Gulf Coral Atlas Part II
Predictive models for management*

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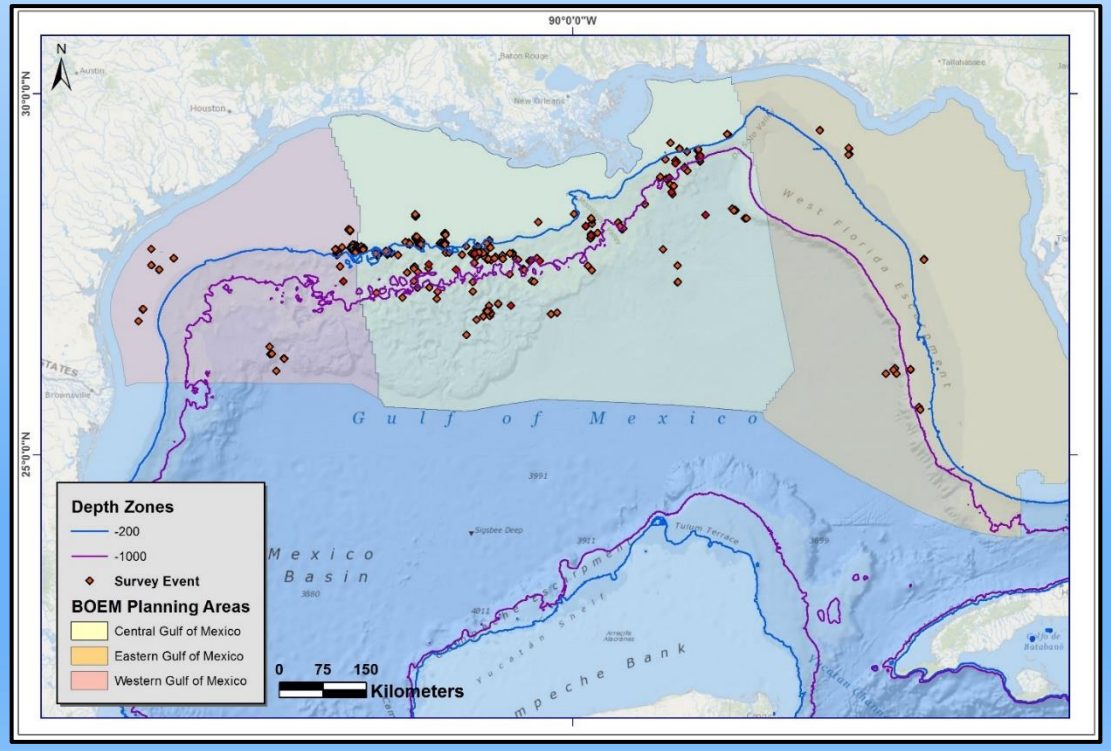
Image: NOAA Okeanos Explorer Program Gulf of Mexico 2014 Expedition

Why predictive models?

