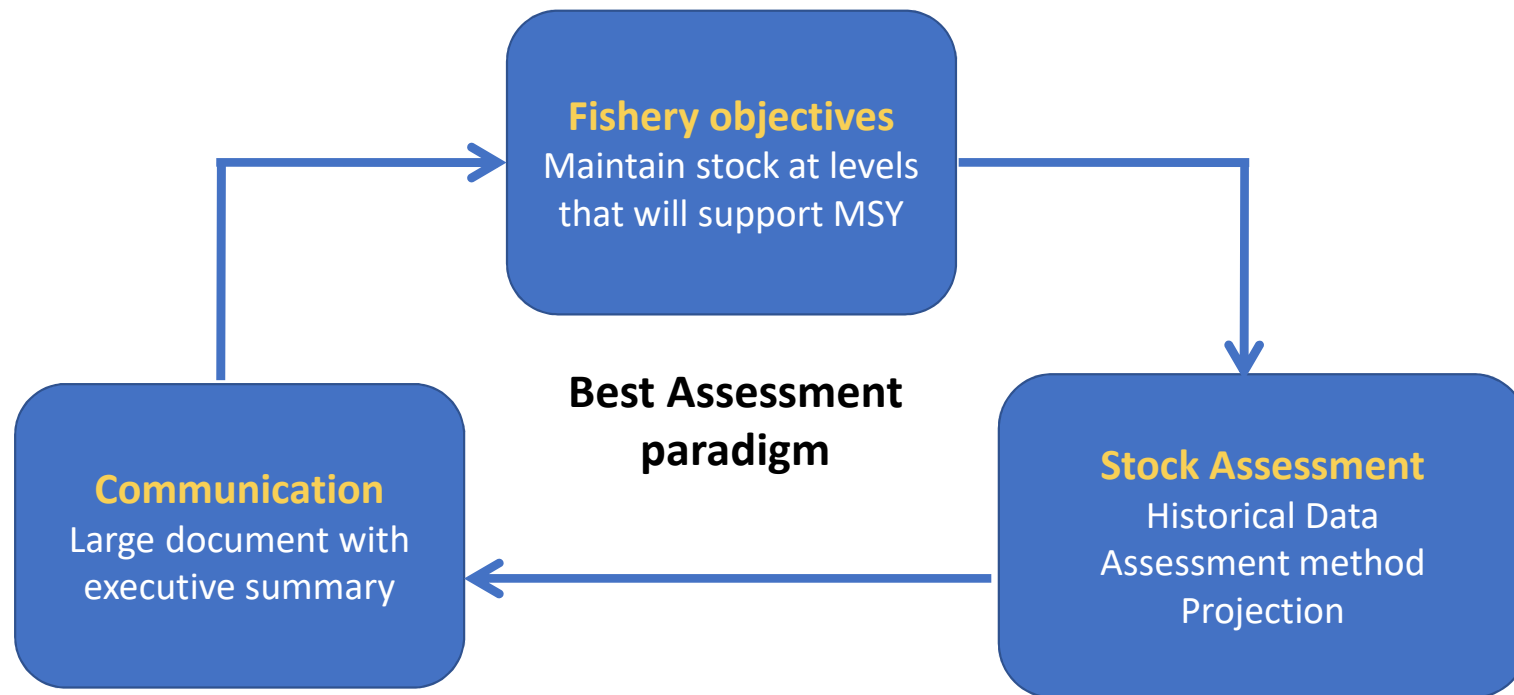# Management Strategy Evaluation (MSE) Introductory Workshop
ICCAT Commission 2019

Nathan Taylor and Ai Kimoto (ICCAT Secretariat)

Outline

1. Motivation

2. Components of MSE?
   a. Management Procedures
   b. Fisheries objectives
   c. Evaluation
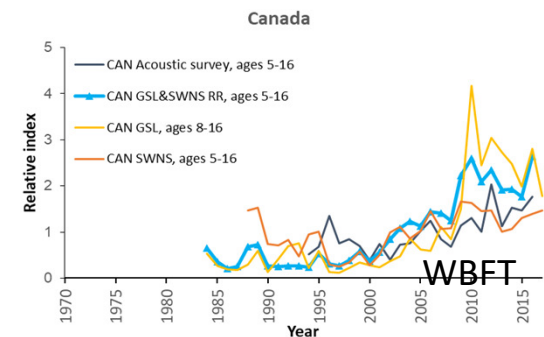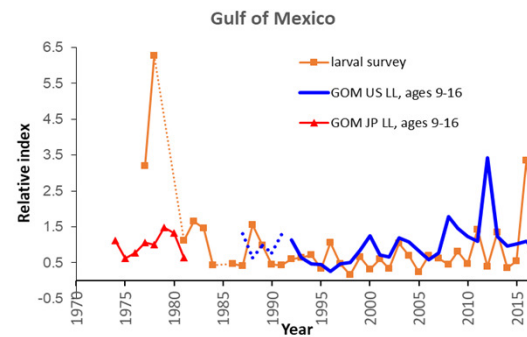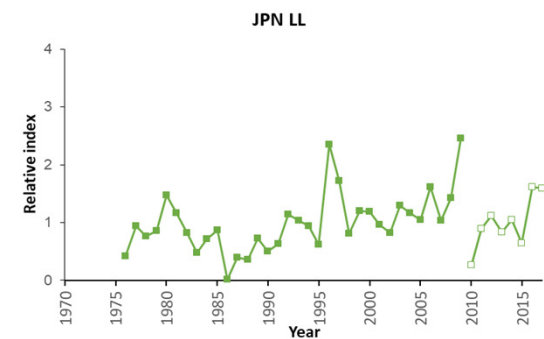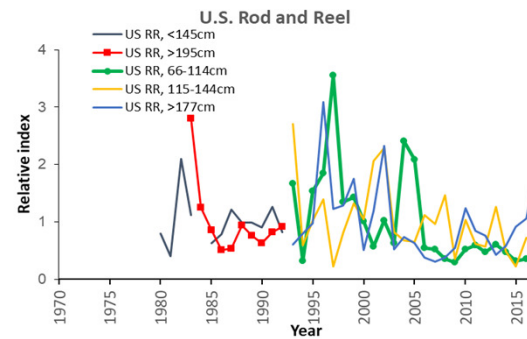   d. Exceptional circumstances

