Department of Conservation
Te Papa Atawhai

NIWA
Taihoro Nukurangi

Nau mai, welcome

Developing the New Zealand Seafloor Community Classification

Department of Conservation
Te Papa Atawhai

NIWA
Taihoro Nukurangi

9:30am	**Webinar 1.1 | Developing the New Zealand Seafloor Community Classification**

- NIWA welcome
- DOC welcome – Shane Geange
- Fabrice Stephenson
- Tea break

10:15am	**Webinar 1.2 | Developing the New Zealand Seafloor Community Classification**

- Fabrice Stephenson
- Q&A session (Webinar 1)
  - Ashley Rowden, Judi Hewitt, Shane Geange, Greig Funnell, Tom Brough, Fabrice Stephenson

1:30pm	**Webinar 2.0 | Applications of the New Zealand Seafloor Community Classification**

- Fabrice Stephenson
- Panel discussion (Webinar 2)
  - Ashley Rowden, Judi Hewitt, Shane Geange, Greig Funnell, Tom Brough, Fabrice Stephenson

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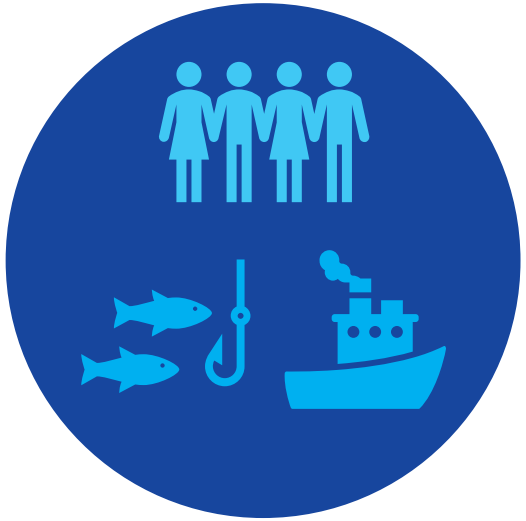
9:30am **Webinar 1.1 | Developing the New Zealand Seafloor Community Classification**

- NIWA welcome
- DOC welcome – Shane Geange
- Fabrice Stephenson
- Tea break

Q&A session before lunch

What is the DOC MPA Research Programme?



Marine habitats and ecosystems under increasing human pressures

MPAs can be effective tools for conserving biodiversity and their ecosystem services

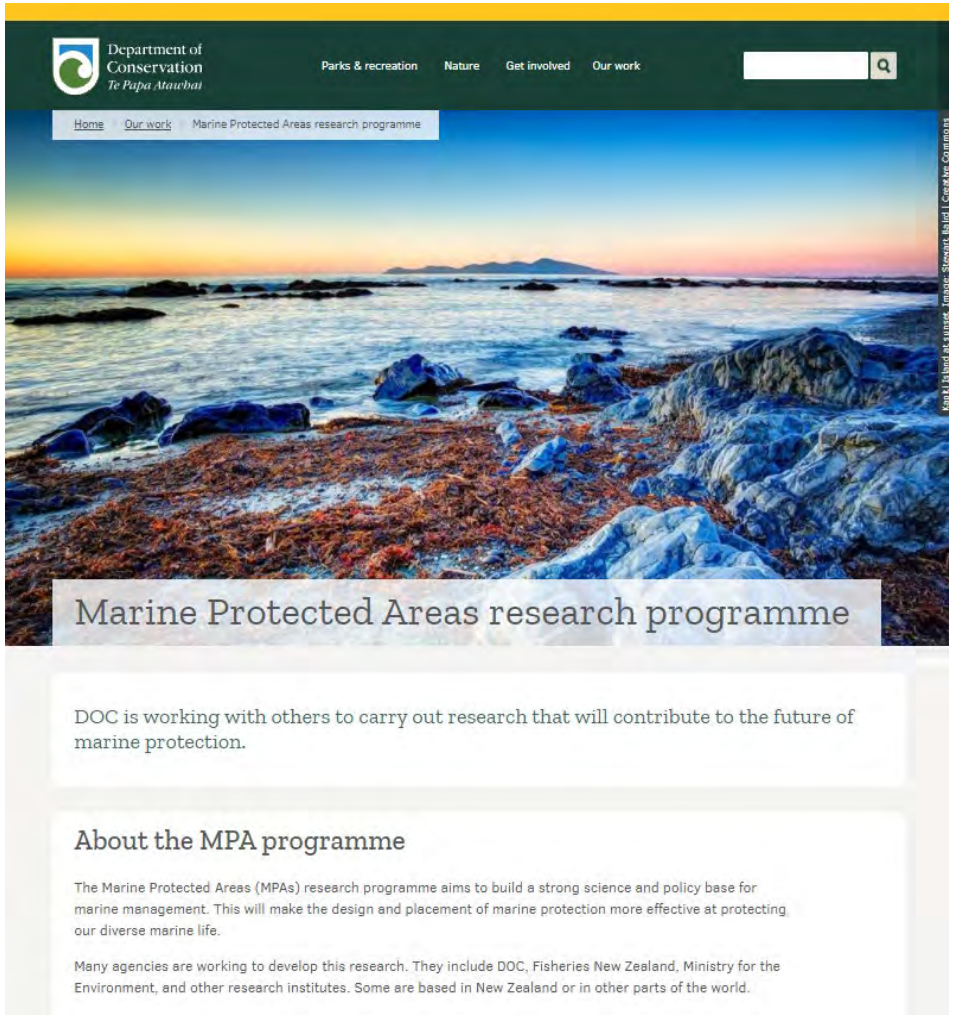
Marine Protected Areas Science Advisory Group (MSAG)

What is the DOC MPA Research Programme?

Completed work

- MPA network design principles
- MPA targets & objectives
- MPA gaps analysis
- Key Ecological Area Criteria
- MPA decision-support tools

Available online



Work underway

- MPA societal awareness
- MPA Benefits & values
- Web content & infographics
- Marine geospatial data portal
- Biodiversity below 2000 m
- Deeper reef ecosystems

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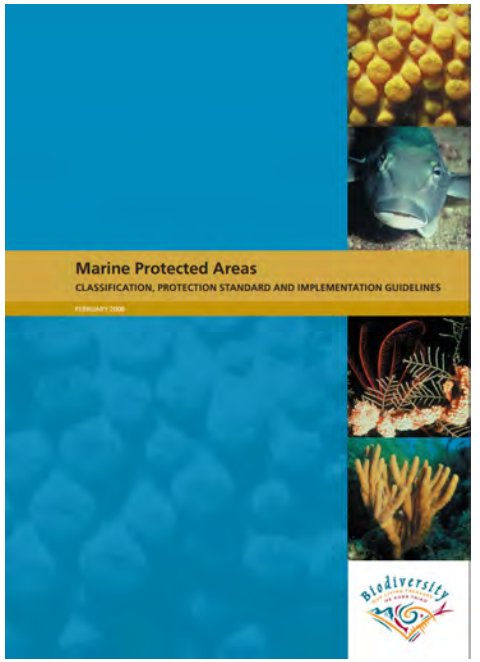
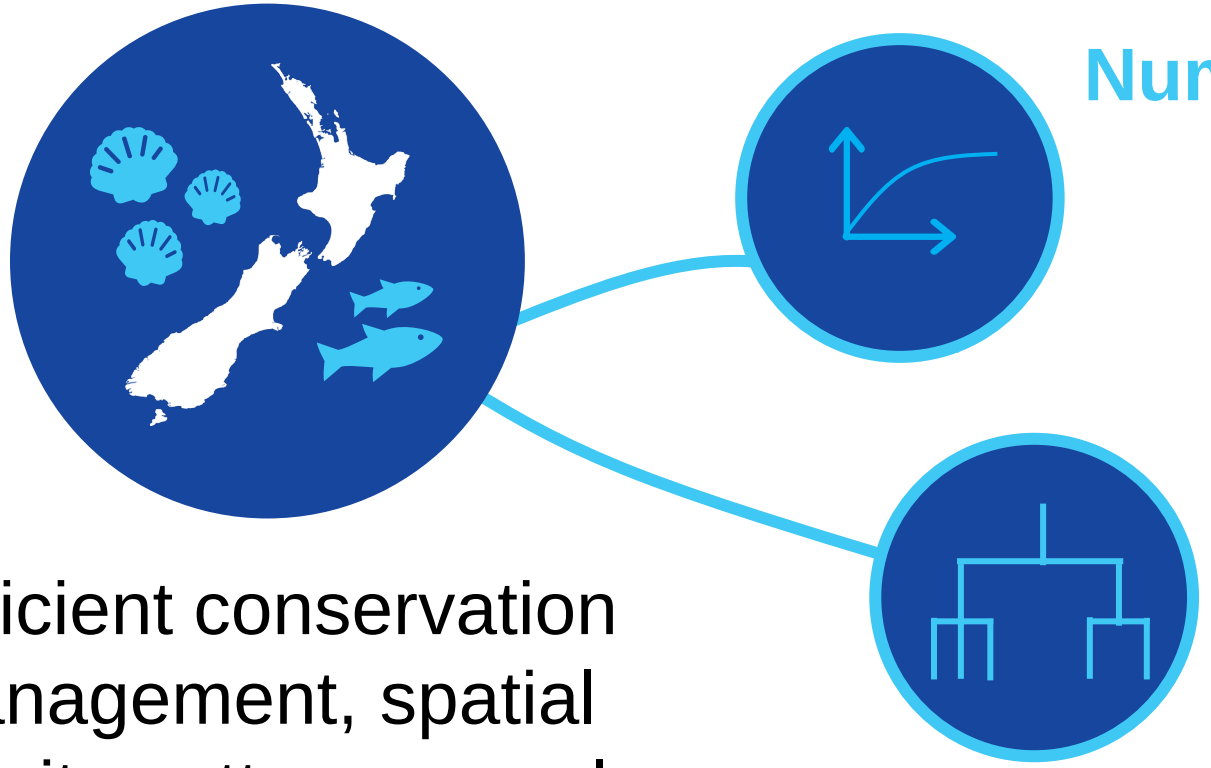
Why do we need an updated habitat classification?

For efficient conservation management, spatial biodiversity patterns over large scales must be understood.



Coastal and Marine Habitat and Ecosystem Classification

Why do we need an updated habitat classification?



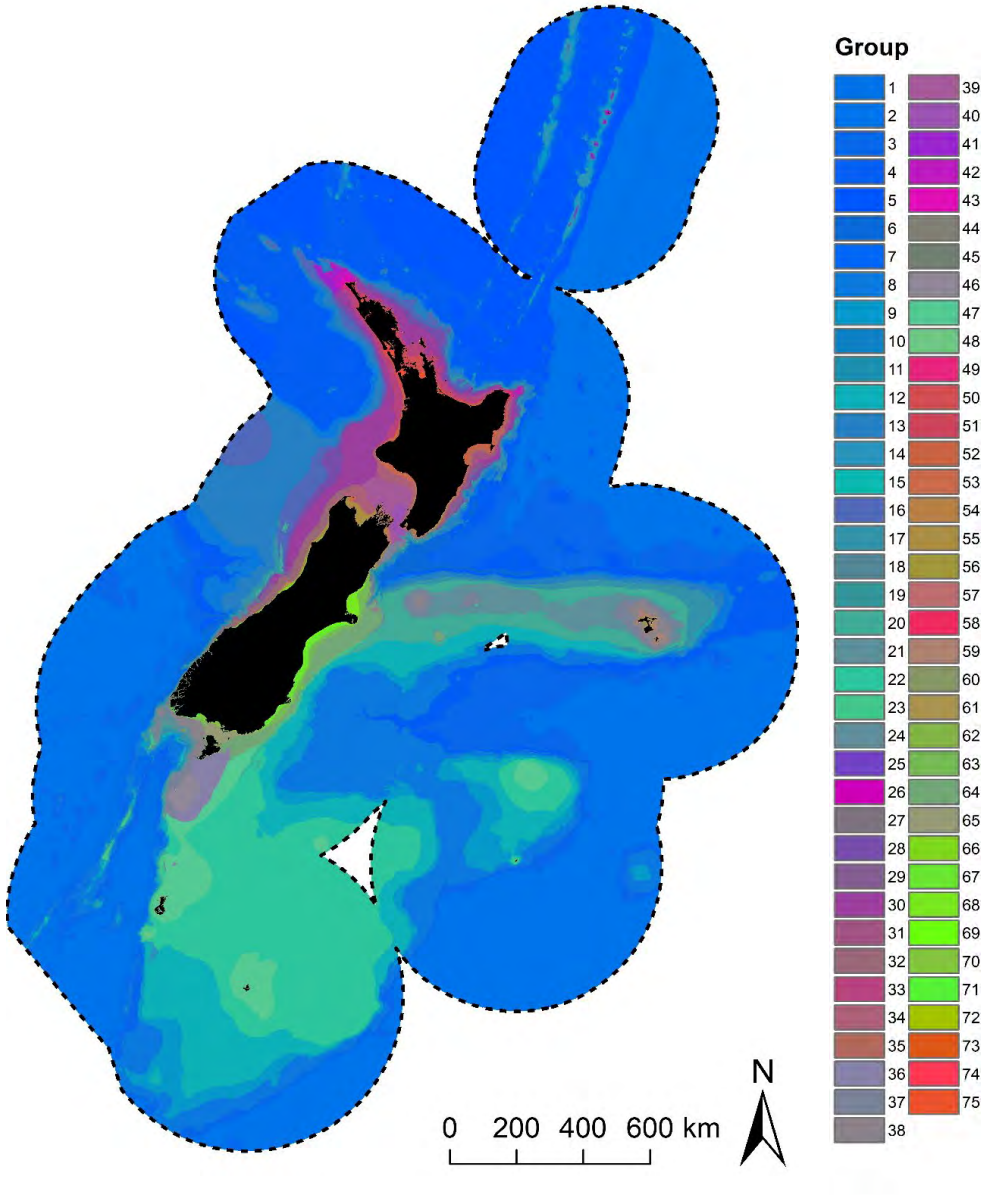
Numeric classification

Thematic classification

For efficient conservation management, spatial biodiversity patterns over large scales must be understood.

Why are we here today?

- While developed for MPA planning, has broader utility
- Introduce the NZSCC
- Independently reviewed and presented at AWEG and BRAG
- How can we facilitate its uptake and shape it for different audiences?



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Webinar 1. Developing the New Zealand Seafloor Community Classification (NZSCC)

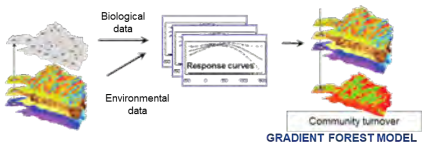
Fabrice Stephenson (fabrice.stephenson@niwa.co.nz)
Ashley Rowden, Tom Brough, Grady Petersen, Richard Bulmer, John Leathwick, Andrew Lohrer, Joanne Ellis, David Bowden, Shane Geange, Greig Funnell, Debbie Freeman, Karen Tunley, Pierre Tellier, Dana Clark, Carolyn Lundquist, Barry Greenfield, Ian Tuck, Theophile Mouton, Kate Neill, Kevin Mackay, Matt Pinkerton, Owen Anderson, Richard Gorman, Sadie Mills, Stephanie Watson, Wendy Nelson & Judi Hewitt

How did we get here?

- MSAG commissioned **a numerical classification** to inform marine protection planning

- A workshop in 2019 discussed
  - **methods** for classification
  - availability of **biological** and **environmental** datasets
  - **model uncertainty**

Gradient Forest Models



For four groups:

- **demersal fish**
- **benthic invertebrates**
- **rocky reef fish**
- **macroalgae**

How to create a Gradient Forest Model for all of NZ?

Challenge

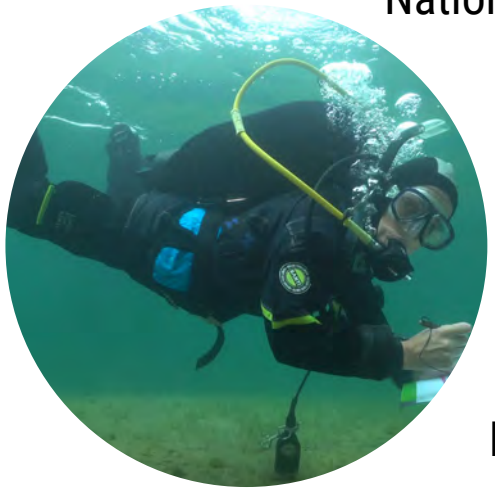
Biological data comes from lots of sources **but** is sparse

Solution

Can **combine** with readily available environmental data across large areas

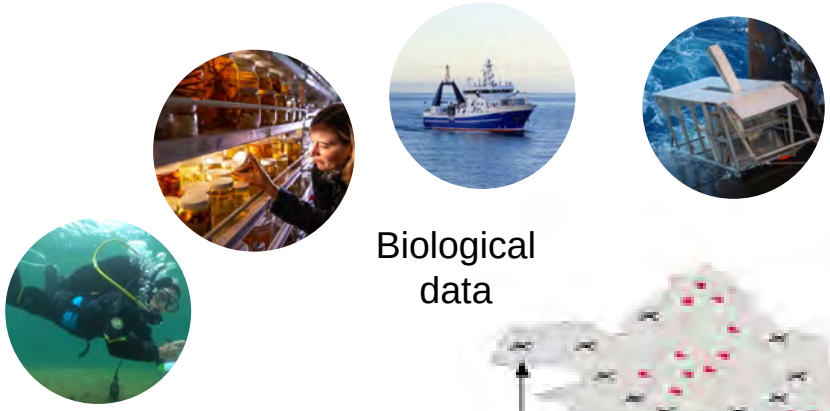
Research trips

National collections

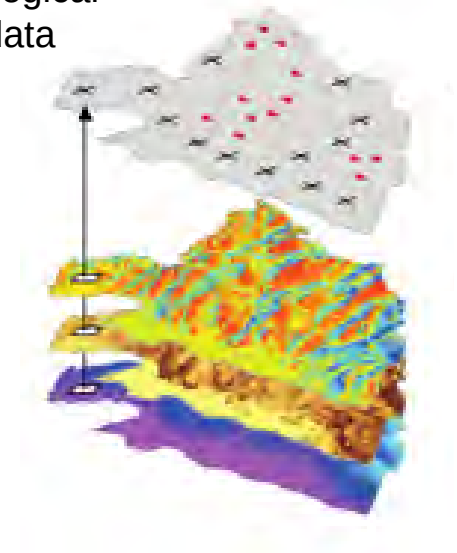


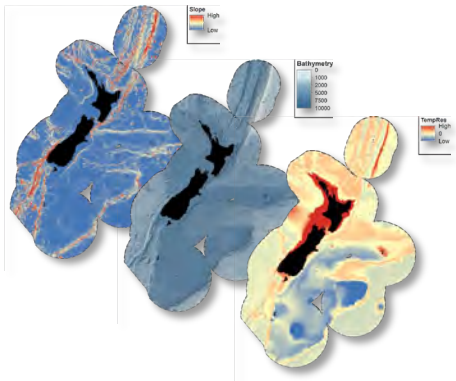
Funded work

How to create a Gradient Forest Model for all of NZ?



Biological data





Environmental data

Climate, Freshwater & Ocean Science

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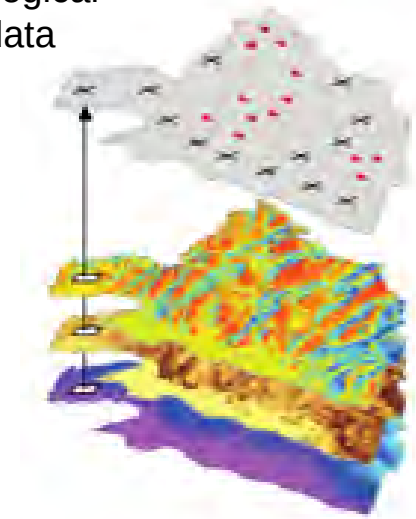
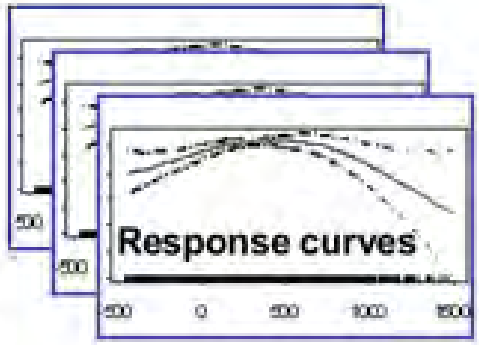
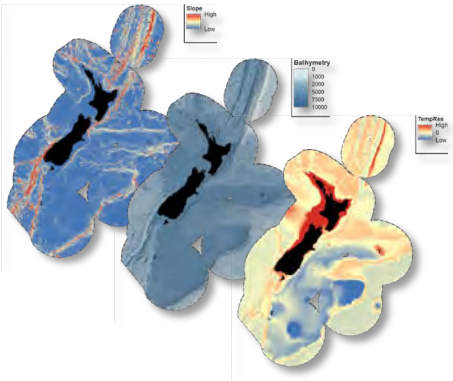
How to create a Gradient Forest Model for all of NZ?

