INTRODUCTION TO MSE

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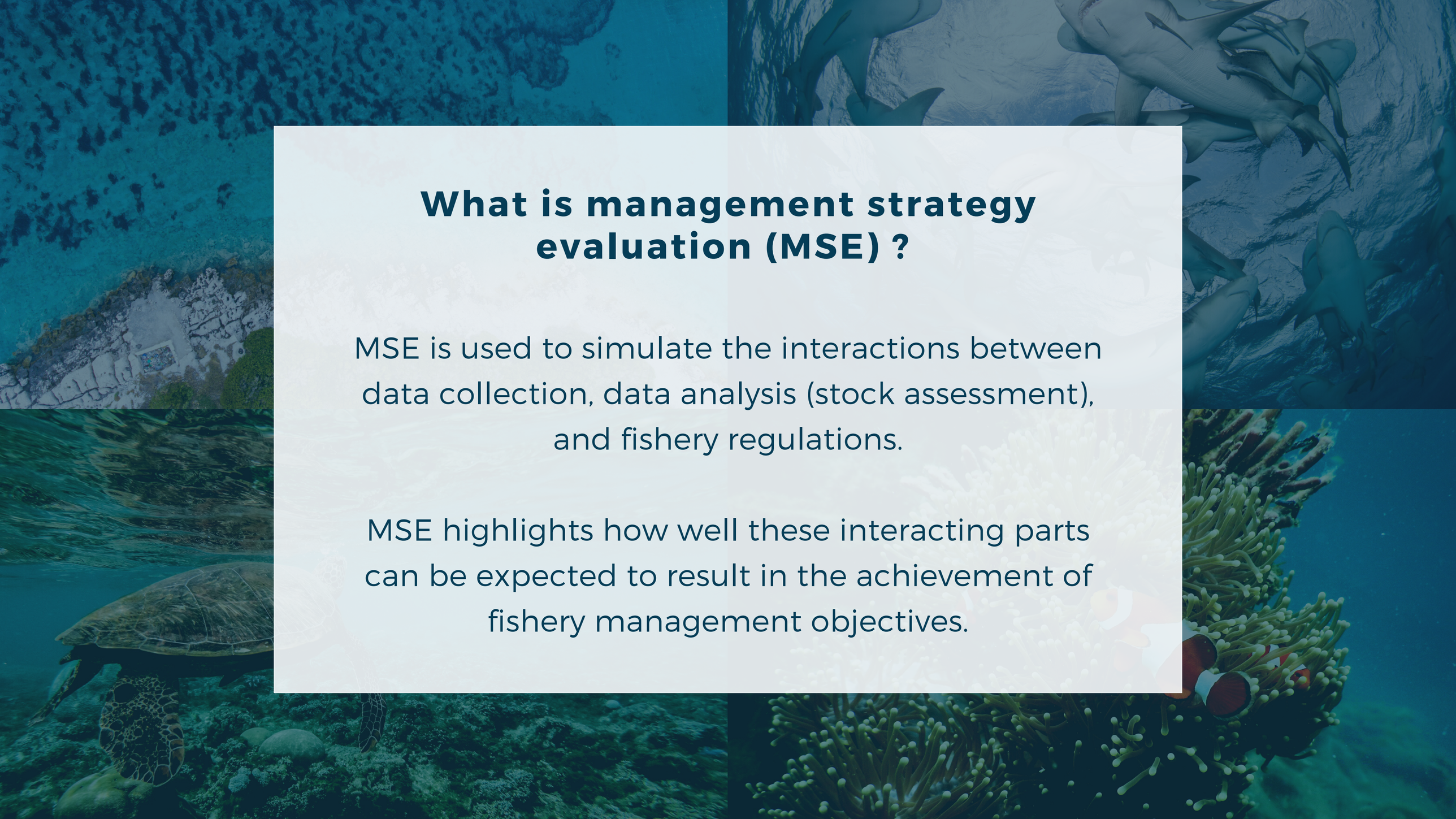
SIMPLE OVERVIEW

High level discussion of key concepts

DETAILED STEPS OF MSE

What details must be considered in setting up MSE?

