# Sustainable use of marine ecosystems

## – the search for practical ways to support and implement Ecosystem-Based fisheries management and regional development.

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# Sustainable use of marine ecosystems
## - practical ecosystem based approaches

Outline

- The reason for the journey: our use of marine ecosystems and the challenges to sustainable use

- What change is needed?

  - ecosystem based approaches to regional multiple use management and to fisheries management

- The approaches and experience with of the Australia's Oceans Policy and AFMA (Australian Fisheries Management Authority)

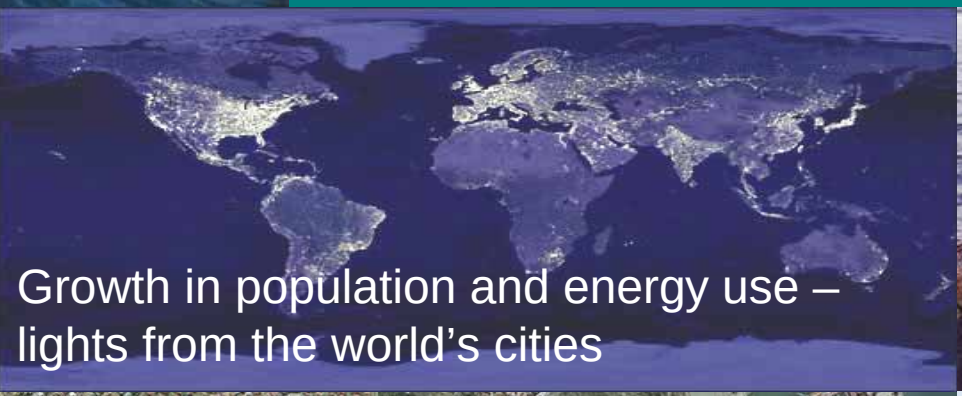
  - general setting, policy, law and governance

  - regional marine planning and management

  - the AFMA tool box for addressing ecosystem-based approaches to fisheries

  - outcomes and where to next

# The oceans, life and humans – our growing use of the ocean



Growth in population and energy use – lights from the world's cities

Fishing more species in more places with better technology

Coastal development

Coastal aquaculture

Oil and gas extraction

Size and number of ships

# The present situation

The five horsemen of the ecological apocalypse are at large:

- over harvest

- habitat loss

- pollution and contamination

- introduced species

- climate change

And climate change means we are losing the key assumption behind most current scientific methods

- the assumption of stationarity

# The challenge

Multiple pressures and impacts, not just fisheries

Species introductions and serious climate change are effectively irreversible and are best avoided

But other uses and impacts are reversible and potentially manageable

- Very few marine extinctions
- Depleted species have been recovered
- Degraded habitats and water quality have been recovered

# What will it take?

**Ecosystem Based** approaches are hoped to be the solution

- Take a whole of ecosystem perspective, not just the species or attributes directly utilised
- Maintain ecosystem function and minimise risk of irreversible change so as to maintain productivity, future options and the range of 'ecosystem service values'
- Obtain and maintain long-term socio-economic benefits
- Objectives and management is inclusive and based on a shared vision
- Economic incentives are aligned with sustainability and cost-effective management
- Management is adaptive and can adequately manage the risks from activities with the information available

**But how do we approach achieving this?**

# Ecosystem-based Management approaches

Without getting bogged down in definitions, there is a spectrum…..

**Myopic single sector management**

**Ecosystem oriented single sector management**

**Integrated regional multi-sector management**

Traditional fishery management

- target species
- single species or multi-species

Ecosystem Approach to Fisheries (EAF sensu FAO)

- Start with the fishery
- add issues of ecosystem impact

Ecosystem Based Fisheries Management (EBFM Sensu Pikitch et al)

- Start with the ecosystem services
- add fishing

Ecosystem Based management (EBM)

- Regional integrated management, multiple use management

ESD policy, Fisheries Act and AFMA fisheries

Australia's Oceans Policy and Environmental Act

# Ecosystem-based approaches in practice

Some examples I'm most familiar with:

- Australian Federal management of oceans

  - Without implication other than that is where I have been most involved in practice

1. Ecosystem Based Management

   - Regional planning and multiple-use management

2. Ecosystem Based Fishery Management

   - The federal Australian Fisheries Management Authority

# Ecosystem-based approaches in practice
## - regional Ecosystem Based Management

## Environment Protection and Biodiversity Conservation (EPBC) Act

Enables the Department of Environment and Water Resources to:

- identify and manage Threatened, Endangered and Protected species
- establish Marine Bioregional Plans
- identify and manage National Representative System of Marine Protected Areas
    - MPAs primarily for regional biodiversity management, not fishery management
- require Ministerial approval for all federal fisheries and any export of native seafood against guidelines for ecological sustainability
- require Ministerial approval for any development that could have a ‘significant impact’ on the marine environment
    - identify ‘conservation values of national significance’

# Ecosystem-based approaches in practice
## - regional Ecosystem Based Management

## Australia's Oceans Policy

- Broad and explicitly for integrated regional management – EBM
- Policy not law
- Applied only in Federal jurisdiction; most state have similar initiatives

⇨ Marine Bioregional Plan

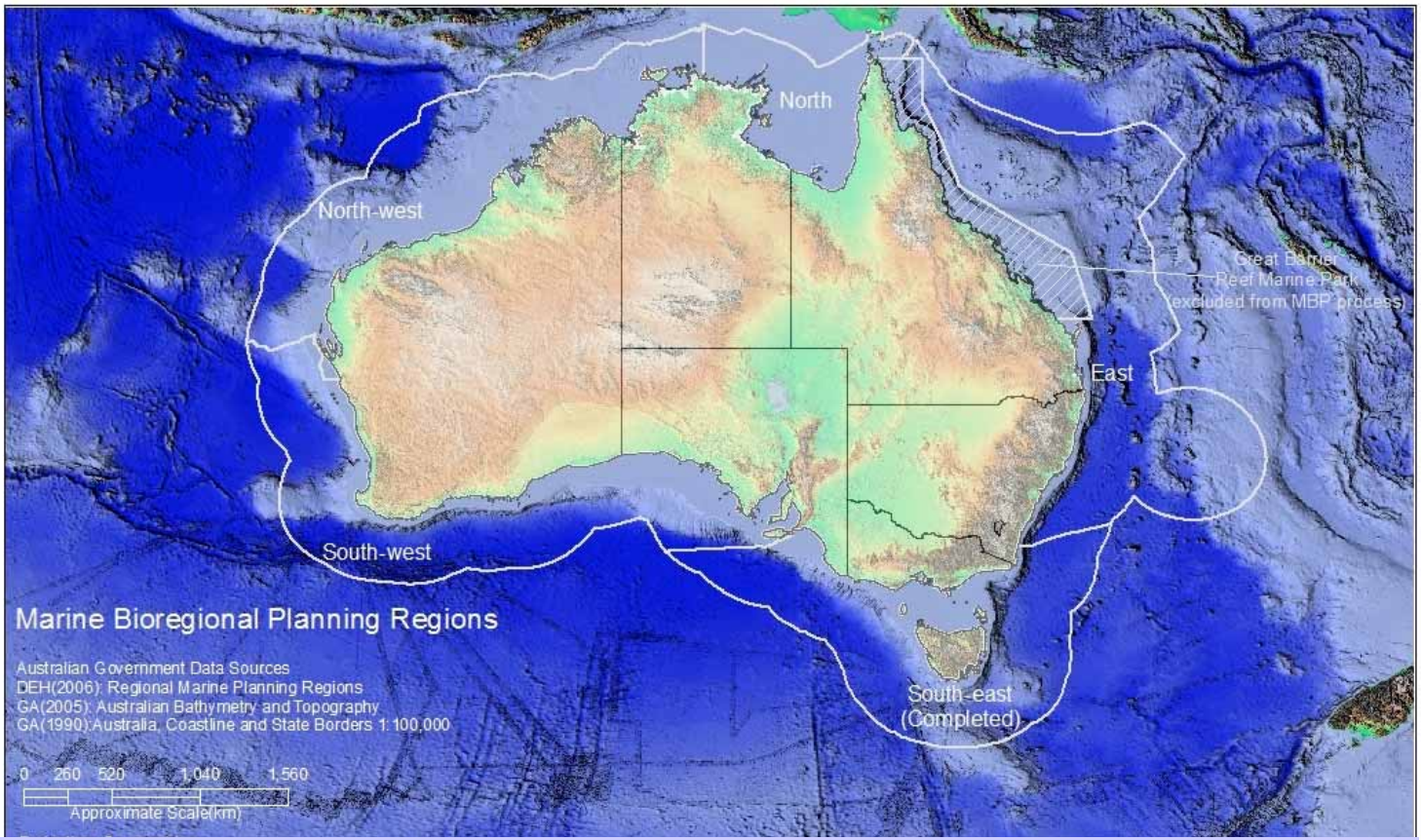
- Characterizes the environment for decisions under EPBC Act
  - Key habitats, fauna, flora, ecological processes and threats to sustainability
  - 'conservation values of national significance'
  - Guidelines on 'Significant impact'

- Changes Federal environmental programs to enhance conservation outcomes
  - socioeconomic cost-benefit

- Develops a system for performance assessment of regional sustainable development

- Identifies national system of Marine Protected Areas

# Bioregional Plan Boundaries




First plan under Oceans Policy completed in 2004
- south east bioregion
- main outcome the MPA system

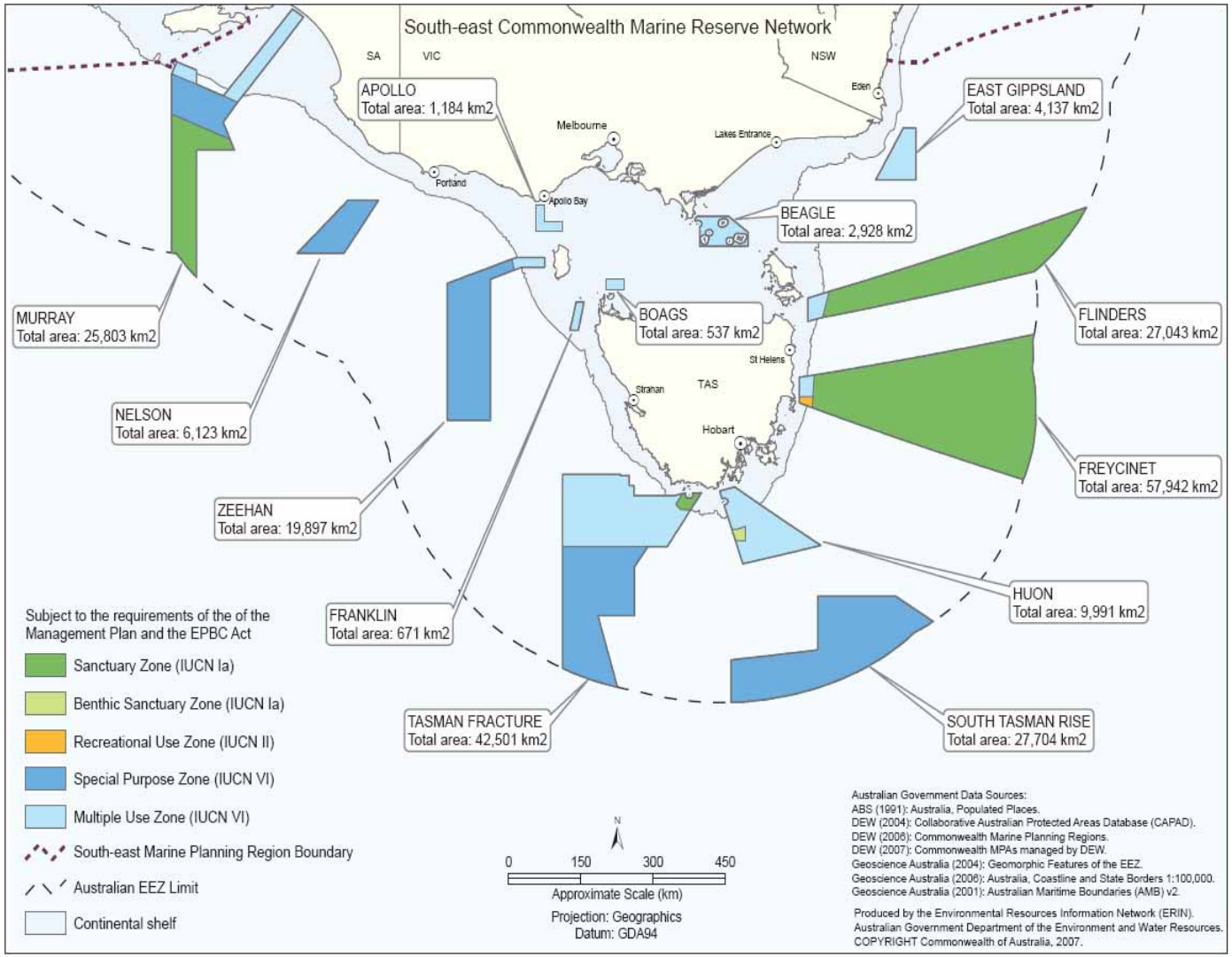
# South-east MPA network established under First Marine Bioregional Plan

Sub-bioregions for representation in MPAs based on geology, some scientific surveys, fisher knowledge.