Biological data







Environmental data

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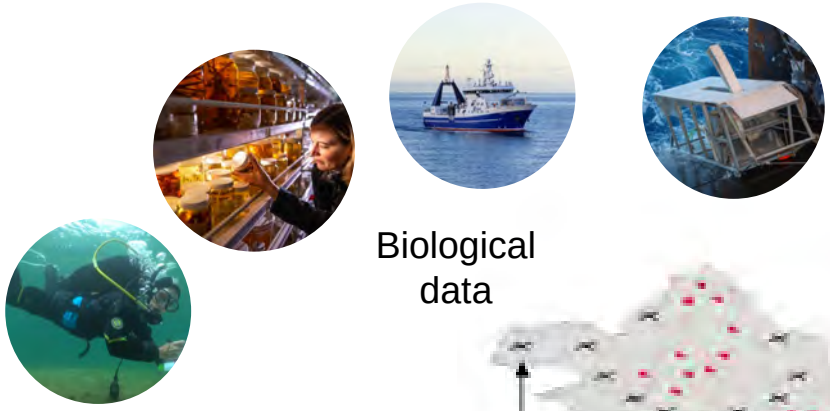
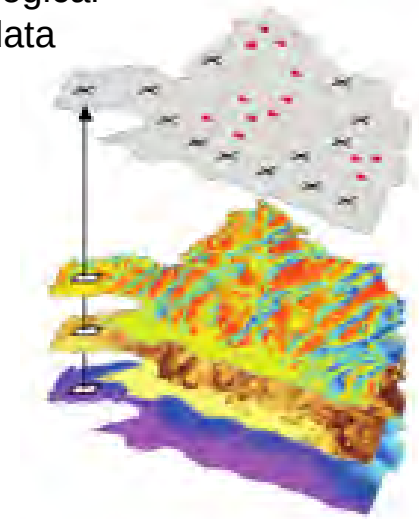
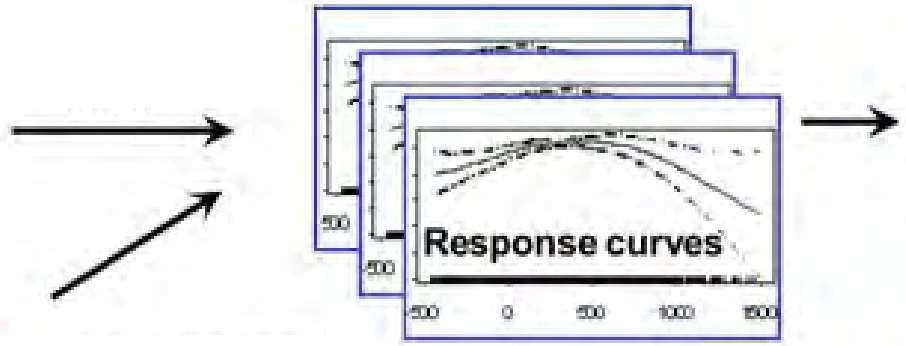
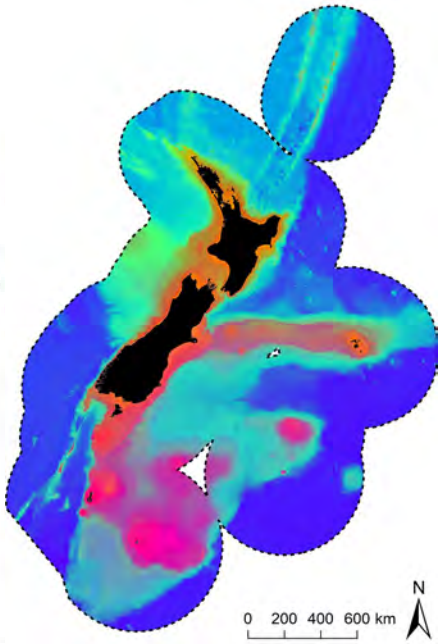


Biological data

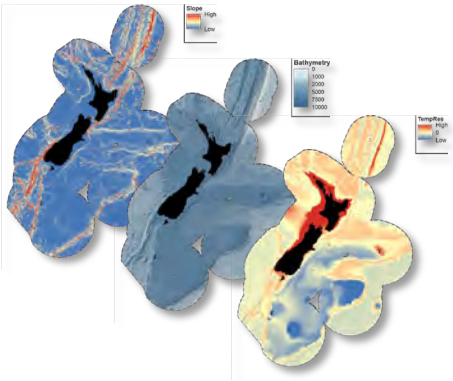


Environmental data



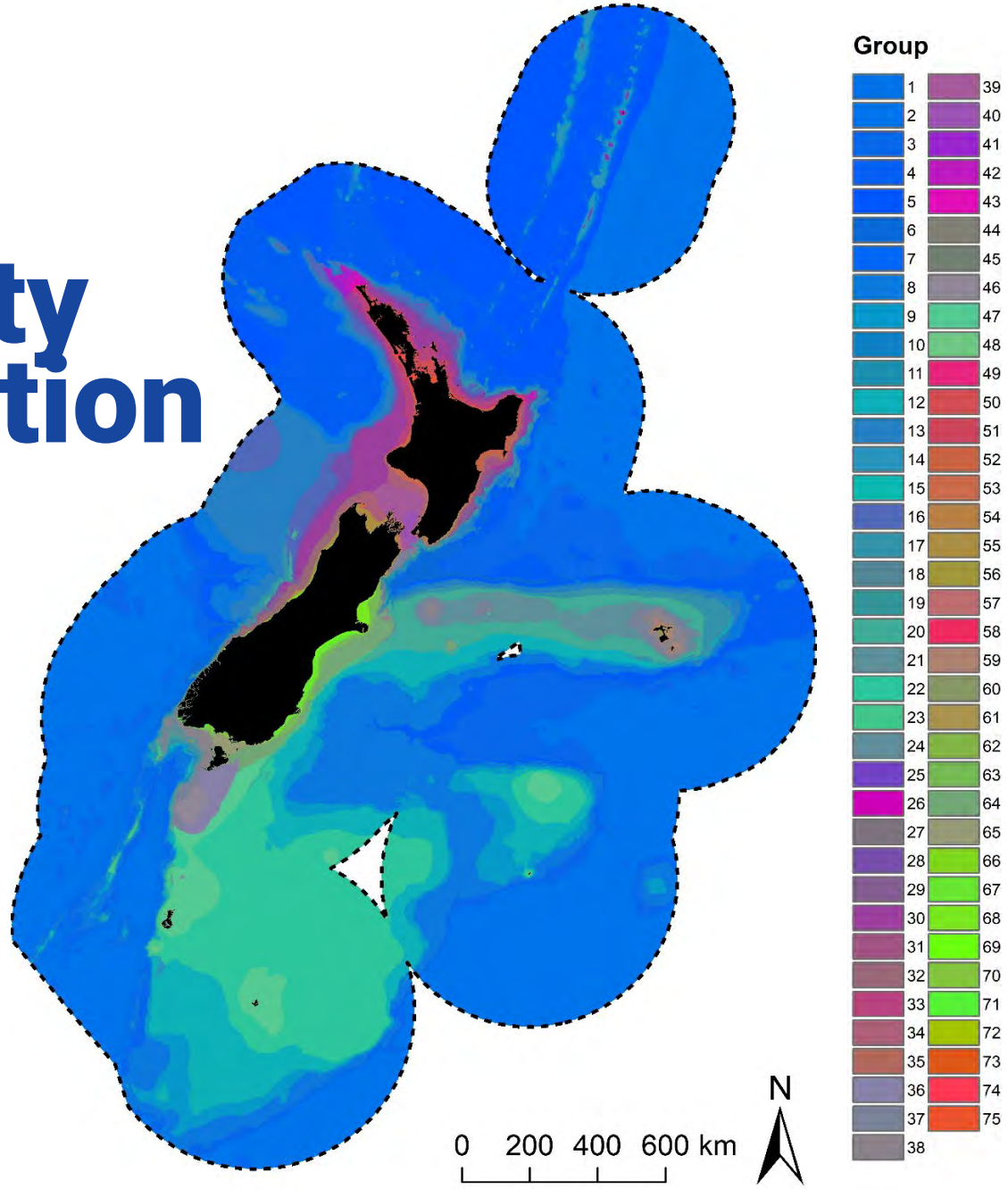


Community Turnover



Can turn the predicted distribution into…

The NZ Seafloor Community Classification



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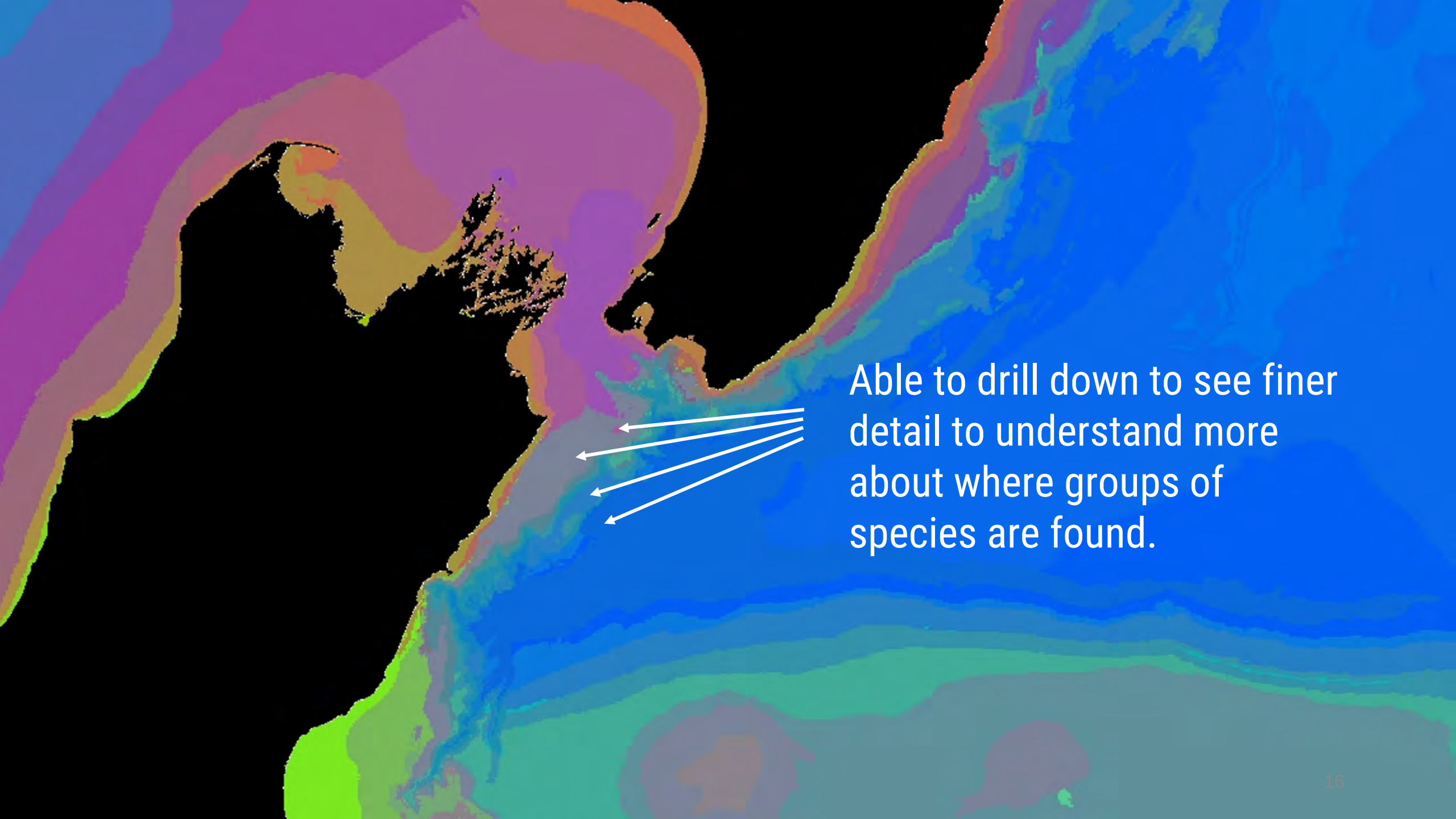
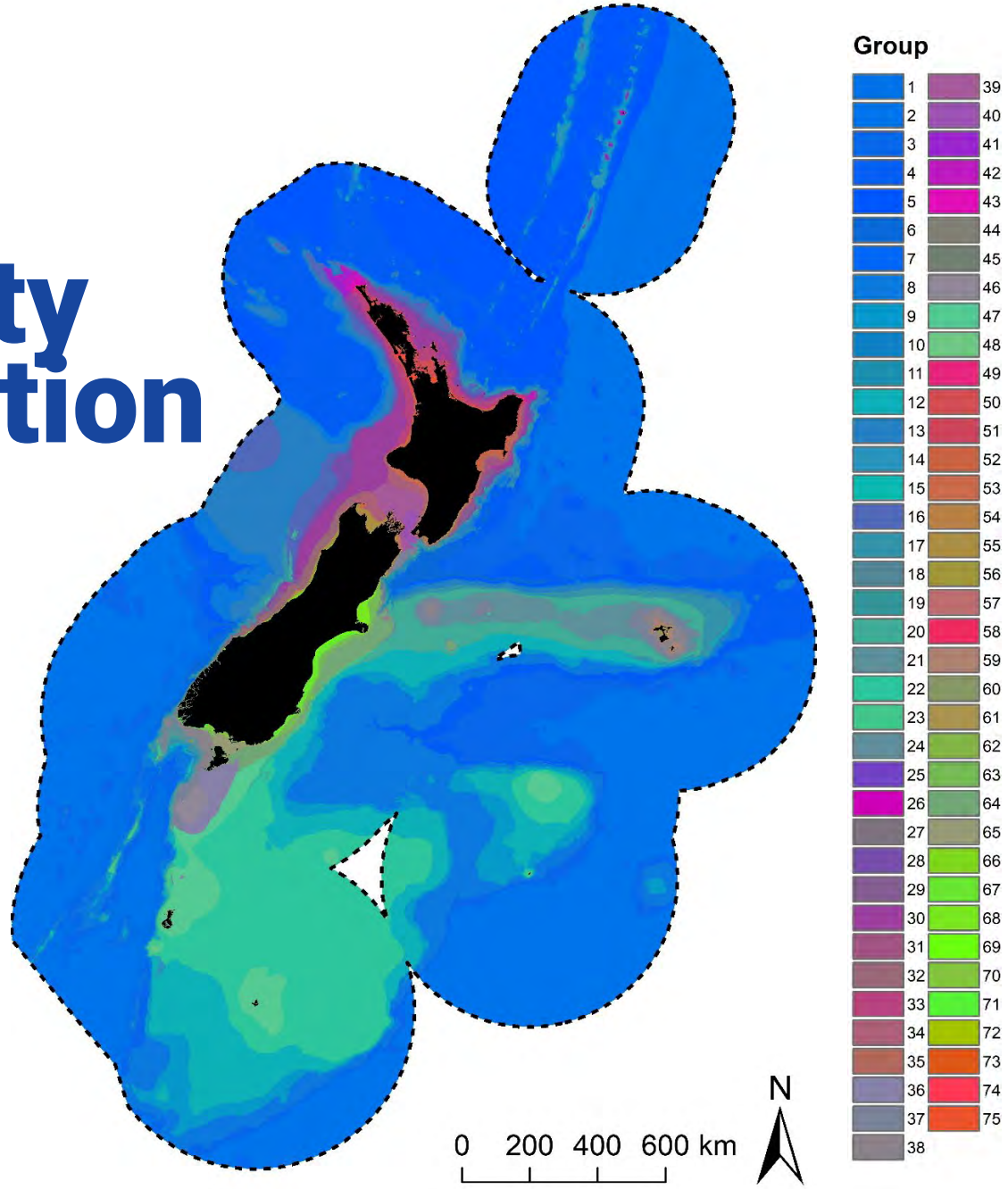
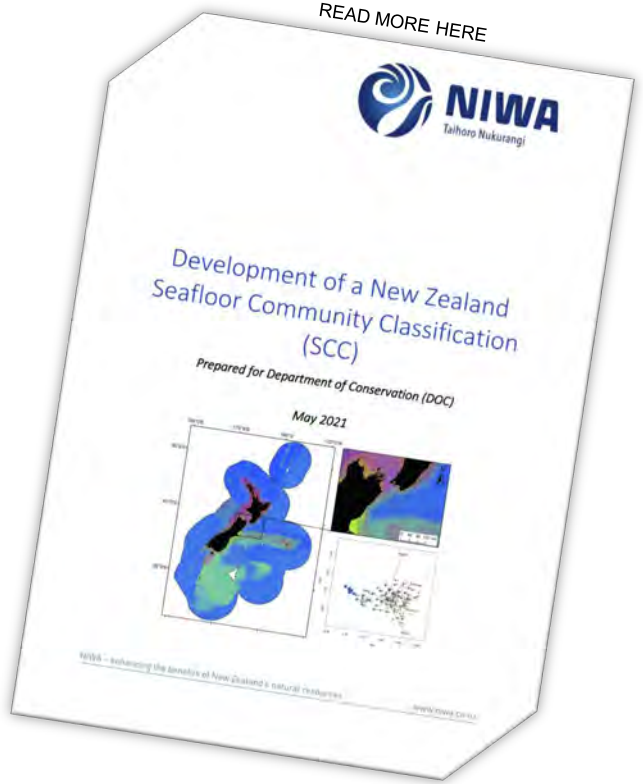


Able to drill down to see finer detail to understand more about where groups of species are found.

The NZ Seafloor Community Classification



READ MORE HERE



All details available in our report:
Stephenson, F., Rowden, A., Brough, T., Leathwick, J., Bulmer, R., Clark, D., Lundquist, C., Greenfield, B., Bowden, D., Tuck, I., Neill, K., Mackay, K., Pinkerton, M., Anderson, O., Gorman, R., Mills, S., Watson, S., Nelson, W. and Hewitt, J. (2021). "**Development of a New Zealand Seafloor Community Classification (SCC)**". NIWA report prepared for Department of Conservation (DOC).

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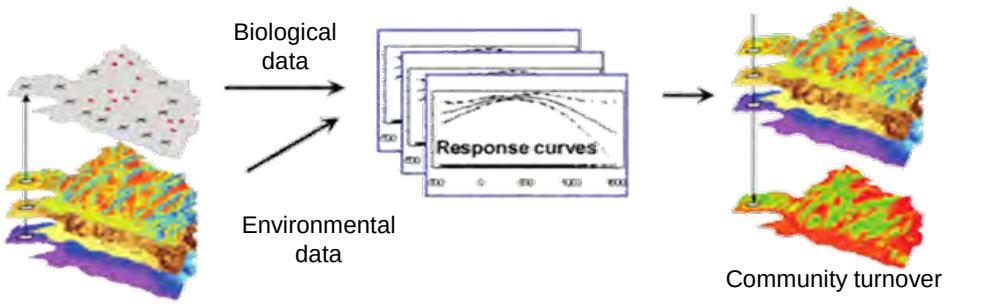
Talk overview

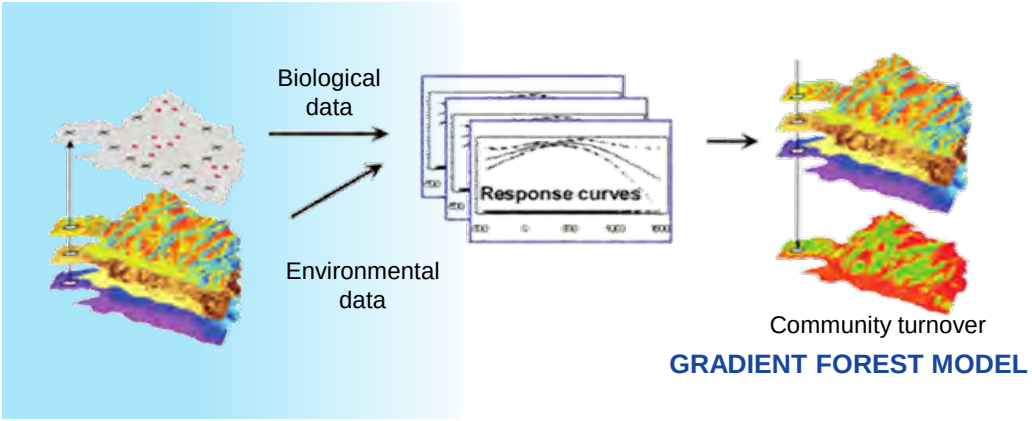
- Data inputs – *what goes into the model*
- Modelling – *how the model works*
- The NZ Seafloor Community Classification – *completed model*



GRADIENT FOREST MODEL

Talk overview

- Data inputs › Biological Data › Environmental Data
- Modelling
- The NZ Seafloor Community Classification



