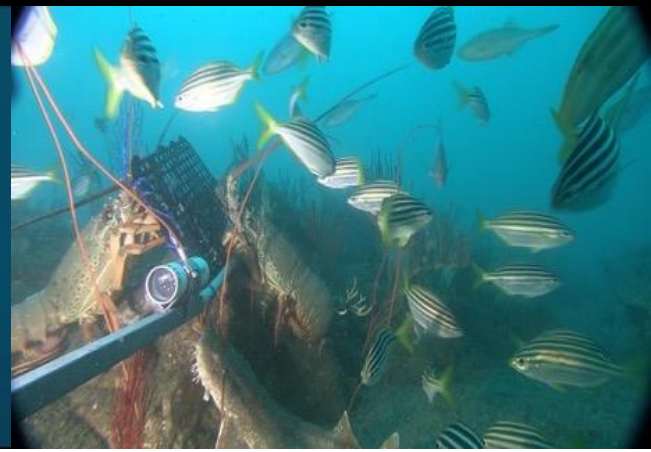
Variability in temperate mesophotic reef fish assemblages explained by fine scale bathymetry data

Joel Williams, Tim Ingleton, David Harasti, Alan Jordan, Nicole Hill, Neville Barrett



Marine Biodiversity Hub
National Environmental Science Programme

NSW GOVERNMENT

UNIVERSITY of TASMANIA
IMAS
Institute for Marine and Antarctic Studies

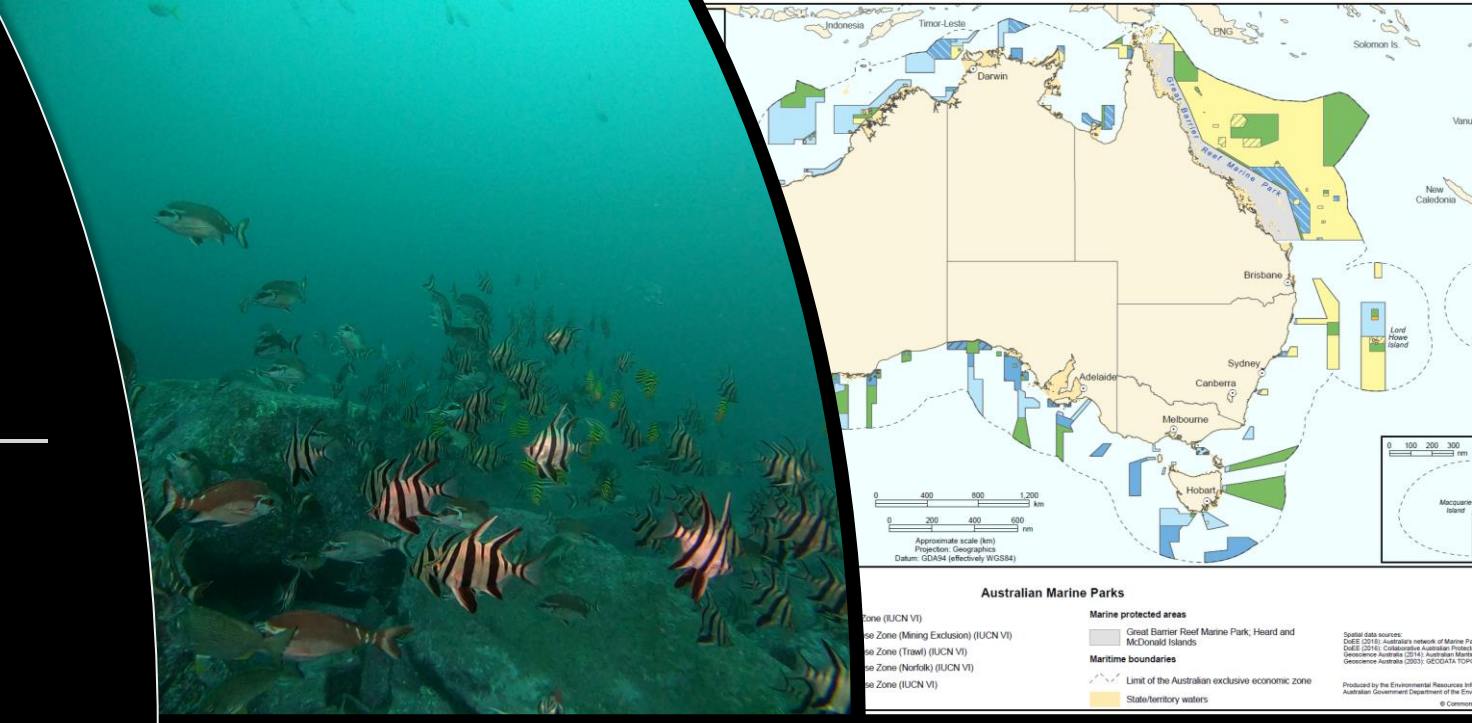
Australian Marine Parks

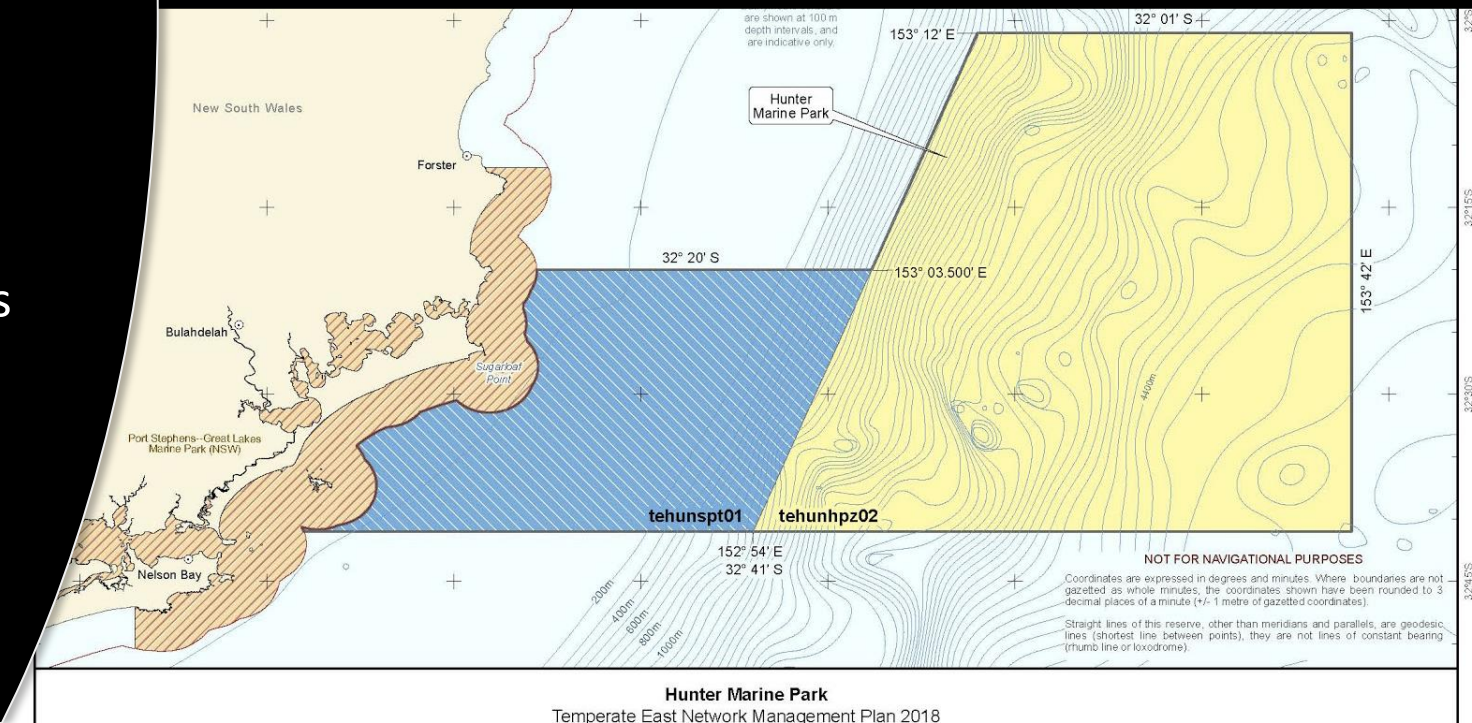
Temperate Mesophotic Ecosystems

- 30-150m depth
- Light limited – transition from algae to sessile invertebrates
- Often disconnected, fragmented reef, shelf reef
- Commercial fisheries, recreational fisheries, renewable energy
- Below diving limits, not deep sea
- Large knowledge gap, undervalued
- Out of sight, out of mind

Australian Marine Parks

- 2018 network of marine parks
- Cover a large area of mesophotic zone
- Shelf rocky reef – key ecological feature
- Need for baseline data
- NESP Marine Biodiversity Hub - Preparing for and implementing monitoring of CMR's and the status of marine biodiversity assets on the continental shelf
- Hunter Marine Park



