Introduction to Harvest Strategies and their Evaluation (MSE)

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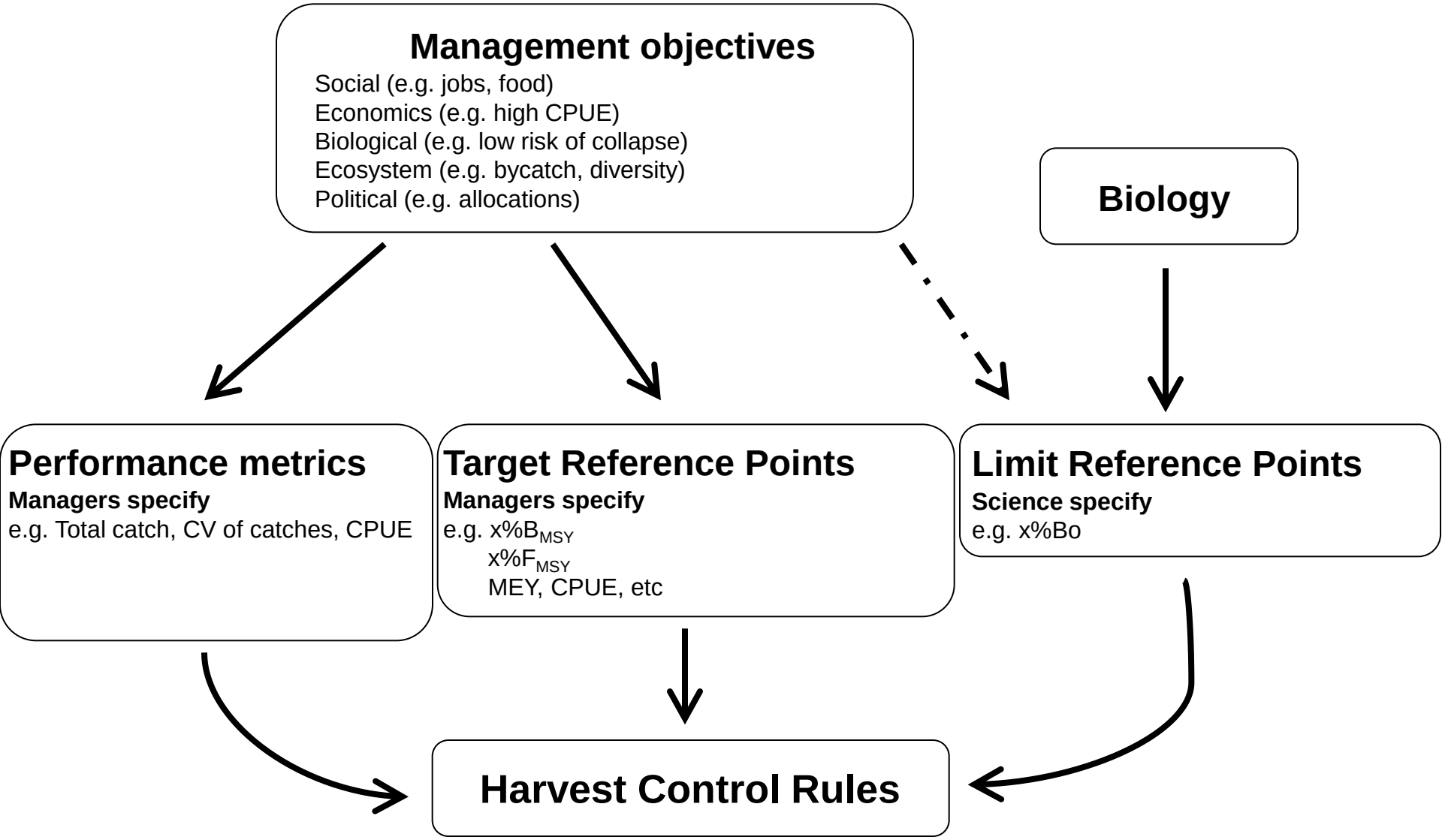
JOINT IATTC AND WCPFC-NC WORKING GROUP INTERSESSIONAL MEETING ON THE MANAGEMENT OF PACIFIC BLUEFIN TUNA

Monterey, California (USA), 5-7 February 2025

What is a Harvest Strategy?

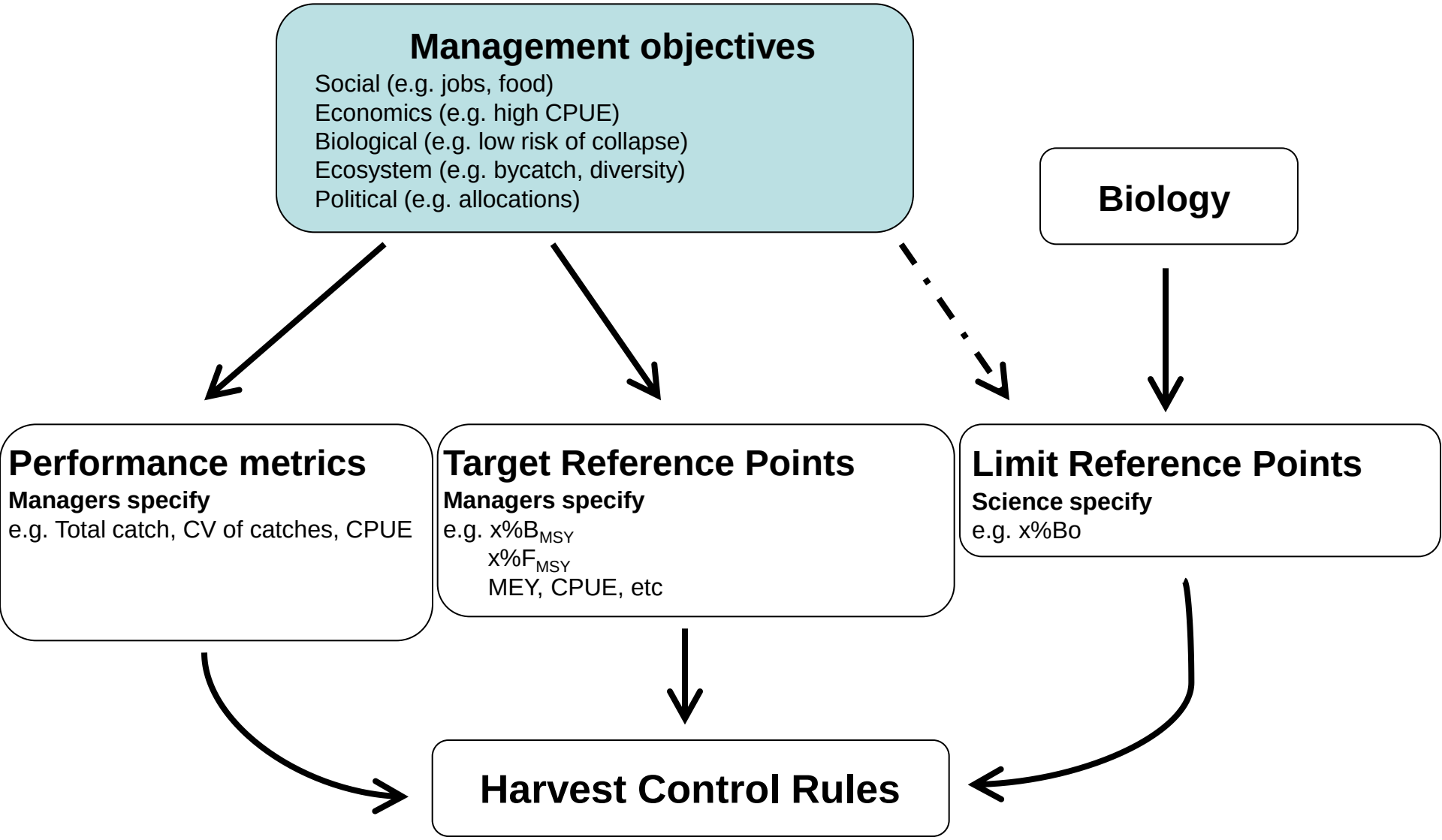
- **HARVEST STRATEGY:** Combination of pre-defined (agreed) monitoring, stock status evaluation, harvest control rule (with or without RPs) and management actions designed to achieve fisheries objectives.
- Development and success of Harvest Strategies benefit from the **involvement of all stakeholders** in the management planning stage.

