

Benthic Habitat Surveys and Predictive Modelling in the NW Atlantic

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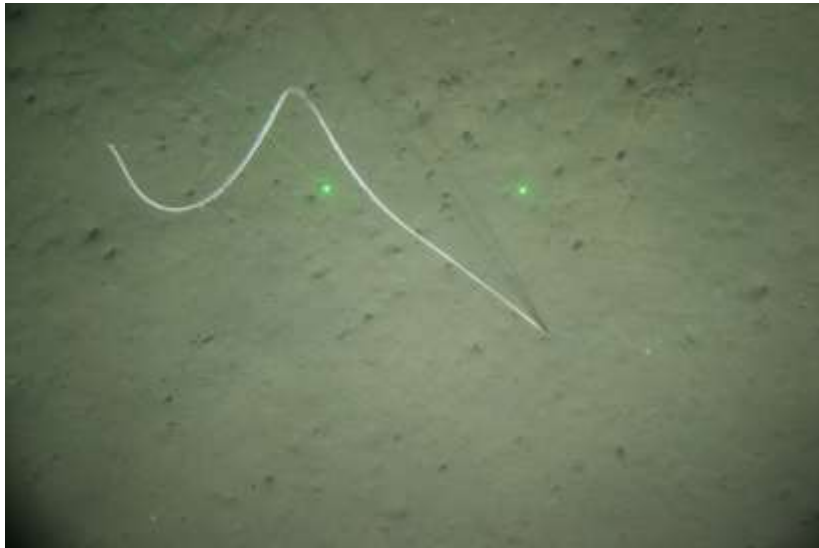
FAO Regional Workshop on Vulnerable Marine Ecosystems (VMEs)
in the North Pacific Ocean
Tokyo, Japan 11-13 March 2014

Modelling Approaches

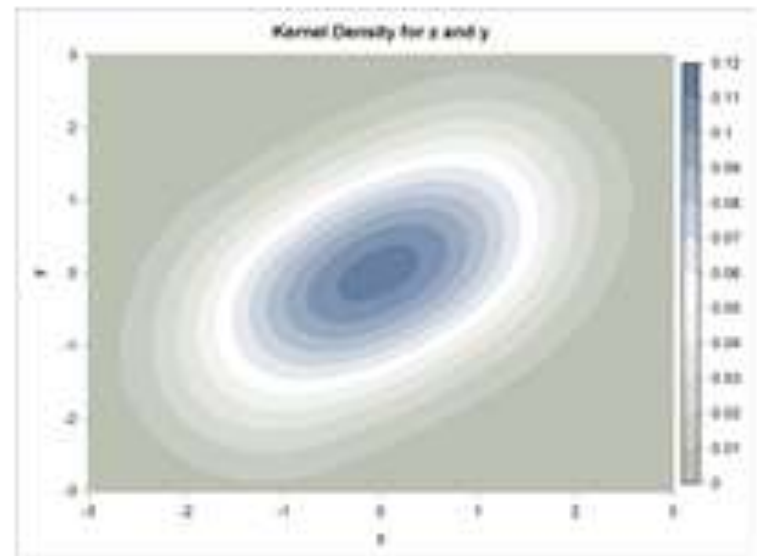
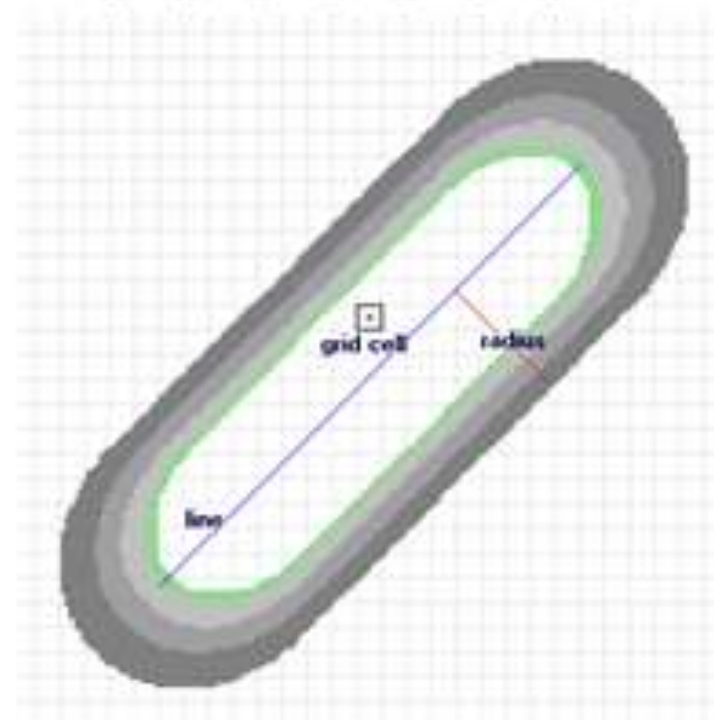
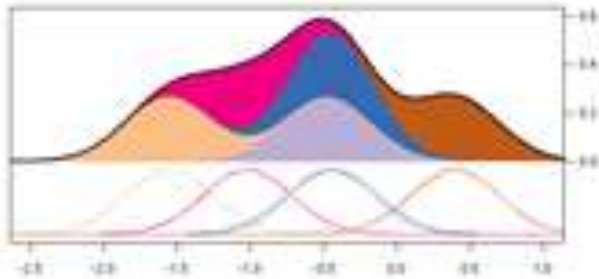
- **Kernel density surface modelling** (KDE) as a means to identify **significant concentrations** of vulnerable marine ecosystem indicators
- **Species distribution modelling** (SDM) as a means to identify areas where VMEs **are likely to occur** using environmental predictors
- **GIS simulation modelling** to evaluate encounter protocols, significant adverse impacts
- **Research modelling** (GLM, Gradient Forest, etc.)

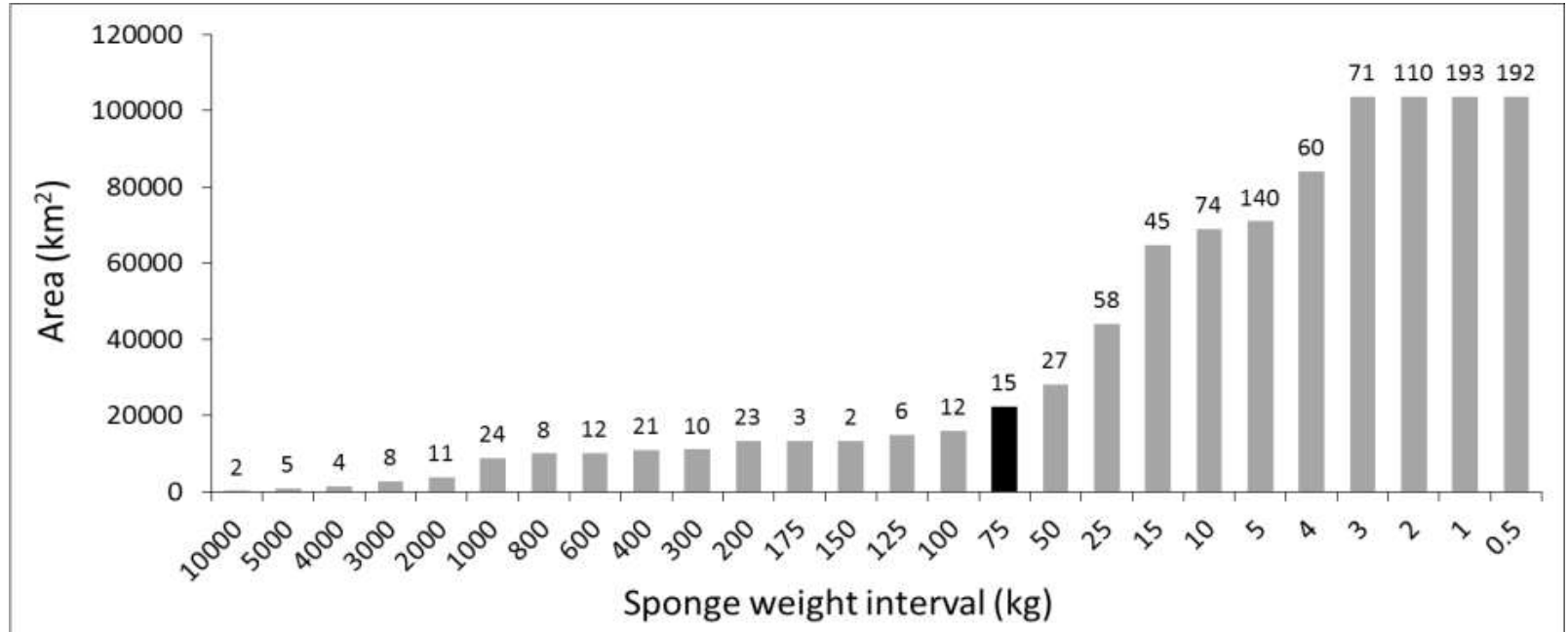
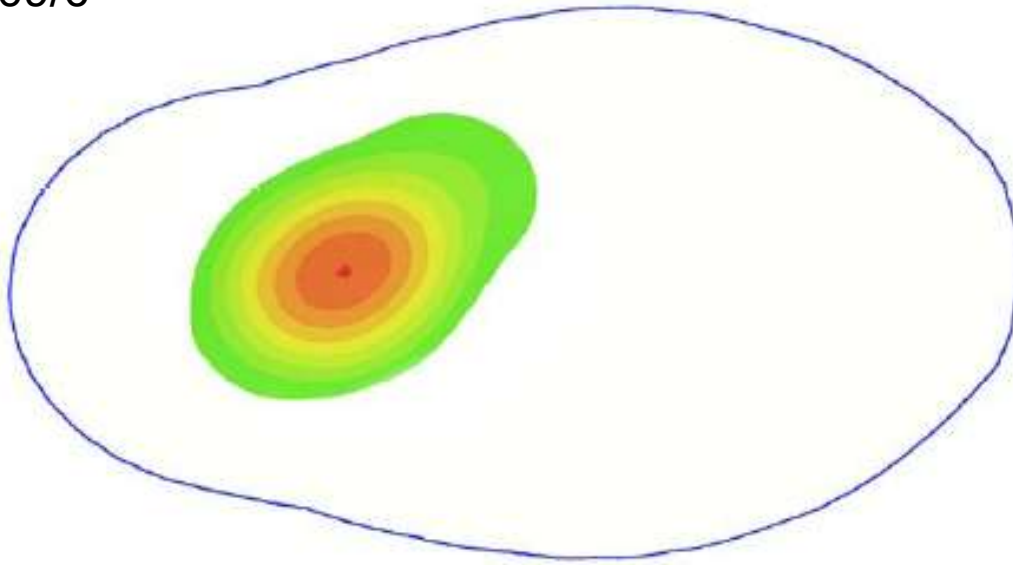
Modelling Approaches

