National SCIENCE Challenges

Webinar starts: 11am, Tuesday 27 April

SUSTAINABLE SEAS

Ko ngā moana whakauka

Cetacean conservation planning: dealing with uncertainty & data gaps

Fabrice Stephenson

NIWA

Acknowledgements

This research was led by 3.2 Communicating risk and uncertainty, in collaboration with 1.2 Spatially-explicit cumulative effects tools, and support from Fisheries New Zealand and NIWA.

Thanks to Department of Conservation, Martin Cawthorn and others for providing the cetacean sightings records used for the modelling.

This research was first presented at the 5th World Conference on Marine Biodiversity in Auckland, 13-16 December 2020.

Today's webinar is presented on behalf of:

Kim Goetz, Ben Sharp, Theo Mouton, Fenna Beets, Jim Roberts, Alison MacDiarmid, Rochelle Constantine, Carolyn Lundquist, Judi Hewitt, Leigh Torres, Tom Brough, & Joanne Ellis.

Fisheries New Zealand
Tini a Tangaroa

Department of Conservation
Te Papa Atawhai

NIWA
Taihoro Nukurangi

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Webinar overview

- Background
- The approach
  - Part 1
    - Distribution of cetacean taxa
  - Part 2:
    - Measures of uncertainty
    - Estimating hotspots
- Accounting for uncertainty and generalisations of results
- Conclusions
- Q+A session

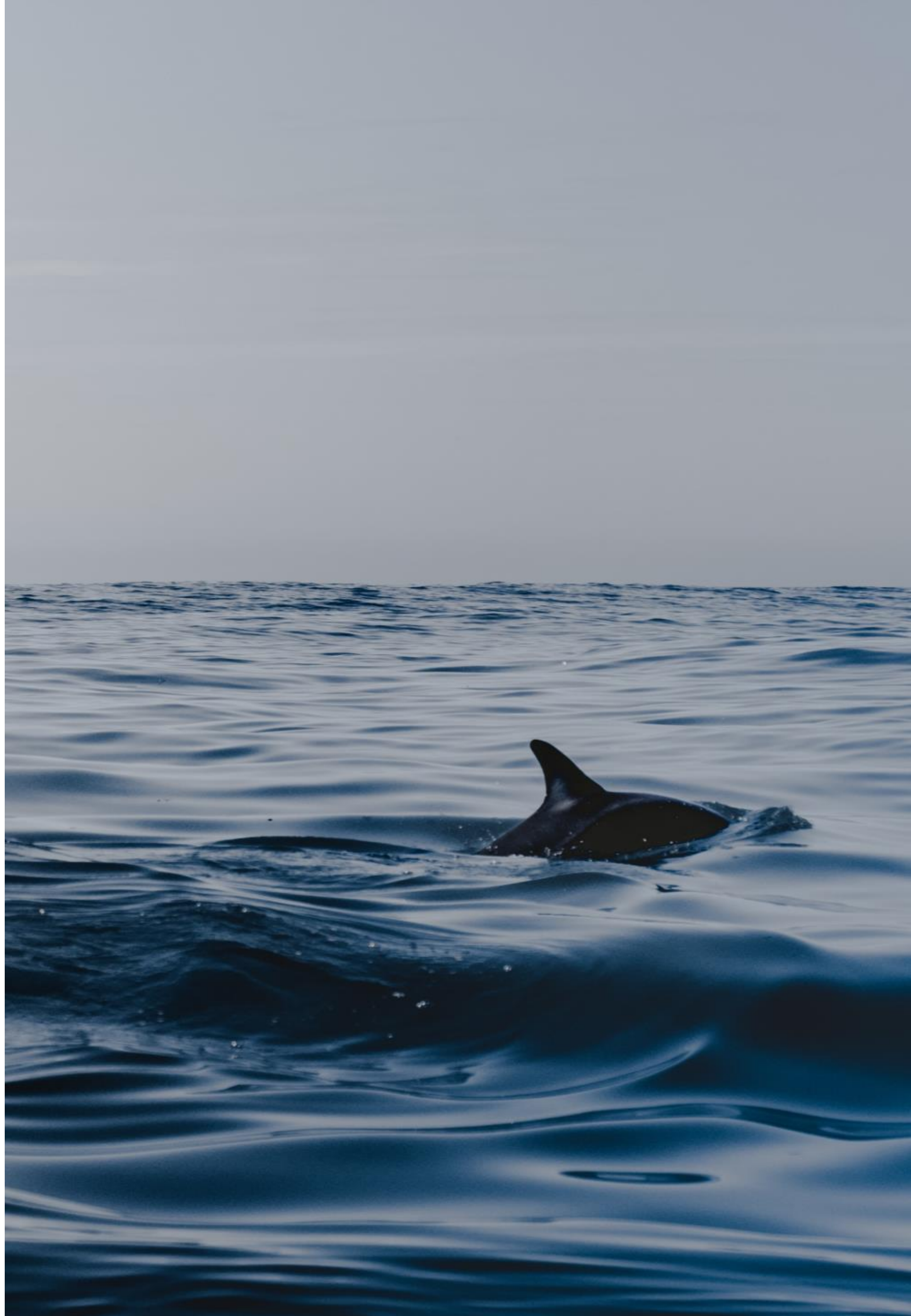
Dolphin in Kaikōura (Jen Milius)

Background

- Marine mammals play key roles in the world's ecosystems

- Cetacean species are thought to be critically at risk from human activities / human caused changes:
  - climate change
  - pollution
  - over-harvesting of marine habitats

- Identifying cetacean hotspots for conservation management is critical



Dolphin in Kaikōura (Iswanto Arif)

Problem: data gaps

- ↑**High information** is accessible for some species (eg, coastal species)

- ↓**Low information** for many species due to their behaviour and offshore habitat use

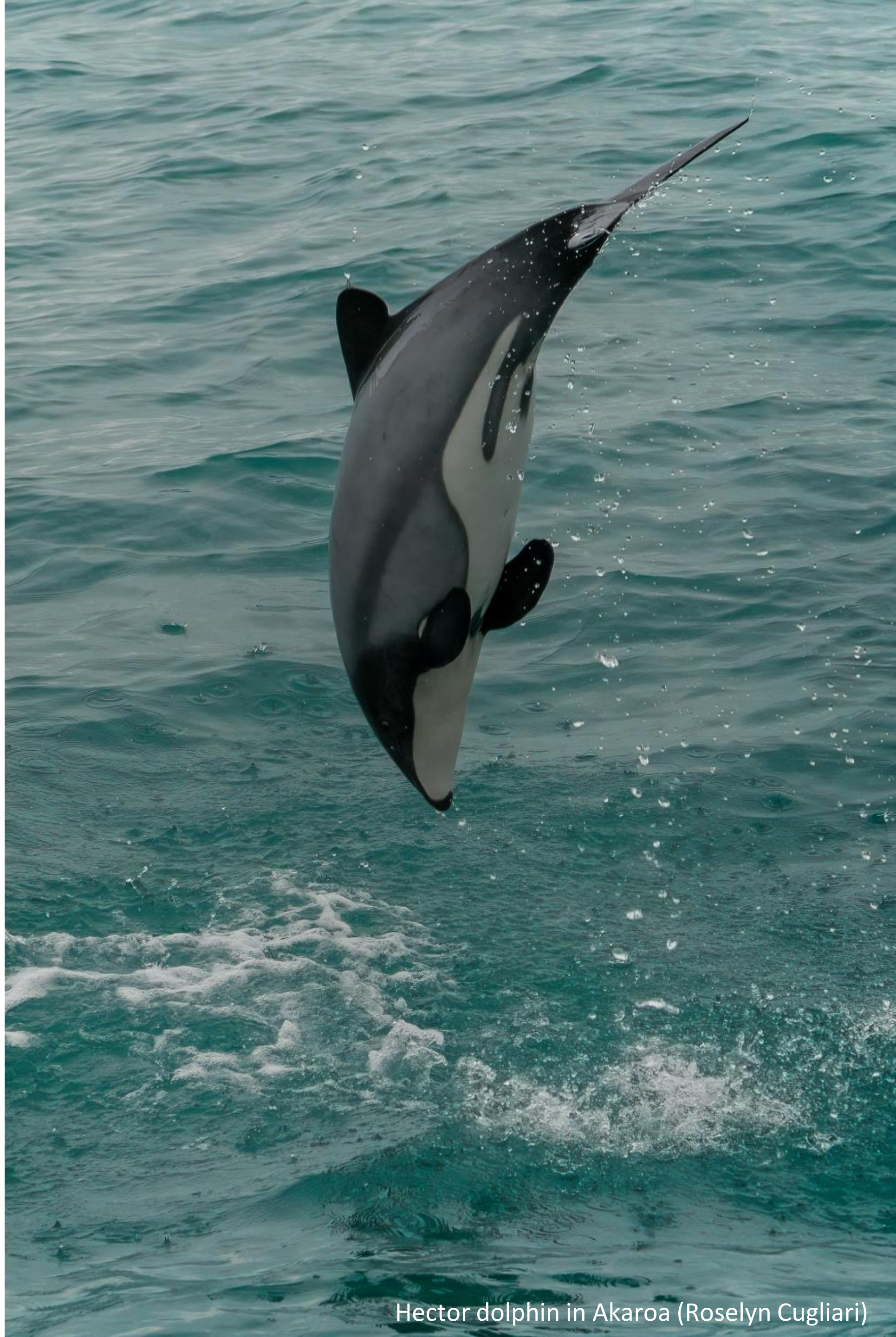
- The distribution, range and behaviour of many species is poorly known: ~40% are considered **Data Deficient** by the IUCN Red List

