# Strengthening Habitats with Oysters on Retrofitted & Engineered Structures

Program Booklet

## Virtual Symposium

## Feb 26-27th, 2025

# Background

This symposium on **Strengthening Habitats with Oysters on Retrofitted & Engineered Structures (SHORES)** is part of an effort to fill key knowledge gaps in support of Maryland's oyster resource and oyster industries. Chesapeake Bay is home to thriving commercial fishing and aquaculture industries and one of the largest oyster restoration efforts in North America. The lack of fresh shell substrate has become a major impediment to all of these activities and alternatives are being considered for large-scale use in restoration and industry efforts. To address this challenge, the Maryland General Assembly mandated a program (SB830 2023) that will evaluate:

1. Types of substrate, including fresh shell, fossilized shell, combinations of shell and alternative substrates that are most appropriate for use in oyster harvest areas.
2. Benefits, including habitat-related benefits, of using stones of various sizes in oyster restoration areas.
3. Alternative substrates used for oyster restoration or repletion in other regions, including the success of efforts to use alternative substrates.
4. Potential for retrofitting existing structures, such as riprap revetments that are unrelated to oyster restoration, but use materials similar to artificial reefs including oyster plantings.
5. Effect of spat size upon deployment on oyster abundance.

This symposium directly addresses topic #4: Potential for retrofitting existing structures, such as riprap revetments, that are unrelated to oyster restoration but that use materials similar to artificial reefs, to include oyster plantings.

In 2024, the Symposium for Alternative Substrates for Oysters (SASSO) addressed topic #3: Alternative substrates used for oyster restoration or repletion in other regions, including the success of efforts to use alternative substrates. If you are interested in learning more about SASSO, see the symposium webpage: **https://www.umces.edu/alternative-substrate-for-oysters**

## Symposium Sponsers

This symposium is sponsered by University of Maryland Center for Environmental Science (UMCES). Lead organizers are Dr. Matthew Gray, Dr. Elizabeth North, and Dr. William Nardin of UMCES Horn Point Laboratory. The symposium team also includes David Nemazie, Conor Keitzer, Roshni Nair, Monica Fabra, and Kurt Florez. Graphic design and logistical support are from UMCES Integration and Application Network (IAN).

For questions regarding this symposium please contact Matthew Gray at **mgray@umces.edu** or see the symposium webpage: **https://www.umces.edu/shores-symposium**

