# Outline

1. Management Strategy Evaluation (MSE): what is it and what is it used for?
2. How does it relate to Adaptive Management, and fisheries management in particular?
3. An example of performance of strategies and trade-offs among objectives.
4. Discussion

# Management Strategy Evaluation

1. MSE is the process of using models to evaluate (compare) the RELATIVE likelihood of different management strategies to meet specified policy/management objectives in the face of different forms of uncertainty about the system (e.g. fishery).
2. It has some features in common with “futures” or “scenario planning” exercises in that one form of uncertainty is “plausible hypotheses about the future dynamics of the system”.
3. It has its origins in systems science, control theory and engineering (i.e. many of the same roots as Adaptive Management)
4. In a fisheries context different forms evolved independently from UBC (Walters, Smith, Sainsbury, Peterman) and various labs involved in the International Whaling Commission (Beddington, Kirkwood, de la Mare, Butterworth, Cooke).

# MSE and Adaptive Management

1. At its simplest level, MSE involves simulating the steps of the AM loop:
    1. Objectives
    2. Management action
    3. Monitoring and assessment
    4. Evaluation against objectives
    5. "learning"
    6. Adjust management

2. In an MSE, the AM process is iterated many times for:
    - Multiple strategies and
    - Multiple "realties", also know as "operating models", and
    - The performance of each strategy against the specified objectives are summarised as "performance measures".
3. This can be done conceptually, qualitatively or using simulation models

# What's the difference between MSE and stock assessment?

**They differ in their primary purpose.**

**Stock assessment aims to estimate:**

- the state of the current state of the stock,
- it's productivity (some measure of sustainable yield),
- the uncertainty for these predictions and their sensitivity to different structural assumptions.

**MSE aims to evaluate:**

- The performance of alternative strategies in meeting stated objectives in the medium to long-term (multiple generation times), subject to,
- the same uncertainties in the state and dynamics of the system and each strategies ability to monitor, detect and respond to signals.
- In this context, the "management strategy" is the combination of monitoring, assessment and decision rule (*aka control rule*)

# Management Strategy Evaluations

- **Evaluate alternative sets of management strategies** ***(relevant to the Reef Line Fishery)***
  - Identify trade-offs between alternative strategies' likelihood of meeting specified objectives
  - *Comparative – not prescriptive*
    - Biological, fleet & management models ~4000 reefs
      - Graphical user interface
    - *Quantitative* Objectives & strategies specified by stakeholders
    - *Today:* Area closures & Effort Control