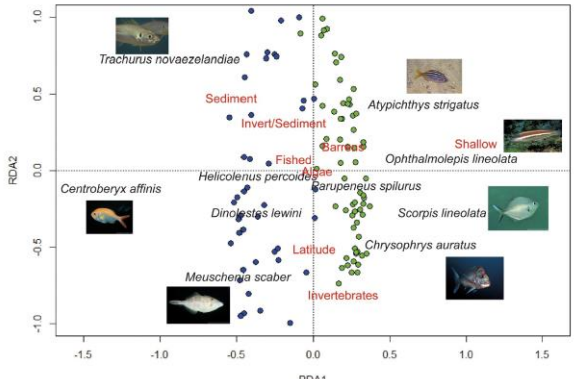


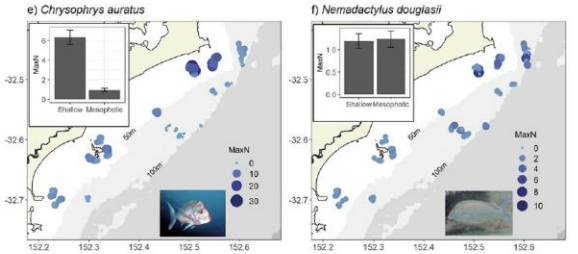
PLOS ONE

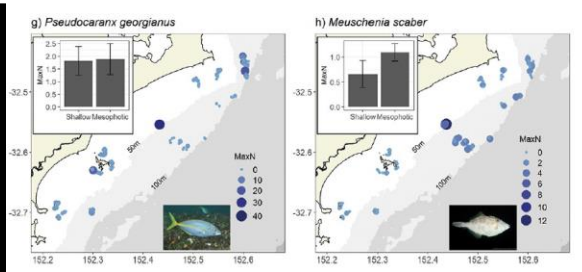
RESEARCH ARTICLE

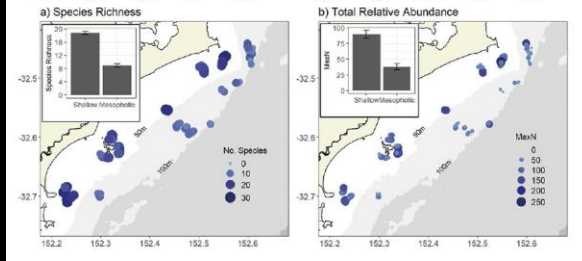
Taking a deeper look: Quantifying the differences in fish assemblages between shallow and mesophotic temperate rocky reefs

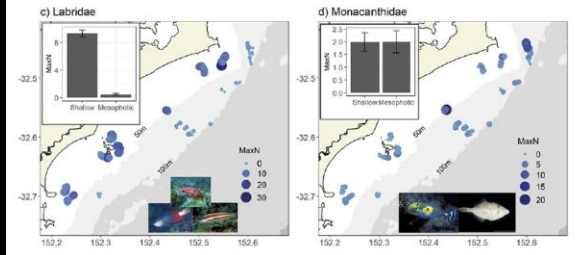
Joel Williams[1☯]*, Alan Jordan[1☯], David Harasti[1☯], Peter Davies[2‡], Tim Ingleton[2‡]











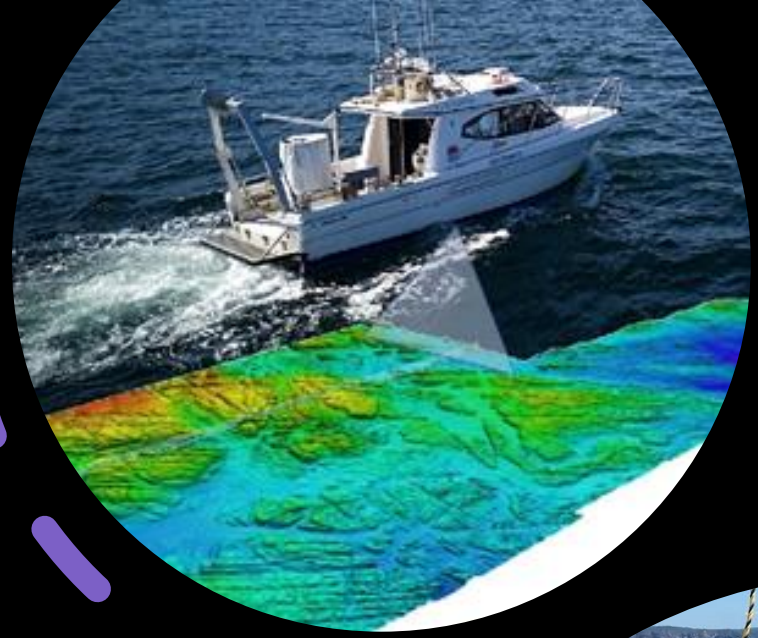
- Hunter MP(mesophotic) v Port Stephens – Great Lakes MP (Shallow)
- Significantly different fish assemblage
- Shallow reefs higher species richness, abundance, herbivores
- Mesophotic reefs, deep water species, large body species, fisheries target species
- Temperate mesophotic reefs in Hunter Marine Park support unique fish assemblage

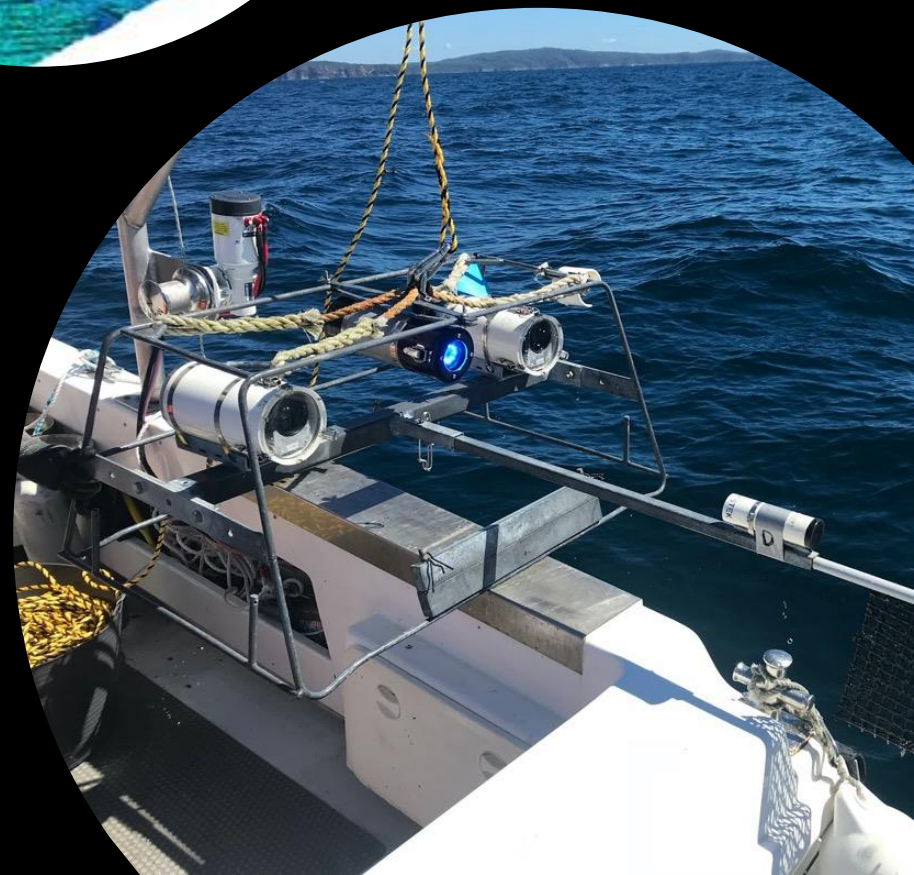
Aim

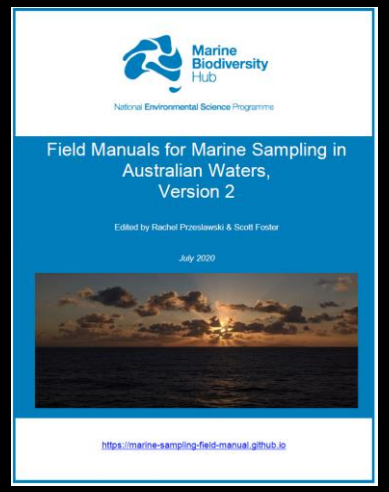
Use multibeam echo sounder (MBES) and baited remote underwater video (BRUV) to understand how season and reef structure explain the fish assemblage at mesophotic depths

