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Examples of NbS versus traditional (grey) infrastructure solutions

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National Research Council Canada

CEC 2022 Workshop 2A | May 18
Retrofitting Existing Infrastructure Using NbS

CASE STUDY #1

Hybrid Dyke-Marsh Systems

Project Background

Many Canadian coastal communities and shorelines are vulnerable to flooding and erosion

Source: CBC

Opportunity to better understand risks and to adapt (be strategic, build back better, leverage co-benefits)

NbS remain underutilized in Canada

- Uncertainty surrounding their performance during storms and extreme weather events

Source: Maugerville Floodwatch 2018

Research Study

Tidal salt marsh platforms are common across Atlantic Canada coastlines

Considerable interest in exploring marsh restoration and managed dyke realignment solutions → improved understanding of marsh-dyke systems needed

Series of 1:20 scaled laboratory experiments were conducted:

- To investigate the role of coastal salt marshes as part of nature-based shore protection systems
- To determine the effectiveness of marsh vegetation in dissipating wave energy, attenuating wave overtopping and reducing flooding for a range of environmental conditions representative of Canadian coastal regions

Source: Cornell Lab Conservation Media

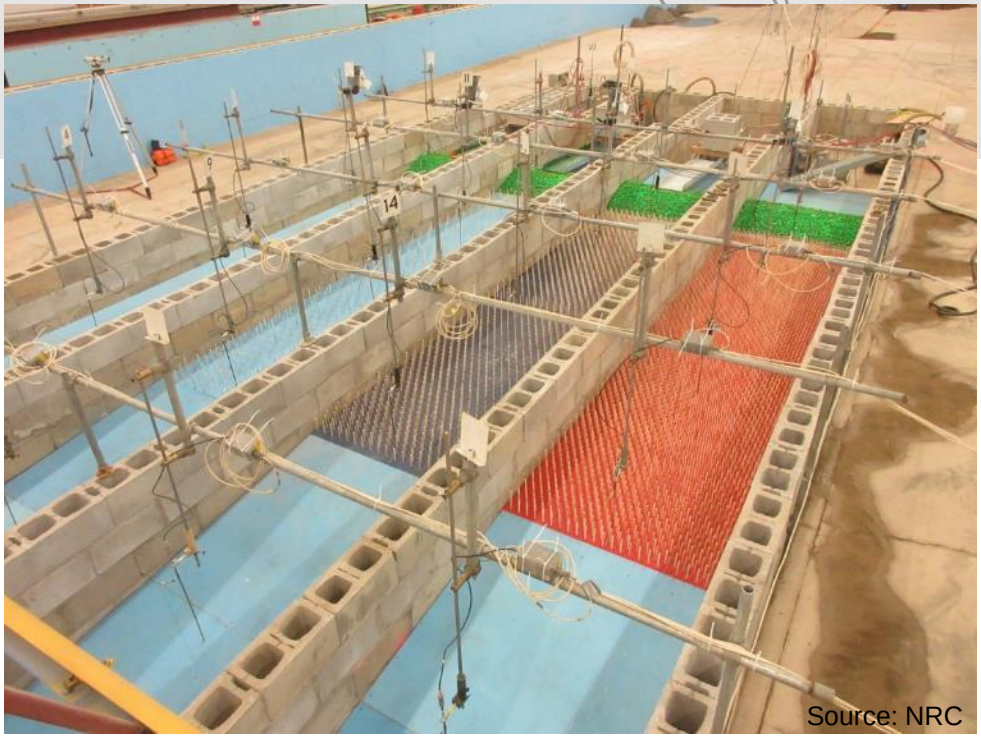
Laboratory Experiments

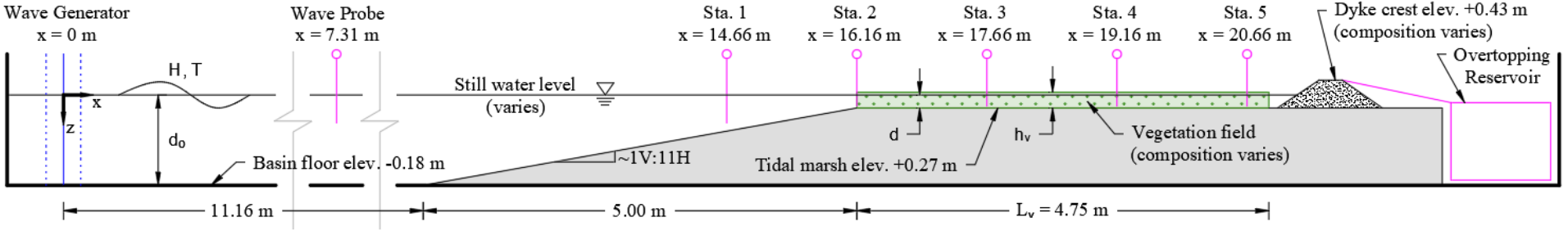
Parallel flumes including sloping foreshore, vegetation field & dyke

