



**Relief in Mesophotic Zones of Gulf of Mexico Banks,  
Incl. Geographic Patterns and Associated Species Diversity**

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Marissa Nuttall<sup>3</sup>, G.P. Schmahl<sup>3</sup>, and Emma Hickerson<sup>3</sup>**

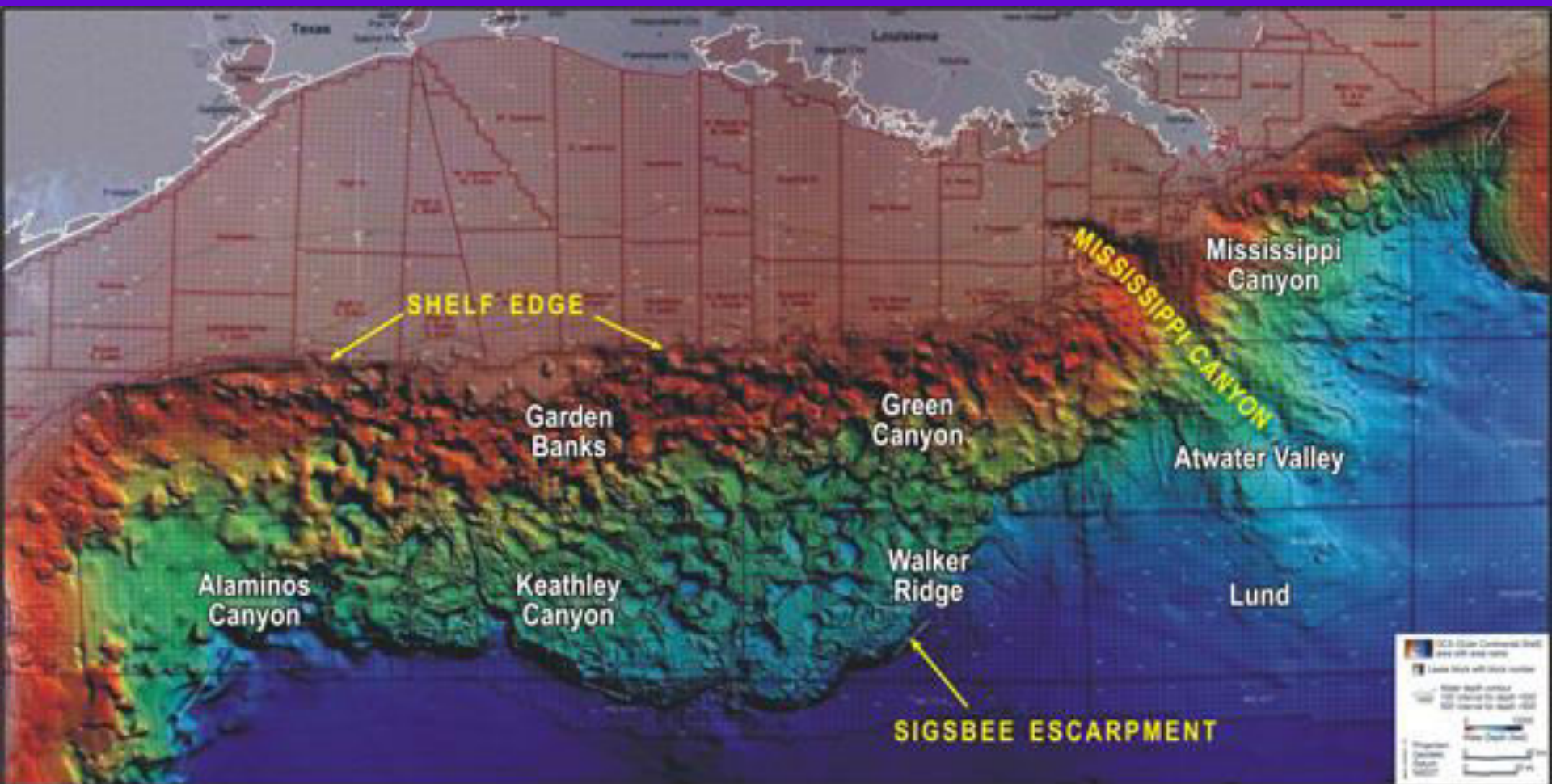
**<sup>1</sup>Louisiana Universities Marine Consortium (LUMCON)  
Chauvin, LA**

**<sup>2</sup>University of North Carolina at Wilmington  
Wilmington, NC**

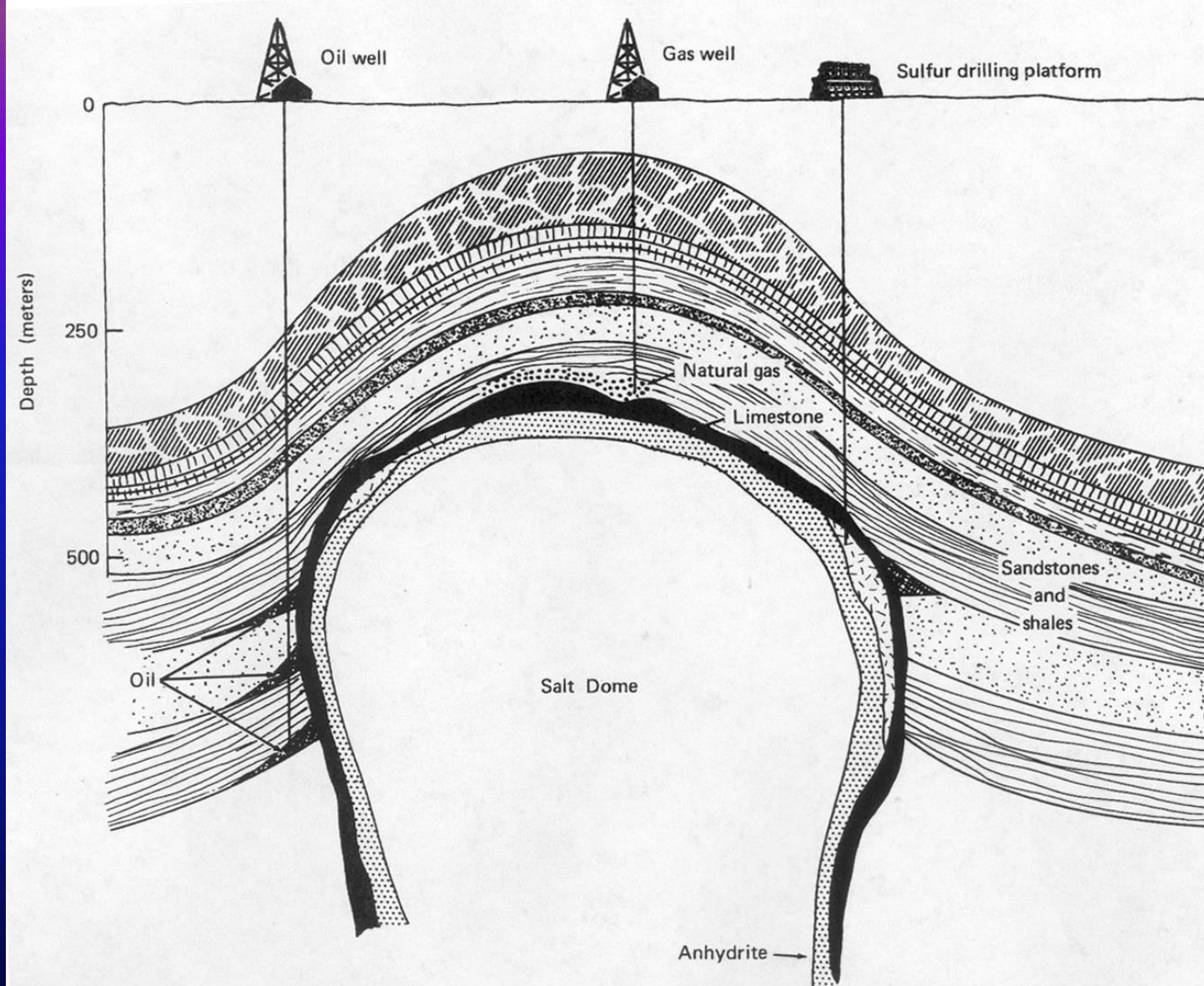
**<sup>3</sup>NOAA Flower Garden Banks National Marine Sanctuary  
Galveston, TX**



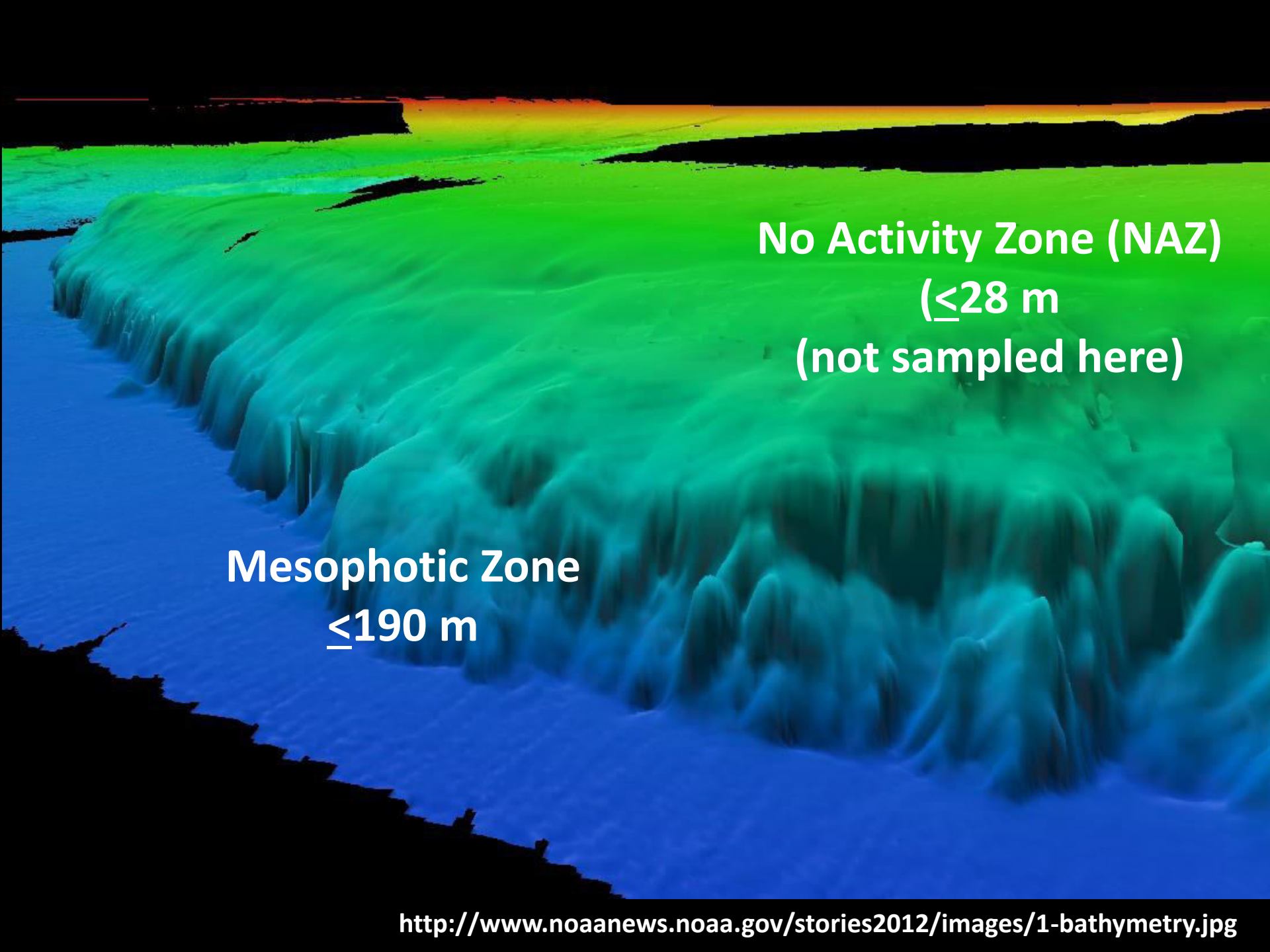
Figure 1.



[http://oceanexplorer.noaa.gov/explorations/06mexico/background/geology/media/gulf\\_600.jpg](http://oceanexplorer.noaa.gov/explorations/06mexico/background/geology/media/gulf_600.jpg)



**Many of the banks of the northern GOM are the result of rising salt domes**



No Activity Zone (NAZ)  
(≤28 m  
(not sampled here)

Mesophotic Zone  
≤190 m

# Mesophotic Coral Ecosystems (MCEs)

Light-dependent coral communities that occur in the deepest half of the photic (light-receiving) zone in tropical or sub-tropical waters. They generally occur between 30 and  $\geq 100$  m depth. They are characterized by low availability of light for photosynthesis and the presence of corals, sponges, and algae as the dominant structural components.



<http://exploringtheenvironment.umwblogs.org/2013/04/06/human-destruction-of-coral-reefs/coral-reef-wiki/>





# Gulf of Mexico Platform Distribution

TEXAS

LOUISIANA

MISSISSIPPI

ALABAMA

■ Platform Structure

**MMS** U.S. Department of the Interior  
Minerals Management Service  
Gulf of Mexico OCS Region



<http://dailycaller.com/2012/06/04/to-protect-sea-turtles-government-pushing-pricey-regulations-on-shrimpers/>



