
L. Boitor

INTERNATIONAL PACIFIC HALIBUT COMMISSION

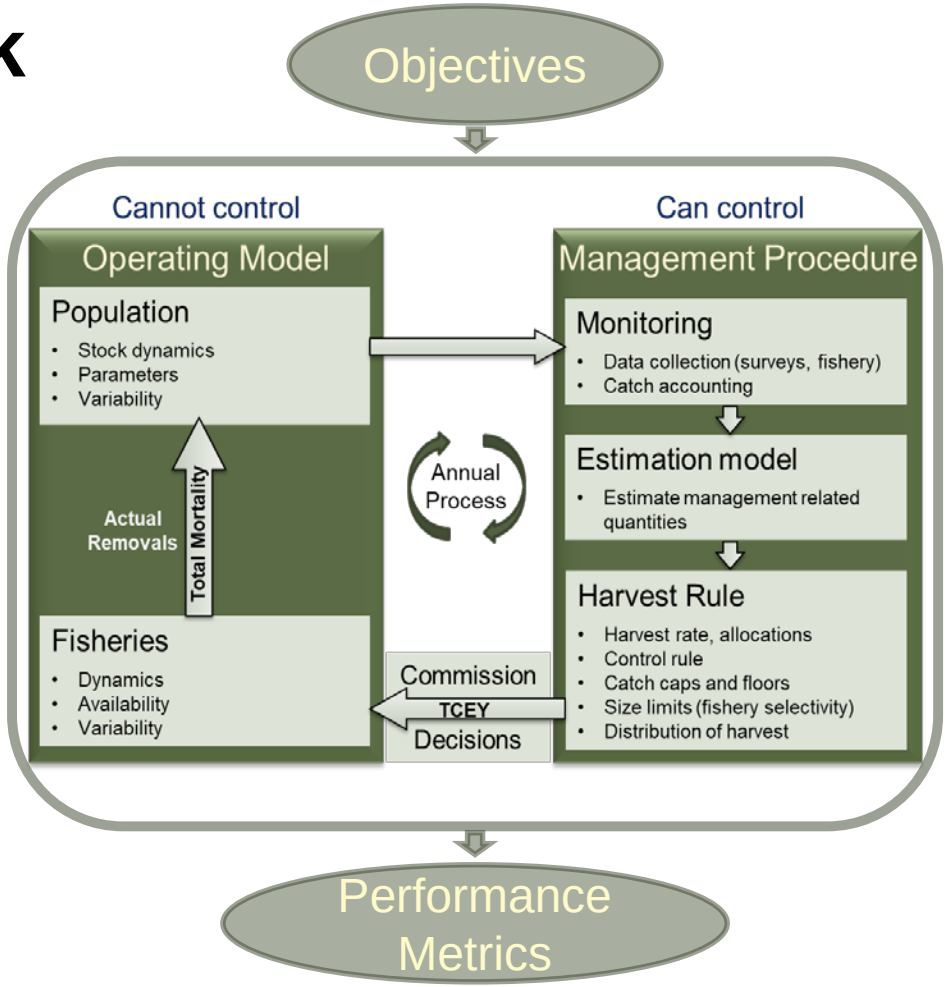
MSE Framework

Agenda Item 5

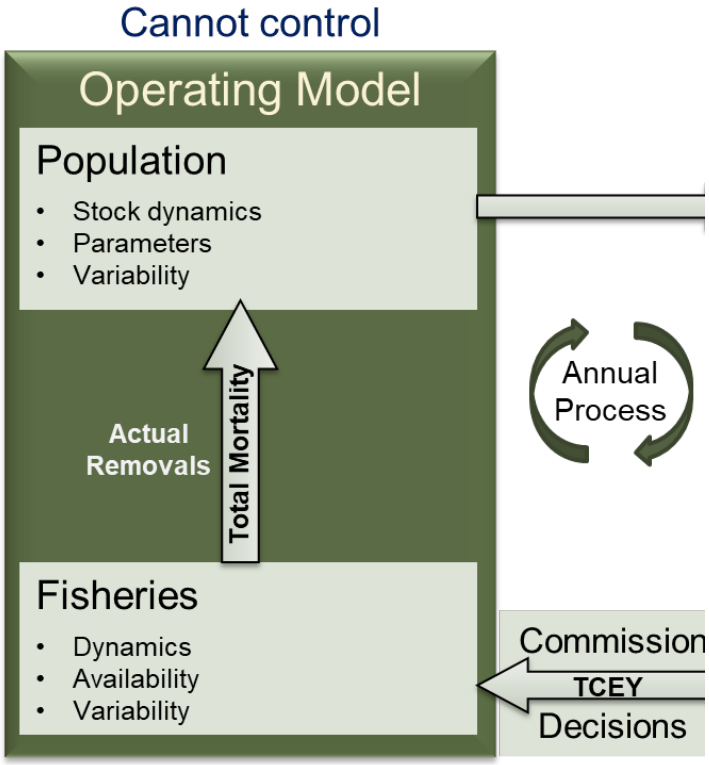
IPHC-2020-MSAB016-08

Simulation Framework

- The framework contains
  - The elements of the closed-loop simulations
  - The input of objectives and output of performance metrics



Operating Model (OM)



For technical details, see:

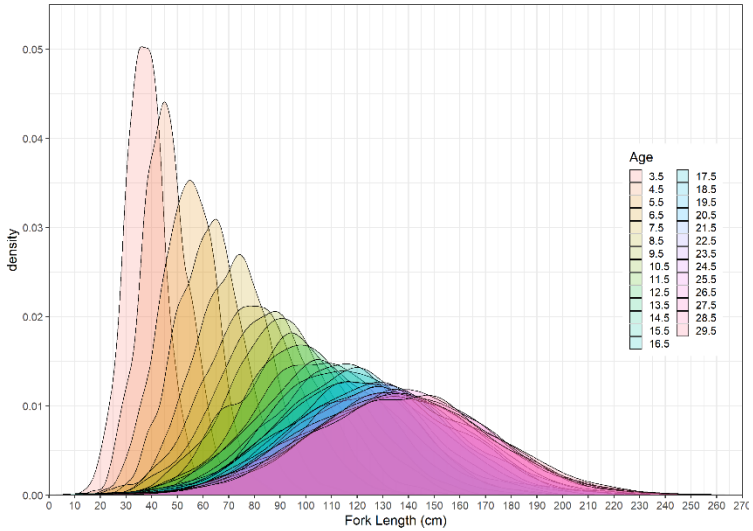
https://iphc.int/venues/details/17th-session-of-the-iphc-scientific-review-board-srb017

and future updates

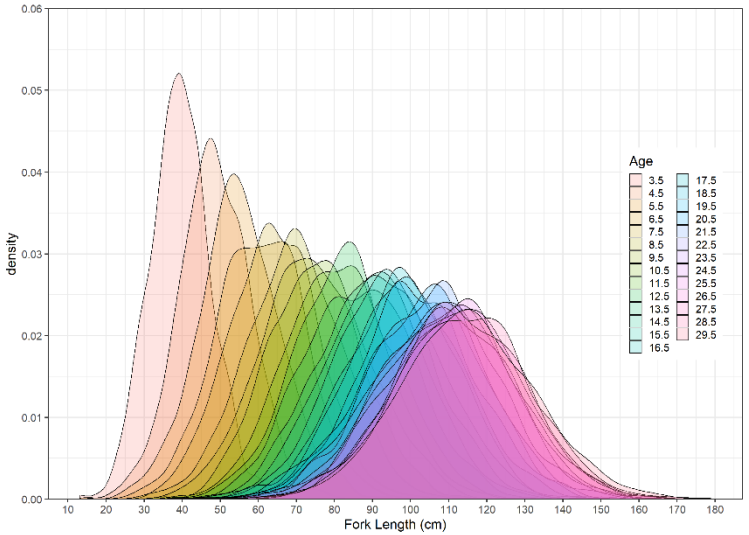
OM specifications

- Age-structured, plus group at 30
- Lengths not modelled
  - U26/O26/O32 determined from assumed length-at-age

