Ripple Marks

The Story Behind the Story

BY CHERYL LYN DYBAS

To Learn about Land-Use Change, Look to the Sea

COULD THE SECOND LONGEST RIVER IN KENYA RECORD THE HISTORY OF THE COUNTRY'S SOIL EROSION? According to scientist Robert Dunbar of Stanford University and his colleagues, the Sabaki River, which drains some 11 percent of Kenya's landmass, covers a 300-year-record of soil erosion—in coral reefs near the mouth of the river at the Indian Ocean. The reefs hold the longest land-use archive ever obtained from corals.

"A chemical analysis of the corals tells us that Kenya has been losing valuable topsoil since the early 1900s, when British settlers started intensively farming the region," said Dunbar, who published his results in the February 22, 2007, issue of the journal *Geophysical Research Letters*. "Soil erosion in Kenya increased dramatically after World War I," he said, "at the time of British colonialism's upswing and a series of large-scale 'agricultural experiments' that resulted in a dramatic change in human use of the landscape.

"Even today, the Kenyan landscape continues to lose soil to the Indian Ocean because of human pressure on the land."

Erosion is a serious problem in countries like Kenya; the loss of fertile soils presages a decline in food production. Soil erosion is an issue worldwide, said Dunbar, causing damage to agriculture and animal husbandry, and placing more than 2.5 billion people at risk of famine.

"This is especially the case in East and sub-Saharan Africa, where per capita food production has decreased for the past 50 years," Dunbar said.

To find out the extent of the situation in Kenya, Dunbar took to the sea—in scuba gear at the Malindi coral reef where the Sabaki meets the ocean. There, he and others retrieved core samples from two coral reefs. The scientists then measured the radio of barium to calcium in the coral. "There's a lot of barium in soils," explained Dunbar, "so when soil erodes and washes into rivers, it's eventually delivered to the sea, complete with barium."

Corals then incorporate the barium into bands that provide an annual record of soil deposition in the river.

To determine barium levels in the Sabaki River corals, Dunbar used a technique that vaporizes the carbonate, then analyzes its chemical composition with a mass spectrometer.

"In the past, it took forever to get the data," he said. "We used a dentist's drill, drilled out a small sample, then dissolved it and took it to the lab, where we measured barium." The new method increased the speed by "a factor of 50," he said.

Before 1915, the scientists discovered, the landscape in Kenya was in equilibrium. In the late 1910s, however, the amount of barium reaching the Sabaki River mouth "suddenly shoots up, and keeps rising and rising," Dunbar found.

The British were coming—in droves. They cleared the African bush to create coffee plantations. "What came next is a dramatic increase in soil erosion that turned rivers in Kenya muddy and brown," Dunbar discovered.

The corals of the Sabaki River carry a global message to those who would listen, say the scientists. "When you perturb a system by clear-cutting the natural vegetation, it loses its essence," said Dunbar. "It changes for not just a few years or a few decades, but for a century or more.

"The Sabaki River—and Indian Ocean—tell us so."

Courtesy of Rob Dunbar.

Herons, Egrets Brave Treacherous Currents

LEAD TO NEW ECOLOGICAL RESTORATION PARADIGM. In summertime and indeed for much of the year, the livin' is easy, at least for the thousands of herons and egrets who have found their way to New York City's harbor islands.

During the city's hottest months, when human New Yorkers escape baking streets for Long Island and points beyond, black-crowned night-herons, snowy egrets, great egrets, and glossy ibis do the opposite: they take up residence on islands dotted throughout New York Harbor. There the birds spend their days in relative peace, nesting in trees and rearing their chicks in a place once thought of as the epitome of degraded waters.

Hundreds of herons and egrets now live on North and South Brother Islands in the East River, for example. In 1982, New York Harbor islands hosted 250 nesting pairs of waterbirds. By 1993, more than 1,000 pairs had found their way to these rocky outcrops. In 2006, the total topped 2,500. Seven species of wading birds, including yellow-crowned night herons, little blue herons, and cattle egrets, were confirmed last year as breeding birds—on seven different islands.

Like any summer place, however, things aren't perfect.

To find their piscine prey in the salt marshes of New Jersey's Meadowlands, the herons and egrets must fly along the East River and navigate treacherous waters known as Hell Gate. Tides from the nearby Atlantic Ocean surge through narrow channels here. In 1614, Dutch explorer Adrian Block named the strait Helegat: "bright passage." But this stretch of dangerous whirlpools and hidden rocks soon became known by the more macabre translation Hell Gate.

