Introduction to Management Strategy Evaluation (MSE)

Philosophy, Concepts, Terminology and Process

Tom Carruthers
tom@bluematterscience.com

Snapper – Grouper Advisory Panel Meeting

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bluematter

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1. What is MSE?
2. How does an MSE differ from a stock assessment?
3. What does an MSE process look like?

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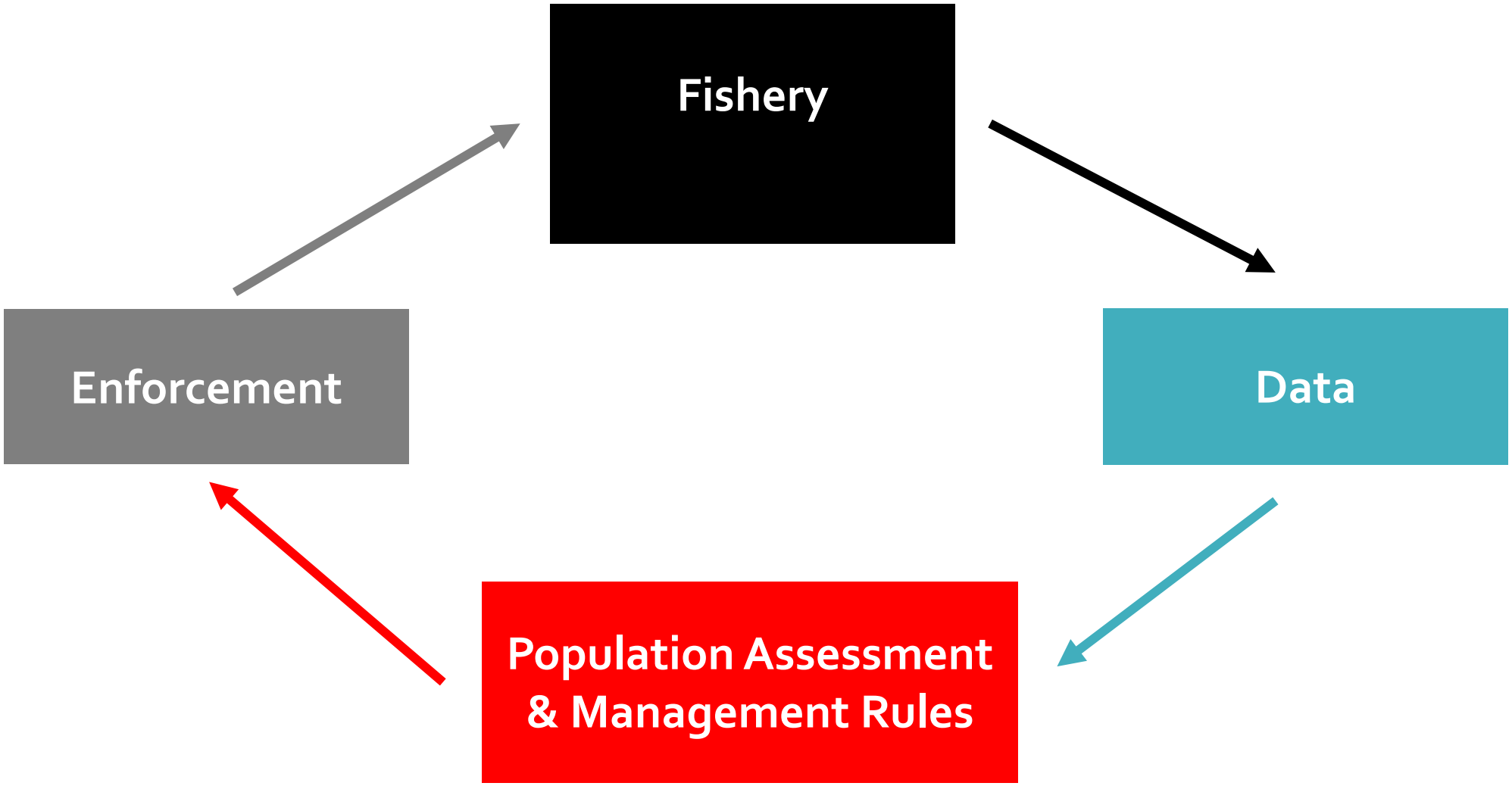
A fishery system



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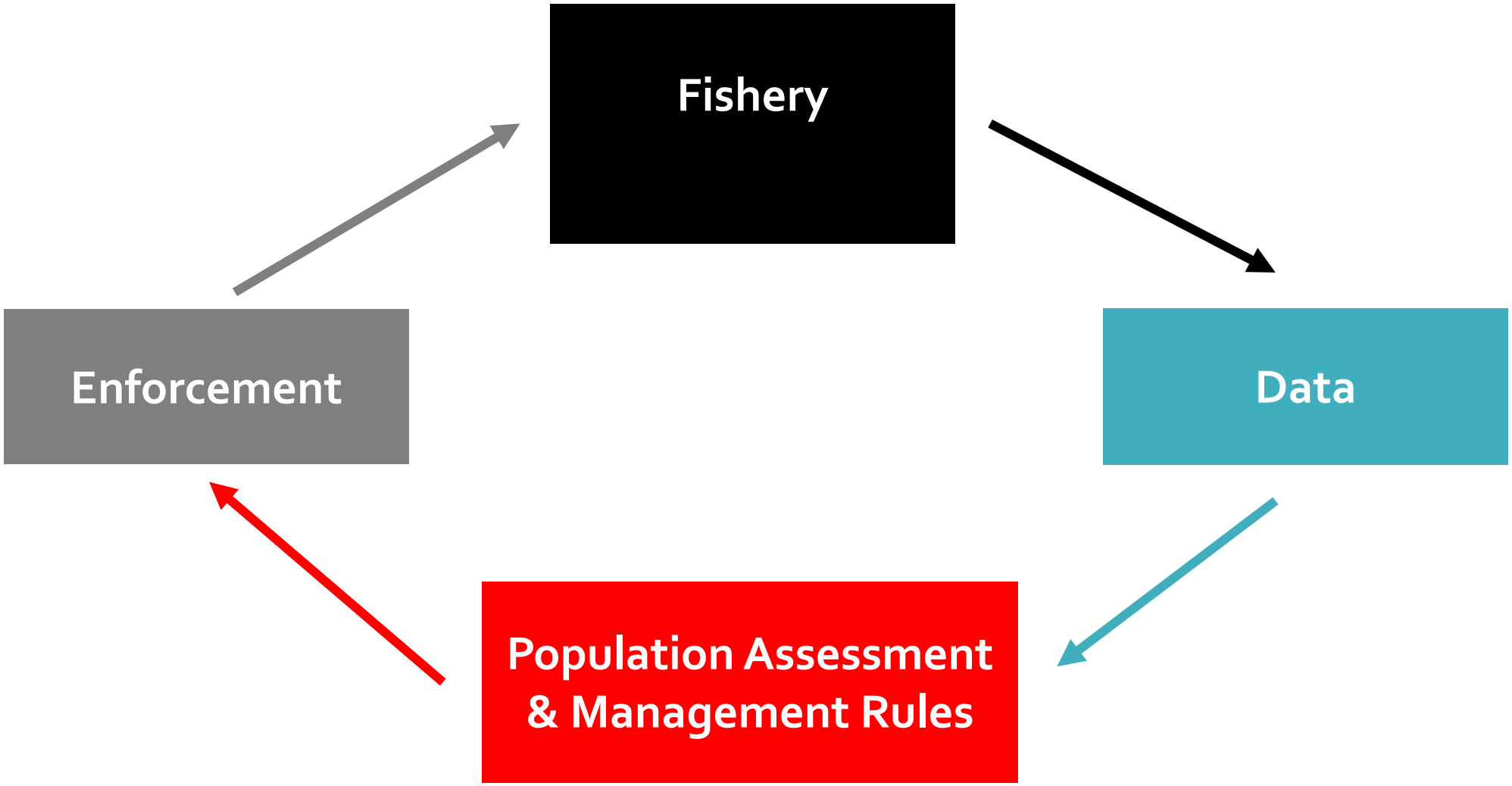
Fishery
Data
Population Assessment
& Management Rules
Enforcement

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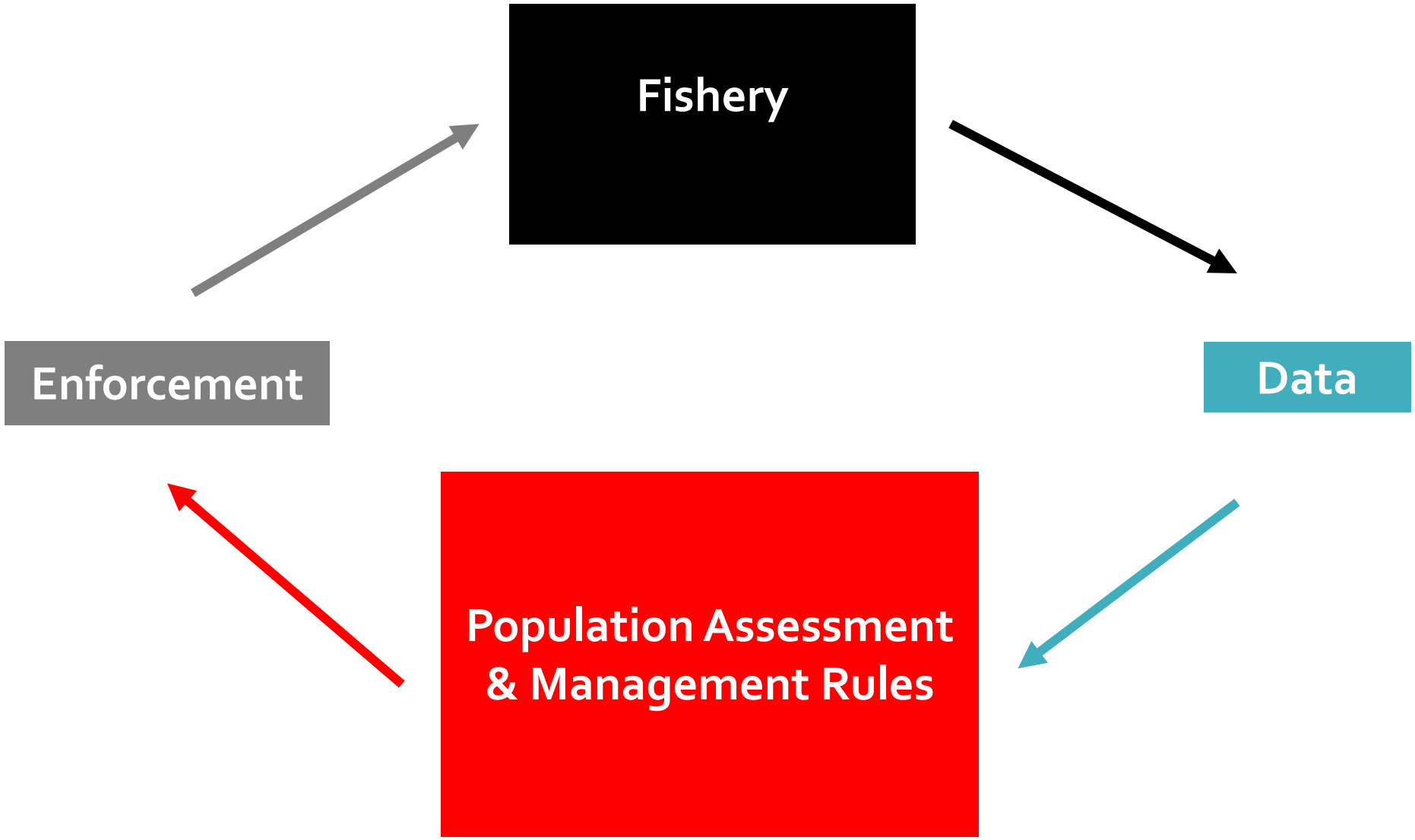
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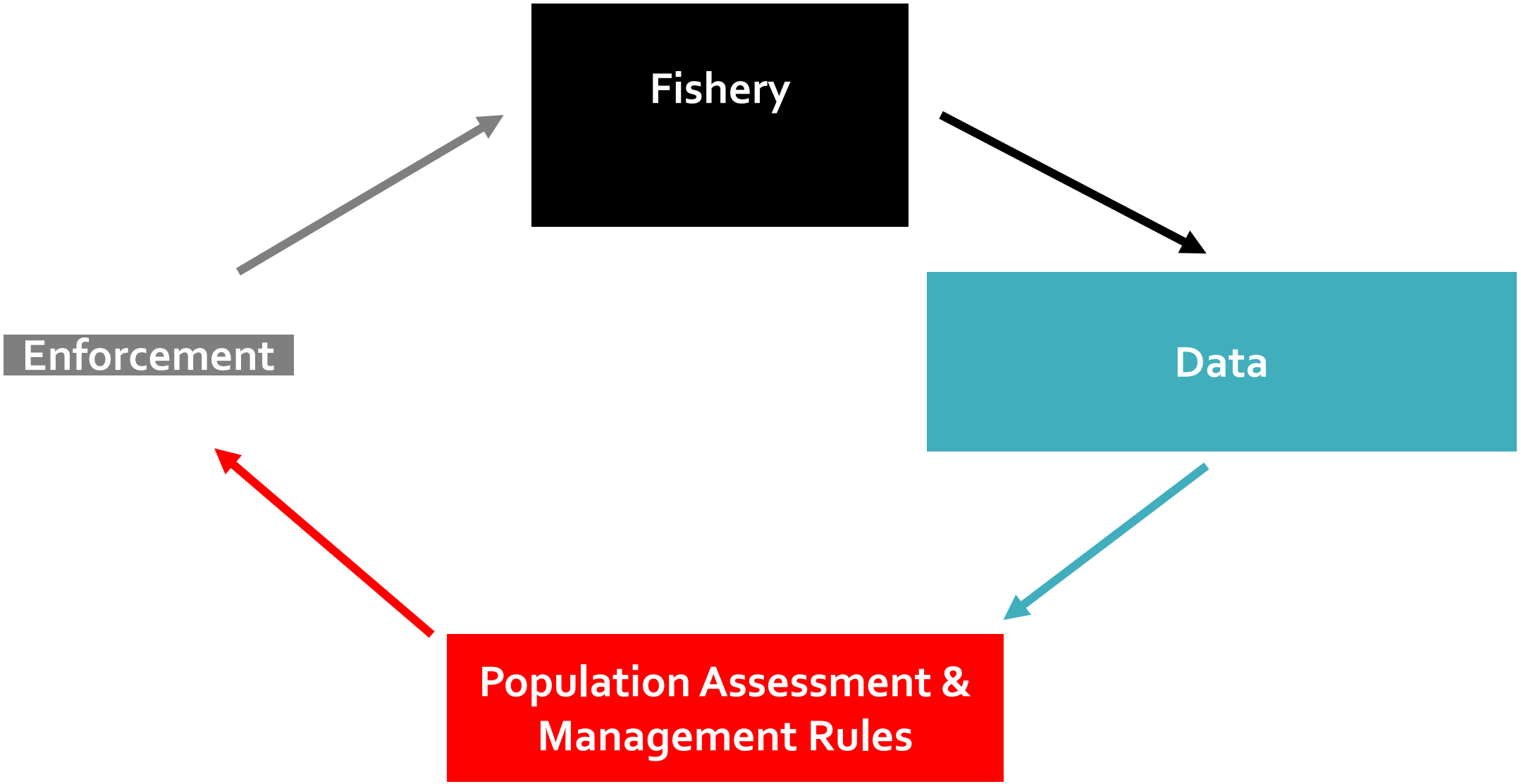
Fishery
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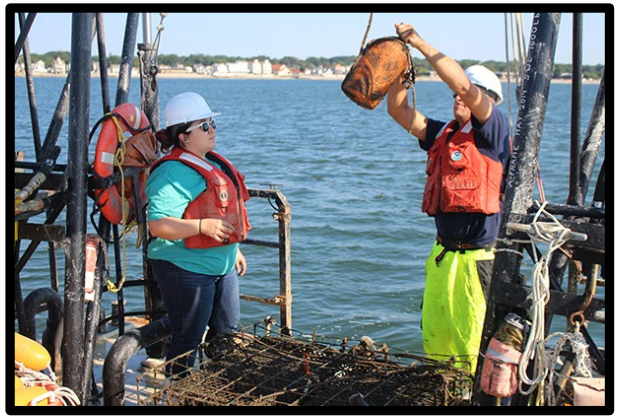
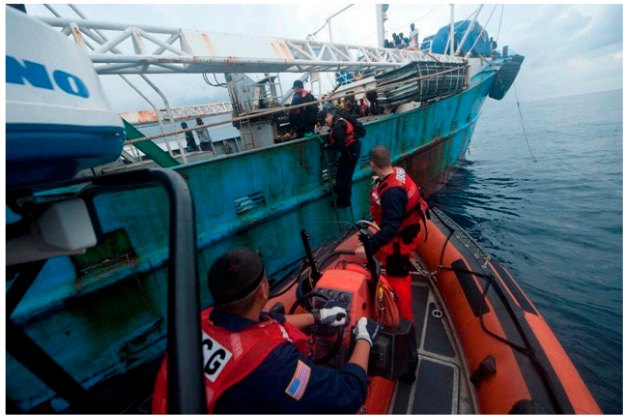
For most fisheries, management decision making could benefit from a more coherent strategy, and increased transparency and accountability.

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

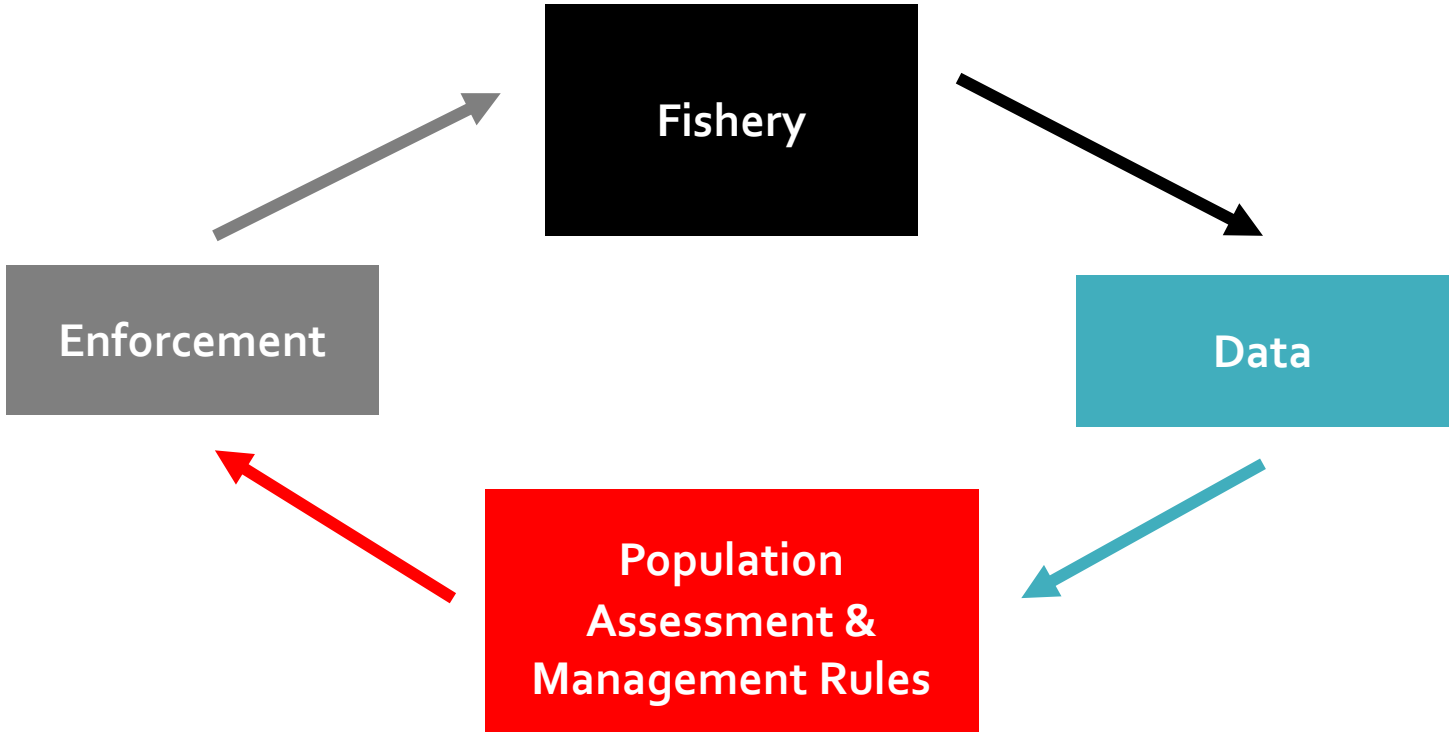
Test by experiment





Test by simulation

Test by simulation: the MSE approach



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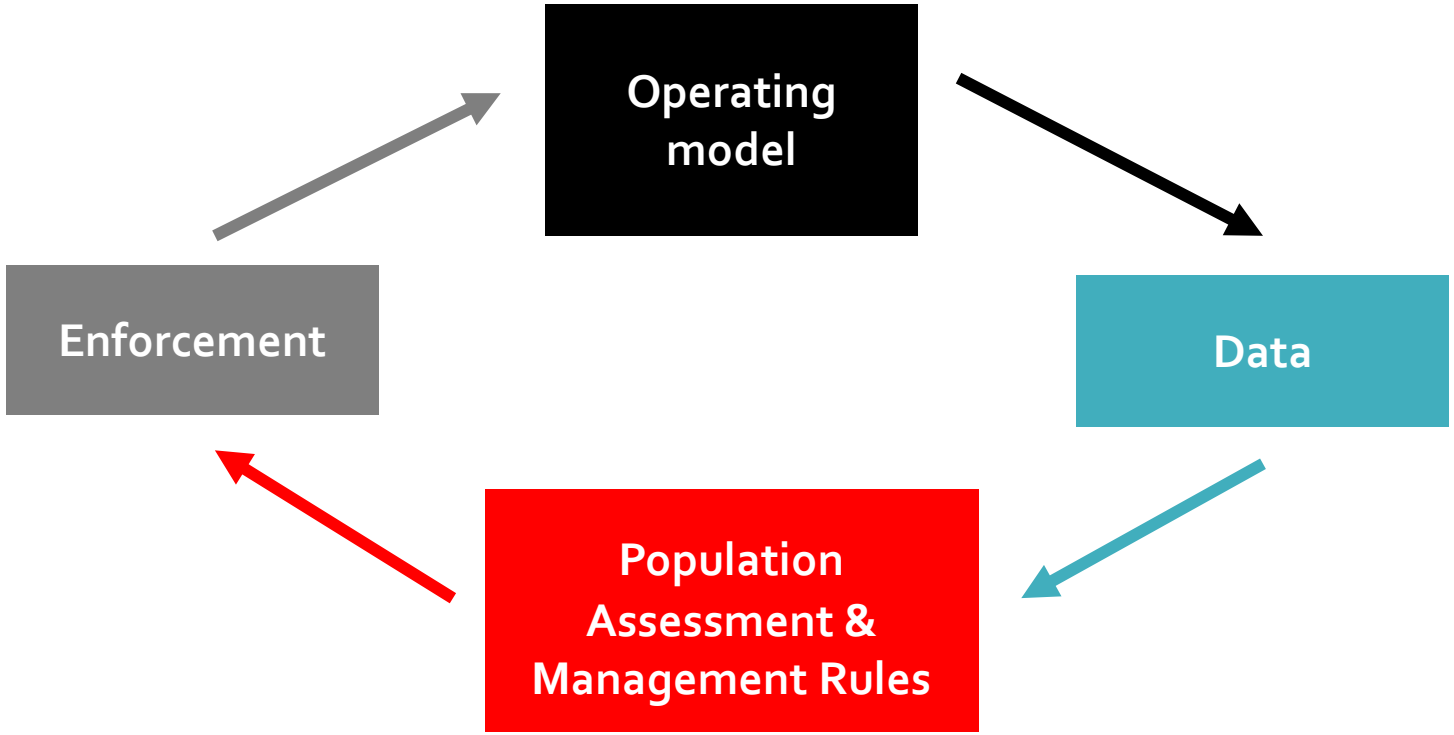

