Seamounts, deep-sea corals, and fisheries in the Pacific Ocean

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presentation to

PICES Biogenic Habitats in the Deep sea

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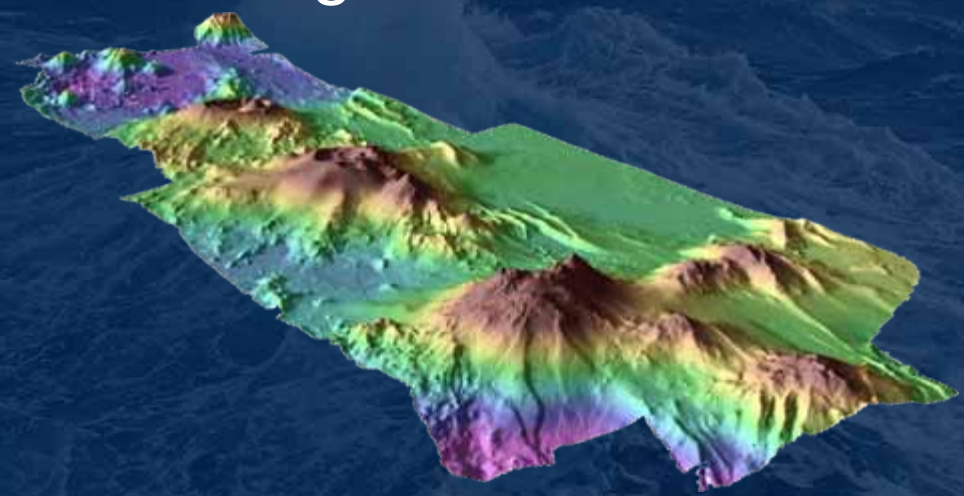
Talk outline

- Background to deepsea fish species and seamount trawl fisheries
- Sustainability issues
  - Effects of bottom trawling
  - Concern about sessile benthos
- Predictive modelling of coral distribution
- Application to seamount management

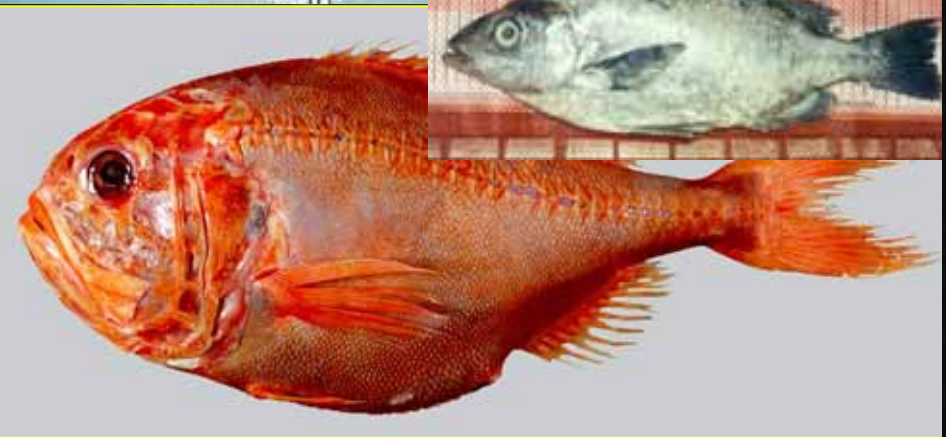


“Deepwater” seamount fishes

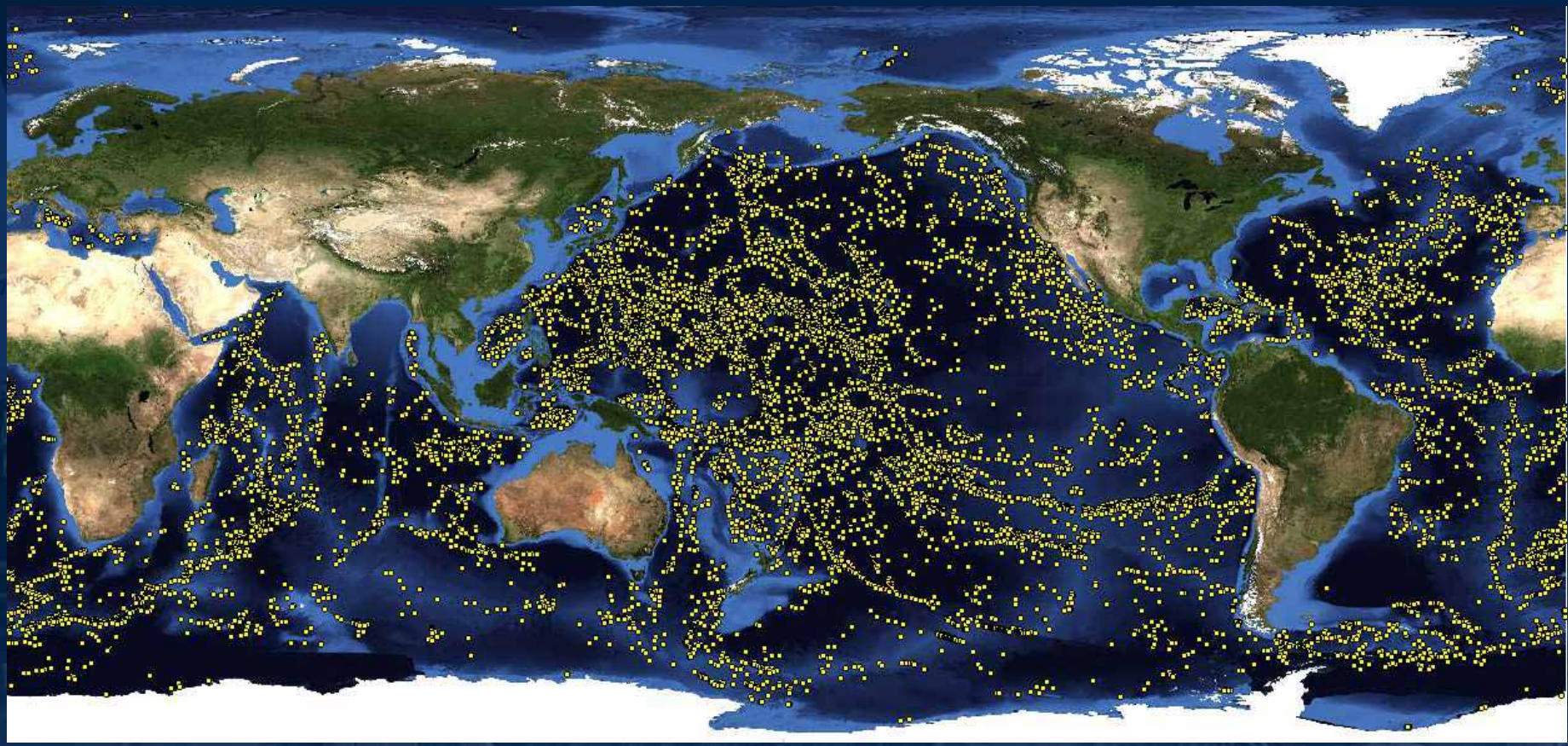
Several definitions (>200 m FAO, ICES, >500 m NZ, AUS)
Slow growth, high longevity, low productivity
Demersal seamount fisheries are a mix of these…
“Seamounts” covers seamounts, knolls, hills, pinnacles

Species	Scientific name	Main depth range (m)
Alfonsino	*Beryx splendens*	300-600
Black cardinalfish	*Epigonus telescopus*	500-800
Rubyfish	*Plagiogenion rubiginosum*	250-450
Black scabbardfish	*Aphanopus carbo*	600-800
Redbait	*Emmelichthys nitidus*	200-400
Sablefish	*Anoplopoma fimbria*	500-1000
Pink Maomao	*Caprodon* spp	300-450
Southern boarfish	*Pseudopentaceros richardsoni*	600-900
Pelagic armourhead	*Pseudopentaceros wheeleri*	250-600
Orange roughy	*Hoplostethus atlanticus*	600-1200
Oreos	*Pseudocyttus maculatus, Allocyttus niger*	600-1200
Bluenose	*Hyperoglyphe antarctica*	300-700
Redfish	*Sebastes* spp (*S. marinus, S. mentella, S. proriger*)	400-800
Roundnose grenadier	*Coryphaenoides rupestris*	800-1000
Toothfish	*Dissostichus* spp	500-1500
Notothenid cods	*Notothenia* spp	200-600

