

# Quantifying impacts of estuarine shoreline stabilization in North Carolina



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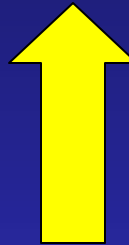
**NOAA**

Science for Coastal Communities

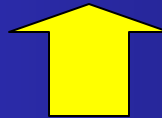
Center for Coastal Fisheries and Habitat Research

**CCFHR**

**Protection of Public Trust Resources**  
**Cost-effective Shoreline Stabilization**



**Public Support of Policy Change**



**Cost-benefit  
Analysis**



**Education &  
Outreach  
Technology Transfer**



**Ecosystem  
Services  
Research**





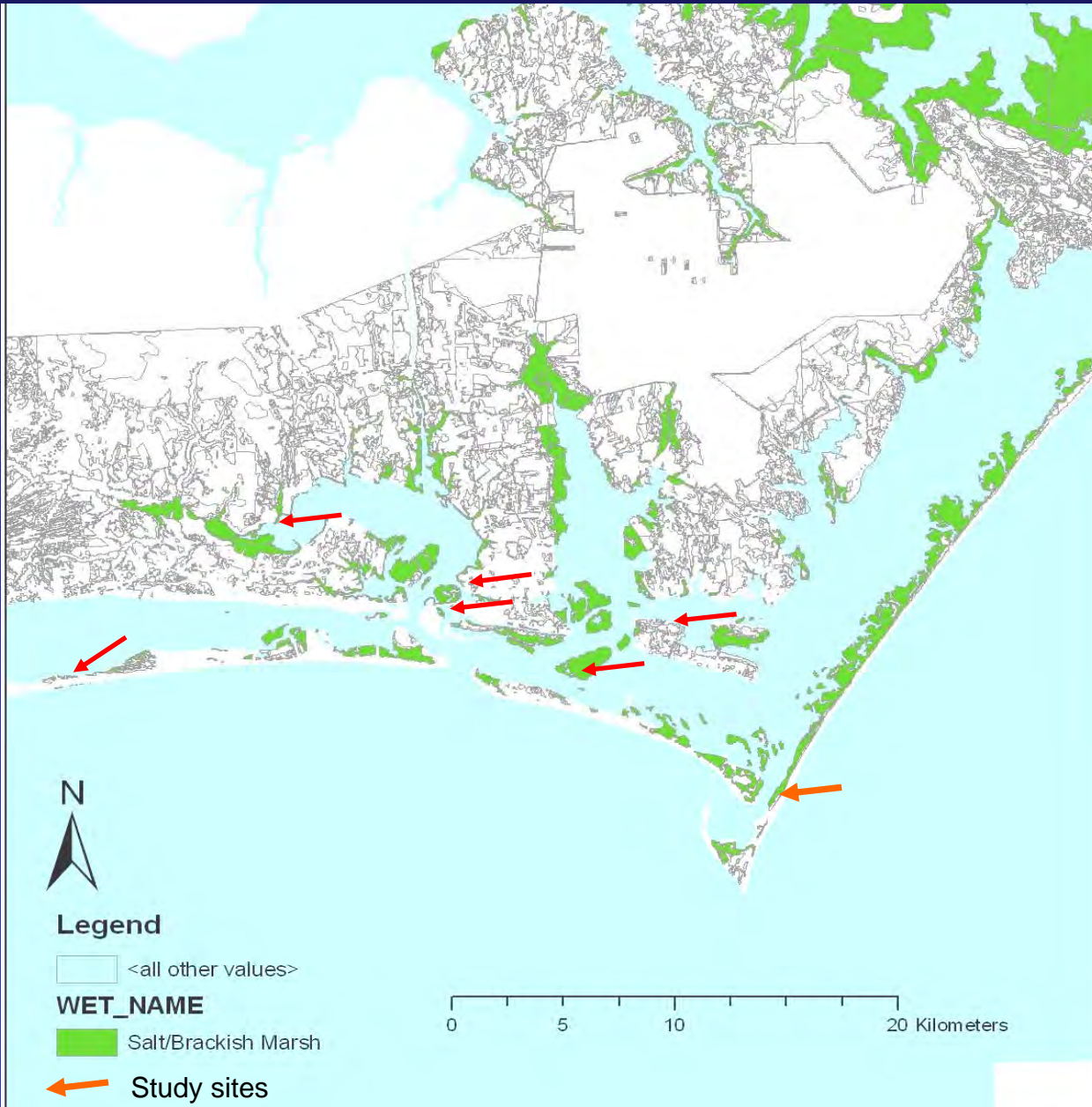
Shoreline habitats pinched by coastal development & Sea Level Rise

**Variability in marsh response to SLR along NC coast**

- Tidal amplitude
- Tidal currents
- Offshore sediment supply
- Riverine sediment supply
- Fetch
- Subsidence/RSLR
- Salinity/vegetation



# Carteret County Salt Marsh Distribution



- Do fringing salt marshes provide same ecosystem services as more extensive marshes?
- Do stone breakwaters significantly effect sediment accretion rates, fish utilization, vegetation or N cycling?
- What features influence sediment elevation change in fringing salt marshes?
  - Wave exposure
  - Vegetation
  - Oyster reefs
  - Tidal elevation/RSL

