Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission




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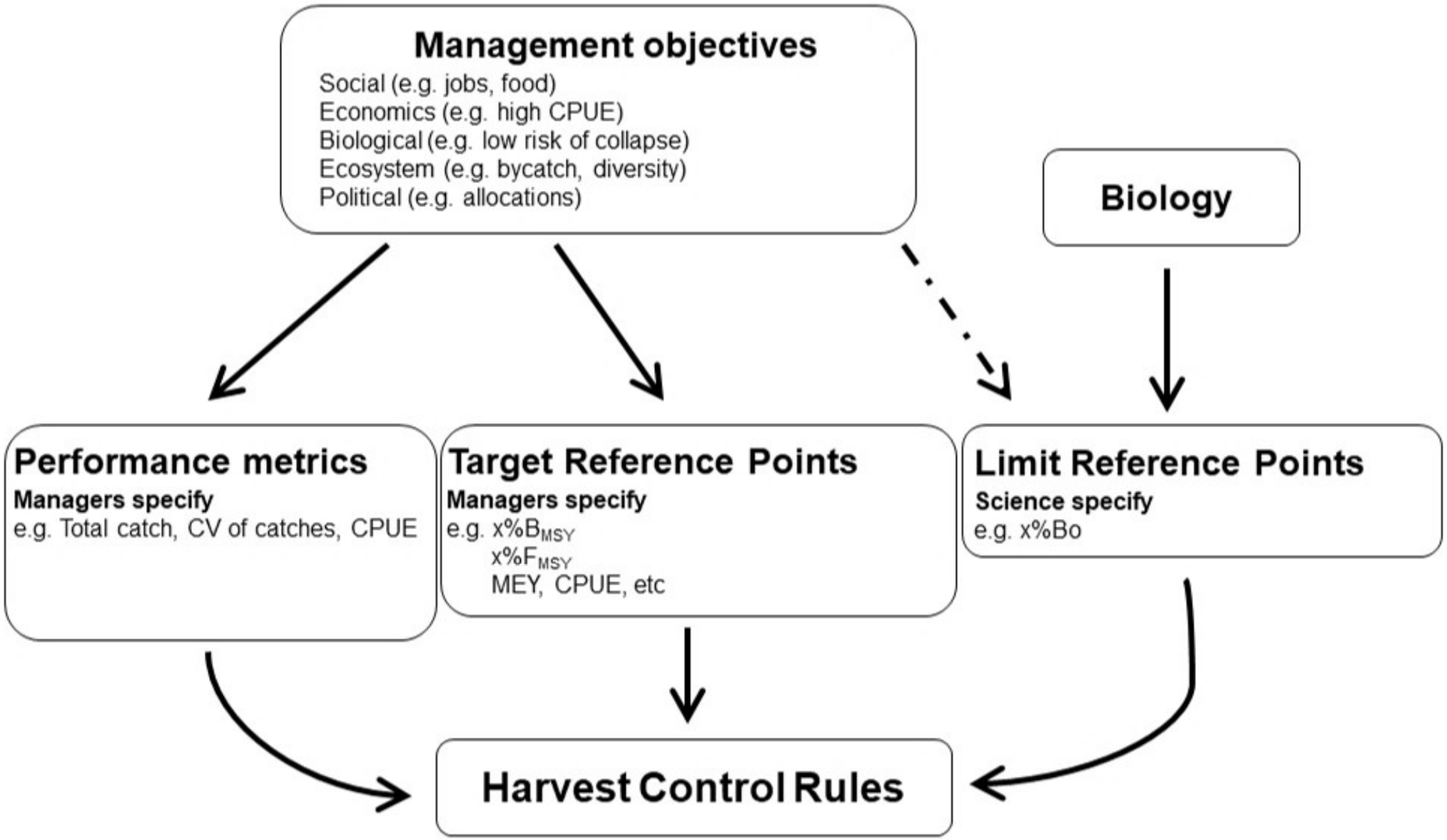
Introduction to Management Strategies

1st IATTC Tropical Tuna MSE Workshop, San Diego, California (USA), December 9-10 2019

What are Management Strategies

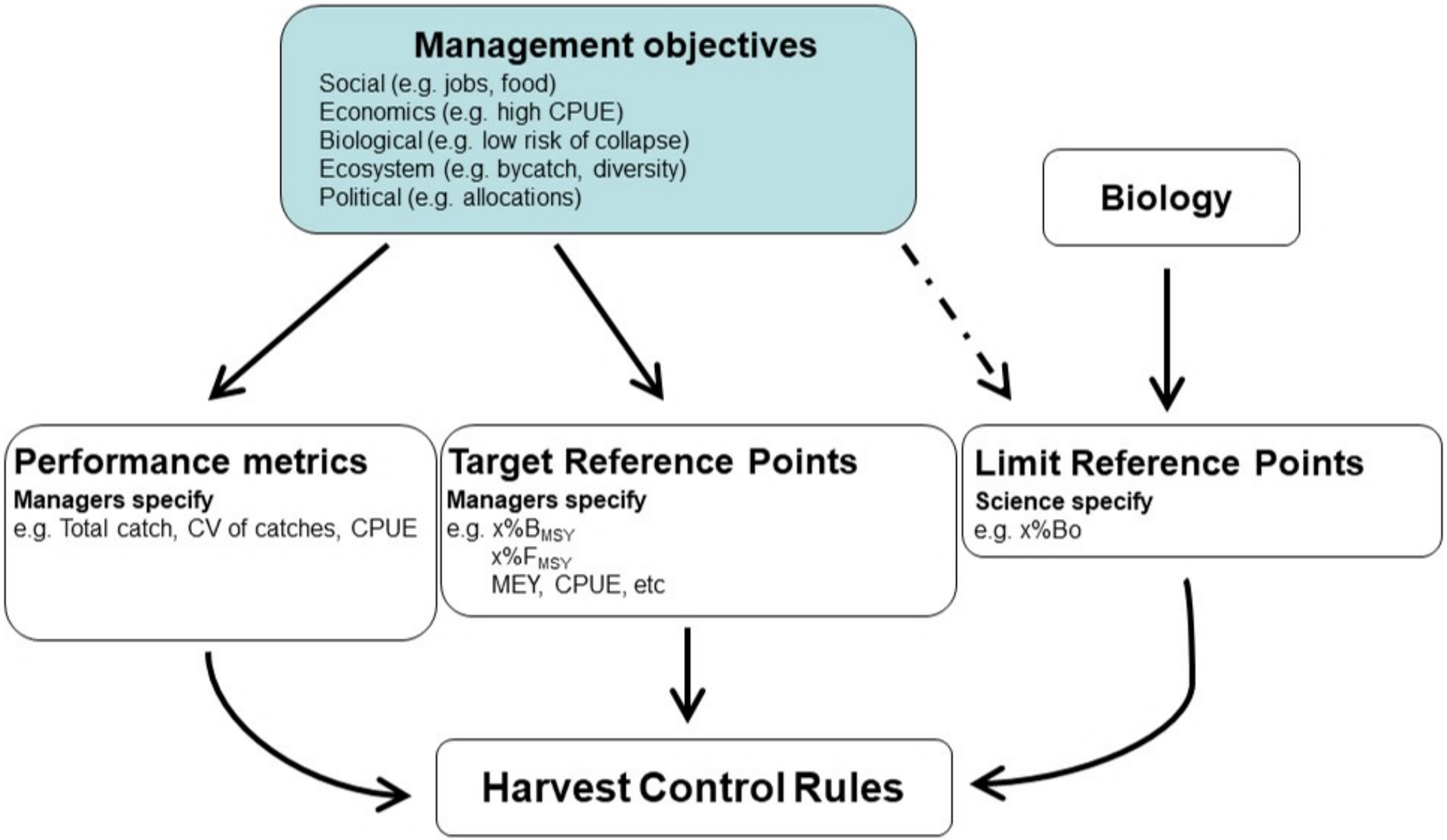
- Combination of monitoring, stock status evaluation, harvest control rule (with or without Reference Points) and management actions **designed to achieve fisheries objectives**.
- Development and success of Management Strategies benefit from the **involvement of all stakeholders** in the management planning stage.

