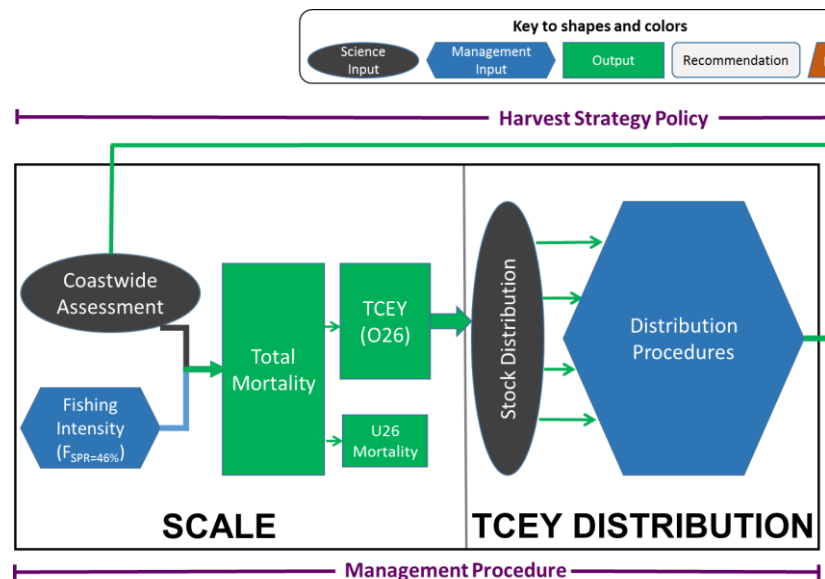
Management foundation

- Procedures based on policy
 - Incorporate other objectives
 - May be based on data
- Examples
 - Use trends from fishery-dependent catch-rates (CPUE)
 - Age or size compositions
 - Economic and social concerns
 - Agreements

Elements of distributing the TCEY

- Coastwide target fishing intensity
- Regional Stock Distribution
- Regional Allocation Adjustment
- Regulatory Area Allocation
 - Various tools have been identified

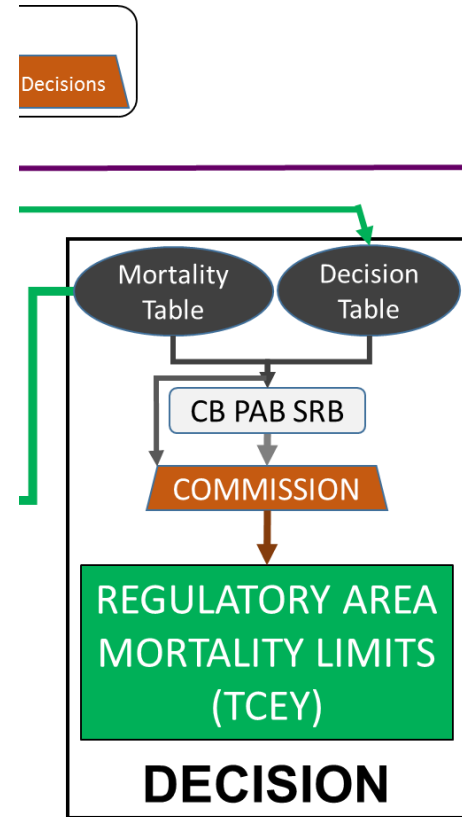
Other orders of elements or procedures may also be evaluated



Decision-Making

Annual Regulatory Area Adjustment





- Adjust Regulatory Area TCEY's to account for other factors as needed
- Policy part of the harvest strategy policy
- May deviate from the management procedure
 - Will have unpredictable consequences



