



# UNIVERSITY OF NORTH CAROLINA SEA GRANT COLLEGE NEWSLETTER

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## *It's hurricane season again*



In August of 1954 Hurricane Hazel swept in at North Carolina's southern border and barrelled northwest through the state. She brought wind speed of 130 miles per hour and tides that had devastating effects in Brunswick, New Hanover, Pender and Carteret Counties. She left a wide path of destruction behind her.

The following year Hurricanes Connie, Diane and Ione hit North Carolina within a period of six weeks. In 1960 Hurricane Donna hit land at the Cape Fear River and moved straight up the coast before it exited at the Virginia border.

By many accounts, Donna was the last severe hurricane to hit the North Carolina coast. The rest have been just "close calls." But, according to the National Weather Service, that pattern of good luck may be changing. From about 1940 to the early 1960s, most Atlantic hurricanes turned east of Florida and affected the Atlantic coast. Since then, however, hurricanes have tended to make a northward curve in the Gulf of Mexico and strike the Gulf states. The weather service contends that the pattern is shifting again, bringing more hurricanes to the North Carolina coast.

(See "Hurricane," p. 2)

# Hurricane: "It hits like a batteri

(Continued from p. 1)

Hurricane Donna was 17 years ago, long enough for many people on the coast to forget how dangerous a powerful storm can be. But the planners in the Division of Civil Preparedness (Department of Crime Control and Safety) in Raleigh haven't forgotten. As this year's hurricane season got underway in June, they were busy putting the finishing touches on detailed plans for emergency hurricane evacuation of all North Carolina's coastal counties. The plans are being drawn up by local governments based on a prototype developed by the division. Called Carolina County, it is being used by coastal counties from Maine to Texas.

Basically, the model plan calls for moving people off the beach strands to higher elevations and into the best available shelters. The division bases its calculations on a maximum storm surge of 18 feet anywhere off the state's coast. That means that residents should be evacuated to an elevation of at least 25 feet. Public shelters must be sturdy and have some means of food preparation, sanitary facilities, food stocks and stand-by power. Though local governments are responsible for them, they are often operated by the American Red Cross.

The beach areas of the coast pose some knotty problems for the evacuation planners. On the fragile strip of islands that make up the Outer Banks, the main problem is limited access. One two-lane road runs from Duck to Hatteras. Two bridges connect Bodie and Hatteras Islands to Roanoke Island and the mainland in Dare County. At some spots, the road washes out easily. The only other access to the mainland is by ferry. Summer-time tourist crowds compound the difficulties.

"On the Outer Banks, you've got a lot of people and limited access roads. If they get caught out there, there's going to be trouble," said Bill Harris, a civil preparedness planner.

The National Park Service has also stated that severe storms might easily open up inlets at three locations on the Outer Banks—on Ocracoke Island, just north of Buxton and just north of Rodanthe.

The Bogue Banks and Brunswick County areas pose the additional problems of being heavily populated during the summer season. A two-lane bridge at each end of Bogue Banks connects it to the mainland of Carteret County.

"On a Saturday night in season, if one exit should be cut off, it would take in excess of ten hours to evacuate all vehicles from the island," said Dan Spurling, operations officer with civil preparedness.

Spurling pointed out that during the warning for Hurricane Belle last year, many people evacuated. Both exits were free and still the traffic was bumper to bumper, he said.

In Brunswick County access roads connect the beach areas to the mainland and there is high

ground three to four miles off the beach. The problem, noted Harris, is to get people away from the beach strand before the tide rises. Many of the access roads have float and draw bridges that can easily wash over when the tide rises. Officials estimate it would take about four hours to clear the beach strand in Brunswick County.

If there is enough time, civil preparedness personnel prefer that residents and tourists evacuate in their own vehicles. The next option is the use of high clearance vehicles, such as trucks, to move people out.

One of the problems evacuating crews face is that residents and vacationers are often reluctant to leave beach areas. "Their experience says, 'We've lived through everything so far. We'll live through the rest.' But the potential for a storm to completely wipe off that bank (Outer Banks) is there," said Spurling.

Spurling believes that there are generally three groups of people who want to be in a coastal area during a hurricane: residents reluctant to leave their homes, surfers and thrill seekers. The surf is up during a storm and some adventurous surfers always want to take to the ocean, he noted.

The thrill seekers, said Harris, are people who don't understand the power of a hurricane. When Hurricane Camille hit Louisiana in August of 1969, 22 people from one household died. They refused to evacuate and stayed at the coast for a "hurricane party." The sole survivor was a child who floated out on a mattress, Harris said.

