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Ecological risk assessment for the effects of fishing

A.J. Hobday[a,*,1], A.D.M. Smith[a,1], I.C. Stobutzki[b,2], C. Bulman[a], R. Daley[a], J.M. Dambacher[a], R.A. Deng[b], J. Dowdney[a], M. Fuller[a], D. Furlani[a], S.P. Griffiths[b], D. Johnson[c], R. Kenyon[b], I.A. Knuckey[d], S.D. Ling[a,3], R. Pitcher[b], K.J. Sainsbury[a], M. Sporcic[a], T. Smith[c], C. Turnbull[e], T.I. Walker[f], S.E. Wayte[a], H. Webb[a], A. Williams[a], B.S. Wise[g], S. Zhou[b]

[a] Wealth from Oceans Flagship, CSIRO Marine and Atmospheric Research, Castray Esplanade, Hobart, Australia
[b] Wealth from Oceans Flagship, CSIRO Marine and Atmospheric Research, Middle St, Cleveland, Australia
[c] Australian Fisheries Management Authority, Canberra, Australia
[d] Fishwell Consulting, Victoria, Australia
[e] Queensland Department of Primary Industries, Brisbane, Australia
[f] Primary Industries Victoria, Australia
[g] Department of Fisheries, Western Australia, Australia

CSIRO

EFAEF in Australian and beyond

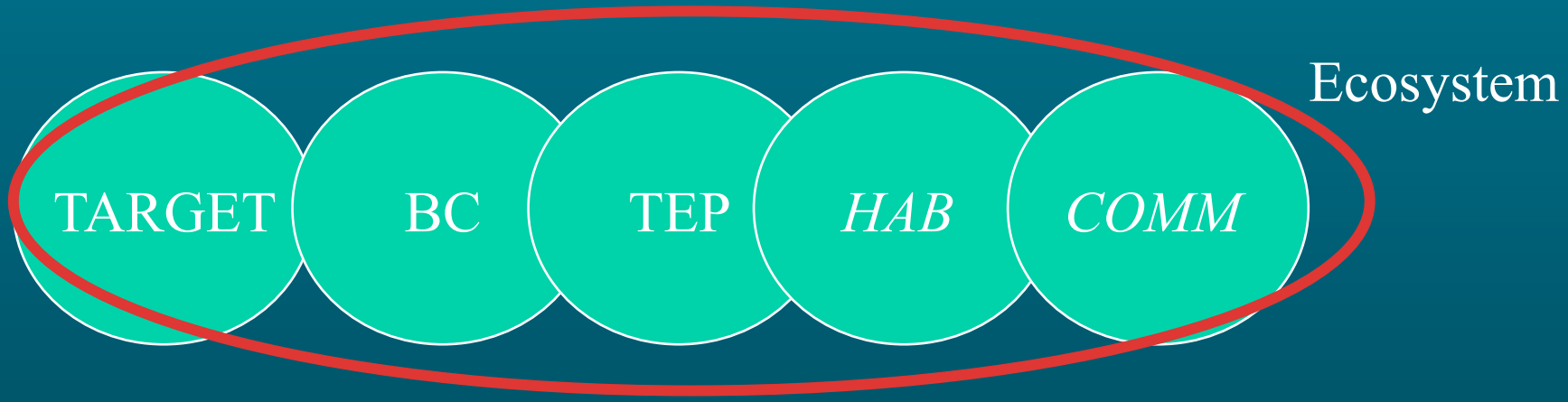
- Applied to more than 30 fisheries around continental Australia
- 4 Sub-Antarctic fisheries (supports MSC re-accreditation)
- MSC use SICA, PSA framework for all fisheries
- Data poor fisheries e.g. Galapagos Islands
- MSC pre-assessment reports e.g Pacific Dogfish

Scope of this talk

- Terminology
- Outline of approach
- Practical application of methods – examples
- Data Requirements

Terminology

- ERAEF Approach: ERA for Effects of Fishing
- Sub-fishery: defined by gear and area
- Activities: what the fishery does (fishing, anchoring)
- Units of analysis: species list (other)
- Components: groups affected (target, bycatch, other)
- Levels of analysis: 1 to 3 (increasing data needs)