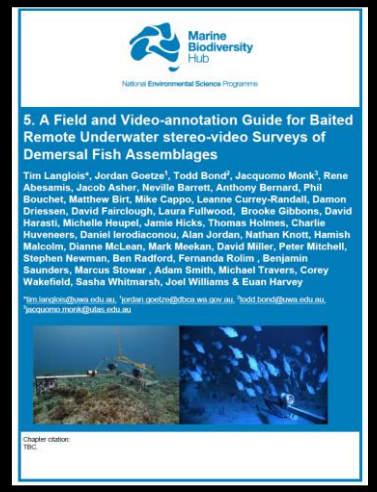
Methods – Data collection

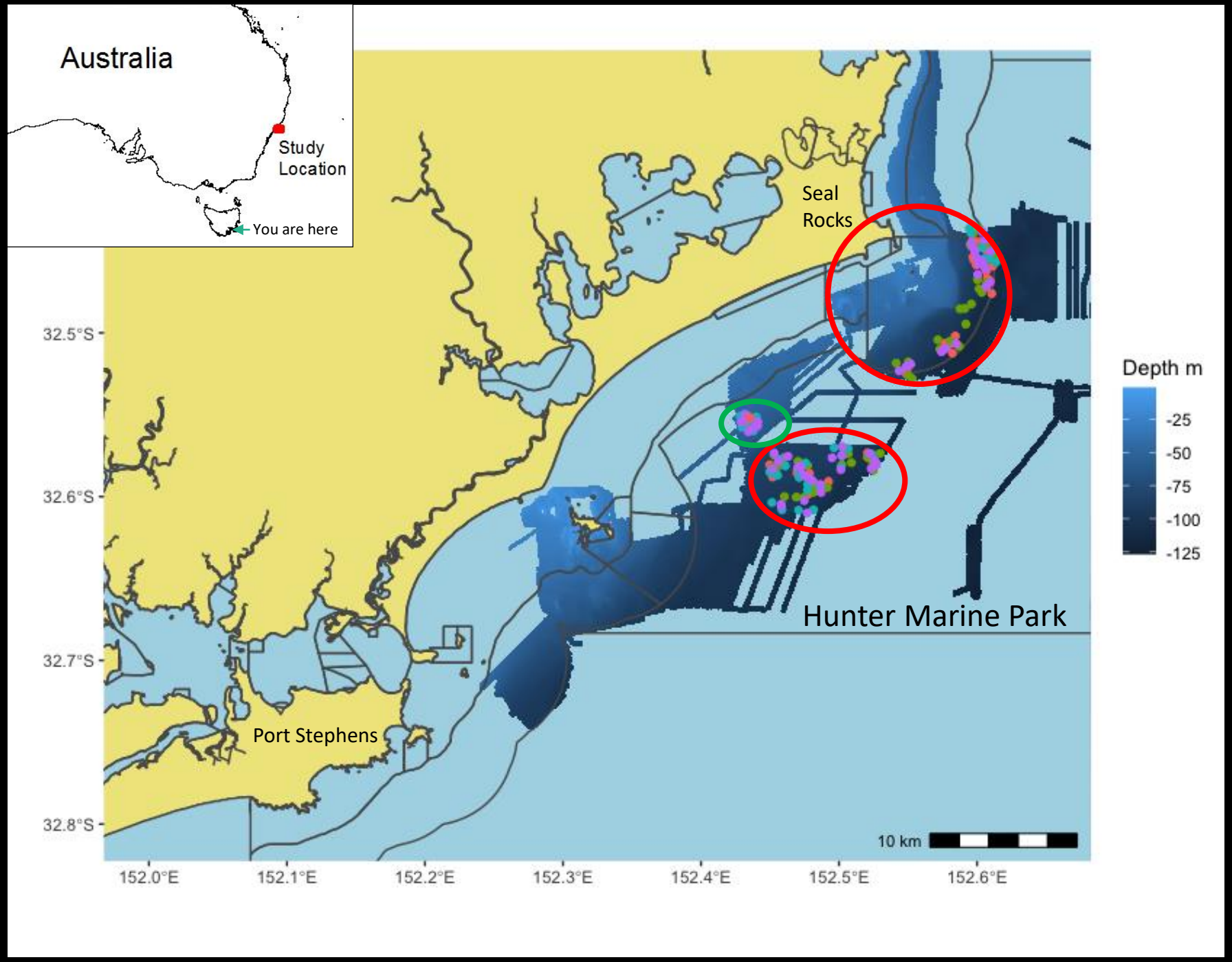
- Multibeam mapping
  - Establish where reef is located
  - Reef structure and complexity
- Fish assemblages
  - Stereo baited remote underwater video
  - Autumn and spring over 2017 and 2018
  - 30-110m depth



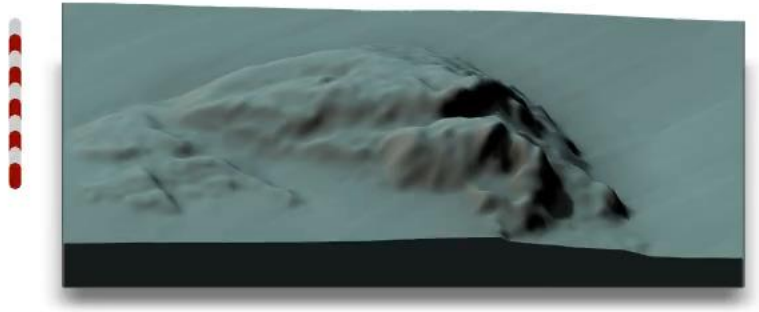




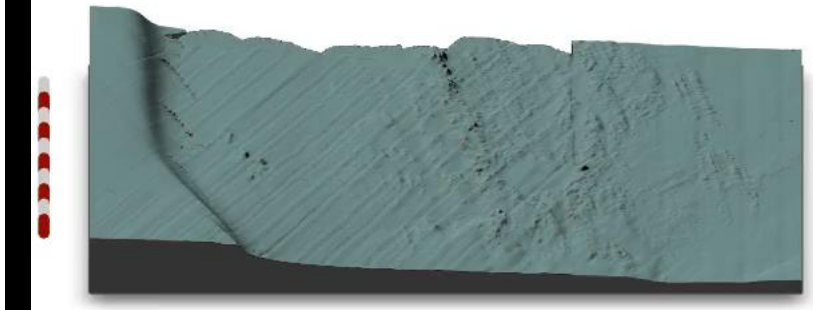



Australia
Study Location
You are here
Seal Rocks
Hunter Marine Park
Port Stephens
Depth m
-25
-50
-75
-100
-125
32.5°S
32.6°S
32.7°S
32.8°S
152.0°E
152.1°E
152.2°E
152.3°E
152.4°E
152.5°E
152.6°E
10 km

