



PERFECT STORMS

—how Hurricane Irene and Tropical Storm Lee slammed NY

By Steve Stanne

On August 15, 2011, a patch of showers and thunderstorms crossed the North African coast, and headed west over the Atlantic Ocean. The unsettled weather accompanied a tropical wave, an area of low pressure spawned in the searing heat of the Sahara Desert.

Four thousand miles away, forecasters at the National Hurricane Center in Miami took note: Nearly 85% of the Atlantic's major hurricanes develop from such tropical waves. As the system neared the

Lesser Antilles on August 20, the center dispatched an Air Force Reserve aircraft for reconnaissance. Based on its report, the hurricane center christened the squalling newborn Tropical Storm Irene.

What mother's milk is to a growing baby, water vapor from warm ocean water is to tropical cyclones. Drawn upward in vast amounts, the moisture cools and condenses, a process that produces drenching downpours and releases heat energy that powers strong winds.

Irene was fed well as it passed over the Leeward Islands and into the Caribbean Sea. The hurricane center foresaw a growth spurt, a prediction realized by Monday, August 22, when Irene became the first hurricane of the 2011 Atlantic season. In discussing the storm's future, a center forecaster opined that "It would not surprise me if this cyclone became a major hurricane at some time during its lifetime..."

Above: Satellite image of Hurricane Irene just 28 minutes before landfall in New York City.

Also keeping an eye on Irene were staff in DEC's Division of Air Resources. Its main mission is improvement and maintenance of air quality, but the division also provides daily information on potential weather hazards to the State Office of Emergency Management (OEM). Division meteorologists started paying close attention to Irene on Tuesday, when the track forecast was highly uncertain; they could only report that the storm posed a significant threat.

Two days later, various track-predicting models began to agree, and the center posted a hurricane watch from the Virginia/North Carolina border northward to Sandy Hook, New Jersey. New York Governor Andrew M. Cuomo had already ordered OEM to be ready for Irene; now he declared a state of emergency. Preparations went into high gear on Friday as forecasters elevated the watch to a warning.

Tropical storm conditions were expected to reach Long Island early Sunday morning with hurricane-force winds by noon. Scientists predicted a storm surge of 4 to 8 feet, with destructive waves pounding the coast. DEC meteorologists were especially concerned about the 6 to 12 inches of rain predicted to fall on already

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saturated soils, warning that it could cause widespread flooding, including life-threatening flash floods.

Given New York City's coastal location, low-lying (and in some cases, subterranean) infrastructure, dense population, and media megaphone, storm preparations there received plenty of attention. Officials ordered about 370,000 residents of flood hazard areas

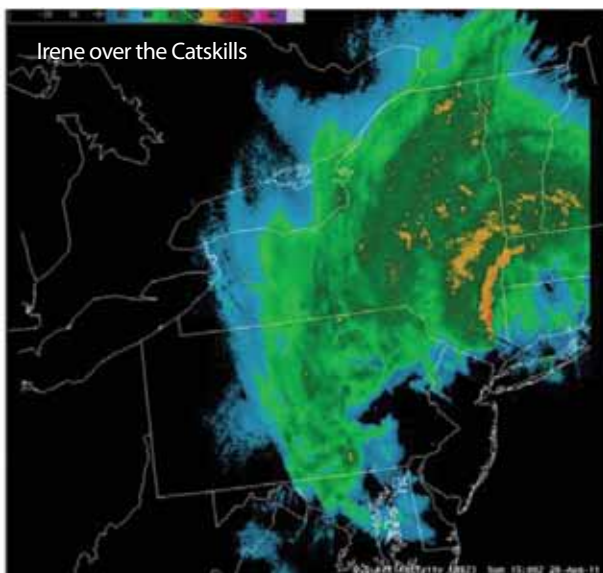
to evacuate. The Metropolitan Transit Authority shut down subways, buses and commuter railroads at midday Saturday. Broadway theaters cancelled their Saturday evening and Sunday shows.

With the Great White Way dark, drama moved to a larger stage. Irene played its leading role to the hilt, taking a direct shot at the city. The cyclone's center came ashore over Coney Island at 9:00 a.m.



James Dayton

New York City's subways shut down as Irene approached.



Radar imagery courtesy of National Weather Service

The yellow and red areas in these radar images show Irene's heaviest rainbands over the Catskills at 11:00 a.m. and over the Adirondacks and Green Mountains at 2:00 p.m. on August 28.

Sunday and continued north over Manhattan. Coinciding with high tide, storm surge added more than four feet to already higher-than-usual lunar tides. The resulting flooding caused hundreds of millions of dollars in property damage in the city and on Long Island.

At landfall, Irene weakened to a tropical storm, with winds strongest east of its center. New York City thus escaped severe wind damage; Long Island was less fortunate. The heavier winds and water-logged soils there brought down many trees, tree limbs and electrical wires; a half-million customers lost power, some for a week or more.

