wildlife & GLOBAL WARMING

written and photographed by john manuel

JUST NORTH OF MANNS HARBOR ON NORTH CAROLINA'S CROATAN SOUND, BEN POULTER WADES AMONG THE SKELETAL REMAINS OF A ONCE-FLOURISHING POCOSIN FOREST. WILDFIRE KILLED THE TREES A FEW YEARS BACK, BUT WHAT CONCERNS THE DUKE UNIVERSITY RESEARCHER IS THE FACT THAT NO TREE SEEDLINGS ARE COMING UP.

Instead, a thick mat of chest-high sawgrass has invaded the forest. Sawgrass thrives in regularly flooded ground and is more tolerant of salt than such species as pond pine and cedar. The forest, it seems, is in retreat. Aerial photographs dating to the 1930s confirm that trend, at Croatan Sound and elsewhere along the coast. Though fire, disease and other factors may contribute to the retreat, Poulter believes that the chief driver is sea level rise, a byproduct of global warming.

NORTH CAROLINA HAS STARTED PLANNING FOR A SHIFT IN CLIMATE. WHAT COULD GLOBAL WARMING MEAN FOR THE STATE'S WILDLIFE?

Global climate is always changing, and sea levels change as well. Nearly 2 million years ago, at the dawn of the Pleistocene Epoch, sea levels began to fall dramatically as growing glaciers locked up increasing amounts of the planet's water. At its lowest level during the Pleistocene, the North Carolina coastline was 20 to 50 miles *east* of today's beaches. Sea levels rose during the interglacial periods, with the ocean covering the entire Coastal Plain as far west as modern-day Roanoke Rapids and Lillington.

Today, glaciers are melting, and sea levels are rising again as the warmer ocean water expands. This time the increase in temperature is relatively sudden and is believed by many scientists to be driven by the release of greenhouse gases into the atmosphere — in direct relation to the industrial-age increase in combustion of fossil fuels.

The drowned forest visible from the U.S. 64 bridge across the Alligator River is evidence of a rise in sea level.

Left: Ben Poulter explains how spartina grass (foreground) and sawgrass (background) are overtaking a pocosin forest as sea level rises. The marsh grasses favor wet ground and are more salt-tolerant than pond pines or cedar trees. Far right: Jeff DeBlieu, director of The Nature Conservancy's Nags Head Woods Preserve, joins Poulter on a survey of places where changes in plant succession may be a sign of climate change.

Scientists agree that the planet is warming. Arctic ice is melting at an increasing rate, and NASA satellites indicate sea level is rising about 2 to 3 millimeters per year. Using a combination of ice cores, lake sediment cores and tree rings, scientists have gathered information on Earth's climate back to A.D. 1000. Their findings show that temperatures started a dramatic rise in the late 1800s. The decade of the 1990s was the warmest in the past millennium for the northern hemisphere.

How will North Carolina's climate change in the next century, and how will wildlife adapt to the change? The National Center for Atmospheric Research predicts that mean temperatures in the southeastern United States will increase 3 to 9 degrees Fahrenheit by 2100. The center's models predict substantial increases (25 to 35 percent) in precipitation in the spring and substantial decreases (20 to 30 percent) in the summer. Changes in fall and winter precipitation will be relatively small. Across the Coastal Plain, Piedmont and Mountain regions, wildlife would encounter higher temperatures and markedly drier summers.

PLANTS

Peter White, director of the N.C. Botanical Garden, points out that North Carolina is the northern limit for trees such as the cabbage palm and the southern limit for trees such as the red spruce. "I've heard experts say the climate of North Carolina would be like that of southern Georgia," White says. "If so, we might see a significant turnover in tree species."

The one place to look for dramatic impacts would be mountain forests, White says. "Over the millennia, as climate has warmed and cooled, these forests have migrated up and down the sides of our mountains. Now they are backed up to the highest elevations. If subjected to increasing temperatures over a long period, they may be shoved off the mountains altogether."

