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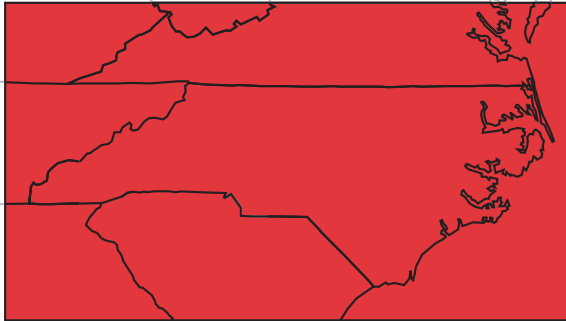
PHYSICIANS FOR  
SOCIAL RESPONSIBILITY

**DEATH**

BY

**DEGREES**

**THE HEALTH THREATS  
OF CLIMATE CHANGE  
IN NORTH CAROLINA**





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**This report was prepared by Physicians for Social Responsibility to alert North Carolina residents to the potential health effects of climate change and to encourage them to reverse global warming's deadly course by reducing reliance on fossil fuels.**

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## Death by Degrees

*The ten warmest years on record have all occurred since 1983. During the past century, global temperatures have increased at a rate near 1.1 degree Fahrenheit (F) per century, but this trend has dramatically increased to a rate greater than 3.0 degrees F per century during the past 25 years.<sup>1</sup>*

—NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Climate fluctuations have occurred during previous centuries, but at the dawn of the 20<sup>th</sup> century a warming trend took hold that shows no signs of stopping. During the past one hundred years average global surface temperatures have increased by approximately 1 degree Fahrenheit (F). Each and every year from 1987 to 2000 has been one of the fifteen warmest years on record.<sup>2</sup> In 2000, scientists at the National Oceanic and Atmospheric Administration (NOAA) announced that the winter of 2000 was the warmest winter on record since the United States government began keeping weather statistics 105 years ago.<sup>3</sup> This was the third year in a row that record had been broken,<sup>4</sup> and many other records concerning heat and temperatures continue to be topped.

Although uncertainties exist in measuring global warming, an overwhelming consensus has emerged over the last decade among scientists on several key points. First, the increase in temperature is real. Second, human activities—in particular our burning of fossil fuels—are affecting the climate system.<sup>5</sup> Third, warmer conditions on Earth will directly affect our lives and well-being.<sup>6</sup>

This report describes how the changing global climate could impact human health. Our focus is on North Carolina, a state that may experience increased illness, mortality, and property damage due to changes in temperature and weather.

## Executive Summary: North Carolina—A State At Risk

*Sectors such as agriculture, food products, and forestry products are at high risk from climate change and they comprise a large part of our state's economy. Rapid industrialization and increasing population in our state will increase North Carolina's share of greenhouse gas emissions. The potential for sea level rise will also cause negative economic impacts in our coastal zones.<sup>7</sup>*

—STATE ACTION PLAN FOR REDUCING  
GREENHOUSE GAS EMISSIONS FOR NORTH CAROLINA

With its rural charm and urban amenities, North Carolina appeals to visitors and natives alike. It is no wonder that the state has experienced explosive growth over the past decade at a rate that far exceeds growth elsewhere in the U.S.<sup>8</sup> The population boom, however, comes at a price. Already North Carolinians are experiencing vanishing farmlands and rural landscapes, increased commute times, stress on local governments, and pollution of the state's once pristine air, streams, rivers, and fisheries.<sup>9</sup> North Carolina's greatest challenges may be on the horizon, though, given the changes that global warming could bring.

Based on the newest projections made by the Intergovernmental Panel on Climate Change, by 2100 temperatures worldwide could increase 2.5 to 10.4

### How Global Warming Could Threaten Health in North Carolina

A number of health hazards may increase as a result of global warming. According to physicians who have studied global warming and its effects, the most severe health risks in North Carolina could include the following:

- Decreased air quality in the state due to increased ozone (smog) levels, leading to more frequent and severe cases of asthma and other respiratory problems. Ozone-related health problems already warrant high concern in the state. In the period from April to October of 1997, there were an estimated 5,700 emergency room visits and 240,000 asthma attacks in North Carolina related to ozone exposure.<sup>10</sup>
- Increased allergy problems due to heightened pollen levels and air pollutants.
- More heat-related illness and death in North Carolina. In Greensboro, deaths resulting from heat stress during a typical summer could increase nearly 70 percent, from about 20 heat-related deaths per summer to over 35 fatalities<sup>11</sup> with the predicted 3 degree F rise in temperature over the next century.
- More injury and property damage from severe storms, hurricanes, tornadoes, lightning, and floods.
- More pfiesteria outbreaks and harmful algal blooms, which have caused massive fish kills and neurological damage in humans.
- More contaminated drinking water supplies, upper respiratory problems, and gastrointestinal ailments linked to the flooding and overflow of hog waste facilities.
- More cases of diseases spread by mosquitoes and ticks such as West Nile Virus, Lyme Disease, and Encephalitis.
- An increase in water-borne illness caused by exposure to infectious agents, like cryptosporidium and giardia, which could be released or become concentrated in the state's water supplies if climate change alters water levels.
- Greater risk of injury and property damage, particularly along the coastal regions and barrier islands, due to coastal erosion associated with accelerated sea level rise.

degrees F. Temperatures in North Carolina could change equally dramatically. According to Environmental Protection Agency (EPA) findings based on older IPCC projections, temperatures in the state could increase by 3 degrees F over the next century. Precipitation is also projected to increase by 15 percent in many parts of the state.<sup>12</sup> Other climate models may show different results.

While projections look to the future, global warming appears to be influencing climate now. Heat stress days and nights have increased throughout the state over the past fifty years.<sup>13</sup> More heat brings more cases of heat cramps, heat exhaustion, and heat stroke. In addition, heat can cause death and tends to exacerbate the death rate from other medical conditions. The elderly, infirm, children, and infants will likely suffer the most.

While global warming could cause overall temperatures to rise during the winter months, predictions also include an increase in the frequency and intensity of winter storms and weather extremes, meaning winters with more days of very low temperatures. In addition, the amount of precipitation on extreme wet or snowy days in winter is likely to increase. Extreme cold also poses direct threats to human health, leading to cases of hypothermia and frostbite. Extreme weather and sudden temperature fluctuations can also affect individuals with pre-existing respiratory and heart problems, exacerbating their conditions.

Climate change means extremes. Greenhouse gas concentrations increase heat and moisture in the atmosphere. Heat and water vapor create instability, leading to more frequent and possibly more severe weather activity,<sup>14</sup> including thunderstorms, lightning strikes and floods. Increased precipitation could lead to more flooding. Flooding increases the risk of water contamination, gastrointestinal illnesses, and property damage and can result in cases of bacterial disease and respiratory problems. Hurricanes, tornadoes and thunderstorms could also result. Strong winds from these events could lead to more property damage, injuries, and fatalities in the state.

North Carolina's air quality will likely deteriorate due to climate change. The pollutants emitted from cars and power plants that burn fossil fuels include carbon dioxide, which causes global warming, and other pollutants. These pollutants help to create ground-level ozone. The amount of ozone, the primary component of smog, commonly rises on hotter days. High ozone levels exacerbate asthma and other respiratory illnesses. In addition to asthma attacks, exposure to elevated ozone levels can cause shortness of breath, pain when breathing, lung and eye irritation, and greater susceptibility to respiratory illness, such as bronchitis and pneumonia.<sup>15</sup> As it stands, 17 North Carolina counties fail to meet federal air pollution standards.<sup>16</sup>

Water quality and availability may also be compromised as the climate changes. We may see reduced availability of water due to increased evaporation, reduced water reserves due to early melting of snow packs, altered seasonal cycles of runoff, and increases in river and stream flow variability. Lowered water levels may also necessitate the dredging of inlets, which could release toxins buried in sediment. Gastrointestinal diseases such as giardiasis and cryptosporidiosis that annually affect many North Carolina residents could become more common.

Contaminated water also could impact North Carolina's food supply as people ingest water-borne toxic agents.<sup>17</sup> Further, increased temperatures can

encourage the growth of food contaminants, such as *E. coli* and salmonella, illnesses that already affect North Carolina's residents.

Global warming also may change the chemical composition of the water that fish and shellfish inhabit, causing the amount of life-sustaining oxygen in the water to decline, while dangerous pollution and salt levels increase.<sup>18</sup> Climate change may also affect the occurrence and severity of pfiesteria and other poisonous algal blooms, known as "red tides," which put fishermen and fish consumers at risk from illness.

Climate change may also increase the cases of vector-borne disease that occur in the state. Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, increasing the potential for transmission of the diseases they carry. Temperature is a limiting factor with respect to transmission of a viral agent by a vector, such as a tick or mosquito.<sup>19</sup> In North Carolina, diseases spread by ticks include Lyme disease, Rocky Mountain Spotted Fever and ehrlichiosis. Mosquitoes already flourish in North Carolina, and some carry different forms of encephalitis and West Nile Virus, a dangerous disease that recently spread to the state. If conditions become warmer and wetter, mosquito populations could increase, thereby increasing the risk of transmission of these diseases.<sup>20</sup>

The sea level along North Carolina's coast falls within that stretch of U.S. coast most vulnerable to rising seas.<sup>21</sup> Therefore, much of the state's 3,375 miles of tidally influenced shoreline, consisting of the barrier islands, salt marshes, and tidal freshwater marshes are at risk from erosion.<sup>22</sup> Studies by EPA and others have estimated that along the Atlantic coast, a one foot (30 cm) rise in sea level is likely by 2050 and could occur as soon as 2025. In the next century, a two foot rise is most likely, but a four foot rise is possible.<sup>23</sup> Such a rise could dramatically increase storm surges and lead to coastal erosion, particularly along the barrier islands, including the Outer Banks. In addition salt water intrusion could affect drinking water supplies.

Climate change could affect the production of North Carolina's primary crops such as corn, wheat, hay, and tobacco. Soybean, corn, and wheat yields could decrease as a result of climate change. Estimated changes in yield vary, depending on whether land is irrigated.<sup>24</sup> Weather-stressed crops also can increase nitrate concentrations in plants, which may lead to respiratory and nervous system disorders in animals,<sup>25</sup> and possibly in humans. If summer temperatures rise significantly, livestock may also be adversely affected.<sup>26</sup>

Finally, North Carolina's forests could change as a result of global warming. North Carolina's warmer mixed forests, dominated by southern pines and oaks, could spread northward replacing the predominantly hardwood forests of the north and west.<sup>27</sup> Forests weakened by pollution and dried from warmer temperatures may be at risk from fire. Fires not only damage wildlife and property, but also create serious health problems. In addition, smoke from forest fires can increase cases of respiratory illness.

Impacts on the farming, fishing, forestry and related tourism could affect jobs and income in the state. This change could influence the ability of individuals to afford health insurance. Already, state uninsured rates are of concern. In 1998, 15 percent of North Carolina residents were without health insurance coverage.<sup>28</sup>

North Carolina needs to be deeply concerned about the potential health impacts of global warming on its population. Only precautions taken now can avert the potential health problems of the future. The following sections describe the specific health effects that are predicted to result from global warming over the next fifty to one hundred years. In some cases, there is a high level of certainty about the predictions. In others, the evidence is less definitive. The United States has the ability to adapt to, and prepare for, these changes because of its health care infrastructure and strong economy. However, we will only ameliorate the potential health effects of climate change by decreasing greenhouse gas emissions today and investing in strategies that will help us to prepare for what is to come.

### The Complex Origins of Climate Change

Since the end of the last Ice Age 10,000 years ago, temperatures worldwide have risen about 9 degrees Fahrenheit, mainly due to natural changes in the geographical distribution of the sun's energy and in the amounts of dust, carbon dioxide, and other gases in the atmosphere.

In recent years, the rate of increase in temperatures has been accelerating. On any given day, the average temperature is about 1 degree F higher than a century ago. Eight of the ten warmest years in recorded history occurred in just the last decade, with 1998 topping them all.<sup>29</sup>

Some greenhouse gases, such as carbon dioxide, methane, nitrous oxide, and water vapor, occur naturally, residing in the atmosphere and insulating the earth. These gases retain heat from the sun's rays and keep the earth's surface some 60 degrees F warmer than it otherwise would be.<sup>30</sup> However, the amount of greenhouse gases in the atmosphere has been rapidly increasing. Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased by 31 percent, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about fifteen percent.<sup>31</sup> The increases are staggering even across short time spans. In 1999, for example, the United States released 13 percent more greenhouse gases than in 1990.<sup>32</sup> Such increases have enhanced the heat-trapping capacity of the earth's atmosphere.

**Human activities are among the most important factors making Earth warmer.** Fuel burned to run cars and trucks, heat homes and businesses, and power factories generates approximately 80 percent of carbon dioxide emissions in the

United States.<sup>33</sup> Deforestation, livestock production, landfills, industrial production, and mining can also change the levels of greenhouse gases by increasing emissions or by decreasing the absorption of gases by plants.

In 1994, the United States was responsible for releasing about one-fifth of global greenhouse gas emissions into the atmosphere. If current trends continue, carbon dioxide concentrations could increase by 30 to 150 percent by the year 2100.<sup>34</sup> As it stands, carbon dioxide is at a level unseen on Earth in 420,000 years, and perhaps even as far back as 20 million years, according to a report issued in January 2001 by the Intergovernmental Panel On Climate Change.<sup>35</sup>

Scientists recently detected a new greenhouse gas 18,000 to 22,200 times more powerful than carbon dioxide, with an atmospheric life span of up to 3,500 years.<sup>36</sup> The gas trifluoromethylsulphur pentafluoride, or SF<sub>5</sub>CF<sub>3</sub>, has been found in the atmosphere five to twenty miles above the Earth's surface, where it contributes to global warming by absorbing heat radiating from Earth's surface. The gas is of human origin and researchers speculate that the gas is a breakdown product of high voltage equipment, but an exact source is unknown. Studies suggest that emissions began in the late 1950s and since then levels have increased from near zero to 0.12 parts per trillion in 1999. In addition, its rate of growth may be accelerating. SF<sub>5</sub>CF<sub>3</sub>'s long lifespan means that unless its production is prevented, its levels can be expected to increase as the gas accumulates in the atmosphere. SF<sub>5</sub>CF<sub>3</sub>, along with other greenhouse gases, will remain there for centuries, trapping heat and threatening human health.

## The State of the Science

*The effects of global warming already seem evident.*<sup>37</sup>

—GEORGE SOMERO, PROFESSOR OF MARINE SCIENCE, STANFORD UNIVERSITY

Recent scientific studies suggest that global warming is underway and that temperatures are rising due to increases in greenhouse gases. Scientists studying ice cores, oceans, solar changes, volcanic activity, and temperature trends are all concluding that warming is occurring and human activities are playing a role. Our current understanding of the potential impacts of climate change is limited by the accuracy of climate models that are still being developed and perfected. However, forecasting models are gaining credibility every day as weather patterns and other environmental occurrences confirm projected scenarios.

