Evaluation of Alternative Harvest Control Rules for New England Groundfish

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NEFMC Meeting

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Gulf of Maine Research Institute

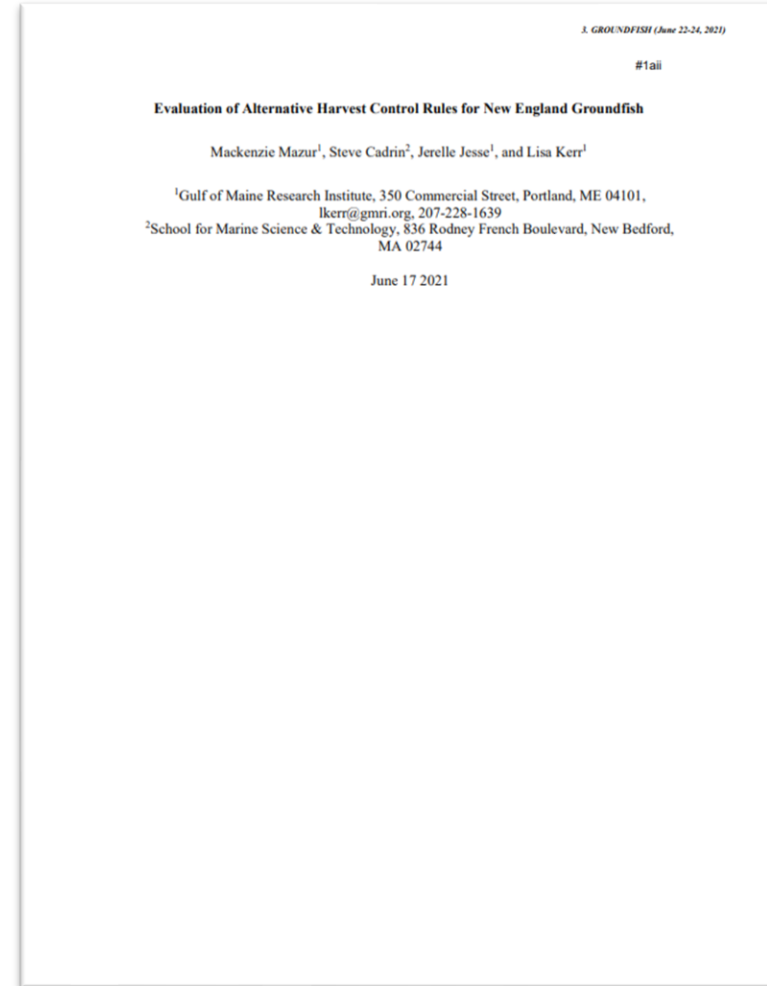Science. Education. Community.

Acknowledgements

Outline

1. Rationale
2. Goal
3. Research questions
4. Simulation tool
5. Approach
6. Results
7. Summary
8. Questions

https://s3.amazonaws.com/nefmc.org/1aii_Summary_HCR_Evaluation_Report.pdf

New England Groundfish

- Performance of current groundfish management and possible alternatives have not yet been simulation tested.
  - Groundfish stocks at very different stock status levels.
  - Changes with policy since implementation of ABC control rule.
  - Issues with management performance.

Data from NEFSC (2019)
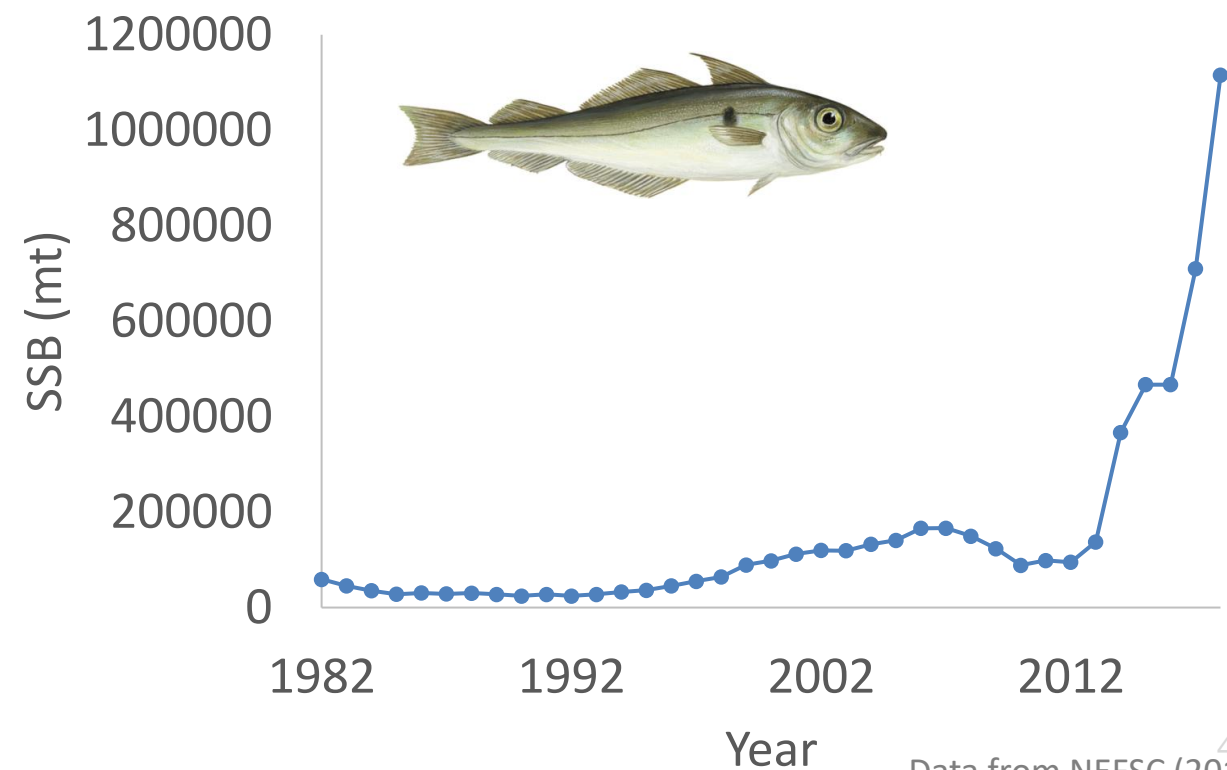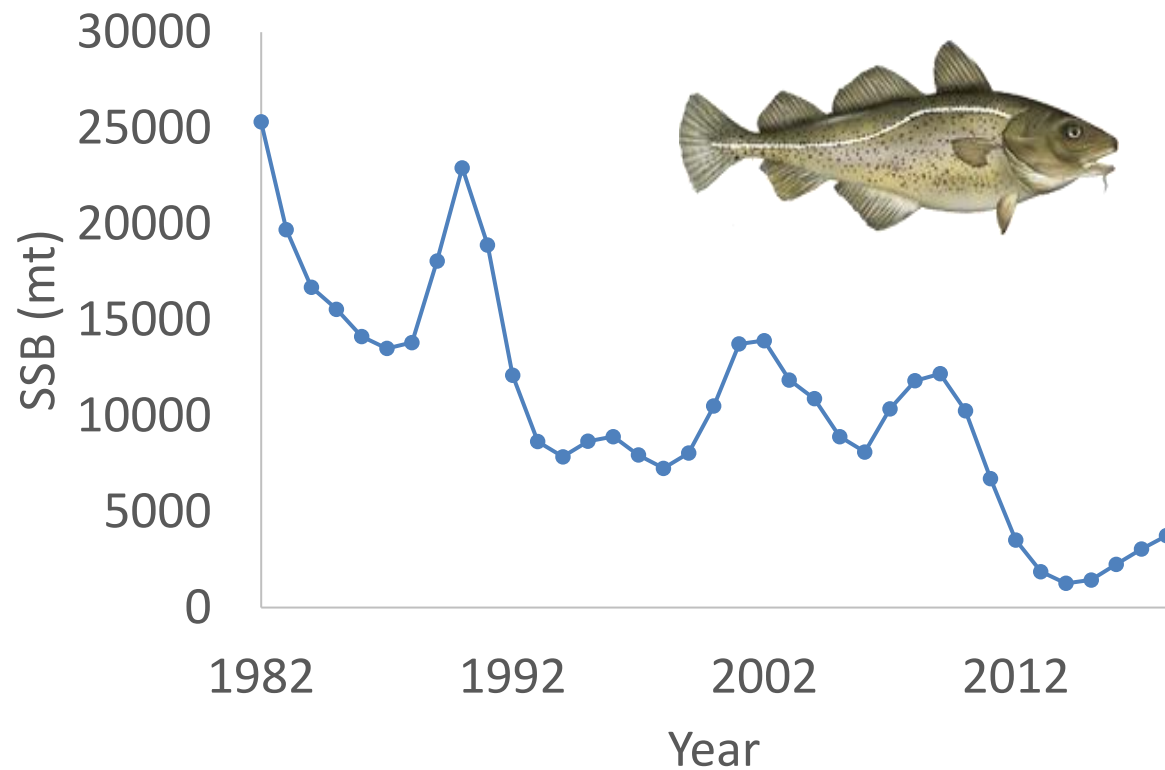
Stock Assessment Issues

- Several New England groundfish assessments have major retrospective patterns (inconsistencies of recent estimates after adding another year of data to the assessment)
    - Large source of uncertainty
    - May be caused by not accounting for changes in stock dynamics
    - Can lead to inappropriate fishery management

Goal

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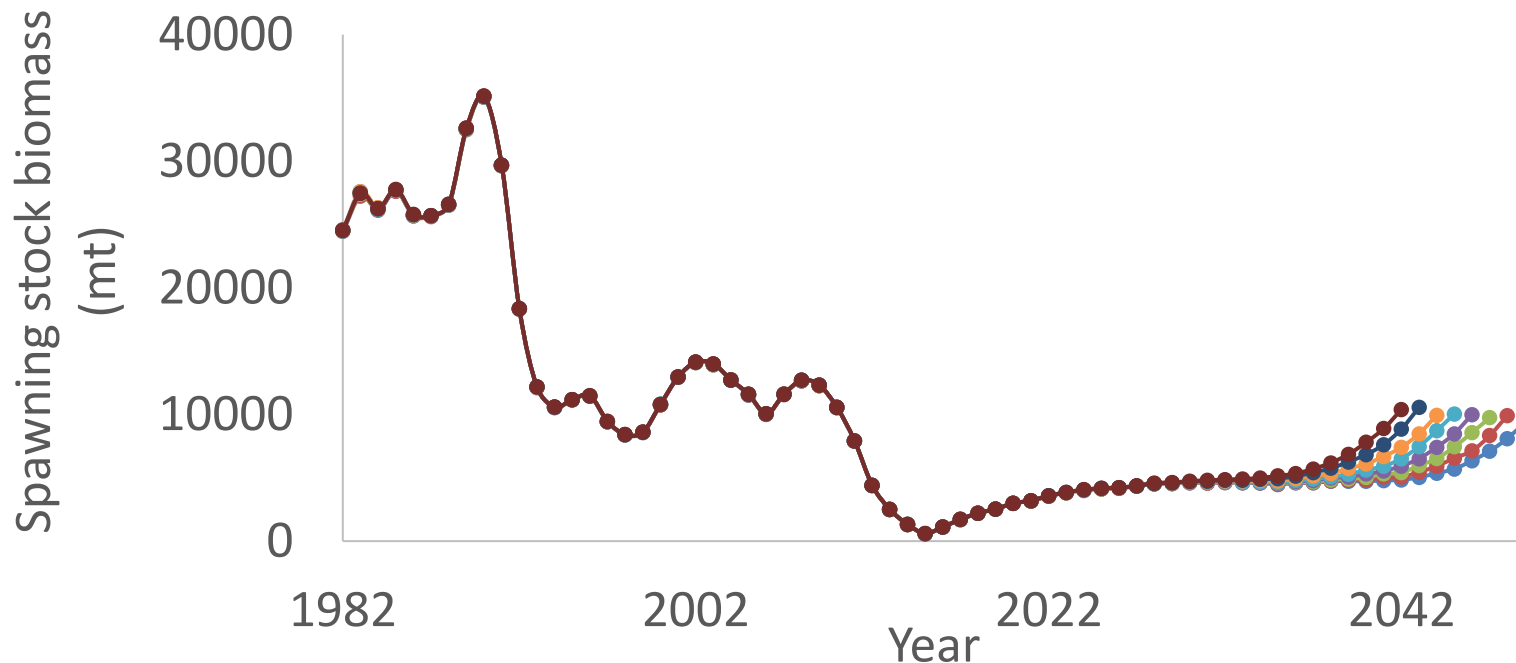
The goal of this analysis is to evaluate the performance of the current and alternative harvest control rules for New England groundfish.