UMCES 100 YEARS OF SCIENCE

**Scan QR code to visit the symposium website**

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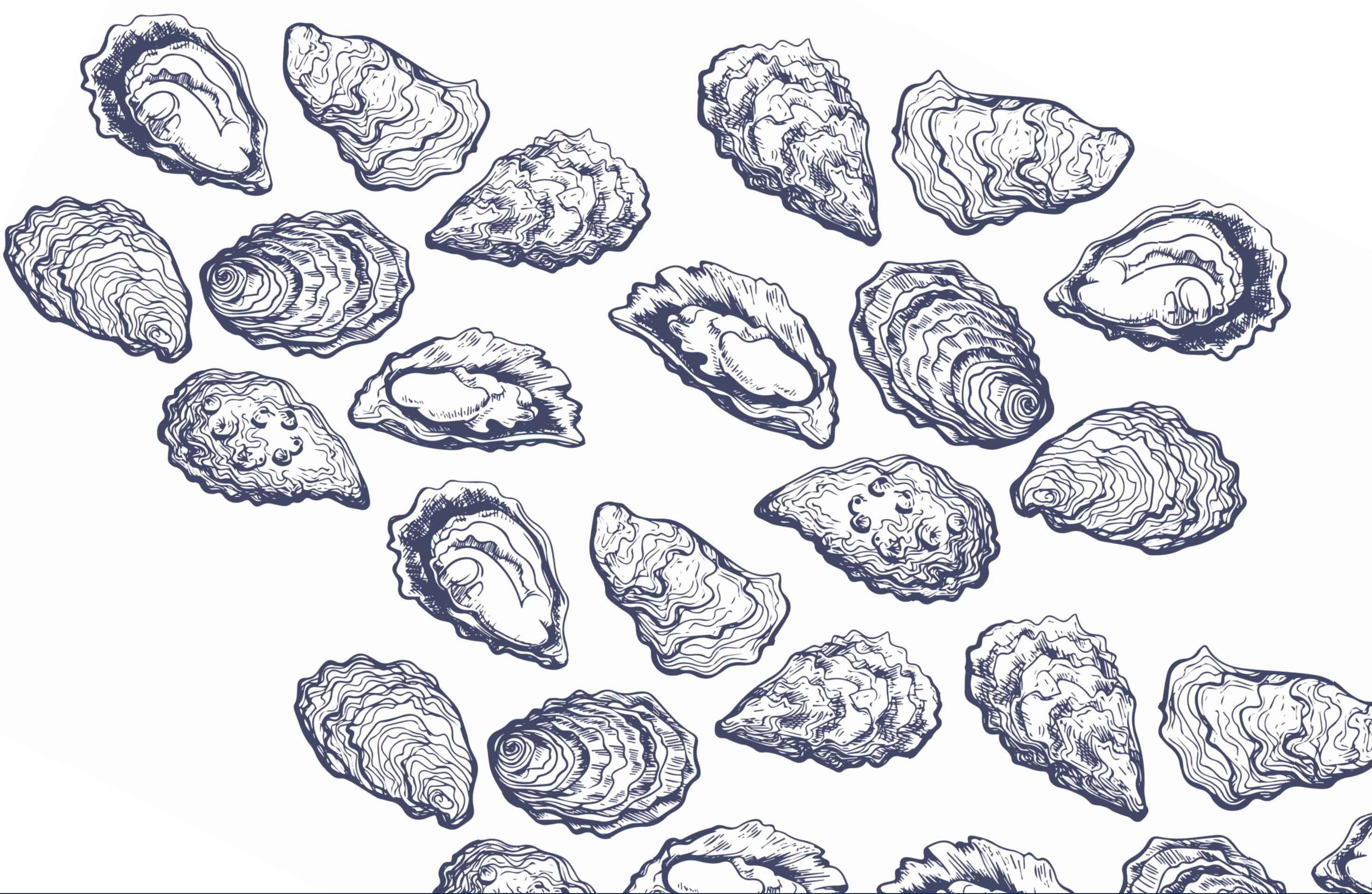

# Schedule of Events and Logistics

## Wednesday, Feb 26: Retrofitting Existing Infrastructure

| | |
|---|---|
| 10:00 | Introduction |
| 10:15 | Rochelle D. Seitz, Virginia Institute of Marine Science, Batten School of Coastal and Marine Sciences |
| 10:30 | Iacopo Vona, University of Central Florida, Department of Civil, Environmental, and Construction Engineering |
| 10:45 | Anthony Dvarskas, Ørsted |
| 11:00 | Jason Spires, NOAA Cooperative Oxford Laboratory |
| 11:15 | Niels Lindquist, SANDBAR Oyster Company Inc. |
| 11:30 | Siddhartha Hayes, Hudson River Park Trust |
| 11:45 | Adrian Sakr, University of Florida |
| 12:00 | Poster session & Chat n' Chew breakouts |
| 01:00 | Plenary discussion |
| 02:00 | Adjourn |

## Thursday, Feb 27: Building Engineered Living Shorelines

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|---|---|
| 10:00 | Introduction |
| 10:15 | Kate Orff, SCAPE |
| 10:30 | Carolyn Khoury, Billion Oyster Project |
| 10:45 | Matt Campbell, Natrx |
| 11:00 | Amanda Poskaitis, Underwood & Associates |
| 11:15 | Mary-Margaret McKinney, Native Shorelines, a Davey company |
| 11:30 | Adrian Sakr, University of Florida |
| 11:45 | Alberto Canestrelli, University of Florida |
| 12:00 | Poster session & Chat n' Chew breakouts |
| 01:00 | Plenary discussion |
| 02:00 | Adjourn |

## Symposium Logistics

**To join the symposium:**
https://tinyurl.com/SHORES-Virtual-Symposium

**To ask the speakers a question:** Type your question in the Zoom chat. Only the speakers will be able to see your questions.

**To join a Chat n' Chew:** Follow the links provided in the Zoom chat at lunch time.

**To ask a question or make a comment during plenary:** Type your question or comment in the Zoom chat. The moderators will be able to see your questions and comments and will relay them to the panelists.

