An Overview of the MSE Process

A Demonstration using the Red Snapper and Gag Grouper

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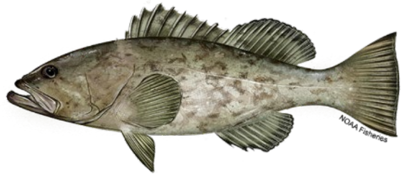
Snapper – Grouper Advisory Panel Meeting

19 October 2022

bluematter

Outline

1. Contrasting Stock Assessment with Management Strategy Evaluation
2. The MSE Process: An Example with the Red Snapper and Gag Grouper



Objectives

1. Demonstrate what the MSE process could look like for this fishery
2. Highlight the key issues that will be discussed further

Contrasting Stock Assessment with Management Strategy Evaluation

Stock Assessment

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

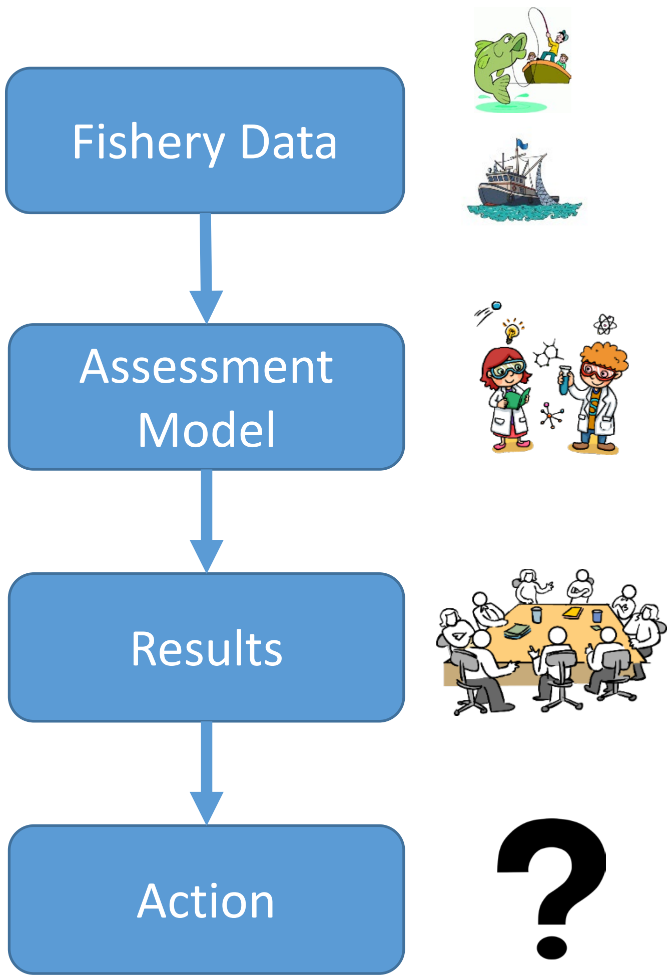
- how many fish are in the water (biomass)?
- is the stock over-exploited (reference points)?
- should the management regulations be changed?

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

Stock Assessment



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?

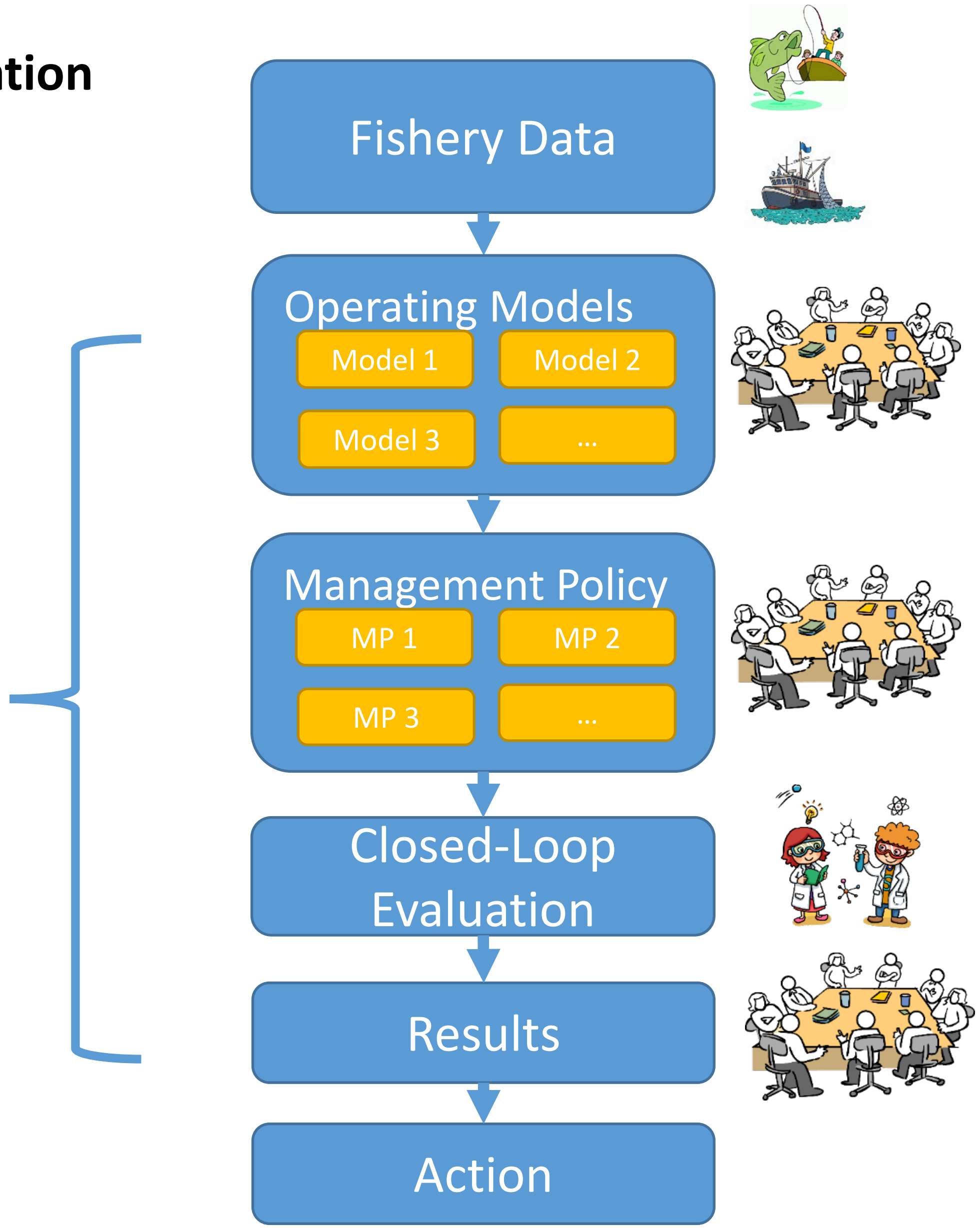
Output:

- 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

Contrasting Stock Assessment with Management Strategy Evaluation

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: The Main Components

Collaboration between Stakeholders to:

1. Develop Operating Models
2. Develop Candidate Management Plans (aka Management Procedures)
3. Determine Evaluation Criteria (aka Performance Metrics)
4. Evaluate Performance of MPs against Performance Metrics

The MSE Process: Operating Models

Operating Models

Model 1 | Model 2

Model 3 | …

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

- stock (biology)
- exploitation (fishing activities)

Model 1

Fish Stock 1
- Biology (growth, maturity, etc)
- Spatial distribution & movement
- etc

Fishing Fleet 1
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

Fishing Fleet 2
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

Fishing Fleet …
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

The MSE Process: Operating Models

Operating Models

Model 1 | Model 2

Model 3 | …

Multi-Species

Interactions:

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

Model 1

Fish Stock 1
- Biology (growth, maturity, etc)
- Spatial distribution & movement
- etc

Fishing Fleet 1
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

Fishing Fleet 2
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

Fishing Fleet …
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

Fish Stock 2
- Biology (growth, maturity, etc)
- Spatial distribution & movement
- etc

Fishing Fleet 1
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
- Spatial distribution & targeting

Fishing Fleet 2
- Selectivity pattern (gear type)
- Fishing effort (seasonal, overall)
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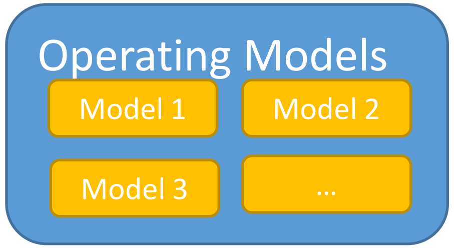
The MSE Process: Operating Models



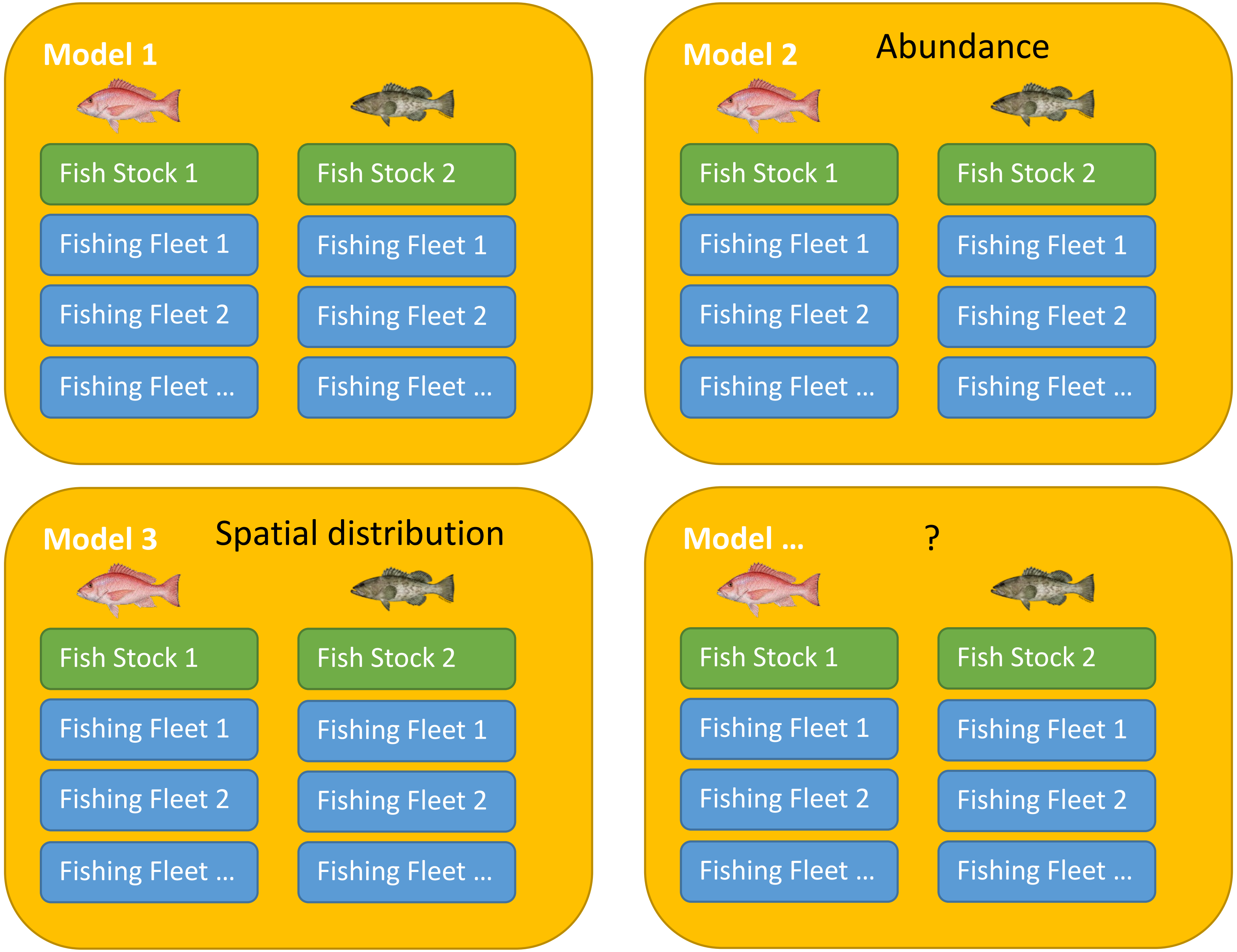
Uncertainties

Stock characteristics:

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

Fleet characteristics:

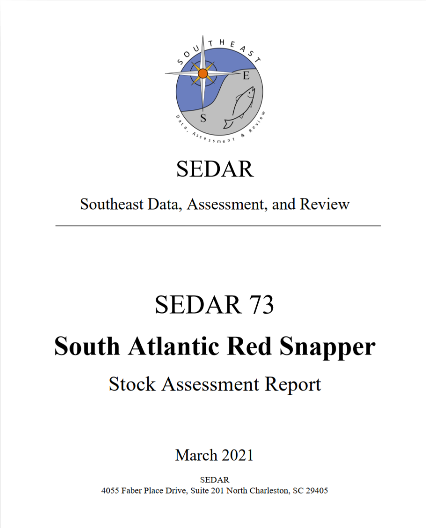
- Selectivity pattern?
- Fishing effort?
- Spatial distribution?



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

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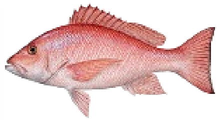
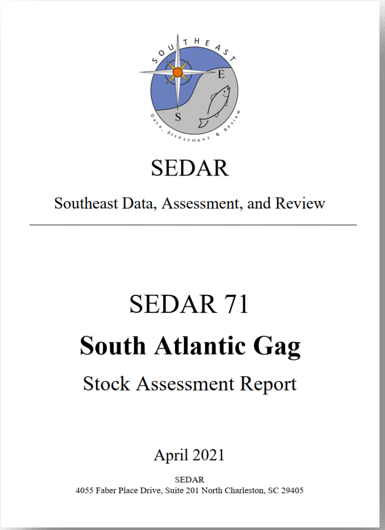


