Biomimicry: applying knowledge and solutions from nature

Dr. Anamarija Frankić
Research Professor, UMass Boston
Director, Green Harbors Project
Biomimicry Fellow
Fulbright Scholar
University of Zadar

Anamarija.Frankic@umb.edu
www.umb.edu/GHP

Photo: A. Frankic
WHY Biomimicry LivingLabs?
Savin Hill Cove Biomimicry LivingLabs: Learning, teaching and doing sustainable projects with local community; 

Students Promo video: http://youtu.be/loIR-ZO3dow

Dr. Anamarija Frankic acquaints us with oysters in the Boston Harbors, shows us their dire plight and what she is hoping to accomplish with this innovative project. Click and see what they are doing to bring back the oysters and restore the salt marshes.


Thank you, Mrs. Wendy Schmidt!
Biomimicry LivingLabs at Savin Hill Cove

Morrissey blvd: Flooding area site

Paten cove with a salt marsh

Erosion at the yacht club

Culvert with a small catchment (water quality data available for 5 y)

Sediment accretion ~ 2 inch/year

Harbor walk

Existing fringing salt marsh

Areas for salt marsh restoration

Potential areas for shellfish bed restoration

Area for a green pier/-floating dock
Savin Hill Cove Cleanup

Organized by the Biomimicry LivingLabs, Dr. Anamarija Frankić
School for the Environment, UMass Boston

When:
Saturday,
September 14, 2013
@ 9:00 am

Where:
Between SHYC and
Dorchester Vietnam
Veterans Memorial

Partners:
Department of Conservation and Recreation (DCR)
MassBaykeeper.org
Savin Hill Yacht Club (SHYC)
Historic Savin Hill Advisors Inc
UMass Boston’s Marine Operations and
Urban Harbors Institute

Savin Hill Cove photo by A. Frankic
DCR operations trucks removed:
35 ton loads
41 ton loads

For a total of 19 tons of marine debris removed!
Partnering with Olin College of Engineering at our bLLs

Dr. Andrew Bennett, Olin and Peter McNamara, Savin Hill Association

the quadrotor and the robot kayak for monitoring
Savin Hill Cove, Biomimicry LivingLabs:
Floating Island without vegetation, planting vegetation on May 31 with local community;
<table>
<thead>
<tr>
<th>Project Description</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of essential fish and shellfish habitats (ESH) and how will sea level rise scenarios and changing climate impact the ESH in the Cove</td>
<td>Connor Bordwick, Kevin O’Brien, Jose Lopez</td>
</tr>
<tr>
<td>Assessment of policy conditions, constraints, and consequences in the process of shellfish restoration: the complex permitting process for restoration of urban harbors (<a href="http://www.permitsandpolicies.blogspot.com">www.permitsandpolicies.blogspot.com</a>)</td>
<td>Stephen Norris, Kevin Carpenter*</td>
</tr>
<tr>
<td>Assessment of potential human health impacts from present water quality in the Cove</td>
<td>Ann Bodnar, Luis Saquich, Ian Ferrari</td>
</tr>
<tr>
<td>Using Floating islands to restore ecological services in urban harbors through biomimicry-based design and engineering (Savin Hill Cove case study)</td>
<td>Keith Reese, Silverio Conte, Rich Babb</td>
</tr>
<tr>
<td>Development of sustainable solutions to mitigate sediment and contaminant re-suspension during storm surge and tidal inundation in urban harbor (Savin Hill Cove)</td>
<td>Peter Hamscher</td>
</tr>
<tr>
<td>Using the LivingLabs to strengthen campus-community interactions in addressing environmental issues in the Savin Hill Cove</td>
<td>Jessica McNiff, Tim Lynam</td>
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<tr>
<td>Shifting Shorelines of Savin Hill Cove (GIS Landuse/Landcover mapping)</td>
<td>Nicole Borgstrom, Sandy Tremblay</td>
</tr>
<tr>
<td>Assessment of existing fish advisories in Boston Harbor and comparison between three urban estuaries: Neponset, Charles and Mystic Rivers</td>
<td>Elisabeth Honig, David Finkenaur</td>
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</tbody>
</table>
Why Savin Hill Cove restoration? flooding, erosion, degradation
Savin Hill Cove Adaptation based on students projects