Harvest control rule: Pre-agreed guidelines that determine the level of fishing that can take place, based on the perceived stock status

Approach

What this is testing:

-Focused testing how alternative harvest control rules perform under a range of current groundfish conditions and stock assessment issues

What this is not doing:

-Testing all potential conditions and stock assessment issues contributing to the current state of groundfish stocks

-Determining optimal harvest control rules based on fishery goals

-Management objectives need to defined and prioritized before optimal harvest control rules can be determined
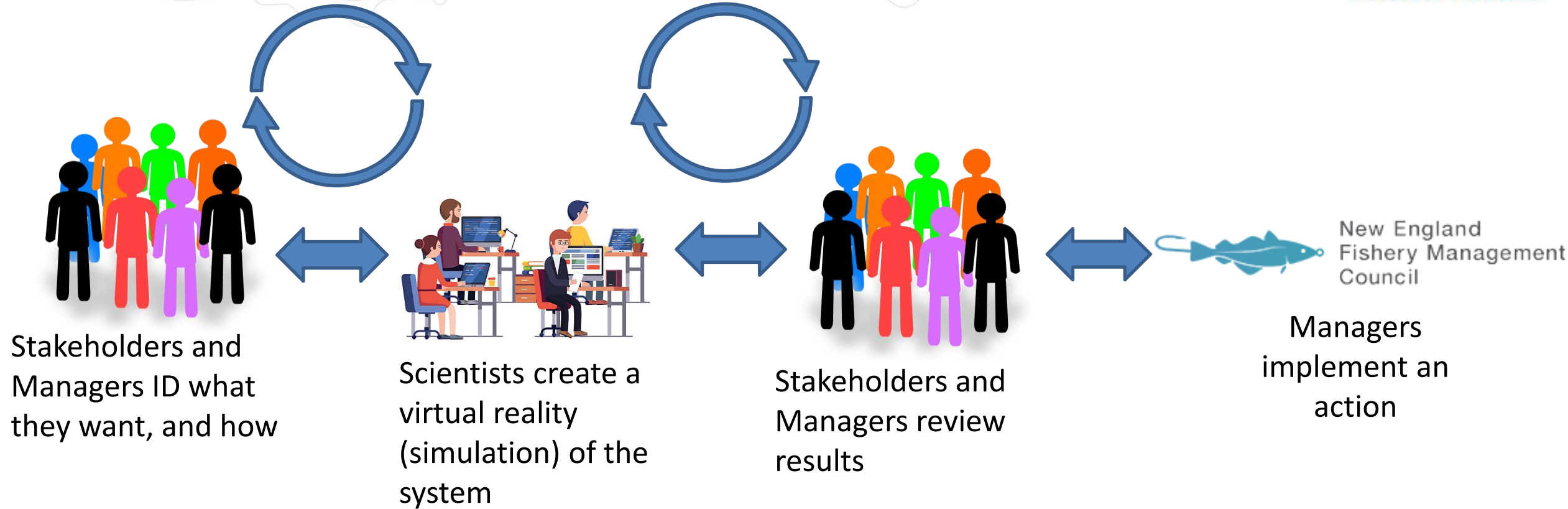
Research Questions

How do alternative harvest control rules perform when:

- A stock is overfished?

- A stock is not overfished?

- When there is a stock assessment misspecification and retrospective patterns?

  - When retrospective patterns exist, do retrospective adjustments result in better performance than no retrospective adjustments?
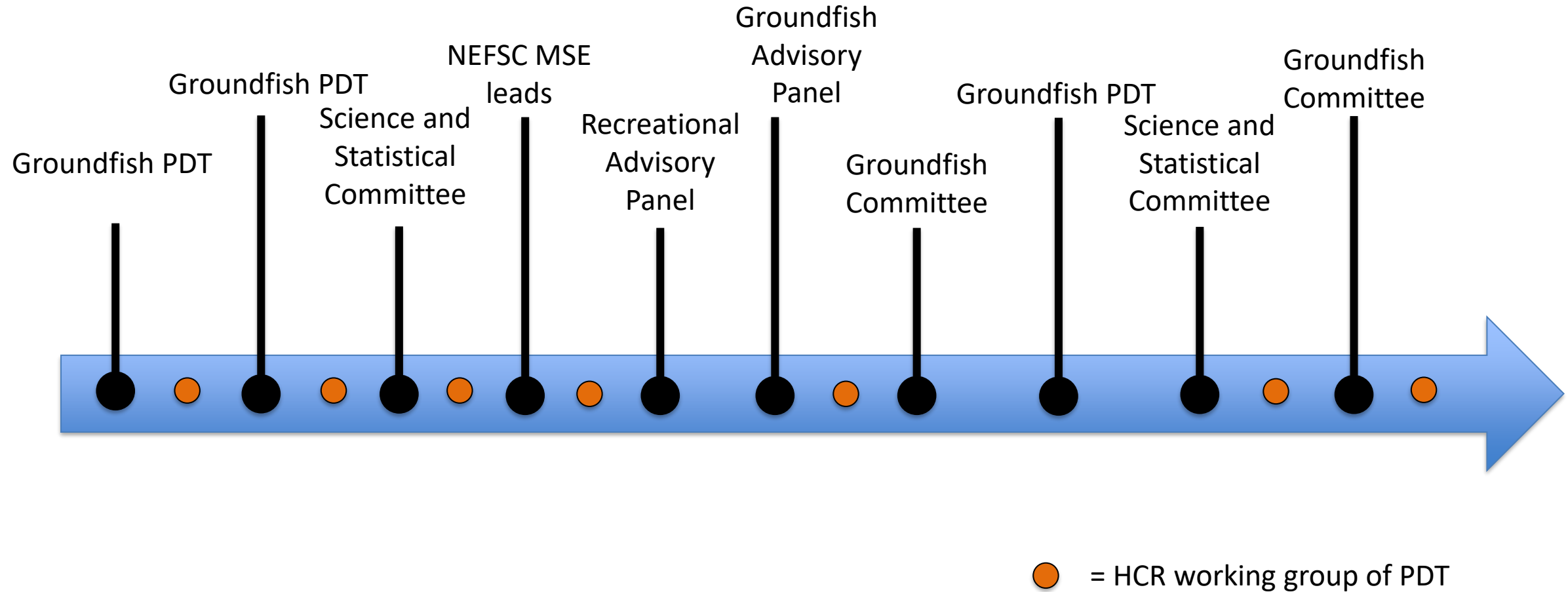
Overview of an MSE Process

Stakeholders and Managers ID what they want, and how

Scientists create a virtual reality (simulation) of the system

Stakeholders and Managers review results

Managers implement an action
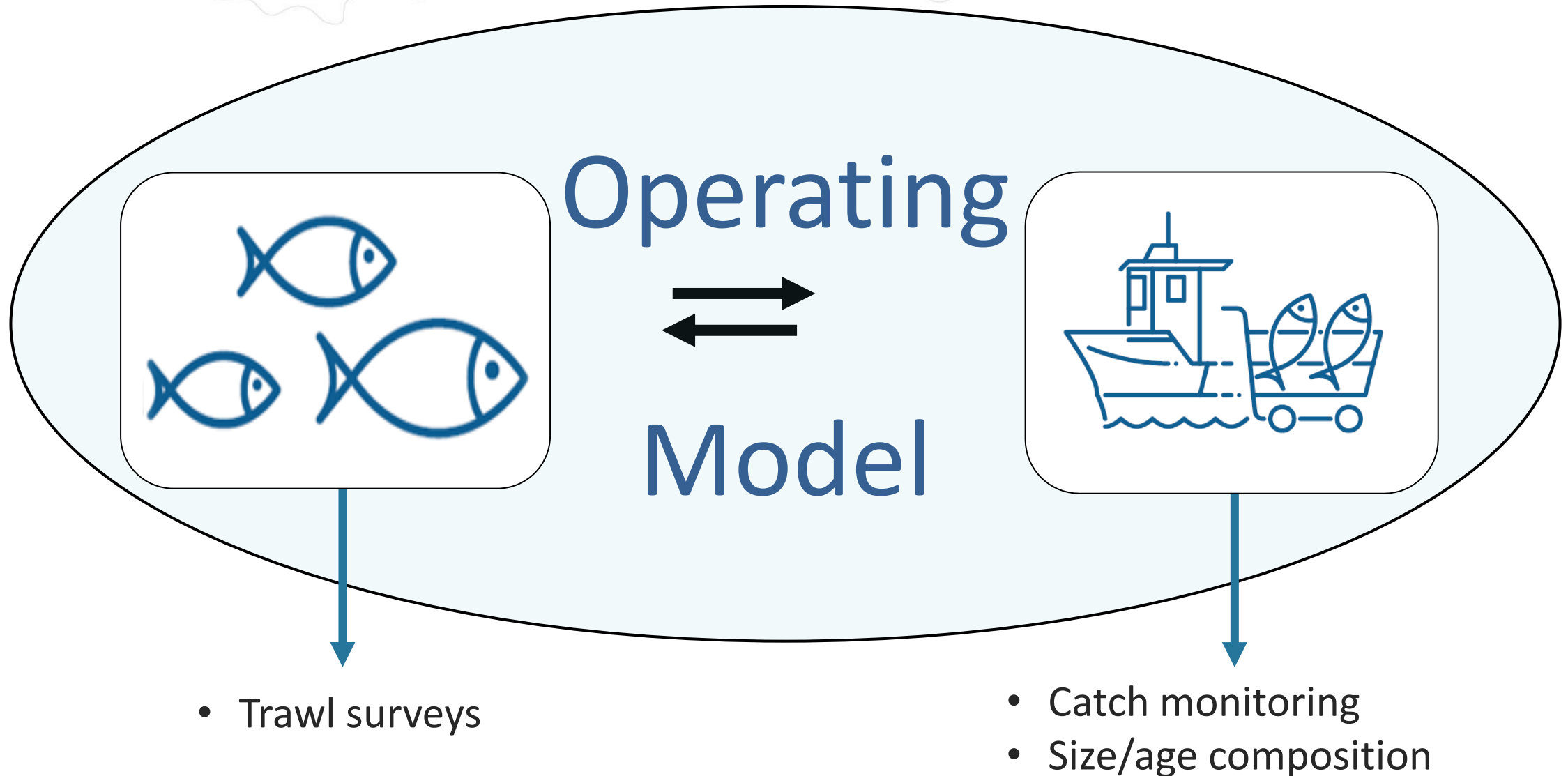
New England Fishery Management Council

Management Strategy Evaluation is intended to be an iterative process that involves substantial dialogue between Scientists, Managers, and Stakeholders
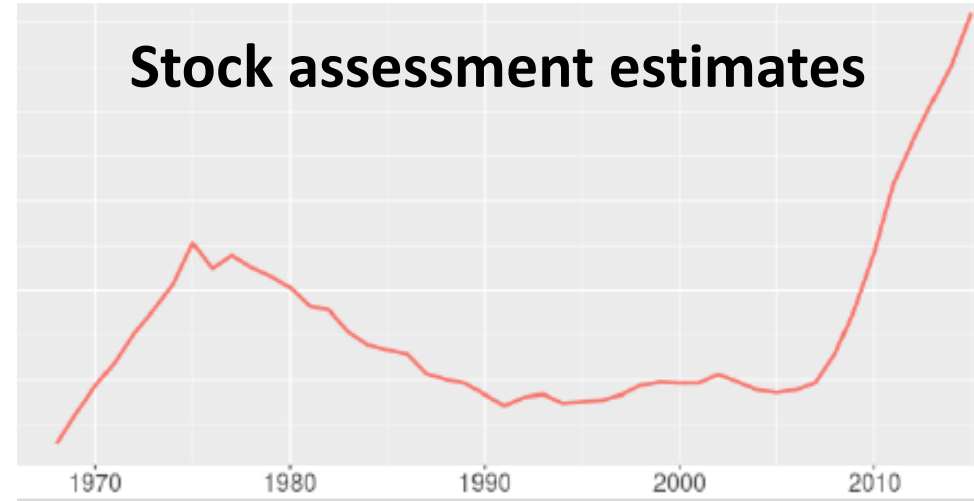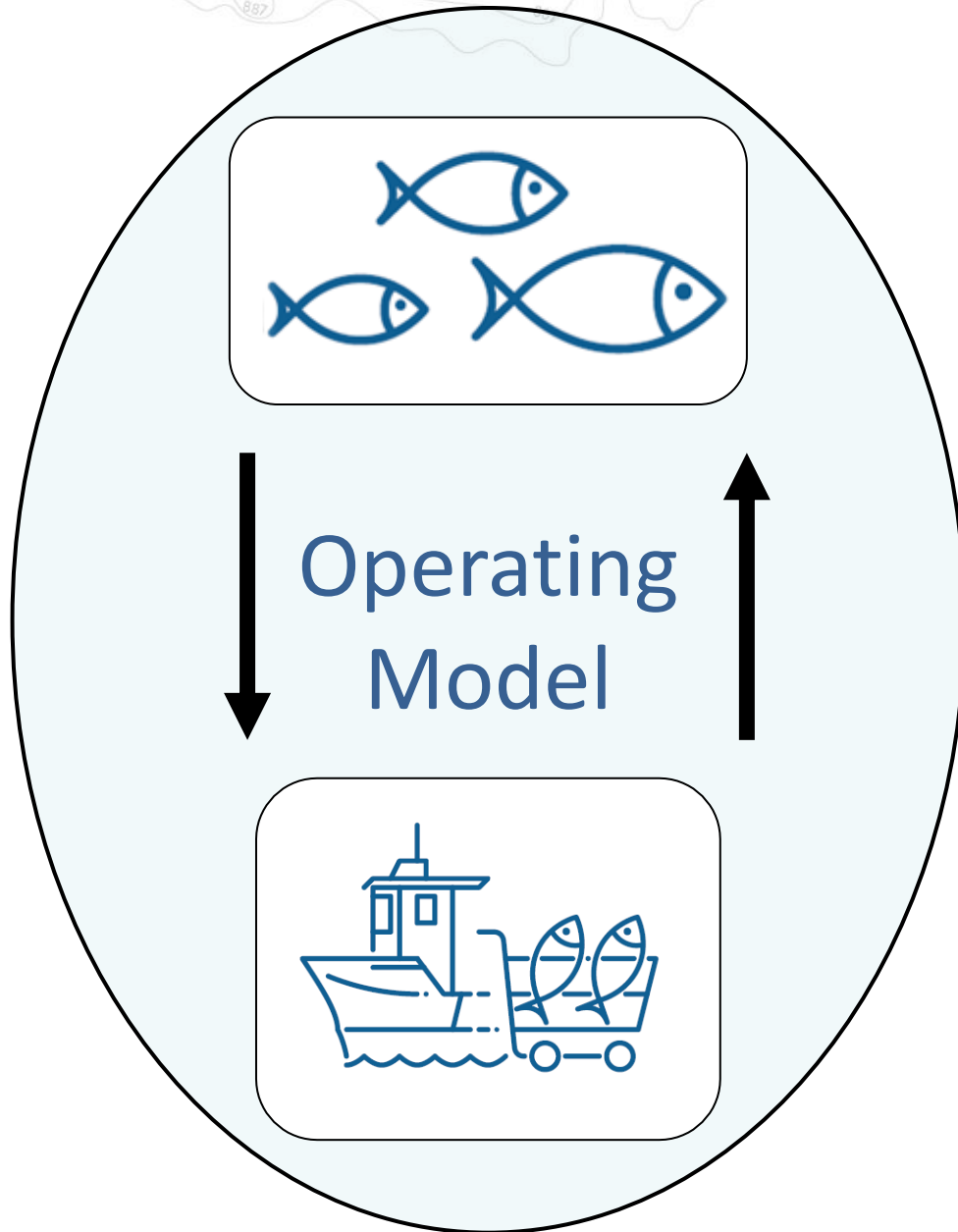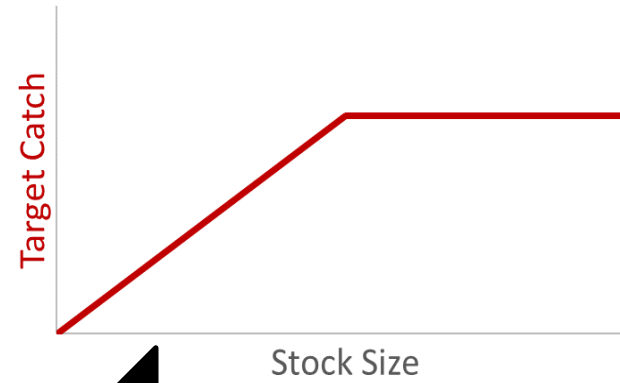
Slide: J. Deroba