Harvest strategies



Modified from Berger et al. 2012

Harvest strategies



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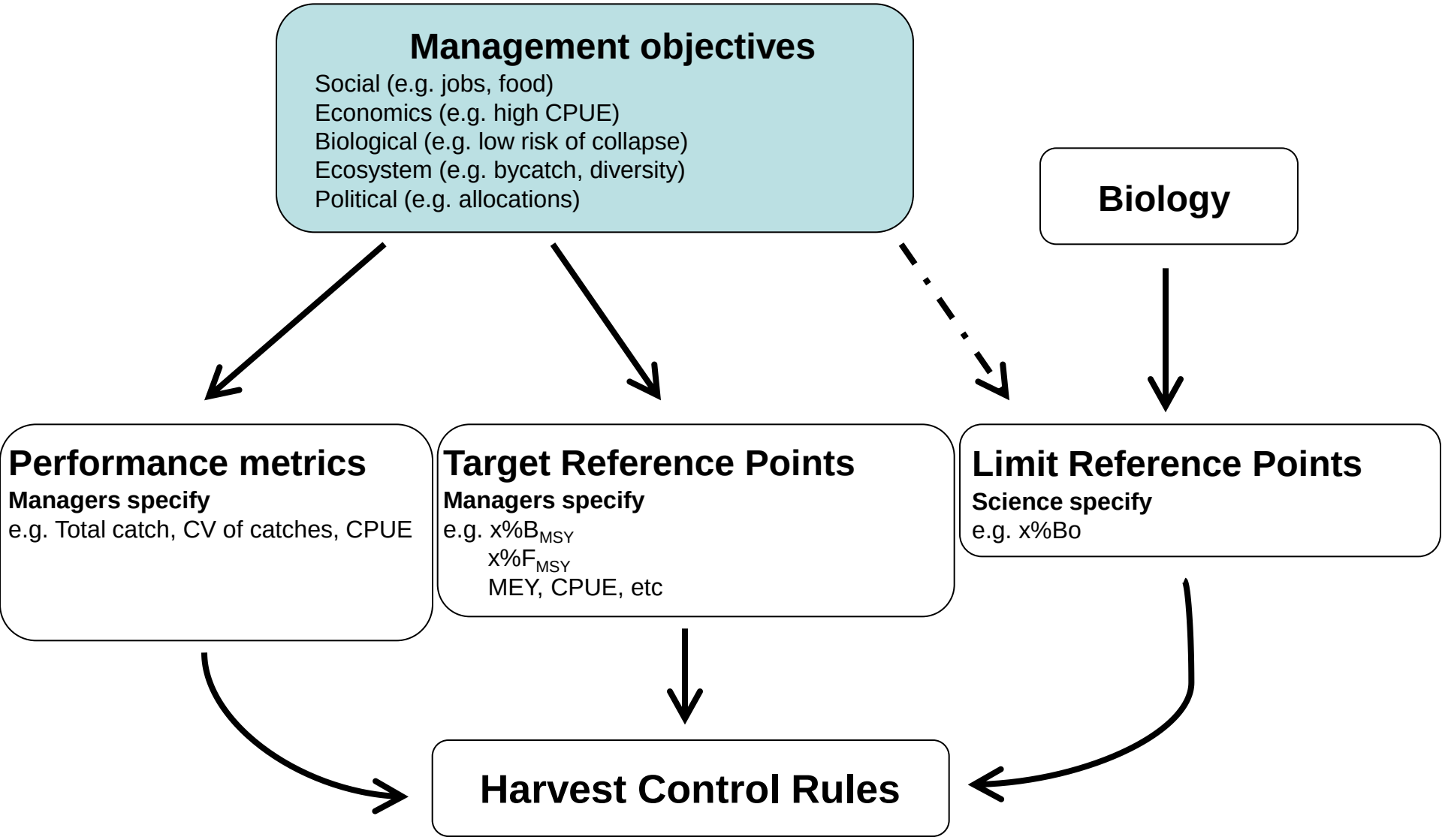
Management objectives

- Clear objectives fundamental to establish reference points and evaluate performance of harvest strategies
- Avoid being too generic (examples)
- Should specify:
  - Quantities
  - Probabilities
  - Timelines

Harvest strategies



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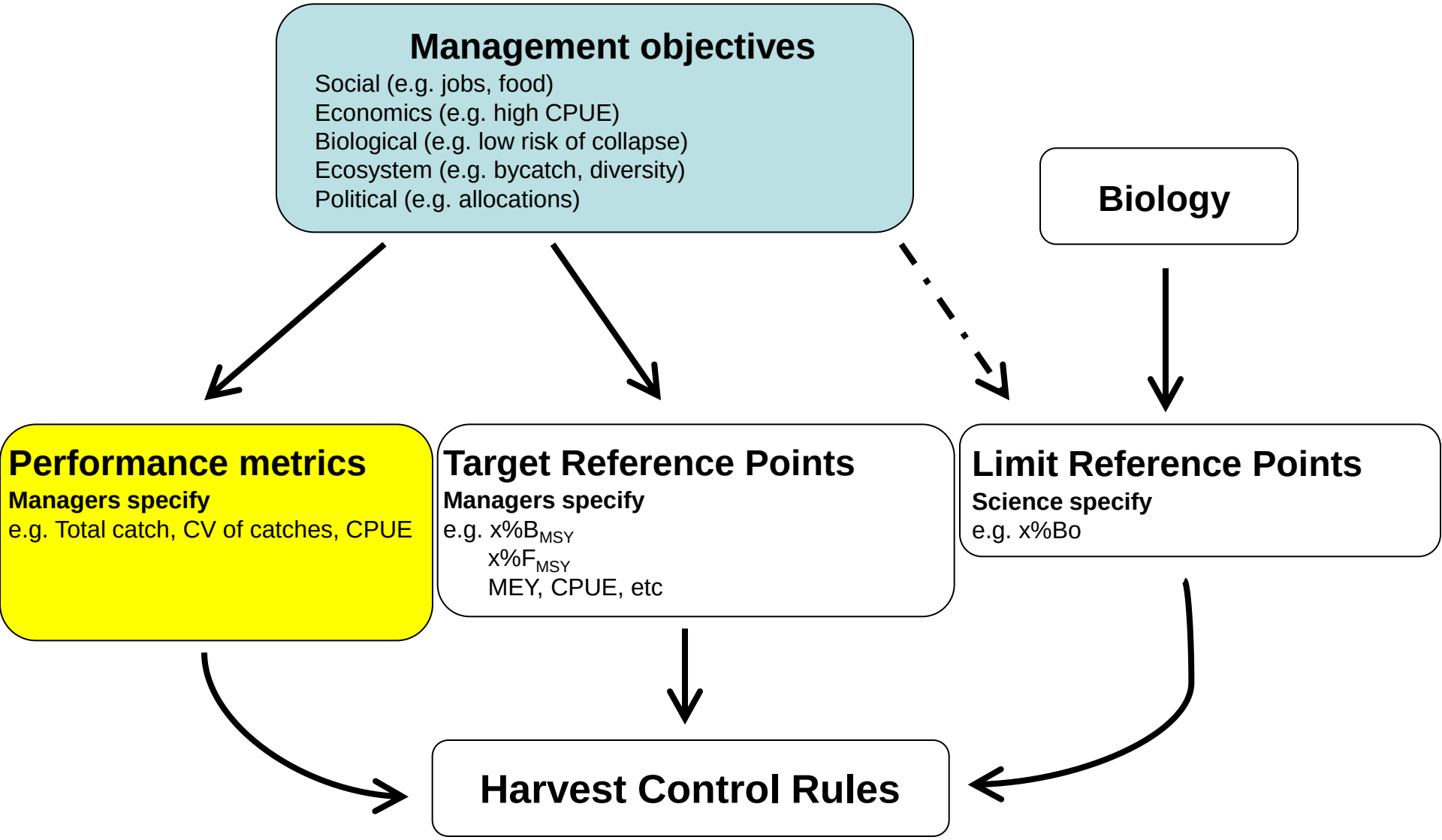

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Performance metrics

"I want it all, and I want it now…"

Freddie Mercury

- Long-term total catch
- Long-term average catch
- Long-term variability in catch
- Short-term variability in catch

- Long-term average CPUE
- Long-term average effort (fishing days)

- Probability of falling below reference points
- Probability of stock recovery

- Many more!