MPA selection process with extensive public and stakeholder participation

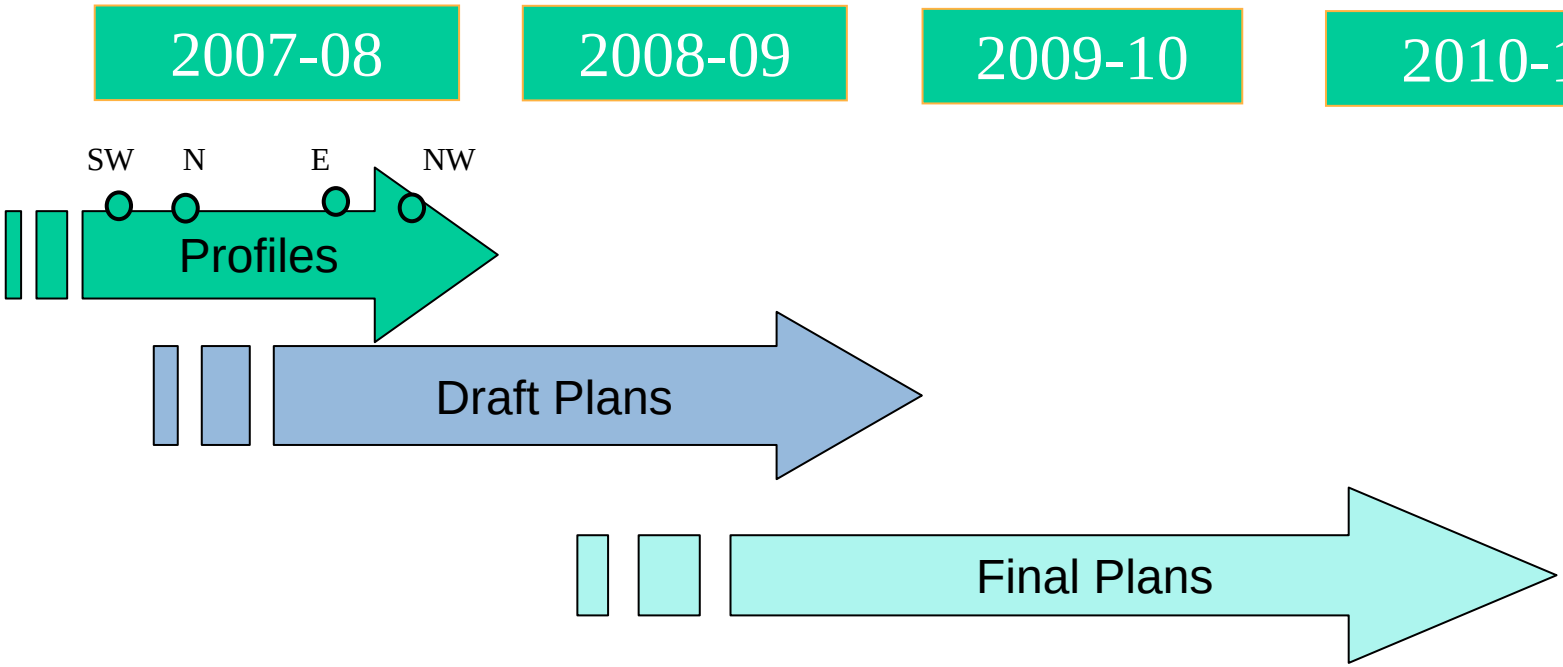
MPAs now proclaimed

Varied zoning within MPAs



# Marine Bioregional Plan Schedule

**After completion of SE plan in 2004 the process for the remaining plans has been streamlined**



# Ecosystem-based approaches in practice

## - regional Ecosystem Based Management

The experience so far has been mixed:

- the first plan under Oceans Policy took 5y and several re-writes to develop; quite painful for all
- State-Federal differences not accommodated
- no mechanism for joint planning or dispute resolution across industry sectors and associated government departments

- contributed significant new scientific information
- identified the regional MPA system

Next steps

- focus on using EPBC powers rather than just policy for remaining regions
- simplify and accelerate Bioregional Planning process
- complete national system of MPAs and identify conservation values of national significance

- likely longer-term need for new legislation to fully enable regional EBM

# Ecosystem-based approaches in practice
## - Ecosystem Based Fishery Management

1. The AFMA Management system
    - the approaches below were all developed and used in this context

2. ‘unpacking’ high level objectives to give operational objectives

3. Reference points

4. Risk assessment and risk management
    - to prioritise and address the vast array of possible ecosystem issues

5. Spatial management

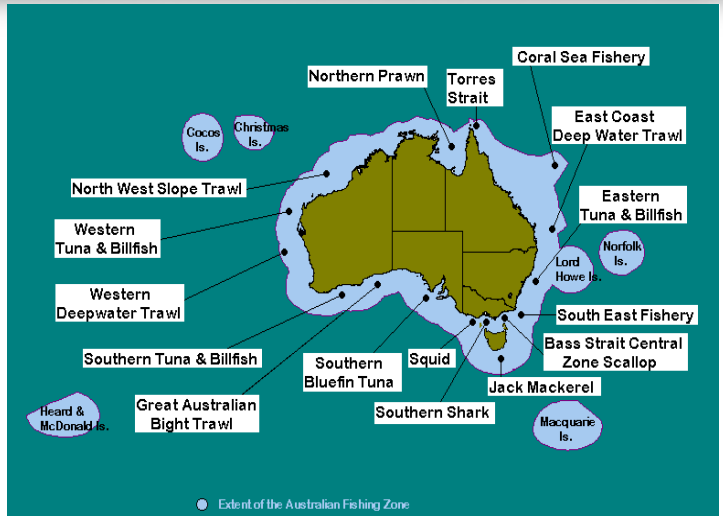
6. Harvest strategies
    - target species
    - the combination of all management measures and options (moving from EAF to ‘true EBFM”?)

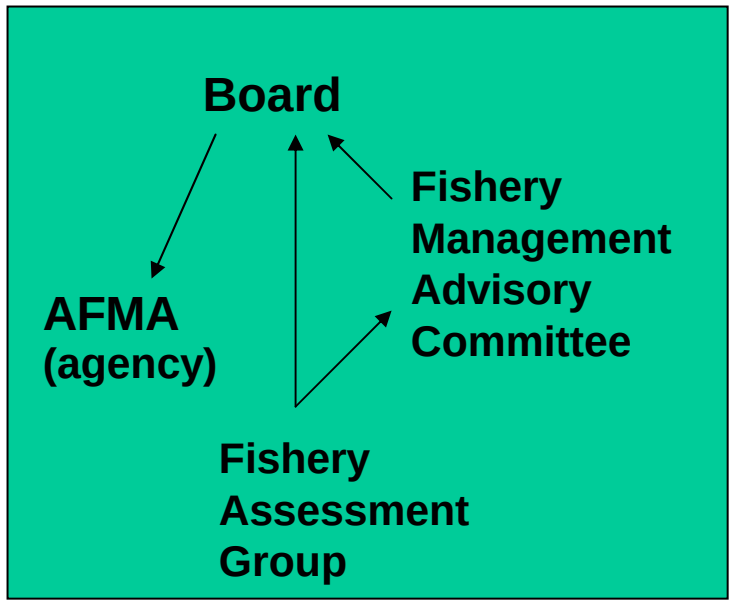
# Ecosystem Based Fishery Management

## 1. The AFMA management system

### - Structure, transparency and participation in decisions

- **Australian Fisheries Management Authority**
  - **For day-to-day management; 'arms length' from politics**
  - **Legislative objectives of ecological sustainability, economic efficiency, administrative efficiency**
- **An expertise based Board**
  - **expertise in fishing industry (not direct interest), natural resource management, marine science, business, government**
- **A partnership and approach**
  - **industry, scientific, conservation, and recreational fishing interests on advisory groups & committees**
- **Science provided independently from AMFA and reported directly to Board**
- **Rights based input and/or output controls used throughout (i.e. statutory fishing rights)**
- **Sustainability audits by Environment Dept**





# 2. ‘Unpacking’ high level objectives to give operational and practical objectives

Australia’s policy for Ecologically Sustainable Development
- Policy from 1982 and in fishery legislation from 1991
- This is essentially the Ecosystem Approach to Fisheries (EAF)
- Gave high level objectives but not operational objectives

Transparent national process used to agree the components

| **Ecological well-being** | **Human well-being** | **Ability to achieve** |
|---|---|---|
| • Retained species<br>• Non-retained species<br>• Other environmental issues | • Indigenous<br>• Local and regional<br>• National social and economic | • Governance<br>• Effects of environment & other users |

Agreed methodology to develop ‘component trees’ linking high level objectives to operational objectives

**Helpful and useful but: fisheries still very inconsistent in operational objectives and management response; and very slow to change**



# 2. ‘Unpacking’ high level objectives to give operational objectives

Clarifications to operational intention made by a Ministerial Direction and changes to the Fisheries Management Act

- defined economic efficiency and cost-effective management
- required:
  - harvest policies (decision rules) for target species
    - for provided reference points and probabilities
  - elimination of overfishing and faster recovery of overfished stocks
  - reduction of by-catch, including discards of target species
  - better management of ecosystem impacts: sustainable by-catch; risk assessment for habitats and trophic dependencies
  - satellite vessel monitoring systems
  - independent monitoring of fishing
  - fishery independent surveys
- provided $220m for restructuring the fishery
  - capacity more aligned with economic and ecological goals
- introduced in 2005
  - accelerated development and use of EAF/EBFM tools



# 3. Reference points – for target (commercial) species

Minimum requirements

- $B_{lim}$ greater than or equal ½ $B_{msy}$ or proxy 0.2 $B_0$
- $F_{lim}$ less than or equal $F_{msy}$
- Target B is $B_{mey}$, with $B_{msy}$ being an interim rebuilding target
- Target F is $F_{mey}$, with $F_{msy}$ potentially an interim rebuilding target
- Proxy for $B_{msy}$ is $0.4B_0$
- Proxy for $B_{mey}$ is 1.2 $B_{msy}$
- Probability of being above $B_{lim}$ at least 0.9 per generation time
- Can vary reference points if biological circumstances mean the defaults give higher than acceptable risk to the stock
- Can use alternative, equivalent proxies

Stocks between $B_{lim}$ and 0.75 $B_{lim}$ may be listed as Conservation Dependent under EPBC meaning the fishery recovery plan requires approval by the Environment Minister

Stocks below 0.75 $B_{lim}$ may be listed as threatened or endangered under EPBC meaning a population recovery plan will be developed by the Environment Minister



# 3. Reference points – for broader ecosystem

Very active area of development and debate

- Scientifically based and broadly accepted reference points for broader environmental impact and sustainability are a key gap in EBFM/EBM
- Being addressed in AFMA in 2 ways
  1. outcome-based reference points
  2. boundaries for risk categories in risk assessment

