Objective of MSE simulations

- Test performance of alternative Management Procedures (MP):
  - Data used (and how collected)
  - Indicators of stock status (and how estimated)
  - Harvest Control rule

  } MP

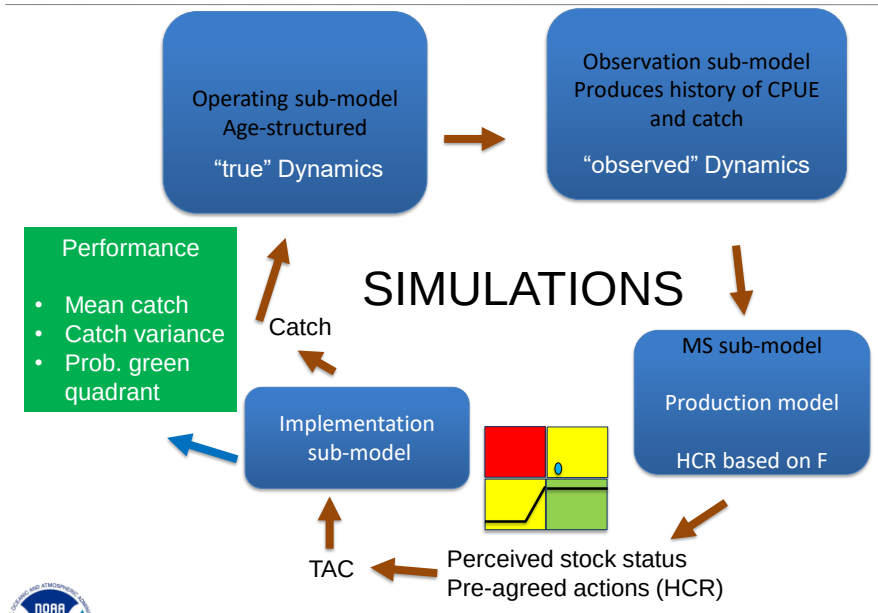
- Report performance of alternative MP to Commission

(Management Procedures are also referred as Harvest strategies)

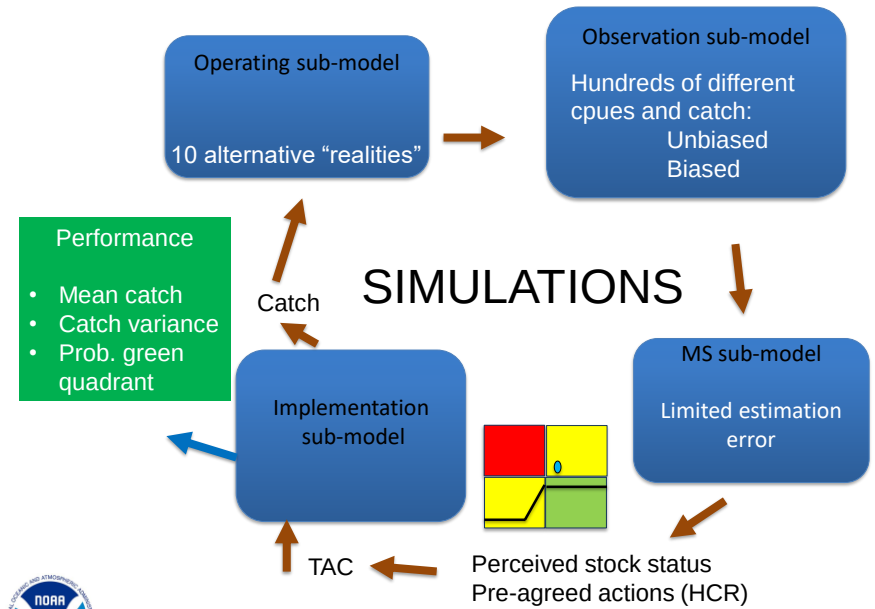
How do we test candidate MP?

Closed loop simulation: The feedback loop of *management strategy evaluation (MSE)*, which simulates the effects of candidate *management procedures* on a stock and fishery into the future. The steps of closed-loop simulation include an operating model, observation error model, management procedure, and *implementation error model*. The output of the implementation error model then feeds back into the operating model for the next management cycle.

MSE simulations



Incorporating UNCERTAINTY



Observation model
Candidate data sets

- Combined longline index
- Size indicators
- Close keen mark recapture
- Fishery independent survey
  - aerial survey
  - Larval index

Harvest control rule

A pre-agreed rule that sets fishing opportunities (catch limit, effort limit, etc.) based on the selected indicator(s) of stock status.

