Seamount biodiversity and ecology:

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Presentation to PEW Workshop
Hawaii, October 2007
Presentation outline

• The Seamount Environment
• Seamount fauna
• Biodiversity
• Seamount isolation
• Endemism
• Predicting faunal distribution
• Issues for exploitation
Seamount characteristics

• “Islands” of shallow seafloor surrounded by the deep ocean, and provide a range of depths for different communities
• Steep slopes, and accelerated currents can make are rock surfaces common, in contrast to most ocean seafloor
• Physical structure can form hydrographic features and current flows that concentrate species and production processes over seamounts
Substrate heterogeneity
Seamount fauna

- Biology only recent attention
- 1987 Wilson & Kaufmann 96 seamounts sampled
- 2007 Seamounts Online c. 300
- Some major gaps in sampling
Future sampling

• Relevant to Co-rich crust seamounts
  – November 2007, sampling near Hawaii
  – 2008, proposal to NOAA for survey work by Okeanos Explorer
  – 2008, possibility of HURL voyage to Line Is/Palmyra region
  – Data are available on seamounts around Hawaii
Seamount fauna (2)

• Sampling indicates rich and varied fauna
• Seamounts with slow currents have frequent sandy/muddy substrate with predominance of deposit feeders
  – polychaetes, echinoderm (ophiuroids, holothurians, echinoids), crustaceans, sipunculids, nemertean worms, molluscs, sponges, nematodes etc.
• Seamounts with faster water flows and more hard surfaces have more suspension feeders
  – Corals, crinoids, hydroids, ophiuroids, sponges. Often form extensive and reef-like structures which themselves provide a diverse habitat for other animals.
Seamount biodiversity

- Rapidly growing information on seamount biodiversity
- Wilson & Kaufmann (1987) reported 449 fish and 596 invertebrate species from 100 seamounts (most from 5)
- 2007 New Caledonia 730 species from 18 seamounts
- Parin et al (1997) 192 invertebrate and 171 fish species from just the Nazca and Sala-y-Gomez chain
- Now (Morato & Clark 2007) 800 fish species recognised from seamounts
- Seamounts Online 3000 taxa (not all to species level though) from 250 seamounts
- Data increasing from national research programmes, and efforts of CoML to collate the available information
Seamount sampling

- Sampling gear often very selective
- Generally small number of samples per seamount
- Taxonomy is a real problem
- Confident that even macrofaunal biodiversity (in particular inverts) is not known for any seamount

Rowden et al. 2002

Richer de Forges et al. 2000
Hotspots of biodiversity?

- Sessile animals (corals, sponges) can be structure-forming, and create additional habitat (e.g. >700 spp associated with *Lophelia*).
- Variability of substrate type, all sorts can occur on a single seamount supporting different communities.
- Depth ranges span faunal transition depths.
- Comparisons of species richness with slope are mixed, some high, some low.
- Scale (km vs km) can make comparisons difficult.
Coral associated diversity
Seamount “productivity”

- Biodiversity “richness” can be variable
- Biodiversity “evenness” characteristically low (i.e. high abundance of few species)
- High biomass of fish and planktivores
- Not due to increased planktonic productivity
- Trophic enrichment does occur, but caused by process such as:
  - entrapment of vertical migrators
  - enhanced horizontal fluxes of suspended food
Seamount isolation

- Seamounts close together **can** have very different faunal communities
- Yet, also have “Stepping Stone” hypothesis
- Mode of recruitment important (whether from local populations, or wider area)
- Large fish and mammals clearly migrate between seamounts and wider areas, and genetic mixing
- Benthic invertebrates have different characteristics, and for some localised reproductive methods, together with oceanographic retention mechanisms, are important for “self-recruitment”
- Many of the common seamount fauna (e.g. stony corals) have wide dispersal capabilities to help chances of some finding the small seamount targets in the deep ocean
Localized distribution of seamount fauna

How widely observed is this pattern?

How robust is the Richer de Forges et al. analysis?

