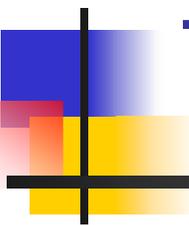
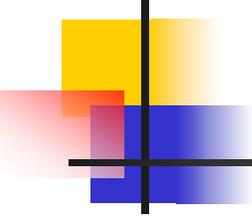


# Benthic Faunal Responses to Sediment Removal: An Example from North Carolina



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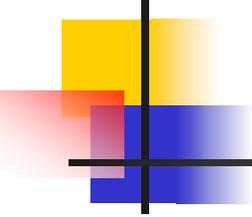
Martin Posey and Troy Alphin  
Center for Marine Science  
UNC-Wilmington



# Issues

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- Demand for beach nourishment has led to search for sources of compatible sand
- Offshore sand deposits are receiving increased attention as possible sources of this sand
- What are effects of sand removal on offshore communities?



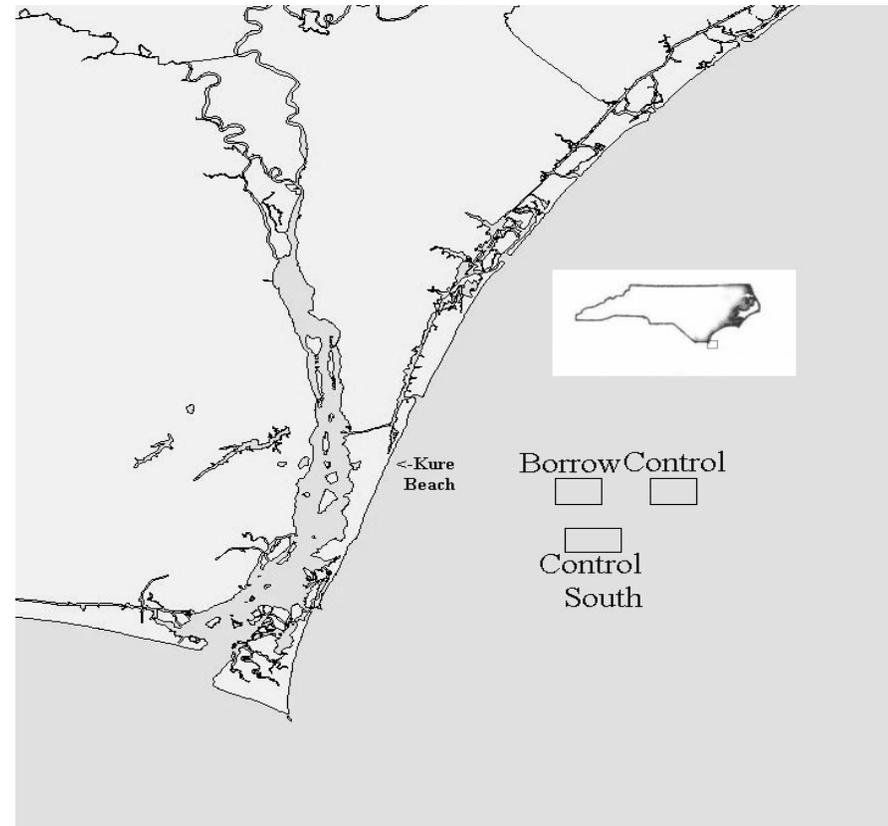
# Effects on Offshore Communities:

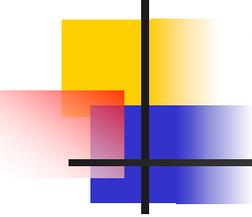
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- Direct effects at sand removal area
  - Expect initial mortality
  - What is rate of recovery?
  - Scaling effects on recovery?
- Indirect effects on adjacent benthic communities
  - Turbidity plumes
  - Sedimentation over adjacent hard-bottoms or soft-bottom habitats
- Effects on fish and other vertebrates
  - Turbidity effects, burial of eggs, resource effects

# Kure Beach Study

- Examined effects of sediment removal at a site near Kure Beach, N.C.
  - Old sand channel
  - Proposed for subsequent borrow activities with anticipated further renourishment of the Kure Beach/Carolina Beach area



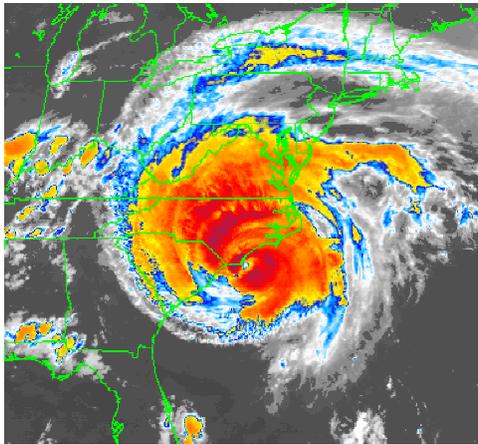


# Soft-sediment Benthic Fauna

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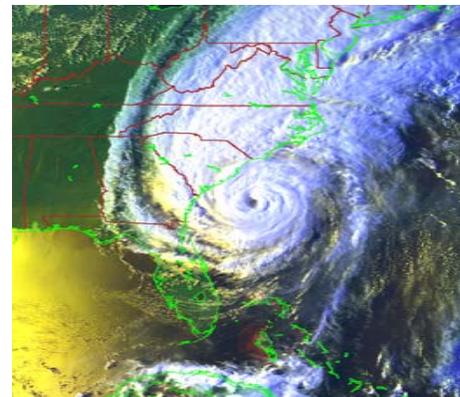
- BACI Design
- Benthic sampling occurred before removal at borrow and control sites in June 1995, October 1995, May 1996, October 1996 and May 1997.
- Sediment removal occurred in August 1997 – January 1998
- Post-borrow sampling occurred February 1998, May 1998, October 1998, May 1999 and October 1999.
- Sampled 5 stations along each of 3 transects for control and borrow sites, with replicate grabs at each station. Because of disruption due to hurricanes in September 1996, 1998 and 1999, fall sampling was limited to one transect per site (5 stations).
- Infauna sampled with grab samples

