Shoreline Seining to Student Training: Shoreline development effects on near-shore communities in Chesapeake Bay

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Brown Bag Seminar; NOAA Central Library

Thursday, August 15, 2013

Photo credit: www.conchology.be

Outline

Photo credit: Jenny Dreyer, VIMS

- Shoreline Seining:
  - BACI study of near-shore communities
  - Findings
  - Future Work
- Student Training:
  - GK-12 Fellowship
  - Who’s a Scientist Project

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Estuarine Systems

Photo credit: Jenny Dreyer, VIMS

Tidal marshes:

- Produce detritus, improve water quality (Valiela 1995, Bertness 2007; Perry and Atkinson 2009)
- Nursery habitat
  - 95% of VA's annual fish harvest (Wass and Wright 1969; Perry and Atkinson 2009; Lipcius et al. 2005)
- Buffer Shorelines
  - Dissipate ≥ 50% wave energy in 2.5 m (Knutson et al. 1982)

Benthic Infauna:

- Highly productive
  - 194,000 metric tons C yr^{-1} (Diaz and Schaffner 1990)
  - Demersal nekton: $39.8 million (Gillett and Schaffner 2009)
- Improve water quality
  - Biodeposition (Graf and Rosenberg 1977)
  - Nutrient removal (Nixon and Buckley 2002)

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detritus

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deposition

Photo credit: www.conchology.be

Shoreline Development as a Stressor

Photo credit: Jenny Dreyer, VIMS

Developed structures interrupt marsh processes:

- Nutrient removal (Kemp et al. 2005)
- Sediment accumulation (Snelgrove 2000)
- Valuable habitat (Jennings et al. 1999, Bilkovic and Roggero 2008)
- Detritus production (Burkholder and Bornside 1957, Teal 1962)
- Dissipation of wave energy (Bendell 2006, Perry and Atkinson 2009)

Photo credit: www.conchology.be

Shoreline Development as a Stressor

Photo credit: Jenny Dreyer, VIMS

Boat Docks:

↓ light availability to seagrass beds (Burdick and Short 1999)

Bulkheads and Riprap (Ahn and Choi 1998, Douglass and Pickel 1999, Burcharth and Hughes 2002, Bendel 2006):

↑
- wave reflection
- Turbulence
- sediment erosion
- grain size
- Intertidal habitat removal

↓ Infaunal density, biomass and diversity adjacent to hardened shorelines.

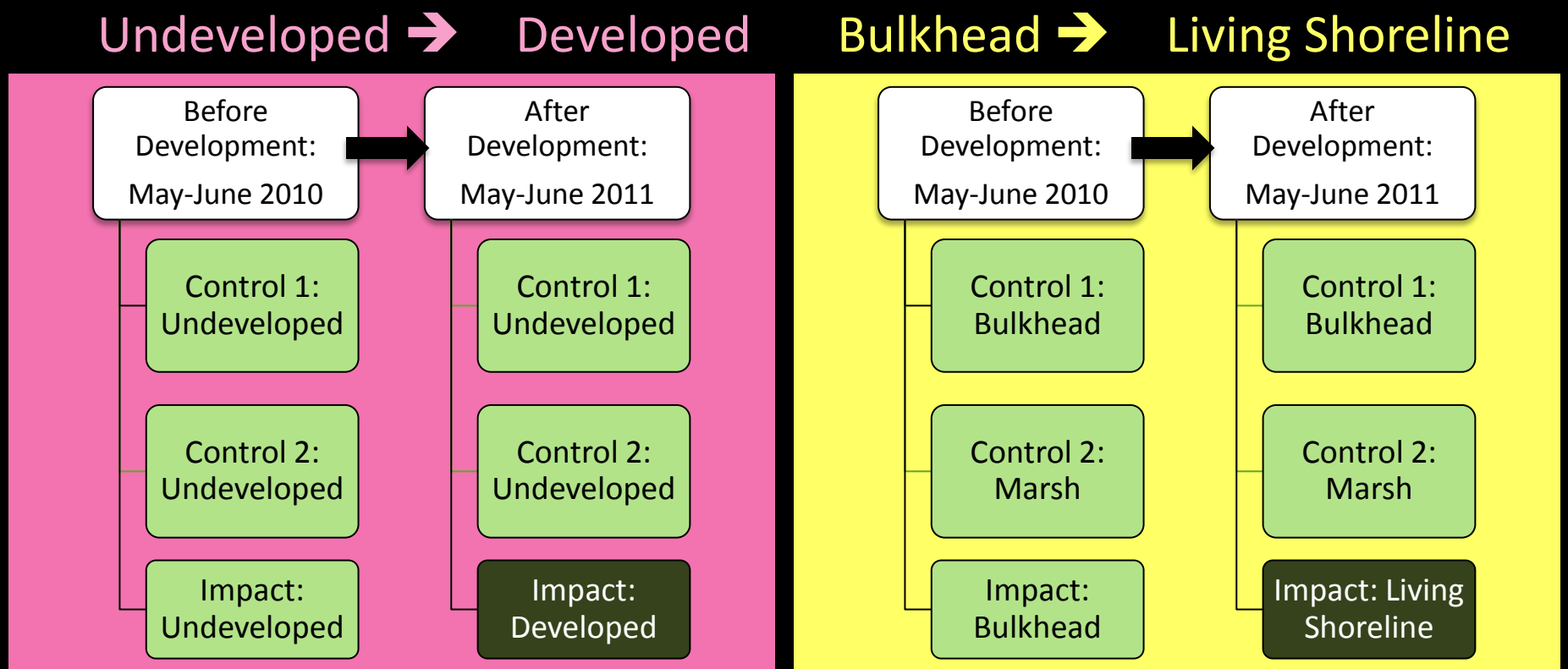
Living Shorelines

- Erosion protection with natural elements (Erdle et al. 2006)

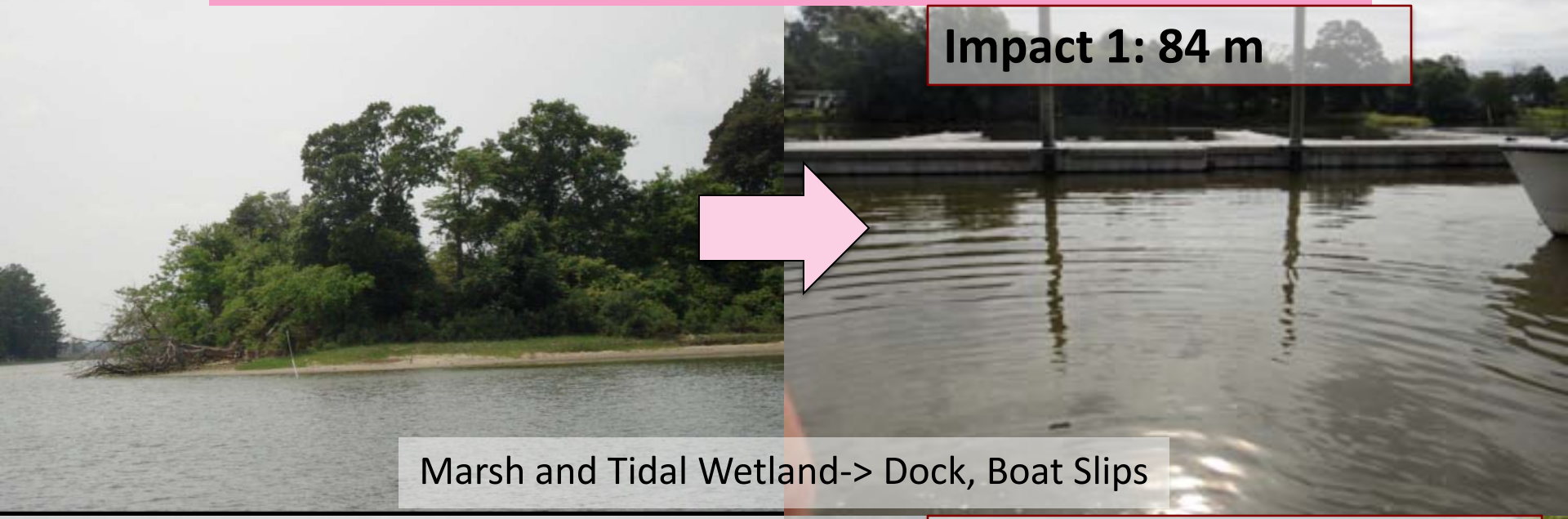
- Hybrid shorelines: incorporate natural and non-natural elements: rock, sand fill (Duhring 2006, Smith 2006)
- Improve protection capability over time (Smith 2006)

