

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



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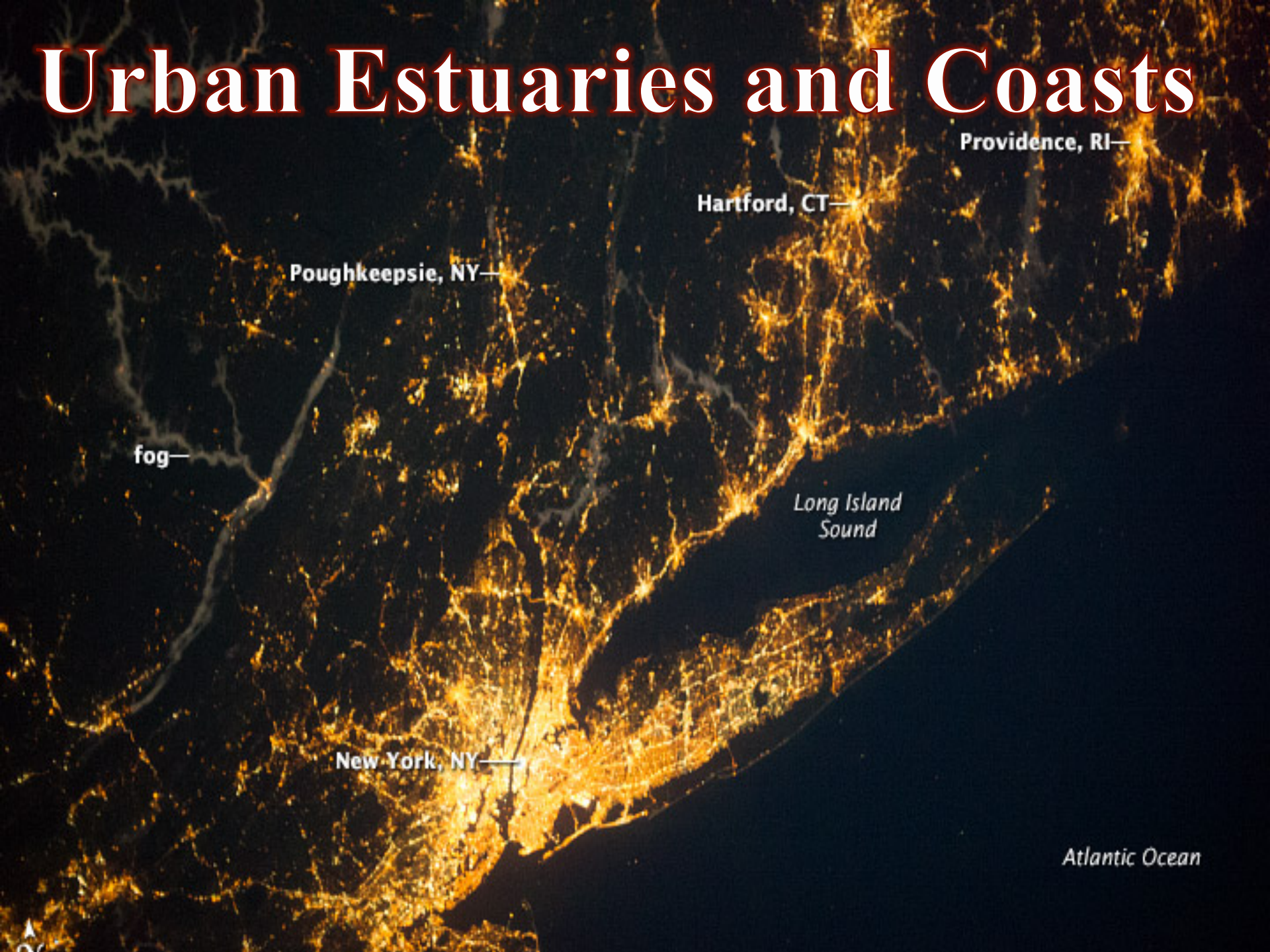
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Professional Science Master's
Environmental Science & Management



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
& CO₂ and atmospheric pollution**

