NCER 2018

National Conference on Ecosystem Restoration

Building connections from the local to the landscape scale

Building resilient urban coastal environments & communities through science based eco-engineering

Shimrit Perkol-Finkel – Session Moderator Intro

1) Shimrit Perkol-Finkel, ECOncrete – Bringing Concrete to Life

2) Mart Black, TPCG – Promoting Resiliency through Science-Based Eco-Engineering

3) Tyler Ortego, ORA Technologies – Let The Oysters Do The Work

4) Leslie Suazo, Ducks Unlimited – Powerful Partnerships Promote Community Resilience

Time permitting - Q&A

Global Climate Change → Coastal Protection

http://www.sintmaartengov.org/special-campaigns/Pages/Hurricane-Campaign.aspx

Global Climate Change → Coastal Protection

onment ▶ Climate change Wildlife Energy Pollution

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Climate change made Louisiana's catastrophic floods much more likely

Human-derived rising temperatures increased the risk of the natural disaster by at least 40%, a National Oceanic and Atmospheric Administration study found

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ep 2016 18.10 BST

article is over 1

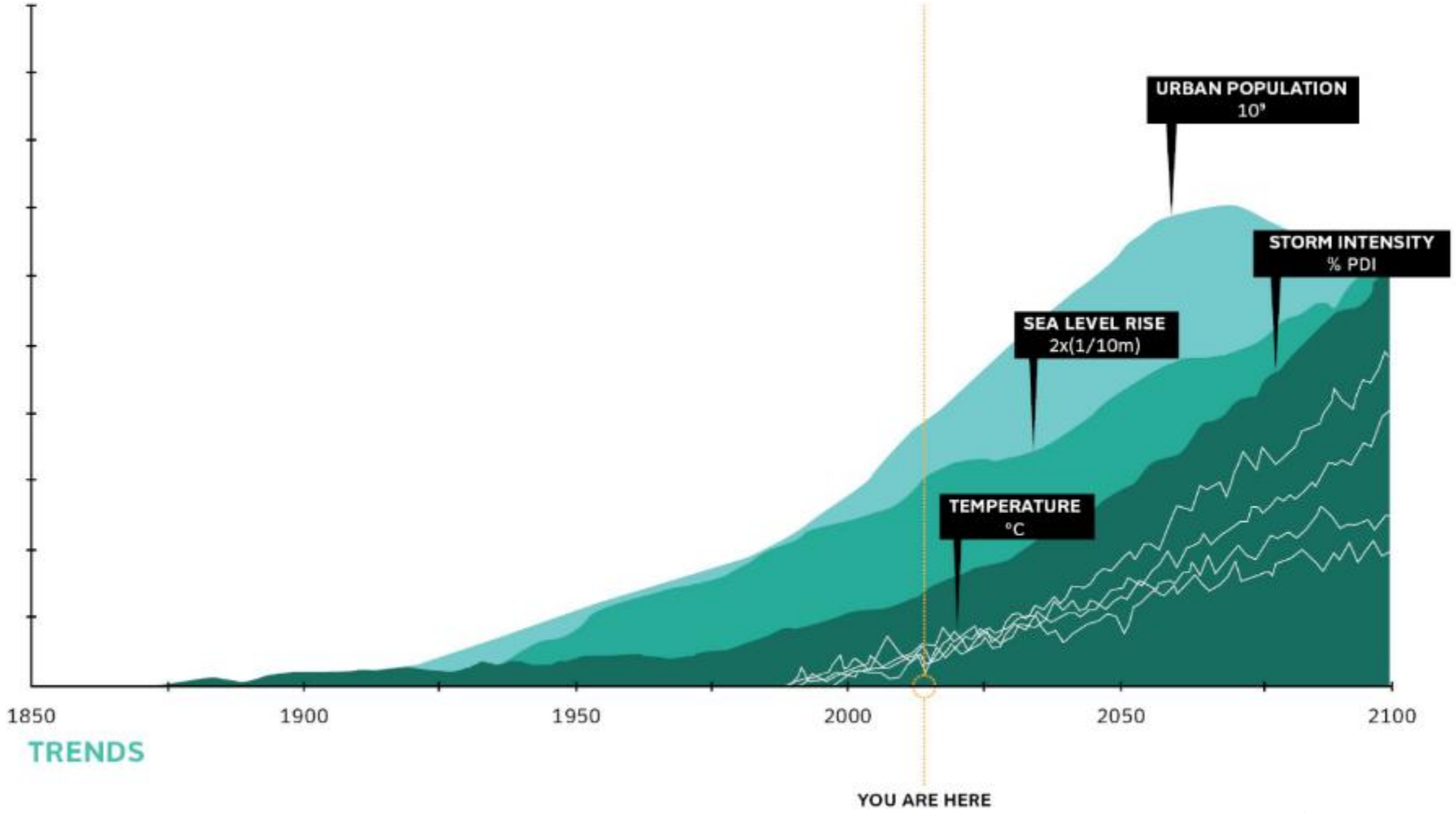
Global Climate Change → Coastal Protection

HURRICANES - TYPHOONS · just in

Storm drifts away from Hawaii 'almost biblical' rains

AUDREY McAVOY and CALEB JONES | **Associated Press**

Global Climate Change → Coastal Protection



Increase proliferation of coastal defense structures

SCAPE TEAM

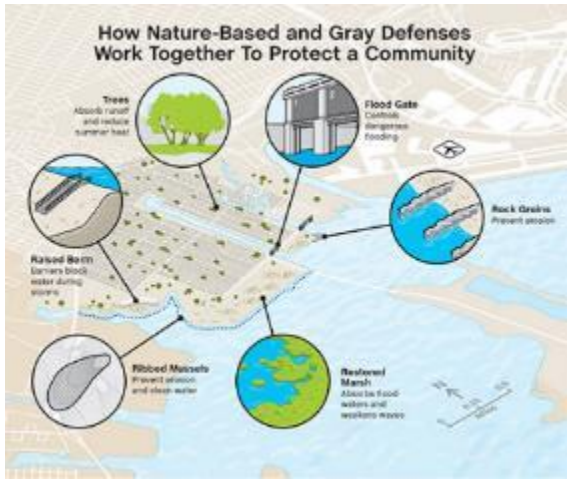
Coastal Development → Severe Stress on Natural Ecosystems

Habitat Loss **Pollution** **Low Biodiversity** **Invasive Species**


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Ecosystem Restoration - Engineering Change

http://oppla.eu/green-infrastructure-conference-nature-based-solutions-sustainable-and-resilient-cities



http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/ucr-infographic.pdf

http://www.ecoshape.nl/files/paginas/ECOSHAPE_BwN_WEB.pdf

http://nebula.rowan.edu/

http://www.t-book.unina.it/

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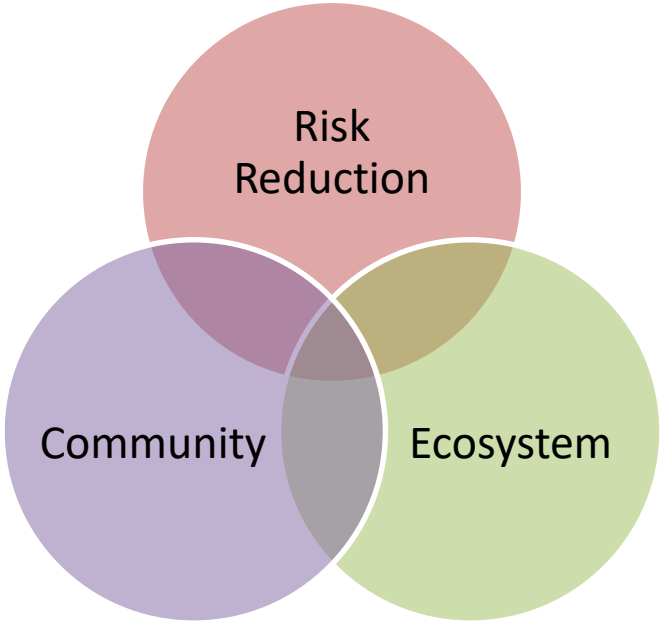


ECOncrete®
Concrete Ecological Solutions
www.econcretetech.com

NCER 2018
National Conference on Ecosystem Restoration
Building connections from the local to the landscape scale

Bringing Concrete to Life

Harnessing biological processes for building resilient coastal infrastructure

Shimrit Finkel, PhD
Shimrit@econcretetech.com









Climate Change



A Concrete Problem

Destruction of Natural Coastal Habitats

Ecosystem Restoration - Engineering Change

Rural

Urban

Boeri Studio

Design solutions

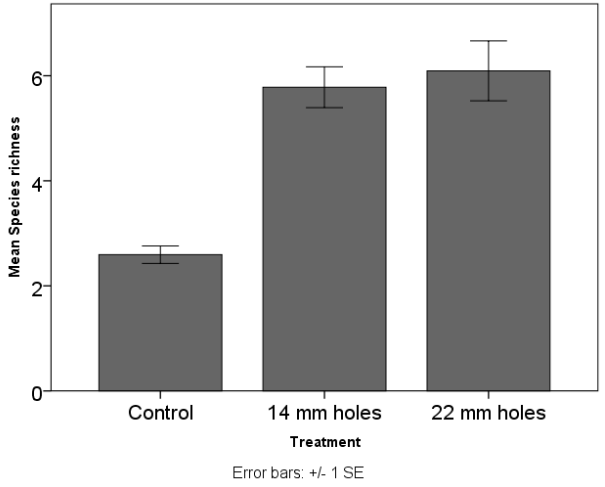
Seattle Waterfront 2015- in progress

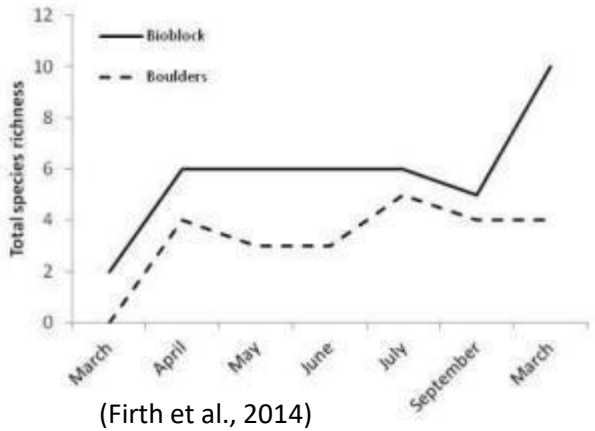
http://waterfrontseattle.org/

- Light penetration
- Vertical Habitats
- Sloping Habitats

Design solutions

THESEUS - coastal risk assessment and mitigation funded by the EU Commission
http://www.theseusproject.eu





(Firth et al., 2014)

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Bringing Concrete to Life

Material composition

Surface complexity

Macro Design

- ✓ Rich and Diverse Marine Life
- ✓ Enhanced Ecosystem Services
- ✓ Improved Structural Performance
- ✓ Low Carbon Solution
- ✓ Cost Effective
- ✓ Aesthetic

Bringing Concrete to Life

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Changing Paradigms: Biofouling → Bioprotection

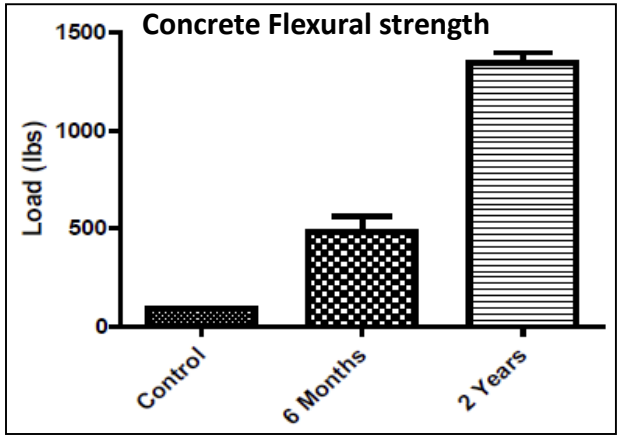
http://urbaneproject.org/assets/pdf/(7)%20Larissa%20Naylor_BIOPROTECTION.pdf

