NORTH CAROLINA COASTAL FEDERATION

2004

STATE OF THE COAST REPORT

GLOBAL WARMING:

The Impending Storm

Cover Photo :
MICHAEL HALMINSKI

NORTH CAROLINA COASTAL FEDERATION

COAST STATE OF THE REPORT

North Carolina Coastal Federation

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The North Carolina Coastal Federation is the state's largest non-profit organization working to protect and restore the coast.

MISSION: To provide citizens and groups with the assistance needed to take an active role in the wise stewardship of North Carolina's coastal water quality and natural resources.

The NCCF headquarters is located in Ocean, NC between Morehead City and Swansboro. Visitors are welcome and the offices, Nature Library, Weber Seashell Exhibit and Gift Shop are open Monday through Friday, 8:30 am to 5 pm. The Patsy Pond Nature Trail is located nearby.

LAYOUT/DESIGN: Anita Lancaster, Jacksonville, NC

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NCCF's 10th Annual State of the Coast Report

The intent of the ***State of the Coast Report*** is to provide citizens who care about our coast with a tool to better understand issues, challenges, and solutions that are key to our coast's health. We hope this publication will move you to participate in the restoration and protection of our coast. To learn more, call the NC Coastal Federation at 252-393-8185. The opinions expressed in the ***State of the Coast Report*** represent the views of the NC Coastal Federation.

Acknowledgements

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We are also grateful to the following people who contributed time and effort: Gary Braasch, Braasch Photography; Richard T. Barber, Nicholas School for the Environment and Earth Sciences, Duke University; Mark Brinson, East Carolina University; Courtney Hackney, the University of North Carolina at Wilmington; Stephen Hall, NC Natural Heritage Program; Michael Halminski; Steve McNulty, US Forest Service; Marjorie Mullhall, Southern Alliance for Clean Energy; Amber Lynn Munger, NC Environmental Defense; Pete Parker, National Marine Fisheries Service; Fawn Pattison, Agricultural Resource Center; Mary M. Peet, NC State University; Ben Poulter, Nicholas School for the Environment and Earth Sciences, Duke University; Doug Rader, NC Environmental Defense; Sethu Raman, NC state climatologist; Stanley R. Riggs, East Carolina University; William Schlesinger, Nicholas School for the Environment and Earth Sciences, Duke University; Katherine Shea, Physicians for Social Responsibility; Michael Shore, NC Environmental Defense; Stephen A. Smith, Southern Alliance for Clean Energy; Guy Stefanski, NC Department of Environment and Natural Resources; and Wes Wallace, University of North Carolina at Chapel Hill.

The Day After Mañana

BY TODD MILLER
Executive Director, North Carolina Coastal Federation

For most of us consumed with the daily demands of work and kids – and perhaps even saving or restoring a wetland here or there – doing something about global-climate change is a lot like saving for retirement. We know it's important to do, but it's always something that can wait 'til tomorrow. Or as the Spanish might say, "mañana!"

Procrastination Takes A Back Seat To Action

The day is fast approaching when people everywhere will frown upon delaying action when it comes to slowing down global warming. Scientific evidence and public concerns about the consequences of greenhouse gasses are mounting. Folks are getting really worried about the effects of sea-level rise, changes in precipitation patterns, ecological shifts of fisheries and vegetation, and increased temperatures, winds, and forest fires. An increasing number of countries and even some leading multinational corporations are already working together to aggressively tackle climate-change issues.

Along the NC coast, a shifting climate is reshaping our coast – and not always for the better. Sea level has risen nearly a foot in the past 100 years and is forecast to rise as much as 10 or more inches in the next 25 years. Extreme weather events such as hurricanes and northeasters are likely to cause more loss of life and property damage. Already, taxpayers shell out billions of dollars to shore up coastal communities from rising seas, winds, and other related concerns linked to global-climate changes.

In August, Hurricane Alex brushed the Outer Banks and gave yet another warning about the implications of global warming. Dangers posed by more frequent extreme weather are easily magnified because such events are extremely hard to accurately forecast. Weathermen, government emergency management agencies, homeowners, and tourists didn't anticipate the rapid development of the storm. Few took precautions that could have prevented millions in dollars of property from occurring. Sneaky Alex turned out to be a weak hurricane. It could have caused terrible loss of life and property if it had intensified even more quickly. Alex's rapid and unpredictable development probably won't be an isolated event in future years if climate experts are right.

Then there are the significant ecological shifts taking place right off our beaches. In the past 30 years, 29 tropical species of fish have migrated onto the ocean reefs off our coast – while no northern species of fish have moved south – a clear signal that a tropical shift in our ecology is occurring. Whether this shift in fish species is a fisheries problem can be debated, but it certainly provides more compelling evidence that our globe is quickly getting warmer.

I'm Concerned, But What Can I Do?

For most of us, climate change is one of those big, long-term issues that someone else needs to worry about. That's because there are so few practical options at the local level to significantly reduce pollutants that cause global warming. To make a major difference on a global scale, our nation's political and business leaders have to get serious about tackling climate issues through our economic, environmental, land use, and transportation policies and programs.

On the other hand, whether you realize it or not you are already dealing with the consequences of a warming climate if you live or visit the coast. This coping means changing the way you do things – either for better or worse.

It's very easy just to become a pawn to the tenacious and persistent natural forces that are being made even more extreme by climate changes. Powerful natural forces like sea-level rise, storms, and ecological shifts in vegetation and fisheries are capable of tearing away at the foundation of "built" and "natural" coastal communities.

The natural impulse is to fight back and try to maintain the status quo. To a large degree, that's the policy of our national, state, and local governments, and private landowners. We're all spending billions of dollars trying to rebuild eroding beaches, walling up our estuaries with bulkheads, building levies around low-lying farmland and communities, reconstructing storm-shattered towns, throwing away flooded automobiles, and even attempting to reverse ecological shifts.

A better, more cost-effective option is to promote ways of using coastal lands and waters that are more resilient to the damaging effects of global warming. This is sound environmental policy even if climate change wasn't occurring. But sound policy won't occur unless citizens get involved and make it occur.

For example, coastal wetlands will only remain healthy if they can migrate landward as sea level rises. Over time, wetlands will be eroded away and lost if we build rigid bulkheads landward next to them. Keep in mind that about 30 miles of estuarine shorelines are "stabilized" each year, so the potential for massive cumulative losses of our highly productive salt marshes is staggering. The loss of this fringing marsh could have a cascading impact on the number of fish in the sea, and the ability of fishermen to have productive catches. Declining fish stocks aren't only an ecological disaster, but would

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About the Cover:

Michael Halminski, a professional photographer on Hatteras Island in Dare County, captured the foreboding anticipation of an approaching hurricane. He shot the photo from the beaches of Pea Island National Wildlife Refuge on Aug. 17, 1991, the day before Hurricane Bob skirted the Outer Banks. Check out his website at www.outer-banks.com/halminski/slides.cfm.

Signs of Global Warming:
Rising Oceans, Worried Business Magazines

The magazine cover screamed in yellow type two inches high: GLOBAL WARMING. A headline over the story inside offered a scary warning, "Consensus is growing among scientists, governments and business that they must act fast to combat climate change."

Those headlines and the accompanying eight-page story appeared this summer in *Business Week*. That's right. Not *E* magazine, not *Nature*, not *National Geographic* or some other publication sympathetic to tree-huggers and their message, but in a staid, reliable voice of Wall Street.

When magazines like *Business Week* start running sobering cover stories about global warming, it's past time to take notice. No longer the subject of an esoteric scientific debate, "climate change" as it is now more politely and less alarmingly called has become as real as a bear market or the latest corporate merger.

It is the greatest environmental challenge we will face as a species. Certainly, it will change our coast – its shape, weather, landscapes, plants and animals – and the way we live on it. And it will do it in the span of a human lifetime, the proverbial blink of an eye in the Earth's history. We could think of no better subject for our 10th annual *State of the Coast Report*.

Scientists now know a great deal more about global warming and its potential consequences than they did 20 years ago when mentioning the subject got you puzzled looks. They have a better understanding of the workings of our climate, and the computer models they use to mimic its complexities are now quite sophisticated. Though many uncertainties still remain, the scientists and their computers can offer us a range of reasonable possibilities about the future of our coast.

You will read about many of them in the following pages. It will be warmer in the future – maybe as warm as it now is in central Florida. Higher temperatures will trigger a range of cascading consequences from higher incidences of childhood asthma and insect-borne diseases to a rising ocean that will reshape the NC coast and heighten damage from hurricanes and other types of coastal storms. One thing our descendants won't have to worry about in 100 years is the kind of storm damage that was done in August to Ocracoke by Hurricane Alex and to the west coast of Florida by Charley. The island and the rest of the Outer Banks, for that matter, and the tip of Florida will likely be gone, swallowed by the rising seas. That's what we're talking about here.

The easy way to deal with those kinds of gloomy prospects is to do nothing and hope for the best. After all, how do you easily save an island? Granted many of the future consequences of global warming are at this point unavoidable, but there are still steps our state leaders can take to better prepare us for the future and lessen some of the effects. There are also many things each of us can do. You'll find those recommendations on pages 15 and 16.

"We have a relatively short period of opportunity – 15 to 20 years – to turn the trends downward," noted William Schlesinger, the dean of the Nicholas School of the Environment and Earth Sciences at Duke University. "Anything we do now can only help."

What the Science Tells Us

Here's what we know: Carbon dioxide and other gases in the upper atmosphere act like the roof of a greenhouse. Energy from the sun passes through, but some of the heat radiated off the Earth's surface is trapped, warming the planet. This so-called "greenhouse effect" is natural and accounts for our relatively balmy climate compared to other planets in our solar system. With no greenhouse gases, we would freeze. The Earth's average temperature would be about 2 degrees, not the pleasant 58 degrees it is today.

CO_2 and other greenhouse gases are produced by natural sources such as volcanoes and from burning wood, coal, gasoline or other fossil fuels. Since the dawn of the Industrial Age at the end of the 19th century, these long-lived gases have been accumulating in the atmosphere. Scientists who study ice cores, tree rings, coral, and other windows into Earth's past climate say that the concentration of these gases are the highest in more than 400,000 years. Every national or international group of scientists who has studied the reasons for the rise attribute much of the gain to us and our long love affair with the internal combustion engine.

We are, in essence, conducting an experiment high over our heads, and the results are becoming more apparent each year. Global temperatures are up about 1 degree in the past 100 years. While the trend towards warmer temperatures has been uneven, the warming since 1976 is roughly three times that for the whole period. In fact, the 10 hottest years in the 143-year-old global temperature record have now all been since 1990, a year that began the hottest decade of the last millennium. Three of the last five years – 1998, 2002 and 2001 – have been the hottest years on record. Yes, the earth's temperature has always fluctuated, but ordinarily these shifts occur over the course of centuries or millennia, not decades.

What the Future Might Bring

In trying to reasonably determine what might happen along the coast if greenhouse gas emissions continue unabated, we talked to experts and looked at recent analysis done by the US Global Change Research Program and the Intergovernmental Panel on Climate Change. The first is a landmark, ongoing effort by the federal government to project changes on a regional scale. The latter is a collaborative program between the United Nations and the World Meteorological Organization that has been assessing global warming since 1988.

These studies tell us that the recent temperature trends will continue and the average daily temperature in the Southeast will rise by as much as 10 degrees by 2100. The experts we consulted think a 4-degree rise is reasonable for North Carolina. Not since the end of the last Ice Age 10,000 years ago will temperatures have risen as quickly. Much of that warming, the experts explain, will occur in the winter and at night.

Precipitation is still a great unknown. One computer model predicts that rainfall along the Southeast coast will increase 10-15 percent, while another forecasts prolonged droughts. Sethu Raman isn't surprised. The state's complex topography and proximity to the Gulf Stream make a 10-day forecast a tough call, noted Raman, the state's climatologist. Even the most powerful computers using the most sophisticated software have a hard time looking 100 years into the future. "What you're seeing in the uncertainty with the precipitation forecasts is the models inability to account for regional variables," he said.