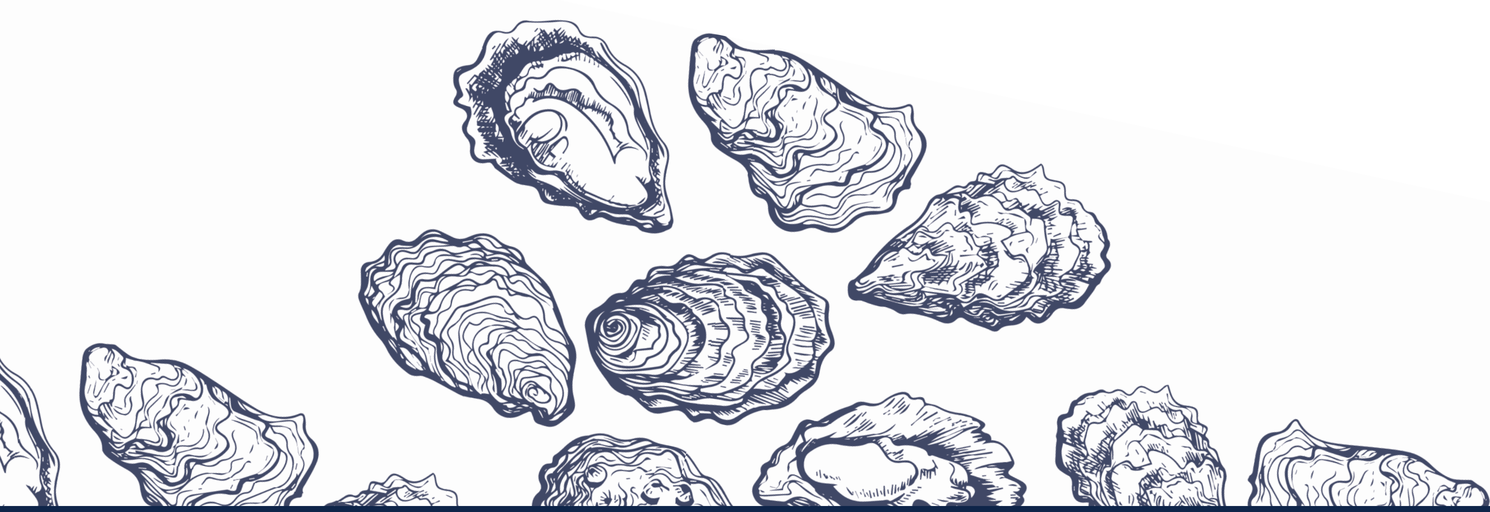
**To recieve a copy of the symposium report:** All registrants will be sent the report this spring.

## Rochelle D. Seitz

***Professor at Virginia Institute of Marine Science, Batten School of Coastal and Marine Sciences***

Rochelle Seitz is a Benthic Ecologist and Professor at the Virginia Institute of Marine Science in Gloucester Point, VA. Her research expertise encompasses three primary areas of focus, including (i) effects of environmental stress, such as shoreline development and hypoxia, upon benthic invertebrate diversity, (ii) predator-prey dynamics and top-down versus bottom-up control of benthic systems, and (iii) restoration ecology.

Her current research projects include the impacts of habitat degradation on faunal communities, restoration of bivalves in the Chesapeake Bay, quantifying nursery habitat quality for the blue crab, and examining benthic predator-prey relationships and food-web dynamics. Additional interests include experimental and theoretical population and community ecology of marine benthic and epibenthic organisms focused on a quantitative understanding of processes operating in estuaries and the coastal ocean.



# Day 2 Invited Speaker: Building Engineered Living Shorelines

## Kate Orff

***Landscape Architect, Founding Principal of SCAPE, and Professor at Columbia University***

Kate Orff, FASLA is the founder of SCAPE, a landscape architecture and urban design practice with offices in New York, New Orleans and San Francisco. SCAPE's celebrated Oyster-tecture and Living Breakwaters (constructed 2024) projects have been celebrated for interweaving social and ecological goals together with climate risk reduction. She is also a Professor at Columbia University with a joint appointment in the School of Architecture and the Climate School.

Kate's talk will focus on the trajectory of oyster restoration in the New York Harbor, and how Living Breakwaters evolved into a funded and implemented project in the post-Super storm Sandy recovery process. She will show how the Living Breakwaters project developed, including its engineering and approvals process,  and will feature the work of SCAPE's many collaborators, including the Billion Oyster Project.