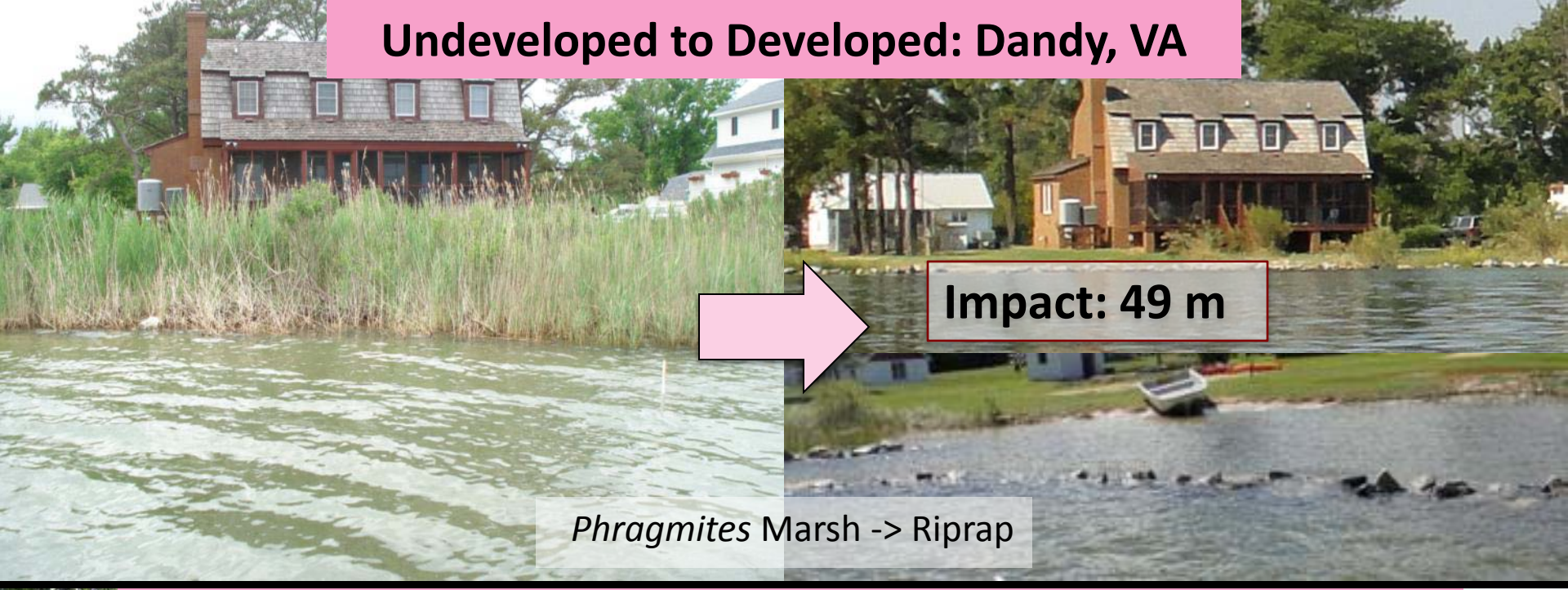
Before-After Control-Impact Study Objective

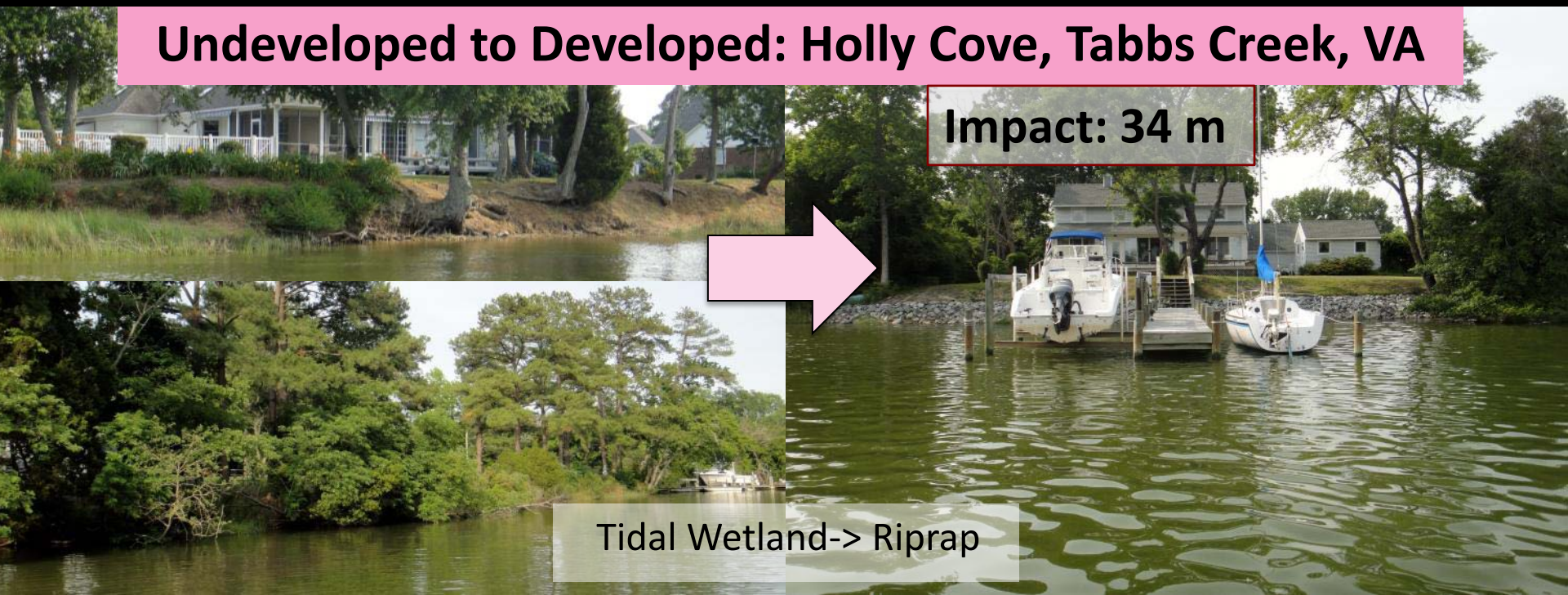
- Examine effects of shoreline **modification** on near-shore communities one year after modification
- Account for interannual variability with multiple controls (Underwood 1992, 1994)
- Applicable to the study of planned disturbances



Undeveloped to Developed: Timberneck Creek, VA




Undeveloped to Developed: Dandy, VA
Impact: 49 m
Phragmites Marsh -> Riprap


Undeveloped to Developed: Holly Cove, Tabbs Creek, VA
Impact: 34 m
Tidal Wetland-> Riprap

Developed to Living Shoreline: Windy Hill, Corsica River, MD

BACI Study

What is collected at each site?