Simple overview



What is management strategy evaluation (MSE) ?

MSE is used to simulate the interactions between data collection, data analysis (stock assessment), and fishery regulations.

MSE highlights how well these interacting parts can be expected to result in the achievement of fishery management objectives.

Common applications of MSE

- Tactical guidance - Develop a management strategy for a particular fishery.
- Strategic guidance - Evaluation of general principles and general strategies.

A fishery system

Fish stock

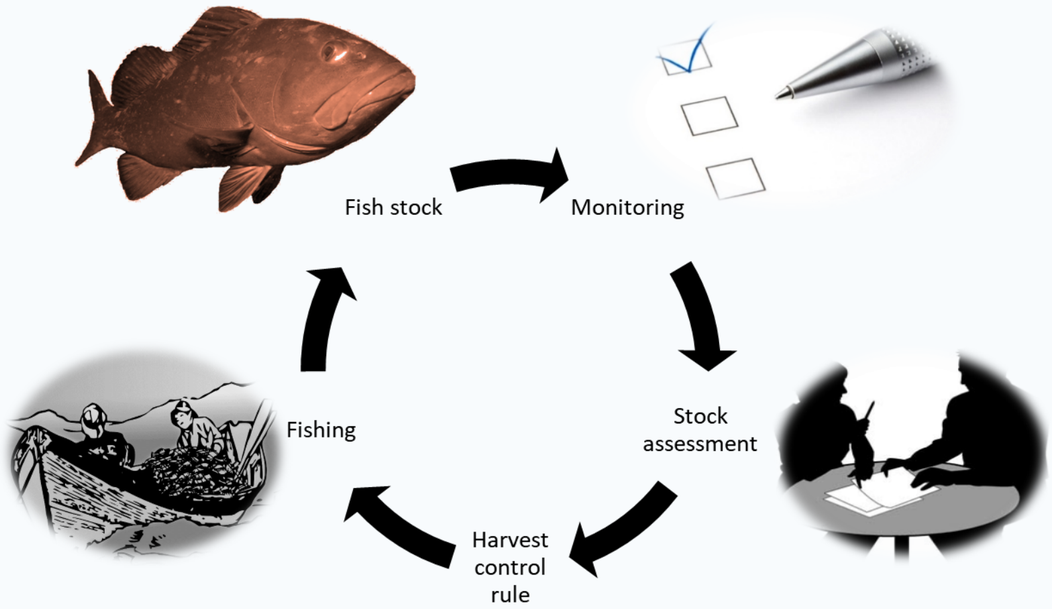
Monitoring

Stock assessment

Harvest control rule

Fishing

What can we achieve with MSE?



SCIENTIFIC DEFENSIBILITY

Design and test a management strategy prior to real-world implementation.