Changing Paradigms: Biofouling → Bioprotection

Structural Advantages:

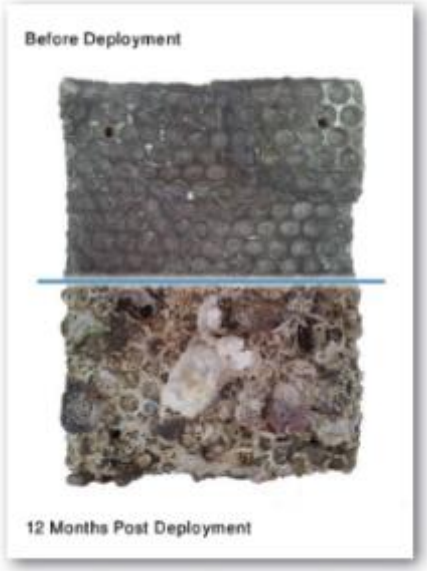
- Strength and durability
- Reduced chloride penetration
- Absorption of wave energy
- Microclimate buffering
- Reduce maintenance

Concrete strengthens with time as oyster growth develops (Risinger, 2012)



Biological & Ecological Advantages:

- Biological niches
- Ecosystem services
- Carbon Sink
- Water quality (filter feeders)
- Reduce ratio NIS/native species
- Esthetics



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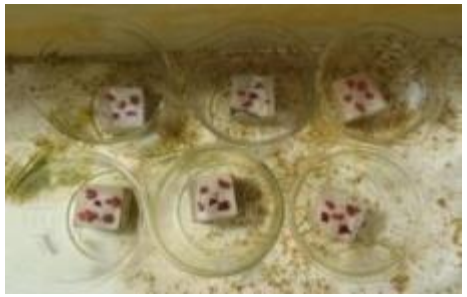
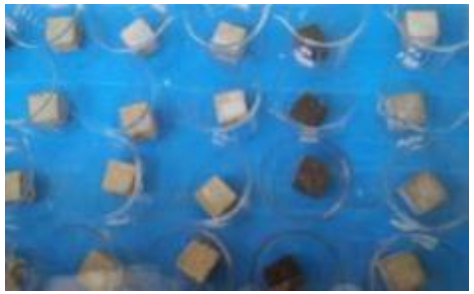
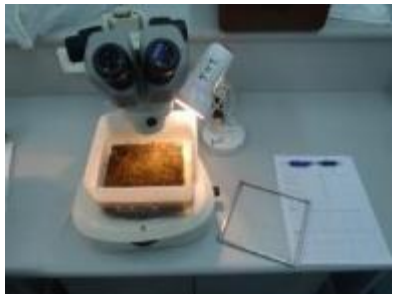
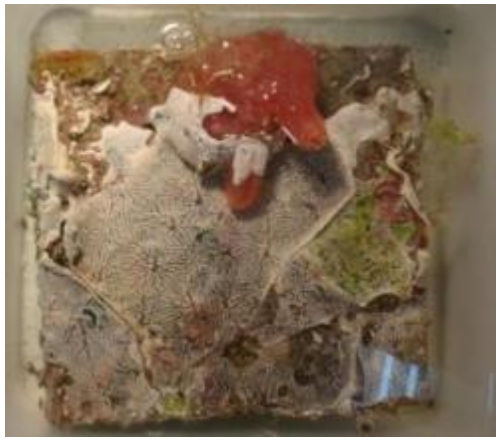
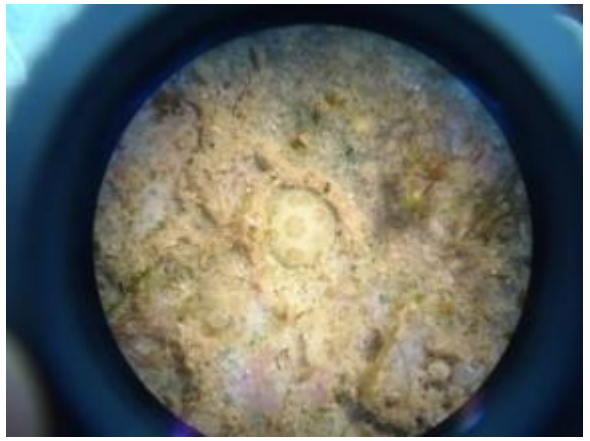
Bringing Concrete to Life

Two years of Field and Lab Experiments:



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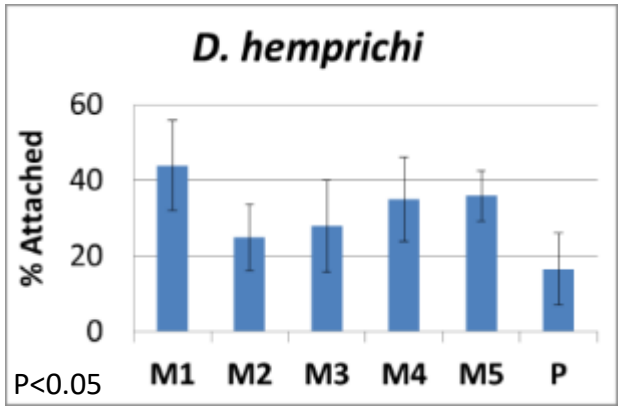
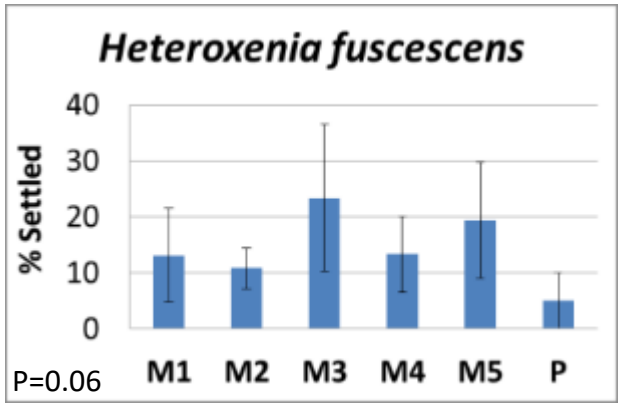
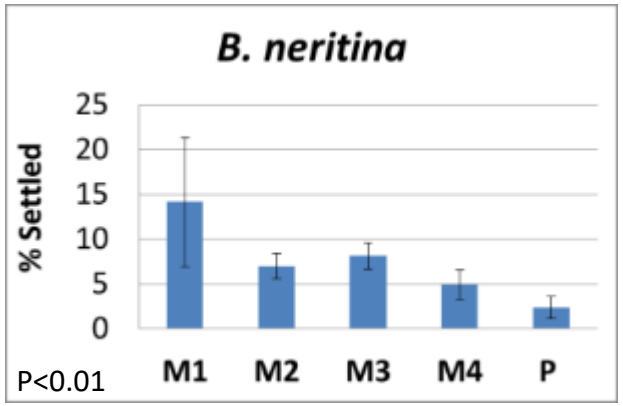
Bringing Concrete to Life

Lab settlement experiments:

- Significant differences between concrete matrices
- Portland based concrete - lower results than other matrices in all experiments

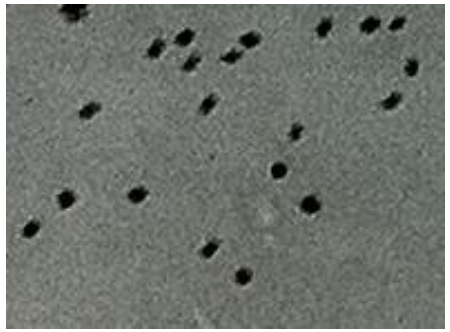






Red

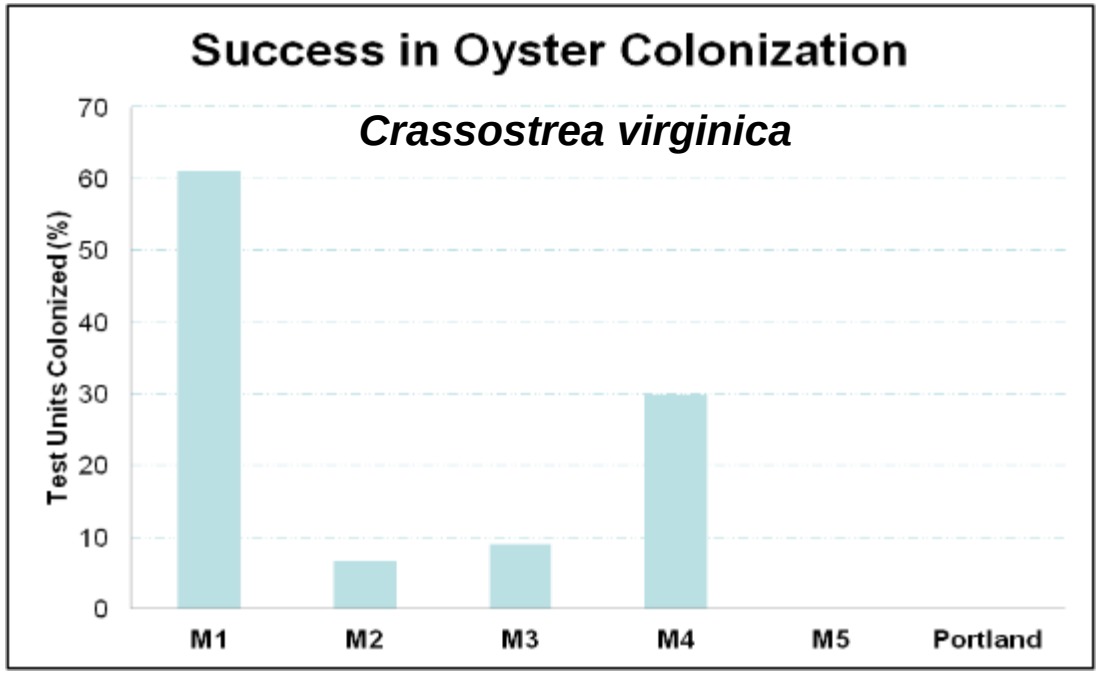
Red



Med

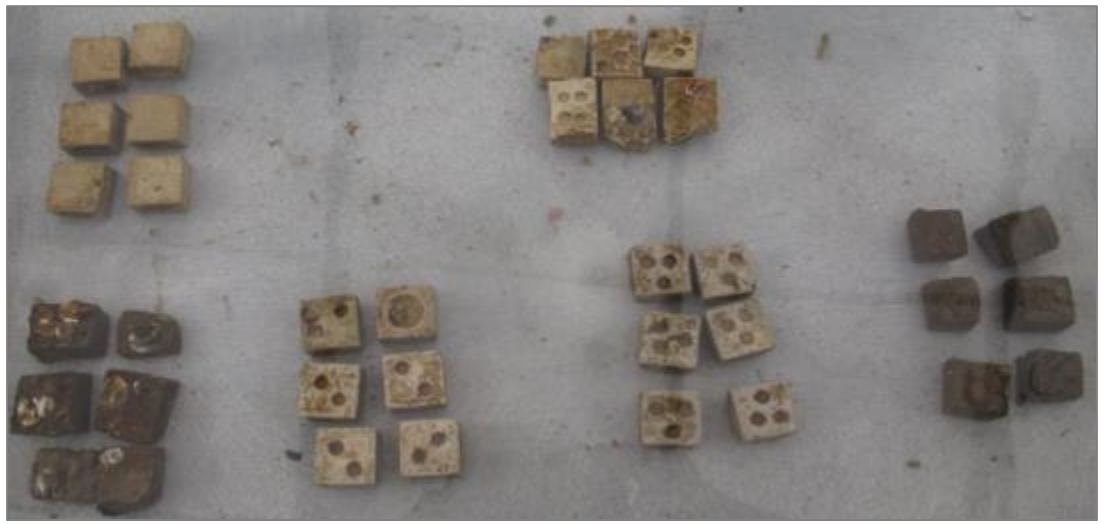
(Perkol-Finkel & Sella , 2014)

