Testing the transferability of species distribution models between shallow seamounts in the North Pacific Ocean

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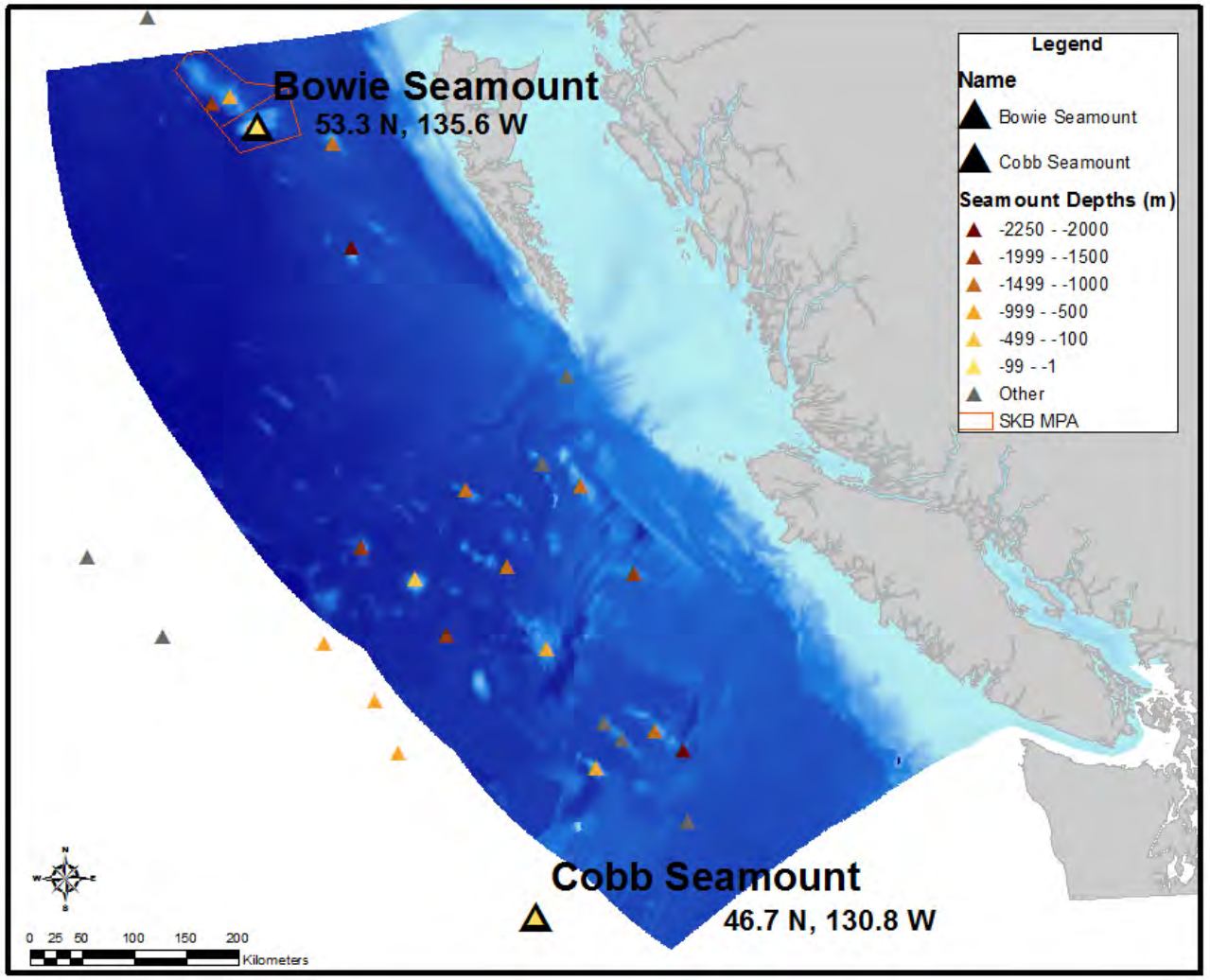
Model Transferability between Seamounts

- Challenge: Studying seamounts is hard!
- Question: Can species distribution models made for one seamount be transferred to other seamounts?
  - Using environmental proxies to map biodiversity and sensitive species would be a benefit to the conservation and management of other seamounts.
- Understand important environmental variables.


Bowie Seamount
53.3 N, 135.6 W
Cobb Seamount
46.7 N, 130.8 W
Legend
Name
Bowie Seamount
Cobb Seamount
Seamount Depths (m)
-2250 - -2000
-1999 - -1500
-1499 - -1000
-999 - -500
-499 - -100
-99 - -1
Other
SKB MPA
0 25 50 100 150 200
Kilometers

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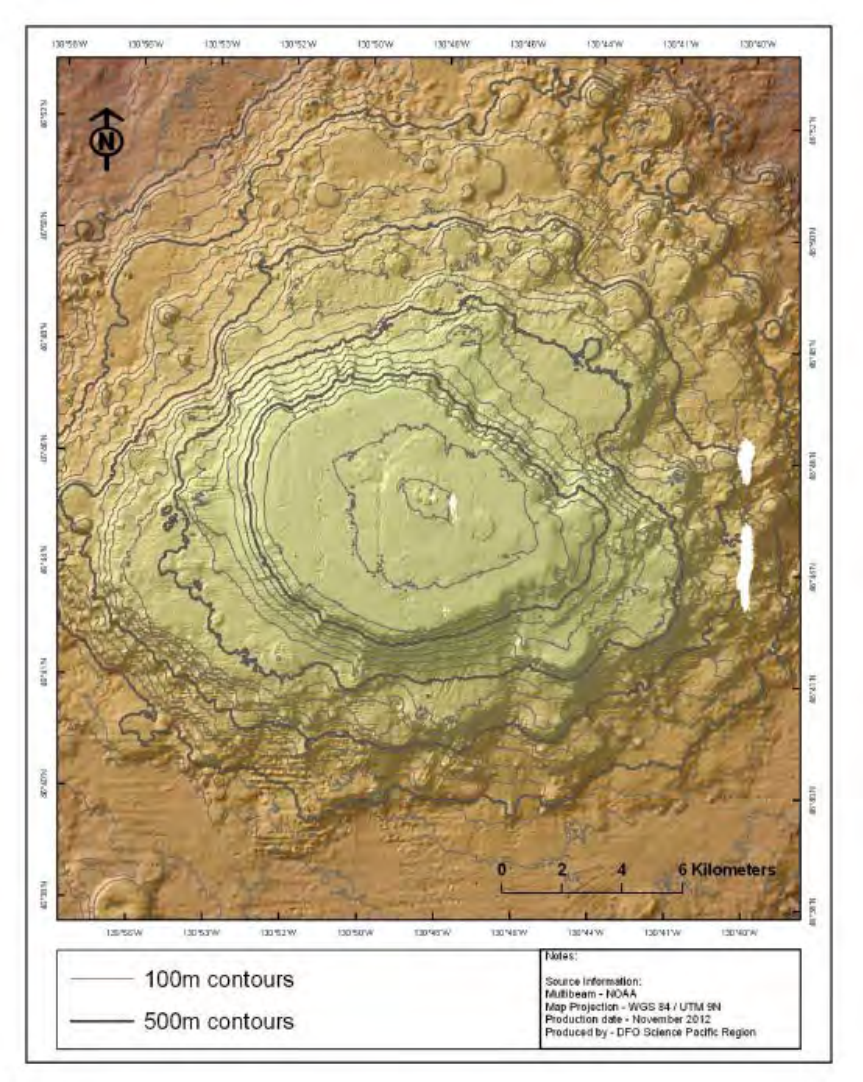
Cobb Seamount