How widely observed is this pattern?
<table>
<thead>
<tr>
<th>Region</th>
<th>Seamount(s)</th>
<th>Fauna</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE Pacific</td>
<td>Gulf of Alaska Seamounts: Dickins, Welker, Quinn, Giacomini, Paton, Durgin, Pratt, Applequist, Surveyor&lt;br&gt;Cobb: Nearby all spp. also found on nearby pacific coast</td>
<td>Commercial&lt;br&gt;Invertebrates</td>
</tr>
<tr>
<td>SW Pacific</td>
<td>Norfolk Ridge Seamounts: Gascoyne, Taupo, Derwent Hunter, Azooxanthellate Scleractinia&lt;br&gt;Elizabeth Reef, Britannia, Gifford, Argo and Nova: Similar to nearby margin</td>
<td>Cairns 2004&lt;br&gt;Molluscs</td>
</tr>
<tr>
<td>(mainly benthic)</td>
<td>Avila and Malaquias 2003&lt;br&gt;Ormonde: Similar to nearby margins and Mediterranean&lt;br&gt;Great Meteor: Mainly similar to nearby margins&lt;br&gt;Gorringe, Galicia, Josephine, Ampere, Lion, Seine: Most spp. found in nearby non-seamount areas or are widespread&lt;br&gt;Atlantis, Hyeres, Josephine, Meteor: Mainly widespread or cosmopolitan spp.&lt;br&gt;Plato, Irving, Meteor, Hyeres, Atlantis: Polychaetes</td>
<td>Meiofauna&lt;br&gt;Brachiopods&lt;br&gt;Polychaetes</td>
</tr>
<tr>
<td>(benthic)</td>
<td>Gillet and Dauvin 2003&lt;br&gt;Great Meteor and Josephine: Similar to nearby margins and islands&lt;br&gt;Gorringe, Josephine, Seine, Ampere, Meteor, Hyeres, Irving, Plato: 25% spp. unknown or rare on nearby margin. Rest were on nearby margin</td>
<td>Tonnoidea&lt;br&gt;Gorgonaria</td>
</tr>
<tr>
<td>(gastropods)</td>
<td>Gofas and Beu 2002&lt;br&gt;Atlantis, Tyro: Fauna: Typical of eastern Atlantic&lt;br&gt;Great Meteor and Josephine: Typical of near continental margin&lt;br&gt;Meteor, Hyeres, Cruiser (=Irving), Plato, Atlantis, Tyro, Antialhair: Strong affinity with Norway (4 of 9 taxa)</td>
<td>Calanoid&lt;br&gt;Living forams&lt;br&gt;Brachiopods</td>
</tr>
<tr>
<td>and Antipatharia</td>
<td>Grasshoff 1985&lt;br&gt;Great Meteor: Most spp. on summit were also found in deep sea.&lt;br&gt;Meteor, Hyeres, Cruizer (=Irving), Plato, Atlantis, Tyro, Antialhair: Typical of near continental margin</td>
<td>Tunicates&lt;br&gt;Pycnogonids</td>
</tr>
<tr>
<td>copepods</td>
<td>Markhaseva and Schnack -Schiel 2003&lt;br&gt;Gorringe, Josephine, Seine, Ampere, Galice: 10 of the 13 spp. known from nearby margin&lt;br&gt;Gorringe, Josephine, Seine, Ampere, Galice: 9 of 10 spp. found in “neighboring areas</td>
<td>Pycnogonids</td>
</tr>
</tbody>
</table>
NW Atlantic
  _Argus, Bowditch, and Challenger_  
  Fauna: Most spp. found elsewhere in Western Atlantic tropical region  

SE Atlantic
  _Vema_  
  Fauna: Very distinct from S. African coast and nearby islands.  

Indian
  _Walters Shoals_  
  Fauna: Most spp. known from region, but some exceptions  

_Invertebrates - depth zone unknown or multiple_

<table>
<thead>
<tr>
<th>Region</th>
<th>Seamount(s)</th>
<th>Taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian</td>
<td><em>Walters Shoal</em></td>
<td>Shrimp</td>
</tr>
<tr>
<td></td>
<td><em>Fred, Error, Equator, Farquhar</em></td>
<td>Cephalopods</td>
</tr>
</tbody>
</table>

_Fish and invertebrates - bottom associated_

<table>
<thead>
<tr>
<th>Region</th>
<th>Seamount(s)</th>
<th>Taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central/NW Pacific</td>
<td><em>Horizon Magellan Rise</em></td>
<td>Fish and invertebrate</td>
</tr>
<tr>
<td></td>
<td>Kaufmann <em>et al.</em> 1989</td>
<td></td>
</tr>
</tbody>
</table>
|                 | _Great Meteor_ | Megafauna  
| (mainly invertebrate) | Piepenburg and Muller 2004 |                |
|                 | _22 seamounts, Nazca & Sala chains_ | Invertebrates |
| SE Pacific      | Parin _et al._ 1997 |                |