3. Summary and Conclusions
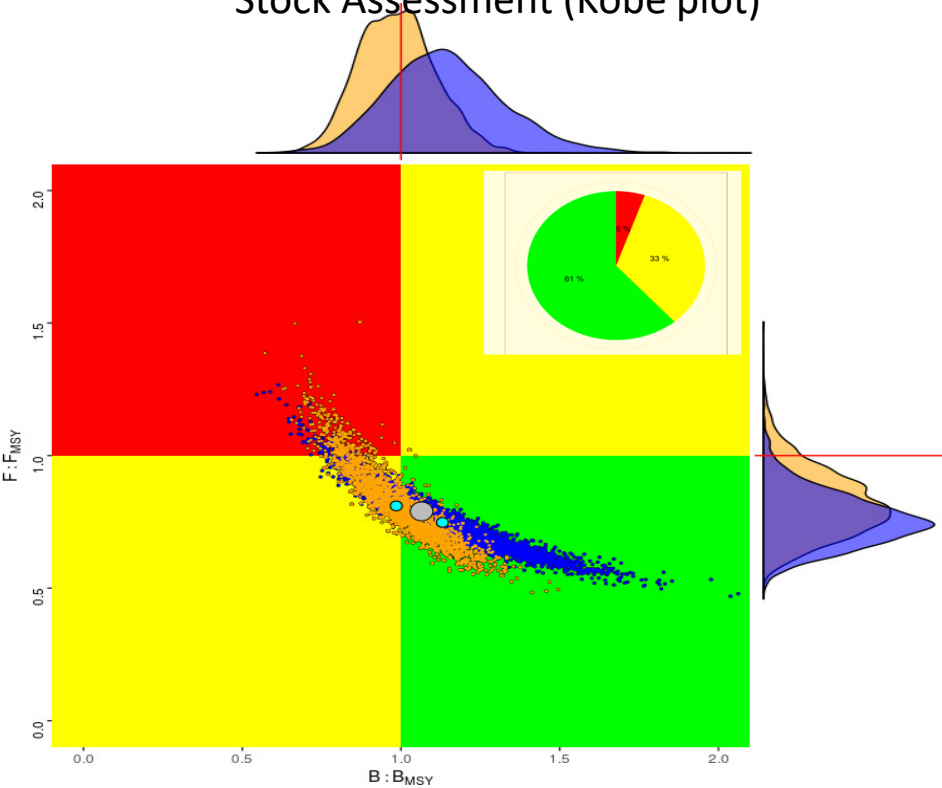
Current management

Stock assessment components

Stock Assessment: Data choices

- CPUEs
- Catches
- Length compositions
- Etc.

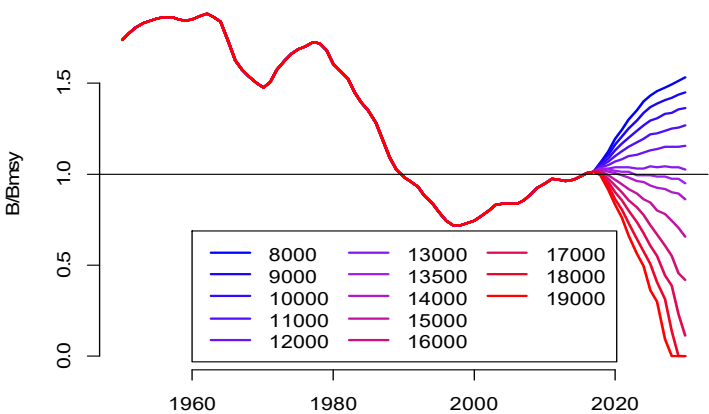# Stock assessment results current and predicted Stock State (B_{MSY} and F_{MSY})

Best assessment paradigm

Stock Assessment (Kobe plot)

SWO Atl.