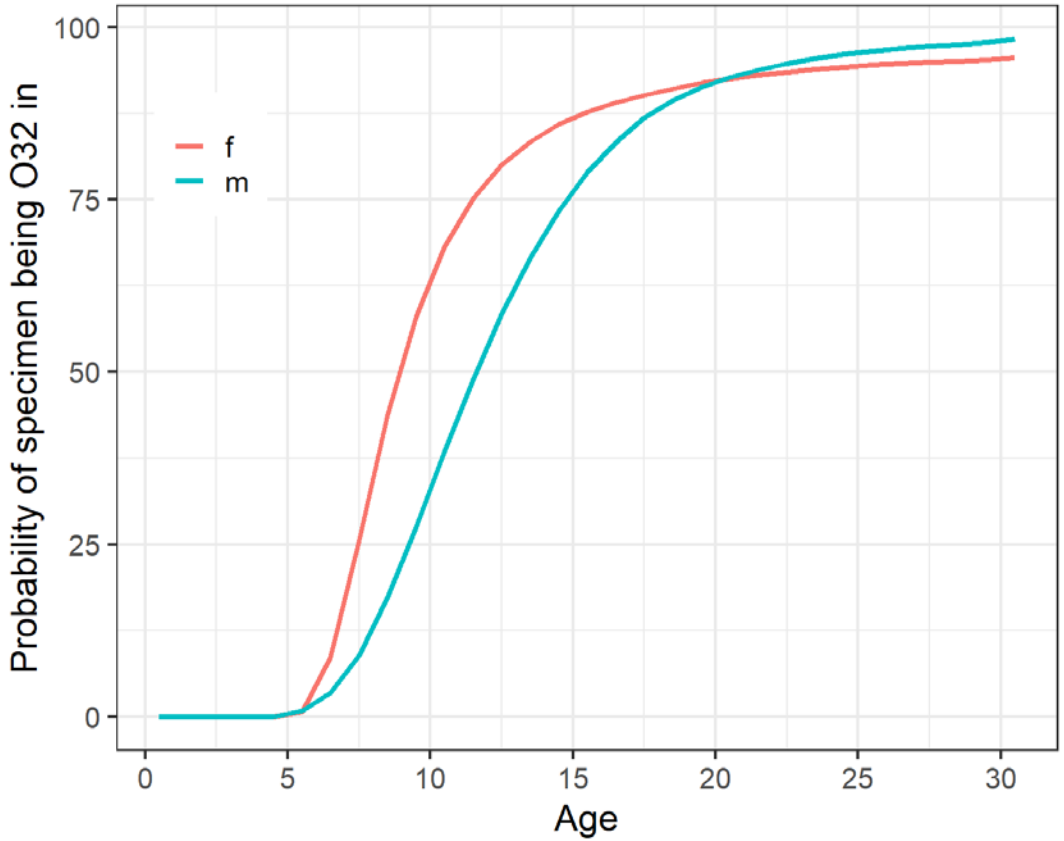
Females



Males

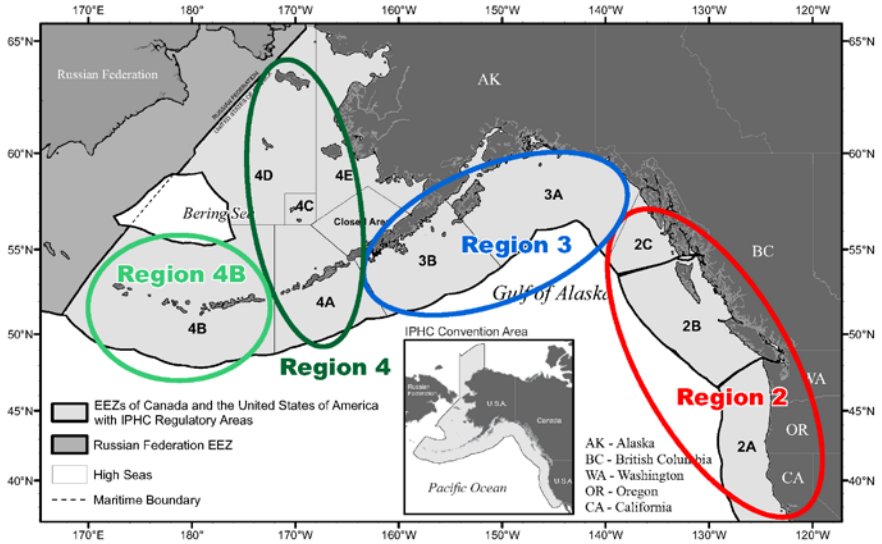


Probability O32



OM specifications: Regions

- Four Biological Regions to model biological processes
- Eight IPHC Regulatory Areas for fisheries



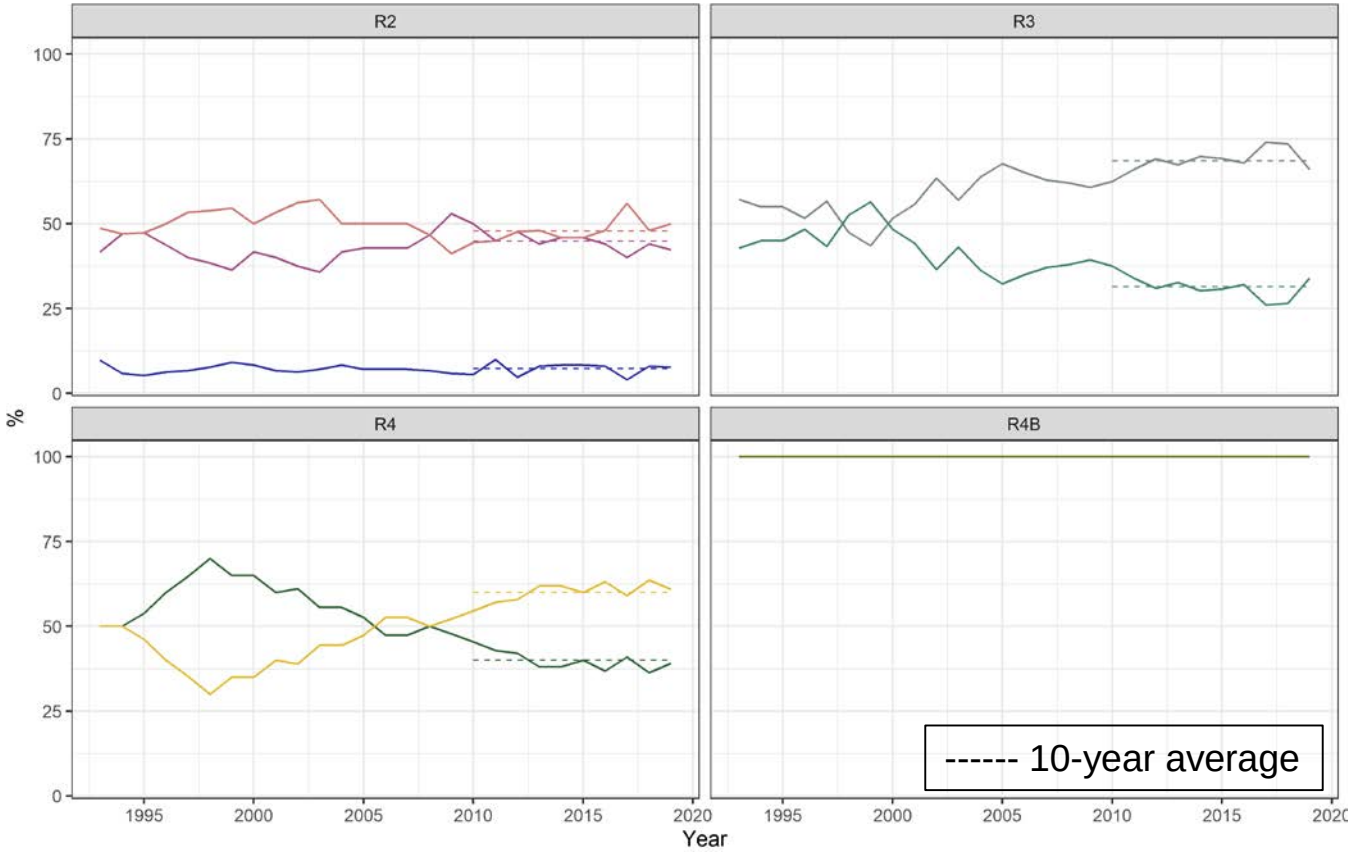
OM specifications: Fishing Sectors

- Five sectors
  1. Directed commercial fishery
     - O32 mortality from directed fisheries
  2. Directed commercial discard mortality (*directed discards*)
     - U32 mortality from directed fisheries
  3. Non-directed commercial discard mortality (*non-directed*)
     - Mortality from non-directed fisheries
  4. Recreational
     - Mortality from recreational landings and discards
  5. Subsistence
     - Mortality from non-commercial, customary and traditional use

