Management Strategy Evaluation for the Snapper-Grouper Fishery

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bluematter

SAFMC – Council Meeting

6 March 2023

Outline

1. Management Strategy Evaluation: A Brief Overview
2. Contrasting Stock Assessment with Management Strategy Evaluation
3. MSE Process for the Snapper-Grouper Fishery
4. The MSE Framework

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Management Strategy Evaluation: A Brief Overview

In most fisheries, management decision making could benefit from:

1. a more coherent strategy (why?)
2. increased transparency and accountability (how?)

But when you consider the options, there are good reasons why achieving this has been difficult…

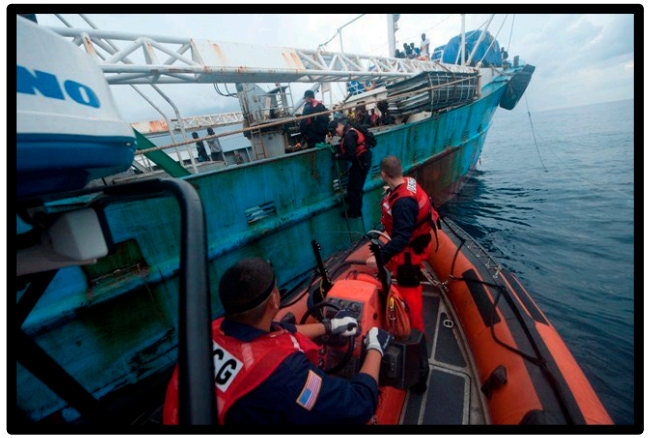
Test by Experiment

Fishery

Data

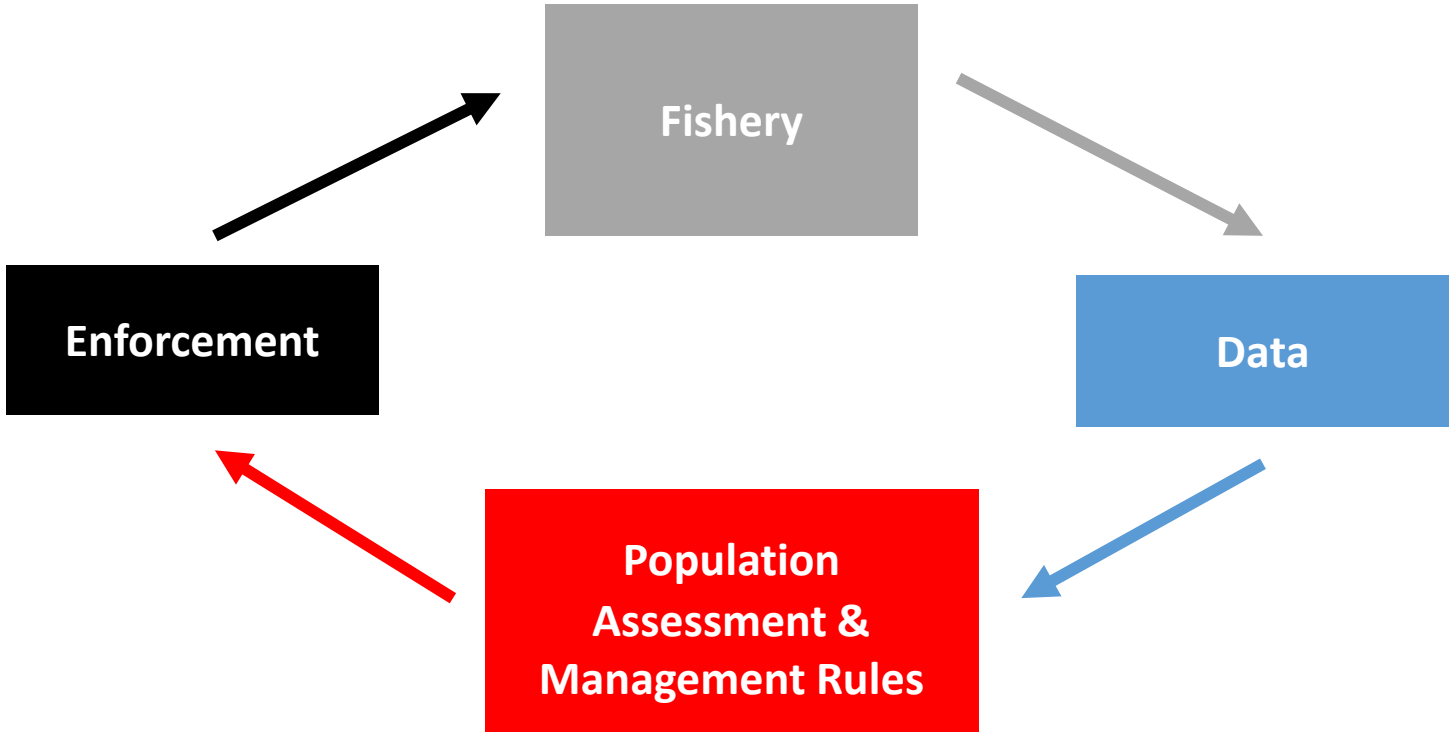
Analysis

Implementation



Test by Simulation

Test by Simulation: the MSE approach



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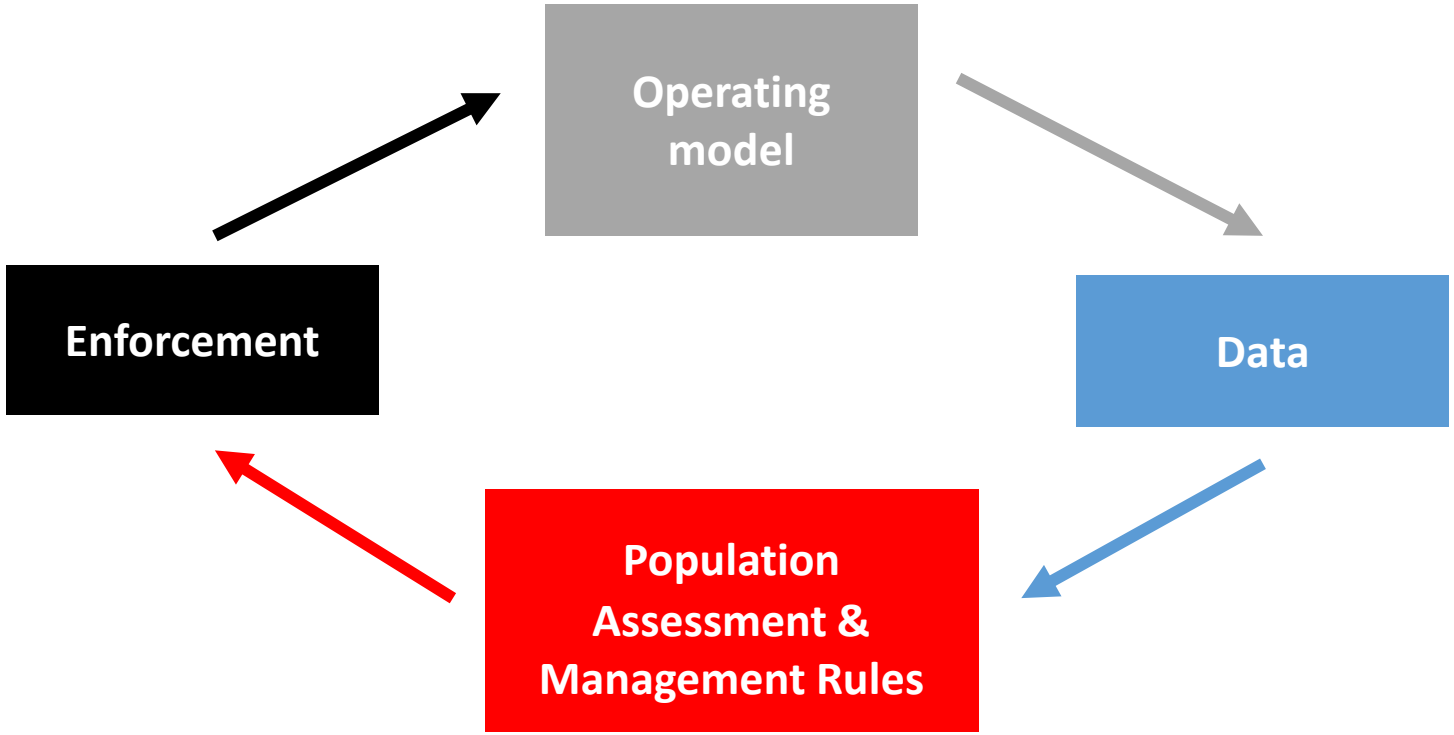

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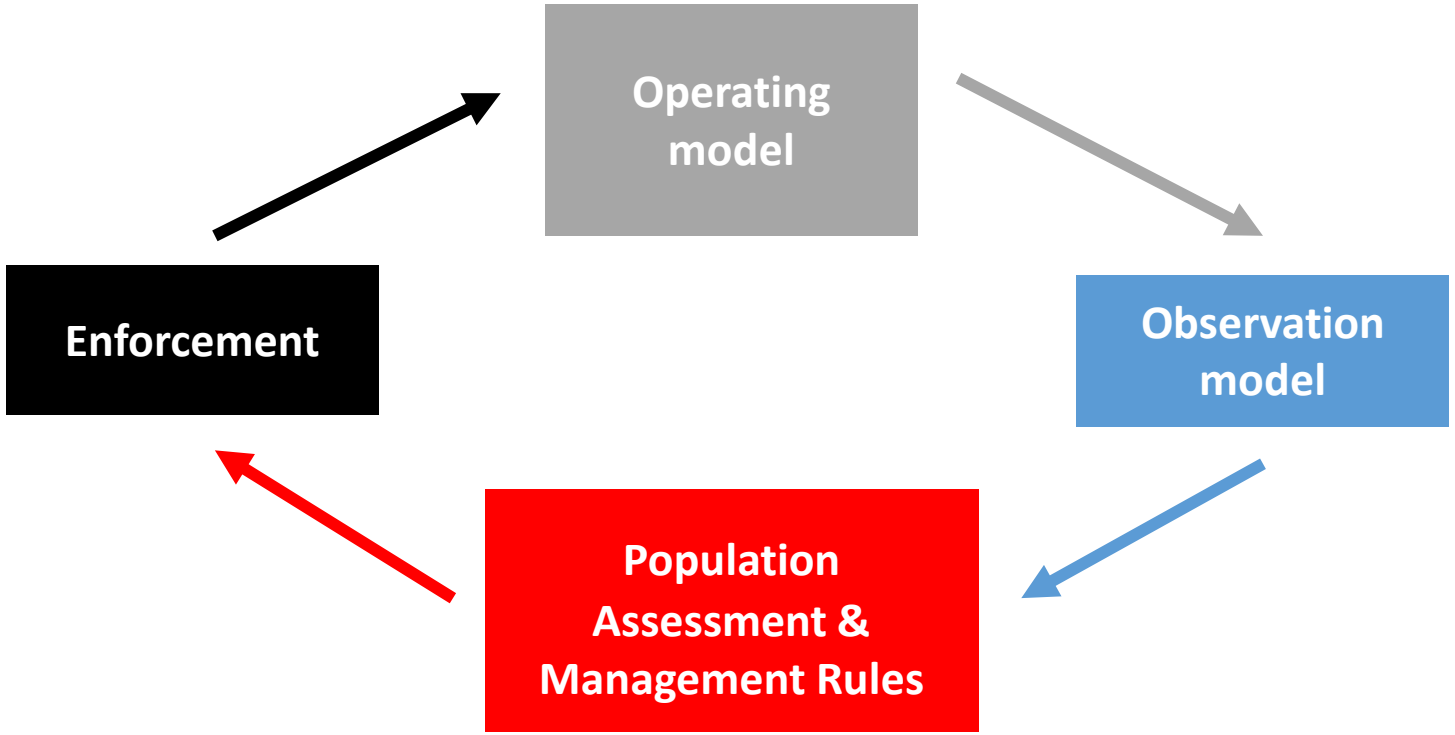

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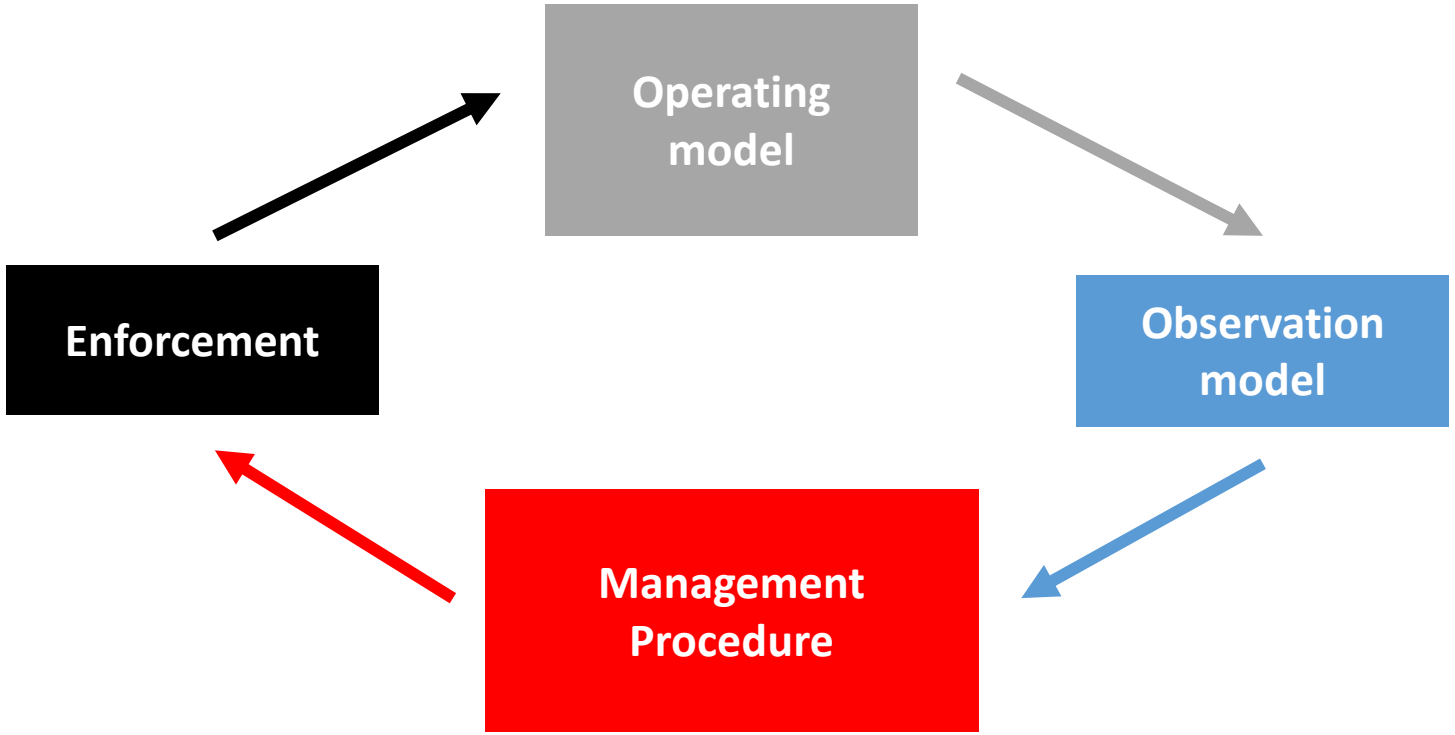

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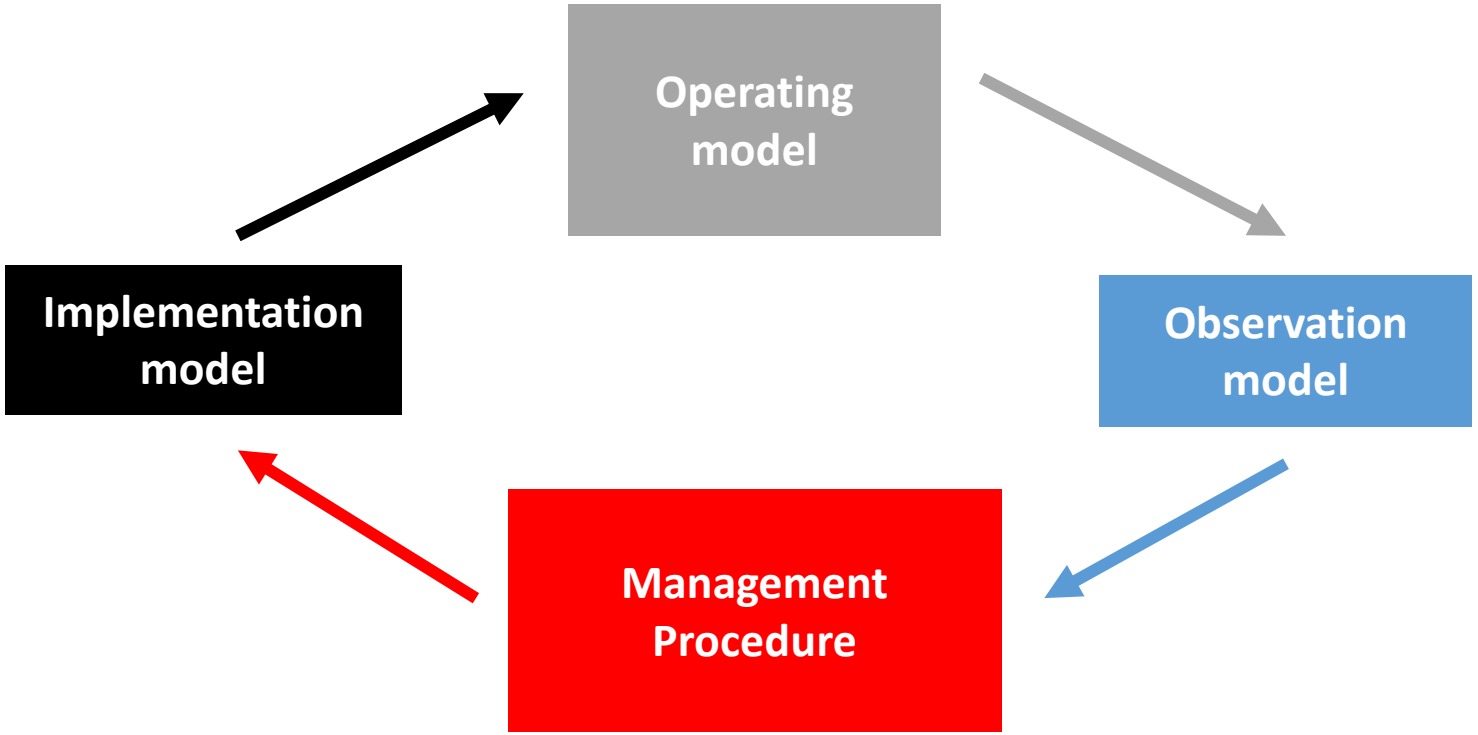

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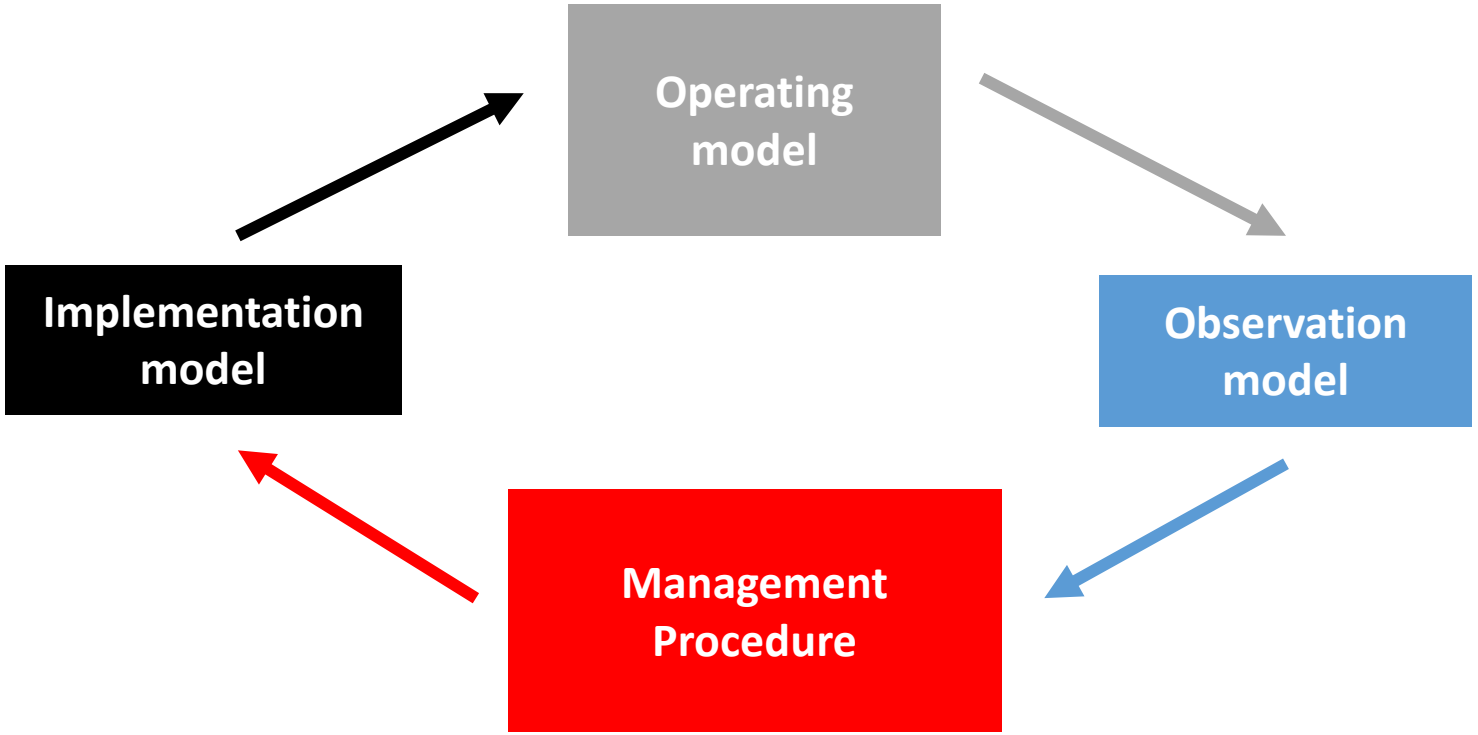
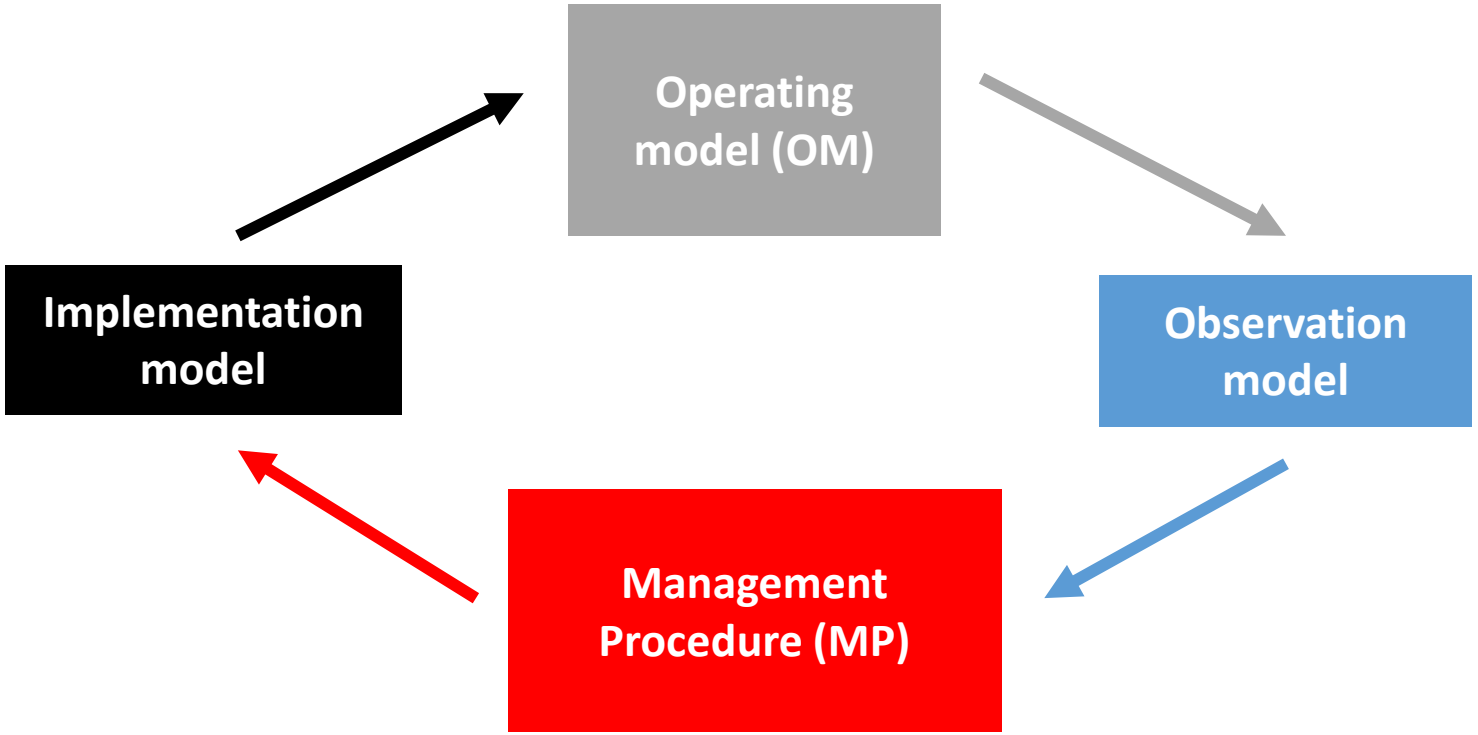


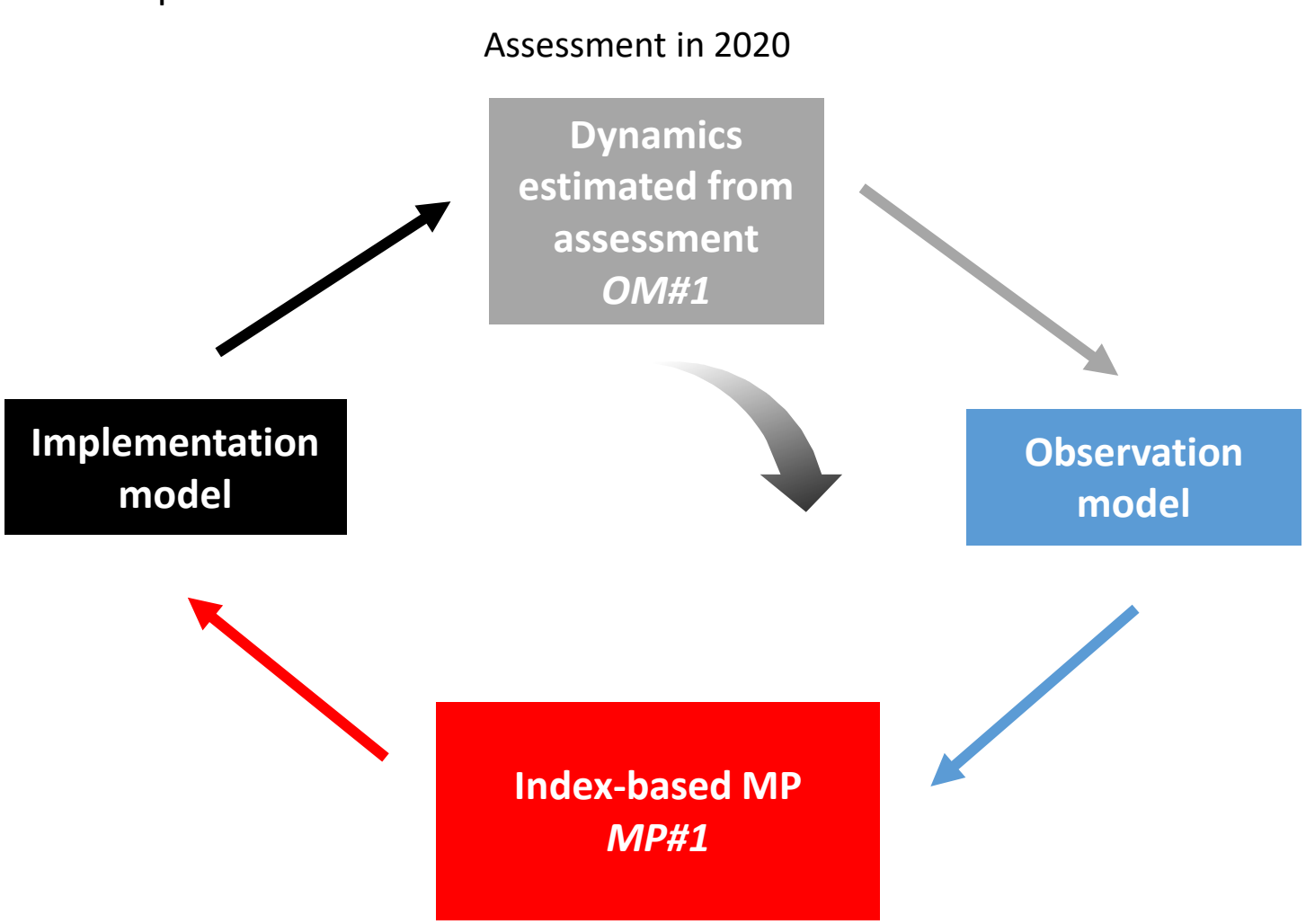
"Harvest strategy"