Need for an alternative approach

- Many species
- E.g. snapper sub-fishery, > 60 target species
- Traditional stock assessments?
- Requires time series data
- Expensive
- Takes years to establish trends

ERAEF – Screening

- Level 1:
  - Most vulnerable species - each component
  - May include other activities (not just capture fishing)
- Level 2:
  - Normally only capture fishing assessed
  - Components treated separately
  - Species list for each component
- Level 3: More detailed methods if required
- Management response at different levels
- Focuses resources where risks are higher

Scoping

- Scoping provides a foundation for all levels

- For each subfishery
- Summarise general fishery characteristics
- Identify activities: (e.g. fishing, anchoring)
- Define units of analysis: species list (other)
- Group units into components: target, bycatch, other

- Carefully define objectives

Carefully defined objectives

- Likely to differ between components

- Target component e.g. maintain population level
- Bycatch species e.g. reduce volume and diversity
- Protected species
  - e.g. avoid disruption to turtle breeding

Level 1 SICA
Target species example

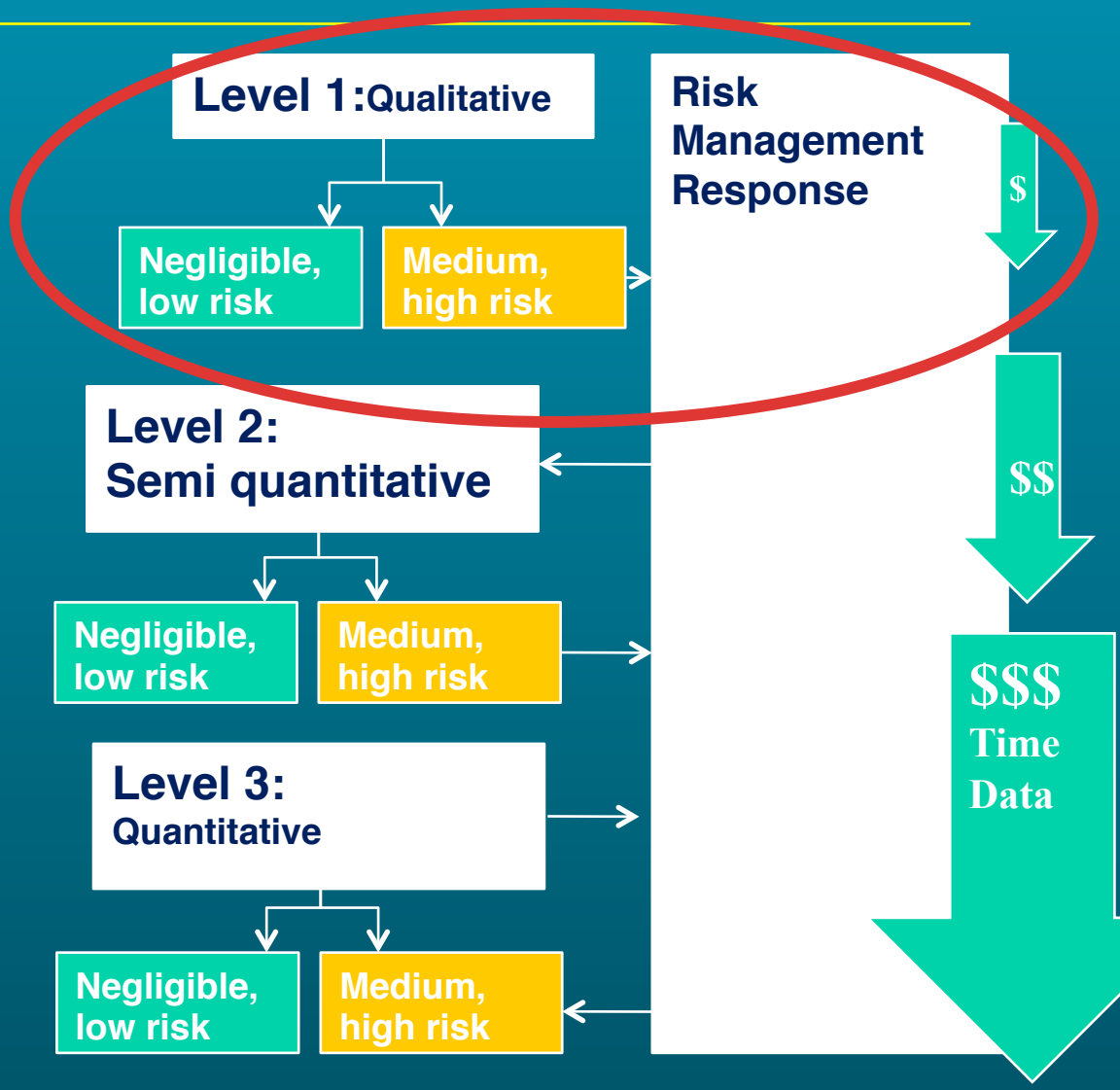
- Sub-fishery: Saint Cruix Trap
- Activity: Capture fishing
- Component: Saddle-tail snapper *Lutjanus malabaricus*
- Objective: Maintain biomass above 30% initial levels