Steps in this Process

Simulation Testing Framework

Operating Model

- Trawl surveys

- Catch monitoring
- Size/age composition

Simulation Testing Framework

Stock assessment estimates

Operating Model

Data → Stock Assessment

Simulation Testing Framework
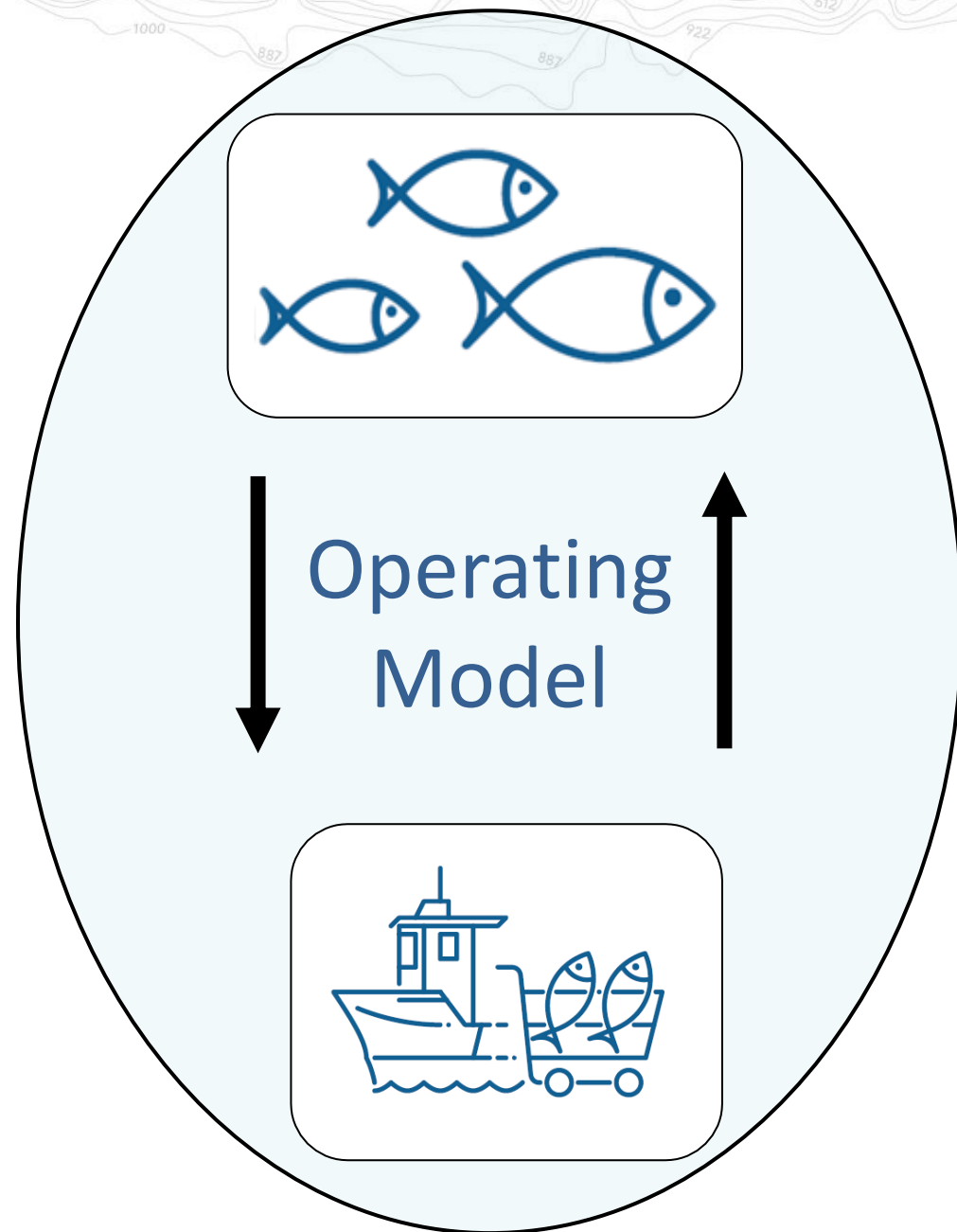
Approach

1. Groundfish operating models that span a range of conditions

Overfished and undergoing overfishing: Gulf of Maine cod

Not overfished or undergoing overfishing: Georges Bank haddock

-Base case (constant natural mortality and moderate productivity)
-Increased natural mortality
-Recruitment influenced by spawning stock biomass and temperature

-Base case (constant natural mortality and random productivity)
-Survey catchability influenced by temperature

Approach

2. Mis-specification of operating and estimation models to generate retrospective patterns

- Incorrect natural mortality assumption
- Incorrect recruitment assumption
- Incorrect survey catchability assumption

Approach

3. Emulate current groundfish stock assessment methods
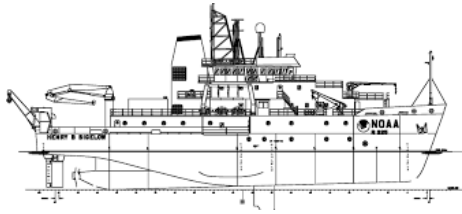
Survey: index of fish abundance

Fishery data: catch information
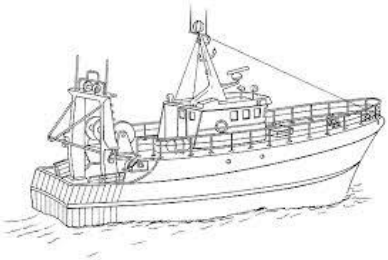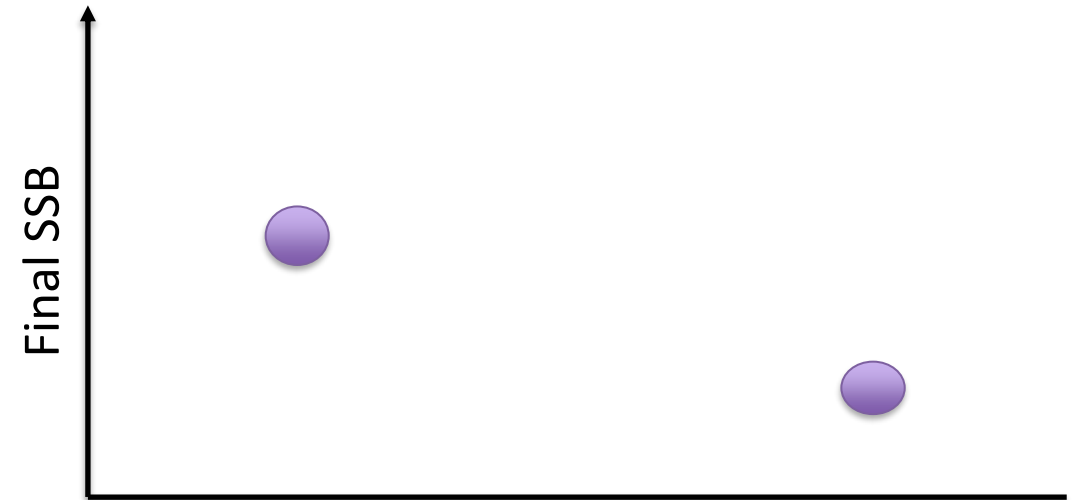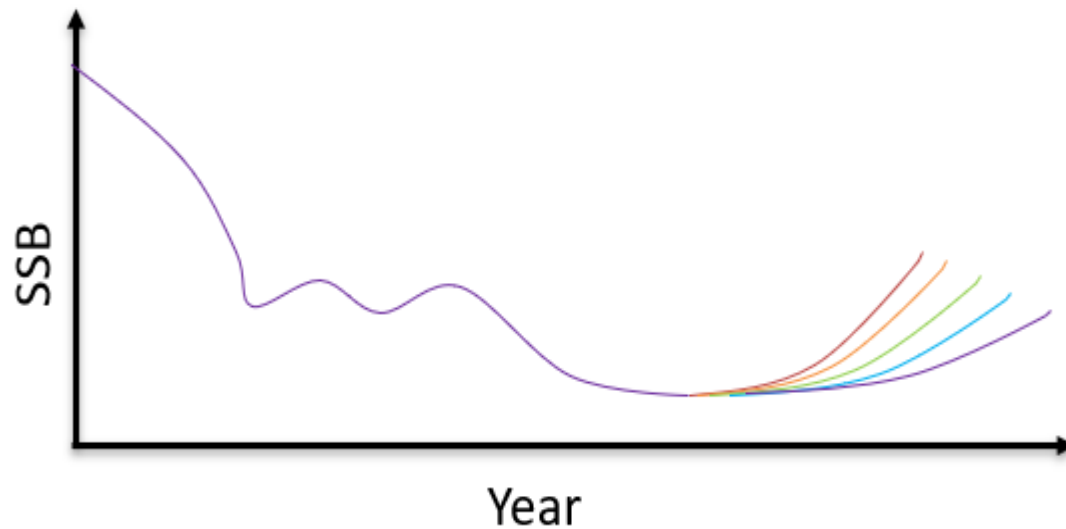
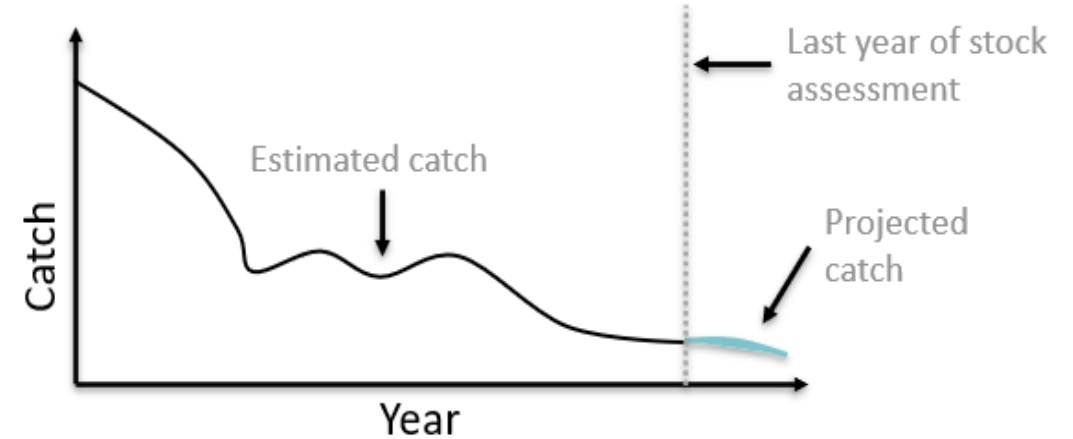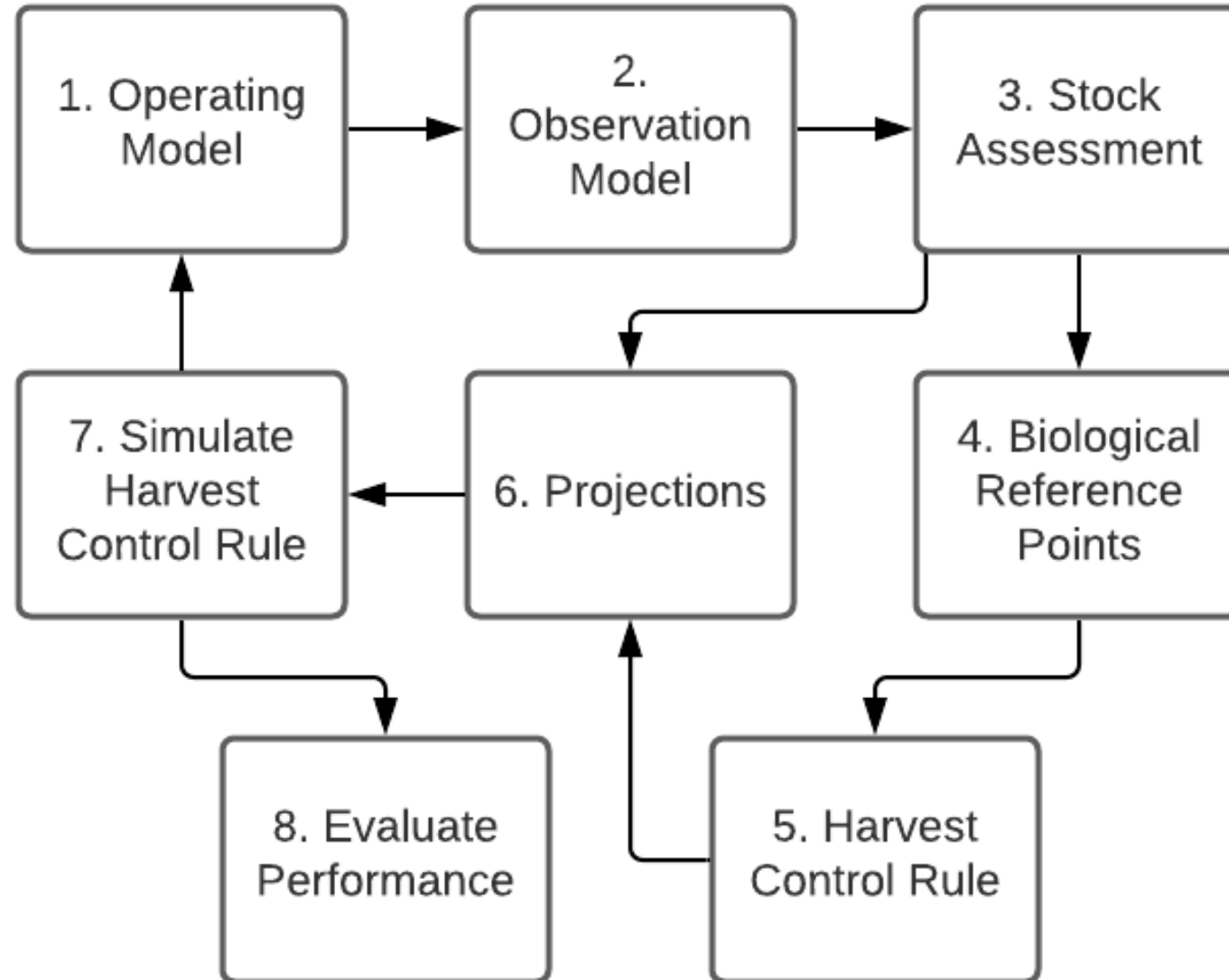Age Structured Assessment Program