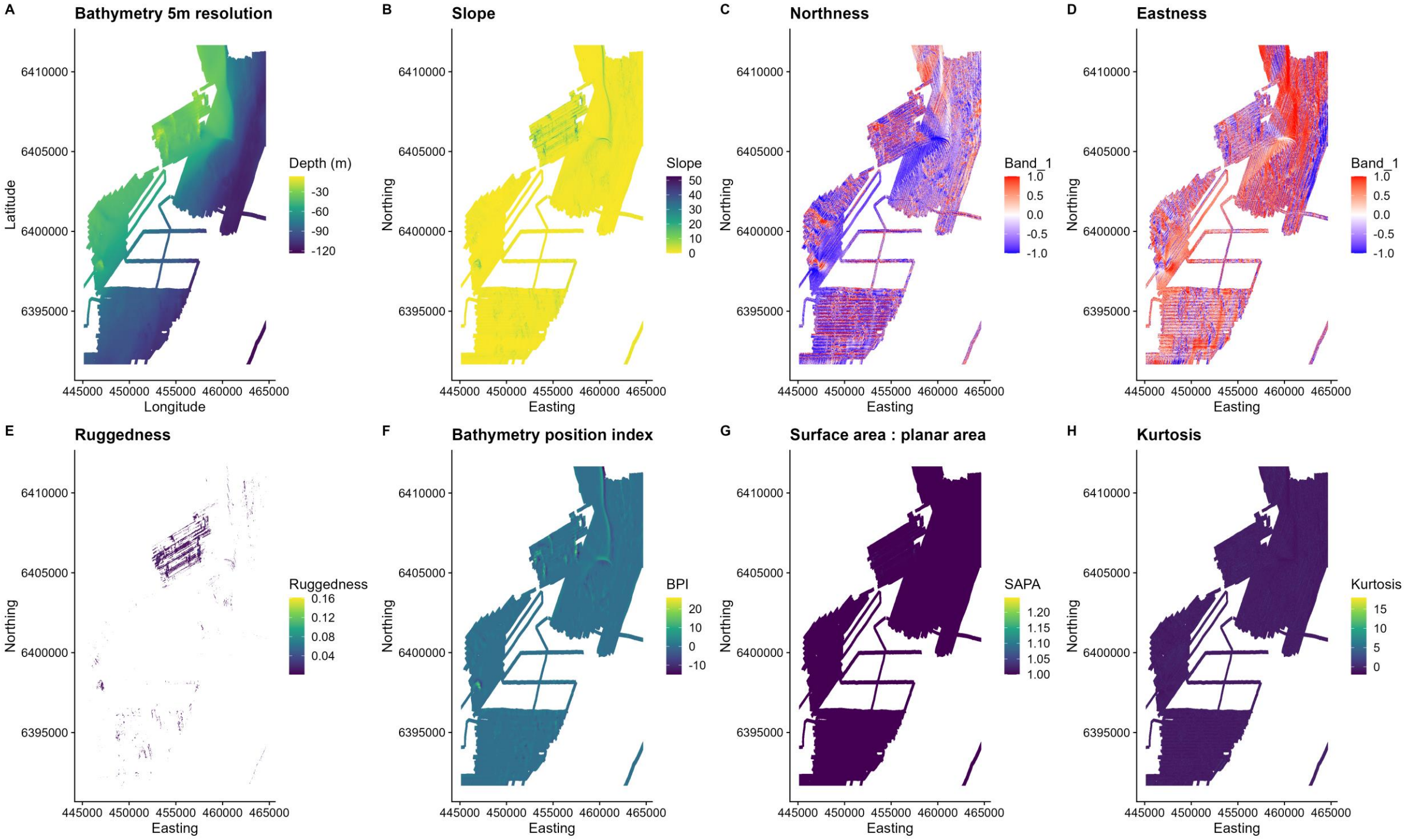
Outer Gibber



Seal rocks

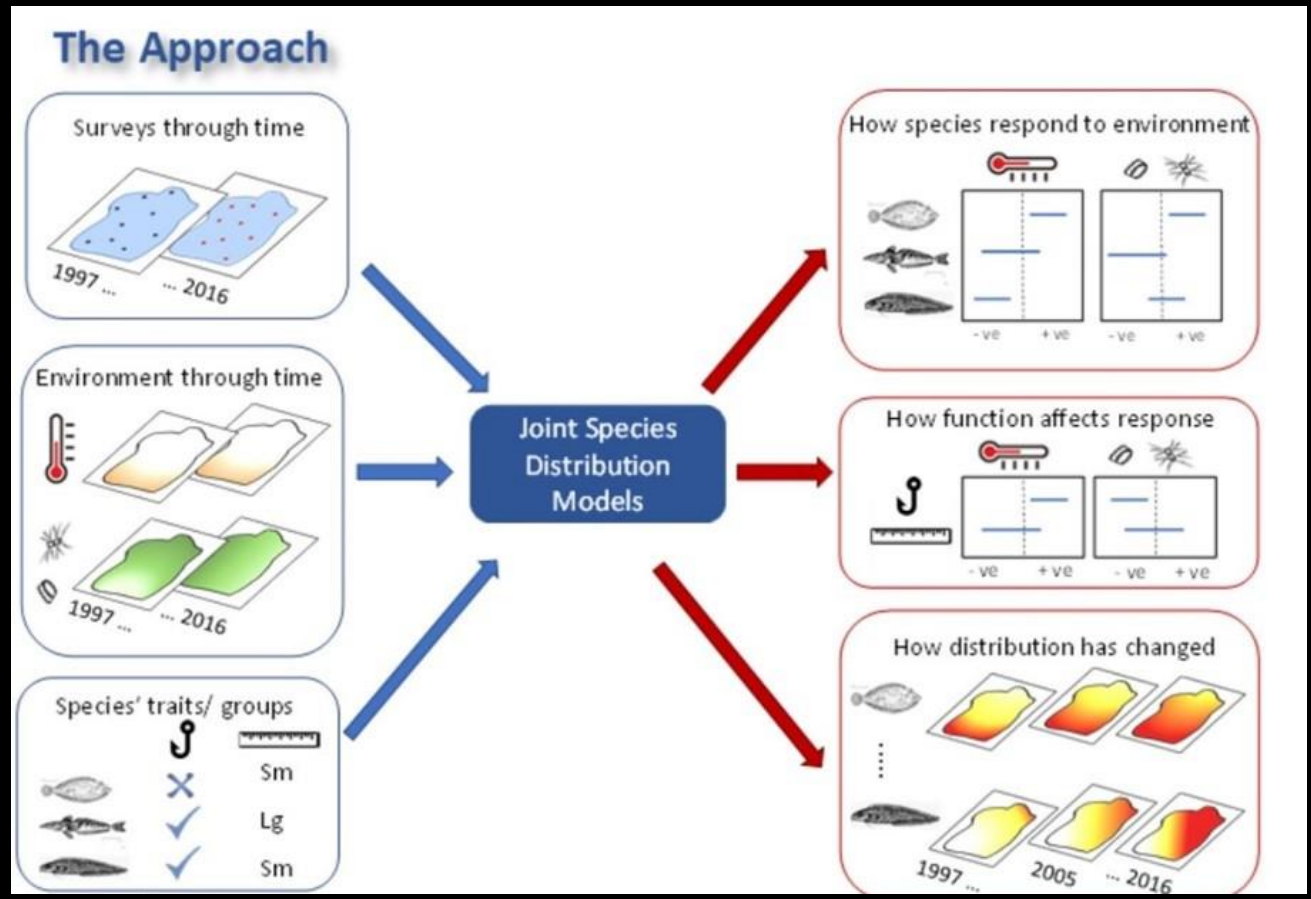


Broughton Offshore


A
Bathymetry 5m resolution
Latitude
Longitude
Depth (m)
-30
-60
-90
-120
B
Slope
Northing
Easting
Slope
50
40
30
20
10
0
C
Northness
Band_1
1.0
0.5
0.0
-0.5
-1.0
D
Eastness
E
Ruggedness
Ruggedness
0.16
0.12
0.08
0.04
F
Bathymetry position index
BPI
20
10
0
-10
G
Surface area : planar area
SAPA
1.20
1.15
1.10
1.05
1.00
H
Kurtosis
Kurtosis
15
10
5
0
6410000
6405000
6400000
6395000
445000
450000
455000
460000
465000

Methods – Joint Species Distribution Modelling

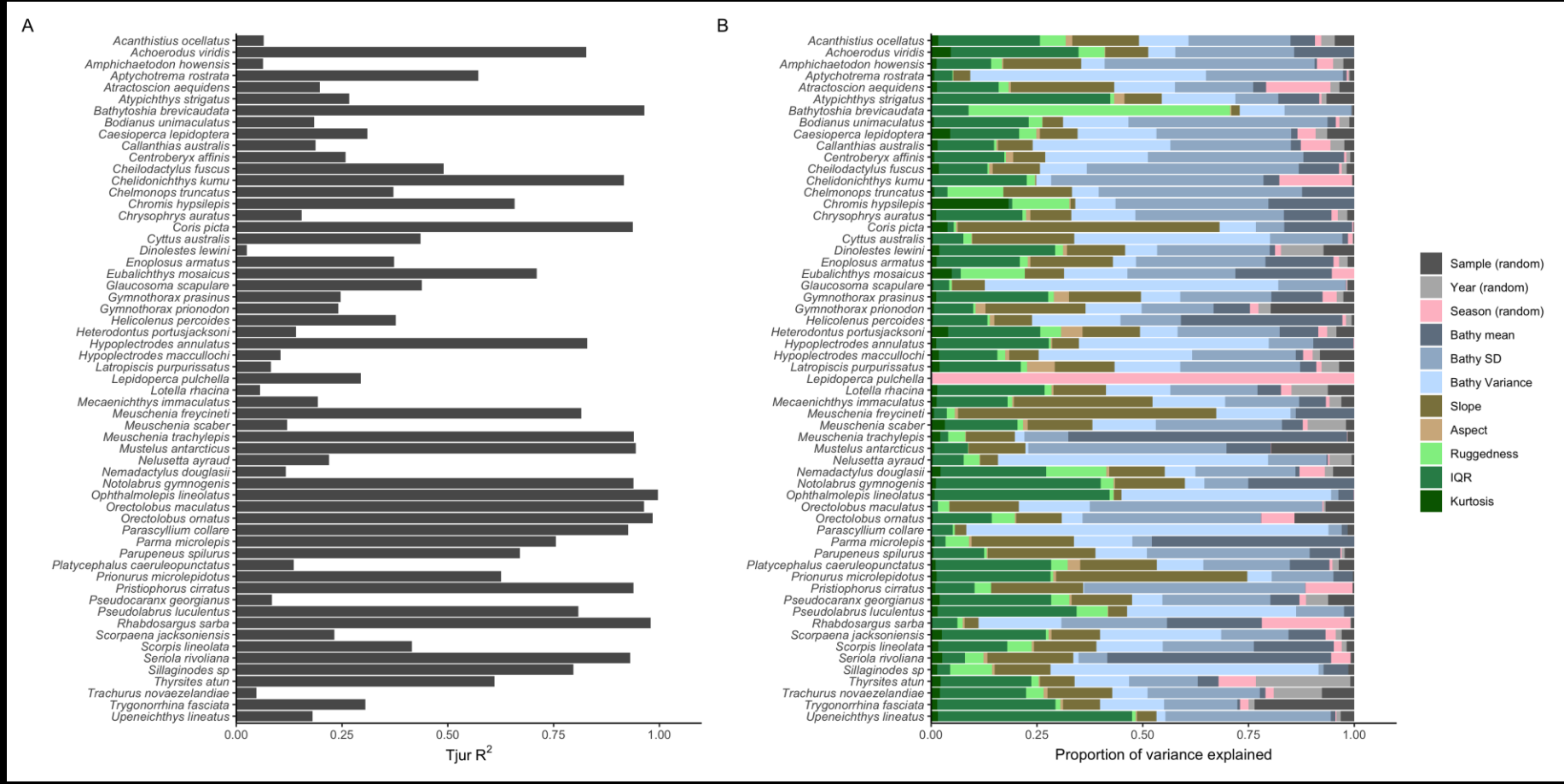
- **HMSC – Hierarchical modelling of species communities**
- Multivariate hierarchical generalised linear mixed model fitted with Bayesian inference
- MaxN = relative abundance
- 4 surveys = Spring 2016, autumn 2017, spring 2017, autumn 2018
- Explanatory variables:
  - Season
  - Bathymetry standard deviation, bathy variation, ruggedness, slope, aspect, IQR and kurtosis
- Traits:
  - Max length
  - Trophic level
  - Targeted species
- Random factors: spatial, year
- Hurdle model: presence/absence & abundance conditional presence



