

The Whitehall Street subway station in lower Manhattan is deep underground. On the long escalator ride to the surface, passengers glide by a series of tile wall mosaics depicting the city's history. At the bottom there's a marshland of flora and fauna; the next panel shows the first non-indigenous settlers; then come images from New Amsterdam, followed by 19th century steamships, and finally modern-day skyscrapers looming over Battery Park. With that, the escalator spits its cargo into the sunshine and wind of New York City's southernmost point.

Every morning, the students of the Urban Assembly's New York Harbor School pass these mosaics, then make the short walk to the Battery Maritime Building and board a ferry bound for Governors Island, an ice-cream-cone shaped landmass 800 yards off Manhattan. The students, high schoolers, line the ferry's benches, gossiping, shouting, reading. The commute seems so ordinary to them that they pay no attention to the extraordinary views of the New York City skyline or the busy harbor, and in ten short minutes they are disembarking.

Stepping onto Governors Island, Whitehall Street's mosaics seem to spring to life. The land is dotted with brick Georgian-style houses, the oldest of which dates from the early 1700s. Fort Jay, a defunct bastion with its cannons still pointing toward the harbor, is a reminder of the island's 200-year military history.

BETTING ON ONE BILLION

BY LINDSEY J. SMITH
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The **Billion Oyster Project** is restoring New York Harbor and connecting New York City youth to their ecosystem.





The New York Harbor School "eco-dock" with the Brooklyn waterfront in the background.

But the island has lain mostly empty since the U.S. Army and Coast Guard left in 1996. Every summer it becomes a local tourist destination, with concerts and art fairs; the rest of the year it has only two permanent tenants, including the New York Harbor School.

This urban wilderness is the perfect setting for such an unusual high school. In addition to traditional coursework, all students enter one of the school's six career and technical education tracks: aquaculture, marine biology research, marine systems technology, ocean engineering, professional diving or vessel operations. They spend their school days diving in the murky New York Harbor, piloting boats, constructing marine infrastructure, culturing algae and spawning oysters.

And oysters are the glue that holds the school together. In April 2014, after some initial experiments with oyster gardening, the school launched a systematic project to plant one billion oysters in the New York Harbor by 2030. An oyster population that large spread over 200 acres of

reefs could, on a hot August day, filter 25 billion gallons of water. This means that in three days, all the standing water from the George Washington Bridge, down to the Goethals Bridge, over to the Verrazano and up to the Triboro would pass through these oysters.

Reintroducing one billion oysters to a distressed environment over the next 14 years is no easy task. But oysters are simply a vehicle for the Billion Oyster Project's true goal: reconnect New York City's 1.1 million public school students to the ecosystem in which they live.

"Guys, Harbor shirts, Harbor shirts!"

Susannah Ceraldi reminds the group of juniors gathered in the aquaculture lab to don their school uniform t-shirt. Ceraldi, one of two aquaculture teachers, is new to the school, but her years of teaching experience show in her warm but firm interactions with the students.

The juniors have just returned from lunch and are a little squirrely as they change into Grundens — the waterproof

overalls that fishermen wear — rain jackets and rubber boots. They're preparing to receive a group of freshman whom they will take through the aquaculture essentials: knot tying, oyster tray stacking and tying, and working on the eco-dock, where young oysters are grown.

Knot tying takes place in the aquaculture lab, which is dominated by four large vats used for oyster spawning and growth. These stand about four feet tall, and it would take at least three of the juniors to encircle their girth. To the left of these containers teeming with life is a rack where algae, the oysters' food, is grown, first in test tubes, then in beakers and flasks, and finally in plastic, five-gallon water jugs. After outgrowing the water jugs, the algae are transferred to a row of huge test-tube-like cylinders that burble behind the oyster vats.

The rest of the classroom is devoted to smaller aquaculture projects, with rows of microscopes, floor-to-ceiling racks of aquaria and drawings of an oyster reef ecosystem above the sink, complete with

Callinectes sapidus (Chesapeake blue crab), *Palaemonetes vulgaris* (the common American prawn), and, of course, *Crassostrea virginica*, the Eastern oyster. The lab smells fresh and good, like living things.