- 46° 44’ N, 130° 48’ W
- 500 km W of Gray’s Harbor, WA.
- Outside EEZ
- Base 2743 m
- Pinnacle <24m
- 4 terraces and a steep sided flat-topped terrace (guyot)
- ~27 MYO



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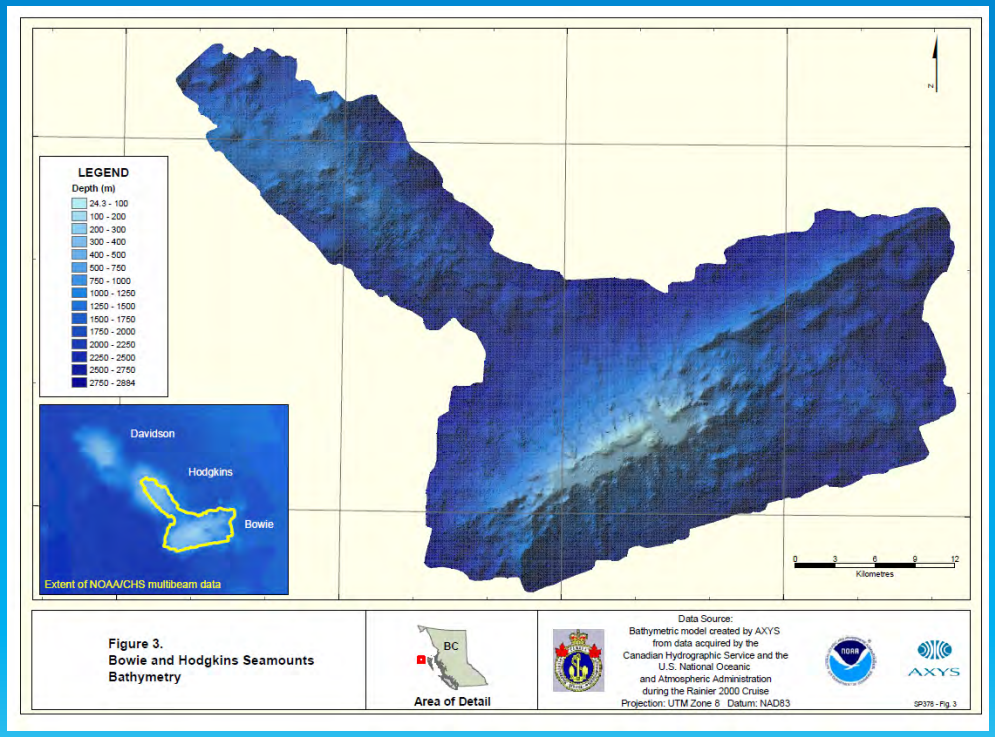
Bowie Seamount (Sgaan Kinghlas)

- 53° 18′ N, 135° 39′ W
- 180 km W of Haida Gwaii
- Inside Canada's EEZ, protected as an MPA
- Base 3100 m
- Pinnacle at 24 m
- Two terraces with steep (>20°) sides
- Area at base 1320 km²
- Hodgkins min 596 m
- Oldest part 600,000 years



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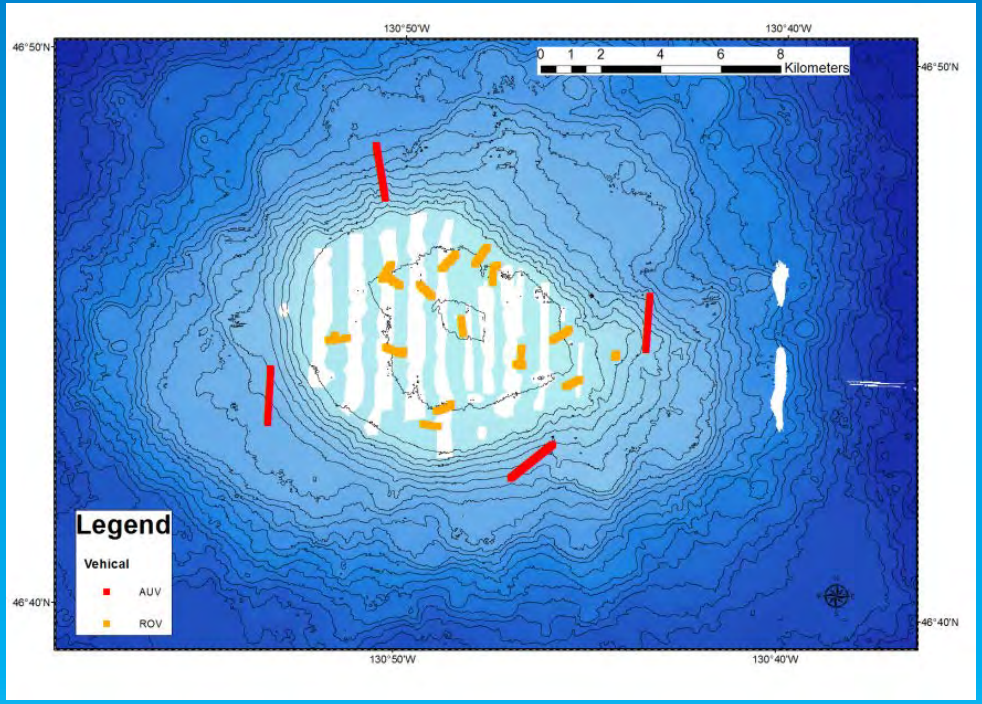
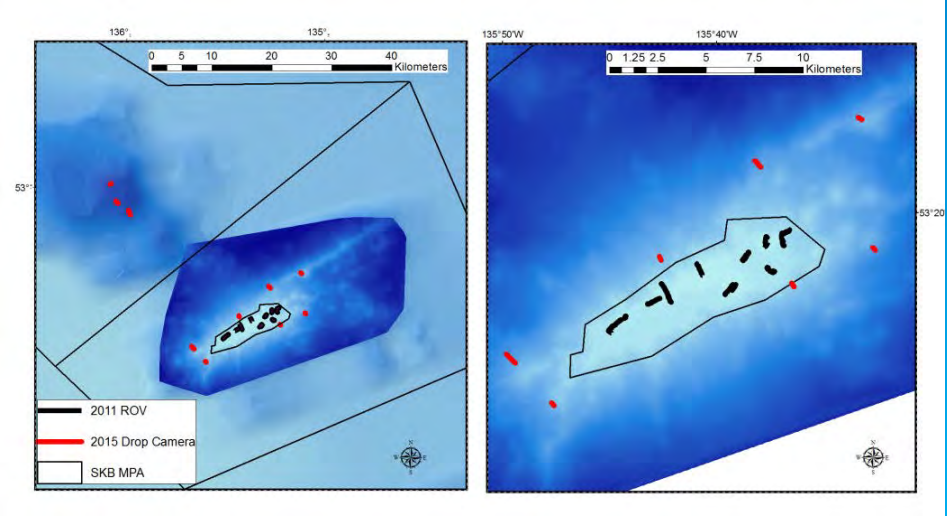
Cobb Survey

- DFO/NOAA survey in 2012
- AUV - 4 transects
- 2 ROVs – 15 transects
- Depths surveyed 34-210 and 473 to 1154 m
- 211-472 m not sampled
- Collection of 7000 high resolution images
- Observations of 144 taxa from 11 phyla



Curtis, J.M.R. et al. 2015. 2012 Expedition to Cobb Seamount: Survey methods, data collections and species observations. Can. Tech. Rep. Fish. Aquat. Sci. 3124: xii + 145 p.

