NOAA FISHERIES

Northeast Pacific Sablefish Management Strategy Evaluation

Maia Sosa Kapur[1], Melissa A. Haltuch[2], Kari Fenske[2], Brendan Connors[3], and the PSTAT

PFMC SSC

November 2020

[1] UNIVERSITY of WASHINGTON

[2] NOAA

[3] Canada FISHERIES AND OCEANS

2018 Sablefish MSE

West coast MSE investigating future climate driven recruitment and harvest control rule performance

SSC March 2017 and 2018 Recommendations

Develop a population model consistent with the understanding of sablefish stock structure

- Create a NE Pacific spatially-structured operating model
- Evaluate transboundary stock structure and connectivity

Overview of progress

The Pacific Sablefish Transboundary Assessment Team (PSTAT)

Scientific collaboration including AFSC, DFO Canada, NWFSC, and ADFG

NOAA NMFS International Science Strategy

First scientific meeting of the PSTAT (Fenske et al. 2018)

PSTAT regional project leads funding

Maia Kapur, Ph.D. Candidate at UW - NE Pacific spatial MSE framework

Luke Rogers, DFO Research Scientist - NE Pacific movement

PSTAT project focus - NE Pacific wide data analyses

Stakeholder feedback

Stakeholder input is fundamental to defining the key elements of a MSE and ensuring that it is grounded in reality

Soliciting input on how each region prefers to provide feedback

- **Further OM development and key uncertainties to be considered**
- **Identify** fishery management objectives and performance metrics
- **Alternative** management strategies to be considered

Stakeholder feedback

Current MSE development is consistent with 2017/2018 SSC recommendations

Focus on spatial mismatch between demographic population structure and NE Pacific management boundaries

Objectives

Maximize catch, stabile catch, maintain a specified spawning stock size

Performance metrics for comparing management actions

Future trends in the time series of spawning biomass, stock depletion, and catches

The proportion of time and the year that the spawning biomass declines below the target stock size, precautionary stock size, and the limit stock size at which the fishery would be closed

Stakeholder feedback

Current MSE development is consistent with 2017/2018 SSC recommendations

- **Alternative** management strategies to be considered (spatial and HCR focus)
  - Assessment method + 40–10 HCR with F45% exploitation rate
  - Survey based HCR

Future MSE iterations

- **Economic**, environmental (e.g. recruitment / growth), ecological interactions, or allocation issues
- **Increasing** scope will require resources

Stakeholder feedback

What process will work for the PFMC for engaging and soliciting stakeholder feedback?

Spring 2021 workshop

Identifying fishery management objectives and performance metrics

A Transboundary Operating Model for NE Pacific Sablefish

M Sosa Kapur kapurm@uw.edu

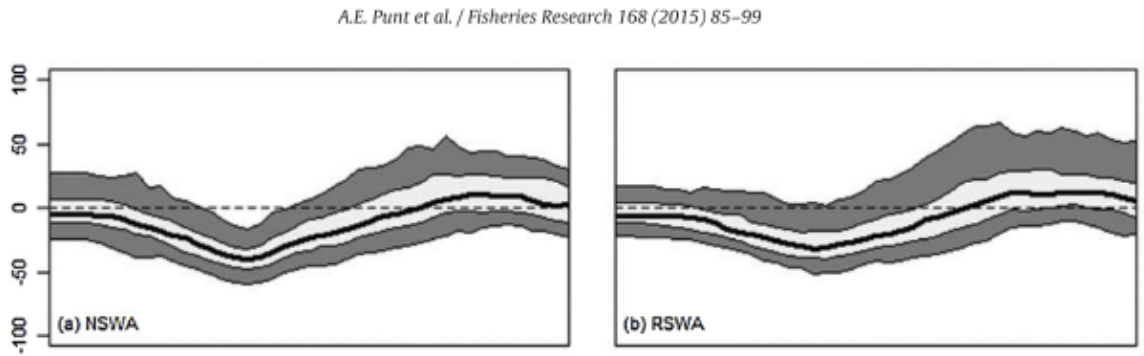
PhD Candidate

NMFS-Sea Grant Population Dynamics Fellow

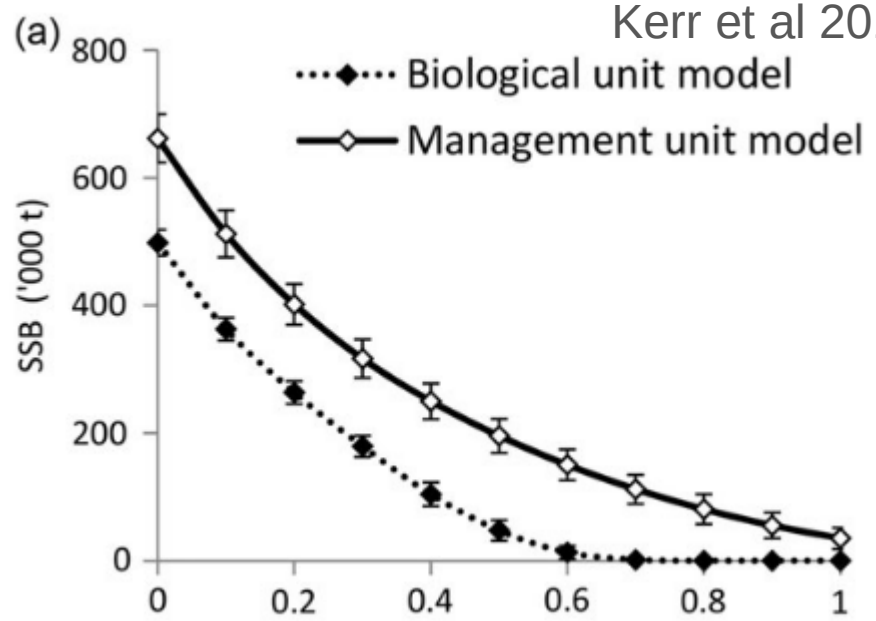
The 30k foot view

“The Why”: Science

- A fair bit has been done on spatial mis-match vs. estimation uncertainty

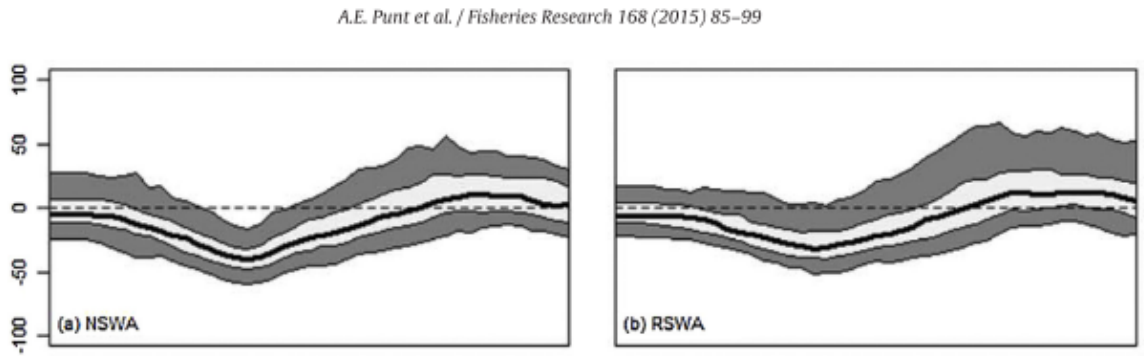


Kerr et al 2014

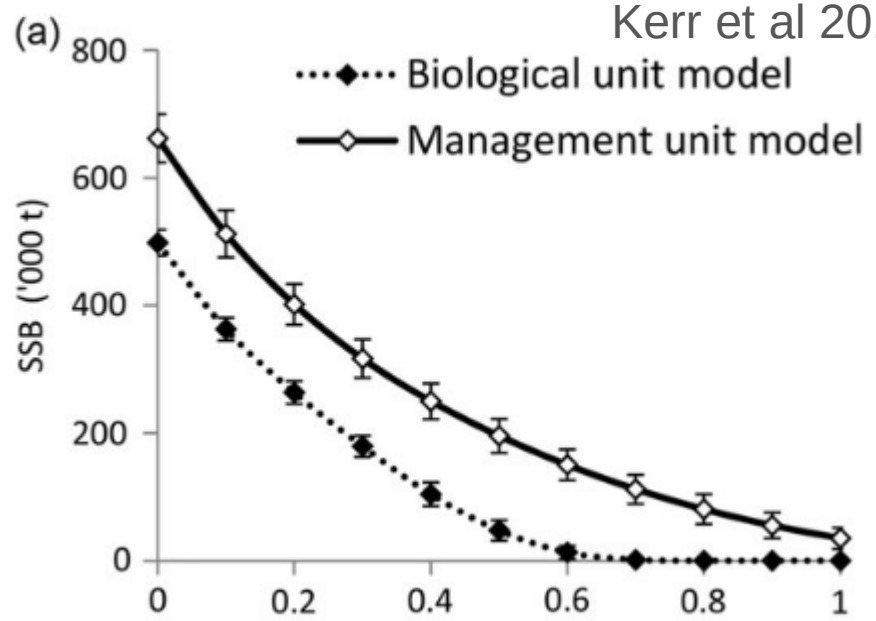


“The Why”: Science

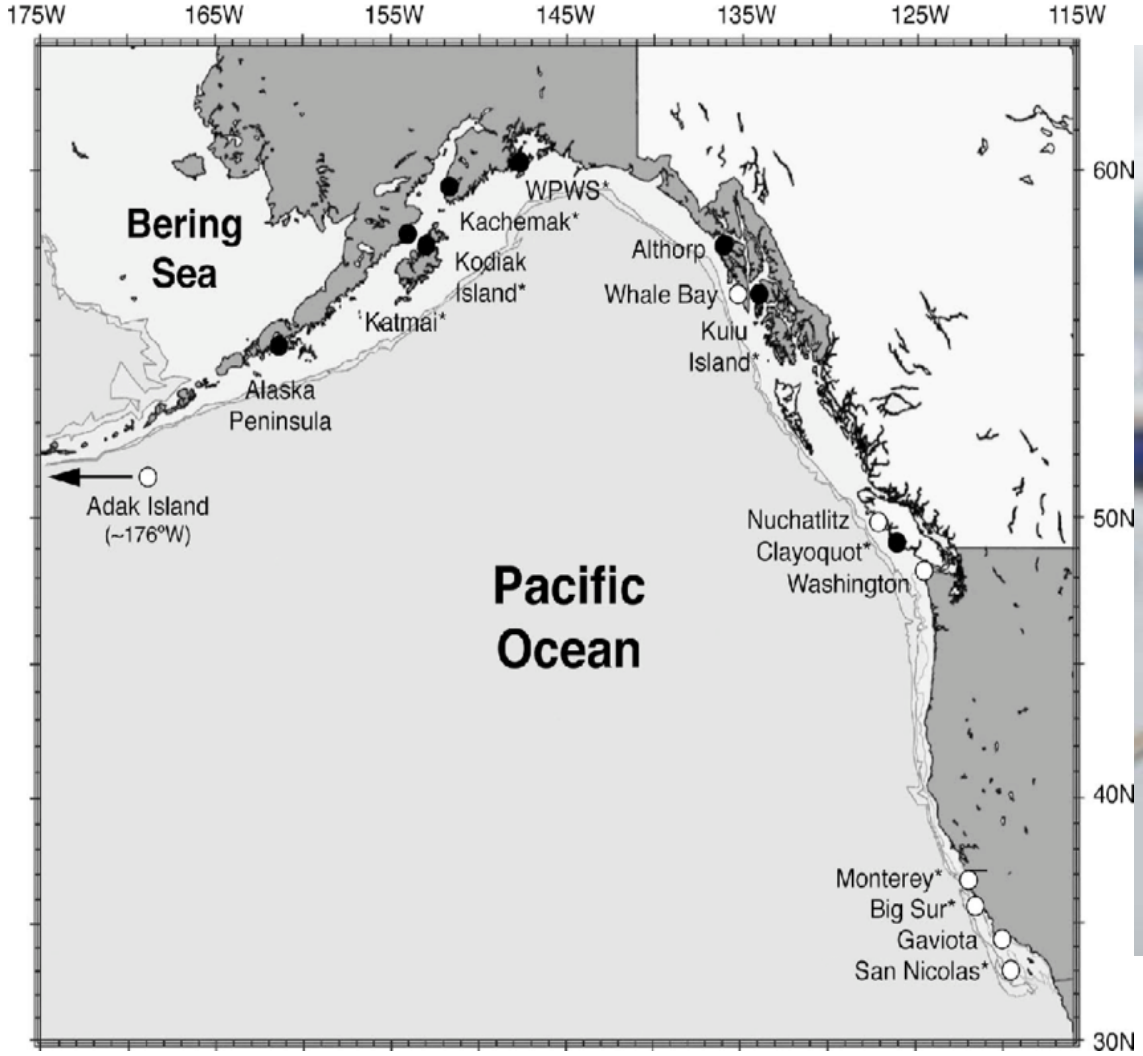
- A fair bit has been done on spatial mis-match vs. estimation uncertaint,
- Less work on how spatial misspecification flows into harvest control rule (HCR) performance