Deep-sea commercial species



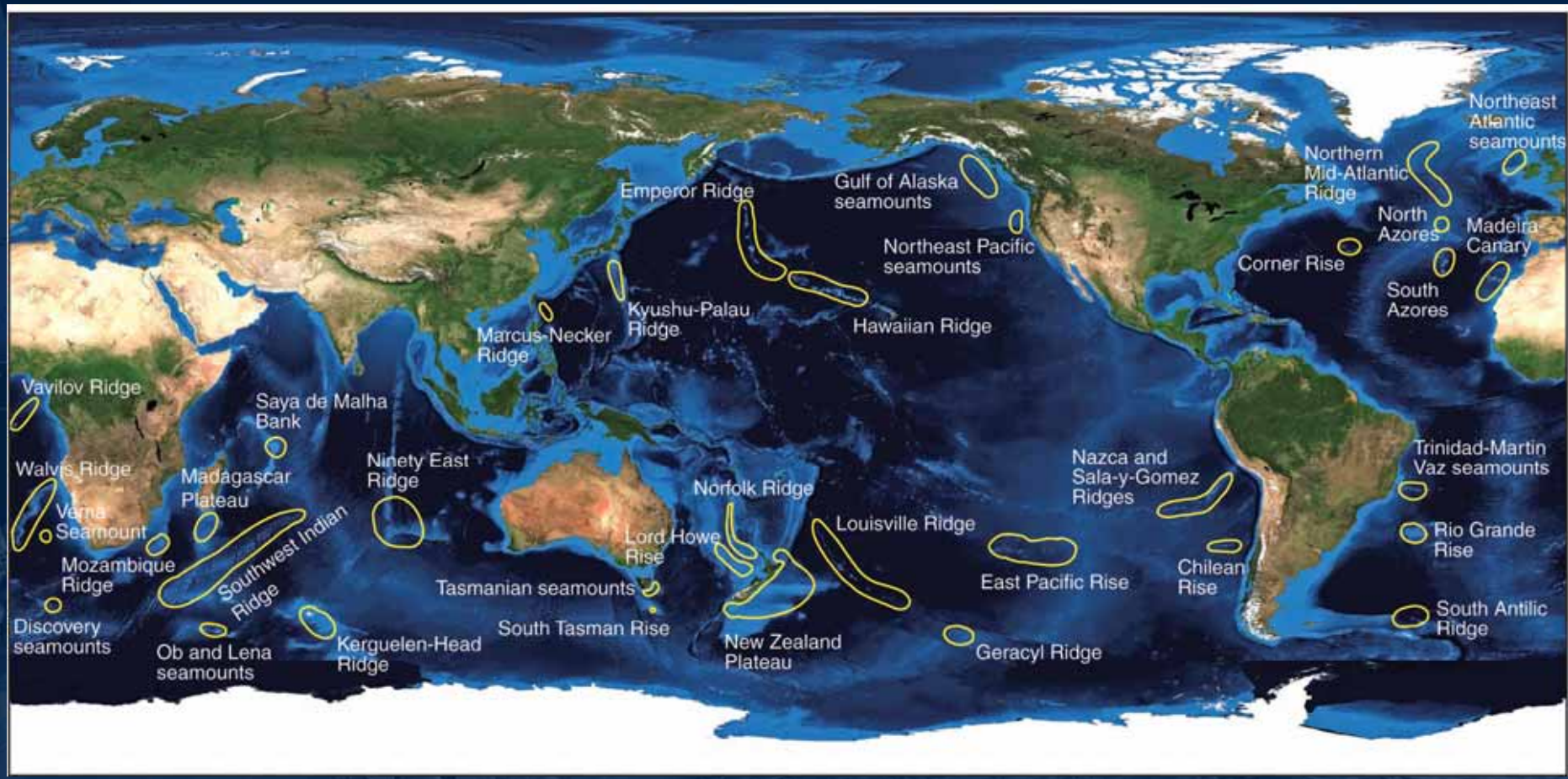
Global seamount distribution



Elevation >1,500 m
Total of 14,000, about 9,000 in Pacific

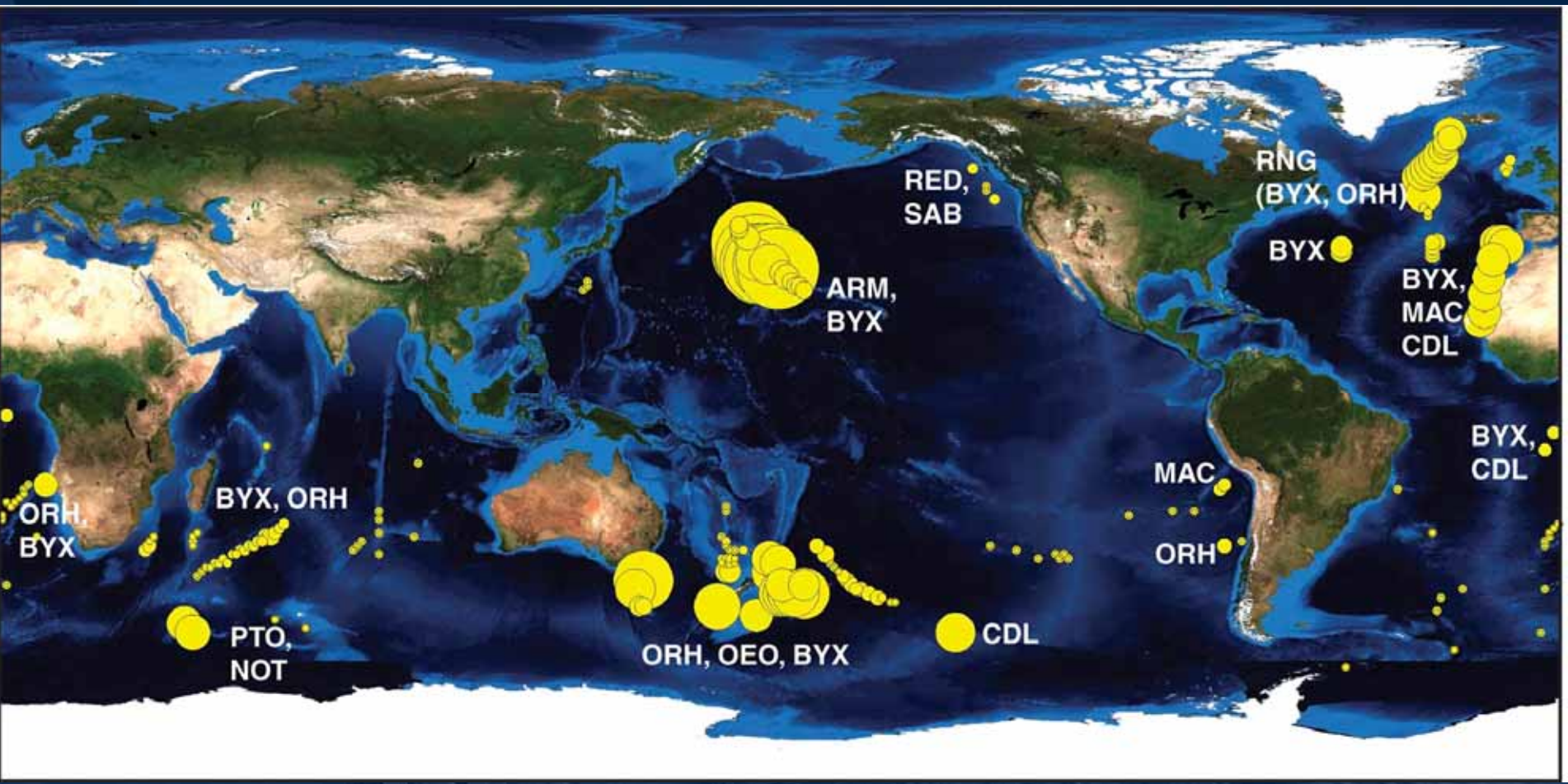
From SAUP 2004

Global seamount trawling



From Clark et al, 2007

Seamount trawl fisheries



From CenSeam 2006, Clark et al, 2007

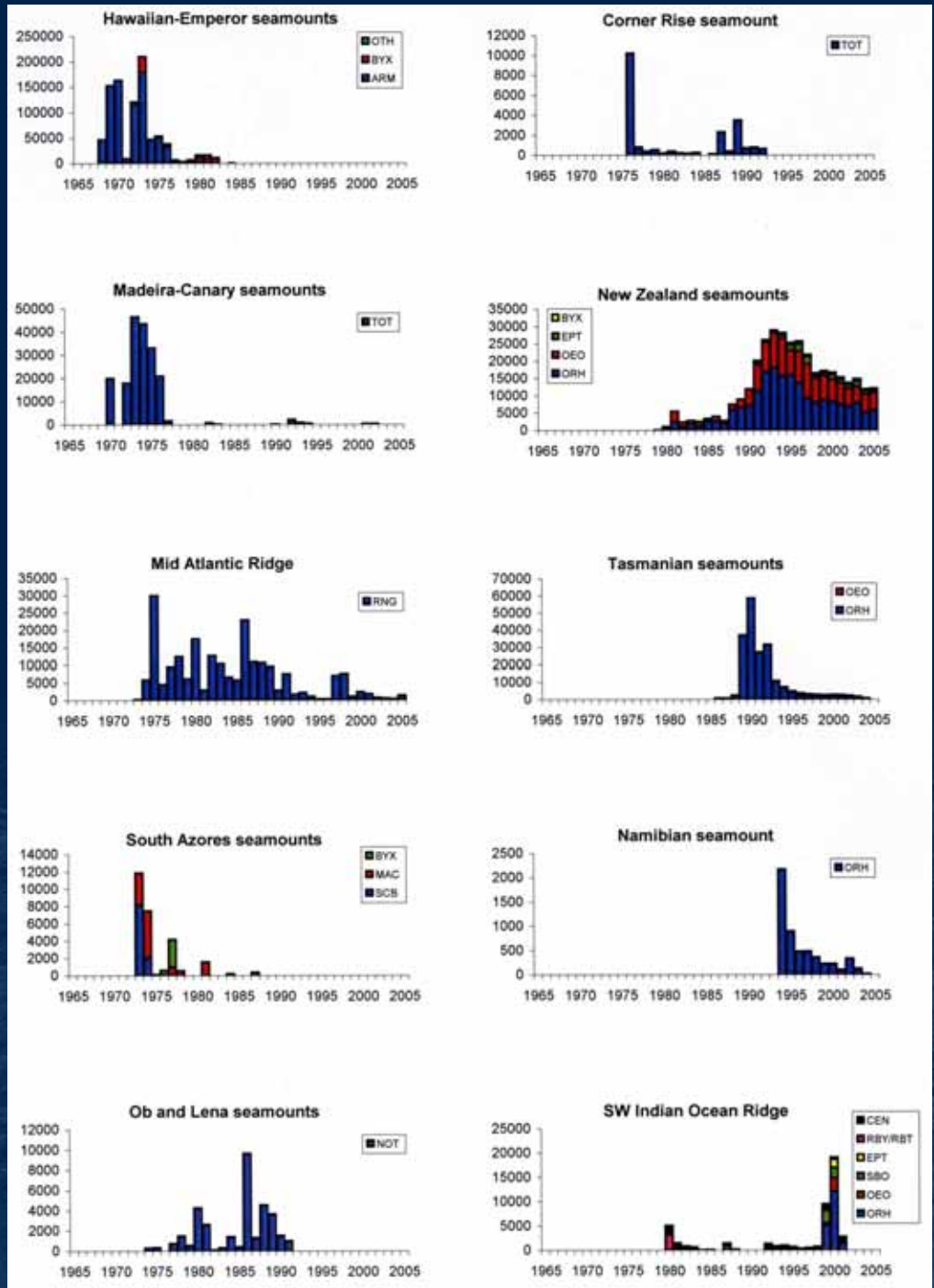
Seamount fishery catch

Species	Total catch (t)
Alfonsino	170,000
Cardinalfish	55,000
Pelagic armourhead	800,000
Orange roughy	420,000
Oreos	150,000
Roundnose grenadier	220,000

Total estimated seamount catch 2 - 2.5 million tonnes (minimum)

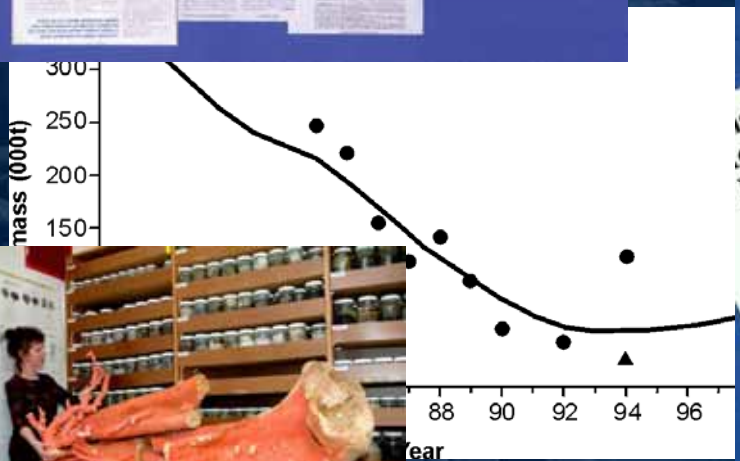
Catch history

- General trends of decreasing catches over time
- Frequent occurrence of fisheries with early large catches, followed by very low catches
