Opportunities for habitat mapping approaches using bathymetry in fisheries assessment

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Deakin Marine Mapping Group

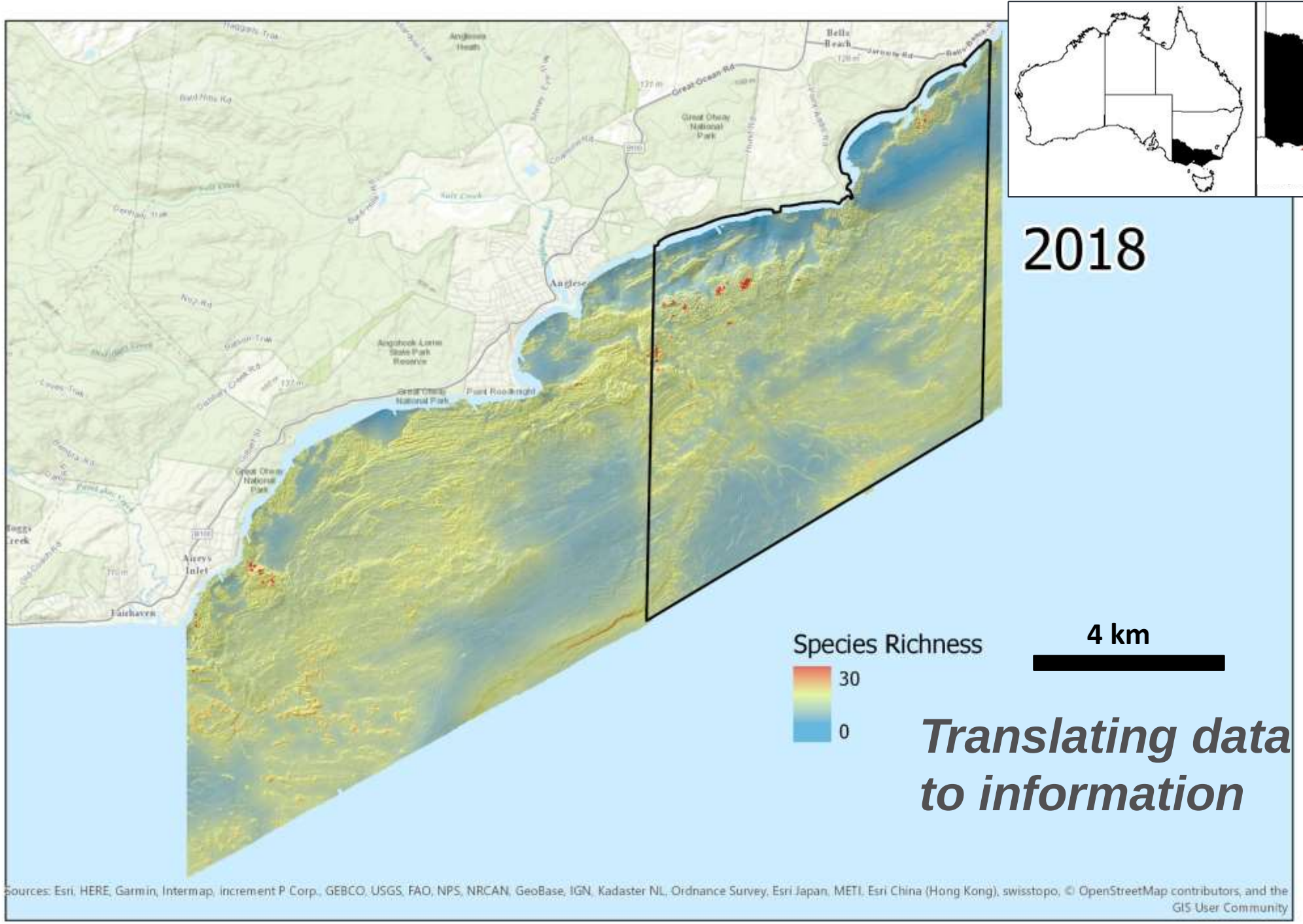
Map the Gaps 2018 Canberra

Overview

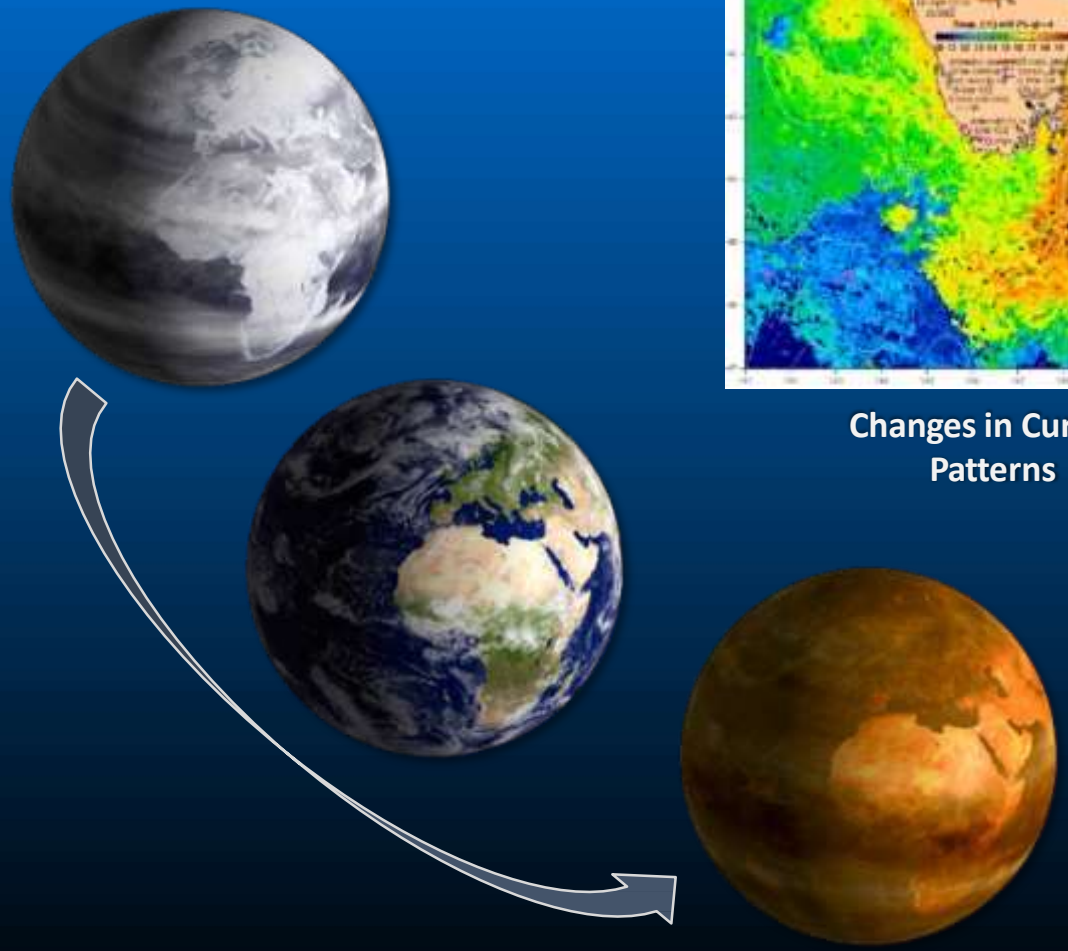
Case studies

- Patterns of interaction between habitat and oceanographic variables affecting the connectivity and productivity of fisheries- Victoria, Australia
- Regional seabed mapping with crowd sourced bathymetry- Newfoundland, Canada

