Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission




CIAT
IATTC

Introduction to Management Strategy Evaluation (MSE)

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

Management Strategy – Management Procedure

"… is analogous to an autopilot, with the associated advantages. However, this does not mean that the aircraft should be left without a pilot.

The pilot must remain on board to look out for unexpected major course deviations that may not have been factored into the design, including appreciable changes in scientific perceptions concerning the resource. "

Doug S. Butterworth, University of Cape Town

Management Strategy: rules and meta-rules

Southern Bluefin Tuna (CCSBT)

Every year

Every 3 years

Review of stock and fishery indicators

Exceptional circumstances?

In depth stock assessment

Exceptional circumstances?

no

yes

no

yes

Apply MP-derived TAC

If exceptional circumstances, advise on other measures

no

Are exceptional circumstances so severe that immediate action on TAC is required?

yes

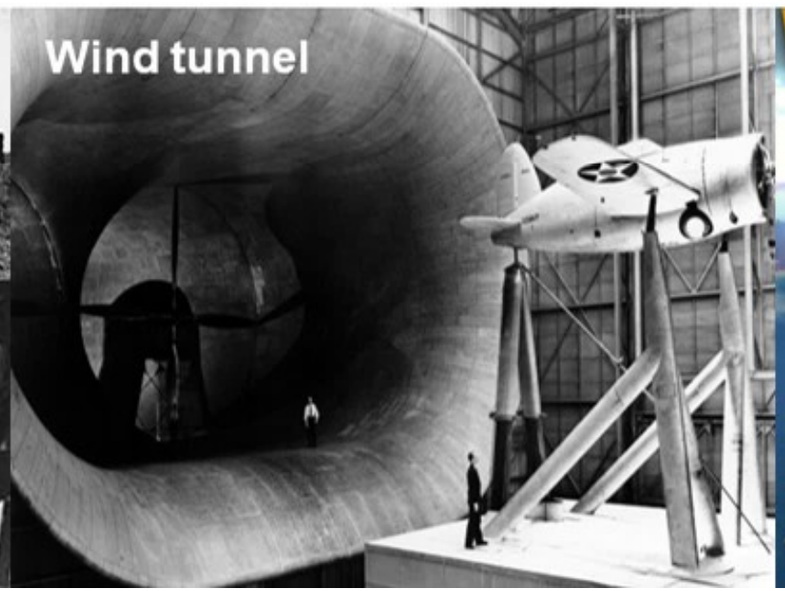
Invoke metarule

Do not apply MP-derived TAC

Advise on TAC

Management Strategy Evaluation (MSE)

- Useful to formally answer what if questions:
  - Quotas (individual / total);
  - Closures (time / spatial);
  - Fishing gear limits (number of sets, FADs, etc);
  - Number/size of vessels
  - Better/other data (tagging, ageing, genetics, etc)



Management Strategy Evaluation

- 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

Why Stock Assessments can fail, become unreliable

*"**All** models are wrong, **some** are useful"* George Box

- Data too noisy, or not representative
- Model ignores or badly describes important issues:
  - Wrong spatial structure
  - Variable o wrong natural mortality, selectivity, growth, etc
  - Fish movement
  - Changes in technology, oceanography, environment, economy, etc

Would more complex/realistic models result in better stock assessments?
We do not know (yet) since more complex models have model parameters and need more data…
…and they still would need to be evaluated!

Strategies, Objectives and Tactics

- **Strategies** are based on choosing **tactics** (quotas, minimum sizes, temporal or spatial closures) to achieve **management objectives**
- If management objectives are **not explicit and clear**, we cannot (sensibly) evaluate alternative strategies
- Problem: often times decision makers **have not agreed on objectives** (or are reluctant to state them publically)

Strategies, Objectives and Tactics

- Distinguish between
  - High level (general) objectives: "*conserve the stock*" and
  - Operational (quantitative) objectives: "the probability of falling below 10% of B_0 should not be greater than 5% over 20 years"

- Often **tactics** (what to do next year) get confused with **objectives** (why we do what we do next year)

How to evaluate strategies

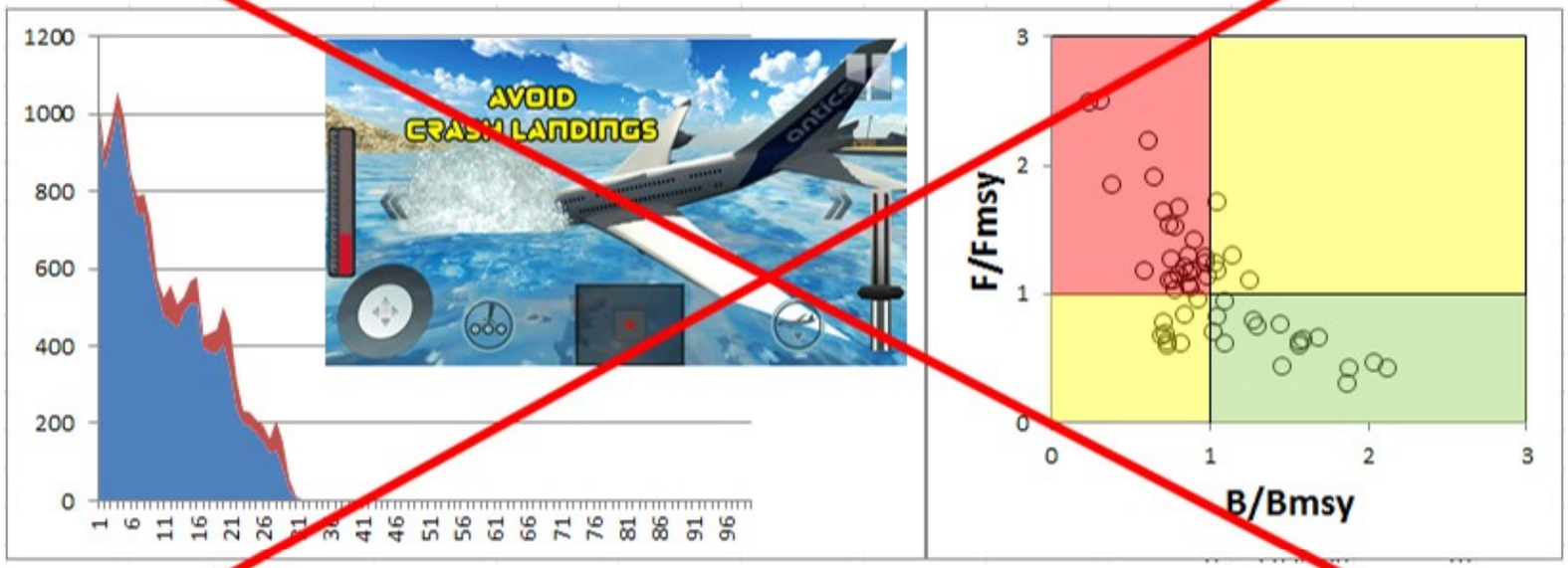
- Rarely we can evaluate alternatives analytically (i.e. formula)
- Typically, we evaluate alternative strategies using computer simulations:
  - Specify general objectives
  - Specify operational objectives
  - Develop models of the system to manage, and its uncertainty
  - Use simulations to explore the results of each alternative strategy
  - Summarize results
  - Decide on what strategy to implement

How to evaluate strategies (example)

- Rarely we can evaluate alternatives analytically (i.e. formula)
- Typically, we evaluate alternative strategies using computer simulations:
  - Specify general objectives
    - Preserve the stock
  - Specify operational objectives
    - Do not fall on the red sector of Kobe plot more than 5% over 100 years
  - Develop models of the system to manage, and its uncertainty
    - Simple model with random errors in assessment
  - Use simulations to explore the results of each alternative strategy
  - Summarize results
  - Decide on what strategy to implement

