

# EXPLORING THE GEOSPATIAL RELATIONSHIPS BETWEEN FISH AND THE SEASCAPE ALONG THE SOUTH ATLANTIC CONTINENTAL SHELF



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## Project Objectives

1. Collect and process water column and bathymetry data aboard the NOAA Ship *Pisces* for potential Essential Fish Habitat (EFH) sites along U.S. Southeast Atlantic continental shelf.
2. Provide a morphometric characterization and quantitative assessment of fish size classes present within each survey site.
3. Identify morphometric features of the bathymetry that may explain the presence of demersal fish.

## Study Area

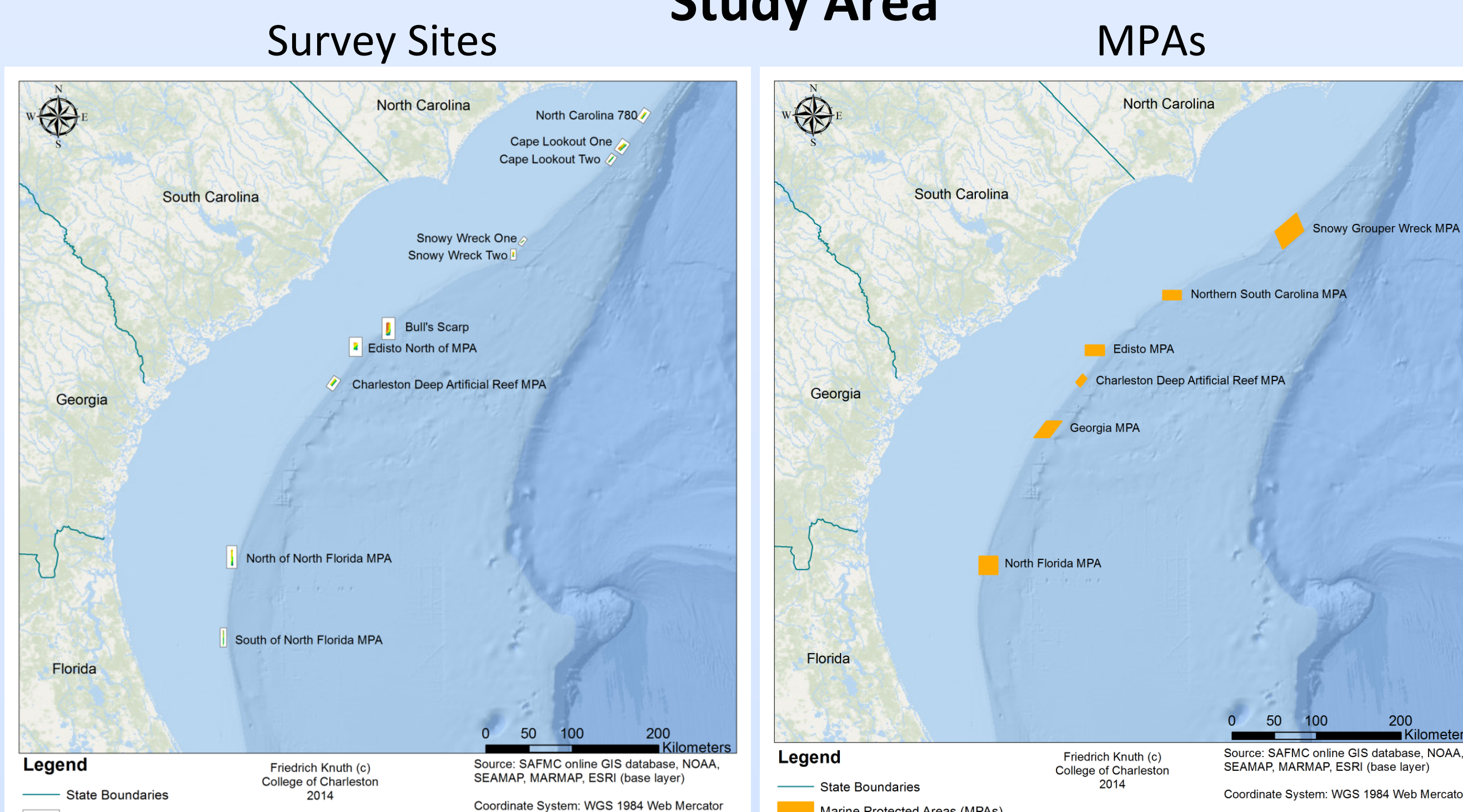


Figure 1. Ten survey sites along South Atlantic Bight. 205 km<sup>2</sup> of potentially critical fish habitat mapped between Mayport, FL and Wilmington, NC. 7410 Fish observations recorded at six of ten sites.

