INTERNATIONAL PACIFIC HALIBUT COMMISSION

MSE Simulation Framework

Agenda Item 5

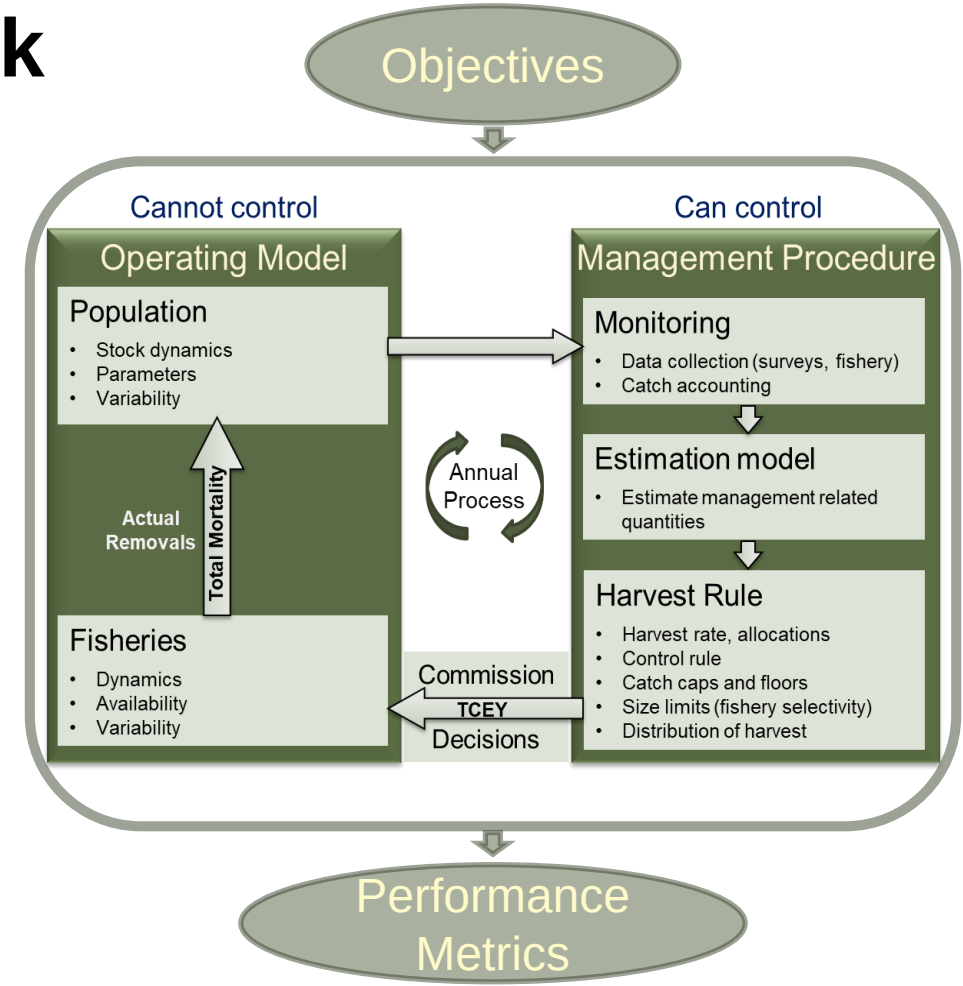
IPHC-2020-MSAB015-08

Outline

- What is the simulation framework
- Operating Model
- Management Procedure
  - Data Generation
  - Estimation Model
  - Harvest Rule

Simulation Framework

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



Framework specifications

- An interaction of C++ and R
- Operating Model (OM) written in C++
  - Fast and generalized
  - JSON input files
  - Many output formats
- Management Procedures (MP) written in R
  - Quick and simple implementation of MPs

Operating Model (OM)

- The aspects that we cannot or choose not to control
- The population and its variability
- The fishery and its variability