**Fran Sept. 1996**



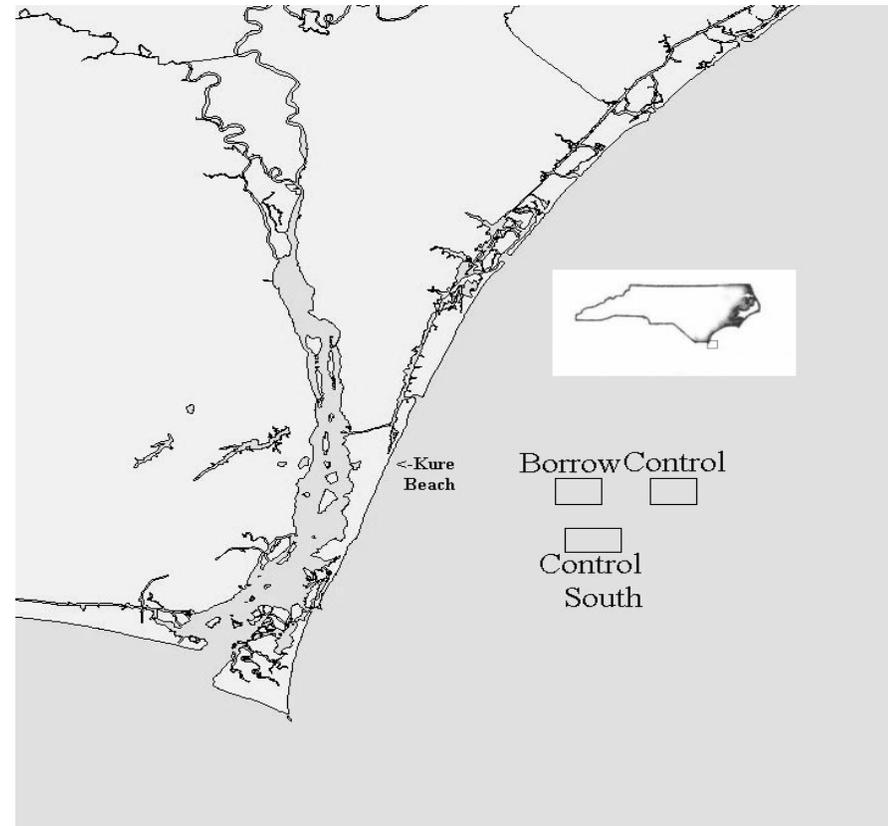
**Bonnie Aug. 1998**

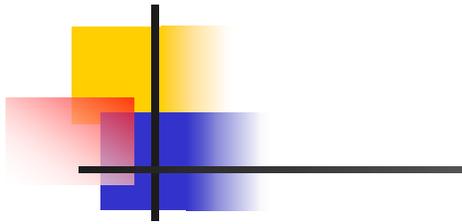
**Floyd Sept. 1999**



# Hardbottom Surveys

- ROV surveys done along 10 transects in borrow and 2 control areas in summer 1995 and summer 1998
- Identified percent cover of soft-sediment, veneer and high-relief hardbottom habitats



