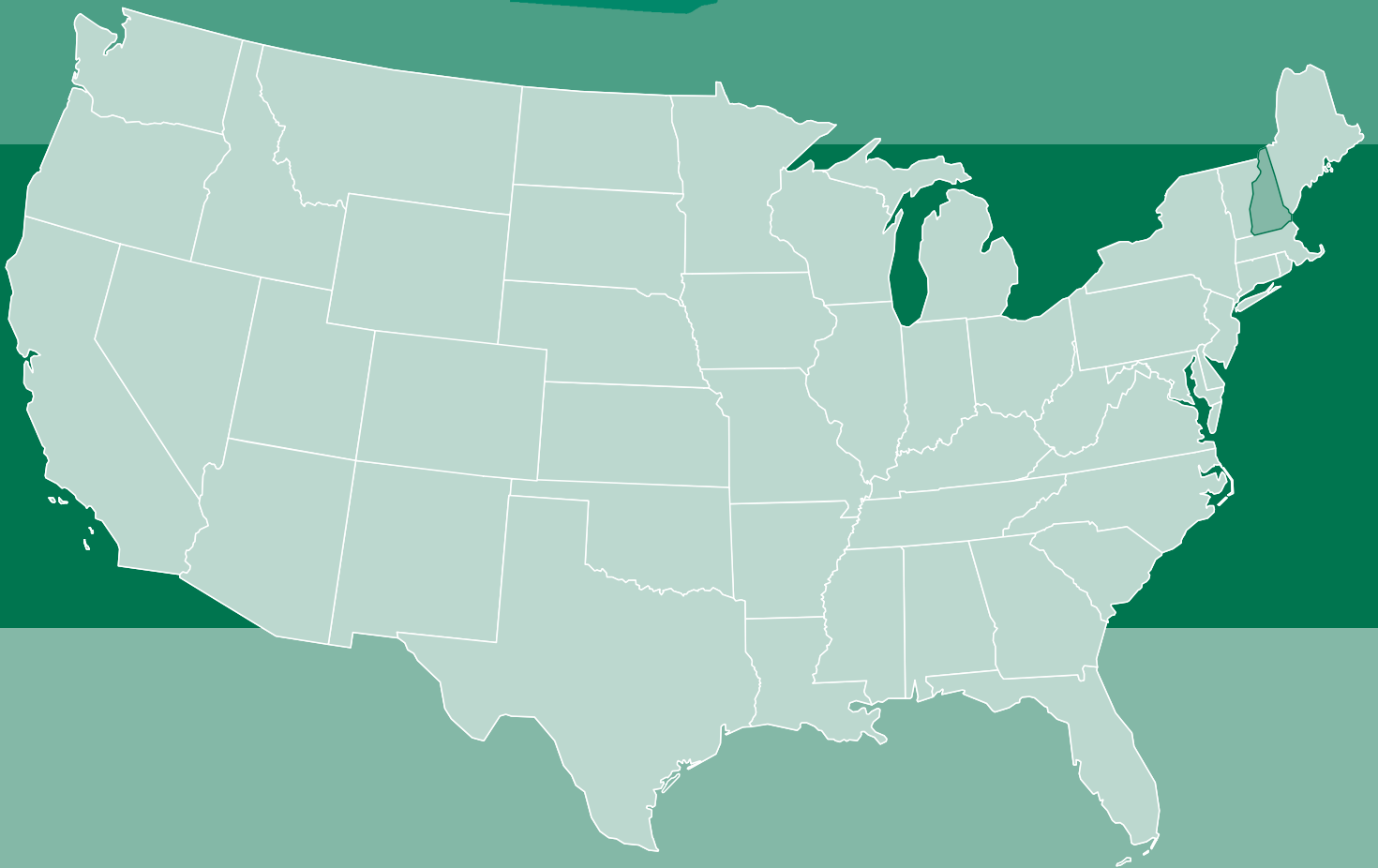


U.S. STATE REPORTS ON POPULATION AND THE ENVIRONMENT

NEW HAMPSHIRE



Center for
Environment &
Population



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U.S. STATE REPORTS ON POPULATION AND THE ENVIRONMENT

NEW HAMPSHIRE

Produced and edited by Victoria Dompka Markham,
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Center for Environment and Population (CEP)

The Center for Environment and Population (CEP) is a non-profit organization that addresses the relationship between human population, resource consumption and environmental impacts. The Center works to strengthen the scientific basis of policies and public outreach to achieve a long-term sustainable balance between people and the natural environment around the world. CEP partners with leading organizations to link science to policy and public education efforts, so as to better understand and effectively address the issues. To do this the Center and its organizational partners undertake a series of activities to: compile and assess the current knowledge and emerging trends on the issues; produce expert and research-based materials for policy makers and the public; and undertake activities to integrate the materials and information directly into policies and public outreach. CEP is a project of the Tides Center, and works in the U.S. and internationally.

The Center has three major program areas: Emerging Issues in Environment and Population, Building New Population-Environment Leadership, and the *AAAS Atlas of Population and Environment* Project. Activities center on producing science-based materials including *U.S. State Reports on Population and the Environment* and the new publication series *Issues on Population & the Environment*, and undertaking directly linked follow-up activities that integrate the materials into policy and public outreach in the U.S. and internationally. The Center utilizes its CEP Experts Network to engage leading scientists and other experts in policy and public outreach projects.

National Wildlife Federation (NWF)

The mission of the National Wildlife Federation (NWF), the nation's largest environmental education and advocacy organization, is to educate, inspire, and assist individuals and organizations of diverse cultures to conserve wildlife and other natural resources and to protect the Earth's environment in order to achieve a peaceful, equitable and sustain-

able future. Founded in 1936, NWF combines the local knowledge and focus of its strong state affiliate and grassroots network with the perspective, resources and strength of a national organization to generate unparalleled support for wildlife, wild places and a healthy environment.

NWF's Population & Environment Program makes a significant contribution toward promoting responsible national and international action by informing people of how population growth and pressure are imperiling the wildlife and wild places that they love and how they can take action. The Population & Environment Program works to achieve a sustainable balance among the world's population, environmental quality, wildlife and wildlife habitat, and our finite natural resources.

About This Report

This is the first in a series of *U.S. State Reports on Population and the Environment*. As part of the series, brief, easy-to-read reports on a selection of states around the U.S. will feature science-based information and analysis on the main human population and environmental interactions in the state. The series will include the *U.S. National Report on Population and the Environment*, a compilation of population-environment highlights for each state, with regional and national analysis.

The U.S. State Reports will be followed by directly related activities to discuss the reports' highlights and generate policy and public action addressing the issues at the local, national and international levels. This project focuses on the U.S. population's environmental impact, in order to better understand and address the nation's role within the global context.

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INTRODUCTION

The world's natural environment is changing in ways fundamentally different from those at any other time in our history. Freshwater resources are increasingly vulnerable, more plant and animal species are becoming endangered or extinct, land-use alteration is pervasive, and even the global climate is changing.¹

Experts now trace these diverse environmental phenomena to *the growing scale of the human presence*.

The impact of the human presence on the environment is particularly acute when one looks at the United States (U.S.). While America represents about one-fifth of the planet's population, the U.S. consumes higher amounts of practically every resource than any other country in the world.²

Much information exists on the population-environment relationship on a global scale. Yet comparatively little has been compiled for the U.S., particularly at the state level. This series of U.S. State Reports on Population and the Environment aims to fill that gap by highlighting the U.S. population's environmental impact at the state level, thus helping us better understand the U.S. role in the global community. This first report examines how the scale of the human presence affects the environment in the state of New Hampshire. Other State Reports will follow.



Population factors in New Hampshire – such as rates of growth, density, movement and composition (age, gender, households, etc.) – influence its natural environment. The effects are felt on all of New Hampshire's natural resources.