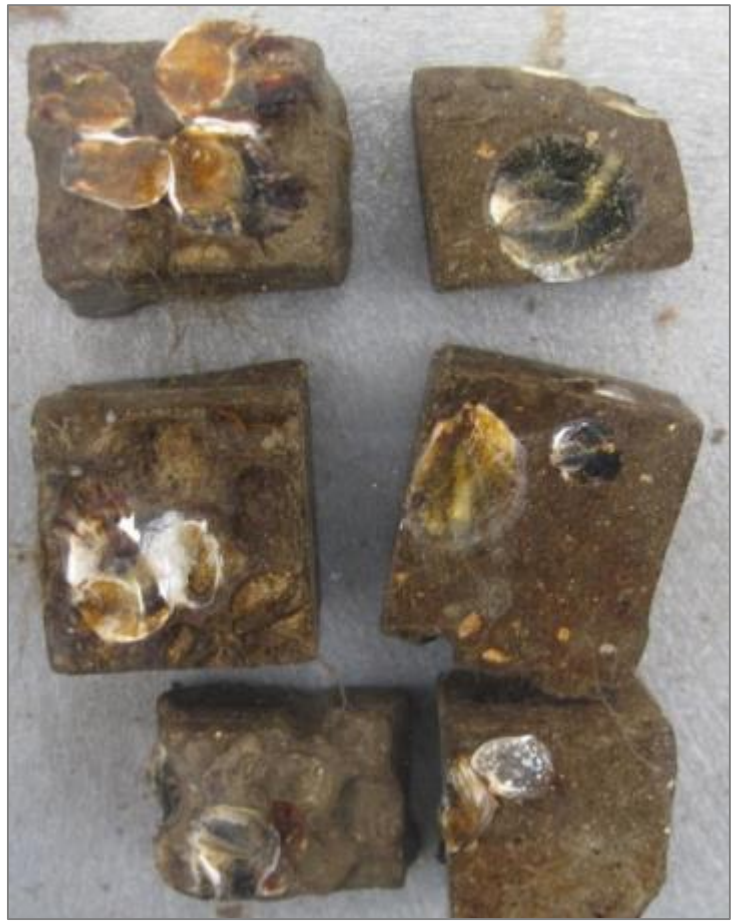
Bringing Concrete to Life



Matrix	Avg #
M1	2.73
M2	1.00
M3	1.00
M4	1.33
M5	0.00
Portland	0.00

Lab settlement experiments





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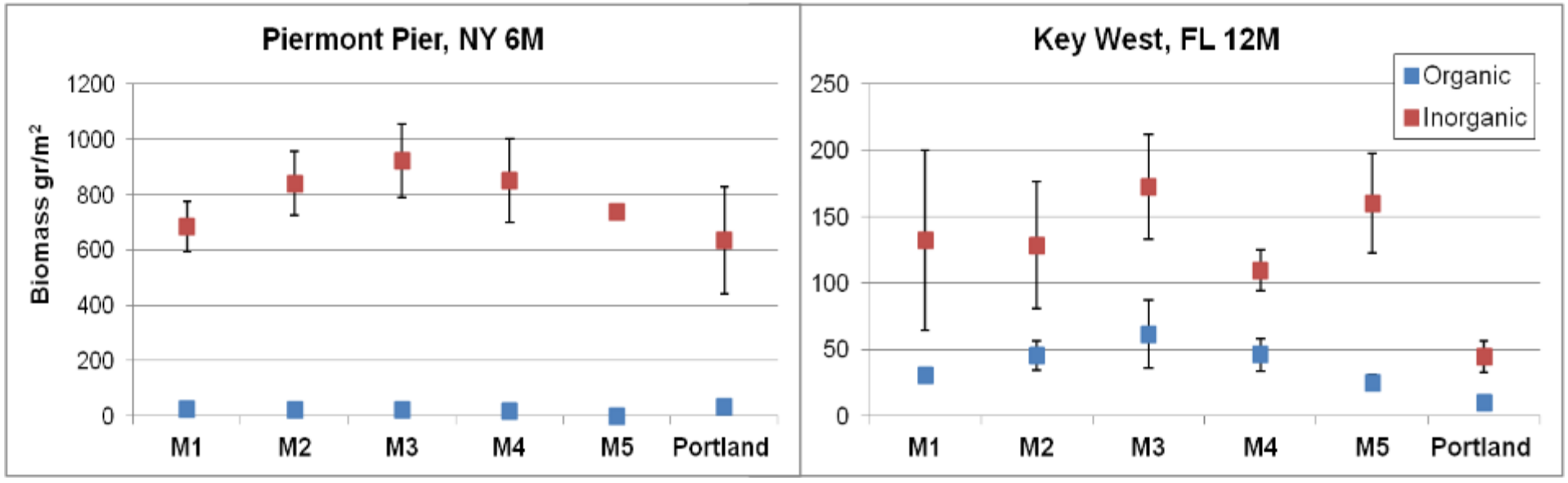
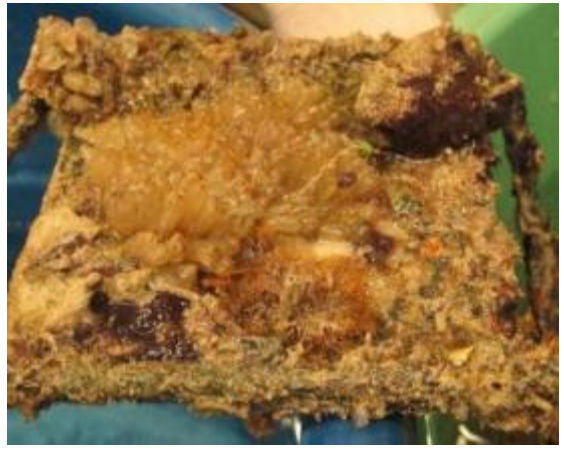
Bringing Concrete to Life

- **Inorganic matter:** significant differences
  - Concrete composition: Portland < Other Matrices
  - Months post deployment: 3 <6 < 12 M
  - Marine Environments: Temperate > Tropical



Maximal values:
Temperate 1 kg/m²
Tropical 0.5 kg/m²



Harnessing biological processes for building resilient coastal infrastructure - Herzliya Marina

Tel Aviv Metropolitan Area: > 3.6 M people

Herzliya Marina: One of the biggest & most innovative marinas in East Mediterranean
Blue Flag Marina
Hosts the World Harbor Project Green Engineering experiment
In the process of transforming its infrastructure to Bio-enhanced

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The Herzliya Municipal Tourism Development Corporation Ltd.

Harnessing biological processes for building resilient coastal infrastructure - Herzliya Marina

1) Armoring Units

2) Anchorage Systems

3) Seawalls

4) Tide-pools

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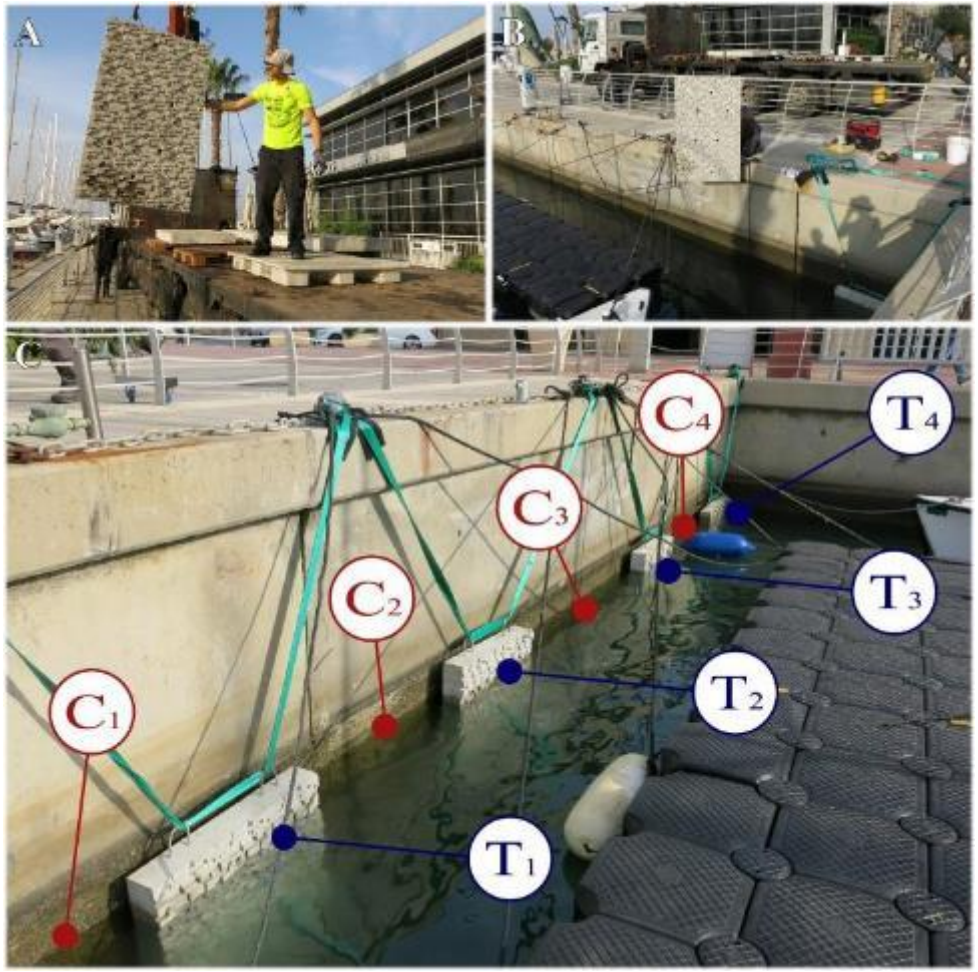
Experimental Array

- Treatment panels (150x90x13cm, 300Kg) placed vertically intertidal to sub-littoral
- Control plots composed of existing concrete seawall, same depths zones (scraped after baseline)