# Fringing shoreline marshes

*It's all about the edge*

- 1. Marsh edge provides most valuable fishery habitat (nursery, food, and refuge)**  
(Hettler 1989, Minello et al. 1994, Peterson and Turner 1994, Currin et al. 2007)
- 2. Marsh edge effectively reduces wave energy and traps sediments**  
(Knutson 1982, Christiansen et al. 2000, Leonard et al. 2002)
- 3. Habitat complexity, trophic linkages and biodiversity all maximized at the marsh edge**



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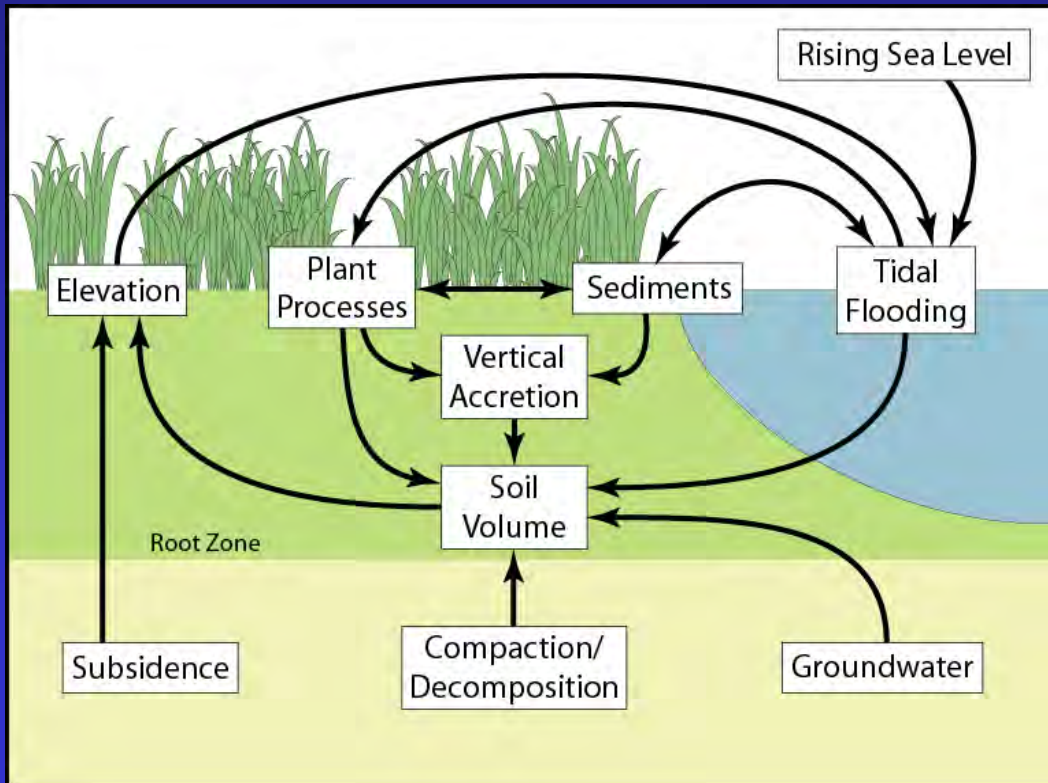
# Shoreline Stabilization and Marsh Sediment Accretion Rates

## Natural shoreline response to SLR



Keep up

Drown/erode  
(or move back)



***Salt marshes in many areas have demonstrated the ability to increase their elevation at a rate equal to recent relative sea level rise***

