Sustainable deep-sea fisheries and environmental conservation: how can we balance conflicting objectives?

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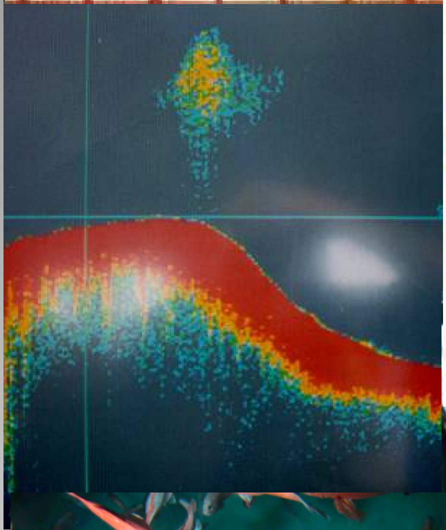
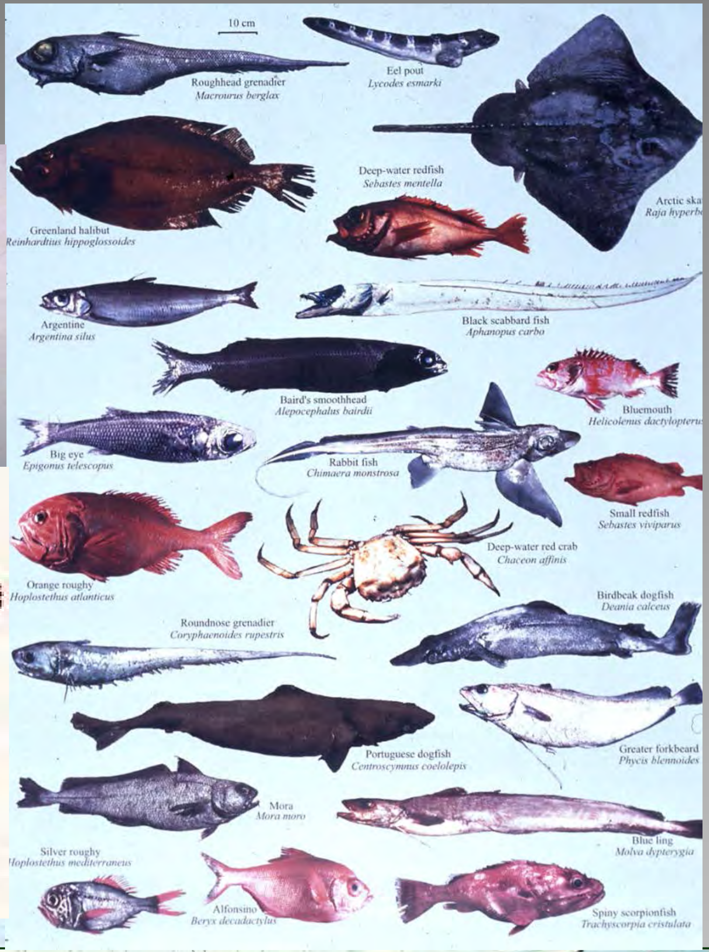
Presentation Outline

- **Background**
  - Deep-sea fish and fisheries (seamount focus)
  - Fisheries impacts
- **Fishery sustainability issues**
  - Fisheries
  - Benthic habitat
- **Management implications**
  - Spatial management options