At sunset on the night after summer solstice, when herons should be flying to and from the islands until late in the evening, the birds are mysteriously absent. A constant rippling of currents under the East River's Hell Gate Bridge—a high train trestle crossing the water—is the only sound. Just beyond the bridge, the whirlpools of Hell Gate await, shimmering dark red in the sun's last rays.

Then a lone black-crowned night heron glides by…a photographer's shutter clicks… and Hell Gate's spell is broken.

The night-heron is free, off to spear fish in the Meadowlands.

As the sun sets each day, black-crowned night herons, also known as night ravens, fly southwestward, then make a hard-right turn along the East River toward the Meadowlands.

As the night herons fly outbound, snowy and great egrets return inbound along the same flight path. The egrets leave New York Harbor islands at dawn for a day of feeding in the salt marshes. "The birds could teach air-traffic-controllers at LaGuardia (located just behind the harbor islands) a thing or two," said Yigal Gelb, an ornithologist with New York City Audubon who has conducted surveys of the harbor herons for more than a decade.

The herons have successfully carved out overlapping niches by feeding at opposite times of day and on different prey, as well as at varying tide and salinity levels.

"Black-crowned night herons are generalists active at night," writes scientist John Waldman in *Heartbeats in the Muck: A Dramatic Look at the History, Sea Life, and Environment of New York Harbor*. "Great and snowy egrets are mainly fish-eaters during the day. Great egrets do well in both fresh water and estuaries, but snowy egrets are more successful in fresh water. Glossy ibis concentrate on marsh snails, locating them with their bills rather than by sight."

Whether by day or night, New Jersey's Meadowlands attract a wide range of bird species, said Gelb. Once the harbor herons return home to their New York islands, however, they share their condo-style rookeries only with other heron and egret species.

The islands were long ago abandoned by all but the wading birds, left to empty buildings, scrubby trees, and the elements.

In the early 1900s, they were the sites of city quarantine and mental hospitals. North Brother Island hid Smallpox Hospital, later renamed Riverside Hospital, a compound where Mary Mallon, the infamous Typhoid Mary, was isolated. Typhoid Mary died in 1938 after 20 years on the island. The hospital then closed. Acres of overgrown vines now completely cover the building's skeleton.

"North Brother Island is an impassable tangle of vegetation," said Gelb. "That's what makes it a perfect 'summer place' for egrets and herons. The low shrubs are in effect a sign to boaters and others who might want to picnic on the island, one that clearly says: keep out."

South Brother Island hosts a large community of mixed herons and egrets, while North Brother is home mostly to black-crowned night herons. But all depend on the Meadowlands for food. "Most people have no idea that the Meadowlands aren't just a patch of reeds surrounded by endless oil refineries," said Gelb.

It's not only a string of oil refineries—and Hell Gate—the birds must face, however, to reach these rich marshes.

Earlier this year, Gelb and colleagues found invasive Asian longhorned beetles on one of New York Harbor's islands—Prall's Island—and reluctantly cut down 3,000 trees there. "Herons stopped nesting on Prall's almost a decade ago," Gelb said, "but taking out the trees still wasn't an easy decision. It could have the unintended effect of preventing a future heron colony from forming."

In this case, though, it was worth the risk, ornithologists believe, as Asian longhorned beetles can spread from island to island, dec-

imating hardwood trees—and heron nesting sites—as they go.

"The islands may seem like they're removed from the human world of factories and airports and tugboats," said Gelb. "But—witness the rising number of invasive species there—they're not."

