Reconciliation Ecology in Urban Waterfronts

Bringing Concrete to Life

Ido Sella, PhD

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Concrete Ecological Solutions

Reconciliation Ecology

Branch of ecology which studies ways to encourage biodiversity in human-dominated ecosystems

Population Growth

50%

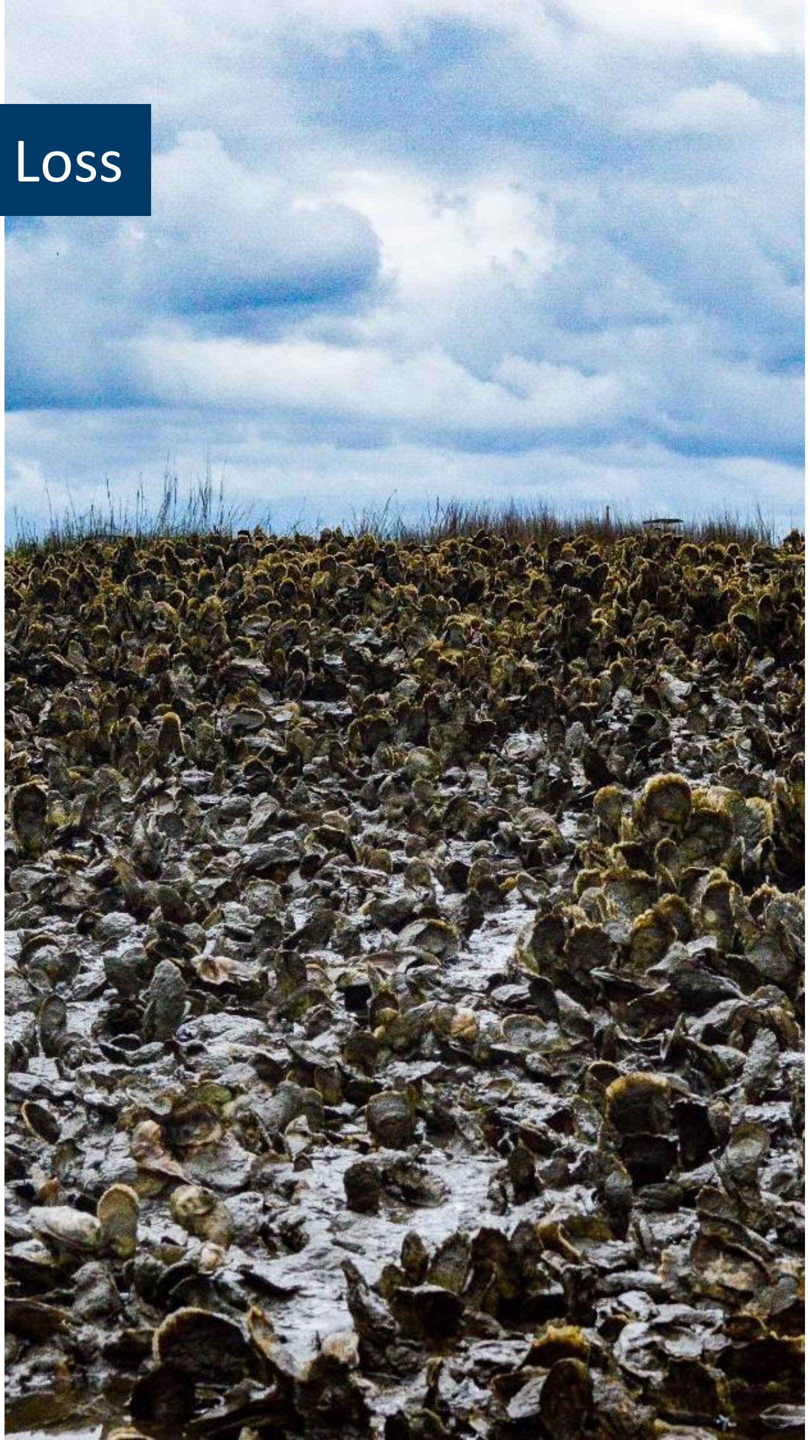
of the world’s population residing along coastlines