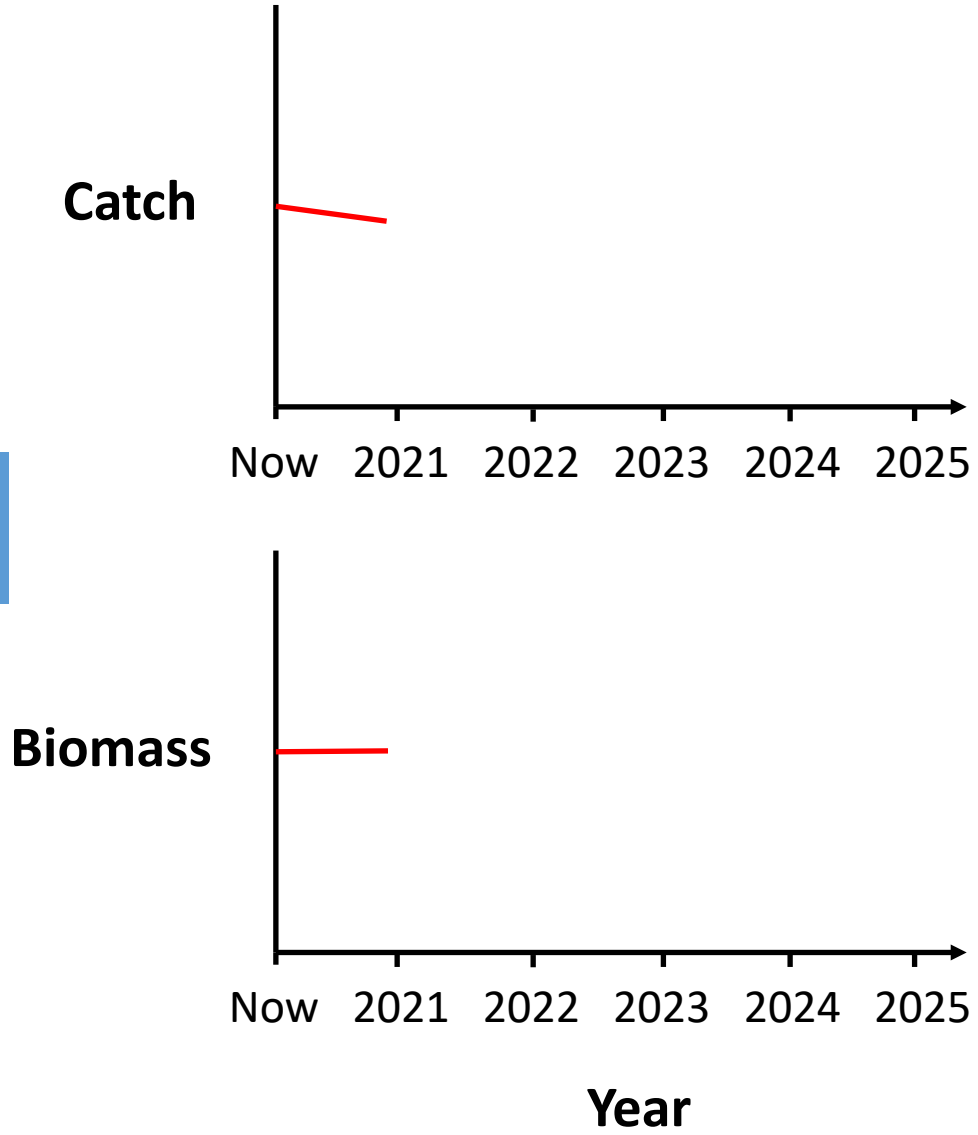
Test by Simulation: the MSE approach



Test by Simulation: the MSE approach

An Example





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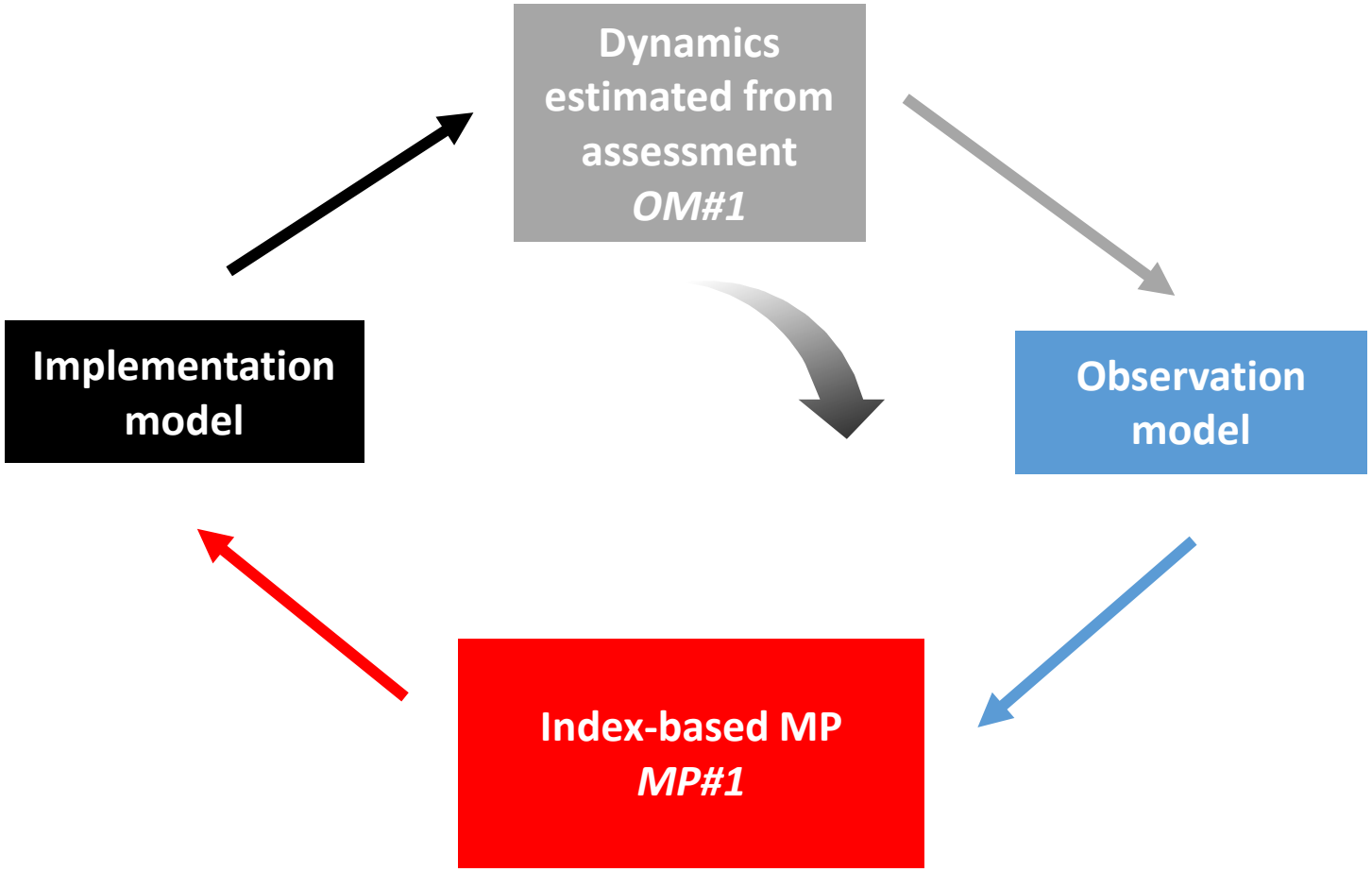

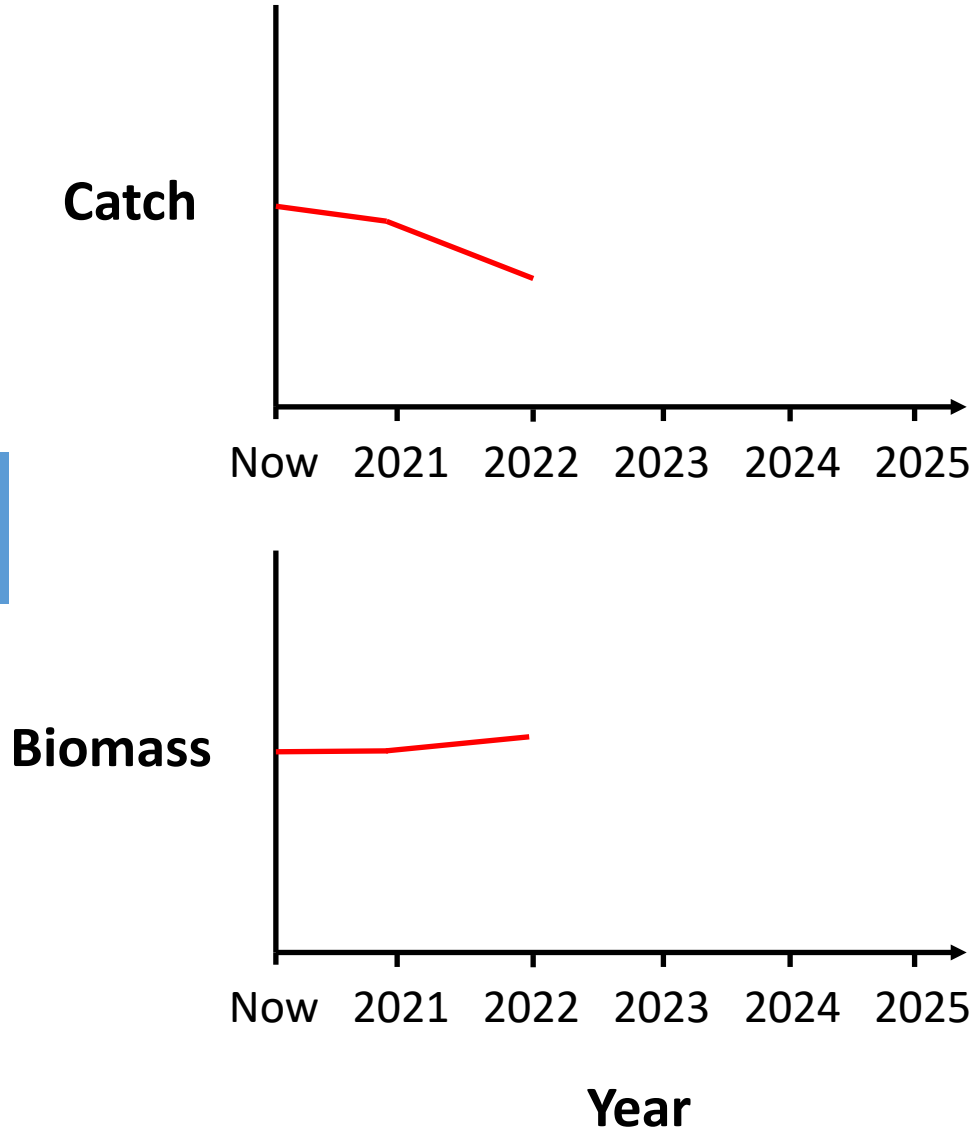

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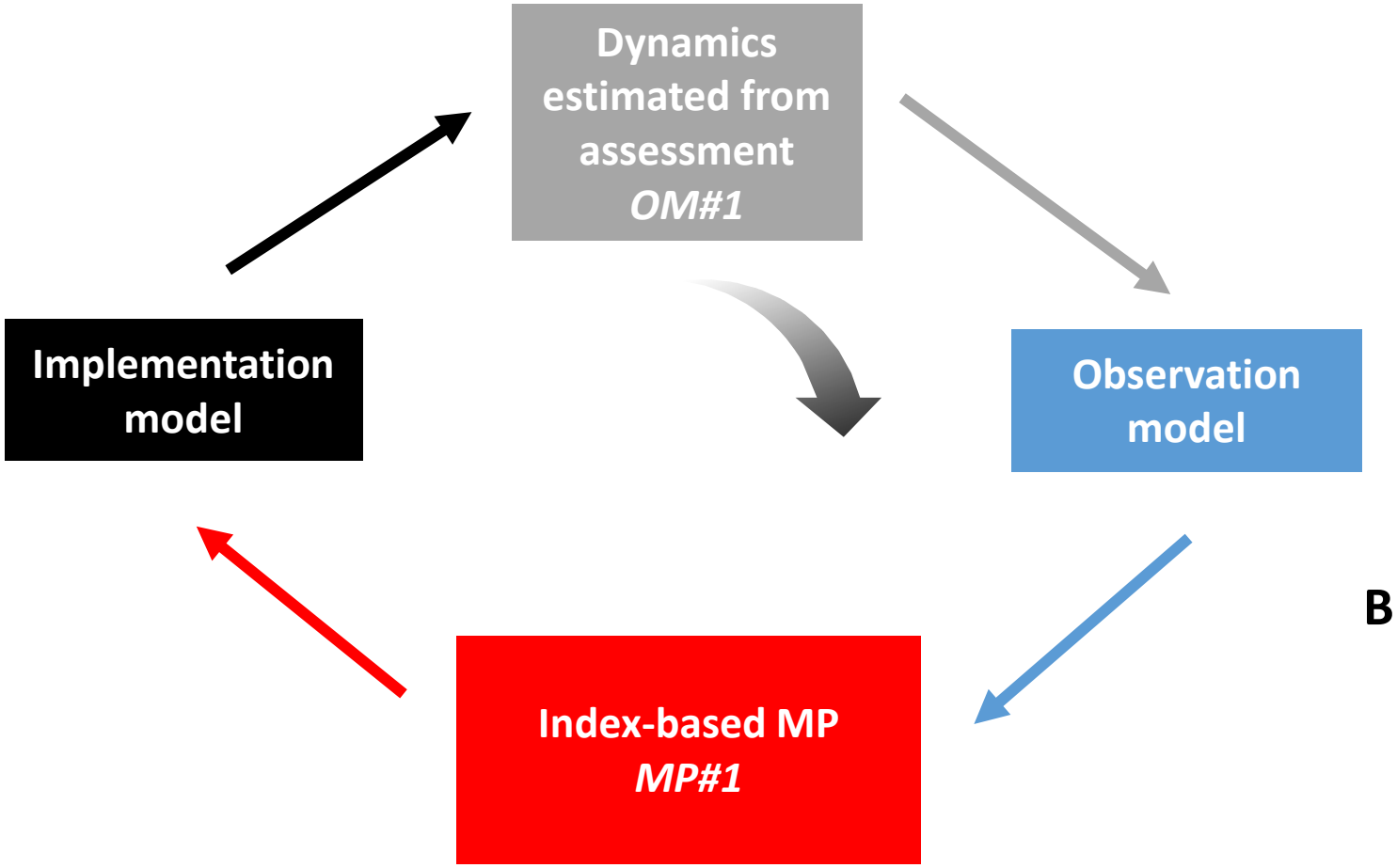

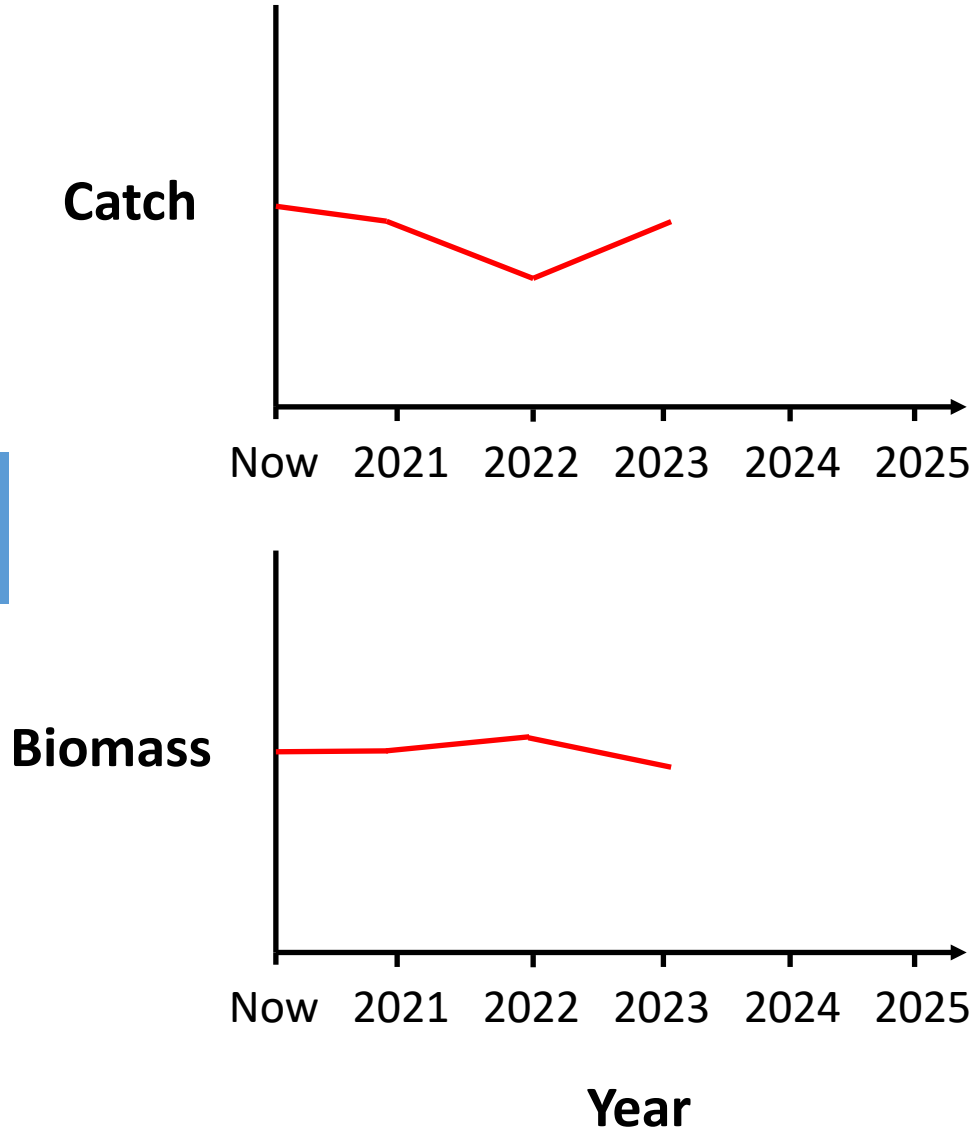

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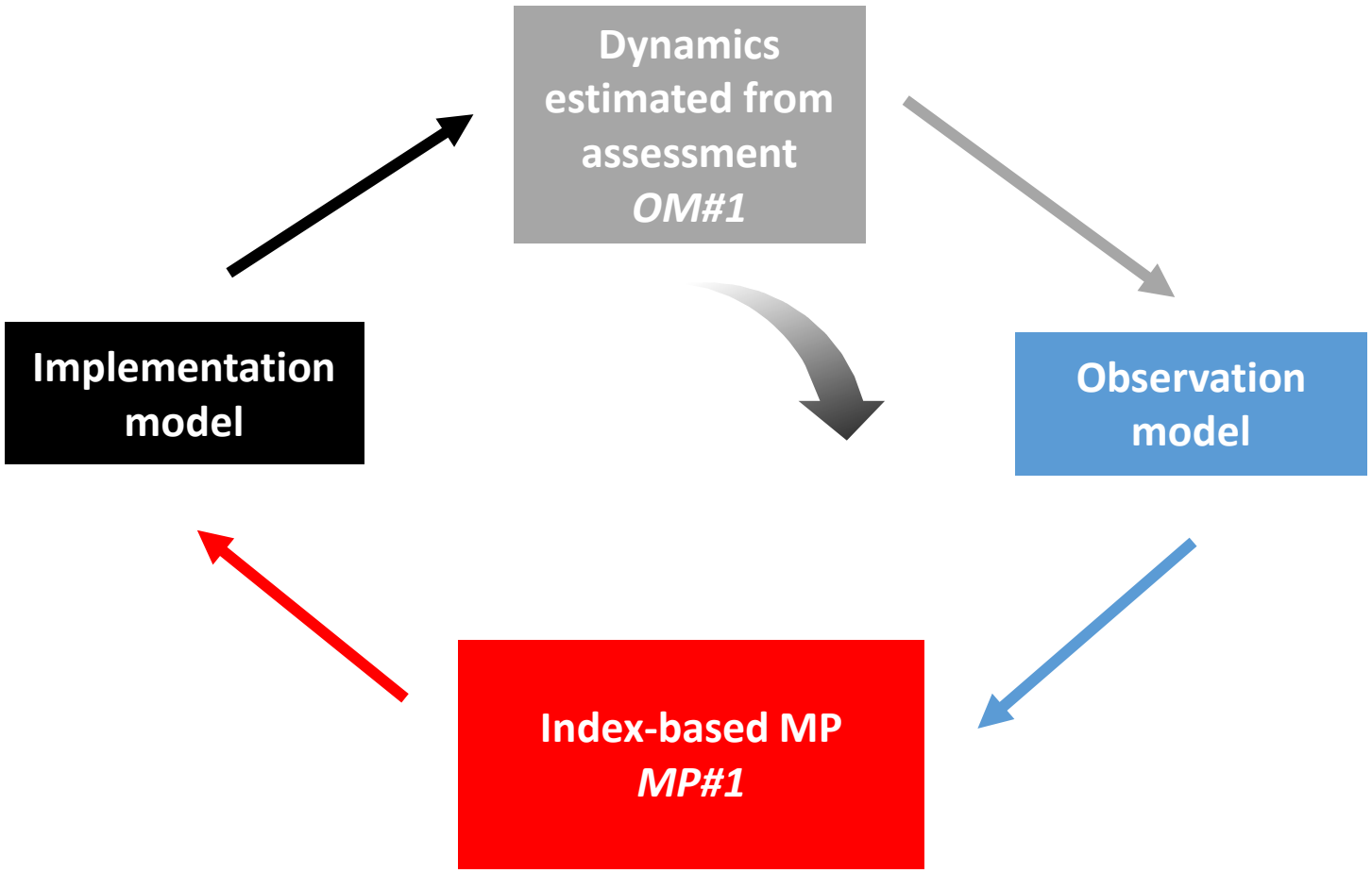

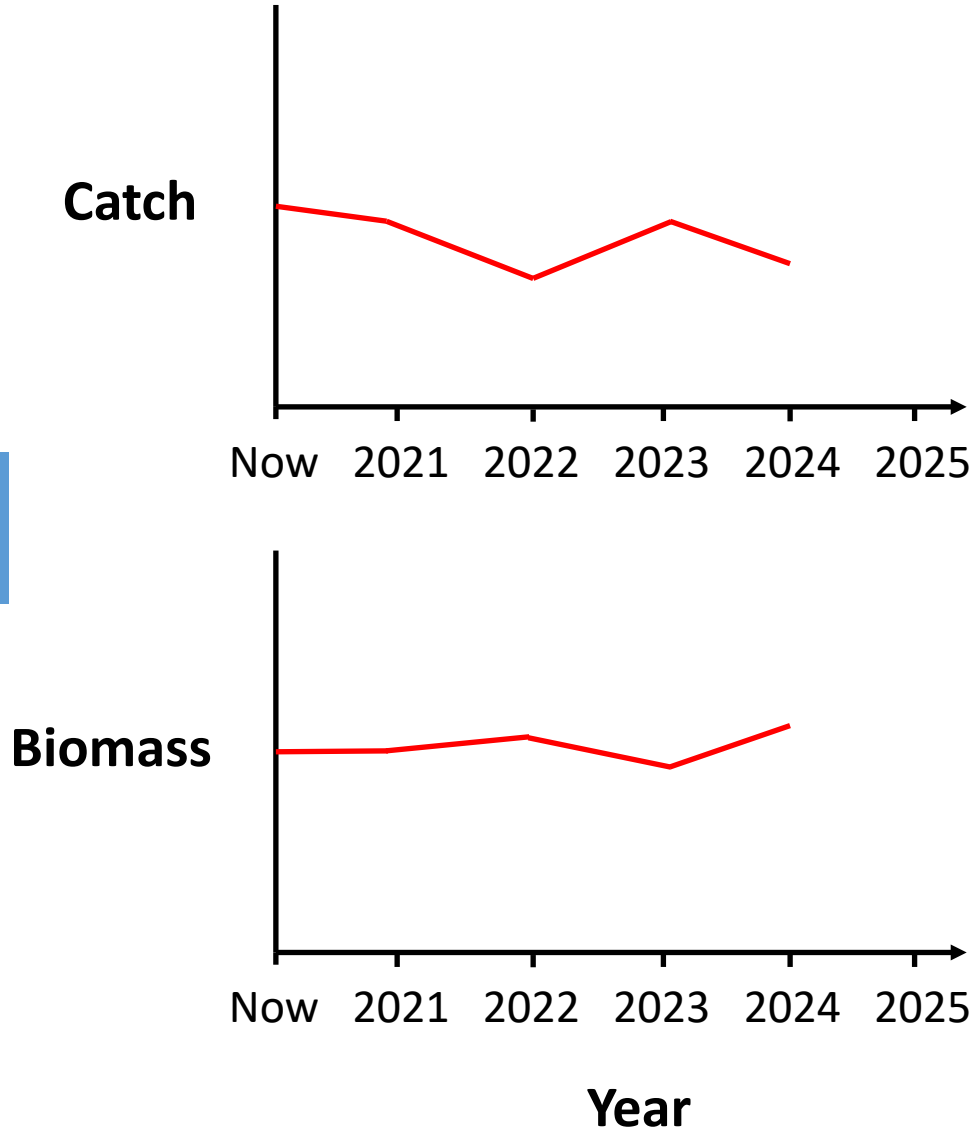

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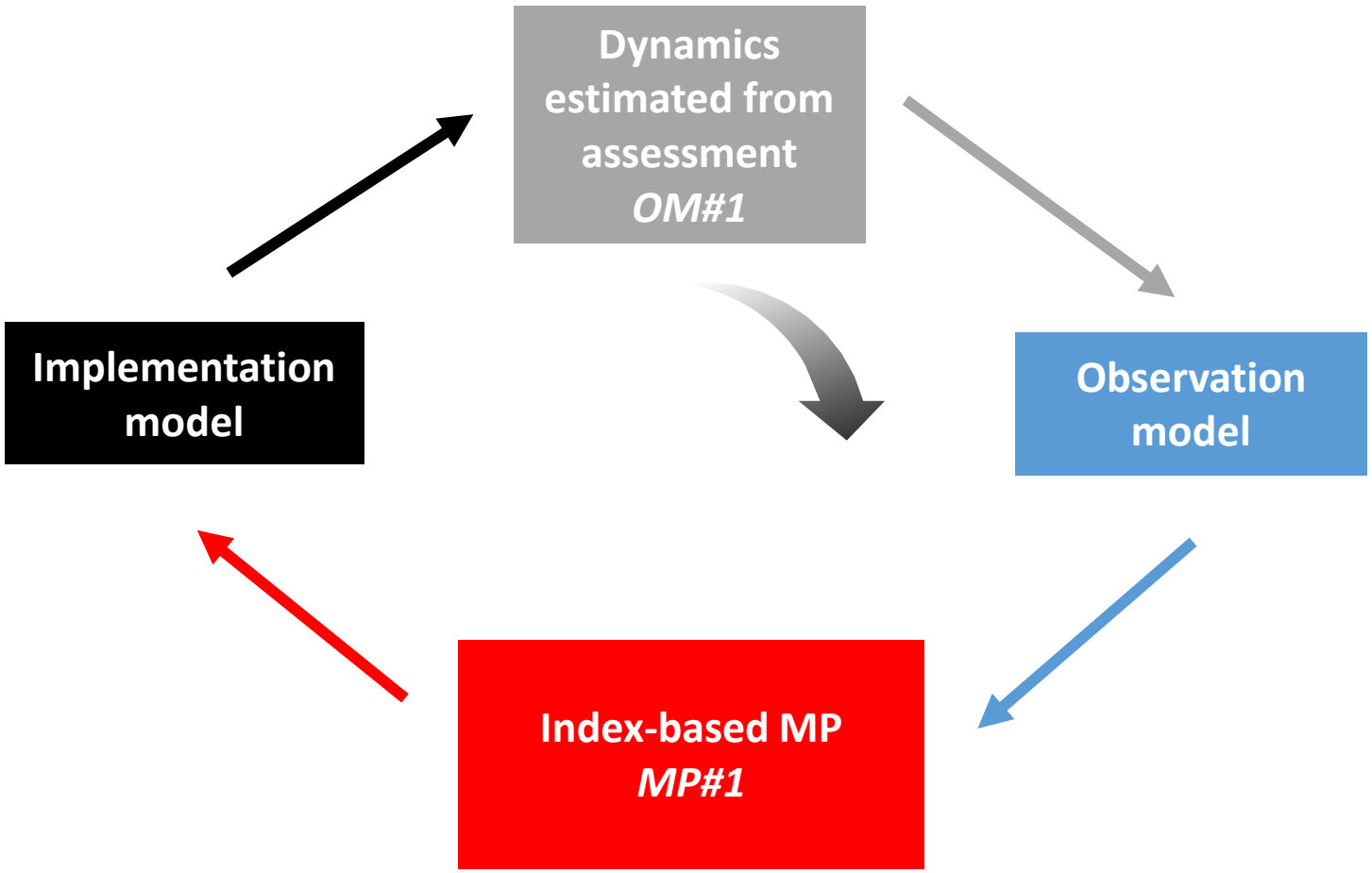