**Anthony Dvarskas**
*Ørsted*

### Integrating oysters into offshore wind lease areas: droppable oyster structure deployment at Borssele 1&2

*Authors: Anthony Dvarskas, Karin Bilo, Tommy Kristoffersen*

In 2021, Ørsted announced its ambition to have a net-positive impact on biodiversity for all renewable energy projects commissioned by 2030 or later. As a part of meeting this ambition, Ørsted is investigating the potential for nature-inclusive design at its offshore lease areas, including the addition of structured habitat and hard surfaces to benefit critical keystone species like cod and oysters. European flat oysters are a particular concern in the North Sea, given the substantial decline in their numbers and the absence of these reef-builders from areas where they had historically been present.

To address this, Ørsted recently collaborated with Van Oord to install droppable oyster structures at the scour protection for Ørsted's Borssele 1&2 wind lease area in the North Sea. Adult oysters were attached to these structures and, if successful, will generate larvae to colonize the areas adjacent to the installation, providing benefits to biodiversity and local water quality. Video footage will be collected at multiple time points following installation to monitor the structures. These structures are innovative for their lightweight design and their potential to be integrated into scour protection during routine maintenance activities. Some of the droppable structures were also composed of reused materials. This presentation will describe the characteristics of the droppable oyster structures, the installation approach, and the planned monitoring activities to evaluate the success of the deployment.

**Siddhartha Hayes**
*Hudson River Park Trust*

### Enhancing infrastructure and nearshore habitat in an urban estuary, Hudson River Park, NYC

*Hayes, S.*[1], C. Roble[1], M. Mincone[1]*
*[1]Hudson River Park Trust*

Located on Manhattan's west side between Chambers and W59th Street, Hudson River Park's 400-acre Estuarine Sanctuary waters are predominantly characterized by a homogenous, fine silt/mud bottom. In a concerted effort to enhance both these mud flats and existing relict marine infrastructure with greater habitat variety, the Park installed over 200 enhancement structures between Piers 26 and 34 from 2021 to 2023. These structures include pile wraps, biohuts, textured concrete pile encasements, reef balls, and gabions. The Park designed the on-bottom reef balls and gabions in clusters to function as a contiguous corridor for nekton seeking shelter in Park piers and piling fields. The pile wraps, biohuts and textured pile encasements were designed to test vertical and off-bottom habitat opportunities that utilize Park pilings. Collectively, these enhancements aim to simultaneously introduce Eastern oysters (*Crassostrea virginica*), to supplement low-but-present annual wild recruitment, and to provide increased and varied benthic and demersal habitat for fishes, crustaceans, other nekton, and non-oyster epibionts. The enhancement structures are being monitored over a five-year period to assess oyster health, estuarine community utilization, water quality, and structure

performance. This enhancement project was supplemented in 2022 by another installation of ~300 reef balls and gabions further north along Gansevoort Peninsula, as well as a ~100m cordgrass (*Spartina spp.*) salt marsh that has an associated four-year monitoring program. The Park is currently planning an additional enhancement project for an area north of 14th street that will continue to explore adapting marine infrastructure for improved habitat value.

**Niels Lindquist**
*SANDBAR Oyster Company Inc.*

### Use of Oyster Catcher™ substrates as oyster-enhancing amendments for hardened structures

*Authors: SANDBAR Oyster Company Inc.*

Hardened structures, such as rock revetments, seawalls, and bulkheads, have long been used for shoreline erosion control and to protect built infrastructure. While certain types of hard armoring, as well as dock and pier pilings, can support the growth of oyster reef communities, their general lack of complex structure and rough surface texturing can limit the extent of oyster community development.

In recent years, structural amendments have been designed to integrate with existing hard structures, aiming to create habitats that foster more robust oyster communities. SANDBAR Oyster Company is currently developing Oyster Catcher™—cement-infused cloth hardscapes—as "cuffs" for pier and dock pilings to enhance oyster community growth in estuarine waters. These cuffs consist of Oyster Catcher™ panels shaped to encircle about half the circumference of a piling and are strapped in place at the optimal intertidal zone for oyster growth (Ridge et al. 2015, Scientific Reports 5; doi:10.1038/srep14785). The cuffs have either a flat or corrugated design. Oyster Catcher™ products are engineered to degrade over time at variable rates, allowing the developing oyster communities to naturally detach and settle on the surrounding seabed. Replacing degraded cuffs can help accelerate oyster accumulation at the base of pilings.