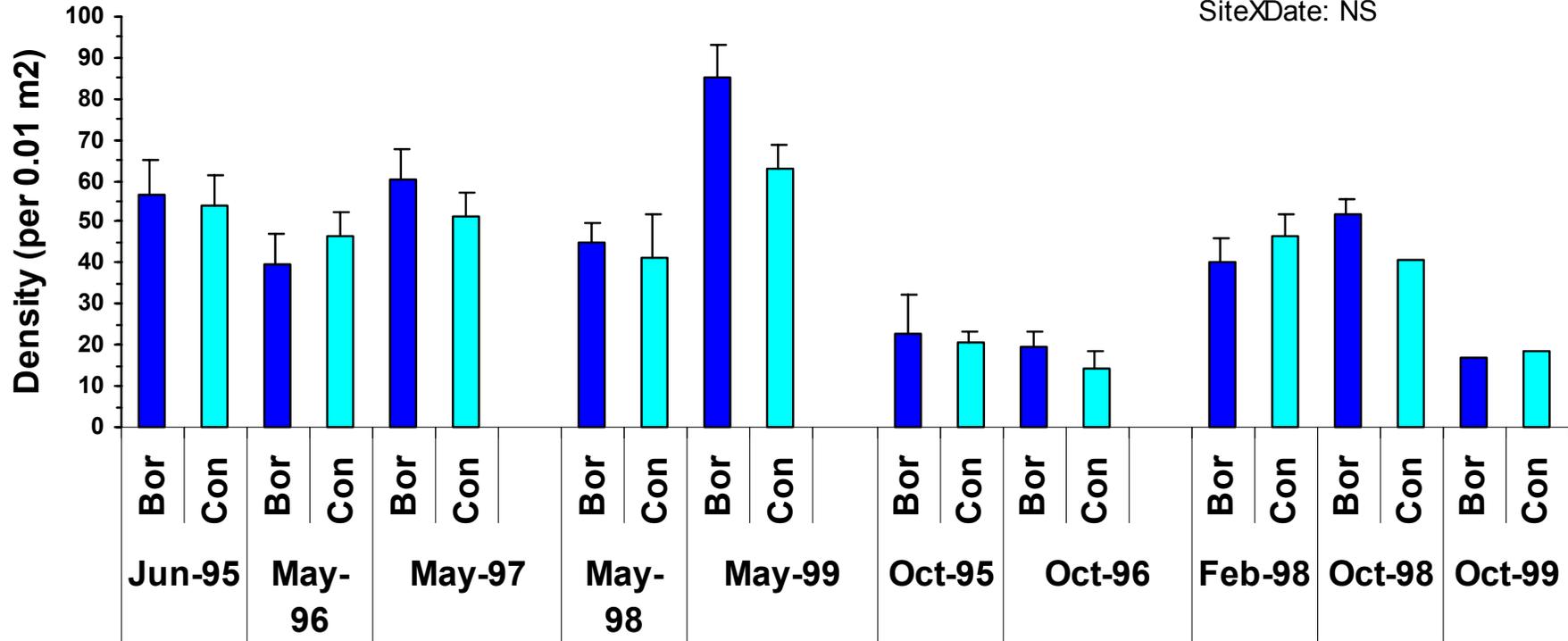


# Total Density

Site (Borrow vs. Control): NS

Date: \*\*\*

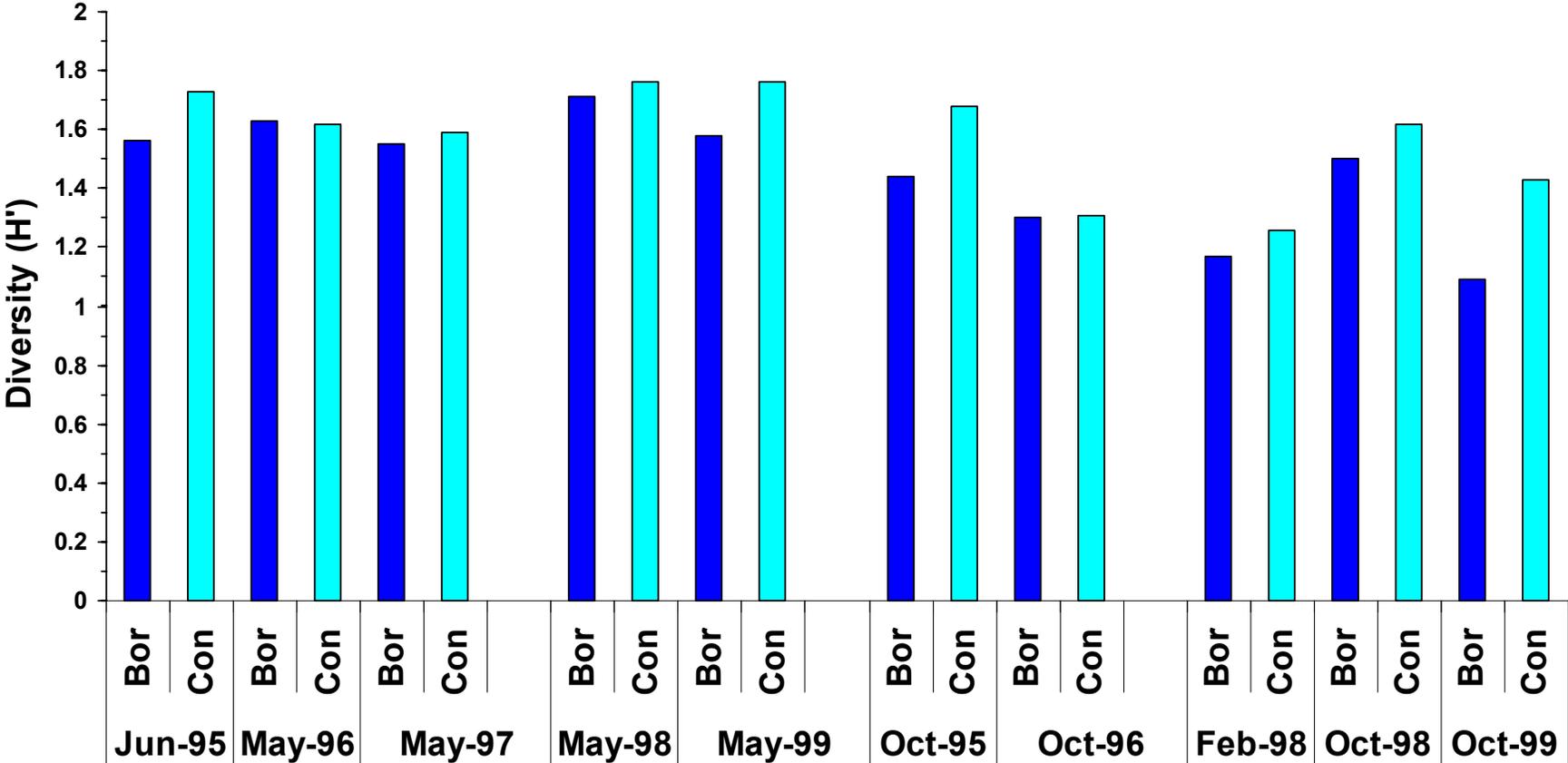
SiteXDate: NS



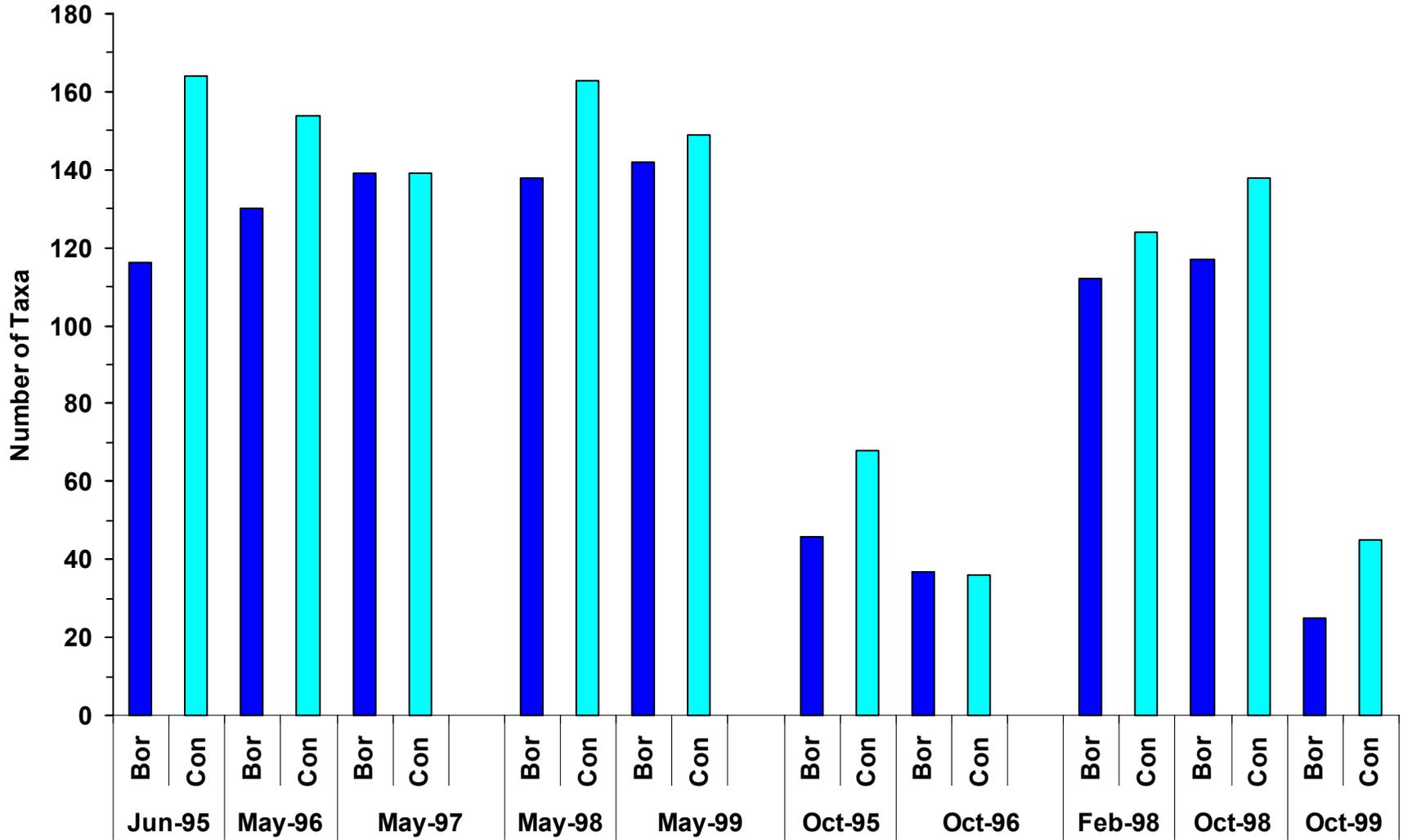
Site (Borrow vs. Control) Effects

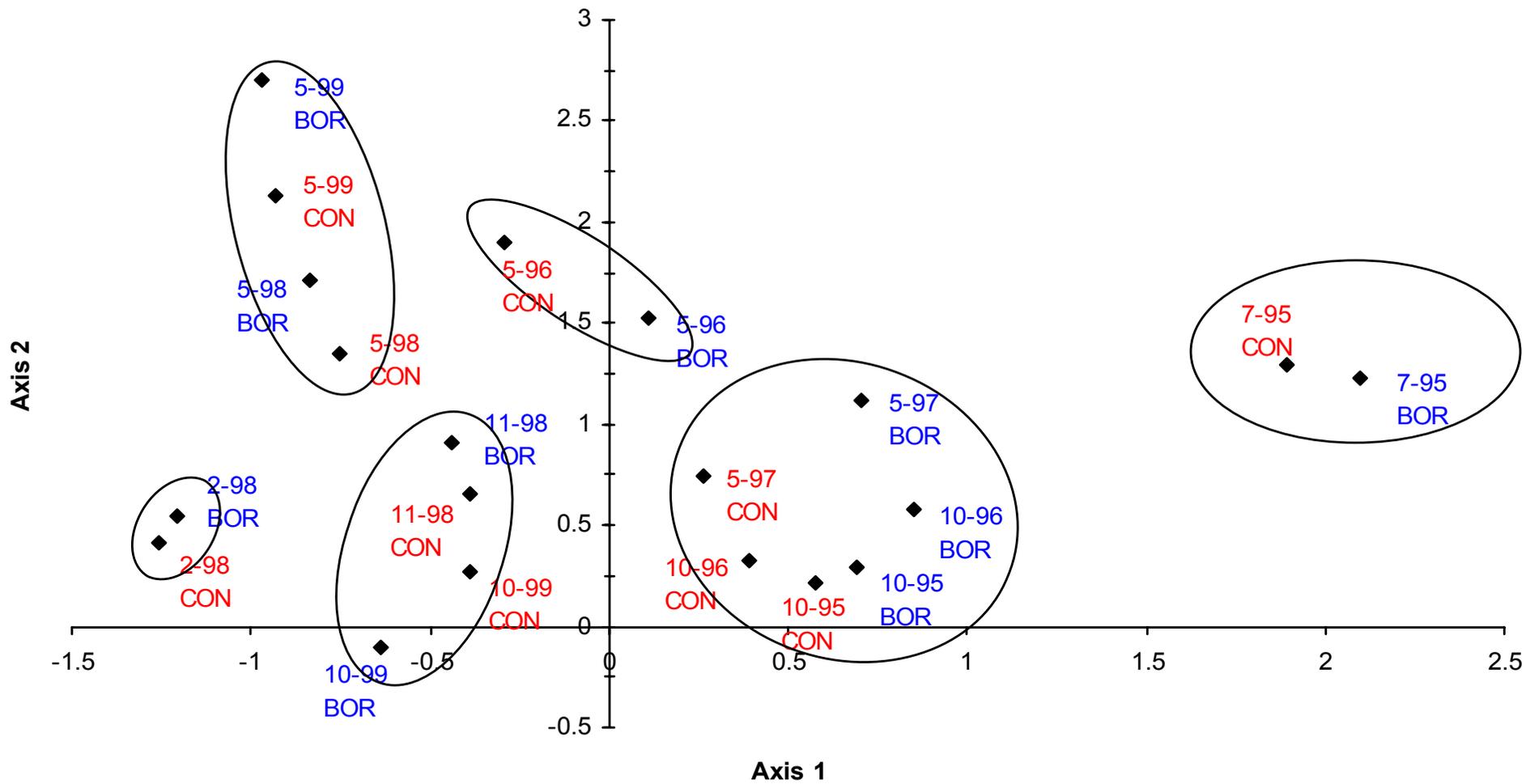
	Site	Date	site*date
<b>Oligochaetes</b>	*** (B)	***	ns
<b>Polychaetes</b>			
<b>Amastigus</b>	*** (C)	***	***
<b>Armandia agilis</b>	ns	***	ns
<b>Armandia macul.</b>	* (C)	***	*
<b>Glycera</b>	ns	***	*
<b>Goniadides</b>	ns	**	ns
<b>Mediomastus</b>	ns	***	ns
<b>Prionospio cris.</b>	ns	***	ns
<b>Prionospio ste.</b>	ns	***	ns
<b>Spiophanes</b>	ns	***	ns
<b>Syllidae</b>	ns	***	ns
<b>Axiothella</b>	ns	***	ns
<b>Prionospio dayi</b>	ns	***	ns
<b>Prionospio fallax</b>	ns	***	ns
<b>Bivalves</b>			
<b>Crysinella</b>	** (B)	***	*
<b>Ervillea</b>	ns	**	ns
<b>Tellina</b>	* (B)	**	*
<b>Astarte</b>	ns	***	ns
<b>Amphipods</b>			
<b>Haustoridae</b>	** (C)	***	ns
<b>Rhepoxynius</b>	* (C)	**	*
<b>Bathyporeia</b>	ns	***	ns
<b>Ophiuroidea</b>	ns	***	ns
<b>Cumacea</b>	ns	***	ns