Biological data

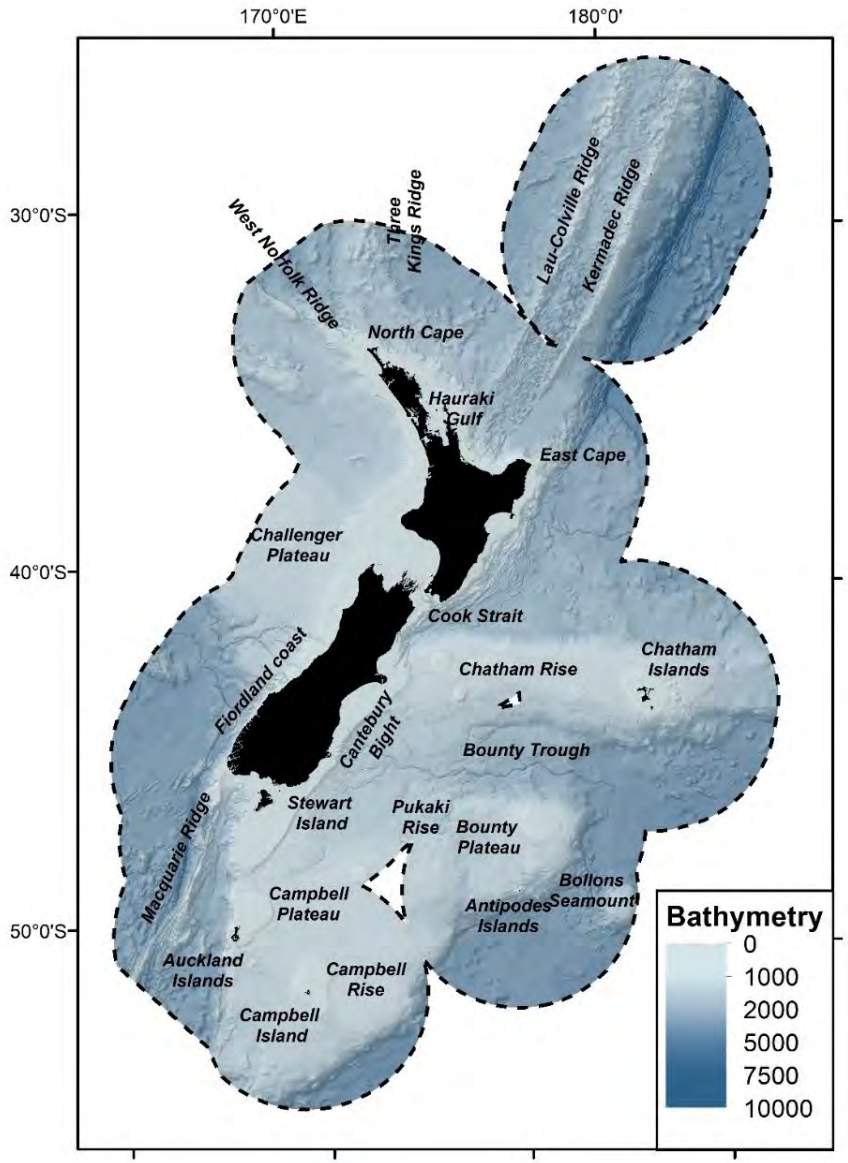
Biological data across 4 biotic groups

Reef Fish

Demersal Fish

Subtidal benthic invertebrates

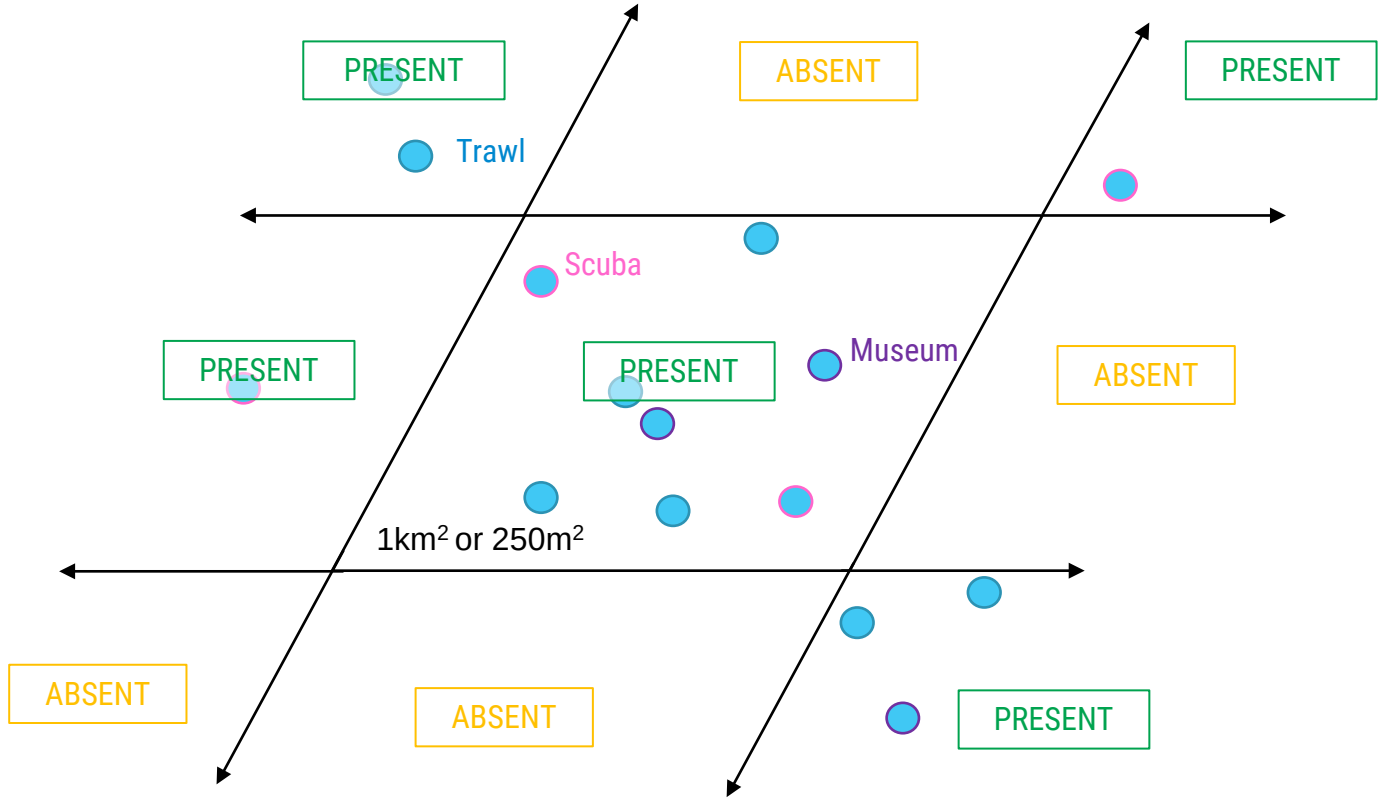
Macroalgae



NZ Exclusive Economic Zone

Collecting data records

- Species records compiled from different databases
- Records were aggregated to different spatial resolutions
- Presence/absence = occurrence



National Invertebrate Collection, NIWA

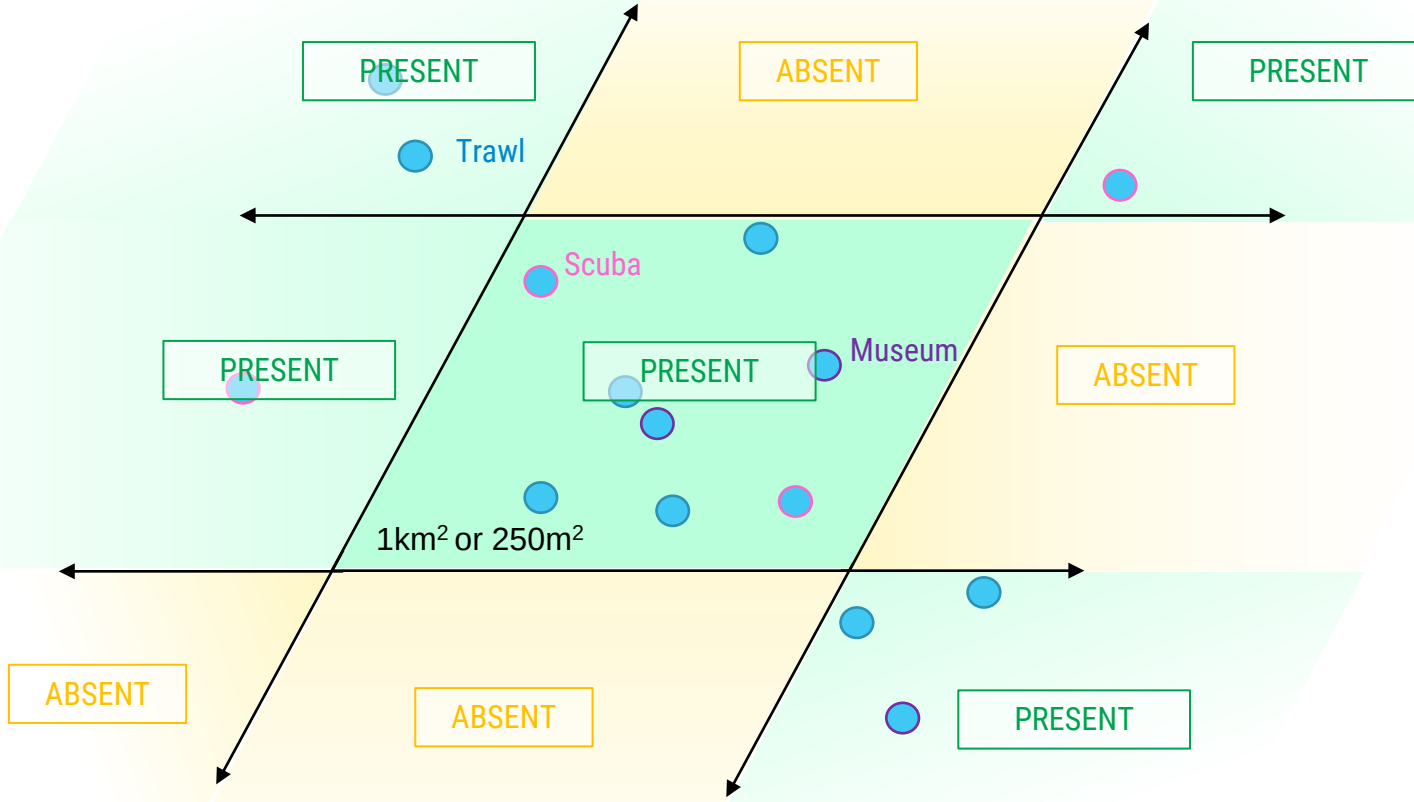
Collecting data records

Final dataset

630,997 records

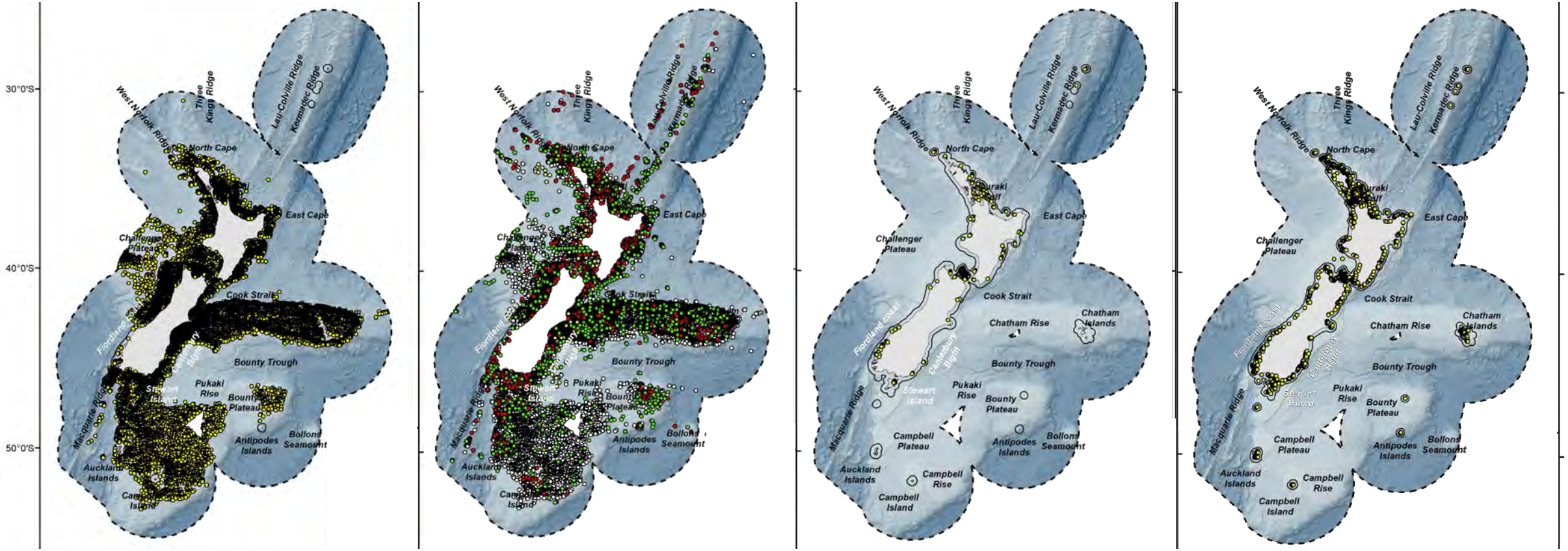
39,766 locations

1692 taxa



National Invertebrate Collection, NIWA

What does this look like?



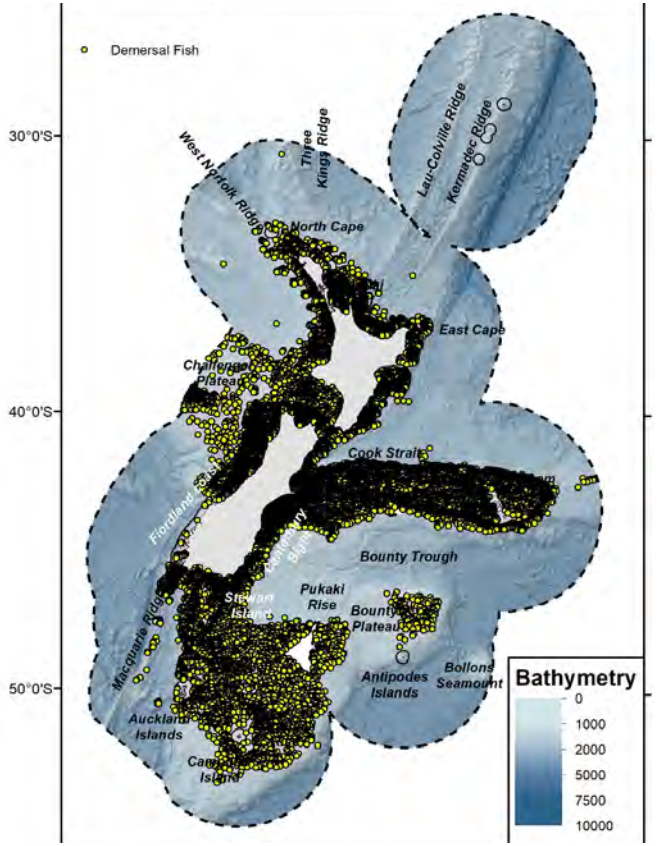
Demersal Fish
317 species
28,599 unique locations
n = 391,198

Benthic Inverts
958 genera
27, 247 unique locations
n = 127, 330

Reef Fish
92 species
339 unique locations
n = 467

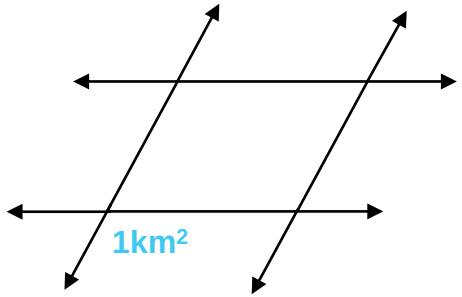
Macroalgae
339 species
3320 unique locations
n = 112,002

Biological Data: Demersal fish



Records from 1979 – 2018 from trawl database

Occurrence to1 km



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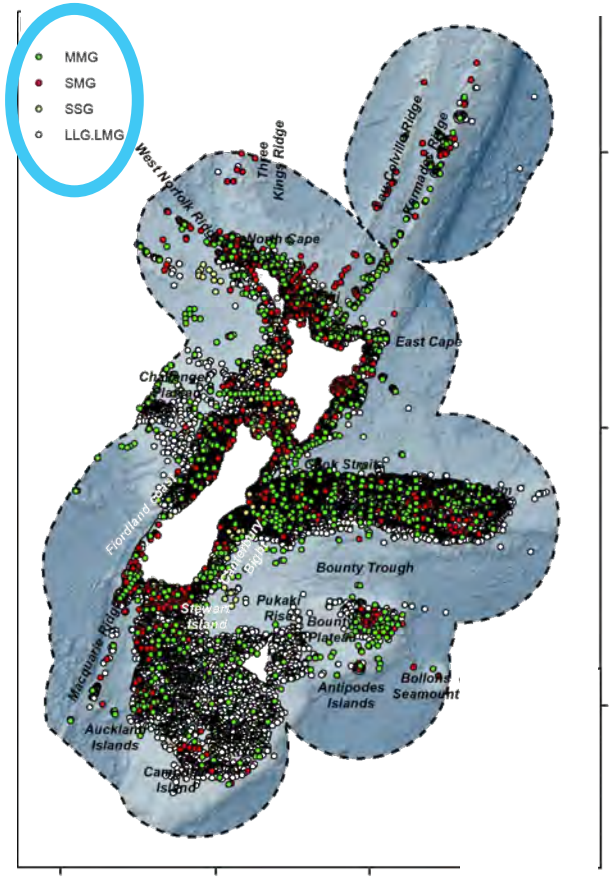
Biological Data: Benthic inverts



Records from 1896 – 2019

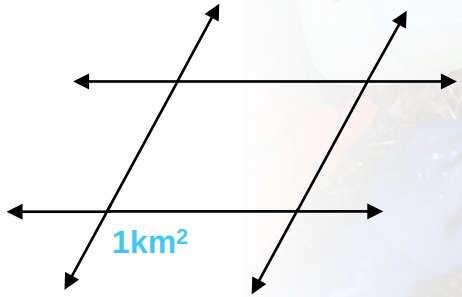
Trawl
(n = 56,841)

Te Papa
(n = 2943)

NIWA invert
(n = 59,144)

Auckland Museum
(n = 8402)

Occurrence to 1km



Different sampling methods accounted for:

- Dependent on size of sampling method
- Size of sampling area
- Selectivity of the method

Benthic sled

Box corer

Trawl

Benthic Inverts
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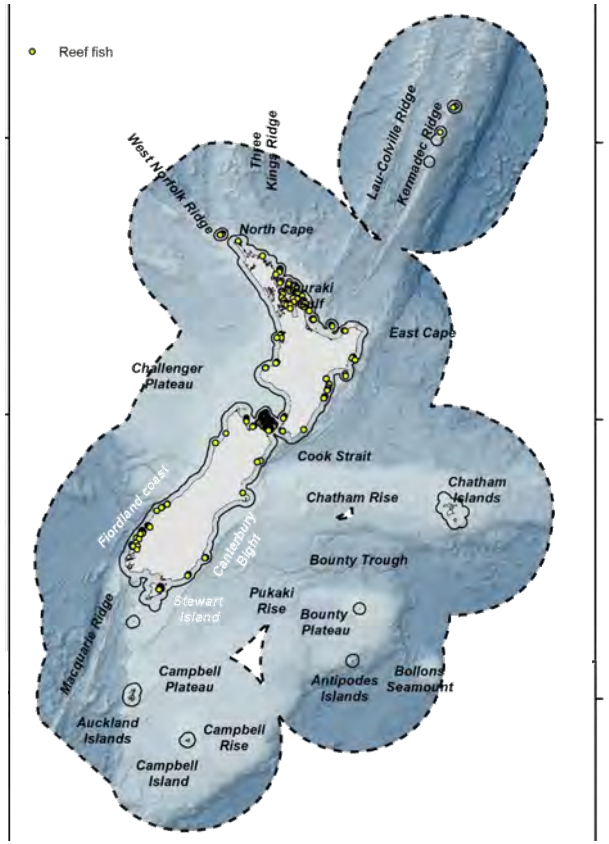
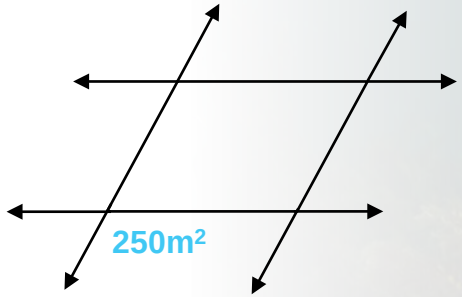
Biological Data: Reef fish



Records from 1986 – 2004

From DOC-funded projects (SCUBA diver surveys)

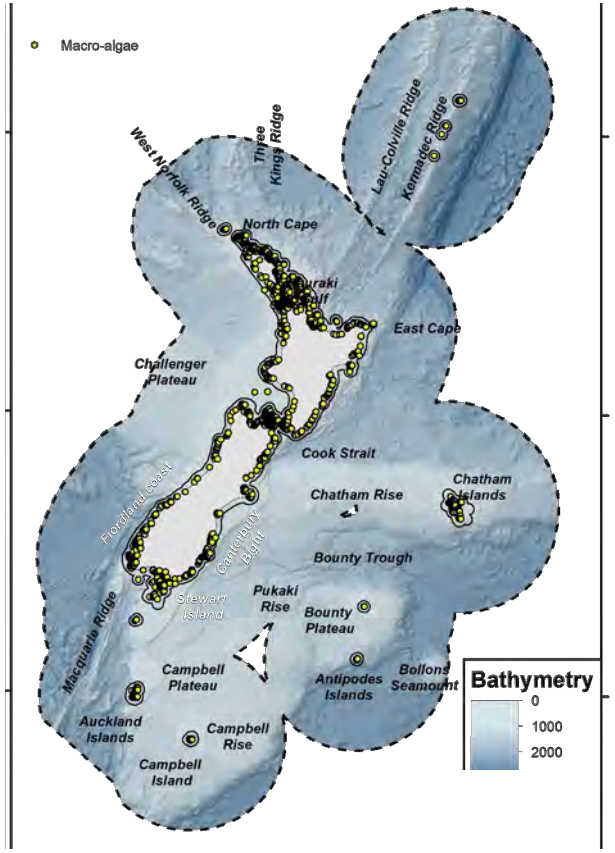
Occurrence to **250 m**



Species > 10 unique spatial observations

Reef Fish
92 species
339 unique locations
n = 467

Biological Data: Macroalgae



Records spanning 1850 – 2018

NIWA 2019

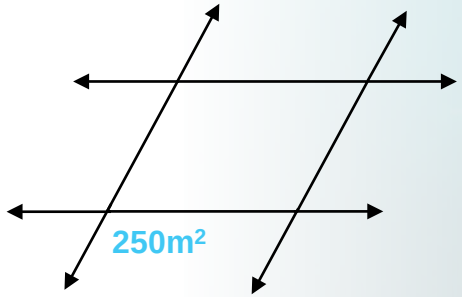
Te Papa 2012

Auckland Museum 2019

Duffy 1979-2007

Shears & Babcock 1999-2002

Occurrence to **250m**



Macroalgae
339 species
3320 unique locations
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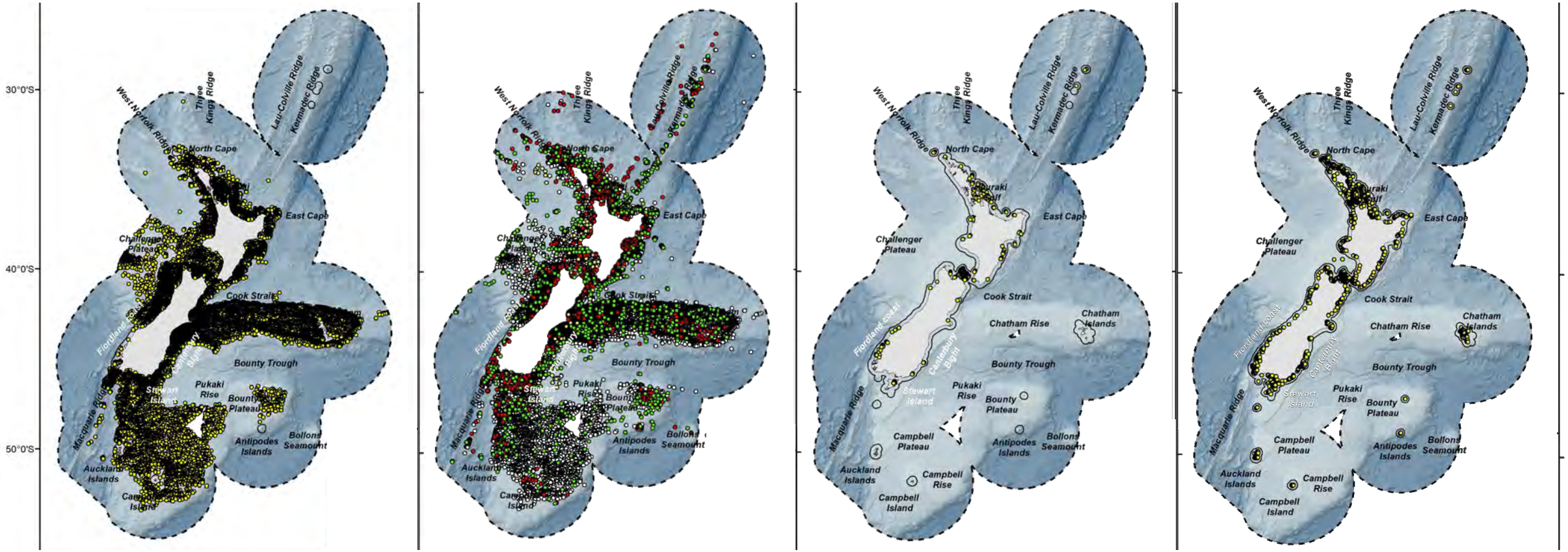
Species > 10 unique spatial observations

