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FLOYD FOLLIES:
What We've Learned

CONTENTS

3

FLOYD FOLLIES: WHAT WE'VE LEARNED

A four-state evacuation from Hurricane Floyd caused massive traffic foul-ups. But South Carolina has since worked hard to improve evacuation planning.

6

WHO LEAVES EARLY?

Tourists are among the first to flee inland during a hurricane. Long-time residents are likeliest to stay home.

7

SAFER AT HOME?

In a few coastal communities, many residents who live in well-built structures are urgently encouraged to stay home during a hurricane.

14

EBBS AND FLOWS

ON THE COVER

Trapped for hours in an I-26 traffic jam during the Hurricane Floyd evacuation, Lynn Snowden stopped along the roadside to change the diaper of her two-year-old son Jonathan. PHOTO/WADE SPEES

WHICH WAY? *South Carolina emergency officials, experts say, failed to provide clear and timely information about various evacuation routes as Hurricane Floyd approached the southeastern coastline.* PHOTO/WADE SPEES

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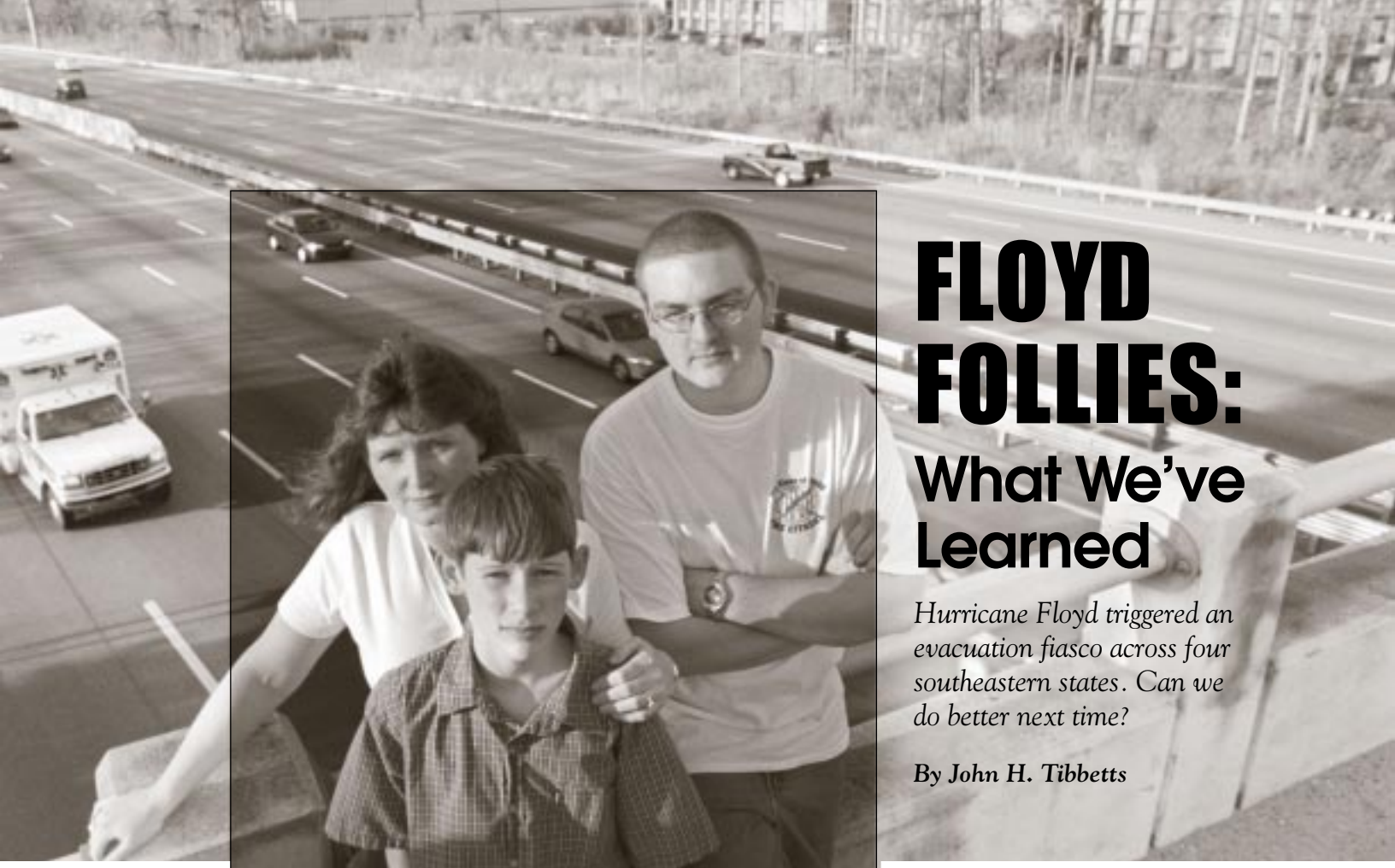


FLOYD FOLLIES: What We've Learned

Hurricane Floyd triggered an evacuation fiasco across four southeastern states. Can we do better next time?

By John H. Tibbetts

FLASHBACK. *Brenda Gonnella and her sons Matt (right) and Andrew stand on a bridge above I-26, where they got stuck for nine hours in a massive traffic jam during the Hurricane Floyd evacuation in September 1999.* PHOTO/WADE SPEES

Brenda Gonnella, with two kids and a dog in tow, evacuated her North Charleston home mid-afternoon on Tuesday, Sept. 14, 1999, heading toward Asheville to escape Hurricane Floyd barreling toward the coast.

She didn't get far, though. Gonnella soon found herself caught by a gigantic traffic jam on I-26 snaking to the midlands. Between 360,000 and 410,000 South Carolinians, obeying Gov. Jim Hodges' evacuation order, also fled the coast that same day.