Evaluate scenarios:

- Scale: Distribution and effort across bank
- Intensity: Multiple vessels fishing daily
- Consequence: Moderate (localised impact but potential to reduce stock size)

Level 1 – Screening

- Score results
- Repeat for each scenario
- Prepare summary table
- Screen out components, activities
- Look at examples



Level 2 PSA – Capture fishing
(Productivity Susceptibility Analysis)

- To date looks at capture fishing only
- Looks at each species (unit) within a component
- Assumes risk depends on two characteristics of the species
  - Productivity – ability to recover (intrinsic, biological)
  - Susceptibility – “exposure”, fishery dependent

Productivity attributes

- Maximum age
- Age at maturity
- Size at maturity
- Annual fecundity
- Maximum size
- Reproductive strategy
- Trophic level

- Data sources: literature, PSA database, close relatives

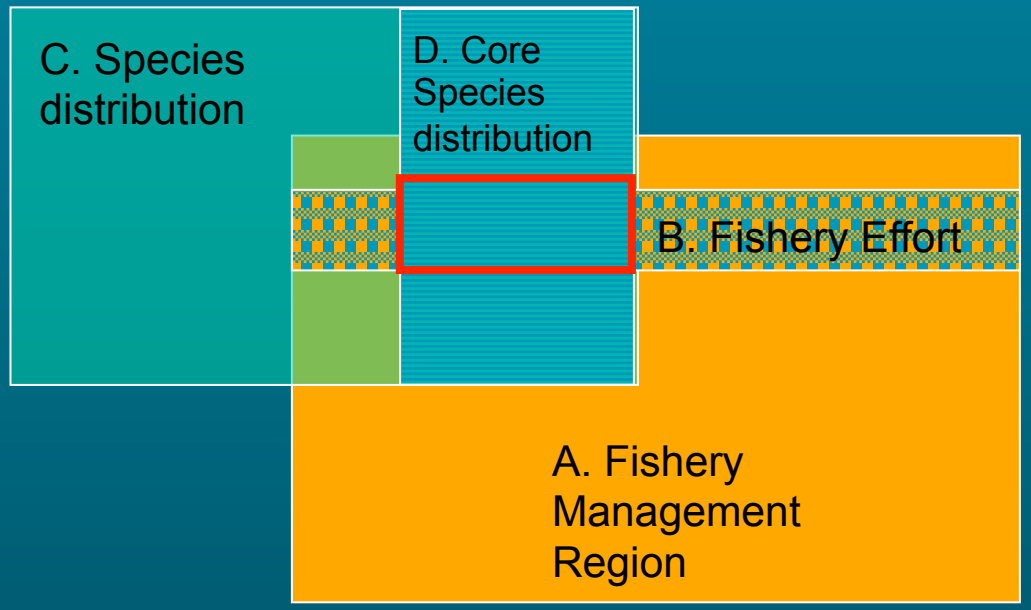
Susceptibility attributes

- Availability: proportion of species range that overlaps with the fleet
- Encounterability: looks at overlap vertical dimension
- Selectivity: if a species encounters the gear can it escape?
- Post capture mortality: if a species is released will it live?