Idealized surrogate vegetation: wooden dowels & flexible tubing

Plant spacing densities: 125, 295, 450 stems/m^2

Varied dyke designs, water levels & wave conditions



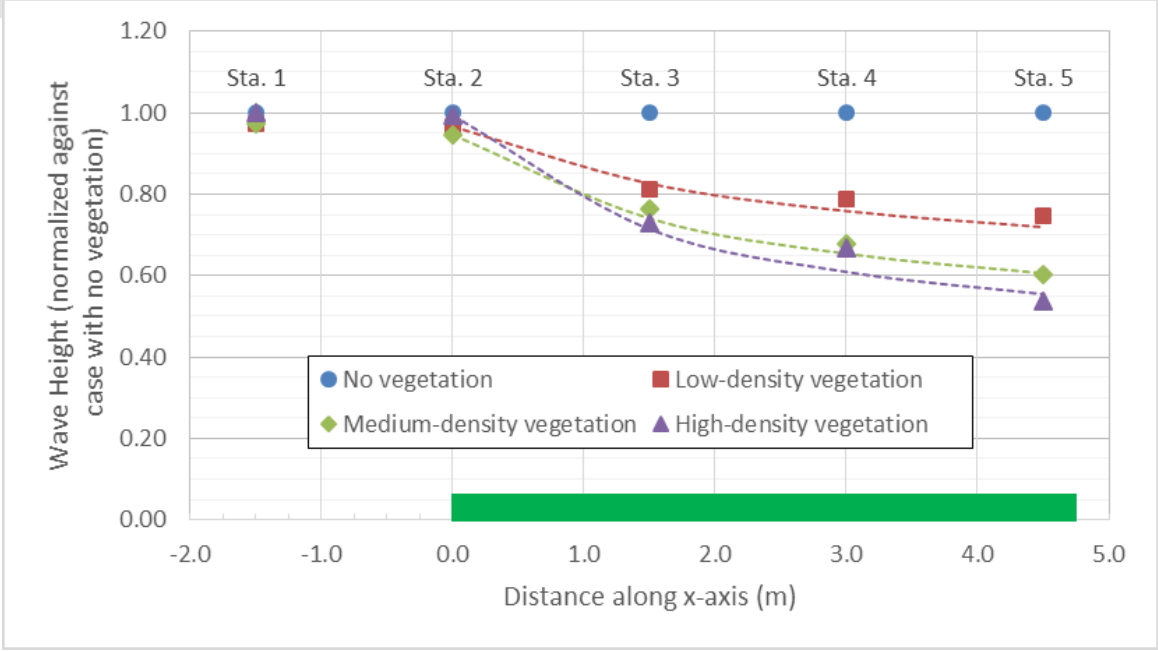


Assessment of Marsh-Dyke System Performance

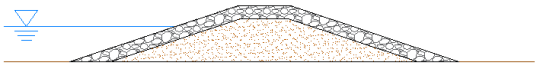
Wave heights at the dyke toe attenuated by nearly 50% in the presence of high-density vegetation

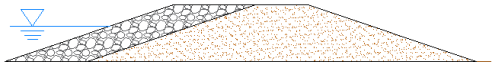
- Significant reduction in damage to the dyke
- 10-fold reduction in wave overtopping discharge

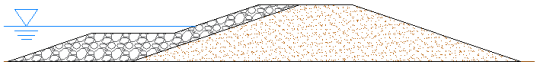
Most wave damping occurs in the seaward portion of the marsh, regardless of vegetation density