Kobe 2 matrix

Catch	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
10000	35	51	65	75	81	85	88	90	92	93	95
10500	35	51	63	72	78	82	86	88	90	91	92
11000	35	49	59	67	74	79	82	85	87	88	90
11500	36	47	57	64	70	75	78	81	83	85	86
12000	36	46	54	60	66	70	74	77	79	81	83
12500	36	44	51	56	60	65	68	71	73	75	76
13000	36	42	47	52	56	59	62	65	66	68	70
13200	36	41	45	50	53	57	59	61	63	65	65
13400	35	40	45	49	51	54	56	58	59	61	62
13600	35	39	43	46	49	51	52	55	56	57	58
13700	35	39	42	45	47	50	52	53	54	56	57
13800	35	38	41	44	46	48	50	51	53	53	54
13900	34	37	40	43	45	46	48	49	50	52	52
14000	35	37	40	42	44	46	47	48	48	49	50
14500	33	34	35	36	36	37	38	38	38	38	39
15000	30	30	30	29	29	28	28	28	27	27	26
15500	26	25	23	22	20	19	18	17	16	16	15
16000	22	19	17	15	13	12	11	9	8	8	7

- Easy right? - what could possibly go wrong?

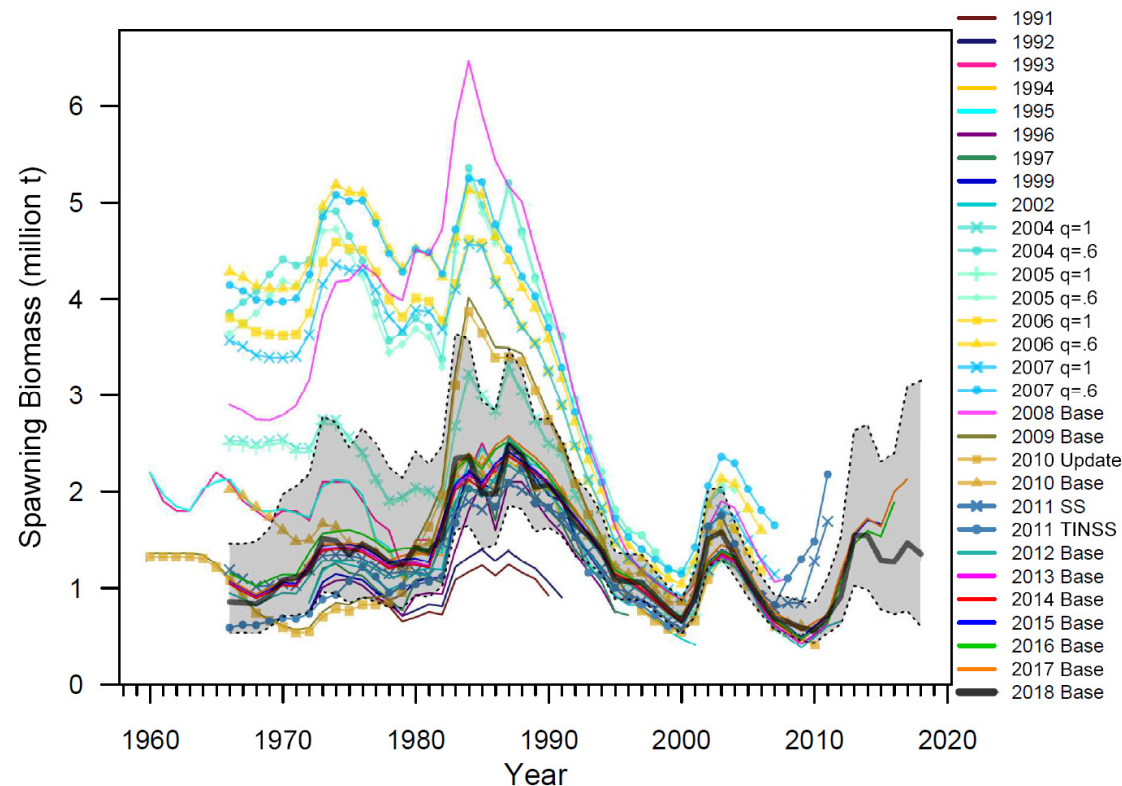# Challenges in stock assessment
Different data choices can mean different stock status

