Distribution modelling of Ningaloo mesophotic (deep reef) communities

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**Ningaloo Outlook –A partnership between BHP and CSIRO**

Ningaloo Outlook is a BHP-CSIRO Industry-Science Marine Research Partnership investing A$5.4 million over five years to gather new knowledge on the Ningaloo reef and its important ecological values

Background: Mesophotic Ecosystems

- Occur from 30 m to bottom of the photic zone (up to 150 m).
- Initially suggested as a refuge (Bongaerts et al., 2010).
- Can harbor distinct communities (Rocha et al., 2018).
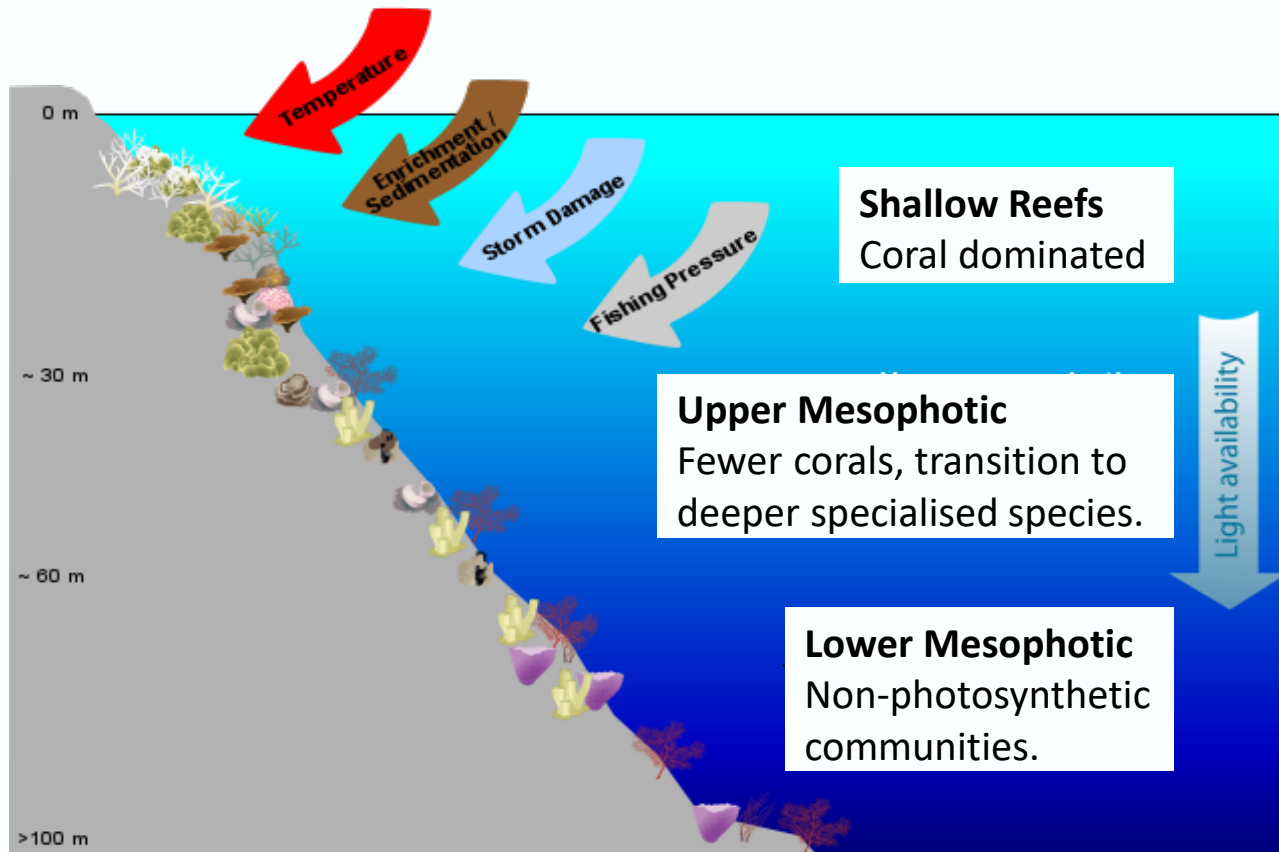
Background: Distribution Modelling

- Distribution models identify relationships between a species and environmental factors.