A small group of freshmen file into the lab for a demonstration in knot tying. “Does anyone know how to tie a bowline?” asks junior Stephen Duer, a length of bright nylon rope in his hands. One of the freshman boys pipes up and demonstrates for the class. Duer then explains why knot tying, and the bowline in particular, is essential to aquaculture: All the oyster cages are attached to the eco-dock via stainless steel c-links and bowline knots. Ceraldi helps the boys tie bowlines through holes in the tops of clipboards, while Duer devolves into conversation with three girls, only occasionally redirecting their attention to bowlines and square knots before the group moves on.

Wind buffets the grassy knoll above the Marine Affairs, Science and Technology (MAST) Center, and the freshmen huddle around a group of black plastic oyster trays. The square trays, used for growing oysters on the eco-dock, are shaped like open-weave baskets, with one-by-one holes for water flow. They sit snugly on top of each other, three or four high, with the topmost covered by a lid.

One of the junior boys threads a special four-pronged length of rope up through channels in a tray stack’s corners, bringing the ends to meet in the middle of the lid. He folds the rope’s ends back on themselves and then knots them together; the trays must be tied together tightly to prevent oysters from falling out, or fish and other creatures from coming in. Then, grinning, he challenges the freshman to a race: fastest tie and tightest tie. “This is for the oysters, my friend!” says one of the freshman boys. The junior leading the station urges them on, “Make sure, whatever you do, you’re using all your strength to make it tight.” He walks between the teams, sharply yanking each one’s knot to check the tension; a group of three girls is declared the winner.

With the relays over, the students head to the last station, the eco-dock, a wooden pontoon with two large sections of movable metal grating, under which hang the

oysters in their trays. Here Jeremy Esposito, the other aquaculture teacher, awaits. Esposito was a commercial oyster farmer before joining the Harbor School two years ago. Standing on the pier, he greets the freshmen with a smile and helps them find life preservers and work gloves before heading to the dock.

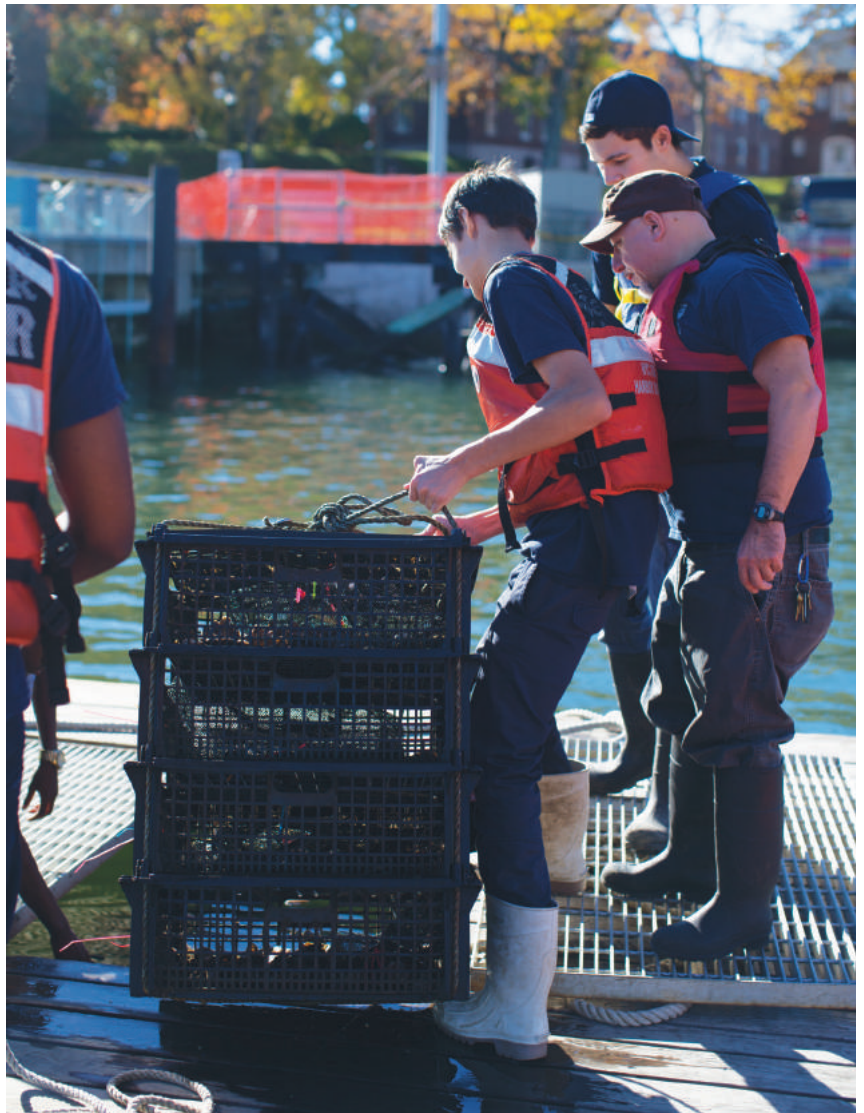
Esposito calls for volunteers and several students help him hoist an oyster cage, dripping and slimy, out of the harbor. He shows them how to untie it, and then unstacks the trays so the oysters can be rinsed. The trays are coated with tunicates — a small, gelatinous filter feeder — and sponges, and the students check for small fish, mussels, worms and other creatures, which may have snuck in with the oysters. They work with a hose and buckets of harbor water to rinse the

