INTERNATIONAL PACIFIC HALIBUT COMMISSION

Framework to investigate fishing intensity and distributing the TCEY

Agenda Item 6

IPHC-2019-MSAB013-09

13th Meeting of the Management Strategy Advisory Board (MSAB013)

A. Hicks

Outline

- Background and recommendations
- Current interim management procedure
- Redefining the interim management procedure
- A framework for the management procedure
- The closed-loop simulation framework
- Potential MPs related to distributing the TCEY

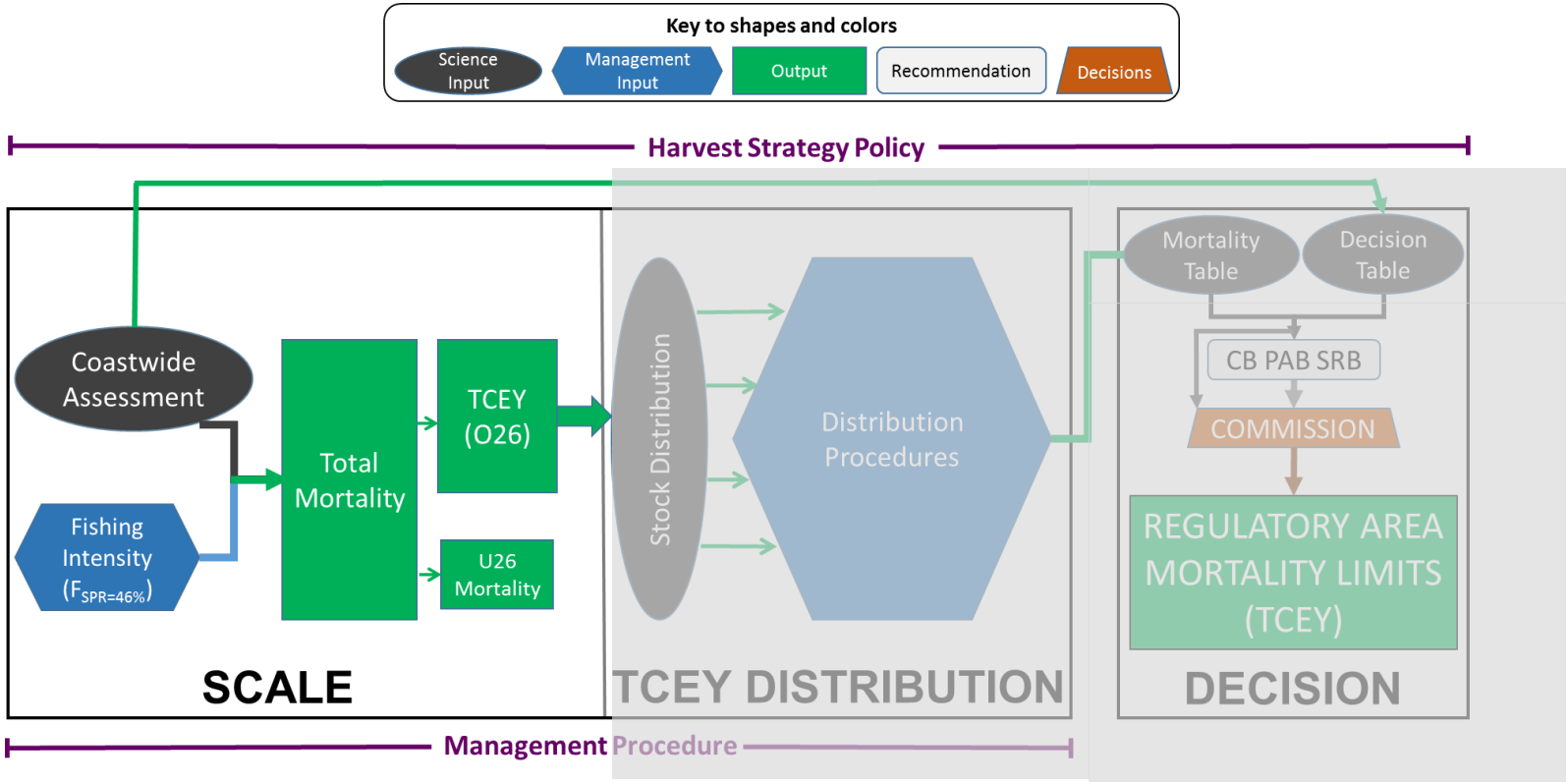
AM095

*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*

Past notes, requests, recommendations

- Distributing the TCEY to IPHC Regulatory Areas may result in a change to the coastwide TM or to the coastwide SPR
- There are science-based and management derived elements to distributing the TCEY. A framework has been proposed that incorporates these elements
- The IPHC Secretariat has described four biological Regions (consistent with IPHC Regulatory Area boundaries) based on the best available science
- The MSAB has identified many potentials tools for use in distribution procedures

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, are based on observations and data from the stock
   - Biologically-based stock distribution
   - Productivity and optimal harvest rates
2. **Management-derived**: decision to shift distribution of TCEY, based on other objectives
   - Can include social and economic considerations