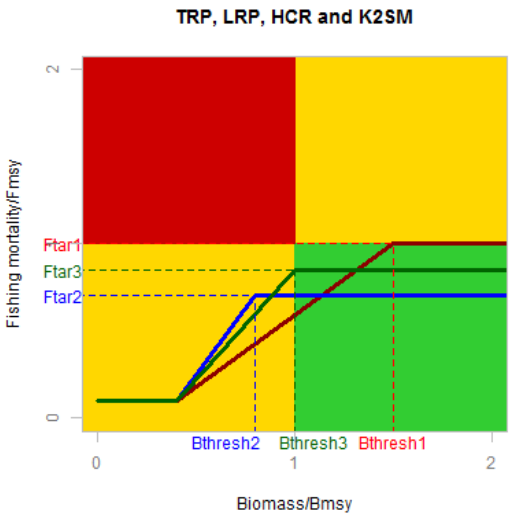
- Model based
  - depends on a population model
- Indicator based
  - based on a reference indicator (e.g. a cpue)

Candidate HCRs

Example:
Initial MSE

Three different HCRs

	$B_{treshold}$	F_{target}
HCR1	1.5	1.0
HCR2	1.0	0.85
HCR3	0.85	0.75



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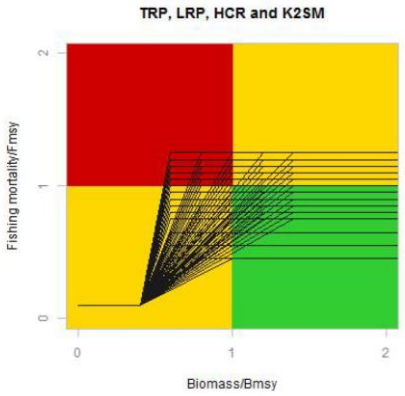
Full set of HCRs tested

B threshold \ F target	0.45	0.55	0.65	0.75	0.80	0.85	0.9	0.95	1.0	1.05	1.1	1.15	1.20	1.25
0.6	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
0.8	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
1.0	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1.2	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1.4	⊗	⊗	⊗	⊗	⊗	●	●	⊗	●	●	●	⊗	⊗	●



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Implementation error model

Implementation error model: The step in an MSE where implementation error, or deviations from the MP-prescribed catch level, are applied. These deviations include quota overages caused by illegal or unreported catch or other issues.

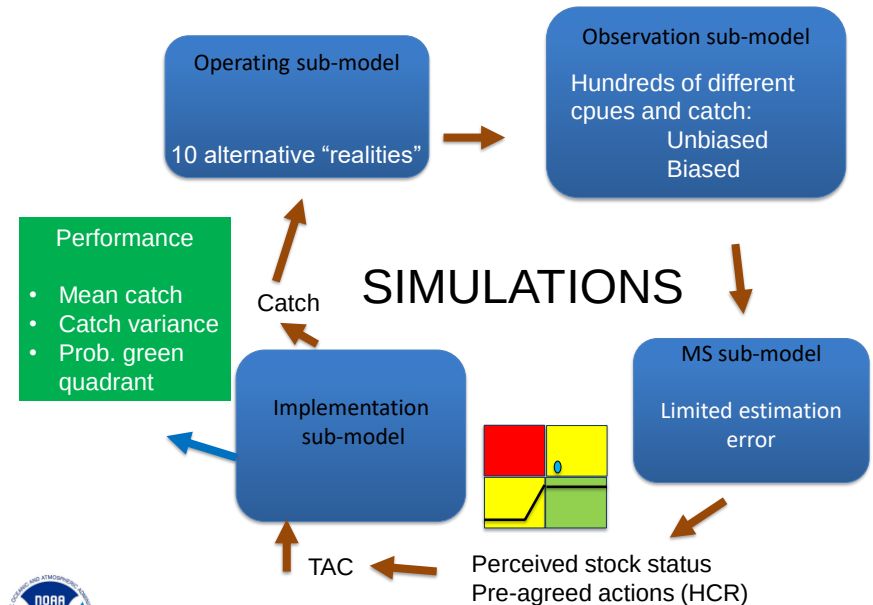
Implementation error model #1

Perfect implementation of TAC
Simulated catch = TAC

Implementation error model #2

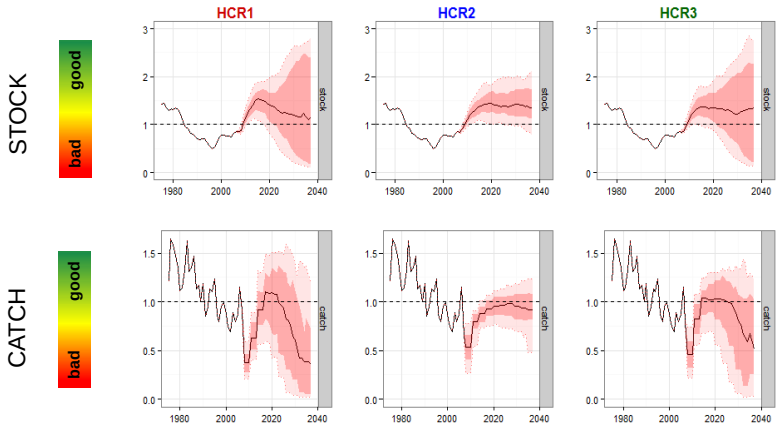
TAC is implemented with error
Simulated catch > or < TAC
Within a % level of variation