Simply Reinforced Dyke


Armoured Dyke


Widened Simply Reinforced Dyke


Simply Reinforced Dyke with Berm

CASE STUDY #2

The *Living Breakwaters* project

Project Background

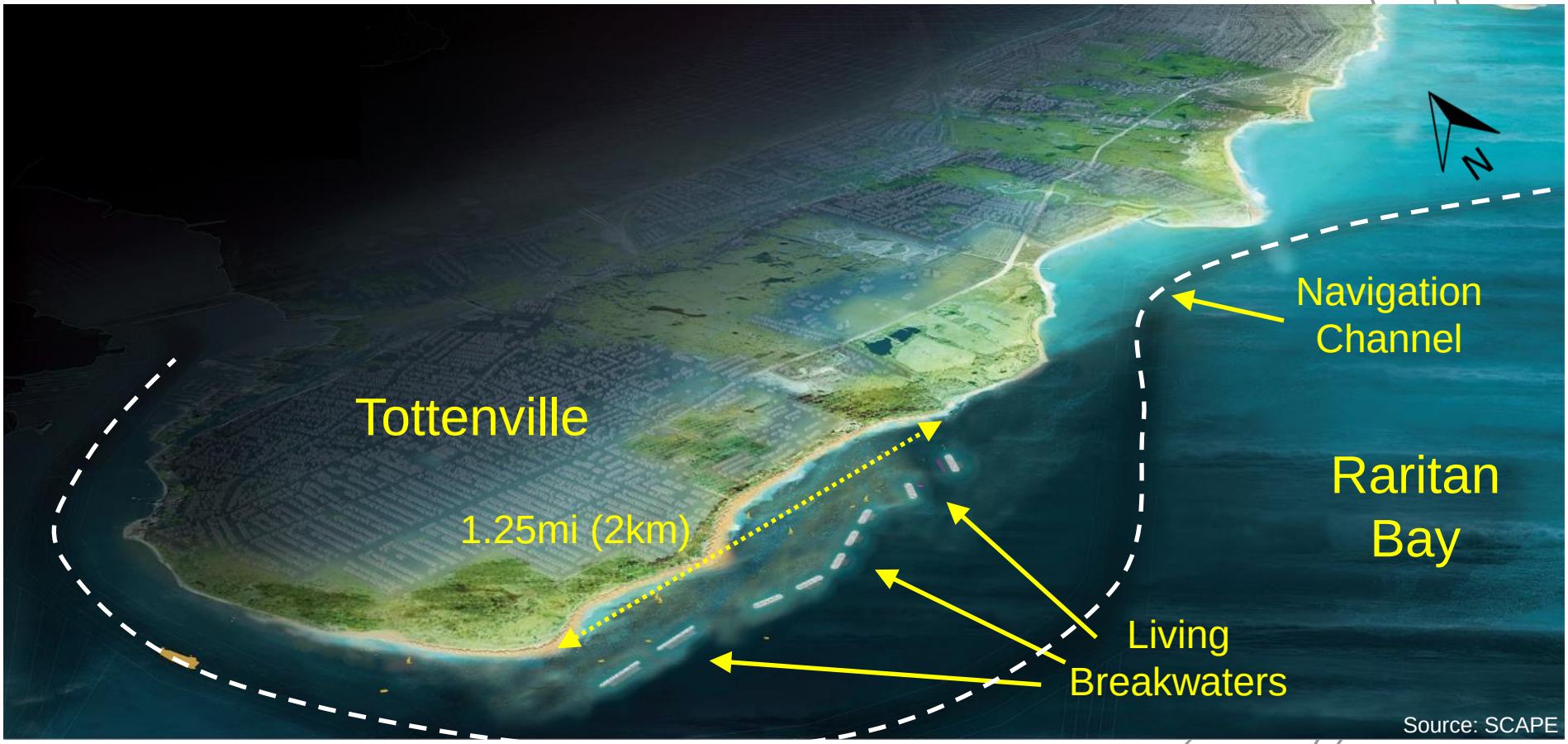
Tottenville area of Staten Island, ~19 miles (30.5km) from NYC

- Experienced significant damage during Hurricane Sandy (2012)
- Caused loss of life and significant harm to the local economy
- June 2013 “Rebuild by Design” competition was launched