In initial tests, cuffs were installed on dock pilings adjacent to a major navigation channel, where they were exposed to boat wakes and large wind-generated waves. Oysters successfully recruited to the cuffs; however, community development was limited by the use of cuffs designed to degrade relatively quickly. Additionally, the complex habitat created by the cuffs served as a refuge for stone crabs (Menippe mercenaria), which preyed on oyster spat and accelerated cuff degradation. Future testing of Oyster Catcher™ cuffs for enhancing oyster communities on hardened structures will involve longer-lasting cuffs and designs that minimize spaces where crabs can shelter.

**Adrian Sakr**
*University of Florida*

### Changing of the garden: evaluating the performance and ecosystem functionality of novel oyster garden structures

*Authors: Adrian Sakr, Logan Mazor, Joseph P. Morton, Andrew Altieri*

Oyster gardening, in which modular oyster reefs are suspended from docks, has become an increasingly common and accessible technique for coastal communities to enhance oyster populations for water filtration and biodiversity enhancement. However, little research has been done to evaluate materials and methods for oyster gardens regarding durability and ecosystem benefits, making it difficult to scale up efforts and maximize project success. We conducted a field experiment in a residential canal system of Sanibel Island, Florida where we deployed a variety of oyster garden structures to evaluate performance in oyster recruitment, durability, water filtration rate, and biodiversity. Additionally, the occurrence of Hurricane Ian during the deployment provided an opportunity to evaluate how these structures resisted severe storm events.

We tested five structures: (1) a conventional design made of drilled oyster shell on steel wire; and four alternatives (2) GROW concrete discs; (3) jute fiber coated with calcium sulfoaluminate cement; (4) BESE biodegradable plastic matrix panels; and (5) BESE biodegradable plastic mesh bags filled with oyster cultch. All structures survived Hurricane Ian; however, both BESE structures ultimately disintegrated without recruiting oysters. Disc, jute, and shell wire structures demonstrated similar levels of durability, oyster recruitment and growth, and biofiltration rates.

Thus, we conclude that material selection considerations may come down to the availability of materials and labor as well as the extent to which cost and biodegradability are prioritized. Our results provide important information for optimizing oyster garden performance while minimizing environmental impacts.

**Rochelle Seitz**
*Virginia Institute of Marine Science*

### Retrofitting seawalls with artificial substrates promotes oyster recruitment and macrofaunal communities

*Authors: Rochelle D. Seitz, Kathleen E. Knick, Alison Smith, Michael S. Seebo, Gabrielle G. Saluta*

With the urbanization of coastal cities, natural shorelines have been extensively modified. Shoreline development has increased the presence of vertical seawalls, which can negatively impact benthic macrofaunal communities. Green engineering techniques can be used to enhance inhospitable seawall structures by creating micro-habitats on the structures and using materials that increase the settlement of bivalves. Oysters enhance benthic communities by creating complexity and heterogeneity, providing microhabitats for other macrofauna, which protects them from predation and physical stressors. At two field sites in the Chesapeake Bay, we retrofitted seawalls with artificial substrates with varying habitat complexity and oyster seeding density and investigated the effects on oyster densities and macrofaunal communities. The substrates included 3D printed tiles (0.25 × 0.25 m) with three levels of complexity (flat, 2.5 cm ridges, and 5 cm ridges) plus control tiles of the existing seawall, at three seeding densities (0, 36, and 56 oysters per tile). Tiles were monitored every three months for oyster survival, oyster growth, and primary cover. After a year, tiles were destructively sampled for oyster survival, oyster recruitment, and the macrofaunal assemblage. Both increased tile complexity and higher seeded oyster density increased seeded oyster survival and recruitment of oyster spat. The high-complexity, high-seeded tiles had 10x more recruits than flat, unseeded tiles and 70x more recruits than the controls of the existing seawall. Macrofaunal abundance and biomass also increased as habitat complexity of the tiles increased, providing habitat for larger organisms, such as mussels and mud crabs. Using retrofitted structures on seawalls increased habitat complexity, leading to higher

seeded oyster survival, oyster recruitment, macrofaunal abundance, biomass, and species richness in coastal ecosystems.