Modelling fisheries

- Need fisheries metrics at IPHC Regulatory Area
- Movement between Reg Areas much more complex
  - Interannual seasonal movement within a Biological Region
- Areas-as-fleets approach
  - Fleets intercept fish in Biological Region
  - Different selectivity patterns
- Survey
  - Specified proportion of biomass in IPHC Regulatory Areas within a Biological Region

Proportion of survey in Regulatory Areas



OM specifications: 33 Fisheries

Fishery	IPHC Reg Areas	2019 Mortality
Directed Commercial 2A	2A	0.89
Directed Commercial 2B	2B	5.22
Directed Commercial 2C	2C	3.67
Directed Commercial 3A	3A	8.16
Directed Commercial 3B	3B	2.31
Directed Commercial 4A	4A	1.45
Directed Commercial 4B	4B	1.00
Directed Commercial 4CDE	4CDE	1.65

Fishery	IPHC Reg Areas	2019 Mortality
Directed Commercial Discards 2A	2A	0.03
Directed Commercial Discards 2B	2B	0.13
Directed Commercial Discards 2C	2C	0.06
Directed Commercial Discards 3A	3A	0.32
Directed Commercial Discards 3B	3B	0.15
Directed Commercial Discards 4A	4A	0.09
Directed Commercial Discards 4B	4B	0.03
Directed Commercial Discards 4CDE	4CDE	0.07

Fishery	IPHC Reg Areas	2019 Mortality
Non-Directed Comm Discards 2A	2A	0.13
Non-Directed Comm Discards 2B	2B	0.24
Non-Directed Comm Discards 2C	2C	0.09
Non-Directed Comm Discards 3A	3A	1.65
Non-Directed Comm Discards 3B	3B	0.48
Non-Directed Comm Discards 4A	4A	0.35
Non-Directed Comm Discards 4B	4B	0.15
Non-Directed Comm Discards 4CDE	4CDE	3.5

Fishery	IPHC Reg Areas	2019 Mortality
Recreational 2B	2B	0.86
Recreational 2C	2C	1.89
Recreational 3A	3A	3.69
Subsistence 2B	2B	0.41
Subsistence 2C	2C	0.37
Subsistence 3A	3A	0.19
Recreational/Subsistence 2A	2A	0.48
Recreational/Subsistence 3B	3B	0.02
Recreational/Subsistence 4	4A,4CDE	0.06

TCEY fishery limits

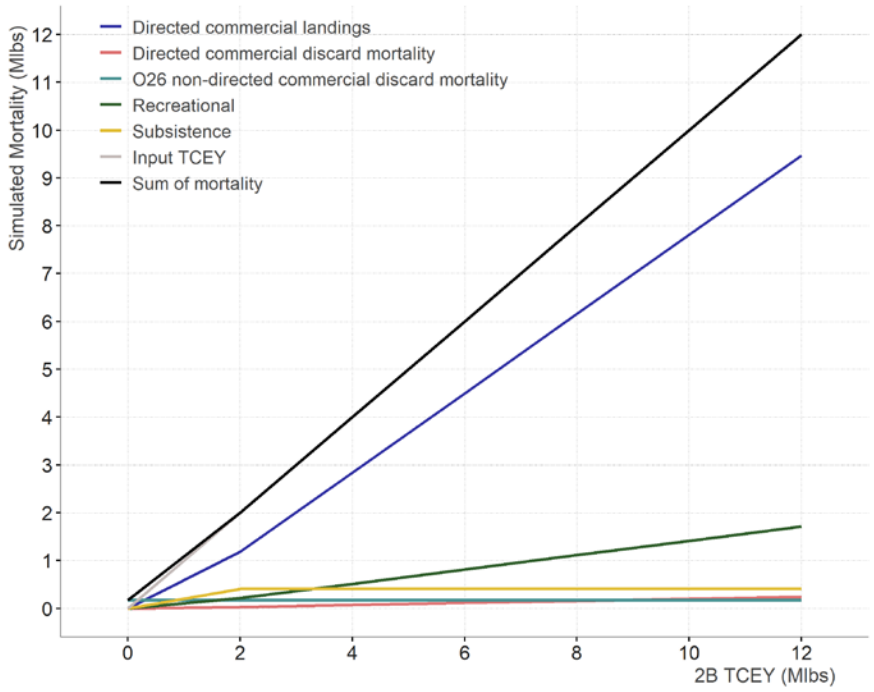
- TCEY = TM – U26 NDDM (previous year's Non-directed Commercial Discard Mortality)
- DirectedTCEY = TCEY – O26 NDDM

Catch-Sharing Plan (CSP)

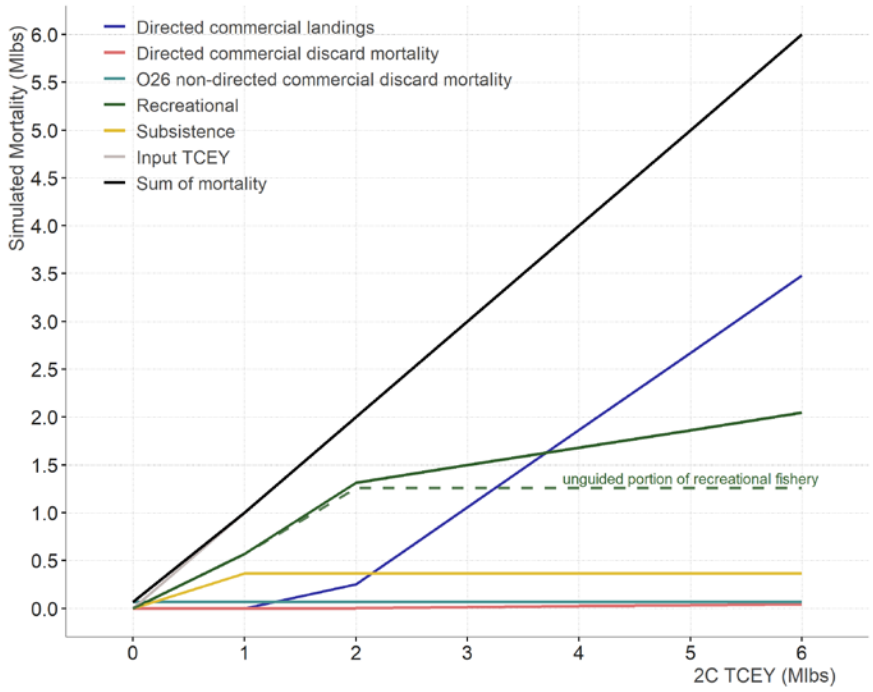
- Subsistence:
  - Observed from previous year, except 2A = 30,000lbs
- Recreational Mortality:
  - Unguided Recreational: 2C and 3A only
    - Random lognormal deviate with mean 1.257 or 1.579 Mlbs, CV=5%
  - CSP limit summed with unguided
- Directed Commercial Discard Mortality
  - Ratio of directed discard mortality to directed commercial mortality from previous year
- Directed Commercial Mortality
  - Remainder after subtracting other sources from DirectedTCEY