CSIRO MARINE RESEARCH

# MSE & ELFSim

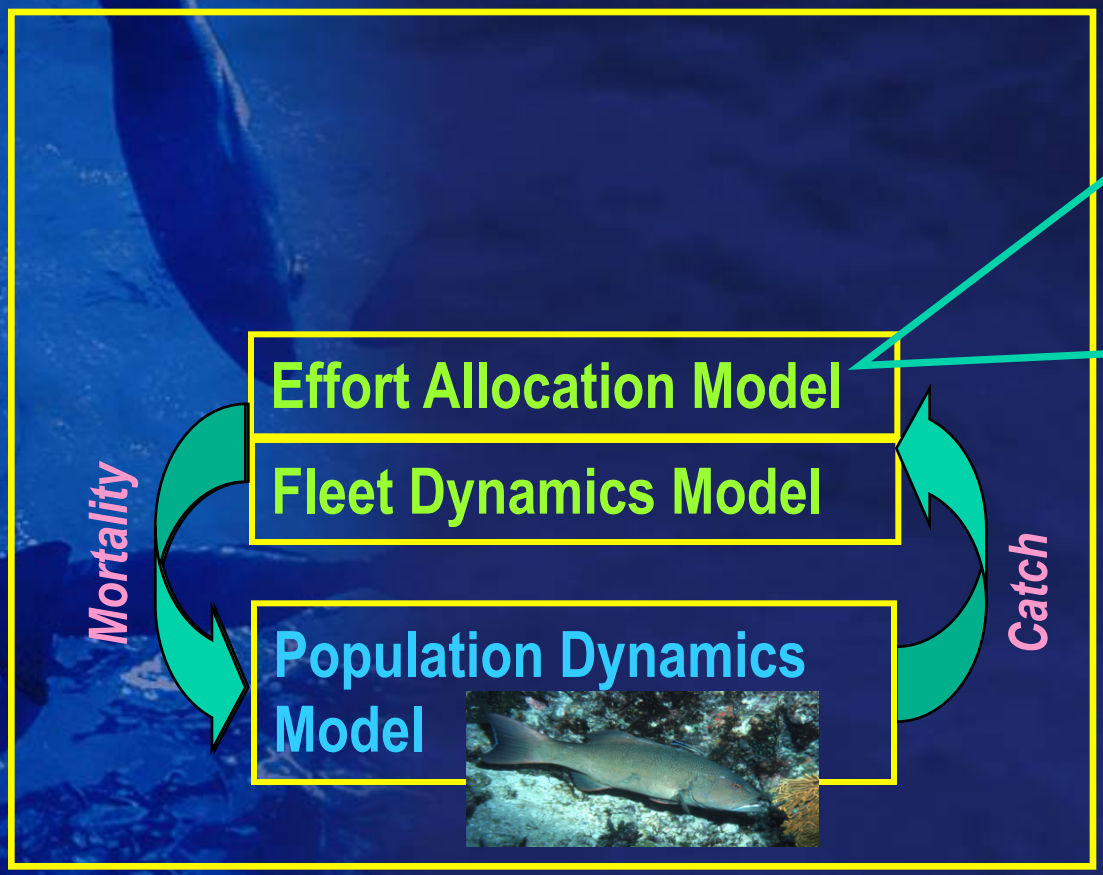
## Modelling the System

**Population Dynamics Model**

- Spatially structured
- Age & Size structured
- Variable growth
- Sex change
- Beverton-hold SRR
- Latitudinal trend in K
- Dispersive larvae
- 3 Dispersal scenarios
- Log-normal settlement
- D-D at settlement
- Multi-scale settlement coherence
- Inter-reef Migration