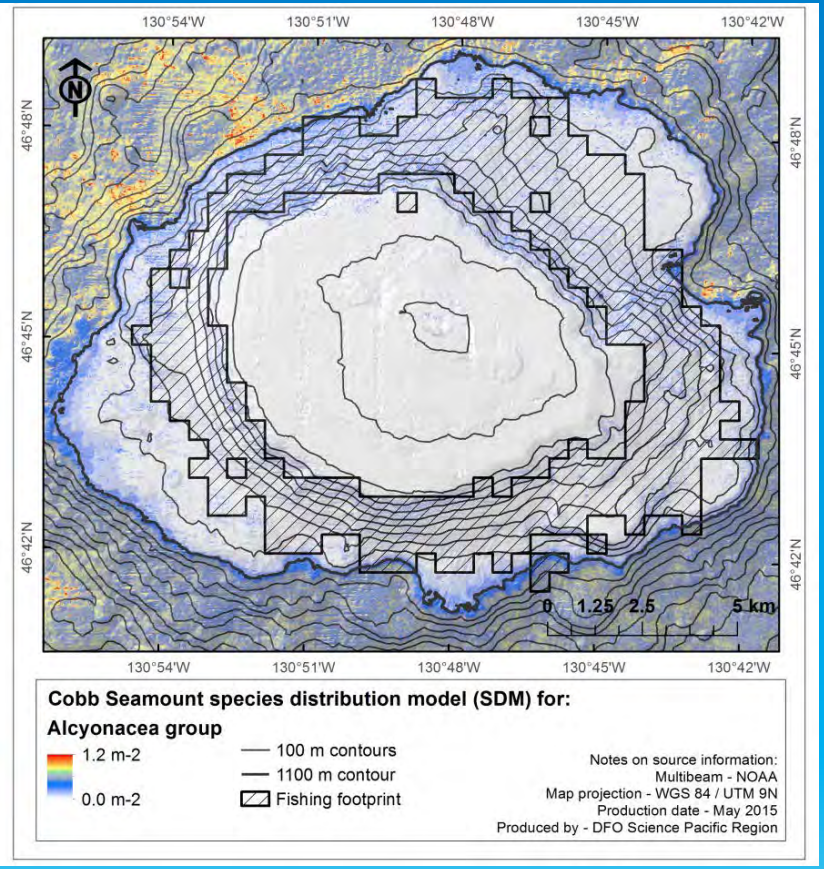
Bowie Seamount Surveys



- ROV - 2011
  - 14 transects
  - 29 - 269 m
- Drop Camera 2015
  - 15 transects
  - 262 – 1245 m
- 191 taxa from 12 phyla

Cobb Seamount Species Distribution Models

- Random Forest Regression
- Parameters: MBES bathymetry and derived layers (20 m)
  - Depth
  - Slope
  - Aspect
  - Broad and Fine Bathymetric Positioning Index (BPI)[1]
  - Curvature
  - Rugosity (arc-chord ratio)[2]



[1]Wright *et al.* ArcGIS Benthic Terrain Modeler (BTM), v. 3.0, Environmental Systems Research Institute, NOAA Coastal Services Center. http://esriurl.com/5754.; 2012

[2]Du Preez, C. A new arc–chord ratio (ACR) rugosity index for quantifying three-dimensional landscape structural complexity. Landscape Ecology. 30:181-192; 2015

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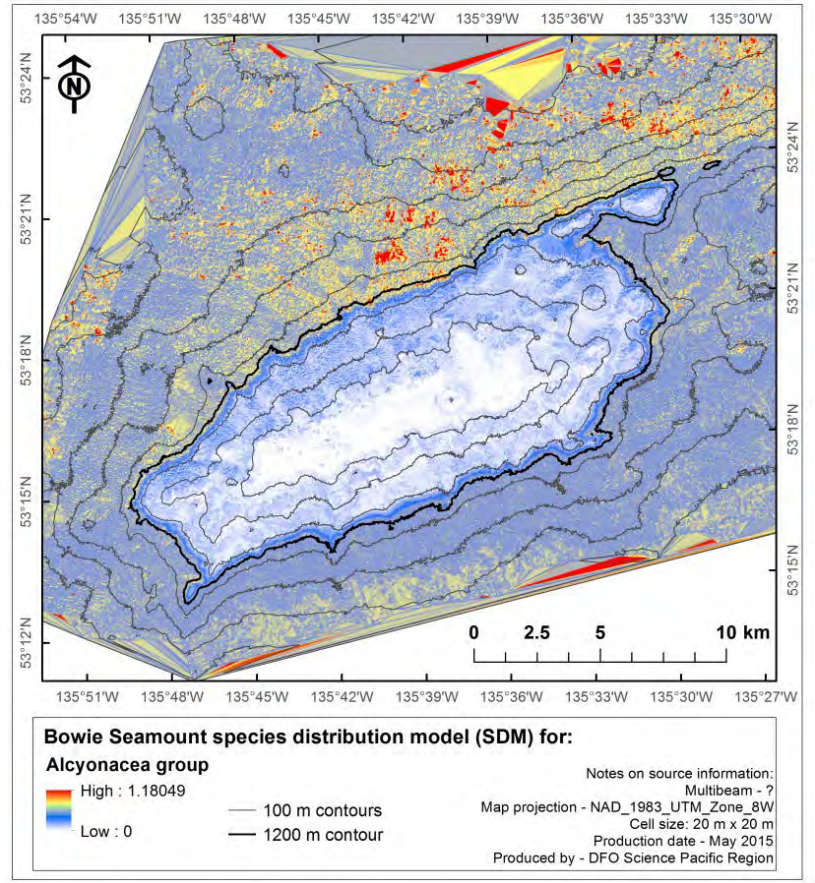
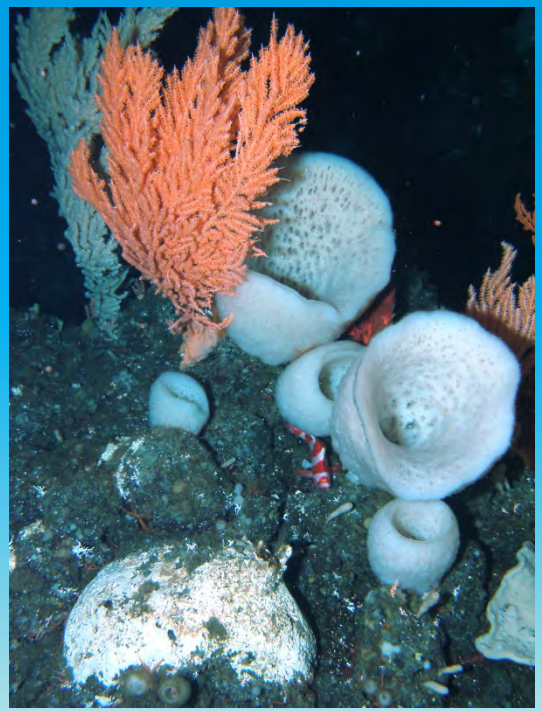
Model Transfer



- Species Distributions from Cobb predicted on Bowie
  - 20 m rasters
  - Depth, slope, aspect, B-BPI, F-BPI, rugosity, curvature
- One of the objectives of the 2015 survey: test transferability of models.

