

BORN TO BE
WILD



OYSTERS
GREEN HARBORS PROJECT

An Urgent Call for Massive Local & Global Oyster Habitat Restoration!



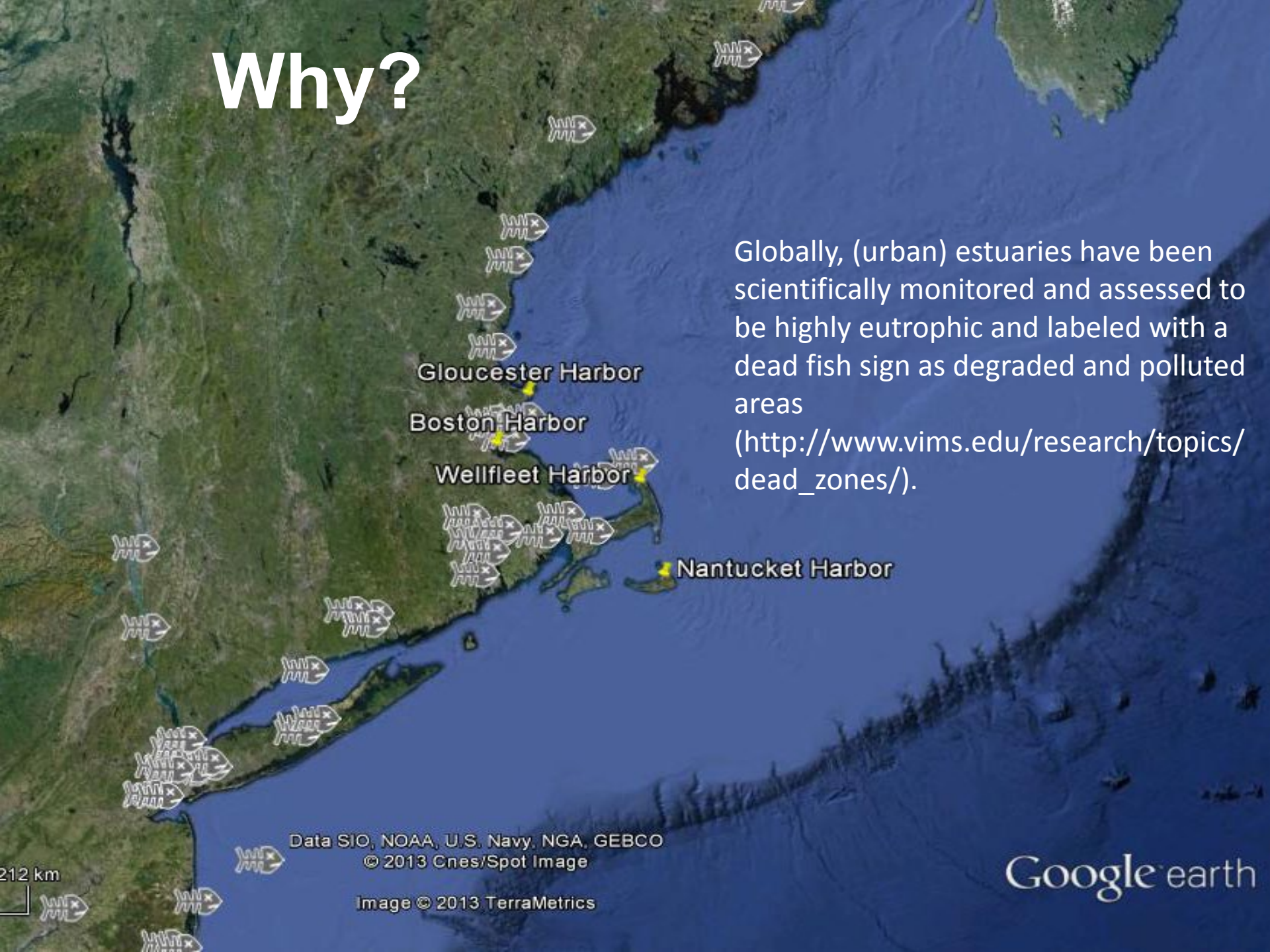
Photo: A. Frankic

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Why?