# MSE & ELFSim

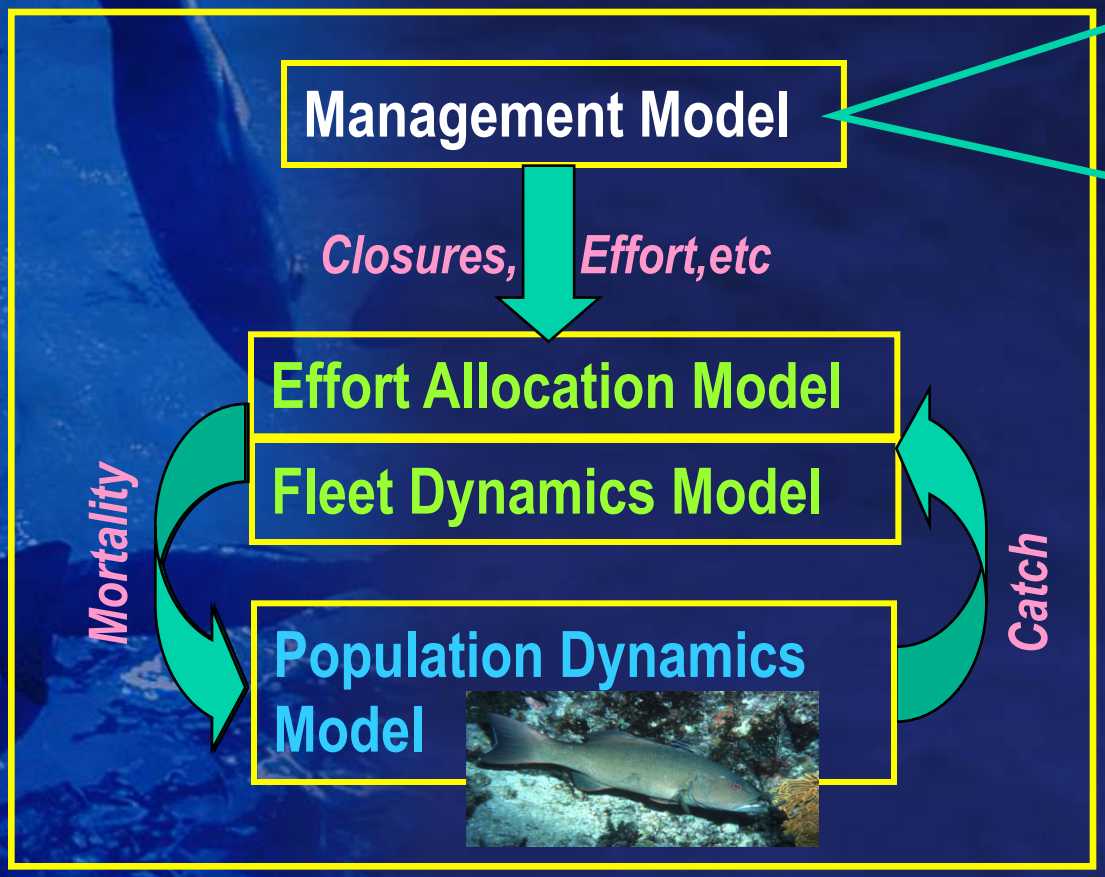
## Modelling the System




- 3 fleets (or more)
- Catch & effort tuned to data 1990-98
- Fleet (& reef) specific catchability
- Common selectivity
- Monthly time step
- Statistical projections
- Seasonality
- Effort =f(CPUE, effort prior years, effort last month)

# MSE & ELFSim

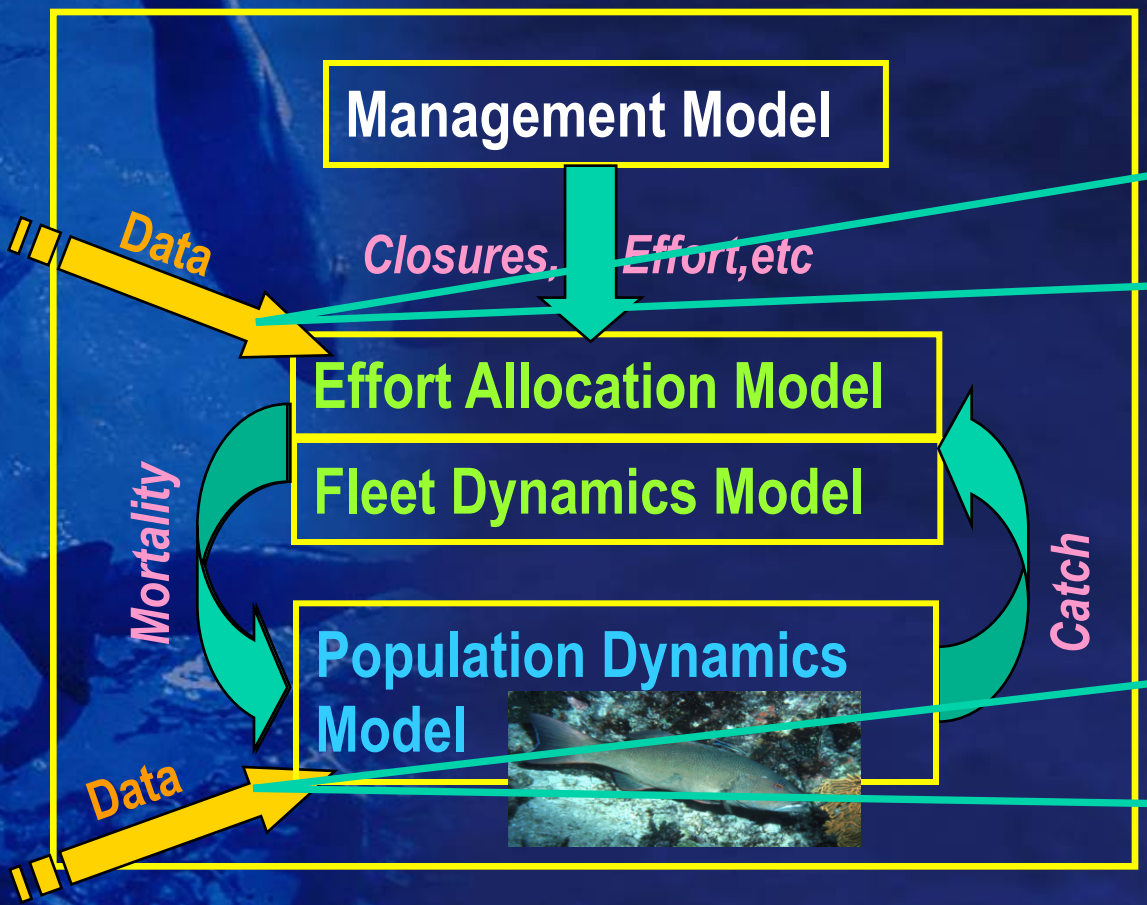
## Modelling the System




- Effort control
- Area closures
- Seasonal closures
- Allows for infringement
- Size limits (PR mortality)
- Catastrophic events
- Spatial flexibility - whole GBR, any regions
- No dynamic feedback