A hurricane is a tropical storm with winds that reach a minimum of 74 miles per hour. In storms



Extensive damage to Wilmington hotel after Hurricane

# "ng ram"

in the Northern Hemisphere, the winds blow in a counterclockwise direction around the calm center of the storm, called the eye. The most ferocious winds are about 20 miles to the right of the eye. There is an average of six hurricanes per year on the Atlantic coast. They are born in the tropical and subtropical North Atlantic Ocean, the Caribbean Sea and the Gulf of Mexico. The storms begin to die once they hit land.

Though the winds can reach ferocious speeds, the water surge is always more dangerous. The hurricane brings with it huge waves, which raise tides 15 feet or more above normal. If the rise comes quickly, it can produce flash floods in nearby estuarine areas. It may bring giant waves, erroneously called "tidal waves."

"That storm surge is a big solid mass of water. It hits like a battering ram. Nothing could stop it," said Harris. Debris which is transported by either air or wind or water is an added hazard.

The Division of Civil Preparedness is responsible for providing emergency services and damage assessment for areas that have been hit by hurricanes. This year UNC Sea Grant is sponsoring an experiment that might make their work more efficient. Simon Baker of Sea Grant advisory services will be helping to test the effectiveness of oblique-angle aerial photography for immediate damage assessment. Baker is currently working with the Raleigh squadron of the Civil Air Patrol to take an initial series of photographs which will be used for comparison with post-hurricane photographs. A squadron plane with photographers will fly over affected areas as soon as possible after a storm.



Hazel hit in 1954

## Here's what to do

The hurricane season has already begun in North Carolina. The National Oceanic and Atmospheric Administration (NOAA) urges you to prepare for a possible hurricane now. Be sure you have an adequate supply of boards, tools, batteries, non-perishable foods and other items you would need.

Remember that a hurricane watch means that a hurricane may threaten your area within 24 hours. A hurricane warning means that a hurricane is expected to strike within 24 hours.

Here are some additional tips from NOAA:

When you hear the first storm advisory, listen for further messages. If there is a hurricane warning, continue your normal activities, but stay tuned to your radio or television.

If you hear a hurricane warning:

*Stay calm.*

*Leave low-lying areas.*

*Leave mobile homes for more substantial shelter.*

*Moor your boat securely before the storm arrives or move it to a safe area. If your boat is moored, don't return to it once the wind and waves are up.*

*Board up windows or protect them with storm shutters or tape.*

*Secure outdoor objects.*

*Store drinking water in clean bathtubs, jugs, bottles and cooking utensils. Your water supply may become contaminated.*

*Check your battery-powered equipment. If utility service is interrupted, you will need a radio, emergency cooking facilities, lights and flashlights.*

*Keep your car fueled.*

*Stay at your home if it is sturdy and on high ground. Otherwise, move to a designated shelter.*

*Evacuate if you are told to do so.*

*Don't go outside until you are advised that the storm is over.*

# *Studying the stability of beaches*

Building a home close to the beach can be a risky business. Deeds to coastal property don't come with guarantees of safety from Atlantic Ocean storm surges. But two Sea Grant-supported scientists are now doing research that might take some of the guess work out of selecting a relatively stable building site.

Paul Hosier and Bill Cleary of UNC-Wilmington are studying the history of overwash from storms on the coast. Using aerial photography and on-site surveys, they are looking at the patterns of overwash between Cape Lookout and Cape Fear from 1938 to the present. So far their study indicates that some areas are much more stable than others. They hope to produce maps and guidelines that prospective homeowners can use to determine the relative stability of beach property.

Overwash occurs when high waters breach the sand dunes and invade coastal land. The wall of water may destroy man-made construction. It also leaves its mark on the natural environment of the beach. It frequently uproots vegetation and flat-

tens sand dunes, carrying sand to the inland side of a barrier island or dragging it out to sea again. The displaced sand is usually deposited in a fan shape behind the original dune line. A severe storm or a series of storms may result in deposits that form terraces.

In almost all cases, natural forces will rebuild the dunes and revegetate the area. In the meantime, though, the overwashed beach is more vulnerable than ever to storm damage. Hosier contends that revegetation of an overwashed beach occurs in predictable stages. Identifying the condition of the dunes and the type of vegetation growing in an area can give one a good idea of when the last overwash occurred there.

According to Hosier, hurricanes are responsible for the greatest amount of overwash on the North Carolina coast. Other storms, such as the winter northeasters that plague the coast, may cause overwash and are frequently responsible for more erosion than hurricanes.