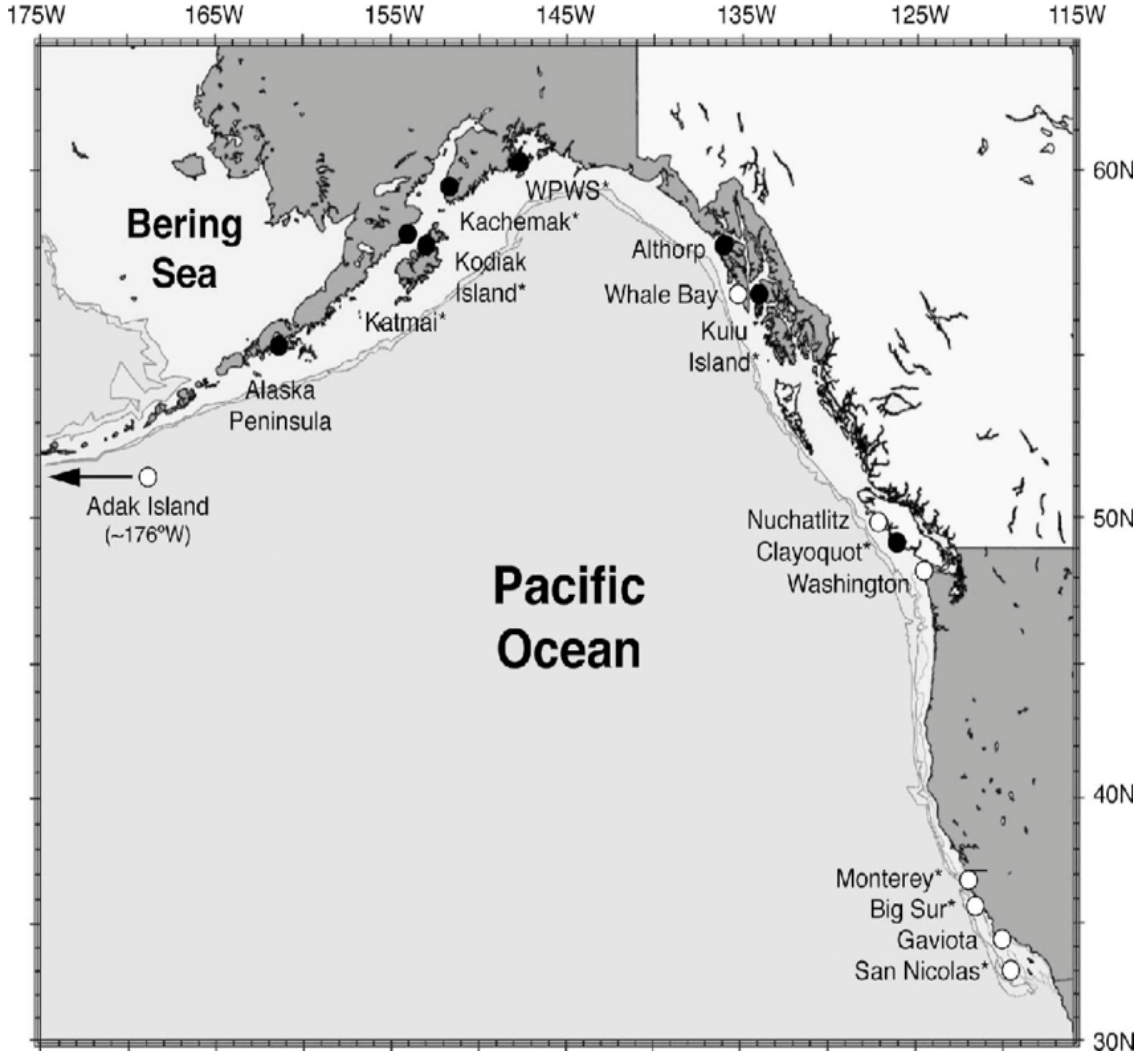
Kerr et al 2014

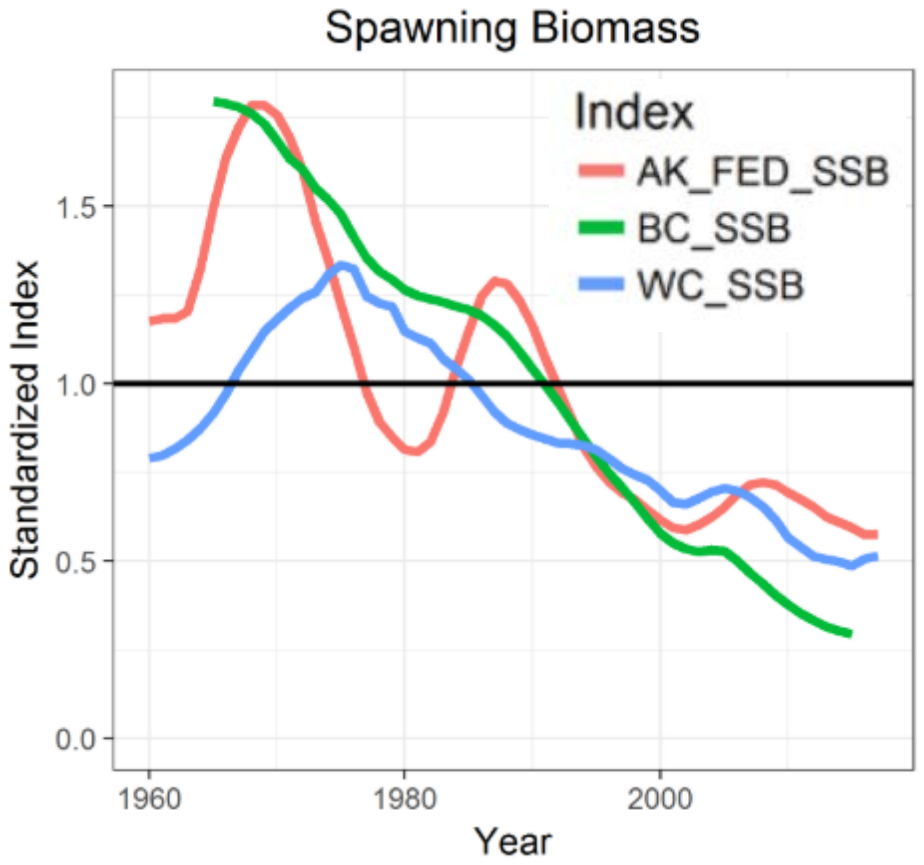


“The Why”: Sablefish



“The Why”: Sablefish





Operating Model as Foundation

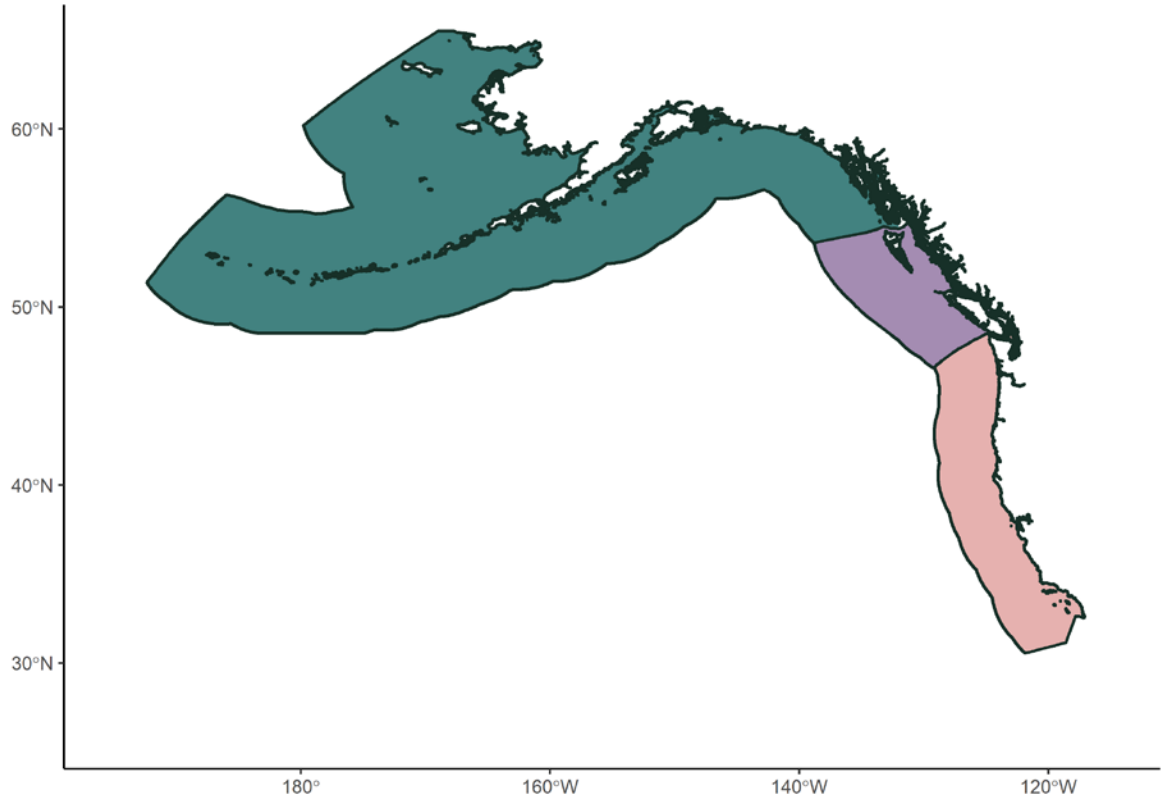
Basic OM Structure

Spatially & age-structured

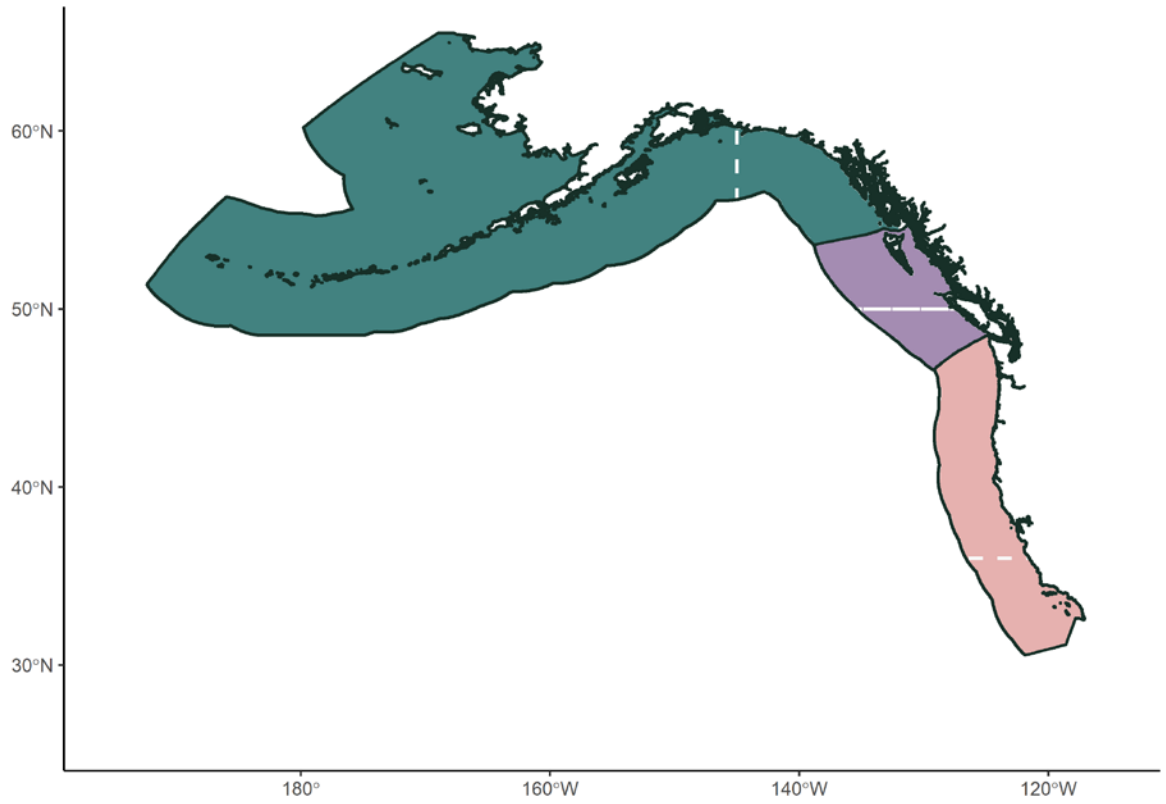
Template Model Builder

Present Status: conditioning model to input data

OM Spatial Structure: Management

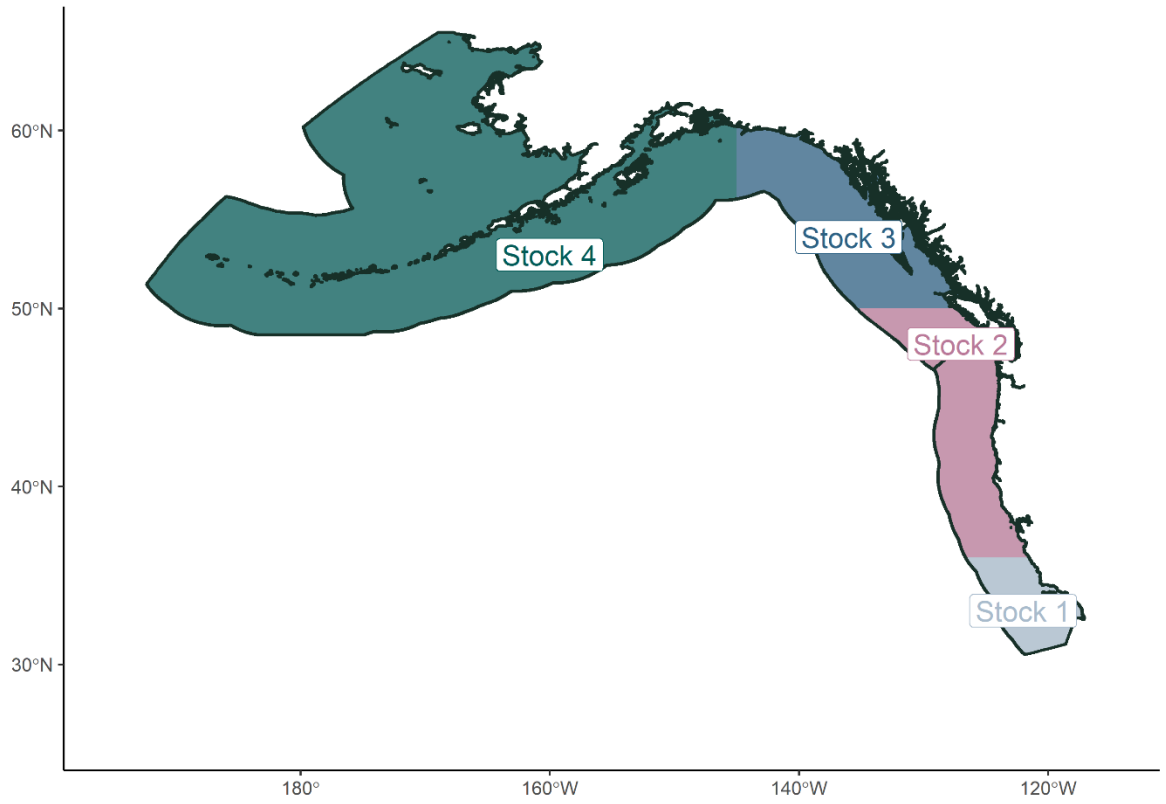


OM Spatial Structure: Growth

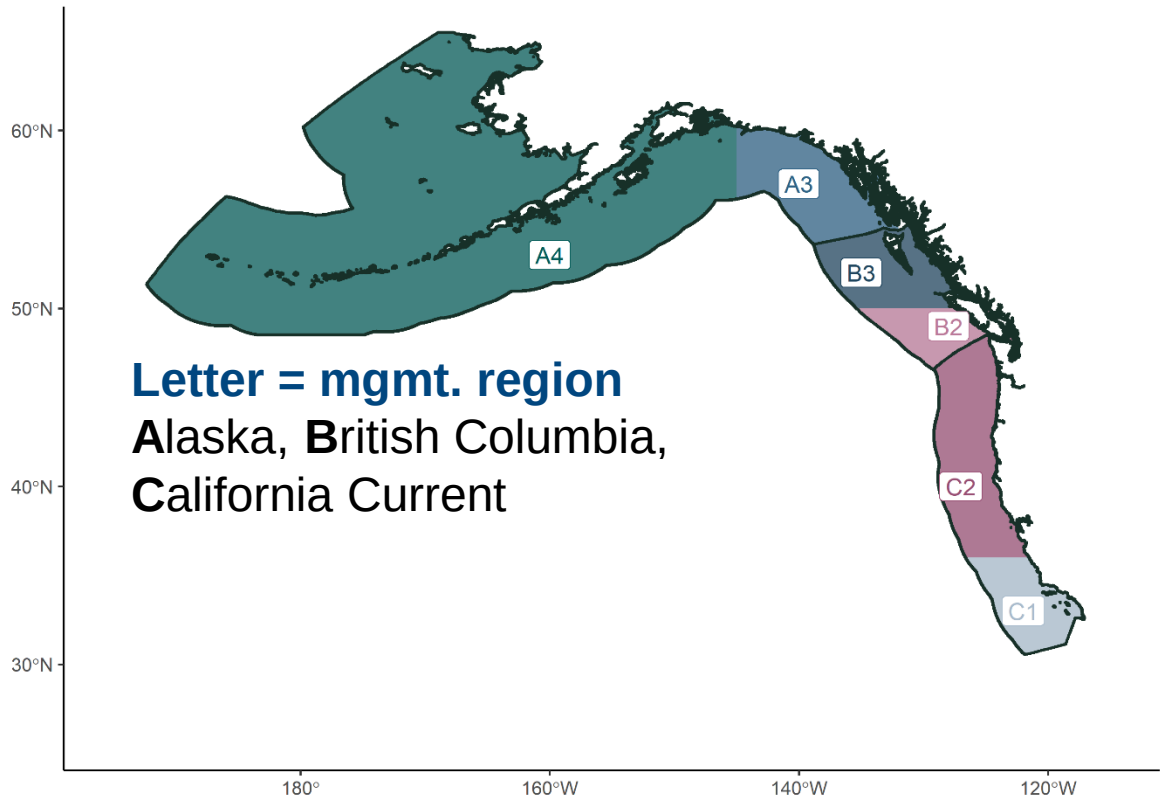