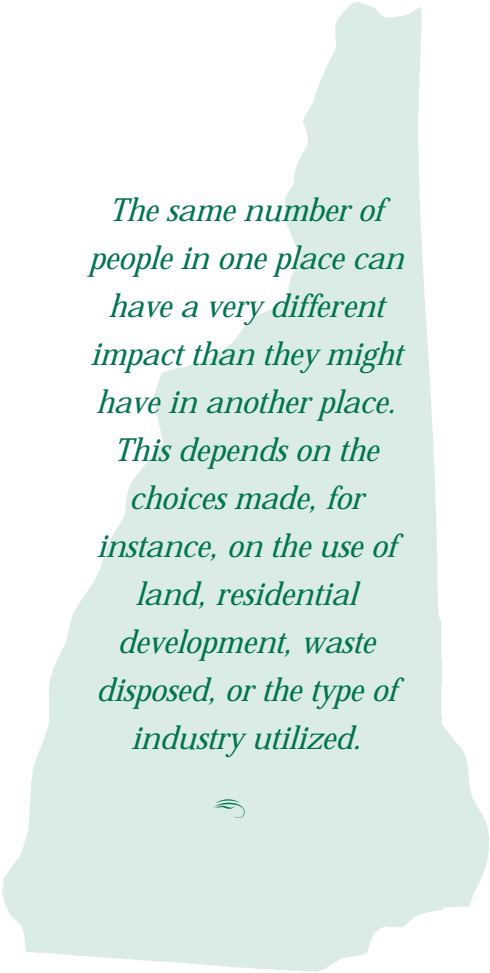
People's choices, whether in New Hampshire or in other states, are central to whether or not a given population is detrimental to the environment. The same number of people in one place can have a very different impact than they might have in another place. This depends on the choices made, for instance, on the use of land, residential development, waste disposed or the type of industry utilized.

A New Hampshire town of 20,000 people that promotes concentrated "cluster" development, energy efficiency, organic farming, non-polluting industry or cross-country ski-centered tourism will have much less

negative environmental impact than the same size town that promotes sprawl development, dependence on long distance commutes or polluting industries.

So, while total population numbers are critically important, large numbers of people do not always have equally detrimental environmental impacts. Clearly, if more people engage in polluting activities, their environmental impacts will be greater.

Understanding how these issues play out in New Hampshire provides us with a better sense of what is needed to prevent, mitigate or adapt to coming changes in the state. By examining the population-environment interactions in this report, we can better target our research, and begin to develop effective policy and public responses to the issues in New Hampshire.



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NEW HAMPSHIRE'S POPULATION & ENVIRONMENT: KEY FINDINGS

The key findings, summarized below, provide an overall snapshot of how New Hampshire's population dynamics are linked to its environment.

- **Population:** New Hampshire is the fastest growing state in New England and among the ten fastest in the U.S. with an average 1% growth per year. Eighty-five percent of the growth is concentrated in the southeastern part of the state – only one-third of the total land area. The state's population has doubled since 1950, and may triple by 2020. New Hampshire ranks fourth in the nation in inter-state in-migration.
- **Land-use and Sprawl:** Each New Hampshire resident effectively occupies one-third more land area for housing, schools, shopping, roads and other uses than s/he did twenty years ago, resulting in major losses of natural areas and widespread sprawl development. Over 150,000 acres were converted to developed uses between 1982 and 1997, a 37% increase in total developed land area in just 15 years.
- **Forests:** Forest cover has been declining steadily in New Hampshire for the past two decades. Between 1983-1997, development consumed almost 3% of the forest area, which is currently shrinking by 9,600 acres (0.2%) each year. Floodplain forests have almost been eliminated, and pine barrens dramatically reduced.
- **Water:** Water use has increased much more rapidly than the state's population. All of the state's surface water is currently considered contaminated by mercury and is covered by fish consumption advisories.
- **Biodiversity and Wildlife:** Historically, 24 species of plants and animals have been eliminated from New Hampshire. The most recent was the Karner blue butterfly in 2001, from habitat loss. Over one-third of New Hampshire's wildlife habitat is at risk from global warming, and several species, including the purple finch (New Hampshire's state bird), are threatened by climate change.
- **Fisheries:** Mercury pollution and acid rain have contaminated most inland freshwater fisheries in New Hampshire, while habitat loss and over-fishing have severely depleted coastal fisheries.
- **Agriculture:** In the 15 years prior to 1997, New Hampshire lost 15% of its cropland. During this same period, nearly 12,000 acres of New Hampshire's best farming soils became unsuitable for farming.
- **Energy:** New Hampshire is more reliant on oil (the burning of which creates greenhouse gas emissions) and nuclear power (with issues of long-term safety and potential health risk) than the national average. Transportation is the largest energy consumption sector, and the state's development patterns are increasing vehicle dependence.
- **Climate Change:** Global warming scenarios project that New Hampshire's average annual temperature could increase by six to ten degrees Fahrenheit before 2100. New Hampshire could become as warm as Allentown, PA and Asheville, NC. Global warming threatens the state's economic activities, including ski tourism, fall foliage viewing, and maple sugaring.
- **Acid Rain:** New Hampshire, like the rest of New England and Eastern Canada, receives some of the highest amounts of acid deposition in North America.
- **Solid Waste:** The state has the highest per capita rate of solid waste disposal in the Northeast. In 1999, New Hampshire generated over 1.3 million tons of solid waste, an average of almost six pounds per person per day.

Population Growth

Understanding the nature of New Hampshire's population and the way it grows and changes is critical to understanding how it impacts the state's environment.

According to the 2002 U.S. Census estimates, New Hampshire was home to 1,275,000 people, making it the tenth smallest state in the country.³ Vermont and Maine, its neighbors to the east and west, have similar or smaller populations, while Massachusetts to the south dwarfs New Hampshire, with over six million residents.⁴ New Hampshire has consistently been among the fastest growing populations in the entire Northeast over the past several decades.⁵ New Hampshire's population is increasing by about 19,000 persons per year, or 1,500 persons per month – a growth rate of 1.3%.⁶

The current population boom began in the 1950s, as New Hampshire's manufacturing base grew rapidly and southern New Hampshire became a bedroom community for commuters to Massachusetts. Population expanded at over 20% per decade for three consecutive decades until the 1990s.⁷ Then, population growth slowed somewhat, though the population still grew by a considerable 11%, adding around 13,000 people annually.⁸ During the 1990s, New Hampshire gained 126,534 residents, more than the number of new residents in Maine and Vermont combined.⁹ New Hampshire's rapid population growth rate in the 1990s nearly matched that of the nation as a whole.

Population Distribution

The environment is affected not only by the rate of population growth, but also how the human population is distributed. A denser population can increase pressures in certain areas and relieve it in other areas.

Only half of the New Hampshire population lives in urban areas, compared to three-quarters nationally and over 80% in nearby Massachusetts.¹⁰ Despite this rural character, New Hampshire is more densely populated than the U.S. as a whole, with about 138 people per square mile, compared with 77 nationwide.¹¹

Residents are unevenly distributed across the state's 9,000 square miles. Two counties bordering Massachusetts (Hillsborough and Rockingham) have absorbed more than half of the state's population growth and half of all new home construction over the past two decades. The northern and western regions are more sparsely populated, with smaller towns and cities surrounded by large tracts of forested land.¹²

New Hampshire's Growth

Population growth is the outcome of two factors: natural increase, resulting from the difference between births and deaths; and net migration, the balance between in- and out-migration (immigration and emigration).

Natural increase has contributed about 40% to New Hampshire's annual population growth in recent years.¹³ In the 1990s, there were typically about 5,000 more births each year than deaths.¹⁴ The fertility rate – the number of children a woman will have in her lifetime given today's birth rate – is 1.9.¹⁵ This is typical of the U.S. as a whole, though it is high compared to other developed countries such as European nations and Japan. Although the New Hampshire rate is below the level of 2.1 needed for long-term replacement, the state has a large proportion of people of childbearing age, resulting in a relatively high birth rate. High childbearing in the previous generation and selective out migration of older persons seeking warmer climes have contributed to the high birth rate.