One group of hardy outdoor folk found a silver lining to the storm. Birders flocked to shoreline vantage points, seeking oceanic birds swept inland and north. They weren't disappointed; terns from tropical waters and petrels from the open sea flew over the Hudson River Sunday afternoon. The storm even pushed an exhausted white-tailed tropicbird from its normal range in the Florida Keys to Rensselaer County, some 1,500 miles to the north.

After the dire warnings, it seemed that New York City had dodged a bullet when Irene moved on. Life there would more or less get back to normal in a few days. Upstate New York was not so lucky.

The storm's heaviest rainbands were west of its center, and as Irene rolled north, they ran headlong into the Catskills. The heavy, moisture-laden air lifted as it passed over the mountains, intensifying condensation as it cooled. The effect was like squeezing a sopping wet sponge: 7.55" of rain fell at Whiteface Mountain in the Adirondacks; 11.48" at Tuxedo Park in the Highlands; and 13.3" at East Durham on the Catskills' northern slopes.

This was simply too much rain, in too short a time period, for the land to absorb. The results were catastrophic.



Scott Daly



Flooding from Irene destroyed many miles of railways and roads, including these tracks in Middletown and this highway.



Adam DuBrowa/FEMA

Flooding at Lock 9 of the NYS Barge Canal on the Mohawk River at Rotterdam Junction severely damaged the lock and a nearby bridge.



NRCS New York

Along many rivers in eastern New York, Irene ruined harvests, fields and farms, including this one in the Schoharie Valley.

Across the state, and in neighboring Vermont, tiny rivulets became mighty rivers of never-before-seen proportions. In dollars, losses reached hundreds of millions; the human cost was incalculable. Eight people died in the flooding. Three entire Catskill villages were rendered uninhabitable. In the Adirondacks, the Keene Valley Volunteer Firehouse was but one of many municipal buildings, homes and businesses that suffered knockout blows. Washouts closed roads and railways for months. Contributors to DEC's Hudson River Almanac reported pumpkins floating down the river; their bright orange symbolized not the joyful spirit of the harvest, but the emergency conditions on the watershed's farms, where damage to crops and land was devastating.

Where communication networks remained operational, frantic calls came into emergency responders, including DEC's environmental conservation officers and forest rangers. In just one of many such incidents, DEC officers

Forest Ranger Joan Oldroyd



During the flooding caused by Lee, DEC airboats rescued many people stranded in Broome County.

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waded through rapidly rising water at a bungalow colony in Sullivan County to carry some ten children to dry ground. Where communications were down, responders went looking for people who had been cut off, making sure they were safe and had food, drinking water and critical medicines.

The scenes of destruction throughout McKinley Hollow, Burnham Hollow and Oliveria Valley in Ulster County were typical of hard-hit regions. Open canyons, gravel piles and debris littered what used to be roadways, blocking vehicles. First thing Monday morning, DEC Region Three Natural Resource Supervisor Bill Rudge and his son Caleb hopped on their mountain bikes, took orders for supplies from their neighbors, and pedaled miles to the nearest emergency command station to deliver them. Prescription refills were given to police to be filled and returned to the

Rudges to take back to those stranded. Bill was even deputized by the postmaster to deliver mail.

In Schoharie, DEC spill response specialists were called to the Ottman and Enders Bulk Oil Storage Terminal, where the Schoharie Creek had upended a 60,000-gallon and two 20,000-gallon tanks. As the water receded, they worked through the night with spills contractors, collecting oil to prevent further contamination.

The Belleayre Mountain Ski Center, a magnet for winter sports enthusiasts, became an evacuation center for tropical storm refugees, where DEC staff eventually accommodated 130 adults and 40 children. A homeowner on Lower Catskill Creek reported that his flooded cellar sheltered refugees of a different kind—he rescued two pumpkinseed sunfish, a white perch and a spottail shiner from his sump pump pit.

Elissa Jun



Elissa Jun



Above: Prattsville was one of the Catskill Mountains communities hit hardest by Irene.

Those fish were lucky. There were worries about the Hudson's 2011 class of newborn river herring and American shad, whose populations are in decline. The estuary is a nursery for these little fish until they move downriver and out to sea in late fall. In Irene's wake, massive freshwater flows swept these youngsters downstream much earlier than usual. Andy Kahnle of DEC's Hudson River Fisheries Unit wonders if they would have had the time and food needed to grow large enough to survive their first winter in the ocean. The answer? "We won't know until it's time for these fish to return to spawn years from now."

Once streams receded, biologists with DEC's Stream Biomonitoring Unit waded in to investigate the record flooding's impacts on benthic macroinvertebrates. These bottom-dwelling insects, crustaceans, and other small creatures are prime indicators of habitat quality and critical food for gamefish. Staff focused on the Upper Esopus Creek, a premier Catskill trout stream, which they had been studying closely since 2009 (see "Bioneers" in June 2010 *Conservationist*). Early findings indicate that species richness decreased on average by 60%, with up to 20 species lost from bottom communities. The dramatic loss of biodiversity, coupled with major physical alterations in the watershed, suggest that ecosystem recovery in the Upper Esopus and similar streams could take years.

