MSE in a nutshell

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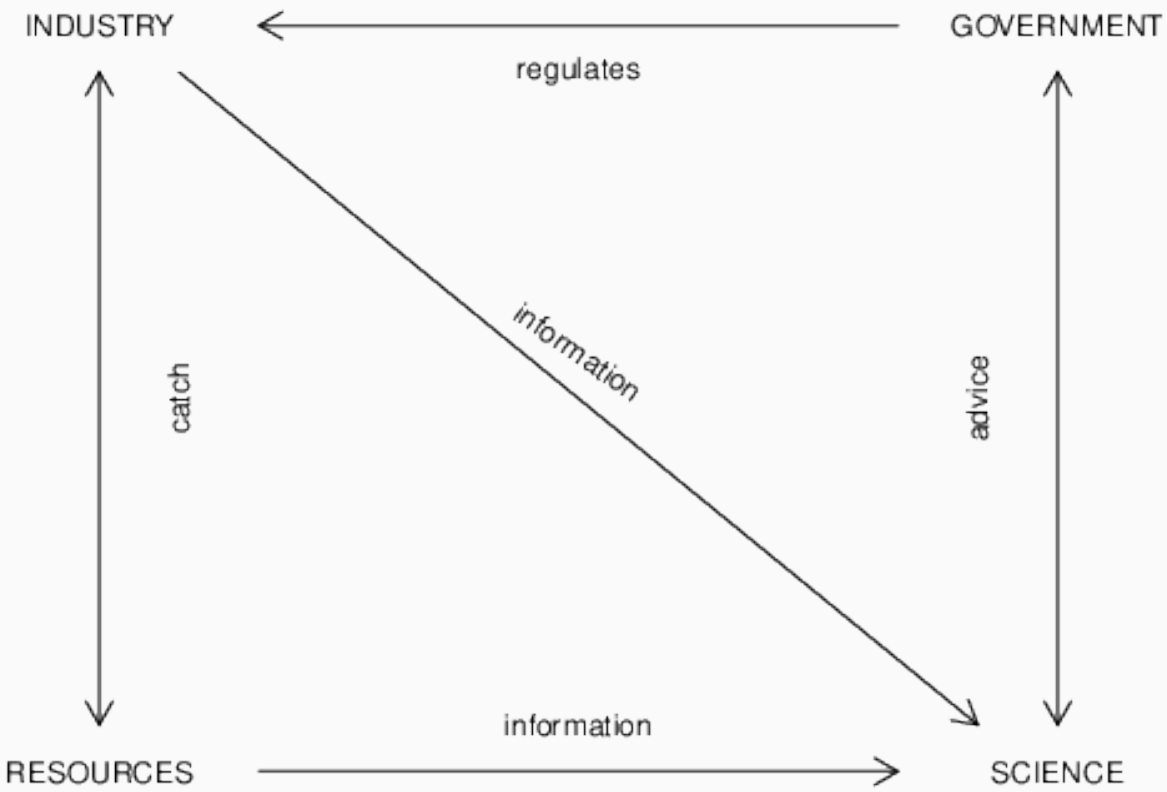
Fisheries management



Goals of fisheries management

- Goals
  - Sustainable benefits from harvesting
  - Conserve stock(s) productivity
  - Minimise impacts on ecosystem

- Requirements
  - Set of clear management objectives
  - Indication of proper harvest and/or stock level
  - Means to monitor status
  - Measures to control fishing

Challenges of fisheries management

- Objectives set to be operational
- Trade-offs between short and long term
- Monitoring impact to ecosystem
- Quantifying uncertainty in status and dynamics
- Making decisions acknowledging risks