Nitrogen & Phosphorous fertilization



Algal and bacterial growth

Wallace et al. 2014. ECSS

Hypoxia

Acidification



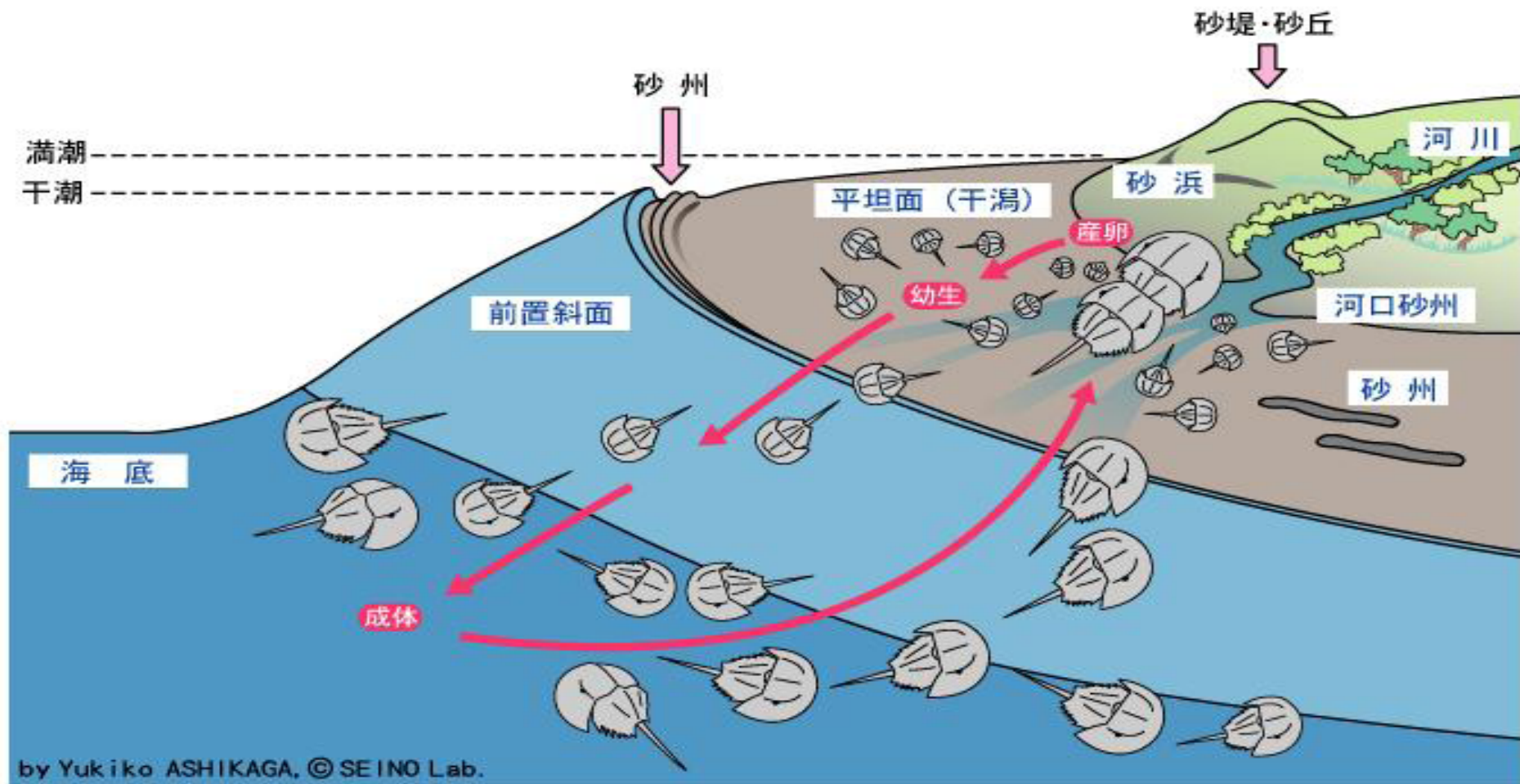
Heavy metals, pesticides, light pollution

**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
Hyman Ct