Fish Stock 1: Red Snapper

Fishing Fleet 1: Commercial handline

Fishing Fleet 2: Recreational headboats

Fishing Fleet 3: General recreational


SEDAR

Southeast Data, Assessment, and Review

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South Atlantic Gag

Stock Assessment Report

April 2021

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Fish Stock 2: Gag Grouper

Fishing Fleet 1: Commercial handline

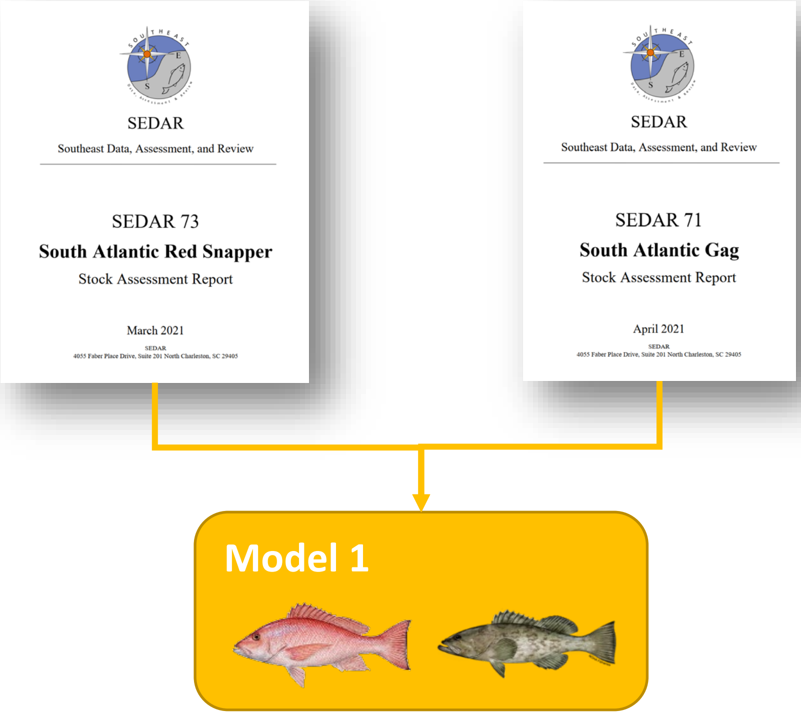
Fishing Fleet 2: Commercial diving

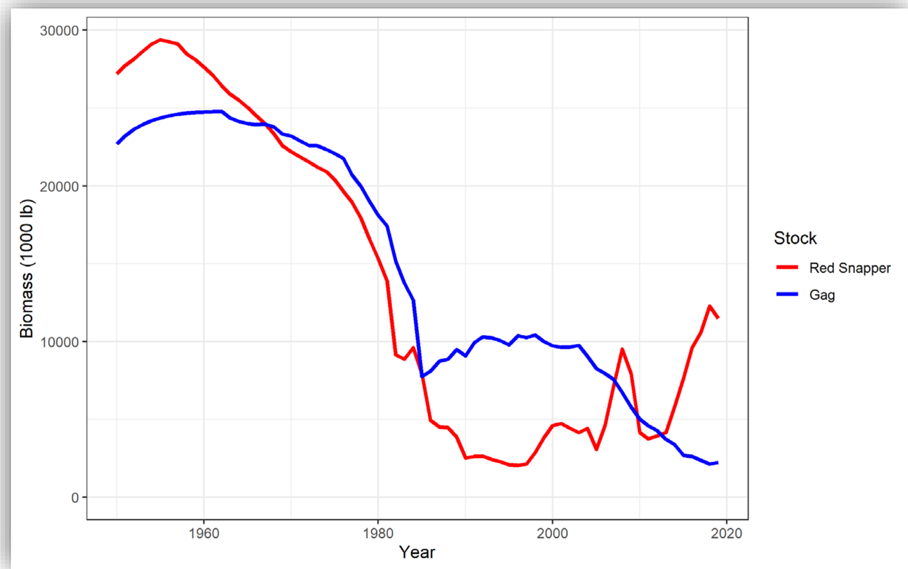
Fishing Fleet 3: Recreational headboats

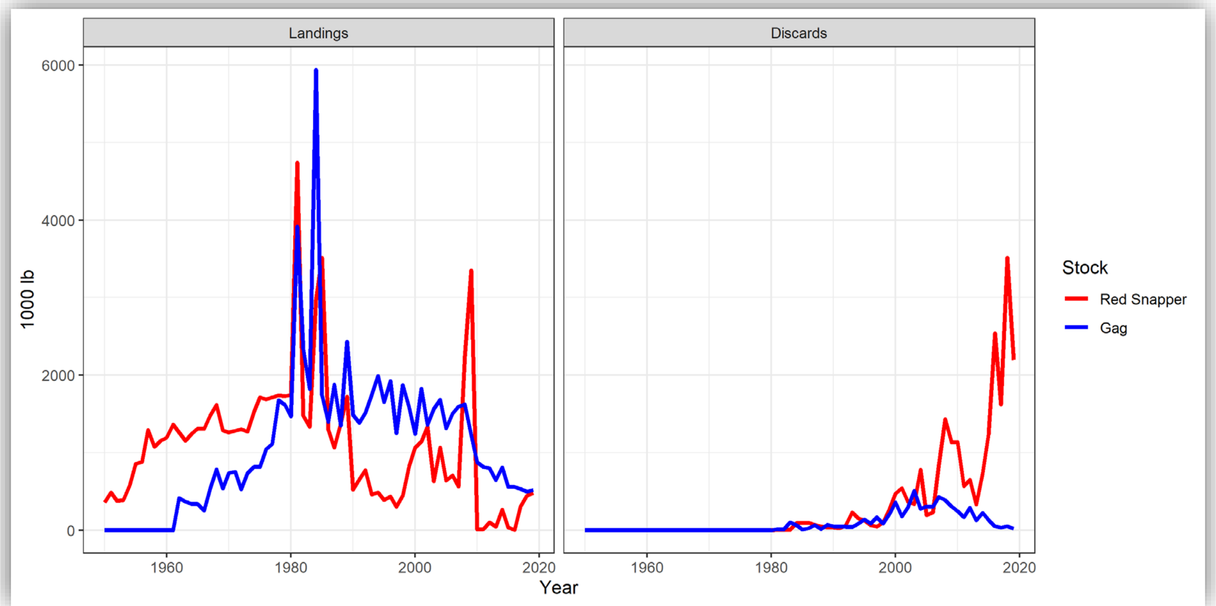
Fishing Fleet 4: General recreational

The MSE Process: Operating Models

Building the Operating Models

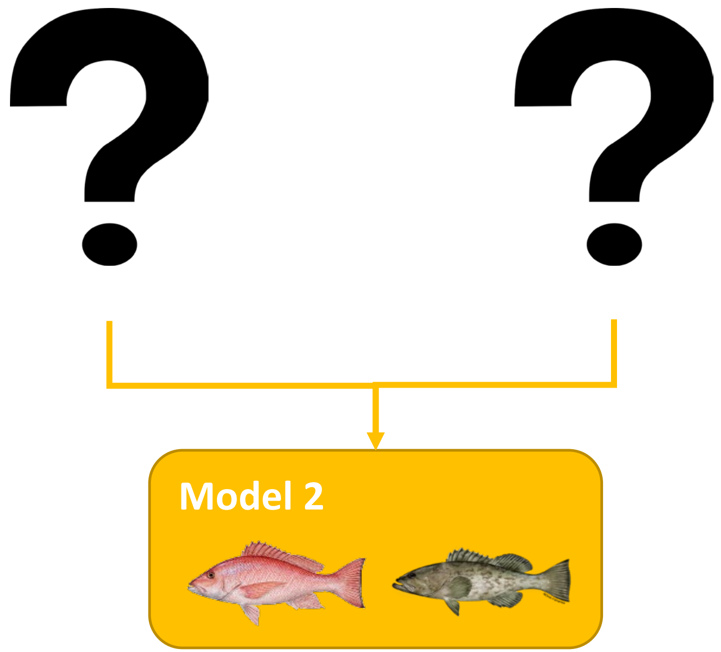


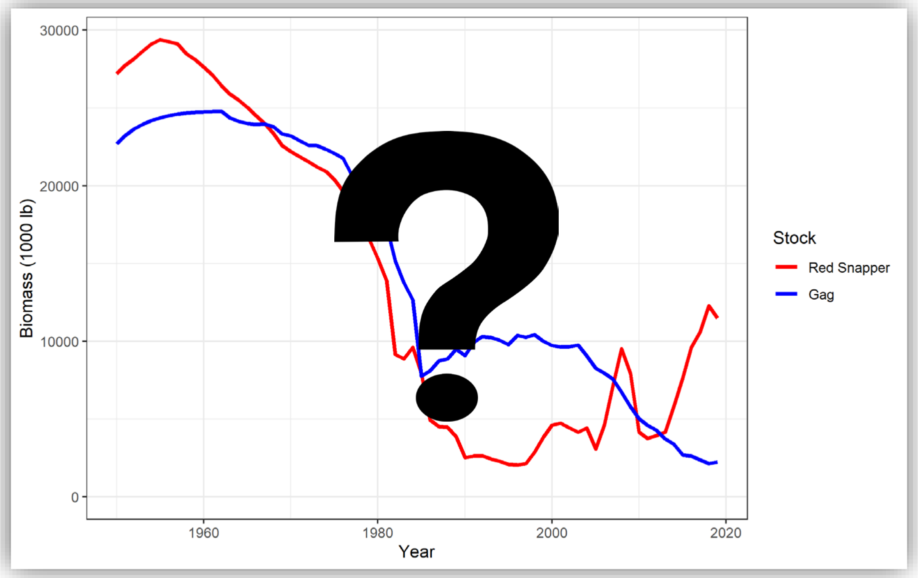


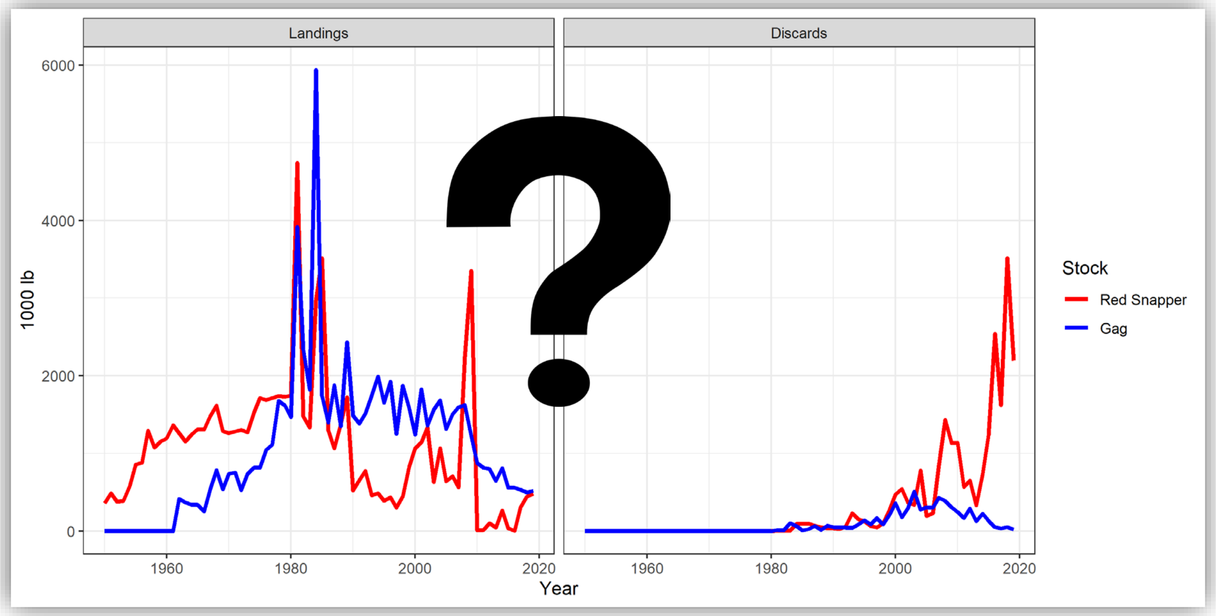


The MSE Process: Operating Models

Building the Operating Models





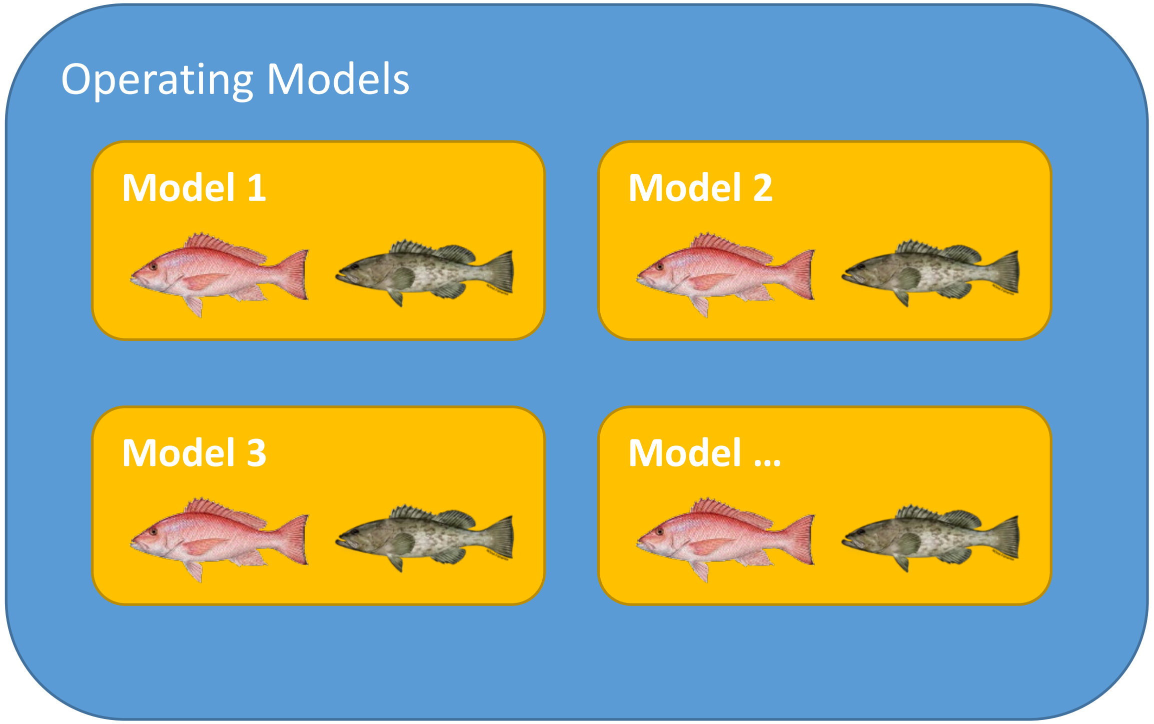


The MSE Process: Operating Models

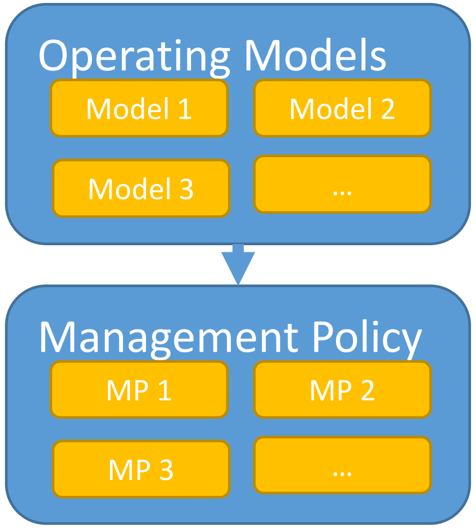
Building the Operating Models

Questions:

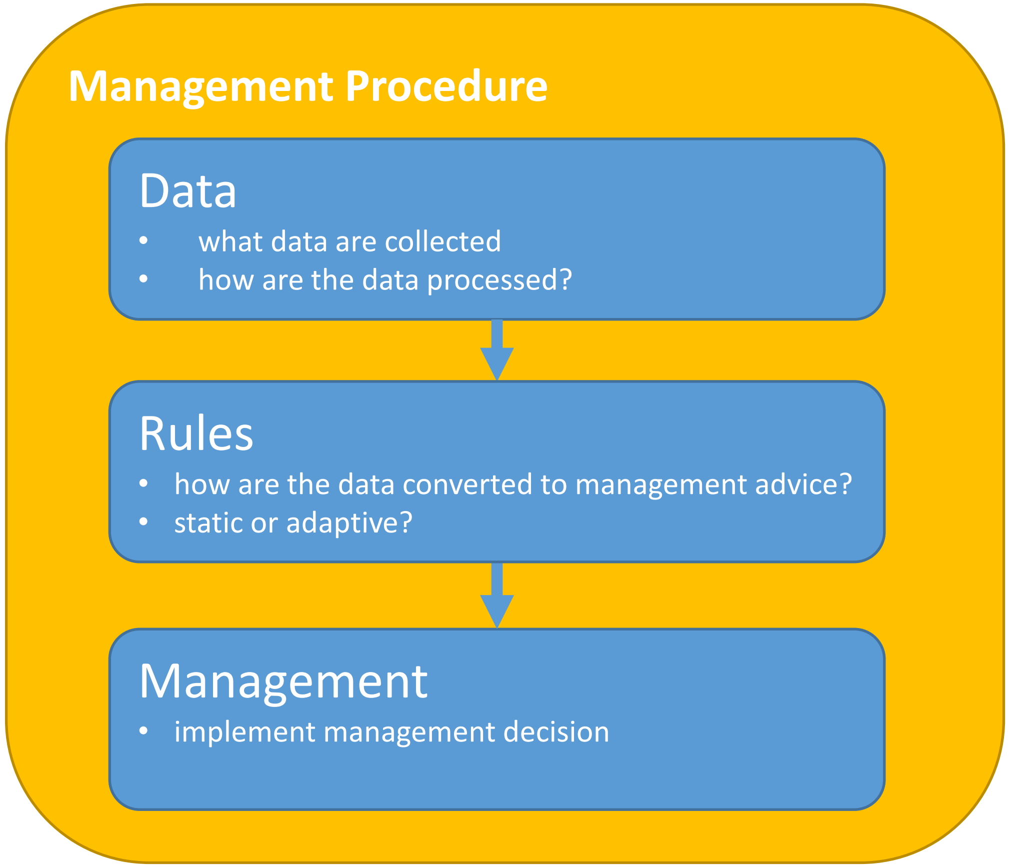
- Which stocks to include?
- What information is available?
- What are the interactions between stocks?
- What are the key uncertainties?



The MSE Process: Management Procedures



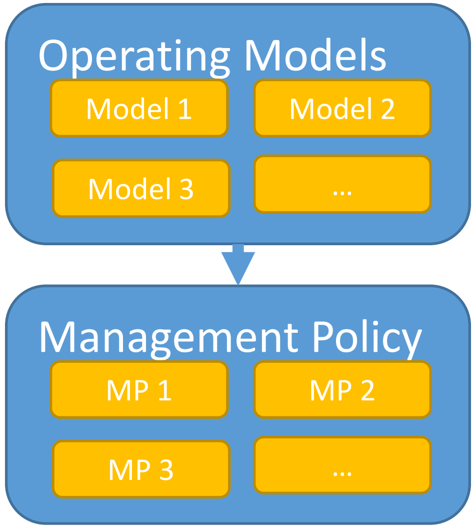
Management Procedure: A process for going from data to a management decision



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



A Simple Example:

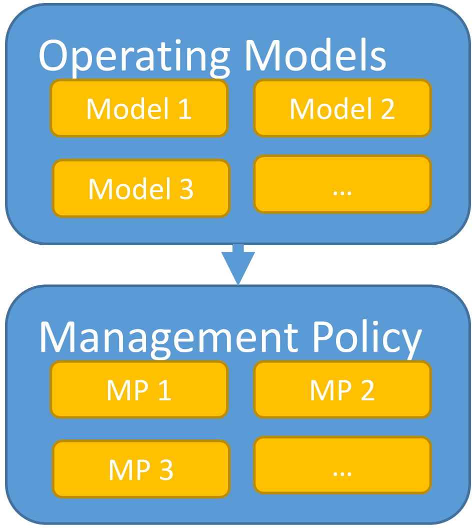
Management Procedure

Data
- collect catch-per-unit-effort data
- standardize it into an index of abundance

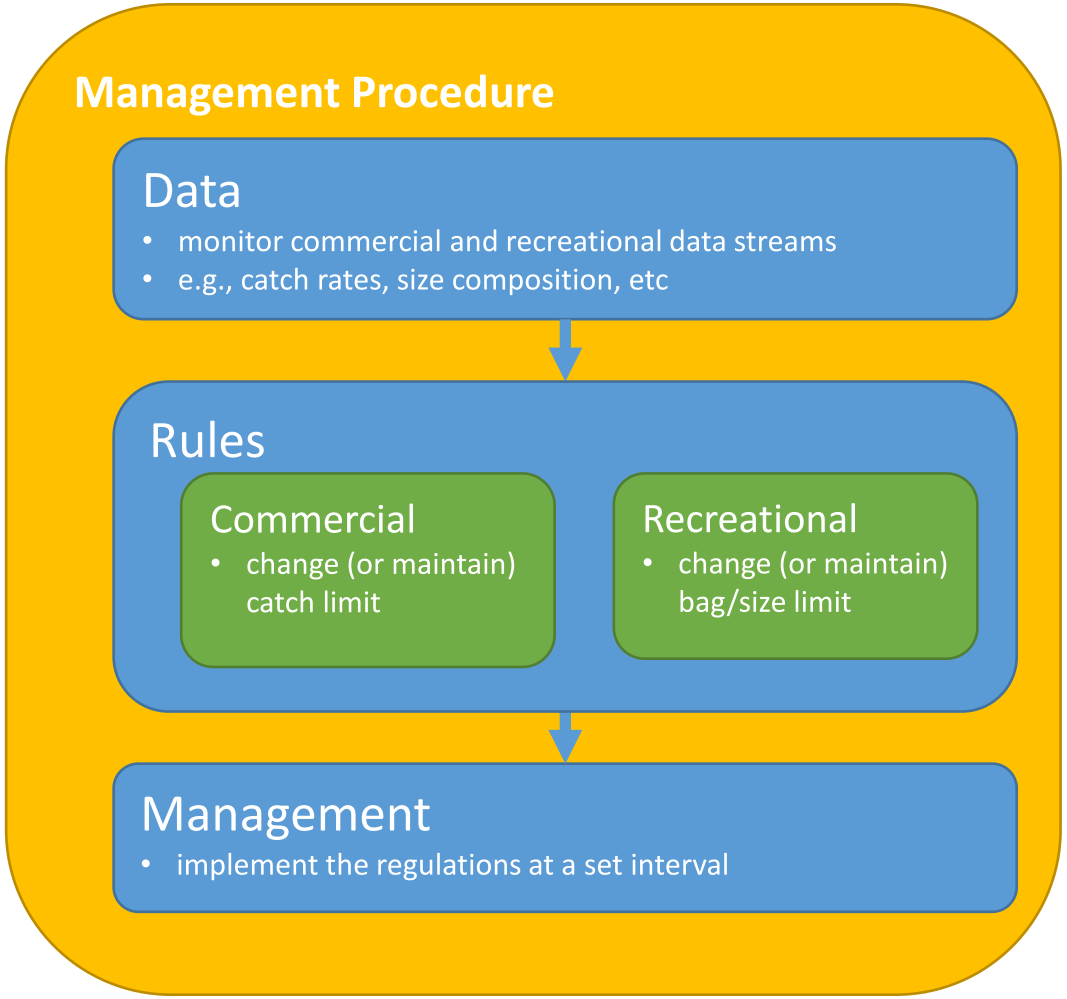
Rules
- if the index is above a target level, increase catch limit by 10%
- if the index is below a limit level, decrease catch limit by 10%
- otherwise, leave it the same

Management
- update the catch limit every 3 years

The MSE Process: Management Procedures



Multi-gear General Example: Commercial and Recreational



The MSE Process: Management Procedures

Operating Models

- Model 1
- Model 2
- Model 3
- …

Management Policy

- MP 1
- MP 2
- MP 3
- …

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

Multi-Species Management Plan

Data

- monitor commercial and recreational data streams
- e.g., catch rates, size composition, etc

Rules

- Commercial
- Recreational

- Commercial
- Recreational

Management

- implement the regulations at a set interval

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

Operating Models

- Model 1
- Model 2
- Model 3
- …

Management Policy

- MP 1
- MP 2
- MP 3
- …

Candidate Management Procedures

Candidate Management Procedures

MP 1
- Data and Rules

MP 2
- Different Rules (and data?)

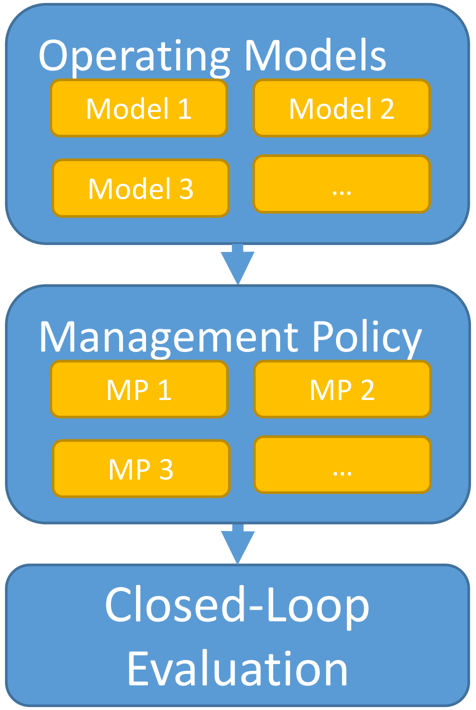
MP 3
- Different Rules (and data?)

MP …
- Different Rules (and data?)

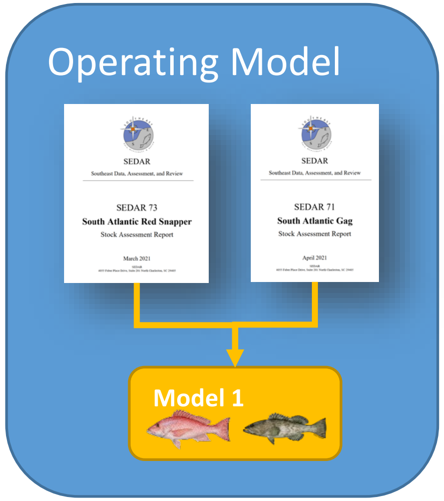
Questions:

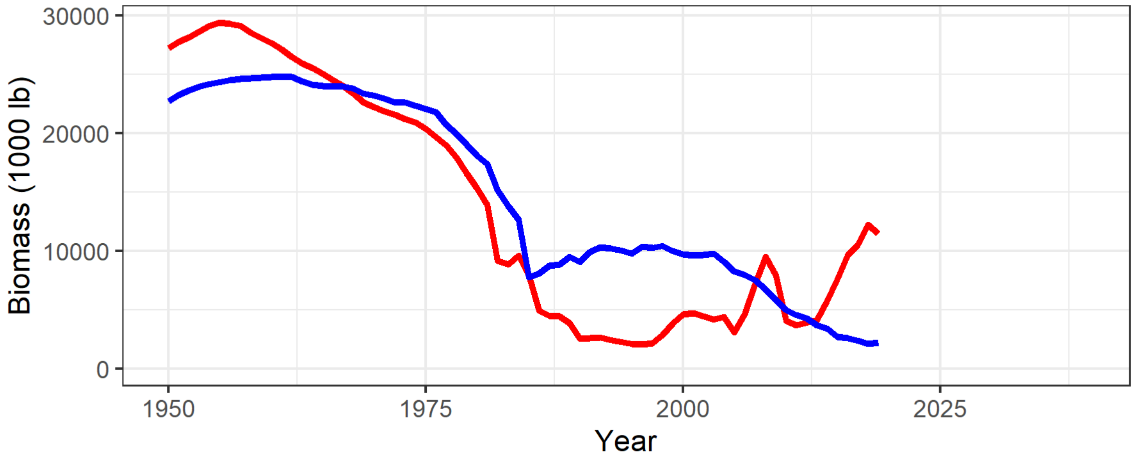
- What data can be used to inform management?
- Feasible management options?
  - by gear type?
  - by stock?
- Management update cycle?