**Jason Spires**
*National Oceanic and Atmospheric Administration*

### Nature based oyster settlement substrate investigations

*Authors: Jason Spires*

Oysters occupy a unique space in coastal ecosystems and communities. These bivalves provide a range of ecosystem services and direct (wild and farmed fisheries) and indirect (habitat for other fauna, recreational fisheries) economic benefits. Additionally, oysters are increasingly considered as a tool for mitigating effects of climate change and promoting coastal resilience. Current oyster restoration practitioners frequently desire to place oysters along hardened shorelines but are hampered by inefficient or costly methods. In regions of high natural recruitment, oysters settle naturally on a variety of hardened surfaces, however, in regions of low natural recruitment this type of greening gray infrastructure is more challenging. Our work investigates novel population replenishment techniques by using biodegradable oyster setting materials (basalt, coconut fiber) and mechanical behavioral manipulation (bubble curtains) to create oyster communities on hardened structures. Our objectives are to develop a cost-effective material/technique that can be used to create oyster populations on hardened surfaces. Initial oyster settlement rates are similar among tested materials, however, retention is poor on the most pliable materials. Additionally, larval behavior was not controlled by bubble curtains and modifications to the experimental design are required.

**Iacopo Vona**
*University of Central Florida*

### Integration on submerged breakwaters offers new adaptive shoreline protection in low-energy environments in the face of sea level rise

*Iacopo Vona and William Nardin*

Sea level rise (SLR) and increasing storm frequency threaten coastal environments. To naturally protect our coasts, living organisms such as oysters can be used. They provide a multitude of benefits for the surrounding environment, including coastal protection. Unlike any common gray structure used for coastal defense, such as breakwaters, oysters can grow with SLR and self-repair from damage following extreme events. In this study, we analyzed the coupling between breakwaters and oysters through a numerical model, Delft3D-SWAN, validated with field data. The research aimed to evaluate the performance of this hybrid solution under future scenarios of climate change and SLR. The study results showed that the coastline was more preserved and protected over time when oysters were included in the simulation, thanks to their capability to self-adapt over a changing climate. Incoming wave heights and sediment export from the shore were reduced compared with the use of gray breakwaters alone, resulting in a resilient and healthier coast. The coupling between oysters and breakwaters may represent a valuable and effective methodology to protect our coast over a changing climate and a rising sea, where optimal conditions for oyster survivability occur and are maintained over time.

**Matt Campbell**
*Natrx*

### Integrating engineered structures and oyster habitat for resilient shorelines

*Authors: Drew Keeley, Tyler Ortego*

The integration of oyster and marine habitat with engineered structures offers a transformative approach to enhancing shoreline resilience and ecological health. Traditional materials and construction methods often lack adequate capability to balance coastal protection with optimal habitat formation. New technologies are emerging that provide new capabilities for coastal resilience and habitat restoration practitioners.

Natrx has pioneered the Dry Forming™ advanced manufacturing technique, which enables development of tailored, habitat-positive structures that address site-specific needs while promoting oyster colonization and ecosystem restoration. Natrx reef structures feature customizable void spaces and biomimetic surfaces to optimize conditions for oyster recruitment, habitat formation, and ecological uplift. These structures support shoreline stabilization and also deliver ecosystem services such as water filtration and biodiversity enhancement. By leveraging digital tools, advanced manufacturing, and material science innovations, Natrx can efficiently produce scalable, site-specific solutions that enhance the longevity of coastal infrastructure and integrate seamlessly with existing gray and hybrid systems.

Case Study: Hog Island, VA - A nature-based wetland protection and habitat restoration solution using Natrx ExoFormsTM along Hog Island in Gloucester County, Virginia. The goals of this project was to protect the residential and commercial properties along Monday Creek and the York River, reduce erosion and sedimentation into the Chesapeake Bay, and a focus on enhancing maritime habitat for shorebirds, oysters, and other marine life. Designed customized interlocking ExoForms for highwave energy areas exposed to Mobjack Bay and low crested oyster reef ExoForms for low energy areas. Placed 972 linear feet of large stacked units and 122 linear feet of low crested oyster reefs. Added available surface area for 14 million oysters that will filter water and provide foundational habitat and prevent 40,000 tons of eroding sediment from entering the bay system and contributing to suspended sediment and nutrient loading.

**Alberto Canestrelli**
*University of Florida*

### Integrating physical and numerical models to assess wave dissipation and sediment accumulation at restored oyster reefs

*Authors: Alberto Canestrelli[1], William Nardin[2], Rafael O. Tinoco[3], Jacopo Composta[1], Salman Fahad Alkhidhr[3], Kamil Czaplinski[3], Luca Martinelli[4], Savanna Barry[1], Anthony Priestas[5], Duncan Bryant[5]*

Oyster reef ecosystems are increasingly recognized for their resilience and ability to provide sustainable, nature-based alternatives to traditional “gray” infrastructure. These reefs offer critical benefits, such as mitigating shoreline erosion, promoting sediment deposition, and supporting adjacent habitats like salt marshes. Despite their potential, there is a limited understanding of the physical processes driving sediment transport around oyster reefs under varying wave and tidal conditions, reef geometries, and locations. Bridging this gap is vital for optimizing sediment retention and supporting

shoreline progradation.