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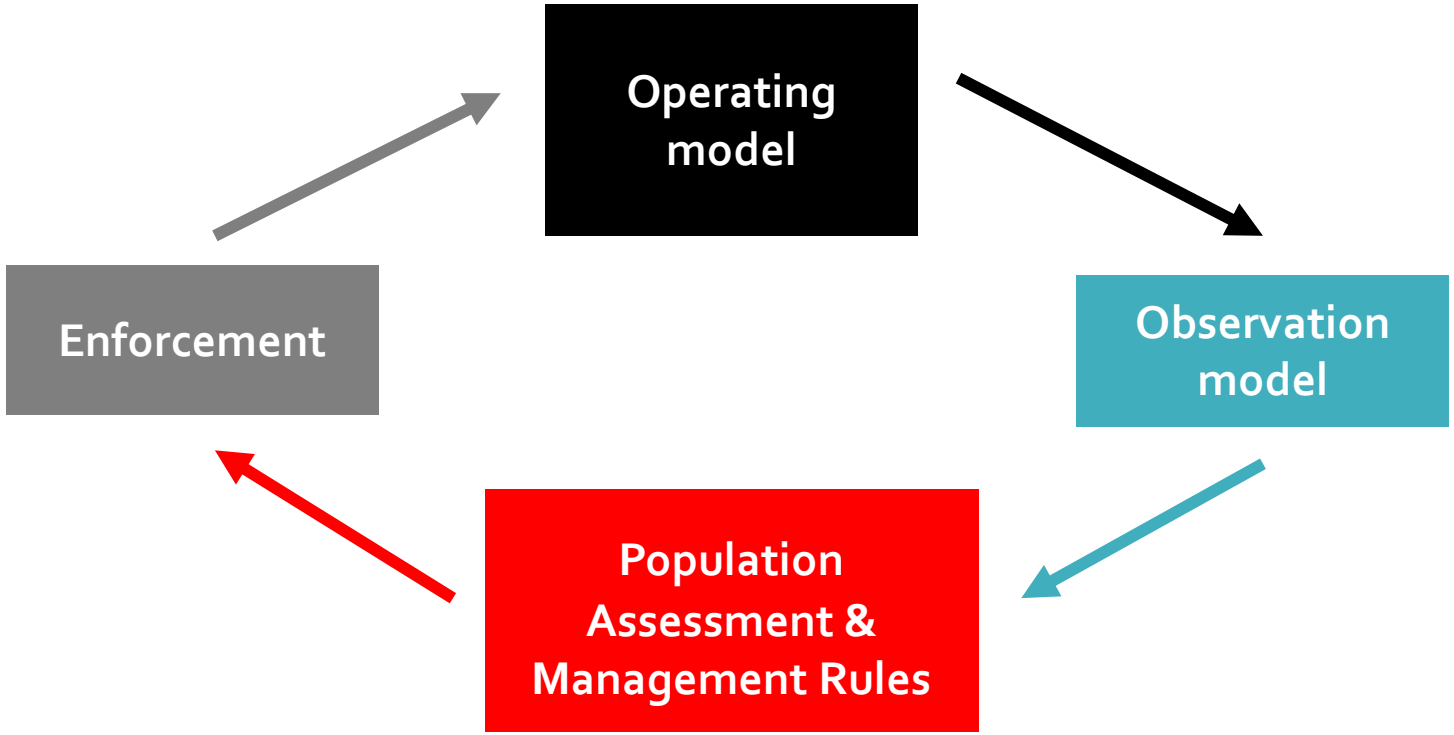

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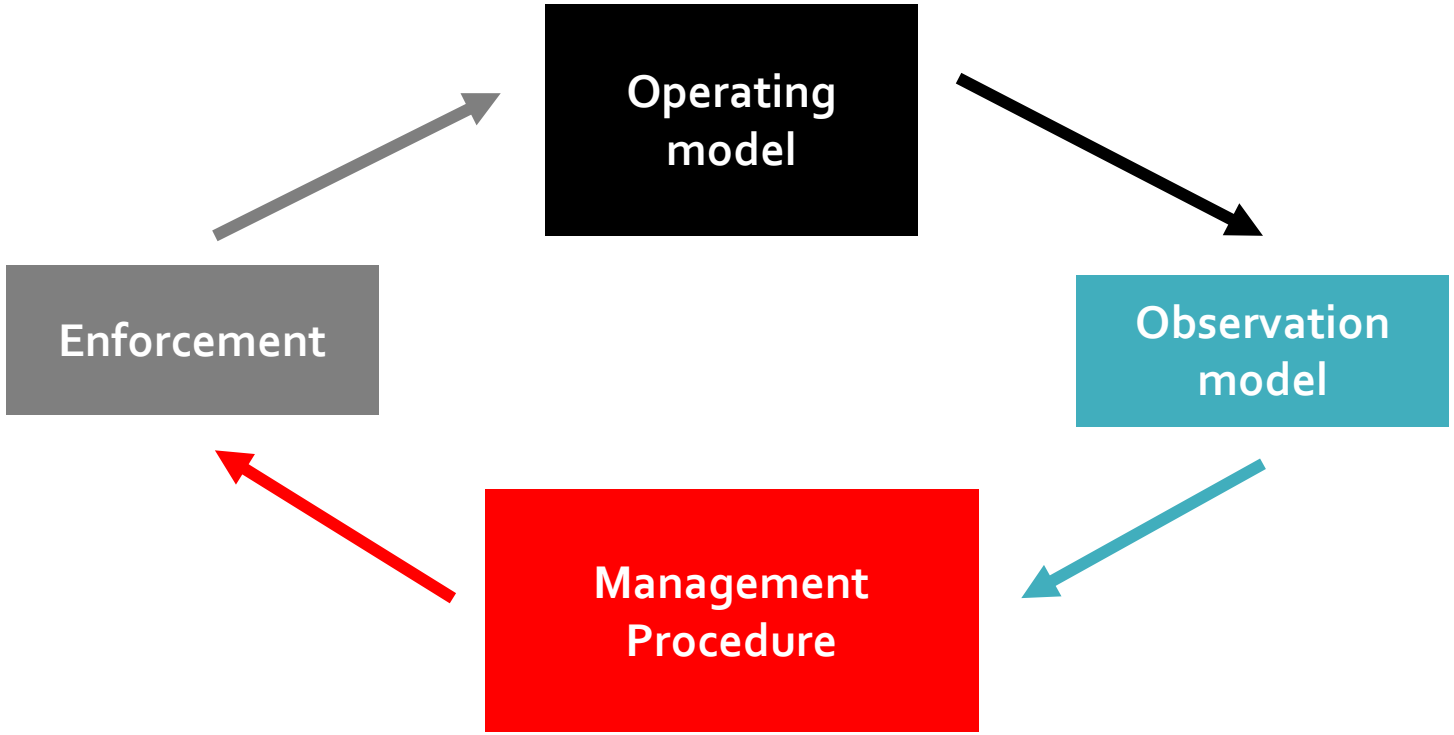

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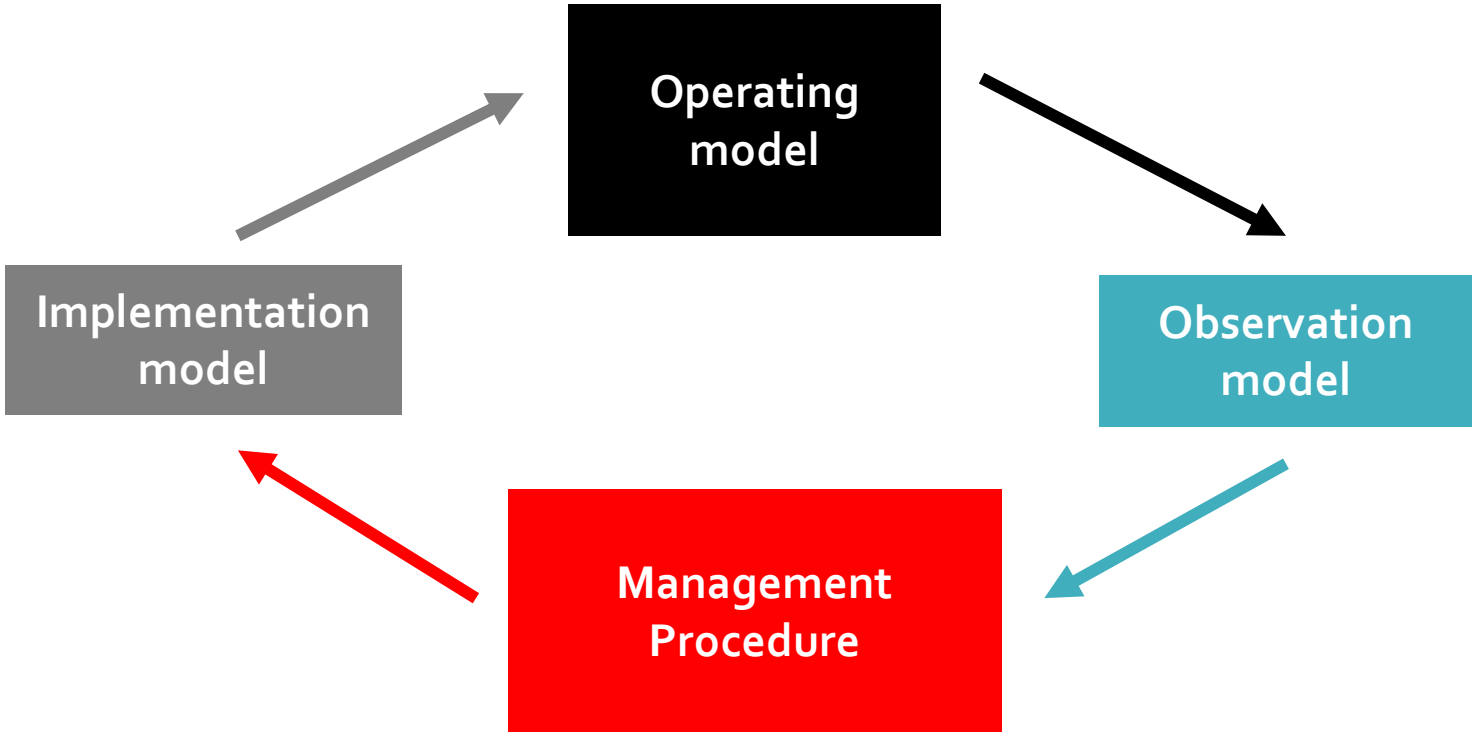

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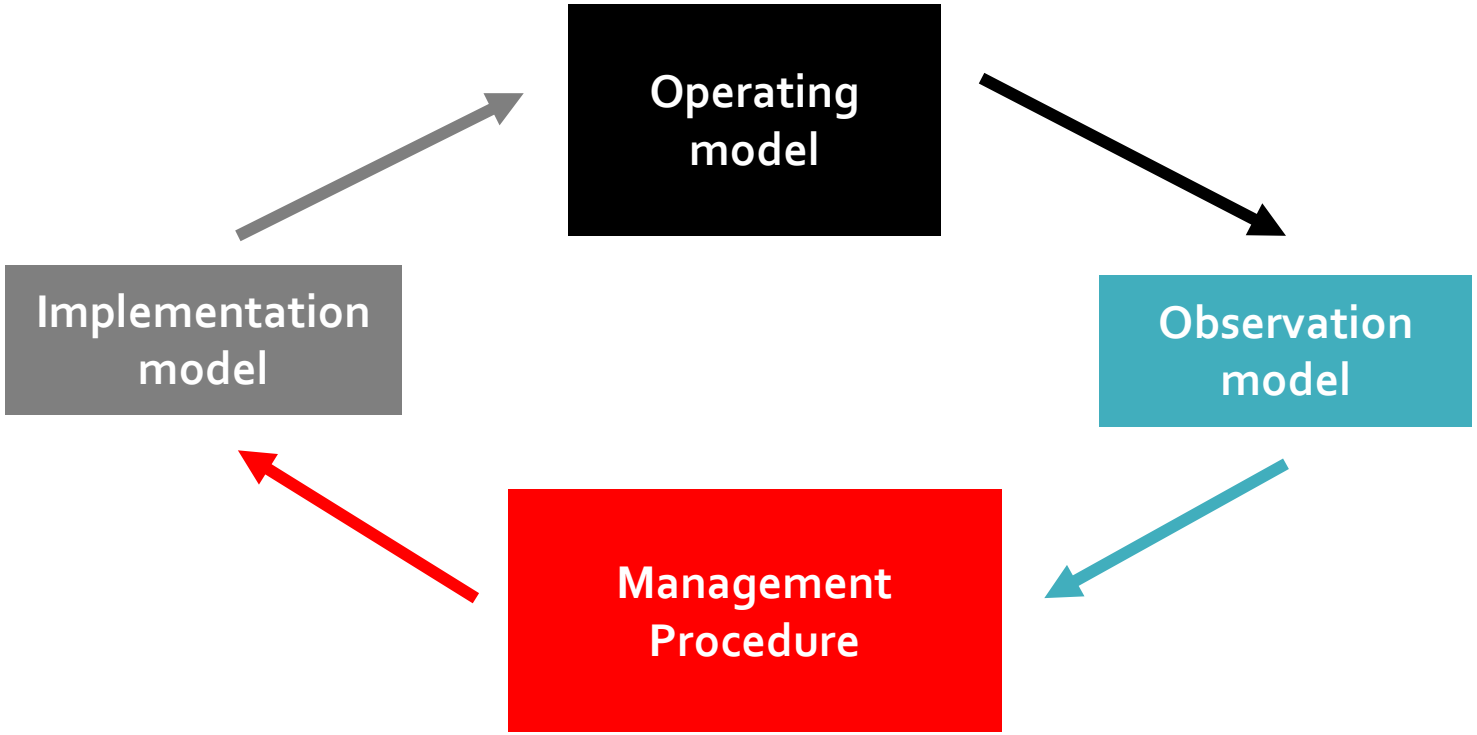

"Harvest strategy"

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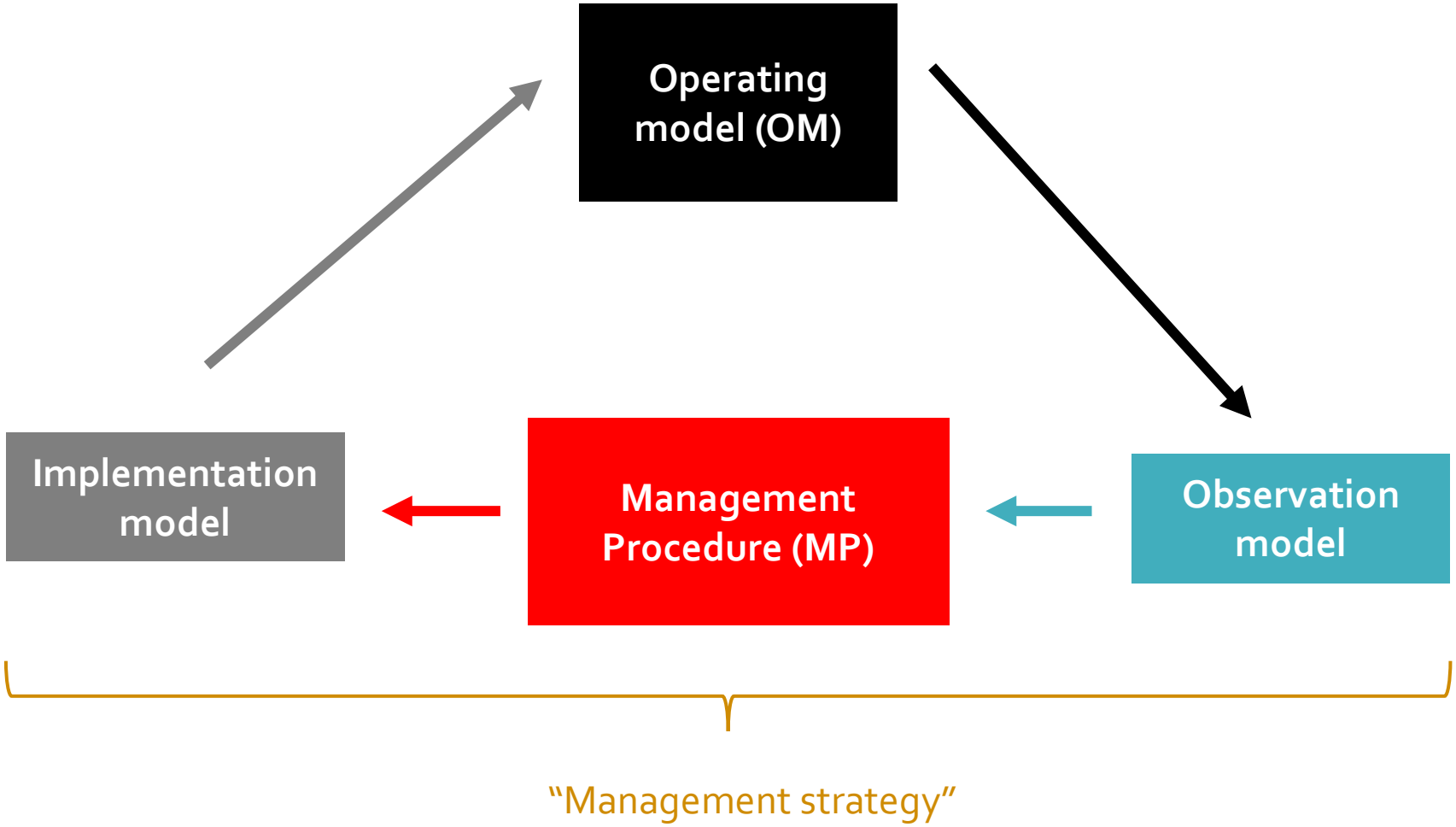

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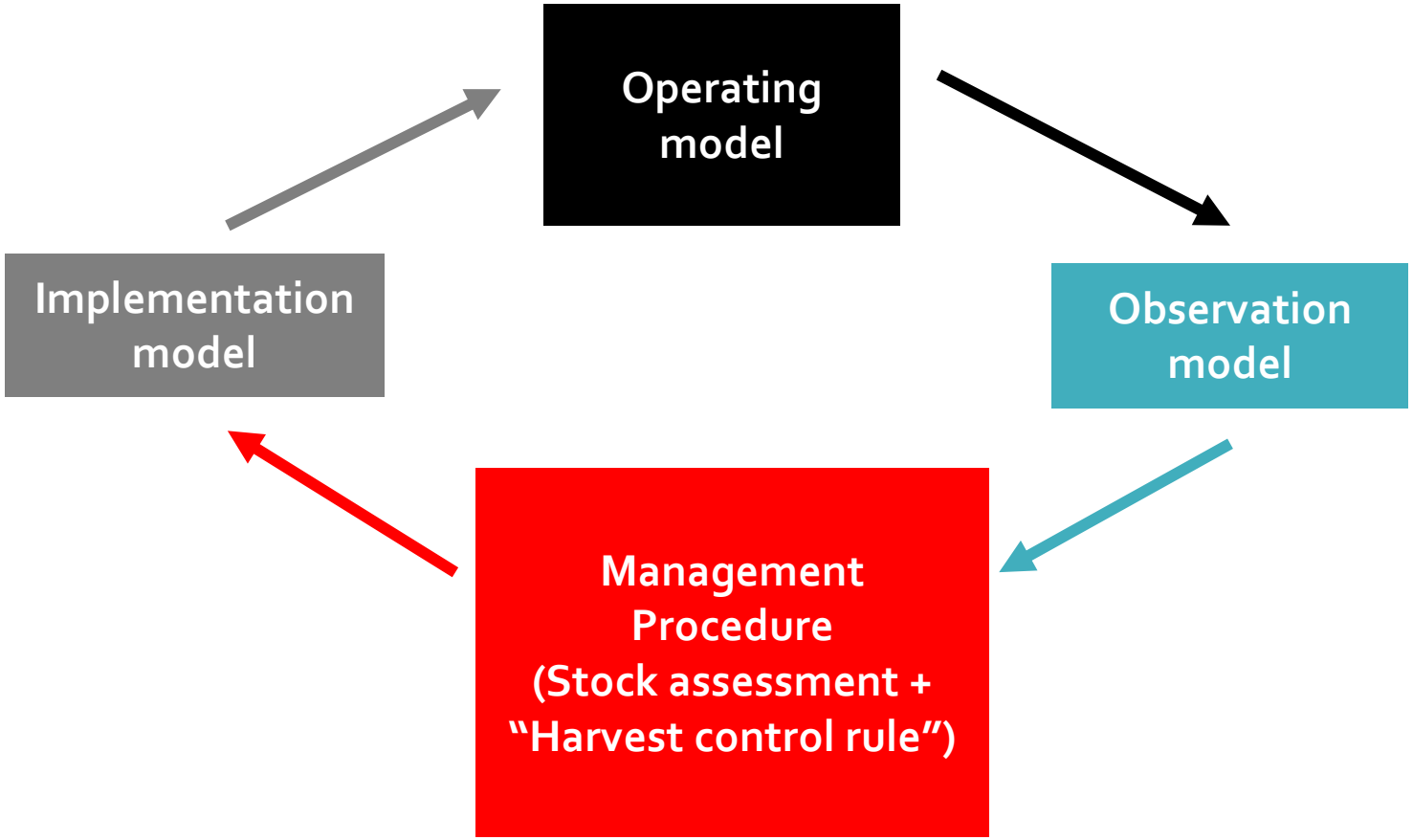