Further, the Intergovernmental Panel on Climate Change (IPCC), a United Nations-sponsored group of hundreds of scientists, recently distributed a report to government officials worldwide stating that human generated pollutants have “contributed substantially” to climate change. The new IPCC assessment on the science of global warming predicts that by 2100, average global surface temperatures will rise from 2.5 to 10.4 degrees F (1.4 to 5.8 degrees C). This is a significantly greater increase than the 1 to 3.5 degree C increased predicted in the second assessment report of the IPCC from 1995.<sup>38</sup>

In March 2000, the National Oceanic and Atmospheric Administration’s Climate Center in Asheville published a report in *Geophysical Research Letters* that concluded that global warming is speeding up.<sup>39</sup> The research team, led by Thomas R. Karl, stated there is only a one-in-twenty chance that the record high temperatures of recent years were simply part of normal climate variation.<sup>40</sup>

In an October 2000 report in the journal *Science*, researchers from the National Climatic Data Center and the National Center for Atmospheric Research analyzed 20 global climate models, along with weather patterns documented over the past century. The scientists concluded that extreme weather will occur more frequently as climate changes, and warned that hotter days, warmer nights, heavier rain and snowfall events and more floods are expected over the coming years, as carbon dioxide and other greenhouse gases affect Earth’s climate.<sup>41</sup>

In December 2000, climate analysts at the National Center for Atmospheric Research quantified the effects of El Niño events and major volcanic eruptions on average global temperatures. Volcanic emissions tend to block sunlight and El Niño episodes can raise overall temperatures, which mask temperature trends. Adjusting for these effects, scientists discovered an intense warming trend over the past century, with temperatures increasing by one quarter of a degree Celsius per decade. Lead analyst Tom Wigley concluded that human activities primarily are to blame for the warming.<sup>42</sup>

In November 2000, scientists at the University of Bremen, Germany, reported in the journal *Nature* that ocean wave activity supports climate change projections. The researchers analyzed microseisms, ground movements with periods of 6 to 14 seconds, as a proxy for ocean wave activity throughout the northeastern Atlantic Ocean over the past 40 years. They

found a consistent level of activity for the years 1954–1977. After 1977, however, wave heights increased steadily, supporting global warming forecasts made since 1988 and coinciding with detected increases in storm activity throughout the region.<sup>43</sup>

Today concentrations of greenhouse gases appear higher than they have been in the past 420,000 years.<sup>44</sup> Even if certain individuals are able to adapt to changes caused by global warming, some populations will remain susceptible. The most vulnerable individuals include infants, children, the elderly, and the infirm.

Clearly the availability and continued development of better information on the potential impacts of climate change, and the interaction of these impacts with other important factors, is critical if society is to understand the science of climate change and to prepare for the changes global warming could bring. Natural climate variability and other factors, such as air quality, land use, population, water quality, health care infrastructure, and the economy can also impact projections. A few scientists even argue that countervailing climatic forces, such as sulfur dioxide, actually are cooling the atmosphere. However, the majority of climate scientists agree that greenhouse gases produced by humans are changing Earth’s atmosphere and that now is the time to take action on a global level.

### **Global Warming at a Local Level**

Although the average temperature worldwide is increasing, hence the term “global warming,” the story becomes more complicated at the local level. One reason is that a warmer atmosphere holds greater amounts of water, resulting in more precipitation. Another is that warmer air means changes in wind patterns. The resulting weather changes will vary from place to place. In general, we can expect more extremes—more heat waves, more storms, wetter climates in some places, drier climates in others, and even cooler temperatures in certain areas. Many scientists, therefore, prefer the term “global climate change” to “global warming.” In this report, we use the two terms more or less interchangeably.

## **Many North Carolina Residents Are Vulnerable to the Health Effects of Climate Change**

*Certain populations within the United States—the poor, the elderly, children and immunocompromised individuals—may be more vulnerable to many of the health risks that might be initially exacerbated by climate change.*<sup>45</sup>

—REPORT OF THE HEALTH SECTOR OF THE US NATIONAL ASSESSMENT

Many North Carolina residents are particularly vulnerable to the potential health effects of climate change. *Children* are at risk because their immune and other protective systems are not yet fully developed. Children less than a year old are especially sensitive to heat stress because their heat regulatory systems have not fully matured.<sup>46</sup> In addition, a child’s higher susceptibility to heat and cold is due to its body surface area being greater by percentage for its weight. A child dehydrates easier due to external heat or fever compared to an adult with the same fever or in the same external temperatures.

*Individuals with existing illnesses* are also especially sensitive to heat stress, air pollution, and other possible effects of global warming. People with

cardiovascular and respiratory illness or impairment are less able to adapt to additional physical stress caused by warmer and more humid environments. Air pollution has also been shown to have a more severe impact on persons suffering from heart and lung diseases.<sup>47</sup>

The number of deaths in North Carolina from heart disease and stroke has prompted the American Heart Association to place the state in an area known as the “Stroke Belt.” Every 21 minutes, someone in North Carolina dies from heart disease or stroke.<sup>48</sup> In 1997, more than 24,899 of the 7,428,579 state residents died from some form of cardiovascular disease.<sup>49</sup> This rate of 335 deaths per 100,000 far exceeds the national average of 268 deaths per 100,000 population.<sup>50</sup> Higher temperatures could elevate the number of deaths due to heart disease. It is also possible that warmer winters could reduce the number of deaths in winter months, however experts agree that the relationship between winter weather and mortality has been difficult to interpret.<sup>51</sup> In addition, many North Carolina residents have behavioral factors that would put them at higher risk of developing these diseases. For example, 53.9 percent of individuals in the state and 61.6 percent of individuals between the age of 55 and 64 reported themselves as being overweight in 1997 in a health surveillance study conducted by the Centers for Disease Control and Prevention (CDC).<sup>52</sup> Another CDC report found that 25.8 percent of the state’s adults smoked in 1997. This was higher than the national average of 23.2 percent.<sup>53</sup>

Several factors could make the state’s *elderly* more susceptible to the potential health-related impacts of global climate change, particularly to heat-related illness. Elderly individuals may have less efficient heat-regulating systems. The temperature at which sweating begins is higher, affecting their ability to adjust to warmer temperatures. In addition, the elderly may have a harder time perceiving changes in temperature, preventing them from taking appropriate measures to prevent overheating. Pre-existing conditions, such as cardiovascular or pulmonary diseases, make a person more vulnerable to the effects of heat. Some commonly-taken medications, such as tranquilizers and anticholinergics, also increase susceptibility to heat-related illnesses.<sup>54</sup>

If global warming increases levels of air pollution, *poorer populations* may be hit hardest. Poverty can be an important risk factor for poor health status. Rates of children hospitalized for asthma, for example, increase as family income declines.<sup>55</sup> If global warming increases levels of air pollution, poorer populations may be hit hardest. According to the U.S. Census Bureau, 19.6 percent of North Carolina’s children live below the nation’s poverty line.<sup>56</sup>

*Individuals without medical insurance* may also be more susceptible to the potential health effects of climate change because they do not routinely see health care providers. They may delay seeking treatment until a condition is severe or at a more advanced, less-treatable stage.<sup>57</sup> Cost can also play a role in deciding whether or not to seek health care. This factor may disproportionately affect minorities in North Carolina. For example, 18.2 percent of African Americans and 25.6 percent of Hispanics reported cost as a barrier to obtaining health care in 1997 compared to 12.4 percent of whites.<sup>58</sup>

## Weather Extremes May Lead to Increases in Illness and Mortality

*Climate change will be manifested in a catalogue of disasters such as storms, droughts and flooding unparalleled in modern times.<sup>59</sup>*

—INTERNATIONAL FEDERATION OF RED CROSS AND RED CRESCENT SOCIETIES

Climate change means extremes. Climate models predict not only higher temperatures, but also more unpredictability in weather patterns and more extreme weather conditions, including extremely cold days.<sup>60</sup> Greenhouse gas concentrations increase heat and moisture in the atmosphere. Heat and water vapor create instability, leading to more frequent, and possibly more severe, weather activity.<sup>61</sup> This may mean more floods, tornadoes, hurricanes, heat waves, and other natural disasters. Extreme weather can cause profound human suffering and huge economic losses. In 1999, insured losses from weather-related natural catastrophes in North Carolina totaled 1.35 billion dollars. During the 1990's, insured losses totaled nearly 4 billion dollars. Among all states, North Carolina ranked fourth for suffering the most damage for the decade.<sup>62</sup>

Weather extremes and temperature fluctuations can have wide-reaching health impacts, including illness, injury, and death. They can disrupt electrical power sources, compromise access to public service broadcasts, and contaminate drinking water supplies placing populations in jeopardy. Downed electrical power lines and leaks from natural gas or propane tanks can cause fires, electrocutions, and explosions. Intense rainstorms and floods can wash raw sewage into drinking water supplies and spread infectious diseases. Tornadoes, hurricanes, high winds, thunderstorms, and drought can intensify forest fires, possibly leading to injuries, fatalities, and exacerbated respiratory illness. Residents displaced from their homes by natural disasters can also experience psychological problems, ranging from depression to post-traumatic stress disorder.<sup>63</sup> In the first two months after Hurricane Floyd struck, one organization reported that it received more than 8,780 outreach and crisis counseling requests weekly.<sup>64</sup>

Depending on their severity, extreme weather events can tax, or even cripple, emergency care programs. The consequences could prove disastrous in North Carolina, where the number of hospital beds is only 3.1 for every 1,000 people.<sup>65</sup> Storm activity can also disrupt power in the state. Over one-half million residents lost power during the aftermath of Hurricane Floyd in September 1999.<sup>66</sup> On March 3 of that same year, high winds knocked out an electrical station, causing a loss of power to 11,000 customers.<sup>67</sup>

## ***Direct Effects of Heat on Health***

*A heat wave caused many to require hospital treatment in Columbus County and in neighboring counties in Southeast North Carolina. A farm worker died of heat stroke after hospitalization.*<sup>68</sup>

—NATIONAL CLIMATIC DATA CENTER REPORT FOR JULY 20, 1999

The fourteen years from 1987 to 2000 are each among the fifteen warmest years on record. Global land temperatures in 1999 made the year the second hottest year recorded, beaten only by temperatures in 1998. This warming trend is also seen in North Carolina. Average temperatures in Chapel Hill have increased 1.2 degrees F over the last century. Based on 1995 projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model, a model that accounts for both greenhouse gases and aerosols, it is projected that by 2100, temperatures in North Carolina could increase by 3 degrees F with a range of 1 to 5 degrees F, depending on the season.<sup>69</sup> To put this into perspective, the average global temperature at the time of the last Ice Age was only nine degrees lower than temperatures are today.

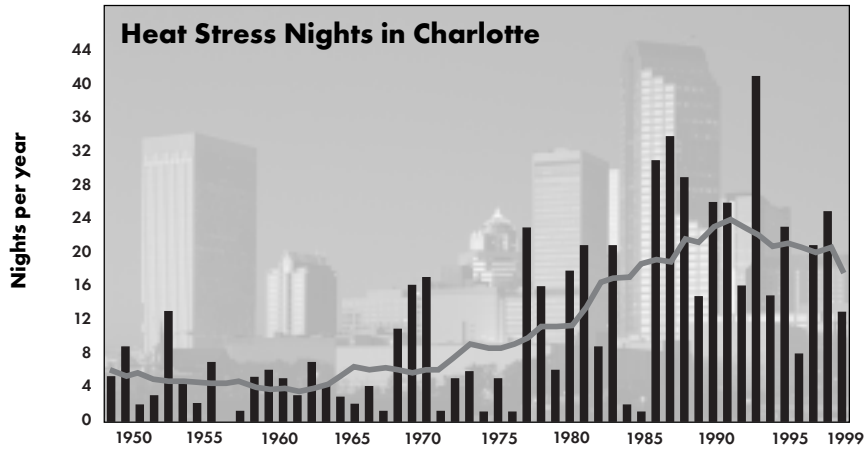
A recent analysis of data from over 100 weather stations nationwide further reveals that the number of heat stress days and heat stress nights as well as the number of 4-day heat waves across the country has increased over the past fifty years. In this National Oceanic and Atmospheric Administration (NOAA) study, heat stress days were calculated using the heat index, a combination of temperature plus humidity.<sup>70</sup>

In North Carolina, the three communities in the study, Cape Hatteras, Charlotte, and Greensboro, all exhibit increases in temperature and number of extreme heat events. From Piedmont to the Outer Banks, heat-stressed days and nights have risen dramatically over the past fifty years. In Charlotte, the number of 4-day heat waves has more than doubled since 1950.

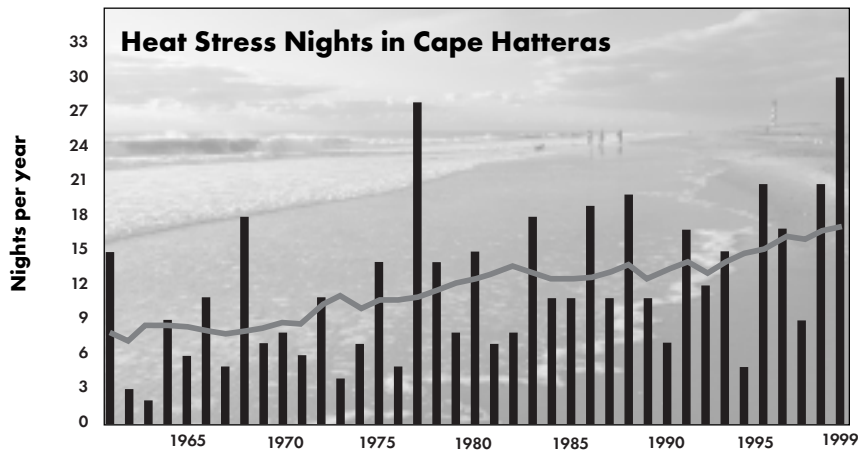
The rise in number of heat-stressed nights poses a particular health concern. At night the body has a chance to cool down, but on unusually hot nights, the body does not get the needed relief from high daytime temperatures. North Carolina normally experiences over 90 degree F temperatures from May through August, especially in Charlotte, Raleigh, Wilmington, and the Piedmont Triangle.<sup>71</sup> If nighttime temperatures continue to offer no relief, we could see an increase in heat-related mortality rates.