2017 West Atlantic Bluefin tuna Assessment
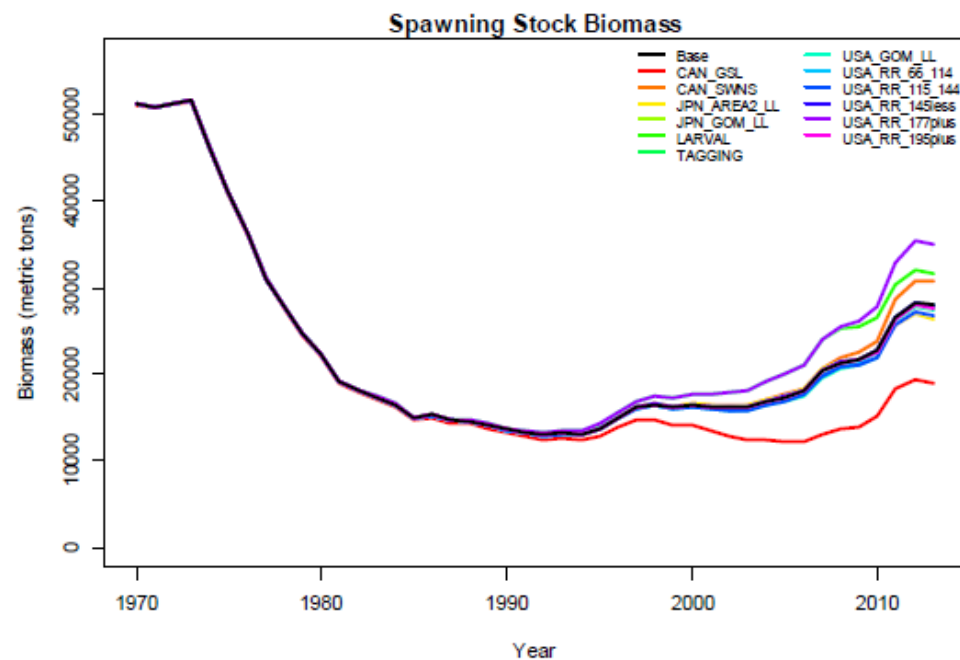
Challenges in stock assessment
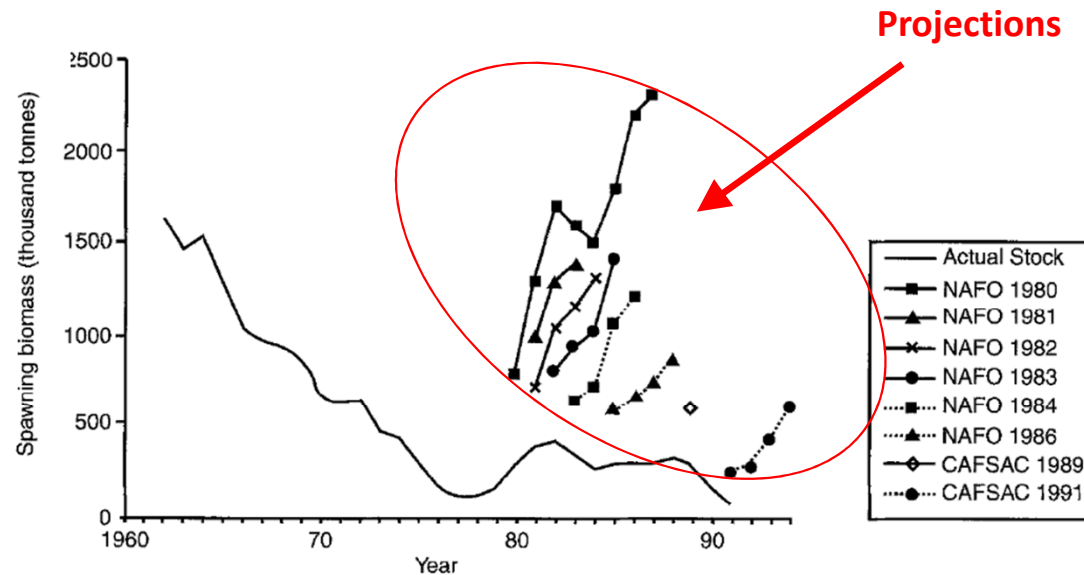Different assessment model choices mean different status