## Data Acquisition

- Data acquired aboard the NOAA Ship *Pisces* (07/01/2013 – 07/14/2013)
- Bathymetry and backscatter collected with the Simrad ME70 Multibeam Echo-sounder System
  - 45 beams in fan with frequency range of 70 to 120 kHz
  - Bathymetry processed in CARIS HIPS at 2m resolution
  - Backscatter processed in QPS FMGT at 2m resolution
- Water column (fish) data collected with Simrad EK60 Echosounder System
  - Split-beam system with frequency range of 18 to 710 kHz
  - Data processed in Echoview.
  - Any fish smaller than 5 cm and higher than 20 m in the water column above the seafloor were excluded.

Survey Site	Approximate Location	Area (km <sup>2</sup> )	Min Depth (m)	Max Depth (m)
South of North Florida MPA	FL, 90 km E off Jacksonville	15	52	72
North of North Florida MPA	FL, 115 km E off Jacksonville	30	43	74
Edisto New MPA	SC, 95 km SE off Charleston	21	100	120
Edisto North of MPA	SC, 90 km SE off Charleston	25	50	142
Snowy Wreck One	NC, 105 km SE off Wilmington	3.8	71	100
Snowy Wreck Two	NC, 110 km SE off Wilmington	9	62	121
North Carolina 780	NC, 60 km E off Harker's Island	14	66	96
Cape Lookout One	NC, 65 km SE off Harker's Island	26	53	147
Cape Lookout Two	NC, 70 km SE off Harker's Island	10	72	120
Bull's Scarp	SC, 125 km E off Charleston	52	45	250

Table 1. Bathymetry and Backscatter mapped for 10 survey sites during the July 2013 NOAA Ship *Pisces* cruise. Fish distributions mapped for six of the 10 sites, highlighted in green.