Taxa Tested

- Phylum Porifera
  - Class Hexactinellida
    - Family Farreidae
    - Family Rossellidae



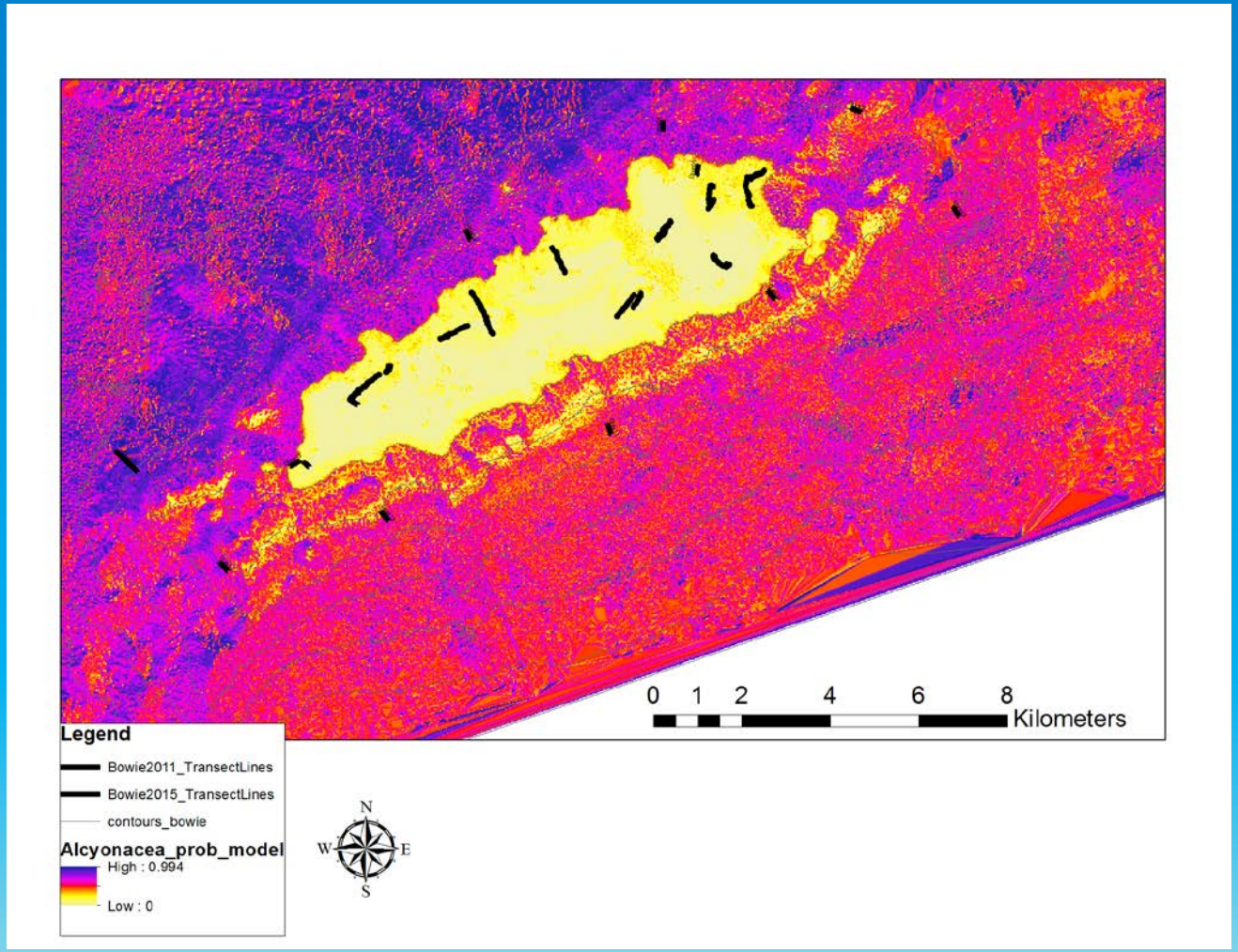
- Phylum Cnidaria
  - Order Alcyonacea
    - Family Primnoidae
    - Family Isidae
    - Genus Swiftia
  - Order Antipatharia
  - Order Pennatulacea
  - Genus Stylaster

Variable Importance

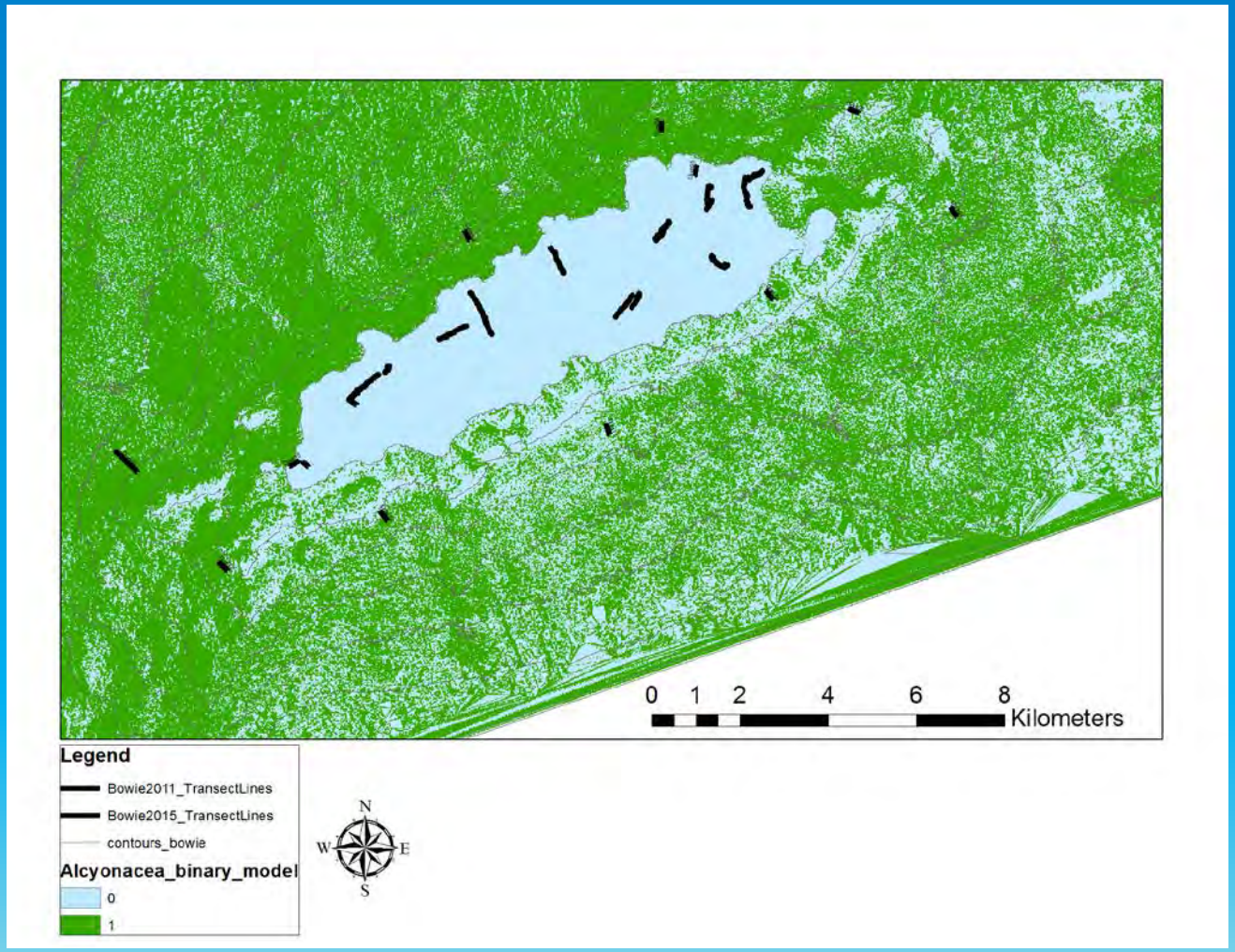
Taxa	1	2	3	4
Alcyonacea	Depth	Aspect	Rugosity	Slope
Antipatharia	Depth	Aspect	Slope	Rugosity
Cnidaria	Depth	Aspect	Slope	B-BPI
Farreidae	Depth	Rugosity	Curvature	Aspect
Hexactinellida	Depth	Aspect	Rugosity	Slope
Isididae	Depth	Aspect	Rugosity	Slope
Pennatulacea	Depth	Rugosity	Aspect	Slope
Porifera	Depth	Aspect	Rugosity	Slope
Primnoidae	Aspect	Slope	Rugosity	Depth
Rossellidae	Depth	Aspect	Rugosity	Slope
Stylaster	Aspect	Depth	Slope	B-BPI
Swiftia	Aspect	Rugosity	Depth	Slope