A 1997 study by scientists at the University of Delaware Center for Climatic Research examined mortality and weather data for a series of cities in the United States. During oppressive heat wave events there was a significant increase in the number of deaths per day for the general population, with the elderly being most at risk.<sup>72</sup> Despite North Carolina's usual high summer temperatures, residents will likely still be susceptible to heat waves and increased temperatures. According to the EPA, one Greensboro study projects that deaths resulting from heat distress during a typical summer could increase by 70 percent, from nearly 20 heat-related deaths per summer to over 35 fatalities.<sup>73</sup>

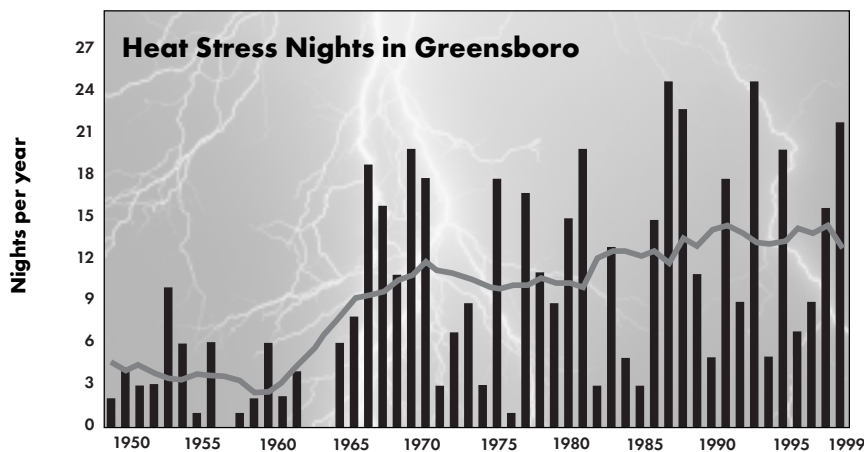
FIGURE 1  
**Extreme Heat in North Carolina**



Number of nights with extreme temperatures per year in Charlotte, 1948 - 1999



Number of nights with extreme temperatures per year in Cape Hatteras, 1961 - 1999



Number of nights with extreme temperatures per year in Greensboro, 1948 - 1999

Source: Ozone Action/Physicians for Social Responsibility. 1948 - 1995 data from Gaffen and Ross, 1998, *Nature*, vol 396, p. 529. 1996 - 1999 NOAA data was analyzed by Physicians for Social Responsibility and Ozone Action.

## Air Conditioning: The Vicious Cycle

As temperatures rise due to global warming, the demand for air conditioning increases. This increased demand unfortunately results in increased energy use and more greenhouse gas emissions. Emissions of other harmful air pollutants from power plants also increase. These emissions, in turn, contribute to global warming, making the problem worse, as well as increase smog levels and exacerbate respiratory diseases. People with respiratory illnesses face an added danger during the summer months when air pollutant levels are at their highest, especially if they do not have air conditioning. As temperatures rise, these people are more likely to keep their windows open to allow for air circulation. By opening windows, people increase their exposure to ozone and other particles in the air that exacerbate asthma and other respiratory conditions. A disproportionate number of asthma sufferers are poor, and are thus less likely to be able to afford adequate air conditioning.<sup>74</sup>

Fans and air conditioning offer valuable relief on

hot days for those who can afford them. However, when these cooling devices fail the results can be deadly. On June 29, 1998 an elderly couple in Mecklenburg County died in their own home when their air conditioning failed.<sup>75</sup> As temperatures rise due to global warming, this unfortunate situation may become more common. The elderly, immunocompromised, and people who do not have air conditioning will suffer the most. In the deadly 1995 Chicago heat wave that killed over 600 people, the highest casualties were among elderly residents with no air conditioning.

Several households in North Carolina do not have any form of air conditioning, as evidenced by programs such as Operation Fan Relief, which provides as many fans as possible to the elderly.<sup>76</sup> Therefore, as temperatures rise in North Carolina, its population may suffer from heat-related deaths.<sup>77</sup> Considering that temperatures across many parts of the state, such as Chapel Hill, have already increased this century, the potential for disaster is certainly present.

Heat can directly affect health. According to the American Red Cross, heat-related disorders are caused by a reduction in, or collapse of, the body's ability to shed heat by circulatory changes and sweating. Such disorders may also develop due to a chemical (salt) imbalance caused by too much sweating.<sup>78</sup> Heat may lead to severe health problems, such as heat cramps, heat exhaustion, exertional heat injury, and heat stroke. In addition to heat and humidity, risk factors for these conditions include advanced age, lack of air conditioning, and use of certain medications. Vulnerable populations, including the elderly, children, infants, and the infirm, will suffer the most. Cardiovascular diseases, like coronary heart disease, also are a risk factor. Compounding the public health burden of heat waves is the fact that as excessive heat increases, so does the death rate from other medical conditions.<sup>79</sup>

**Heat cramps** are muscle spasms that primarily affect people who exert themselves through strenuous work or exercise. Mineral imbalances likely cause these cramps and salt and water replacement usually relieves them. A more severe condition is exertional heat injury that commonly occurs among runners who are not properly conditioned and hydrated. The body can reach 102 to 104 degrees, with symptoms that include goose bumps, chills, nausea, vomiting, and unsteady gait. In severe cases, people may have incoherent speech, or even lose consciousness. Muscles, kidneys, and blood cells may be damaged.

**Heat exhaustion**, or heat collapse, is the most common heat-related condition. It occurs when the cardiovascular system cannot keep up with heat demands. An affected person feels dizzy, weak, cold, and clammy, and has ashen skin and dilated pupils. The individual may require hospitalization.<sup>80</sup>

At greatest risk are infants, small children, the elderly, those working or exercising outdoors, persons with impaired mobility, and individuals suffering from cardiovascular disease.<sup>81</sup> When moved to a cool place, victims of heat exhaustion usually recover. On July 23, 1999, a North Carolina farm worker was hospitalized for heat exhaustion. His body temperature was measured at 108 degrees.<sup>82</sup>

**Heat stroke**, the most severe of these conditions, can be fatal. If body temperature reaches 106 degrees or above, damage to the kidneys, muscles, heart, and blood cells is likely. Sweating stops altogether. Death can occur immediately, or could be delayed up to several weeks due to complications, such as renal failure.<sup>83</sup> On average, 400 people die each year in the United States from heat-related causes.<sup>84</sup> In the summers of 1998 and 1999 in North Carolina several people died of excessive heat, including an elderly woman,<sup>85</sup> a farm worker<sup>86</sup> and a couple who perished in their own home when the air conditioning failed.<sup>87</sup>

### ***Health Consequences of Extreme Cold and Wet Weather***

*When exposed to cold temperatures, your body begins to lose heat faster than it can be produced. Prolonged exposure to cold will eventually use up the body's stored energy. This can cause hypothermia, or abnormally low body temperature.<sup>88</sup>*

—DENNIS MCBRIDE, M.D., NORTH CAROLINA STATE HEALTH DIRECTOR

While average temperatures are expected to rise in North Carolina in the winter, the increased frequency of weather extremes may also mean winters with more days of extremely low temperatures.<sup>89</sup> In addition, over the next several decades, the state could experience much heavier precipitation. Some locations in the state have already experienced a 5 percent increase in precipitation, much of it falling in more heavy precipitation events. According to the EPA, over the next century precipitation in North Carolina could increase by 15 percent (with a range of 5 to 30 percent, depending on the season).<sup>90</sup>

As overall temperatures increase, more of the North Carolina's winter precipitation may fall in the form of rain, sleet, and ice, increasing the likelihood of events such as the coastal flood caused by October 1991's infamous "Perfect Storm." For five days waves off of North Carolina rose 10 to 15 feet high, flooding coastlines and damaging 525 houses and 28 businesses. The cost of damage throughout North Carolina totaled 6.7 million dollars.<sup>91</sup>

Unexpectedly cold weather and large snowfalls can pose a variety of health risks, such as hypothermia, frostbite, cardiac-related deaths, pedestrian falls on icy surfaces, automobile accidents, and carbon monoxide poisoning.

1. **Hypothermia**, an unintentional lowering of the core body temperature to, or below, 95 degrees F, is a deadly medical emergency. Early signs of hypothermia often are insidious. They include shivering, numbness, fatigue, poor coordination, slurred speech, impaired mental state, blueness or puffiness of the skin, and irrationality.<sup>92</sup> More serious cases can result in coma, low blood pressure, and cardiac irregularities.

2. **Frostbite** occurs when the skin is exposed to temperatures below 23 degrees F. Such extreme cold increases the size of ice crystals under the skin.<sup>93</sup> These crystals can cause damage at varying levels of severity:
  1. **frostnip**, where skin turns white and may be slightly numb,
  2. **superficial frostbite**, involving the skin and tissue, and,
  3. **deep frostbite**, involving skin, tissue and bone.<sup>94</sup> At the final level, affected areas may have to be amputated.
3. **Congestive heart failure** is the most frequent reason for hospitalization among older adults.<sup>95</sup> The predicted increase in the number and severity of storms could lead to more deaths due to heart failure and other forms of cardiovascular disease. Already North Carolina has a high death rate for diseases of the heart and stroke. In 1997, stroke caused 29,900 hospitalizations in the state at a cost of more than 343 million dollars.<sup>96</sup>

In a 1999 study published in the American Journal of Epidemiology, researchers looked at deaths from heart attacks, strokes, and respiratory diseases during the month of January over a six-year period. Total mortality increased on days of extreme climatic conditions, defined as days with temperatures below 19.4 degrees F and snowfall greater than 1.18 inches. The combination of snow and cold caused death rates from heart attacks to triple among men 35 to 49 years old and rise for men over 50. Death rates for women over 65 also increased.<sup>97</sup>

During cold weather cardiovascular systems must work harder in order to keep the body at the correct temperature, thereby putting people with heart problems at risk.<sup>98</sup> Snow shoveling poses a particular hazard. It is a demanding aerobic activity that can endanger people with cardiac risk factors and may contribute to cardiovascular events reported after heavy snowfalls.<sup>99</sup>
4. **Pedestrian falls on icy surfaces** are another winter health risk that could increase with more extreme weather events. Slippery and uneven surfaces, which often occur as a result of winter storms, are a primary risk factor for falls.<sup>100</sup> Falls already are a serious public health problem among older adults, causing 90 percent of America's 350,000 hip fractures.<sup>101</sup> One out of three people 65 years and older are injured or killed in the United States each year. These are costly injuries as well. In 1994, the total direct cost of all fall injuries nationwide for people aged 65 years or over was 20.2 billion dollars.<sup>102</sup>
5. **Automobile accidents** where weather is a contributing factor could increase in number with the forecasted rise in extreme weather events. Weather events can cause poor driving condition and accidents frequently occur. For example, on December 20, 2000, an arctic storm covered North Carolina roads with snow and made others dangerously slick. These conditions resulted in numerous pile-ups and at least one death. In Asheville alone, the state Highway Patrol Office logged more than 200 accident calls.<sup>103</sup>
6. **Carbon monoxide poisoning** poses yet another winter health risk in North Carolina. Carbon monoxide is the leading cause of non-intentional poisoning deaths in the United States.<sup>104</sup> Carbon monoxide poisonings can

occur during blizzards when people sit in idling automobiles with exhaust pipes blocked by snow.<sup>105</sup> Poisonings also occur during power outages when people are more likely to use unvented residential appliances such as stoves and heaters.<sup>106</sup> Kerosene and propane-fueled space heaters, gas-fueled log sets, and cooking devices used improperly for heating can expose people to potentially hazardous levels of carbon monoxide, as well as other toxic gases.<sup>107</sup> During Hurricane Fran in 1996, North Carolina hospitals treated several individuals for carbon monoxide poisoning, primarily resulting from improperly ventilated gas-powered generators.<sup>108</sup>

Carbon monoxide is an odorless, colorless, and tasteless gas produced from incomplete combustion of fuels containing carbon, such as kerosene, natural gas, liquid petroleum, and wood.<sup>109</sup> Carbon monoxide can attach itself to hemoglobin, impairing the oxygen-carrying capacity of the blood and starving a body's tissues and organs of oxygen.<sup>110</sup>

Colder winters are arriving just as the cost of fossil fuels is on the rise. During cold winters individuals burn more heating oil and other fossil fuels, increasing greenhouse gas emissions, and creating a better chance that we will experience even more severe winter weather in the future due to climate change.

Demand already is high for heating oil in North Carolina. When oil supplies plummeted in January 2000, prices rose 78 cents, to \$1.96 per gallon.<sup>111</sup> An average home heating bill in the winter of 2000–2001 is projected to be \$1,044 for oil users. Natural gas prices are also up. Average gas bills are predicted to cost \$834, up 62 percent from 1999.<sup>112</sup>

### ***Dangers Related to Freezing Rain and Hail***

Dangerous freezing rain and hailstorm events may occur more frequently and with heightened severity because of greater instability in the atmosphere due to climate change. Freezing rain is precipitation that falls onto a surface, such as trees, cars and roads, and forms a coating of ice. Even small accumulations of ice due to freezing rain can cause significant hazards.<sup>113</sup> On January 2, 1999, freezing rain caused severe icing of roadways, especially in Alexander, Buncombe, Burke, Caldwell, Catawba, Davie, Henderson, McDowell, Mitchell, Polk, and Rutherford Counties. Numerous traffic accidents were attributed to the storm, including at least one fatal crash that occurred on Interstate 26 in Polk County. Sleet was so thick that a boathouse actually collapsed under the ice's weight.<sup>114</sup>

Hail develops when strong rising currents of air carry water to a height where freezing may occur. Ice particles grow in size, until they become too heavy to be supported by the updraft and fall to the ground in the form of hail. Hailstones often fall at speeds exceeding one hundred miles per hour<sup>115</sup> and can cause damage, injury and on rare occasion, even death. On May 1, 1998, tennis ball-sized hail significantly damaged 78 homes, 3 churches, and 300 cars in Altamahaw. The hail shattered windows, tore gutters from the sides of homes, ripped lawn furniture to shreds, and destroyed roofs.<sup>116</sup> A similar event occurred just a few weeks later, on May 16, when hail the size

of golf balls fell in Surry County, breaking windows and damaging several cars.<sup>117</sup>

### ***Deaths and Injuries Due to Snow Storms***

Climate change may also lead to more frequent and intense snowstorms during winter months. Such events can be deadly. On February 2, 1996, 5 fatalities and 165 injuries were attributed to a winter storm that brought with it 2 to 3 inches of snowfall and single digit temperatures.<sup>118</sup> Heavy snow often results in auto accidents, such as vehicle collisions that occurred on February 1, 1999,<sup>119</sup> February 19, 1999,<sup>120</sup> and January 19, 1998. During the latter, 14 individuals were injured and 2 people, a mother and son, died.<sup>121</sup>

### ***Risks Posed By Hurricanes, Thunderstorms, Tornadoes and Strong Winds***

*Extreme climate events in the U.S. over the past 20 years has resulted in 40 weather-related disasters with damages/costs in excess of \$1 billion; 23 of these disasters occurred in the southeastern states with total damages/costs of about \$85 billion. Most of the property damages were associated with floods and hurricanes.*<sup>122</sup>

—SOUTHEASTERN REGIONAL CLIMATE ASSESSMENT, JULY 18, 1999

Atmospheric instability could increase the likelihood of more severe and more frequent wind and thunderstorms. A greater number of hurricanes of heightened intensity may develop off the coast and reach land as the climate changes. Hurricanes begin as tropical cyclones, or low-pressure systems that form over warm water. When maximum sustained winds reach or exceed 74 miles per hour (mph), the tropical cyclone becomes a hurricane. North Carolina's protruding coastal regions, such as Cape Hatteras, Cape Fear, and Cape Lookout, make the state a favorable target for tropical storms and hurricanes, like Hurricane Floyd.<sup>123</sup>