oysters, then re-stack and tie the trays as they were taught, and return them to the murky, choppy depths.

Murray Fisher, the New York Harbor

School’s founder, read *The Riverkeepers* by John Cronin and Robert F. Kennedy, Jr., when he was a senior, studying biology at Vanderbilt. The book united his interests in social and environmental change and started him on a long journey of working for Riverkeeper and then the Waterkeeper Alliance, where he supported bay, river and waterkeepers around the world. It was through this work that he became aware of the tremendous disconnect between the environment and education and was inspired to open the school in fall 2003 in landlocked Bushwick, Brooklyn.

“Education throughout this country is



Students stacking and tying oyster trays. A single oyster can filter 50 gallons of water a day.



The New York Harbor School's 432 students receive training in a variety of marine careers.

mostly devoid of nature,” Fisher said in an interview. “We’re not educating people about the environment. So the environment suffers because people don’t know about it, they don’t care about it, they don’t see opportunity there.”

He founded the Harbor School to train students in marine careers, and, hopefully, restore the harbor. They got off to a slow start in Bushwick, where, without water nearby, it was hard to connect the spirit of the school to its day-to-day activities. After a competitive process, they moved to Governors Island in 2010, and that’s when his vision began to come to life.

Inspired by Million Trees NYC, a project to plant one million new trees in the city in a decade, Fisher was searching for an equally ambitious marine restoration project. “We wanted to wave the flag high in the air saying, ‘Hey people, we live on an estuary!’” He discussed ideas with Pete Malinowski, then the aquaculture teacher, now the director of the Billion Oyster Project. Malinowski’s parents are oyster farmers and that background, along with the model of Million Trees NYC, led them to start the Project. The Harbor School is a public school, but its many special programs, including the Billion Oyster Project, require more funding than the Department of Education can provide. Luckily, they have attracted big-name

funders, including the Clinton Global Initiative and the Robin Hood Foundation.

“[It] came together both as something that Harbor School needed and also that we felt the city needed,” said Fisher. “We live in an area that used to be one of the most abundant and biodiverse places on the planet, and it’s still possible to restore that, but only if we all recognize that it’s not just a pretty thing to look at, and it’s not just a commercial port, but it’s an actual ecosystem that needs human intervention to come back.”

Before they were named Ellis Island

and Liberty Island, those famous spots were simply known as Little Oyster Island and Great Oyster Island, because of the plentiful beds surrounding them, Mark Kurlansky writes in *The Big Oyster: History on the Half Shell*. The oyster drawn above the sink in the aquaculture lab, *Crassostrea virginica*, appeared in the New York area around 10,000 BC and served as a vital food source; the oldest shell midden on the Atlantic is in what is now Dobbs Ferry, NY, and dates to about 6,950 BC. Oysters were a vital resource not only for the Lenape, the indigenous people of western Long Island and the lower Hudson Valley, but also for early settlers of the area, and the first law regulating oyster harvesting predates the Revolutionary War.

