

# An example of a living shoreline installment at Stratford Point: Lessons learned after one year.



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# Urban Estuaries and Coasts

Providence, RI—

Hartford, CT—

Poughkeepsie, NY—

fog—

Long Island  
Sound

New York, NY—

Atlantic Ocean



# Human Population Domination

**Human and animal waste  
& CO<sub>2</sub> and atmospheric pollution**

**Nitrogen & Phosphorous fertilization**

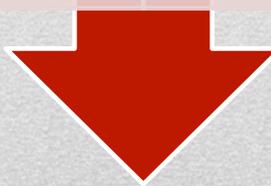


## Algal and bacterial growth

Wallace et al. 2014. ECSS

**Hypoxia**

**Acidification**



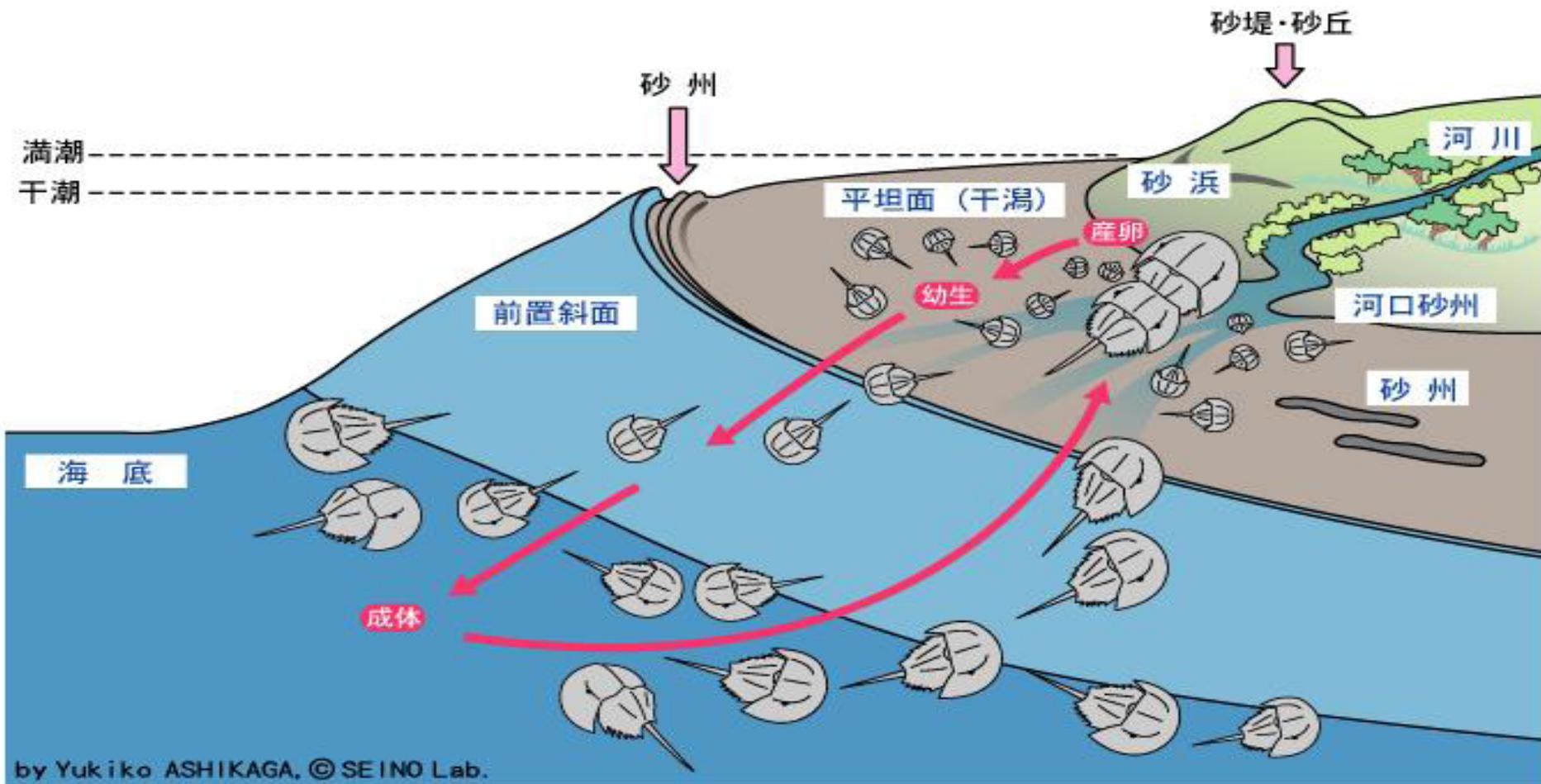
## Heavy metals, pesticides, light pollution

**Global Climate Change and Sea  
Level Rise**

**Warming, increases in storm  
frequency and intensity**



# Armoring the shoreline: Short-term solution and Shortsighted!





7/2/2014

Gerritsen Beach

Opal Ct  
Post Ct  
Ivan Ct  
Hyman Ct  
Lois Ave  
Frank Ct

Knapp St  
Brigham St  
Bragg St  
Leif Ericson Dr  
Shore Pkwy  
Plumb 3rd St  
Plumb 2nd St