Meanwhile, the tropical weather scene remained active. One system gained tropical storm status as Jose for a few days before dissipating. Another, named Hurricane Katia, stayed well offshore. And while Katia howled over the Atlantic, an area of disturbed weather in the Gulf of Mexico became Tropical Storm Lee on September 1.

Lee showed little ambition to become a hurricane. Its tropical storm status lasted only a few days, and by the time its remnants reached New York, Lee was no

Susan L. Shafer



In the affected region's streams, diversity among macroinvertebrates that support gamefish populations was significantly reduced by record floods.

longer even a cyclone. But while drifting over the Gulf's warm waters, Lee accumulated a huge reservoir of water vapor.

Heading ashore, Lee dropped 10 to 15 inches of rain on Mississippi and Louisiana. Its moisture pushed north, ahead of the storm's center, and met a weather front that lifted it upward. The result repeated what happened when moisture was wrung out of Irene by condensation over New York's mountains.

From September 6 to September 8, rainfall totaled 10 to 12 inches just west of Binghamton, and exceeded 5 inches over large parts of eight counties in the region. The Susquehanna River rose to record levels, overflowing retaining walls and flooding downtown Binghamton and other communities. Ninety-five percent of the Village of Owego was under water. As with Irene, losses ran from hundreds of millions of dollars when they could be measured to uncountable sums in lives upended and dreams ruined.

Again, emergency workers braved the deluge. Forest rangers responded

to calls for assistance with airboats to rescue people from swiftly rising waters in Nanticoke and Conklin. After Broome County initiated mass evacuations, one of the airboats safely rescued 62 people from flooded homes in Johnson City. Temporary repairs to roads and bridges upstate were dealt a second significant, albeit lesser, blow.

National Weather Service/Binghamton



In this radar image of the remnants of tropical storm Lee, the yellow and orange areas indicate very heavy rainfall in the Southern Tier on September 7, 2011.

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The collective damage from Irene and Lee precipitated much discussion on dealing with floods. DEC authorized emergency construction and repairs in Irene's wake, but as Commissioner Joe Martens noted, "Restoring streams must be done properly to ensure that lives, property and the environment are protected."

With good intentions, many local officials and residents called for deepening or straightening stream channels and armoring and raising streambanks with heavy stone. While these seem like commonsense solutions, in many cases they do little or nothing to limit future flooding impacts. In fact, they can worsen flooding and erosion by increasing a stream's velocity, and transfer the problems downstream.

Maintaining connections between a stream and its floodplain reduces water velocity and flood height while decreasing erosion and sedimentation. According to Scott Cuppet, watershed coordinator for DEC's Hudson River Estuary Program, "Poor choices about watershed development have placed people and investments in floodplains and directly in harm's way. Although difficult, the only sure way to reduce flooding is to keep our assets out of these areas, while creating a more resilient watershed that can absorb and retain rainfall from intense storms."

Direct hits on New York by hurricanes like Irene are uncommon. More frequently, the remnants of tropical systems produce heavy rainfall and flooding, as happened with Lee. While scientific models suggest that climate change could increase the intensity or frequency of

hurricanes, data so far do not show that either has happened.

However, tropical storms are not the only serious threat. Over the last half century, the frequency and intensity of extreme precipitation events have increased in the Northeast. As residents of a coastal state, New Yorkers must prepare to deal with the impacts of these events locally, regionally and statewide—by keeping development out of floodplains and by creating robust emergency response capabilities. Just as meteorologists issued watches and warnings for Irene and Lee, the storms themselves reminded us that we must prepare now for extreme weather events likely to blow our way in years to come.

Steve Stanne coordinates the education efforts of DEC's Hudson River Estuary Program through a partnership with Cornell University.

New York's Hurricanes

Since the mid-1800s, 13 hurricanes have scored direct hits on New York State. The most intense was 1938's "Long Island Express," also called the Great New England Hurricane. It killed more than 600 people in New York and New England, largely due to storm surge. Storm tide heights reached 14 to 18 feet on Long Island, while sustained winds around 100 miles per hour (a 181-mph gust was recorded near Boston) drove 30 to 50 foot waves into the coast. The damage estimate for the 1938 hurricane was \$620 million. Today, that cost would be closer to \$41 billion.

Nearly 80% of New York's coastal residents have never been through a storm as intense as the Long Island Express. In the last couple of decades, Hurricanes Gloria and Irene have been the strongest to make landfall in the state, but neither came close to the power of the 1938 storm. Emergency officials worry that modern tracking and forecasting technologies have made us complacent; it's worth remembering that while these techniques can predict what's coming, they are unable to lessen the blow. And intense storms will come; there is a 90% probability that during the next 50 years a hurricane as intense as 1938's will strike New York City or Long Island.

As Irene and Lee demonstrated, the intensity of a storm's winds is not the only measure of the disruption it may cause. Flooding from rainfall can be devastating; in this respect, 1972's tropical storm Agnes, whose costs totaled \$702.5 million (not adjusted for inflation) in New York, probably outdid Irene. (For more information on Agnes, see the June 1997 *Conservationist*.)

