



Stone Living Lab

Quarterly Summary

Research, Monitoring & Education Projects



Fall 2023

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About the Stone Living Lab

The Stone Living Lab (SLL) partnership is an innovative and collaborative initiative focused on testing and scaling up nature-based approaches to climate adaptation in Boston Harbor and beyond. We are a unique partnership between government agencies and nonprofits: UMass Boston School for the Environment, Boston Harbor Now, the City of Boston, the Massachusetts Department of Conservation and Recreation, the Massachusetts Executive Office of Energy & Environmental Affairs, and the National Park Service.

As a “Living Lab,” we bring research into the real world by engaging scientists and the community in collaborative design and exploration. Our work brings us not only along the coastline of Boston Harbor, but into the water itself and out among the Boston Harbor Islands and other locations. Our areas of focus are research and monitoring, education and engagement, policy innovation, and climate preparedness.

Letter from the Directors

The Stone Living Lab is excited to share our first *Quarterly Summary of Research, Monitoring, and Education Projects*, which covers the period of January 1, 2023 through August 31, 2023.

This quarterly summary is intended to serve as a regular update on the Lab's work that we hope will be useful for municipal and community leaders, practitioners in the field of climate resilience, fellow researchers, and the general public.

Throughout the quarterly summary, we cover a range of projects that our staff members are leading across the Lab's four areas of focus - research and monitoring, education and engagement, policy innovation, and climate preparedness.

Each quarter we will also highlight one or more featured projects. This fall's edition features our Cobble Berms project and our Summer Teacher Institute.

This first quarterly summary is a prototype, and our next one will be shared through our newsletter in January, covering the period of September 1, 2023 through November 30, 2023. We would love to hear your feedback! Please share recommendations with us at the email addresses listed below, so we can improve as we go.

Sincerely,

Joe Christo, Managing Director

Paul Kirshen, Research Director

For feedback and recommendations for this quarterly summary, please reach us at info@stonelivinglab.org, jchristo@bostonharbornow.org, or paul.kirshen@umb.edu.

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Featured Project
Core Research and Monitoring Projects - Cobble Berms

Project Overview

This project is evaluating the performance, morphology, and ecological impacts of recently constructed cobble berms (also called dynamic revetments) throughout coastal areas of Massachusetts using robust monitoring protocols. Additionally, the project is also providing outreach focused on coastal community planners, municipal staff, community advocates, restoration professionals, and engineers and designers who are working in the coastal zone. As such, the primary overarching goals of this project are:

1. Provide improved clarity on optimization of the design parameters relative to the dominant coastal processes at site-specific locations.
2. Identify biological effects and potential impacts associated with dynamic revetments.
3. Provide robust performance and environmental information and data for the efficacy, design, public education, and regulatory guidance purposes.
4. Facilitate improved understanding of Nature-Based Approaches to coastal resilience through field courses, workshops, and digestible and user-friendly CZM Fact sheets, FAQ sheets, and community guidance documents.

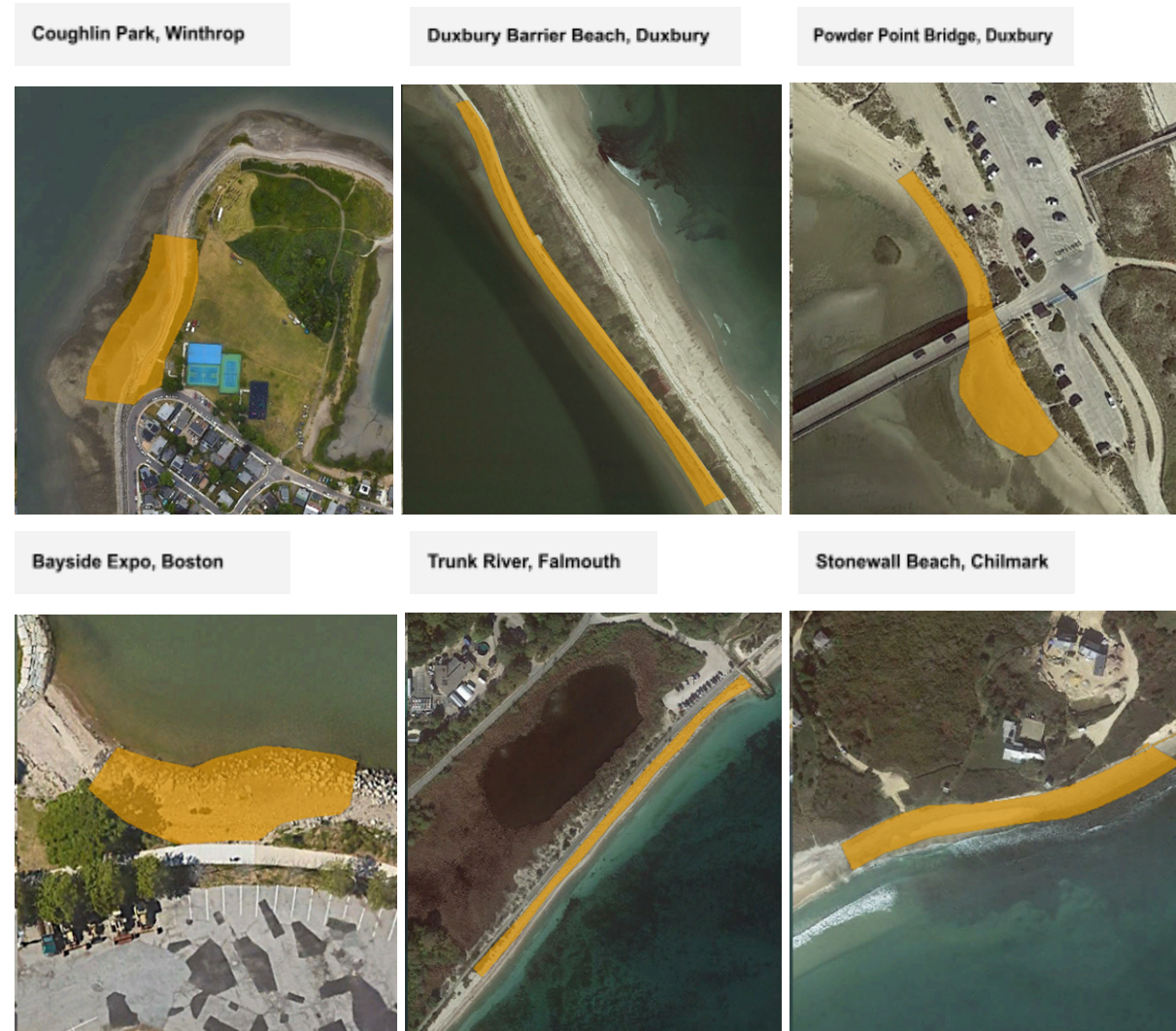
The project includes sites in a number of different coastal municipalities, and is engaging all coastal communities throughout Massachusetts via the outreach portion of the project. The outreach portion of the project is providing regional field courses, community guidance documents, and factsheets and FAQs for municipal employees, restoration professionals, and the general public. Through this process the Stone Living Lab project team (which includes our partners at Woods Hole Group) is working closely with CZM staff, cooperatively working through the outreach process and ensuring that all relevant materials are created as a team.

