INT2022-04 Risk Assessment for protected corals:
Introduction and overview

Malcolm Clark

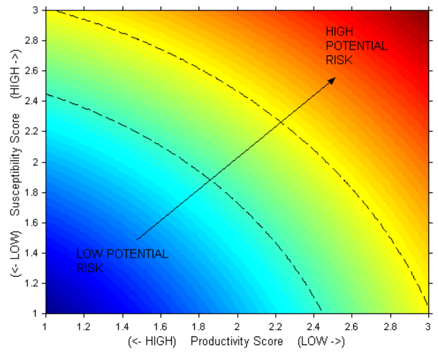
The project team comprises Malcolm Clark (co-lead), Brit Finucci (co-lead), Fabrice Stephenson, Di Tracey, Owen Anderson, Laura Kaikkonen

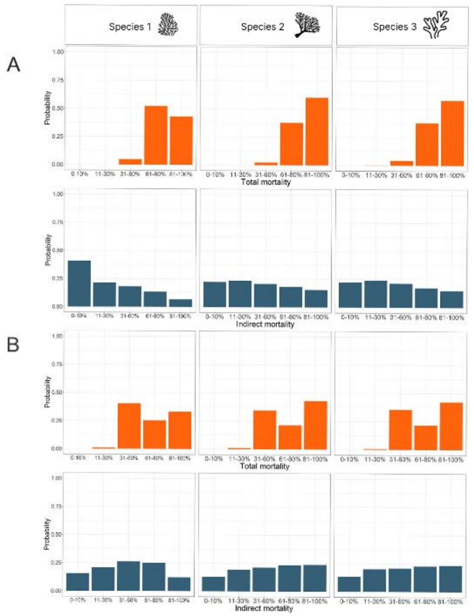
Climate, Freshwater & Ocean Science

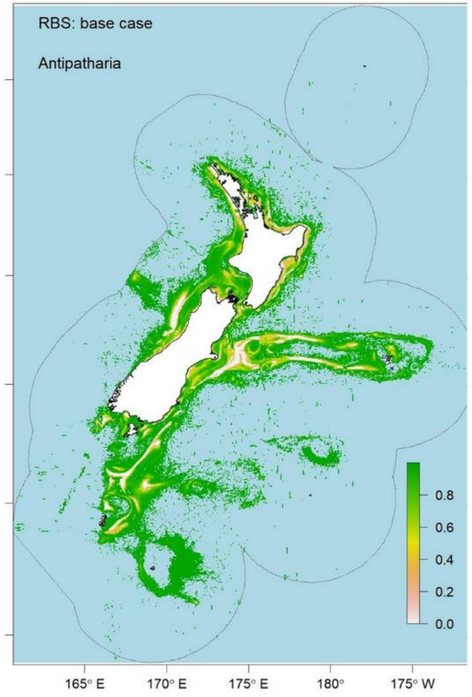
NIWA
Taihoro Nukurangi

Presentations outline

- Introduction to the project (Malcolm)
  - Approach, new data inputs
- Relative Benthic Status (Fabrice)
- Productivity-Susceptibility Analysis (Brit)
- Bayesian Network Analysis plans (Laura)







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Objectives

- Context (from RfP)
  - The aim of the project is to undertake an inventory of applicable data, develop methodology for, and conduct a quantitative coral risk assessment, following on from a pilot risk assessment undertaken in 2014 (POP2013-05). The current lack of a risk assessment is noted as the most needed and important gap in the CSP Coral Plan and is a priority for CSP.
- Specific objectives

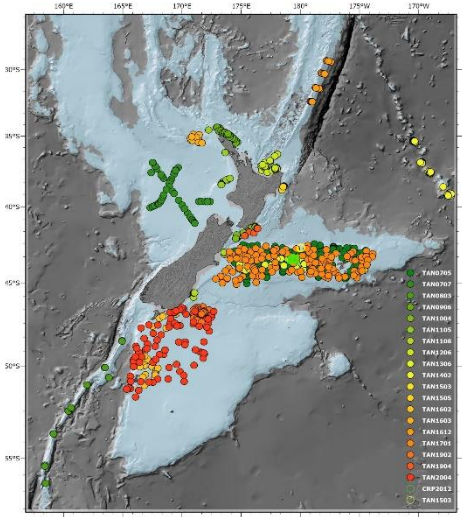
1. To develop a semi- or fully quantitative coral risk assessment model, incorporating updated coral biological, distribution and abundance data.
2. To implement the model to determine relative risks and vulnerabilities of different coral taxa to fishing activity.

The approach

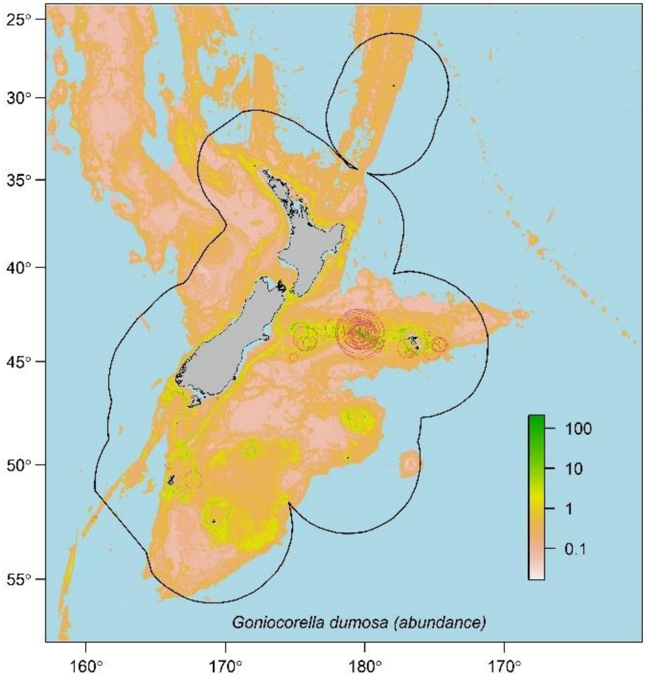
- Evaluate existing data on protected coral groups, as well as assess the nature and extent of research projects that are currently being undertaken under a combination of DOC, CSP, and FNZ research projects. This will cover all coral taxa initially but subsequently be reduced to a core set based on data availability.
- Evaluate the suitability of current or anticipated data to support a range of risk assessment methods, considering three options as a progression in the applicability of methods to actually deliver something useful for corals (and benthic communities more generally).
  - Firstly, update of the semi-quantitative PSA approach. This method highlights relevant data for assessing risk, and is a proven useful method for relative risk that can be completed
  - Second, building on methods used in SPRFMO, trial the data in a more quantitative and spatially and temporally explicit "Relative Benthic Status"
  - Third, and representing a further increase in complexity, consider a probabilistic approach using Bayesian Network (BN) methods

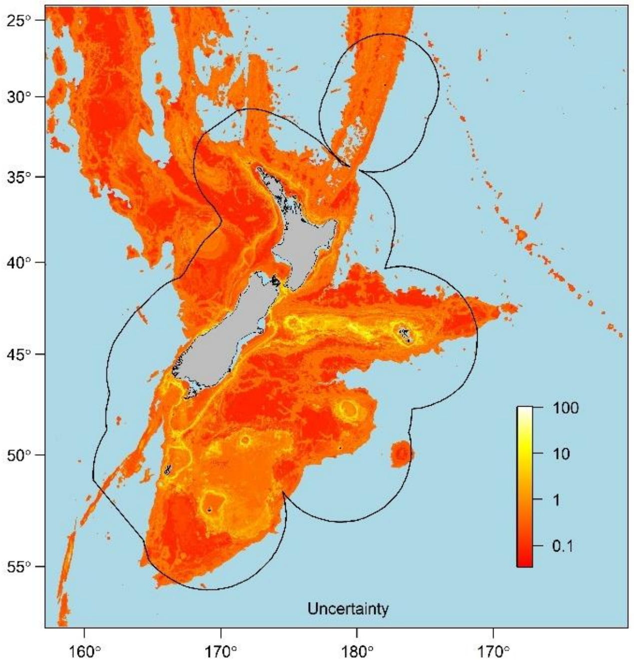
New data (1)

- Distribution
  - Abundance based HSM (Random Forest, Boosted Regression Tree)
  - Done under the coral hotspots project (POP2021-02) based on comparable DTIS surveys
  - Felt more appropriate than previous presence-absence outputs, and enables future assessment of certain densities for priority management consideration



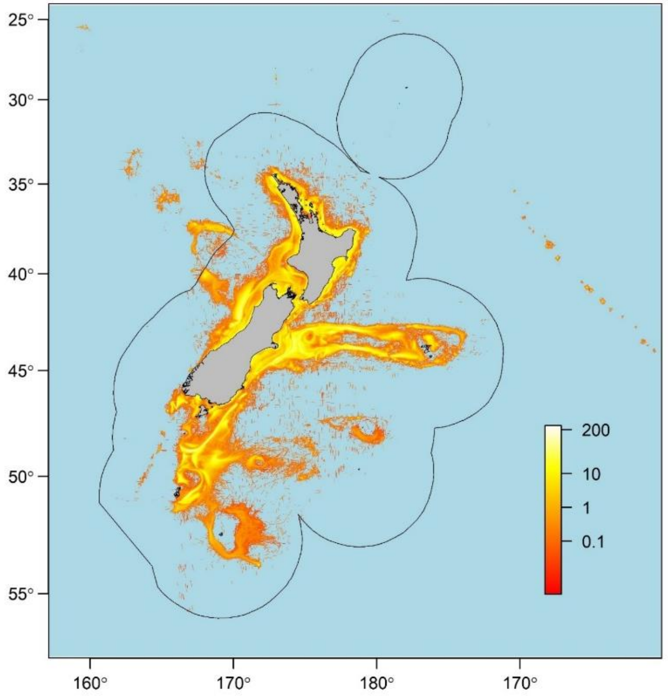
	Solenosmilia variabilis	*Goniocorella dumosa*	Caryophyllidae	*Flabellum*	Gorgonians	Keratoisididae/Mopseidae	Primnoidae	*Radicipes*	Antipatharia	Stylasteridae	Pennatulacea	Rank
BPI-broad	1	2	1	4	2	4	6	8	1	2	4	3.2
POC	*	1	9	2	5	7	1	1	5	3	1	3.5
Dissolved oxygen	*	6	3	1	6	5	5	2	4	*	3	4.2
Bottom temperature	*	3	7	5	4	8	3	5	2	*	2	4.5
Percent mud	*	*	4	3	1	2	2	7	8	*	5	4.6
Slope SD	2	*	8	7	3	1	8	4	3	5	7	5.1
Percent gravel	*	*	2	*	*	3	4	3	*	1	8	5.4
Aragonite	*	5	5	6	–	–	–	–	–	*	6	5.5
Ruggedness	*	4	6	*	8	6	9	*	7	4	*	6.8
Calcite	–	–	–	–	7	9	7	6	6	–	–	7.0
Fishing effort (SAR)	*	7	*	*	*	*	*	9	*	*	*	8.4
Seamount	3	*	*	*	*	*	*	*	*	6	*	8.4