Management strategies



Modified from Berger et al. 2012

Management strategies



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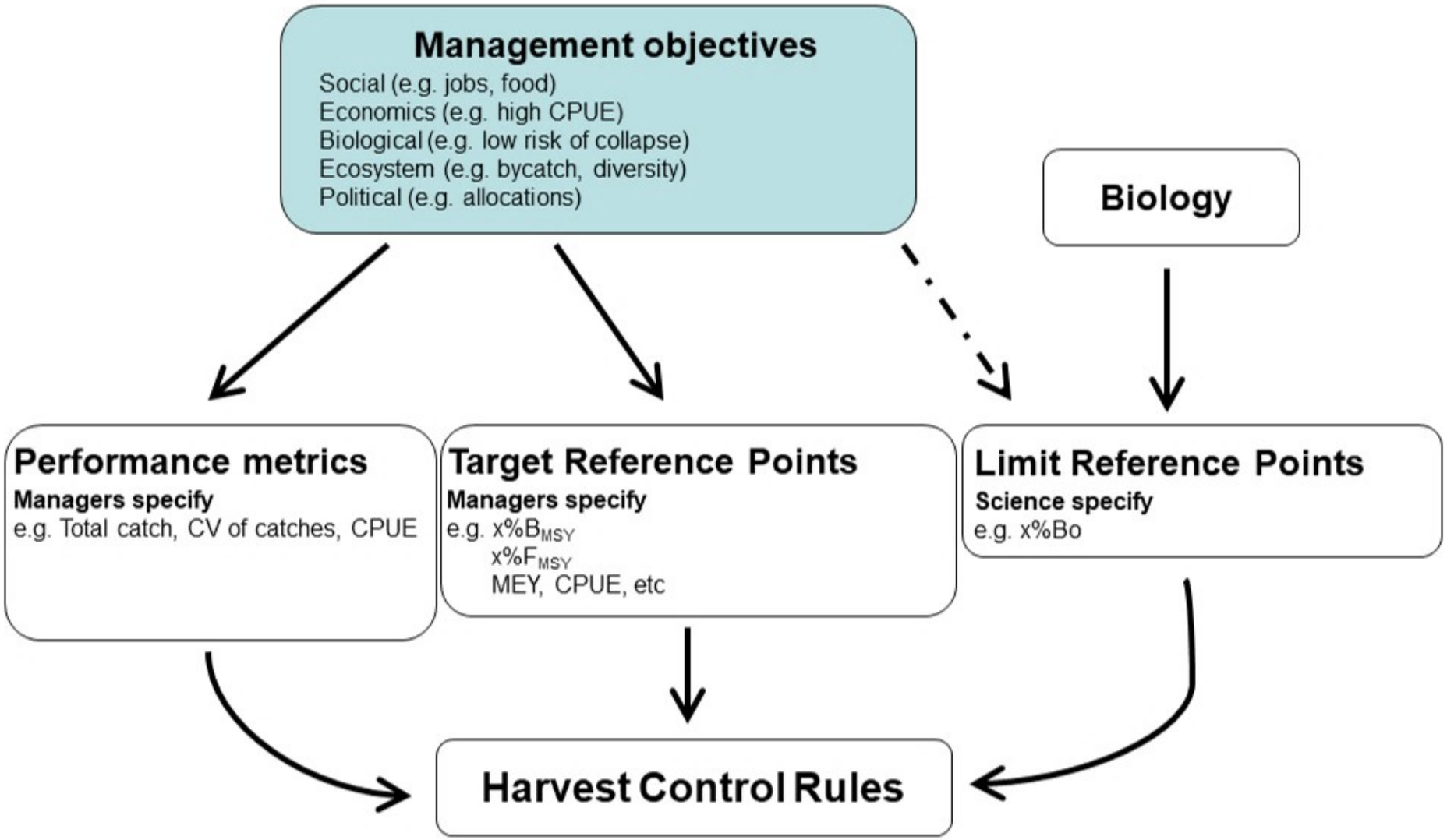
Management objectives

- Stated explicitly, specifically and unequivocally
  - Social (e.g. jobs, food access)
  - Economical (e.g. profitability)
  - Biological (e.g. low risk of collapse)
  - Ecosystem (e.g. bycatch, diversity)
  - Political (e.g. allocation)

Management objectives

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

Management strategies



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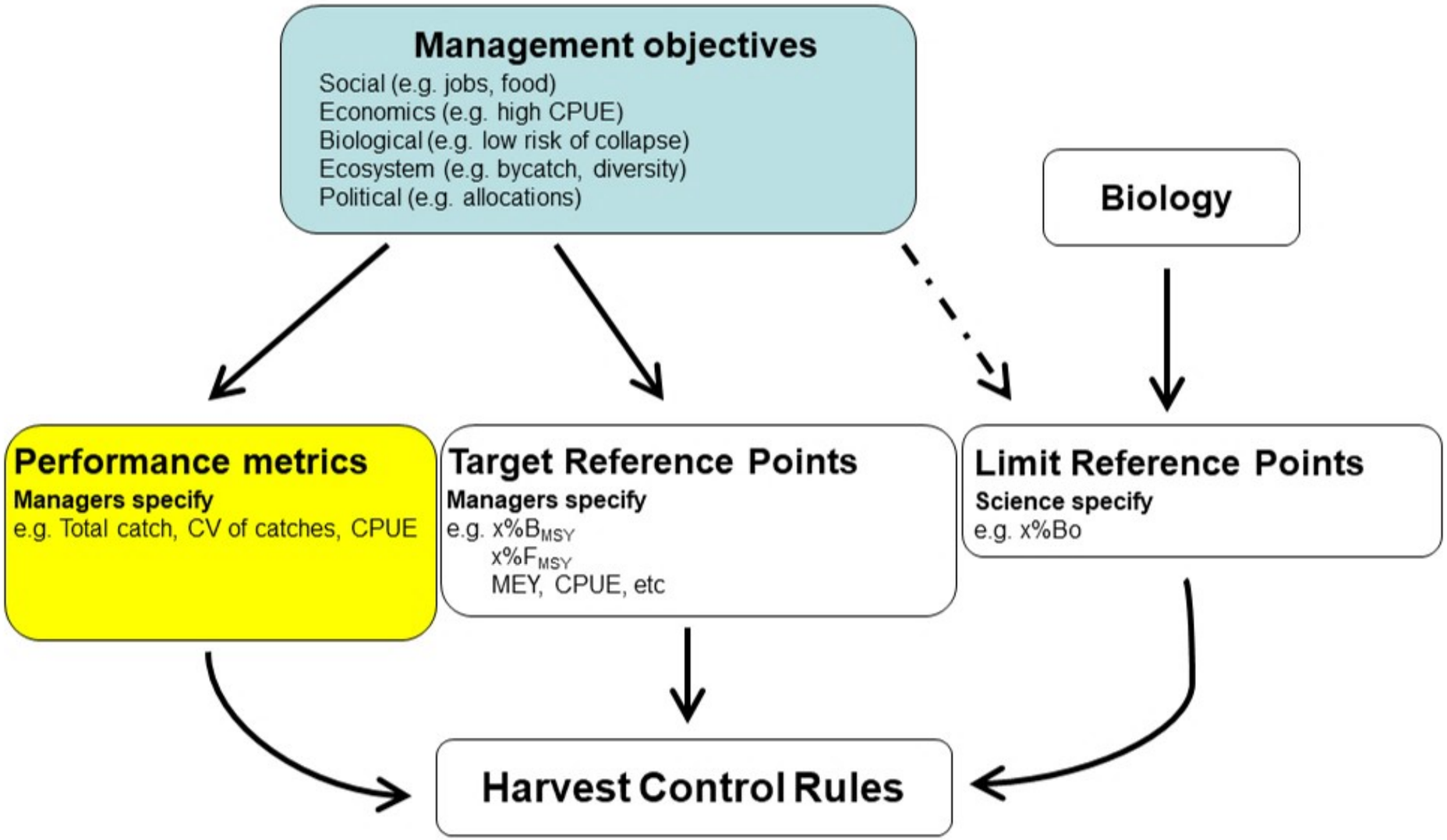
Management strategies



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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

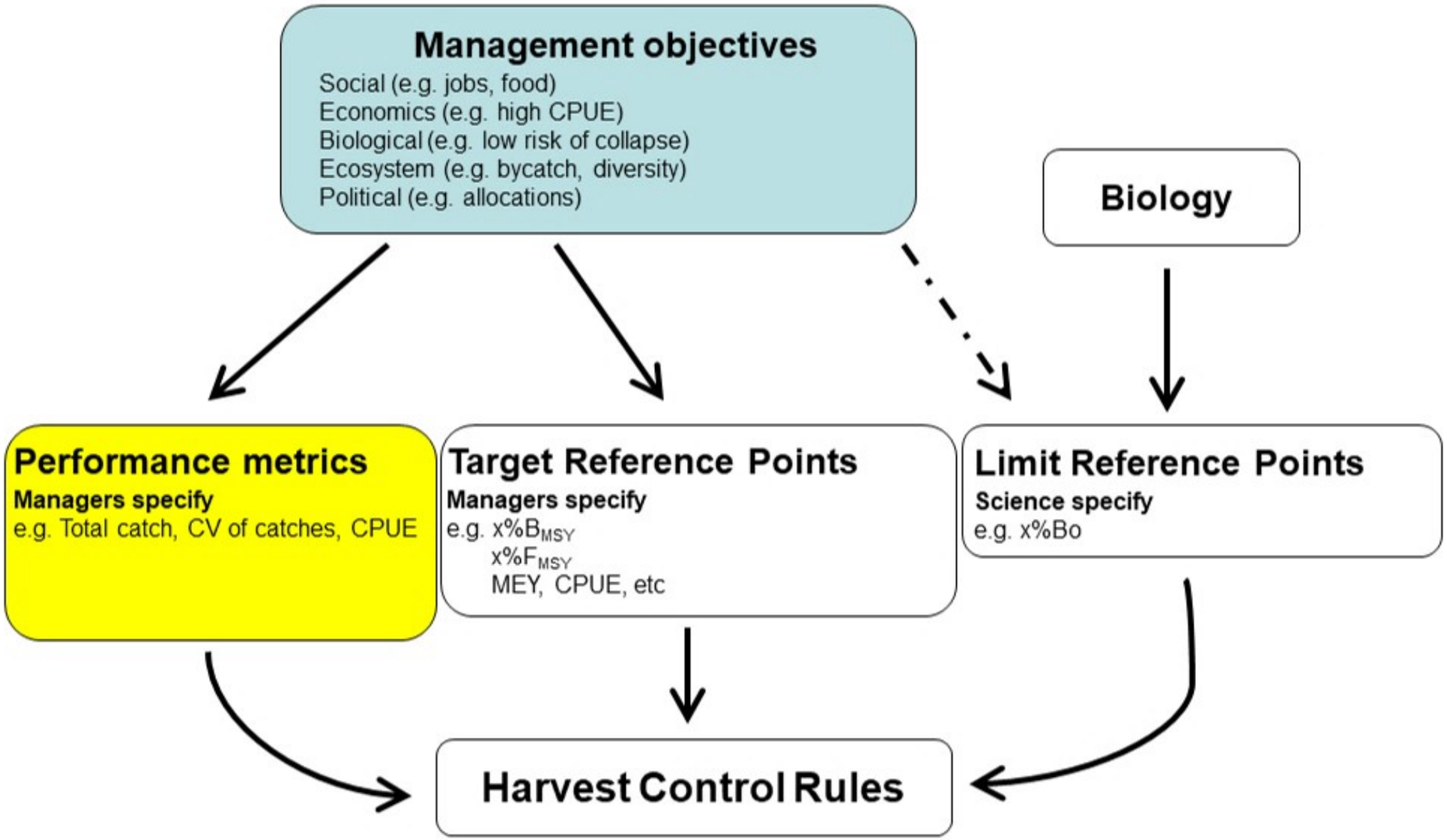
- Long-term catch & Long-term CPUE
- Long-term catch & *Probability* below reference points
- Long-term catch & Short-term catch
- Long-term CPUE & Annual catch variability
- Long-term effort & *Probability of* stock recovery