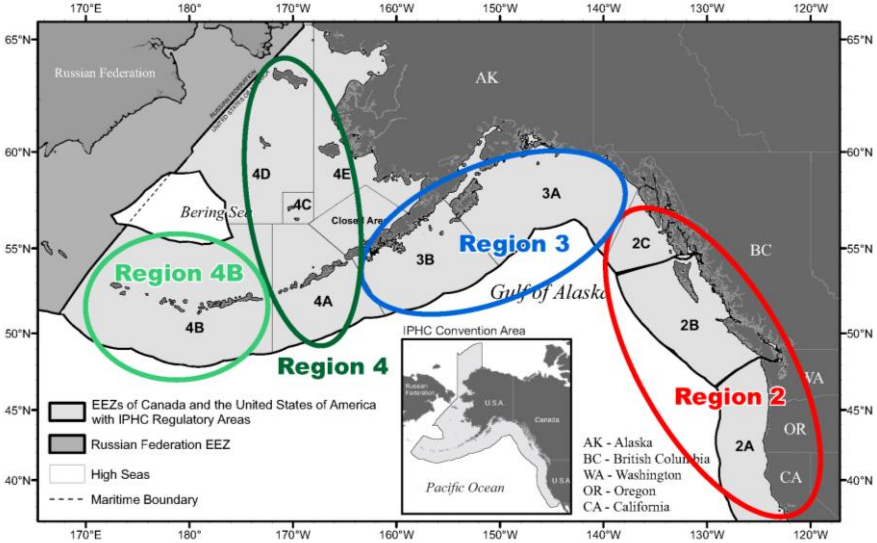
- Generalized simulation model that can be specified to mimic many spatial and biological characteristics

Overview of OM

- Workflow options
  1. OM calls R scripts for application of the MP
  2. OM called from R and restarted at the previous state
  3. OM self-sufficient for simple MPs
  4. OM and MPs are one executable (in development)

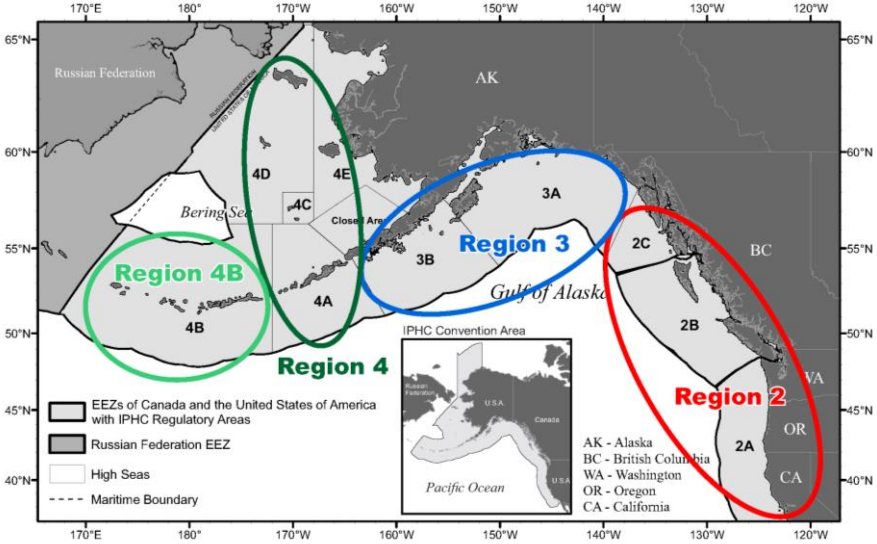
OM specifications: Regions

- Four Biological Regions to model biological processes
  - Movement
  - Natural mortality
  - Size-at-age
  - Recruitment
  - …



OM specifications: Areas

- Eight IPHC Regulatory Areas for fisheries
- An area is completely within a Region



OM specifications: Sectors

- Four sectors
  1. Directed fishery
     - O32 mortality from directed fisheries
  2. Directed fishery discard mortality (*directed discards*)
     - U32 mortality from directed fisheries
  3. Non-directed discard mortality (*non-directed*)
     - Mortality from non-directed fisheries
  4. Recreational/Subsistence
     - Combined into one fishery

OM specifications: Fisheries

- A fishery is a specific sector within an IPHC Regulatory Area or Biological Region

Summed mortality (1992-2019) by sector and area

Year	2A	2B	2C	3A	3B	4A	4CDE	4B
Commercial	18	260	206	552	252	78	73	63
Sublegal discards	<1	7	5	17	11	2	1	<1
Non-directed	28			110		168		16
Rec/Subsistence	12	39	70	135	1	2	2	<1