For nine hours, Gonnella and her sons Matt and Andrew waited in the thick summer heat, their car scarcely moving on I-26. By midnight, they had traveled just 35 miles, and she was worried about running out of gas. She thought of her husband, Jim, a master sergeant who remained behind for emergency duty at the Charleston Air Force Base. "I figured he would want me to stay on the road, but my main concern was getting stuck there during the storm. I felt that I'd rather be in my house where I had some protection than sitting in my car, trying to ride it out."

Finally, she left the interstate, turned onto a side road, and headed toward home. "People were yelling, 'You're going the wrong way! A hurricane's coming!'"

Gonnella and her children soon arrived at her house. "My husband was preparing to leave for the base, and I told him, 'I couldn't take it anymore,' and he understood."

At least 3.5 million people from four states—Florida, Georgia, South Carolina, and North Carolina—evacuated during Hurricane Floyd. It was the largest evacuation in U.S. history. Lines of cars backed up for hundreds of miles on several interstates. Trips that would have taken two hours on a normal day took 16 or 18. Many evacuees could not find bathrooms, motel rooms, or shelters. Cars ran out of gas or broke down, littering highways and small roads.

"It was a horrendous evacuation," says Don Lewis, an evacuation expert with Post, Buckley, Schuh & Jernigan, a consulting firm based in Tallahassee, Florida.

Since the Floyd debacle, South Carolina emergency planners have worked diligently to improve evacuation planning. The state has established lane-reversal strategies on some major highways, expanded traffic monitoring tools, disseminated public-information materials on evacuation routes, collaborated on multi-state evacuation planning, and other measures. South Carolina's hurricane preparedness ranks at the very top in the region, experts

say. Next time a huge hurricane threatens the coast, South Carolina will be better equipped to move hundreds of thousands of people inland.

That said, what really went wrong during Floyd? Why did so many people get stuck on the road with such little guidance or aid from government?

Floyd's huge size complicated matters. Approaching the U.S. mainland, Floyd was a monster category 4 storm on the Saffir-Simpson scale. At one point, the storm churned with 155-mph winds, flirting with the rare category 5 status. Since the 1880s, only two category 5 hurricanes have struck the United States: an unnamed 1935 storm that hit the Florida Keys and Camille that swamped the Mississippi coast in 1969.

If you'd studied satellite imagery on Sunday, Sept. 12, 1999 you might have noticed that Floyd's path resembled that of Hurricane Andrew, which ripped through South Florida in 1992, causing $25 billion in property damage. But Floyd, with a diameter almost 600 miles wide, was far larger than Andrew, although its strongest winds were confined to an area around the hurricane's eye. Still, such a huge hurricane could endanger lives within 50 to 100 miles of the eye's landfall.

Floyd, forecasters predicted, would probably turn north, pushed by an approaching trough from the west. But forecasters could not say when or where this turn would occur.

Tourists and residents along South Florida's coastline were ordered to leave, and emergency officials along the entire East Coast nervously waited for updates. If Floyd did turn north, the South Florida megalopolis would be spared. But unless the storm swerved sharply and unexpectedly out to sea, another community up the coast would get battered.

Emergency officials have grown a little weary explaining that the most dangerous hurricanes to strike the U.S. mainland in recent years did not hit major metropolitan areas head on. In 1989, Hurricane Hugo's highest storm surge swept across coastal villages 30 miles north of downtown Charleston, sparing the city from the worst. In a similar fashion, Hurricane Andrew's most destructive winds did not strike Miami. Instead, Andrew ravaged unincorporated Miami-Dade County, its winds scarcely affecting downtown Miami farther north, before sweeping through the Everglades and into the Gulf of Mexico.

JAY BAKER

"During Floyd, emergency managers didn't know how bad the problem was—they didn't know how many people were going from Florida to Georgia or Georgia to South Carolina."

But Floyd, experts worried, might be The Big One, which could dwarf the American death toll of any other tropical cyclone in recent memory. If a category 4 or 5 hurricane struck a major urban area, it could drive a 20- to 25-foot storm surge up creeks and rivers, killing hundreds or even thousands. (A storm surge is the rise in coastal water level caused by high winds and low barometric pressure.) Emergency officials, hurricane experts, and media were blunt about Floyd's dangers. A Florida state meteorologist described Floyd as "Andrew's big brother." Jerry Jarrell, then director of the National Hurricane Center, declared that Floyd was "much more dangerous than Andrew."