How to deal with all this? MSE

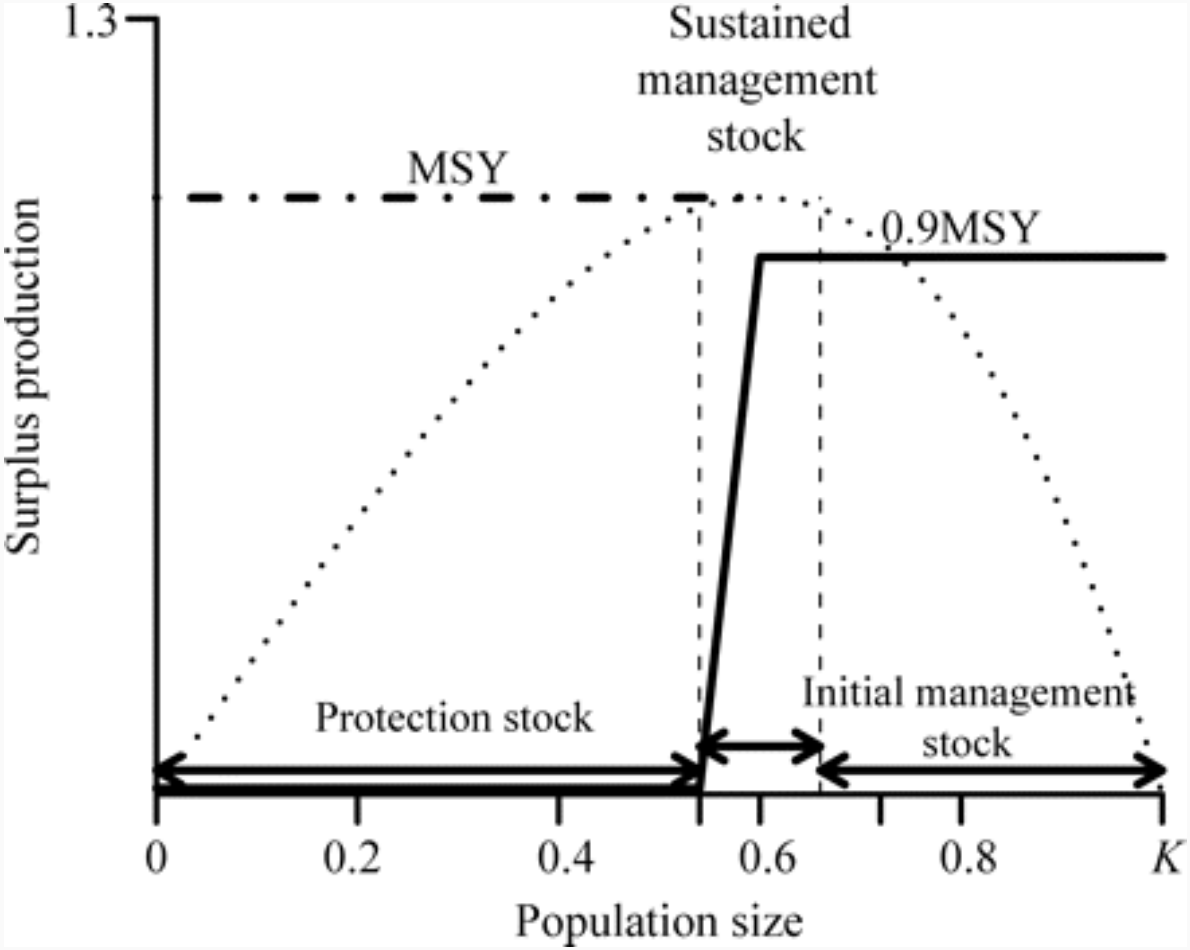
Evaluate the consequences of a range of different management strategies to determine which one will be the most appropriate to meet the operational objectives of the fishery. By:

- Testing how robust the management options are against uncertainty.
- Comparing the relative performance of alternative management options.
- Simulation-testing management options under a wide(r) range of possible states of nature.

Where does this come from?

- The International Whaling Commission developed simulation-based management methods using Management Strategies Evaluation (MSE), leading to the Revised Management Procedure (RMP) approved in 1994.
- The Revised Management Procedure (RMP) applies MSE to test different whale hunting strategies through simulations before using them in real-world management.
- These MSE-based methods account for uncertainty in whale populations and data quality to protect whale stocks through transparent, science-based decisions.