(See "Storms," p. 6)

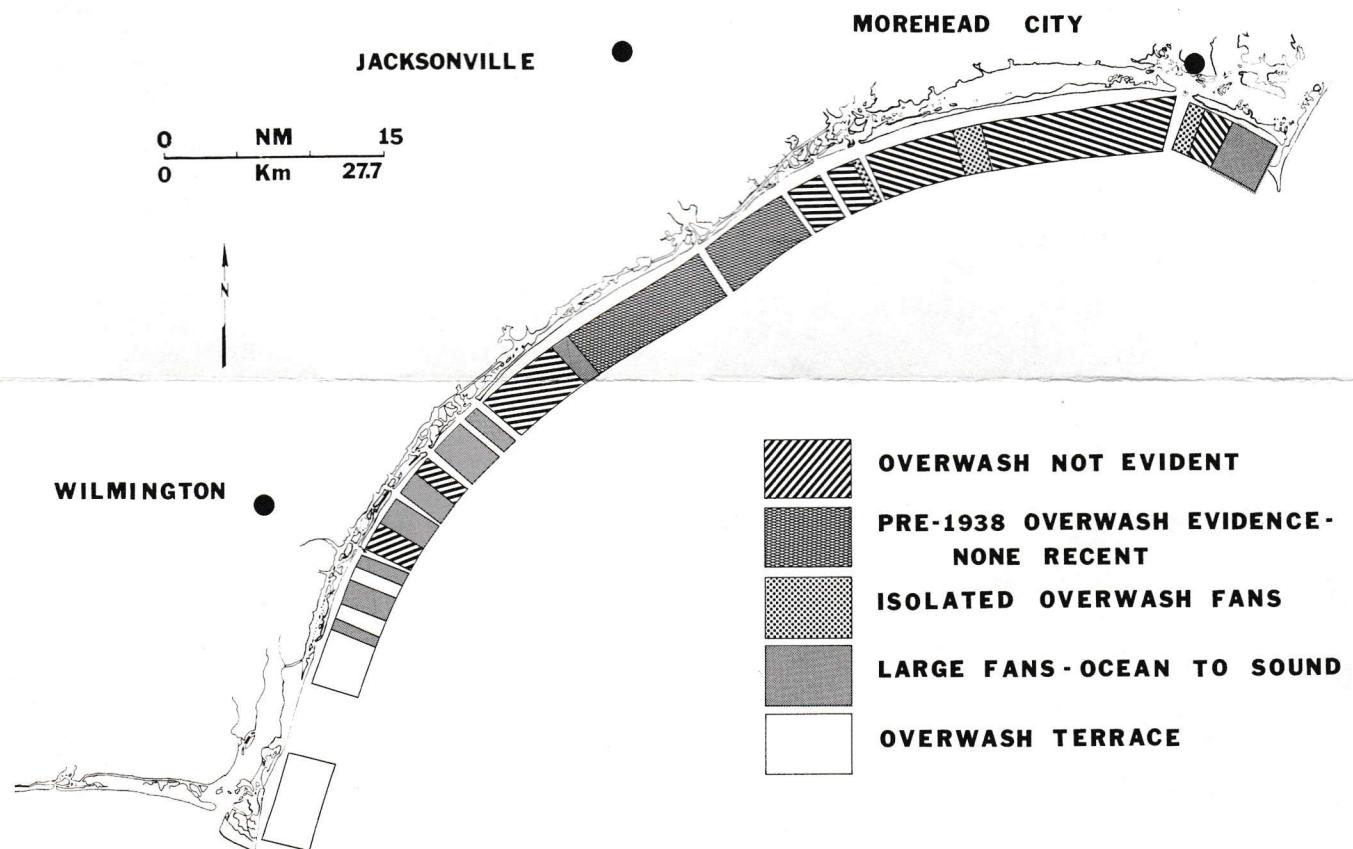


Chart illustrates overwash intensity between Cape Lookout and Cape Fear.

# Our shifting tidal inlets

North Carolina's tidal inlets are fickle products of an ever-changing coastline. They open, close, widen, narrow and migrate—sometimes with no warning at all. The impetus for change is often a hurricane or similar storm.

Coastal North Carolina now has 22 open inlets. But there have been many others in the past. Three inlets, Cape Hatteras, Oregon and Ocracoke Inlets, are now open on the Cape Hatteras National Seashore. According to the National Park Service, eight other inlets have opened and closed along the seashore (some of them several times) since the earliest records in 1585. Tubbs Inlet in Brunswick County migrated a total of 3400 feet between 1938 and 1969. In fact, of the inlets now open, only Cape Fear and Barden Inlets and the west side of Beaufort Inlet appear to be relatively stable.