Concrete Problem

70%

of coastal and marine structures are concrete based

Habitat and Ecosystem Services Loss



Problem

Coastal infrastructure induce severe stress on natural ecosystems

Challenge

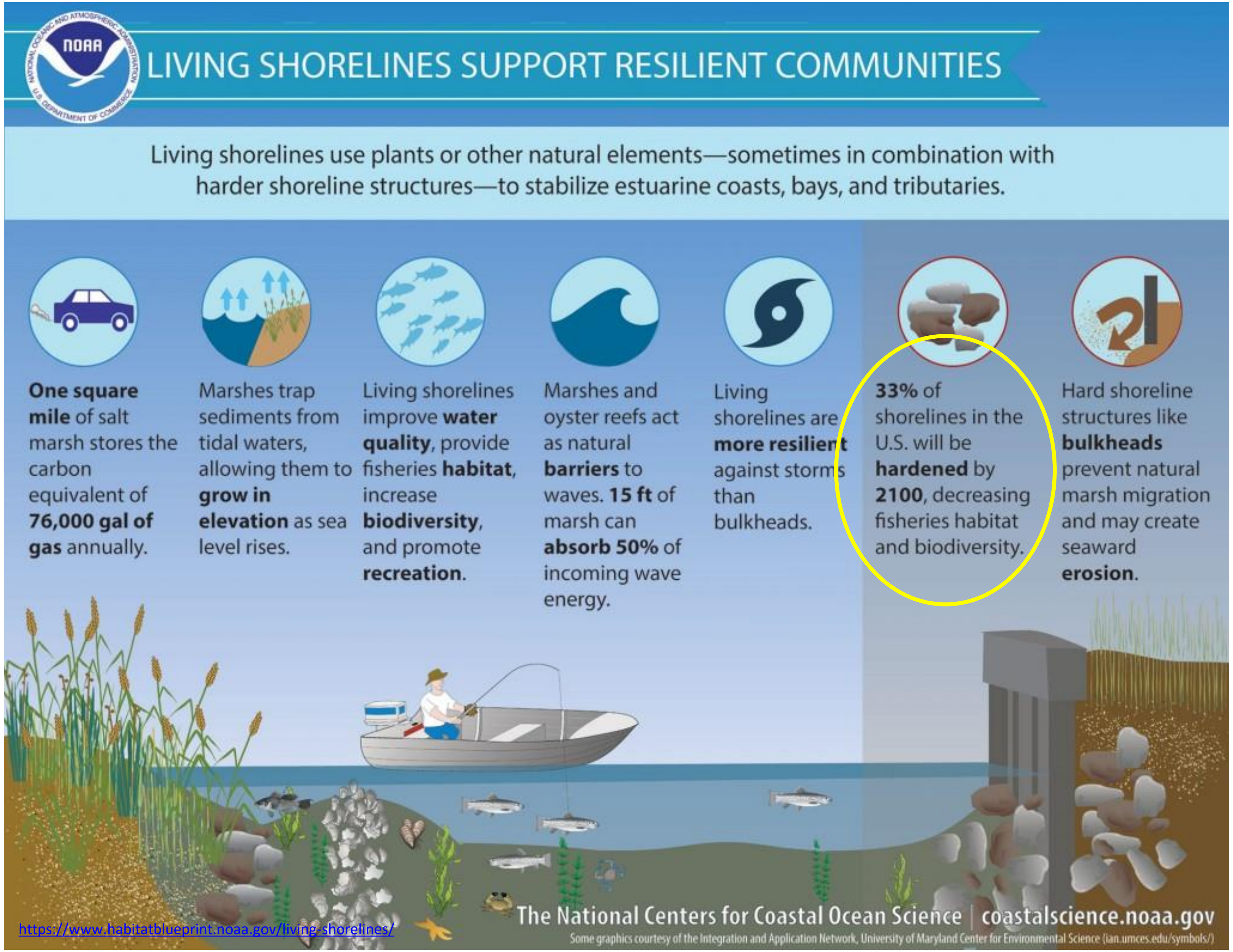
Development ⟷ Sustainability

Solution

Bringing Concrete to Life

Reconciliation Ecology standards for coastal & marine infrastructure

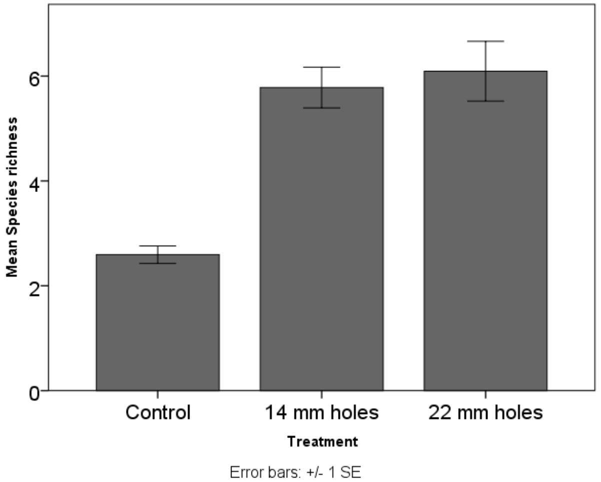
Greening the Gray

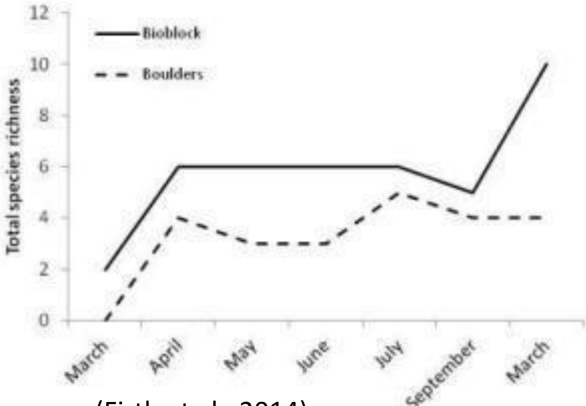


https://www.habitatblueprint.noaa.gov/living-shorelines/

Design solutions

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





(Firth et al., 2014)

Design solutions

Seattle Waterfront 2015- in progress

http://waterfrontseattle.org/

- Light penetration
- Vertical Habitats
- Sloping Habitats

Design and Material: Bringing Concrete to Life

Material composition

Surface complexity

Macro Design

- ✓ Rich and Diverse Marine Life
- ✓ Enhanced Ecosystem Services
- ✓ Improved Structural Performance

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Bio & Eco Advantages

- Biological niches
- Ecosystem services
- Water quality
- Reduce invasive species
- Aesthetics
- Carbon Sink

Bioprotection

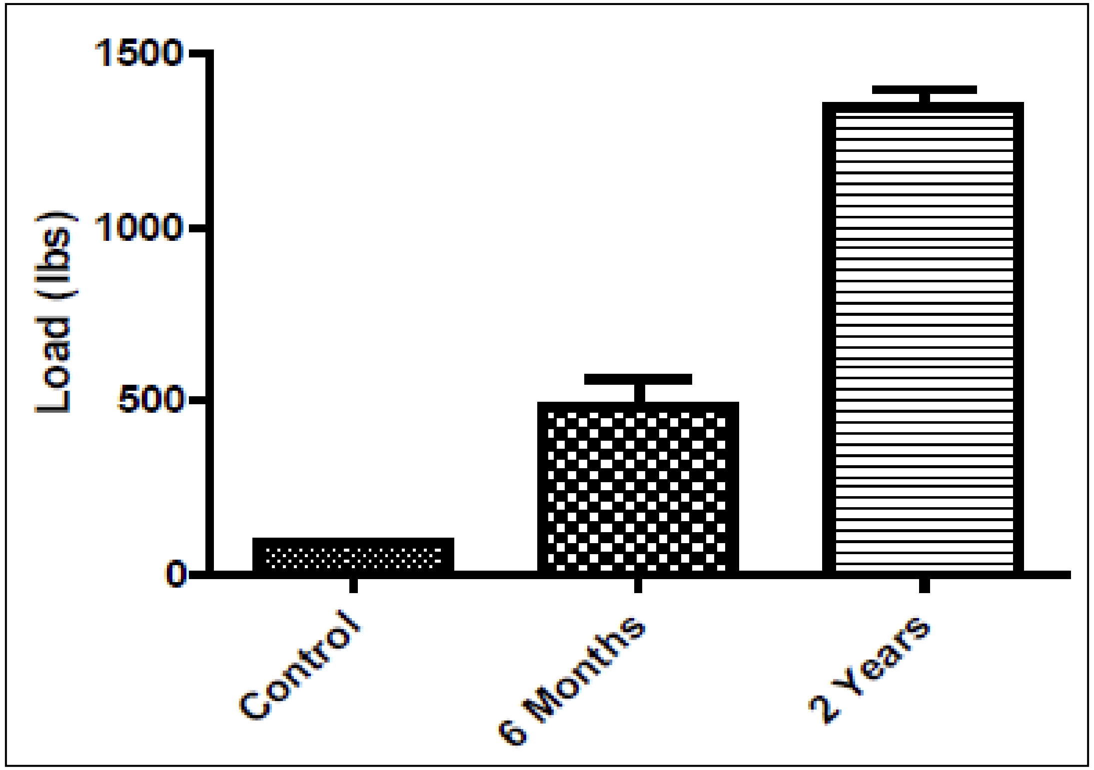
Changing Paradigms:

Biofouling → Bioprotection

Bioprotection

Concrete strengthens with time as oyster growth develops

(Risinger, 2012)



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Bioprotection

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

Carbon Sink

1 Km
ECOncrete seawall *

=

2 ton
CO_2/Year

=

100 trees**

* For a 7 m tall seawall
** Average 20kg/Year CO_2 absorbed per adult tree http://urbanforestrynetwork.org