- **Depth**
- Aspect
- Rugosity
- Slope

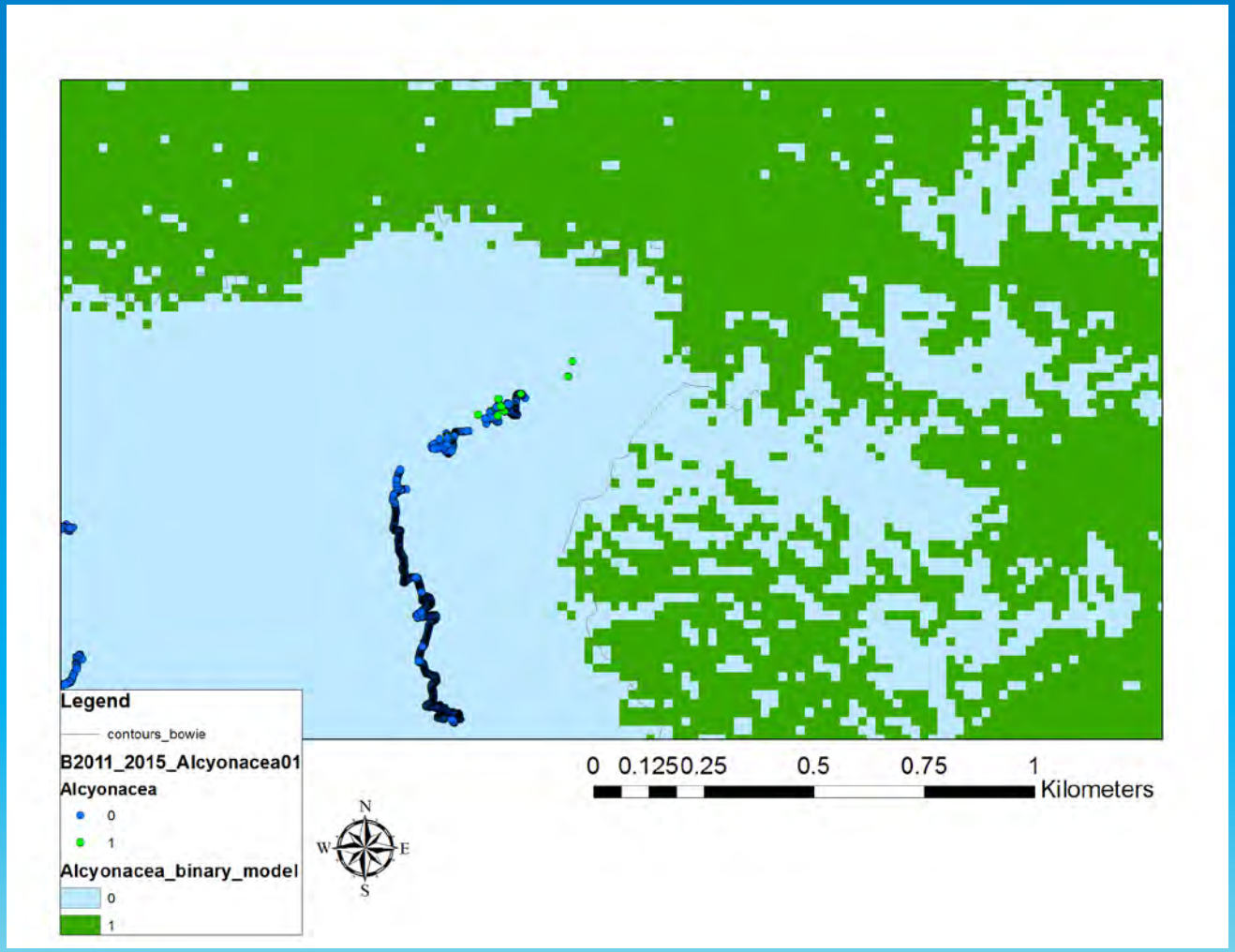
Bowie Model Transfer Test



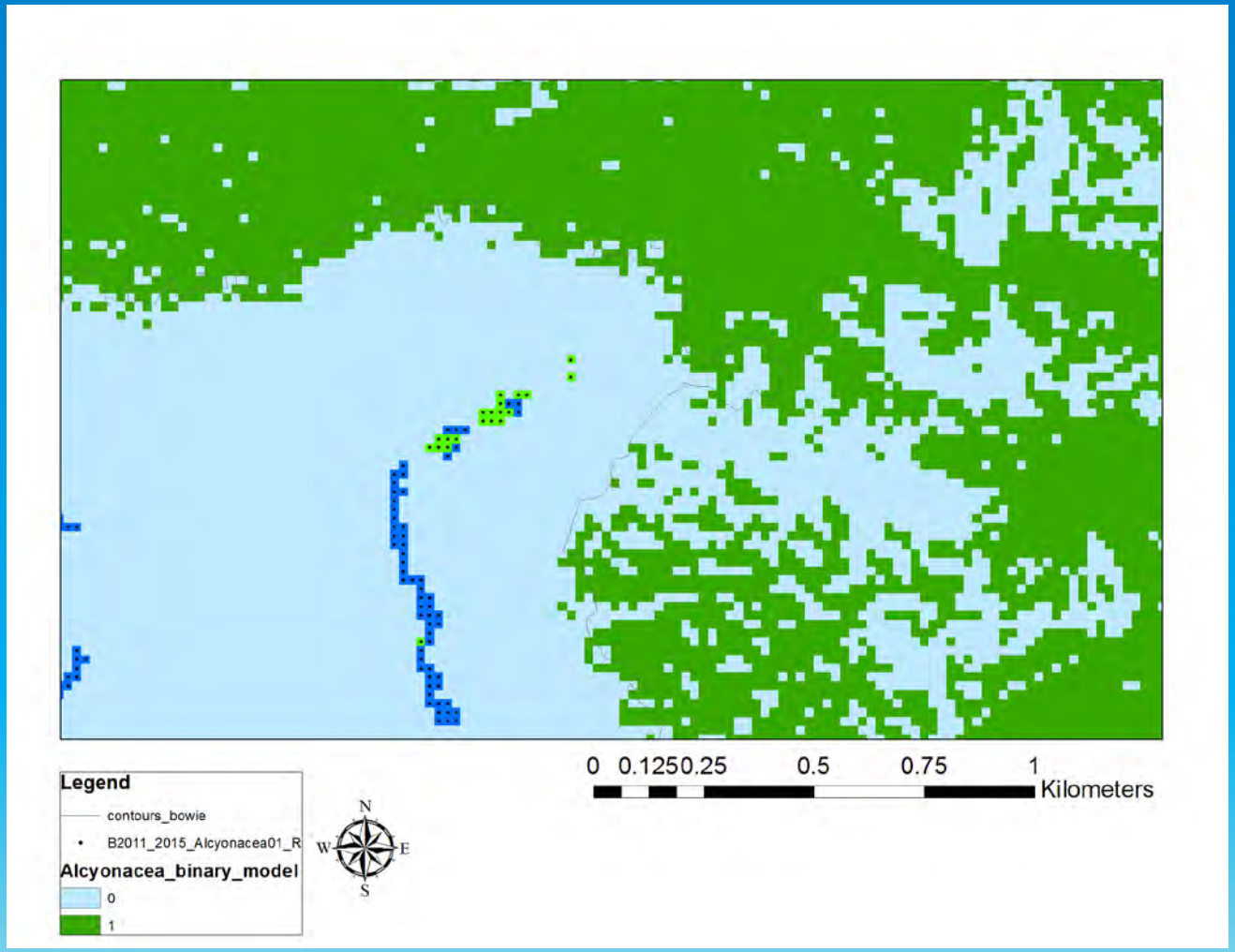
Bowie Model Transfer Test



Bowie Model Transfer Test



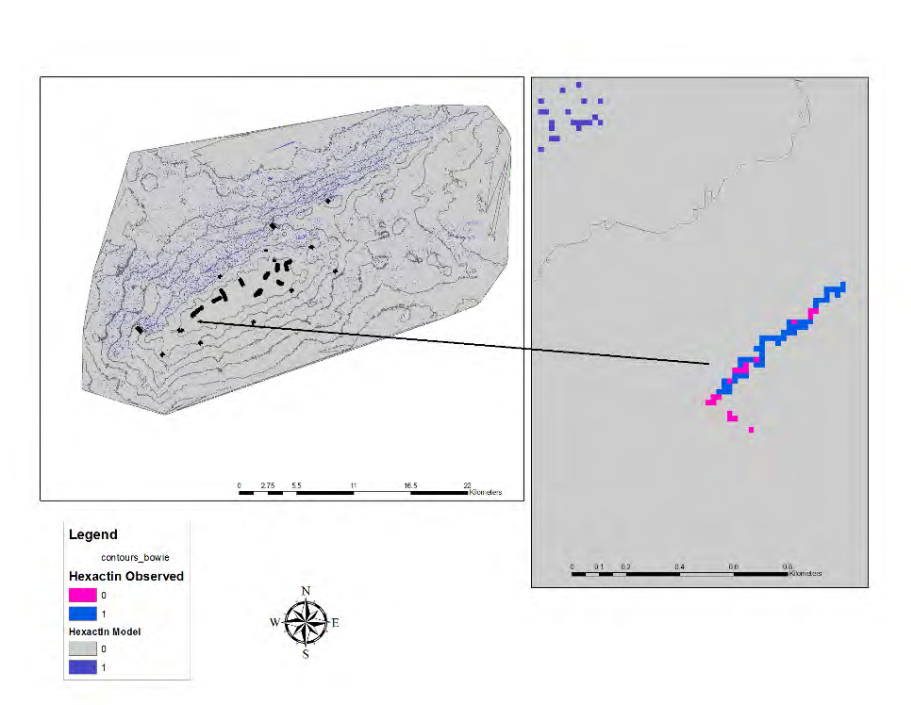
Bowie Model Transfer Test



Bowie Model Transfer: Porifera

	Phylum	Class	Family	Family
Statistic	Porifera	Hexactinellida	Farreidae	Rossellidae
AUC Cobb	81	85	88	82
AUC Bowie	50	52	55	50
Kappa Bowie	0.00	0.04	0.15	-0.02

