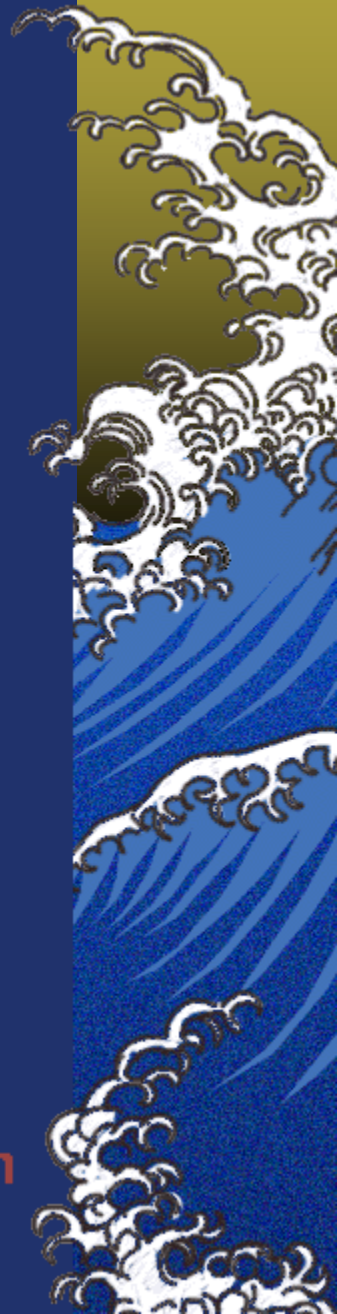# Part 3: MSE
Introduction to Management Strategy Evaluation

Thanks to colleagues at CSIRO and the CCSBT
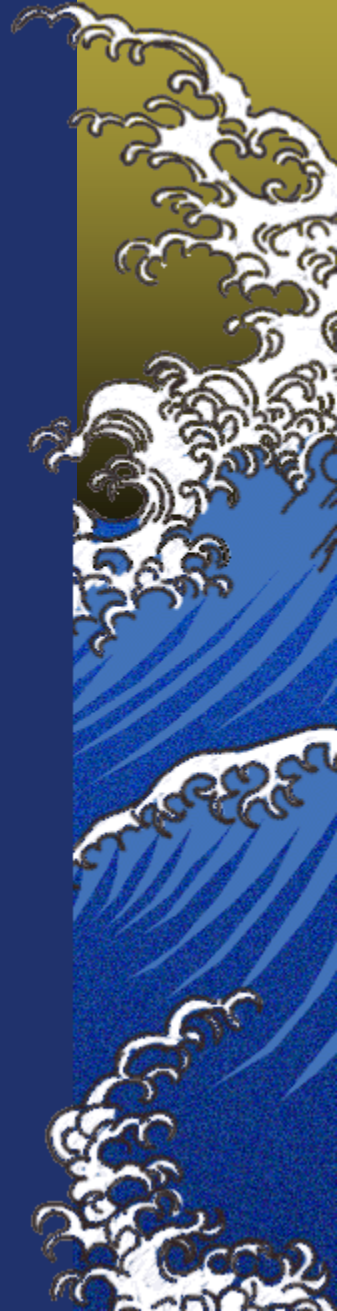
iotc ctoi Indian Ocean Tuna Commission
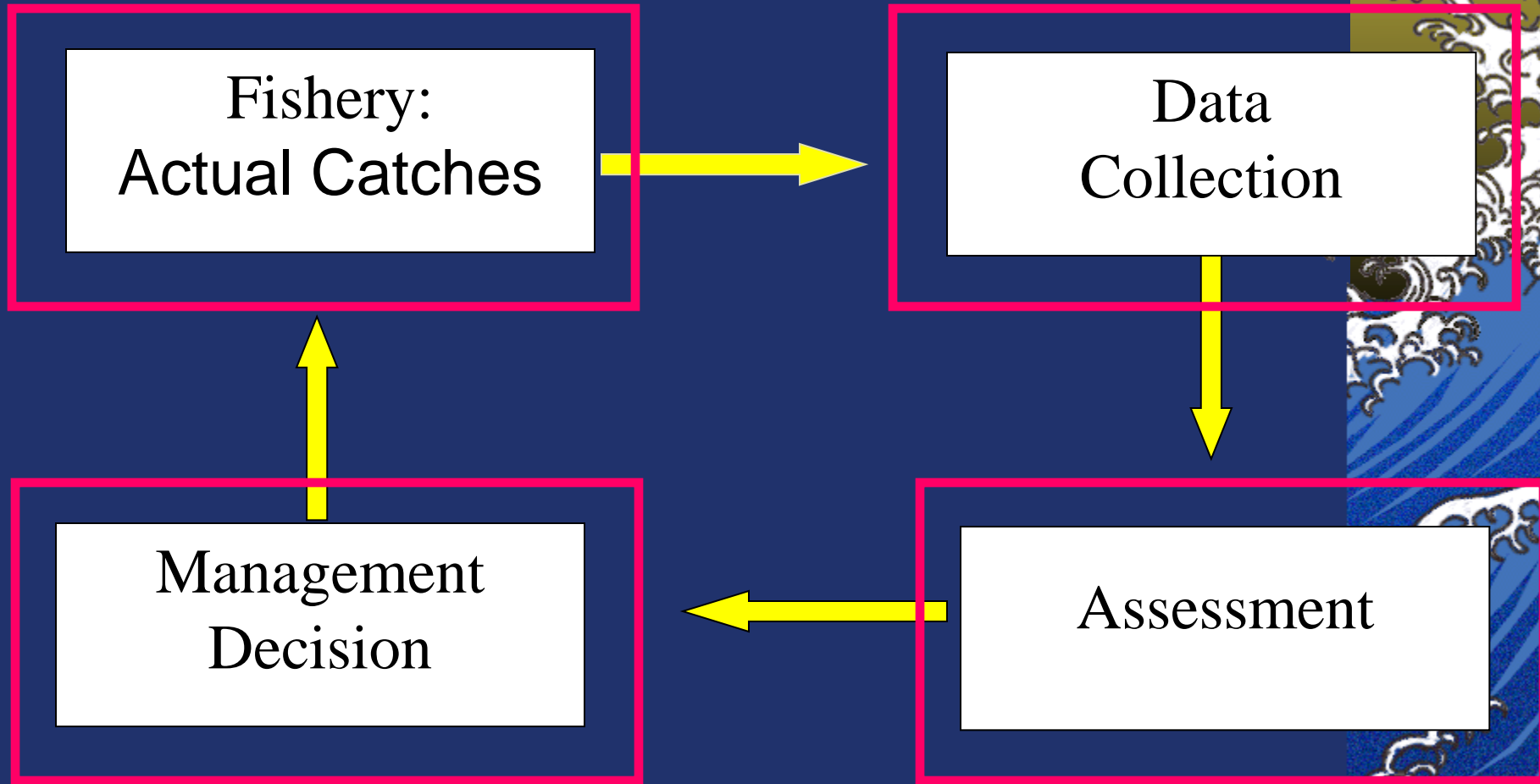Commission des Thons de l'Océan Indien

MSE

- ~ *'Harvest Strategy'*
- ~*'Management Procedure'*
- *International Whaling Commission*
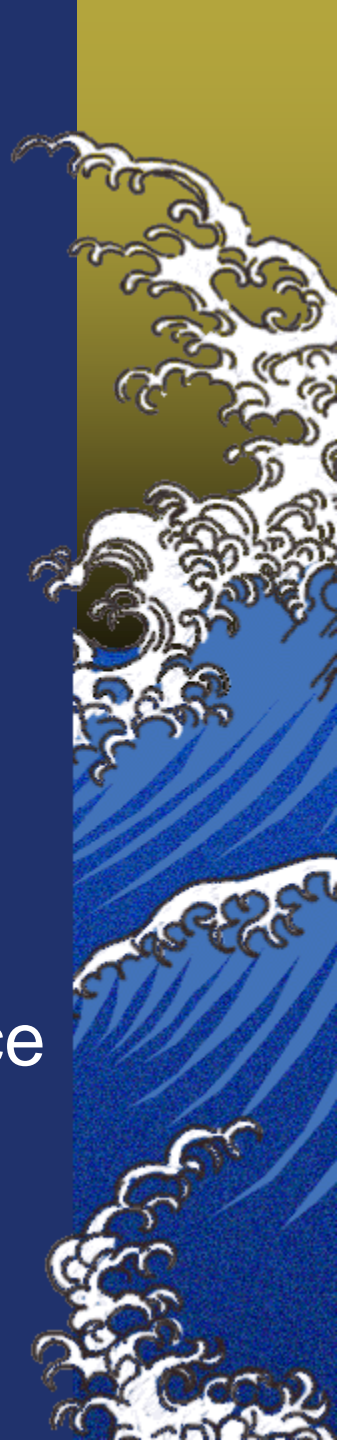- *CCSBT (Southern Bluefin Tuna)*

Traditional Management Cycle

Problems in the Traditional Management Cycle

- Assessment uncertainty
- Management outcome not quantified
- Management objectives unclear
- Short time horizon
- Undermines industry confidence in decision process
- Potentially undermines consumer confidence in product

Assessment Uncertainty (Koeller 2003)

➤ *"The amount of uncertainty in an assessment is directly proportional to the amount of scientific rigor applied."*