Weather records shed a little more light on what's ahead. Annual rainfall totals in North Carolina haven't changed much in 100 years,

noted Peter Robinson, a professor of geography at the University of North Carolina at Chapel Hill and a former state climatologist. The records, however, show dramatic shifts in the rainy season. Forty percent less rain now falls in the summer, Robinson said, with more rain coming in the fall. Such seasonal shifts, he noted, would have a dramatic effect on farmers and backyard gardeners.

Another certain consequence is sea-level rise. As the air warms, so will the ocean, though more slowly. Add water from melting glaciers, and sea level could rise as much as10 inches by 2030 and two feet by 2100 – about twice the current rate. Although a foot or two of sea level rise may not sound like much, the effect could be severe. For example, models show that a 13.7-inch sea level rise would inundate about 770 square miles of the NC coast, an area nearly the size of Great Smoky Mountains National Park. North Carolina's coastal wetlands and other low-lying areas could be inundated, much of the Outer Banks would disappear, and the Albemarle and Pamlico sounds could merge with open waters that Stan Riggs, a geologist at East Carolina University, calls "Pamlico Bay."

Beach towns up and down our coast are responding to the rise tide. They call it beach re-nourishment.

Welcome to the Greenhouse World

The rush to pump sand on rapidly eroding beaches isn't the only sign that the world is changing. Gary Braasch, a renowned nature photographer, has traveled the world recording the changes. Glaciers are melting rapidly on every continent he has visited. "Some of the melting glaciers I photographed in 2000 on the Antarctic Peninsula have reportedly changed so much since then that the ice features in the photos are just gone," he said.

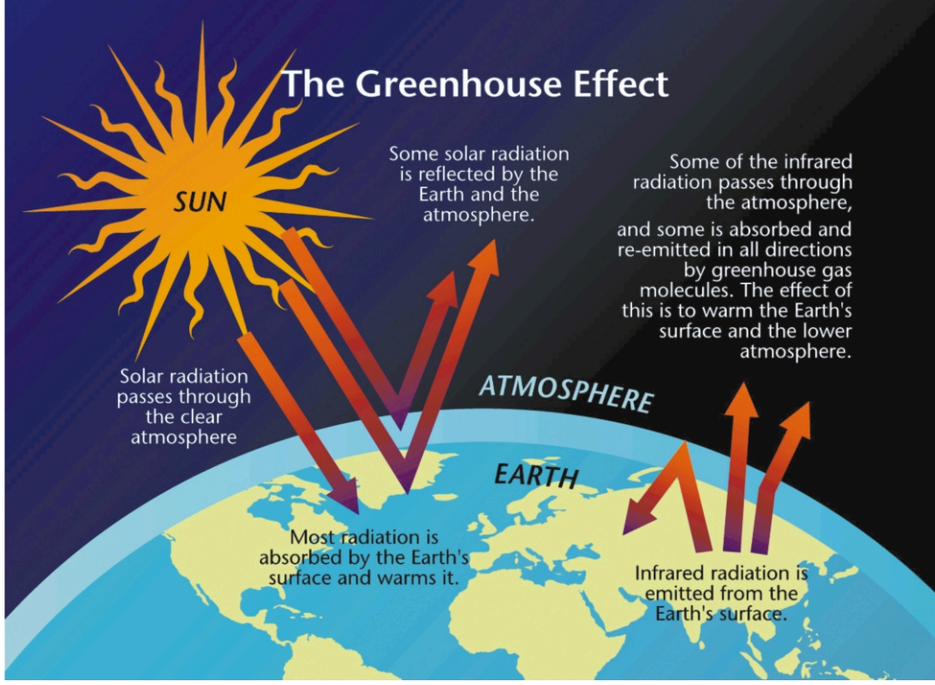
Arctic ice extent has been declining by 7 percent a decade for the last 20 years and Arctic sea ice has been thinning up to 15 percent a decade. Native hunters in Alaska are falling more frequently through the thinning ice, and habitats for plants and animals are also disrupted. The icy Hudson Bay in Canada could be uninhabitable for polar bears within just 20 years.

On Mount Everest, the glacier that ended at the historic base camp of Edmund Hillary and Tenzing Norgay, the first humans to reach the summit, has retreated three miles since their 1953 ascent. Glaciers in Bhutan are retreating at an average rate of 10 feet a year.

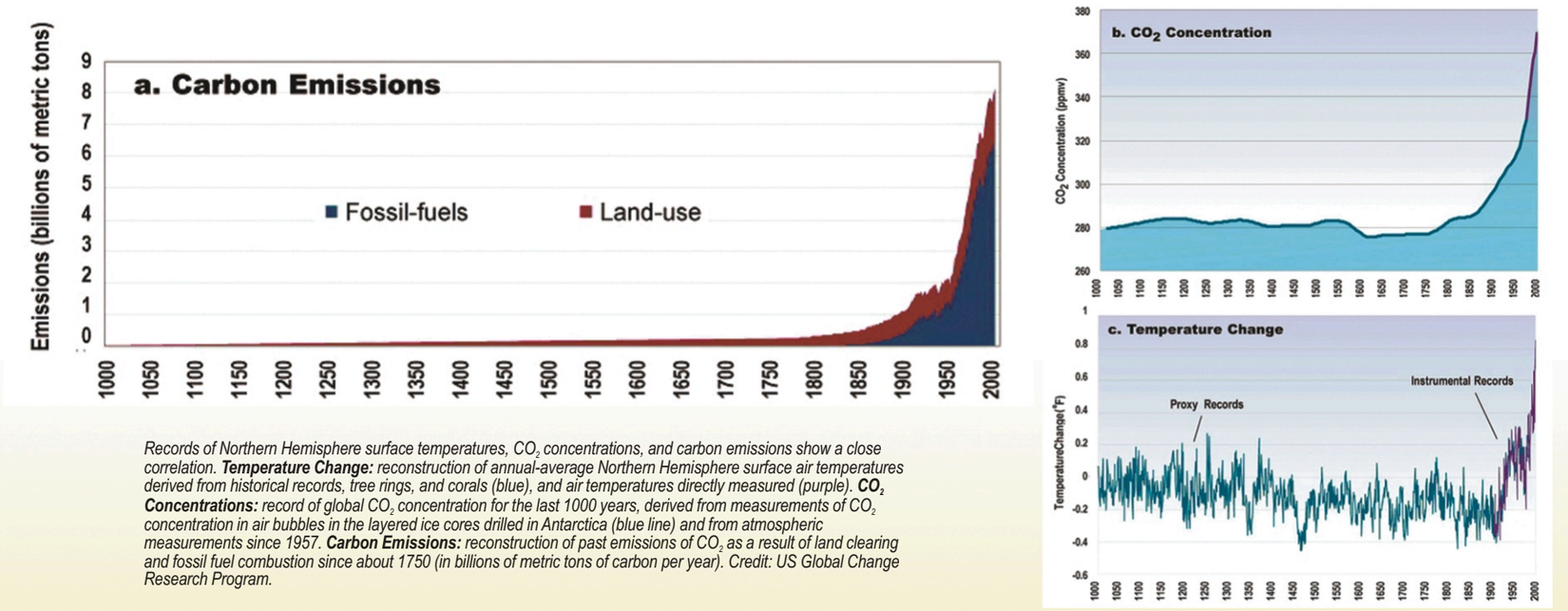
The start of the frost-free season in the Northeast now occurs 11 days earlier than the 1950s. Warmer winters have reduced apple harvests in New York and will eventually drive maple syrup production from New England.

"I have documented the science of many researchers who are reporting changes that correlate to rising temperature," Braasch said. "These include insects moving north into new habitat, ocean changes in temperature and ecosystem makeup from plankton to fish, and an increase in less-salty water in the North Atlantic that is beginning to affect the speed of certain currents."

We or our children will not get out of bed one day 50 years from now and the world will suddenly be different. "These changes occur slowly so if you watch it nothing seems to be happening," Schlesinger said, "but it allows for complacency in the voting public. It's one reason why it's so difficult to deal with this issue."



1000 Years of Global CO_2 and Temperature Change



Records of Northern Hemisphere surface temperatures, CO_2 concentrations, and carbon emissions show a close correlation. ***Temperature Change:*** *reconstruction of annual-average Northern Hemisphere surface air temperatures derived from historical records, tree rings, and corals (blue), and air temperatures directly measured (purple).* ***CO_2 Concentrations:*** *record of global CO_2 concentration for the last 1000 years, derived from measurements of CO_2 concentration in air bubbles in the layered ice cores drilled in Antarctica (blue line) and from atmospheric measurements since 1957.* ***Carbon Emissions:*** *reconstruction of past emissions of CO_2 as a result of land clearing and fossil fuel combustion since about 1750 (in billions of metric tons of carbon per year). Credit: US Global Change Research Program.*

People Could Be Global Warming's Biggest Victim

Heat strokes could become more common during coastal summers of the future. More kids could end up in hospital emergency rooms with asthma attacks. West Nile virus or malaria could be common, and flooding rains could contaminate water supplies or kill people in floodwaters. And you think your hay fever is bad now.

The effects of global warming on humans are not to be underestimated, the Intergovernmental Panel on Climate Change warned. The United Nations' panel concluded that climate change "is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life."

Too Hot to Handle

Swift or prolonged changes in temperatures can have major consequences for human health and safety. Climate models predict that the heat index – a calculation using maximum temperature and relative humidity – could rise 8 to 15 degrees in the Southeast this century. That means that those days this summer that the weathermen said felt like 105 degrees could be more like 120 in the future.

Prolonged and frequent heat waves can kill, especially the elderly, poor, very young children and those with respiratory or cardiovascular illness. More than 700 people died in Chicago during a heat wave in July 1995. A study projects that a 3-degree rise in average temperature in Greensboro – well within the forecast range – could increase heat-related deaths from 20 to about 35 a year.

To some degree, Southerners have learned to adapt to heat. We merely turn up the air conditioning. Doing so, though, means that power plants have to produce more electricity and spew more pollutants into the air. A warmer climate, then, will also increase air pollution and the frequency of those red-alert ozone days.

Ozone, the main ingredient of smog, is produced when the gaseous byproducts of burning coal, oil or other fossil fuels interact with sunlight. Smog can damage lung tissue and is especially harmful to people with asthma or respiratory illnesses. Even healthy people can experience chest pain, nausea and coughing with relatively low exposure to ground-level ozone. Smog in North Carolina in 1990 triggered 1,900 hospital admissions for respiratory illness, 630 emergency room visits for asthma and 240,000 asthma attacks.

Some health experts warn that rising carbon levels in the atmosphere could lead to an epidemic of asthma, especially in cities. According to the Center for Health and the Global Environment, Harvard Medical School and the American Public Health Association, asthma rates have tripled in the last two decades due to higher levels of global CO_2, which increases the production of mold and ragweed. More than nine million children in the US have been diagnosed with asthma, according to the Centers of Disease Control.

That ragweed won't do your allergies any good, either. High CO_2 levels could also trigger more allergies by mid-century. Harvard University researchers found that ragweed grown in an atmosphere with double the current carbon dioxide levels produced 61 percent more pollen than normal. Such a doubling of atmospheric carbon dioxide is expected to occur between 2050 and 2100.