- Data sources: catch and effort data, database

Availability scoring

- Score the overlap of core species distribution (D) with core fishing effort (B) (red square)



If no effort/catch picture…

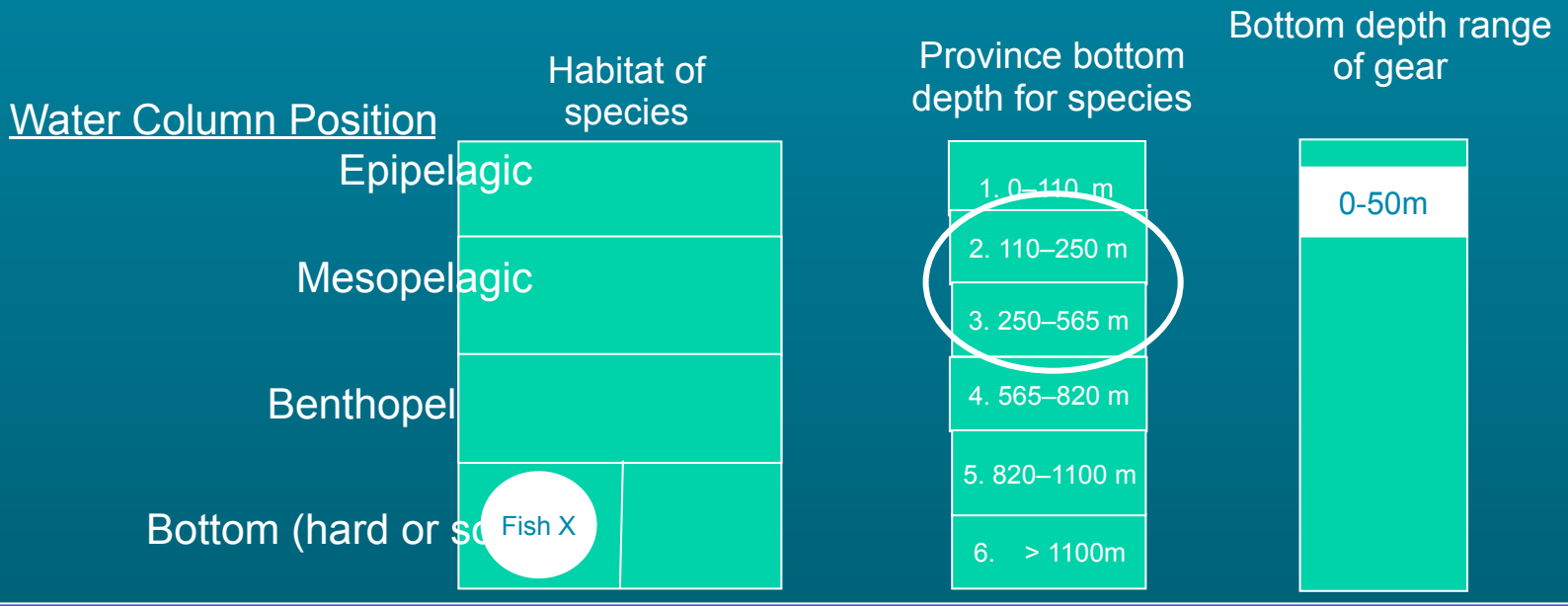
Use worldwide distribution

- Worldwide (low availability to fishery)
- Southern hemisphere (med availability to fishery)
- Endemic (highest availability to fishery)

- Often applied to pelagics e.g. tunas

But also consider likelihood of separate stocks

Encounterability Scoring



Scoring Example:

Risk: H
Bottom species living on soft ground
Overlap with demersal gear on soft ground is High

Bathymetry check

Risk: L
Depth range for the species is outside the depth range of the fishery: encounterability score is corrected to Low

Selectivity

Selectivity is a measure of the proportion of animals encountering the fishing gear that is captured.