Biological Data



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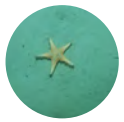

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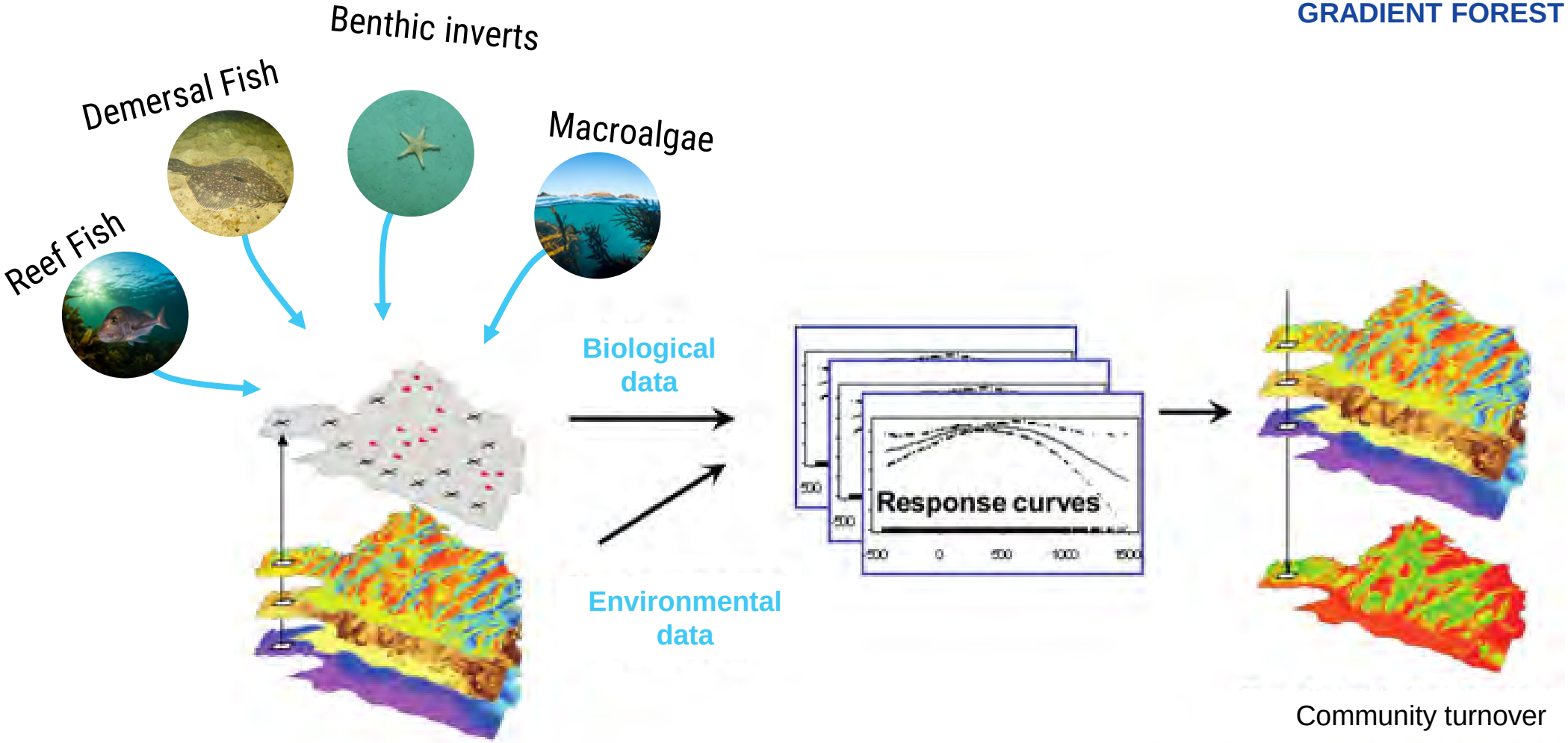
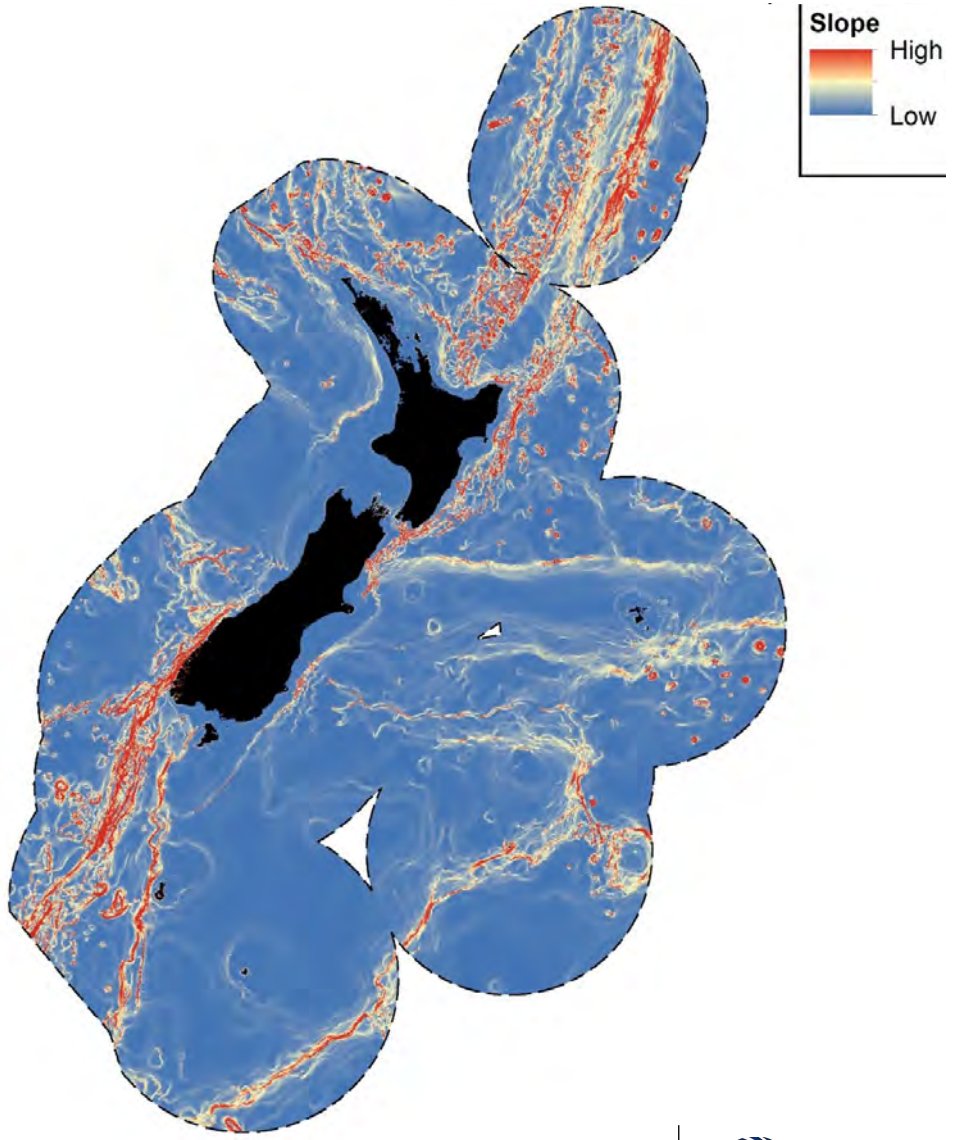


Environmental Data

Abiotic properties that influence distribution of species

- E.g. Bathymetry, temperature, slope….



Environmental Data

Abiotic properties that influence distribution of species

- E.g. Bathymetry, temperature, slope….

Chose 20 environmental layers

Seafloor characteristics

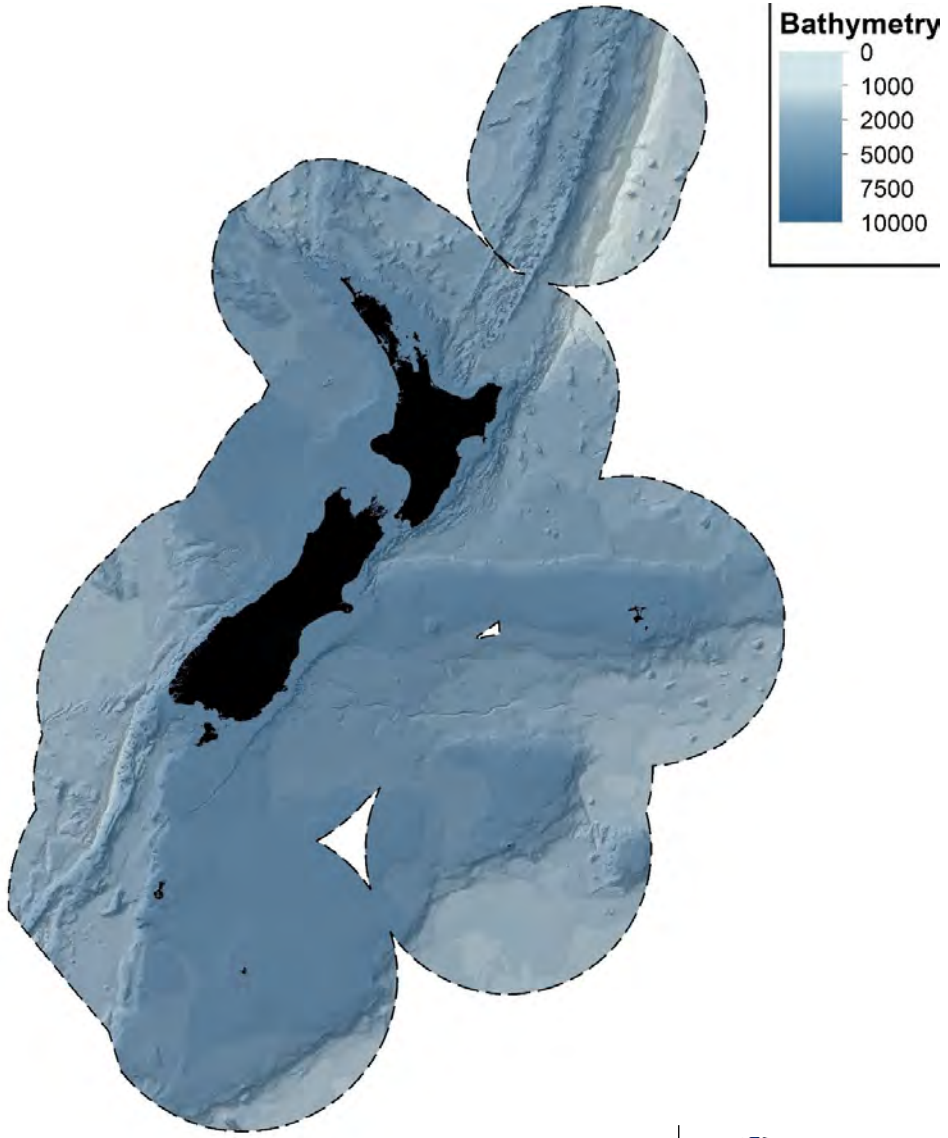
Bathymetry
Benthic sediment disturbance
BPI broad
BPI fine
Sediment classification
Slope
Tidal Current speed

Water chemistry

Bottom nitrate
Turbidity
Bottom phosphate
Dissolved oxygen at depth
Salinity at depth
Bottom silicate
Temperature at depth
Annual amplitude of sea floor temp.
Suspended particulate matter

Productivity

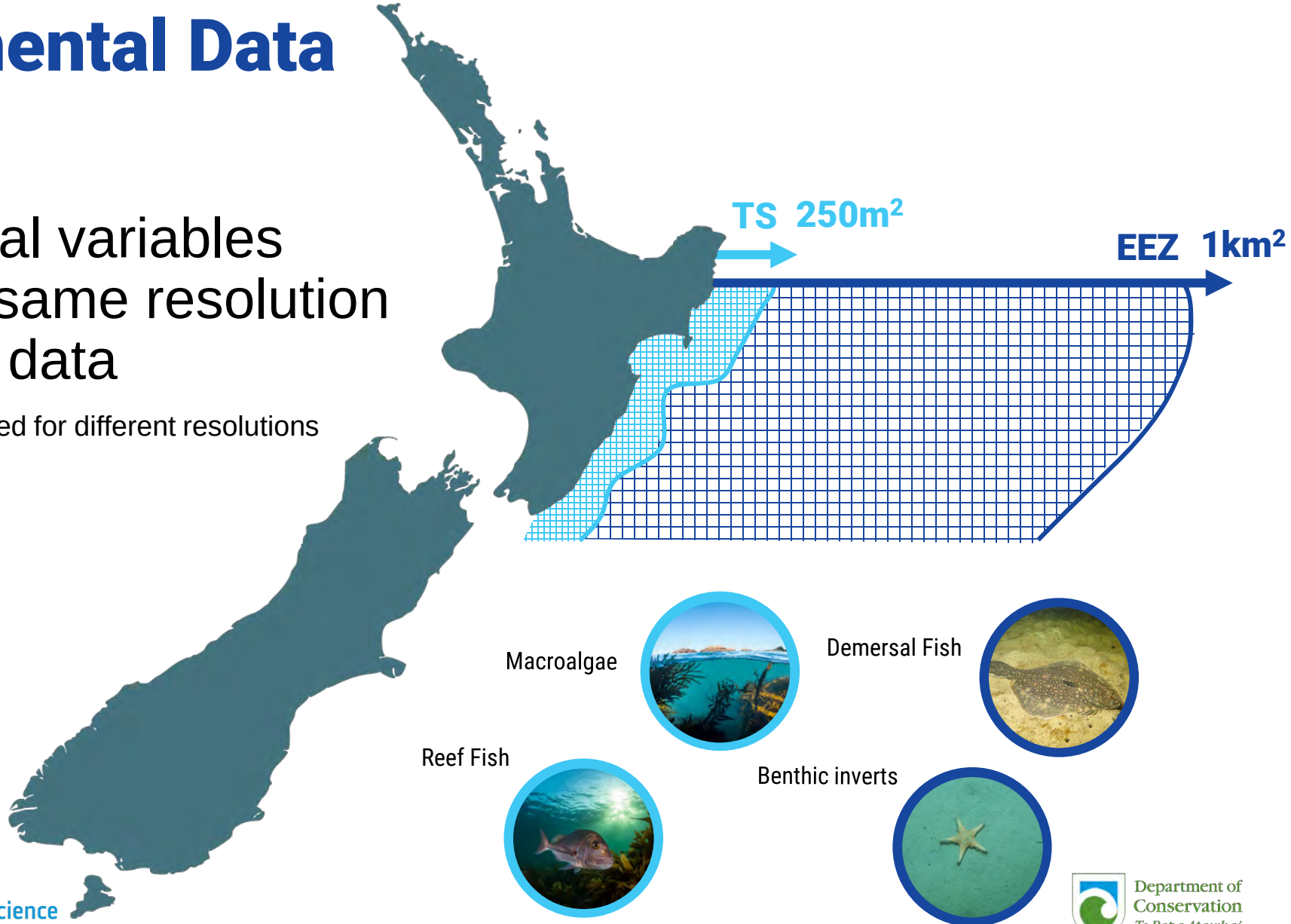
Chlorophyll-a concentration spatial gradient
Detrital absorption
Seabed incident irradiance
Downward vertical flux of POM at the seabed



Environmental Data

Environmental variables extracted at same resolution as biological data

Some interpolation required for different resolutions



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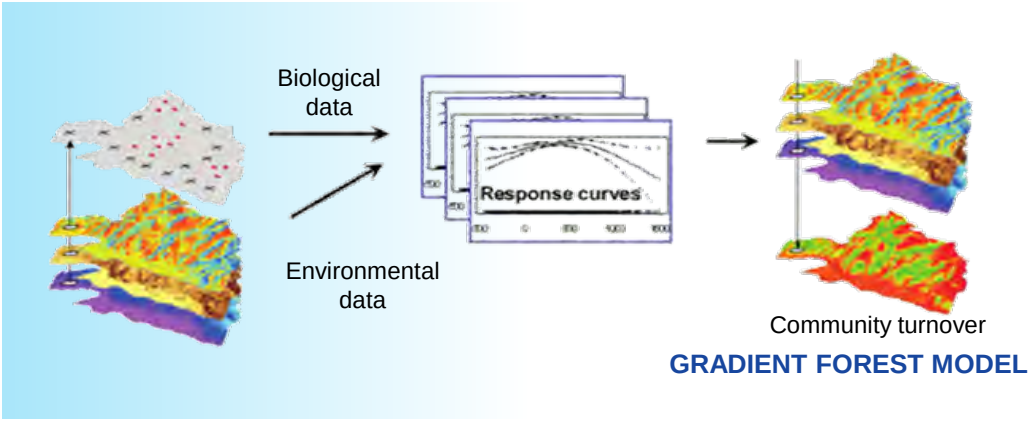
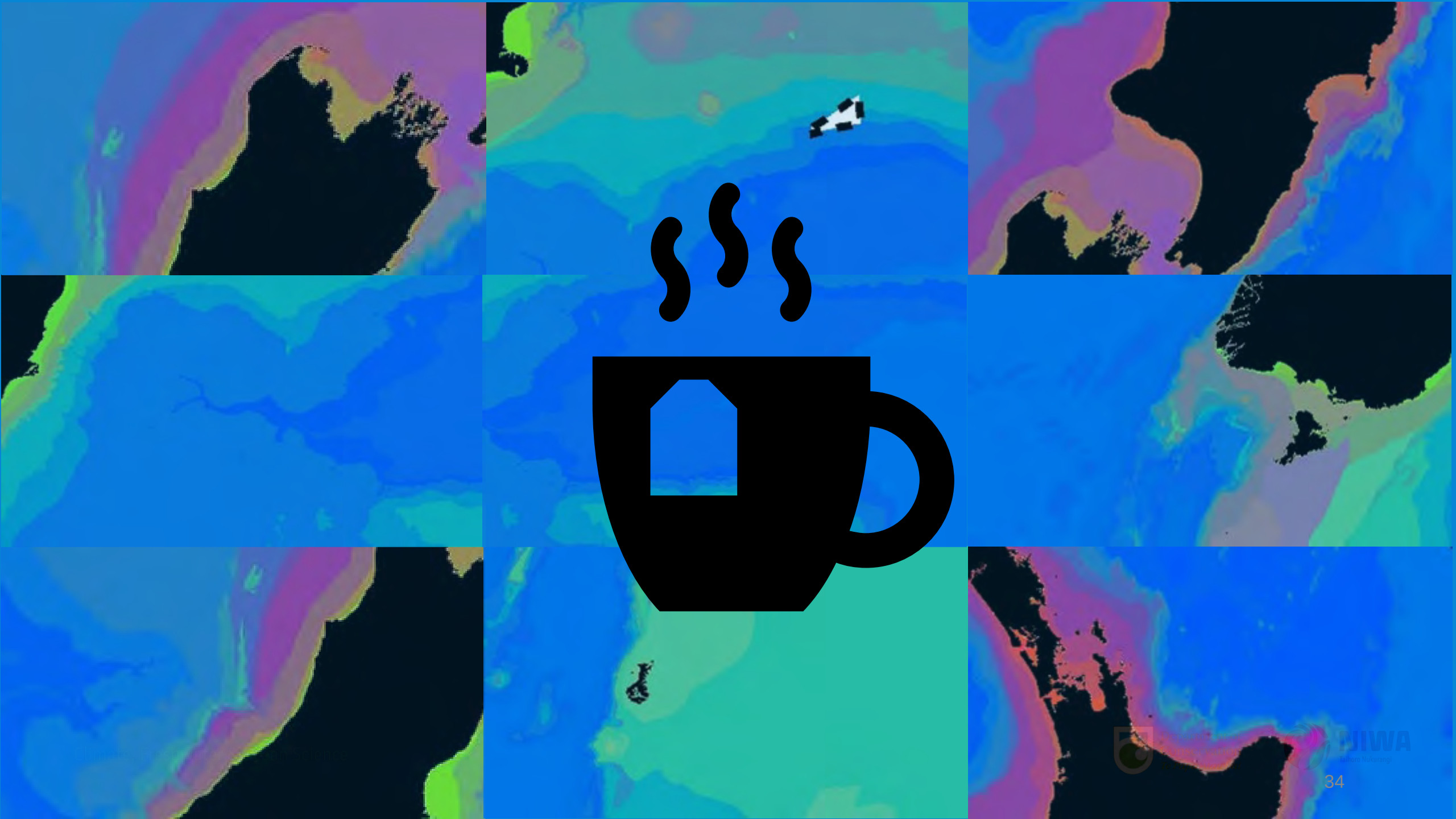
- The NZ Seafloor Community Classification