Intertidal Habitat of Savin Hill Cove, MA

Environmental Sensitivity Index (ESI) for Savin Hill Cove

Intertidal Habitats
- Salt- and Brackish-water Marshes
- Salt- and Brackish-water Marshes/Sheltered Tidal Flats
- Exposed, Solid Man-made Structures
- Exposed, Solid Man-made Structures/Exposed Tidal Flats
- Mixed Sand and Gravel Beaches
- Mixed Sand and Gravel Beaches/Sheltered Tidal Flats
- Sheltered, Solid Man-made Structures
- Sheltered, Solid Man-made Structures/Sheltered Tidal Flats
- Sheltered Riprap/Sheltered Tidal Flats

Created by Jose Lopez
12/5/2013
Source: ESRI, USGS, MassGIS, NOAA
Restoring 45 acres of coastal habitats in Savin Hill Cove ($550K, NFWF, pending)

<table>
<thead>
<tr>
<th>Ecological services</th>
<th>Salt marsh m²/year</th>
<th>Restore 25 acres of fringing salt marsh (101,171m²)</th>
<th>Shellfish beds (one oyster)</th>
<th>Restore 20 acres of oyster habitat (80,937m²) ~250 oysters/m² = 21mil oysters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrients/ Total nitrogen take</td>
<td>~ 21gN/m²/y</td>
<td>~2,1tN/year</td>
<td>0.5 – 1.5 gN/y</td>
<td>21 million gN/y</td>
</tr>
<tr>
<td>Bio-sequestration (Amount of carbon sink)</td>
<td>~ 210gCO₂/m²/y</td>
<td>~21 tCO₂/year</td>
<td>42% dry weight soft tissue; and 12% of shell mass (CaCO3)</td>
<td>To be measured</td>
</tr>
<tr>
<td>Sediment accretion</td>
<td>~ 1.3 cm/y (vertical accretion)</td>
<td>~131,522 cm/year</td>
<td>Sediment oxygenation &amp; bioturbation</td>
<td>To be measured</td>
</tr>
<tr>
<td>Water storage, filtration/ Bioremediation</td>
<td>~ 4 million liters of water/acre</td>
<td>~ 400million liters/25 acres</td>
<td>Filters 190 liters/day (50 gallons/day)</td>
<td>~4billion liters or 1 billion gallons of water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>bLLs</th>
<th>Funding (2013-14)</th>
<th>Students (2013-14)</th>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savin Hill Cove</td>
<td>$100K Schmidt FF</td>
<td>28 Capstone 20 Honors 4 MBA (business plan) 80 Open Course Coasts &amp; Communities 1 Graduate</td>
<td>Savin Hill Association, Marine Operations UMB, CAPS, SHYC, DCR, DMF, MA Baykeepers, BluePlanet Ltd (Brent Constantz), Floating Islands SE, Bill Sullivan (FLEXcon), NPS, NRWA, CDC Hyde Park and Green Teams</td>
</tr>
<tr>
<td></td>
<td>$10K MIT Sea Grant</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>$550K (NFWF, declined)</td>
<td></td>
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</table>
According to the Environmental Protection Agency, the acceptable levels of Fecal Coliform in marine waters can at the most be 200 parts/100 mL. According to the data in the Table 1, the levels of Fecal Coliform well exceed the acceptable amount, making the water quality specifically in Pattens Cove very dangerous to human health.

