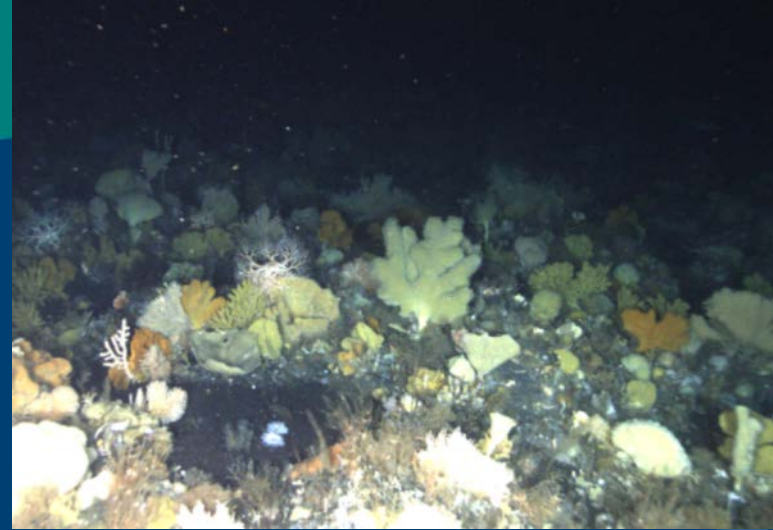*Science, Service, Stewardship*

Distribution modeling for deep-sea corals and sponges in Alaska

Chris Rooper, Mark Zimmermann, Mike Sigler and Jerry Hoff
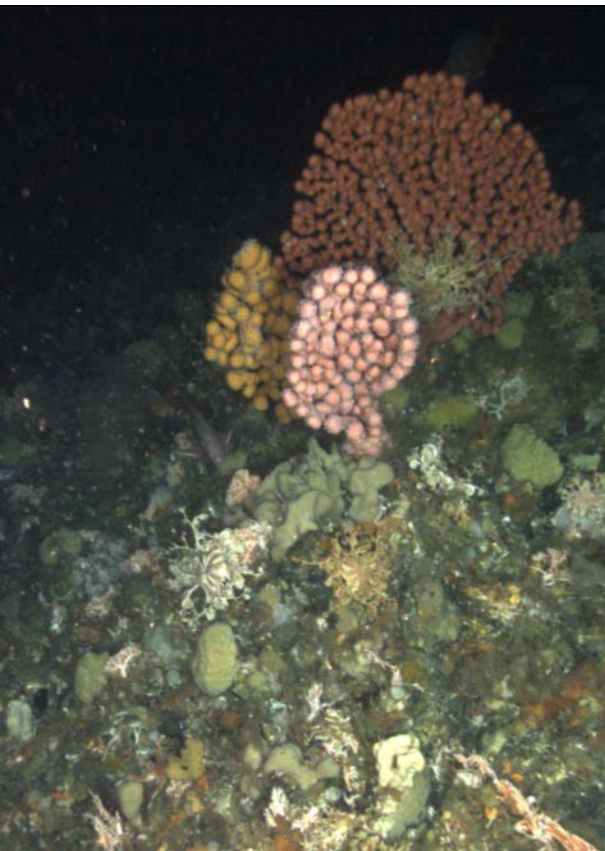
Outline

Objective: Produce maps of the distribution and abundance of deep-sea corals for all regions in Alaska

- Generic modeling methods

- Distribution model results
  - Aleutian Islands
  - Gulf of Alaska
  - Eastern Bering Sea

- Groundtruthing
  - Aleutian Islands
  - Eastern Bering Sea

- Method Comparisons

- Conclusions

Dependent Data:
Bottom trawl survey catch 1991–2011 (AI & WGOA)
Bottom trawl survey catch (2012 to test)

Flavors:
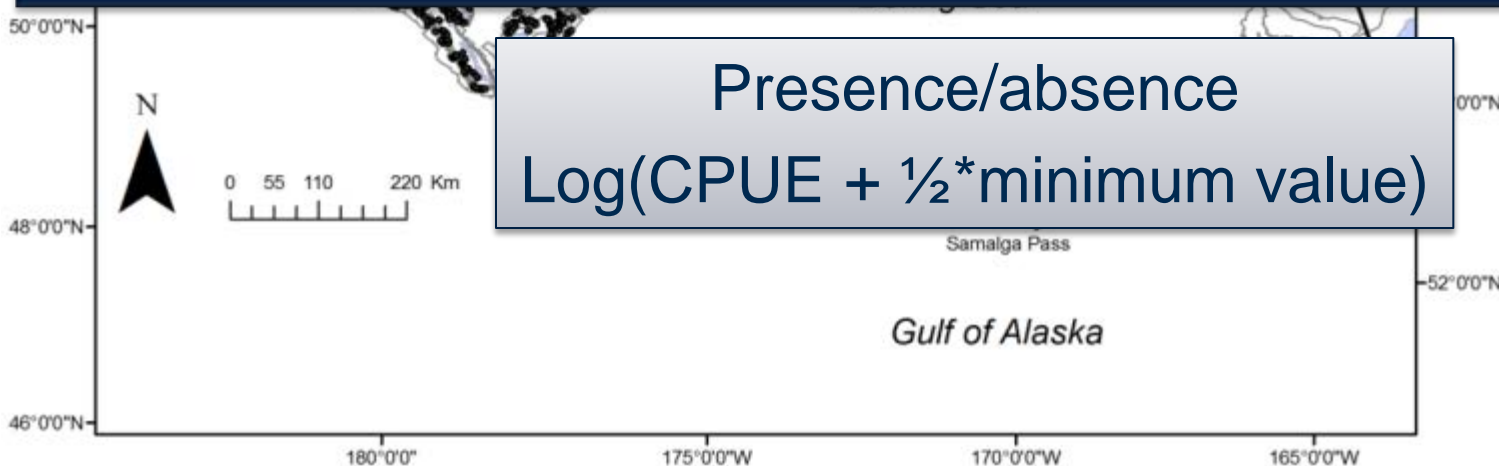
Upright sponges (vase, branching, monolithic, etc.)