- Often irregular or sporadic catches
- Switching species/areas in some instances



Sustainability concerns

- For fisheries
- For the habitat



Environmental conservation

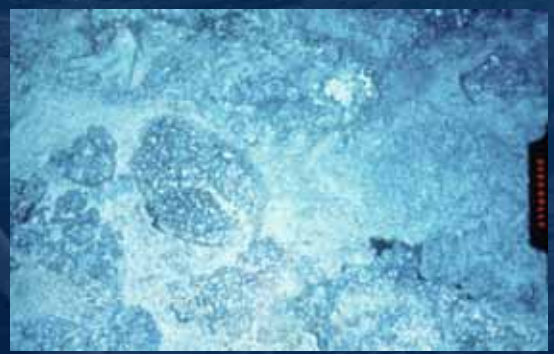
- Ecosystem requirements
  - Essential fish habitat. e.g. long-term influence of effects of fishing, damage to habitat, removal of key benthic fauna such as corals
  - Environmental responsibility. e.g., the need to protect biodiversity

Dense deepwater coral occurs at 1000 m

Tasmanian seamounts

From Koslow et al. 2001

Macro-invertebrate	Light fished	Heavy fished
Biomass (kg)	7.0 (+/- 5.8)	1.1 (+/- 3.4)
No. of species	20 (+/- 4)	9 (+/- 6)

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10
Leak
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Depth