BET 2009
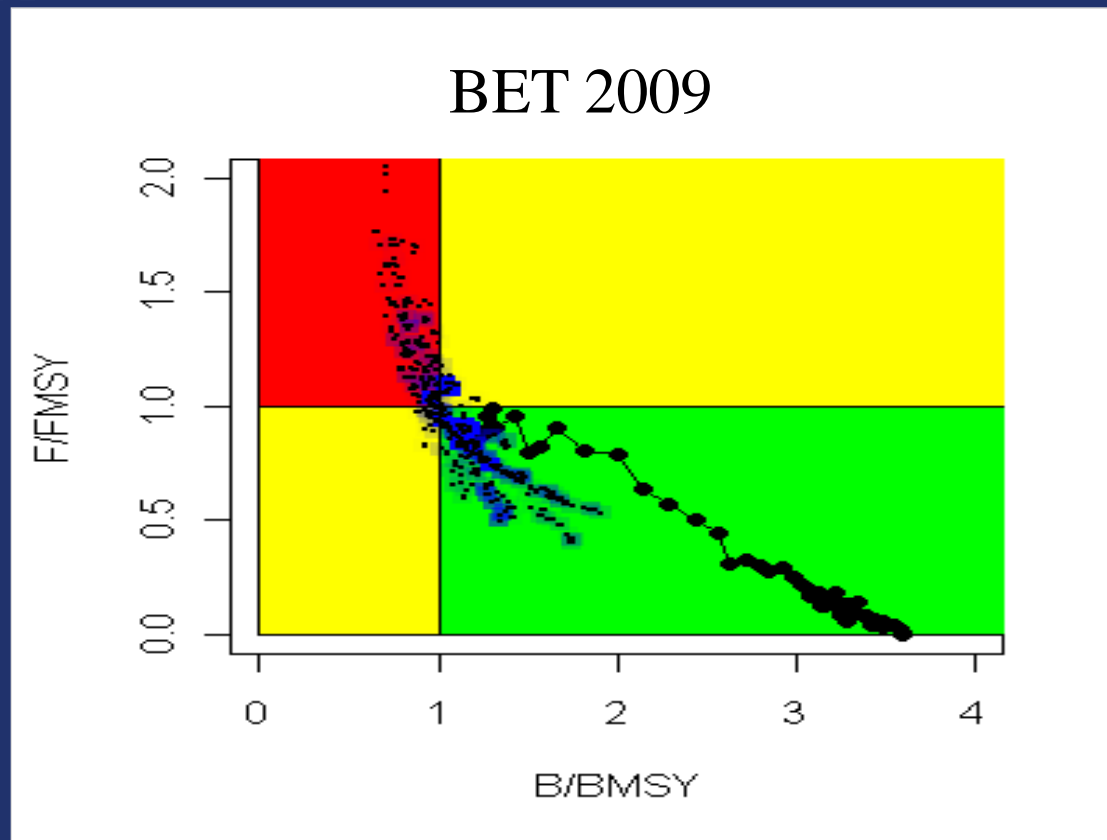
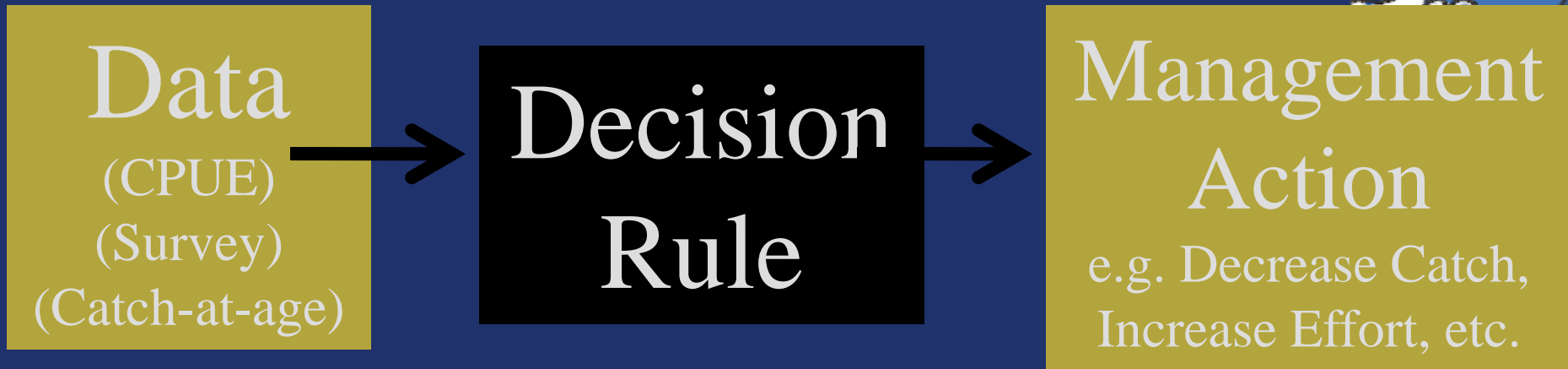➤ *"The better you get at describing uncertainty, the worse you will be at providing useful advice."*

MSE

- Adopt a management decision rule that has a high probability of achieving management objectives. Use simulation models to evaluate harvest strategies, and choose one that performs well under a broad range of circumstances.

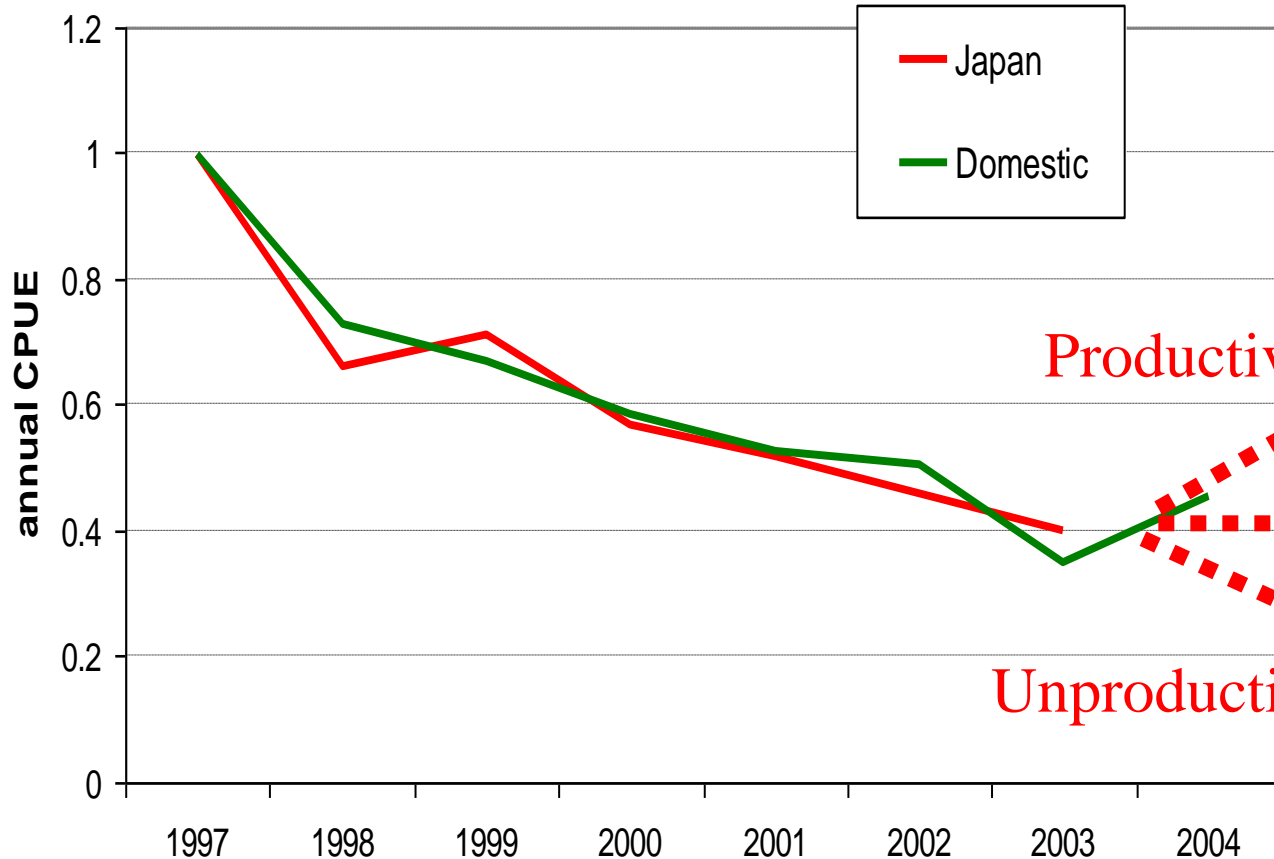- *"agreeing the rules of the game, before the game is played"*

Harvest Strategy

- *Decision Rule + Data*

```
┌─────────────────┐      ┌──────────────┐      ┌──────────────────────┐
│ Data            │      │              │      │ Management           │
│ (CPUE)          │ ───► │ Decision     │ ───► │ Action               │
│ (Survey)        │      │ Rule         │      │ e.g. Decrease Catch, │
│ (Catch-at-age)  │      │              │      │ Increase Effort, etc.│
└─────────────────┘      └──────────────┘      └──────────────────────┘
```

Catch Rates in SW Pacific (2006) Short SA Summary: Rapid depletion

Annual CPUE trends in Areas 2, 3 and 5

Legend: Japan (red), Domestic (green)
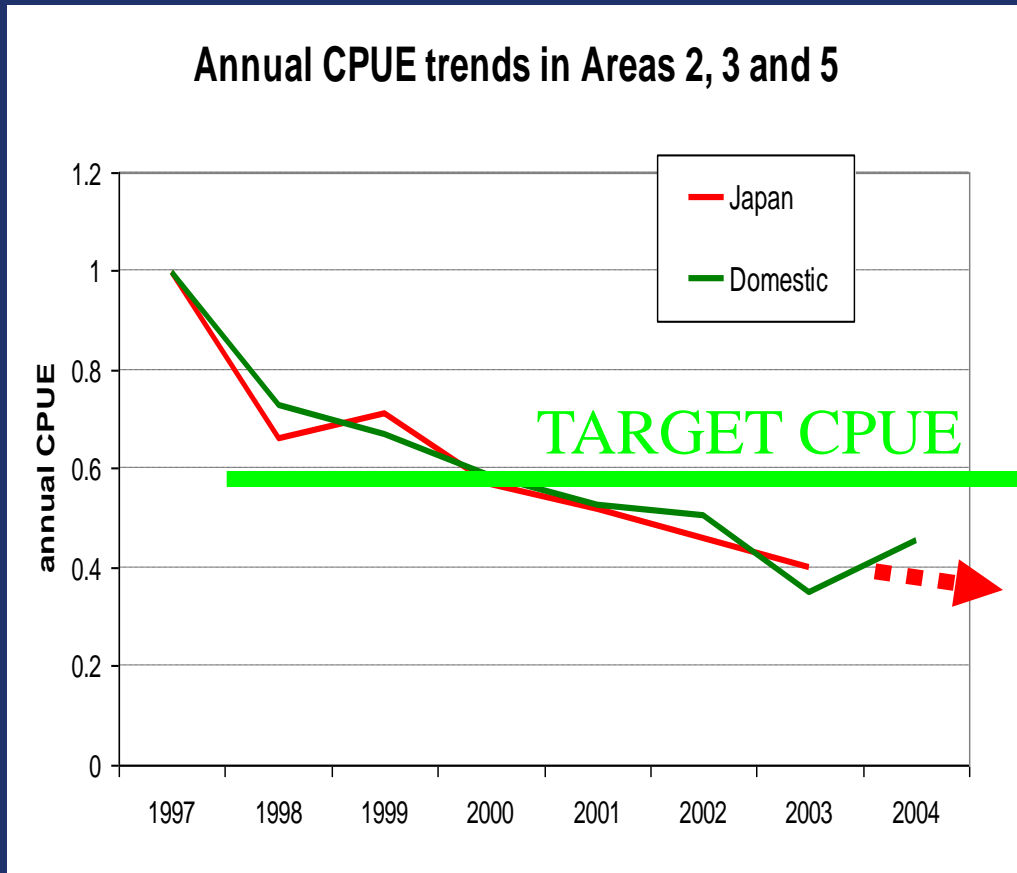
Productive