Example fishery mortality limits

2B

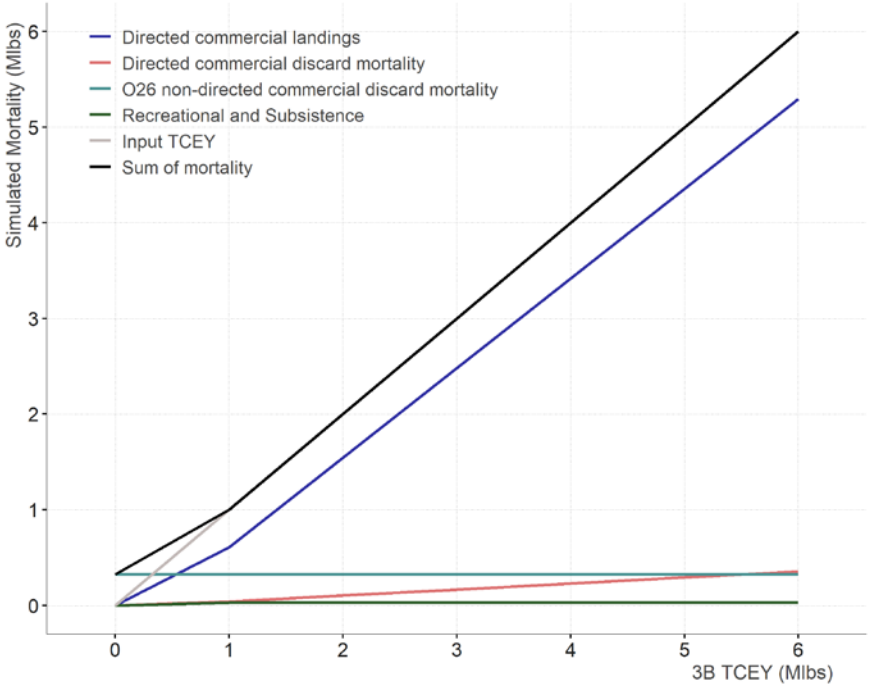


2C

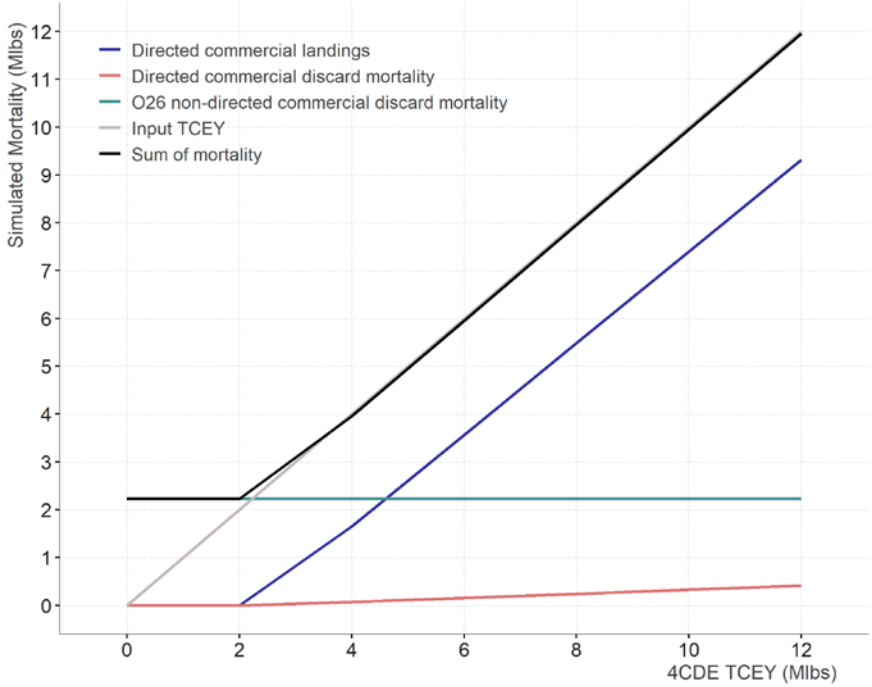


Example fishery mortality limits

3B



4CDE



Realized fishery mortality

- TCEY = TM – U26 NDDM (simulated Non-directed Commercial Discard Mortality)
- DirectedTCEY = TCEY – O26 NDDM

Catch-Sharing Plan (CSP)

- Subsistence:
  - Simulated from lognormal with mean equal to fixed value and CV=15%
  - Not greater than one-half coastwide TCEY, but no lower than a minimum
- Recreational Mortality:
  - Unguided Recreational: 2C and 3A only
    - Random lognormal deviate with mean 1.257 or 1.579 Mlbs, CV=5%
  - CSP limit summed with unguided
- Directed Commercial Discard Mortality
  - Function of total directed mortality and male weight at age 8
  - Minimum of 0.05%
- Directed Commercial Mortality
  - Remainder after subtracting other sources from DirectedTCEY

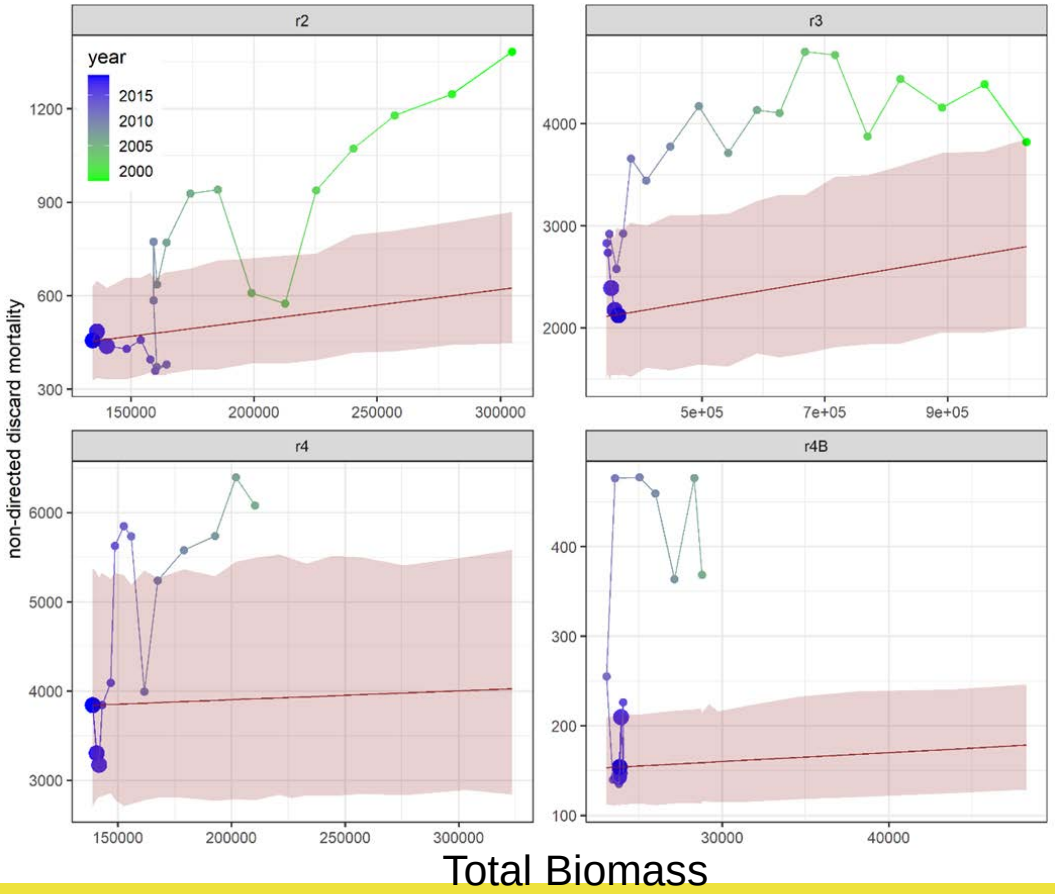
Ad hoc MSAB meeting (1)

Para 8.1: Explanation of how realized non-directed commercial discard mortality is modelled:

- Linear relationship between the non-directed discard mortality by region and the total biomass in that region.
- Fit forced through the last observed year (2019).
- The realized non-directed discard mortality was then randomly drawn from the value determined from total biomass by region using a log normal distribution with a 20% CV

Ad hoc MSAB meeting (1)

- Non-directed commercial discard mortality (NDDM) plotted against total biomass from the conditioned multi-region OM
- U26 and O26 determined using length-at-age relationship



Ad hoc MSAB meeting (2)