The RMP


1.3
Sustained
management
stock
MSY
0.9MSY
Surplus production
Protection stock
Initial management
stock
0
0.2
0.4
0.6
0.8
K
Population size

IWC: Uncertainties in RMP[1]

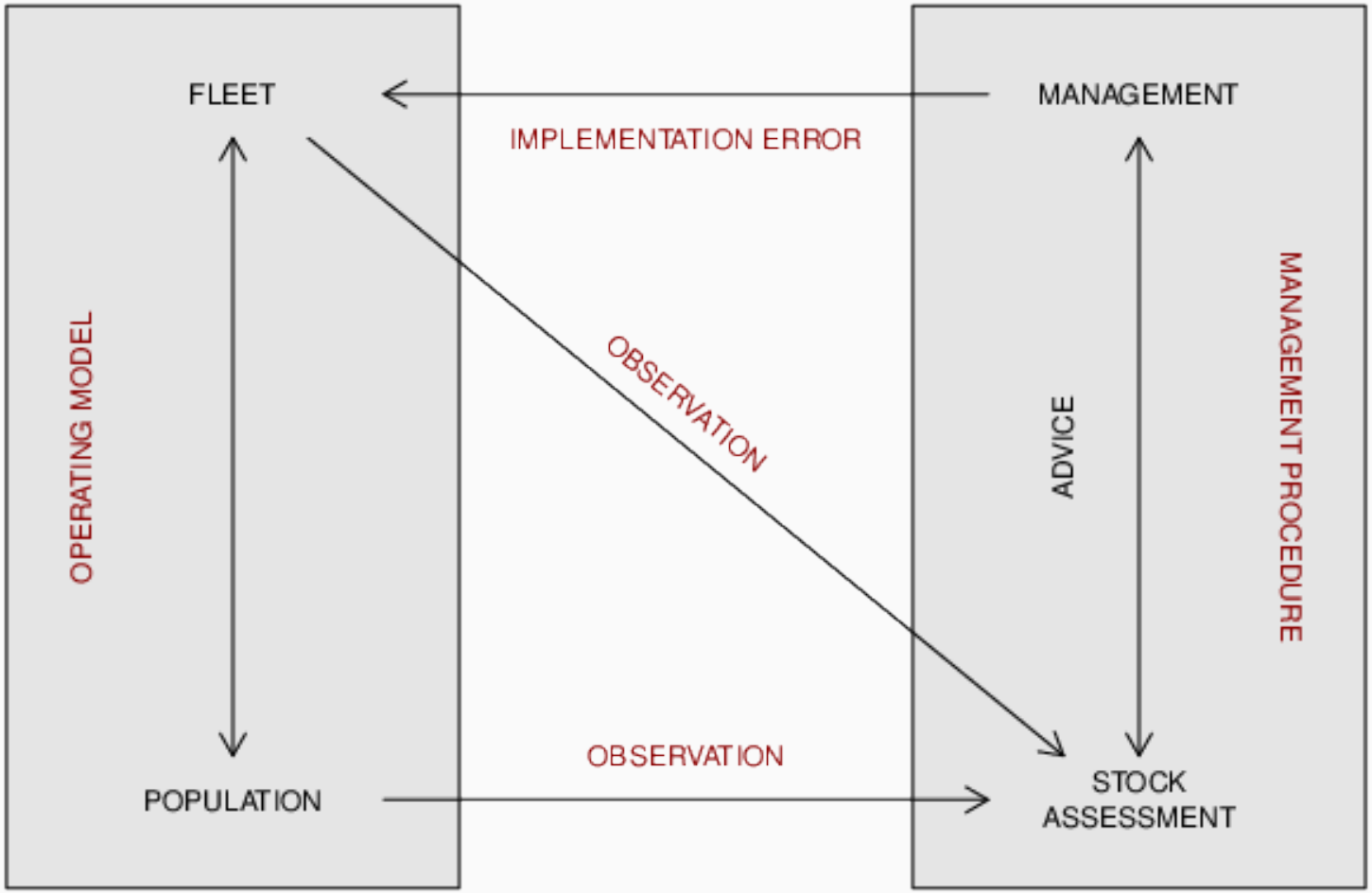
- Alternative population models.
- Initial population size from 5-99
- Rates of productivity and changes over time.
- Uncertainty and bias in the estimated population size.
- Frequencies of abundance surveys (every 1, 5 or 10 years).
- Changes in carrying capacity (climate change, habitat degradation).
- Errors in historic records of catches.
- Occurrence of catastrophes (major disease).
- Uncertainty about stock structure.