Globally, (urban) estuaries have been scientifically monitored and assessed to be highly eutrophic and labeled with a dead fish sign as degraded and polluted areas (http://www.vims.edu/research/topics/dead_zones/).



Gloucester Harbor

Boston Harbor

Wellfleet Harbor

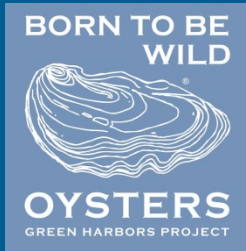
Nantucket Harbor

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Google earth

212 km



Oyster habitats in USA



http://www.habitat.noaa.gov/images/map_images/habitat_oysters.jpg

Coastal Keystone Habitats in NE: 'Nature's Nature is NOT Random'

- Salt Marsh
- Oyster reefs
- Sea grass beds



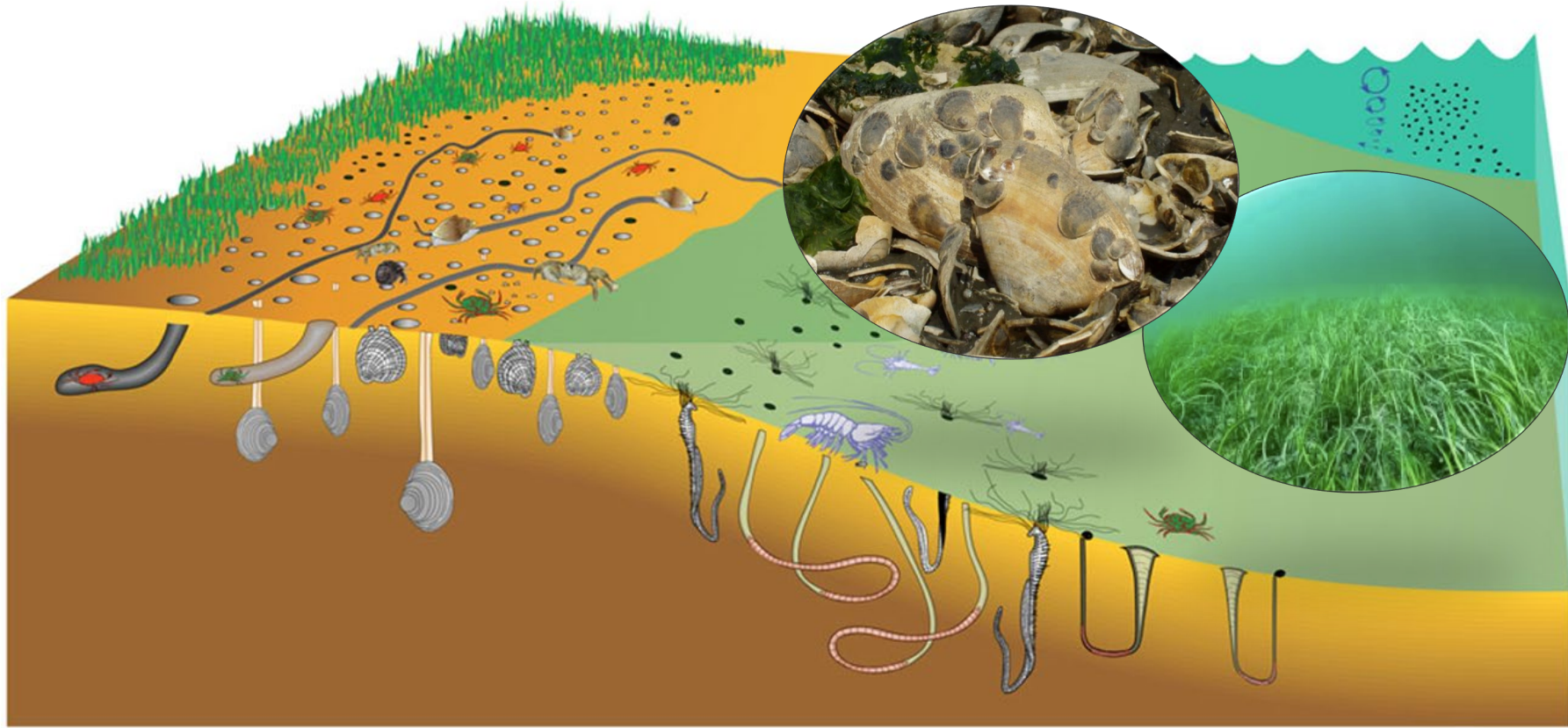
Biomimicry approach in understanding
and restoring the coastal systems together;
([Frankic et al, 2011](#))

How can we apply nature's designs and solutions
in human built environments?