Kobe plot: simple simulation model

Constant catch

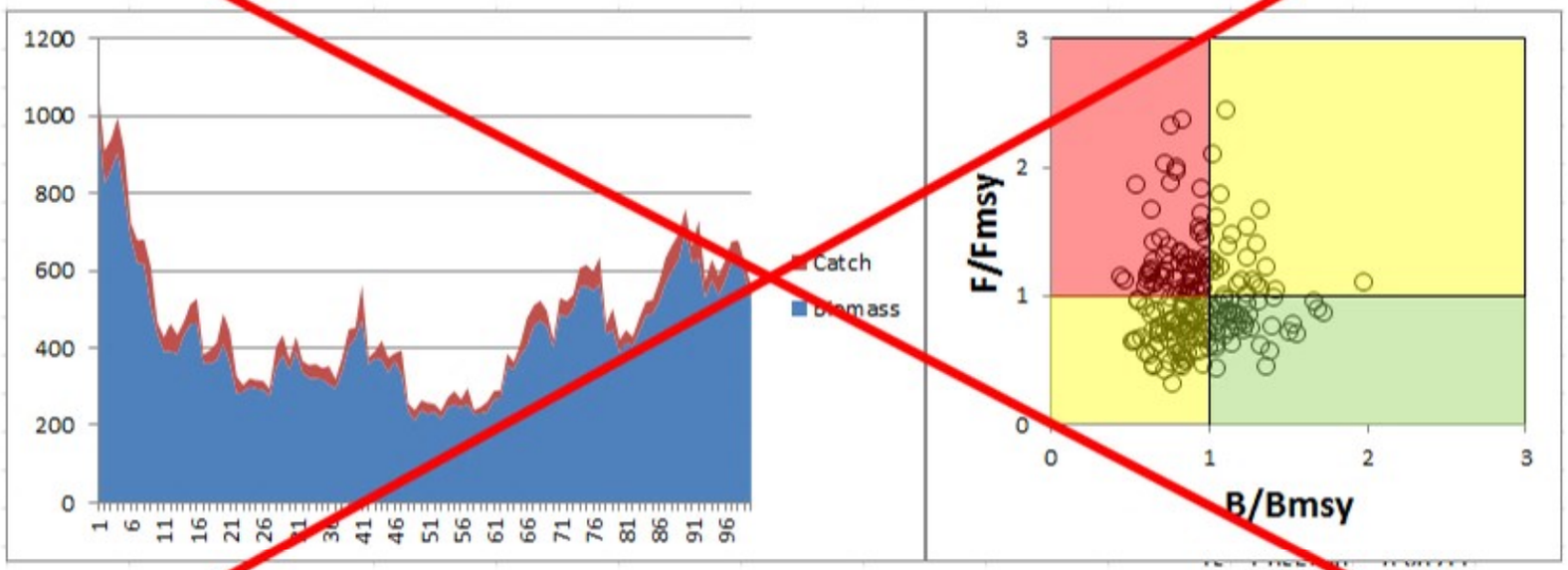


This strategy collapses the stock

See Schaefer_Kobe.xlsx

Kobe plot: simple simulation model

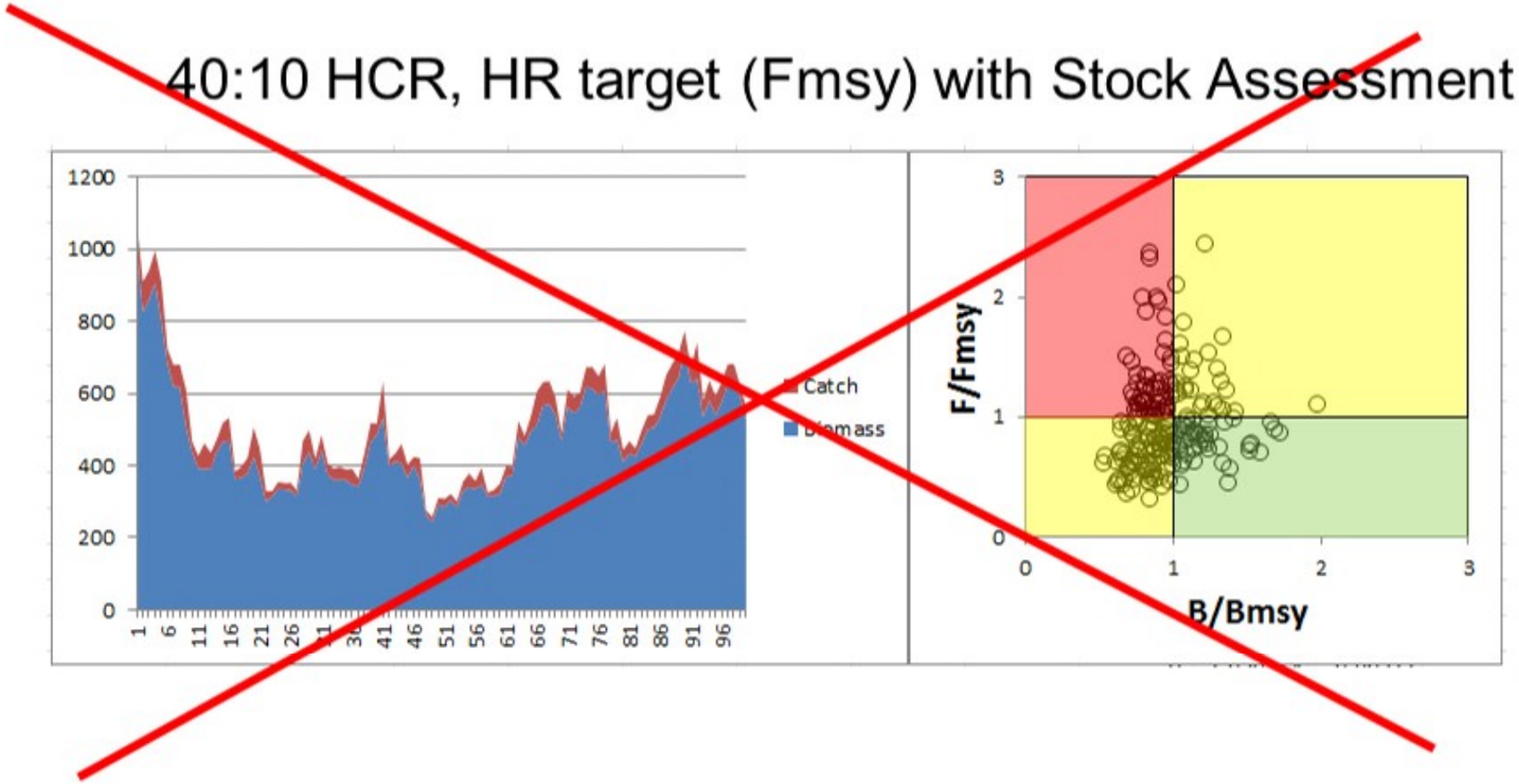
Constant HR (Fmsy) with Stock Assessment error