"Hard" coral (Primnoidae, Stylasteridae, Plexauridae, Paragorgidae, Acanthogorgiidae, Cladopathidae, Isididae)
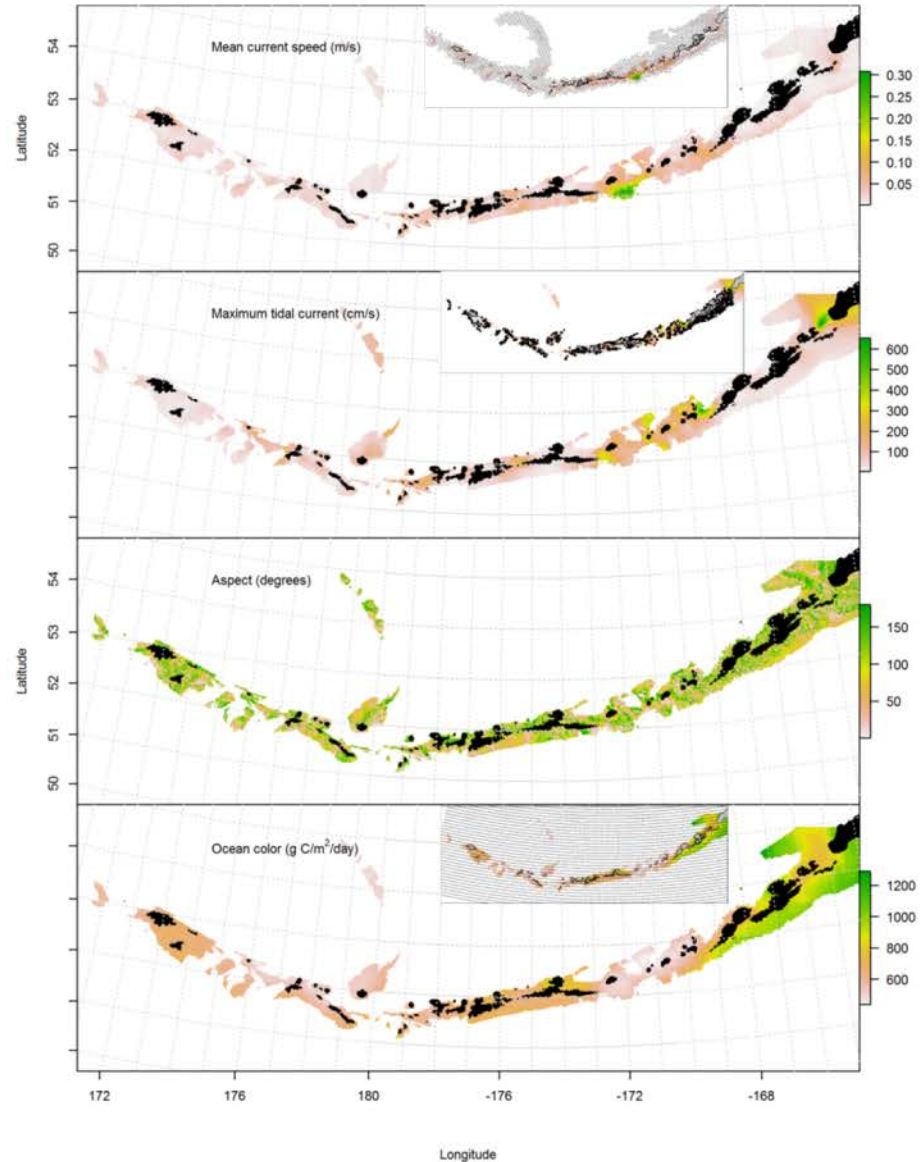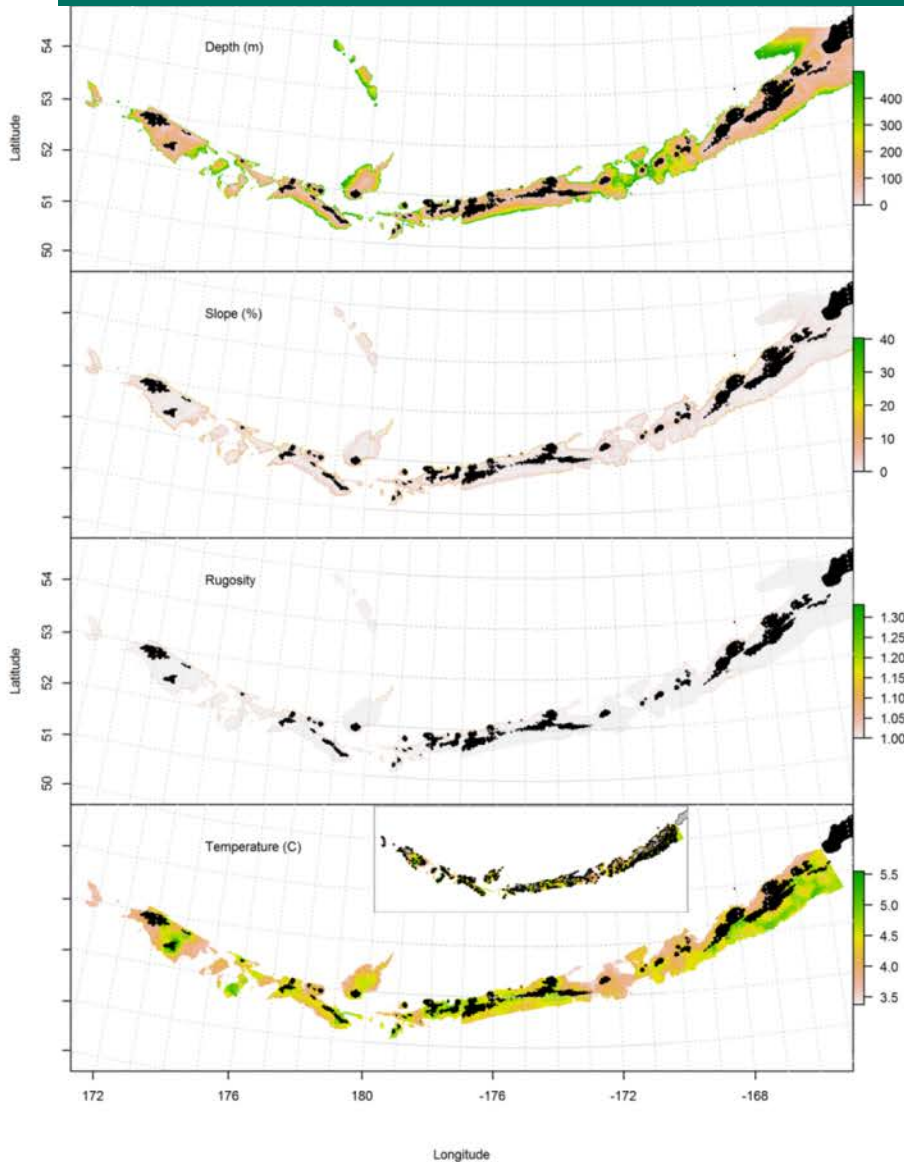
Primnoidae

Stylasteridae

Coral Diversity

Presence/absence
Log(CPUE + ½*minimum value)

Samalga Pass

Gulf of Alaska

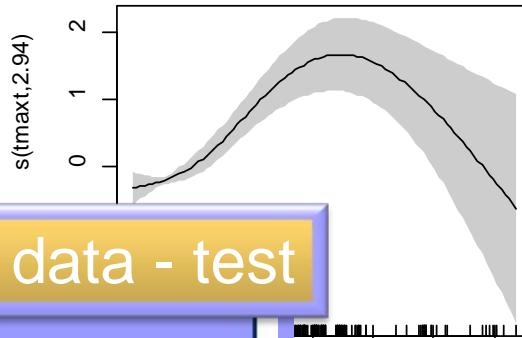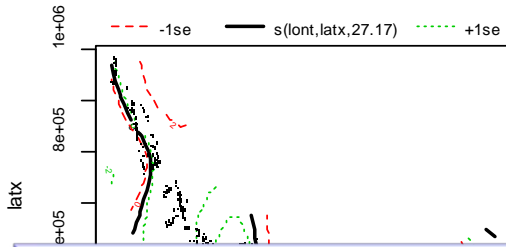# Independent Variables

Results I. Coral presence or absence (example)

$y = s(longitude, latitude)+s(maximum\ tidal\ current)+s(ocean\ color)+s(slope)$

2012 Bottom trawl data - test

Corals	Predicted	
Observed	Absent	Present
Absent	153	55
Present	84	109

65% Correct
AUC = 0.74

Corals	Predicted	
Observed	Absent	Present
Absent	1560	408
Present	675	816

69% Correct
AUC = 0.75
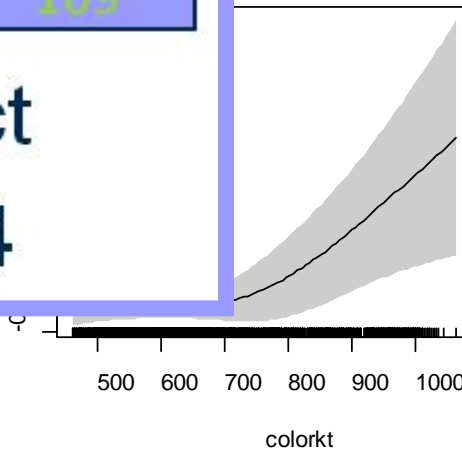
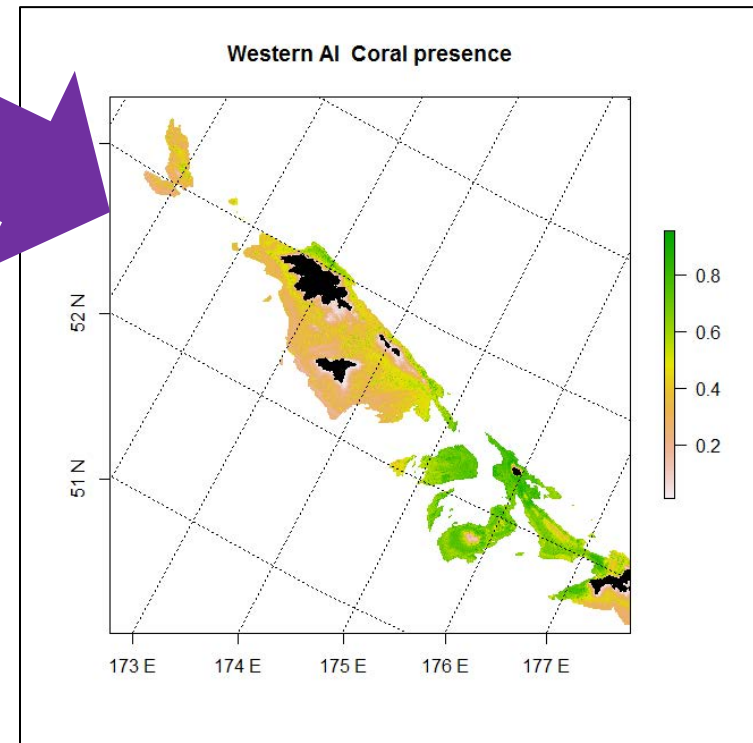# Distribution of coral and sponge in the Aleutian Islands