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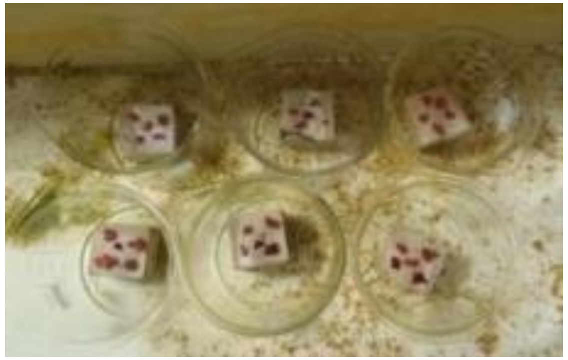
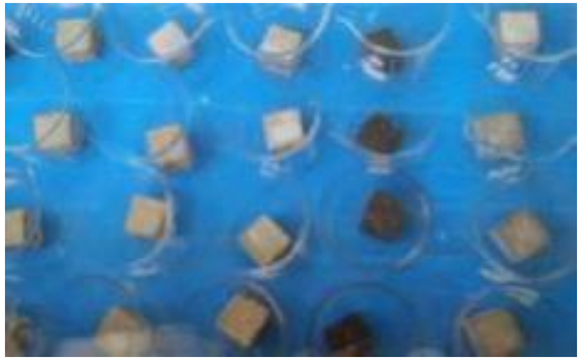
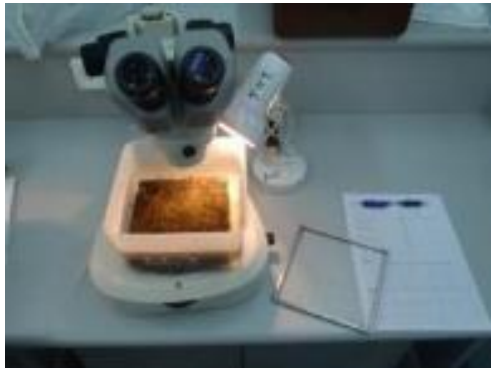





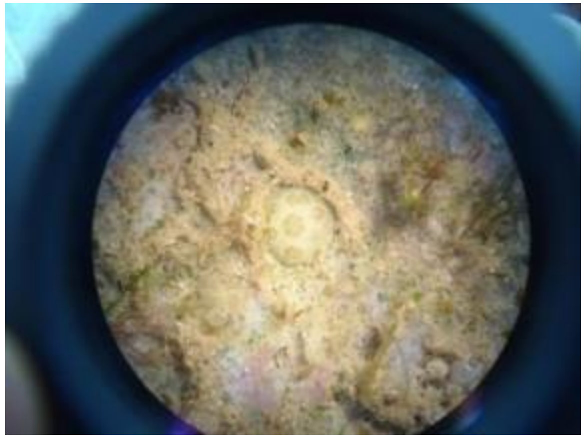

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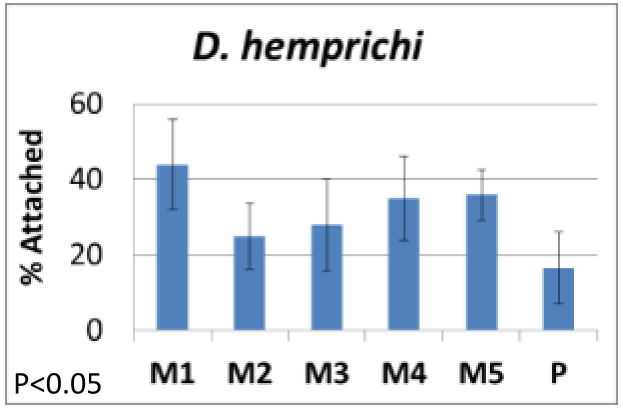
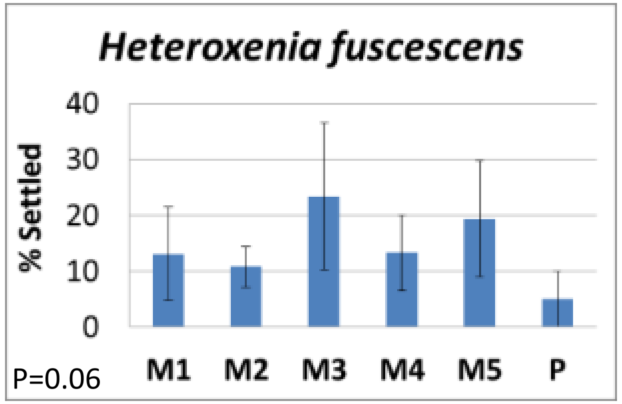
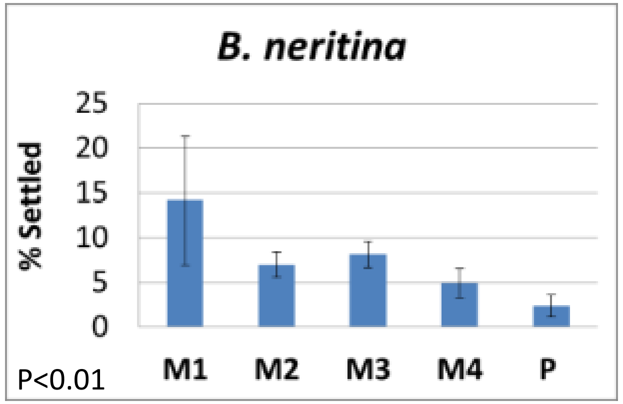
Lab settlement experiments:

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

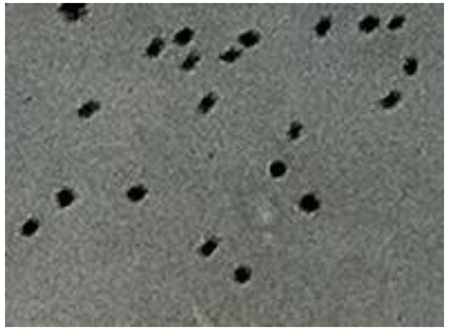






Red

Red



Med

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(Perkol-Finkel & Sella , 2014)

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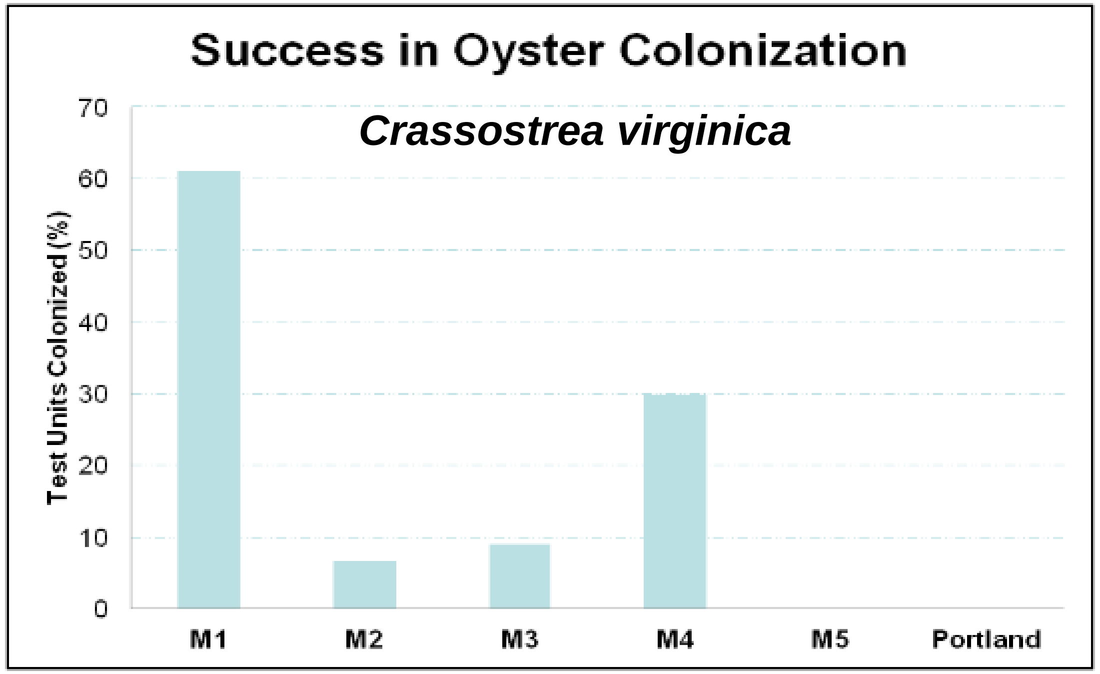
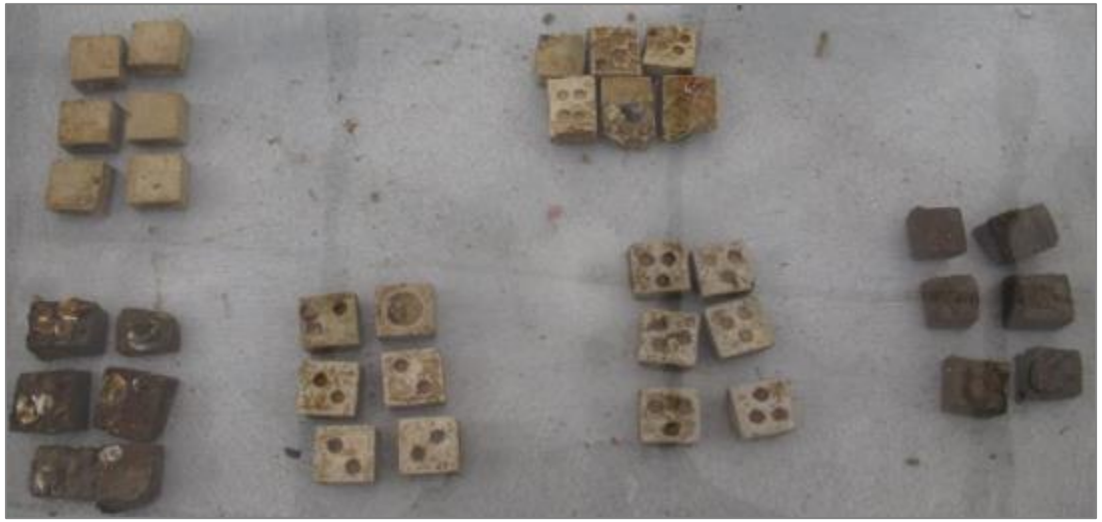