Source: Museum of the City of New York

Source: NY Daily News

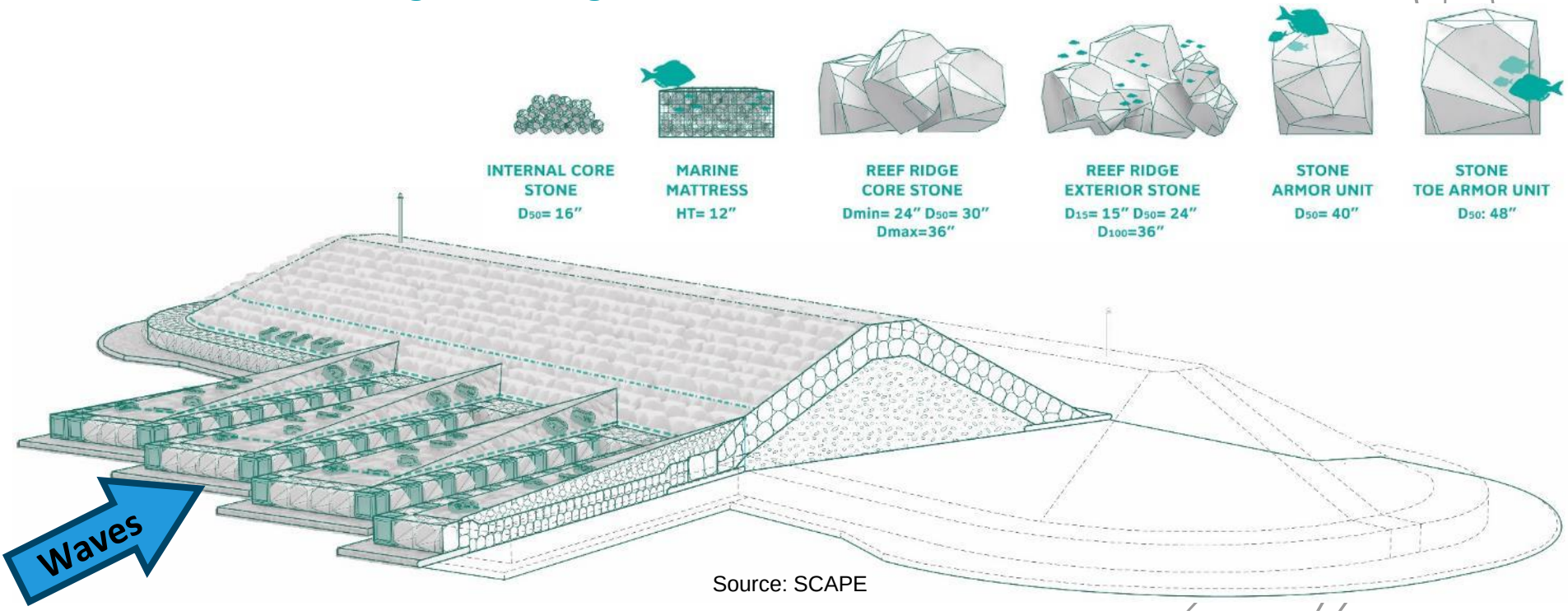
Living Breakwaters – Project Concept



Living Breakwaters – Conceptual Design

Linear trunk section with two roundheads (conventional breakwater)

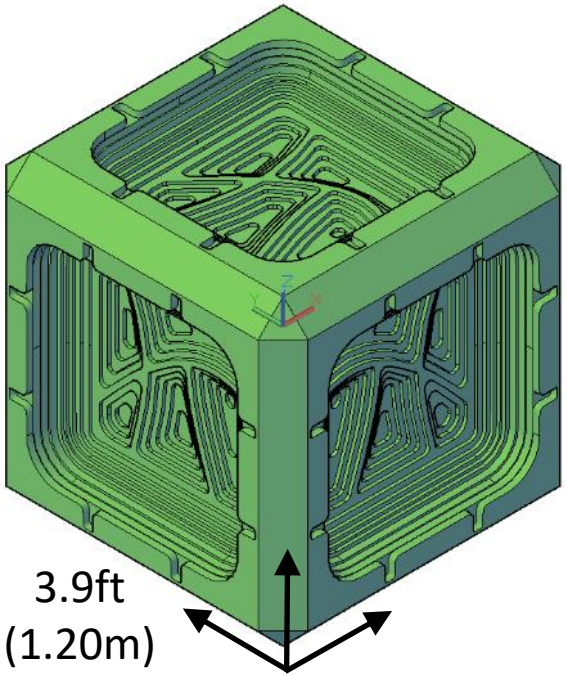
Several ocean-facing "reef ridges" and "reef streets"