Outputs
SSB
R
F
Catch

Approach

3. Emulate current groundfish stock assessment methods

- Projections
  - Integrated reality of lagged information
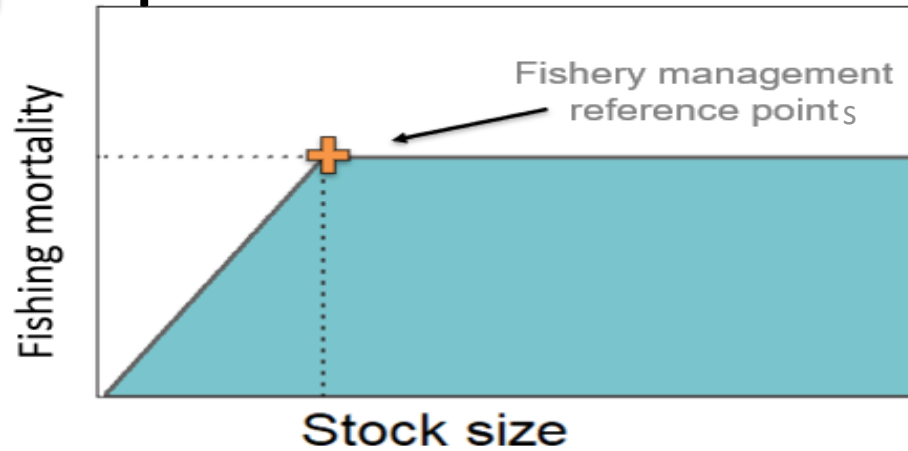

- Retrospective pattern adjustments
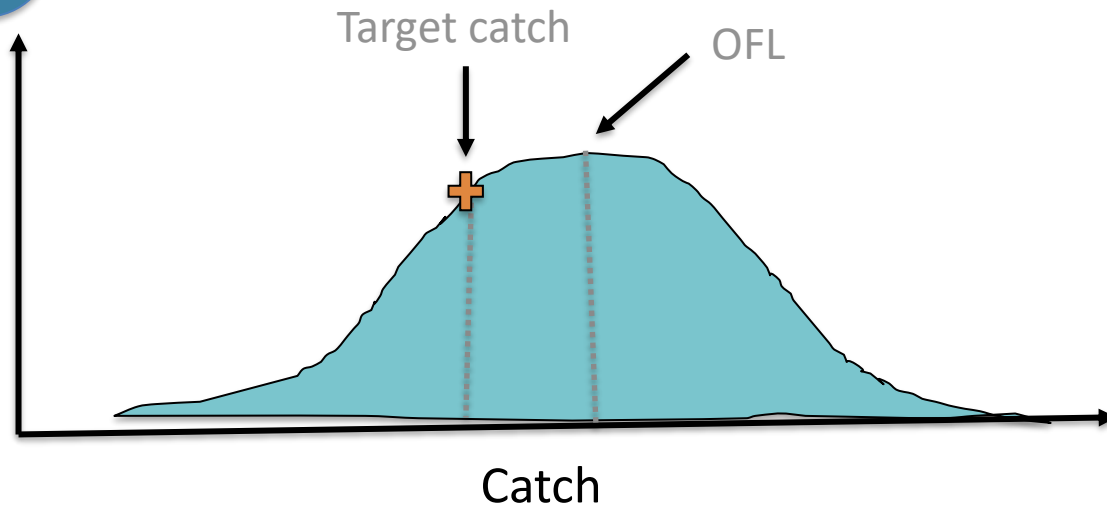
MSE framework used in this study:

Approach

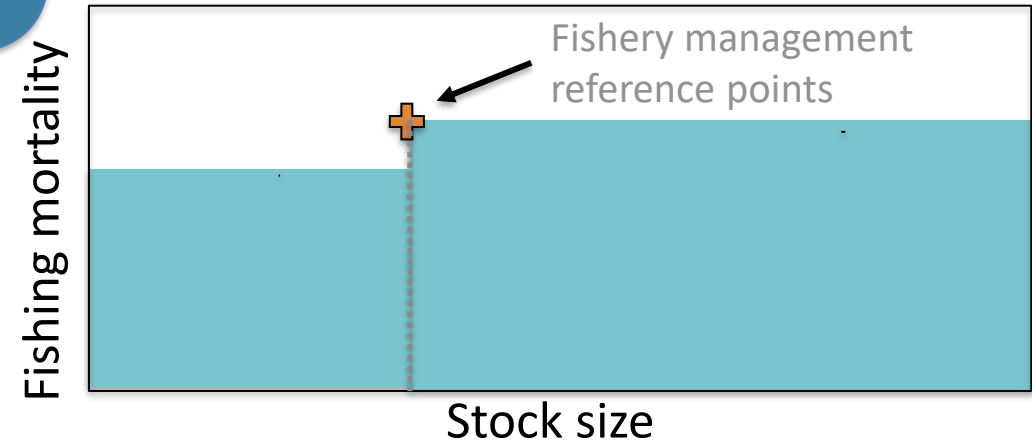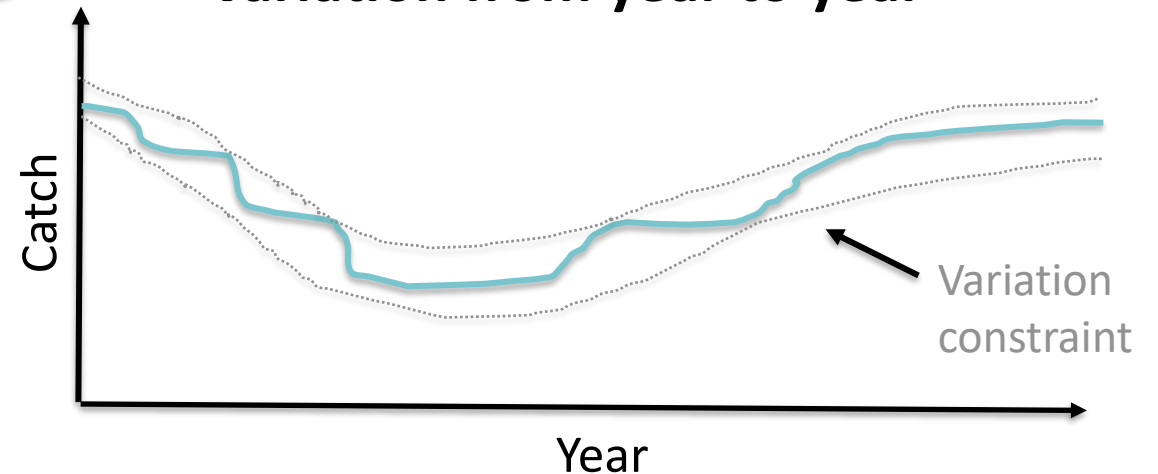## 4. Design and simulation testing of alternative HCRs

1 **Ramped HCR**

Fishery management reference points

Fishing mortality

Stock size

3 **Step in fishing mortality HCR**

Fishery management reference points

Fishing mortality

Stock size

2 **P* Approach**

Target catch

OFL

Catch

4 **1** **with constraint on catch variation from year to year**

Catch

Variation constraint

Year

Performance metrics

Stock Performance:

- Trajectories:
  - Spawning stock biomass
  - Fishing mortality
  - Catch
  - Recruitment
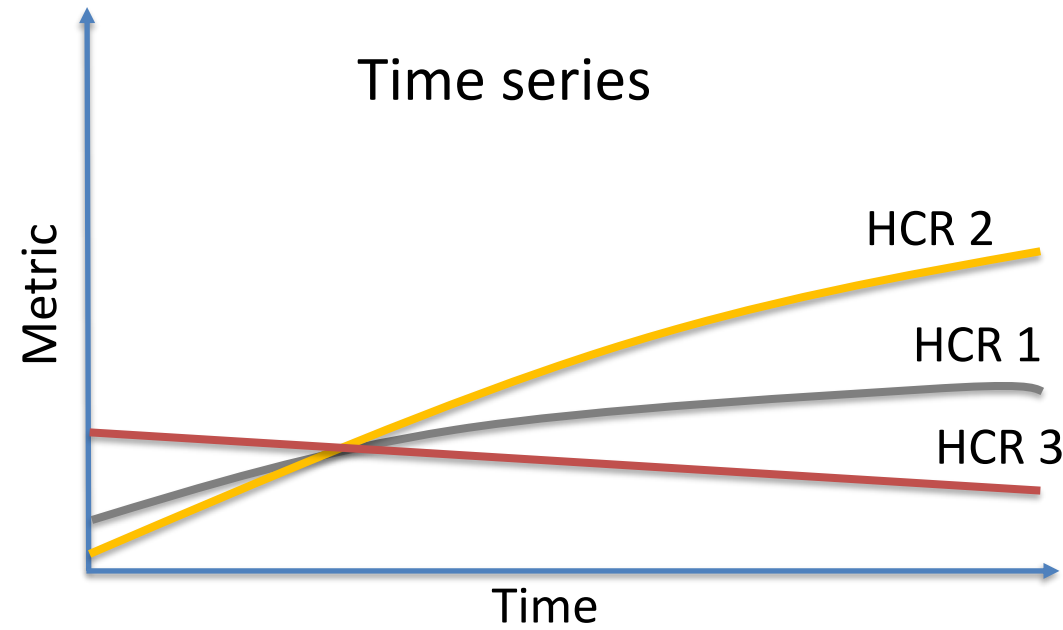- Catch stability

Assessment performance:

- Relative error for terminal estimates
- Measure of retrospective patterns
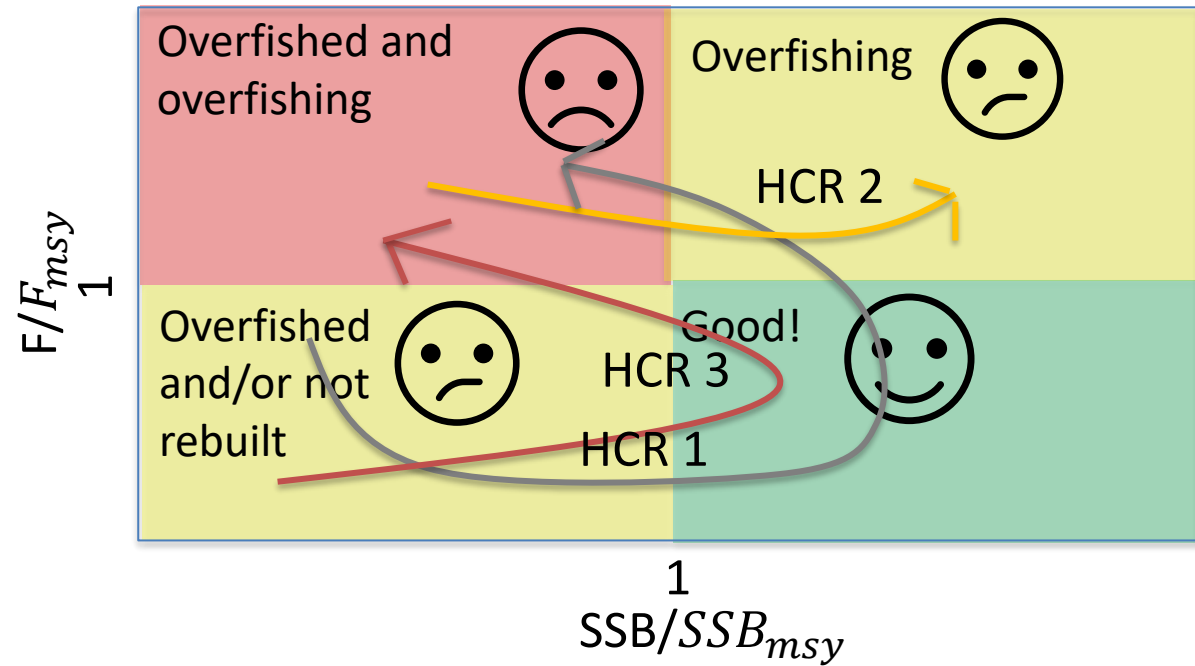- Accuracy of reference points

Management performance:

- Stock status trajectories
- Frequency of overfishing status
- Frequency of overfished status
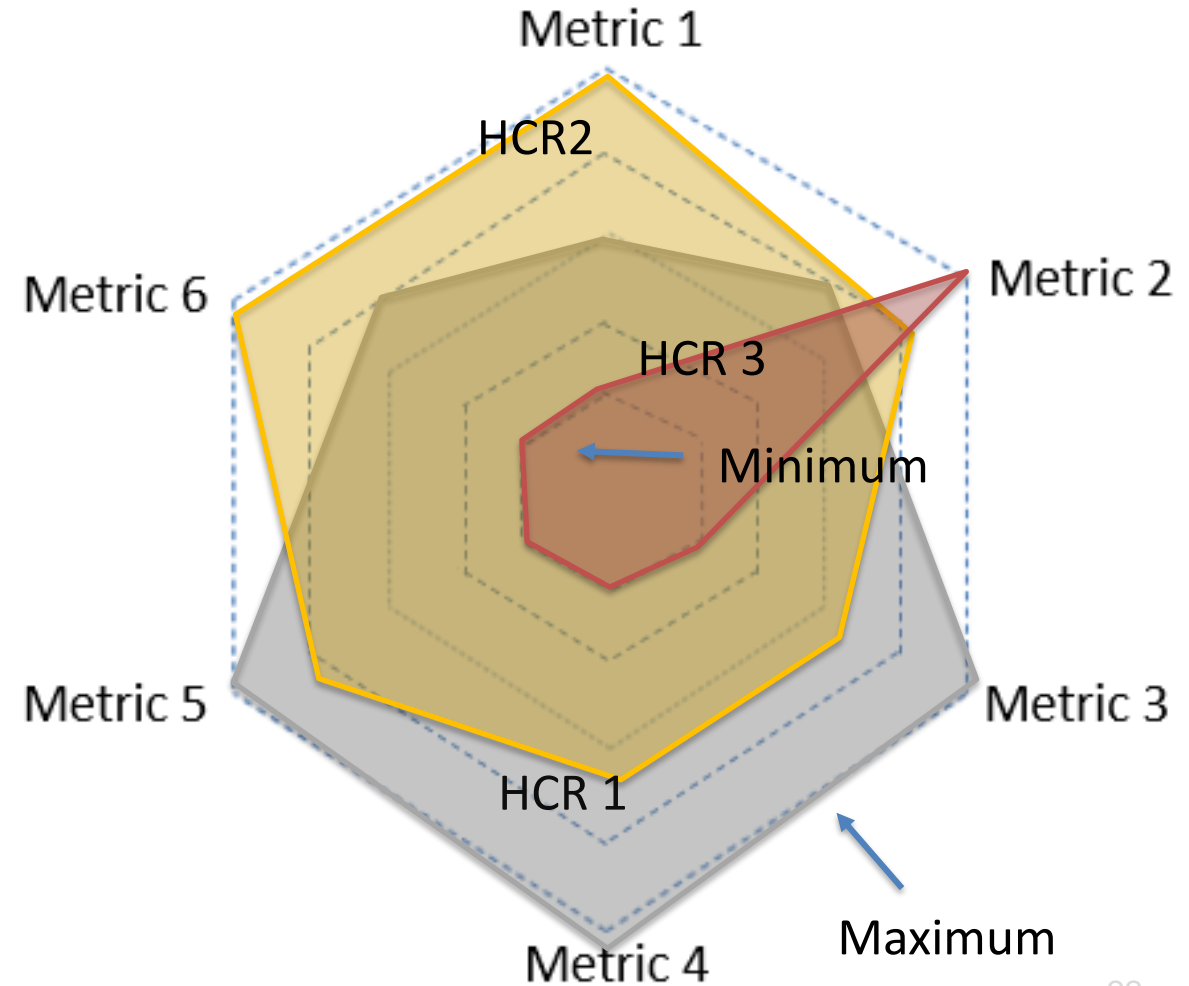- Estimated terminal stock status at each year

Characterized in short-term (1-5 years), medium-term (6-10 years), and long-term (11-21 years).
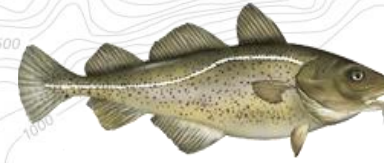
Visualizations

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Kobe Plot

Overfished and overfishing 🙁

Overfishing 😕

HCR 2

F/F_{msy}
1

Overfished and/or not rebuilt 😕

Good! 🙂
HCR 3

HCR 1

1
SSB/SSB_{msy}

Radar chart

Metric 1

HCR2

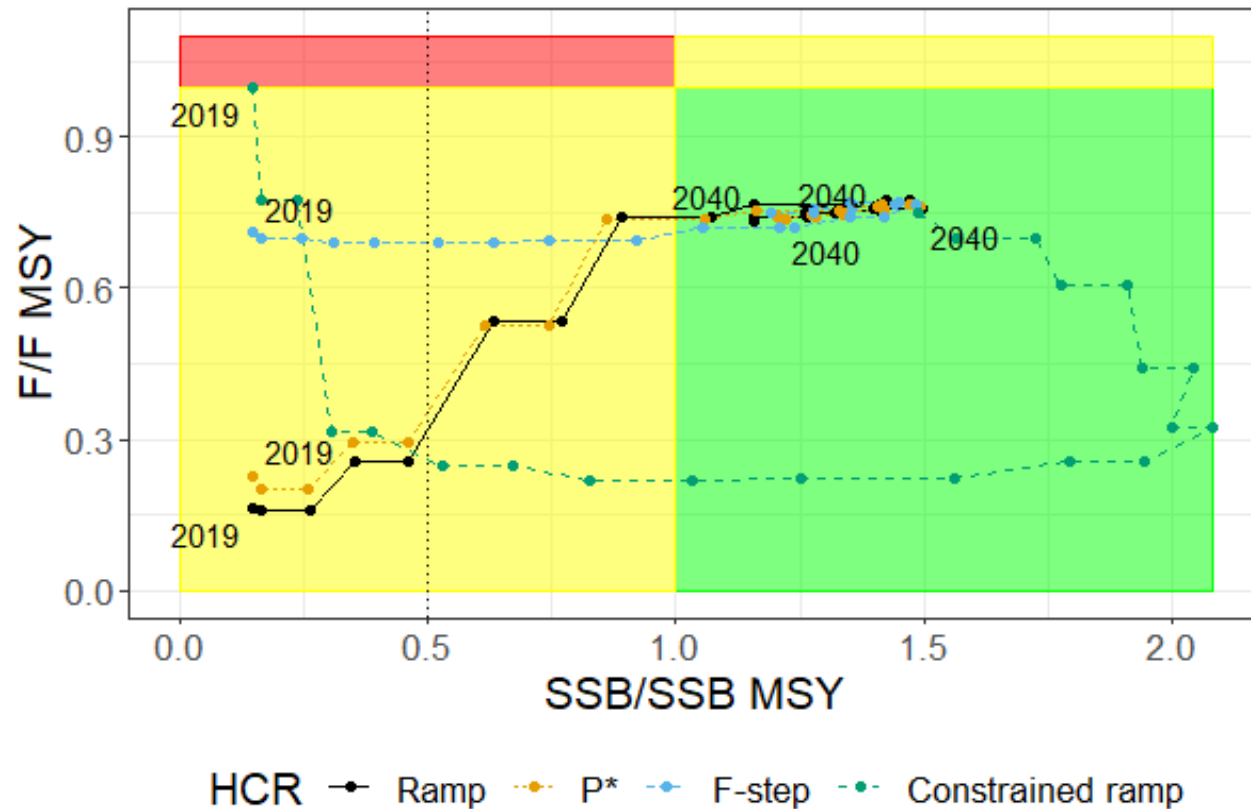Metric 6

Metric 2

HCR 3

Minimum

Metric 5

HCR 1

Metric 3

Metric 4

Maximum

22

How do alternative harvest control rules perform when a stock is overfished?

All HCRs rebuilt the stock in the long-term, but the F-step HCR rebuilt the stock a year later than the other HCRs.

The ramp and P* HCRs resulted in lower catch and catch stability in the short-term.
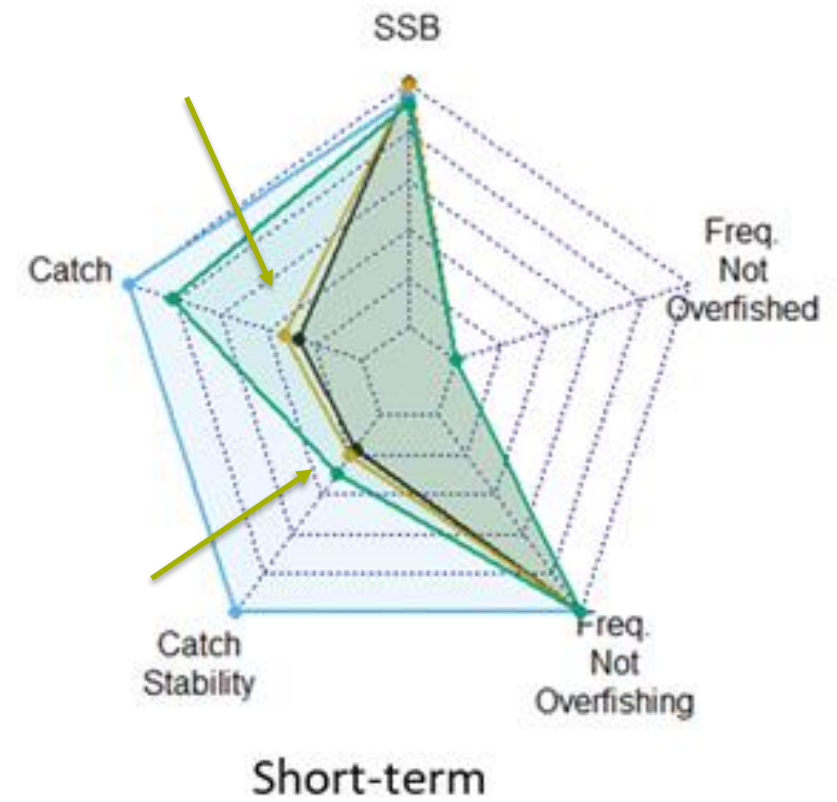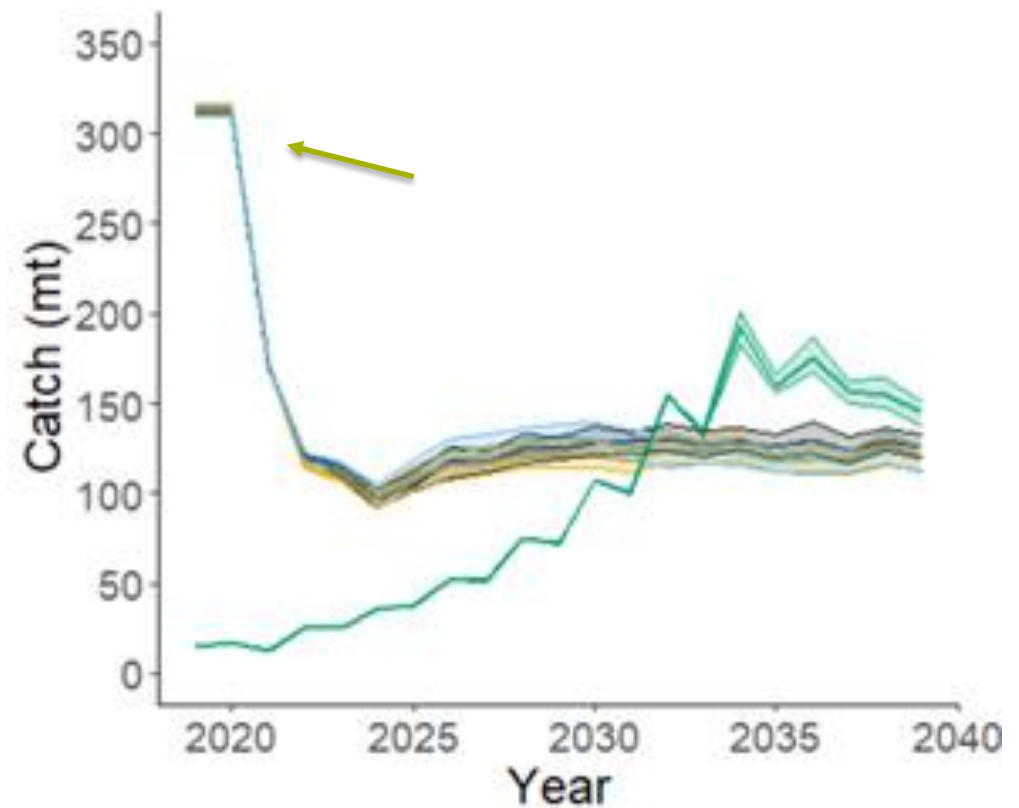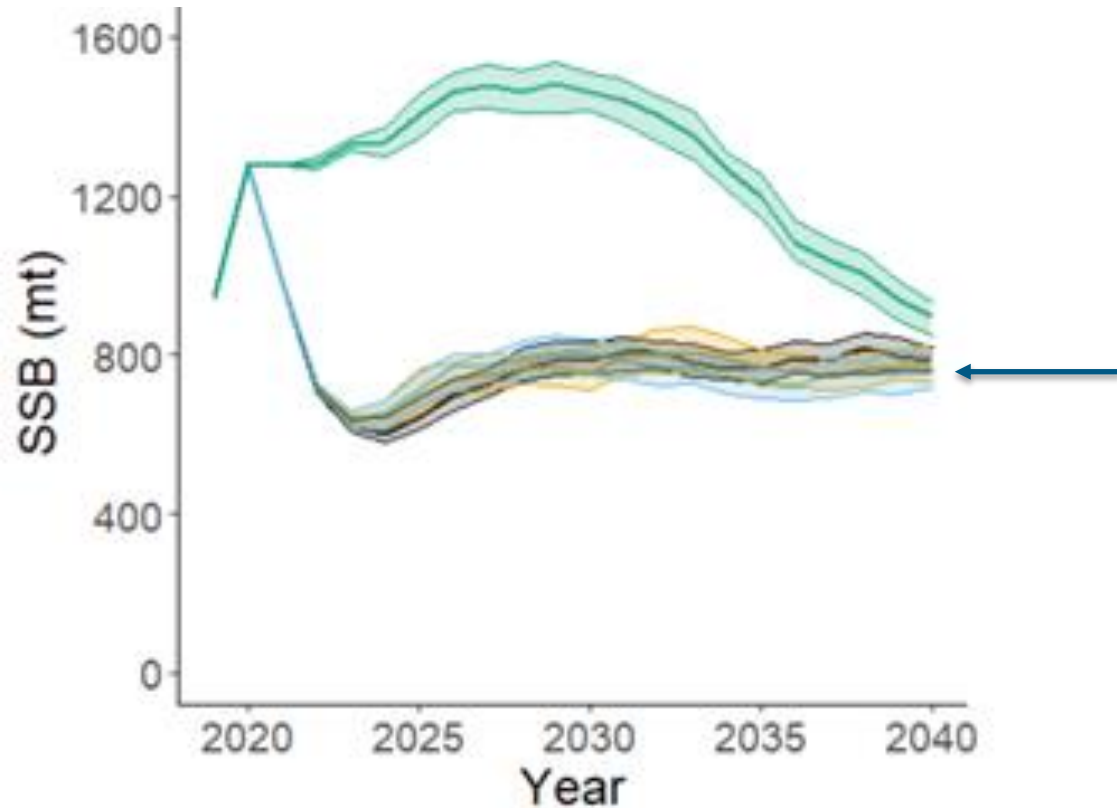
Base Case Not Overfished Scenario

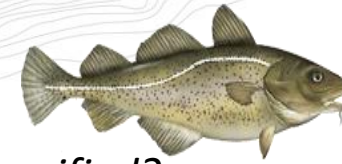*How do alternative harvest control rules perform when a stock was not overfished?*

The ramp, P*, and F-step HCRs performed similarly.