Tradeoffs

"You can't always get what you want…"

Mick Jagger

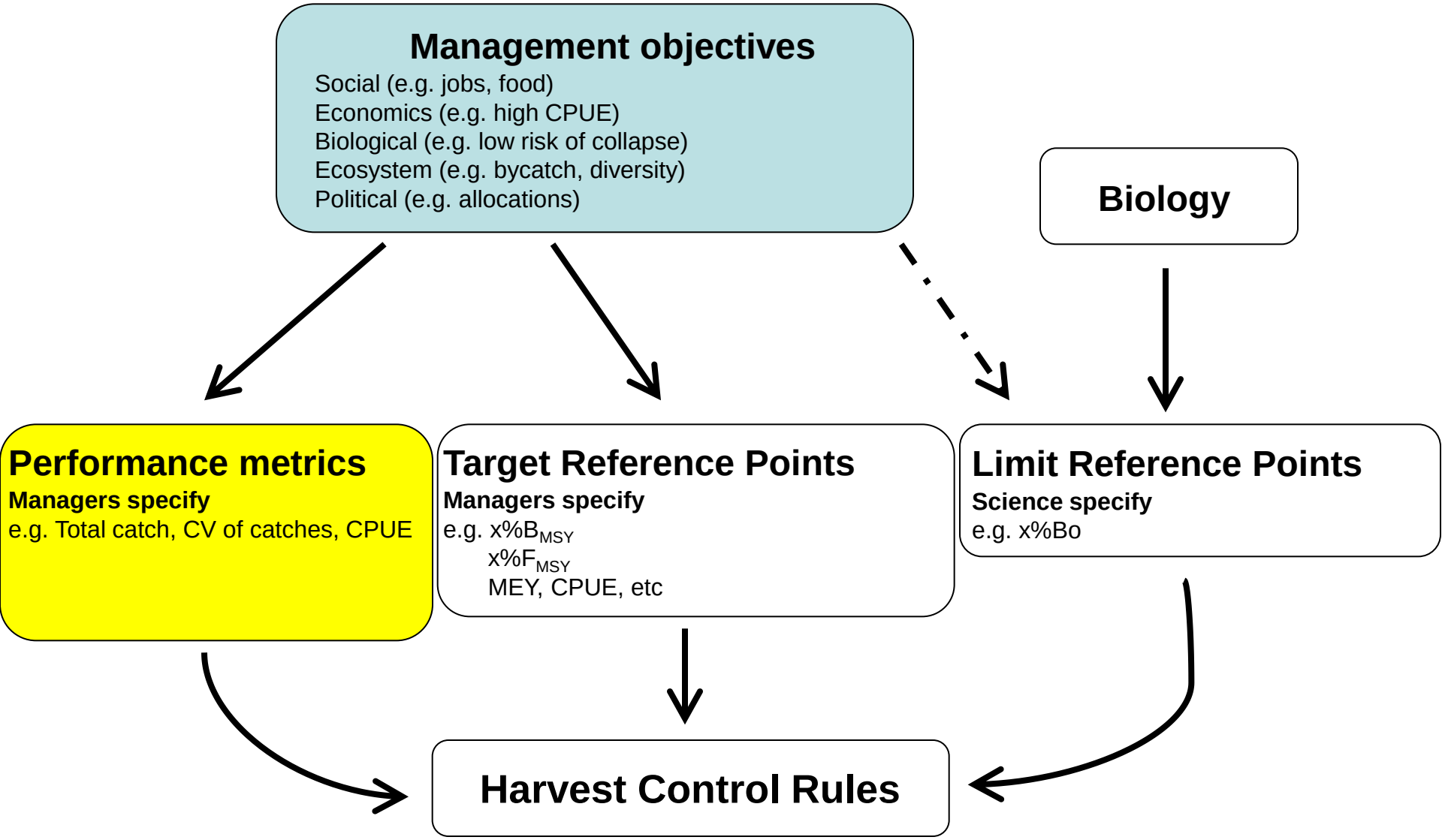
- Long-term catch & Long-term CPUE
- Long-term catch & *Probability* below reference points
- Long-term catch & Short-term catch
- Long-term CPUE & Annual catch variability
- Long-term effort & *Probability of* stock recovery

Tradeoffs

- Risk metrics
  - Probability of overfishing/overfished
  - Probability of collapse (economical o biological)
  - Probability of closures (spatially or temporally)

- Behavior towards risk
  - Risk Averse (avoidance)
  - Risk Prone (seeking)
  - Risk Neutral (indifferent)

Harvest strategies



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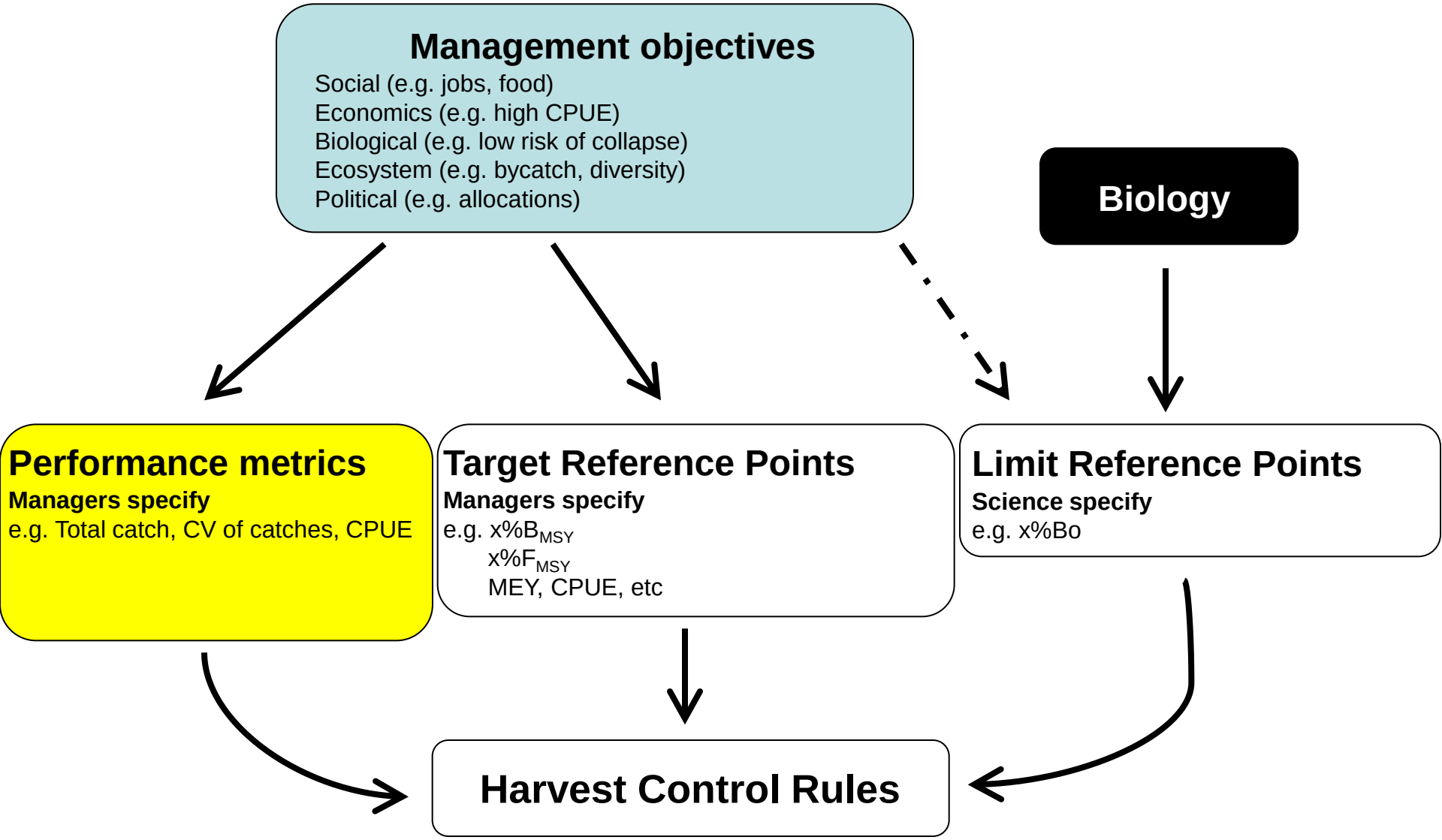