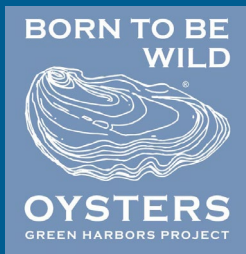
Photos:
A. Frankic

FEEDBACK LOOPS





Water – energy – food nexus in coastal ecosystems design and engineering is based on system's collaboration not a competition: sediment transport, bioturbation, hydrodynamic processes (nature of water), biodiversity (image source: Bouman et al, 2005)

The goal is to emulate coastal systems' processes, strategies, designs and functions in human built environments. (Frankic et al, 2011)



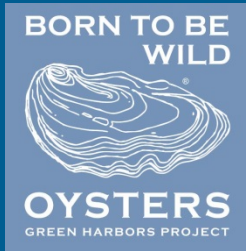
We know what are the missing Ecological Functions & Services: 'creating conditions conducive to life'

Ecological Functions & Services			Restoration activities and Biomimicry:
Nutrients/ total nitrogen take	~ 21gN/m ² /y	~1.0 – 2.0 gN/y/oyster	oyster reefs & living shorelines, floating islands
Carbon Sequestration & biomineralization	~ 210gCO ₂ /m ² /y	42% dry weight soft tissue; and 11% in shell mass (CaCO₃)	Oyster reefs, Green cement, Recycled shells, salt marsh
Sediment accretion and oxygenation	~ 1.3 cm/y (vertical accretion)	Bioturbation	Oyster reefs, Salt marshes, sea grasses
Water storage, Filtration, Bioremediation,	1 acre = 1mill gallons	30-50 gallons/day Coastal engineers	Oyster Reefs, Salt marshes, sea grasses

Data Source: Feagin et al. 2010; Shepard et al, 2011; Beck et al, 2011, Frankic et al, 2011; Grabowski et al, 2012; Carmichael et al. 2012; Kellogg et al. 2013; Rose et al. 2014; Ridge et al, 2017;

Supporting biological diversity and water-energy-food nexus.





Comparison of restoration efforts for five coastal habitats in the United States:

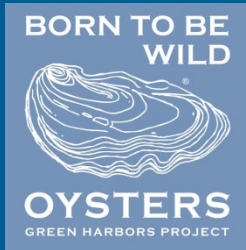
Habitat Type	Global Loss (%)	Area Restored (hectare)	Restoration Cost (\$1000/hectare)
Salt marsh	80	36,625	242
Seagrass	65	3946	1035
Oyster reef	85	69	260
Coral Reef	20	150	9267
Mangroves	50	1399	771

Modified from Source: Grabowski et al 2012.

For thousands of years humans have been working with nature to produce sustainable food & seafood;

Seafood production depends on water quality, and oysters are masters in filtering ~ 100liters/day/oyster!





Green Harbors Project®
With locally attuned
Biomimicry LivingLabs®

www.umb.edu/ghp

**Vision & Mission: Making
urban harbors healthy,
wealthy and resilient, here
and now;**

**Locally applied science,
research and technology
solution based projects in
collaboration with local
communities, addressing
their needs.**



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OYSTERS
GREEN HARBORS PROJECT