- Infaunal Samples
  - Suction samples: 0.11 m^2 to 20-30 cm; 3-mm sieve
  - Hand-held cores: 0.01 m^2 to 15 cm; 500-µm sieve
  - WQ parameters (Salinity), Sediment samples (% Coarse)
- Crab scrapes: 20 m tow × ~1 m in width
- Seines: 15.2 m net

Photo courtesy of Rochelle Seitz

Data Analysis

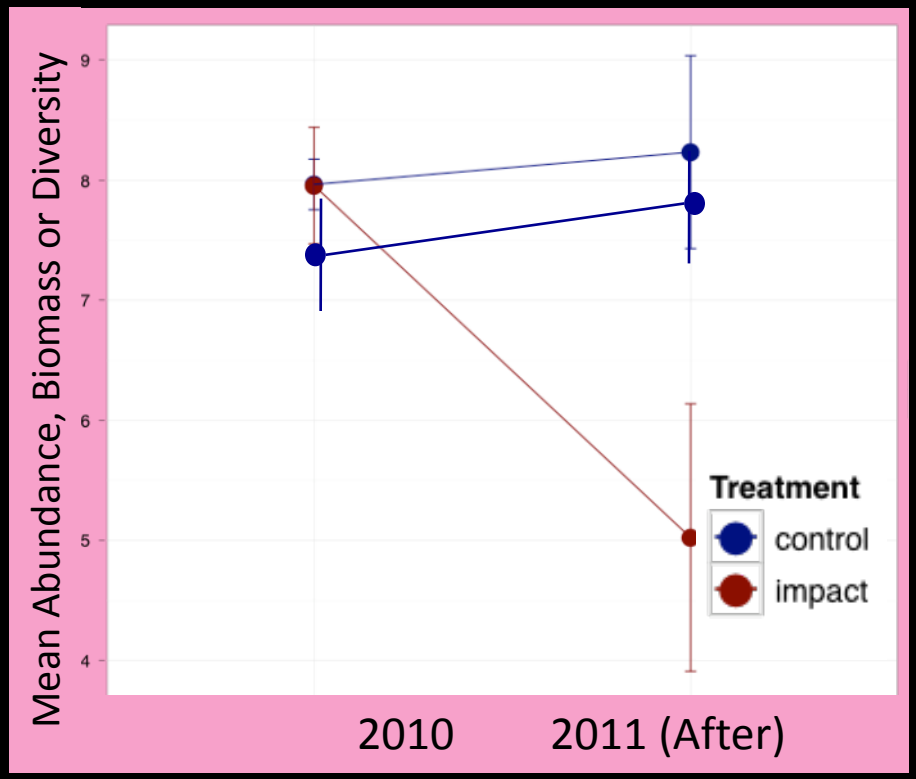
Compared linear models (of density, biomass, and diversity) with AIC

- combinations of predictor variables

Analyzed model fit with R^2

Predictor Variables (Independent):	• Year (before or after) *Interactions* • Treatment (control, impact shoreline) • Sediment Grain Size • Salinity

Hypotheses



Undeveloped ➔ Developed

Timberneck | Dandy | Holly Cove

at impact shorelines:

Abundance: Infauna, Crabs

Biomass: Infauna

Shannon Diversity: Infauna

Developed ➔ Living Shoreline

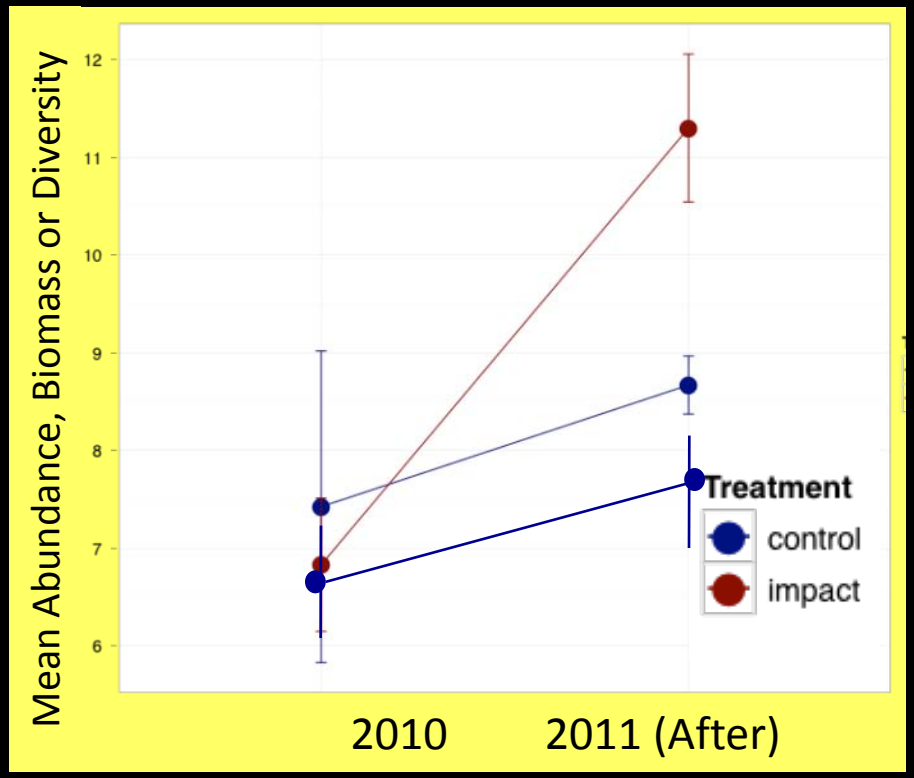
Windy Hill, MD

at impact shorelines:

Abundance: Infauna, Crabs

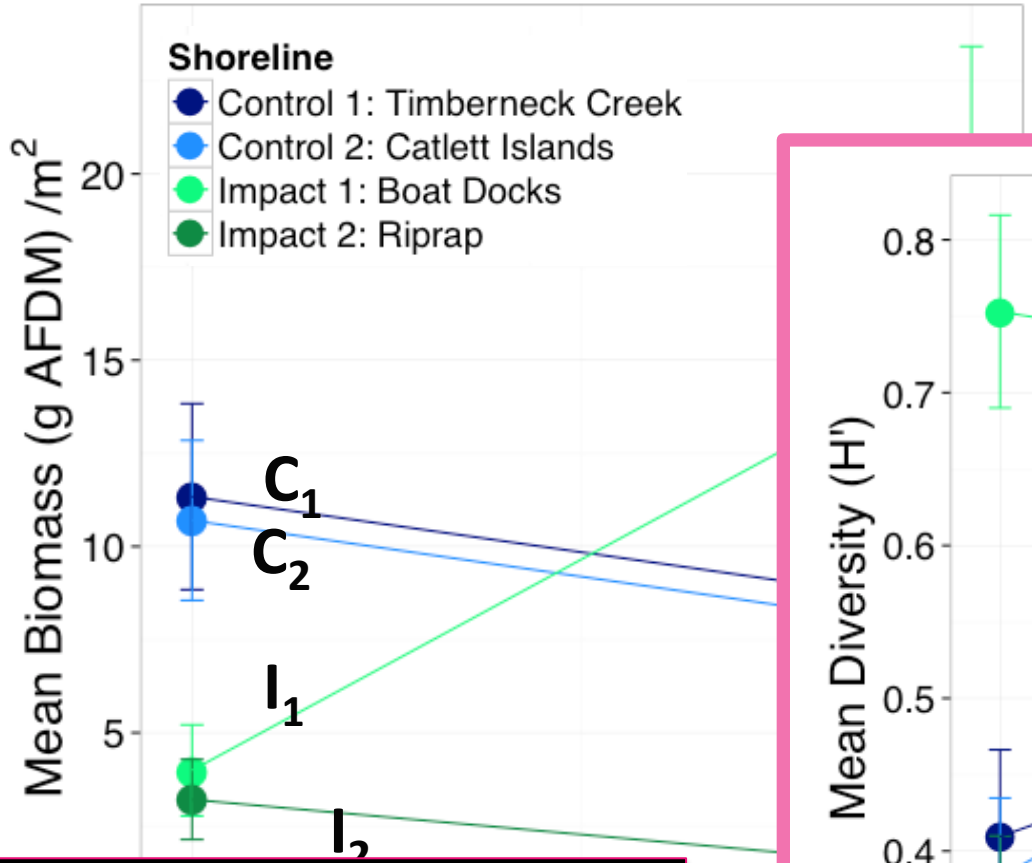
Biomass: Infauna

Shannon Diversity: Infauna

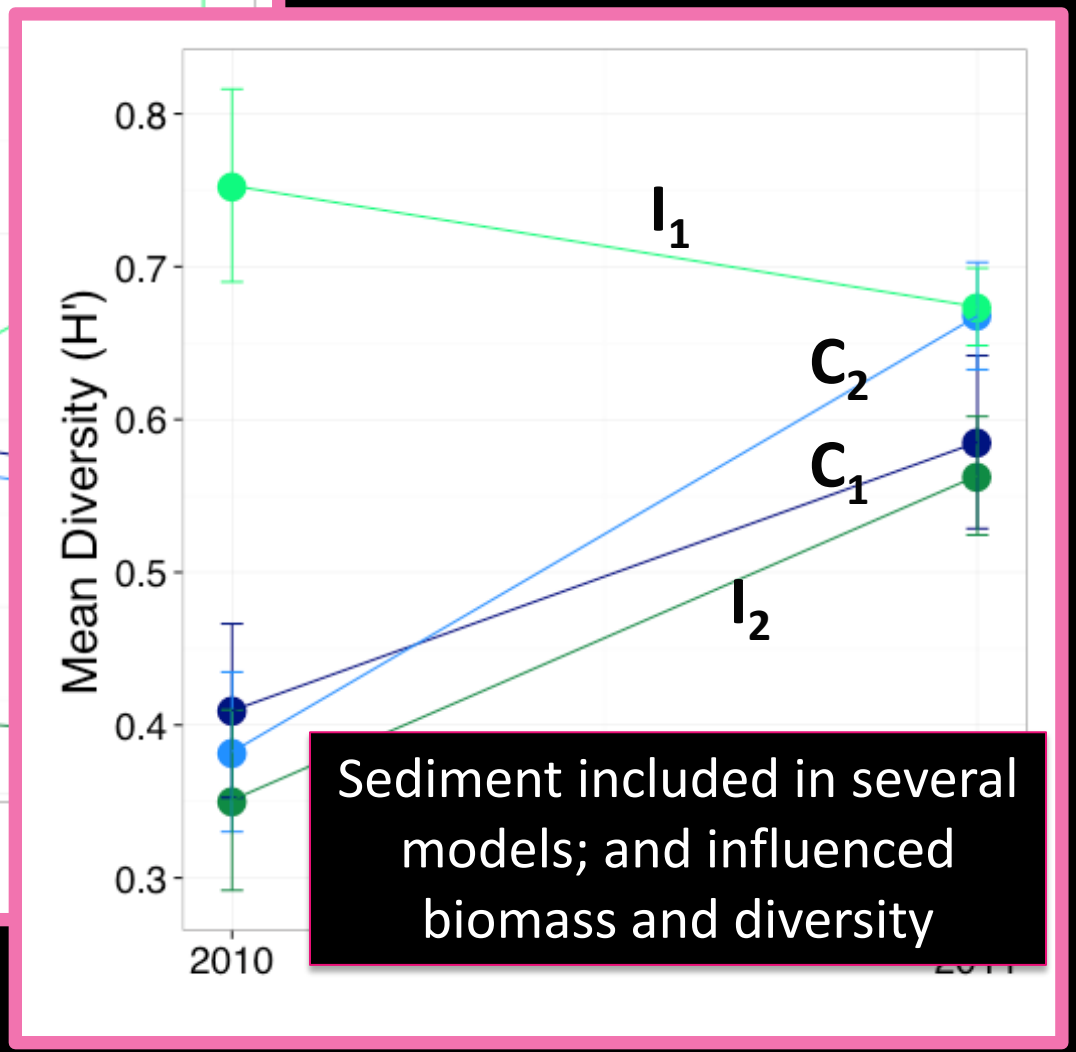


Results: Timberneck 3-mm Biomass, Diversity

Undeveloped to Boat Docks, Riprap



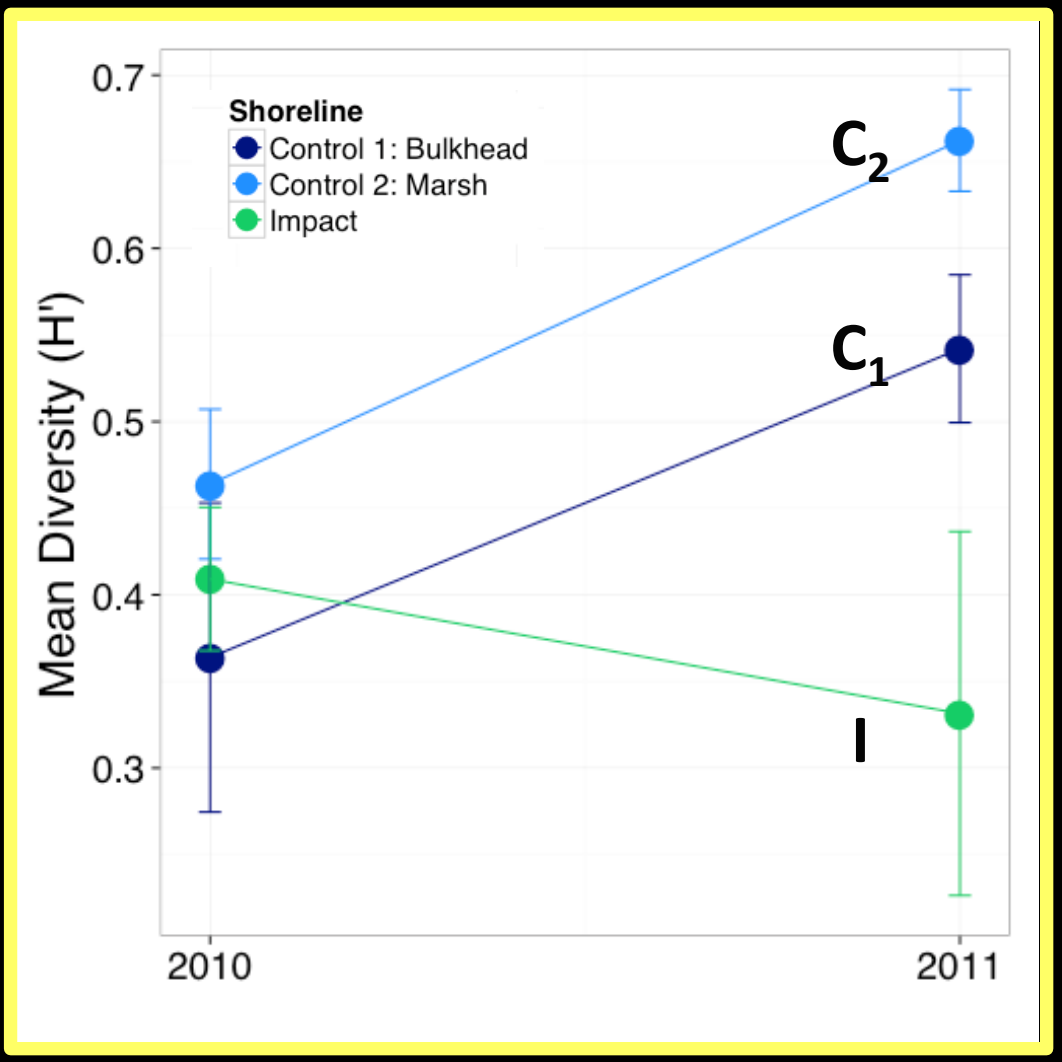
Y × T interactions for both biomass and diversity