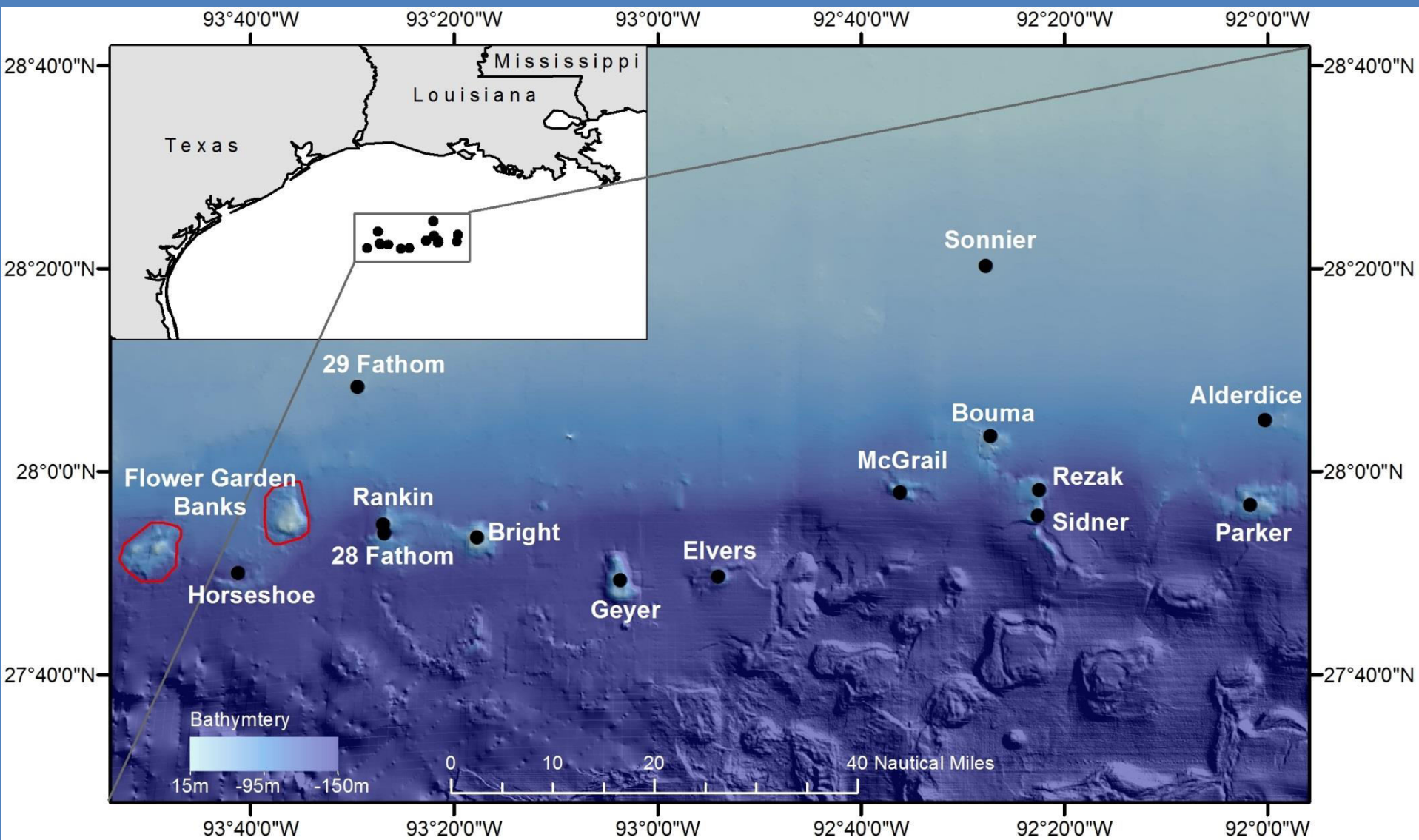
Sea floor before bottom trawling



Sea floor after bottom trawling

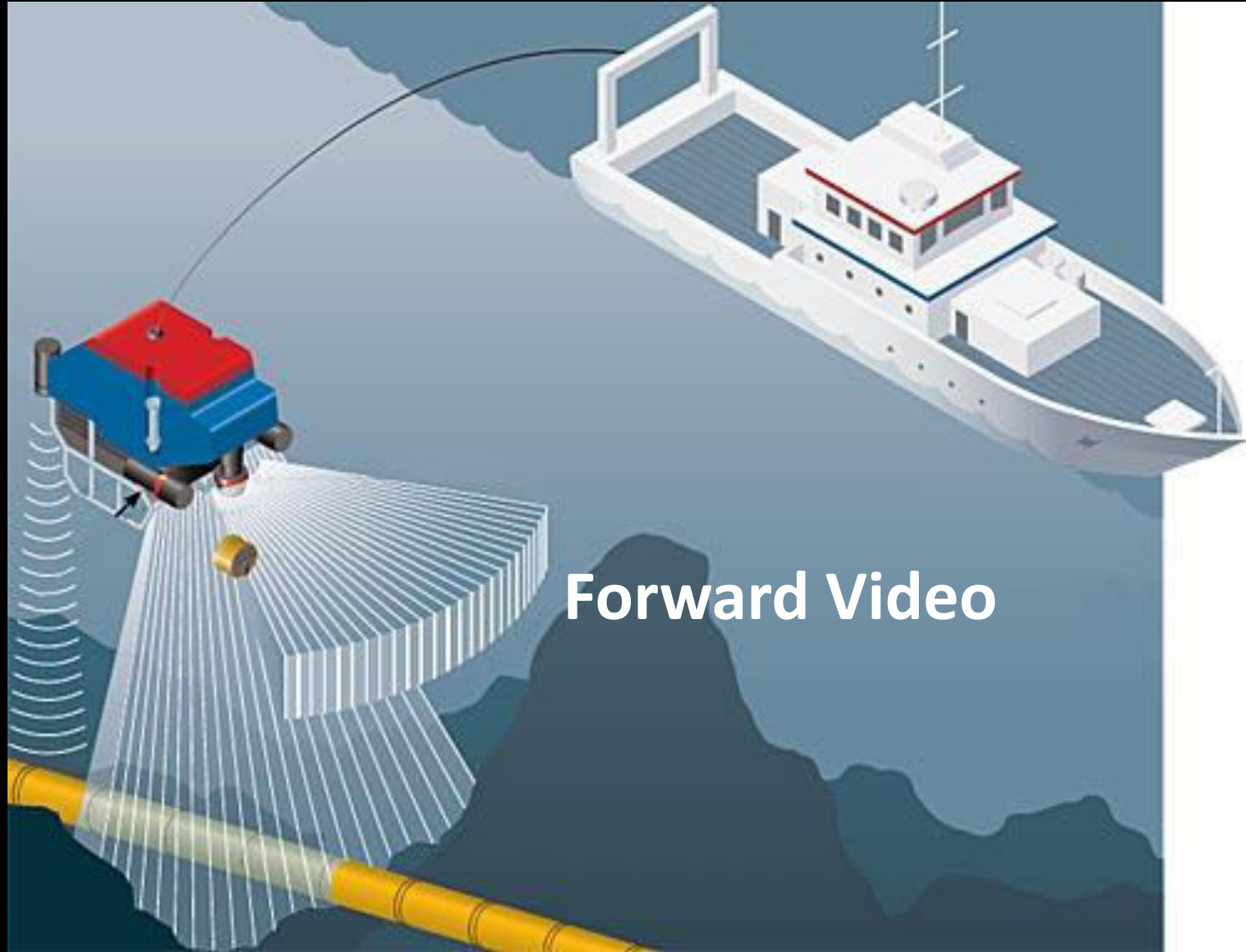
# Potentially Sensitive Biological Features (PSBFs) Mesophotic Zone Fauna and Flora







# ROV Sensors



Rear Video

Depth  
Sensor

Bottom,  
Unit, &  
Surface

Forward Video

Downward Vertical Still Camera



**OPEN 9 DAYS A WEEK**

99 *cents*

CASH ATM & CREDIT CARD

99 *cents*



# Low Relief Feature (~0.5 m)



## Medium Height Feature (~1-2m)





# High Relief Features (~5-6m)

<http://blogs.elpais.com/.a/6a00d8341bfb1653ef017d3e898b4f970c-pi>

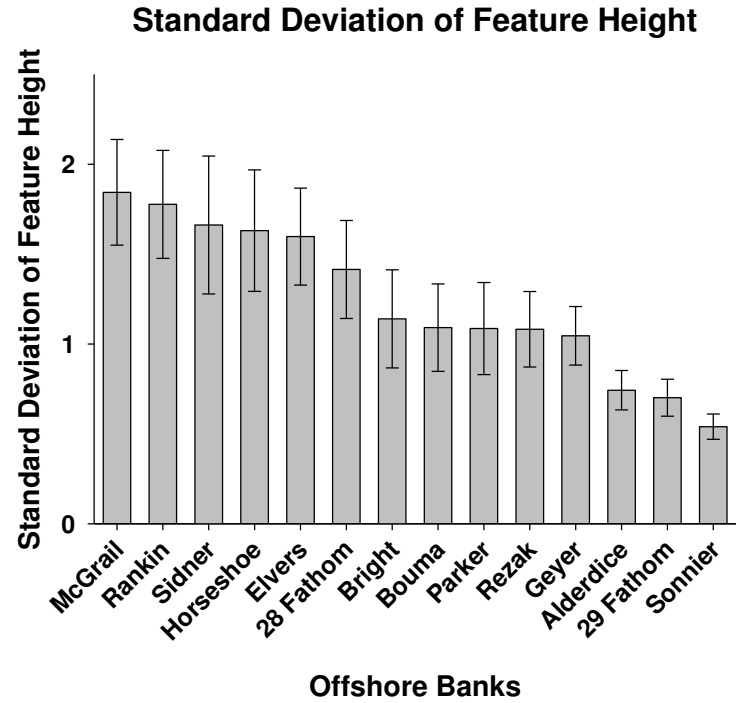
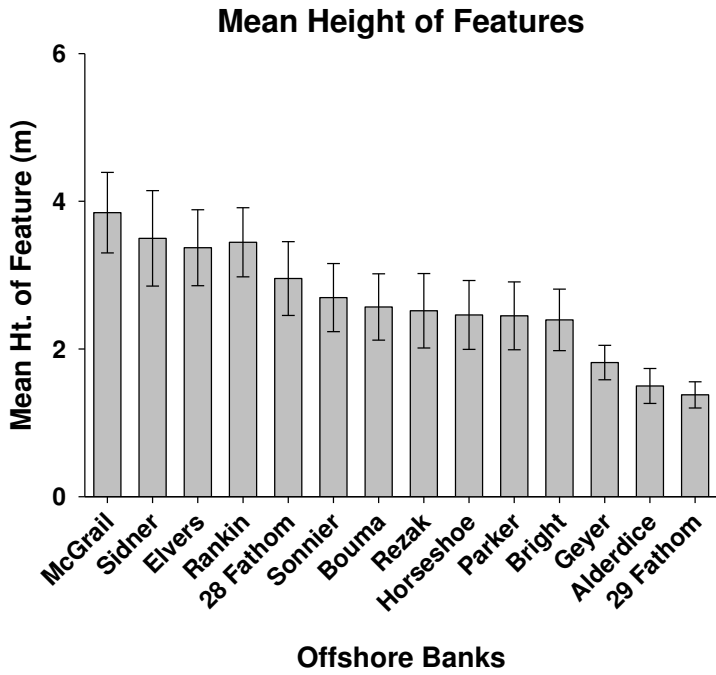
# Measures of Relief

- . **Statistic of Location - Mean Height**
- . **Statistic of Dispersion - Standard Deviation**

## Biological Species Diversity Measure

**Number of Species**

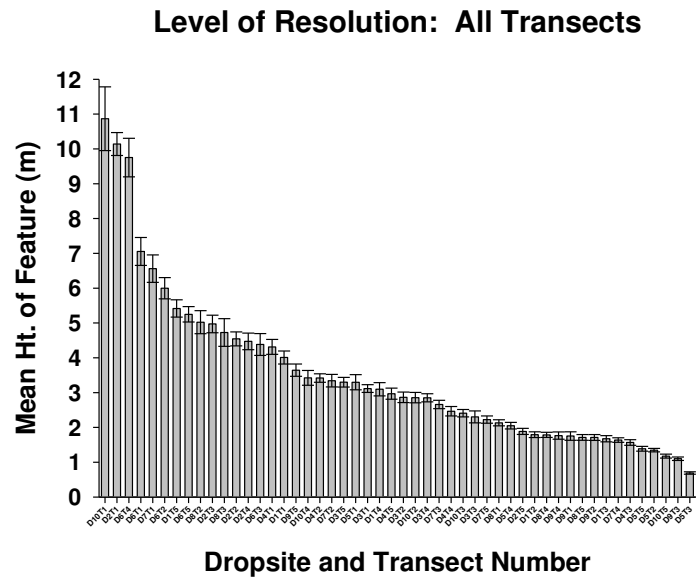
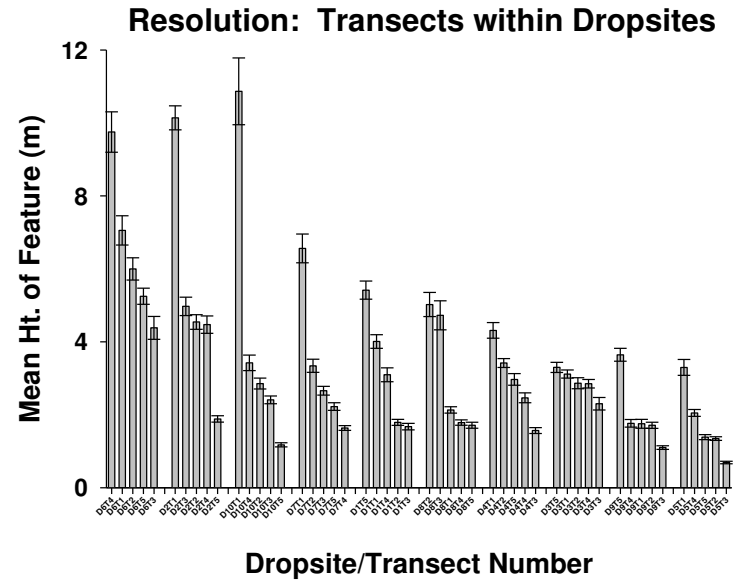
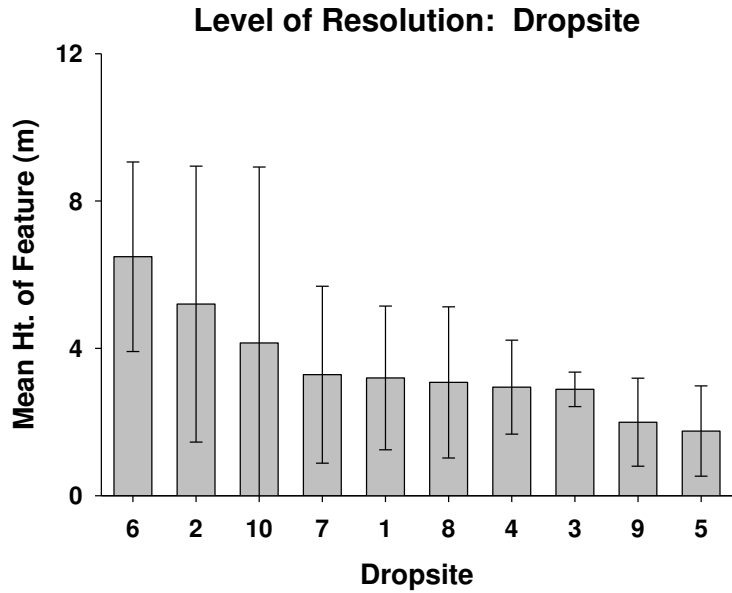
# All Banks



Level of Resolution: Transects within Dropsites

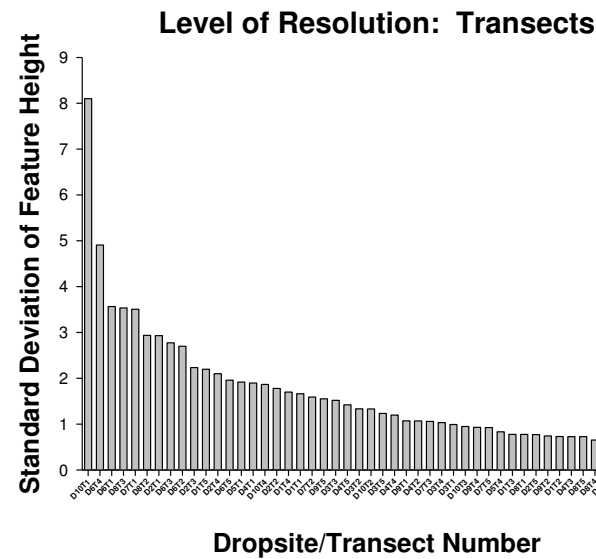
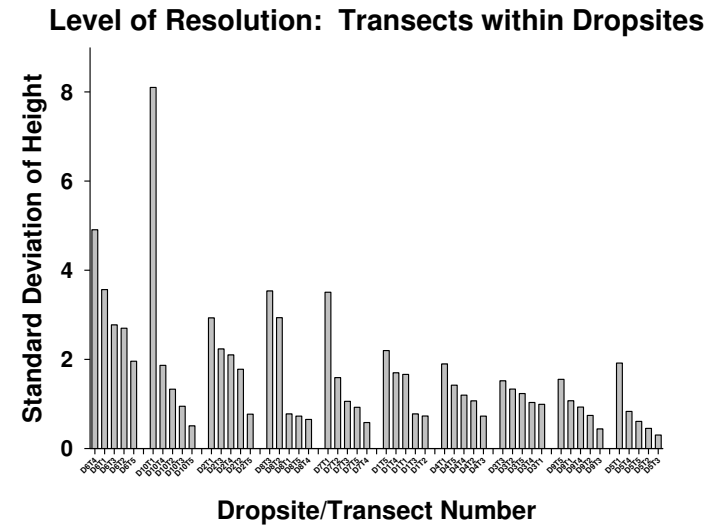
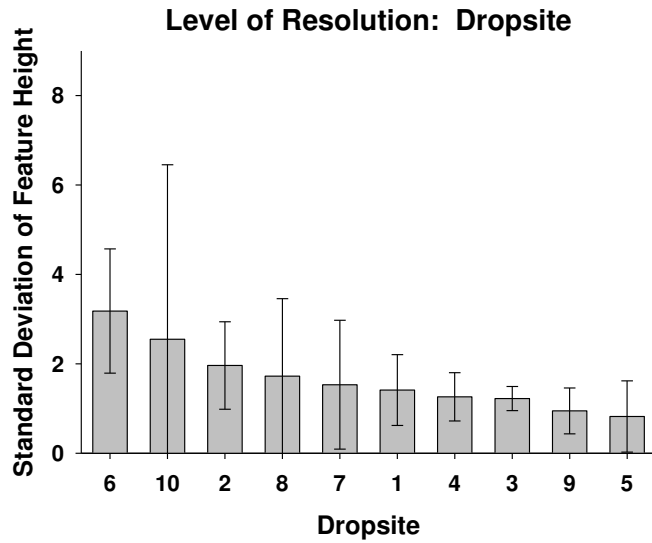
# Sidner Bank