2018 Pacific Hake Assessment
Figure **60**, Page **148**

Challenges in stock assessment
Projections can be wrong

Projections

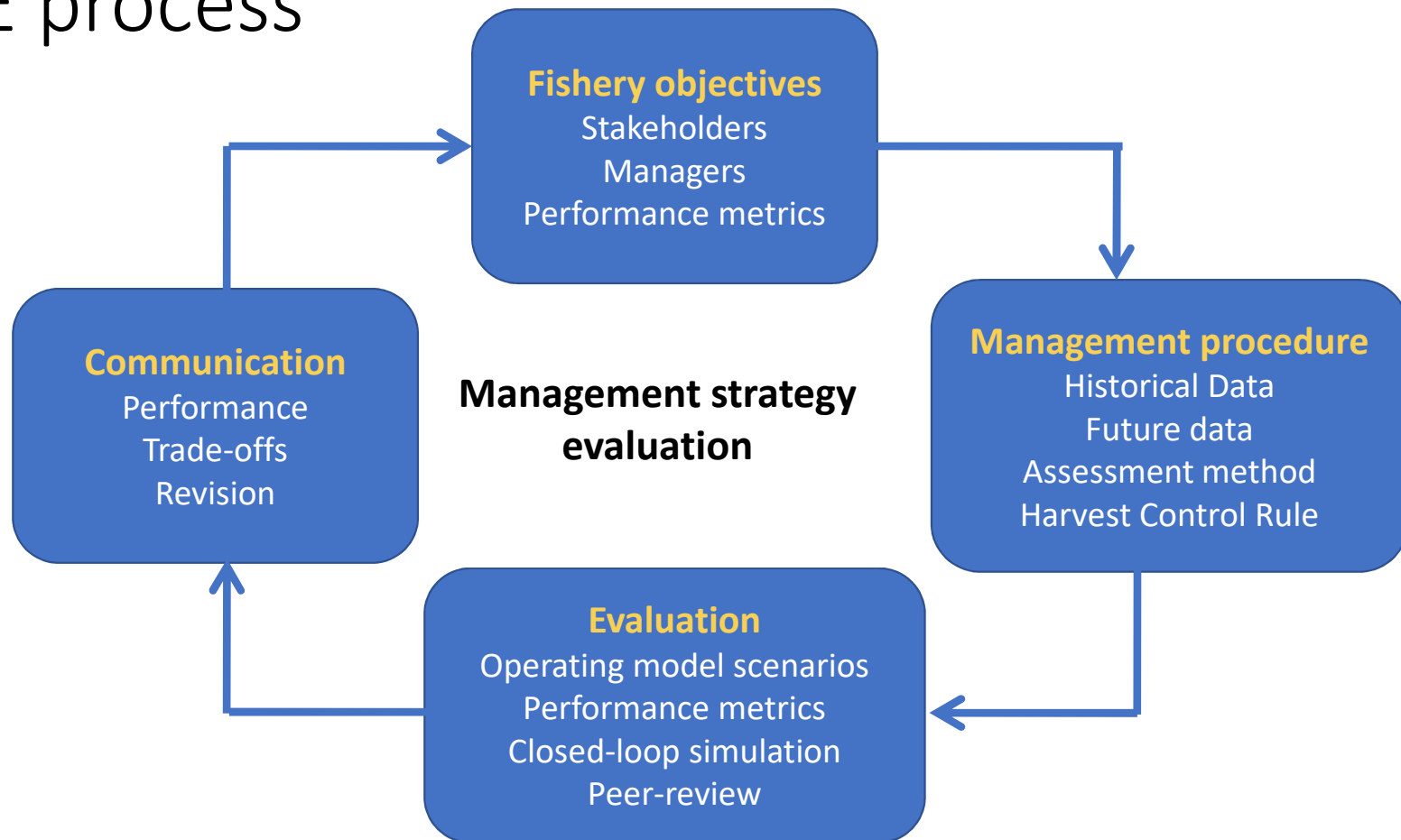Newfoundland Cod

Walters and MacGuire, 1996

Summary of Challenges

- Assessments can produce many different answers depending on choices made by the analysts
  - Model choices
  - Data choices
  - Other assumptions

- Disagreements over model choice, data choices, difficult to resolve

- Every time there is a new full assessment, there are new projections using potentially:
  - New catch data
  - New index data, possibly new indices
  - New biological data
  - A new model(s)?
  - Resulting in different historical biomass estimates, different stock status, different predictions

- Generates confusion and inconsistent/no feedback control. We cannot answer the question: is our management effective?
  - Because it is constantly changing

Why MSE?

- MSE is a remedy for some of the challenges described with ¨the best assessment paradigm¨

- Definition: MSE is *iterative process* whereby the performances of alternative harvest strategies are tested and compared using stochastic simulations of stock and fishery dynamics against a set of performance statistics developed to quantify the attainment of management objectives

- NB emphasis on iterative process: not just the simulations. It is a different way of conceiving stock assessment and management

- Because it illustrates the effects of alternative data choices, model choices, and harvest control rules on meeting fisheries objectives.

MSE process

Fishery objectives
Stakeholders
Managers
Performance metrics

Management procedure
Historical Data
Future data
Assessment method
Harvest Control Rule

Management strategy evaluation

Communication
Performance
Trade-offs
Revision

Evaluation
Operating model scenarios
Performance metrics
Closed-loop simulation
Peer-review

What is a Management Procedure?
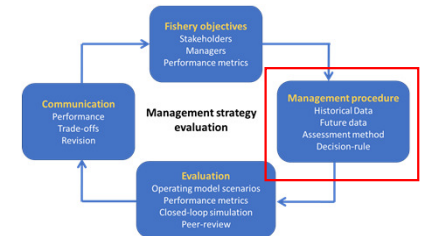
- The stock assessment is replaced by a management procedure with MSE

- Definition: Management Procedure is **formally specified,** *and* **the combination** of **monitoring data**, **analysis method**, **harvest control rule** and management measure has been **simulation tested** to demonstrate adequately robust performance in the face of plausible uncertainties about stock and fishery dynamics.

What is a Harvest Control Rule?

- Definition: A pre-agreed and well-defined rule or action(s) that describes how management should adjust management measures in response to the state of specified indicator(s) of stock status. This is described by a mathematical formula

- Empirical and model-based MP

Harvest Control Rule
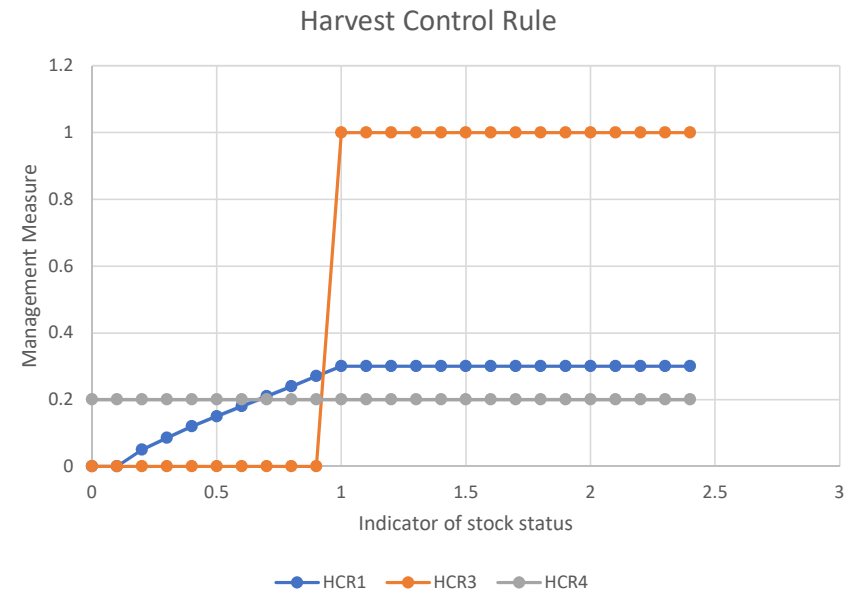
Management Procedures: Data selection and assessment model choices

- Whereas in the Best Assessment paradigm, data choices stock for assessment models and harvest control rule are flexible, in MSE these choices are formally specified and tested (evaluated)

- Why?