# Shoreline Marsh Sites Surface Elevation Tables

↓ ↓ SET locations



*At each site established  
Upper and Lower SETS  
15-25 m apart*

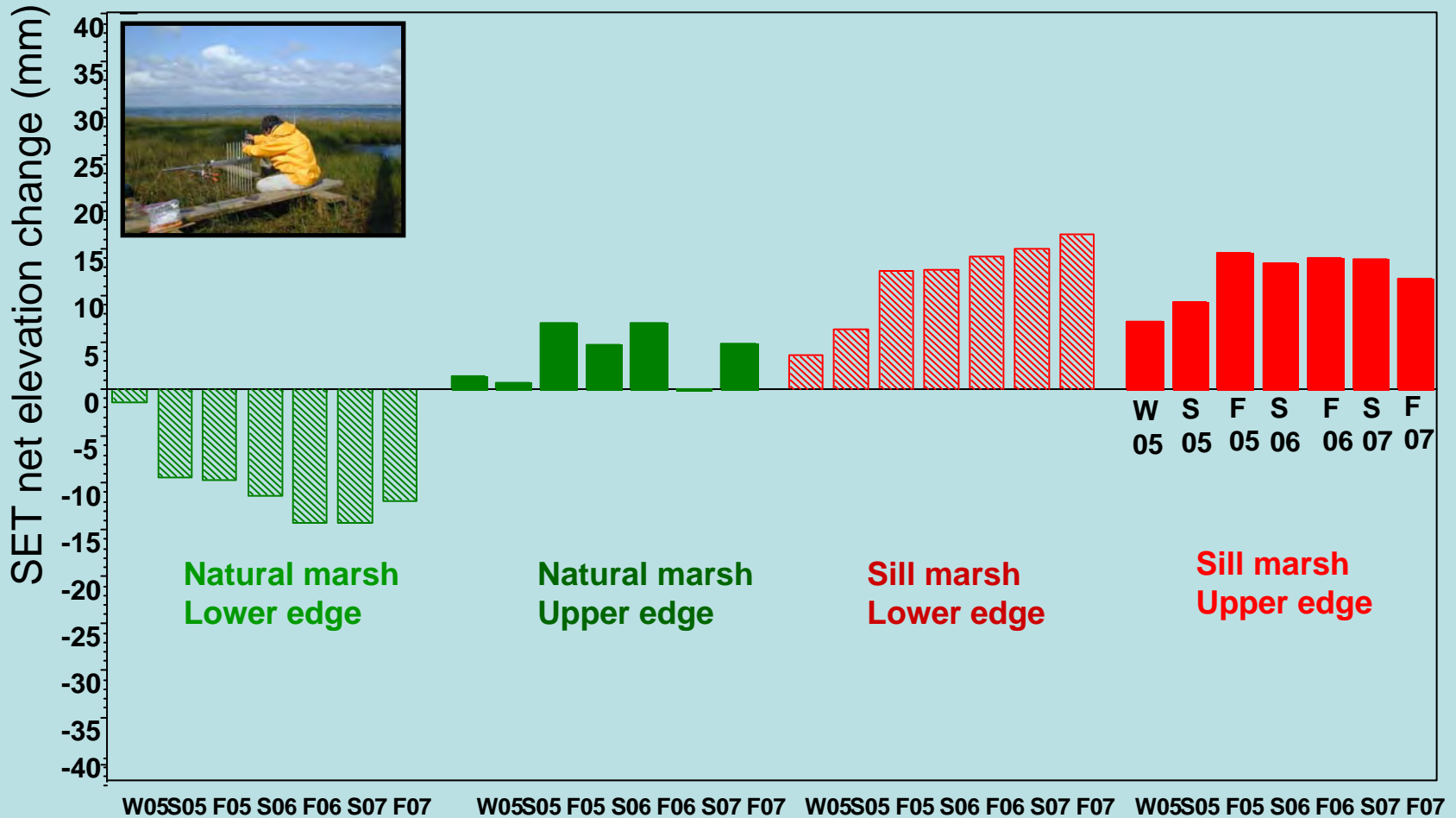
*Paired sites;  
unstabilized natural  
fringing marshes with  
nearby marshes with  
sills or oyster reefs*