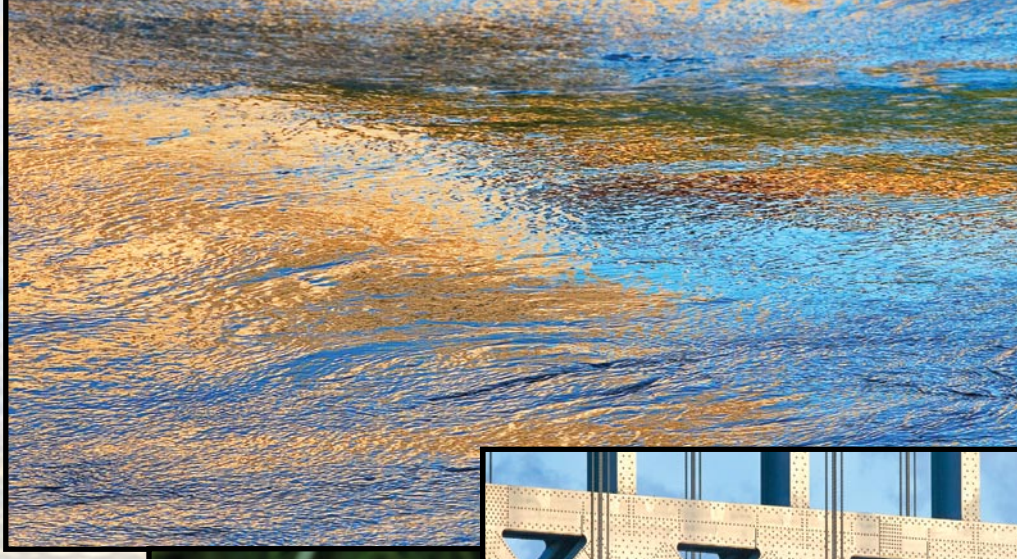
Enter a project that may help to better integrate people and wildlife in New York Harbor, and result in a paradigm shift for ecological restoration in the harbor and points beyond. Scientists Mark Bain of Cornell University and Jim Lodge and Dennis Suszkowski of the Hudson River Foundation are developing a new alternative to a long-standing and seemingly unsolvable problem—resuscitating nature within sight of Manhattan's Wall Street rush. Their efforts may change how scientists and the public think about ecosystem restoration.

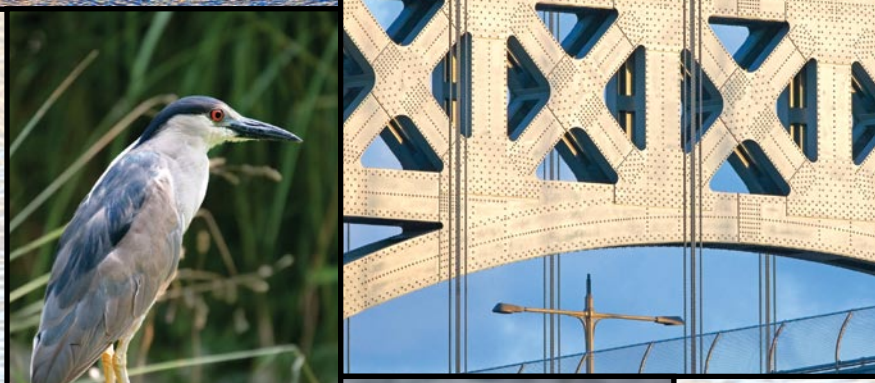
Ecosystem restoration has been defined as returning a habitat to its former condition. The traditional approach is aimed at getting an area back to its original state—in an approximation of the 15th century. "But do we really know what any place was like in the 15th century?" asks Suszkowski.

Other ways of addressing restoration include revitalization, which involves measures of ecological health; "rewilding," in which the goal is to reestablish the original setting such that natural selection guides the future; and "renaturing," or designing ecosystems for nature and people.

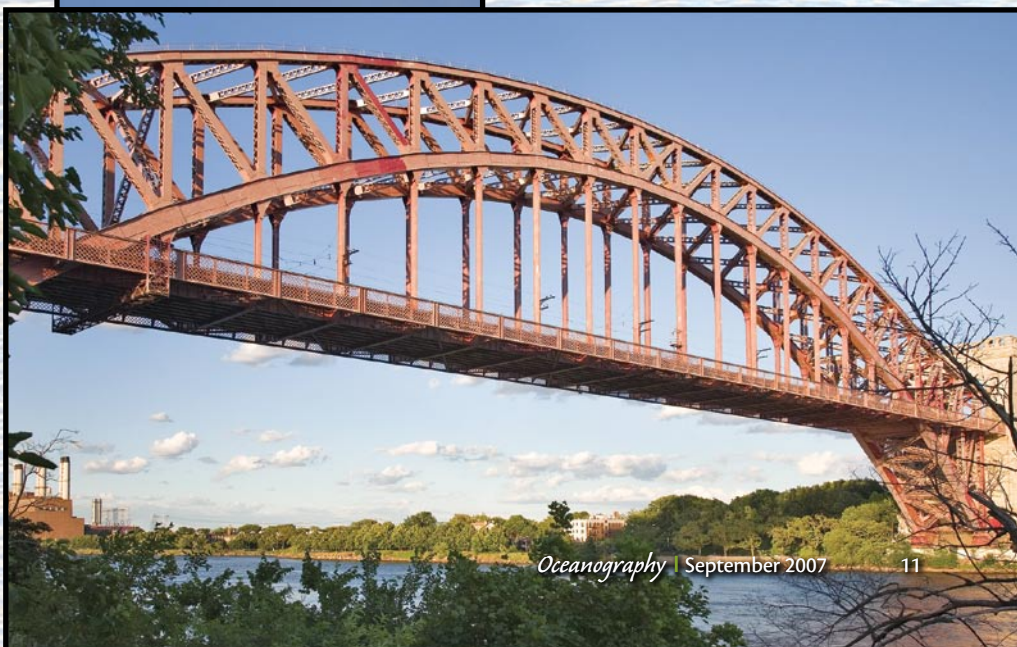
The new effort is an adaptation of renaturing, said Bain.