OM specifications: 25 Fisheries

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

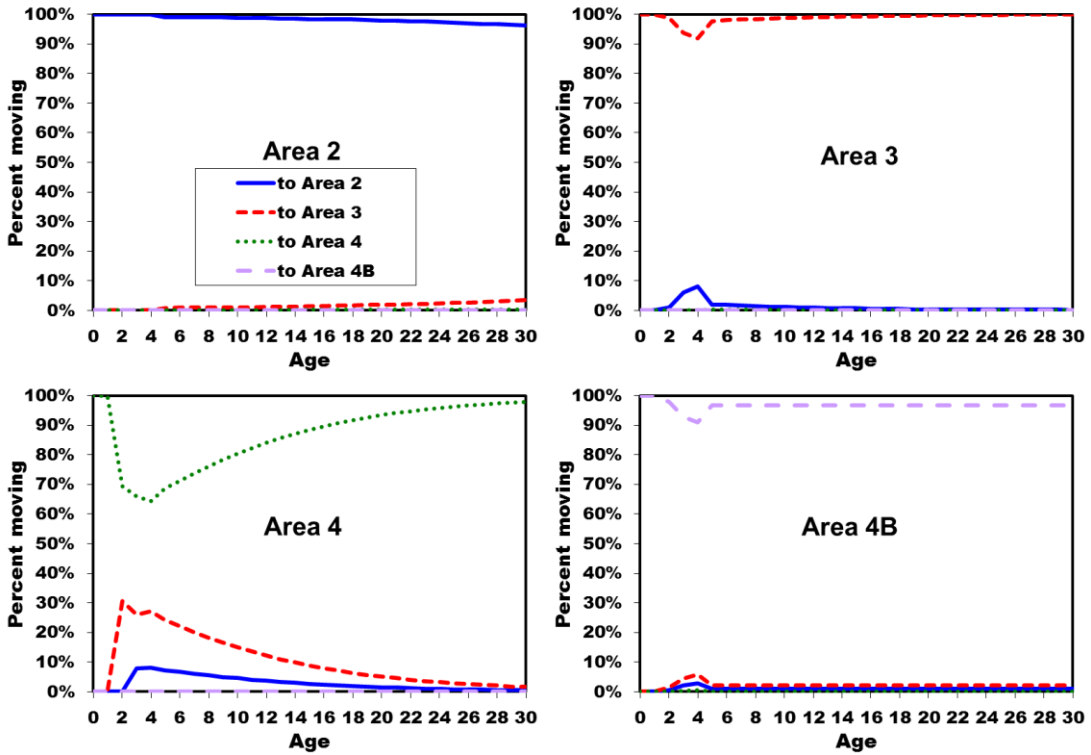
Fishery	IPHC Reg Areas	2019 Mortality
Discards 2A	2A	0.03
Discards 2B	2B	0.13
Discards 2C	2C	0.06
Discards 3A	3A	0.32
Discards 3B	3B	0.15
Discards 4A	4A	0.09
Discards 4B	4B	0.03
Discards 4CDE	4CDE	0.07

Fishery	IPHC Reg Areas	2019 Mortality
NonDirected 2	2A, 2B, 2C	0.46
NonDirected 3	3A, 3B	2.13
NonDirected 4	4A, 4CDE	3.84
NonDirected 4B	4B	0.17

Fishery	IPHC Reg Areas	2019 Mortality
RecSubsist2A	2A	0.48
RecSubsist2B	2B	1.27
RecSubsist2C	2C	2.26
RecSubsist3	3A, 3B	3.9
RecSubsist4	4A, 4CDE	0.06