Whale watching in Kaikōura (Iswanto Arif)

NZ is a global hotspot for whales and dolphins

- Our Exclusive Economic Zone (EEZ) is a recognised **global cetacean diversity hotspot**

- **53%** of the world's 47 known cetacean species, subspecies and/or have been identified in our EEZ
    - **7** are listed as **Endangered** or **Critically Endangered** under the IUCN threat classification system
    - **28** are considered **Data Deficient**



Hector dolphin in Akaroa (Roselyn Cugliari)

Why we did this research

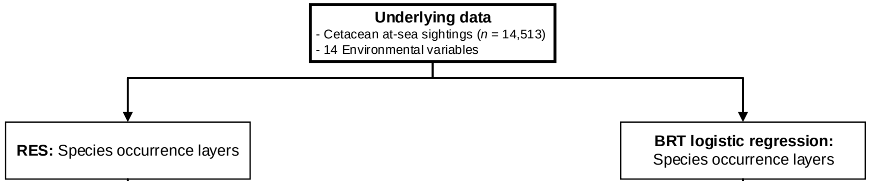
- Identifying cetacean hotspots for conservation management is therefore critical

- Project 3.2 co-development workshop [September 2019]
  - Co-developers identified spatial tools with visualisations as important / useful for communicating risk and uncertainty.

- These types of tools are useful because generalisations can be made = useful for other taxa and management questions

Dusky dolphins (Lana Young)

The approach – estimating hotspots



Part 1:

- Distribution of cetacean taxa

Academic Publication

Stephenson, F., Goetz, K., Sharp, B.R., Mouton, T.L., Beets, F.L., Roberts, J., MacDiarmid, A.B., Constantine, R., and Lundquist, C.J. (2020). Modelling the spatial distribution of cetaceans in New Zealand waters. *Diversity and Distributions* 26, 495-516

Part 2:

- Measures of uncertainty
- Baseline scenario, Moderate & High weighting of uncertainty scenarios

Academic Publication

Stephenson, F., Hewitt, J.E., Torres, L.G., Mouton, T.L., Brough, T., Goetz, K.T., Lundquist, C.J., MacDiarmid, A.B., Ellis, J. & Constantine, R. (in press). Cetacean conservation planning in a global diversity hotspot: dealing with uncertainty and data deficiencies. *Ecosphere*

Part 1: Distribution of cetacean taxa

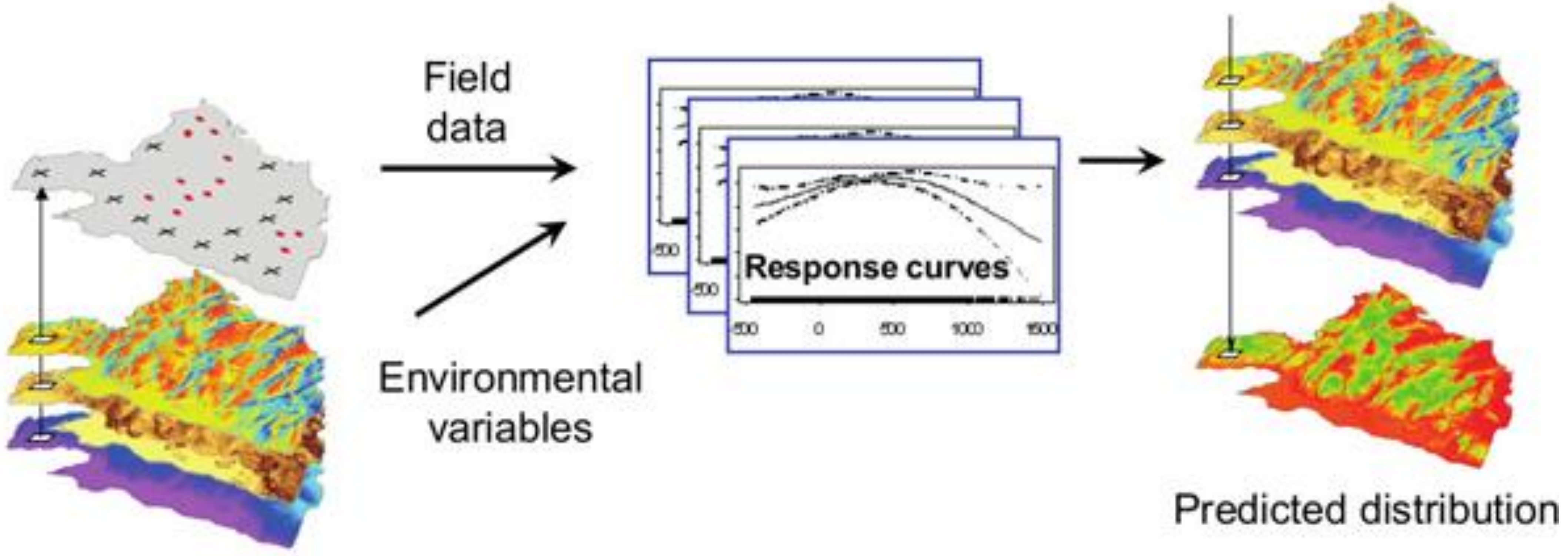
- Collation of at-sea sightings data for 30 species, subspecies and species complexes (1970 – 2017)
  - *n* = 14,513 records (after grooming)

- **High information** species ≥ 50 sightings (15 taxa)
- **Low information** species < 50 sightings (15 taxa)

Use this biological information with environmental variables (14 with spatial resolution 1km^2) to estimate **species distributions**

Staff on NIWA's RV Tangaroa spotted a blue whale (Dave Allen/NIWA)

Sidebar – Species Distribution Modelling



Credit: Wim Hordijk, 2016, Plus Magazine, part of the Millennium Mathematics Project.