Matrix	Avg #
M1	2.73
M2	1.00
M3	1.00
M4	1.33
M5	0.00
Portland	0.00

Lab settlement experiments



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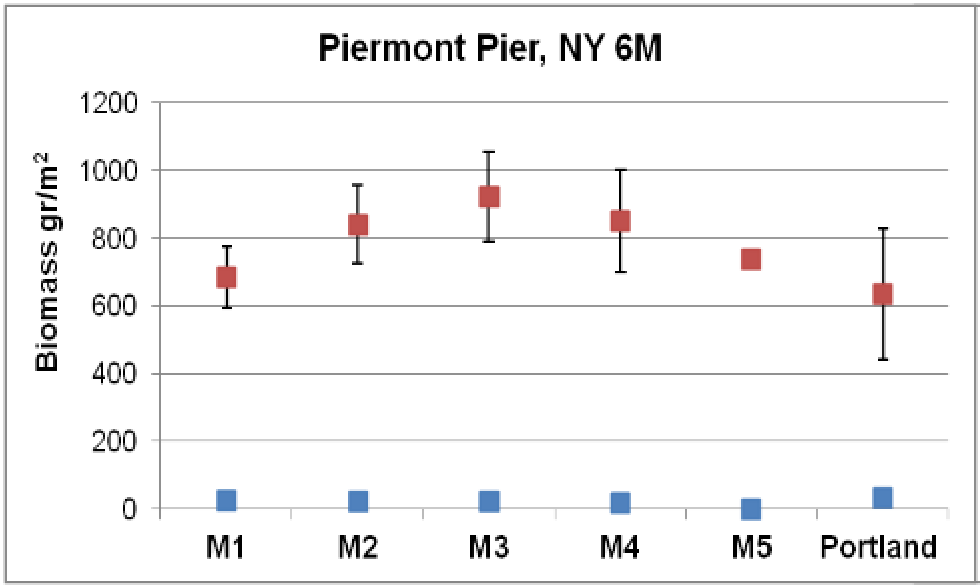
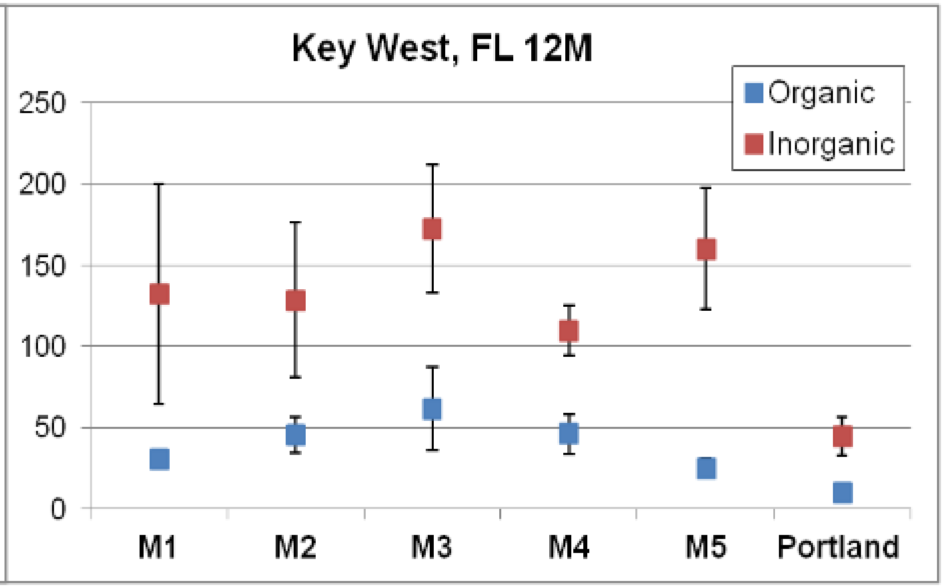
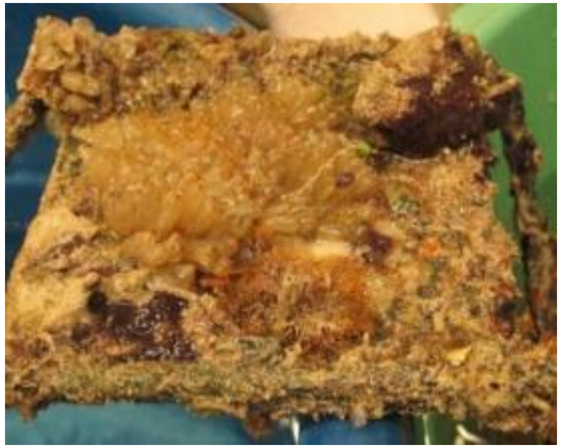
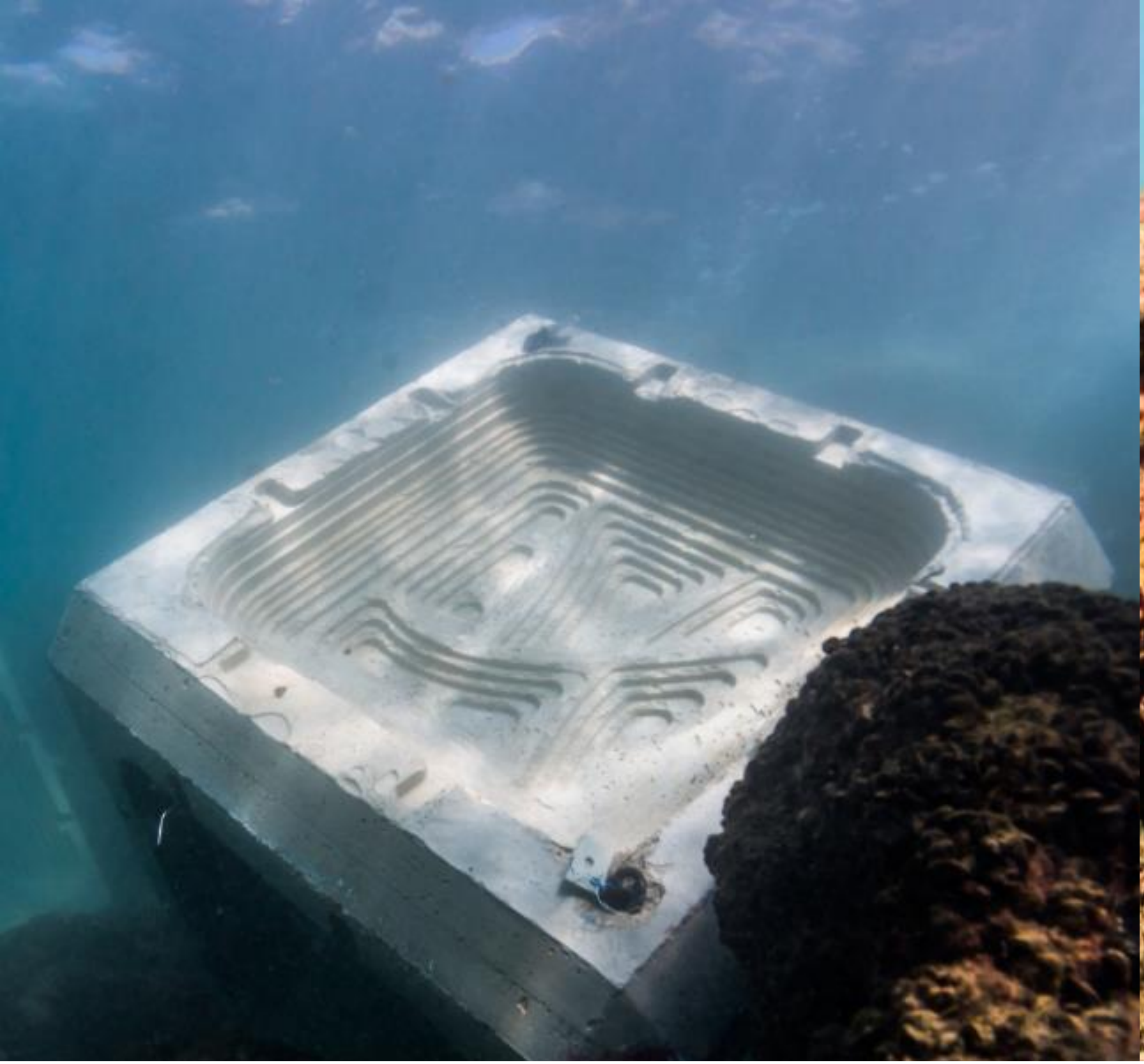
- **Inorganic matter:** significant differences
  - Concrete composition: Portland < Other Matrices
  - Months post deployment: 3 <6 < 12 M
  - Marine Environments: Temperate > Tropical