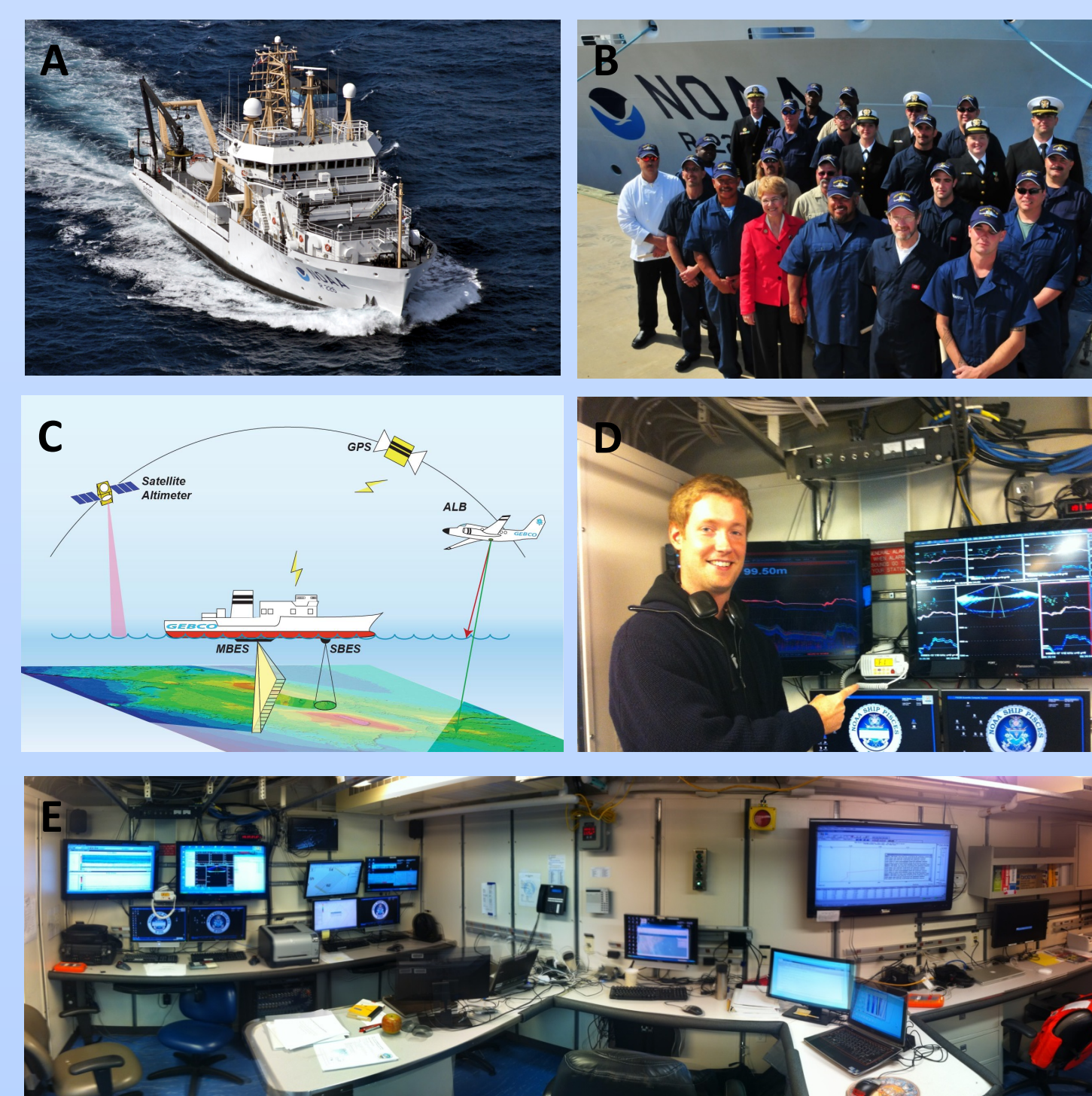


Figure 3. A. NOAA Ship *Pisces* B. *Pisces* Crew C. How the ME70 and EK60 transducer work conceptually (Hashimoto 2013) D. Friedrich in front of ME70 and EK60 control screens E. Office Panorama