The monitoring data will also be incorporated into a unique outreach and educational effort aimed at providing science-based information to the community and public users that need it most.

Updates, Progress, and Opportunities

The initial cobble berm monitoring that was started by the Stone Living Lab at Coughlin Park in 2021 is now being partially supported through an additional 2022-2024 grant from Massachusetts Office of Coastal Zone Management (CZM). This grant supports the SLL by expanding its work on cobble berms to include other locations in Boston Harbor (e.g. the former

Bayside Exposition Center) and beyond, including sites in Falmouth, Chilmark, and Duxbury. The Cobble Berms project continues to move forward on multiple fronts, consisting of both monitoring aspects and educational outreach components.



Specific updates and progress include:

Geomorphology Monitoring Updates and Progress

- Geomorphology surveys using Structure from Motion (SfM) approaches were conducted at 4 of the 6 cobble berm locations in June 2023. This included surveys at Duxbury Barrier Beach in Duxbury (MA), Trunk River in Falmouth (MA), Coughlin Park in Winthrop (MA), and Bayside in Boston (MA).

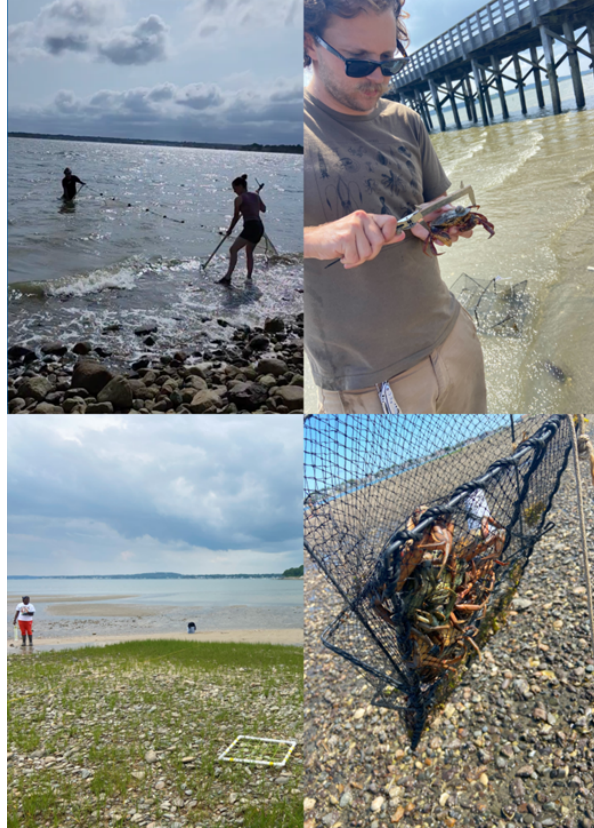
- Geomorphology surveys using RTK based systems at the remaining 2 locations in June 2023. This included surveys at Powder Point Bridge in Duxbury (MA) and Stonewall Beach in Chilmark (MA).
- Due to the limitations of flying a drone in some areas (e.g. the proximity of Coughlin Park to Logan International Airport), Dr. Mark Borrelli and his team, leading the SfM surveying effort, have developed a method to use photographs collected along shore-perpendicular transects to create *Three-Dimensional Beach Profiles* (3DBPs). This method uses the same principles as mapping with drones but without the need for flying. The pictures are collected and a georeferenced photomosaic is constructed as well as a 3D surface. The initial work was submitted to the peer reviewed literature in 2023 (Solazzo, et al., 2023). Kalinda Roberts, a UMass Boston masters student, funded by the SLL, is writing her thesis to refine this method and develop a step-by-step protocol for collecting these data. The approach also has the added benefit of collecting grain size information in addition to elevational information, which significantly benefits the design and monitoring of cobble berms. Through this effort the SLL is working to empower communities with the ability to collect high quality data and to actively participate and guide the management of their coastal resources going forward.
- Fall 2023 geomorphology surveys are being scheduled for September to November. Geomorphic comparisons will start to occur following this third set of surveys.



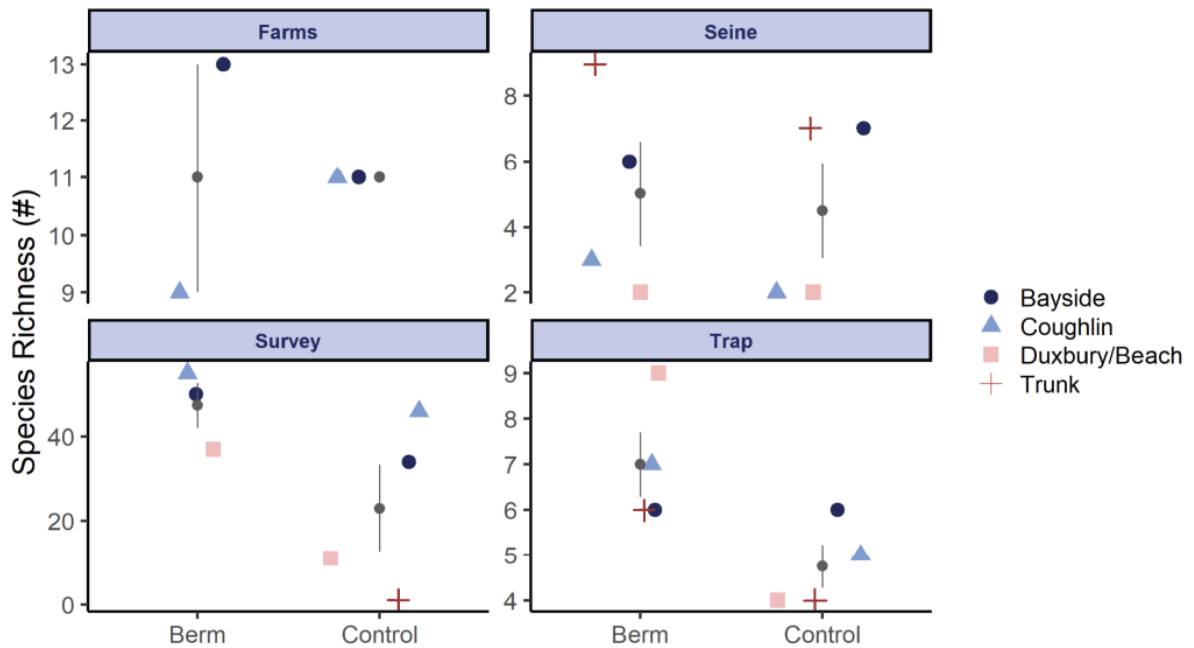
Kalinda Roberts collecting data for 3D-beach profiles at Trunk River, Falmouth. This method will yield data on beach slope, vegetation, grain size and overall geomorphological characteristics and may be useful for coarse rocky intertidal surveys.