Tradeoffs

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

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

Management strategies



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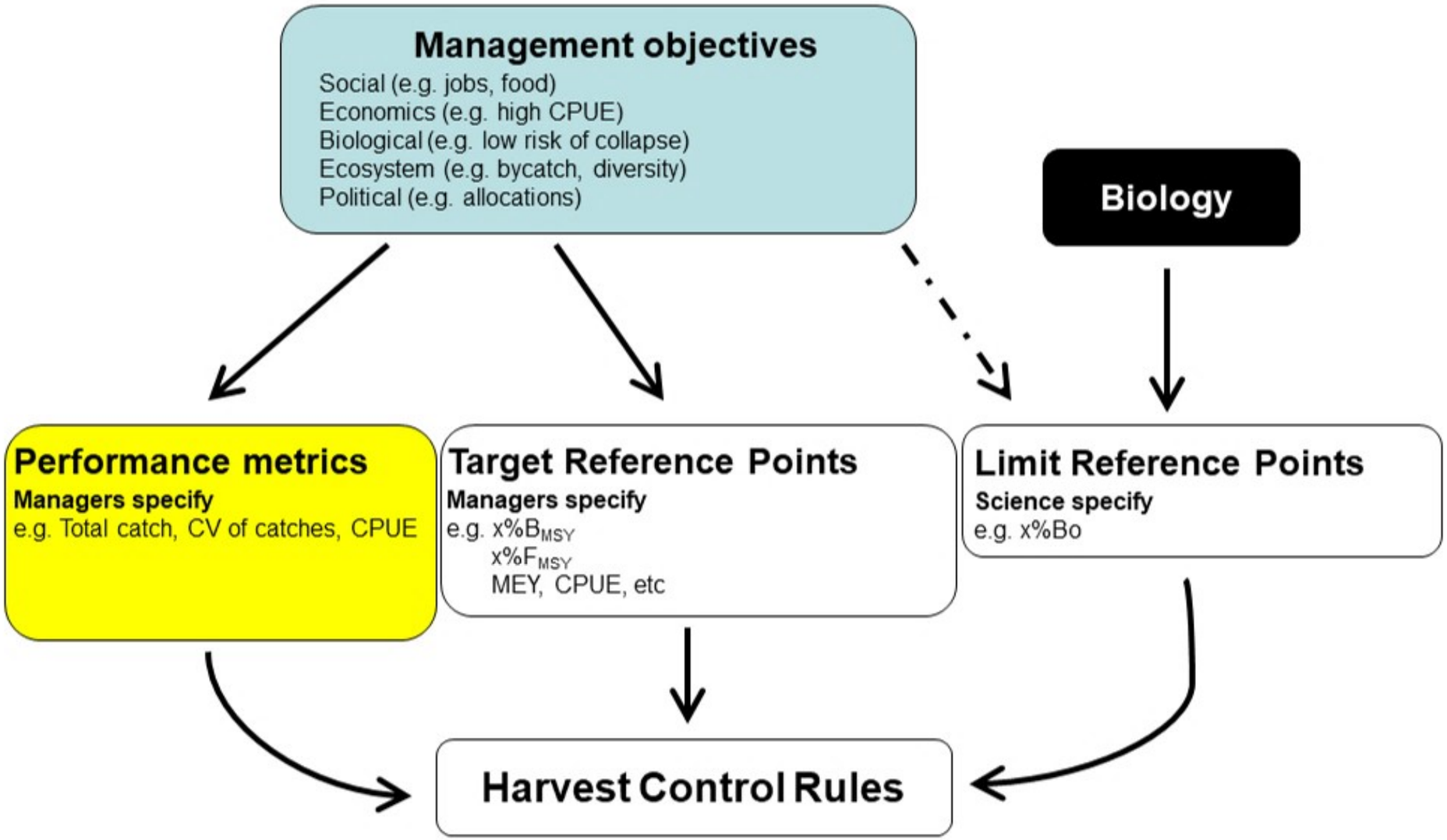
Management strategies



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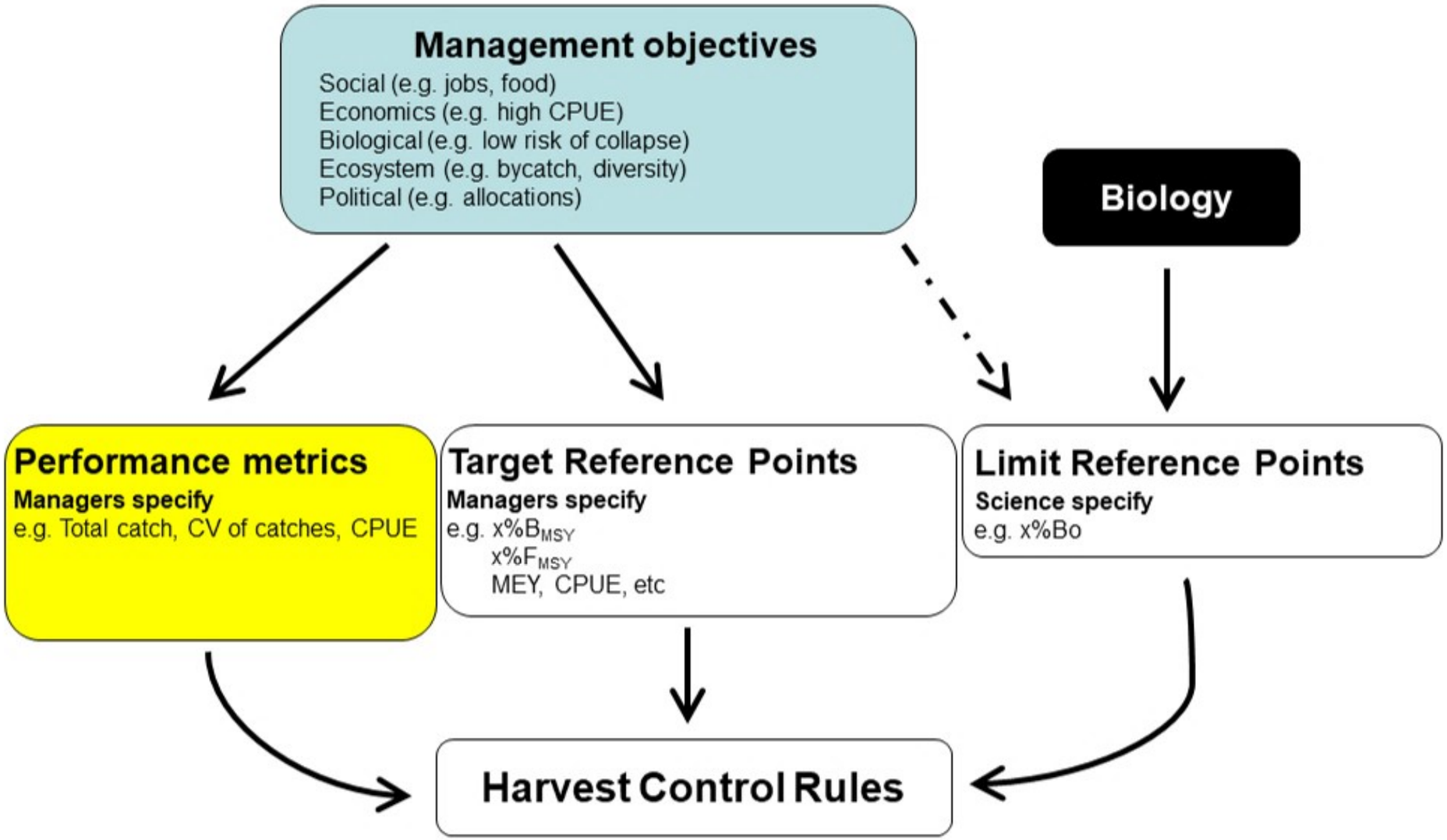
What do we know about the biology?

"Counting fish is like counting trees…

…except they are invisible and they move."