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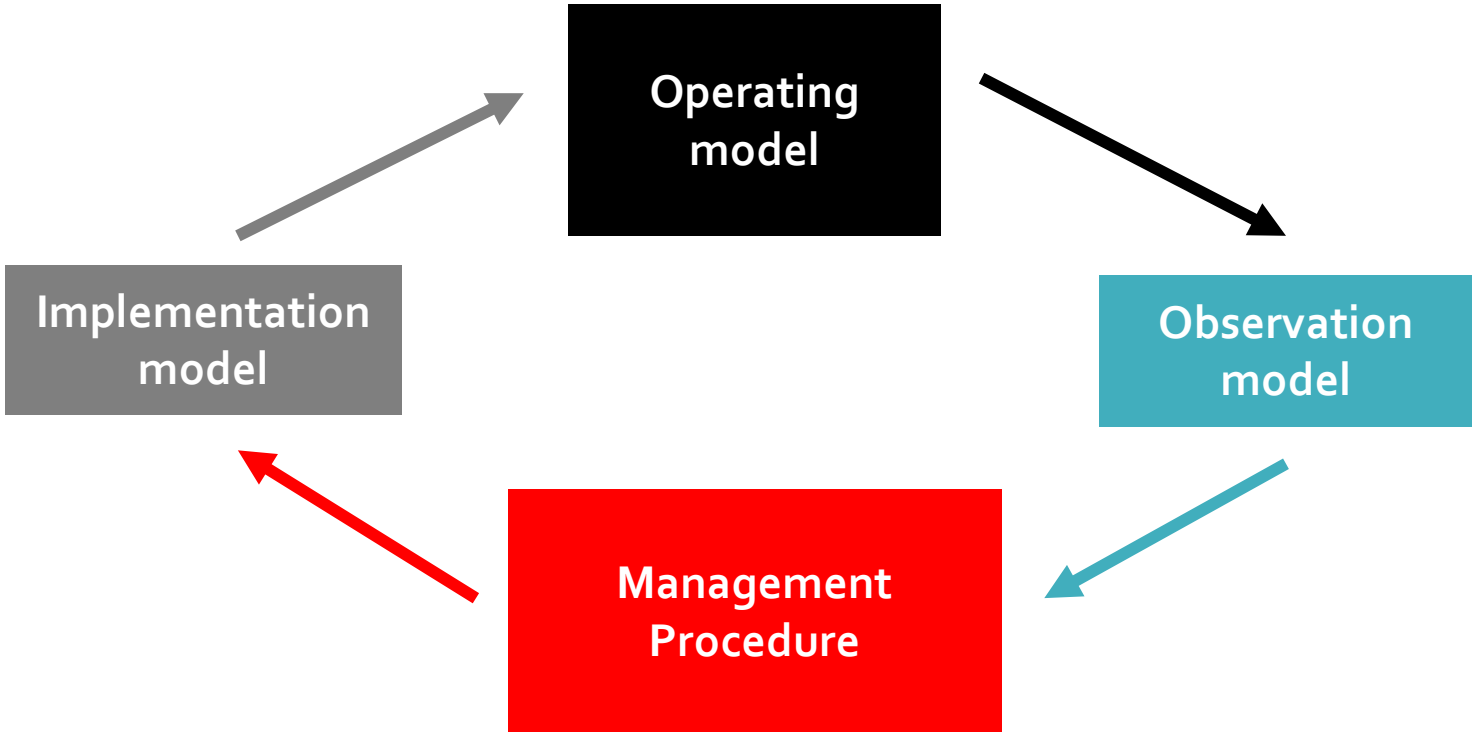

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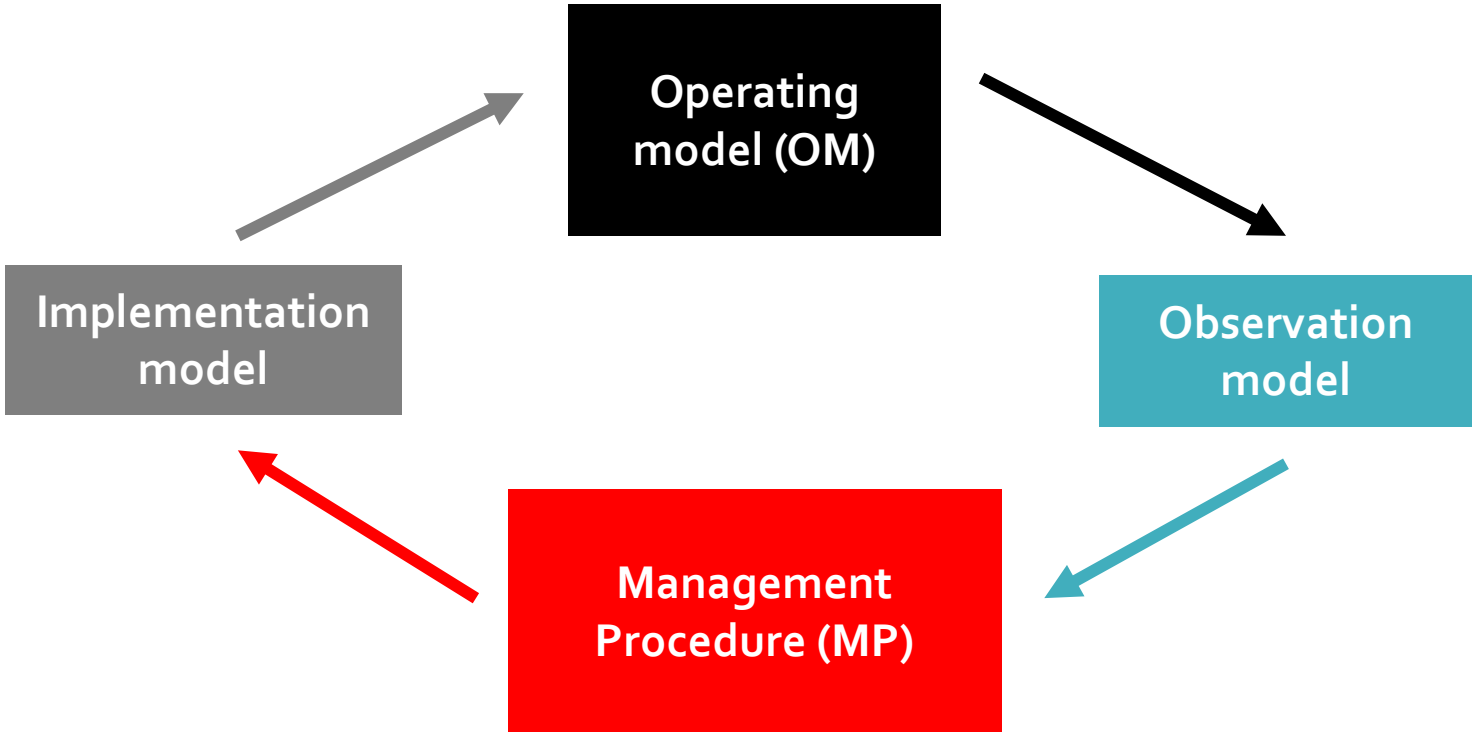

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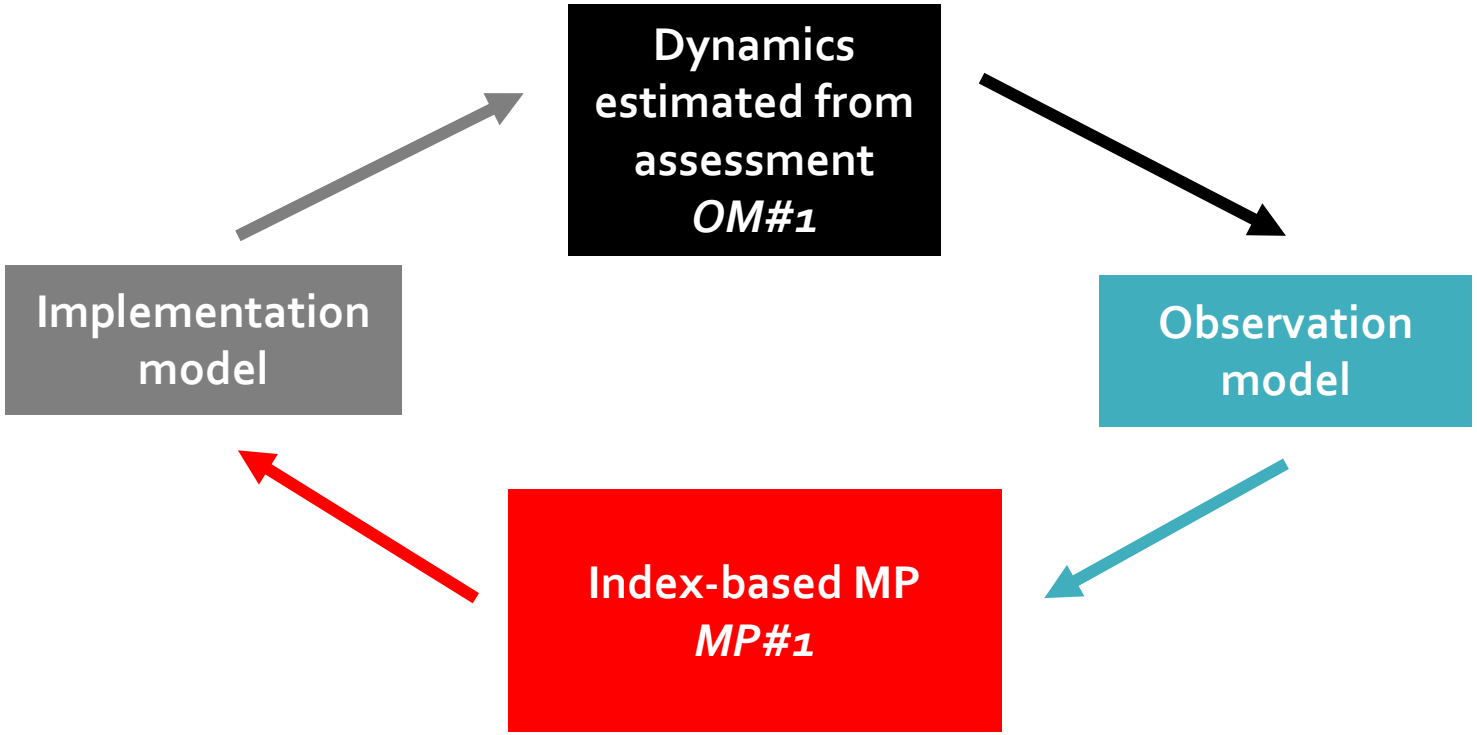

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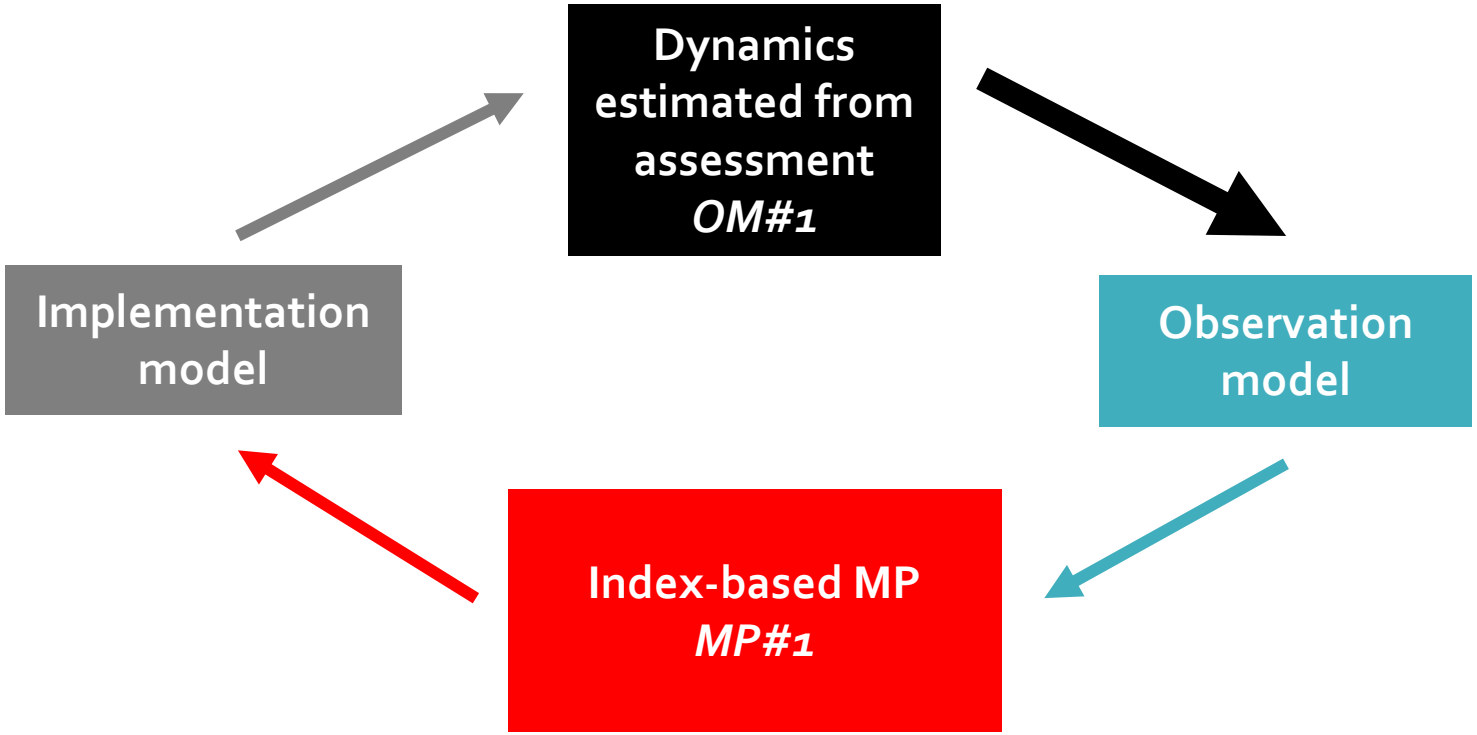

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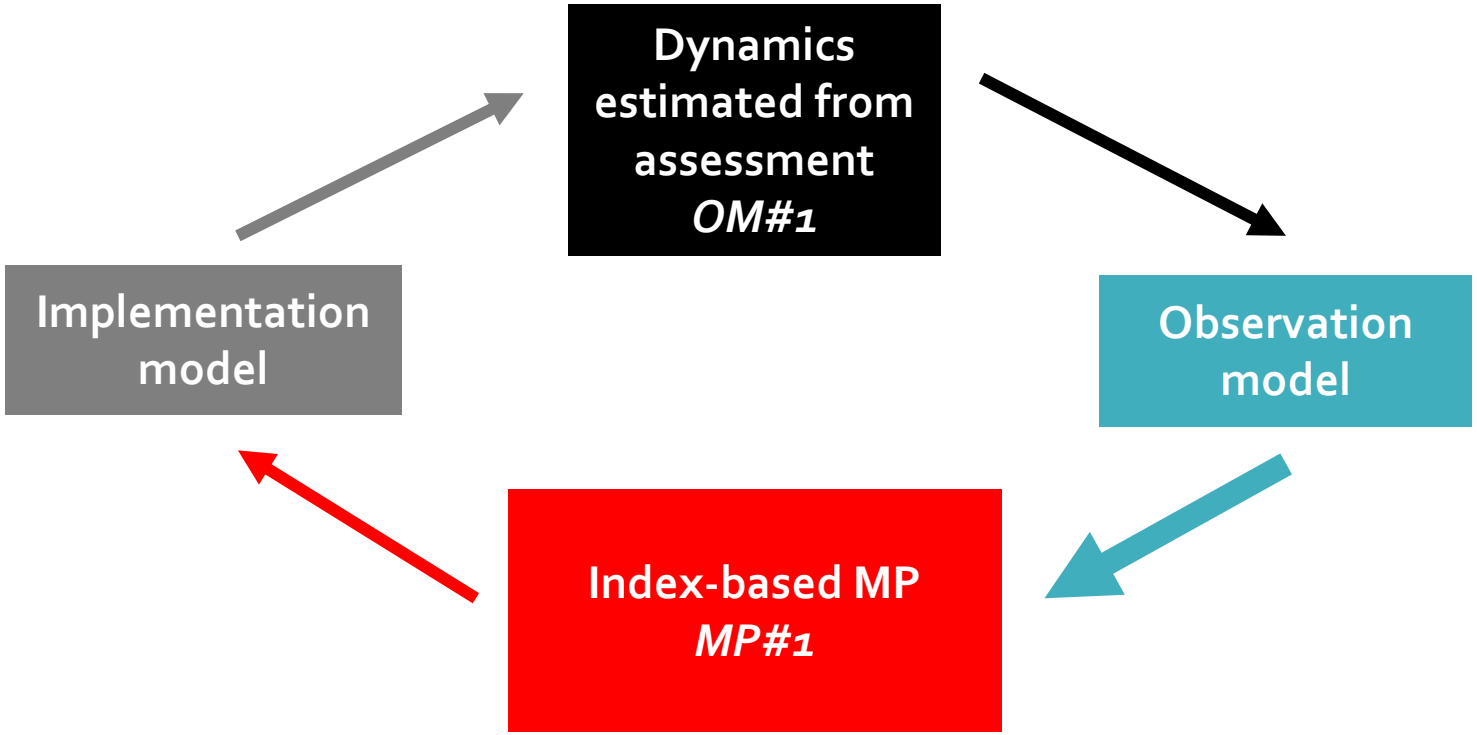

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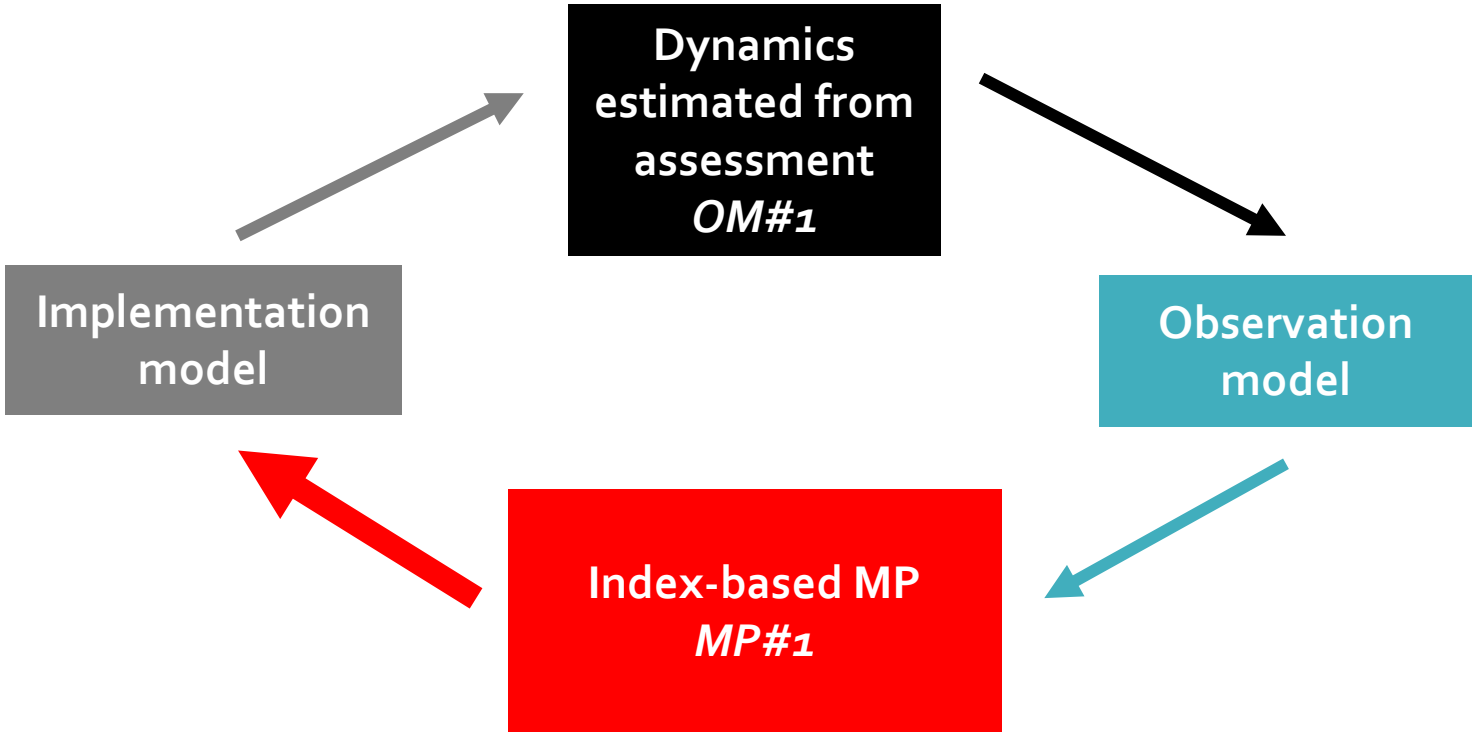