Hurricane Floyd resulted in at least 52 fatalities<sup>124</sup> and the largest peacetime evacuation in U.S. history. Winds up to 110 mph gusted across the state. Storm surges 4 to 6 feet above normal caused extensive beach erosion and resulted in at least 10 new dune breaks along Highway 12.<sup>125</sup> Decedents ranged between 1 to 96 years in age. Causes of death included drownings, motor-vehicle crashes, burns and trauma from trying to escape fires related to the hurricane, as well as fatalities due to heart failure. In addition to those who perished, 59,398 individuals sought treatment at hospital emergency rooms. Most of the visits were due to injuries, respiratory illness, gastrointestinal distress and cardiovascular disease. Nineteen cases of hypothermia also occurred following the hurricane, with one case resulting in death. Surveillance reports following Hurricane Floyd also noted increases in insect stings, dermatitis, diarrhea, dog bites, asthma attacks and psychiatric conditions.<sup>126</sup>

Tornadoes pose another wind-related danger in North Carolina and may develop more often and with greater intensity due to climate change. Wind speeds from tornados can exceed 250 mph and can cut a path of damage in excess of 50 miles long and one mile wide.<sup>127</sup>

Several tornadoes have touched down on North Carolina in recent years, with two of the worst occurring on March 20, 1998 in Rockingham County. The first developed near Pine Hall in Stokes County and traveled 1.5 miles, breaking windows, lifting cars, and causing property damage along the way. The second, which developed one mile southwest of Mayodan, was even stronger. In its wake, this tornado damaged or destroyed 500 to 600 residences and destroyed nearly all of the business in Stoneville and some in Mayodan. Two fatalities were reported: a man who was blown out of his house and tossed 500 feet in the air, and a woman who was crushed by a wall that collapsed when her car blew into a building. Dozens of other injuries were reported.<sup>128</sup>

High winds themselves also can be deadly. On April 11, 1999, thunderstorm winds in Dare County injured 8 workmen, destroyed 4 planes, and damaged an airport hangar. Property damage was estimated at 230,000 dollars.<sup>129</sup> A cold front on March 3 of that same year produced winds strong enough to blow a woman off of her porch and to overturn a mobile home, injuring 3 of its occupants. 11,000 customers also lost power during the storm.<sup>130</sup>

When high winds combine with cold temperatures, a dangerous wind chill can develop.<sup>131</sup> According to the National Weather Service, wind chill is based on the rate of heat loss from exposed skin caused by the combined effects of wind and cold. As the wind increases, heat is carried away from the body at an accelerated rate, driving down body temperature.<sup>132</sup>

Lightning, which often occurs during turbulent thunderstorms, can have deadly consequences. A person struck by lightning can experience unconsciousness, cerebral bleeding, brain damage, and severe burns. The force of a strike can also stop a victim's breathing.<sup>133</sup> This is not surprising when one considers that a single bolt of lightning could power a 100-watt light bulb for more than three months.<sup>134</sup> From 1980 to 1995, 1,318 deaths were attributed to lightning nationwide.<sup>135</sup> Many victims are caught outside and cannot reach proper shelter. On June 25, 2000, lightning in Mitchell County struck a tree in a picnic area at Roan Mountain. An entire family was struck as the lightning spread through the adjacent ground and pavement. The force of the shock caused one man to fall backwards and hit his head on the pavement. Five days later, he died from a blood clot in his brain. Others at the site suffered burns, cuts, and bruises.<sup>136</sup>

### ***Health Threats From Floods***

*Initially, the impact of the flood was nearly devastating in terms of our ability to deliver health care. People were totally isolated.*<sup>137</sup>

—DEAN PATTON, M.D., CHAIR OF THE FAMILY MEDICINE DEPARTMENT  
AT EAST CAROLINA UNIVERSITY MEDICAL SCHOOL,  
COMMENTING ON FLOODING ASSOCIATED WITH HURRICANE FLOYD

Flooding occurs in North Carolina virtually every year. The location and severity vary according to ground conditions and weather. Areas near the mountainous regions of western North Carolina are particularly at risk for flooding, due to steep stream slopes<sup>138</sup> and residential development in floodplain locations. Given the forecasted rise in precipitation throughout the

state by 2100 and the expectation of heavier precipitation events, more floods could be on the way. The danger is compounded as more pavement and other impervious surfaces are laid in and around floodplain areas.

Floods cause an average of 146 deaths per year nationwide.<sup>139</sup> North Carolina has substantially added to this figure. Floods after Hurricane Floyd alone caused at least 36 deaths.<sup>140</sup> In Grifton, water blocked transportation routes, leaving thousands of people isolated. In addition to direct threats such as drowning, people with chronic illnesses were threatened by lack of treatment for diabetes, cardiac problems, and hypertension. When volunteer medical help reached Grifton residents, they found individuals suffering from reactive airway diseases due to mold and mildew caused by floodwaters, as well as mental and emotional distress.<sup>141</sup>

Hurricane Floyd's drenching rains also caused widespread release of toxic chemicals, human and animal waste, and other pollutants into the environment, including water sources. At least 1,500 drinking water wells were contaminated. The North Carolina Department of Health and Human Services has recently begun a study to look at other possible long-term health effects of flooding, which are currently unknown.<sup>142</sup>

If floodwaters are contaminated with bacteria and parasites, cases of intestinal illness and infectious disease can result. Intestinal illnesses occur with symptoms of nausea, vomiting, diarrhea, and fever. Diarrhea usually lasts only a few days, but for individuals with suppressed immune systems, depending on the organism, this condition can persist and even be fatal.

Floodwaters also may contain human and animal fecal material causing water-borne infectious disease outbreaks. Sources include overflowing sewage systems and flooded croplands. When pastures and crop fields are flooded, the state's farming communities, in particular, may face health risks from water-borne disease and increased exposure to pesticides in runoff. Although skin contact with floodwater rarely poses a serious health risk, there is a threat of disease from eating or drinking anything contaminated with floodwater.

Diseases and conditions such as tetanus, head lice, scabies, tularemia and leptospirosis also can occur after a flood.<sup>143</sup>

**Leptospirosis** is a group of bacterial diseases with various manifestations. Symptoms include sudden onset of fever, headache, chills, severe muscle aches, watery



Besides closing roads and causing property damage, floodwaters can carry bacteria and parasites causing illness and infectious disease.

## Hog Farms Foul North Carolina's Water And Air

*Over and over again, we've heard folks living near these large hog operations saying that the smell was making them sick. We went to UNC (the University of North Carolina) seeking an answer to one question—are emissions from these operations making neighbors sick. UNC has given us a sound study that answers that question affirmatively.*<sup>144</sup>

—DENNIS MCBRIDE, M.D.,  
HEALTH DIRECTOR FOR THE STATE OF NORTH CAROLINA

One of the greatest threats to water quality and public health in North Carolina is waste from the more than 2,200 factory hog farms in the state. In just the last decade, North Carolina's hog population has grown from 2 million to nearly 10 million. Hogs produce around 19 million tons of feces and urine each year, much of which is stored in open-air lagoons and then later sprayed onto crops.<sup>145</sup>

Studies have shown that persons living near large hog farms suffer significantly higher levels of upper respiratory and gastrointestinal ailments. Studies conducted by the University of North Carolina and Iowa State University link hog factory waste to increased rates of asthma, other respiratory ailments, and psychological problems, such as depression.<sup>146</sup> People living near hog farms report higher occurrences of headaches, runny nose, sore throat, excessive coughing, diarrhea, and burning eyes compared to other populations. Hog farms also pose a hazard to drinking water. One study found an increase in nitrates in over 10 percent of 1,600 residential well-water samples taken near hog farms. High nitrate levels in drinking water can cause

reduced levels of usable oxygen in the blood, posing a particular health risk to infants under six months old.<sup>147</sup> Nitrates and other nutrients can further cause toxic algal blooms, changes in biodiversity, and suffocation of fish and other aquatic species.<sup>148</sup>

Waste stored in lagoons can seep into rivers, lakes, and coastal estuaries, causing a build-up of phosphorous and nitrogen.<sup>149</sup> Open-air lagoons are also vulnerable to flooding during heavy rains or hurricanes. In the aftermath of Hurricane Floyd, 50 lagoons leaked, about 4 ruptured, and another 1,000 were filled to capacity.<sup>150</sup> Many areas, such as the town of Princeville, experienced water contamination. State health officials advised residents to boil water, but young infants and children were advised to not even drink boiled water, as boiling can concentrate nitrate contamination.<sup>151</sup>

Hog waste fouls North Carolina's air. Each day, over 425,000 pounds of nitrogen escape into the air. Rainfall later causes the airborne ammonia nitrogen to redeposit onto land and into bodies of water. The nitrogen overload can cause soil acidification, which may affect crop yields.<sup>152</sup>

Lastly, hog waste-water spraying causes a release of phosphorous from soils. The runoff can transport phosphorous to water bodies where it contributes to toxic algal blooms and fish kills.<sup>153</sup>

While state officials are hoping to conduct additional studies on how hog farms impact the environment and human health, they advise residents, particularly those with respiratory problems, to limit their exposure to hog waste and to test their well water.<sup>154</sup>

eyes, rash, anemia, jaundice, mental confusion, and depression.<sup>155</sup> Symptoms usually appear within ten days. At least 6 cases have been reported since 1992 in North Carolina.<sup>156</sup>

**Tularemia**, or rabbit fever, is a bacterial disease caused by the bite of ticks, mosquitoes, or deer flies, contact with the blood or tissue of an infected animal, or by drinking contaminated water. Floods increase the likelihood of contracting the disease by contaminating water supplies, creating environments in which vectors proliferate, and drowning animals. Symptoms of tularemia may include slow-growing ulcers, usually on the hands, and swollen lymph nodes. If the bacteria are inhaled, a pneumonia-like illness can follow. If ingested, the bacteria can cause sore throat, abdominal pain, diarrhea, and vomiting. Symptoms can emerge two to ten days after exposure.<sup>157</sup> From 1990–1999, at least 13 cases of tularemia were reported in North Carolina.<sup>158</sup>

Flash floods pose further risks in North Carolina. Flash floods occur within a few minutes or hours of heavy rains, a dam or levee failure, or a sudden release of water held by an ice jam. Their power is tremendous. Flash floods can roll boulders, tear out trees, destroy buildings and bridges, and carve out new channels. Because these events happen so suddenly, and with little warning, most flood deaths are due to flash floods.<sup>159</sup>

Many people underestimate the dangers of flash floods. Water weighs 62.4 pounds per cubic foot and just two feet of water is enough to overtake most automobiles.<sup>160</sup> Flash floods after Hurricane Floyd led to 8 fatalities in Edgecombe County alone, mostly due to drownings.<sup>161</sup>

## The Toll from Coal

*Rising above the fields of Stokes County, the smokestacks of Duke Power's massive Belews Creek power plant tower against the sky. Further east, stacks at CP&L's Roxboro power plant, in Person County, rise hundreds of feet into the air. What do these two power plants have in common? They are among the dirtiest in the nation. Duke's Belews Creek is the country's third-largest producer of smog-forming nitrogen oxides, and CP&L's Roxboro plant ranks tenth, according to EPA data.<sup>162</sup>*

—MOLLY DIGGINS, DIRECTOR OF THE NORTH CAROLINA CHAPTER OF THE SIERRA CLUB

Like old cars, old power plants are allowed to emit more pollution than more modern and efficient plants due to legal loopholes in the Clean Air Act (CAA). The CAA, as amended in 1977 and 1990, exempts coal-burning power plants from new source standards, allowing them to emit from 4 to 10 times the amount of pollution that new plants can.<sup>163</sup> The CAA also allows all power plants, regardless of age, to emit unlimited amounts of carbon dioxide and mercury.<sup>164</sup> Following this unfortunate trend, North Carolina's plants are some of the worst polluters in the nation.

All 15<sup>165</sup> of the state's power plants are exempt from modern clean air protections.<sup>166</sup> As a result, in 1999, North Carolina's power plants emitted 197,607 tons of smog-forming nitrogen oxide. This is 373 percent more smog than allowed by modern emission standards.<sup>167</sup> In 1999, North Carolina exceeded federal health standards for smog more frequently than all but two other states<sup>168</sup> and North Carolina ranked 12<sup>th</sup> for carbon dioxide emissions, with 72.5 million tons.<sup>169</sup>

The state's dirty air is taking its toll on public health. Air pollution causes an average of 5,700 visits to

emergency rooms each summer. In 1998, 240,000 asthma attacks were triggered by ozone.<sup>170</sup> Environmental health has also suffered. Smog now blankets the Great Smokey Mountains, where visibility has been reduced by 80 percent in the last 40 years. In 1997, one out of every three summer days had unhealthy smog levels in Great Smokey Mountains National Park.<sup>171</sup> The state's once thriving black cherry trees also have been affected, with 90 percent of plants showing foliage damage due to ozone pollution.<sup>172</sup>

Mercury is yet another harmful pollutant released in very high levels by North Carolina's power plants. 37,600 river miles and 306,584 lake acres are under mercury advisory in the state. Due to mercury poisoning risks, the state has issued advisories for at least one species in all lakes and rivers statewide.<sup>173</sup> Bacteria convert air-borne mercury into methyl-mercury, an even more toxic substance. Fish ingest methyl mercury as they feed. They also absorb it from water as it passes over their gills. The substance is stored in fish flesh. Trimming or cooking cannot remove it. Nearly all fish contain methyl mercury, with large fish and sport fish having the greatest concentrations.<sup>174</sup>

Methyl mercury is rapidly absorbed from the gastrointestinal tract and readily enters the adult and fetal brain.<sup>175</sup> In January 2001, the U.S. Food and Drug Administration warned pregnant women and women who might become pregnant that they should not eat shark, swordfish, king mackerel, or tilefish because they could contain mercury at levels high enough to damage an unborn child's developing brain.<sup>176</sup> In a study known as the Jacobsons' Michigan Maternal Cohort Study, researchers looked at 242 mother-infant pairs. Each of the mothers had consumed contaminated fish before and during their pregnancies. The study determined that infants of these mothers were born early, had a

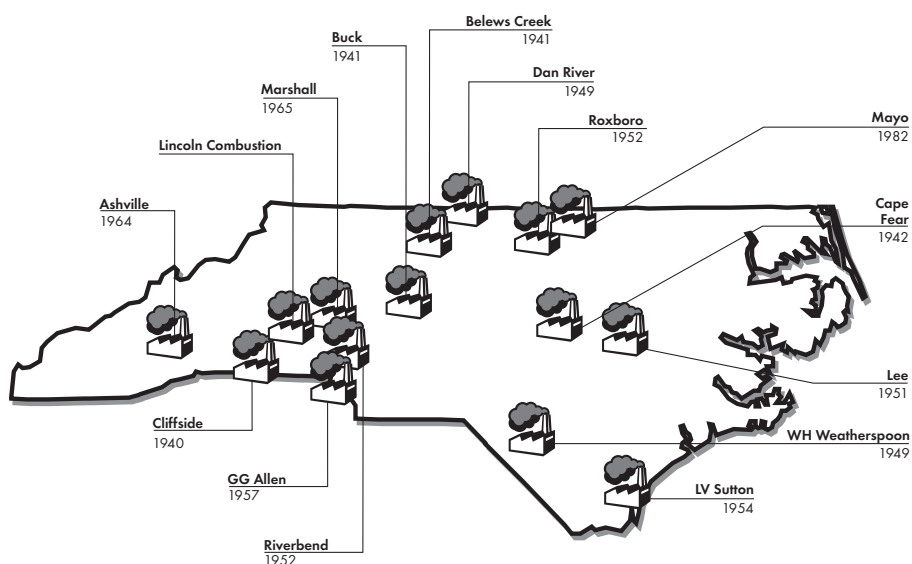
decreased birth weight and smaller heads. The report's authors examined the children again when they were 11 years old. At that age, the children had lower than normal IQs, poor reading comprehension skills, reduced memory span, and attention deficits.<sup>177</sup>

Emissions of mercury, sulfur dioxide, nitrogen oxide and other pollutants rise even more during

heat waves and cold spells, which themselves may be fueled by climate change. The increased energy used to provide air conditioning and winter heating can result in more greenhouse gas emissions in the atmosphere that may cause global warming, as well as increased emissions of other air pollutants from power plants.