In spite of their fluid natures, tidal inlets play crucial roles in the coastal environment. They connect rivers and estuaries with the ocean and so con-

trol the circulation of water and sediment in the whole estuarine system. They affect pollution control, navigation, recreation, flood discharge and fish migration.

Inlet changes sometimes affect man very dramatically. If a storm opens a new inlet, it may flood private property and destroy communities. But in recent years man has had a growing effect on inlets. Two of North Carolina's inlets—Drum Inlet and Carolina Beach Inlet—are man-made.

As is often the case when man tinkers with natural forces, unexpected things happen. The case of Drum Inlet is an example of the kinds of difficulties that can ensue. In 1971 the U.S. Army Corps of Engineers blasted open Drum Inlet in Core Banks, just off the coast of Carteret County. The inlet was opened to increase the salinity of Core Sound and to give fishermen a passageway to the ocean. Old Drum Inlet, which was located two miles north, had previously filled with sand.

The new inlet was expected to widen to about 1500 to 2000 feet. Erosion continued at an unexpected rate, though, until the inlet was 3350 feet wide. Residents of the area complained that the widened inlet exposed them to increased danger from storm waves. In 1974 the Corps of Engineers stopped maintenance dredging and the inlet opening has narrowed to about 2000 feet. The corps is now considering several alternatives designed to break the force of storm waves and to decrease erosion south of the inlet. One plan calls for building man-made islands at the mouth of the inlet.

This year UNC Sea Grant is sponsoring research which is aimed at predicting the effects of man-made changes on flow dynamics and sediment movement in tidal inlets. Jerry Machemehl of NCSU has already developed a finite element flow model for a typical barrier island inlet. The model can be used by coastal engineers to assess the effects of inlet alterations on the shoreline and estuaries.

Machemehl is also studying the flow dynamics of Carolina Beach Inlet, located 18 miles north of the Cape Fear River in New Hanover County. The Corps of Engineers is now considering altering the inlet to improve navigation and to halt excessive erosion on the beach south of the inlet. One alternative is to construct jetties with an excavated channel or to excavate an entrance channel and use frequent maintenance dredging. Machemehl will be using the model he has developed to predict the effects of proposed navigation improvements at the inlet.

UNC Sea Grant has recently published a booklet which tells the stories of North Carolina's existing inlets through photographs. *The Citizen's Guide to North Carolina's Shifting Inlets*, was written by Simon Baker of Sea Grant advisory services.



Aerial photograph shows migration of inlet.

# **Storms affect formation of dunes**

(Continued from p. 4)

So far Hosier and Cleary have seen some definite patterns emerge. The most chronic overwash appears to have occurred between Ocracoke and Cape Lookout, and the area from Figure Eight Island to Carolina Beach runs a close second. Hosier notes that the land just north of all the capes seems to be particularly vulnerable to overwash. He believes that Bogue Banks, Bear Island and Browns Island have never been overwashed.

Areas of chronic overwash have a number of characteristics in common, said Hosier. These beaches generally have scattered individual stands of salt meadow cord grass and individual clumps of sea oats. They also may support ten to 15 species of annual or perennial plants, such as goldenrod or dune spurge. There is little or no dune formation.

If a barrier island has been overwashed about every ten years, there will be a weakly developed dune ridge, Hosier said. A single strand of shrub thicket and a salt marsh will be behind the dunes.

Areas that are seldom or never overwashed have the classic barrier island features. Dunes form in ridges or fields and slope gently to the beach. There is a strand line, indicating that the beach is not eroding. And there are shrub thickets and a salt marsh behind the dunes.

Hosier and Cleary are also finding that the type of sand available in an area has a significant effect on the stability of dunes. Because it can be easily blown by the wind, fine-grained sand forms into dunes more quickly than coarse-grained sand.

Coarse sand tends to form smaller, broken lines of dunes, called haystack dunes. Fine sand forms ridges or fields of dunes which act as a better barrier.

Two of the islands near Wilmington which were overwashed during the Ash Wednesday storm of 1972 clearly illustrate that point. On Masonboro Island there is coarse sand and poor dune formation, but on nearby Coke Island fine-grained sand has formed stable dunes.

Preliminary studies indicate that the difference in sand may be responsible for the fact that beaches along the southern portion of the coast are smaller and less stable than those in the north. Cleary conjectures that Hurricane Hazel of 1954 may have caused a deficit of fine sand on southern beaches. He believes that the storm may have taken much of this dune building sand five to ten miles out in the ocean.

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