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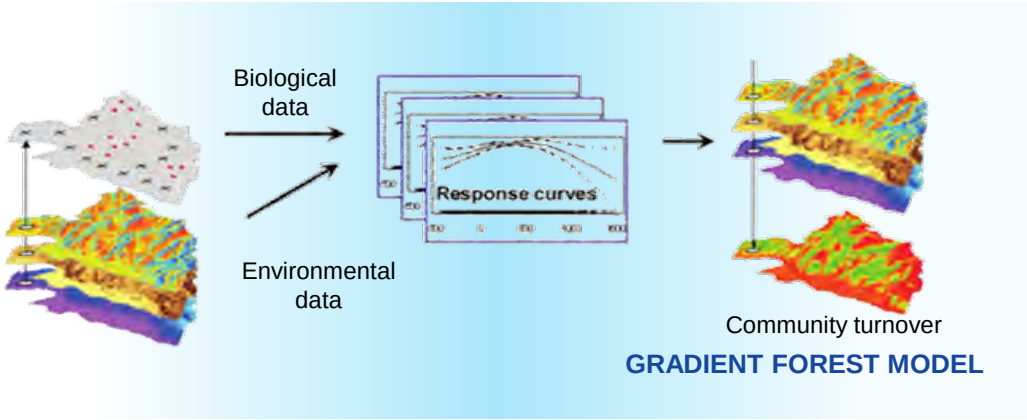
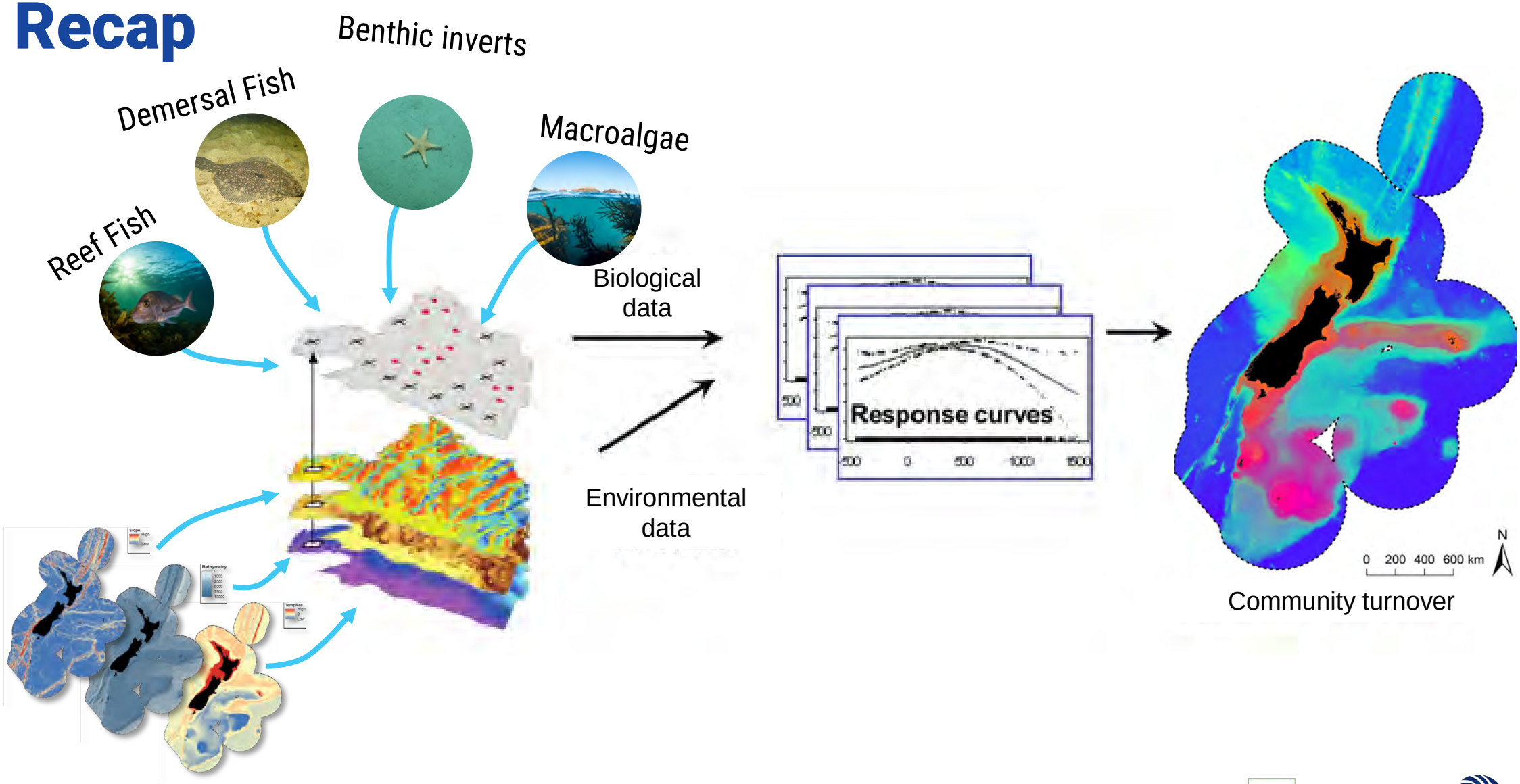
Welcome back

Talk overview

- Data inputs › Biological Data › Environmental Data
- Modelling › Species Turnover › Communities
- The NZ Seafloor Community Classification



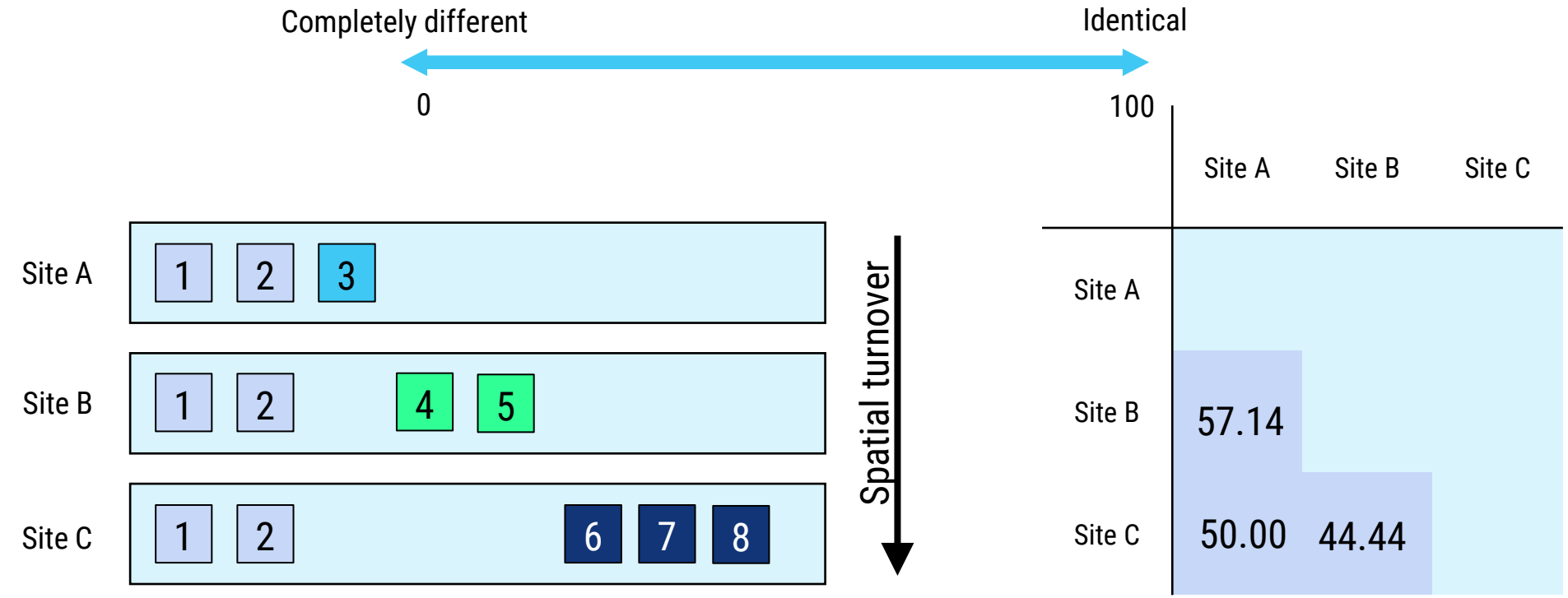
Recap


Benthic inverts
Demersal Fish
Macroalgae
Reef Fish
Biological data
Environmental data
Response curves
0 200 400 600 km
N
Community turnover

Turnover

Which species are often found together

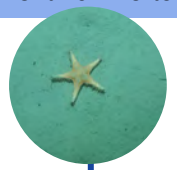
Difference in species between sites.



Environmental Variables

Demersal Fish

Benthic inverts



Macroalgae

Reef Fish

Bootstrapping

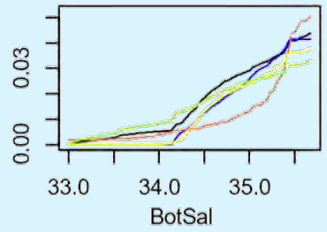
Compositional Turnover

Compositional Turnover

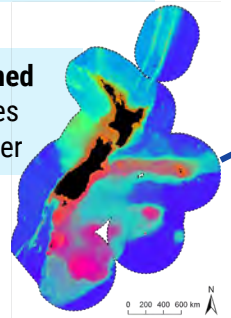
Compositional Turnover

Compositional Turnover

Weighting



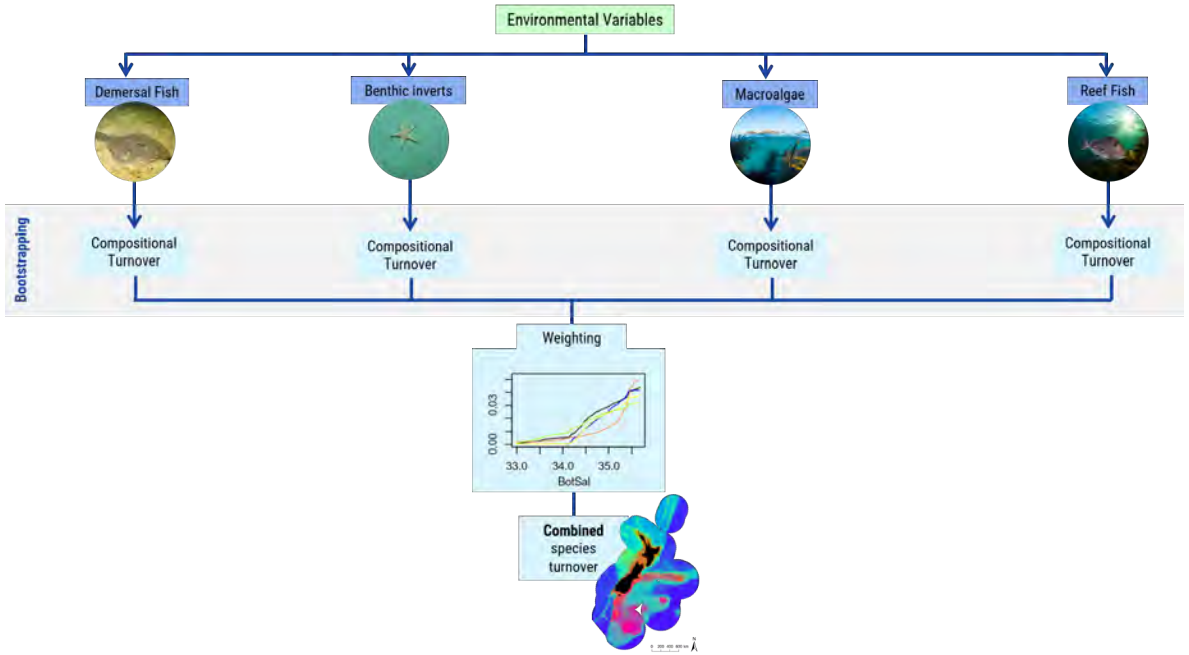
Combined species turnover



How do we group this to represent our seafloor community?

Estimating species turnover

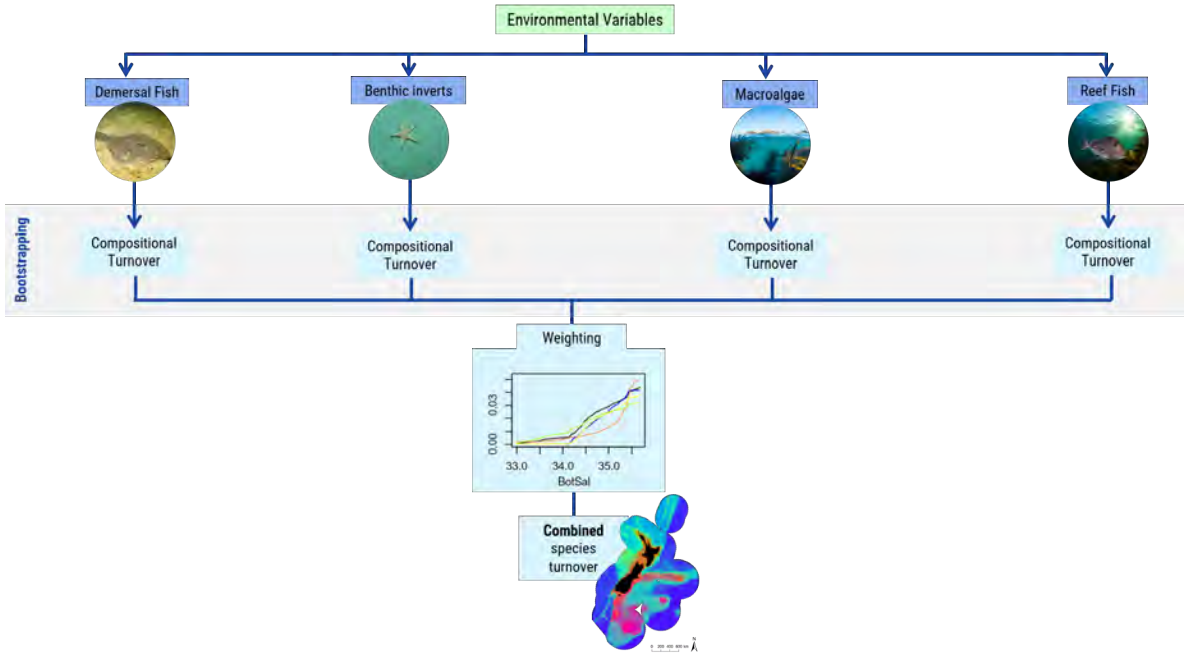
- Gradient Forest (GF) modelling
  - Aggregation of Random Forest models
  - GF builds a generalized model of species turnover in relation to the environmental predictors by aggregating the split information from all these individual species models



Estimating species turnover

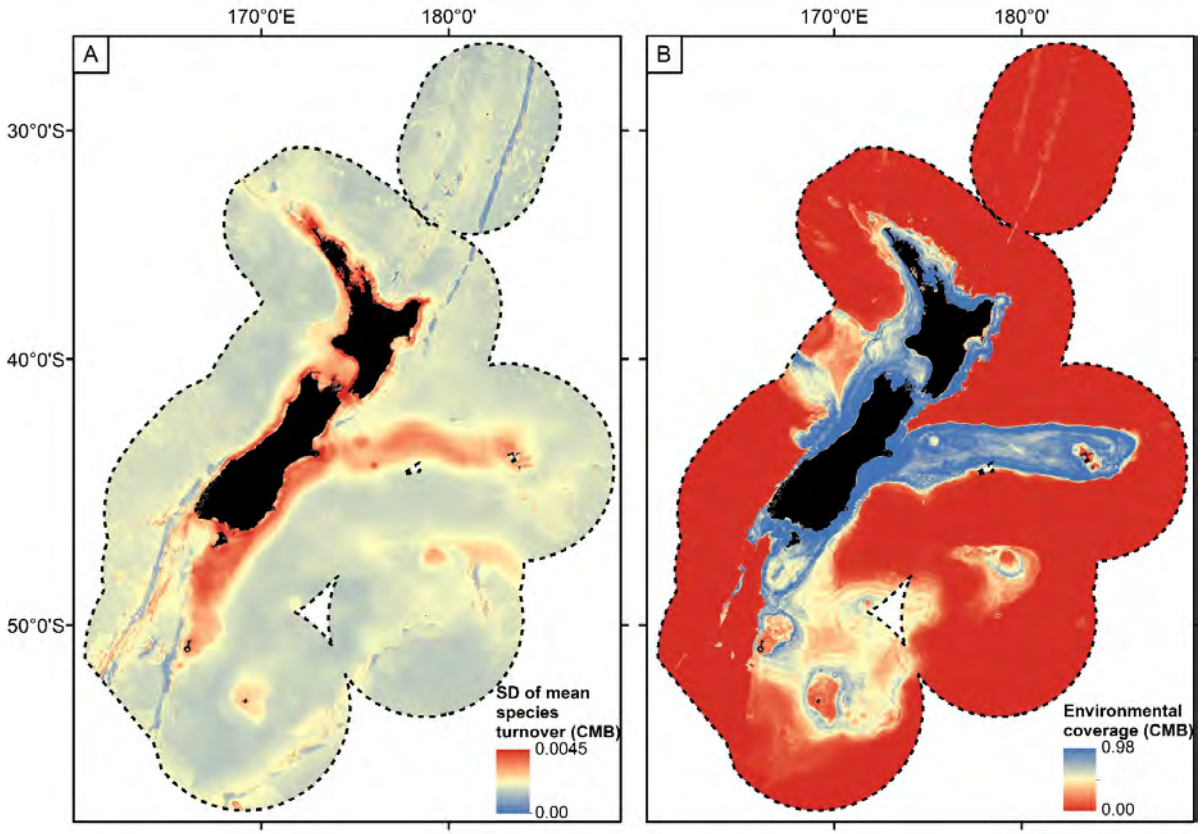
- Species turnover estimates are each biotic group are **bootstrapped 100 times**

- Then combined into a single estimate



Uncertainty in species turnover

- Spatially explicit model uncertainty was estimated using two methods



A. How well we think the model works
B. How well we think we have sampled the NZ environment

Blue — Red
Confident — Less confident

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Estimating species turnover by environment