FIGURE 2  
**North Carolina Power Plant Locations and Initial Years of Operation**

For 30 years the Clean Air Act has exempted North Carolina's old and dirty power plants from complying with modern emissions standards. Thus, North Carolina's power plants continue to emit harmful levels of carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury into the air.



Source: Clear the Air

## Air Pollution and Respiratory and Cardiovascular Disease May Increase

*Too many of our citizens are being exposed to high ozone levels in the summer months.*<sup>178</sup>

—BILL HOLMAN, SECRETARY OF THE NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Some air pollutants are affected by heat, such as ozone and volatile organic compounds (VOCs). When these pollutants increase, air quality decreases, especially in urban areas. Both ozone and VOCs have adverse health impacts. Climate change could also affect pollen levels that exacerbate allergies.

The American Lung Association ranked both the greater Charlotte area (8<sup>th</sup>) and the Research Triangle (17<sup>th</sup>) among the top 25 metropolitan areas with the worst ozone air pollution in the nation.<sup>179</sup> As it stands, 17 North Carolina counties fail to meet federal air pollution standards. They are Alamance, Cabarrus, Catawba, Cumberland, Davidson, Durham, Forsyth, Gaston, Guilford, Harnett, Lincoln, Mecklenburg, Orange, Randolph, Rowan, Union, and Wake. Parts of Alexander, Buncombe, Burke, Caldwell, Caswell, Chatham, Davie, Duplin, Edgecombe, Franklin, Granville, Haywood, Iredell, Jackson, Johnston, Lenoir, McDowell, Northampton, Person, Pitt,

Rockingham, Swain, and Yancey also have high air pollution levels, based upon monitor readings.<sup>180</sup> Given North Carolina's overwhelming amount of air pollution, the possible effects of global warming on the state's air warrant high concern.

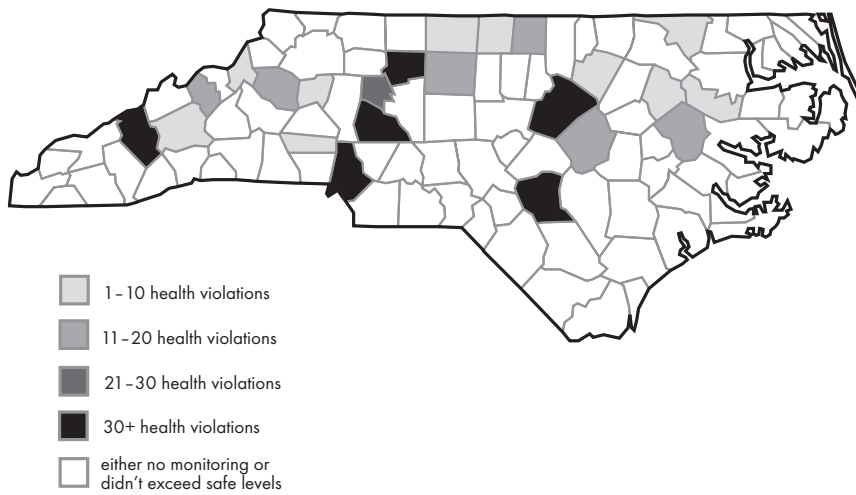
### *Smog*

Ground-level ozone is the major component of what we commonly call smog, the most pervasive outdoor air pollutant in the United States. Smog is at its worst on hot, sunny days, which are likely to become more numerous with global warming. Ozone is a toxic and irritating gas that, even in small amounts, can affect lungs and health. Ozone, or smog, is formed when nitrogen oxides and VOCs, emitted from motor vehicles, power plants, refineries, factories, and other combustion and industrial sources are heated by sunlight.<sup>181</sup>

Increased temperatures in North Carolina likely will increase ozone levels. Already ground-level ozone concentrations in the state have exceeded national standards during periods throughout the past several years. In 1999, for example, 68 days exceeded federal ozone level standards.<sup>182</sup> Without even taking into account the effects of climate change on ozone, the state currently experiences serious threats to air quality due to ozone.

In 1999, there were 539 violations of the proposed EPA eight-hour standard for ozone statewide. This means that the state's air quality had ozone levels exceeding 85 parts per billion (ppb) on those occasions. By contrast, Arkansas, Hawaii, Montana, North Dakota, Oregon, South Dakota and Wyoming had 0 such days. During this same year, North Carolina violated the less strict current ozone standard of 125 ppb twenty times.<sup>183</sup> North Carolina's air pollution not only affects air in the state itself, but also travels to neighboring states where it contributes to poor air quality.

FIGURE 3  
**Smog Pollution in North Carolina, May–September 1999**



All across North Carolina air pollution is endangering the health of many residents. During the summer of 1999, the air was unhealthy to breathe somewhere in the state one out of every three days.

Source: Clean Air Network

Exposure to elevated ozone levels can cause severe coughing, shortness of breath, pain when breathing, lung and eye irritation, and greater susceptibility to respiratory illness such as bronchitis and pneumonia.<sup>184</sup> Numerous studies have shown that higher ozone levels cause more asthma attacks, increase the need for medication and medical treatment, and result in more hospital admissions and visits to emergency rooms.<sup>185</sup>

Even moderately exercising healthy adults can experience a 15 to an over 20 percent reduction in lung function from exposure to low levels of ozone over several hours.<sup>186</sup> And, some healthy people simply are more sensitive to ozone than others, experiencing more health effects from ozone exposure than the average person.<sup>187</sup> In just one period, from April to October of 1997, there were 5,700 emergency room hospital admissions and 240,000 asthma attack cases in North Carolina related to ozone exposure.<sup>188</sup>

A Harvard Medical School study has found a link between air pollution and heart problems.<sup>189</sup> An individual's heart rate varies somewhat throughout the day, depending on the person's physical activities and emotions. The heart of a healthy person is generally able to respond quickly to activity changes, such as going from a state of rest to exercising. On days with high ozone levels, the heart function of test subjects showed lower heart rate variability, an indicator that has been associated with heart problems and death. Everyday air pollution may therefore impair the heart's ability to change the speed at which it beats, which could lead to cardiovascular problems and heart-related deaths.<sup>190</sup>

The relation between ozone and asthma episodes is of special concern. Asthma is reaching epidemic proportions in the United States, affecting fifteen million people, including five million children nationwide. A leading cause of absences from school, asthma can reduce lung capacity and, if left untreated, can be fatal.<sup>191</sup> Asthma accounts for one in six pediatric emergency room visits in the U.S. In 1997, 150 adults and children in North Carolina died from asthma.<sup>192</sup> In 1998, the death toll rose to 168.<sup>193</sup> Asthma's overall death rate in the United States is up 66 percent in the last decade, and 117 percent in the in the last two decades.<sup>194</sup> Children have smaller airways than adults and breathe more rapidly, making them more vulnerable to asthma. When a person suffers repeated asthma attacks, lung pathways become so narrow that simple breathing is as difficult as "sucking a thick milk shake through a straw."<sup>195</sup>

Asthma's greatest cost is to human health, but it also impacts North Carolina's economy. A total of 1.9 billion dollars per year is spent directly to treat both insured and uninsured children with asthma nationwide. Total health care costs in the U.S. for asthma amount to 7.5 billion dollars annually.<sup>196</sup>

### **North Carolina Asthma Statistics**

As reported by the American Lung Association of North Carolina<sup>197</sup>

- Nearly 300,000 North Carolinians currently suffer from asthma.
- The state's overall asthma rate increased by 63 percent between 1982 and 1995. Pediatric asthma rates during that same period rose 86.8 percent.
- African Americans suffer from asthma nearly three times more than Anglo individuals in the state.
- The asthma rate for women rose 83.7 percent from 1982 to 1995.

## **Nuclear Power Is Not the Answer**

*An additional topic that adds to the environmental risks that we face, particularly in the Carolinas, is MOX plutonium bomb fuel, which appears to be destined for use in the 4 Duke Power nuclear reactors within 25 miles of Charlotte. The worst-case scenario of such an experiment would be a meltdown of Chernobyl-like proportions.<sup>198</sup>*

—LEWIS E. PATRIE, M.D., PRESIDENT,  
WESTERN NORTH CAROLINA  
PHYSICIANS FOR SOCIAL RESPONSIBILITY

Currently, nuclear energy supplies 30.6 percent of electricity generated in North Carolina.<sup>199</sup> Proponents of the 5 nuclear power plant units in the state suggest that nuclear energy is better for the environment due to lowered air pollution emissions.<sup>200</sup> Nuclear power, however is not the answer to climate change as it creates more problems than it solves, given the costs and dangers associated with nuclear waste and the threat of plant containment failure.

From 1996 to 1999 alone, North Carolina's nuclear power plants produced 110,000 to 120,000 cubic feet of low-level radioactive waste.<sup>201</sup> Unsafe for public dumps, the waste is housed in special storage sites at enormous expense. Since 1983, consumers of electricity from nuclear power plants in the state have committed over \$722.1 million into the federal

Nuclear Waste Fund to finance nuclear waste management.<sup>202</sup>

Additionally a government study released in October 2000 by the Nuclear Regulatory Commission indicated that four plants located in the vicinity of Charlotte—Catawba One and Two and McGuire One and Two—exceed the “acceptable risk” of containment failure. These four Duke Energy plants utilize an ice condenser containment system that may be prone to failure if both on and offsite power is lost.<sup>203</sup> During such a blackout, a meltdown is likely to cause a containment rupture exposing local residents to carcinogenic substances.

Increasing the danger to health, Duke Power may utilize surplus plutonium, previously used for nuclear weapons, to fuel the plants. Plutonium is combined with uranium to create a mixed oxide known as MOX, a more volatile substance than typical plutonium fuel.<sup>204</sup>

The costs and dangers associated with nuclear power far outweigh any benefits it may provide in reducing greenhouse gases associated with climate change. The air pollution/nuclear waste trade-off does not make sense, particularly in light of more effective strategies for reducing greenhouse gases, such as increasing energy efficiency and using renewable forms of energy.

Physicians do not fully understand what causes asthma, but warmer weather likely will make it worse. One study found that warmer average temperatures are associated with increased asthma prevalence, possibly because higher temperatures are associated with higher levels of allergen exposure.<sup>205</sup>

### ***Volatile Organic Compounds (VOCs)***

Another set of air pollutants consists of VOCs, which are generated by power plants and municipal waste combustors, as well as motor vehicles, solvent use, and the chemical and food industries. VOCs include a variety of hazardous air toxins, including benzene, butanes, and toluene. VOCs in the atmosphere have two major health impacts: they are precursors to the photochemical production of ozone, and some VOCs are directly toxic. These hazardous air pollutants are associated with cancer as well as adverse neurological, reproductive, and developmental effects.<sup>206</sup> Cancer is a leading cause of death in North Carolina. Between 1990 and 1995, 133.2 North Carolinians per 100,000 population died from cancer.<sup>207</sup> Higher temperatures cause VOCs to evaporate and disperse more rapidly into the atmosphere

causing ozone formation and health problems near and far from the pollutant's source.<sup>208</sup>

## **Pollen**

As the thermometer starts rising on warm days, pollen counts may rise as well. A recent report from the U.S. Department of Agriculture indicates that higher carbon dioxide levels may have doubled the amount of pollen that ragweed produces over the past four or five decades. Another doubling could occur by the end of this century.

Studies of pollen counts on ragweed grown in indoor chambers resulted in alarming findings. At carbon dioxide levels of 280 parts per million (ppm), the amount that was in the air in 1990, pollen production was approximately 5.5 grams per plant. In today's atmosphere consisting of 370 ppm of carbon dioxide, pollen reached 10 grams per plant. At carbon dioxide levels of 660 ppm, the amount models project to exist in the next 50 years, pollen production hit 20 grams per plant. Findings also showed that high carbon dioxide levels might produce ragweed pollen earlier in the year. Earlier springs

### **Car Trouble: The Gasoline-Greenhouse Gas Connection**

Driving a private car is one of the most polluting activities a typical citizen does each day.<sup>209</sup> In North Carolina, from 1970 to 1995, the state's population grew by 40 percent, while driving increased by 150 percent.<sup>210</sup> Cars, minivans, and sports utility vehicles (SUVs) produce up to 33 percent of the nation's carbon dioxide, a greenhouse gas that causes global warming.<sup>211</sup> This is largely due to the imperfect combustion process involved in running all gasoline-powered cars. When gasoline is combined with air in a typical engine combustion system, unburned hydrocarbons, nitrogen oxides, carbon monoxide, and carbon dioxide are all released into the atmosphere.<sup>212</sup>

Hydrocarbons react in the presence of nitrogen oxides and sunlight to form ground-level ozone, or smog.<sup>213</sup> Ozone can damage lung tissue, aggravate respiratory disease, and make people more susceptible to respiratory infections. Otherwise healthy individuals can suffer from the choking, coughing, and stinging eyes associated with smog.<sup>214</sup>

Nitrogen oxides, like hydrocarbons, help to form smog. They also contribute to the formation of acid rain, which can contaminate drinking water, damage



vegetation, hurt aquatic life, and erode buildings and other structures.<sup>215</sup>

Carbon monoxide enters the bloodstream through the lungs and forms a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Infants, the elderly, and individuals with respiratory and heart diseases are particularly sensitive to the effects of carbon

monoxide. But even a healthy person can experience impaired exercise capacity and problems with visual perception, manual dexterity learning functions, and ability to perform complex tasks after breathing this dangerous pollutant.<sup>216</sup>

Diesel fuel is also dangerous. A study published in the July issue of the American Journal of Respiratory and Critical Care Medicine found that diesel fuels cause respiratory inflammation, which has been linked to asthma.<sup>217</sup>

Until drastic steps are taken to solve North Carolina's, and the nation's, car troubles, pollutants emitted by automobiles likely will continue to threaten human health and heighten environmental, health, and economic problems associated with global climate change.

and warmer winters could also impact pollen counts. Additionally, exposure to air pollutants such as ozone can make people more sensitive to ragweed pollen.<sup>218</sup>

Scientists believe that rising temperatures will create favorable conditions for an even wider variety of pollen-producing plants to grow, leading to an increase in levels of airborne pollen and spores that aggravate respiratory disease, asthma, and allergic disorders.<sup>219</sup> The EPA notes that a two degree F warming and wetter conditions could increase respiratory allergies.<sup>220</sup> Thus, North Carolina's residents who suffer from allergies could experience more attacks during more months of the year as the climate changes.