## Mean Height of Features



# Sidner Bank

## Standard Deviation of Heights of Features

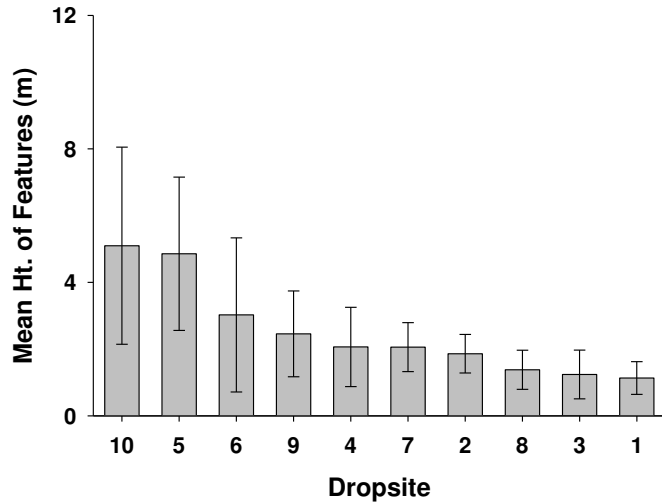




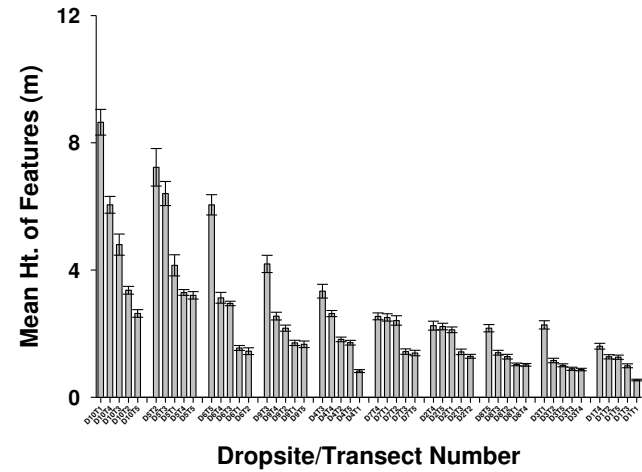
# Bright Bank

## Mean Height of Features

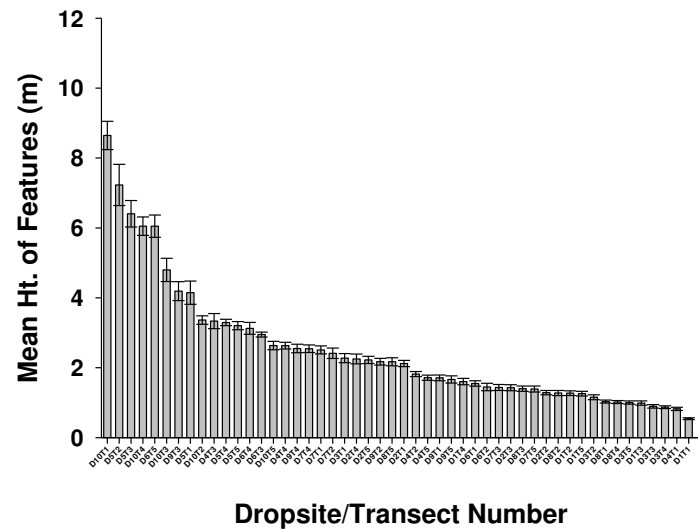
Level of Resolution: Dropsites



Level of Resolution: Transects within Dropsites

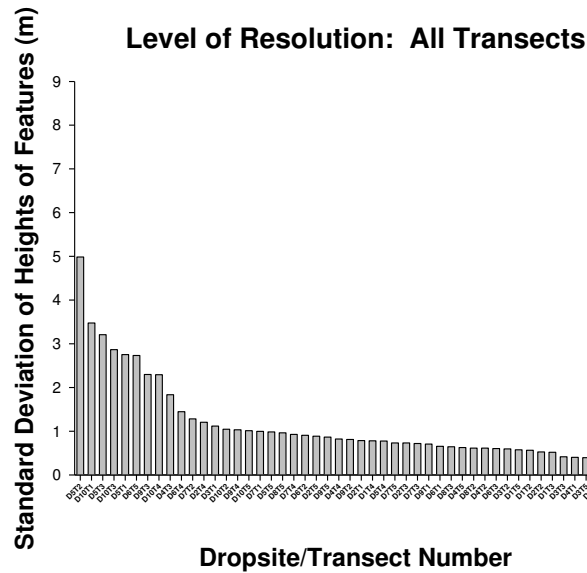
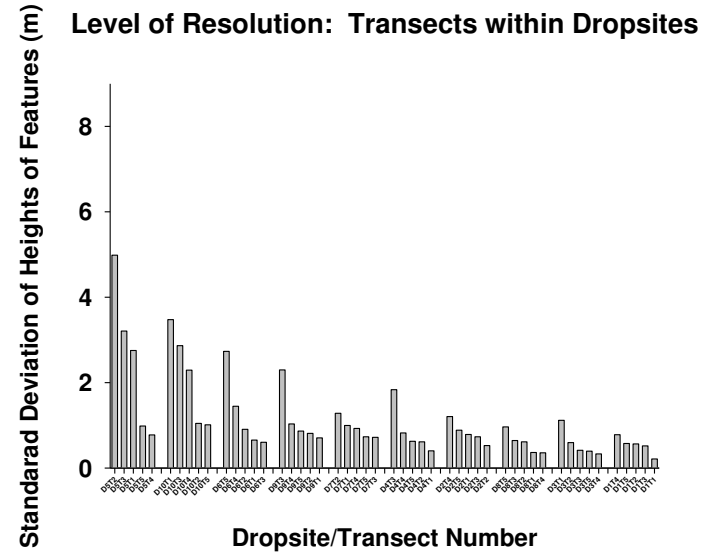
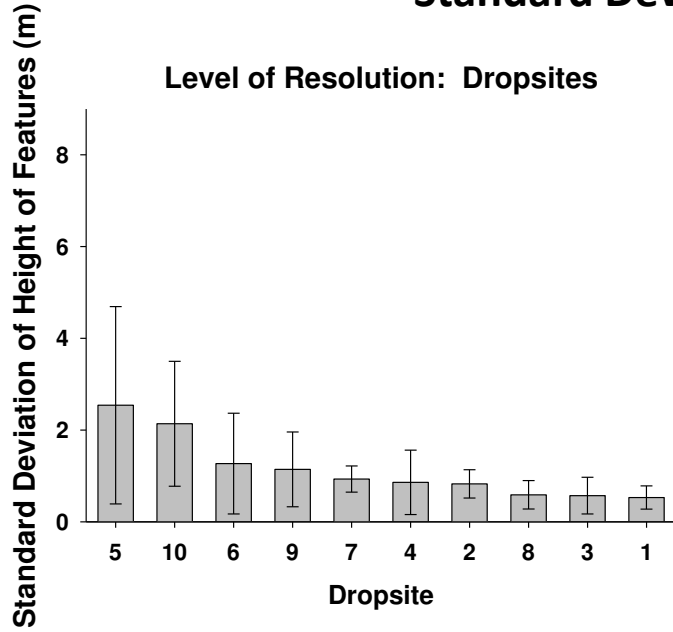


Level of Resolution: All Transects



# Bright Bank

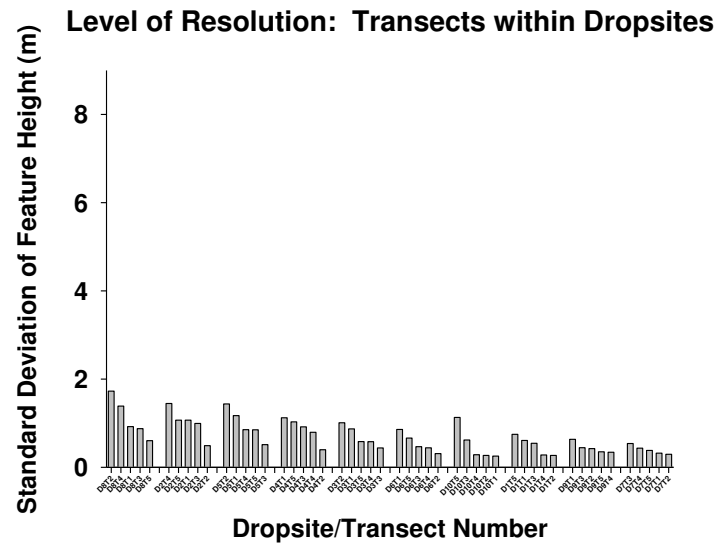
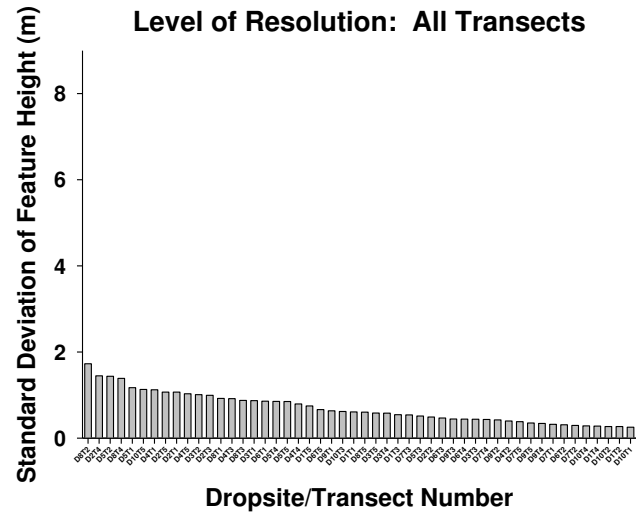
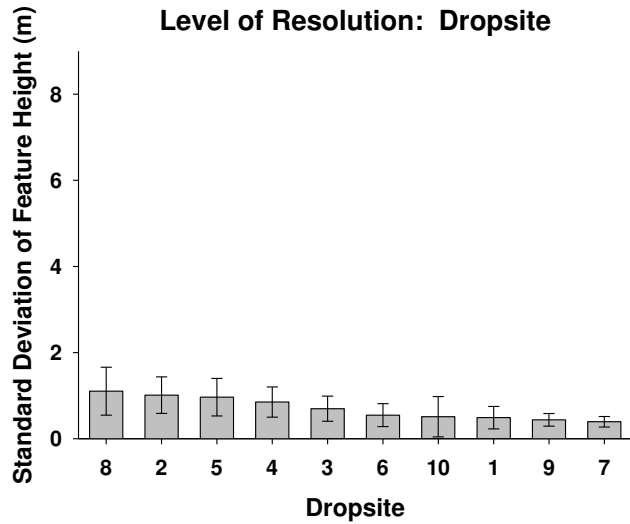
## Standard Deviation of Heights of Features





# 29 Fathom Bank

## Standard Deviation of Heights of Features

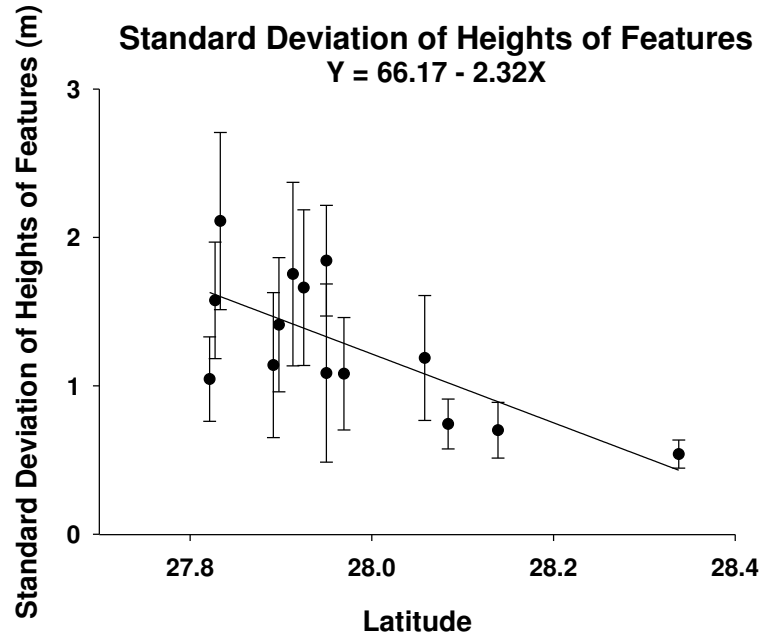
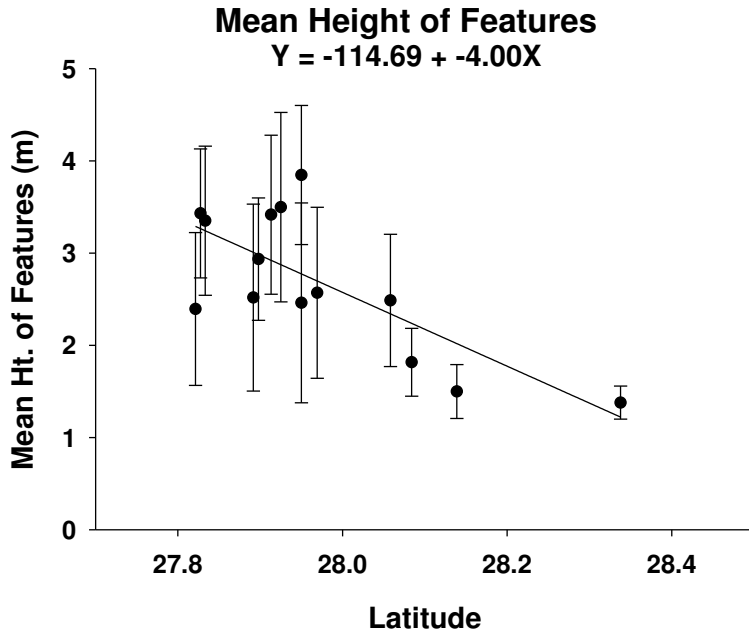


## Relief: Significant Differences between Drop-sites On Each Bank Sampled

	Relief Index	
		Standard
Bank	Mean	Deviation
Sidner	*	n.s.
Rankin	***	***
Parker	***	***
McGrail	n.s.	n.s.
Elvers	n.s.	*
Geyer	***	**
Horseshoe	***	***
Bright	***	***
28-Fathom	n.s.	**
Bouma	*	**
Rezak	***	**
Alderdice	n.s.	*
Sonnier	n.s.	n.s.
29-Fathom	n.s.	*

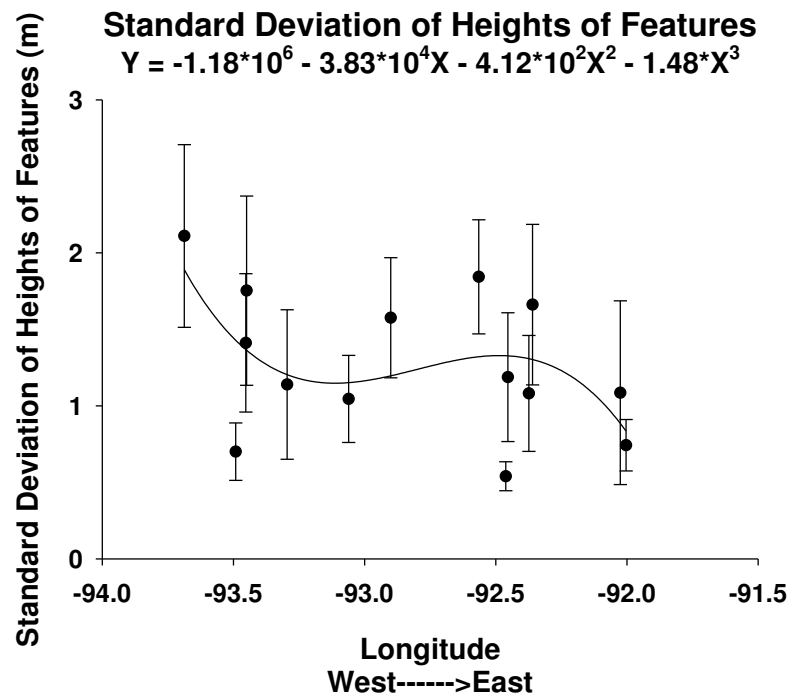
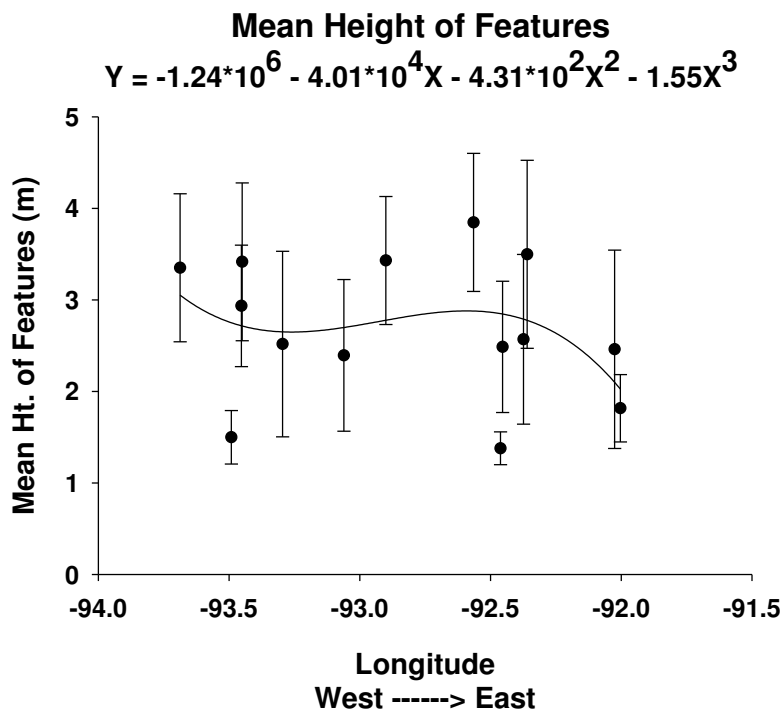
# Offshore Banks by Latitude