This strategy results in more than 5% of the time in the red sector of Kobe

See Schaefer_Kobe.xlsx

Kobe plot: simple simulation model

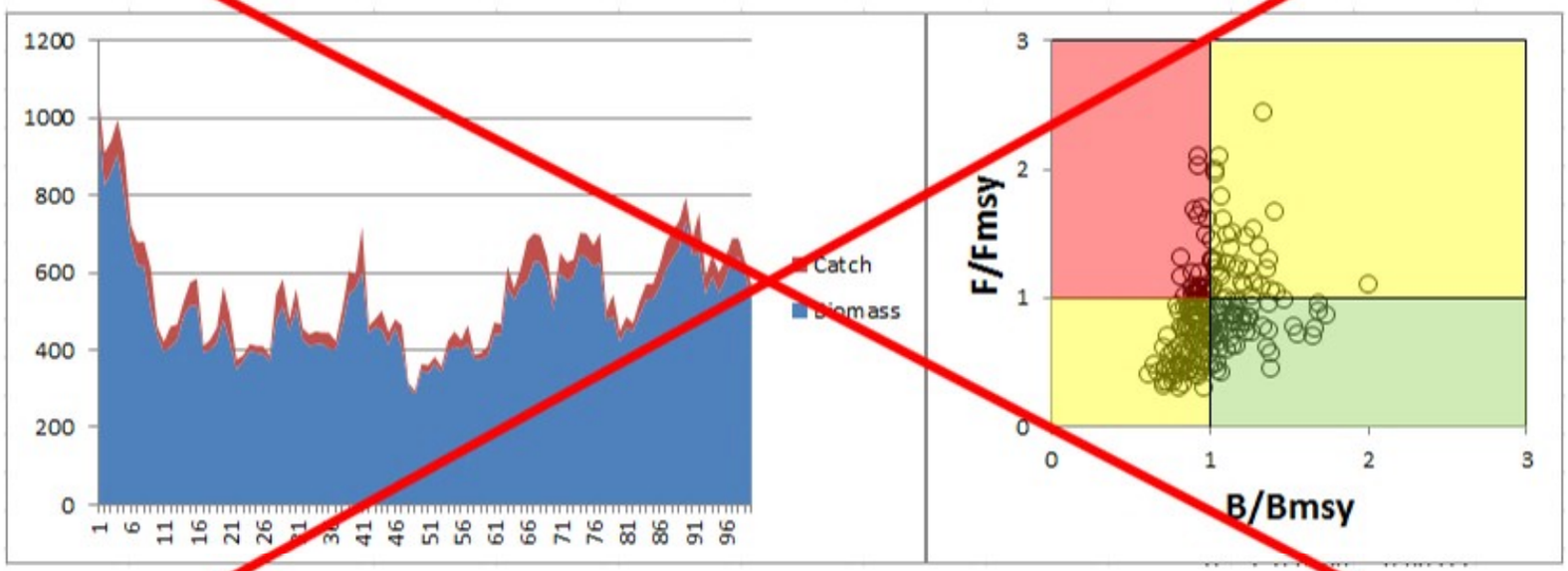


This strategy results in more than 5% of the time in the red sector of Kobe

See Schaefer_Kobe.xlsx

Kobe plot: simple simulation model

50:20 HCR, HR target (Fmsy) with Stock Assessment error

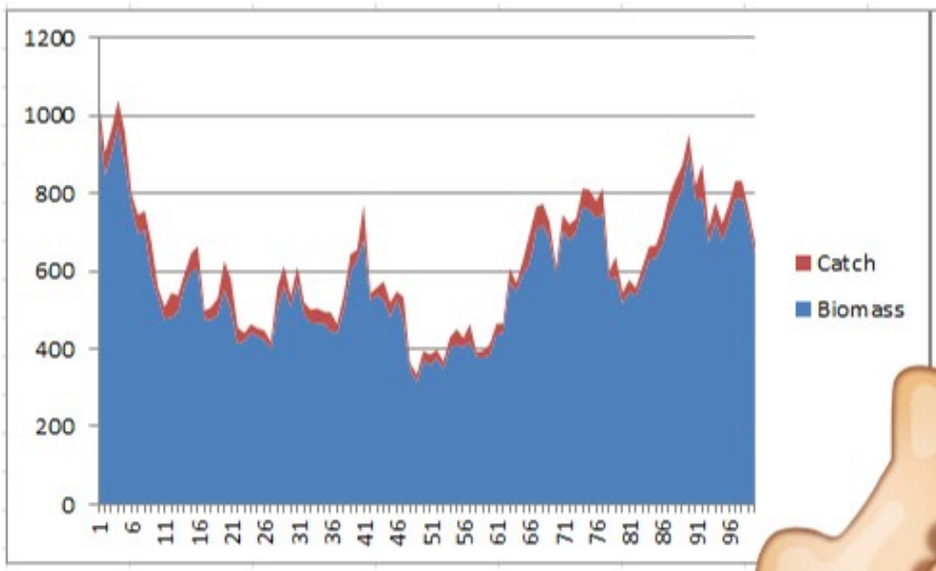


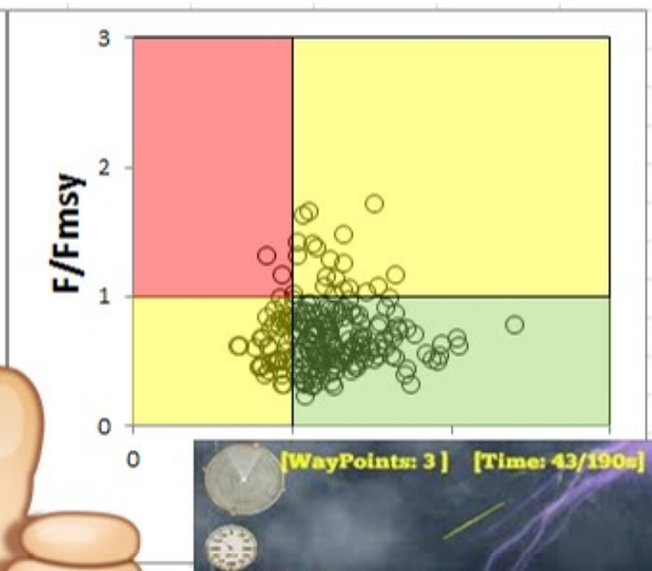
This strategy results in more than 5% of the time in the red sector of Kobe