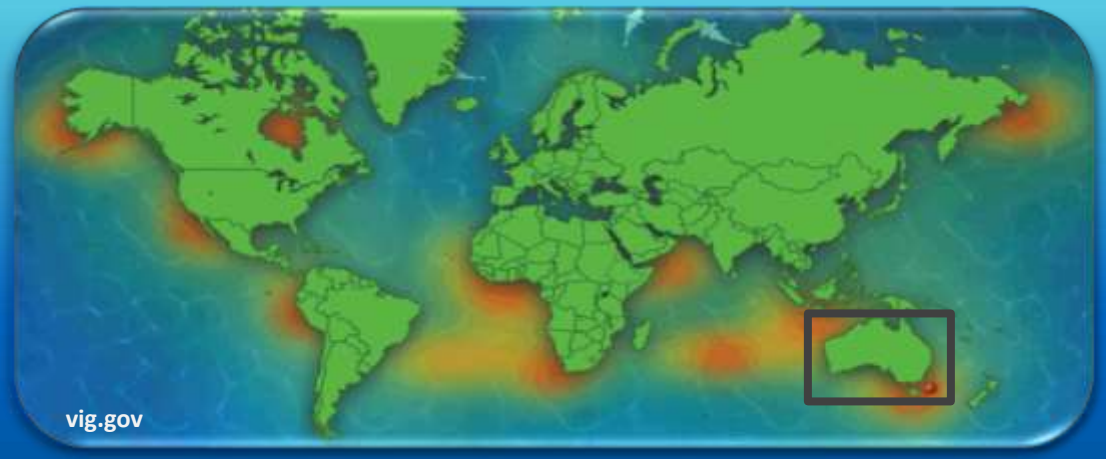

Rope
Camera
Camera
Bait
bag
Synchronising
diode


2018
Species Richness
30
0
4 km
Translating data to information
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

A changing climate

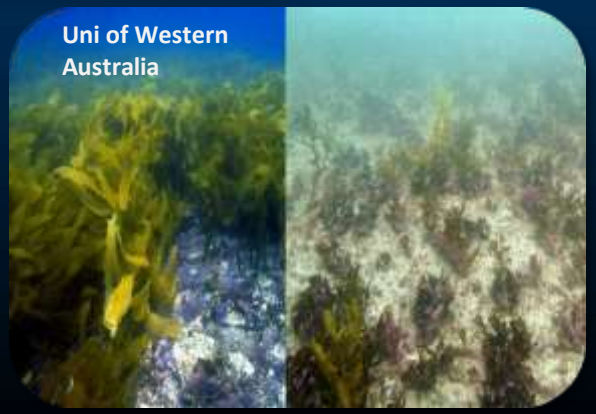


Changes in Current Patterns



Increasing Ocean Temperatures

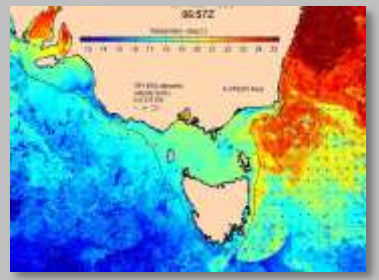
Changes in Wave Environment



Determine the drivers of spatio-temporal productivity fisheries

ENVIRONMENTAL VARIABLES

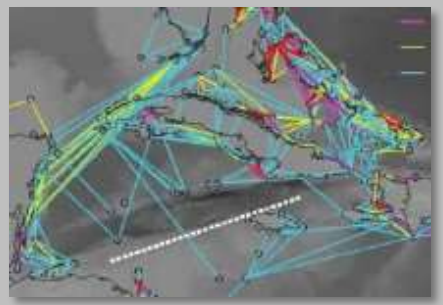
Spatially Variable & Temporally Dynamic



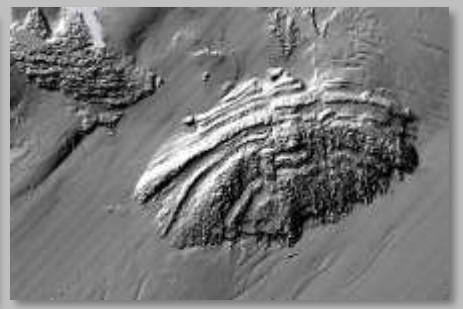
Oceanography

Spatially Variable & Temporally Static

Depth

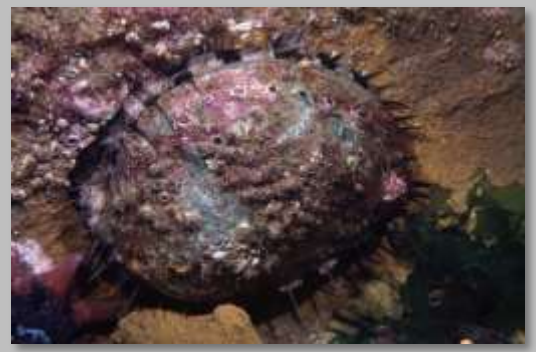


Connectivity



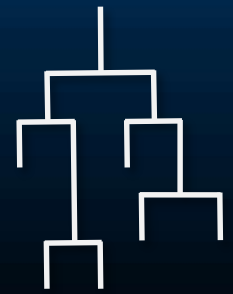
Seafloor Structure

PRODUCTIVITY



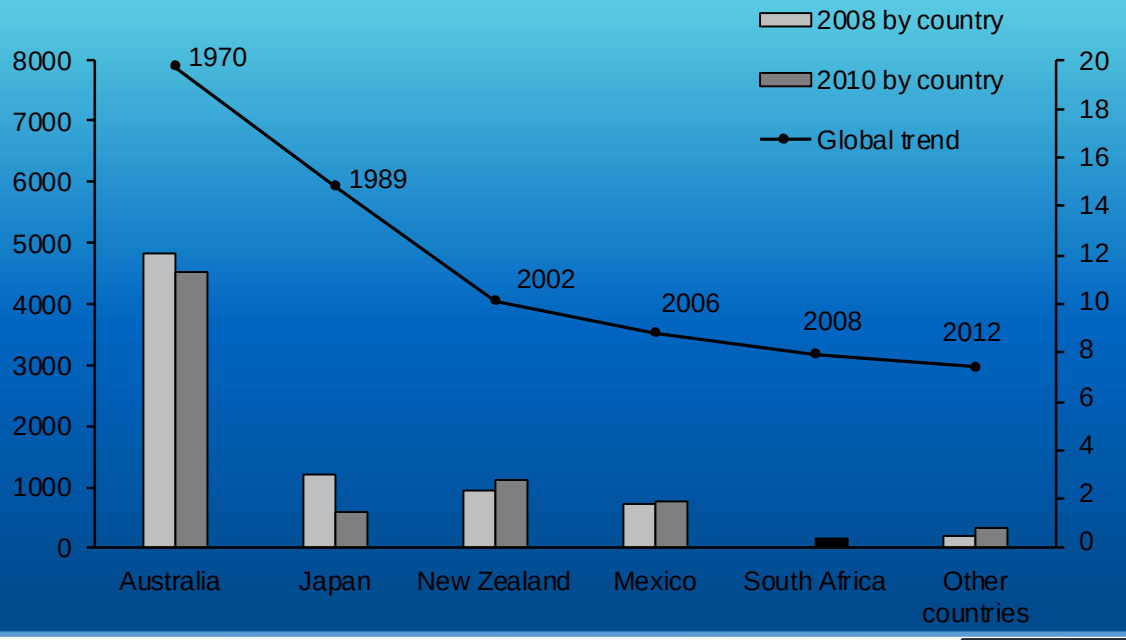
Biomass and fishing pressure

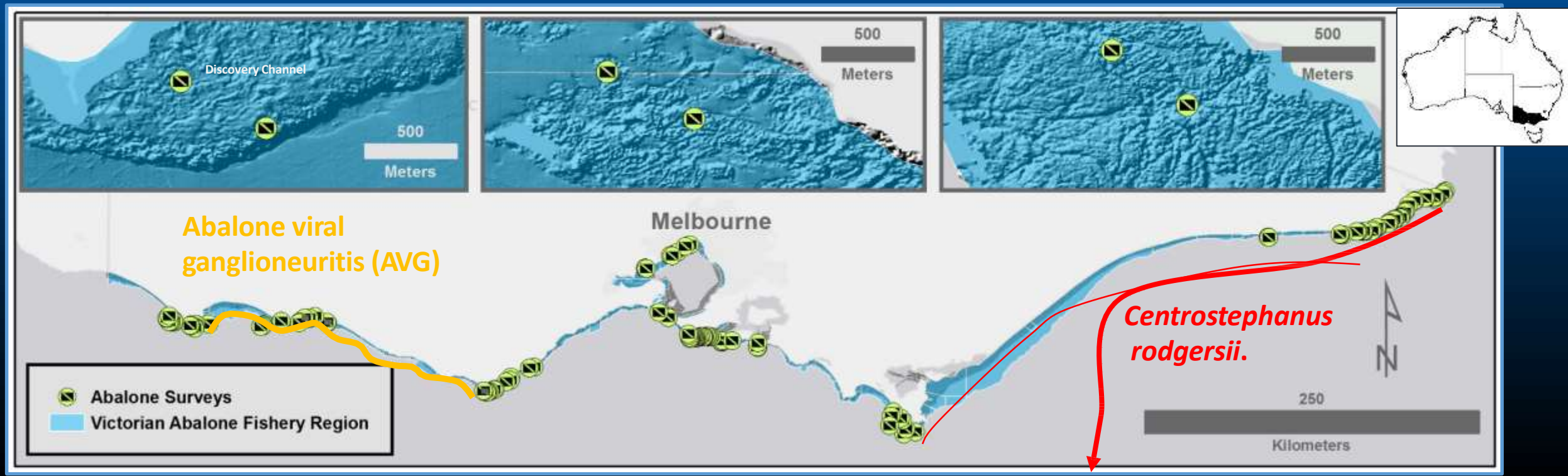
Boosted Regression Tree (BRT)