This summary (from Stocks & Hart 2007) shows seamount fauna (non-endemic) have strong affinity with nearest continental margin). Of 24 studies, only 3 showed differences from the general biogeographic regional fauna
Seamount endemism

• Often quoted as a seamount faunal “characteristic”, yet studies show variable levels (from 5 to over 50%)
• Likely higher for benthic invertebrates than fishes
• Recent review by Stocks & Hart estimated overall about 20%
• But true rates poorly known, artefact of limited sampling, variable taxonomy also an issue
## Published endemism estimates

<table>
<thead>
<tr>
<th>% Endemism</th>
<th>Taxa</th>
<th>Seamount(s)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% of 15 spp.</td>
<td>Brachiopods</td>
<td>NE/North Central Atlantic: 6 seamounts</td>
<td>Gaspard 2003</td>
</tr>
<tr>
<td>0% of 8 spp.</td>
<td>Brachiopods</td>
<td>NE/North Central Atlantic: 7 seamounts</td>
<td>Logan 1998</td>
</tr>
<tr>
<td>0% of 20 spp.</td>
<td>Foram s (living)</td>
<td>NE/North Central Atlantic: Great Meteor</td>
<td>Heinz et al. 2004</td>
</tr>
<tr>
<td>0% of 15 spp.</td>
<td>Gorgonaria and Antipatharia</td>
<td>NE/North Central Atlantic: Great Meteor and Josephine</td>
<td>Grasshoff 1985</td>
</tr>
<tr>
<td>0% of 3 spp.</td>
<td>Hydroids</td>
<td>NW Atlantic: Argus, Bowditch, Challenger</td>
<td>Calder 2000</td>
</tr>
<tr>
<td>0% of 18 spp.</td>
<td>Madreporaria coral</td>
<td>Atlantic: Great Meteor, Atlantis, Rockaway, Reykjanes ridge</td>
<td>Keller 1985</td>
</tr>
<tr>
<td>0% of 31 spp.</td>
<td>Molluses</td>
<td>NE/North Central Atlantic: Ormonde</td>
<td>Avila and Malaquias 2003</td>
</tr>
<tr>
<td>0% of 16 ssp.</td>
<td>Tonnoida (Gastropoda)</td>
<td>NE/North Central Atlantic: 10 seamounts</td>
<td>Gofas and Beu 2002</td>
</tr>
<tr>
<td>low or none of 95 spp.</td>
<td>Invertebrates</td>
<td>NE Pacific: Cobb</td>
<td>Parker and Tunnicliffe 1994</td>
</tr>
<tr>
<td>2% of 57 spp.</td>
<td>Azooxanthellate Scleractinia</td>
<td>SW Pacific: 8 Norfolk Ridge seamounts</td>
<td>Cairns 2004</td>
</tr>
<tr>
<td>6% of 53 spp.</td>
<td>Polychaetes</td>
<td>NE/North Central Atlantic: Atlantis, Hyeres, Josephine, Meteor,</td>
<td>Gillet and Dauvin 2000</td>
</tr>
<tr>
<td>6-75% of 84 spp.</td>
<td>Polychaetes</td>
<td>NE/North Central Atlantic: Plato, Irving, Meteor, Hyeres, Atlantis</td>
<td>Gillet and Dauvin 2003</td>
</tr>
<tr>
<td>7% of 13 spp.</td>
<td>Tunicates</td>
<td>NE/North Central Atlantic: 5 seamounts</td>
<td>Monniot and Monniot 1992</td>
</tr>
<tr>
<td>9% of 11 spp.</td>
<td>Hydrozoans</td>
<td>NE/North Central Atlantic: 6 seamounts</td>
<td>Ramil et al. 1998</td>
</tr>
<tr>
<td>10% of 10 spp.</td>
<td>Pycnogonids</td>
<td>NE/North Central Atlantic: Gorringe, Josephine, Seine, Ampere, Galice</td>
<td>Stock 1991</td>
</tr>
</tbody>
</table>