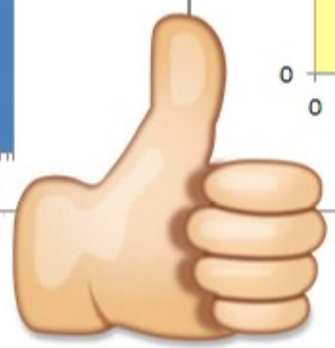
See Schaefer_Kobe.xlsx

Kobe plot: simple simulation model

40:10 HCR, HR target (0.7*Fmsy) with Stock Assessment error



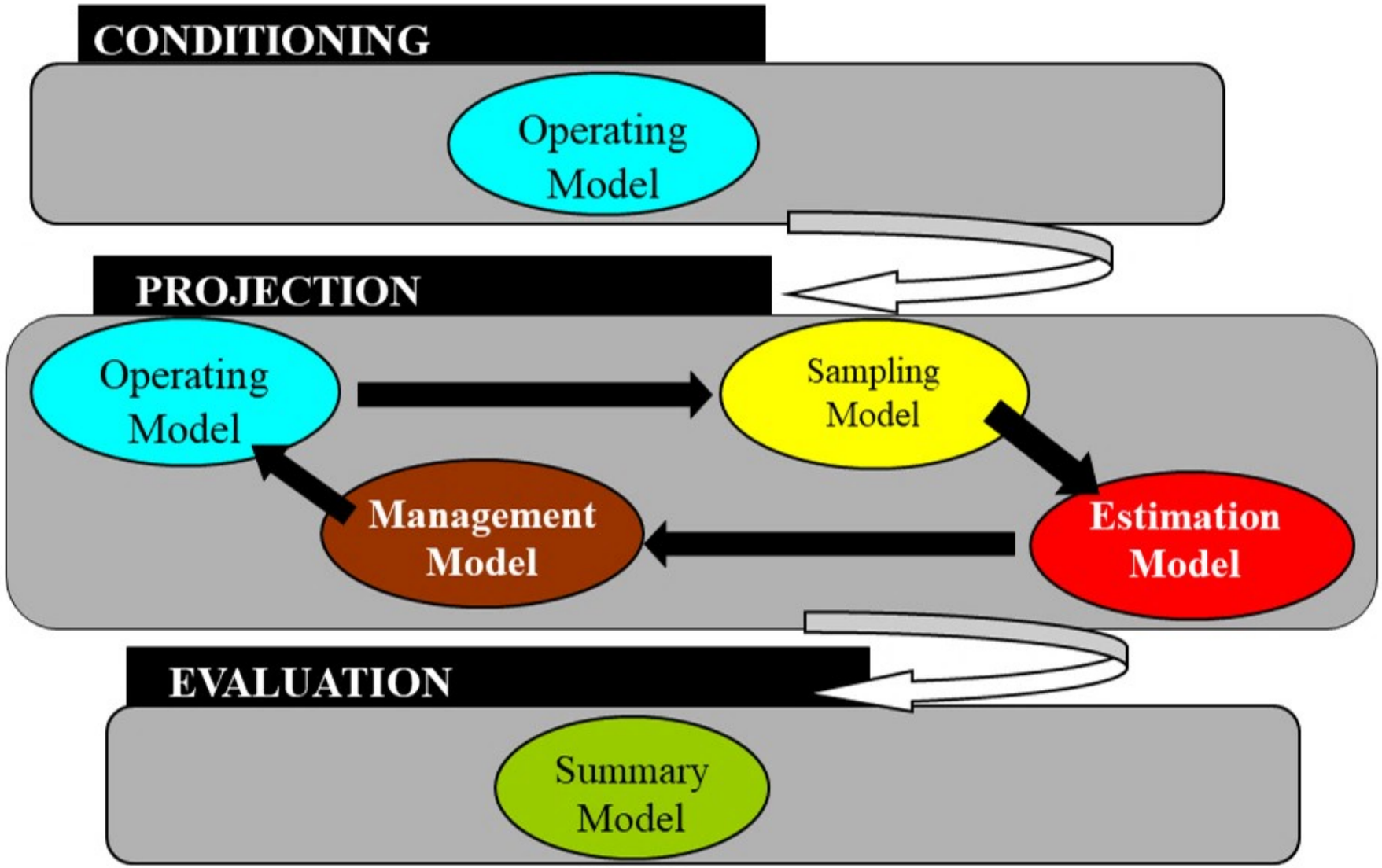




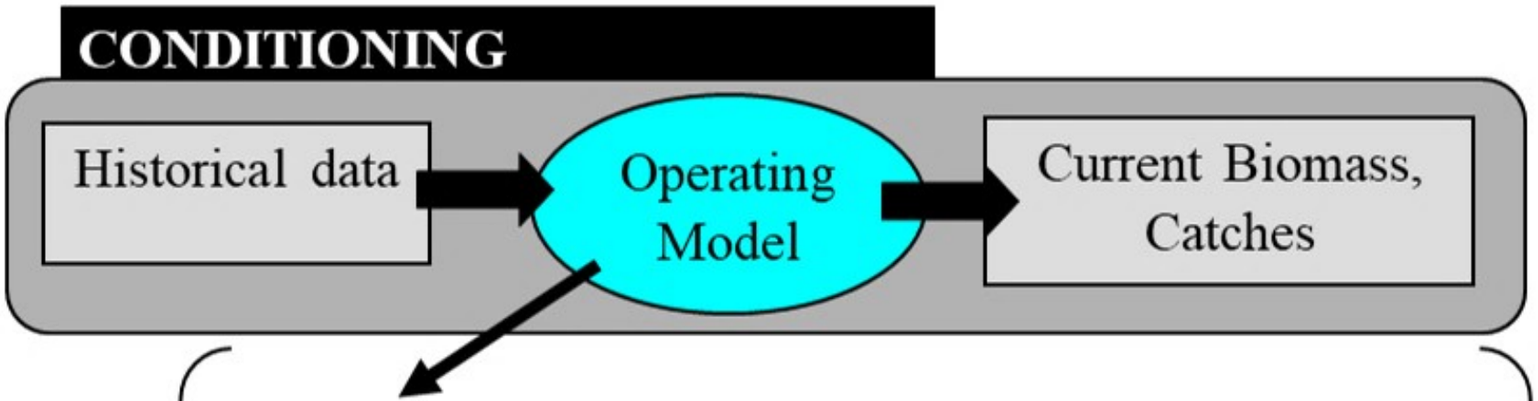
This strategy results in less than 5% of the time in the red sector of Kobe

See Schaefer_Kobe.xlsx

Management Strategy Evaluation: Components



Operating Model and Conditioning

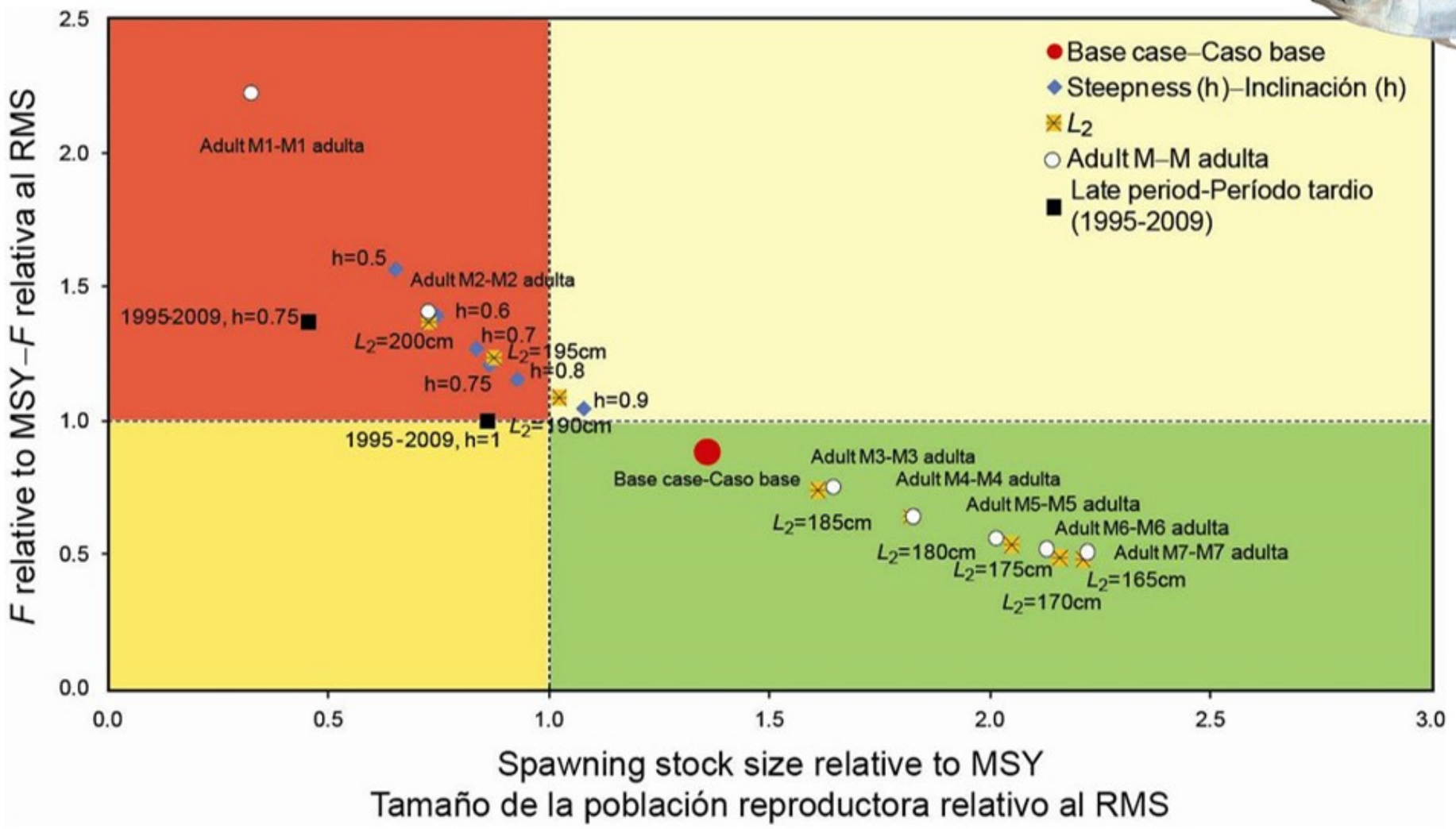


- Describes fishery and population dynamics
- Different hypotheses / model configurations to incorporate real world uncertainty; e.g.:
  - -Spawner / recruit relationship
  - -Selectivity / catchability changes
  - -Changes in fleet composition
  - -Spatial structure
  - -Alternative growth scenarios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