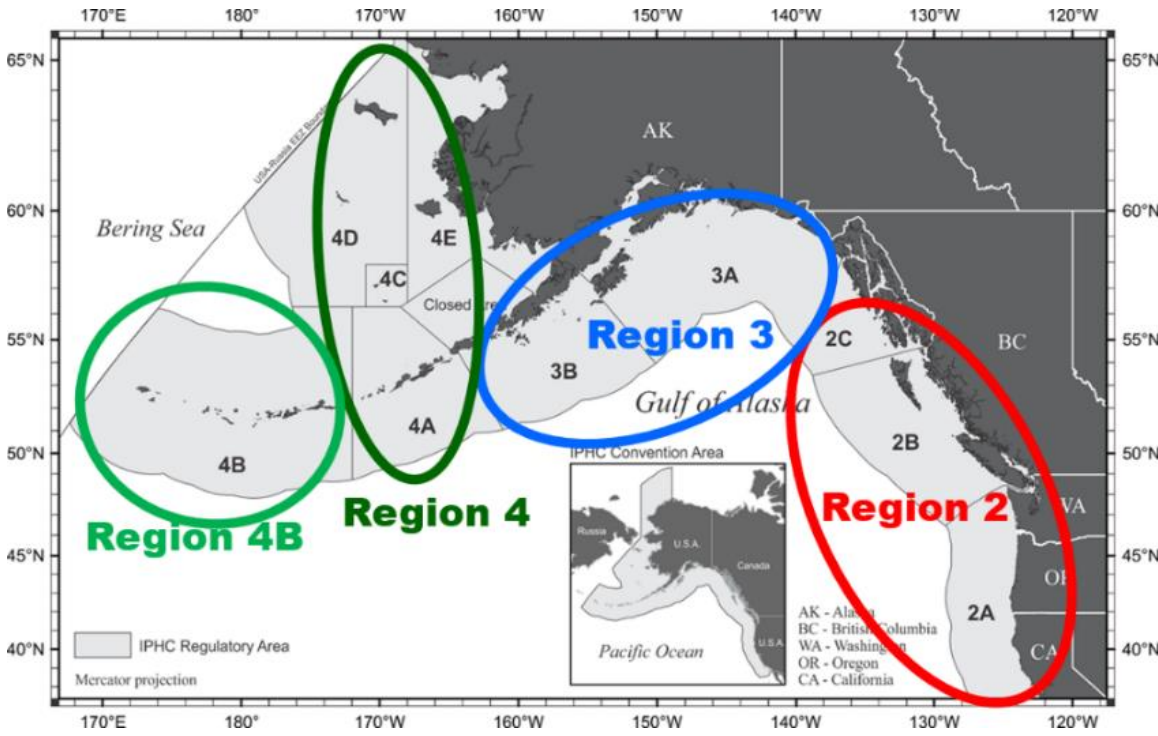
Recent Interim MP: Stock Distribution

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
- Has historically used O32 WPUE index
- Linked to Biological Sustainability objectives
  - Specifically “Conserve Spatial Complexity”

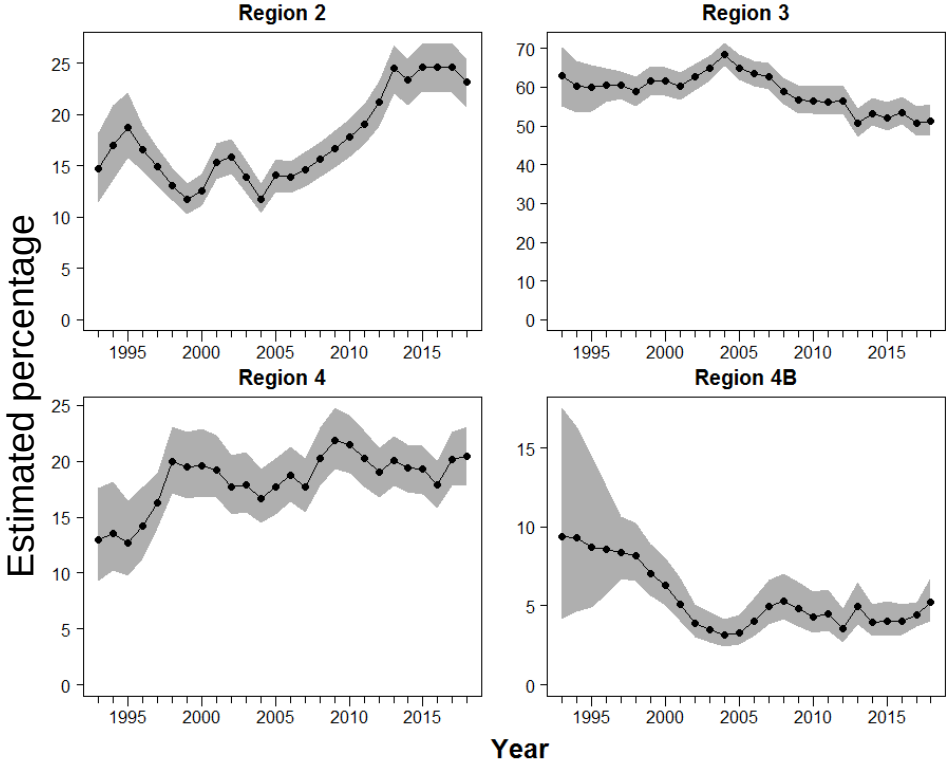
Changes to Stock Distribution

- 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



Current Interim MP: Relative Harvest Rates

Science-based and management foundations

- Shift stock distribution to account for additional factors
- Science-based inputs
  - Studies on productivity in each area
- Management inputs
  - Quantity and quality of data (uncertainty)
  - Other area-specific objectives
- Using coastwide SPR, only relative harvest rates needed
  - The intensity of fishing in an area relative to other areas
- Recent harvest rates
  - Areas 3B, 4A, 4B, and 4CDE were 3/4 the target in other areas
  - Based on 21.5% and 16.125% before using coastwide SPR

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

Other elements for distributing the TCEY

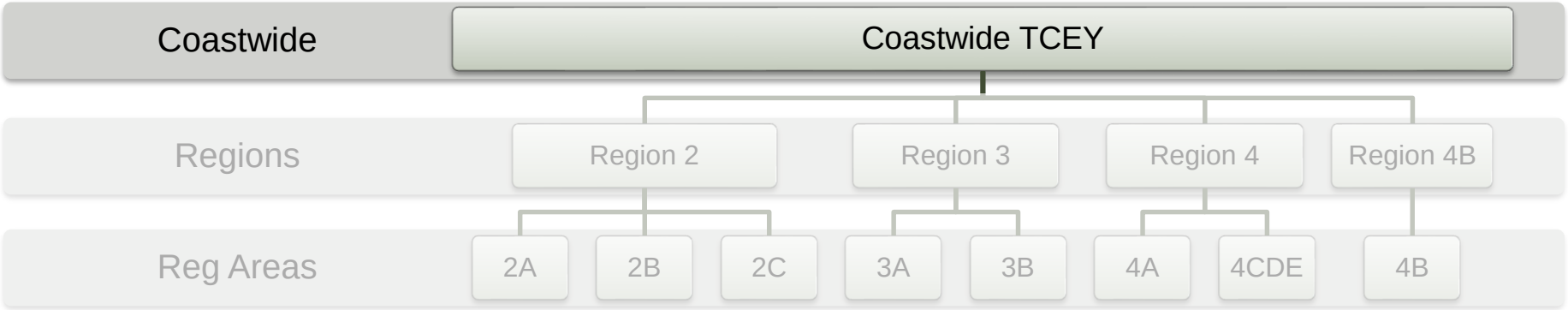
Management foundation

- Procedures based on policy
  - Important to remember that these are a part of the management procedure, not decision-making
  - 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

A procedure for distributing the TCEY (1)

Coastwide Target Fishing Intensity

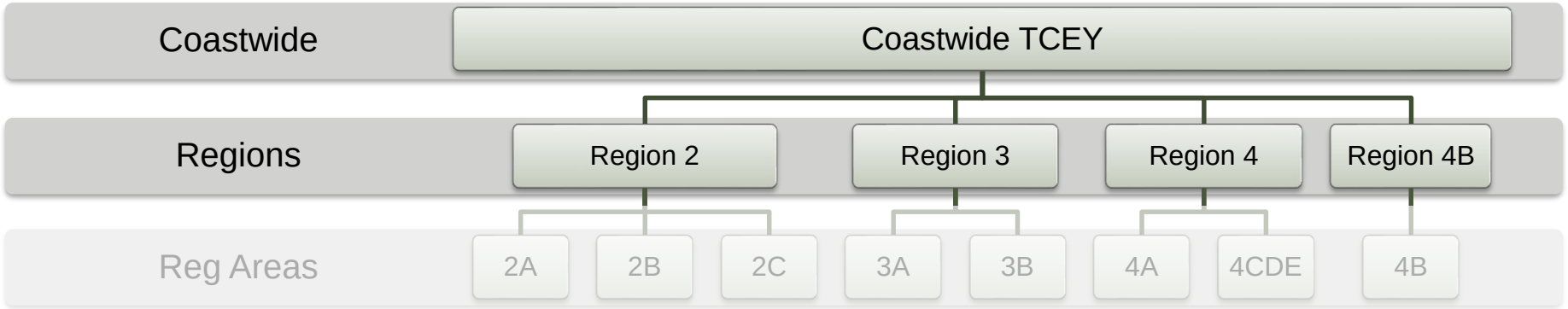
- Determine coastwide Total Mortality from Scale MP
- Separate TM into O26 (TCEY) and U26 components