Maximal values:
Temperate 2.5 kg/m²
Tropical 0.5 kg/m²





Ecological Armoring Unit

BIOMIMICRY
GLOBAL DESIGN
CHALLENGE
Winning Design

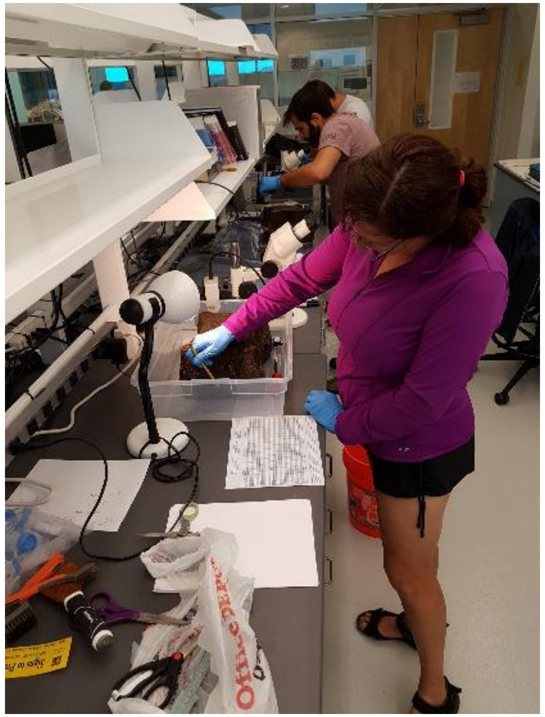
Tide Pool Armor

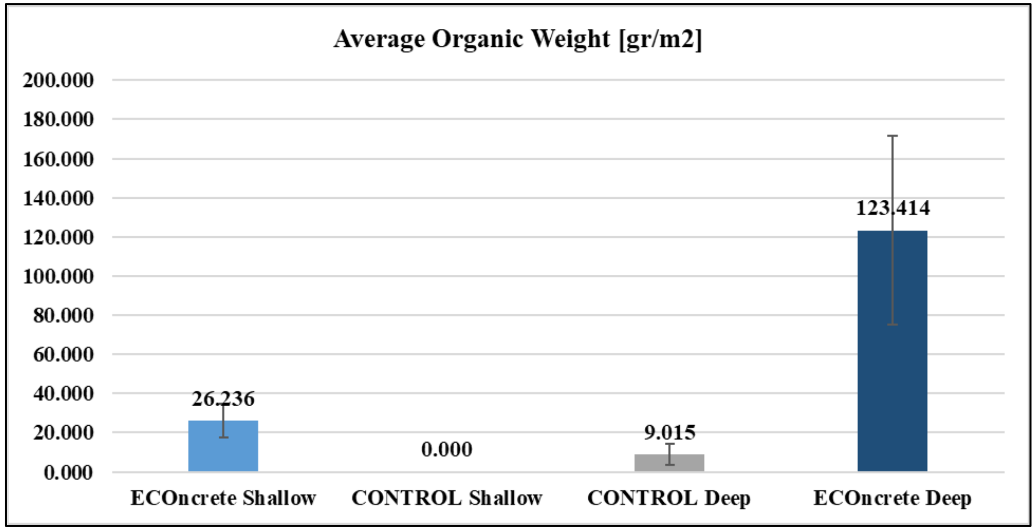
Enhanced Seawalls

Eco-Marine Mattress

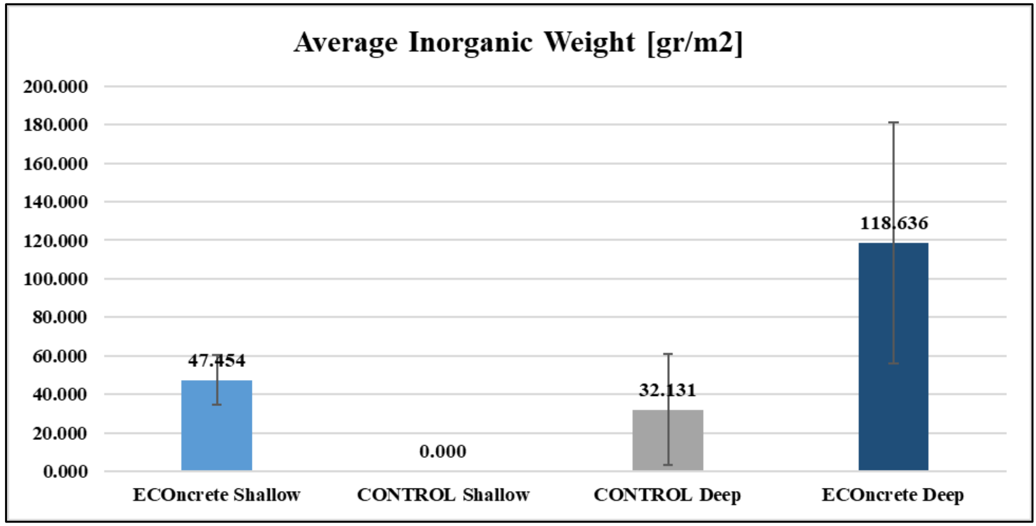
Case Study

Miami, FL





Results of Average Organic Weight (Neptune)