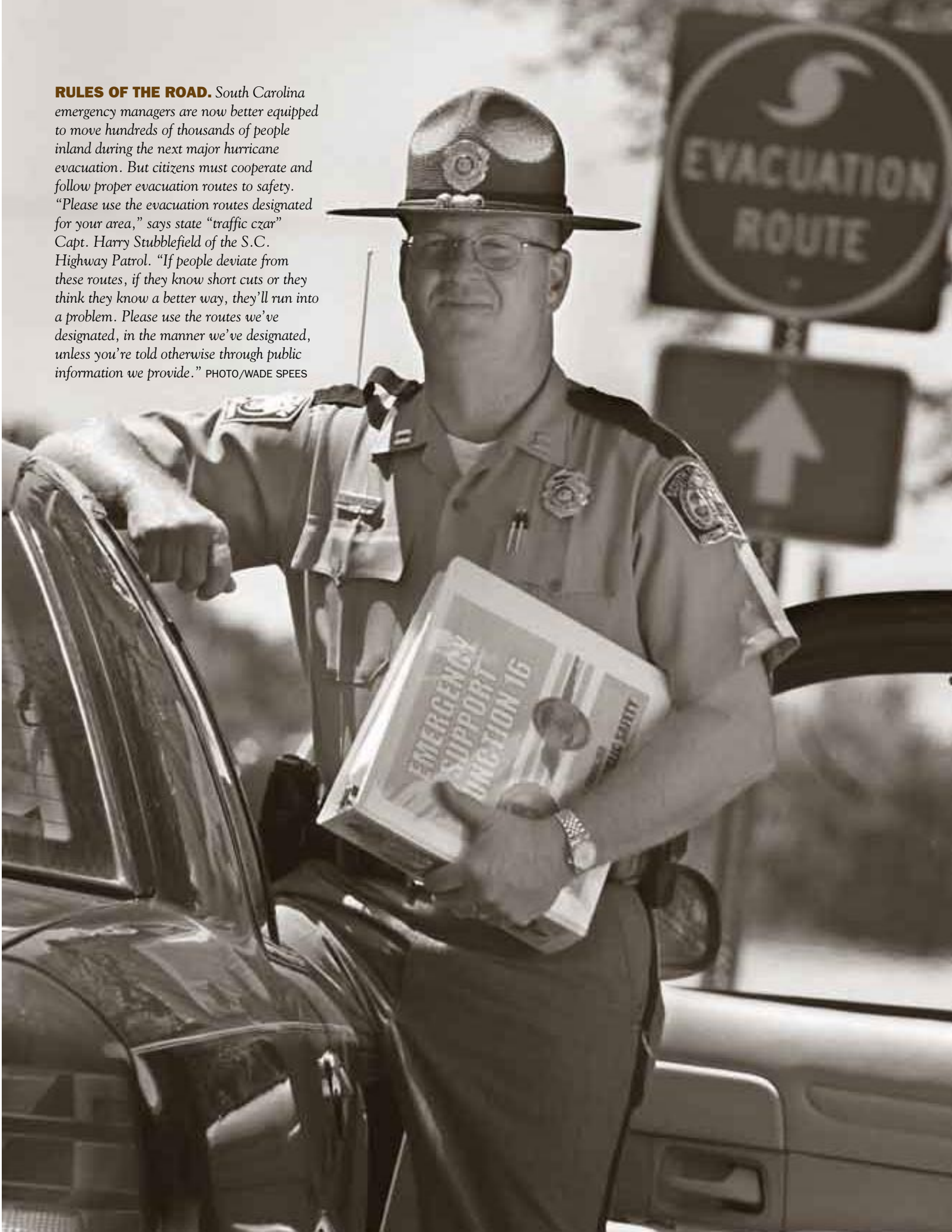
The hurricane did turn north before it could cause a catastrophe in South Florida. But then it churned a parallel path along the coast, threatening the rest of the Florida shoreline. Some Floridians fled west across the peninsula, while others scurried north, hoping to outrun the storm, but the hurricane followed them up the coast.

As many as two million Floridians left home during Floyd, an exodus that overwhelmed highways and transportation networks. As they poured into Georgia and South Carolina, they bumped into people traveling west from Savannah and Charleston to escape the hurricane. The result was massive traffic gridlock.

To compound the problem, each state planned and carried out its evacuation in isolation as if it were an independent republic with restricted borders. "Everyone did his own thing," says William Massey, hurricane program manager for the Federal Emergency Management Agency (FEMA). "The evacuation was not a concerted, coordinated effort."

State emergency managers had scant awareness of the evacuee flood coming up the road. "During Floyd, emergency managers didn't know how bad the problem was—they didn't know how many people were going from Florida to Georgia or Georgia to South Carolina," says Jay Baker, a Florida State University geographer who studies evacuations.

Meanwhile, South Carolina's leaders were not able to receive basic information about traffic flow. Various South Carolina agencies used incompatible radio systems and frequencies, and cell phones were unreliable at peak usage times. So when vehicles got stacked up for miles, top public-safety officials couldn't communicate with personnel on the ground and didn't know



RULES OF THE ROAD. *South Carolina emergency managers are now better equipped to move hundreds of thousands of people inland during the next major hurricane evacuation. But citizens must cooperate and follow proper evacuation routes to safety. "Please use the evacuation routes designated for your area," says state "traffic czar" Capt. Harry Stubblefield of the S.C. Highway Patrol. "If people deviate from these routes, if they know short cuts or they think they know a better way, they'll run into a problem. Please use the routes we've designated, in the manner we've designated, unless you're told otherwise through public information we provide."* PHOTO/WADE SPEES

Who leaves early?

From long experience, emergency planners have learned which populations respond quickly during hurricane evacuations and which dawdle or dig in their heels and refuse to leave. Tourists, especially ones from inland states, are fastest responders.

"Tourists from Ohio, for example, don't know the difference between a hurricane and a tornado," says Ashby Ward, president of the Myrtle Beach Area Chamber of Commerce. "They only know that a hurricane is larger. They think that a hurricane can strike at a moment's notice, so they start getting very skittish when a hurricane is a thousand miles away. We start getting callers a week in advance (of a hurricane's potential landfall in South Carolina), asking, 'Should I leave now?'"

Vacationers with children evacuate earliest of all. "Family vacationers will be gone from the area quickly," says Paul Whitten, director of public safety for Horry County. "They'll say, 'I don't need this.'" During summer months, hurricane-evacuation routes fill up rapidly with family tourists heading out of town.

It's the old-timers, people who have lived on the coast for 10 or more years, who are most resistant to leaving for a hurricane, says Whitten. "You have people on the front beach who will not evacuate."

Some of these long-time residents claim that they've survived several hurricanes in Horry County, including Hugo, Bonnie, Fran, and Bertha, yet these windstorms only lightly touched the Myrtle Beach area. Whitten reminds people that the last major storm to cause severe damage in Horry County was Hazel, which made landfall along the South Carolina-North Carolina border in 1954, destroying beachfront homes.

Some homeowners in floodprone areas remain stubbornly blind to the risks they face. "Some people want to stay with their homes," says Stacy R. Stewart, a hurricane specialist with the National Hurricane Center. "They say, 'I put my life into it.' Yes, but they may literally put their lives into it."

the extent of the problem. "We had a failed, fractured communications system," says state "traffic czar" Capt. Harry Stubblefield of the S.C. Highway Patrol. "We didn't have a good feel for monitoring (the evacuation), and we couldn't give our commanders the big picture to let them know what was going on."