New data (2)

- Fishing footprint
  - Update of bottom trawl 1989-2021 (BEN2020-01)
  - Swept area ratio approach
  - Bottom longline data can be added
- Biological updates
  - Age and growth data
    - Black coral, stony corals, bamboo corals
  - Reproduction
    - Review of all taxa data in 2021
    - New histology project
  - Connectivity
    - Recent studies on larval dispersal, gene flow, seascape genetics



Selected taxa

- Based largely on the final taxa where abundance could be modelled.
- Consideration also of supporting biological data (NZ wherever possible)

SpeciesCode	SpeciesName	List2	List_6	Distrib_PA	Distrib_AB	Age	GrowthRate	ReprodMode	Fecundity	Genetic_conn
SVA	Solenosmilia variabilis	HotSpots		Y	Y	Y	Y	Y		Y
GDU	Goniocorella dumosa	HotSpots	Histology	Y	Y	Y	Y	Y		Y
PMN; PRI	Primnoa	HotSpots	Histology	Y	Y	Y (PMN)	Y	Y (proxy)	Y (proxy)	
COB; AHL; ATP	Antipatharia	HotSpots	Histology	Y (COB)	Y	Y (COB, ATP, AHL)	Y (COB, AHL)	Y (AHL, ATP proxy)	Y (AHL proxy)	Y (AHL, COB)
ISI	Bamboo corals	HotSpots		Y	Y	Y	Y	Y		
GOC; PAB; CLL	Gorgonians_GOC_PAB+Corallium	HotSpots		Y	Y	Y (GOC)	Y (CLL proxy)	Y (CLL proxy)	Y (CLL proxy)	
RAD	Radicipes spp.	HotSpots			Y					
COR; STY; ERR	Hydrocorals_COR_STY+Errina	HotSpots	Histology	Y (COR)	Y			Y (COR, ERR, proxy)		Y (ERR proxy)
COF; FAP	CUPcoral_Flabellum	HotSpots			Y			Y		
CUP; CAY	CUPcoral_Caryophylliidae	HotSpots			Y			Y	Y (CUP, proxy)	

Milestones

Milestone	Performance Standards	Due date
1. Preliminary scoping and project planning meeting with DOC contract Manager	Meet with DOC contract manager to determine timeframe for project, logistics and planning. Brief written summary of the agreed approach for next steps to be provided.	1 4 /04/2023
2. Data collation	Collate all relevant data for model parametrisation and agree proxy values, identify focal taxa. Brief summary of available and/or informative data to be included in subsequent model testing to be provided	15/06/2023
3. Model and methodology testing	Initial scoping of methods and model testing with data-subset to assess utility for proposed methods. Presentation and discussion with focus TWG	1/10/2023
4. Progress report	A progress report to date outlining methods exploration. Presentation to CSP technical working group.	1/11/2023
5. Methods finalisation and modelling	Agreement with CSP on methods for next steps incorporating feedback from the CSP TWG. Provide a written summary of the approach for Year 2	1/12/2023
6. Data analysis and modelling complete	Complete data collation, data analysis, and modelling. Presentation and discussion with focus TWG Provide written summary of risk assessment methods and data inputs	15/06/2024
7. Draft Final report and CSP TWG presentation	Draft report describing the work undertaken under each objective (methods, results, conclusions, recommendations). Presentation of findings to CSP TWG	1 /09/2024
8. Final report and data provision	Revised draft final report taking into account feedback from CSP TWG	1/11/2024

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Thank you

Questions, or over to: Fabrice

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Testing the application of dynamic Relative Benthic Status to deepwater corals in New Zealand.

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INT2022-04 Coral Risk Assessment TWG

20 March 2024

OVERVIEW

- Background
- Relative Benthic Status
  - RBS
  - dRBS
- Example results with *Goniocorella dumosa*
  - *Theoretical*
  - *Mapped*
  - *Risk metrics*
  - *Absolute region-wide assessment*

Relative Benthic Status - overview

- Pitcher et al. (2017) describe **two approaches** for calculating disturbance and recovery of seabed habitats following direct impacts of trawling. *Modification of the Schaefer (1954) logistic population growth equation*

    - **Depletion rates from trawling (d)**
    - **The taxon-specific recovery rates (r)**

Pitcher, C. R., et al. (2017). Estimating the sustainability of towed fishing-gear impacts on seabed habitats: a simple quantitative risk assessment method applicable to data-limited fisheries. Methods in Ecology and Evolution, 8(4), 472-480.

Relative Benthic Status - overview

Taxa	**Taxa code**	**d (+/- 20%)**	**r (+/- 20%)**
Solenosmilia variabilis	SVA	0.54; 0.67; 0.80	0.08; 0.10; 0.12
Goniocorella dumosa	GDU	0.40; 0.50; 0.60	0.16; 0.20; 0.24
Caryophylliidae	CUP; CAY	0.40; 0.50; 0.60	0.20; 0.25; 0.30
Flabellum spp.	COF; FAP	0.40; 0.50; 0.60	0.24; 0.30; 0.36
Gorgonians (all)	GOC; PAB; CLL	0.40; 0.50; 0.60	0.20; 0.25; 0.3
Keratoisididae/Mopseidae	ISI	0.40; 0.50; 0.60	0.20; 0.25; 0.3
Primnoidae	PMN; PRI	0.28; 0.50; 0.42	0.20; 0.25; 0.3
Radicipes spp.	RAD	0.27; 0.34; 0.41	0.20; 0.25; 0.3
Antipatharia (all)	COB; AHL; ATP	0.40; 0.50; 0.60	0.24; 0.30; 0.36
Stylasteridae	COR; STY; ERR	0.33; 0.41; 0.49	0.31; 0.39; 0.47
Pennatulacea	PTU	0.27; 0.34; 0.41	0.20; 0.25; 0.30

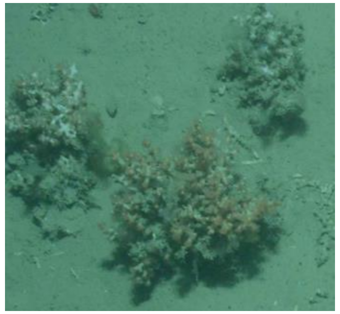
Relative Benthic Status - overview

- Pitcher et al. (2017) describe **two approaches** for calculating disturbance and recovery of seabed habitats following direct impacts of trawling. *Modification of the Schaefer (1954) logistic population growth equation*

  - Depletion rates from trawling (d)
  - The taxon-specific recovery rates (r)
  - **Spatial distribution of a taxon**
  - **Spatial distribution of trawling intensity (SAR)**

Pitcher, C. R., et al. (2017). Estimating the sustainability of towed fishing-gear impacts on seabed habitats: a simple quantitative risk assessment method applicable to data-limited fisheries. Methods in Ecology and Evolution, 8(4), 472-480.

Relative Benthic Status - overview



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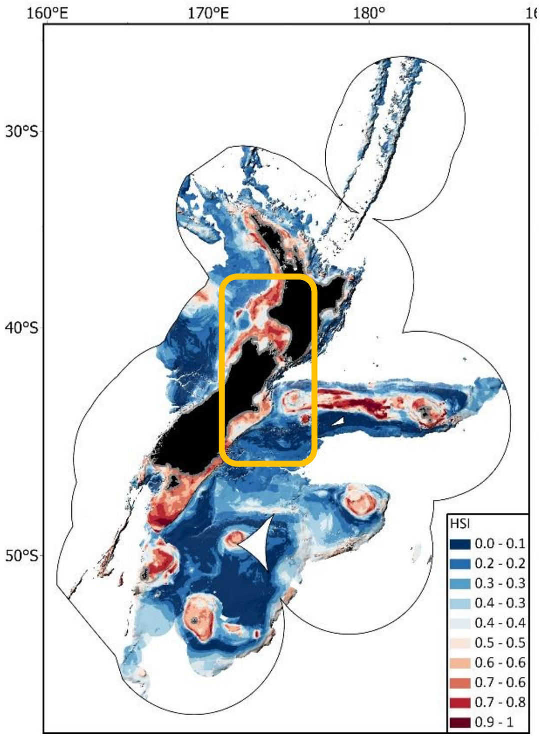
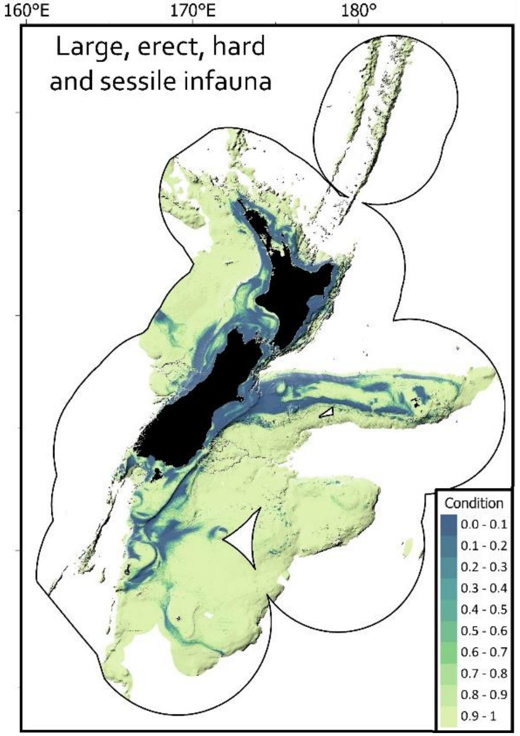
High prob of finding species

Low prob of finding species

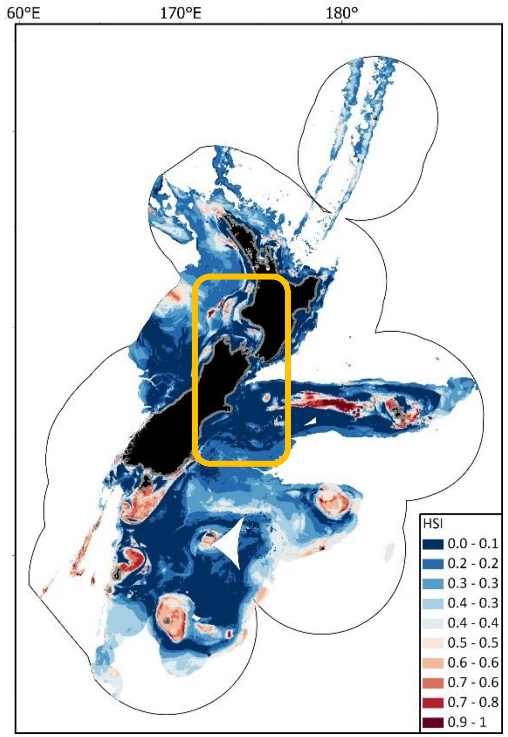
Goniocorella dumosa – Environment only



Fishing footprint and expected impact (D and R)



Goniocorella dumosa – What's likely to be there



RBS vs dynamic RBS (dRBS)

- RBS = mean SAR

  Assumption that fishing effort doesn't change over time

  E.g., SPRFMO BFIA (2020)