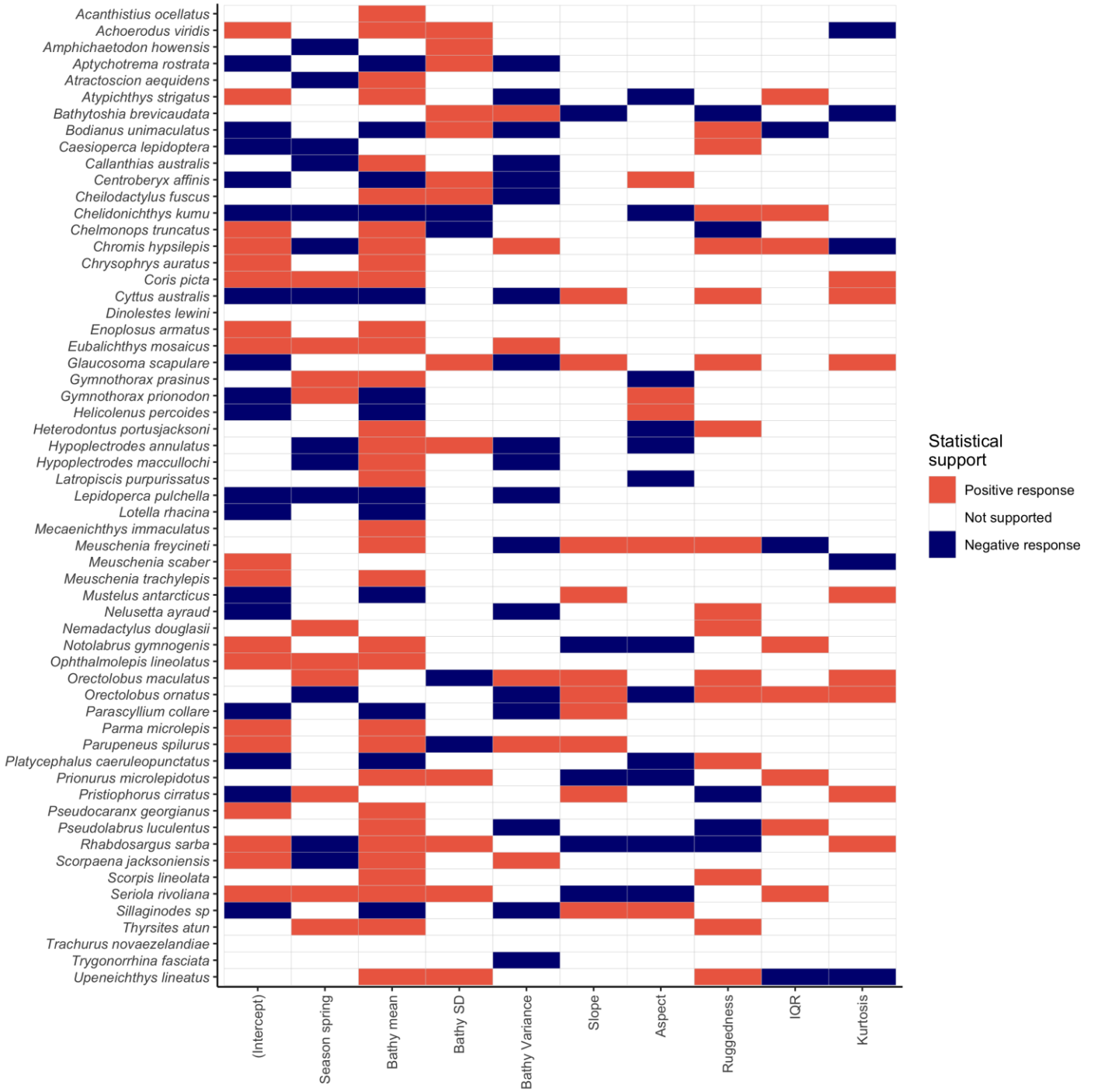
Summary statistics

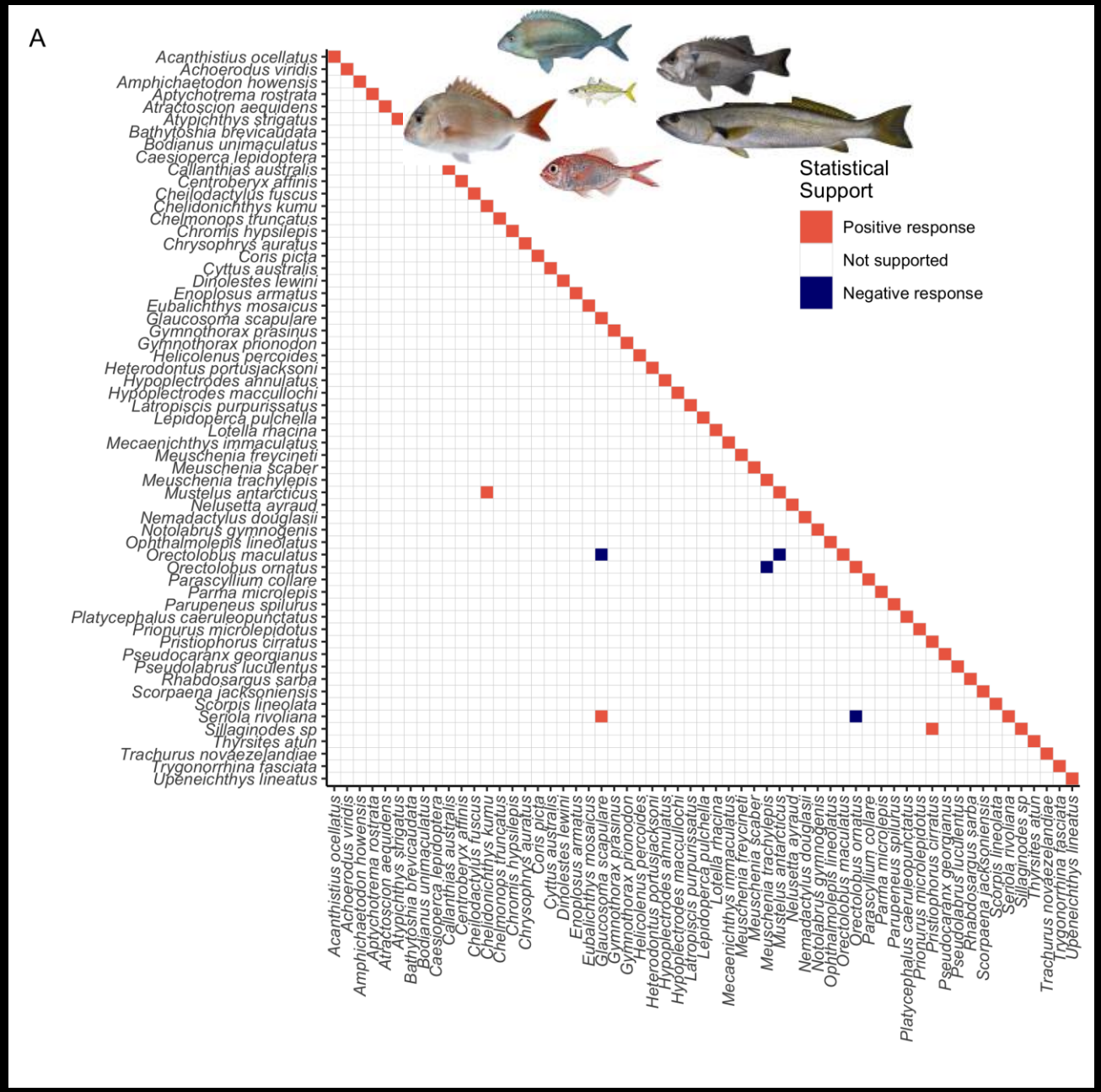
- 182 successful BRUV deployments
- 37 to 107m depth range
- 113 species, 58 families
- Species richness range 5-25 species
- Most common:
  - yellowtail scad *Trachurus novaezelandiae*,
  - Australian mado *Atypichthys strigatus,* and
  - redfish *Centroberyx affinis*