Table from Stocks & Hart 2007
<table>
<thead>
<tr>
<th>Percentage</th>
<th>Taxonomic Group</th>
<th>Geographic Region</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>11% of 9 spp.</td>
<td>Calanoid copepods</td>
<td>NE/North Central Atlantic: Great Meteor</td>
<td>Markhaseva and Schnack - Schiel 2003</td>
</tr>
<tr>
<td>15%+ of 414 spp.</td>
<td>benthic megafauna</td>
<td>SW Pacific: New Zealand hills</td>
<td>Rowden et al. 2002</td>
</tr>
<tr>
<td>25% of 4 spp.</td>
<td>Fasciolariidae (Gastropoda)</td>
<td>NE/North Central Atlantic: 11 seamounts</td>
<td>Gofas 2000</td>
</tr>
<tr>
<td>43% of 7 spp.</td>
<td>Ascidians</td>
<td>SE Atlantic: Vema</td>
<td>Primo and Vazquez 2004</td>
</tr>
<tr>
<td>59%+ of 17 spp.</td>
<td>Epsilonematidae (Nematoda)</td>
<td>NE/North Central Atlantic: Great Meteor</td>
<td>Gad 2004a</td>
</tr>
<tr>
<td>63% of 27 spp.</td>
<td>Pyramidellidae (Gastropoda)</td>
<td>NE/North Central Atlantic: Great Meteor, Hyeres, Irving, Atlantis</td>
<td>Pen as and Rolan 1999</td>
</tr>
<tr>
<td>94% of 33 spp.</td>
<td>Harpacticoid copepods</td>
<td>NE/North Central Atlantic: Great Meteor</td>
<td>George and Schminke 2002</td>
</tr>
<tr>
<td>100% of 12 spp.</td>
<td>Loricifera</td>
<td>NE/North Central Atlantic: 5 seamounts</td>
<td>Gad 2004b</td>
</tr>
<tr>
<td>100% of 10 spp.</td>
<td>Trituba (Gastropoda)</td>
<td>NE/North Central Atlantic: Great Meteor</td>
<td>Gofas 2002</td>
</tr>
<tr>
<td>100% of 9 spp.</td>
<td>Meiofauna</td>
<td></td>
<td>Gad and Schminke 2004</td>
</tr>
</tbody>
</table>

**Invertebrates - mixed benthic and pelagic, or bottom**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Taxonomic Group</th>
<th>Geographic Region</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5% of 52 or 53 spp.</td>
<td>Cephalopods</td>
<td>India n: Walters Shoal</td>
<td>Nesis 1994</td>
</tr>
<tr>
<td>2% of 45 spp.</td>
<td>Cephalopods</td>
<td>Indian: Fred, Ero, Equator, Farquhar</td>
<td>Nesis 1986</td>
</tr>
<tr>
<td>6% of 33 spp.</td>
<td>Caridea (Decapoda)</td>
<td>Central/NW Pacific: 8 seamounts</td>
<td>Allen and Butler 1994</td>
</tr>
<tr>
<td>7% of 29 spp.</td>
<td>Shrimp</td>
<td>Indian: Walters Shoal</td>
<td>Burukovsky 1992</td>
</tr>
<tr>
<td>15% of 506 spp.</td>
<td>Invertebrates</td>
<td>global: 100 seamounts worldwide</td>
<td>Wilson and Kaufmann 1987</td>
</tr>
<tr>
<td>36% of 11 spp.</td>
<td>Anomuran &amp; Brachyuran Decapods</td>
<td>Central/NW Pacific: Nintoku, Jingu &amp; Kinmei</td>
<td>Sakai 1980</td>
</tr>
<tr>
<td>0% of 31 (but not all identified to species) spp.</td>
<td>Cephalopods</td>
<td>NE/North Central Atlantic: Great Meteor</td>
<td>Diekmann and Piatkowski 2004</td>
</tr>
<tr>
<td>Species Type</td>
<td>Depth Habitat</td>
<td>Geographical Area</td>
<td>Endemism Description</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Fishes - bottom associated</td>
<td>Fishes (deep-water)</td>
<td>Central/NW Pacific: Cross</td>
<td>Published rates are indicative only, may increase as more cryptic species are differentiated, or decrease as species ranges are better described…</td>
</tr>
<tr>
<td>Fishes - mixed benthic and pelagic, or bottom association unknown</td>
<td>Fishes (shallow-water)</td>
<td>Indian: Walters Shoal</td>
<td>Edwards 1993</td>
</tr>
<tr>
<td>Fishes and Invertebrates - bottom associated</td>
<td>Fishes and invertebrates</td>
<td>Central/NW Pacific: Horizon Magelland Rise</td>
<td>Kaufmann et al. 1989</td>
</tr>
<tr>
<td>Fishes and Invertebrates - mixed benthic and pelagic, or bottom association unknown</td>
<td>Fish and mega invertebrates</td>
<td>SW Pacific: 6 Norfolk Ridge, 4 Lord Howe and 14 Tasmanian seamounts</td>
<td>Richer de Forges et al. 2000</td>
</tr>
</tbody>
</table>