Frank Ct
Lois Ave

Leif Ericson Dr

Belt Pkwy

Image © 2015 DigitalGlobe

Google earth

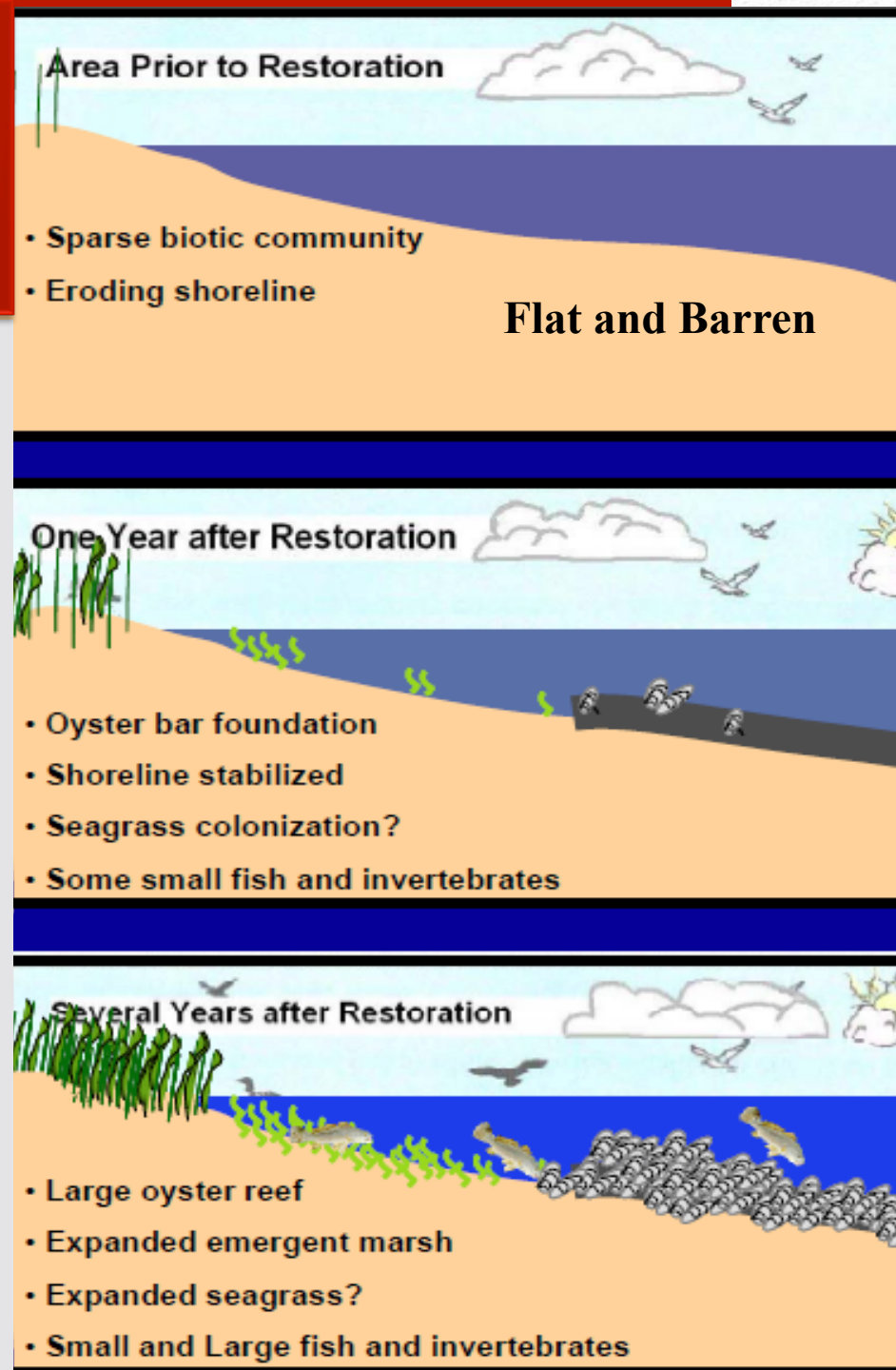
One Possible Solution: Interconnected habitats are needed to repair structure and function of the Urban Estuary.