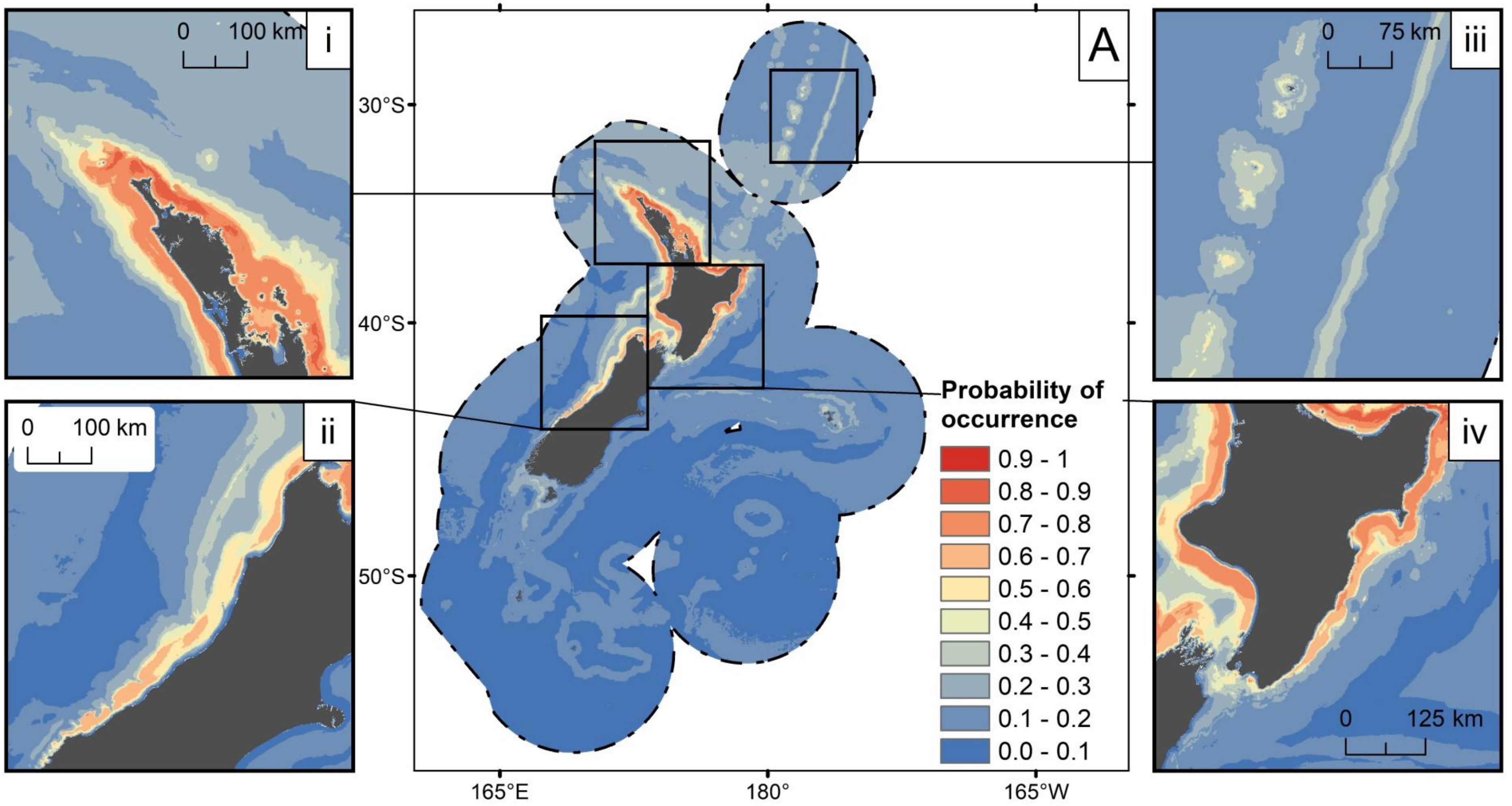
High information cetacean taxa

Species/subspecies/species complex names	Species/subspecies	Number of sightings records
Minke whale	*Balaenoptera acutorostrata*	57
Fin whale	*Balaenoptera physalus*	61
Sei whale	*Balaenoptera borealis*	70
Blue whale (spp. & sub spp.)	*Balaenoptera musculus musculus* *Balaenoptera m. brevicauda*	354
Southern right whale	*Eubalaena australis*	477
Sperm whale	*Physeter macrocephalus*	497
Bottlenose dolphin	*Tursiops truncatus*	498
Killer whale	*Orcinus orca*	569
Bryde's whale	*Balaenoptera edeni brydei*	593
Humpback whale	*Megaptera novaeangliae*	629
Pilot whale (2 spp.)	*Globicephala melas* *Globicephala macrorhynchus*	679
Dusky dolphin	*Lagenorhynchus obscurus*	823
Māui dolphin	*Cephalorhynchus hectori maui*	1,051
Hector's dolphin	*Cephalorhynchus hectori hectori*	3,688
Common dolphin	*Delphinus delphis*	4,411

- High number of records
- Boosted Regression Trees

BRT example: Distribution of the common dolphin

- High number of records (n=4,411)
- Complex relationships
- Good predictive power (withheld data: AUC: 0.90 ± 0.01)
- **Spatial estimates of uncertainty** available



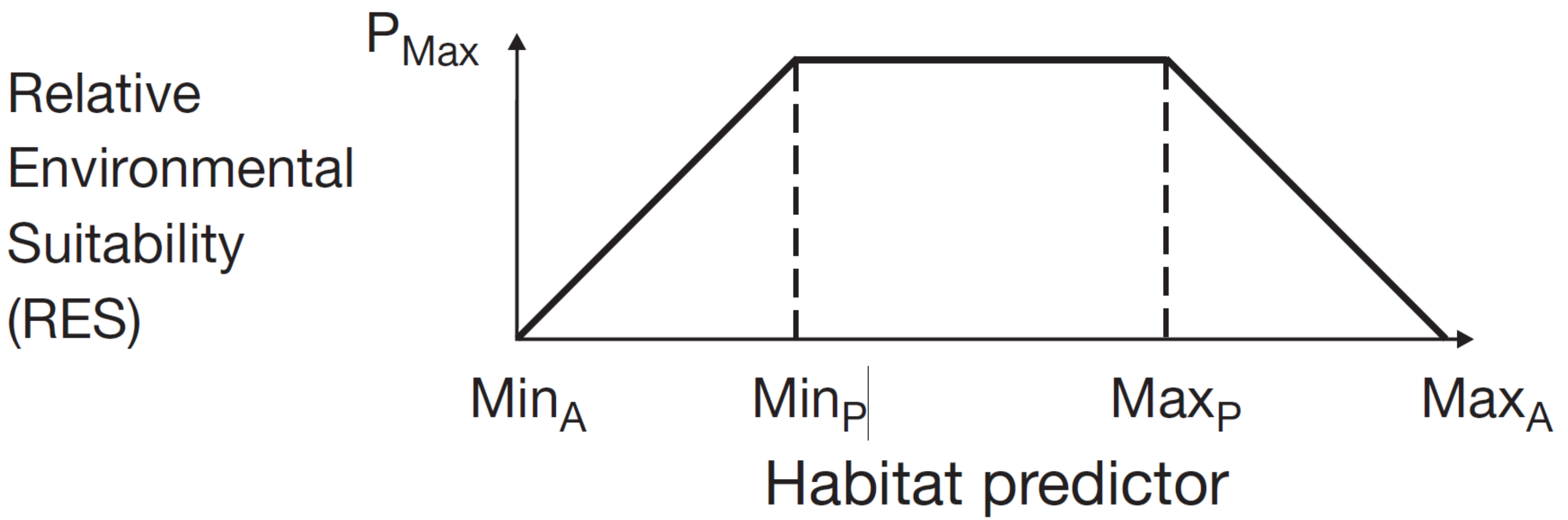
Low information cetacean taxa

Species/subspecies/species complex names	Species/subspecies	Number of sightings records
Blainville's beaked whale	Mesoplodon densirostris	1
Dwarf minke whale	Balaenoptera acutorostrata	1
Spectacled porpoise	Phocoena dioptrica	1
Striped dolphin	Stenella coeruleoalba	1
Andrew's beaked whale	Mesoplodon bowdoini	2
Hourglass dolphin	Lagenorhynchus cruciger	2
Pygmy sperm whale	Kogia breviceps	2
Southern bottlenose whale	Hyperoodon planifrons	4
Risso's dolphin	Grampus griseus	5
Shepherd's beaked whale	Tasmacetus shepherdi	5
Cuvier's beaked whale	Ziphius cavirostris	7
Gray's beaked whale	Mesoplodon grayi	9
Southern right whale dolphin	Lissodelphis peronii	27
False killer whale	Pseudorca crassidens	28
Arnoux's beaked whale	Berardius arnuxii	31

- Low number of records
- Mechanistic method: Relative Environmental Suitability (RES)

About the Mechanistic method: Relative Environmental Suitability (RES)