For 1: Project supported by AFMA and the Environment Department to give reference point options considering broader ecosystem issues for

- target species
- by-catch or incidentally damaged species
- habitats
- food-webs, including key prey species that are also target species

Developmental and guidance rather than mandated

- how ecosystem issues might be reflected in reference points for components



# 3. Reference points – for broader ecosystem

| Species | Target reference point | Limit reference point |
|---|---|---|
| All (biodiversity at species and genetic levels) | - No loss of spawning areas or local extinctions<br>- Low selective differential<br>- Small reduction in effective population size (Ne)<br>- Viable and representative species biodiversity in protected areas | - No stocks or species below genetically viable levels<br>- Effective population size (Ne) not less than half the unfished level. |
| Target | - Biomass greater than MSY | - 0.3 $B_{unfished}$ as time-varying limit and $0.2B_{unfished}$ as longer-term (2 generation time) fixed limit.<br>- $F_{MSY}$ |
| By-catch and incidentally impacted | - Zero fishing mortality, or as close to zero as feasible<br>- Minimise | - As for target species |
| Threatened, endangered or protected | - Zero fishing mortality, or as close to zero as feasible while still giving acceptable protection/recovery | - Potential Biological Removal (PBR) or similar catch/mortality level |



# 3. Reference points – for broader ecosystem

| **Ecosystem feature** | **Target reference point** | **Limit reference point** |
|---|---|---|
| Habitats | - Zero impact or as close to zero as feasible<br>- Viable and representative habitats in protected areas | - 0.3 of the unfished habitat extent and quality<br>- If habitat dependent target species then 0.6 of the unfished habitat extent and quality |
| Food-web structure and dependencies<br>- key prey species | - No clear reference points<br>- Food-web In Balance (FIB) or like indices not decreasing<br>- Viable and representative food-webs in protected areas | For key prey species:<br>- Median abundance of not less than half way between $B_{msy}$ and $B_{unfished}$<br>- 0.3 $B_{unfished}$ as time-varying limit and $0.2B_{unfished}$ as longer-term (2 generation time) fixed limit. |



# 4. Risk assessment and risk management

Ecological Risk Assessment (ERA) is a key tool for EBFM

- developed primarily by Tony Smith (CSIRO) and Alistair Hobday (CSIRO/University of Tasmania)

Used to assess impacts of fishing on target species, by-catch species, protected species and habitats

- under development for communities

Provides a prioritisation for management, research, monitoring

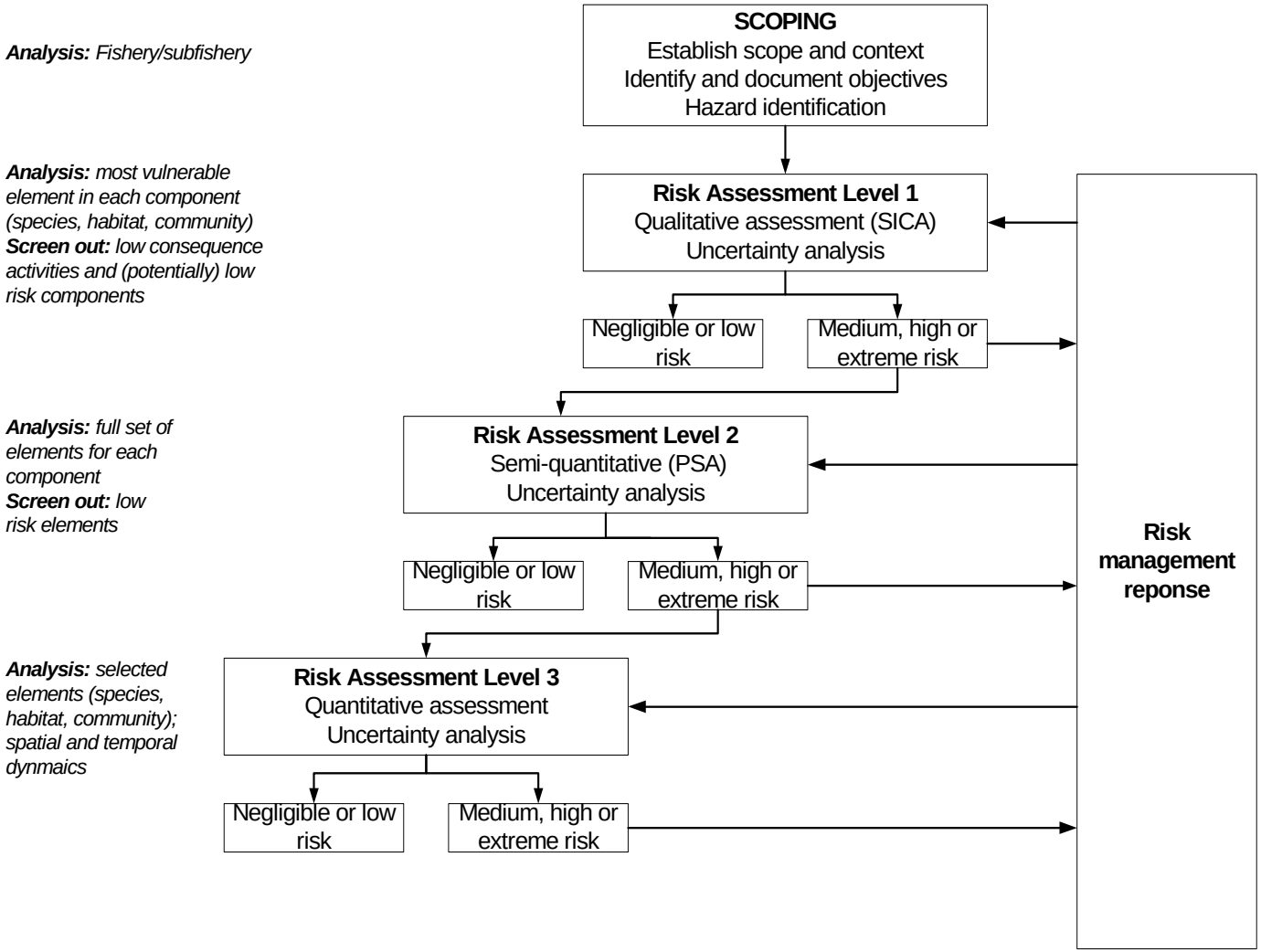
Precaution built into the ERA assessment process

# Outline of ERA approach

Hierarchical

Proceed to subsequent level depending on risk at current level

Document rationale and decisions at each level





# ERA methodology

## Level 1 - qualitative

- Scale and intensity of all activities in a fishery.
- Identify key components of species, habitat etc
  eg population size, range, age structure, reproductive capacity…
- Plausible worst case impact scenarios of activity on components
- Standardised consequence scores for risk, including precaution

## Level 2 - semi quantitative

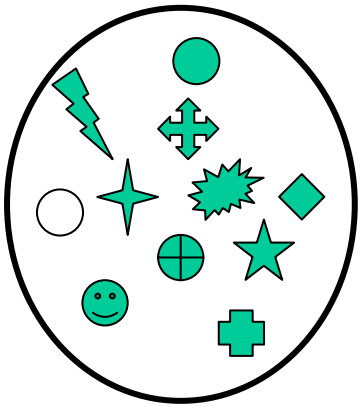
- Assessment of each species, habitat etc. for ecological productivity and susceptibility to fishing activities
- Standardised tables for productivity based on ecological properties
- Susceptibility= availability x encounterability x selectivity x post capture mortality
- Standardised scores for productivity and susceptibility, including precaution

## Level 3

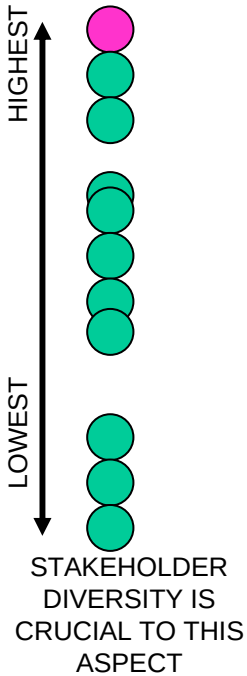
Quantitative risk assessment based on measuring abundance eg. Stock assessment, population viability analysis, ‘landscape’ model of habitat dynamics

# Level 1 rationale

A SET OF ACTIVITIES

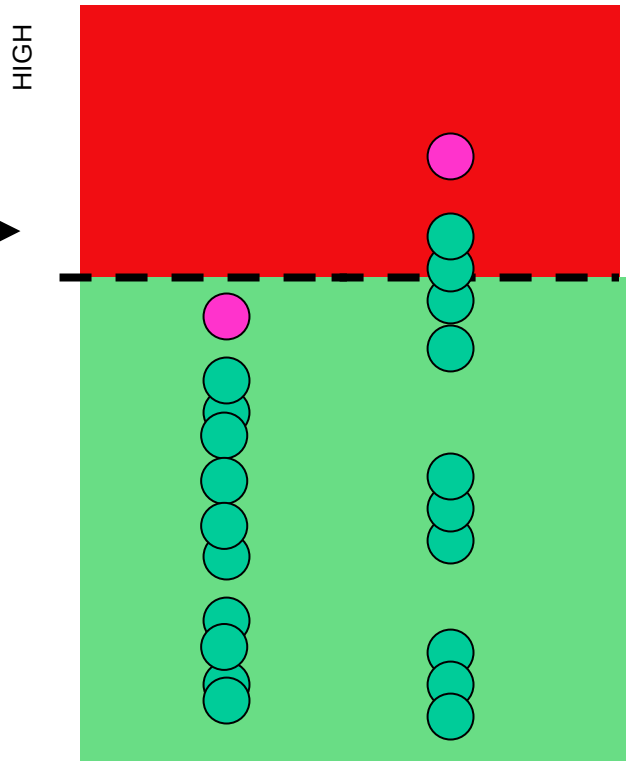


DEVELOP IMPACT SCENARIOS: FOR EACH ACTIVITY. AGREE ON THE WORST EFFECT ON ANY OF THE SUBCOMPONENTS IN THE COMPONENT




STAKEHOLDER DIVERSITY IS CRUCIAL TO THIS ASPECT

SCORE THE CONSEQUENCE OF THAT WORST SCENARIO ON THE MOST VULNERABLE SUBCOMPONENT




IF WORST IS BELOW THE LINE SO WILL BE ALL OTHERS **(safe so exclude component)**

IF WORST IS ABOVE THE LINE SO MIGHT BE OTHERS **(not safe so continue this component in ERA)**

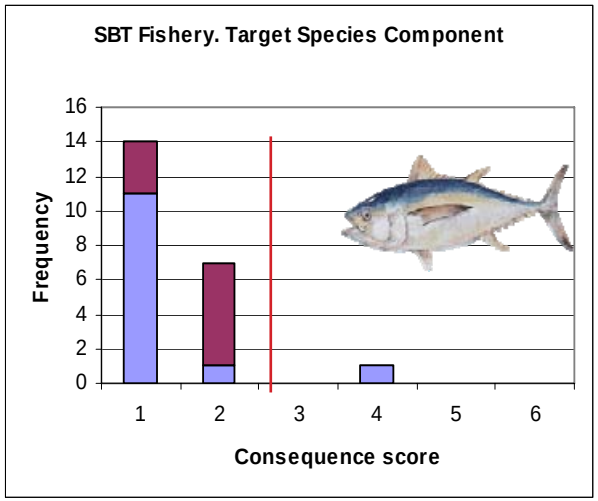
**Components are target, by-catch or TEP species, habitats etc**