This study aims to quantify the mechanisms through which oyster reefs stabilize sediments. Using a combination of physical and numerical modeling, researchers are investigating the influence of tidal and wave dynamics, longshore currents, reef geometries, and distances from the coast. Initial experiments employ 1:7 scaled 3D-printed oyster reefs in a wave flume at the Ven Te Chow Hydrosystems Lab, University of Illinois Urbana-Champaign. Concurrently, numerical simulations with OpenFOAM on the HiPerGator
high-performance cluster analyze wave-reef interactions under varying conditions.

Findings from these efforts will guide large-scale experiments at the Large-scale Sediment Transport Facility (LSTF) in Vicksburg, MI, conducted at a 1:2 scale. These tests will include regular and irregular waves (i.e., wave spectra in both frequency and direction), wind-driven and tidal longshore currents, and tidal variations in water level. Four distinct reef geometries will be tested under these hydrodynamic conditions. The collected data will calibrate a numerical model, enabling predictions of reef-induced sediment aggradation beyond experimental conditions and identifying optimal reef designs.

The outcomes of this research include a robust dataset on sediment dynamics, calibrated models, and actionable guidelines for oyster reef restoration. These results will inform sustainable coastal management strategies, enhancing shoreline protection and promoting the use of oyster reefs as effective, nature-based solutions for long-term resilience in coastal environments.

## Carolyn Khoury
*Billion Oyster Project*

### Living breakwaters: engineering with nature and restoring oyster reef habitat

*Authors: Pippa Brashear, Carolyn Khoury*

Widely considered a model for climate-adaptive nature-based infrastructure, Living Breakwaters is a $111 million project with a layered approach to risk reduction—enhancing physical, ecological, and social resilience along the South Shore of Staten Island.

The project consists primarily of 2,400 linear feet of near-shore breakwaters—partially submerged structures built of stone and ecologically-enhanced concrete units—that break waves, reduce erosion of the beach along Staten Island's Tottenville shoreline, and provide a range of habitat spaces for oysters, fin fish and other marine species. The Living Breakwaters concept was developed by a large, multi-disciplinary team led by SCAPE as part of a winning proposal for Rebuild By Design, the design competition launched by the U.S. Department of Housing and Urban Development (HUD) after Superstorm Sandy.

The breakwaters are designed to reduce the impact of climate-intensified weather events on the low-lying coastal community of Tottenville, which experienced some of the most damaging waves in the region and tragic loss of life during Superstorm Sandy. Informed by extensive hydrodynamic modeling, the breakwaters are also designed to slow and, eventually, reverse decades of beach erosion along the

Tottenville shoreline. The breakwaters are constructed with "reef ridges" and "reef streets" that provide diverse habitat space. Billion Oyster Project (BOP), a non-profit organization based in New York City whose mission is to restore functional, self-sustaining oyster reefs to New York Harbor, will introduce additional substrate seeded with juvenile oysters to the breakwaters beginning in 2025.

Beyond the physical breakwaters and habitat restoration, the project also aims to build social resilience in Tottenville through educational programs and the implementation of an open-access curriculum for local schools for local schools in partnership with BOP and local community committees and action groups.

**Mary-Margaret McKinney**
***Native Shorelines, A Davey company***

### Quantitative evaluation of an alternative oyster-centric living shoreline system

*Authors: Mary-Margaret McKinney, Worth Creech, Whitney Thompson, Chris Paul, John Darnall, and Bret Webb.*

Coastal erosion and shoreline retreat, resulting from both from extreme weather events and sea level rise, pose great challenges to coastal management across U.S. coastal areas. To address this challenge, many State, Local, and Federal stakeholders have deployed living shorelines as a cost-effective method of reducing shoreline retreat rates and providing ecological benefits such as marine habitat, fish spawning areas, and shellfish and oyster habitat.