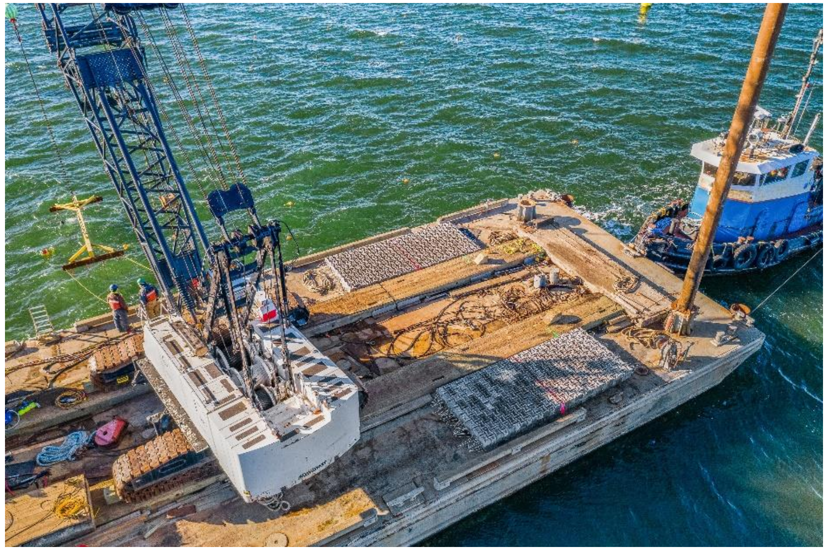


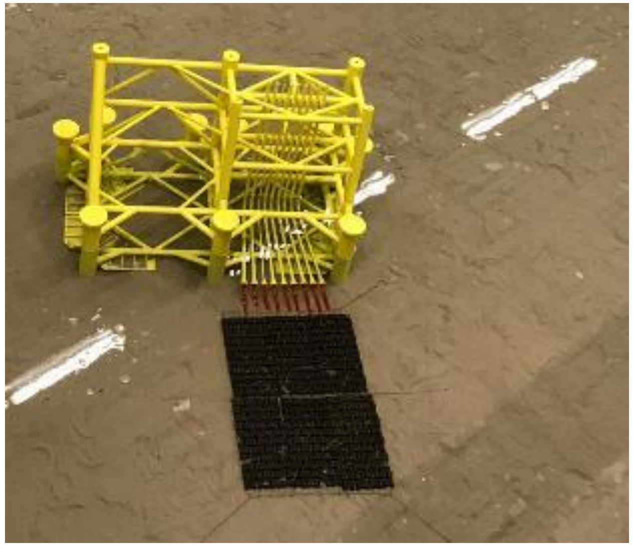
Results of Average Inorganic Weight (Neptune)


Eco-Piles & Jackets

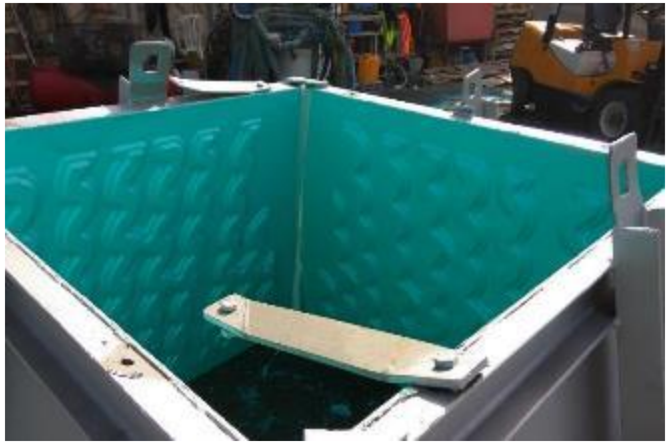
Offshore Energy

Marine Mattress Scour Protection





Mooring & Anchoring Systems



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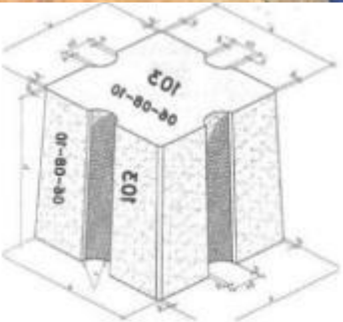
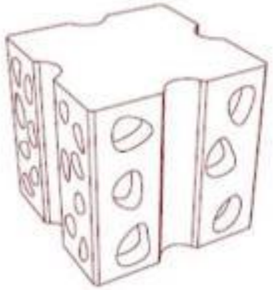
Case Study

Environmentally Sensitive Breakwater





(Haifa, Israel, East Mediterranean)

Case Study

Environmentally Sensitive Breakwater

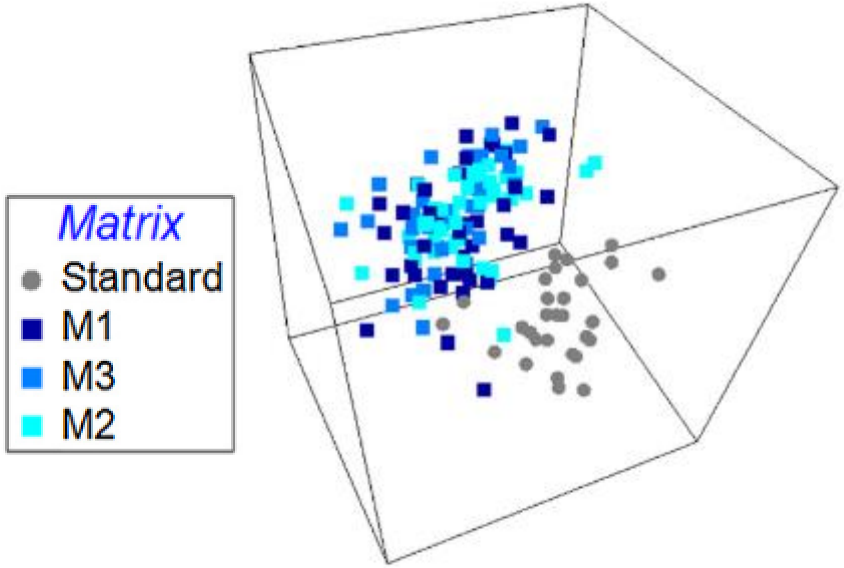
- Ecological Enhancement of Fish & Invertebrates: x 2 Richness & Biodiversity
- Greater Similarity to Typical Rocky Reef Communities
- Reduced Dominance of Invasive Species