Level of Resolution: Dropsites



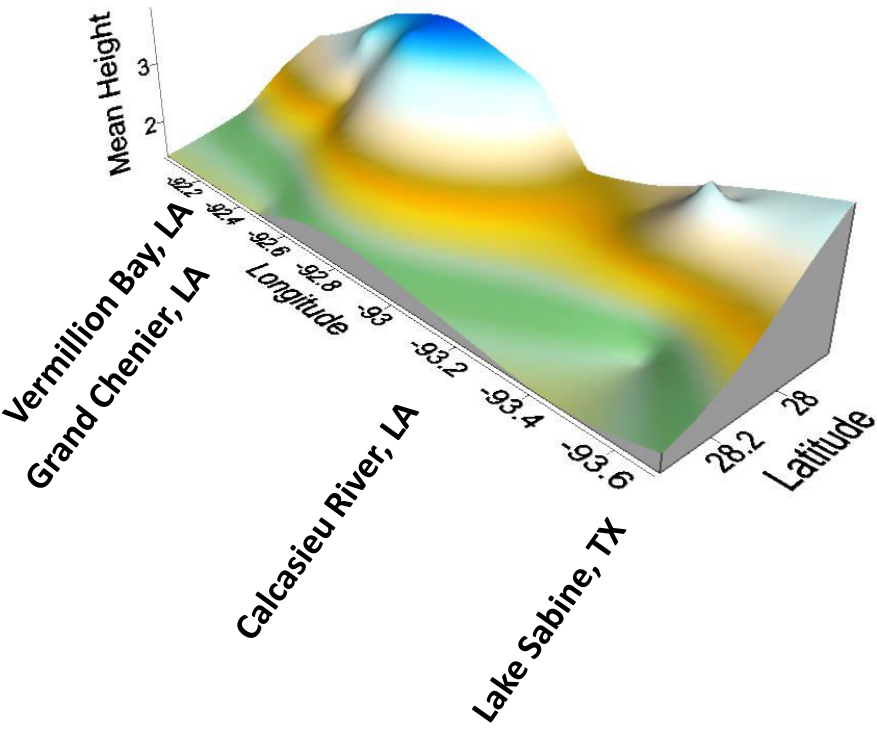
# Offshore Banks by Longitude

Level of Resolution: Dropsites

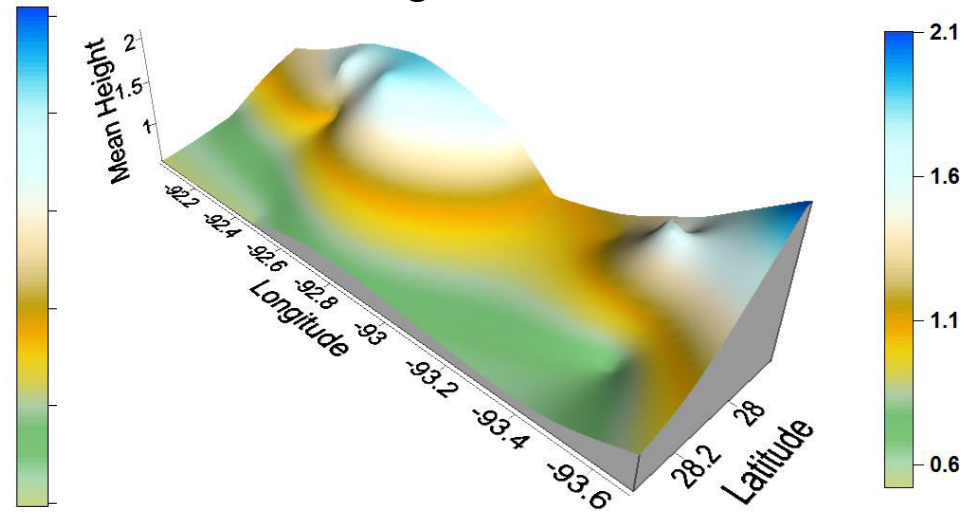


# Rugosity of All Banks Surveyed

## Using Mean of Feature Heights



## Using Standard Deviation of Heights of Features



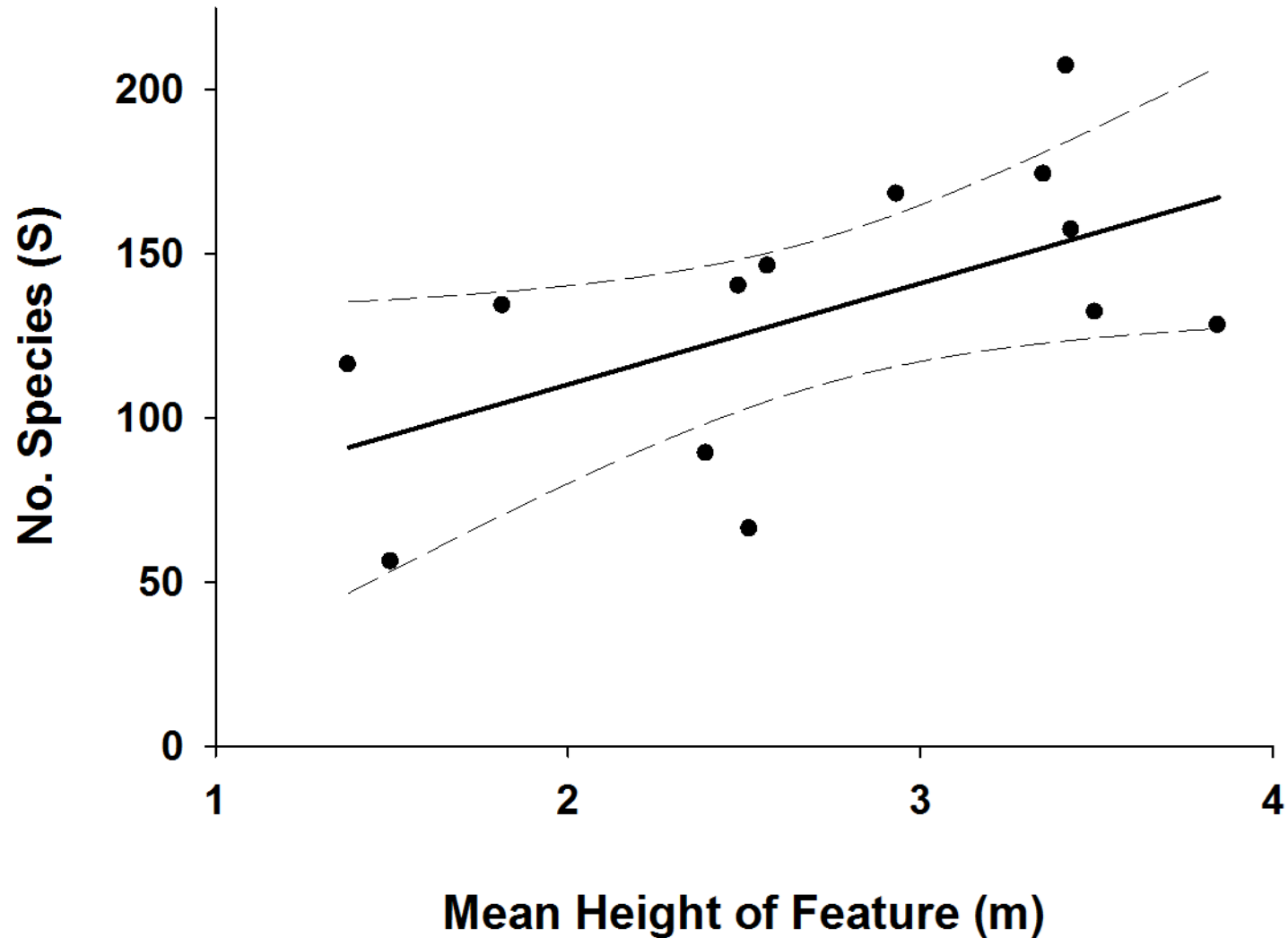


# Processes Potentially Driving Differences in Relief between Banks, and Influencing Geographic Patterns

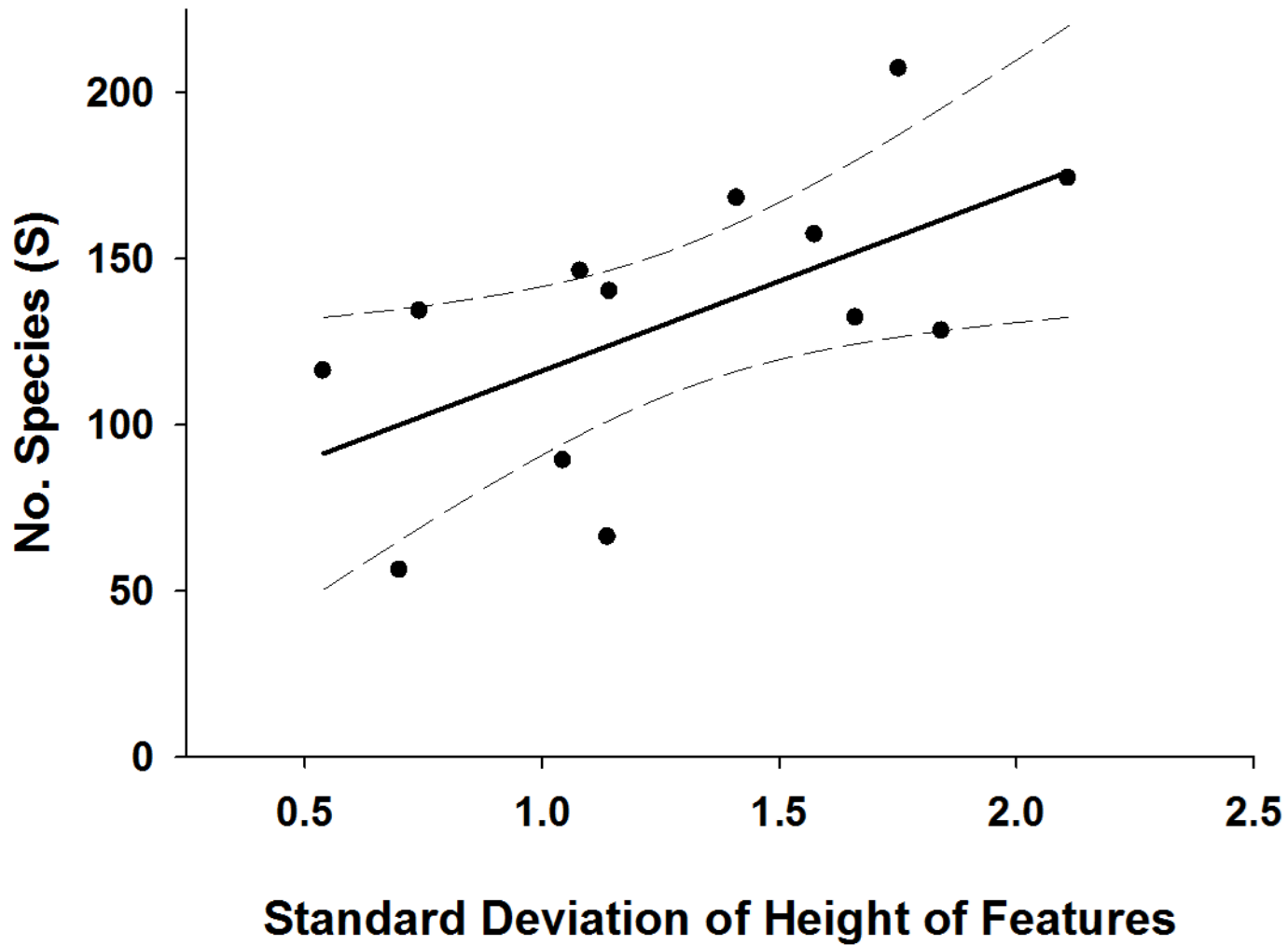
- **Faulting**
- **Dissolution of salt in a diapir and subsequent collapse of a portion of the bank**
- **Erosion**
- **Sediment accumulation**
- **Calcium carbonate accretion**
- **Precipitation of authigenic carbonates at hydrocarbon seeps.**

**Relief of Banks -  
Correlations with  
Marine Sessile Epibenthic Species Diversity**

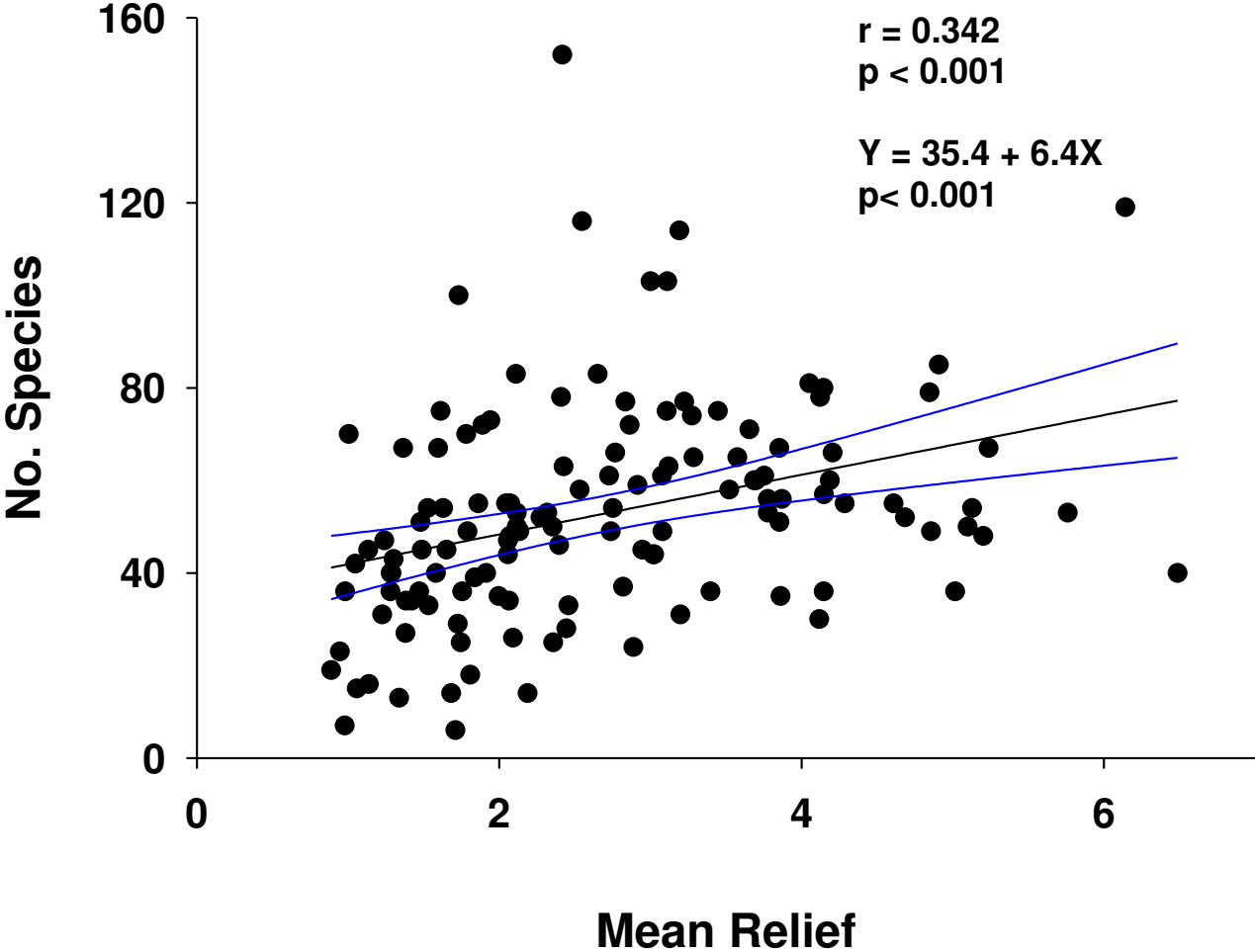
# Mean Height of Feature vs. No. Species All Banks