• 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.



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**







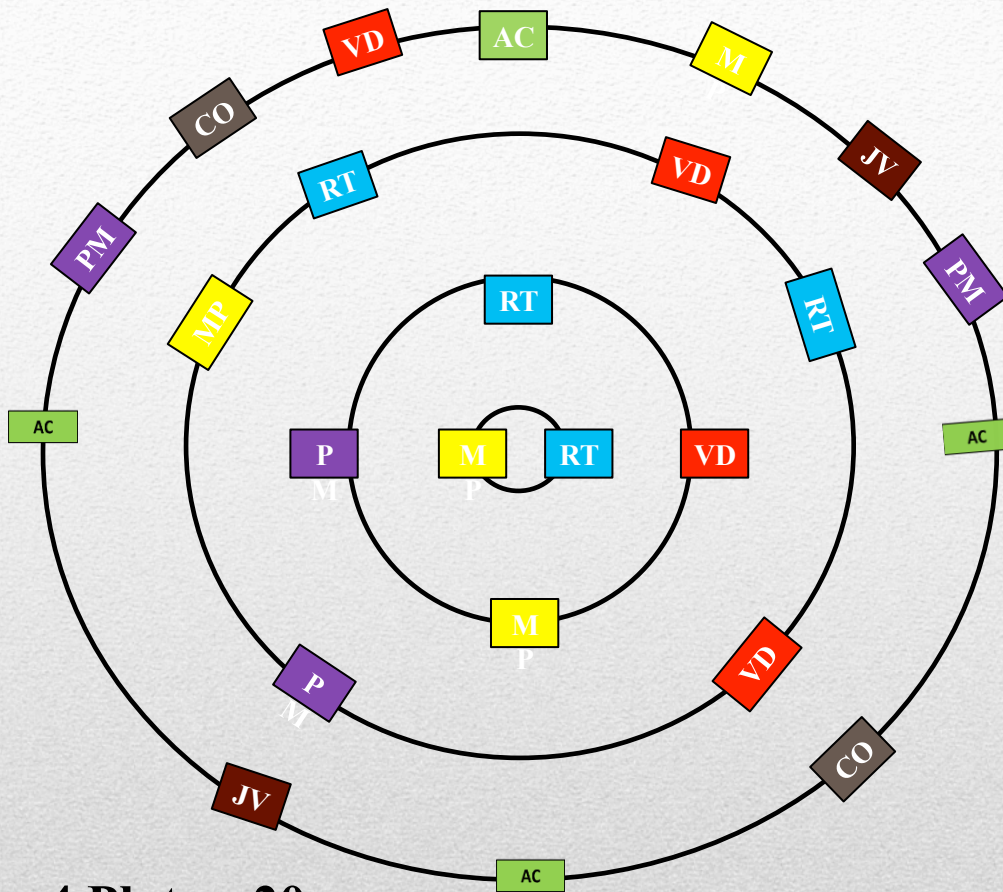
Lesson 1: The Sequence of habitat installment matters! Habitat restoration of Coastal Dune & Marsh in isolation may not last long in the current climate.