MAR 20 2007

# Effect of offshore sills on marsh sediment accretion rates

## 2004-2007 North Carolina Marsh SET results *Spartina alterniflora* marshes



*Significant treatment effect*

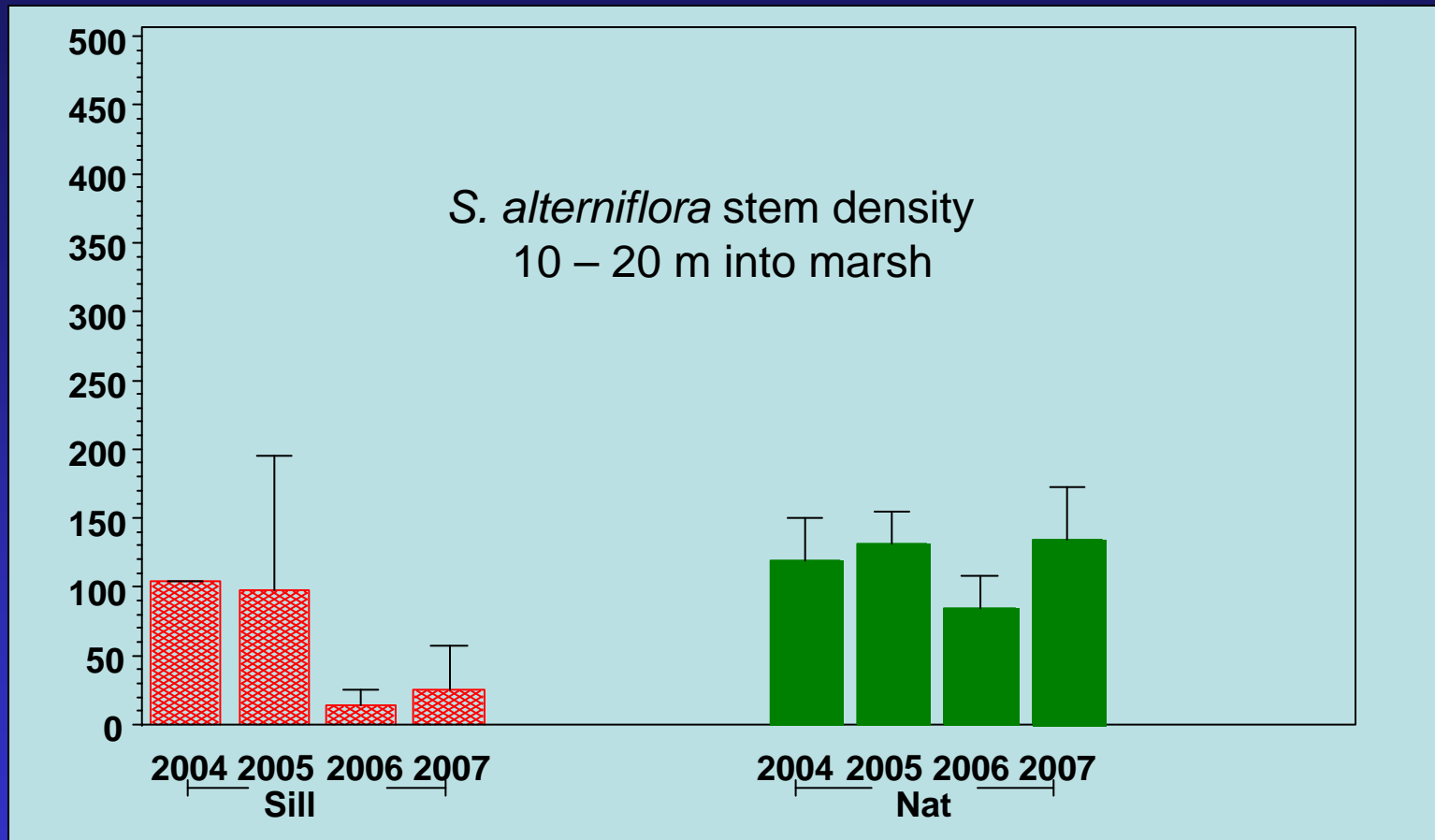
**SILL > NATURAL**

*Spring 07 (.0047)*

*Fall 07 (.0089)*

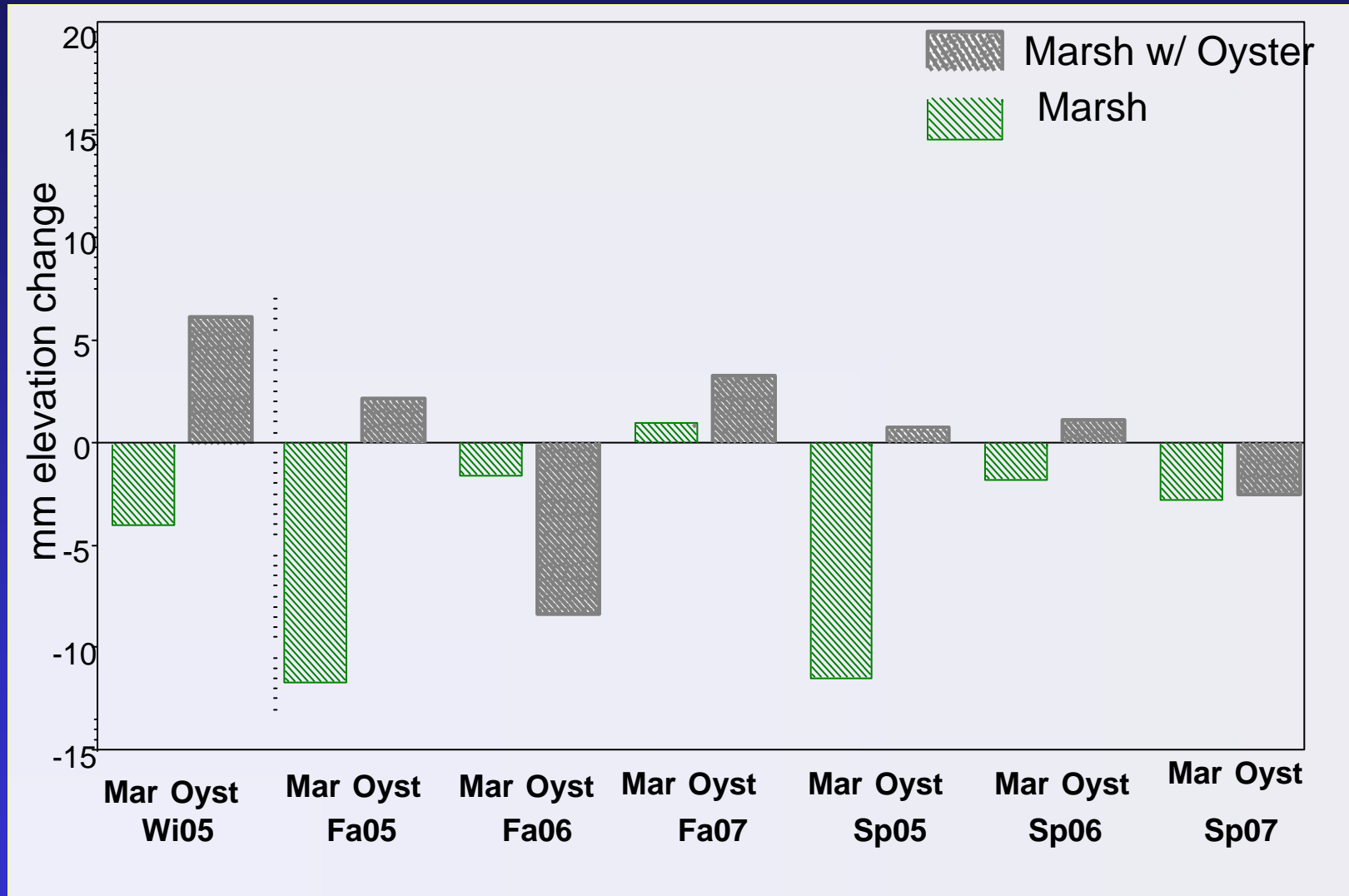


## Loss of *Spartina* biomass at upper elevations in Sill marshes



Research Coming Soon...Relationship between tidal elevation, *Spartina* biomass and sediment accretion rates in stabilized and natural fringing salt marshes