# Standard Deviation of Height of Features vs. No. Species All Banks

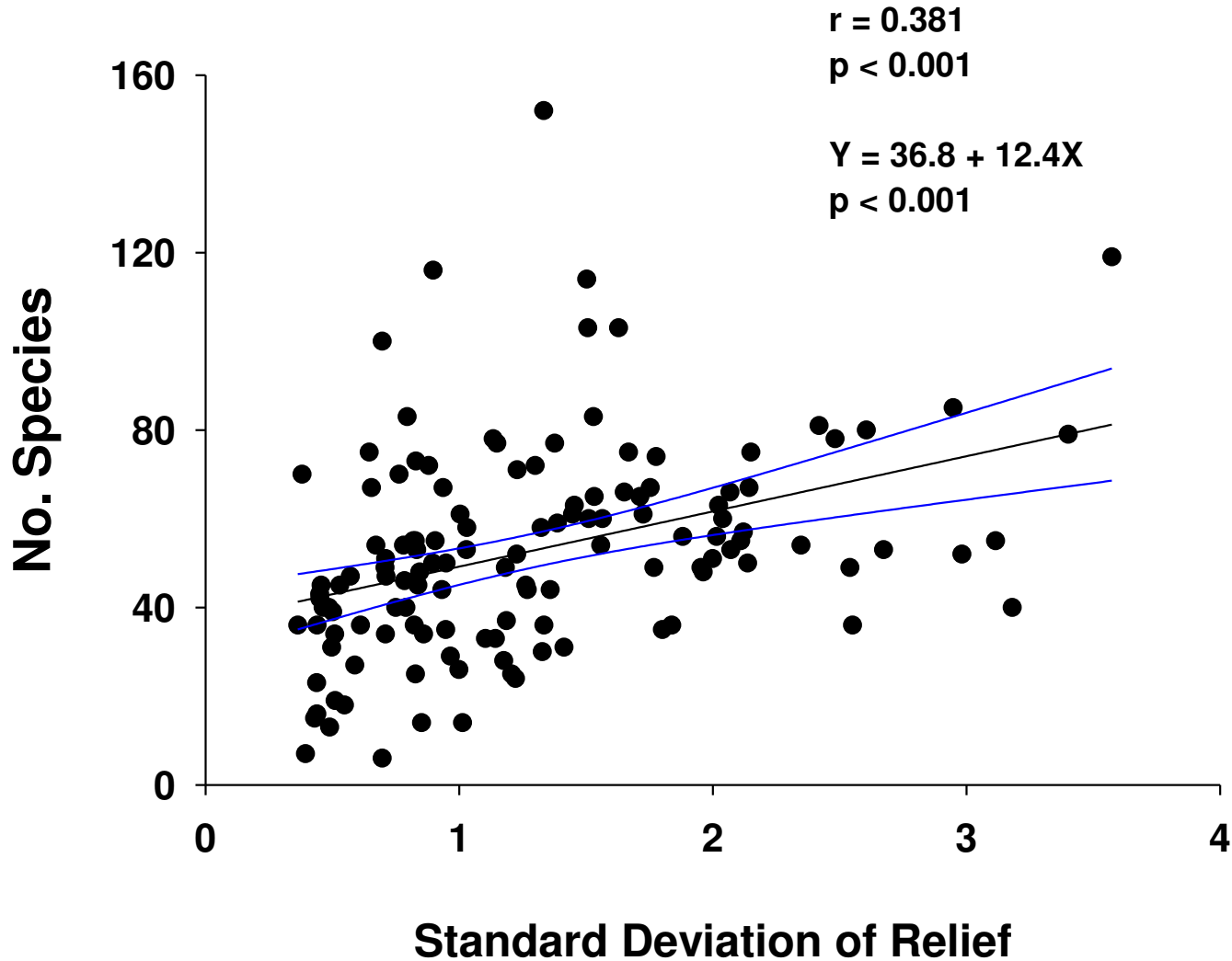


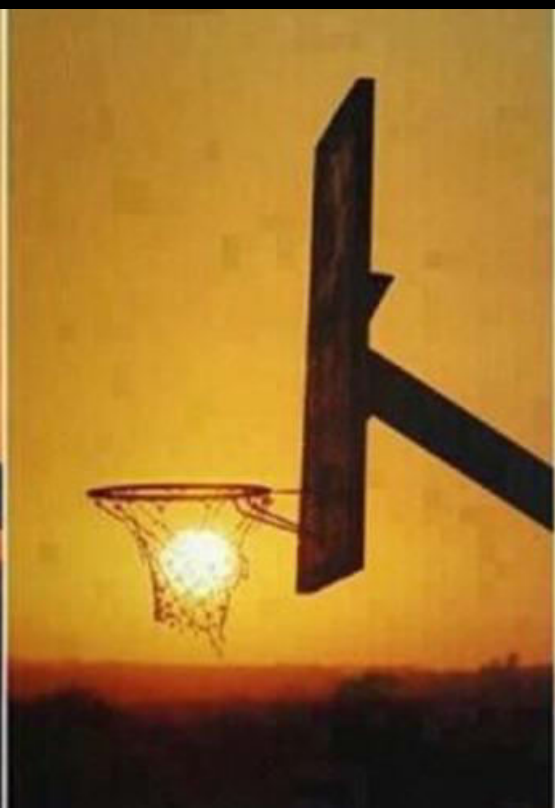
# Mean Relief vs. No. Species All Dropsites



# All Dropsites

## Standard Deviation of Relief vs. No. Species





# Summary

- **14 Banks surveyed via ROV – varying levels of spatial resolution**
- **Species diversity of benthos analyzed**
- **Relief on banks associated with mesophotic banks analyzed**
- **Wide variability in relief between banks, dropsites, and transects**
- **Low relief banks more predictable than intermediate or high relief ones**
- **Geographic patterns in relief latitudinally and longitudinally**
- **Possibly due to a number of geological and geochemical processes**
- **Species diversity of banks predictable via relief, but still high variability**



# Acknowledgements

## **Topside and Laboratory Assistance**

**V. Cardona  
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A. Kuba  
M. McCoin  
C. Moore  
B. Mayberry  
S. Morgan  
M. Nannen  
M. Scott  
A. Sterne  
T. Sterne  
M. Stout  
O. Tobacia  
M. Weekly**

## **R/V *Manta* (NOAA-FGBNMS)**

**J. O'Hern  
M. Perry  
M. Pitre  
A.J. Rutter  
M. Shetler  
T. Thompson  
D. Walker**

## **LSU-DOCS Comments on ms.**

**H.H. Roberts**

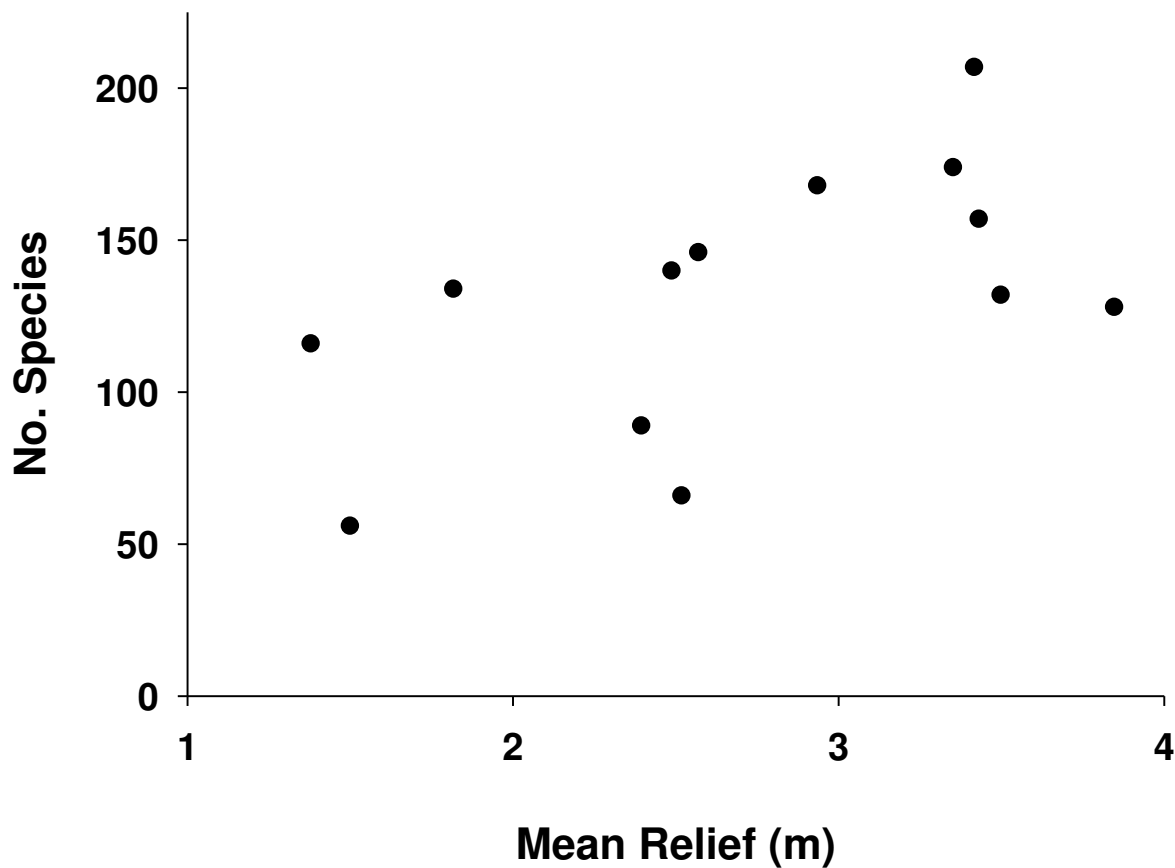
An underwater photograph of a coral reef. The top half of the image shows a rocky overhang covered in green and yellow coral, with its reflection visible in the water below. The middle section is a clear blue water column containing several small, colorful fish. The bottom half shows a diverse coral reef with various species in shades of green, yellow, and purple.