Bowie Model Transfer: Porifera



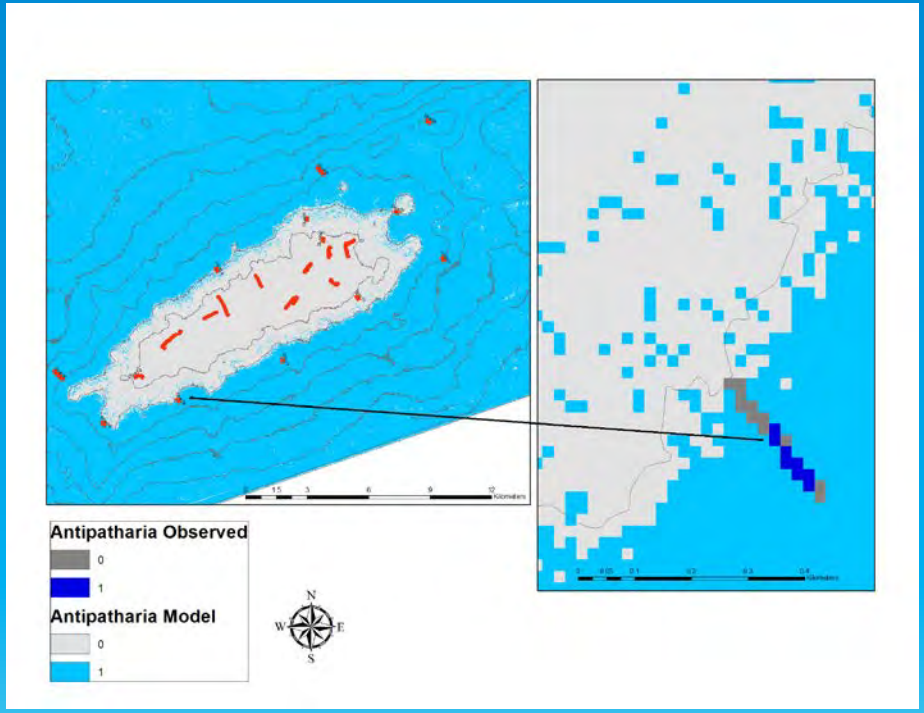
- Hexactinellida Results
  - Balanced Accuracy/ AUC = 0.52
  - Kappa = 0.04

Bowie Model Transfer: Cnidaria

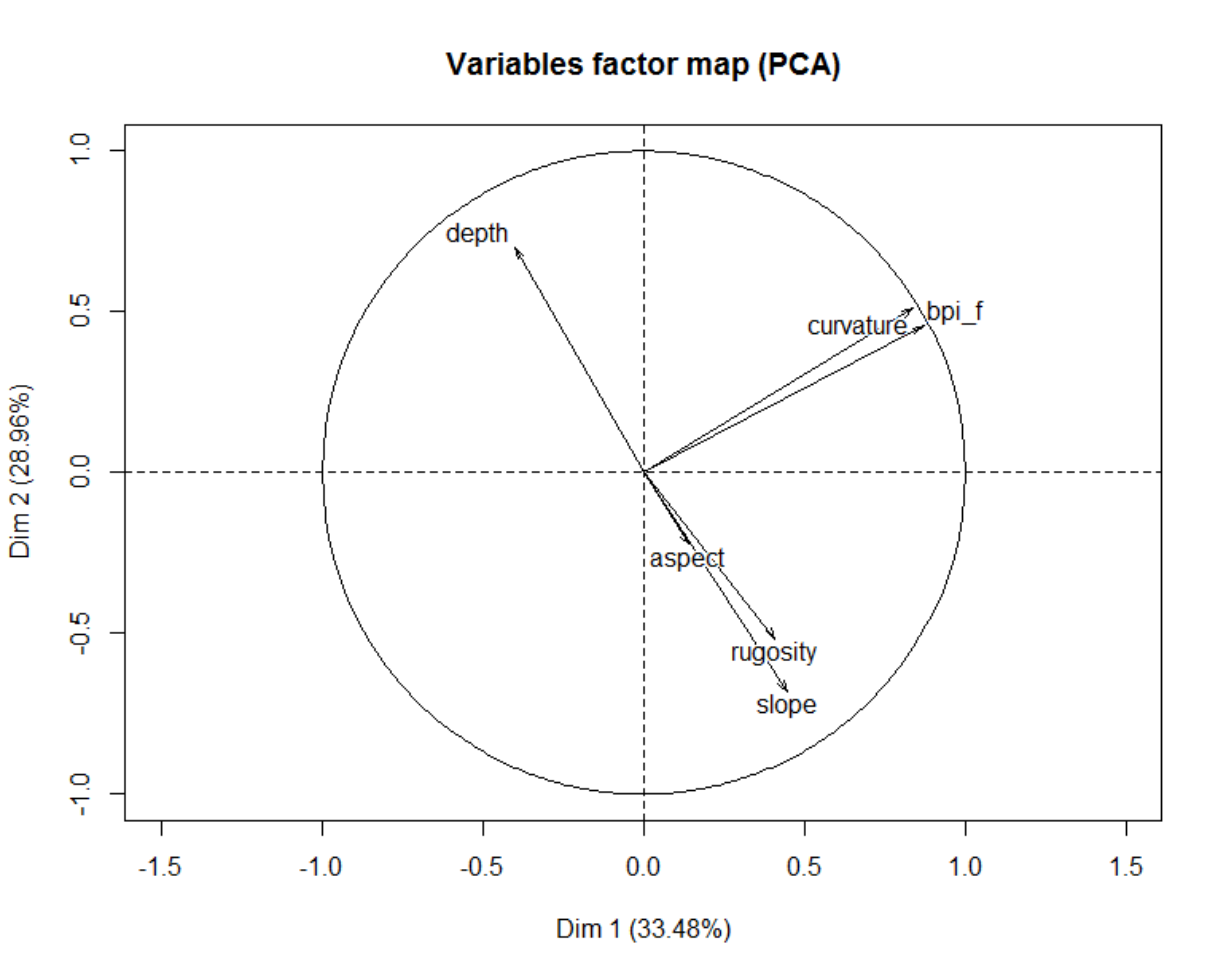
	Phylum	Order	Family	Order	Order	Family	Genus	Genus
Statistic	Cnidaria	Alcyonacea	Primnoidae	Antipatharia	Pennatulacea	Isididae	Stylaster	Swiftia
AUC Cobb	86	94	93	94	80	93	92	85
AUC Bowie	44	65	55	90	49	69	49	50
Kappa Bowie	-0.09	0.28	0.12	0.12	-0.02	0.28	-0.02	0.00