John Shepherd

Management strategies



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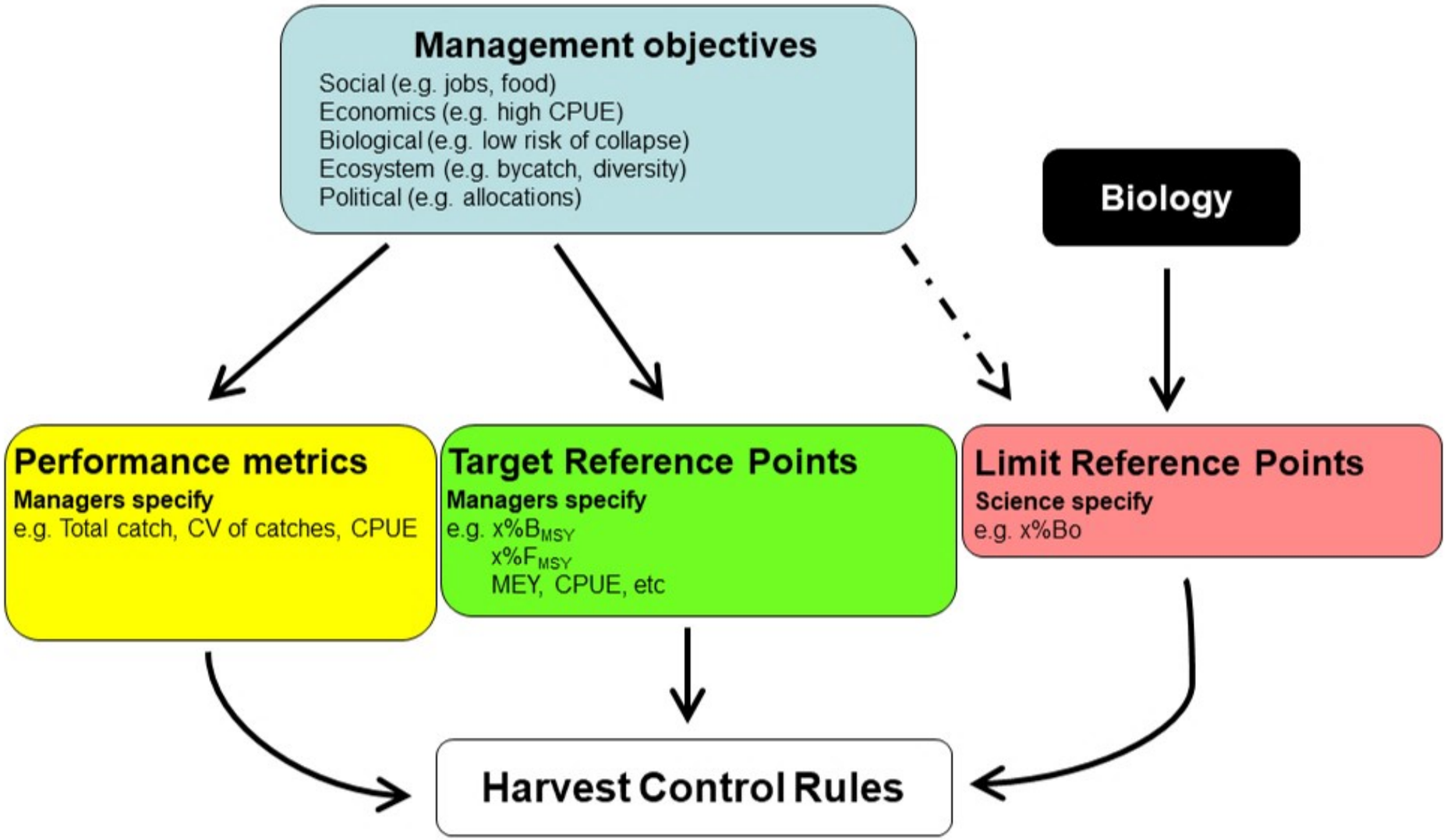
Management strategies



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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.

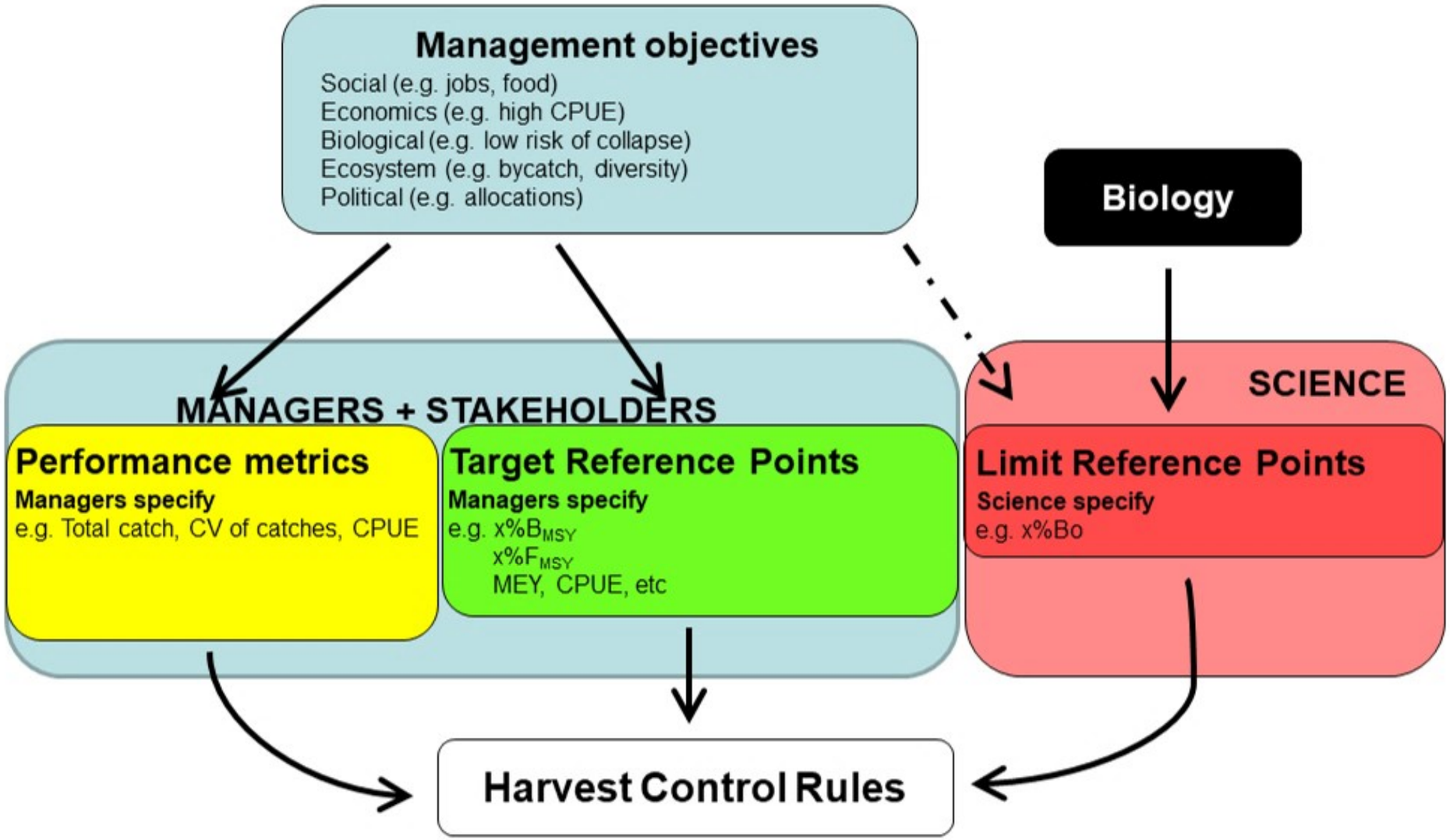
Reference Points

- Based on models
  - Biomass (B_{MSY}, B_{MEY}) or fishing mortality (F_{MSY})
  - F_{max}, $F_{0.1}$, $F_{35\%}$, $F_{40\%}$, per-recruit calculations
- Based on data alone (empirical)
  - CPUE
  - Fish size

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.

Management strategies: Roles



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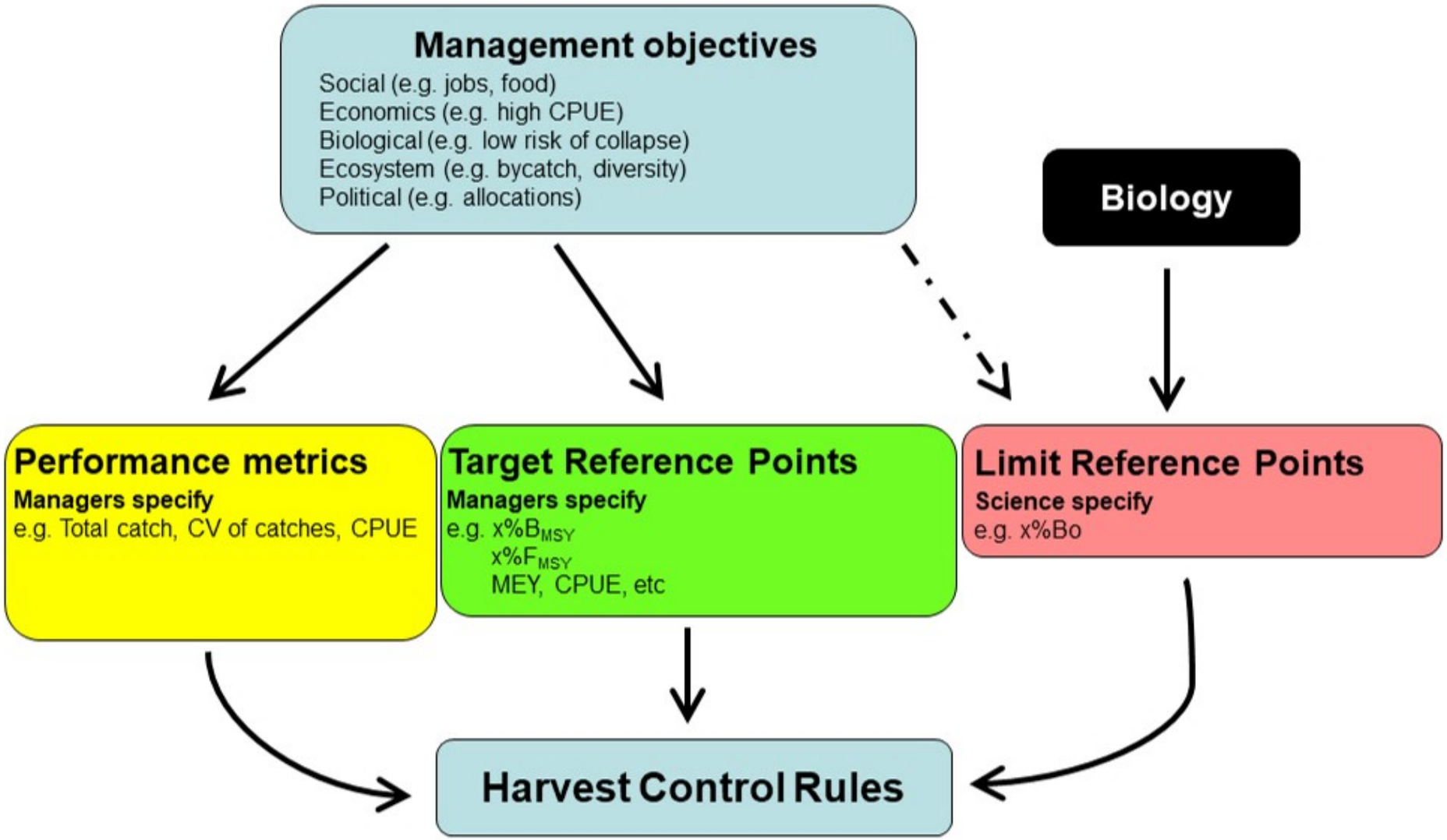
Management strategies: Roles