Intertidal
4 Treatment + 4 Control

Sub-littoral
4 Treatment + 4 Control

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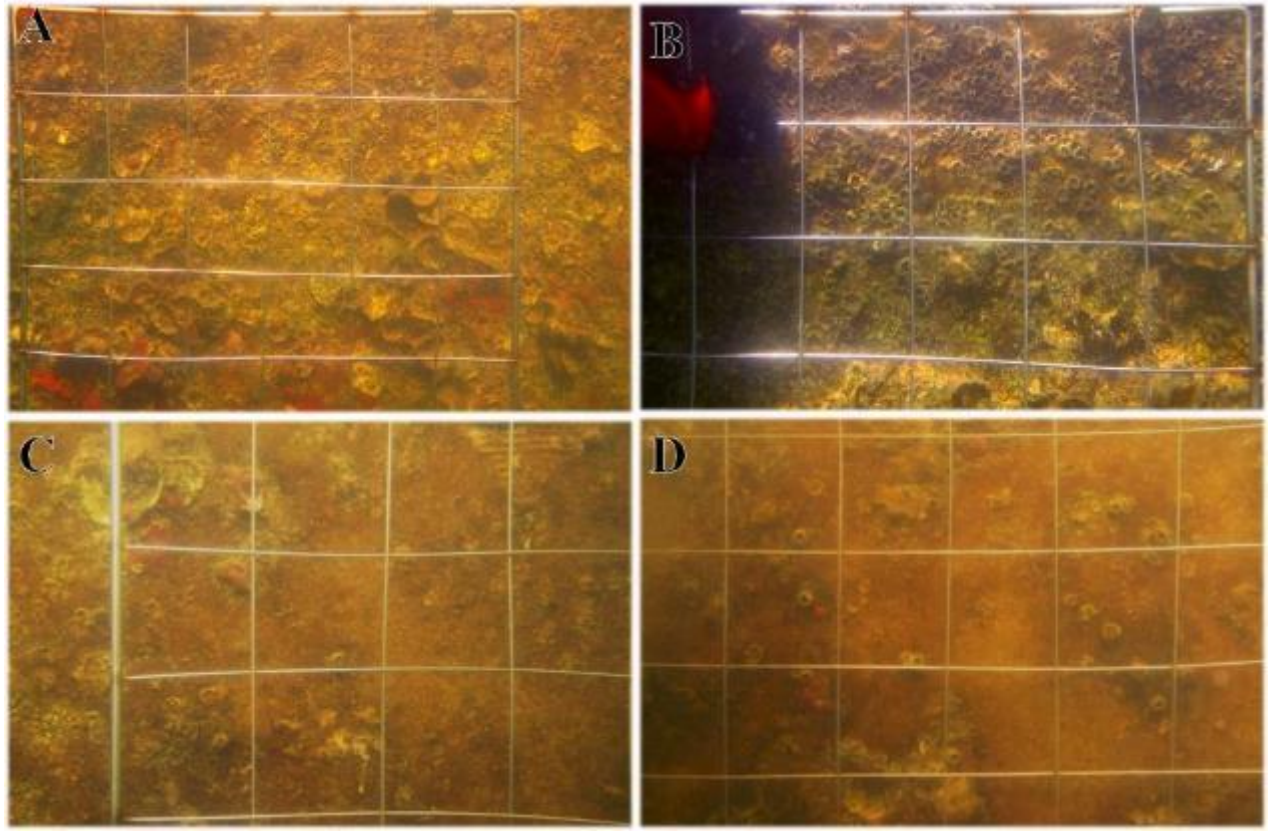
Results

Baseline Survey – Existing Marina Concrete Seawall

- 8 taxa
- 100% cover turf algae
- Thick layer of dead barnacles
- Few small patches of *Mycale erythraeana* sponge
- Some live oysters (sub-littoral)



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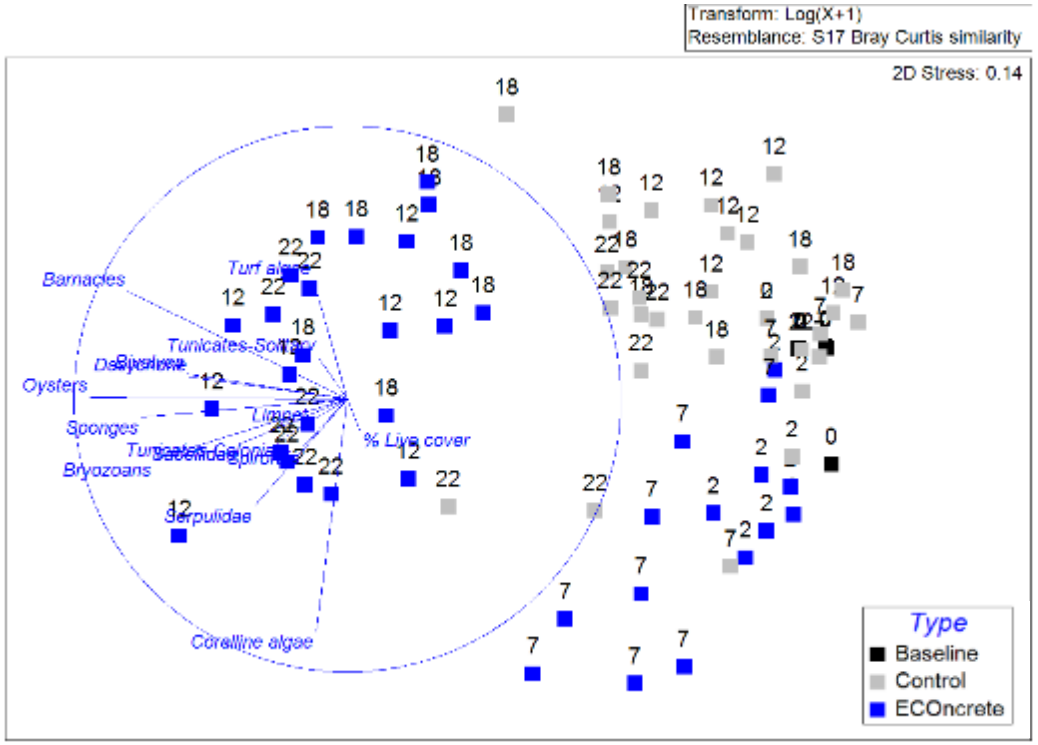
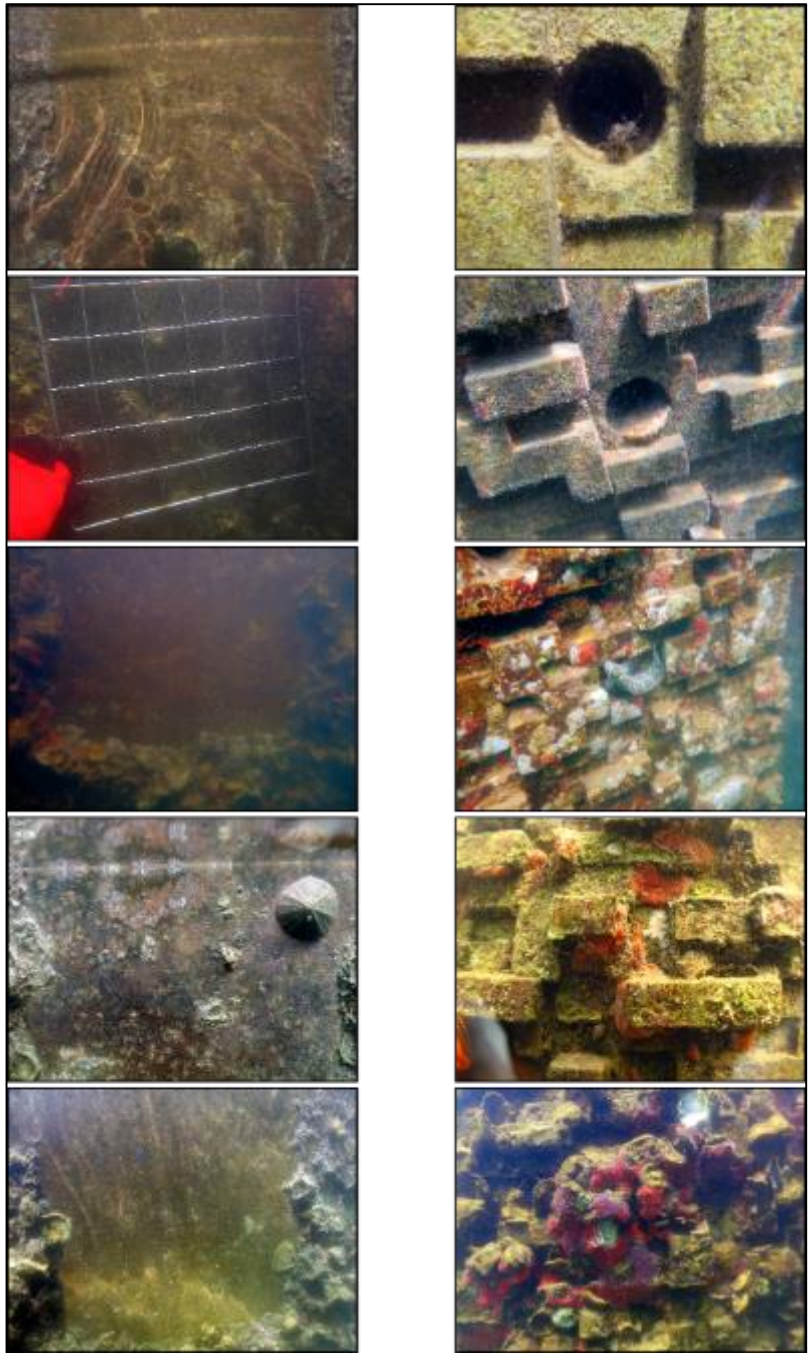
Results





- Following 2 years of monitoring, ECOncrete seawall panels supported 23 different taxa compared to only 12 taxa identified on the marina seawall
- Frequent appearance of motile species (fish, crabs, shrimps) on enhanced panels

(Perkol-Finkel & Sella , 2015)

ECOncrete
Concrete Ecological Solutions

The Herzliya Municipal Tourism Development Corporation Ltd.

world harbour project

Building resilient urban ports and harbours through globally integrated research and management

WHP Partners

Original partners	New since 2015	New since 2016
Abu Dhabi, UAE	Coquimbo, Chile	Boston, USA
Auckland, New Zealand	Darwin, Australia	Penang, Malaysia
Bremerhaven, Germany	Dublin, Ireland	
Chesapeake Bay, USA	Galway Bay, Ireland	
Heraklion, Greece	Hobart, Australia	
Hong Kong, China	Plymouth, UK	
Jakarta, Singapore	Port Elizabeth, South Africa	
New York, USA	San Francisco, USA	
Qingdao, China	Santander, Spain	
Ravenna, Italy	Shanghai, China	
Rio de Janeiro, Brazil	Taipei, Taiwan	
St Georges, Grenada	Tel Aviv, Israel	
Sydney, Australia	Xiamen, China	
Vigo, Spain		

Credit: Steinberg et al - World Harbour Project

world harbour project

Building resilient urban ports and harbours through globally integrated research and management

The efficacy of eco-engineered interventions for enhancing the native biodiversity of seawalls in harbours across the globe

World Harbour Project Supporters

THE IAN POTTER FOUNDATION

NSW GOVERNMENT

sims foundation supporting sydney institute of marine science

sims sydney institute of marine science

world harbour project

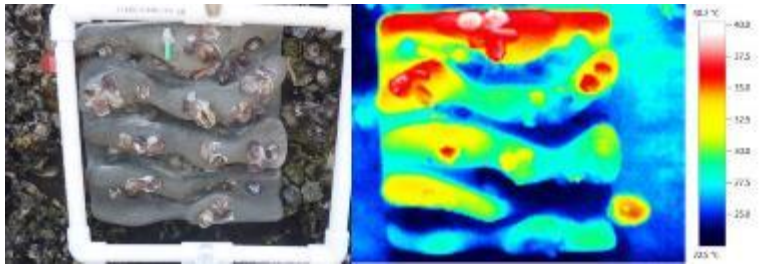
Credit: Strain, Steinberg and Bishop - Green Engineering Group - World Harbour Project

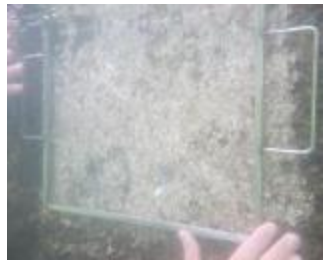
Harnessing biological processes for building resilient coastal infrastructure - WHP