A procedure for distributing the TCEY (2)

Regional Stock Distribution

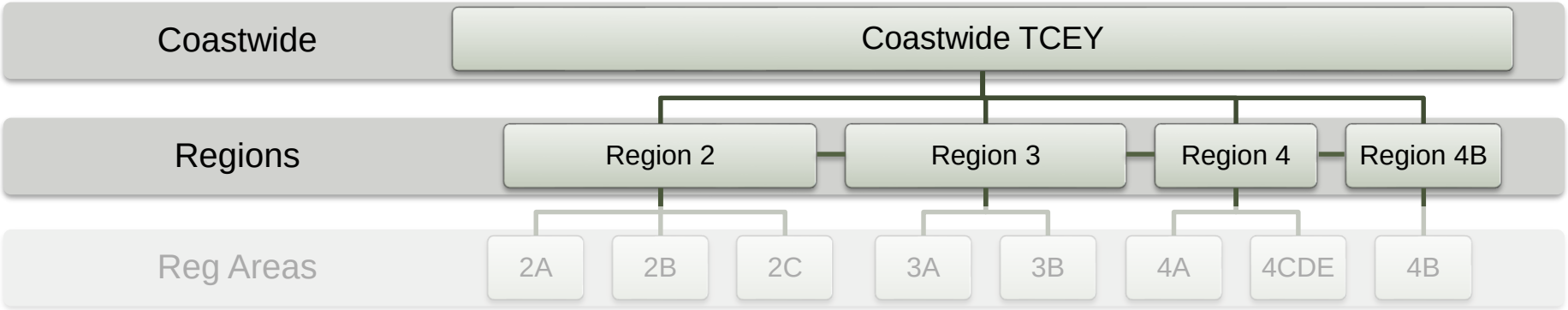
- Distribute the coastwide TCEY to biologically-based Regions
  - use proportion of the stock estimated from the “all sizes” WPUE index
- Biological Sustainability objectives



A procedure for distributing the TCEY (3)

Regional Allocation Adjustment

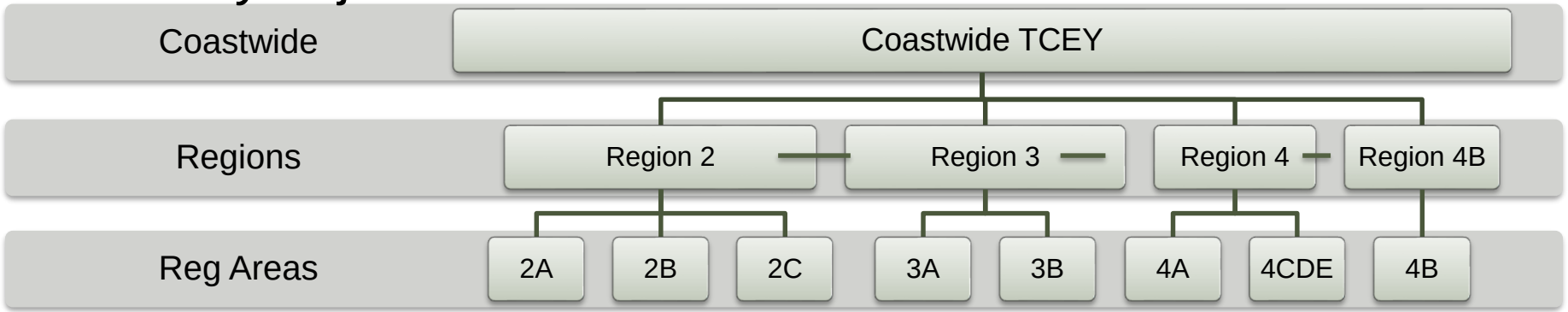
- Adjust the distribution of the TCEY among Regions
  - For example, use relative target harvest rates by Region
- Biological Sustainability and Fishery objectives



A procedure for distributing the TCEY (4)

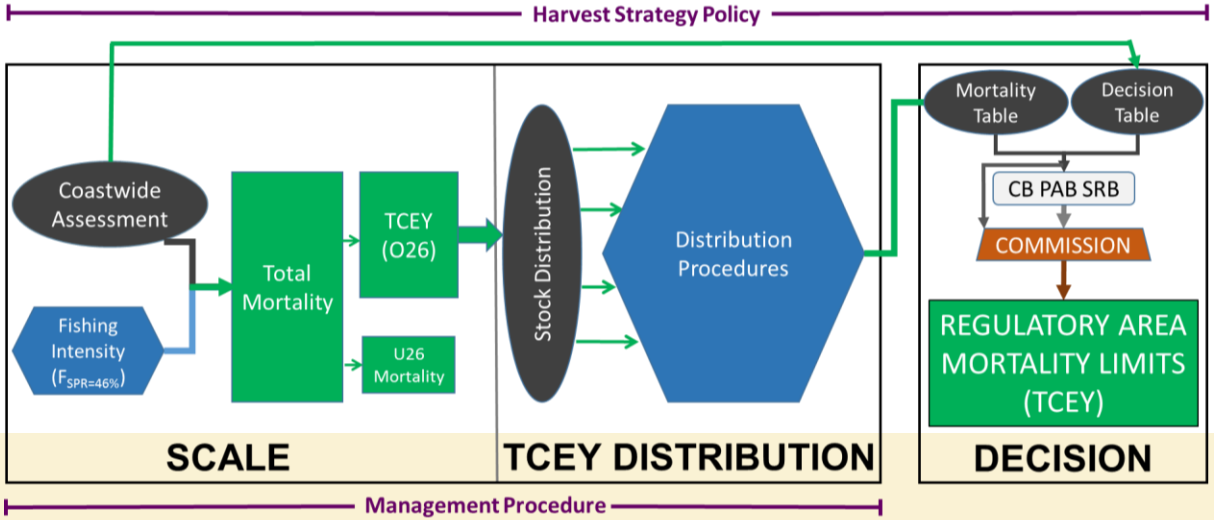
Regulatory Area Allocation

- Apply allocation percentages for each Regulatory Area within a Region
- Based on policy, data, observations, or agreement
- Fishery objectives