Attributes related to selectivity :

- Size
- (Morphology)
- (Swimming capability)

Scoring set by thresholds

e.g. mesh size 6 inches, species size at maturity 3 inches, risk low

Post-capture mortality

Post-capture mortality is a measure of the proportion of animals that die as a result of interaction with activity (e.g. caught in the fishing gear).

To date based on observer data

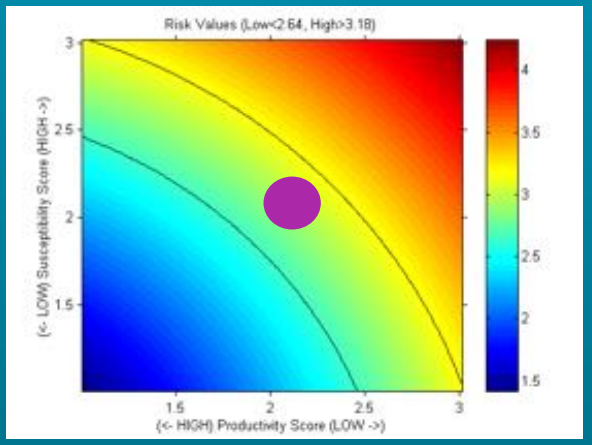
PSA data analysis

Catch susceptibility =
Availability x Encounterability x Selectivity x Post-capture mortality

Productivity – additive, attributes are not independent

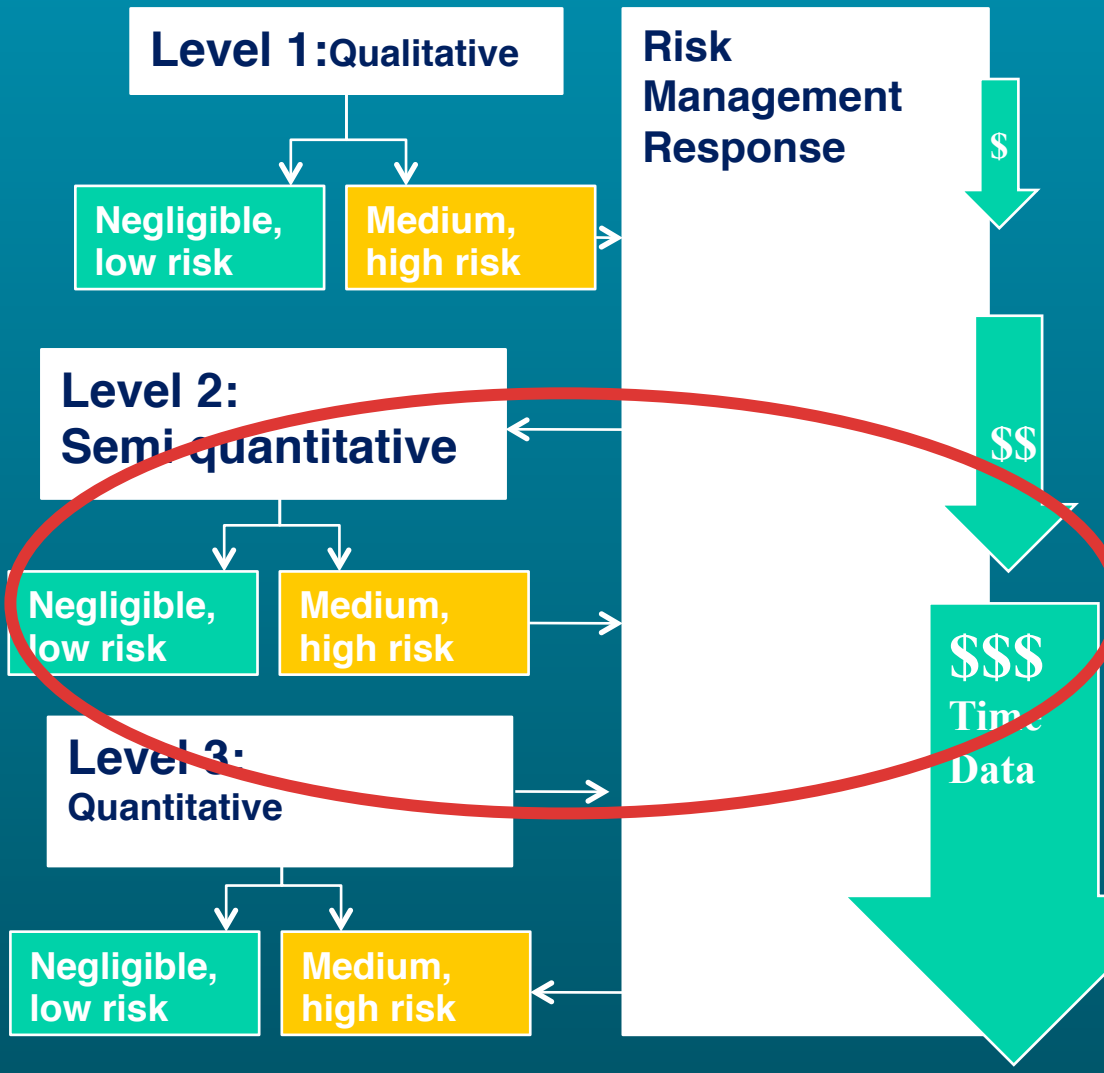
A spreadsheet tool is used to tabulate the data and automate the scoring