## **Climate Change Conditions that Foster the Spread of Disease**

### ***A Plague of Ticks and Mosquitoes***

*Because of the heating of the atmosphere, disease-bearing insects are breeding faster and living longer at higher altitudes and latitudes. Witness the rapid increases in malaria, yellow fever, hantavirus, and Lyme disease in the northern latitudes. Most remarkably, there is no debate over climate change in any country except the United States.*<sup>221</sup>

—ROSS GELSPAN, CLIMATE AUTHOR

In the warmer and wetter days to come, insects and rodents—referred to as vectors—could multiply in number, increasing the human health risks from the diseases they spread. In terms of vector-borne disease, meaning diseases carried by a host, such as a mosquito or tick, the rate of insect biting and the rate of maturation for the disease-carrying microorganisms are temperature-dependant. Both rates can increase with warmer weather.<sup>222</sup> In fact, field and laboratory studies have shown that temperature is a limiting factor with respect to transmission of a viral agent by a vector.<sup>223</sup> A changed climate could allow vectors and the diseases they carry to spread to, and survive in, new territories. Therefore, in the future, North Carolina's residents could suffer from diseases only previously seen in other parts of the country.

### ***Diseases Transmitted By Mosquitoes***

*Am I surprised to see it (West Nile Virus) spread into North Carolina? No. And I wouldn't be surprised to see it spread farther south.*<sup>224</sup>

—ROBERT MCLEAN, M.D., CHIEF OF THE U.S. GEOLOGICAL SOCIETY WILDLIFE HEALTH CENTER

West Nile Virus, Eastern Equine Encephalitis, LaCrosse Encephalitis, and malaria are mosquito-borne diseases that pose current or potential health threats in North Carolina.

**West Nile Virus** is a deadly disease that can cause inflammation of the brain, the lining of the brain, and/or the spinal cord.<sup>225</sup> About 3 to 5 percent of infected individuals who develop these symptoms die from the disease.<sup>226</sup> Mild West Nile Virus infections cause fever, headache and body aches, often

coinciding with a skin rash and swollen lymph glands. Severe infections can lead to neck stiffness, stupor, disorientation, coma, tremors, convulsions, and paralysis.<sup>227</sup> The disease is spread to humans by the bite of an infected mosquito. Mosquitoes, in turn, become infected after biting a bird that is carrying the virus. Persons greater than 50 years old have a higher risk of serious illness if bitten by an infected mosquito. There is no known cure for the disease, but doctors can treat the underlying symptoms.<sup>228</sup> Victims who survive may never fully recover.<sup>229</sup>

## The Problem with Pesticides

*We obviously need to deal with the spread of this virus, but in doing so we don't want to create a whole new public health problem by exposing residents to these pesticides.*<sup>230</sup>

—MATT WILSON, TOXICS ACTION CENTER,  
COMMENTING ABOUT THE USE OF PESTICIDES TO STOP  
THE SPREAD OF WEST NILE VIRUS

To control mosquito numbers in North Carolina, state health officials conduct aerial spraying where mosquitoes tend to proliferate. Two primary insecticides are used: malathion and pyrethroids,<sup>231</sup> the latter of which may fall under the brand names of products such as Resmethrin, Scourge and Anvil. Both malathion and pyrethroids could impact the environment and human health.

Malathion can be absorbed into a person's body by inhalation, ingestion and skin penetration.<sup>232</sup> Early symptoms of poisoning can include headache, nausea, dizziness, sweating and salivation. As the condition worsens, other symptoms may appear, such as tremor, weakness, muscle twitching, lack of coordination, abdominal cramps, vomiting, diarrhea, anxiety, restlessness, depression, and memory loss. Loss of consciousness, incontinence, convulsions and respiratory problems indicate a life-threatening level of poisoning.<sup>233</sup> In terms of the environment, fish, bees, and aquatic animals are at particular risk for malathion poisoning. After Hurricane Floyd, several North Carolina counties were sprayed with malathion and pyrethroids, including Bertie, Camden, Chowan, Currituck, Dare, Duplin, Edgecombe, Gates, Greene, Halifax, Hertford, Lenoir, Nash, Northampton, Onslow, Pasquotank, Pender, Perquimans, Pitt, Robeson, Washington, Wayne, and Wilson.<sup>234</sup>

Although synthetic pyrethroids may be less harmful to humans than malathion, all pesticides are inherently toxic and therefore are not risk-free to humans.<sup>235</sup> A commonly-used pyrethroid like Resmethrin, for example, contains two active

chemicals—resmethrin, a synthetic pesticide, and piperonyl butoxide, which prevents insects from detoxifying resmethrin in their bodies<sup>236</sup> along with a petroleum distillate. Both resmethrin and piperonyl butoxide may impact human health.

Exposure to high levels of resmethrin could affect the nervous system, causing lack of coordination, tremors, tingling or skin numbness. Short-term exposure to high levels of resmethrin may cause irritation of the eye, skin, nose, throat, or lung.<sup>237</sup> There also is evidence that chemicals like resmethrin can harm the thyroid.<sup>238</sup>

Both resmethrin and piperonyl butoxide have been shown to affect pregnancies among laboratory animals.<sup>239</sup> Further studies of piperonyl butoxide reveal that it can cause liver tumors in rats and mice.<sup>240</sup> Piperonyl butoxide has been classified by the Environmental Protection Agency as a possible human carcinogen. Resmethrin could also harm ecosystems as it is highly toxic to bees and fish.<sup>241</sup>

Now that West Nile Virus has been documented in North Carolina, it is probable that spraying programs will continue throughout the state to keep the virus in check. Many scientists, including Paul Epstein of Harvard Medical School, believe climate change may be fueling the emergence and spread of disease. Therefore, pesticides are only treating the symptom rather than the cause of the overall problem. Spraying is only one method of curbing proliferation of the disease. For example, regular spring cleaning of urban drains and catch basins could decrease breeding sites for the mosquitoes involved. Periods of drought are particularly hazardous as they dry up the water in drains and concentrate organically rich material in mosquito breeding sites. Cleaning out drains may also make bacteria used as larvaecides more effective, decreasing the use of chemicals now used for larvaecidal activities. All this could decrease the potential for widespread use of pesticides.

West Nile Virus was first discovered in Uganda in 1937 and spread to the United States in 1999.<sup>242</sup> Although West Nile Virus has only threatened parts of this country for a short time, the disease already has claimed the lives of at least 8 individuals and sickened at least 78 others.<sup>243</sup> Once established, the virus quickly spread to New York, New Jersey, Maryland, and the District of Columbia.<sup>244</sup>

In October 2000, a bird carrying the disease was found in North Carolina.<sup>245</sup> While the risk to human health was minimal in 2000, according to health officials 2001 could prove to be a different story. Already entomology experts are advising North Carolinians to take precautions, such as wearing protective clothing when near areas where mosquitoes thrive.<sup>246</sup>

Many scientists believe that climate change contributed to the emergence of West Nile Virus in the United States, and that it may be fueling the virus' spread. In an August 2000 report in *Scientific American*, Dr. Paul Epstein of Harvard Medical School theorized that the mild winter, and spring and summer drought in 1998–1999 contributed to the amplification of West Nile Virus among urban mosquitoes and birds, while the means of entry into the U.S. remains unknown. Drought during the spring and summer months can increase mosquito breeding in organically-rich city storm drains and catch basins, and may have reduced the mosquitoes' natural predators, such as frogs and darning needles. The drought also reduced water sources, which could have caused birds to congregate near dwindling watering holes frequented by mosquitoes. The mixture of hot weather, which speeds viral maturation of the West Nile Virus, and the likelihood of blood exchange taking place between the birds and mosquitoes may have set the stage for West Nile's current threat to human health in the northeastern and southern states.<sup>247</sup>

**Eastern Equine Encephalitis (EEE)** is another deadly disease that is spread by mosquitoes in the state. Since 1990, at least 283 individuals in North Carolina have become infected with encephalitis diseases such as EEE.<sup>248</sup> (The number does not include LaCrosse Encephalitis cases.) Mosquitoes contract the EEE virus from infected birds and pass it to humans when feeding on their blood. Sixty percent of all human cases result in death, and the disease is nearly 100 percent fatal to horses. In humans, a severe headache may be the only warning sign of the disorder, which attacks the central nervous system. The disease may also result in sudden fever, weakness, and irritability. Within a day, and sometimes within hours, the victim can become disoriented and comatose. A human vaccine is in development, but so far there is no available protection for the disease.<sup>249</sup>

**LaCrosse Encephalitis (LAC)** is mostly associated with small mammals, but it affects humans as well and is particularly found in the western part of North Carolina.<sup>250</sup> In 1999, 10 cases were reported.<sup>251</sup> Many other milder incidences of the disease likely go unreported. LAC is spread by infected mosquitoes. Symptoms of LAC may include fever, headache, nausea, and vomiting. In severe cases, LAC may cause convulsions, tremors, coma, and death. Young children appear to be most susceptible to contracting LAC.<sup>252</sup>

**Malaria** generally is associated with the tropics, but every year residents of North Carolina contract malaria abroad and bring the disease home. In 1999 and 2000 there were 36 reported cases of malaria in North Carolina each year.<sup>253</sup> Anopheline mosquitoes that can transmit the disease are already found

in North Carolina. Temperature, precipitation, and extreme weather events can have an effect on the viability and geographical distribution of these mosquitoes. Many scientists estimate that an increase in average global temperatures of several degrees by the year 2100 could increase the capacity of mosquitoes to transmit the disease 100-fold in temperate countries.<sup>254</sup> Although excellent disease surveillance programs and health care infrastructure make a malaria epidemic in the United States unlikely, as the climate warms and becomes more humid, locally transmitted malaria could appear in North Carolina.

### ***Tick-Borne Disease in North Carolina***

Lyme disease, Rocky Mountain Spotted Fever, and ehrlichiosis are diseases spread by ticks in North Carolina.

**Lyme disease** is endemic to several regions of the United States and accounts for more than 95 percent of all reported cases of vector-borne illness in the country.<sup>255</sup> The number of cases reported annually in the United States has increased about 25-fold since national surveillance began in 1982.<sup>256</sup> From 1993 to 1997, 12,500 cases were reported annually,<sup>257</sup> a figure that has likely gone up during the past few years. In 1999, 74 cases were reported in North Carolina.<sup>258</sup> In 2000, there were 46 reported cases.<sup>259</sup> Most of the cases that are reported are done so during the summer months when ticks thrive, but a warming trend could increase North Carolina's tick population even more, while warmer winters will permit people to enter tick-infested habitats earlier in the season, thereby increasing the risk for transmission of the disease.<sup>260</sup> A recent Swedish study found that a combination of mild winters (fewer days with minimum temperatures below -7°C) and extended spring and autumn seasons (more days with minimum temperatures from 5 to 8°C) was related to increased tick density.<sup>261</sup>

If left untreated, Lyme disease causes chronic conditions such as arthritis, neurological symptoms, and cardiac problems. Early symptoms include a rash or ring lesion at the site of the tick bite, fatigue, headache, neck pain, stiffness in muscles and joints, fever, and swollen glands. The rash may not develop for more than a month, if it does at all. Chronic disease symptoms may develop weeks, months, or even years after being bitten.<sup>262</sup> Although a new vaccine for Lyme disease is available in certain states, health experts warn that it does not offer complete protection from the disease.<sup>263</sup>

**Rocky Mountain Spotted Fever (RMSF)** is commonly seen in North Carolina during late spring and summer, but global warming could broaden the lifespan and range of the tick that carries the disease, allowing RMSF to pose a health threat during even more months out of the year. From 1990 to 1999, there were at least 1,319 cases of RMSF reported in the state.<sup>264</sup> RMSF is caused by rickettsia that can be transmitted to humans by the bite of the American dog tick. The tick often is found in areas with tall grass and weeds, such as uncultivated fields and meadows. They cling to grass at the edges of paths or animal trails, waiting to latch onto an animal or human.

Rocky Mountain Spotted Fever can be fatal. Symptoms can include sudden fever, headache, and muscle pain, usually followed by a rash that first appears on the arms and legs, before spreading to the trunk, palms and

soles. During the early stages of the disease, it may be confused with other illnesses, including meningitis.<sup>265</sup>

**Ehrlichiosis** is a relatively new disease caused by a bacteria carried by the Lone Star tick. The first ever case was diagnosed in 1986 when a man from Michigan was exposed to ticks in Arkansas. Since then cases have been recorded from the southeastern United States to the Great Lakes. In 1999, 12 cases of the disease were reported in North Carolina.<sup>266</sup> Symptoms of Ehrlichiosis appear 7 to 21 days after infection and include sudden fever, headache, and muscle pain. Ehrlichiosis can be fatal if left untreated. Risk of severe infection is greatest for people taking immunosuppressant drugs, individuals with chronic illness, and the elderly.<sup>267</sup>

### The Precautionary Principle

Legislators and environmentalists often refer to a legal term called “the precautionary principle” when dealing with global warming issues. The term’s definition states, “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context, the proponent of an activity, rather than the public, should bear the burden of proof.”<sup>268</sup>

This principle comes down to common sense. In practice it is nothing new. An early example of the precautionary principle in action happened in 1854. During that year, London had a cholera epidemic. A doctor by the name of John Snow mapped the locations of local cholera deaths and discovered that most of them occurred within 250 yards of a public water pump. Suspecting that the water pump was the source of the contagion, Dr. Snow had the handle removed, making the pump inoperable and ending the plague. This was years before the biological cause of cholera was known.<sup>269</sup>

The precautionary principle has four main components. First, communities have a duty and a right to take anticipatory action to prevent harm. Second, the burden of proof of the harmlessness of a new technology, process, activity, or chemical is the responsibility of the proponents, not the public. Third, communities have an obligation to discuss and to explore a full range of alternatives to the hazards posed. Lastly, decisions must be open, informed, and democratic.

The precautionary principle is no different than practicing preventive medicine. Most of us go to the doctor when we feel that we may be at risk for a certain ailment. In other words, we take action to prevent something bad from happening to us. Global warming requires that same sense of precaution and a willingness to take action.

### Warm Weather Impacts on Water and Food

*First, we must recognize that human activity has put more greenhouse gases into the atmosphere than it has ever contained before and do something about them . . . Second, we should plan for global warming and the sea level rise that will inevitably accompany it. In North Carolina a sea level rise of 20 feet would cover much of the coastal counties.*<sup>270</sup>

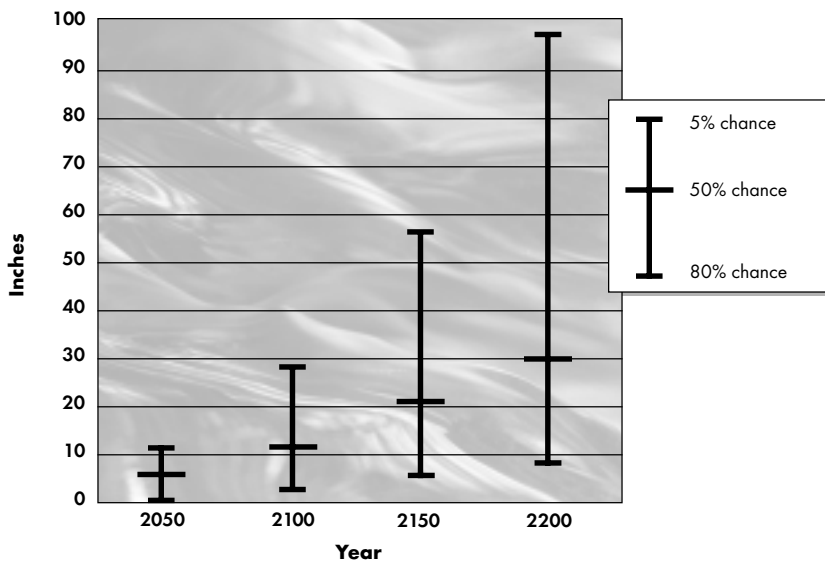
—DR. JOHN J.W. ROGERS,  
PROFESSOR EMERITUS OF GEOLOGY,  
UNIVERSITY OF NORTH CAROLINA

Global warming is predicted to impact sea level rise and food and water quality in North Carolina.