Sediment included in several models; and influenced biomass and diversity

Results: Windy Hill 3-mm Diversity

Bulkhead to Living Shoreline

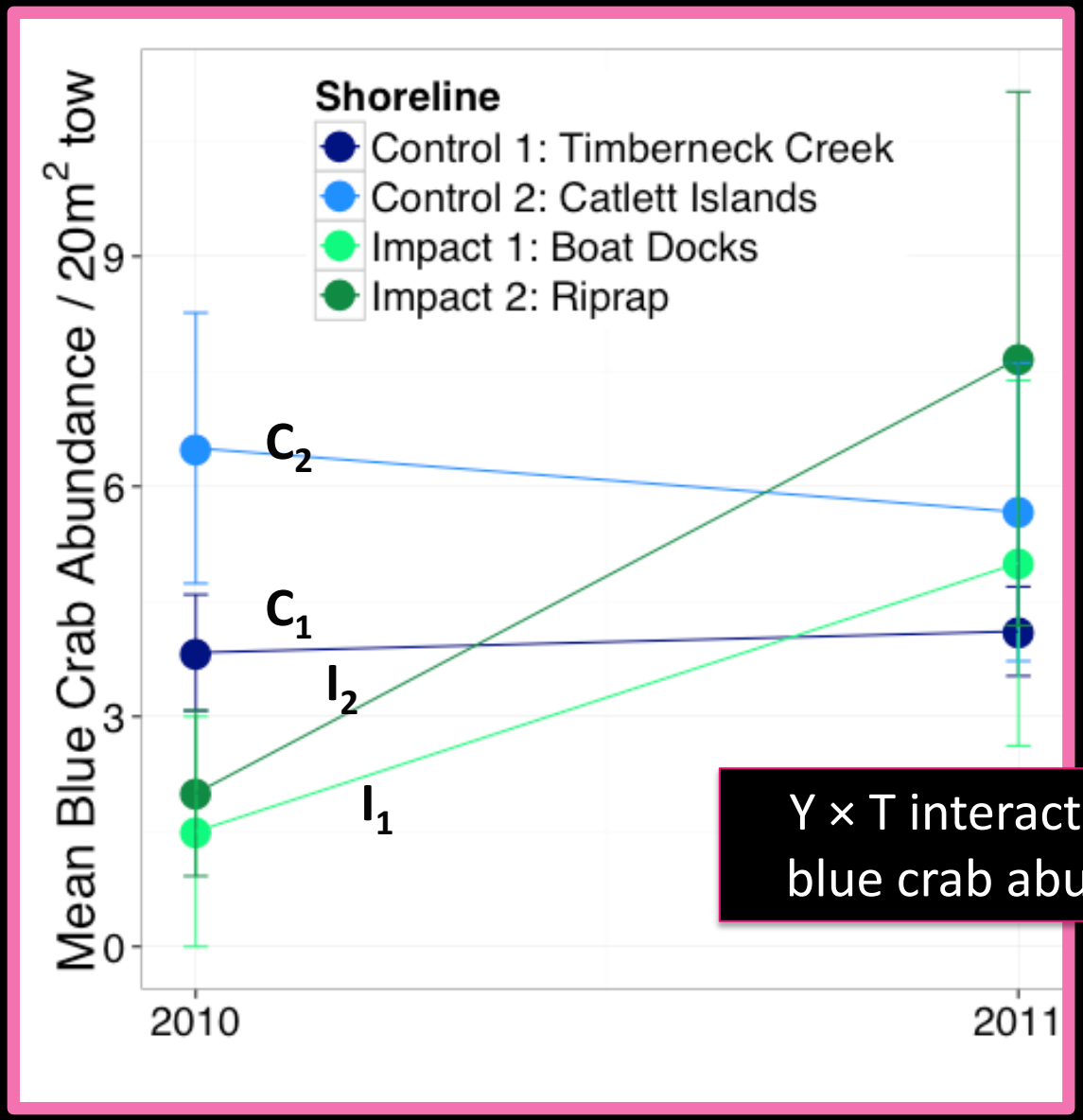


Y × T interactions for diversity

Sediment included in one likely model, but did not influence diversity

Results: Timberneck Blue Crab Abundance

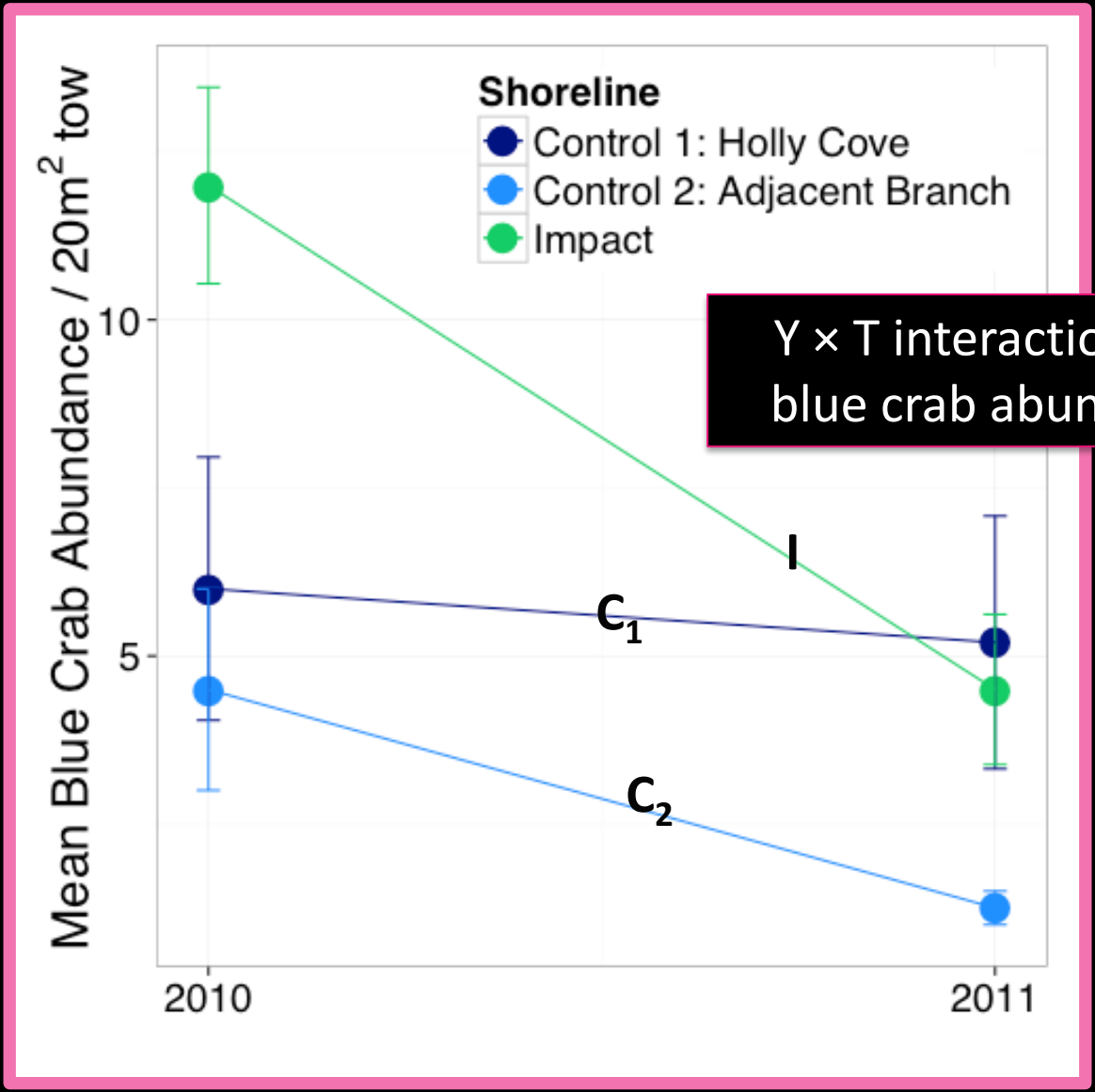
Undeveloped to Boat Docks, Riprap



Y × T interactions for blue crab abundance

Results: Holly Cove Blue Crab Abundance

Undeveloped to Riprap



Y × T interactions for blue crab abundance

Significant Y x T interaction (effect of shoreline modification)
↑: Positive effect
↓: Negative effect
1 or 2: Which impact (TIM only)

	Infauna: 3-mm			Blue Crabs
Site	Dens	Biom	Div	Abund
TIM	x	Boat Docks ↑ I1	↓ I1	Docks, Riprap ↑I1 ↑I2
DAN	x	x	x	x
HOL	x	x	x	Riprap ↓
WIN	x	x	↓ Living Shoreline	x

Bulk. to LS Undev. To Dev.

Benthic Communities are sensitive to shoreline modification, though effects are variable

3-mm infauna: significant impacts on biomass and diversity

Blue crabs: significant impacts on abundance

Infauna

Capitellids

	Infauna: 3-mm			Blue Crabs
Site	Dens	Biom	Div	Abund
TIM	x	Boat Docks ↑ I1	↓ I1	↑I1 ↑I2
DAN	x	x	x	x
HOL	x	x	x	↓ I
WIN	x	x	Living Shoreline ↓ I	x

Undev. To Dev.

Bulk. to LS

Capitellids

Spionids

Neanthes

Corophium

Densities of opportunistic species quickly increase:

- **Sediment Disturbance**(Rhoads et al. 1978, Zajac and Whitlatch 1982, Commito 1995)
- **Timberneck**

Biomass and diversity reduced in favor of opportunistic species

- **Habitat Destruction** (Thrush et al. 2001)
- **Windy Hill (Disturbance)**

Macoma balthica

Macoma mitchelli

Holland et al. 1987

Tagelus plebeius

Clam photos: www.conchology.be, G. & Ph. Poppe.

Mulinia lateralis

Rhoads et al. 1978

Gemma gemma

F. Maltagliati Univ. of Pisa

Commito et al. 1995

Neanthes succinea

Photo credit: Jenny Dreyer, VIMS.

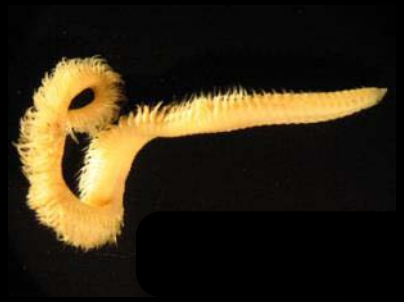
Holland 1985

Clymenella torquata

Photo credit: Trampus Goodman, Univ British Columbia.

Leitoscoloplos spp.

http://www.macrofauna.cl/fi/Leitoscoloplos_kerguelensis.html



Capitellidae

USGS Non-indigenous Aquatic Spp Database

Rhoads et al. 1978

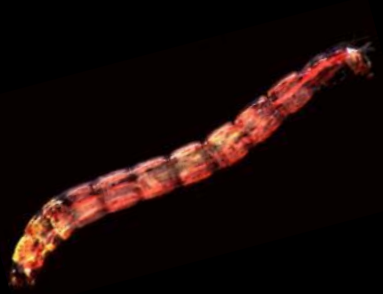
Spionidae

SERTC: http://www.dnr.sc.gov/marine/sertc/

Rhoads et al. 1978

Chironomidae

www.flyfishingreporter.com



Leptocheirus plumulosus

http://www.eeusa.com/?p=18

Santos and Simon 1980

Corophium spp.

Photo Credit: Dean Janiak, Flickr.com

Santos and Simon 1980

Blue Crabs

Crabs associated with structure and complexity
(Lipcius et al. 2007)

	Infauna: 3-mm			Blue Crabs
Site	Dens	Biom	Div	Abund
TIM	x	Boat Docks ↑ I1	↓ I1	Docks, Riprap ↑I1 ↑I2
DAN	x	x	x	x
HOL	x	x	x	Riprap ↓ I
WIN	x	x	Living Shoreline ↓ I	x

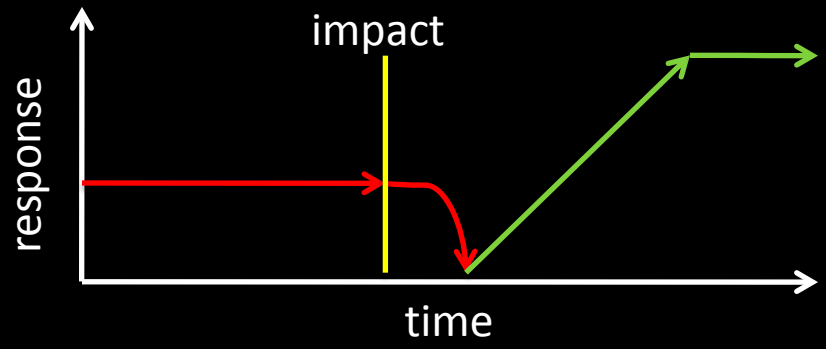
Undev. To Dev.