- Uses niche theory.

- **Fundamental niche**: Environmental conditions where a species will persist.

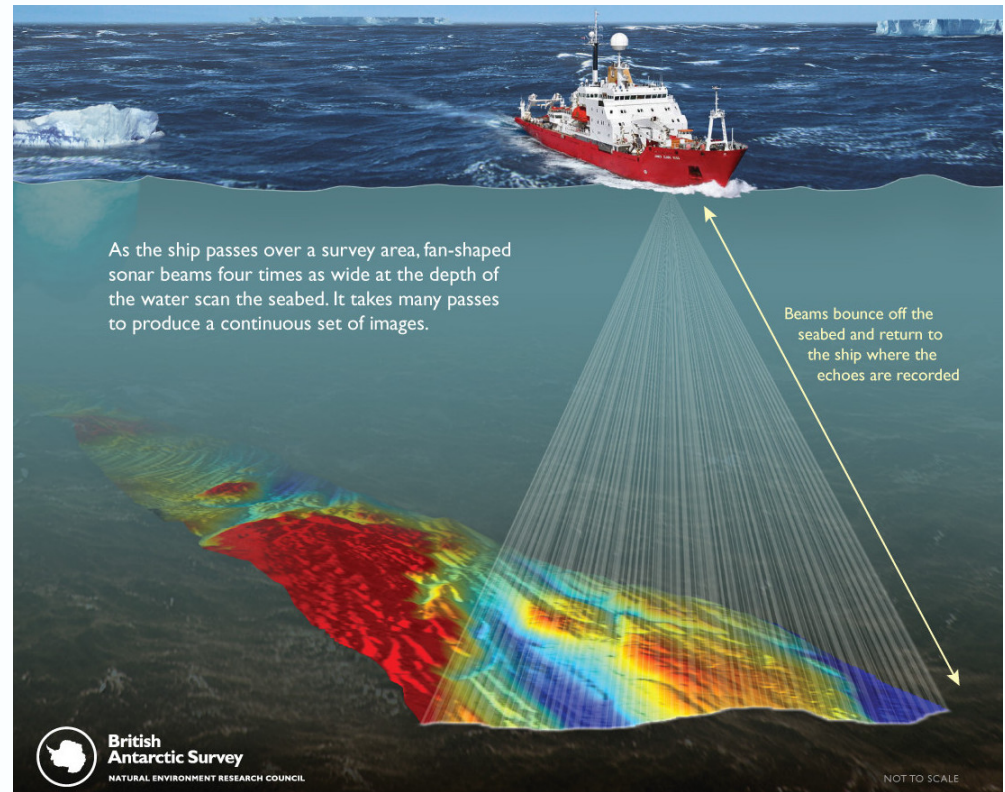- **Realised niche**: The