- dRBS = annual (or other temporal unit) SAR

  E.g., Pitcher et al. (2015)

Example difference: for a **vulnerable taxa** (d = 0.67), with two years of **high fishing intensity** (SAR = 2) but no other fishing in subsequent years

dRBS = locally extinct

RBS = 0.067 impact to abundance (minor)

Pitcher, C. R. et al. (2015). Effects of trawling on sessile megabenthos in the Great Barrier Reef and evaluation of the efficacy of management strategies. *ICES Journal of Marine Science, 73*

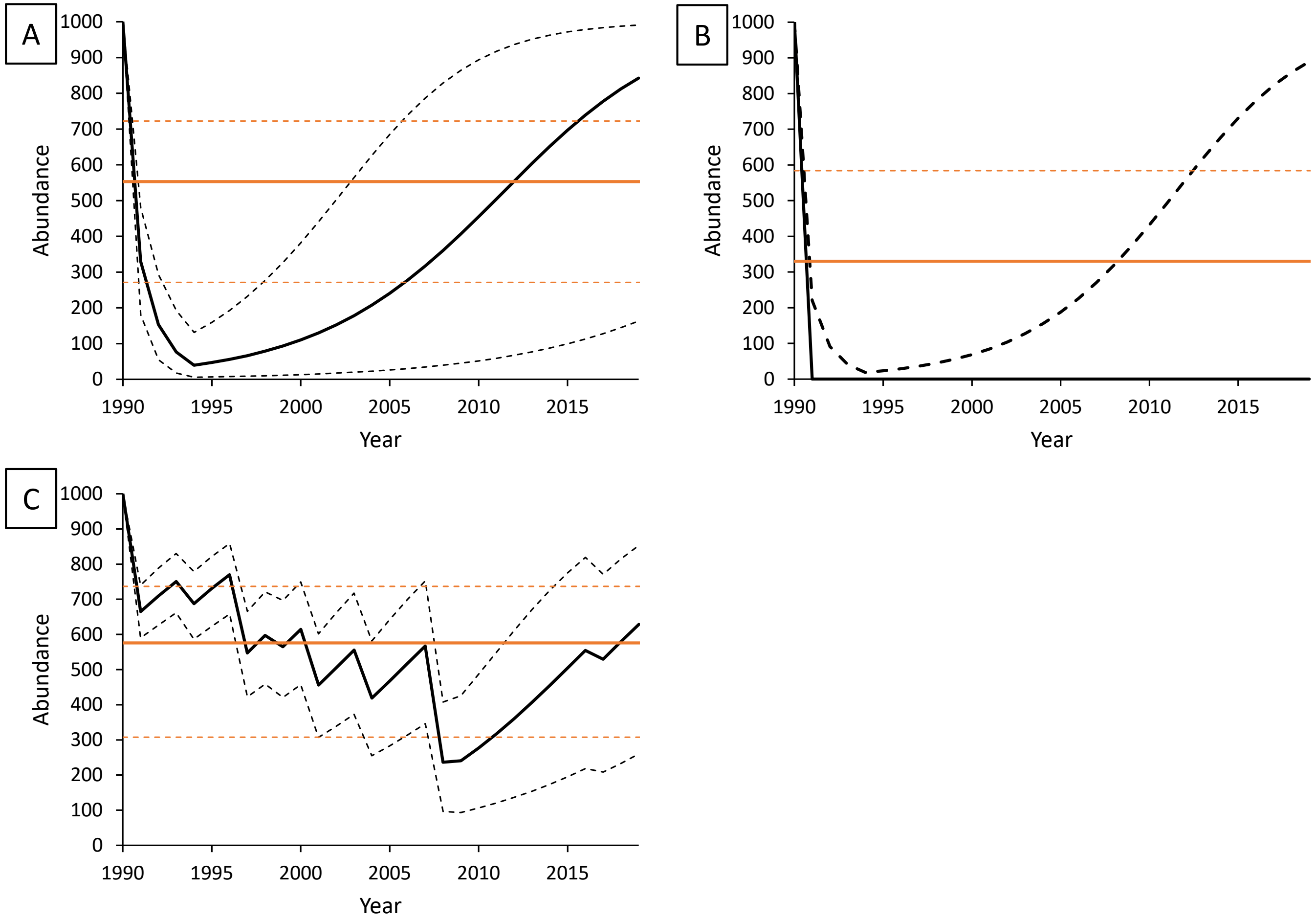
Objectives for the risk assessment

- Explore differences in outputs between RBS and dRBS using theoretical and practical examples for abundance estimates (Anderson et al., 2023)

- Produce best-, base- and worst-case estimates of dRBS for 11 protected coral taxa (*Solenosmilia variabilis, Goniocorella dumosa*, Caryophylliidae, Flabellum spp., Gorgonians (all), Keratoisididae/Mopseidae, Primnoidae, *Radicipes* spp., Antipatharia (all), Stylasteridae, Pennatulacea).

Anderson, O. et al. (2023). Identification of protected coral hotspots using species distribution modelling. Report Prepared by NIWA for Project POP2021-02, Conservation Services Programme, Department of Conservation

Theoretical comparison - *Goniocorella dumosa*

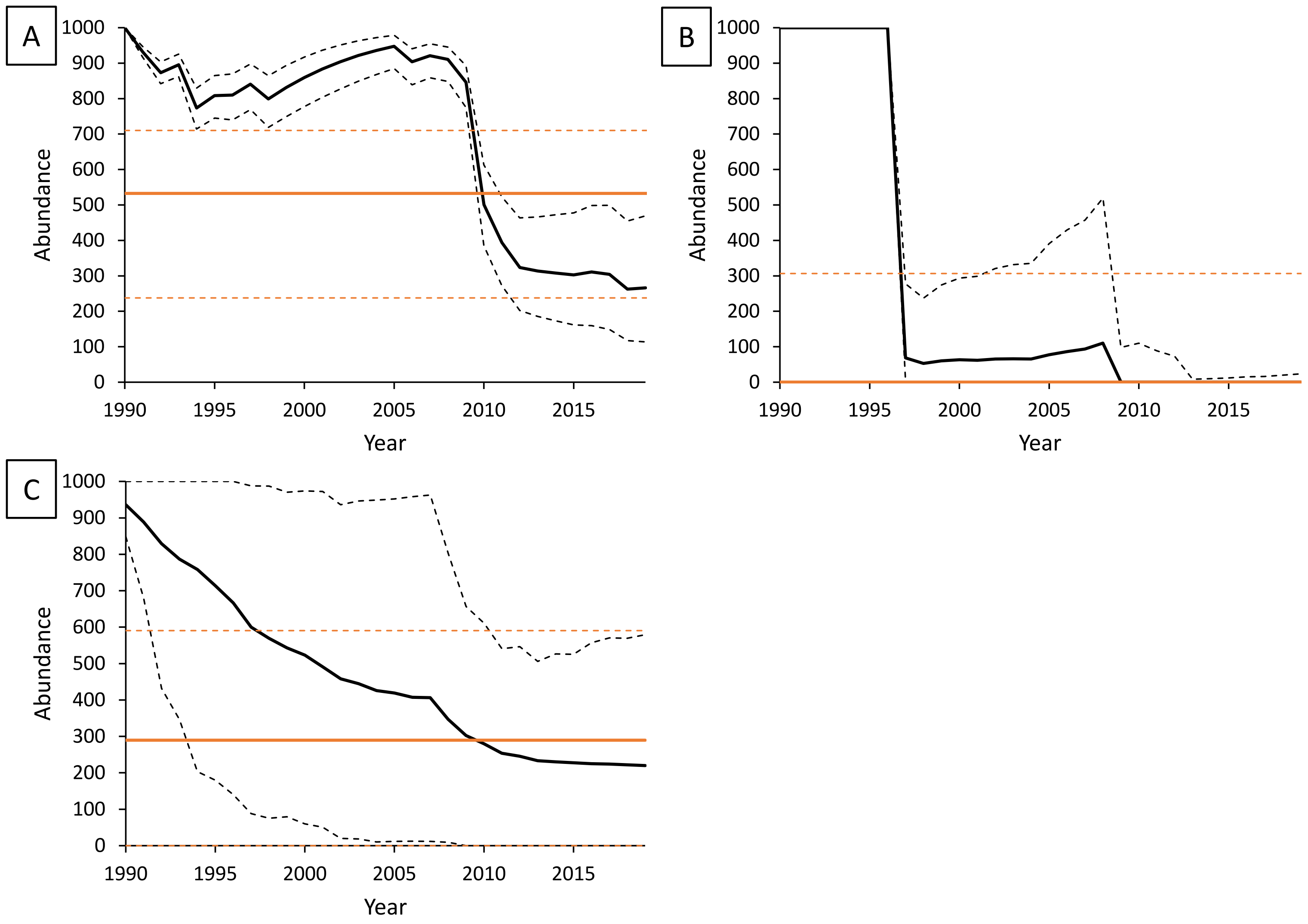


A) SAR = 1 from 1990 – 1994 (years 1 – 4), then SAR = 0 from 1995 – 2019.

B) SAR = 1.5 from 1990 – 1994 (years 1 – 4), then SAR = 0 from 1995 – 2019.

C) SAR between 0.2 – 1 for 9 years (randomly interspersed within the 30-year time-series).

Theoretical comparison - *Goniocorella dumosa*



A) Single location with low mean SAR (mean SAR = 0.15 ± 0.17 (SD)).

B) Single location with low mean SAR (mean SAR = 0.34 ± 0.54 (SD)).

C) All cells with low mean SAR mean (SAR = 0.23 ± 0.30 (SD))

Summary of theoretical comparison

Estimates of dRBS can account for the timing and magnitude of pulse trawling impacts.