# Diversity

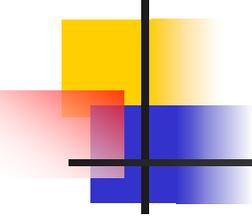


# Species Richness





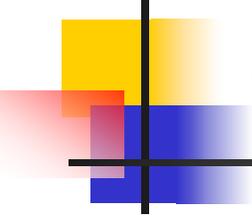
<u>Site</u>	<u>Sampling Period</u>	<b>% of each habitat type</b>		
		<u>sand</u>	<u>vener</u>	<u>high relief</u>
<b>East Control</b>	<b>Before sediment removal</b>	<b>78.0</b>	<b>16.2</b>	<b>5.8</b>
	<b>After sediment removal</b>	<b>93.0</b>	<b>4.5</b>	<b>2.5</b>
<b>South Control</b>	<b>Before sediment removal</b>	<b>92.6</b>	<b>4.6</b>	<b>2.8</b>
	<b>After sediment removal</b>	<b>80.0</b>	<b>17.8</b>	<b>2.5</b>
<b>Borrow</b>	<b>Before sediment removal</b>	<b>99.6</b>	<b>0.4</b>	<b>0</b>
	<b>After sediment removal</b>	<b>90.5</b>	<b>9.5</b>	<b>0</b>



# Summary of Results

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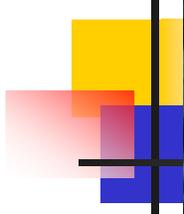
- Little difference between borrow and control sites for any date
- Between date differences apparent. For some taxa, these coincide with sand removal and hurricane effects
- Little net change in hardbottom habitat cover in control areas.
- Limited detectable effect of hurricanes



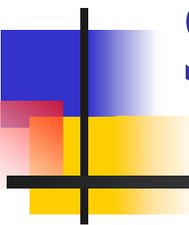
# Conclusions

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- Borrow effects either minimal relative to temporal variability or else covered a much greater area than initially anticipated
  - Opportunistic nature of dominant taxa
  - Timing of sediment removal (fall/early winter)
  - Little change in sediment grain size
  - System subject to other disturbances
- Coincidence of patterns between control and borrow sites emphasizes the need for both before-after comparisons and the use of control sites.
- Little evidence for short-term effects of hurricanes, but design not adequate to test chronic effects



# Trophic Connections Between Reef Habitats and Adjacent Soft-Substrates

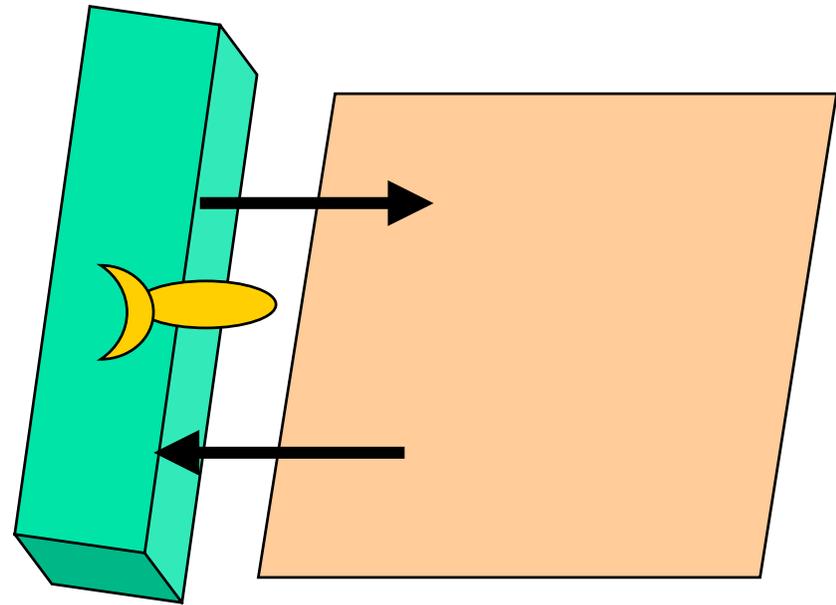


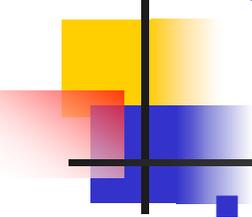
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# Trophic Connections Between Structural and Adjacent non-Structural Habitats

- Coral Reefs
- Offshore Hardbottom Communities
- Seagrass beds





# Types of Linkages and Implications

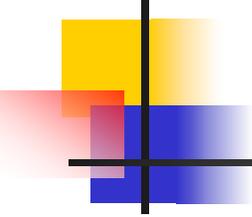
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## ■ Types

- On-reef predators utilizing prey immigrating from adjacent habitats
- Higher predators foraging facultatively over reefs
- On-reef predators foraging over adjacent habitats

## ■ Implications

- Reefs cannot be viewed in isolation, but rather must be considered as a complex of habitats, including structural and adjacent non-structural areas
- We have been studying connections between reef and adjacent sandflat habitats for temperate rock outcrops off the North Carolina coast, artificial reefs in Florida, and for oyster reefs