Stakeholders and other experts can work through scoring at workshops



Level 2 – Screening

- Look at examples



ERAEF Methodological Highlights

- Hierarchical aproach
- Precautionary in the absence of data
- Efficient at screening and prioritizing
- Allow comparisons (e.g. between fisheries)
- Framework fits with a range of level 3 metods
- Help fisheries be “strategic”

Acknowledgements

- Forum for inviting me
- Bob Trumble and Kimberly Gordon provided useful feedback during preparation of this presentation
- Scientists and stakeholders for their insights

Literature

- Smith. A. D. M., Fulton, E. J., Hobday, A. J., Smith, D. C., Shoulder, P. (2007). Scientific tools to support the practical implementation of ecosystem-based fisheries management. ICES Journal or Marine Science.

Extra slides

Availability corrections: Global distribution (Stock Structure Likelihood)

Proxy for stock structure	Low risk (low chance of local stocks)	Medium risk (medium chance of local stocks)	High risk (high risk of local stocks)
1. Geographic barriers to dispersal	1L	1M	1H
	Deepsea, >650 m. *Semi-global water mass - Antarctic bottom water. Some depth barriers, too shallow*	Pelagic and upper slope. Depth and water temperature barriers -mode water.	embayments on the shelf. Combination of lat, long, depth, coastal, water temperature barriers
2. Temporal barriers to dispersal	2L	2M	2H
	No seasonal peaks in feeding, mating, spawning	Some seasonal peaks but breeding not restricted to a particular season. E.g. batch spawning teleosts, some dogfishes	Species forms breeding colonies or breeding aggregations. Fishing is permitted at or near breeding or feeding aggregations
3. Ecological barriers to dispersal	3L	3M	3H
	Occupiable habitat is dispersed through a species range. E.g. pelagics		Occupiable habitat is restricted by food availability or bottom topography (reefs, canyons etc). Fishing occurs near restricted habitat
4. Behavioral barriers to dispersal	4L	4M	4H
	No behavior. E.g. algae	No social behaviour e.g. sunfish	to spawn. Birds remain near rookery to rear chicks. Migrating populations targeted by fishing activity
5. Life history barriers to dispersal			5H
			Species can not complete its life history. Most individuals at a particular life history stage are vulnerable to fishing or a fishing related activity

PSA For habitats

- MSC – 3 components including “ecosystem”
- Possible application in Coral fishery in the Caribbean
- Alternative to assessment by species > 100 species harvested
- Define units by bottom type x geomorphology x invertebrate fauna
  - e.g. Rock x outcrop x octocoral