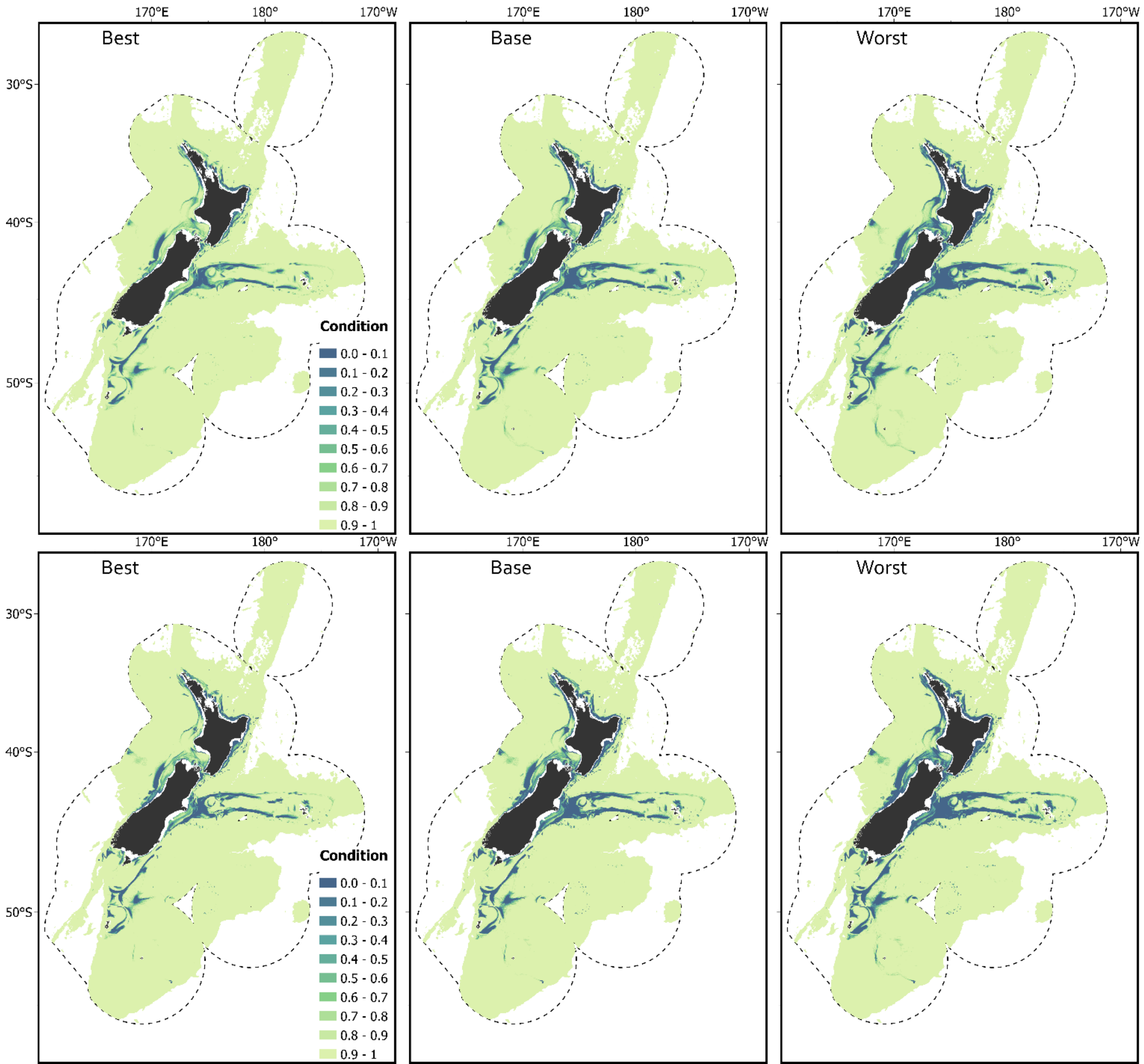
*Particularly important where bottom trawling **occurs early in the timeseries:***

the taxa may be locally extinct (if SAR > 1/D)

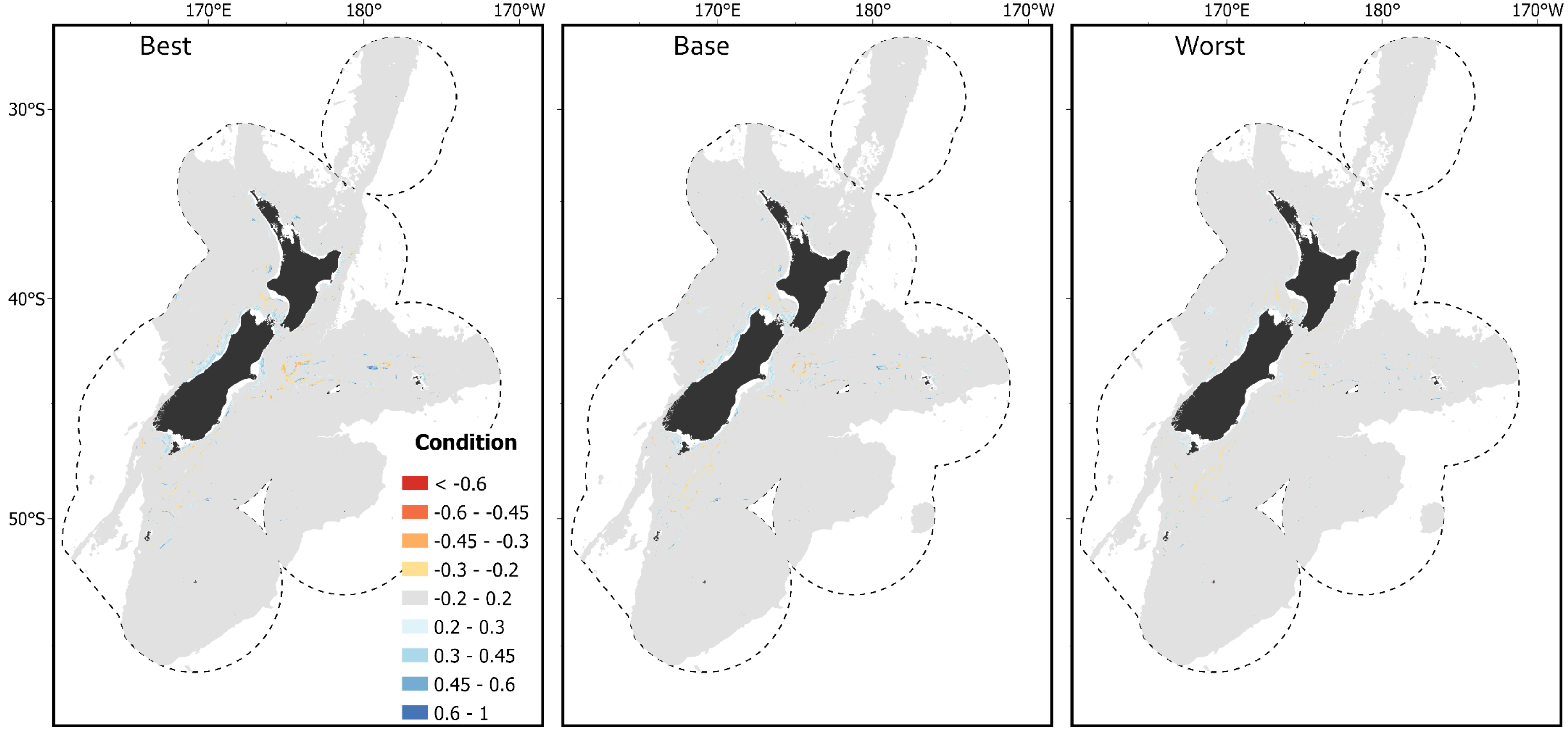
conversely it may have recovered substantially

Where fishing is consistent over time, estimates are similar between dRBS and RBS.

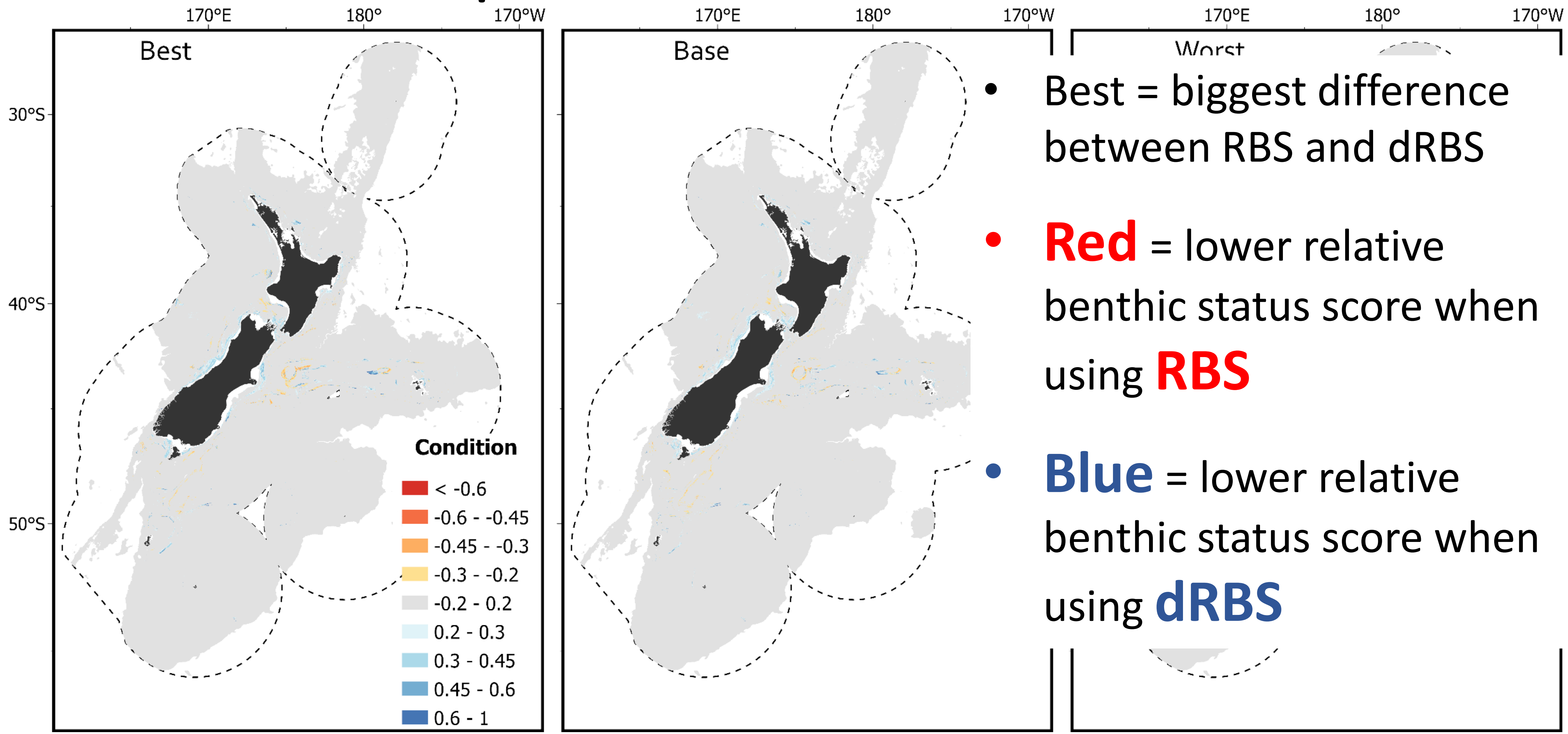
Practical comparison - *Goniocorella dumosa*