Biting Bugs

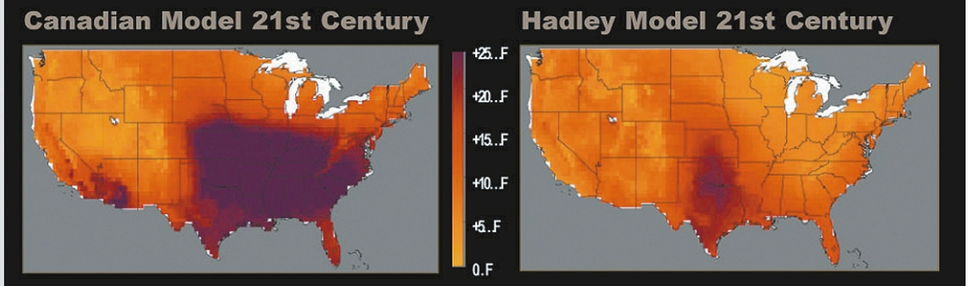
As the state warms up, North Carolinians will become susceptible to infectious diseases normally associated with tropical climates. Mosquitoes and ticks are no strangers to coastal residents, but warmer and wetter summers could increase their populations along the coast. If winters aren't cold enough to kill them, the biting season would lengthen.

Mosquitoes and ticks, as we know, can be more than mere irritants. They can transmit a variety of serious diseases. With mosquitoes, the big three are West Nile virus, encephalitis and malaria. Ticks transmit Lyme disease, Rocky Mountain spotted fever and the newly recognized ehrlichiosis.

"The prevalence of vector-borne illness is likely to increase with global warming because increases in temperature accelerate the life cycles of disease vectors, shorten incubation times of

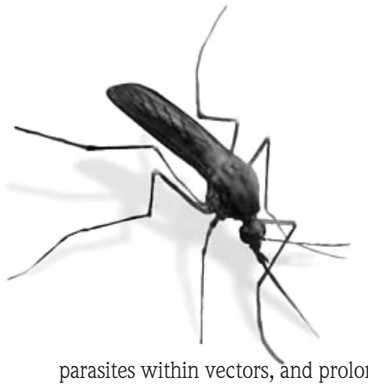
July Heat Index Change

The projected changes in the heat index for the Southeast are the most dramatic in the nation with the Hadley model suggesting increases of 8 to 15...F for the southernmost states, while the Canadian model projects increases above 25...F for much of the region.



Two major computer models used to forecast the effects of climate change project substantial increases in the July heat index (which combines heat and humidity) over the 21st Century. These maps show the projected increase in average daily July heat index relative to the present. The largest increases are in the Southeastern states, where the Canadian model projects increases of more than 25 degrees. For example, a July day in Jacksonville, NC, that now reaches a heat index of 105 degrees would reach a heat index of 115 in the Hadley model, and 130 in the Canadian model. Credit: US Global Change Research Program.

Increased power generation could lead to more pollutants that would trigger more smog and asthma.



Populations of mosquitoes and other insects that transmit diseases could increase in a warmer climate.

parasites within vectors, and prolong transmission seasons," according to Dr. Katherine M. Shea in an August 2003 article in *The Journal of Pediatrics.* Dr. Shea is a pediatrician in Chapel Hill and a medical consultant for the Physicians for Social Responsibility.

Public health officials will have an enormous challenge to control potential disease-carrying insects. Spraying insecticides to control vectors is a tricky business that if done improperly can present even greater health risks than getting sick from a mosquito or tick.

Water Woes

Climate change could mean weather extremes. Rain is likely to fall in large downpours, increasing the chances of flash floods. In *Death by Degrees: The Health Threats of Climate Change in North Carolina,* the Physicians for Social Responsibility see a number of potential health risks from torrential storms and floods, "including gastrointestinal distress from contaminated drinking water, car accidents due to damaged roadways, drowning associated with storm surges, and psychological distress from lost income and property."

Floods are the leading cause of death and property destruction during torrential weather. After a major downpour, low-lying areas and roads become pools of water and streams flow rapidly and sometimes overflow their banks. Floodwaters from Hurricane Floyd in 1999 killed 36 people and injured many more.

Flooding septic systems, farm field, sewage plants, and hog lagoons can unleash harmful fecal bacteria into the drinking-water supplies, creating dangerous conditions for infectious diseases. In the aftermath of Hurricane Floyd, at least 1,500 drinking-water wells were contaminated.

Public health and emergency management officials will have their hands full responding to the effects of climate change. Preparing for climate change will require better planning and surveillance, including community-wide heat emergency plans and enhanced early warning systems for air quality and severe weather conditions. Improved insect-control programs that emphasize public education and targeted spraying of larvacides will be also critical.

"It's an unknown whether we can arrest rapid global warming," Dr. Shea said. "We must prepare for the worst case scenario by optimizing our public health infrastructure, and, at the same time, proactively bring green house gas emissions under control to slow down global warming."

The Trouble with Pesticides

Here's the scenario:

A hurricane strikes. The governor tours the stricken areas and declares them disasters. He vows immediate help to control the outbreak of mosquitoes. The planes take to the air, covering the land, the rivers and marshes with fine clouds of insecticides.

It happened in 1999 after Hurricane Floyd and then again four years later after Isabel. Each time, more than 20 coastal NC counties were sprayed with malathion and naled. The two related insecticides are just marginally effective against adult mosquitoes but deadly to fish and shrimp.

The label for Dibrom, one of the brand names for naled, is quite explicit: "Direct application to water is prohibited. This rate of application will kill shrimp. Do not apply to tidal or marsh water which are important shrimp producing areas."

Fyfanon, one of the major malathion formulations used for aerial spraying to control mosquitoes, contains this directive on its label: "Broadcast use only over intermittently flooded areas. Application may not be made around bodies of water where fish or shellfish are grown and/or harvested commercially."

Yet, both are used routinely after hurricanes and, most disturbing of all, no laws are broken. State and county health officials, it seems, have broad power to ignore labels and misapply dangerous chemicals in order to combat a perceived public-health threat. No plans, no controls, no assessments. The US Environmental Agency is even considering weakening the label restrictions to allow spraying in aquatic environments if public health is threatened.

Now, here's the real scary part: These chemicals are likely to be used with even more abandon in the future if hurricanes or major flooding becomes more frequent because of climate change.

"A raft of evidence shows that adulticiding (killing mosquitoes in their adult stage) is not effective for controlling mosquito populations, and that the risks to human health, wildlife and water quality posed by exposure to pesticides far outweigh the potential benefits of such a spray program," says Fawn Pattison, executive director of the Agricultural Resources Center, a non-profit group that works in North Carolina to minimize human and environmental exposure to pesticides.

The chemicals, which belong to a group known as organophosphates, have clear effects on aquatic creatures, though. Levels of malathion as low as five parts per million in water were shown to cause heart defects in some types of fish, according to research at Rutgers University in New Jersey. Researchers found that malathion, if exposed to newly fertilized eggs, caused circulatory defects including "mild degenerative changes" in their gills after 24 hours, scientists at Kent State University found. They noted that "damage was more pronounced" after 48 hours and severe after 96 hours.

Frogs have been shown to be very susceptible to developing mutations from exposure to malathion. Scientists in India found that levels as low as 1 to 5 parts per million caused malformed tails and heads and unusual swimming patterns in tadpoles.

Short-term exposure in humans can cause numbness, headache, dizziness, nausea, and slow heartbeat. More severe exposures can cause unconsciousness, incontinence and convulsions, which may lead to death.

The payback in dead adult mosquitoes is slim because the insecticides generally miss their target and fail to kill the eggs and larvae. Dr. David Pamentel, an entomologist at Cornell University, found that one-tenth of one percent of sprayed pesticides actually hit the target pest.

There's even evidence that some skeeters might actually like the stuff. Naled was used in central New York to control a species of mosquito responsible for transmitting eastern equine encephalitis. After 11 years of spraying, the disease wasn't controlled and the number of mosquitoes had increased 15-fold.

Humans, in fact, may be more at risk. According to the New York City Department of Health, more people were reported to have gotten sick from pesticide spraying (157) than from exposure to West Nile Virus (19) in 2001.

"While traditional adulticide methods look like action, in actuality they accomplish very little," said Pattison.

Using substances, like bacteria, that attack larval mosquitoes are more effective, she said.

The indiscriminate use of pesticides to control mosquitoes and crop pests could pollute water and harm marine organisms.

Sea Level Rise:
Welcome to NC of 1,000 Years Ago

On the northeast branch of the Cape Fear River just upstream from Wilmington lies a stretch of shore where salt water is exacting a heavy toll. Not long ago the river flowed through bottomland forest, filled with cypress and hardwood species like red maple and green ash. Songbirds nested within the deep woods. Cypress roots threaded through the peat soil. Wakes from passing boats rolled smoothly across the banks of the swamp and into its interior.

Now the forest is almost gone, though a few hardy cypresses remain. Where woody groves stood, salt-tolerant reeds like saw grass and Spartina cynosuroides fill broad pastures. The edge of the marsh is undercut by waves and wakes, which slap sharply against a small cliff of eroding soil.

Courtney Hackney knows this part of the river well. For the past five years he has helped coordinate a major study to determine if new dredging in the Cape Fear River will increase salt water and tides upstream. When the ocean washes into waterways that have been deepened, its waves push farther inland, reaching into rivers that were previously fresh. This sets in motion a complex chain of natural events, including an odd chemical reaction within the peat soils.

It also gives scientists a sneak preview of what's in store as sea level rises along the North Carolina coast.

Hackney, an ecologist at the University of North Carolina at Wilmington, is documenting changes in the Cape Fear estuary in collaboration with a team of scientists. "We started to realize that something really significant was happening during the drought two years ago," he says. "That year all the fresh water that normally comes downriver was being held in Jordan Lake, up near Raleigh. Salt water was able to move way upstream. We started seeing places where the ground was subsiding around the stumps of dead trees."

What was happening to the soil? Through lab tests the researchers were able to show that two bacteria were present in the peat soils. One feeds on dead plant materials, turning them into methane. It feeds so slowly that the soils can usually accumulate faster than sea level rise. The second feeds on sulfates, which are abundant in seawater. It can lay dormant for years in freshwater systems. But when a pulse of salt water moves upstream, both bacteria become active – causing the soil to quickly break down. "These bacteria use sulfates and methane the way we use oxygen," Hackney says.

If the estuary moves gradually from fresh to salt, the methane bacterium exhausts itself and shuts down. "But when the system reverts to fresh and then receives a new pulse of sea water, both bacteria are active at the same time," Hackney says. "That was a surprise to us. And it looks like that's what we're going to get as sea level rises – salt water moving upstream in pulses."

The end result is sobering. "We've got very accurate elevation readings for the whole estuary," Hackney says. "The elevation actually slopes down three to four inches as you move farther upstream. We just never imagined something like that could happen."

A Rising Tide

Sea level rise: The phrase brings to mind pictures of waves lapping slowly higher along the coast with each passing year. Though North Carolina has one of the highest rates of sea level rise in the world, ranging between 12 and 17 inches a century, the yearly increase is indeed a gentle centimeter or so.

As the world's temperature increased since the end of the last Ice Age about 15,000 years ago, the oceans of the world have responded by rising. Melting glaciers are responsible for some of the rise, but most is due to the ocean expanding as it too warmed.

Ben Poulter adds another variable. The NC coast is sinking, he says, at something on the order of eight inches a century. A researcher at the Nicholas School of the Environment and Earth Science at Duke University, Poulter says that continents continue to adjust to the weight of the long-gone Ice Age glaciers by rising or falling. Norway, he says, is rising. North Carolina is subsiding.

If it continues, North Carolina is in for an even bigger mess. Computer models predict that because of global warming the oceans will rise 10 inches by 2030 and as much as three feet by 2100. Throw in subsidence, says Poulter, and the ocean could rise as much as 43 inches.

All those numbers may seem small but consider that a one-foot rise in sea level will erode an average of 200 feet of ocean beach along our coast. On the uniformly flat coastal plain of the NC coast that could amount to 770 square miles of underwater territory, Poulter estimates. More than 1,800 square miles of coastline – an area the size of Onslow and Pender counties with Currituck thrown in for good measure – would be flooded if the ocean rose 43 inches.