White believes that localized extinction has happened in the past. While researching rare plants in the high mountains, White noticed that a number of plant species, such as small mountain bittercress and mountain avens, were absent in the lower-elevation mountains, even though the species are certainly capable of surviving there under present climate conditions. White believes such plants lived on these lower mountains at one time but were unable to retreat high enough to escape the heat during past warming trends and became locally extinct. Now, White says, the high mountain ecosystems are threatened by rapid climate change. Cool and moist climates that occur on north-facing slopes in the Piedmont might also become a thing of the past.

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The U. S. Forest Service has predicted the potential for redistribution due to climate change of 80 tree species. Sugar maple, which now grows in our Piedmont and Mountains, could be absent south of New York state, except in a small region of West Virginia. Longleaf pine, on the other hand, could expand from the southern Coastal Plain all the way to the foothills.

ANIMALS

As with plants, North Carolina represents the northern range limit of some animal species and the southern range limit of others. Species from the south would logically be expected to extend their range northward, and those that are at their southern limit would retreat, as the climate warms.

"Historically, species have moved north and south, and up and down in elevation — the so-called ice age yo-yo effect," says Jesse Perry, director of public programs with the N.C. Museum of Natural Sciences. "The problem now is that the landscape is more fragmented, and that can interfere with migration. Plants and animals may hit a wall and go extinct."

Species at their northern limit include the chicken turtle, the American alligator, the diamondback rattlesnake and a variety of frogs. Museum biologist Alvin Braswell says at least one frog species is already spreading north and westward in North Carolina, though factors other than climate may be involved.

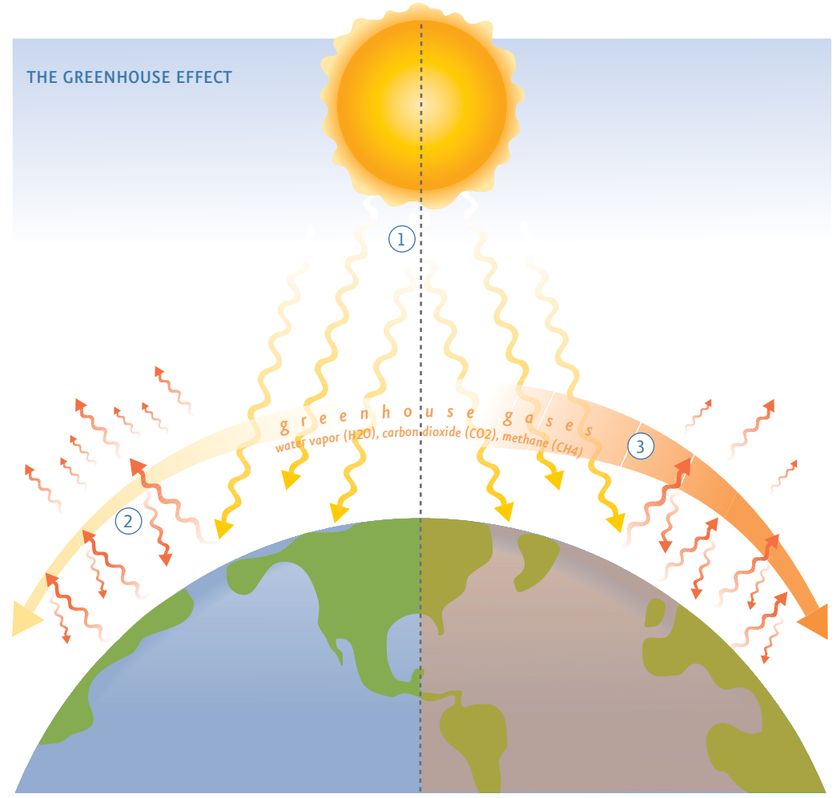
"We saw our first green treefrogs in Wake County in the 1980s," Braswell said. "[This species] has now been documented in Durham and Orange counties. Warmer temperatures may play a role, but I suspect its range has expanded with the spread of hydrilla, which provides cover."