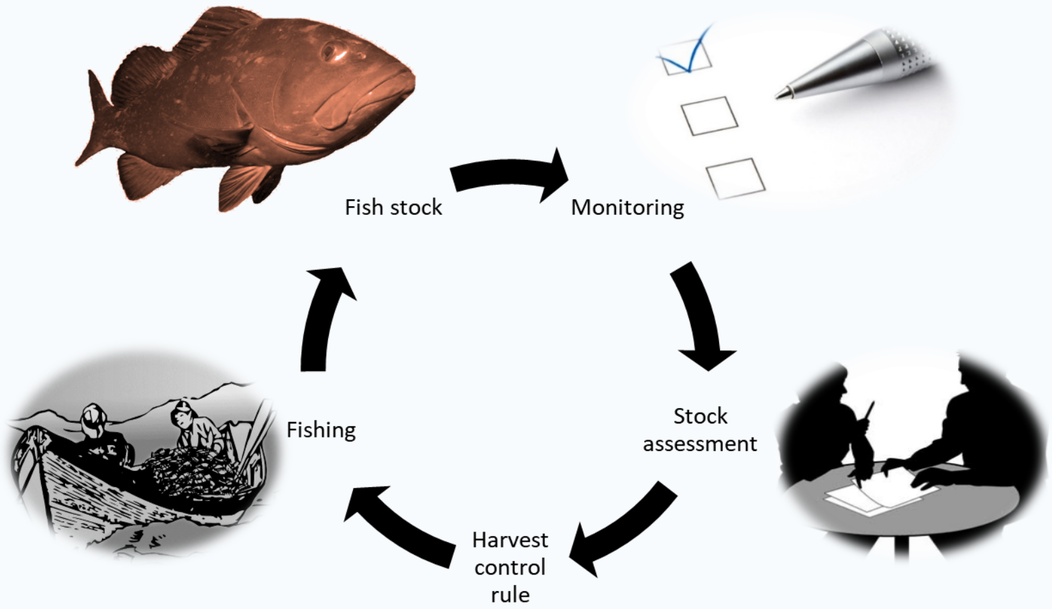
BUY-IN

Create capacity & knowledge sharing through stakeholder and decision-maker engagement.

INFORMED DECISION-MAKING

MSE is a form of trade-off analysis. Not all fishery harvest strategies will produce the same outcomes.

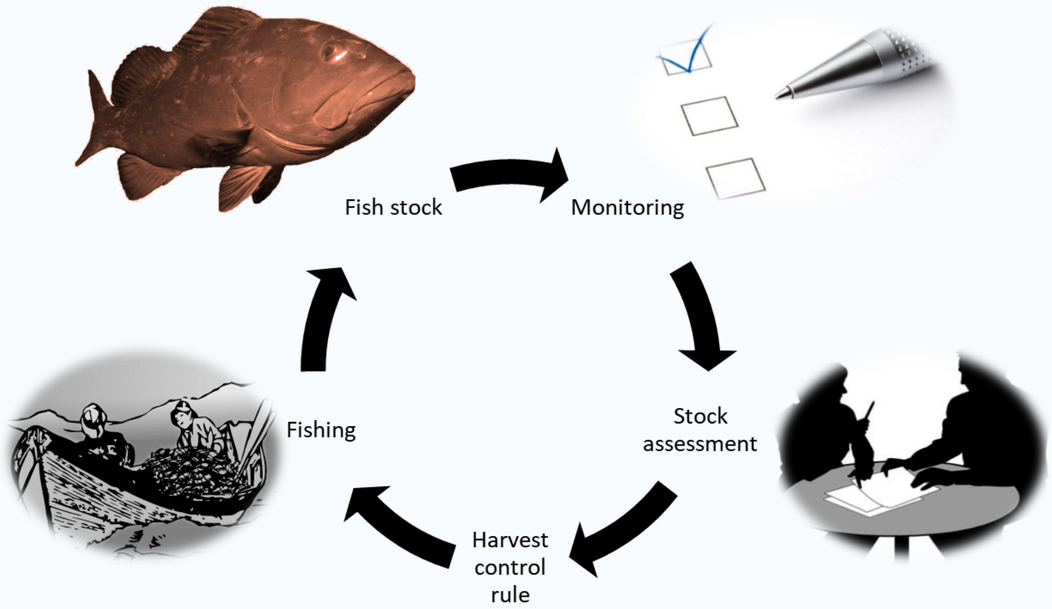
How can MSE help?



COHERENCY & COHESIVENESS

Because MSE is used to simulate the interconnections between monitoring, assessment and decision-making, **performance of the strategy as a whole is revealed.**

How can MSE help?

