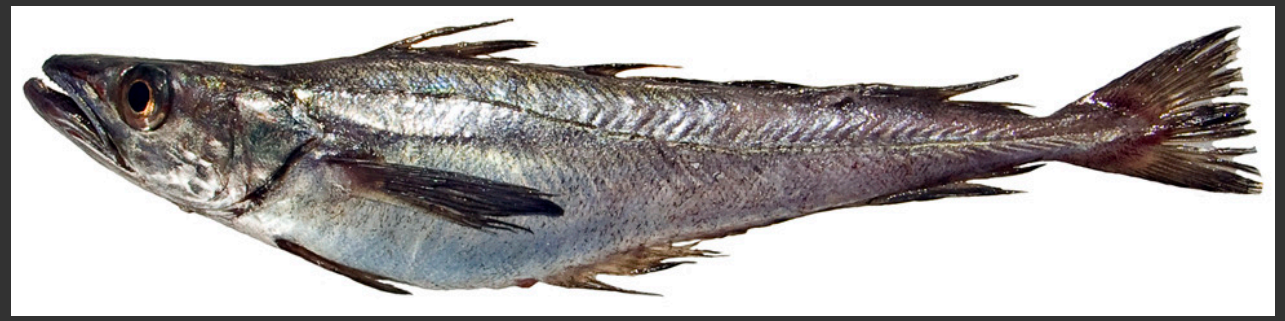


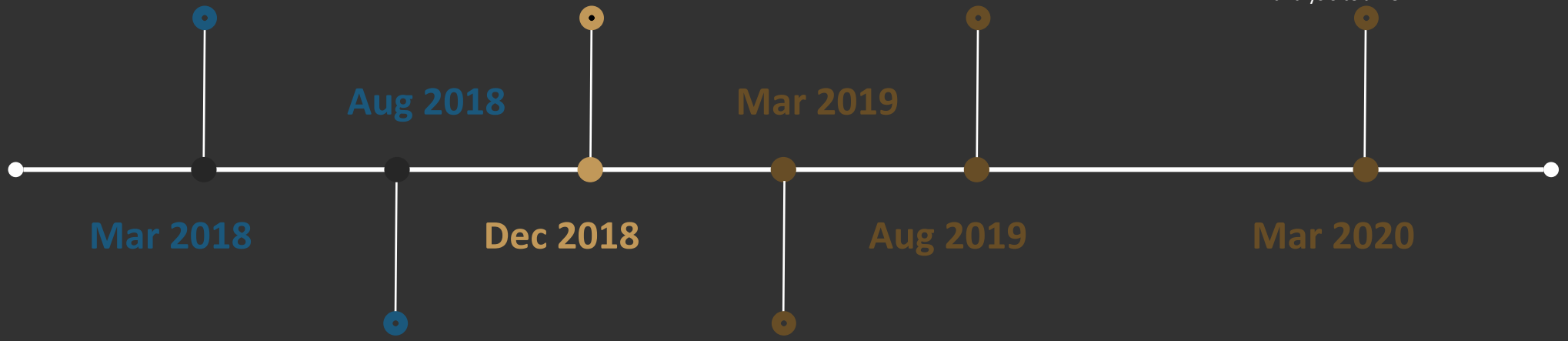
A management strategy evaluation of Pacific hake: simulation model structure, conditioning, and preliminary projections

Nis S. Jacobsen, Aaron M. Berger, Kristin N. Marshall, Ian G. Taylor

Disclaimer

Results show in this presentation are preliminary and should currently not be used for management decisions.

Hake MSE Project Timeline



Project Planning

- Establish MSE project team and MSE working group
- Finalize workplan
- Establish JMC's goals for this iteration of MSE

Model Development

- Develop code to run closed loop simulation
- Parameterize and condition initial operating model

Expand Operating Models

- Develop operating models with environmental drivers of movement
- Preliminary second phase results

Second Phase Results

- Final second phase results with multiple operating models
- Review of second phase analysis by SRG
- Presentation of full analysis to JMC

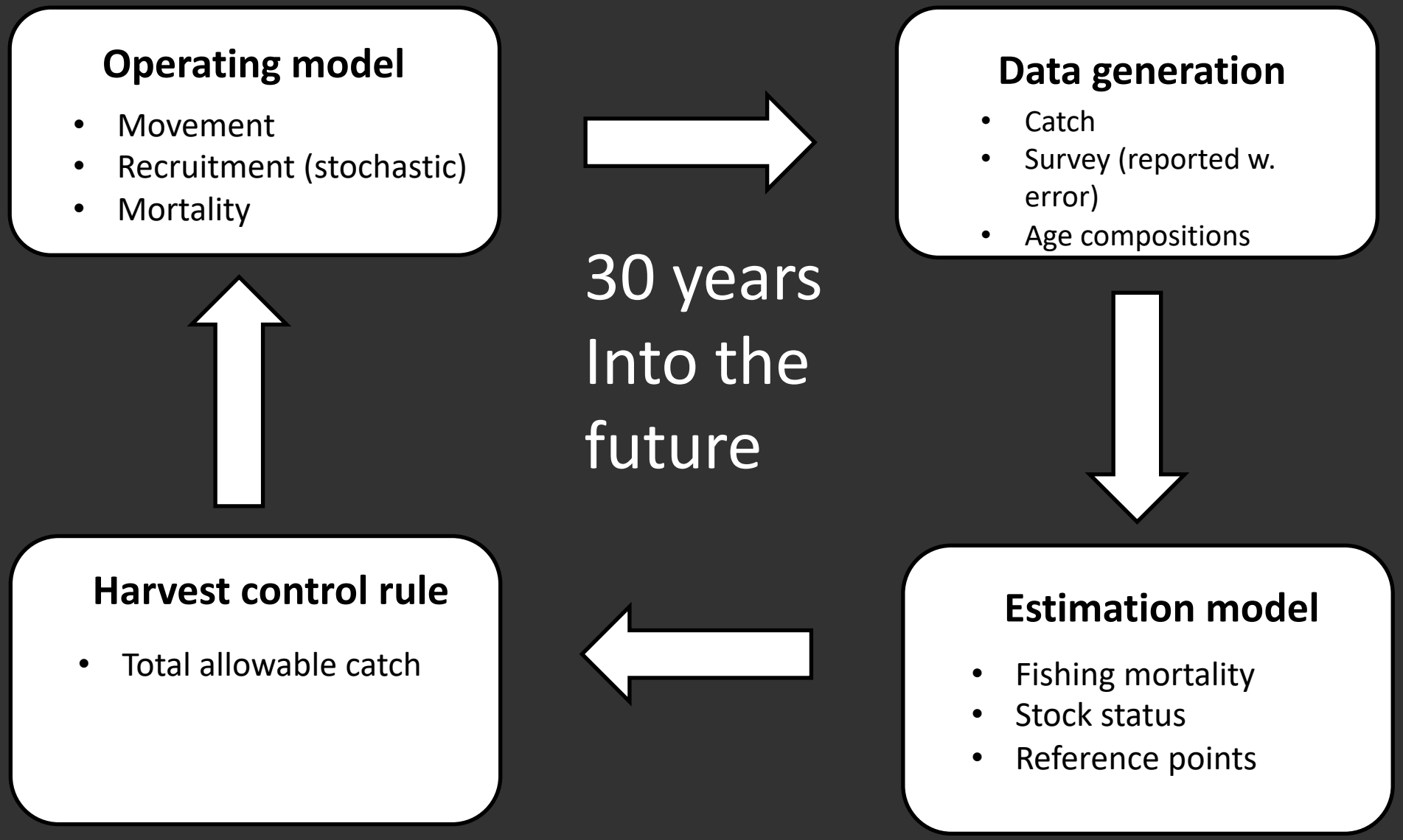
Model Design

- Review and update management objectives and performance metrics
- Specify management procedures to test
- Develop initial environmental scenarios
- Develop initial spatial operating model
- Feedback from JMC on initial operating model structure

First Phase Results

- Develop communication tools for simulation results
- Initial operating model reviewed by SRG
- First phase of results from conditioned operating model shared with JMC