# MSE & ELFSim

## Modelling the System




- QFS Data
  - Commercial Logbooks
  - Charter Logbooks
  - Rec Surveys (RFish)
- Boat Ramp surveys
- On-board observers
- Interviews
- Research Logbooks

- Prior biological research
- ELF Experiment
  - Catch Surveys
  - Diver Surveys
  - Biological data
- Tag-Release data
- Historical diver surveys
- Dispersal Models

# MSE & ELFSim

## Modelling the System

Management Model

Alternative Strategies, Specific Objectives

Data

Closures, Effort,etc

Effort Allocation Model

Fleet Dynamics Model

Mortality

Catch

Population Dynamics Model

Data

Fishery Performance

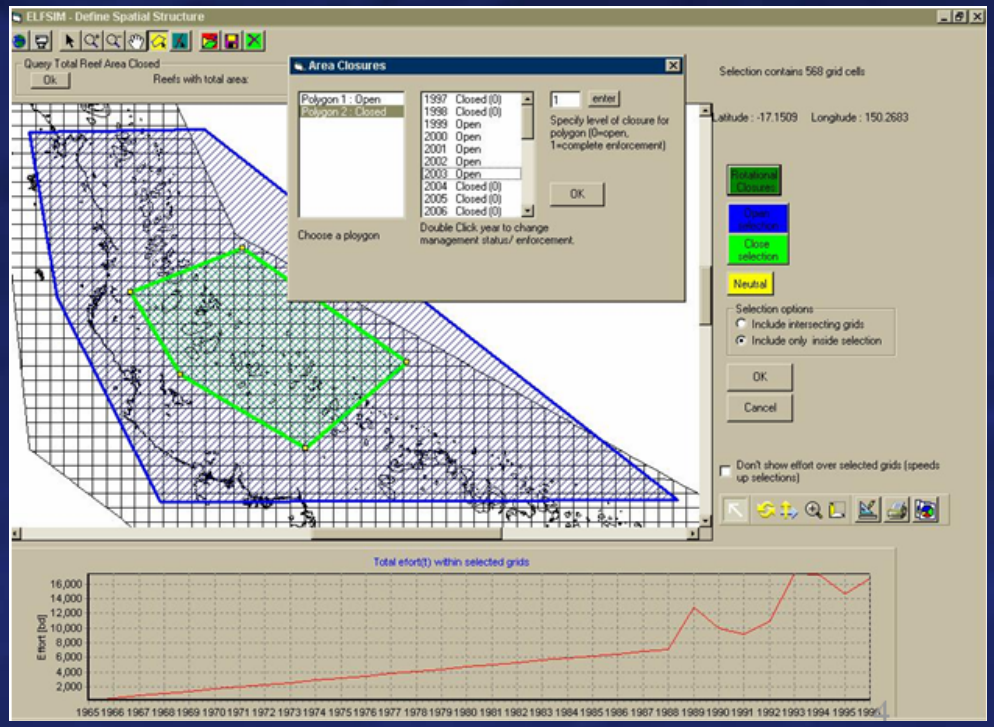
CPUE, Harvest, size of fish, Effort Distribution

Stock Performance

Relative Biomass, Population Structure

# Cutting edge science

ELFSim = “Effects of Line Fishery Simulator”