New Hampshire has the lowest infant mortality rate in the country, at only four deaths per 1,000 live births, and the second lowest incidence of low birth weight babies, child deaths and births to teens.¹⁶ Life expectancy, at 74 years for men and 80 for women, are each one year longer than the national average.¹⁷

Immigration is the major source of population growth in New Hampshire, generating in recent years roughly 60% of annual population growth.¹⁸ New Hampshire is ranked fourth in the U.S. for inter-state in-migration, contrasted to ranking 39th for international in-migration.¹⁹ In recent years, while more than 40,000 people have moved into the state each year, about 35,000 people have moved out,²⁰ providing a net increase from migration of 5,000 annually.

New Hampshire's strong positive migration balance is unusual in the Northeast. In the region as a whole, emigration to other parts of the country is just barely balanced by immigration from outside of the U.S.²¹

There are several main drivers of New Hampshire's high rate of in-migration: taxes, affordability of homes, quality of life, employment and the draw of seasonal residents. New Hampshire has no sales or income tax, relatively inexpensive housing, a strong and competitive job market, and is a tourist attraction, all of which draw people to the state from other parts of the U.S.

NEW HAMPSHIRE'S POPULATION PROFILE

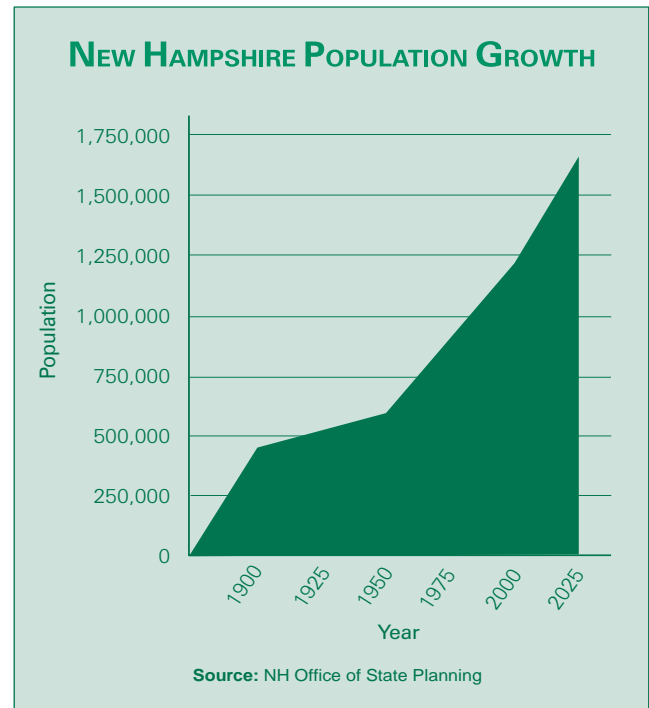
During the mid-1990s, rapid employment growth in all sectors drew new residents to New England. New Hampshire's employment growth from 1992 to 1996 was more rapid than in the rest of New England, and in most sectors, faster than the nation as a whole.²² The state unemployment rate was 2.9% in 1998, the third lowest in the country, and labor force participation was high for both males and females.²³ Also, people began to settle in southern New Hampshire and commute to parts of Massachusetts.

While permanent migration is the only type that affects U.S. Census population, temporary migration also has considerable environmental effects.

New Hampshire is third highest in the U.S. in increase of construction and ownership of seasonal second homes, reflecting a nationwide trend.²⁴ Over 10% of New Hampshire's 547,000 housing units are for seasonal, recreational, or occasional use.²⁵ Second home development has been particularly pronounced in the Lakes and White Mountain Regions. Belknap, Carroll and Grafton counties, areas that did not have the most rapid population growth, experienced some of the most rapid growth in new home construction during the 1970s and 80s.²⁶

As far as "temporary migration," New Hampshire hosted over 26 million visitor trips, each an average of about two days long, in 2000. Typically, this temporary influx of people comes largely from other nearby states, and is significant year-round, though more pronounced in summer than in winter.²⁷ Tourism contributes over 53 million person-days of residence in New Hampshire, the equivalent of an additional 146,593 people living full-time in the state, or a 12% larger year-round population. Tourists therefore represent a significant additional population that is supported by New Hampshire's natural resource base and human-made infrastructure, causing environmental impacts.

New Hampshire's population is among the oldest in the U.S., ranking eighth in the nation, with a median age of 37.1. (Florida's median age is 38.7.) The latest state projection for a doubling of the 65-74+ population in ten years is expected to drive the median age up in the near future. New Hampshire is following the U.S. trend in fewer "married with children" households (25% of the population).²⁸



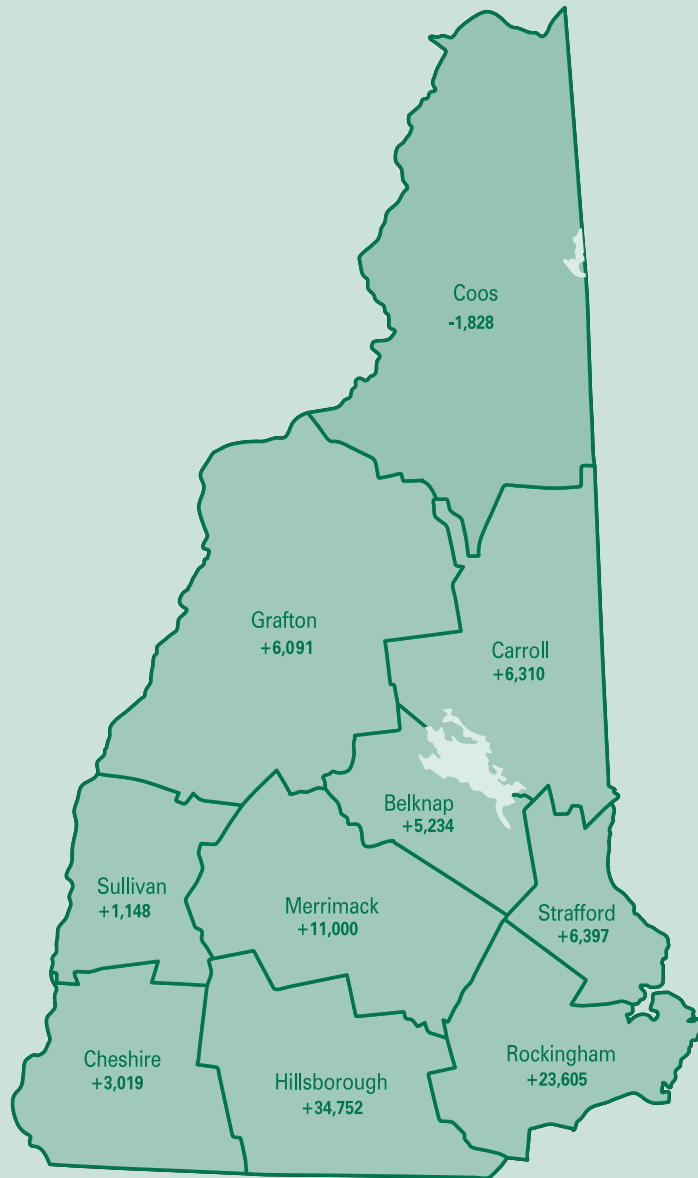
Households

Two demographic factors with considerable environmental impacts are household size (the number of people within a given household), and the number of households.

The average household size in New Hampshire fell from 3.14 people in 1970 to 2.63 in 1990.²⁹ The smaller households were due to a number of factors such as later marriage, rising divorce rates, and increased life expectancy. Approximately 500 new households are added to the state each month.³⁰

Since every household tends to have certain minimum possessions, occupy a certain minimum space, and emit a minimum amount of pollutants, an increase in the number of households can increase environmental impacts even when the population as a whole is not growing. "Increased numbers of households" is covered in more depth in the "Land-Use and Sprawl" section following.