The first oyster restoration in Boston Harbor

Env. Assessment: European and native oysters (*C. virginica*) in Savin Hill Cove



Before

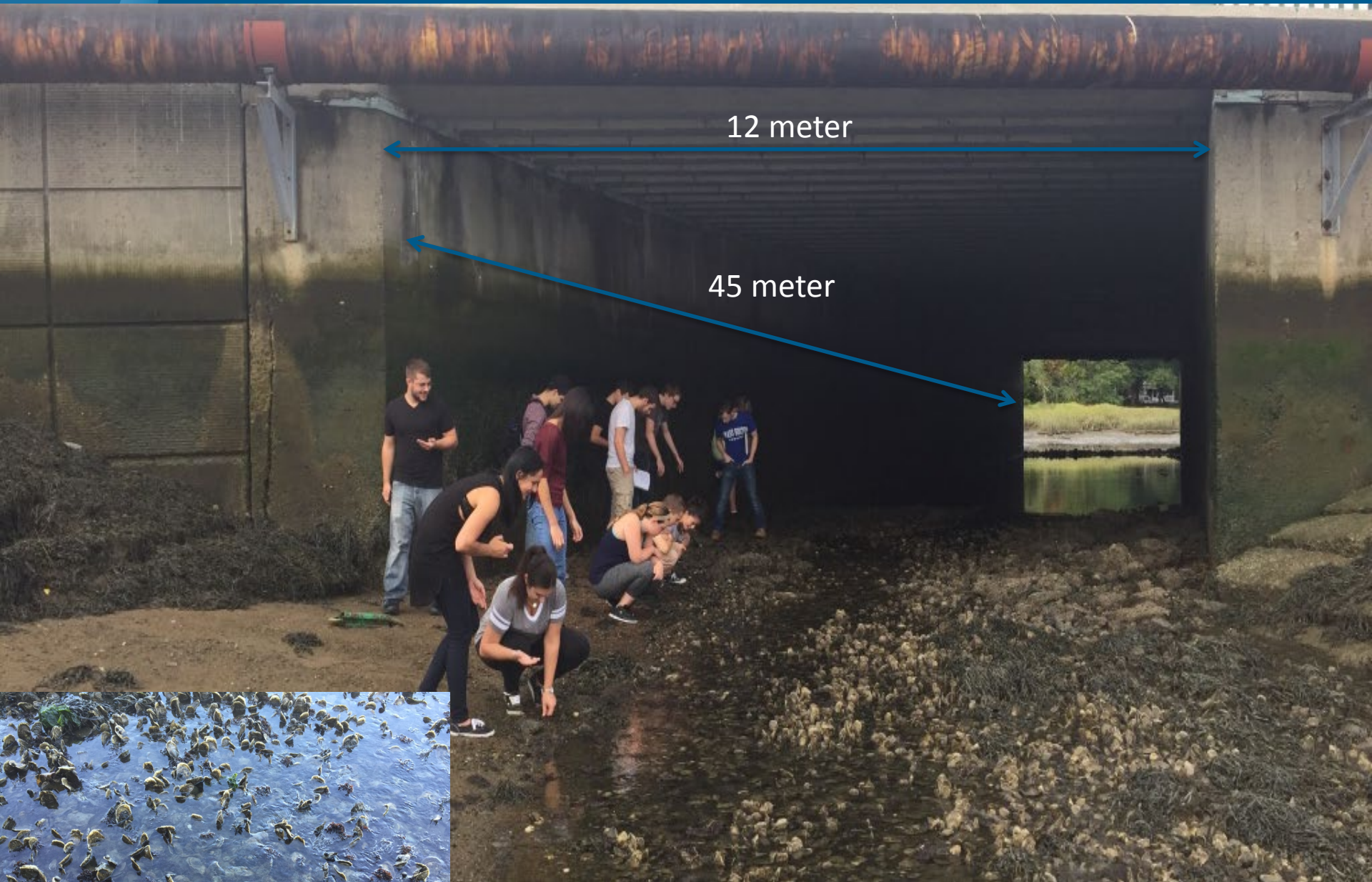


Savin Hill Cove Biomimicry LivingLabs: urban coastal restoration and adaptation

Oyster reef and fringing salt marsh = living shorelines in urban harbors

After (our vision)





Biomimicry LivingLabs, Savin Hill Cove, culvert area as restoration site for ~250K of native oysters! Nature & built environment are supporting cleaner water, biodiversity and shoreline protection;







Fog Nets: making
water from air like
nature does
www.nbdnano.com



Biomimicry LivingLabs®



Honors College Students designed
floating classroom project: they want
to learn from and with nature!