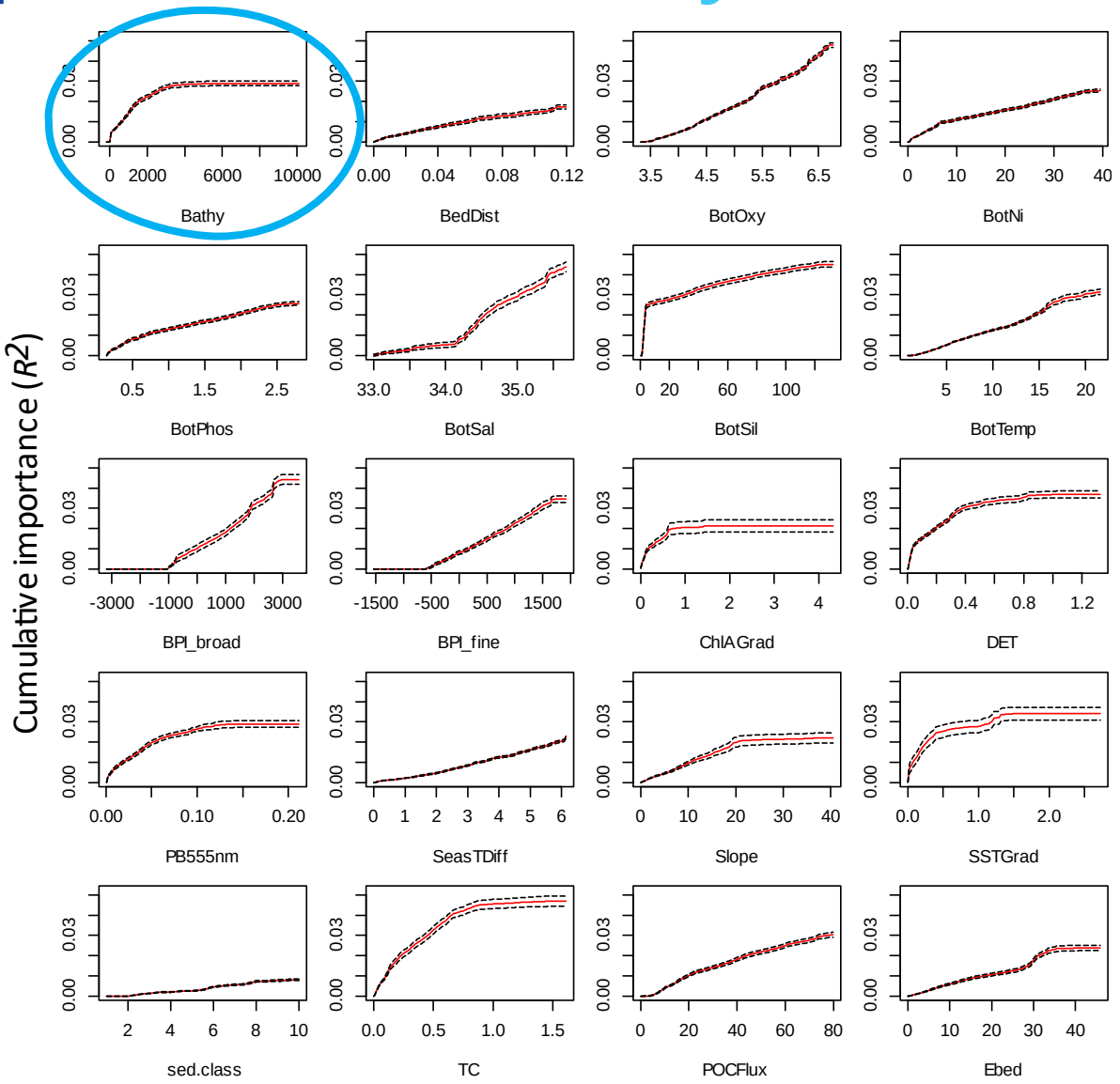
Demersal Fish

Benthic inverts

Reef Fish

Macroalgae

Weighted average



Averaged

Climate, Freshwater & Ocean Science

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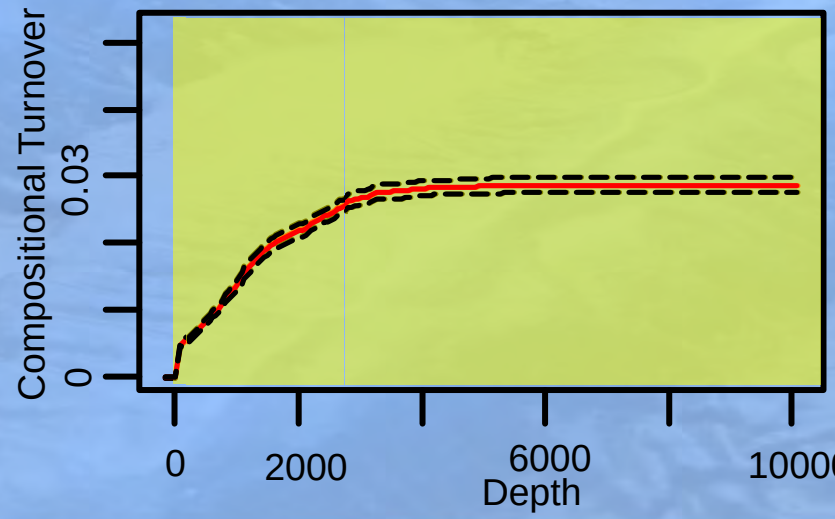
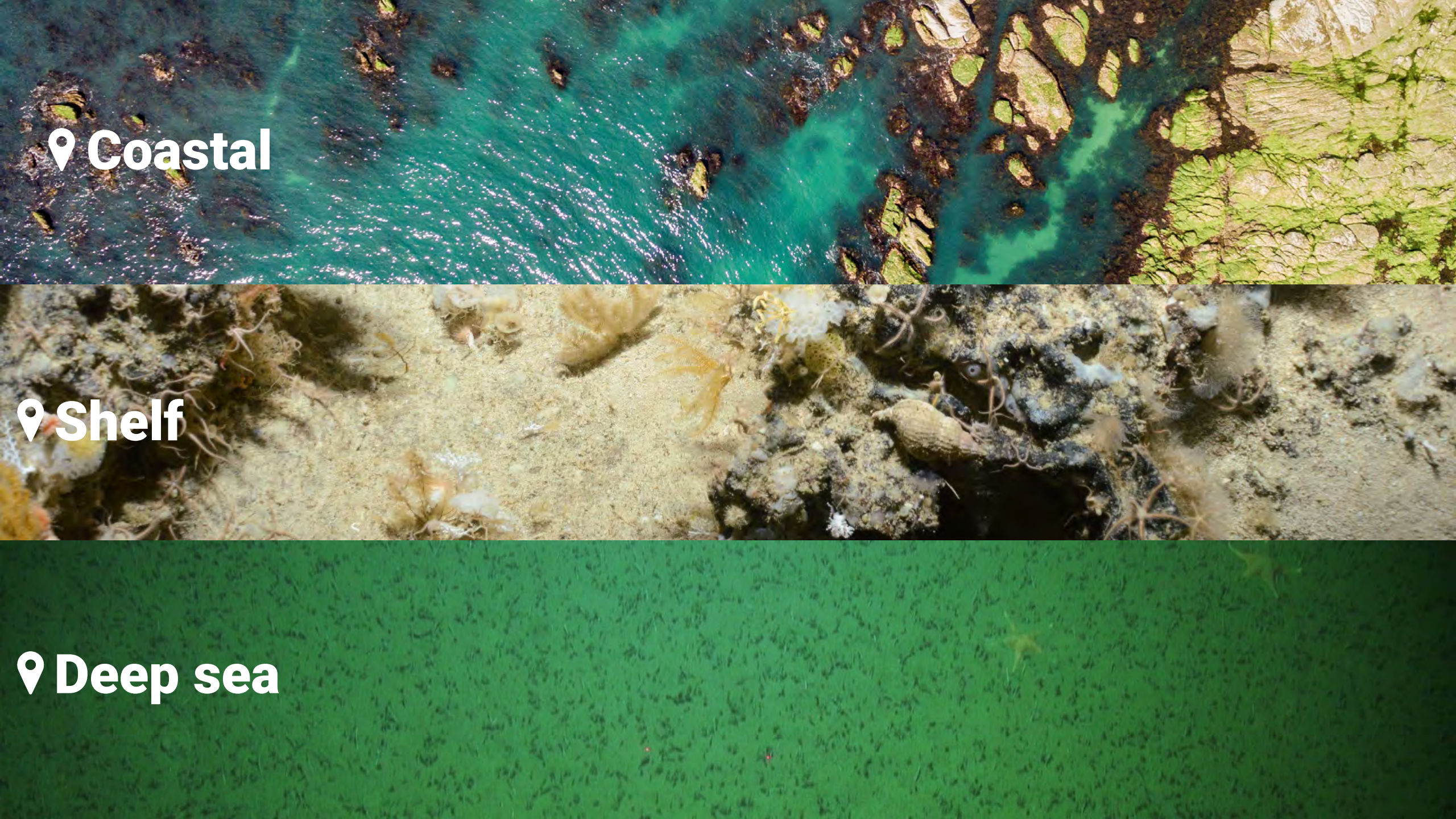
DEPTH

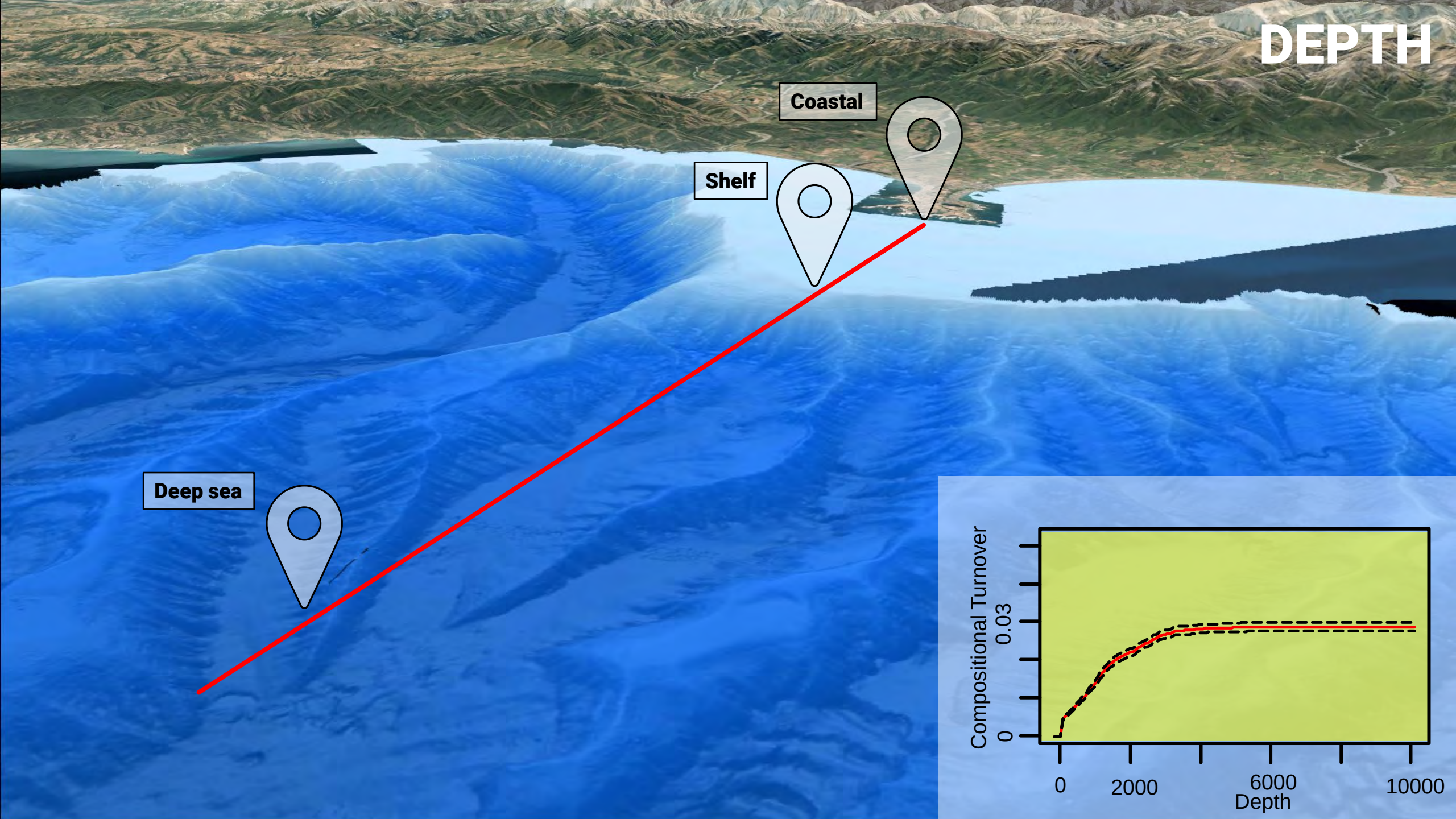
Coastal

Shelf

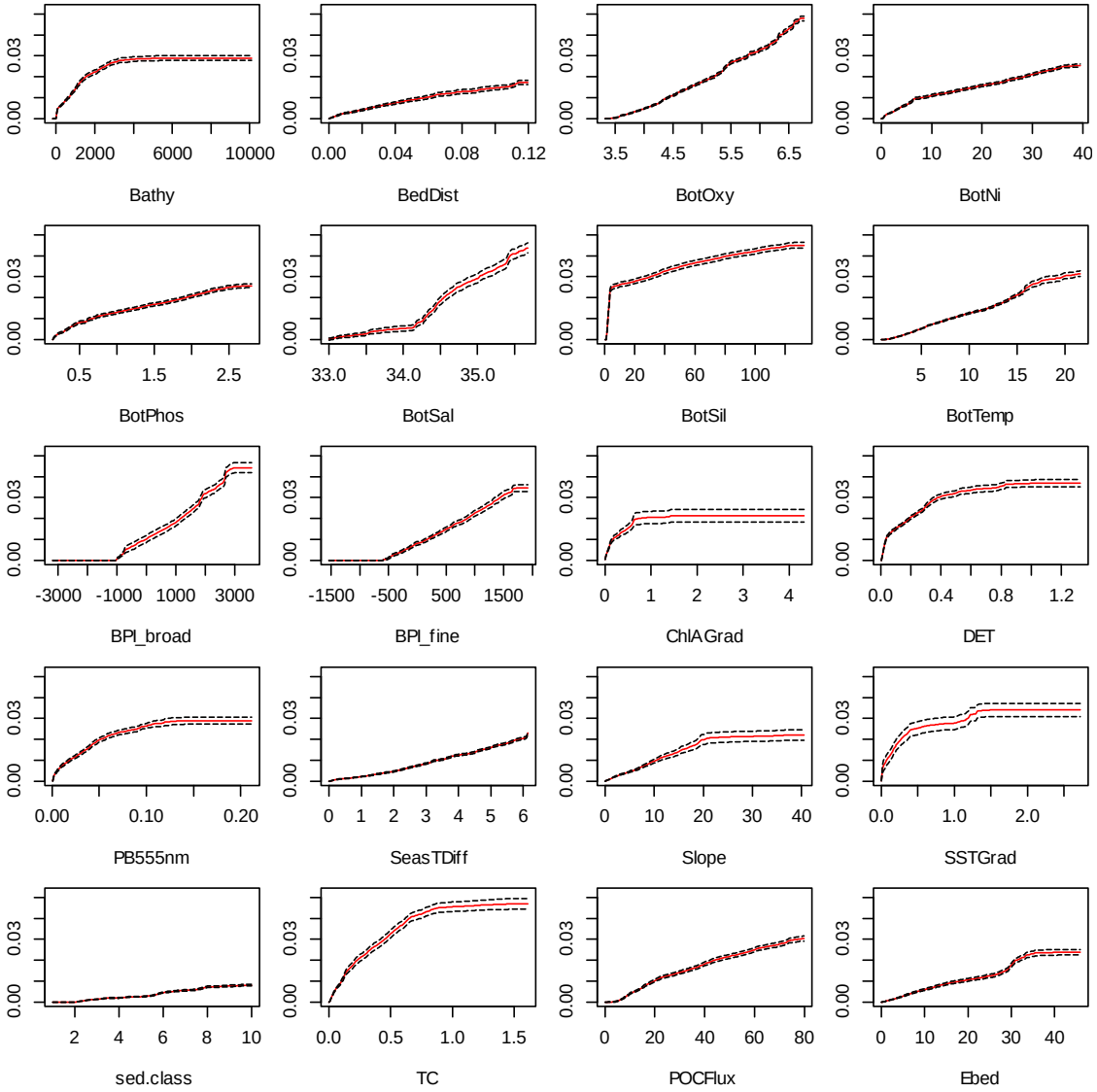
Deep sea




Coastal
Shelf
Deep sea


DEPTH
Coastal
Shelf
Deep sea
Compositional Turnover
0
0.03
0
2000
6000
10000
Depth

Estimating species turnover by environment



Averaged

Estimating species turnover: results

- **Importance** of environmental variables differed in across biotic groups
- Top 4 most important included:

Oxygen concentration at **depth**

Salinity concentration at **depth**

Tidal current speed

Seafloor topography

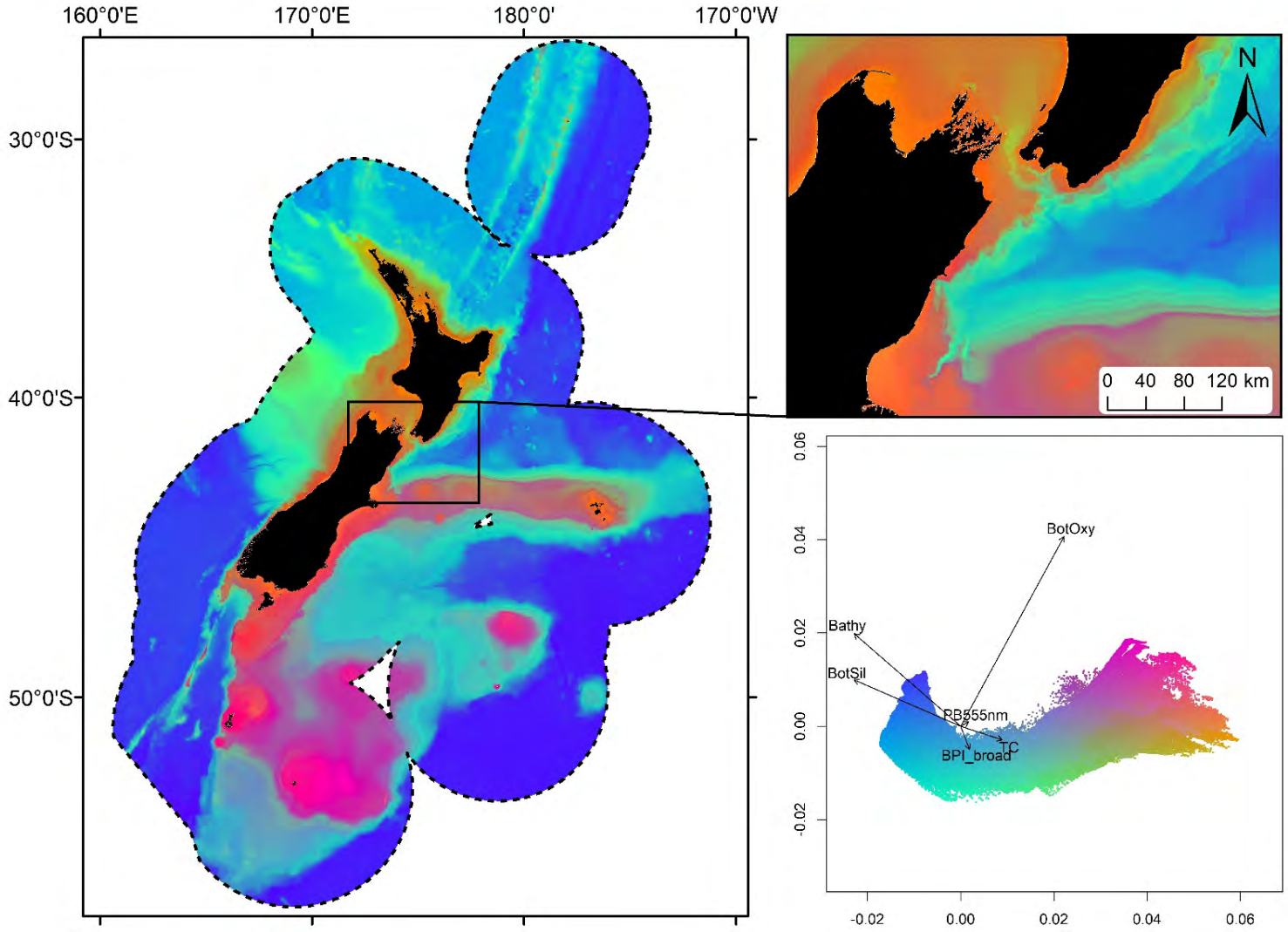
Estimating species turnover: results

- Species model fits (underpinning the GF model)




Model fit metric	Demersal fish (317 taxa)	Benthic inverts (958 taxa)	Macroalgae (349 taxa)	Reef fish (92 taxa)
Mean taxa effectively modelled (± SD)	313.76 (±1.57)	955.20 (±3.36)	335.99 (±0.11)	91.99 (±0.11)
Mean Taxa R^2_f (± SD)	0.52 (< 0.01)	0.48 (< 0.01)	0.47 (< 0.01)	0.53 (< 0.01)

Species turnover: map



Similar colours = similar species

However, this map doesn't tell us *which* species those are.

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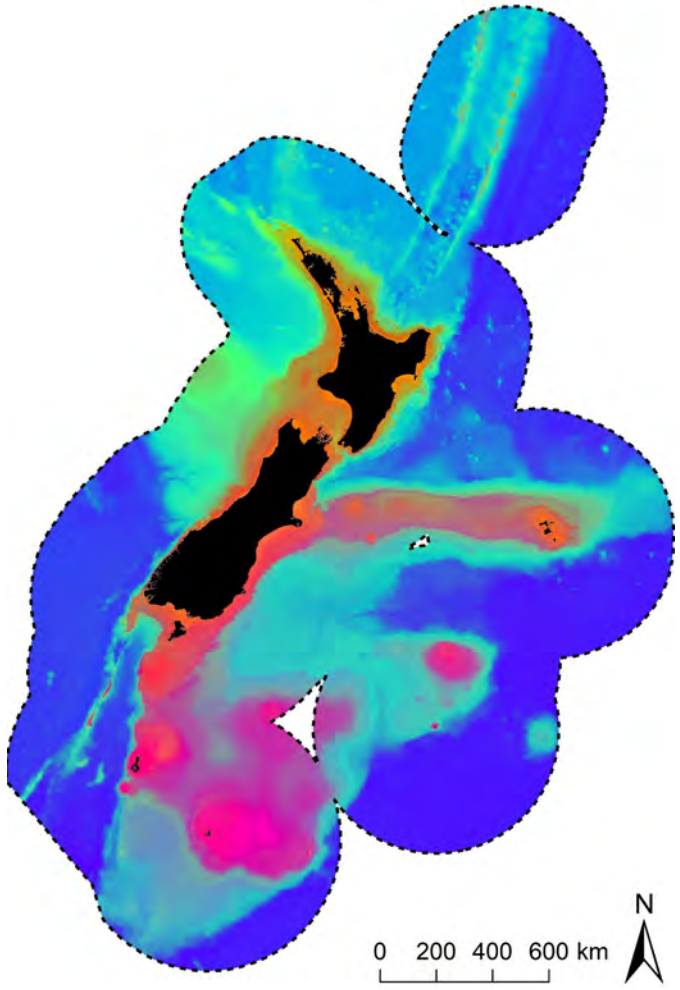
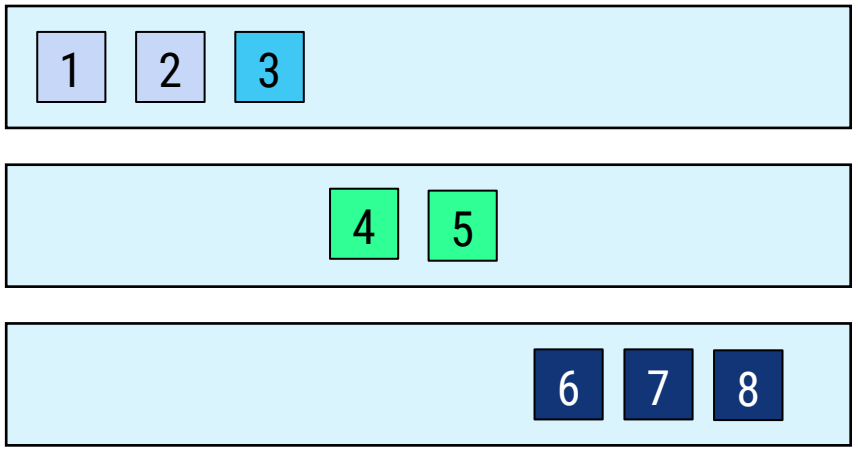
Classification: creating groups



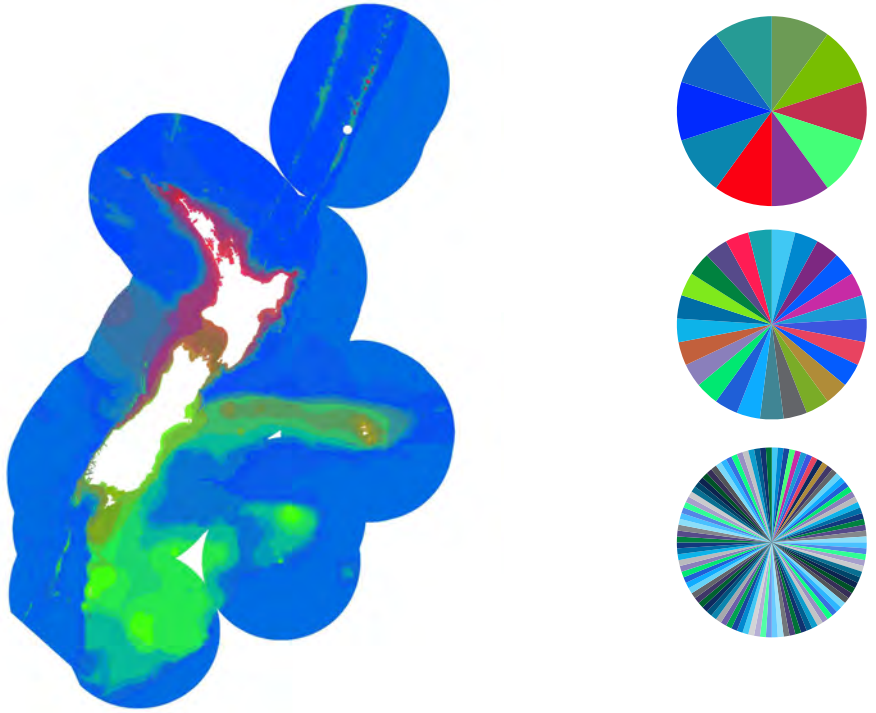
- Divide species turnover into groups
  Groups = animals known to 'hang out' together
- How many groups best represent the variation we see?
- Test this with: *hierarchical classification*

Classification: creating groups

Each group
is made up of some species



Know that 1 group won't represent heterogeneity of our seafloor community



Does 10? Does 25? …Does 100?

Where is the sweet spot?

And how many is too many?