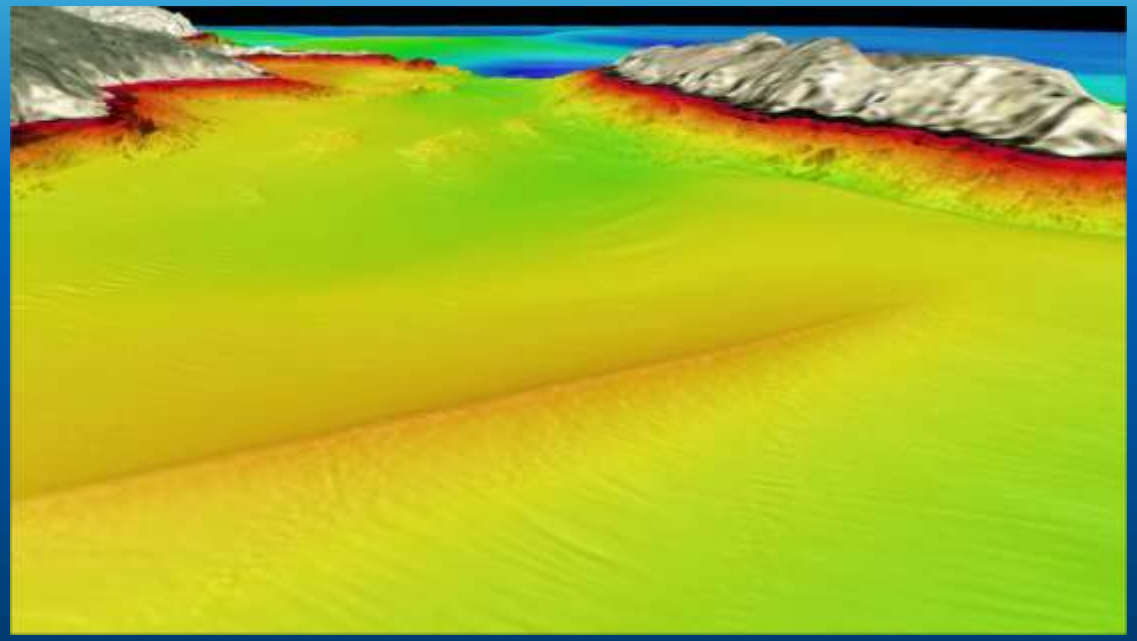
Abalone Fishery

20yrs of data ~180 sites
6 Transects/Sites
30 m long, 1 m wide

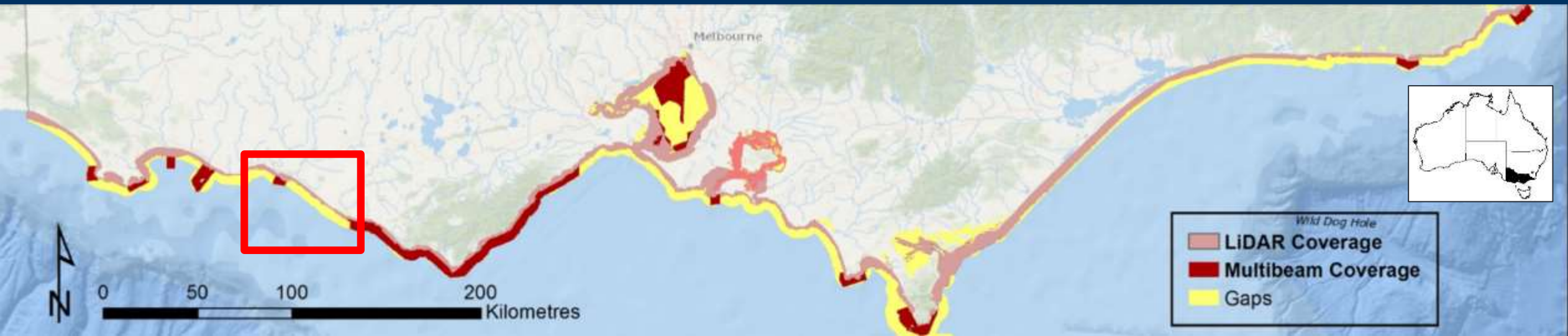




State Seabed Mapping Coverage

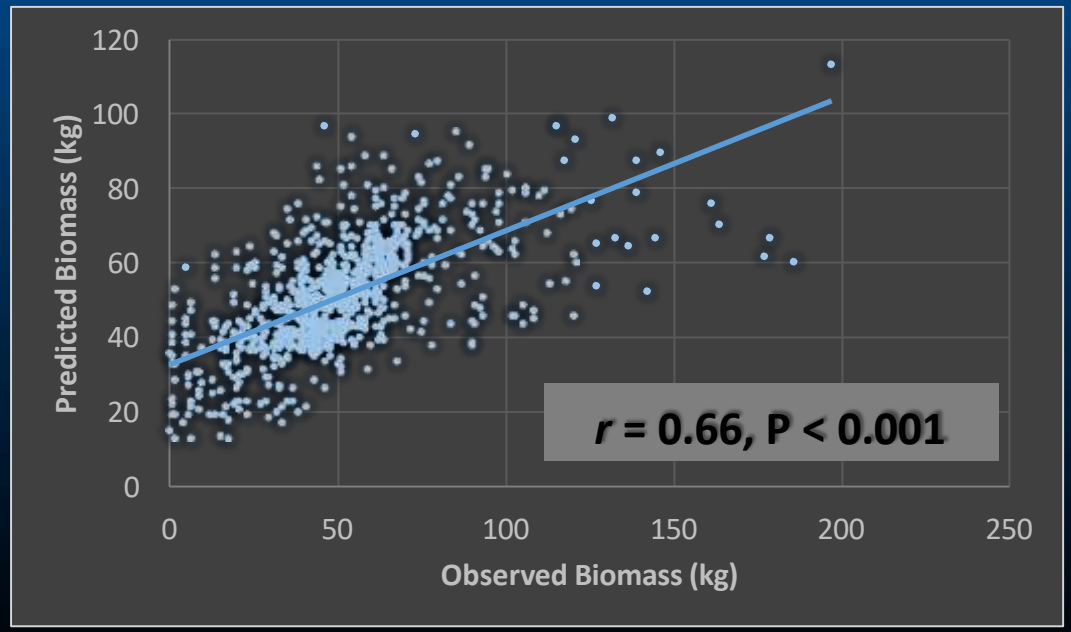


https://vmdp.deakin.edu.au/

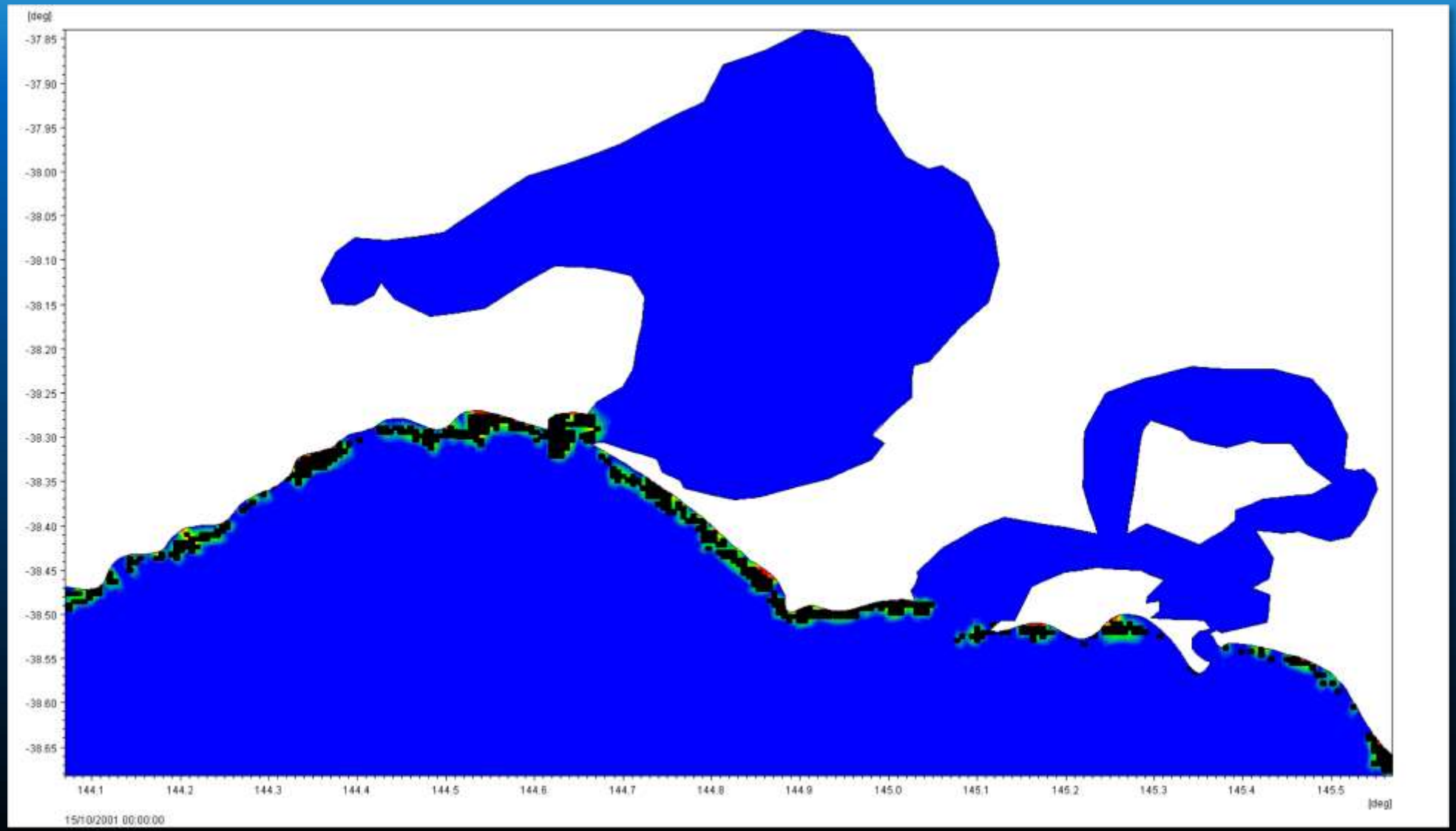


Boosted Regression Tree (BRT) Results

Variable	Influence on Model
Summer SST	25%
Annual Self Recruitment	13.1%
Max Annual Current Speed	12.1%
Annual In Degree	11.8%
Max Winter Wave Orbital Velocity	10.6%
Depth	7.9%
Reef Area	6.3%
BPI 50 m	6%
Vector Ruggedness Measure	4.9%
AVG Infection	2.2%