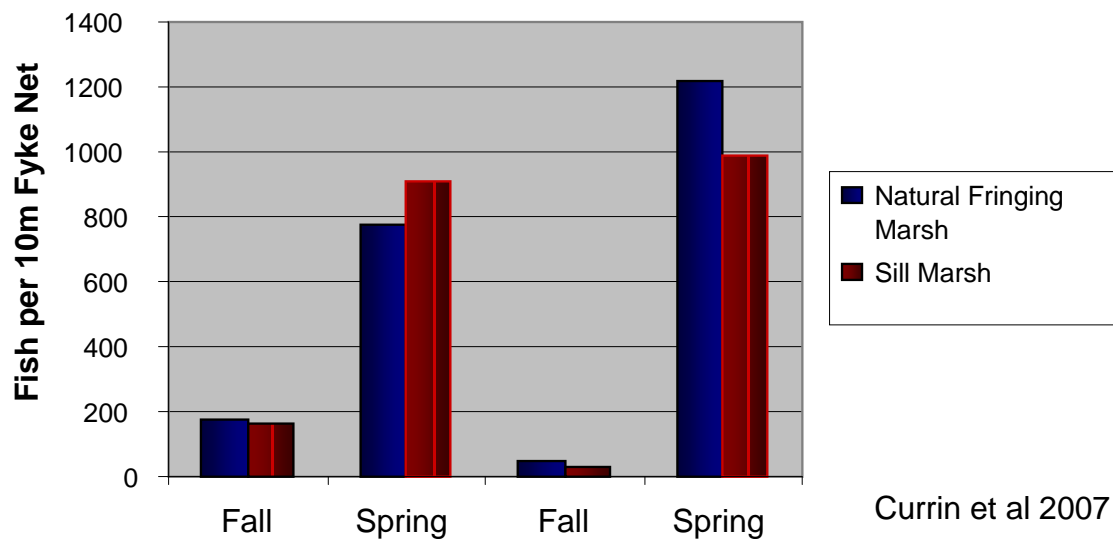
# Does presence of offshore oyster reef affect marsh sediment accretion rates?



*Accretion rates all dates  
Oyster > None  $p=.0011$*

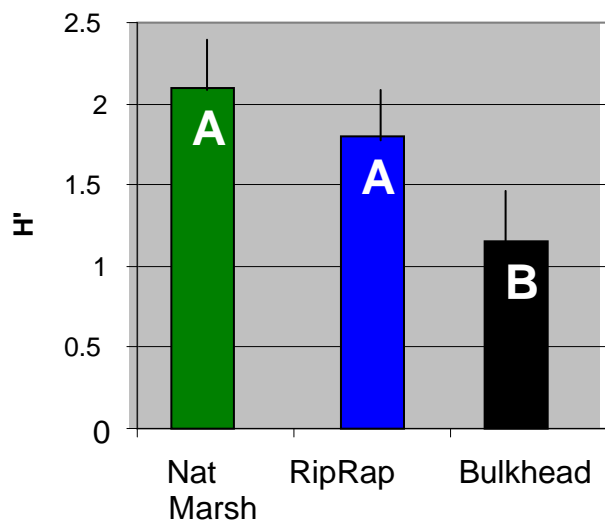
# Shoreline Stabilization and Fishery Utilization of marshes