Studies by coastal geologists show that erosion is driven not so much by the day-to-day lapping of waves along coastlines, but by the extreme storms that take huge bites out of shorelines. Last September, Hurricane Isabel cut a new inlet across Hatteras Island and caused extensive erosion all along the Outer Banks. And the damage reached far inland. On the upper Chowan River, high bluffs were flattened by the storm surge, leaving behind a sandy beach strewn with chunks of clay.

It's these kinds of events that drive salt water inland, where it can activate the sulfur- and methane-loving bacteria that cause peat soils to break down. If the soil loss documented by Hackney and his collaborators proves to be widespread, the Southeast will lose millions more acres of coastal wetlands – more, that is, than are already expected to be lost to the creeping tides. And as the soils sink, the salty waters will be able to push farther upstream, especially in areas that have been heavily ditched or cut by canals.

Back to the Future

Stanley Riggs, a geologist at East Carolina University, has spent his career walking the state's beaches and poking holes in its islands and sounds. He thinks he has a pretty good idea of what the NC coastline looked like 1,000 years ago when the ocean was rising at the rates the computers are predicting this century.

"One thousand years ago Pamlico Sound was a big open bay. Only a portion of the barrier islands existed," he said. "In another 100 years, maybe 200 years at the outside, it could look like that. We're talking about short-term human history. We know that because we drilled holes all over the place. It's not a mystery anymore. It's pretty clear. It's like reading a book. It's just a matter of getting people to read the words."

The coast from Cape Lookout south will be least affected by sea level rise. The back sounds are shallow and there should be enough sand moving in storms to allow places like Core Banks to retreat in the face of the rising sea.

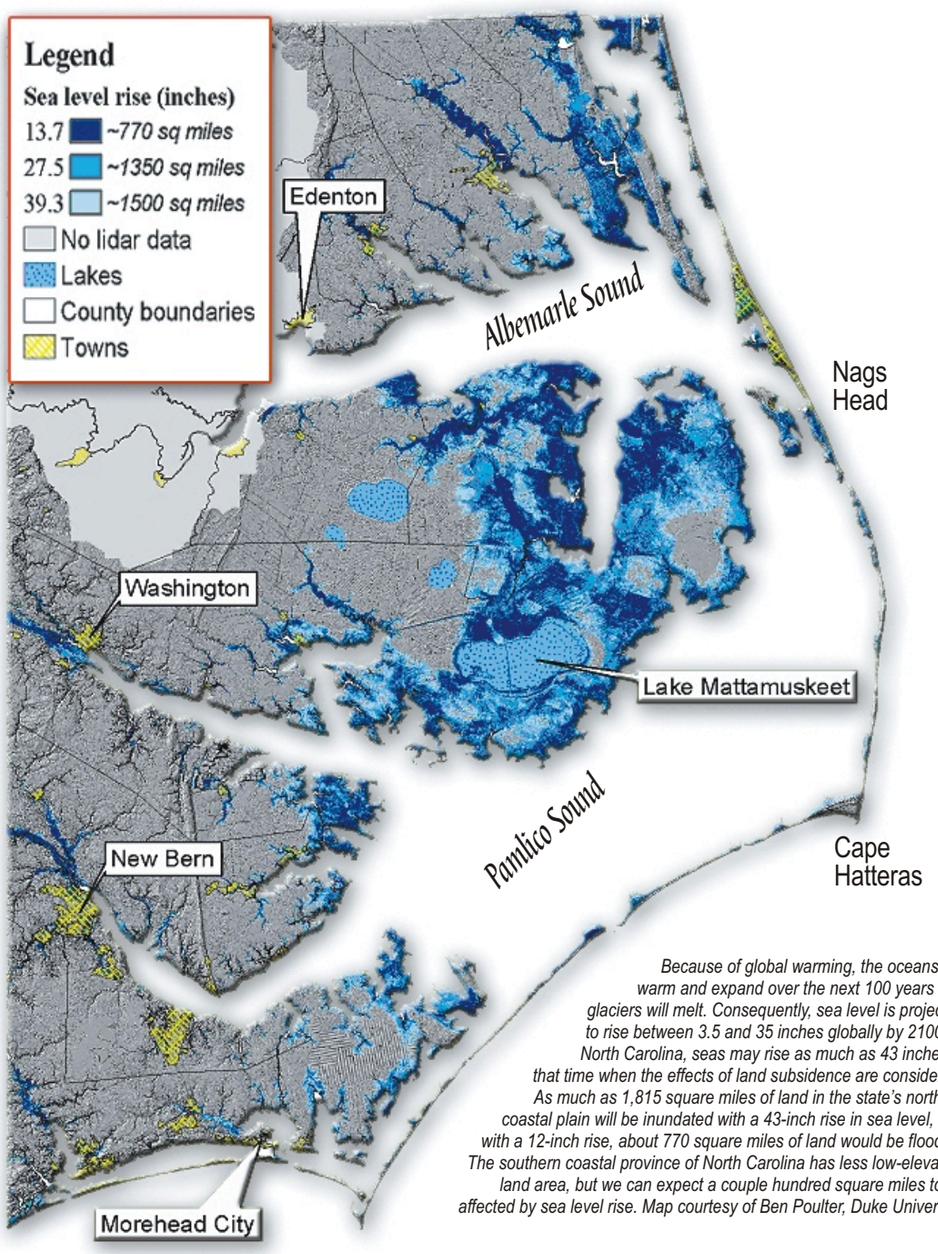
From Ocracoke north, however, the story is drastically different. The Outer Banks sit on a ridge backed by Pamlico Sound. "And Pamlico Sound is a big hole," Riggs explained. "Storms first have to fill that hole with sand before the islands can retreat, and there's not enough sand."

If sea level continues to rise at just its current rate and hurricane activity remains intense, the Outer Banks will begin to break up in a couple of decades, Riggs said. Large sections of Hatteras, Ocracoke, and Portsmouth islands will be underwater. Instead of a long strand of connected sand reefs, the Outer Banks will become small, isolated islands separated by bays, Riggs said.

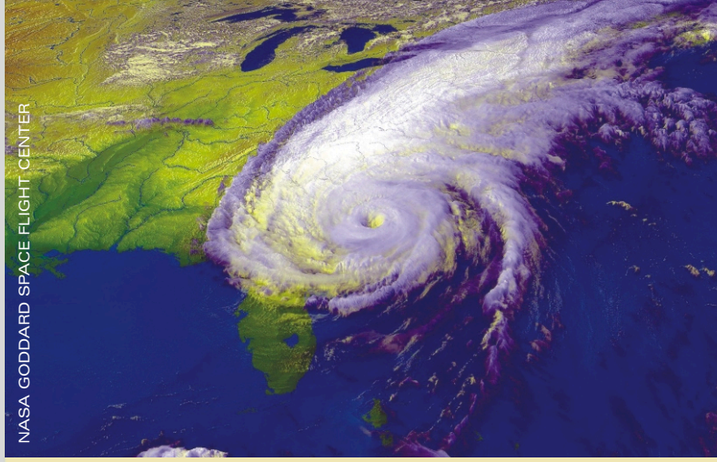
"If we were to double sea-level rise, we would maintain that barrier for 100 years, but ultimately it will collapse," he said. "An inner barrier would form closer to shore in Pamlico Bay."

Hatteras Island will be completely submerged, except for portions of Buxton, Riggs said. Only the southern tip of Ocracoke Island will remain. New inlets will form in south Nags Head, Duck, and Corolla. The Alligator River peninsula will become an extensive marshland, and the Alligator River will grow into a wide coastal sound. Vast portions of mainland Dare and Hyde counties will be underwater.

"There will always be a shoreline," Riggs said. "You will have a beach of some kind but it may not be what you have right now and it may not be a beach you like."



Because of global warming, the oceans will warm and expand over the next 100 years and glaciers will melt. Consequently, sea level is projected to rise between 3.5 and 35 inches globally by 2100. In North Carolina, seas may rise as much as 43 inches in that time when the effects of land subsidence are considered. As much as 1,815 square miles of land in the state's northern coastal plain will be inundated with a 43-inch rise in sea level, and with a 12-inch rise, about 770 square miles of land would be flooded. The southern coastal province of North Carolina has less low-elevation land area, but we can expect a couple hundred square miles to be affected by sea level rise. Map courtesy of Ben Poulter, Duke University.



NASA GODDARD SPACE FLIGHT CENTER

Higher Seas Would Make Hurricanes More Damaging

Whether they're stronger or more frequent, hurricanes and other coastal storms of the future are likely to inflict more damage because of the greater storm surges brought about by a rising ocean.

Experts and the computer models they use to mimic climate remain divided about the effects of rising air temperatures on hurricanes. Some early work on typhoons in the Pacific Ocean suggested that a storm's wind speed could increase by as much as 20 percent as the ocean water warmed.

The conclusion coincided with the physics of hurricanes, which are giant heat engines that are brought to life and sustained by warm ocean water. Global warming, then, would likely raise sea surface temperatures, making conditions more favorable throughout the world for hurricanes. Warmer ocean water, the early computer models suggested, could spawn more frequent and intense storms and lengthen the hurricane season.

Recent research, however, shows that hurricane dynamics are more complicated. Other factors determine if a hurricane will hold together during its Atlantic passage. Wind, for instance, plays a key role. Winds high in the stratosphere switch direction every so often. When they're westerly, they seem to enhance hurricane formation. But when they blow from the east, they tend to shear off the tops of hurricanes like huge buzz saws. Scientists aren't sure what these high-altitude winds will do as the atmosphere warms.

Then there's the Southern Oscillation, better known as El Niño and its opposite La Niña. These periodic, large-scale changes in sea temperature in the Pacific seem to affect hurricane formation in the Atlantic. Fewer hurricanes form during El Niños and more during La Niñas. Although it's far from conclusive, there is some evidence that global warming will decrease the strength and frequency of El Niños.

William Gray, the Colorado State University researcher known for his annual predictions of hurricane activity, believes that when all the factors are tallied, global warming may have little effect on hurricane formation. But he's not placing any bets. "If you imbalance the atmosphere, it's difficult to say how it will right itself," says Philip Klotzbach, a researcher in Gray's program. "Different models show different outcomes. There's just no consensus."

It is clear, though, that hurricanes of the future will be more destructive regardless of their strength or frequency. Sea levels are rising, and the ocean could be as much as 10 inches higher in 30 years than it is today. The higher the ocean, the more destructive a hurricane's storm surge – the wind-driven waves pushed ahead of a storm. A Category 1 or 2 hurricane that causes minor damage today could cause moderate to severe damage in the 2030s when sea levels are higher.

And the coastal populations are denser. The permanent population of the 20 coastal counties increased nearly 65 percent since 1970. During that time, the federal flood insurance program paid out more than $321 billion in claims to North Carolina policyholders.

The State Data Center forecasts that populations in the 20 coastal counties will rise another 45 percent, to almost 1.2 million, by 2030. Federally subsidized flood policies, which increased 42 percent in North Carolina since 1997, will also rise. More people living in hurricane-prone areas as the ocean rises guarantees that higher insurance trends will continue. Over the past 10 years, insurers paid out more than $100 billion in catastrophe-related losses – about $700 million per month – many times more than in previous decades.

10 KEY COASTAL IMPACTS OF GLOBAL WARMING

Here is what the computer models and experts tell us about the potential effects of global warming on coastal North Carolina. There's general agreement on some things – that temperatures and sea level will rise – and disagreement on others – the frequency of rainfall and hurricanes.

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1 PRECIPITATION The amount and timing of precipitation are among the great unknowns. Some computer models predict prolonged droughts while others forecast increased rainfall. Either way, it seems likely that more rain will fall during heavy downpours, increasing the risk of flash floods.

2 INCREASED WARMING The average daily temperatures in North Carolina will rise by about 4 degrees by the end of the century, giving the state temperatures that are now normal in central Florida. Some models predict a 10-degree rise.