Rocky Intertidal Habitat Monitoring Updates and Progress

- Rocky intertidal habitat monitoring was conducted throughout June and July 2023 at 5 of the 6 cobble berm locations, including surveys at Duxbury Barrier Beach and Powder Point Bridge in Duxbury (MA), Trunk River in Falmouth (MA), Coughlin Park in Winthrop (MA), and Bayside in Boston (MA). Methods used at each site include Baited Remote Intertidal Video (BRIV) systems, fish traps, crab traps, random quadrat intertidal surveys, beach seining, and Fish-specific Autonomous Reef Monitoring Structures (FARMS). This array of techniques is designed to allow multiple components of these systems to be studied and compared between berm and non-berm treatments. Video footage from survey work at the various sites can be found here:
<https://www.youtube.com/@StoneLivingLabBiological-ed1ue>
- At all sites, intertidal predation and scavenging pressure was dominated by the European green crab (*Carcinus maenas*). The number of fish species among all sites remain low, with one American eel (*Anguilla rostrata*) collected from the Bayside Berm site, one northern pipefish (*Syngnathus fuscus*) collected from Coughlin Berm, and several striped killifish (*Fundulus majalis*) at Powderpoint Bridge.
- Preliminary survey results indicate cobble berms appeared to have a positive impact on total species richness, which was seen across all of the locations. Overall, berms do not appear to negatively change ecological conditions, indicating that there is no net ecological cost to using berms as a coastal protection solution.
- Rocky intertidal habitat surveys will be conducted again in the fall of 2023 at the same 5 sites.
- The first round of surveys led to the development of a poster entitled “Understanding the impact of cobble berms on biodiversity” led by Madison Lin.



Rocky intertidal habitat monitoring being conducted by our team across a variety of sites.



Species richness found across berm and control sites faceted by method. ANOVA with Poisson regression of location and treatment show that higher levels of species richness was found at berms compared to control when all methods were aggregated. Figure from Madison Lin poster.

Salt Marsh Monitoring Updates and Progress

- Salt marsh monitoring was conducted in July 2023 at Duxbury Beach and Coughlin Park and expected to be conducted again in the fall of 2023.
- Further updates and analyses will be completed after fall 2023 data collection.

Public Outreach and Education Updates and Progress

- Outreach and educational site visits were conducted on July 24 (Coughlin Park) and August 22 (Duxbury Beach), following the initial field trip on June 5 (Boston Harbor). These have been exceedingly successful in reaching out to community leaders to provide an understanding of cobble berm design and applications.
- The ArcGIS Storymap “Nature Based Approaches: Cobble Berms” (<https://arcg.is/1LPzKH0>) covers how the Stone Living Lab and Woods Hole Group are monitoring cobble berms along the Massachusetts coast to understand how they can help protect our shorelines.
- As a result of the outreach and education field trips, new nature-based cobble berm projects are now being considered in Hull, MA and New Bedford, MA. This is a direct result of the project, as project proponents for both communities attended cobble berm field trips. At both of the sites, erosion and flooding concerns are ongoing and the cobble berm approach is replacing other less environmentally friendly alternatives.
- A final outreach field trip for this year is being conducted on September 20 to Trunk River in Falmouth, MA. Trip evaluations and creation of new outreach materials will be developed during the winter and spring months of 2024.

Core Research and Monitoring Projects - Living Seawalls

Project Overview

In 2021, the Sydney Institute of Marine Science's (SIMS) Living Seawalls Program was named a finalist in the Reviving Our Oceans category of the prestigious Earthshot Prize. In 2022, Earthshot organizers invited the Stone Living Lab to partner with the Living Seawalls team on groundbreaking research in Boston Harbor, which will build upon pilot research carried out by the Lab from 2020 to 2021.

It is not always possible to install nature-based approaches in all areas of a city - sometimes, a hard, narrow structure such as a seawall must be used. What can be done, however, is to install an ecosystem-friendly surface on the hard structure so that it becomes a viable habitat for marine life: a living seawall.

For this mutually beneficial eco-engineering approach to reach its full potential, however, we must understand how its benefits vary across a range of environmental settings. This project will establish the first installation of Living Seawalls' habitat-mimicking concrete tiles in North America and investigate ecological and other impacts of this nature-based approach on built structures in Boston Harbor.