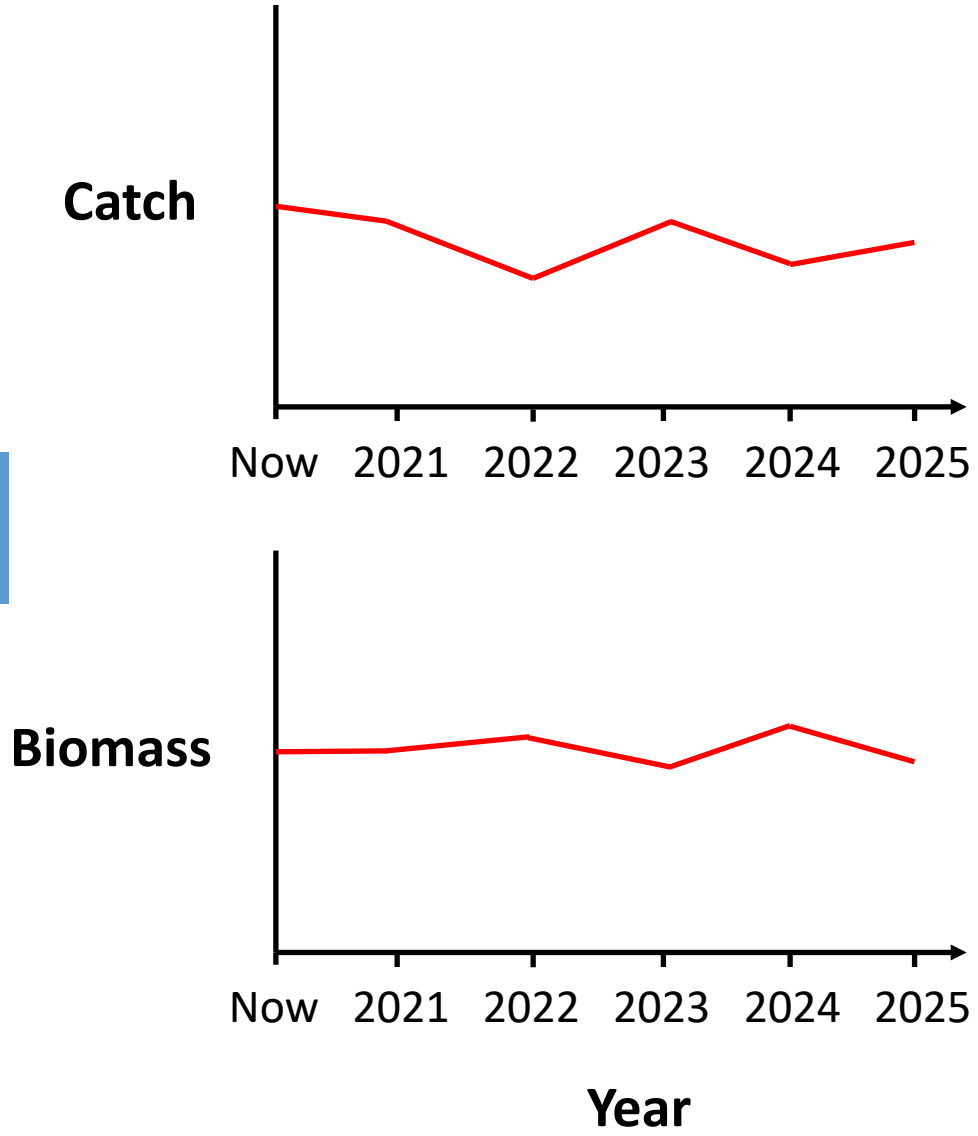

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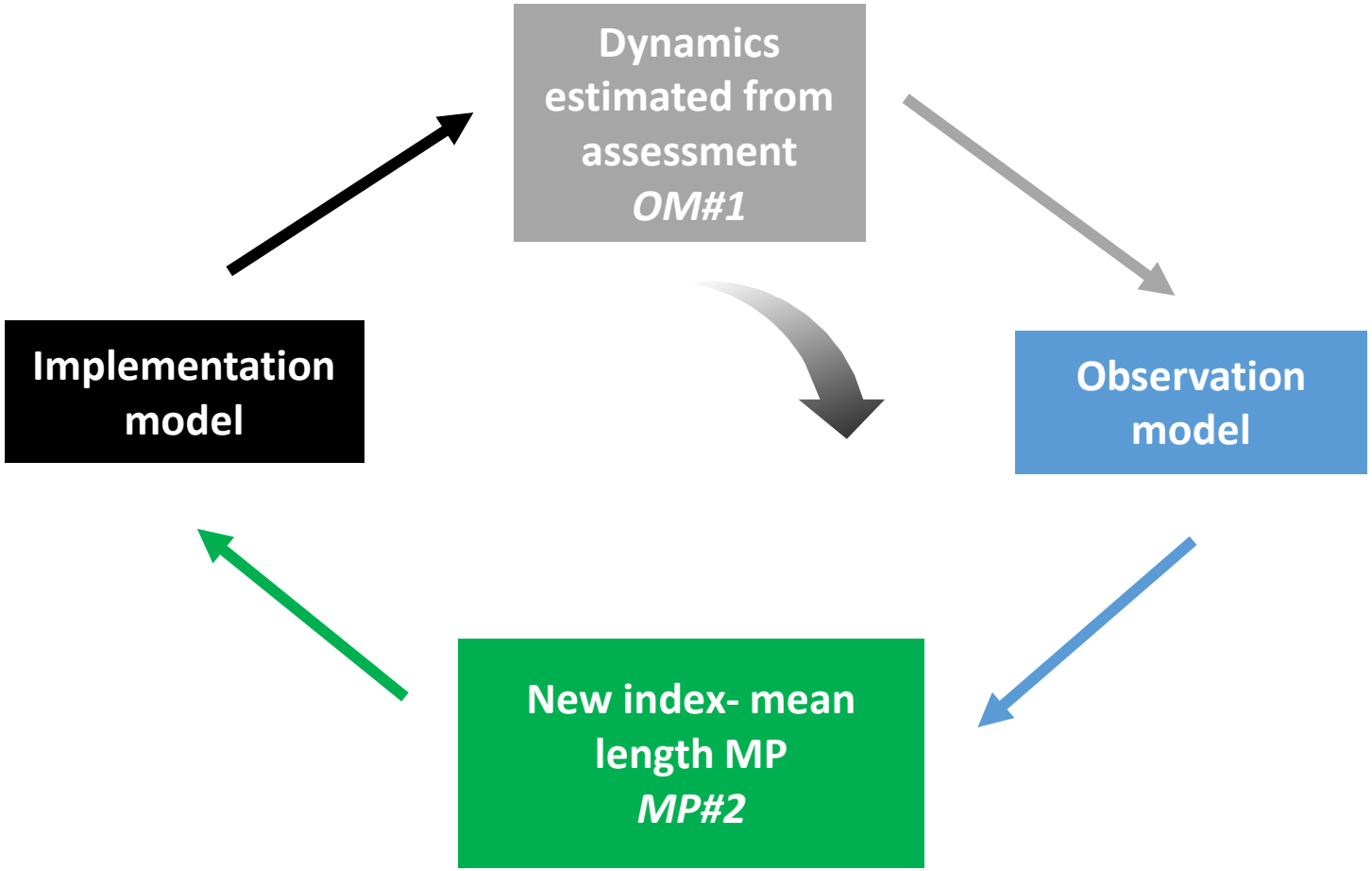
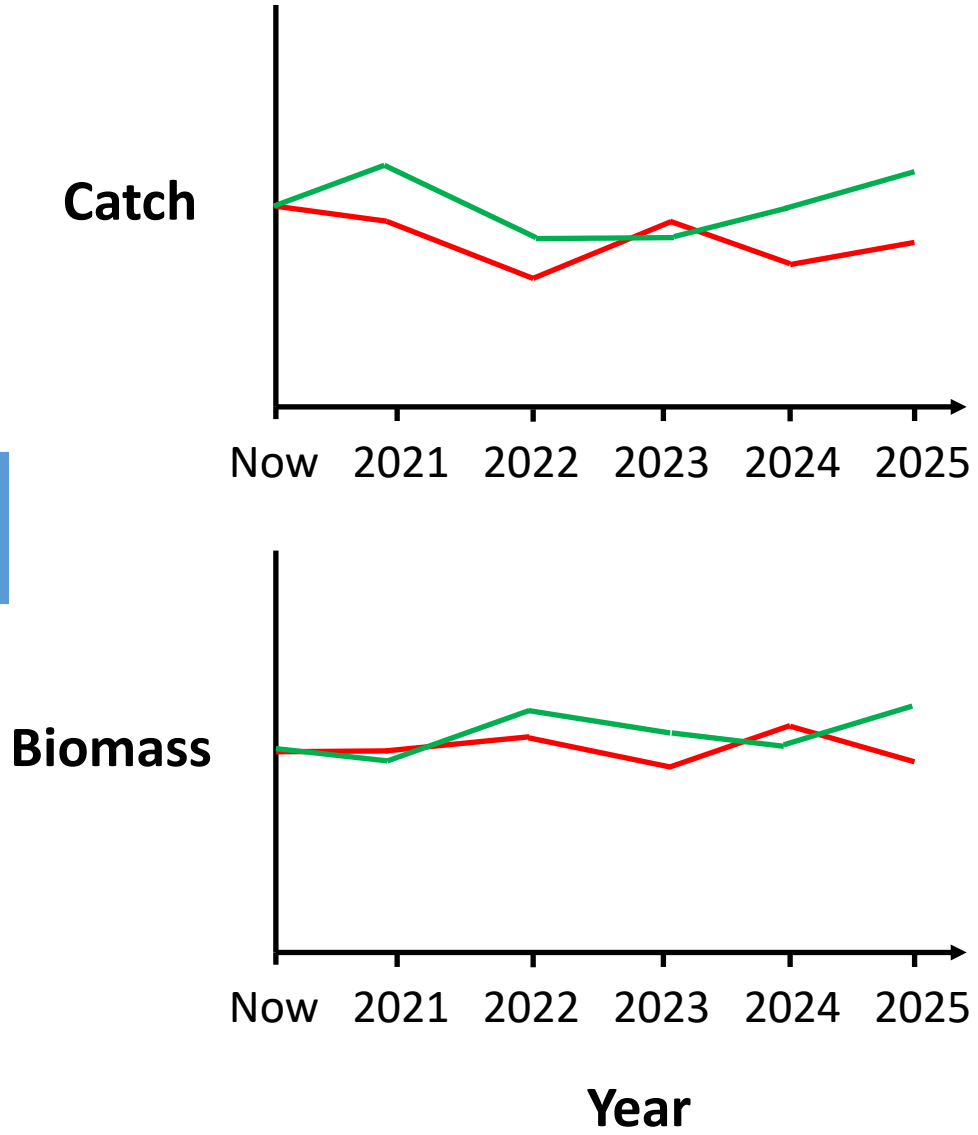


Index-based MP
New index-mean length MP



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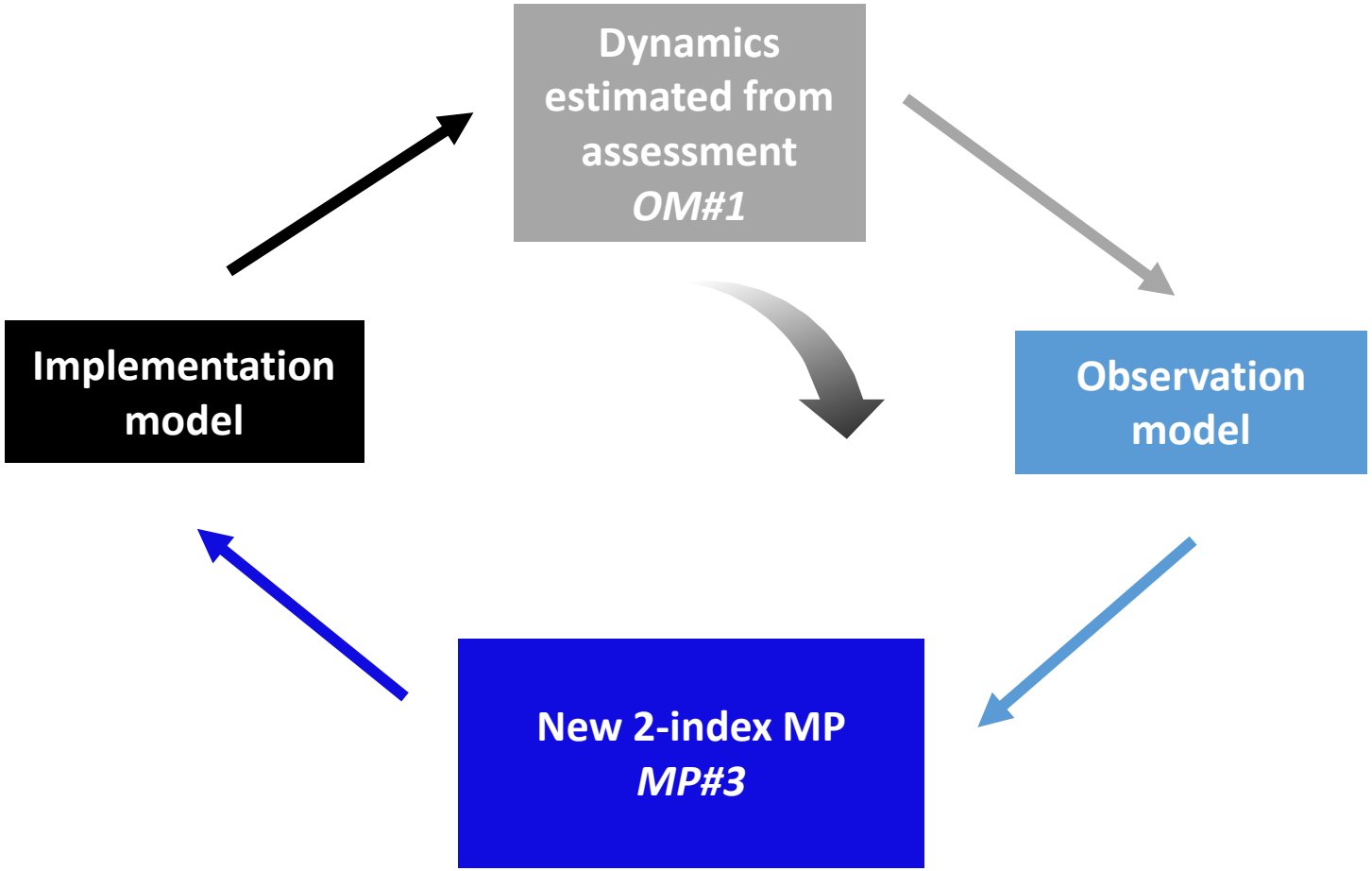
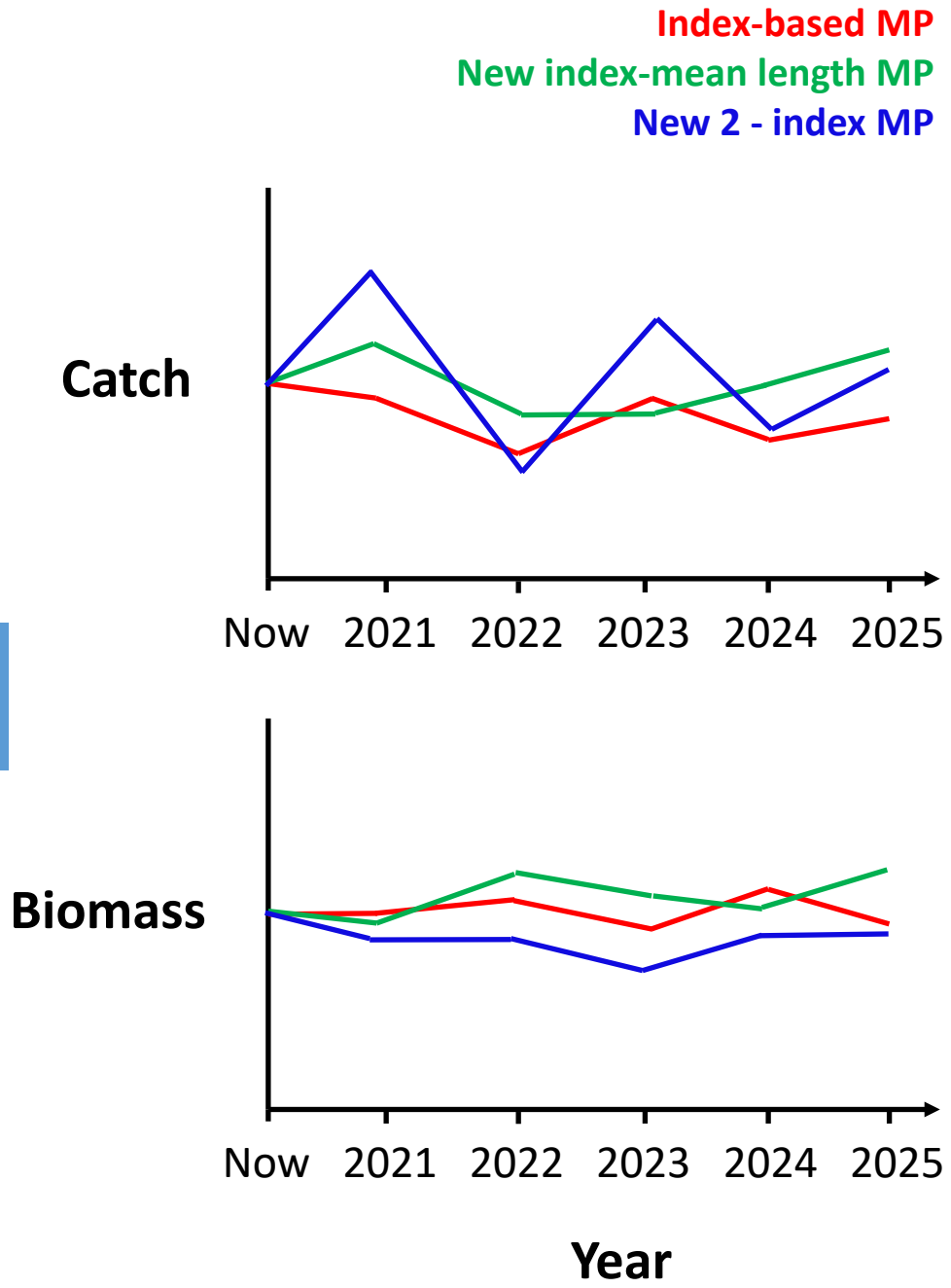
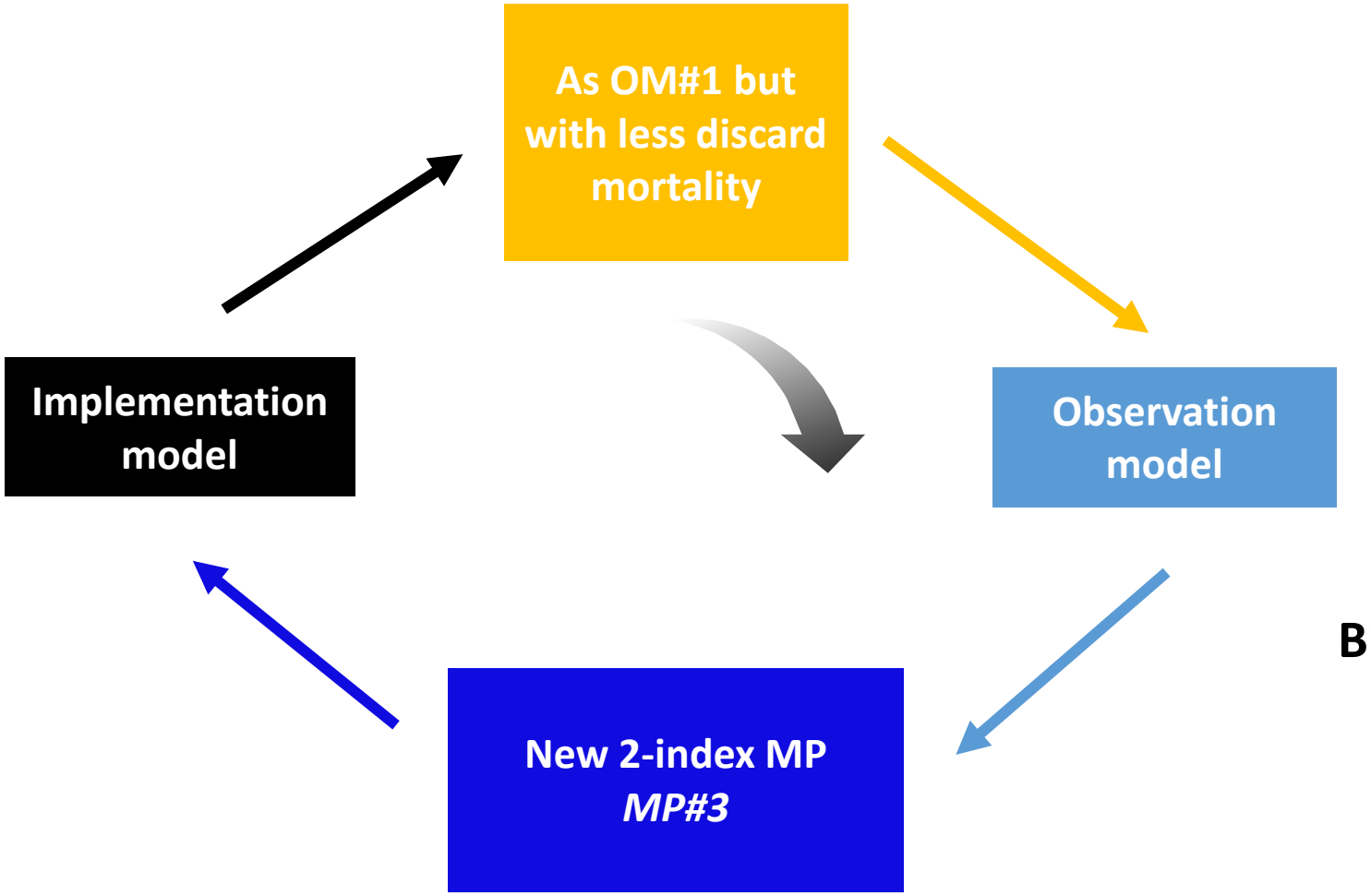




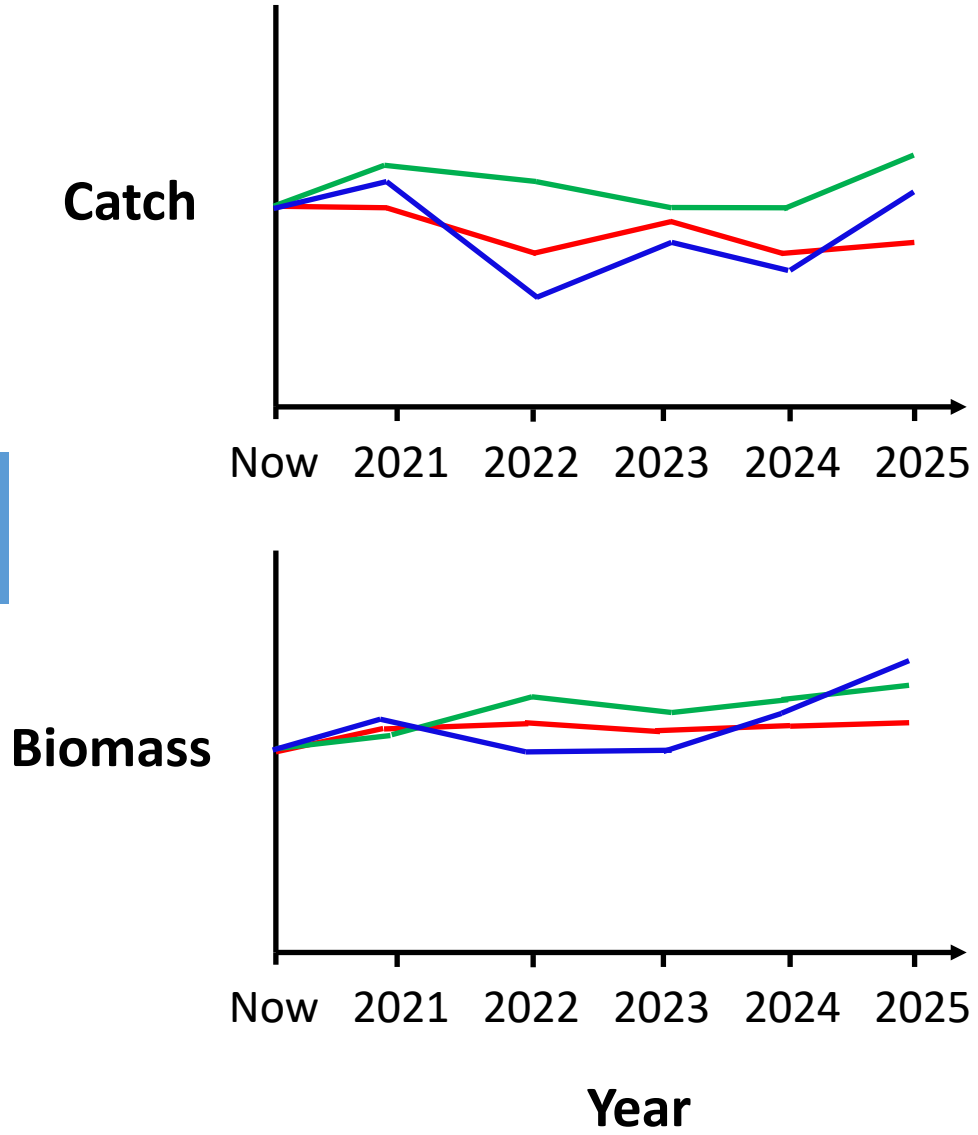
Test by Simulation: the MSE approach

An Example



"Closed-loop simulation"

Index-based MP
New index-mean length MP
New 2 - index MP



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Contrasting Stock Assessment with Management Strategy Evaluation

Stock Assessment

Key Question: What is the current (and historical) state of the fish stock?