Longitude

Latitude

Maximum tidal current
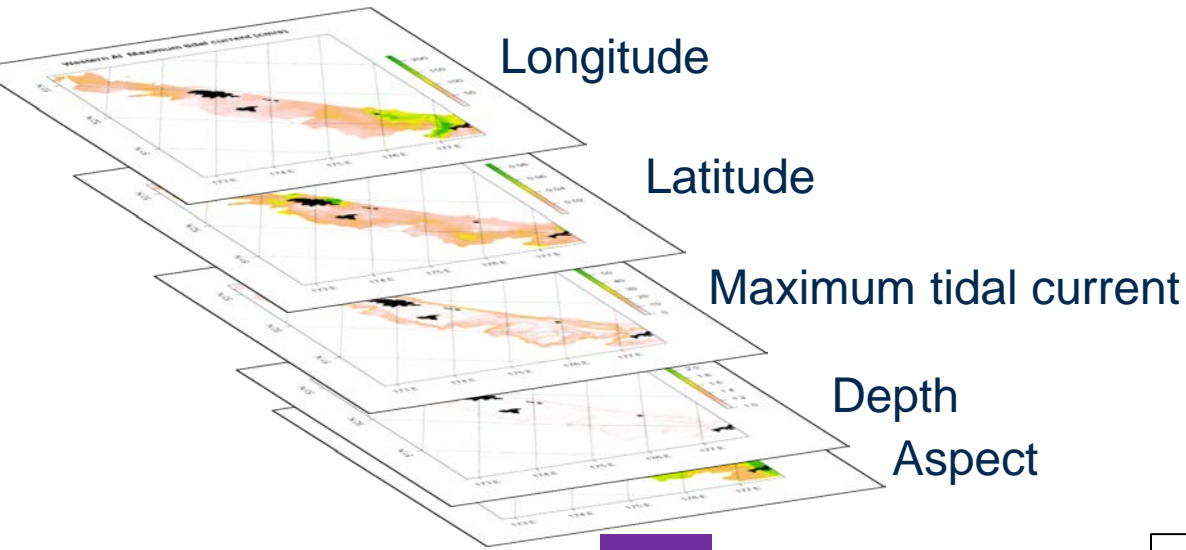
Depth

Aspect
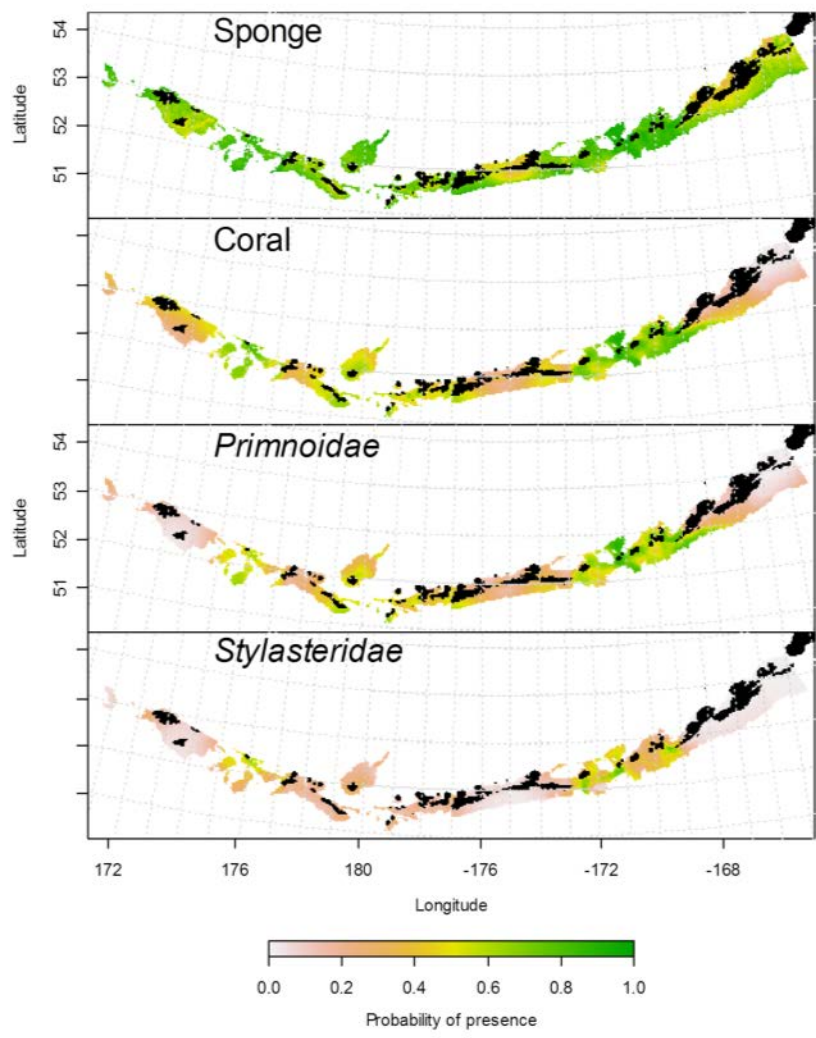
Best fitting GAM model

$y = s(longitude, latitude) + s(depth) + s(maximum\ tidal\ current) + s(aspect)$
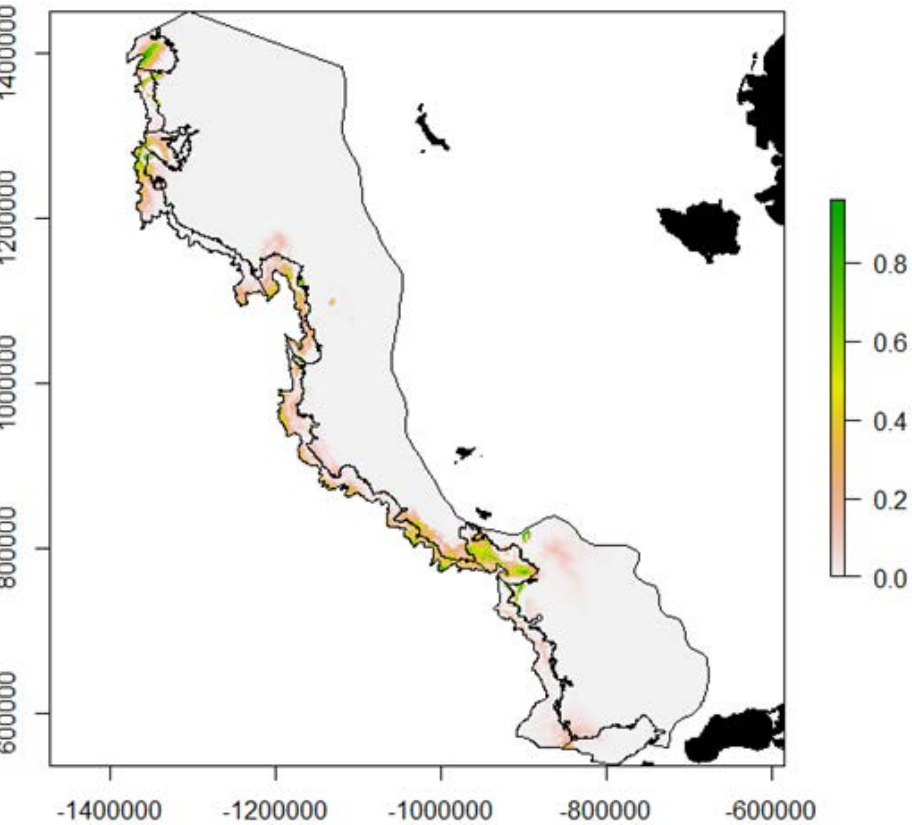
Western AI Coral presence
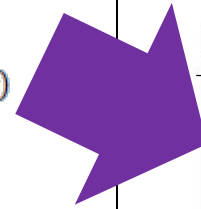
AI coral and sponge – Presence, Abundance, Diversity
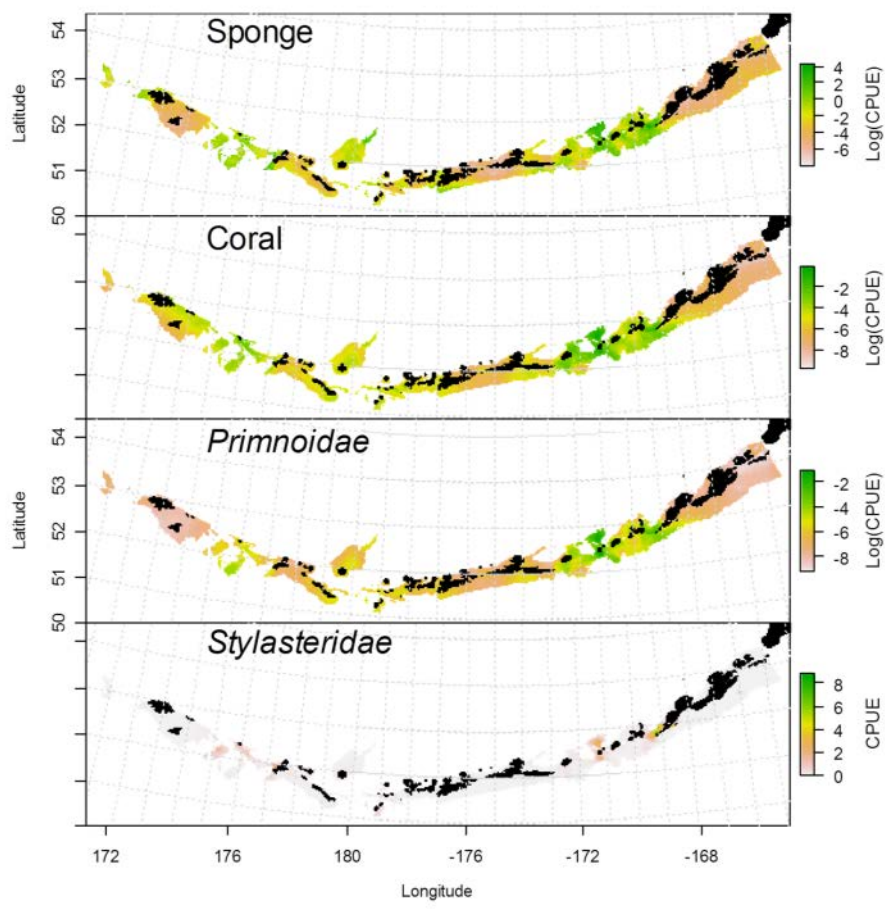
Eastern Bering Sea – Hurdle GAM