## Data Analysis and Visualization

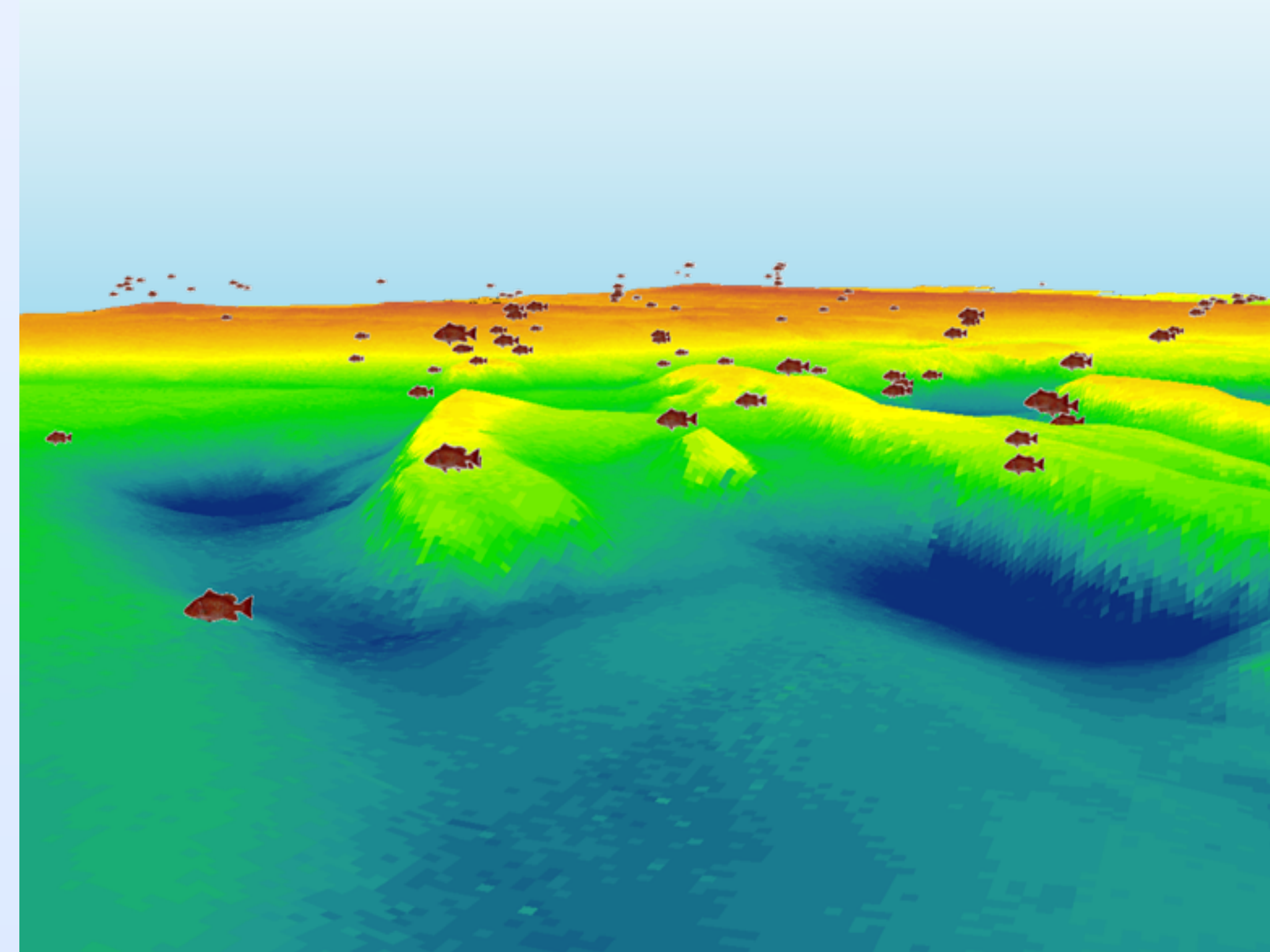


Figure 4. Three dimensional view of large fish plotted over survey site Snowy Wreck Two, generated in ArcScene. Fish seem to congregate near steep slopes and topographically complex bathymetry.