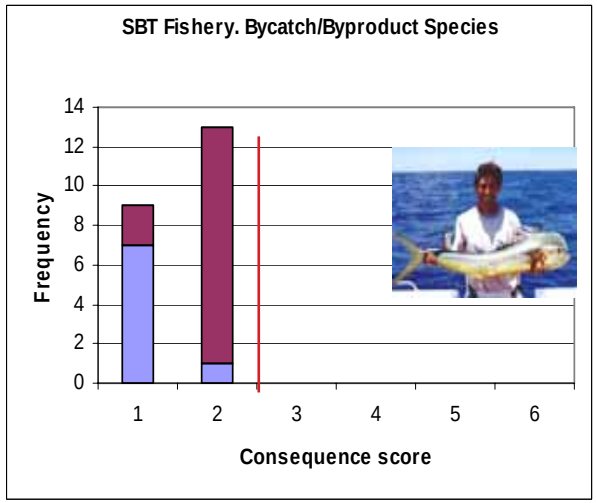
- **Select most vulnerable subcomponent**

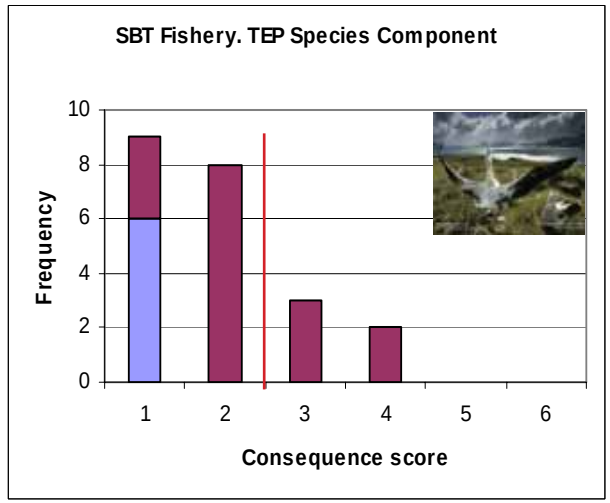
- **Use it to screen whole component**

# Level 1 – example results

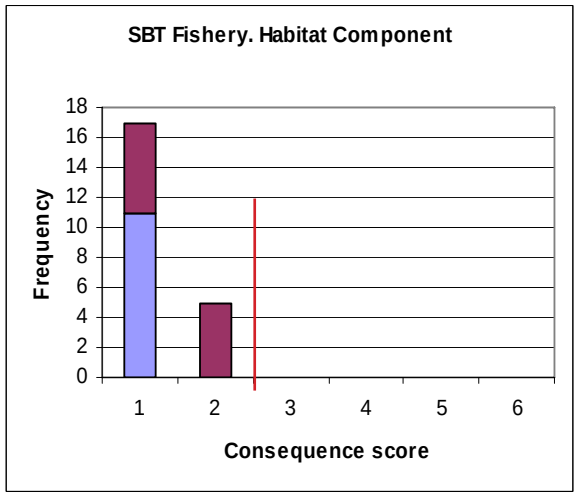
## frequency of consequence scores for sub-components in each component

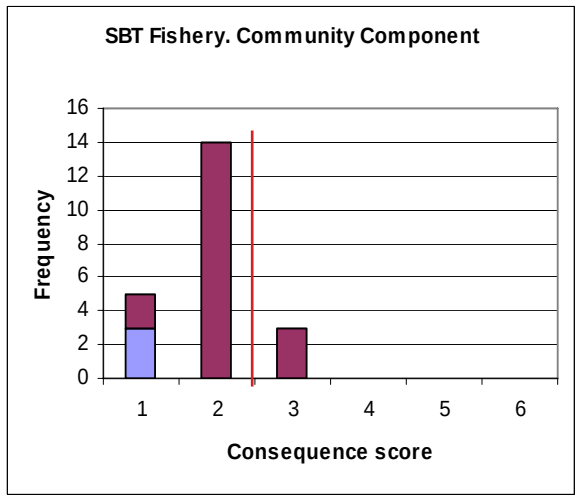



By-catch and habitats eliminated from further consideration in this example




Confidence
- Low
- High

# Level 2 rationale

Semi – quantitative approach based on the rationale of a simple growth model for the components (species, habitats etc)

$$\frac{dB}{dt} = rB\left(1 - \frac{B}{K}\right) - qEB$$

B = units of species, habitat or community components

Level 3 would solve this equation…e.g. quantitative assessment

Level 2 infers r and q from available attributes related to these terms

- Productivity (r) from ecological properties (data bases etc)
- Susceptibility (q) from fishing operations (area, gear, depth etc)
- does not require estimates of B, K or catch (qEB)

# Level 2 – example results

## Susceptibility and productivity by species, and agreed boundaries for low, medium and high risk combinations

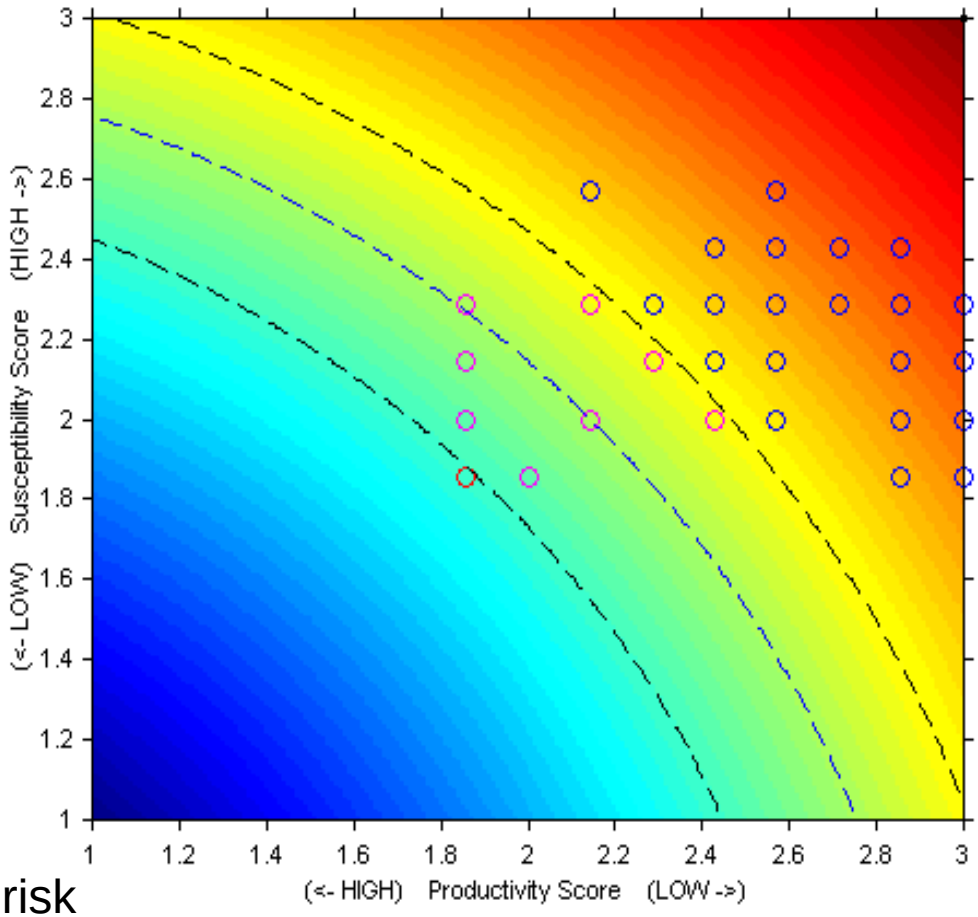
By-catch species in a demersal seine fishery

- Risk is the Euclidean distance from (0,0) to the (p,s) point of the scored component

- The high, medium and low risk categories have equal area under the cumulative distribution curve

- A risk standard under management selection similar to a reference point

high risk

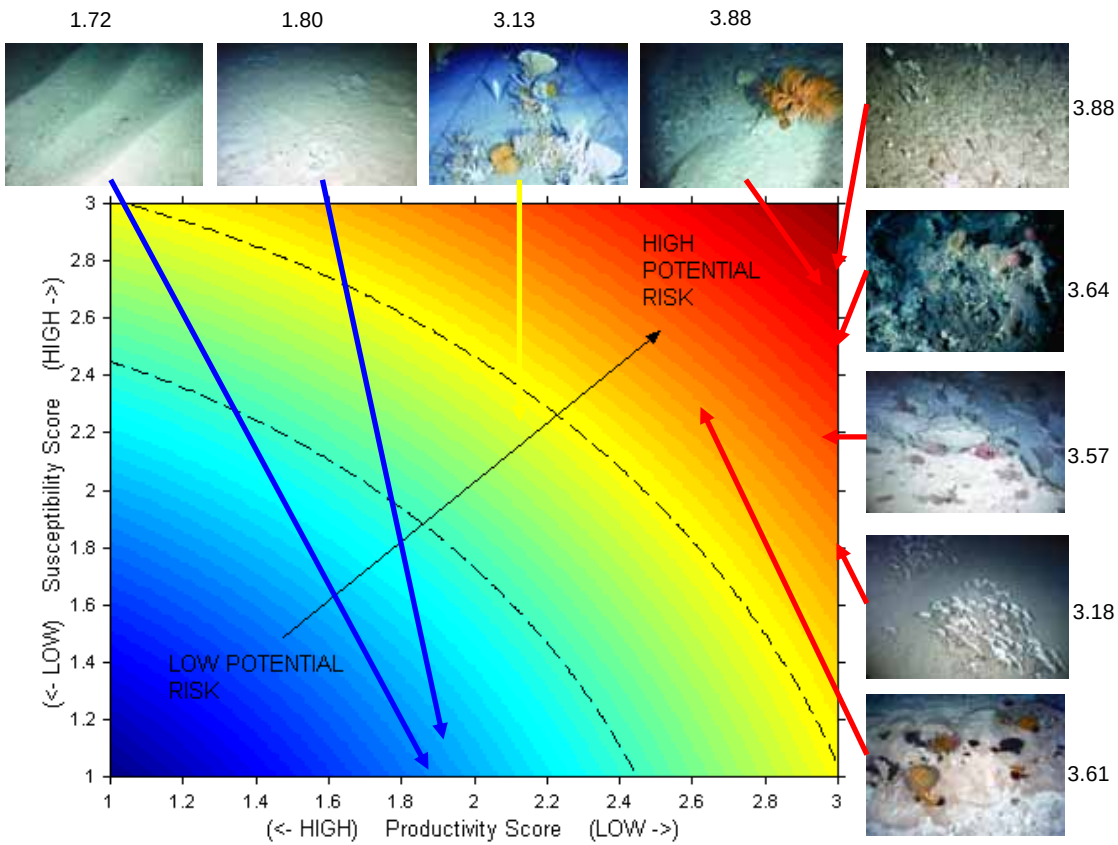



Low risk

# Level 2 – example results
## Seabed habitats

Susceptibility and productivity scores for various seabed habitats and bottom trawling

- Use of geological surrogates, scientific surveys and fisher knowledge



# Example results from full application of the ERA methodology

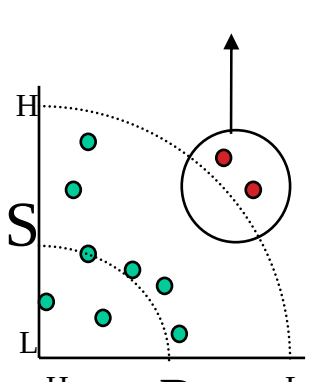
Level 3

e.g. stock assessment

e.g. Popln. Viability Analysis

e.g. ecosystem modelling

Level 2

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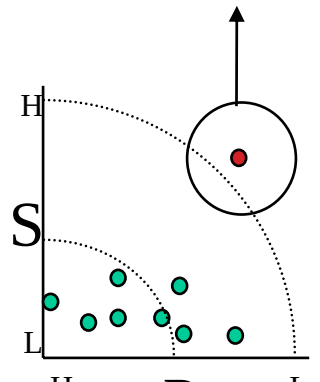


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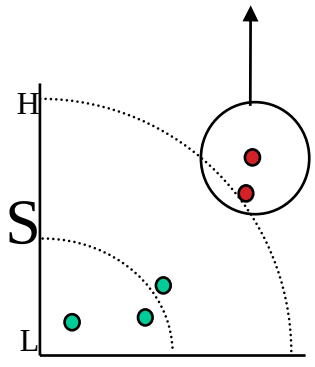
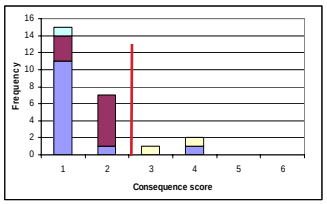
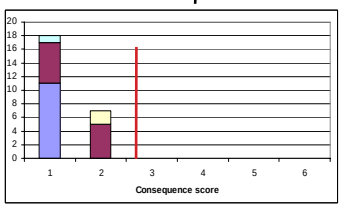


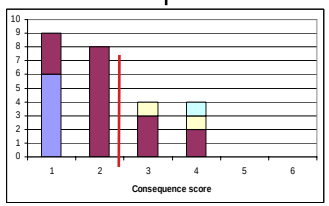

Level 1



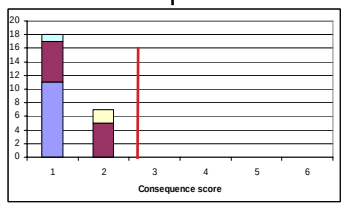

Target



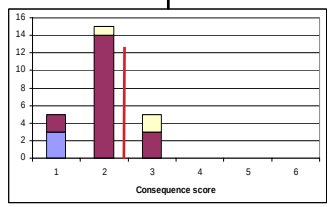

Bycatch




TEP




Habitats




Communities

Scoping

**Fishing Activities**

# 4. Risk assessment and risk management

ERA applied to…..