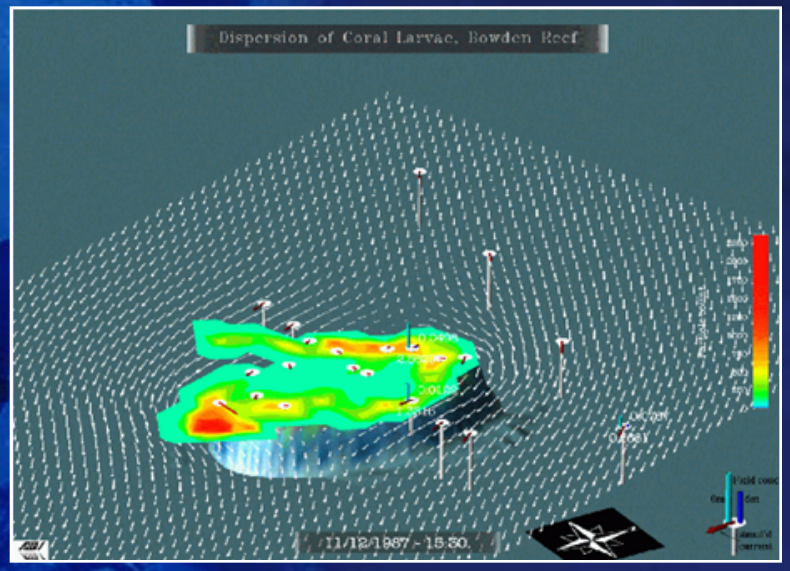
# Cutting edge science

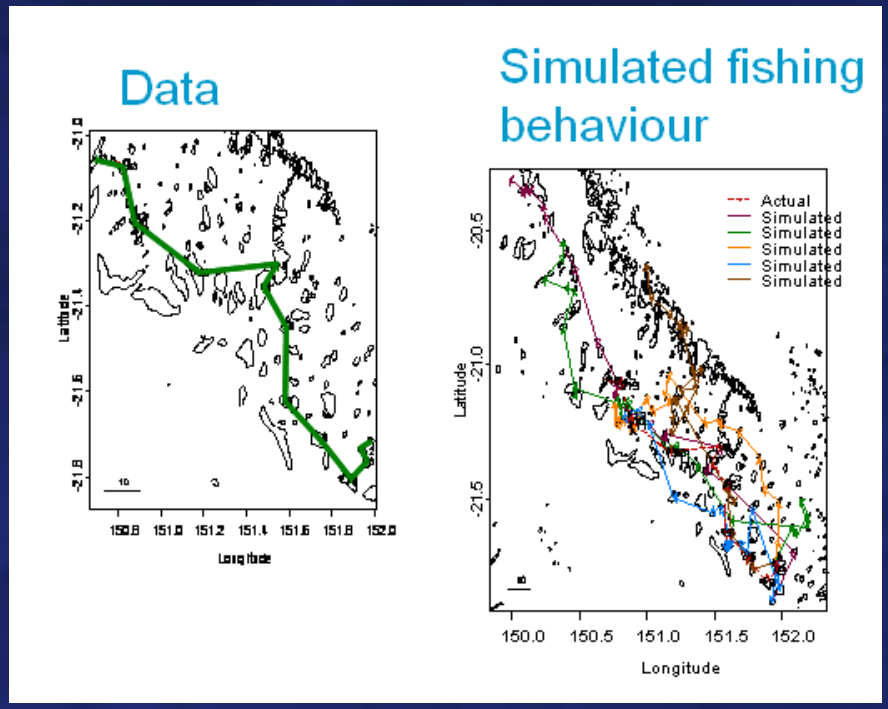
**Biological model**

- Reef-based
- Age structured
- Variability in growth
- Sex-change
- Larval advection among reefs

**Harvest model**

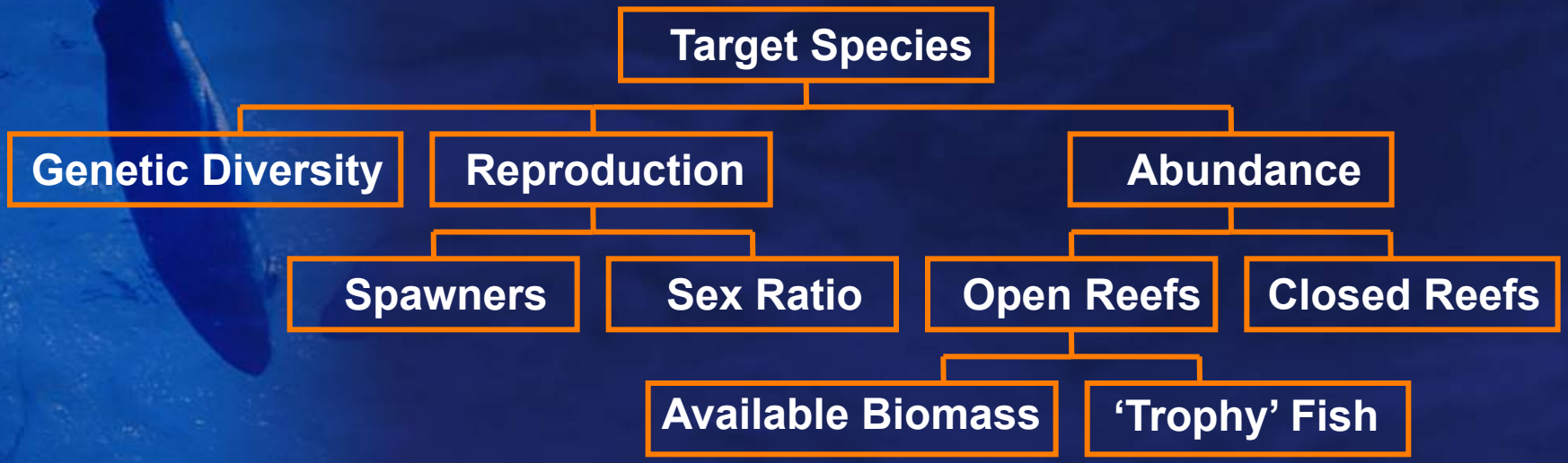
- Agent-based
- Behaviour is governed by a Random Utility model