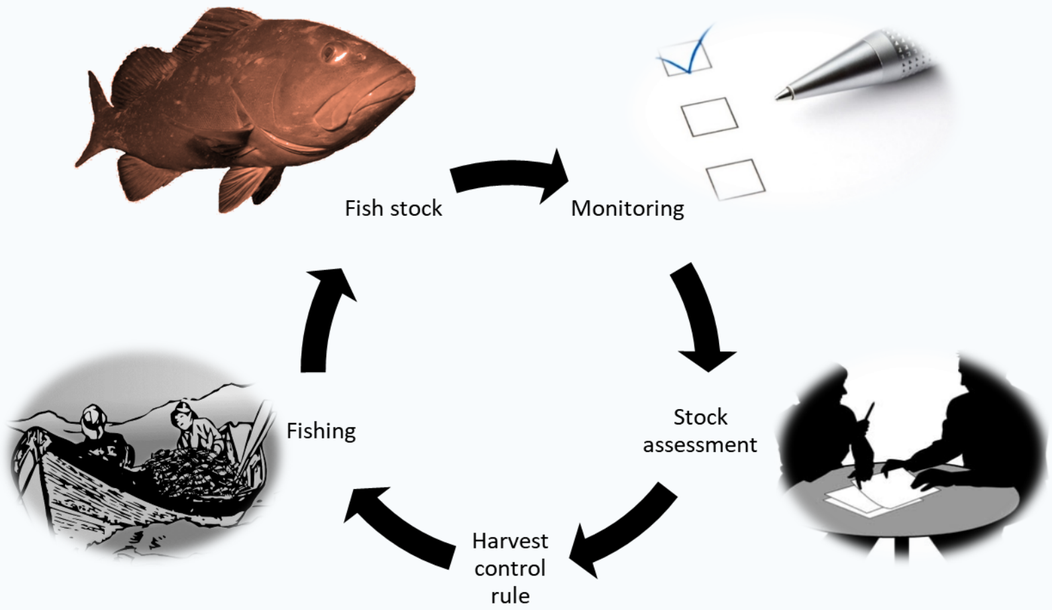


TRANSPARENCY

A harvest strategy is a **pre-agreed process** for decision-making, so stakeholders know what to expect.

Understanding trade-offs between conservation and provision of food and social and economic benefits is central to successful fishery management.

How can MSE help?



DISCOVERY

Conducting MSE is an iterative process. Through exploration, management strategies will often need to be refined or discarded for better alternatives. **This is often an opportunity for scientists to collaborate with stakeholders and decision-makers.**

Detailed steps in conducting MSE

MSE STEPS

IDENTIFY MANAGEMENT OBJECTIVES

Objectives form the basis for performance measures

IDENTIFY KEY UNCERTAINTIES

Those related to biology, environment, fishery & management system

DEVELOP AN OPERATING MODEL

Biology, fishery & implementation model

Punt et al. 2016

MSE STEPS

SELECTION OF PARAMETERS

Those used in the operating model; also, need to quantify parameter uncertainty

IDENTIFY CANDIDATE MANAGMENT STRATEGIES

Monitoring, assessment, and harvest control rule

SIMULATION & INTERPRETATION

Use performance metrics to inform and refine strategies

Punt et al. 2016

A fishery system

Operating model

Fish stock

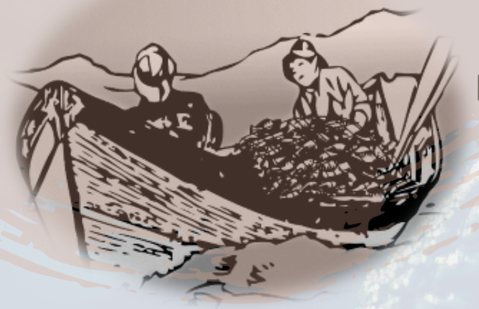
Monitoring

Management strategy
or Harvest strategy

Stock
assessment

Harvest
control
rule

Fishing



Step 1: Identify management objectives

- Formally stated goals for the fishery.
- Ideally, they are measurable, with timelines for achievement and with stated levels of acceptable risk or acceptable levels of performance.
- Form the basis for performance measures used to capture and understand the consequences of alternative management strategies.

Examples with (Performance measures)