### Sea Level Rise

Sea level is rising more rapidly along the U.S. coast than worldwide<sup>271</sup> and North Carolina falls within that stretch of U.S. coast most vulnerable to rising seas.<sup>272</sup> Therefore, much of the state’s 3,375 miles of tidally-influenced shoreline, consisting of the barrier islands, salt marshes, and tidal freshwater marshes are at risk from erosion.<sup>273</sup> Studies by EPA and others have estimated that along the Atlantic coast, a one foot (30 cm) rise in sea level is likely by 2050 and could

FIGURE 4  
**Future Sea Level Rise at Long Bay**



At Long Bay, sea level is already rising by approximately 2 inches per century, and it is likely to rise another 12 inches by 2100.

Source: EPA (1995)

occur as soon as 2025. In the next century, a two foot rise is most likely, but a four foot rise is possible; and sea level will probably continue to rise for several centuries, even if global temperatures were to stop rising in a few decades.<sup>274</sup>

Sea level rise can result in flooding of low-lying property, loss of coastal wetlands, erosion of beaches, intensified flooding, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges.<sup>275</sup> Some of these effects may be further compounded by other effects of a changing climate.<sup>276</sup>

Each of these possibilities brings with it a number of health risks, including gastrointestinal distress from contaminated drinking water, car accidents due to damaged roadways, drownings associated with storm surges, and psychological distress from lost income and property.

The economic well-being of individuals who live near coastal areas could also be threatened as coastal erosion undermines the economies of these regions. As it stands, the areas have limited local economies, due to isolation and transportation limitations. The region's tourist economy is seasonal and subject to weather patterns. Erosion, extreme weather events and property damage that climate change is likely to bring could disrupt the financial growth of these areas and threaten the jobs of locals who work in all industries.

Some of the most economically important vulnerable areas are the recreational resorts on the "coastal barriers" of the Atlantic coasts. The low bay sides of developed barrier islands could be inundated while their relatively high ocean sides erode. Undeveloped barrier islands will tend to migrate landward through the overwash process.<sup>277</sup> Many ocean shores are currently

eroding 1 to 4 feet per year. Coastal engineers generally estimate that a 1 foot rise in sea level will cause beaches to erode 2 feet along the Carolinas. Because many US recreational beaches are less than 100 feet wide at high tide, even a 1 foot rise in sea level would threaten homes in these areas.<sup>278</sup> Erosion occurs at an even faster rate after extreme weather events due to storm surges. For example, as much as 90 percent of some beach areas in the state were destroyed after Hurricane Fran made landfall in 1996.<sup>279</sup>

### *How Climate Change May Affect Water Supplies*

Research shows that climate change will have major effects on precipitation, stream flows, storm surges, runoff, water temperatures, and evaporation, thereby affecting North Carolina's water supply. In addition, increased saltwater intrusion from rising sea levels may impact rivers, aquifers,<sup>280</sup> and wells. Both the quantity and quality of available water could be at risk.

More extreme weather would likely mean a more "tropical-like" climate for North Carolina. This means more heavy rain, resulting in more flooding. Despite the predicted increase in precipitation, North Carolina could also experience more droughts, like the drought conditions experienced by western North Carolina over the past two years, due to increased evaporation resulting from overall warmer temperatures, a decrease in soil moisture, and an inability to store the excess precipitation for later use.

There remains considerable uncertainty as to specifically how regional precipitation and waterways could be affected by global climate change. Certain facts, however, are clear. Low stream flows cause substances in water to concentrate, leading to more polluted waters. Rivers such as the Catawba, which supplies water to Charlotte and other large cities, may be affected along with aquifers in the Coastal Plains, which already suffer from declining water levels and saltwater intrusion.<sup>281</sup> If water supplies in lakes, rivers, and underground aquifers are impacted, there may be an increased likelihood of widespread water shortages for both public and private water users. Areas of the state with rapidly expanding populations, such as Mecklenberg County and the Research Triangle would be most affected, since development and loss of forest cover accelerate runoff, preventing groundwater supplies from recharging even when it does rain. Drought conditions can also damage crop production.

On the other end of the spectrum, flooding causes excess water runoff and it can cause more pesticides, along with agricultural and human wastes, to enter rivers and the water supply. Higher streamflows also could bring dangerous waste into water sources for the state's low-lying coastal areas that are being developed for agriculture and peat mining.<sup>282</sup>

Extreme weather events that cause flooding or disruptions in water supplies may bring on gastrointestinal disease. Two of the greatest threats are from giardia and cryptosporidium.

**Giardiasis** is an illness caused by a one-celled microscopic parasite that lives in the intestines of people and animals. It survives well in water. During the past 15 years, *Giardia lamblia* has become recognized as one of the most

common causes of water-borne human disease in the United States.<sup>283</sup> Diarrhea, abdominal cramps and nausea are the most common symptoms of giardiasis.

**Cryptosporidiosis:** Another major threat to the United States water supply is from an organism called *Cryptosporidium*, which is small, difficult to filter, resistant to chlorine, and ubiquitous in many animals.<sup>284</sup> Symptoms of the illness include diarrhea, stomach cramps, upset stomach, and slight fever. Cryptosporidiosis can be serious, long-lasting and sometimes fatal for people with AIDS, and others with weakened immune systems.<sup>285</sup> In 1999, there were almost 3,500 cases of cryptosporidiosis in the United States. There were 35 reported cases of the illness in North Carolina in 1999 and 28 cases in 2000.<sup>286</sup>

### ***Warmer Weather Could Increase Food Contamination***

Warmer, moister weather encourages the spread of diseases caused by food contaminated with toxic *E. coli*, salmonella, shigella, and campylobacter. People ingest these microbiologic agents by drinking contaminated water, eating seafood from contaminated waters, or by eating fresh produce irrigated or processed with contaminated water.<sup>287</sup> Higher ambient temperatures foster the growth of the pathogens that cause these illnesses.<sup>288</sup> Heavy rainfall and runoff can wash the contaminants into public water supplies thereby helping to spread the disease.<sup>289</sup>

***Escherichia coli (0157:87)*** is a bacterium that can cause bloody diarrhea. In the worst cases infection may result in kidney failure, particularly in young or elderly victims whose blood cells may be destroyed by the illness.<sup>290</sup> About two to seven percent of all infections lead to this complication. Every year there are approximately 100 to 200 cases of *E. coli* reported in North Carolina.<sup>291</sup>

**Salmonellosis** is caused by the salmonella bacteria. There were over 2,000 cases of salmonellosis reported in North Carolina in 1999 and 2000.<sup>292</sup> Most infected persons develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. Hospitalization is required in some cases. In the most severe cases, the salmonella infection may spread from the intestines to the blood stream, and then to other body sites. At that point, the illness can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more vulnerable. A small number of victims can develop Reiter's syndrome, which can lead to chronic arthritis that can last from months to years.<sup>293</sup>

**Shigella** is the name of one of the bacteria that causes shigellosis, or dysentery of the bowel. Severe cases can lead to dehydration that can be life threatening for young, old or immunocompromised individuals. In rare cases, the disease may spread to other parts of the body and the victim could experience seizures.<sup>294</sup> 211 cases were reported in North Carolina in 1999, and 400 cases were documented in 2000.<sup>295</sup>

Campylobacter is another bacterial disease that could increase in North Carolina due to predicted warmer temperatures that may foster its growth, and runoff following heavy rains, as water usually becomes contaminated

with campylobacter bacteria when sewage enters the drinking water supply. The disease may cause diarrhea, abdominal pain, fever, vomiting, and nausea.<sup>296</sup> Since climate change leads to land subsidence that in turn can result in broken sewer systems, there may be an increased risk for developing this disease in the near future. In 1998, there were 492 cases of campylobacter in North Carolina. The caseload increased to 544 in 1999.<sup>297</sup>

## **Pfiesteria: The “Cell from Hell”**

*When water pollution results in massive fish kills, or when the Environmental Protection Agency or the state declares the fish or shellfish from a particular river to be unfit for human consumption, we are suddenly reminded that their environment and our environment are one and the same.*<sup>298</sup>

—JOSEPH RUDEK, PH.D. ET AL, COMMENTING ON SEDIMENT POLLUTION IN NORTH CAROLINA WATERS

In recent years, a tragedy of Biblical proportions has occurred in North Carolina’s waters. Hundreds of thousands of fish covered by large, red, bleeding sores are washing up dead along the shores of waters such as the Pamlico and Neuse Rivers. Dr. JoAnn Burkholder, an aquatic botanist at North Carolina State University and the foremost expert on pfiesteria, investigated the die-offs. She and a colleague became dizzy, disoriented and unable to speak or walk after collecting samples of fish and water to examine in a lab. In 1996, she told the *New York Times* that a “cell from hell” was causing the fish deaths and the symptoms both she and her colleague experienced.<sup>299</sup>

The cell, *Pfiesteria piscicida*, is actually an organism that can transform itself from a plant alga into an amoeba animal that feeds on fish. Water containing fish affected by pfiesteria can turn an eerie bright red or maroon-brown, both from the cell’s presence and from blood emitted by the fish sores produced by the feeding amoeba. Pfiesteria also releases an aerosol that is dangerous for humans to breathe.<sup>300</sup>

No one knows for sure what made this ancient cell turn into a mass fish killer, but, some scientists, including Burkholder, theorize that environmental changes are to blame. In particular, they point to runoff from nearby farms, especially pig farms in North Carolina that dumped high levels of animal waste and fertilizer into rivers and lakes. These substances give rise to blooms of algae and bacteria, which in turn

spur a population explosion of pfiesteria.<sup>301</sup>

Pfiesteria can change from plant to animal and back under conditions affected by pollution and climate. For example, when the amount of freshwater entering estuaries decreases due to periods of drought and low rainfall, estuaries tend to form stratified layers, with lighter freshwater lying on top of layers of dense, heavy saltwater. When temperatures increase, water becomes less able to hold oxygen. The bottom layer of saltwater is cut-off from almost all oxygen, creating a condition that the National Oceanic and Atmospheric Administration recognizes as a precursor to pfiesteria development.<sup>302</sup>

Sediment pollution primarily resulting from agriculture, livestock grazing, timber cutting, and municipal land use practices also becomes more concentrated during periods of low rainfall and warmer conditions. Extreme weather events, such as Hurricane Floyd, can wash such pollutants into the state’s waters, where they concentrate during warm weather months.<sup>303</sup>

The impact of pfiesteria on human health has yet to be firmly established, but fishermen near massive fish kill areas, such as the Pamlico and Neuse Rivers, have reported experiencing dizziness, disorientation, and open sores on their arms.<sup>304</sup> At this point state health officials advise citizens to avoid fish kill areas and consumption of fish or seafood collected from pfiesteria-infected waters. The North Carolina Department of Health and Human Services suggests that individuals exposed to water or fish affected by pfiesteria should remove wet clothing and keep it separated from other items until it is washed. Exposed individuals should also thoroughly wash any parts of the body that come into contact with infected waters and use waterproof gloves when handling pets or objects that have had contact with the water.<sup>305</sup>

## *North Carolina Fisheries*

*Scientists have observed an increase in toxic phytoplankton blooms, both in the U.S. and worldwide, since the early 1970s. In the U.S., over the last 25 years we've had more frequent blooms, caused by more different species, and affecting larger geographic areas.*<sup>306</sup>

—VOLUNTEER WATER QUALITY MONITORING NATIONAL NEWSLETTER

According to the EPA, global warming could have a devastating impact on fisheries. Some bodies of water may become too warm for the fish and shellfish that inhabit those areas. Global warming also may change the chemical composition of the water that fish inhabit, causing the amount of life-sustaining oxygen in the water to diminish, while dangerous pollution and salt levels increase.<sup>307</sup>

Such effects impact human health in two ways: they can hurt the fishing industry, causing economic and psychological stresses; and they may lead to diseases caused by consumption of contaminated fish and shellfish.

## *Red Tides and Seafood Poisonings*

Certain seafood-related health problems arise when poisonous algae, known as dinoflagellates, bloom along North Carolina's shores in the spring or fall. Global warming may increase the occurrence and severity of such blooms. The harmful algae often stain water red—hence the expression “red tides.”

Nationally, such harmful algal blooms (HABs) are on the rise and appear to be expanding throughout the United States.<sup>308</sup> Red tides and other HABs such as *parvovirus*, impact human health when individuals consume or come into contact with fish and shellfish from infected waters. Raw or cooked, these animals can pass the toxins to humans, causing shellfish poisoning.

There are five principle types of seafood/shellfish poisoning: Amnesic Shellfish Poisoning, Ciguatera Fish Poisoning, Diarrhetic Shellfish Poisoning, Neurotoxic Shellfish Poisoning, and Paralytic Shellfish Poisoning. Neurotoxic Shellfish Poisoning has been found in North Carolina.<sup>309</sup> Symptoms caused by poisonings include nausea, vomiting, abdominal cramps, diarrhea, dizziness, headache, seizures, disorientation, short-term memory loss, respiratory difficulty, coma, muscular aches, anxiety, sweating, numbness and tingling of the mouth and digits, paralysis and death.

## **How Global Warming Could Change North Carolina's Agriculture and Forests**

*Smoke from forest fires in Western North Carolina is making outdoor air unhealthy to breathe for people who are sensitive to air pollution, including young children, the elderly and those with respiratory ailments such as asthma and emphysema, state health and environmental officials said today (November 3, 2000).<sup>310</sup>*

—NORTH CAROLINA DEPARTMENT OF ENVIRONMENT  
AND NATURAL RESOURCES PRESS RELEASE

### ***How Climate Change Could Impact Agriculture***

Production agriculture in North Carolina earns the state 5.4 billion dollars in annual revenues. 60 percent of this amount is derived from livestock. If summer temperatures rise significantly, livestock may lose weight as forage areas decline, causing impacts on meat and dairy production. Major crops in the state include corn, wheat, soybeans, hay and tobacco. Both soybean and wheat yields are predicted to fall as a result of climate change, with soybeans dropping by 3 to 39 percent and wheat falling between 5 and 11 percent as temperatures rise beyond the tolerance levels of these crops. Depending on how the climate changes, corn yields may drop by 28 percent.<sup>311</sup> Plants that do survive may change biochemically as a result of warmer temperatures. Such changes could impact human and animal health.