Close loop simulations

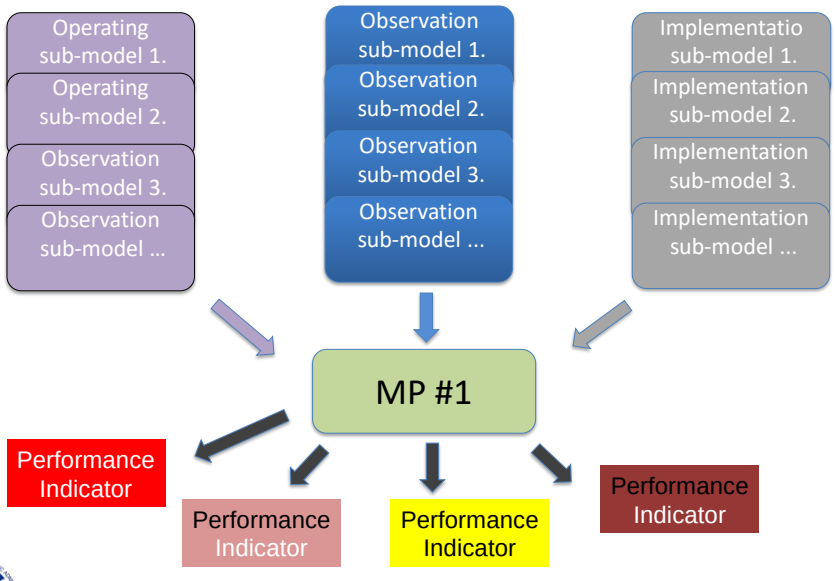


Uncertainty inherent part of MSE predictions

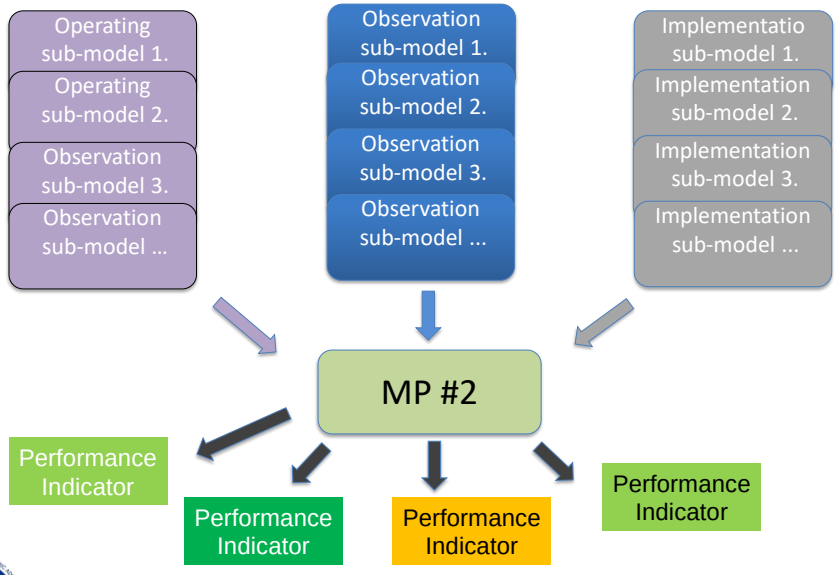
Performace indicators:
Predicted state of stock and catch