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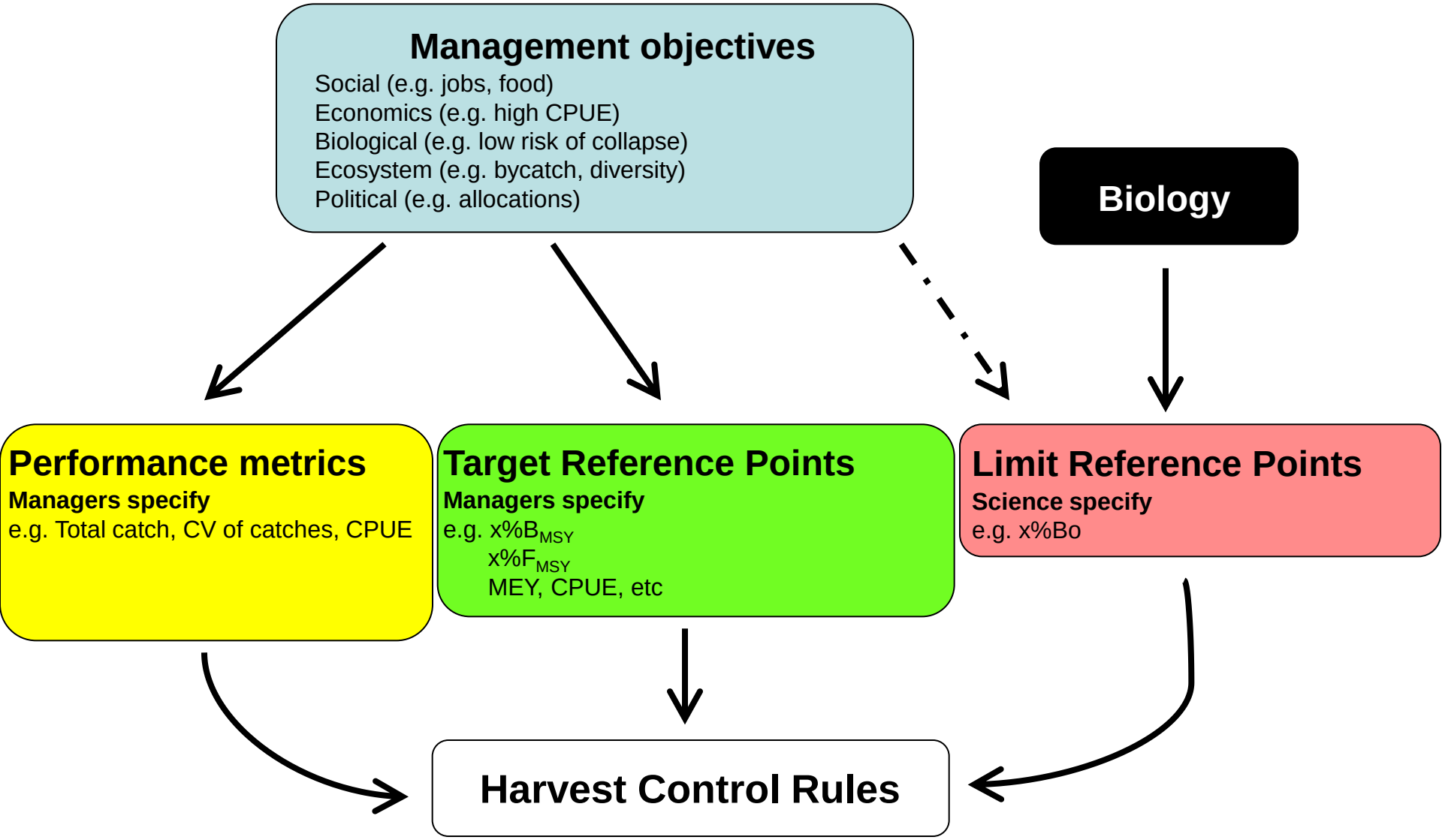

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Reference Points

- Management benchmarks against which to measure stock abundance, fishing mortality or social/economic indicators to determine status.

Reference Points

Limit Reference Point

Threshold Reference Point

Target Reference Point

Target Reference Point

- Should be met, on average, given a set of management objectives. Corresponds to a desirable fishery or stock status.

Threshold Reference Point

- Indicates the biomass fell below the **Target**, or the fishing mortality is over the **Target**, additional management actions are required to prevent the stock reaching the **Limit.**

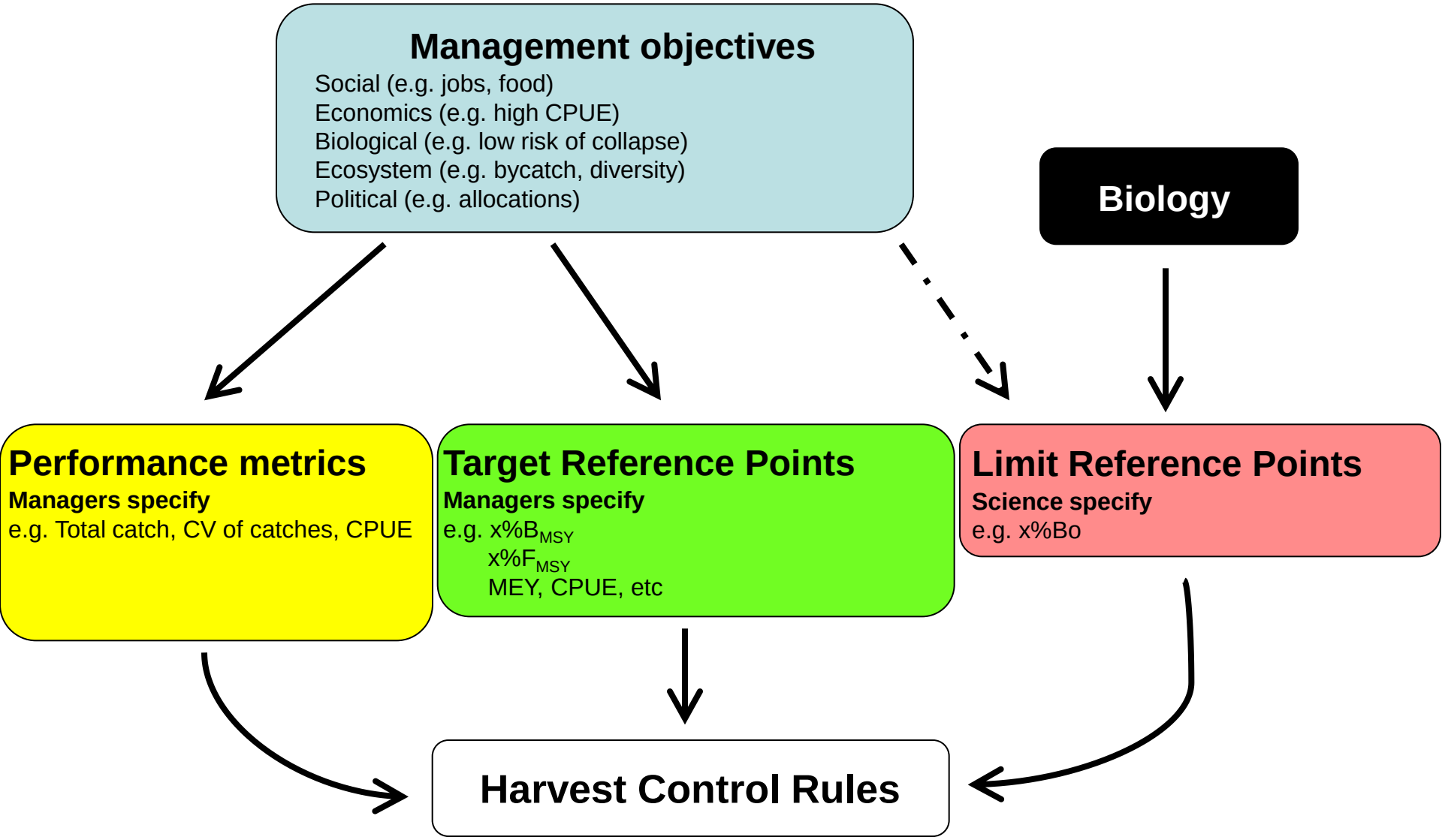
Limit Reference Point

- Not to be exceeded with any substantial probability, given a set of management objectives. When reached, the status of the stock is not desirable and management actions are required. When stock abundance is very low, may result in fishery closures.

Rebuilding Targets

Implemented for depleted stocks. Important to consider rebuilding level, probability and timeline of recovery, subsequent actions after recovery such as defining a target reference point and rebuilding to it.