The MSE Process: Evaluation



Closed-Loop Simulation Testing

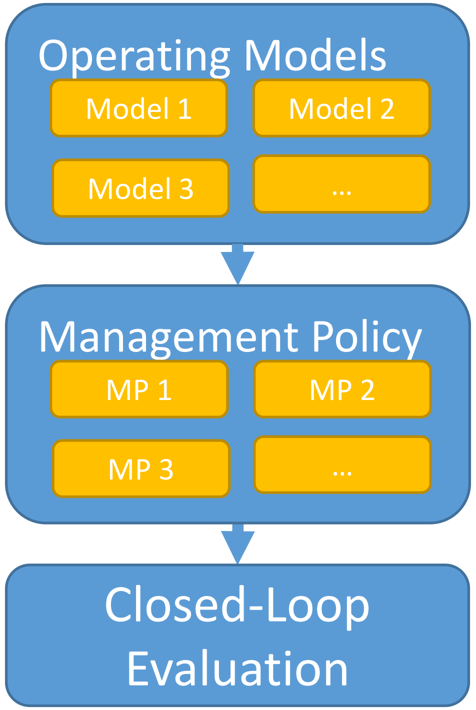




Simulate Fishery

Operating Model

The MSE Process: Evaluation



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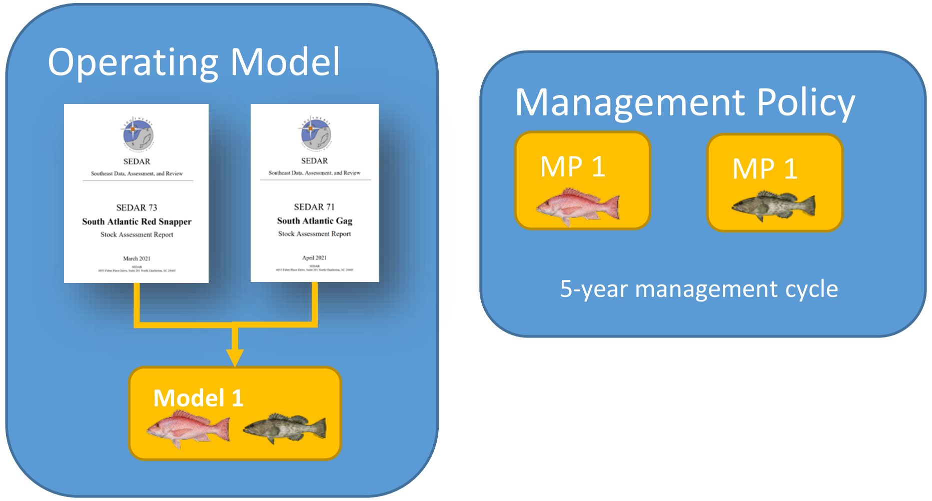

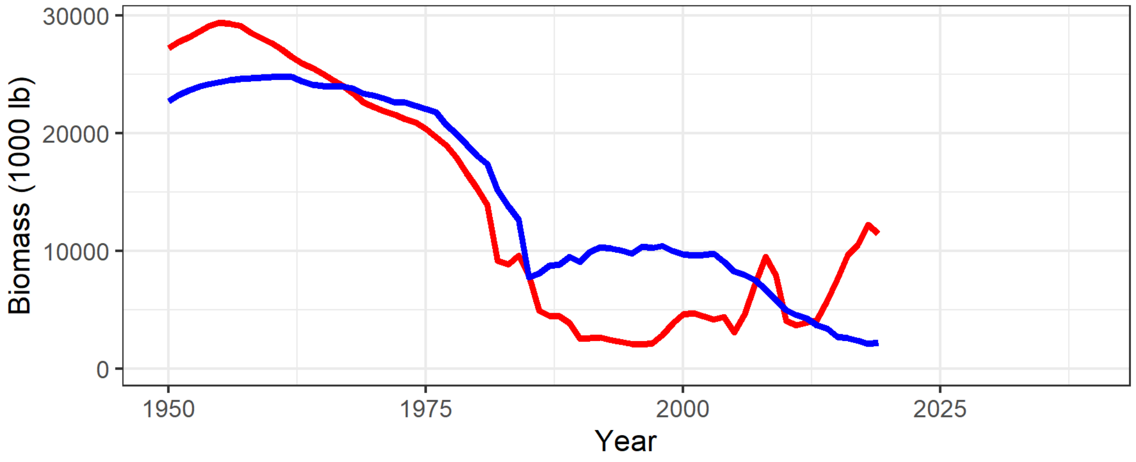

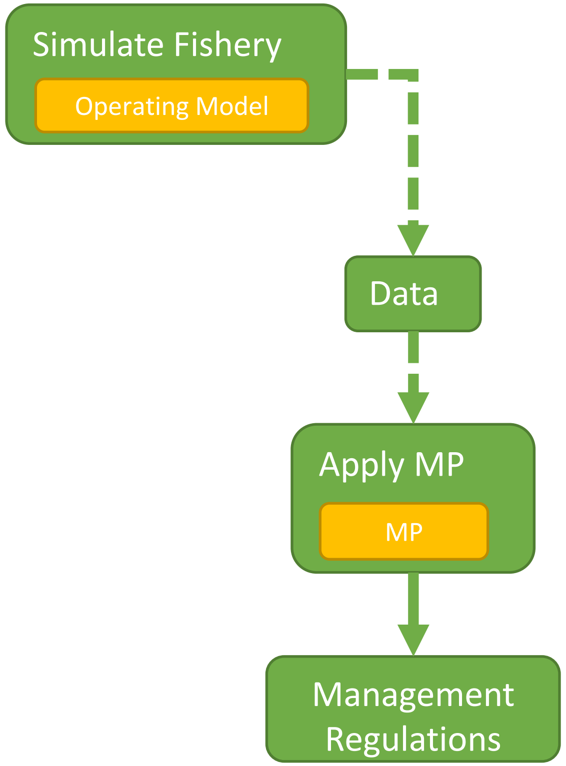

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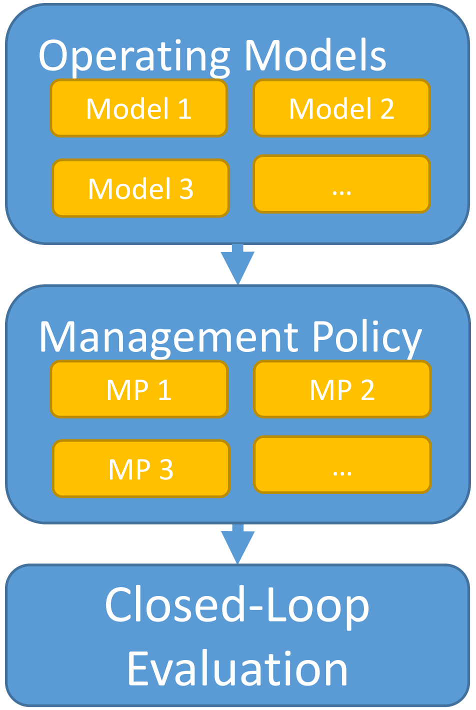

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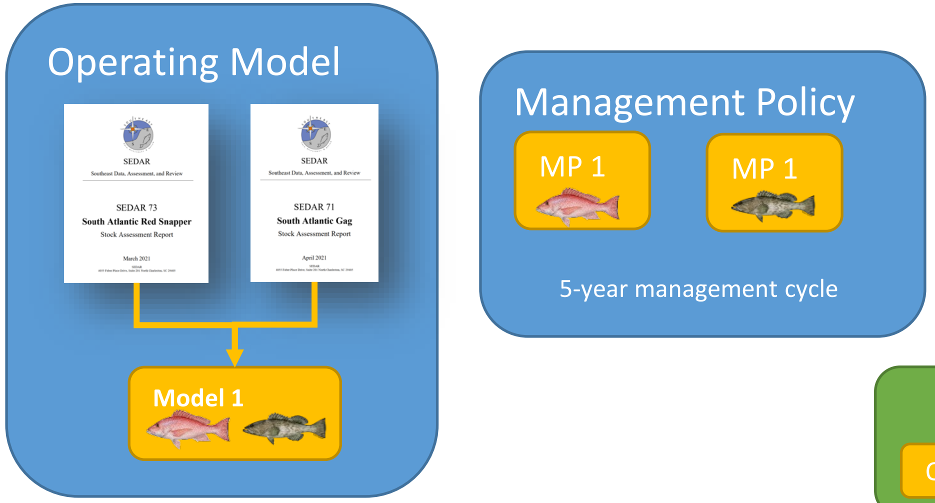

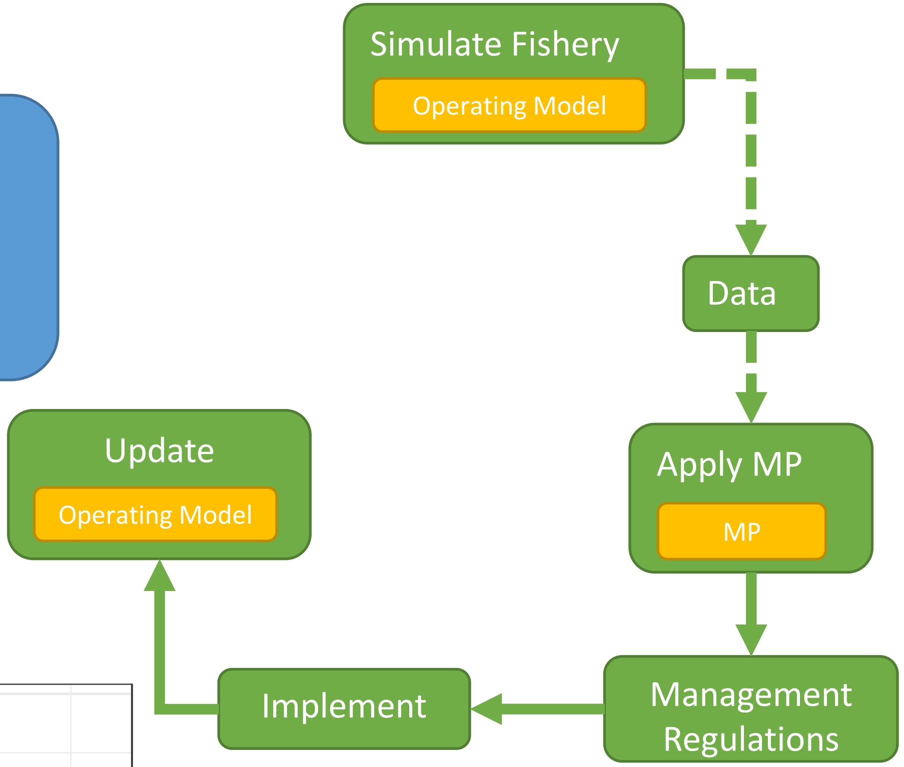

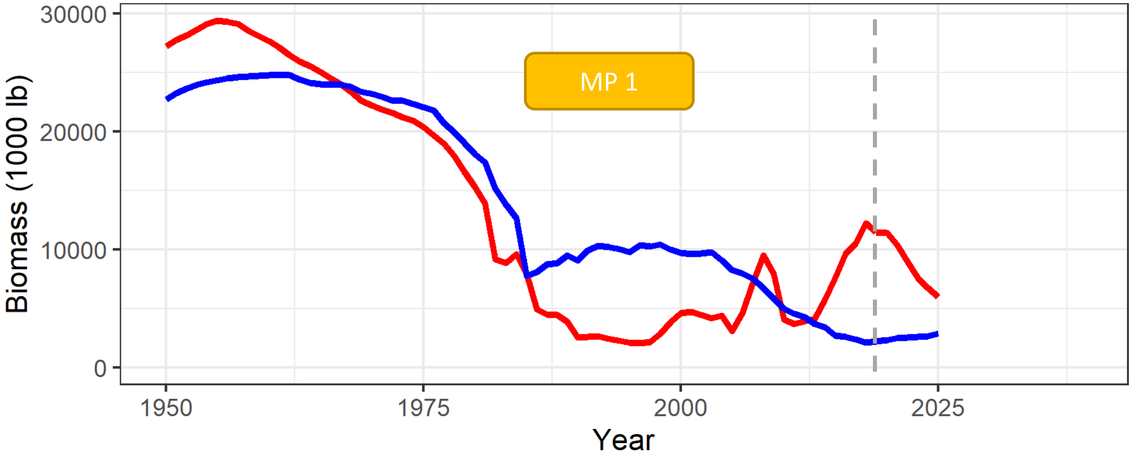

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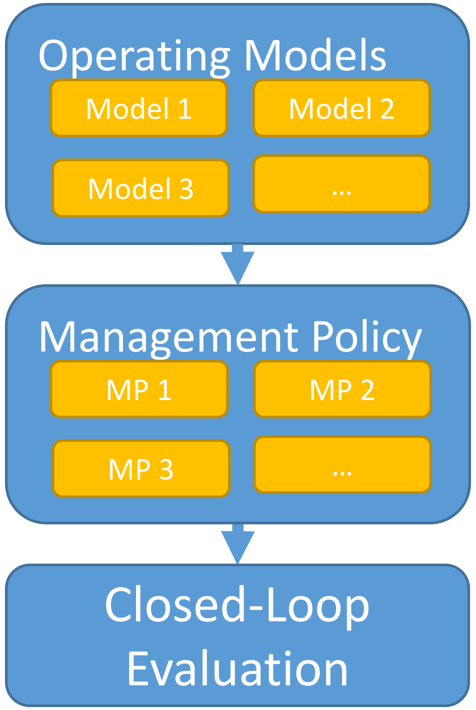

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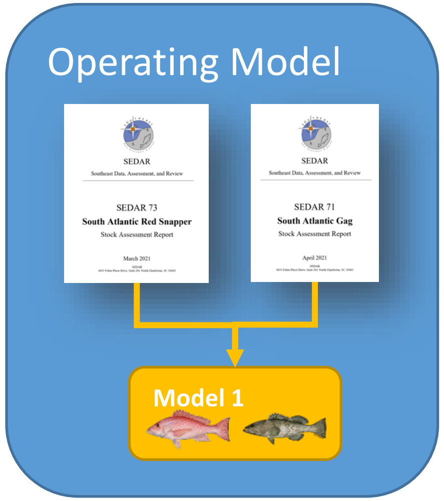

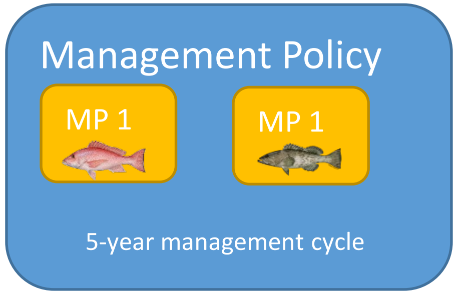

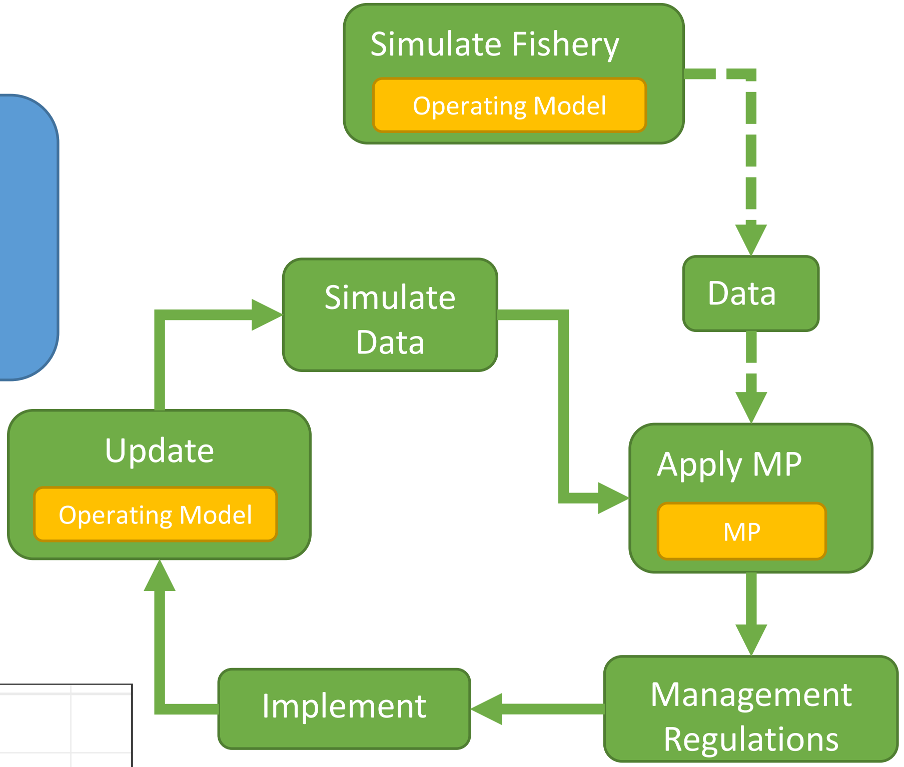

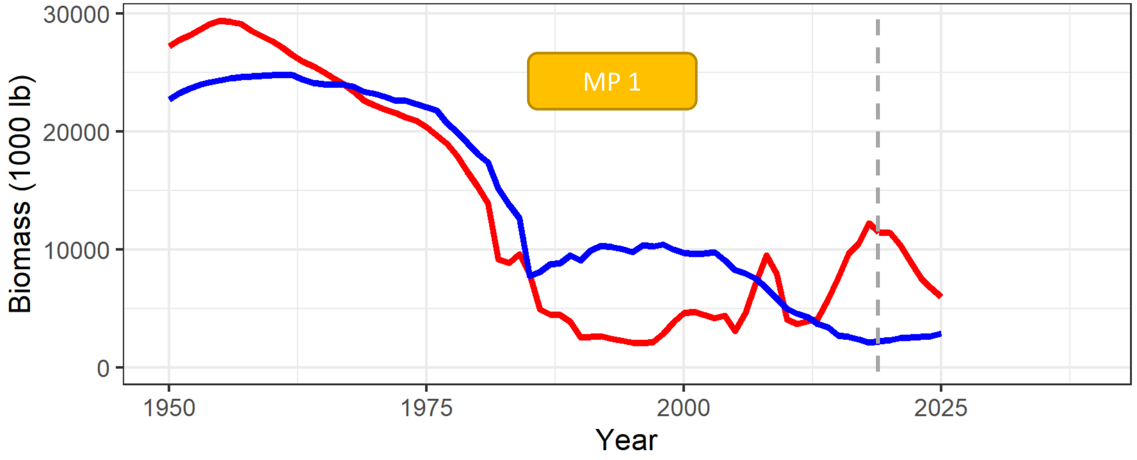

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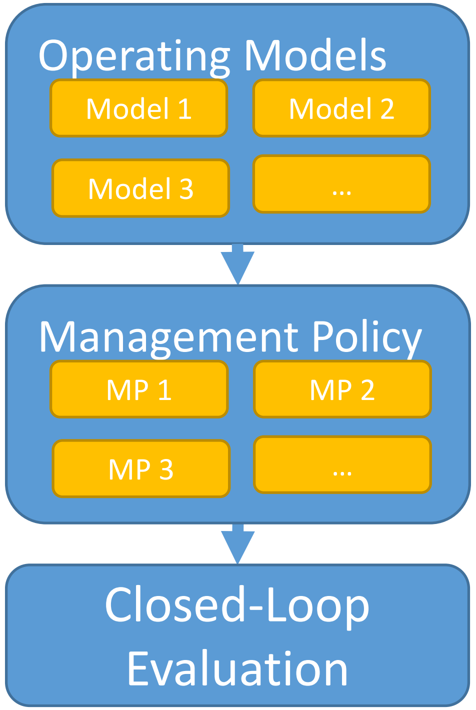

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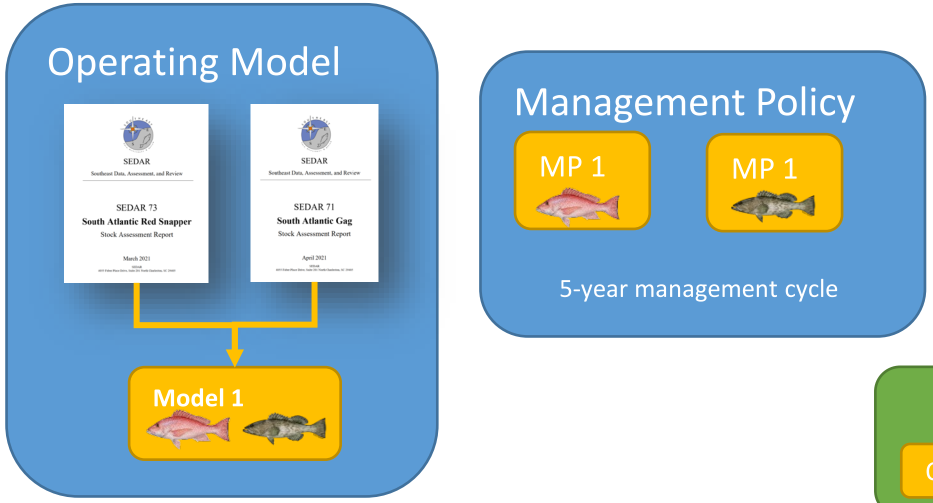