Plus recent papers by Samadi et al., O’Hara, Hall-Spencer et al that indicate endemism is not as high as often quoted.
Macro-invertebrate biodiversity - surveys

• Since 1999 NIWA has conducted 10 seamount-specific research cruises
• 40 seamounts from subtropical (30°S) to sub-Antarctic waters (51°S)
• ~ 200 – 3000 m water depth
• wide geographic spread and including seamounts located on ridges, rises, plateaux
• Same sampling gear used
• Same taxonomist for each specific taxon
Macro-invertebrate biodiversity – *pattern analysis*

*Expectation #1 & #2 – based on theory/previous study:*

- Dissimilar assemblages on different seamounts
- Assemblages dissimilar between seamounts on different ridges or in different clusters (locations)

*Data analysis:*

- Epibenthic sled P/A data for stations with $\geq 2$ taxa
  - Porifera: 24 seamounts, 81 stations, 181 taxa
  - Mollusca: 32 seamounts, 116 stations, 225 taxa
  - Polychaeta: 30 seamounts, 103 stations, 113 taxa
  - Bryozoa: 24 seamounts, 78 stations, 364 taxa

- Multivariate stats (PRIMER) - 2-way ANOSIM, MDS plots of seamount averaged data, BIOENV
Macro-invertebrate biodiversity – results

Assemblage composition

- **Overall**, statistical significant differences between assemblages on different seamounts
- However, observed dissimilarities generally **small**
- Porifera < Bryozoa < Mollusca < Polychaeta

(R values = 0.20, 0.29, 0.33, 0.45)
Macro-invertebrate biodiversity – results

- Overall, no ‘location’ effect
  - However, pairwise test – CR assemblages very different from those on NP for Porifera, Bryozoa & Mollusca
    (R values = 0.98, 0.98, 0.88)

- For Polychaeta – difference between CR/HP and smaller dissimilarities between CR/KR, HP/KR
  (R values = 1.0, 0.18, 0.28)
Interesting to compare biodiversity of seamount assemblages to those elsewhere in region

..... coarse comparison

<table>
<thead>
<tr>
<th></th>
<th>Porifera</th>
<th>Bryozoa</th>
<th>Mollusca</th>
<th>Polychaeta</th>
</tr>
</thead>
<tbody>
<tr>
<td># taxa in region</td>
<td>763</td>
<td>1166</td>
<td>4515</td>
<td>873</td>
</tr>
<tr>
<td># taxa on seamounts</td>
<td>181</td>
<td>370</td>
<td>225</td>
<td>113</td>
</tr>
<tr>
<td># taxa on only seamounts to date</td>
<td>154</td>
<td>193</td>
<td>~173</td>
<td>~91</td>
</tr>
<tr>
<td>'apparent seamount endemism'</td>
<td>20%</td>
<td>17%</td>
<td>~4%</td>
<td>~10%</td>
</tr>
</tbody>
</table>

However, level of ‘apparent seamount endemism’ is probably result of various sampling artefacts, e.g. sampling of comparable substrata in the deep-sea is very limited
Macro-invertebrate biodiversity- *pattern analysis*

- More robust regional context of seamount biodiversity from analysis using measures of Taxonomic Distinctness

*Expectation #3 based on island biogeography theory:*

Variation TD (‘variation in relatedness’ or ‘taxonomic evenness’) *lower* for seamount assemblages than for any given assemblage in the region (drawn from the same species pool)

*Data analysis:*

VarTD for each seamount station compared to mean for regional assemblage using TAXDTEST (PRIMER)
Illustration of output of method