NEW HAMPSHIRE COUNTIES' GROWTH



Population numbers in New Hampshire from 1990-2000

Source: NH Office of State Planning, US Census Bureau

NEW HAMPSHIRE'S POPULATION PROFILE

Consumption and Income

The rate and manner in which natural resources are consumed by increasing numbers of people is an important factor in population's environmental impact. These issues are covered in the sections following. Consumption is also associated with "income" as an indicator, because data indicate that more affluent societies tend to consume more resources, resulting in more environmental impact. In relation to income, New Hampshire's population on average is relatively affluent. It is the seventh wealthiest state in the U.S., with the median household income comparatively high at \$49,509 – 20% higher than the national average.³¹ For people over 65, the income average is 1.7 times the national average.³² There are pockets of poverty in the state, but the poverty rate is half of the national average.

Projections

New Hampshire's population is expected to continue expanding. Over the next several decades, the state's population is expected to increase at over 1% per year,³³ with a doubling in just 70 years. At this rate, approximately 215,000 people will be added to New Hampshire's population over the next quarter century, raising the projected population to over 1.5 million people by 2025.³⁴ The vast majority (85%) of population growth in the next twenty years will likely be concentrated in four southeastern counties.³⁵ The far North Country, in contrast, is expected to stabilize or have slight population decline.

Population's Ecological Footprint

Population factors, whether in New Hampshire or in other sites, can be linked to environmental impacts in three primary ways. First, the environment suffers when there are rapidly increasing demands for a finite resource (such as water) or demands beyond a renewable resource's ability to regenerate (such as fisheries). The environment becomes degraded when increasing quantities of contaminants are put into a natural system beyond its natural capacity to buffer the toxin. Finally, when natural habitats are degraded or destroyed, the environment becomes uninhabitable by formerly native plant or animal species (such as through climate change or habitat loss from development).³⁶

A state's "ecological footprint" compares its consumption of natural resources with nature's biological production capacity. The footprint is the total land-area required to: produce the food, fibers, and energy a given population consumes; provide infrastructure space; and, absorb its wastes.³⁷

The population-environment linkages have been highlighted in the equation "I = PAT", or "Environmental Impact = Population x Affluence/Consumption x Technology:"

- ▶ **Population** – the total number of people. Population always acts in combination with other IPAT factors.
- ▶ **Affluence/Consumption** – often associated with income, it is how much each person consumes in terms of resources, such as water, energy, passenger miles, space for housing and so on.
- ▶ **Technology** – this represents how a resource is used, and how much waste and pollution is created by the production and consumption of the resource. Sometimes it improves environmental impact (e.g., with the use of energy efficient products), or it can worsen it (e.g., through inefficient coal-burning power plants).³⁸

POPULATION-ENVIRONMENT FACTS

	N.H.	U.S.	World
Population, 2002	1.275 m	288.368 m	6,215 b
Projected population, 2025	1.439 m	346 m	7,859 b
Annual growth rate/% change, 2001-2002	1.2	1.1	1.3
Number of people added, 2001-2002	15,697	3.0 m	77 m
Annual natural increase (births minus deaths)	4,324	1.6 m	79.2 m
Annual migration (interstate)	9,170	—	—
Annual migration (international)	2,298	1.4 m	—
Doubling time at current rate	54 years	78 years	53 years
Percent change 1990-2000	11.4	13.2	—
Percent under 18 and over 65	37	34	37
Percent female	50.8	50.9	50.01
Percent male	49.2	49.1	49.99
Median age	37	35.3	26.4
Fertility rate (Average number of children/woman)	1.9	2.1	2.8
Birth rate (Annual number births/1000 population)	11.6	14.1	21
Infant deaths per 1,000 live births	4.3	6.6	54
Life expectancy m/f	74/80	73/79	65/69
Density (persons per square mile)	137.8	77	120
Percent urban	51	75	47
Housing Units	474,606	105.480 mil	—
Average persons per household	2.53	2.59	—
Gross State Product (1997/4/5 per capita)	\$32,494	\$26,434	\$4,909
Per Capita Income/Gross National Income	\$23,844	\$34,280	\$5,120
Median household income	\$49,467	\$41,994	—
Persons below poverty level	6.5%	12.4%	24.27%
Percent in labor force	70.5	63.9	—
Labor force in management, professional	35.8%	33.6%	—
Labor force in sales, etc.	26%	—	—
Labor force in production, transport, etc	14.8%	14.6%	—
Labor force in services	13%	14.9%	—
Labor force in agriculture	0.8%	1.5%	—
Adults/high school graduates	87%	80%	—
Adults/bachelors degree or higher	29%	24%	—
Endangered/threatened animal species	36	829	5,453
Endangered/threatened plant species	289	168	5,714
Percent of land protected	24	13.1	6.4
Wetlands loss up to 1980	9%	46%	—
Daily water use per capita	1,152 gal	1,512 gal	465 gal
Water use for domestic purposes	12%	12%	8%
Water use for agriculture	1%	35%	69%
Water use for industry	4%	6%	23%
Water use for energy production	84%	47%	—
Cropland per capita (acres)	0.2	4.7	0.7
Energy use per capita (oil barrels equiv)	44.7	59.4	2.8
Persons per motor vehicle	1.1	1.3	9
Commute to work outside resident community	33.3%	26.7%	—
Number of vehicles per 1000 people (Year 2000)	1,142	774	176

Sources: Centers for Disease Control and Prevention, IUCN Red List, New Hampshire Office of State Planning (NHOSP), Population Reference Bureau (PRB), UNESCO, UN Population Division, US Census Bureau, US Central Intelligence Agency, World Bank, World Resources Institute, US Department of Transportation
Where no numbers appear indicates no data available.

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

The population dynamics in New Hampshire are not without impacts—on the land, forest, water and fishery resources, to name a few. This section highlights the ways population growth, density, and movement all have an effect on the state.

Land-use and Sprawl

New Hampshire's growing population is having significant impacts on land-use in the state. Development for homes, roads, workplaces and services consumes farmland, forests and wild lands, and fragments wildlife habitat. It paves over soils with impervious surfaces, reduces groundwater replenishment and increases runoff and flooding.³⁹

"Sprawl" development (the conversion of land to various forms of human habitat) multiplies these effects. Many scientists now consider sprawl to be "Earth's greatest menace,"⁴⁰ and New Hampshire is no exception, with its high and rising consumption of land per unit of human activity. According to the New Hampshire state government, sprawl in the state is characterized by "inefficient, lower-density use of land resources, automobile dependency, traffic congestion and higher highway expenditures."⁴¹ Sprawl is apparent in low-density residential subdivisions, commercial strip development, large retail complexes surrounded by acres of parking, office parks far from homes and shops, and a growing network of roads linking them all.⁴²

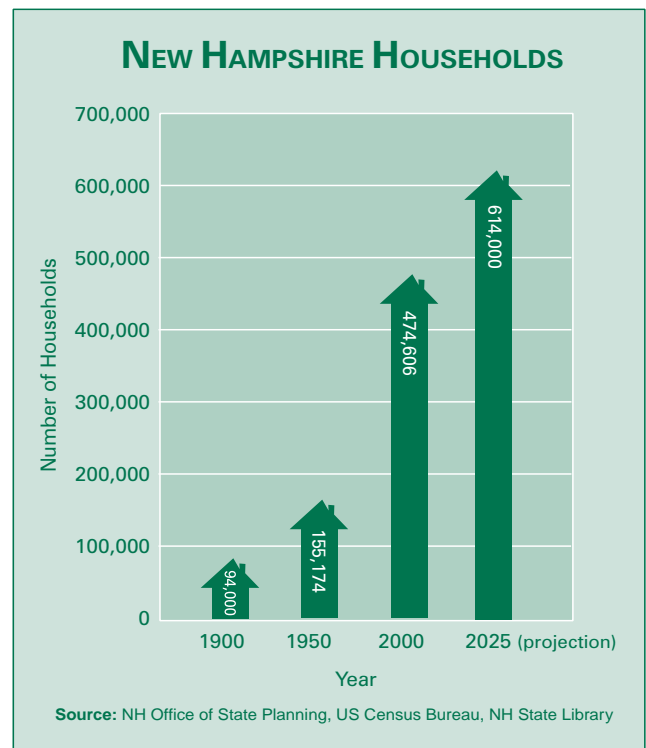
Some urban centers in New Hampshire are approaching built-out conditions, and many new residents now select rural and suburban residential settings. Over 150,000 acres were converted to developed uses between 1982 and 1997 – a 37% increase in total developed land area in just 15 years.⁴³ Recent studies estimate that the state is now losing 13,000 acres per year to development,⁴⁴ mostly for residential purposes. Population and housing growth has been most extreme in southeastern Hillsborough and Rockingham counties.⁴⁵

The sprawl pattern of New Hampshire's recent development has three main results: rapid land-use change, an increase in dispersed housing and an increase in travel for everyday purposes.