3 THREATS TO HUMAN HEALTH Adaptation is likely to protect most coastal residents from the wide range of negative health effects – asthma, heat stress, insect- and water-borne diseases.

4 VULNERABLE ECOSYSTEMS Wetlands will disappear as sea level rises rapidly, and the forests of the coastal plain are likely to experience major species shifts or break up into a mosaic of grasslands, woodlands, and forests.

5 GREATER STORM DAMAGE A higher ocean means greater storm surges. Combined with a growing coastal population living closer to the water's edge, coastal storms of the future are likely to create more damage than storms of today.

6 RISING SEAS Higher sea level is a natural consequence of warmer air temperatures as the ocean warms and glaciers melt. Along the NC coast sea level is forecast to rise from 12 to 36 inches by the end of the century, with as much as a 10-inch rise by 2010. About 200 feet of shoreline is lost to erosion for every foot of sea-level rise.

7 HURRICANE FREQUENCY Another of the unknowns. The physical dynamics of hurricanes would seem to suggest that warmer ocean temperatures should spawn more, intense hurricanes and lengthen the hurricane season, but the computer models can't agree.

8 WATER QUALITY AND QUANTITY Quick, intense downpours increase stormwater runoff – currently the greatest source of water pollution. Prolonged droughts would have severe effects on aquifers, the drinking water sources for more coastal residents. Rising seas could push saltwater into those aquifers.

9 TIMBER PRODUCTION Trees should do well with higher carbon dioxide levels if there are no seasonal shifts or drastic declines in precipitation. Forest productivity should increase along the coastal plain, at least in the short term. Fires, insects, droughts and disease could decrease productivity over time, though.

10 FOOD SUPPLY The region's farmers will likely be able to adapt to the new climate. If there are no seasonal shifts or drastic declines in rainfall and if temperatures don't climb too high, crop production is very likely to increase over the next few decades.

Illustration by Suzanne Grover
loveandhonesty.com/grover/gallery.html

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Plants and Animals Will Struggle to Adapt

Because humans have advance warning of climate change, we can plan ahead for its most devastating consequences. Plants and animals aren't so lucky. A report issued by the Pew Center in April predicts that the biggest impacts will be felt in the natural world as species struggle to adjust to a rapidly changing world.

No formulas exist that can tell us what will happen to the natural resources of the coast if regional temperatures rise as predicted or precipitation patterns change. From their knowledge of ecological relationships, scientists can make some educated guesses.

Biologists warn that natural communities will not adapt smoothly to global warming. Heat may stress some species more than others, and plants and animals may not expand their ranges to the north at the same rate. Important ecosystems such as the coast's fringe marshes or sand flats favored by so many shorebirds may disappear under a rapidly rising sea.

Change is certain, and complex new relationships will develop. In the constant struggle that marks life in the natural world, some species will thrive and some will suffer. Species that are endangered or threatened are particularly vulnerable. Their diminished numbers put them at a distinct disadvantage to adapt to a change in climate. Many became rare because they require specific habitat needs. Piping plovers like barren beaches and tidal islands to forage and nest, while the Carolina bogmint grows only in wetlands. Both types of habitats will be threatened by sea-level rise.

Evidence is beginning to accumulate from around the globe that the natural rites of spring – the budding of the first flowers, bird nesting, frog breeding, the arrival of migrant birds and butterflies – is advancing about 2.3 days a decade, and that pace is likely to quicken. Songbirds and shorebirds that nest in the Arctic may be at particular risk, since the far northern latitudes are expected to warm much more than equatorial zones. Migrating birds follow a tight schedule that's driven by food, and that gives them just enough time to raise their young before flying south for the winter. Cues for migration will stay the same in the tropics. But since the Arctic will warm earlier, nesting birds may arrive too late to take advantage of peaks in prey abundance. Scientists expect other, unforeseen changes to cause problems in the delicate equation of migration.

The species shifts that take place will depend heavily on whether regional temperatures rise quickly or slowly and smoothly, giving coastal species time to adapt. The ranges of plants and animals are limited not by average temperatures but by extremes. So if quirks in atmospheric circulation bring unusual heat one year and unusual cold another, or drought one year and rainfall-induced floods the next, plants and animals may be subject to unprecedented stress.

Such drastic swings take an incremental toll that will build up over time. As species struggle to adapt by moving north, they will likely find themselves competing for habitat that's been badly fragmented by development, road building, and agriculture – none of which existed during previous epochs of altered climate.

Temperatures in the estuary will likely rise faster than in the open ocean. At the same time, increased rainfall may bring greater pulses of nutrients and pollution from stormwater runoff, though the computer models disagree on precipitation patterns in the Southeast. The heat and nutrients could trigger massive algal blooms that may drastically reduce the amount of oxygen in the water, causing fish kills. Warmer, nutrient-laden water may also play host to increased blooms of harmful plankton. If the clarity of the water decreases, introduced aquatic grasses may edge aside natives that need sunlight to thrive.

At first sea level rise may make estuarine waters more productive for marine species that are caught commercially, such as shellfish and estuarine fish. Over time, however, as peat soils break down, scientists fear that thousands of acres of coastal wetlands will be lost in North Carolina – some from subsiding soils, some from bad land management practices like building bulkheads. Marsh sediments accumulate gradually. During a rapid rise in sea level, wetlands will be submerged more quickly than they can build. A loss in coastal wetlands will mean that fewer pollutants and sediments will be filtered from coastal waters. Inevitably water quality will decline. So will the fishing, since about 70 percent of the commercially or recreationally important fish and shellfish depend on the state's estuaries.

It's not a heartening forecast. But only one thing is for certain: The changes, when they come, will be complex, with abundant surprises.

Winners & Losers

Our understanding of global warming's implications aren't yet so refined that we can predict with great accuracy the coastal plants, animals or ecosystems that would benefit or lose in a warmer climate. But we can make some educated guesses.

Possible Losers

- Endangered or threatened species. There aren't many of them, and some, like the red-cockaded woodpeckers, require specific habitat needs and others are at the limits of their natural range. These plants and animals would be less likely to adapt to a relatively sudden change in climate.
- Miigrating songbirds and shorebirds
- Pocosin swamps
- Loblolly pines
- Native aquatic grasses and some native plants

Possible Winners

- Kudzu, poison ivy and other weeds
- Oaks, hickories, and other hardwood trees
- Exotic species like the lionfish


LOSERS: Red-Cockaded Woodpecker and Loblolly Pine


WINNERS: Lionfish


LOSERS: Piping Plover

Crops and Trees May Benefit from Higher CO_2

Future farmers and loggers along the NC coast may like the greenhouse world. But, then, so will kudzu and poison ivy. Backyard tomato growers, on the other hand, may find that the warmer temperatures aren't kind to their Big Boys and Better Girls.

According to the computer models, the main agricultural crops grown in Eastern North Carolina should do well in an atmosphere of increased carbon dioxide, assuming it doesn't get very hot and enough rain falls at the right time. Corn and peanut yields, for instance, could increase as much as 50 percent by 2090 and soybeans as much as 10 percent, the models predict.

CO_2 acts like a fertilizer. The more, the better. Through photosynthesis, plants use sunlight to convert water from the soil and carbon dioxide from the air into sugar, starches, and cellulose – the carbohydrates that are the foundations of the entire food chain. CO_2 enters a plant through its leaves. Greater atmospheric concentrations tend to increase the difference in partial pressure between the air outside and inside the plant leaves, and as a result more CO_2 is absorbed and converted to carbohydrates.

Now a Word of Caution

That's the theory, anyway, and Mary Peet doesn't seriously question it. She is professor of horticultural science at NC State University, and she points out that most researchers have just looked at the effects of CO_2 on agricultural crops and not paired concentration with temperature. "Not many people have looked at the CO_2-temperature interaction," Peet said. "Where they've looked at it, they sort of get a different answer. The assumption was that high CO_2 would compensate for high temperature."

Peet tested that assumption on tomatoes and began seeing very dramatic decreases in fruit set as nighttime temperatures increase. By studying the scientific literature she found that that was the case in almost all plants that set fruit or seeds. "High temperatures have really adverse effects on pollen dispersal," Peet explained. "Every time someone's looked at it, it pretty much shows up."

Most global warming scenarios for the Southeast have average temperatures increasing by about 4 degrees by 2100. Winters will get warmer, and nighttime low temperatures will rise. Research is now suggesting that under those conditions plants can't release enough pollen for good seed production. "So it really doesn't help in our studies to have more CO_2," Peet said.

Warmer winters, she said, may not be good for many types of fruits and vegetables. "A lot of them, especially the tree species, are dependent on chilling," Peet said. "The reason that plants flower in the spring is usually because they received enough chilling. For fruit trees, raspberries, blueberries, strawberries, pretty much any fruiting crop has to have a certain amount of chilling."

If it doesn't, fruit production could suffer. Apple growers in New York, Peet said, have already seen declines in production as winter temperatures warm.

Milder winters, Peet said, could also trigger flowers to bloom earlier then the arrival of insects required for pollination. Seed formation would suffer. "That could threaten native species," she said.

High nighttime temperatures during the growing season would shorten plants' reproductive period and reduce quality, Peet explained. "You could have less sweet watermelons or a less sweet apple," she said. "It's developing over a shorter period of time so it doesn't get as much sugar into the plant."

Gardeners and farmers could adapt by planting earlier or by using cultivars that would be better suited for the new climate. But it would take years to develop an apple tree, say, that can make do with warmer winters and then 15 years from planting before a grower sees the first apple.

"Horticulturalists don't like surprises, and people don't like to live in a different climate," Peet said. "You live in North Carolina, you don't want to have Florida's climate or Alabama's climate. You want to have the climate that you've been expecting for the last 50 years. That's what the whole production system is adapted to – marketing, cultivars, planting. So it's like trading spaces."

Changes in Forestland

The composition of eastern forests shouldn't change as drastically as those in the state's mountains. There, the high-elevation pine forests are doomed. The spruce and fir trees atop the mountains are at the limits of their range. They can't retreat higher up the mountain as the climate warms.

"Most of the trees in the coastal plain are in the center of their ranges," explained Steve McNulty, who heads the US Forest Service's Southern Global Change Program. "They should be able to adapt to temperature shifts."

In fact, computer models predict that with moderate warming and adequate rainfall the productivity of the region's managed forestland should increase by 2090. Carbon dioxide, it seems, has the same positive effect on trees that it does on corn.

Increased production, though, won't be evenly distributed among forest types. Hardwood and mixed forests, the models note, will do better than loblolly pine plantations. The tree is the backbone of the region's paper and pulp industry, but will shift northward hundreds of miles as the climate warms. The industry could follow the trees, making it less reliant on NC plantations.

Not all the computer models have such a rosy outlook. One of the major models predicts prolonged drought in the coastal counties and frequent forest fires. Under such conditions, the region's forests will be dominated by oaks and other hardwoods and marked by open savannahs.

Goats and Global Warming

Across from McNulty's office on the Centennial Campus at NC State, goats serenely munch on a two-acre field of kudzu. It's an experiment to see if the animals will graze on the "Plant That Ate the South." They do – right down to the ground.

So, here's a tip to survive the greenhouse world: Buy a goat.

Because as kudzu goes, you ain't seen nothing yet.

Tests done at Duke University and elsewhere have shown that the growth of weedy vines like kudzu, honeysuckle, and poison ivy could increase by as much as 70 percent with high CO_2.

"That's one of the problems," said Mary Peet. "We have no choice as to which plants are affected during climate shifts."

Fisheries Likely To See Shift In Species

Fishing is a big business in North Carolina, and one that is likely to see big changes in the future because of global warming. The state ranks in the top 10 seafood-producing states with 3,500 active full-time commercial fishermen, and two million recreational anglers. Fishing is not only an economic engine to the coastal economy; it's also part of its heritage and a way of life.