Bulk. to LS

- **Increased Complexity**
  - Docks on soft bottom
  - Riprap replaced beach
- Response to infaunal biomass
- Timberneck

- **Decreased Complexity**
  - Riprap replaced tidal wetland and marsh
- Holly Cove

Windy Hill, 2012



BACI Discussion

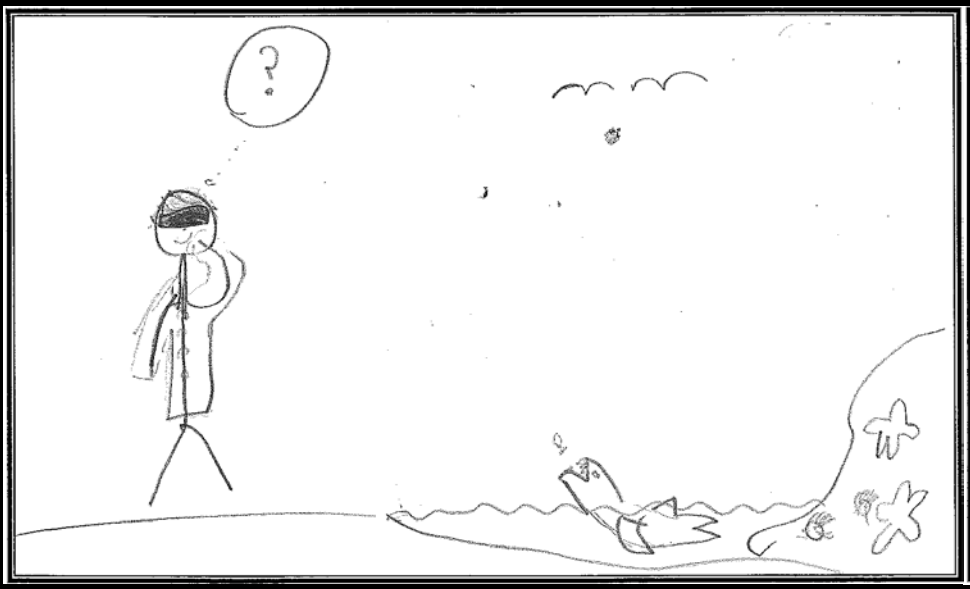
- Infauna responded to shoreline change after one year
  - Opportunistic species drive community responses
  - Recovery may be incomplete, or responses may continue as a result of habitat change
- Complex responses driven by
  - Habitat (alteration, shoreline complexity and structure)
  - Sediment alteration
- Monitor shoreline modifications over time

GK-12 PERFECT Program

Who's A Scientist?

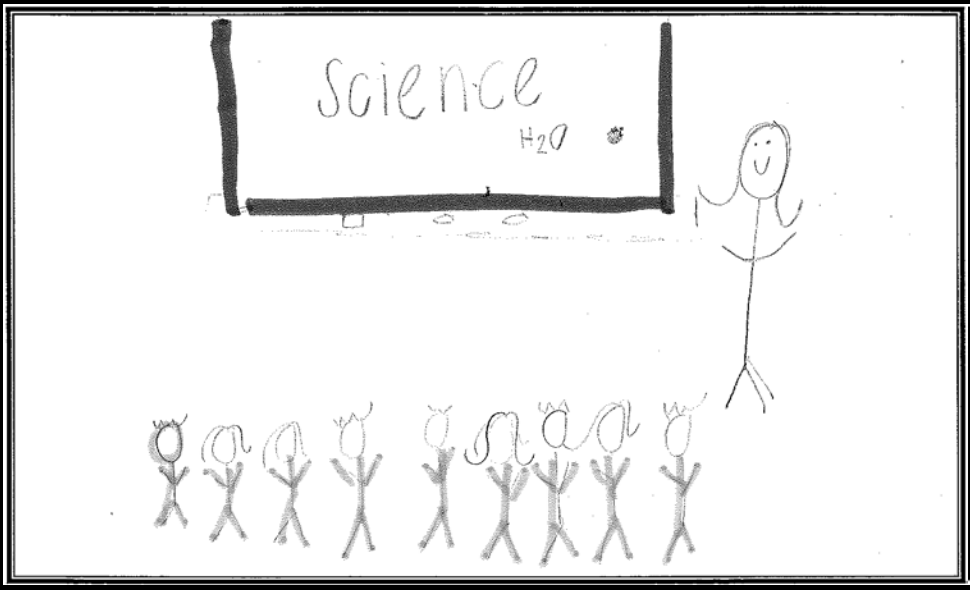
- Examine students' perceptions of science
  - Draw yourself as a scientist
  - Specific Questions about your ideal career and your drawing as a scientist
  - Three words that come to mind when you think "scientist"
- Classrooms with and without GK-12 Fellows
  - Repeated at beginning and end of school years