Case Study

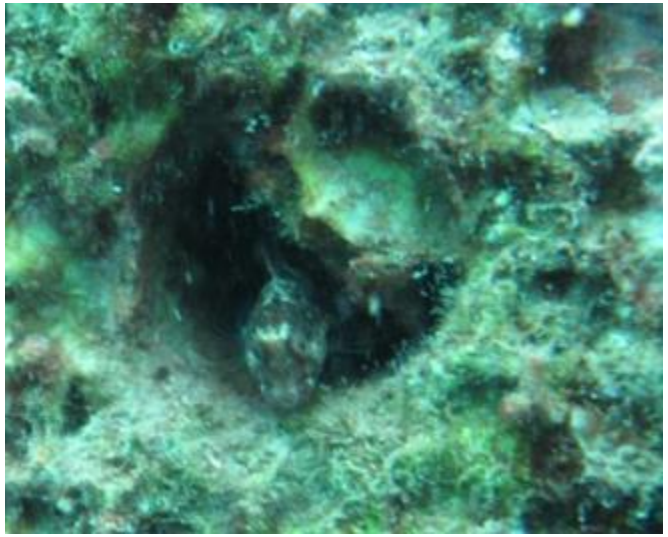
Environmentally Sensitive Breakwater

- **Reduced Dominance of Nuisance & Invasive Species**
- **Opening the Substrate to Compotation**



INVERTEBRATES Species Count	**ECOnrete**	**Portland**
Native	21	5
Invasive	12	10
Cryptogenic	3	0
Total	**36**	**15**
Ratio Invasive/Native	***0.57***	***2.00***

FISH 24M Species Count	**ECOnrete**	**Portland**
Native	14	7
Invasive	2	3
Total	**16**	**10**
Ratio Invasive/Native	***0.14***	***0.43***



Case Study

Environmentally Sensitive Breakwater

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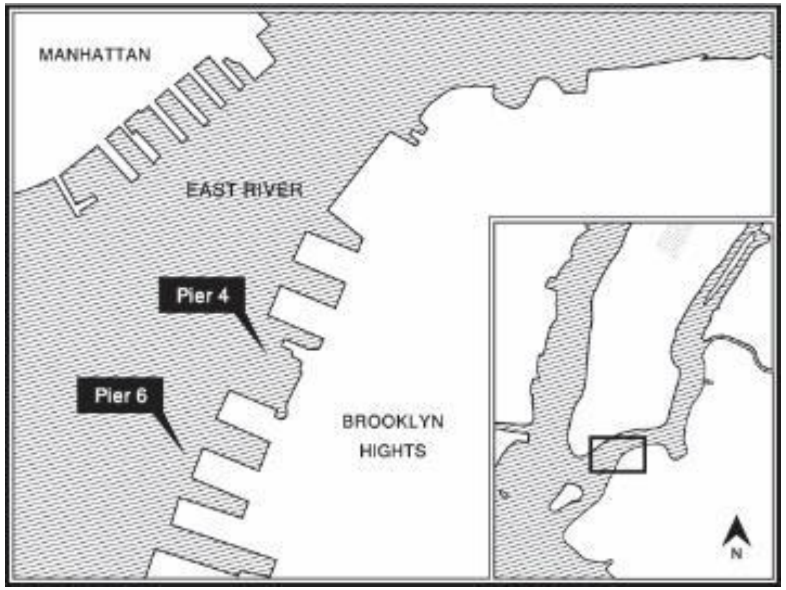
Case Study

Concrete Pile Encasement

Brooklyn Bridge Park, NYC, NY, USA



Case Study

Concrete Pile Encasement

- Problem:

- **Current "Gray" solution**: concrete encasement ("jacket") cast into fiberglass forms

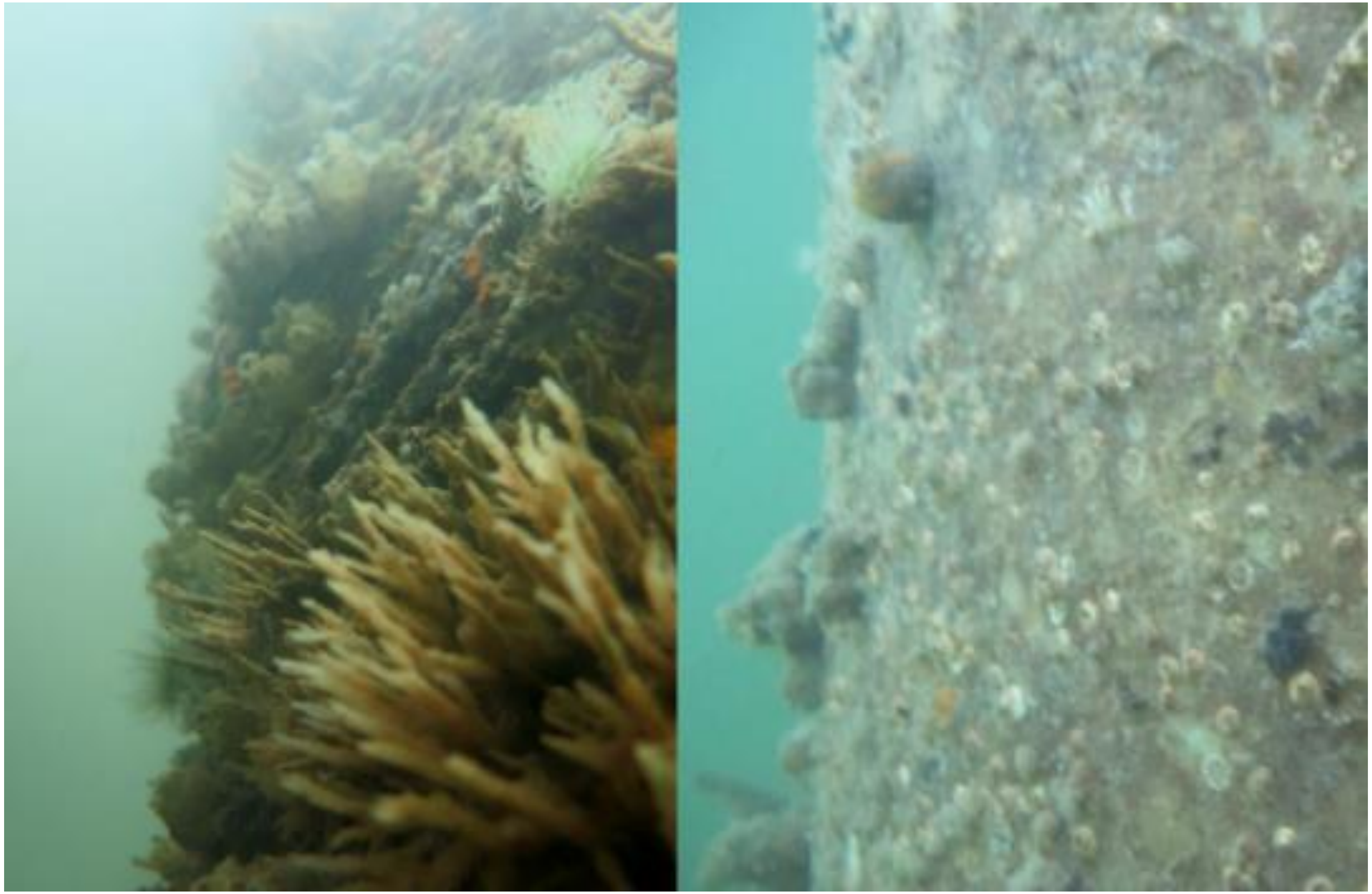
- **Ecological solution:** innovative concrete mix + textured multi-use forms