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



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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



ISCO Autosampler 6712





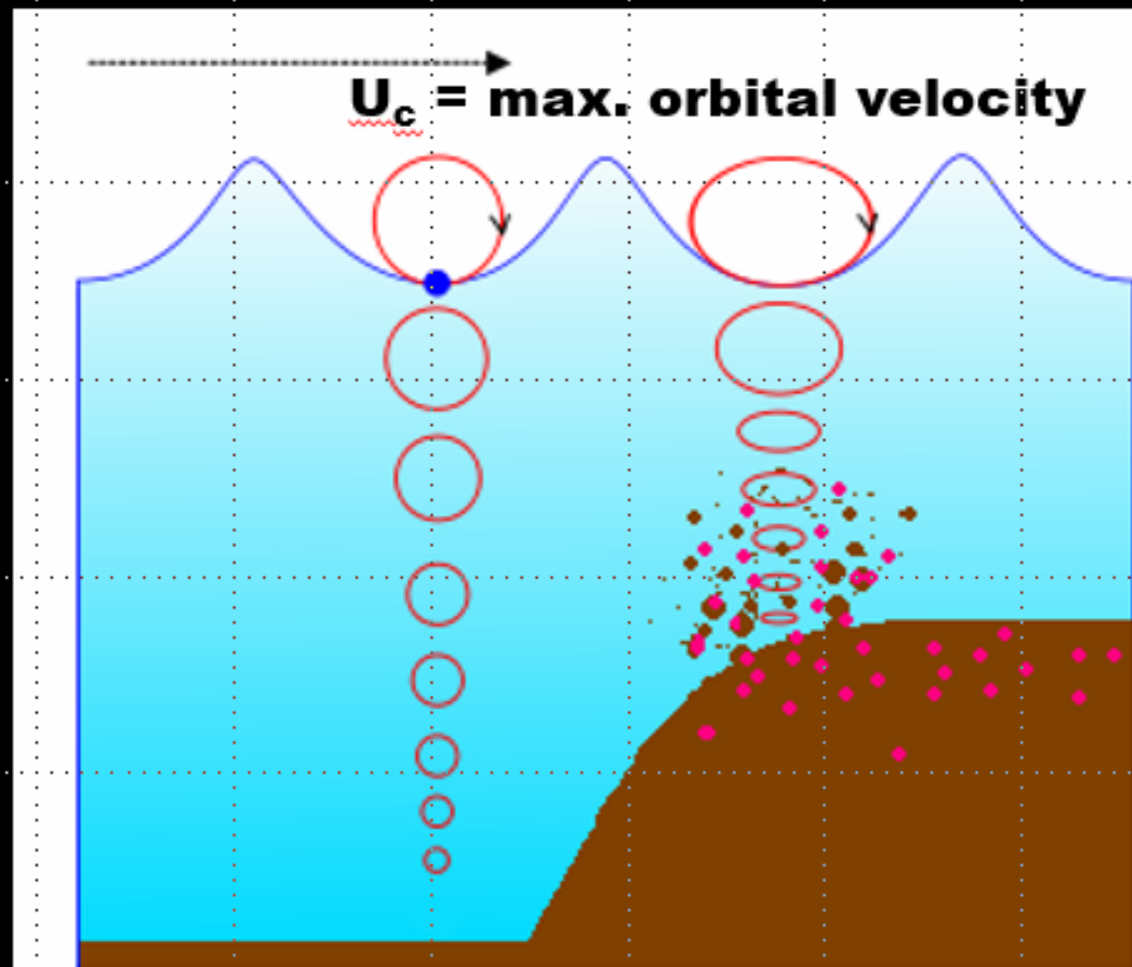
Orbital velocity— sediment resuspension

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

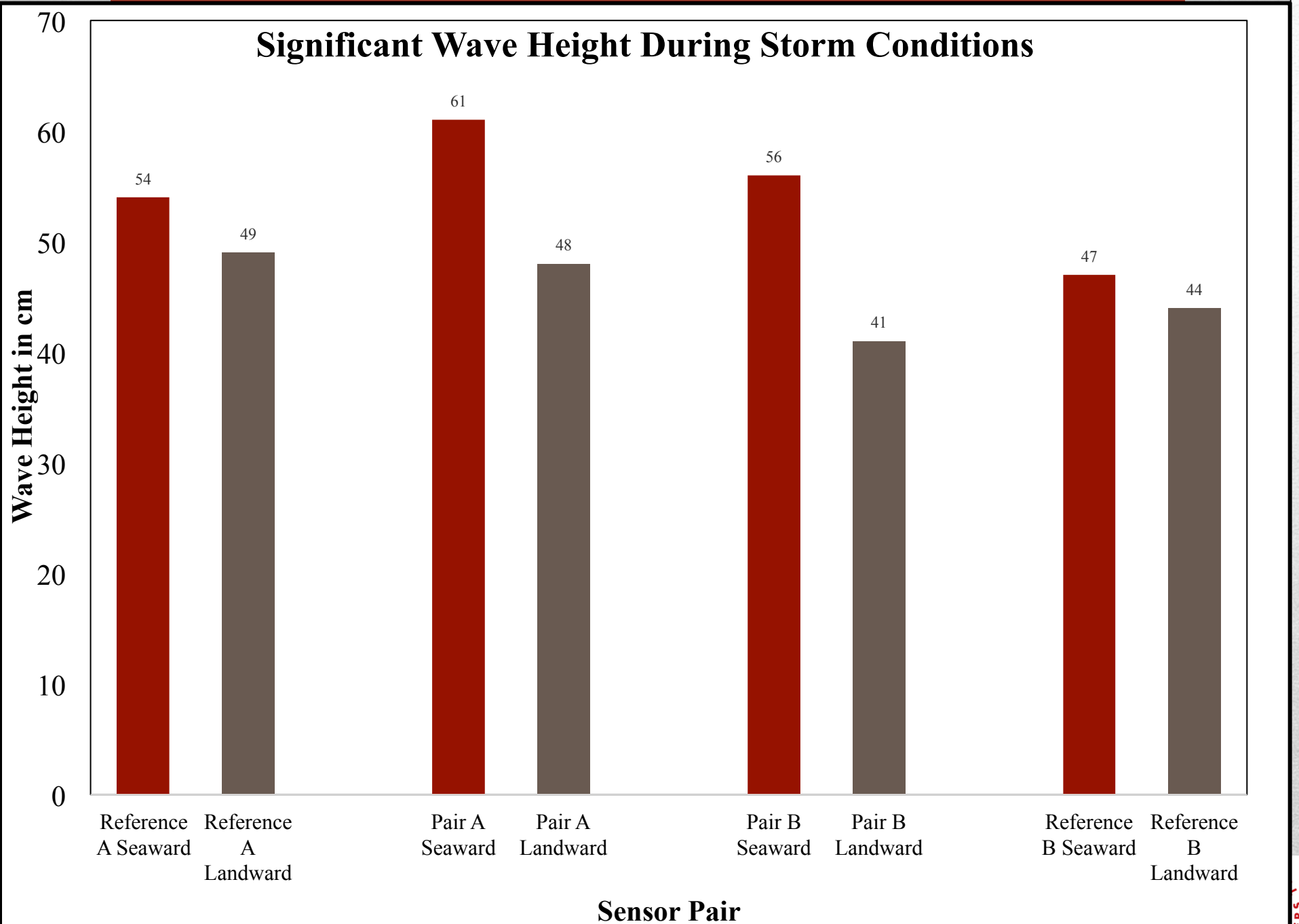
$$U_{max} = \frac{H}{2} \sqrt{\frac{g}{h}}$$