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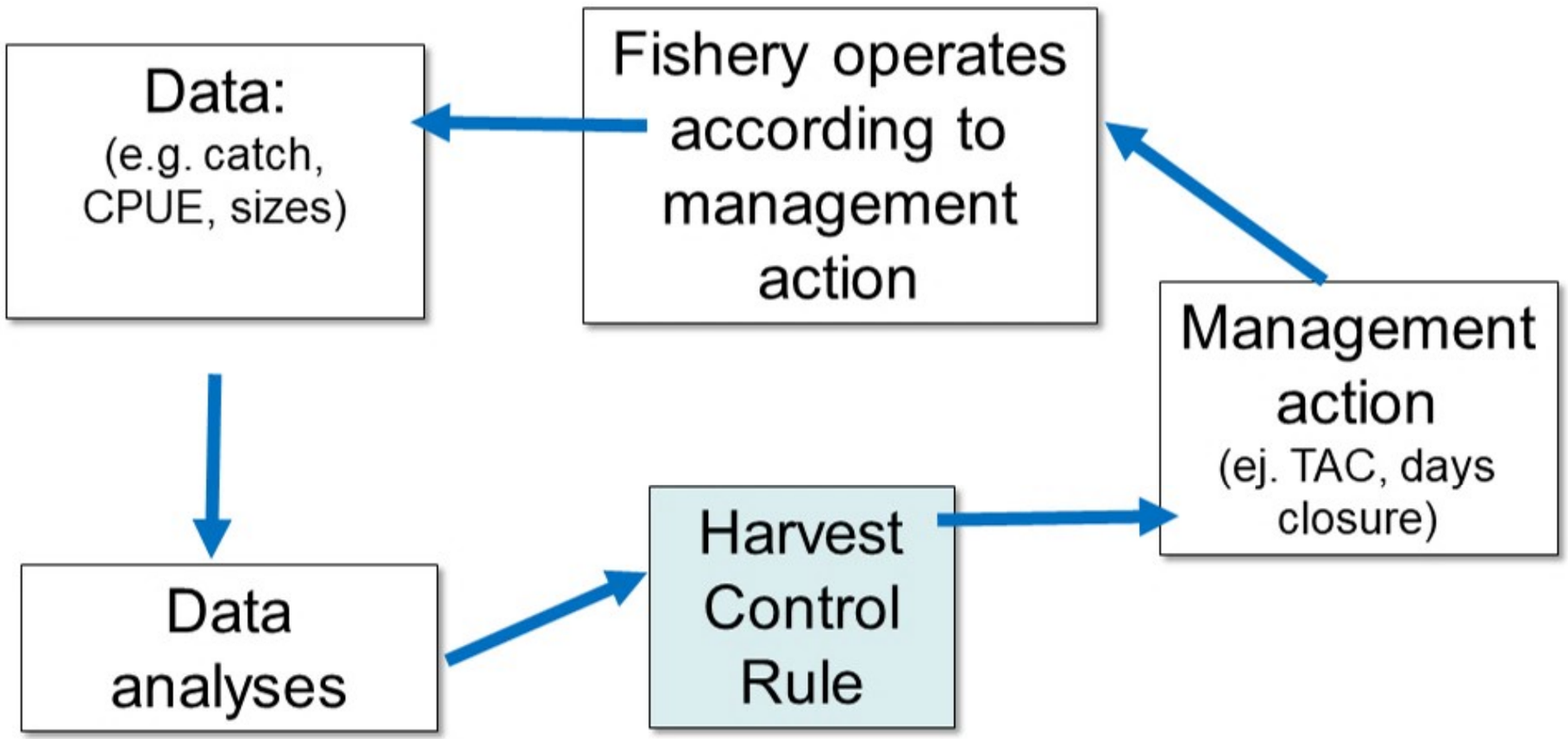
Harvest Control Rules (HCR)

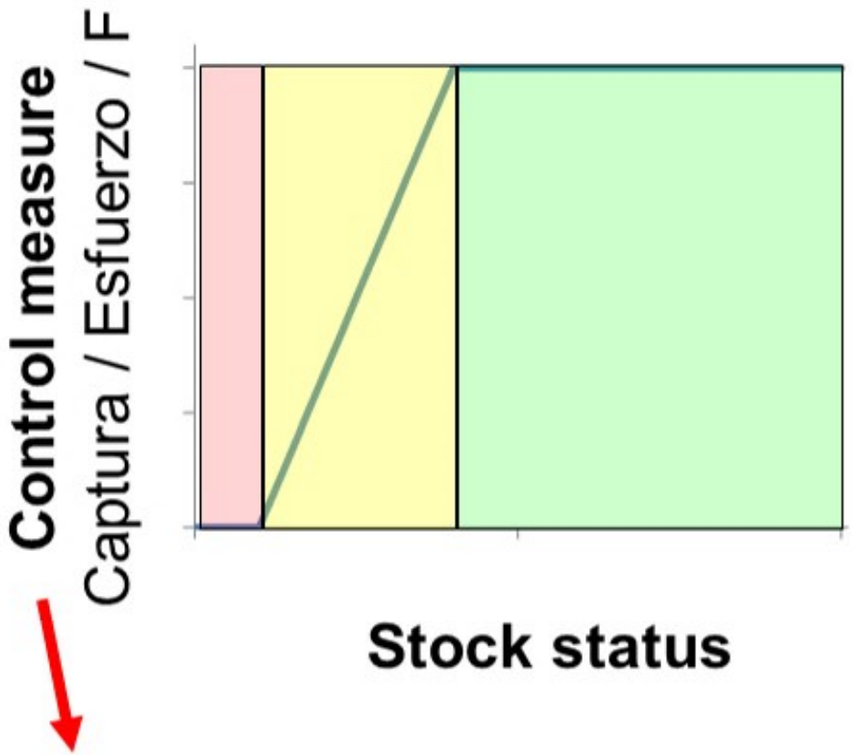
- **Pre-agreed** management actions to changes in the stock and/or environmental, economic factors relative to **reference points**, **or trends** in stock indicators.
- Operationalize **management objectives**
- Increase management decisions **transparency**
- Framework to implement harvest strategies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

Harvest Control Rule Cycle



"Stock"	Reference Points	Control Rule
	 Green Backlight (32-37.3 °C) normal	→ Keep on playing
	 Orange Backlight (37.3-38 °C) low fever	→ Hydration
	 Red Backlight (>38 °C) high fever	→ Hospital

Harvest Control Rule elements



- **Control measure, tactics:**
  - Regulations available to apply the strategy

Control measures / Tactics

Input Controls – regulate fishing effort

- number and size of fishing vessels
- length of fishing season
- spatial closures

Output Controls – regulate catch

- total allowed catch (TAC)
- transferable quotas (ITQ)
- Quota allocation by gear/fleet

Control measures / Tactics

Why **Output Controls**?

- Better adherence to allowed catch
- Reduce (not always) the “race for fish”

Challenges of **Output Controls**

- Incentivize catch misreporting
- Less robust to assessment errors
- More difficult and costly to monitor

Control measures / Tactics

Why **Input Controls**?

- Simple and inexpensive to implement
- Easy to monitor
- Mixed fisheries where it is difficult to monitor all species.

Challenges with **Input Controls**

- Incentivize a “race for fish”
- More robust to assessment errors
- Difficult to limit all sources of fishing effort
- Fishing effort can re-distribute or change
- Tend to exceed the allowable catch

Types of
Harvest Control Rules (HCR)

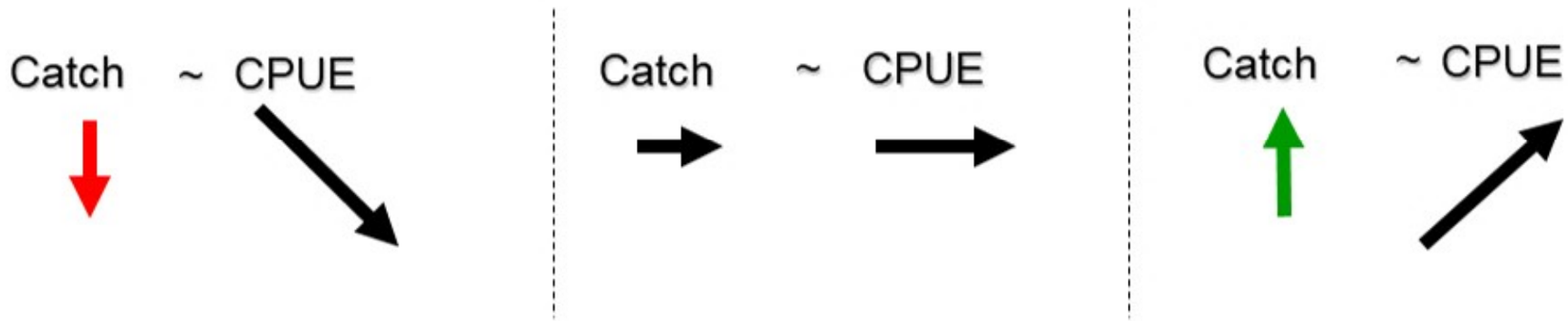
Harvest Control Rule types

- **Constant**
- **Empirical Rule**
  - Minimum treatment of data
  - Easy to compute, explain and understand
  - Care required to minimize responses to noisy data
- **Model-based Rule**
  - Based on models of varied complexity (e.g. assessments)