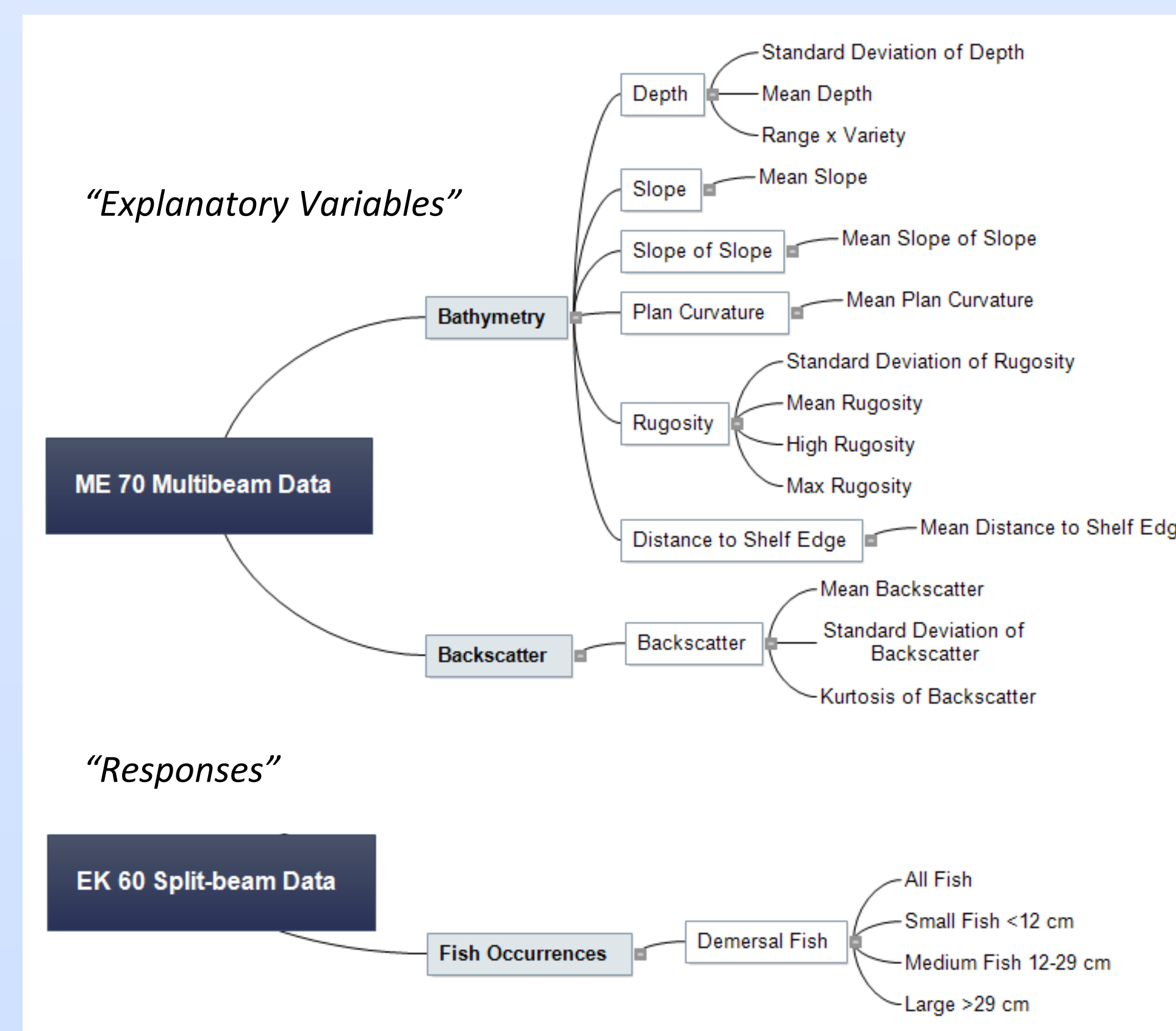


Figure 5. Schematic of explanatory and response variables generated from raw multibeam and split-beam data. In ArcGIS, using Spatial Analyst and Raster Calculator, a total 14 explanatory variables and 4 responses were generated.