Conceptual Pacific hake MSE simulation framework

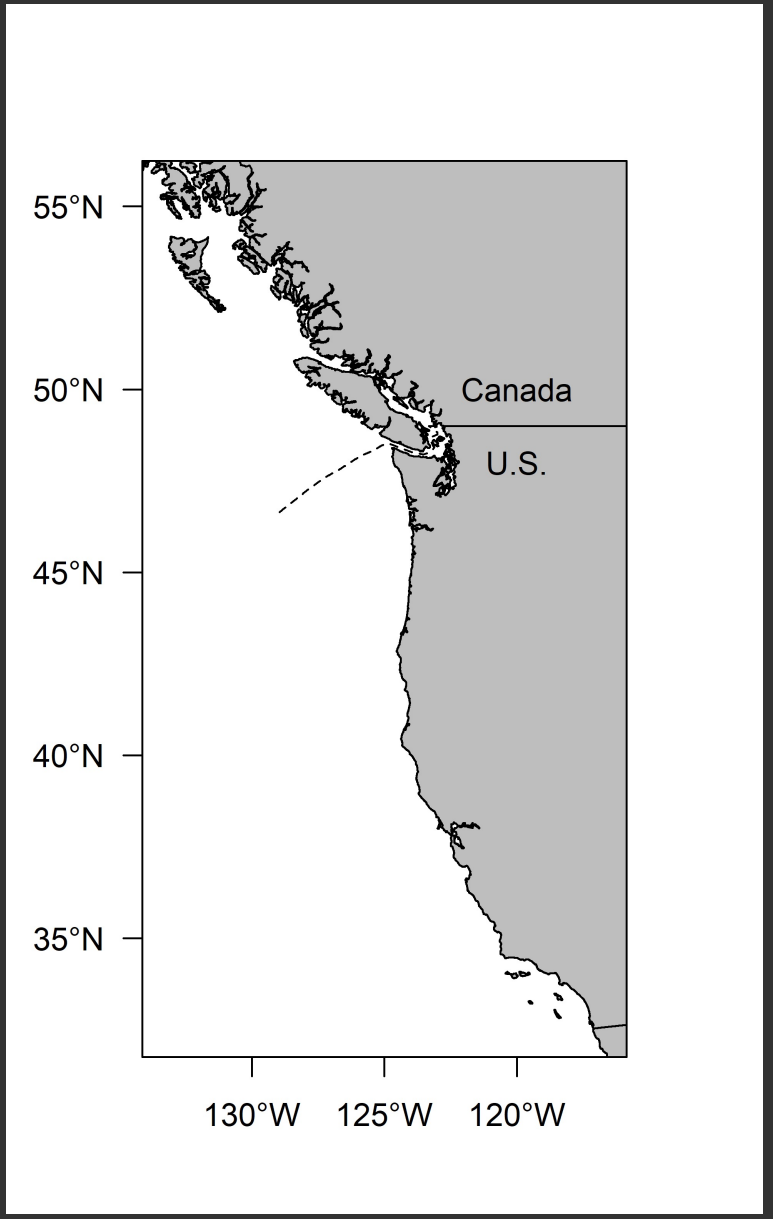


Estimation model

- Standard Stock Synthesis stock assessment model
- Rewritten in TMB for speed, R integration and increased transparency
- Faster than SS, and with possibility of adding random effects

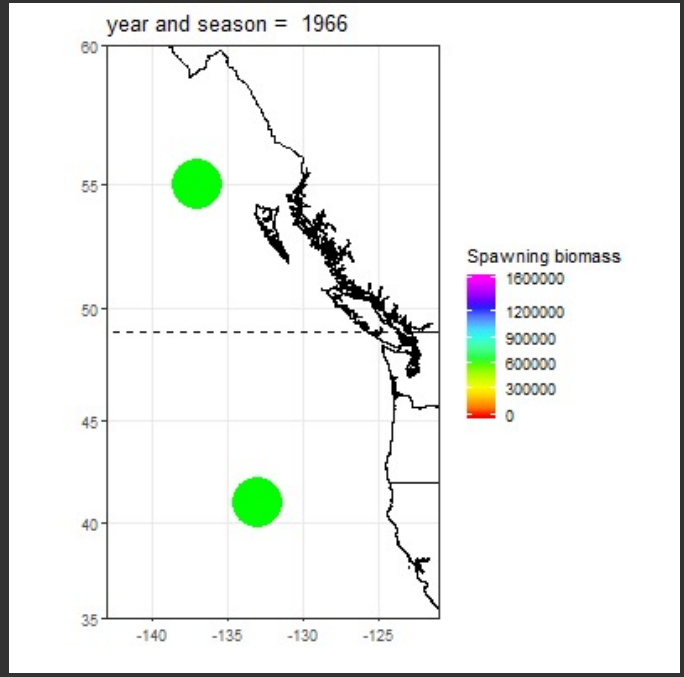
Operating model

- Age based model
- Time scale is four seasons per year
- Spatial: fish movement, fisheries, spawning, selectivity
- Movement happens in every season
- Produces data similar to the data available from the fishery
- Written in a flexible framework to allow exploration of different scenarios and OM configurations
- Conditioned upon available data from survey and fishery
- Written in R



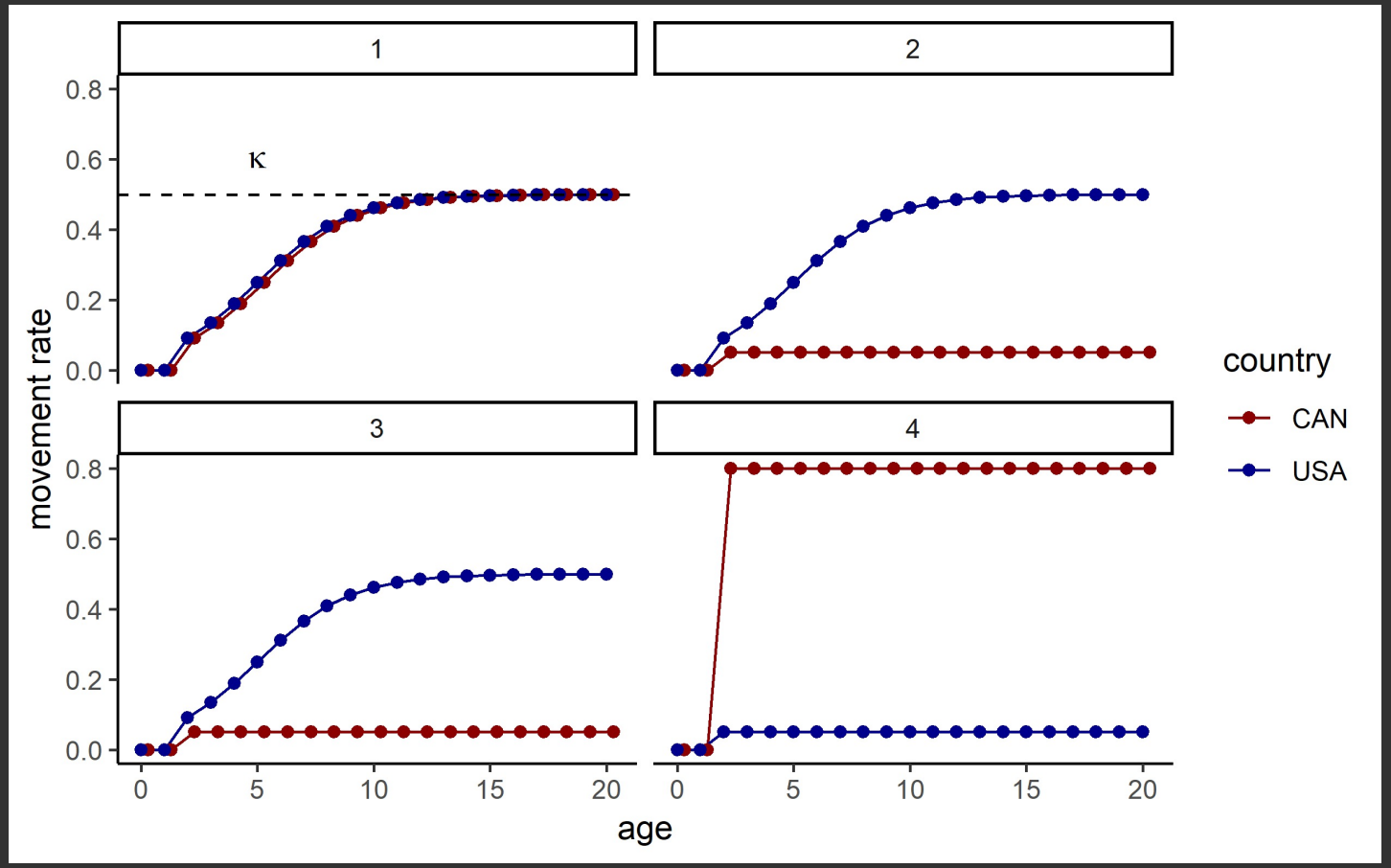
Movement

- Modeled as a fraction of the age group that moves out of an area
- Currently implemented as 2 boxes (they either move north or south) – the software is flexible
- Older individuals have a greater probability to move than smaller ones
- Most spawners move south in the last season of the year to spawn
- (The fish do not move south before spawning)