Rapid land-use change: Each New Hampshire resident effectively occupies one-third more land area for housing, schools, shopping, roads and other uses than s/he did twenty years ago. New development consumes even more land. At the national level, each new person added to the population used 1.7 acres per

person between 1992 and 1997. A recent estimate for New Hampshire is that each new resident uses 2.33 acres for housing, roads and other infrastructures.⁴⁶ Thus, in a state that already stands out for its rapid population expansion, land development is growing even faster than population.

A study of ten New Hampshire towns found that population growth averaged 71% from 1974 to 1992, while the area of developed land increased nearly twice as fast, by 137%.⁴⁷ Most of the land conversion in these towns was for residential development. This is in part due to the lack of affordable housing. When affordable housing is not available close to people's employment, they either build new housing to be near work, or drive farther to work. New Hampshire is considered to be the ninth least affordable state (including housing), with Portsmouth among the ten least affordable areas in the U.S.⁴⁸



NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Increased housing: While the average size of New Hampshire households fell, the number of housing units grew more quickly than population. Between 1980 and 1998, population grew by 60%, but the number of housing units almost doubled.⁴⁹ Some housing development consists of seasonal homes, which now comprise 11% of the state's housing stock.⁵⁰

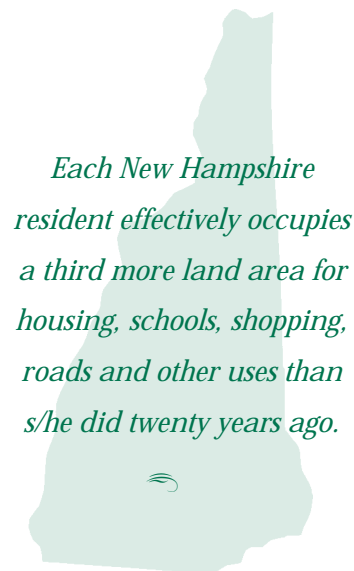
At the same time as the number of dwellings is increasing, so is the average lot size. The 1997 American Housing Survey showed that nationally the average lot size per single family home increased from 1.05 acres in the 1950s to 1.82 acres in 1997. This also holds true in New Hampshire.⁵¹

Increased driving: Sprawl means greater distances between the places people need to visit, and increased car dependence. Nationwide, the number of miles driven has increased at four times the rate of population growth since 1980. The average American driver now spends 443 hours each year behind the wheel. Residents of sprawling communities drive three to four times as much as those living in more compact areas.⁵²

New Hampshire residents now drive 9,694 miles per person per year, close to the national average of 9,785. The state's increasing driving habit is supported by the major disparity in public expenditures on highways (about \$330 per person) compared with public transit (less than \$5 per city resident).⁵³ Increased investments in road infrastructure create a vicious circle by attracting new residents to an area, causing another increase in cars on the road and miles traveled. All of this has implications for increased carbon dioxide (CO₂) emissions and ground level ozone in the state.

Impacts of sprawl development: Sprawl development has already had major environmental effects. Approximately 10% of the state's cropland has been lost to development in recent years. As of 2001, development covered 10% of New Hampshire's critical water supply lands, and paved over 2% of the state's total land area with impervious surfaces.⁵⁴ In a recent survey of New Hampshire residents, over 80% were concerned about the loss of open space or historic and cultural resources.⁵⁵ Other effects are described below.

Forecasts show considerable expansion of development over the next 20 years. New Hampshire's population is expected to increase by over 340,000 people by 2025.⁵⁶ Most of this growth (85%) will likely be concentrated in the southeastern third of the state. New Hampshire is projected to lose 144,000 additional acres of forestland to development by 2020, and forest cover is projected to drop to 80%, from a current 84%.⁵⁷



Each New Hampshire resident effectively occupies a third more land area for housing, schools, shopping, roads and other uses than s/he did twenty years ago.

Most parts of southeastern and central New Hampshire are expected to be fully developed (with no more land left to develop) within 50 to 100 years.⁵⁸ Specific transportation infrastructure projects are expected to accelerate sprawl. For example, the proposed widening of Interstate 93 from Manchester to the Massachusetts border will likely bring in an additional 41,000 residents to nearby communities and indirectly cause the development of another 100,000 acres in the region.⁵⁹

Forests

New Hampshire is the nation's second most forested state. Approximately 84% of the state's land is considered forested. It has four acres of forest per person, twice the national average.⁶⁰

Four and one-half million of its 4.8 million forested acres are classified as capable of growing commercial timber. The remainder are classified noncommercial, including urban forests and designated wilderness.⁶¹

New Hampshire's forests support a thriving tourism and recreation industry, including fall foliage and wildlife viewing, camping, skiing, snowmobiling and hunting, and an important wood products industry – the state's fourth largest in the manufacturing sector. Forest-related activities add over \$2 billion annually to the state's economy,⁶² representing 12% of the gross state product.

Yet, forest cover has been declining steadily in New Hampshire for the past two decades. The major forces are rapid and sprawling residential development, and commercial, industrial, and tourism growth. Between 1983-97, development consumed almost 3% of the forested area. The forested area is currently declining by 9,600 acres (0.2%) per year.⁶³

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Three-fourths of the forest base decline so far has occurred in the southern part of the state, where rapid commercial and residential development has been focused.⁶⁴ All of the municipalities that are less than 50% forested are located in the Seacoast Region, or in the urban corridor along the Merrimack River.⁶⁵

Forest Land Conversion

Unlike earlier deforestation in New Hampshire, much of the current loss is due to one-way "terminal" harvests, or permanent conversions of forest to roads, parking lots, shopping centers, houses and other structures. Statewide, these terminal harvests account for an estimated 10% of the annual volume of timber harvested.⁶⁶

Forest Parcelization and Fragmentation

In addition to New Hampshire losing forests due to "conversion," the state's population growth is resulting in forest "parcelization" (the division of land into smaller units of ownership) and "fragmentation" (the dividing of contiguous blocks by roads, development, and other non-forest uses).⁶⁷

The average parcel size for privately owned commercial forestland has fallen from 114 acres in 1948 to 37.5 acres in 1997.⁶⁸ Typically, the average forested land parcel size drops as population increases, because more development to support increasing numbers of people consumes more of the forested land. Once population density reaches 130 people per square mile, as in medium-sized southern New Hampshire towns, it is rare to have any forested land parcels over 500 acres left, unless they are protected.