space inhabited following competitive interactions.
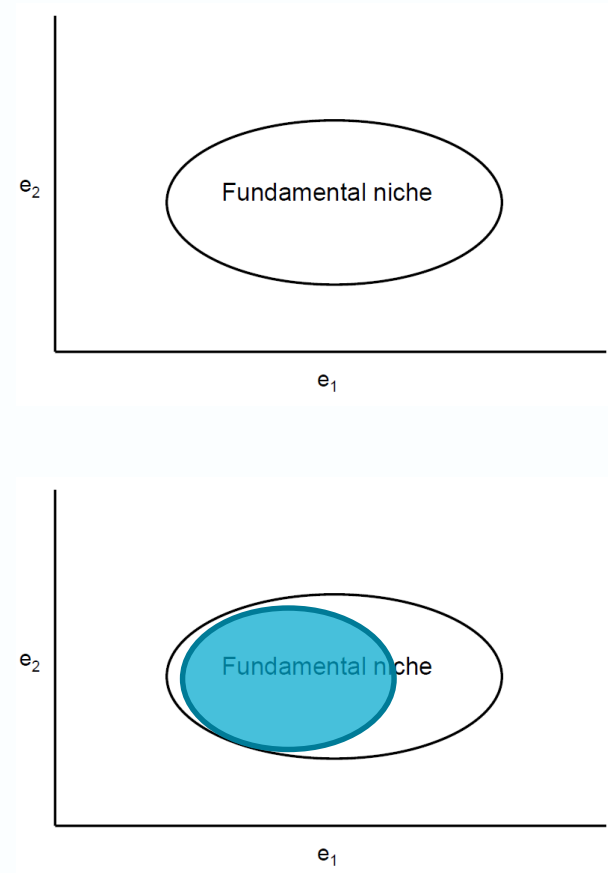
Study Area: Ningaloo
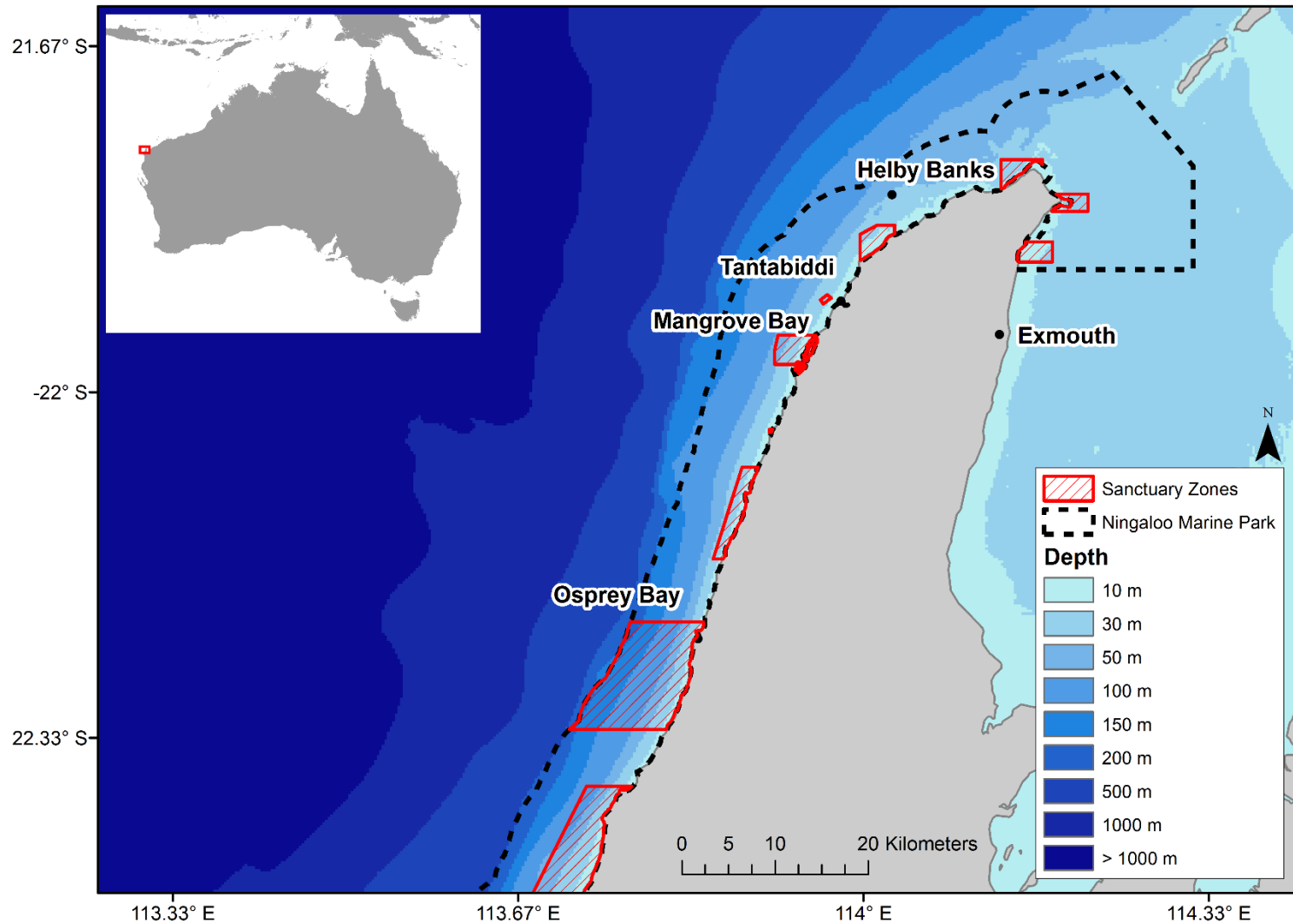
Methods: Acoustics