Funnel Plot

95% probability funnel – expected range of simulated value for given number of species in sample

Assemblage of sample A has value no different from what would expect if drawn randomly from regional species pool; Assemblage of sample B has value significantly lower than that of theoretical mean for regional species pool
Macro-invertebrate biodiversity - results

- Measures of VarTD revealed that assemblages on seamounts generally **not** significantly different from mean for regional species pool – though mostly higher

*Polychaeta & Mollusca*

Number of stations with values outside of funnel – but other stations from these seamounts fell inside
• However, values for all stations from two seamounts are outside (or just on the edge) of probability funnel

**Bryozoa**
Seamount #441 on Northland Plateau

**Porifera**
Ghoul on Chatham Rise
Macro-invertebrate biodiversity – summary so far

• Assemblage composition differences between seamounts relatively small

• No overall differences in assemblages between different locations – though seamount assemblages of some locations were different

• Patterns somewhat different between different taxonomic groups

• Generally seamount assemblages do not have different taxonomic evenness from theoretical mean for regional species pool

....more work to do, including explaining why.....
What do we think seamounts are? – right now?

Evidence from the NZ study and others…


O’Hara (2007)

Hall-Spencer et al (in press)

Schlacher & Rowden (in prep)

…..is beginning to change our perception of what seamounts are…looking like they might not be islands of high endemism…..
CenSeam work (Schlacher & Rowden)

- Started at ISA workshop in 2006
- Based on SW Pacific galatheids
- Striking some taxonomic issues
- Preliminary results showing lack of consistent differences between seamounts and seamount groups
Kermadec Ridge
Lord Howe Ridge
Tasmania
Norfolk Ridge
Reinga Ridge
West Norfolk Ridge
Tonga
Wallis & Futuna
Fiji
Kermadec
Tasmania
BUT…

• The SW Pacific data sets are from a small geographical region, in areas generally close to continental land masses (Australia) or islands with large continental shelf areas (e.g. New Zealand).

• Need to be careful to generalise based on such comparisons

• Region is also geologically very complex, so huge diversity of habitat “types” in the area which may explain the differences between faunal groups (and makes overall conclusions difficult).
NZ Seamount classification

- Based on biologically “useful” physical parameters
- 12 groupings were differentiated (cluster analysis)
- Main drivers were depth (summit, base, elevation) and distance to continental shelf
- Some geographic association, some environmental
- Raises the issue of the spatial scale at which we may expect some differences in faunal community composition
What else 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 (15,000 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)
Scleractinean (stony corals) distribution

1700 records, 249 spp
Includes large reef-forming genera,
*Lophelia, Madrepora, Solenosmilia*
But note distribution of samples not flash!
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
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]
Modelling distribution
0-250m
750-1250m
Habitat suitability

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

- Fishing and mining efforts can be highly concentrated on seamounts.
- Deepwater, coral-dominated, communities are highly vulnerable to physical disturbance, fragile to impact.
- Levels of endemism are critical to evaluate the seriousness of impact.
- Indirect effects through sedimentation (smothering impact), changes in community composition with selective removal, and interactions between benthic-pelagic components may change.
- Given slow growth rate of many seamount species, recovery may be slow.
- Natural changes are also occurring (e.g., ocean acidification) but in the short-term, human impacts are of most concern.
Conclusions and challenges

- Seamounts provide a different set of environments in the deep ocean, enabling a rich and varied fauna to exist
- Seamount biodiversity is poorly known, but data increasing rapidly
- Seamount ecology is in a state of flux, with issues of isolation and endemism becoming less clear
- Evident that seamounts are highly variable in their fauna, and also their biogeographic qualities and affinities
- Components of the fauna are vulnerable to human impact
- Management is urgently needed to balance exploitation and conservation
- In many cases this needs to occur in the absence of good scientific data, and predictive modelling of faunal distributions, as well as environmental classification based on physical proxies, are options here.
Acknowledgements

- My thanks to the organisers of the Workshop (Craig Smith and Tony Koslow) and the PEW Foundation for funding and the opportunity to make this presentation.
- This presentation has used material from a number of NIWA research projects funded by the Foundation for Research, Science and Technology (including FRST CO1X0508 (Seamounts)) and the Ministry of Fisheries (ENV200516).
- The predictive modelling work was carried out by CenSeam.