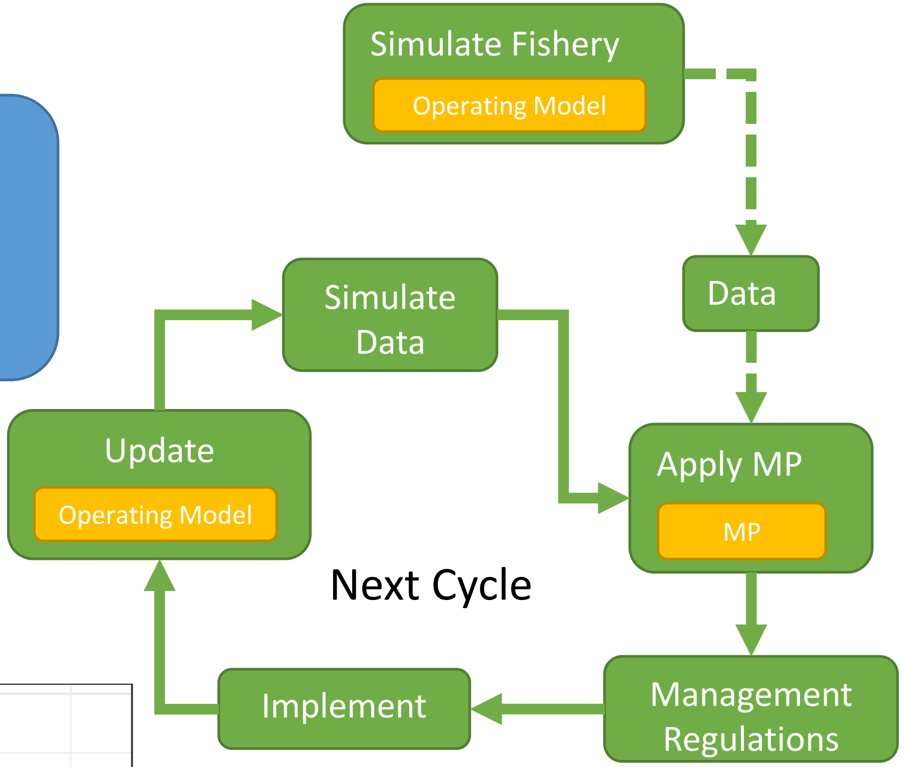

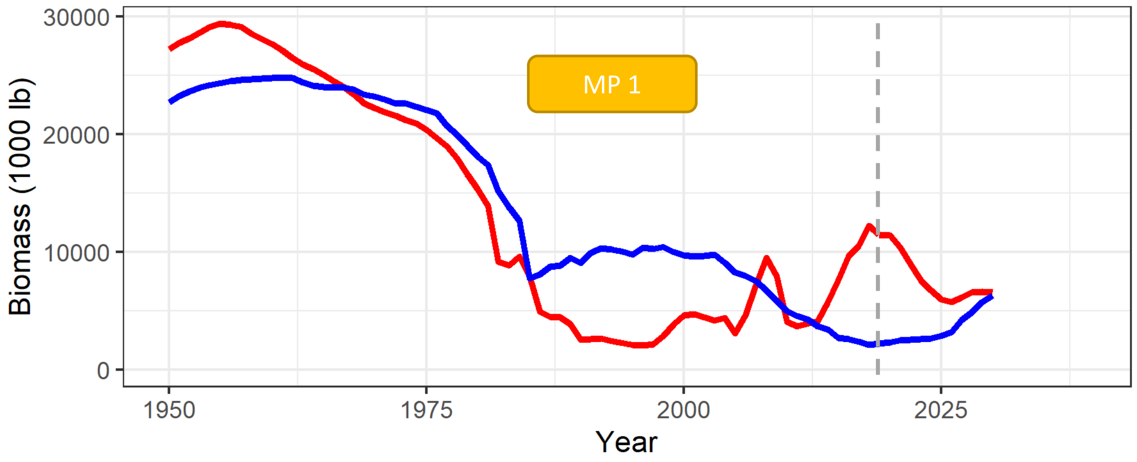

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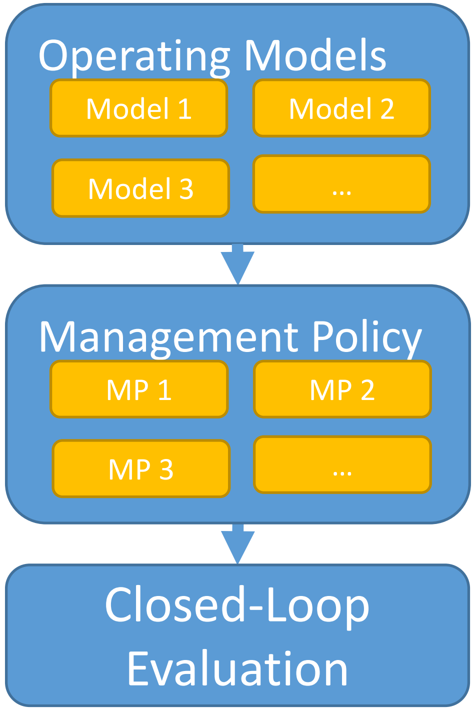

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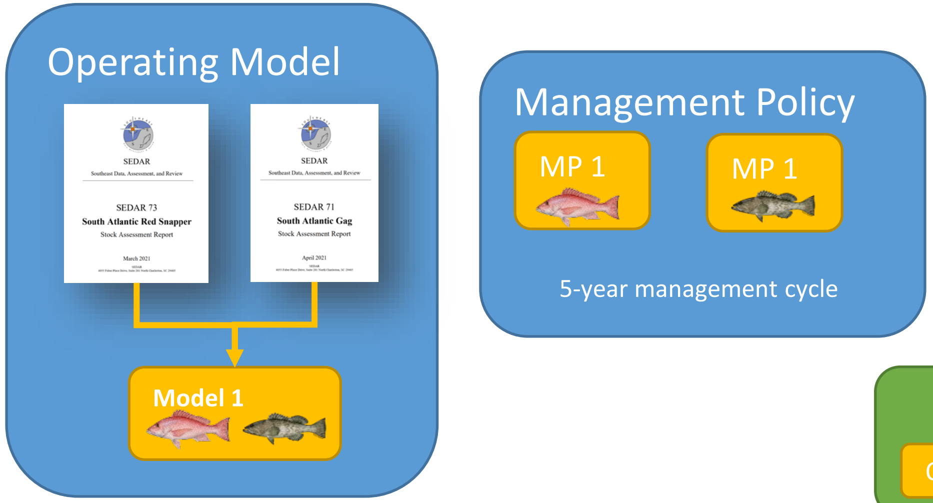

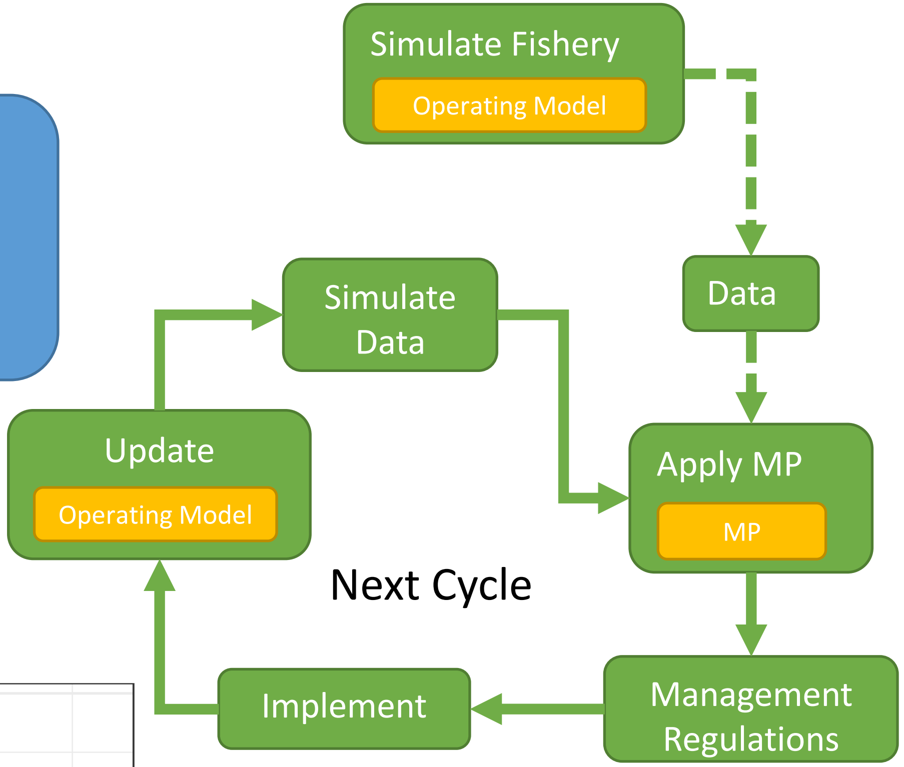

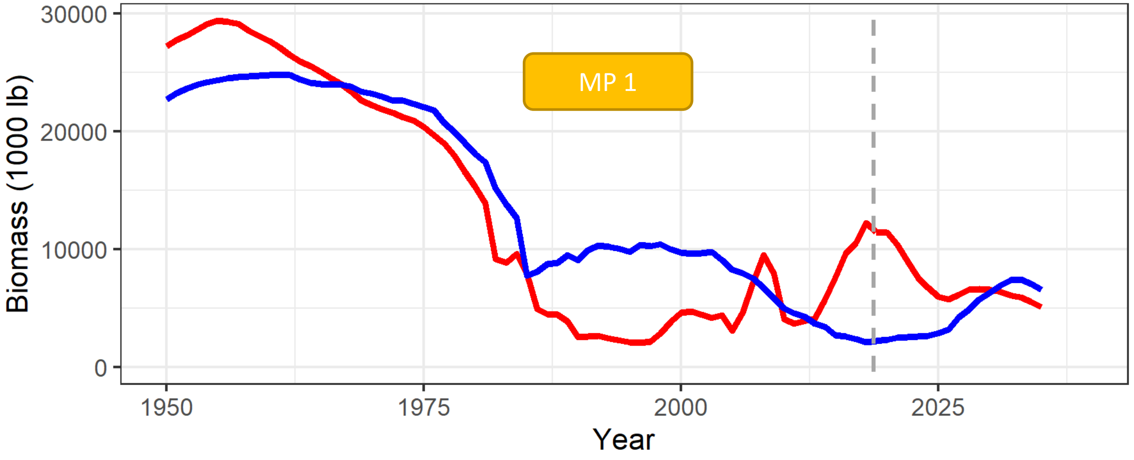

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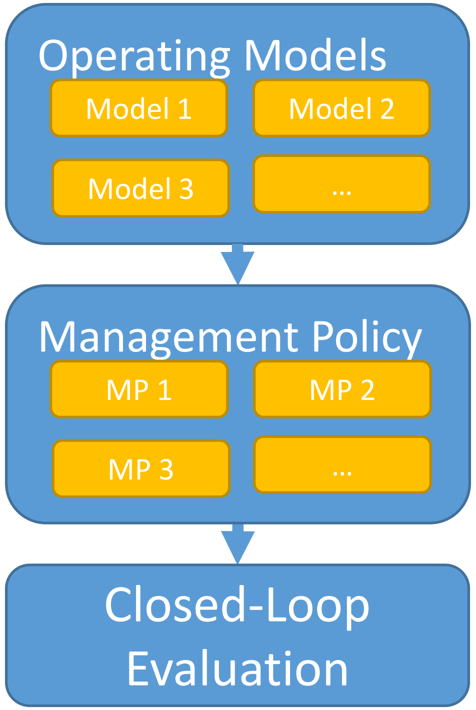

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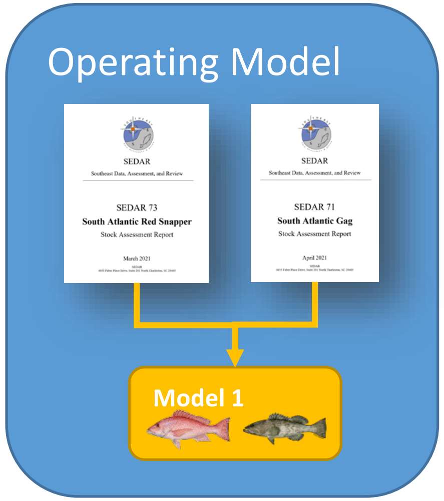

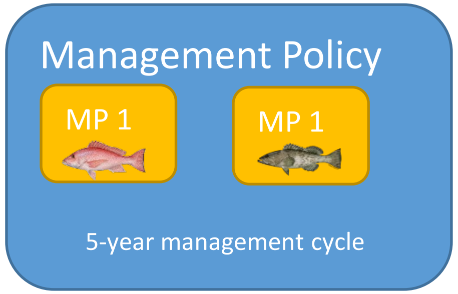

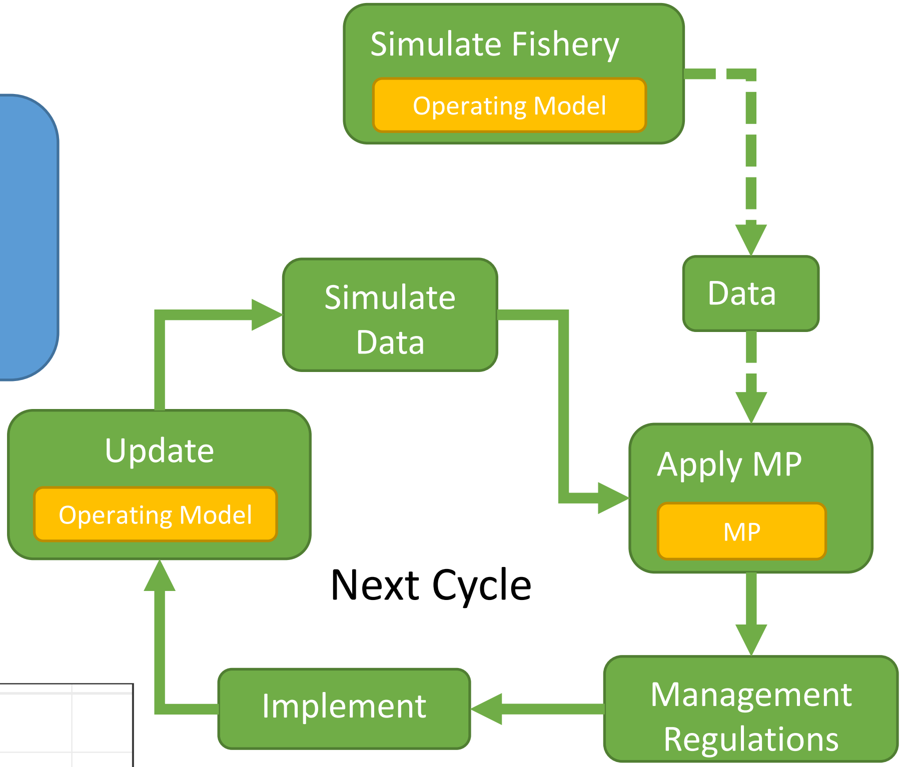

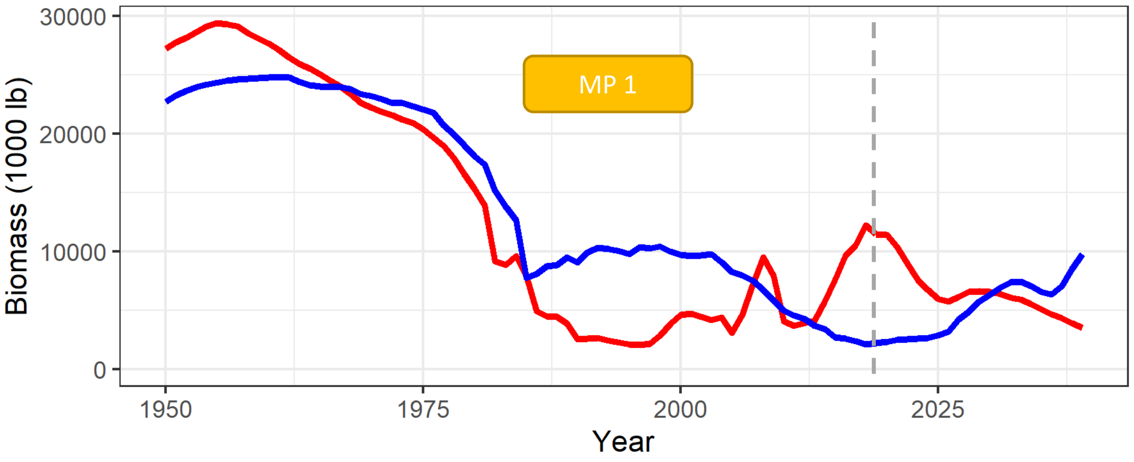

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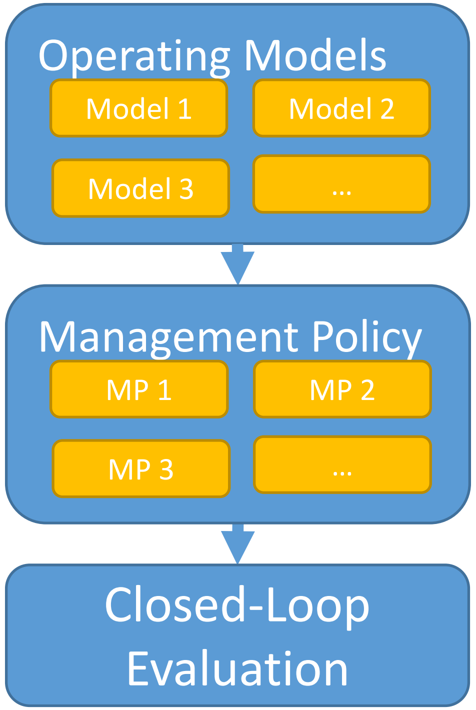

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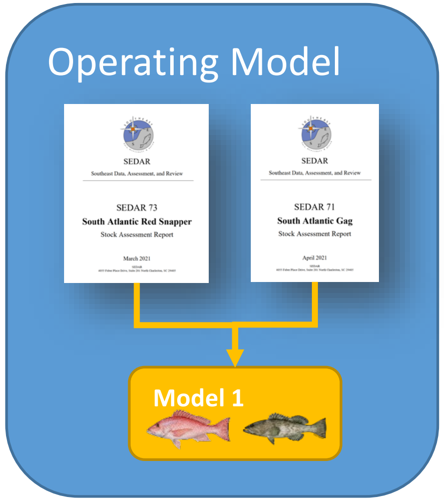
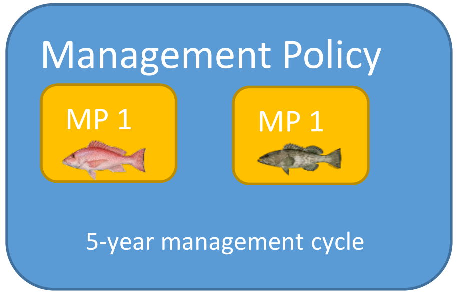
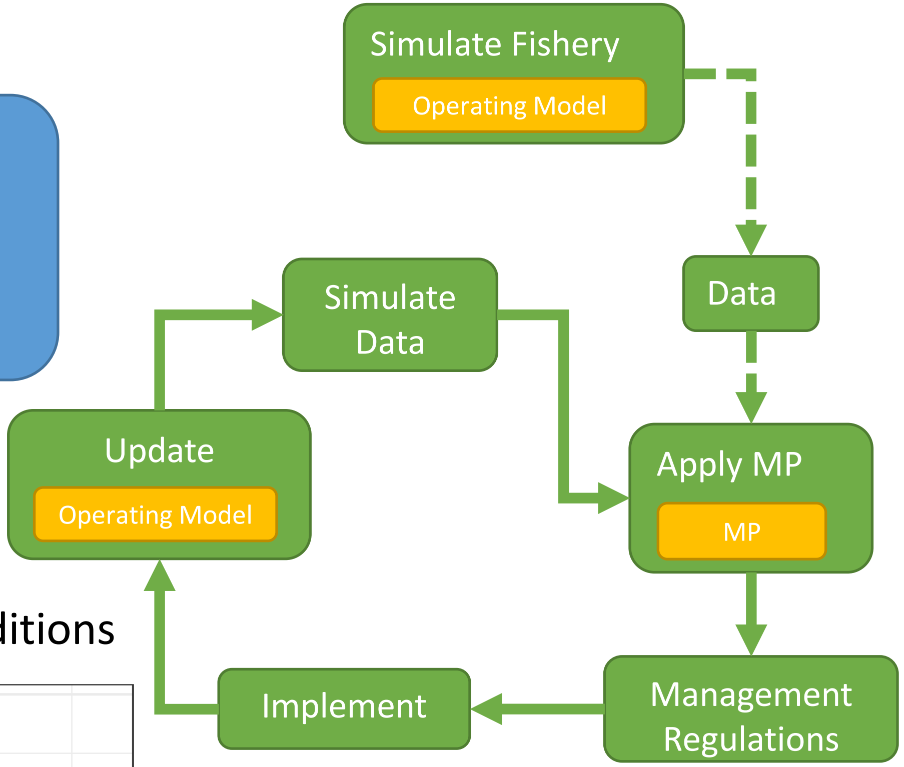
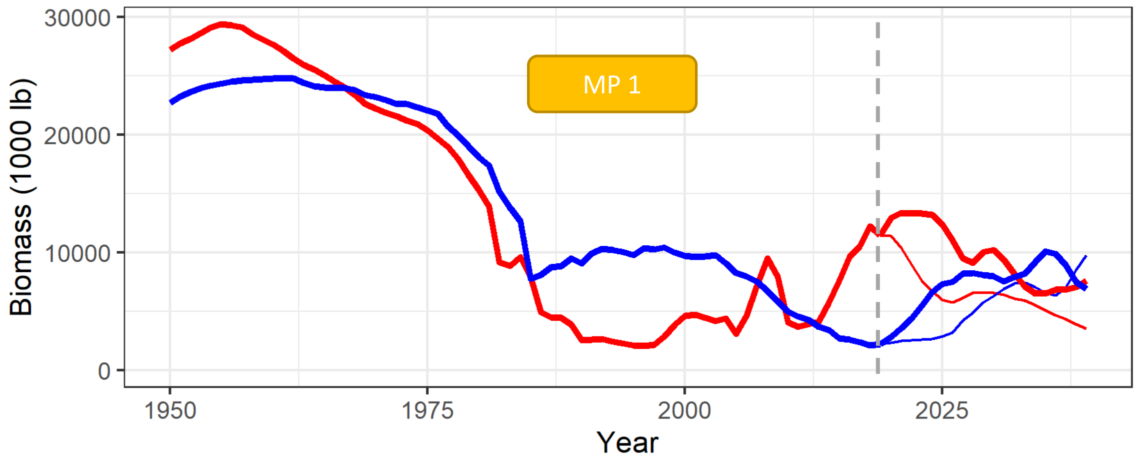