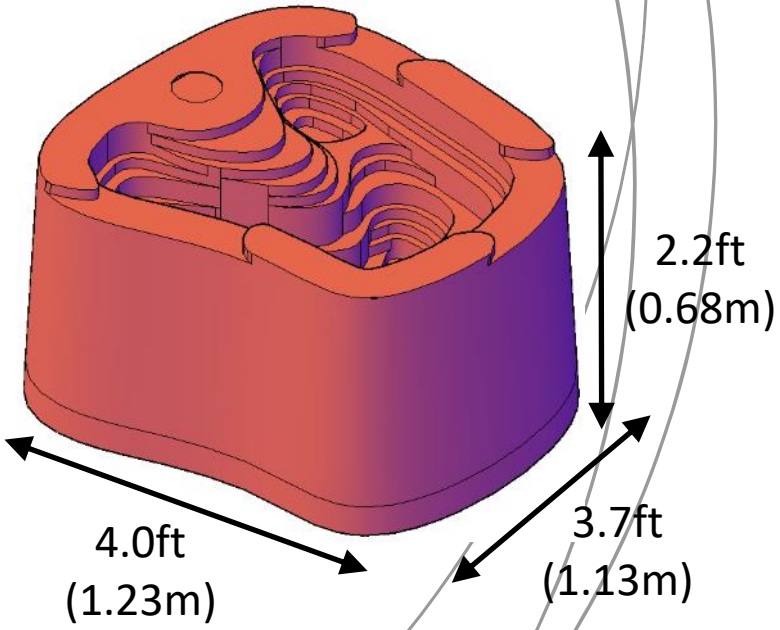
Source: SCAPE

Living Breakwaters – Conceptual Design

ECOncrete® Armour Unit



ECOncrete® Tide Pool



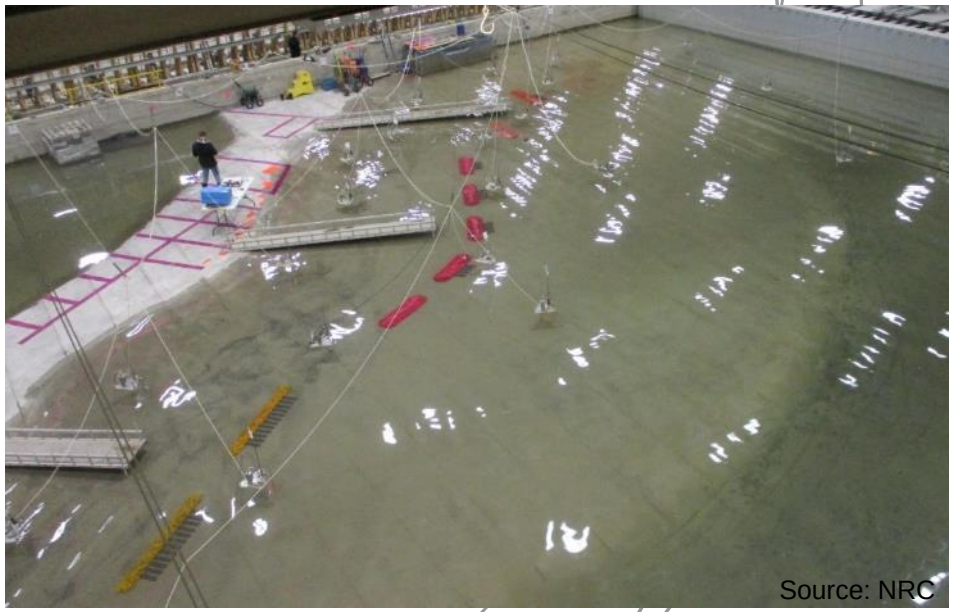
Source: SeArc

Two Physical Modelling Studies

Study objectives:

- Confirm and refine initial breakwater design and layout
- Determine wave transmission characteristics
- Determine flow characteristics around the reef ridge features for ecological design


Source: NRC


Source: NRC

Breakwater Stability Model

- 1:20 scale physical model to evaluate breakwater stability (2D and 3D)
- Stone materials and gradations to replicate the proposed prototype materials
- Photographic damage analysis system used to monitor performance