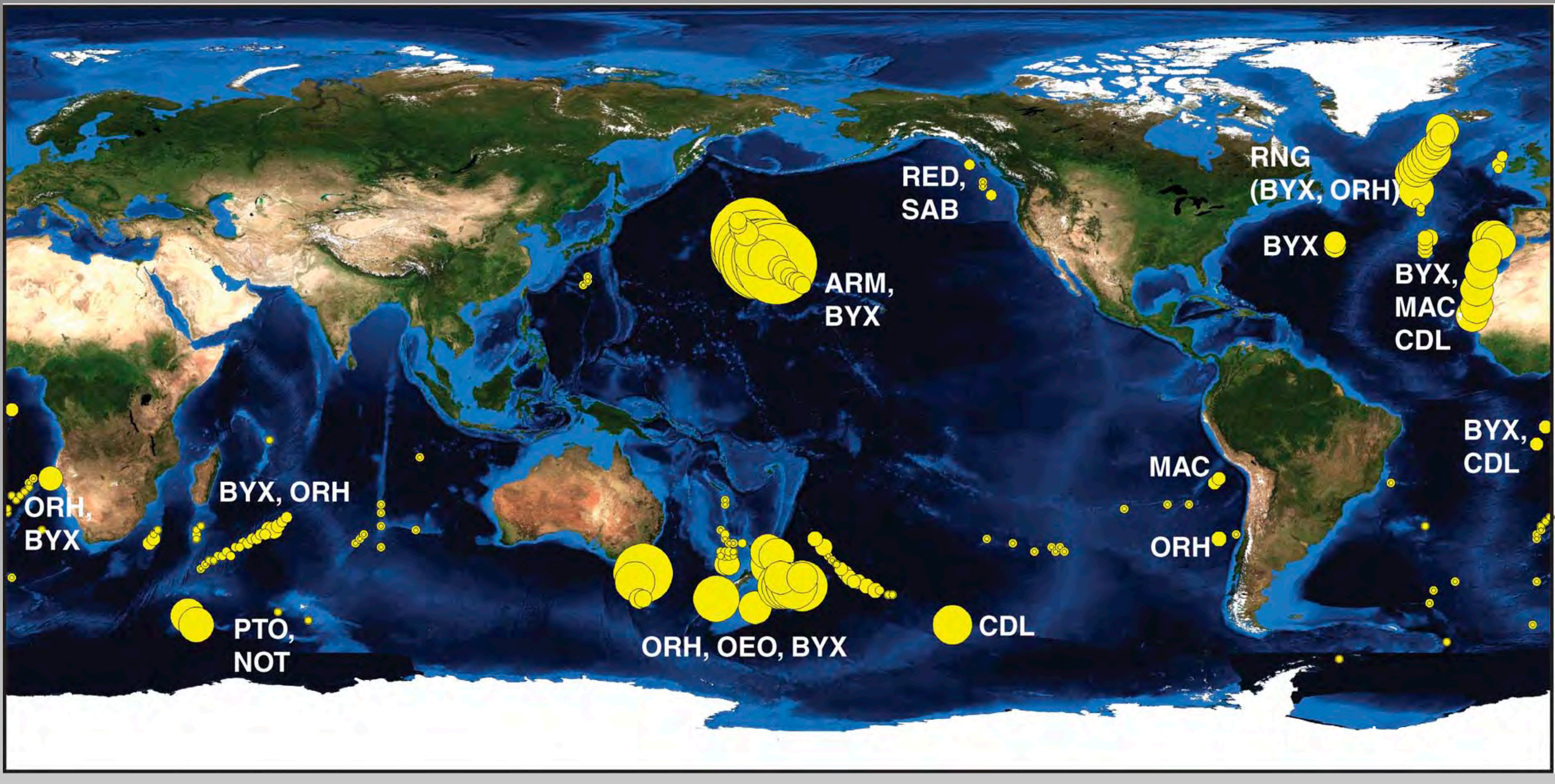



- Target of deep-sea fisheries





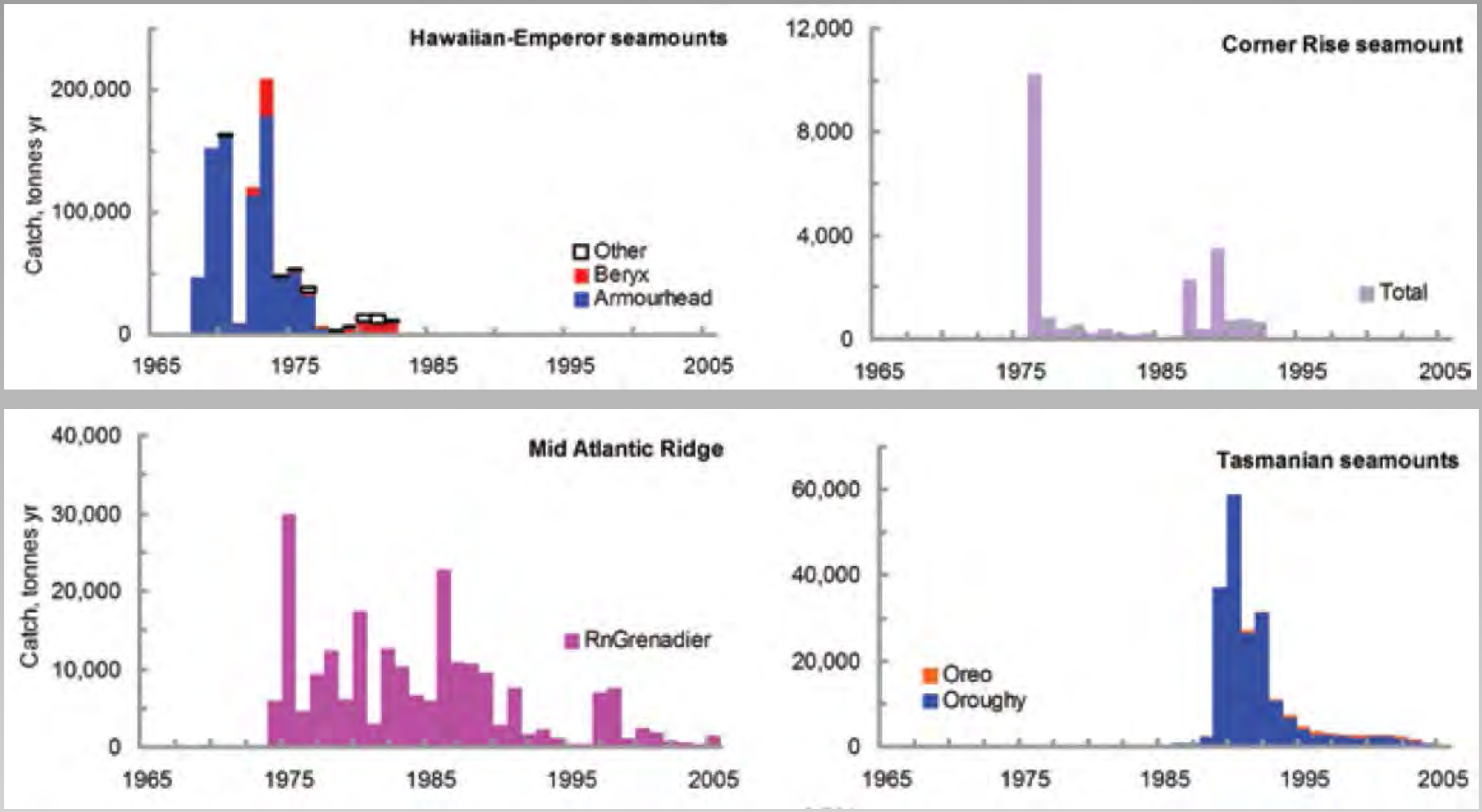
Global seamount trawling



Extensive bottom trawl fisheries developed from 1970s
Total historical catch about 2.5 million t