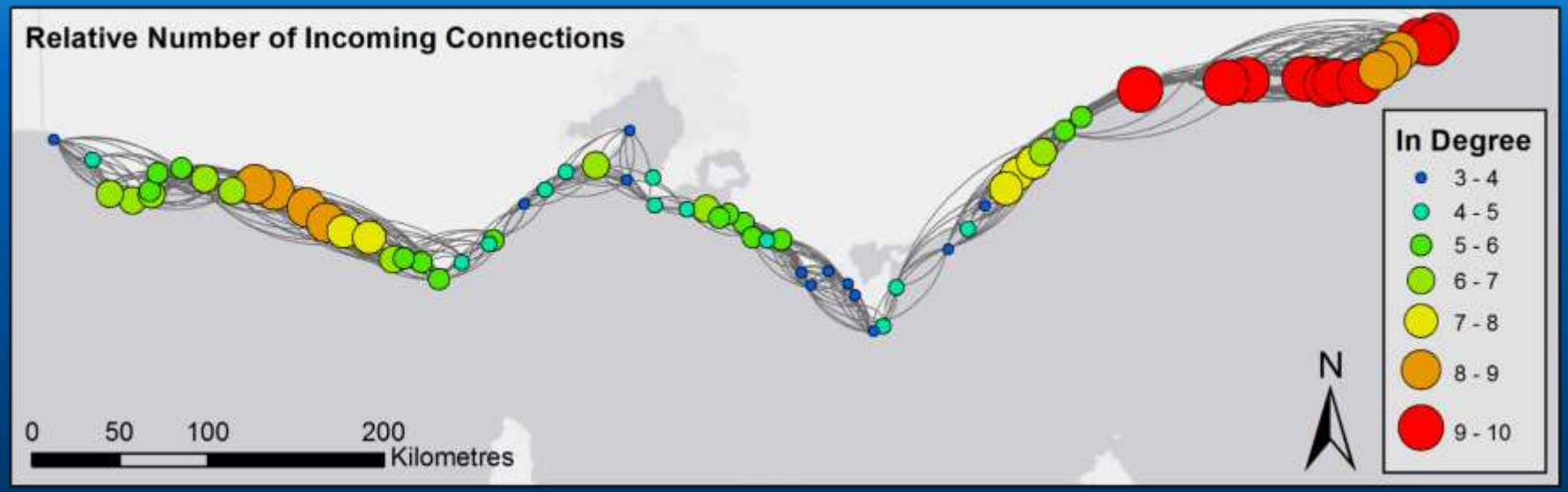


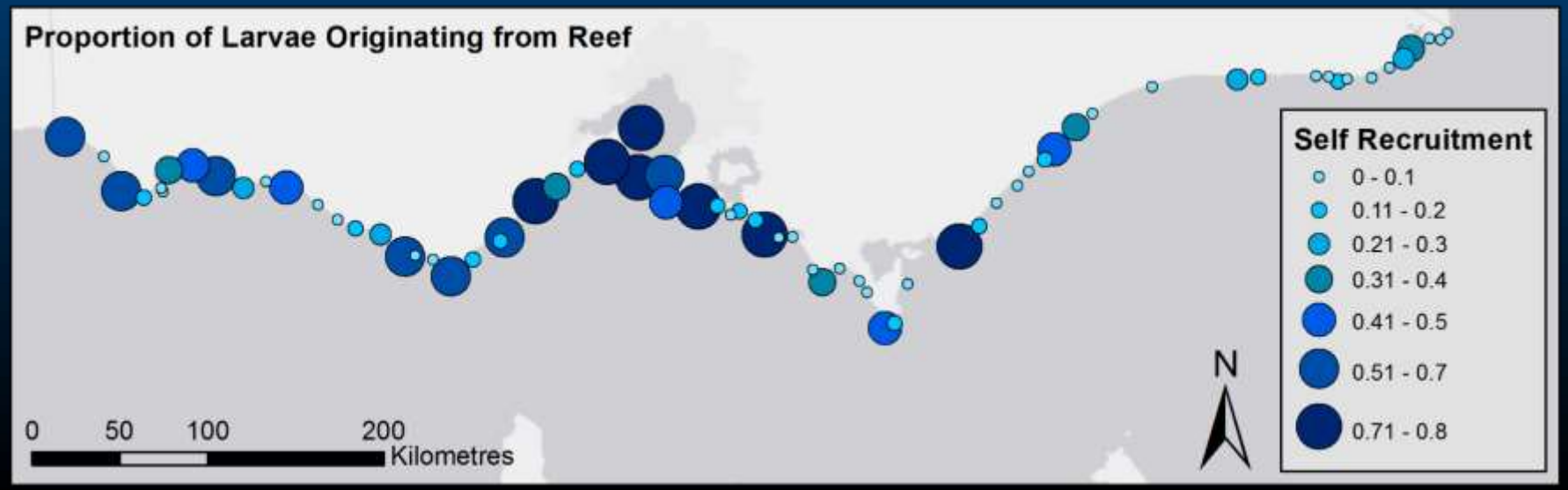
Biophysical Modelling



Spatial & Temporal Connectivity

Annual Variability in Connectivity from 1990-2015

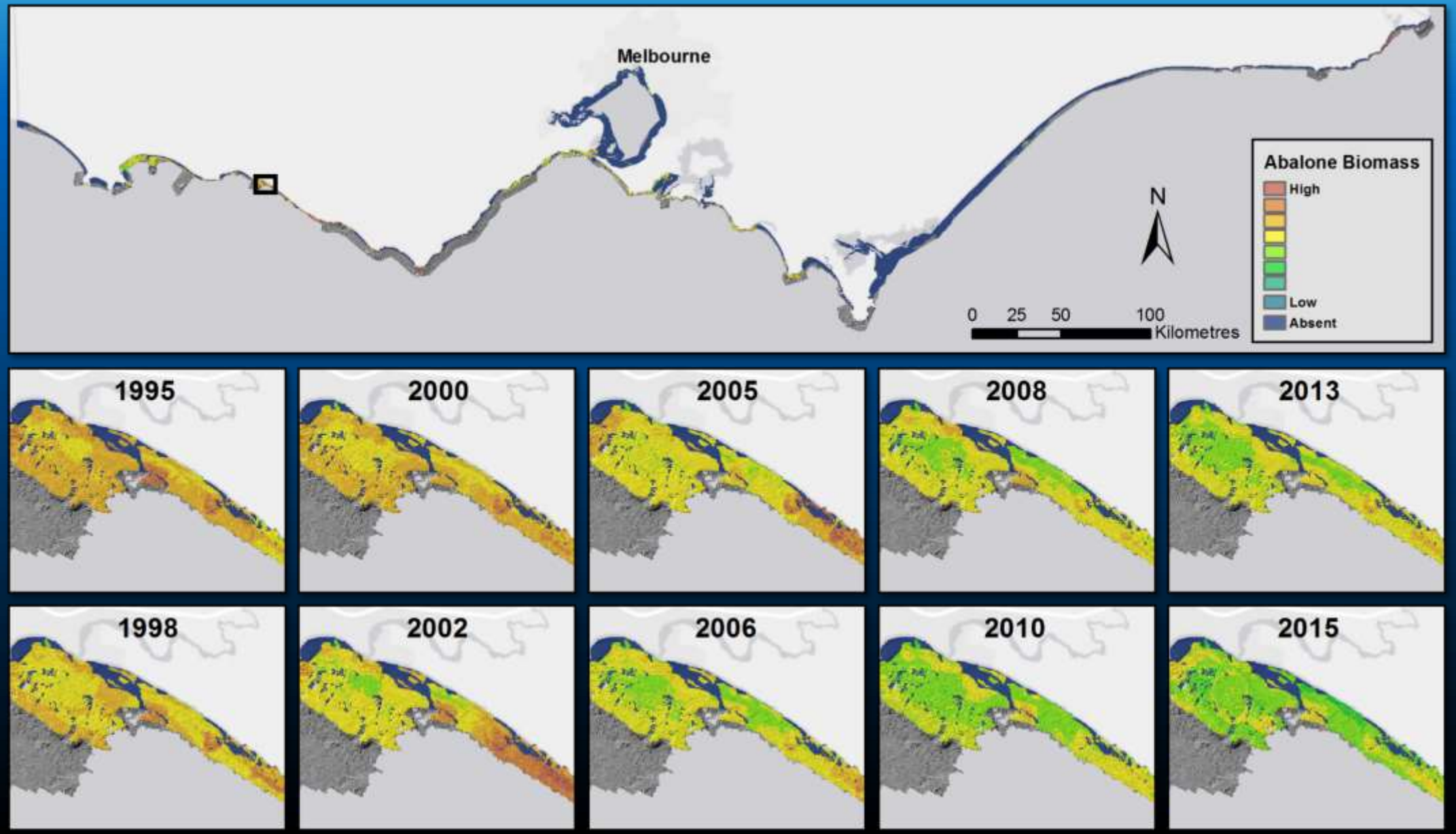




Larval connectivity distance of abalone appears to be on the order of less than 50 km (perhaps occasionally up to 100 km).

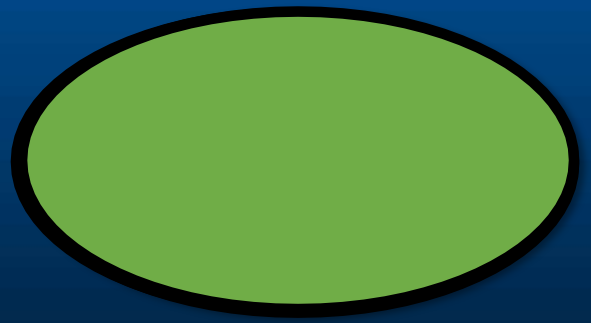
The primary sources of abalone larvae are from those large populations in the west half of the state, with a few strong sources in the east.