Floating islands: design
with nature and green
chemistry

Wellfleet Harbor, Cape Cod



Oyster Restoration project sites to establish shellfish Sanctuaries as No Take Zones throughout the Harbor ;

<https://www.umb.edu/uploads/File/gbhp/FRANKICCataldo.pdf>



Source: billionoysterproject.org;
www.vims.edu;



Oyster reef restoration project in Wellfleet Harbor (15.6sq mi/40.5km²)

The Facts:

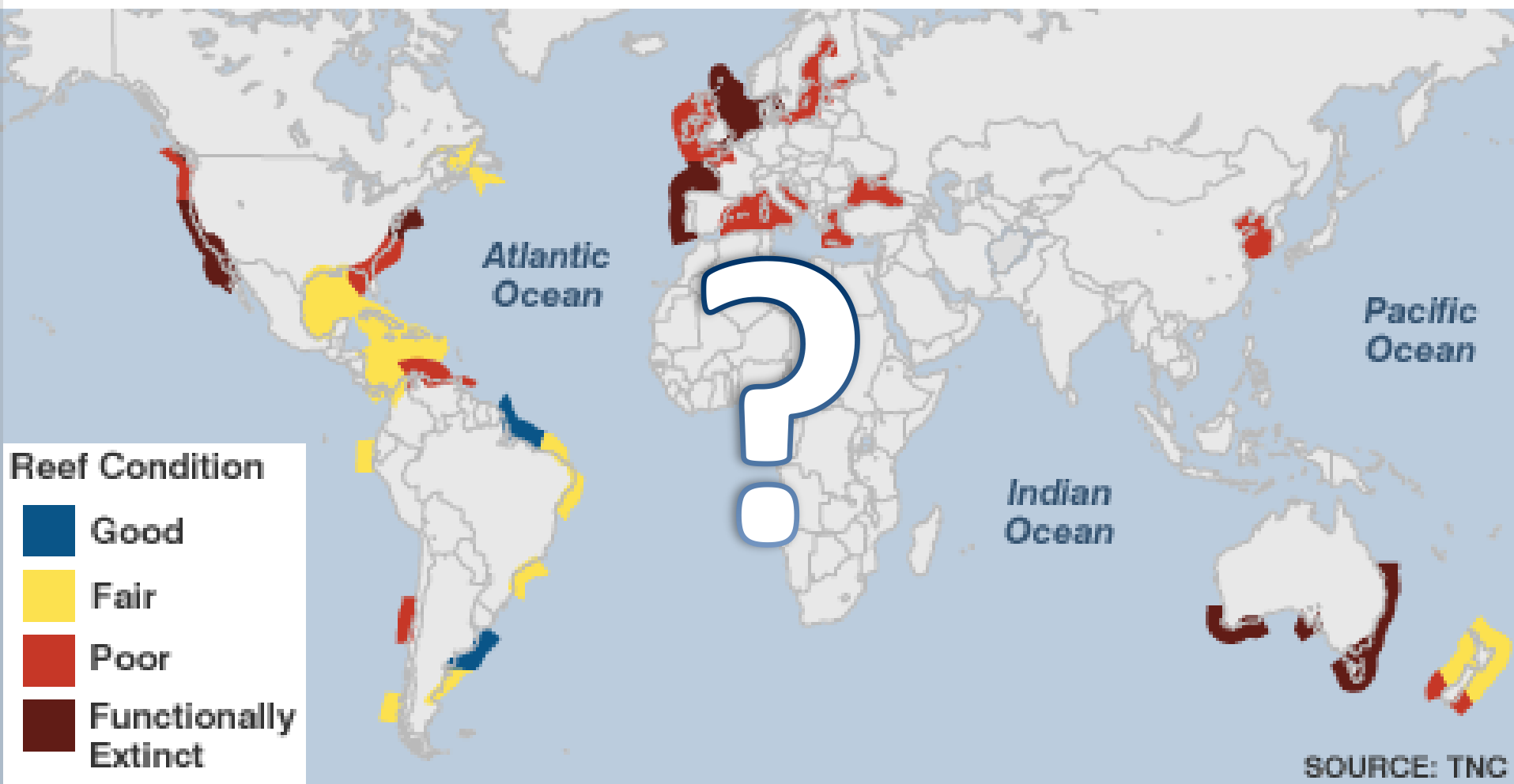
In **Spring 1877**, a Wellfleet schooner in 5 trips in one day landed **16,254 bushels** of oysters (Ernest Ingersoll, 1881);

If 1 bushel ~ 100 oysters = **1.6 mill oysters/schooner/DAY**

Present oyster harvest in the Harbor ~ 7.8 mill oysters/YEAR (1.2 from commercial harvest, the rest from aquaculture)

Luntz (1960), estimated that **5,895 oysters**, the equivalent of 45 bushels (130/bushel), occurred within a single square yard of a natural oyster reef.