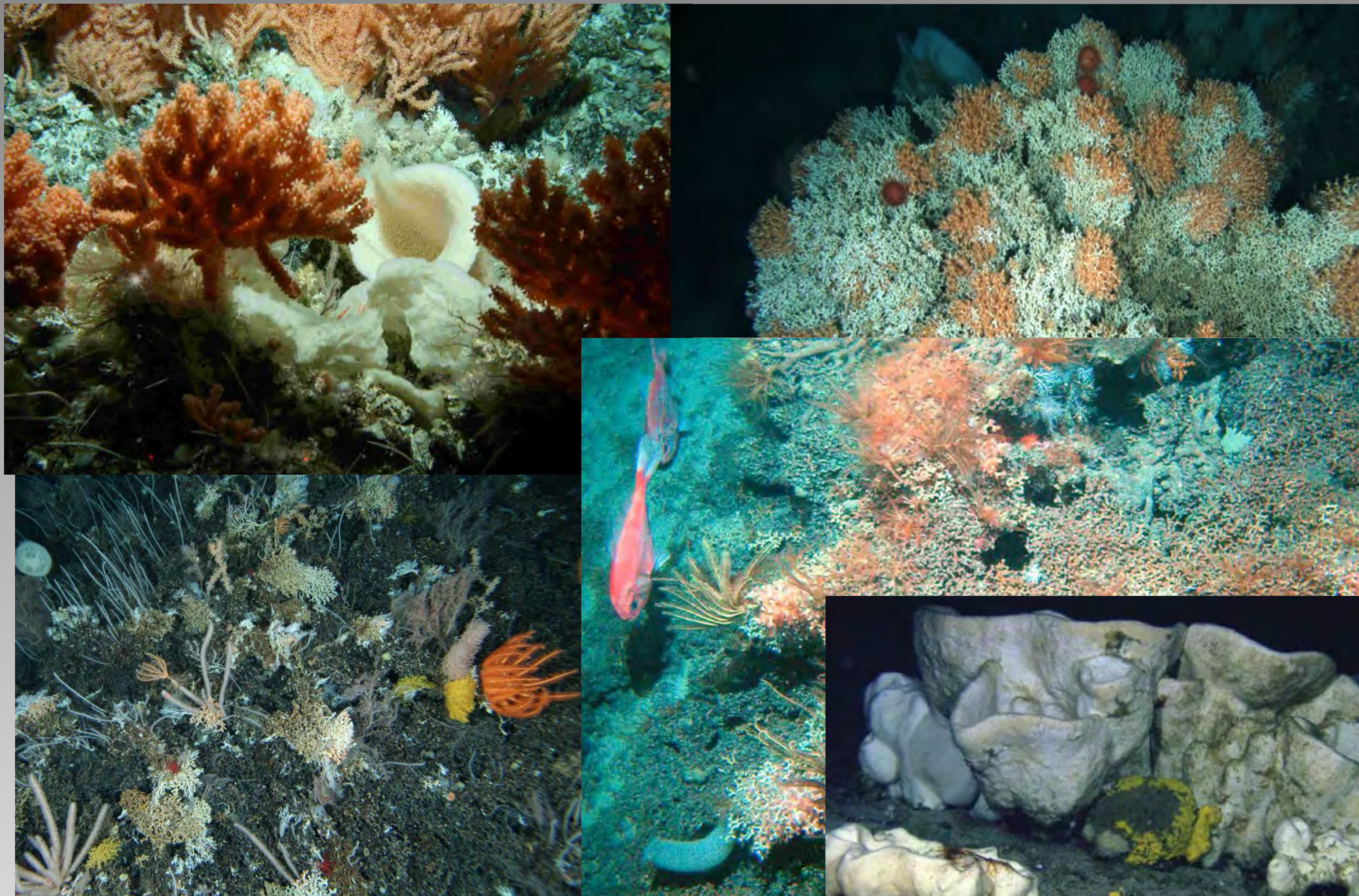
Seamount fisheries history

- Not a good track record
- Patterns of boom and bust

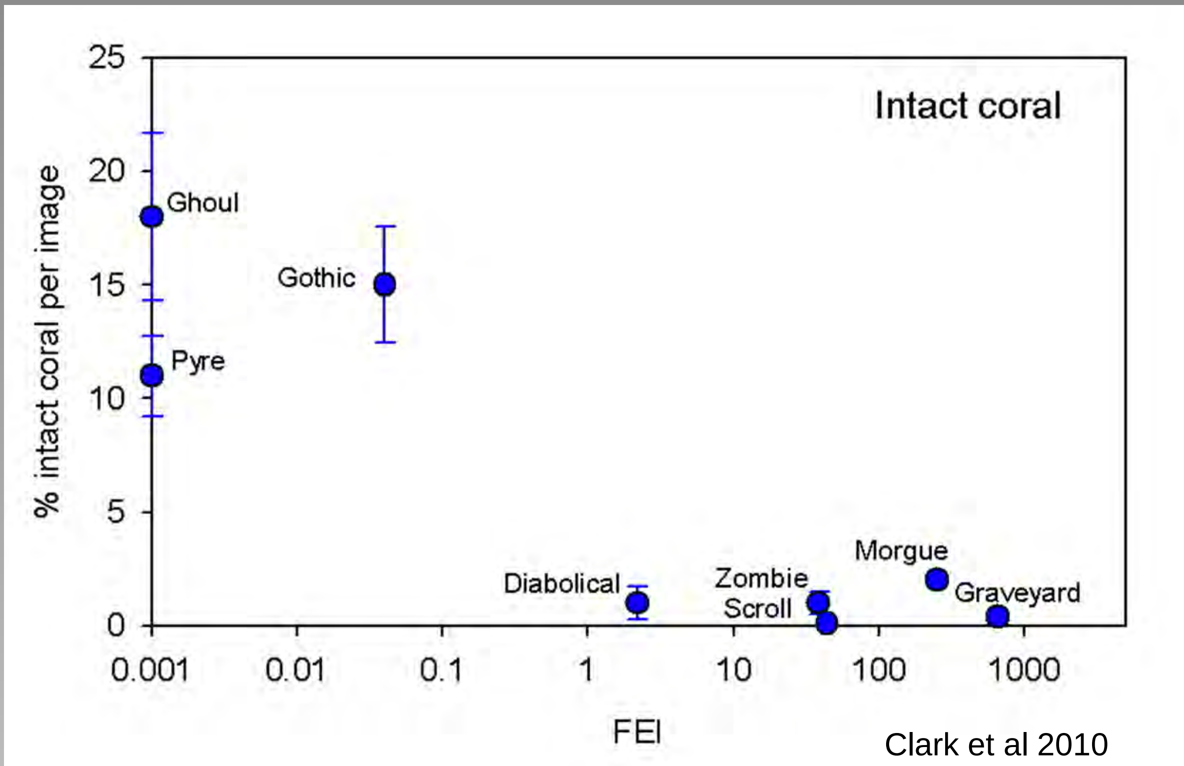


Clark et al. 2007, Pitcher et al. 2010

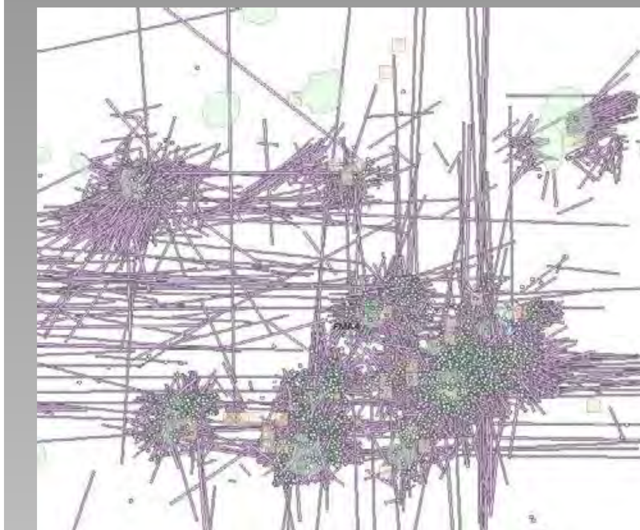
Deep-sea habitats



Corals and fisheries don't mix



Clark et al 2010



SOUTH TASMAN RISE	1997-98	1998-99	1999-2000	2000-01
Orange roughy	3930	1705	4110	830
Oreos	1200	1590	245	270
Coral	1078	725	423	147

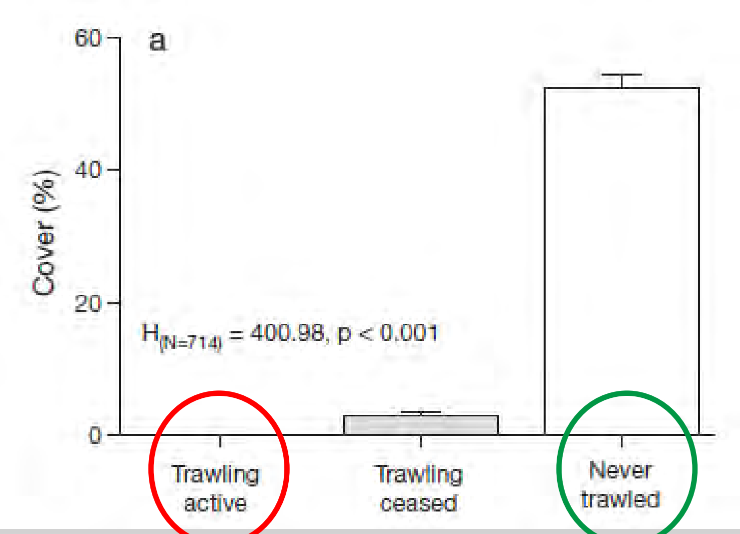
Anderson & Clark 2003

Trawling impacts

- Removal patterns
  - Reduced biodiversity
  - Reduced abundance
  - Reduced distribution
- Recovery very uncertain

	Heavily fished (n = 11)	Lightly fished (n = 11)	PA (n = 12)
Biomass (kg)	1.1 ±3.4	7.0 ±5.8	6.1 ±3.8
No. of species	8.7 ±6.3	20.1 ±3.6	22.2 ±4.6

Koslow et al. 2001



Althaus et al. 2009

Group	Mean density (no. 100m^{-2}) Trawl	Reference	p
Sessile groups			
Finger sponges	71.4	119.1	0.3125
Anthozoans	5.7	13.2	0.0156*
Morel sponges	0.1	1.1	0.0156*
Vase sponges	1.0	3.7	0.0078*
Motile groups			
Asteroids and ophiuroids	17.1	20.0	0.7422
Holothurians	3.3	3.6	0.3672
Arthropods	2.4	1.3	0.0781
Molluscs	1.6	0.6	0.0547
Echinoids	9.5	18.7	0.0391

Freese et al. 1999

Deep-sea Fisheries sustainability issues

- Fish species
  - Aggregation behaviour, natal fidelity
  - High longevity, slow growth
  - Late maturation, low fecundity
  - Non-annual spawning, irregular recruitment
  - Overall low productivity
- Habitats
  - Very intensive bottom trawling effort
  - Biogenic habitat forming species on seamounts
  - Fragile and easily damaged
  - High longevity, slow growth

Fishery solutions

- Slow and controlled development
- Strong cooperation between industry, research, management ("stakeholders" collective responsibility)
- Low catch levels relative to productive shelf species and to initial catch rates (ORH: MAY=2%B_0)
- Low effort levels (small number vessels)
- Effective research and monitoring (focus on large fisheries)
- Decision rules based on low information (e.g., monitoring of CPUE). Recent shift in NZ to (F=M)*Bcurr
- Speed of management required to respond to change
- Small spatial scale to avoid serial depletion (i.e., spread catches). Feature limits (per seamount)
- Seasonal/area closures may be needed (e.g.,spawning)