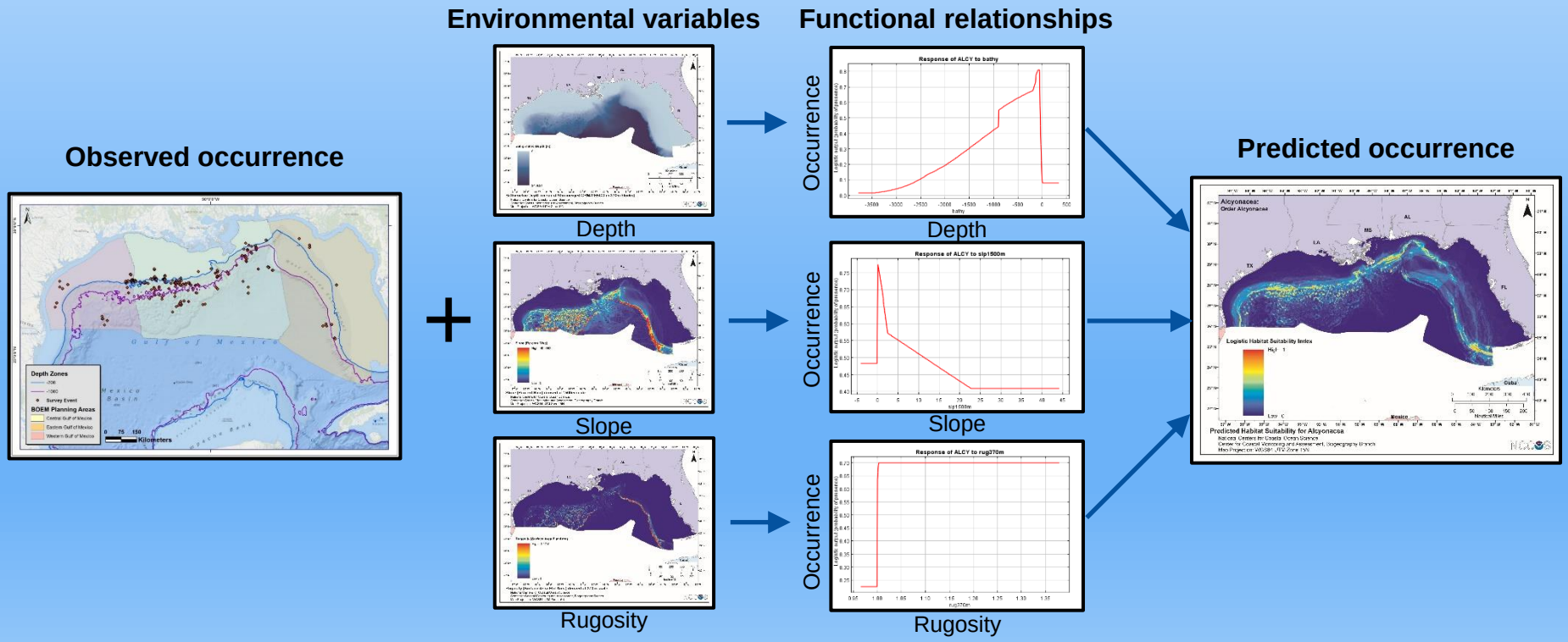
- Field surveys provide crucial data but expensive
- Management requires comprehensive maps



Gulf of Mexico Atlas project study areas and dives included in Coral and Chemosynthetic geodatabase as of June 2017

Habitat-based predictive modeling

- Comprehensive environmental datasets available
- Relate species occurrence to environmental variables
- Predict across entire region



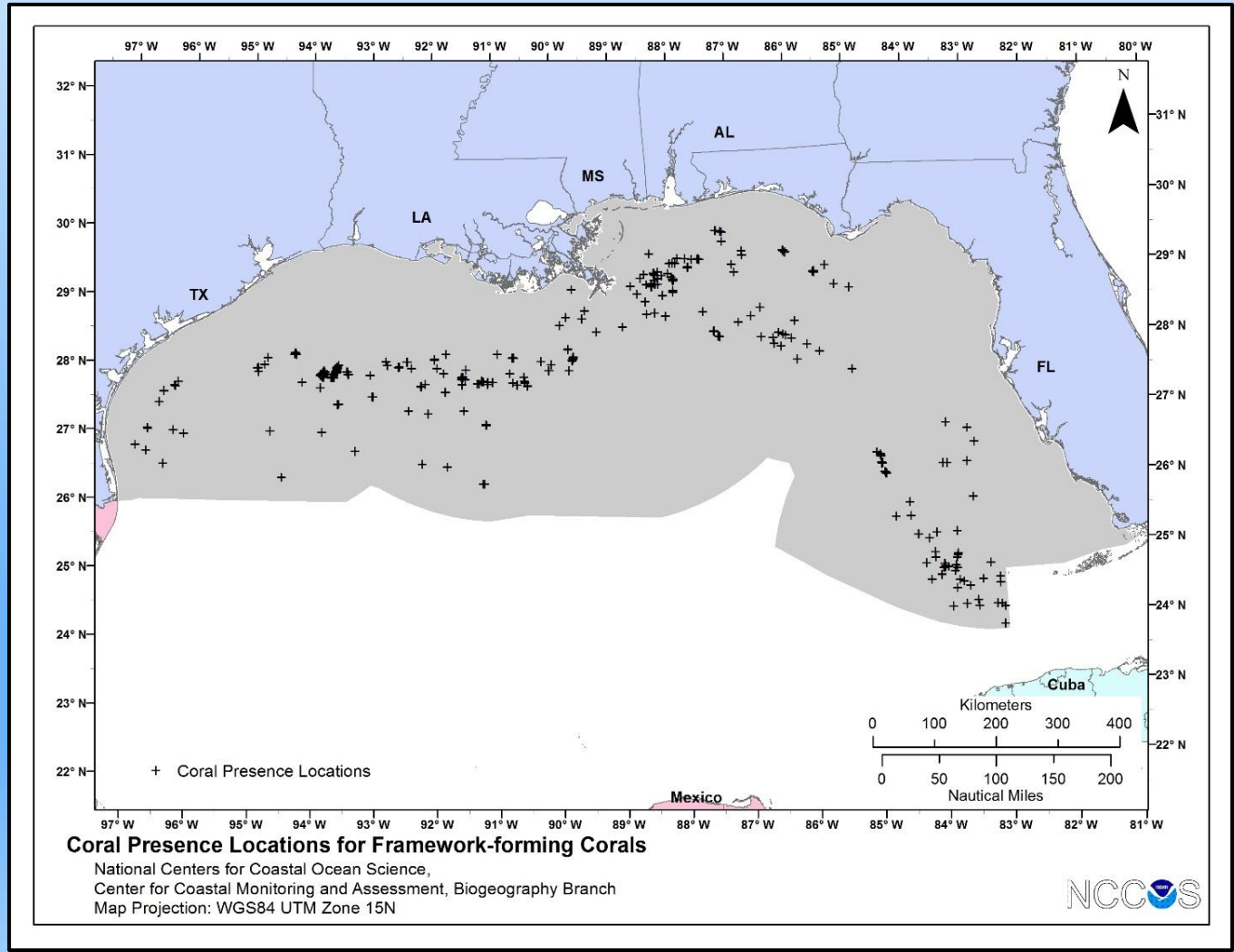
Previous Gulf of Mexico modeling (2013)