Belt Pkwy

Seawall Ave

Image © 2015 DigitalGlobe

Google earth

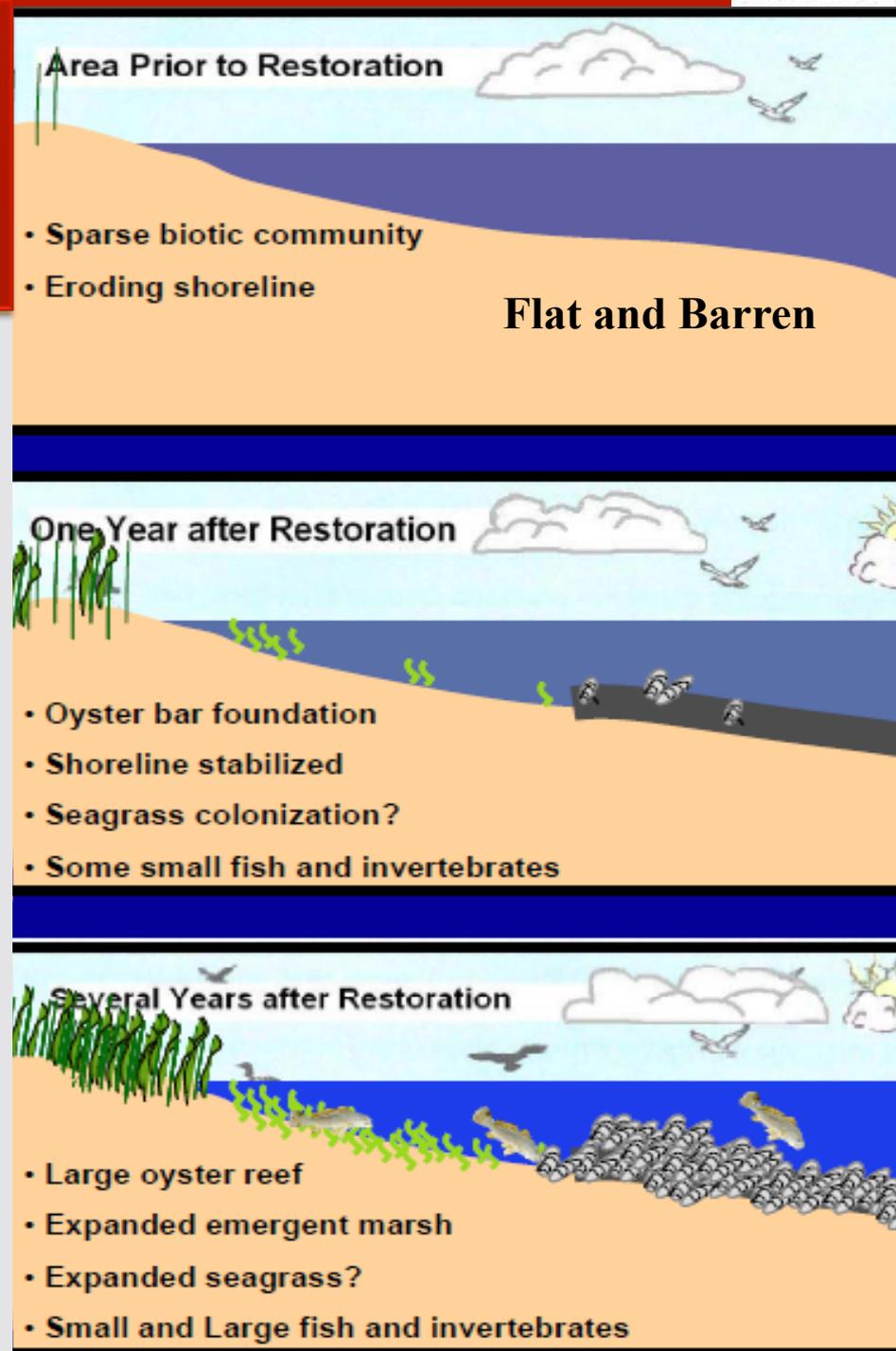
# One Possible Solution: Interconnected habitats are needed to repair structure and function of the Urban Estuary.

## • Stabilize shoreline:

- Dampen wave action
- Trap sediments
- Cap heavy metals
- Provide food, refuge, and nursery area for fish and shellfish
- Remove suspended sediments and phytoplankton
- Sequester excess nutrients

## • Stabilize upland:

- Restore forest-shrub-grass matrix



# The Experimental Restoration Site, Stratford Pt.



Wheeler Marsh,  
CTDEEP

HOUSATONIC RIVER

Stewart B. McKinney NWR  
Great Meadows Marsh

Silver Sands State Park

Charles Island

Milford Point

Short Beach Park

Stratford Point

Long Beach

# Living Shoreline Design (Engineers and Biologists)

The design was based on models of currents and wave action.  
This is an experiment and can be modified (adaptive management).

- Shoreline stabilization
- Habitat enhancement
- Sediment deposition from Housatonic
- Nutrient Sequestration
- Water filtration by plants/shellfish



# Lesson 1: The Sequence of habitat installment matters!

## Habitat restoration of Coastal Dune

- **December, 2011**
  - **Dune Construction:**
    - **Geotubes - underlying soft erosion control structures**
    - **Prevent further loss of upland**
    - **Beach Grass planting**