Temporal Variation in Biomass

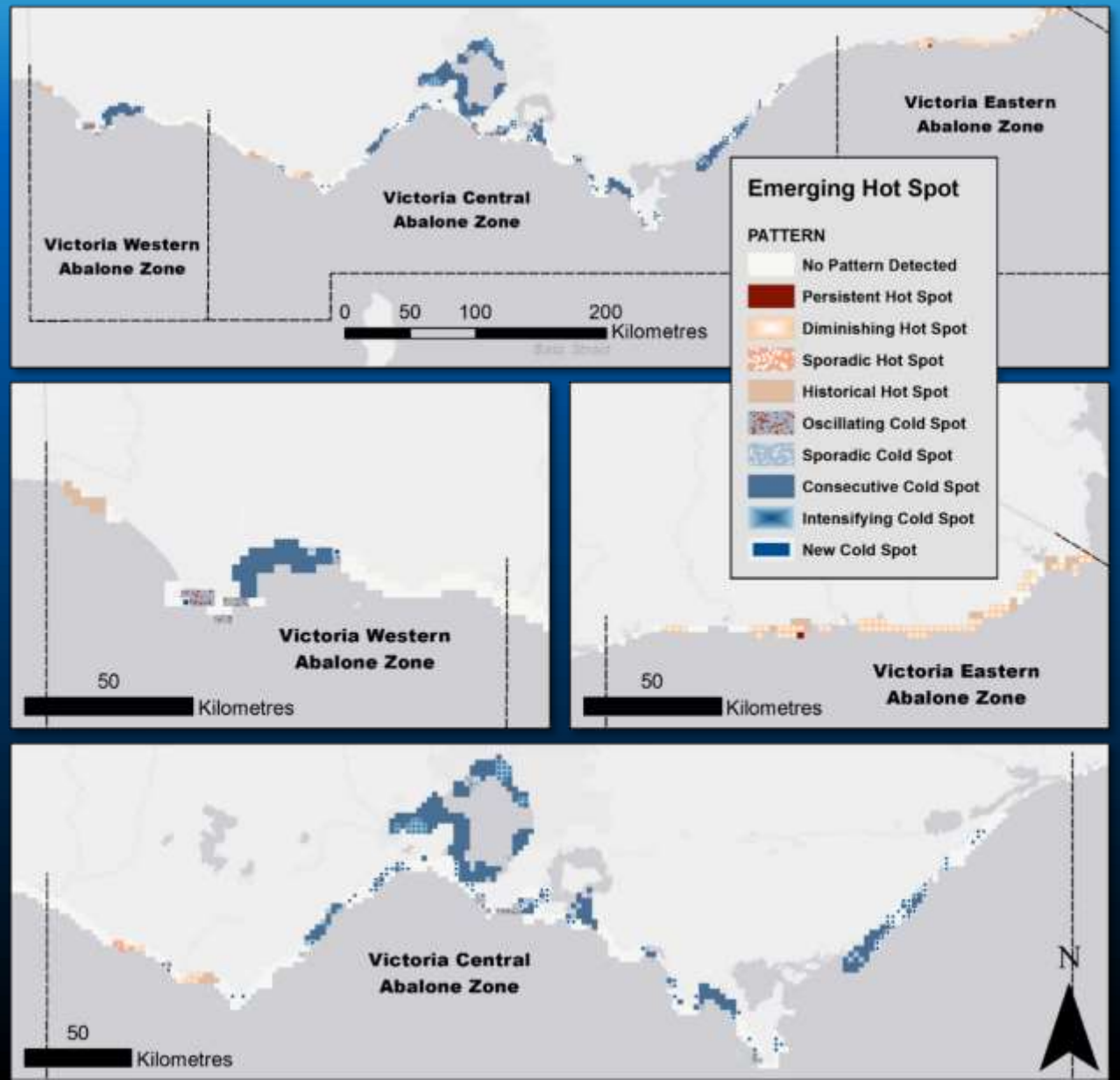


Annual Biomass Predictions

Space Time Cube



Biomass: Emerging Patterns



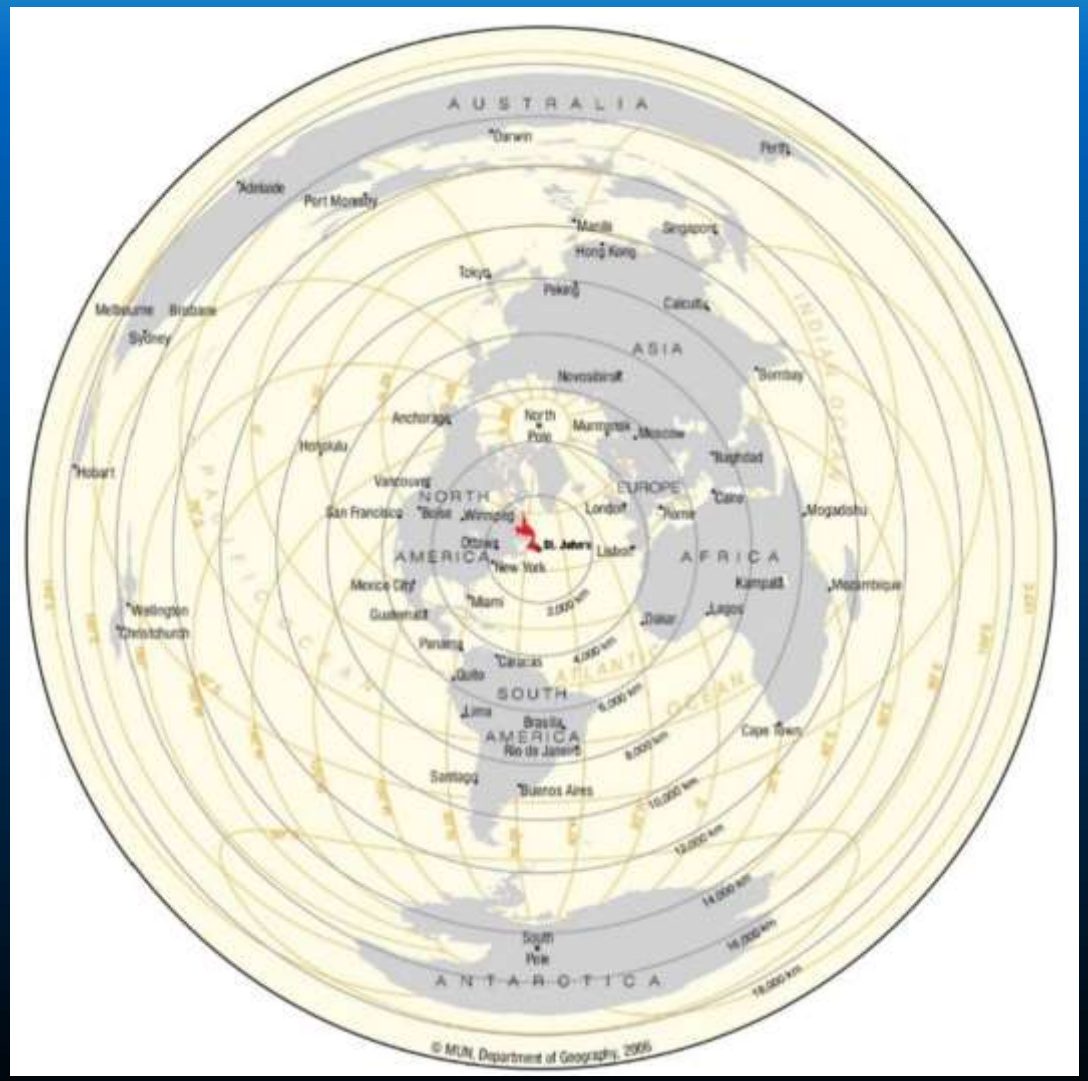
38% - No Pattern

12% - Hot Spots

50% - Cold Spots

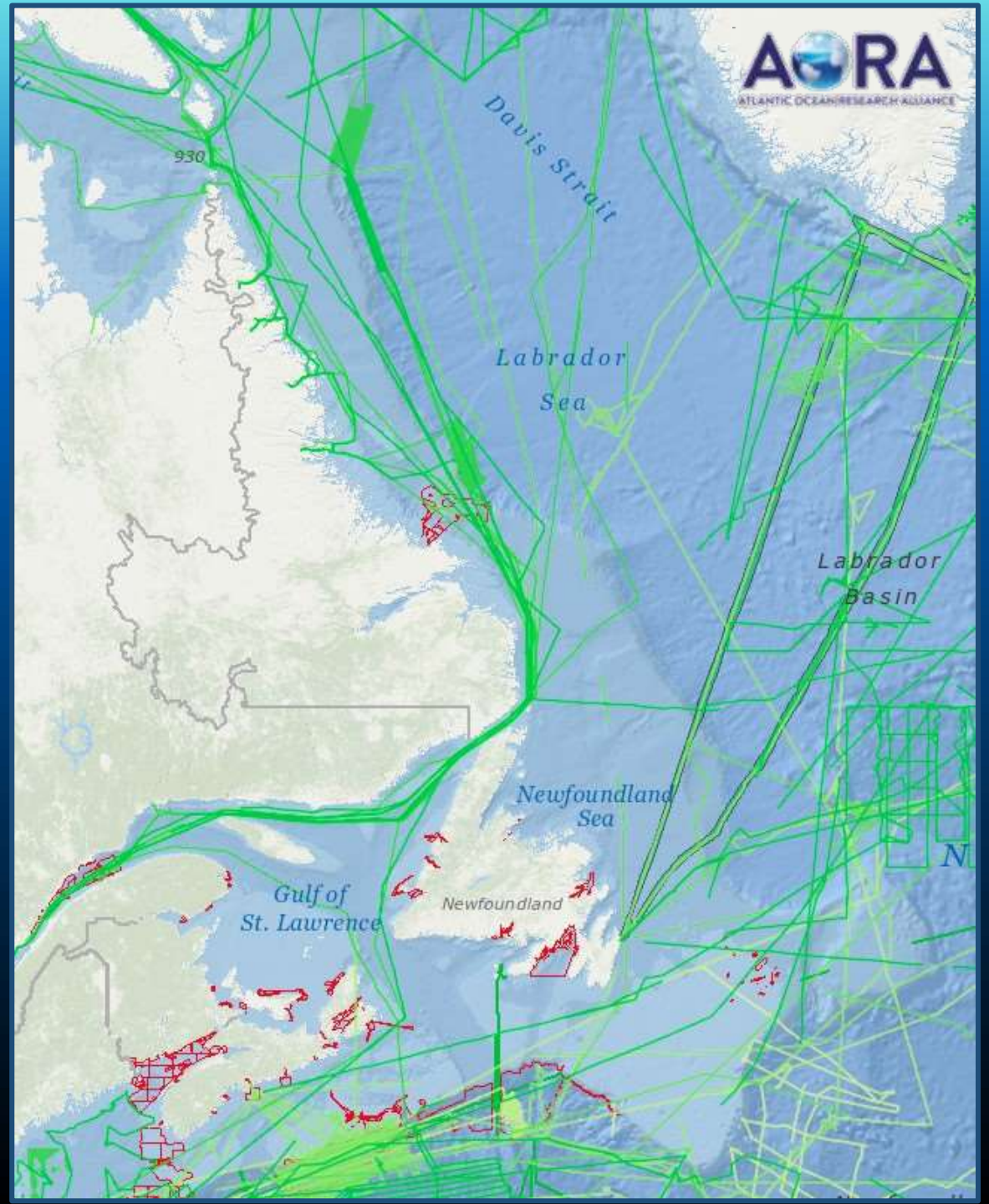
Emerging Hot Spot Pattern	Percentage of Victoria
No Pattern Detected	38%
Persistent Hot Spot	< 1%
Diminishing Hot Spot	8%
Sporadic Hot Spot	< 1%
Historical Hot Spot	4%
Oscillating Cold Spot	9%
Sporadic Cold Spot	32%
Consecutive Cold Spot	3%
Intensifying Cold Spot	4%
New Cold Spot	3%

Regional seabed mapping with crowd sourced bathymetry

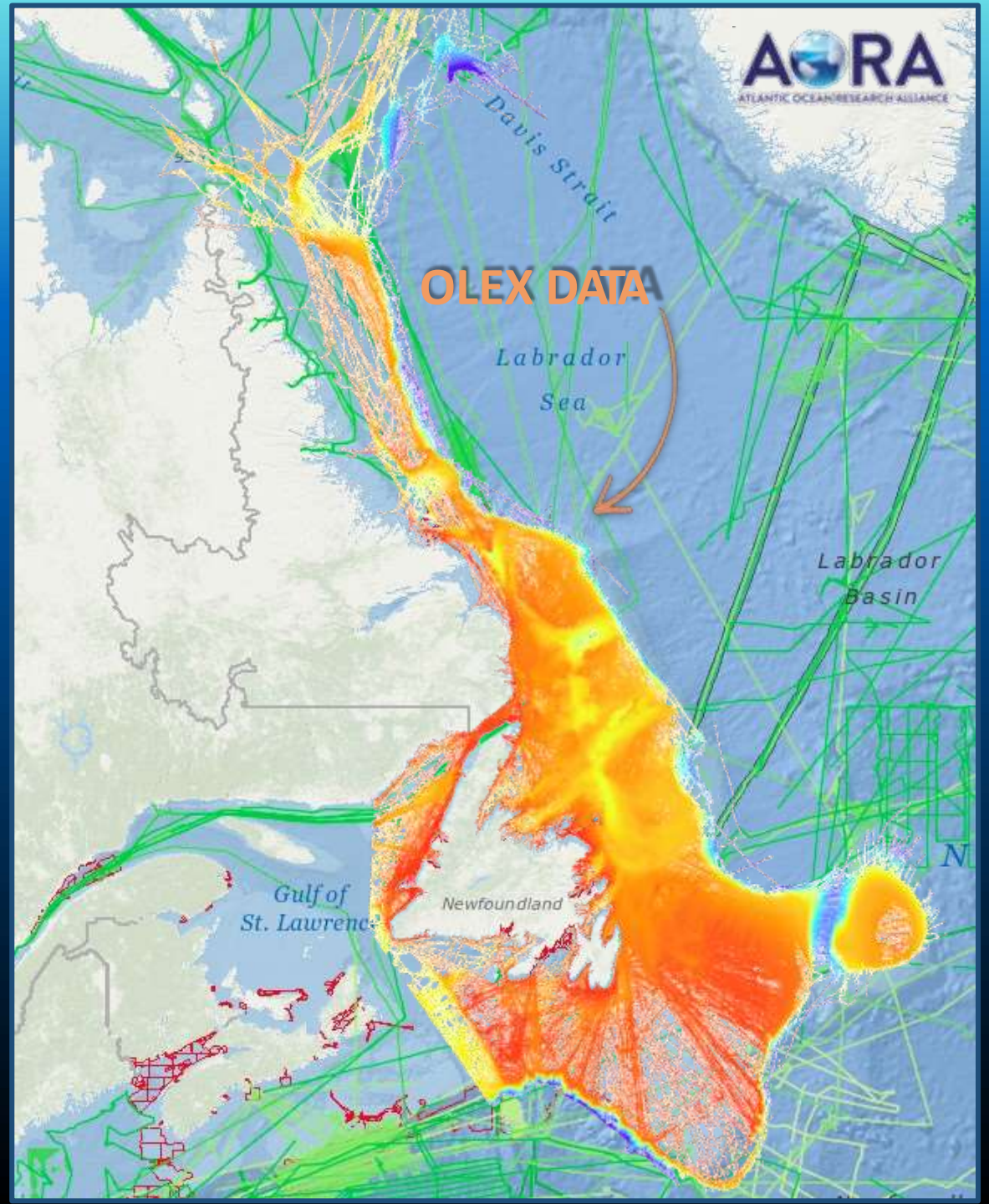


Newfoundland and Labrador Shelf Case Study

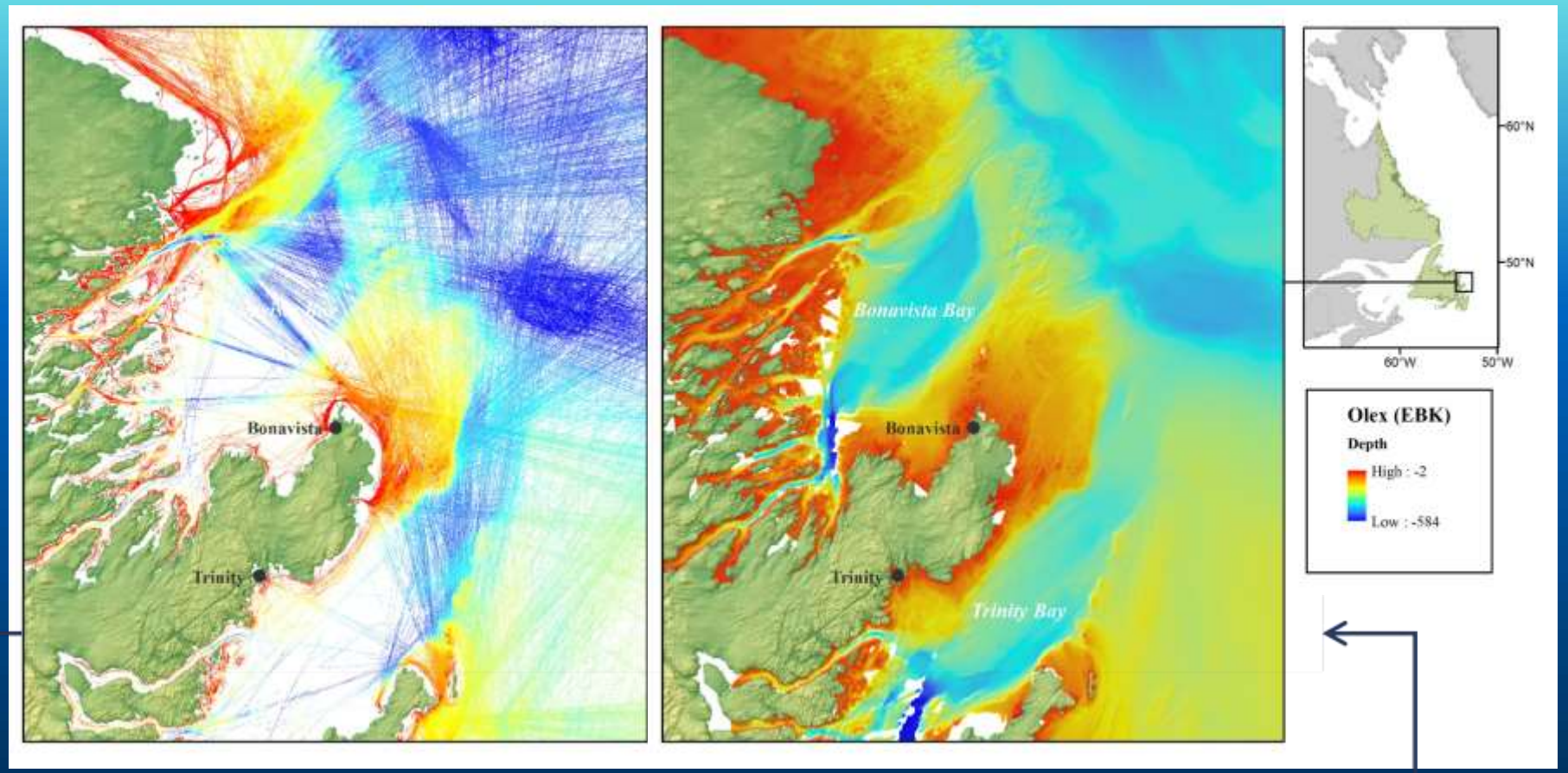
- Need for habitats maps for seabed type, structure and ecosystem based management
- DFO need for spatially explicit models for ESBFM
- Decrease in groundfish linked to overfishing and a changing climate