Alligators have recently colonized Merchants Millpond in Gates County and have been seen as far north as Chesapeake, Va. "I've been at Merchants Millpond for 25 years and had heard of only one or two alligators ever being found north of Albemarle Sound," said Floyd Williams, head ranger at Merchants Millpond State Park. "They've been here now for nine years."

Increased ocean temperatures could be luring a whole host of tropical fish to reefs along the North Carolina coast. The National Marine Fisheries Service has been counting and tagging fish in Onslow Bay since 1975. In the last decade, biologists recorded 29 new species of tropical fish on the reef and increased numbers of previously observed tropical fish. Meanwhile, no new temperate fish have been found, and some, such as the black sea bass, are markedly less abundant.

Species at their southern limit that could suffer from hotter and drier summers include a number of salamanders: Weller's salamander, Wehrle's salamander and the red-cheeked salamander. "If you crank up the temperature a few degrees, you could lose those species," Braswell said. "Some of these are already receiving pressure due to forest change."

Trout found in our mountain streams would also be harmed by hotter and drier summers. "Anything that leads to widespread



1) Sunlight warms Earth's surface. 2) Earth's surface radiates heat to the atmosphere. Some heat goes into space. Greenhouse gases absorb some heat and reradiate it toward Earth, making it warm enough for life to exist. 3) Higher concentrations of greenhouse gases send more heat back to Earth's surface. "The current concentration of carbon dioxide is higher than at any time during the past 420,000 years, and the increase can be directly linked to human activities."

–National Wildlife Federation, "The Waterfowler's Guide to Global Warming"

EVERYDAY ACTIONS CAN HELP CUT EMISSIONS THAT INCREASE GREENHOUSE GAS CONCENTRATIONS

Reduce, reuse, recycle. www.epa.gov

Keep tires inflated and engines tuned. www.fueleconomy.gov

Make your house and place of business more energy efficient. www.energystar.gov

Go car-free now and then. www.ncdot.org

Buy "green power" from your utility company. www.ncgp.org

Plant and care for native trees. www.ncbg.unc.edu

THE FOREST FACTOR

Could forests benefit from one aspect of global warming, namely increased carbon dioxide? Could forests and soils help reduce carbon dioxide buildup in the atmosphere by storing carbon? William Schlesinger, dean of the Nicholas School of the Environment at Duke University, says the answer to both questions is a qualified yes.

An experiment using Free-Air CO_2 Enrichment (FACE) technology has been in progress at Duke Forest for a decade. Towers fumigate plots of loblolly pines with carbon dioxide at concentrations designed to approximate Earth's atmosphere in the year 2050. The study has shown that increased carbon dioxide enhances the growth of trees, though it appears that the availability of nitrogen in the soil may reduce production over time.

In the first year, the fumigated trees produced 25 percent more wood than trees in control plots, though the margin has declined to around 16 percent in later years. More carbon was retained in soils and woody materials in the experimental plots than in control plots. But compared with the amount of carbon now entering the atmosphere, the effect is minimal. Schlesinger says forests and soils shouldn't be counted on to solve the global warming problem.

warming of streams would have a negative impact on the distribution of trout," said Mallory Martin, fisheries biologist for the N.C. Wildlife Resources Commission. Martin says extreme water temperatures (above 80 degrees Fahrenheit) are deadly to trout. Heat and drought in combination could kill fish throughout an entire watershed, as high-elevation streams dry up and lower-elevation streams become too warm.