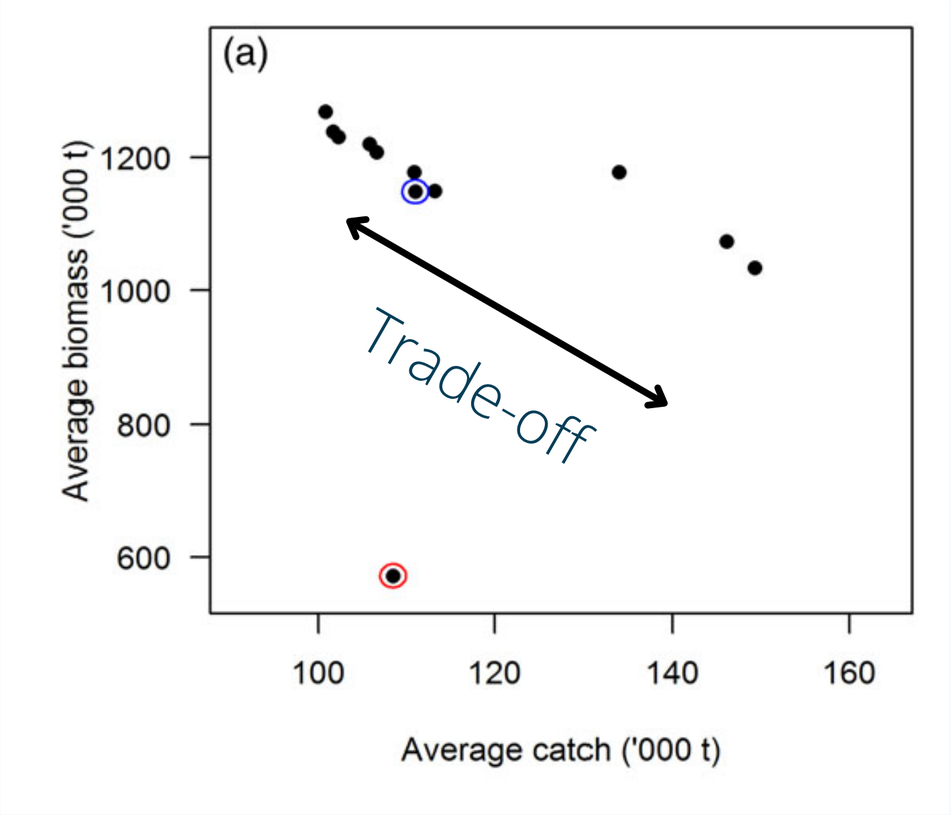
- Stock status (probability of stock being overfished).
- Avoid stock collapse (probability of avoiding lower limit reference point).
- Achieve high yield (catch in relation to theoretical optimum).
- Catch stability (inter-annual variation in catch).
- Less decision-making uncertainty (precision of quantities).

Trade-offs in fishery management

- Seldom is there a best management strategy once multiple objectives are considered.

- Focus on a few performance metrics that are understandable. Usually this means focusing on catches, biomass, and variability in catches.

- Identifying trade-offs allows decision-makers the ability to make decisions. 'Options and anticipated consequences'



Punt et al. 2017

Step 2: Identify key uncertainties

- Especially those thought to have potentially important influences on performance of a management strategy.

- MSE can be used to evaluate whether reduction in uncertainties is useful, like comparing high & low precision monitoring programs.

- MSE can be used to understand how to cope with uncertainty. Instead of reducing uncertainty, we ask: **can we make good decisions in the face of uncertainty?**

Examples of key uncertainties

- Uncertainty in life history parameters.
- Uncertainty in historical trends in abundance and catches.
- Uncertainty in the effects of the environment on catchability.

When is a management strategy robust?

- A management strategy is said to be robust to a key uncertainty when it results in satisfactory performance across all plausible operating model configurations.

Step 3: Develop an operating model

- Consists of fish population dynamics, characteristics of the fishery, and precision with which management tactics are implemented.

- How do we develop an operating model in data-moderate or data-limited circumstances?

- How do we use existing information to build an operating model?

Data-rich MSE

Gather:
Complex stock assessment

→

Operating model(s)

Data-moderate or data-limited MSE

Gather:
Assessments
Life history
Trends over time

→

Model tuning and/or build alternative scenarios

→

Operating model(s)

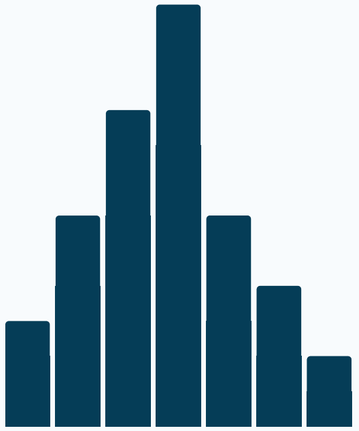
Step 4: Selection of parameters

- For example, plausible ranges of uncertainty for biological parameters and how uncertainty is represented in the operating model.