Global warming will likely change fishing seasons and types of fish that are caught. Tropical waters will become warmer and likely expand into temperate zones, while cold Arctic waters will shrink. Salinity will also shift as portions of icecaps and glaciers melt and increase the volume of freshwater in colder regions, while greater evaporation of the oceans will make water saltier everywhere else. The dynamics will be complex and varied, as will the effects on fisheries.

Warm tropical conditions have already caused a shift in fish species. North Carolina waters are becoming more hospitable for southern fish as they migrate to adapt to changes in water temperatures and food sources. (See sidebar)

For the most part, fish in the ocean waters are expected to adapt. Warmer waters generally increase biological productivity. The ocean already experiences periodic natural variability that cause swings in weather and warmth as seen with El Niño and La Niña. According to Dr. Richard Barber, a scientist at Duke Marine Lab, "Natural regime shifts are supposed to go in both directions. Now all we're seeing is relentless shifts in one direction, toward more tropical conditions throughout the world."

Coastal Warning

Coastal waters may face the greatest impacts due to climate change, said Eileen Claussen, president of the Pew Center on Global Climate Change. "Particularly vulnerable are coastal and shallow water areas already stressed by human activity, such as estuaries and coral reefs. The situation is analogous to that faced by a human whose immune system is compromised and who may succumb to a disease that would not threaten a healthy person,"

Estuaries and wetlands are among the most biologically productive environments in the world. They are the spawning grounds for about half of ocean fish and shellfish, such as shrimp, menhaden, flounder, sea trout, croaker and red drum.

The rise in sea level will inundate large areas of coastal marsh, which serve as primary nursery areas for numerous species. Shoreline protection measures such as bulkheads and riprap halt the inland migration of coastal marsh and accelerate its demise. If significant areas of coastal marsh are lost because of shoreline armoring, fisheries can be expected to decline as well. As we say, no wetlands, no seafood.

Manmade pollution is the other edge of this sword. Population continues to boom in counties bordering the Atlantic Ocean at rates well above the state average. In these counties, properties along sounds and tidal creeks are a hot commodity. With an influx of people will come more development and increased stormwater pollution of estuaries. Without meaningful controls, that pollution will increase if future rainfall falls in more intense downpours as is predicted.

Regrettably, existing state and local stormwater rules for new development do little to protect shellfish beds from frequent closures and result in degradation of many primary nursery areas. With heavier rain on the horizon, existing stormwater systems will simply be insufficient to handle and treat the increase flow.

Don't Count on the Weather

Along with warmer temperatures, climate change will bring extremes in precipitation. Heavy rains and droughts alike could present serious challenges for the state's fisheries.

With more frequent torrential downpours, freshwater runoff from land will cause juvenile fish and shrimp to temporarily retreat from the safety of shallow water grasses to deeper, saltier waters where they could be subject to predation.

Sea level rise or droughts could cause estuaries to be saltier. Oyster diseases such as MSX and dermo flourish in salty water. Increased salinity in the estuary could lead to a significant increase in oyster mortality.

Droughts or low rain years combined with warmer temperatures can also cause a reduction in dissolved oxygen in surface waters. Anadromous fish, such as striped bass river herring, and shad, spawn in freshwater streams, but live in saltwater. Fresh water fish and anadromous fish could be particularly at risk in warm, low-flowing freshwater streams because of low dissolved oxygen levels.

There may also be some positive news. Warmer winters may improve the recruitment of shrimp populations, a major cash crop of the sea. Although climate change could yield benefits of increased production, they will be dependent on how well we manage our fisheries and coastal development in the years ahead.

"The next 20 to 30 years are the most critical," said Doug Rader, a senior scientist at NC Environmental Defense. "How we act and react in this timeframe will govern our abilities in the long run."

Big Changes At 210 Rock

The warmer climate may already be changing the fish species off our coast.

Pete Parker, a research fishery biologist with National Marine Fisheries Service, began in 1975 studying fish that live on reefs. His goal was to learn about recreationally and commercially important fish stocks by counting and tagging fish during dives in Onslow Bay at an inshore reef known as "210 Rock."

Parker's team repeated the study in 1990-92, and the changes they saw were so remarkable that it changed the study's focus. Parker had been documenting the changing number and abundance of fish caused by fishing pressures. What he found was an entirely new structure of the reef community. The expanded focus of his study became the new tropical species that had settled at 210 Rock.

Parker documented surprising changes. Twenty-nine new tropical fish were found, and twenty-eight previously observed tropical species had become abundant. The frequency of red grouper increased five-fold. Four new types of sea bass became common and even hogfish showed up.

More importantly, black sea bass, a fish once common to the reef, had become twenty-two times less abundant. Only two tropical fishes decreased in abundance, and no new temperate fish were found.

The changes Parker saw in the makeup and abundance of fish are due to climate change. The bottom water temperature in winter is 2-9°F warmer than in 1975. Even with this slight wintertime temperature increase, the kinds of fish that are comfortable in our waters have changed dramatically.

Six Things NC Needs To Do Now

We asked the experts a simple question: If you were king – or queen – of North Carolina what are some things that you would command we do to lessen the future effects of global warming? Recognizing that the problem extends beyond their kingdom's borders, the monarchs-to-be all agreed that each state needed to act to reduce its dependence on fossil fuels and to prepare its future citizens for the hotter world to come.

1 Prepare for the inevitable: Rising Sea-level

All our experts and the computer models agree: The ocean is rising and will continue to do so this century, maybe at rates not seen since the end of the last Ice Age 15,000 or so years ago. There will never be enough money or good sand, for that matter, to continually build levies around low lying coastal mainland fields and communities or re-nourish barrier island beaches to combat a conservative 10-inch rise, let alone the drastic 24-inch or catastrophic three-foot rises that some models forecast.

Damage from a rising sea depends on the rate of rise, elevation, and the proximity of development to the shoreline. There is currently no state strategy to address the consequences of sea level rise on mainland communities.

On the oceanfront, the state attempts to curtail damage by determining building setbacks based on average long-term erosion rates. It was a forward-thinking policy when conceived in the 1970s, but it will have no practical application in the 21st century because the ocean won't reliably behave as it has in the past.

Clearly, any attempt to seriously address the consequences of climate change on our oceanfront must start with throwing away those assumptions and refiguring setbacks based on what the ocean is likely to do in the future, not on what its done in the past.

Replacing vertical bulkheads and rock walls along the estuarine shoreline also must be considered if the state intends to save its marshes. Locked in front of a wall, those wetlands can't retreat as the sea rises rapidly.

2 Make the coast more resilient

With the rising tide will come greater winds and storm surges that will challenge even the deep pockets of the federal government. Coastal development is still a topic of hot debate, but the stakes will be much higher in the greenhouse world of higher seas and winds, more flooding rains, and greater storm surges. The state needs to re-sharpen and combine current tools such as the land-use plans required by the Coastal Area Management Act, as well as disaster relief laws. Most of these plans fail to provide coherent growth strategies that result in environmentally sound development practices. If they did that, coastal communities would be much better prepared for the consequences of global warming.

But new tools are also needed. Setback requirements for new subdivisions along the estuarine shoreline could serve the dual purpose of protecting buildings from flood damage while allowing valuable marshes to retreat from the onslaught of a rapidly rising sea.

The state should also consider acquiring storm-prone land, especially tracts adjacent to vulnerable wetlands. Acquiring large tracts would also connect fragmented habitat, thus protecting coastal ecosystems and providing migration routes for wildlife. The NC Clean Water Management Trust Fund should include sea level rise as one of the criteria for evaluating funding requests.

3 Develop a comprehensive state plan to cut emissions

North Carolina is the country's ninth-fastest growing state that contributes almost 200 million tons of carbon dioxide and other greenhouse gases into the atmosphere each year. Yet, it isn't among the some 39 states that are actively pioneering strategies to reduce greenhouse gases.

It was Connecticut's plan that kept coming up in our conversations with the experts. Alarmed by forecasts that Hartford's average daily temperature in 2100 would approach those in … *gulp* … Raleigh, state leaders in 2001 worked with their counterparts in neighboring New England states on a pact to reduce greenhouse-gas emissions to 1990 levels by 2010 and a further 10 percent reduction by 2020.

To achieve those reductions, Connecticut officials held public meetings across the state, published brochures and newsletters and partnered with nearly 100 local governments, non-profit organizations, businesses and academic institutions. They inventoried their energy use and came up with 38 recommendations that the state's governor endorsed in January. *(www.ctclimatechange.com)*

In the process, cities, towns and state residents saved money. Fairfield, for instance, saved nearly $1 million in power bills by making 24 municipal and school buildings more energy efficient.

A similar plan in North Carolina to reduce emissions could include provisions to improve energy efficiency of new and existing commercial and residential buildings, increase vehicle fuel efficiency, emphasize recycling, increase methane recovery from landfills, and expand forestlands because trees take up CO_2.

4 Require renewable energy sources

As a strategy to reduce greenhouse-gas emissions, a statewide plan should include requirements that a percentage of a utility's overall or new generating capacity or energy sales come from renewable sources, such as wind, solar, and biomass. To date, nearly 20 states have passed such legislation.

5 Adopt policies that encourage low-emission vehicles

Nearly one third of our state's total CO_2 emissions comes from cars and trucks. So any successful effort to reduce North Carolina's greenhouse-gas emissions must include them. The state should entice drivers out of their SUVs and other gas-guzzlers by offering hefty tax incentives for low- or zero-emission vehicles.

6 Prepare to take economic advantage of national climate legislation

With legislation to curb carbon dioxide emissions gaining more and more support in Congress, it is only a matter of time before national carbon caps are implemented. These carbon caps will assuredly bring about a national carbon marketplace, characterized by the buying and selling of carbon equivalence "credits." North Carolina can capitalize on this market by implementing policies that prepare potential carbon credit suppliers in the North Carolina economy to sell carbon credits for their emissions reductions or for sequestering carbon in trees and soil.

10 Climate Smart Tips

You are the cause of global warming. That's right, you. It's because of you and your neighbors and we here at the Coastal Federation and the millions of Americans just like us that the power plants burn all that coal and oil and natural gas and spew carbon dioxide and other heat-trapping gases into the atmosphere each day. We are the ones driving all those cars that clog the highways. Did you know that for the first time in history American households now average more cars than licensed drivers?

Yet, we somehow have room in our garages for lawn mowers and weed-eaters and hedge trimmers and blowers and other gasoline-powered gizmos.

In fact, if you are like the average American, you personally contribute about 22 tons of carbon dioxide and other heat-trapping gases into the atmosphere each year. Drive an SUV? Then double that amount. That's almost four times the per capita average in the rest of the world. It's the reason why the United States pumps more carbon dioxide into the atmosphere than any other country.

The good news is that there are many ways you and your family can help reduce carbon dioxide pollution. Of course, everyone will have to take the following 10 steps to make an appreciable difference. But even if you go it alone, you'll save money and improve the environment in other ways.

Reduce, reuse, recycle. Buy products that feature reusable, recyclable, or reduced packaging to save the energy required to make new containers. Also, by recycling all of your home's waste newsprint, cardboard, glass, and metal, you can reduce carbon dioxide emissions by 850 pounds annually.

Consider a fuel-smart car. When buying a car, purchase a fuel-efficient vehicle – one that gets more miles to the gallon than your current vehicle.

Give your car a day off. Consider transportation alternatives such as mass transit, carpooling, bicycling, and telecommuting. By leaving your car at home two days a week, you can reduce carbon dioxide emissions by 1,590 pounds a year. When you do drive, keep your car tuned up and its tires properly inflated to save on fuel costs.

Tune up your home to save dollars. Your house is responsible for more air pollution and carbon dioxide emissions than the average car. Insulate your home and caulk windows and doors. Potential savings in carbon-dioxide emissions: 2,480 pounds a year. Buy energy-efficient appliances. A high-efficiency refrigerator, for instance, will reduce carbon dioxide emissions by 220 pounds a year. A washing machine that uses water and energy efficiently will reduce emissions by 440 pounds a year.