Variance partitioning – Presence/absence



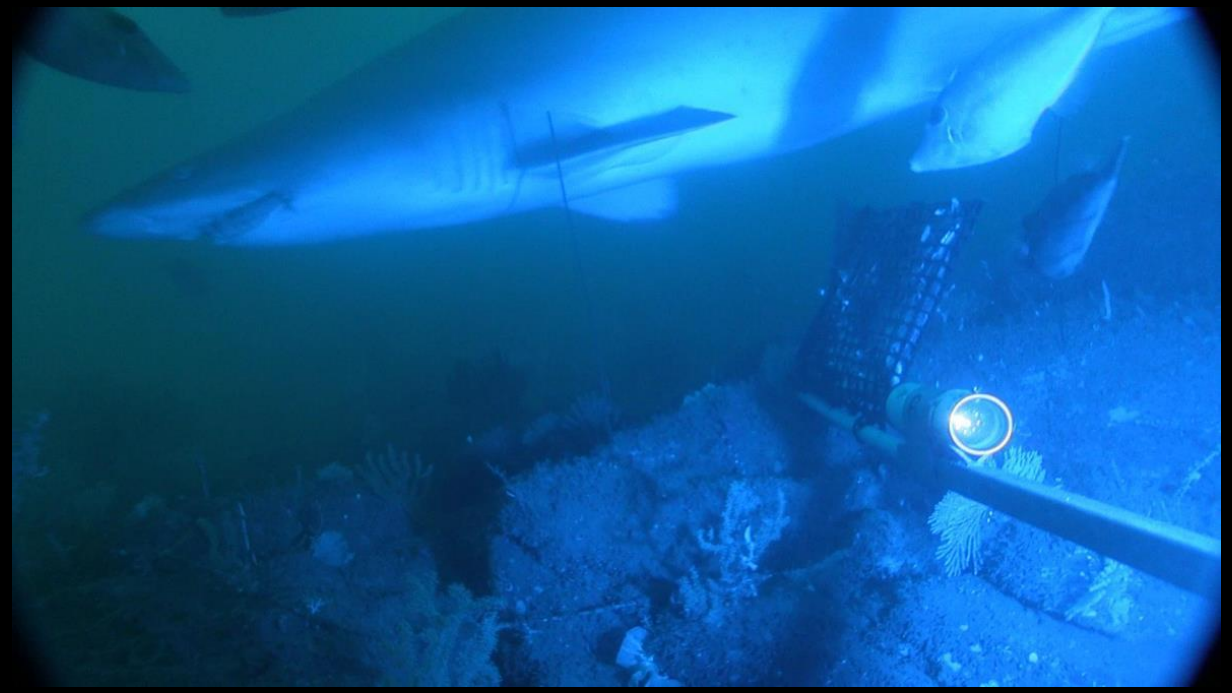
Presence/Absence



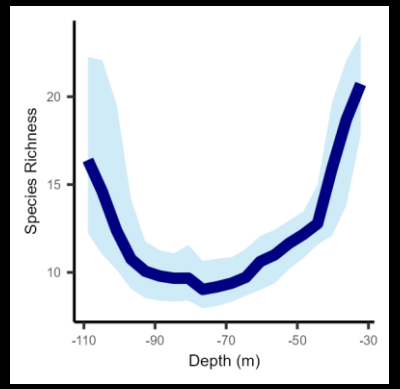

A
Acanthistius ocellatus
Achoerodus viridis
Amphichaetodon howensis
Aptychotrema rostrata
Atractoscion aequidens
Atypichthys strigatus
Bathytoshia brevicaudata
Bodianus unimaculatus
Caesioperca lepidoptera
Callanthias australis
Centroberyx affinis
Cheilodactylus fuscus
Chelidonichthys kumu
Chelmonops truncatus
Chromis hypsilepis
Chrysophrys auratus
Coris picta
Cyttus australis
Dinolestes lewini
Enoplosus armatus
Eubalichthys mosaicus
Glaucosoma scapulare
Gymnothorax prasinus
Gymnothorax prionodon
Helicolenus percoides
Heterodontus portusjacksoni
Hypoplectrodes ahnulatus
Hypoplectrodes maccullochi
Latropiscis purpurissatus
Lepidoperca pulchella
Lotella rhacina
Mecaenichthys immaculatus
Meuschenia freycineti
Meuschenia scaber
Meuschenia trachylepis
Mustelus antarcticus
Nelusetta ayraud
Nemadactylus douglasii
Notolabrus gymnogenis
Ophthalmolepis lineolatus
Orectolobus maculatus
Orectolobus ornatus
Parascyllium collare
Parma microlepis
Parupeneus spilurus
Platycephalus caeruleopunctatus
Prionurus microlepidotus
Pristiophorus cirratus
Pseudocaranx georgianus
Pseudolabrus luculentus
Rhabdosargus sarba
Scorpaena jacksoniensis
Scorpis lineolata
Seriola rivoliana
Sillaginodes sp
Thyrsites atun
Trachurus novaezelandiae
Trygonorrhina fasciata
Upeneichthys lineatus
Statistical Support
Positive response
Not supported
Negative response

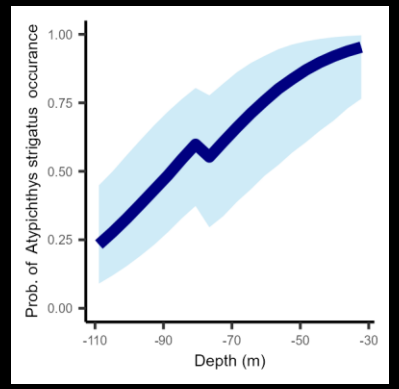
Traits

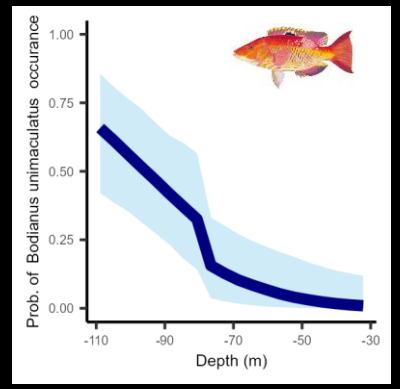
- Max length relationship with depth = Larger bodied species are deeper
  - **Smooth Stingray, *Dasyatis brevicaudata***
  - ***Eastern Shovelnose Ray, Aptychotrema rostrata***
  - **Spotted Wobbegong, *Orectolobus maculatus***

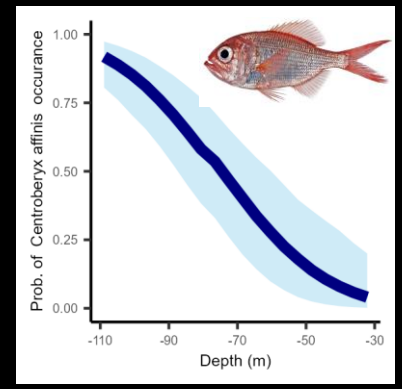


Depth


Species Richness
20
15
10
-110
-90
-70
-50
-30
Depth (m)


Prob. of Atypichthys strigatus occurance
1.00
0.75
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Bodianus unimaculatus occurance
1.00
0.75
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Centroberyx affinis occurance
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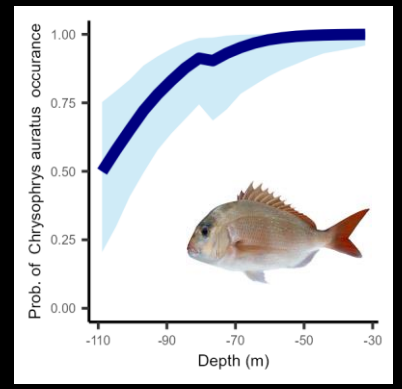
0.75
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Chrysophrys auratus occurance
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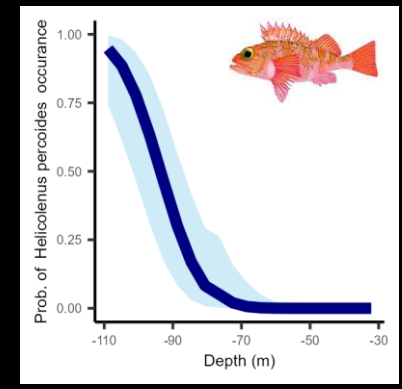
0.75
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Helicolenus percoides occurance
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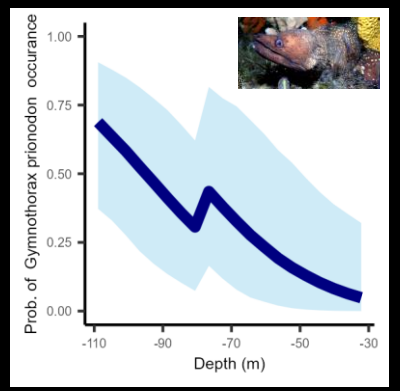
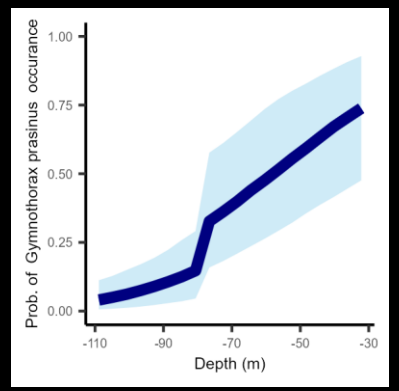
0.75
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Gymnothorax prionodon occurance
1.00
0.75
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Gymnothorax prasinus occurance
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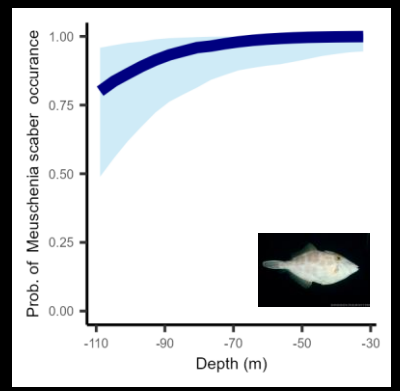
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Meuschenia scaber occurance
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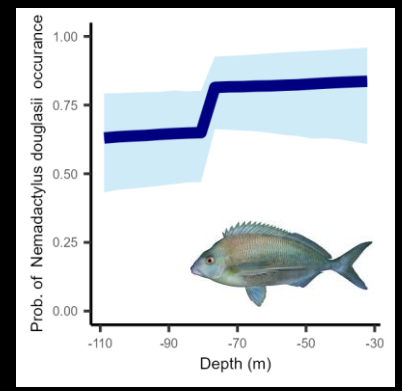
0.00
-110
-90
-70
-50
-30
Depth (m)