- von Bertalanffy growth
- Natural mortality
- Maturity
- Steepness of stock-recruitment
- Historical trends
- Catchability

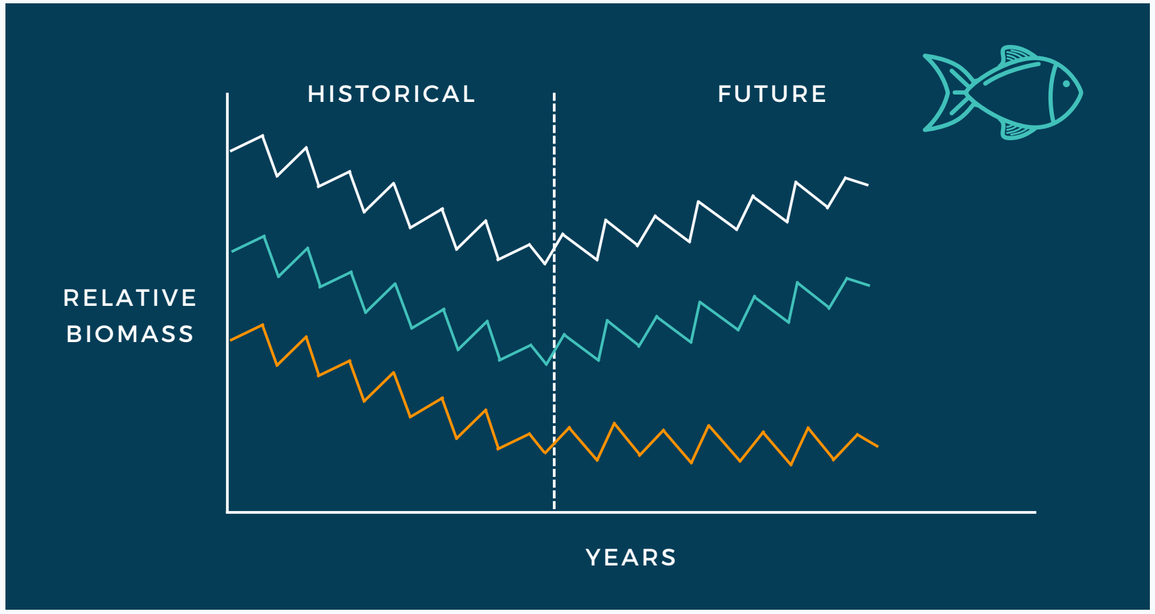
- Let's review two approaches to representing uncertainty.

Continuous distributions



Initial biomass

Monte Carlo-like simulations



Discrete scenarios

Scenario 1:
Declining trend in historical biomass

Scenario 2:
Stable trend in historical biomass

Step 5: Candidate management strategies

Management strategy

- Consists of three parts: monitoring program, assessment, and harvest control rule.

Harvest control rule

- HCR guides the adjustment to a management measure, such as a total allowable catch (TAC), total allowable effort.

- HCR determines the degree of management responsiveness to measures of prevailing conditions.

A simple harvest control rule

- Let's assume a fishery-independent survey is available. No assessment is made, instead, the survey index is used directly in the HCR.