**Thank you**





# For All Banks Surveyed Mean Relief vs. No. Species

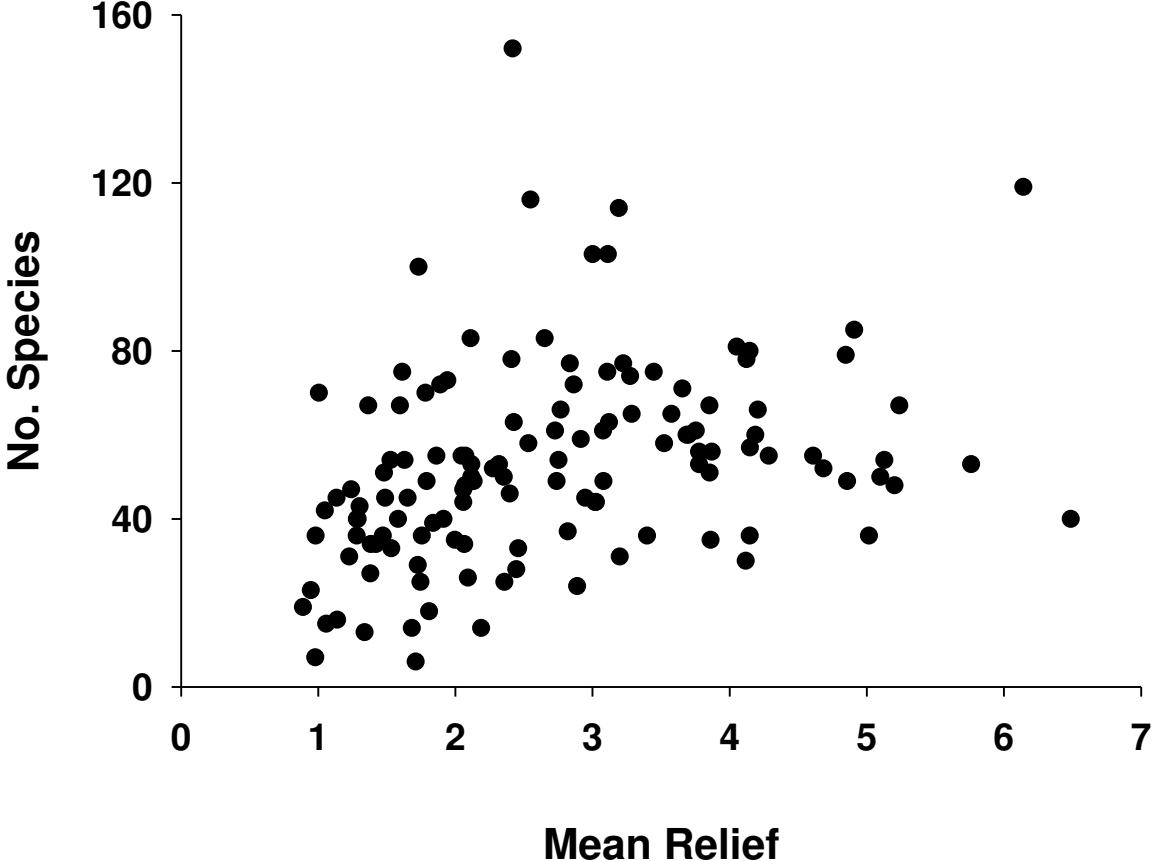


$r = 0.577$

$p < 0.05$

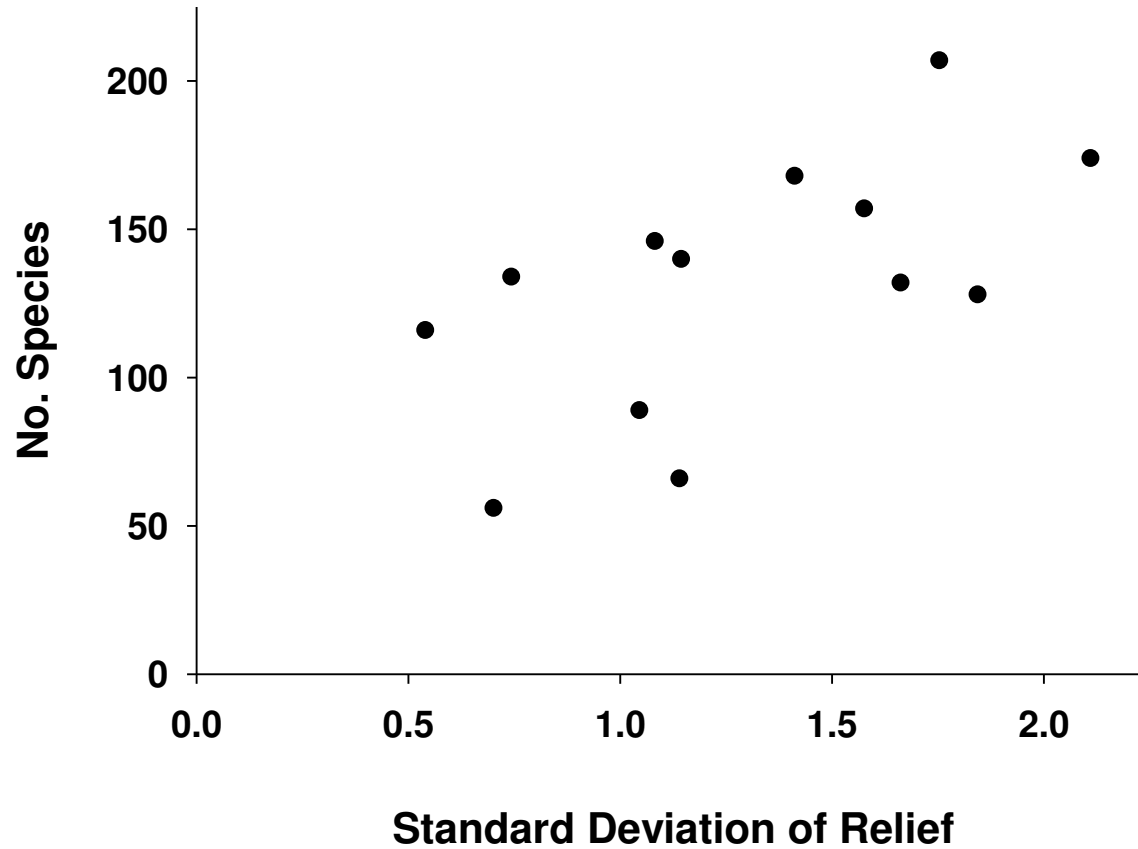
# All Dropsites

## Mean Relief vs. No. Species



$r = 0.342$   
 $p < 0.001$

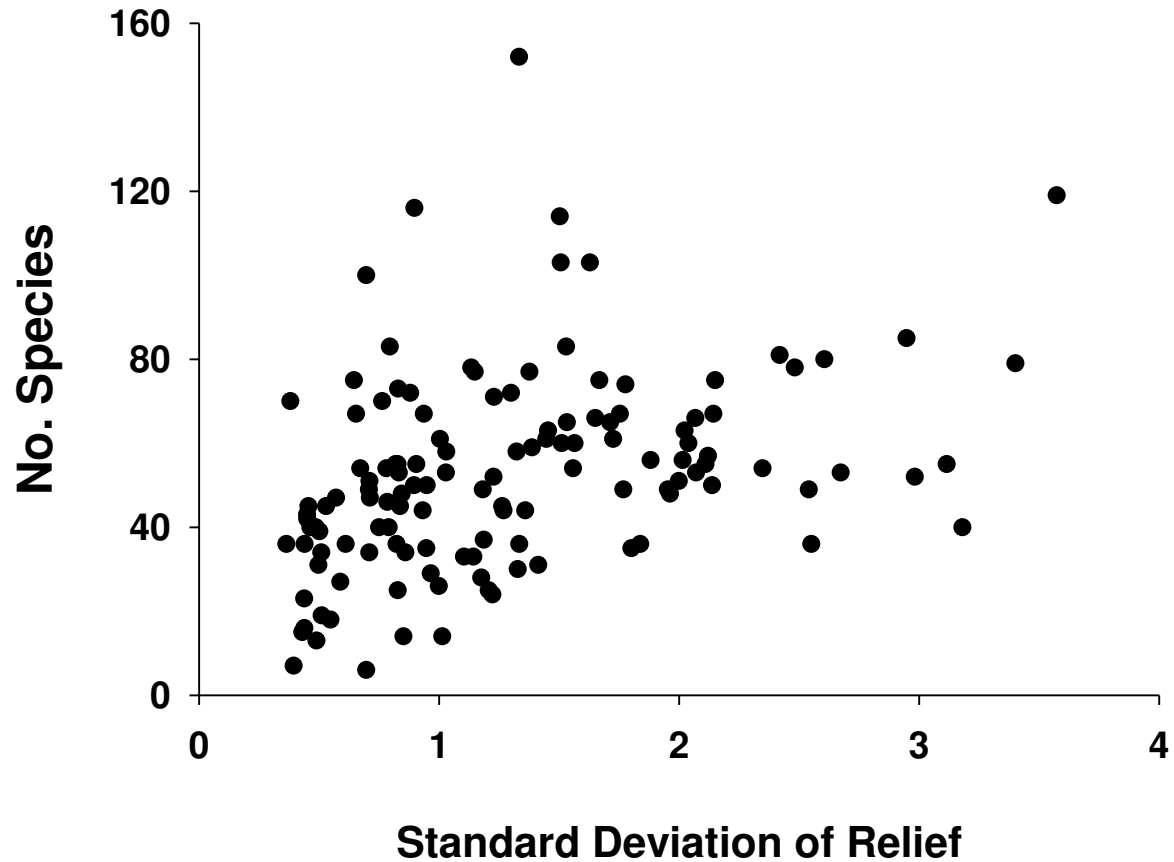
# For All Banks Surveyed Standard Deviation of Relief vs. No. Species



$r = 0.611$   
 $p < 0.05$

# All Dropsites

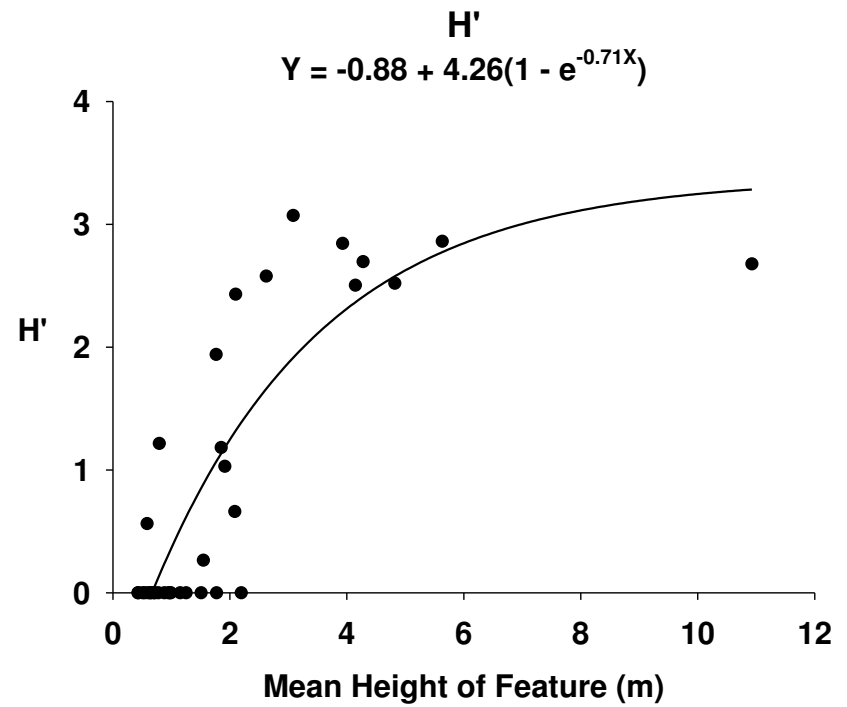
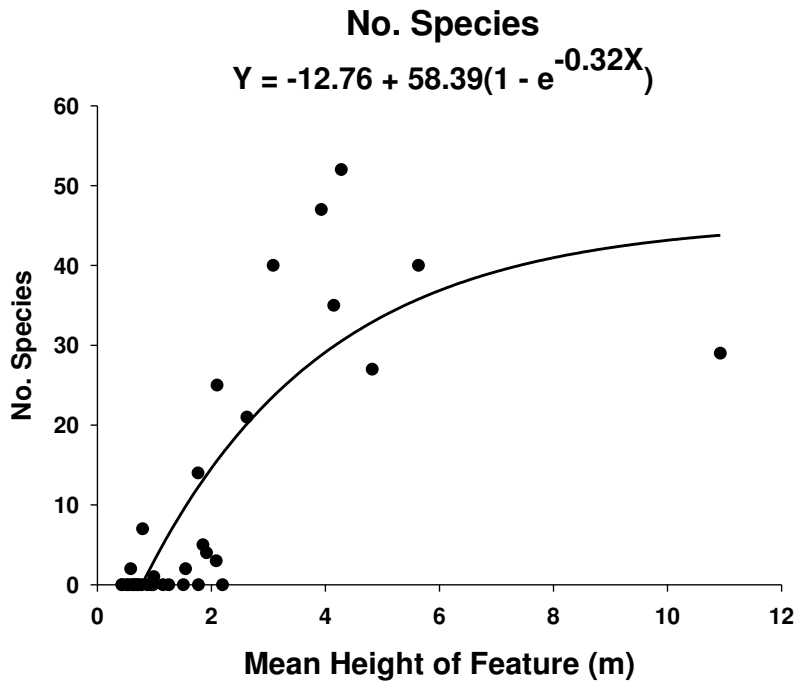
## Standard Deviation of Relief vs. No. Species



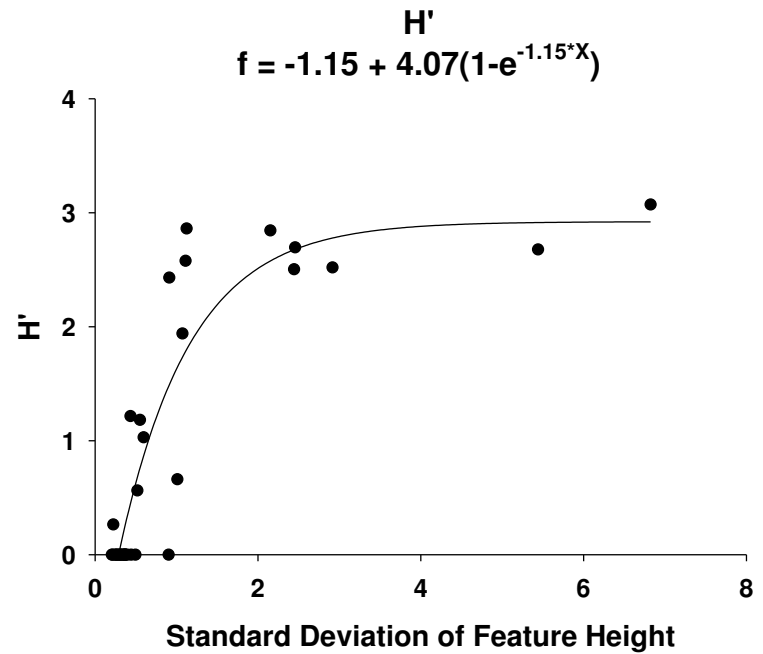
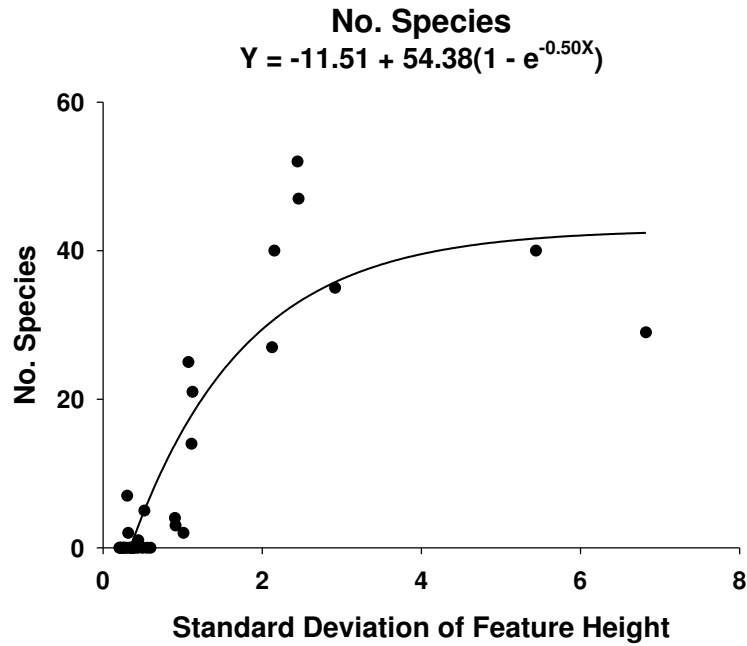
$r = 0.381$   
 $p < 0.001$



# Mean Height of Feature Vs.



# Standard Deviation of Heights of Features Vs.



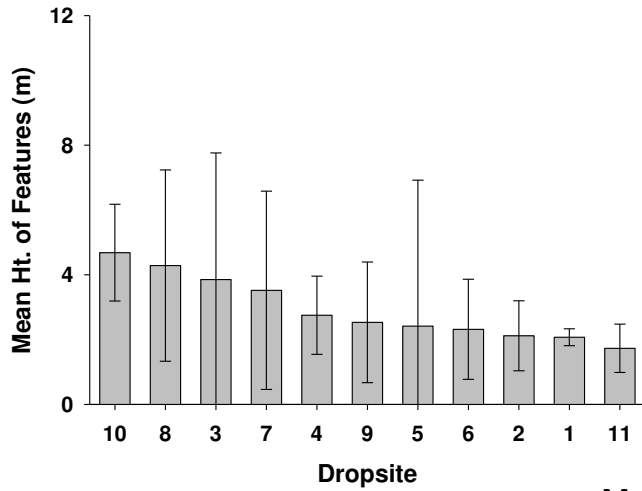


## **Rugosity Measures not Recommended:**

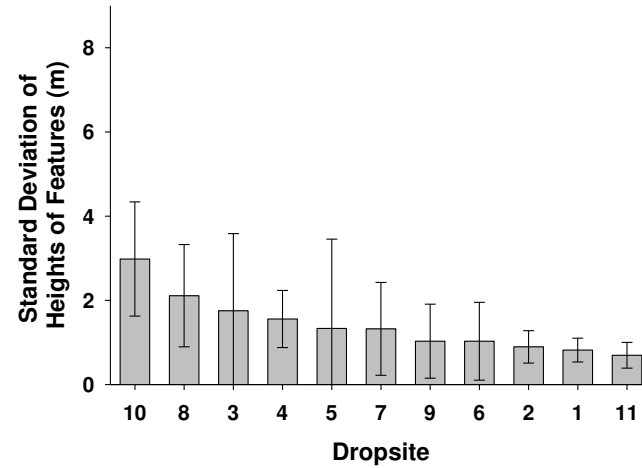
- . Variance**
- . Coefficient of Variation**
- . Chain Transect Technique**

# 28 Fathom Bank

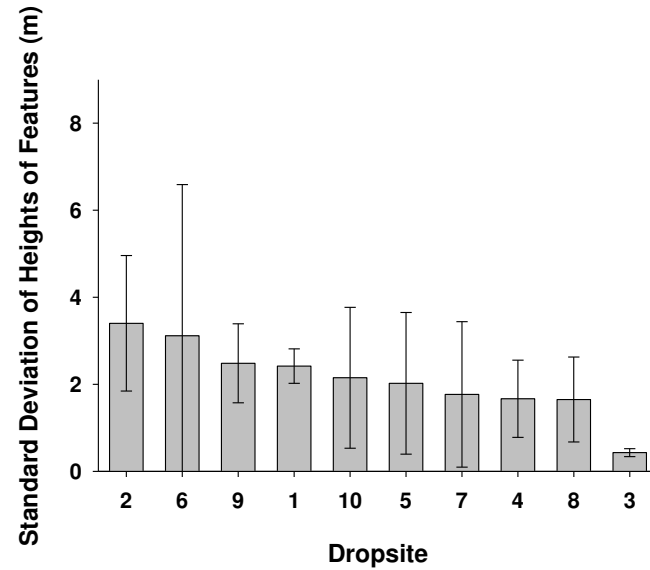
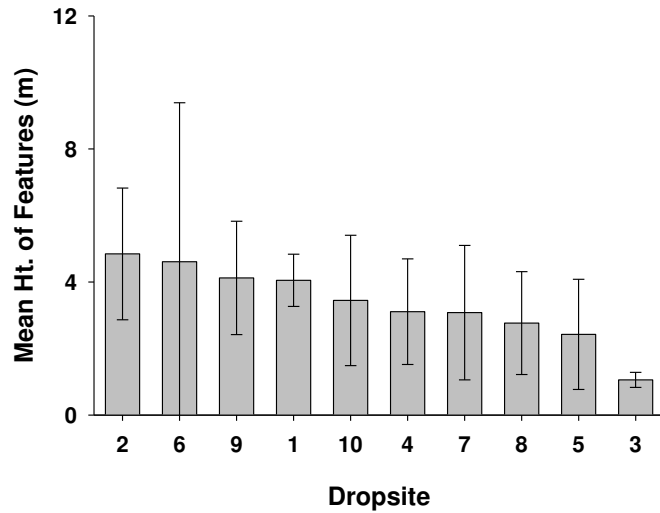
## Mean Height of Features