- Multibeam Echo Sounders
  - Bathymetry – Depth
  - Backscatter – Hardness

- This data is then used to create Digital Elevation Models (DEMs) of the seafloor.

- Use ArcGIS to compute topographical derivatives e.g. slope, aspect, rugosity.

As the ship passes over a survey area, fan-shaped sonar beams four times as wide at the depth of the water scan the seabed. It takes many passes to produce a continuous set of images.

Beams bounce off the seabed and return to the ship where the echoes are recorded

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NOT TO SCALE

https://www.bas.ac.uk/wp-content/uploads/2015/07/SWATH-illustration_FINAL-e1436863385756.jpg

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Methods: Ground Truthing
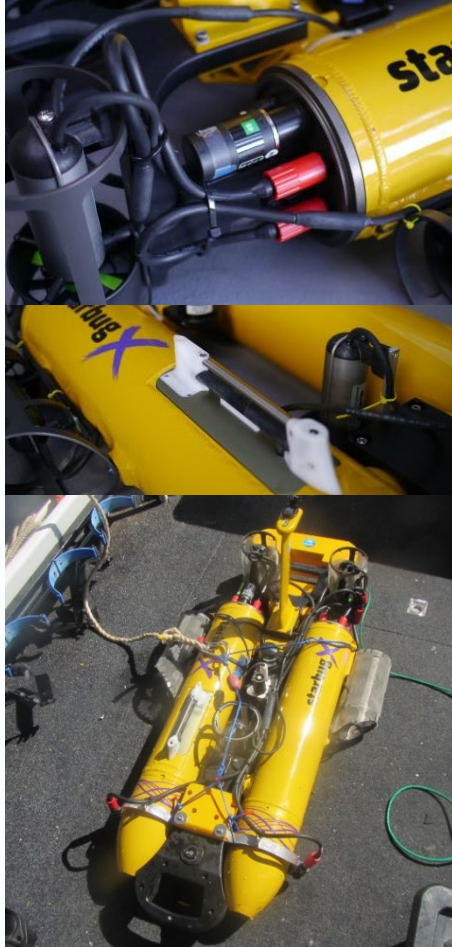
- Acoustic data does not provide a direct observation of the seabed.

- Need to use visual methods to confirm what is there.

- Towed Video

- Starbug AUV

Methods: Modelling Techniques

- Uses statistical techniques so that computers "learn" from the input data to identify patterns and make predictions.

- Video/AUV points = Training data.

- Three taxonomic groups:
  - Corals
  - Macroalgae
  - Sponges

- Each point has associated values with the predictor variables e.g. depth.

https://imgs.xkcd.com/comics/machine_learning.png

Methods: Modelling Techniques

- Six modelling methods used:
  - Simple: Classification Trees, MARS, Generalised Linea
  - Complex: Random Forest, Boosted Regression Trees,
  - Ensemble.

- Change grid size used:
  - 10 m; 50 m; 100 m; 250 m

- Subset data:
  - 5-Fold cross-validation, 10 replicates.
 - Validation data: Osprey Bay (Southernmost area).