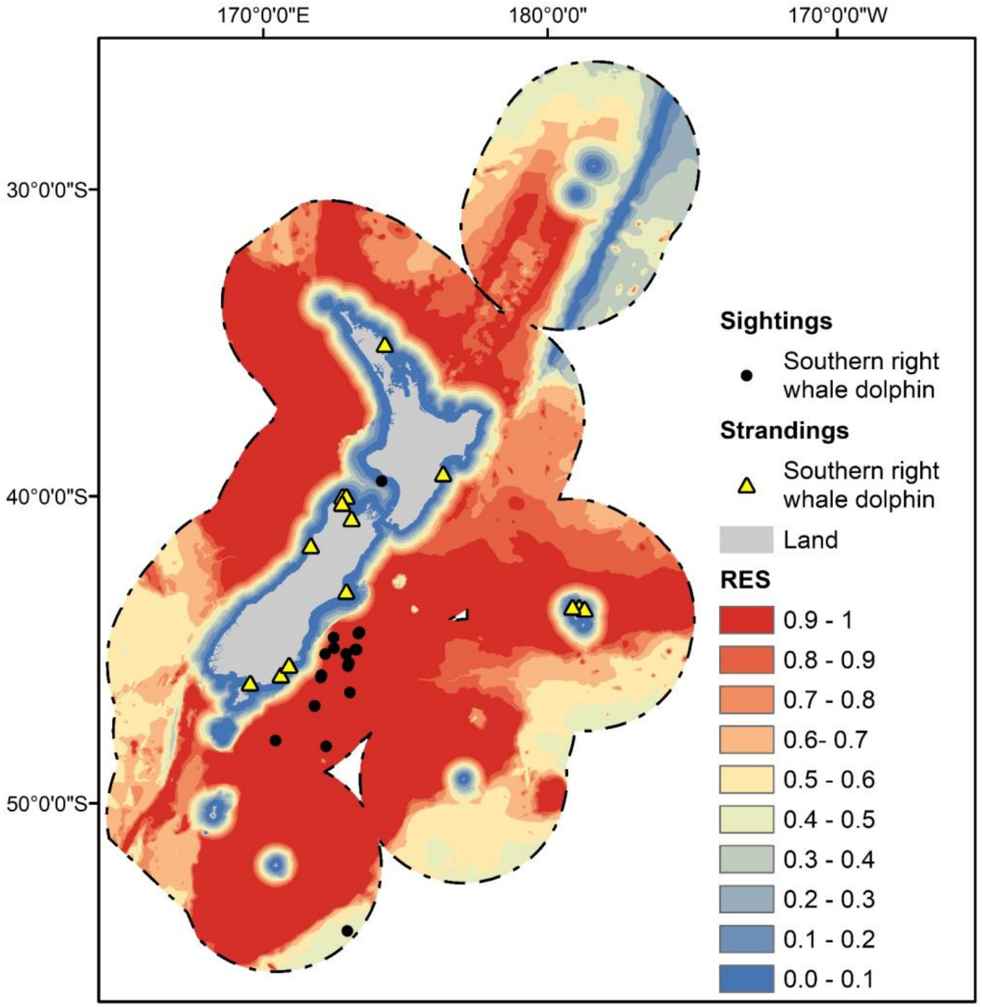
- **Expert estimated relationships** (envelopes) with 3 environmental variables:
  - Sea surface temperature
  - Water depth
  - Distance to shore



RES example: Distribution of southern right whale dolphin


commons.wikimedia.org

- Small number of records (*n*=27)
- Simple
- Expert opinion / literature review
- Visually seems like it covers broad niche – consistent with sightings
- Only 3 variables considered to affect distribution (are they the right ones?)
- No estimate of uncertainty….

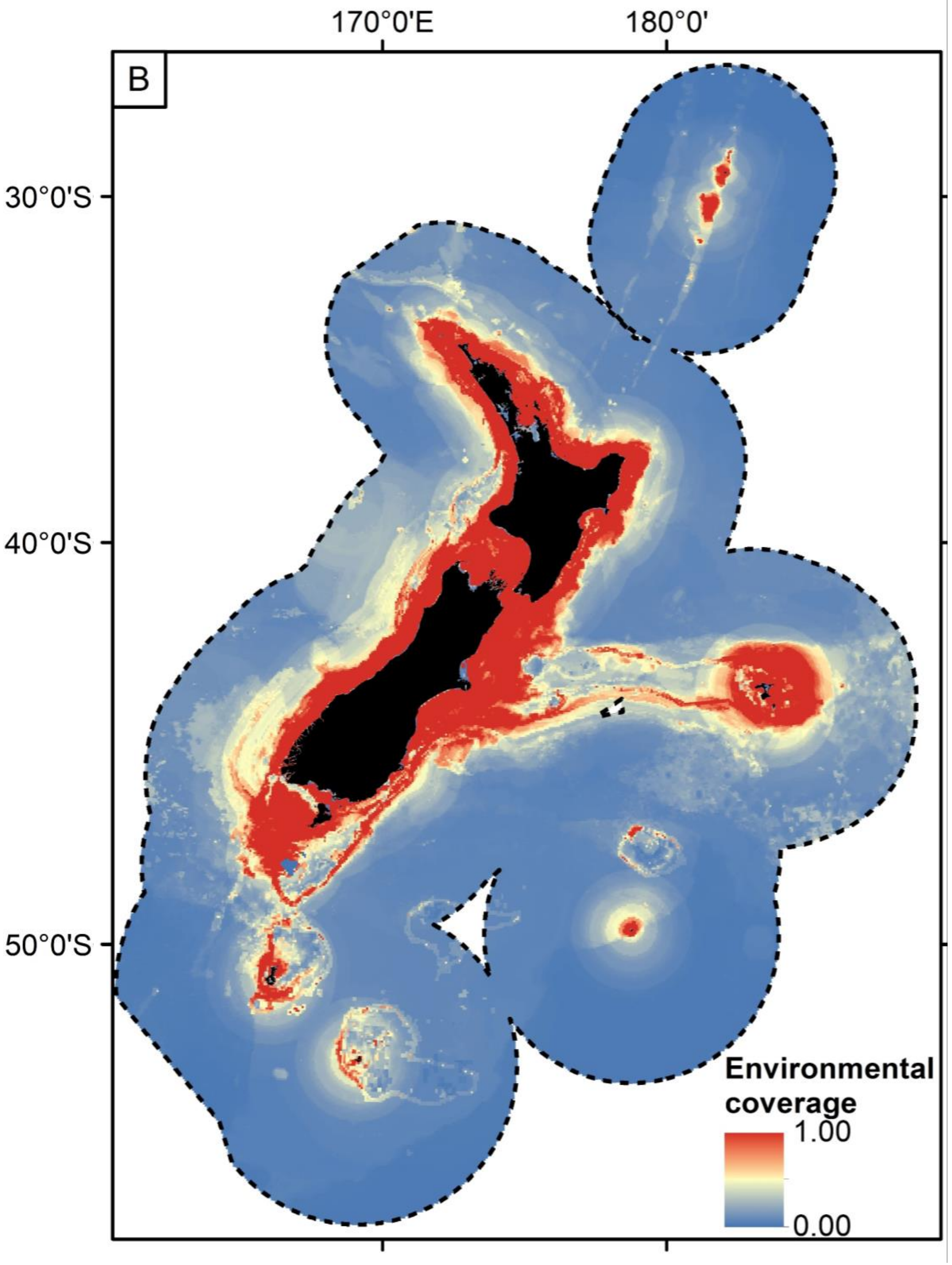


Measures of uncertainty

1) Spatial estimates of uncertainty (for BRT models only)

2) How well our samples cover the study area

3) How well 'realistic' we think the models are (AUC)



Part 2: Estimating hotspots

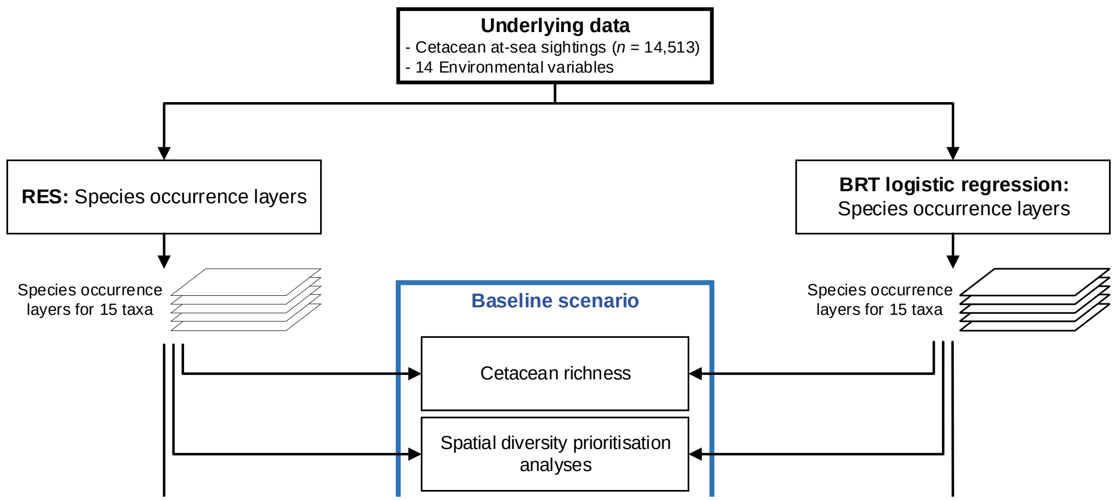
- Using the geographic predictions and associated uncertainty estimates, **cetacean hotspots were identified** using two methods:
    - Estimates of cetacean richness (sum of predictions)
    - Spatial prioritisation analysis (Zonation – accounts for representativeness)
- **Increasing levels of uncertainty** were incorporated and the effect of this investigated on the distribution of hotspots