Another Simulation: Different Environmental Conditions



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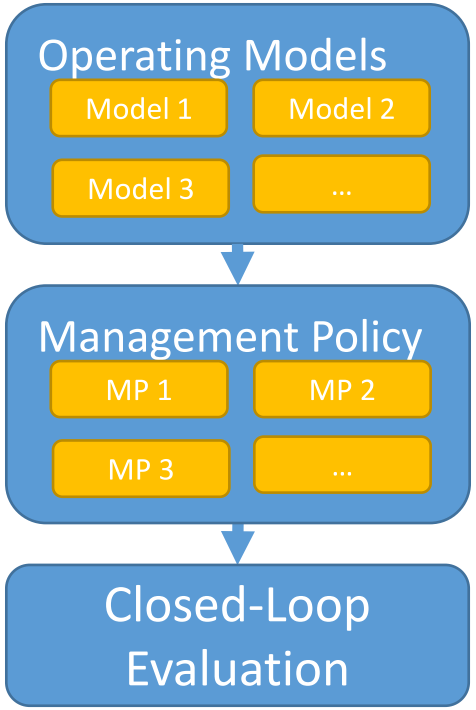

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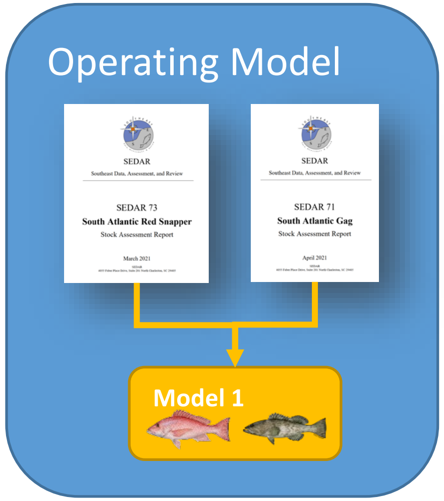
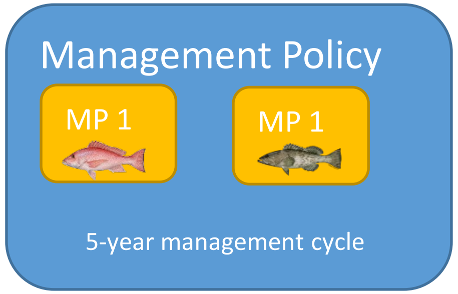
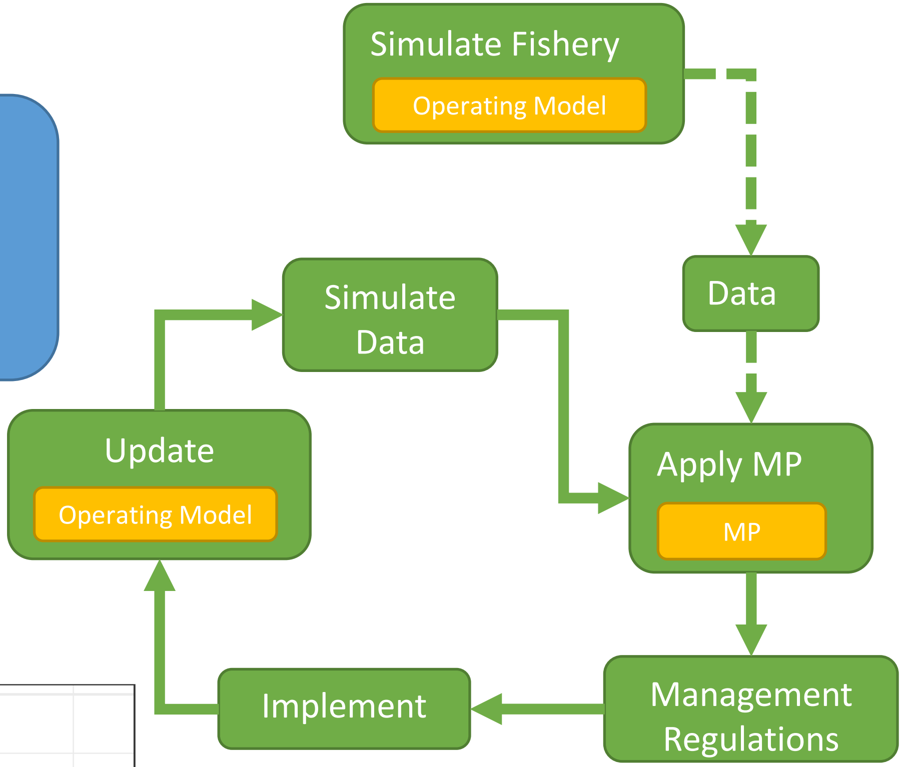
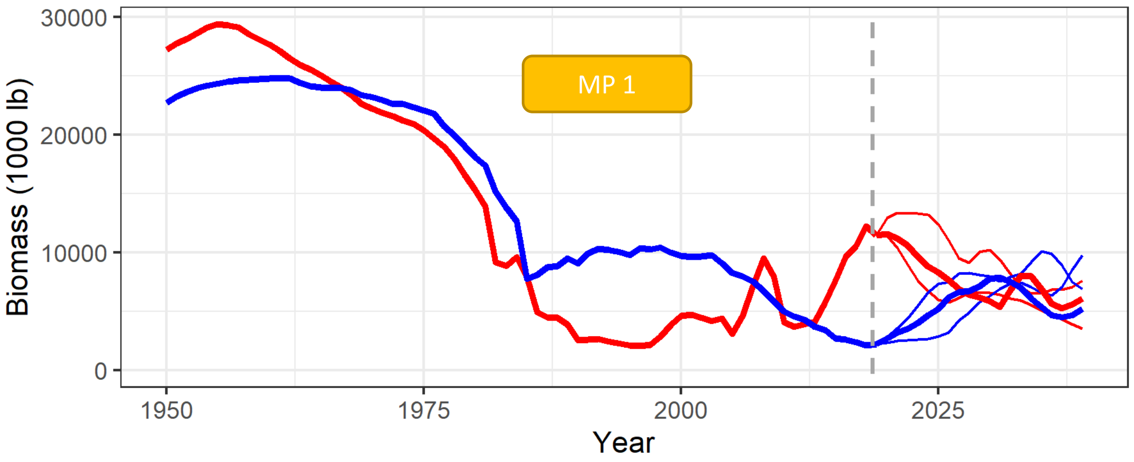


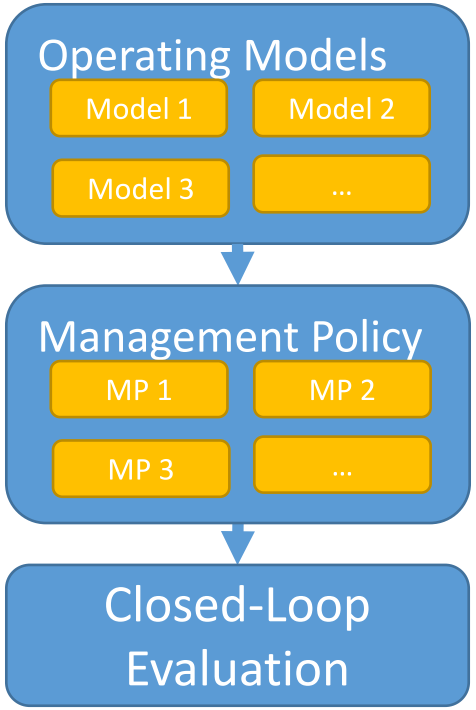




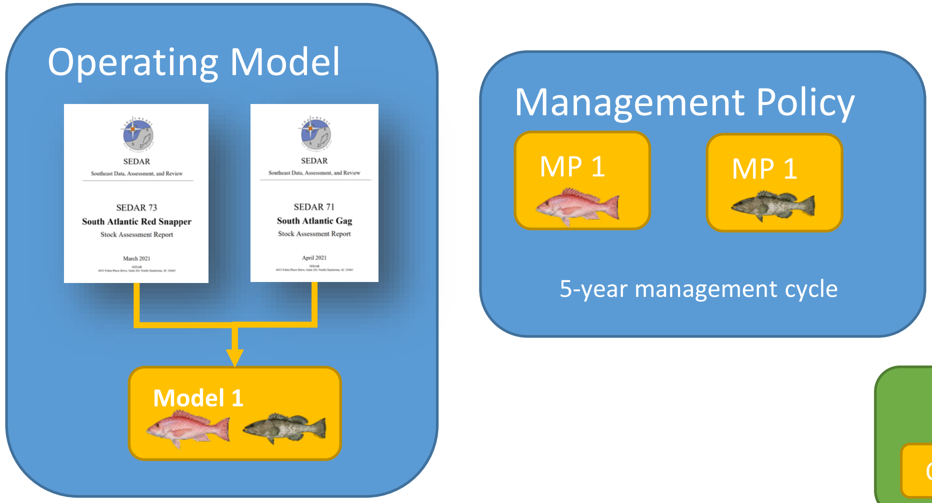
A Third Simulation

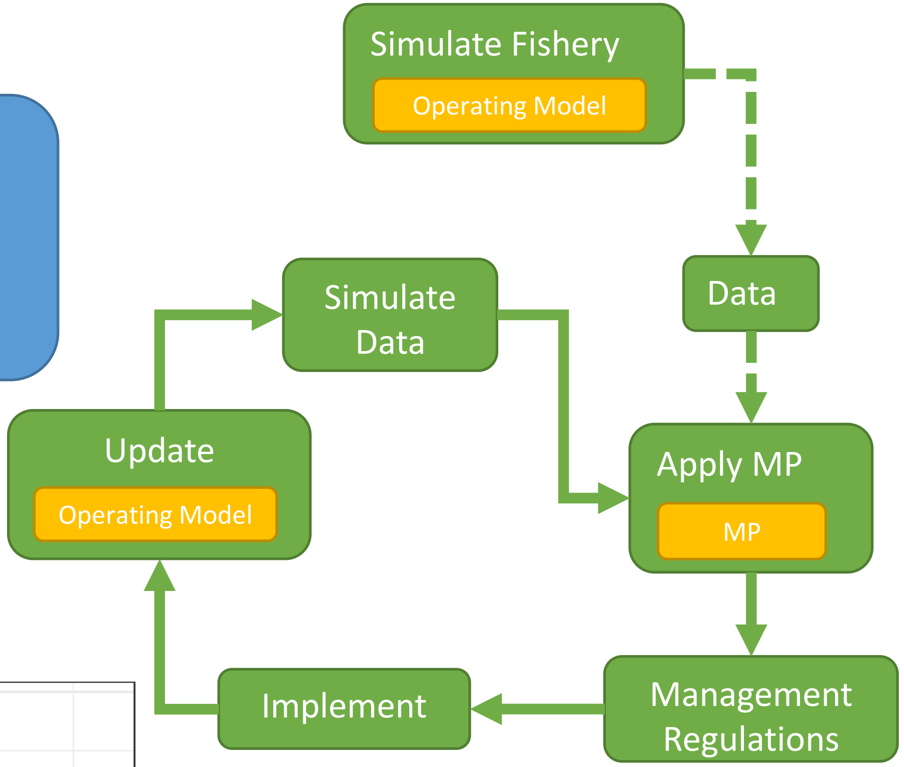


The MSE Process: Evaluation

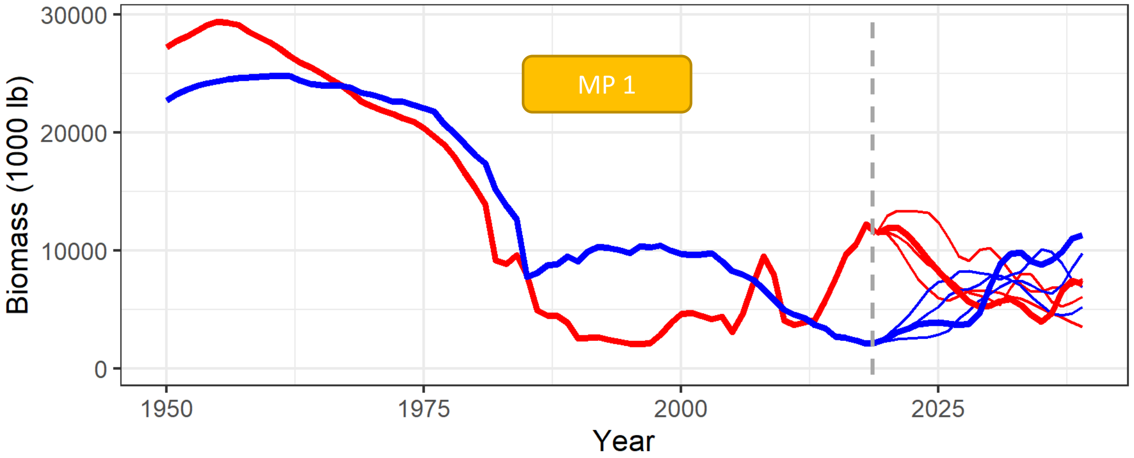


Closed-Loop Simulation Testing





And Another



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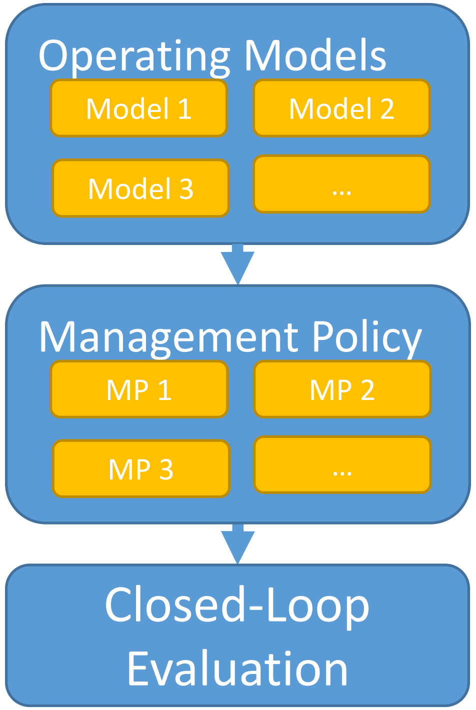

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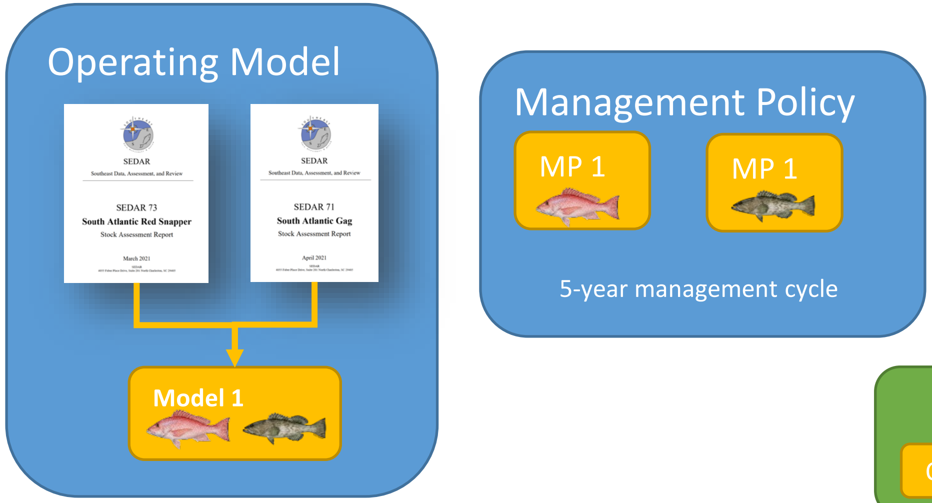

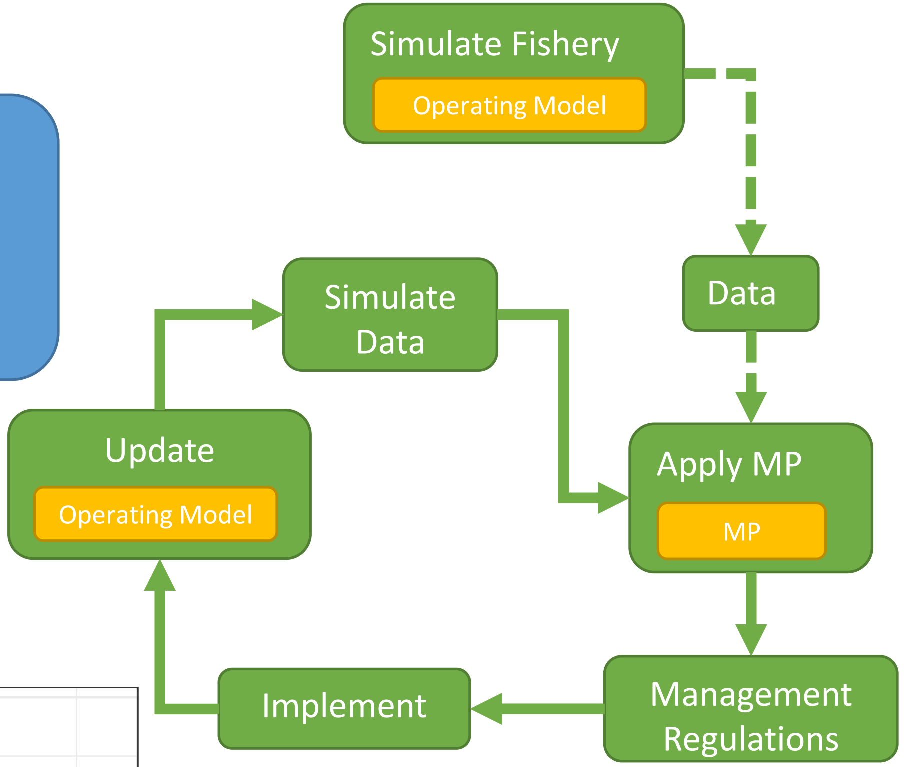

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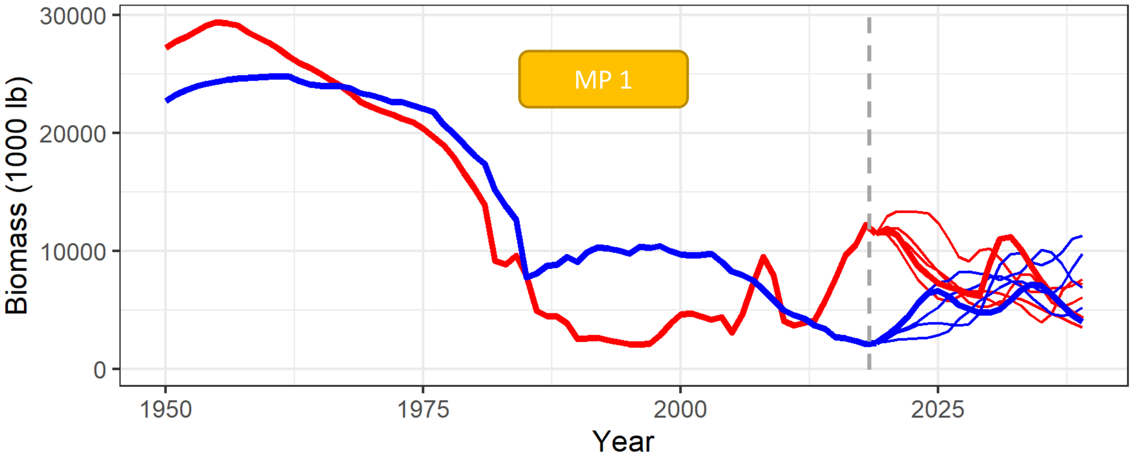

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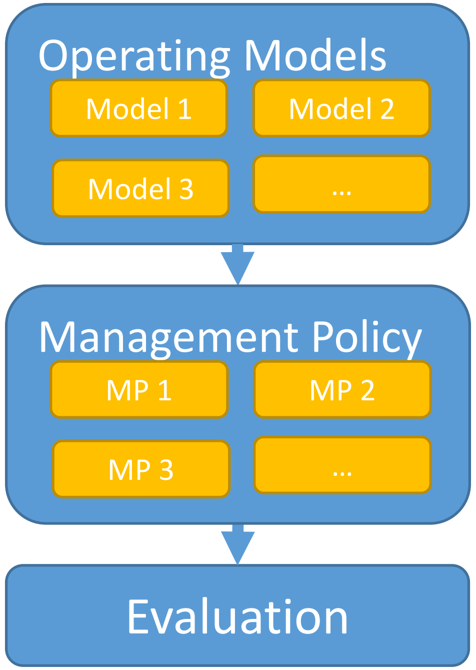