- how many fish are in the water (biomass)?
- is the stock over-exploited (reference points)?
- should the management regulations be changed?

Output:

- estimate of key population parameters (scale and productivity)
- current state of the stock relative to reference points
- advice to managers: short-term projections of population state subject to different harvest policies

Contrasting Stock Assessment with Management Strategy Evaluation

Management Strategy Evaluation

Key Question: What *management policy* (management procedure, management strategy) is most appropriate for this fishery?

- what process should be used to convert fishery data into management advice?
- is this process robust to uncertainty?
- under what conditions is this process likely to fail?

Output:

- A *reproducible* and *transparent* process for selecting a *management plan*
- An agreed process (management plan) for going from data to management advice
- Identification of conditions where the management plan requires revision

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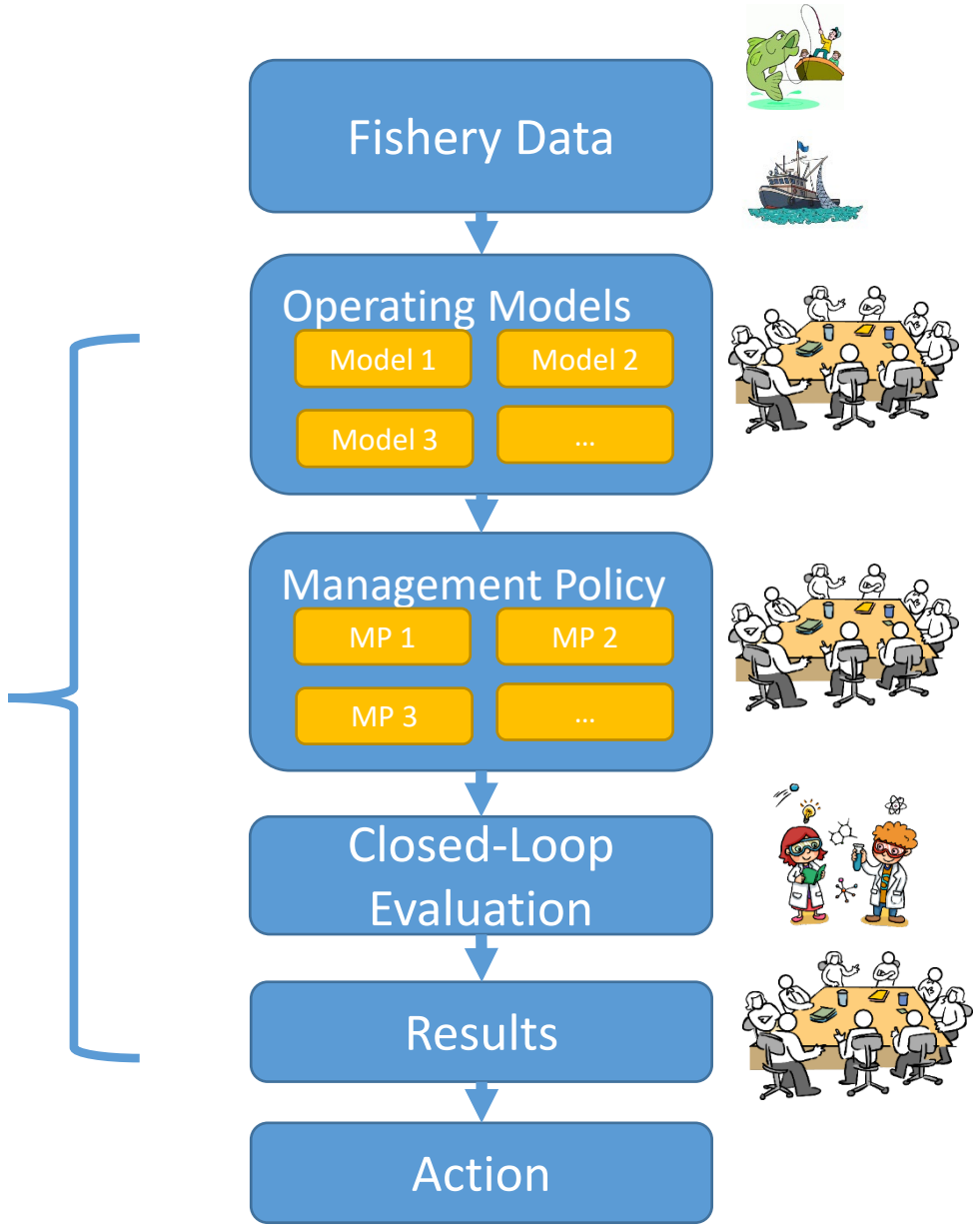
Management Strategy Evaluation

Stakeholder driven process

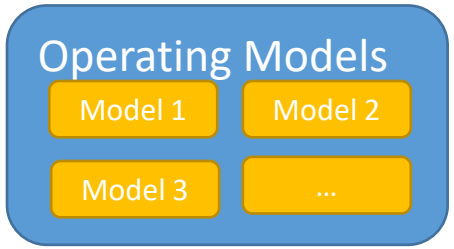


Evaluate the MPs using Closed-Loop Simulation Testing

Quantity and compare the performance of the MPs

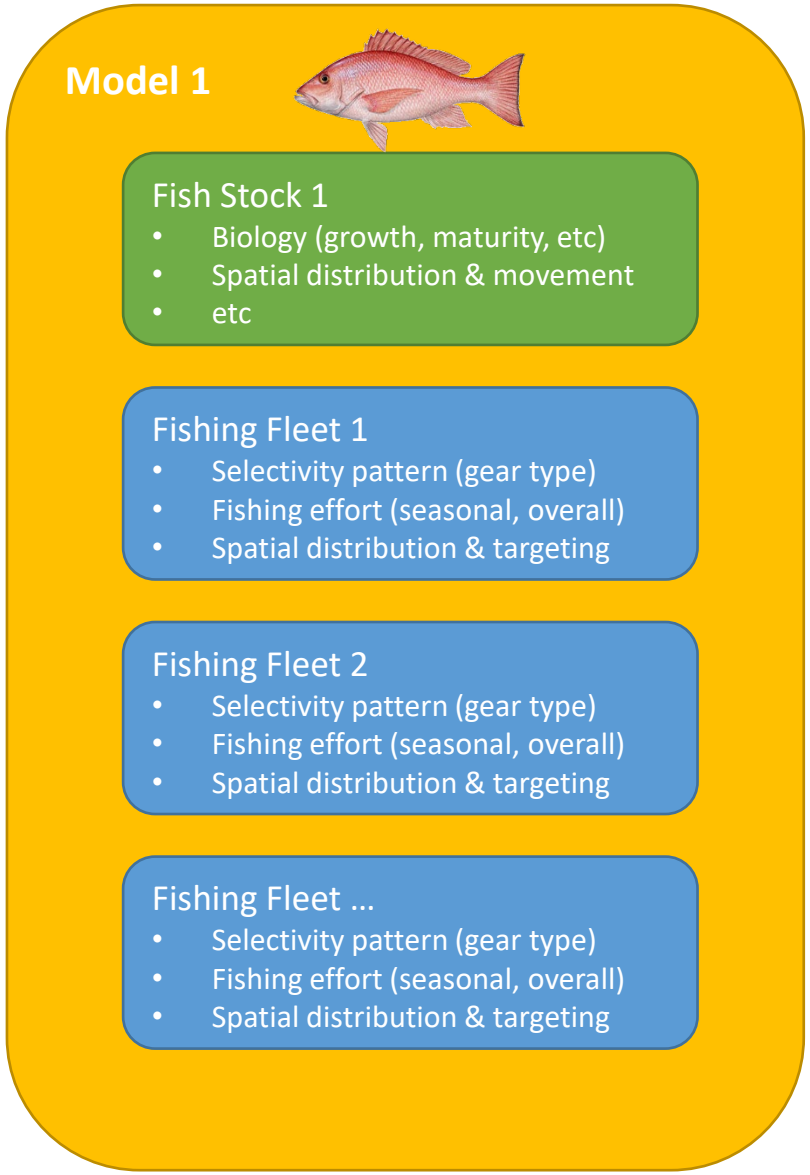
Select the best performing MP and adopt for managing the fishery

The MSE Process: Operating Models



A *plausible* description of the properties of the fishery system:

- stock (biology)
- exploitation (fishing activities)



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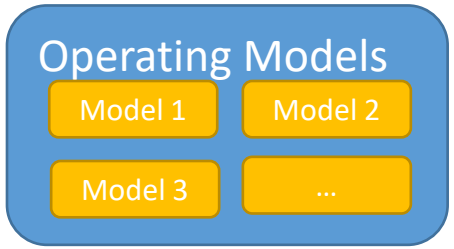
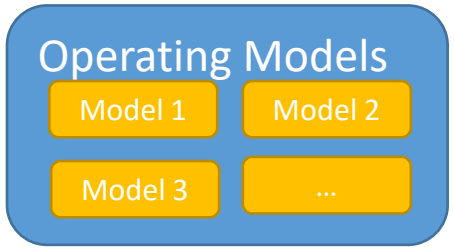


Multi-Species

Interactions:

- Spatial over-lap
- Preferential targeting
- How will management regulations for one stock affect the other?

The MSE Process: Operating Models



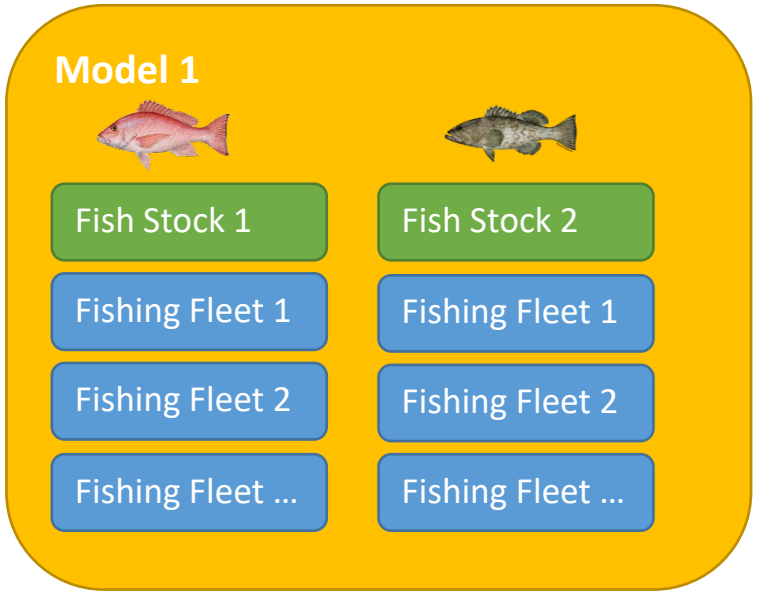
Uncertainties

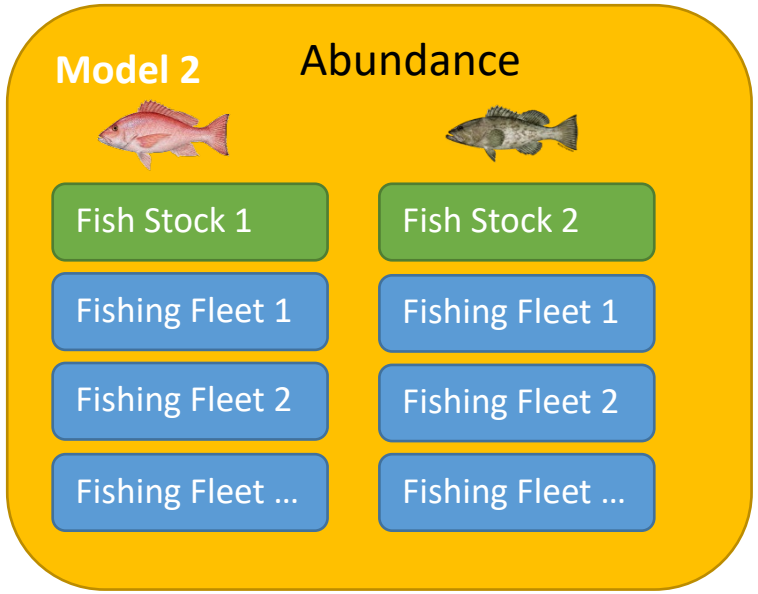
Stock characteristics:

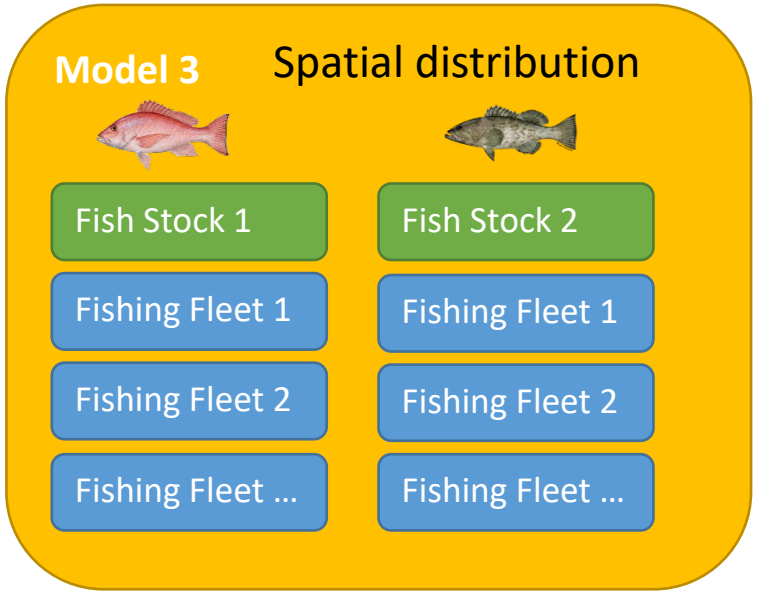
- Biological parameters?
- Spatial distribution & movement?
- Abundance?
- Discard mortality?

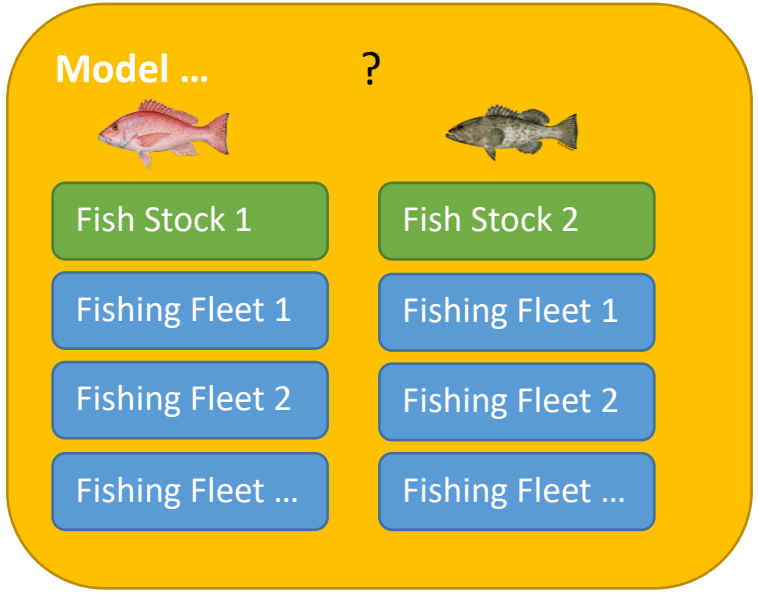
Fleet characteristics:

- Selectivity pattern?
- Fishing effort?
- Spatial distribution?





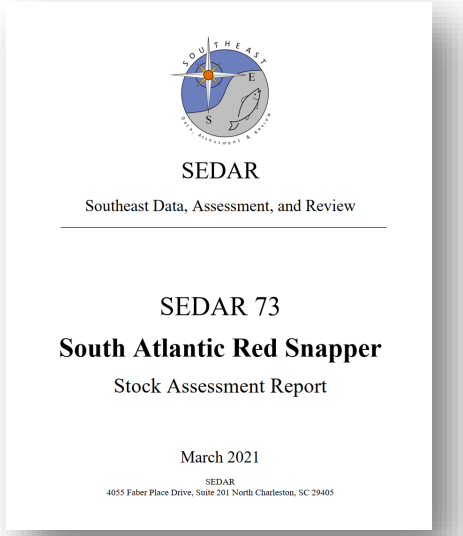




The MSE Process: Operating Models

Building the Operating Models

Model 1


SEDAR

Southeast Data, Assessment, and Review

SEDAR 73

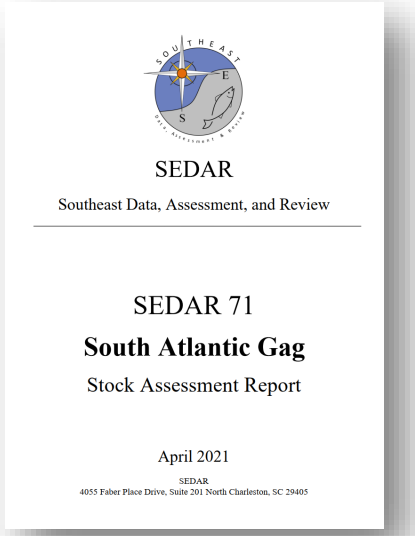
South Atlantic Red Snapper

Stock Assessment Report

March 2021

SEDAR
4055 Faber Place Drive, Suite 201 North Charleston, SC 29405

- Fish Stock 1: Red Snapper
- Fishing Fleet 1: Commercial handline
- Fishing Fleet 2: Recreational headboats
- Fishing Fleet 3: General recreational


SEDAR

Southeast Data, Assessment, and Review

SEDAR 71

South Atlantic Gag

Stock Assessment Report

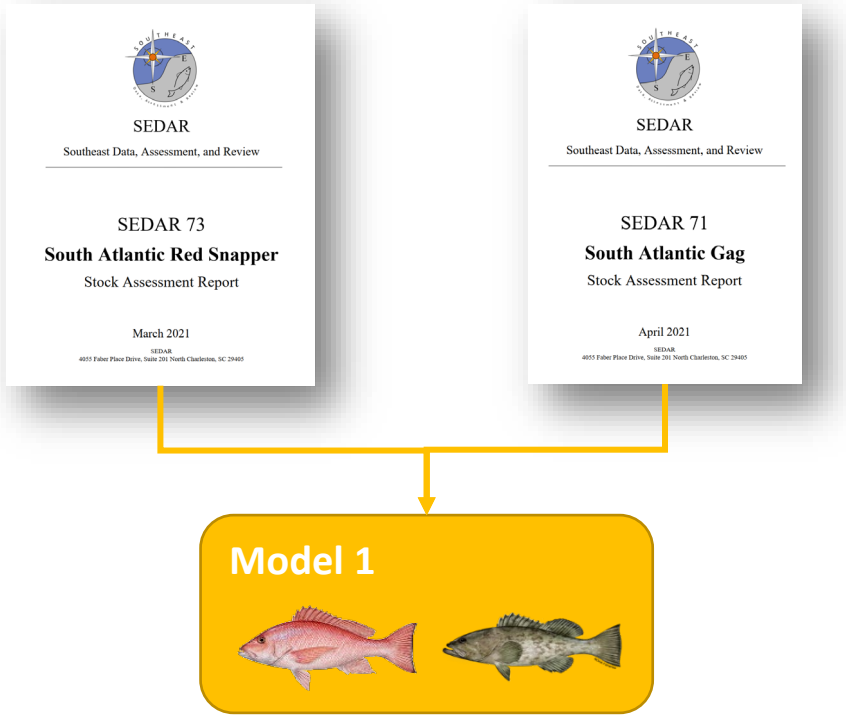
April 2021

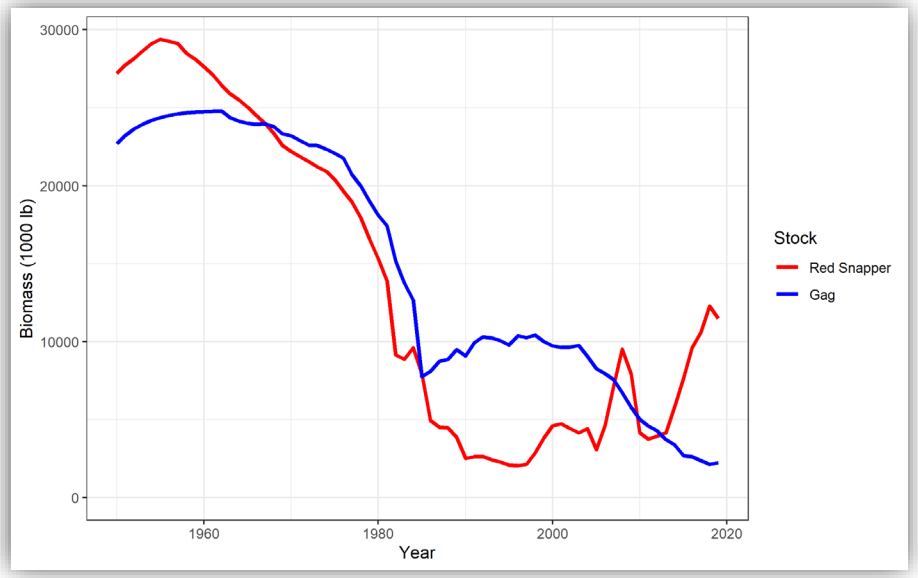
SEDAR
4055 Faber Place Drive, Suite 201 North Charleston, SC 29405

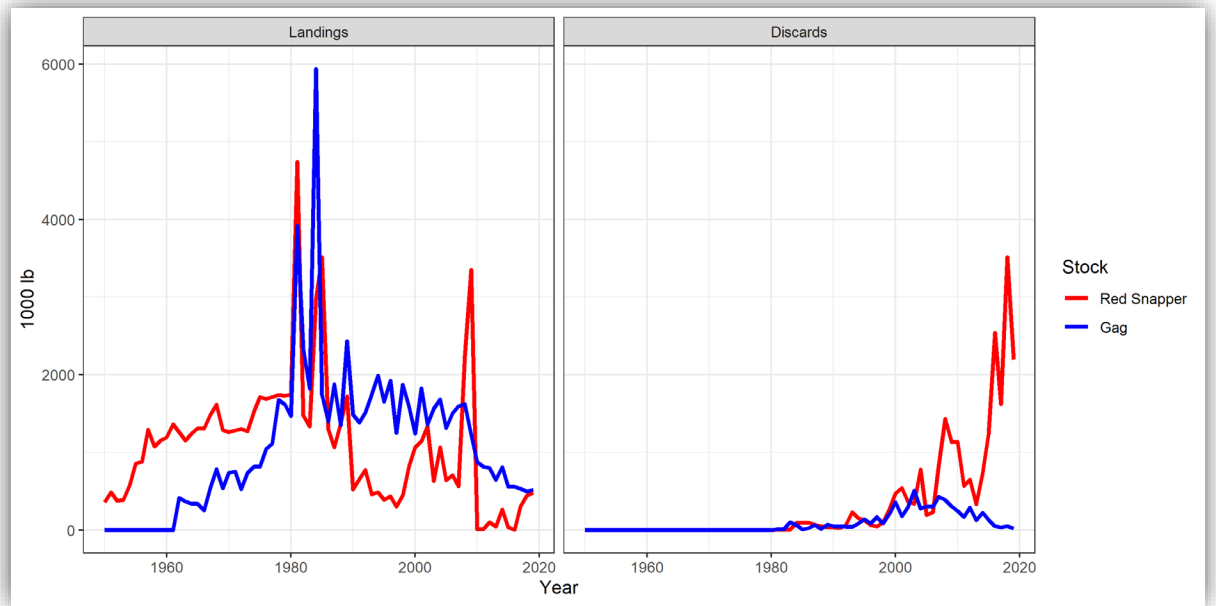
- Fish Stock 2: Gag Grouper
- Fishing Fleet 1: Commercial handline
- Fishing Fleet 2: Commercial diving
- Fishing Fleet 3: Recreational headboats
- Fishing Fleet 4: General recreational

The MSE Process: Operating Models

Building the Operating Models







The MSE Process: Operating Models

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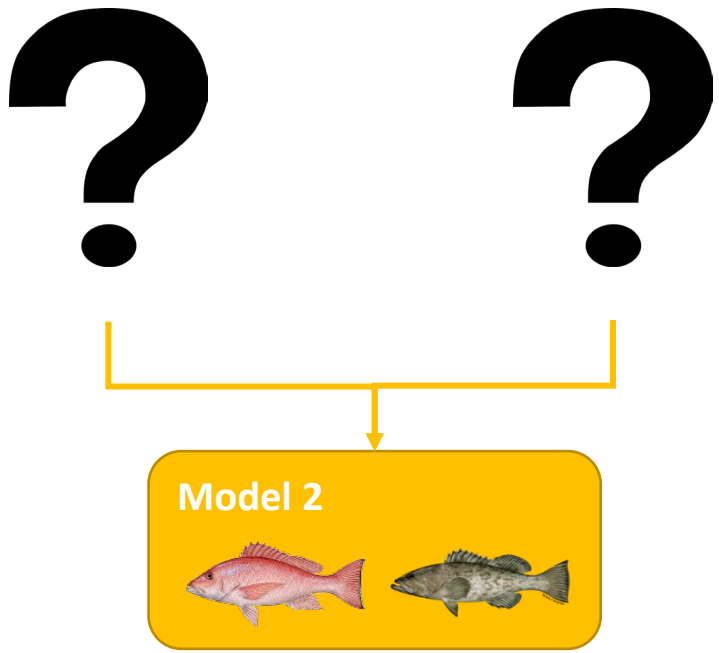
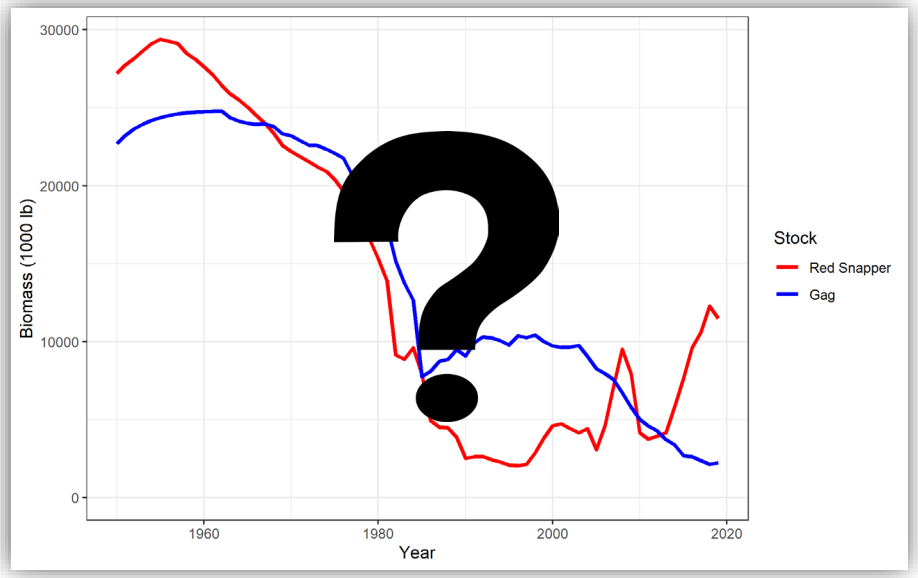
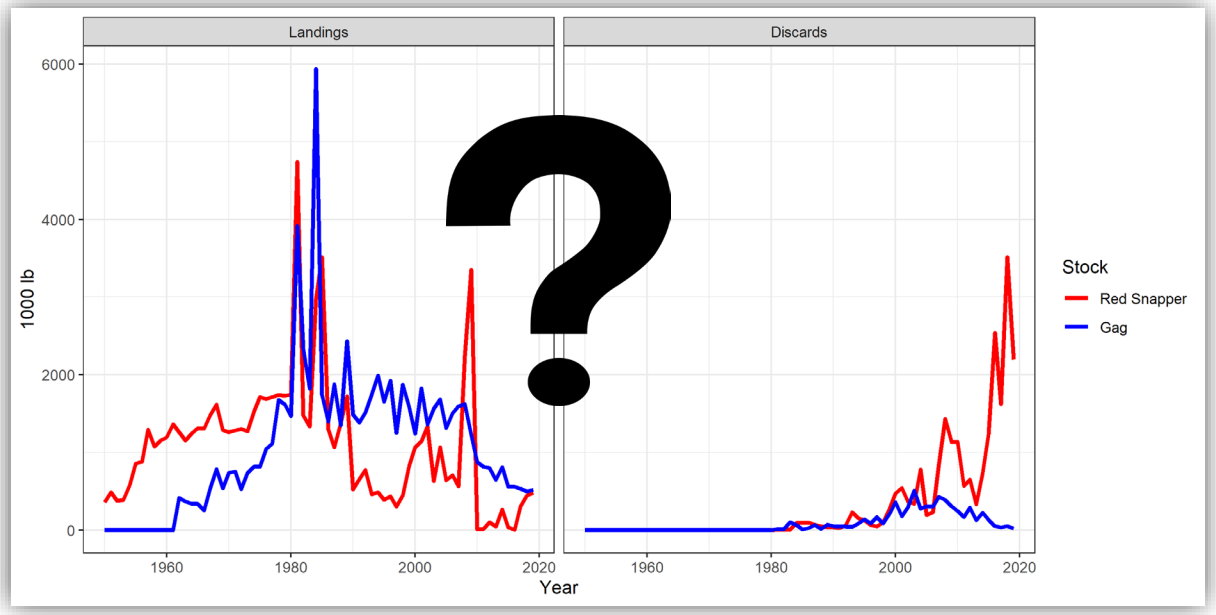
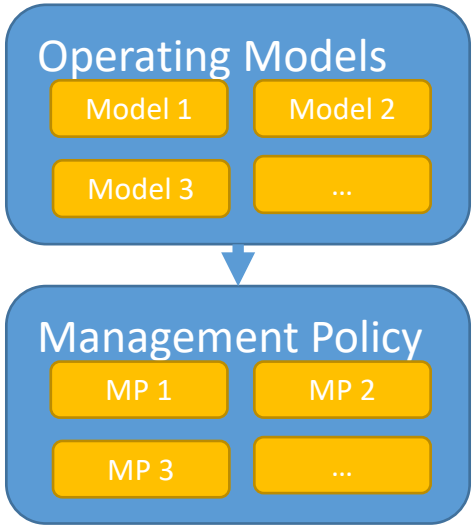