[1] https://iwc.int/rmp2, https://doi.org/10.1093/icesjms/fsm035

MSE - some examples

- South African pelagics
- Australian fisheries
- Commission for the Conservation of Southern Bluefin Tuna
- European multi-stocks and multi-gear Management Plans
- North Sea Demersals Management Plans
- ICCAT ...
- IOTC ...

A model of the fishery system



Six steps to MSE[2]

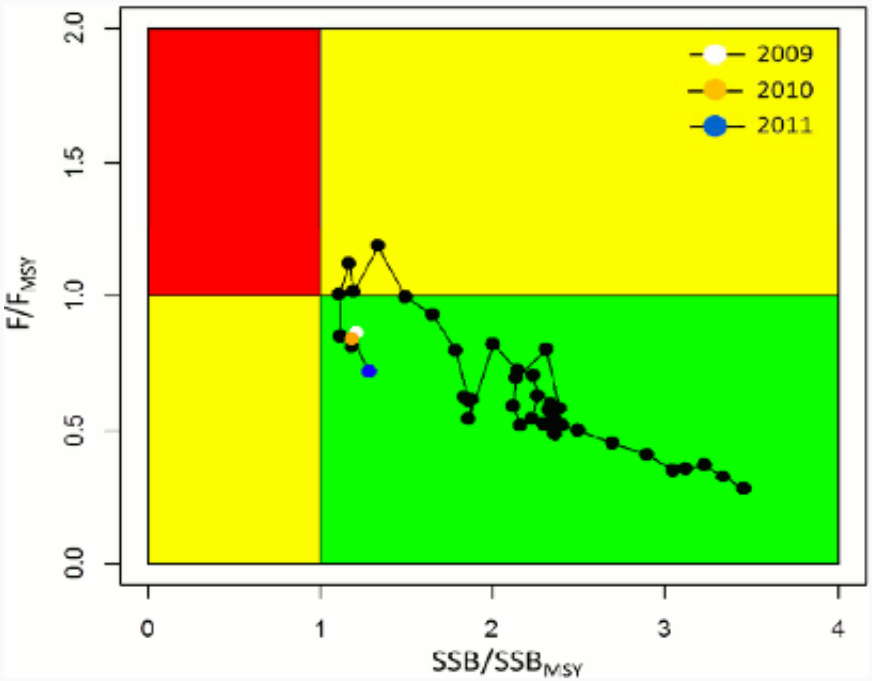
1. Define and agree on objectives & limits
2. Identify appropriate Management Procedures
3. Define a set of Operating Models
4. Conduct simulations
5. Summarize performance
6. Select best Management Procedure

[2]Punt, A. E., Butterworth, D. S., de, Moor, C. L., De Oliveira, J. A. and Haddon, M. (2016), Management strategy evaluation: best practices. Fish Fish, 17: 303-334. doi:10.1111/faf.12104

Define objectives & limits

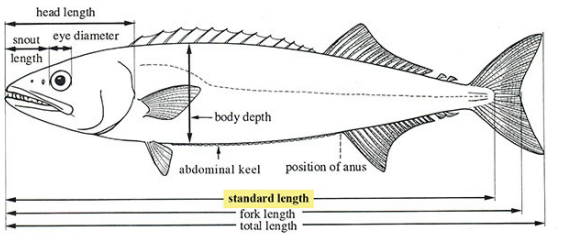
IOTC example:

- objective = B_{MSY},
- limit = $0.40 \cdot B_{MSY}$ & $P(Green) > 60\%$, over next 20 years.