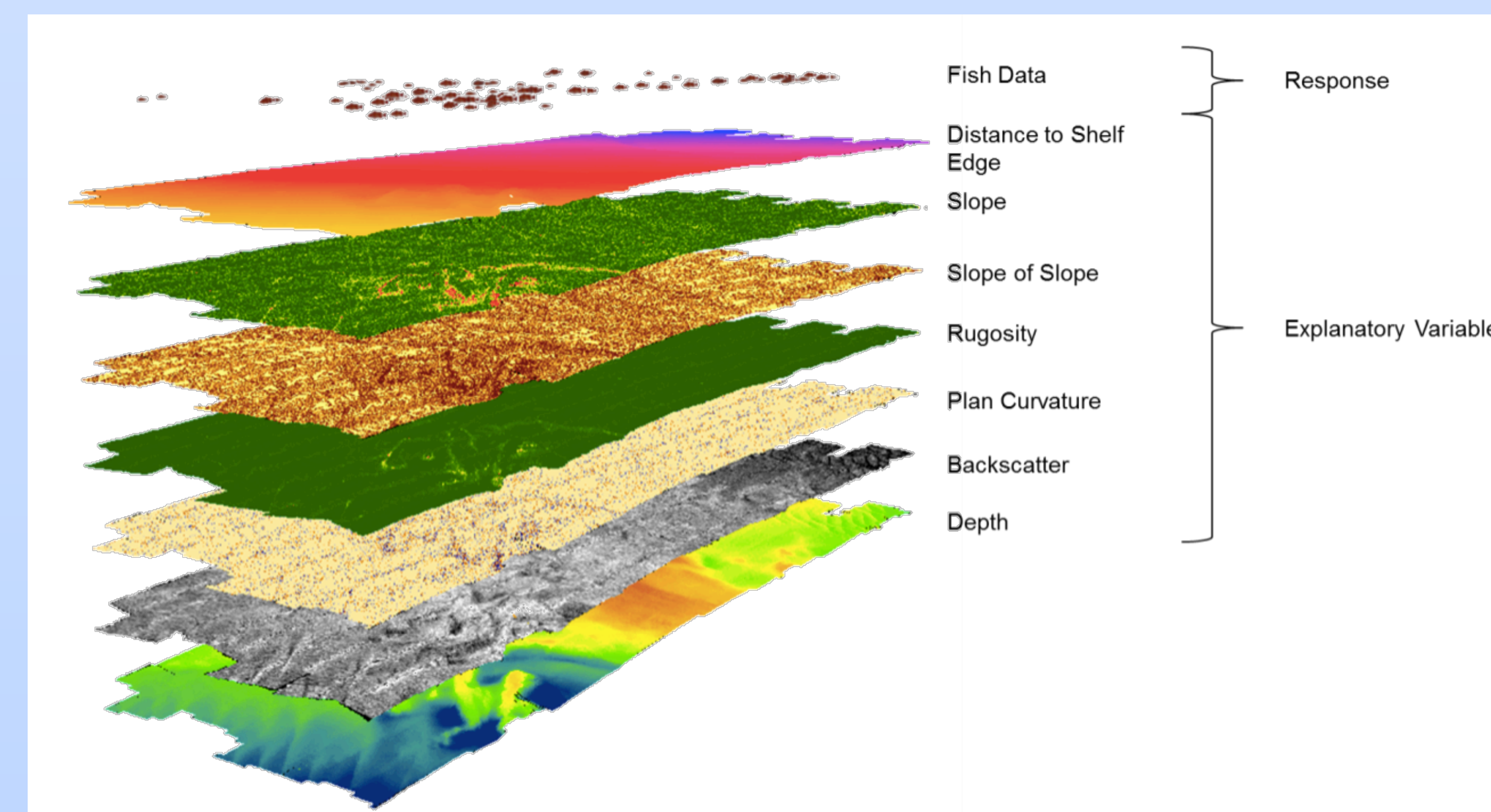


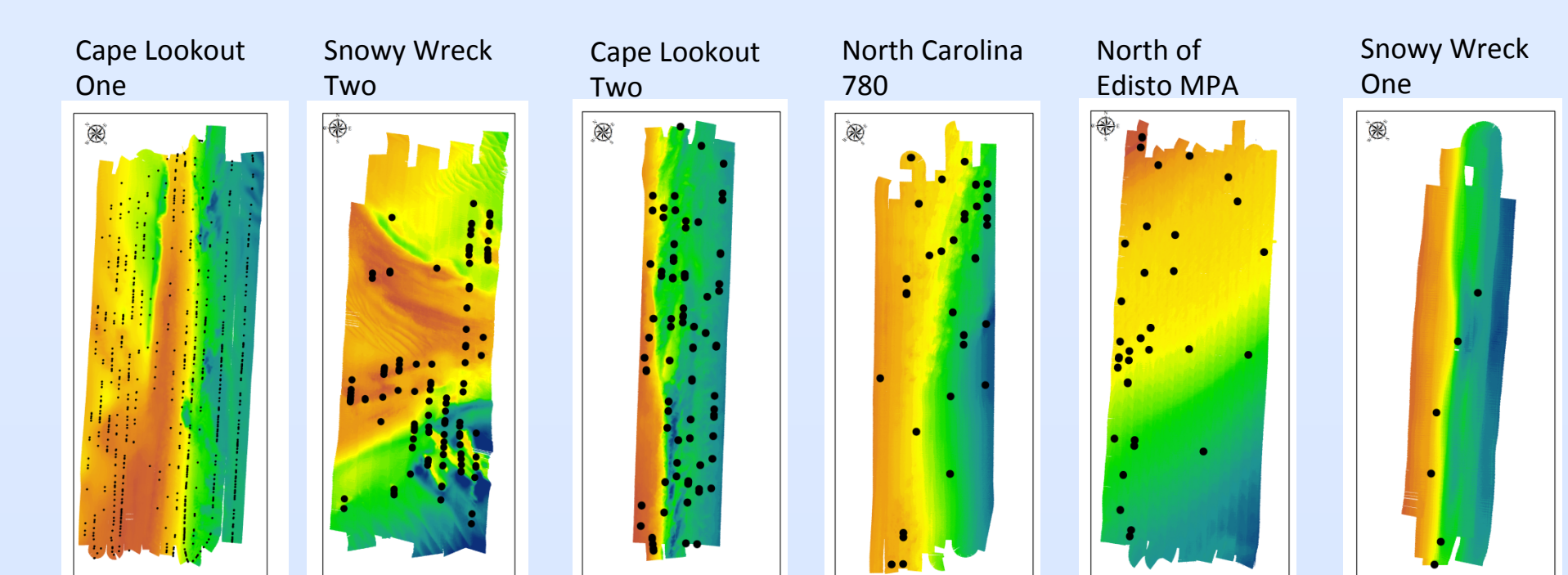
Figure 6. Conceptual view of spatial relationships between explanatory variables and response. Each explanatory variable was averaged for the entire site and plotted against the total fish count for a given response category, either All, Small, Medium or Large fish.

## References

- Costa, Bryan M., Christopher Taylor, Laura Kracker, Tim Battista, Simon Pittman. "Mapping Reef Fish and the Seascapes: Using Acoustics and Spatial Modeling to Guide Coastal Management." *PLOS ONE* (2014): e85555
- Pittman, Simon J., Bryan M. Costa, and Tim A. Battista. "Using lidar bathymetry and boosted regression trees to predict the diversity and abundance of fish and corals." *Journal of Coastal Research* (2009): 27-38.
- Hashimoto, Takafumi. Equipment for hydrographic survey. 06 15, 2013. <http://ccom.unh.edu/gebco2013/survey.html> (accessed 10 30, 2014).