Bowie Model Transfer Test

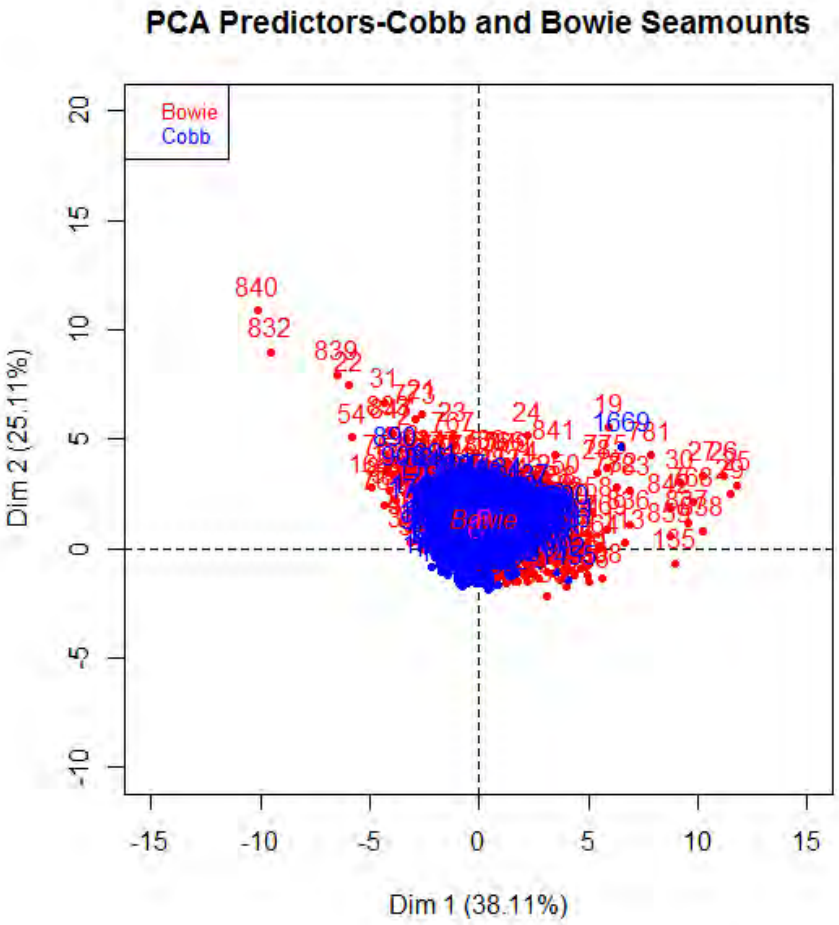
- Antipatharia Results
  - Balanced Accuracy/ AUC = 0.90
  - Kappa = 0.12
- Important Variables
  - Depth, aspect, slope rugosity



Model Predictors-PCA



Model Predictors-PCA



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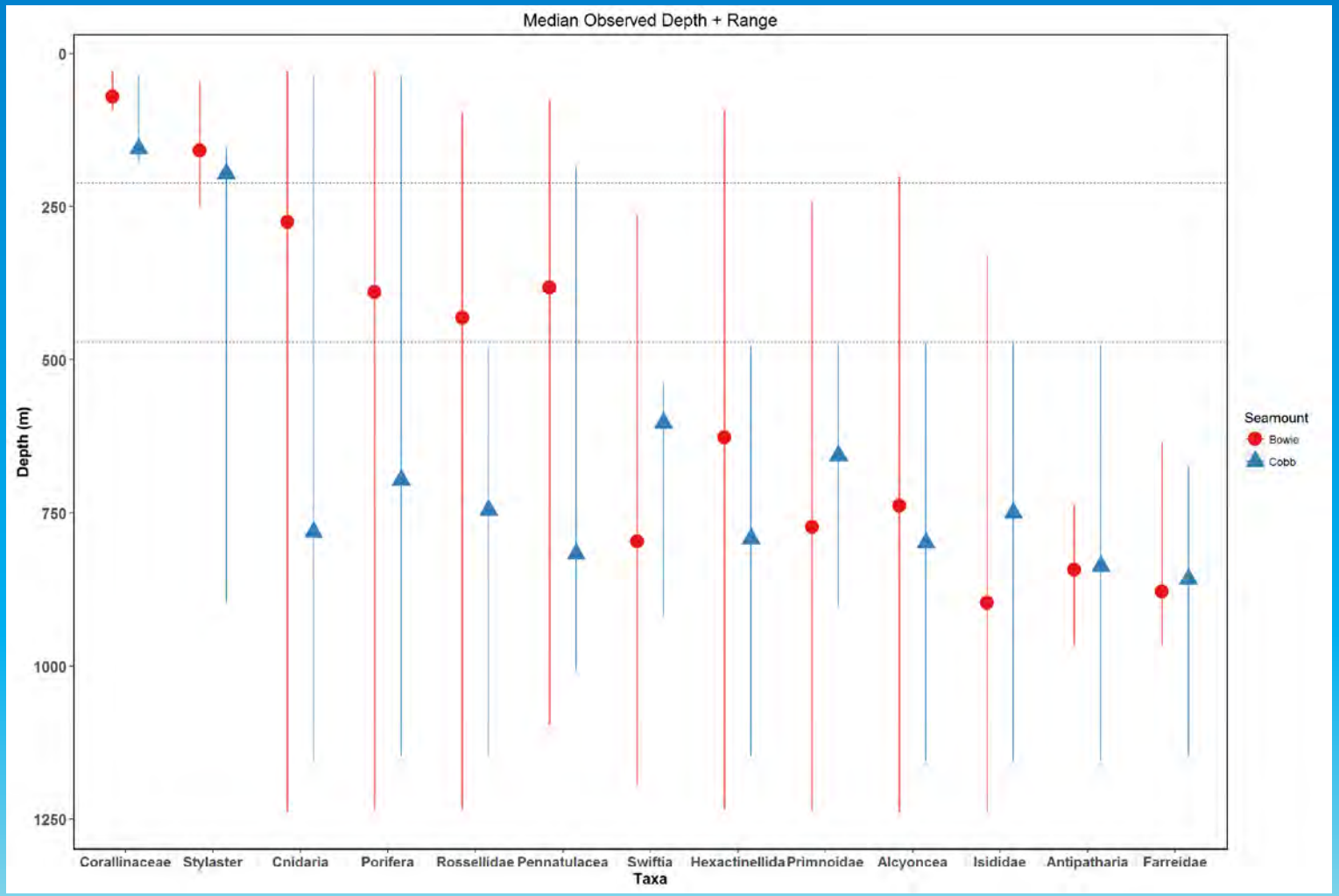
Observed Depth Distributions