- 14 fisheries and 25 sub-fisheries
- 3160 Taxa, 2500 Species
- Over 1400 species assessed at Level 2
- Database on 68 productivity/susceptibility attributes for 1400 species

  - In one shrimp fishery over 500 species considered, less than 30 found to be at high risk by level 2, and less than 10 at level 3



# 4. Risk assessment and risk management

**Risk Management response for all high risk components**

- Some risks can be cost-effectively managed at ERA levels 1 and 2

- Only move to additional information, quantitative assessment, more complex management intervention if it is cost-effective

- Immediate responses to mitigation developed by task team and fishery Management Advisory Committee, Board
  - gear modifications, closed areas, operational changes
  - targeted R&D for medium term change or updated ERA

- Part of AFMA sustainability reporting

- ERA/ERM institutionalised throughout the organisation

Ecosystem Based Fishery Management

# Turning risk assessment into risk management

## - The institutionalised risk management system

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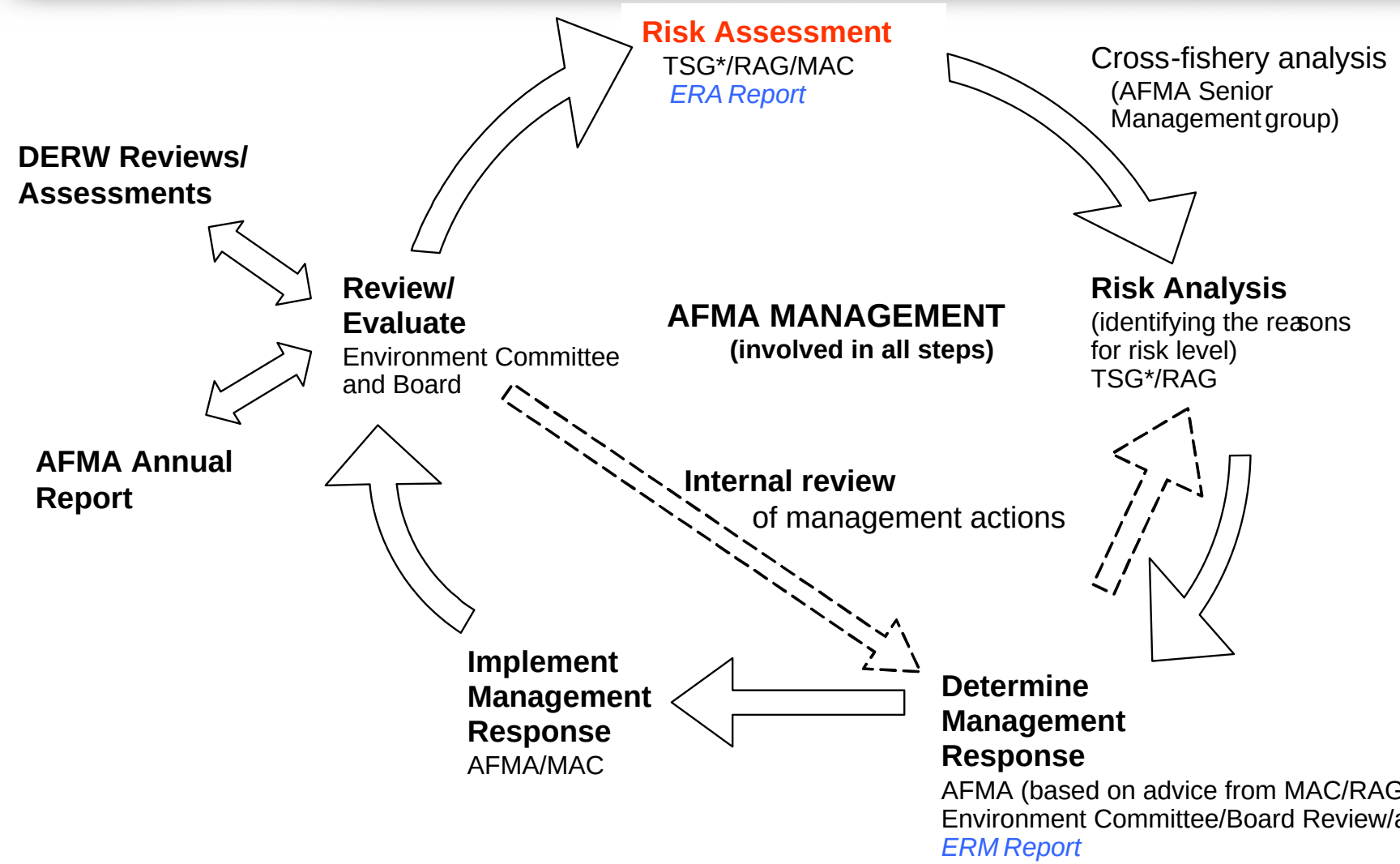




# 5. Spatial management

Spatial and temporal controls on fishing activities are useful tools for risk management under EBFM

Especially for issues related to by-catch, habitat and ecological community
- that can be difficult or expensive to address more directly
- e.g. one spatial gear restriction could simultaneously address many ecological risks without reducing catch

Spatial management can cause re-distribution of access so the basis for the measure must be well understood, well based, and ideally widely supported

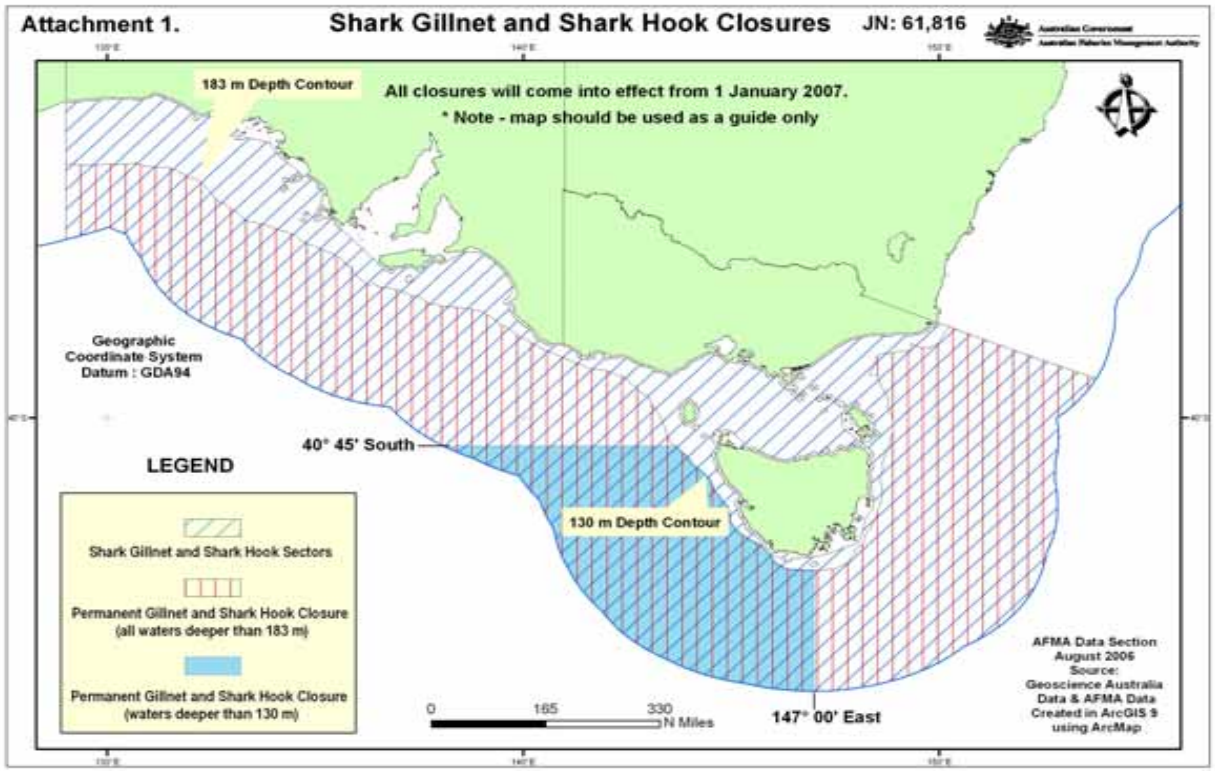
AFMA is making increasing use of spatial management to cost-effectively manage risk

Ecosystem Based Fishery Management

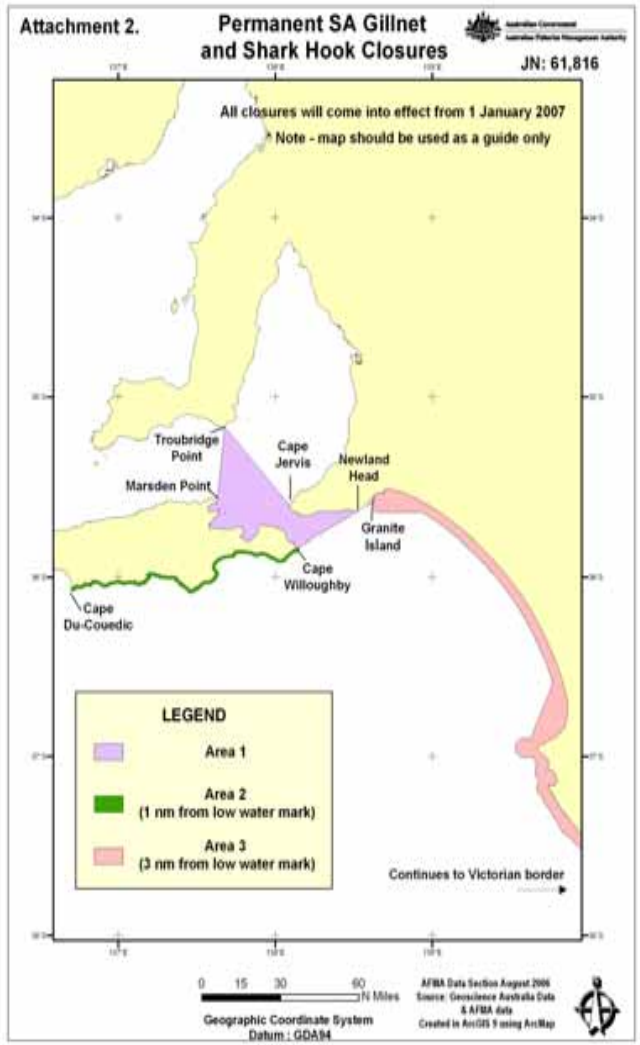
# Spatial management - Cost effective risk management of target species

**Two target shark species with different productivity**

Large scale – delivering moderate school shark catches while allowing large gummy shark catches