Habitat solutions

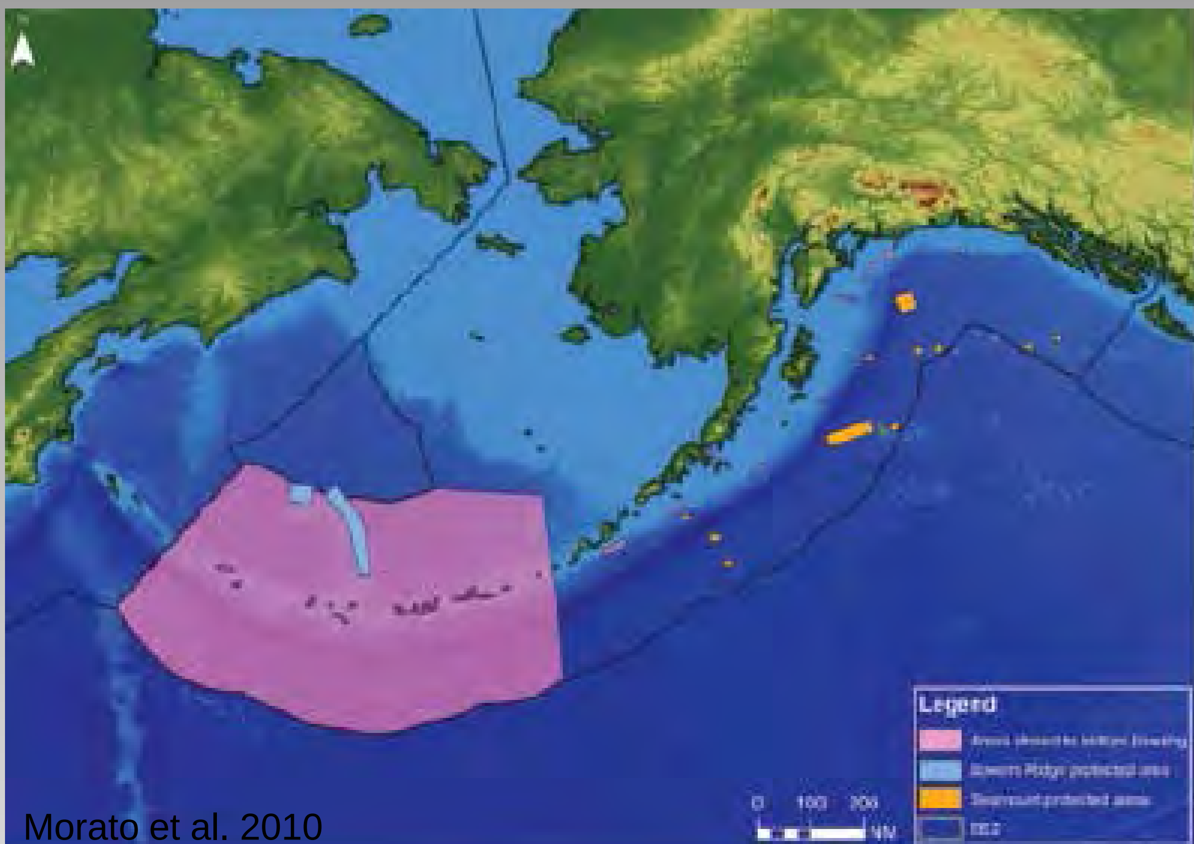
- Bottom trawl impacts undeniable
- Gear changes not an option for some fisheries
- Need protection **before** fishing takes place. Controlling/freezing the fishing footprint is key.
- Have to have good fishing location data, so need to engage and cooperate with the fishing industry
- Benthic habitat protection zones /MPA network to conserve **unfished** biodiversity (need to be careful using fishing operations to id VME areas).
- Basis of individual seamount. Sector management unlikely to be fully effective, hard to control trawl gear at 1000m. Includes habitat variability within the seamount.

The balance….

- Conflict between fisheries conservation (favours spreading catch) and habitat conservation (favours localising fisheries catch)
- A mixture of open and closed areas can be a workable approach, without wholesale fishery area closures.
- Spatial management options are a way forward

Spatial management options

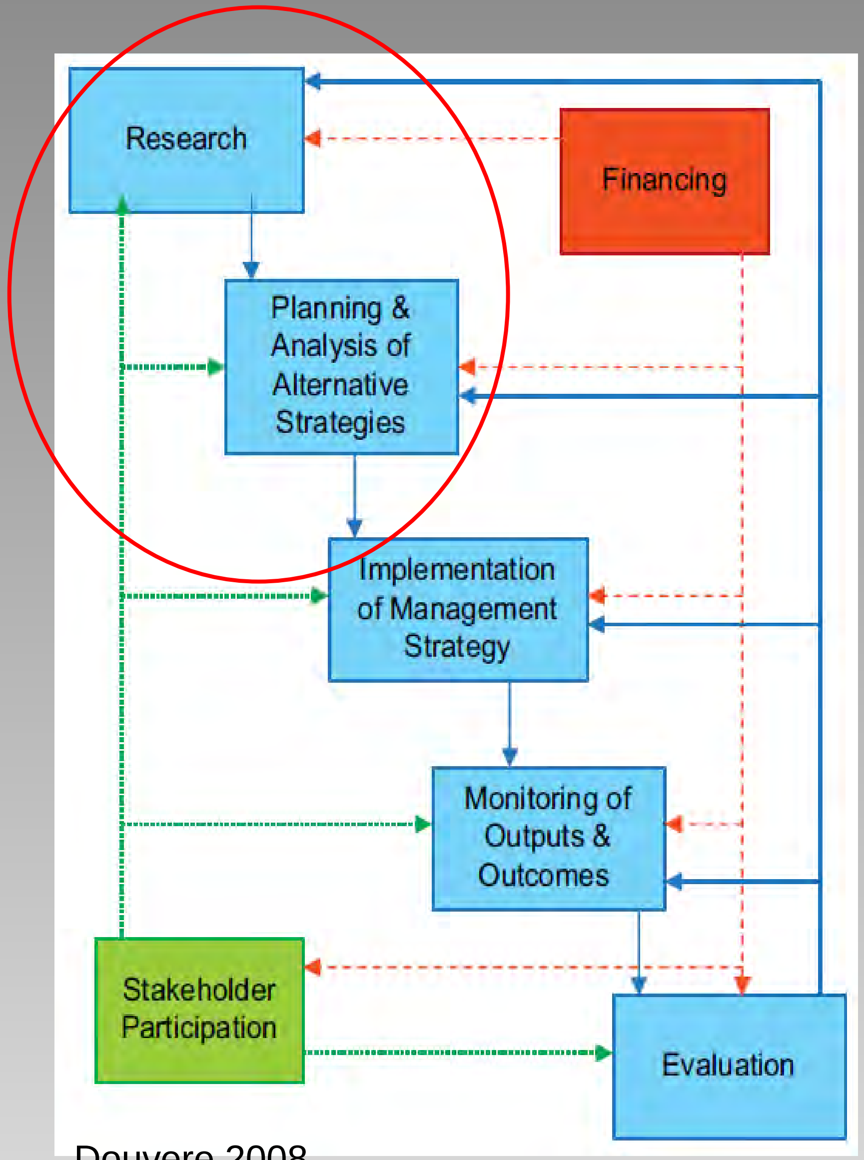
- Growing array of protection measures in the deep sea.
- Fishery closures, Benthic Protection Areas, offshore MPAs, habitats of conservation importance, Essential Fish Habitats