GLOBAL CONDITION OF OYSTER REEFS



How much oyster population and oyster species used to thrive in coastal systems? Did we lose 85%? 90%? How long can oysters live?

(‘The unnatural history of the sea’ by Collum Roberts)



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Oyster reef restoration, Wellfleet Harbor



100 m

Oysters make us happy!
Do we make oysters happy?



Recycling shells and placing cultch for naturally occurring oyster spats to settle on at the 2 acres oyster restoration site in Wellfleet Harbor, now spread throughout the Cape Cod area;

Applying Green Cement materials would be the next step in restoring our urban harbors (e.g. BluePlanet Ltd.)



8-7-11

Oyster habitat restoration in Duck/Mayo
Creeks, **Wellfleet Harbor**, Images: A. Frankic



10-16-13

**On 2 acres, in 3 seasons, established
population of ~ 6 mill oysters!**



Results: Increased biological diversity supported by the restored oyster reef; improved water quality by 70% (sink of nutrients)

Dozens of terrapin turtles (endangered species) at the project site; one of the reasons why (we believe) there were no oyster drill snail predation;



Monitoring Results 2011-15



Source: Amy Costa and Anamarija Frankic (PI) (Frankic et al, 2015)

OYSTER REEF RESTORATION - WELFLEET HARBOR, MA

PRESENT

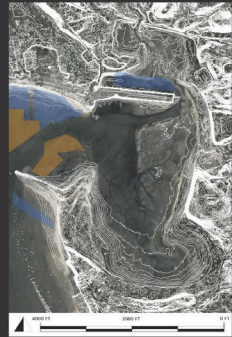


FIGURE 4



PROPOSED



FIGURE 5

AREA OF PROPOSED REEF: 11,189,978 FT²
= 256 ACRES

OYSTER DENSITY: @ 10,000 OYSTERS / M²
= 10.5 BILLION OYSTERS (10.5 X 10¹⁰)

WATER FILTRATION: @ 85L / INDIVIDUAL / DAY
= 570 BILLION GALLONS / DAY (5.7 X 10¹¹)
= 863,965 OLYMPIC SWIMMING POOLS/DAY

SOURCES:

- PIETROS, JENNIFER. "THE IMPACTS OF AQUACULTURED OYSTER, *CRASSOSTREA VIRGINICA* ON WATER COLUMN NITROGEN AND SEDIMENTATION." AQUACULTURE 330 (2008) 407 - 423
- FRANKIG, ANAMARIA. "OYSTER REEF RESTORATION PROJECT QUICK AND MARY GREENS, WELFLEET HARBOR." UNIVERSITY OF MASSACHUSETTS, BOSTON (2018)
- REYNOLDS, ANNE. "SHELLFISH ZONE MAP - BRANT AND PUBLIC AREAS." MAPE CODE COMMISSION (NORIS, MA GEM 3/4/15)



THE COASTAL TOWN OF WELFLEET, MASSACHUSETTS, WAS HISTORICALLY HOME TO A MARINE SYSTEM RICH WITH OYSTER REEFS. IN THE 1800'S, THERE WERE RECORDED HARVESTS OF NEARLY 1.5 MILLION OYSTERS PER DAY, WHILE PRESENT DAY FIGURES ARE A MERE FRACTION OF WHAT THEY ONCE WERE WITH APPROXIMATELY SIX MILLION OYSTERS CURRENTLY BEING HARVESTED EACH YEAR.