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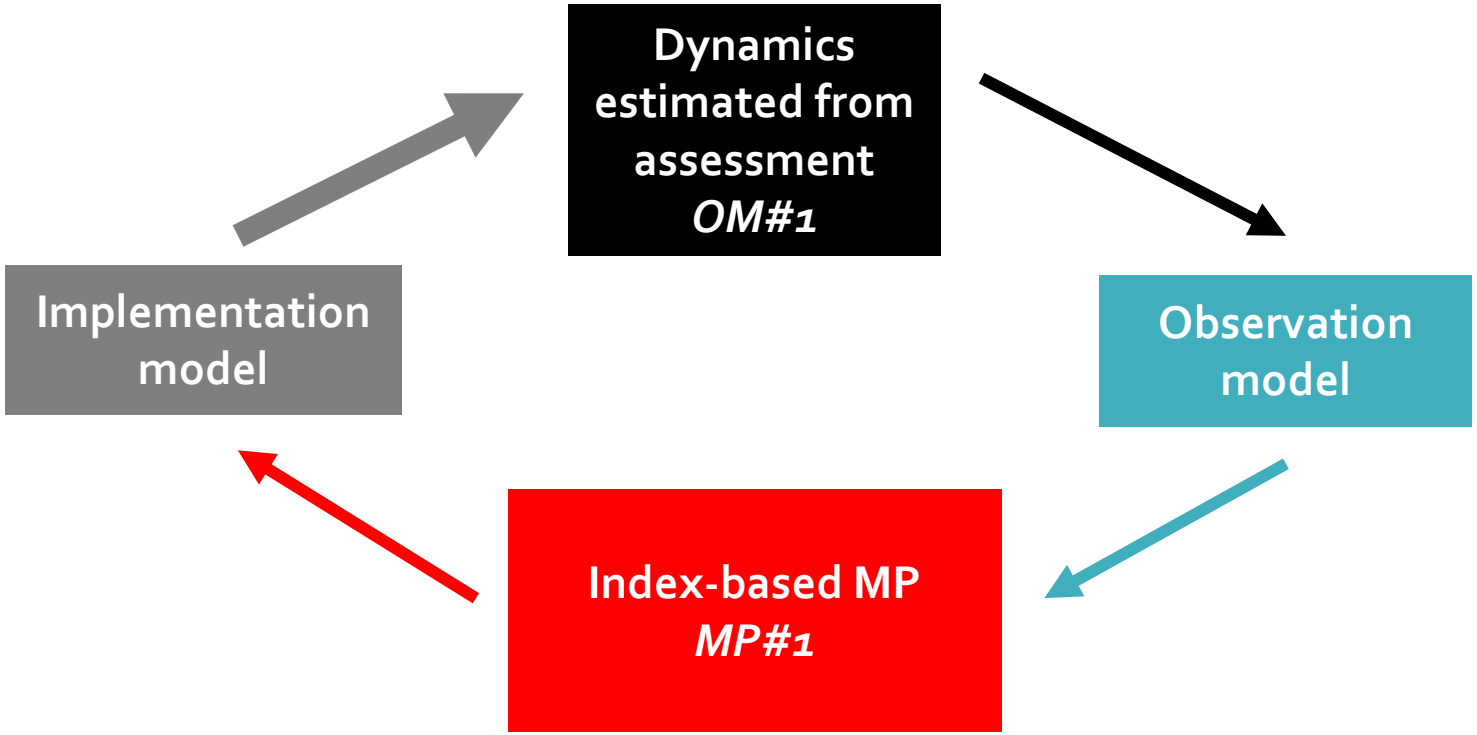

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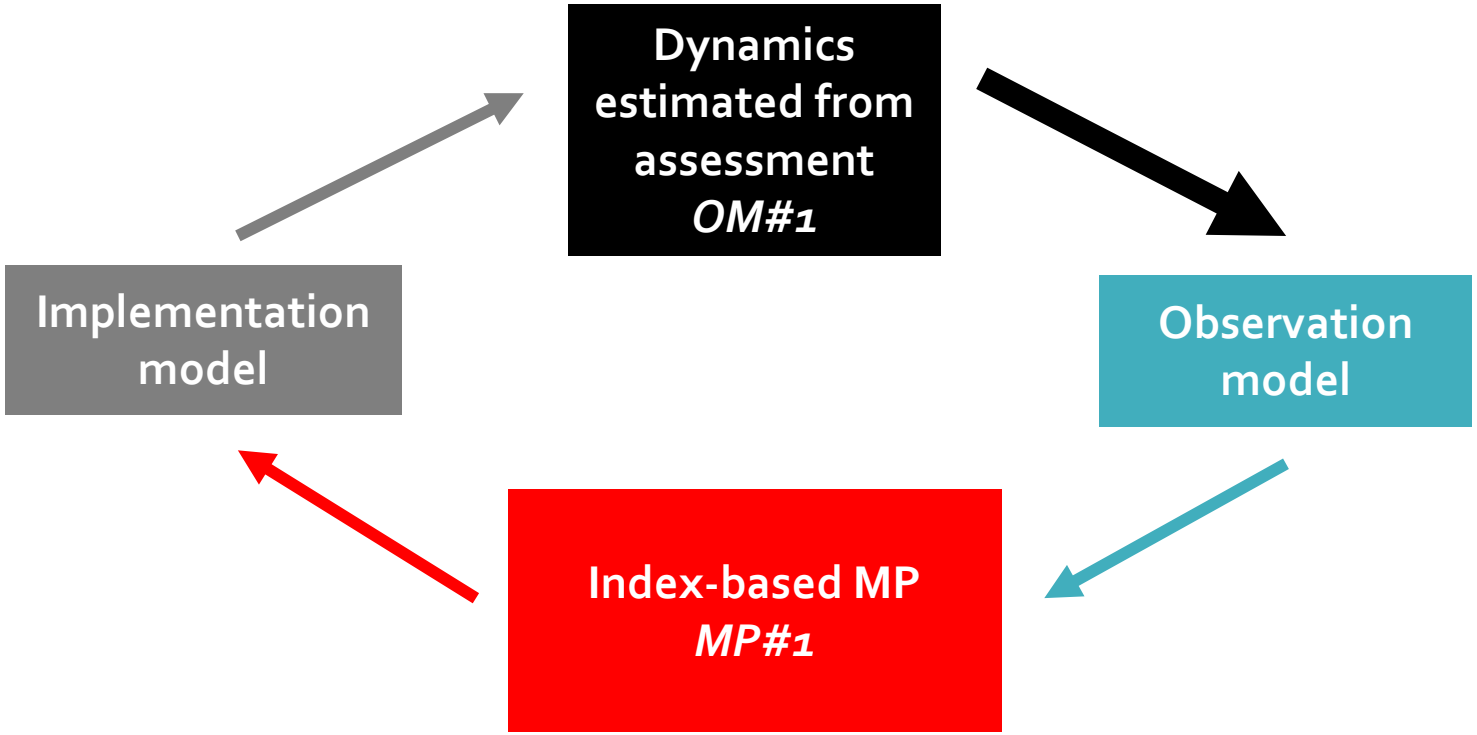

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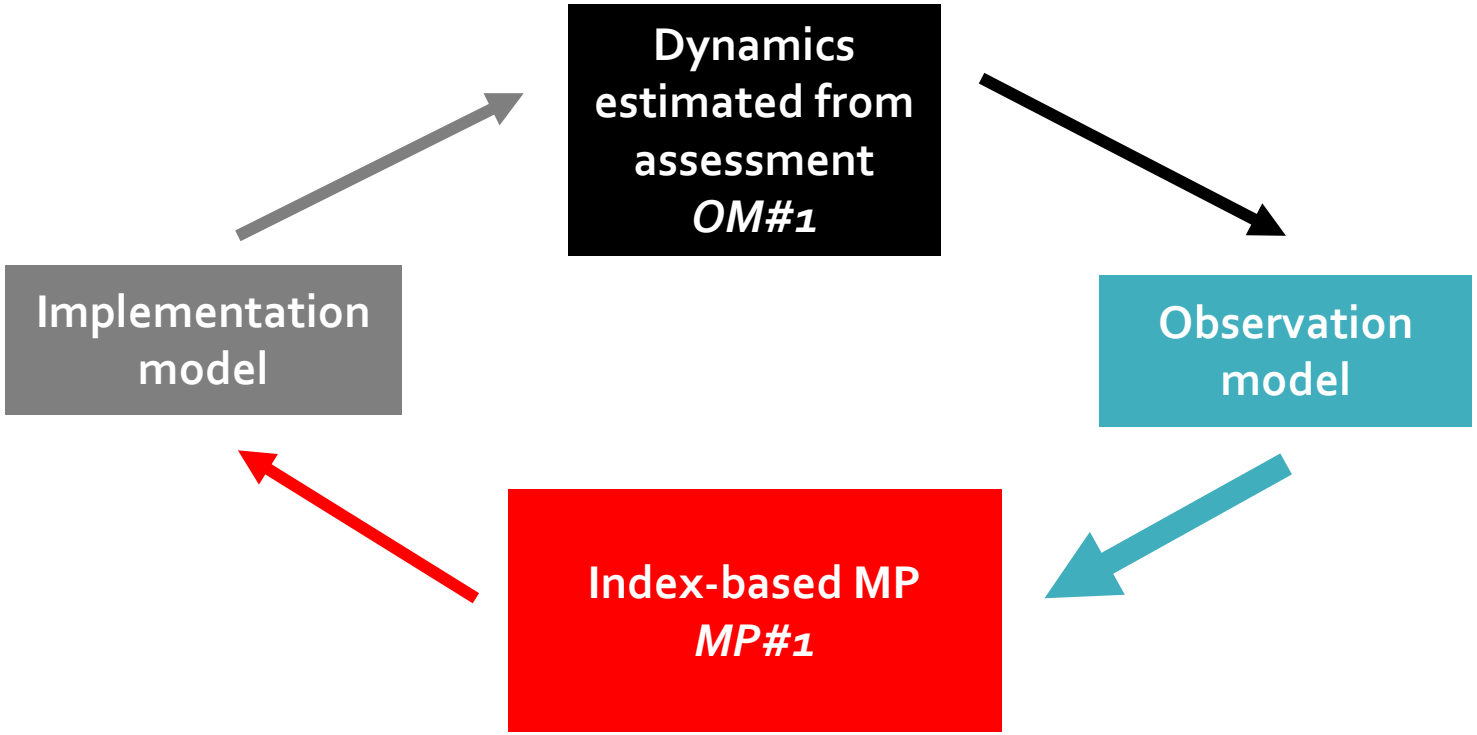

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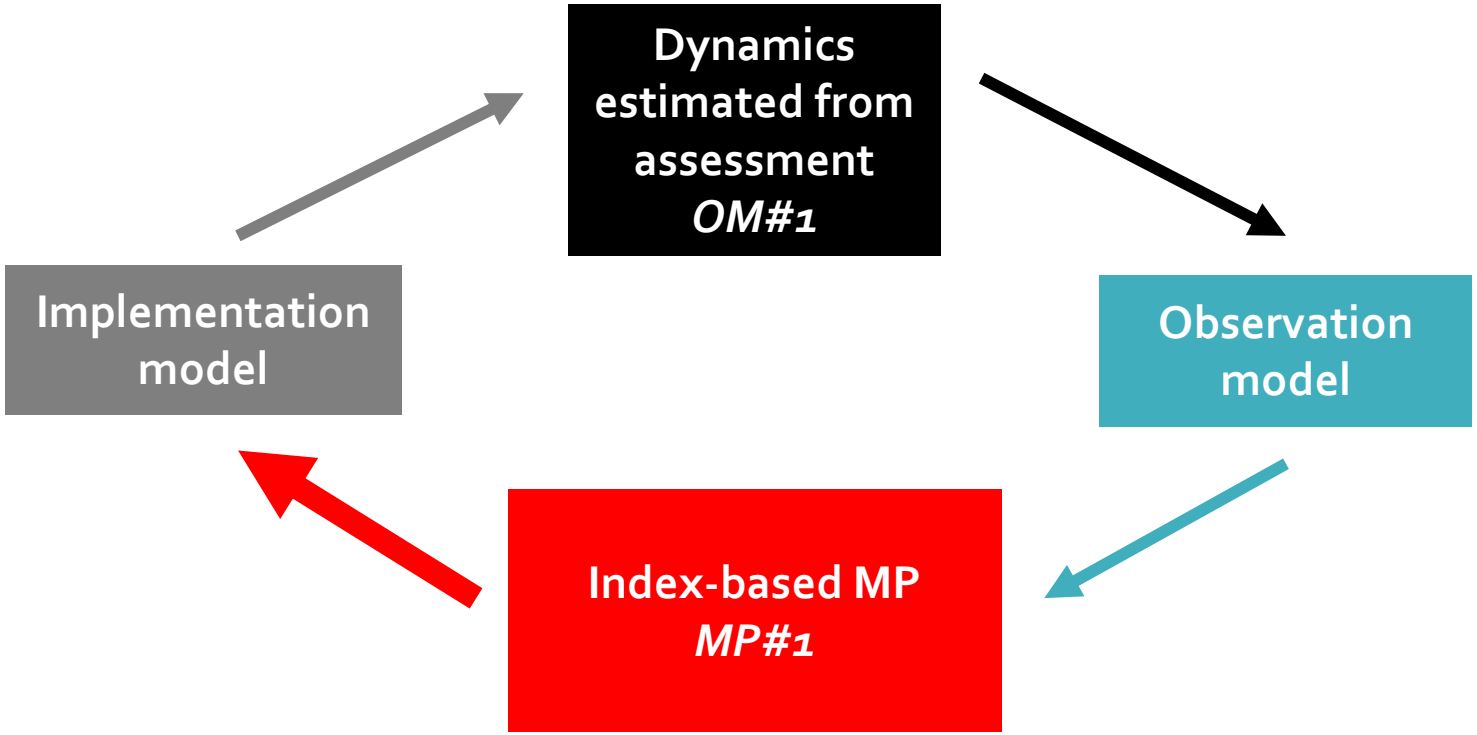

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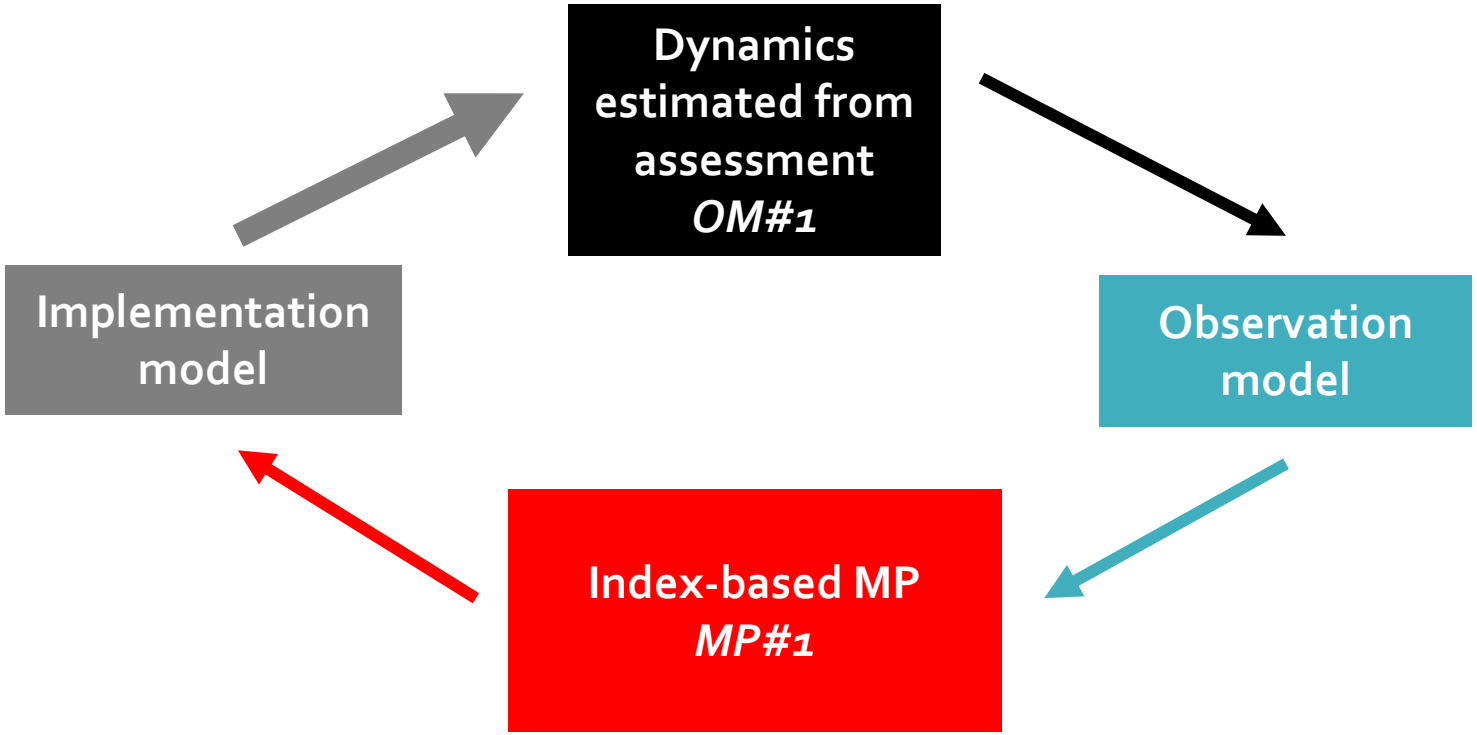

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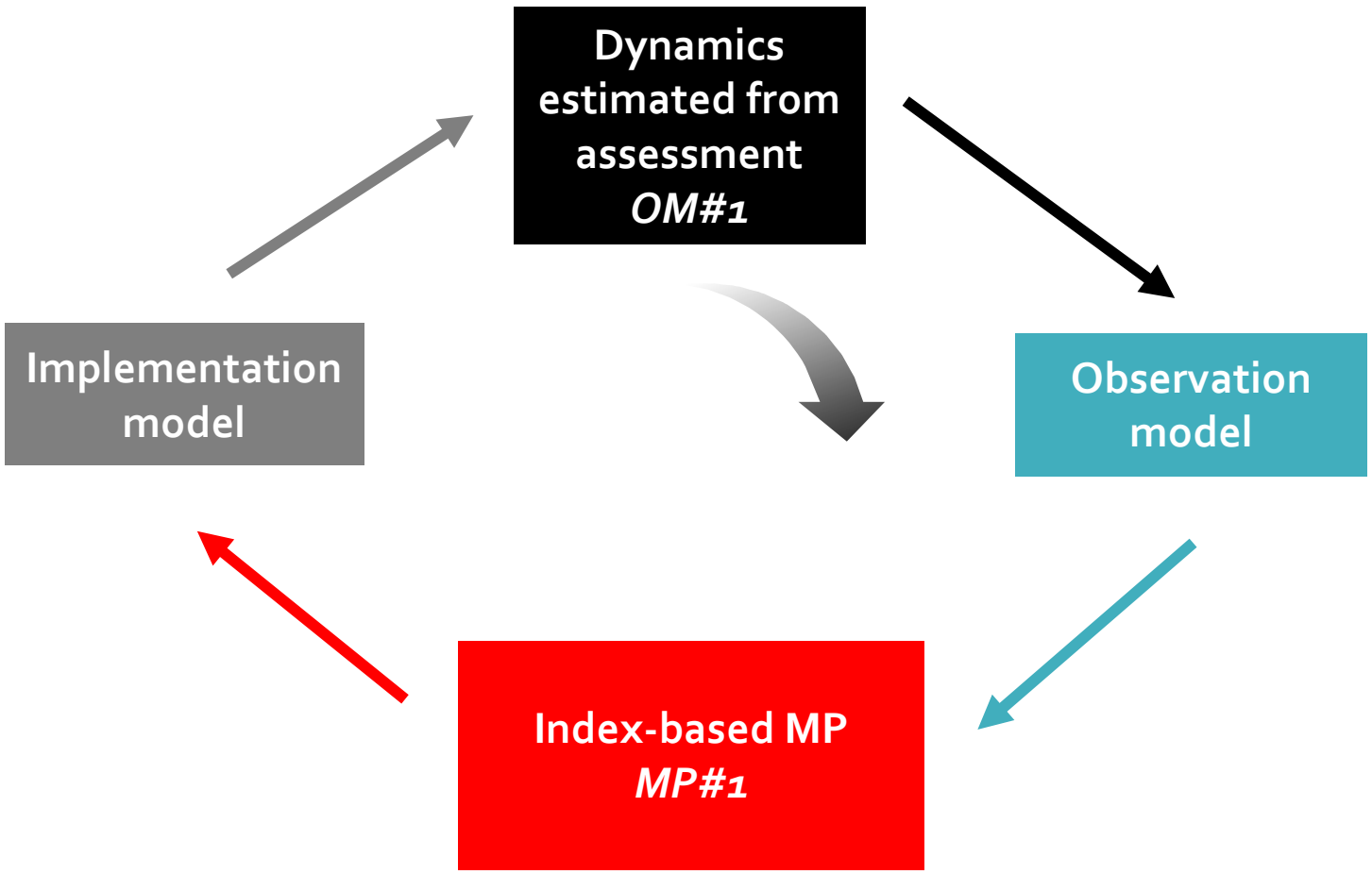