South Carolina officials were unprepared to reverse lanes of I-26, that is, to turn coast-bound lanes into inland-bound lanes, allowing traffic to flow faster from the storm. "Our decision-making was a little bit behind," says Jon Boettcher, hurricane coordinator with the S.C. Emergency Management Division. After receiving blistering criticism for the stalled traffic, Gov. Jim Hodges ordered lane reversals on I-26, which took several hours to complete.

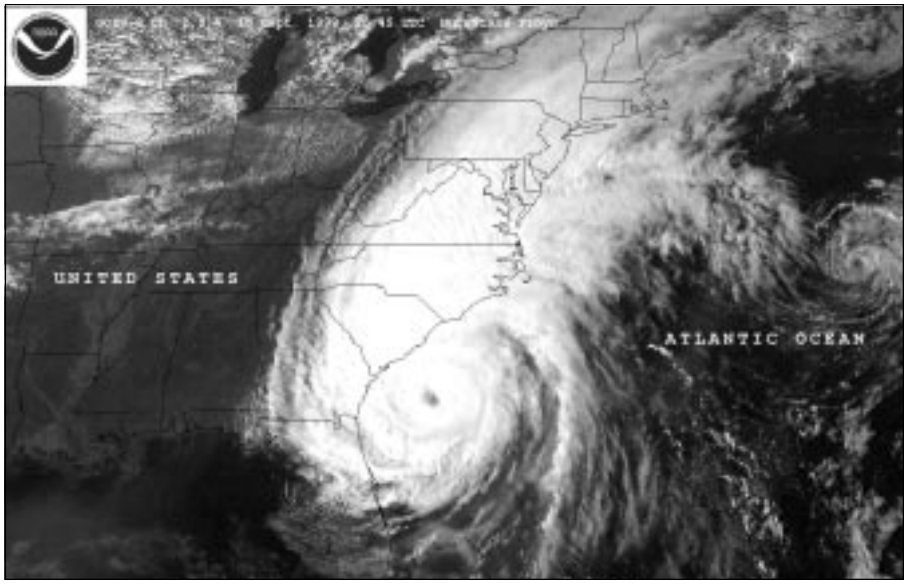
Most Charleston-area evacuees piled onto I-26, ignoring parallel routes on smaller roads. People were left to their own navigational resources because emergency planners did not offer enough information about other possible routes. "The problem was that we were not managing the road network," says Stubblefield.

Luckily for South Carolina, Floyd eventually lost strength and continued due north, its weaker, western edge sweeping the state's coastline with relatively light winds.

When the storm made landfall near Cape Fear, North Carolina, at 2:00 a.m. on Sept. 16, it was a category 2 storm, with maximum winds just over 100 miles per hour. Even so, Floyd dumped 15 inches of rain in 12 hours in eastern North Carolina, driving a record storm surge across Albermarle Sound. By the time Floyd moved out to sea on Sept. 17, it had been responsible for 56 deaths—all from falling trees and inland riverine flooding.

It's important to remember, however, that the Floyd evacuation was effective in some respects. Throughout the four-state region, there were no recorded deaths from storm surge, historically the biggest killer during hurricanes.

Moreover, Horry County residents offered few complaints about the Floyd evacuation, perhaps because



THE BIG PICTURE. *Hurricane Floyd was a monster category 4 hurricane. At Floyd's peak, it had stronger winds than Hugo, which devastated South Carolina in 1989, and Andrew, which crushed South Florida in 1992.* PHOTO/COURTESY OF NOAA

they had faced so many trial runs, having been evacuated three times in the previous three years—Bertha and Fran in 1996, and Bonnie in 1998. Each of those hurricanes swept past and hit North Carolina.

Nevertheless, the typical 75-minute drive from the Grand Strand to Florence still required five to six hours during the Floyd evacuation's peak traffic congestion. "Maybe there are more realistic expectations here" about travel times, says Paul Whitten, public-safety director for Horry County. Also, most of Horry County's evacuees had dispersed before they bumped into heavy northbound traffic on I-95.

Elsewhere, though, the Floyd evacuation was considered a flop. Traffic tie-ups on interstate highways embarrassed political leaders and infuriated voters.

Since Floyd, Brenda Gonnella and her husband have discussed whether to stay home when another giant hurricane approaches South Carolina. Jim Gonnella notes that their house could not withstand a major hurricane, and he plans on getting his family out early next time. Brenda says, "I wouldn't fight that traffic again. That experience put me in the mindset of, 'I'll just stay here next time.' But my husband says, 'I don't think so.'"

MAJOR IMPROVEMENTS

Emergency officials are always searching for glitches in their disaster plans. Drills are rarely sufficient. Sooner or later, planners must experience the real thing—the major disaster—to find the inevitable kinks in their systems. And that's what Floyd did: it exposed some flaws in hurricane preparedness that the state is working to fix.

For many evacuees, the most glaring flaw was a lack of reversed lanes on major highways. Since Floyd, the S.C. Dept. of Public Safety has developed workable lane reversals for I-26 between Charleston and Columbia, U.S. 17 south in Georgetown County, and U.S. 278 in Beaufort County. If a giant storm threatens South Carolina anytime soon, the governor would probably reverse lanes of I-26 and perhaps other highways, experts say. Each state from Texas to North Carolina, moreover, plans to reverse at least one road in case of a major storm.

Safer at home?

Officials in a few hurricane-prone communities are vigorously encouraging residents who live outside of storm-surge areas in well-built structures to stay home.

One example is the South Florida megalopolis (pop. 5.1 million), where evacuation routes are extremely limited. Evacuees from Miami, Ft. Lauderdale, and Palm Beach have only two directions to escape a storm: north and west, along highways where traffic jams occur during daily rush hours.

That's why emergency officials urgently encourage most South Florida residents to stay home or move to a well-built structure nearby, preferably within their own county, and avoid an evacuation on overcrowded roads.