Unproductive

Constant Catch Projections – the simplest Harvest Strategy

Annual CPUE trends in Areas 2, 3 and 5
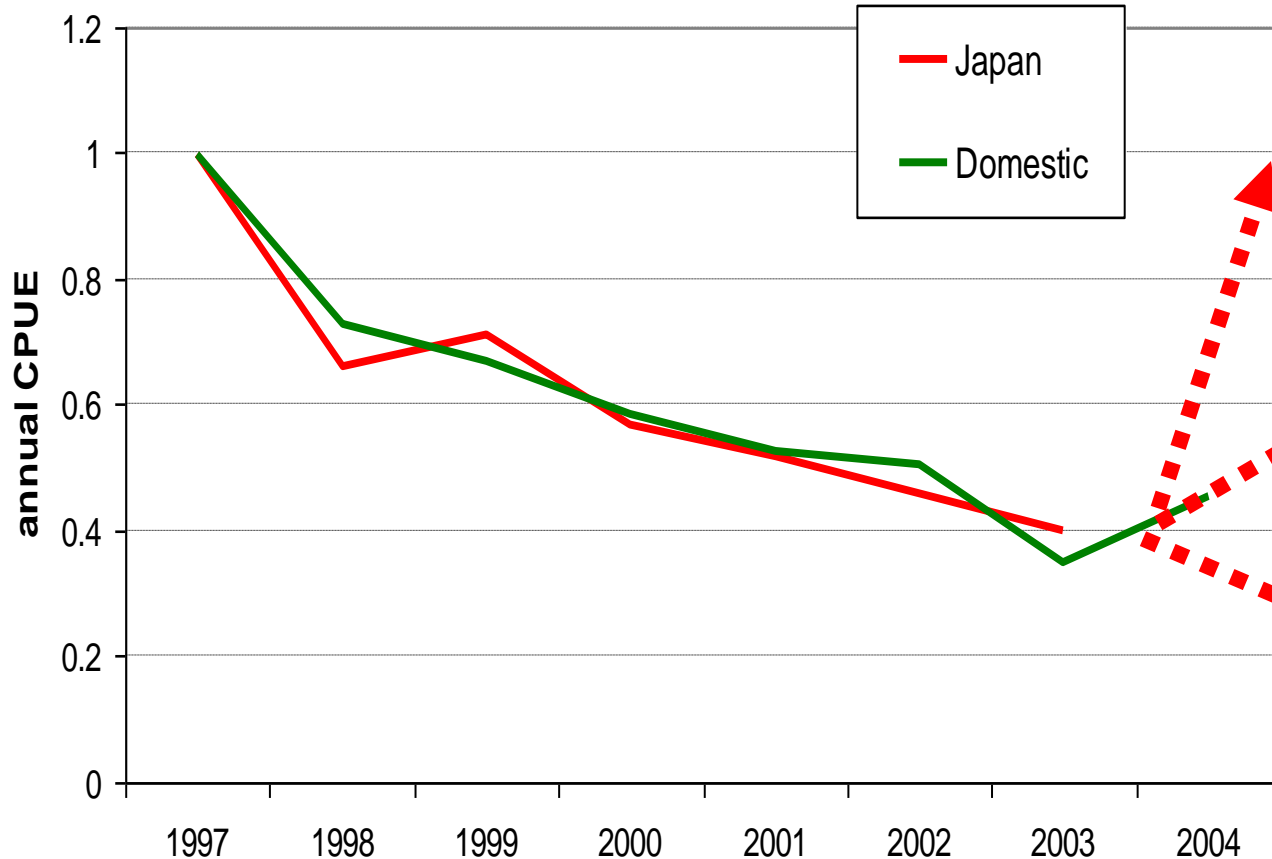
A Simple Harvest Strategy with feedback

- *TAC(y+1) = TAC(y) X (1+beta(CPUESlopeToTarget(y)))*
- *i.e. If (CPUE too low) -> Decrease Catch*
- *If (CPUE above target) -> Increase Catch*

Annual CPUE trends in Areas 2, 3 and 5

TARGET CPUE

— Japan
— Domestic

annual CPUE

1.2
1
0.8
0.6
0.4
0.2
0

1997 1998 1999 2000 2001 2002 2003 2004

Management Strategy Evaluation: The Process

1. *Management Objectives*
2. *Candidate Harvest Strategies*
3. *Operating Models*
4. *Simulation Testing*
5. *Harvest Strategy Selection*
6. *HS Implementation*

MSE 1. Defining Management Objectives

MSE 2. Candidate Harvest Strategies

➤ *Decision Rule*

   ➤ *Empirical (simple, transparent)*

   ➤ *Model-based (capacity to 'learn')*

➤ *Data collection*

   ➤ *Value of information*

MSE 3. Operating Models

➤ *Plausible*

➤ *Encompass Uncertai*
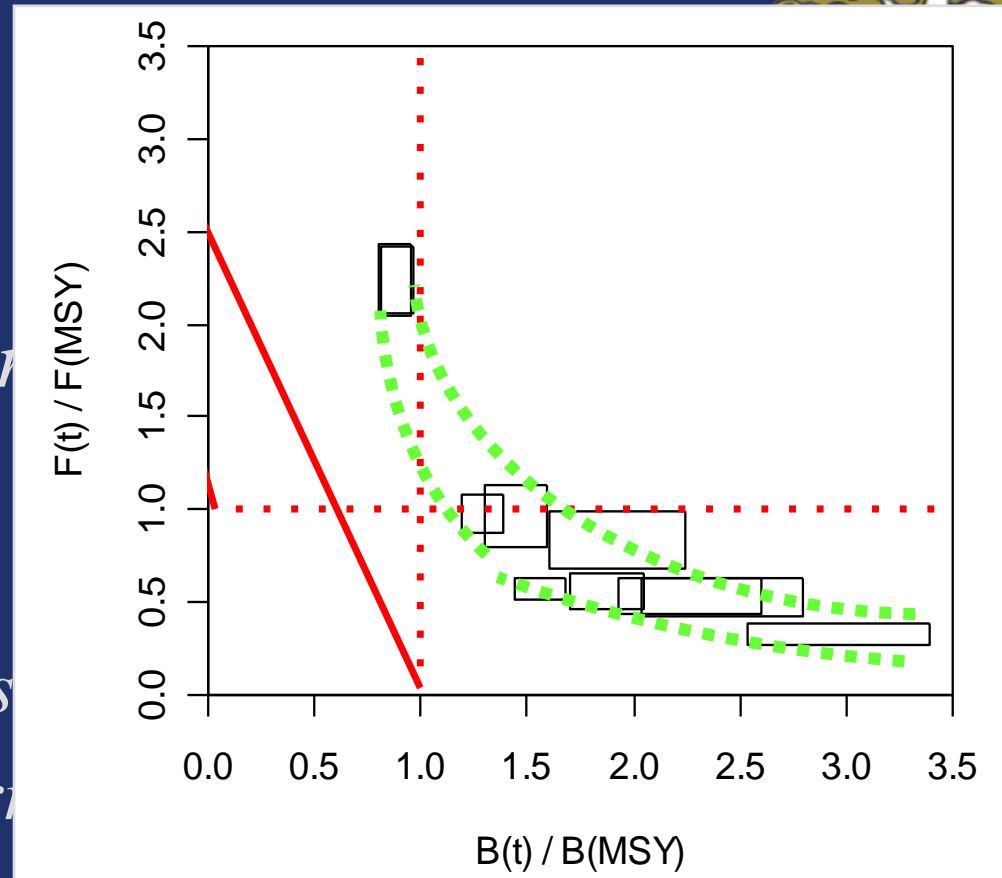 - ➤ *Current stock status*
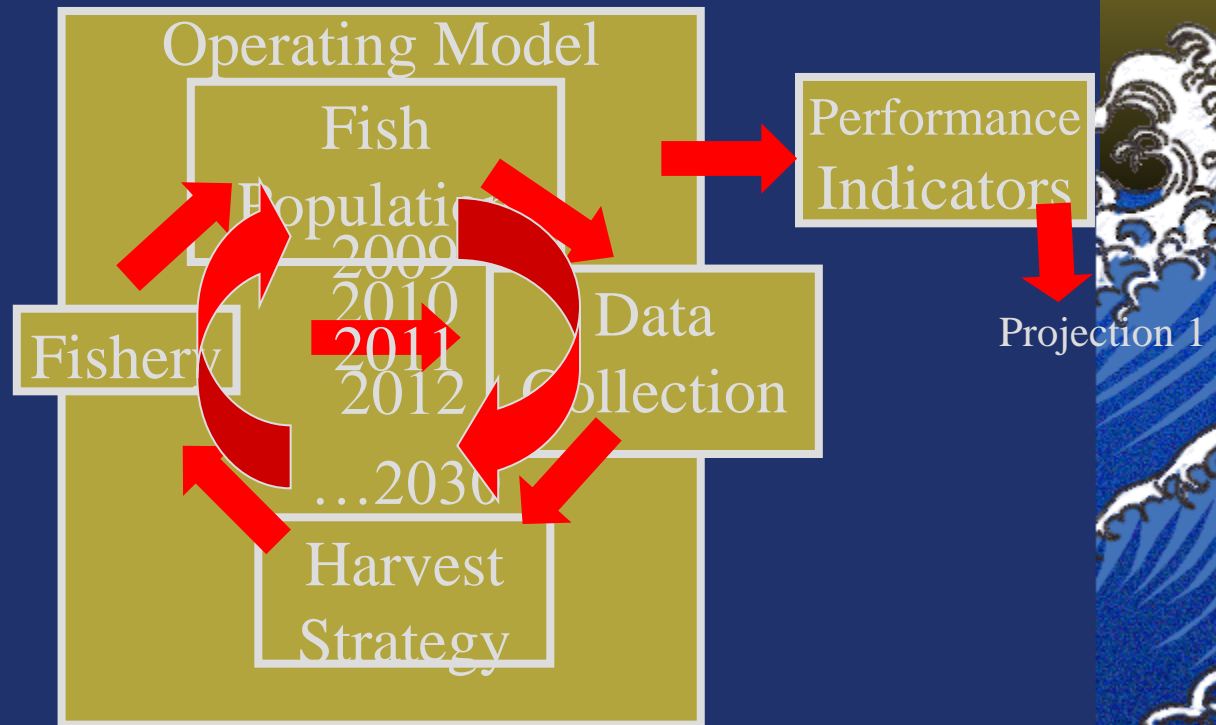 - ➤ *Future production*
  - ➤ *Data collection errors*
  - ➤ *HS implementation er*