The project has three specific objectives:

- Developing a pathway for nature-based approaches to be incorporated into marine built structures in Boston Harbor
- Identifying the enhancement contours and configurations that maximize biodiversity gains in Boston Harbor
- Determining the site-scale benefits of habitat enhancements of seawalls in Boston Harbor

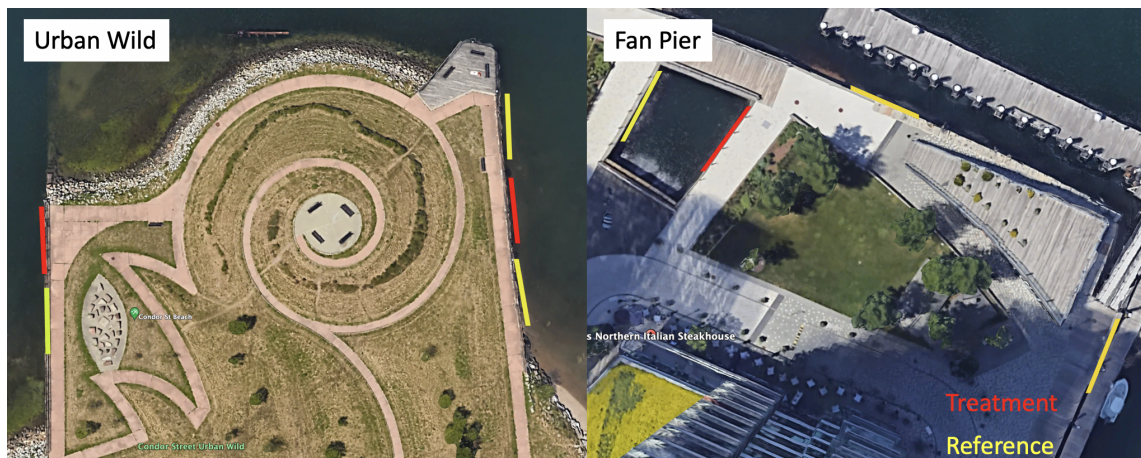
Updates, Progress, and Opportunities

During the reporting period, the Living Seawalls (LSW) project focused on three main goals:

- Identifying sites for LSW installation

- Doing a before-installation sample according to LSW protocols from our Australian partners, in order to create a Before-After-Control-Impact design for LSW ecological community-level impacts
- Deciding on an appropriate tile design to mimic New England intertidal communities or provide similar habitat types and place orders

Out of five proposed locations, we identified the Condor Street Urban Wild in East Boston, and the inlet at the Fan Pier in the Seaport as our two proposed study sites, and are discussing their viability with the property owners. The Urban Wild is a park in an environmental justice community, hosts many people every day, has good visibility to the public, has a flow exposed and flow protected side, and is subject to numerous urban stressors that a LSW installation would have to tolerate. The Fan Pier inlet is a seawall that extends lower into the shallow subtidal, is highly visible to the public, and has multiple easily accessible reference sites nearby.



Layout of the Living Seawalls installations at both the proposed Urban Wild and Fan Pier sites.

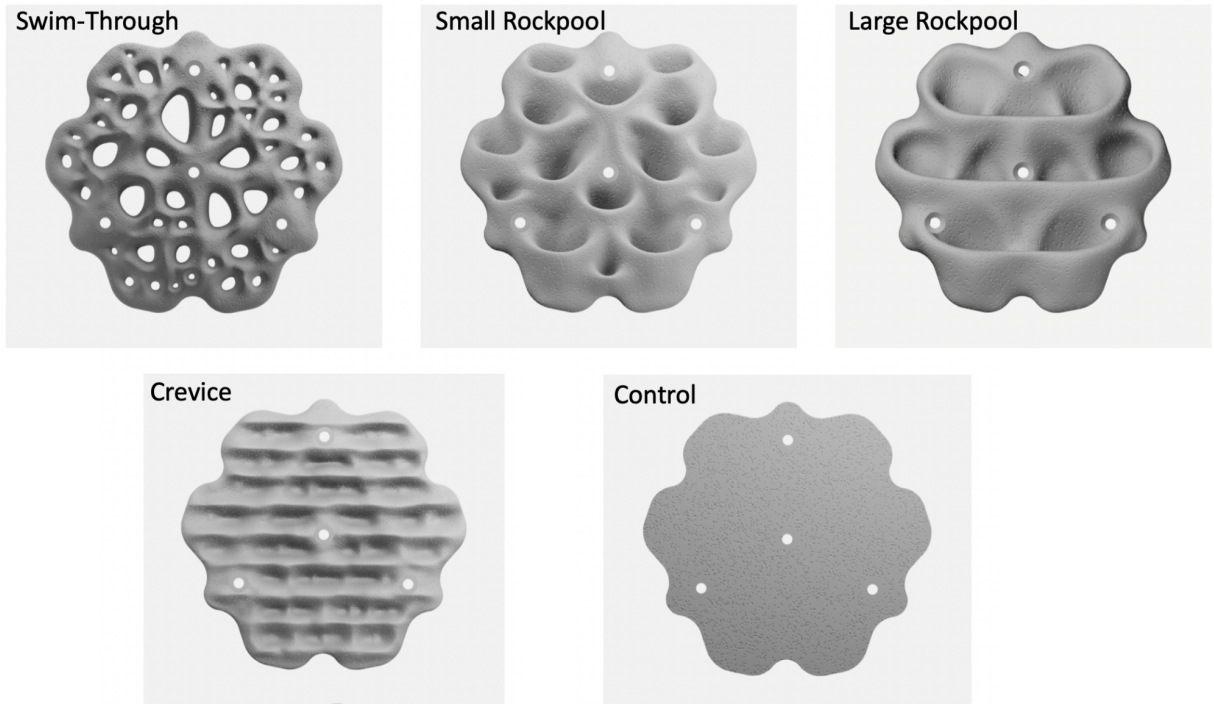
We are also working with Brian Cheng at UMass Amherst to design a LSW installation for the upcoming renovations of the Gloucester Marine Station pier, enabling a cross-site comparison in urbanized and non-urbanized areas.

We worked with our Macquarie University partners in Australia to revise and update sampling protocols for the unique biota of New England. Boston has both a larger tidal range and a high abundance of canopy forming algae that are missing from other LSW installations around the world. We revised both their standard point count and fish sampling protocol, developing a device that can be deployed to observe fish at high tide even from very high seawalls without requiring researchers to enter the water.



Researchers sampling the intertidal biota at the proposed Fan Pier site.

Finally, after sampling, we consulted with the Macquarie University team to determine what panel types and in what arrangement we'd be deploying. We agreed on use of the control panels, small rockpool panels, large rockpool panels, crevice panels, and swim-through panels. This allowed for: 1) a comparison of all types to blank no-structure panels, 2) a comparison of the thermal effects of different rockpool sizes, 3) an investigation of adding water-filled areas versus pure structure, and 4) a comparison of the swim-through design to other sites around the world where it has promoted algal and mussel growth greater than expected. At each site, these designs will be employed with 4 replicates per tide height, allowing us to evaluate the effects of panel design as well as how each panel affects the ecology at different tide heights (e.g., perhaps the rockpools facilitate biodiversity at high tide heights while the crevice has more impact at low tide heights). This experimental analysis will allow us to make policy-relevant suggestions for future LSW deployments when they are adopted by municipalities in the course of building coastal protection structures.