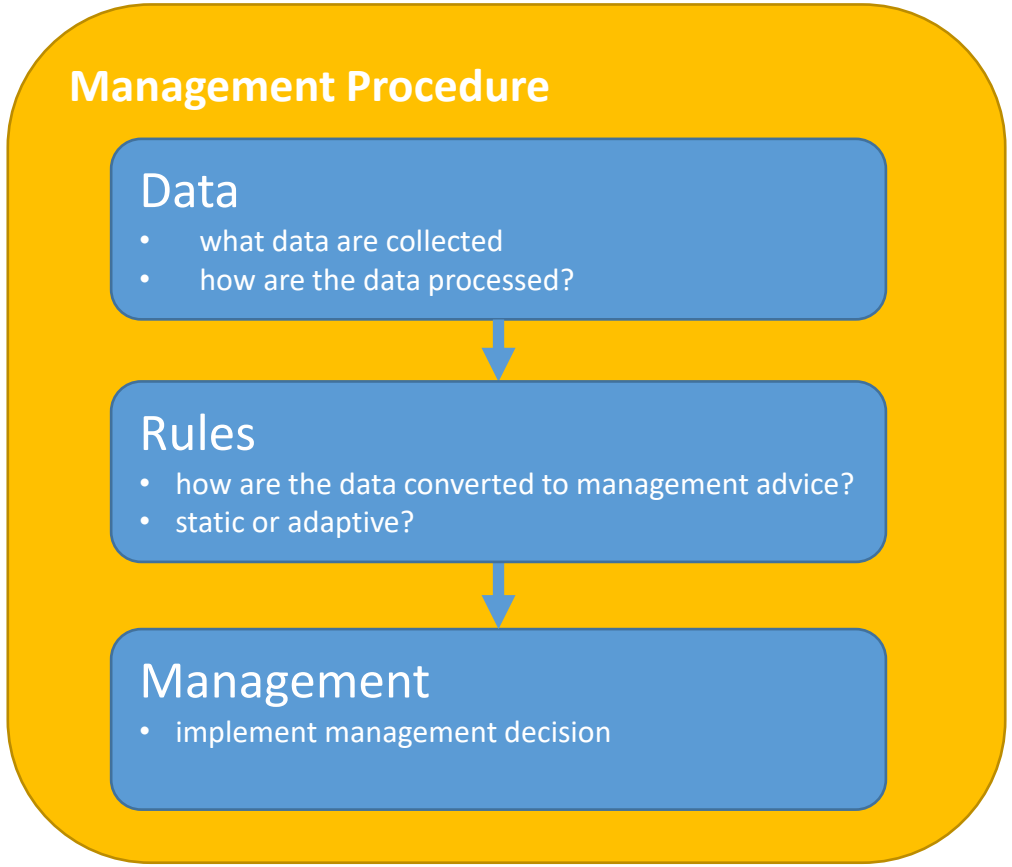




The MSE Process: Management Procedures



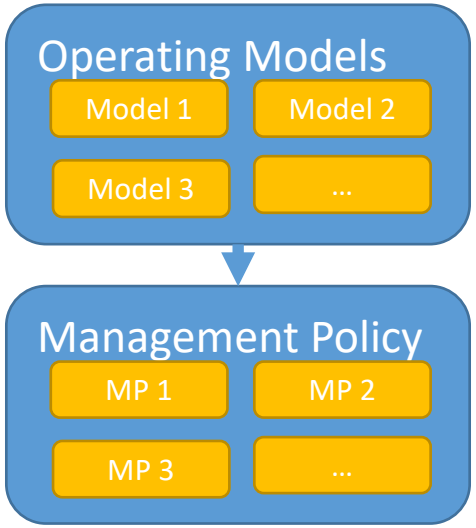
Management Procedure: A process for going from data to a management decision



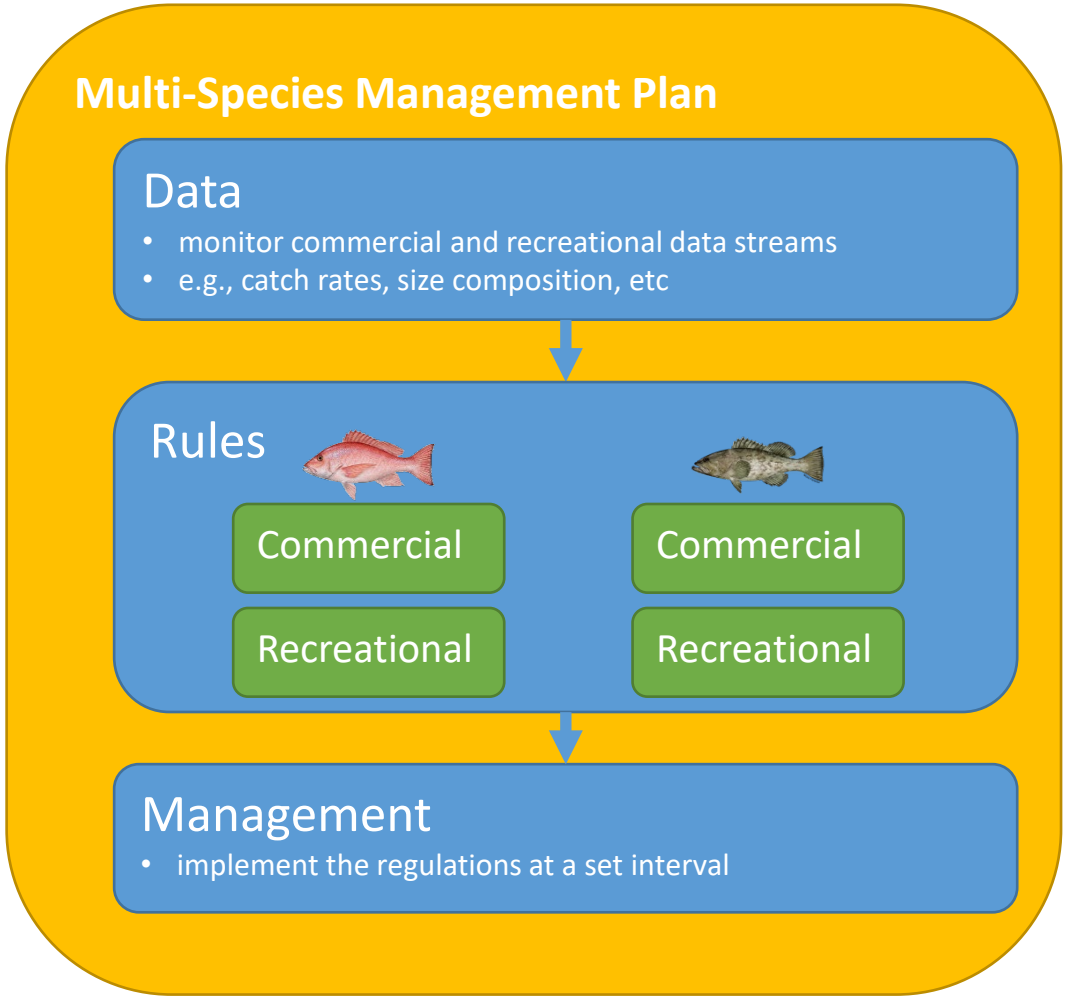
How is this different to the traditional approach?

1. reproducible (different people, same result)
2. agreed upon (no haggling)
3. simulation tested (some confidence the approach will achieve the objectives)

The MSE Process: Management Procedures



Multi-species and Multi-gear General Example: Commercial and Recreational

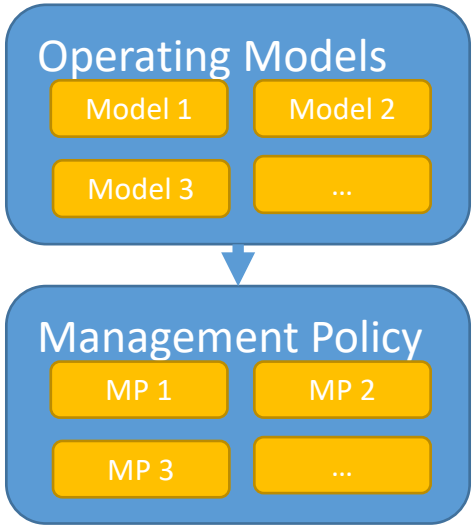


Management Controls:

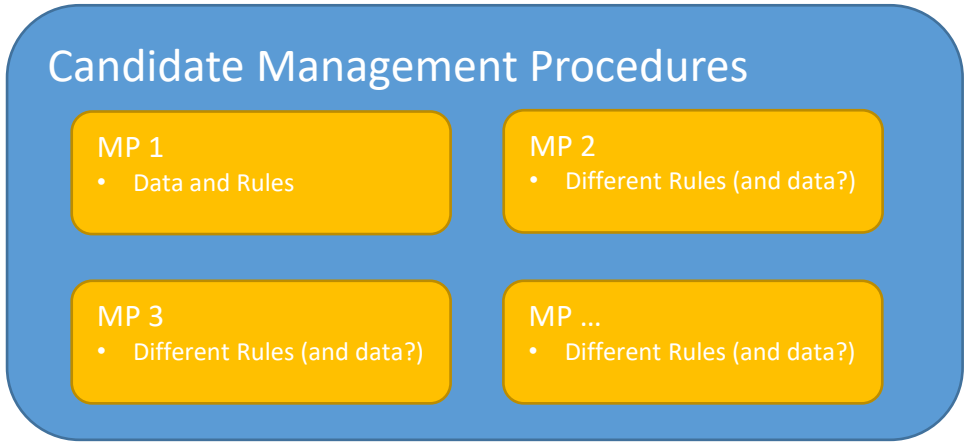
Any combination of:

1. spatial closures
2. seasonal closures
3. size limits
4. bag limits
5. total effort limits
6. total catch limits

The MSE Process: Management Procedures



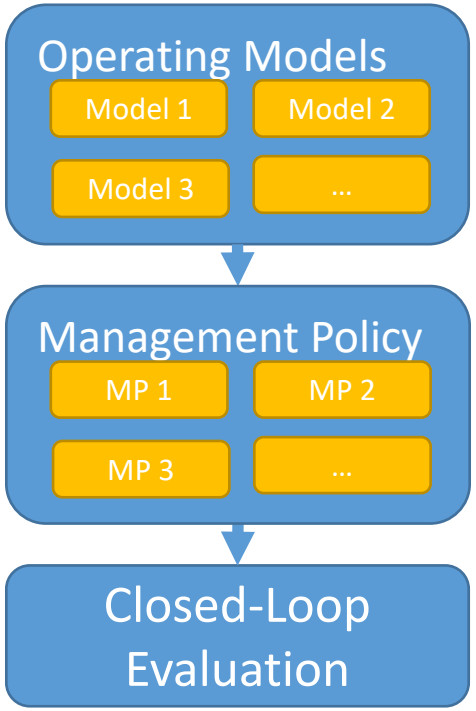
Candidate Management Procedures



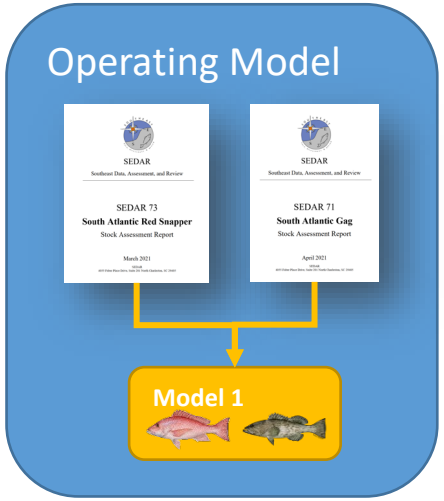
Questions:

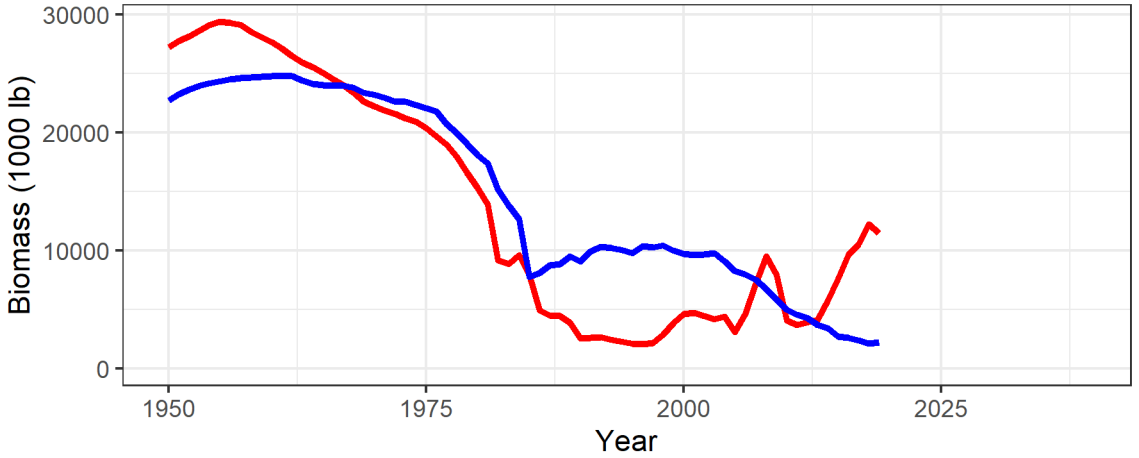
- What data can be used to inform management?
- Feasible management options?
  - by gear type?
  - by stock?
- Management update cycle?

The MSE Process: Evaluation

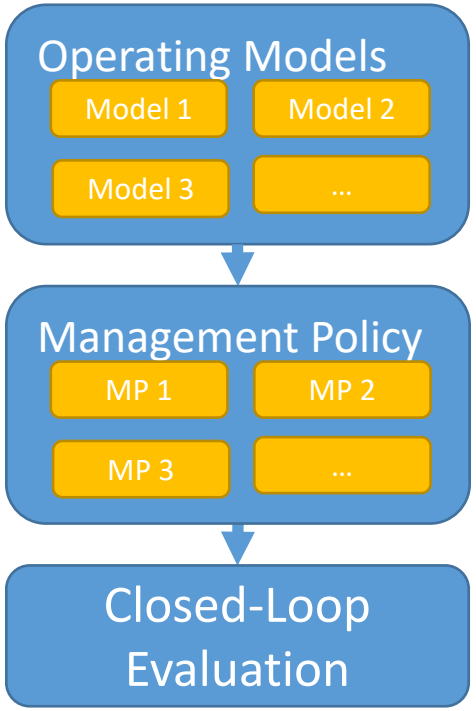


Closed-Loop Simulation Testing

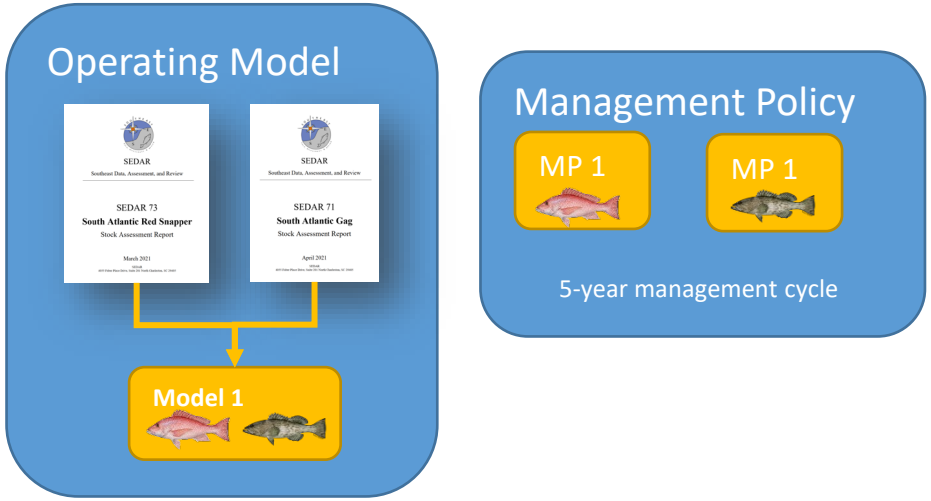


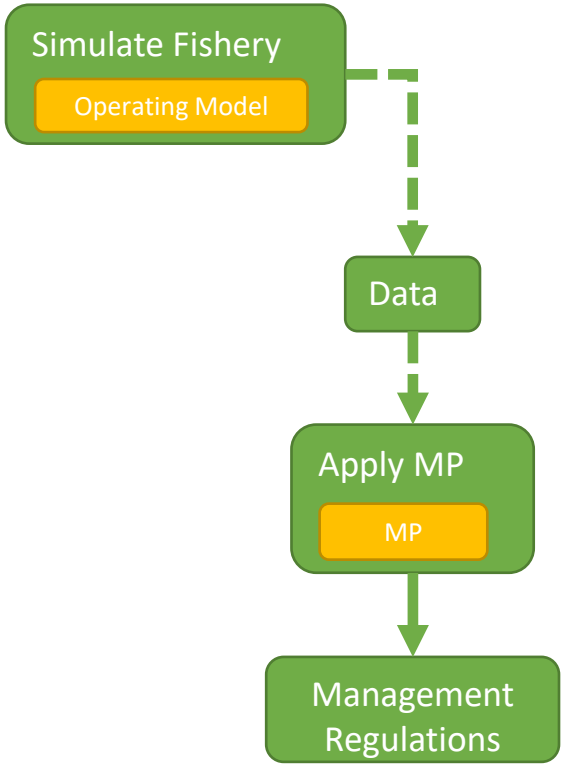


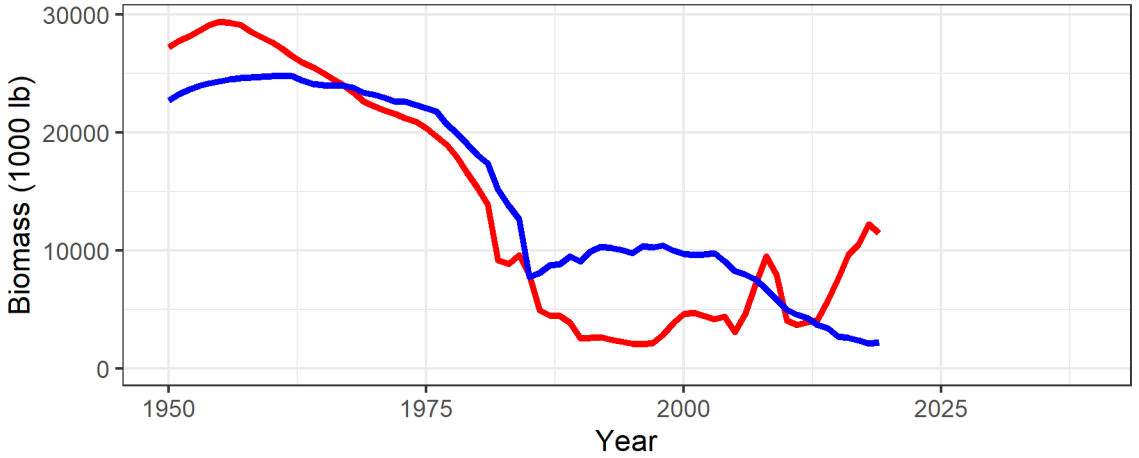
The MSE Process: Evaluation



Closed-Loop Simulation Testing







The MSE Process: Evaluation

Operating Models

Model 1 | Model 2 | Model 3 | …

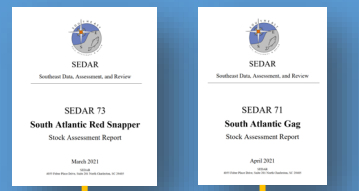
Management Policy

MP 1 | MP 2 | MP 3 | …

Closed-Loop Evaluation

Closed-Loop Simulation Testing

Operating Model



Model 1

Management Policy

MP 1 | MP 1

5-year management cycle

Simulate Fishery

Operating Model

Data

Apply MP

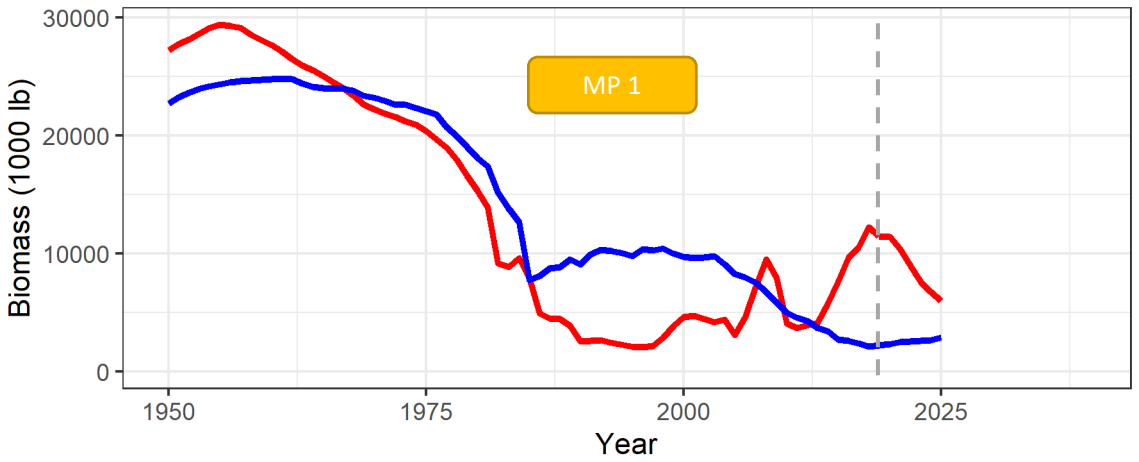
MP

Management Regulations

Implement

Update

Operating Model



The MSE Process: Evaluation

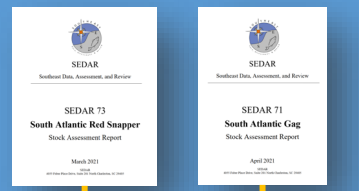
Operating Models
Model 1
Model 2
Model 3
…

Management Policy
MP 1
MP 2
MP 3
…

Closed-Loop Evaluation

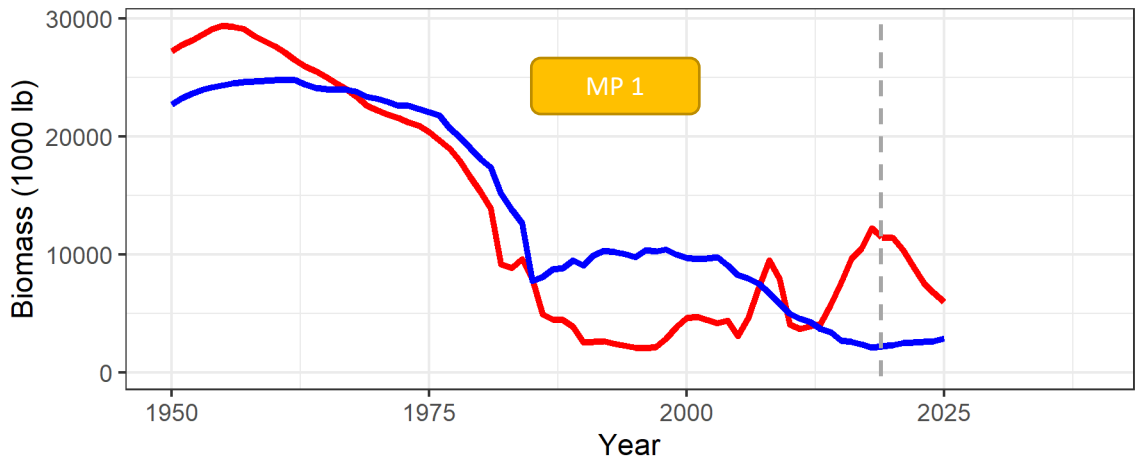
Closed-Loop Simulation Testing

Operating Model



Model 1

Management Policy
MP 1
MP 1
5-year management cycle



Simulate Fishery
Operating Model
Data
Simulate Data
Update
Operating Model
Apply MP
MP
Implement
Management Regulations

The MSE Process: Evaluation

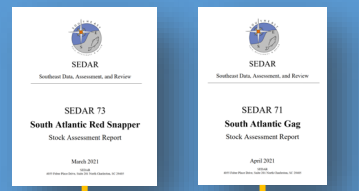
Operating Models
Model 1
Model 2
Model 3
…