Kapur et al. 2020 *Fisheries Research*

OM Spatial Structure: Stocks

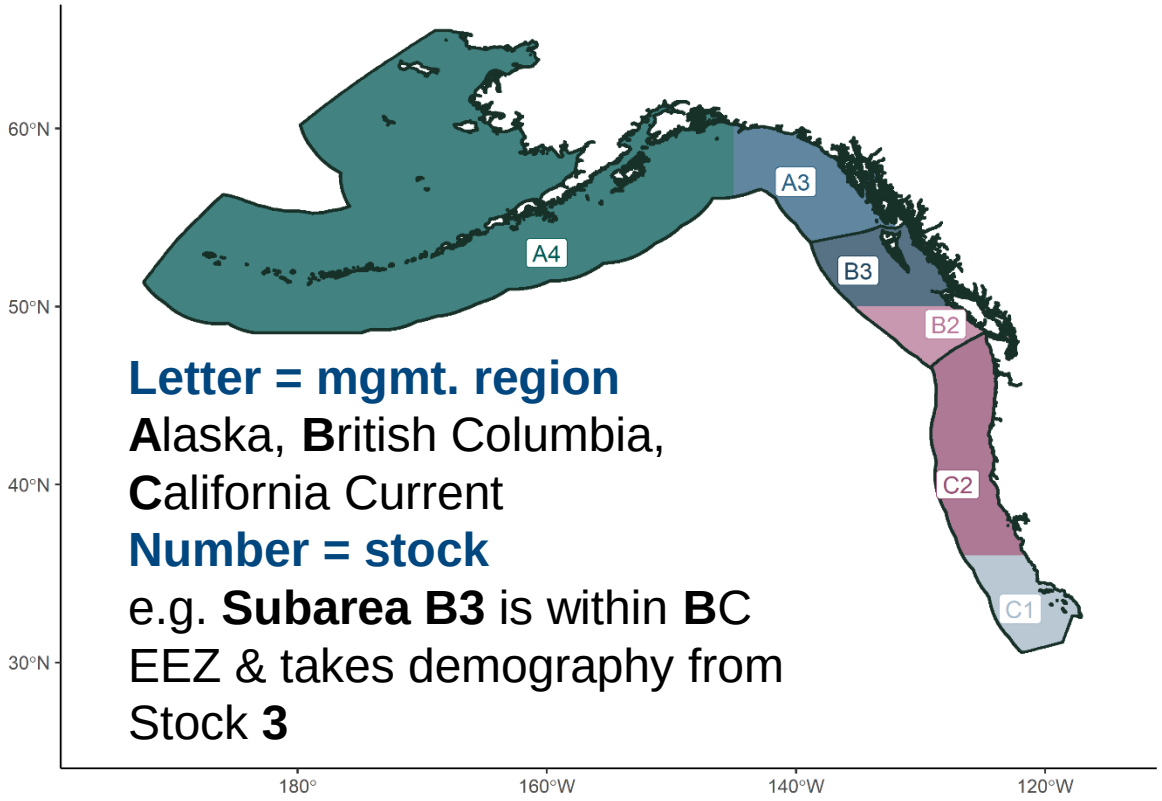


OM Spatial Structure: Subareas



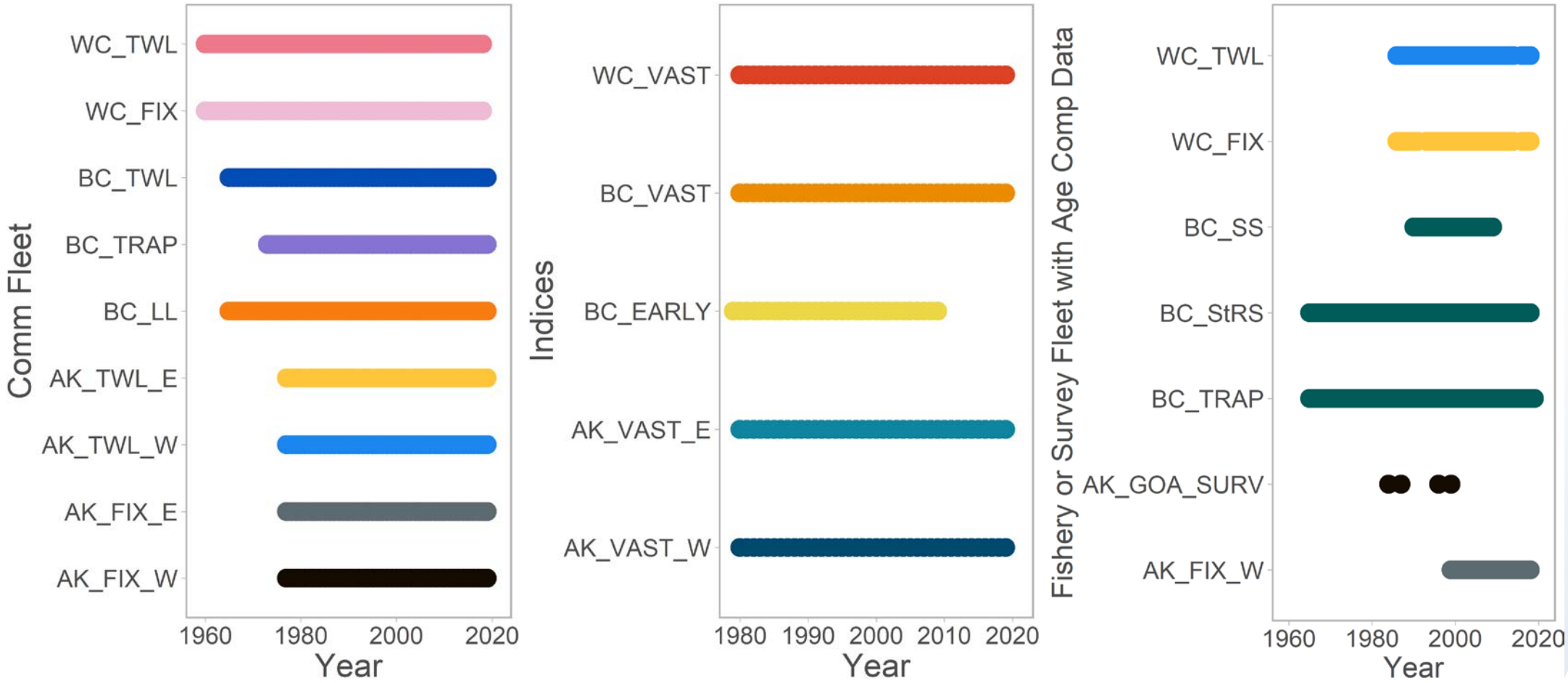
Letter = mgmt. region
Alaska, **B**ritish Columbia,
California Current

OM Spatial Structure: Subareas

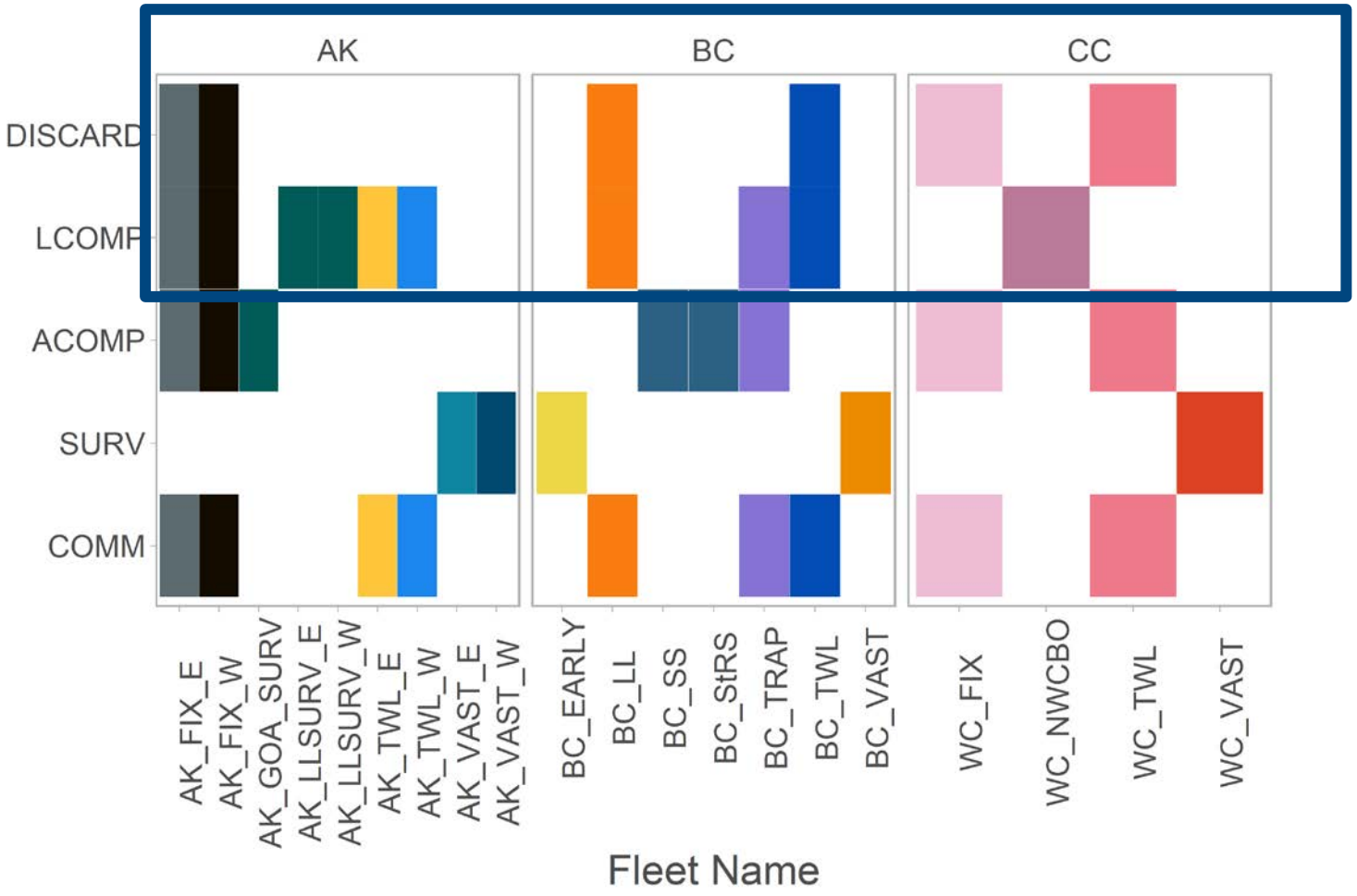


Letter = mgmt. region
Alaska, **B**ritish Columbia, **C**alifornia Current
Number = stock
e.g. **Subarea B3** is within **B**C EEZ & takes demography from Stock **3**