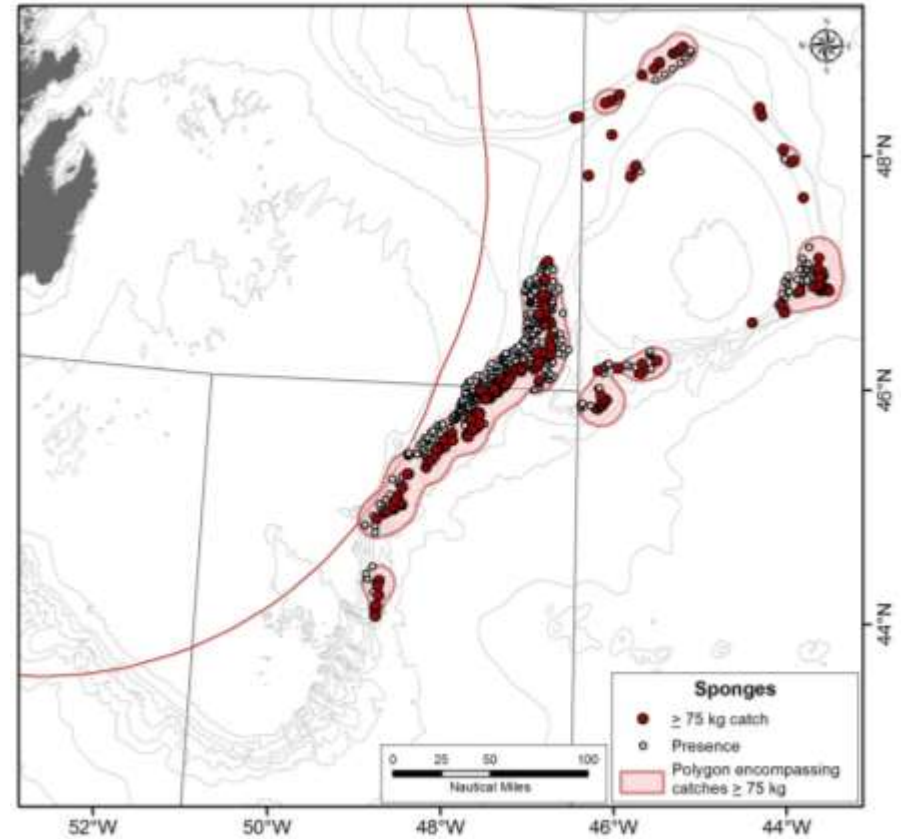
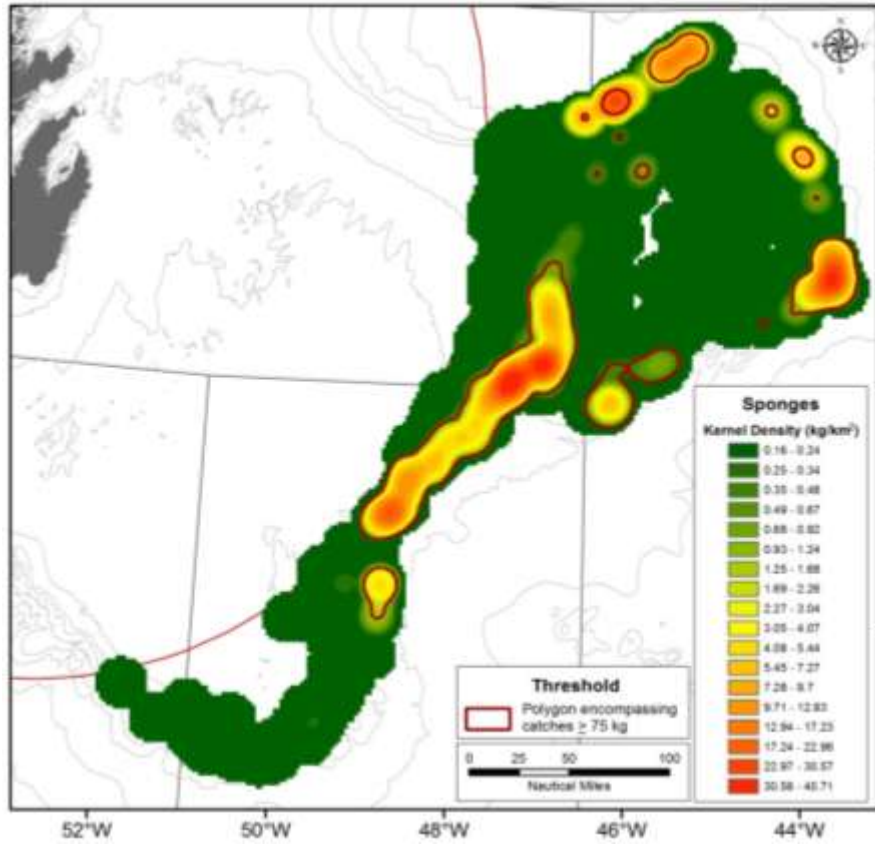
- v. Structural complexity – an ecosystem that is characterized by complex physical structures created by **significant concentrations** of biotic and abiotic features. In these ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high diversity, which is dependent on the structuring organisms.
- **Kernel density surface modelling** (KDE) as a means to identify **significant concentrations** of vulnerable marine ecosystem indicators



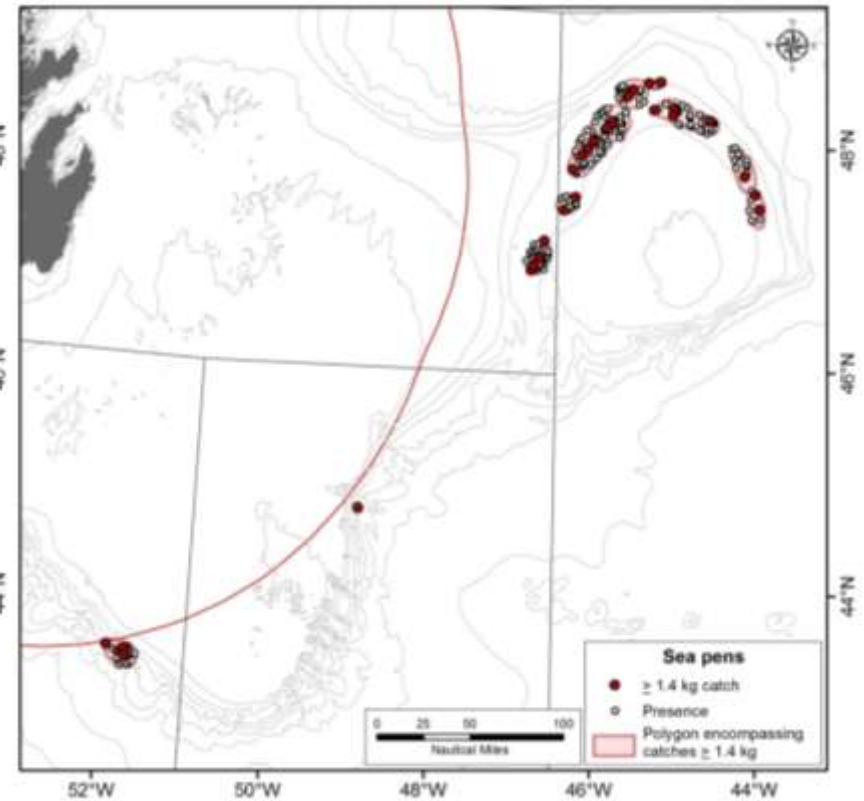
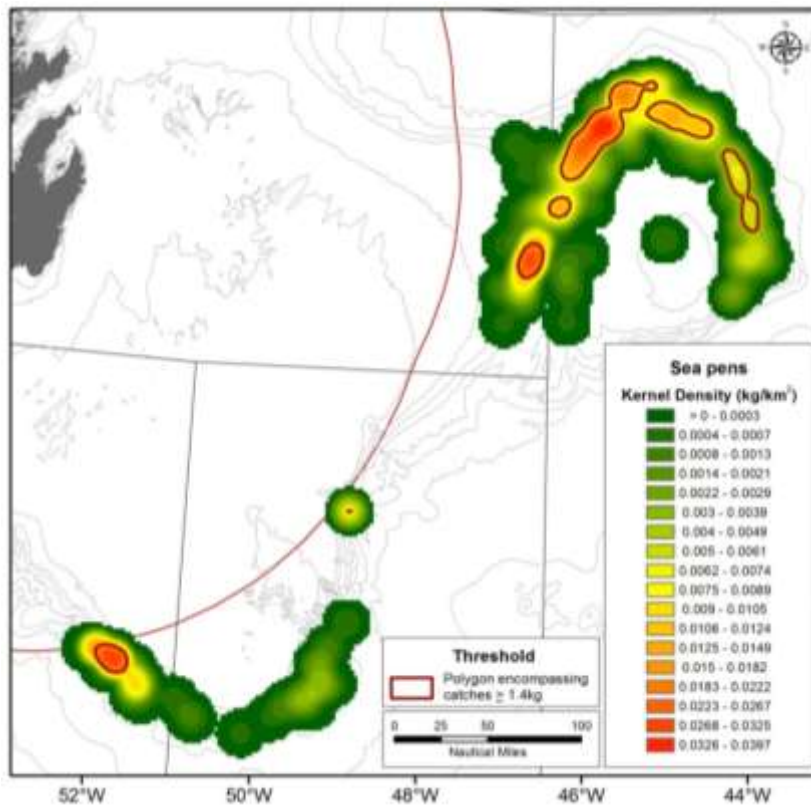
Kernel Density Estimation