Panels are being ordered, and we are in the process of beginning to secure permits for installation. We currently estimate a January or February installation of the panels, and will resample them after the spring recruitment period. Project Masters student Daniel Lopez also has plans to further expand sampling of fish, recruitment of invertebrates, and changes in the thermal environment due to panels in the next year.

Core Research and Monitoring Projects - Camp Harbor View Partnership Project

Project Overview

Camp Harbor View (CHV) is located on the northeastern end of Long Island in Boston Harbor. It is a summer camp for Boston youth from middle and high schools. The western and eastern sides of the camp have erosion issues and may have flooding that could increase over time due to climate change-associated sea level rise (SLR) and increases in tropical storm intensities.

The objectives of the this Lab project are to:

- Document the nature of onshore and offshore physical processes (e.g., ocean waves, tidal currents, and sediment transport) and biological habitats for baseline assessment purposes
- Determine, based on those data, the causes and impacts of any erosion or flooding at the sites in question
- Support the educational program of CHV

Updates, Progress, and Opportunities

Staff at Camp Harbor View (CHV) reached out to SLL to visit their facility on Long Island in Boston, since they are concerned about an ongoing erosion problem and storm-related flooding. Bob Chen, Paul Kirshen, and Mark Borrelli visited the island in May of 2023 and discussed the possibilities of a research and monitoring project. In July, a proposal for a 12-month period of data collection and analysis was sent to CHV. In August, after a presentation to the CHV Board of Directors, the project was approved for funding. This 12-month project will see the SLL collect data needed for our Science-based *BACI* approach (Before-After-Control-Impact). The main role of the Lab on this project is to establish baseline conditions at CHV by collecting scientific data to more accurately document the impacts of any alteration to the shoreline. In this way we are forwarding the mission of the Lab as well as influencing and improving resiliency of the shoreline of Boston Harbor. The project started this summer and will continue through September of 2024.

Recently completed and upcoming milestones for this project:

- Internal kick-off meeting with project team held in August 2023, with Dr. Mark Borrelli as PI/PM and others at the SLL who will provide additional support when needed
- External Kick-off meeting with CHV held in August 2023 to review scope of work, deadlines, deliverables and contract
- September 2023 - Finalize details of the UMass/Camp Harbor View contract
- Fall 2023 - begin to analyze baseline information - topographical and bathymetric surveys onshore and offshore, wetland delineation surveys, and intertidal surveys of biota
- Fall 2023 - Install/deploy monitoring equipment - Acoustic Doppler Current Profilers (ADCPs) to collect data on waves, water levels, and currents for 4 weeks
- Winter 2024 - Install 8 tilt meters
- Continue to document the nature of onshore and offshore physical processes (ocean waves, tidal currents, and sediment transport (after equipment is installed)
- Spring 2024 - Re-deploy the ADCP on back side of CHV
- Spring 2023 - In collaboration with CHV, Boston Harbor Now and UMass Boston will develop/confirm details for the upcoming educational program to be implemented in summer of 2024
- Spring 2024 - In collaboration with CHV, Boston Harbor Now will develop a communications, outreach, and engagement program for summer of 2024 through, social media platforms, Climate Cart, and other outlets
- Fall 2024 - Completion and submission of a Final Report to CHV team

Core Research and Monitoring Projects - Socio-Economic Research

Project Overview

The Lab awarded three research grants to study the social and economic impacts of nature-based approaches to coastal flood protection in spring 2022. Salem State University, UMass Dartmouth, and A Better City each received grant awards to examine the connections between nature-based approaches and topics such as public health and wellness, access to open space and economic opportunity, and climate justice.

Updates, Progress, and Opportunities

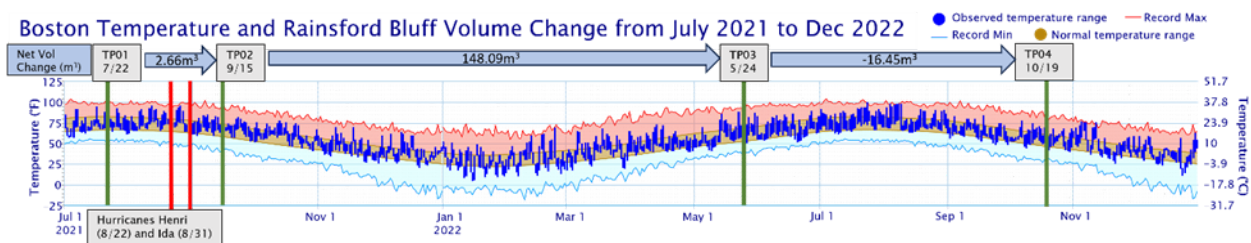
Each grant recipient recently submitted a draft report, and preliminary results from all three were presented at the Lab's conference in April 2023. All three reports will be discussed in more detail in the next quarterly report.

- *Greening The Blue Line: Evaluating The Potential Of Nature-Based Solutions to Protect Critical Transportation Infrastructure and Uplift Communities Along the Blue Line In East Boston* - A Better City, Civic Space Collaborative, and Weston & Sampson
 - This project investigates the potential to deploy nature-based approaches along the MBTA's Blue Line corridor in East Boston to protect critical transportation infrastructure from flooding, to support ecosystem restoration, and to improve the health and vibrancy of marginalized communities and commercial districts.
- *Recreational Co-Benefits Associated with Shoreline Protection Design* - University of Massachusetts Dartmouth
 - This project examines whether social media and cell phone data can be used to understand the demographics of visitors to the shoreline. This research will help inform whether or not these types of data can be used to assess social impacts (for example, changes in demographics of visitors to a particular site following a nature-based intervention).
- *From Analysis to Action: Strategies for Promoting Climate Justice when Implementing Nature-based Solutions to Coastal Risk* - Salem State University, and Industrial Economics Incorporated
 - This project identifies recommendations for key policy and regulatory measures to better ensure that the benefits and co-benefits of nature-based systems can accrue to socially vulnerable populations in close proximity to planned or installed nature-based resilience investments.