## Standard Deviation of Heights of Features



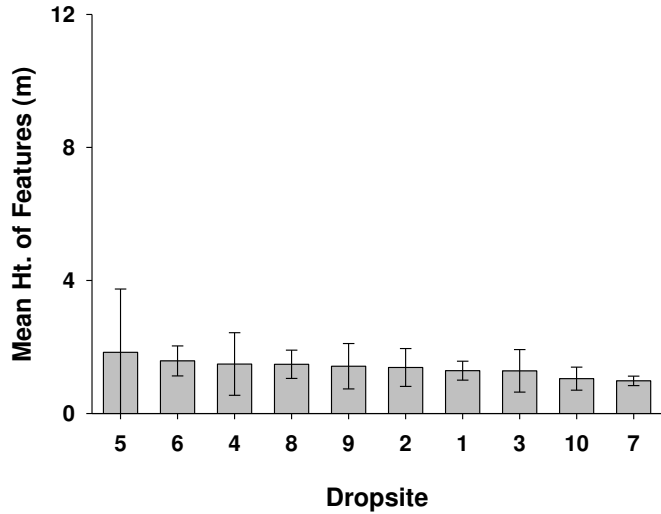
# Horseshoe Bank



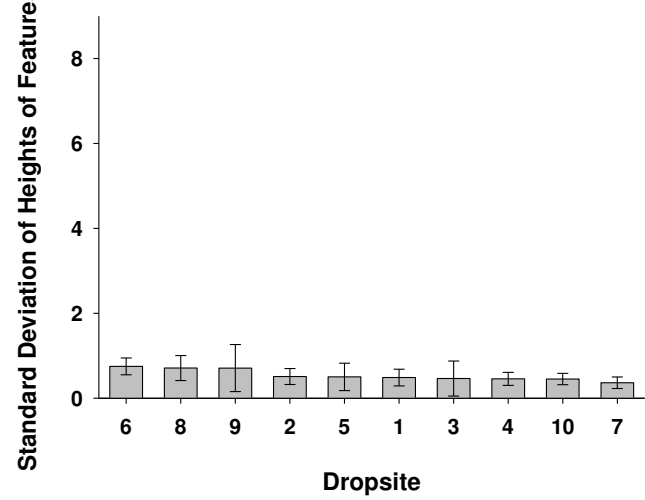
Level of Resolution: Dropsites

# Sonnier Bank

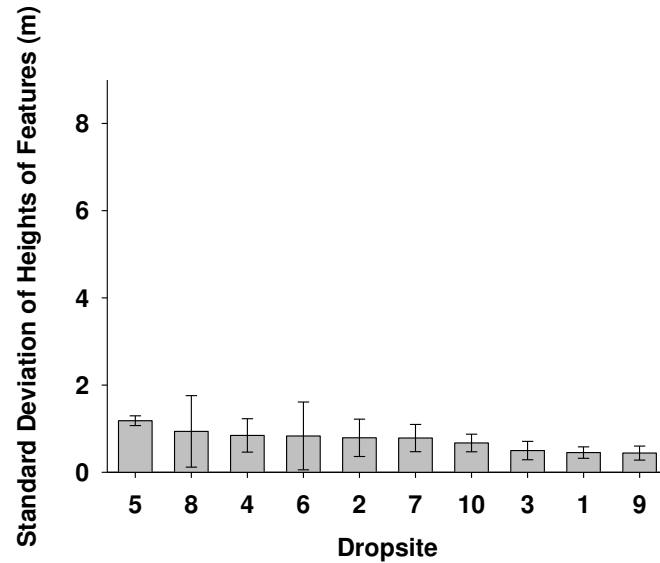
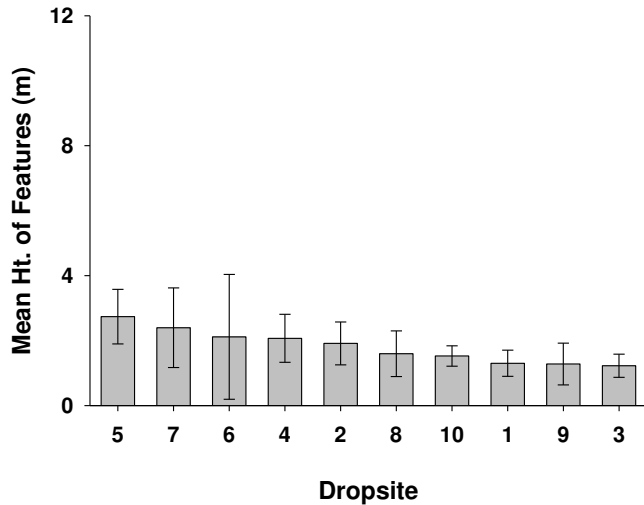
## Mean Height of Features



## Standard Deviation of Heights of Features (m)



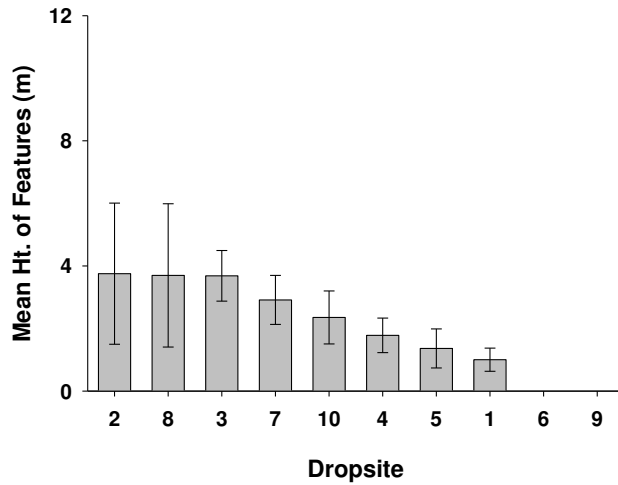
# Alderdice Bank



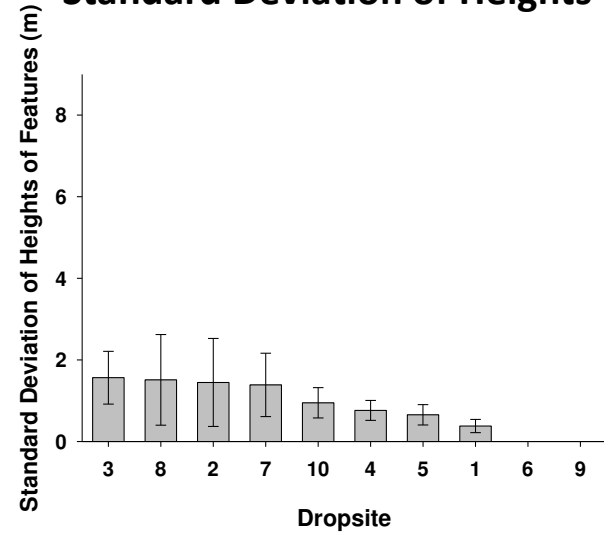
Level of Resolution: Dropsites

## Rezak Bank

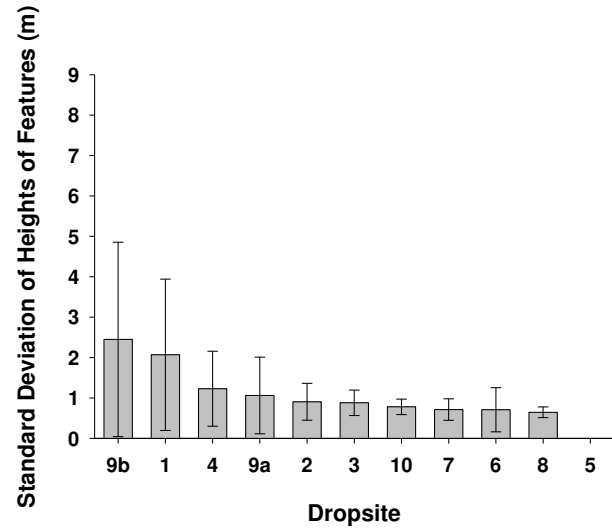
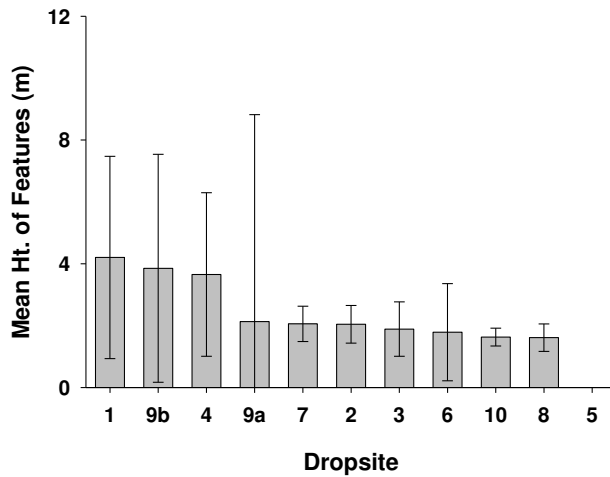
### Mean Height of Features



### Standard Deviation of Heights of Features



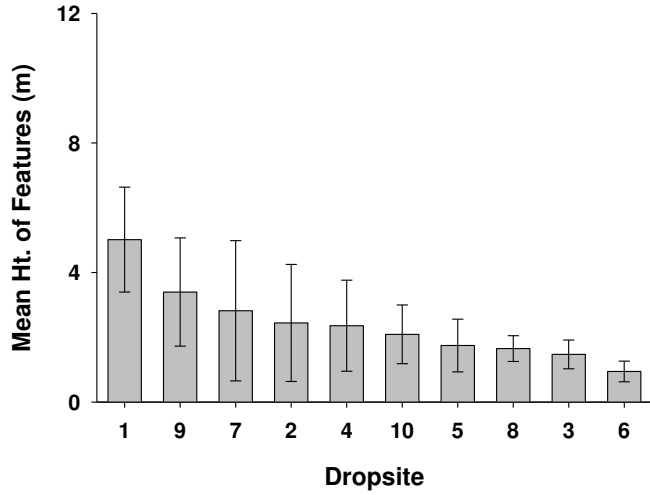
## Bouma Bank



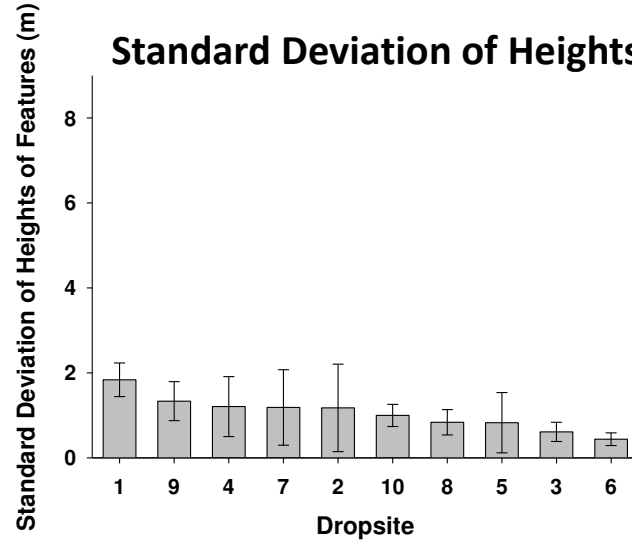
Level of Resolution: Dripsites

## Geyer Bank

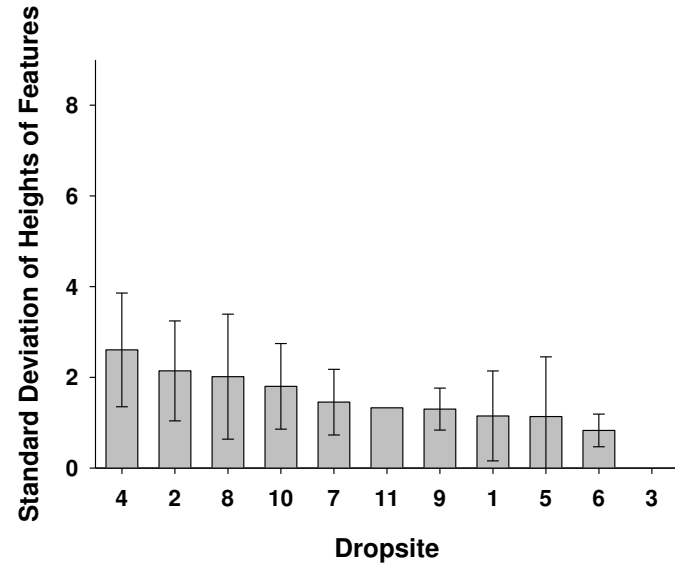
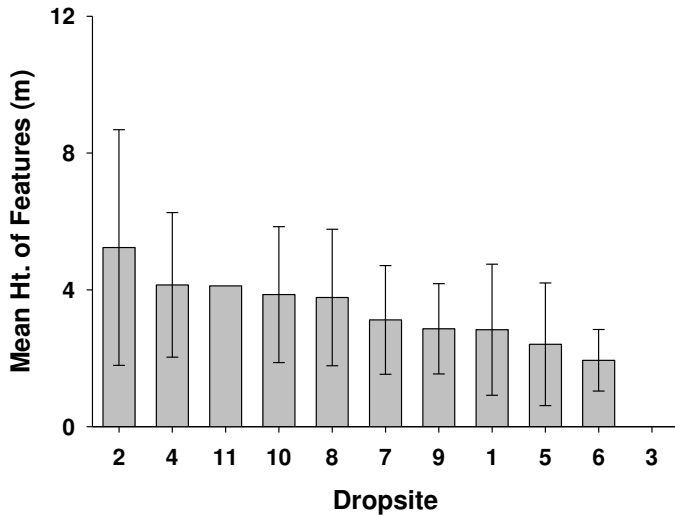
### Mean Height of Features



### Standard Deviation of Heights of Features



## Elvers Bank



Level of Resolution: Dropsites



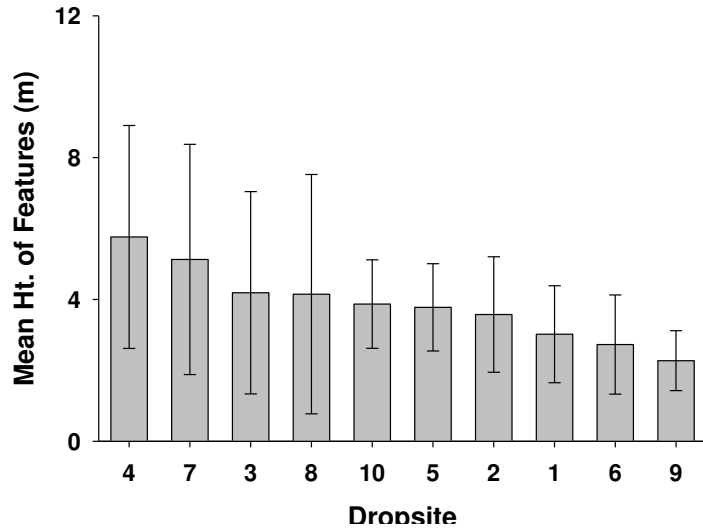
# R/V Manta



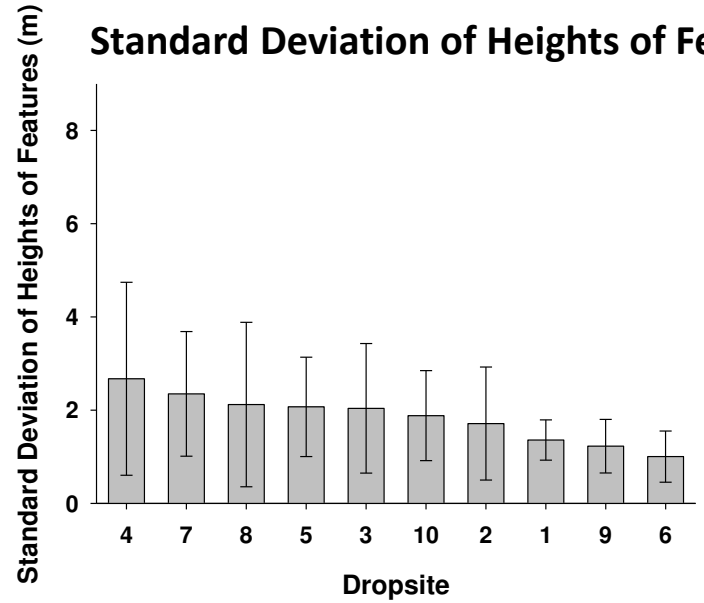
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# McGrail Bank