# Evidence

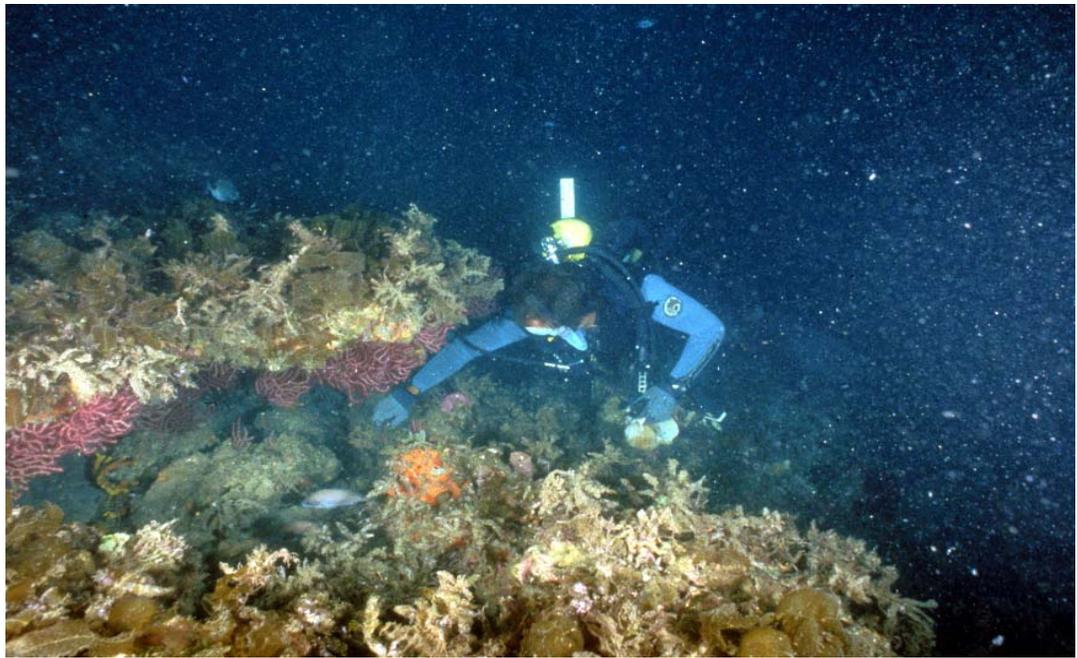
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- Observations of predator foraging
- Infaunal abundances in sand flat areas adjacent to reefs (“halos”)
- Increasing predation influence near reef structures
- Reduction of physiological or abundance measures for reef-associated fish when reef:edge:sand flat ratios are reduced below some threshold

# North Carolina Rock Outcrops

- Rock ledges and outcrops common off the North Carolina coast
- Support an important fishery
- Are reef associated predators foraging on adjacent sand flats?
- Collaborative with Ambrose

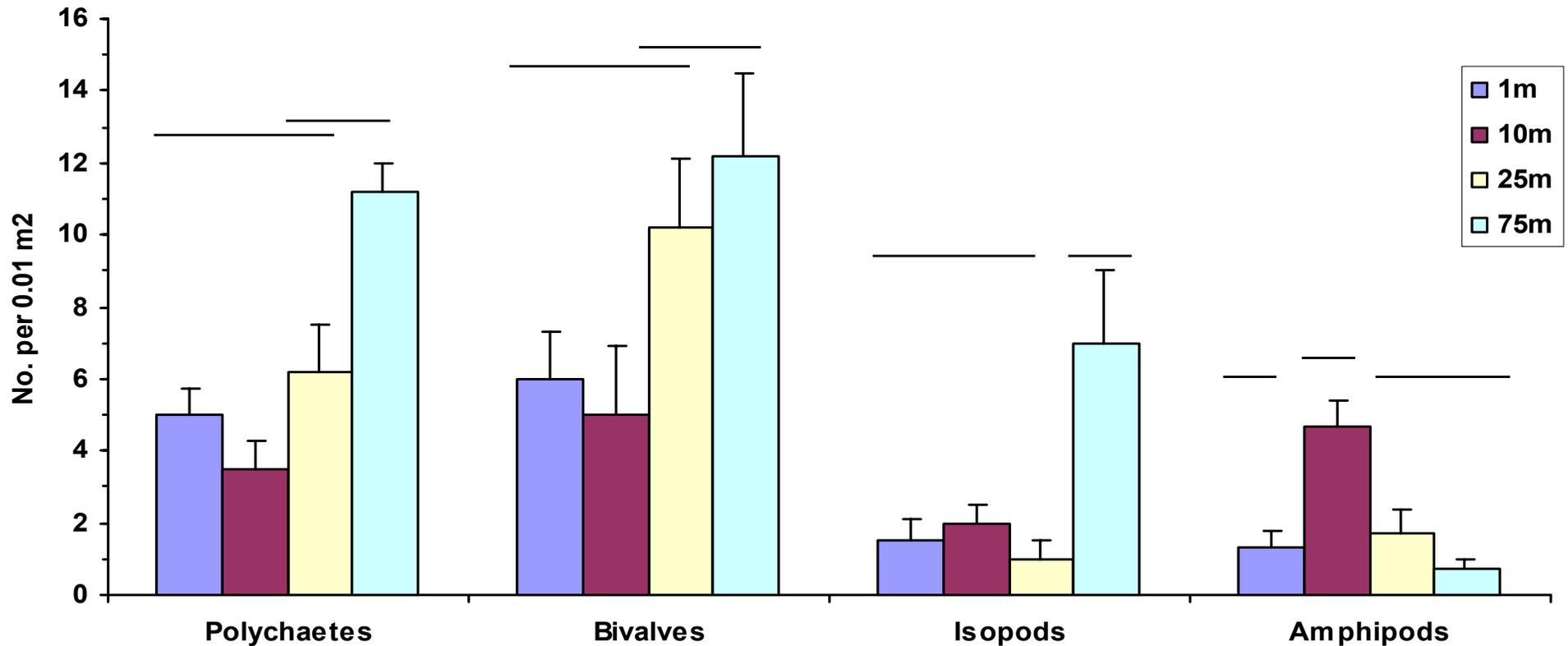




# Infauna Adjacent to a Temperate Reef

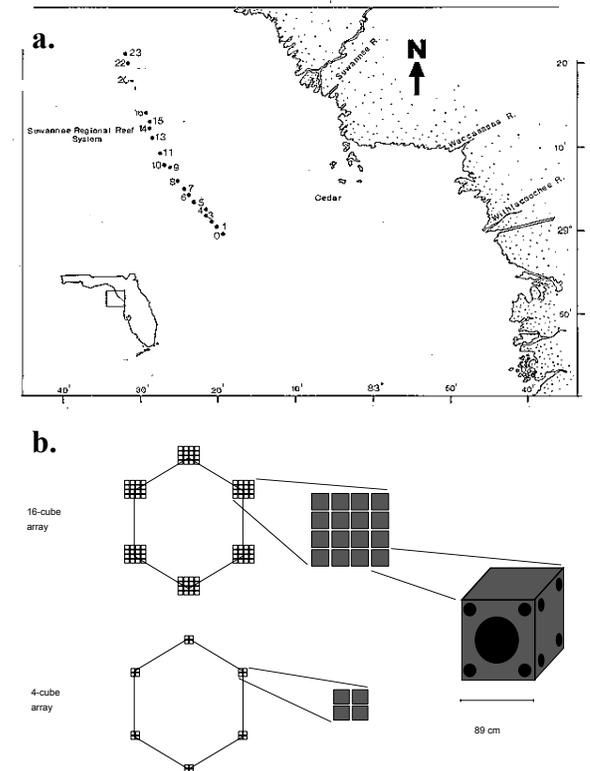
(from Posey and Ambrose 1994)