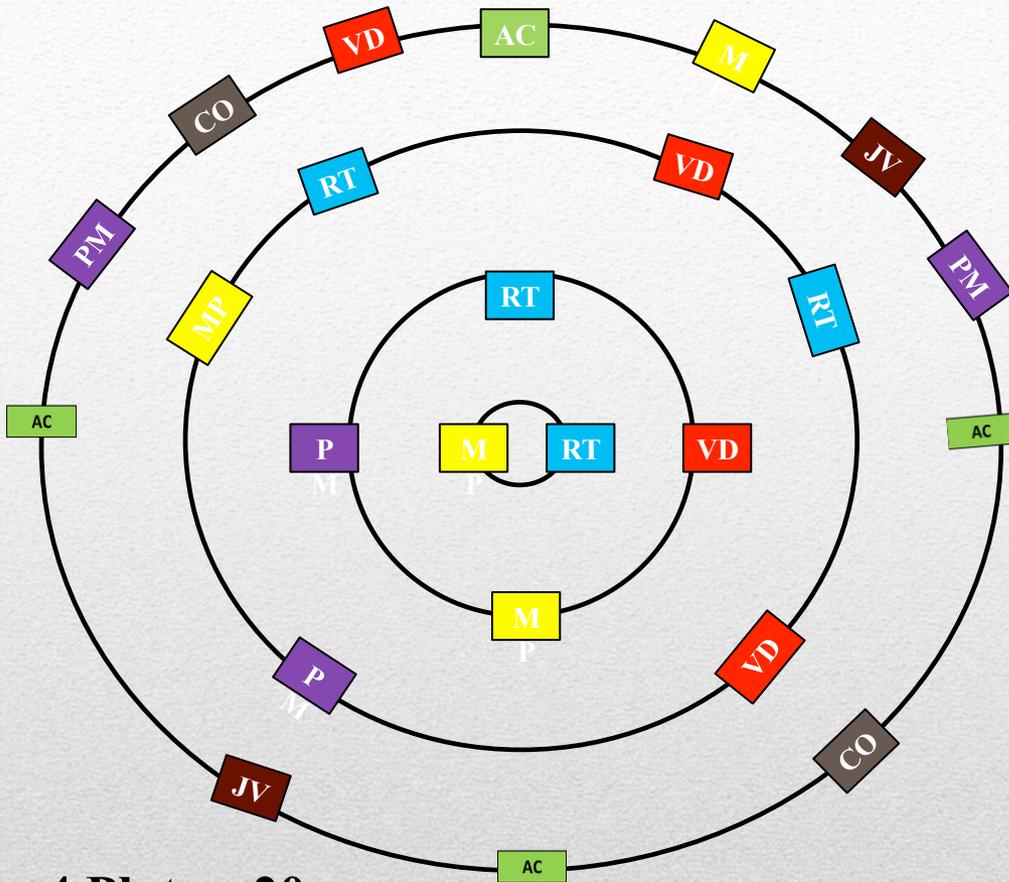
# Lesson 1: The Sequence of habitat installment matters! Habitat restoration of Coastal Dune & Marsh in isolation may not last long in the current climate.



# Planting of native trees and shrubs:

- Enhance migratory bird stop-overs on site
- Provide cover for winter resident birds
- Increase seed rain (deposition) by birds
- Increase natural succession in upland area
- Shade out invasive plants





4 Plots – 20  
plants each plot  
6 species  
18 m diameter

**Installation 2012**

**Plant List:**

- Hackberry (CO) – 2
- Red Cedar (JV) -- 2
- Shadbush (AC) -- 4
- Bayberry (MP)-- 4
- Beach Plum (PM)-- 4
- Staghorn sumac (RT)-- 4



**Lesson 2: Coastal Woodland/Shrub-land/Grassland Mosaic can be installed early to speed upland succession and shade out invasive plant species.**



# May 2014 Reef Installation





# Spartina planting May 14, 2014



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# What could happen if we use Reef Balls?

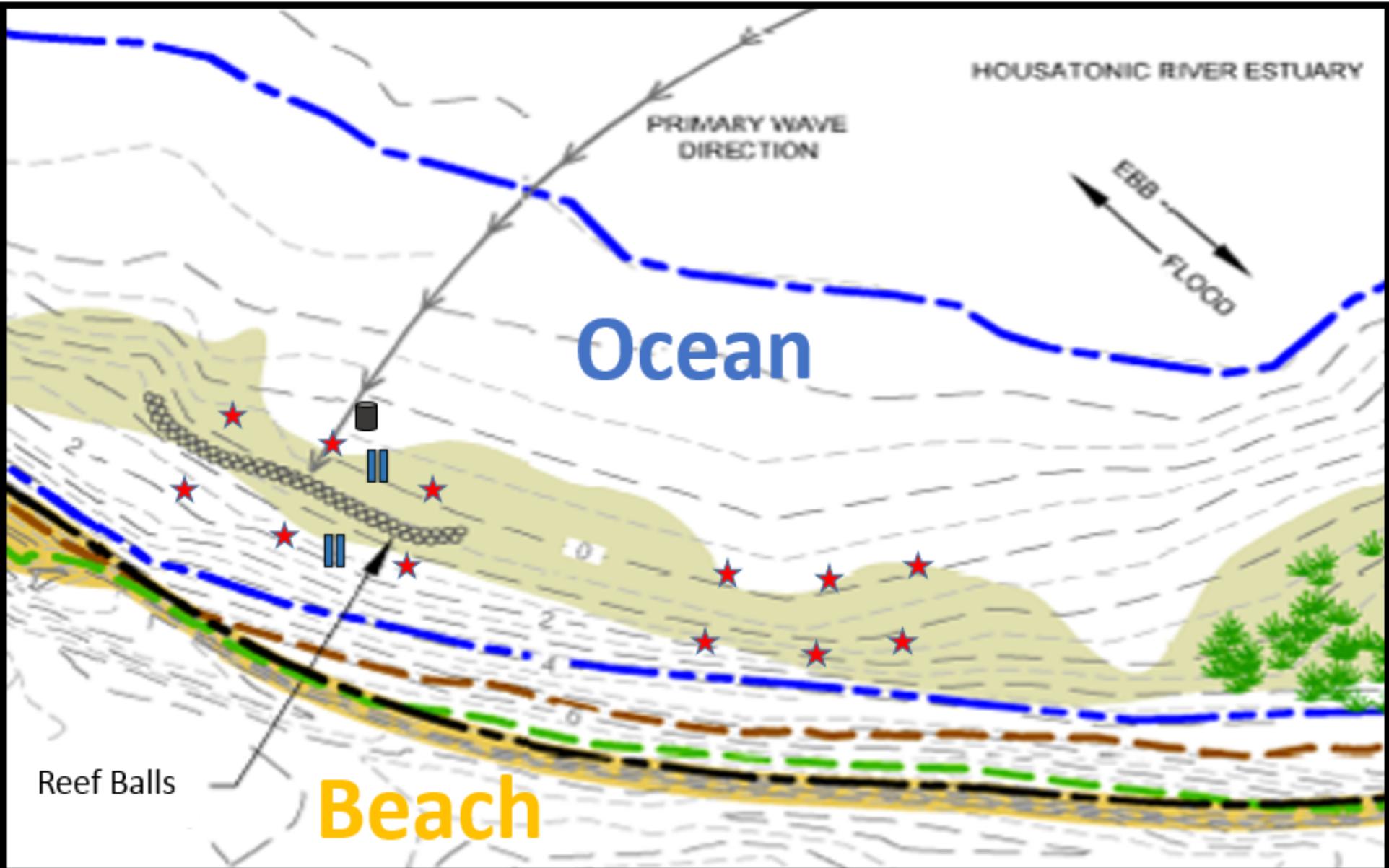
- 1) The reef could cause erosion,
- 2) The reef could have no effect, effectively neutral,
- 3) The reef installed is too short or too small to tell us anything,