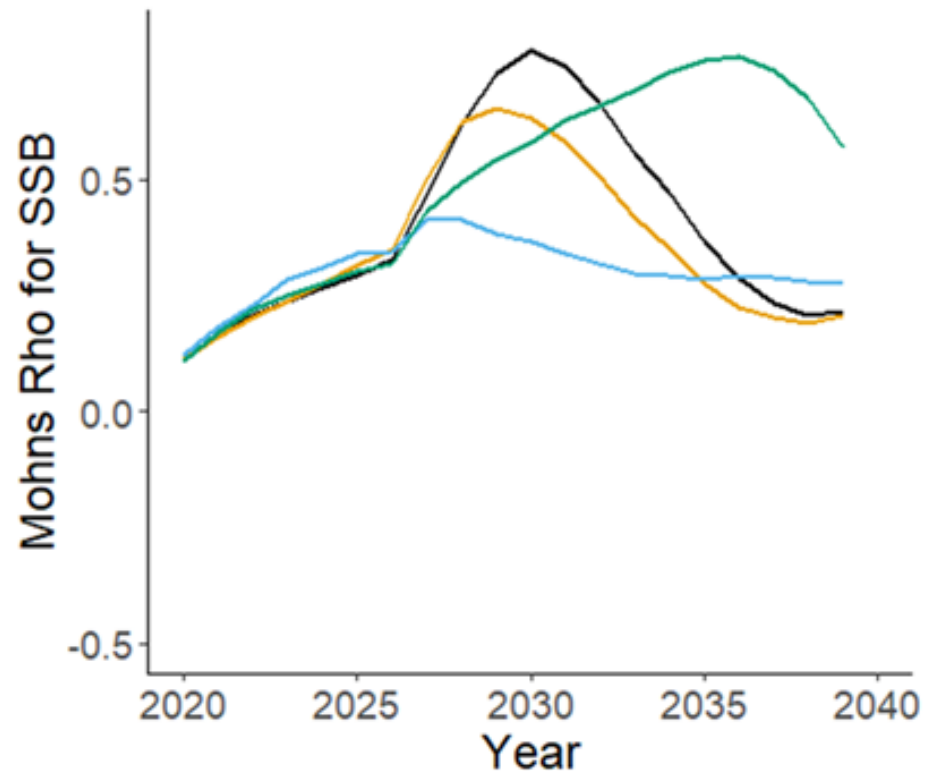The ramp, P*, and F-step HCRs allowed the fishery to take advantage of large recruitment events.

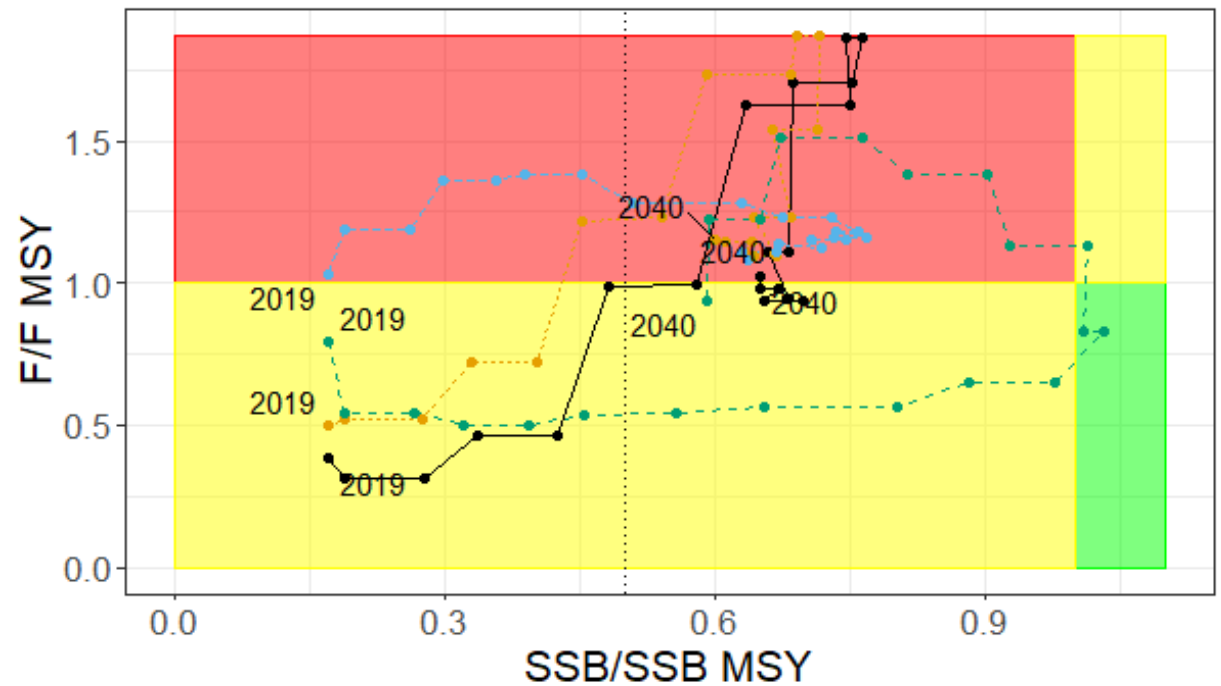# Overfished Mortality Misspecification Scenario

How do alternative harvest control rules perform when stock assessments are misspecified?

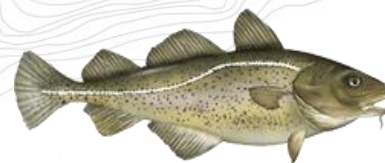The natural mortality misspecification resulted in retrospective patterns.

Increased natural mortality and incorrect stock assessment assumptions lead to more time spent overfished and more overfishing, especially under the F-step HCR.

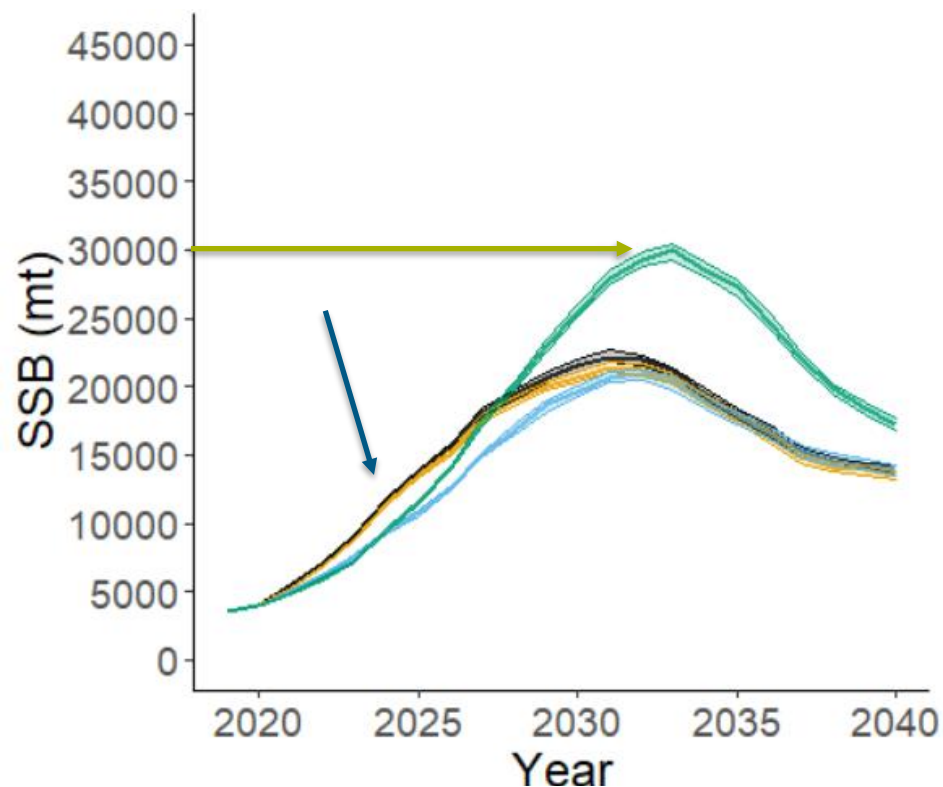# Overfished Recruitment Misspecification

How do alternative harvest control rules perform when stock assessments are misspecified?

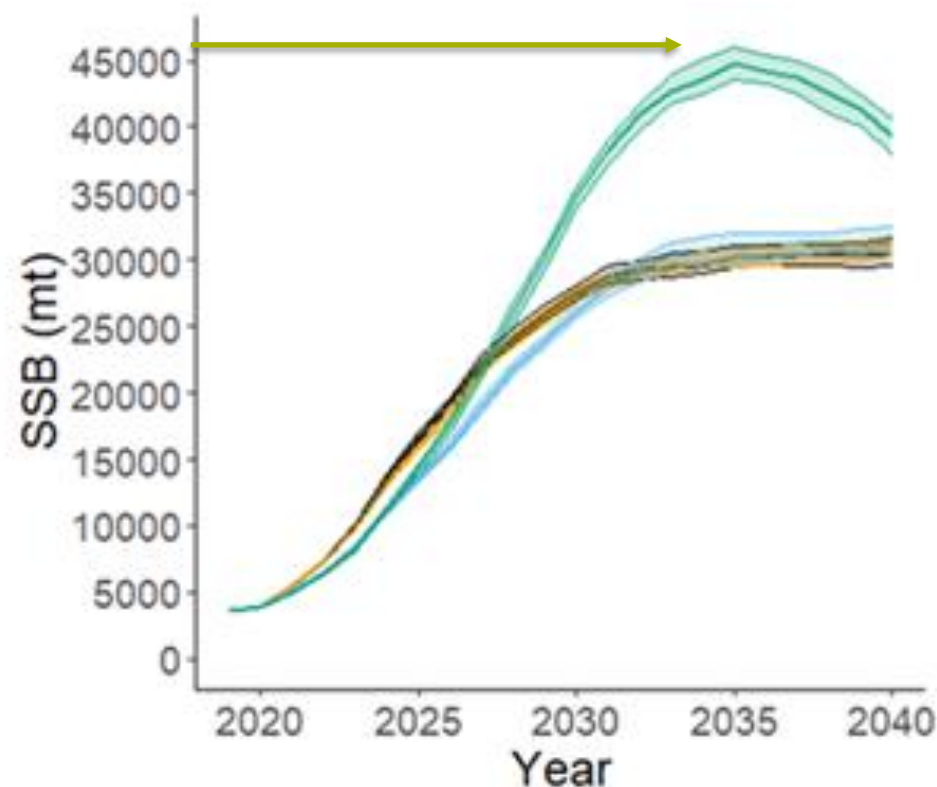The ramp and P* HCRs increased SSB at the fastest rate and decreased the frequency of being overfished.

SSB was lower due to the decreased recruitment.

Overfished Recruitment Misspecified Scenario

Base Case Overfished Scenario

Overfished Natural Mortality and Recruitment Misspecification

How do alternative harvest control rules perform when stock assessments are misspecified?

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SSB and F were over and underestimated.