Morato et al. 2010

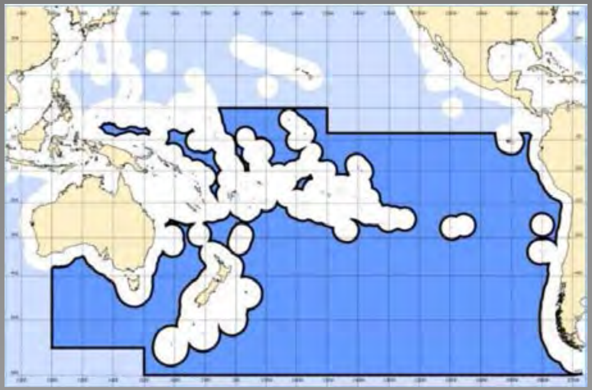
Spatial management planning

- A well-developed approach, especially in Europe and the US.
- Integrates multiple components of a process that involves all stakeholders
- Includes scientific research and analysis at an early stage
- Intended to be applied more widely in New Zealand situations



Douvere 2008

South Pacific example



- SPRFMO covers large areas in the South Pacific, including around New Zealand outside the EEZ
- Have locally important orange fisheries around New Zealand, on banks, ridges and seamounts
- Have VMEs (and EBSAs)
- Approach to spatial management
  - Use known catch and effort from NZ vessels
  - Use predicted habitat suitability distributions for scleractinian corals (vulnerable to fishing)
  - Use “Zonation” planning software (Moilanen 2007). Not dissimilar to Marxann, but more flexibility and options. Well used in New Zealand.

Modelling approach

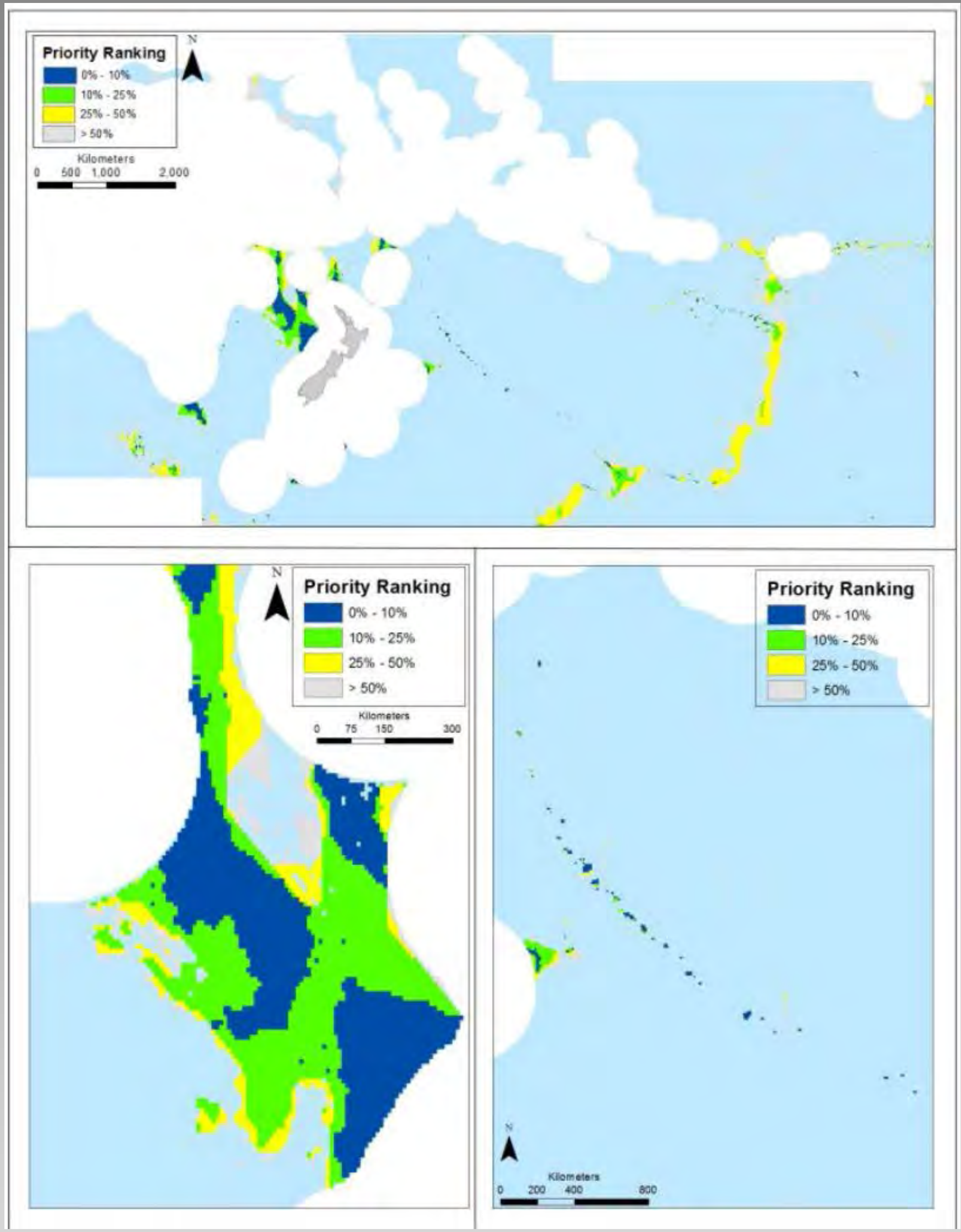
- What zonation does
  - Starts with full set of grid cells
  - Sequentially removes grid cells of “low” value
  - Value of a cell is defined by its biodiversity attributes (e.g., high HS for multiple taxa). Representativeness is included as well. Value can be weighted (e.g., for endangered species, endemics).
  - Then cost layers are included (e.g., fisheries, mining)
  - Cells are removed preferentially if no fishing occurs in high biodiversity value areas.
  - Produces priority maps, based on the top 10%, then 10-25%, etc for biodiversity protection