Small scale – breeding sites

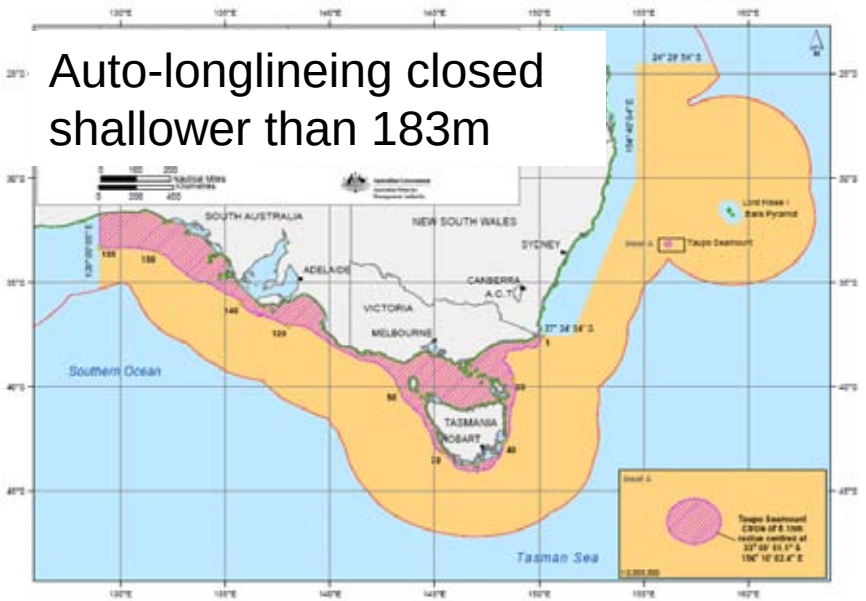


Ecosystem Based Fishery Management

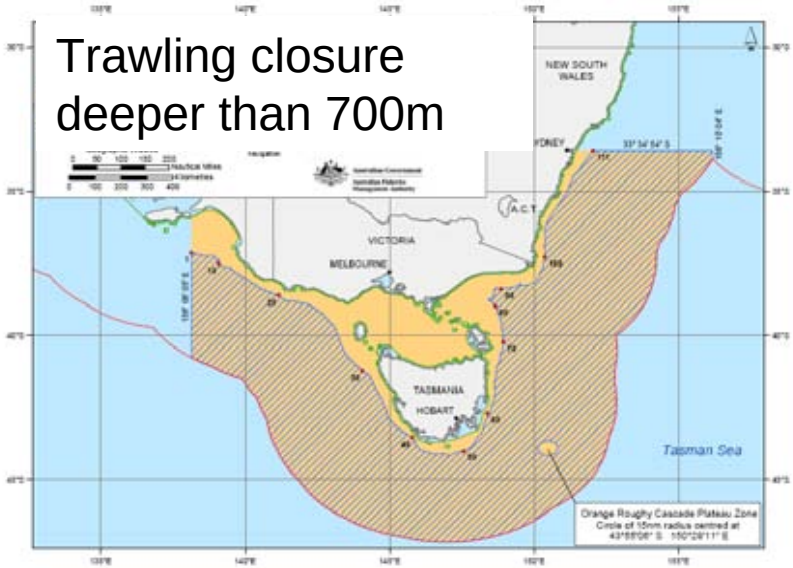
# Spatial management - Cost effective risk management of by-catch

Spatial management of gear types – by-catch management, transitions in target species management (i.e. changing selectivities from changing gear types)

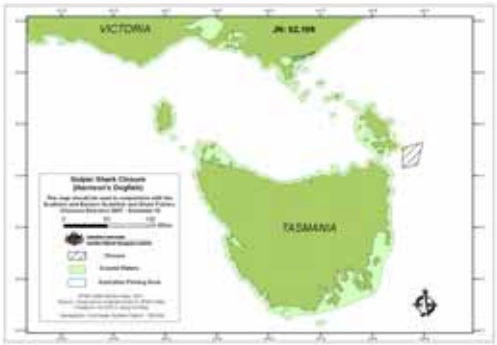
Auto-longlineing closed shallower than 183m

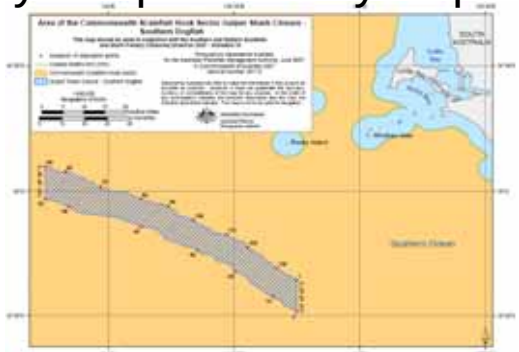



Trawling closure deeper than 700m




Closures to maintain very low productivity slope shark species

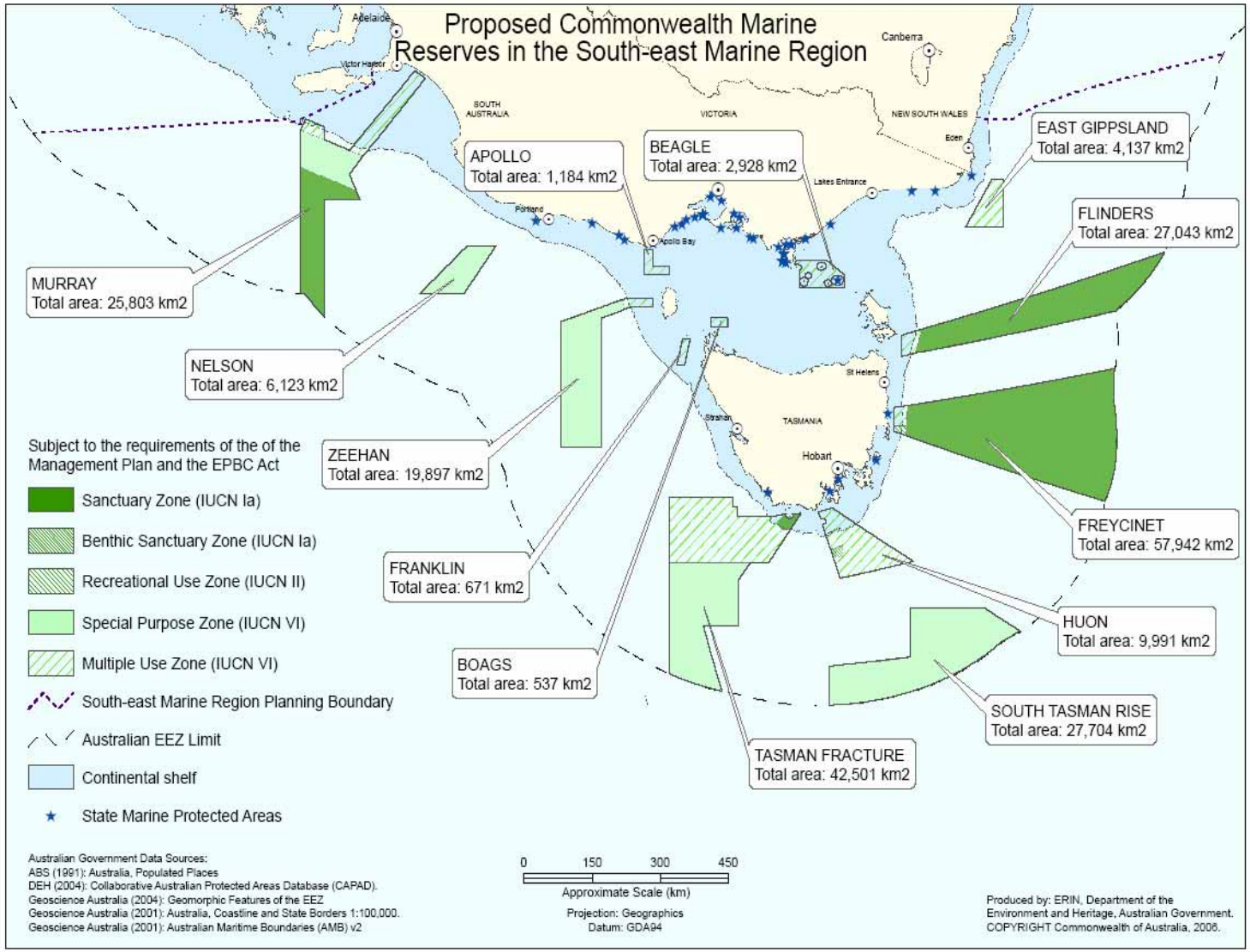


# As a fishery management overlay to the MPA system

Protection provided by MPAs included in the ecological risk assessment of fishing.

-Target species, by-catch species, habitats





# 6. Harvest strategies

Harvest strategy = monitoring + assessment + decision rule

⇨ Achieve the targets and avoid the limits

⇨ Provide transparency and certainty for stakeholders about the management response in different circumstances

⇨ Allow scientific testing that the strategy has good chance of delivering intended outcomes for the information available (Management Strategy Evaluation)

Developed for target and commercially retained species, mostly managed by catch or effort limit



# 6. Harvest strategies

- Use a 4 Tier system for dealing with uncertainty
  - -Tier 1 species have formal and agreed quantitative stock assessments;
  - - Tier 2 species have formal quantitative assessments that are less certain;
  - - Tier 3 species have catch and effort data with ageing information (e.g. catch curve analysis) or size information (e.g. age decomposition or length based assessments or indicators)
  - - Tier 4 species catch and effort data only.

- Progressively more precautionary for more uncertainty
  - - e.g. by adjusting target reference points from tiers 1 to 2

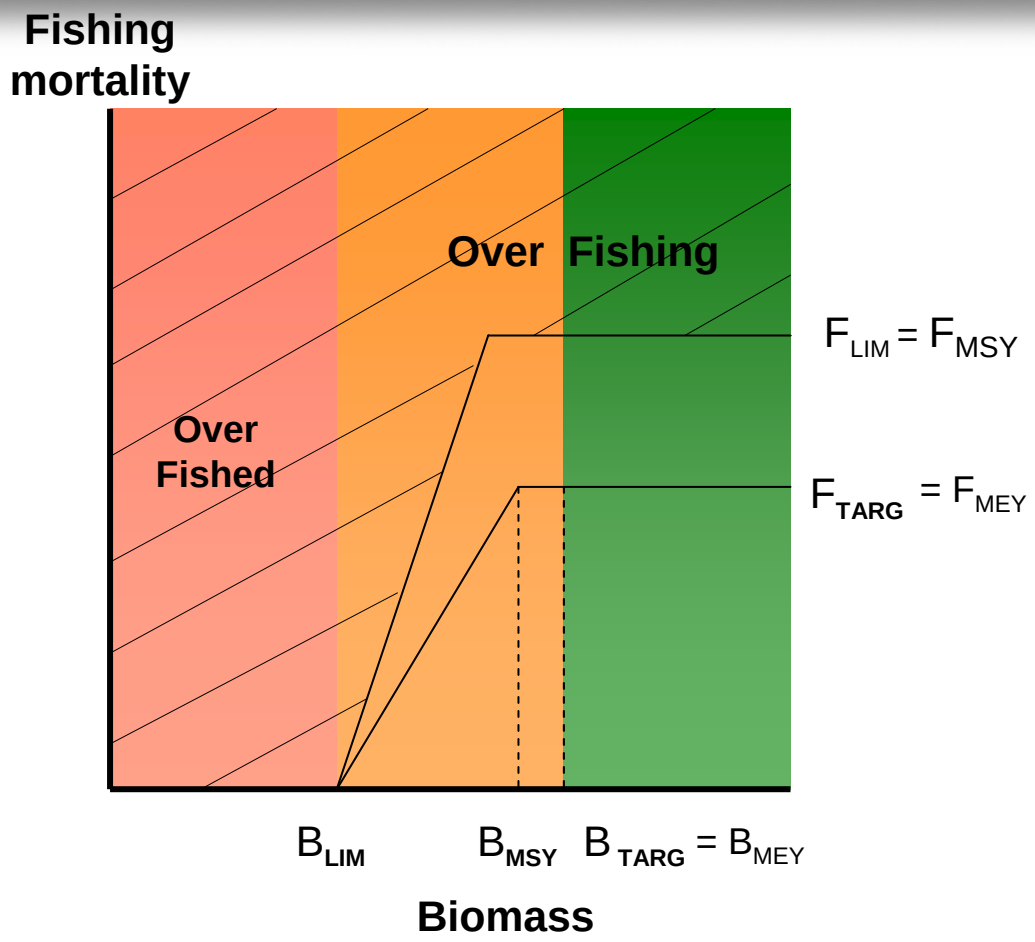
- Assessment produces a recommended biological catch (RBC) → TAC by Board decision