Distributing the TCEY

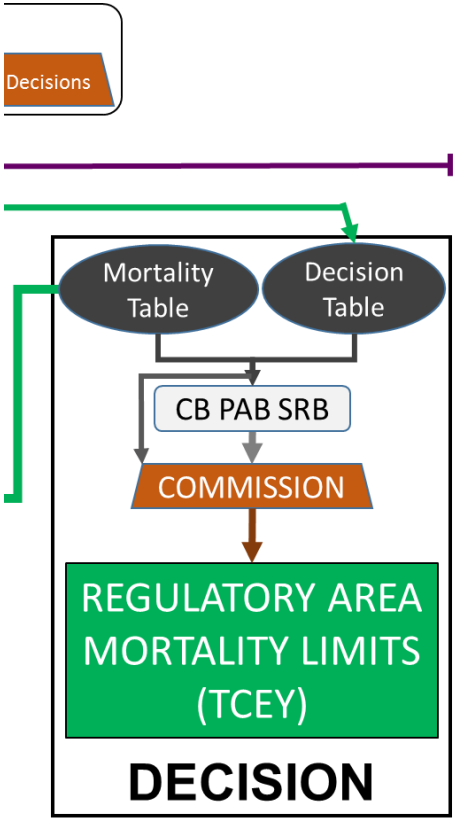
- Coastwide target fishing intensity
- Regional Stock Distribution
- Regional Allocation Adjustment
- Regulatory Area Allocation



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

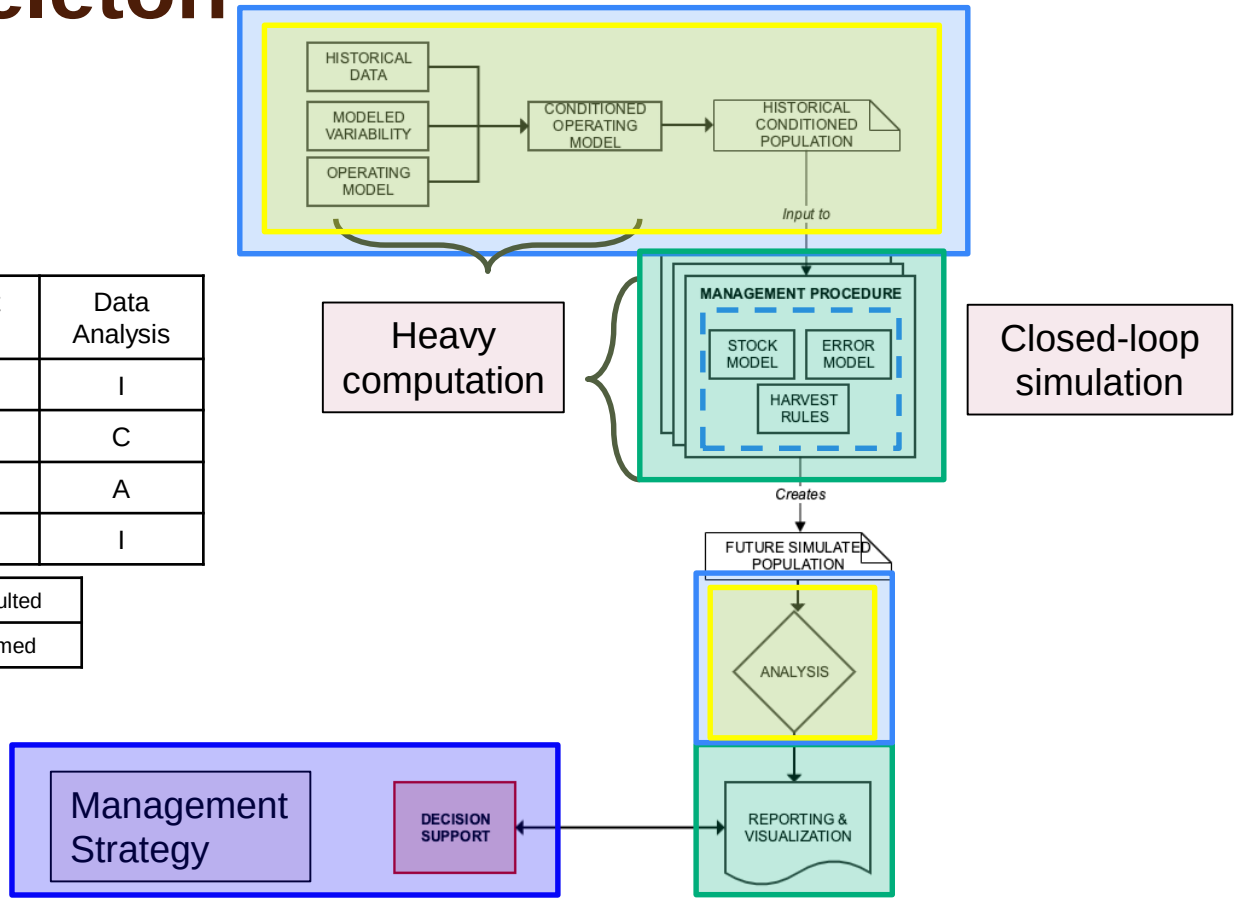
- Goals
  - Performance
  - Fidelity
  - Easy to use
  - Modular, extensible
  - Maintainable

- Structure & Use

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



Structure

- Configure
- Initialize & Manage
- Closed-Loop Simulation
- Report & Visualize

Configure

- Goals
  - Emphasize user experience
    - Customized MSE investigation
    - Simplify set-up
    - Dry-run
  - Flexible Automation
    - Can use different models, management procedures
- Implementation
  - Human-readable text files (YAML)
  - Syntax checker

```yaml
# Configuration for MSE closed-loop simulation

# data sources for conditioning
histdata:
  input:
    type: 'setline'
      path: '/home/steve/iphc/mse/setline'
      fmt: 'csv'
    type: 'survey'
      path: '/home/steve/iphc/mse/survey'
      fmt: 'csv'
  output:
    type: 'histcond'
      path: '/data/cond'
      fmt: 'hdf5'

# operating model Configuration
operatingModel:
  population:
    fishBiology: {active: 'yes', model: 'standard' }
    growth: {active: 'no', model: 'vonBertalanffy'}
    migration: {active: 'yes', model: 'flux' }
  environmental:
    oceanRegime: {active: 'no'}
    ecology: {active: 'no'}
  fishery:
    sectors:
      - commercial
      - discard
      - recreational
      - bycatch
      - subsistence
  spatial:
    coastwide: 'yes'
    regArea: 'yes'
    region: 'yes'
    subArea: 'no'

# Reporting
partitions:
  - year
  - age
  - sex
  - maturity
spatial:
  - region
  - regArea
```