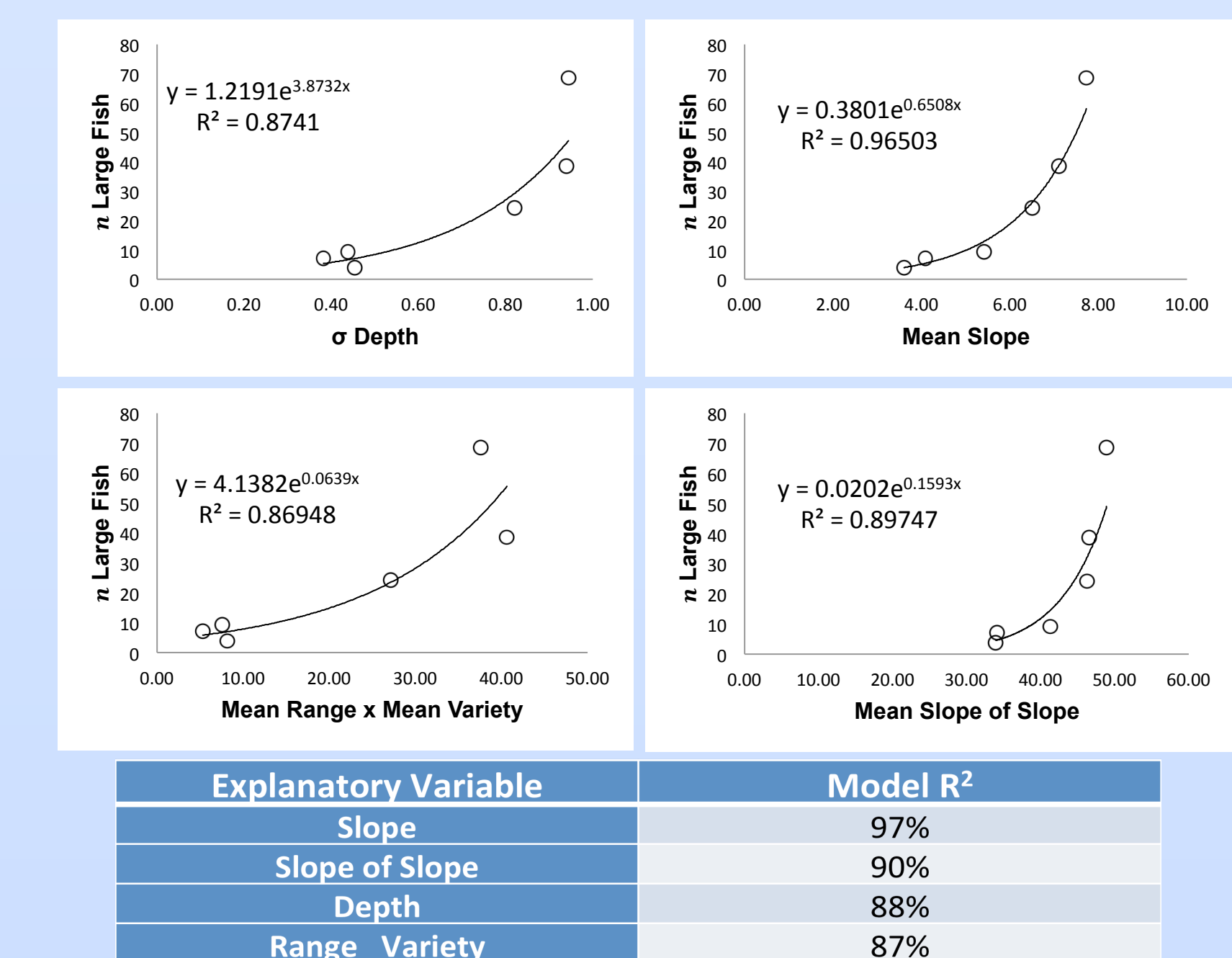
## Results by Project Objective

1. Collect and process water column, bathymetric and backscatter data for potential habitat sites along the U.S. South Atlantic continental shelf.
  - 10 sites mapped for a total of 205 km<sup>2</sup> of Bathymetry and Backscatter.
  - 7401 fish counts recorded at six of ten survey sites. See Figure 7 and Table 2.
2. Provide a morphometric characterization and quantitative assessment of fish populations present within each survey site.
  - 7 Base Layers created for 10 sites (70 total) that describe the morphometric nature of the seafloor in the form of maps. See Figure 6.
  - Subset and map fish distributions for seafloor dwelling fish < 20 m above the seafloor.
3. Identify morphometric features of the bathymetry that may explain the presence of demersal fish.
  - Created 14 explanatory morphometric variables, averaged to a site-wide scale.
  - Generated fish responses in small, medium and large classes.
  - From the 14 explanatory variables, we identified Mean Slope, Slope of Slope, Range/Variety and the  $\sigma$  Depth to have a strong relationship with Medium and Large fish at the site-wide scale. See Figure 8.



Survey Site	Area (km <sup>2</sup> )	All Fish	Large Fish	Medium Fish	Small Fish
Cape Lookout One	26	2285	336	1080	869
Snowy Wreck Two	9	2052	160	766	1126
Cape Lookout Two	10	1160	91	563	506
North Carolina 780	14	658	48	230	380
Edisto N of MPA	25	1181	39	145	997
Snowy Wreck One	4	157	6	74	77

Figure 7 and Table 2. Six of ten survey sites with recorded fish observations. Large Fish > 29cm depicted above bathymetry in Figure.



Explanatory Variable	Model R <sup>2</sup>
Slope	97%
Slope of Slope	90%
Depth	88%
Range Variety	87%

Figure 8. Linear exponential univariate model showing Mean Slope, Slope of Slope, Range/Variety and the  $\sigma$  Depth to have strong relationship ( $R^2 > 0.8$ ) with Large Fish > 29cm at the site-wide scale.