Practical comparison - *Goniocorella dumosa*



Practical comparison - *Goniocorella dumosa*



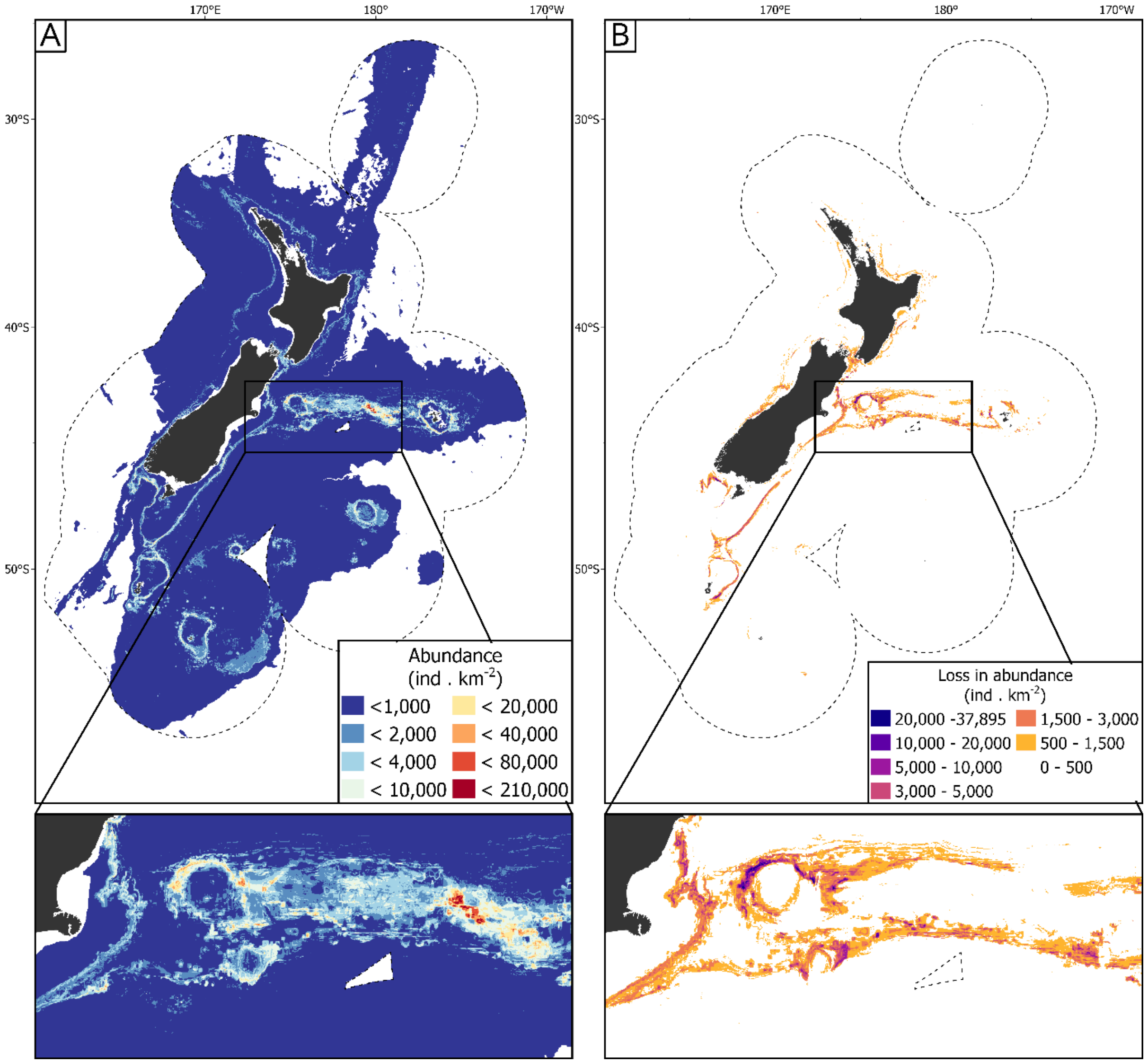
- Best = biggest difference between RBS and dRBS
- **Red** = lower relative benthic status score when using **RBS**
- **Blue** = lower relative benthic status score when using **dRBS**

Practical comparison - *Goniocorella dumosa*

	RBS	dRBS
Best-case	91.04%	90.98%
Base-case	88.46%	88.49%
Worst-case	85.63%	85.92%

- *Impact-adjusted abundance estimates were similar between approaches because fishing was consistent over time in areas overlapping with its distribution.*
- *This conclusion is **taxon dependent**, i.e., if areas with differences in predicted relative benthic status score also overlap with areas of moderate - high abundance*

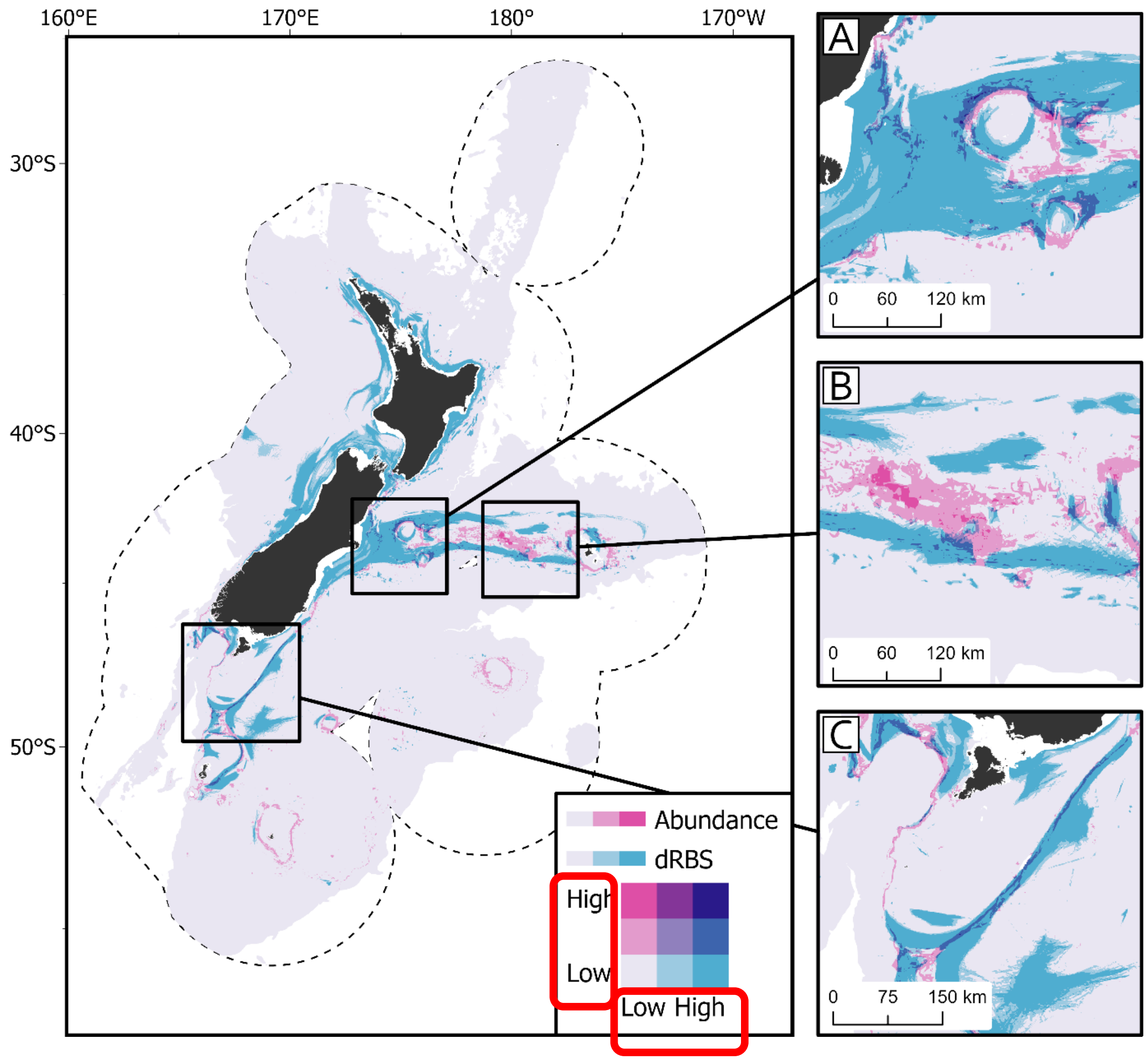
Dynamic Relative Benthic Status



Predicted impact-adjusted abundance of *Goniocorella dumosa* (dRBS for base-case)

Absolute predicted loss in abundance compared to initial abundance estimates from Anderson et al., 2023.

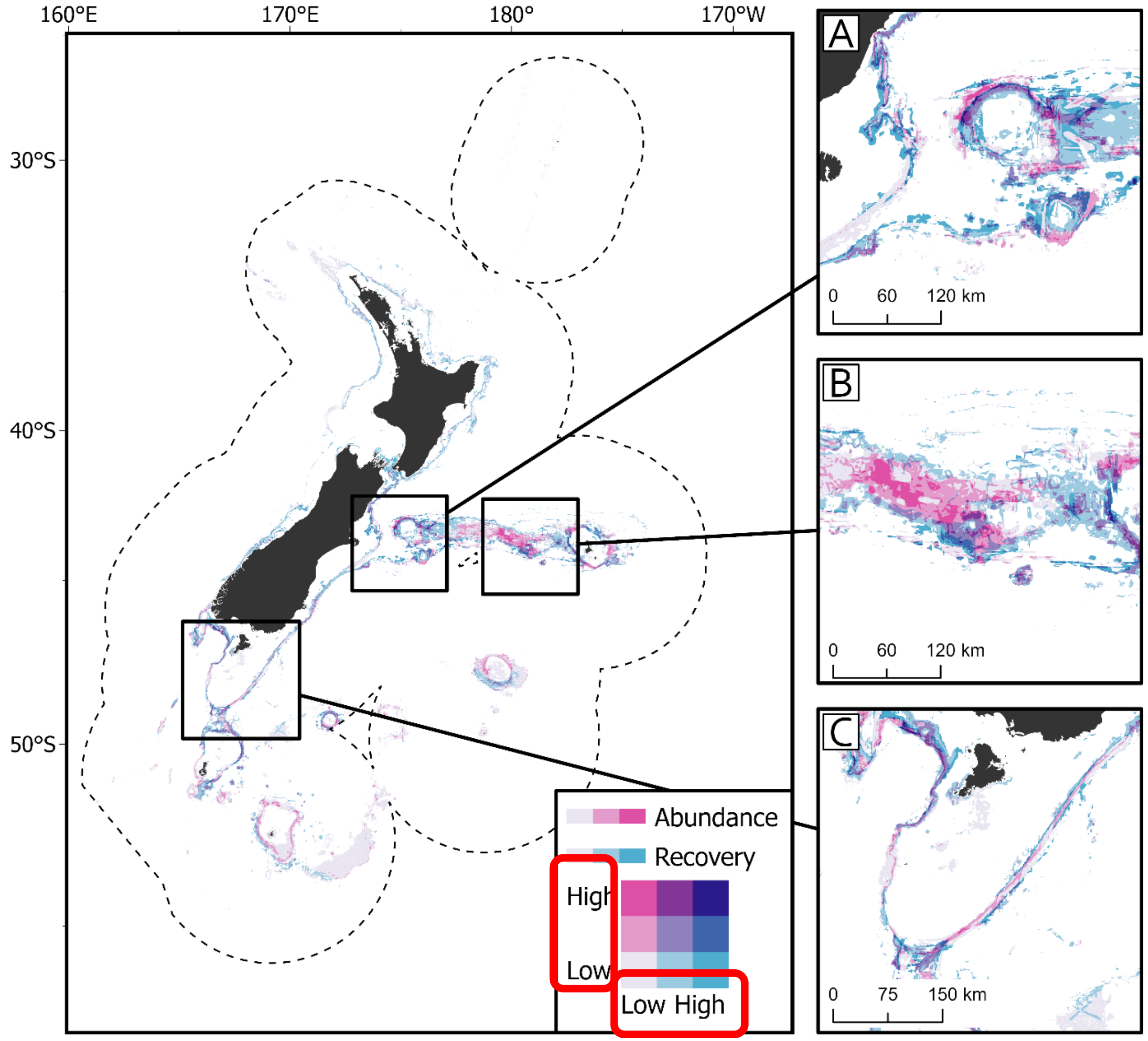
Dynamic Relative Benthic Status



Relative benthic status score was split into three (subjectively defined) risk categories (low risk: 0.8- 1.0; moderate risk: 0.5-0.8; high risk: 0.0-0.5).