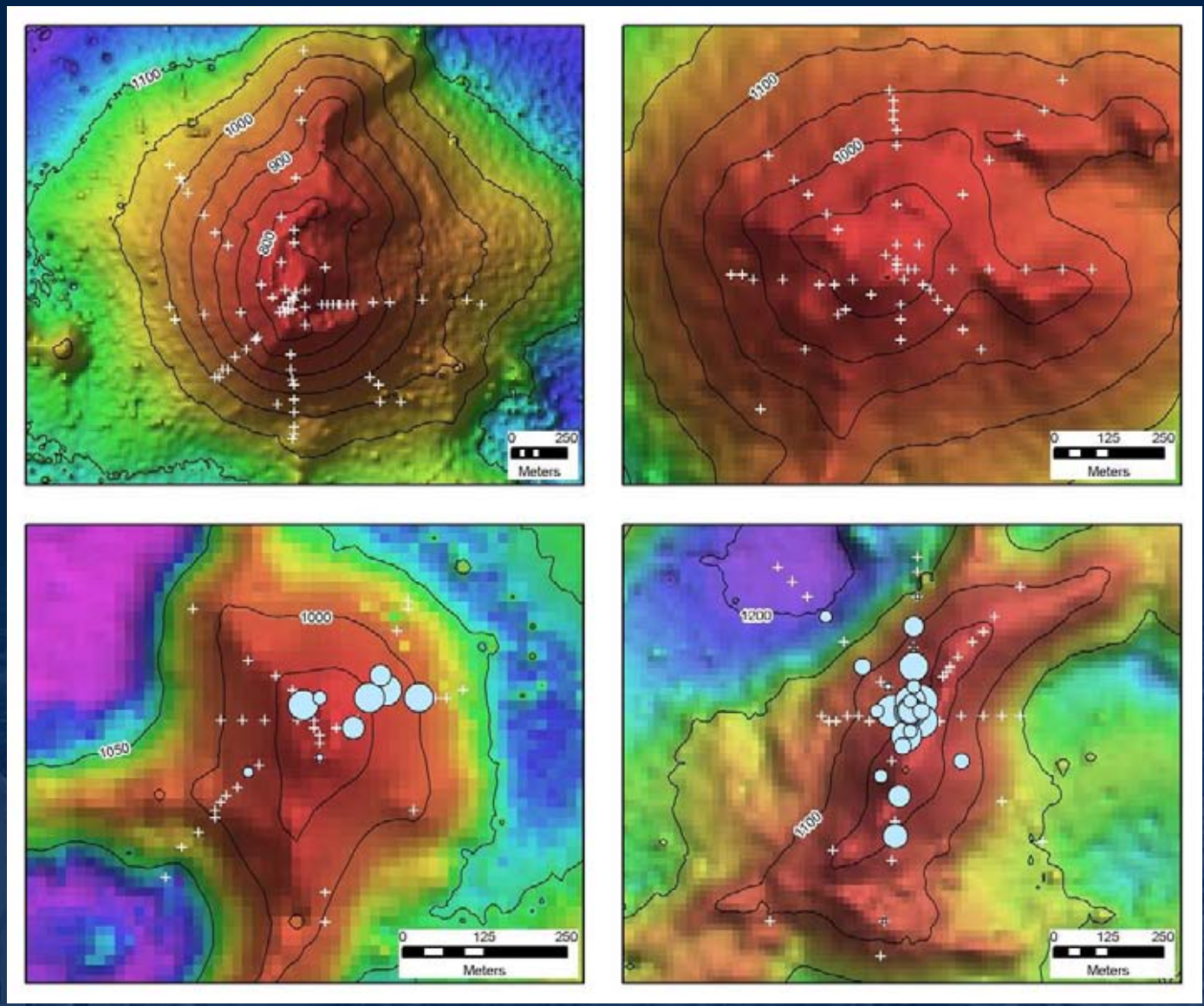
NZ: Distribution of coral

Fished

Mean cover
<0.05%

Unfished

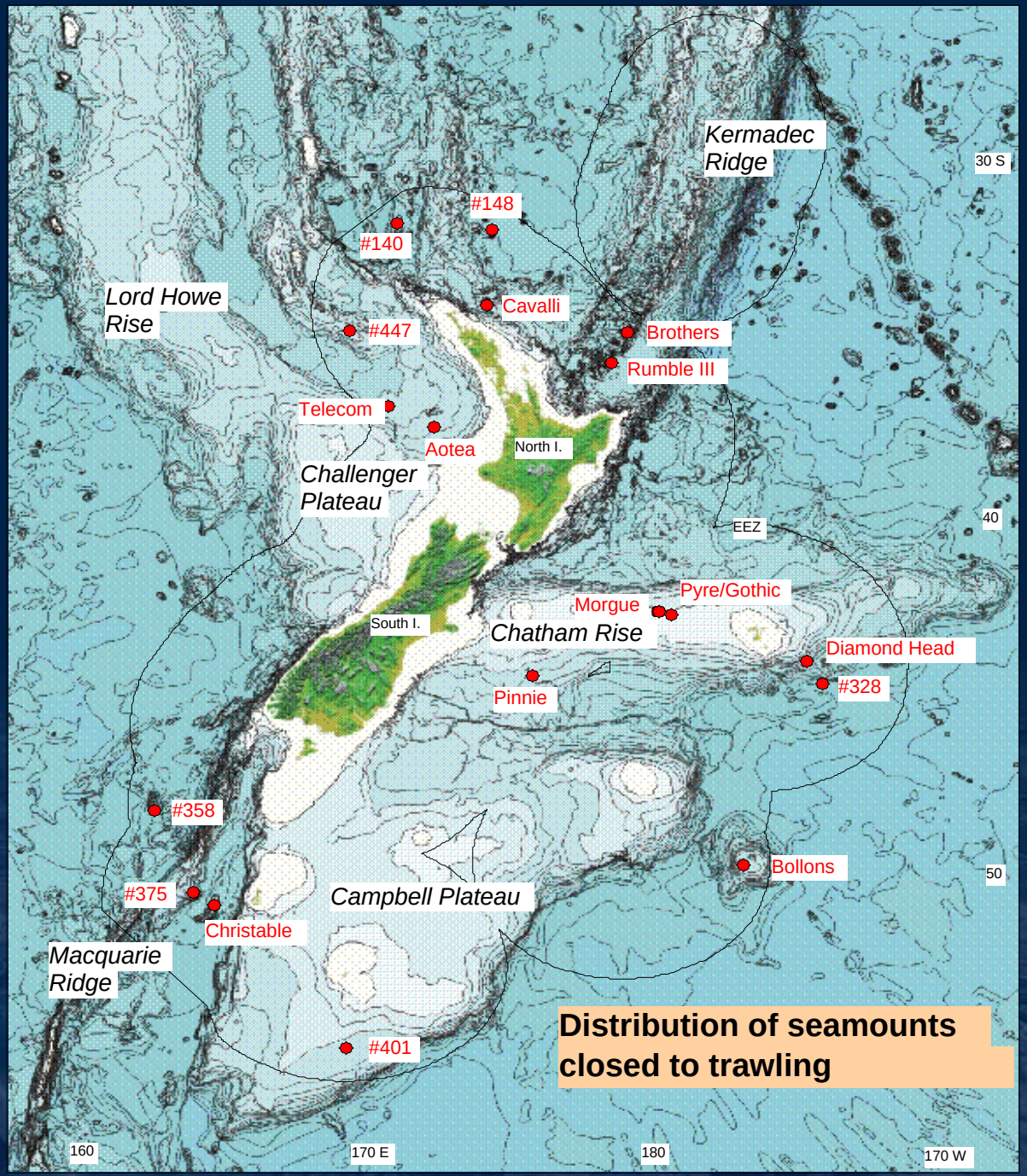
Mean cover
15%



From Clark & O'Driscoll 2003

Seamount closures

- Typical management has been to close seamounts to all trawling.
- Tasmania, Hawaii, USA, North Atlantic (RFMOs), New Zealand