Harvest strategies



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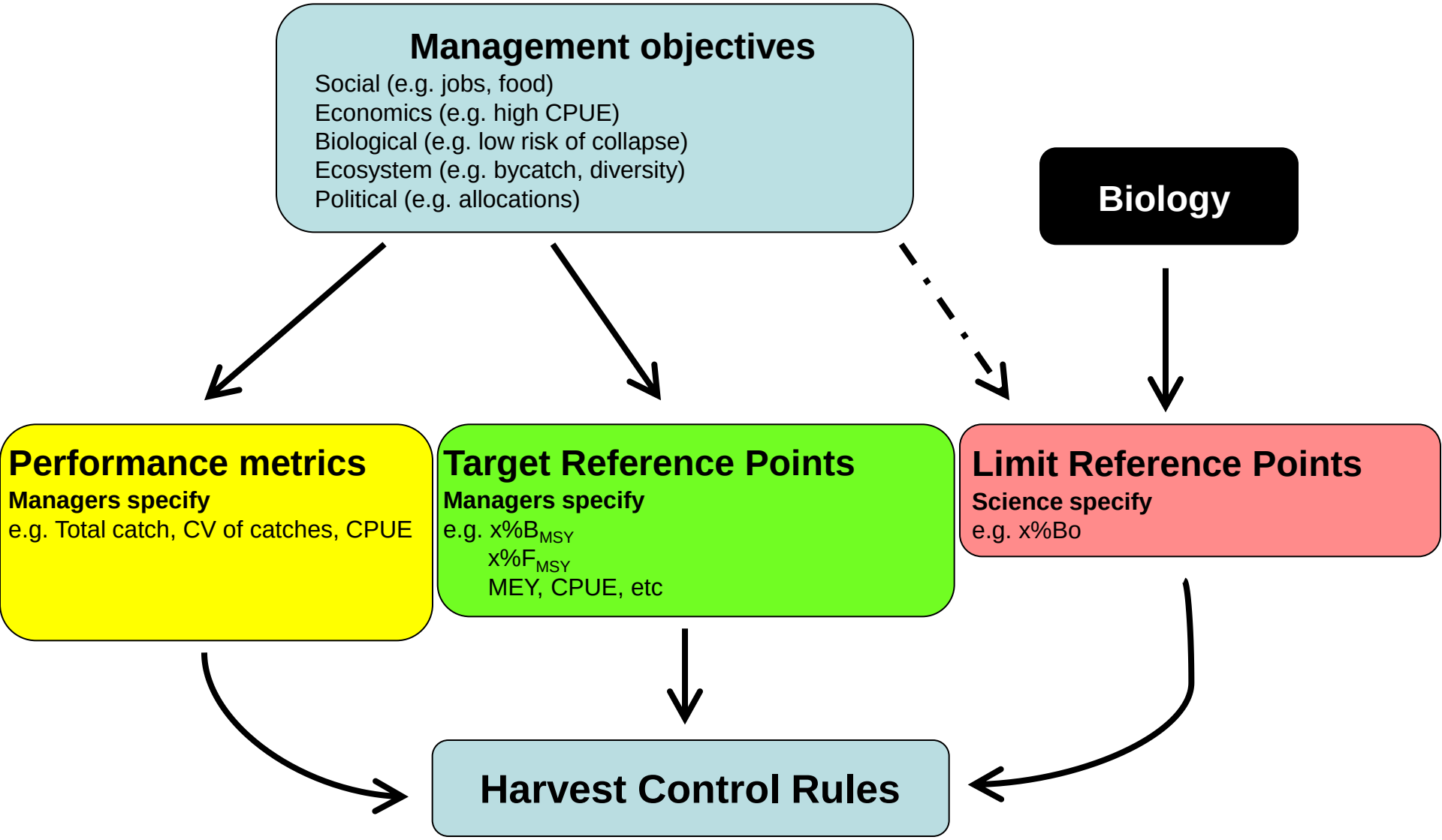

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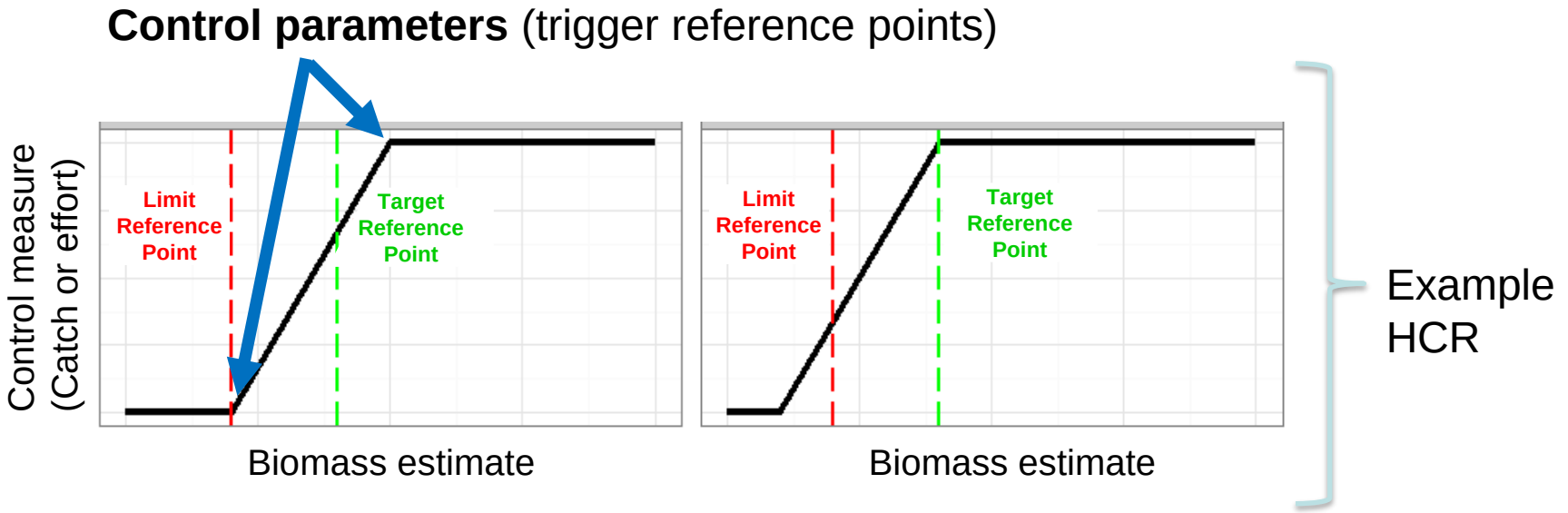
Harvest Control Rules (HCR)

- **Pre-agreed** management actions to changes in the stock and/or environmental, economic factors relative to **reference points**, **or trends** in stock indicators.
- Operationalize **management objectives**
- Increase management decisions **transparency**
- Framework to implement harvest strategies using decision making based on science.

Reference Points & HCR Control Points

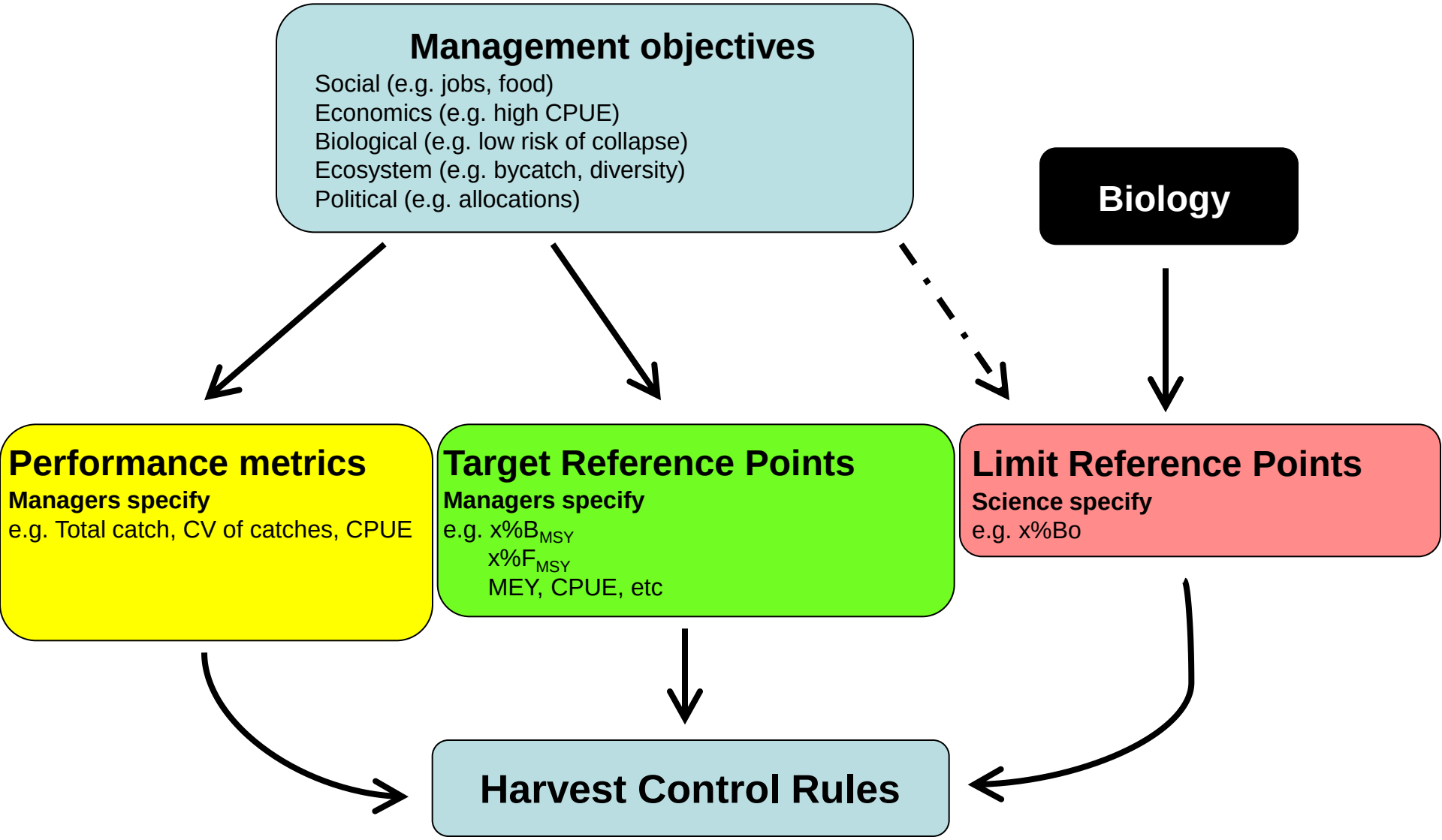
- Current HCR uses Reference Points
- Harvest Control Rules (HCR) can have **arbitrary control parameters**
- **Formal Reference Points** (**limit**, **target**) can be used to evaluate the performance of the HCR (but they do not need to be part of the HCR)