Data Inputs: Fleets I

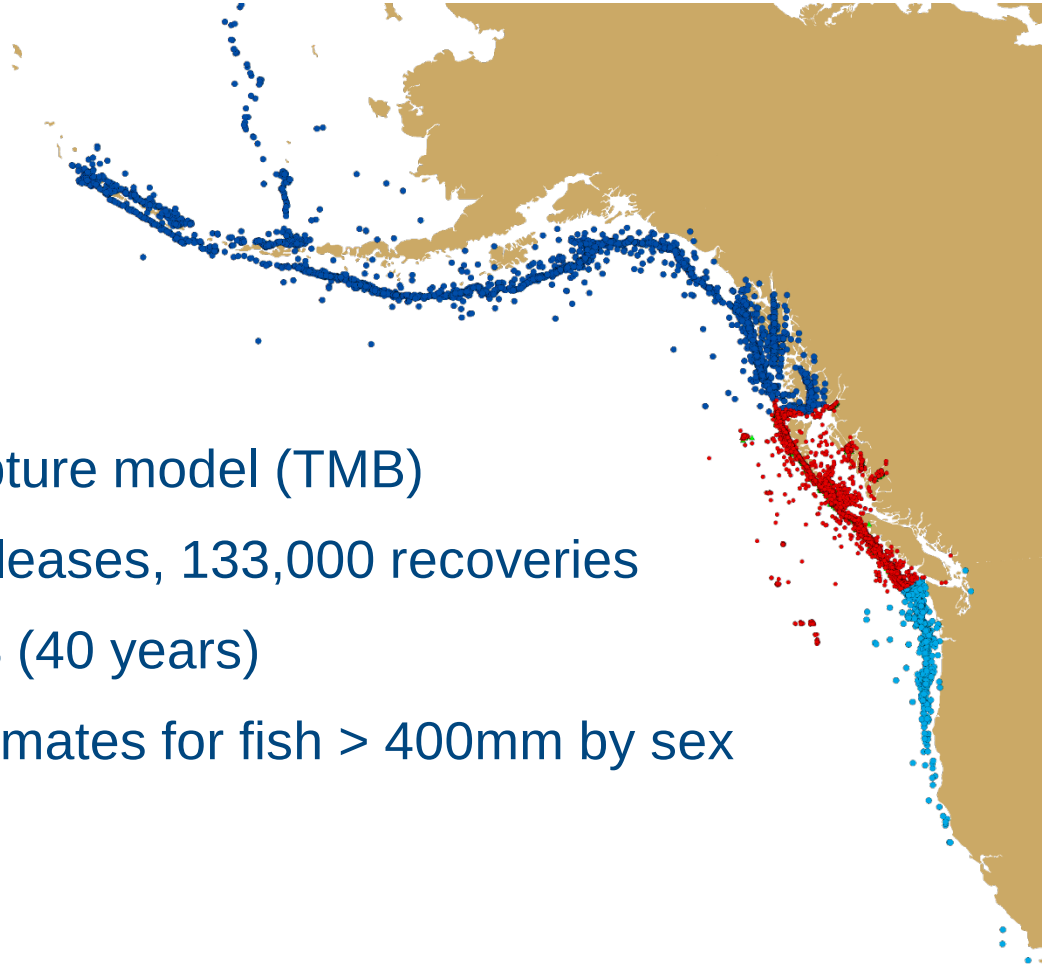


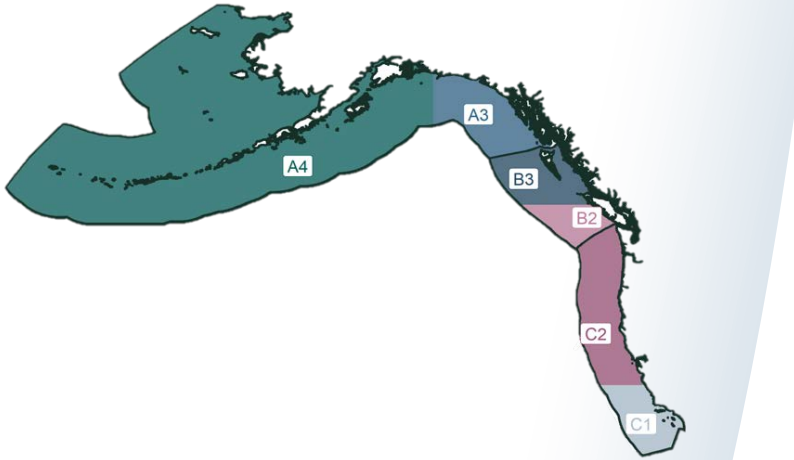
Data Inputs: Fleets II



- No discards
- No length compositions

Data Inputs: Movement





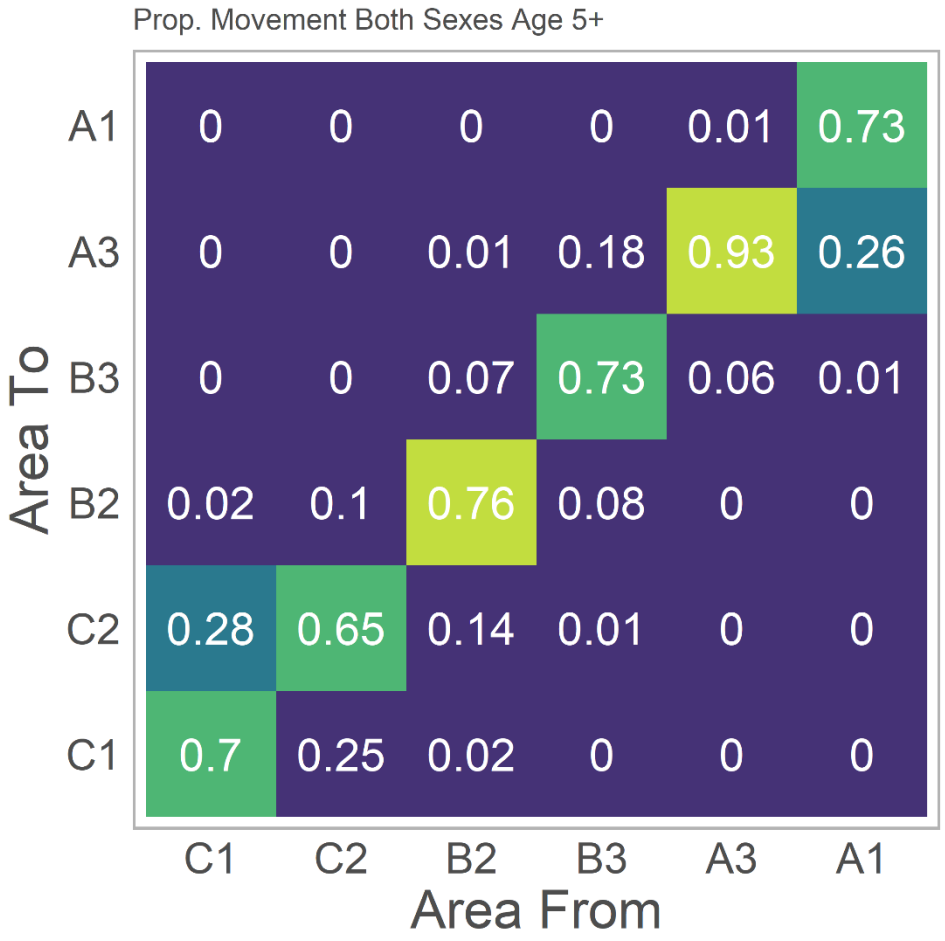
- Mark-recapture model (TMB)
- 1 million releases, 133,000 recoveries
- 1979–2018 (40 years)
- Pooled estimates for fish > 400mm by sex

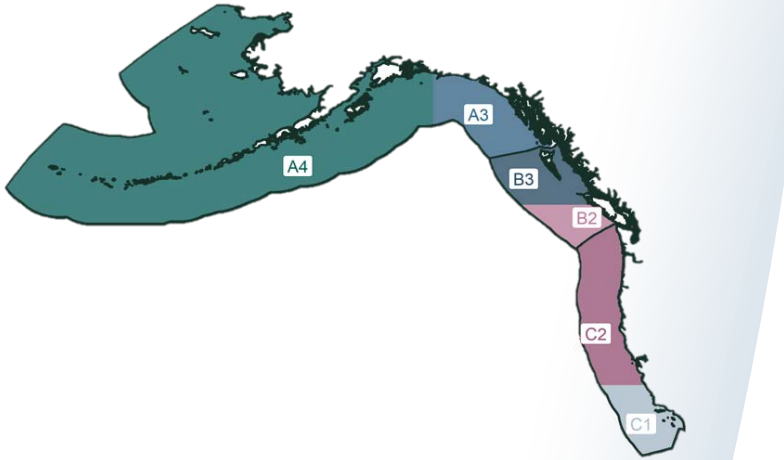