## Future Work

As seen in Figure 9 below, there appears to be a visible pattern in which Large vs. Small and Medium fish are congregating at survey site Snowy Wreck. Large fish are present amongst the slopes of the topographically complex plateau in the south eastern section of survey site, while Small and Medium fish are more predominant on the western shallow plateau. All fish size classes seem to be avoiding the what seem to be sand ridges in the mid-western and north eastern sections of the survey site.

Using spatial statistics, we aim to model and quantify these observable spatial patterns at multiple scales. The success of this approach will hopefully aid in identifying the spatial extent of ecologically relevant seafloor and can aid managers in effectively delineating Marine Protected Areas and efficiently managing Essential Fish Habitat.

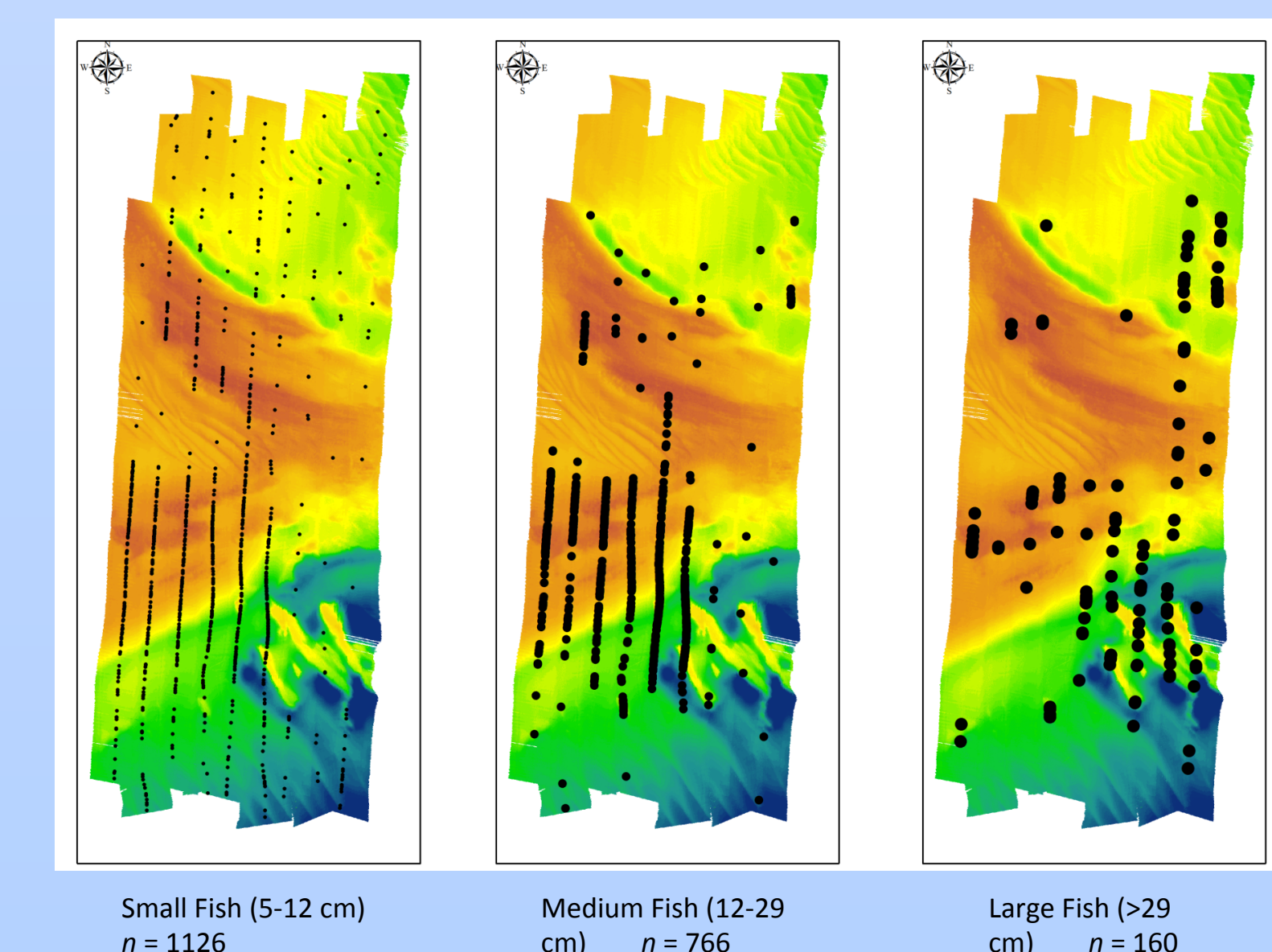


Figure 9. Depiction of Small, Medium and Large Fish recorded across survey site Snowy Wreck Two.