# Setting Objectives

- **Informal workshops with each stakeholder group**
  - Feedback on objectives & strategies




- **Formal workshops with all stakeholder groups**
  - Emphasis on diversity of objectives & strategies
  - Not seeking consensus
  - No objectively correct objectives

# Objectives & Performance Indicators

- **Some Stakeholder Objectives**
  - Spawning Biomass on closed reefs > 80% VSB 90% of time
  - Available Biomass on open reefs > 30% VAB
  - $CPUE_{comm}$ > 80% average (1993-96)
  - 'Good' chance of catching fish > 50cm TL
  - Minimise annual variation in catch

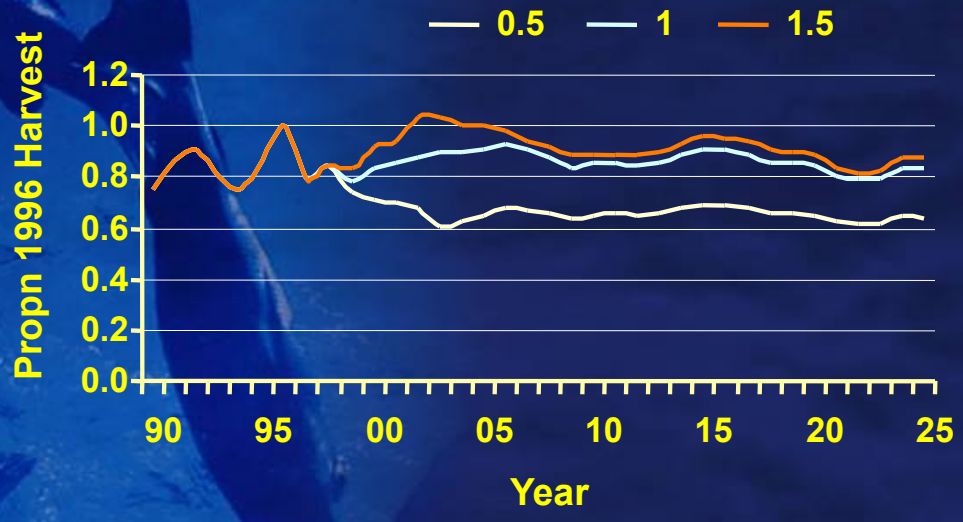
- **Some performance indicators**
  - Prob($SSB_{closed}$) > 90% VSB
  - Prob($AvB_{open}$) > 30% VAB
  - Prob($CPUE_{comm}$) > 80% average (1993-96)
  - Proportion catch > 50cm
  - Average annual catch from open areas
  - Variation in annual catch

# Management Strategies

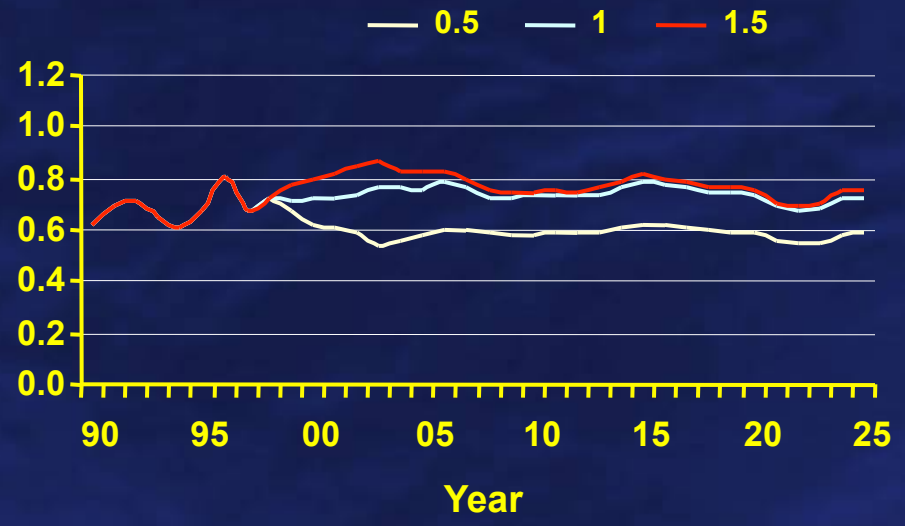
- Agreed in multi-stakeholder workshops
- Area Closures
  - Current (~16.7%), 30%, 50%
  - ~ Built around existing ‘green zones’
  - Balanced distribution
- Effort Controls
  - 1996, ½ 1996, 1½ 1996
  - Rapid implementation
  - Based on historical distribution