Through development of what he and other biologists call Target Ecosystem Characteristics, or TECs, "we hope to restore natural communities throughout the New York Harbor area by focusing on what could be, rather than what might have been," said Bain. "By using forward-looking TECs, instead of expending effort on habitat goals derived from a long past state of the harbor—goals





Photographs by Ilya Raskin, Rutgers University



that are unreachable in today's world—we may be able to accomplish what hasn't been done in decades."

The scientists have set the deadline for meeting initial TEC goals at five years from now: by 2012.

They've developed a TEC, for example, for waterbirds like herons and egrets. Success is met by increasing to certain levels the number of islands where herons nest; number of waterbird species nesting and roosting on the islands; re-establishing habitats the birds need, especially wetlands; and improving water quality in the harbor.

By any measure, the effort already has been a success.

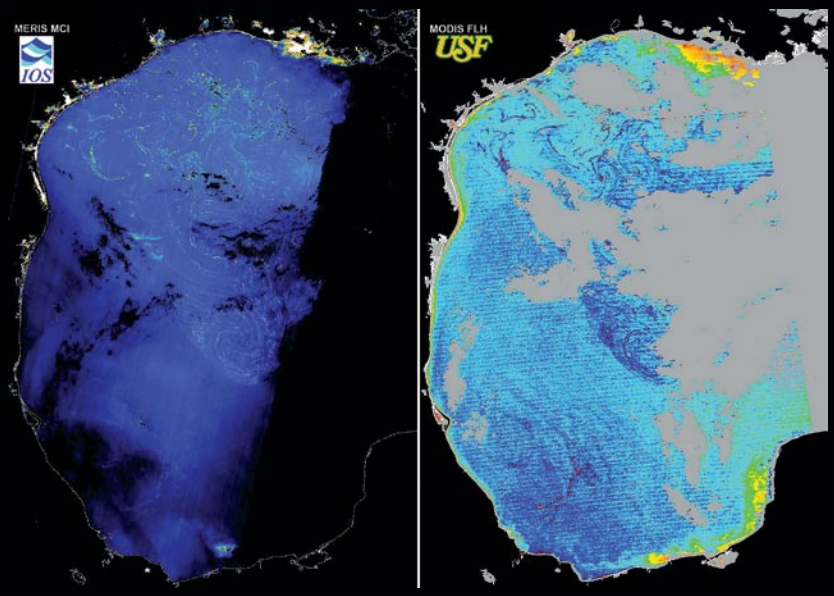
"Among the most glorious renaissances performed by the creatures of New York Harbor," writes Waldman, "has been that of its wading birds."

The harbor's herons and egrets are a powerful statement, Gelb believes, about the health of the wider Hudson River-Raritan Bay estuary, a network of waterways once synonymous with a polluted-beyond-hope environment.

"As long as herons are able to thrive in the harbor," said Gelb, "there's reason to believe that other creatures will be able to live there, too. That includes us."

Hell Gate's true meaning may well be "bright passage."

First Image of Sargassum Weed—From Space



"The Sargasso [Sea] is a definite body of water, measurable and separated from the surrounding water, but no better mapped than the far side of the moon," wrote John and Mildred Teal in 1975 in *The Sargasso Sea*.

Almost 40 years later, it's time to rethink this middle-of-the-ocean sea.

The Sargasso Sea is defined by the Gulf Stream on the west, the North Atlantic Current on the north, the Canary Current on the east, and the North Atlantic Equatorial Current on the south. The Sargasso long has been the oceanic equivalent of Nowheres-ville.