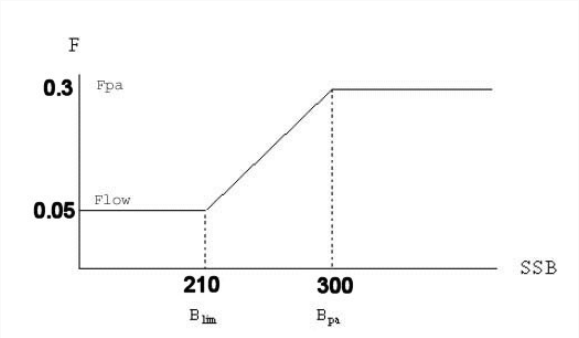
Identify Management Procedures

1. Observations

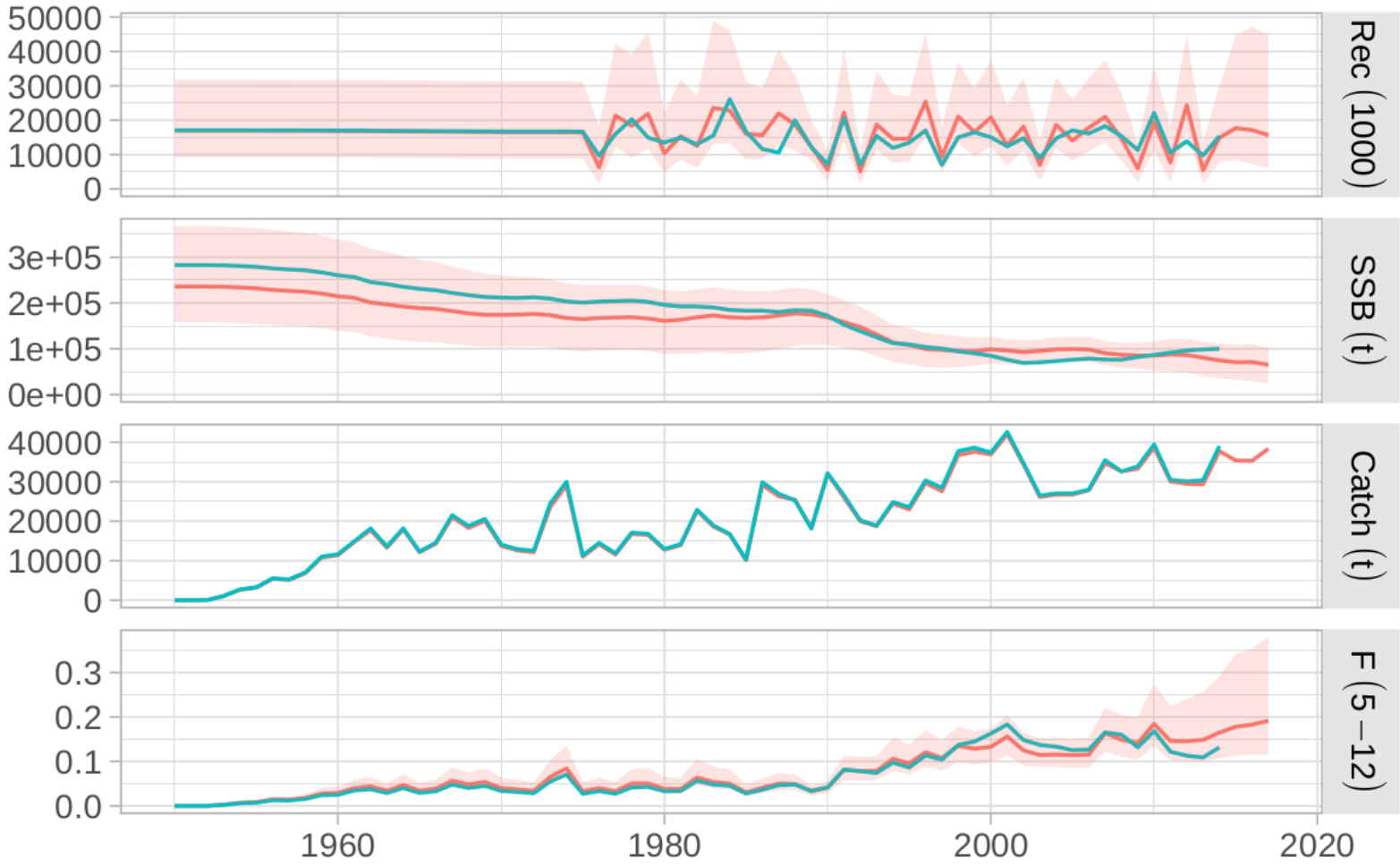


2. Estimator of stock status
   - stock assessment model, *e.g.* ss3, spict, a4a
   - or model-free indicator, *e.g.* survey index, CPUE
   - or data-poor indicator, *e.g.* mean length in the catch