- ‘Presence only’ data

Image: NOAA Okeanos Explorer Program Gulf of Mexico 2014 Expedition

Data sources

1) *NOAA National Deep-Sea Coral Geodatabase*
2) *Peter Etnoyer’s dissertation work*
3) *John Reed SEADESC Reports (HBOI)*
4) *Okeanos Explorer 1202-Leg II (NOAA OER)*
5) *FGBNMS ROV surveys*



Previous Gulf of Mexico modeling (2013)

- 19 coral species/groups

all framework forming corals

Scleractinia
- all
- framework forming
- non-framework forming

Madracis spp.

Madrepora spp.

Lophelia pertusa

Antipatharia

Alcyonacea
- all
- gorgonian
- non-gorgonian

Ellisellidae

Gorgoniidae

Isididae

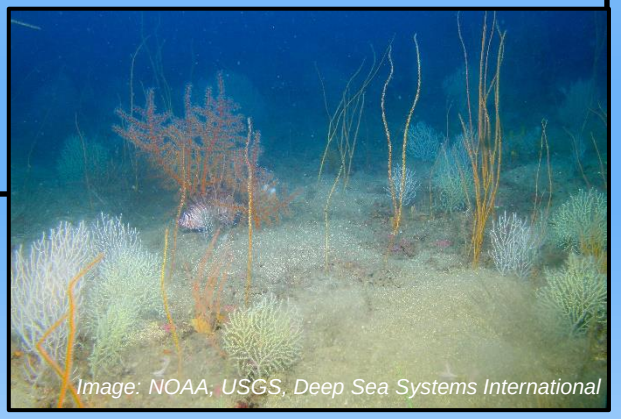
Paramuriceidae

Plexauridae

Bebryce spp.

Hypnogorgia spp.

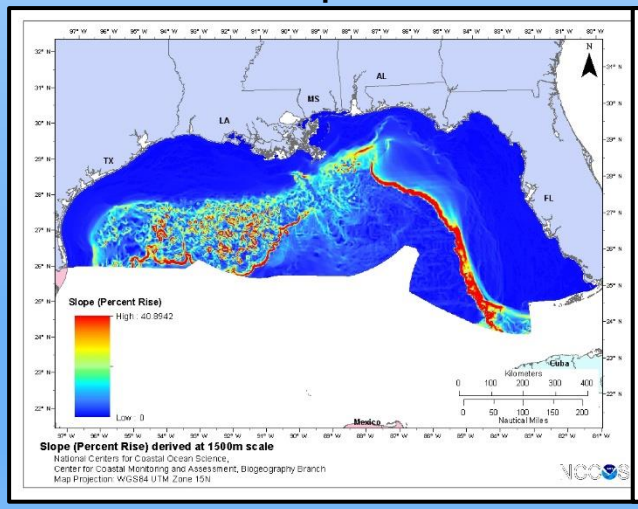
Callogorgia spp.