Special Projects Highlight - LiDAR Monitoring of Annual and Storm-Driven Episodic Erosion at Rainsford Island

Project Overview

Boston Harbor and its thirty-four islands are subject to erosion driven by rain, winds, and waves. Climate change threatens to increase erosion over time as sea levels rise and the frequency and intensity of storms increase. To better understand the impact of both annual weather and episodic severe storms, the high-resolution Riegl VZ400i terrestrial LiDAR was deployed to scan and monitor the eroding northeast bluff of Rainsford Island. These scans were acquired four times (TP01-TP04) over 14 months from July 22, 2021, to October 19, 2022. Of particular interest, these scanning campaigns included dates both before and after the region experienced two hurricanes, Henri and Ida, in late August 2021.



Updates, Progress, and Opportunities

- The majority of bluff volume change occurred over winter (between TP02 and TP03)
- Hurricanes Henri and Ida caused moderate erosion with many small erosion events and a few large ones, including one in which a tree toppled over the top of the bluff.
- Terrestrial LiDAR data and transformation of the lidar pointclouds into cubic voxels (Voxelization) accurately capture 3D structures and allow for comparisons over time.
- The data processing pipeline in this project utilized multithreading, improving computational speed by 22x on a consumer laptop. These improvements would further scale using a multi-core data server.

This project and the data processing techniques developed within, turning LiDAR observations into quantifiable erosion events, are adaptable and scale-able. Larger-scale techniques such as airborne LiDAR could survey large swaths of coastline, allowing municipalities to track erosion around harbors or beaches.

On a smaller scale, with the increasing prevalence of accessible consumer LiDAR such as the Apple iPhone, this technology could perhaps be adapted to empower individuals to quantify the erosion impact of episodic storms or a long-term process like sea level rise on their own property or on vulnerable public spaces. With almost 40% of the US population living in high-population-density coastal areas and vulnerable to flooding and erosion, more widespread erosion data collection could help individuals with insurance claims, states and municipalities with coastal resilience planning, and researchers with the development of nature-based approaches.

Featured Project

Education and Engagement Projects - Summer Teacher Institute

Project Overview

This year the Lab hosted our second Summer Teacher Institute, in direct partnership with National Parks of Boston. We recruited 11 Boston-area teachers for a free, five-day workshop, during which participants explored climate change through the lens of place-based learning and citizen science. Guest presenters from 11 partner institutions joined us throughout the week, while participants developed their capstone lesson plans to be implemented in the 2023-2024 academic year. Final presentations of these capstone projects will take place in September 2023.

Updates, Progress, and Opportunities

This summer, the Institute team included: Holly Rosa-Watson (Boston Public Schools), Elisabeth Colby (National Park Service), Rebecca Shoer (Stone Living Lab), Cathay Radonic (National Park Service), and Daria Healey (Stone Living Lab). During the winter and spring of 2023, staff redeveloped and updated the Institute curriculum in response to evaluations collected from our 2022 pilot cohort. Revisions included greater exposure to participatory science protocols, increased project work time, and opportunities to hear about in-classroom lessons implemented by our 2022 alumni.

The 2023 course ran from July 24-28, with the application process taking place in February and March of 2023. Twelve participants were selected from a pool of 36 applicants, all from the Greater Boston area (one dropped out due to illness). Our participants mainly teach middle school STEM classes, ranging from environmental vocation programs to chemistry. One pair of teachers applied together from Medford Technical High School, and collaborated on their capstone lesson, to be implemented together between each of their classes.

Our participants submitted their capstone projects on August 11, and staff are currently reviewing the proposals and providing feedback to each participant. Participants will give a final presentation of their plans in late September, once school has begun and teachers have the opportunity to prepare for the academic year. Once the presentations have been completed, teachers will each receive a \$1,000 stipend to support purchasing supplies, providing bus transportation, etc., as needed.

Evaluations of this year’s Institute were overwhelmingly positive. Free graduate-level programs for STEM teachers are increasingly rare, and the graduate credits earned allows teachers to advance up the salary ladder. Highlights from our course surveys include:

“I am eager to recommend this Teacher Institute to my other science teaching peers, and look forward to the opportunity to engage with the SLL again in the future.”

“It rejuvenated me during a time when I was losing motivation for my lessons.”

“I am more aware of local projects and see the value/benefit in students feeling like they have made a very real contribution to science.”

You can read a summary of the week, including daily excursions, on our website here:

<https://stonelivinglab.org/news-article/2023-institute>.

We look forward to planning our next Institute in 2024, and also hope to plan year-round events to support our growing network of teachers!



Stone Living Lab Summer Teacher Institute participants with Lab team members and partners.

Education and Engagement Projects - Climate Cart

Project Overview

Over the past two years, SLL staff have developed a series of pop-up tabling activities called the Climate Cart. These activities support our Coastal Resilience Principles, and are directly tied to coastal climate issues affecting Boston Harbor: coastal erosion, shifting ocean temperatures, preparing for extreme events, and interpreting climate change data. After piloting these activities at a small number of events in 2022, program staff (including two summer interns) revamped and redeveloped these activities for a broad range of events in 2023. Through the Climate Cart, we reached over 1,000 residents and visitors over the course of the summer. We also developed new tabling materials, including a zine, and partnered with a range of new organizations including the Esplanade Association, Boston Children's Museum, Massport, and The American City Coalition.

Updates, Progress, and Opportunities

During winter and spring of 2023, SLL program staff evaluated and assessed our pilot Climate Cart activities, which had been developed and run during summer 2022. As part of this evaluation process, we brought and demoed four Climate Cart activities with education staff at Boston Children's Museum. BCM staff were able to provide expert feedback on the activities, and provide suggestions to enhance activities for accessibility and interest for youth. In addition, our two summer interns (Sarah Hope and Daria Healey) piloted expanded versions of each activity, including a new climate data art activity.

Between May and August, the Climate Cart was featured at 30 events around Boston, from the Boston Harbor Islands Welcome Center to community cruises and beach events. These tabling opportunities not only provide fun and educational experiences for visitors and residents of all ages, they allow Lab staff to meet and engage with residents, visitors, and community organizations throughout Boston.

With the additional capacity of our two interns, we were also able to revamp the Climate Carts with new outreach materials, including a zine, refresh activity designs, and develop activity guides for public use (available on our website). Although the fall and winter seasons are often slower for public events, many partners have expressed interest in the Cart joining for 2024 summer events.