- Fewer units

- Alternative attributes

Attribute	Equivalent
Availability	depth range, overlap
Encouterability	Ruggedness, gear type
Selectivity	Removability, size class, seabed slope
Productivity	Regeneration time

Susceptibility - multiplicative

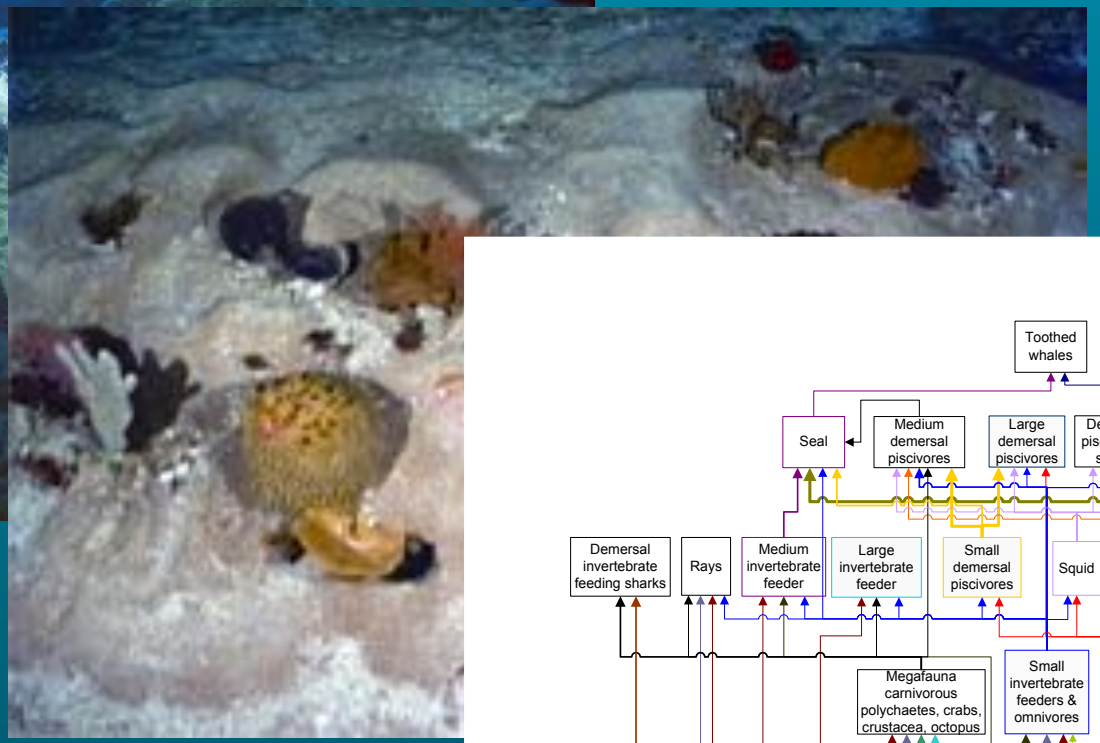
Catch susceptibility =
Availability x Encounterability x Selectivity x Post-capture mortality

If any one of the four susceptibility aspects is low, it makes sense that overall catch susceptibility should be low.

Examples :
However easy a species is to catch in a trawl, if it is not encountered by the trawl gear, then it will not be susceptible to capture.

If a species is readily encountered, but is too large to be caught in a trawl net, then it will not be susceptible.