MS #1 – not so good



MS/MP #2 – not good enough



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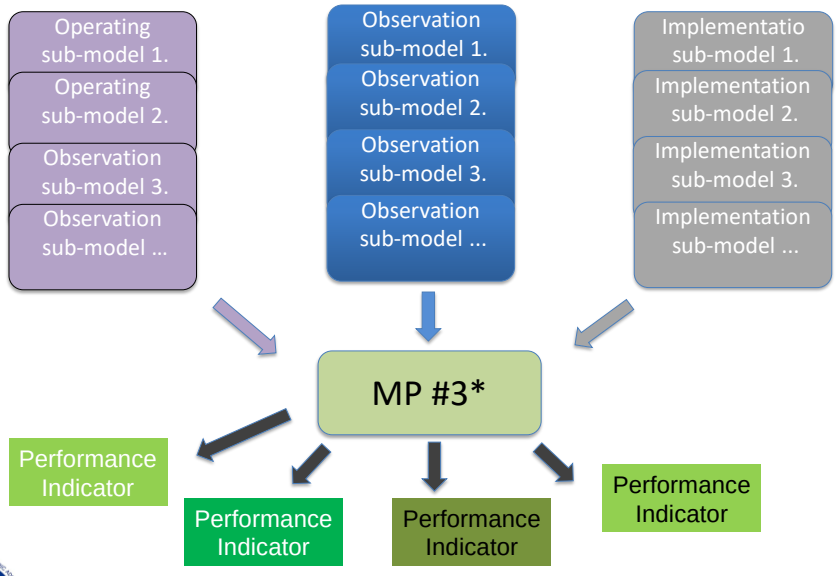
MS good- robust to uncertainty



* It is the Commision that decides what is best!!!

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MSE Performance indicators

Must align with operational management objectives

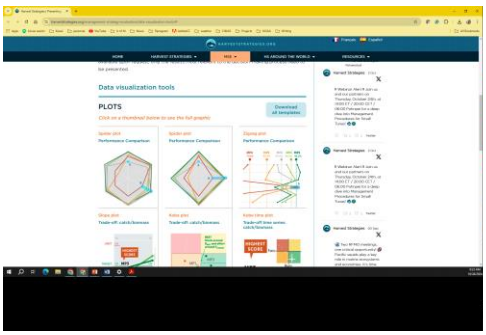
1. **Status of stock/fishery**
2. **Safety**
3. **Yield**
4. **Stability**

Indicator	Units	Definition
Long term catch	1000 tonnes	Average annual catch in 2030
Short term catch	1000 tonnes	Average catch for years 1-3 of simulation
Medium term catch	1000 tonnes	Average catch for years 5-10 of simulation
pGreen	Probability	Probability of the stock being in the green quadrant during the simulation (for a specific time period)
Safety	Probability	Probability of the stock being above Blim during the simulation (for a specific time period)
Stability of catch	% Change TAC	1- variability of TAC between management cycles
Stability of F	% change F	1- interannual variability of F all over the simulation.

How do we present results

Attempts to standardize communications tools:

https://harveststrategies.org/management-strategy-evaluation/data-visualization-tools/



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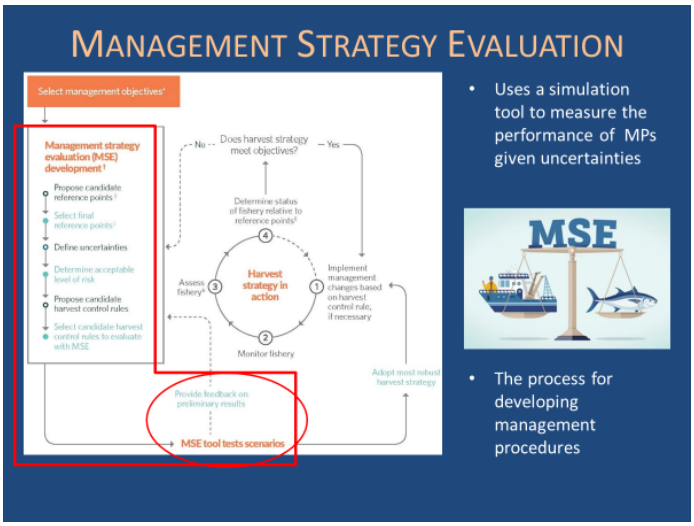
How does the process work



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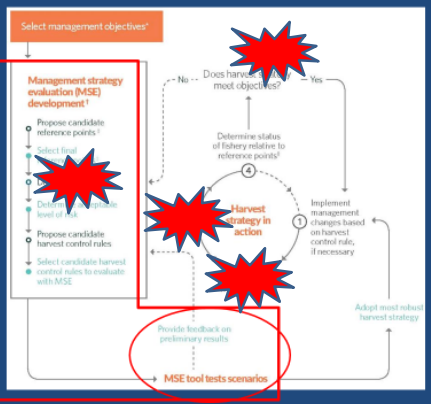
Exceptional Circumstances

EXCEPTIONAL CIRCUMSTANCES

- Triggered when must abandon the MP because
  - Stock trajectories get outside of the ranges tested by the MSE;
  - Extreme environmental regime shift occurs; or
  - Absence of data makes it impossible to estimate stock status and/or apply the agreed harvest strategy
- Managers must pre-agree what happens if exceptional circumstances are triggered, both for management and future of management procedure

Exceptional Circumstances

MANAGEMENT STRATEGY EVALUATION



- Uses a simulation tool to measure the performance of MPs given uncertainties

- The process for developing management procedures

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