Prob. of Nemadactylus douglasii occurance
1.00
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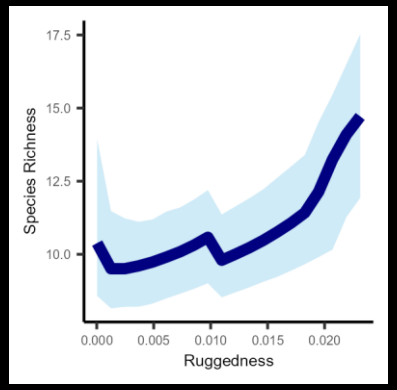
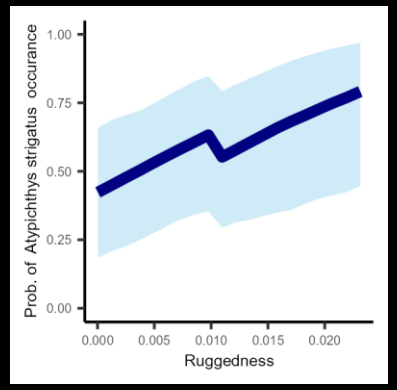
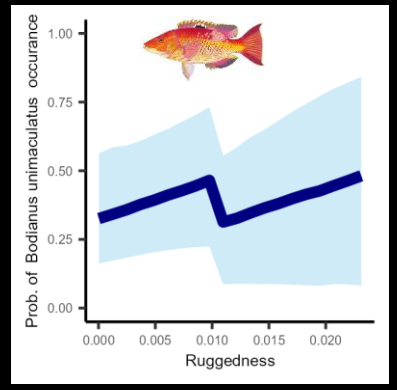
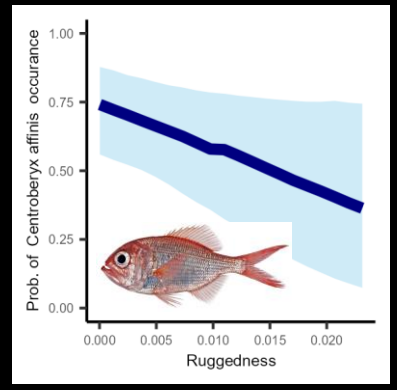
0.50
0.25
0.00
-110
-90
-70
-50
-30
Depth (m)

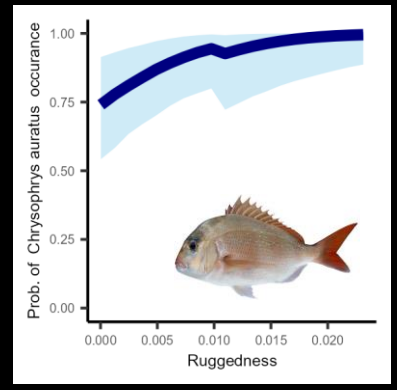
Ruggedness

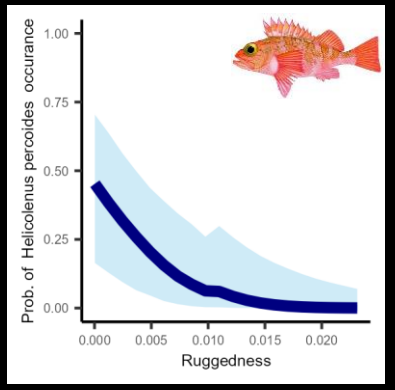

Species Richness
17.5
15.0
12.5
10.0
0.000 0.005 0.010 0.015 0.020
Ruggedness

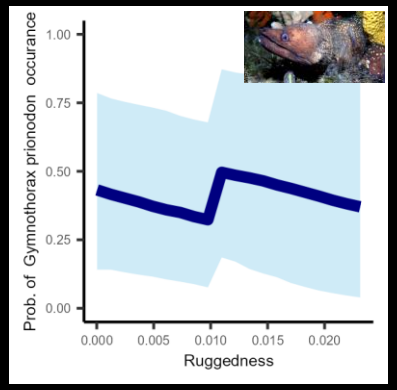

Prob. of Atypichthys strigatus occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

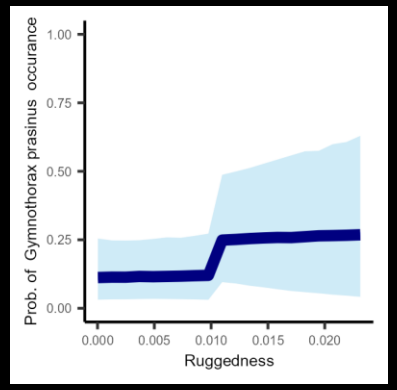

Prob. of Bodianus unimaculatus occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

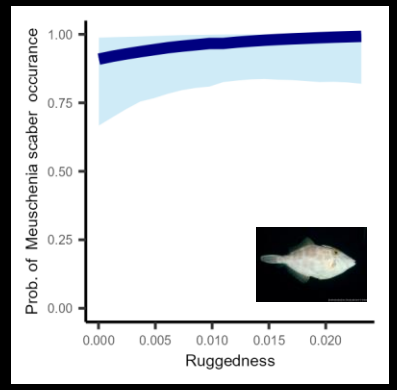

Prob. of Centroberyx affinis occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

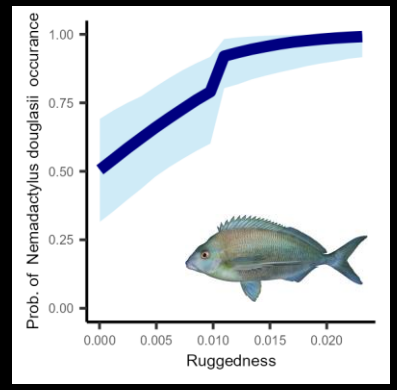

Prob. of Chrysophrys auratus occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness


Prob. of Helicolenus percoides occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

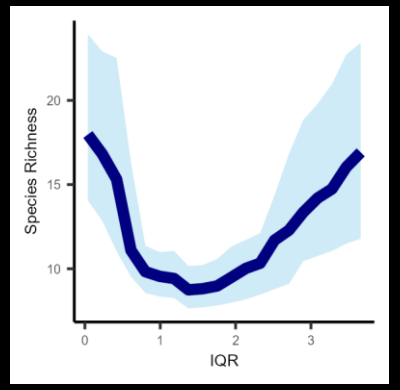

Prob. of Gymnothorax prionodon occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

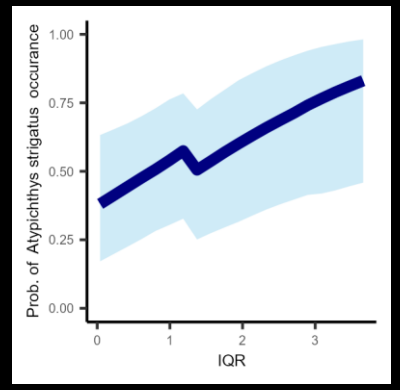

Prob. of Gymnothorax prasinus occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

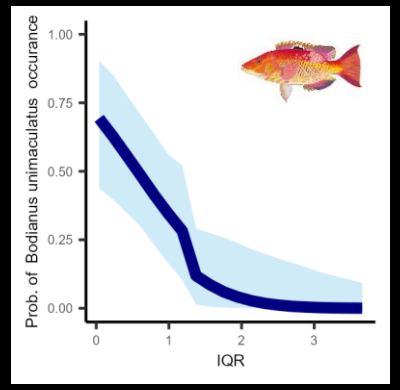

Prob. of Meuschenia scaber occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

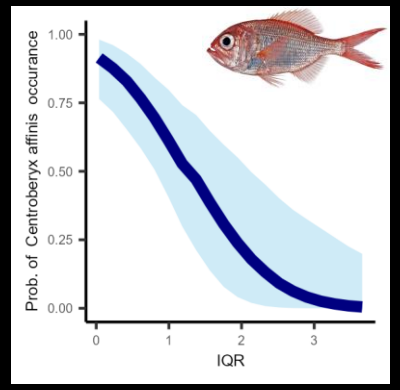

Prob. of Nemadactylus douglasii occurance
1.00
0.75
0.50
0.25
0.00
0.000 0.005 0.010 0.015 0.020
Ruggedness