<table>
<thead>
<tr>
<th>Table 1:</th>
<th>Wet Conditions</th>
<th>Storm Conditions</th>
</tr>
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<tbody>
<tr>
<td>Year</td>
<td>Tests</td>
<td>Fecal Coliform</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(col/100mL)</td>
</tr>
<tr>
<td>2010</td>
<td>15</td>
<td>716.31</td>
</tr>
<tr>
<td>2011</td>
<td>40</td>
<td>951.04</td>
</tr>
<tr>
<td>2012</td>
<td>53</td>
<td>1462.47</td>
</tr>
</tbody>
</table>
Water sampling for Enterococci was done multiple times in 2012, and according to the Environmental Protection Agency, the acceptable levels of Enterococci in marine waters can at the most be 30 parts/100 mL. According to the data in the Table 2, the levels of Enterococci well exceed the acceptable amount, making the water quality in the Cove very dangerous to human health.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Tests</th>
<th>Enterococci (col/100 mL)</th>
<th>Year</th>
<th>Month</th>
<th>Tests</th>
<th>Enterococci (col/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>June</td>
<td>8</td>
<td>1437.5</td>
<td>2012</td>
<td>June</td>
<td>8</td>
<td>1372</td>
</tr>
<tr>
<td>2012</td>
<td>July</td>
<td>4</td>
<td>745</td>
<td>2012</td>
<td>July</td>
<td>4</td>
<td>788</td>
</tr>
<tr>
<td>2012</td>
<td>Sept.</td>
<td>8</td>
<td>1316.25</td>
<td>2012</td>
<td>Sept.</td>
<td>7</td>
<td>7225.5</td>
</tr>
<tr>
<td>2012</td>
<td>Oct.</td>
<td>6</td>
<td>1863.33</td>
<td>2012</td>
<td>Oct.</td>
<td>6</td>
<td>2528.5</td>
</tr>
<tr>
<td>2012</td>
<td>Nov.</td>
<td>7</td>
<td>267.43</td>
<td>2012</td>
<td>Nov.</td>
<td>7</td>
<td>247.5</td>
</tr>
<tr>
<td>2012</td>
<td>Dec.</td>
<td>4</td>
<td>712.5</td>
<td>2012</td>
<td>Dec.</td>
<td>4</td>
<td>756</td>
</tr>
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</table>
new local initiatives: communities want their own Biomimicry LivingLabs!

<table>
<thead>
<tr>
<th>Partner</th>
<th>Activity</th>
<th>Community</th>
<th>Next steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston Trinity Academy</td>
<td>Biomimicry LivingLabs</td>
<td>Hyde Park, City of Boston</td>
<td>Develop summer program and engage honors students</td>
</tr>
<tr>
<td>NE Aquarium</td>
<td>Biomimicry LivingLabs</td>
<td>City of Boston, State of MA,</td>
<td>Develop educational program for middle school and high school</td>
</tr>
<tr>
<td>Olin College of Engineering</td>
<td>Biomimicry LivingLabs</td>
<td>Olin College students and faculty</td>
<td>Designing robotic devices for in situ water quality and biodiversity monitoring</td>
</tr>
<tr>
<td>Town of Winthrop</td>
<td>Biomimicry LivingLabs</td>
<td>Winthrop</td>
<td>Cultching activities for oyster restoration</td>
</tr>
<tr>
<td>Charlestown Civic Association</td>
<td>Sea Level Rise workshop</td>
<td>Charlestown, Boston</td>
<td>Educational programs with local schools, To start local LivingLabs</td>
</tr>
<tr>
<td>Friends of Wollaston Beach</td>
<td>Biomimicry LivingLabs</td>
<td>Quincy</td>
<td>Coastal restoration activities and building floating islands</td>
</tr>
<tr>
<td>Squantum Scoop</td>
<td>Biomimicry LivingLabs</td>
<td>Squantum and N Quincy</td>
<td>Restoration of salt marsh and shellfish</td>
</tr>
<tr>
<td>Nantucket Shellfish Association</td>
<td>Biomimicry LivingLabs</td>
<td>Nantucket Island</td>
<td>Restoration of oyster population in the harbor</td>
</tr>
<tr>
<td>Cape Cod Commission</td>
<td>208 Watershed Project</td>
<td>Cape Cod</td>
<td>Activity plan for nitrogen management in coastal waters</td>
</tr>
<tr>
<td>Ashmont Adams Civic Association</td>
<td>Biomimicry LivingLabs</td>
<td>Ashmont, Boston</td>
<td>Community engagement and education</td>
</tr>
<tr>
<td>Cohaset Center for Student Coastal Research</td>
<td>Biomimicry LivingLabs</td>
<td>Cohaset</td>
<td>Education and outreach</td>
</tr>
<tr>
<td>San Jose State University</td>
<td>NSF conference on MOOC</td>
<td>National STEM education</td>
<td>Developing an online course for Biomimicry LivingLabs</td>
</tr>
<tr>
<td>RISD</td>
<td>Biomimicry Workshop</td>
<td>International education</td>
<td>Students Design Challenge</td>
</tr>
</tbody>
</table>
The Biomimicry LivingLabs Challenge (funded by FLEXcon):