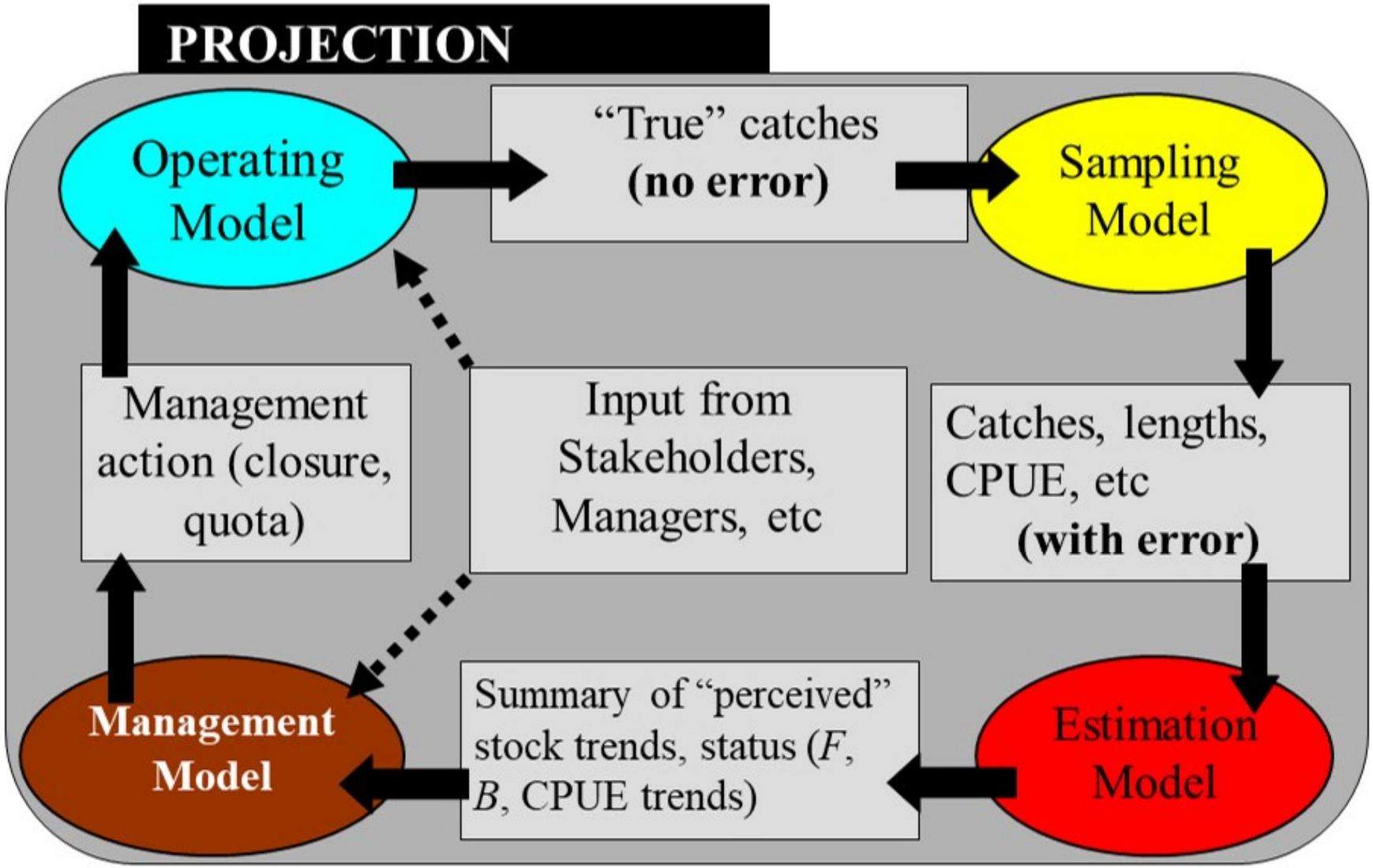
Operating Model

- **Key**: ensure that it incorporates appropriately the uncertainty about the stock, its dynamics and the sampling process.

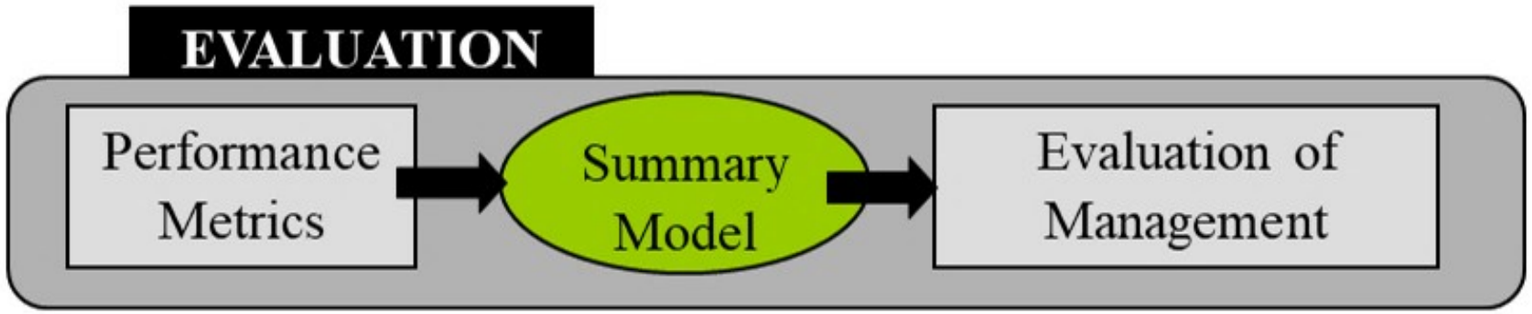
Kobe plot with sensitivities around BET uncertainties



Projection component



Evaluation component



Implementation uncertainty

- How the intended management action relates, or not, to the actions in the real world
- It can have a large impact (e.g. if quotas that are too small are ignored and exceeded).
- Different types of implementation uncertainty must be considered so that the management strategy evaluation is realistic.

Implementation with catch limits

- Some fisheries are managed with a simple TAC

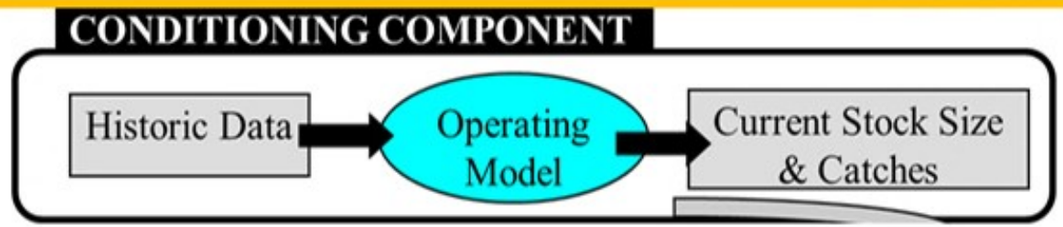
- Implementation problems:
  - Small TACs may be socio-economically unacceptable
  - Large TACs may be unacceptable given markets, capacity
  - Large changes in TACs are generally not desirable

Implementation with effort limits

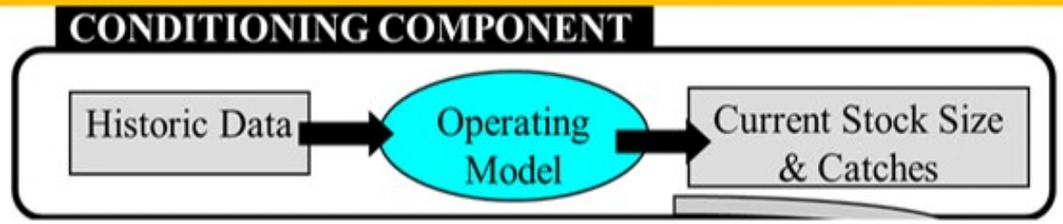
- Effort restrictions (closures, number of sets, FADs) are common management tools

- Implementation problems:
  - Relationship between fishing effort and fishing mortality is often noisy, difficult to understand
  - Fishermen change their behavior to maximize revenue
  - Enforcement of effort limits can be as difficult as catch limits!