Forest "fragmentation," in New Hampshire jeopardizes wildlife species that require large unbroken areas to thrive. Most terrestrial species, except those that fly, require development-free corridors to migrate and seek mates to maintain genetic diversity. Generally, fragmentation is most advanced where population and recreational development are greatest. Large blocks of unbroken forestland are less common in more densely populated areas unless cluster zoning or village centers concentrate development in one area and keep rural land open elsewhere.⁶⁹

Loss of Forest Productivity

Fragmentation, along with a parallel decline in the average parcel of forestland, impairs the profitability of forest management and mill operation. Forest loss reduces the acreage available for future harvest. In

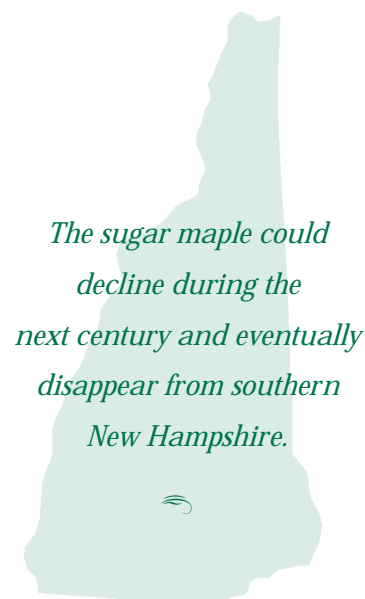
New Hampshire, loss of the most potentially productive timberland has been greater than for the forest base as a whole. Between 1983 and 1997, approximately 290,700 acres of timberland were lost, an average decline of 0.42% of the forest base per year.

Forest loss has been most pronounced on the most valuable lands for growing trees, which are also the most desirable for roads, buildings and other developed uses. Some 42% of natural pinelands have been converted to development and other non-forest uses.⁷⁰

Acid Rain and New Hampshire's Forests

Acid rain (or acid deposition) is linked with population because high energy and transport demands drive fossil fuel consumption, resulting in the sulfur and nitrogen oxide (SO₂ and NO_x) emissions that cause acid rain. Acid rain poses threats to certain New Hampshire tree species by altering the forests' soil chemistry.⁷¹ It increases acidity in the soil, lakes and streams it falls upon, harming both plant and animal ecosystems.

Efforts have been made to try to reduce the amount of acid deposition in New Hampshire. While SO₂ from power plants has been significantly reduced, NO_x reduction efforts have been hampered by the rise in number of vehicles and vehicle miles driven in the state and the lack of a national cap in NO_x emissions.



NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Climate Change and New Hampshire Forests

Climate change itself, partly driven by population growth and increased greenhouse gas emissions throughout the world, poses several threats to New Hampshire's forests. It is likely to bring increased temperature, precipitation, and severity of storms, floods and droughts in the coming century.⁷² Changes in tree species and their geographic range will occur, and some conifer and northern hardwood forests will be eventually displaced by forest types now found farther south.

⁷³ A warmer and wetter climate would favor oak, hickory, and pines.⁷⁴

The sugar maple, essential to maple syrup manufacturing and fall foliage tourism, is highly sensitive to warming and may decline during the next century and eventually disappear, at least from southern New Hampshire. Vulnerable spruce and fir forests may thin, dwindle, or disappear. Forest wildlife would also be affected, especially species that inhabit New Hampshire's northern and higher altitude forests. On the other hand, if conditions become drier rather than wetter, some of the state's forests could be replaced by grasslands, a scenario with enormous economic and ecological implications.⁷⁵

Although there is no certainty yet as to how climate change will affect New Hampshire over the next century, attention to the existing data is critical so that policy makers, public activists, and scientists can prepare to prevent, mitigate, or respond to its potential negative environmental and health effects. See the "Climate Change" section following for more on this topic.

Future Trends for the Forest Base

Experts project that New Hampshire's forest base will shrink to about 80% forest cover by 2020. While this may not seem like much by national standards, it means the state will lose over 10,000 acres of forest annually.⁷⁶ The highest rate of population growth is projected in the counties of Rockingham or Hillsborough in the southern part of the state, representing 46 of the 50 municipalities predicted to lose the most forest area.⁷⁷

Water

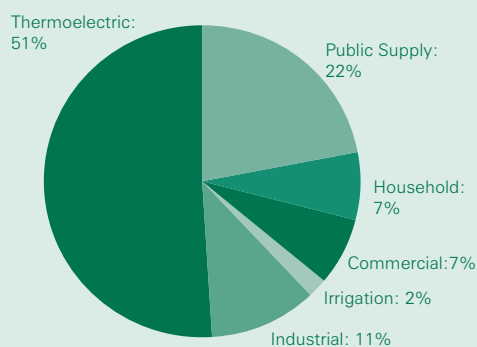
At first glance, New Hampshire has ample freshwater resources. It receives an average of 42 inches of annual precipitation,⁷⁸ much of which collects in its 1,300 lakes and ponds and flows through 10,000 miles of rivers and streams.⁷⁹ Up to 10% of the land area is wetlands.⁸⁰

Yet the state faces a number of water challenges. Population growth and economic development are raising water demand rapidly, increasing the pressures on a limited water supply. These combined factors are also increasing the output of water pollutants, such as industrial waste and sewage, which pose challenges for New Hampshire's water quality and aquatic ecosystems.

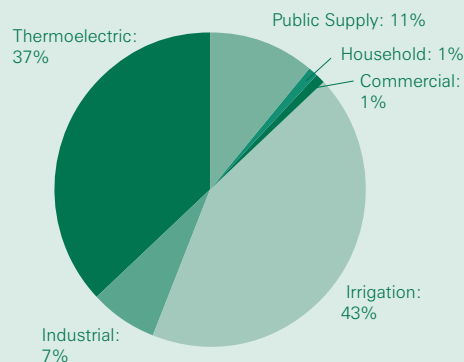
Water Use

Water is a renewable resource, yet it is limited in terms of its quantity and accessibility. New Hampshire residents consume on average 388 gallons of water per person per day, 7% less than the national average.⁸¹

New Hampshire



United States



Percent of million gallons of freshwater used per sector per day.

Sources: USGS, NH/VT District, 1995

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Groundwater is being withdrawn unevenly throughout the state. Nearly 50% of all groundwater withdrawal takes place in the two southeastern counties of Rockingham and Hillsborough, where much of New Hampshire's human population is concentrated.⁸² Demand in these counties has been increasing at a rate of 900 million gallons per year.⁸³

Just over 50% of New Hampshire water withdrawals are for thermoelectric power generation, 22% for public water supplies, 10% for industry, 7% for domestic and 7% for commercial uses (mostly fish hatcheries and snow-making), and the remaining 4% is for mining, livestock, and irrigation. At the national level, water withdrawal for irrigation is much higher (35%).⁸⁴

Water use is increasing rapidly. The state's domestic and industrial withdrawals grew by 18% and 15% respectively between 1990 and 1995.⁸⁵

Over four-fifths of water withdrawn in the state is from surface sources.⁸⁶ However, there is a trend toward groundwater as a primary residential water source,⁸⁷ even though recent droughts, plus the spread of sprawl development, have slowed groundwater replenishment. If climate change increases the frequency and intensity of droughts, groundwater sources could face further pressures.

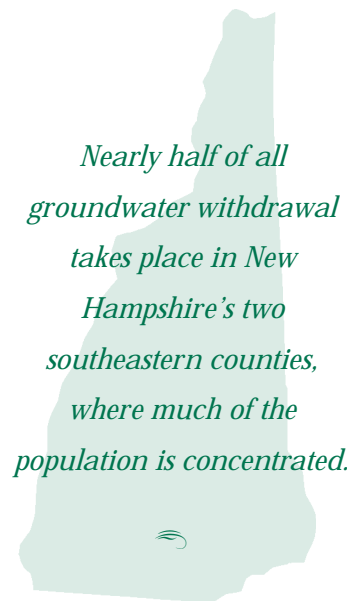
There are about 65,000 public and private wells registered in the state. During the rapid economic expansion in recent years, as many as 5,000 new wells were drilled each year,⁸⁸ mainly to service the thousands of new single family homes.

Water Quality

Water quality is affected by five main elements: pollution from point sources (chemical and industrial) and non-point sources (urban and agriculture runoff); septic systems; site development activities; and the atmospheric deposition of acid rain and mercury. These types of contaminants all stem from population pressures combined with economic growth.