## Fish Utilization of Fringing Marshes

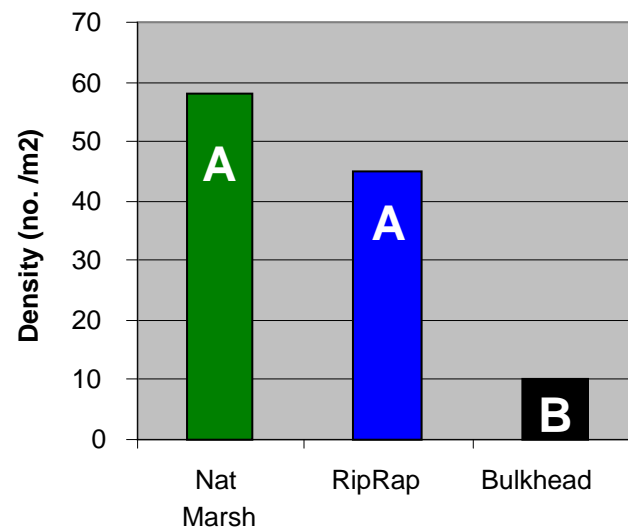


The fish are there...  
the food may not be

## Infauna Diversity

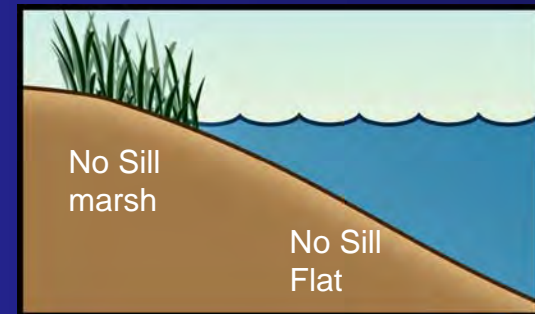
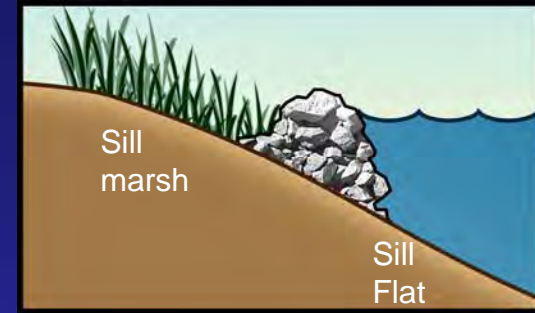
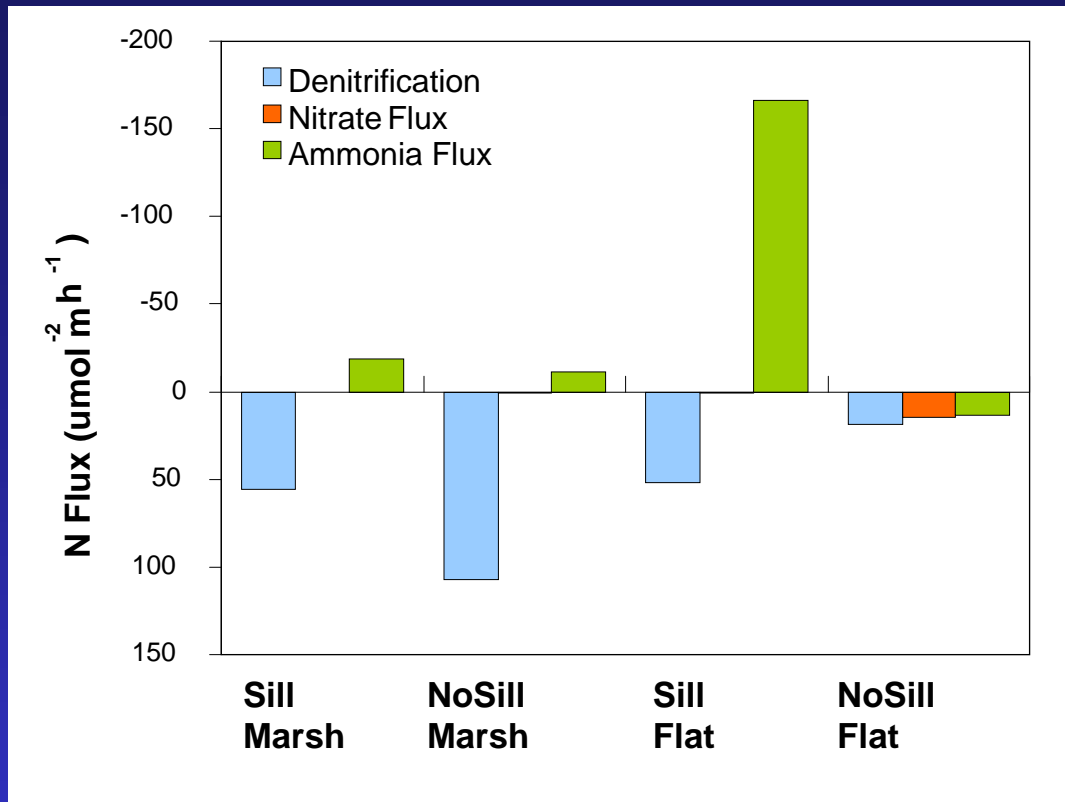


## Infauna abundance





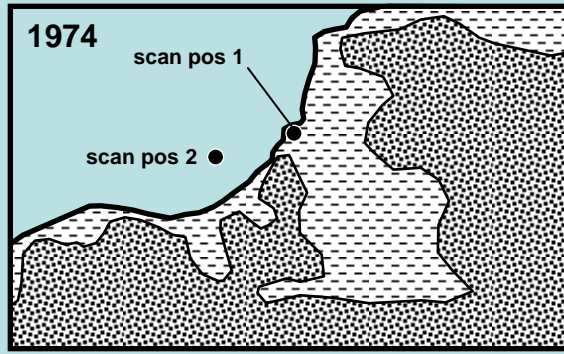
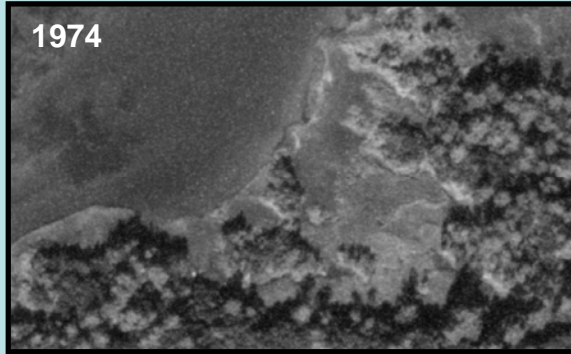
# Denitrification and DIN flux in natural and stabilized fringing marshes



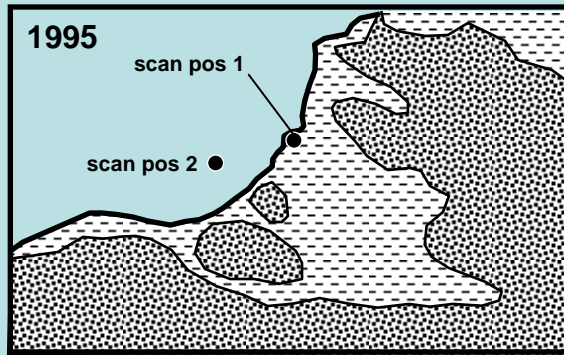
M.Piebler, UNC-Chapel Hill IMS

Presence of sills alters biogeochemistry and Nitrogen cycling rates in intertidal habitats