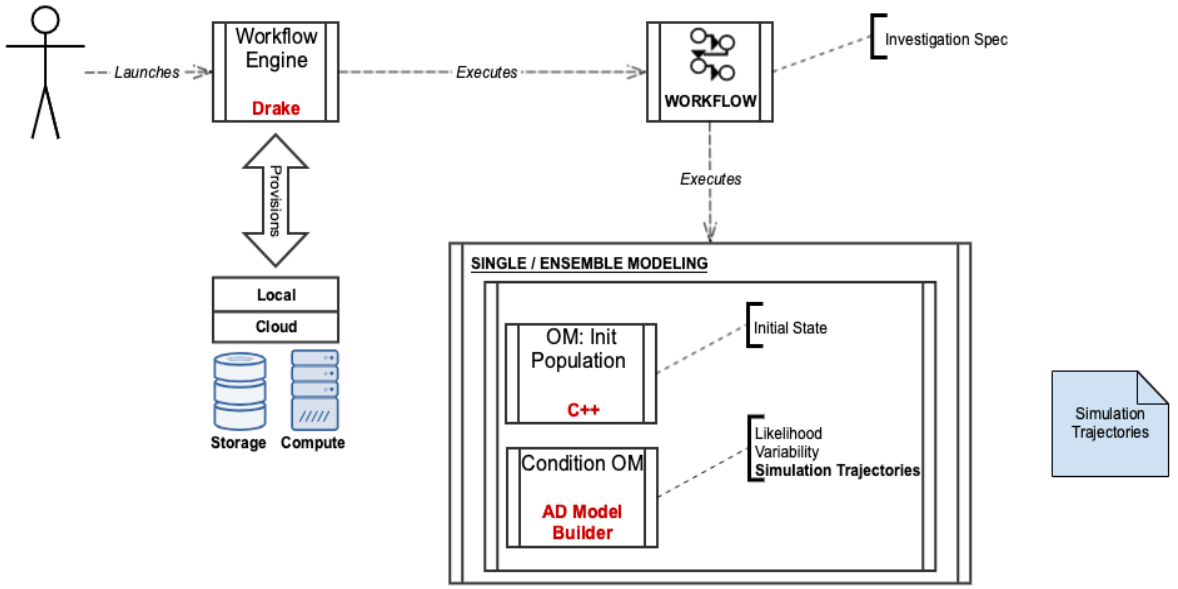
```yaml
# compute resources
compute:
  locn: 'local'
    cpu: 'x86_64'
    numcores: '4' # physical cores
    mem: '16'  # in GB
    datadir: '/data/model'
  locn: 'azure'
    cpu: 'D32v3'
    numcores: '32'
    mem: '128'  # in GiB for Azure
    datadir: '/mnt/azure/msedata'
    credential:
      appID: '335B3J2B34I4N5O3NB3D2E3K24N34H4'

# workflow specification
workflow:
  path: '/home/steve/iphc/mse/workflow/120419'
  engine: 'drake'
  resources:
    conditioning: 'azure'
    analysis: 'local'
```

Initialize & Manage

- Goals
  - Check configuration, resources
  - Manage & monitor computing tasks
  - Condition operating model

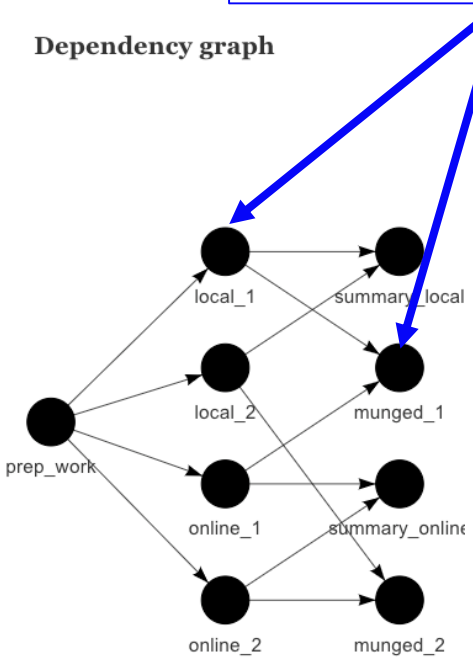
- Implementation
  - Dry-run
  - Workflow engine
  - State-of-the-art Operating Model
  - Statistical tools (ADMB, R)



Aside: Workflows

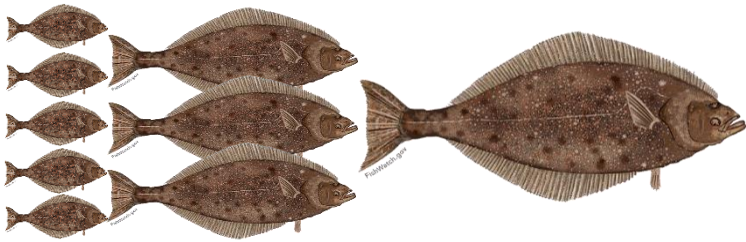
- Visibility into long-running & numerous tasks
- Check logic via visualization
- Reproducibility
- Automation

Computing tasks in R



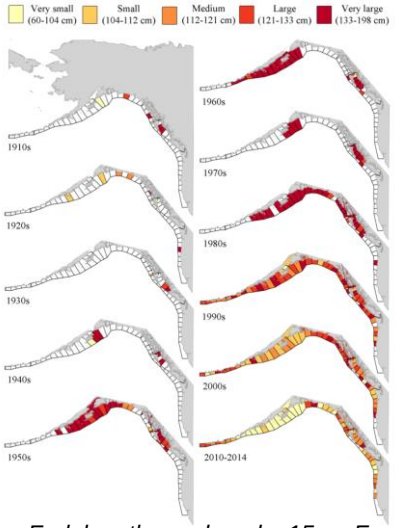

```
plan <- drake_plan(
  prep_work = do_prep_work(),
  local = target(
    get_local_data(n, prep_work),
    transform = map(n = c(1, 2), .tag_in = data_source, .tag_out = data)
  ),
  online = target(
    get_online_data(n, prep_work, port = "8080"),
    transform = map(n = c(1, 2), .tag_in = data_source, .tag_out = data)
  ),
  summary = target(
    summarize(bind_rows(data, .id = "data")),
    transform = combine(data, .by = data_source)
  ),
  munged = target(
    munge(bind_rows(data, .id = "data")),
    transform = combine(data, .by = n)
  )
)
```

Operating Model



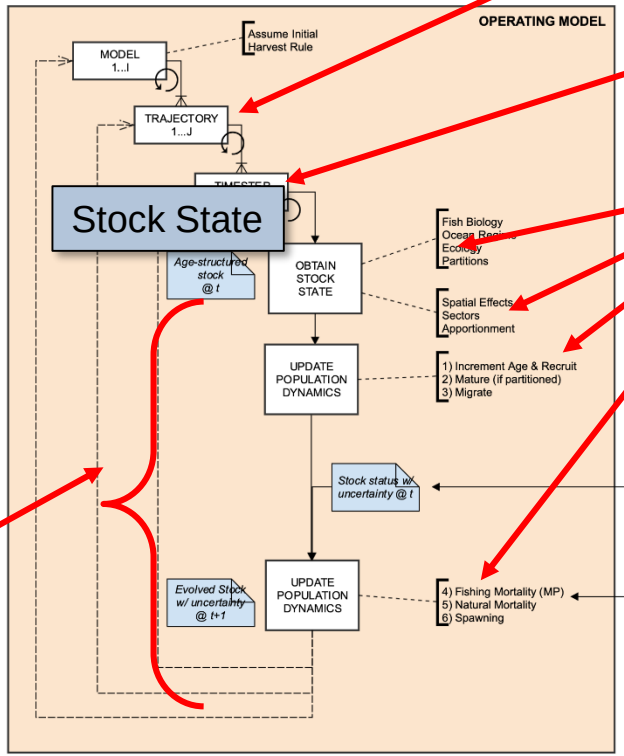
- Goal
  - Simulate the stock over time, spatial areas
    - Biology: demography, recruitment, aging, mortality
    - Dynamics: migration
    - Related impacts: marine, environment
  - Produce time/area snapshots of stock (aka “partitions”)
    - *e.g., length-at-age per IPHC Regulatory Area in 2022*