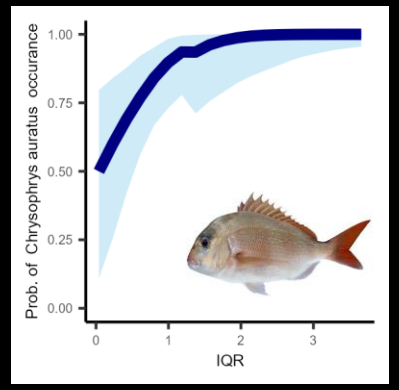
Interquartile range

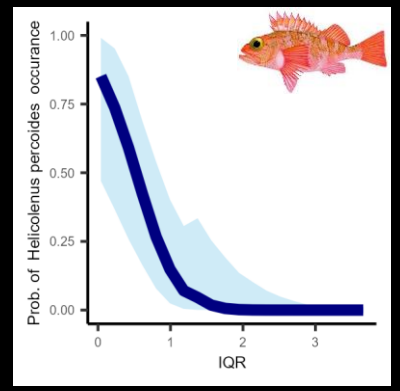


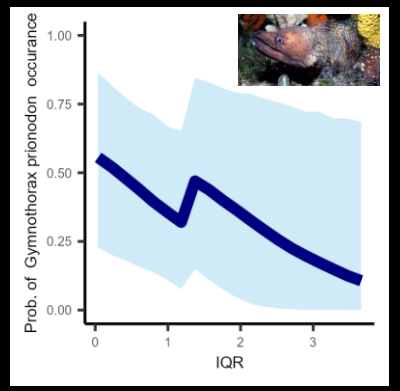


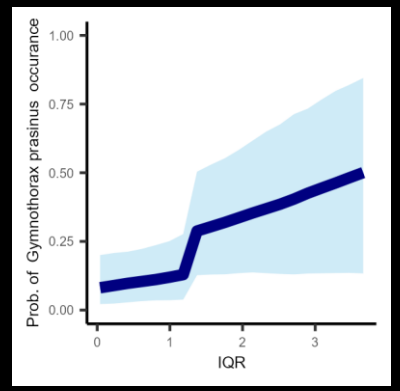


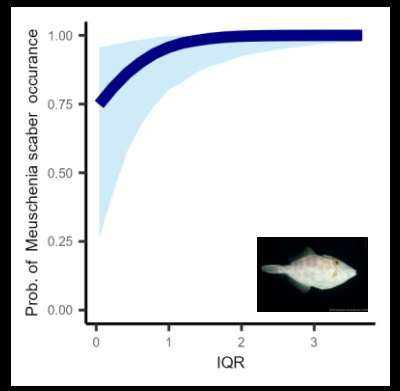


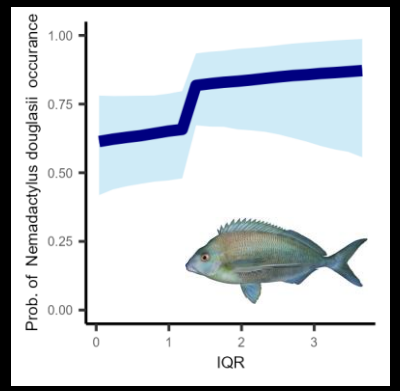






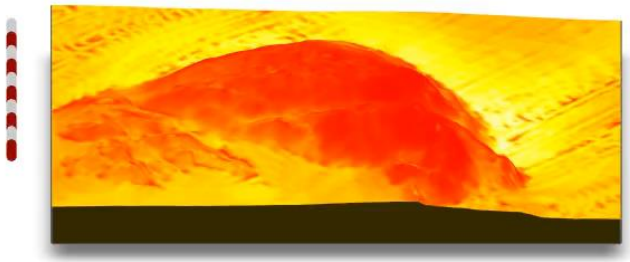




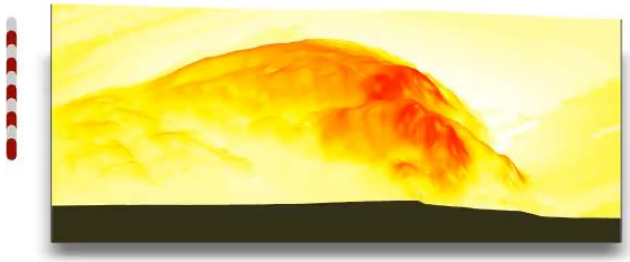


Outer Gibber - Species Richness

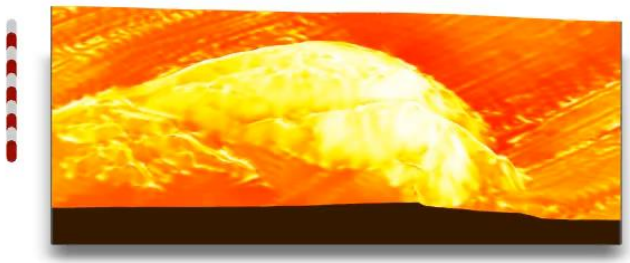
Outer Gibber - Prob. of Snapper occuring



Outer Gibber - Prob. of teraglin occuring

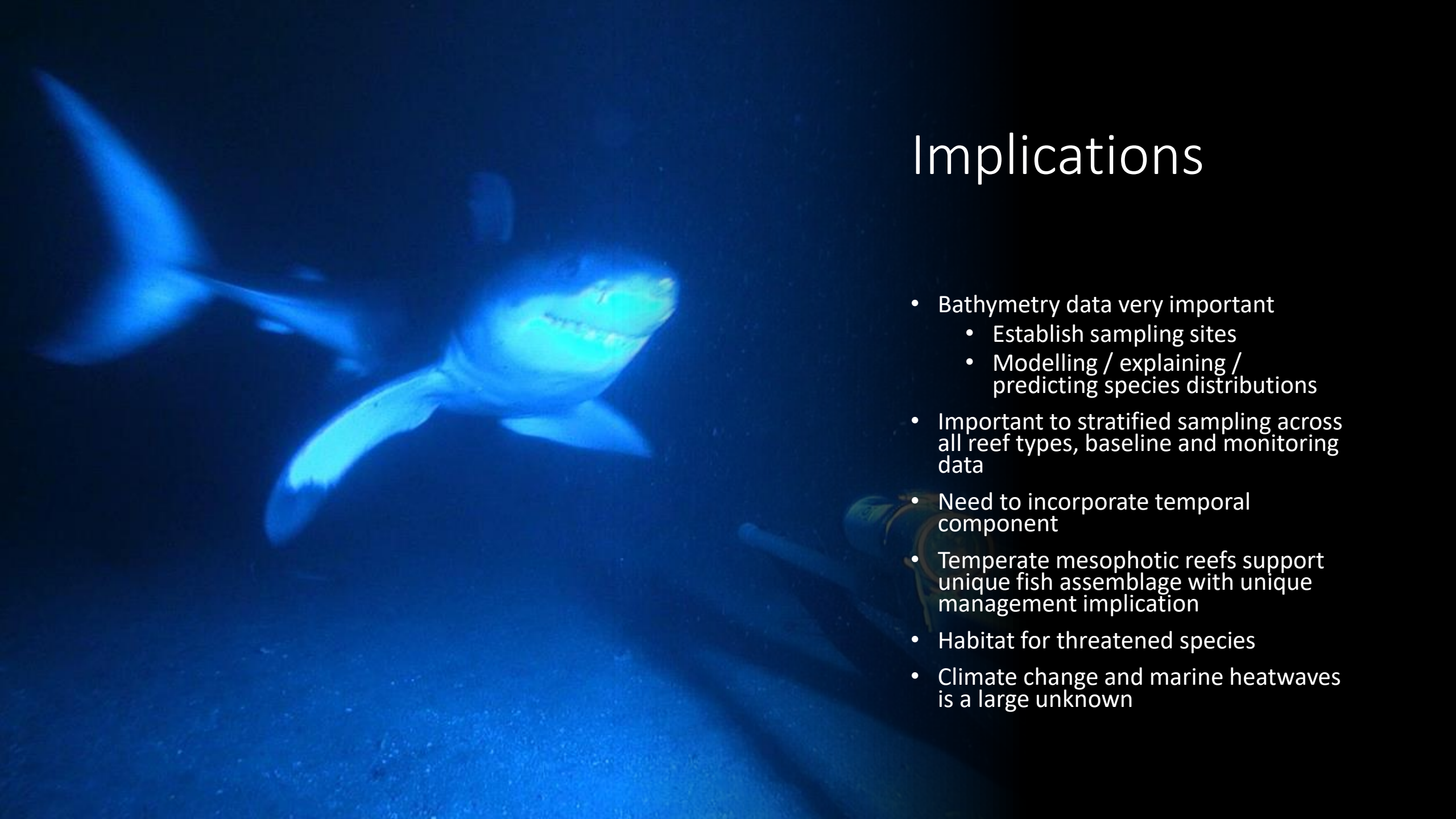


Outer Gibber - Prob. shovelnose ray occurir



Conclusions

- Variability at mesophotic depths
- Differences between upper and lower mesophotic depth
- Season + bathymetry important
- Uncommon variables, kurtosis, interquartile range important
- Differences between warm and cold water periods
- Need to expand spatial coverage, include depth 50-80m
- Multibeam + BRUV + JSDM = a lot of biodiversity information!



Implications

- Bathymetry data very important
  - Establish sampling sites
  - Modelling / explaining / predicting species distributions
- Important to stratified sampling across all reef types, baseline and monitoring data
- Need to incorporate temporal component
- Temperate mesophotic reefs support unique fish assemblage with unique management implication
- Habitat for threatened species
- Climate change and marine heatwaves is a large unknown

Thank you listening

Thank you to all the field assistants, students and staff at Fisheries NSW and Department of Planning and Environment for helping in the field, project support, manuscript reviews.

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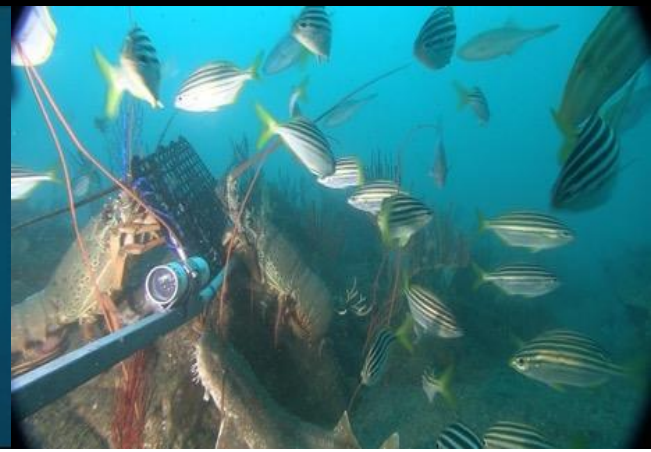

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