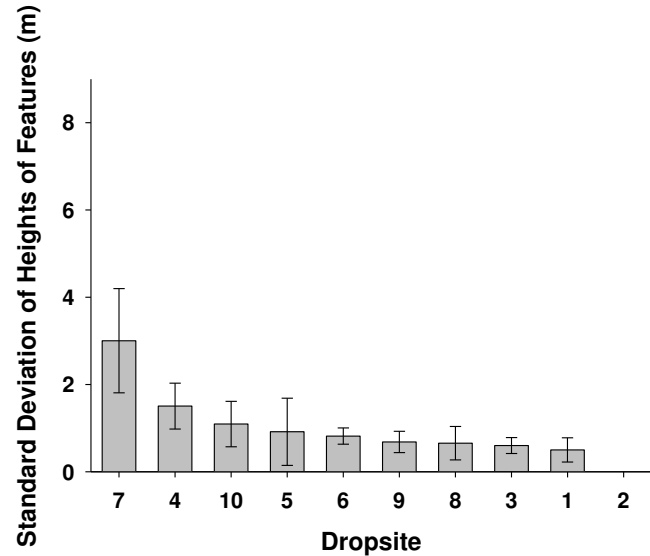
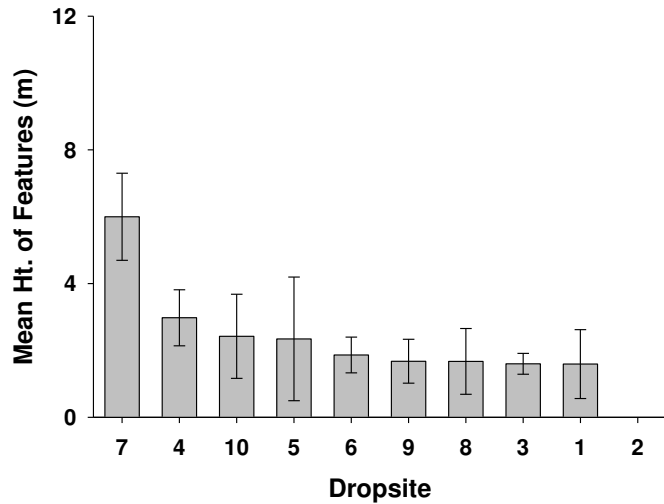
## Mean Height of Features



## Standard Deviation of Heights of Features



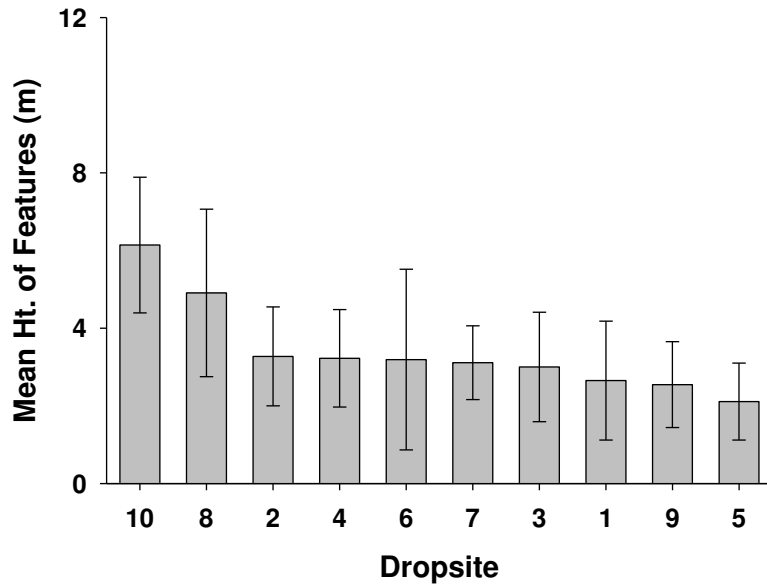
# Parker Bank



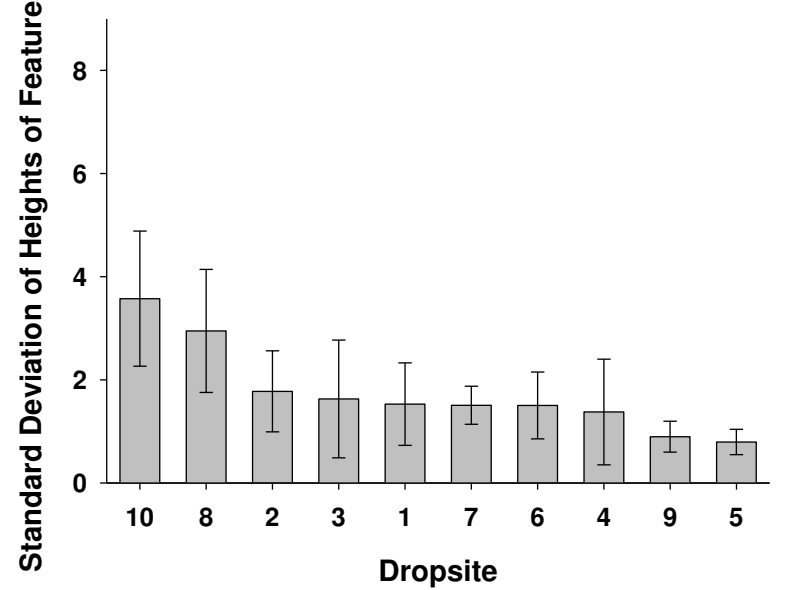
Level of Resolution: Dropsites

# Rankin Bank

## Mean Height of Features

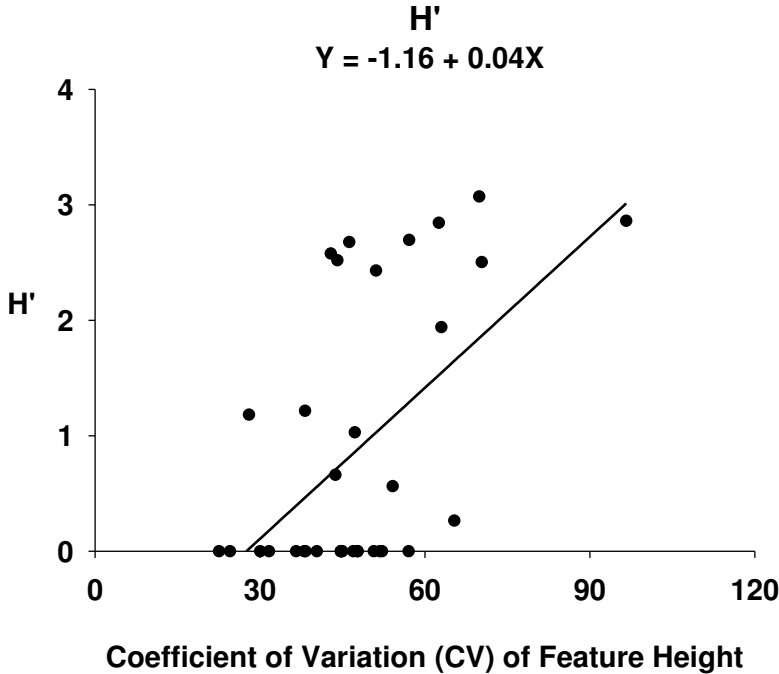
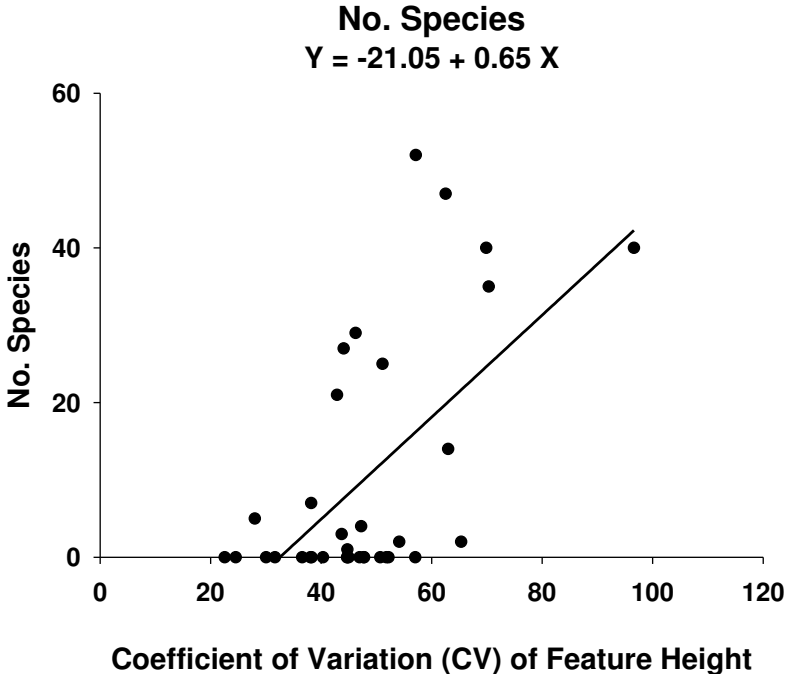


## Standard Deviation of Heights of Features (m)

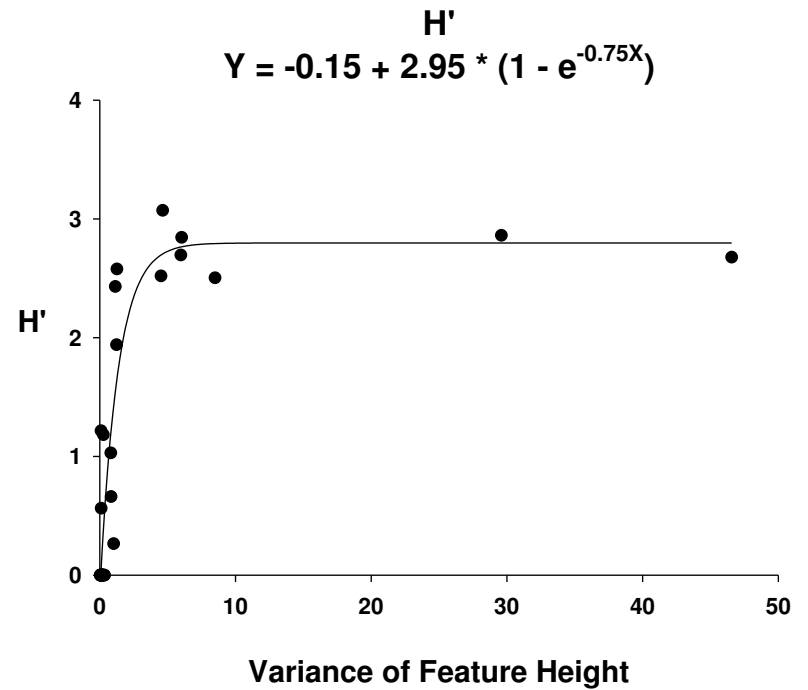
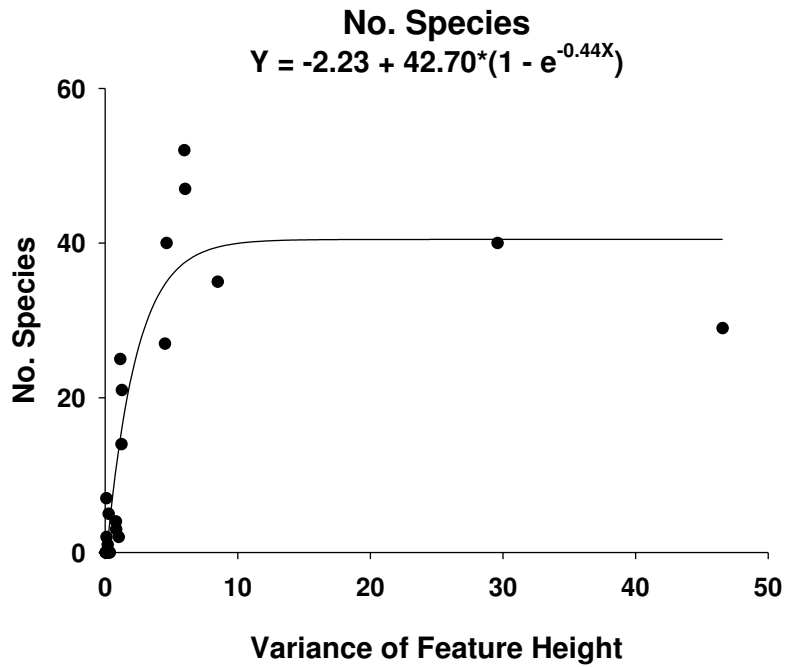


Level of Resolution: Dropsites

# Coefficient of Variation (CV) of Heights of Features Vs.

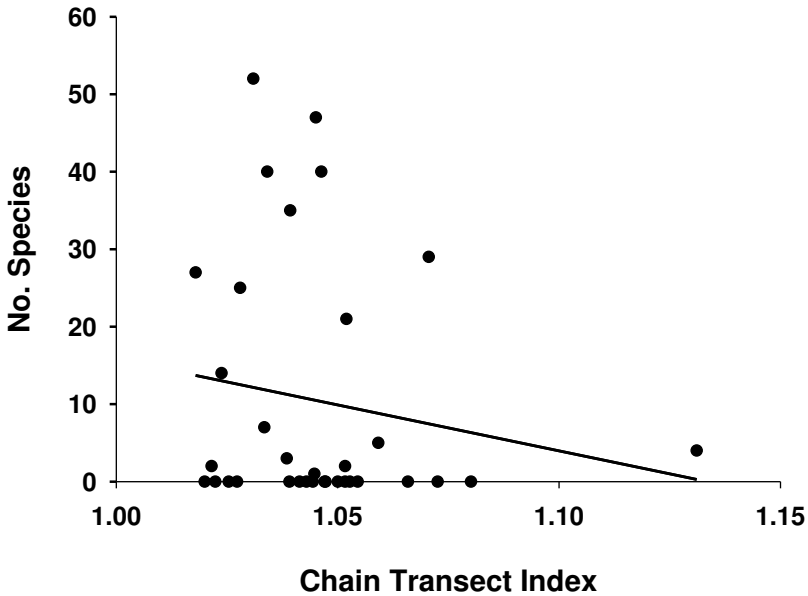


# Variance of Height of Features Vs.

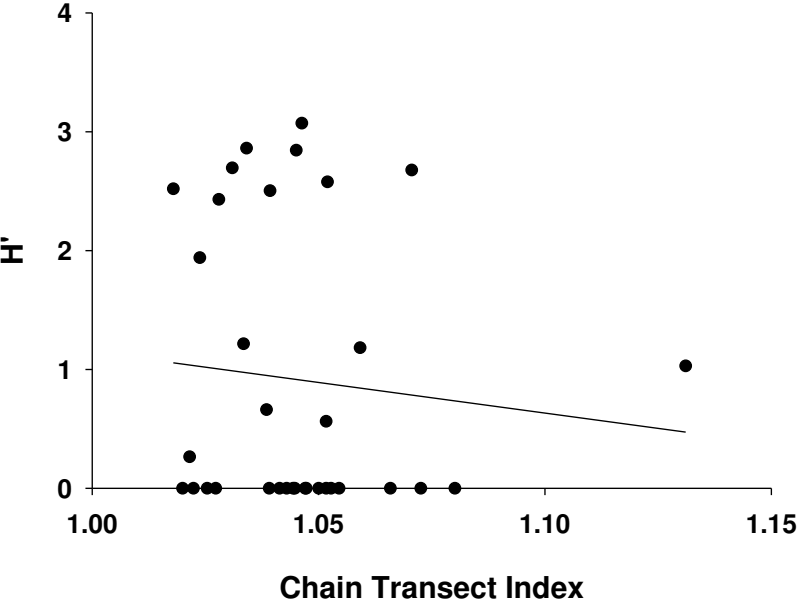


# Chain Transect Index Vs.

**No. Species**  
 $Y = 134.49 - 118.66X$



**H'**  
 $Y = 6.31 - 5.16 X$



High Relief





# High Relief

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Aaron, Wong, <http://www.divephotoguide.com/underwater-photography-special-features/article/sailing-sirens-underwater-photography-fiji/>