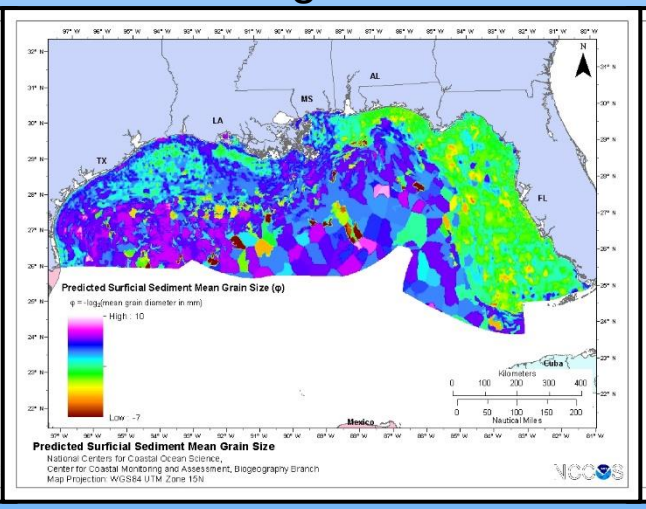
Previous Gulf of Mexico modeling (2013)

- 27 bathymetric, surficial sediment, and oceanographic environmental predictor variables
- 370 m resolution
- Examples:

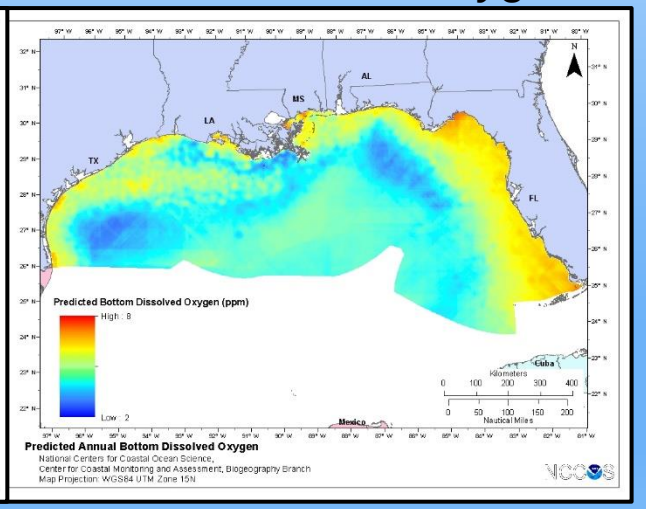
Depth



Mean grain size



Bottom dissolved oxygen

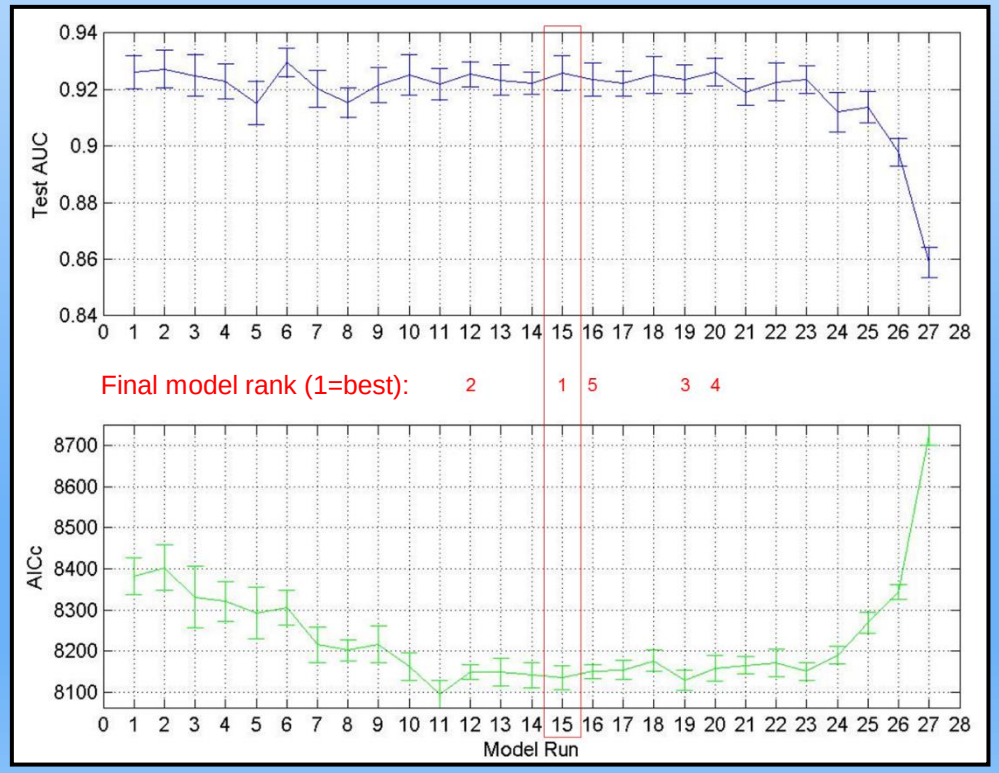


Previous Gulf of Mexico modeling (2013)

- Maximum Entropy (MaxEnt) modelling framework
- Stepwise variable selection through cross-validation
- Maximize predictive accuracy of parsimonious models

Area Under the receiver operating characteristic Curve

corrected Akaike's Information Criterion (AICc)



Accuracy

Parsimony

Fewer predictor variables

Previous Gulf of Mexico modeling (2013)

- Environmental predictor variable importance

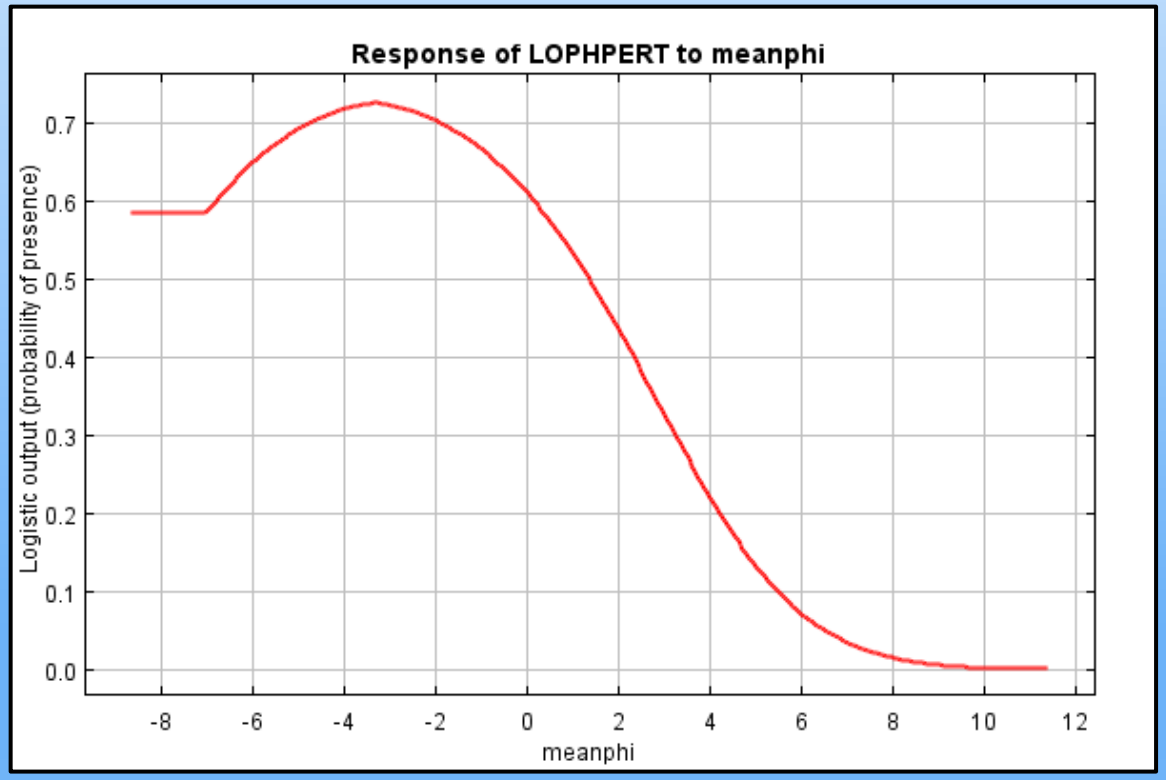
Type	Variable	%of groups for which variable selected
bathymetric	depth	98%
surficial sediment	interpreted 3D seismic anomalies	95%*
bathymetric	slope of slope (1500m)	55%
surficial sediment	% sand	52%
oceanographic	annual surface chlorophyll-a	50%
surficial sediment	mean grain size	50%
bathymetric	rugosity (370m)	50%
bathymetric	slope of slope (5km)	43%
oceanographic	annual bottom salinity	40%
oceanographic	annual bottom temperature	38%
bathymetric	profile curvature / slope categories (20km)	38%
bathymetric	BPI / slope categories (20km)	33%