HCR development

- Harvest control rules (including their component biological reference points) should be developed in the management planning stage with the **involvement of all stakeholders**
- The success of HCRs is generally enhanced by involvement of stakeholders in the definition of the problem, including assumptions, and as it **facilitates trust and policy "buy in"**

Harvest strategies



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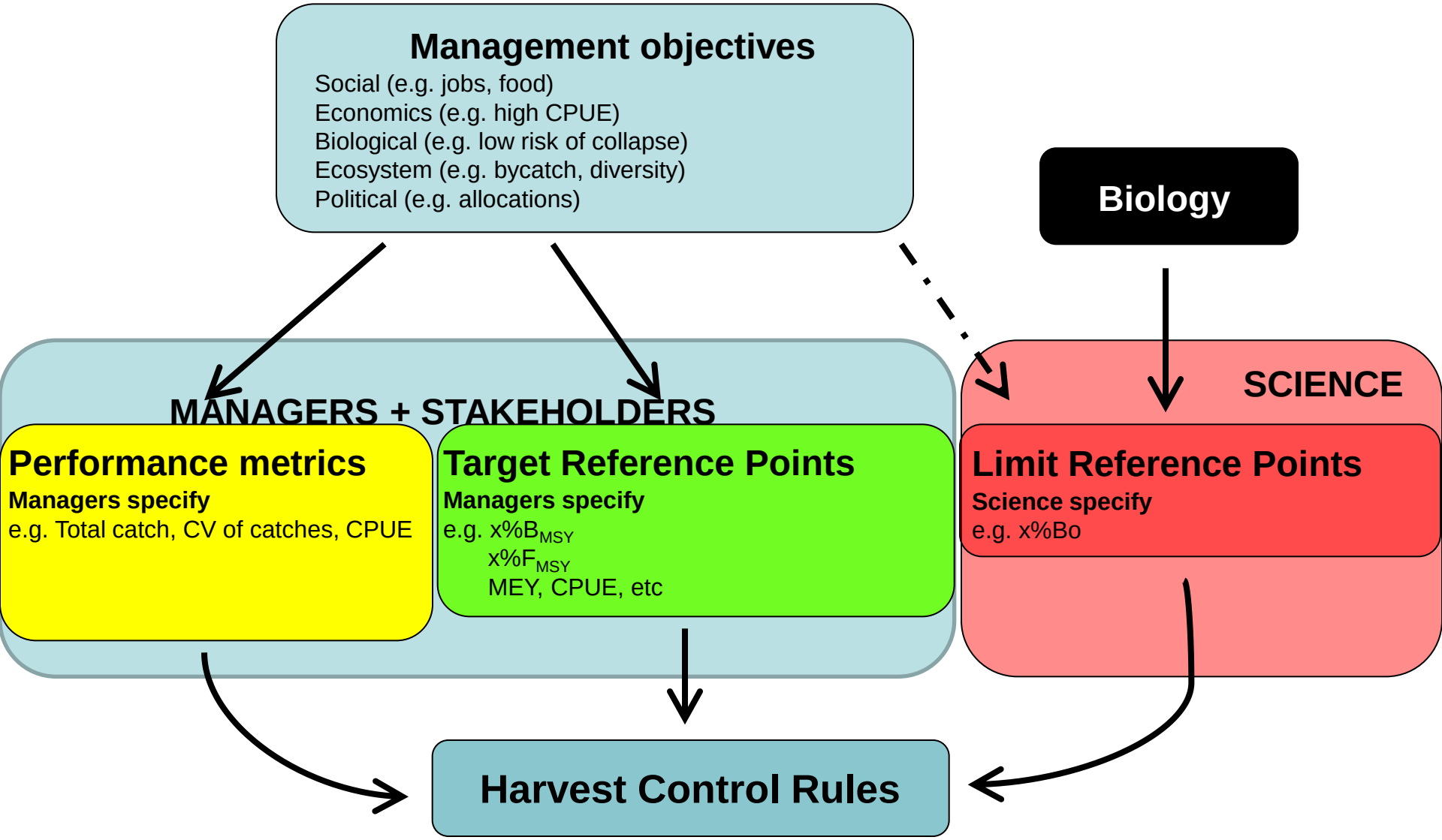
Typical roles of participants

- Managers and stakeholders identify:
  - Management objectives,
  - Candidate target reference points,
  - Candidate harvest control rules, criteria against which their performance should be evaluated.
- Scientists identify appropriate biological limits to exploitation and evaluate the performance of identified candidate harvest control rules.

Harvest strategies: Roles



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Harvest strategies: evaluation (example)

- Rarely we can evaluate alternatives analytically (i.e. formula)

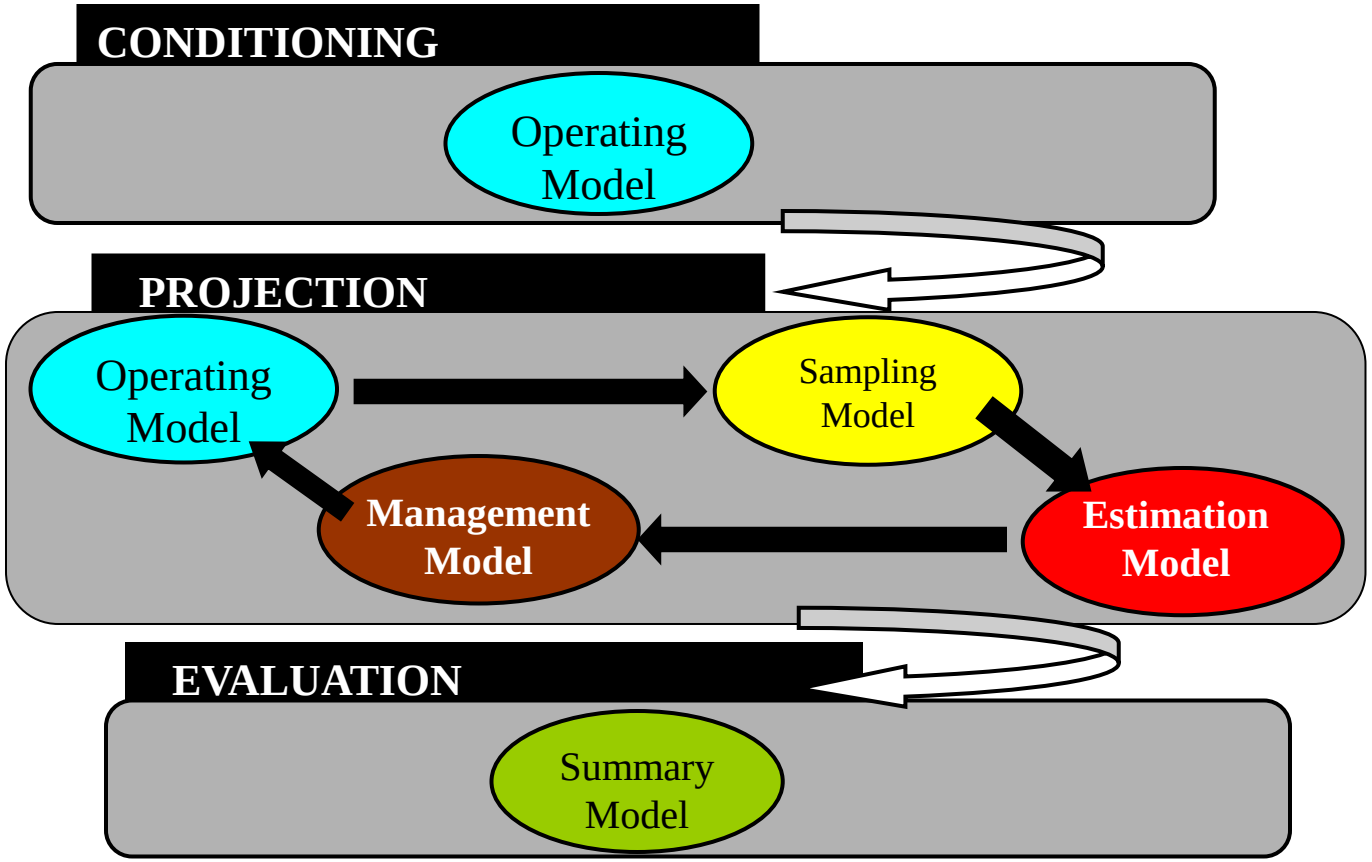
- Typically, we evaluate strategies using computer simulations (MSE):
  - Specify general objectives
    - Preserve the stock
  - Specify operational objectives
    - Maintain the stock in the green sector of Kobe plot more than 50% over 30 years
  - Develop candidate management strategies, harvest control rules, etc.
  - Develop models of the system to manage, and its uncertainty
    - Simulation models describing biology, fisheries, sampling, management, etc
  - Use simulations to explore the results of each alternative strategy
  - Summarize results
  - Decide on what strategy to implement