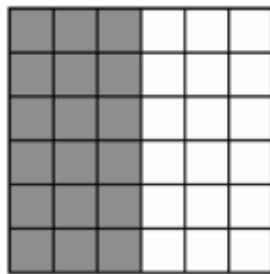
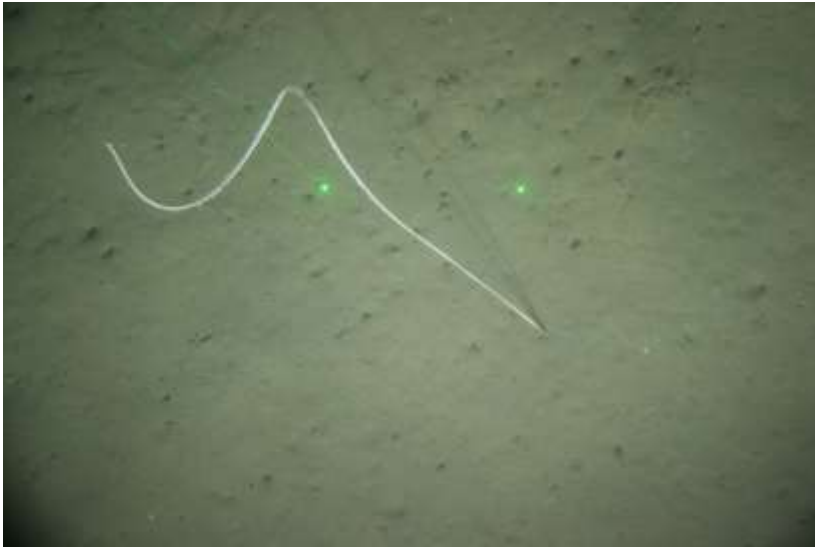
Sponges



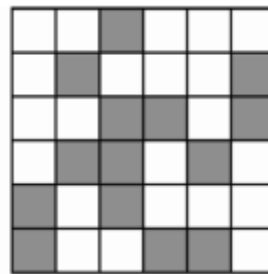
Sea Pens

Photo Transect Data

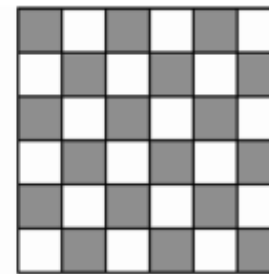
Spatial autocorrelation Indices



Positive spatial
autocorrelation



No spatial
autocorrelation

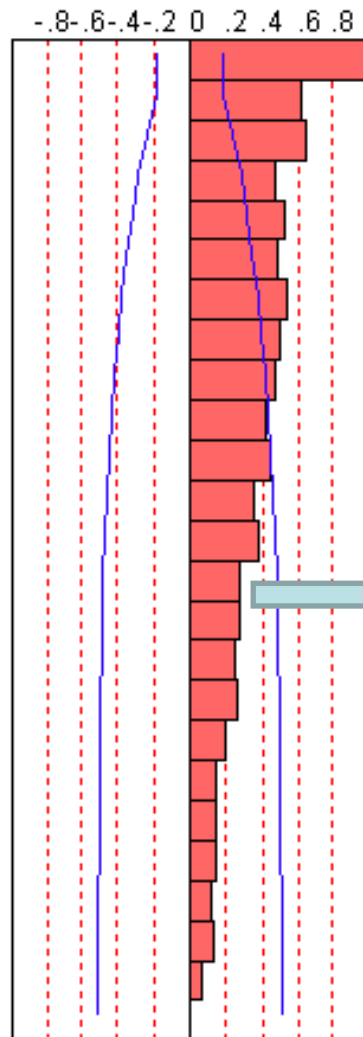


Negative spatial
autocorrelation

G11

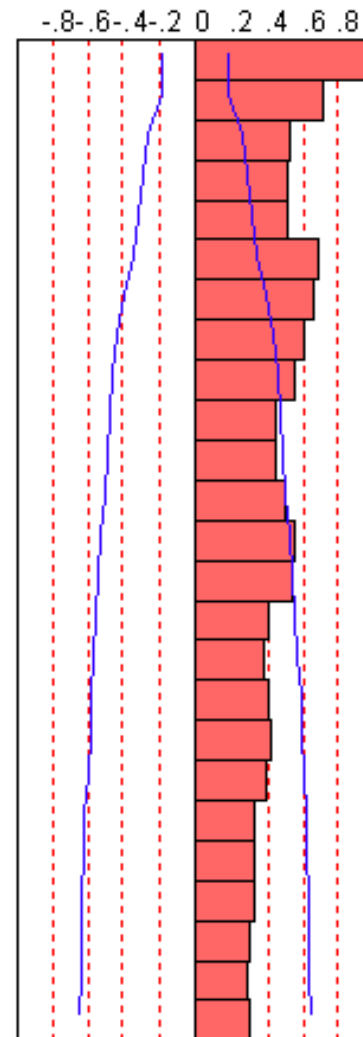
Lag	Auto Corr
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1	0.6145
2	0.6408
3	0.4809
4	0.5297
5	0.4903
6	0.5479
7	0.5042
8	0.4736
9	0.4176
10	0.4426
11	0.3628
12	0.3741
13	0.2856
14	0.2754
15	0.2450
16	0.2687
17	0.1949
18	0.1533
19	0.1527
20	0.1519
21	0.1300
22	0.1336
23	0.0768
24	-0.0021

Xenophyophorida



Actinaria

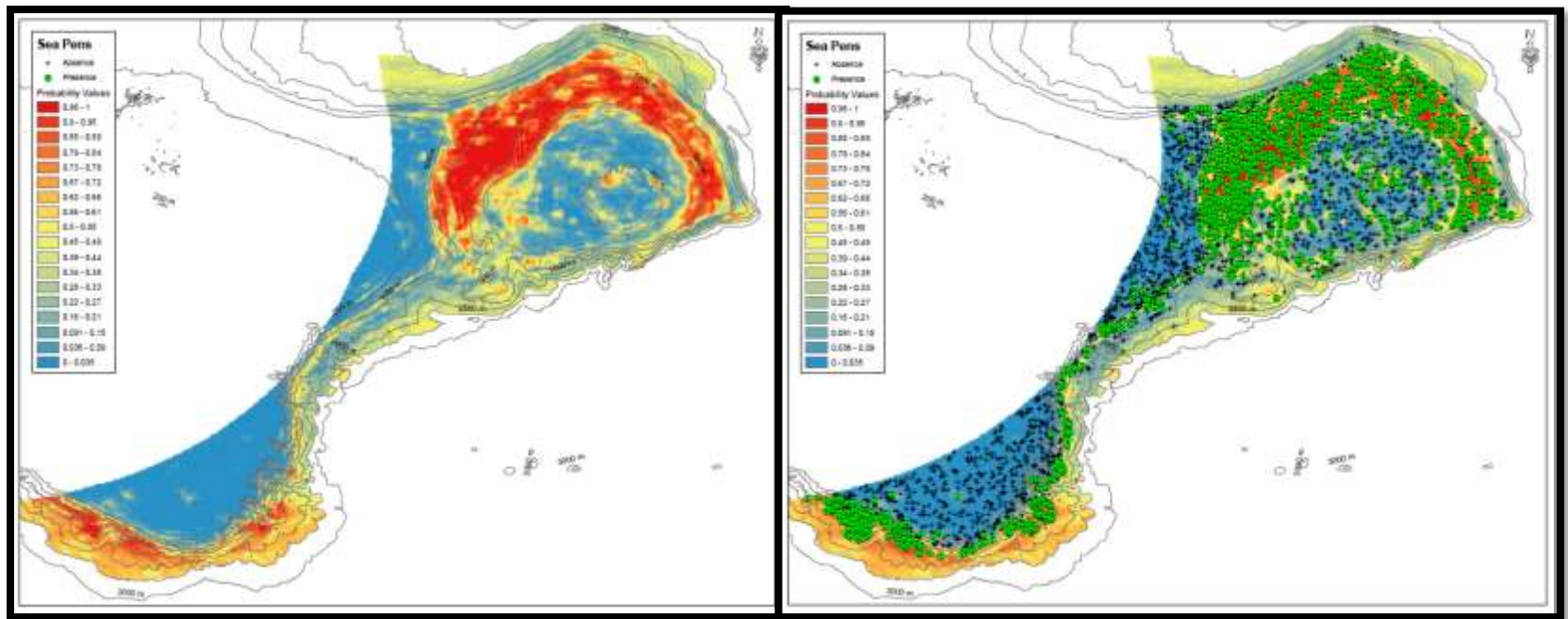
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3	0.5114
4	0.5180
5	0.6824
6	0.6620
7	0.6050
8	0.5646
9	0.4517
10	0.4513
11	0.5067
12	0.5579
13	0.5447
14	0.4116
15	0.3746
16	0.3988
17	0.4155
18	0.3915
19	0.3362
20	0.3393
21	0.3304
22	0.3028
23	0.2923
24	0.3034