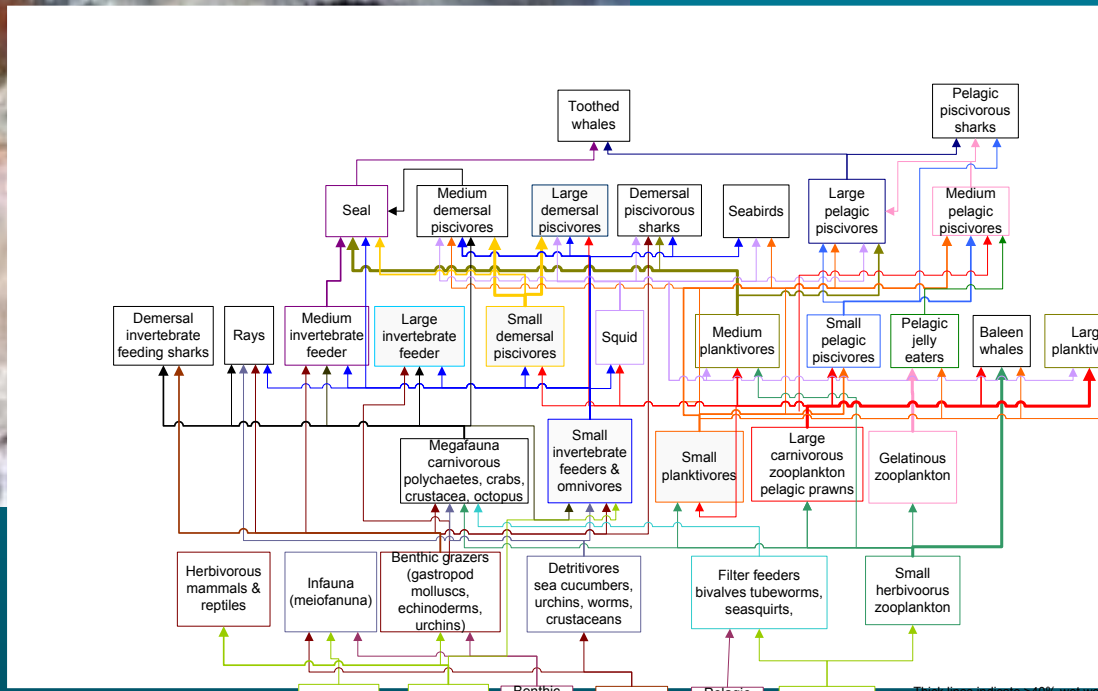
Habitat and community units



Species

Habitats

Communities



Each type evaluated against 11 attributes of habitat vulnerability

Aspect	Attribute	Concept	Rationale
Availability	General depth range (biome)	Spatial overlap of subfishery with habitat defined at biomic scale	Habitat occurs within the management area
Encounterability	Depth zone and feature type	Habitat encountered at the depth and location at which fishing activity occurs	Fishing takes place where habitat occurs
	Ruggedness (fractal dimension of substratum and seabed slope)	Relief, rugosity, hardness and seabed slope influence accessibility to different sub-fisheries	Rugged substratum is less accessible to mobile gears. Steeply sloping seabed is less accessible to mobile gears
	Level of disturbance	Gear footprint and intensity of encounters	Degree of impact is determined by the frequency and intensity of encounters (inc. size, weight and mobility of individual gears)
Selectivity	Removability/ mortality of fauna/ flora	Removal/ mortality of structure forming epifauna/ flora (inc. bioturbating infauna)	Erect, large, rugose, inflexible, delicate epifauna and flora, and large or delicate and shallow burrowing infauna (at depths impacted by mobile gears) are preferentially removed or damaged.
	Areal extent	How much of each habitat is present	Effective degree of impact greater in rarer habitats: rarer habitats may maintain rarer species.
	Removability of substratum	Certain size classes can be removed	Intermediate sized clasts (~6 cm to 3 m) that form attachment sites for sessile fauna can be permanently removed
	Substratum hardness	Composition of substrata	Harder substratum is intrinsically more resistant
	Seabed slope	Mobility of substrata once dislodged; generally higher levels of structural fauna	Gravity or latent energy transfer assists movement of habitat structures, eg turbidity flows, larger clasts. Greater density of filter feeding animals found where currents move up and down slopes.
Productivity	Regeneration of fauna	Accumulation/ recovery of fauna	Fauna have different intrinsic growth and reproductive rates which are also variable in different conditions of temperature, nutrients, productivity.
	Natural disturbance	Level of natural disturbance affects intrinsic ability to recover	Frequently disturbed communities adapted to recover from disturbance