THIS IS A PROPOSAL TO IMPLEMENT OYSTER REEF RESTORATION THROUGHOUT WELFLEET HARBOR AND THE SURROUNDING BAY IN AN EFFORT TO IMPROVE WATER QUALITY BY REDUCING PHYTOPLANKTON COUNTS, REDUCING NITROGEN LEVELS, AND PROVIDING HABITAT FOR OTHER MARINE SPECIES. IF IMPLEMENTED STRATEGICALLY, OYSTER REEFS CAN ALSO PROVIDE AS A WAVE BREAK TO MITIGATED SHORELINE EROSION. THE TOP MAP (FIG 4) SHOWS THE CURRENTLY DESIGNATED AREAS FOR PUBLIC SHELLFISHING AND AQUACULTURE GRANTS, THE BOTTOM MAP (FIG 5) SHOWS THE PROPOSED EXTENT OF RESTORATION FOR NO TAKE OYSTER REEFS. THE REEFS ARE ESTIMATED TO GROW TO A HEIGHT OF FOUR FEET WITHIN FIVE YEARS (FIG 2) AND TO A DENSITY OF 10,000 OYSTERS/M² (FRANKIG ET AL).

THE PROPOSED AREA MEASURED TO 256 ACRES IN SIZE, WHICH WOULD YIELD APPROXIMATELY 10,300,000,000 OYSTERS, BASED ON A WATER FILTRATION RATE OF 85 L PER OYSTER PER DAY (PIETROS ET AL). AN OYSTER REEF OF THIS SIZE COULD FILTER 570 BILLION GALLONS PER DAY OR ENOUGH WATER TO FILL 863,965 OLYMPIC SIZED SWIMMING POOLS.

PROPOSED OYSTER BED RESTORATION



FIGURE 3

WELFLEET, MASSACHUSETTS - PRESENT



FIGURE 1

TRANSECT OF PROPOSED RESTORATION AREA

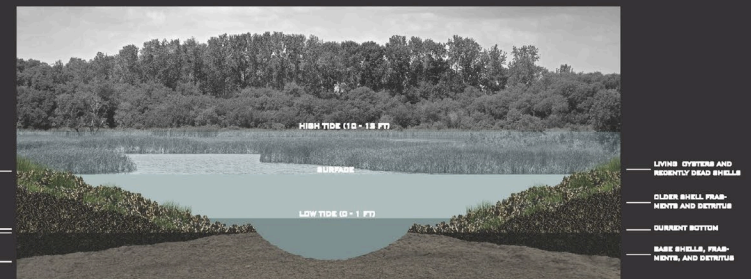




FIGURE 2



The existing shellfish suitability area is 1,700 acres (Division of Marine Fisheries Shellfish Suitability Area). Assuming 4,900 oysters per square meter (Luntz, 1960) the potential total oyster population would be 34 billion.

Wellfleet Harbor

**Oyster suitable sites**

**Saltmarsh**

Created by Martina McPherson
Data source: MORIS, MA CZM
2/4/15



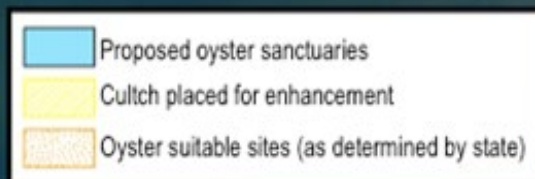
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Proposed Next Steps

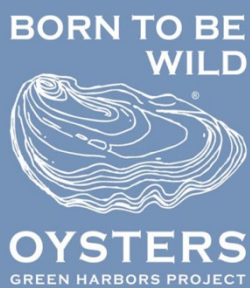


Shellfish aquaculture and
commercial fishing are
supported by oyster habitat
restoration!

Holistic approach for
resilient estuary;



Source: Esd, Dig2@lels, 944By, 1-01-20, USDA, USGS, AEM, 9-01-20, 19N, 19P,



The fact is that we all need oysters, but oysters need our help,
As we all depend on resilient oceans ,
and conditions conducive to life

How can WOS through the work of its Chapters and members help promote oyster restoration and gain support from aquaculture industry, so that together we can lobby policy makers to fund and accelerate the oyster restoration efforts. Time is of the essence...



'Spiral economy'
locally attuned and adaptive
collaboration



Green Harbors Project® (GHP)



**THANK YOU
OYSTERS!**

Network of Biomimetic LivingLabs®
'Adopt a student for a green job'