Seasonal movement parameters

$$\omega_a = \frac{\kappa_i}{1 + e^{-\gamma a - a_{50}}}$$



κ is the maximum movement rate

Spawning

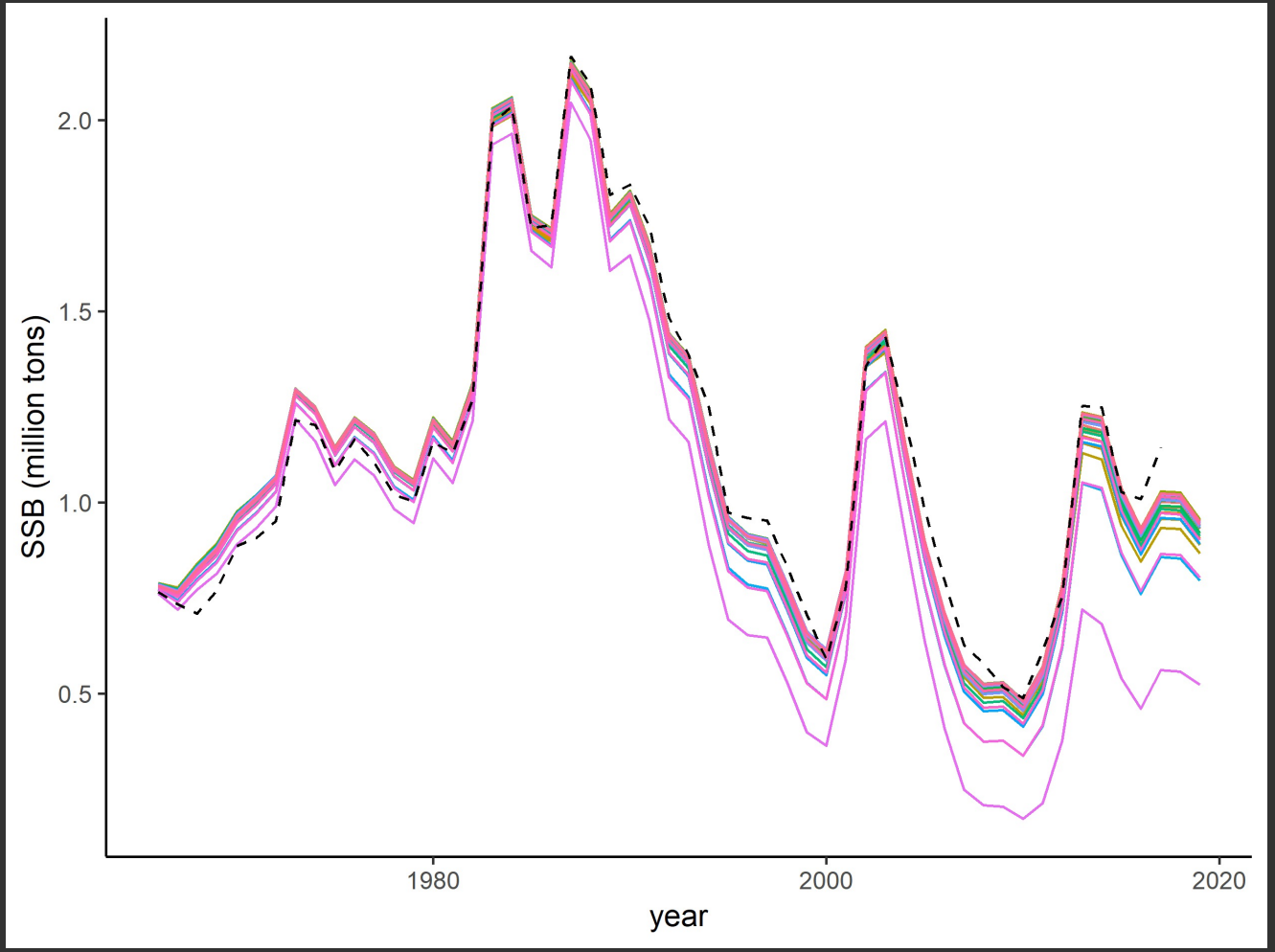
- Beverton Holt with annual recruitment deviations
- Spawning occurs in the beginning of season one
- Stock recruitment relationship is area specific (depends on the spawners in each area) – deviations are the same for all areas
- Recruits (0-1 year) do not move

Photo credit Pete Frey (NWFSC)

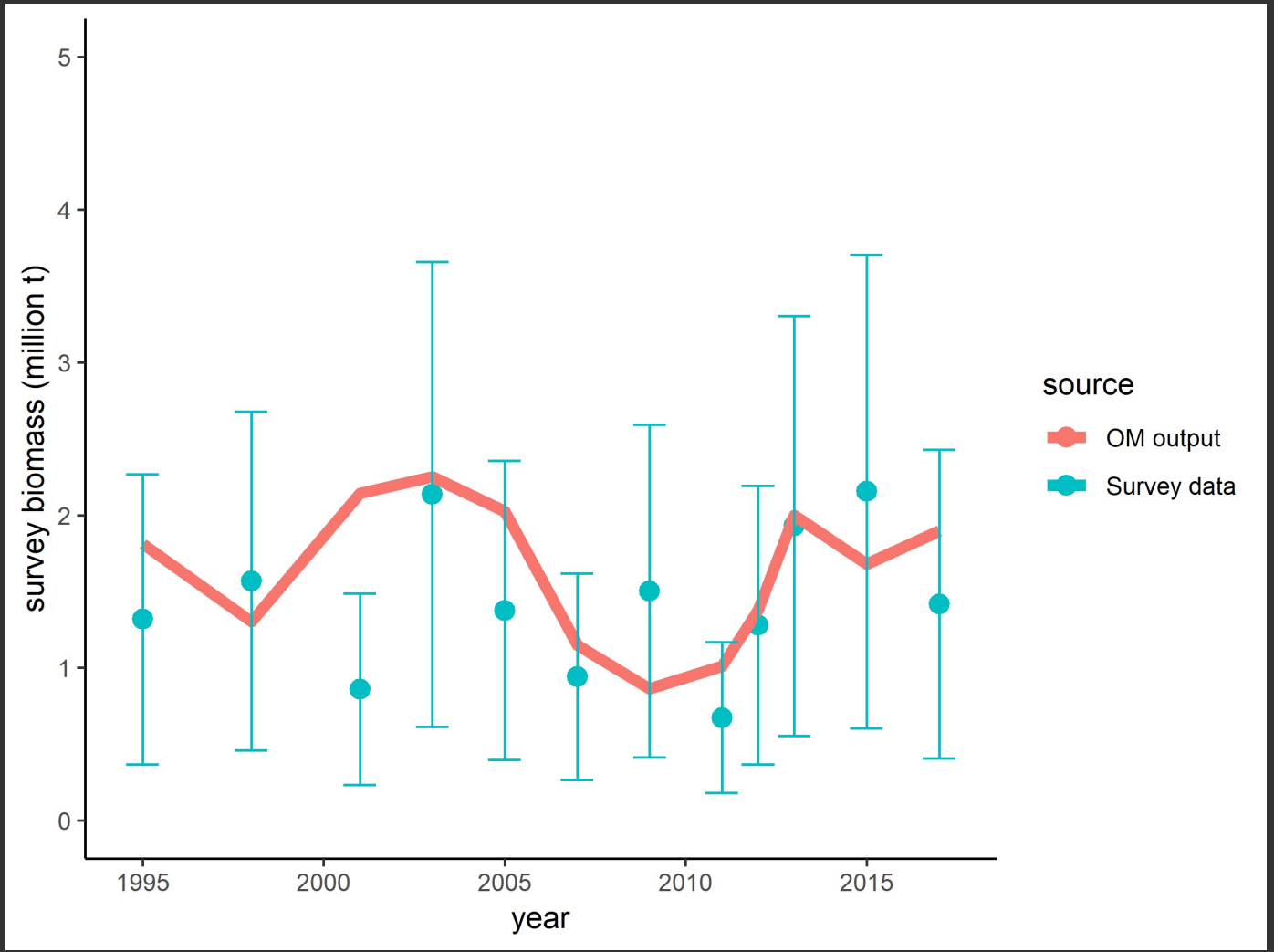
Fisheries

- Catch is divided by areas according to the Treaty
- The operating model calculates the fishing mortality in each area depending on the catch distribution per season
- Selectivity can be area specific or constant
- Catches occur predominantly in season 2 and 3