Empirical Harvest Control Rules

- Based on monitoring and feedback
- Simple rule, even when evaluation of its performance uses complex computer simulations (such as MSE)

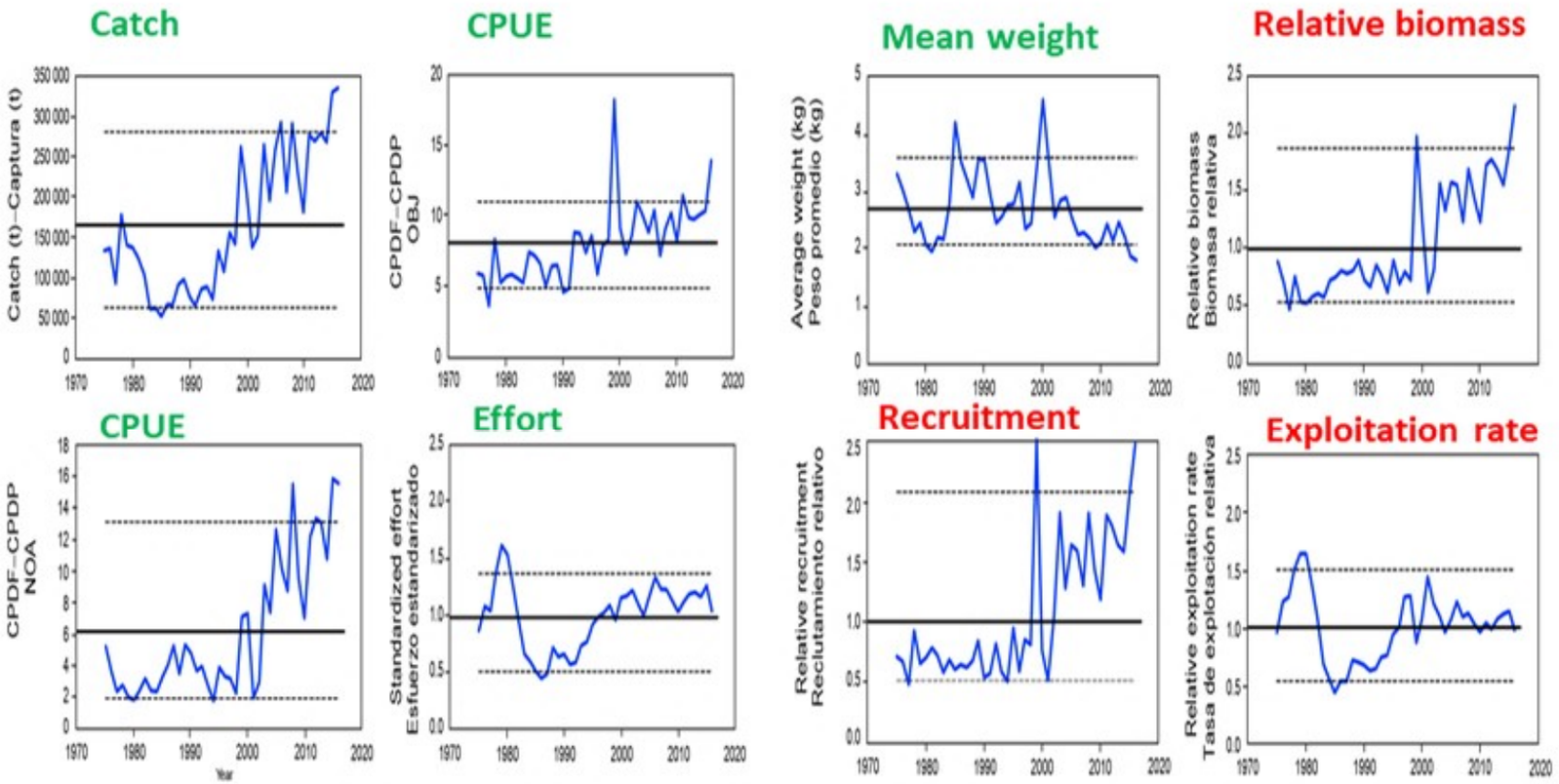
Example: adjust catch using CPUE trends



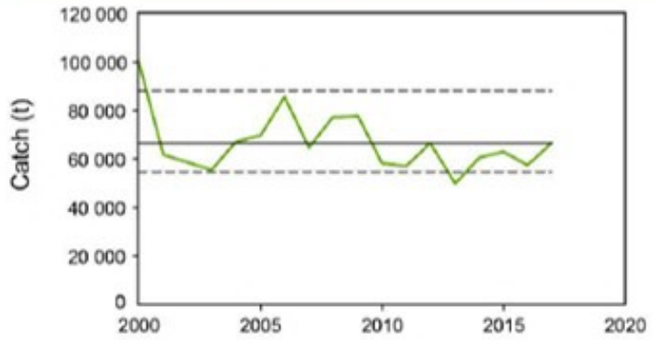
Indicators EPO Skipjack tuna

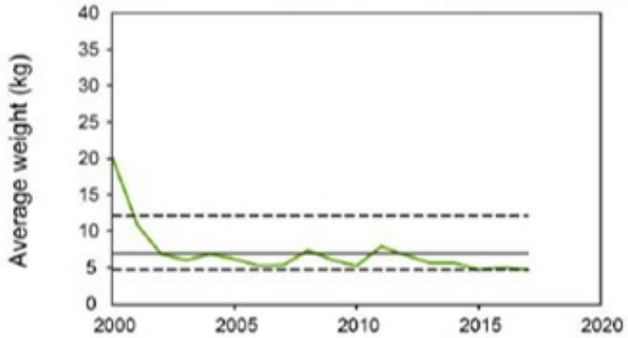
Based on data or simple model population estimates

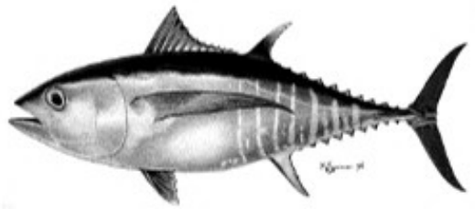
- **Data** (catch, effort, CPUE, mean weight)
- **Simple model estimates** (biomass, recruitment and exploitation rate)