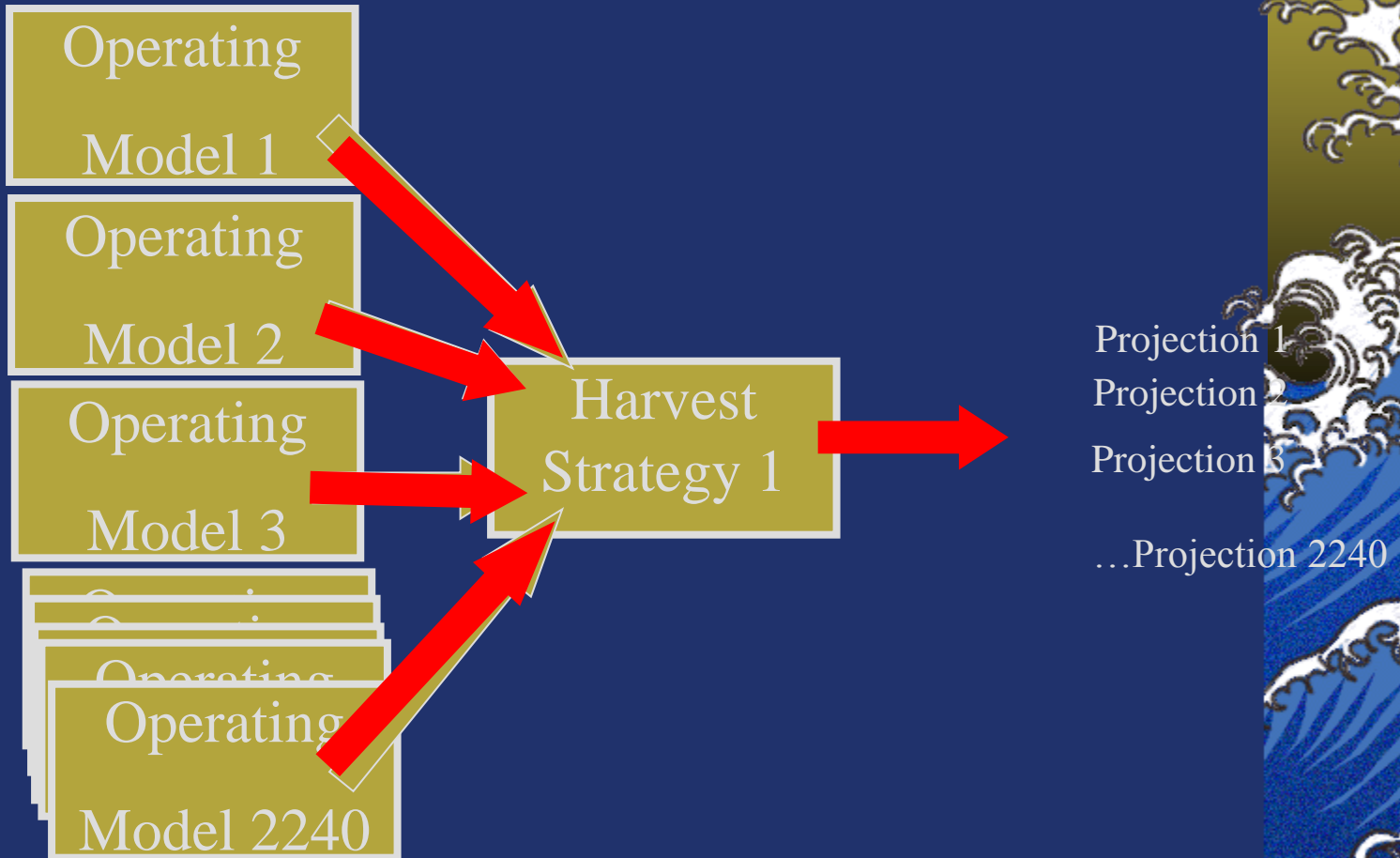➤ *Stock Assessment Models good starting point*
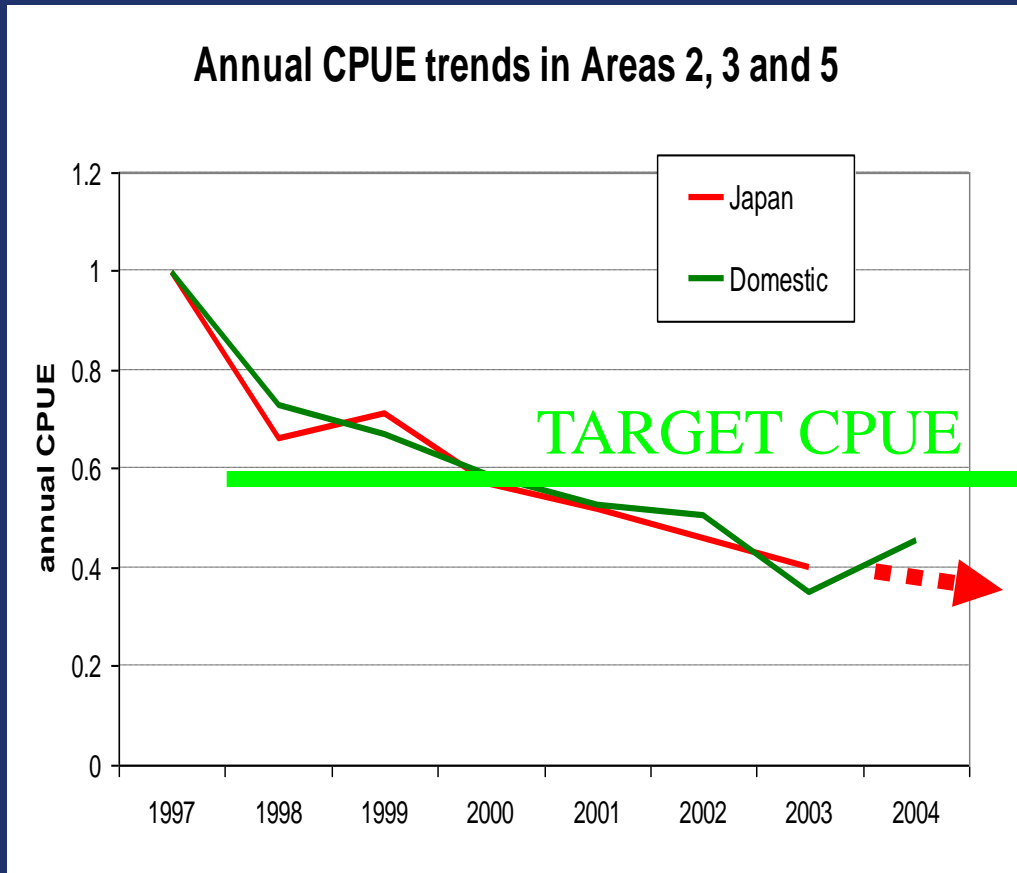
MSE 4:
Simulation Testing – 1 Projection

MSE:
4. Simulation Testing –
Uncertainty -> Many operating models –> Many Projections

Operating

Model 1

Operating

Model 2

Operating

Model 3

Operating

Operating

Model 2240

Harvest
Strategy 1

Projection 1
Projection 2
Projection 3

…Projection 2240

So does the Harvest Strategy work for Pacific SWO?