Modelling Approaches

- 12. In order to achieve these objectives, States and RFMO/As should:
 - i. adopt and implement measures
 - ii. identify areas where VMEs **are known or likely to occur**; and
 - iii. take action using the best information available.
- **Species Distribution Modelling** (SDM) as a means to identify areas where VMEs **are likely to occur** using environmental predictors
- MaxEnt (presence only); Random Forest (presence and absence)

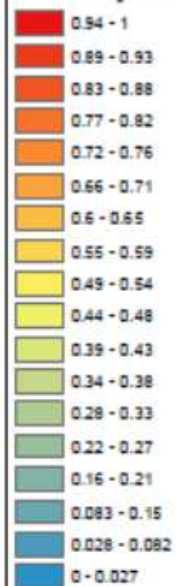
Predictor variable	Quantification	Unit	Data source	Native resolution
Depth		m	GEBCO	30"
Slope		degrees	GEBCO	30"
Annual chlorophyll	Min	mg m ⁻³	OceanColor	9 km
Winter chlorophyll	Range, Min, Mean	mg m ⁻³	OceanColor	9 km
Spring chlorophyll	Range	mg m ⁻³	OceanColor	9 km
Summer chlorophyll	Range, Min	mg m ⁻³	OceanColor	9 km
Fall chlorophyll	Range, Min	mg m ⁻³	OceanColor	9 km
Surface temperature	Range, Min	°C	GLORYS	1/4°
Surface salinity	Range, Max	PSU	GLORYS	1/4°
Bottom temperature	Min, Max	°C	GLORYS	1/4°
Bottom salinity	Max	PSU	GLORYS	1/4°
Surface current	Range, Min, Mean	m/s	GLORYS	1/4°
Shear	Range, Min	Pa	GLORYS	1/4°



Sea Pens Probability of Occurrence Surface
Random Forest Model

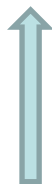
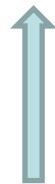
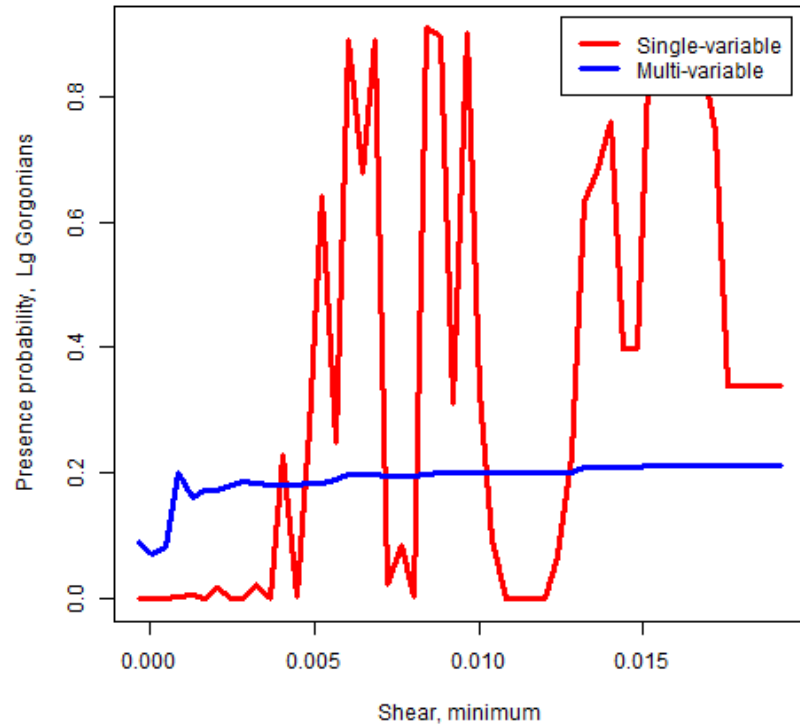
Large Gorgonians

Probability Values

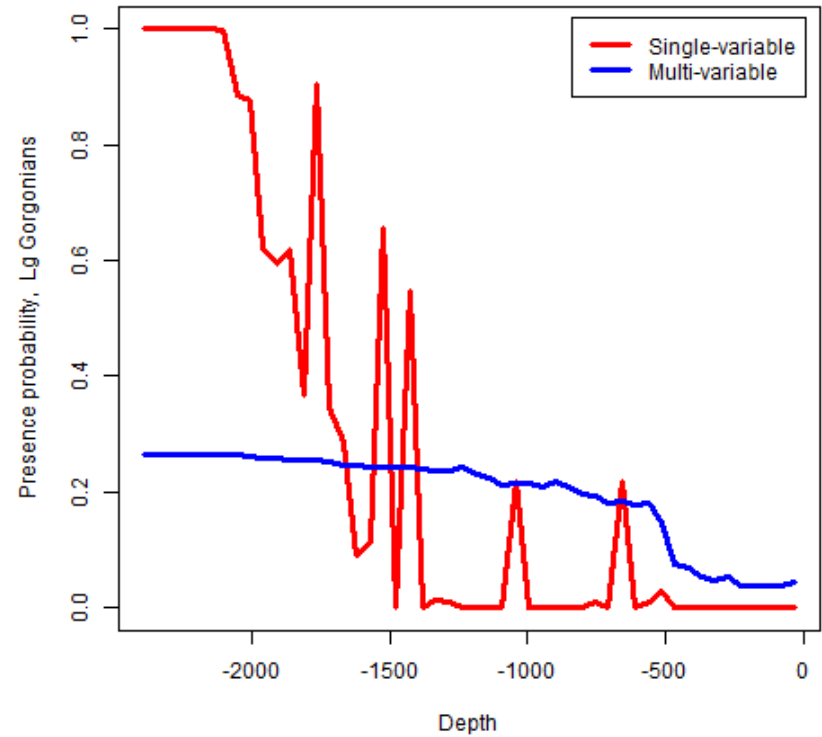


Response variable	Predictor Variables in Order of Importance	Variable Importance
Large Gorgonian Corals	Bottom shear, minimum	0.049
	Depth	0.045
	Bottom temperature, mean	0.019
	Summer Chl a, minimum	0.019