Academic Publication

Stephenson, F., Hewitt, J.E., Torres, L.G., Mouton, T.L., Brough, T., Goetz, K.T., Lundquist, C.J., MacDiarmid, A.B., Ellis, J. & Constantine, R. (in press). Cetacean conservation planning in a global diversity hotspot: dealing with uncertainty and data deficiencies. *Ecosphere*

Estimating hotspots

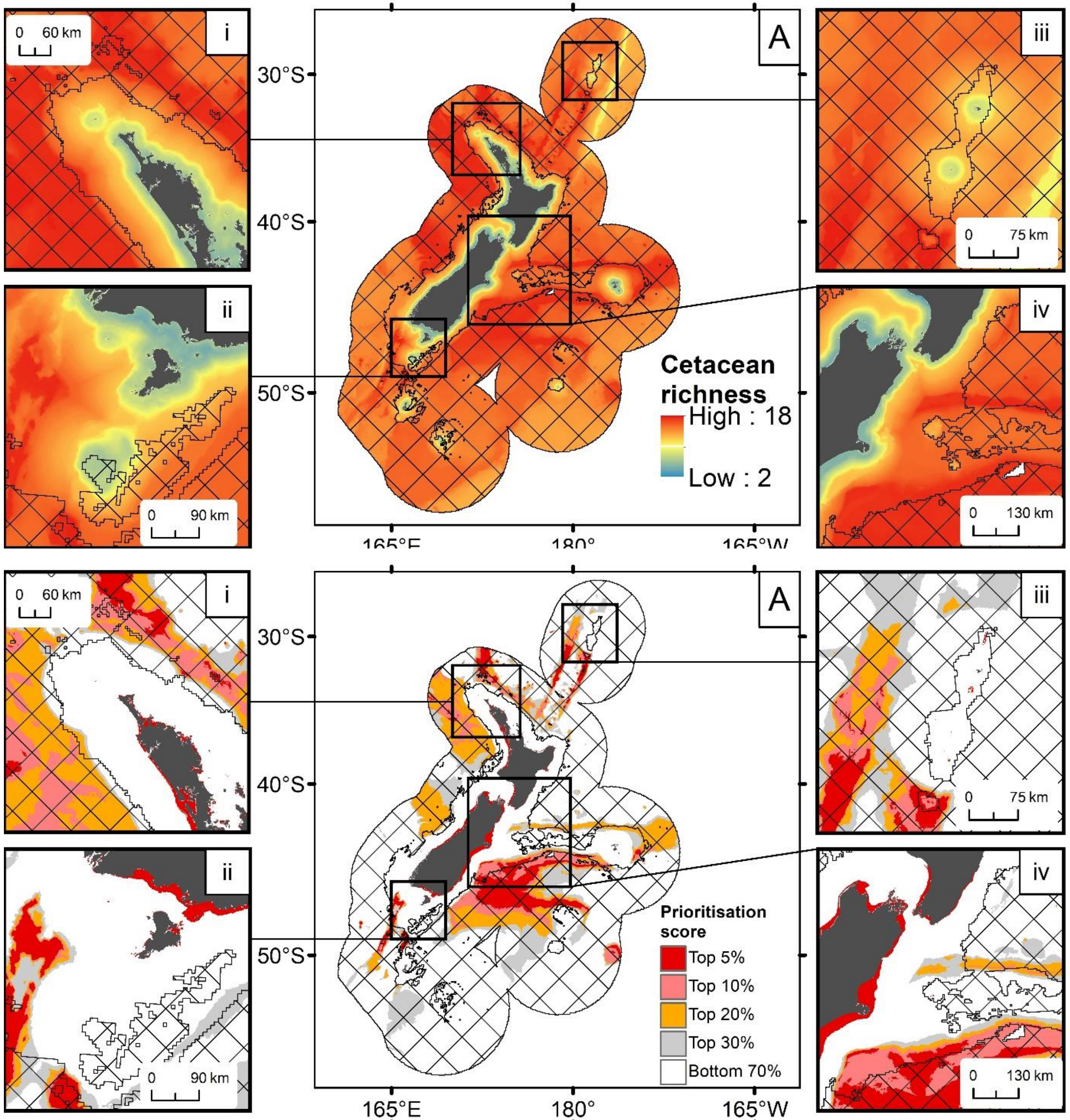
- Baseline (no uncertainty)
- Moderate uncertainty
- High uncertainty



Estimating hotspots: baseline scenario

- Baseline (no uncertainty)
- High predicted richness offshore
- Important areas very close to shore and offshore

Note: species contributing to patterns are provided Stephenson et al., in press



Estimating hotspots

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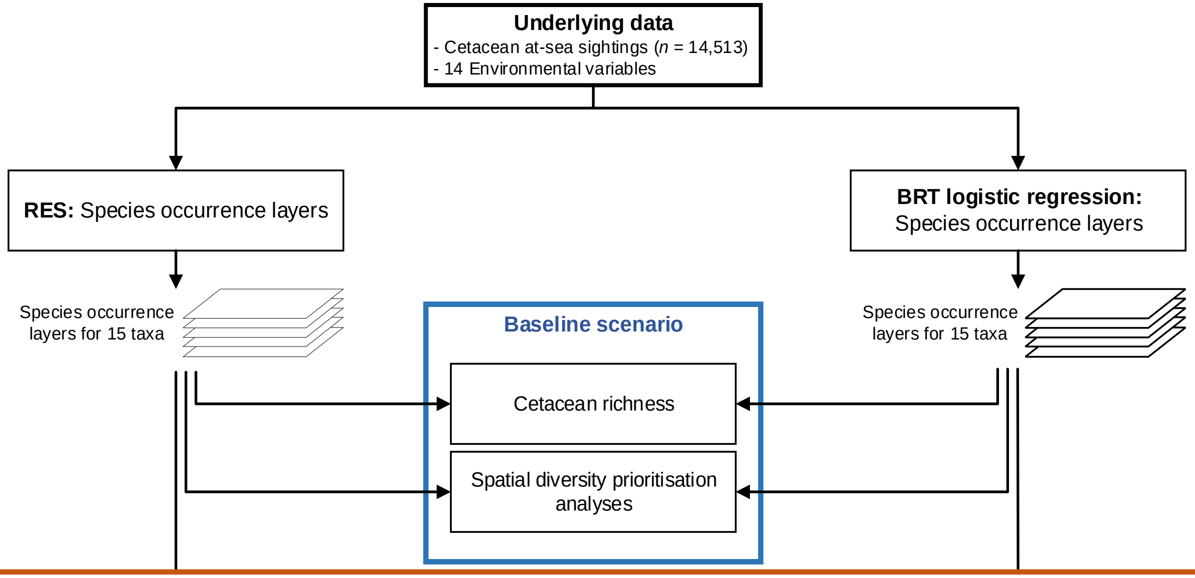
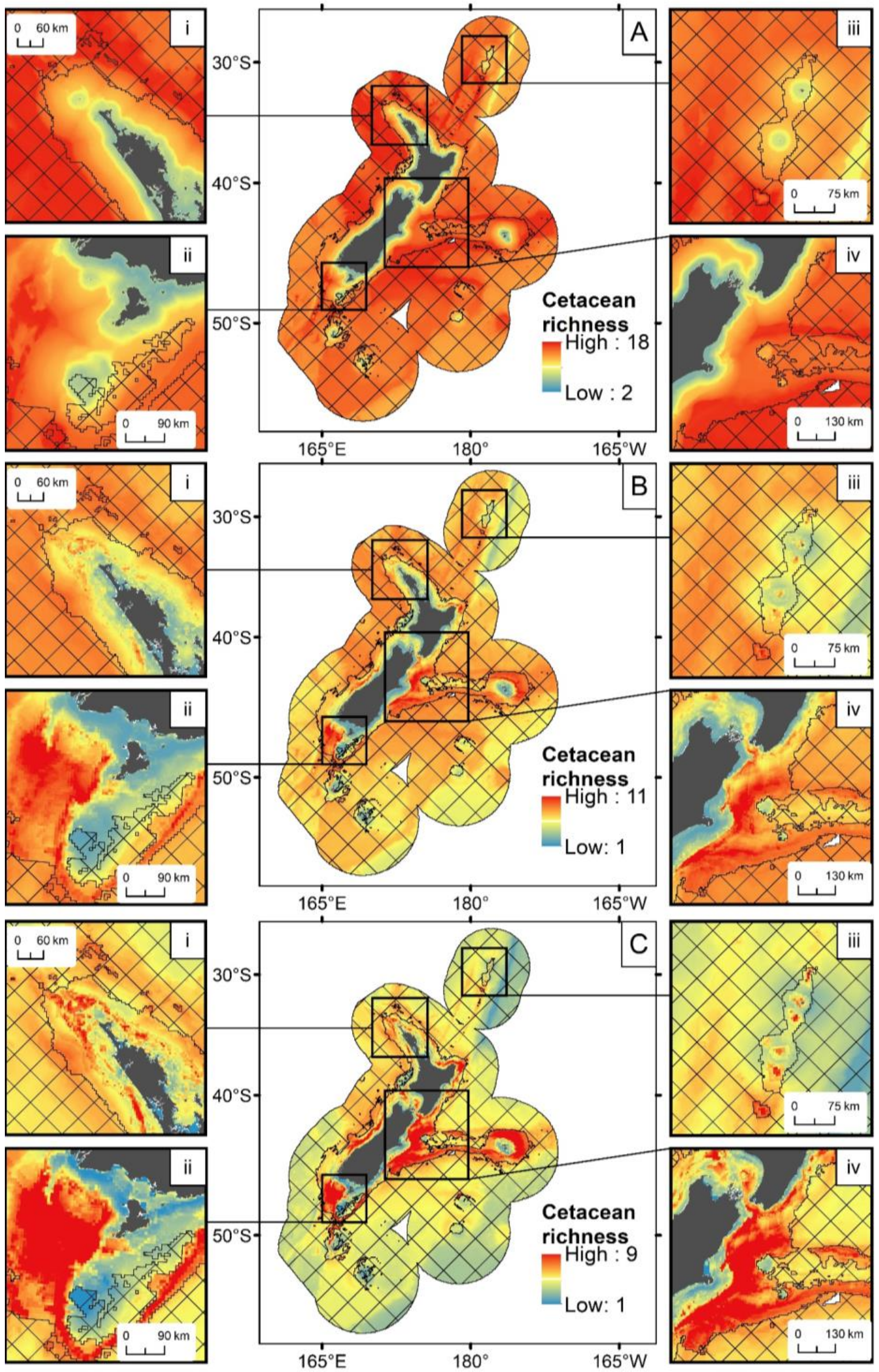