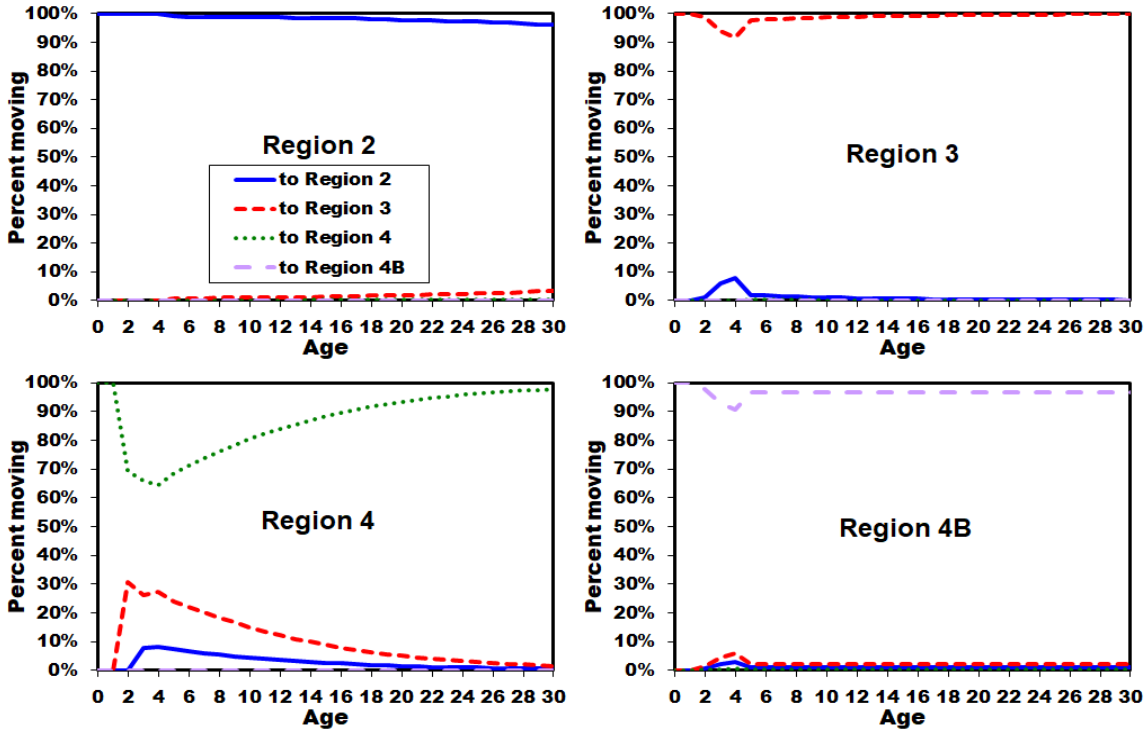
Para 8.2: Allocation at low TCEY values

- Sequential approach
  1. Remove non-directed discard mortality from each IPHC Regulatory Areas TCEY;
  2. Remove Subsistence from each IPHC Regulatory Areas TCEY;
  3. Remove unguided recreational from each IPHC Regulatory Areas TCEY.

This way at low TCEY values, subsistence will always have some share (if non-directed discard mortality allows it), and unguided recreational will get whatever is left (if any).

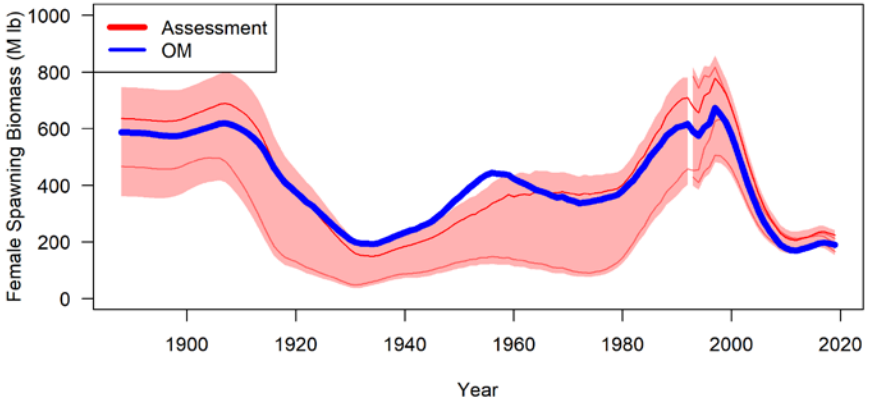
Movement

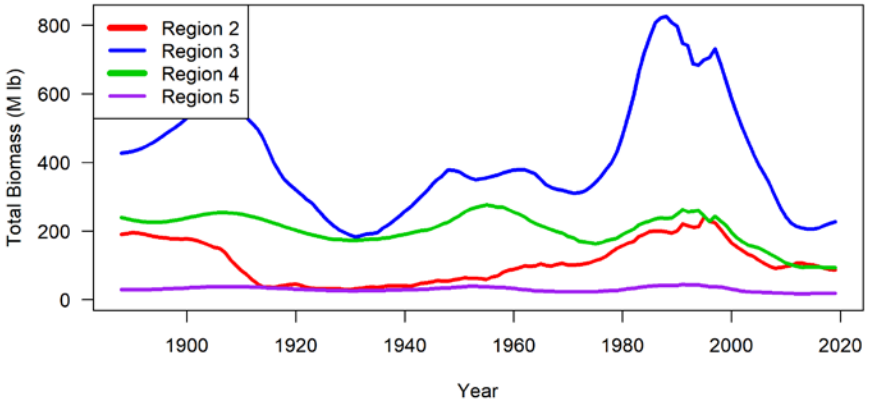
- Integration of information from many sources
  - Recent review of halibut movement
  - Estimated annual movement rates
  - Tuned to observations

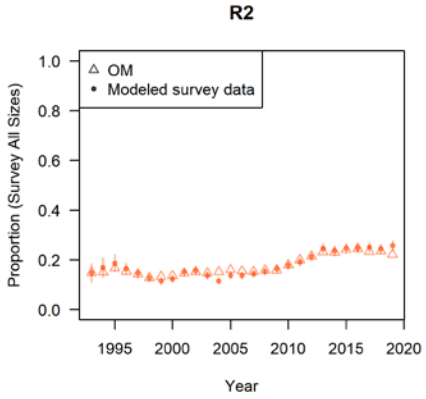


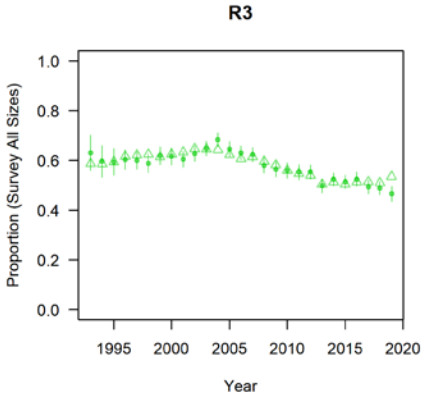
Estimated aggregate annual movement rates by age from Biological Regions (panels) based on currently available data