- Formal decision rules for Tiers 1, 2 and some variations of 3

# 6. Harvest strategies

## Decision rules for stocks with quantitative assessments

- **Maximum and target exploitation rate**
- **Minimum biomass level**
- **Catches reduce below the target biomass**
- **Targeted catches go to zero at the biomass limit**
- **Rebuilding from below BLim is to BMSY**
- **Flexibility otherwise, including how to get to $B_{MEY}$ from $B_{MSY}$**



# Ecosystem Based Fishery Management

## 6. Harvest strategies

### Decision rules for stocks without quantitative assessments

- empirical indicators
- CPUE and body weights
-Tier 3
- simulation tested to show achieves the aims of the Harvest Strategy Policy

**Swordfish**

**CPUE of Prime fish (dressed wt)**

Old Fish >150kg
Prime Fish 50-100kg
Recruits <50kg

**Rising**

**A.** If CPUE Old Fish above and Prop'n Old Fish above $SPR_{40}$
**B.** If CPUE Old Fish above and Prop'n Old Fish below $SPR_{40}$

**A. Stock Increasing or Effort Creep**
Has Recruitment been high?
Yes - No Change
No - Reduce TAE

**B. SPR Declining Effort Creep and/or Stock Increasing**
Has Recruitment been high?
Yes - No Change
No - Reduce TAE

**C. Not Possible**

**D. SPR decreasing Effort Creep or Recruitment Increasing**
Is Recruitment high?
Yes - No Change
No - Reduce TAE

**Stable**

**C.** IF CPUE Old Fish below and Prop'n Old Fish above $SPR_{40}$
**D.** If CPUE Old Fish below and Prop'n Old Fish below $SPR_{40}$

**A. All Stable or lightly fished (?)**
No Change

**B. SPR Declining Effort Creep**
Are Recruits Declining?
Yes - 2x Reduce TAE
No - Reduce TAE

**C. Recruitment decline or transition state**
Are Recruits Declining?
Yes - Reduce TAE
No - No Change

**D. SPR Declining Effort Creep and/or Recruitment declining**
Are Recruits Declining?
Yes - 2x Reduce TAE
No - Reduce TAE

**Falling**

**A. Failing Recruitment**
2x Reduce TAE

**B. Not Possible**

**C. Failing Recruitment**
2x Reduce TAE

**D. General Stock decline**
3 x Reduce TAE

# 6. Harvest strategies

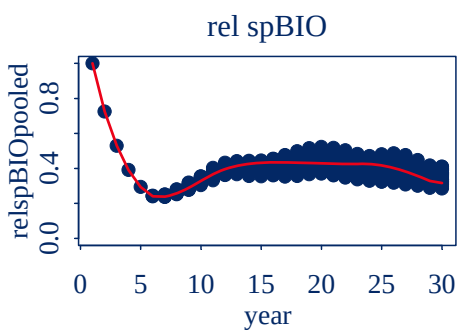
## Decision rules for stocks without quantitative assessments

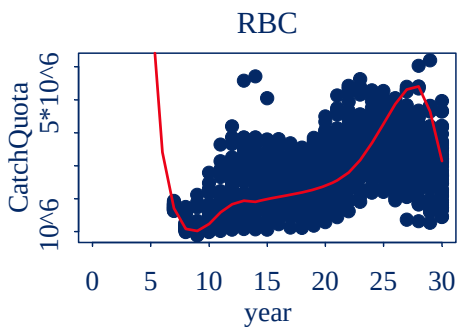
Management Strategy Evaluation simulation results of the swordfish decision rule based on empirical indicators (Tier 3) – Campbell Davies, CSIRO

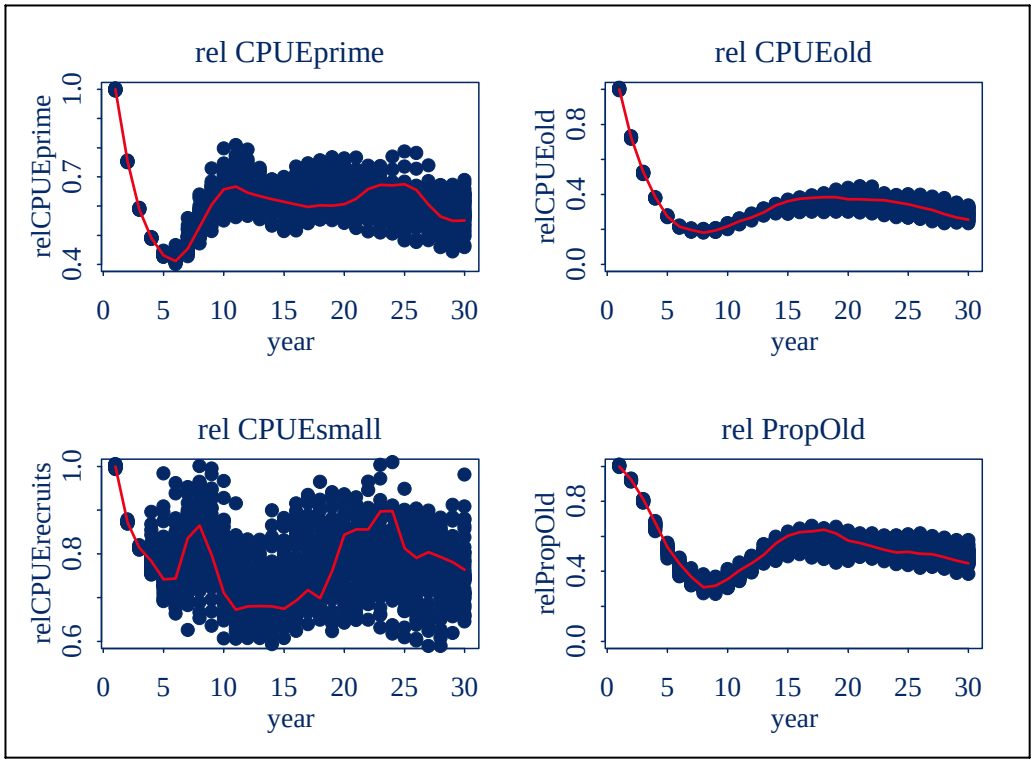
The four measured indicators

The unobserved population

The catch from the decision rule





## 6. Harvest strategies become management strategies for EBFM

Harvest strategy = monitoring + assessment + decision rule

Management strategy = combination of all the ecological risk management, spatial management, input/output controls, harvest strategies, economic incentives, monitoring, compliance, governance (e.g. co-management) and R&D used in the set of fisheries operating in the same ecosystem

EBFM involves doing all these things better individually

But also being able to look at the whole picture and make the ‘over-arching’ management selections about the mix

# Ecosystem Based Fishery Management

## 6. Harvest strategies become management strategies for EBFM

Major change needed in management for the “multi-everything” SE Australian fisheries

- with stakeholders
- with science

Alternative management strategies developed and evaluated:

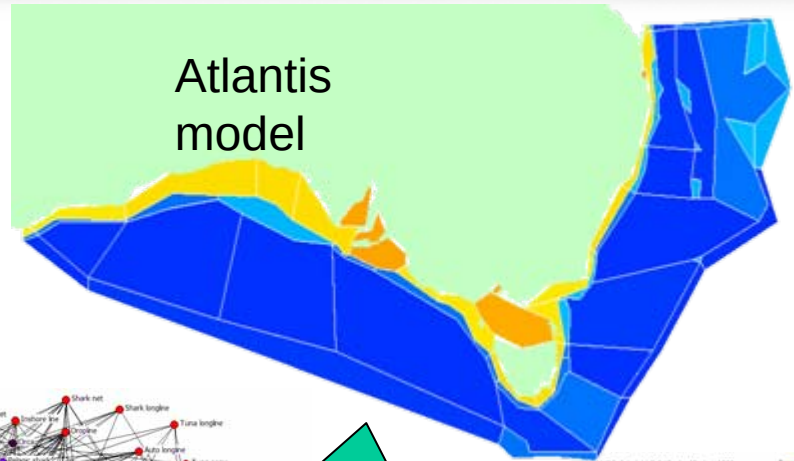
1. qualitatively by facilitated stakeholder groups
2. quantitatively by simulation testing (Atlantis model as the operating model in Management Strategy Evaluation)

- same strategy options and performance measures for both

# 6. Harvest strategies become management strategies for EBFM

## Alternative strategies

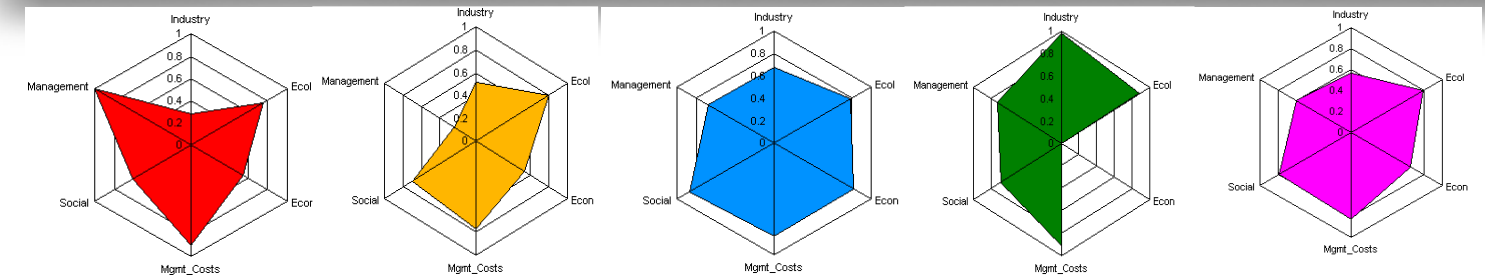
1. Status quo
2. Extend ITQs to cover everything of value and tightened up
3. Integrated strategy (zoning, gear restrictions, some ITQ changes, by-catch limitations)
4. Extensive spatial management (large closed areas and open ‘production zones’)
5. Pragmatic adjustment (tighten up on the existing measures)




oceanography, age-based population models, food-webs, sectoral fishing strategies, regional infrastructure and economics