Harvest Strategies: Evaluation
Management Strategy Evaluation (MSE)

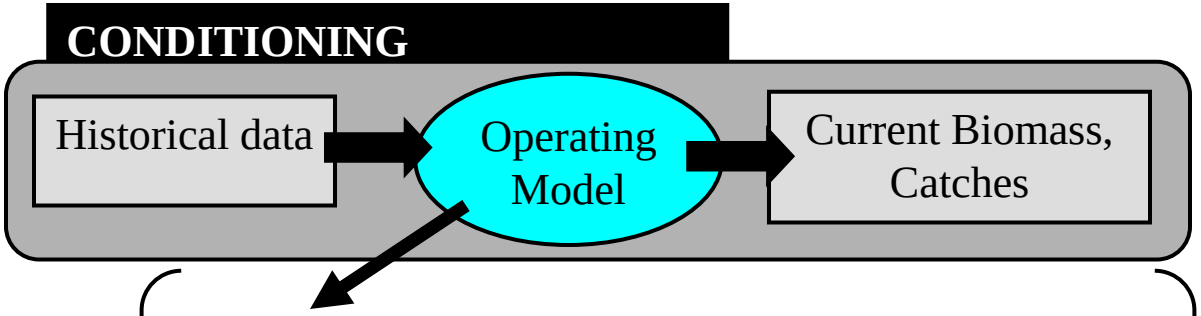
- Not looking for **optimal** strategies
- Looking for strategies **robust** to:
  - Estimation errors
  - Uncertainty about the correct model
  - Uncertainty about implementation
  - Environmental impacts
  - Etc, etc, etc…
- Discarding strategies that don't work
  - If they do not work on the computer, little chance they work in the real world

- **Optimal** strategies can be found if we knew the correct model, but can perform badly if applied to the wrong model

Management Strategy Evaluation: components

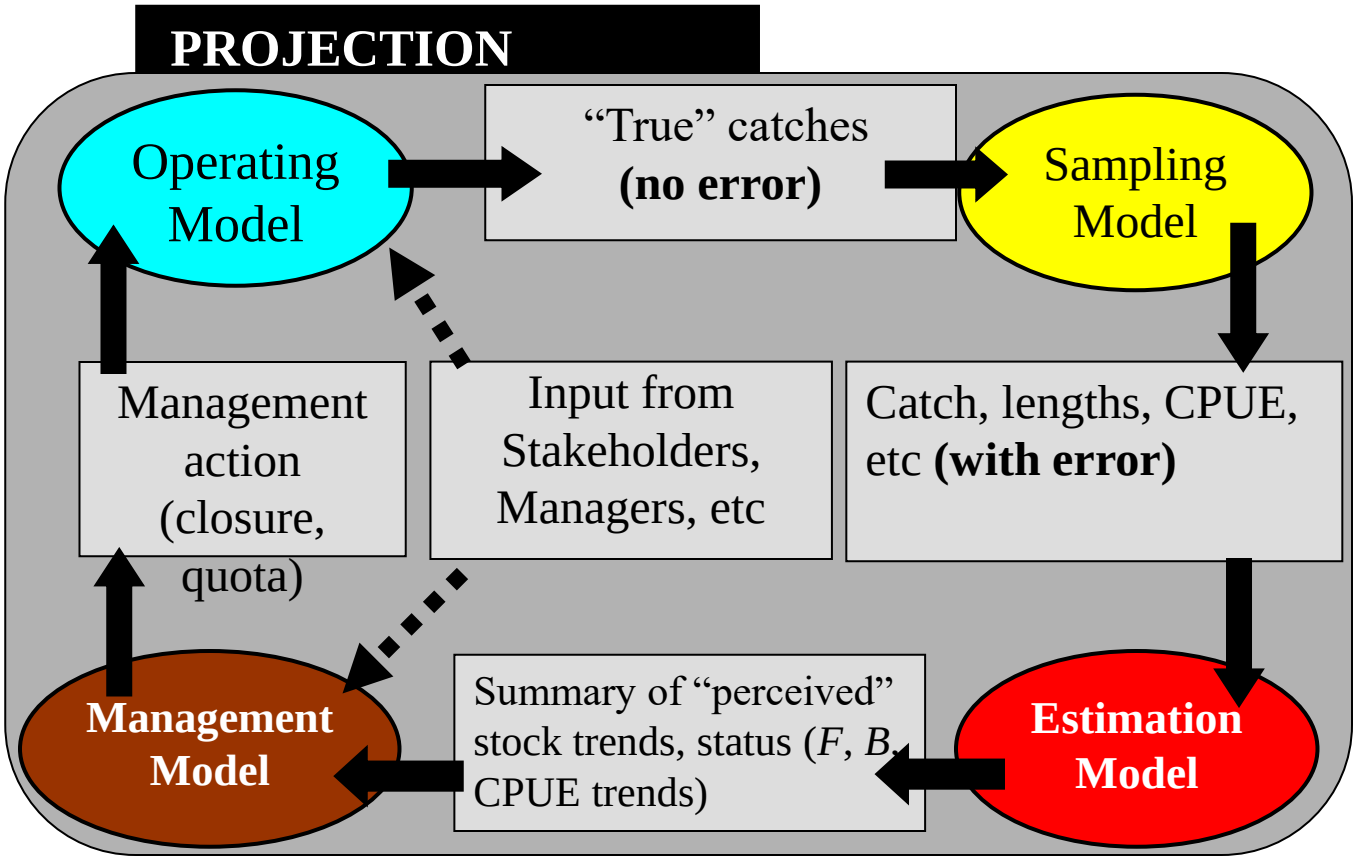


MSE: Operating models, Conditioning

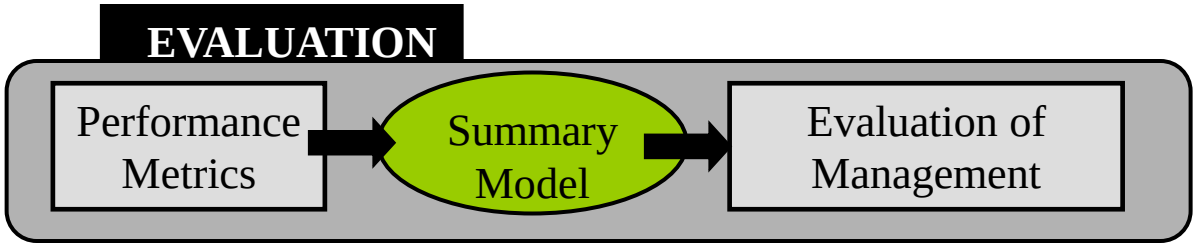


- Describes fishery and population dynamics
- Different hypotheses / model configurations to incorporate real world uncertainty; e.g.:
  - -Spawner / recruit relationship
  - -Selectivity / catchability changes
  - -Changes in fleet composition
  - -Spatial structure
  - -Alternative growth scenarios
  - -Etc, etc, etc…
- **Consistent with historical data!**