Coral probability of presence

Coral abundance (Log(CPUE))

AUC = 0.93

$R^2 = 0.39$

NOAA FISHERIES
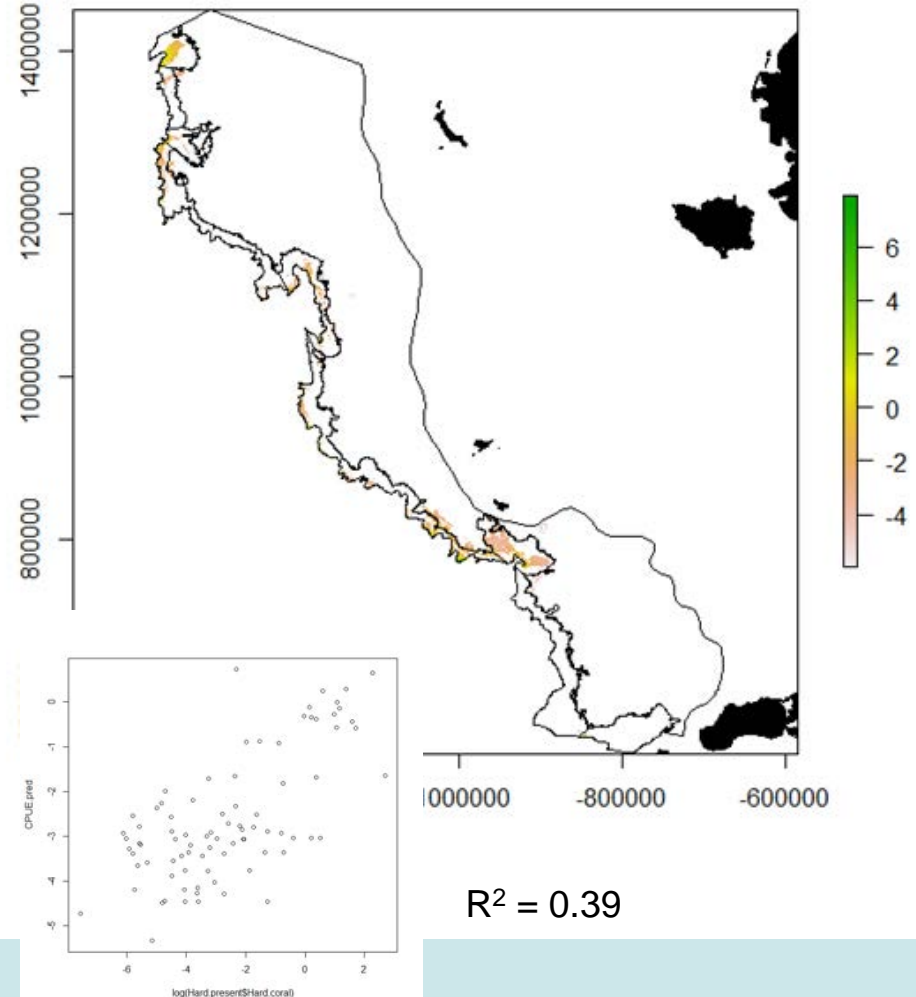
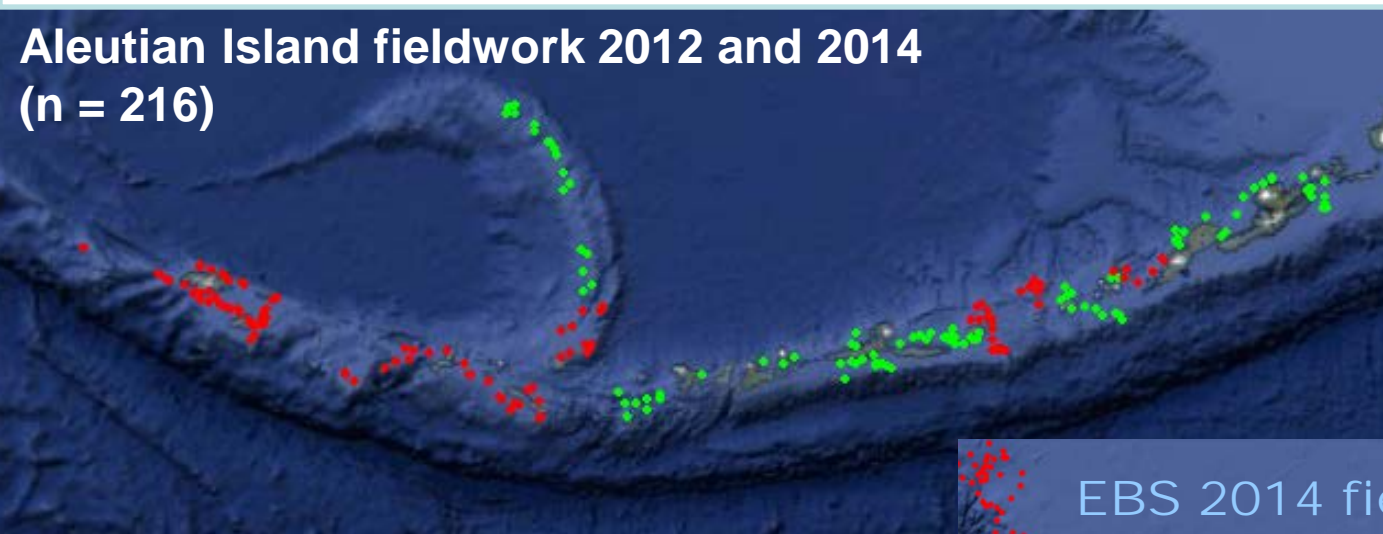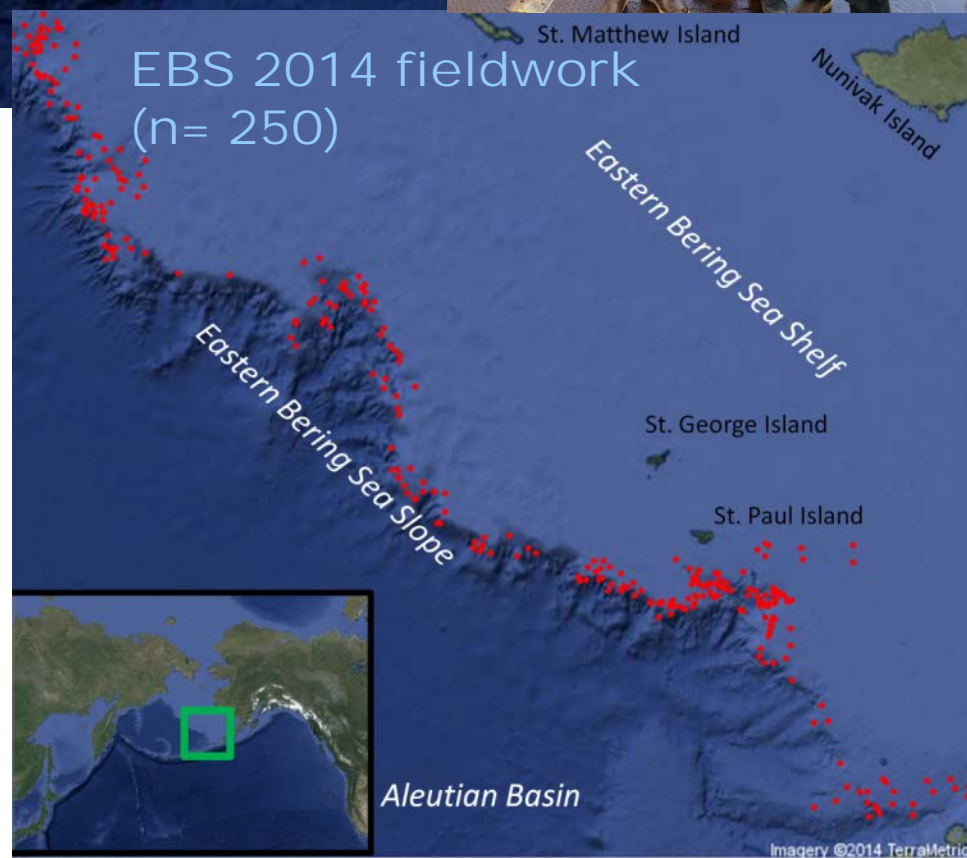# Gulf of Alaska Hurdle GAM