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

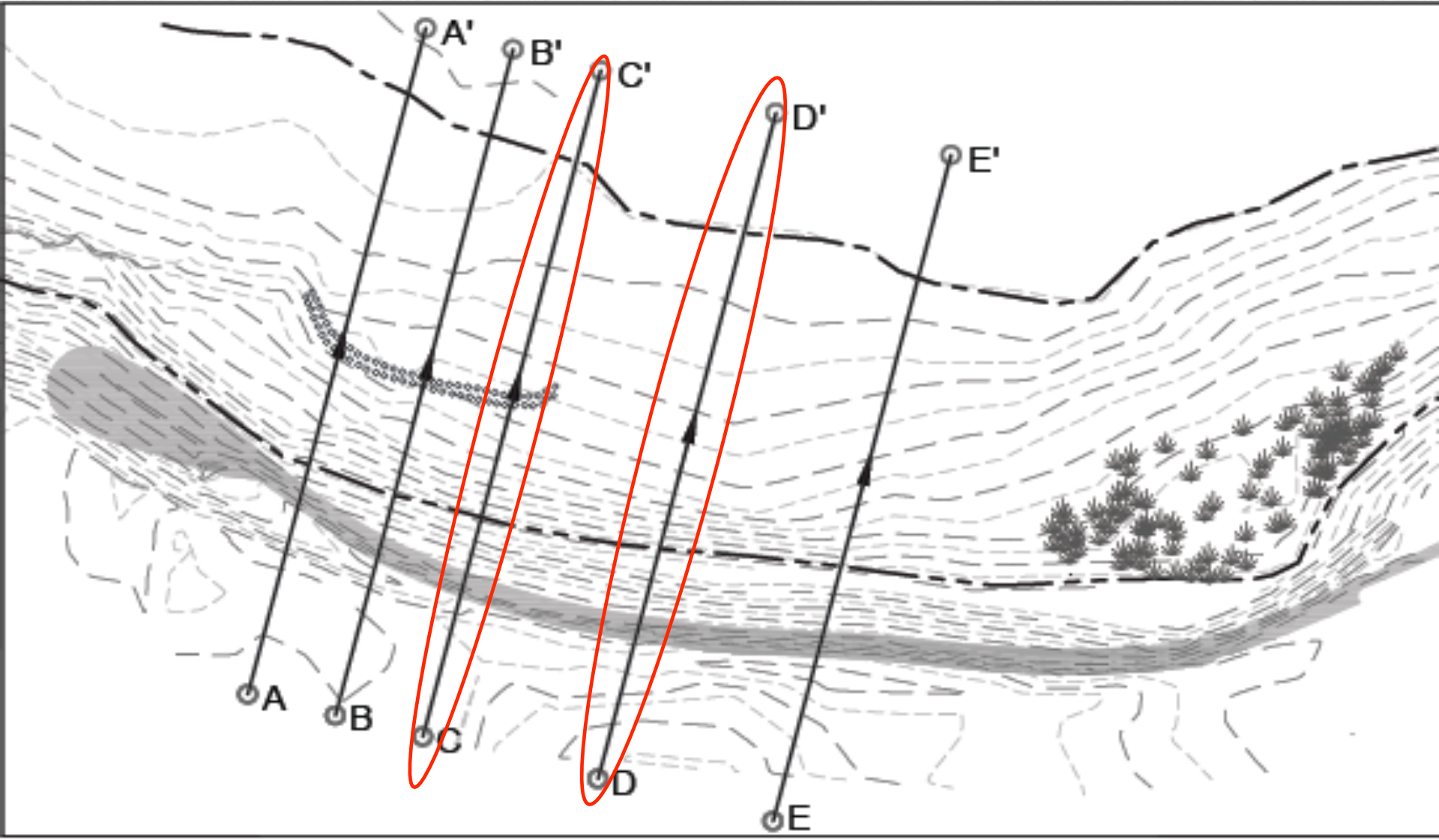


April 2015

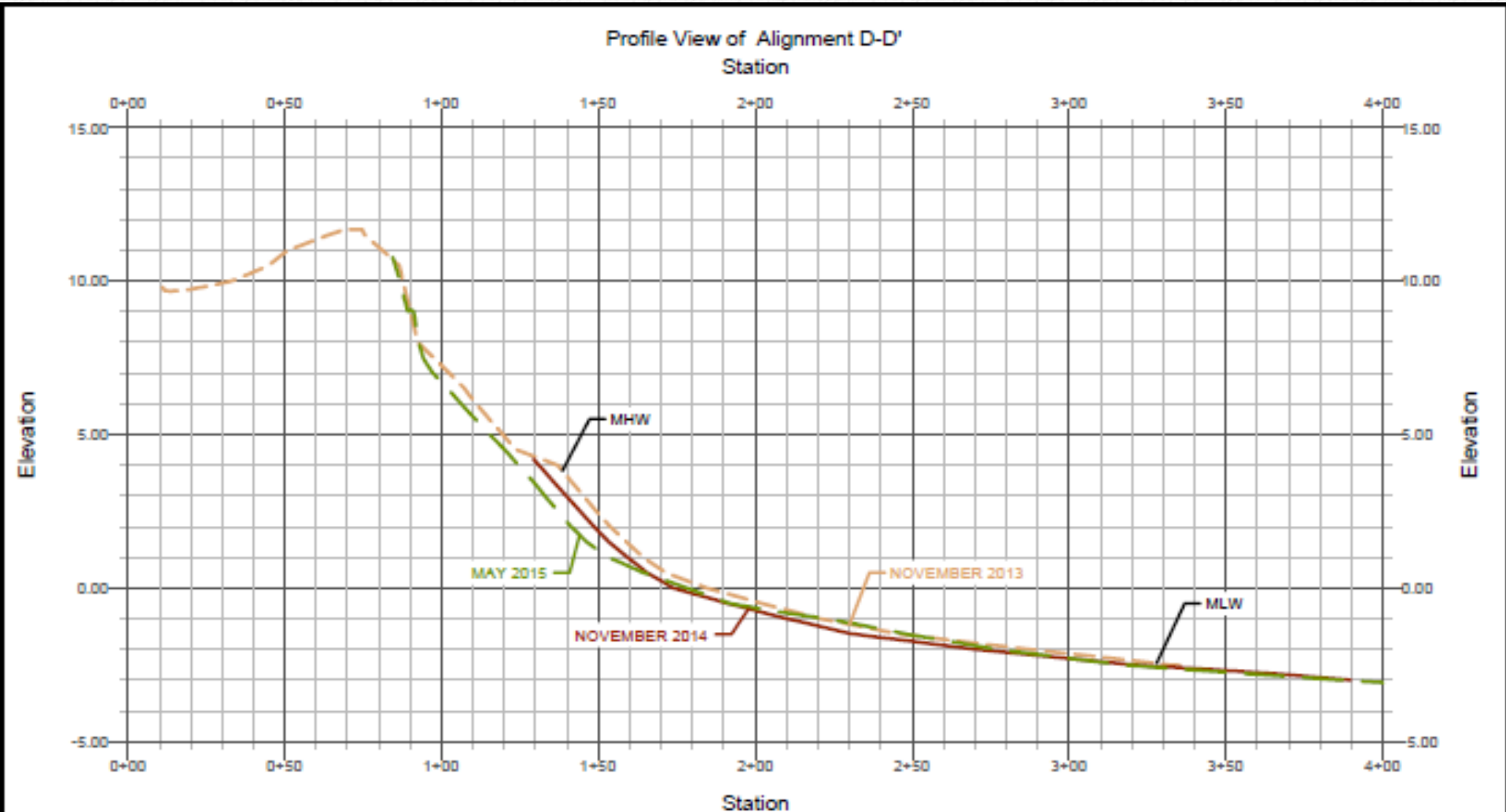