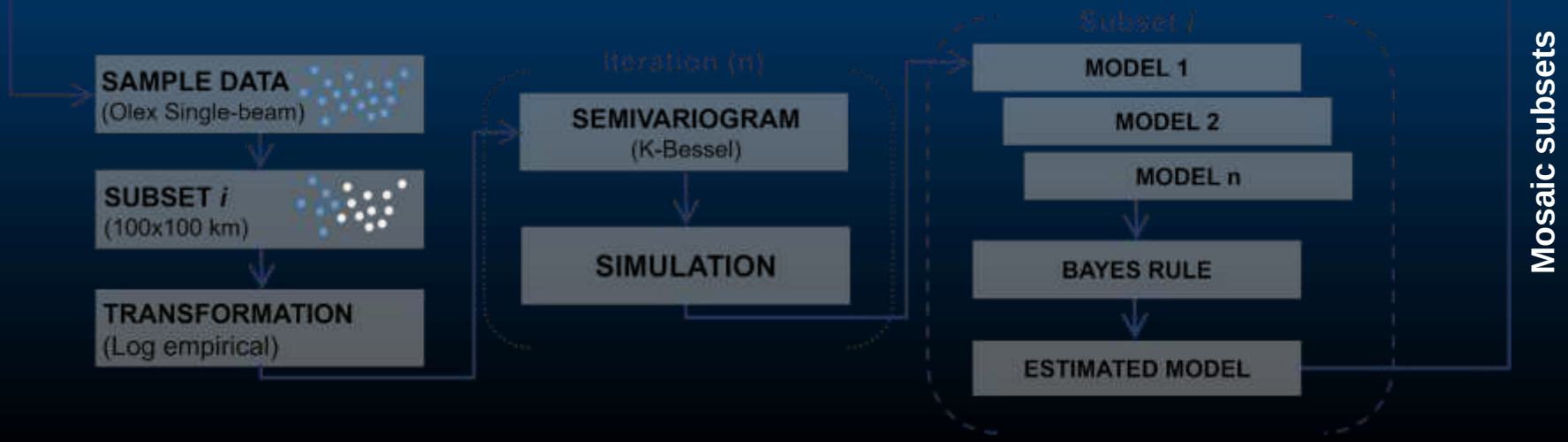


- Multibeam Sonar coverage limited by cost and effort



- Multibeam Sonar coverage limited by cost and effort
- OLEX crowd sourced bathymetry dramatically improving coverage



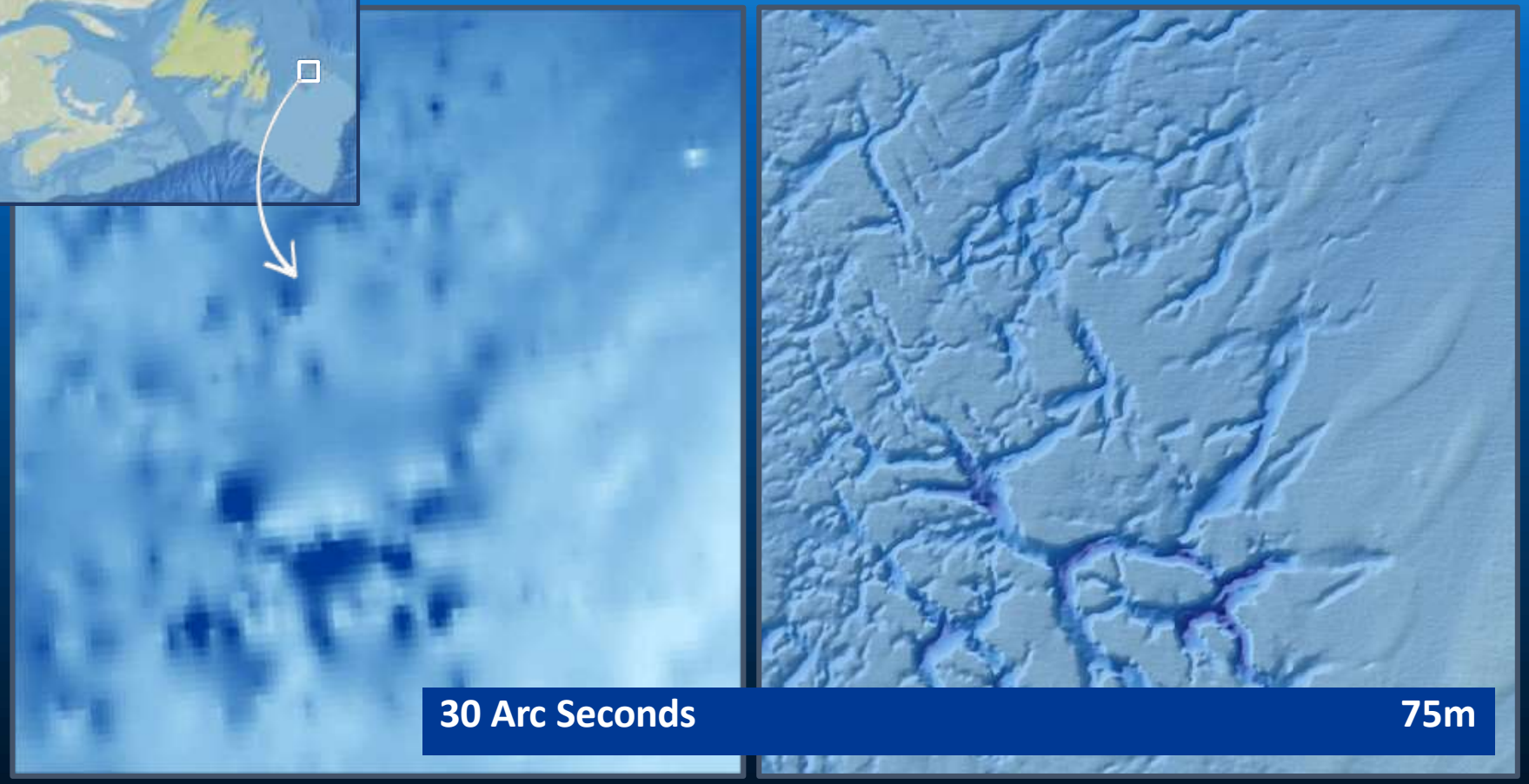


Geostatistical interpolation using **Empirical Bayesian Kriging**

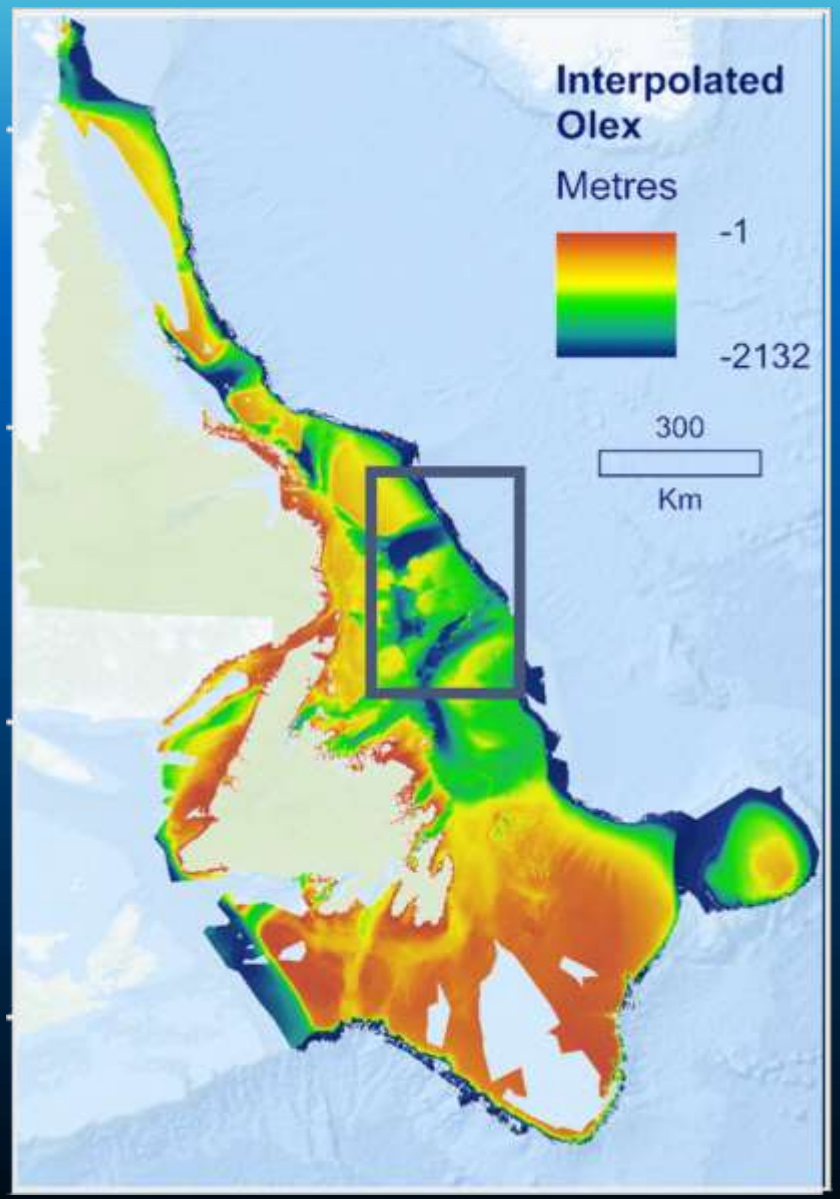
- estimating the underlying semi-variogram from hundreds of iterations for error estimation
- 100 x 100km subsets interpolated to speed up EBK process
- Mosaicked post EBK processes