The combined natural mortality and recruitment misspecification contributed to more time spent overfished and overfishing, especially under the ramp and P* HCRs in the long-term.
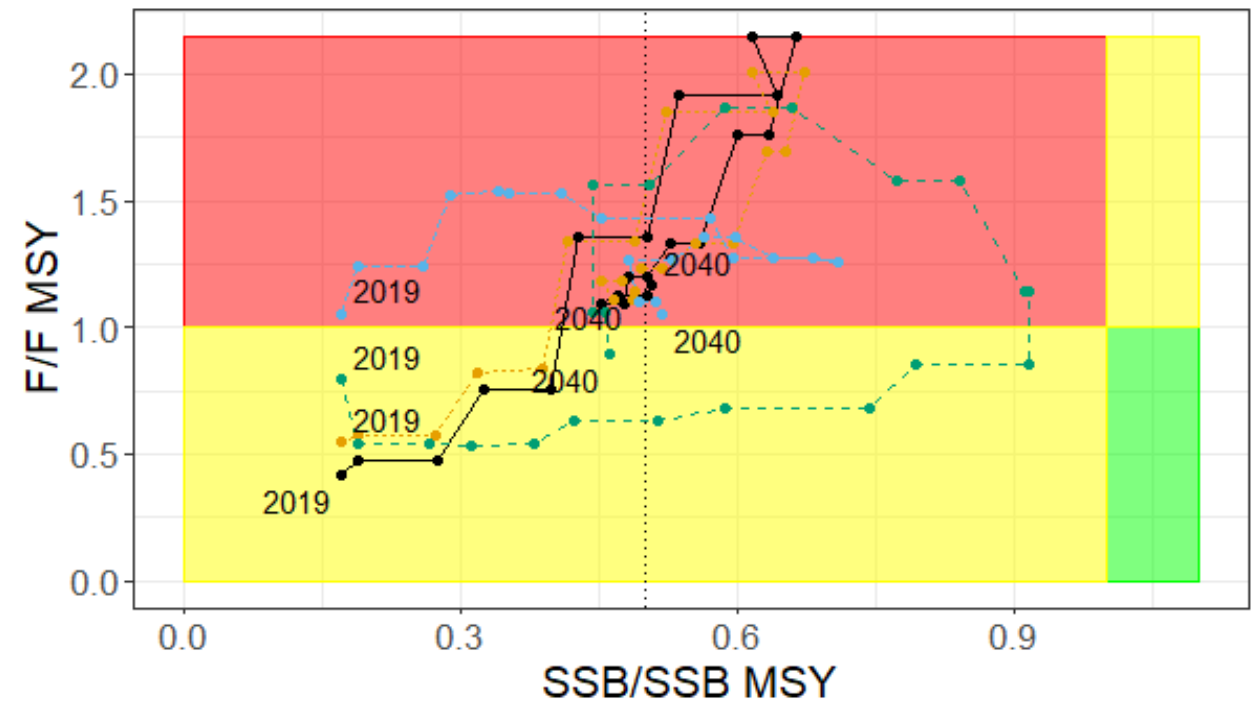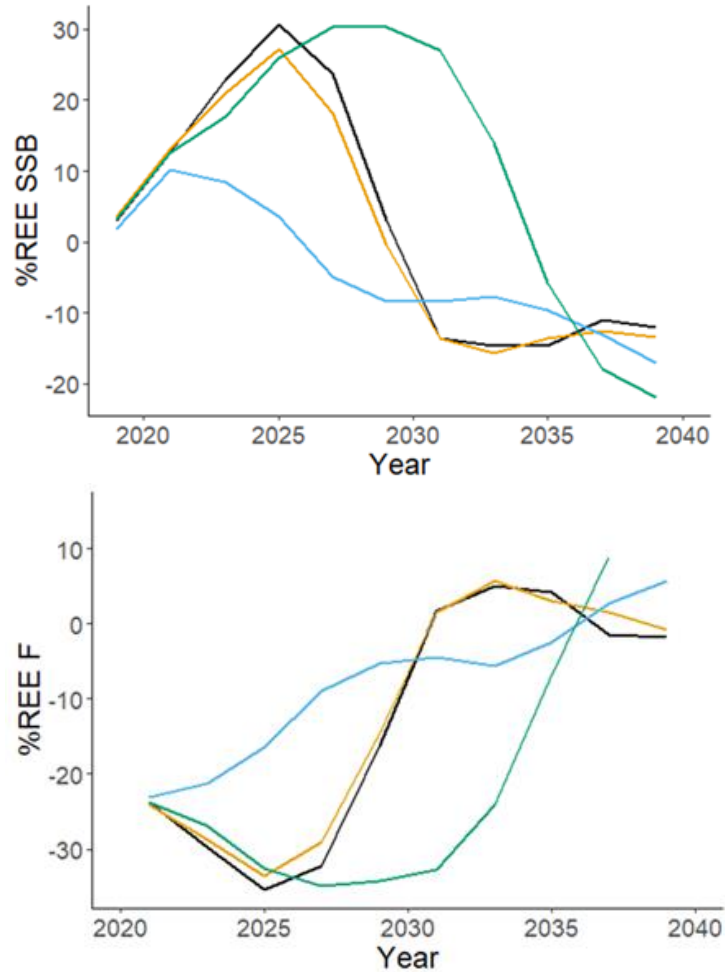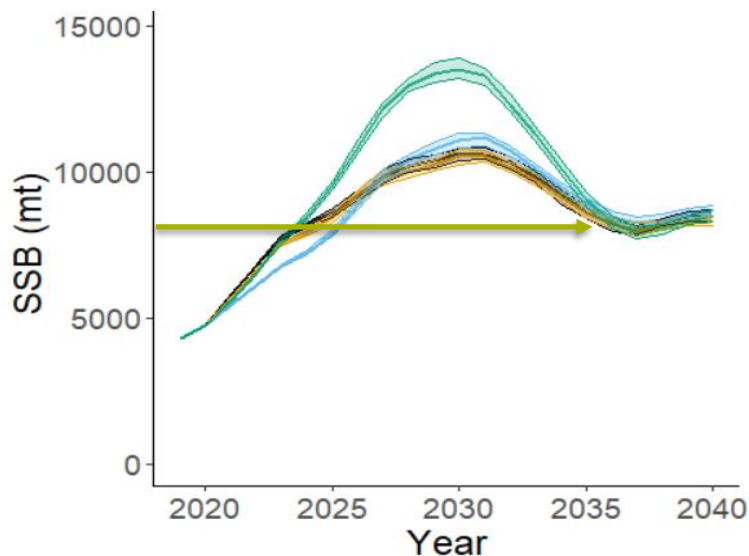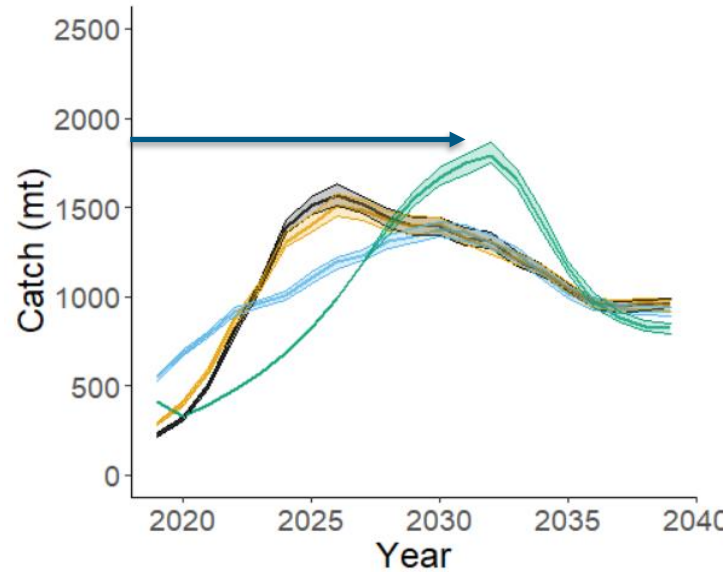

HCR — Ramp — P* — F-step — Constrained ramp

Overfished Mortality and Recruitment Misspecification Scenario with Annual Stock Assessment Updates
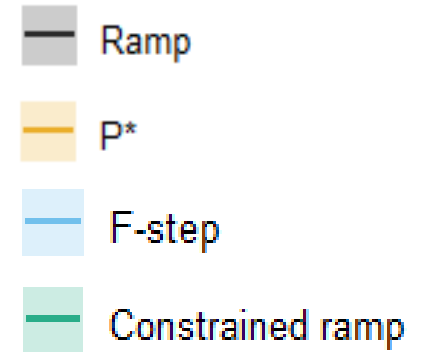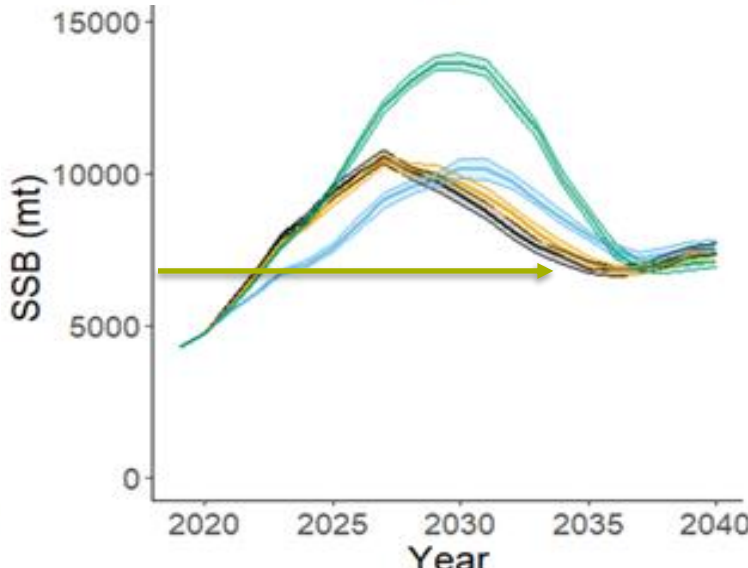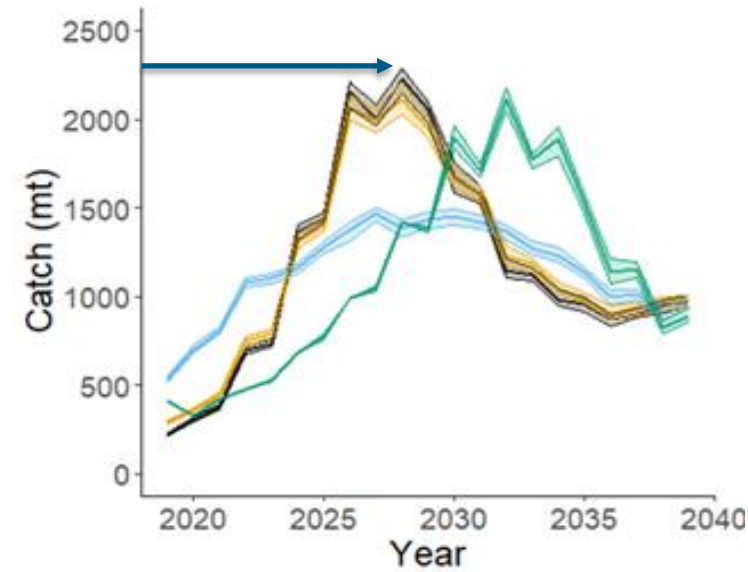
Annual updates

Two-year updates

HCRs performed more conservatively in the long-term with annual updates.

Annual updates lead to higher SSB in the long-term.

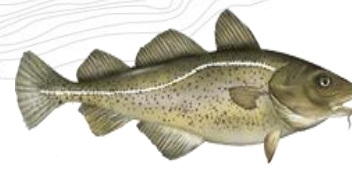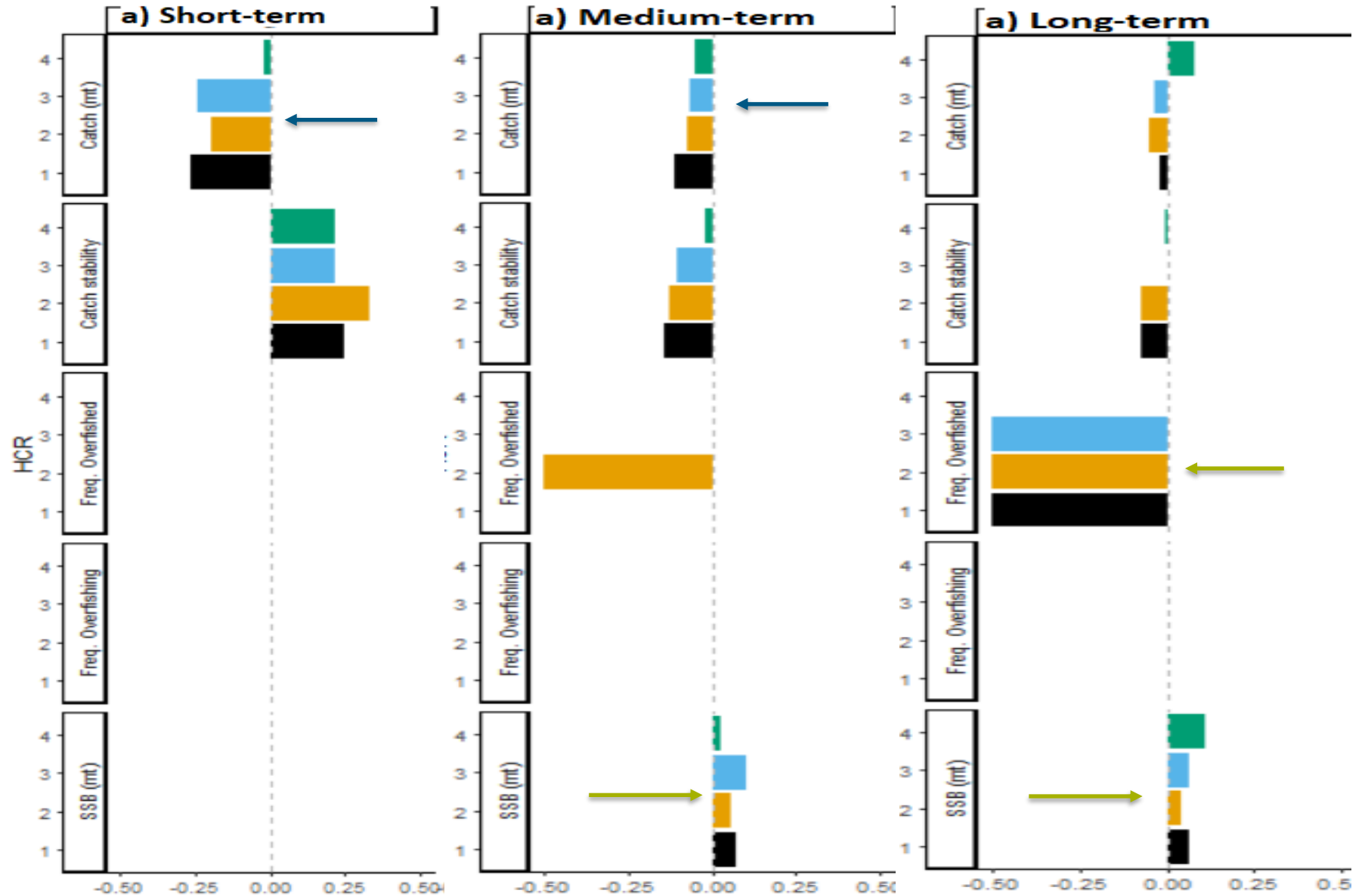# Overfished Mortality and Recruitment Misspecification Scenario with Year One Projection Held Constant

HCRs performed more conservatively when catch advice was based on year one of the projection.