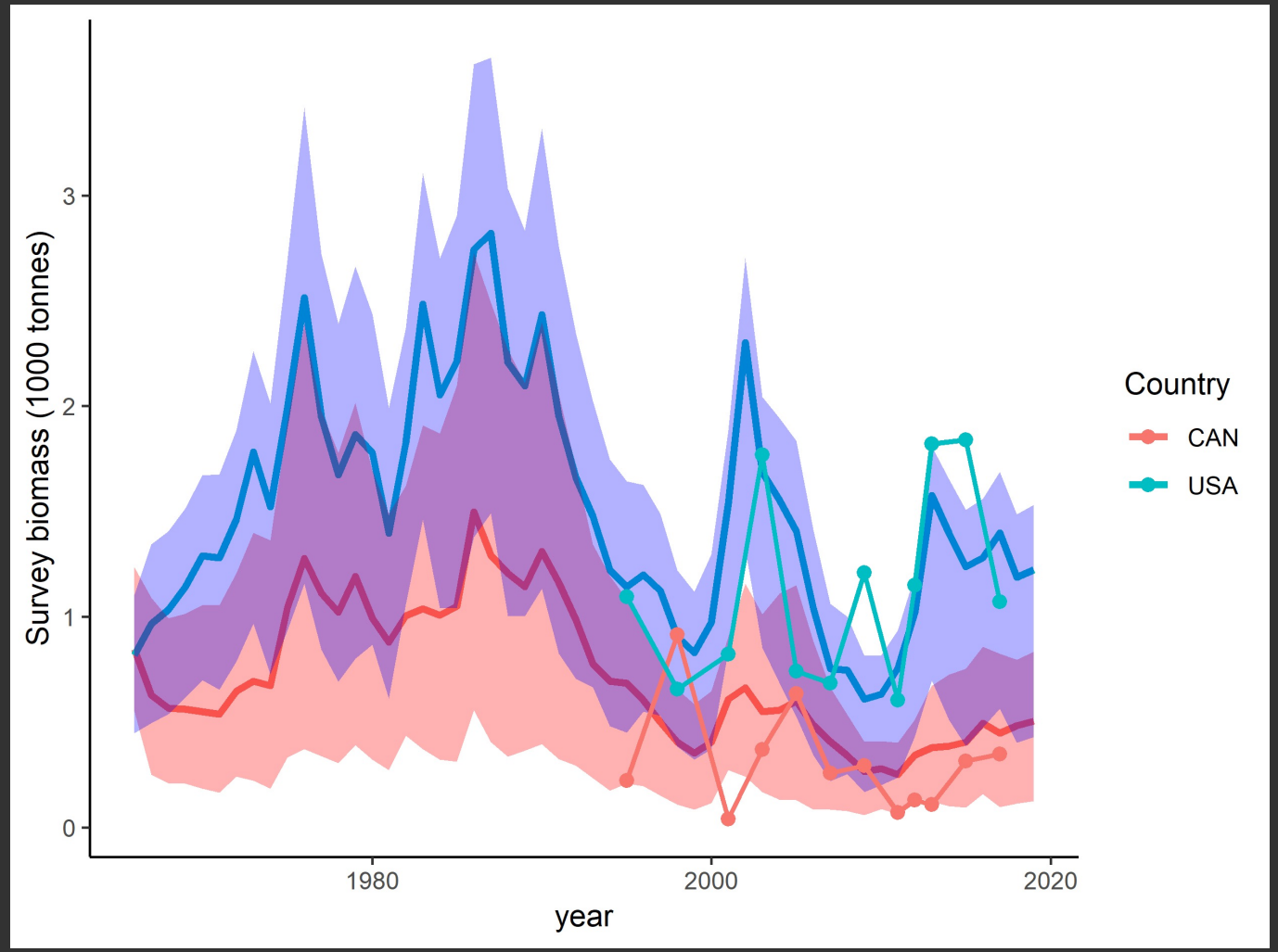
Total spawning biomass with varying movement parameters