# Are waves abated and sediments brought into the site during storms?

- Wave energy reduction measured using pressure sensor array
- Suspended sediments using Optical Backscatter array and by ISCO Autosampler
- Shoreline sediment accretion using GPS and total station elevation survey





- ★ - Cera Diver pressure sensors
- ▬▬ - OBS rig
- ▭ - ISCO Autosampler

# ISCO Autosampler 6712





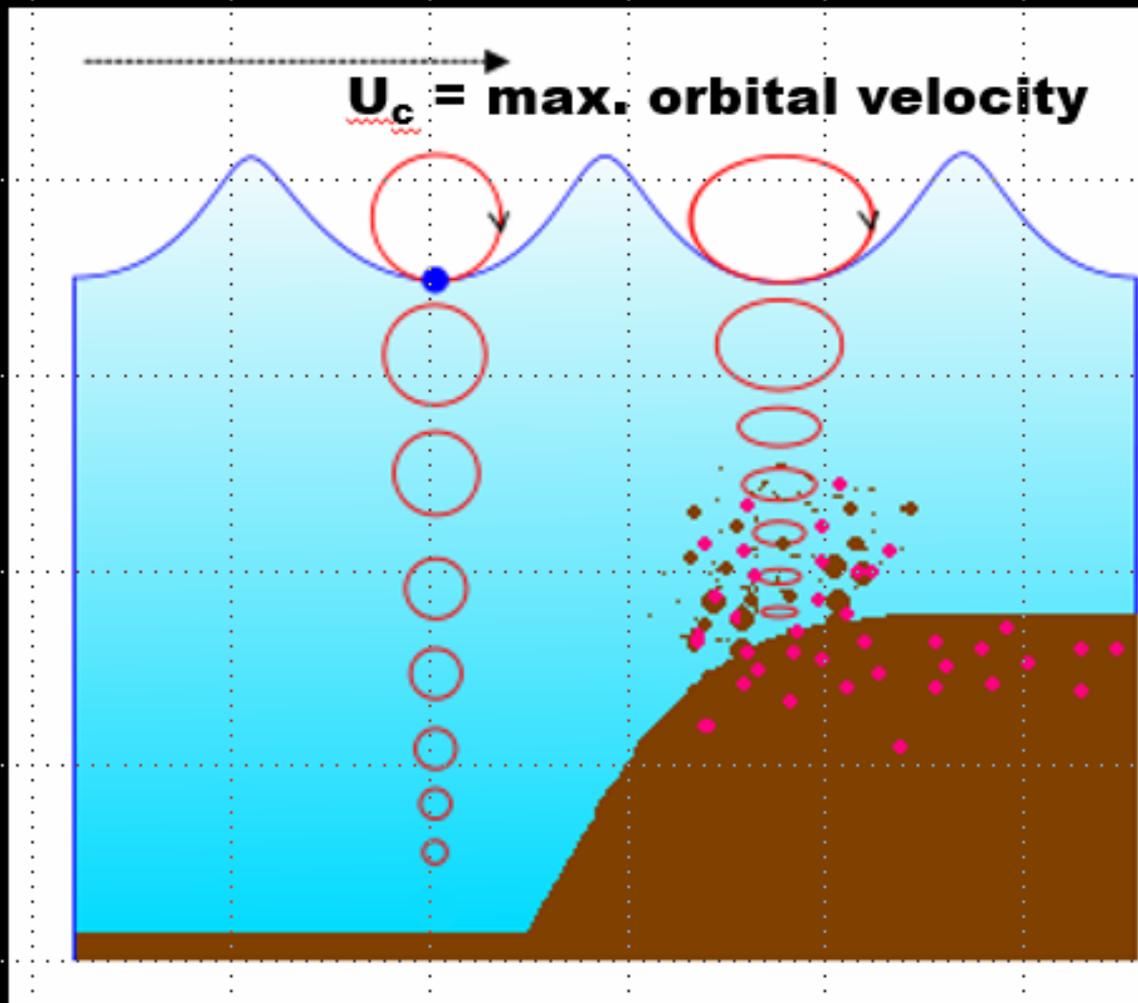
# Orbital velocity— sediment resuspension

Wave height ( $H$ ) is directly proportional to orbital velocity ( $U_{max}$ ):