Sea pens and whips

Sponges

Coral

Groundtruthing the distribution of coral and sponge

Aleutian Island fieldwork 2012 and 2014 (n = 216)


EBS 2014 fieldwork (n= 250)

St. Matthew Island

Nunivak Island

Eastern Bering Sea Shelf

Eastern Bering Sea Slope

St. George Island

St. Paul Island

Aleutian Basin

Imagery ©2014 TerraMetrics

Stereo drop camera
15 minute tows

Ground-truthing objectives

- Determine the presence/absence and density for major coral taxa

- Measure the size and height of a subsample of the major coral taxa

- Compare the presence or absence and density of coral at each site and the probability of presence predicted by the model
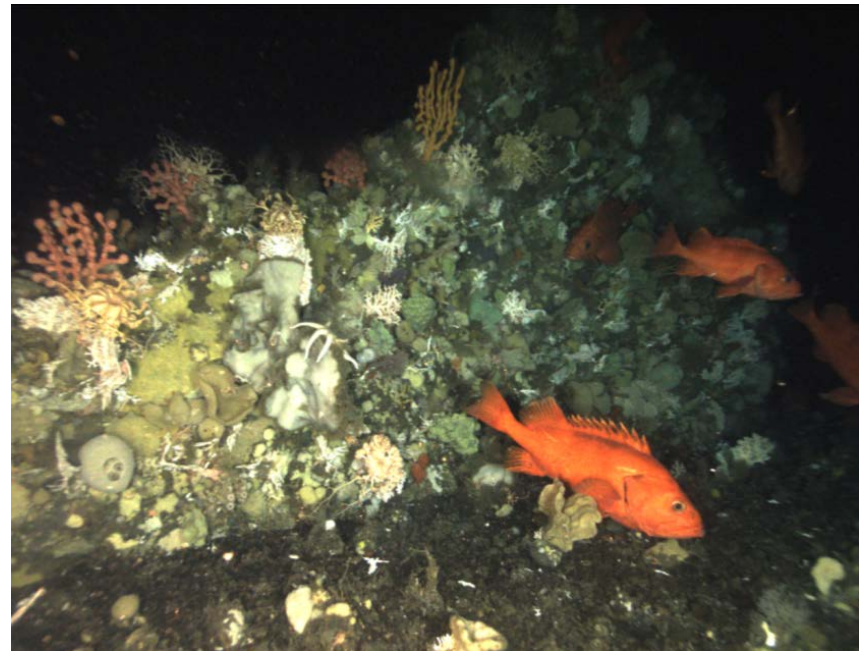
Aleutian Islands Presence-Absence Results

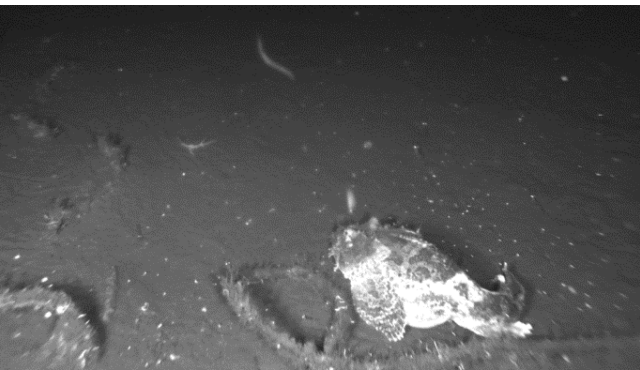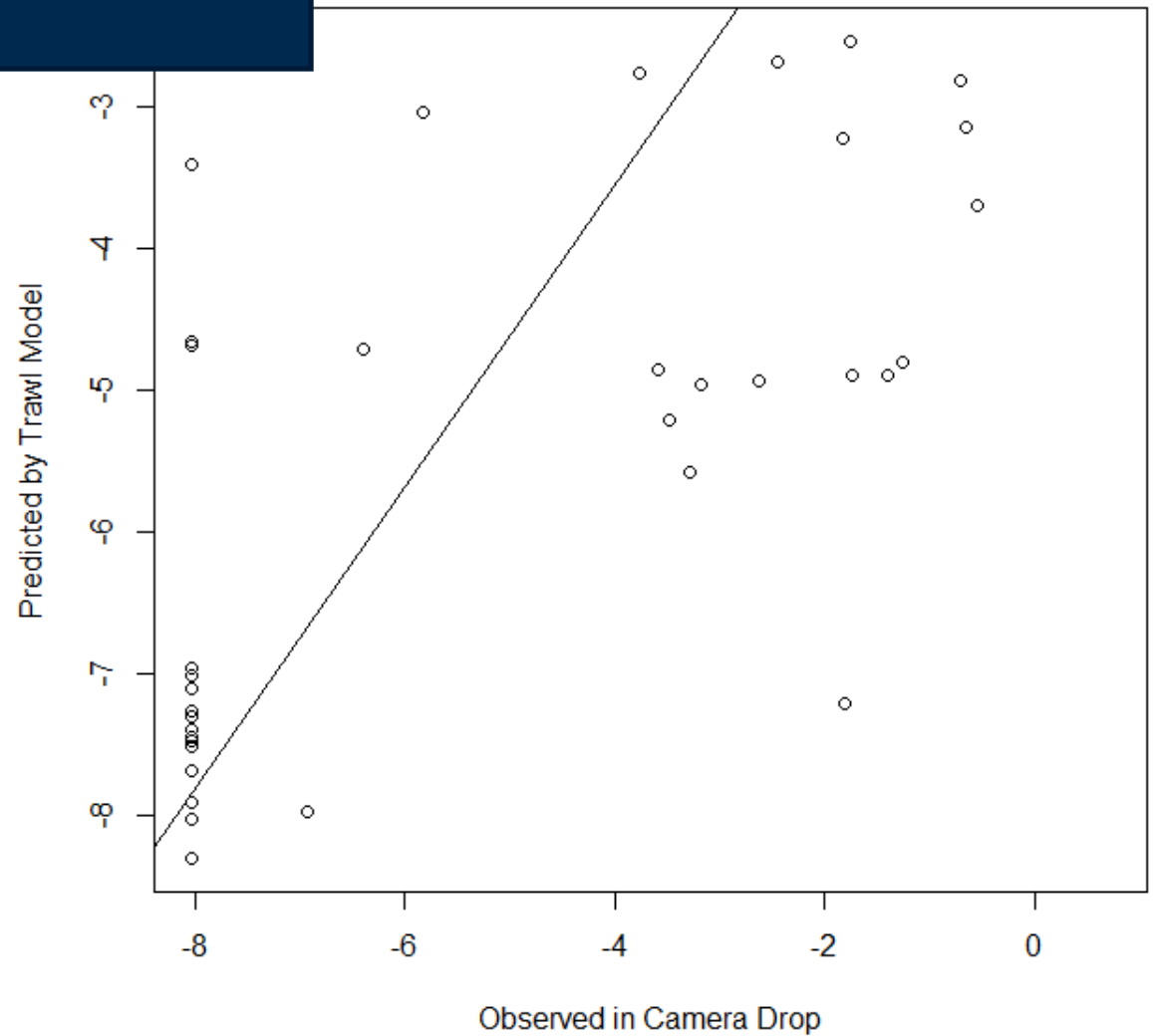Predicted = Trawl survey model
Observed = Seen in camera drops