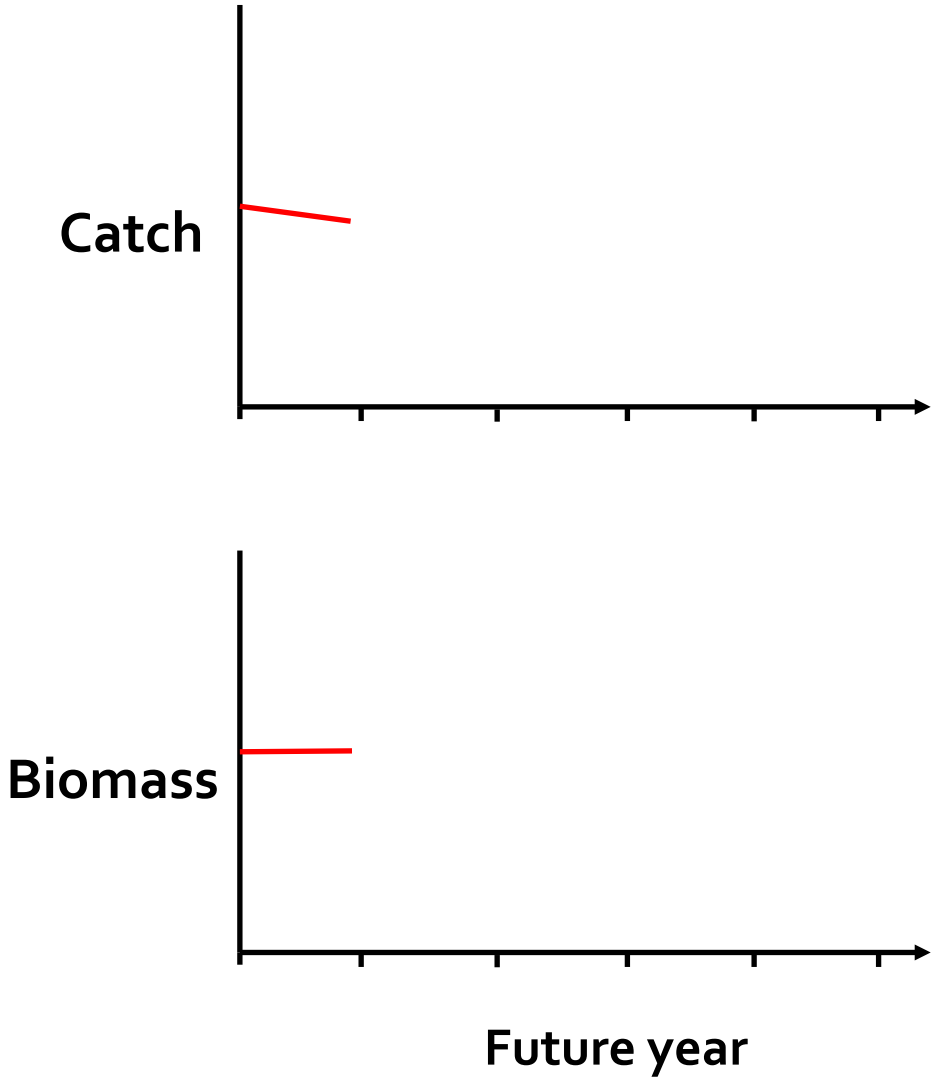

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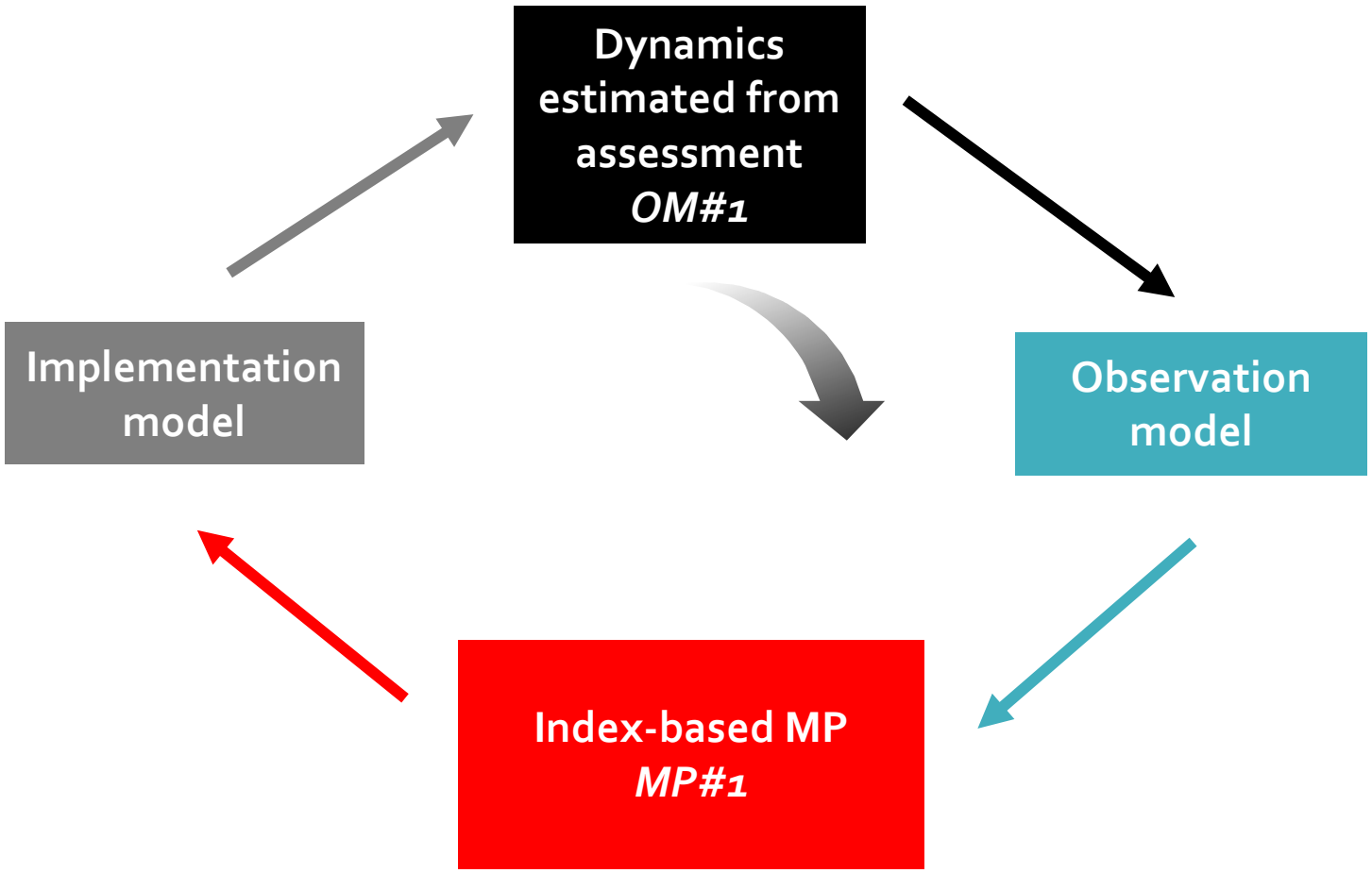

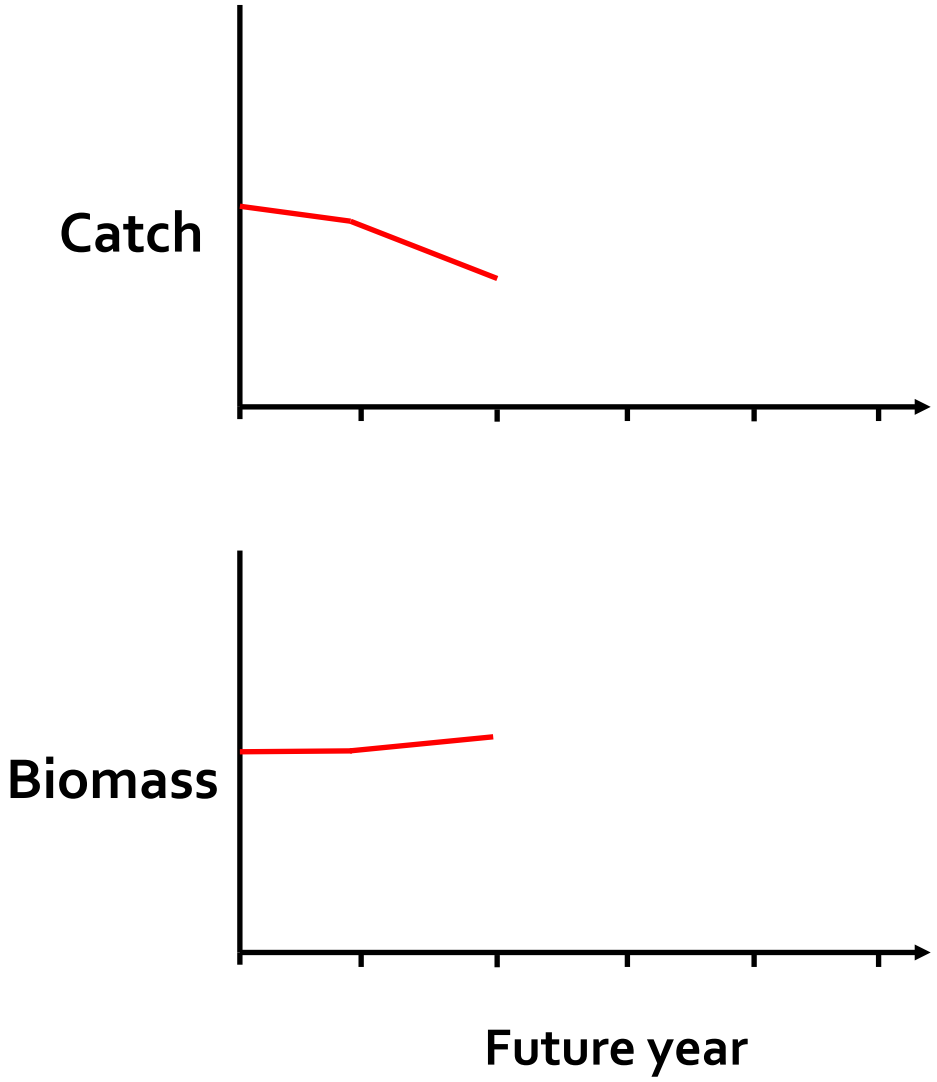

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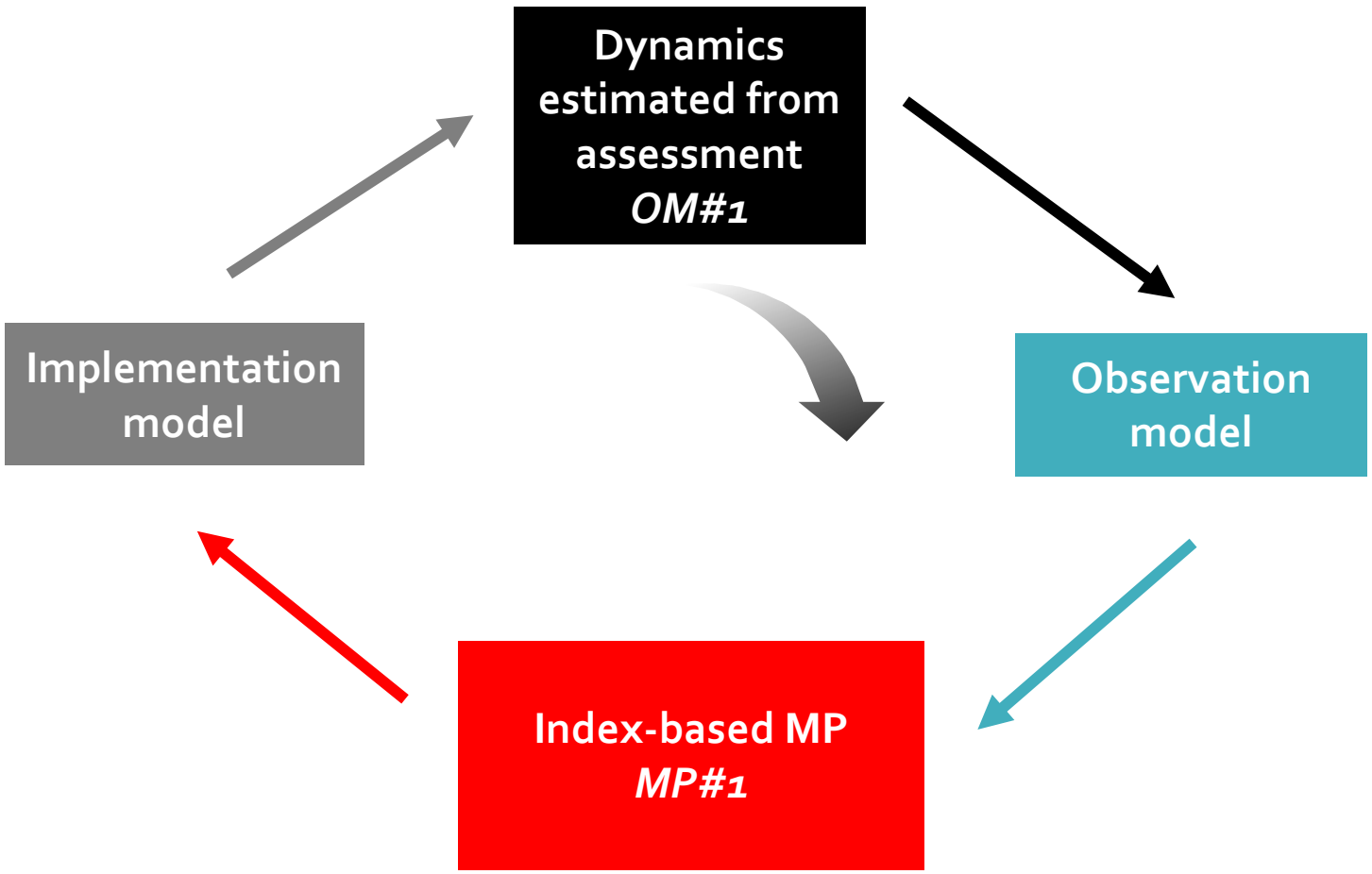

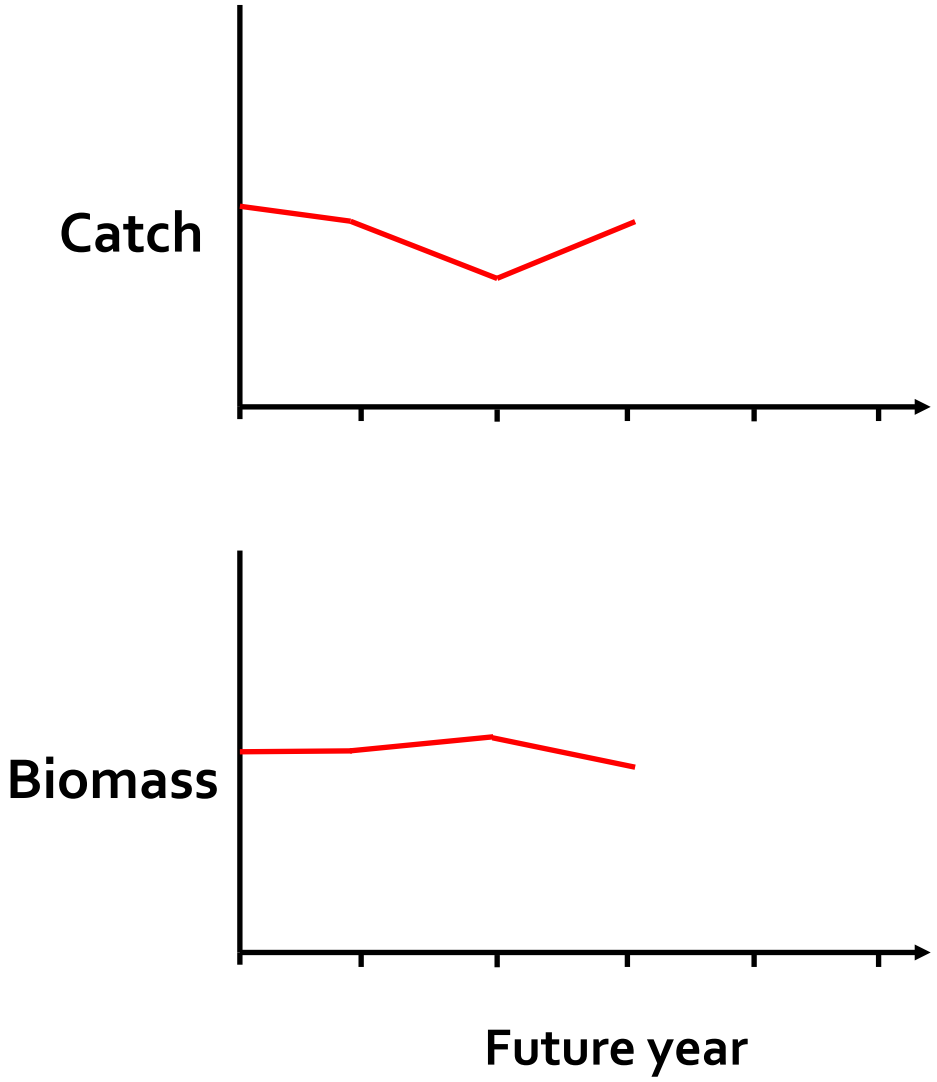

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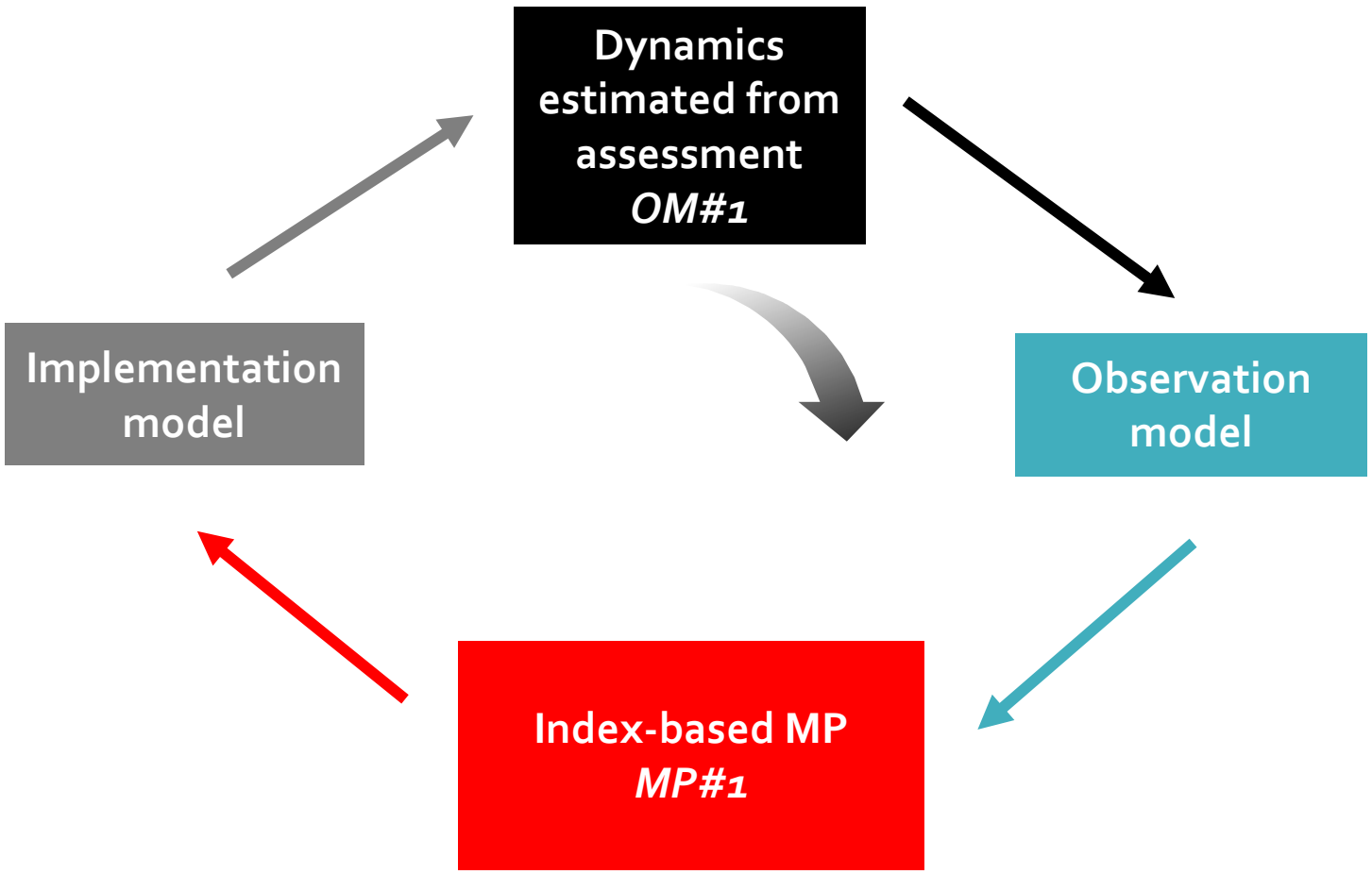