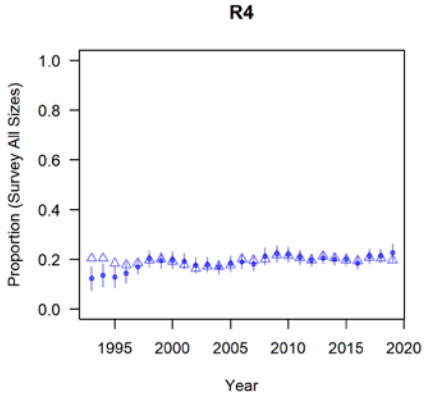
Conditioned model

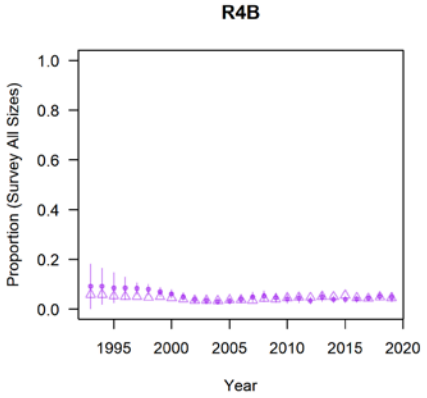




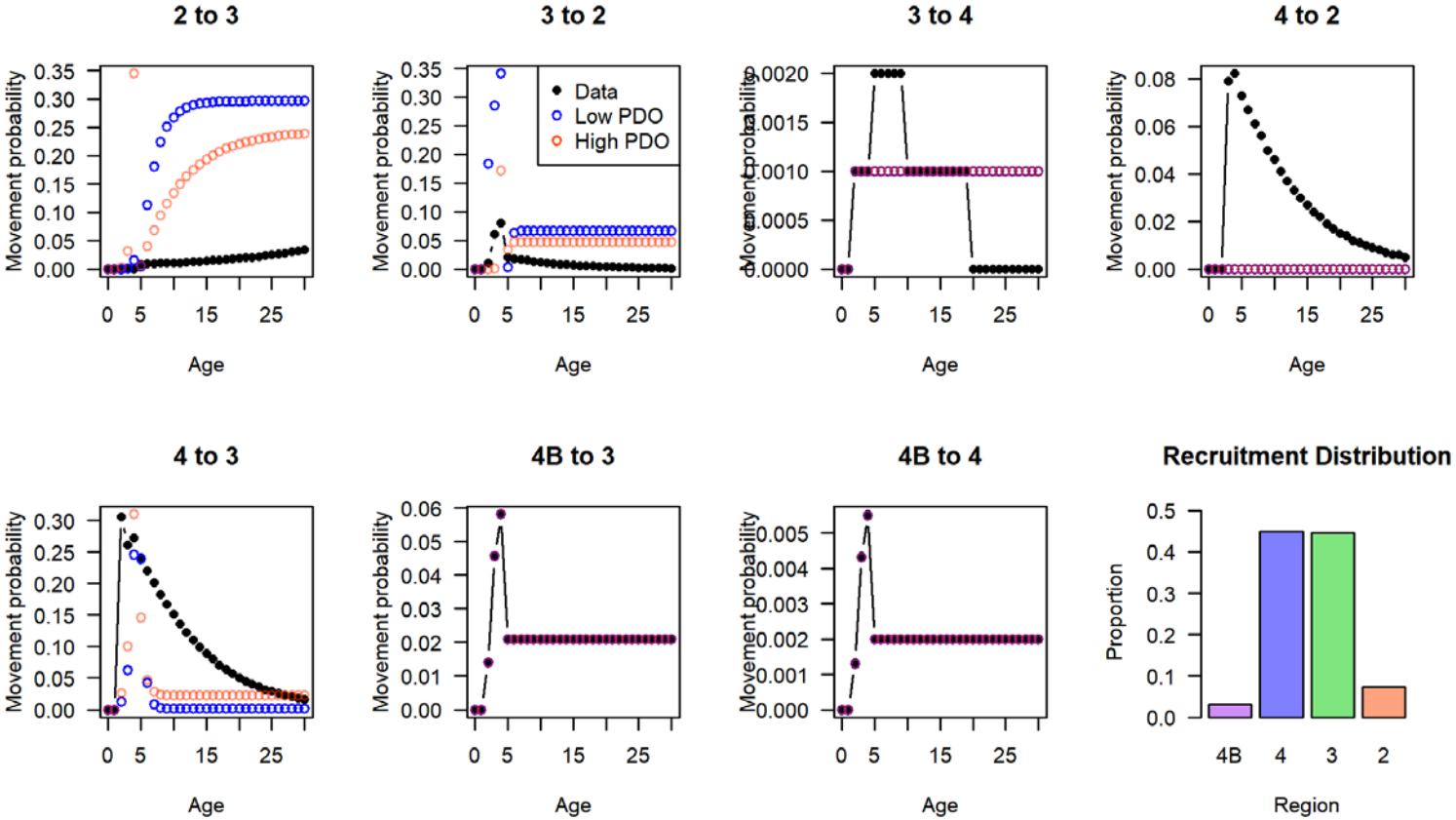








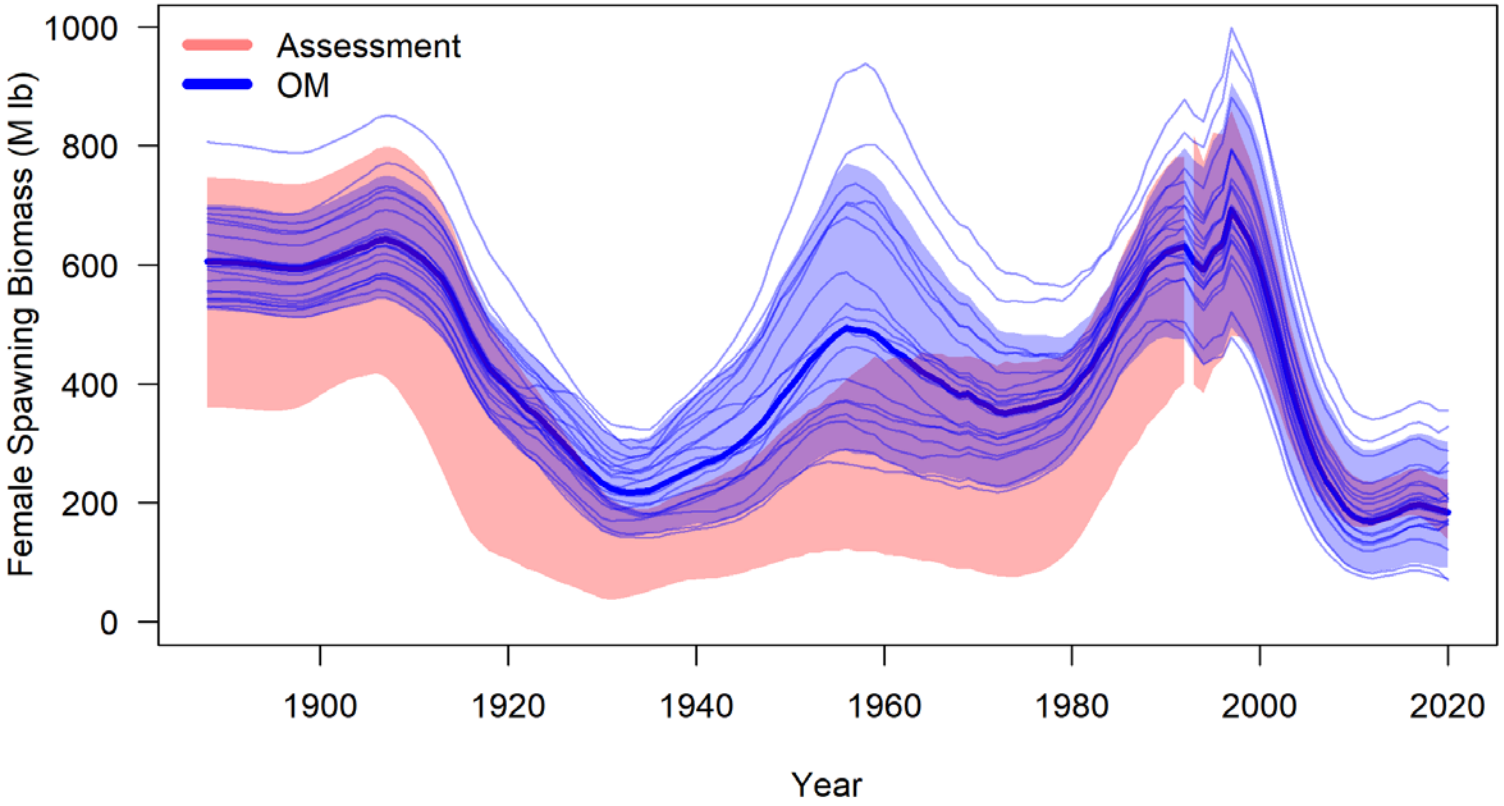
Conditioned Model



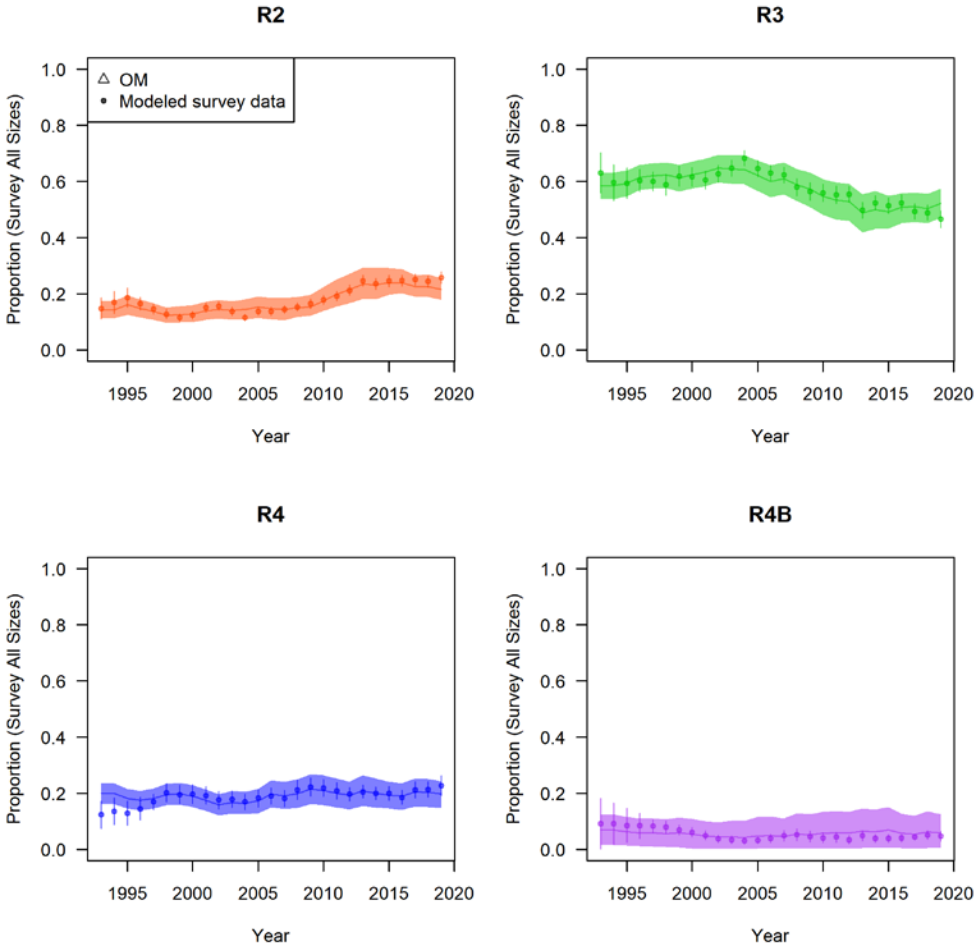
Uncertainty and variability

1. Integrated uncertainty
   - Uncertain parameters
     - M, R_0, recruitment, movement
   - Variability in projections