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

Uncertainty and variability

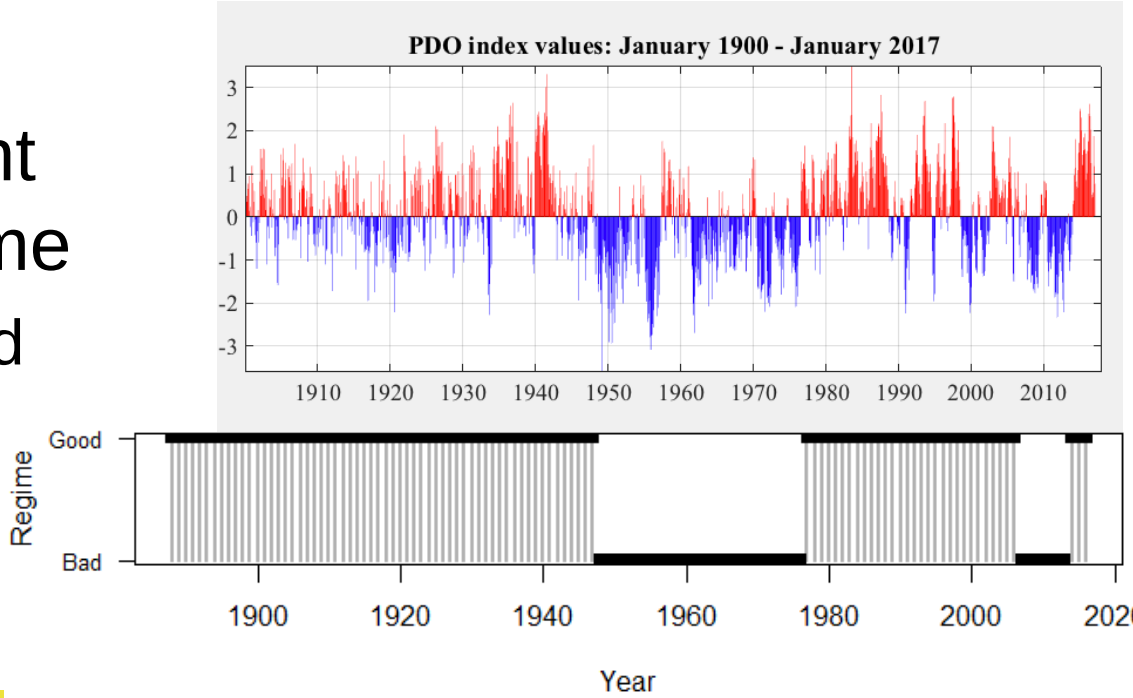
- Uncertainty implemented in two ways
  1. Integrated uncertainty
     - Uncertain parameters
       - M, steepness, R_0, movement, selectivity parameters
     - Variability in projections
       - selectivity, weight-at-age, recruitment, movement
  2. Scenarios
     - Specific case to investigate departure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

Uncertainty and variability

Process	Uncertainty
Natural Mortality (M)	Estimate appropriate uncertainty when conditioning OM
Steepness	Estimate appropriate uncertainty when conditioning OM
Recruitment	Random, lognormal deviations
Size-at-age	Annual and cohort deviations in weight-at-age with bounds
Regime Shifts	Autocorrelated indicator based on properties of the PDO for regime shift
Sector mortality	Allocating mortality to sectors within an area
Selectivity	Directed fishery and survey selectivity projections
Implementation	Implementation variability (annual mortality and decisions)

Recruitment variability

- Annual deviations from average recruitment
- Average recruitment dependent on regime
  - Regime is simulated as a random process
    - Good or bad