## Infauna Adjacent to 23 Mi Reef

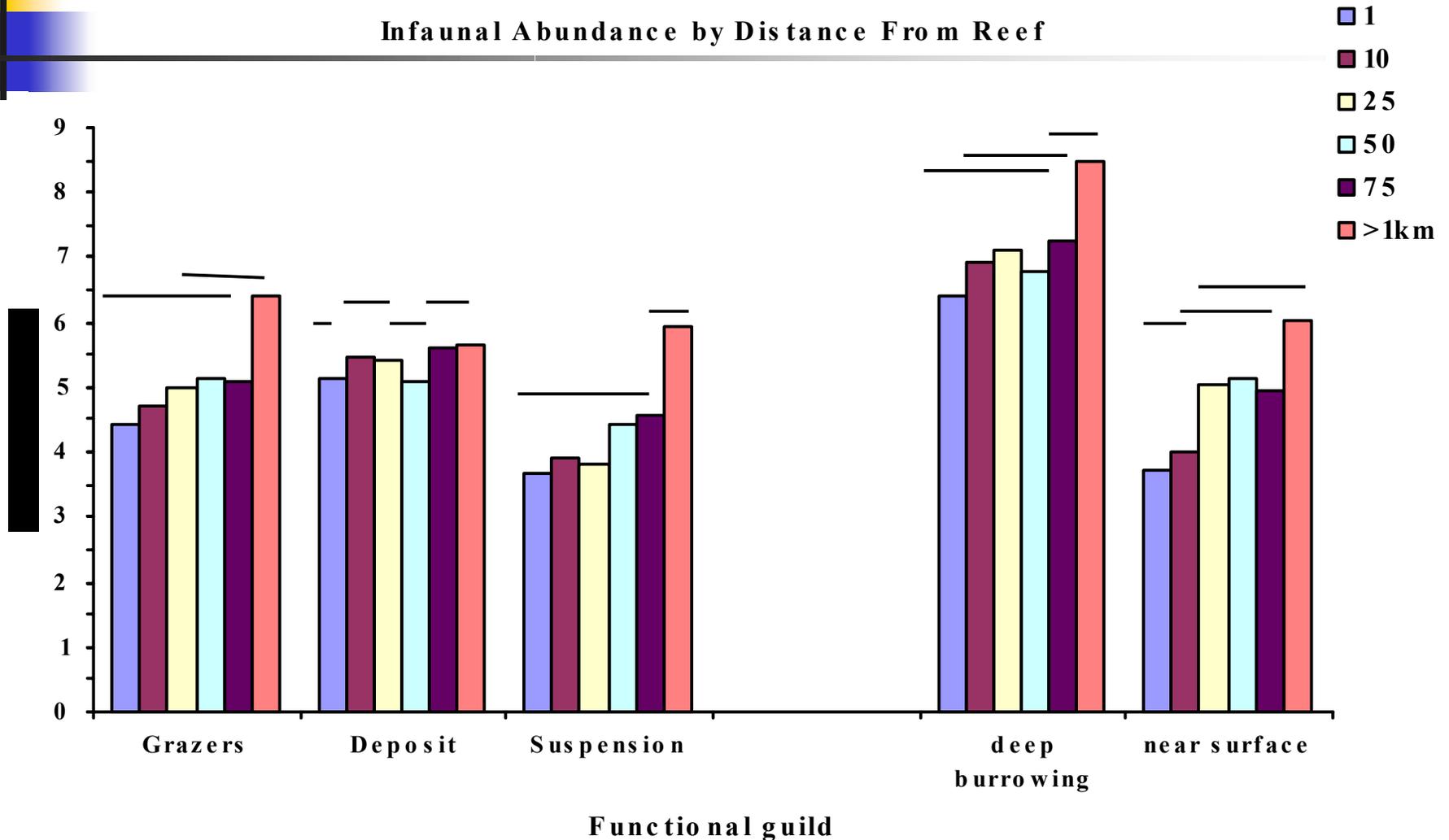


# Artificial Reefs

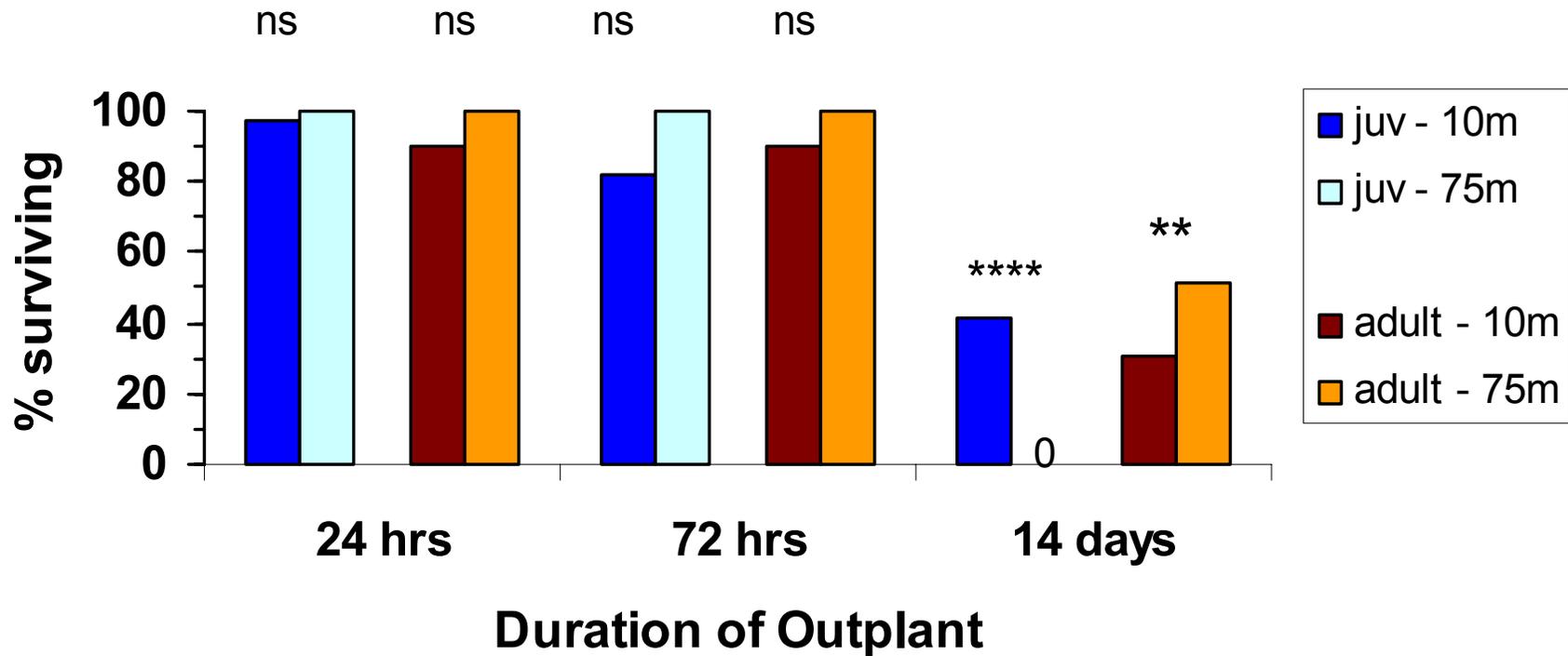
- Examined various aspects of reef architecture, including how fish foraging off-reef affected adjacent sand flat habitats
- Work conducted with Dr. William Lindberg