**only includes models fit in seismic anomaly footprint area*

Previous Gulf of Mexico modeling (2013)

- Functional relationships

Lophelia pertusa response to surficial sediment mean grain size



Relative habitat suitability

boulders, cobbles, pebbles ← $\log_2$(mean grain size in mm) → *silt, clay*

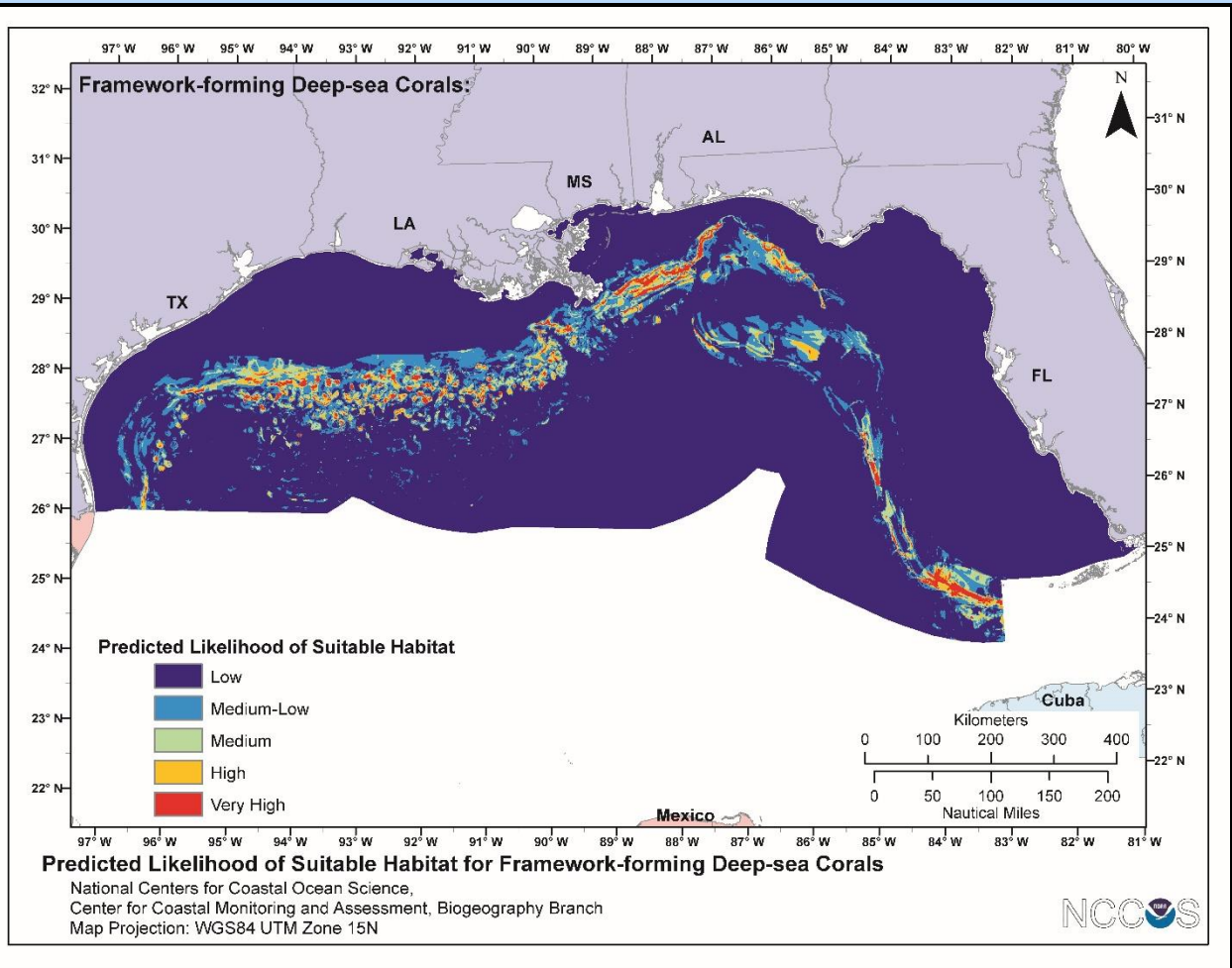
Previous Gulf of Mexico modeling (2013)

