Intensifying Winds of Change

Hurricanes Leave Footprints on Coastal Ecosystems

ERICA GOLDMAN

Inundated. *Flooding during Hurricane Isabel in September 2003 covered the grounds of the Chesapeake Bay Maritime Museum (CBMM) in St. Michaels, Maryland. Photo courtesy of CBMM.*

Gut-wrenching images of people on rooftops in New Orleans with floodwaters rising around them are now forever burned into our national psyche. In the wake of Katrina's devastating human toll, it seems almost too clinical to think about hurricanes as heat-fueled atmospheric convection events, seasonal disturbances in coastal ecosystems that change the dynamics of populations of fish and invertebrates. But emerging research provides an invaluable context for describing the potential of hurricanes to alter coastal ecosystems on regional and even global scales. Two new studies show that hurricanes are more intense now than they were 35 years ago, a trend that correlates with rising global temperatures. Closer to home, another study demonstrates that Hurricane Isabel, which slammed into Maryland's coastline two years ago this week, changed the biological resources of the Chesapeake Bay, actually enhancing fish and plankton abundance.

Bad Storms Rising

Since 1970, the number of Category 4 and 5 hurricanes has increased by 80 percent, with the most dramatic increase occurring in the past ten years, according to a paper published in the 16 September issue of *Science*. The increase in hurricane intensity correlates with rising sea surface temperatures worldwide, according to an analysis of satellite records of storms by meteorologist Peter Webster and colleagues from the Georgia Institute of Technology in Atlanta. The team found no change in the number of storms per year or in storm duration, only in storm intensity.

Another complementary study examined the same problem through a different lens. Published in 4 August issue of *Nature*, meteorologist Kerry Emanuel from the Massachusetts Institute of Technology evaluated the intensity of a storm relative to its duration, calculating a measure known as the "power dissipation index." He found that this index has increased dramatically since the 1970s and correlates with global warming trends. Emanuel's results also suggest that continued warming would further increase the destructive potential of storms which, taken in the context of growing coastal populations, could augment hurricane-related losses.

"This information gives us more of a sense of the consequences of global warming," says estuarine ecologist Donald Boesch, president of the University of Maryland Center for Environmental Science and a New Orleans native. "This is just one more crucial reason that we need to think about reducing greenhouse gas emission," he says.

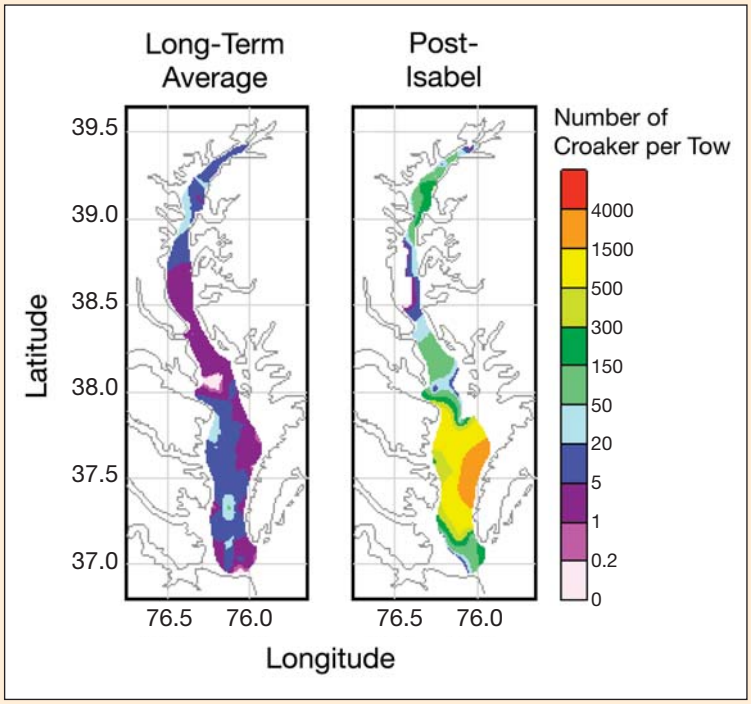
Prior to these two papers, connections between global warming and hurricanes were basically "religion," explains climate scientist Richard Murnane, a program manager for the Risk Prediction

Initiative (RPI) — a science-business partnership based at the Bermuda Biological Station for Research. "There were believers and non-believers," he says.

Murnane plans to take these new research findings to a meeting next week to recruit new sponsors for RPI. These findings are especially significant for the catastrophic insurance industry, he explains, because the most intense storms have the greatest storm surge and pose the greatest threat to the coastline. "It only takes a one-meter wave to knock down an average house wall," he says.

Isabel's Legacy

A Category 2 hurricane on the Saffir-Simpson scale when it hit in September 2003 (Katrina was a Category 4), Isabel brought a significant storm surge that caused widespread flooding in low-lying areas. Beyond measuring its impact on property, however, scientists have also begun to evaluate the footprint of Isabel on biological response of the Chesapeake Bay itself.



Bay's Bounty. *Six weeks after Hurricane Isabel, researchers detected a large influx of juvenile Atlantic croaker in the Chesapeake. Source: Michael Roman, Horn Point Laboratory, University of Maryland Center for Environmental Science.*

Every storm has a unique signature that depends largely on when in the season it hits and how much rain it brings, explains biological oceanographer Michael Roman from the University of Maryland Center for Environmental Science Horn Point Laboratory. Unlike the infamous Tropical Storm Agnes, which fundamentally altered the structure of the Bay ecosystem in 1972, Hurricane Isabel did not bring heavy rains and huge pulses of fresh water. Most of Isabel's effects appear related to wind-driving mixing and movement of water, he says.

Roman, first author of a paper on Isabel's effects on Chesapeake Bay published 12 July in the American Geophysical Union's journal *Eos*, found that the storm caused a mix of ecological impacts, actually enhancing populations of certain fish and plankton. In the short term, mixing of nutrients in the water column by the storm sparked a short-term increase of dissolved oxygen in the Bay. Soon after, however, a massive algae bloom covered a large area of the Bay's main stem. According to the team's research, this bloom likely led to the early onset of low-oxygen (hypoxic) conditions in the spring of 2004.

On the other hand, populations of certain species of fish and zooplankton apparently received a boost from Isabel. Overall, researchers observed an increase in species richness after the storm — with 21 species of fish found in the upper bay after Isabel, five more than the 1995-2000 average. Populations of two species in particular, the bay anchovy and juvenile Atlantic croaker, saw a significant post-storm boom.

"If you want to catch croaker, I would suspect you would be in good shape next year," says Roman.

Storms like Isabel may play an important role as ecological disturbances, says Roman. Although estuaries are already very dynamic, storms can play a role similar to that of forest fires in enhancing species richness.

Roman, continuing his studies of zooplankton ecology on the continental shelf, last week faced a reminder that scientific research is not immune to the forces of nature. Still slogging through a hurricane season that no one will ever forget, Roman was tracking recently hatched blue crabs outside the mouth of Chesapeake Bay from the research vessel *Henlopen*. With Hurricane Ophelia brewing off the coast of North Carolina, the swells would soon grow too large to safely deploy the large plankton net to sample blue crab larvae. The scientists aboard had no choice but to cut short their sampling efforts and return to port.

Contact: Erica Goldman, Maryland Sea Grant Communications, 301.403.4220, x20