GEBCO 2014

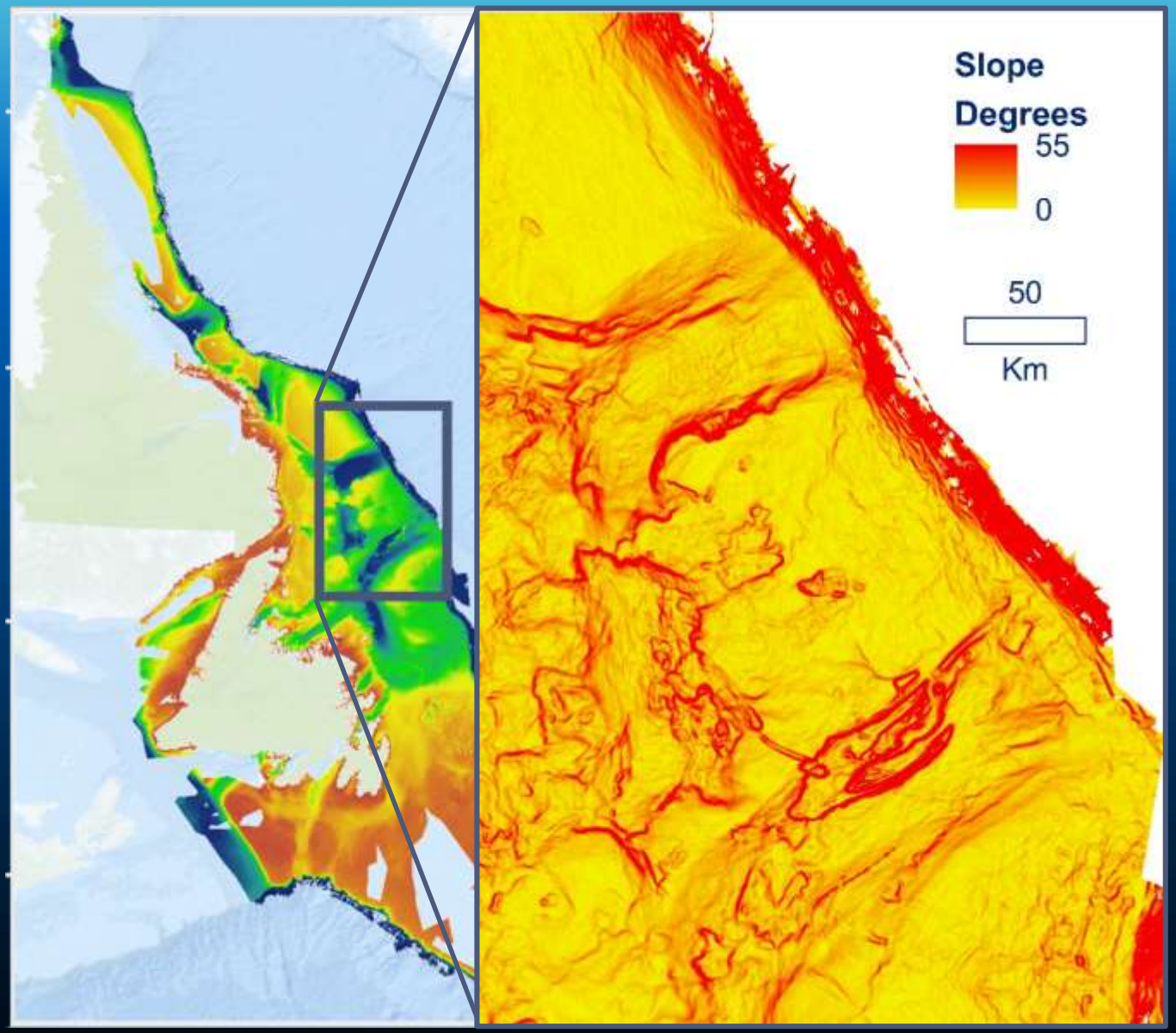
INTERPOLATED OLEX



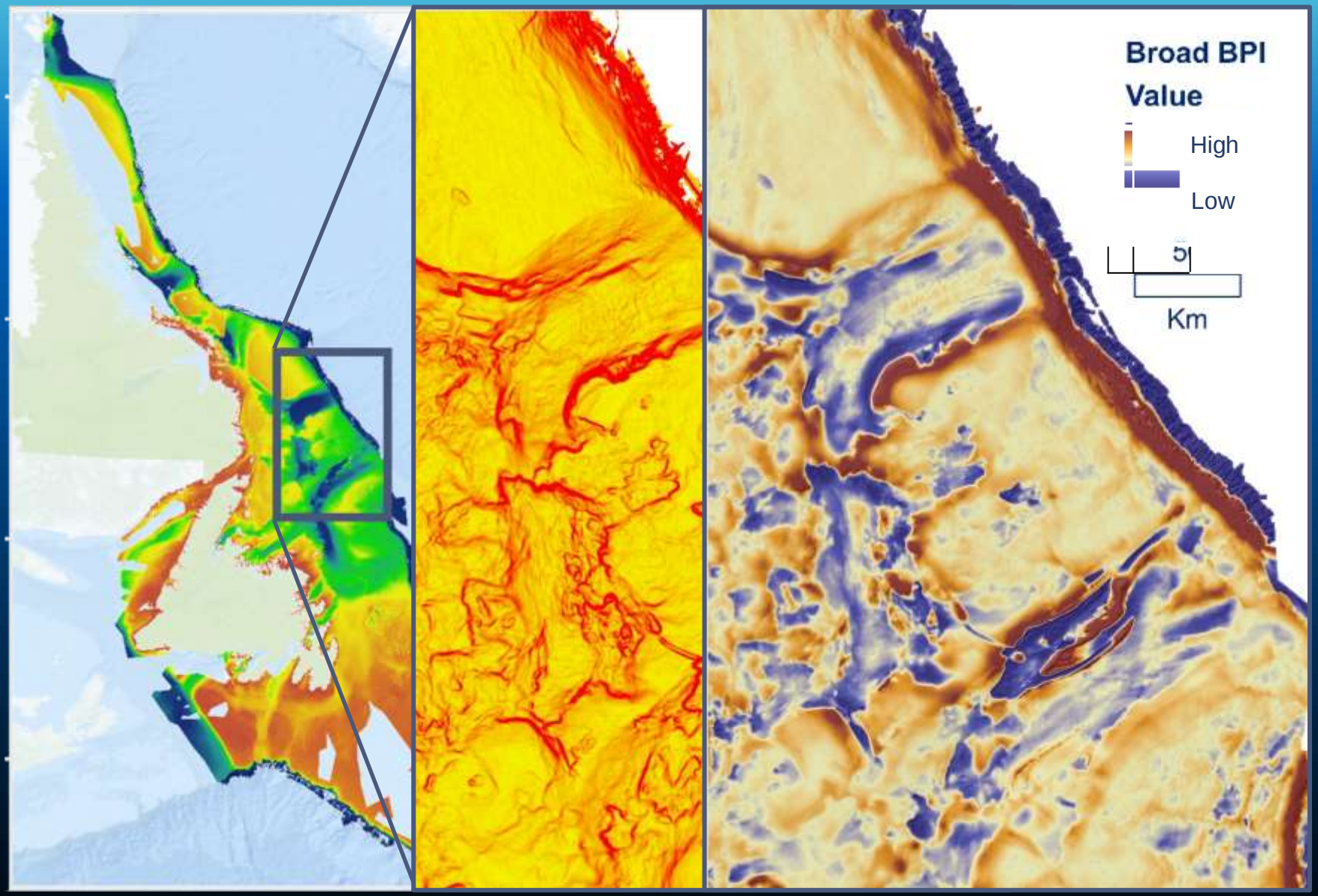
>100x finer resolution bathymetry than previously available for the majority of the study area



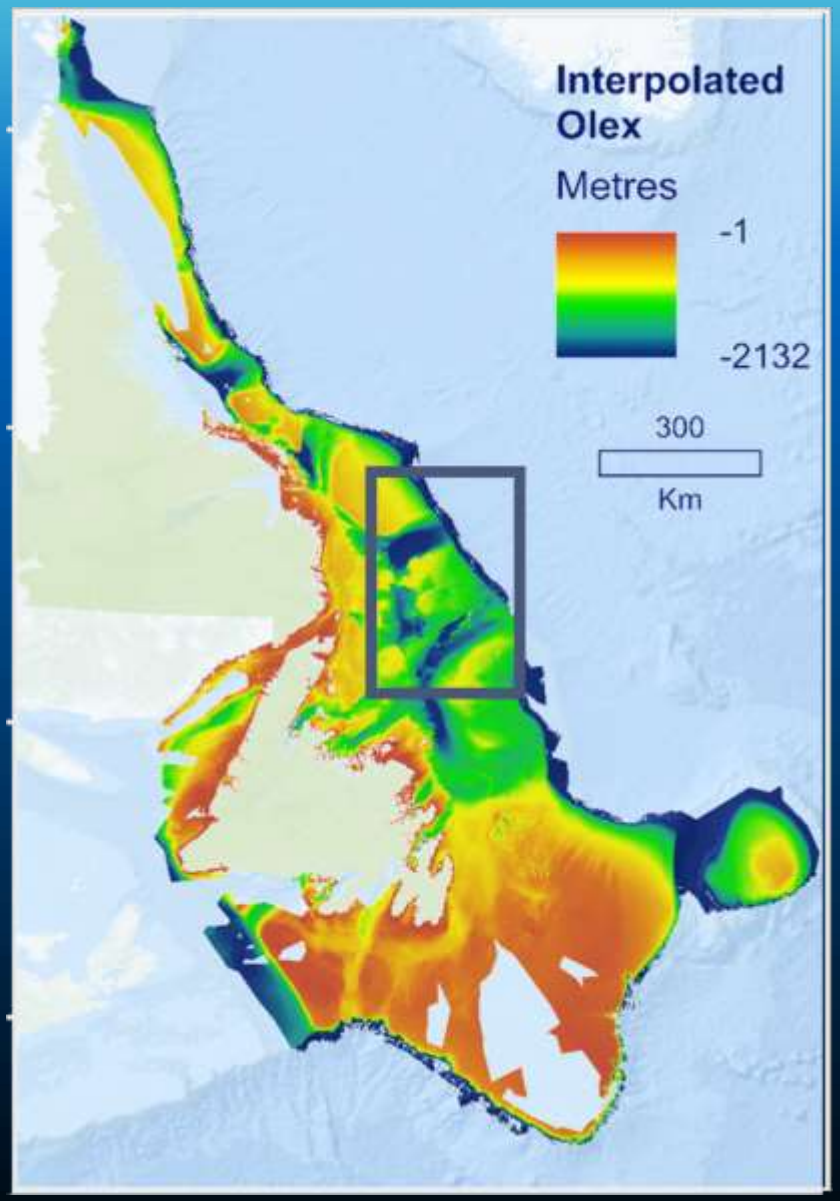
690 725 km² of continuous bathymetry and terrain derivatives



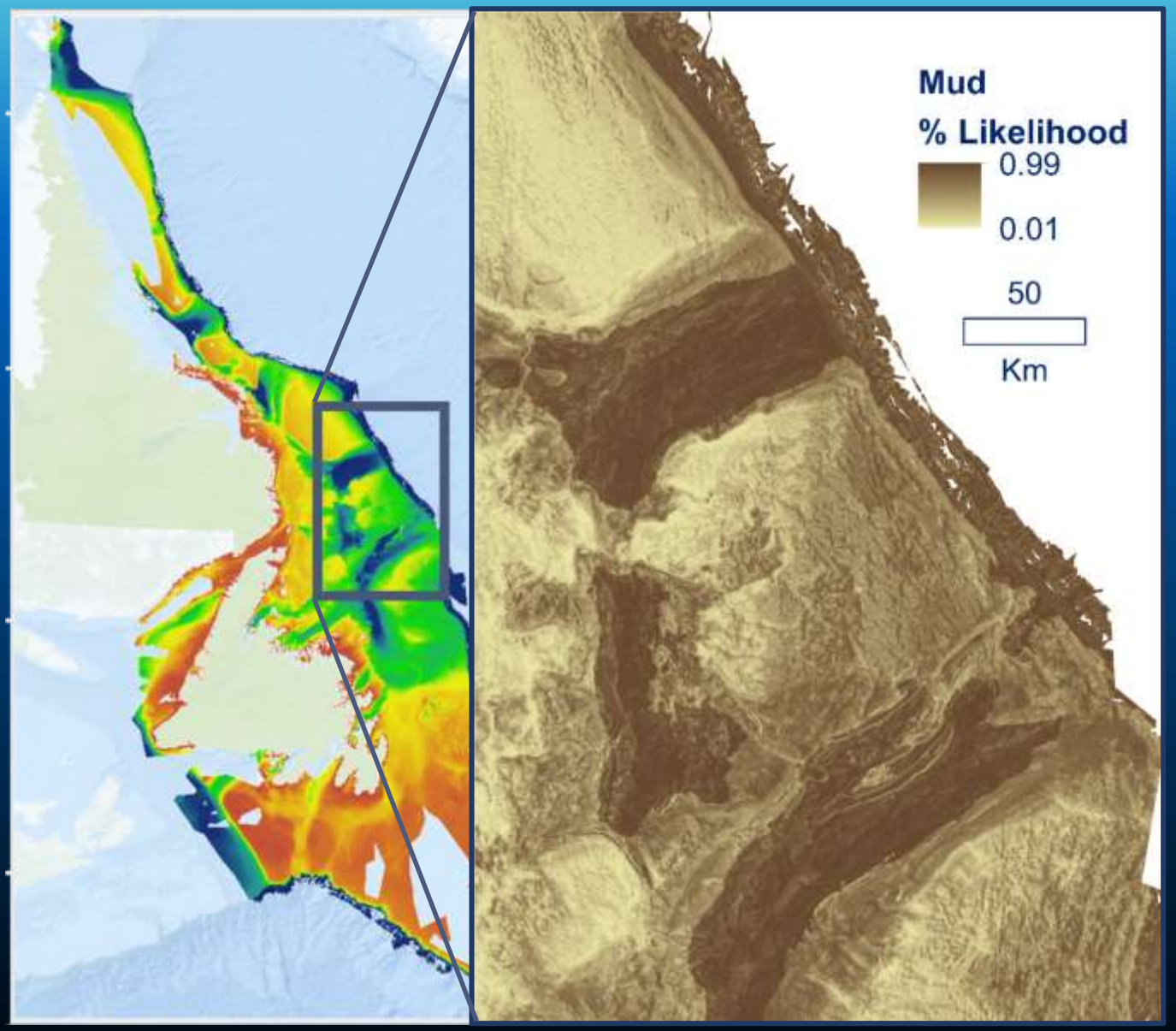
690 725 km² of continuous bathymetry and terrain derivatives