Tony Carper, director of the Broward County (Florida) Emergency Management Agency, says, "If you're out of the storm-surge zone and you live in substantial housing and you apply the necessary window and door protections and get the necessary emergency supplies, you'll be more comfortable staying at home. If you're going to evacuate, travel the shortest distance possible. Stay with friends or family who live nearby in substantial housing. But do not attempt to get onto our interstate highway system and travel to another part of the state."

With the help of Florida Atlantic International University, Broward County did an extensive topographic survey of the county's coastal zone using an innovative laser technology called LIDAR (Light Detection and Ranging), which has an accuracy of plus or minus 15 centimeters. Next, the county compared its coastal elevation to the storm-surge modelling done by the National Hurricane Center. The comparison allowed the county to redefine its evacuation zones much more accurately.

Now many Broward County residents who live in areas that would experience minor (not life-threatening) storm-surge flooding would not have to evacuate during a hurricane. Experts say that's a radical departure from the norm. In most hurricane-prone coastal areas, flood maps are cruder, and emergency managers have less information about the potential depth of coastal flooding during hurricanes. As a result, larger areas must be evacuated in advance of a storm.

Since Hurricane Andrew hit South Florida in 1992, Broward County has also established and enforced stricter standards for hurricane-resistant construction. Contractors, for example, must install high-quality shutters or super-strong glass in each new single-family home. When windows shatter, hurricane winds pour through the opening, dramatically increasing air pressure inside the house. This internal pressure, combined with external wind pressures, can break the house "envelope" at its weakest point, usually the roof.

Window-protection devices and stronger roofs make houses safer during hurricanes, so that more residents can stay home instead of relocating during hurricanes, engineers say.

"You need to think about ways to strengthen your house or move to another structure locally that is safe, so you don't have to become involved in the larger evacuation," says Sea Grant researcher Tim Reinhold, a civil-engineering professor at Clemson University.

Some new homes in coastal South Carolina will soon have greater protection from high winds. The city of Charleston and Charleston and Georgetown counties will require that all new houses be supplied with window-protection devices such as impact-resistant glass, shutters, or pre-cut plywood.

A new statewide building code, the International Residential Code, is to be adopted by all jurisdictions between April 1 and July 1, 2002. But the S.C. Building Code Council has placed a moratorium on the seismic and high wind/wind-borne debris sections until July 1, 2003, pending further study. The city of Charleston, however, has received an exemption from the moratorium, as have Charleston and Georgetown counties.

THE GREAT ESCAPE. *Heading toward I-26, cars were backed up on I-526 during the Hurricane Floyd evacuation. In four southeastern states, co some major highways, which should reduce traffic snarls next time.* PHOTO/WADE SPEES

South Carolina emergency personnel and law-enforcement agencies also now have better communications tools, with improved two-way radio equipment and coordination among agencies. "We'll be able to talk to who we need to, when we need to," says Stubblefield.

The state has expanded its traffic-monitoring capabilities with 34 closed-circuit television cameras on hurricane routes, aircraft, and automated speed detectors. Traffic information will be relayed to the state emergency operations center. From there, emergency managers can send messages via cell phone to solar-powered highway signs, which guide evacuees to less congested routes, according to Dick Jenkins, an engineer with the S.C. Dept. of Transportation. The state will roll out portable roadside radio transmitters that provide detailed traffic information.

The idea is "to keep people moving," says Stubblefield, "so they are able to get on and off the interstate at will, to find food and refuge, rather than being stacked up."

Next time, federal traffic experts will monitor any multi-state evacuation. A special team led by federal highway officials will gather at FEMA's Atlanta regional headquarters to coordinate information during a major storm that sends people scurrying across multiple state lines. In the past, "federal highway officials were not major players in hurricane evacuation planning, but that situation has improved dramatically," says Baker.

The team will employ a Web-based program called the Evacuation Traffic Information System (ETIS), which relies on built-in data from hurricane evacuation studies and real-time information from states and counties on tourism occupancy, traffic counts, evacuation participation rates, and other data. The program, displaying information on an interactive map, predicts traffic volumes across a multi-state region. Hurricane program managers at state emergency-operations centers will view the map at the same time. Thus, if there is a huge northward

ars were stalled for hundreds of miles on major highways. South Carolina emergency managers are prepared to implement lane-reversal procedures for

movement of people from Florida and Georgia next time, South Carolina will have early warning.

Southeastern states have conducted two major exercises to test the ETIS program. The system, says Lewis, seemed to work well, though "we've not had a major hurricane requiring a big evacuation during the past two years, so it hasn't been tested in real time."

When each hurricane season begins on June 1, the S.C. Emergency Management Division disseminates 500,000 evacuation maps, offering route guidance for each coastal region. In a voluntary evacuation, travelers can take any road they wish. But once the governor announces a mandatory evacuation, law enforcement will likely guide many travelers to predetermined routes. "We put a lot of effort into making sure that we can maintain traffic flow, as much as we possibly can, on the routes we've determined to be evacuation routes," says Stubblefield. "If people deviate from those routes—if they know short cuts or they think have a better way—they'll run into a (traffic) problem. Please use the routes that we've designated unless you're told otherwise through public information that we provide."

Not every state vulnerable to hurricanes learned lessons from Floyd. "There are states where evacuees are on their own," where people receive little guidance from government about the best routes to take, says Lewis. "Then there are other states that are really getting their acts together." South Carolina is one of the latter. Lewis says, "There is no state that has better preparation for hurricane evacuations."

For an evacuation to work smoothly, emergency managers must do their jobs efficiently, citizens must heed evacuation orders promptly, and the hurricane must stay offshore long enough to allow people to escape.

Government, however, can't evacuate the entire South Carolina coastline as quickly as many would like. An estimated 64 percent of South Carolina's coastal residents—591,000 to 673,000 people—left their homes during Floyd over two days, according

to a study by the University of South Carolina Hazards Research Lab. "When you're trying to move as many people as we're trying to move, there will be some delays," says William Winn, emergency manager for Beaufort County. "If people want to avoid those delays, they need to leave earlier. If everybody tries to get on the road at the same time, we're going to have problems."