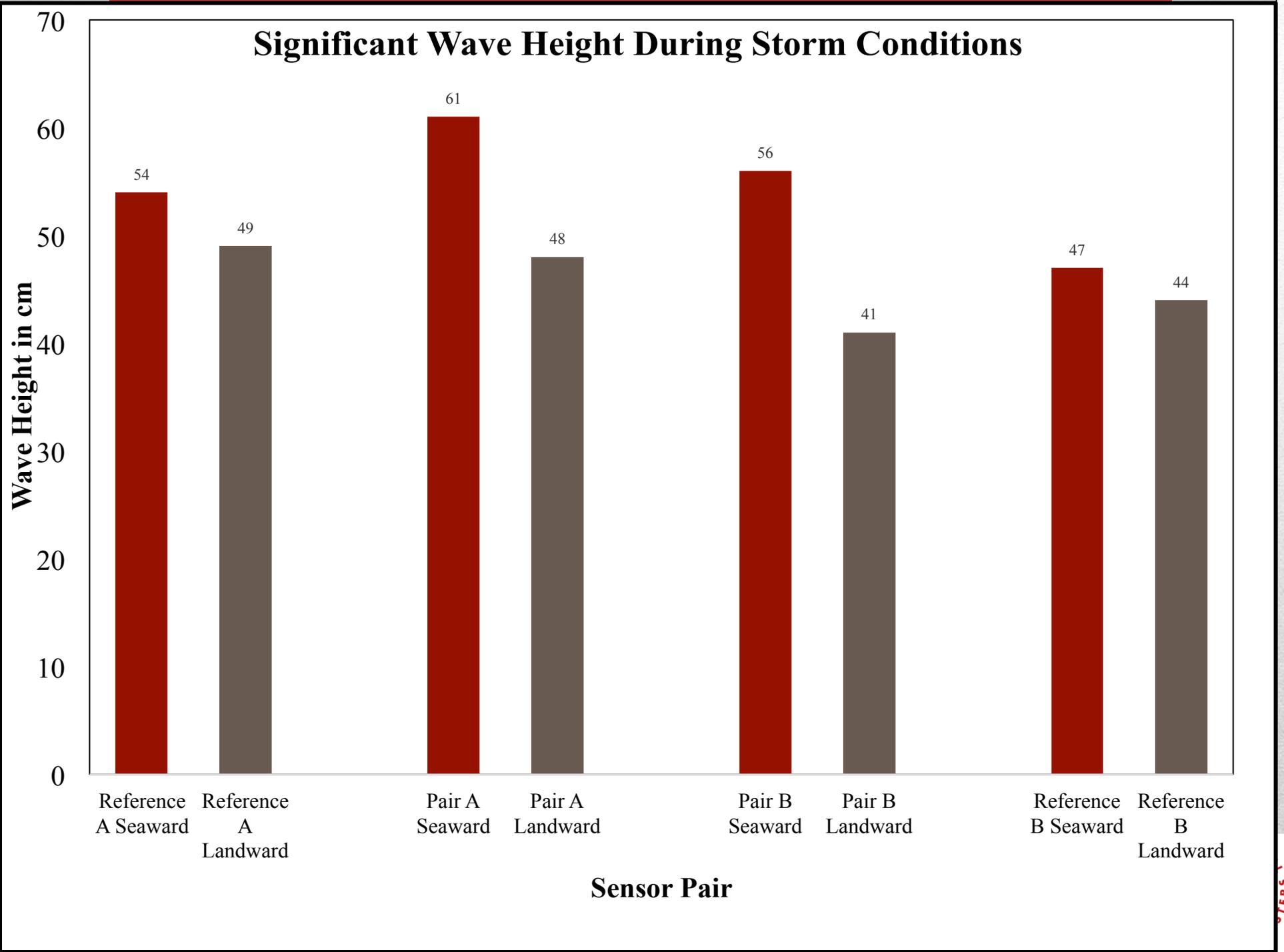
$$U_{max} = \frac{H}{2} \sqrt{\frac{g}{h}}$$

Orbital velocity is also proportional to sediment resuspension ( $C_d$  = empirical drag coefficient)

$$\tau_0 = C_D \rho \bar{U}^2,$$



# Significant Wave Height During Storm Conditions



# What else could happen if we use Reef Balls?

- 4) The reef balls could move (thrown ashore by a hurricane),
- 5) The reef could sink (underlying peat and mud matrix),
- 6) The reef will crack and disintegrate from freeze/thaw cycle,
- 7) Ice coming down the Housatonic River will pulverize the reef.
- 8) The reef will not serve as habitat for shellfish/fish