Nitrate poisoning is one such threat. Weather stresses, such as hot, dry conditions, can cause inefficient fertilizer uptake by certain crops, like corn. This, in turn, causes nitrate to accumulate in the plants. Nitrate concentrations above 1,000 parts per million can pose health problems. In livestock, for example, acute nitrate poisoning may result in breathing difficulty, blue mucous membranes, a rapid weak pulse, dark brown blood, weakness, muscle tremor, or sudden death. Longer exposures may result in abortions and retarded growth.<sup>312</sup>

Plants subjected to heightened levels of carbon dioxide, a greenhouse gas associated with global warming, also showed surprising impacts. James Teeri, Director of the University of Michigan Biological Station, found that plants grown in high concentrations of carbon dioxide grew to large sizes, displaying a form of gigantism. Despite the apparent vigorous growth, they had fewer nutrients than normal.<sup>313</sup> Considering that carbon dioxide levels are projected to double from today's already high levels in 50 to 60 years,<sup>314</sup> the findings merit high concern.

### ***Projected Impact on Forests***

Global warming could alter North Carolina's forests by influencing biological diversity and forest growth.<sup>315</sup> Changes in precipitation, higher temperatures, and extreme weather events could wreak havoc on the state's timber stands, such as those found in and around the Great Smokey Mountains National Park. Specifically, droughts dry out forests, paving the way for forest fires.

Forest fires pose numerous public concerns. They can have a devastating effect on timber production and wildlife. They may destroy homes and other high value property. Wildfires can kill young trees that represent the timber for tomorrow.<sup>316</sup> From a health standpoint, fires may cause injuries and fatalities to firefighters and nearby residents. Smoke, which can cover a wide area, may increase respiratory illness, such as asthma and chronic obstructive pulmonary disease, particularly for people with pre-existing respiratory conditions.<sup>317</sup> Nationwide, between 1990 and 1998, 133 individuals died while involved in wild land fire activities.<sup>318</sup>

An economic impact could also be felt if, as projected by the EPA, North Carolina's warmer mixed forests, dominated by southern pines and oaks, spread northward replacing the predominantly hardwood forests of the north and west. The forests of western North Carolina in and around the Great Smoky Mountains National Park support a rich variety of plants and animals, and they are important recreation areas. Maritime forests, important for their recreational and aesthetic value and for their role in coastal hydrology, could be affected adversely by changes in the frequencies of large storms caused by climate change.<sup>319</sup>

## What You Can Do

*The remaining skeptics of global warming must consider the likely outcome should they be wrong. For the sake for our grandchildren and all future generations can we fail to take the necessary steps to prevent a calamity of epidemics of old diseases which we thought would never again plague us and new diseases for which we have no means of control? Would we fail to try to prevent the predicted climate changes which could unleash ever increasingly disastrous weather extremes? The answer must be no, that we will act promptly and decisively to reduce the likelihood of such risks.<sup>320</sup>*

—LEWIS E. PATRIE, M.D., PRESIDENT, WESTERN NORTH CAROLINA  
PHYSICIANS FOR SOCIAL RESPONSIBILITY

This report has reviewed in depth the threats to human health that could result from climate change. The United States has a greater ability to adapt to, and prepare for, these changes than other countries due to our health care infrastructure and strong economy. However, the potential health effects of climate change are real and demand attention. Increased levels of heat, extreme weather events, vector-borne and water-borne diseases, air and water pollution can affect all Americans. The poor, elderly, young, and immunocompromised will be the hardest hit.

We have the power to ameliorate the impacts of climate change by decreasing greenhouse gas emissions, but we must act now. In addition, we need to invest in strategies that will help us to prepare for what is to come. It is essential that we formulate and implement plans to improve our health care infrastructure and emergency response capabilities, as well as train the medical community to identify new diseases and treat larger and more diverse case loads.

Can residents of North Carolina do anything to reverse global warming before it creates a perpetual state of emergency? Yes, they can. The number one priority is to lower the use of fossil fuels. Opportunities for doing so are everywhere. This needs to be done both on a personal level, by limiting our personal contributions to greenhouse gas emissions, and on a government level, through smart energy policies, the development and use of new technology, and the preparation of improved emergency preparedness plans.

As an added benefit, the energy conservation techniques recommended here to combat global warming are very similar to those desperately needed to cut air pollution. Reducing greenhouse gas emissions through sound energy policies is a win-win scenario because we will not only prevent the associated health effects of global warming, but also we will reduce the current threats to health from air pollution. In addition, these policies can increase our standard of living while reducing economic costs. Our quality of life in the future depends upon the actions we take today.

There is a lot you can do in North Carolina, starting now, to combat global warming and bring down consumption of fossil fuels.

**1** Contact your local representatives, government officials, and Mayor. Find out if your city or county has a plan to reduce carbon dioxide emissions, and if not, encourage them to consider it. Demand user-friendly public transportation. Support efforts to separate sewer and flood water lines in the state. Many water systems in North Carolina are vulnerable

to contamination from pollutants and pathogens in untreated sewer water during flood events. Urge officials to continue to update sewer and flood water lines to avoid such problems in the future.

**2** Contact your State Representatives and Governor. Encourage them to develop and implement state carbon emission reduction plans and to create incentives for citizens and businesses to make more efficient energy choices. For example, provide tax incentives for families that purchase newer cars with better mileage. Ask your Governor to support shutting down or cleaning up old, dirty power plants like those at Belews Creek and Roxboro and to discourage the use and development of nuclear power. Contact information for your state representatives can be found in the blue pages of your phone book.

**3** Contact your Members of Congress and the President. Encourage your lawmakers and President Bush to adopt a balanced energy policy that promotes efficiency and use of clean, renewable sources of power. Specifically ask them to:

- Fund research and implementation of new next-generation energy technologies such as solar and wind power. This will not only give the oil supply we currently have a longer life, but also it will reduce the unhealthy pollution associated with both the burning of fossil fuels and the recovery of fossil fuels.
- Clean up power plants! Require that power plants that were grandfathered under the Clean Air Act be cleaned up or shut down now.
- Support “Four-Pollutant” bills regulating carbon dioxide, oxides of nitrogen, sulfur dioxide, and mercury.
- Support an increase in Corporate Average Fuel Economy standards, or minimum miles per gallon standards, for cars, SUVs, and light trucks.
- Support international agreements to lower carbon emissions, and take responsibility for our disproportionate contribution of greenhouse gas emissions to the world’s global warming problem.

Contact information for your Members of Congress and the President can be found in the blue pages of your phone book, or on the following websites: [www.senate.gov](http://www.senate.gov); [www.house.gov](http://www.house.gov); [www.whitehouse.gov/contact/](http://www.whitehouse.gov/contact/).

**4** Get your own house and business office in order. Use energy-efficient light bulbs. Install a solar thermal system to help provide your hot water (carbon dioxide reduction: 720 pounds per year). Recycle all of your waste newsprint, cardboard, glass and metal (carbon dioxide reduction: 2,480 pounds per year). Lower your thermostat in winter and raise it in summer, or use a thermostat that shuts off when you are not home, thereby reducing the demand for electricity and the burning of fossil fuels. When purchasing a home or remodeling, request efficient insulation, and energy efficient appliances, refrigerators, and water heaters.

**5** Be conscious of how your actions create carbon emissions. Americans' love for automobiles contributes 30 percent of U.S. greenhouse gas emissions. As population increases so does pollution from cars. In North Carolina, the state's population grew by 40 percent from 1970- 1995, while driving increased by 150 percent.<sup>321</sup> Do your part by carpooling and leaving your car at home as much as possible. When you do have to drive: Keep your car's tires properly inflated at all times. This ensures the maximum efficiency of your car. If your car's tires are under-inflated by just 4 pounds, it could cost up to a half-mile per gallon of gasoline.<sup>322</sup> Nationally cars and light trucks are responsible for as much as 45 percent of the ozone causing compounds that can aggravate respiratory problems. When purchasing a new car buy the most efficient vehicle for your needs. At a web site launched by the EPA and the U.S. Department of Energy (<http://www.fueleconomy.gov>), you can do a side-by-side comparison and select the right car for your needs.

**6** Urge the businesses you patronize to become energy-efficient. U.S. businesses spend about \$100 billion on energy each year to operate commercial and industrial buildings. By using energy efficient products and procedures, organizations could reduce their energy use by 35 percent, or \$35 billion nationally. There are now numerous programs in place to help businesses change their energy use strategies and save money at the same time. Put your favorite businesses in touch with EPA's Energy Star Buildings program (1-888-STAR-YES, <http://www.epa.gov/greenlights>), and Climate Wise program (1-800-459-WISE, <http://www.epa.gov/climatewise>).

**7** Work with local groups and chapters of national organizations to promote awareness of global warming and related issues in North Carolina. These include: the North Carolina chapters of Physicians for Social Responsibility—PSR/North Carolina Triangle (919-942-9365) and PSR/Western North Carolina (828-299-1242), North Carolina Solar Energy Association (910-832-7601), American Lung Association of North Carolina (800-892-5650 or 919-832-8326), American Heart Association North Carolina, AHA/Raleigh, Durham, Chapel Hill (919-968-4453), AHA/Charlotte (704-374-0632), AHA/Goldsboro (919-739-3806), AHA/Triad Office 336-668-0167), AHA/Asheville (828-252-4160), AHA/Fayetteville (910-323-9387), AHA/Greenville (252-355-1112), AHA/Rocky Mount (919-442-7169), AHA/Wilmington (910-686-6786), AHA/North Wilkesboro (336-667-3833), North Carolina Public Interest Research Group (919-933-5889), Sierra Club North Carolina Chapter (919-833-8467), Environmental Defense Fund Inc. North Carolina Office (919-881-2601), Southern Environmental Law Center North Carolina Office (919-967-1450), American Fisheries Society, North Carolina Chapter (704-875-5236), Conservation Council of North Carolina (919-839-0006), North Carolina Coalition Inc. (828-369-7877), North Carolina Coastal Federation Inc. (252-393-8185), North Carolina Forestry Association (919-834-3943), Save Our Rivers Inc. (828-369-7877), Scenic North Carolina (919-832-3687).

## **Where Physicians for Social Responsibility (PSR) Stands**

Physicians for Social Responsibility (PSR), the active conscience of American medicine, uses its members' expertise and professional leadership, influence within the medical and other communities, and strong links to policy makers to address this century's greatest threats to human welfare and survival.

While we recognize that uncertainties exist in the measurement of global warming—just as all scientific measurement is uncertain—we are moved to action for several compelling reasons. First, the overwhelming consensus among scientists is that the Earth's temperature is increasing and weather patterns are changing in ways potentially harmful to human health. This fact is overlooked in statements funded by the energy industry that attempt to minimize the severity of global warming. Second, just like businesses, governments, and responsible individuals, PSR feels the need to act decisively in the face of uncertainty to protect those whose welfare has been entrusted to us.

We cannot say exactly when to expect a noticeable increase in floods, or in deaths from asthma among people living in smog-congested cities. No one can. But as Surgeon General Luther Terry stated in his 1962 report on motor vehicles and air pollution, the need for further research should not stop us from taking "all practicable steps to minimize" the hazard. We are certain that fossil fuels play a role in global warming, one step that we can control. For the sake of our own well-being, and that of future generations, we need to act now.

PSR is working to create a world free of global environmental pollution, nuclear weapons, and gun violence. PSR is an organization in official relations with the World Health Organization. In 1985, PSR shared the Nobel Peace Prize with the International Physicians for the Prevention of Nuclear War.

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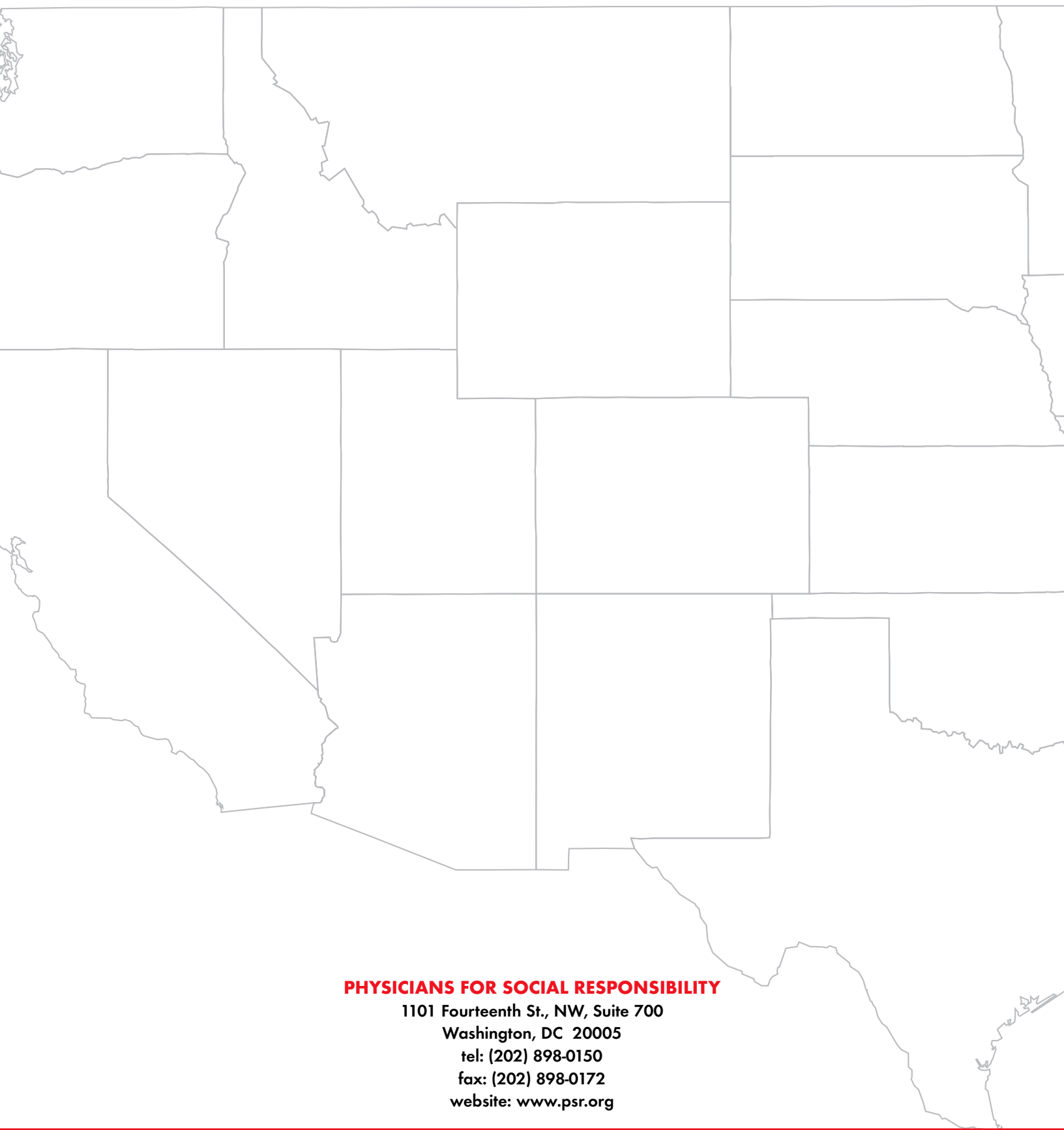
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