Assessing groups strength

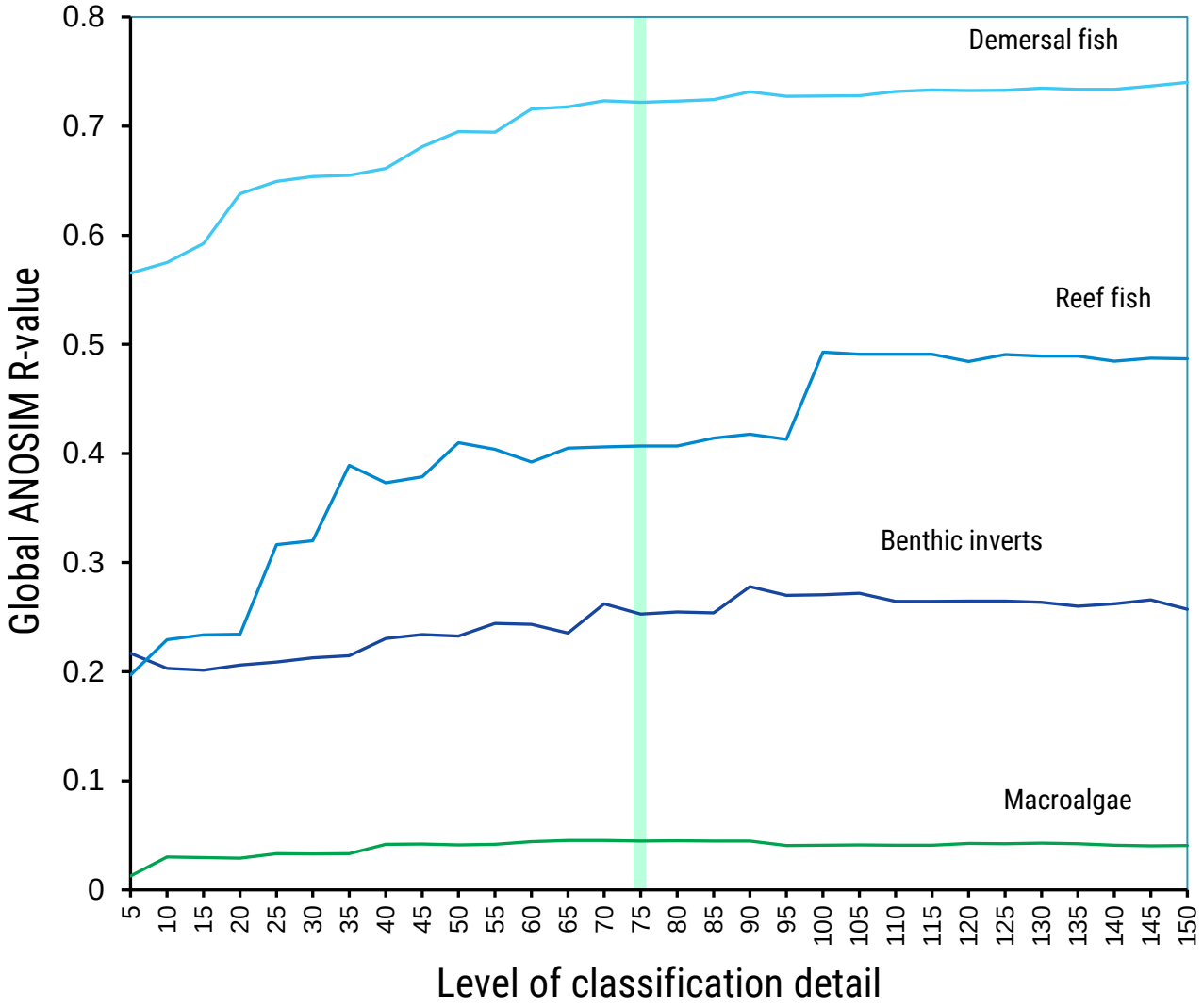
- Example for demersal fish

	Number of groups
Demersal Fish	5
	25
	50
	75
	100
	125
	150

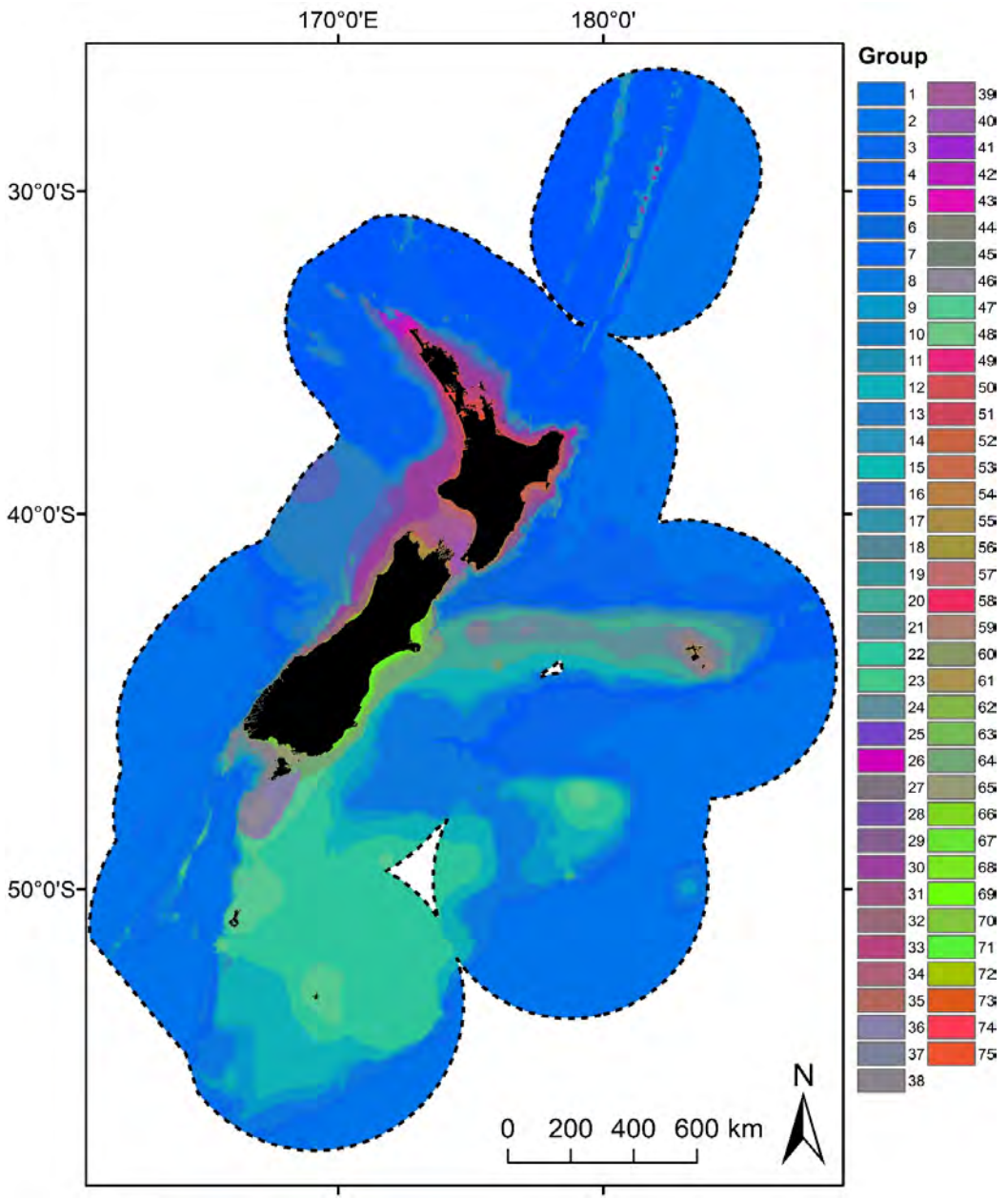
Assessing group strength

Trade-off with proportion of groups with

- **adequate sampling**
- **ease of communication**



75
Appropriate for NZ SCC


170°0'E
180°0'
30°0'S
40°0'S
50°0'S
Group
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6
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8
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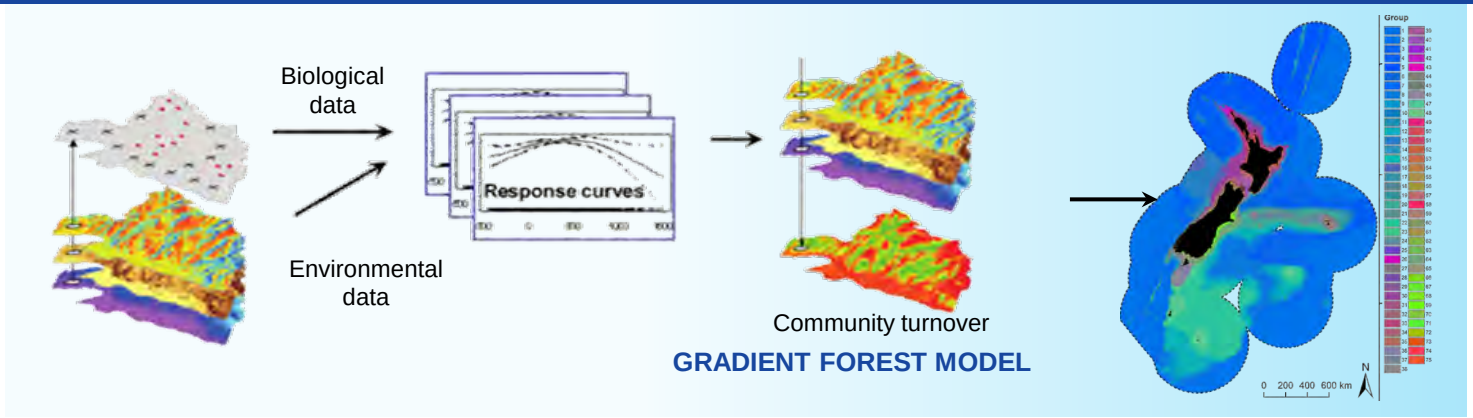
N
0 200 400 600 km

75

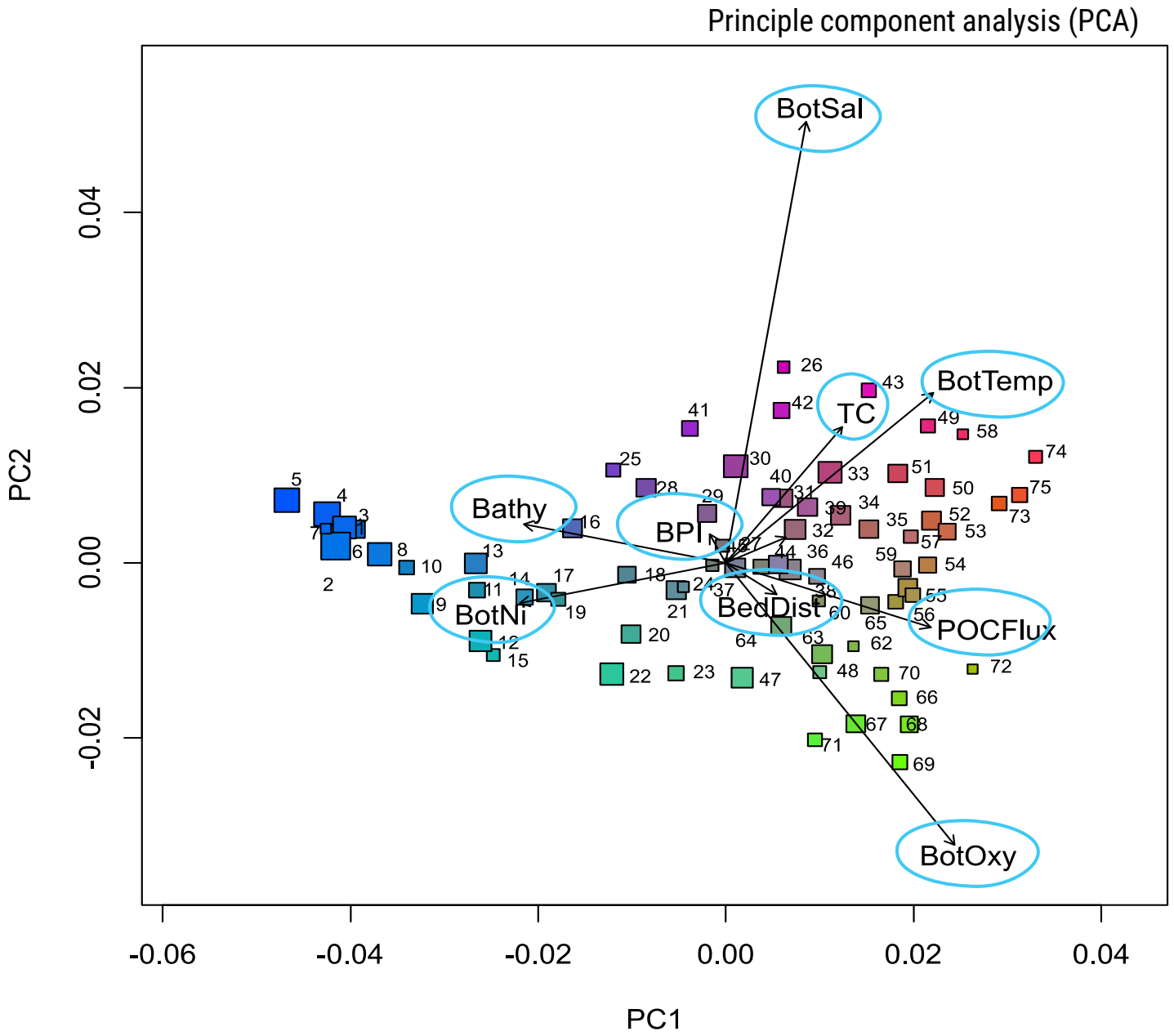
Talk overview

- Data inputs › Biological Data › Environmental Data
- Modelling › Species Turnover › Classification to assemblages
- The NZ SCC › Trends, Group Descriptions, Strengths and Weaknesses

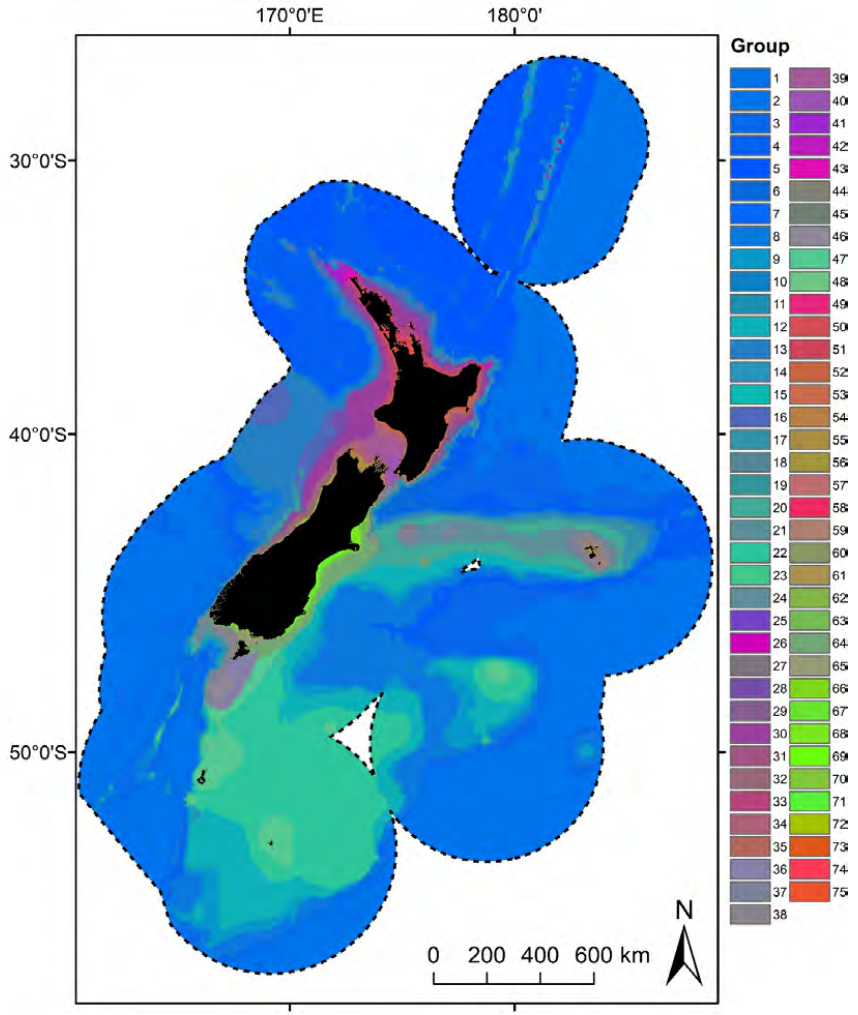


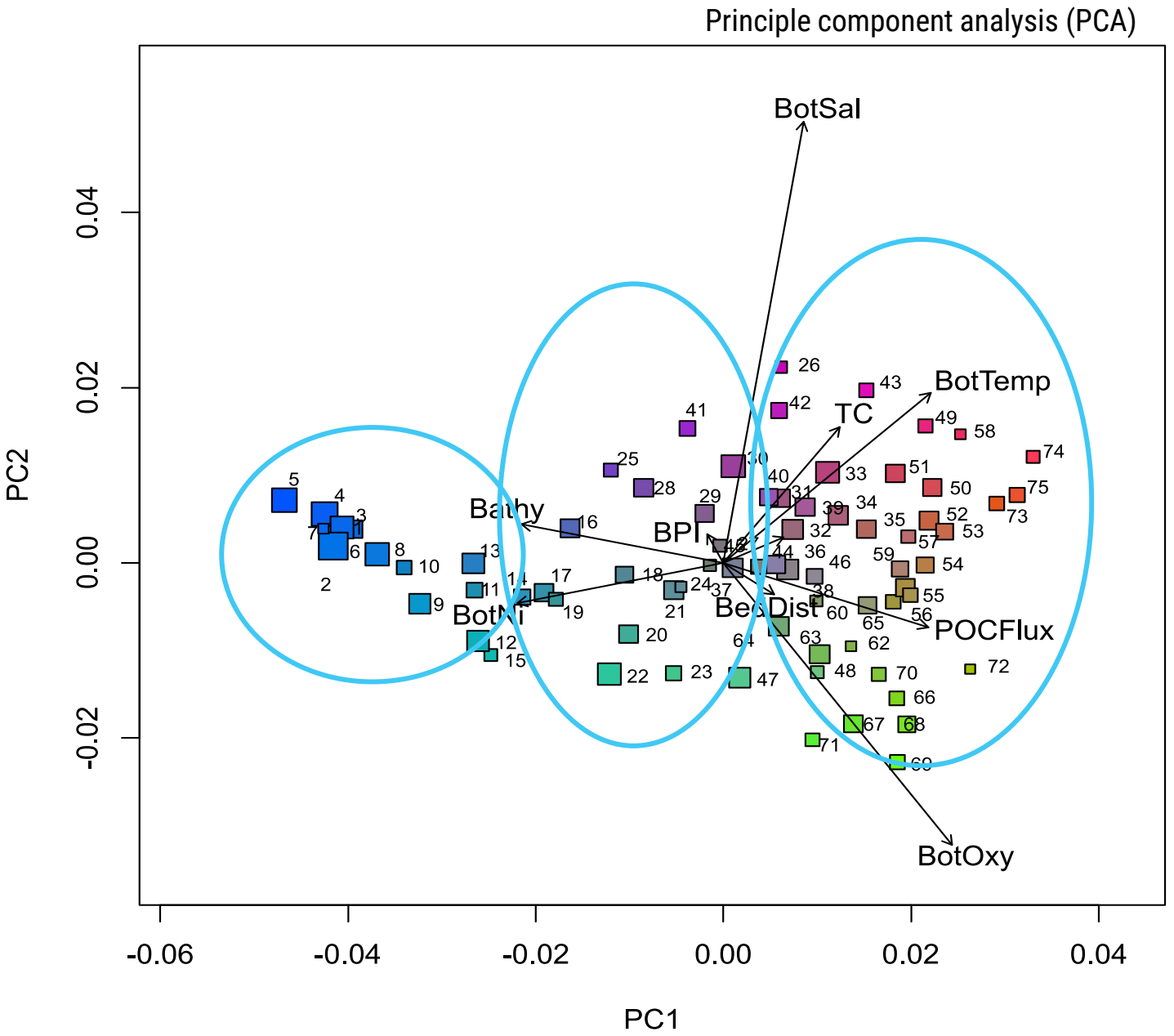
Broad trends

- A more detailed look at the 75 groups
- Which environmental variables drive these groups?
  Nine most important predictors
- Size of symbols = geographic area