- Predicted likelihood of suitable habitat

Image: NOAA Okeanos Explorer Program
Gulf of Mexico 2014 Expedition

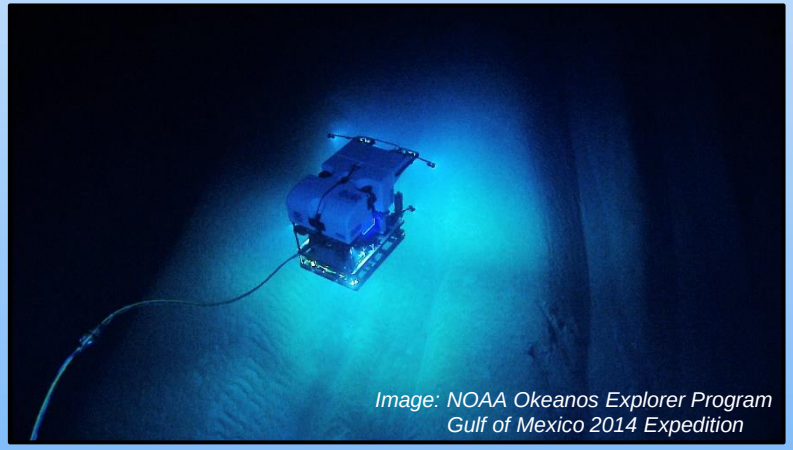
Available on Marine Cadastre

https://marinecadastre.gov/



New Gulf of Mexico modeling

- ‘Presence-absence’ data
- Transect segments with area searched



CruiseName	ObsDate	DepthZone	SegmentID	StartLatitude	StartLongitude	EndLatitude	EndLongitude	StartDepth	EndDepth	SegmentAreaEst	ObservationID	BlackCoralTaxon	GorgonianTaxon
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	5		Hypnogorgia pendula
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	7		Thesea sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	8		Villogorgia sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	9		Bebryce sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	10		Ellisella sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	11		Thesea sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	12	Antipathes atlantica	
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	13	Stichopathes sp.	
NRDA Mesophotic 2014	2014/06/27	Mesophotic	22	29.4394	-87.57596	29.44018	-87.57581	62	61	327	14	Tanacetipathes sp.	
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	15		Thesea sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	16		Nicella sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	17		Villogorgia sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	18		Yellow Plexauridae
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	19		Ellisella sp.
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	20	Antipathes atlantica	
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	21	Stichopathes sp.	
NRDA Mesophotic 2014	2014/06/27	Mesophotic	23	29.44015	-87.5758	29.44057	-87.57558	62	61	173	22		Swiftia exserta

New Gulf of Mexico modeling

- Coral taxa representing 95% of known occurrences by depth zone
  - Scleractinia, Antipatharia, and Alcyonacea
- Chemosynthetic habitat and communities