Comparison of benthic recruitment on different substrates
Data collection included full biological survey and biomass measurements

7 typologies x 5 reps at 1.5 meter depth

- ECOncrete Flat
- ECOncrete Complex
- RDL Flat
- RDL 2.5cm
- RDL 5cm
- Portland Concrete Flat
- Cleared Marina Seawall (existing Portland Concrete)





Tiles on the day of deployment, and existing seawall scraped as baseline control

Tiles covered with marine growth 12 month post deployment

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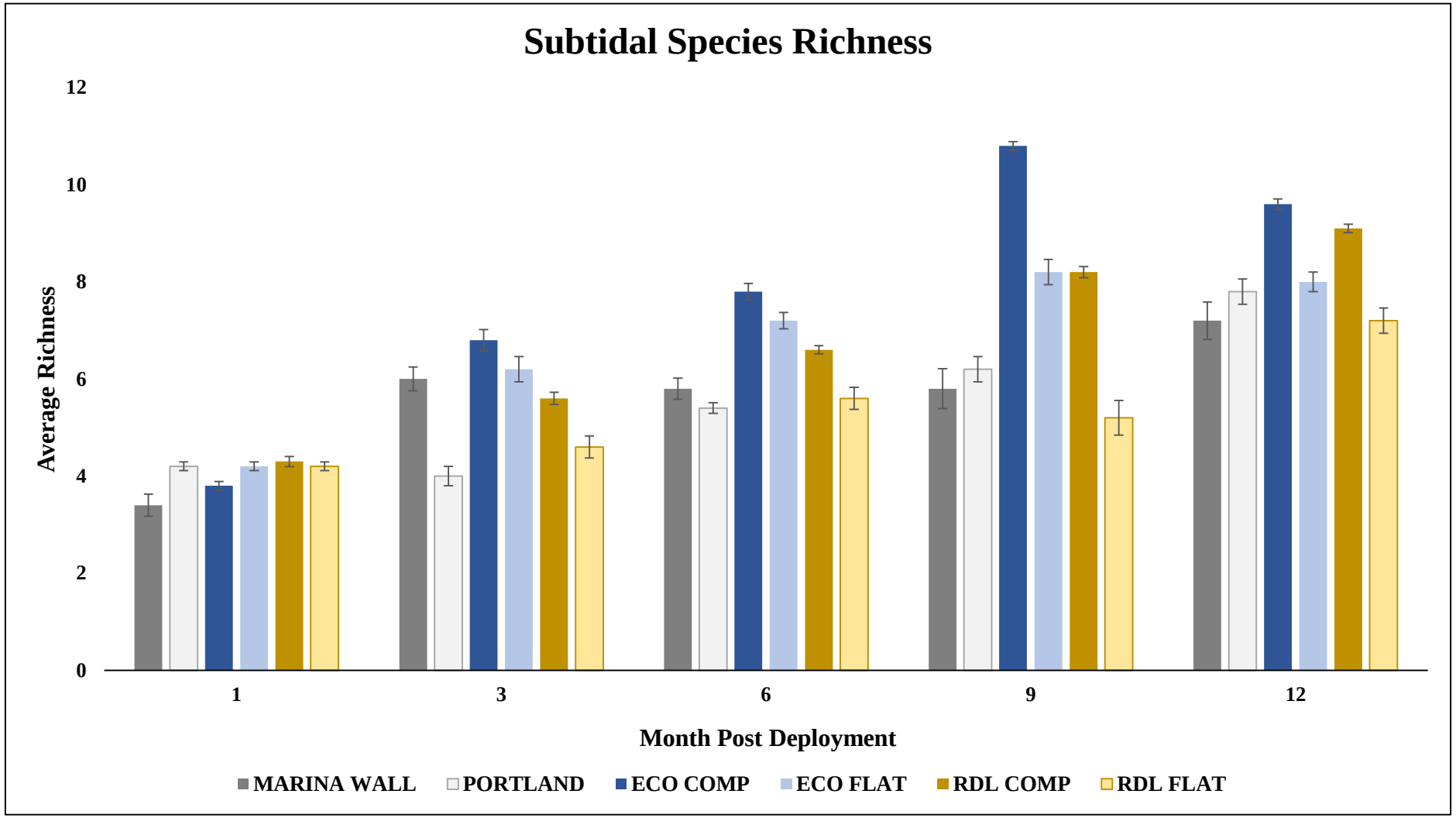
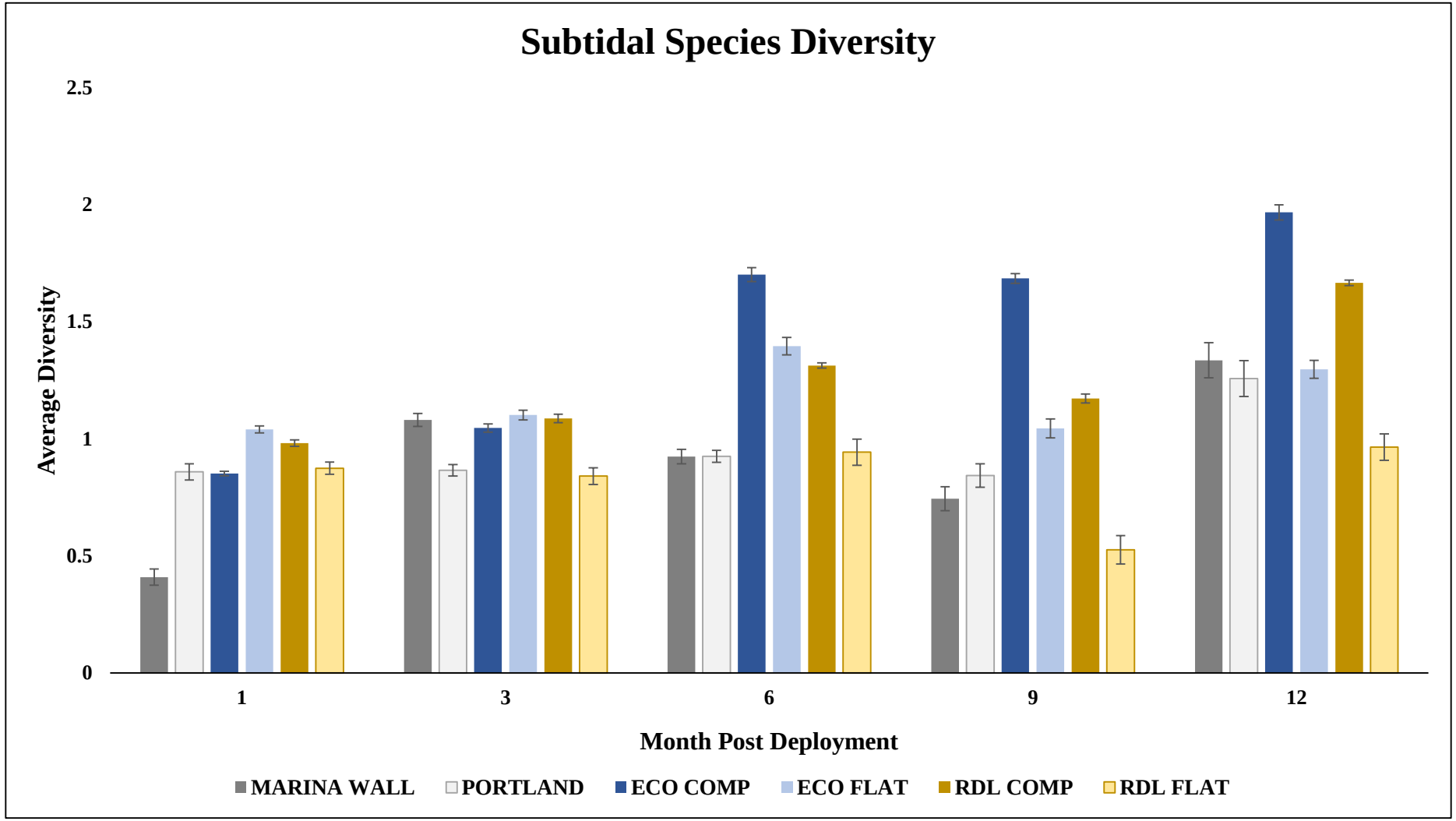
Harnessing biological processes for building resilient coastal infrastructure - WHP



Species richness was significantly higher on complex ECOncrete tiles compared to all other tiles as of the 9 months sampling ($P<0.05$)

ECOncrete
Concrete Ecological Solutions

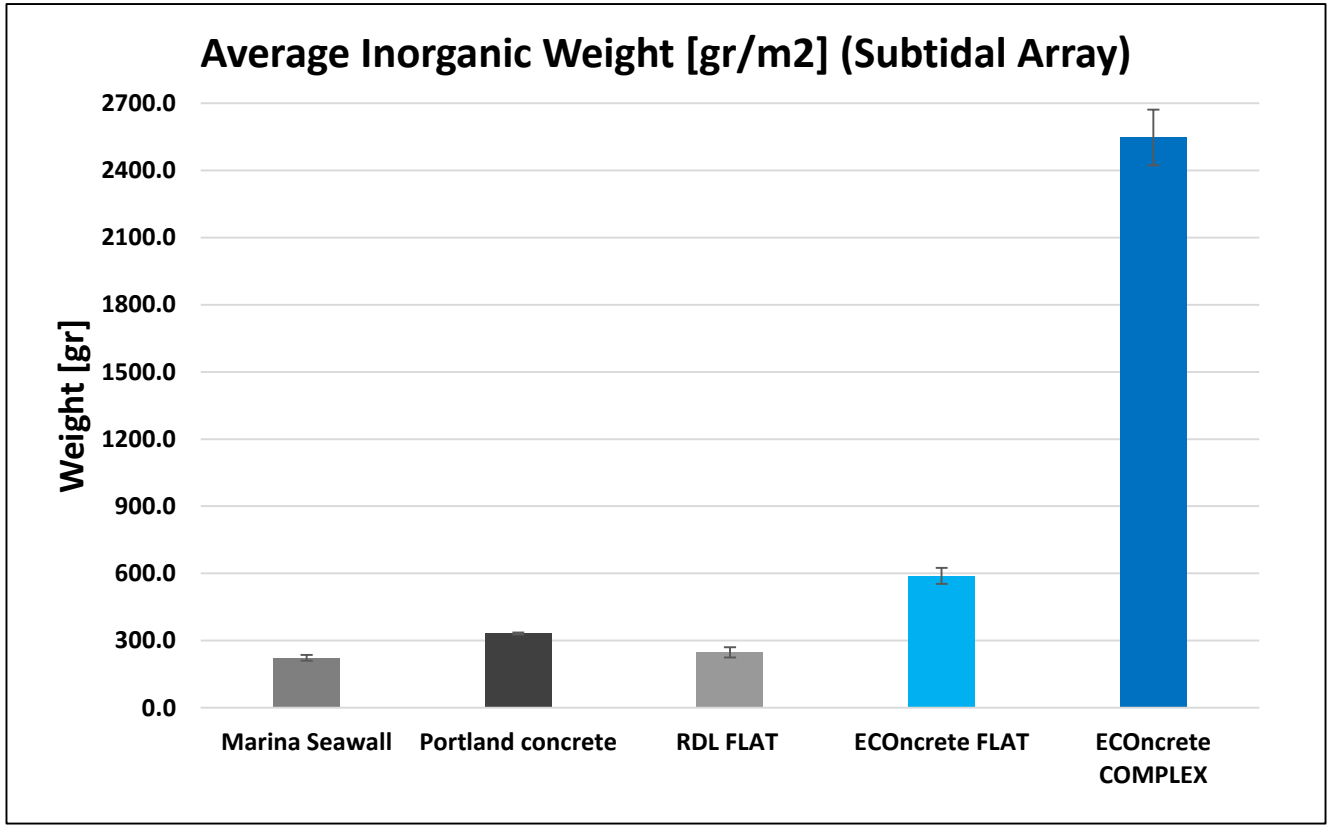
Harnessing biological processes for building resilient coastal infrastructure - WHP