Go solar. Install a solar thermal system in your home to help provide your hot water, and reduce your carbon dioxide emissions by about 720 pounds annually. Encourage your utility to do its part. Many local utility companies offer energy from clean sources (landfill gas recovery, high-efficiency natural gas-fired power plants, or renewables such as solar and wind).

Buy "Green Power." Green power is electricity that is generated from renewable sources such as solar, wind, geothermal, or biomass. Although the cost may be slightly higher, you'll know that you're buying power from an environmentally friendly energy source.

Get involved at work. Your company can save money by joining EPA programs such as Energy Star® Buildings and Waste Wi$e recycling programs, and by buying office equipment with the Energy Star® label.

Plant trees. Trees absorb carbon dioxide from the air. Join family members, neighbors, environmental groups or community service groups in planting trees in your yard, along roadways, at schools, and in parks.

Educate yourself. There are many good books and websites that will help you learn about global warming. See the accompanying list to get you started.

Educate others. Encourage others to take these practical, energy-saving steps that save money while protecting the environment.

Educate Yourself

Here are a few websites and books to help you learn about global warming and its implications for coastal North Carolina.

WEBSITES

www.usgcrp.gov
US National Assessment of the Potential Consequences of Climate Variability and Change is a mouthful but this federal report, published in 2000 by the top experts in the field, is indispensable for understanding what might happen.

www.yosemite.epa.gov/oar/globalwarming.nsf
A fairly comprehensive and straightforward EPA site that allows visitors to search for information by region or state.

www.fs.fed.us/ne/delaware/atlas
Called the *Climate Change Tree Atlas*, this US Forest Service site presents distribution maps for 80 eastern tree species based on various climate-change predictions. See what might happen to your favorite tree.

www.pewclimate.org
The Pew Center has been funding research on the subject for years. Its site offers a wealth of information on the environmental and economic effects and on policy issues. It also offers profiles of corporations that are taking steps to reduce greenhouse-gas emissions.

www.geo.appstate.edu/bulletin/EPA_projects/NC_action
The Department of Geography and Planning at Appalachian State University in Boone, NC, prepared a state action plan analyzing the options that might be used to reduce North Carolina's greenhouse gas emissions.

BOOKS

Global Warming: The Complete Briefing by John Houghton
In this second edition of his highly acclaimed book, Houghton examines the science and the politics of global warming. Succinct, lucid, and comprehensive, this is the definitive guide to the subject.

Red Sky at Morning: America and the Crisis of the Global Environment by James Gustav Speth
A renowned environmental visionary, Gus Speth makes an impassioned plea to take these issues seriously before it is too late. With concise statistics, bulleted lists, and the calm professionalism of an oncologist, he is sympathetic to our civilization's economic needs, but firm in prescribing some pretty serious lifestyle changes.

The Heat Is On: The Climate Crisis, The Cover-up, The Prescription by Ross Gelbspan
Gelbspan, a Pulitzer Prize-winning journalist, exposes the machinations of oil and coal companies and some politicians to undermine the public confidence in science and to defer action against global warming. This riveting expose is a spirited call to action against a corporate disinformation campaign.

Feeling the Heat: Reports From the Frontline of Climate Change edited by Jim Motavalli
A team of environmental writers report from the world's "hot spots" where dangerous shifts in climate have already started. They document with vivid, on-the-spot prose the dramatic impact of rising tides, melting glaciers, disappearing beaches and intensifying storms on people's lives today.

The Pelican Awards

The Pelican Awards recognizes citizens, government agencies, legislators, journalists, educators, and non-profit groups that have demonstrated exemplary commitment, and undertaken meaningful actions to protect and restore our coastal environment. In 2004, we've even added several new categories for the best environmental projects by educational institutions and a lifetime achievement award. Congratulations to all!

2004 Pelican Awards

Lifetime Achievement Award
Feather and Willy Phillips

Best Initiative by Easley Administration
NC Shellfish Sanitation and Recreational Water Quality Section

Best Senate Legislation
State Senator John Kerr

Best House Legislation
State Rep. Danny McComas

Best Local Government Projects
Northern Coast: Town of Manteo
Central Coast: Morehead City
Southern Coast: Brunswick County

Citizen Action Awards
Northern Coast: Ginger Webster
Central Coast: Sandra Gaskill
Southern Coast: Lena Ritter

Best News Story or Series
Bill Sandifer of the *Washington Daily News*

Most Significant Legal Challenge
NC Environmental Management Commission

Best State or Federal Official or Entity
US Army Corps of Engineers' Regulatory Field Office in Washington, NC

Best Restoration/ Conservation Projects
Northern Coast:
Festival Park Restoration Team
Central Coast:
North Carolina Coastal Land Trust
Southern Coast:
Hewlett's Creek Initiative

Best Environmental Project (Primary or Secondary School)
Roland Grise Middle School

Best Environmental Projects (Post Secondary School)
Carteret Community College

Lifetime Achievement Award

During their long residency in coastal North Carolina, **Feather and Willy Phillips** have left an enduring mark on fishing communities. The Phillips became outspoken advocates for clean water in the early '80s when they became one of the Coastal Federation's first members in 1983 and helped us fight large-scale peat mining. At that time, they ran a boat building and repair shop and a crabbing operation in Bath. They set out to get commercial fishermen – a fiercely independent group – working with state officials and environmentalists to clean up local waters.

In 1987 the couple moved to the Alligator River area. During a stint as an arts teacher in Tyrrell County schools, Feather became alarmed that coastal arts and culture were dying out. She founded the Pocosin Arts Center, a nonprofit organization that helps coastal artists develop their talent and stresses the relationship between humans and nature. Pocosin Arts has been a key factor in Tyrrell's transformation from a county desperately courting industry – including a peat mining operation and a hazardous waste incinerator – to a hub for ecotourism. "We wanted to build our lives to emphasize the positive," Feather says. "We just got tired of lying down in front of bulldozers." Among other projects, center staff and volunteers helped plant a 7,000-tree cypress Millennium Forest that was featured this summer at the Smithsonian Folk Life Festival in Washington, DC.

Willy continues to work as a commercial crabber and fish dealer. This summer his Full Circle Crab Company opened a new retail outlet just outside Columbia, offering only local seafood, plus ecotourism outings like frog gigging and pound-net fishing. He often tells people that economic health is tied to environmental and community health. "Every time you spend money, you're essentially voting," he says. "We're trying to give people choices about what they buy and help tourists understand the place they're visiting." The Phillips and their son, Jake, have a home in Fort Landing.

Willy and Feather Phillips

Best Initiative By Easley Administration

The **NC Shellfish Sanitation and Recreational Water Quality Section,** through a grant from US EPA, is reinventing the way it documents pollution sources affecting shellfish beds. The new protocol utilizes a Global Positioning System (GPS) to pinpoint and a Geographic Information Systems (GIS) to map sources of pollution near shellfish growing areas, including stormwater outfalls. Working through a central state computer system, regulatory agencies will automatically receive emails of potential violation with pictures attached. The project is being tested in Carteret County and could be replicated coast wide.

Best Senate Legislation

As chair of the Senate Finance Committee, **State Senator John Kerr** of Goldsboro introduced legislation to allow the Clean Water Management Trust Fund, the Parks and Recreation Trust Fund and the Natural Heritage Trust Fund to use future funds to secure sensitive lands today. Certificates of participation (COPS) of up to $20 million may be issued to purchase land near military bases and up to $25 million in COPS to buy parks and gamelands. The new law will help finance the acquisition of lands bordering NC military bases in the coastal region.

Sen. John Kerr


Rep. Danny McComas


Ginger Webster


Sandra Gaskill


Lena Ritter

Best House Legislation

State Rep. Danny McComas, a five-term legislator and conservationist from New Hanover County introduced a bill to extend the Conservation Tax Credit for a year. Under the program, individuals or corporations may apply for substantial state tax credits for donations of real property for conservation purposes. McComas was also instrumental in forging a compromise that should allow beach driving and wildlife to coexist at Fort Fisher State Recreation Area.

Best Local Government Projects

■ ***Northern Coast:*** The **Town of Manteo** is making plans to overhaul its antiquated system for handling stormwater, with the help of the Clean Water Management Trust Fund (CWMTF). Currently stormwater is shunted into Shallowbag Bay through ten outfall pipes. Town officials hope to construct a holding pond near the existing sewage treatment plant, and then pump the water into a constructed wetland for gradual release into Croatan Sound. CWMTF has awarded Manteo a $627,000 planning grant.

■ ***Central Coast:*** In what we hope will be a model that other towns and counties will follow, **Morehead City** has agreed to apply for a stringent state stormwater permit, to ban sewer service to now undeveloped islands in the Newport River, and to look for ways to retrofit storm drains and reduce its sewage discharge into Callico Creek. Town officials included the measures in their written comments on the state's environmental assessment of the new plant. NCCF, in its comments, endorsed the measures and applauded the town for suggesting them. We also encouraged the state to include the measures as conditions of its permit for the plant.

■ ***Southern Coast:*** Last year in our "Too Soon To Tell" category, we stated that **Brunswick County** was at a crossroads in dealing with its booming development and said the county would be wise to apply for a meaningful Phase II Stormwater Permit. Since last October, the NC Coastal Federation and the county are attempting to chart a new course – collaborating on a two-year project funded by the US Environmental Protection Agency to develop a workable watershed management program for the Lockwood Folly River. The county is one of the few in the state that has submitted a comprehensive Phase II stormwater permit application. What a difference a year makes.

Citizen Action Awards

■ ***Northern Coast:*** Growth management isn't an issue, it's a lifetime commitment, according to **Ginger Webster** in Currituck County. She was co-founder in 1997 of Corolla Concerned Citizens, the first civic association on the Currituck Outer Banks dedicated to educating and informing residents and property owners about issues, including growth management. Ginger also served as the county's representative on the Coastal Resources Advisory Council for the Coastal Resources Commission, and her stellar service meant that she ended up serving as its chair where she worked to reinvigorate the role of the council. Recently, she stepped down from this leadership role, and turned her energies to helping the county update its Coastal Area Management Act land-use plan.

■ ***Central Coast:*** **Sandra Gaskill** proved that the much-maligned CAMA land-use plans could actually work. Her diligence and perseverance persuaded the Carteret County Board of Commissioners to use its plan to stop the construction of a major marina that residents didn't want and would have posed serious pollution problems. Sandra feared what the proposed Cape Lookout Marina would do to her beloved Harkers Island and to the water of Eastmouth Bay where generations of her people have fished and played. Sandra organized local opposition to the marina and personally lobbied her county commissioner, noting that their land-use plan opposed "marina-related dredging through active shellfish areas." The marina developers planned to dredge a 7,000-foot-long channel through the bay. The commissioners agreed, voting unanimously to ask the NC Division of Coastal Management to deny a Coastal Area Management Act permit for the marina. The division eventually did.

■ ***Southern Coast:*** When **Lena Ritter** takes on a cause, things happen. So when she started pushing the Coastal Federation, NC Division of Marine Fisheries, the Boy Scouts, the NC Clean Water Management Trust Fund, state legislators, county commissioners, and local Onslow County residents to buy a 52-acre waterfront parcel of land at Morris Landing, she saw to it that this traditional waterfront public access to Stump Sound near Holly Ridge would not be sold to private developers. Lena kept after everyone until we secured nearly $900,000 to purchase the land from the Boy Scouts to maintain public use of the property, as well as to provide an area for the NC Division of Marine Fisheries to stockpile oyster shells for its program to restore oyster reefs in Stump Sound. Lena was the spark plug that ignited the interest and necessary follow-up to save this land from development.