Luke Rogers, PhD
DFO (Canada)

Canada
FISHERIES AND OCEANS

NOAA FISHERIES

Data Inputs: Movement



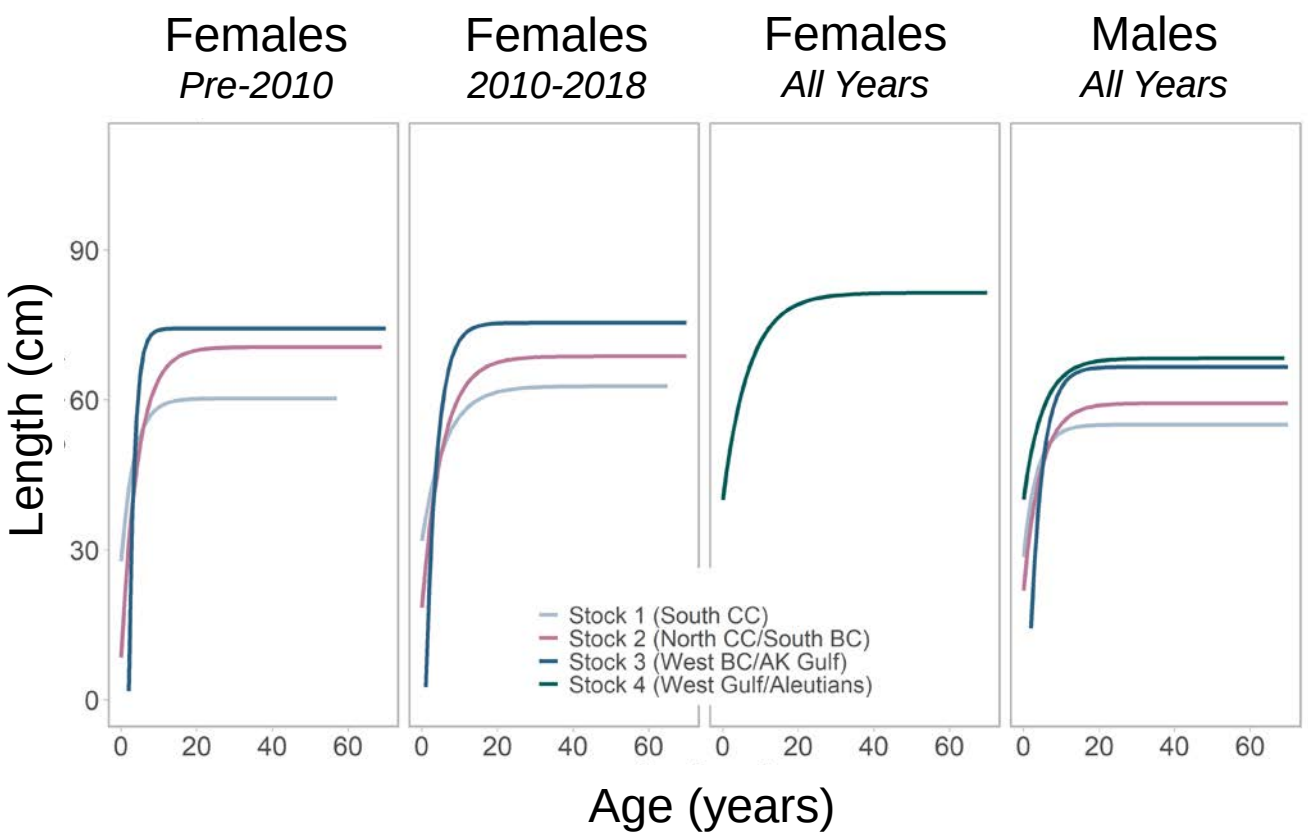


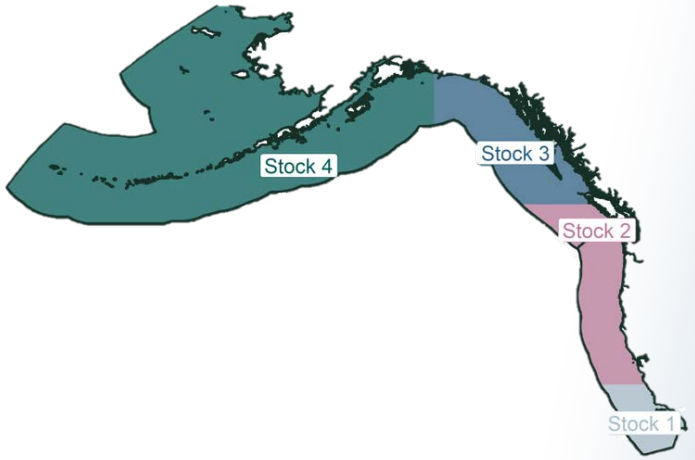
Luke Rogers, PhD
DFO (Canada)

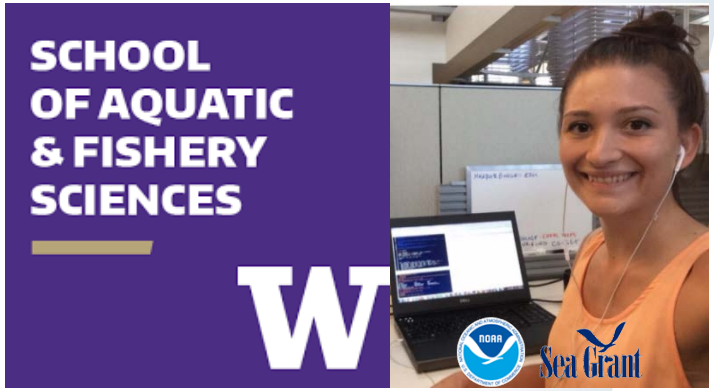
Canada
FISHERIES AND OCEANS

NOAA FISHERIES

Data Inputs: Growth





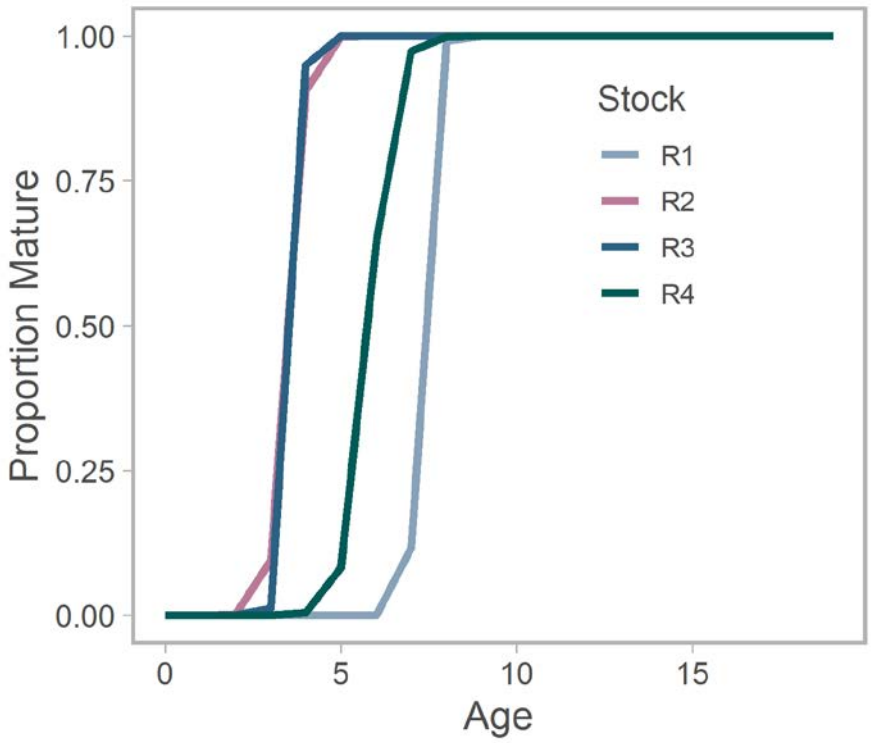


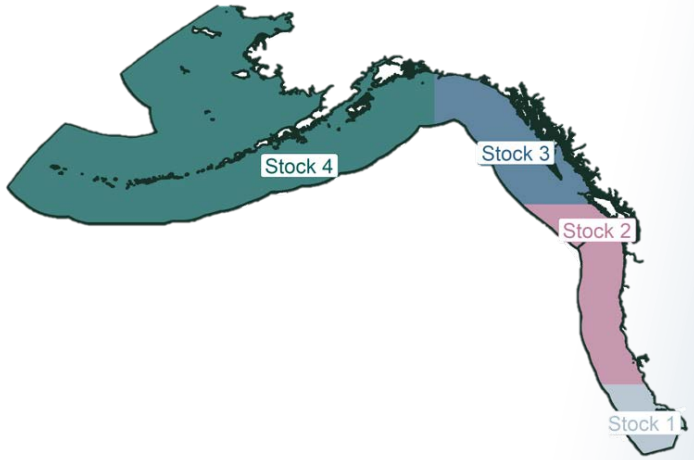
Myself (Maia Kapur)