Species diversity was significantly higher on complex ECOncrete tiles compared to all other tiles as of 6 months sampling ($P<0.05$)

ECOncrete
Concrete Ecological Solutions

Harnessing biological processes for building resilient coastal infrastructure - WHP



Inorganic biomass on complex ECOncrete tiles was significantly higher than all other substrates sampled (Permanova P<0.05)

ECO Flat X 2 RDL Flat/Portland/ Seawall (P<0.05)

ECO Comp* X 4 ECO Flat X 11 Marina Seawall (P<0.05)

* Surface area of ECO Comp tile (0.0910m^2) is X 1.5 compared to Flat tiles (0.0625m^2), yet recruited X 4 inorganic biomass than ECO Flat and more than x 8 than Flat/Portland/ Seawall

ECOncrete® Concrete Ecological Solutions

Enhanced Biogenic Buildup → Carbon Sink

ECOncrete® - Up to 86% Reduced Carbon Footprint

up to 86% less carbon footprint compared to standard Portland cement based concrete products

I. Combination of proprietary admix integrating by-products and recycled materials

II. Unique ability to enhance biological processes:
   - Biocalcification
   - Photosynthesis

In temperate environments, ECOncrete gained an average of 2.5 Kg/m^2/y of inorganic matter from biogenic buildup by calcifying species storing up to 0.3 Kg/m^2/y CO_2

ECOncrete® Concrete Ecological Solutions

Eco Engineering for Climate Change

Working Together to Build a More Resilient Region

Photo 1 of 1 ← Prev Next →

Since June 2013, ten interdisciplinary design teams have been working with a diverse range of stakeholders throughout the Sandy-affected region to develop innovative solutions to rebuild. On June 2nd, Secretary Shaun Donovan of HUD announced the winning proposals. Read More about the final designs.

Winning Proposals

LIVING BREAKWATERS

SCAPE / Landscape Architecture
Staten Island, New York

Hunts Point Lifelines

PennDesign/OLIN
Bronx, New York

Resist, Delay, Store, Discharge: A Comprehensive Strategy for Hoboken

OMA
Hoboken, New Jersey

New Meadowlands: Productive City + Regional Park

MIT CAU + ZUS + URBANISTEN
The Meadowlands, New Jersey

Living with the Bay: A Comprehensive Regional Resiliency Plan for Nassau County's South Shore

Interboro Team
Long Island, New York

BIG U

Eco Engineering for Climate Change

LIVING BREAKWATERS & TOTTENVILLE SHORELINE PROTECTION PROJECT

NEW YORK
STATE OF
OPPORTUNITY.

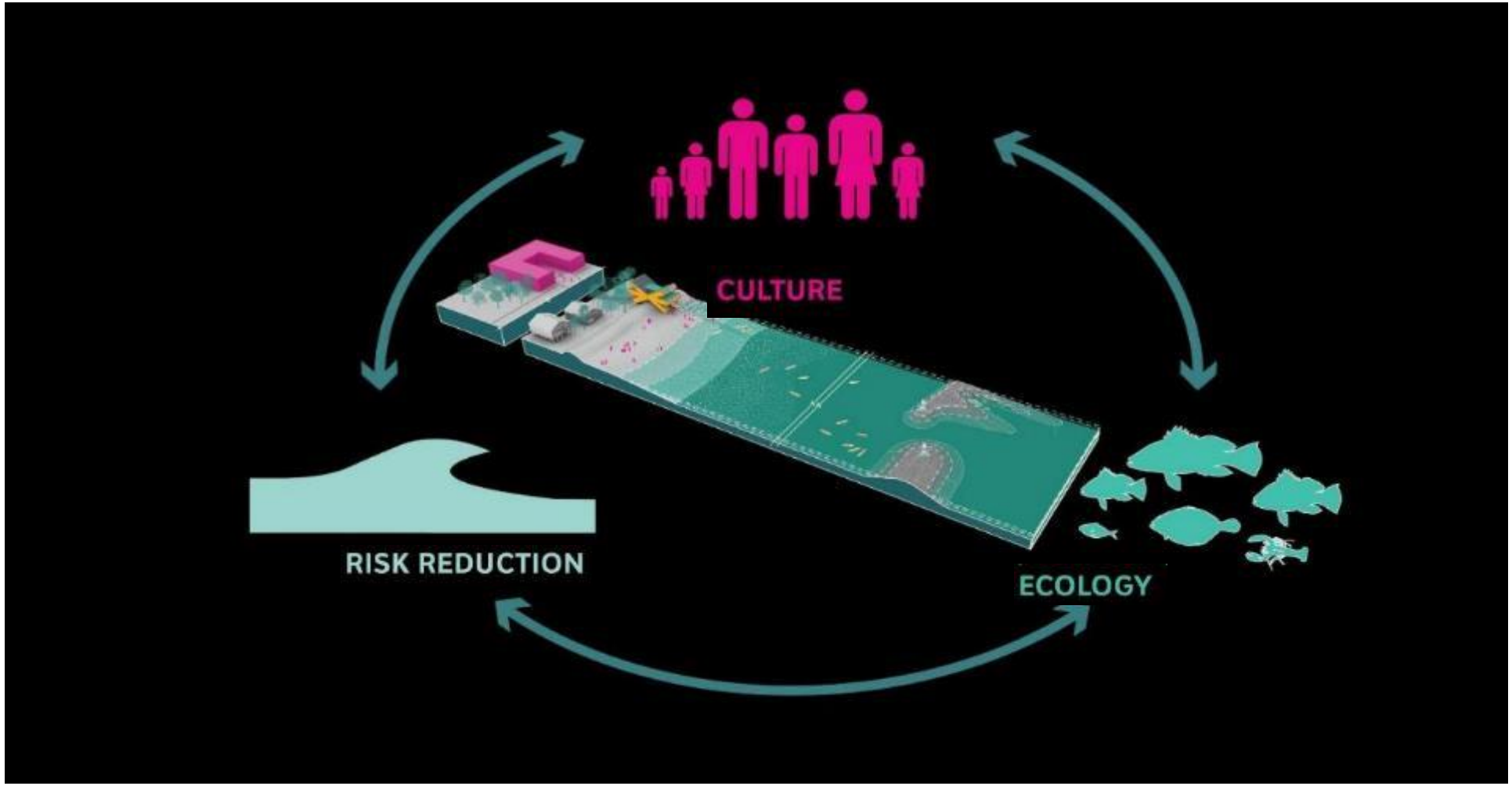
Governor's Office of
Storm Recovery

SCAPE TEAM

SCAPE / LANDSCAPE ARCHITECTURE
OCEAN AND COASTAL CONSULTANTS
PARSONS BRINCKERHOFF
ARCADIS
SEARC ECOLOGICAL MARINE CONSULTING
NEW YORK HARBOR FOUNDATION
LOT-EK ARCHITECTURE
MFS CONSULTING ENGINEERS
PRUDENT ENGINEERING

Eco Engineering for Climate Change

LIVING BREAKWATERS & TOTTENVILLE SHORELINE PROTECTION



SCAPE TEAM

Eco Engineering for Climate Change

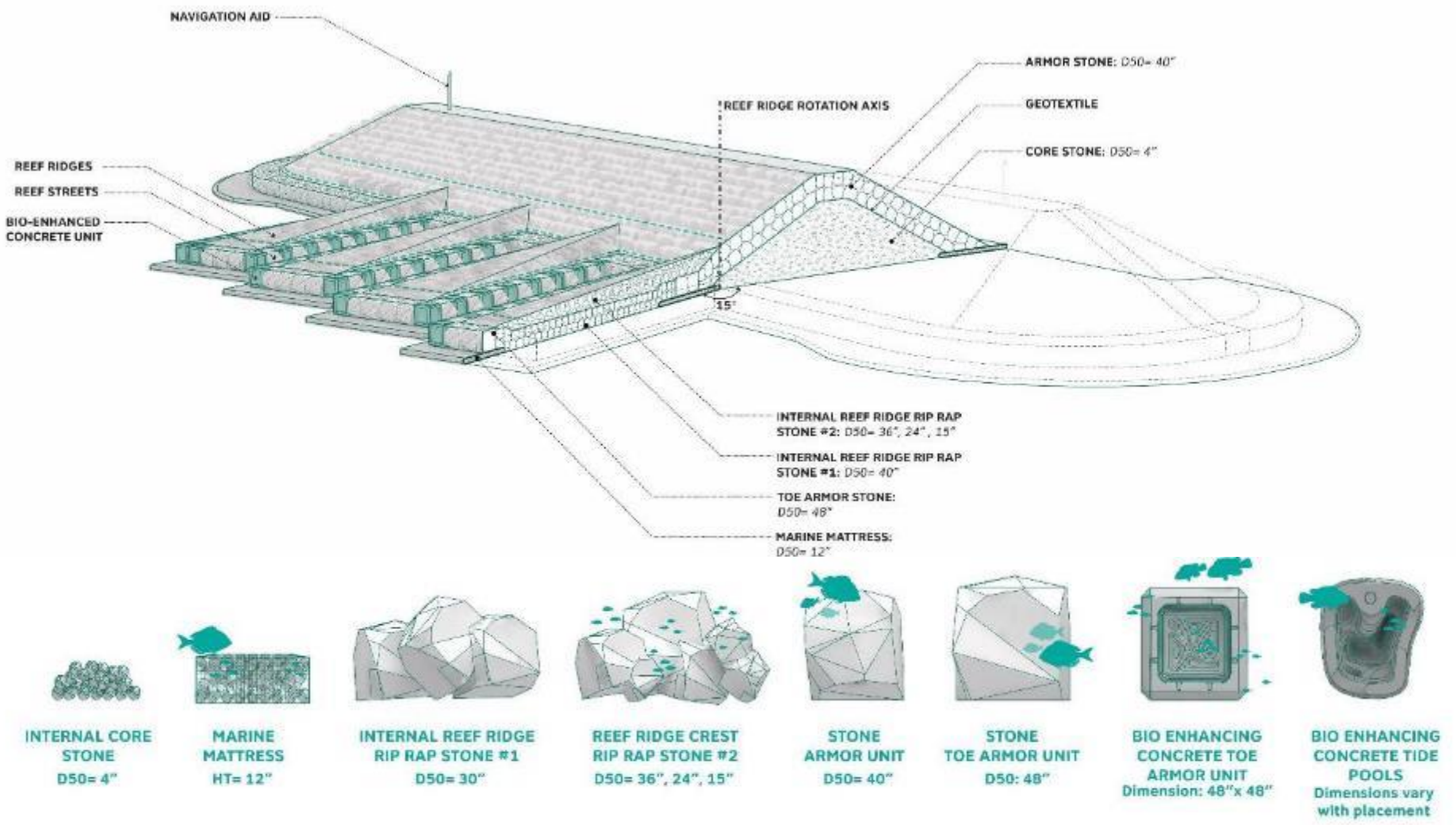
LIVING BREAKWATERS DESIGN
PRELIMINARY 60% DESIGN