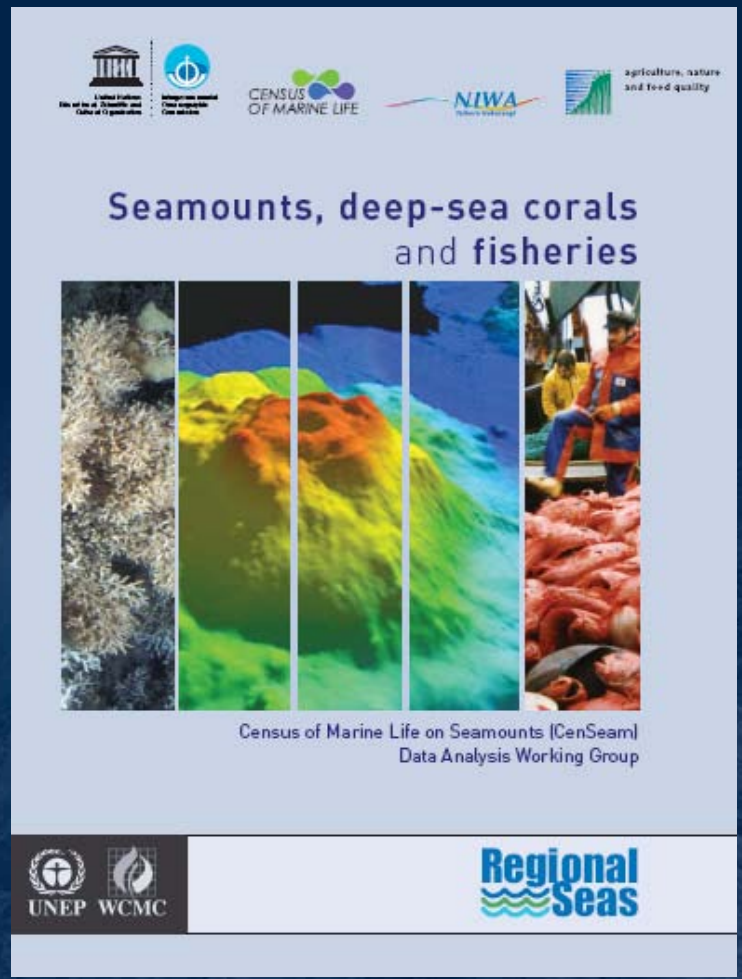
Seamount management

- Fine when we know something on which to base management

Only about 300 of the >14,000 have been sampled (Seamounts Online 2007)

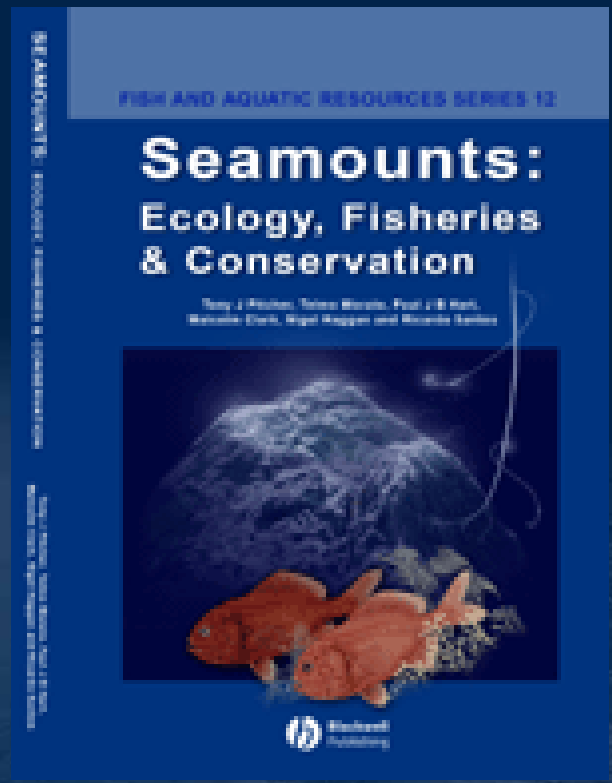
So, what can we do when we don't know anything??

- Recent work undertaken by the CoML programme on seamounts (CenSeam)
- Compile and summarise data for the distribution of large seamounts, deep-sea corals on seamounts, and deep-water seamount fisheries
- Predict distribution of deepwater corals, and identify the seamounts on which they are most likely to occur
- Qualitatively assess the vulnerability of communities living on seamounts to putative impacts by deep-water fishing activities



Data sets

- SAUP seamount location and depth (14,000 seamounts from satellite altimetry) (Kitchingman et al. data)
- Physical oceanographic data available from World Ocean Atlas
- Deep-sea coral distribution (Rogers et al. data compilation)
- Predictive coral distribution analysis (ENFA) (Derek Tittensor, FMAP)
- Seamount fish and fisheries distribution (Clark et al. data compilation)



ENFA approach

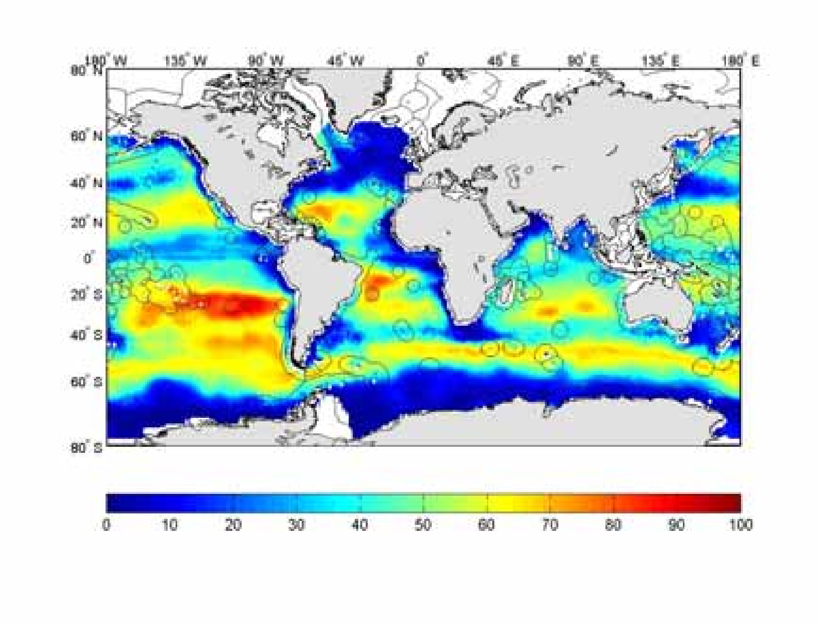
- Environmental Niche Factor Analysis
- Compares observed distribution of a species to background distribution of environmental factors
- Reveals important factors in determining distribution
- Assesses how different the environmental niche a species occupies is from the background environment, and how narrow this niche is
- Suited to presence only data