Too many people squeezing onto too few roads—there's the rub. Each year, thousands of new residents migrate to the South Carolina coast, but our highway systems can't keep pace. Horry County's population swelled by 37 percent in the 1990s, Beaufort County by 40 percent, and the Charleston metropolitan area by 8 percent. And tourism in the coastal plain is flourishing. The Grand Strand alone routinely attracts 400,000 tourists on summer weekends and up to a half-million on Labor Day weekend.

"Coastal population growth is outstripping the transportation network's capacity to efficiently handle all the traffic," says Boettcher. "Traffic engineers are constantly looking for new routes, better ways to do things, better ways to gather evacuation information. But the road infrastructure just isn't there."

The number of vehicles on the road during evacuations has grown even faster than the coastal population. During Floyd, about 25 percent of households from the Charleston area evacuated in more than one vehicle. "One of the reasons that the roads were so clogged was because people were taking more than one car," says Susan L. Cutter, a geographer at the University of South Carolina who studies evacuation behavior. Many families also hauled boats or recreational vehicles, adding to congestion. "People were evacuating as a household unit, but they were traveling in separate cars and communicating by cell phone, doing it in a caravan."

LEAVE EARLY!

The best evacuation plan in the world, experts say, won't work if citizens fail to leave dangerous places early.

If you're thinking about escaping the coast during the next hurricane, remember one thing: leave before you're ordered to go. That is, leave early—at least 36 to 48 hours before a major storm's expected landfall—if you live in a flood-prone house or a mobile home in a coastal area. Leave early if you think your house can't bear up to hurricane-force winds. Leave early if you have special needs—an elderly relative, for example, who can't cope with hours stuck in traffic.

It's important to leave early because tropical cyclones are unpredictable. Hurricane forecasts have become more accurate over the past 30 years due to improved computer models and satellite information. But when the National Hurricane Center forecasters estimate that a hurricane would strike 24 hours before landfall, they still have an average error of nearly 70 miles. At 48 hours before landfall, they have an average error of almost 130 miles. At 72 hours, they have an error of 200 miles. A hurricane expected to strike a couple hundred miles from your house three days hence could turn and hit you instead.

Forecasting inaccuracies are inevitable, given tropical cyclones' erratic temperaments. Hurricanes can turn on a dime, loop crazily, and abruptly speed up or slow down. Tropical cyclones can intensify dramatically and suddenly, but scientists still have the greatest difficulty in forecasting storm intensity, says Stacy R. Stewart, a hurricane specialist with the National Hurricane Center. Andrew and Hugo each grew from a category 2 to a category 4 storm in less than 12 hours.

Twenty-four hours before landfall, a hurricane could be a dawdling category 2. Just before it comes ashore, however, it could speed up and intensify to a category 4, driving floodwaters much farther inland than anticipated. People who stay home expecting a relatively mild hurricane could face a massive storm—and then it'd be too late to leave.

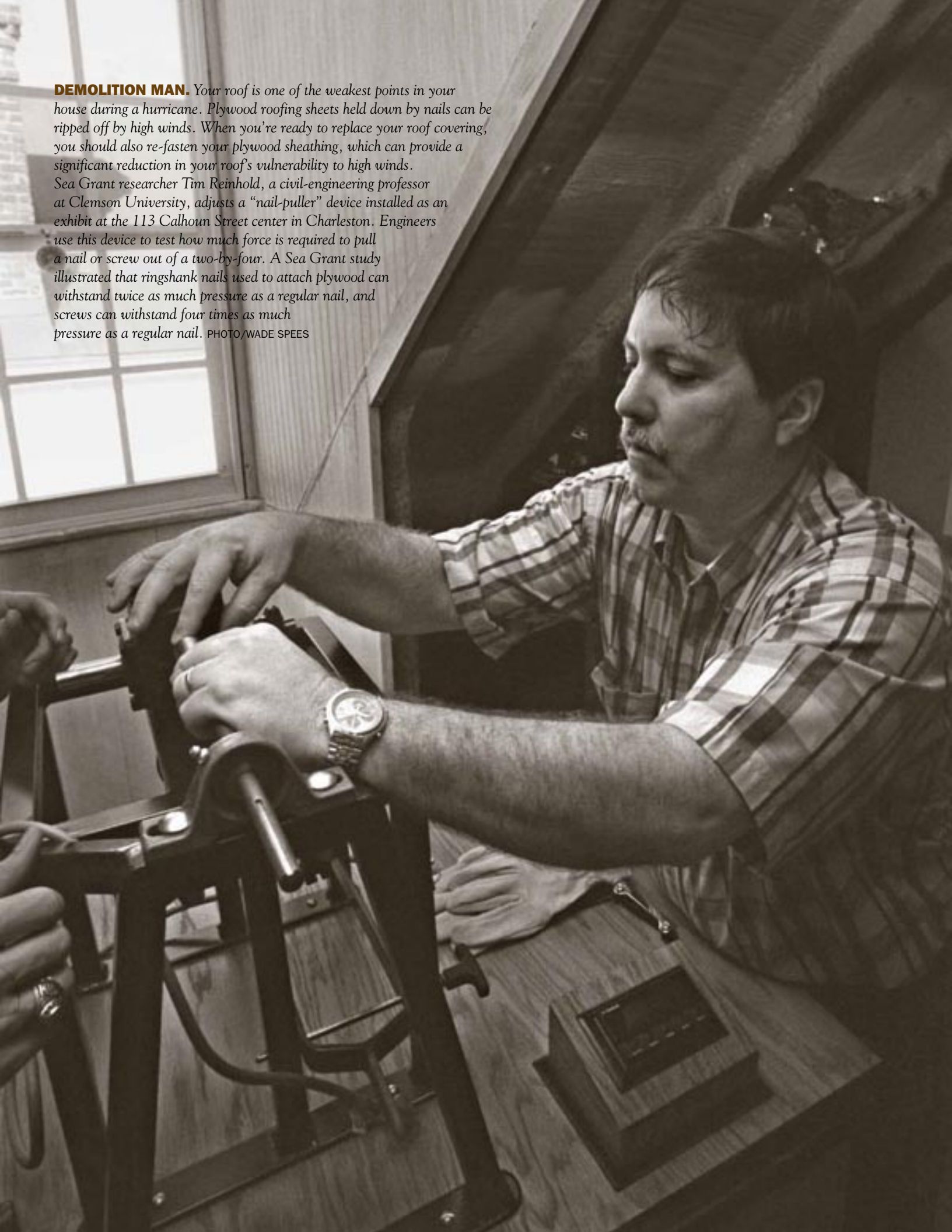
An evacuation order must be issued far in advance of a storm eye coming ashore. That way, residents have enough time to travel to a safe location before the arrival of gale-force winds (39 miles per hour). To ensure public safety, emergency planners want everyone off the road 15 to 24 hours before the storm's eye makes landfall, depending on the storm's forward speed.