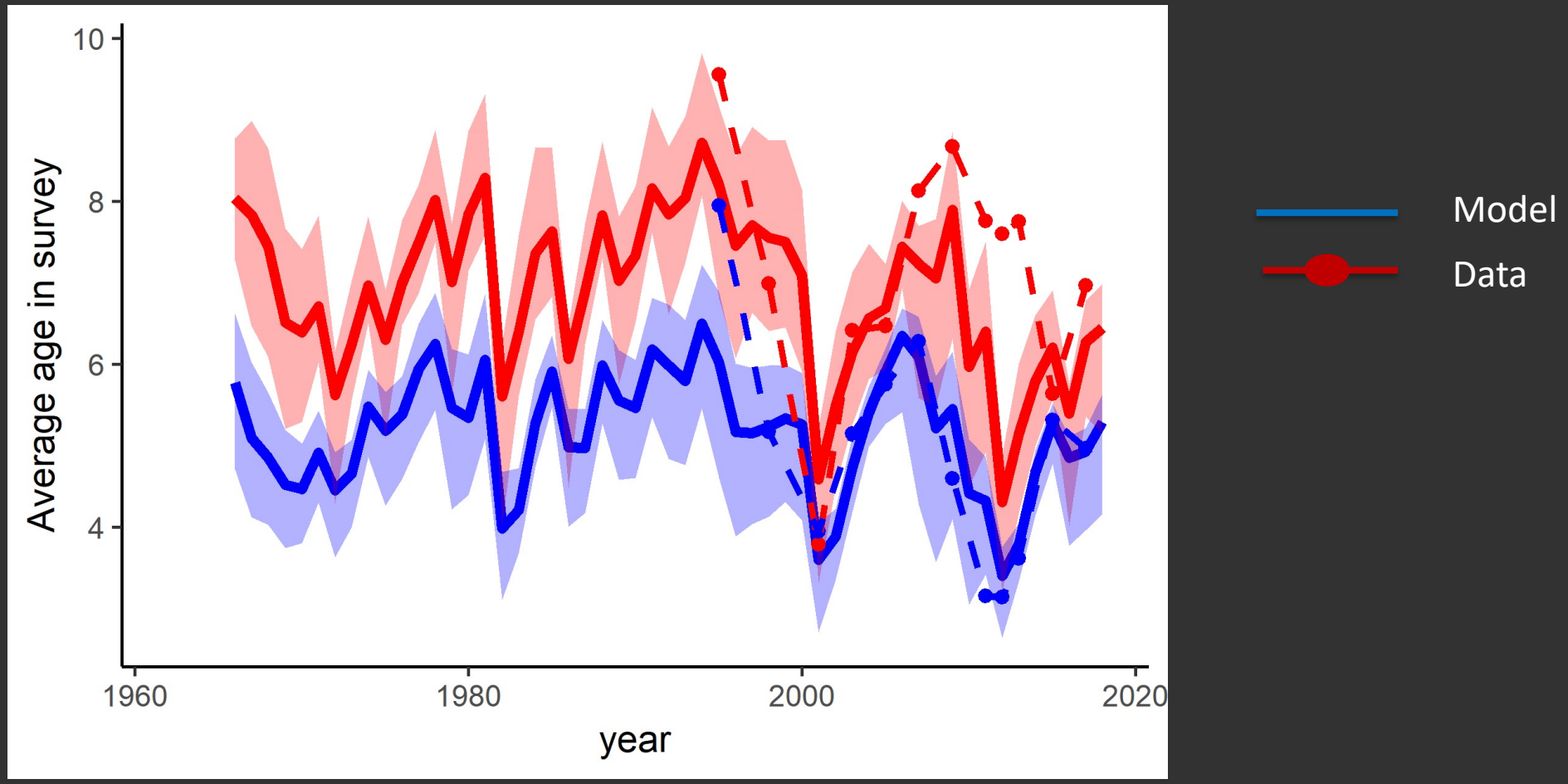
Biomass observed in survey



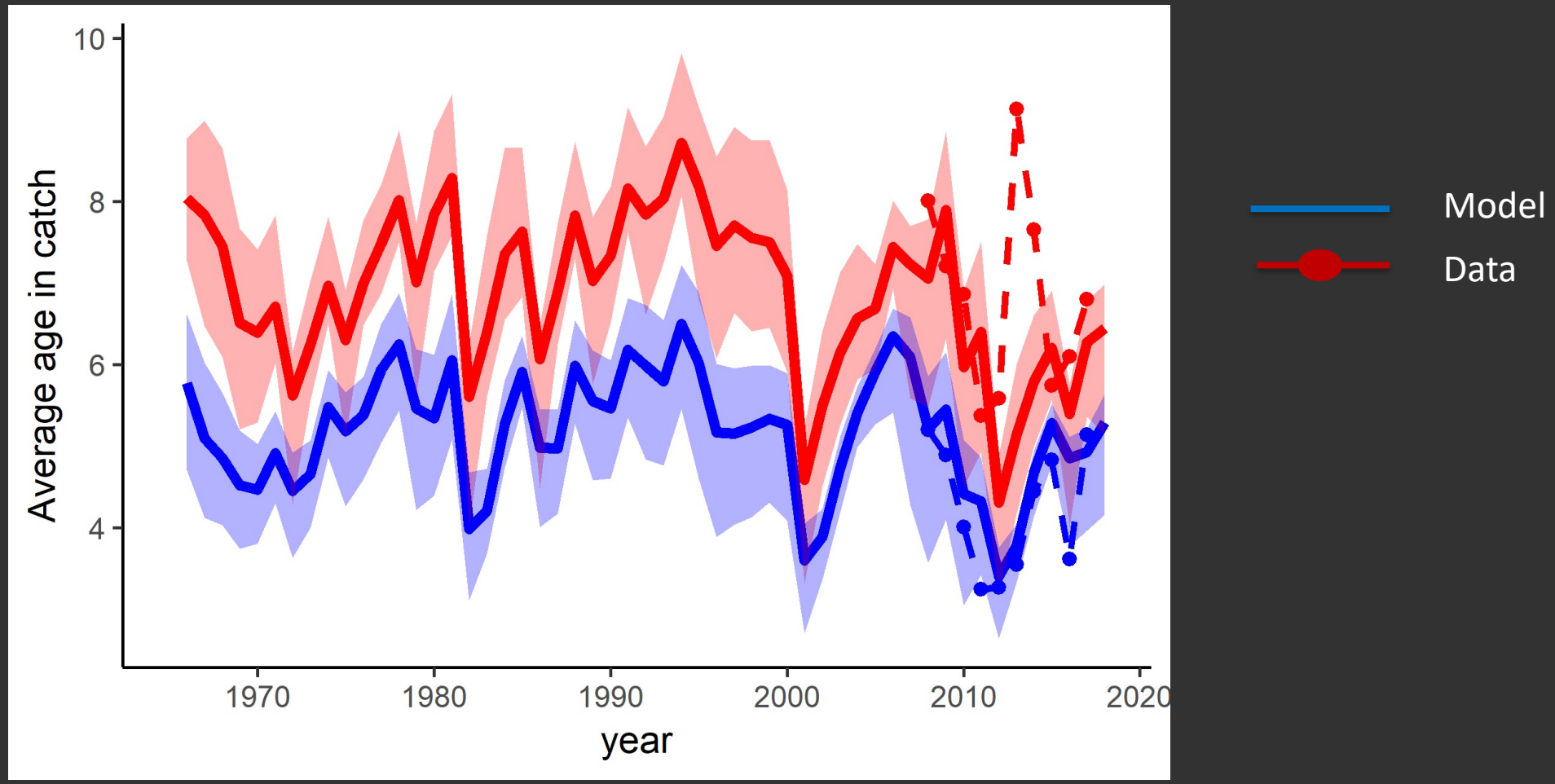
Survey biomass in Canada and USA



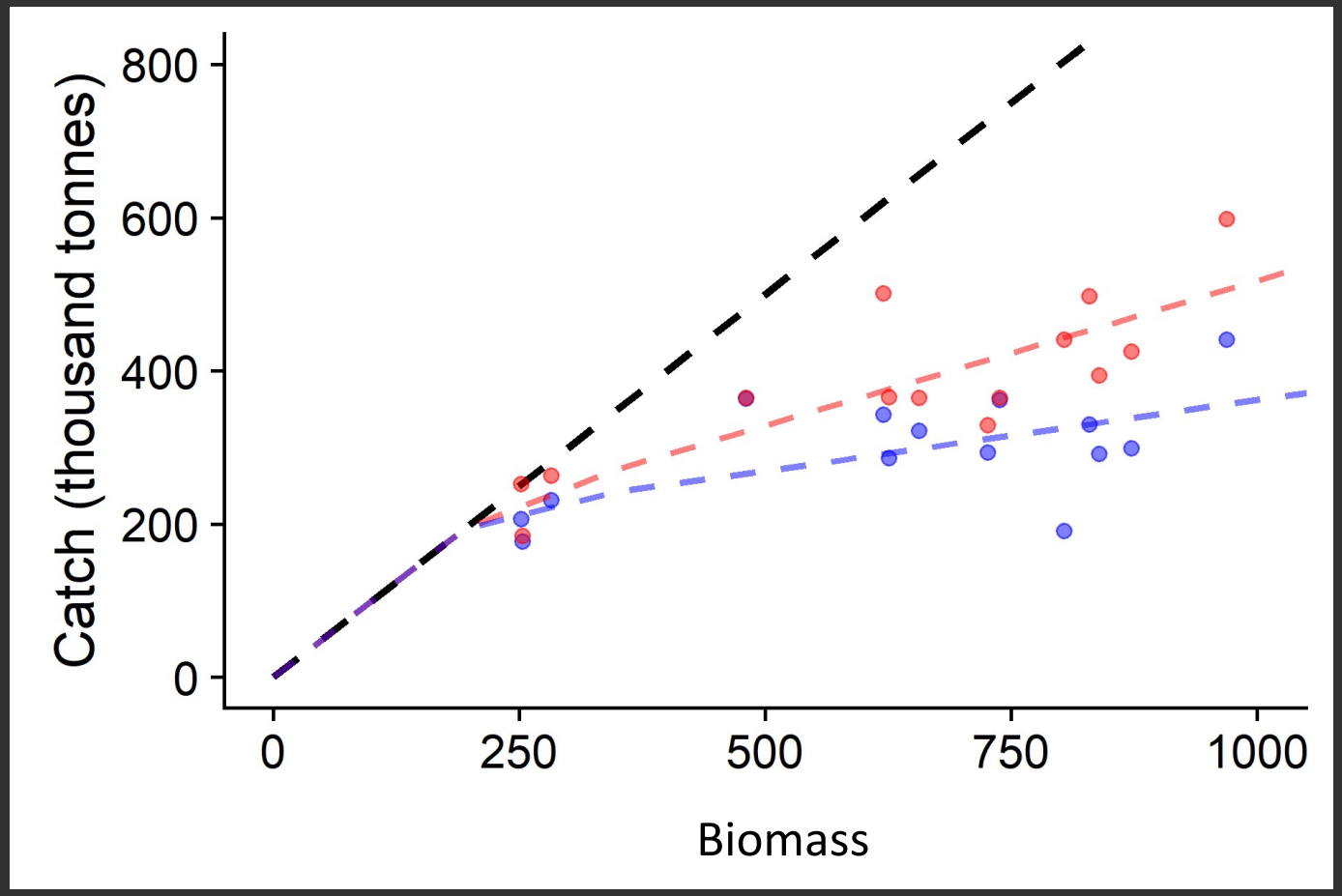
Average age in the survey



Average age in catch



Treaty control rule and alternative catch “buffers”



- Standard HCR
- JMC catch buffer
- Realized catch buffer

Scenarios

- 6 different scenarios (first ones have a median movement rate)

1. Standard HCR
2. JMC catch buffer
3. Realized catch buffer

Movement scenarios (realized catch buffer)

1. Movement scenario 1 (low max movement rate)
2. Movement scenario 2 (high max movement rate)
3. Movement scenario 3 (low min. age to start movement)