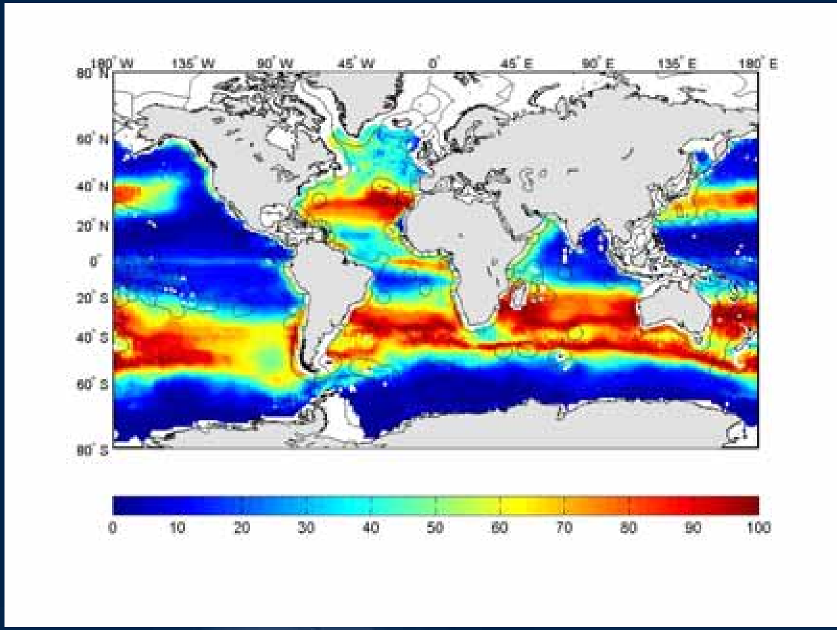
ENFA physical variables

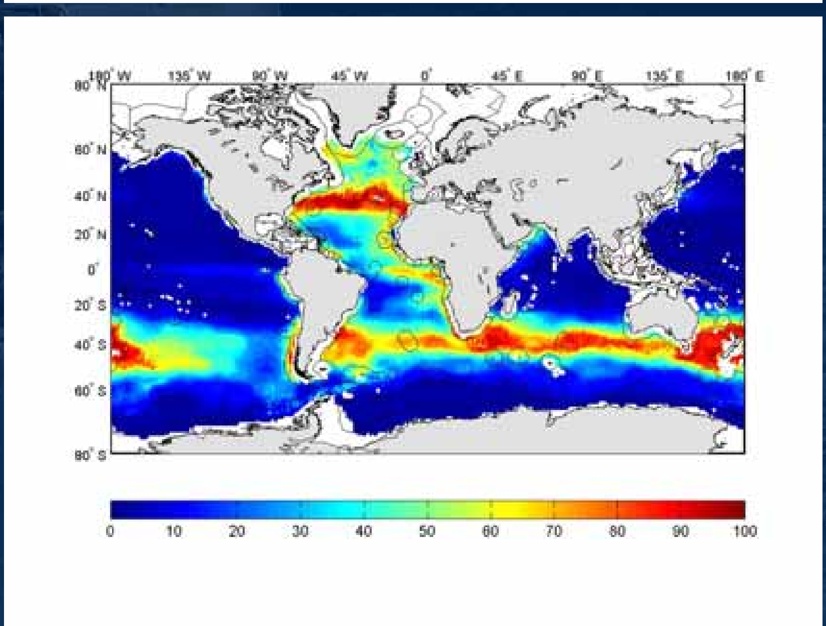
Parameter	Units	Source	Reference
Temperature	ºC	WOA	Conkright et al., 2002
Salinity	Pss	WOA	Conkright et al., 2002
Depth	m	WOA	Conkright et al., 2002
Surface chlorophyll	µg l^{-1}	WOA	Conkright et al., 2002
Dissolved oxygen	ml l^{-1}	WOA	Conkright et al., 2002
Percent oxygen saturation	%	WOA	Conkright et al., 2002
Overlying water productivity	mg C m^{-2} yr^{-1}	VGPM	Behrenfeld and Falkowski, 1997
Export primary productivity	g C m^{-2} yr^{-1}	VGPM	Behrenfeld and Falkowski, 1997
Regional current velocity	cm s^{-1}	SODA	Carton et al., 2000
Total alkalinity	µmol kg^{-1}	GLODAP	Key et al., 2004
Total dissolved inorganic carbon	µmol kg^{-1}	GLODAP	Key et al., 2004
Aragonite saturation state	µmol kg^{-1}	Derived from GLODAP data	Key et al., 2004; Orr et al., 2005; Zeebe and Wolf-Gladrow 2001

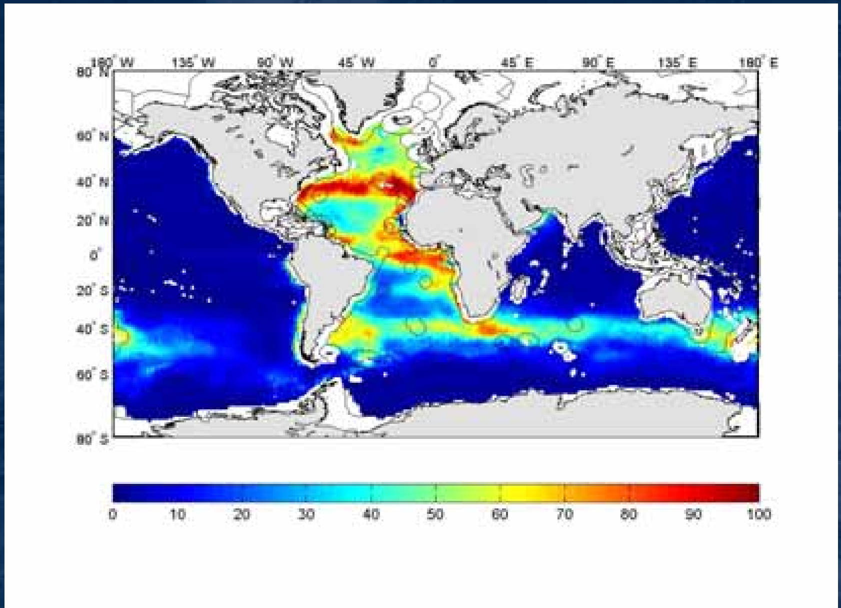
Table 5.1: Environmental parameters used to predict habitat suitability [GLODAP = Global Ocean Data Analysis Project; SODA = Simple Ocean Data Assimilation 1.4.2; VGPM = Vertically Generalized Productivity Model; WOA = World Ocean Atlas 2001] (From Clark et al 2006)

Stony corals (centred at 150m, 500m, 1000m, 1500m)