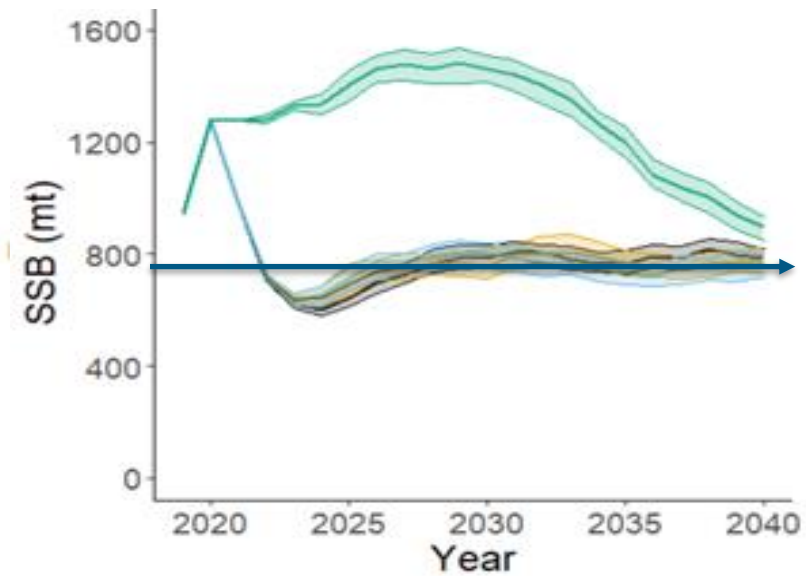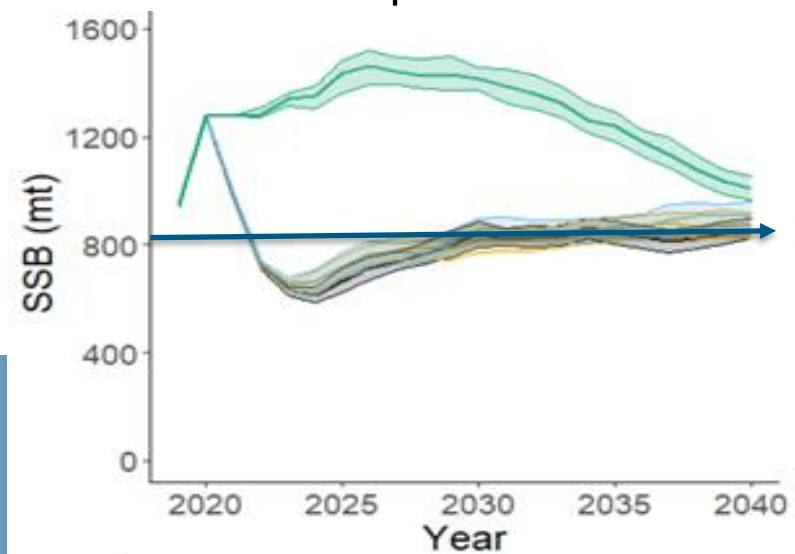SSB increased more and the stock rebuilt faster.
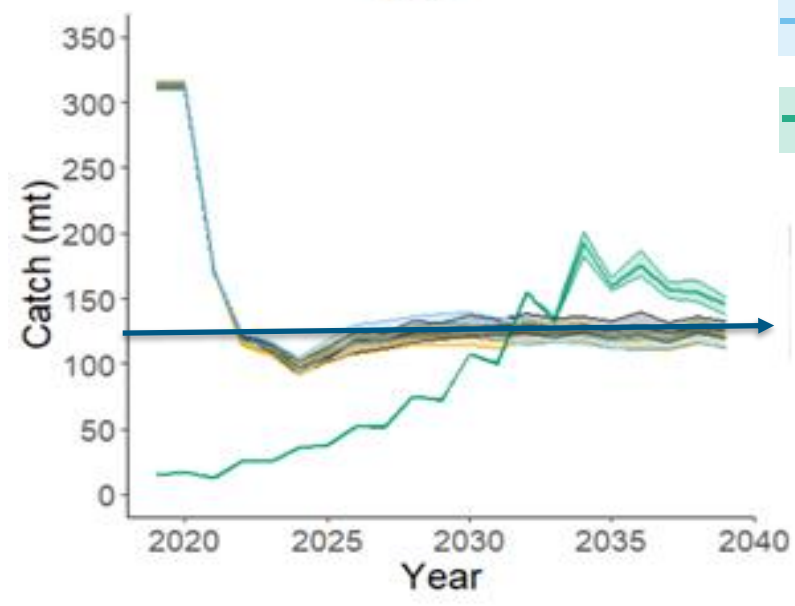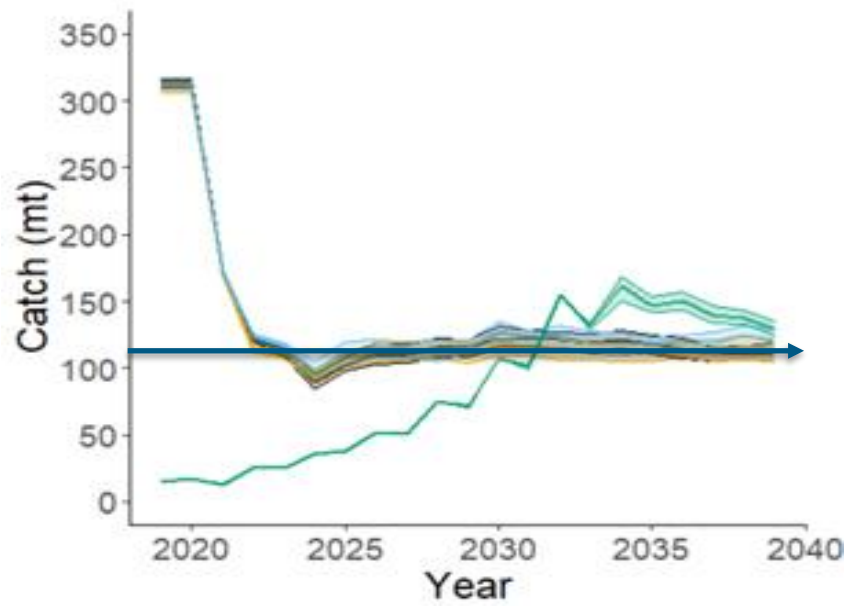
Not Overfished Catchability Misspecification

Survey catchability misspecification

No misspecification

HCRs performed more conservatively with the survey catchability misspecification.

Legend:
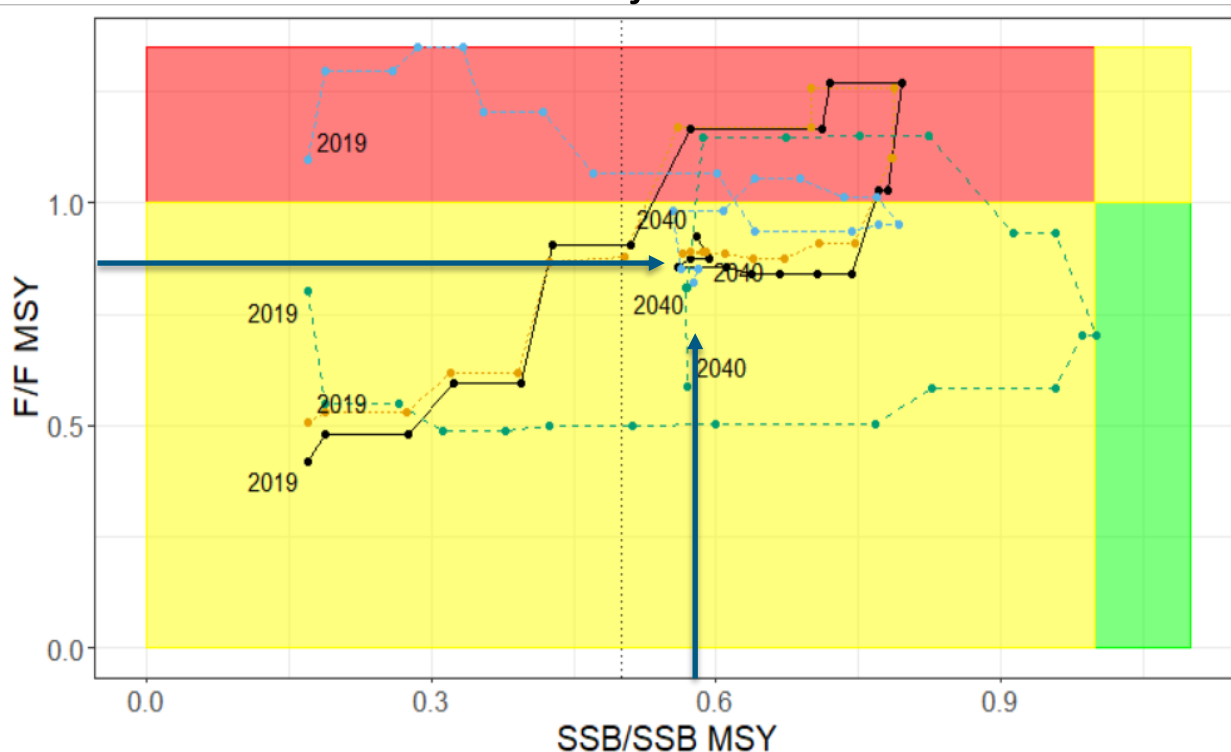- Ramp
- P*
- F-step
- Constrained ramp

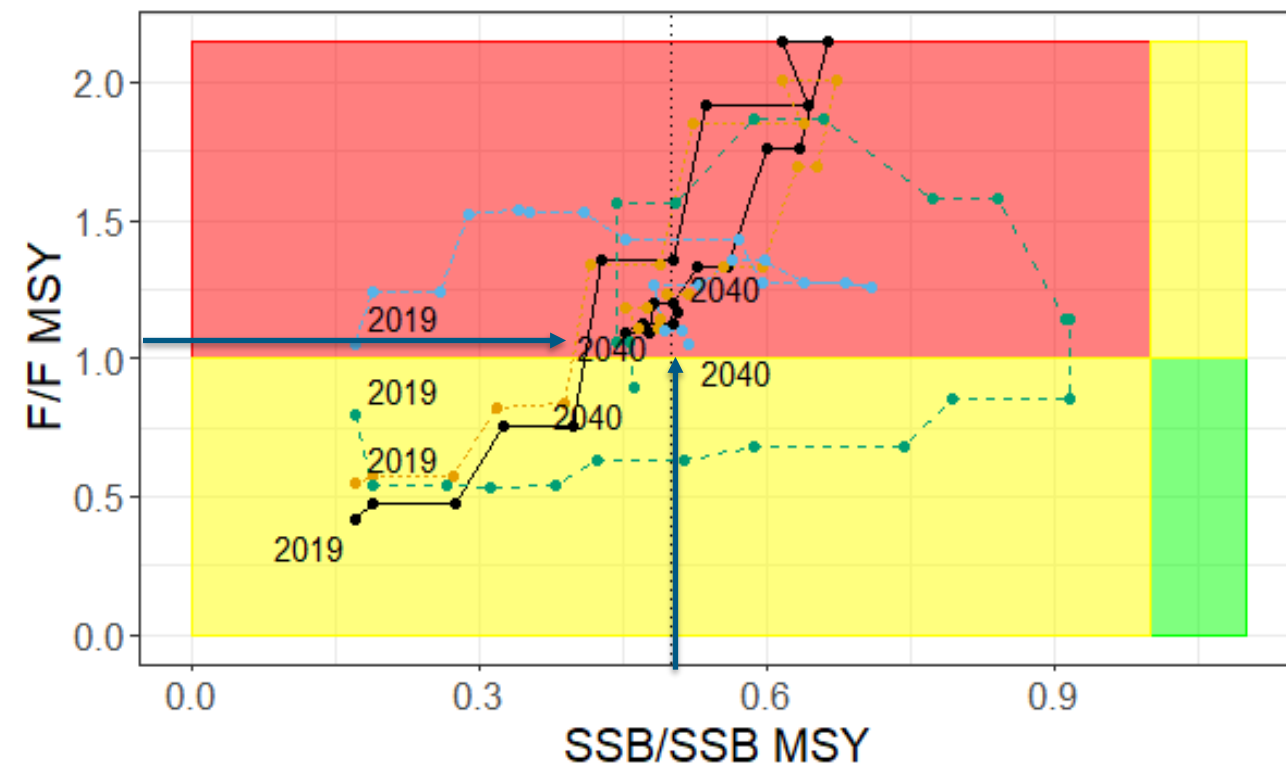# Overfished Mortality and Recruitment Misspecification Scenario with a Rho-Adjustment

When retrospective patterns exist, do retrospective patterns result in better performance than no retrospective patterns?

A rho-adjustment resulted in more conservative catch advice and caused less overfishing and a lower frequency of overfished stock status.

Summary

- Scenarios with different combinations of stock size, population dynamics, and stock assessment model specifications were simulated to evaluate the performance of alternative HCRs.

- HCR performance differed between scenarios, metrics, and time periods.

- When the stock was not overfished, the ramp, P*, and F-step HCRs performed similarly.

- HCRs performed differently with a stock assessment misspecification.

- Frequency of overfished and overfishing depended more on the type of stock assessment misspecification, and there were some differences across HCRs in years spent overfished and overfishing.

- The classification of an optimal HCR will depend on the definition and prioritization of management objectives for the groundfish fishery.

Thank you and questions?