- While it is obvious that changes to the harvest control rule will result in changes to quotas, changes to the assessment model result in changes to the quota for the same stock so that data/assessment model choices=management choices

Fishery objectives
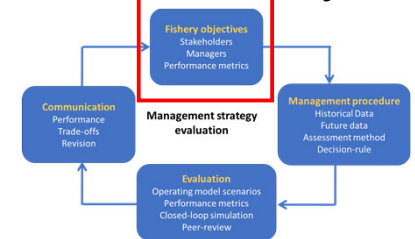
- You might recall that management procedures were tested to achieve <u>adequately robust performance</u>
- what does <u>adequately robust performance</u> mean?
  - It is the fisheries objective that determine adequately robust performance
- The social, economic, biological, ecosystem, and political (or other) goals for a given management unit (i.e. stock).
- Objectives typically conflict and include concepts such as maximizing catches over time (Yield), minimizing the chance of unintended stock depletion (safety), and enhancing industry stability through low inter-annual variability in catches (stability).
- For the purposes of MSE, objectives need to be quantified in the form of Performance metrics
- MSE can be used to consider other objectives. These can be very broad and may also include the feedback of managers in designing MP and OMs to suit

Three components of measurable fishery objectives

1. *Outcome*: What outcome do you want

2. *Time Horizon*: When you want the outcome

3. *Probability*: How certainly you want the outcome

eg) Probability (Biomass is greater than threshold values)>50% for the next 20 years

Conflicting fishery objectives

- Yield and safety objectives are typically in conflict (high mean yield is typically associated with lower safety)

- Yield and stability are typically in conflict too. High mean yield creates high variability in yield

- Because objectives are a question of value, they have to be defined by fisheries managers (where there may also be conflicts).
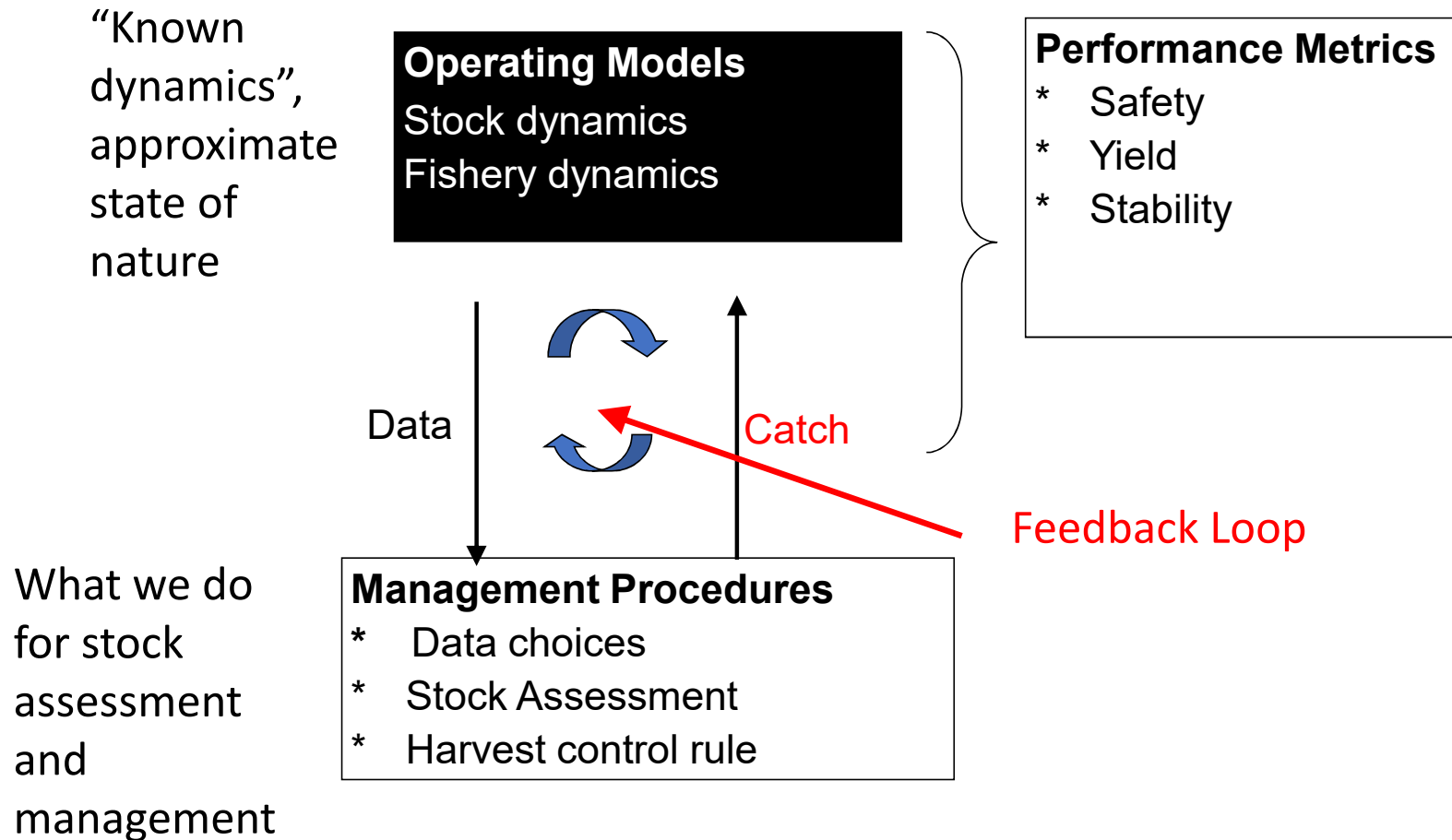
Operating models