- Implementation
  - Customizable parameters, on/off options
  - Written in C++
  - Extensible
  - Parallelizable



Fork length per decade, 15 yo F
Sullivan et al. 2018
DOI: 10.4027/icedhlff.2018.06

Operating Model



Loop: trajectories

Loop: years

Stock State

Effects on Stock State

Given stock state, apply biology, fishery impacts, & update

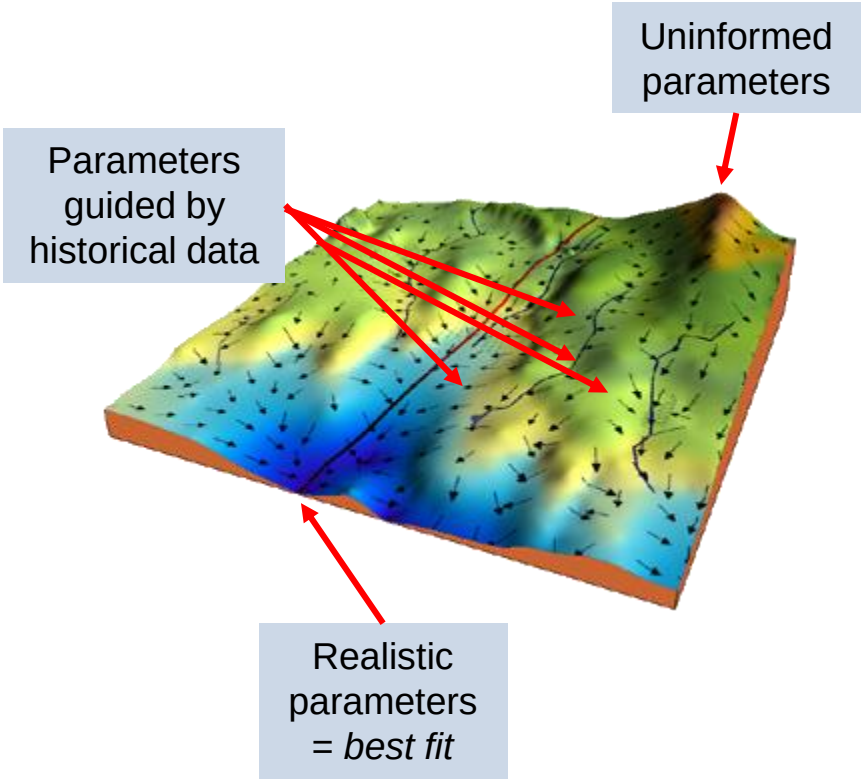
Stock Assessment

Management Procedures

Condition the Model

- Goal
  - Generate representation of present stock state with uncertainty
  - Increase realism of simulation parameter values
  - Ready model for forward simulation
  - Assess variability

- Implementation
  - IPHC Operating Model
  - Optimization algorithms (ADMB)
    - e.g., gradient descent
  - Use available historical data
  - Significant upfront investment
    - Hours-days computing time
    - 10s-100s GB generated data

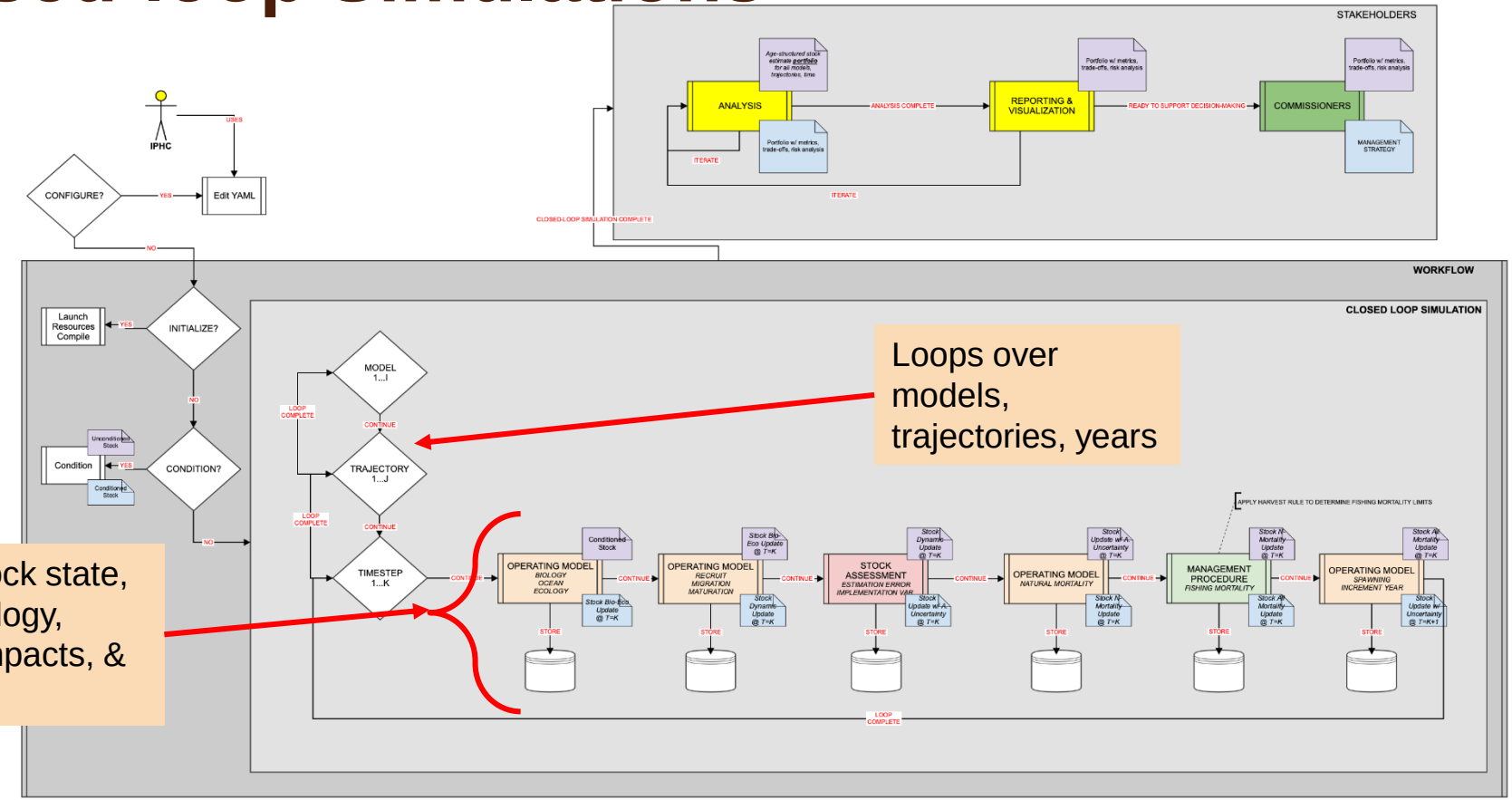


Closed-loop Simulations

- Goals
  - Iterative, annual simulation of
    - spatially distributed halibut stock
    - impact to stock of fisheries & management procedures
  - Produce simulated data sets, with uncertainties, to guide decision-making