     - weight-at-age, recruitment, movement
2. Scenarios
   - Specific case to investigate departure in an assumption
     - Weight-at-age at a specified level
     - Non-directed mortality at a specific amount
     - Movement at specific amounts or alternative hypotheses
   - May or may not be integrated into results

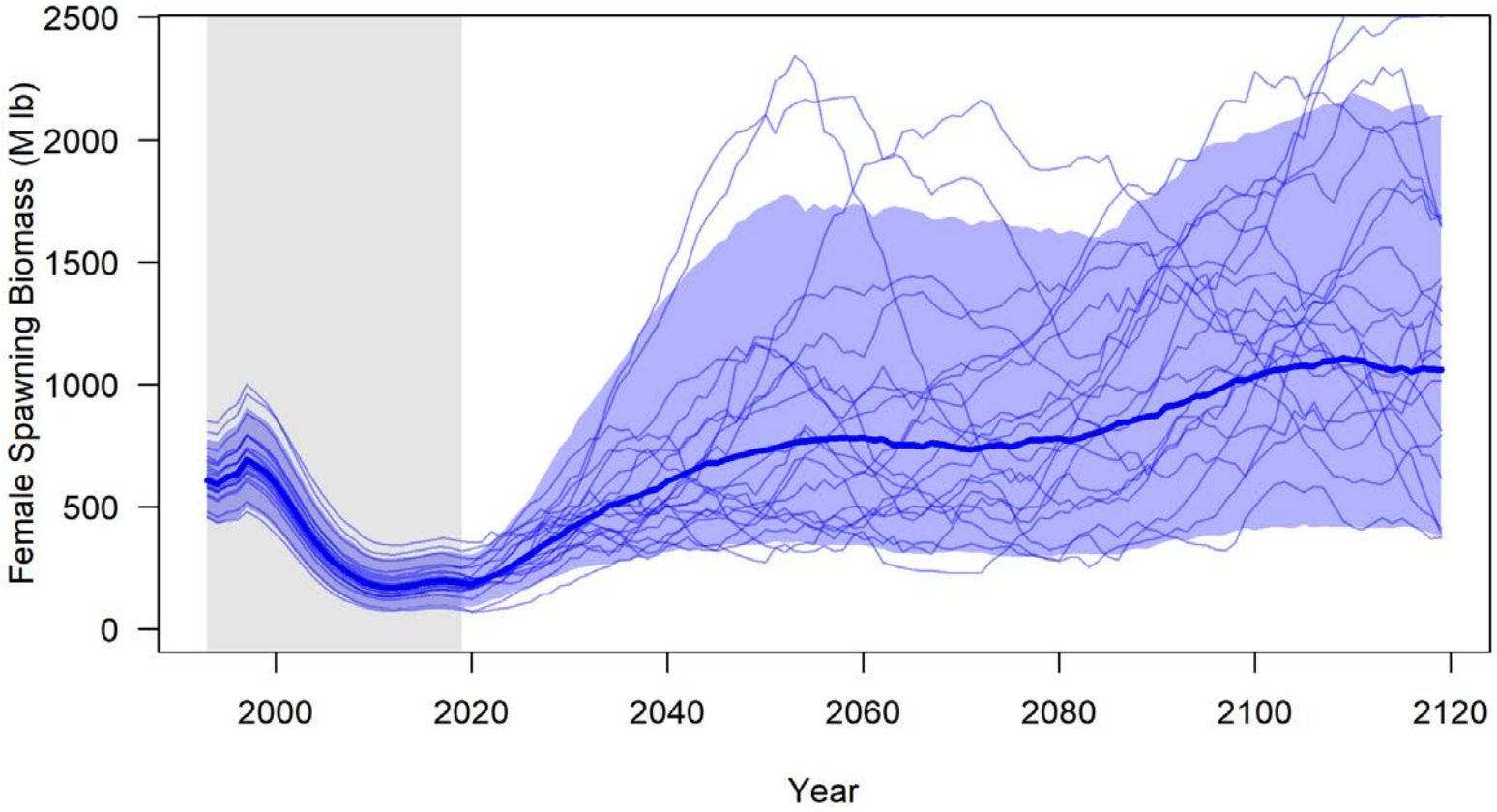
Variability in conditioned model trajectories