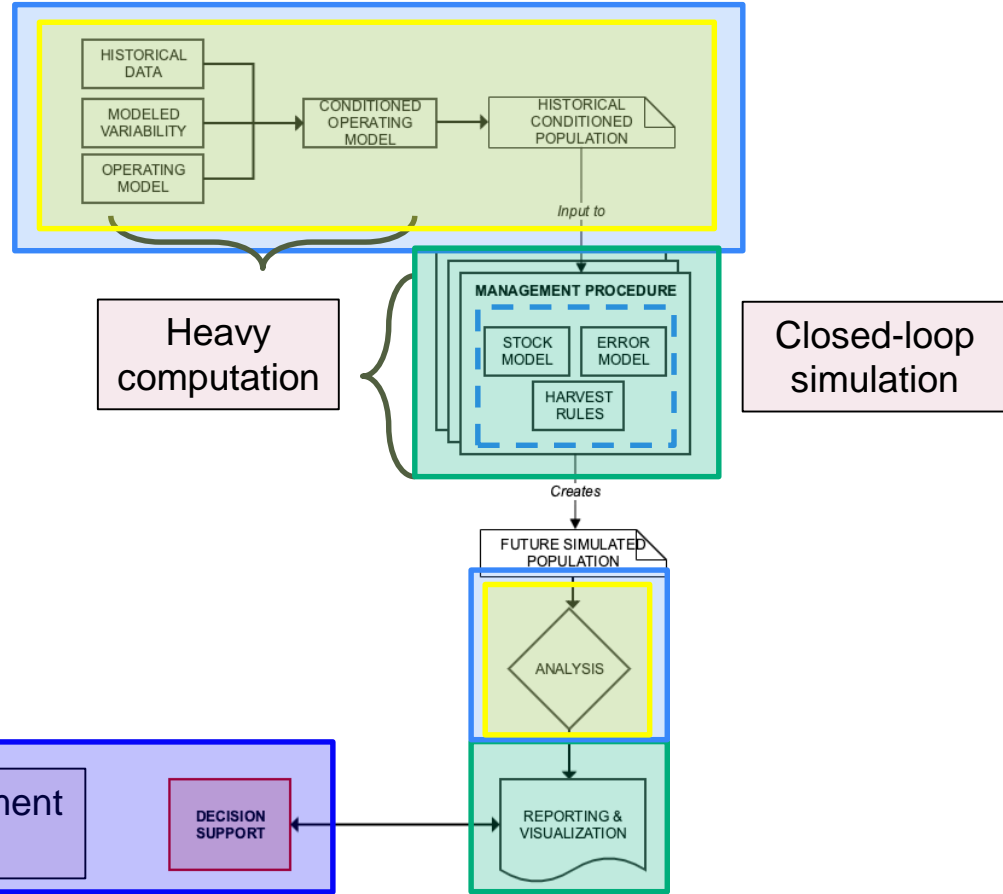
MSE Framework

- Goals
 - Performance
 - Fidelity and reproducible
 - Easy to use
 - Modular, extensible
 - Maintainable

Framework Skeleton

| | Operating Model | Management Procedures | Data Analysis |
|---|-----------------|-----------------------|---------------|
| MSAB  | I | C | I |
| SRB  | C | I | C |
| IPHC  | R/A | R | A |
| Comm.  | I | A | I |

| | | | |
|---|-------------|---|-----------|
| R | Responsible | C | Consulted |
| A | Accountable | I | Informed |



Operating Model Specifications

- Regional biological dynamics
- IPHC Regulatory Area fishery dynamics
- Multiple sectors within each area

- Generalized to accommodate different structures

Operating Model Specifications

- Parameterized using
 - current and past knowledge
 - Input from MSAB and SRB
- Conditioned using data and informed assumptions
- Incorporate variability and uncertainty
- Technical details will be reviewed at SRB015

Program of Work

| |
|--|
| May 2019 MSAB Meeting |
| Evaluate additional Scale MPs |
| Review goals and objectives |
| Identify MPs (Distribution & Scale) |
| Review Framework |
| June 2019 SRB Meeting |
| Review goals and objectives |
| Review final scale results |
| Information on development of distribution framework |
| September 2019 SRB Meeting |
| Review goals and objectives |
| Review technical details of multi-area OM |
| Review development of distribution framework |
| October 2019 MSAB Meeting |
| Review Goals and Objectives |
| Identify MPs (Distribution & Scale) |
| Review Framework |
| Review multi-area model development |
| Annual Meeting 2020 |
| Update on progress |

Program of Work

May 2020 MSAB Meeting

Review goals and objectives

Review multi-area operating model

Review preliminary results to be presented at AM097

June 2020 SRB Meeting

Review goals and objectives

Review multi-area operating model

Review preliminary results

September 2020 SRB Meeting

Review goals and objectives

Review multi-area operating model

Review final results

October 2020 MSAB Meeting

Review Goals and Objectives

Review final results

Annual Meeting 2021

Presentation of first complete MSE product to the Commission

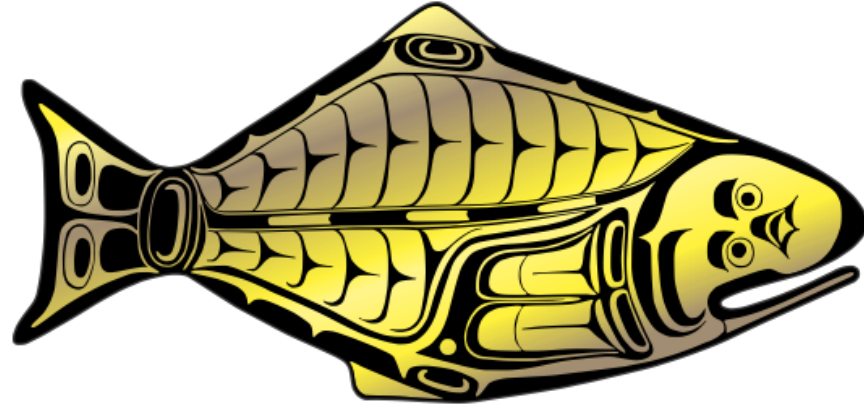
Recommendations on Scale and Distribution MP

SRB014

NOTE:

- paper IPHC-2019-SRB014-08
- the primary objectives used to evaluate management procedures related to coastwide scale
- additional primary objectives related to a target biomass.
- that no coastwide management procedure without constraints met the stability objective.
- that the three different constraints were ranked in the top 5 management procedures (a slow-up fast-down approach, a maximum change of 15%, and a multi-year limit).
- the distribution framework consisting of
 - a coastwide TCEY distributed to Biological Regions based on stock distribution,
 - relative fishing intensities, and
 - other allocation adjustments, distributed to IPHC Regulatory Areas
- the development of a closed-loop simulation framework to evaluate management procedures related to coastwide scale and distribution of the TCEY.
- that the SRB will review the technical details of the MSE framework and operating model in September 2019, and review the full MSE in September 2020
- methods to investigate B_{MSY}

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