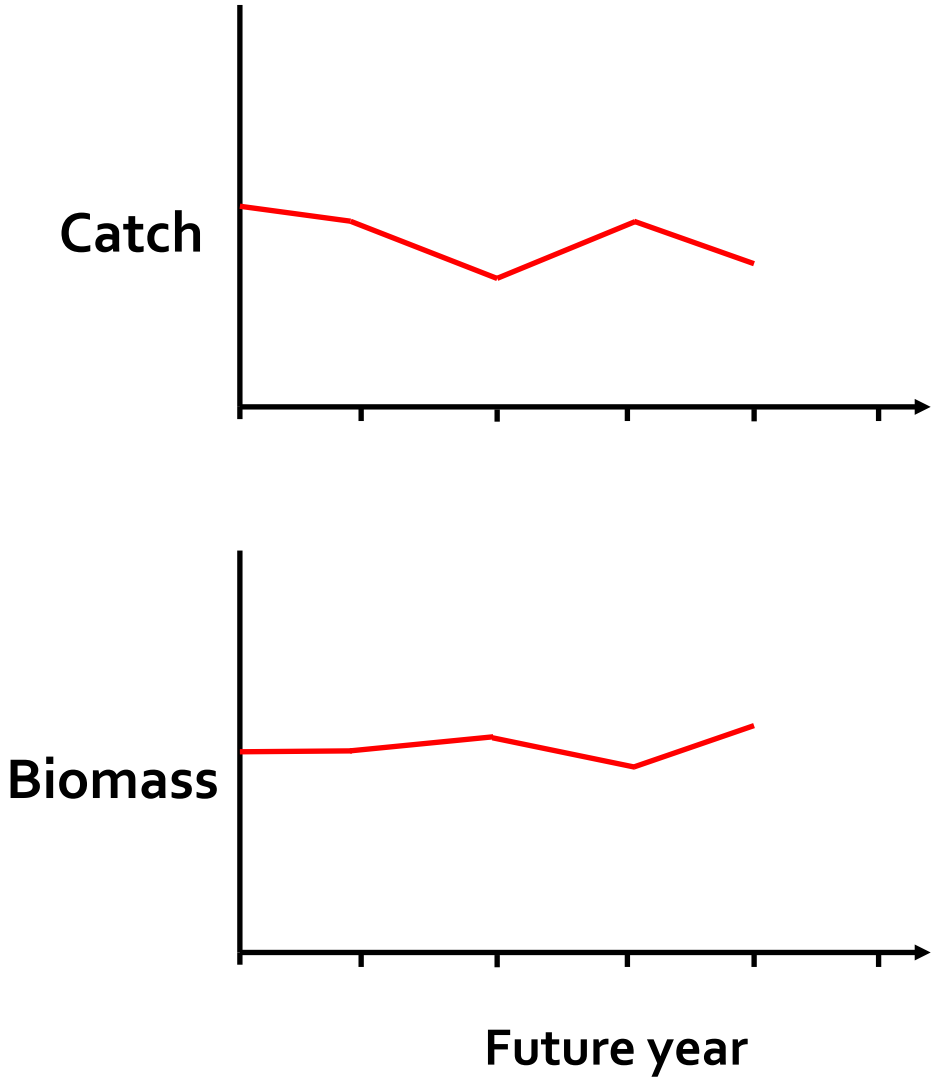

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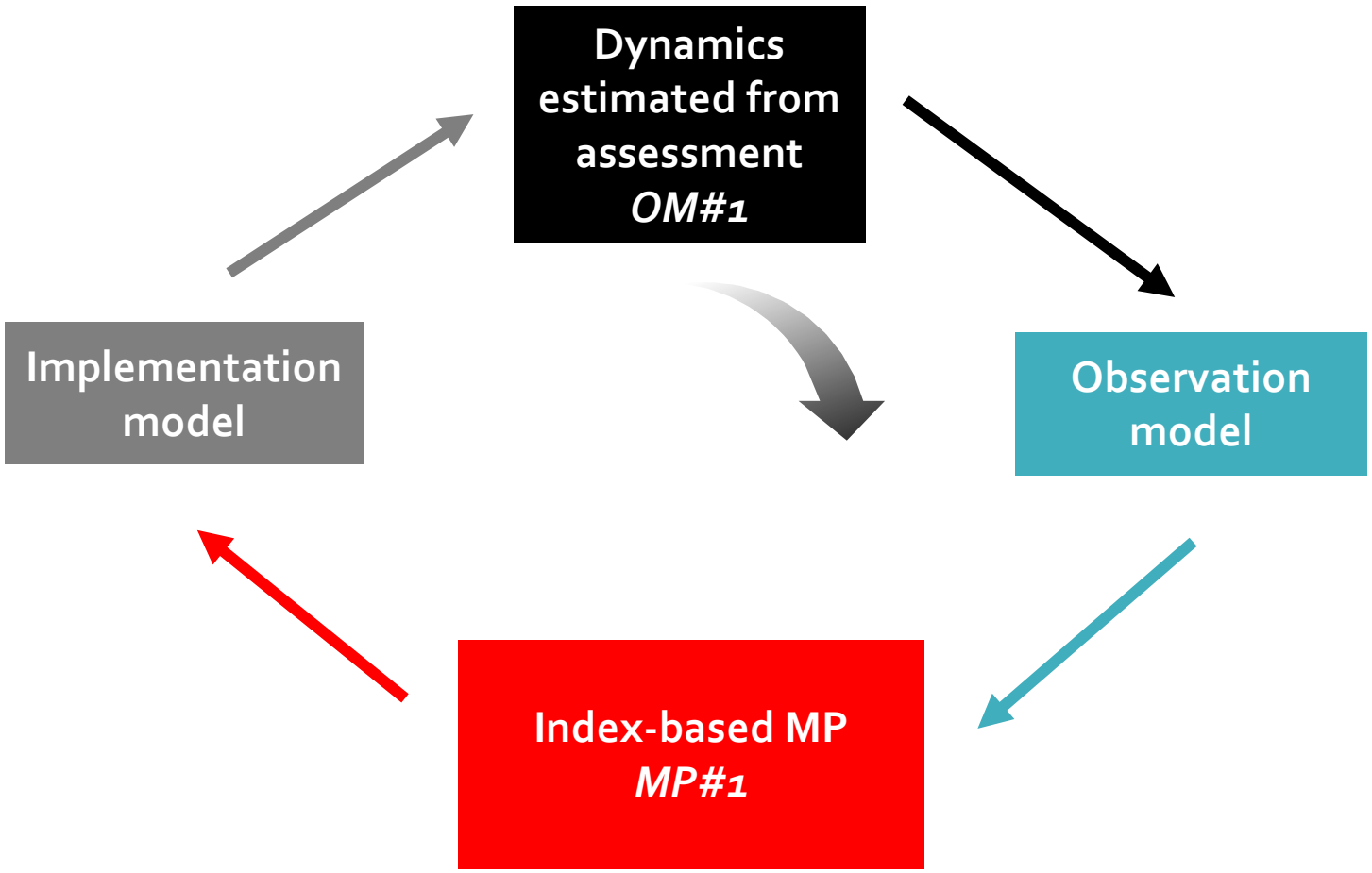
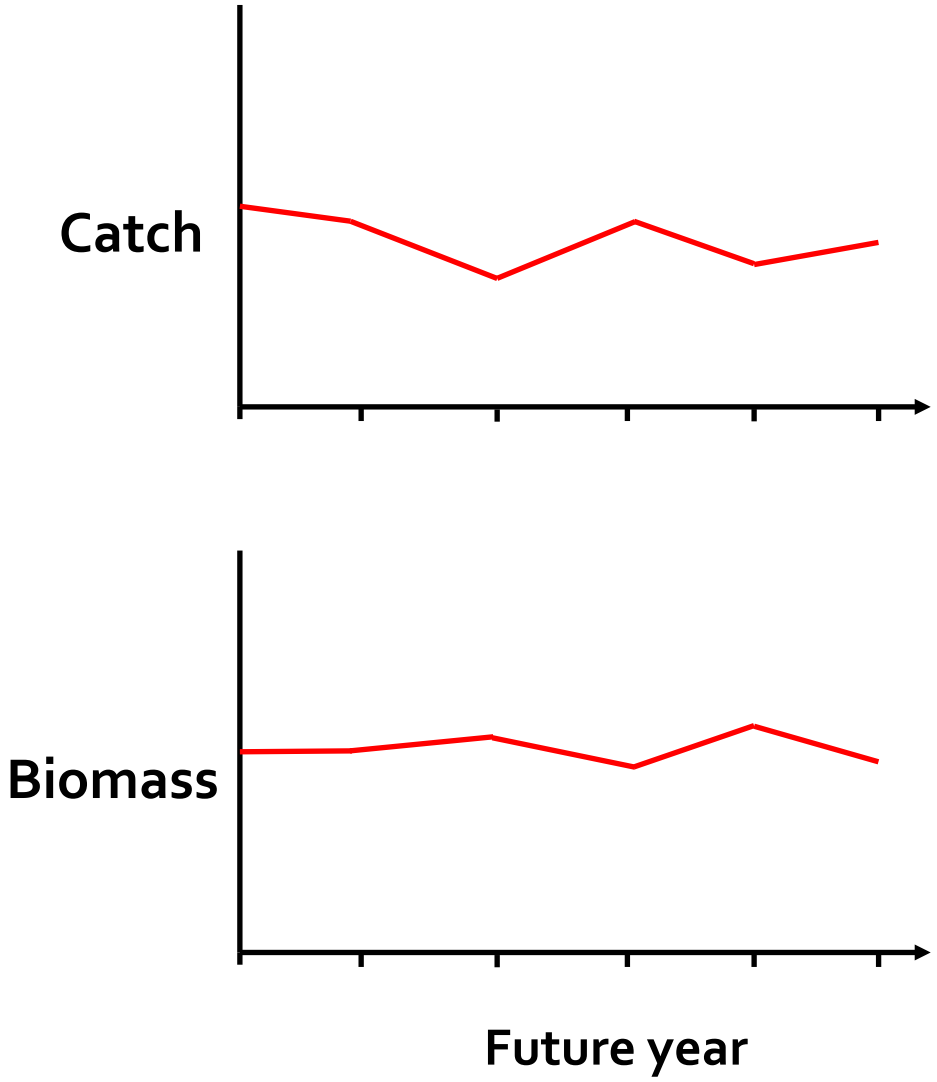
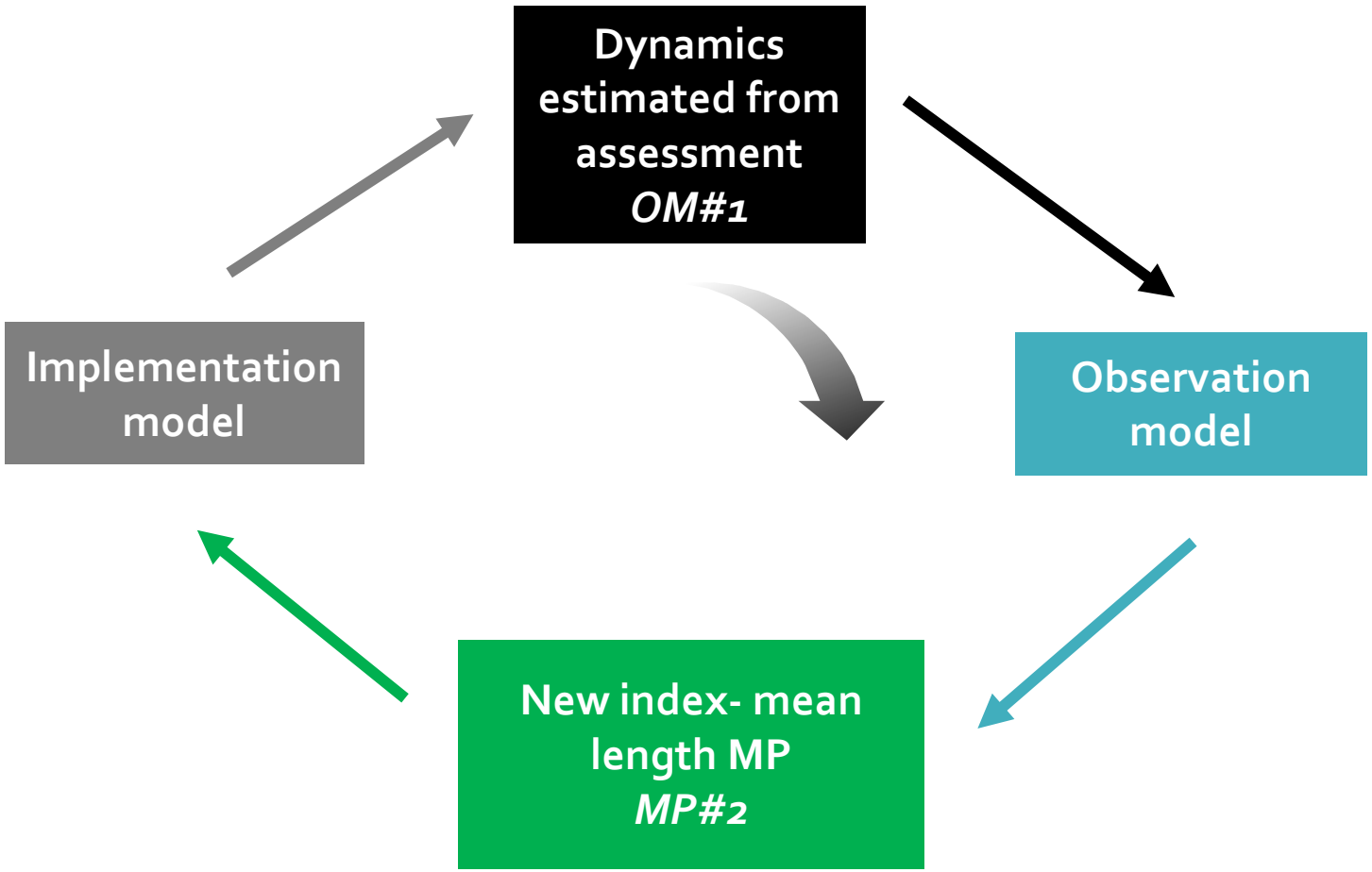
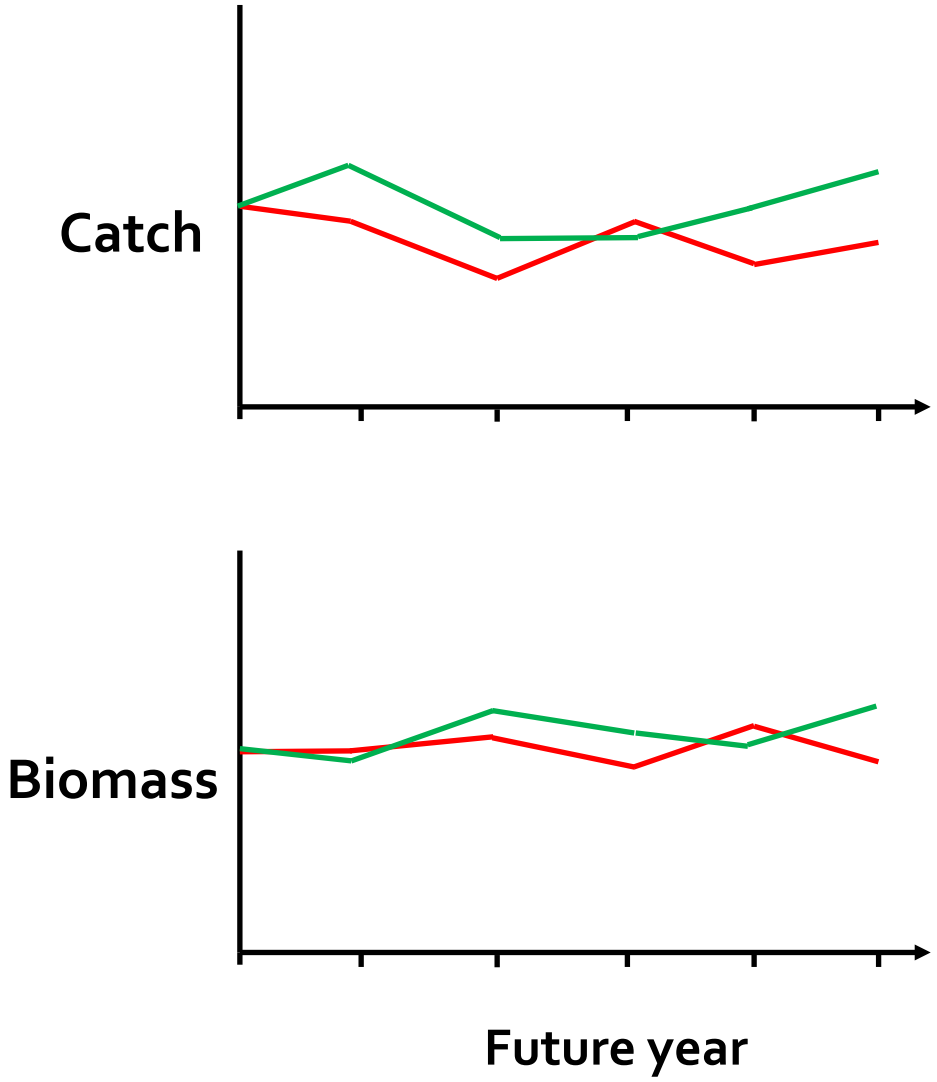




Test by simulation: the MSE approach

Index-based MP
New index-mean length MP





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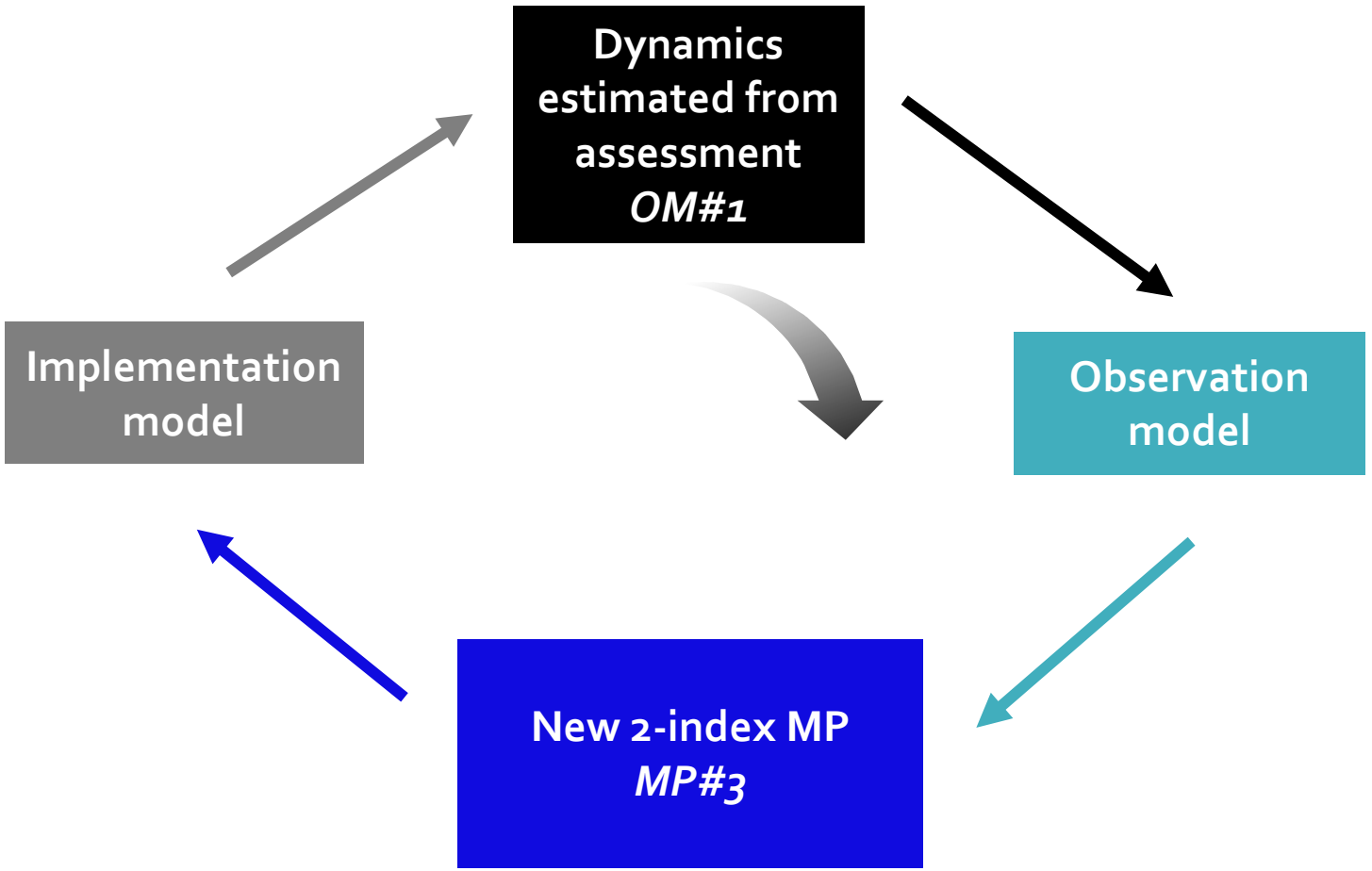
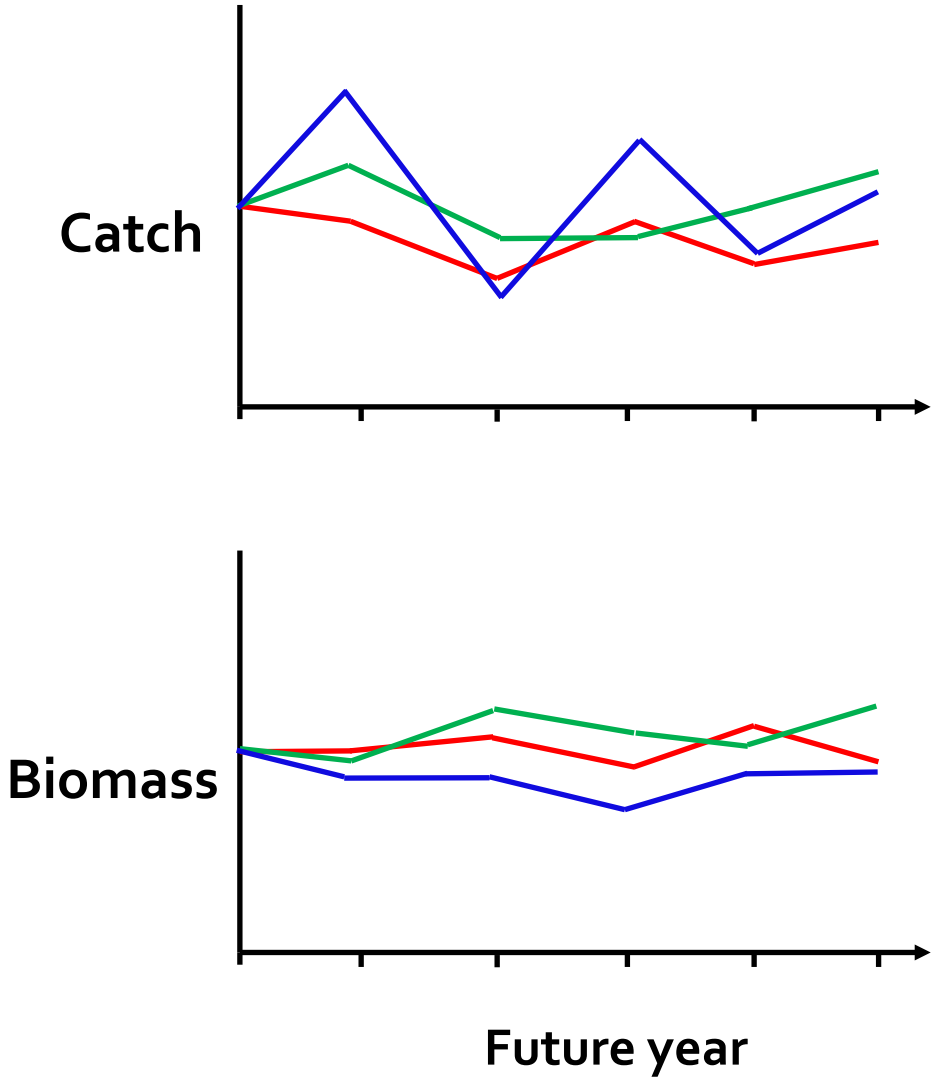