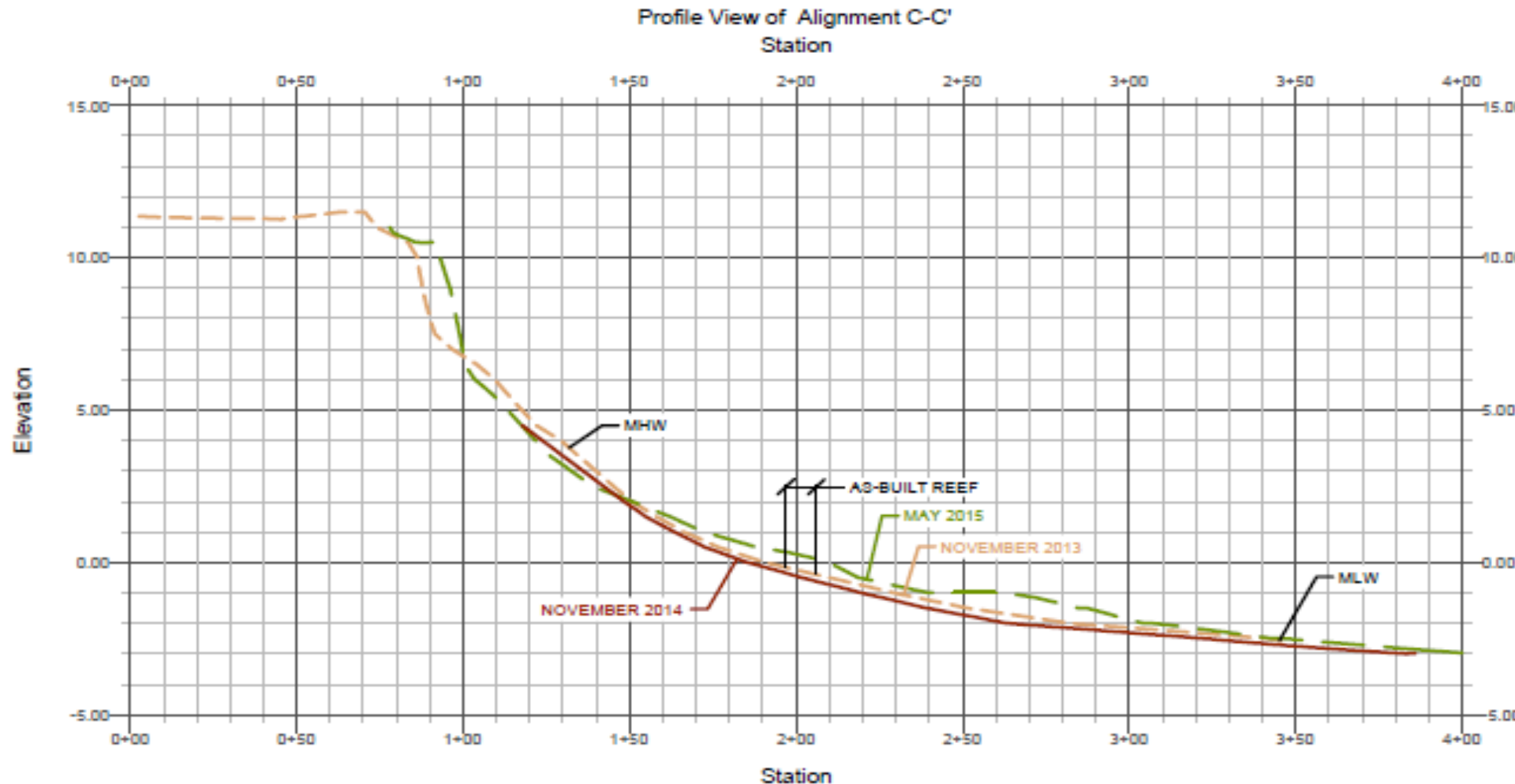
Contour profile maps drawn annually by
AECOM personnel along the same transects