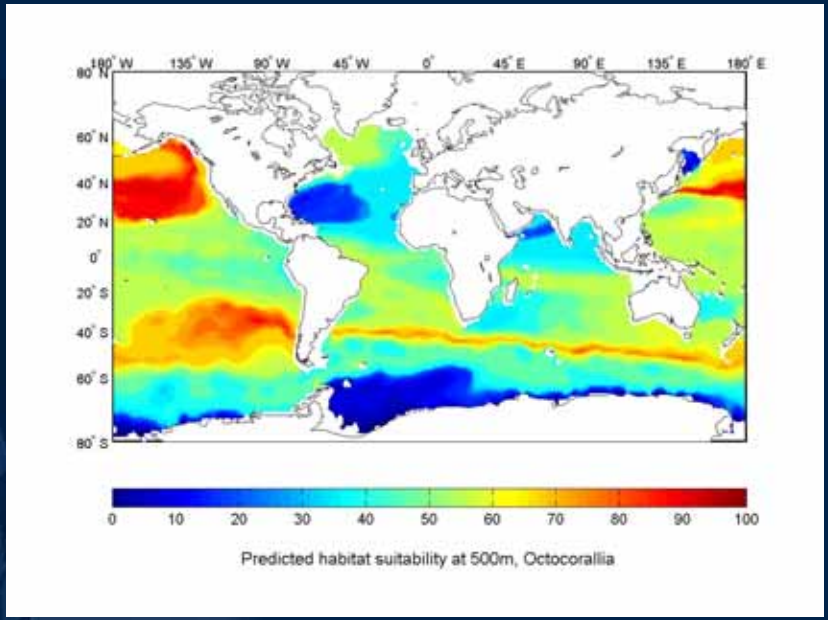




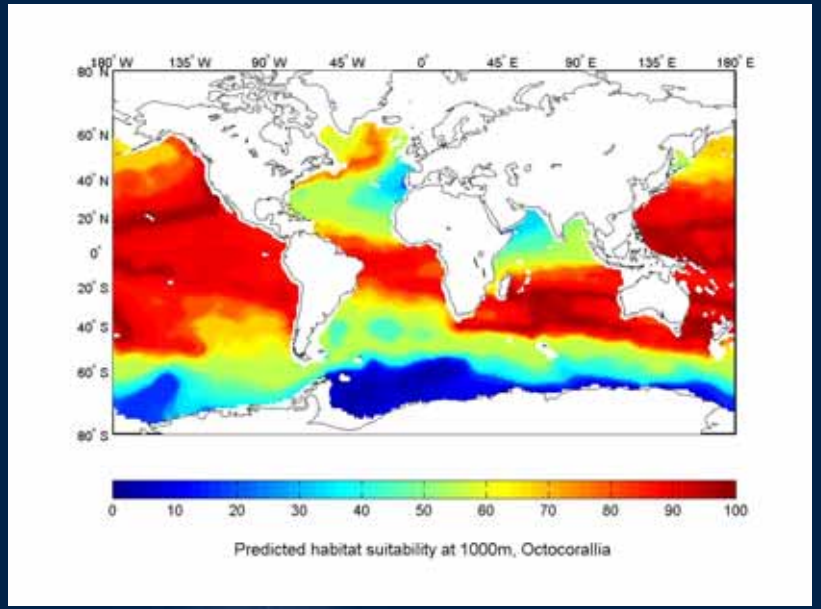




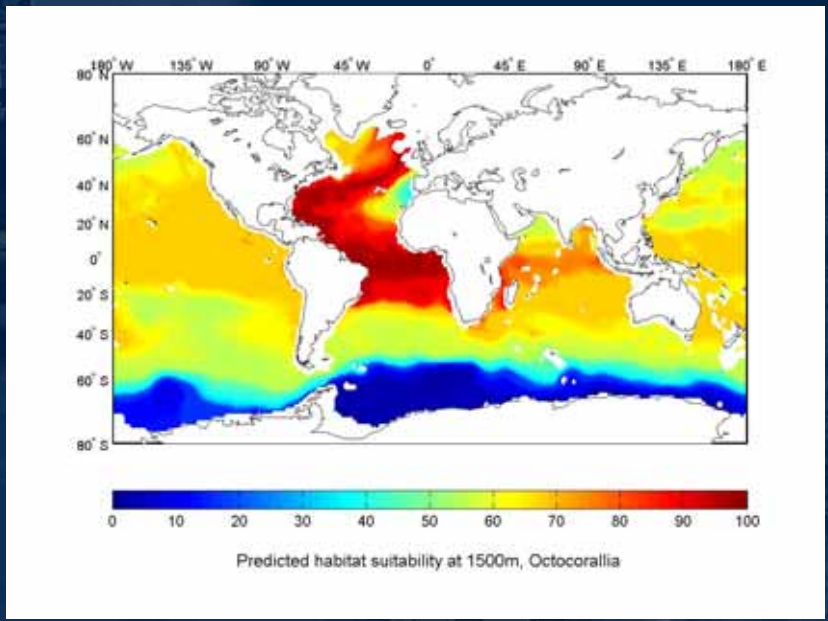
Octocorals (centred at 500m, 1000m, 1500m, 2000m)



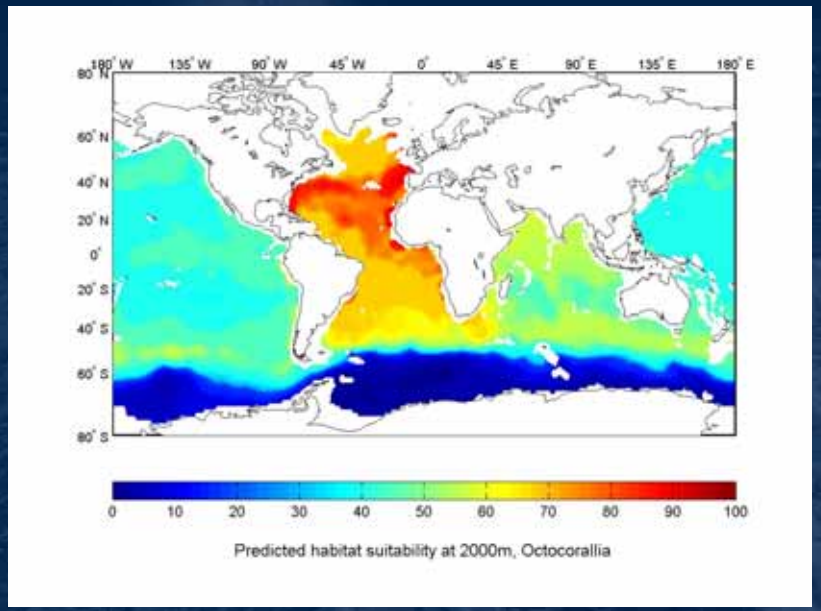
Predicted habitat suitability at 500m, Octocorallia



Predicted habitat suitability at 1000m, Octocorallia

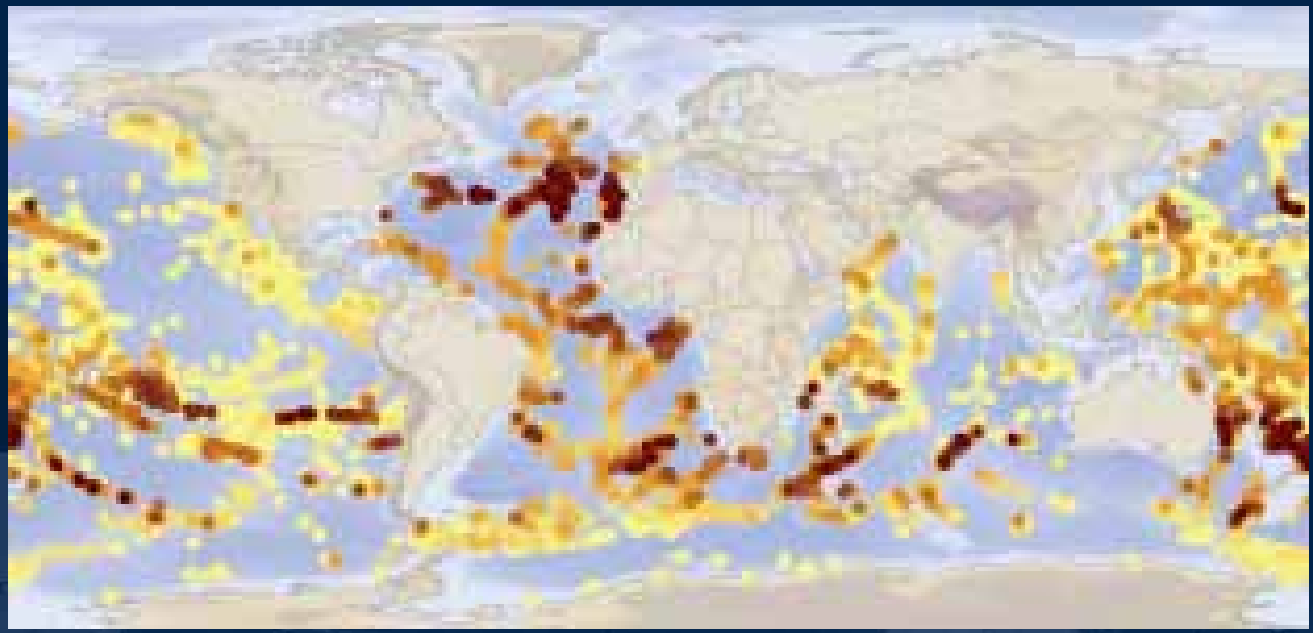


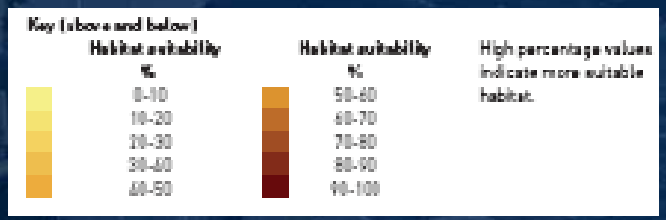
Predicted habitat suitability at 1500m, Octocorallia