Initial abundance of *Goniocorella dumosa* was split into three risk categories using (rounded) natural jenks (low risk: < 3000; moderate risk: 30000 – 20000; high risk: > 20000).

Dynamic Relative Benthic Status



Estimated Recovery time was split into three risk categories using natural jenk breaks (low risk: 0 - 10; moderate risk: 10 – 33; high risk: 33 – 77).

Initial abundance of *Goniocorella dumosa* was split into three risk categories using natural jenk breaks (low risk: < 3000; moderate risk: 30000 – 20000; high risk: > 20000).

General discussion

Dynamic RBS → where SAR > 1/d = local extinction

What percent of loss is considered risky?

Applications for Spatial planning:

- Understanding best places for conservation
- Estimating best places whilst accounting for recovery

R and D values make a difference to the RBS estimates

Coral ERA: Productivity-Susceptibility-Analysis (PSA) update

Brit Finnuci

INT2022-04 Coral Risk Assessment TWG

20 March 2024

Productivity-Susceptibility Analysis (PSA)

- Part of Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework
- Level 2 risk assessment; semi-quantitative

- PSA approach was first trialled on 15 coral species/groups on Chatham Rise as a preliminary assessment of the relative risk to protected coral species from deepwater bottom trawling (Clark et al. 2014)

- Use criteria for the "Habitat" component of the ERAEF to accommodate sessile corals on the seafloor
- Examines the extent of fishing activity impact:
    - **Susceptibility** of the unit to fishing activities – three aspects (availability, encounterability, selectivity)
    - Attributes scored, final score weighted with corrections for the number of attributes scored
    - **Productivity** of the unit (determines recovery potential) – one aspect
    - Attributes scored, given equal weight and final score averaged (1=low; 3=high)
- Overall risk score is taken as the Euclidean distance from the origin, which allows a single risk ranking

PSA process – susceptibility attributes

Attribute	Description	Concept and Rationale	Ranks		
			1 (low risk)	2 (medium risk)	3 (high risk)
Availability (1)	Spatial overlap (geographical and depth range)	Spatial overlap of the general geographic area with the geographical and depth range of the coral taxon	Very little overlap (<10% of its distribution in NZ is located in the region of focus)	Partial overlap (10-50%) with its distribution range around NZ	Considerable overlap (>50%) with species distribution (e.g., NZ endemic)
Encounterability (4)	Depth zone	The depth of distribution of the coral species relative to the depth at which fishing activity occurs	Depth overlap <10% (generally <500 m or >1200 m)	Depth overlap 10-50% (generally 500-800 m)	Depth overlap >50% (800-1200 m)
	Geographical area	Encounters driven by expectation of finding target fish species. Overlap of the trawl footprint and modelled distribution	<10% overlap between trawl footprint and species distribution	10-50% overlap between trawl footprint and species distribution	>50% overlap between trawl footprint and species distribution
	Ruggedness	Relief, rugosity, hardness and seabed slope influence accessibility to bottom trawling and coral occurrence	Predominately high relief (>1.0 m), rugged, difficult to trawl (crevices, overhangs, boulders); >30 slope	Predominantly low relief (<1.0 m), rough surface but trawlable (rubble, small boulders); <30 slope	No relieft to impede trawling, smooth simple surface; <30 slope
	Level of disturbance	The degree of impact that an encounter will have on individual colonies of a taxon	Many encounters needed for a significant impact on individual colonies	Several encounters needed to damage individual colonies	Single trawl will cause significant damage to individual colonies
Selectivity (3)	Removability/mortality of morphotypes	Erect, large, rugose, inflexible, delicate forms incur higher impacts	Low, robust or small (<5 cm), smooth or flexible types	Erect or medium sized (5-30 cm), moderately robust/inflexible	Tall, delicate or large (> 30 cm high), rugose or inflexible
	Associated faunal diversity	Diversity/species richness associated with the coral species or biogenic habitat, including relative ecological importance for other species	Diversity low. Few, if any, species grow on or with the coral	Diversity medium. Some species grow or live on or in the coral	Diversity high. Many species utilize the matrix of a biogenic form
	Areal extent	Proportion of predicted coral distribution relative to total area considered. Larger areal extent means less risk for maintaining biodiversity and community function	Common (>10%) within the area	Moderately common (1-10%) within the area	Rare (<1%) within the area. Small impacts may affect a large proportion of the taxa

PSA process – susceptibility attributes

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PSA process – productivity attributes

Attribute	Description	Concept and Rationale	Ranks		
			1 (low risk)	2 (medium risk)	3 (high risk)
Productivity (4)	Regeneration of fauna	Accumulation/recovery of coral habitat to a mature successional state. Based on intrinsic growth and reproductive rates that vary with temperature, nutrient, productivity	< Decadal	> Decadal	> 100 years
	Natural disturbance	Level of natural disturbance affects how organisms or communities are adapted to being disturbed, and their intrinsic ability to recover	High disturbance (e.g., volcanism, earthquakes, landslides)	Intermediate	Little natural disturbance
	Naturalness	The historical level of trawl impact determines present status of benthic habitat	High trawling effort	Medium effort	Low effort
	Connectivity	The dispersal distance or connectedness of coral habitats is important for recruitment to trawled areas or patches of coral habitat	High connectivity (able to disperse large distance, or distance between coral patches <25 km)	Moderate (25-100 km)	Low connectivity (limited dispersal ability, or isolated patches (>100 km)

PSA update

- Same approach, retaining PSA criteria for susceptibility and productivity, and ranking system
- Species' **susceptibility** was considered across the entire NZ EEZ
- PSA was updated with new information on life history characteristics for taxa of interest (**productivity**)
- Since Clark et al. (2014) ecological knowledge of New Zealand corals has improved
    - Distribution (occurrence and abundance)
    - Age and growth
    - Reproduction, histology
    - Connectivity

- Species and taxa groups not directly comparable to Clark et al. (2014); e.g., here we used a combined 'Gorgonians' taxa group, separate 'Gorgonians' and 'Paragorgia' categories considered
- For combined taxa groups with varied ranking of risk for a productivity attribute, the most conservative ranking selected

PSA ranking for 2023 - susceptibility

	Availability		Encounterability					Selectivity				
	Spatial overlap	Availability score	Depth Zone	Geographical area	Ruggedness	Level of disturbance	Encount. score (average)	Removability/ mortality of flora/ fauna Score	Associated faunal diversity	Areal extent	Selectivity score (average)	Susceptibility score (Multiplicative)
Solenosmilia variabilis	2	2	3	2	2	3	2.5	3	3	1	2.3	**1.86**
Goniocorella dumosa	2	2	1	2	3	2	2	2	3	1	2	**1.59**
Caryophylliidae	2	2	3	2	2	2	2.25	1	1	1	1	**1.33**
***Flabellum* spp.**	2	2	2	1	3	2	2	1	1	1	1	**1.30**
Gorgonians (all)	2	2	3	2	2	3	2.5	3	2	1	2	**1.74**
Keratoisididae/Mopseidae	2	2	2	2	1	3	2	3	2	1	2	**1.59**
Primnoidae	2	2	2	2	1	2	1.75	2	2	1	1.6	**1.43**
***Radicipes* spp.**	2	2	2	2	2	2	2	1	1	2	1.3	**1.39**
Antipatharia (all)	2	2	2	2	1	3	2	3	2	1	2	**1.59**
Stylasteridae	2	2	2	2	2	2	2	2	2	1	1.6	**1.49**

*lightly shaded area are updated

PSA ranking for 2023 - productivity

	Productivity attributes				
	Regeneration of fauna Score	Natural disturbance Score	Naturalness	Connectivity	Productivity score (average)
Solenosmilia variabilis	3	3	1	2	2.25
Goniocorella dumosa	2	3	3	2	2.50
Caryophylliidae	2	3	1	1	1.75
***Flabellum* spp.**	2	3	2	1	2.00
Gorgonians (all)	3	3	2	3	2.75
Keratoisididae/Mopseidae	2	3	2	2	2.25
Primnoidae	2	3	2	2	2.25
***Radicipes* spp.**	2	3	2	3	2.50
Antipatharia (all)	3	3	2	2	2.50
Stylasteridae	1	3	2	2	2.00

PSA ranking for 2023

Species	Productivity (Average)	Susceptibility (Multiplicative)	Overall Risk Value	Clark et al. (2014)
Solenosmilia variabilis	2.25	1.86	2.92	2.92
Goniocorella dumosa	2.50	1.59	2.96	2.93
Caryophylliidae	1.75	1.33	2.20	2.40
Flabellum spp.	2.00	1.30	2.38	2.60
Gorgonians (all)	2.75	1.74	3.25	3.00*
Keratoisididae/Mopseidae	2.25	1.59	2.76	2.80*
Primnoidae	2.25	1.43	2.67	2.71
Radicipes spp.	2.50	1.39	2.86	2.86*
Antipatharia (all)	2.50	1.59	2.96	3.25*
Stylasteridae	2.00	1.49	2.50	2.44*

* Not directly comparable

Next steps

- Confidence for PSA attributes and the evidence used to derive the single scores will be assessed and given a probability estimate

- Probability estimates for each attribute score of the PSA will be integrated into the Bayesian Network analyses

Climate, Freshwater & Ocean Science

NIWA

Taihoro Nukurangi

Application of Bayesian networks to the PSA for assessing risks from fishing to protected corals