Management Policy
MP 1
MP 2
MP 3
…

Closed-Loop Evaluation

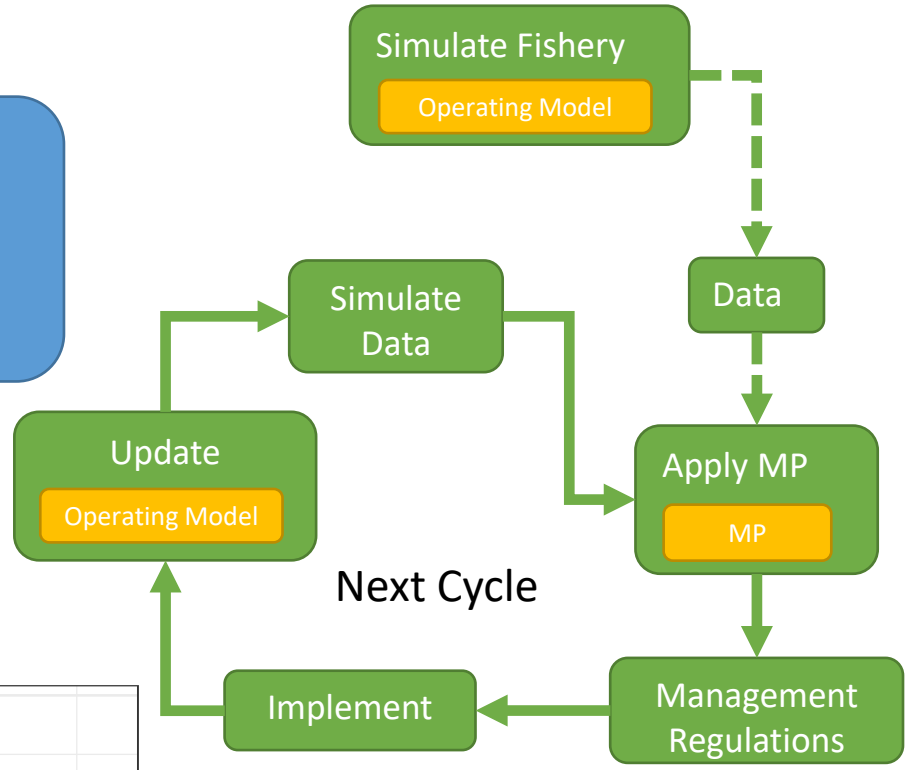
Closed-Loop Simulation Testing

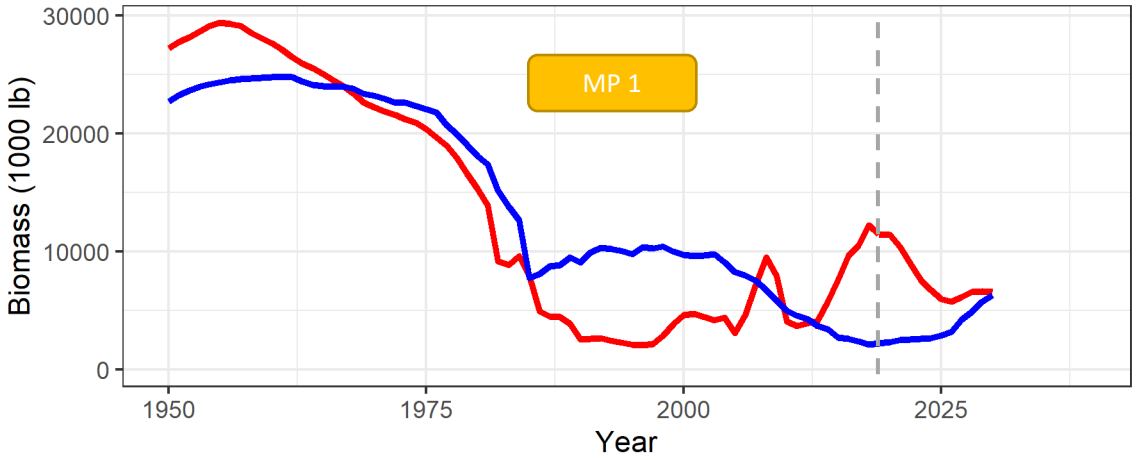
Operating Model



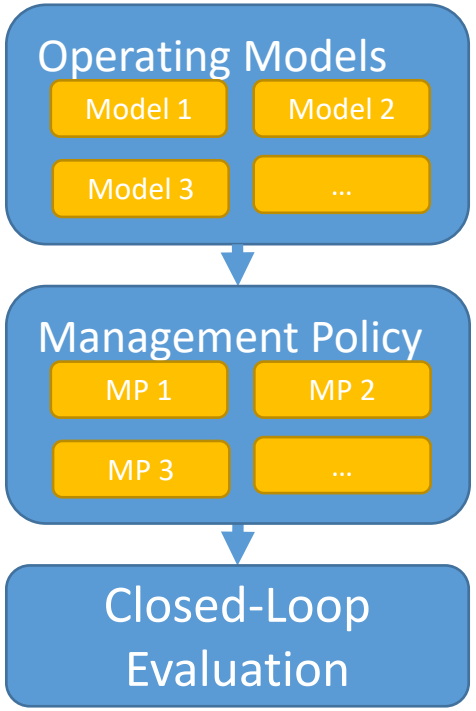
Model 1

Management Policy
MP 1
MP 1
5-year management cycle

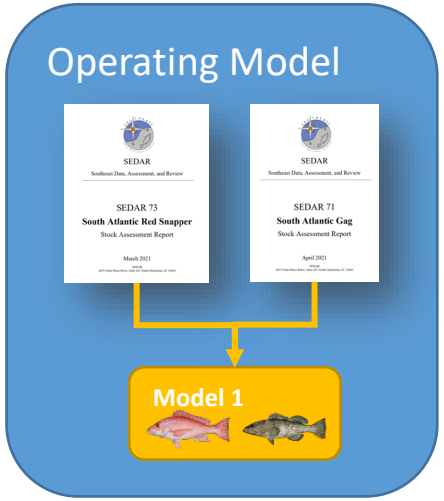


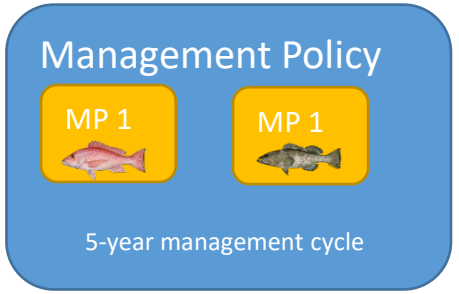


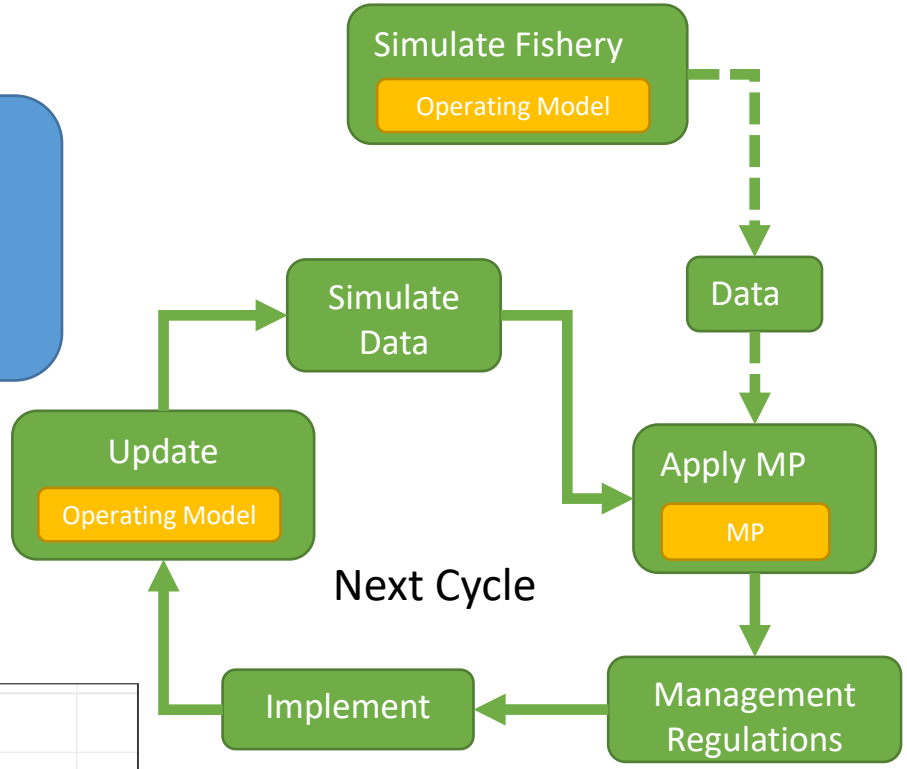
The MSE Process: Evaluation

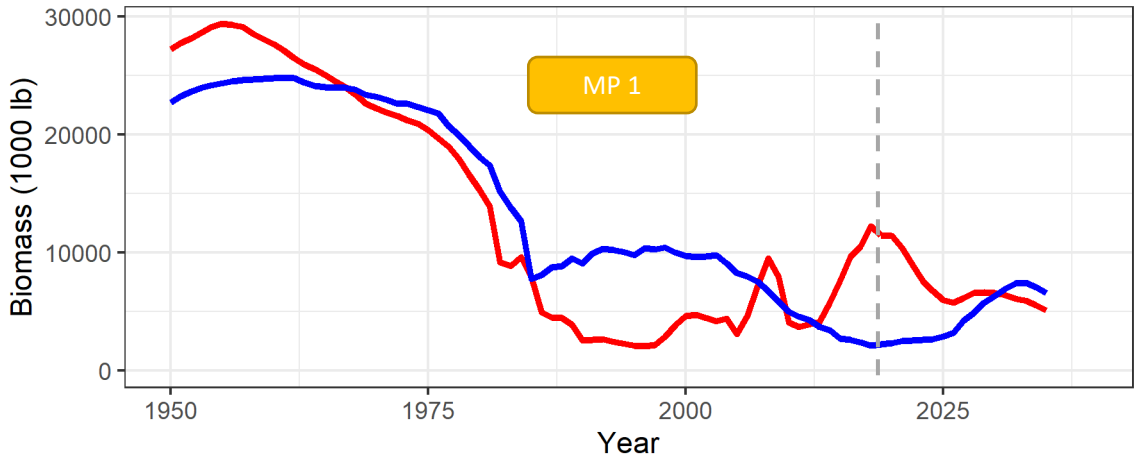


Closed-Loop Simulation Testing









The MSE Process: Evaluation

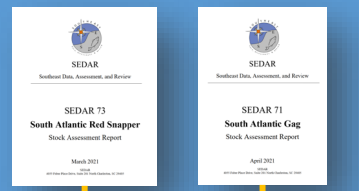
Operating Models
Model 1
Model 2
Model 3
…

Management Policy
MP 1
MP 2
MP 3
…

Closed-Loop Evaluation

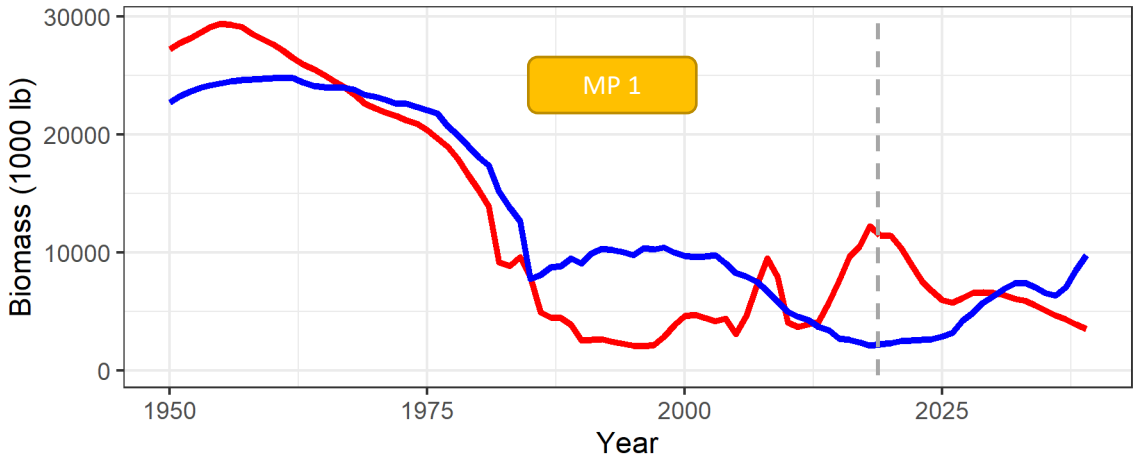
Closed-Loop Simulation Testing

Operating Model



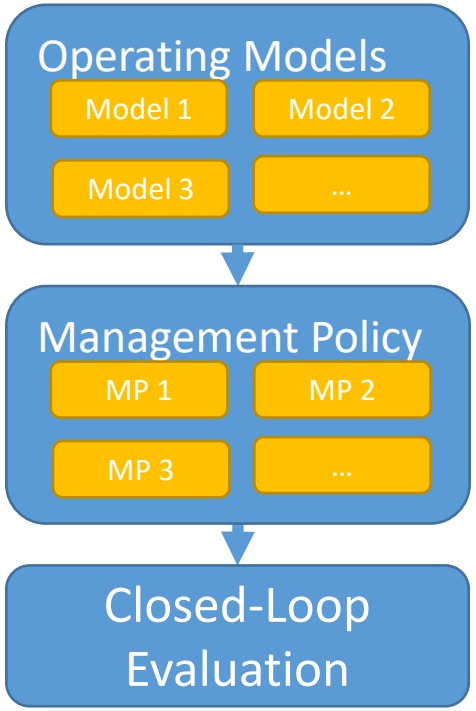
Model 1

Management Policy
MP 1
MP 1
5-year management cycle

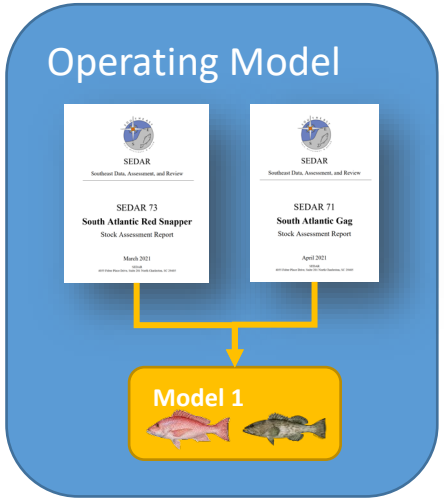


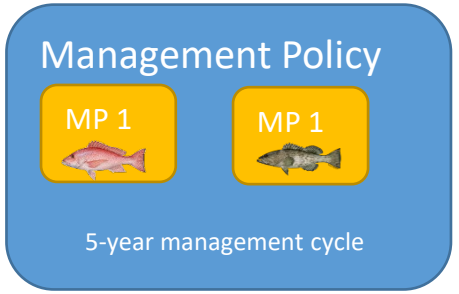
Simulate Fishery
Operating Model
Data
Simulate Data
Update
Operating Model
Apply MP
MP
Next Cycle
Implement
Management Regulations

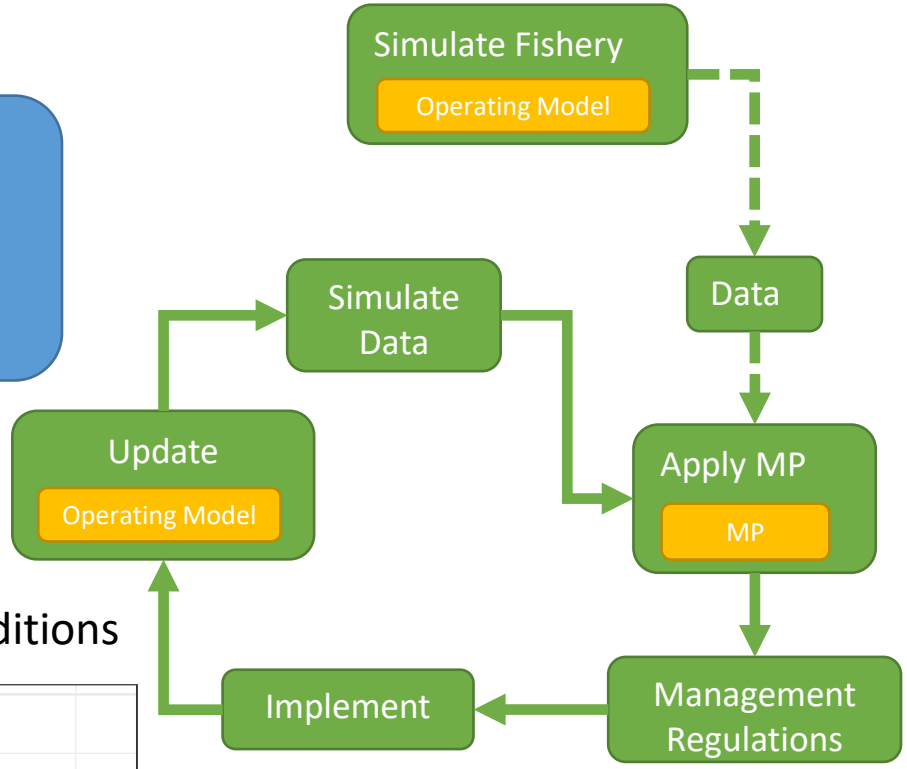
The MSE Process: Evaluation



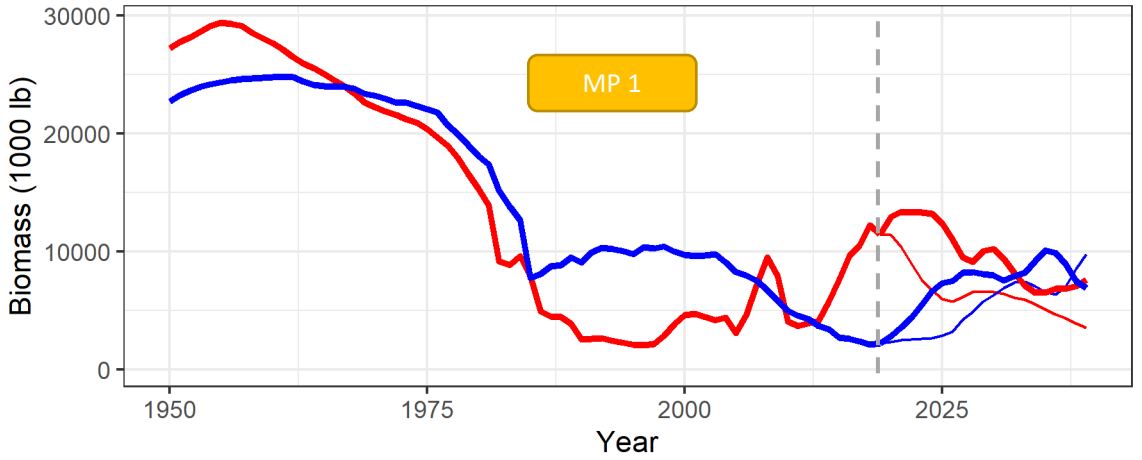
Closed-Loop Simulation Testing



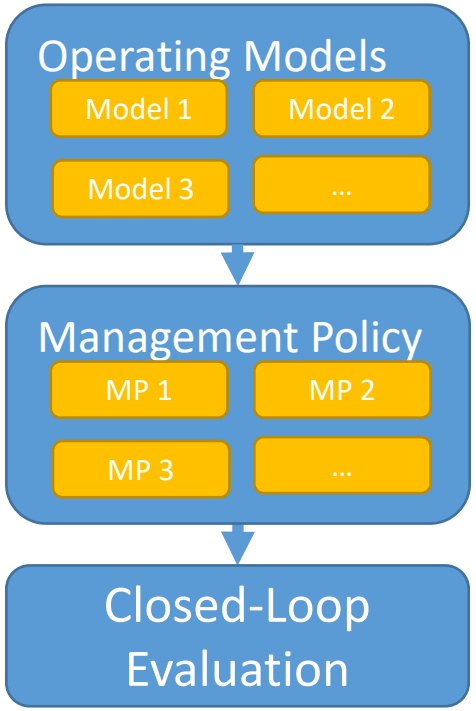




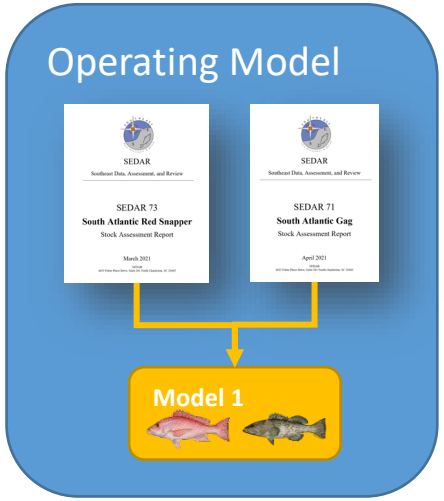
Another Simulation: Different Environmental Conditions

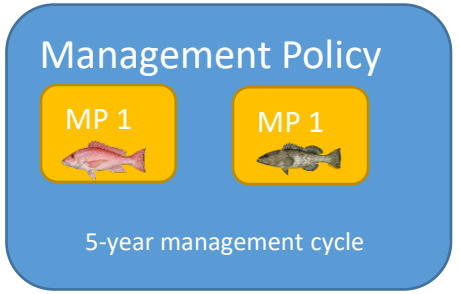


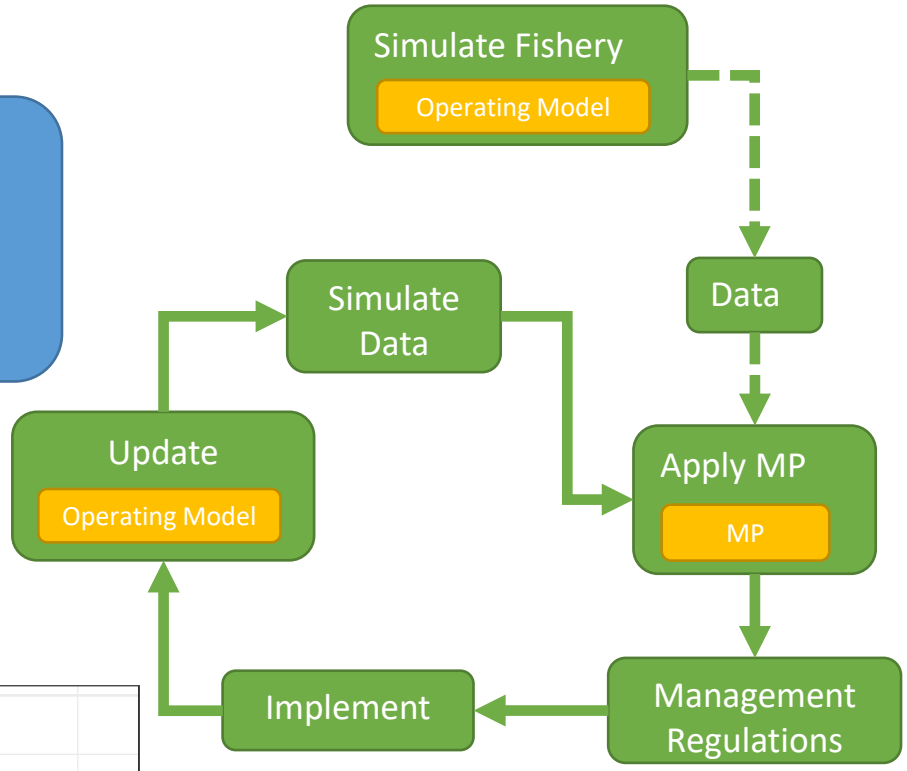
The MSE Process: Evaluation



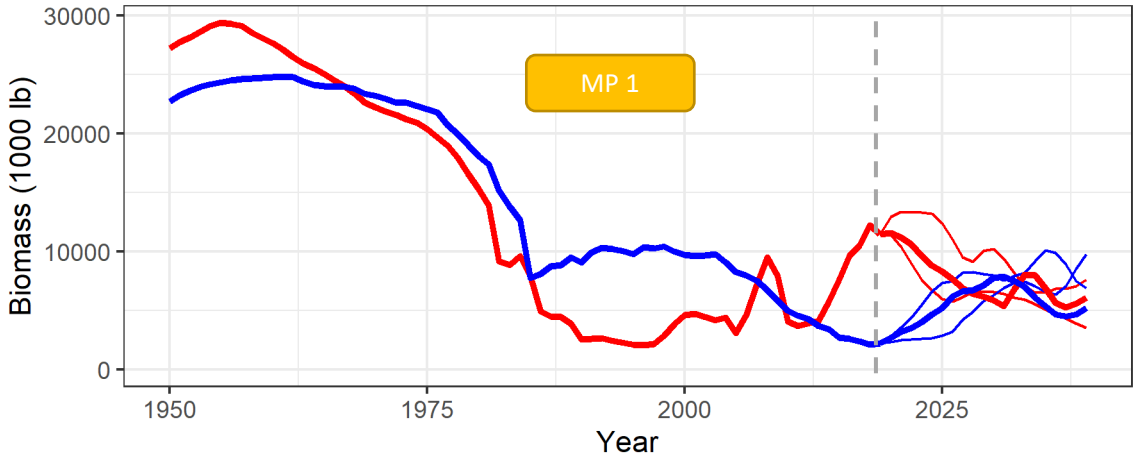
Closed-Loop Simulation Testing



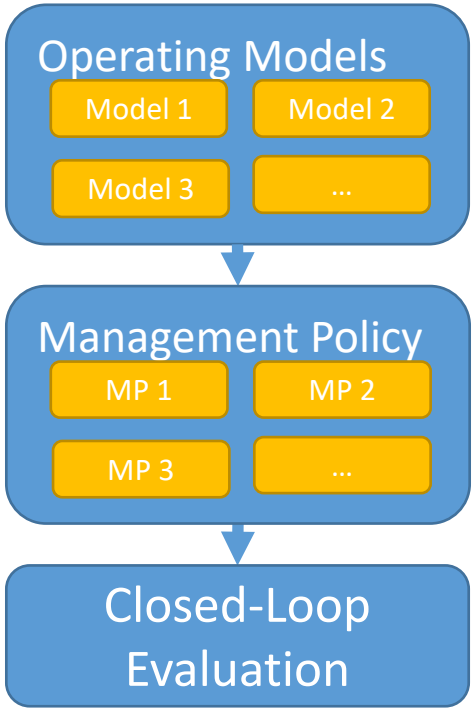




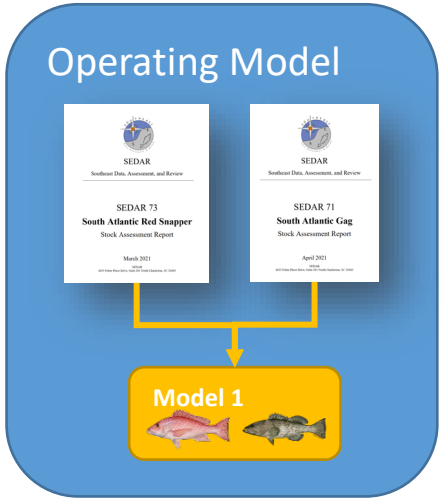
A Third Simulation

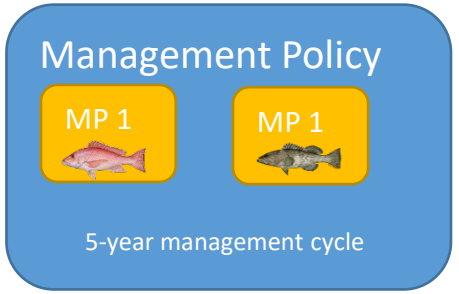


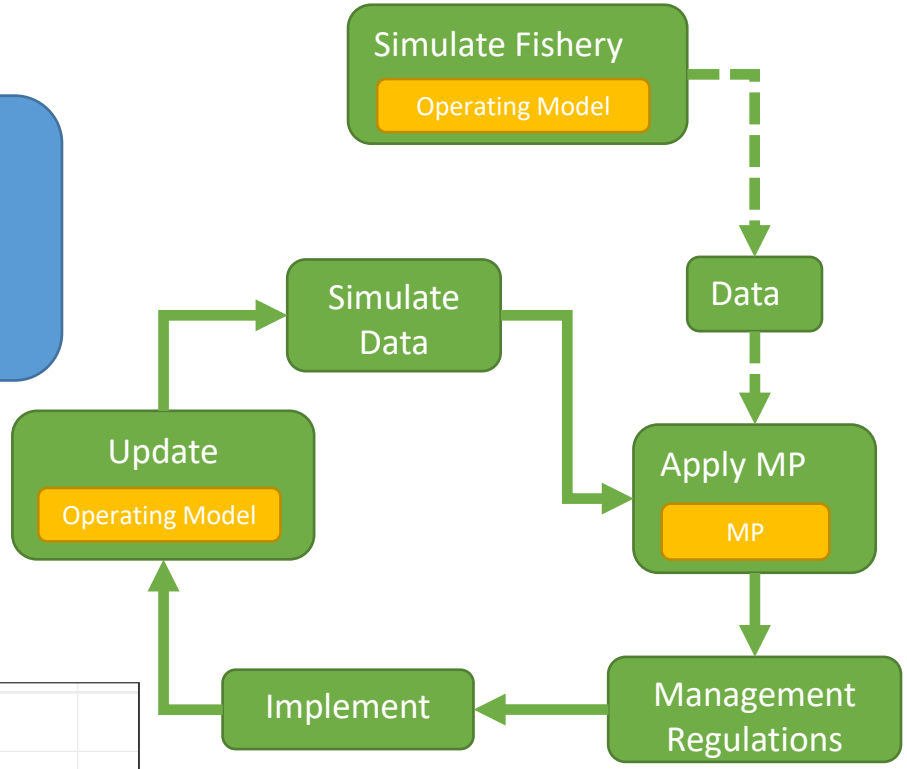
The MSE Process: Evaluation



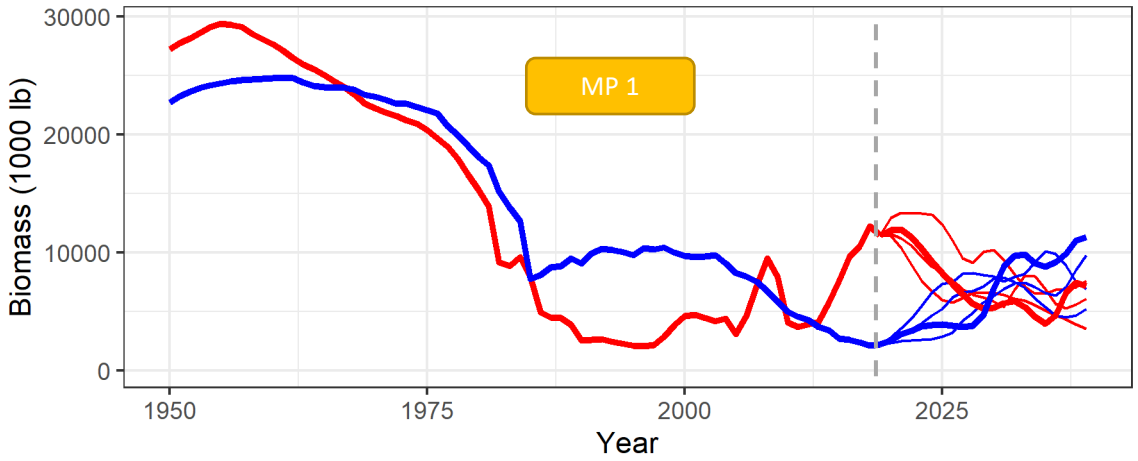
Closed-Loop Simulation Testing







And Another



The MSE Process: Evaluation

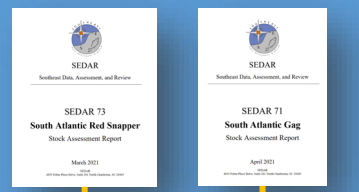
Operating Models
Model 1
Model 2
Model 3
…