$$TAC(y+1) = TAC(y) \, X \, (1+beta(CPUESlopeToTarget(y)))$$

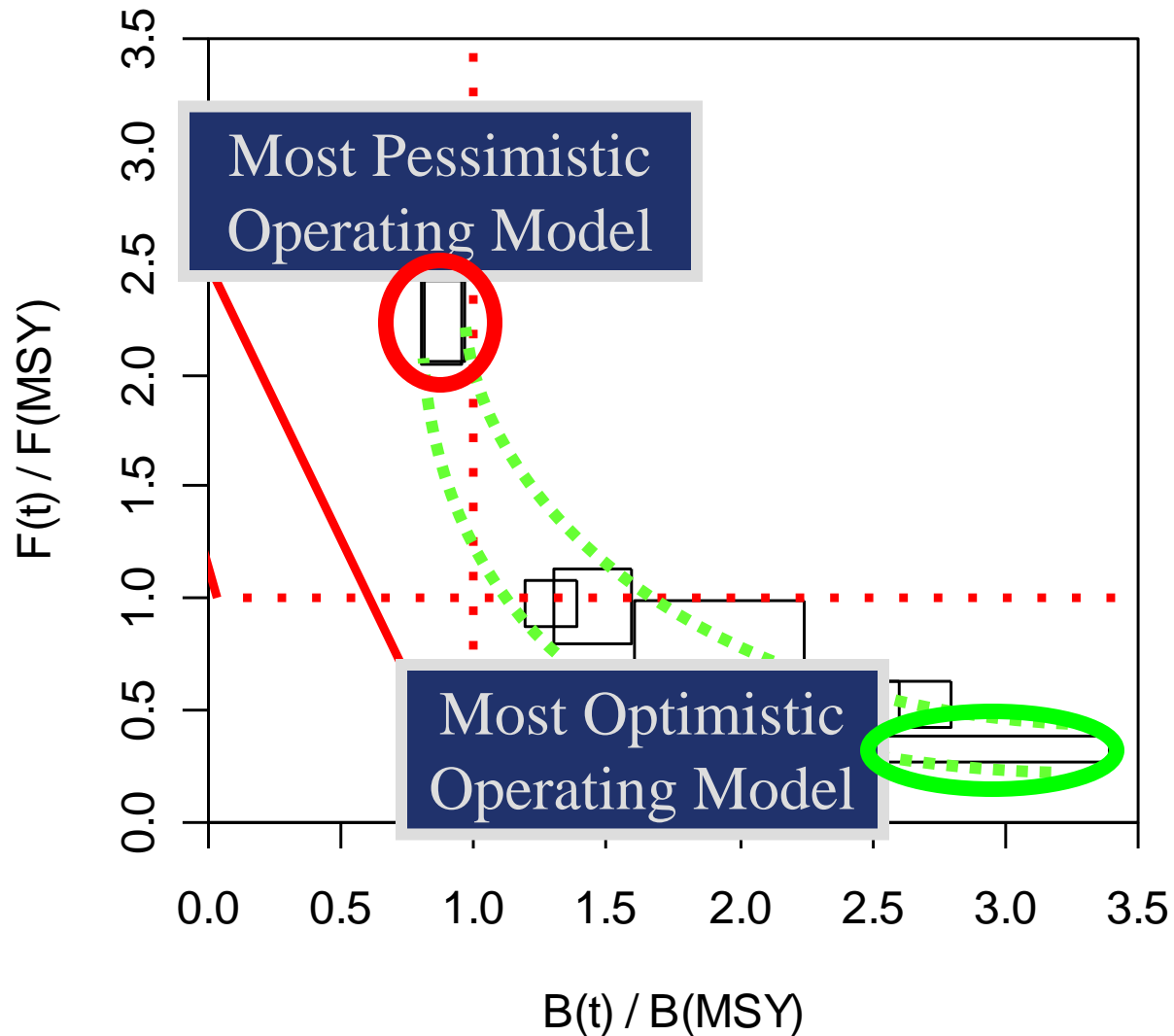**Annual CPUE trends in Areas 2, 3 and 5**
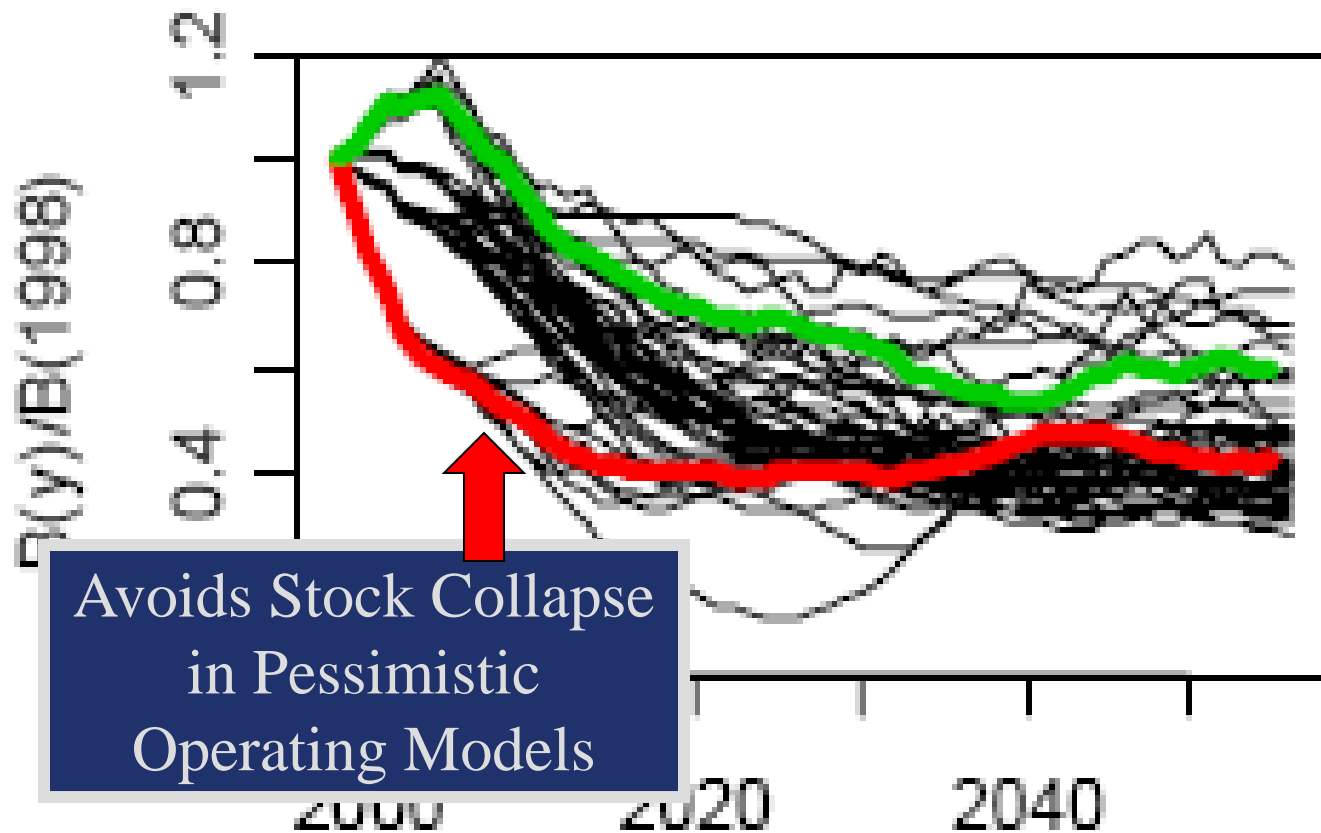
TARGET CPUE

Some Simulation Results
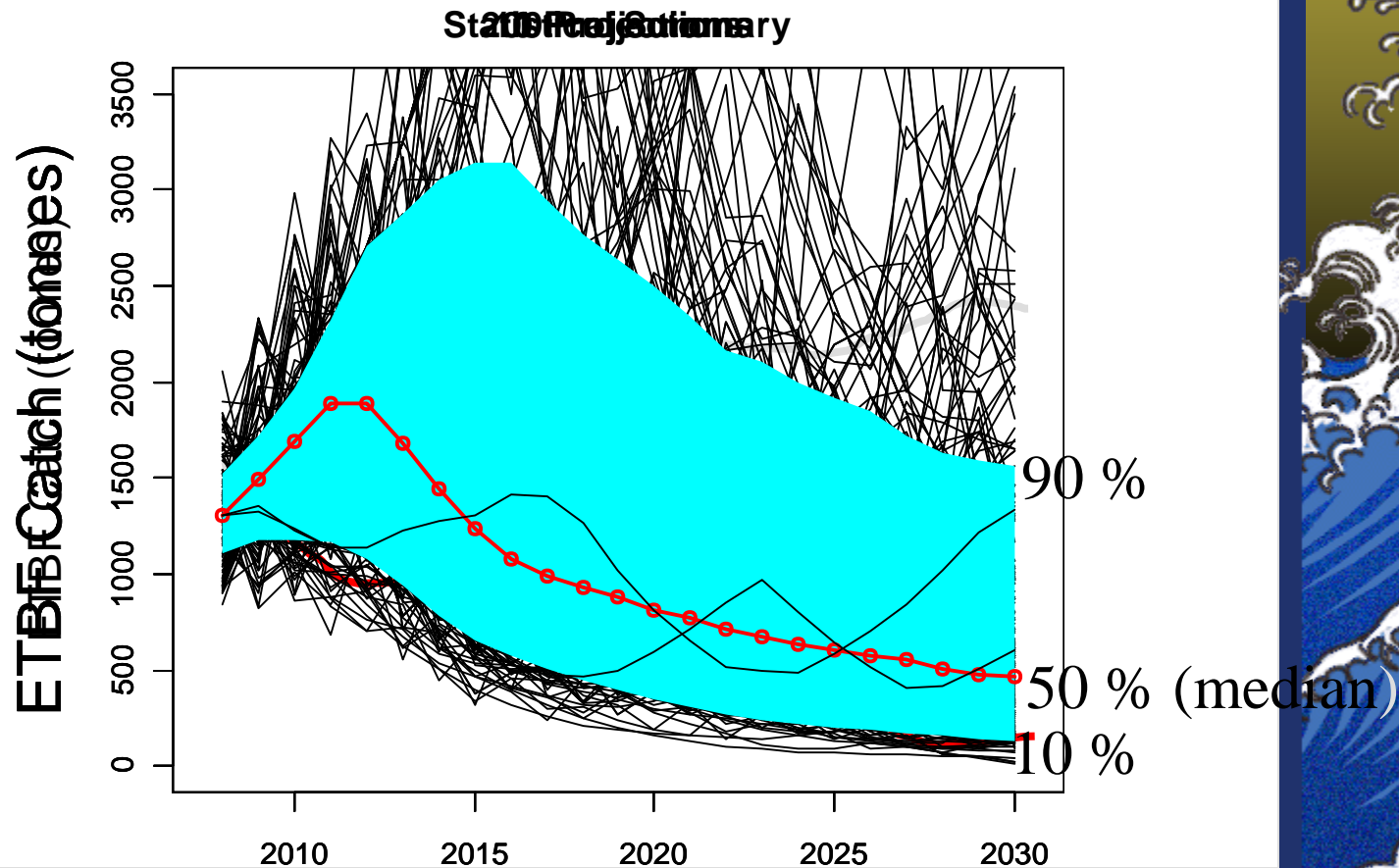
- *Uncertainty is represented by repeated simulations*
- *Statistical summaries are required to interpret the results*