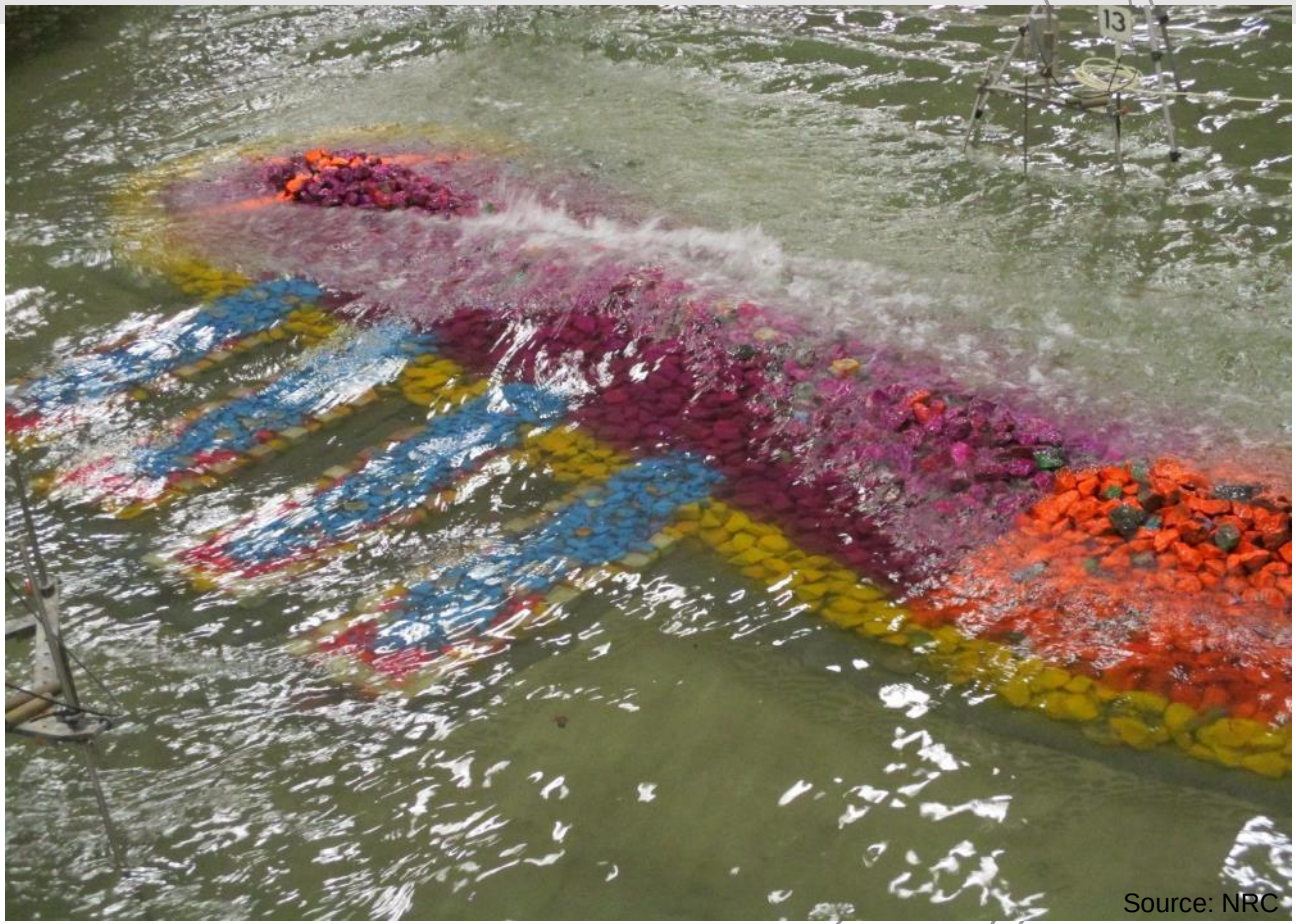

Source: NRC


Source: NRC

Breakwater Stability Model

Stability of proposed cross-sections was confirmed under design and overload conditions

Several recommendations made regarding prototype placement requirements for the bio-enhancing concrete units