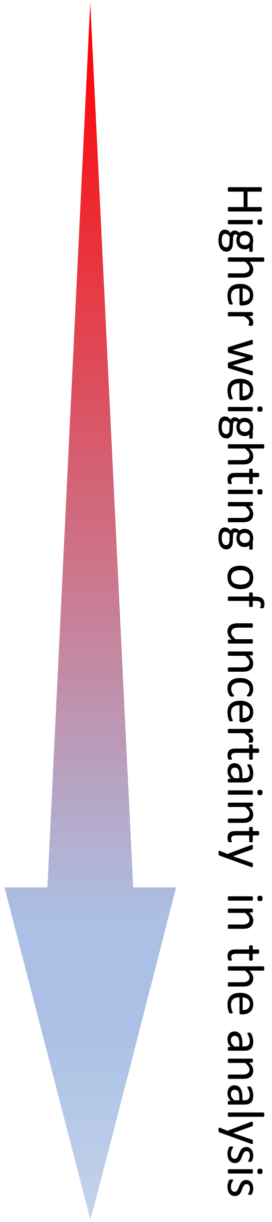
Accounting for uncertainty with two weightings:

- Model accuracy
- Spatially explicit uncertainty
- Distribution of records

Estimating hotspots: moderate/high uncertainty scenario

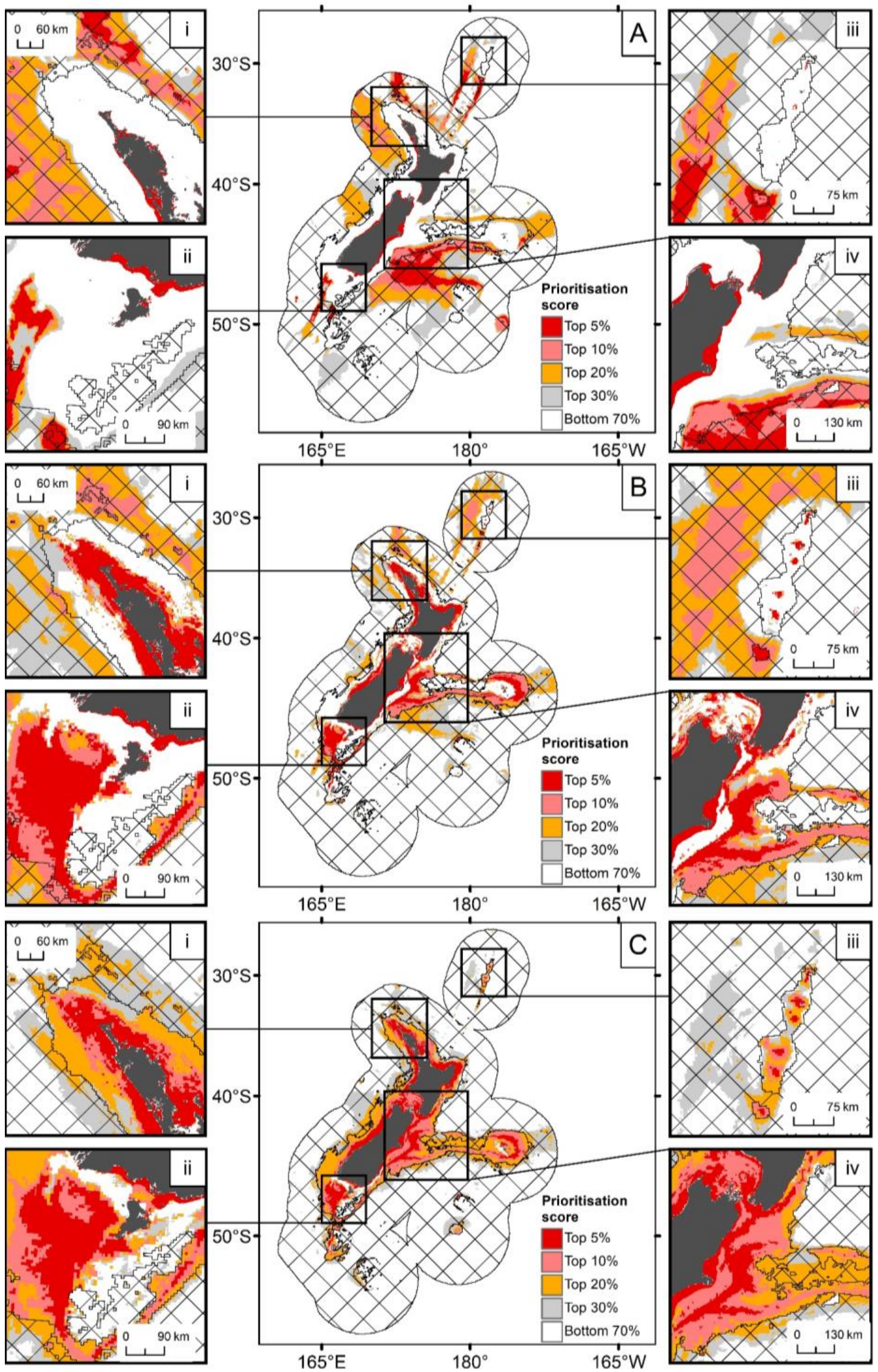
- Shift to inshore with higher weighting of uncertainty
- Offshore important across scenarios
- Somewhat subjective weighting of uncertainty
- But allows generalisations