Stone Living Lab summer interns Daria Healey and Sarah Hope engaging youth at the Climate Cart.

Education and Engagement Projects - Youth Engagement

Project Overview

The Lab regularly partners with organizations serving youth (typically high-school aged) via employment and development programming. Regular partners include National Parks of Boston (PLACE fellows, Youth Conservation Corps, etc.) and the Trustees (Waterfront Ambassadors). Lab staff provide single or multi-day engagements with these programs, providing experience and exposure to field science and climate careers, while also hearing directly from youth about their concerns and interests. This year, staff also engaged with two new organizations, GreenRoots ECO and City Apprentice, and have begun work on a new NPS program: the Climate Conservation Corps.

Updates, Progress, and Opportunities

During spring and summer 2023, SLL program staff provided one-day field experiences to 35 Boston area youth. These experiences bring youth into the field to experience authentic scientific protocols, explore skills and fields related to climate change work, and provide space for youth to express their own interests and concerns in the environmental realm. This year, youth measured beach profiles, conducted mini bio-blitzes, and used [Dr. Johnson's Climate Venns](#) to brainstorm their own climate actions. By partnering with established community organizations, Lab staff are able to support and connect with Boston youth without duplicating the good work being done by well-established community groups.

In addition to these groups, the Lab works closely with the National Parks of Boston (NPB) supporting their youth employment programs: the Public Lands and Career Exploration (PLACE) Fellowship, the Youth Conservation Corps (YCC), and the new Climate Conservation Corps (CCC). For the first two youth programs, Lab staff provided one-day engagements with youth employees. In direct collaboration with NPB staff, Lab staff are currently engaged in developing programming to support and be supported by a pilot corps of youth via the CCC. The Lab will provide initial orientation and introductions to climate change threats and research in Boston, and will then be supported by a youth employee in the development of new education and outreach activities. CCC employees will begin onboarding in mid-September 2023 and be employed through July 2024.

Education and Engagement Projects - Participatory Science

Project Overview

Through this participatory science project, the Lab is engaging a wide range of perspectives in contributing to our sustainable future. Focused specifically on storm surge, this project involves collaboratively designing and deploying equipment to measure both the vertical rise of flooding as well as the horizontal extent of flooding. The day before a storm, volunteers will deploy three vertical indicators as well as twelve horizontal indicators. Within 12 hours of the storm, volunteers will collect the equipment and report their results to the Stone Living Lab.

Climate change is anticipated to make powerful episodic storms and their impacts, including storm surges, more frequent and more severe. Our team of participatory science volunteers are helping us understand today's storm surges so that we can better prepare for those of the future.

Updates, Progress, and Opportunities

The SLL team leading this participatory science project includes Bob Chen and Kayla Bradley, supported by Rebecca Shoer. In the spring of 2023 the SLL team worked to recruit community volunteers and design a preliminary design for the research equipment. The main goal was to design a low-cost methodology to measure flooding from coastal storm surges without being on-site during the storm.

During the summer of 2023, the SLL team worked in collaboration with community volunteers recruited during the Spring to test and redesign the equipment. Four volunteer groups deployed the equipment during a storm in July and reported back their findings, feedback, and recommendations about the equipment design. Using this information and suggestions from the volunteers, the teams redesigned the equipment to be more robust.

The current design involves two types of “indicators” using cobalt chloride test strips to detect the presence of flood water. The first indicator is a tall pole with multiple test strips to indicate the level of flooding. The second indicator is a smaller PVC cage that contains a singular test strip to indicate whether or not a single spot flooded. The project currently involves seven sites of interest: Long Wharf, Clippership Wharf, Shaw’s in East Boston, Tenean Beach, Carson Beach, Morrissey Boulevard, and the Marine Park.

As the project continues, the team and volunteers hope to further improve the equipment's accuracy and design. The team plans to use the methodology developed through the summer to measure the flooding of larger flooding events in the fall and winter of 2023.



The flood measurement equipment. The photos on the left show the vertical (top) and horizontal (bottom) indicators deployed at a site. The photos on the right show the cobalt chloride paper in each indicator.

Policy Innovation Projects - Robust Policies for NBA Implementation

Project Overview

The purpose of this research is to generate a better understanding of how to incorporate human values and community knowledge into adaptation planning, including the design and implementation of nature-based approaches. When thinking about successful climate change adaptation, it is important to apply a contextual lens as local community dynamics and decision-making processes often define people's access to resources and thus determine whether outcomes are equitable (See & Wilmsen 2020). Specifically, this research examines the influence and significance of human values in climate change adaptation planning by examining diverse human perceptions on climate change risks associated with sea-level rise (SLR) and proposed adaptation strategies for flood protection (i.e., nature-based approaches) in the coastal urban context and recommend potential policies to achieve transformative adaptation.

The primary objective of this research is to demonstrate how climate change adaptation strategies designed and informed by diverse stakeholder perspectives and values, placing the human face of climate change at the center of adaptation discourse, can support transformative adaptation. Transformational adaptations have been widely accepted as necessary to achieve social, ecological, and economic equity across generations (Eriksen et al. 2011; O'Brien 2012; O'Brien et al. 2015). Transformative adaptation builds resilience in order to support socio-ecological system functions into the future while enabling changes in social organization (Pelling 2011). However, the steps towards achieving transformative adaptation futures are relatively unclear and it is necessary to better define what adaptation futures community stakeholders seek and how they can occur (Pelling et al. 2015).

The primary research objective will be addressed by applying a case study approach and following a Values-focused Thinking (Keeney 1992) framework of analysis. The case study focuses on the City of Boston, which faces mounting vulnerabilities to coastal flooding as a result of the projected 5-feet of SLR by 2100. In light of these challenges, Boston has committed to pursuing nature-based approaches for coastal flood protection based upon recommendations from the Kirshen et al 2018 report. Considering these circumstances, this research will examine the community's various stakeholder perspectives to determine how nature-based approaches, in comparison to other strategies, can be developed and implemented to meet community needs to address increasing coastal flood risks with underlying vulnerabilities. This research follows an exploratory case study design (Yin 2018) to consider the city's diverse stakeholder needs and values in order to ensure adaptation strategies may be designed and implemented effectively and equitably.