Best News Story or Series

Covering important environmental stories isn't easy because they usually involve complicated science, confusing legalities, entangling politics and impassioned emotions. A reporter must negotiate through all that while ensuring that all voices are heard. **Bill Sandifer of the Washington *Daily News*** did it all expertly in his reporting of the Navy's proposed Outlying Landing Field (OLF) in Washington County. Bill has written scores of stories in the paper's continuing coverage of the most contentious environmental issues in the state over the last year. Whether writing from inside a courtroom or from the middle of a farmer's field, Bill has been thorough and fair.

Most Significant Legal Challenge

The award goes to the **NC Environmental Management Commission** (EMC) for challenging the seemingly unbridled authority of the NC Rules Review Commission (RRC). Earlier this year, the RRC threw out five years of effort to create a statewide program to control stormwater. The EMC fought back by filing a lawsuit that alleges the RRC failed to follow a legal decision-making process. If the lawsuit is successful, the state stormwater rules could be brought back on track.

Best State or Federal Official or Entity

After Hurricane Isabel slammed into the Outer Banks last September, some property owners loaded up the sand that had been pushed across roads and trucked it away. Much of it was dumped illegally into wetlands. Using aerial photographs taken before and immediately after the storm, staff from the **US Army Corps of Engineers' Regulatory Field Office in Washington, NC,** documented dozens of fill violations in Dare and Hyde counties. In November two teams of regulators visited Hatteras Island to inspect the illegal filling. They wrote nearly 20 citations, many of which required removal of the sand. The Corps' Washington office also prosecuted several landowners for using FEMA money to dig new, illegal canals on the Hyde County mainland. And recently the office has taken an active role in investigating the illegal dredging of a channel off the Whalehead Club in Currituck Sound.

Best Restoration/Conservation Projects

■ ***Northern Coast:*** Led by the US Army Corp of Engineers, Wilmington District, the **Festival Park Restoration Team** is recognized for their efforts to restore Roanoke Island Festival Park's maritime forest and shallow water estuarine ecosystems, and promote oyster reef development. The team approach to restoration at Festival Park represented a unique partnership between state and federal agencies, local governments and commissions, and non-profit organizations (including NCCF). The Festival Park Restoration Team has also been recognized

nationally, and will receive a 2004 Coastal America Partnership Award for outstanding efforts to restore and protect the coastal environment.

- ***Central Coast:*** Nearly 900 acres of prime long-leaf pine forest along **Pettiford Creek** in Carteret County are forever protected thanks to the outstanding efforts of the **North Carolina Coastal Land Trust** (NCCLT). The NCCLT worked with owner and developer Paxon Holz for 2 ½ years on every detail until the entire 841-acre site was acquired. This magnificent ecosystem is home to three colonies of federally endangered red-cockaded woodpecker and other rare animals and plants. The land abuts the Croatan National Forest and includes more than 2.4 miles of waterfront along Pettiford Creek, a tributary of the White Oak River. The NCCLT is a non-profit organization that has worked since 1992 to conserve more than 26,000 acres of land in 21coastal counties.

- ***Southern Coast:*** Hewlett's Creek 10-square-mile watershed is straining under the development pressures, and most of the creek is closed to shellfishing, primarily as a result of urban stormwater runoff. The **Hewlett's Creek Initiative** is a partnership that includes the City of Wilmington Stormwater Service Department, New Hanover County's Tidal Creek Program, the NC Clean Water Management Trust Fund, the University of North Carolina at Wilmington, New Hanover County Soil and Water Conservation District, NC Ecosystem Enhancement Program, Pine Valley Golf Club, NC Sea Grant and the consulting firm Dewberry are taking the watershed approach to restore the shellfishing waters of Hewlett's Creek. The Hewlett's Creek Initiative is utilizing stormwater best-management practices; land conservation; a protected creek-side greenway and buffer; education; and research to achieve the goal of reopening the shellfish waters of the creek.

Best Environmental Project (Primary or Secondary School)

Roland Grise Middle School teachers Penny Windsor, Gwen O'Quinn, and **Sabrina Hill-Black** have participated in the Wetlands Nursery project with NCCF for the past two years. These sixth grade teachers have successfully expanded and incorporated this educational restoration project into their daily curriculum by having students conduct independent seed germination projects and create an environmental magazine highlighting their restoration efforts. The magazine includes their germination conclusions, pictures of their restoration planting, and letters to NC senators expressing the students' concern for the coastal environment.

Best Environmental Projects (Post Secondary School)

Under the leadership of the President, Dr. Joseph T. Barwick, **Carteret Community College** (CCC) has undergone an ambitious process of "green" growth throughout the Morehead City campus. Assisted by grants from the NC Clean Water Management Trust Fund, CCC undertook a planning process to identify ways within the existing and growing campus operations to improve the quality of the adjacent waters of Bogue Sound, and dedicating the campus and shoreline as a resource for the teaching and enjoyment of North Carolina's citizens. New buildings constructed on the campus are designed to be energy efficient and "green", and CCC includes new and retrofit projects demonstrating state-of-the-art stormwater best management practices throughout the campus. During 2005, CCC will undertake a shoreline and riparian buffer restoration project, and the construction of two new wetland areas to receive and pre-treat stormwater runoff generated from the campus.

Roland Grise Middle School teachers (left to right): Sabrina Hill-Black, Gwen O'Quinn, Penny Windsor.

MAÑANA continued from page 3

leave thousands of coastal residents without jobs either in the commercial fishing industry or in the tourist trades. For these reasons, it's essential to leave space for shorelines to adjust to sea changes, and to promote stabilization methods that don't establish rigid unmovable shoreline barriers.

Recognizing the long-term pitfalls of walling up estuaries, there's already a movement afoot to promote alternative methods of controlling estuarine shoreline erosion that both protects property and allows room for wetlands to move. It's an effort being pushed by groups like the Coastal Federation, government resources agencies, the NC General Assembly, and even some marine contractors and waterfront property owners. Policies are beginning to change because local people recognize the need to change old ways of confronting shoreline changes.

A report recently released by the US Global Change Research Program notes that other no-risk measures for achieving broader coastal protection goals and reducing climate change impacts include: linking presently fragmented wetlands and waters to provide the corridors needed for plant and animal migration; using water control structures for some wetlands to enhance particular functions and address decreased precipitation or increased evaporation; increasing management programs for invasive species control; restoring coastal habitats so that there's room for shorelines to migrate; and controlling hazardous coastal development practices so that less people end up in harms way.

As it turns out, our coast is already a focus area for the US Fish and Wildlife Service to explore the potential to restore forested wetlands so as to remove the excess carbon from the atmosphere. If this carbon sequestration strategy pans out, we may actually see power companies and other major corporations from around the world contributing huge sums of money to restore wetland habitats and grow more trees around our coast.

Some areas of our coast have good potential for generating electricity from wind. Perhaps some innovative folks will even devise a way to use restored wetlands as a platform for wind energy turbines – helping to improve water and air quality at the same time.

Necessity Is The Mother Of Invention

Clouds gathering on the horizon foreshadow rough times ahead as our coast adjusts to significant climate changes. We can choose to ignore the gathering storm, and be a victim of its consequences. Or, we can decide to act to make our coast – its natural and built communities – more resilient and accommodating of climatic events and changes.

Typically, problems tend to encourage creative efforts aimed at solving them. We'll need a lot of ingenuity and determination to promote the prudent coastal management actions that will be necessary in the future. But rest assured that this change will not occur just because it's needed. It will take active participation by engaged citizens in all our coastal communities to prompt decision-makers to make policy changes that reflect our long-term challenges and needs.

This *State of the Coast Report* will help you understand climate change issues as they relate to the North Carolina coast. On page 15 there are specific ideas for what you can do about this huge, vexing threat to our built and natural environments. Once you learn more, ultimately it will be up to you and your community to use this information in ways that help to address climate change issues.

In last year's *State of the Coast Report,* we noted that on the 30th Anniversary of the NC Coastal Area Management Act it was time to engage in some big-picture thinking about how to better protect and restore our fragile coast over the next 30 years. From our research described in this year's report, it's now clear that a significant part of this rethinking has to focus on the known consequences of global warming so that we adjust our coastal management strategies to ensure that our coast remains healthy and productive for ourselves, our kids, and our fish and wildlife.

NCCF LICENSE PLATE PROGRAM

Commonly Asked Questions

When will I get my plate?

Before the North Carolina Division of Motor Vehicles (DMV) will begin manufacturing our plate, we must obtain 300 completed applications with payment. Once we submit the applications, our design will be submitted for approval. The process should take two to three months after we receive the 300 applications. Please feel free to make copies of this application and share with friends who might like to have a Coastal Federation plate. We appreciate the help!

Can you put the NCCF plate on all vehicles?

Specialized plates may be purchased for automobiles, trailers and trucks with weight up to 26,000 pounds. Unfortunately, because of plate size, they cannot be purchased for motorcycles.

Can I personalize my plate?

Yes you can, but it is not required. There will be four spaces available for personalization. There is an additional $30 charge for personalization. You may request your personalized plate at any time. If you wish to do so with this application, please remit a check for $55 and list your 1st three choices on the application.

Can I change my mind?

We hope you'll always want to support the coast, but should you change your mind, you may go back to a regular license plate at any time.

How much does it cost each year?

- $25 for the special NC Coastal Federation ($15 goes to NCCF and $10 to state projects, including highway beautification and Visitor's Centers support)
- $20 to $25 annual license fee (price varies from county to county)
- $30 for personalization (optional)

How does purchasing a plate help the Coastal Federation?

The NCCF will receive $15 per plate as a contribution, which will be used to support the mission of the NCCF.

Questions? Please call the NC Coastal Federation at 252-393-8185.

Additional applications may be found on the NCCF web page at www.nccoast.org.

NORTH CAROLINA COASTAL FEDERATION
STATE OF THE COAST REPORT

North Carolina Coastal Federation
3609 Highway 24 (Ocean)
Newport, North Carolina 28570
252-393-8185

You may want to keep your State of the Coast Report for future reference. If not, please recycle it.

Printed On Recycled Paper

NC Coastal Federation License Plate to Hit the Road

Those who love the coast can now show their support by buying the NC Coastal Federation's new specialty license plate. Designed by volunteer Reggie Byrum of Nautica Communications (www.nauticacommunications.com), the full color plate is sure to be a popular sight on the road in the near future. But before we can install our license plates on vehicles, NCCF must receive 300 completed applications and checks for the first year's fees. Please order your coastal license plate today!

APPLICATION FOR A

NORTH CAROLINA COASTAL FEDERATION LICENSE PLATE

(License plate will be produced in full color. Plate design is still in approval stages)

Remit check or money order with this application.
Please make payable to NCCF and mail to: NCCF, Hwy 24 (Ocean), Newport, NC 28570

☐ Regular NC Coastal Federation **$25.00** | ☐ Personalized NC Coastal Federation **$55.00**

NOTE: You are allowed four (4) spaces for a personalized message. ___ ___ ___ ___
(The $30.00 personalized fee is an ANNUAL fee due in addition to the regular license fee)

Home

AREA CODE-TELEPHONE NUMBER

Office

AREA CODE-TELEPHONE NUMBER

NAME (To agree with certificate of title)

FIRST MIDDLE LAST

ADDRESS

CITY STATE ZIP CODE

Current North Carolina

Plate Number

Driver License #

Vehicle Identification Number

Year Model Make Body Style

Owner's Certificate of Liability Insurance

I CERTIFY FOR THE MOTOR VEHICLE DESCRIBED ABOVE THAT I HAVE FINANCIAL RESPONSIBILITY AS REQUIRED BY LAW.

PRINT OR TYPE FULL NAME OF INSURANCE COMPANY IN NC – NOT AGENCY OR GROUP

POLICY NUMBER – IF POLICY NOT ISSUED, NAME OF AGENCY BINDING COVERAGE

SIGNATURE OF OWNER

DATE OF CERTIFICATION