Corals	Predicted	
Observed	Absent	Present
Absent	45	23
Present	37	67

→ 67%
AUC = 0.75

Density comparisons
(Trawl model vs. Camera data)
n = 38

Coral (r2= 0.46, p < 0.0001)

Coral Presence/Absence
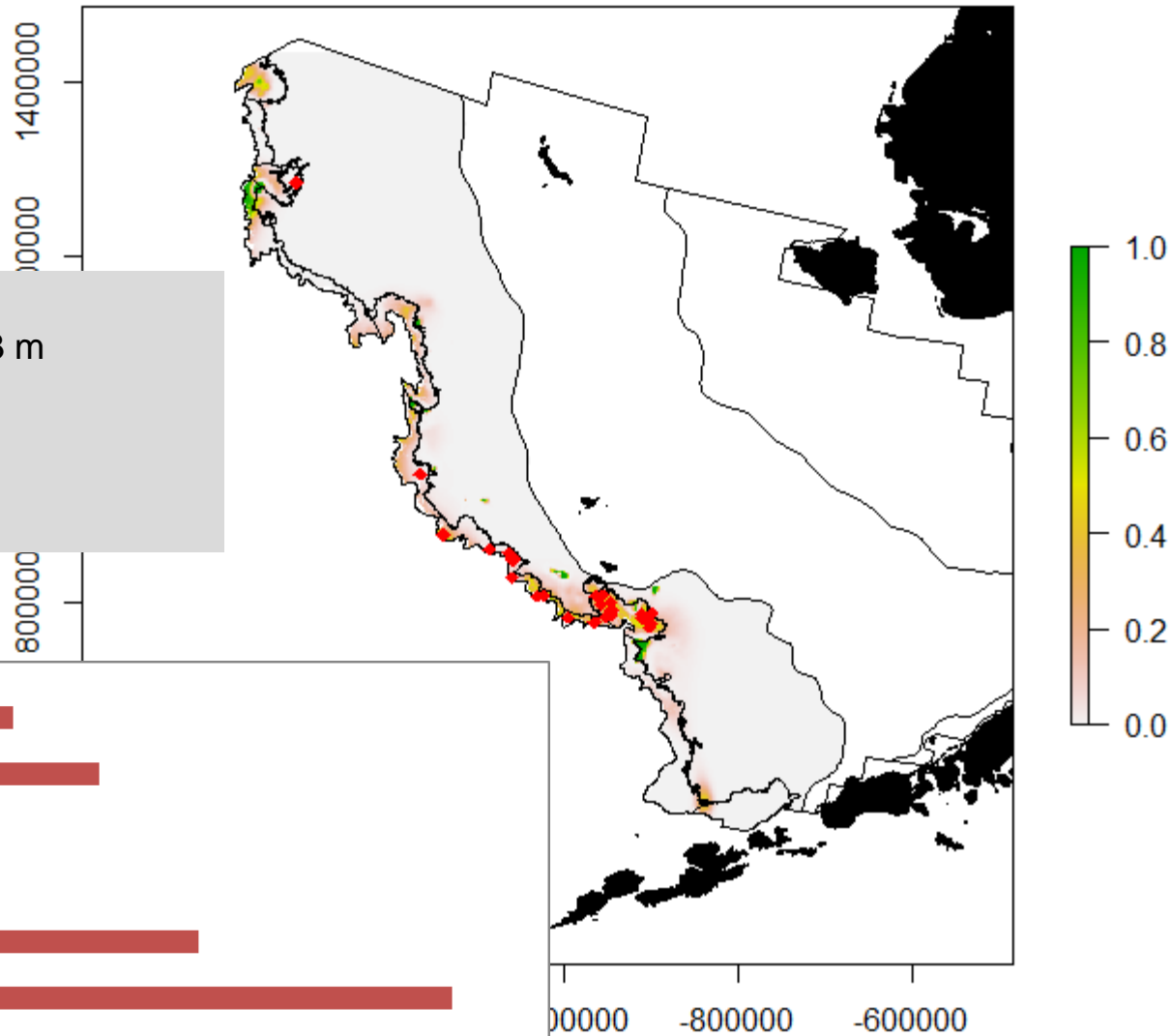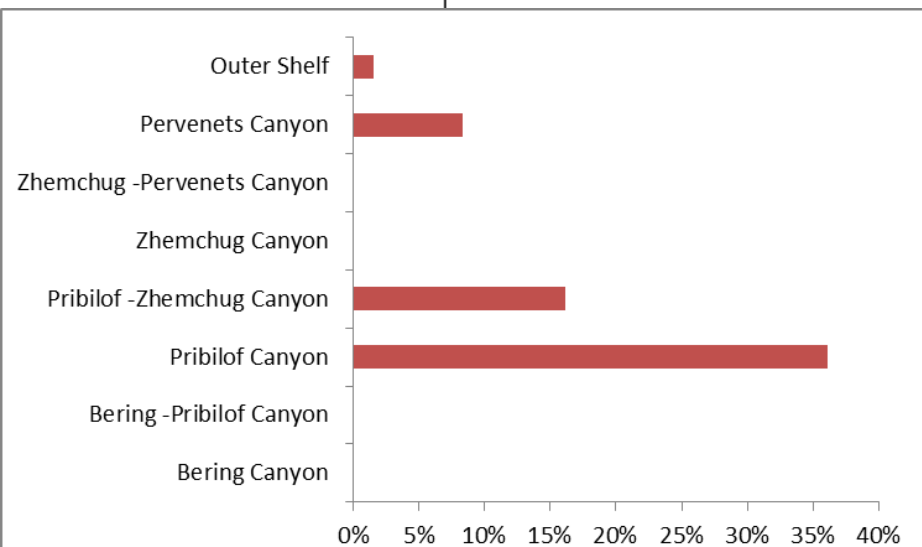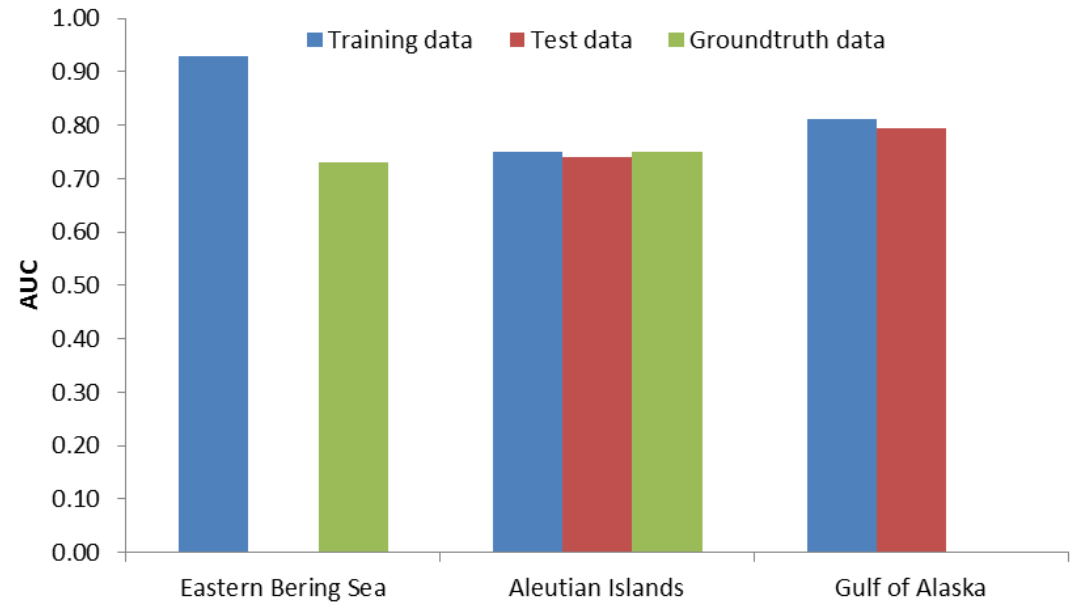