Single index-based MP
New index-mean length MP
New 2 - index MP



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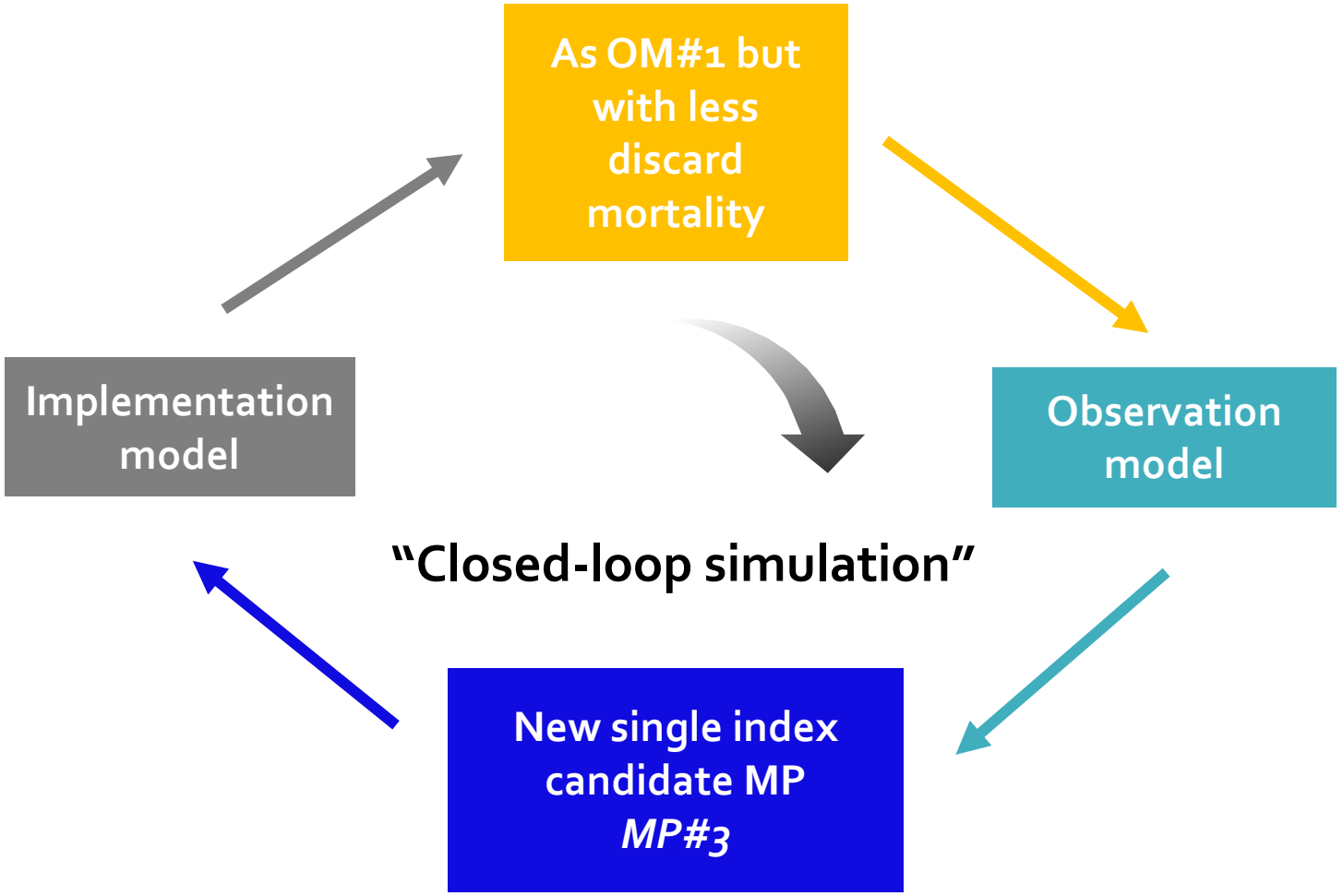
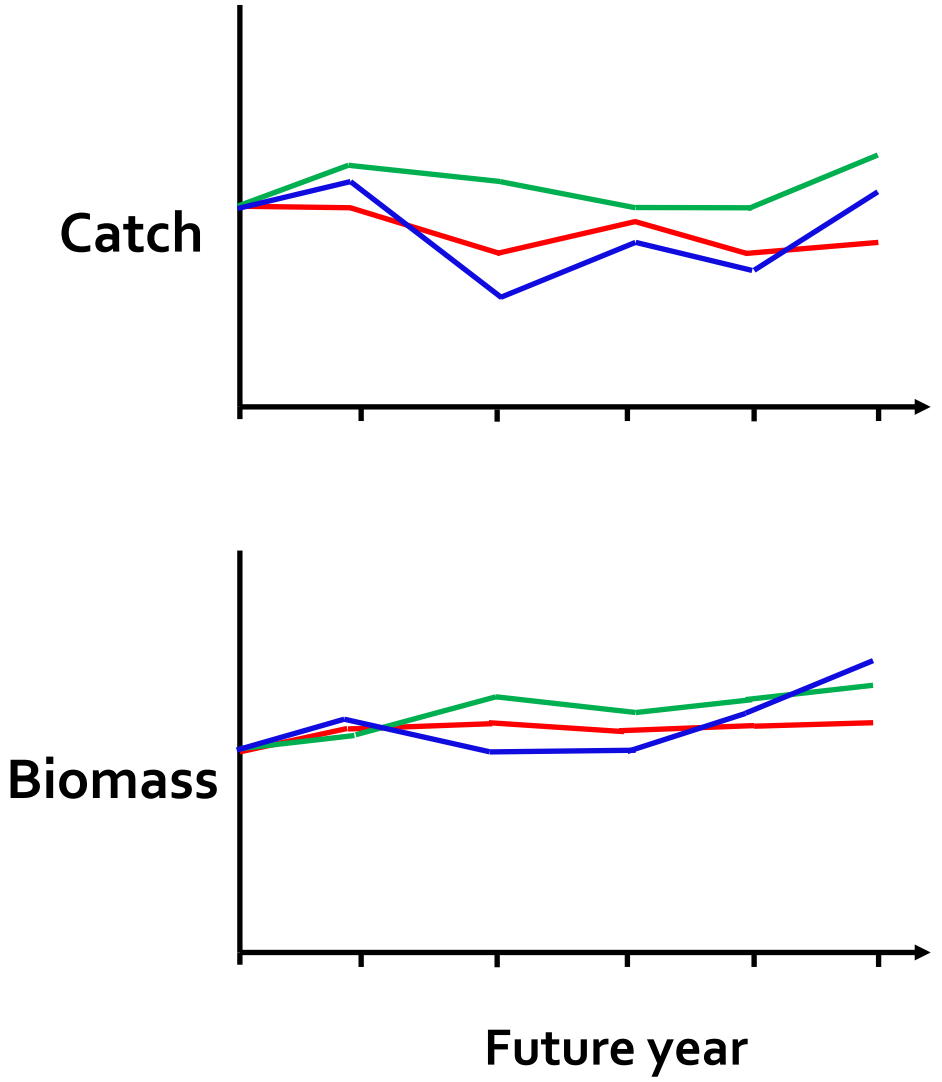


Current Index-based MP
New index-mean length MP
New single index candidate MP



A brief history of using models to test management ideas

Early 1980s: Adaptive Management (Walters, Hilborn)

Late 1980s: South Africa anchovy / sardines (Bergh & Butterworth 1987)

International Whaling Commission – Management Strategies for potential commercial catch and actual strike limits for subsistence whaling (Kirkwood, Punt and Donovan 2007)

1990s: Cape hake & rock lobster (Radermeyer et al. 2008)

1998 ICES Symposium on Confronting Uncertainty in the Evaluation and Implementation of Fisheries-Management Systems

2000s: CCSBT to select a management strategy for southern bluefin tuna (Kurota et al. 2010 2010s: recently horse mackerel

Today MSE is widely applied

- By-catch management of seabirds (Tuck 2011).
- Australian Southern and Eastern Scalefish and Shark Fishery (Punt et al. 2002; Wayte and Klaer 2010; Little et al. 2011)
- Queensland spanner crab (Dichmont and Brown 2010),
- The Northern Prawn Fishery (Dichmont et al. 2008, 2013)
- Southern rock lobster (Punt et al. 2012a)
- Tasmanian abalone fishery (Haddon and Helidoniotis 2013).
- Southern rock lobster off New Zealand (Starr et al. 1997; Breen and Kim 2006).
- In North America, northern subpopulation of Pacific sardine (PFMC 1998)
- Sablefish off British Columbia (Cox and Kronlund 2008),
- West Greenland halibut (Butterworth and Rademeyer 2010; NAFO 2010) and pollock (Rademeyer and Butterworth 2011).
- Tristan rock lobster (Johnston and Butterworth 2013, 2014).
- San Francisco Bay herring (Valencia 2019)

Questions about the concept of closed-loop simulation

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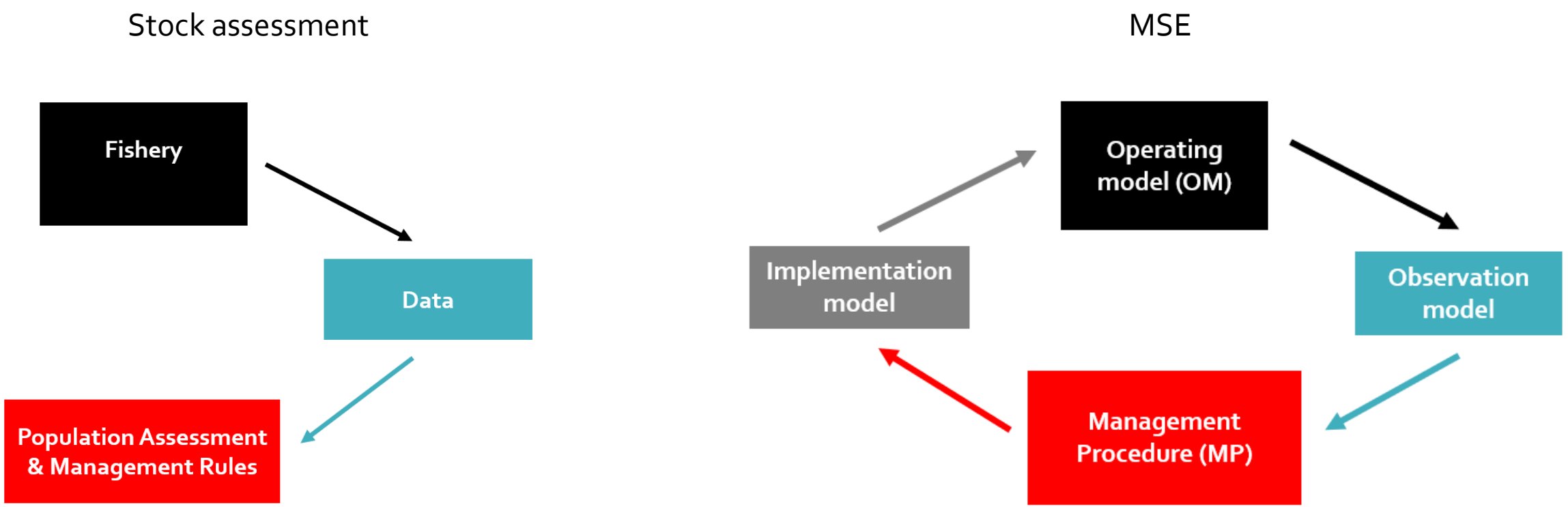
1.2 The difference between stock assessment and MSE



Stock assessment does not tell us much about expected management performance!

NASA test pilot

Crazy person

MSE vs Stock Assessment

Stock assessment: Data goes in - advice comes out. Sound familiar?

Yes, when used to provide advice, a stock assessment is part of a management procedure!

When simulation tested, typical stock assessments are often:

- not very good at estimating scale (overall size of the stock)
- sensitive to alternative plausible assumptions
- often over-parameterized (too complex for the data and assumptions)
- numerically unstable (advice can vary widely due to chance)
- incapable of representing potentially important system uncertainties

Stock assessments can provide a precarious basis for decision making where data sources are conflicting and system dynamics are not relatively certain.

There may be many plausible scenarios for the real system dynamics (stock assessment estimates are uncertain)




But we can have confidence in the management procedure because we have tested it across all of those scenarios

MSE vs Stock Assessment: Objective

Stock assessment

Provides management advice (e.g. a TAC – but we don't know how reliable this advice is)

MSE

Identifies a robust *way* to provide management advice - a management procedure that can achieve management performance objectives.

MSE vs Stock Assessment: Emphasis

Stock assessment

Provide advice (TAC) from the single best possible interpretation of the available data.

Scientific accuracy.

MSE

Find a management procedure that can meet performance objectives and is robust to various interpretations of the available data.

Account for a range of plausible fishery scenarios.

Provide confidence in the adopted management approach.

Management performance and robustness to scientific uncertainties.

MSE vs Stock Assessment: Expected performance of the management approach

Stock assessment

Unknown

MSE

Tested by simulation and quantifiable by metrics relating to yield and biomass, for example.

MSE vs Stock Assessment: Uncertainty

Stock assessment

Uses sensitivity analyses to investigate uncertainty in the *estimated* fishery system.

MSE

Uses multiple scenarios for the ‘true’ fishery system (operating models) as a testbed for management procedures.

MSE vs Stock Assessment: Communication of uncertainty

Stock assessment

Focuses on variance in model estimates (e.g. stock depletion) and advice (e.g. a TAC) within the assessment model and among sensitivity analyses.

MSE

Focuses on uncertainties that matter: which OM uncertainty affects management performance and the *selection* of management procedures?

MP ranking is often invariant to dynamics that strongly impact TAC advice – i.e. some uncertainties affect all MPs equally.

MSE vs Stock Assessment: Generation of Advice

Stock assessment

Management advice arises from models that are often quite complex and difficult to interpret for a wider range of stakeholders (sometimes only understandable to the assessment team and the reviewers).

Managers may often diverge from assessment-based advice in response to broader indicators such as catch rates.

MSE

Advice can be derived from very simple rules (e.g. higher TAC if index above a target level, TAC lower if index below a target level) or even be prescriptive such as a gear configuration, seasonal closure, size limit or a fixed level of fishing effort (e.g. days at sea).

The advice provided by the MP is generally followed.

MSE vs Stock Assessment: Robustness

Stock assessment

Unknown robustness to uncertainties.

MSE

Uses multiple scenarios for the ‘true’ fishery dynamics (OMs) as a testing platform for management procedures.

If an MP is adopted we can know its strengths and weaknesses (which system properties to look out for).

Confidence in management approach.

MSE vs Stock Assessment: Complexity of the process

Stock assessment

Depends on the data, fishery and assessment approach. The complexity exists in the model that generates advice (essentially the management procedure itself).

MSE

Generally more arduous in terms of identifying operating models, performance metrics and candidate MPs.

High technical demands in terms of making an MSE framework

TAC advice is calculated by an MP that is generally much easier to understand than a stock assessment.

MSE vs Stock Assessment: Stakeholder Involvement

Stock assessment

Stakeholders often feel like observers to the process and unable to relate assessment outputs to their objectives.

MSE

Stakeholders are central to the process. Since performance objectives are at the heart of MP selection it is vital that stakeholders communicate what are good and bad outcomes for them.

Stakeholders often also provide candidate MPs for testing

MSE vs Stock Assessment: Transparency

Stock assessment

Since management performance of assessments is unknown, it is not clear how decisions regarding modelling and data were made. For example, when we changed to model X that uses data Y, what was the expected benefit in terms of yield and biomass?

MSE

At the end of the MSE process if an MP is adopted it will be clear why the MP was chosen, what performance managers were aiming for / avoiding, and what performance trade-offs were involved.

Questions about assessments vs MSE

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MSE process 1

A clear problem statement

What is the objective? What is the MSE intended to solve? For example:

- High degree of uncertainty in fishery dynamics leading to uncertain stock assessment outputs
- Multi-species management impacts not accounted for by single-species management
- Unknown robustness of current assessment-control rule to ecosystem changes or climate impacts

MSE process 2

Three principal groups:

Oversight (strategists)

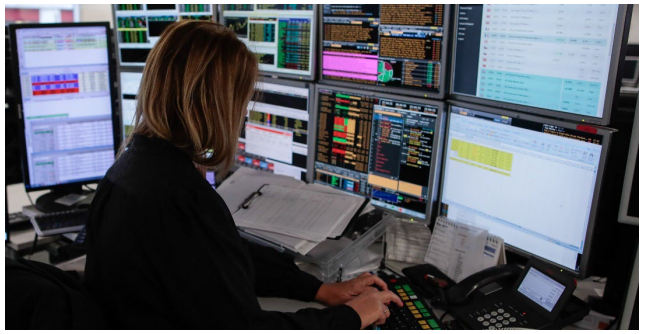
Steers the process, sets objectives, communicates with decision makers, organizes the timeline and stages of the process including deadlines, guillotines, decision points and meetings.

User (drivers)

Stakeholders, scientists, managers interested in MSE results and the testing of candidate MPs.
Experts in various aspects of the fishery (e.g. growth, movement, fishing efficiency, datasets)

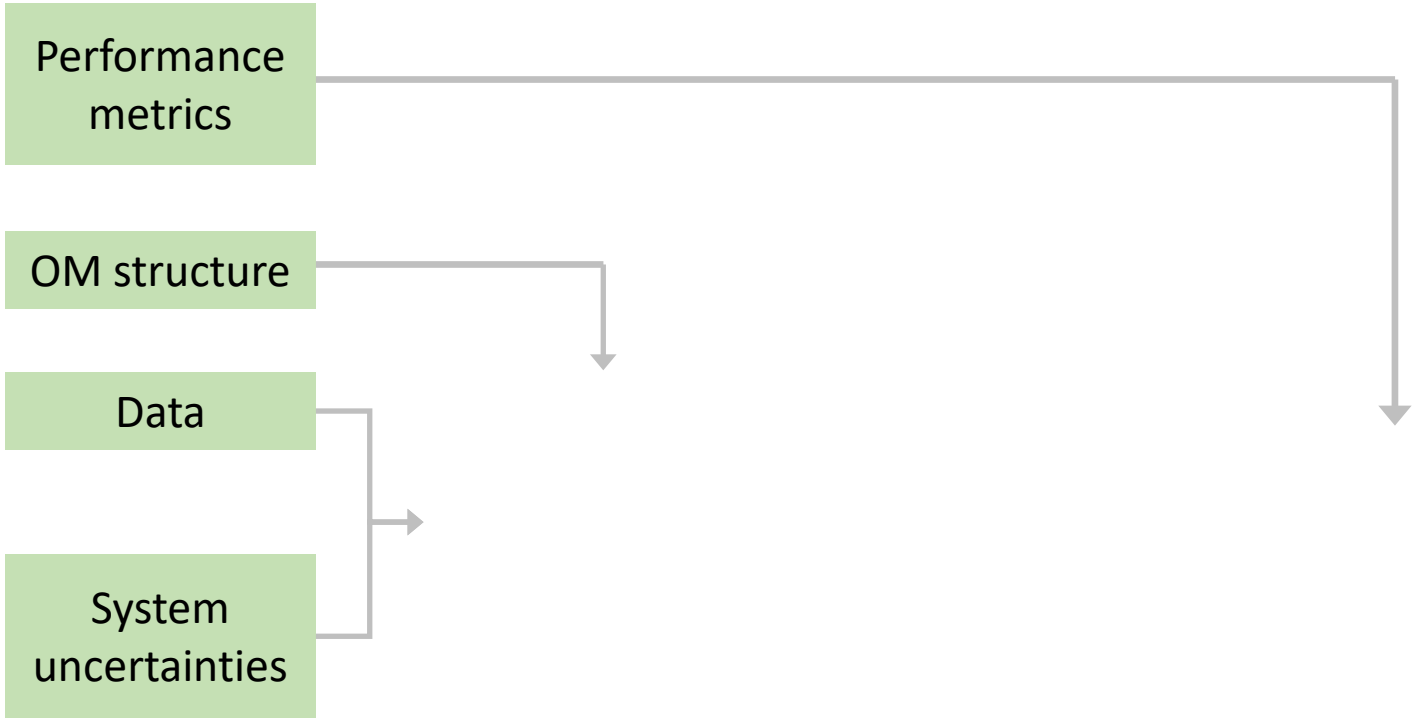
Technical (engineers)

Work on mathematical, statistical and computer programming tasks required to get the MSE implemented.