About half of all toxics that pollute New Hampshire's rivers come from surface runoff and air deposition, rather than direct discharge. As of the early 1990s, the surface waters with the most direct toxic water pollution were the Merrimack, Androscoggin, Ashuelot and Contoocook Rivers.⁸⁹

Mercury is a major contaminant affecting New Hampshire's water quality. It enters aquatic systems from industrial sources and the burning of fossil fuels. It also leaches into groundwater when mercury-laden materials (thermometers, batteries, packaging) are disposed of in landfills or incinerated. Mercury con-



tamination is responsible for neurological damage in humans and reproductive problems in other species (particularly waterfowl such as loons and osprey). Many species, especially fish and some birds, concentrate mercury and other contaminants in fatty tissue from which it travels throughout the food chain.⁹⁰ The U.S. Department of Agriculture (USDA) has established "safe" levels of mercury exposure at less than one part per million. Fish samples taken from throughout New Hampshire exhibit mercury accumulation ranging from 0.02 to 2.26 parts per million.⁹¹

All the state's surface water is currently considered impaired by mercury contamination.⁹² New Hampshire officials have issued fish consumption advisories urging strict curtailment of fish intake, especially for children, pregnant women and women who may become pregnant.⁹³

Septic tank waste also poses challenges for New Hampshire's water resources. Most new houses in New Hampshire rely not on public wastewater treatment, but on individual septic systems that need to be pumped out regularly. Currently over 83 million gallons of this waste is generated annually, up from 55 million gallons in 1979. Disposal capacity has not kept pace, and many wastewater treatment plants are already at or near capacity. More stringent quality standards have caused less efficient cleanup operations to close.

Other groundwater contaminants in New Hampshire include hazardous waste, MtBE (a fuel additive to gasoline), arsenic and wastewater treatment plant effluent.⁹⁴ About 15% of the public water systems in the state are contaminated with MtBE due to seepage from

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

storage tanks into the groundwater. About 13% of all groundwater supplies are also contaminated with dangerous levels of arsenic (some of which is naturally occurring).

Watershed areas (or the "water supply lands" which feed water into surface and groundwater drinking supplies) are critical to maintaining safe water resources. Yet water supply lands are under threat. Critical water supply lands are four times as developed as other type lands in New Hampshire. They support twice as many roads, and are 25% less forested than the state average.⁹⁵ It is estimated that only 11% of these critical lands are protected. In addition, some 39% of community water systems do not control even the minimum sanitary protective areas around their wells.⁹⁶

Acid rain impairs the water quality of New Hampshire's lakes and streams in three ways: by increasing their acidity; by decreasing acid-neutralizing capacity; and, by increasing aluminum concentrations. About 15% of lakes in New England, including those in New Hampshire, exhibit signs of chronic and/or episodic acidification.⁹⁷

In addition, nitrogen pollution affects coastal waters off New Hampshire and the other northeast states. One of the largest sources of this pollution is nitrogen discharged from wastewater treatment plants that comes from nitrogen in the food that people consume. Thus, the amount of nitrogen pollution reaching treatment plants and then discharged to coastal waters is driven by population. The more people there are, the more food/nitrogen is consumed, and the more nitrogen discharged to surface waters.⁹⁸

Biodiversity

New Hampshire, home to over 15,000 plant and animal species and over 100 different natural communities, is considered relatively rich in biological diversity.⁹⁹ However, at least 11 species of animals and 13 species of plants have become extirpated (a species no longer surviving in regions that were once part of its range) over the past 300 years, for a variety of reasons.¹⁰⁰ Scores of species remain at risk today, primarily due to habitat destruction from human activities that lead to permanent habitat conversion or fragmentation.¹⁰¹

Of the species that remain, the ones at most risk include: 22 plant, 30 animal, and 25 natural communities (or groups of species) considered "globally rare" or "imperiled,"¹⁰² 12 federally-listed plant and animals and 34 state-listed animals as being threatened or endangered; and 289 plants listed as threatened or endangered under New Hampshire state law.¹⁰³

Role of Habitat Destruction

Habitat destruction, the primary cause of biodiversity loss in the state, manifests itself in a variety of ways. Permanent conversion of habitat is widespread. Less than 1% of the New Hampshire landscape is now left unaltered by human activity.¹⁰⁴ Between 10,000 and 25,000 acres of open space are lost and fragmented annually by development.¹⁰⁵ Each additional state resident means the permanent conversion to development of two to three acres of open space.¹⁰⁶

Biodiversity loss can occur both on land and in aquatic ecosystems. Few, if any, undisturbed aquatic ecosystems remain in New Hampshire.¹⁰⁷ Once pristine, many, if not all, of the state's freshwater lakes, ponds, rivers and streams are now threatened by increased human activity generated by population and economic growth. Altogether some 6,276 acres of New Hampshire lakes and ponds, and nearly 300 miles of rivers, are now considered impaired and not suitable for fishing or swimming.¹⁰⁸

Wetlands provide critical wildlife breeding areas and habitat. In the past 200 years, however, the expanding scale of human activity has destroyed about 50% of New Hampshire's tidal wetlands. About one-tenth of non-tidal wetlands have been destroyed for roads, buildings and farmland, displacing the amphibians, insects and other wildlife that depend on this habitat. Between 1997 and 2000 alone, more than 400 acres of wetlands were legally destroyed for permitted activities, mostly associated with sprawl development.¹⁰⁹

Development also fragments existing wildlife habitats, isolating populations from one another and inhibiting natural processes. Many of the areas with the greatest concentrations of rare species and natural communities are in southeastern New Hampshire – also the area with the highest concentrations of human population.¹¹⁰

New Hampshire now lacks many undisturbed natural habitats that it once had, including grasslands, water bodies, riparian corridors and mature forests. Several natural community types, especially pine barrens and floodplain forests, have declined significantly. Only one of the four original pine barrens remains. Pine barrens provide critical habitat to the federally endangered Karner blue butterfly, declared eliminated from New Hampshire in 2001.¹¹¹ Floodplain forests have been almost entirely eliminated from New Hampshire by agriculture or development.¹¹²

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Endangered and Threatened Wildlife of New Hampshire

	Endangered	Threatened
Mammals	Canada lynx * small-footed bat	pine marten
Birds	pied-billed grebe bald eagle * northern harrier golden eagle peregrine falcon piping plover * upland sandpiper roseate tern * common tern least tern purple martin sedge wren	common loon osprey Cooper's hawk arctic tern common nighthawk three-toed woodpecker grasshopper sparrow
Fish	Sunapee trout shortnose sturgeon *	(none currently listed)
Reptiles	timber rattlesnake	eastern hognose snake
Amphibians	marbled salamander	(none currently listed)
Invertebrates	dwarf wedge mussel * brook floater frosted elfin butterfly Karner blue butterfly * (extirpated from NH in 2001) Persius dusky wing skipper Ringed bog haunter dragonfly	pine pinion moth pine barrens Zanclognatha moth cobblestone tiger beetle

* Federally threatened or endangered

Source: NH Fish and Game Office, 2003

Loss of Biodiversity Due to Pollution

Air and water pollution also threaten New Hampshire's biodiversity. Sources of pollution include human waste from failing septic systems, chloride from road salt, pesticides, waste incineration, untreated industrial discharge and acid rain. Loons are currently threatened by high concentrations of mercury in the fish they eat.¹¹³ Pesticides were likely responsible for the decline of peregrine falcon and bald eagles in New Hampshire in the 1960s, though these species have recovered due to the 1970 ban on the pesticide DDT

and re-introduction of the species.¹¹⁴ Acid rain has caused high concentrations of aluminum and increased acidity reducing species diversity and the abundance of aquatic life in many lakes and streams in the Northeast, including in New Hampshire.¹¹⁵

Changes in water temperature, the occurrence of sediment loads and the deposition of acidic compounds from power plants and automobiles harm biodiversity in New Hampshire's aquatic ecosystems. Nitrate deposition from auto emissions leaches calcium and magnesium from tree foliage and soil, reducing the frost

hardiness of certain trees, and causing other damage. The introduction of non-native species and species over-harvesting have also put native species at risk.