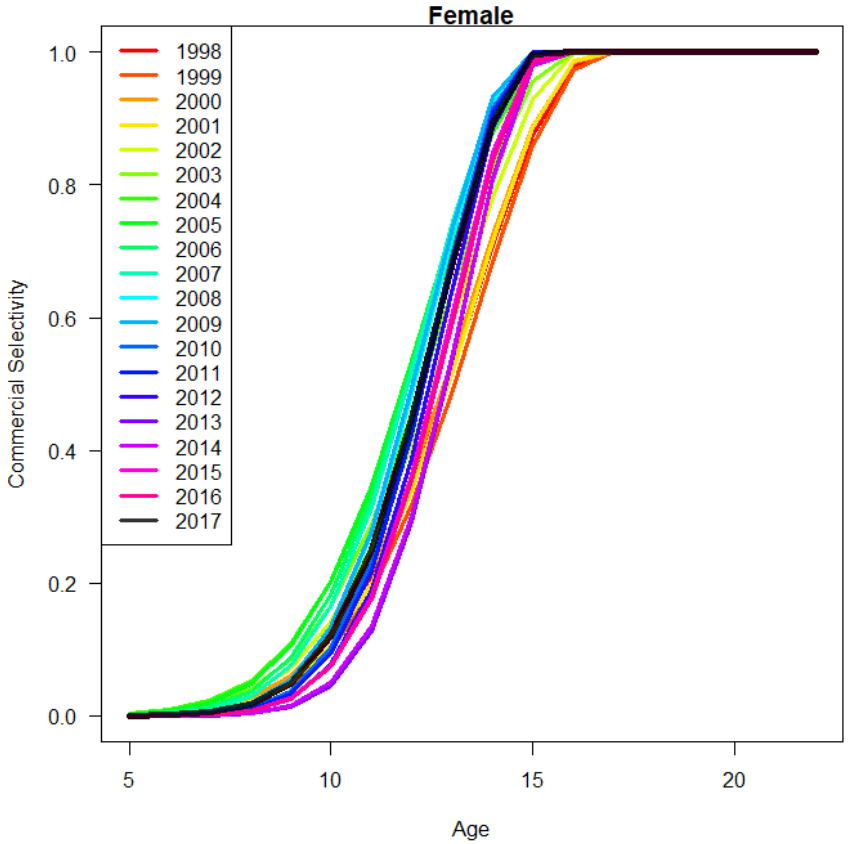


Weight-at-age variability

- New method for projecting weight-at-age
- ARIMA model uses previous three years to project the next year
  - Improved trends (smoother) and less subjective definition of autocorrelation
- Deviations consistent across regions and ages
- Deviations independent of regions and ages

Selectivity and retention variability

- Annual deviations for directed fisheries and FISS
- Starting point from assessment estimates
- Linked with size-at-age



Mortality allocation

- Distribution procedure will distribute TCEY to each IPHC Regulatory Area
- Allocation of mortality to each sector will be done within IPHC Regulatory Area
  - Based on historical observations
    - Discard mortality
  - Catch Sharing Plans (CSP)

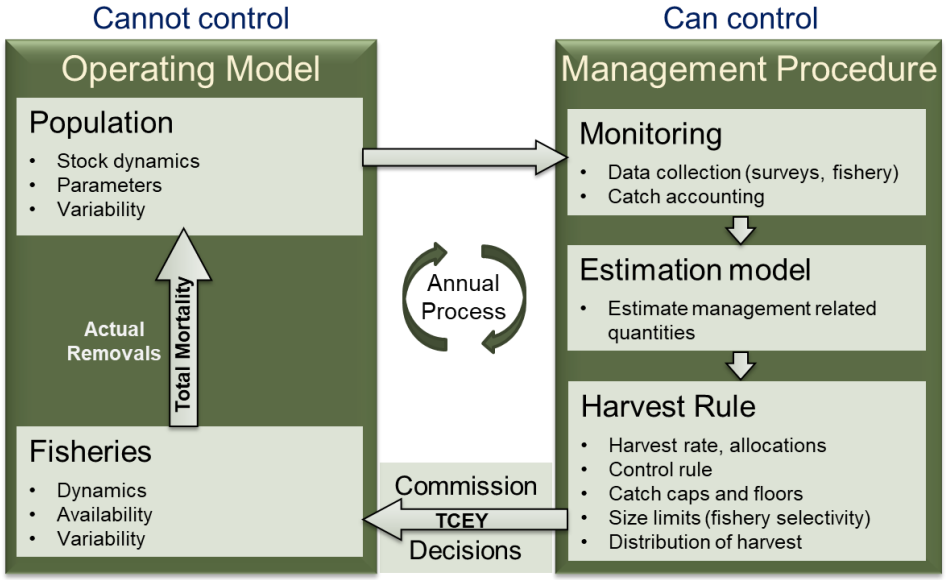
Implementation variability

- Decision-making
  - Adopted TCEYs may depart from the MP outcomes
- Actual fishing mortality
  - Fisheries do not exactly catch the set limit

- Will look at past observations to determine reasonable methods

Management Procedure

- Can or choose to control
- Uncertainty comes from
  - Data generation
  - Estimation of management quantities



Recommendations

- **NOTE** paper IPHC-2020-MSAB015-08 which provides an update on the development 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.
- **RECOMMEND** alternative specifications and additional features needed to evaluate management procedures related to coastwide scale and distribution of the TCEY in 2020, also **NOTING** document IPHC-2020-MSAB015-INF01.

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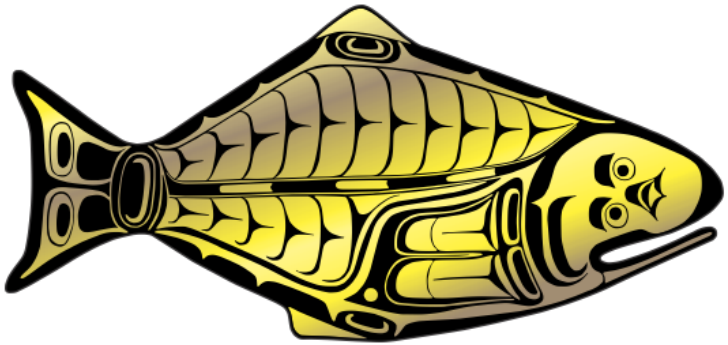

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