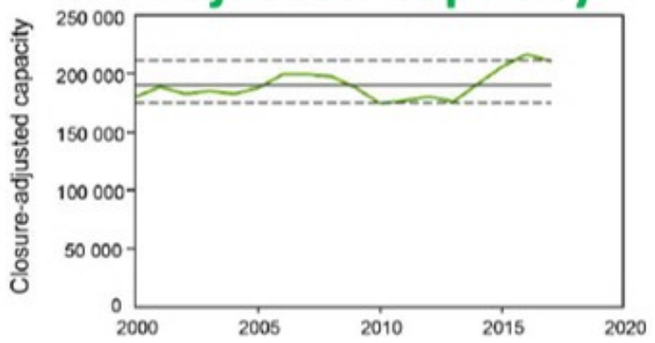
Indicators EPO Bigeye tuna



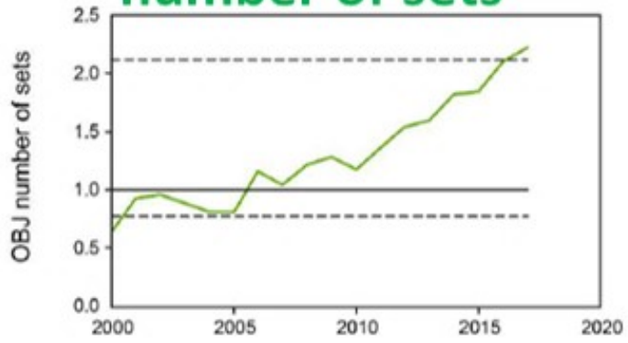




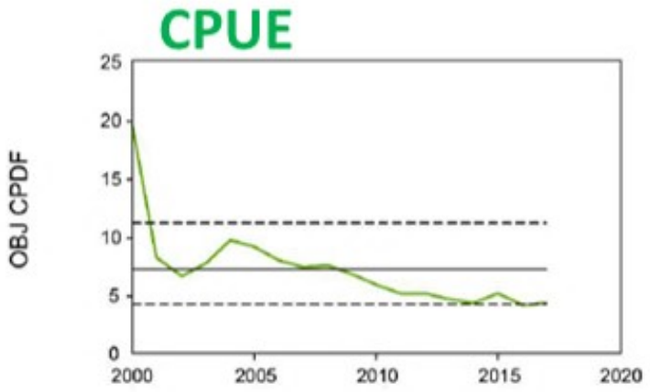
adjusted-capacity



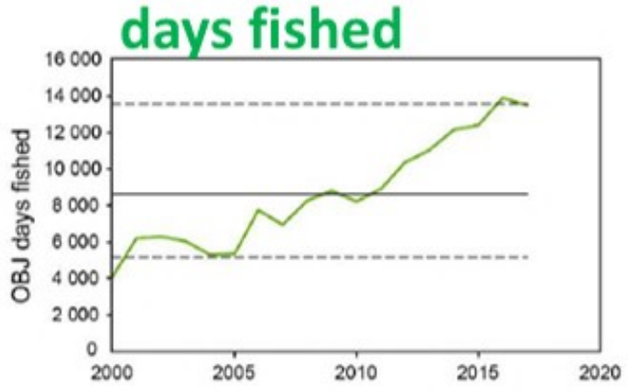
number of sets



CPUE



days fished



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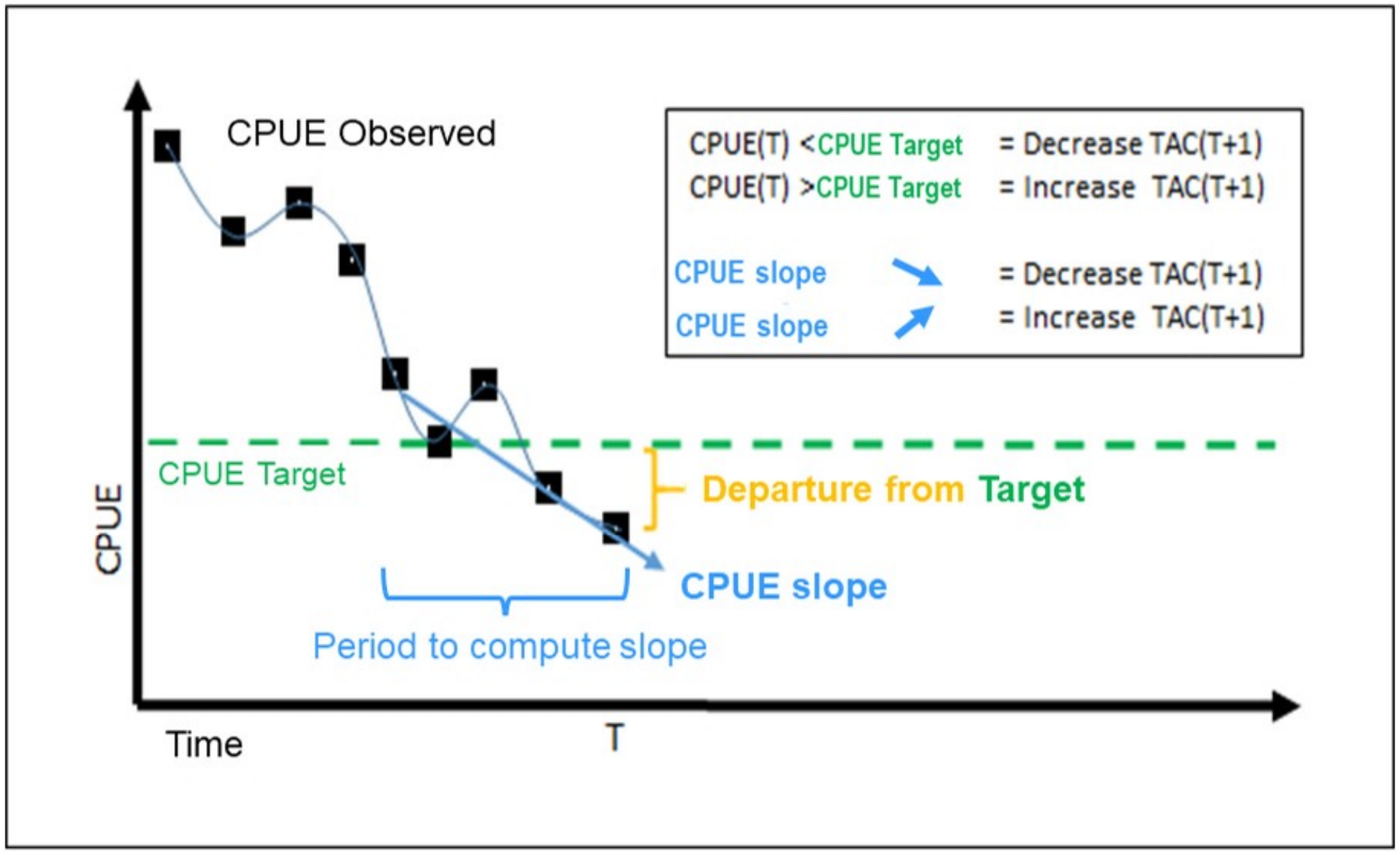
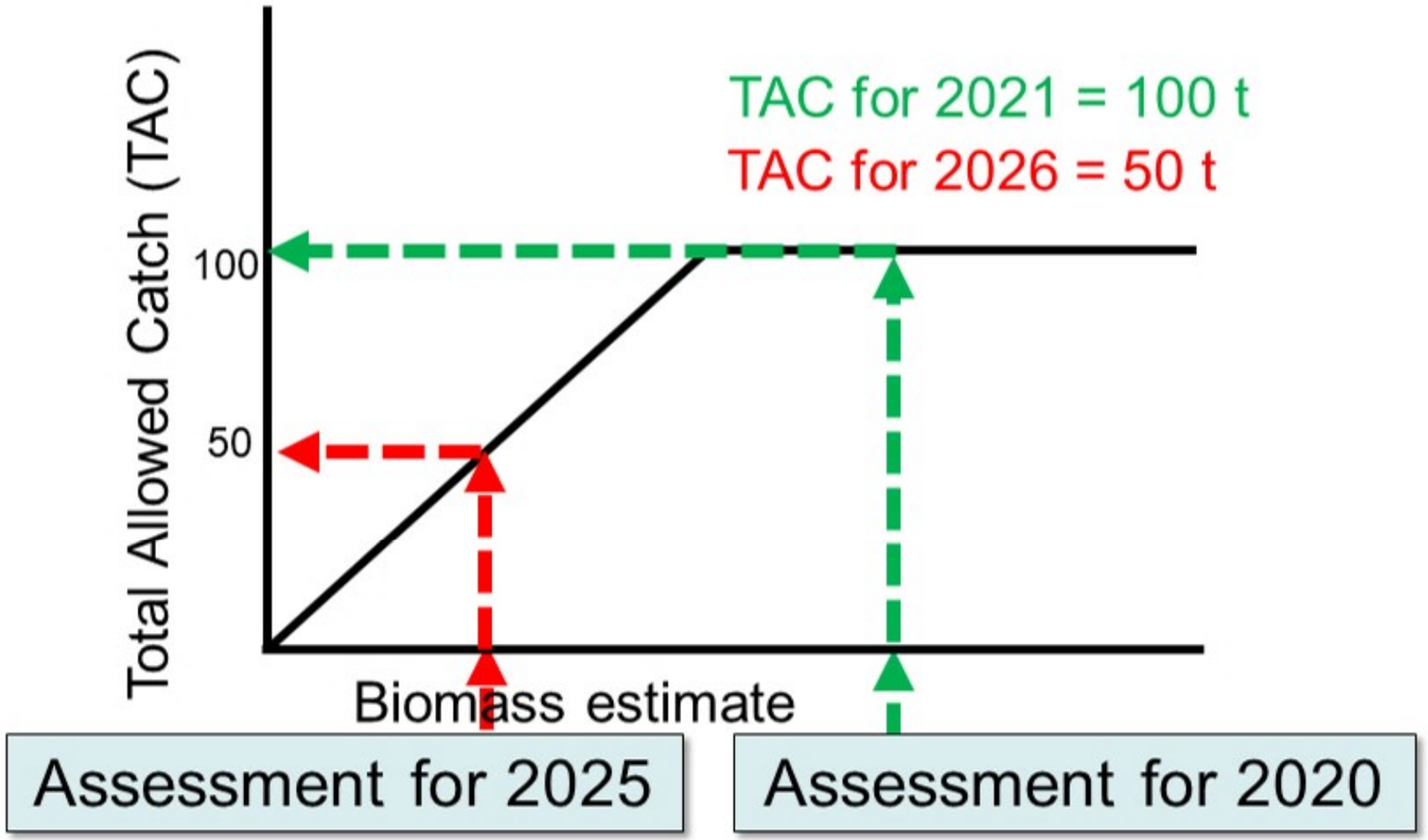
Empirical Rule example