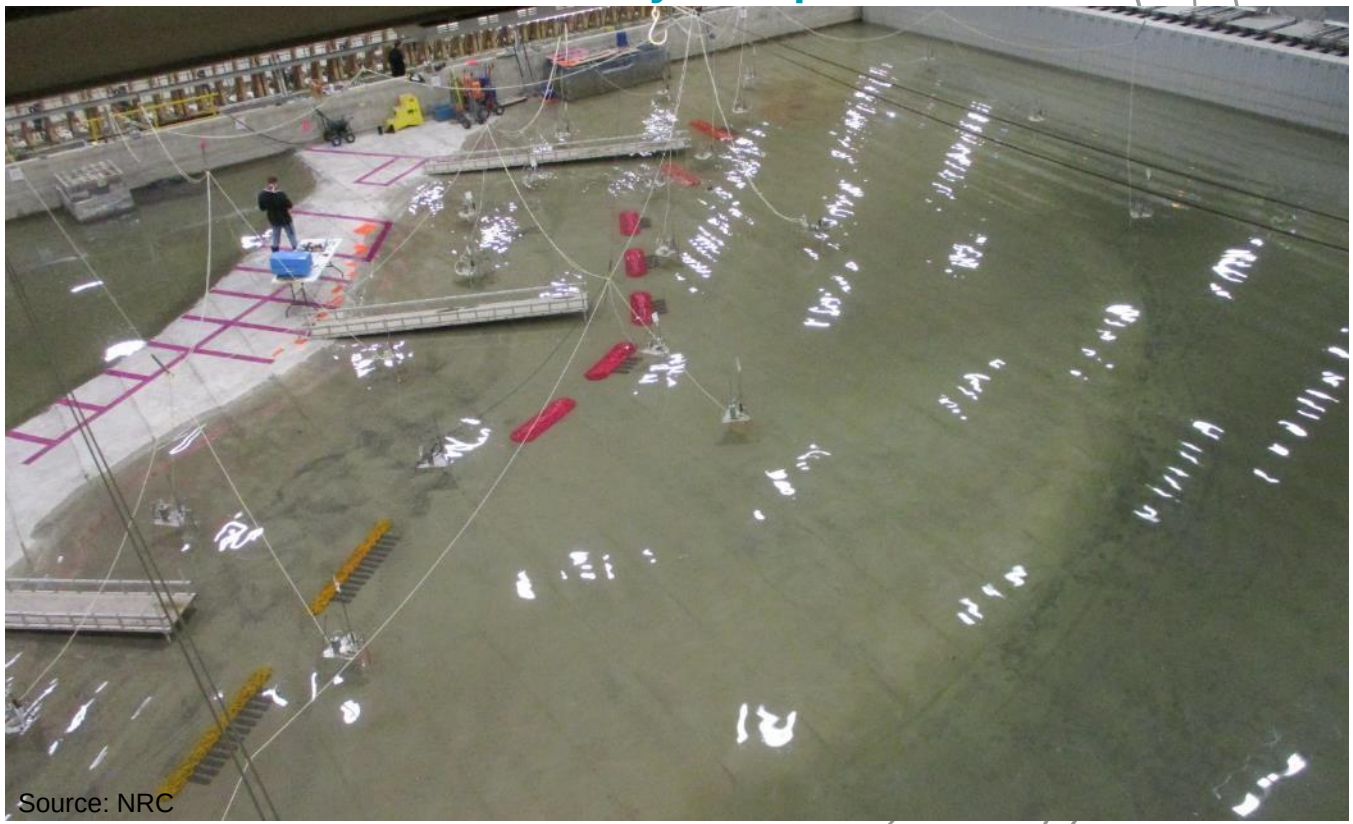


Source: NRC

Breakwater System Layout Model

1:80 scale 3D physical model to validate the overall system performance

- Assessed over a wide range of conditions
- Optimization of breakwater lengths and alignments
- Result: significant nearshore wave attenuation