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

Seaward Row

Landward Row

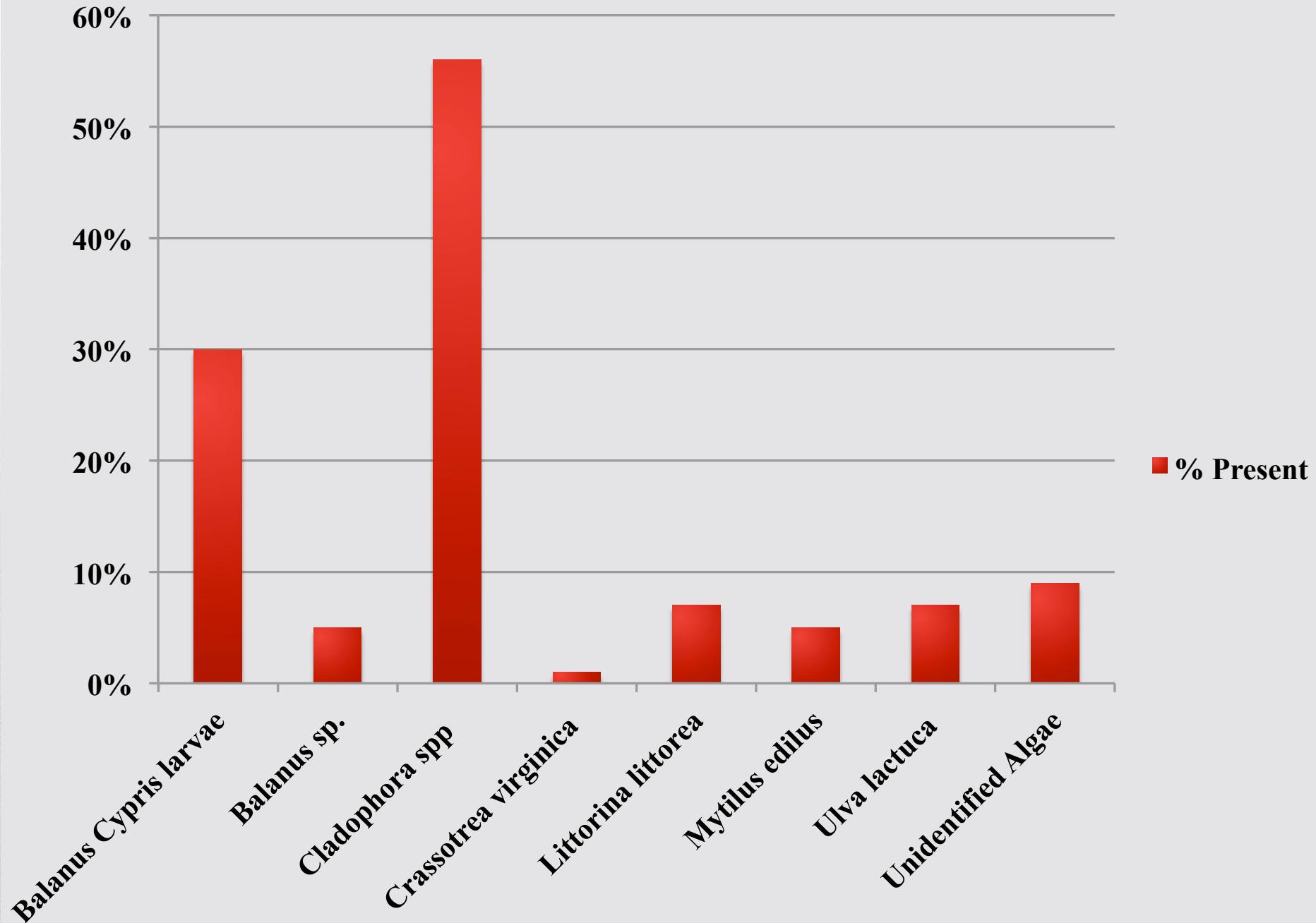
33,34,35,36,37,38,39,40,41,42,43

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

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



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

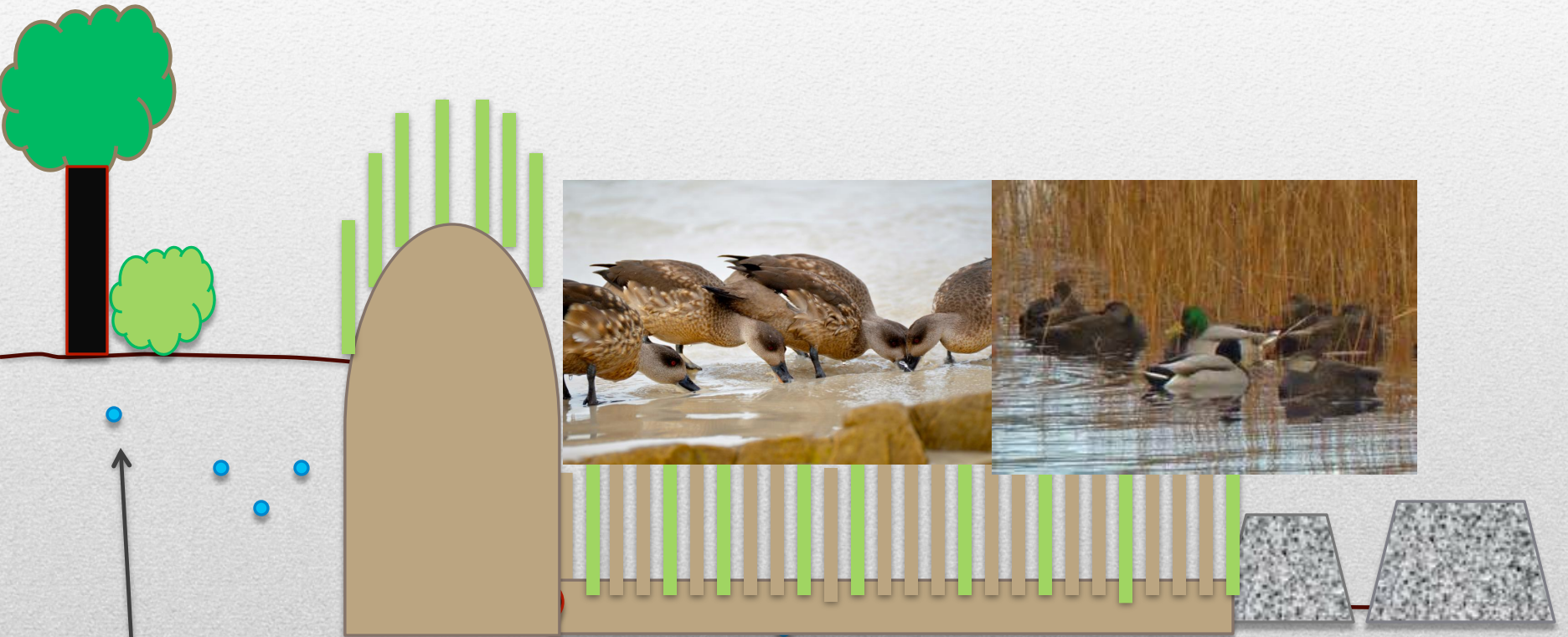


Results to date

- 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



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SHU Monitoring Team