n = 26 (10%)
Median depth = 423 m
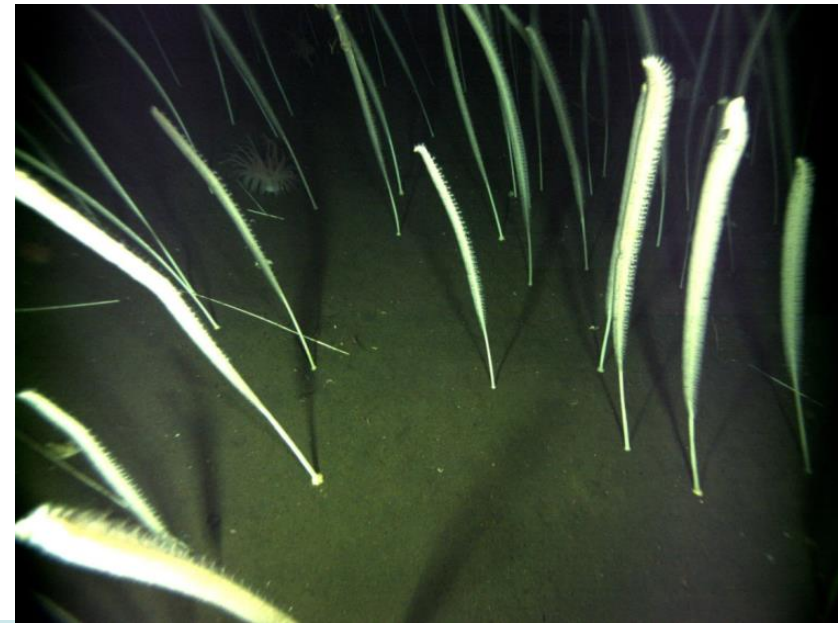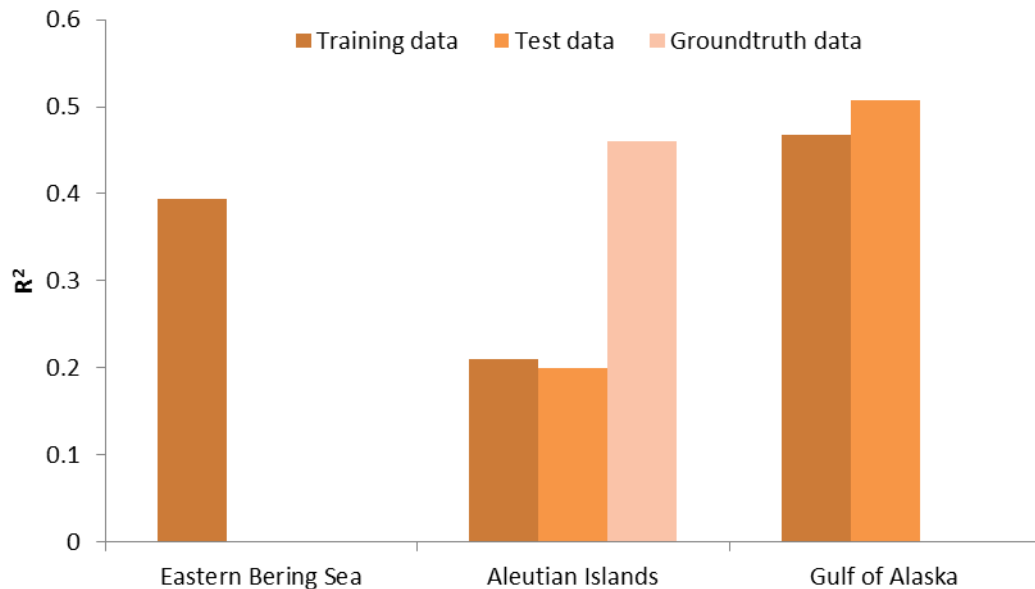Min = 204 m
Max = 783 m

AUC = 0.73

Model Fits to Independent Data
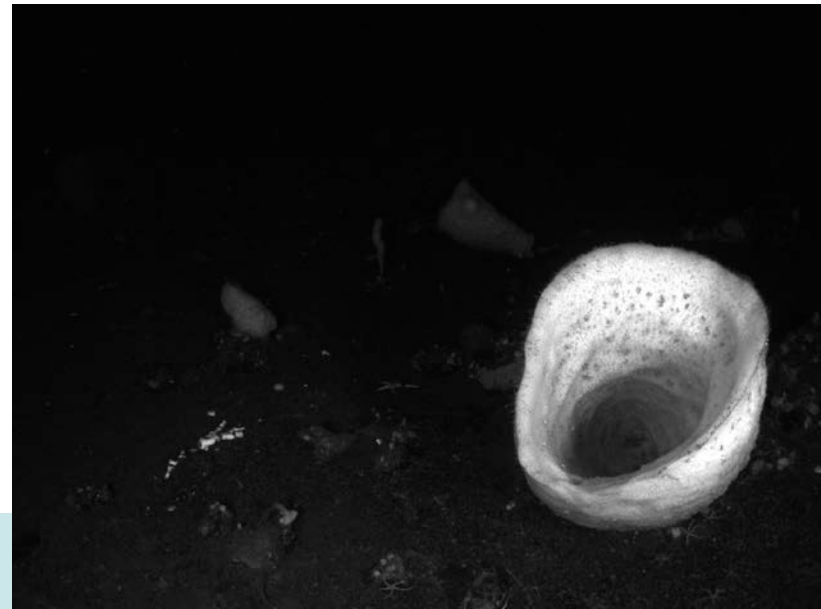
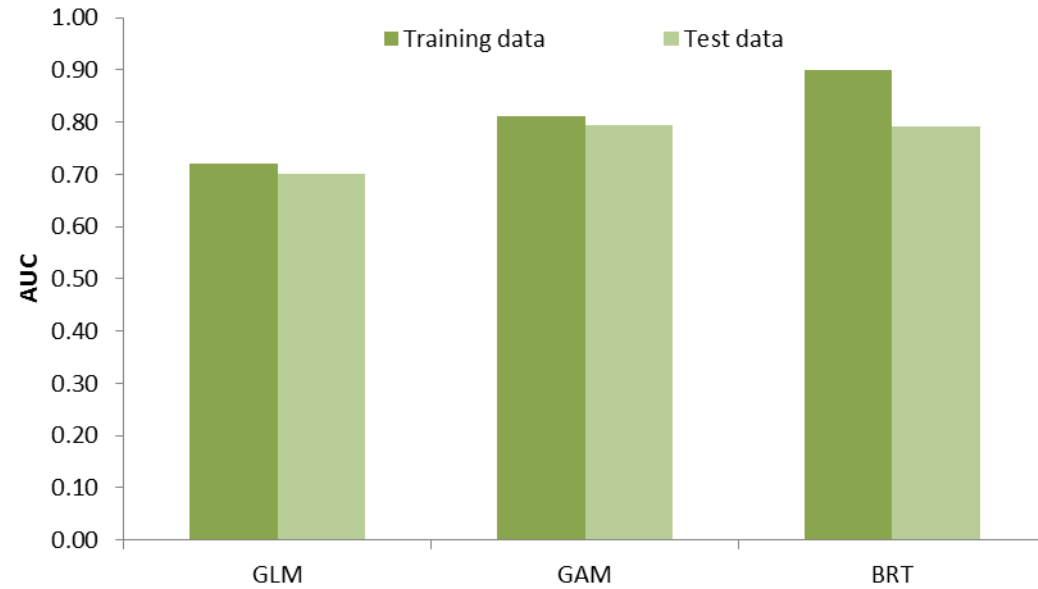## Presence/Absence models