- Previously I told you that MPs were simulation tested to demonstrate adequately robust performance in the face of plausible uncertainties about stock and fishery dynamics
- Where do the plausible uncertainties about stock and fishery dynamics come from?
  - These dynamics come from operating models
- A mathematical-statistical model (usually models) used to describe the fishery dynamics in simulation trials, including the specifications for generating simulated resource monitoring data when projecting forward in time.
- Multiple models will usually be considered to reflect the uncertainties about the dynamics of the resource and fishery?
- Why operating models?
  - If we acknowledge the shortcoming of the best assessment approach (estimation errors, projection errors, poor data etc.) then we need a standard against which to test management procedures
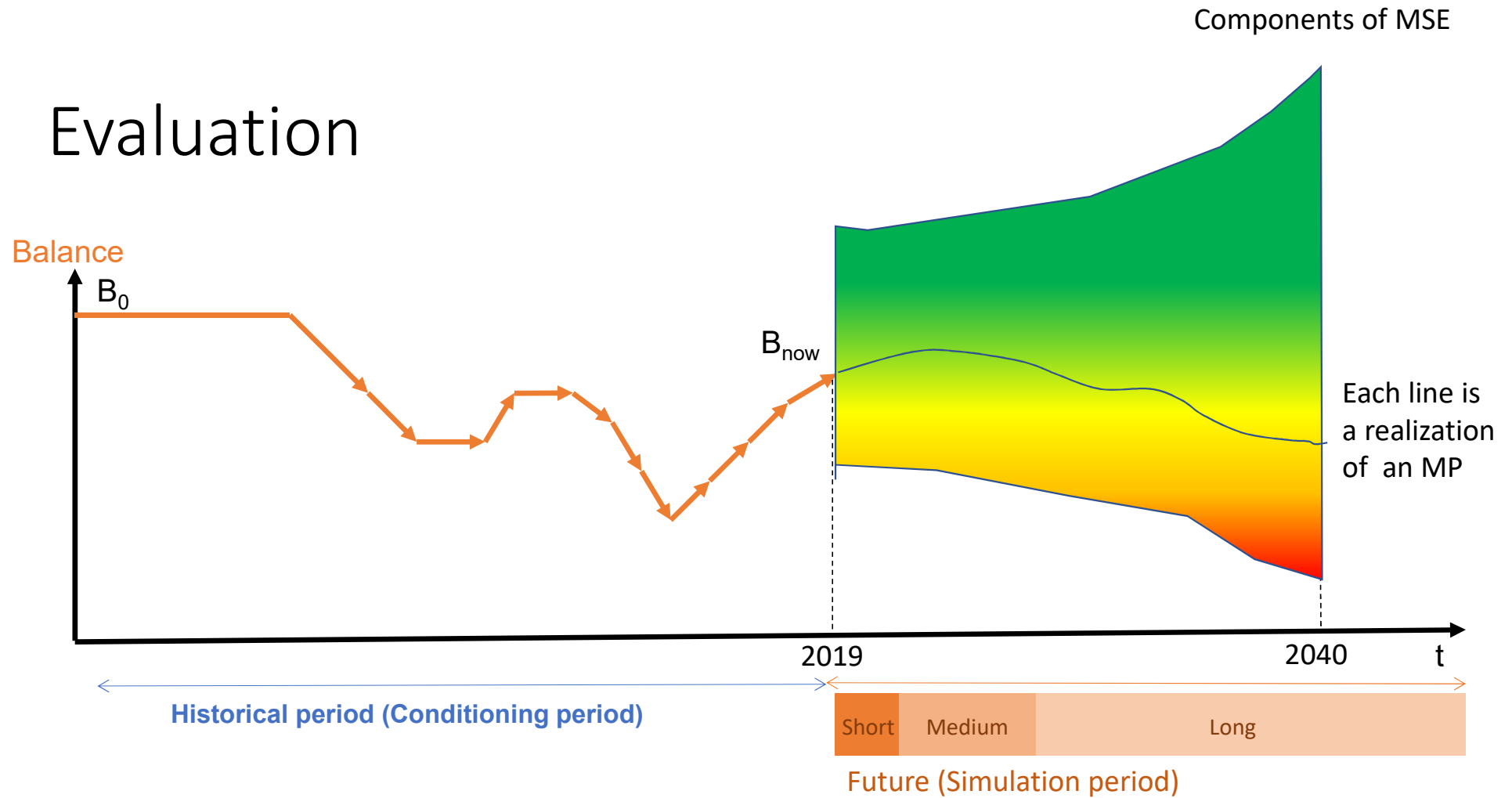
Evaluation