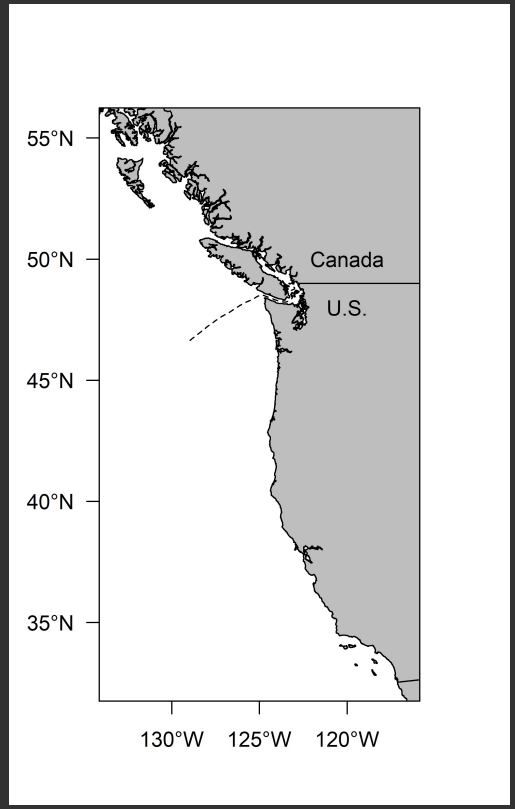
Management objectives identified by MSE working group

Coastwide objectives

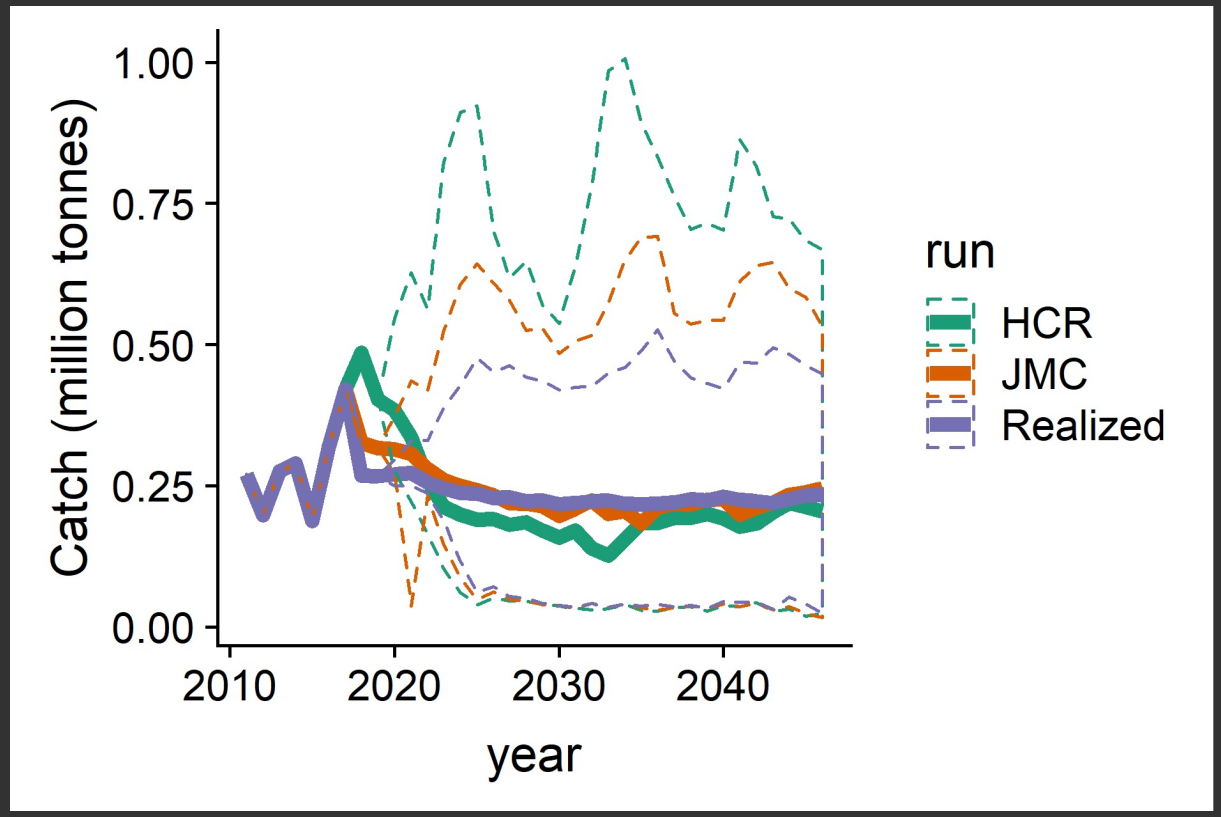
- Minimize risk of severe overfishing and closing the fishery
- Minimize the risk of spawning biomass dropping below the specified management target for >3 years
- Avoid closing the fishery
- Avoid high variability in total catches
- Given above, maintain high average coast wide catch

Spatial objectives

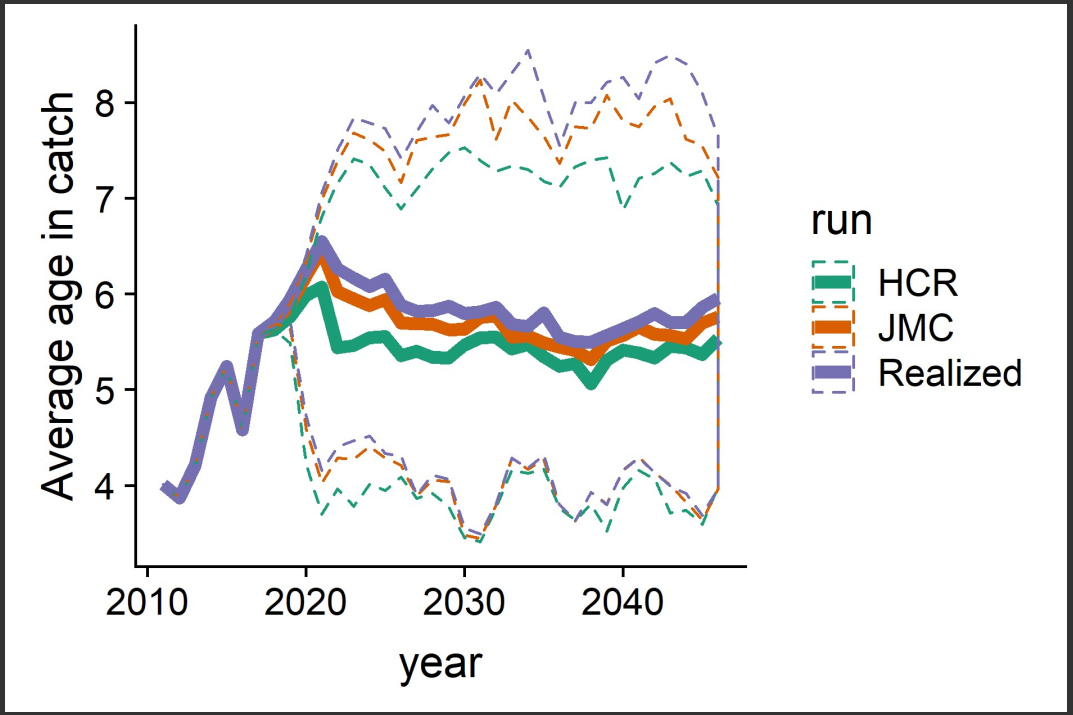
- Maintain enough biomass in both countries to maintain TAC allocation