Abundance models

Modeling methods

- Presence/Absence – Gulf of Alaska
  - General Linear Model (GLM)
  - Generalized Additive Model (GAM)
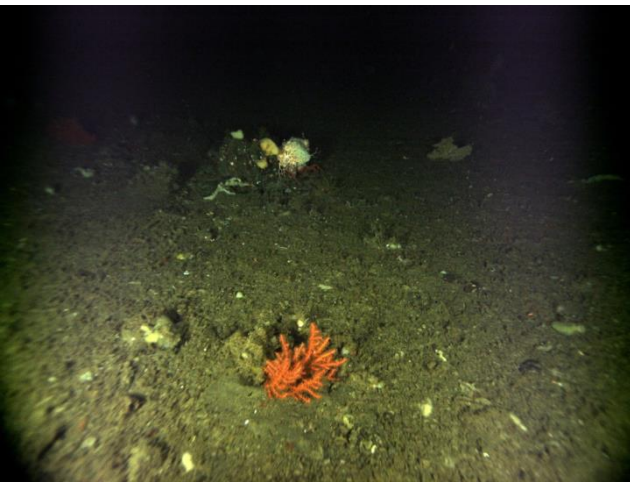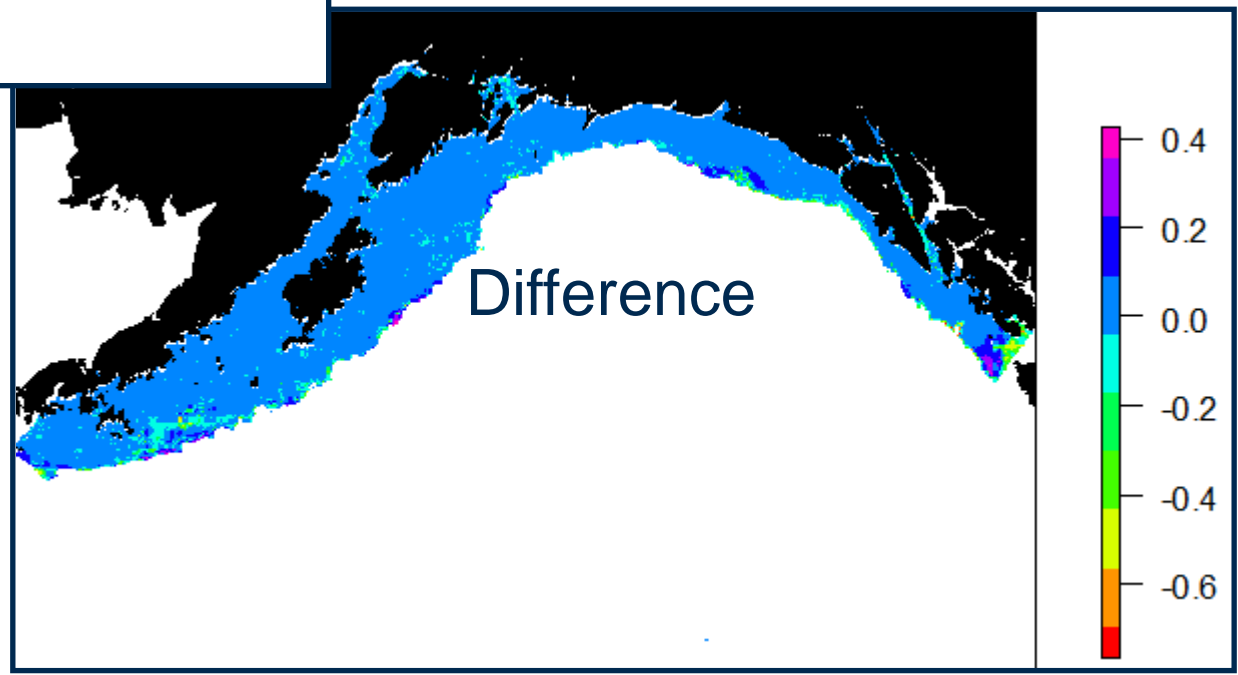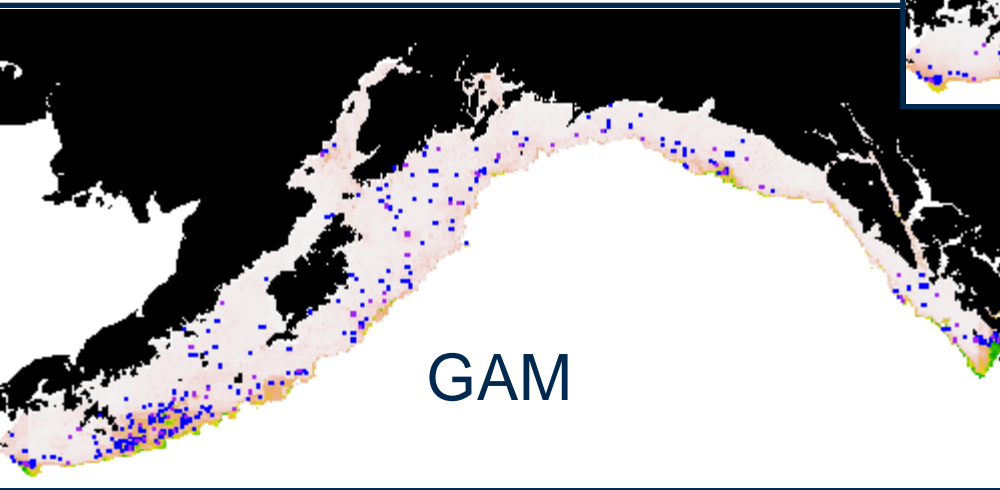 - Boosted Regression Tree (BRT)

Modeling Methods
Gulf of Alaska

Presence/Absence models

Abundance models

GAM v. BRT GOA Models

BRT

GAM

Difference

0.4
0.2
0.0
-0.2
-0.4
-0.6
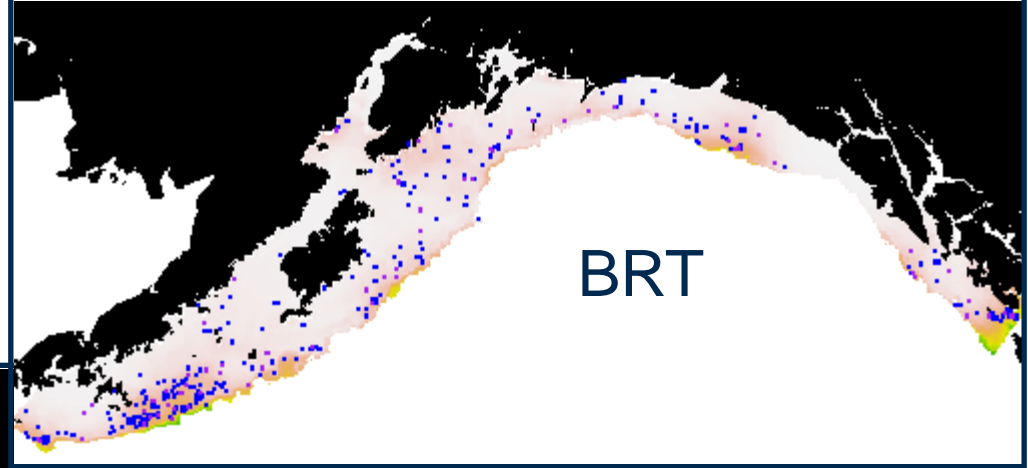
Conclusions

- Coral models fit the training data well - generally

  - Agreement in predictions ~60-80%

  - AUC ~ 0.70-0.90

  - R^2 ~ 0.20 – 0.50

- Coral models fit the test and groundtruth data well

  - Agreement in predictions ~60-80%

  - AUC ~ 0.70-0.90

  - R^2 ~ 0.50

- Modeling methods produced varying levels of accuracy

  - Model diagnostics varied

  - Pictures were consistent throughout the region of prediction

Next Steps

- Further refine and test modeling approaches (new regions, new data)

- Identify common predictors of coral habitats among ecosystems

- Explore relationships with commercial fish species and role in enhancing biodiversity

- Determine interactions with commercial fishing and measure of vulnerability that can be applied to the predictions for use in spatial management

Acknowledgements

Collaborators

B. Stone

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