Laura Kaikkonen

INT2022-04 Coral Risk Assessment TWG

20 March 2024

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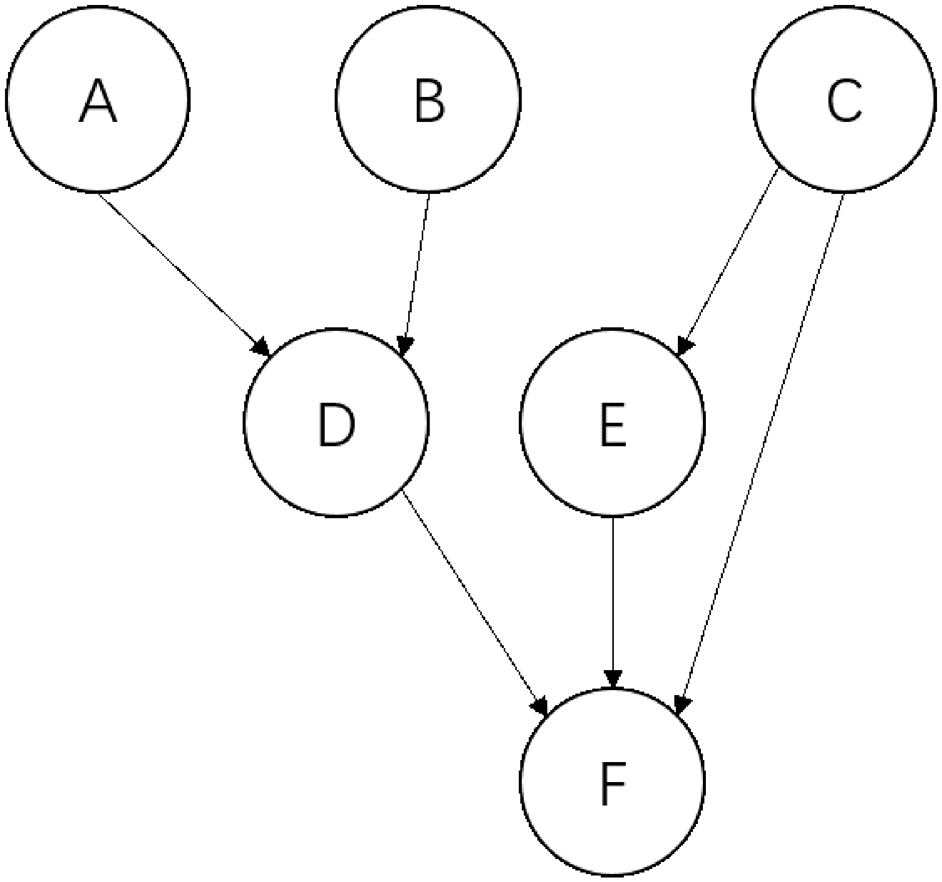
Why a probabilistic approach to PSA?

- PSA incorporates taxa specific attributes and environmental/fisheries related attributes
- Uncertainty in the estimates stemming from
    - Variability between species in a broad taxa group
    - Spatial variability in the environmental conditions underpinning risks
    - Lack of information on the environment and organisms affected by fishing
- Original PSA operates with single values = **uncertainty** at different levels **not accounted for**

Bayesian networks

- Graphical **probabilistic** models
- Illustrate the modelled system as a network of (causal) influences, quantified by **conditional probabilities**
- The dependencies between variables propagate through the network and influence the probabilities of other nodes
- Modular structure = easy to add more variables
- Useful tool for scenario testing



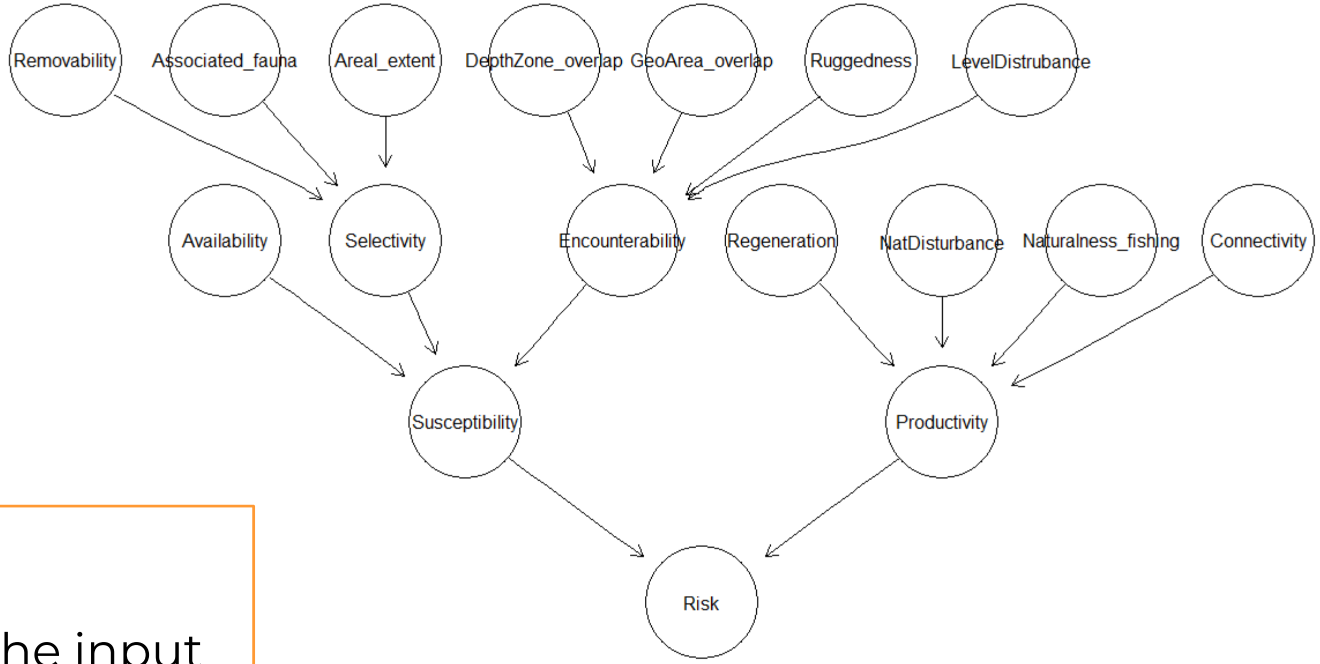
PSA as a BN model

Independent variables:

PSA input attributes

Dependent variables:

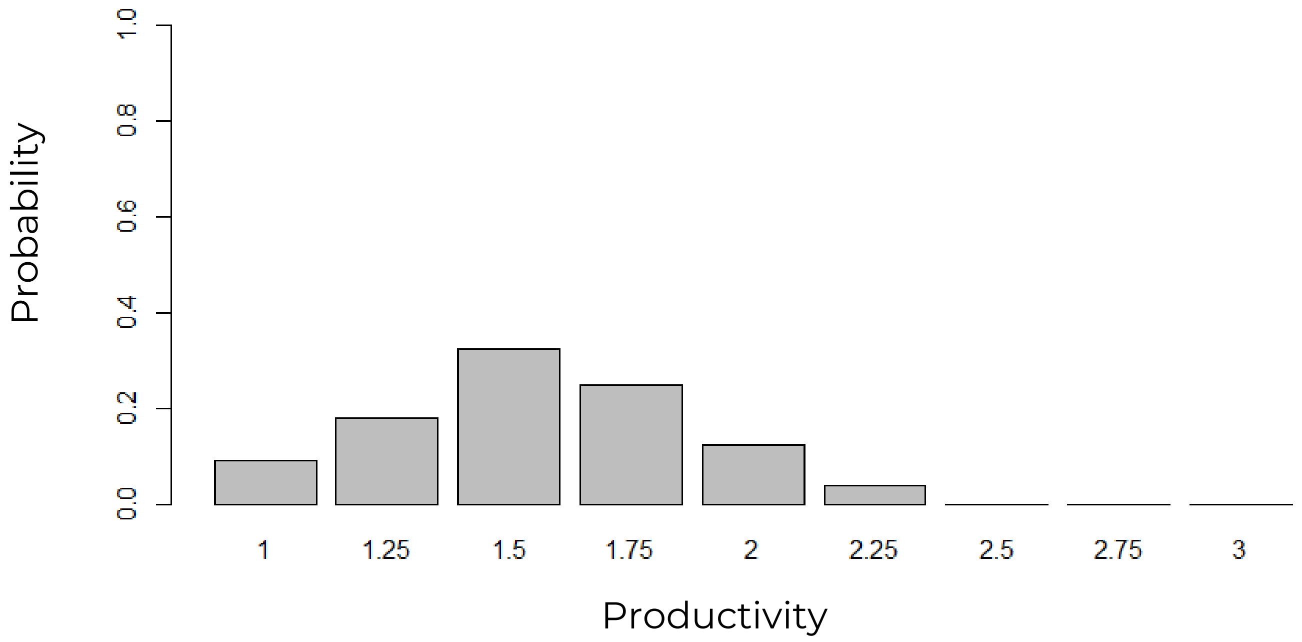
Calculated as in original PSA



Use of BNs allows for the uncertainty in the input data to be reflected in the assessment, without changing the risk assessment procedure

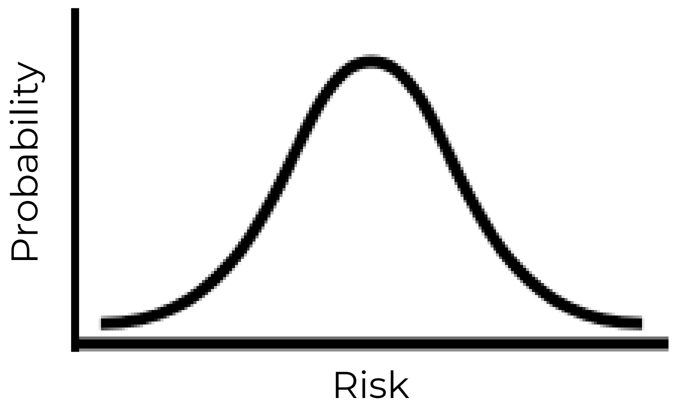
PSA inputs as probability distributions instead of single scores

Coral species	Regeneration			Connectivity		
	1	**2**	**3**	**1**	**2**	**3**
Solenosmilia variabilis	0	0.2	0.8	0.05	0.95	0
Goniocorella dumosa	0.2	0.7	0.1	0.1	0.9	0



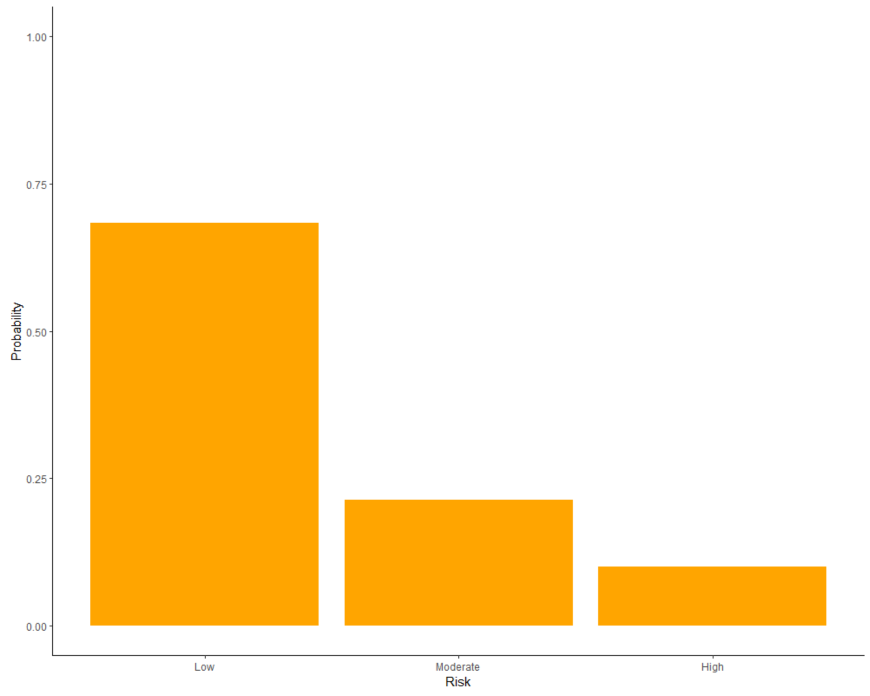
Probabilities will be derived from most recent data collected in the project, literature, and expert assessment