- Implementation
  - IPHC operating model
  - Simulated stock assessments
  - Workflow software

Closed-loop Simulations



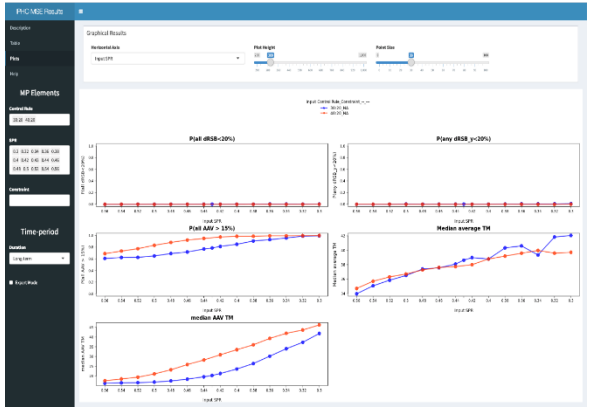
Loops over models, trajectories, years

Given stock state, apply biology, fishery impacts, & update

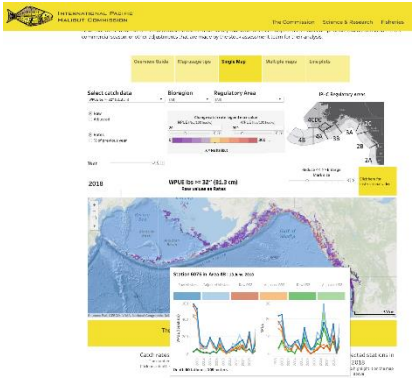
Reporting & Visualization

- Goals
  - Explore MP impact on stock
  - Visualize tradeoffs
  - Highlight useful metrics
  - Easy to use & accessible
  - Customizable

- Implementation
  - Custom web application (Shiny/R)
  - Commcercial tools (Tableau?)



Initial webapp (*A. Hicks*)
http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/IPHC-MSAB013/



IPHC Setline Survey (*R. Webster*)
https://iphc.int/data/setline-survey-catch-per-unit-effort/

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
- Conditioned using data and informed assumptions
- Incorporate variability and uncertainty
- Technical details will be reviewed by the SRB

MPs related to distribution

- Relative harvest rates
  - As above in Regional Allocation and Regulatory Area Allocation
  - Can be science or management based
- O32:O26 ratios
  - Need more discussion
- Trends in setline survey WPUE by IPHC Reg Area
  - Regulatory Area Allocation
  - Trends within a Region may be inconsistent with location of halibut when fishery occurs
- Trends in modelled survey WPUE by biological region
  - Regional Stock Distribution
  - Survey data already used to distribute the TCEY to regions

MPs related to distribution

- Trends in fishery CPUE
  - Regulatory Area Allocation
  - A more direct representation of what the fishery has observed
  - Subject to uncertainty
- Smoothing algortihms on area-specific catch limits
  - Can reduce variability
  - May slow down a necessary response
- Percentage allocation with a minimum TCEY
  - When coastwide catch limit is small, may be difficult

MPs related to distribution

- Max fishing intensity with distribution using modelled survey WPUE
  - Is this similar to status quo?
- Coastwide TCEY target with maximum fishing intensity; distribution using target, but with ability to adjust TCEY up to maximum
  - What happens when the MP would need to be evaluated at the max then distribution results in an SPR greater than maximum

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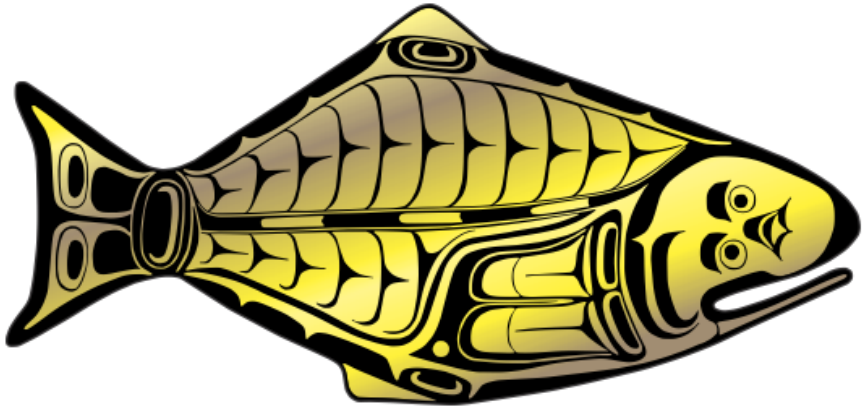