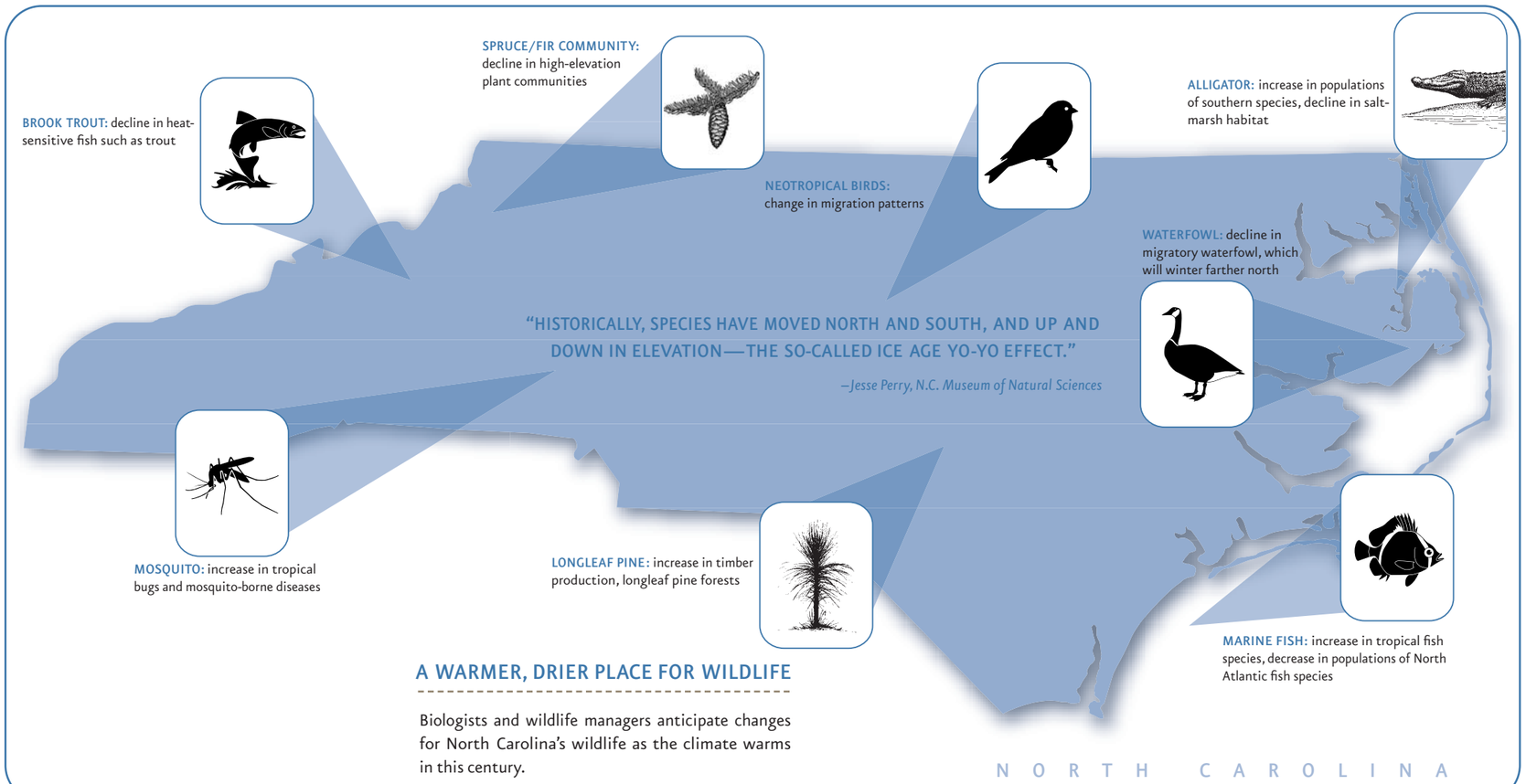
Warmer temperatures could also lead to fewer ducks along North Carolina's coast. Waterfowl could stop farther north in winter to find ice-free water and suitable food. The National Wildlife Federation has made global warming a top priority, citing among other changes the northward shift that the U.S. Forest Service projects for the breeding range of mallard and blue-winged teal in the Atlantic Flyway. State officials with N.C. Ducks Unlimited have expressed concern about the effects of global warming.

OUTER BANKS WILDLIFE

The fate of the more than 400 bird, mammal and reptile species that frequent the Outer Banks is harder to predict. The banks are basically sand ridges that have been moving westward through the process of storm overwash. Artificial dunes and fences that protect shore roads and buildings actually narrow the islands as erosion eats away at both shorelines. The disappearing act could threaten habitat for species such as the piping plover, which nests in sand flats created by overwash, and the loggerhead turtle, which can't scale the steep oceanfront scarps to lay its eggs.