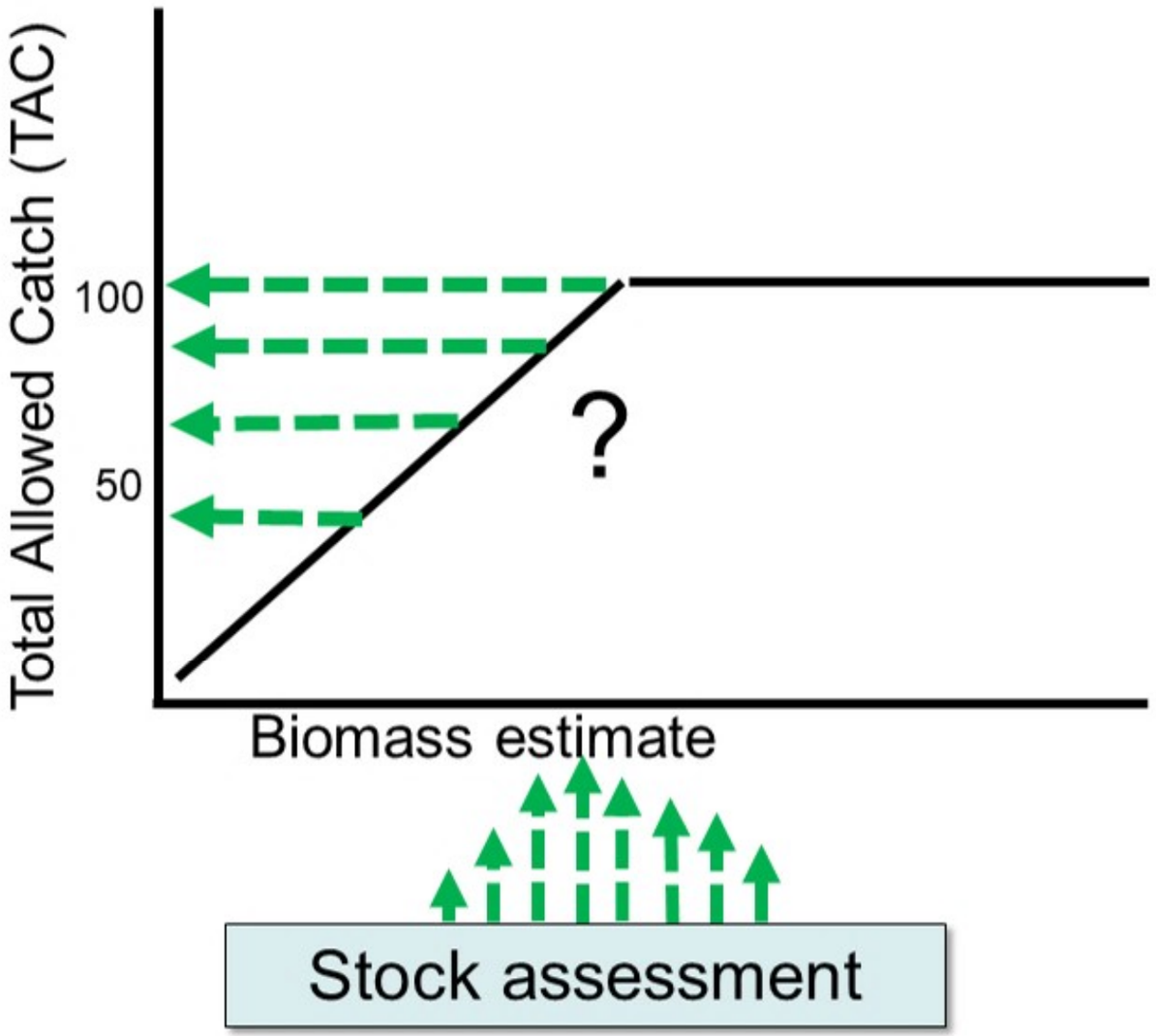


Model-based Control Rule

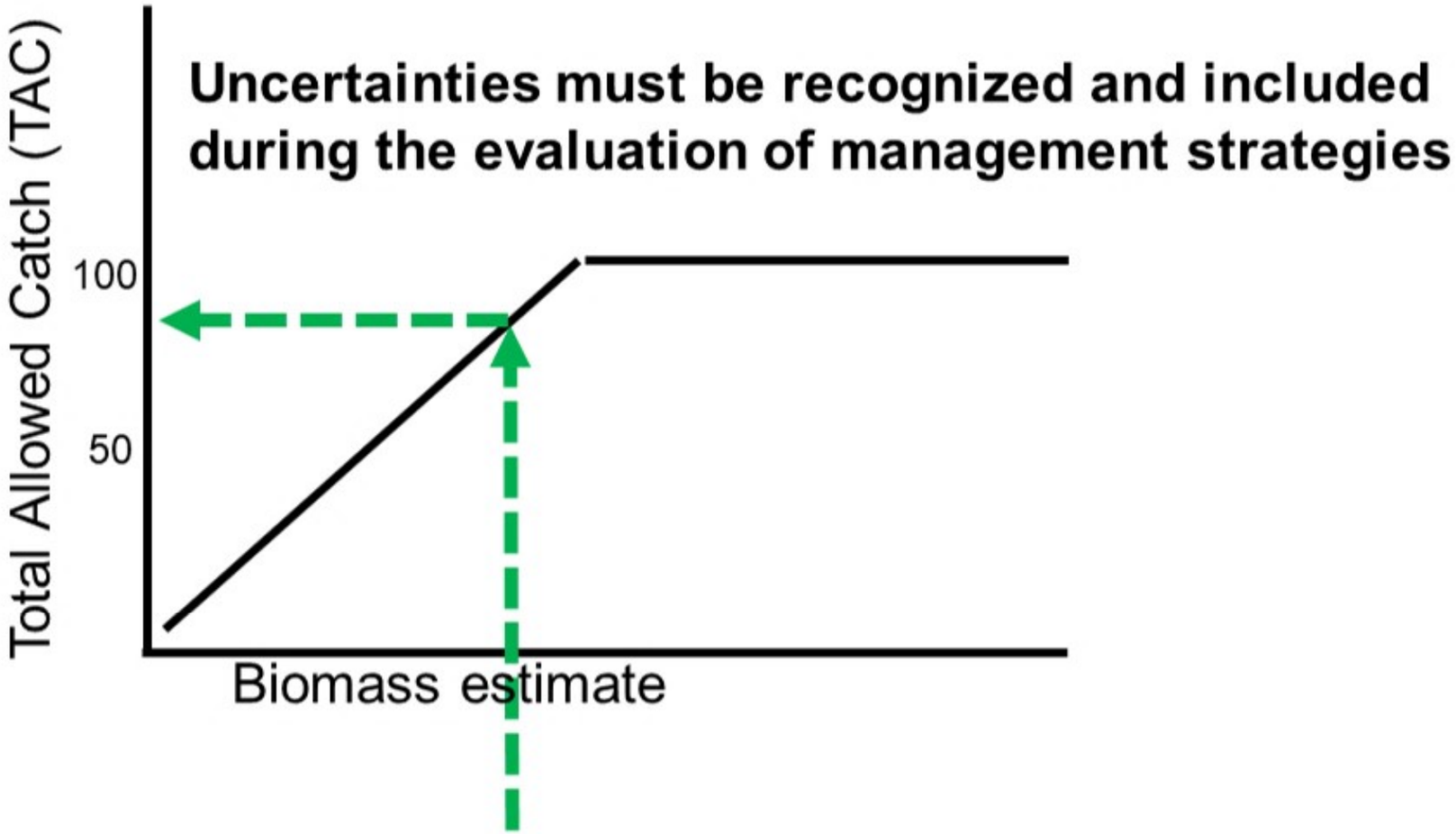
1) Fit a pre-specified stock assessment
2) Use the HCR to determine next year's TAC



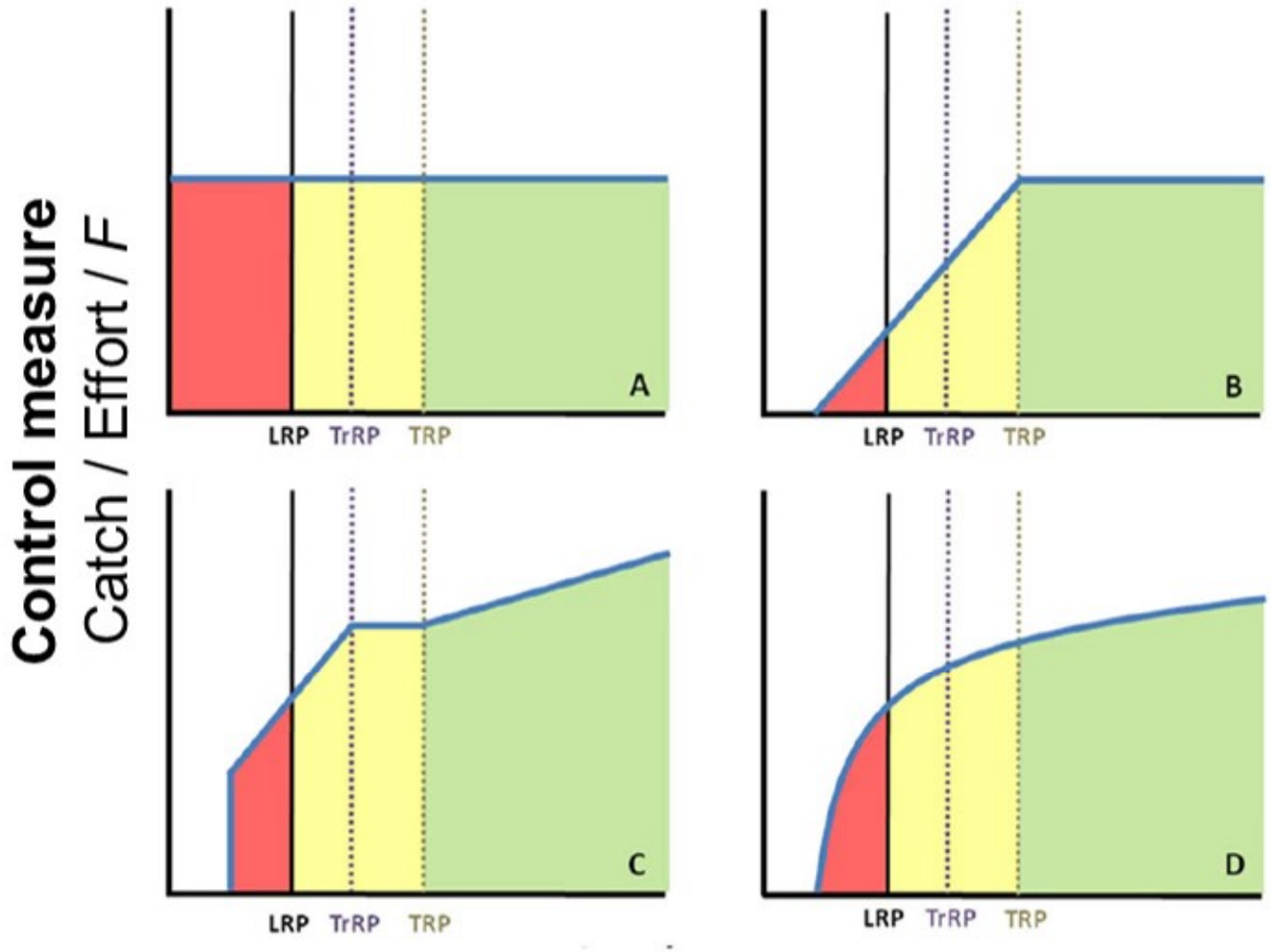
Stock Assessment Uncertainty



HCR must provide unique action



HCR and Reference Points



Modified from Berger et al. 2012

Harvest Control Rule 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"**

Management Strategies Summary

- Combination of monitoring, stock status evaluation, harvest control rule (with or without RPs) and management actions designed to achieve **fisheries objectives**.
- The emphasis of management strategy elements varies by fishery, their historical context (e.g. developing, stable, rebuilding) and the level of monitoring, available analyses and management systems.
- RPs and HCRs cannot be properly evaluated without specific management objectives, data collection, analyses, treatment of uncertainty and other components of a management strategy.

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Questions?