- Image design inspired by Nature
- Able to make it into an epoxy min 1” x 1”
  - Height – 285nm -10 microns
  - Width and Length - 285nm – 50 microns
  - Side wall angle – should not be less than 17% from vertical
- Finalists chosen by Dr. Frankic
- Tool made by FLEXcon
- Sample roll of material provided by FLEXcon for testing
Dr. Frankic with students at Roxbury Community College, during SPLASH! Festival, 2012. In front of them, an exhibit with two containers with water from the Boston Harbor demonstrating how shellfish can improve water quality: one with invasive species and no shellfish (left), and the other with native species of shellfish (hard clams, two oysters, two blue mussels, two soft-shell clams (right). Within several hours, the water in the right container became crystal clear.
Restoration of Ecosystem Services and Public Policies at Savin Hill Cove

By
Stephen Norris & Kevin Carpenter

Fall 2013 Capstone Project

Prof. Anamarija Frankic

The School for the Environment
The College of Science and Mathematics
The University of Massachusetts at Boston

Image courtesy of Stephen Norris
Shellfish Growing Areas

Detailed Features

Shellfish Growing Areas

- APPROVED
- CONDITIONALLY APPROVED
- RESTRICTED
- CONDITIONALLY RESTRICTED
- PROHIBITED

Courtesy of MassGIS
Currently the Savin Hill Cove area is classified as “Prohibited” for shellfishing by the Division of Marine Fisheries.

This designation prevents most shellfishing activities in the area, including harvesting and propagation.

Specific laws that cover shellfishing in Massachusetts include MGL Chapter 130, specifically, sections 17, 69, 75, 75A, 80, and 83.

These laws establish the police power of the DMF, as well as the technicalities associated with shellfishing.

The overlapping jurisdiction between the state and city in this area further complicates permitting process.

- The state ultimately has jurisdiction over shellfishing activities due to public health concerns; while municipalities have the authority to permit shellfishing activities within their waters.
The top concern the DMF with shellfish propagation in “prohibited” waterways is public health issues (Hickey 2011):

- The area of greatest concern is illegal harvesting of shellfish from prohibited areas.

- Such shellfish could be infected with *Vibrio parahaemolyticus* (*Vp*), and may find their way into the food supply.

*Vp* can be contracted through the consumption of undercooked shellfish and causes gastrointestinal illnesses (CDC).

Cases often occur in the summer as *Vp* requires warm waters to thrive.
Next Steps

- The current permitting scheme is difficult to navigate and highly complex due to the overlapping jurisdiction between City of Boston and MA state. Furthermore, tracking down the necessary permits and relevant laws is extremely difficult and time consuming.

- Current regulations and policies are counterproductive to ecological restoration. Some of the very same groups tasked with protecting the environment prevent its restoration!

- Moving forward, public engagement is necessary in order to encourage a change in public policy and regulation.

- Due to high barriers of entry, Savin Hill Cove LivingLabs should not pursue a change in state policy; rather it should focus on working with the Boston City Council to establish a municipal containment action plan for Savin Hill Cove.
Next steps: oyster reef and coastal habitat restorations

Testing and applying new innovative materials based on green chemistry and biomimicry to build our urban harbors and make them green and resilient. [www.umb.edu/ghp](http://www.umb.edu/ghp)

“It is horrifying that we have to fight our own government to save the environment.”

Ansel Adams
Over 85% of oyster reefs have been lost globally.

Adopt a student for a green job!

Thank You!

Green Harbors Project (GHP)

Thank You!