As New York City grew, the oyster business boomed. They were the food of rich and poor alike, and on Canal Street many oyster cellars featured the “Canal Street plan,” all-you-can-eat oysters for six cents. But by 1820, a little over a century after the first American oyster law, the beds around Staten Island were completely exhausted and the wider oyster population was in decline. Nevertheless, New York gained a reputation for its oysters, and, as Rebecca Stott writes in her book *Oyster*, in 1911 the United States was the world leader in oyster production, with over 26 million bushels produced. Just two decades later, after over-harvesting and crippling pollution, the city’s famous oyster beds had to be shut down. Abuses to New York’s waterways continued until the Clean Water Act, which regulates industrial and municipal polluters, was amended in 1972.

The harbor’s degradation meant that, for many years, oysters could not grow. Although the harbor is far from perfect, and the oysters grown by the Project cannot be eaten or sold, it’s now ready for their return. As oysters take hold in their former habitat, they will further repair it.

Oysters benefit the environment in numerous ways, the two most notable being filtering nitrogen from the water and sequestering carbon. Oysters are filter feeders, and as adult oysters suck in phytoplankton, they can filter up to 50 gallons of water a day. Anything that cannot be digested is expelled as a pellet of solid waste and eventually decomposes. Oyster shells, which grow in thin fingernail-like layers, are made from calcium carbonate, and thus sequester carbon from the water as they grow. Oysters further benefit the environment by providing reef habitat for fish and other small marine creatures, and the reefs themselves act as wave breaks, protecting low-lying coastal areas from flooding.

The Billion Oyster Project hopes to do all this, and more. They’re aiming for one billion oysters across 200 acres of reef by 2030 and have already planted 11.5 million on just a little over one acre. In the next five years, Pete Malinowski wants the Project to grow to 16 acres of restored habitat, producing 90 million oysters.



A student inspecting a tray of oysters, removing other unwanted organisms and hosing off silt.

That's no easy task. Oysters spawn by releasing sperm and egg into the water; the fertilized larvae then swim and feed for about ten days before finding a permanent home. However, for these young oysters, called "spat-on-shell," to survive, they need a hard surface to attach to, and the bottom of New York Harbor is fine silt. The Billion Oyster Project uses artificial reef structures to establish their beds, but even then a self-sustaining population where new spat-on-shell, are attaching to existing reef, is hard to come by.

Malinowski is betting that the tipping point at which the population could become self-sustaining is somewhere around the one billion mark. But the truth is, one billion is an arbitrary number; the tipping point could be 100 million or one trillion, and they'll only find out by trying. Murray Fisher sees the benchmark a little differently. "I think that big plans are the ones that get done, and big plans are the ones that attract funding, and big plans are the ones that attract partners," he said. He is certainly attracted to the challenge of the number, but it is not his end game.

In his mind the goal has always been restoration through education. "A more engaged and educated citizenry will lead to a more restored harbor, which will lead to a more engaged and educated citizenry," he said. "It's just exciting and complex enough that it doesn't break down well into 'it's an education program,' or 'it's a restoration program.'" Supporters and funders often look to put them in one box or the other, but, for Fisher, that contradicts the philosophy behind the endeavor. The Billion Oyster Project and the New York Harbor School are about connecting education to the ecosystem. Fisher's ultimate goal is to bring together educational reformers and environmental activists through the public school system. He hopes that one day, "education about the harbor and education about the ecosystem, and working together to restore it, will be a much more common experience for those growing up and going to public school in New York City."

The school day has ended and a few students are hanging around the aquaculture lab, helping out Ceraldi and Esposito.

"Before I came to this school, I had no idea about the water bodies in New York City," says Stephen Duer, the junior who had led the knot-tying station. D'lylah Nazario, a junior who had been working on the eco-dock earlier in the afternoon chimes in, "I had no idea that *that* was an estuary." She gestures to the water outside the window. "I didn't know that was even a word. This is a water-based city, and we don't know a lot about the history of our ecosystem."

Nazario credits the school with opening her eyes to a host of environmental issues, and being aware of them all can be stressful. "Sometimes you have doubts," she says, "Like, what if we fail? What if it's not that effective?" But when faced with the overwhelming nature of their endeavor, she thinks about how proud she is to be part of the school and its larger work. "When it gets better it's gonna be like, 'I was there for the start, when the New York Harbor got cleaned up.'" **WH**

To find out more about the New York Harbor School, visit www.newyorkharborschool.org, and to learn about volunteer opportunities with the Billion Oyster Project, visit www.billionoysterproject.org