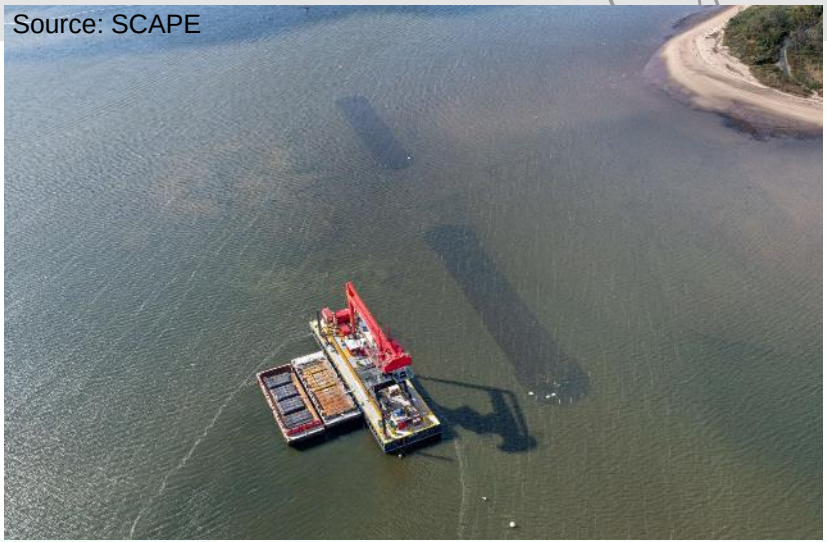


Source: NRC

Living Breakwaters – Implementation

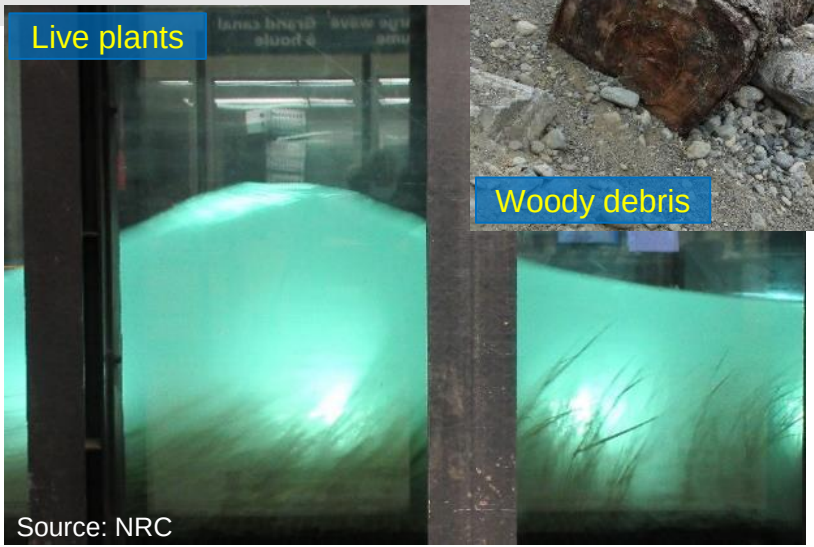
Physical modelling study generated valuable information to support the final design

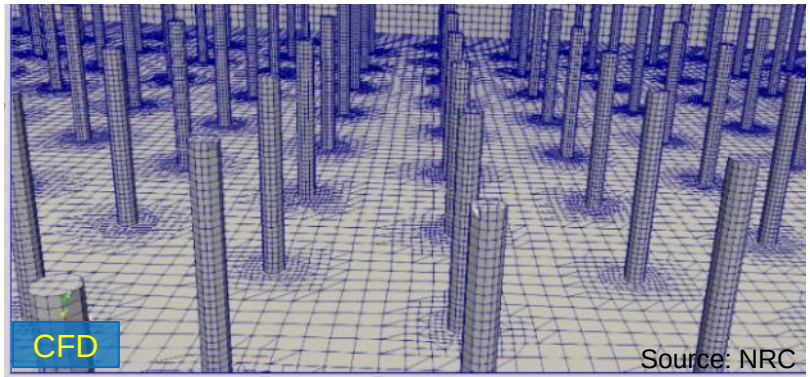
Demonstrated performance of innovative features that have potential for retrofit applications to improve ecological performance


Source: SCAPE

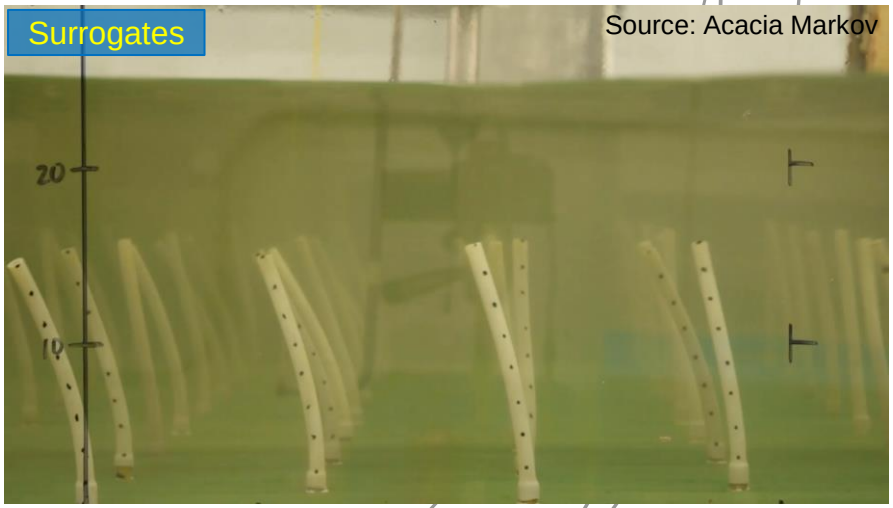

Source: Governor's Office, State of New York

Next Steps





Living laboratory research project: field monitoring, numerical & physical modelling



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Thank you!

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