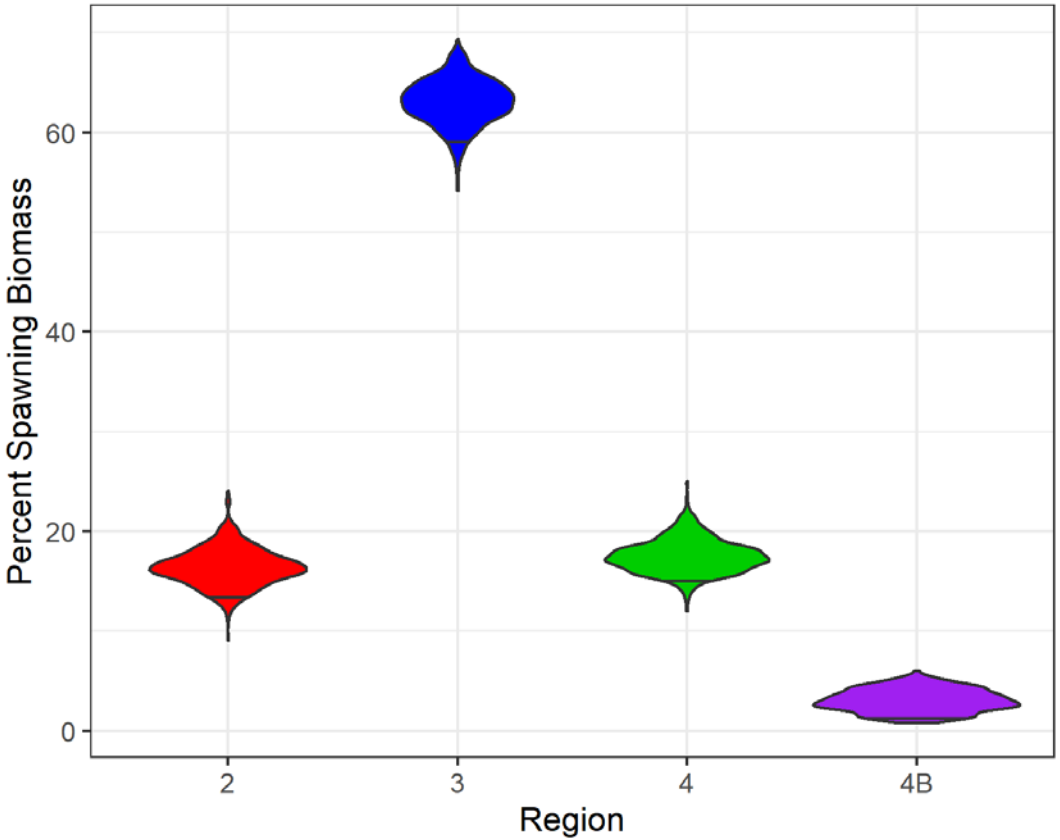
Variability in conditioned distribution

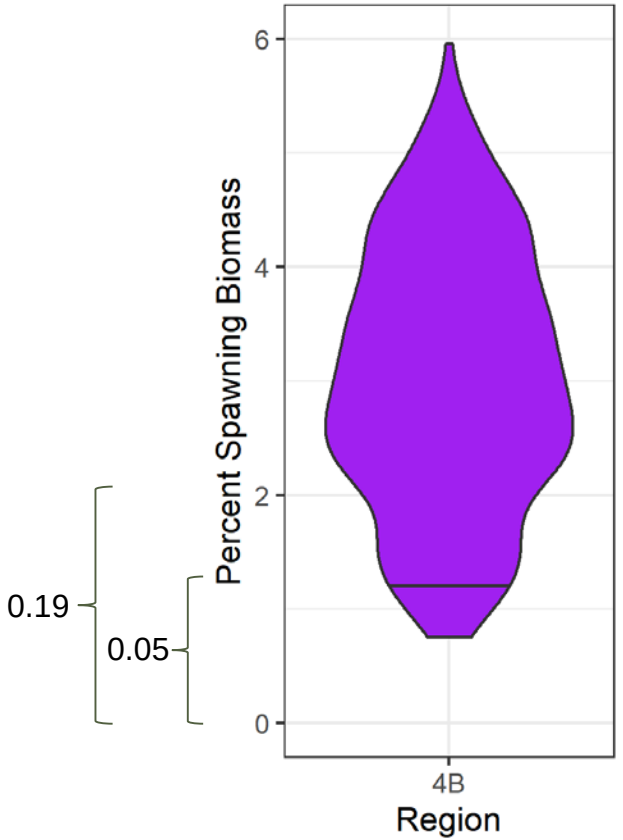


Projections without fishing



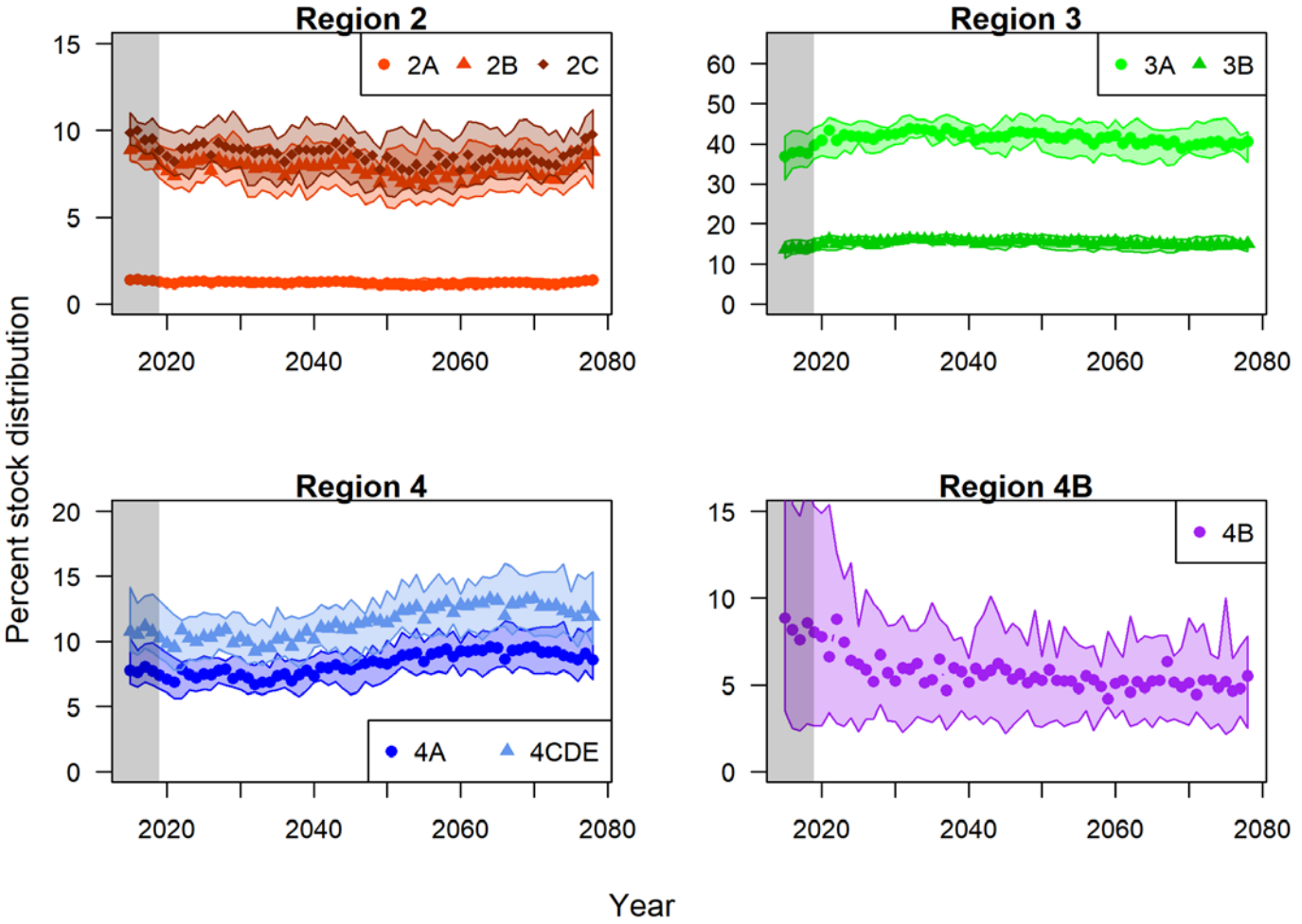
Projected year 2100 %SB in each Region





Projected O32 stock distribution

SPR=43%
MP-G



Implementation variability

1. Decision-making (not currently simulated)
   – Adopted TCEYs may depart from the MP outcomes
2. Actual fishing mortality (some simulated)
   – Fisheries do not exactly catch the set limit
3. Uncertainty in the estimated amount of mortality (not currently simulated)

- Can look at past observations to determine reasonable methods

Ad hoc MSAB meeting (3)

Para 20: Future improvements & considerations

- Whale depredation
- Model bycatch with different assumptions
- Changes in productivity
- Accounting of non-directed commercial U26 mortality
- Impacts of climate change
- Phasing in application of management procedures

Other future improvements & considerations

- Migration
  - Investigate alternative migrations as sensitivities and robustness tests
- Recruitment distribution
  - Time-varying recruitment distribution
- Selectivity
- Additional variability
  - Parameter uncertainty
  - Parameter variability
  - Implementation variability

Recommendations from SRB017

Para 59. The SRB **RECOMMENDED** using the current MSE results to compare and contrast management procedures incorporating scale and distribution elements, but **NOTED** that, current results are conditional on some parameters and processes that remain uncertain. The uncertainty in applying the untested current approach potentially creates greater risk than adopting a repeatable management procedure that has been simulation tested under a wide range of uncertainties.

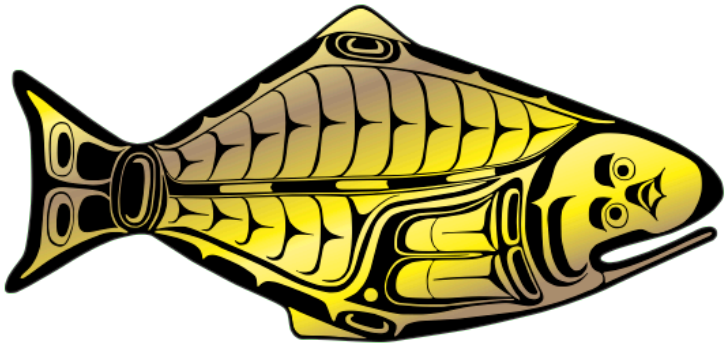
Para 60. The SRB **RECOMMENDED** that Exceptional Circumstances be defined to determine whether monitoring information has potentially departed from their expected distributions generated by the MSE. Declaration of Exceptional Circumstances may warrant re-opening and revising the operating models and testing procedures used to justify a particular management procedure.

Recommendations

a) **NOTE** paper IPHC-2020-MSAB016-08 which provides a description of the IPHC MSE framework, a description of the specifications of the multi-area operating model, and a brief overview of the implementation of management procedures.

b) **RECOMMEND** alternative specifications and additional features needed to evaluate management procedures related to coastwide scale and distribution of the TCEY, also **NOTING** document IPHC-2020-MSAB016-INF01.

INTERNATIONAL PACIFIC



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