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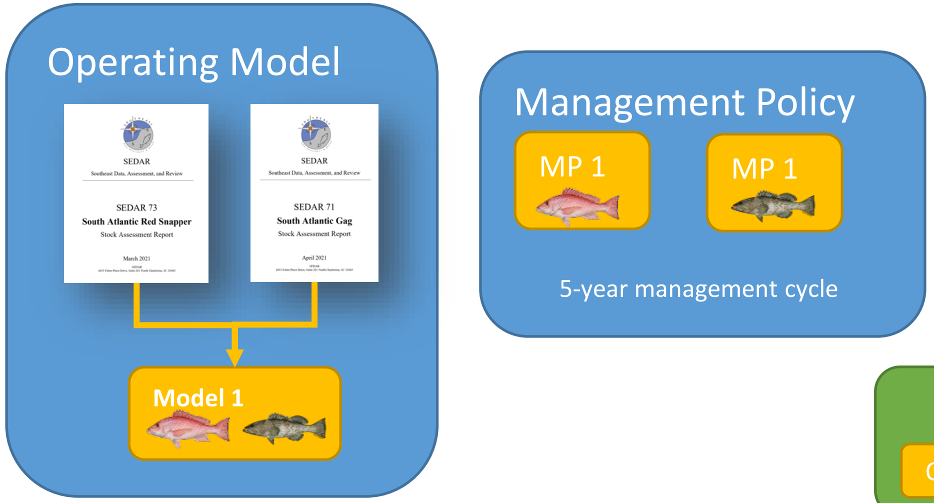

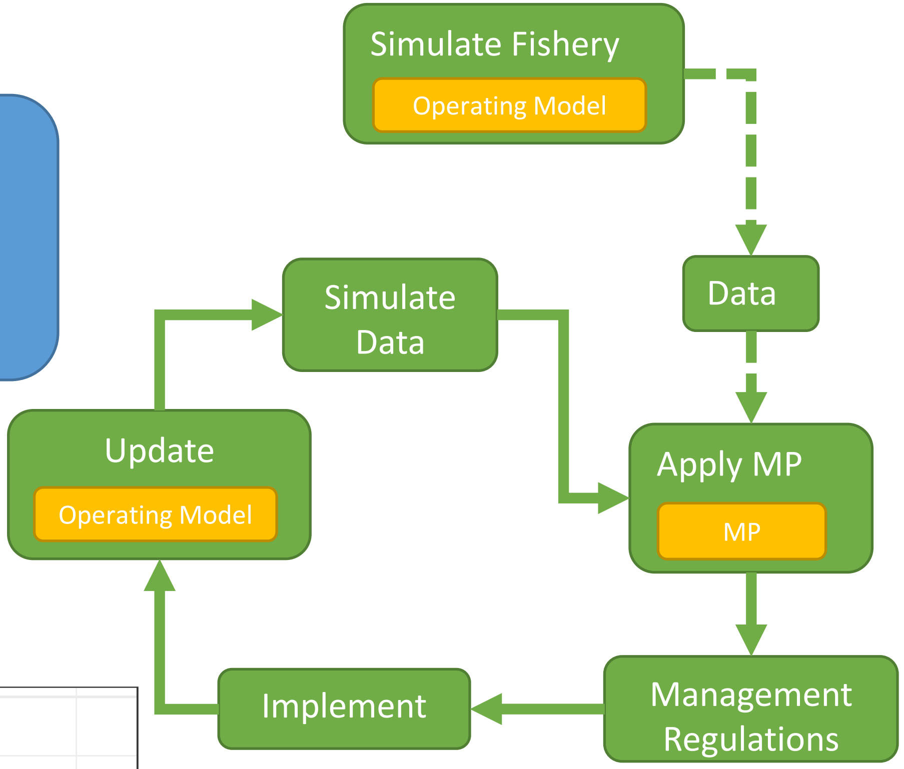

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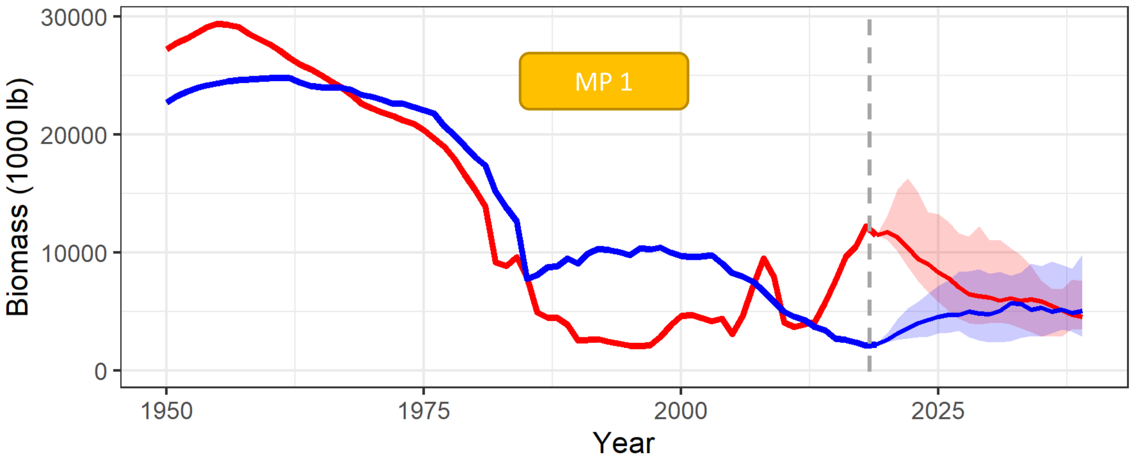

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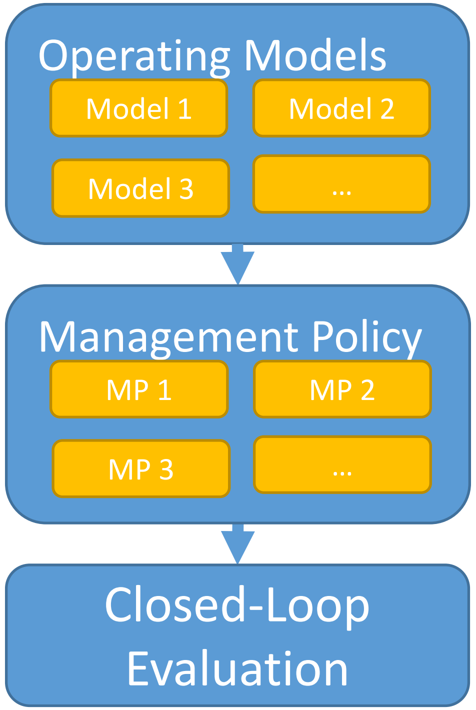

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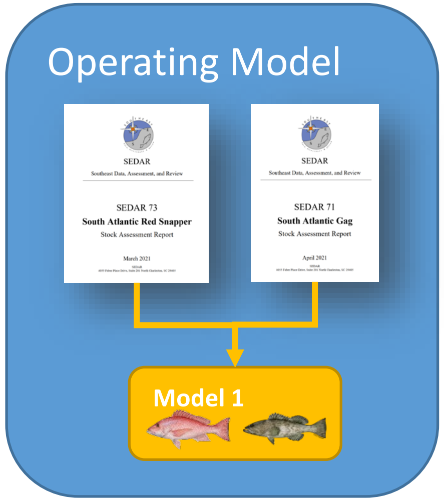
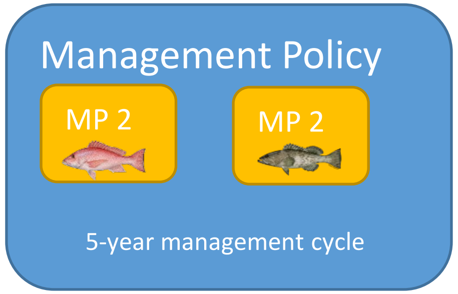
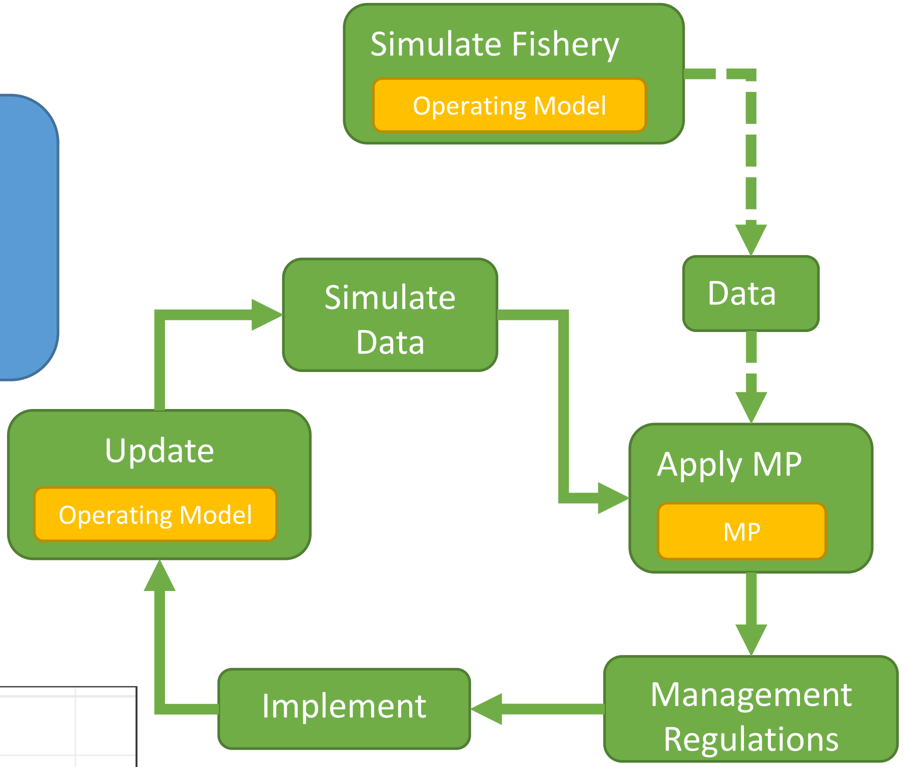
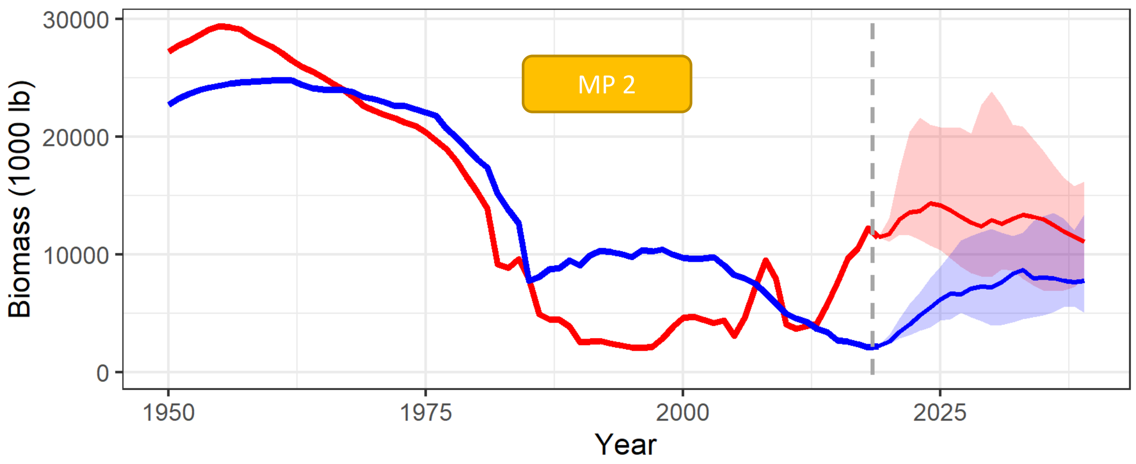






Repeat for MP 2



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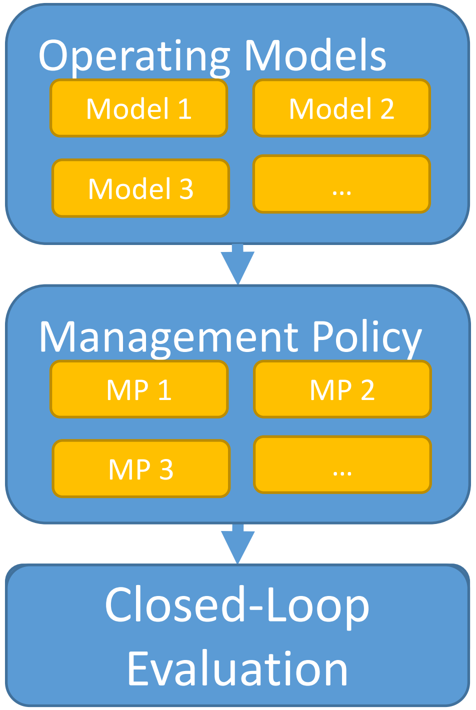

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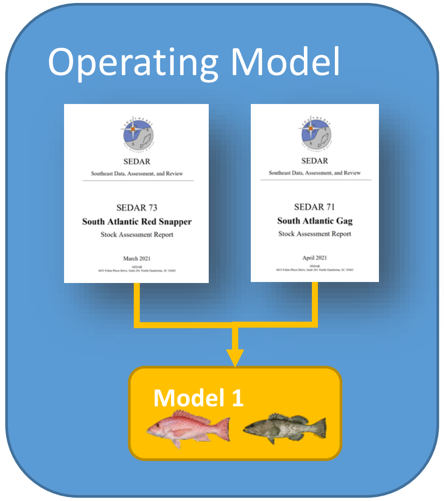
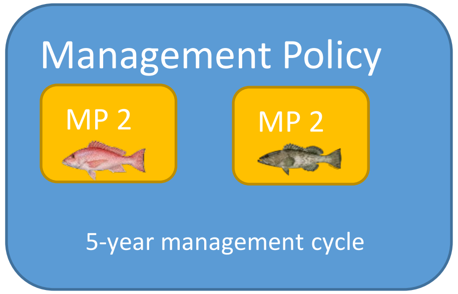
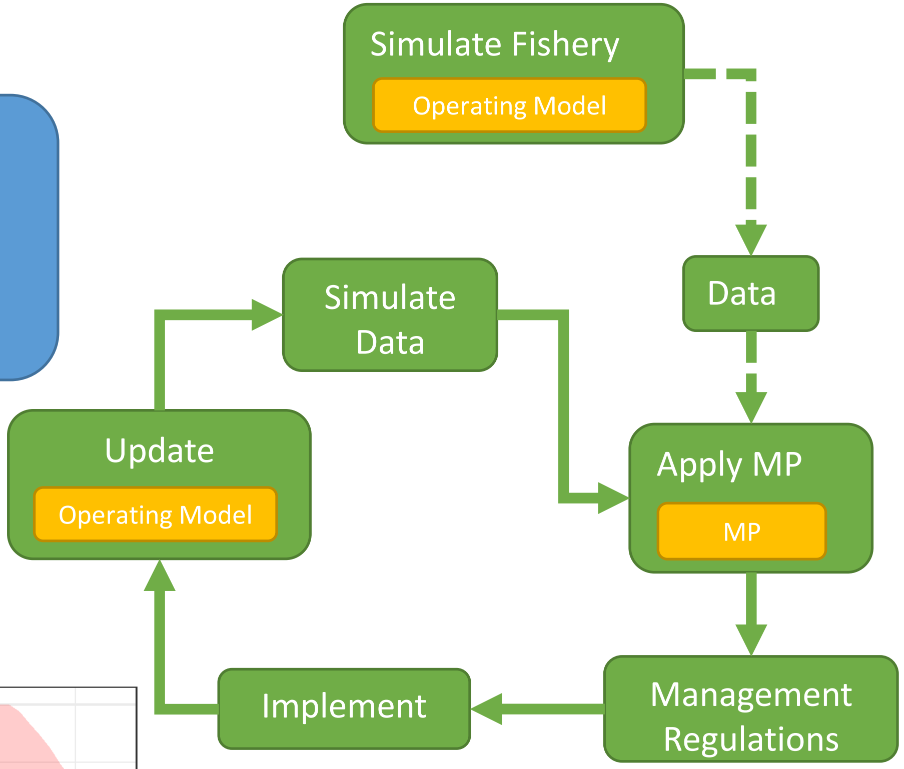
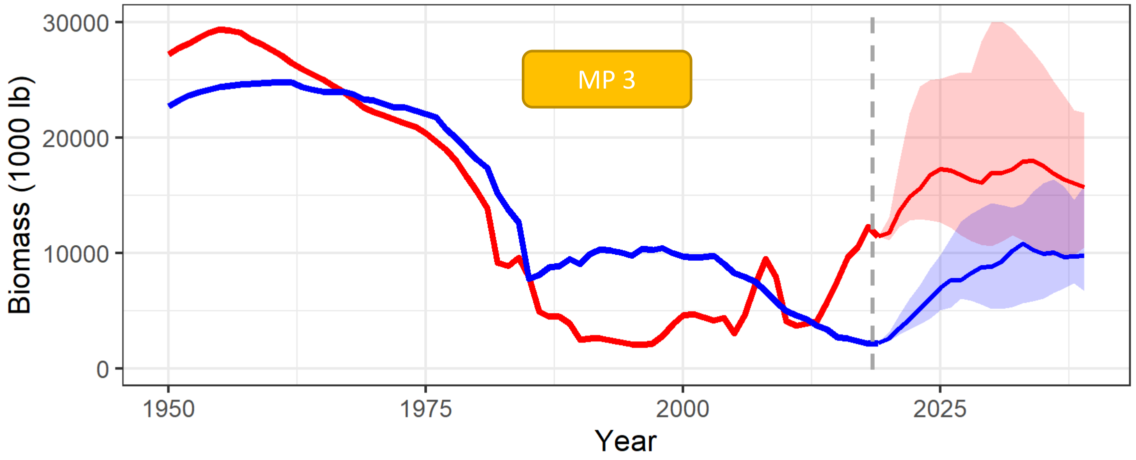