Zonation “scenarios”

- Scenarios = runs to cover management options
  - All VME taxa equal, or some weighting (e.g., stony corals)
  - Fishing expression (catch or effort)
  - Fishing period (historical, or just recent)
  - Biogeographical province divisions (force protection in different provinces)
  - Aggregation values (binning of adjacent cells to reduce fragmentation)
  - Spatial scale of data (matching the various datasets)
- Need strong management input
  - Require clear management objectives

Example 1

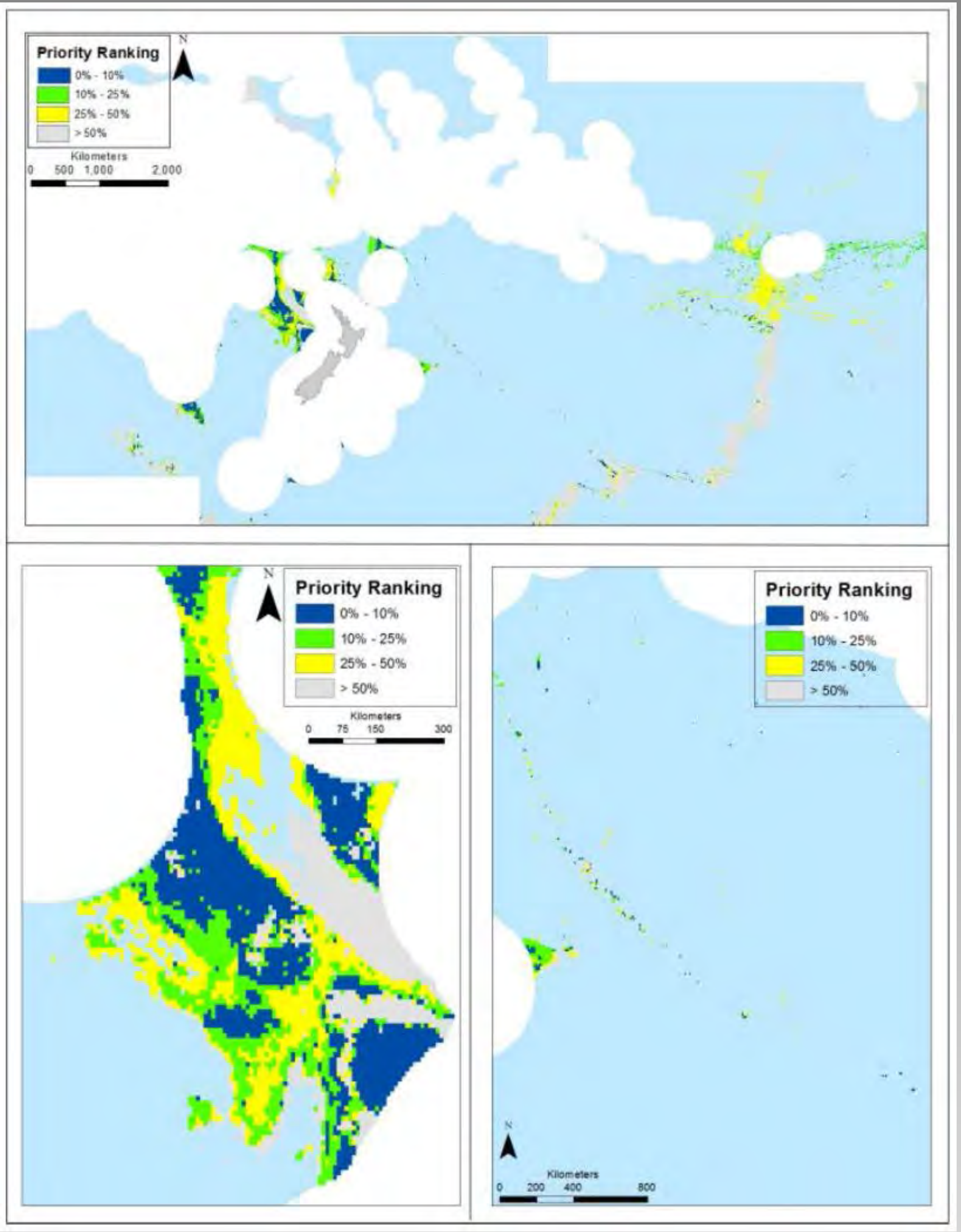
- All HS values for all VME taxa
- Aggregation rule applied
- No fishing cost layer
- No bioregionalisation