Symbols of Research / Knowledge



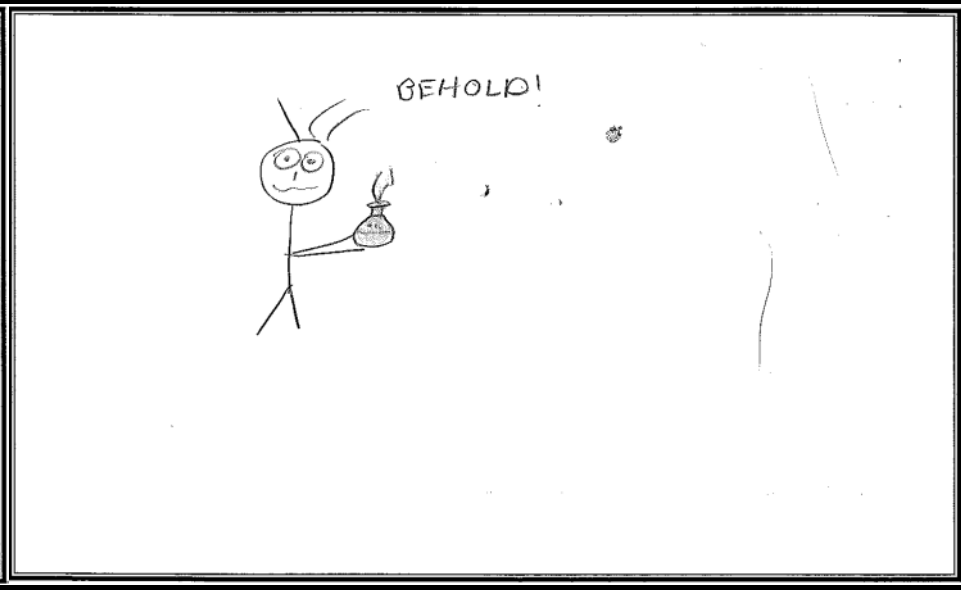
Symbols of Technology / Research

Locations / Applications of science

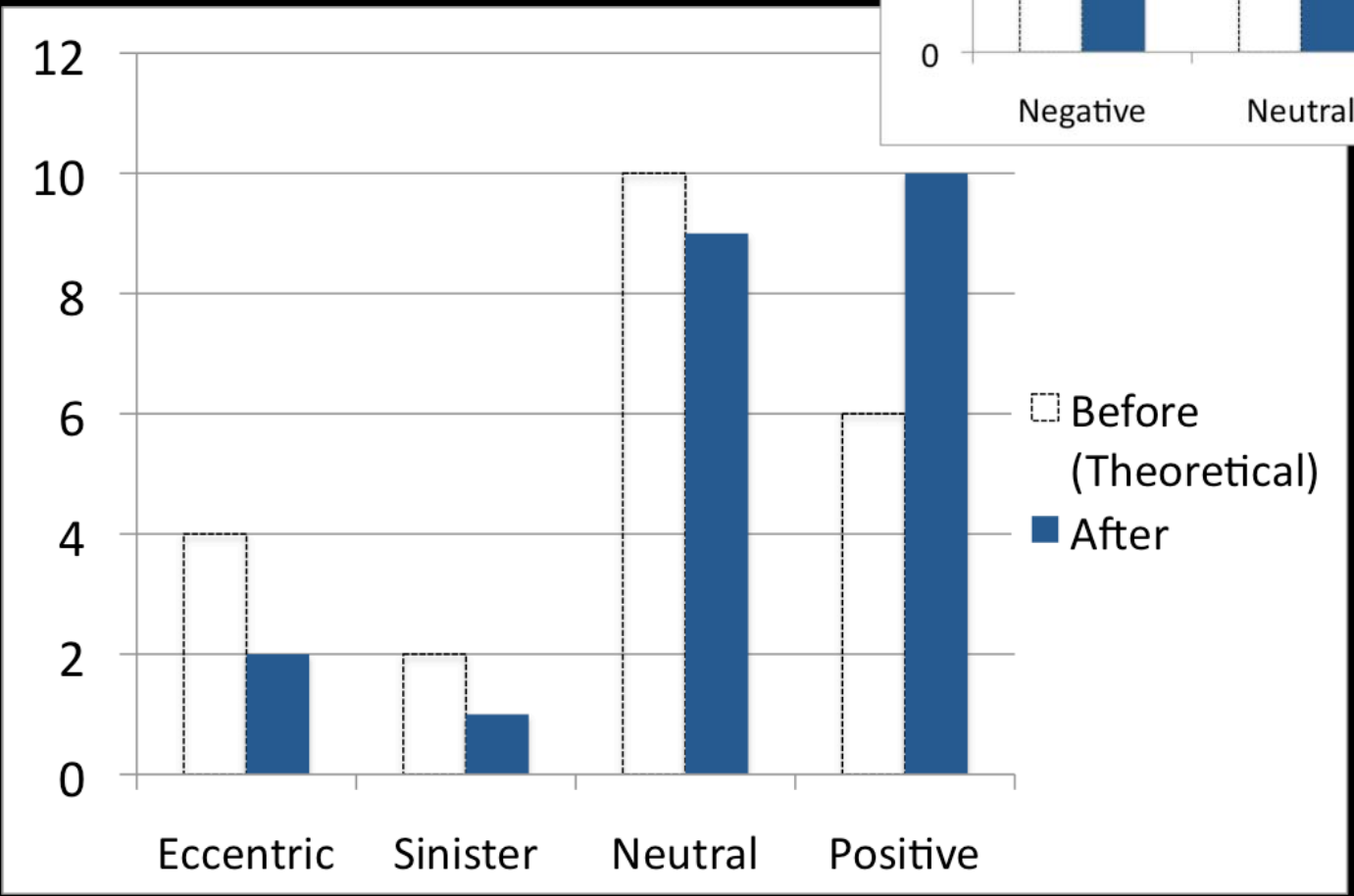


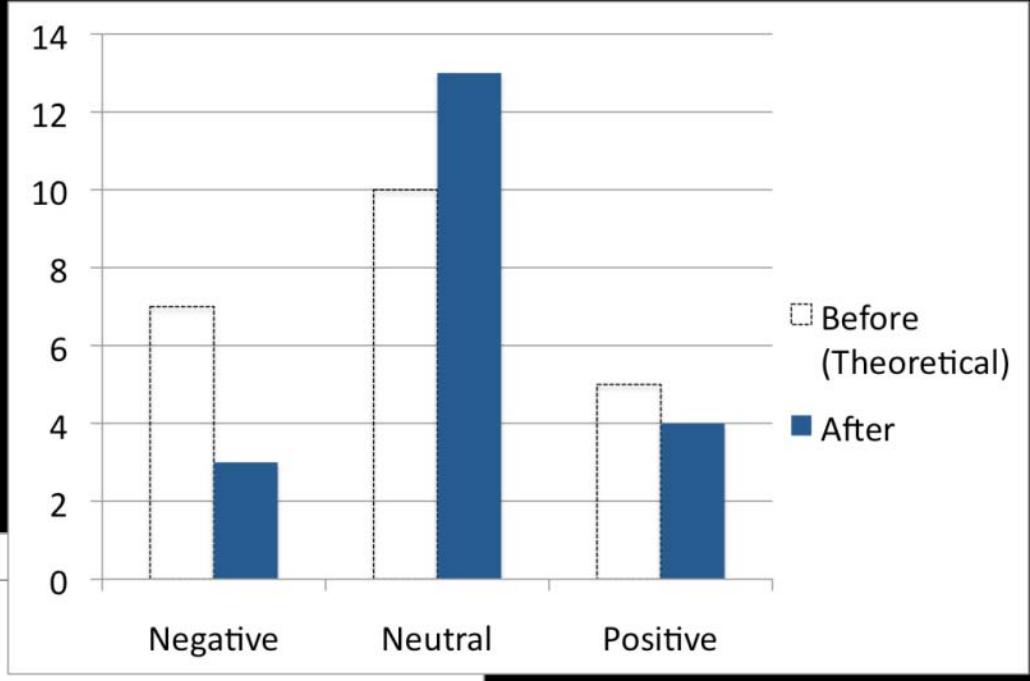
Personal characteristics:

Eccentric / Sinister / Neutral / Positive



Pictures





Words

Preliminary Results: 9th and 10th grade biology

53% of students did not correctly classify their ideal careers as scientific

- Narrow concept of what science "is" (thinking)
- Dislike class (memorizing historical results), but like concepts / applications
- Limited career Knowledge

Job	Why student does not want to be a scientist
Obstetrician	Science does not interest me
Veterinarian	"I just want to be a veterinarian, other sciences don't interest me"
Sports Medicine	"I'm not interested in science"
Psychologist	not specified
Physical Therapist	"too much thinking"
"Something with Computers"	Science does not interest me"

Acknowledgments

Adivsor: Rochelle Seitz

Committee: Emmett Duffy, Carl Friedrichs and Linda Schaffner

WASP Collaborators: Sam Lake, Christie Pondell, Jenna Spackeen, Lindsey Kraatz, Stephanie Salisbury

Funding: NOAA, VIMS Graduate Program, W&M Marine Science Minor, NSF GK-12 Program at VIMS

Questions?