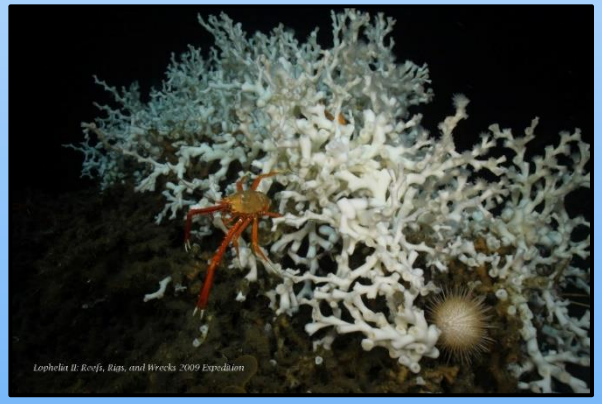


Image: Lophelia II: Reefs, Rigs, and Wrecks 2009 Expedition, NOAA OER/BOEM

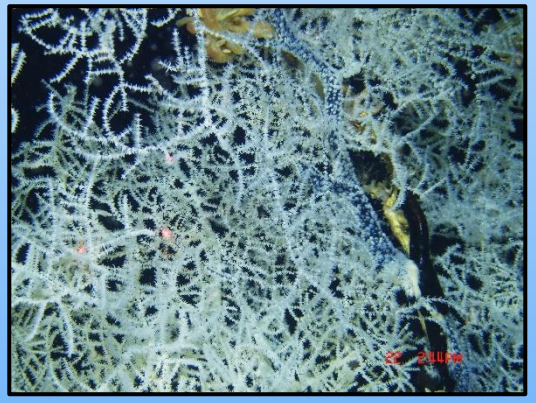


Image: Lophelia II: Reefs, Rigs, and Wrecks 2008 Expedition

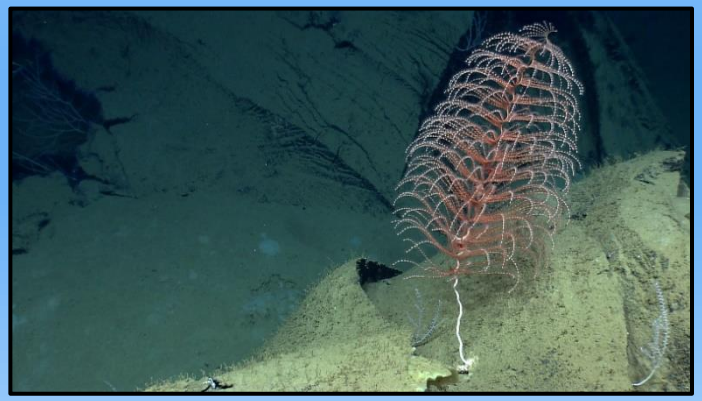
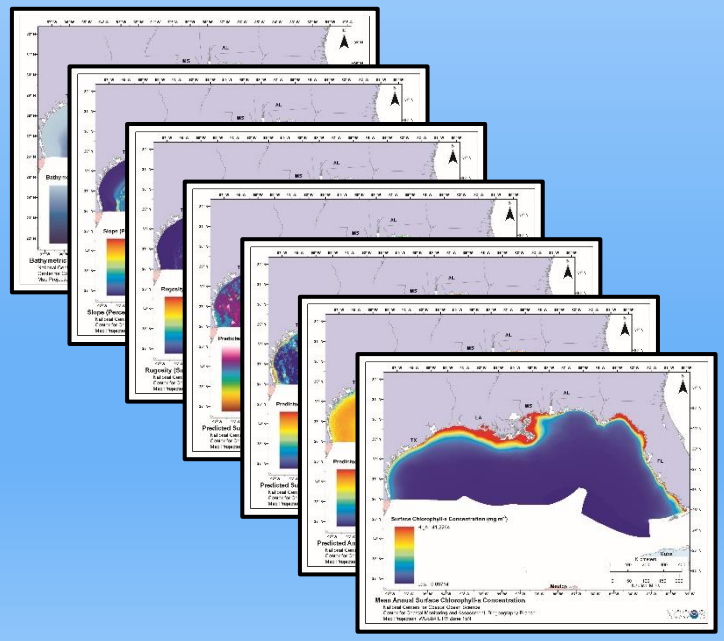


Image: NOAA Okeanos Explorer Program Gulf of Mexico 2014 Expedition

Image: NOAA Okeanos Explorer Program Gulf of Mexico 2012 Expedition

New Gulf of Mexico modeling

- Updated and new environmental predictor variables
- New bathymetry data synthesis
  - *depth -> slope, slope-of-slope, aspect, rugosity, curvature, BPI*
- New oceanographic variables from ocean dynamics model
  - *bottom current speed and direction, temperature, salinity, mixed layer depth*
- New geographic variables
  - *distance to shore, shelf break, and hard substrate*
- Surficial sediment variables
  - *mean grain size, percent mud/sand/gravel*
- Other oceanographic variables
  - *surface chlorophyll-a, turbidity*
- 100 m spatial resolution



New Gulf of Mexico modeling

- Predicted probability of occurrence
- Bayesian statistical framework
- Incorporate varying survey positional accuracy
- Posterior probability distributions characterize uncertainty in model predictions

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Outcomes

- High-resolution maps of predicted probability of occurrence of corals and chemosynthetic communities throughout region
- Associated maps of uncertainty
- Inform management applications
- Inform future exploration and data collection
- Compilation of spatial environmental datasets
- Ecological hypotheses

Image: Lophelia II: Reefs, Rigs, and Wrecks 2009 Expedition, NOAA OER/BOEM

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- Thank you for your time