5th run
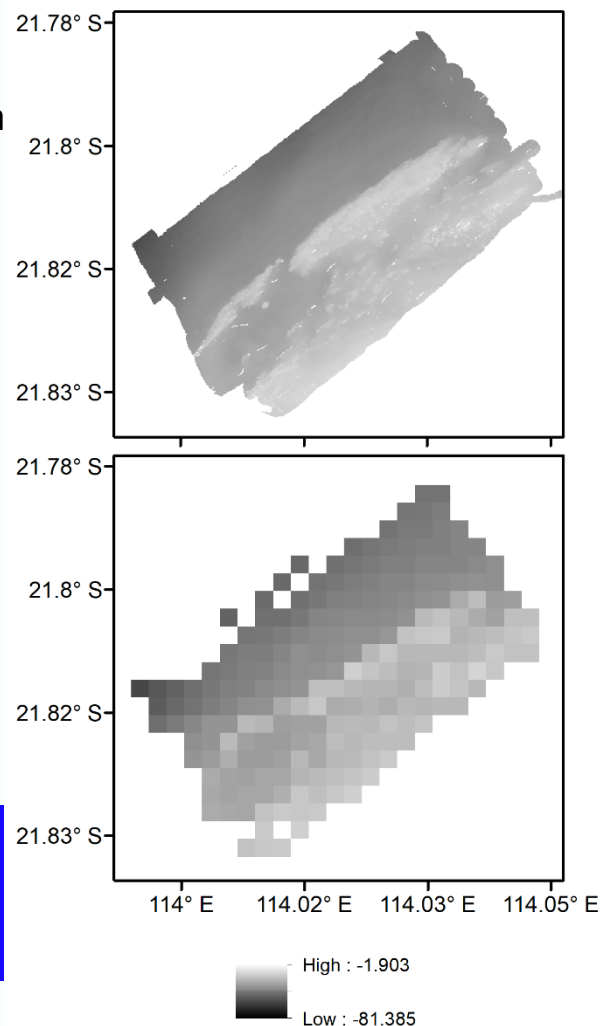
Training data

Methods: Map/Model Accuracy

- Power of a model to represent the world as measured against reality.

- **Sensitivity** (true positive rate): proportion of positives that are correctly identified.

- **Specificity** (true negative rate): proportion of negatives that are correctly identified