But now *Sargassum* seaweed, found only in and near the Sargasso and well known for entangling ships in its dense floating fronds, has been detected for the first time from space, thanks to an instrument aboard the European Space Agency's environmental satellite Envisat.

The ability to monitor *Sargassum* will allow oceanographers to better understand the primary productivity of the oceans and better predict climate change, say James Gower and Stephanie King of the Canadian Institute of Ocean Sciences and Chuamin Hu of the University of South Florida. Using optical radiance data from the Medium Resolution Imaging Spectrometer (MERIS) aboard Envisat, coupled with information from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the Terra and Aqua satellites, the researchers were able to identify extensive lines of floating *Sargassum* for the first time.

"The combined satellite data from both sensors show the seasonal cycle of weed density in different areas in the Gulf of Mexico," said Gower. "These observations suggest that *Sargassum* may represent a significant fraction of total biomass and, consequently, productivity."

The Sargasso Sea was once thought of as lifeless but for its extensive *Sargassum*. Then scientists discovered that American eels migrate there from freshwater rivers to reproduce, and young loggerhead sea turtles use the sea's *Sargassum* as a cover from predation until they're mature.

More recently, a metagenomics project by scientist J. Craig Venter and others looked at the diversity of microbial life in the Sargasso. Venter's effort led to the discovery of thousands of new species—and 1,214,207 new genes.

Sargassum, seen from space, is certainly not floating by itself in the Sargasso Sea or the Gulf of Mexico, home alone.

Less Salty Oceans: Climate Change Dead Ahead?

A French fairy tale tells of a long-ago princess who professes to her father, "I love you like salt." He, angered by the perceived slight, banishes her from his kingdom, relates Mark Kurlansky in *Salt: A World History*. Only later when the father is denied salt, does he realize its true value and therefore the depth of his daughter's love.

For us today, salt still plays a valuable role—its importance an indicator of climate change. Salinity increases or decreases in certain ocean areas could foretell large-scale climate alterations, according to Rainer Zahn of the Autonomous University of Barcelona in Spain.

Paleoclimate data show that the ocean's currents can shift gears suddenly, but until now it wasn't clear how that happened. Scientists are increasingly realizing that salt is the answer. "Salt plays a far more important role than we first thought," said Zahn.

Zahn predicts that the waters around South Africa are the place to watch for clues: salty waters off the coast of South Africa could speed up ocean circulation in the North Atlantic, despite the areas being thousands of kilometers apart. A decrease in salinity in South African waters could be linked to a slowing down of North Atlantic circulation.

Models and data indicate that these changes can occur over very short time scales, said Zahn, less than a decade or two. Since ocean water can't travel that fast (it takes almost a century for water to move from the South Atlantic to the North Atlantic), Zahn thinks that a surge of salt generates a deep pressure wave or pressure gradient in the ocean that sends energy to the north without water actually being transported.

Salt increases the density of water. Once water becomes salty enough, it sinks, drawing in additional water from surrounding areas and initiating an ocean circulation loop called thermohaline overturning. A build-up of saline water can stimulate deep water circulation, while diluting is linked to more sluggish flow.

Arrival on deck of a long Calypso sediment core later used for paleoceanographic analyses to detect changes in ocean circulation. The core was taken during an IMAGES (International Marine Global Change Study) cruise aboard the RV *Marion Dufresne*. *Photo courtesy of Rainer Zahn*

"Salt in high latitudes is the most important ingredient to keeping the ocean moving," Zahn said. "Without it, the ocean 'conveyor belt' simply stops."

For example, large parts of the tropical and subtropical ocean during the last ice age retained salt and kept it away from high latitudes.

Oceanographers have known that salt was missing from high latitudes during that time. "But we didn't know where it went, or how it got back to high latitudes as the oceans shifted into their interglacial 'warm-age' modes," said Zahn. "Salt, it turns out, was retained in the low latitudes. Due to altered ocean circulation patterns, it didn't find its way to high latitudes."

Then most of the salt "stored up" was released very quickly from the Caribbean, Gulf of Mexico, and southern tip of Africa.

"The sudden release of salt was likely involved in setting the stage for ocean and climate to swiftly progress into interglacial mode," Zahn said.

Salt release from low latitudes may be one of a very few switches that control global ocean circulation and climate, Zahn maintains.

"If you add salt to the oceans, things really get moving," said Zahn. "If you take it away, the oceans—and with them, global climate—change dramatically."

The world is not in a grain of sand, Zahn believes.

Rather, it's in a grain of salt.

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