Emergency planners must also factor in a community's *clearance time*—the time needed to move all residents and tourists who want to leave to higher ground or safe shelter. During a major hurricane threat, Horry County, for example, requires a clearance time of about 24 hours to evacuate its peak coastal population.

All told, a mandatory evacuation might have to start 48 hours before a major storm strikes a community. Yet vulnerable residents and tourists should leave the coastline during the voluntary evacuation, which precedes the governor's mandatory order.

Web sites

National Hurricane Center: www.nhc.noaa.gov
S.C. Emergency Management Division: www.state.sc.us/emd
S.C. Traffic Network: www.sctraffic.org
113 Calhoun St.: www.113Calhoun.org
Sea Grant HazNet: www.haznet.org
National Data Buoy Center: www.ndbc.noaa.gov
Hurricane tracking site: hurricane.terrapin.com



DEMOLITION MAN. *Your roof is one of the weakest points in your house during a hurricane. Plywood roofing sheets held down by nails can be ripped off by high winds. When you're ready to replace your roof covering, you should also re-fasten your plywood sheathing, which can provide a significant reduction in your roof's vulnerability to high winds. Sea Grant researcher Tim Reinhold, a civil-engineering professor at Clemson University, adjusts a "nail-puller" device installed as an exhibit at the 113 Calhoun Street center in Charleston. Engineers use this device to test how much force is required to pull a nail or screw out of a two-by-four. A Sea Grant study illustrated that ringshank nails used to attach plywood can withstand twice as much pressure as a regular nail, and screws can withstand four times as much pressure as a regular nail.* PHOTO/WADE SPEES

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Paul Whitten, Horry County, (843) 248-1225.

William Winn, Beaufort County, (843) 470-3100.

"If people who are in harm's way wait for a governor's mandatory order to evacuate, then they're missing the boat, it's too late," says Dennis Clark, emergency manager for Charleston County.

Waiting for a mandatory order heightens your risks of getting stuck on the highway network. When Floyd roared up the coastline, thousands of cars heading west and north from Jacksonville, Florida, were still stuck in traffic jams. Floyd, a category 4 hurricane at that time, could have made landfall in northeastern Florida, catching them on the road. At 100 miles per hour–the wind speed of a category 2 hurricane–wind pressures can begin lifting cars, says Baker.

That's the nightmare of every emergency manager in a hurricane-prone area: thousands of evacuees trapped in cars thrown around like toys by high winds.

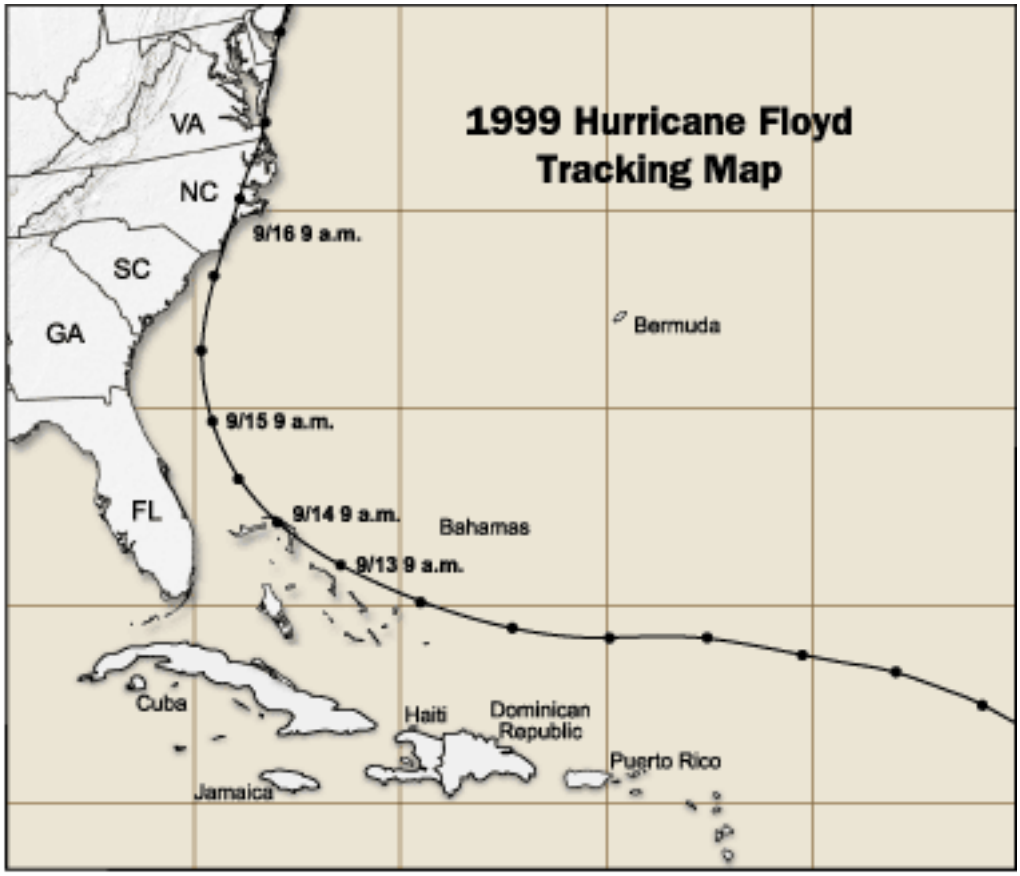
But leaving early isn't easy. One-third of Charleston-area residents polled by Florida State University researchers reported that someone in their household had to work during the Floyd evacuation, and many said it delayed their departure.