Possible outputs

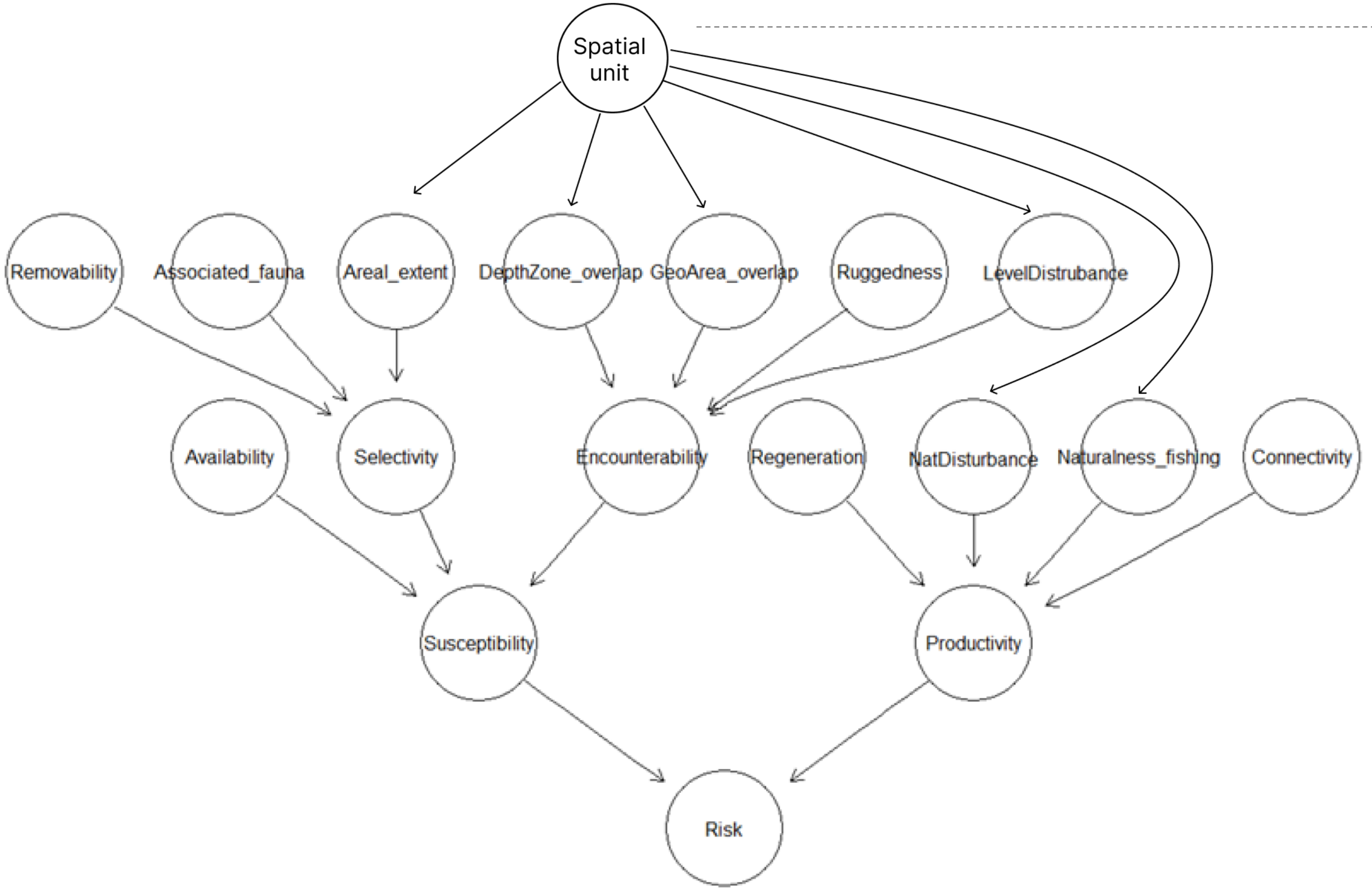


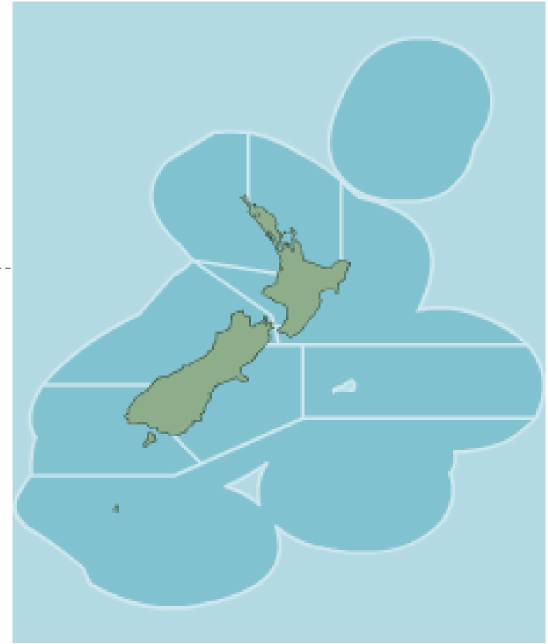
Probability across all possible risk scores

- Identify most likely output given the input data
- Evaluate confidence in risk scores between taxa
- Evaluate outcomes based on set risk thresholds



Spatial applications

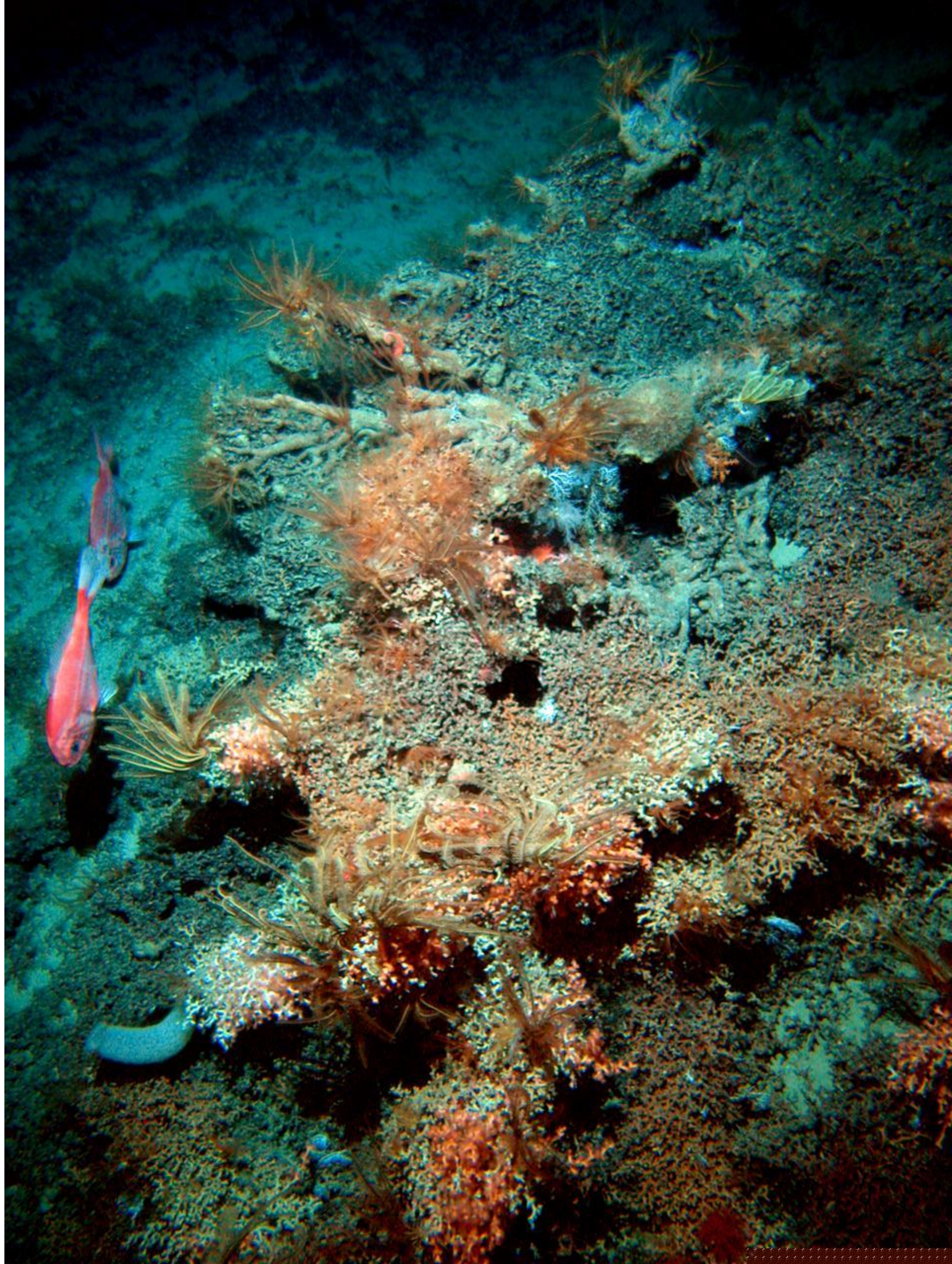




Option to compute **separate results for the desired spatial areas** instead of attaining only one risk result for the entire EEZ

Broadening the scope

- Addition of fisheries and environmental factors that affect the PSA attributes (allows to evaluate different fishing scenarios)
- The existing data and model structure allow refining the risk assessment to a more quantitative



INT2022-04 Risk Assessment for protected corals:

Next Steps

- An extract of all historic fishing effort data for bottom longlining has been received from FNZ. These data will be checked, groomed and formatted to produce annual spatial grids of bottom contact values (SAR) for this method. We will run an illustrative RBS analysis using a combined trawl/longline SAR for the Chatham Rise, where there is a major longline fishery for ling.
- The RBS method will be completed for all taxa at the EEZ-scale. Additional model runs will be carried out for *Goniocorella dumosa* by bioregion to illustrate the effects of scale, and how results might look for a smaller management area.
- The probability values for each attribute score of the PSA for input to BN analyses for the entire EEZ will be formulated based on a combination of literature, unpublished data, and expert assessment. This involves reviewing each of the PSA attributes and assessing the confidence in those estimates.
- The spatial resolution of the static PSA-BN will then be augmented by undertaking a semi-spatial BN analysis, as an example of how this method could be used at a smaller spatial scale. For this, the probabalistic PSA attribute scores will be drawn from spatial data layers at a resolution of biogeographic regions (a 9-class revision of the NZSeafloorCommunityClassification) . This will first be carried out for *Goniocorella dumosa* as an example.
- Presentation of draft final results to focus TWG (milestone 6, scheduled for June 2024, but this may be optimistic).

Thank you