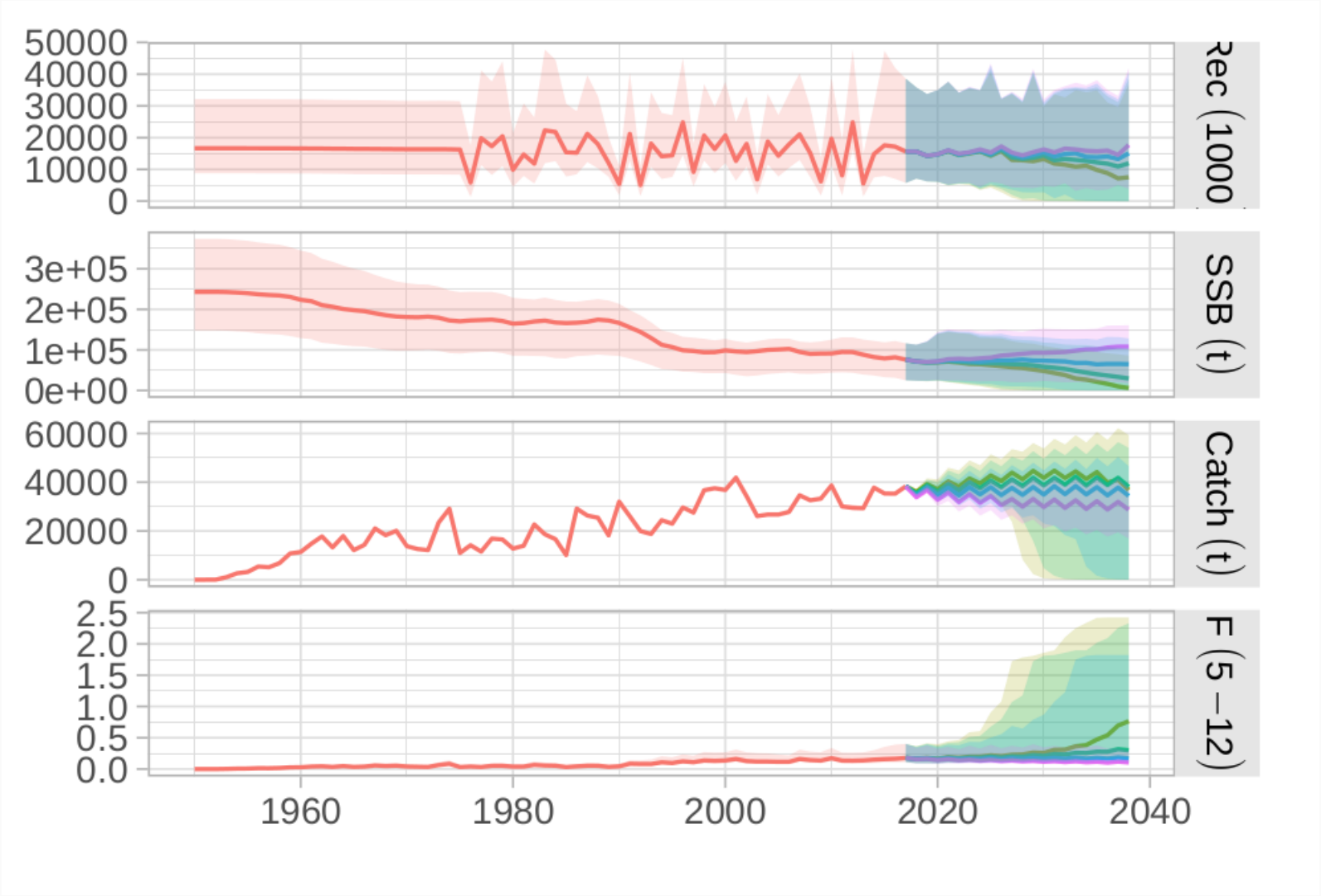
3. Decision



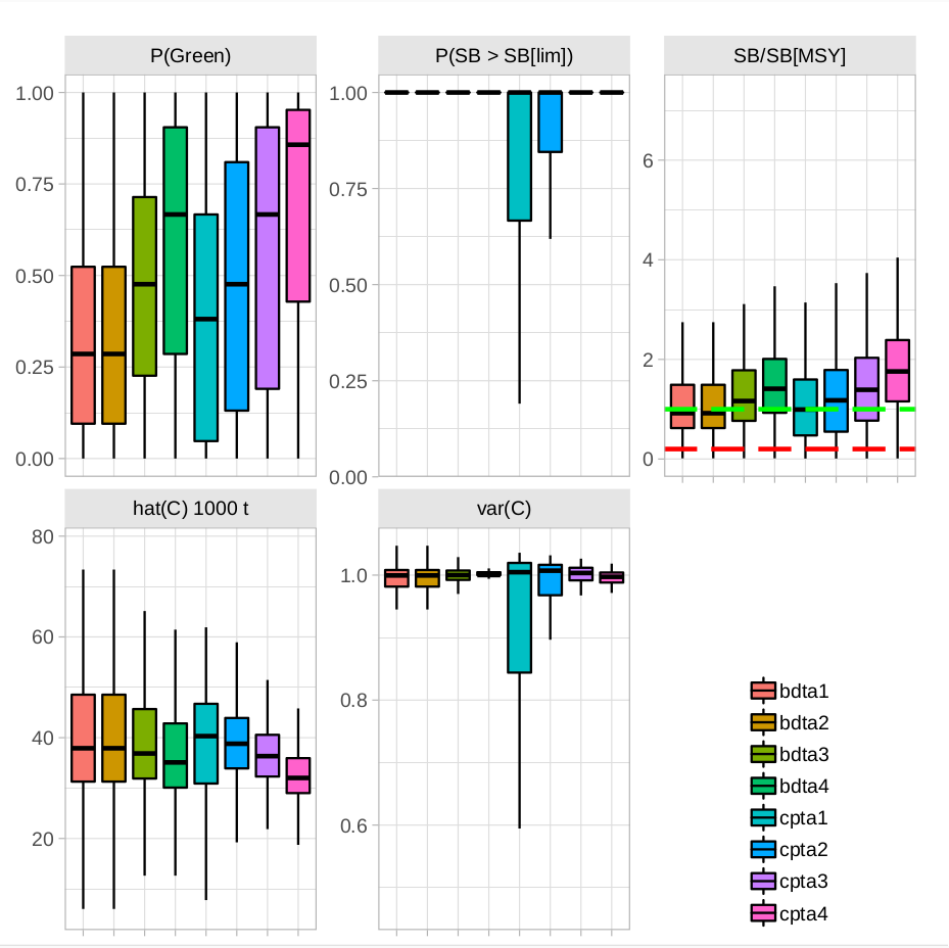
Define Operating Models

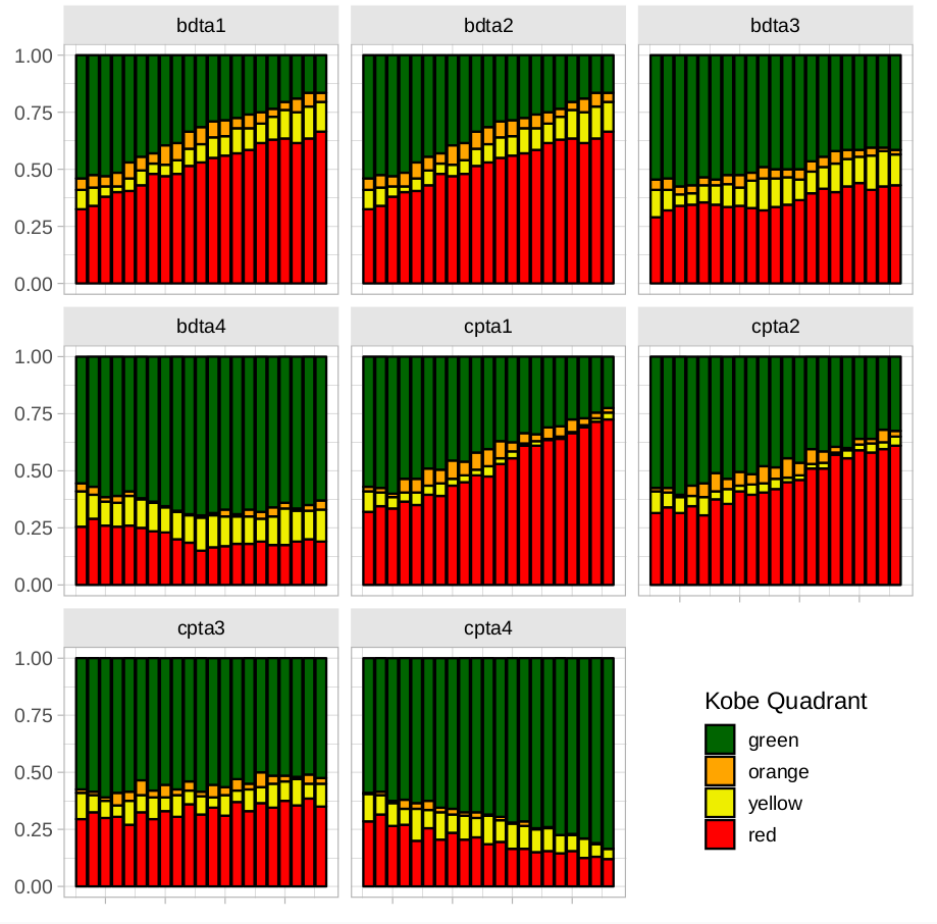


Conduct simulations



Summarize Performance





Select best MP

Resolution on the Adoption of a Management Procedure

(adopted at the Eighteenth Annual Meeting – 10-13 October 2011)

The Extended Commission for the Conservation of Southern Bluefin Tuna

Seized by the need to ensure the conservation and optimum utilisation of southern bluefin tuna based on the best available scientific advice,

Taking account of the current status of the stock and, in particular, the most recent stock assessment from the Extended Scientific Committee advising that the spawning stock biomass is between 3% and 7% of the original spawning stock biomass,

What are the advantages?

1. Explicitly Accounts for Uncertainty
2. Facilitates Stakeholder Involvement and Transparency
3. Supports Ecosystem-Based Management
4. Improves Policy Performance and Risk Assessment

What are the advantages?

- Explicitly Accounts for Uncertainty