Lg Gorgonians dependence on 'Shear, minimum', RF model

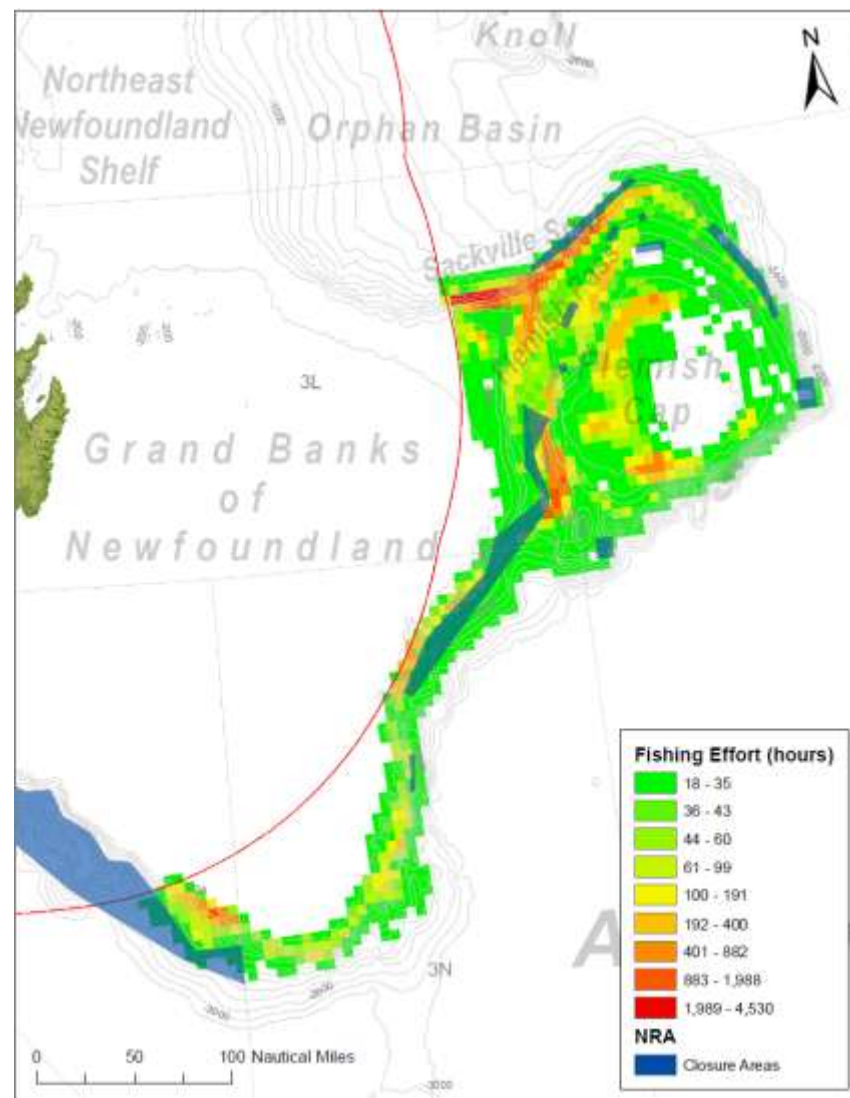
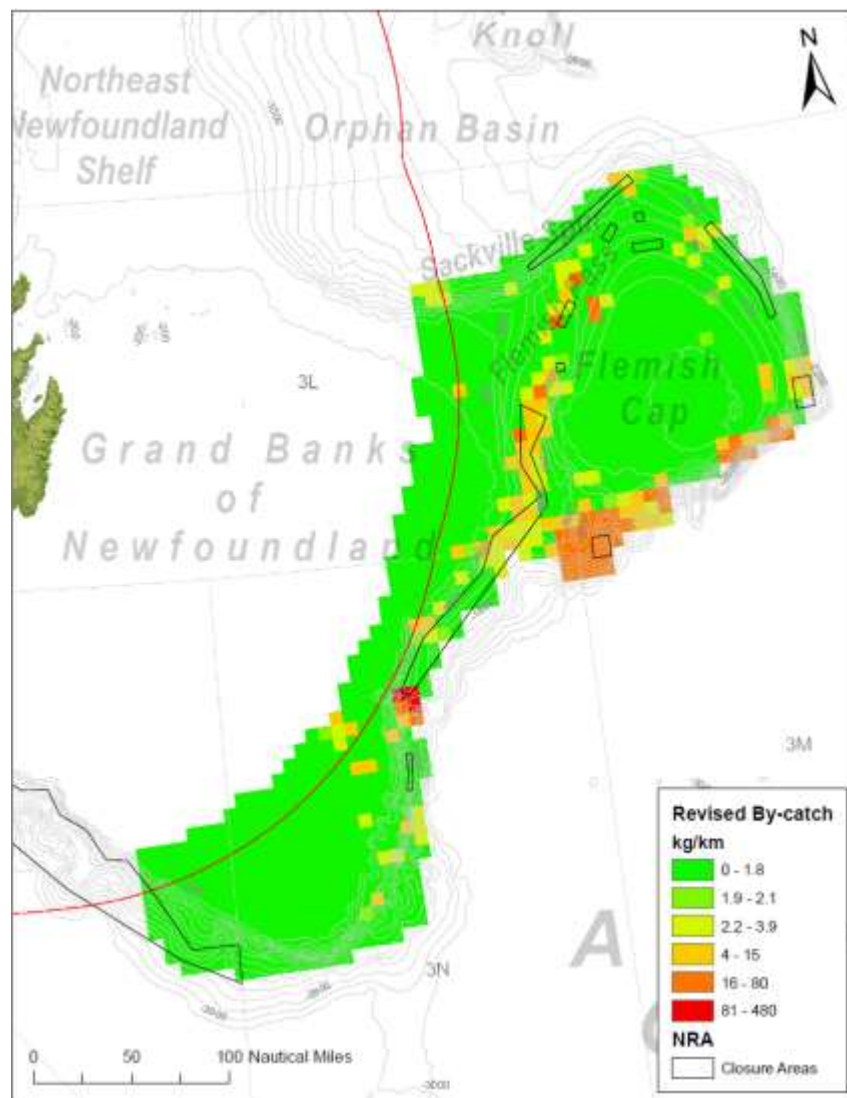


Lg Gorgonians dependence on 'Depth', RF model

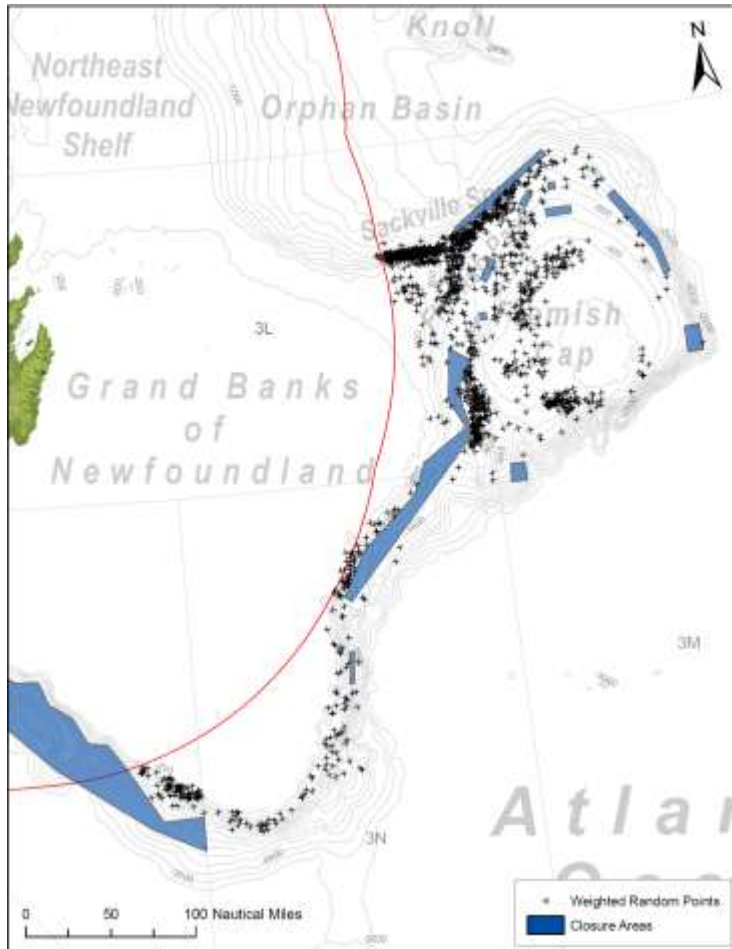


Simulation Models

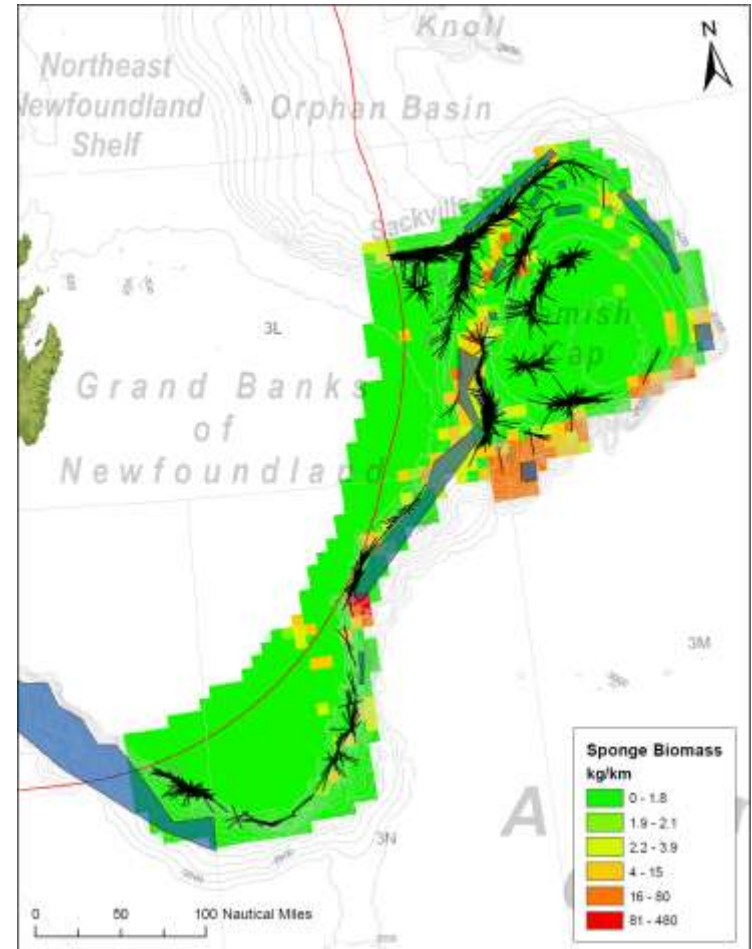
- Using GIS to approximate commercial groundfish trawling sponge by-catch in NRA
- No by-catch of VME reported – why?
- Model can be run under varying management scenarios to with or without VMS data:
 - optimize closure size,
 - evaluate effect of encounter thresholds, and
 - minimize impact to both vulnerable marine ecosystems and the fishery