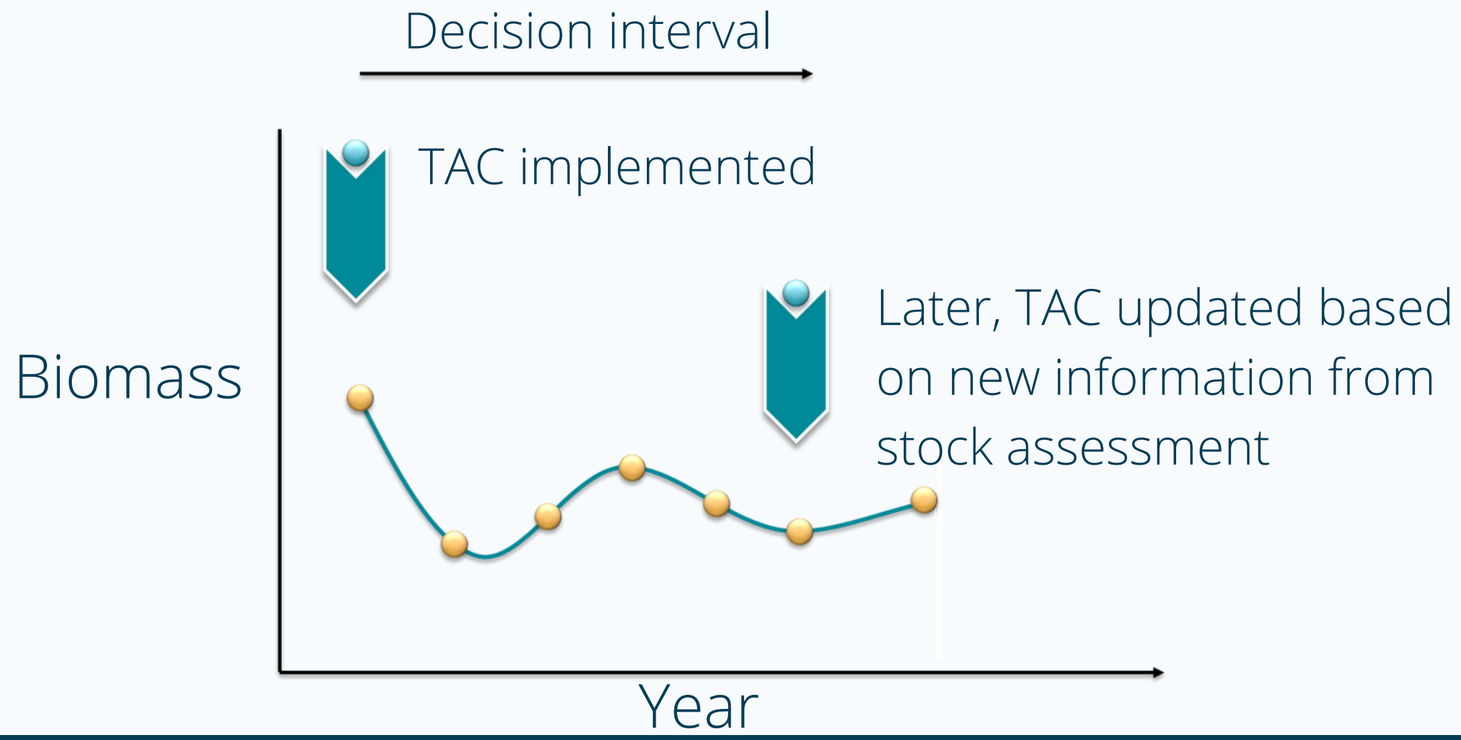
HCR:

- If the survey index is above a target level:
  TAC *next year* = 1.1 x TAC *this year*

- If the survey index is below a target level:
  TAC *next year* = 0.9 x TAC *this year*

MSE vs. Stock assessment projections

- MSE replicates the management responsiveness to changing conditions. Stock assessment projections (usually) forecast constant F or constant TAC into the future.



MSE vs. Stock assessment projections

- Stock assessment provides immediate guidance. However, we rarely know how reliable this advice is and whether continuing to rely on this approach will result in long-term achievement of objectives.

- MSE is objectively focused on how management advice is provided and whether a given management strategy is likely to achieve management objectives.

- MSE simulates the recursive decision-making.

MSE vs. Stock assessment projections

- Stock assessment is focused on scientific accuracy.

- MSE is focused on achieving successful management in a way that is robust to uncertainties.