**February 2015**

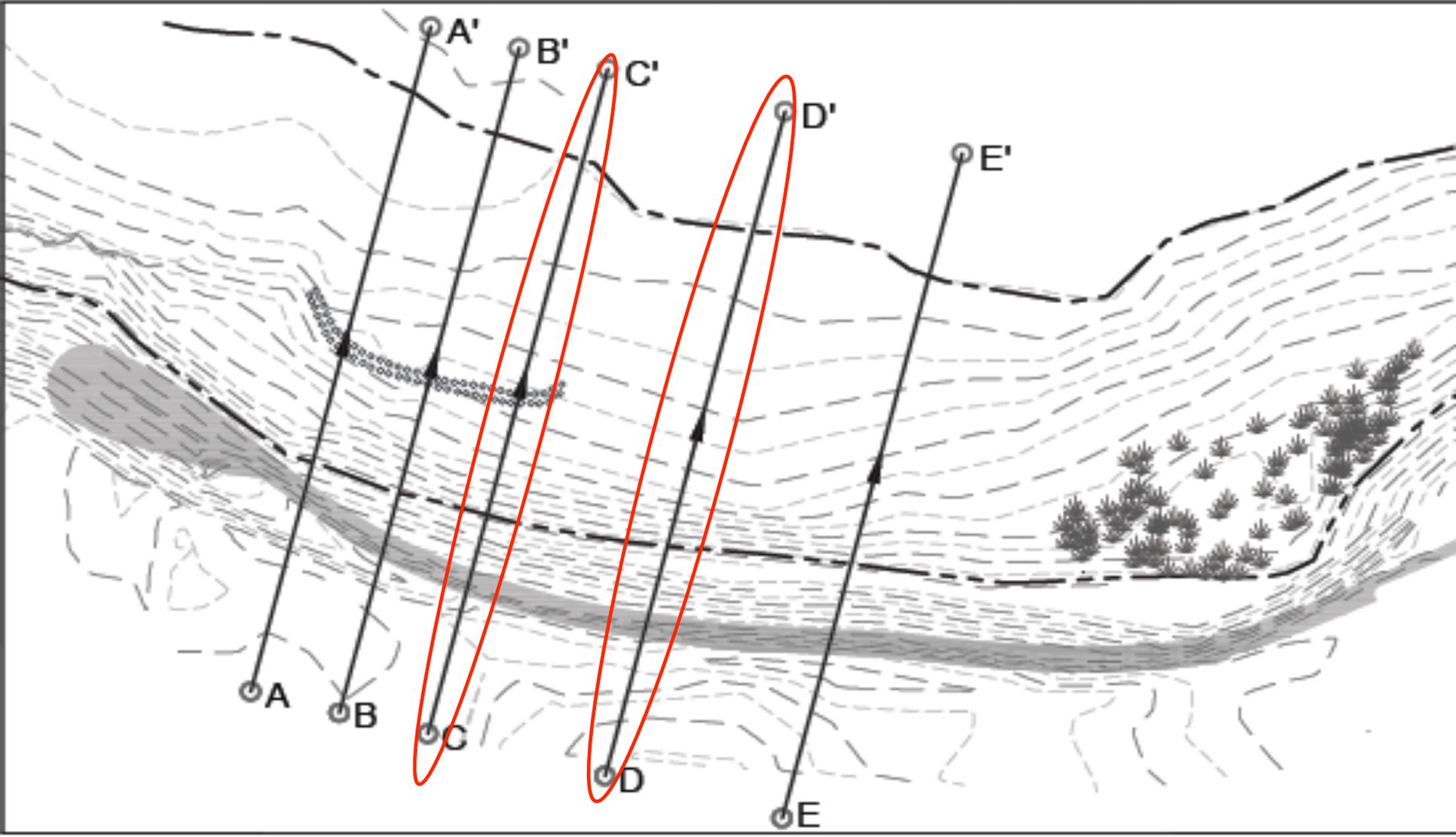


April 2015

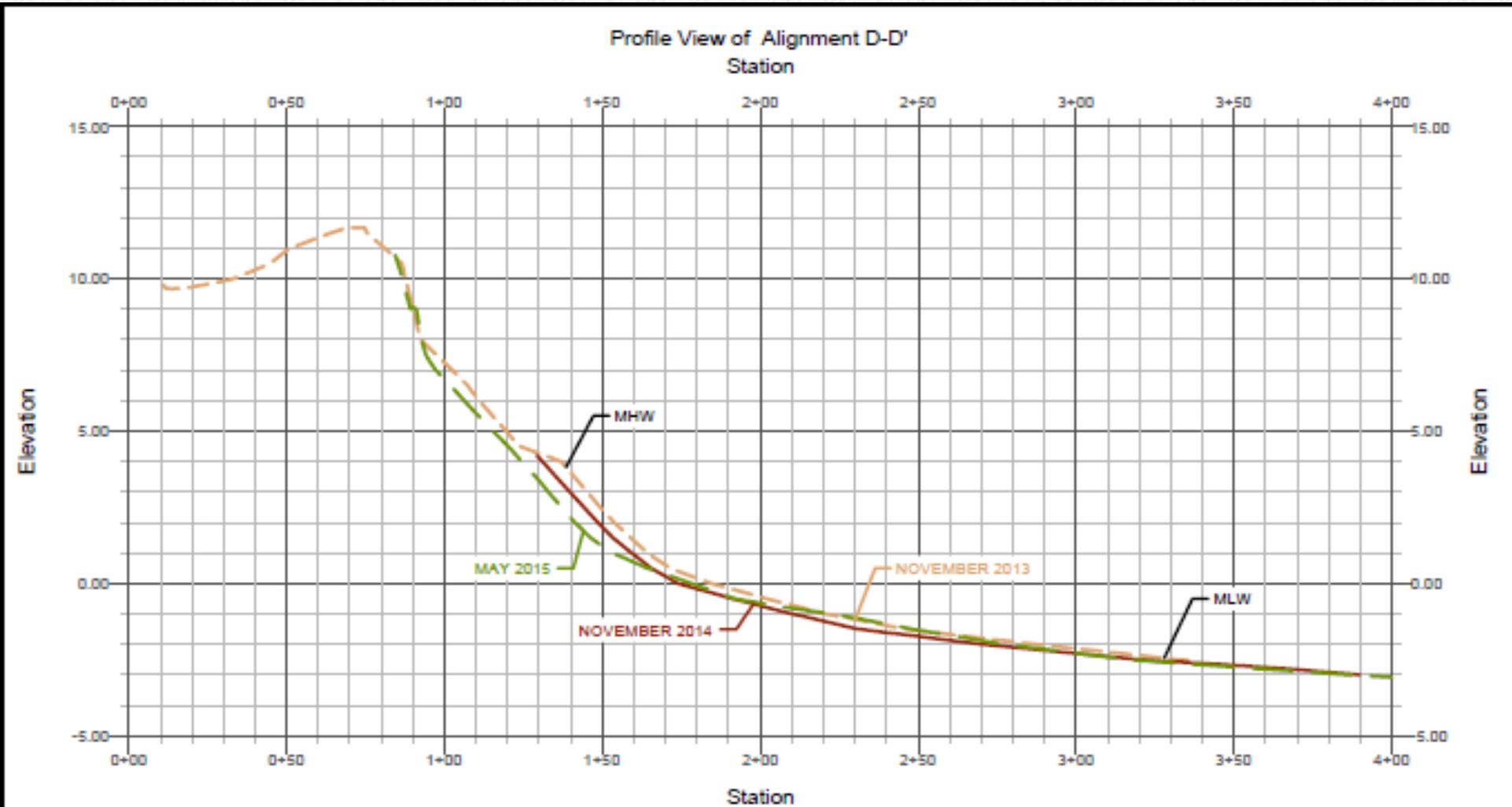




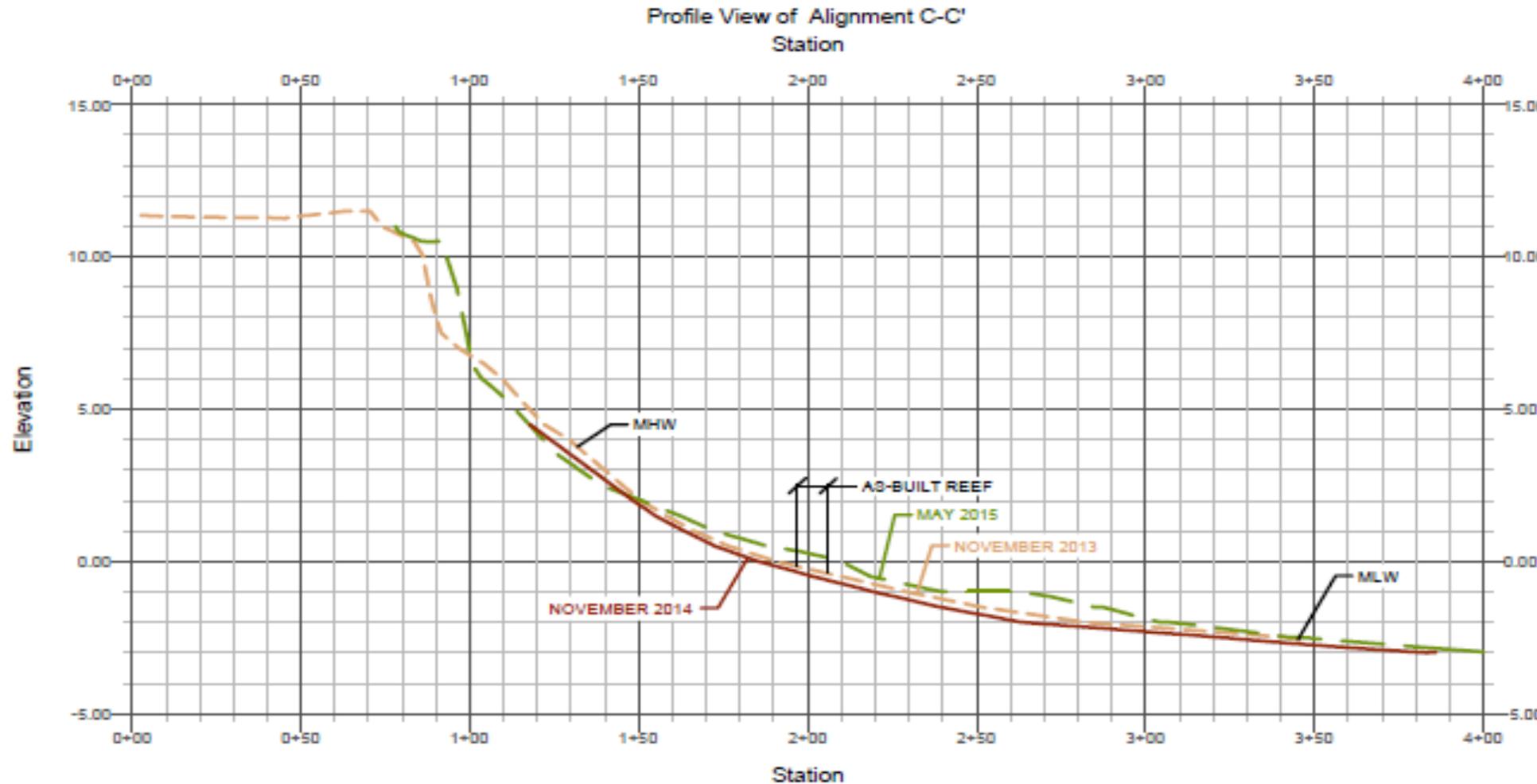
Contour profile maps drawn annually by AECOM personnel along the same transects



Contour profile outside the reef is below or equivalent to the 2013 levels.



After one year the sediment is measurably higher on both sides of the reef.