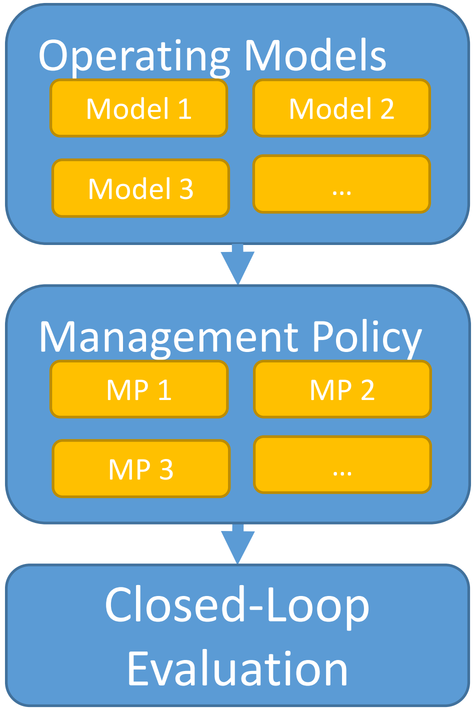




And so on for all MPs



The MSE Process: Evaluation



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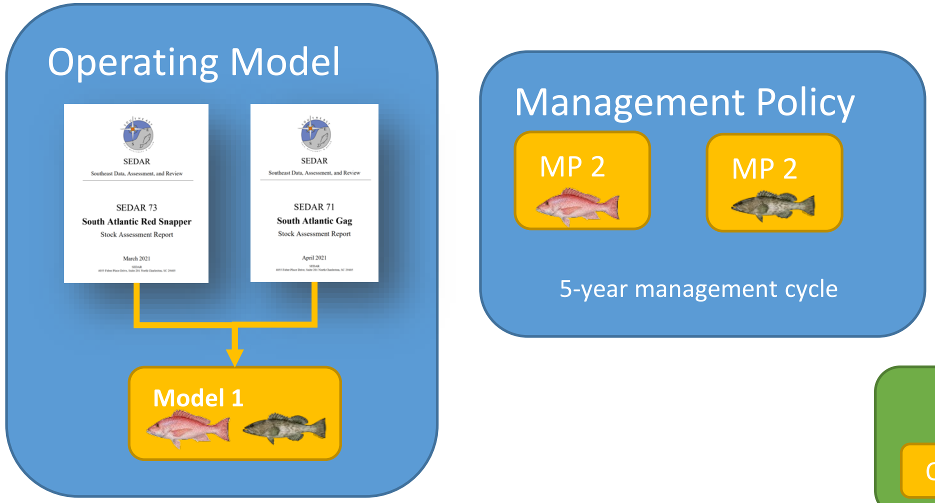
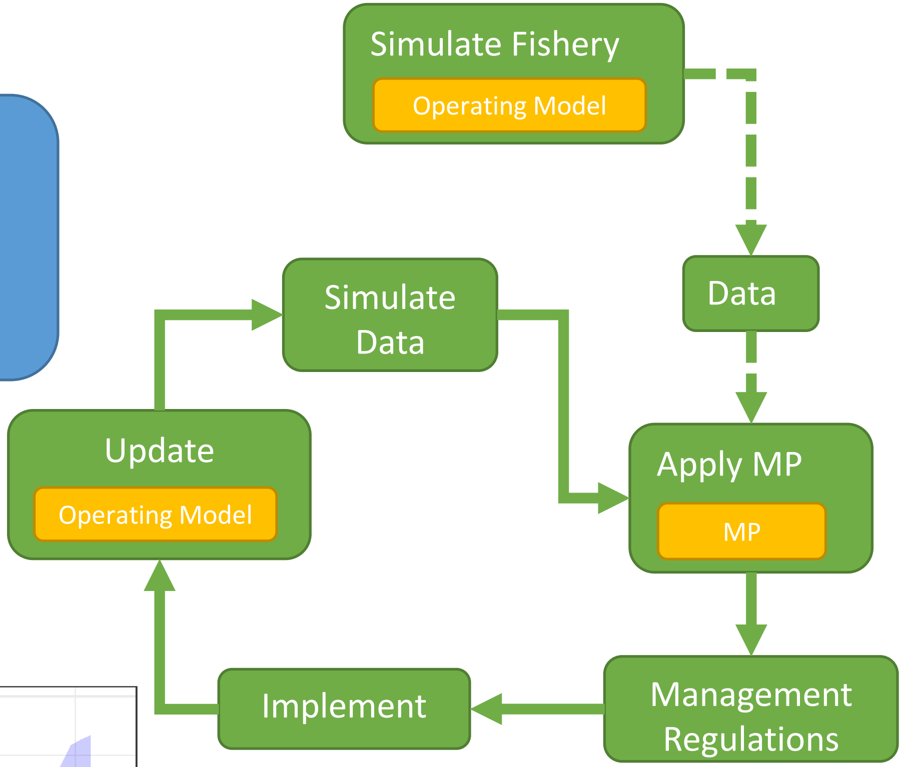
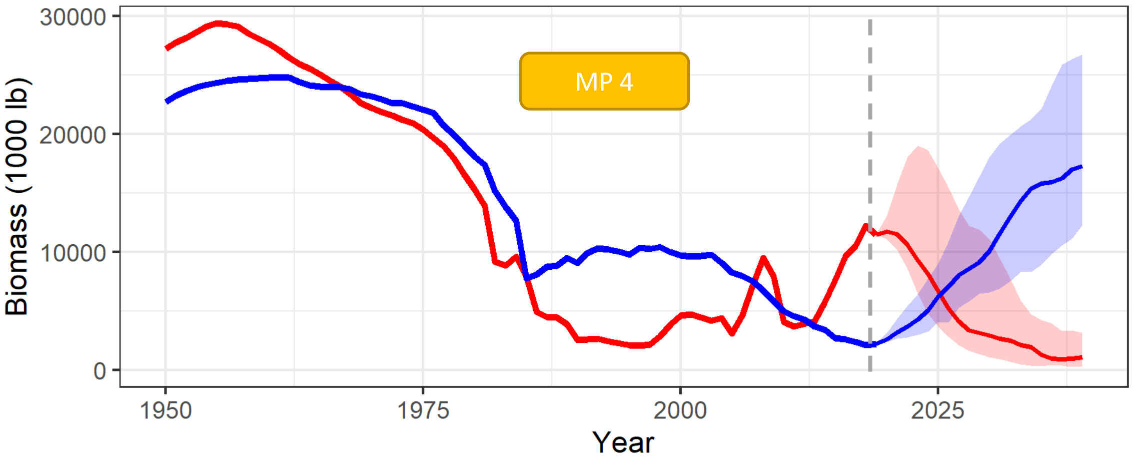
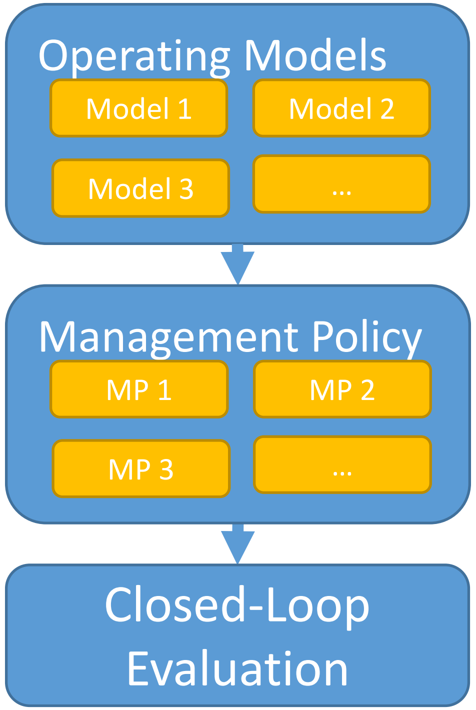


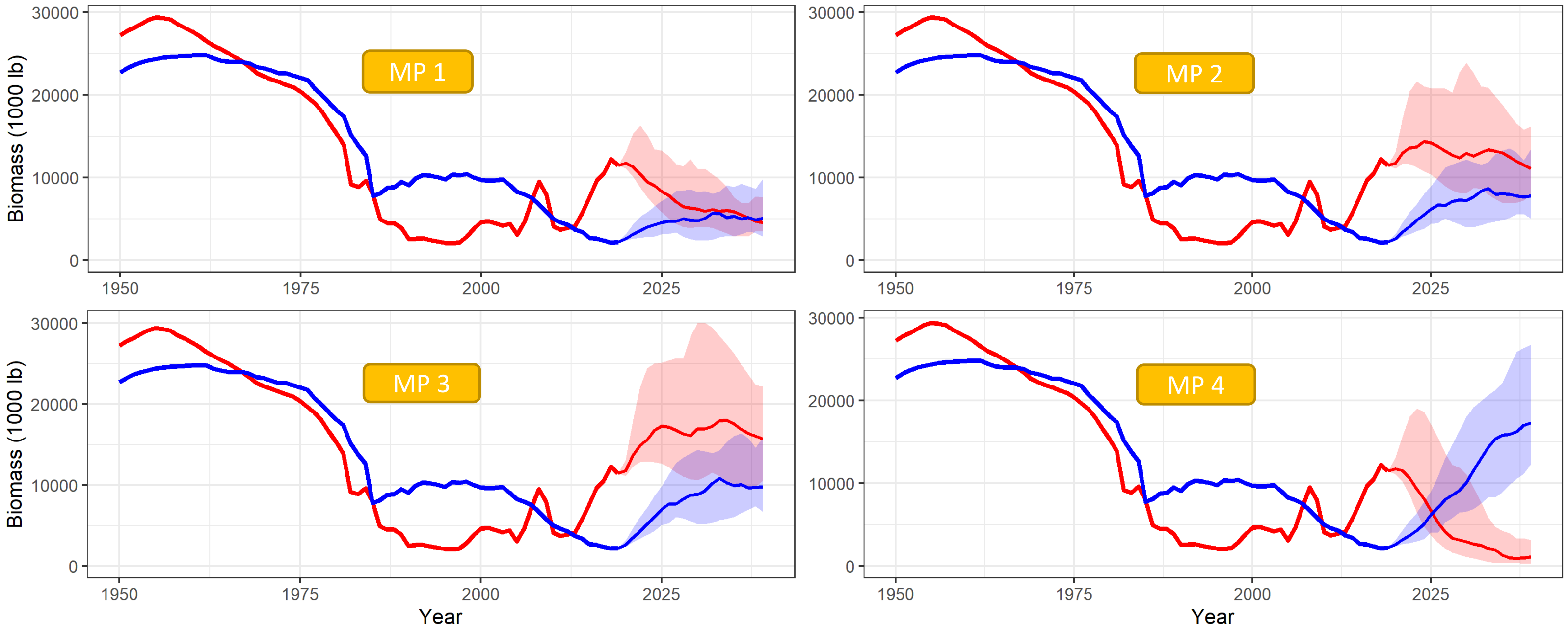


And so on for all MPs



The MSE Process: Evaluation

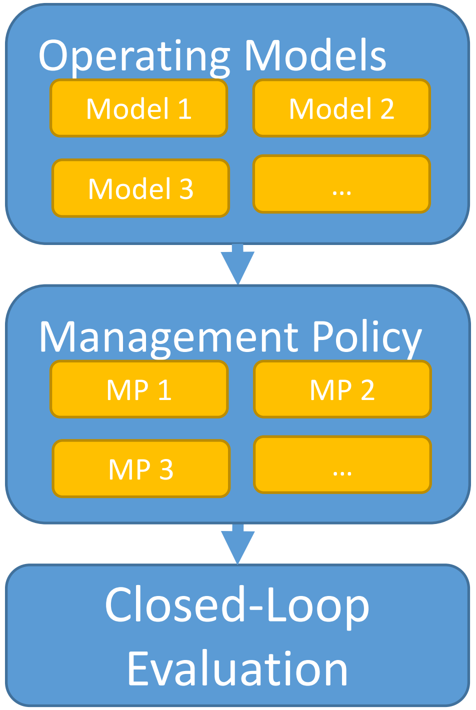




How do we rank the MPs?

- 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?

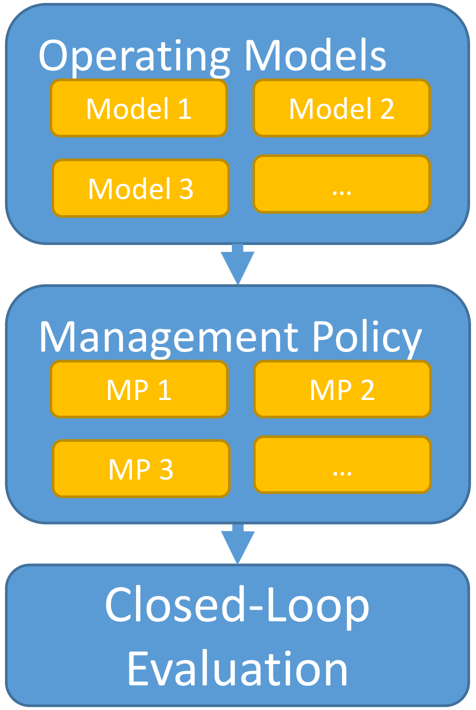
- How do we define good management outcomes?
- How do we define bad management outcomes?

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
- MSE results used to evaluate the trade-offs among the performance metrics

The MSE Process: Evaluation Criteria



How do we determine good and bad performance?

Some examples:

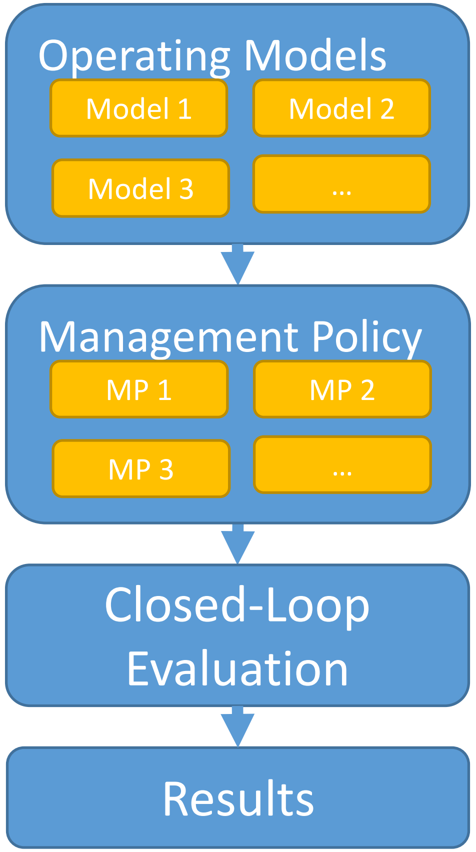
In order to be considered acceptable for management, an MP must demonstrate:

1. **Biological Sustainability**: at least 90% probability that the stock remains above the limit reference point
2. **Stability:** no more than 15% change in catch/effort limits between management cycles
3. **Yield:** while satisfying 1 and 2, provide the highest catch
4. **Catch composition**: main acceptable probability of catching 'trophy' sized fish
5. **Others**: fraction of the catch that must be discarded; length of fishing season;

Key Points:

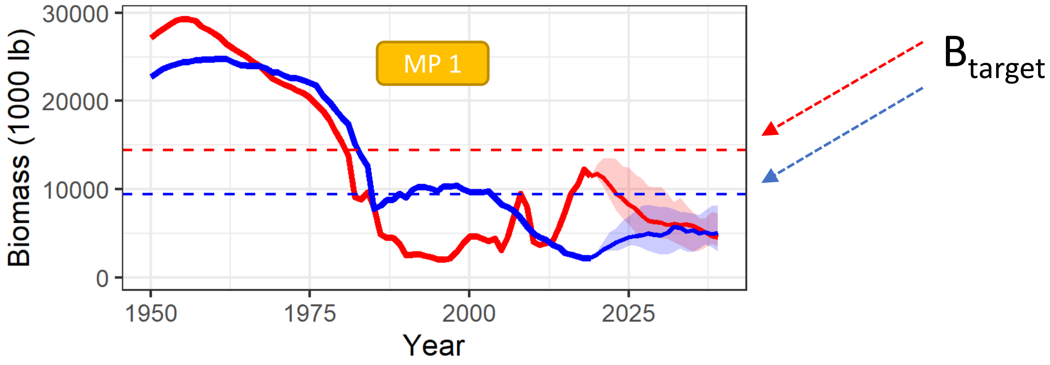
- Must be defined quantitatively: e.g., the limit reference point is defined as $0.5B_{MSY}$
- Require associated probabilities to define acceptable performance: e.g., >90%
- Framed so high values = better performance
- Can include an number of proposed metrics, but should aim to limit to 4 – 6 key objectives

The MSE Process: Calculating Performance

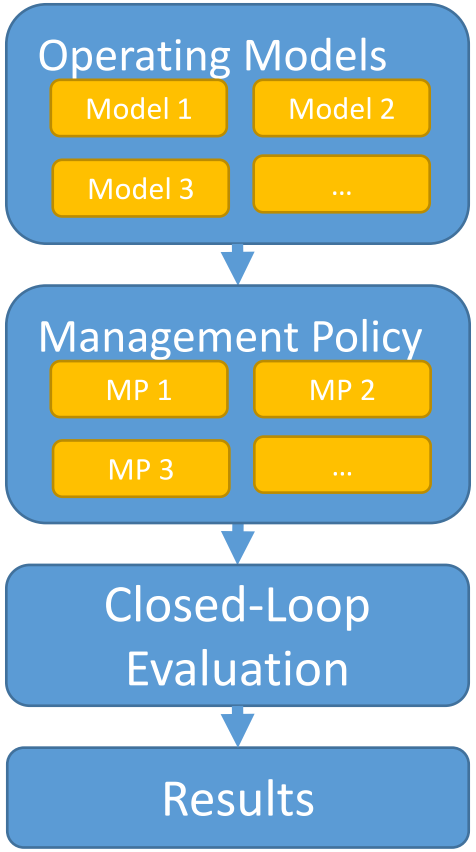


Performance Metrics: A Simple Example

1. At least 50% probability stock is above B_{target}



The MSE Process: Calculating Performance



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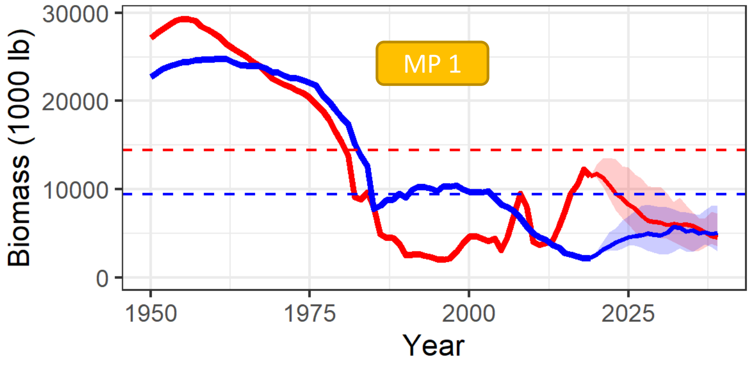
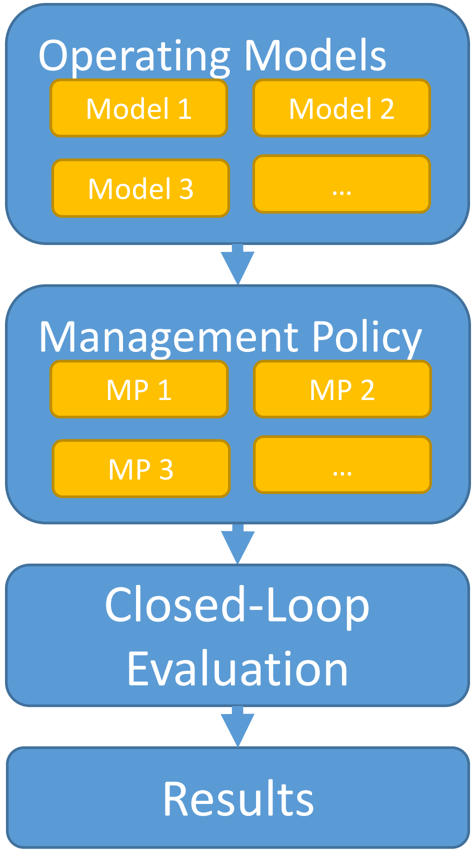


B_{target}

Low probability for both stocks (<50%)

The MSE Process: Calculating Performance



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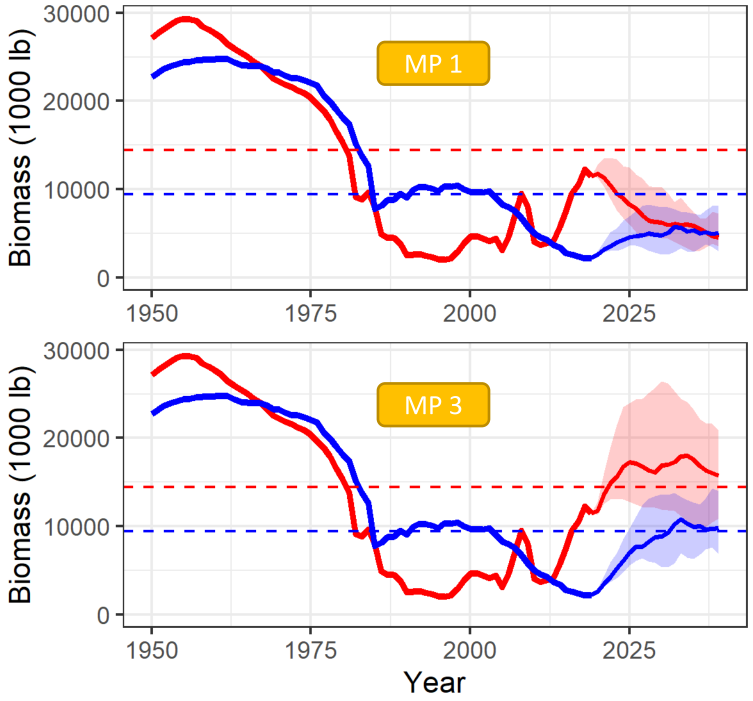
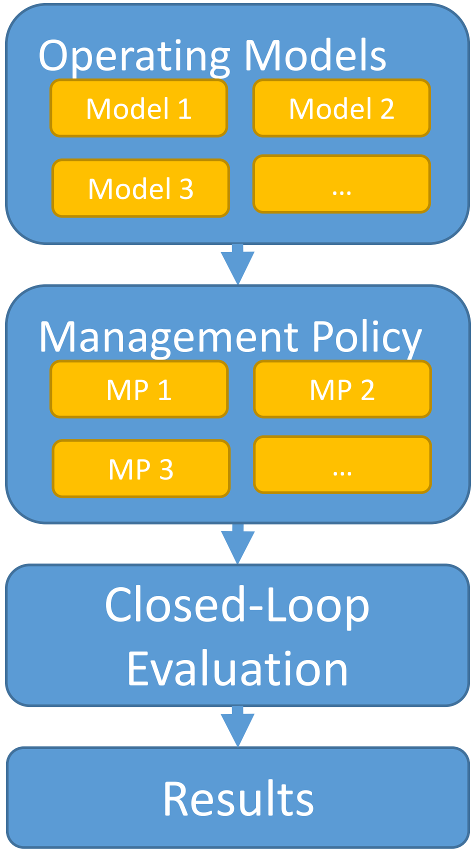


Low probability for both stocks (<50%)