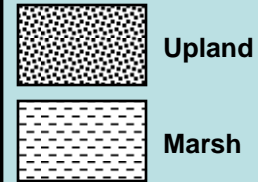
# Shoreline erosion adjacent to offshore stone sill



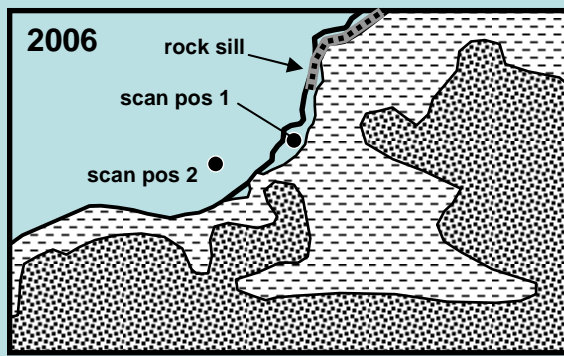
1974-1995 virtually no change in shoreline



20 m



● SET location



Post sill-construction significant erosion to adjacent shoreline

From R. Mattheus, UNC IMS

Estuarine shoreline mapping & determination of historic erosion rate being done on the New River Estuary (Camp Lejeune)

# Offshore Sills or breakwaters- a better solution?

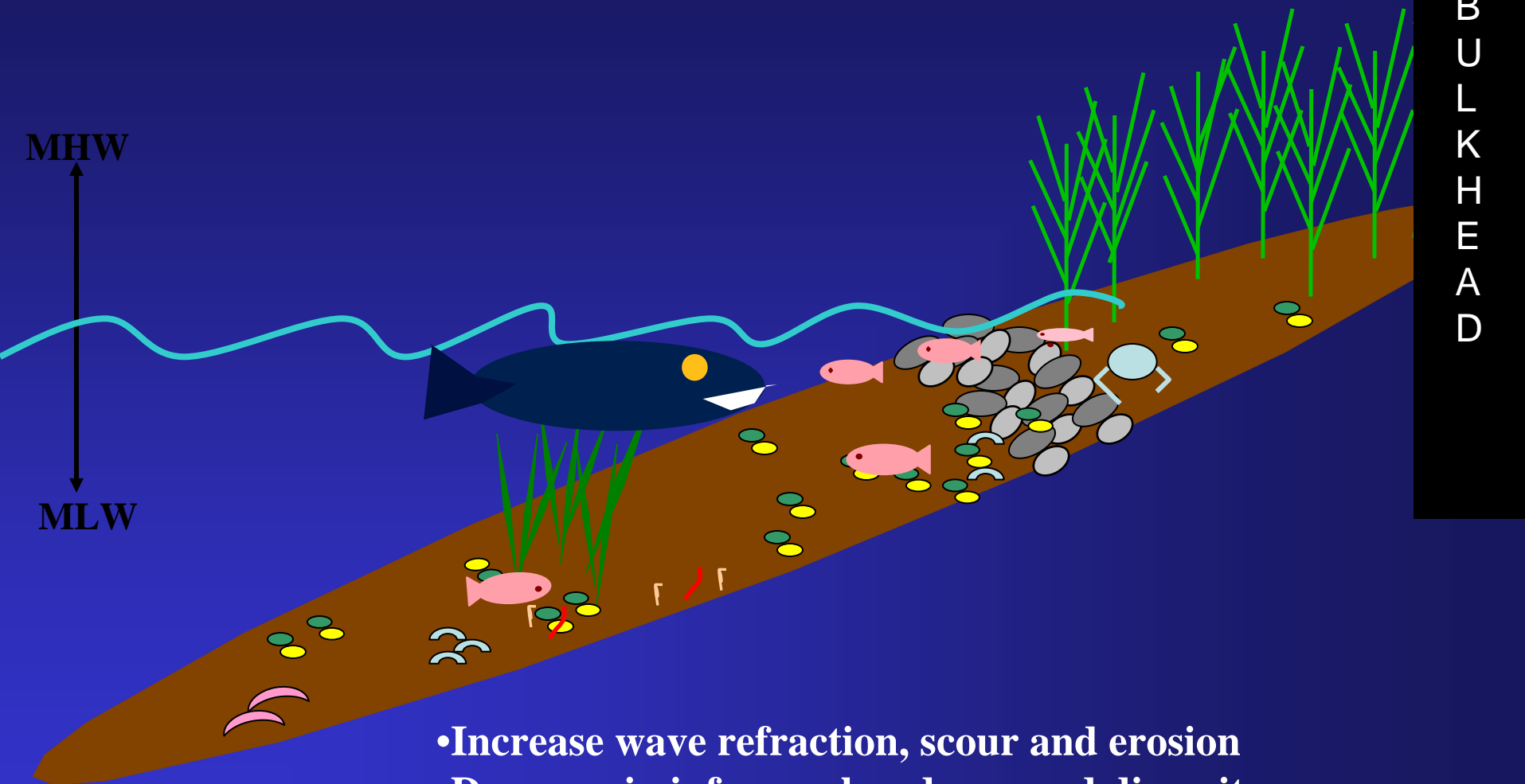
Preserves marsh habitat along shoreline



**Design carefully and avoid overbuilding**

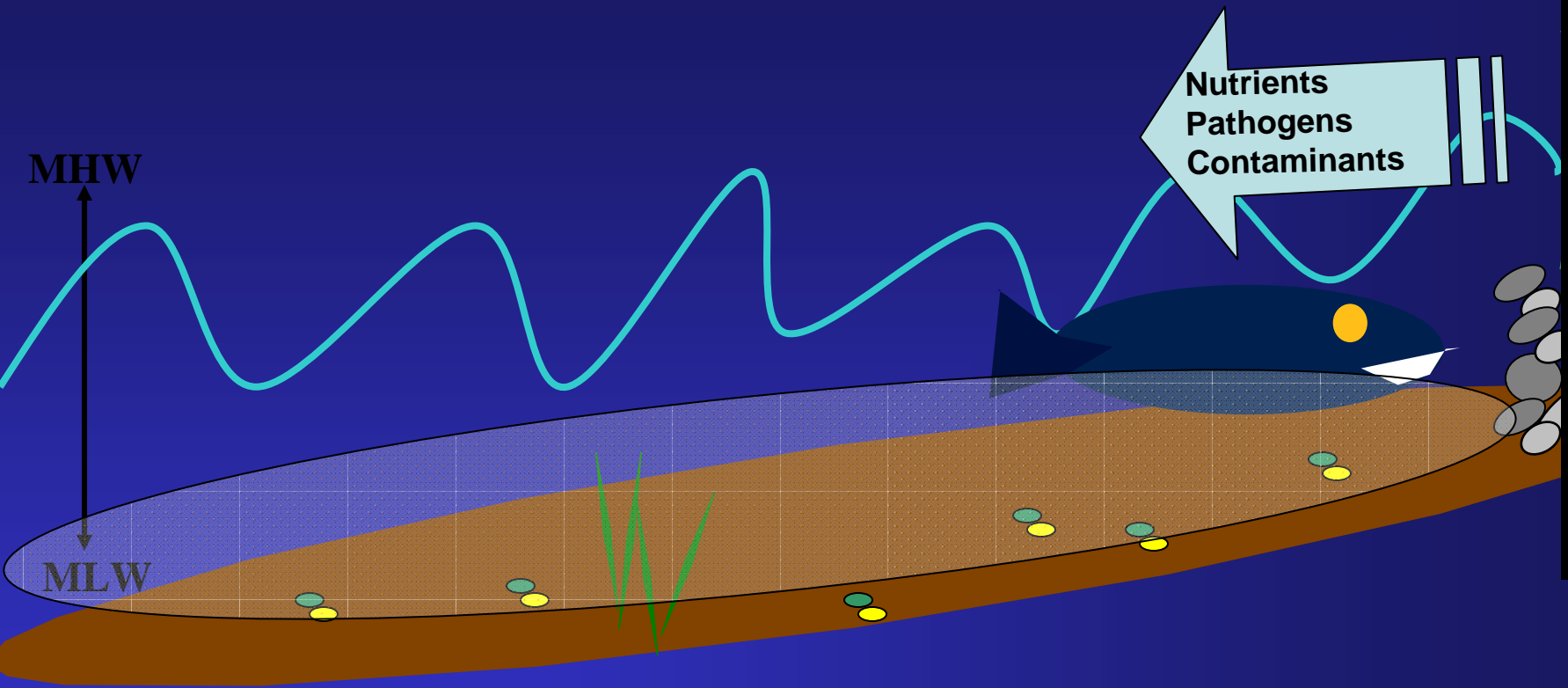


# What impact do vertical bulkheads have on the ecosystem?



- Increase wave refraction, scour and erosion
- Decrease in infauna abundance and diversity
- Wood preservatives can poison animal communities (sub-lethal effects)
- Artificial substrate supports invasive species

# What impact do vertical bulkheads have on the ecosystem?



**Loss of intertidal habitats results in loss of ecosystem services**

- **Scour deepens bottom**
- **Results in loss of plant communities and shallow-water refuge**
- **Increased wave energy increases sediment resuspension, which decreases light reaching bottom, reducing productivity**

BUT>>>Little quantitative field data collected from bulkheads at this point...

## Summary of Ecosystem Services Research

- Fish occupy marshes behind sills in numbers similar to fringing marshes
- Lower edge of natural fringing marshes losing elevation, upper edges “keeping up” with RSLR in NC
- Loss in elevation at natural edge results in fewer, taller plants, little change in edge location  
(*Spartina alterniflora* growing from -0.45 to + 0.60 MSL)
- Marsh surface behind sills increasing 2-3x RSLR
- Greater accretion during summer-fall than winter-spring in upper natural marshes
- Sills make great sediment traps, but....reduction in *S. alterniflora* with increasing elevation at upper edge of distribution. Fish and infauna abundance decreases with elevation increase.
- Marshes adjacent to intertidal oyster reefs have higher accretion rates (positive elevation change) compared to fringing marshes without oyster reefs
- Rates of Nitrogen cycling lower in intertidal sediments adjacent to sills