- Desirable to test (evaluate) management procedures before we try them on real fisheries
- The simulations illustrate the consequences of alternative strategies using computers where the consequences of poor strategies are cheap without taking the risk of trying them in practice (where errors are costly)
- Not *optimal solutions* but rather trade-offs
- Collaborative roles

Evaluation

"Known dynamics", approximate state of nature

Operating Models
Stock dynamics
Fishery dynamics

Performance Metrics
* Safety
* Yield
* Stability

Data

Catch

Feedback Loop

What we do for stock assessment and management

Management Procedures
* Data choices
* Stock Assessment
* Harvest control rule

Evaluation

Components of MSE

Balance

B_0

B_{now}

Each line is
a realization
of an MP

2019

2040

t

Historical period (Conditioning period)
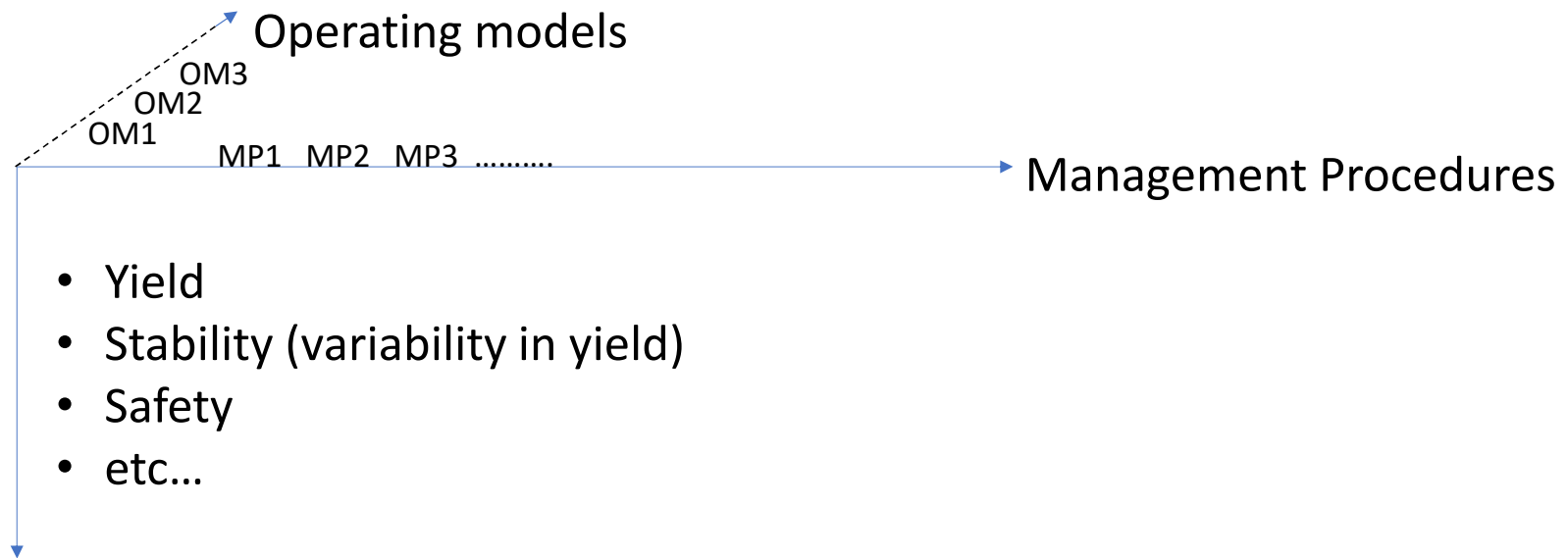
Short Medium Long

Future (Simulation period)

Evaluation methods and results

- Simulations are repeated many times for a given operating model (hypothesis about how the fishery works) and

- Simulations are repeated across several operating models

- Across all the simulations, performance metrics (discussed above) are computed and presented

MSE Output

Operating models

OM3
OM2
OM1

MP1   MP2   MP3   ……….   Management Procedures

- Yield
- Stability (variability in yield)
- Safety
- etc…

Performance metrics

Hierarchy of objectives helpful for choosing

Exceptional circumstances

- Definition: Specifications of circumstances where overriding of the output from a Management Procedure should be considered, together with broad principles to govern the action to take in such an event.

- Eg1: if data are outside the range considered in the simulation

- Eg2: What if the abundance index (eg. Australian aerial survey at CCSBT) used in the Management Procedure is no longer available?!
  → Need to reconsider MP!!

Summary and Conclusions

- We cannot forecast fish stock abundance accurately over the long-term

- We can evaluate the response under particular fishery scenarios as long as a consistent management procedure is followed

- With MSE, we can follow a structured process for testing the likelihood that our management procedures will meet objectives over the long term

- Every process will have its own unique approaches and difficulties

Thanks!