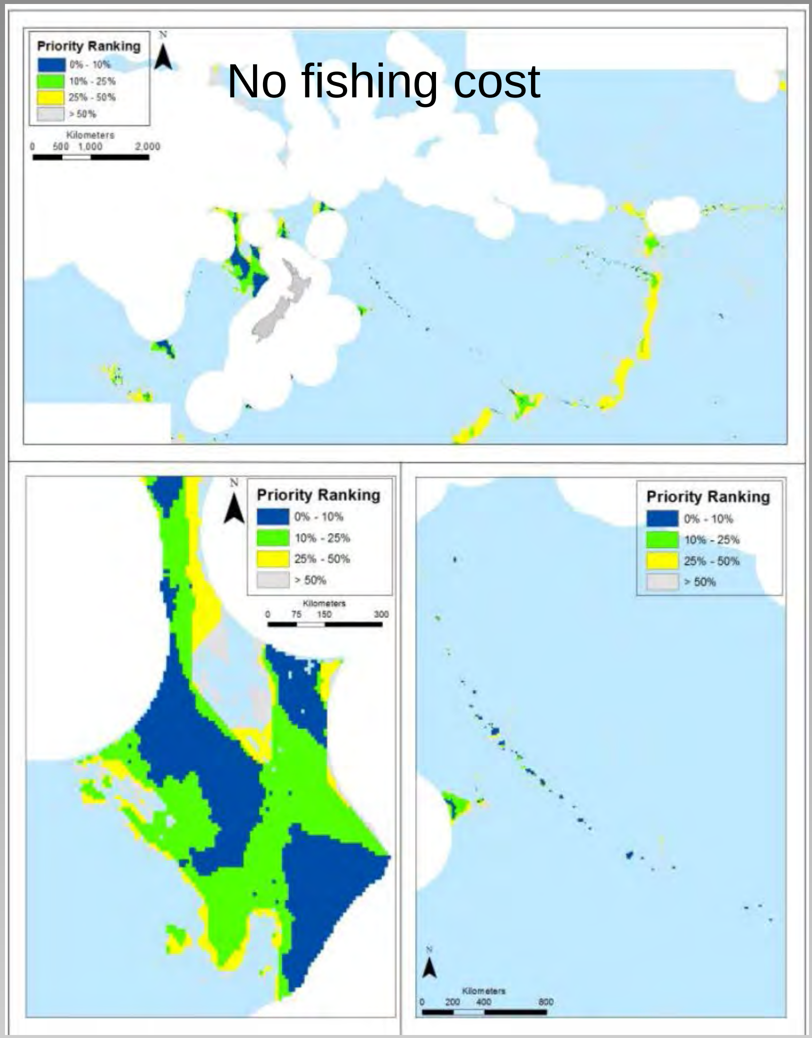
Rowden et al. 2015

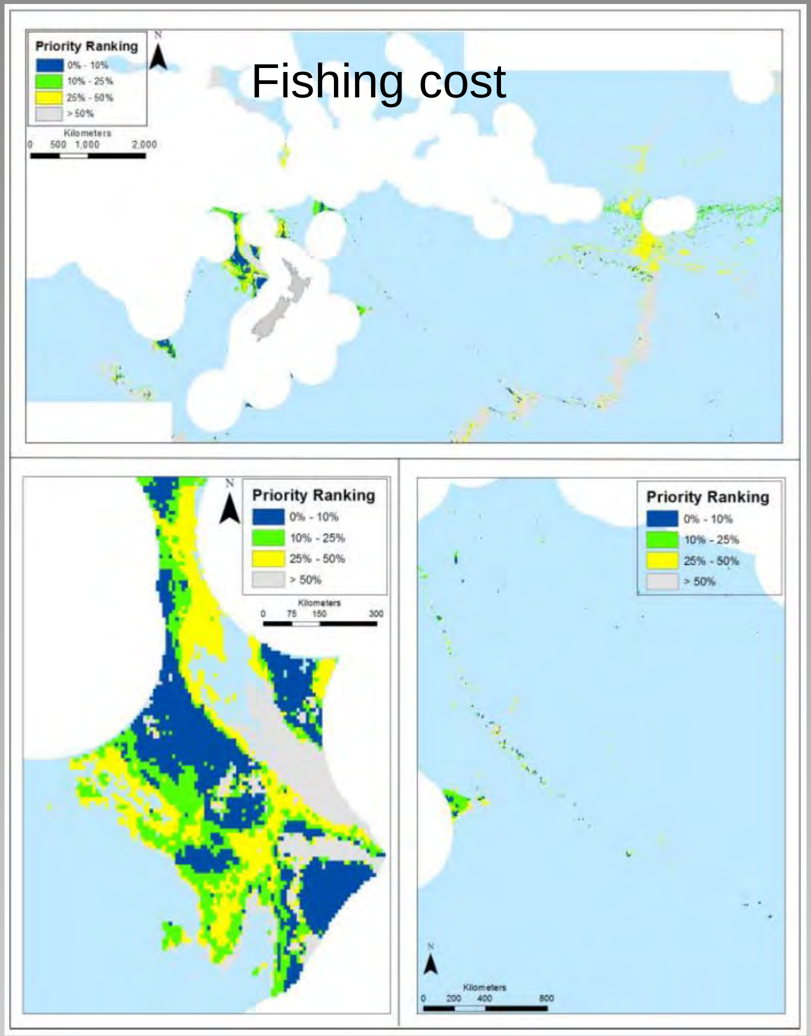
Example 2

- All HS values for all VME taxa
- Aggregation rule applied
- Fishing cost layer
  - 1980-2012
- No bioregionalisation



Output managers can evaluate





Presented to SPRFMO Scientific Committee in 2015, well received. But is work in progress…

Conclusions

- Deepwater seamount fisheries can be sustainable
- Small-scale, low volume, high value species/products
- The precautionary approach to development and management needs to be applied very strongly
- Habitat protection an integral part of fishing operations and fishery management (will constrain fishing).
- An “MPA” network, or system of spatial management, needs to be established outside the main fishing “footprint” to protect biodiversity
- Management planning software has a key role to play
- There is a lot we don’t know, but enough lessons from, and options for, deep-sea management to enable a balance that sustains fisheries and protects the environment

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