Kapur et al. 2020 *Fisheries Research*

NOAA FISHERIES

Data Inputs: Maturity @ Age

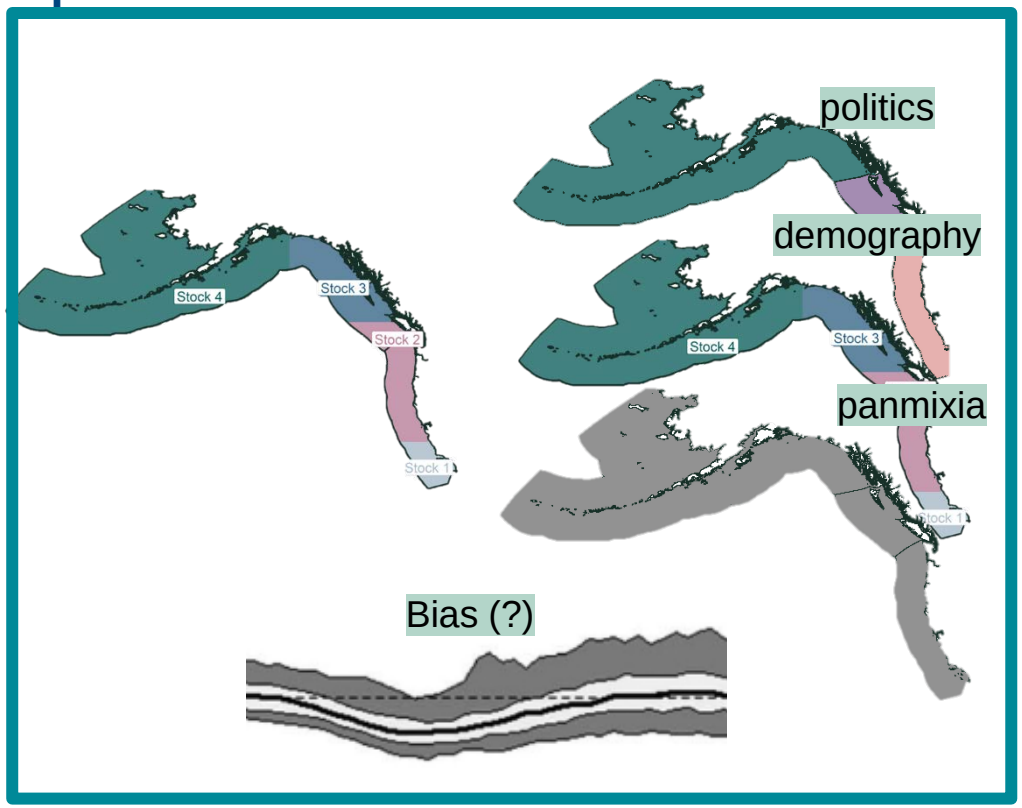




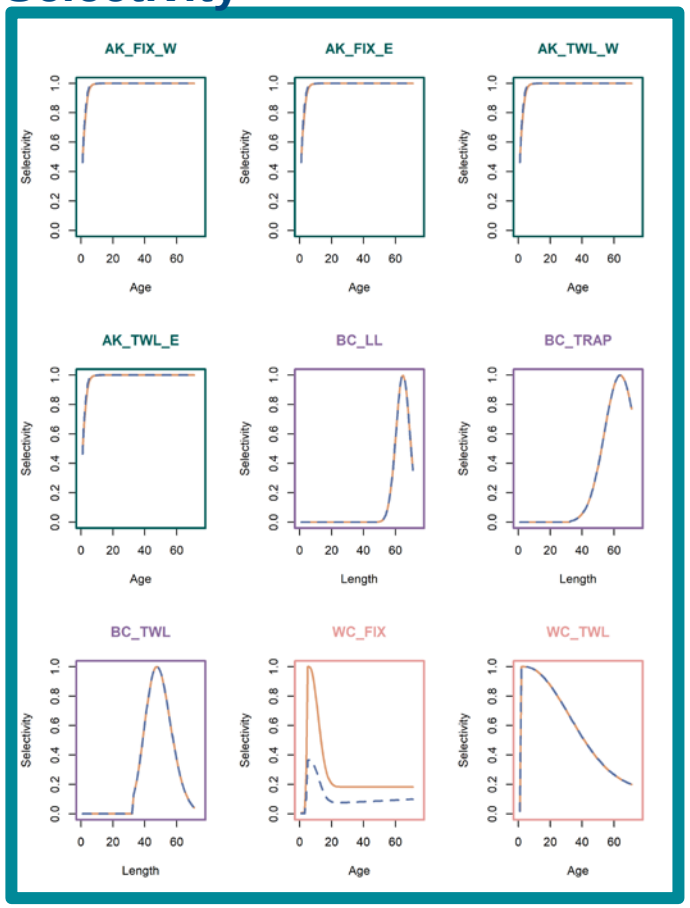
Ben Williams PhD +co
Alaska Dept. of Fish & Game, now AFSC (NOAA)

Principal Uncertainties

Spatial Structure



Selectivity



Recruitment and Movement

$$R_y^k = \frac{4h^k R_0^k S_y^k}{S_0^k(1-h^k)+S_y^k(5h^k-1)} e^{-0.5\sigma_R^2+\tilde{R}_y^k}$$

$$S_y^k = \sum_a \phi^{ik} N^i_{y,\gamma=female,a} w^k_{y,\gamma=female,a} E^k_a$$

- Spatial Bev-Holt at stock level k
- SSB in k is summation over i in k

$$R_y^i = \tau^{ik} R_y^k$$

NOAA FISHERIES

Thanks & Contacts

Operating Model Development

Maia Sosa Kapur - kapurm@uw.edu

PSTAT Regional Project Leads

Dr. Melissa Haltuch (NWFSC), West Coast
Melissa.haltuch@noaa.gov

Kari Fenske (AFSC), Alaska
Kari.Fenske@noaa.gov

Dr. Brendan Connors (DFO), British Columbia
Brendan.Connors@dfo-mpo.gc.ca

Funding (M Kapur)

NMFS-Sea Grant Pop Dy Fellowship

NWFSC Fisheries Research Analysis and Monitoring Division

NMFS Sustainable Fisheries NMFS West Coast Region

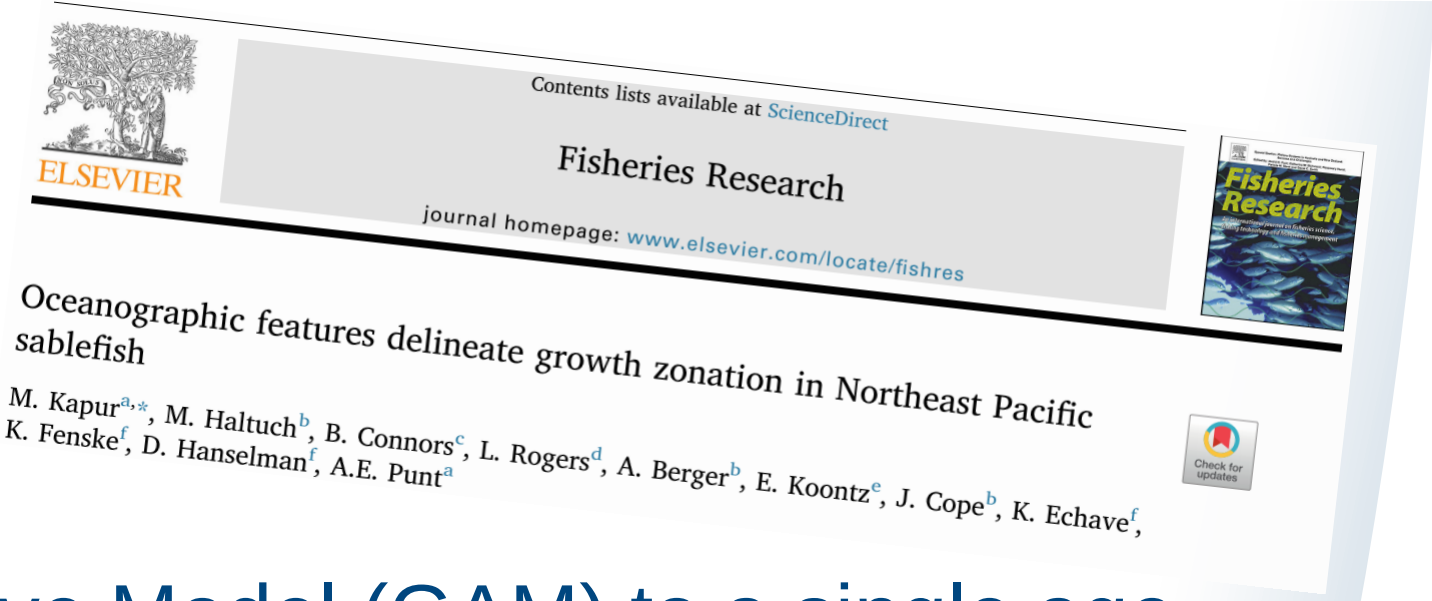
AFSC Auke Bay Laboratories Marine Ecology and Stock Assessment Program

Basic OM Structure

Spatially & age-structured
Template Model Builder
Present Status: conditioning model to input data

$$N^i_{y+1,\gamma,a} = \begin{cases} 0.5R^i_{y+1} & \text{if } a = 0 \\ \sum_{i \neq j} \left[\left(1 - \mathbf{X}^{i,j}_a\right) \; N^i_{y,\gamma,a-1} e^{-Z^i_{y,\gamma,a-1}} + \mathbf{X}^{j,i}_a N^j_{y,\gamma,a-1} e^{-Z^i_{y,\gamma,a-1}} \right] & \text{if } 1 \leq a < A \\ \sum_{i \neq j} \left[\left(1 - \mathbf{X}^{i,j}_a\right) \left(N^i_{y,\gamma,A} e^{-Z^i_{y,\gamma,A}} + N^i_{y,\gamma,A-1} e^{-Z^i_{y,\gamma,A-1}} \right) \right. & \text{if } a = A \\ \left. \ldots + \mathbf{X}^{j,i}_a \left(N^j_{y,\gamma,A} e^{-Z^j_{y,\gamma,A}} + N^j_{y,\gamma,A-1} e^{-Z^j_{y,\gamma,A-1}} \right) \right] & \end{cases}$$

Growth Analysis



ELSEVIER

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Oceanographic features delineate growth zonation in Northeast Pacific sablefish

M. Kapur[a,*], M. Haltuch[b], B. Connors[c], L. Rogers[d], A. Berger[b], E. Koontz[e], J. Cope[b], K. Echave[f], K. Fenske[f], D. Hanselman[f], A.E. Punt[a]

- "Let the data talk"
- Fit a Generalized Additive Model (GAM) to a single age and sex