- True skill statistic (**TSS**)
  - Sensitivity + Specificity – 1

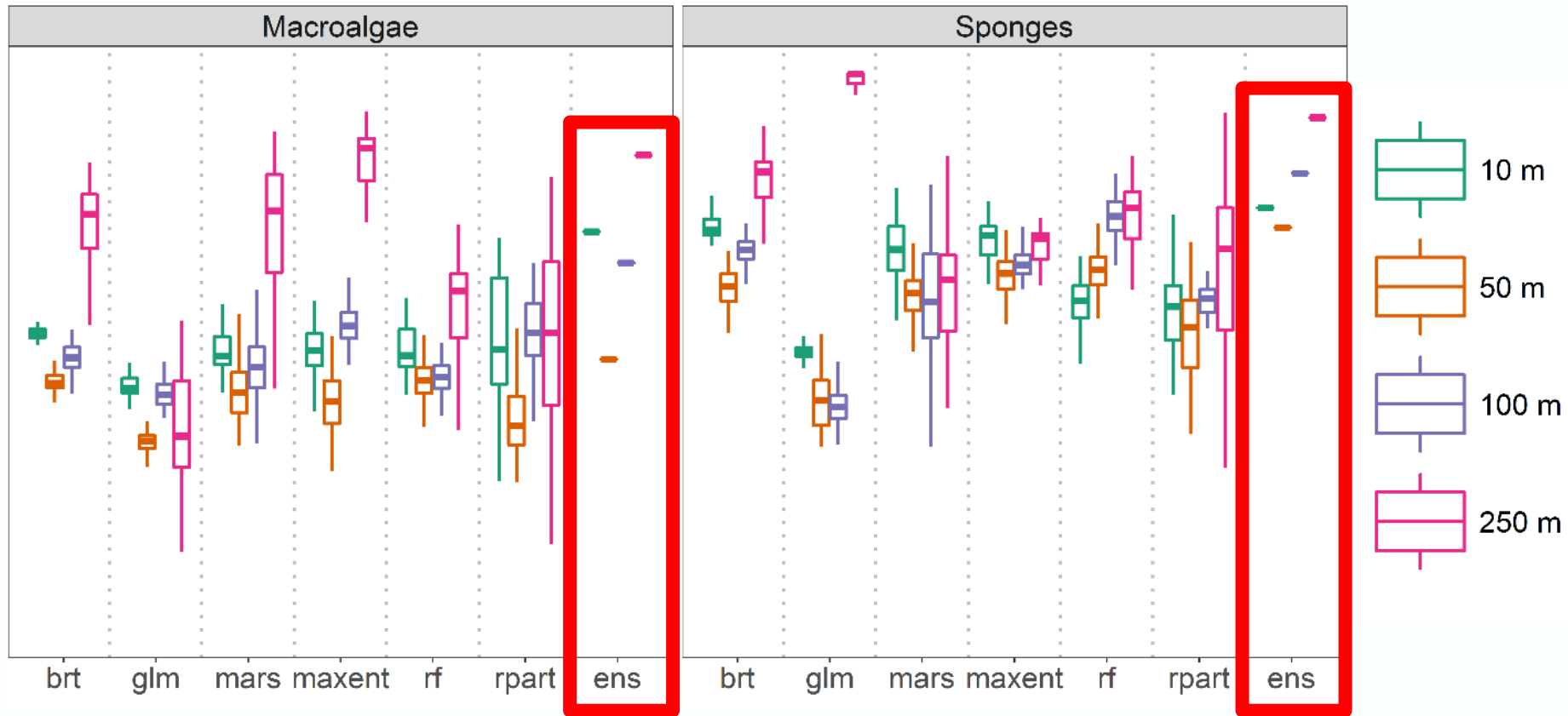- Area under receiver operating characteristics curve (**AUC**)