Step 6: Simulation & interpretation

Simulation

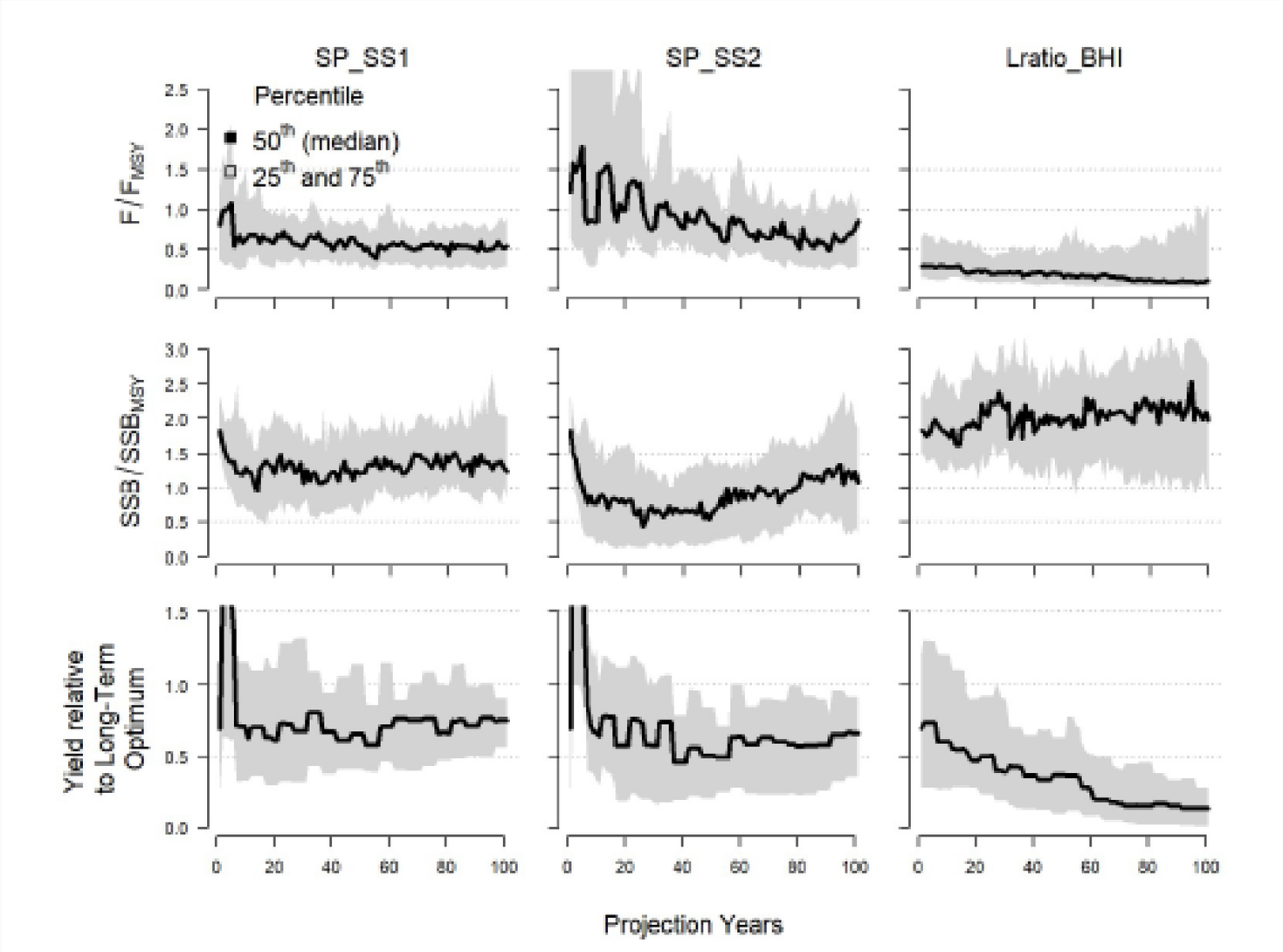
- Each operating model configuration is simulated against each candidate management strategy.

Performance metrics

- Used as objective measures of the outcomes of the simulations. Form the basis for trade-offs between different candidate management strategies.

Simulation in practice

- Three management strategies (columns).
- Three performance metrics (rows).
- Performance shown over time.
- What are the trade-offs?



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- Punt, A. E., D. S. Butterworth, C. L. de Moor, J. A. A. De Oliveira, and M. Haddon. 2016. Management strategy evaluation: best practices. Fish Fish. 17:303–334.

- Punt, A. E. 2017. Strategic management decision-making in a complex world: quantifying, understanding, and using trade-offs. ICES Journal of Marine Science 74.