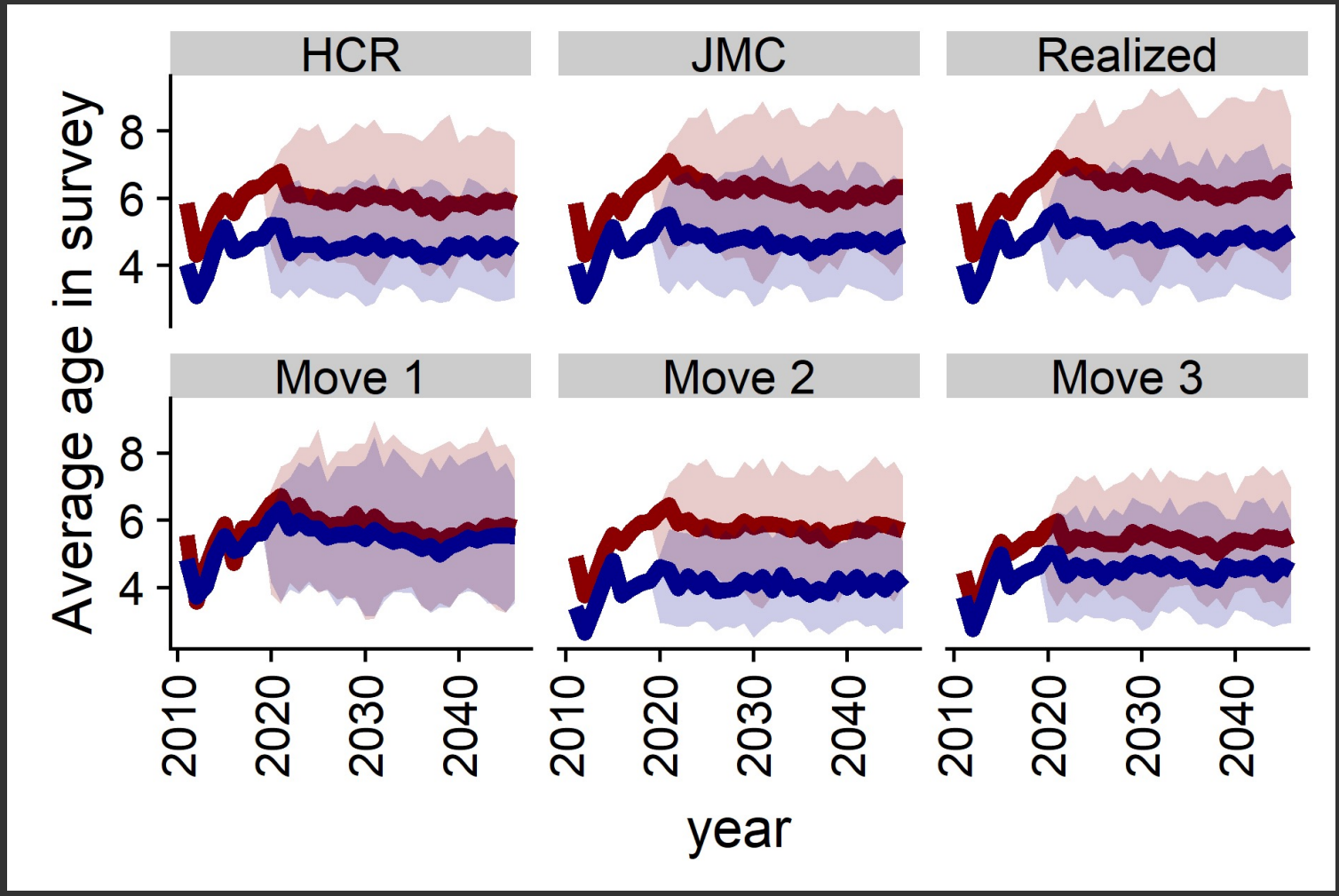
Total catches



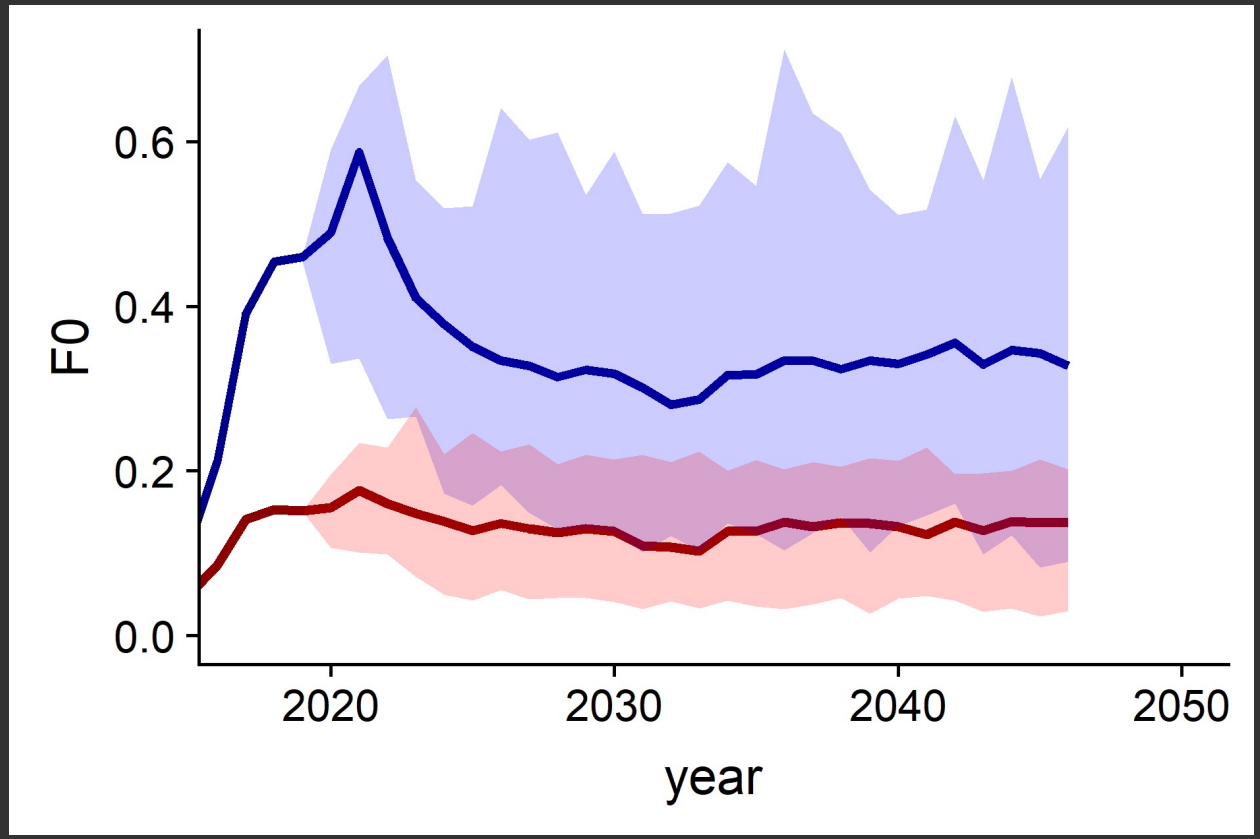
Age composition in the catch



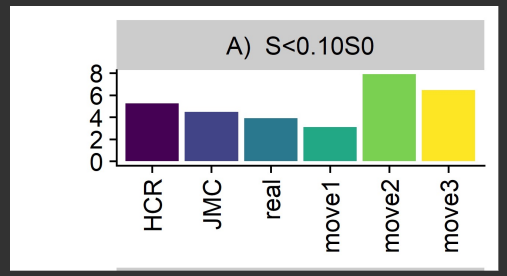
Age composition between the countries



Harvest rates



Performance metrics



Move 1 = Low max movement

Move 2 = High max movement

Move 3 = Low age to start movement

Next steps

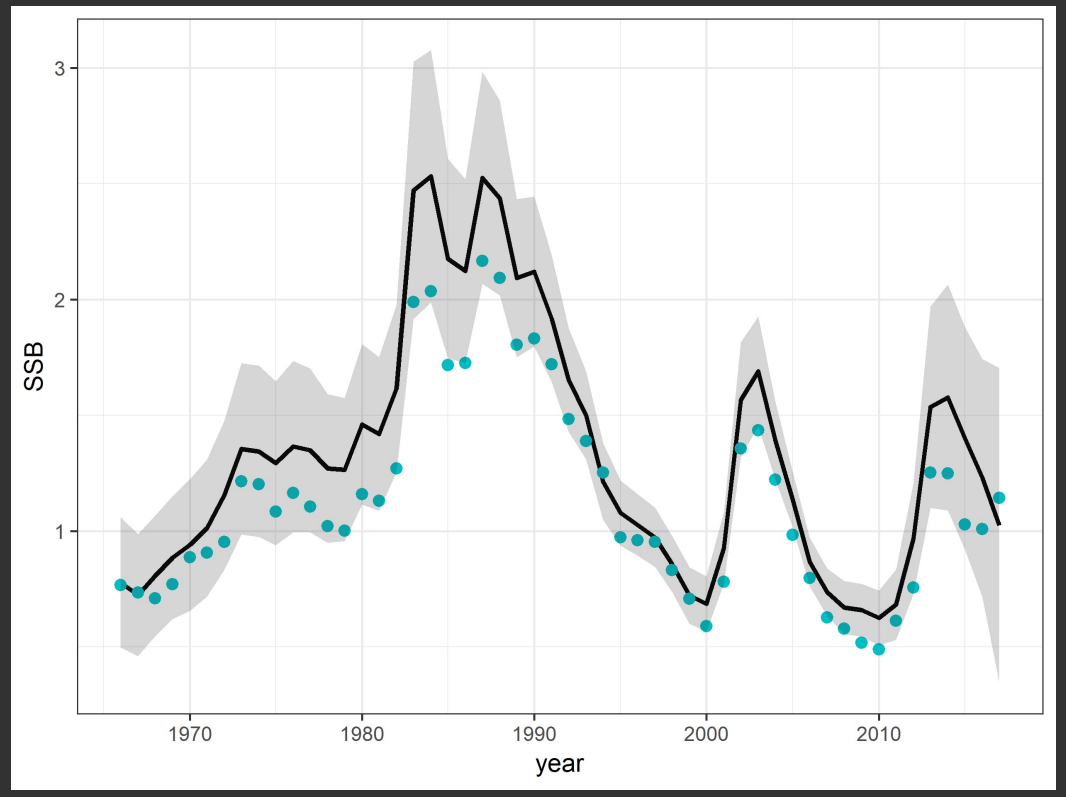
- Investigate how movement influences selectivity estimation
- Test catch limits to achieve full TAC utilization for the two countries
- Time and spatially varying biological parameters