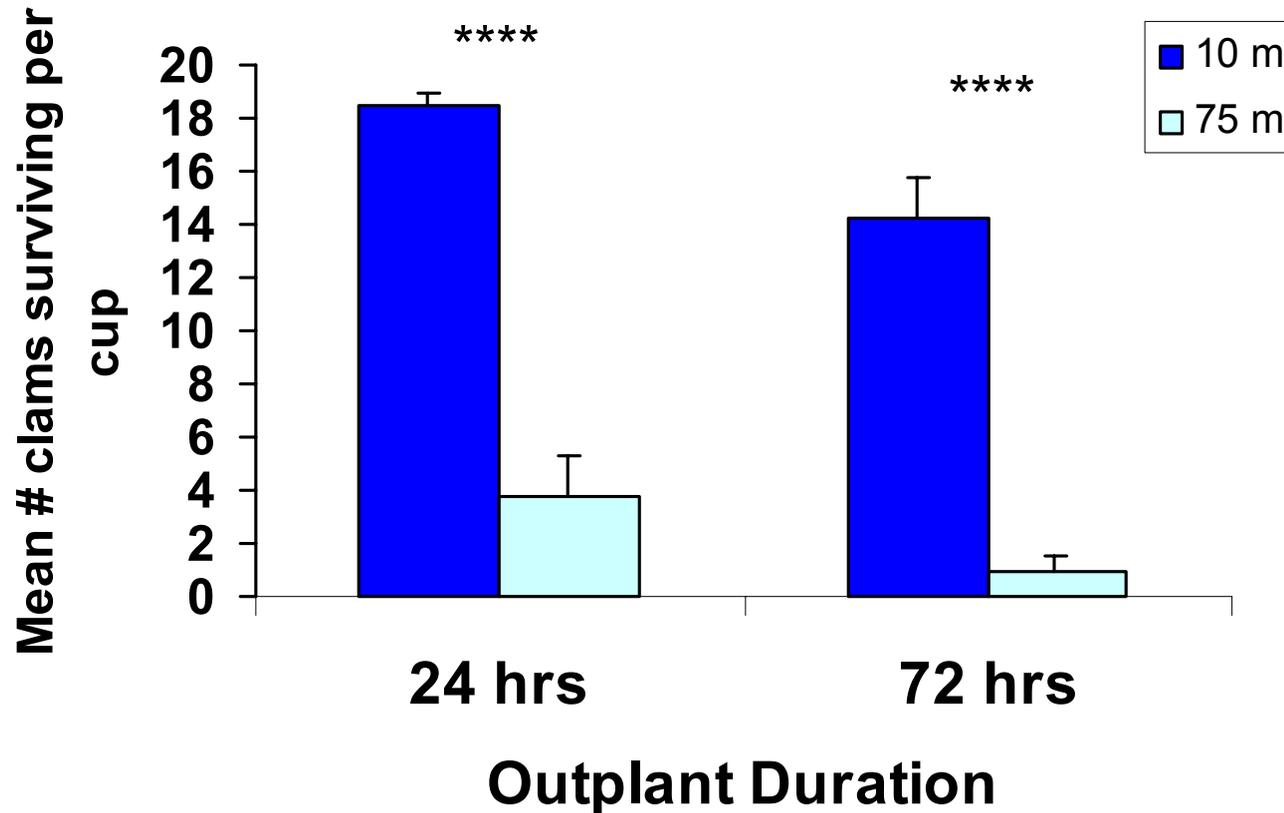
# Infauna Abundances Adjacent to Artificial Reefs



# Sand Dollar Survivorship



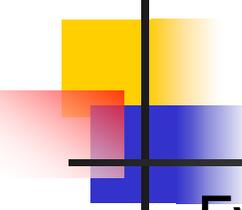
# Survivorship of Clam Outplants



# Oyster Reefs

- Shallow-water and smaller spatial scale, but may exhibit some of the same linkages as other reefs systems
- We have been examining infaunal communities adjacent to oyster reefs in southeastern North Carolina
- Find similar evidence of halos near reefs, greater predation effects near reefs and observations of off-reef foraging and foraging along the reef edge.





# Summary

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- Evidence from a variety of systems suggests linkages between structural habitats (e.g. reefs) and adjacent sand flat habitats
  - “halos” of reduced faunal abundance
  - Off-reef foraging by reef-associated predators
  - Apparent greater predation effects near reefs
- Among the unanswered Questions:
  - Importance of adjacent habitats in supporting reefs systems
  - Spatial extent of interactions and temporal variability in linkages
  - Characteristics of adjacent sand flats that are optimal for reef-associated fauna