**Upstream 1/3**

32,31,30,29,28,27,26,25,24,23,22

**Middle 1/3**

21,20,19,18,17,16,15,14,13,12,11

**Soundside 1/3**

10,9,8,7,6,5,4,3,2,1

33,34,35,36,37,38,39,40,41,42,43

44,45,46,47,48,49,50,51,52,53,54

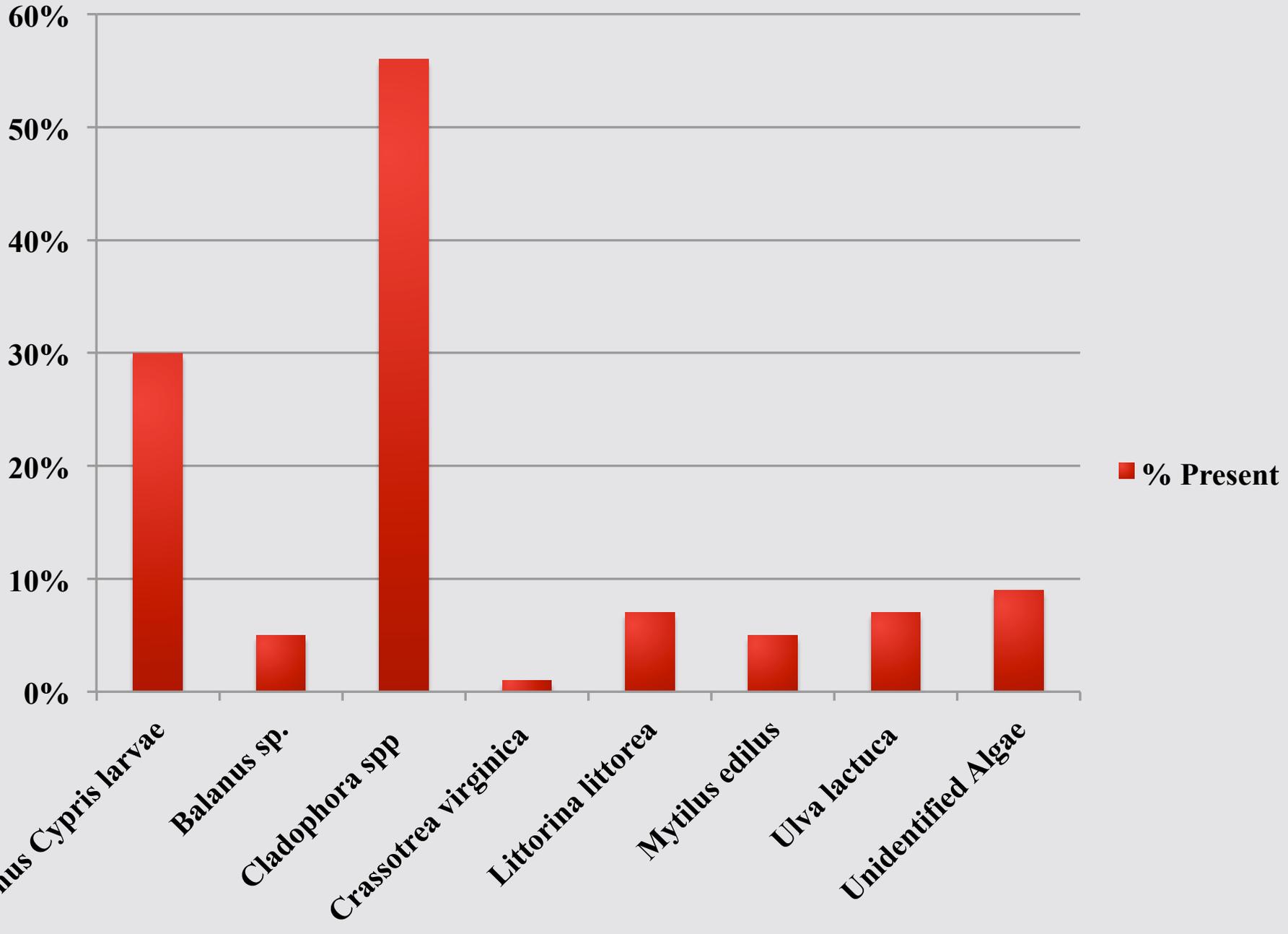
55,56,57,58,59,60,61,62,63,64

**Seaward Row**

**Landward Row**



# Average % Present on 18 Reefballs





# Oysters (*Crassostrea virginica*)



# Nekton Diversity

- Monitor seasonal changes in nekton community
- Species observed
  - Atlantic silverside
  - Banded killifish
  - Mummichog
  - Bluefish
  - Porgy

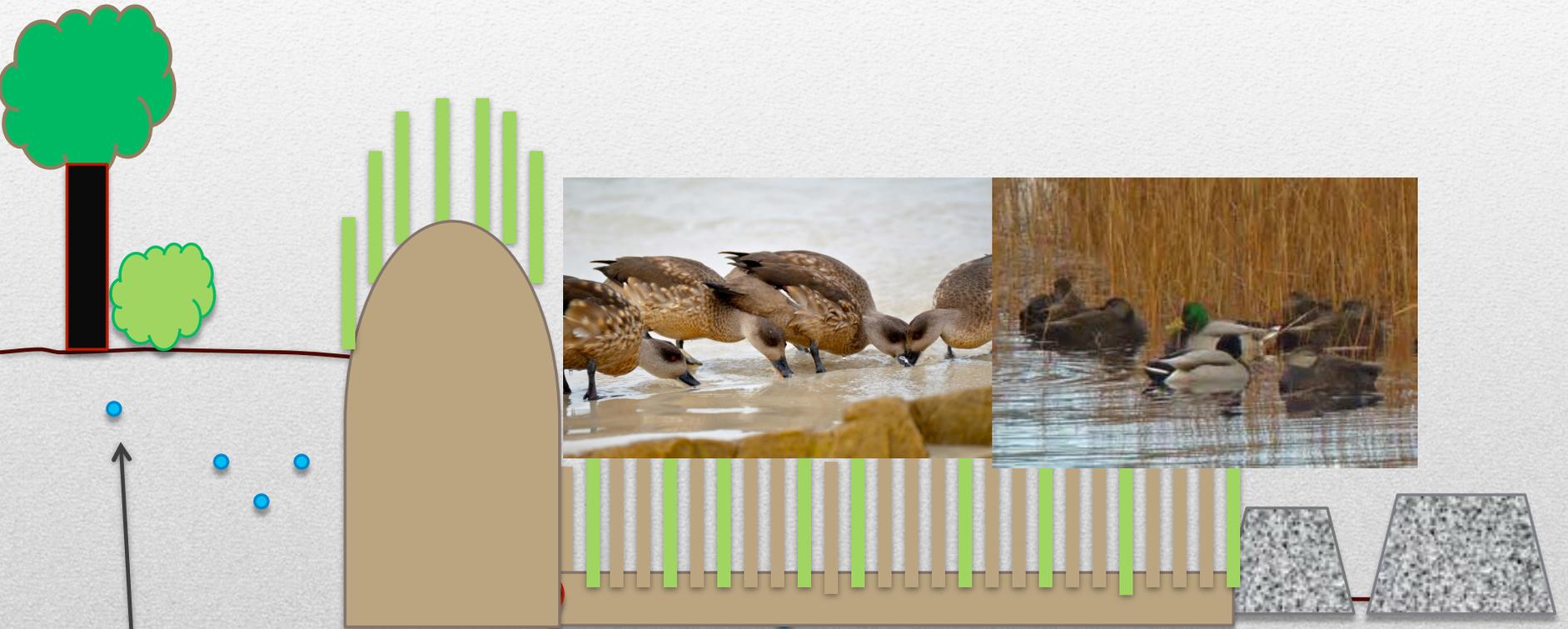


# Results to date

- Reef not crushed or cracked by ice!
- No sinking, no movement of reef of any kind!
- Sediment accretion (3cm)
- Wave energy reduction (2 foot waves)
- Spartina survival/growth
- Recruitment of oysters/barnacles/algae
- Fish utilizing reef ball habitat
- No change in invertebrate community



# Remediation Strategy & Proposed Living Shoreline cap.



Contaminant + Pathway + Exposure = Risk







# Environmental Science & Management Program



NATIONAL FISH AND WILDLIFE FOUNDATION



**SHU Monitoring  
Team**