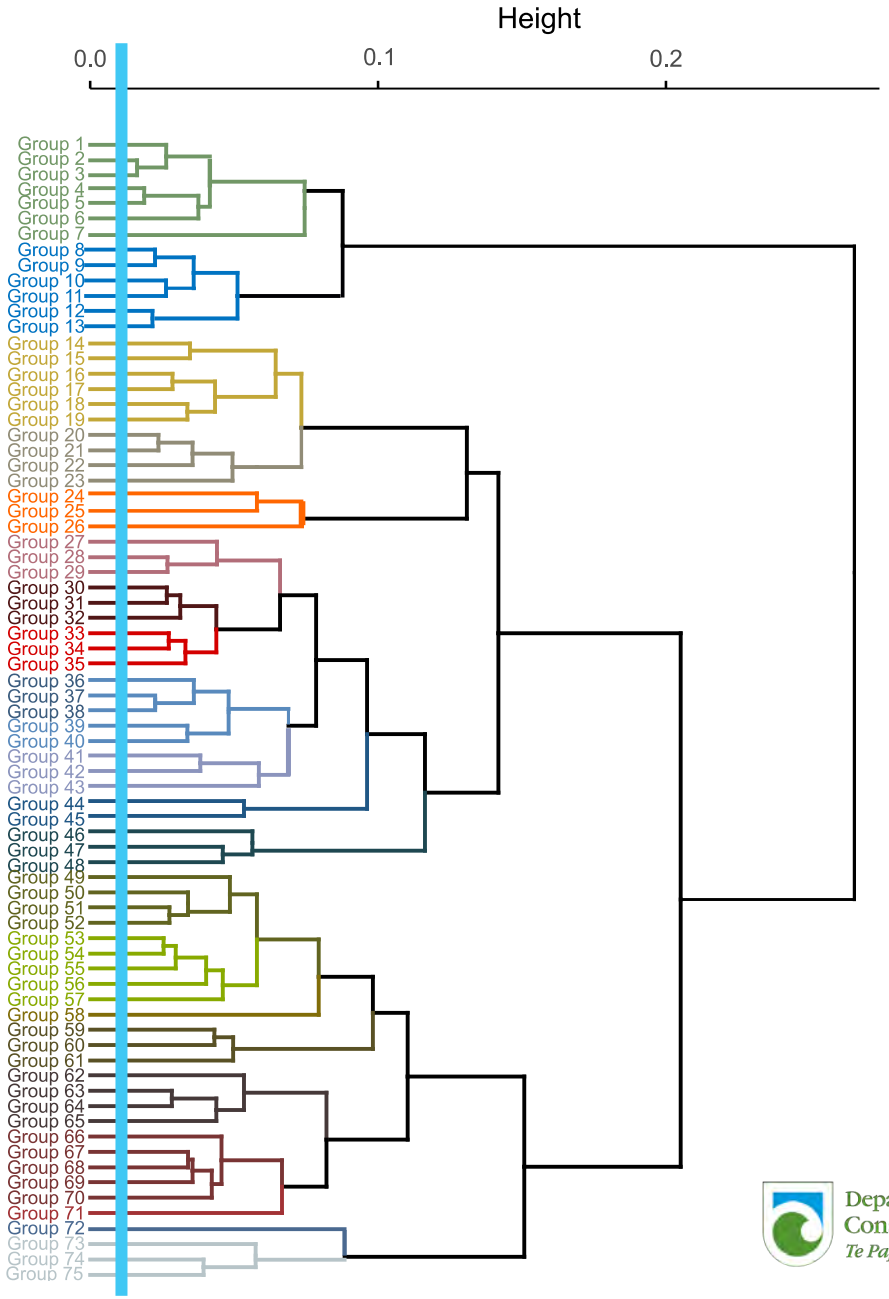
Broad trends





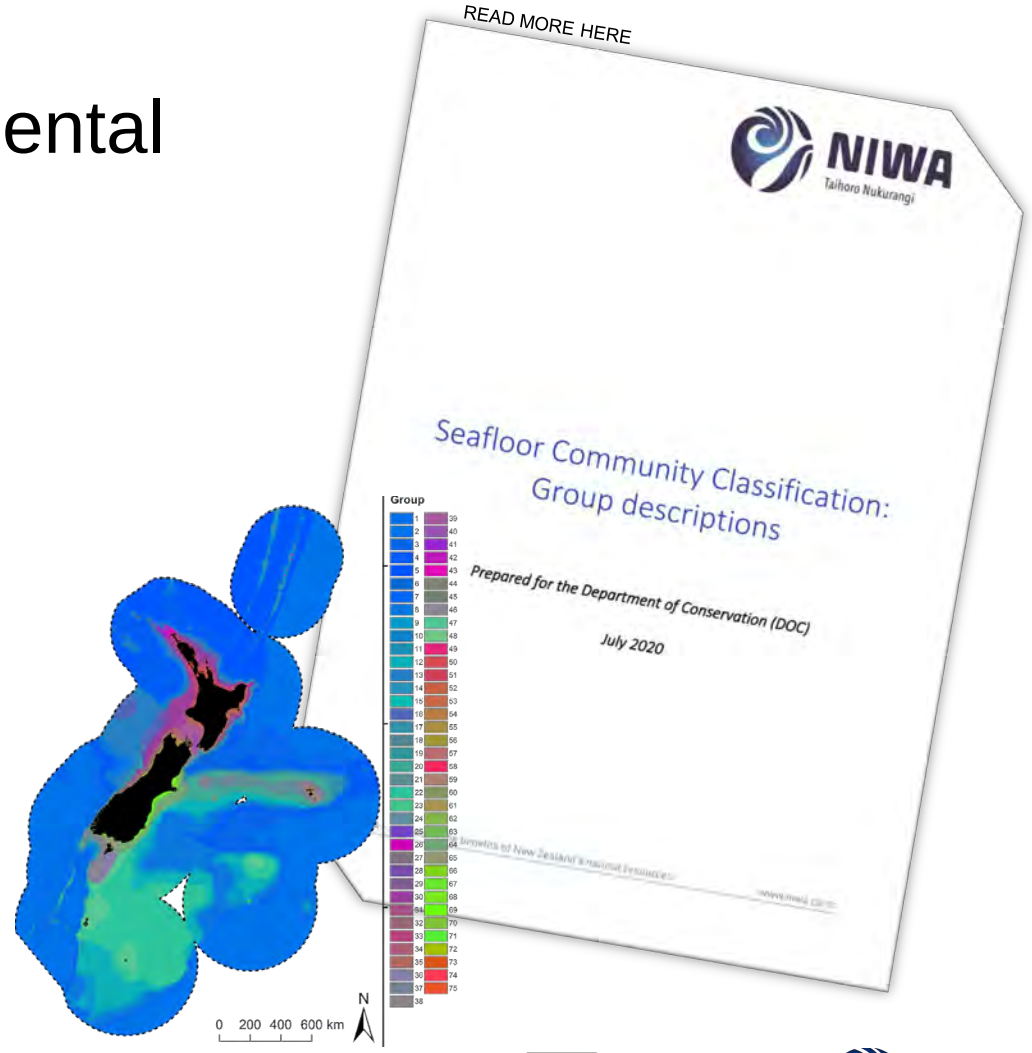
Broad trends

Groups are nested



Group descriptions – what's there?

- Summarising biological and environmental information for each group
- Includes:
  - Geographic location and extent of group
  - Characterising environmental conditions
  - Characterising species
  - Model uncertainty



Example: Group 30

2. Group Description

Group 30 is a large widespread group (Figure 6.1) occurring on the continental shelf north of the Subtropical Front in warm, moderate productivity coastal waters (Table 6.5). This group is characterised by moderate oxygen concentrations and low dissolved silicate and nitrate concentrations at depth (Table 6.5). Benthic invertebrate assemblages are diverse and are characterised by high frequency occurrence of the squid Nototodarus, multiple coral species, and low frequency bivalve, brachiopod and gastropod occurrence (Table 6.6). Fish assemblages are diverse, with ~130 demersal fish taxa and ~50 reef fish taxa. Demersal fish assemblages are characterised by high frequency tarakihi, barracouta, jack mackerel and school sharks, and reef fish assemblages are characterised by very high frequency occurrence of nearly 20 taxa including perch, damselfish and morwong (Table 6.6). This group has a very high number of samples for benthic invertebrates and demersal fish and very low samples for macroalgae and reef fish (Table 6.6). Overall confidence in modelled relationships is moderate – high for this group (high confidence for 'combined' biotic group environmental coverage and moderate for model variability (SD), Table 6.7). Note, there is low sample number and low confidence associated with model variability of reef fish (Table 6.7).

3. Similar groups

Closely related to group 31; more loosely related to group 32.

4. Characterising environmental conditions

Table 6.5: Group 30 characterising environmental conditions

Environmental variable	Mean value	Qualitative description
Bathymetry	129 m	Shelf depth
Slope	0.34 °	Low slope
Bottom silicate	4.91 µmol l^{-1}	Low concentrations of silicate at depth
Dissolved oxygen at depth	5.21 µmol l^{-1}	Moderate concentrations of oxygen at depth
Temperature at depth	14.15 °C km^{-1}	High bottom water temperature
Downward vertical flux of particulate organic matter at the seabed	41.22 mgC m^{-2} d^{-1}	Moderate productivity
Turbidity	0.002 m-1	Low turbidity

5. Characterising Species

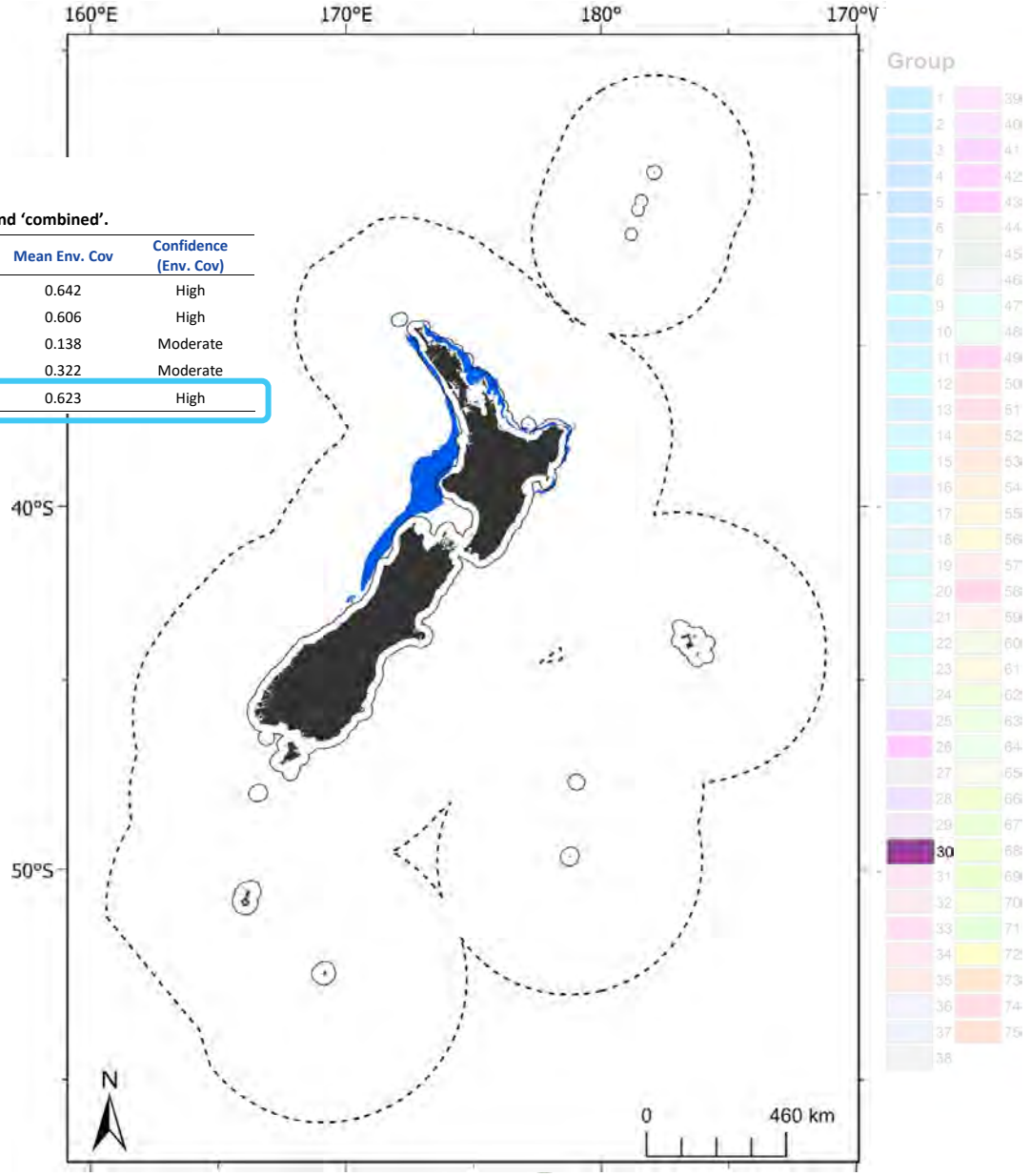
Table 6.6: Species name, mean frequency occurrence and % contribution to group 30 similarity for those species contributing to a total of 70% of the group similarity or > 4 % to the group similarity. Groups with no species present or where data was insufficient to run analyses are reported as na.

Taxa type	Sampling gear	n samples	Unique taxa	Scientific name	Common name/broad descriptor	Mean frequency occurrence	% contribution to similarity
Benthic invertebrates	LLG.LMG	1271	154	*Nototodarus*	Squid	0.92	99.06
	MMG	65	191	*Lyreidus*	Crab	0.4	15.8
				Heteromolpadia	Sea cucumber	0.31	10.71
				Ophiozonoida	Brittle star	0.31	10
				Monomyces	Coral	0.32	7.15
				Peronella	Sea cucumber	0.26	5.21
	SMG	70	154	*Monomyces*	Coral	0.13	11.8
				Saccella	Bivalve	0.11	10.51
				Caryophyllia	Coral	0.1	7.98

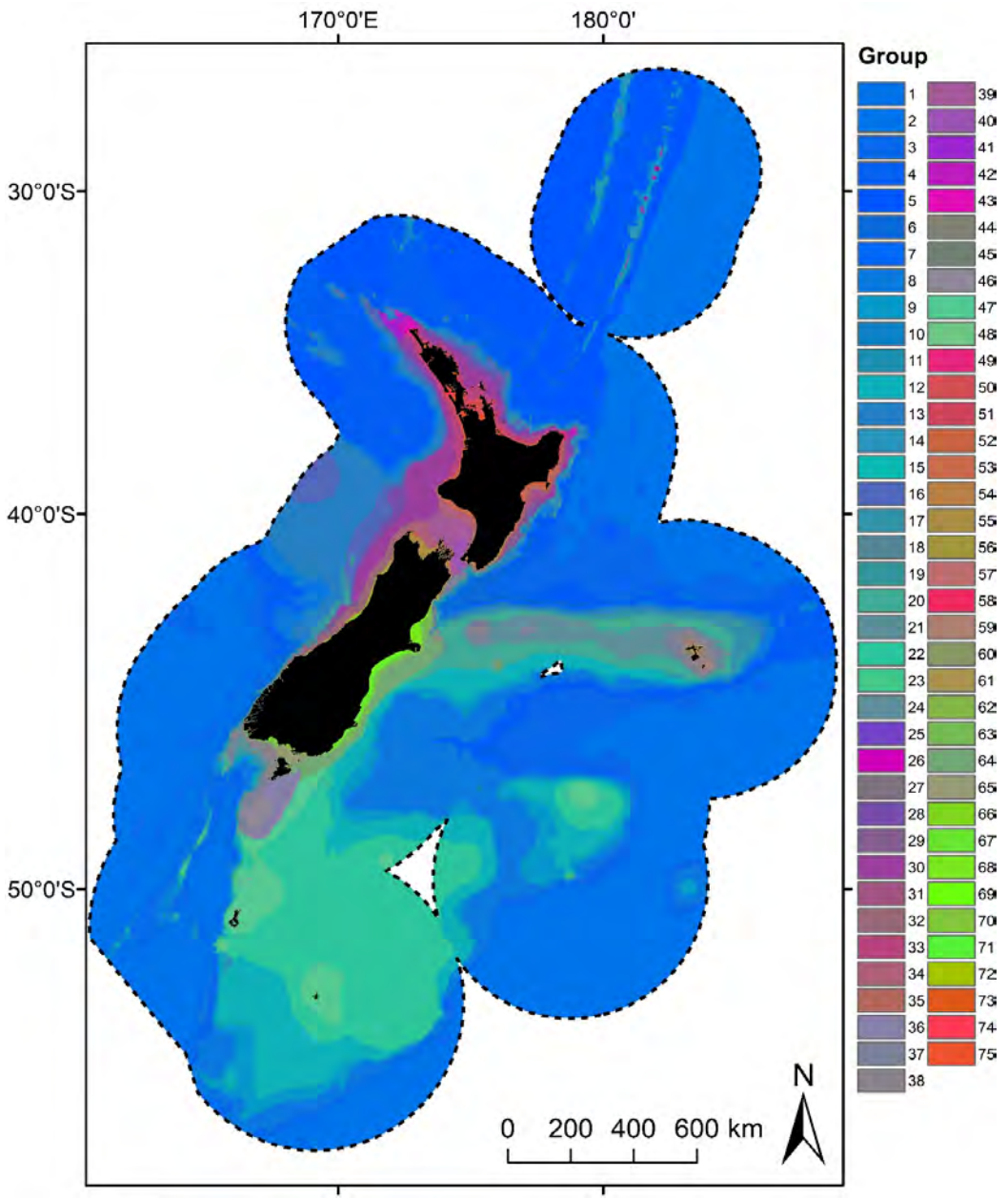
6. Uncertainty ranges

Table 6.73: Mean uncertainty values for group 30 by biotic group and 'combined'.

Taxa	Mean SD	Confidence (SD)	Mean Env. Cov	Confidence (Env. Cov)
Benthic invertebrates	0.002	Moderate	0.642	High
Demersal fish	0.003	Moderate	0.606	High
Macroalgae	0.002	Moderate	0.138	Moderate
Reef fish	0.004	Low	0.322	Moderate
Combined	0.003	Moderate	0.623	High



Can dive into all 75 groups in this way



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Caveats and assumptions

- Co-occurring species **considered** assemblages
- Assume **biodiversity is well represented** (approx. 1700 taxa across 4 biotic groups) → **validation** planned to test this assumption
- **Data coverage appropriate**

  Environmental coverage → deep water not well covered
- Subtidal invertebrates → **genus** (ideally better to have species data)

Strengths and weaknesses: Weaknesses

- **No abundance** information

  When does presence of a sponge indicate a sponge garden?

- **Temporally** and spatially **smoothed**

  Mismatch between biological and environmental data, no seasonality explicitly incorporated

- **Only seafloor taxa**

  No pelagic taxa / water column

- **Data 'quality'** varied by biotic group

  Differences in sampling techniques

- Patchy knowledge of **seafloor types**

- Despite descriptions of biodiversity, **'Groups' are not intuitive**

Strengths and weaknesses: Strengths

- **Comprehensive** dataset collated

  Biological and environmental

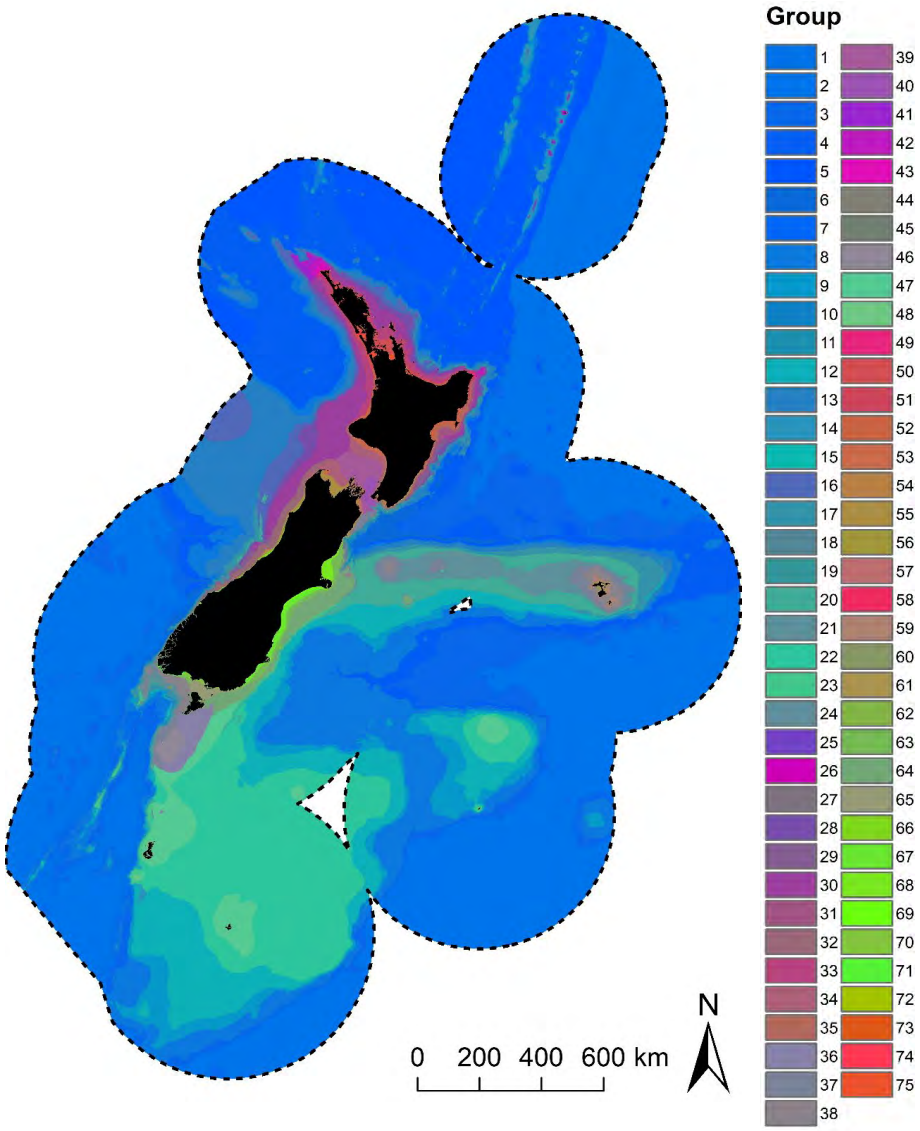
- **Hi-resolution** (1km) spatial predictions across the EEZ

  250m in the Territorial Sea

- Estimates of **uncertainty** produced
- **Turnover** information (spatial estimates) retained
- **Different number of groups** can be used
- More manageable **description of biodiversity**

  Group description created & 75 groups easier than > 1700 species

The NZ Seafloor Community Classification

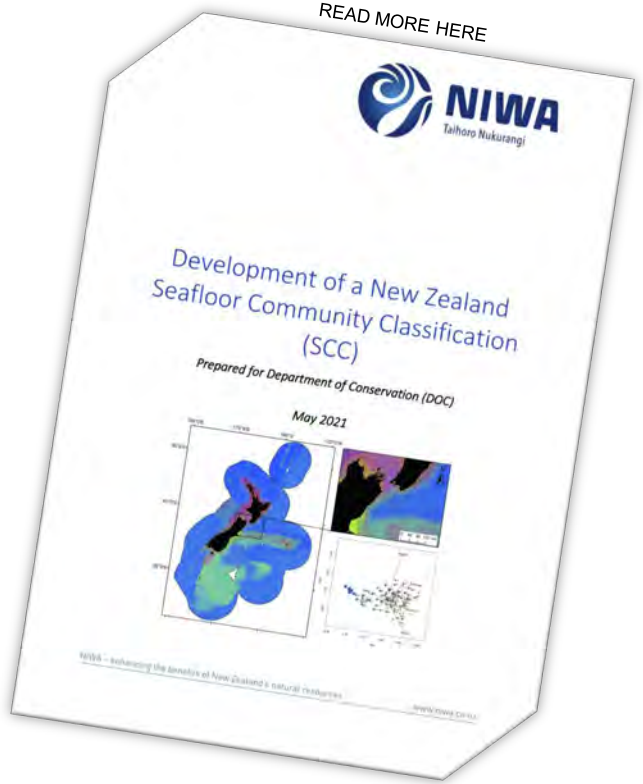


Summary

Components
Rationale
Analysis
Results

Implementation for Policy Makers
Tune into Webinar 2

READ MORE HERE



All details available in our report:
Stephenson, F., Rowden, A., Brough, T., Leathwick, J., Bulmer, R., Clark, D., Lundquist, C., Greenfield, B., Bowden, D., Tuck, I., Neill, K., Mackay, K., Pinkerton, M., Anderson, O., Gorman, R., Mills, S., Watson, S., Nelson, W. and Hewitt, J. (2021). "**Development of a New Zealand Seafloor Community Classification (SCC)**". NIWA report prepared for Department of Conservation (DOC).

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Ngā mihi – any questions?

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