LIVING BREAKWATERS & TOTTENVILLE
SHORELINE PROTECTION

Eco Engineering for Climate Change

BREAWATER MATERIALS

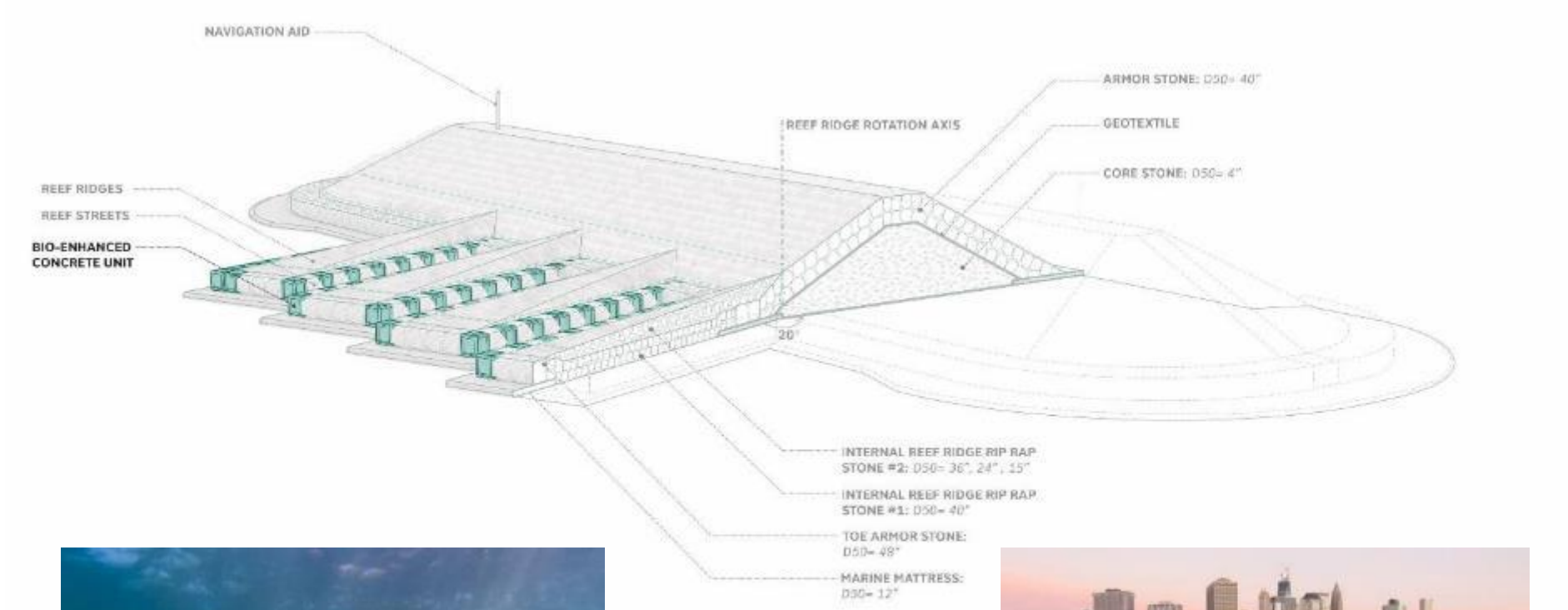
LIVING BREAKWATERS & TOTTENVILLE SHORELINE PROTECTION



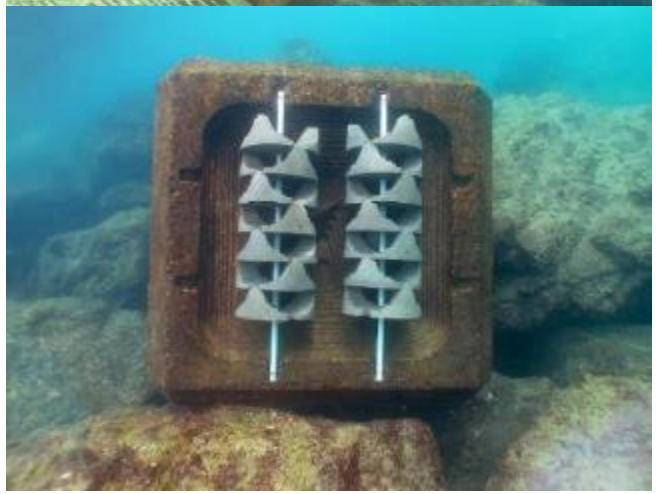
Eco Engineering for Climate Change

BIO-ENHANCED CONCRETE UNITS

LIVING BREAKWATERS & TOTTENVILLE SHORELINE PROTECTION



Eco Engineering for Climate Change



BIO ENHANCING CONCRETE TOE ARMOR UNIT
Dimension: 48"x 48"x 48"

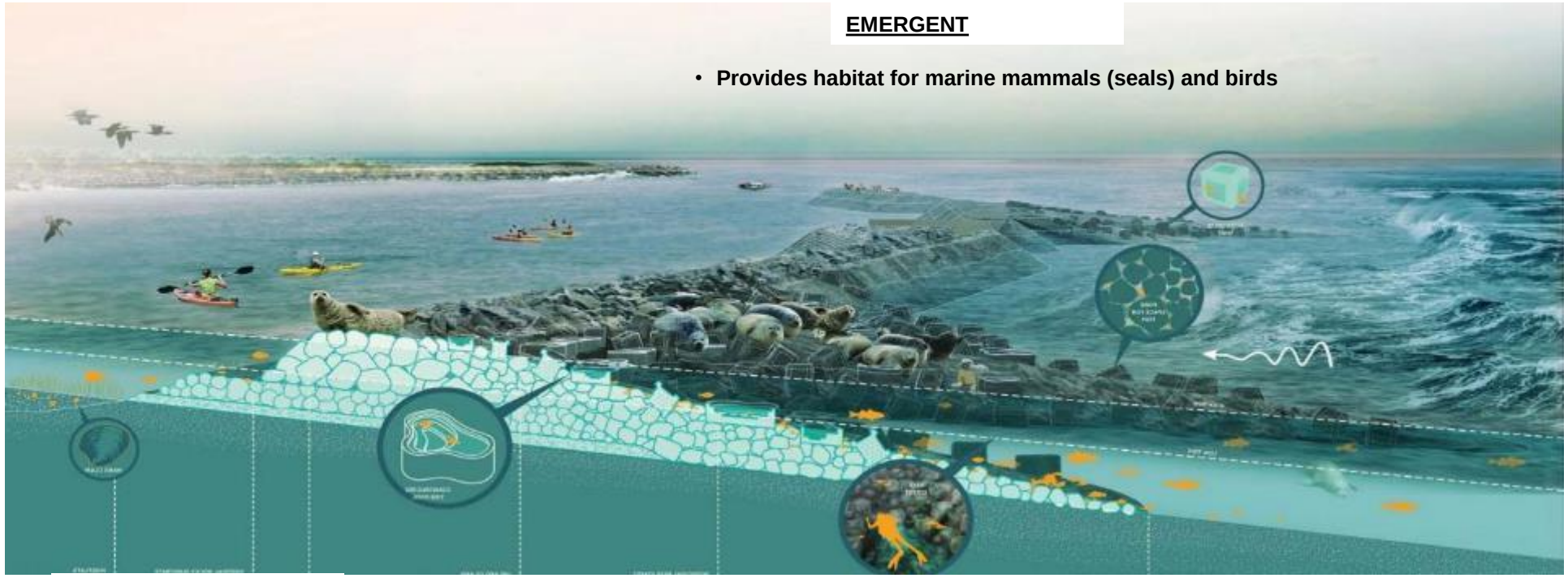
BIO ENHANCING CONCRETE TIDE POOLS
Dimension: 44"X 48"X27

Eco Engineering for Climate Change

Eco Engineering for Climate Change

Breakwater Cross-section: Habitat Potential

LIVING BREAKWATERS & TOTTENVILLE SHORELINE PROTECTION



EMERGENT

- Provides habitat for marine mammals (seals) and birds

CORE / LEESIDE

- Higher likelihood of fine grain sediment build up
- Habitat for Hard Clams and Flounder
- Eelgrass habitat creation

CORE / WAVESIDE

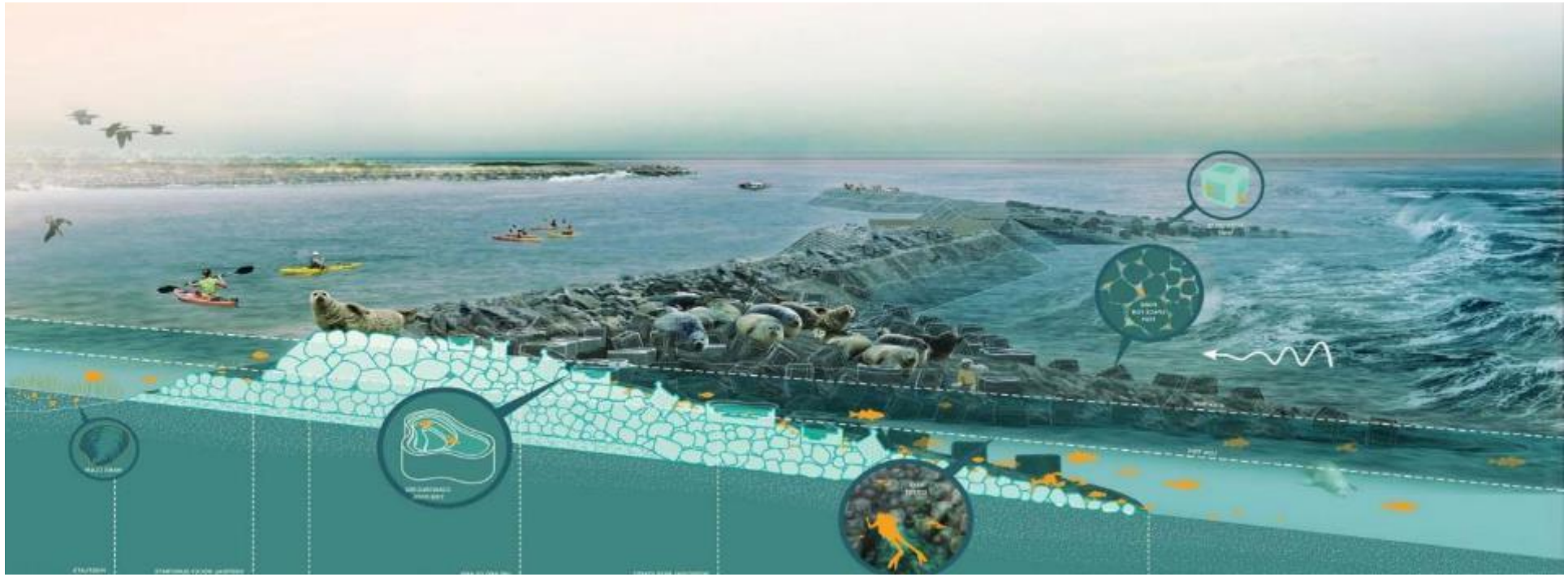
- Habitat for predatory fish and other larger animals
- Likely to have low amounts of sedimentation

REEF FINGER / STREET

- High diversity of niche ranges & varied habitat
- Habitat for juvenile fish and crustaceans
- Sediment halo provides enhancement to soft-bottom
- Increased water circulation through streets

Eco Engineering for Climate Change

LIVING BREAKWATERS & TOTTENVILLE SHORELINE PROTECTION



- **Eco-Design reduced mitigation penalty by over 50%**
- **All Breakwater regions below MHHW = Habitat Creation**