Does HS Work for SW Pacific SWO?
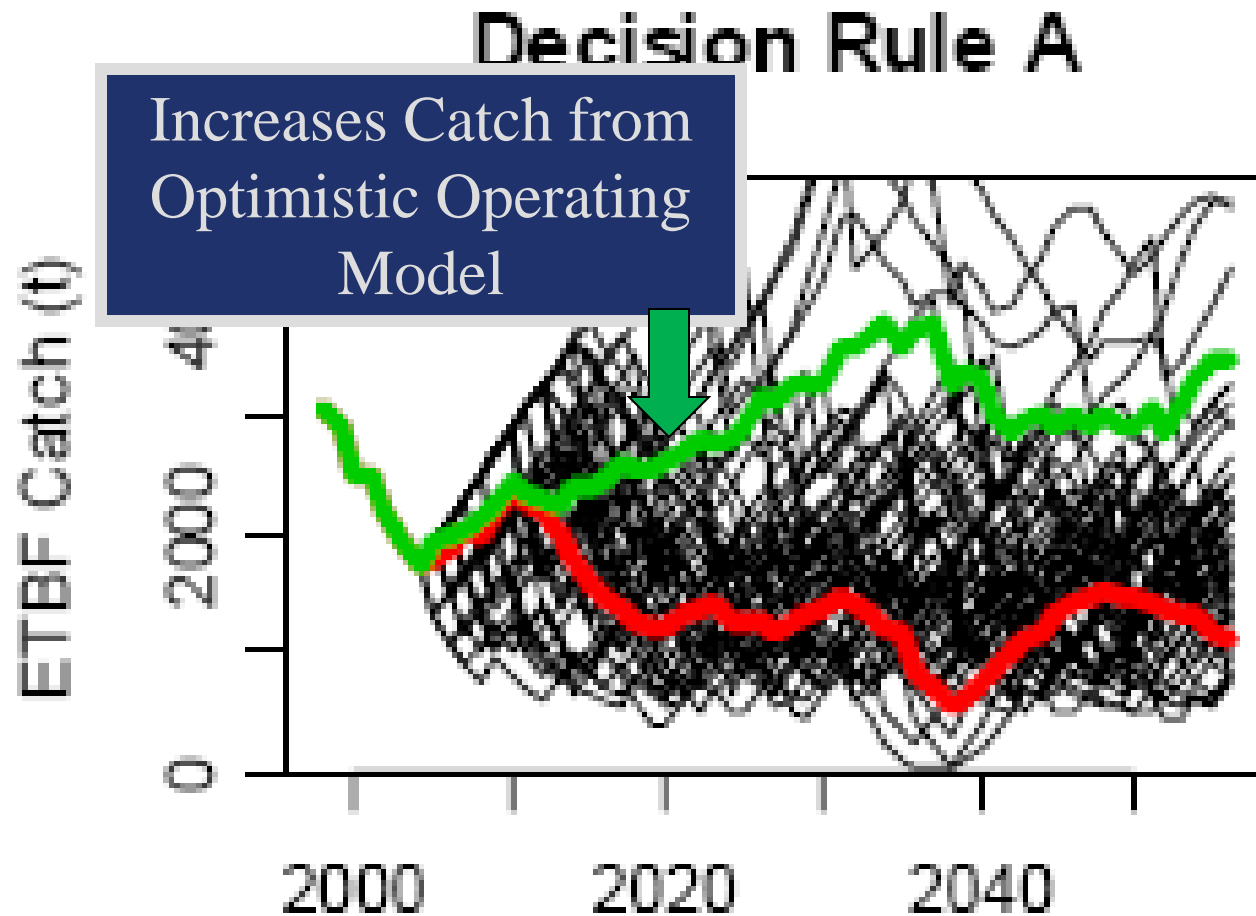

SW Pacific Swordfish 2006

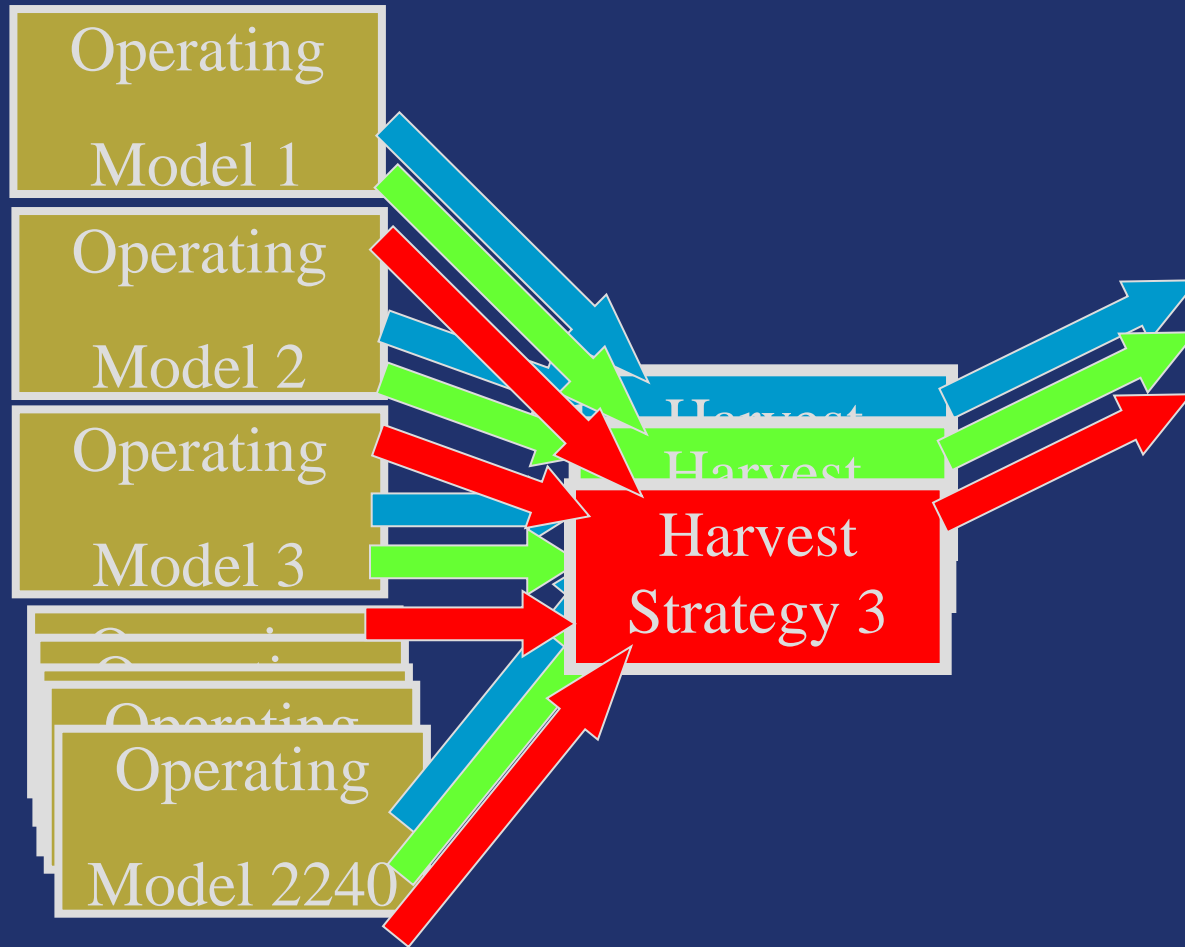# Does HS Work for SW Pacific SWO?

Decision Rule A

Avoids Stock Collapse in Pessimistic Operating Models
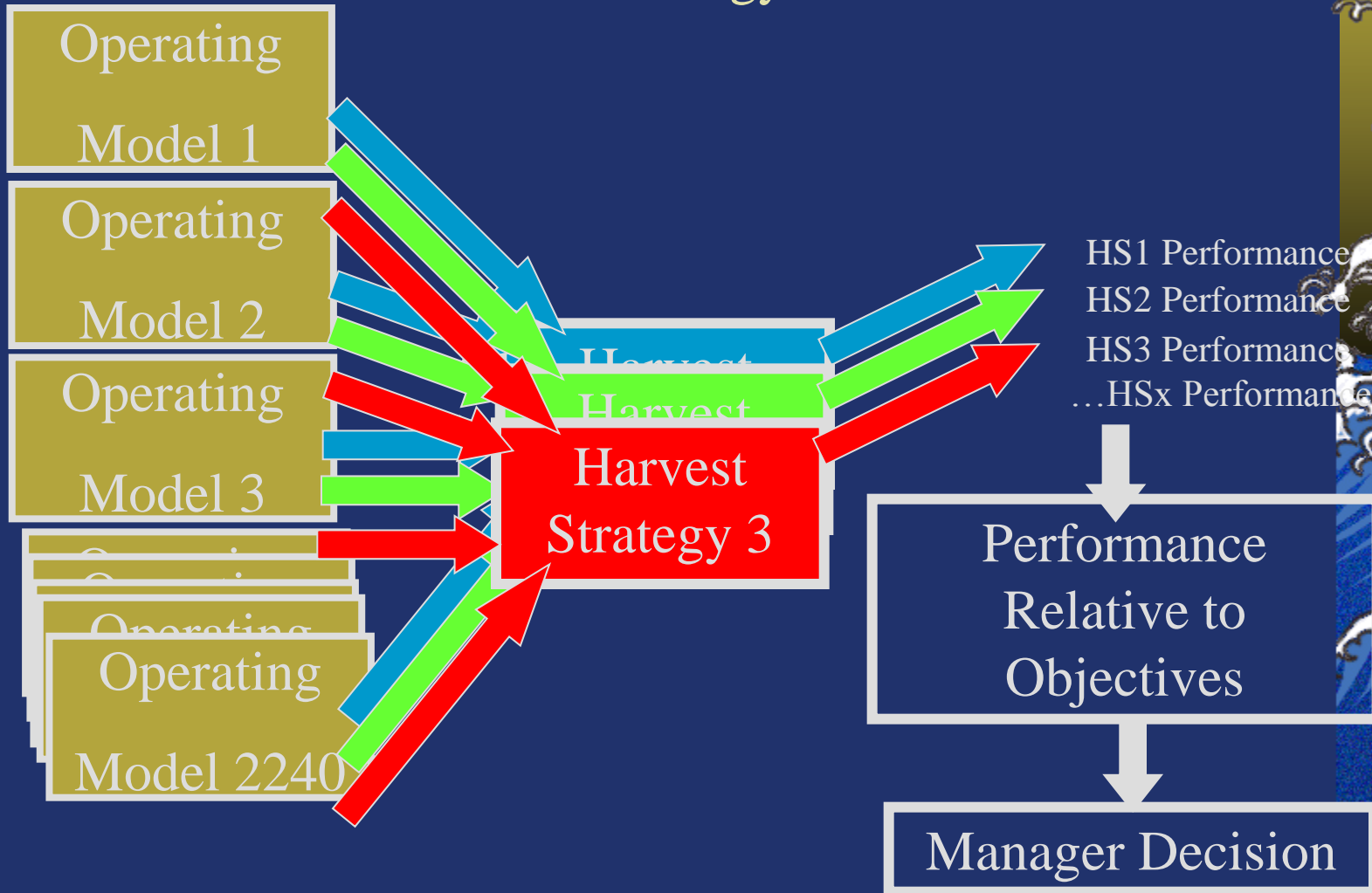
Does HS Work for SW Pacific SWO?