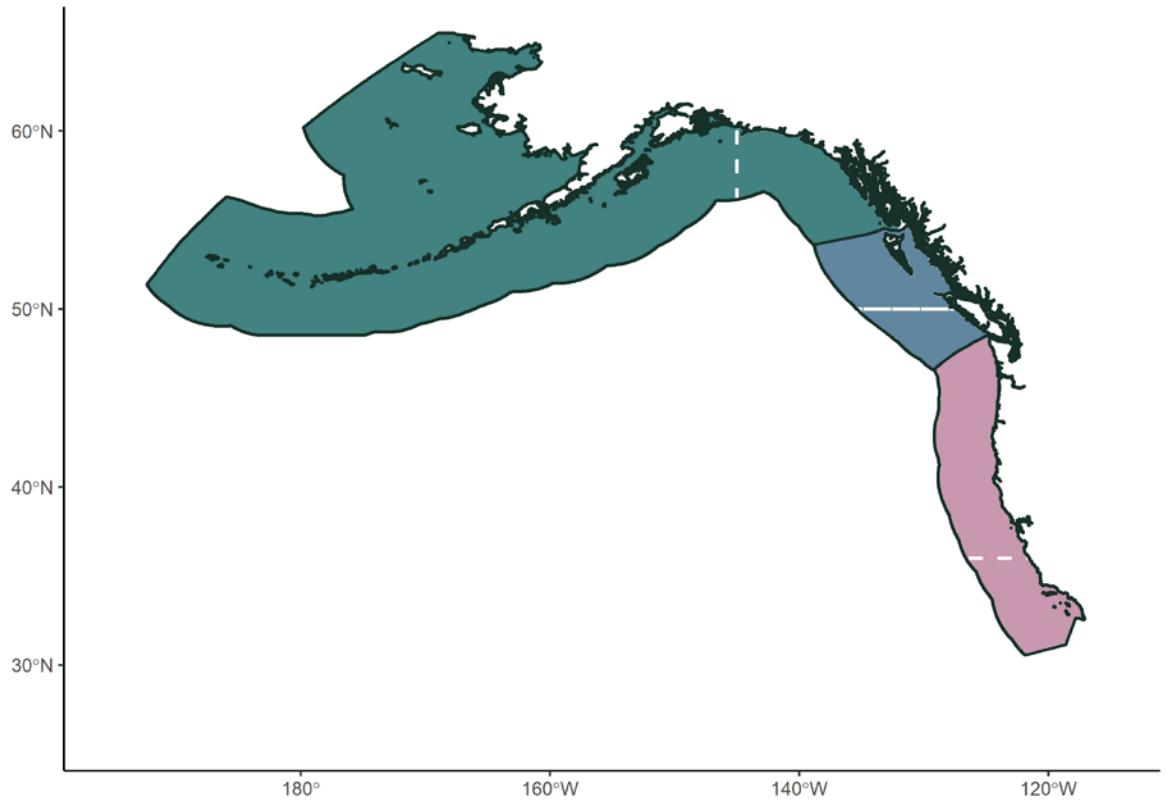
$$g(\mu_t) = \beta_0 + f(x_t) + f(s_{1t}) + f(s_{2t}) + \epsilon_t$$

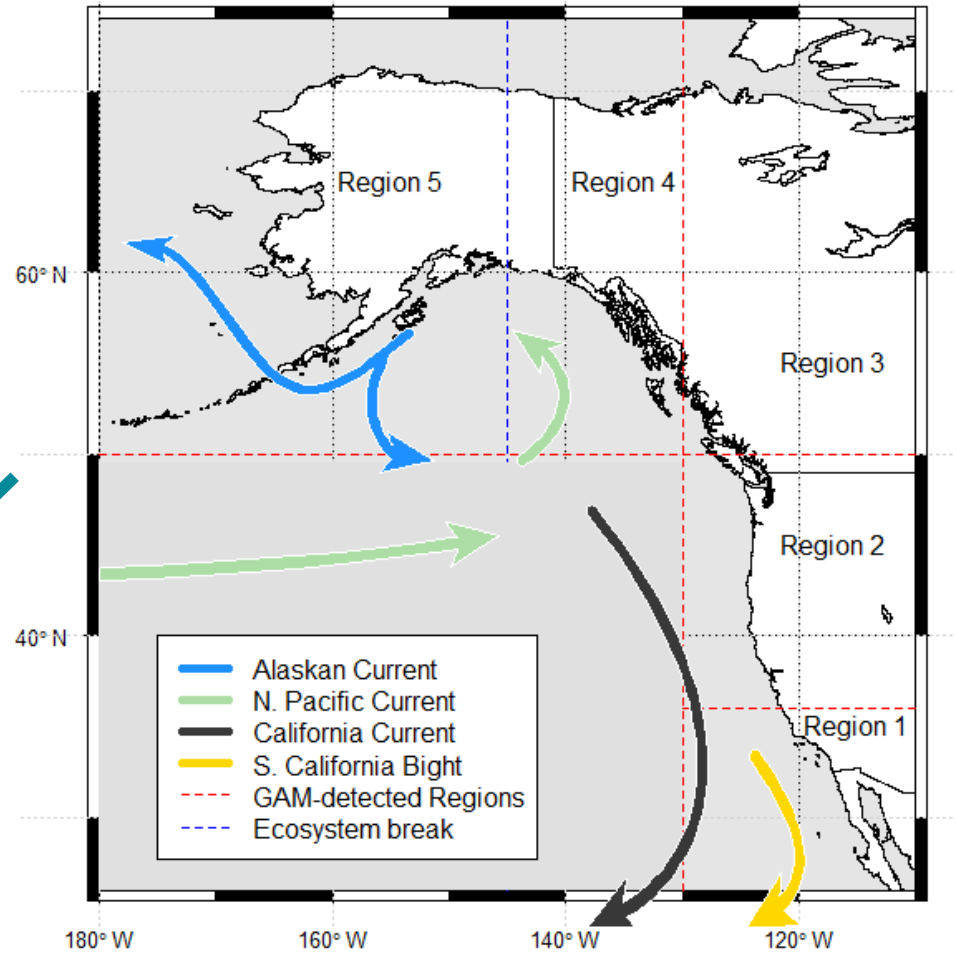
$$length = intercept + smoother(year) + smoother(latitude) + smoother(longitude) + \epsilon_t$$

- Evaluate 1st derivative of the latitude/longitude/year smoother to see where it is changing most

Kapur et al. 2020 *Fisheries Research*

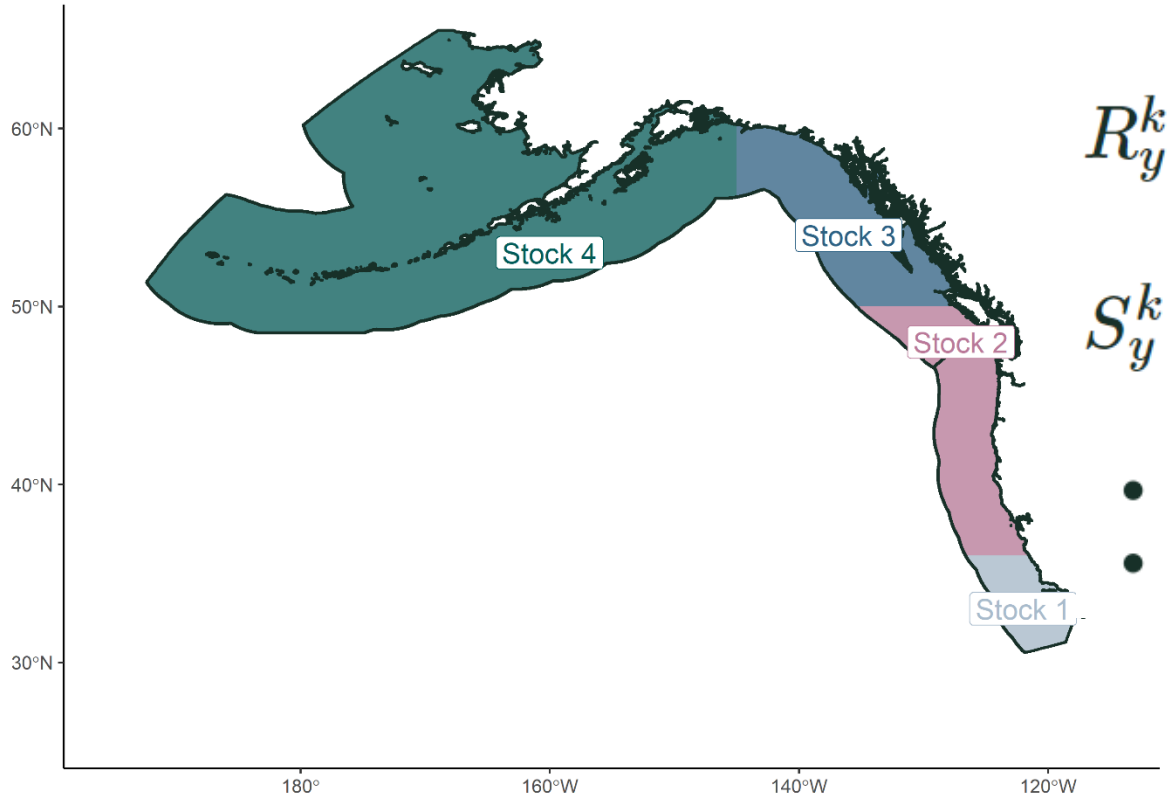
Growth Analysis





Kapur et al. 2020 *Fisheries Research*

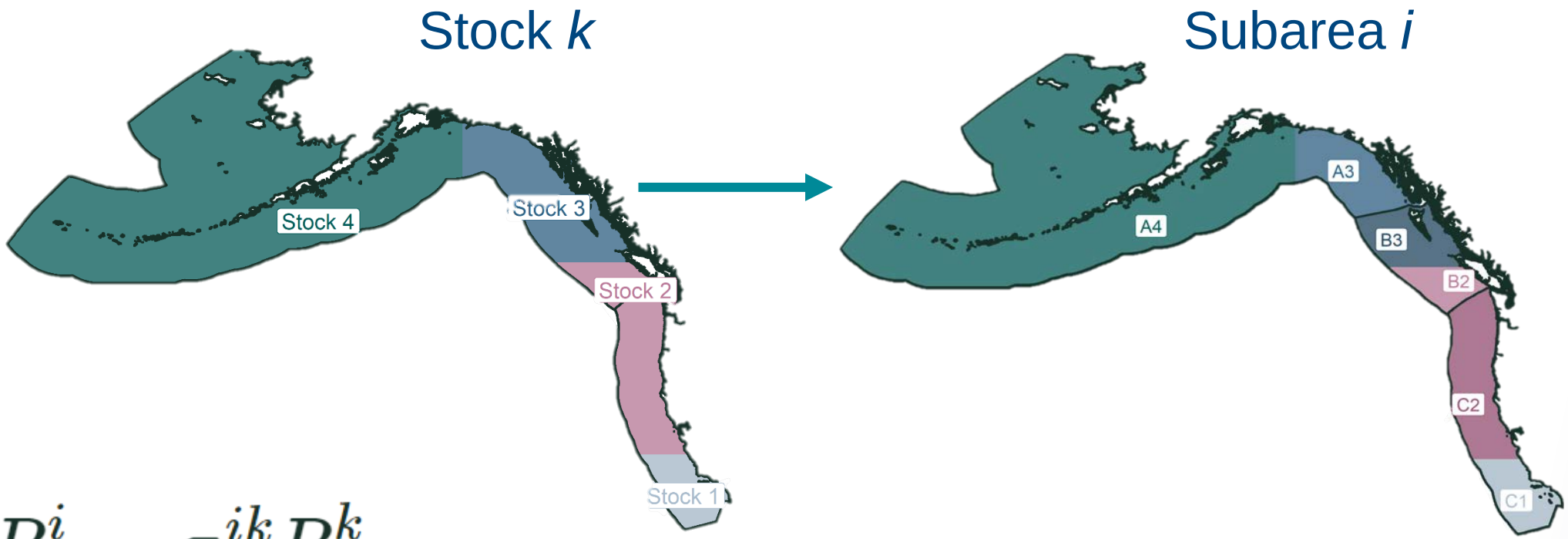
OM Spatial Structure: Stocks



$$R_y^k = \frac{4h^k R_0^k S_y^k}{S_0^k(1-h^k)+S_y^k(5h^k-1)} e^{-0.5\sigma_R^2+\tilde{R}_y^k}$$

$$S_y^k = \sum_a \phi^{ik} N^i_{y,\gamma=female,a} w^k_{y,\gamma=female,a} E^k_a$$