Without VMS Data

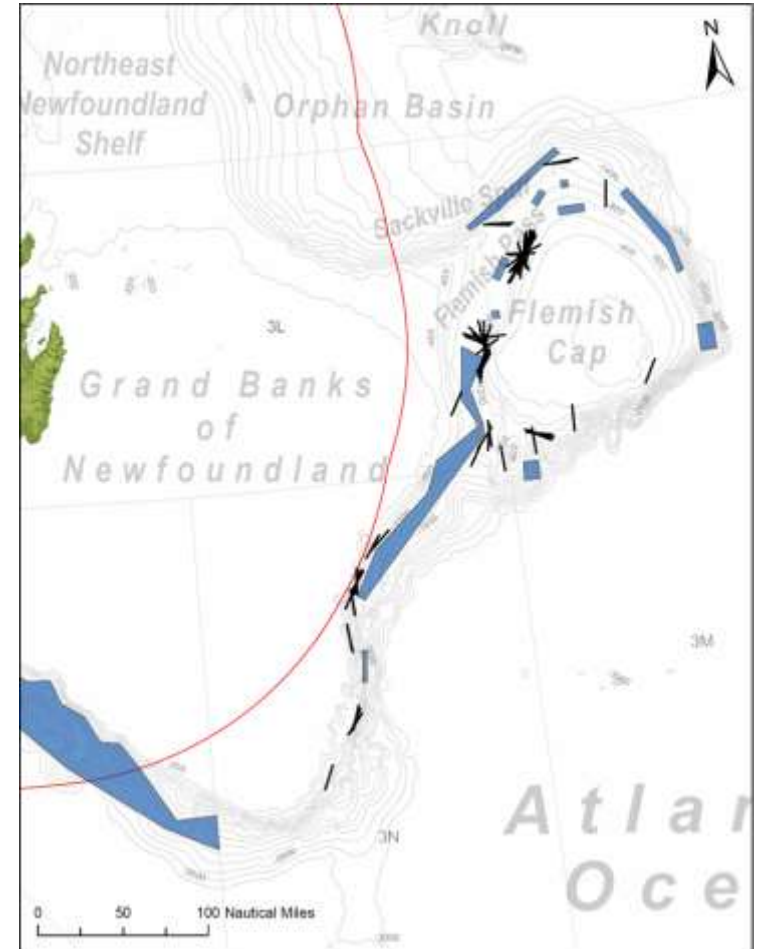


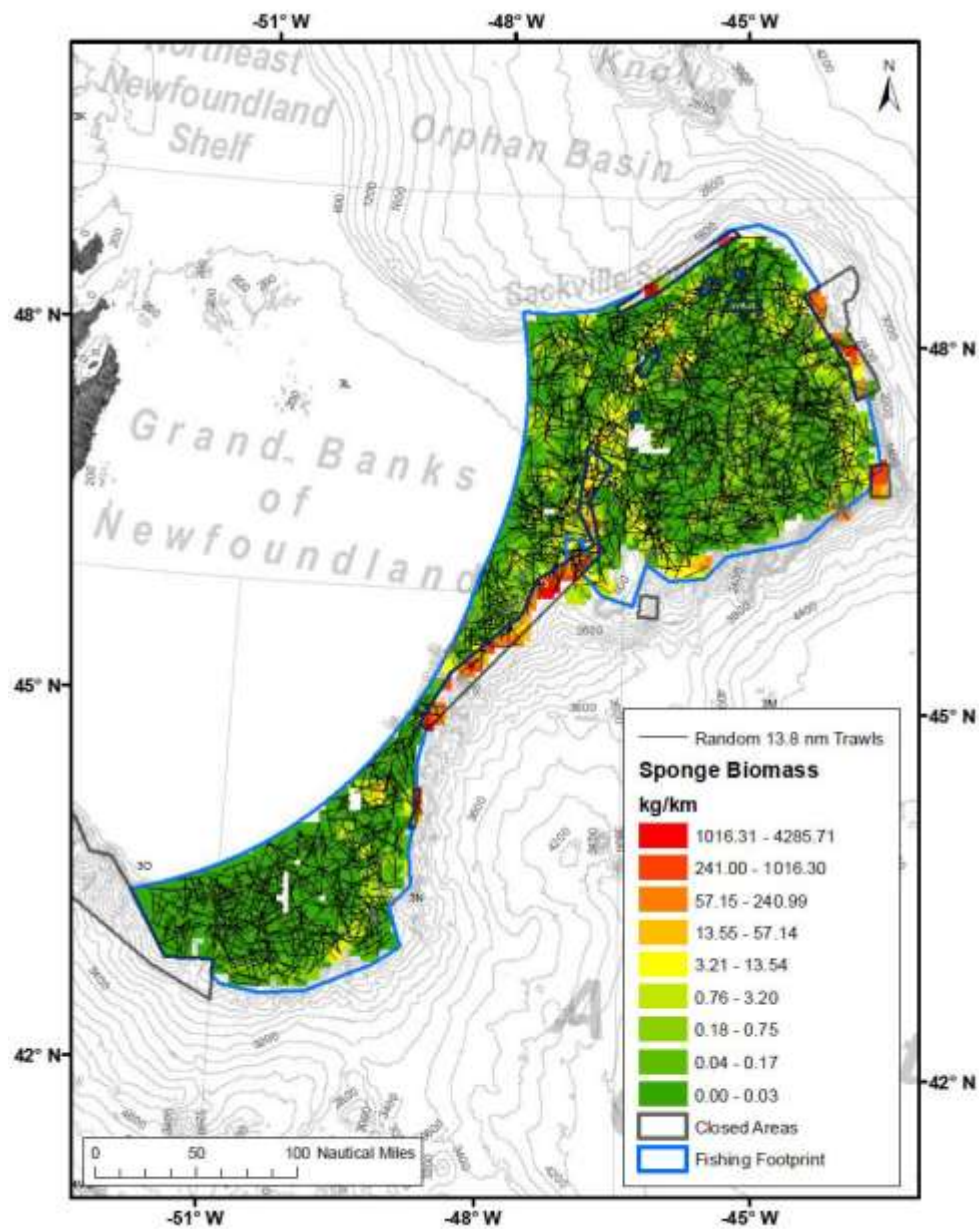
**Simulated Start
Locations**



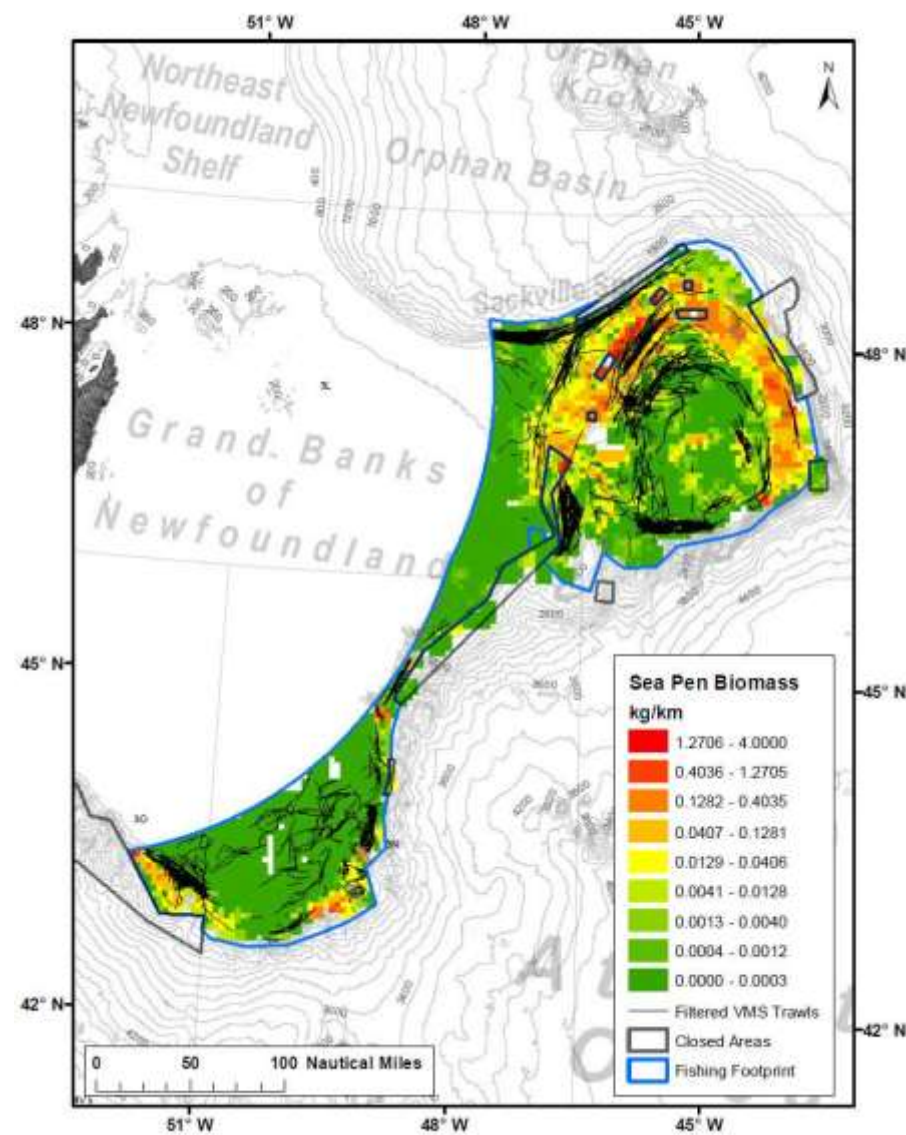
**Simulated 15 nm
Trawl Lines Over
Sponge Bycatch**