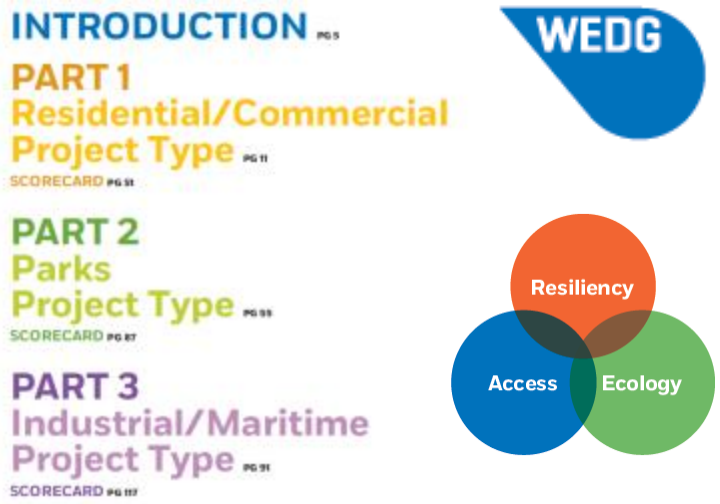
Blue ***is the new*** *Green*

Need for established incentives/regulations

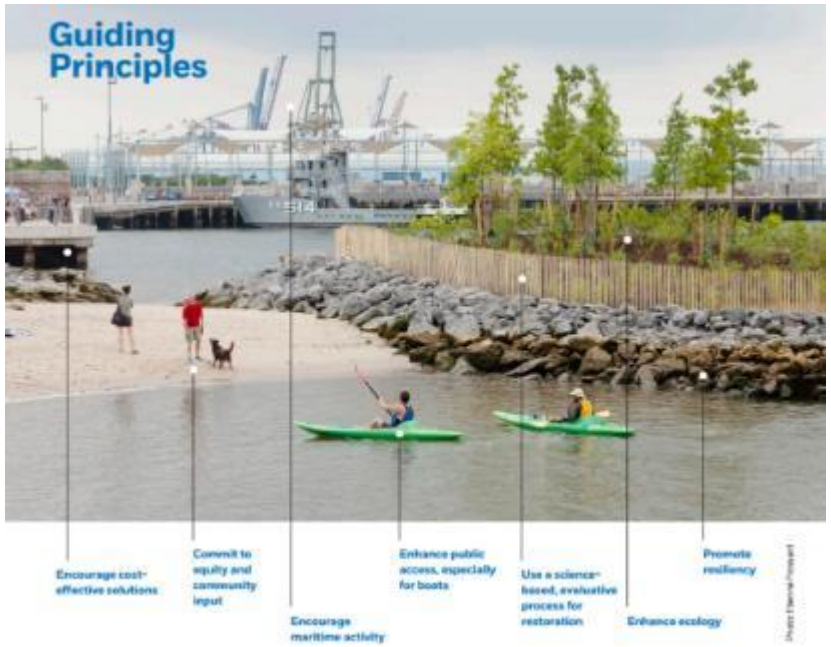
While “green” building standards such as the LEED system are applied globally, “blue” standards for coastal infrastructure are only now spurring (Envision™, WEDG) calling for further R&D of innovative environmentally sensitive technologies

Waterfront Edge Design Guidelines (WEDG)

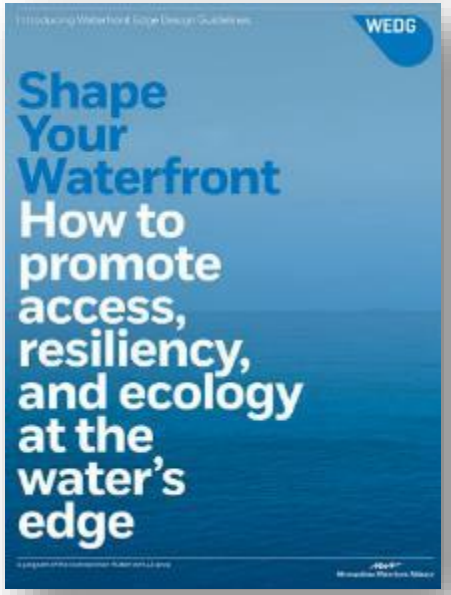
"A well-designed edge is one where waterfront access, resilience, and ecological benefits are all incorporated into an integrated design."

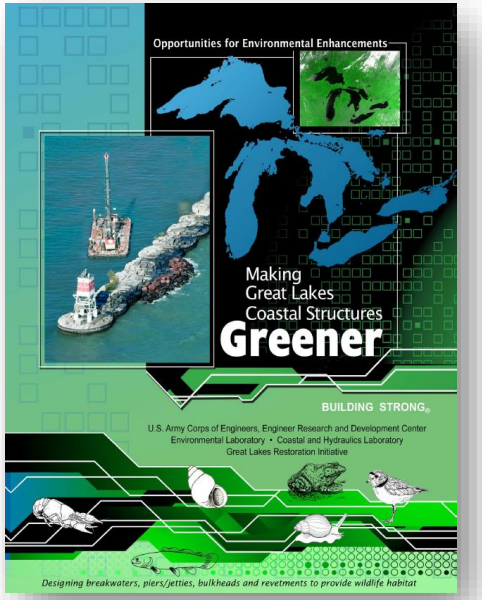


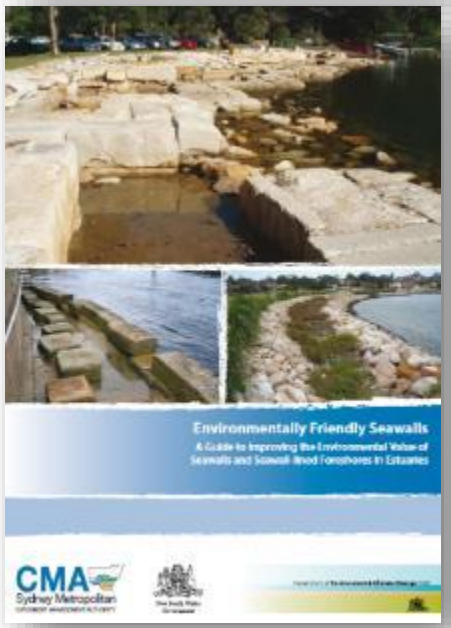
www.waterfrontalliance.org/WEDG

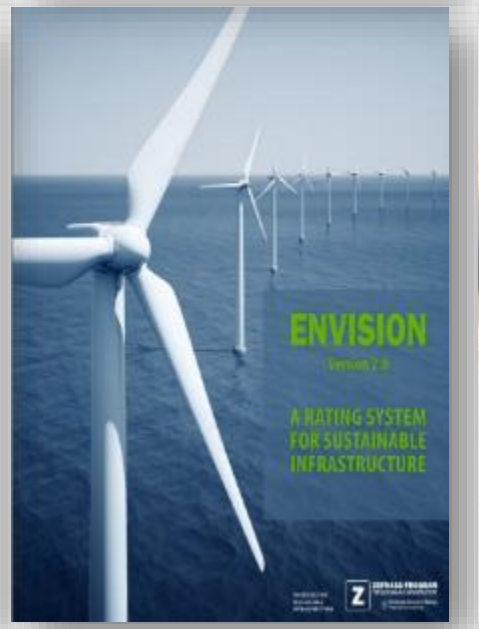


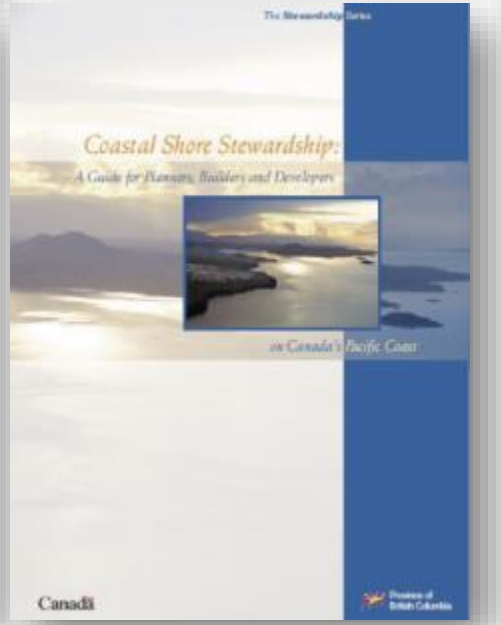
Blue is the new *Green*



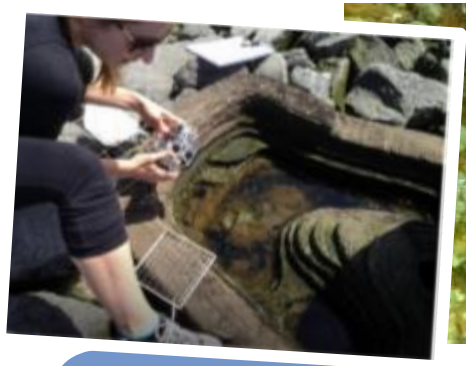








Blue is the new *Green*



Invasive & Nuisance Species

Sensitivity to Wave/Temp/Chlorides

ECOSYSTEM GOODS & SERVICES
Biodiversity, Nursing grounds, Food & Shelter, Water Quality

BIOPROTECTION
Resistance to Wave/Temp/Chlorides

OUTGREENING VALUES
Reduced Carbon Footprint, Permitting, Bidding

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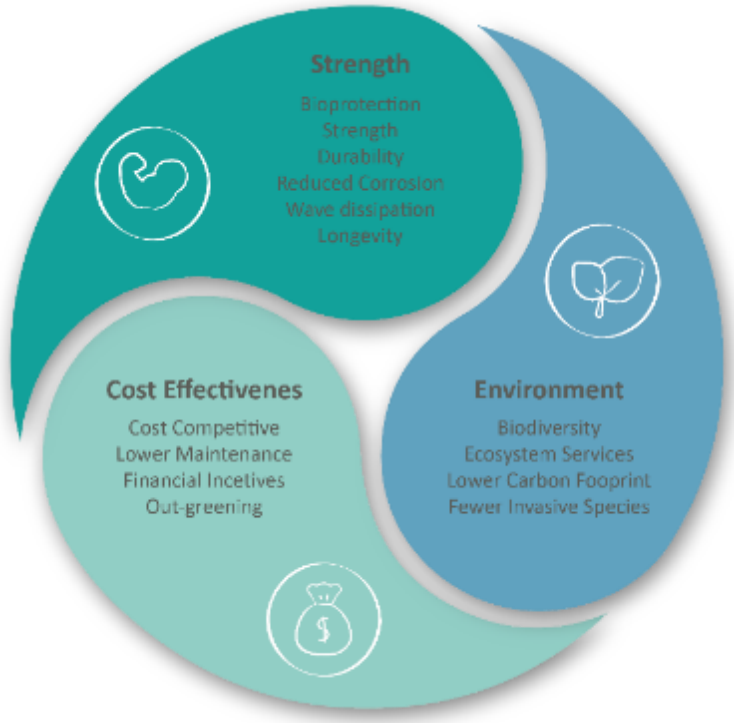
Bringing Concrete to Life

Conclusions & Recommendations

- Bringing life to coastal and marine infrastructure is a feasible, scalable and effective means for reducing the ecological footprint of coastal infrastructure even in a heavily urbanized settings
- Sustainable project - Importance of multi-disciplinary collaborations
- Harnessing biological processes can increase both ecological and structural performance
- Benefits of biogenic buildup and bioprotection (longer life span, reduced maintenance)
- Importance of integrating ecological considerations into planning, design, and implementation of future hard coastal infrastructure and management schemes in light of global climate change and population growth



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Building connections from the local to the landscape scale

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