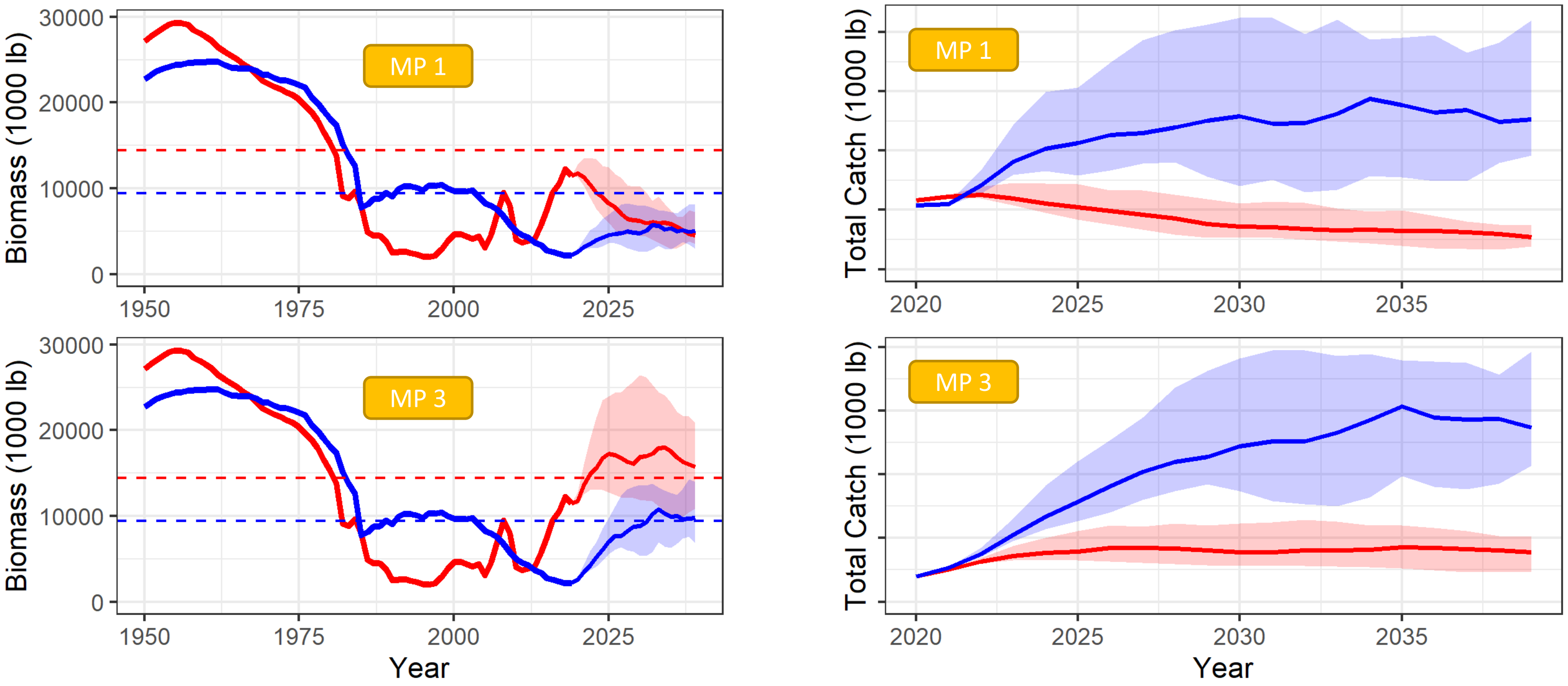
>50% both stocks

The MSE Process: Calculating Performance



Performance Metrics: A Simple Example

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

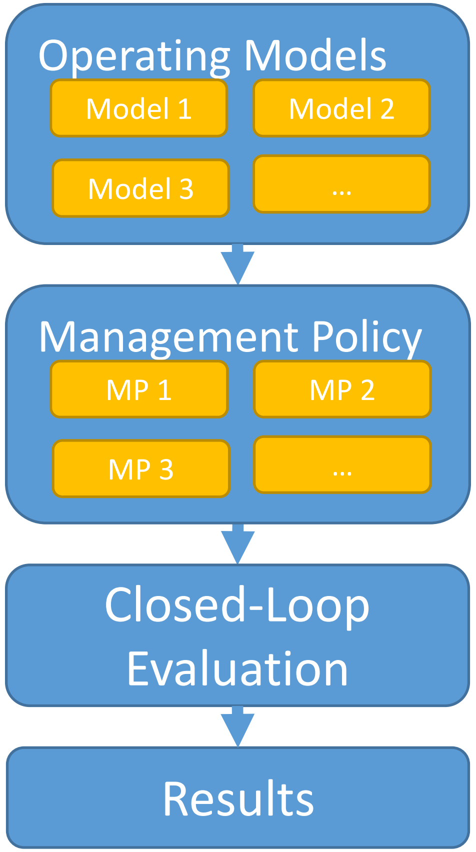


Conclusion:

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

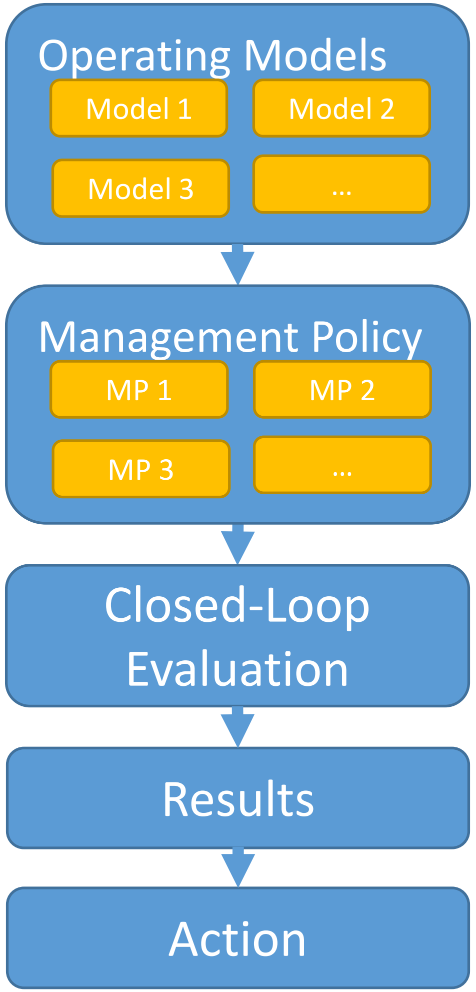
The MSE Process: Calculating Performance



Summary of Calculating Performance:

1. Perform this analysis for all candidate MPs and across all Operating Models
2. Eliminate MPs that fail to meet mandatory performance criteria
3. Examine trade-offs among remaining MPs:
   - e.g., some may have greater average catch but also more variability
4. Identify MP(s) that perform the best (most acceptable trade-offs) across all the operating models (different plausible descriptions of the fishery dynamics)

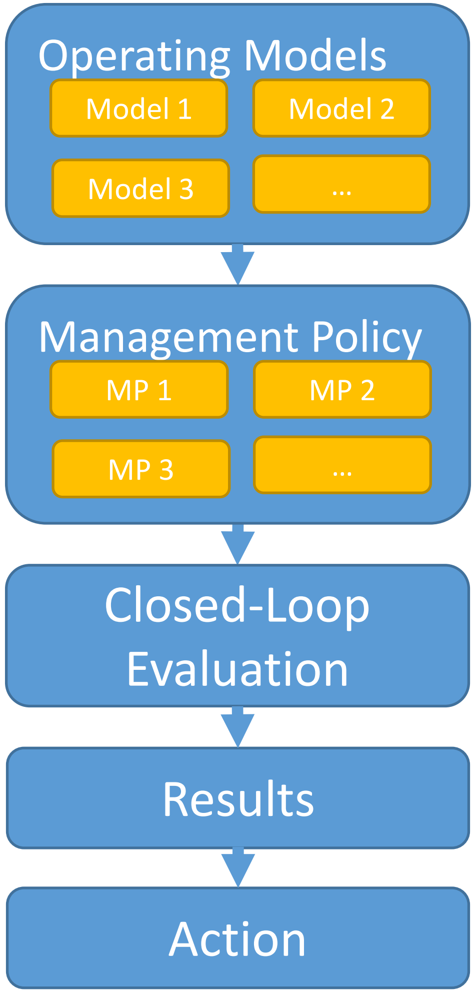
The MSE Process: Action



Action:

1. Stakeholders evaluate trade-offs among MPs
2. Select an MP that is most acceptable
3. Adopt the MP for managing the fishery
4. Future management decisions are determined by collecting data and providing it to the MP at the agreed management interval
5. Monitor the fishery to detect unexpected changes in stock dynamics (exceptional circumstances)

The MSE Process: Review of the Process

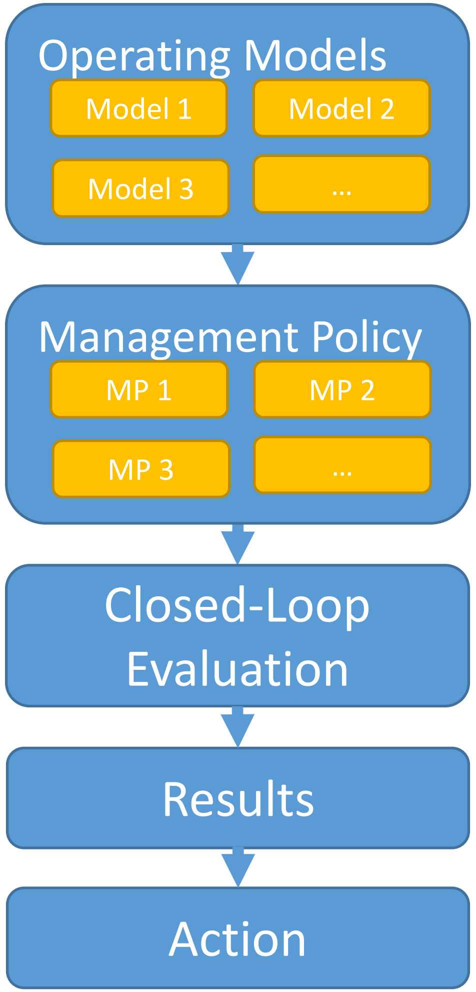


1. Operating Models: develop alternative plausible models of fishery dynamics

Key points to consider:

- stocks to include
- key uncertainties: plausible descriptions of stock dynamics
- methods & data for generating the alternative OMs
- interactions between stocks & management (spatial distribution, preferential targeting)

The MSE Process: Review of the Process



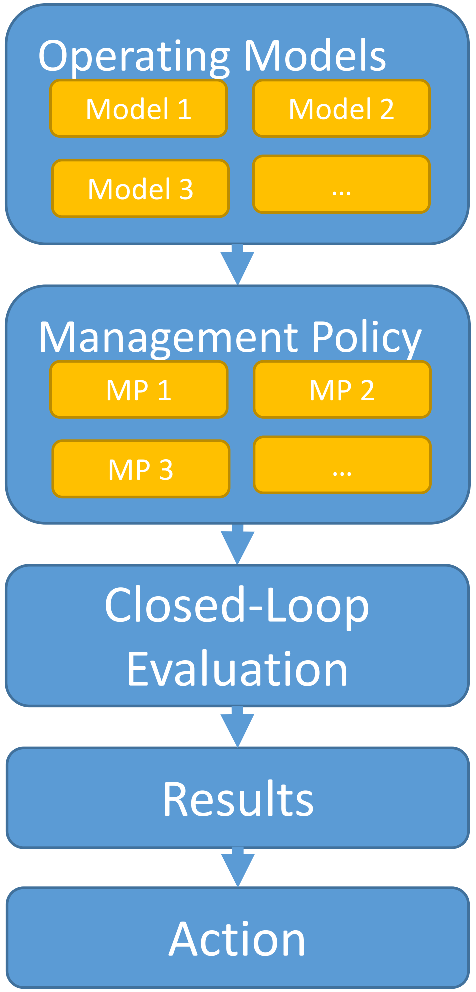
1. Operating Models: develop alternative plausible models of fishery dynamics

2. Management Procedures: develop candidate management procedures

Key points to consider:

- rules for converting data into management actions
- feasible management actions by stock and/or gear type
- no good or bad ideas: cannot predict expected performance; need to do the closed-loop evaluation

The MSE Process: Review of the Process



1. Operating Models: develop alternative plausible models of fishery dynamics

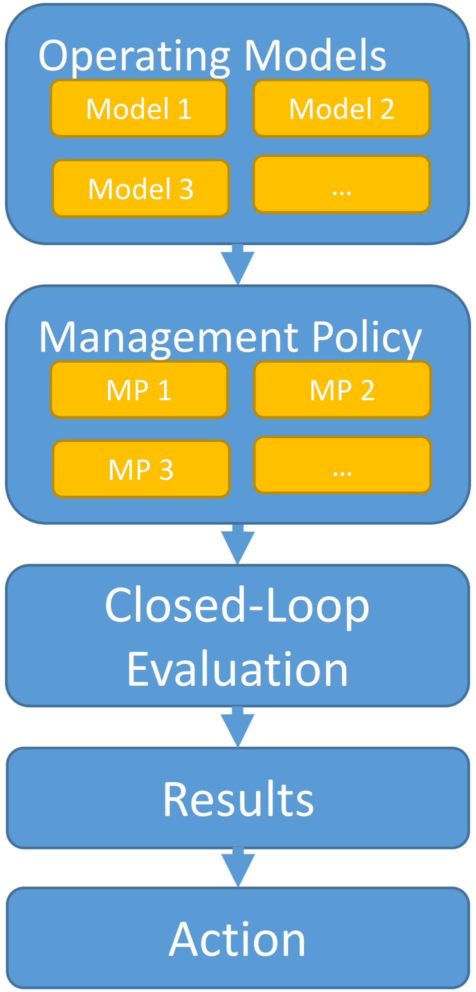
2. Management Procedures: develop candidate management procedures

3. Closed-Loop Evaluation: calculate the performance of all MPs for all OMs

Key points to consider:

- management objectives: what are we aiming for?
- performance metrics: quantitative measures of the management objectives
- different stakeholders may value different things: examine the trade-offs in the results

The MSE Process: Review of the Process



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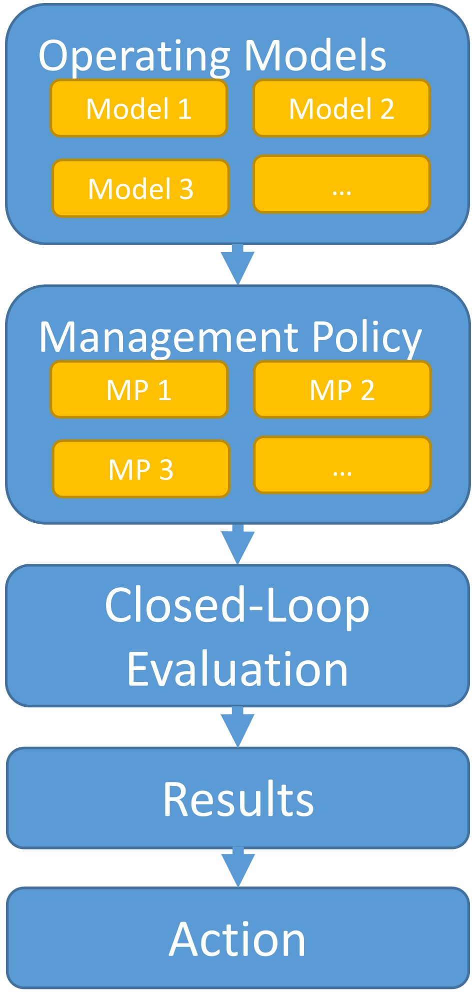


1. Operating Models: develop alternative plausible models of fishery dynamics

2. Management Procedures: develop candidate management procedures

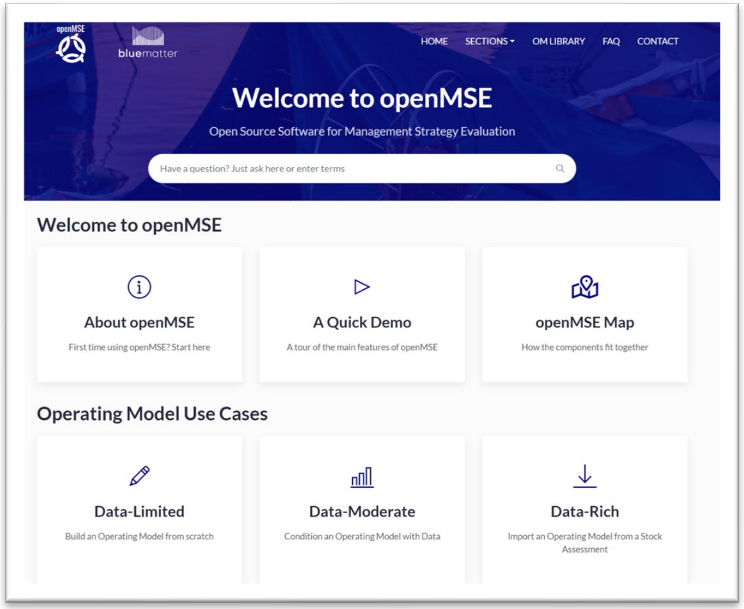
3. Closed-Loop Evaluation: calculate the performance of all MPs for all OMs

4. Results: identify the MP that best meets the objectives

5. Action: adopt the selected MP for determining future management actions based on the observed data

Resources and Information

Closed-Loop Evaluation

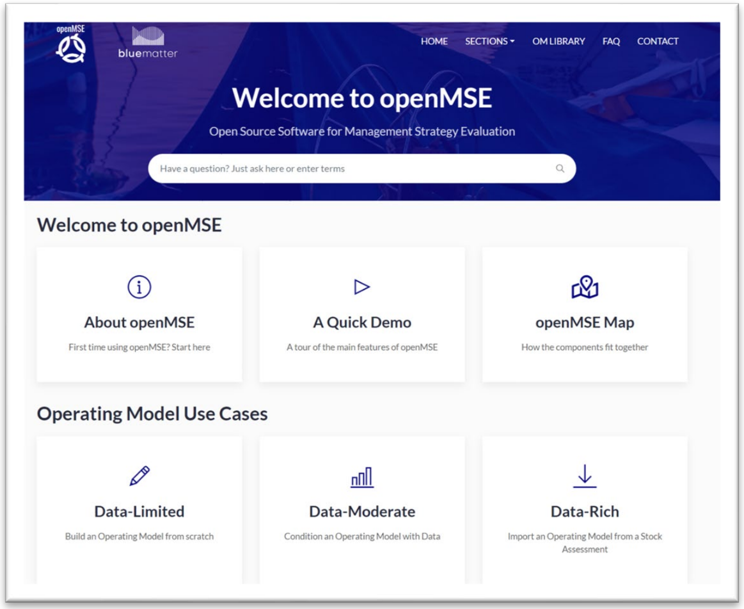


- open-source
- help documentation

openmse.com

Resources and Information

Closed-Loop Evaluation



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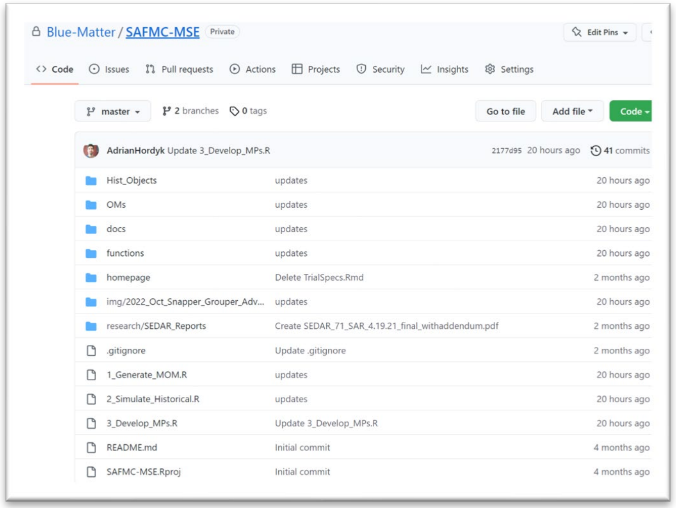


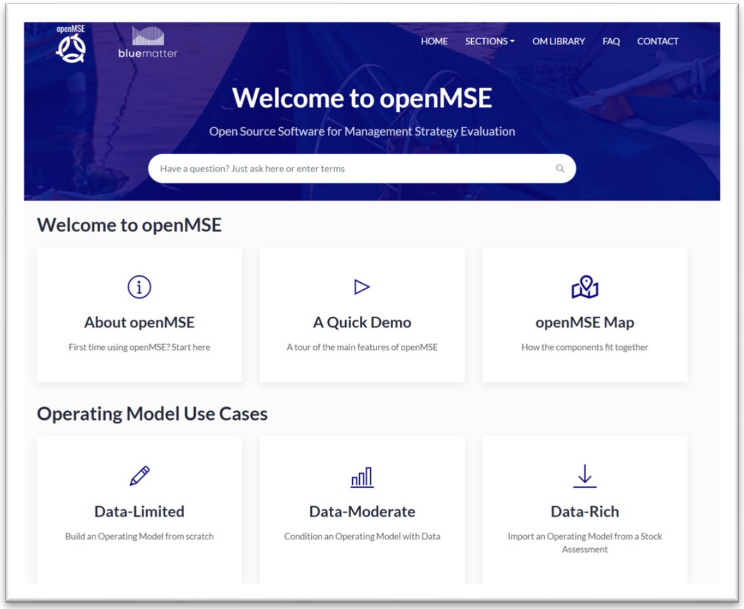
https://github.com/Blue-Matter/SAFMC-MSE

- all code related to the project

Resources and Information

Closed-Loop Evaluation

openMSE



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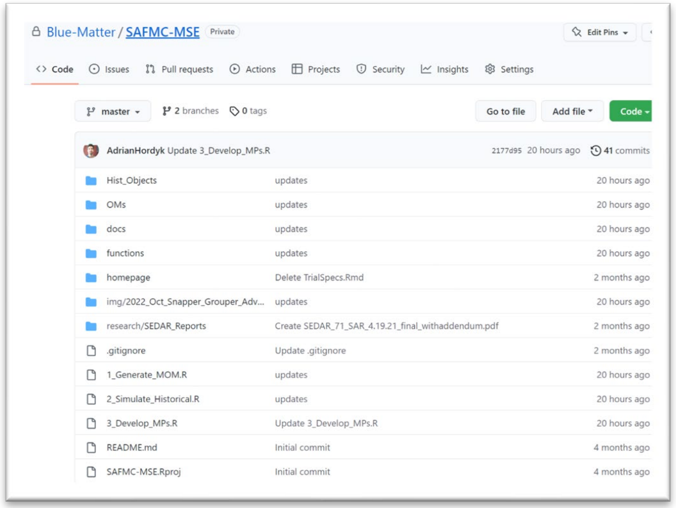

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https://safmc-mse.netlify.app/

Home page:

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

Thank You