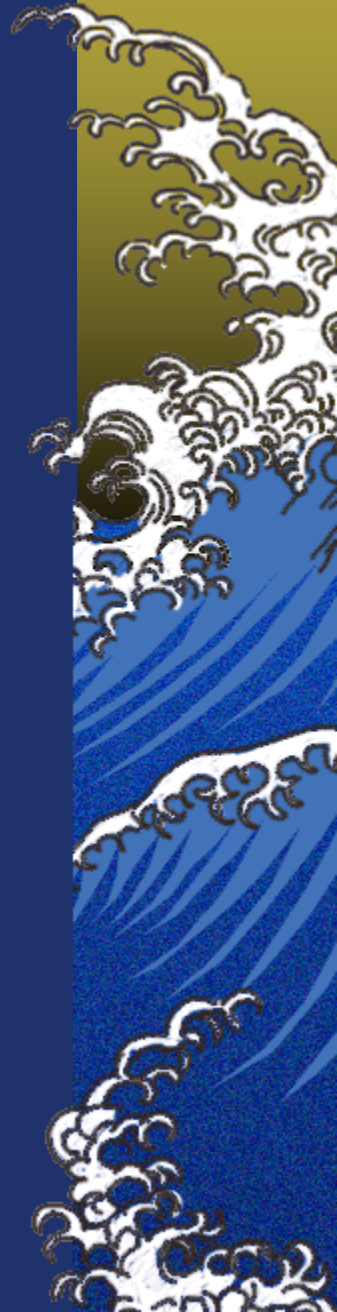MSE: 4. Simulation Testing
Comparing many Harvest Strategies

Operating Model 1

Operating Model 2
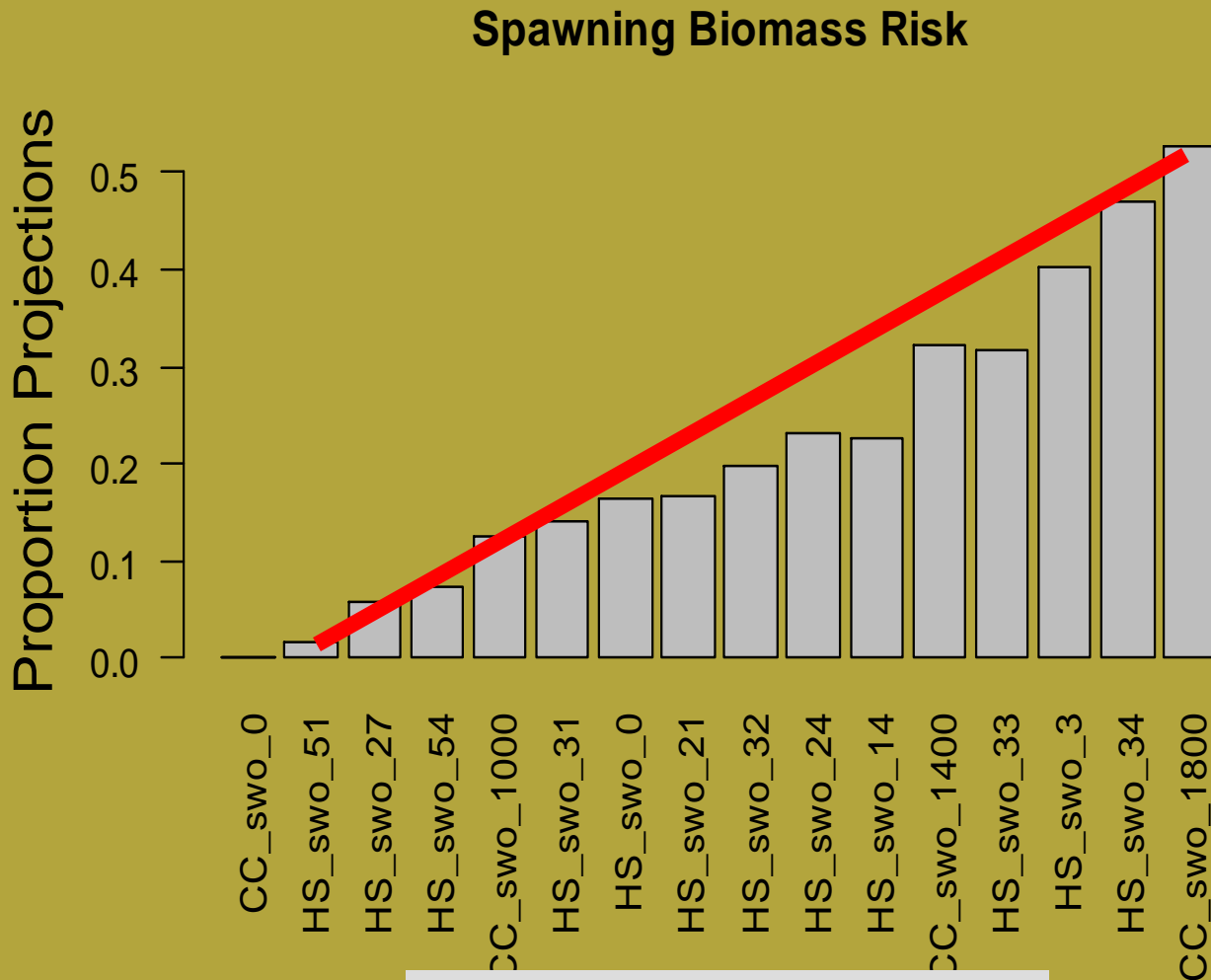
Operating Model 3

Operating

Operating

Operating Model 2240

Harvest Strategy 3

HS1 Performance
HS2 Performance
HS3 Performance
…HSx Performance

MSE: 5. Harvest Strategy Selection

Operating Model 1

Operating Model 2

Operating Model 3

Operating

Operating

Operating Model 2240

Harvest Strategy 3

HS1 Performance
HS2 Performance
HS3 Performance
…HSx Performance

Performance Relative to Objectives

Manager Decision

Management trade-offs
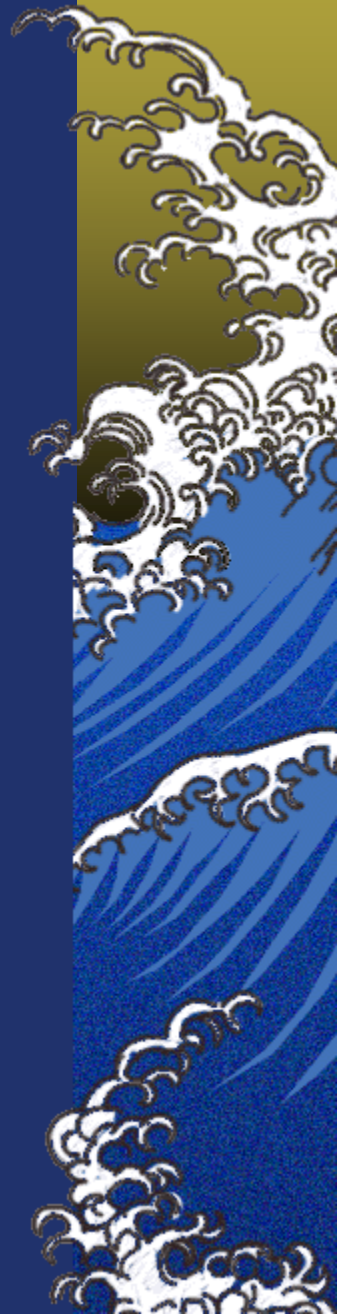
Comparing HS Performance

Spawning Biomass Risk — bar chart of Proportion Projections (B below Blim) versus Harvest Strategy, with a red trend line rising from left to right.

Y-axis: Proportion Projections (0.0 to 0.5); label "B below Blim"