690 725 km² of continuous bathymetry and terrain derivatives



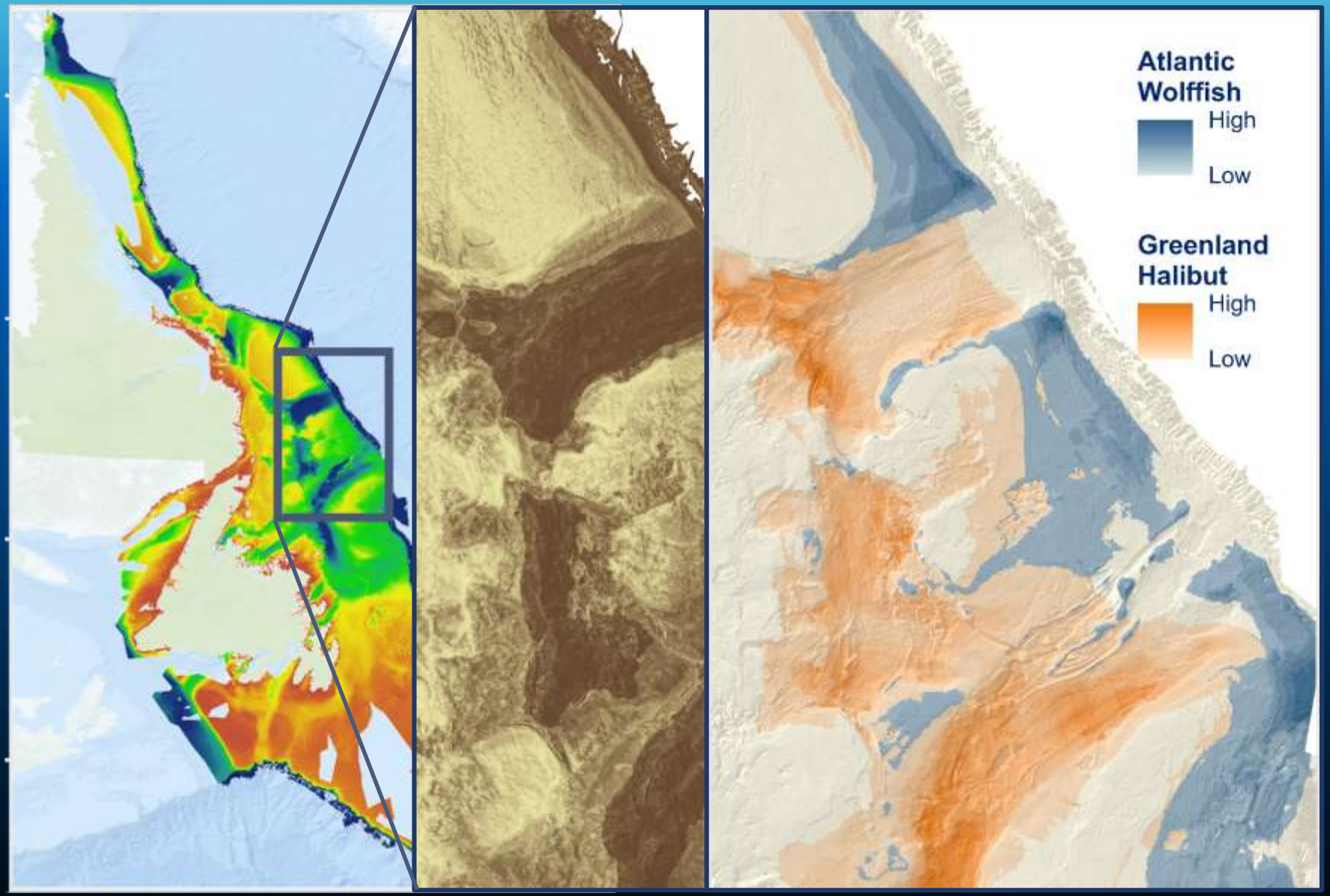
Geomorphology as predictors of substrate type and species distribution.



Boosted regression trees

- Grab samples + crowdsourced bathymetry + GLORYS2 oceanographic data
- CV correlation = 0.81
- CV ROC = 0.945
- Hold-out accuracy = 0.78

Substrate class ~ depth + slope + BPI + rugosity + aspect + current speed + current direction



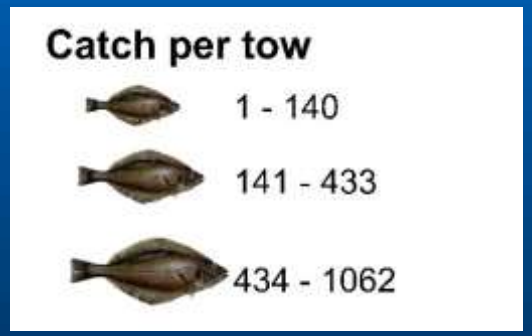
Fish density ~ depth + slope + BPI + rugosity + current + salinity + temperature

Fish distribution (Autumn 2014)

- Fish distribution models trained on all preceding survey years (1995-2013)
- Predictions generated based on environmental conditions in 2014

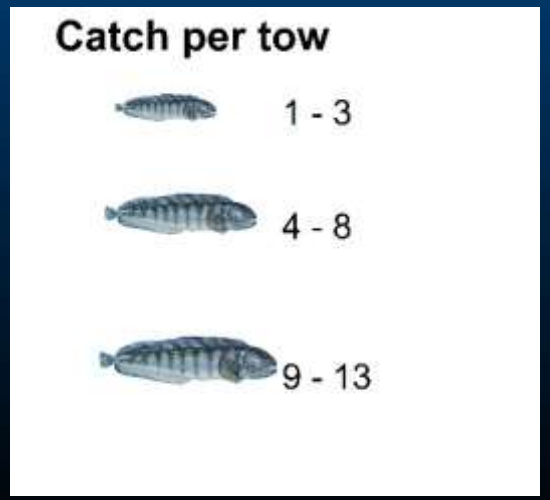
Greenland Halibut
(Commercial fishery)

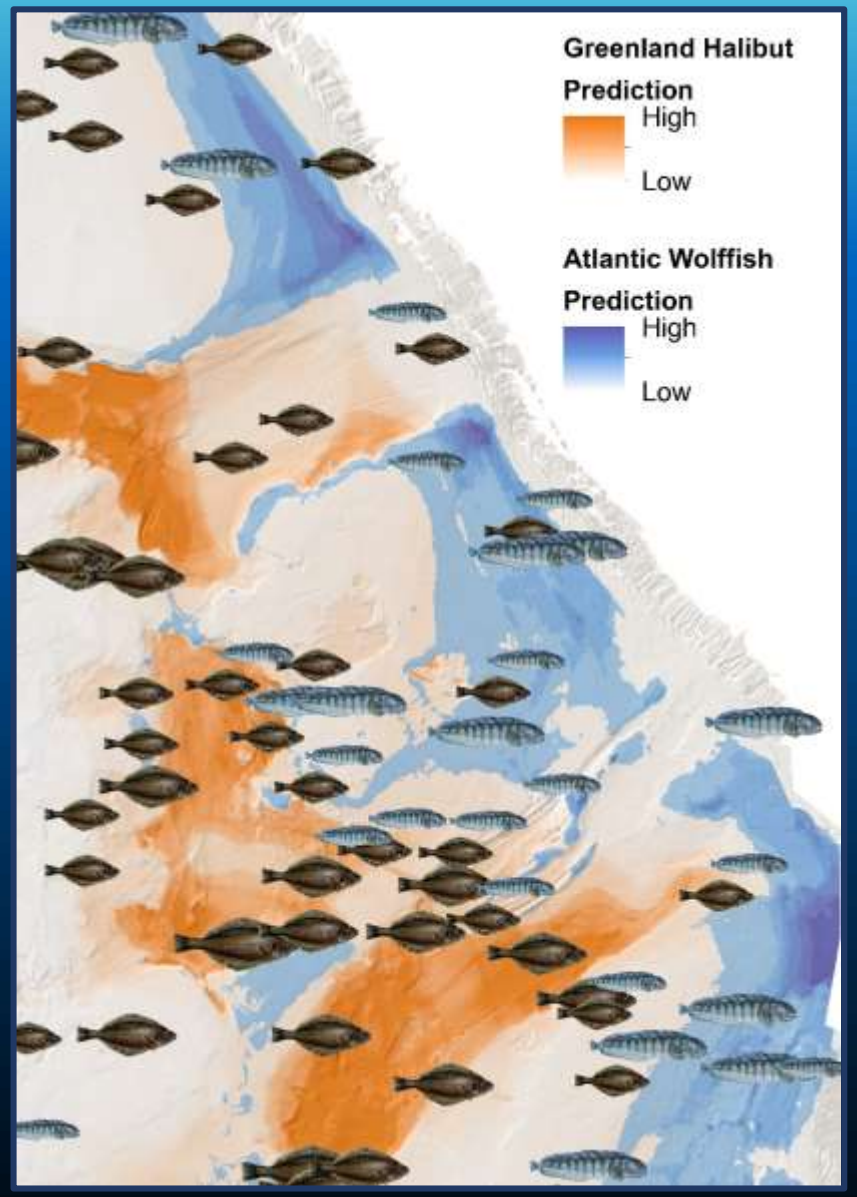
- CV correlation = 0.78
- CV ROC = 0.95
- Correlation to 2014 tows = 0.75



Atlantic Wolffish
(Species at Risk)

- CV correlation = 0.61
- CV ROC = 0.87
- Correlation to 2014 tows = 0.57





Conclusions

- Whilst not a replacement for high resolution bathymetry data CROWD SOURCED BATHYMETRY does provide a source for planning, reconnaissance, groundtruthing and modelling

- Opportunity to creatively use existing datasets (collect once use many times) and resources to improve seafloor maps at minimal cost.

- Develop/ adopt a data structure to handle scalable bathymetry, uncertainty and associated metadata

Thanks for listening….

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www.marinemapping.org

Deakin Marine Mapping Group

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