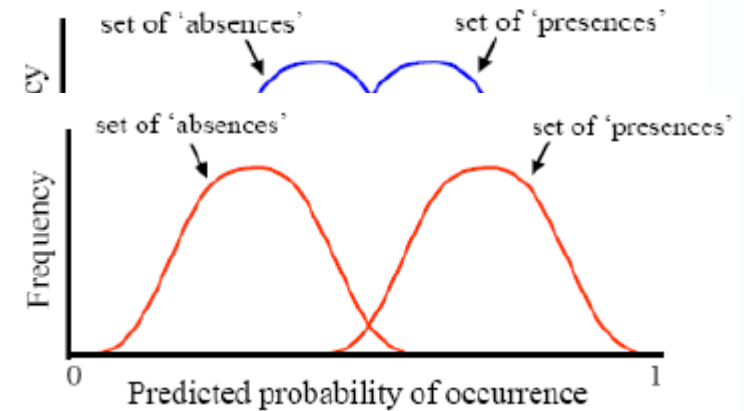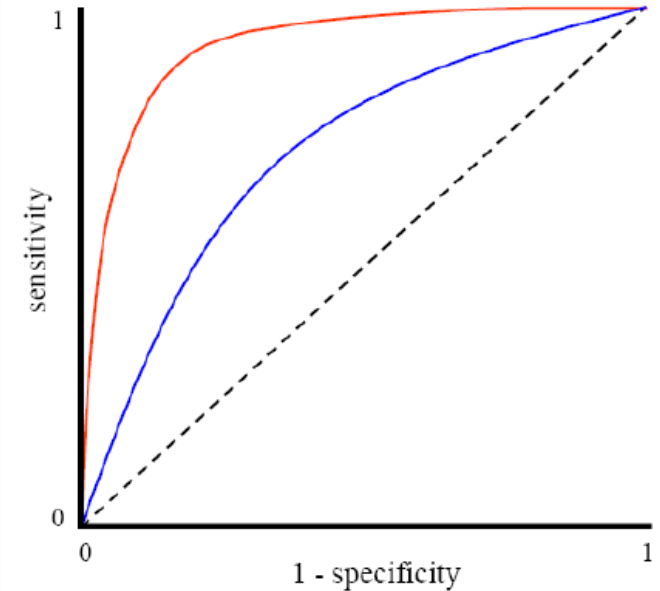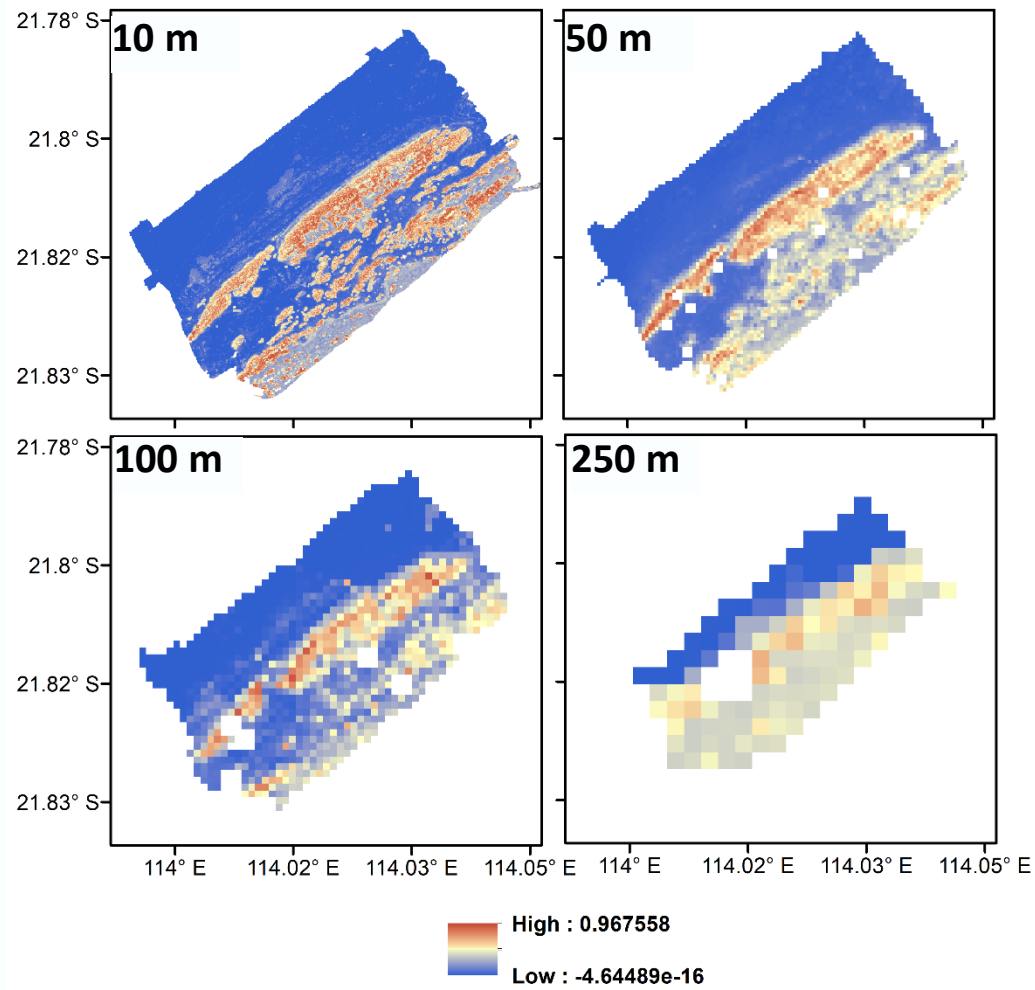
Results: Model Resolution