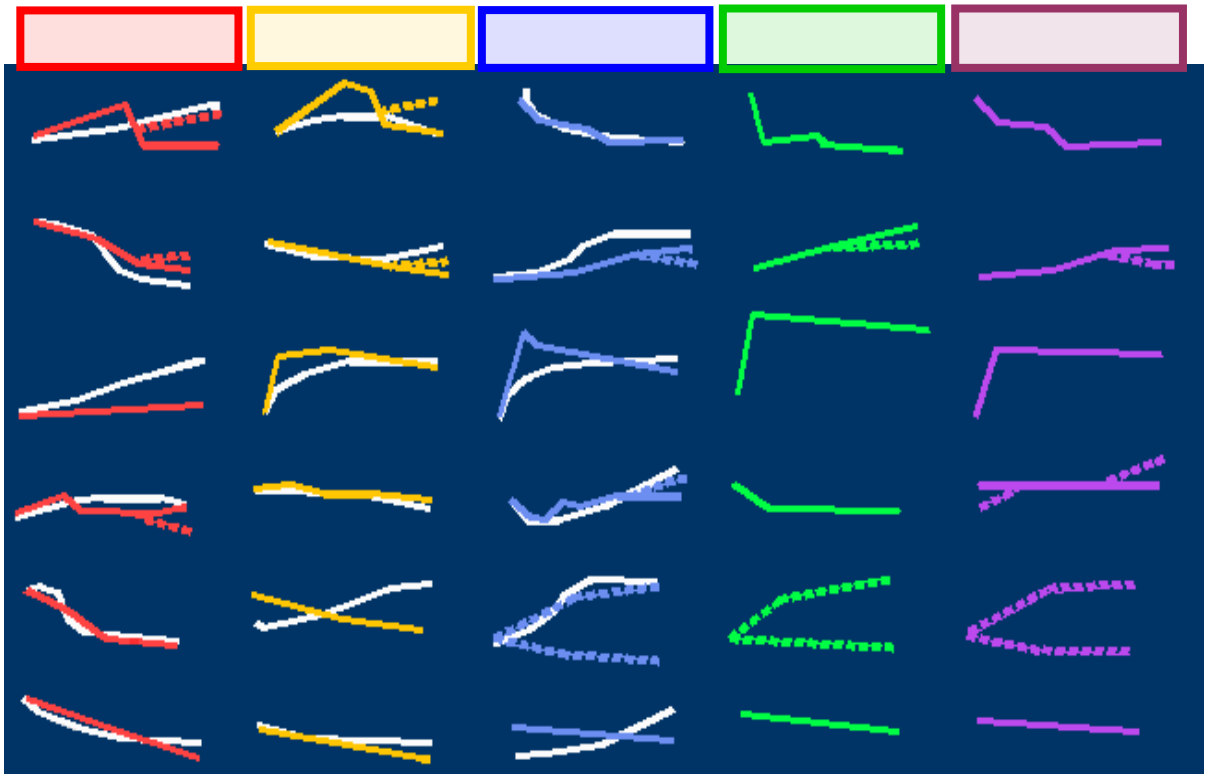
# Ecosystem Based Fishery Management

## 6. Harvest strategies become management strategies for EBFM - performance of alternative EBFM strategies




1 2 3 4 5

Modeled performance for industry, environment, economy, management costs, social value, management agency




Modeled vs qualitative predictions of time trends in indicators under each strategy



# 6. Harvest strategies become management strategies for EBFM

This process was unexpectedly and profoundly successful in several ways:

Some outlier strategies, initially added for completeness as long-term aspirations, were quickly supported

Variations on the status quo were quickly abandoned despite their inclusion having been fought for initially

The qualitative and quantitative assessments were very similar

- not scientifically independent, but dependent in a constructive way for decision making; kept both groups ‘real and honest’

The build support for a way forward through constructive and structured engagement with all stakeholders

- all knowledge had a place

Was accepted by all – industry, NGOs, AFMA staff to Board

The Integrated Management Strategy (#3) is what we are implementing



# Conclusions

Like many others AFMA is struggling to find practical ways to implement EBFM

We have small fisheries in a large area and limited management/science resources

There has been progress, which has taken

- serious support from the government in policy and in funding restructuring
- focus and innovative new approaches from science, especially in supporting relatively fast decisions with the information available
- significant engagement by stakeholders, and industry in particular, through numerous mechanisms

There is no ‘silver bullet’ apparent and all the management tools, assessment/modelling tools and stakeholder engagement tools are involved



# Conclusions

There have been demonstrable outcomes in the last 3y of focus on EAF/EBFM in a regional EBM context

- There are now no fully AFMA managed fisheries suffering overfishing, although it will take some time to recover some already overfished

- The fishing capacity has been about halved, bringing capacity more in-line with sustainable and profitable levels

- Harvest strategy policy is agreed and harvest strategies are being put in place

- By-catch species at high ecological risk have been identified and risk management is being put in place: including extensive use of zoning

- The Marine Protected Area network is being established

- Ways to further engage stakeholders at all steps are being actively pursued, including greater industry involvement and responsibility with Quality Assurance/Quality Control processes



# Conclusions

EBFM: can we do it?

We can and must

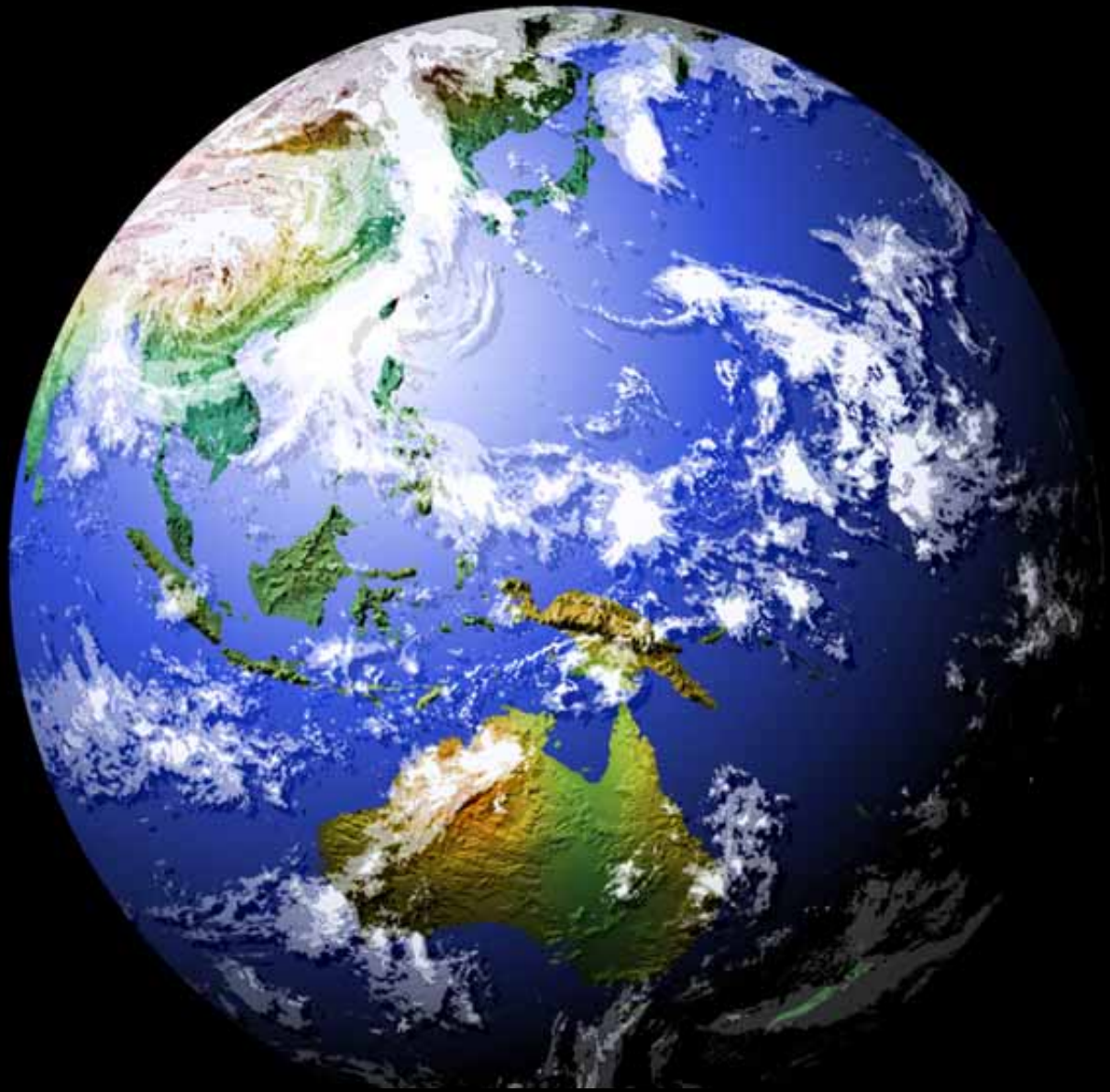
And we must be able to make a start with what we have

- we actually know a lot about the biophysical system
- the scientific methods to inform decisions
- and the management system that is necessary

We do not need to know ‘everything about everything’

- “the perfect is the enemy of the good” in this context

We just need to get on with it, and keep getting on with it!



# Ecosystem Based Fishery Management

## Various relevant websites

Commonwealth of Australia Fisheries Harvest Strategy (2007)
http://www.daff.gov.au/fisheries/domestic/harvest_strategy_policy

Australia's Oceans Policy (1998)
http://www.environment.gov.au/coasts/oceans-policy/index.html
Marine Bioregionl Planning
http://www.environment.gov.au/coasts/mbp/index.html

National Representative System of MPAs
http://www.environment.gov.au/coasts/mbp/mpa.html

Guidelines for Ecologically Sustainable Management of Fisheries (2007) for EPBC Act export approval
http://www.environment.gov.au/coasts/fisheries/publications/guidelines.html

AFMA's risk assessment and risk management approaches
http://www.afma.gov.au/environment/eco_based/eras/default.htm
http://www.afma.gov.au/environment/eco_based/eras/docs/fact_sheet.pdf



# Principles of ecosystem based approaches

**Ecosystem Based** approaches are hoped to be the solution

- Take a whole of ecosystem perspective, not just the species or attributes directly utilised

- Maintain ecosystem function and minimise risk of irreversible change to maintain productivity, future options and the range of ‘ecosystem service values’

- Obtain and maintain long-term socio-economic benefits

- Objectives and management is inclusive based on a shared vision

- Management is adaptive and can adequately manage the risks from activities with the information available



# What will it take?

Spelling this out……

- Social awareness and commitment to a sustainable future
- Being less greedy and prepared to leave more for other species, future human generations and a fully functional ecosystem
- Transparent and participatory decision-making
- Anticipatory and precautionary decision-making
- Decision-making that emphasises long-term outcomes and benefits, not just short term
- Clear limits and standards for sustainable impacts and use
- Regulators that use appropriate input and/or output controls
- Regulators capable of implementing decisions
- Managing safely within our understanding

  - recognise uncertainties and their effects
  - manage uses within acceptable limits despite uncertainty

# Qualitative AMS

- Scenarios
  - status quo (pessimistic)
  - status quo (optimistic)
  - quota focus
  - integrated management

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  - ITE, gear limits, fine-scale spatial (industry idea)
  - integrated with more quota, less spatial
  - regional + basket quotas, some spatial
  - integrated, zoning, biodiv closures + buy-back
  - climate change and closures (NGO idea)

# Scenario Summary

**Status Quo** - effort high, push into marginal areas until economic collapse; shift in targeting to extreme trophic levels, system and public opinion collapses

**Quota on Everything** - effort high until fleet adjust (economically driven); deepwater unprofitable so shift to shelf; overcatch issues; trawl benefits most

**Integrated Management** – fleet re-adjust quickly; footprint concentrated on hot-spots; byproduct quota critical; discarding issues; gear switching not common; good all-round

**Conservation Driven** - closures very restrictive; strong recovery; significant industry and human cost

**Pragmatic Reality** - ban on discards has large implications (grounds, constraining byproduct TAC, discontinuity in indicators, product quality, volume of trades); patchy success



# Habitat model and reference points

**Harvesting a species dependent on a habitat mix when the habitat can be altered by fishing**

$1/B\ dB/dt = r(1- B/K)- qE = r(1- B/D\Sigma a_i H_i)- qE$ where D is a proportionality constant, $a_i$ is the preference for habitat i (e.g. relative density in habitat i without fishing) and $H_i$ is the relative area of habitat i

$MSY = rK/4 = rB_0/4 = (rD\Sigma a_i H_i)/4$

$F_{MSY} = r/2$ (ie independent of $H_i$)

$B_{MSY} = K/2 = B_0/2 = (D\Sigma a_i H_i)/2$

E.g. if just one habitat used

$B_0 = DaH_{unfished} = K_{unfished}$

Fish at $F_{MSY}$ and expect to achieve $B_{MSY} = K/2 = DaH_{unfished}/2$

But habitat changed to $H_{fished}$ so instead achieve $B = DaH_{fished}/2$

To avoid depletion below $0.2B_0$ then

$DaH_{fished}/2 > 0.2\ B_{unfished} = 0.2DaH_{unfished}$

$H_{fished} > 0.4\ H_{unfished}$

Similarly to maintain above $0.3B_0$ then $H_{fished} > 0.6\ H_{unfished}$

And this is just to avoid the limit RP, not to maintain the productivity and yield from the dependent species