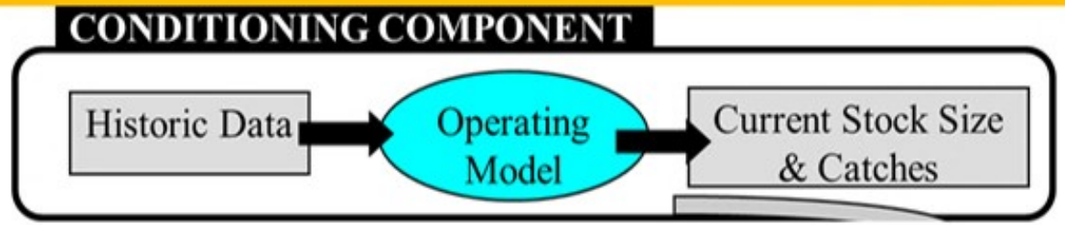
Management Strategy Evaluation example

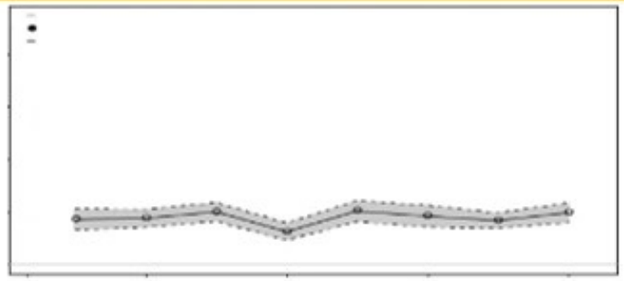


Management Strategy Evaluation example



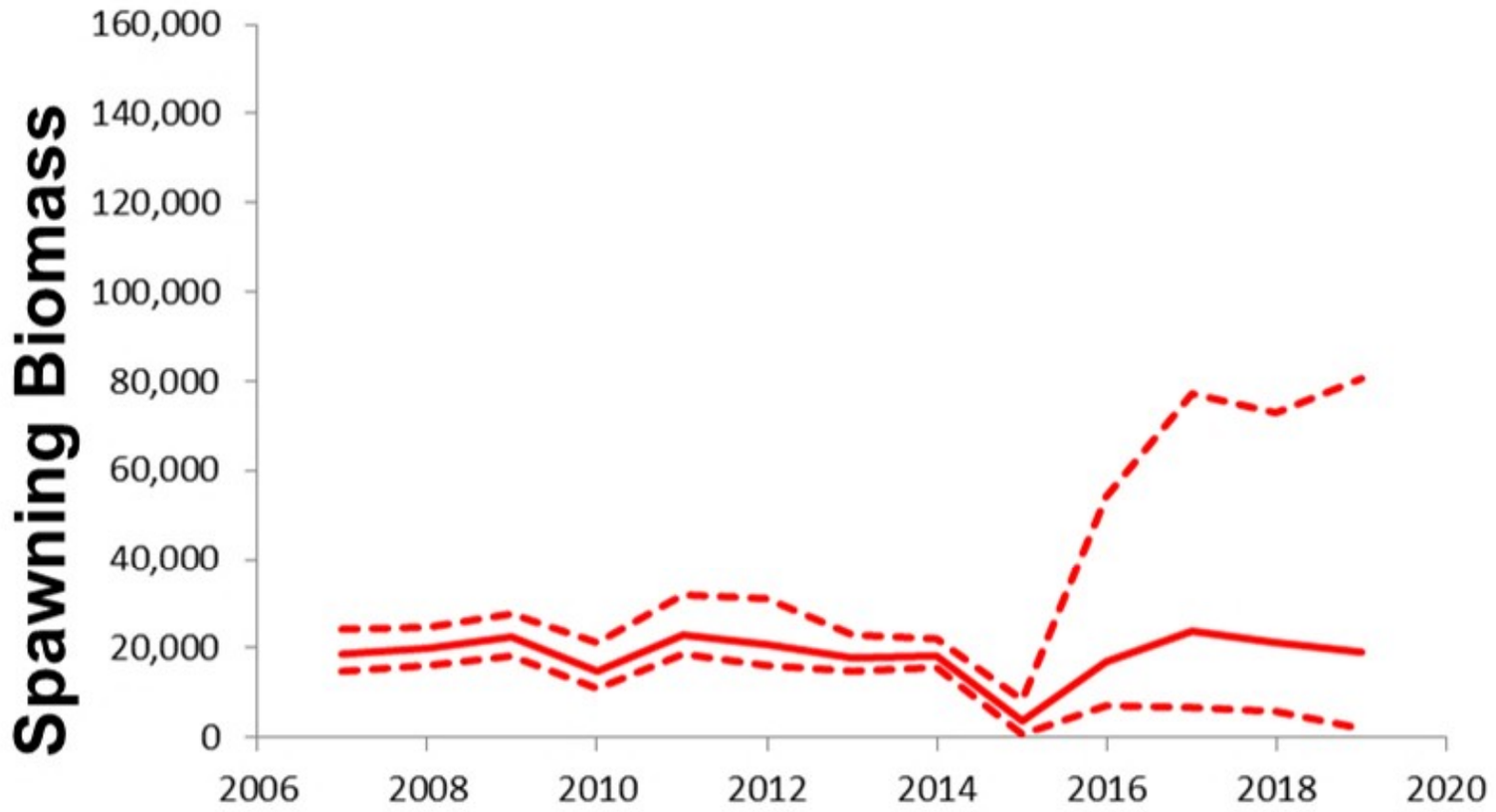
Management Strategy Evaluation example



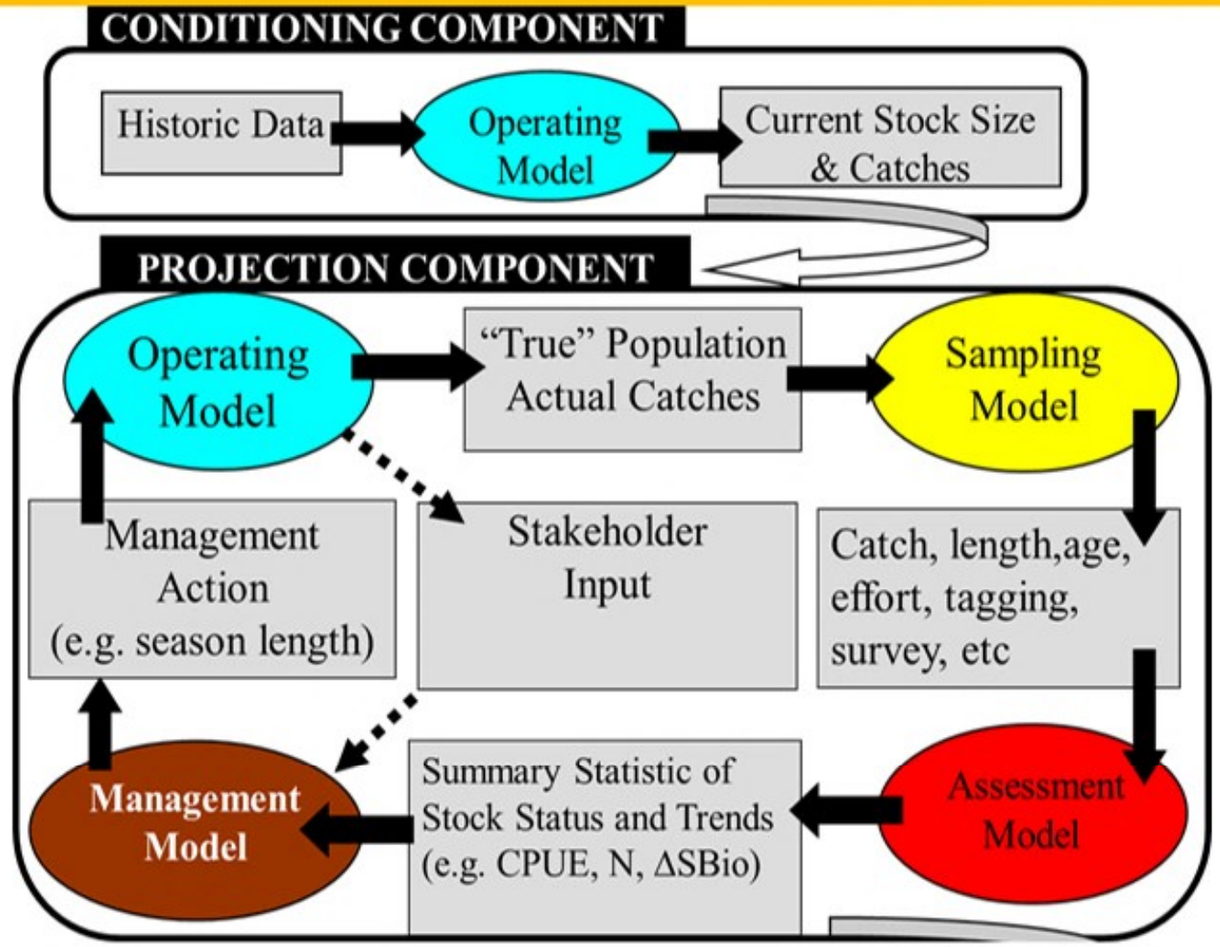


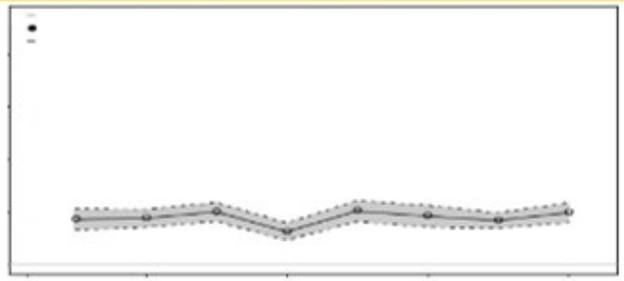
Management Strategy Evaluation example

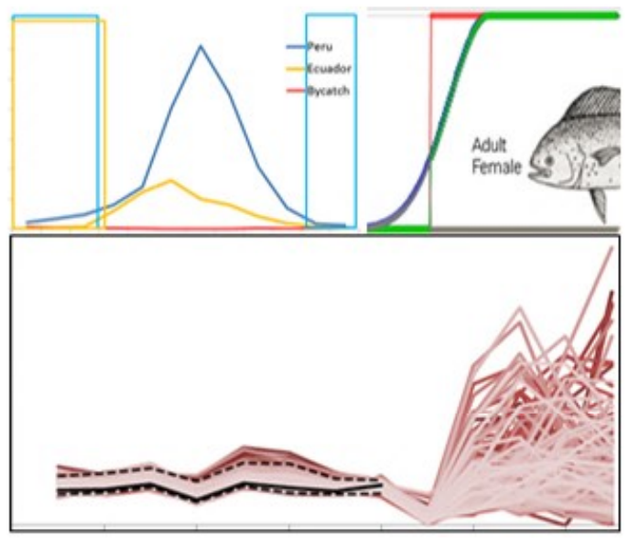
Projection component



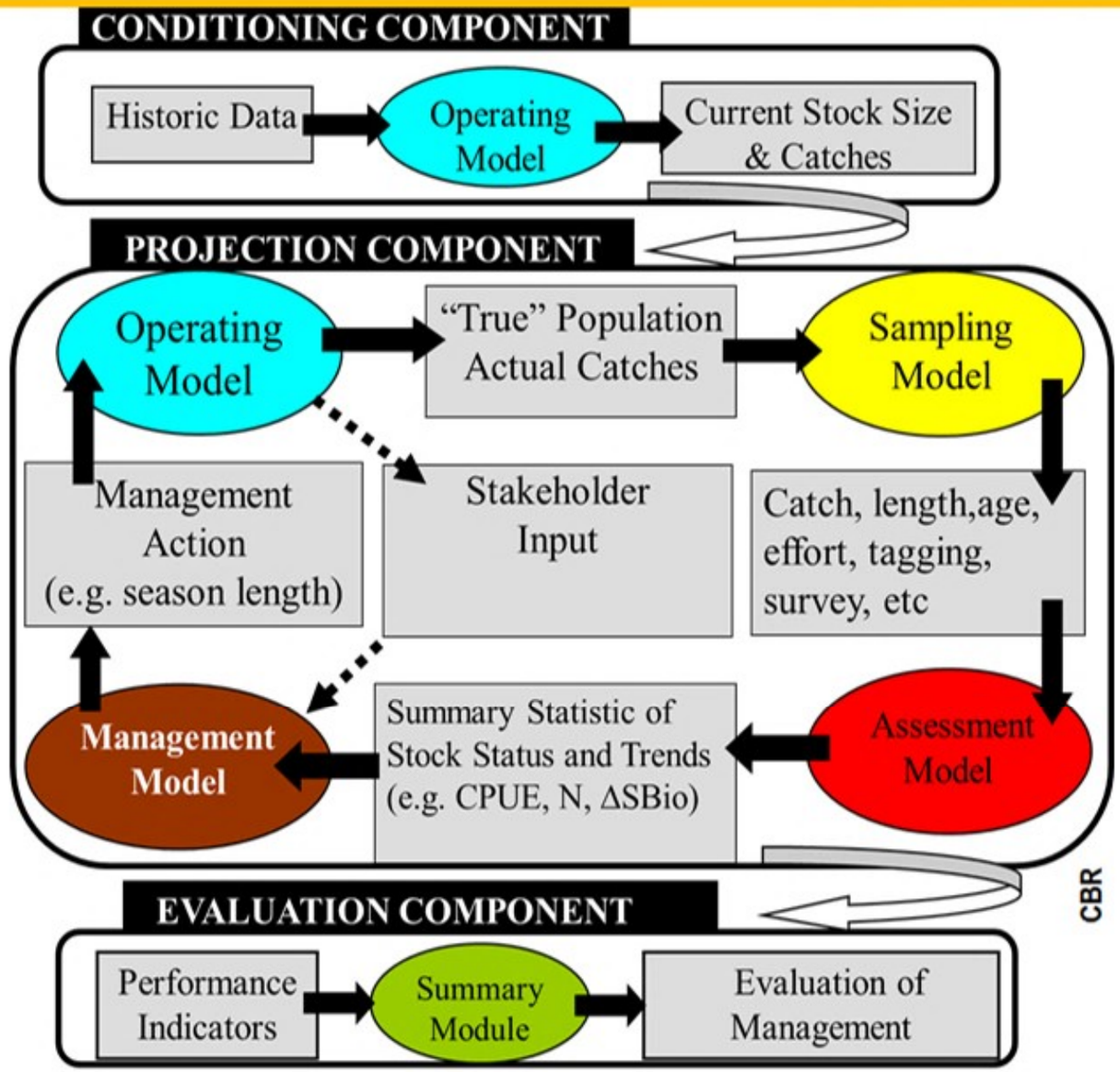
Management Strategy Evaluation example

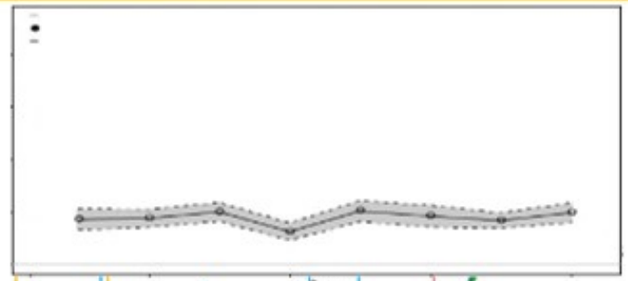


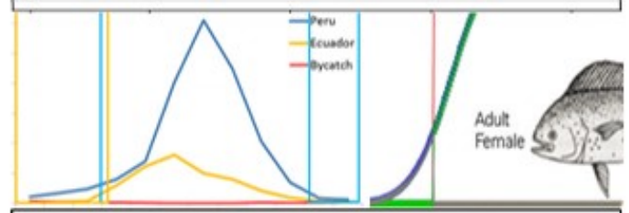


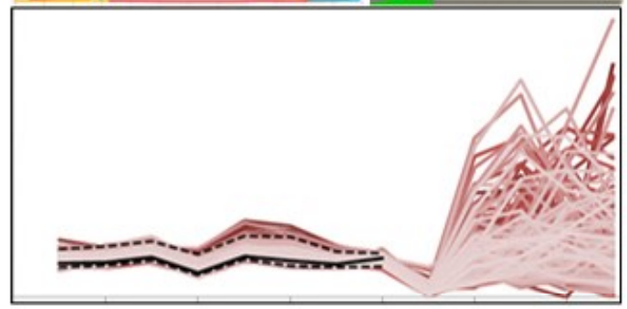


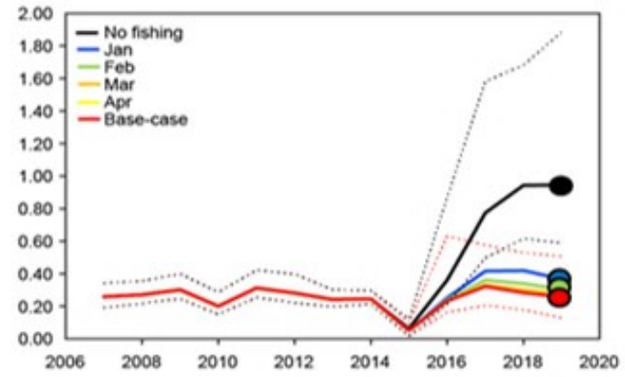
Management Strategy Evaluation example







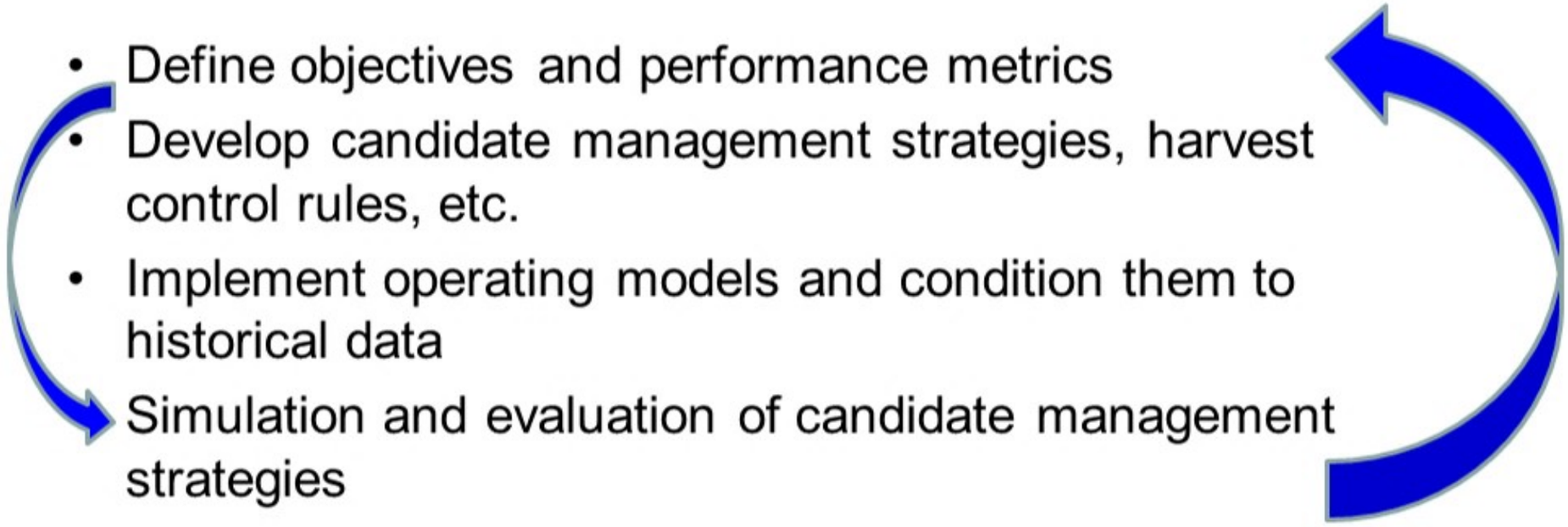




CIAT
IATTC

Management Strategy Evaluation Steps

- Define objectives and performance metrics
- Develop candidate management strategies, harvest control rules, etc.
- Implement operating models and condition them to historical data
- Simulation and evaluation of candidate management strategies
- Select a management strategy
- Consider implementing the management strategy