"A lot of employers, during both Hugo and Floyd, told their workers to come in to work that morning, during the voluntary evacuation," says Clark. "They said they would let workers go at mid-day. So you had a lot of folks who were hitting the road when they got off work," and they drove immediately into the worst of the congestion. "Plenty of those people would've already left home ten hours earlier if they'd had the chance."

WHO SHOULD GO?

The largest evacuation in American history was also the largest "over-evacuation," some experts say. Many who ran from Floyd probably did not need to. Meanwhile, many vulnerable people who should have evacuated did not leave.

About one-half of the 3.5 million evacuees in the four-state region were actually ordered to leave, Massey points out. Only a narrow strip of Florida's eastern coastline was evacuated under mandatory



COUNTDOWN. *Approaching the coast, Hurricane Floyd swerved away from South Carolina, striking near Cape Fear, North Carolina.*

ANIMAL HOUSE. *During Hurricane Floyd, Shakia Rivers of James Island held her dog Foxy Lady at the North Charleston Coliseum, a shelter for pets and their owners. For a list of pet-friendly motels in South Carolina, visit this Clemson University Web site: www.clemson.edu/ep/motels.htm*
PHOTO/WADE SPEES

orders, yet frightened inland dwellers from places like Orlando, a hundred miles from the sea, also fled north. Many upland dwellers in South Carolina left town, although the governor evacuated primarily low-lying areas under a mandatory order.

People who live in solidly built homes on high ground but who relocate anyway are called "shadow" evacuees, in the parlance of emergency managers. Shadow evacuees greatly exacerbated the massive multi-state traffic jam during Floyd, making it more difficult for the most vulnerable people to get out of harm's way.

Yet emergency officials "are not very aggressive about telling people (who live in upland areas in well-built homes) not to evacuate," says Baker. "Maybe they're afraid of being sued." Or maybe they're afraid to have deaths and injuries on their conscience. "What if you tell someone 'Don't leave' and then a tree falls through their house and kills them?" asks Massey.

The South Carolina coast, with its many creeks and rivers, complicates individual evacuation decisions. Under a worst-case scenario during a category 4 storm, some Charleston-area neighborhoods along the rivers 20 miles inland from the coast can face a dangerous storm surge, according to a Jan. 2001 study by the U.S. Army Corps of Engineers. As a storm surge is driven into a river basin, it can pile up higher and higher as the basin narrows. "A lot of people aren't aware of how far surge can go inland," says Stewart. To learn if you live in a flood-hazard area, contact your insurer or local planning and zoning department.

For now, the Palmetto State has enough roadways to evacuate all coastal residents and tourists, regardless of whether they live or play along the beachfront or in a well-built structure on high ground 30 miles from the shoreline. But can South Carolina's transportation network keep pace with an ever-growing coastal population? Can the regional transportation highway network cope with population increases along the coast from South Florida to North Carolina?

Floyd's track, after all, was not so unusual. Hurricanes Bertha and Fran also traveled north up the coast, threatening Florida, then Georgia, then South Carolina, before striking North Carolina. "The only difference is that Bertha and Fran were not very strong storms when they made the pass" up the coast, says Massey. "The Floyd track was a pretty common track if you look at history and climatology." We should expect and plan for another multi-state evacuation like the one for Floyd, he says.

But the effectiveness of the next major hurricane response will "depend on how quickly people follow the recommendations by state government to evacuate early and along designated routes," says Stubblefield. "If people wait until the last minute to get on the road network and we have a tremendous number doing that at one time, it'll be difficult."

EBBS & FLOWS

Beach Sweep/River Sweep 2002

Statewide, South Carolina
Sept. 21, 2002

Each year thousands of people become part of the "Solution to Pollution" during Beach Sweep/River Sweep, South Carolina's largest one-day cleanup of beaches and waterways. The event is part of the International Coastal Cleanup and anyone can participate—individuals, families, schools, civic clubs, or businesses.

To volunteer call Susan Ferris, coastal coordinator, at (843) 727-2078 or Bobbie Adams, inland coordinator, at (803) 734-9108. For more information, visit http://scseagrant.org/education/education_bsrs.htm.

6th International Conference on Shellfish Restoration

Charleston, South Carolina
Nov. 20-24, 2002

This conference will provide an opportunity for government officials, resource managers, and users to discuss approaches to restore coastal ecosystems through shellfish habitat management and enhancement, shellfish restoration through watershed management and community-based strategies to restore shellfish habitat. Those interested in participating and gaining information about submitting an abstract should visit http://www.scseagrant.org/icsr.htm.

Southeast Coastal Ocean Science Conference

Charleston, South Carolina
January 29-31, 2003

The conference will focus on current and planned research, outreach, education, observations, monitoring, assessments, and management in the South Atlantic Bight. Scientists, resource managers, and others working in coastal and coastal ocean environments in the southeastern United States, from watersheds out to the shelf-edge environment, are invited to attend. For additional information, contact Rick DeVoe at Rick.DeVoe@scseagrant.org or (843) 727-2078.

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