  MSE integrates ecological, observational, and implementation uncertainties into the management decision-making process. This allows strategies to be tested under a range of plausible future conditions, providing robustness against unforeseen changes.

What are the advantages?

- Facilitates Stakeholder Involvement and Transparency

  MSE fosters transparent, participatory processes by involving stakeholders in defining objectives and evaluating trade-offs. This enhances buy-in and legitimacy of management decisions, which is critical for successful implementation.

What are the advantages?

- Supports Ecosystem-Based Management

  MSE can incorporate multi-species and ecosystem-level dynamics, moving beyond single-species approaches. This is particularly valuable for ecosystem-based fisheries management (EBFM), where species interactions and broader ecological goals must be considered.

What are the advantages?

- Improves Policy Performance and Risk Assessment

  MSE systematically compares the outcomes of various management procedures, helping to identify strategies that achieve sustainability, economic efficiency, and catch stability. It enables risk-based decision-making by quantifying trade-offs between different management objectives.

And disadvantages?

1. Resource-Intensive and Technically Demanding
2. High Demands on Stakeholder Engagement
3. Potential Misinterpretations and Implementation Risks

And disadvantages?

- Resource-Intensive and Technically Demanding

  MSE requires substantial computational resources, extensive data, and advanced modeling expertise. This complexity can be a barrier for resource-limited management bodies and may slow decision-making processes.

And disadvantages?

- High Demands on Stakeholder Engagement

  Successful MSE requires meaningful and sustained stakeholder involvement, which can be logistically difficult and time-consuming to achieve, particularly in international settings or for multi-sector fisheries.

And disadvantages?

- Potential Misinterpretations and Implementation Risks

  Complexity of MSE models may obscure the intuitive understanding of results for decision-makers and stakeholders. Furthermore, interpretation of MSE outputs can be complex, particularly around uncertainty quantification, and lead to incorrect assumptions or suboptimal decisions.

MSE in a nutshell

Questions?