Management Policy
MP 1
MP 2
MP 3
…

Closed-Loop Evaluation

Closed-Loop Simulation Testing

Operating Model

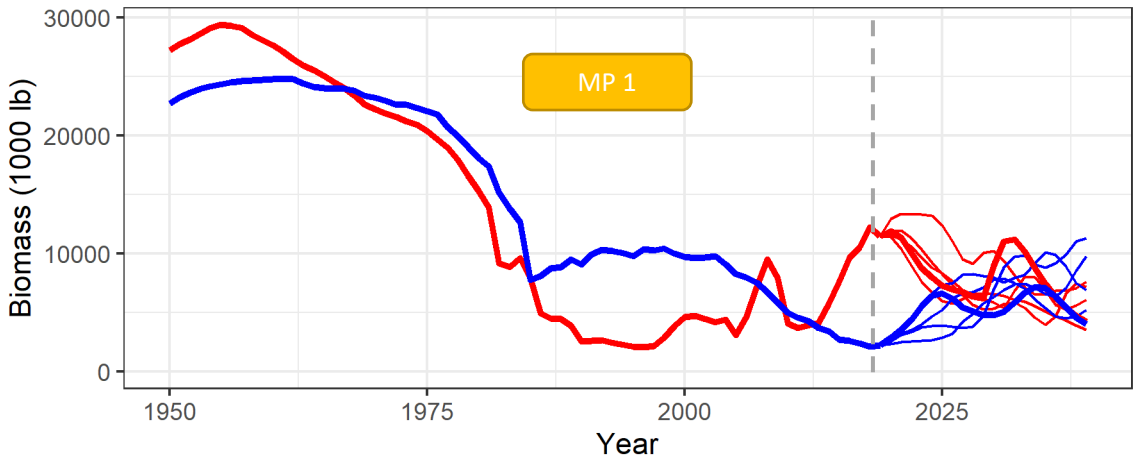


Model 1

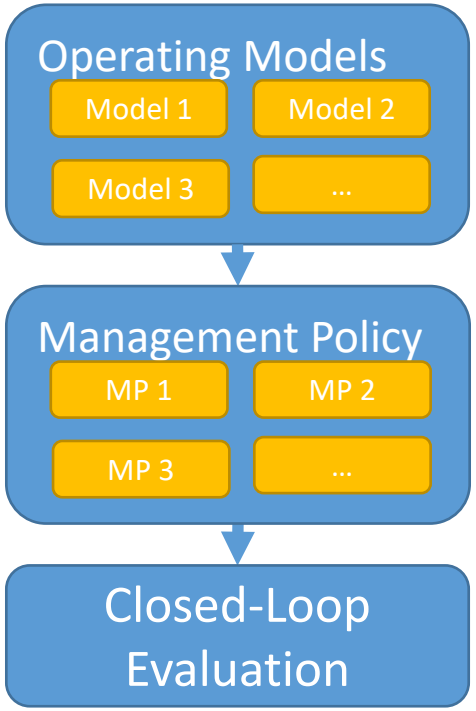
Management Policy
MP 1
MP 1
5-year management cycle

Simulate Fishery
Operating Model
Data
Simulate Data
Update
Operating Model
Apply MP
MP
Implement
Management Regulations