Threshold (kg)	15 nm Trawls > Threshold	15 nm % > Threshold
800	6	0.4
700	7	0.5
600	10	0.7
500	15	1.0
400	26	1.7
300	37	2.5
200	44	2.9
100	58	3.9
90	62	4.1
80	67	4.5
70	73	4.9
60	77	5.1
50	82	5.5
40	113	7.5
30	169	11.3
20	284	18.9
10	546	36.4
5	911	60.7
1	1092	72.8
0.1	1301	86.7





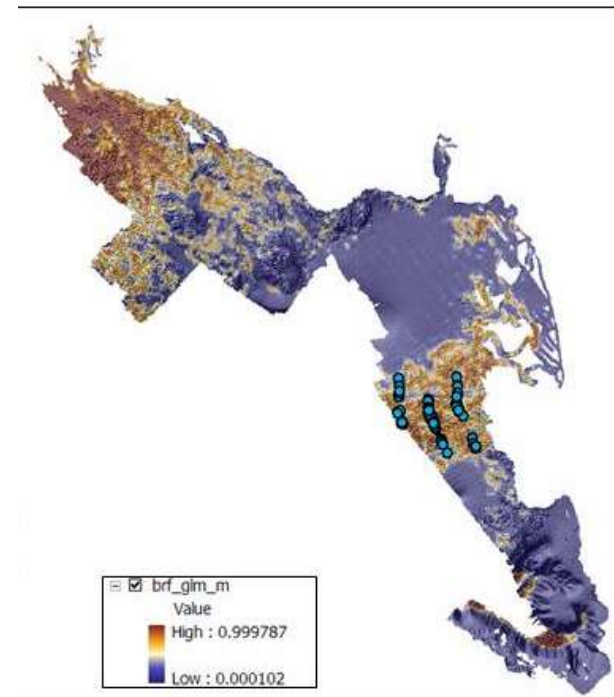
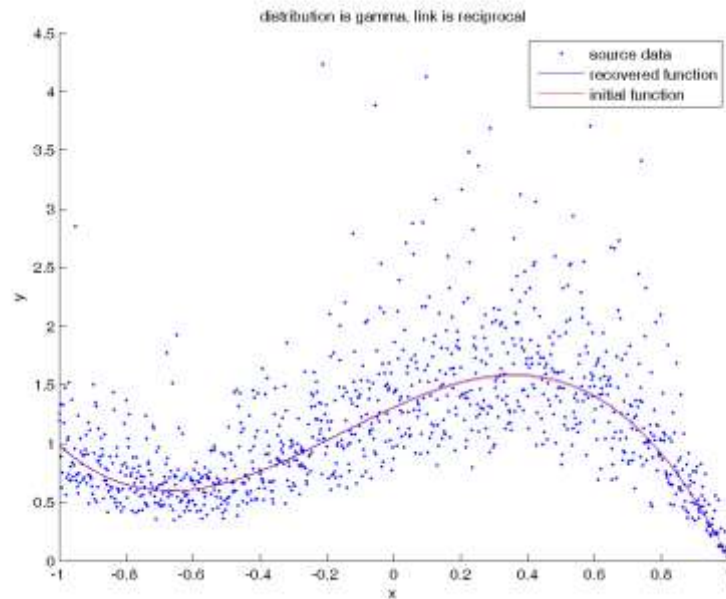
With VMS Data



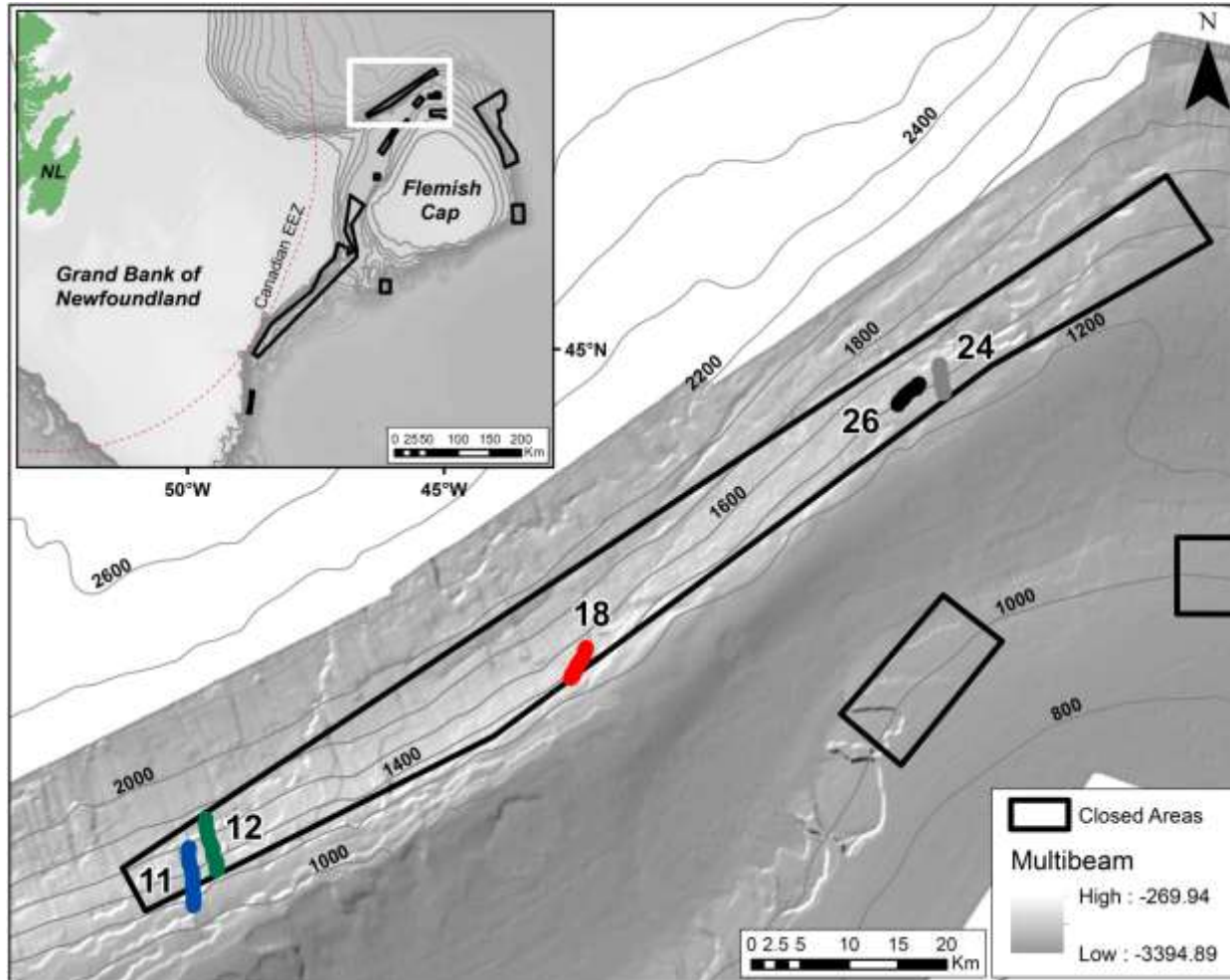
Threshold (kg per tow)	No. Filtered VMS Trawls	% Filtered VMS Trawls ≥ Threshold
16	2	0.1
15	5	0.3
14	6	0.3
13	6	0.3
12	6	0.3
11	6	0.3
10	6	0.3
9	8	0.4
8	8	0.4
7	8	0.4
6	15	0.8
5	17	0.9
4	26	1.3
3	41	2.1
2	72	3.6
1	129	6.5