Updates, Progress, and Opportunities

This year the project shifted approaches from one focused on agent-based modeling (ABM), to values-focused thinking (VFT) in order to get a deeper understanding of the dynamics that contribute to and influence adaptation strategies and potential outcomes. Rather than conducting simulation experiments through a model to test adaptation strategies and community dynamics, the research is now focused on expanded traditional data production methods such as interview and focus groups. This approach entails developing distinct forms of knowledge by going directly to the source local stakeholders to understand what is needed for climate change adaptation in the City of Boston and how strategies like nature-based approaches can align with stakeholder values for successful implementation.

After submitting a revised proposal to the Stone Living Lab Steering Committee and Scientific Advisory Committee in January 2023, the project re-commenced with various presentations and the next phase of data collection. Major updates on project activities include the following:

- April 2023 - Poster presentation on initial findings – University of Massachusetts Boston School for the Environment Earth Day Symposium and Stone Living Lab Conference
- May 2023 - Ethical Approval (IRB Review) to conduct interviews and focus groups
- June-August 2023 - Conducted 38 interviews with 40 interviewees consisting of Boston stakeholders (i.e., leaders and representatives from community-based organizations, foundations, City and State agencies, developers, and consultants)

Next steps include analysis of interview findings, writing reports to publish and share results, and conducting focus groups/s with study participants. The primary next steps are currently underway and include the following:

- Qualitative analysis focusing on identifying key themes, values and objectives amongst stakeholders
- September 2023 - Development of a concept map rooted in relevant literature and social theory to visualize information on how motivations and priorities vary by stakeholder group – written report
- September 2023 - Initial application of the VFT approach to create a fundamental value hierarchy, which connects fundamental objectives to means objectives as a network from most general to most specific, and shows the interrelationships between means objectives – written report
- October 2023 - Focus group/s to present and discuss VFT networks and initial findings with participants, amending networks based on feedback
- November/December 2023 - Final report and findings

Climate Preparedness Projects - Stone Living Lab 2023 Conference

Project Overview

The Lab convenes conferences to formally discuss coastal research and climate resilience with researchers, practitioners, and other interested stakeholders doing work in Boston Harbor and around the globe. The conferences foster coordination and collaboration amongst individuals from a variety of fields. In addition to discussions about the research, conveners focus a special emphasis on place-based participatory science, education, policy, environmental justice, and community participation.

Updates, Progress, and Opportunities

The Lab's 2023 conference was titled *Nature-Based Coastal Resilience in Urban Settings*, and was held at UMass Boston from April 26 to April 28. The conference offered the 250+ participants and attendees a bounty of ideas and inspiration for how we can all join together to create a future where people work with nature to make coastal regions resilient and adaptive to climate change, while enhancing and beautifying both natural and built environments.

The conference featured 2 keynote panels, 1 keynote talk, 12 breakout panel presentations, and 3 field trips, all of which were in one of the following tracks - Permitting, Policy, Financial Implementation, Assessment of Success, and Nature-Based Approaches and Social Equity. The keynote panels and keynote talk are summarized below, and videos of them, as well as abstracts and other information on the breakout panels, can be found at <https://stonelivinglab.org/conference>.

Day 1 featured an Indigenous Knowledge Fireside Chat, a conversation with National Park Service Director Charles F. "Chuck" Sams III and Elizabeth Solomon, of the Massachusetts Tribe at Ponkapoag. The chat was moderated by the City of Boston's Chief of Energy, Environment, and Open Space Rev. Mariama White-Hammond. Director Sams, the National Park Service's 19th Director and the first indigenous person to serve in that role, is Cayuse and Walla Walla and is an enrolled member of the Confederated Tribes of the Umatilla Indian Reservation in Northeast Oregon where he grew up. He also has blood ties to the Cocopah Tribe and Yankton Sioux of Fort Peck. Elizabeth Solomon serves on the Stone Living Lab's Executive Committee, representing indigenous interests and helping to guide the Lab's work.

A highlight of the conference, this conversation offered a deep exploration of indigenous traditional ecological knowledge, ways of knowing and living gained from thousands of years of knowledge and practice. “It really was the earth making its own decision about what it was going to do,” Director Sams says during the conversation, “but that being said, our relationship with the land told us how we were to interact with it and to adapt to it.”

We were also honored on Day 1 to hear from Massachusetts’ first-ever cabinet-level Climate Chief, Melissa Hoffer. Chief Hoffer outlined the vision that she, Governor Maura Healey, Lieutenant Governor Kim Driscoll, and their administration share to make the Bay State’s coastline and coastal communities more resilient to climate change, including quickly and aggressively reducing carbon emissions and the environmental damage they cause. Drawing close connections between human and ecological resilience, Chief Hoffer describes the need for “an immediate resetting of governmental and private sector priorities and resources.” She also highlighted the importance of moving ahead rapidly with “low-cost/low-regrets activities” to build resilience to climate change, like protecting ecologically critical salt marshes, as stakeholders gain more clarity about the timing and extent of future climate impacts and the most effective, sustainable approaches to addressing them.

Day 2 featured our panel discussion “Co-Lab-Oration: How Three Climate Labs in Boston and New York City are Approaching Their Work.” Moderated by Kimberly Lucas of Northeastern University’s School of Public Policy and Urban Affairs, this discussion offered a rich, nuanced look at the critical role of partnerships and collaboration in climate resiliency research and implementation from the perspective of three “living laboratories.” Panelists were Stone Living Lab Managing Director Joe Christo; Sheetal Shah, Operations & Engagement Lead at the Urban Ocean Lab in New York City; and Lauren Wang, Director of Climate Programs at The Trust for Governors Island in New York City. While all three labs have their own unique focus, geography, mission, and activities, they also complement each other so well, and the Urban Ocean Lab’s vision statement is one that captures the conference’s theme perfectly: That Boston, New York, and all coastal cities will be “climate-ready, implementing rigorous and world-leading climate and ocean policy solutions, ensuring environmental justice for coastal communities, and serving as models for state and federal policy change.”



Conference attendees listen to National Park Service Director Charles Sams, Massachusetts Tribe at Ponkapoag Elder Elizabeth Solomon, and moderator Rev. Mariama White-Hammond of the city of Boston during Day 1's Indigenous Knowledge Fireside Panel.



Day 2's Co-Lab-Oration panel participants: Moderator Kimberly Lucas of Northeastern University's School of Public Policy and Urban Affairs, Lauren Wang of The Trust for Governors Island, Sheetal Shah, of the Urban Ocean Lab, and Stone Living Lab Managing Director Joe Christo.