Estimating hotspots

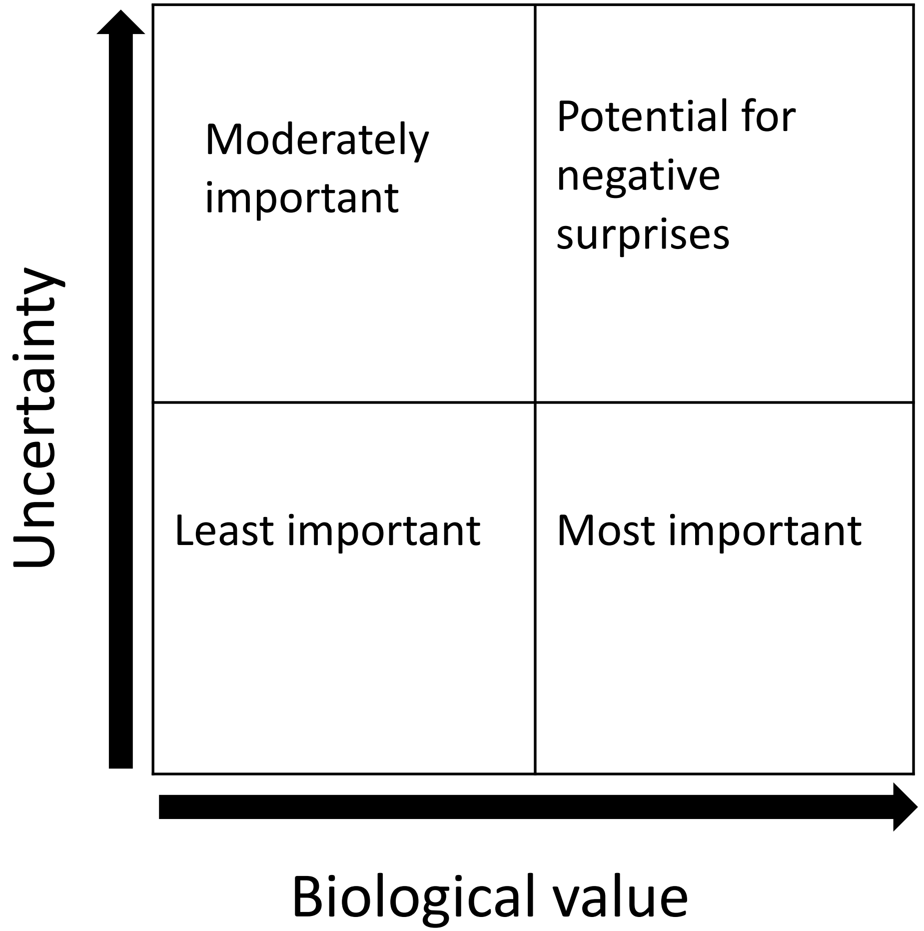
- Similar patterns to those observed in richness
- Inshore important regardless of certainty



Higher weighting of uncertainty in the analysis

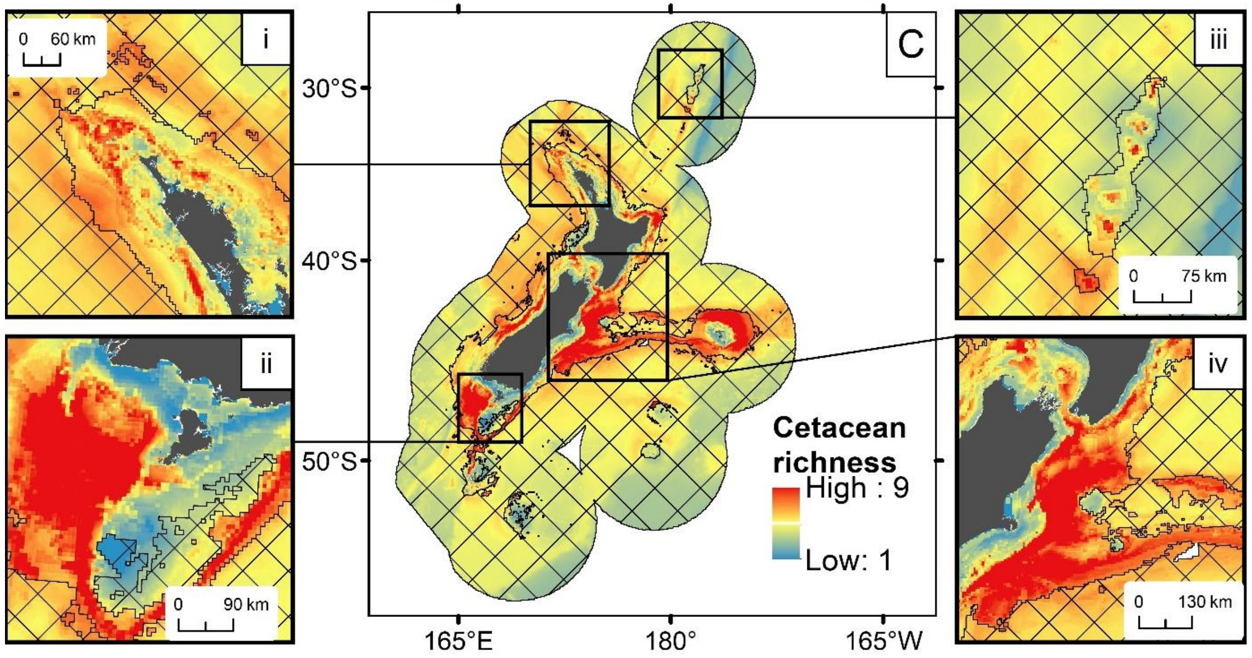
Evaluating trade-offs

- Uncertainty analysis in conservation planning is used to **evaluate trade-offs** between biological quality and the certainty of that information (Moilanen et al., 2006).



Most important areas highlighted

- Hotspots identified important offshore habitats (across scenarios) → limited information
  - Lau-Colville and Kermadec Ridges, Macquarie Ridge
  - Western edges of the Bounty Trough
  - Chatham Rise



- Inshore - richness:
  - Kaikōura
  - East and North Cape

- All inshore – representativeness:

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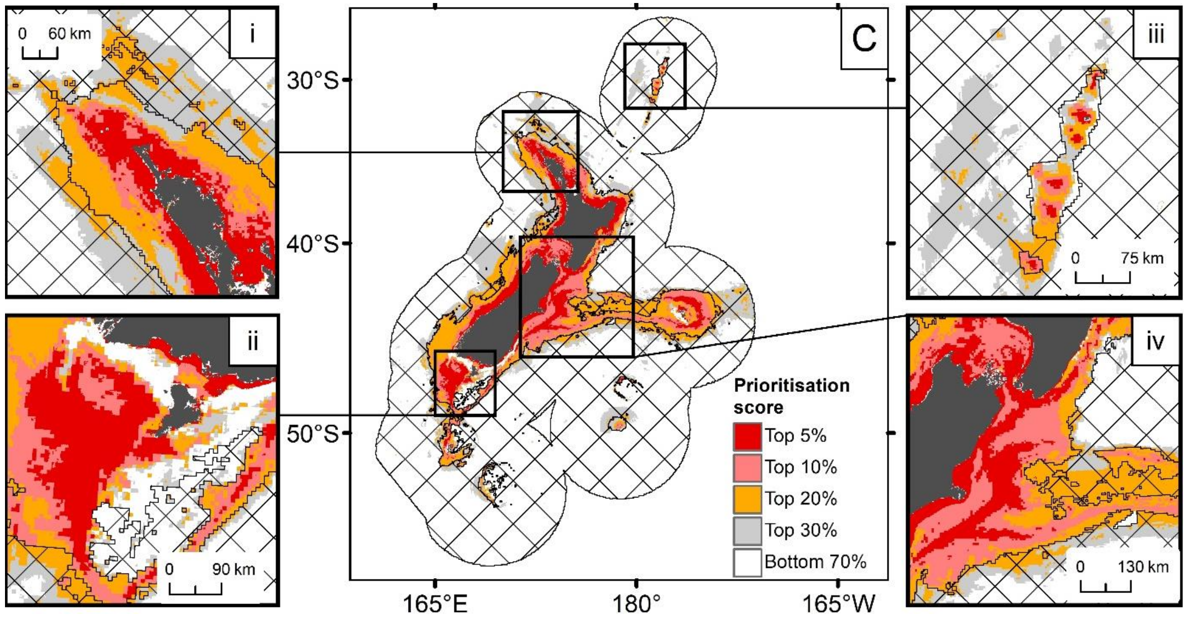