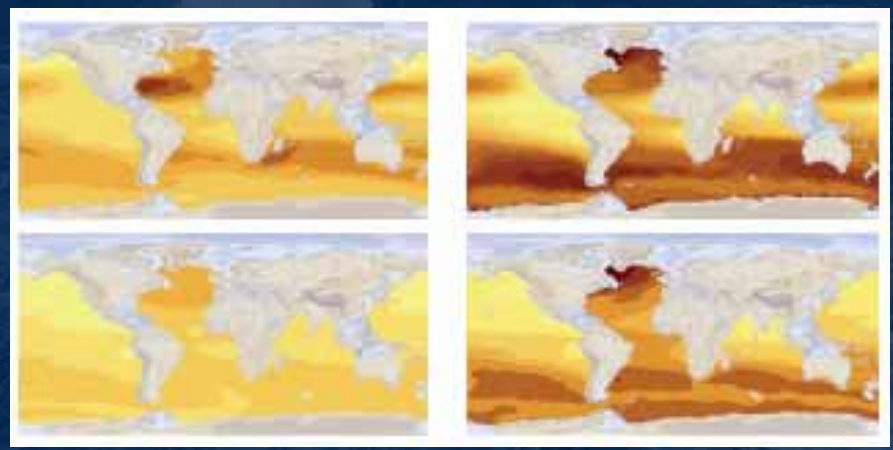


Predicted habitat suitability at 2000m, Octocorallia

Habitat suitability for STONY corals







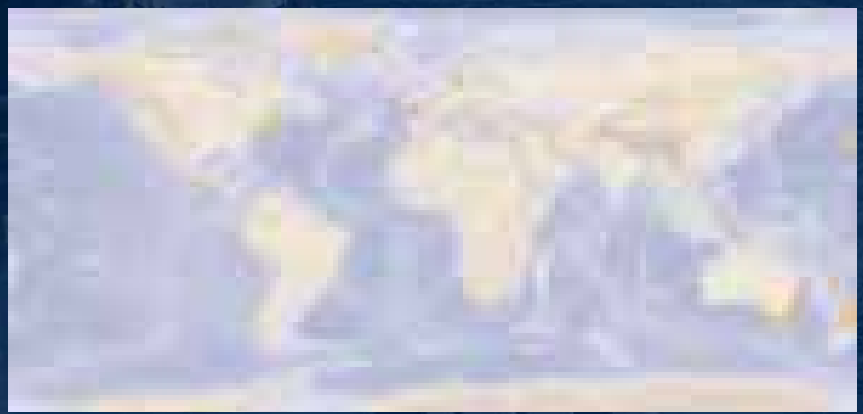
Driven by:
Aragonite saturation (left) and
Dissolved oxygen (right).
Top = 500m, bottom = 1000m

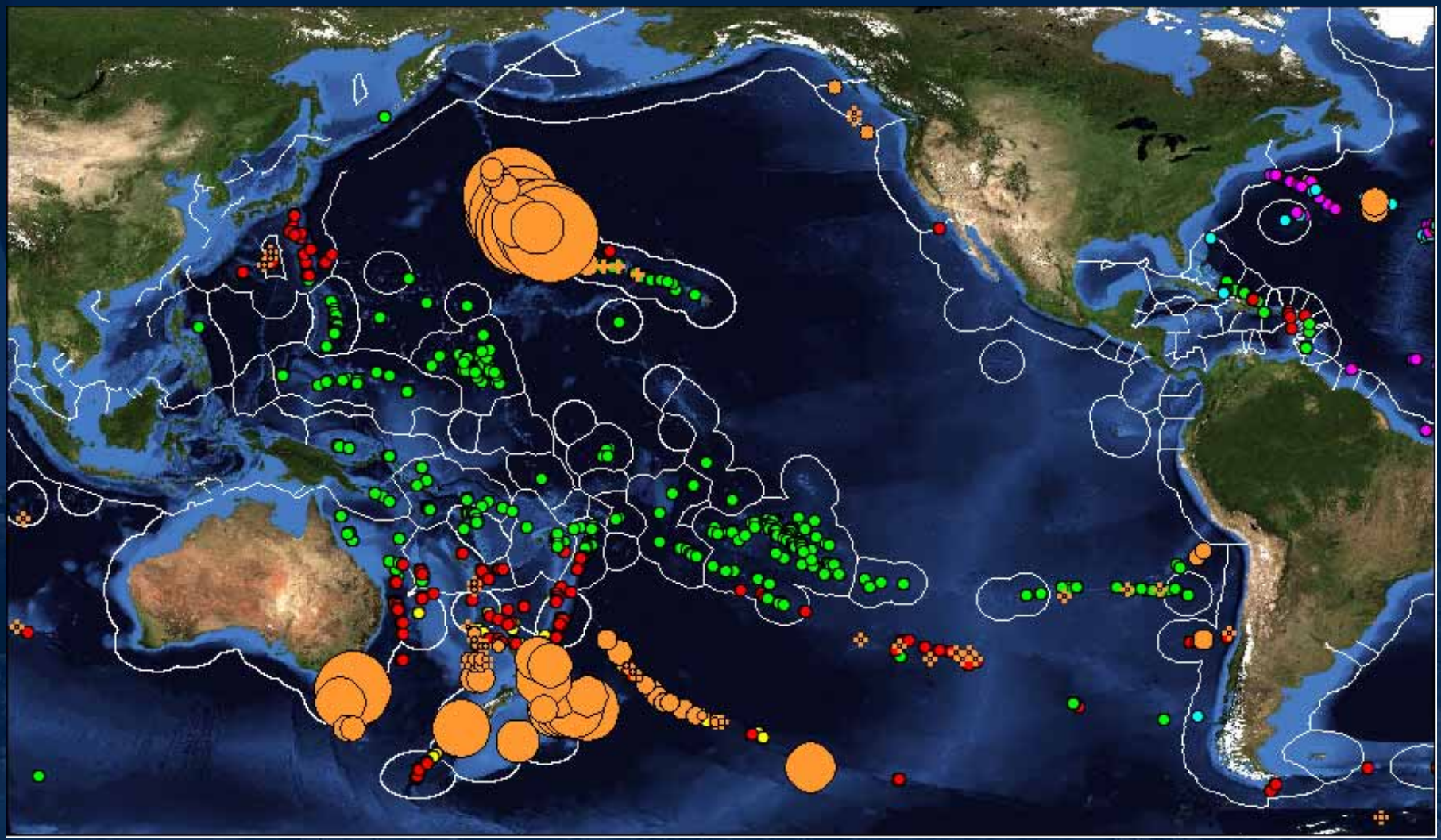
Seamount protection context (UNGA 2006, FAO 2007, SPRFMO 2007)

- Vulnerable Marine Ecosystems (e.g., seamounts, cold-water corals)
  - Predicted distribution of large seamounts
  - Habitat suitability models for cold-water (stony) corals
  - Information on historical fishing distribution
  - Information on likely target fish species
  - Depth distribution of fisheries
  - Gives a series of overlays to identify areas of relative “risk”

2 groups of major trawl fisheries

- **Alfonsino fisheries:** approximately 250 – 750 m. Bycatch species include black cardinalfish, southern boarfish, bluenose.
- **Orange roughy fisheries:** approximately 750 – 1250 m. Bycatch species include various oreos species (black, smooth, and sometimes spiky).





Some conclusions and challenges

- Deepwater species and seamount fisheries can have a role as low volume, high value, fisheries.
- Environmental considerations and an “ecosystem approach” need to be included in management.
- Some positive signs for habitat conservation and deep sea fisheries worldwide (seamount closures, BPAs)
- Balanced approach with open and closed areas can work
- Identification of sensitive habitat needs to occur before any substantial trawling. In absence of extensive (and perhaps expensive) research, environmental proxies have a role to play (but need more validation!!). Global data set collation and analysis (e.g. CoML programmes) potentially gives ability to extend beyond national boundaries
- Benthic impact assessment and protocols being talked about within the EU and SPRFMO as an integral part of fishery operation are encouraging, and the way forward…..

Acknowledgements

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- Global seamount data are from a Blackwells book just published: Pitcher et al: Seamounts-ecology, fisheries, and conservation.
- The predictive modelling work was carried out by CenSeam
- CenSeam funded attendance at this conference

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