PROCESS NOT LINEAR!!!

ITERATIVE!!!

Effective Communication is essential

- **Several audiences:**
  - Scientists ↔ Commissioners (Objectives, preliminary results)
  - Scientists ↔ General public (Industry, NGOs, etc)
  - Commissioners ↔ NGO, Industry, other stakeholders (national level)
  - Scientists ↔ Scientists (technical support, communication support)

- **Communication mechanisms:**
  - Dialogues and ”spaces”/ Intermediate groups (formal or informal)
  - Presentation of results in a standard and clear way

IATTC Staff Activities and Research Plan

MSE - EEO

DOCUMENT SAC-10-01a

Green: completed; blue: funded; red: unfunded

SSP ref.	Target/Project	2018		2019		2020		2021		2022		2023	
		1	2	1	2	1	2	1	2	1	2	1	2
1. SUSTAINABLE FISHERIES													
Goal I: Test harvest strategies using Management Strategy Evaluation (MSE)													
I.1.	MSE for tropical tunas in the EPO: bigeye tuna												
I.1.a	1. Conduct an MSE for tropical tunas in the EPO												
	a. Improve the bigeye assessment for use as spatial OM												
	b. Run preliminary simulations with spatial OM												
	c. Technical meeting to agree on overall/revised MSE Plan by IATTC staff and collaborators												
	2. Continue technical development of MSE, HCR, MP, outputs (with Project R.1.b)												
	a. Run preliminary MSE based on initial input from managers and stakeholders												
	b. Run final MSE based on revised input from managers and stakeholders												
	c. Propose evaluated HCR/MP to Commission for adoption, plan work for other tropical tunas												

2. KNOWLEDGE TRANSFER AND CAPACITY BUILDING													
Goal R: Improve communication of scientific advice													
R.1.	Improve communication of the staff's scientific work to CPCs												
R.1.a	Workshop on training, communication and evaluation of management strategies for tuna fisheries in the EPO												
	a. Other MSE workshops for scientists-managers (to be planned)												
R.1.b	Technical development, communication and evaluation of MSEs for tropical tuna fisheries in the EPO involving managers, scientists and other stakeholders												
R.2	Participate in global initiatives for the communication of science: t-RFMO MSE working group												

CIAT
IATTC

Questions?