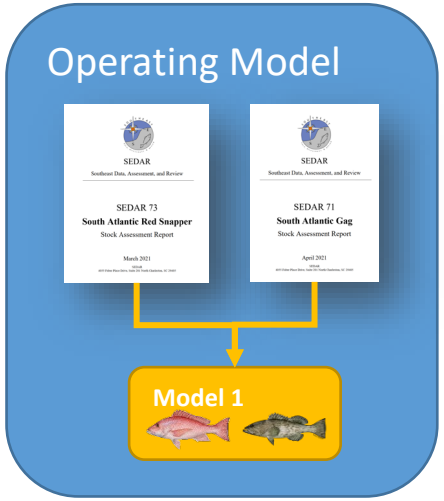
And so on …

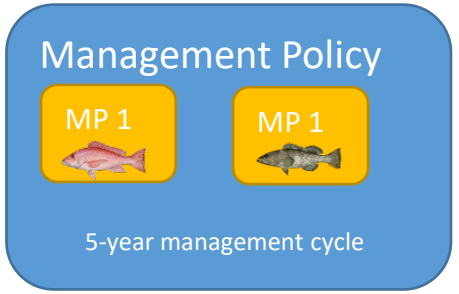


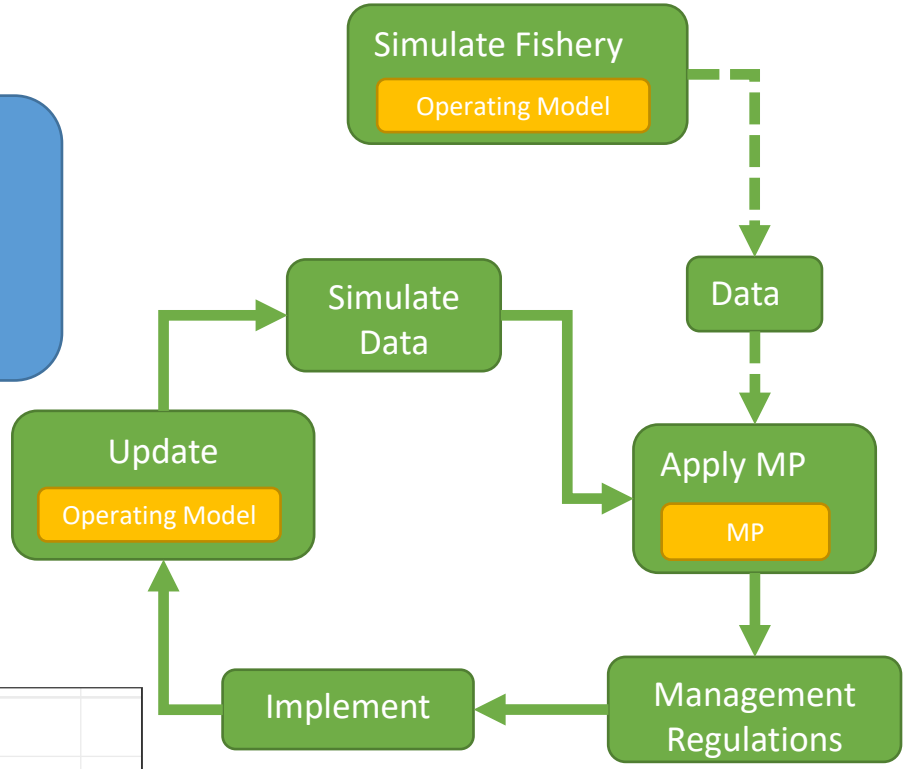
The MSE Process: Evaluation



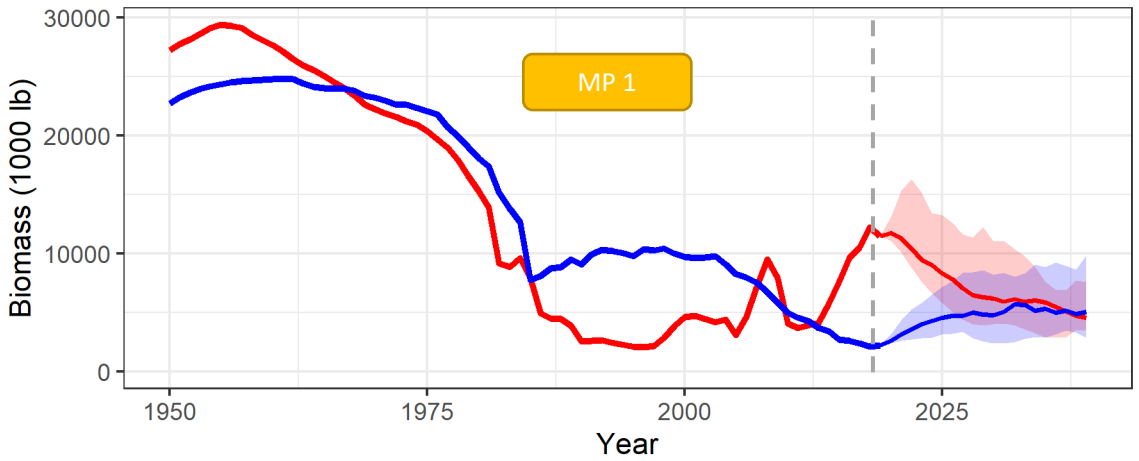
Closed-Loop Simulation Testing







And so on …



The MSE Process: Evaluation

Operating Models

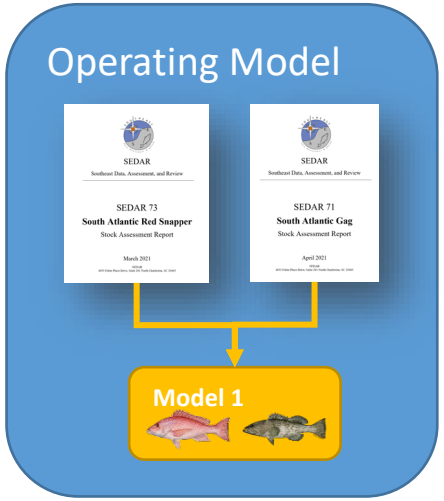
Model 1 | Model 2 | Model 3 | …

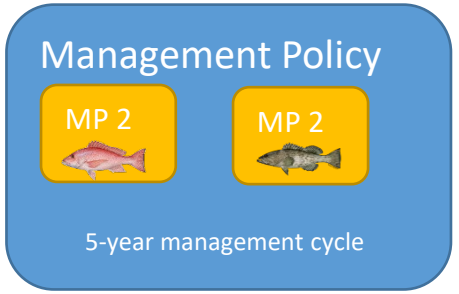
Management Policy

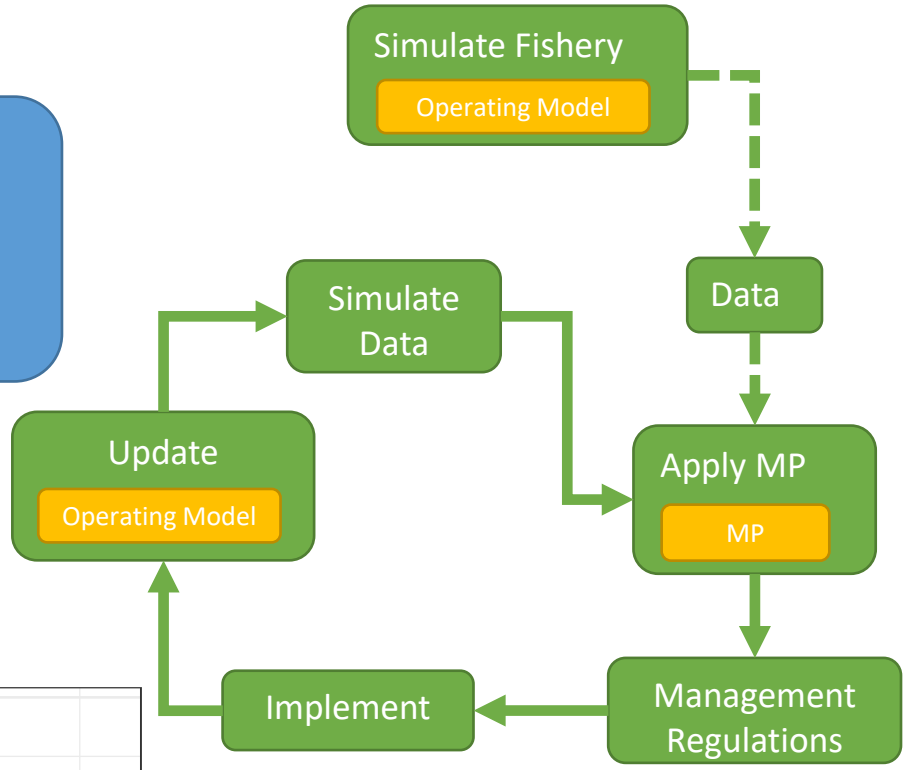
MP 1 | MP 2 | MP 3 | …

Closed-Loop Evaluation

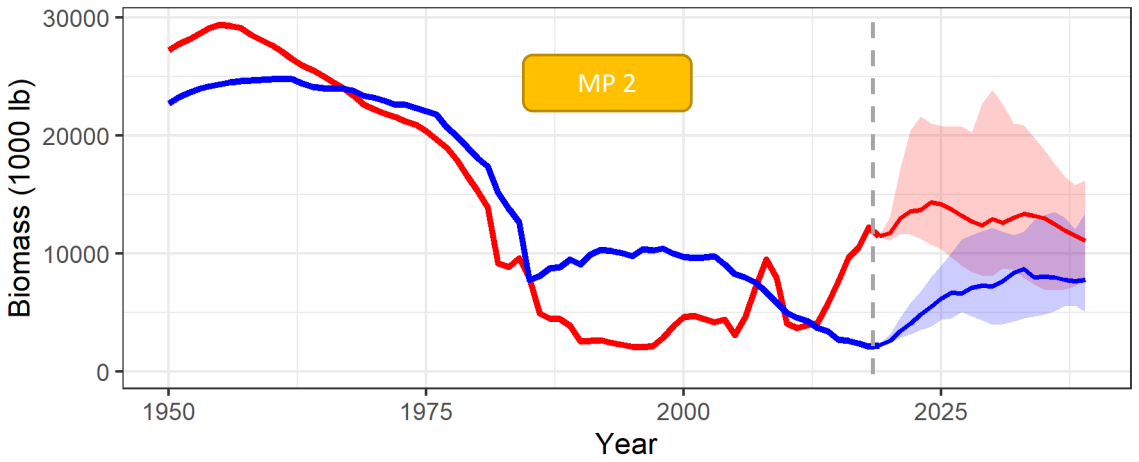
Closed-Loop Simulation Testing



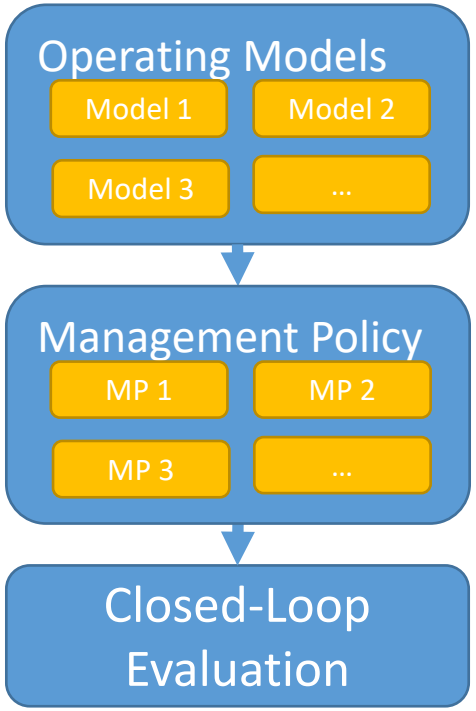




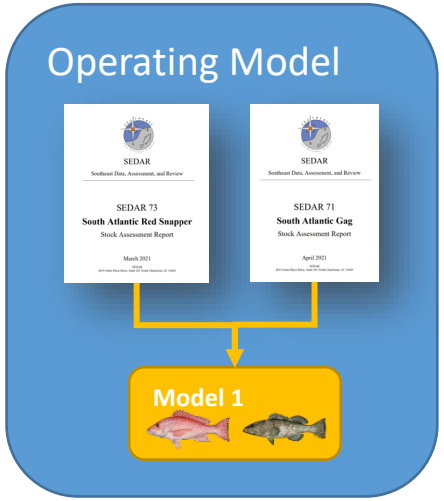
Repeat for MP 2

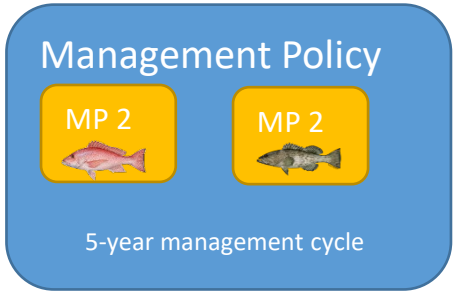


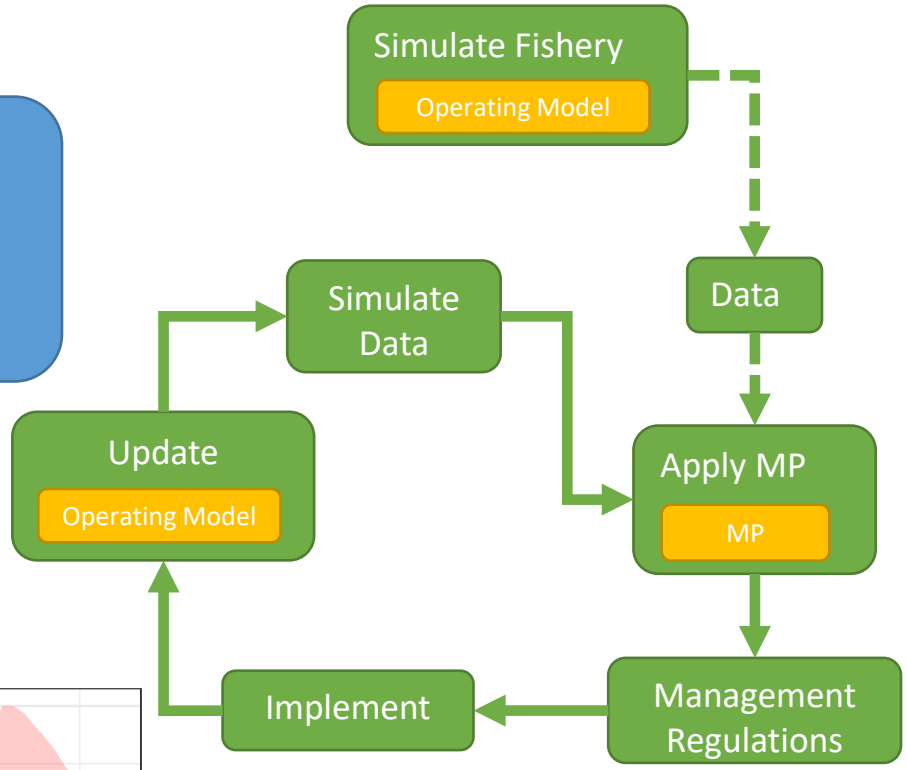
The MSE Process: Evaluation



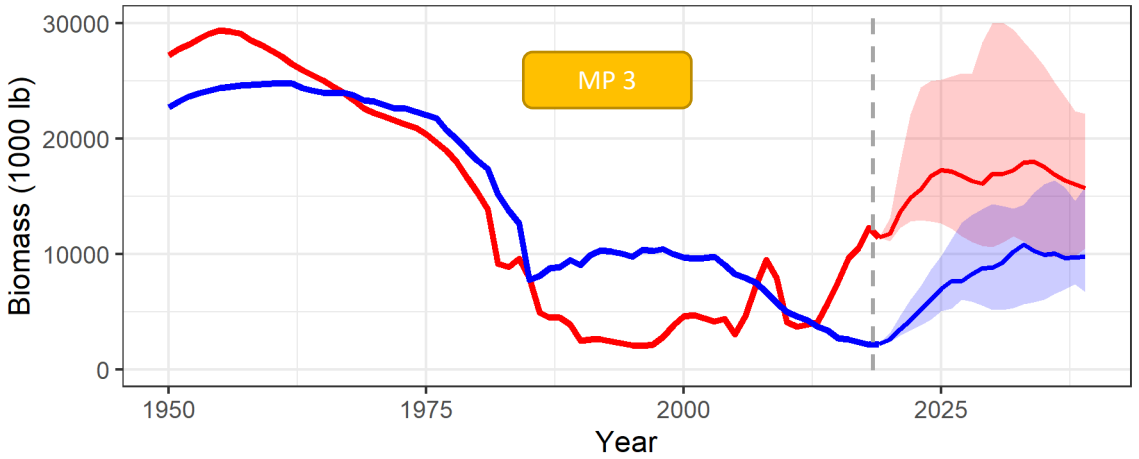
Closed-Loop Simulation Testing



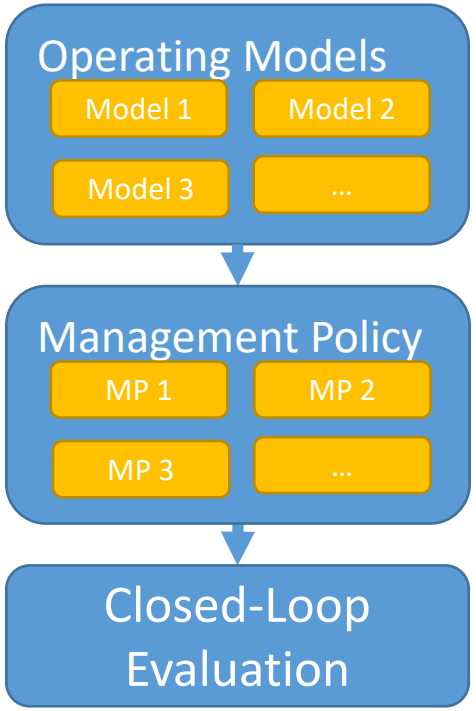




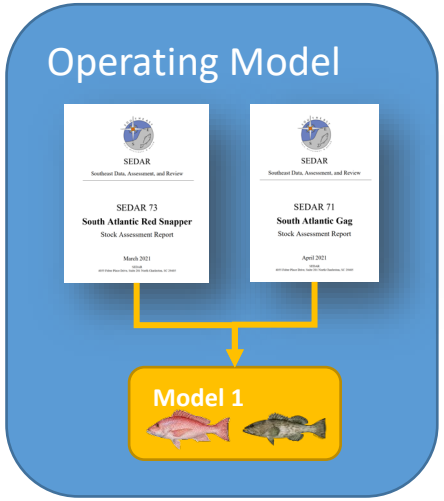
And so on for all MPs

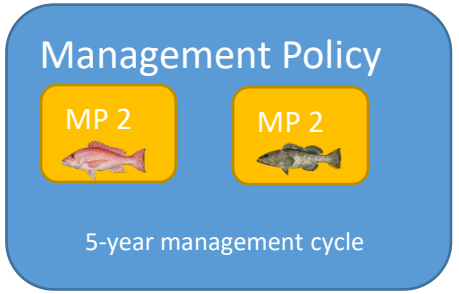


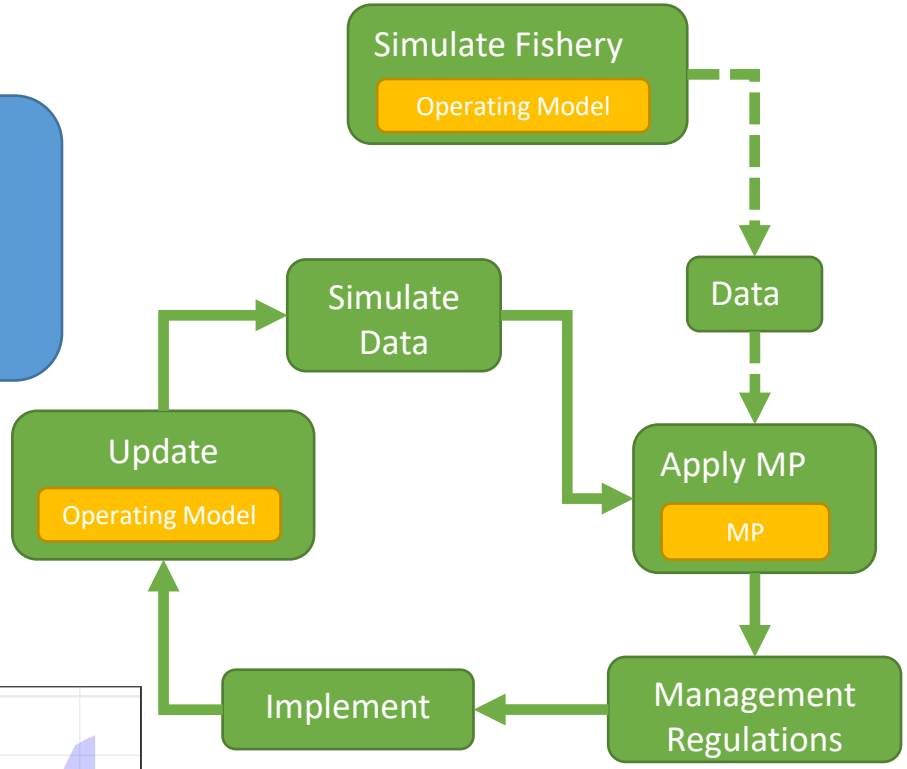
The MSE Process: Evaluation



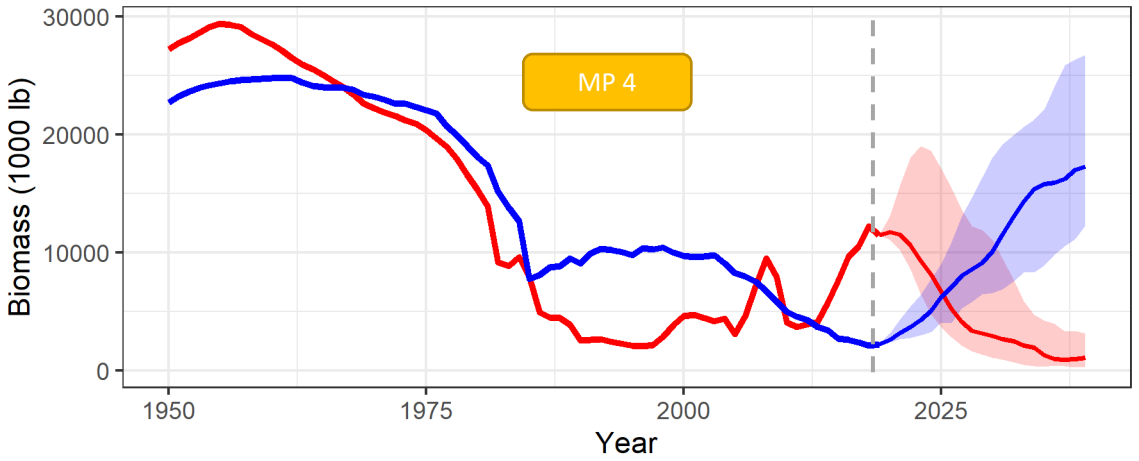
Closed-Loop Simulation Testing



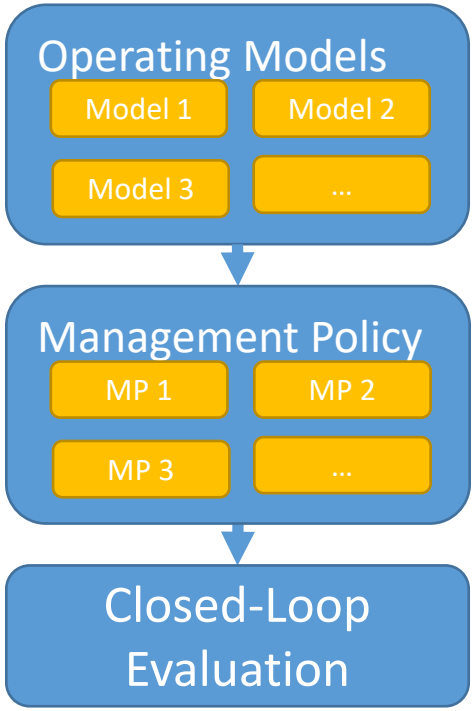


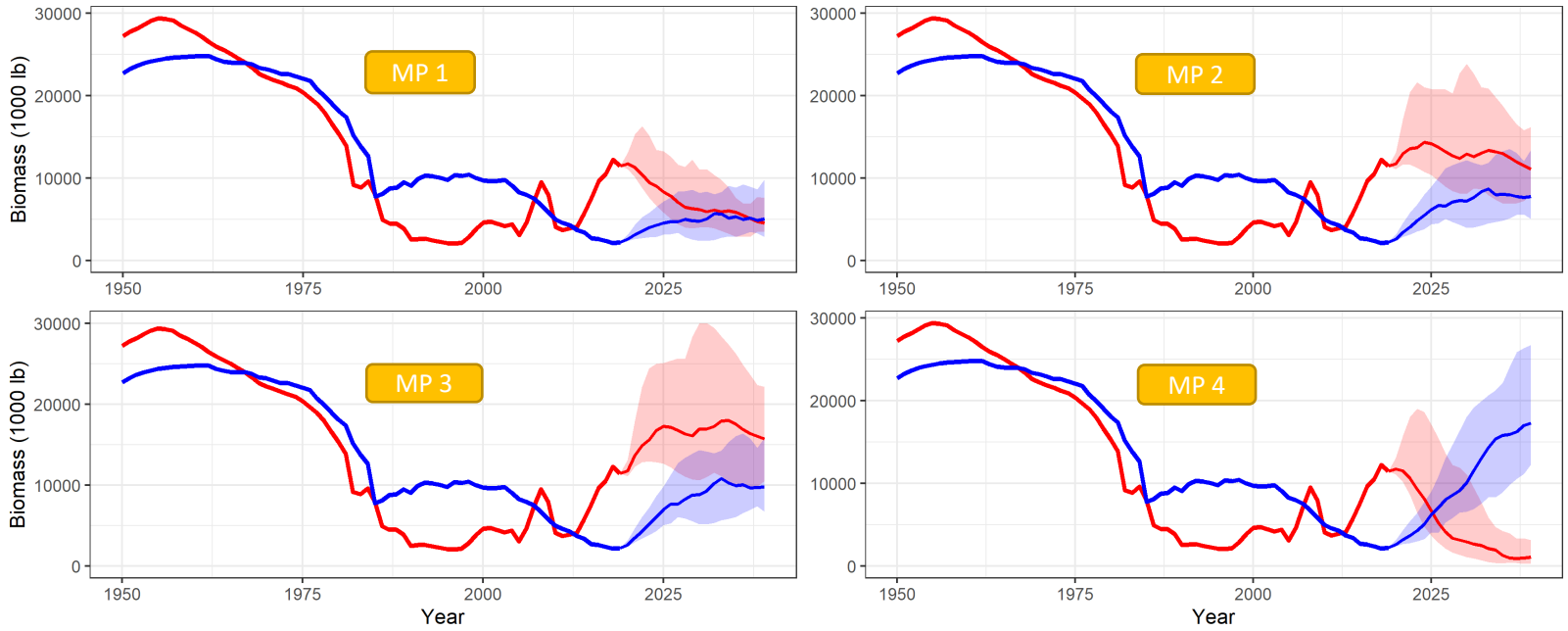


And so on for all MPs



The MSE Process: Evaluation

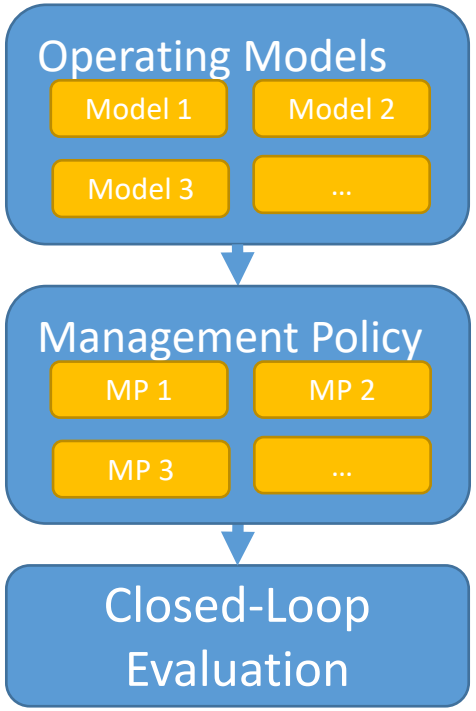




How do we rank the MPs?

- Which have good performance?
- Which have bad performance?

The MSE Process: Evaluation Criteria



How do we determine good and bad performance?

What do we care about?

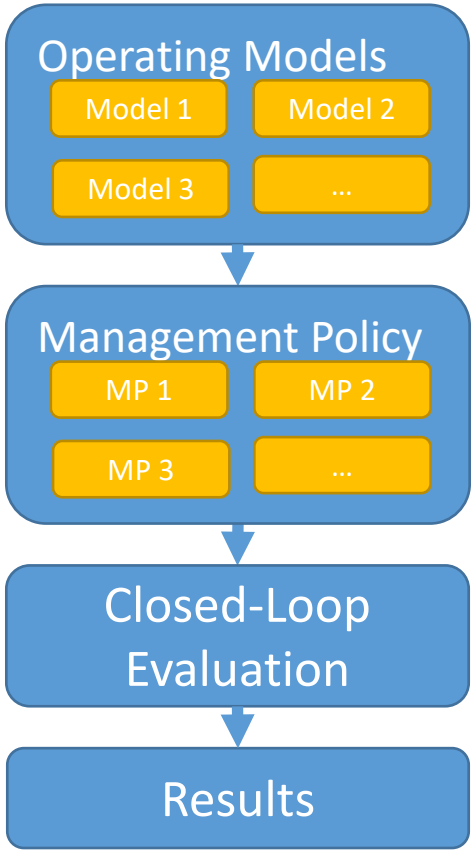
- How do we define good management outcomes?
- How do we define bad management outcomes?

Performance Metrics:

Quantitative measures of management outcomes to be achieved (or avoided)

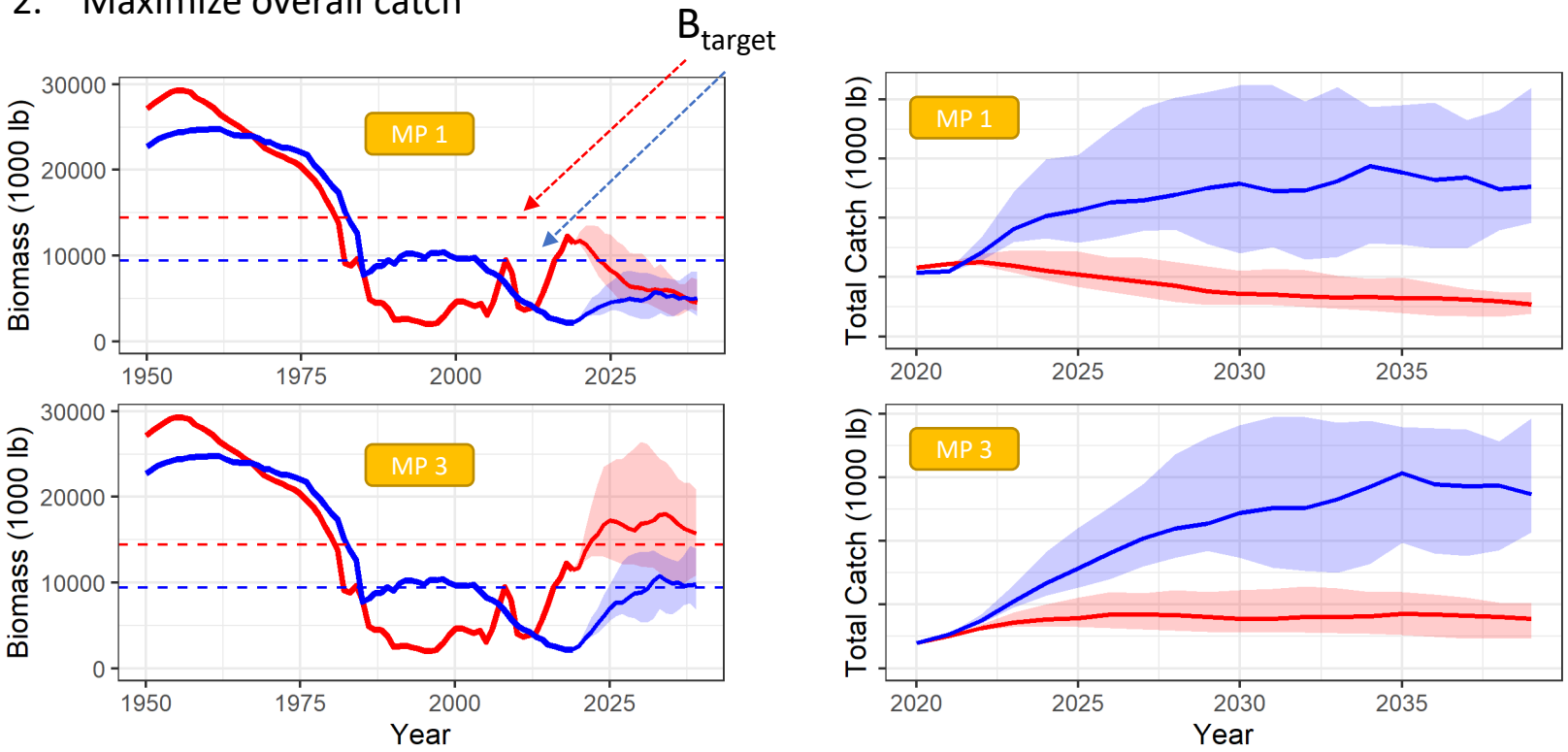
- Determined by stakeholders
- Some required by law, e.g., to ensure sustainability of resource
- May differ among stakeholders
- Used to evaluate the trade-offs among the management procedures

The MSE Process: Calculating Performance



Performance Metrics: A Simple Example

1. At least 50% probability stock is above B_{target}
2. Maximize overall catch



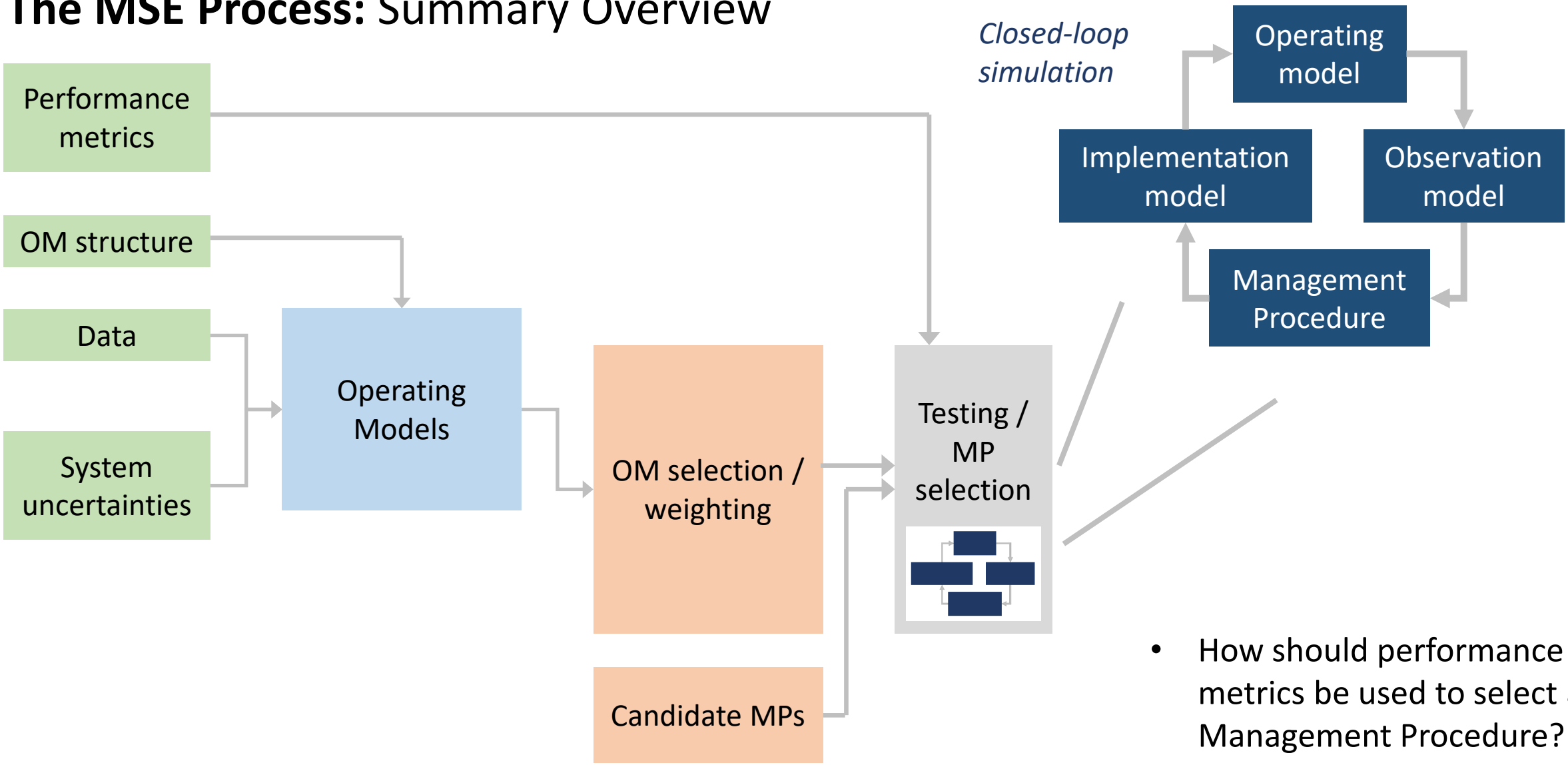
Conclusion:

MP 1 has lower probability of stock reaching target level AND a lower average yield

MP 3 is a better option: reject MP 1 and keep MP 3 for consideration

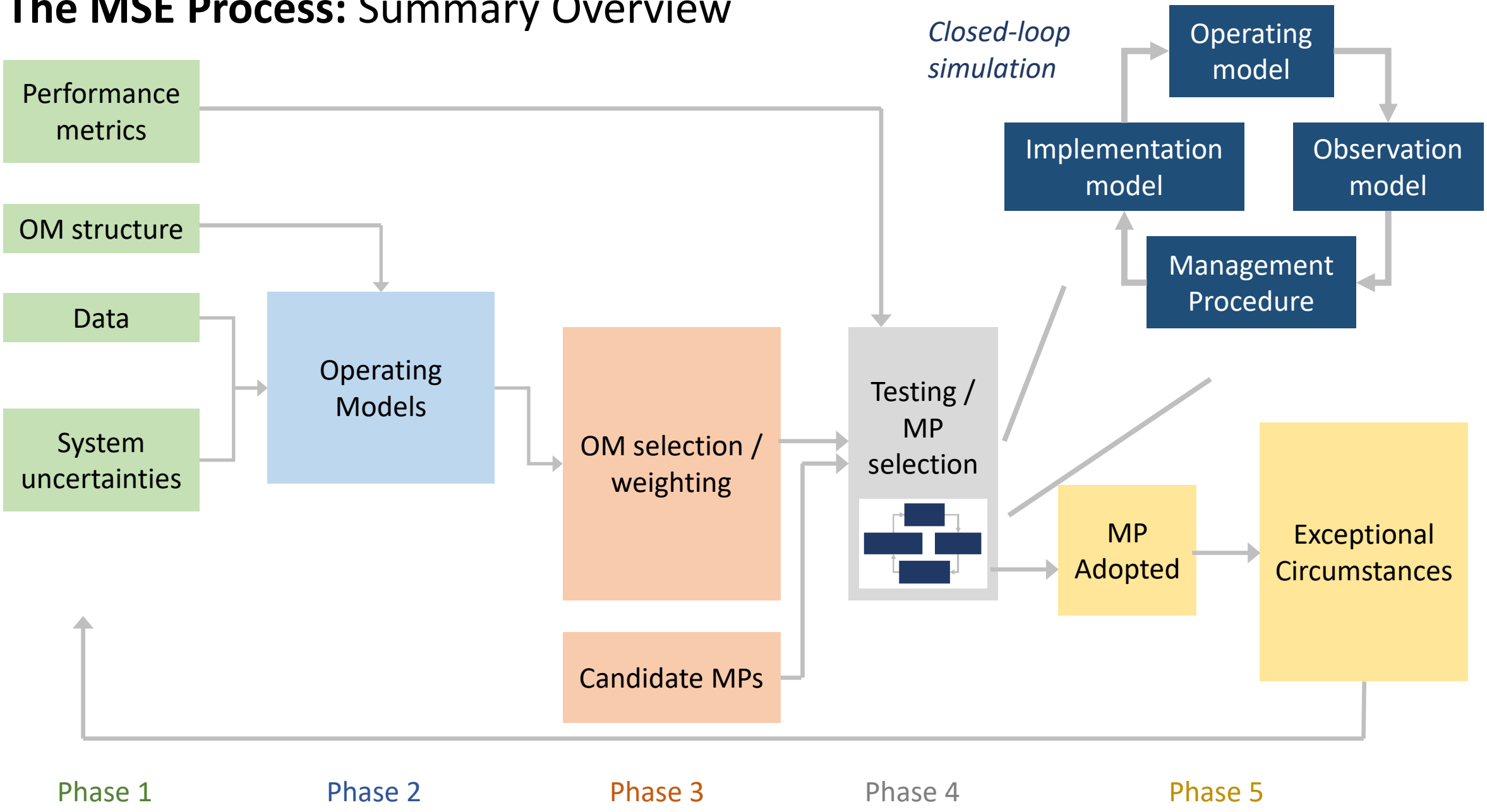
The MSE Process: Summary Overview

The MSE Process: Summary Overview



- How should performance metrics be used to select a Management Procedure?

The MSE Process: Summary Overview



Outline

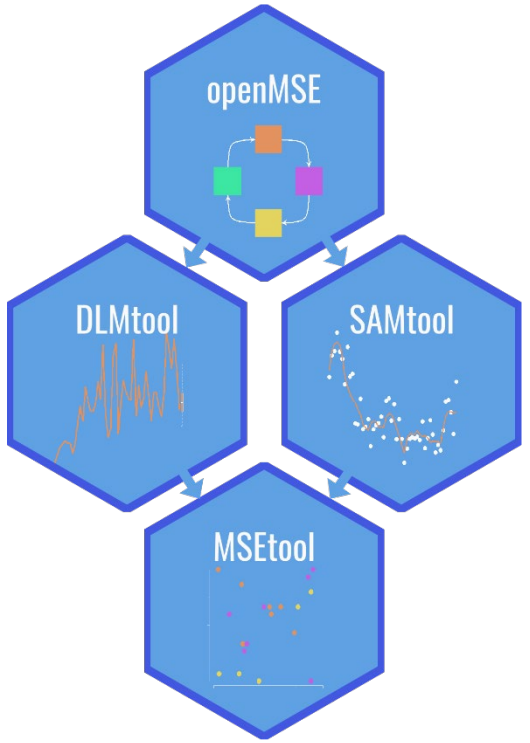
1. Contrasting Stock Assessment with Management Strategy Evaluation
2. Management Strategy Evaluation: A Brief Overview
3. MSE Process for the Snapper-Grouper Fishery
4. **The MSE Framework**

The MSE Framework

openMSE

An umbrella R package for:

- Building Operating Models
- Analyzing fishery data
- Conducting Management Strategy Evaluation (MSE)



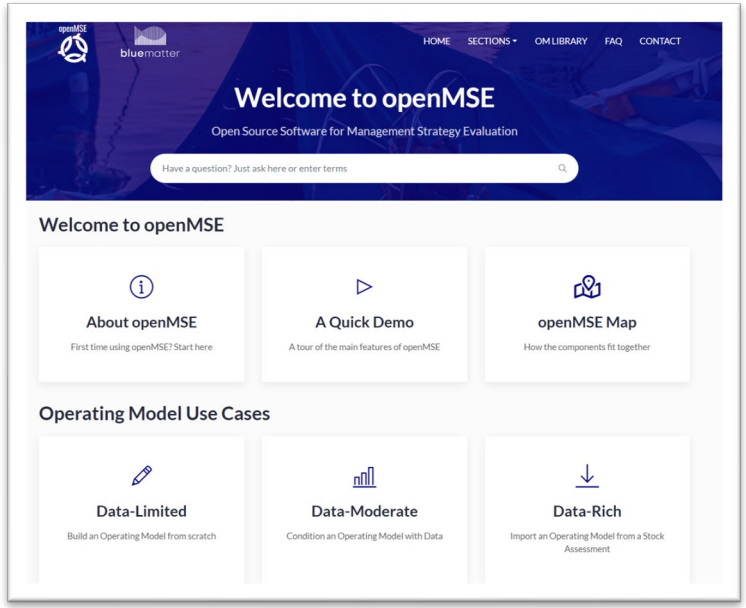
Dependency Packages

- *MSEtool*: core openMSE package – building OMs and running MSE
- *DLMtool*: collection of data-limited management procedures
- *SAMtool*: collection of stock assessment methods and data-intensive MPs

The MSE Framework

openMSE: Structure & Features

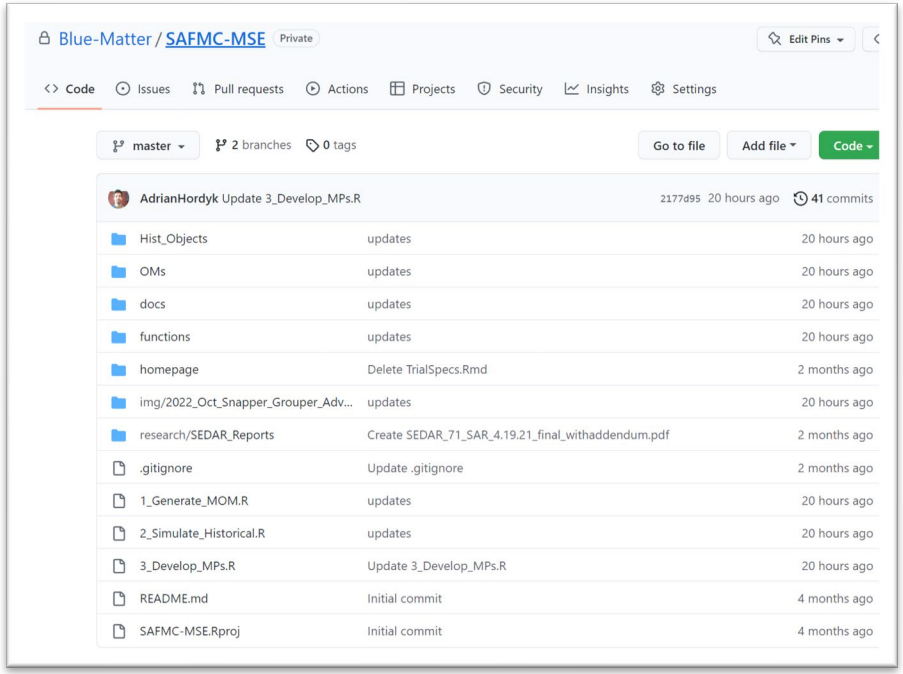
- Age-structured, spatial operating model
- Built with R (with C++, TMB, & parallel processing)
- Open-source: https://github.com/Blue-Matter
- 100+ MPs (data-limited, moderate, & rich)
- Extensible (develop custom MPs)
- Options for multi-stock/fleet OMs
- Unlimited spatial areas (+ movement by age)
- Option for bio-economic model



openmse.com

The MSE Framework

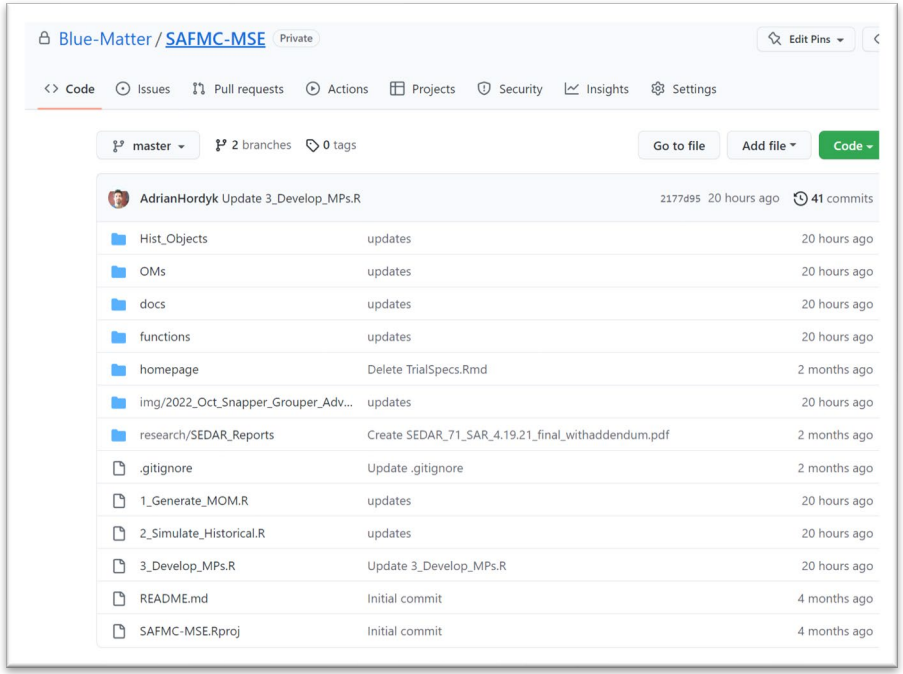
Project Code



https://github.com/Blue-Matter/SAFMC-MSE

The MSE Framework

Project Code



https://github.com/Blue-Matter/SAFMC-MSE

Project Homepage

https://safmc-mse.netlify.app/

- resources (papers, presentations, etc)
- description of MSE process (living document)
- record of decisions made by Group

Thank You