As such, the deployment of these structures has gained increasing popularity, and many new technologies and variations of living shorelines have been developed in recent years. However, coastal engineering metrics such as wave attenuation, structural stability, and changes to current velocities are rarely validated prior to deployment. Native Shorelines' QuickReef® technology is one of the new types of living shorelines and has been deployed along over 5 miles of shorelines in North Carolina and Virginia. Qualitative observations from deployment sites appeared to show significant oyster spat recruitment and a reduction in shoreline retreat rates. In early 2024, QuickReef® designs were evaluated via physical and numerical modeling to determine the effectiveness and stability of the structures.

A desktop study evaluating field conditions at representative sites was performed to inform critical design forcings for flume study purposes, which was then conducted at the University of South Alabama Center for Applied Coastal Engineering and Science. Wave attenuation, stability, and current velocities were measured during physical modeling. Results from the wave flume study were utilized to calibrate FLOW-3D models. This presentation will discuss findings from the physical and numerical modeling studies as well as demonstrate the overall effectiveness of living shoreline designs using quantitative methods.

## Kate Orff
*SCAPE*

### Living Breakwaters

*Designed by SCAPE, COWI, Arcadis, SeArc Ecological Marine Consulting, WSP, MFS Engineers, Prudent Engineering. Engagement by Billion Oyster Project. Construction by Weeks Marine, Ramboll, Baird. Environmental Review & Permitting by AKRF.*

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## Amanda Poskaitis
*Underwood & Associates*

### Oyster recruitment on dynamic living shorelines

*Authors: Underwood & Associates, Maryland Coastal Bays Program*

Underwood & Associates, a design/build stream and living shoreline contractor, developed the dynamic living shoreline, which can be adapted to various site conditions to create critical shallow water wildlife habitat and solve erosion issues for communities and property owners. Underwood uses all native stone material in our vegetated headland designs and we have been working to incorporate oysters into our living shorelines to achieve even greater habitat co-benefits on our project sites. An example of oysters thriving on one of our projects is at the Assateague State Park Living Shoreline – a partnership between Assateague State Park, Maryland Coastal Bays Program, and Underwood & Associates.

Oyster surveys have been conducted at the Assateague Living Shoreline site since 2021 by the Maryland Coastal Bays Program. The surveys started after noticing an abundance of oysters along the vegetated headlands. Years of surveying has shown that although this site experiences oyster recruitment, the oysters tend to not live past 1-2 years due to disease or other environmental factors. This is typical in the Maryland Coastal Bays watershed, which has not had a self-sustaining wild oyster population in over 50 years. In addition to the research conducted on oysters at the Assateague Living Shoreline, we are working on many other living shoreline projects throughout the Chesapeake and Coastal Bays that have potential for incorporation of oysters. We will be presenting on our work and exploring how to incorporate oysters into living shoreline designs effectively. We will share multiple projects, research, and lessons learned.

**Adrian Sakr**
*University of Florida, Department of Environmental Engineering Sciences*

### Living in a material world: support for the use of natural and alternative materials in coastal restoration and living shorelines

*Authors: Adrian Sakr, Andrew Altieri*

The size and expense of coastal restoration efforts are increasing exponentially to mitigate anthropogenic environmental impacts and achieve international conservation goals. As part of these efforts, a variety of conventional materials including plastic, metal, and concrete are used in breakwater, settling substrate, vegetation stabilization, and sediment retention structures because of their availability, inexpensive purchase price, and predictable properties. However, questions regarding sustainability arise given the adverse environmental impacts of the life cycle processes for each material.

Life cycle impacts from production, transportation, installation, and degradation should be key considerations in material selection, with criteria that allow decision makers an opportunity to evaluate less impactful alternative materials. Natural and reduced-impact alternative materials include natural elements such as plant fibers and rock as well as reduced-impact materials such as bio-based and biodegradable plastics. These items may have comparable availability and functionality and exhibit reduced carbon, chemical, and particulate emission impacts. However, they are often not selected for full-scale restoration applications due to uncertainties regarding their financial cost and ability to replace conventional materials. Here, we compare conventional and reduced-impact alternative materials for use in coastal restoration applications. The function, engineering performance, and life cycle environmental impacts are reported for each material followed by a presentation of case studies that illustrate the value of appropriate material selection. We then compare the impacts of material sourcing and product lifespan to develop a material selection framework enhancing the selection process of reduced-impact alternatives.

This study reveals a need for more detailed and standardized life cycle information about the materials used in the coastal environment. The proposed framework allows more emphasis on material life-cycle implications in the design process, which could lead to enhanced use of alternative over conventional materials and improved project value and outcomes.