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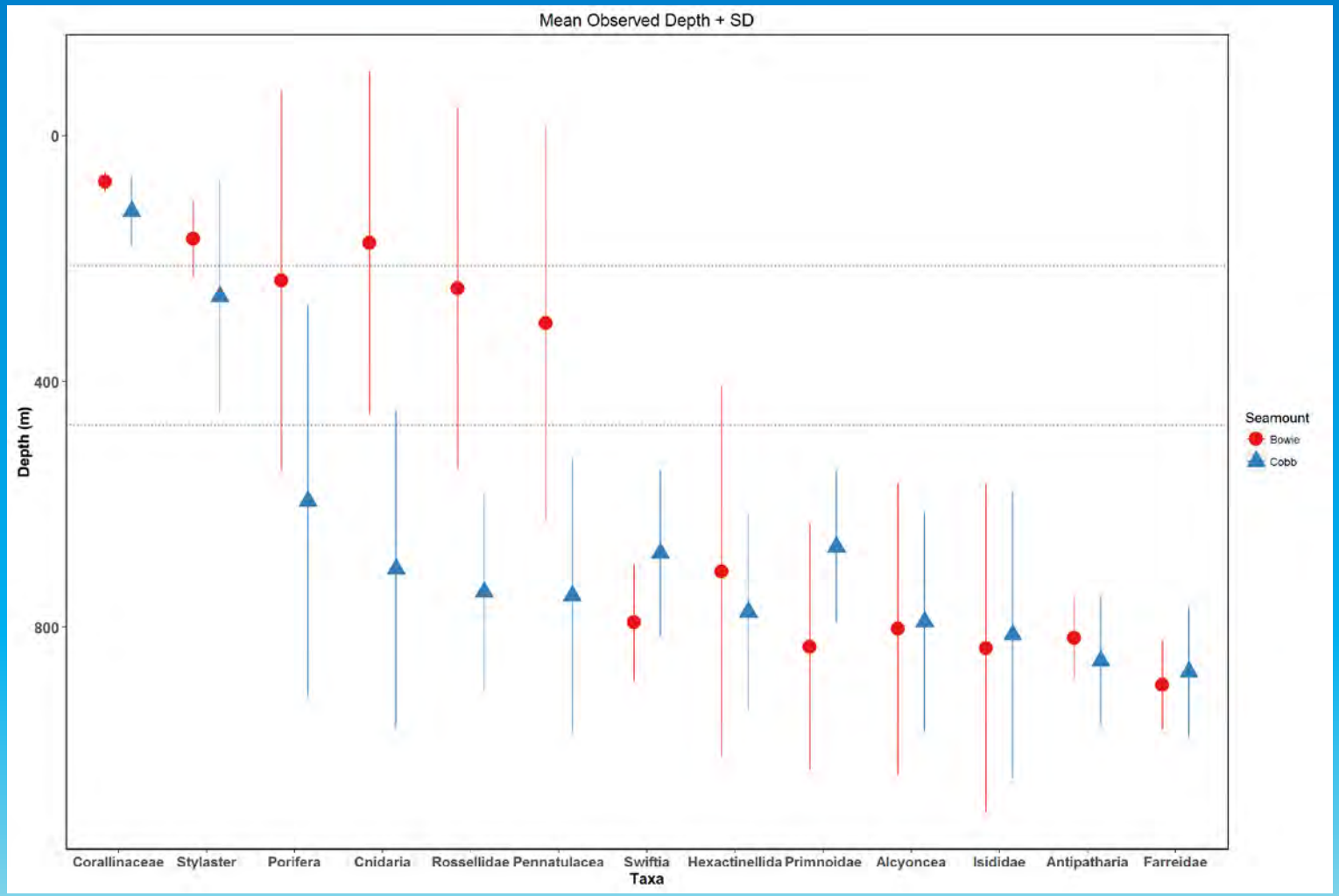
Observed Depth Distributions



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Model Considerations

- Low success with model transfer to date.
- Refine/modify model predictors:
  - Rugosity at different scales
  - Include modeled substrate type
  - Categorical variables: euphotic zone depth
  - Latitude/longitude
- Explore different model structures-mechanistic models.
- Consider data distribution

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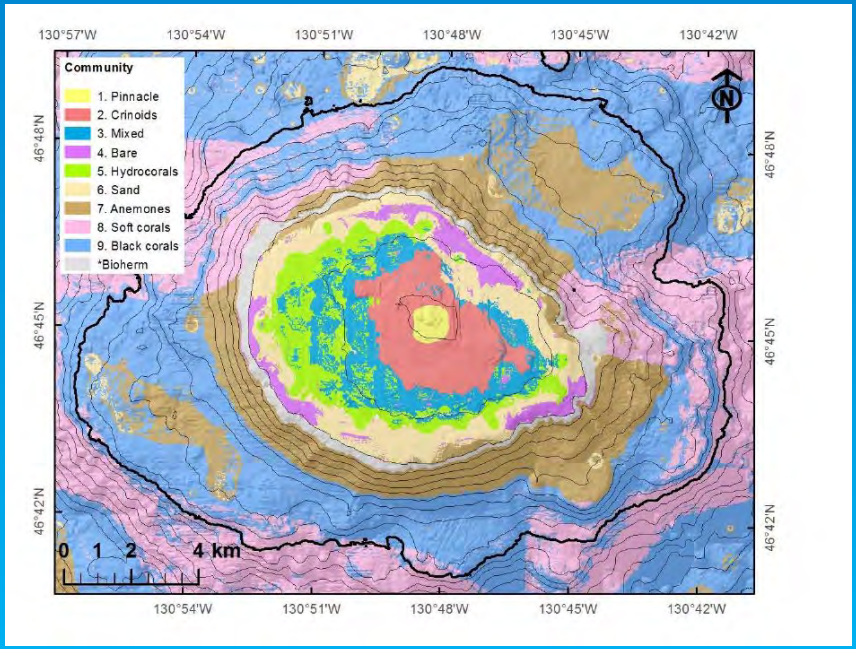
Cobb Community Distributions



- Depth strongest environmental proxy, also substrate type, rugosity and slope.
- Identified nine communities, often typified by corals, sponges and algae.

Du Preez, C., J. Curtis and M.E. Clarke. 2016. The structure and distribution of benthic communities on a shallow 1 seamount (Cobb Seamount, Northeast Pacific Ocean). PLoS ONE 11(10): e0165513.

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Future Work

- Community Analysis of Bowie Data and comparisons with Cobb communities
- Refine SDM
  - Depth of the euphotic zone
  - Substrate
  - 10 m resolution
- Additional work on model transferability among seamounts in BC.

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