MSE process 3

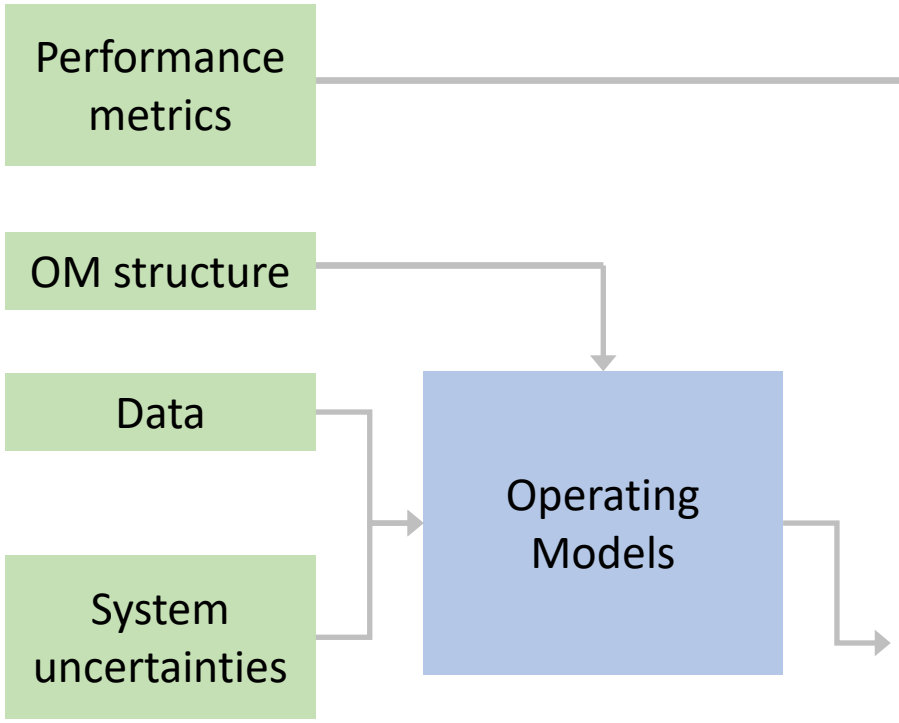
Closely following Punt et al. 2014 (MSE best practices)



- How should successful management be measured?
- What are the necessary features of an operating model for this stock?
- What data do we have to inform models that can characterize these uncertainties?
- What are the key system uncertainties that a Management Procedure should be robust to?

Phase 1

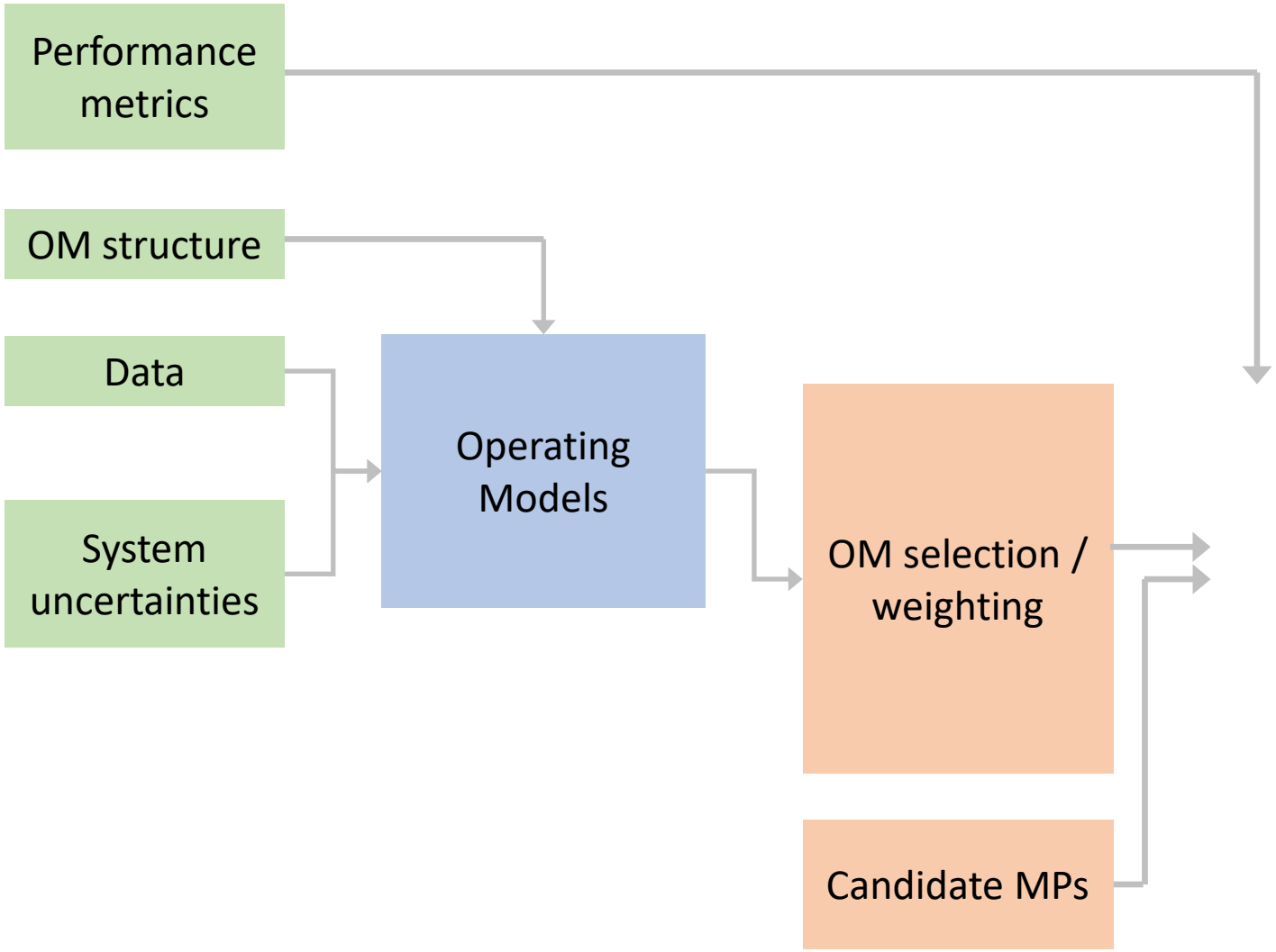
MSE process 3



- Fitting Operating Models to data (conditioning)
- Constructing a range of OMs that span primary uncertainties (‘Reference set’) and secondary uncertainties (‘Robustness set’)

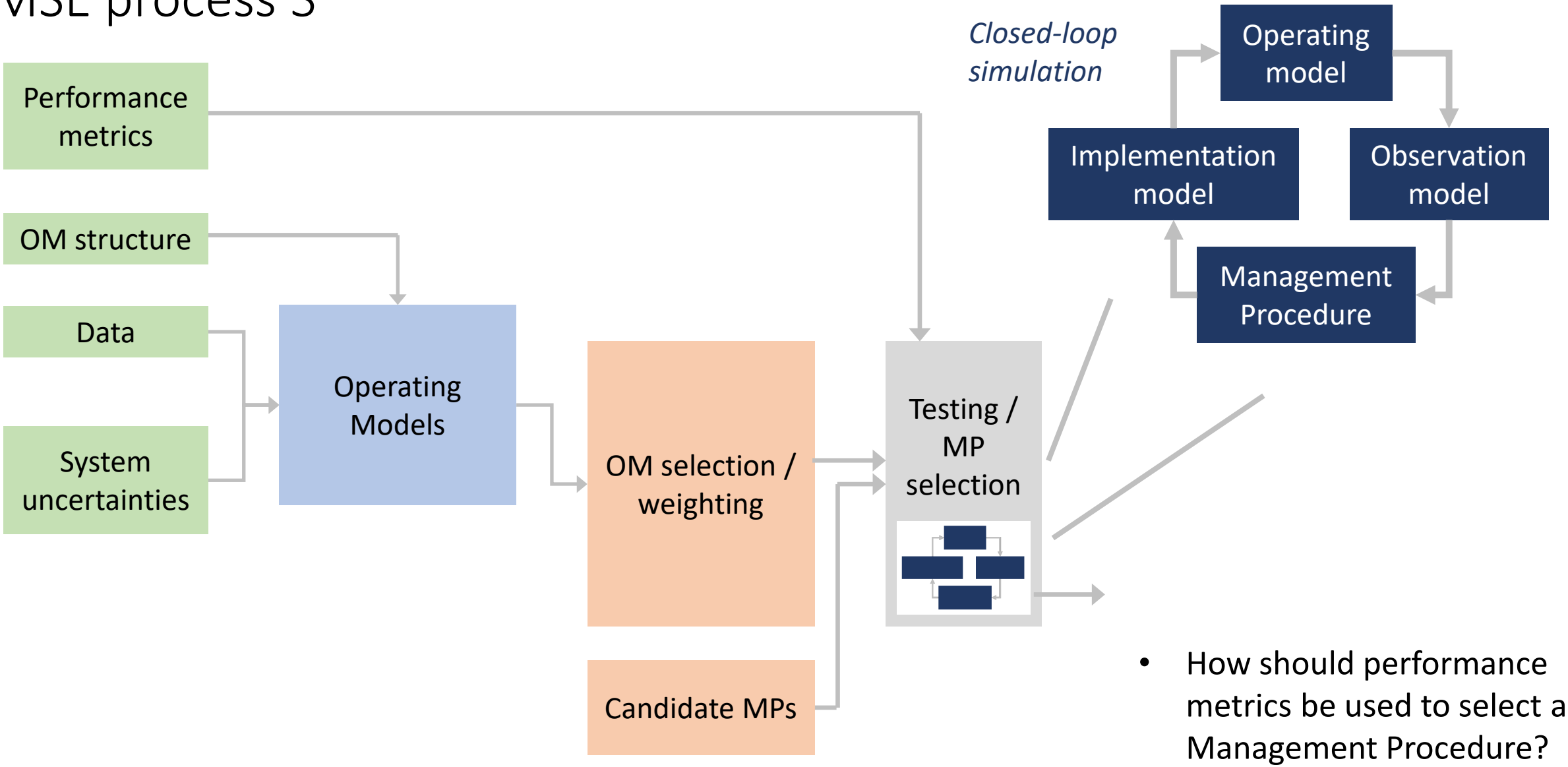
Phase 1 Phase 2

MSE process 3



- Can operating models be weighted according to plausibility?
- What types of management procedure should be considered – what management levers are available (TACs, effort control, size limits, discarding devices etc.)?
- What data will be collected in the future?

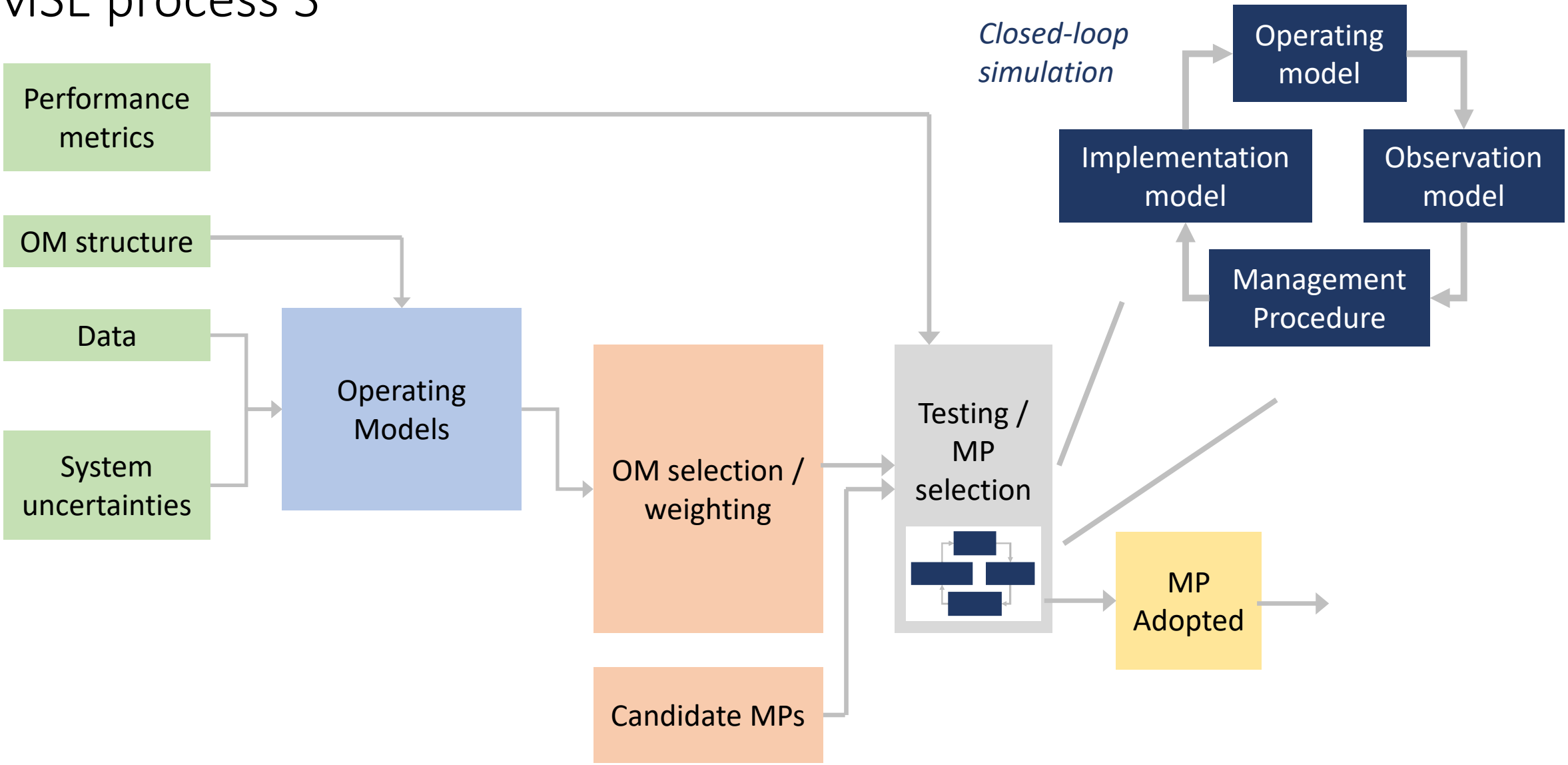
MSE process 3



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

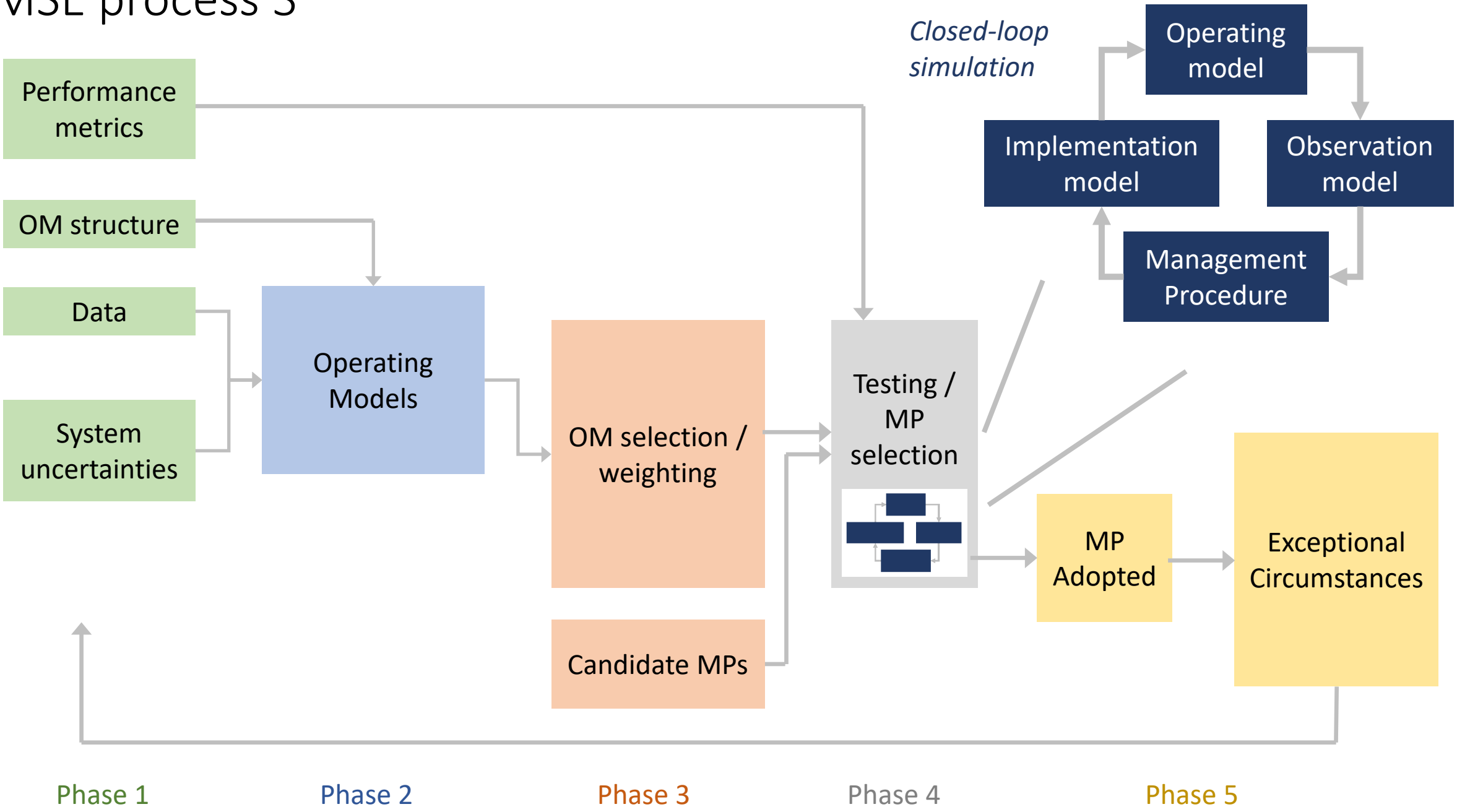
Phase 1 Phase 2 Phase 3 Phase 4

MSE process 3

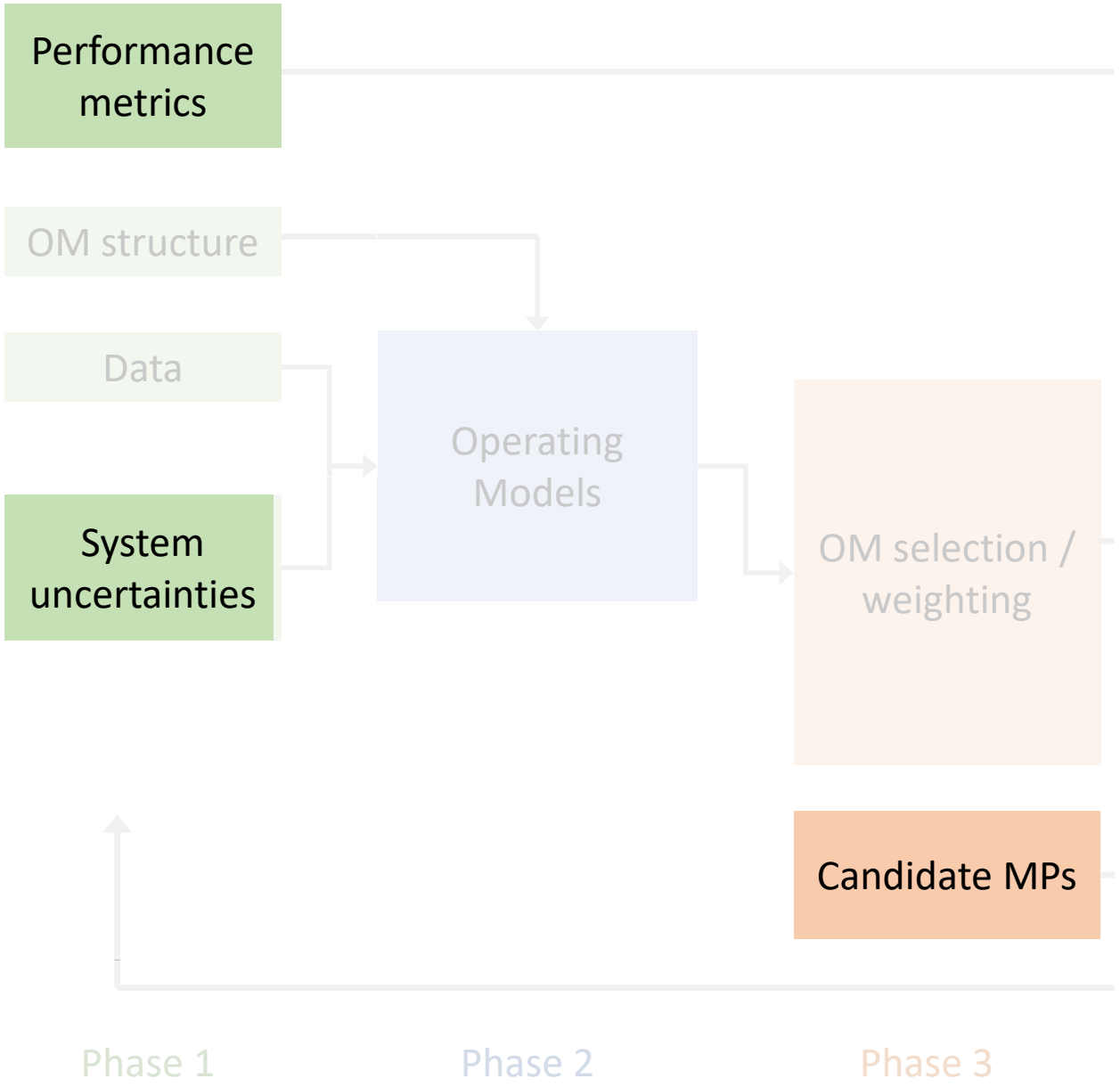


Phase 1 Phase 2 Phase 3 Phase 4 Phase 5

MSE process 3



Initial priorities



- **What is good management performance in this context?**
- **What current uncertainties in the system should management be robust to?**
- **What management levers are available and what data can be used in the future to make management recommendations?**

Questions about MSE process and priorities

Contents

1. What is MSE?
2. How does an MSE differ from a stock assessment?
3. What does an MSE process look like?

Further questions / discussion?