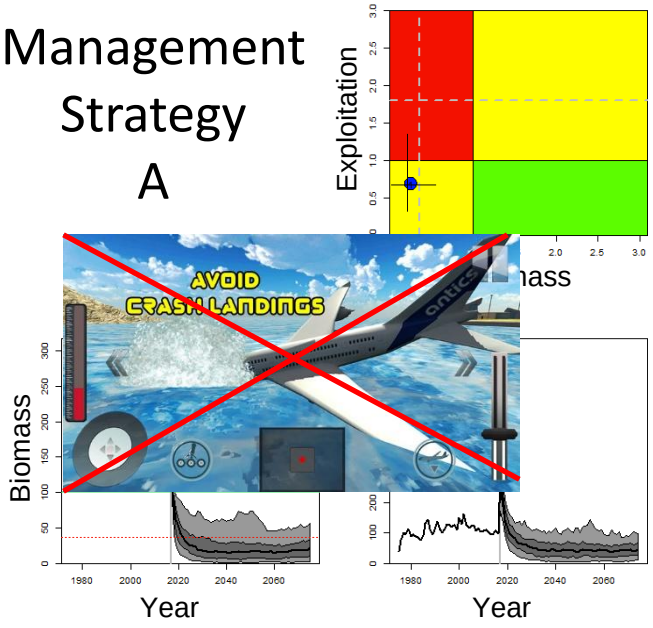
MSE: Projection component



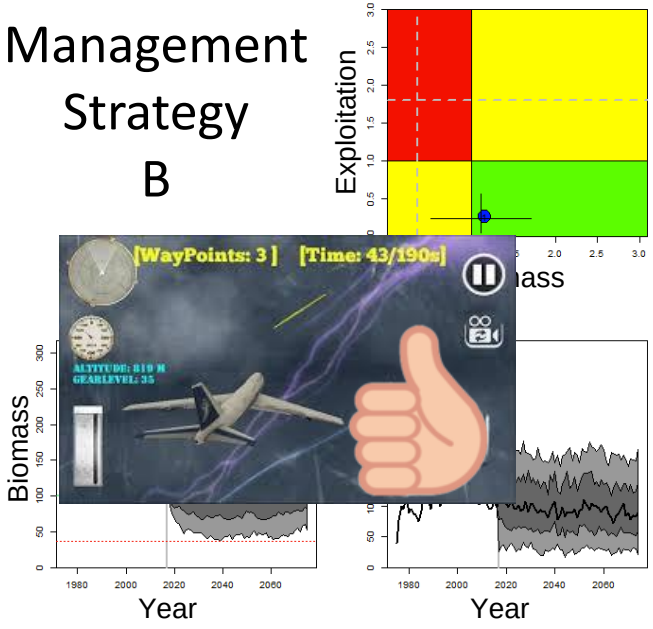
MSE: Evaluation component



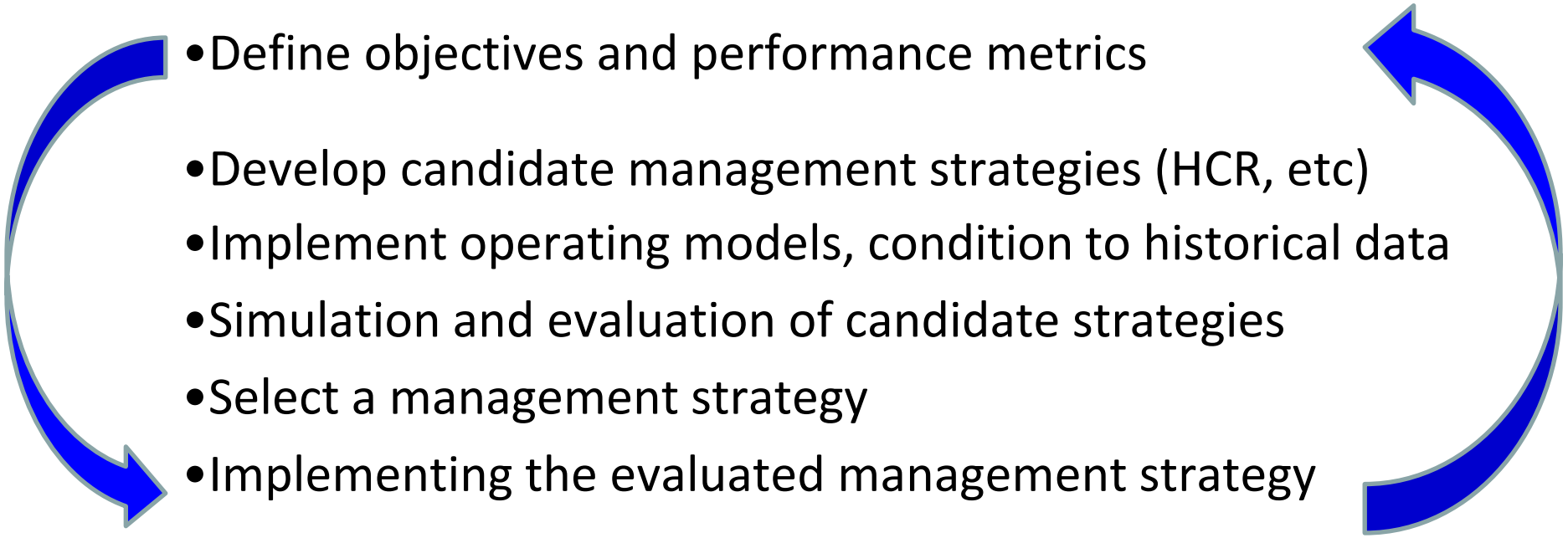
Management Strategy A



Management Strategy B



Management Strategy Evaluation: Steps



- Define objectives and performance metrics
- Develop candidate management strategies (HCR, etc)
- Implement operating models, condition to historical data
- Simulation and evaluation of candidate strategies
- Select a management strategy
- Implementing the evaluated management strategy

PROCESS NOT LINEAR!!! / ITERATIVE!!!

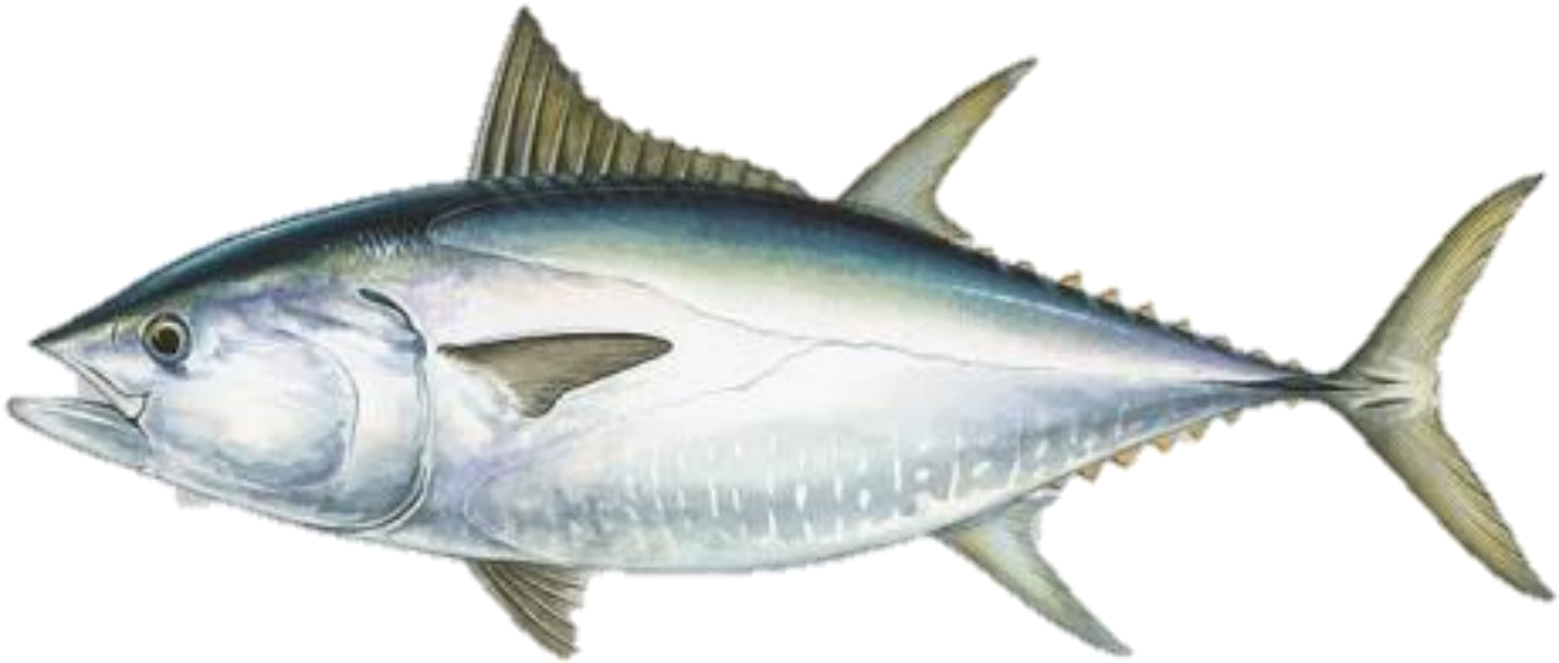
Expected benefits of Harvest Strategies

- Basis for pre-agreed and transparent decision making. Stability
- More time for scientists and managers to investigate and decide on other important issues.
- Stock assessments are still important, typically different role:
  - Exploring hypotheses about stock dynamics, long-term status of stock, checking whether Exceptional Circumstances triggered
- Better understanding of cumulative impacts of management decisions and uncertainty
- Helps planning, providing an evaluation of performance via MSE
- Based on the experience of other fisheries, improved results for fish populations, fisheries and communities

Summary

- **HARVEST STRATEGY:** Combination of agreed monitoring, stock status evaluation, harvest control rule and management actions designed to achieve **fisheries objectives**.
- The emphasis of harvest strategy elements varies by fishery, their historical context (e.g. developing, stable, rebuilding) and the level of monitoring, available analyses and management systems.
- Strategies cannot be properly evaluated without specific management objectives, data collection, analyses, treatment of uncertainty and other components of a harvest strategy.
- Development and success of strategies and MSE benefit from the **involvement of all stakeholders** in the management planning stage.

Thank you!
Questions?



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