# Catch Relative to 1996

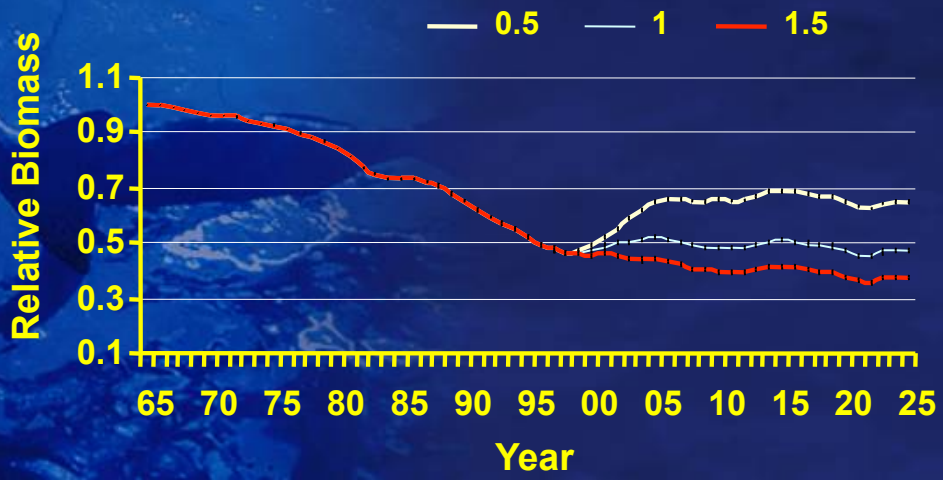
## Commercial Harvest - Current



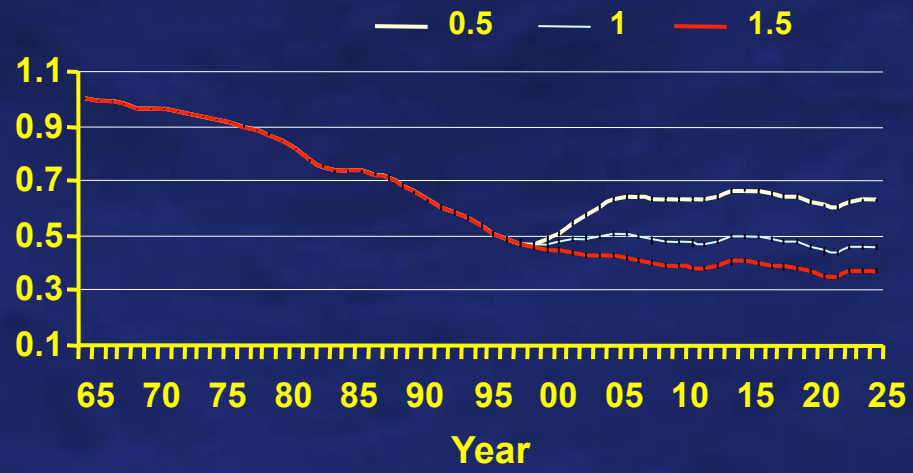

## Commercial Harvest - 30%




## Available Biomass - Current




## Available Biomass - 30%



# MSE Performance Table

## Objectives

| Strategies: Closure | Effort | Conservation: *Protected Spawners* | Stock: *Available Biomass* | Harvest: *Total Catch* | Economic: *Catch Rates* | Satisfaction: *Big Fish in Catch* |
|---|---|---|---|---|---|---|
| *Current* | 1½ | 0.35 | 0.63 | 0.95 | 0.50 | 0.08 |
| | 1 | 0.47 | 0.82 | 0.91 | 0.72 | 0.10 |
| | ½ | 0.59 | 0.96 | 0.71 | 1.10 | 0.14 |
| 30% | 1½ | 0.41 | 0.59 | 0.84 | 0.45 | 0.07 |
| | 1 | 0.47 | 0.78 | 0.82 | 0.64 | 0.09 |
| | ½ | 0.58 | 0.95 | 0.66 | 1.02 | 0.13 |
| 50% | 1½ | 0.52 | 0.55 | 0.64 | 0.34 | 0.06 |
| | 1 | 0.56 | 0.70 | 0.64 | 0.50 | 0.08 |
| | ½ | 0.63 | 0.91 | 0.55 | 0.86 | 0.11 |