X-axis (Harvest Strategy): CC_swo_0, HS_swo_51, HS_swo_27, HS_swo_54, CC_swo_1000, HS_swo_31, HS_swo_0, HS_swo_21, HS_swo_32, HS_swo_24, HS_swo_14, CC_swo_1400, HS_swo_33, HS_swo_3, HS_swo_34, CC_swo_1800
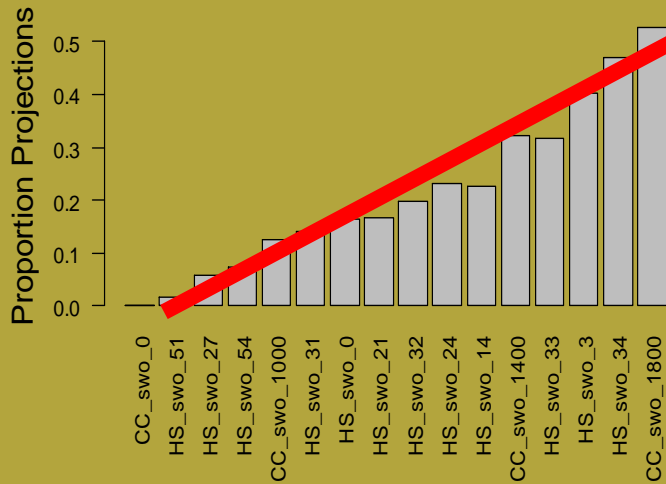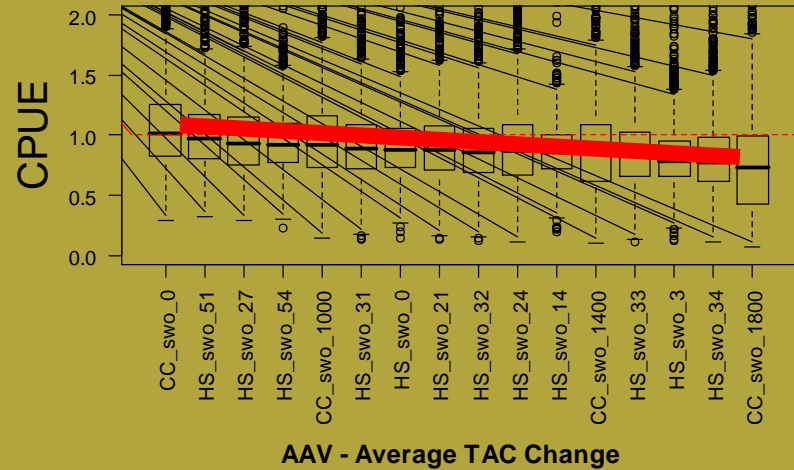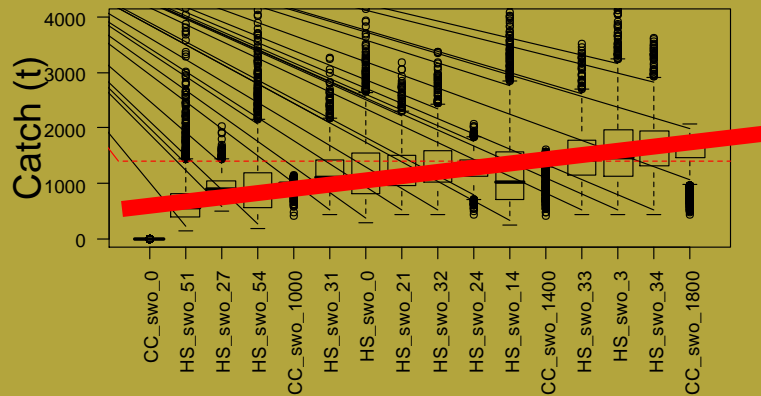
Comparing HS Performance
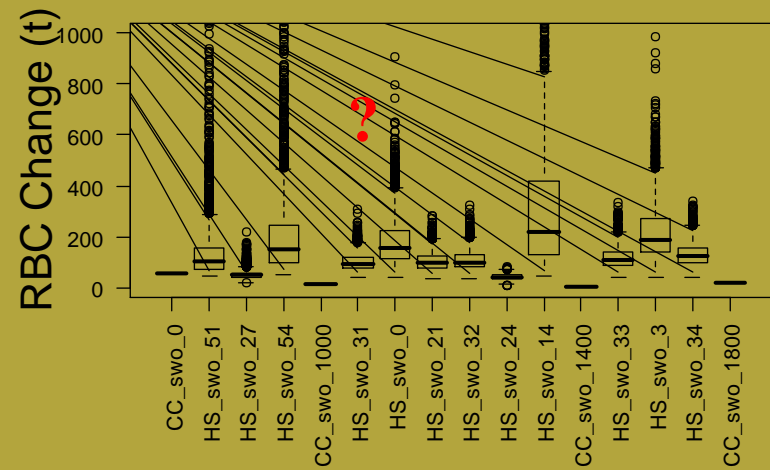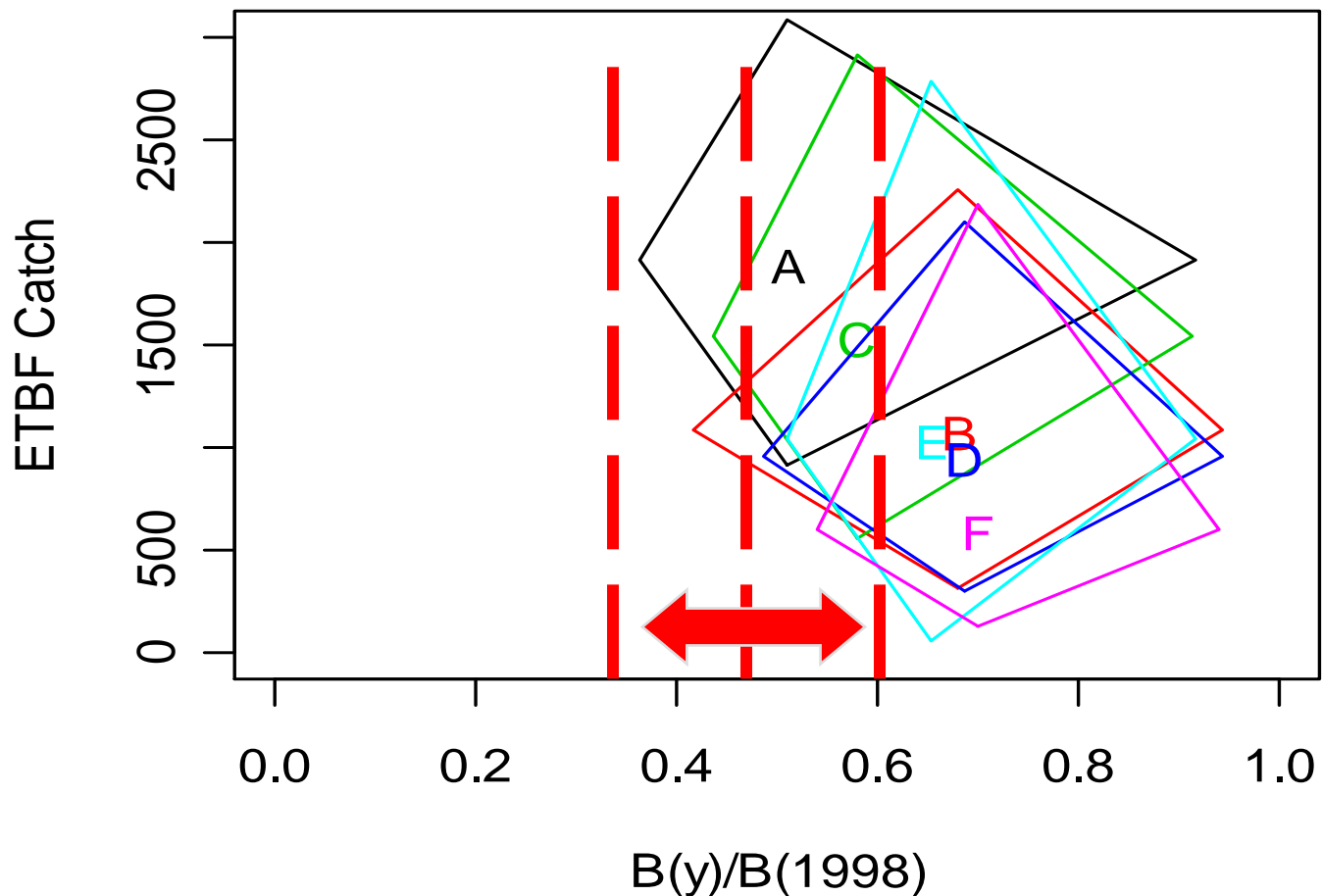
Common Trade-offs

- *Higher Catch = Lower CPUE*
- *Higher Catch = Higher conservation risk*

- *For given level of conservation risk:*
  - *Higher Catch = Higher Variability in Catch*
  - *Higher Catch = More Expensive Research*

Harvest Strategies often more similar than might be expected

Catch-Conservation Risk Trade-off

MSE Advantages

1. *Improved Communication – scientists, industry, managers*
2. *Designed for specific management trade-offs*
3. *Robustness - explicitly manage uncertainty (precautionary approach)*
4. *Increased transparency in decision process for industry*
5. *Refocussing of research effort away from repetitive assessment crank turning*

MSE Disadvantages

1. *Resource intensive (initially)*
2. *Education process required for stakeholders*

MSE Limits

1. *Does not remove need for quality data*
2. *Does not remove hard decisions about quota allocations or overcapacity*
3. *Exceptional circumstances*
4. *Managers unwilling to give up negotiation option?*
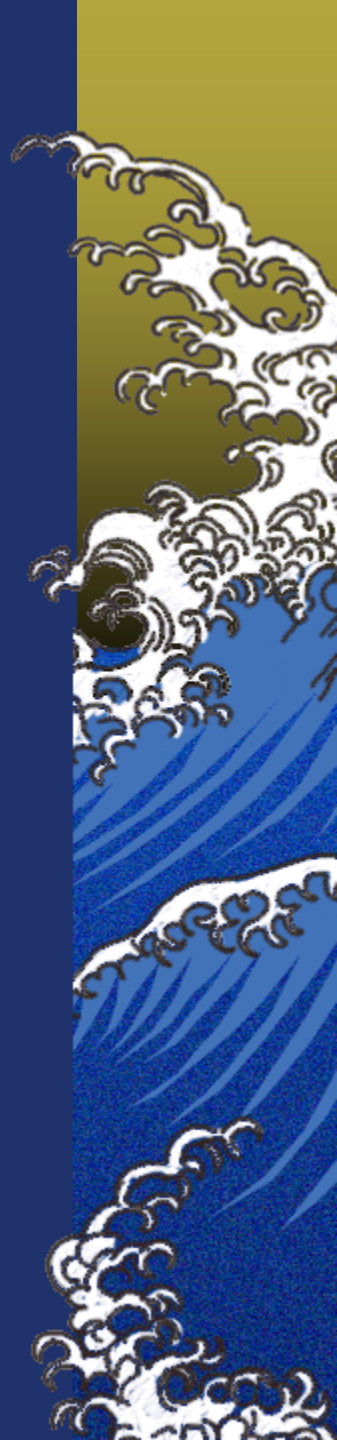
The Role of MSE in IOTC

- *Educational stage*
- *Preliminary examples*

Useful References

Koeller, P. (2003). The lighter side of reference points. Fish. Res.: 62: 1-6.

Fisheries Research Vol. 94, iss. 3. Special Issue – Advances in the analysis and application of harvest policies in the management of fisheries.

Fisheries Library in R: http://flr-project.org/