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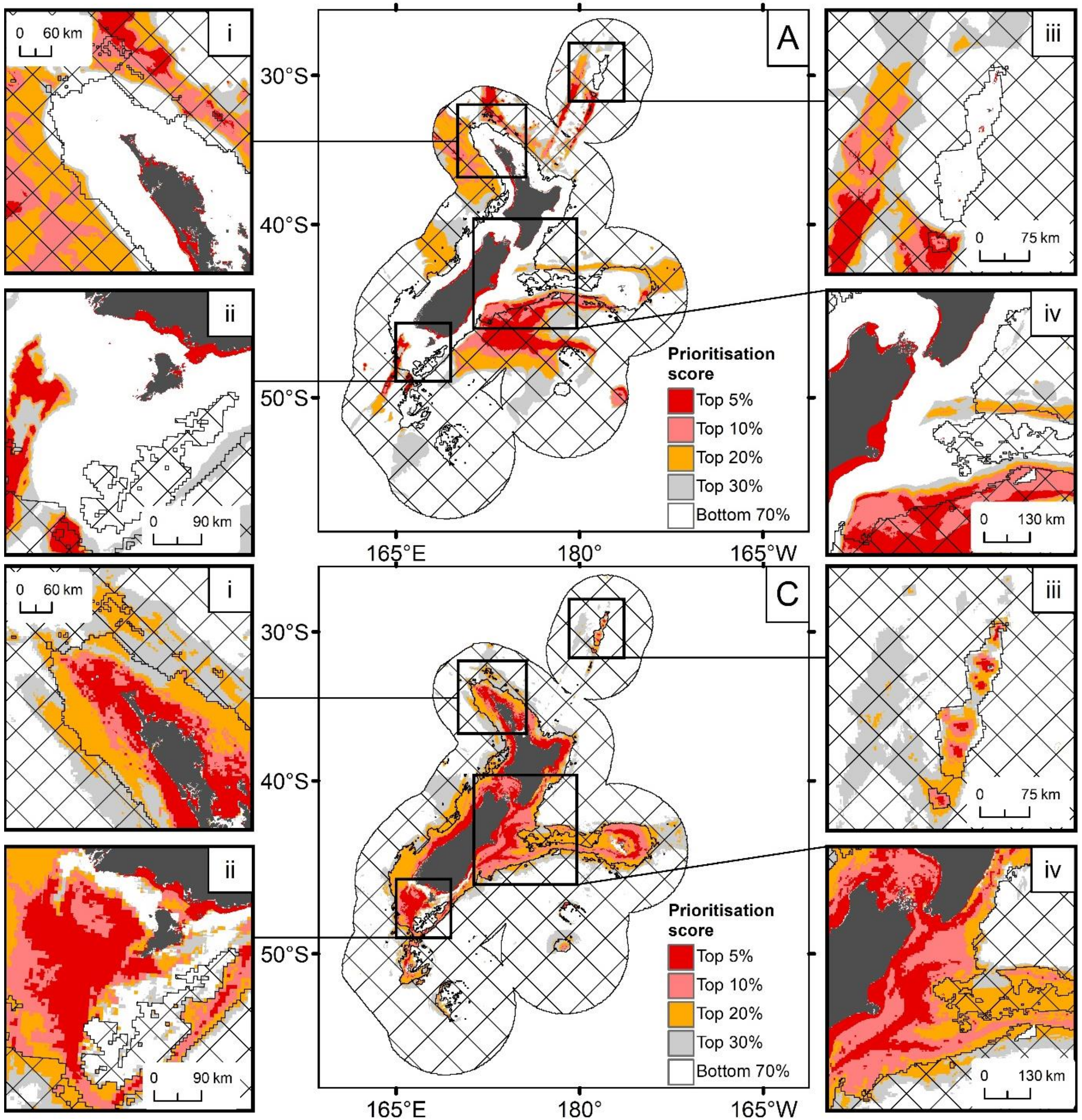
Potential for negative surprises

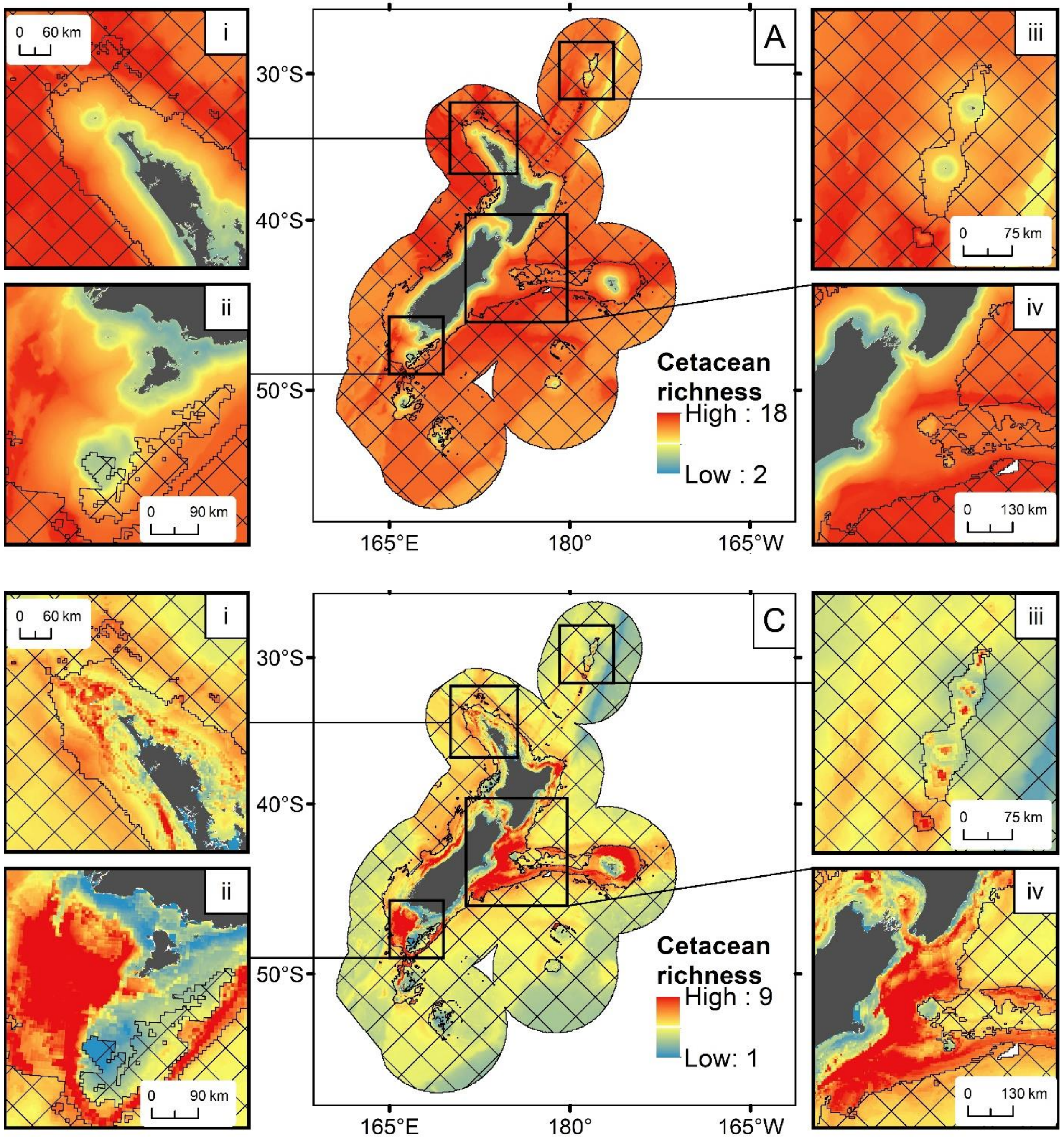
- Large parts of the offshore (driven by rare species)
- Can be important but further work needed to reduce uncertainty



Moderately important

- Can be important but further work needed to reduce uncertainty → but less risky

- Cook Strait, Kermadec Islands, South Taranaki Bight and the west coast of South Island and northern parts of the North Island



Conclusions

- Conservation planning is an integral part of EBM
  - Uncertainty is part of any decision-making process
  - Knowledge gaps of marine species distributional data are common → spatial conservation management needed and must account uncertainty

- Our approach explicitly accounts for varying levels of spatial uncertainty
  - Two important measures compared (richness and representativeness)
  - Integration of distributional information from differing sources
  - Including for rare species (important but rarely considered)

Whale watching in Kaikōura (NZ Story)

Conclusions

- Work as part of 3.2 Communicating risk and uncertainty project
  - First step exploring methods that can feed into risk assessment
  - Tool for managers / decision makers

- Generalisations can be made = useful for other taxa and management questions

Whale watching in Kaikōura (NZ Story)

Resources/contact

Contact: fabrice.stephenson@niwa.co.nz

Academic publication

Part 1:

Stephenson, F., Goetz, K., Sharp, B.R., Mouton, T.L., Beets, F.L., Roberts, J., MacDiarmid, A.B., Constantine, R., and Lundquist, C.J. (2020). Modelling the spatial distribution of cetaceans in New Zealand waters. *Diversity and Distributions* 26, 495-516

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Graphic

Conference poster:
www.sustainableseaschallenge.co.nz/conference-poster-cetacean-conservation-planning

A mother humpback whale and her calf (NIWA)