**Larger Values are Better**

# MSE Performance Table

## Objectives

| Strategies: Closure | Strategies: Effort | Conservation — *Protected Spawners* | Stock — *Available Biomass* | Harvest — *Total Catch* | Economic — *Catch Rates* | Satisfaction — *Big Fish in Catch* |
|---|---|---|---|---|---|---|
| Current | 1½ | 0.35 | 0.63 | 0.95 | 0.50 | 0.08 |
| | 1 | 0.47 | 0.82 | 0.91 | 0.72 | 0.10 |
| | ½ | 0.59 | 0.96 | 0.71 | 1.10 | 0.14 |
| 30% | 1½ | 0.41 | 0.59 | 0.84 | 0.45 | 0.07 |
| | 1 | 0.47 | 0.78 | 0.82 | 0.64 | 0.09 |
| | ½ | 0.58 | 0.95 | 0.66 | 1.02 | 0.13 |
| 50% | 1½ | 0.52 | 0.55 | 0.64 | 0.34 | 0.06 |
| | 1 | 0.56 | 0.70 | 0.64 | 0.50 | 0.08 |
| | ½ | 0.63 | 0.91 | 0.55 | 0.86 | 0.11 |

**Larger Values are Better**

# MSE Performance Table

| Strategies | | Objectives | | | | |
|---|---|---|---|---|---|---|
| Closure | Effort | **Conservation** *Protected Biomass* | **Stock** *Available Biomass* | **Harvest** *Total Catch* | **Economic** *Catch Rates* | **Satisfaction** *Big Fish in Catch* |
| *Current* | 1½ | Worst | 7 | Best | 6 | 6 |
| | 1 | 6 | 4 | 2 | 4 | 4 |
| | ½ | 2 | Best | 5 | Best | Best |
| 30% | 1½ | 8 | 8 | 3 | 8 | 8 |
| | 1 | 6 | 5 | 4 | 5 | 5 |
| | ½ | 3 | 2 | 6 | 2 | 2 |
| 50% | 1½ | 5 | Worst | 7 | Worst | Worst |
| | 1 | 4 | 6 | 7 | 6 | 6 |
| | ½ | Best | 3 | Worst | 3 | 3 |

**Lower Values are Better**

# MSE Performance Table

| Strategies | | Objectives | | | | |
|---|---|---|---|---|---|---|
| Closure | Effort | **Conservation** *Protected Biomass* | **Stock** *Available Biomass* | **Harvest** *Total Catch* | **Economic** *Catch Rates* | **Satisfaction** *Big Fish in Catch* |
| Current | 1½ | Worst | 7 | Best | 6 | 6 |
| | 1 | 6 | 4 | 2 | 4 | 4 |
| | ½ | 2 | Best | 5 | Best | Best |
| 30% | 1½ | 8 | 8 | 3 | 8 | 8 |
| | 1 | 6 | 5 | 4 | 5 | 5 |
| | ½ | 3 | 2 | 6 | 2 | 2 |
| 50% | 1½ | 5 | Worst | 7 | Worst | Worst |
| | 1 | 4 | 6 | 7 | 6 | 6 |
| | ½ | Best | 3 | Worst | 3 | 3 |

**Lower Values are Better**

# Conclusions from Management Strategy Evaluations

- More no-take MPAs are not necessarily better for all objectives – but are good for conservation objective
- Controlling effort is generally more effective than increasing area of MPAs for fisheries objectives
- Fisheries 'benefits' of MPAs will depend on connectivity between MPAs & surrounding areas
- MSE Process is one tool for evaluating MPAs
- Targeted monitoring and assessment feedback are necessary others.

# Acknowledgements


- CRC Reef
- Fisheries Research & Development Corporation
- Great Barrier Reef Marine Park Authority
- Queensland Fisheries Service
- Queensland Seafood Industry Association
- Queensland charter boat associations
- Sunfish
- WWF
- North Queensland Conservation Council
- Many commercial, charter & recreational fishers