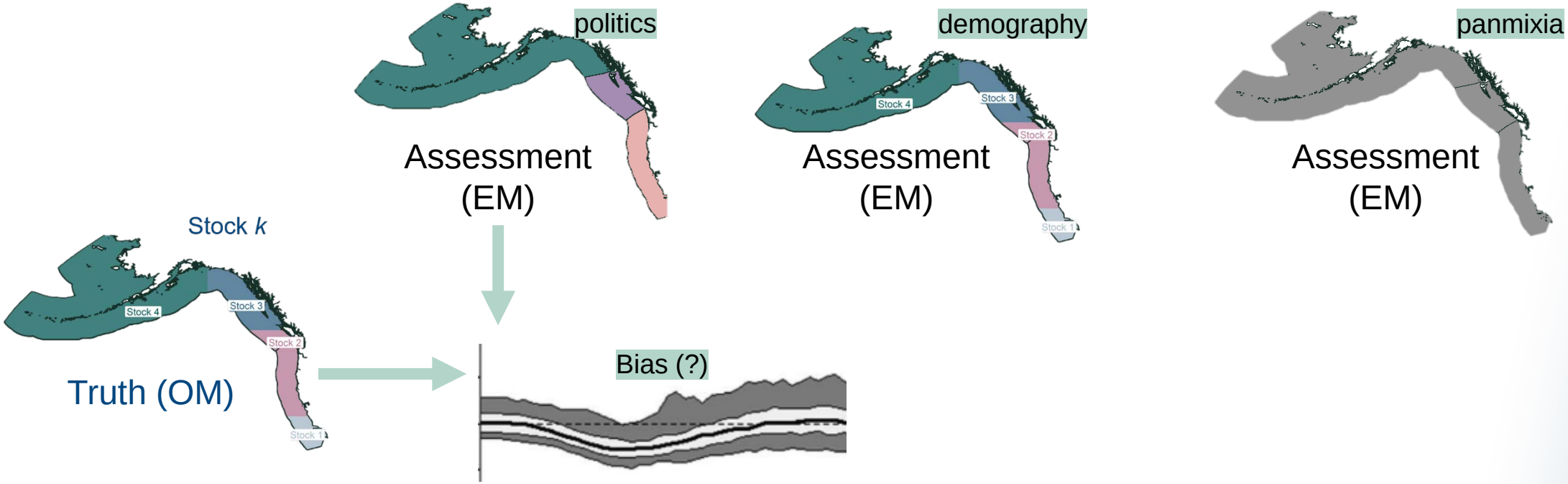
- Spatial Bev-Holt at stock level k
- SSB in k is summation over i in k



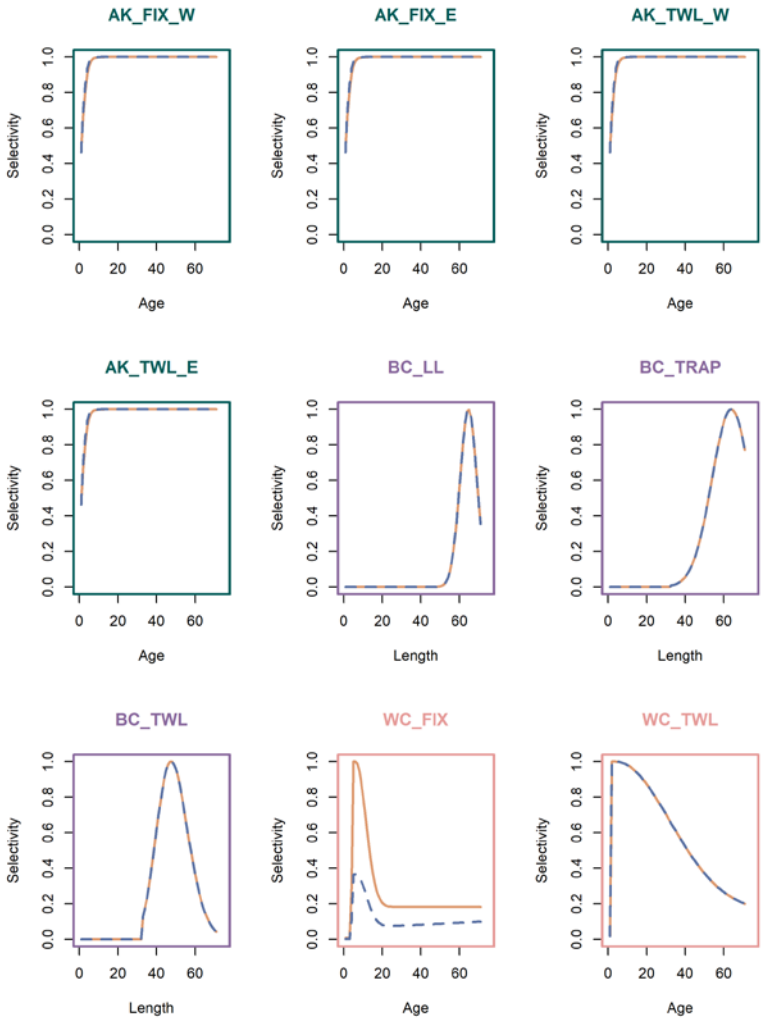
$$R_y^i = \tau^{ik} R_y^k$$

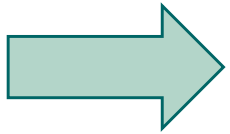
- Recruitment happens at stock k and is partitioned into sub-area i
- τ^{ik} user-defined, by geographic area

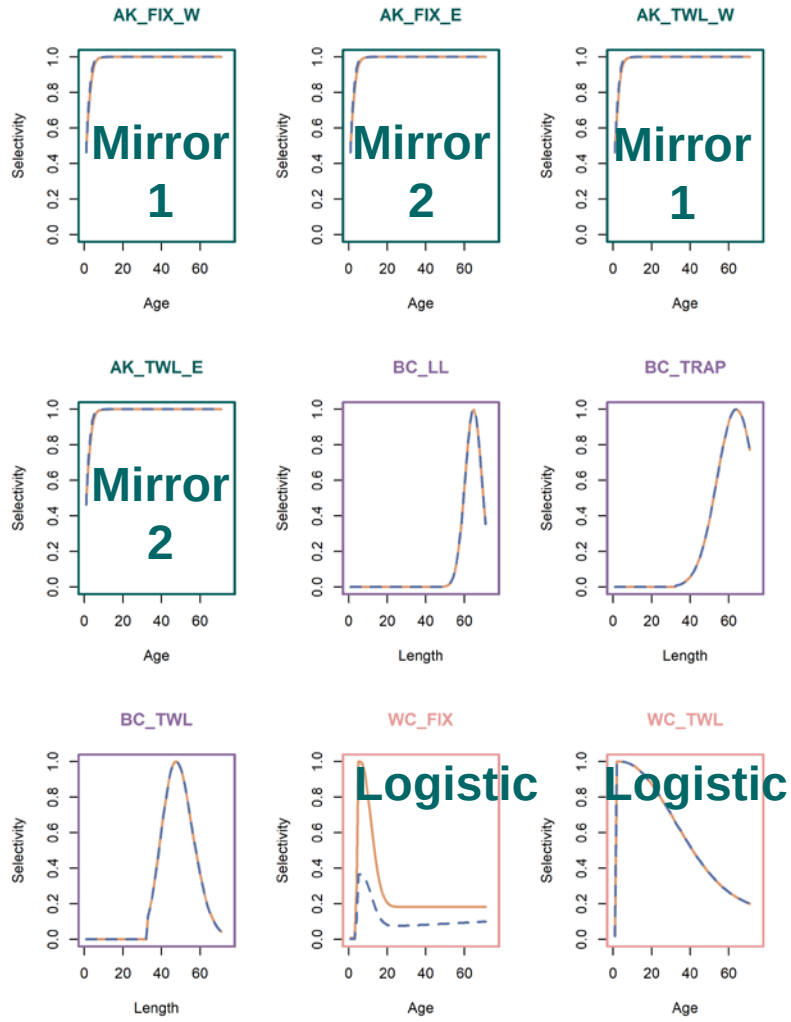
Principal Uncertainties I: Space



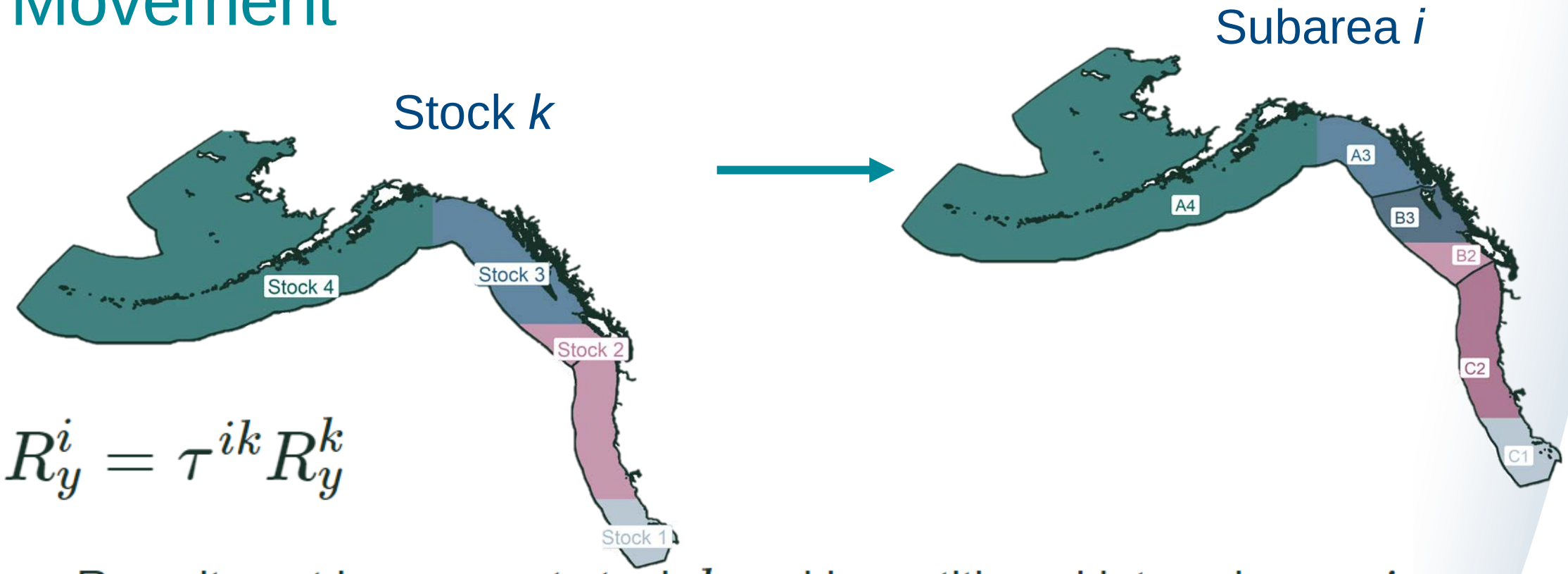
Principal Uncertainties II: Selectivity







Principal Uncertainties III: Recruitment vs Movement



$$R_y^i = \tau^{ik} R_y^k$$

- Recruitment happens at stock k and is partitioned into sub-area i
- τ^{ik} user-defined, by geographic area