Research Models

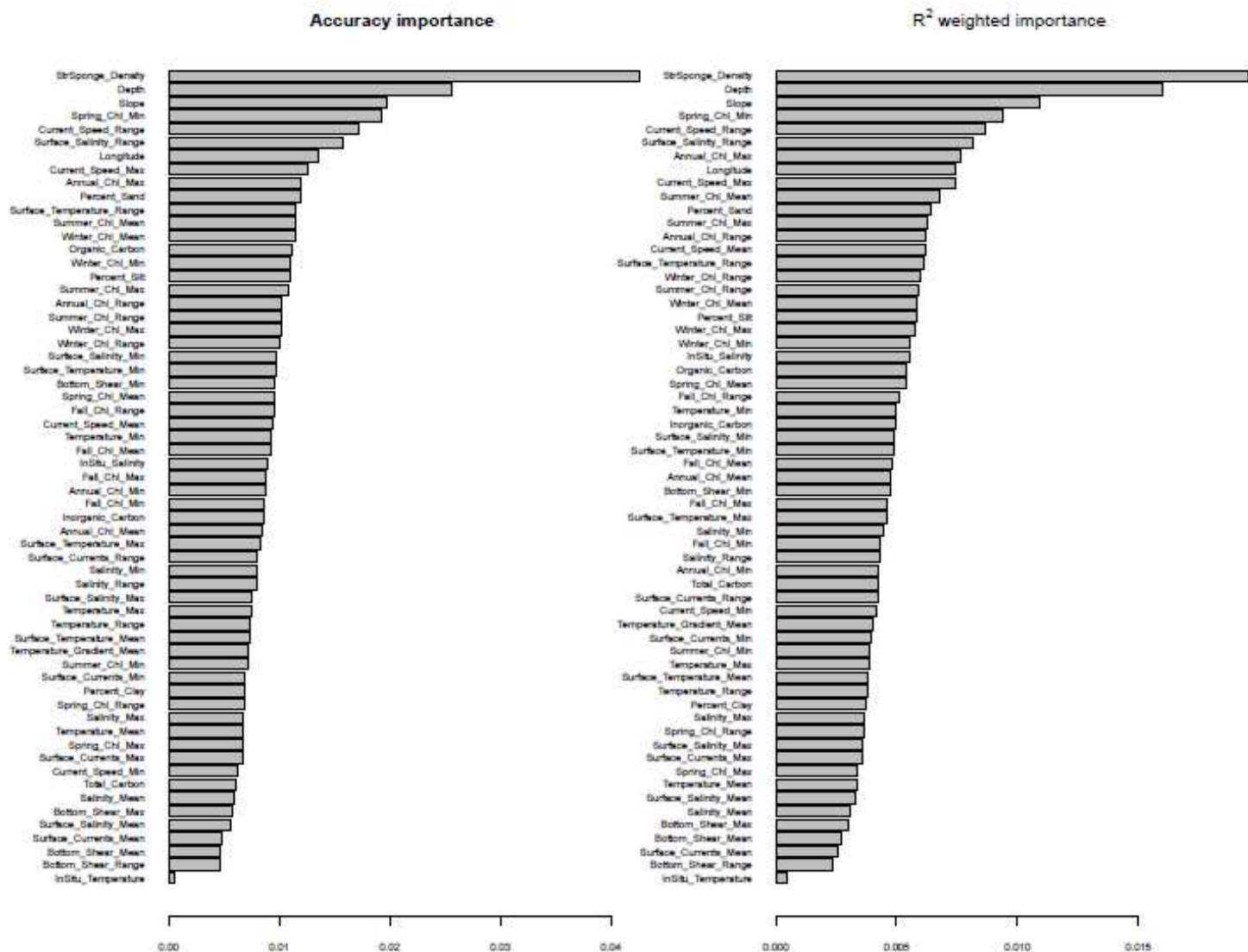
- Specific to individual data sets and hypotheses
- GLMs, GAMs, ANOVA etc.
- Gradient forest models

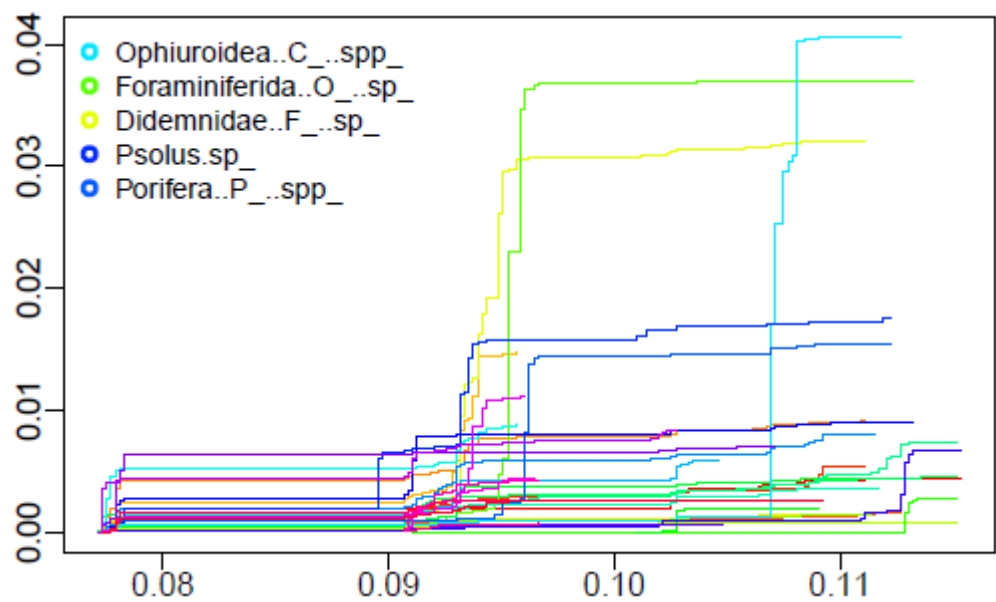
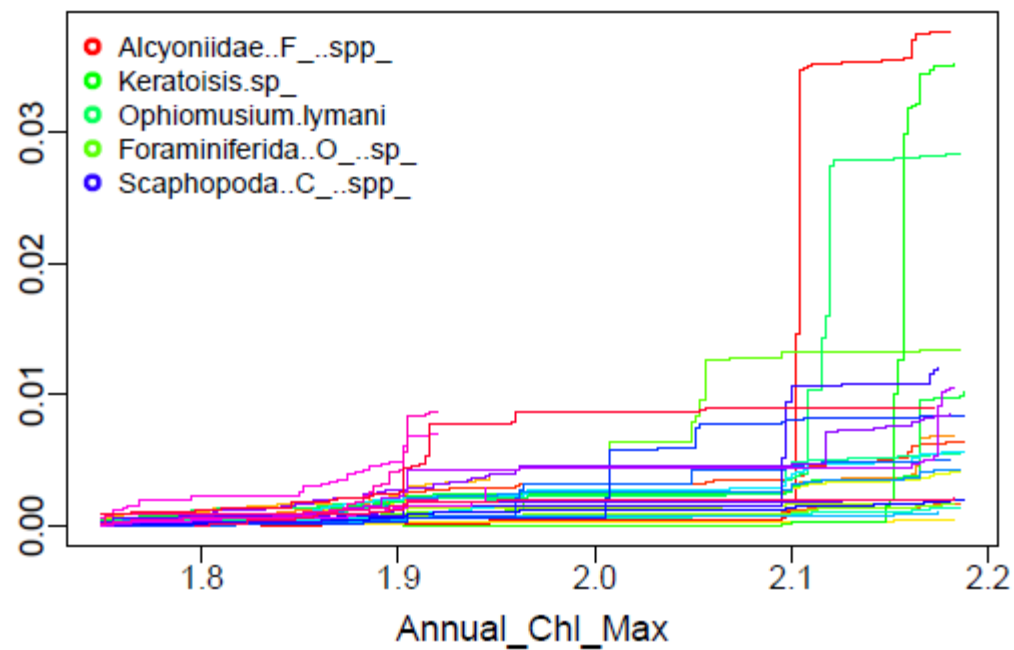


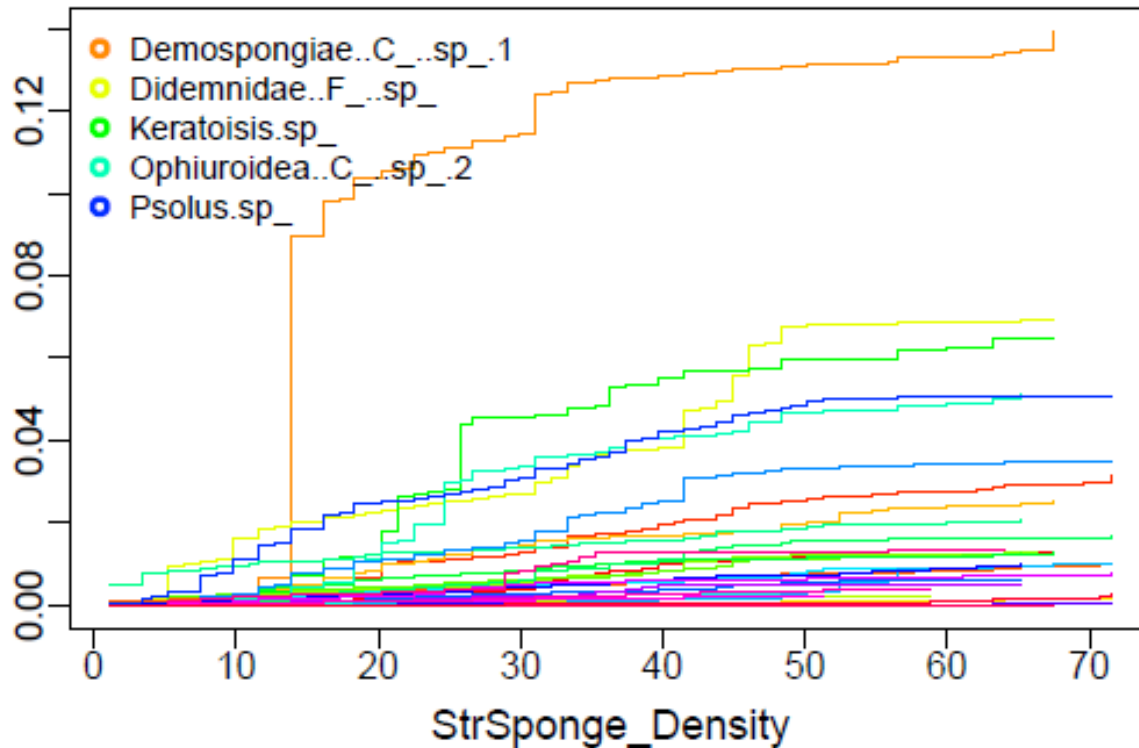
Gradient Forest Analysis: Sackville Spur Sponge Grounds



Gradient Forest Analysis: Sackville Spur Sponge Grounds







At what density of structure-forming sponges do you see increased numbers of associated species?

Density for ecosystem functioning of biodiversity for SAI evaluation