CHRIS HILDRETH/ DUKE PHOTOGRAPHY

The same process applies to the marshes. Where shorelines are protected and gradients are shallow, marshes can migrate landward as sea levels rise. Sediment and plant materials build up on the back side of a marsh at the same time that wave action erodes the outer edge. But where gradients are steep, or where structures such as sea walls, buildings and roads prevent their movement, marshes will simply disappear when flooded by rising sea level.



A WARMER, DRIER PLACE FOR WILDLIFE

Biologists and wildlife managers anticipate changes for North Carolina's wildlife as the climate warms in this century.

Stan Riggs of East Carolina University has seen dramatic erosion—as much as 23 feet per year—on the shores of the Pamlico and Albemarle sounds and on the Outer Banks north of Cape Hatteras. "If the [foremost climate models] turn out to be true, North Carolina is in for serious consequences," Riggs says. "Within the next century, the Outer Banks could be reduced to a few scattered islands, and there would be major land losses in Currituck, Camden, Dare, Hyde, Tyrrell and Pamlico counties."

Today, Pamlico Sound's shallow, low-salinity waters and marshy edge provide a high-quality nursery habitat for finfish and shellfish. If salt water washes over the Outer Banks, Pamlico Sound would become a bay, with the corresponding loss in nursery habitat.

"If we lose Pamlico Sound, it would reduce our productivity tremendously," said Louis Daniel of the N.C. Division of Marine Fisheries. "We would see more coastal migratory pelagic fish—king mackerel, false albacore and cobia—but adding that region to the oceanic habitat would be insignificant compared to the loss of estuarine habitat."

Can we minimize the negative effects of climate change on North Carolina wildlife? The U.S. Fish and Wildlife Service and The Nature Conservancy are teaming up on a study of how to manage their refuges in the Albemarle-Pamlico region as sea levels rise. The peninsula is crisscrossed by canals connected to the sounds, constructed to drain the land for timber and agricultural production. Dennis Stewart, manager of the Alligator River National Wildlife Refuge, is concerned that these canals may allow saltwater to permeate the peninsula, which would break down the peat soils and kill trees.

"We can't stop sea level rise, and we can't fill in the canals, but we do have water control structures that could be closed to prevent saltwater intrusion," Stewart said. "Our goal is to provide the highest-quality habitat for the widest range of species, especially federal trust species like the red-cockaded woodpecker."

Some people would like to see policies that allow barrier islands and marshes to migrate landward as sea level rises. North Carolina law currently prohibits hardening of beachfront property, but not soundfront property. "It's essential to leave space for shorelines to adjust to sea changes, and to promote stabilization methods that don't establish rigid, unmovable shorelines barriers," said Todd Miller, executive director of the N.C. Coastal Federation.

In August 2005, North Carolina joined nearly 40 other states in taking the initiative on global warming with passage of the N.C. Global Warming Act. The legislation established a 34-member commission whose charge is to consider potential impacts on the state from rising temperatures and evaluate recommendations on state goals for pollution reduction. The commission will also study how the state can prepare its economy to capitalize on emerging markets related to climate change.

Changes in global climate have been driven by forces that humans cannot hope to alter in the short term. But a growing number of organizations have joined state and local governments in seeking long-term solutions.

The same holds true for individuals. The choices we make, from the energy efficiency of our homes to the vehicles we drive, have a direct impact on the amounts of greenhouse gases released into the atmosphere. For the past century, carbon dioxide emissions, global temperatures and sea level have all been rising. Collective action now and in the future may be the only way to stem the rising tide. ◆

John Manuel is author of "The Natural Traveler Along North Carolina's Coast."

Scientists have produced several models of climate change. Unless otherwise stated, the author has used predictions developed by the United Nations' Intergovernmental Panel of Climate Change for this article.