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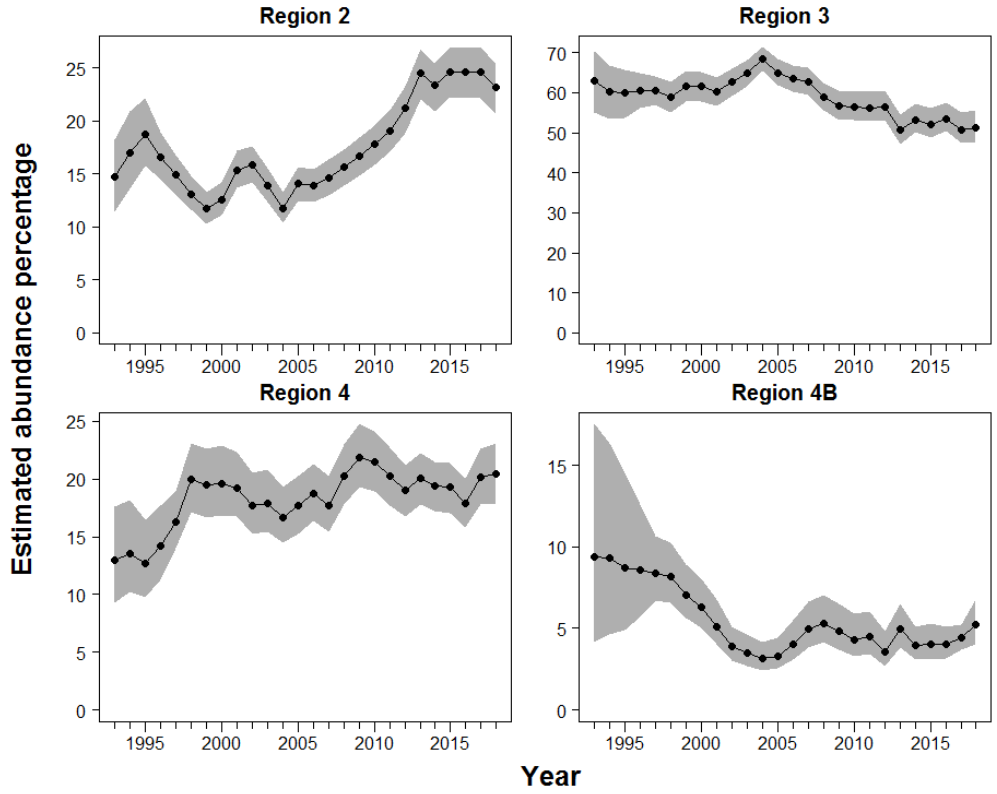
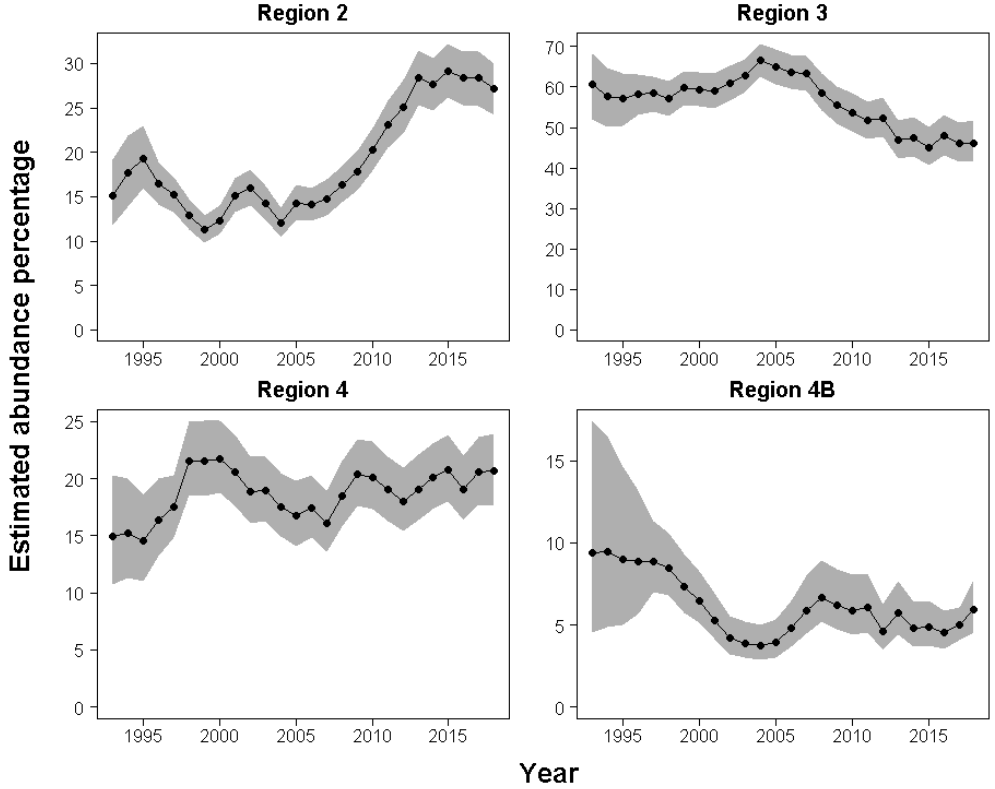
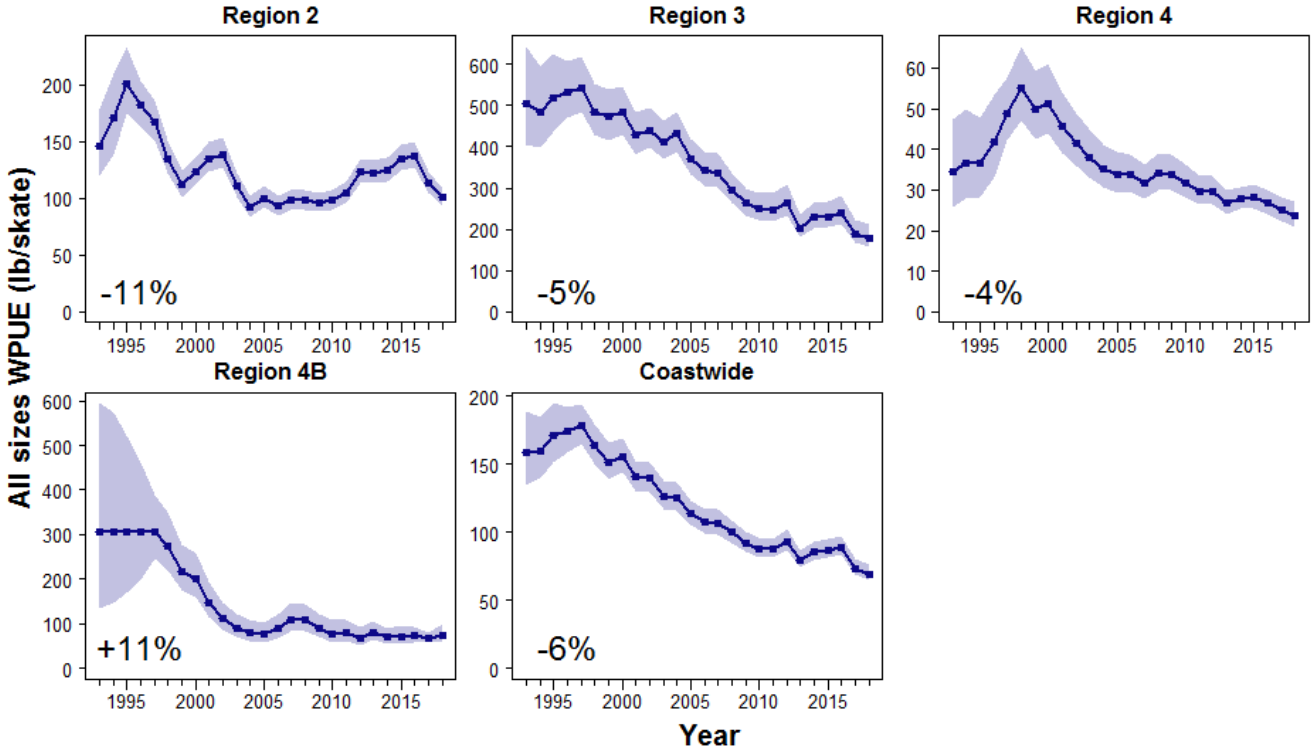
Biological stock distribution (all sizes)



Stock distribution (O32)




Region 2
Region 3
Region 4
Region 4B
Coastwide
All sizes WPUE (lb/skate)
Year
-11%
-5%
-4%
+11%
-6%