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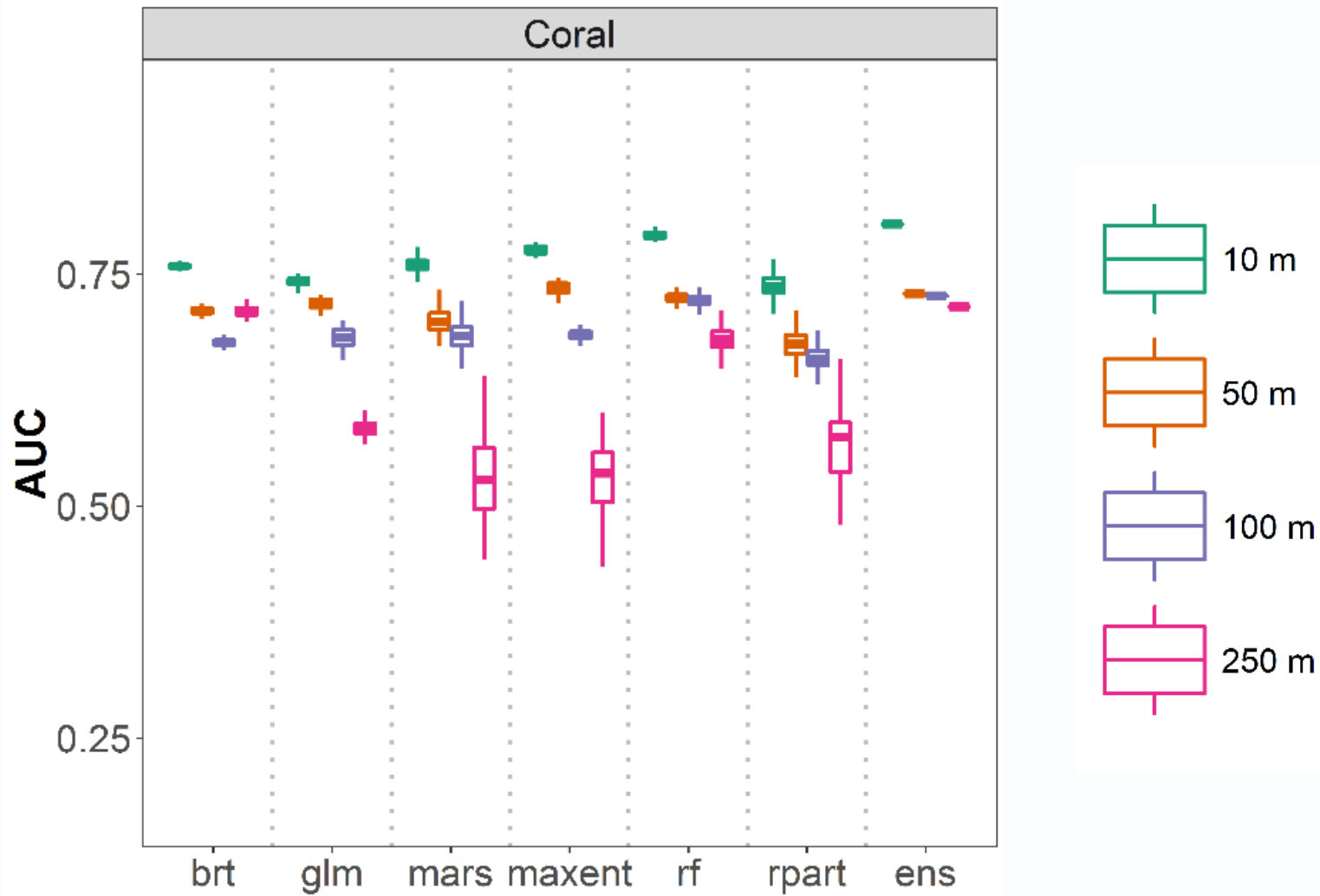
Results: Model Resolution

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Summary

- Corals:
  - Fine-scale best
  - Narrow niche

- Macroalgae and Sponges:
  - Larger grid sizes best
  - Broad groups = diversity of niches

- Ensemble methods extremely useful

Acknowledgements:

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