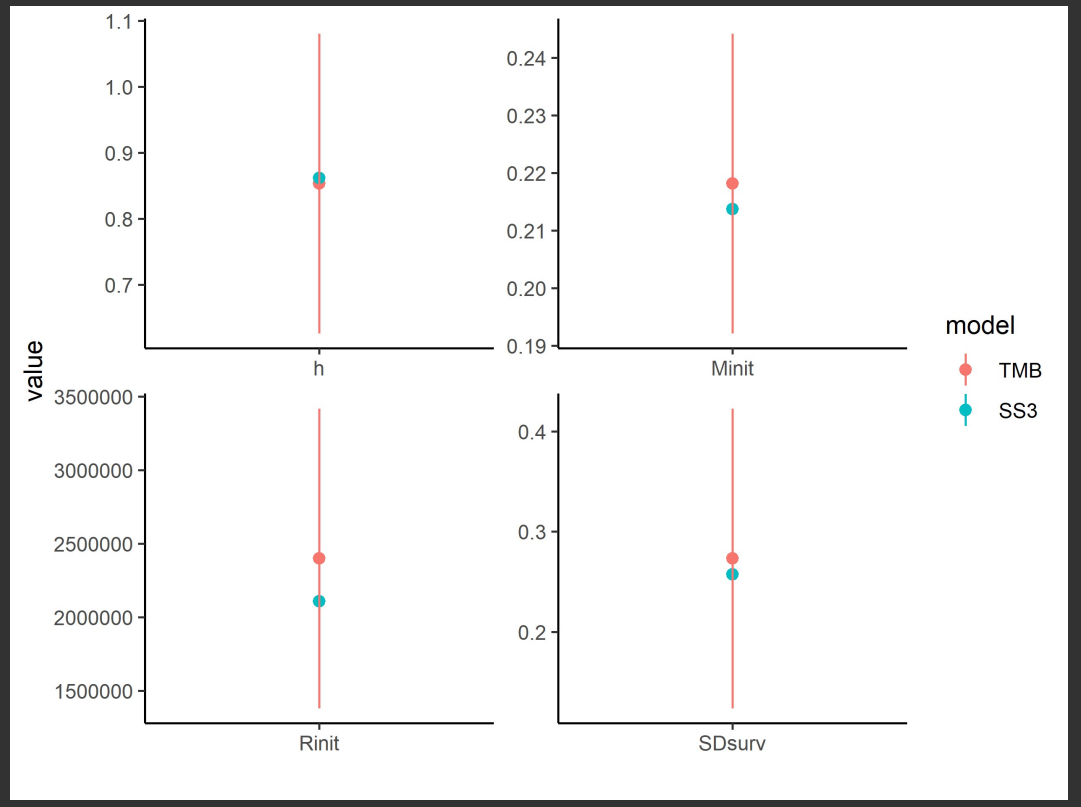
Conclusions

- The spatial structure has little impact on the management objectives
- If movement changes in the future it might influence movement
- Recruitment deviations are the primary drivers of uncertainty

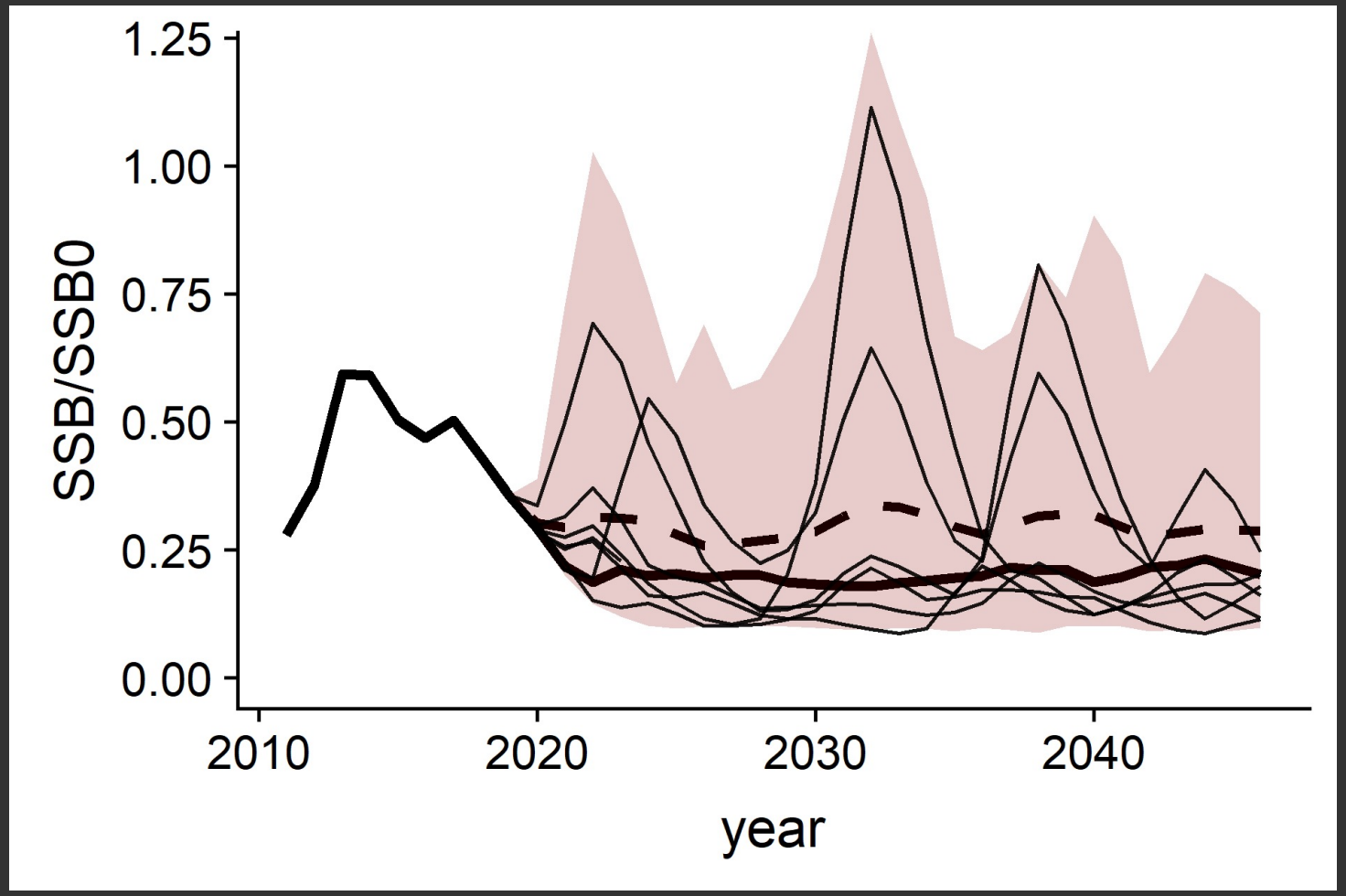
Thank you

Hake EM vs assessment model





Add runs….



Perfect information