Case Study

Concrete Pile Encasement

- Richer and more diverse
- Enhancement of filter feeders
- Enhancement of habitat forming species
- Good Structural performance

Ecological Jacket **Control**



(Perkol-Finkel and Sella 2015)

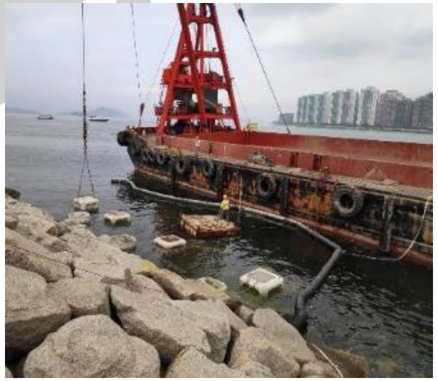
6 Countries - 6 Seas - 30 Locations

NL

Israel

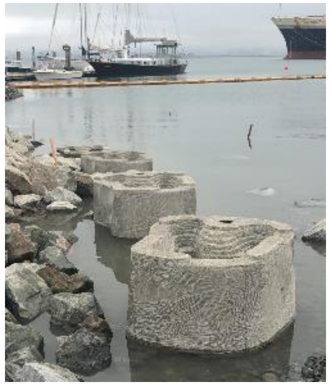
Monaco

HK



UK

USA



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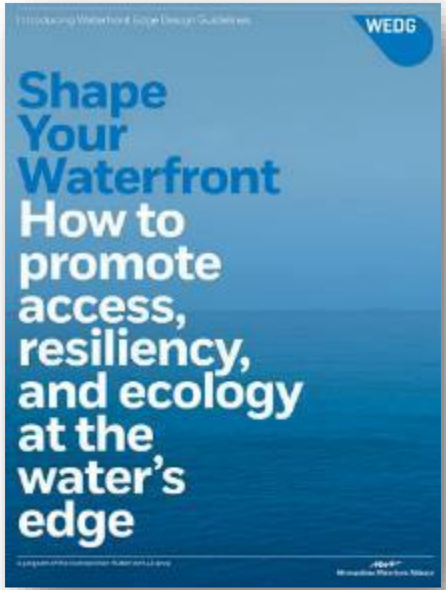
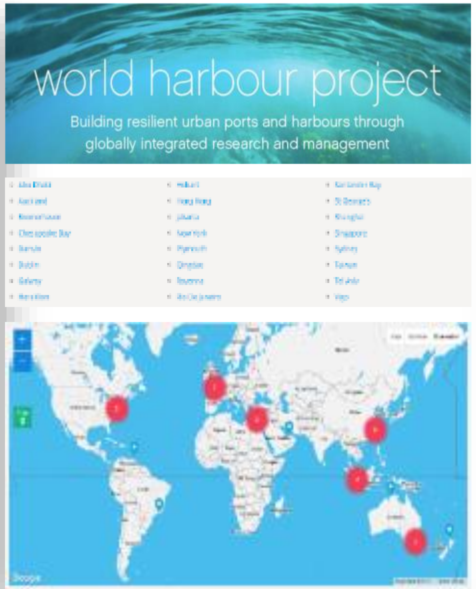
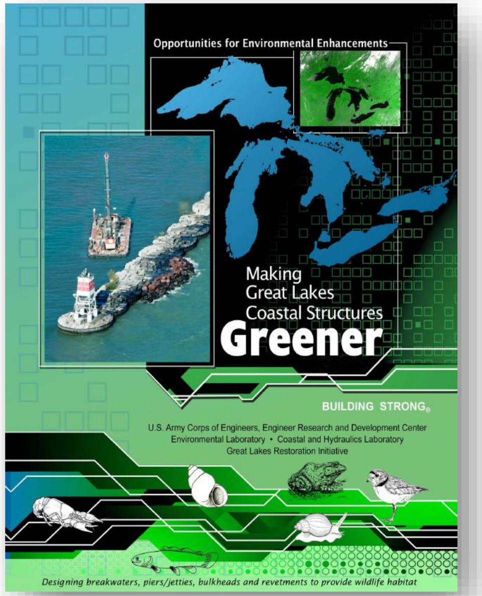
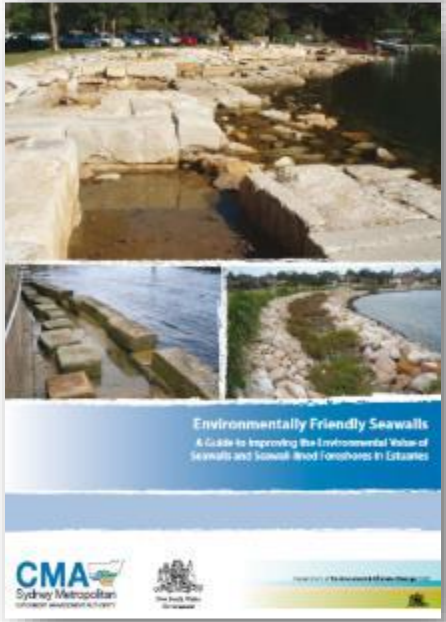
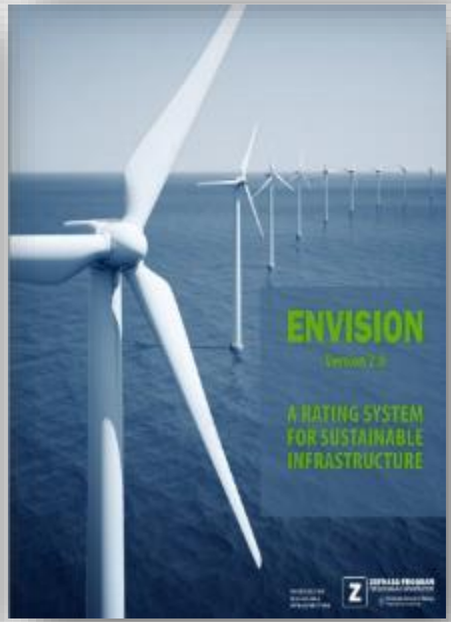
Blue is the new *Green*

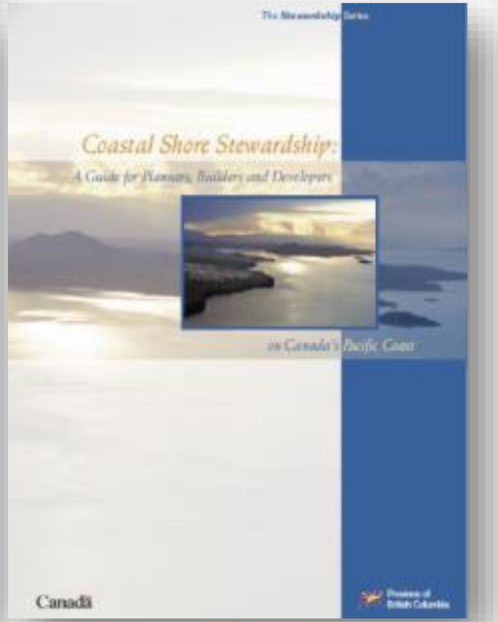












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