Biodiversity and Climate Change

Climate change is an emerging threat to New Hampshire's biodiversity. Rising temperatures, changes in precipitation, increases in ground level ozone and in the frequency of extreme hot days, and heightened intensity of storms are all anticipated. Each of these could affect the distribution and survival of native species and the natural communities that support them. Moreover, each would exacerbate the existing stresses.¹¹⁶

Increasing average temperatures favor tree species such as oak, hickory and pines more than northern hardwoods and spruce-fir forests. Any increased frequency and intensity of ice storms and wildfires would favor early-successional over climax forest types, further accelerating the northward spread of southern species.¹¹⁷

Milder winters are expected to increase the vulnerability of forests to insect pests (potentially including spruce budworm, gypsy moth, pine bark beetle and hemlock wooly adelgid), and to increase health risks to humans of Lyme disease and West Nile Virus, as well as other diseases more prevalent in warmer climates. Alpine ecosystems such as those in the New Hampshire White Mountains are also vulnerable to warming.

Freshwater aquatic systems will be affected by warmer water temperatures and changes in rainfall. Cold-water fish species including both native and non-native trout could be significantly reduced. Meanwhile, non-native invasive plant species, including purple loosestrife, garlic mustard, and two varieties of honeysuckle, will likely benefit from climate change.¹¹⁸

Coastal ecosystems are expected to be significantly affected because sea level rise will likely accompany changes in temperature and precipitation. Rising sea levels may cause flooding, loss of coastal wetlands and estuaries, erosion of beaches and increased vulnerability to storms. New Hampshire has 6,200 acres of salt marshes along the coast and around the Great Bay estuary, which are critical habitat for certain wildlife species including sharp tailed sparrows, snowy egrets and great blue herons. Sea level has already risen by seven inches in Portsmouth in the last century, and is likely to rise at least another 18 inches by 2100 or earlier. Because the coastal region of New Hampshire is highly developed for human use, ecological adaptation to climate change and rising sea levels may be especially difficult.¹¹⁹

Reducing Mercury Pollution

A coalition of organizations working on the **Zero Mercury Campaign** are breaking new ground in the regulation of mercury emissions in the Northeast region, including in New Hampshire. National Wildlife Federation's Northeast office, with its coalition partners, is urging more stringent regulation of coal burning power plants, the reduction of mercury-filled wastes such as batteries and dental amalgams, the labeling of household products containing mercury, and stronger fish advisories for contaminated fish. In addition to posing serious human health threats, unsafe levels of mercury found in fish threaten the survival of both the fish themselves and of the many bird species, such as loons and the great blue heron, that depend on fish for their survival.

Fisheries

Once abundant and thriving, New Hampshire's inland freshwater and oceanic and coastal marine fisheries are challenged by over-fishing, habitat loss and water pollution.

Freshwater Inland Fisheries

In the eighteenth and early nineteenth centuries, New Hampshire supported spectacular inland commercial fisheries for most anadromous species (those that return from saltwater to freshwater for breeding, such as Atlantic salmon, shad, alewives, lampreys, Atlantic sturgeon and striped bass) and for lake trout. Many of these New Hampshire fisheries have since been lost to over-fishing, dams and pollution.¹²⁰ However, efforts have been partially successful in restoring some of the species for recreational fishing, such as Atlantic salmon, shad and striped bass.¹²¹

While direct municipal and industrial pollution of rivers has virtually ceased over the past several decades, airborne pollutants such as acid rain and heavy metals have offset this improvement. Acid rain, in particular, continues to pose a problem to inland fisheries. The New Hampshire Hubbard Brook Ecosystem Study recently concluded that acid rain continues to have subtle and insidious environmental effects. It states, "New Hampshire soils have absorbed about as much acid as they can handle before a dramatic die-off in [fish and other] species is triggered."¹²²

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Today, New Hampshire's inland fisheries focus on recreational fishing rather than fishing for food.¹²³ State advisories against eating inland fish species are partly responsible for this shift in fish consumption.

Habitat loss – particularly coldwater fish habitat – due to development is another concern for inland fisheries. Logging practices often remove too much forest cover, leading to higher temperatures in brook trout streams. About a century ago, recorded water temperatures in Pittsburgh's Perry Stream were at least twenty degrees cooler than they are today.¹²⁴ In addition, lowered summer water levels increasingly marginalize streams as habitat. Trout either die or seek relief in the cooler waters of lakes or larger rivers, where young fish are vulnerable to predation.

While warm water species such as bass and pickerel can sustain themselves through natural reproduction, coldwater species of trout and land-locked salmon are heavily dependent on hatchery support, and thus are disappearing as more and more hatcheries close.

Saltwater Oceanic and Coastal Fisheries

Since the 1620s, New Hampshire's fishermen have pursued commercially important saltwater fish species in the Gulf of Maine, off the New Hampshire Atlantic coast. Landings of cod, haddock and flounder showed fluctuations earlier this century, but fish stocks appeared to remain at levels that allowed for adequate replacement.

This changed dramatically in the 1960s, when foreign fishing fleets moved into the Gulf of Maine and onto nearby Georges Bank. As many as 13 nations fished these waters during the 1960s, and their annual catches were sometimes triple those of the U.S. fleet. New England groundfish (bottom-dwelling) stocks were unable to match the increased pressure and began to decline around 1964. As the abundance of preferred fish species (cod and haddock) declined, foreign fleets moved to secondary species, such as hake, herring and mackerel. Since 1980, there have been steep declines in New Hampshire landings of key species such as haddock (from 1,970,000 lbs in 1980 to 135,000 lbs in 2001) and plaice (from 1,817,000 lbs to 196,000 lbs).¹²⁵

Over-fishing was and still is the predominant cause for the decline of New Hampshire coastal fisheries. Sophisticated fish-finding technology, better nets and larger boats have greatly increased fishing efficiency. Another element of over-fishing is the take of unwanted immature fish and non-target fish species as by-catch. Habitat destruction associated with bottom trawling gear has also been recognized as a potential problem.¹²⁶

There have been a series of attempts to manage New Hampshire's coastal fisheries. In 1976, the Fishery Conservation and Management Act set a 200-mile Fishery Conservation Zone, and effectively chased foreign fleets out of the Gulf of Maine and off Georges Bank. With the foreign fleets gone, U.S. fishermen were encouraged to fish through government tax incentives and attractive financing programs. From 1978 to 1984, the New England trawling fleet nearly doubled from 650 to 1021 boats.¹²⁷

Fishery managers first tried to continue the quota system that had limited fish catch. This was partly successful in reducing the catch of groundfish. It did not, however, prevent new entries into the fishing fleet, and the number of fishing boats continued to increase. Various additional means of regulating fish harvesting were tried, such as limits on the number of boat trips, minimum fish size limits, net mesh size regulations and fishing exclusion zones. Despite their efforts, fish stock indices continued a downward trend. In 1996, the federal Sustainable Fisheries Act effectively reduced the permitted harvest limits in an effort to rebuild stocks.¹²⁸

The story for shellfisheries is similar. Early unexploited shellfish resources were harvested at first without regulatory control. As their abundance diminished, authorities have attempted to stem declines, for example, by banning commercial fishing (oysters and clams), prescribing fishing seasons (oysters, clams, shrimp, scallop, urchins), closing certain areas (clams), limiting size (lobster), and restricting gear (all species).¹²⁹

Potential threats to coastal fisheries include offshore mining, ocean sewage outfalls, dams on coastal rivers, shore-side electric power plants, oil spills, and others. All of these activities are now covered by environmental laws and are subject to public scrutiny.

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Agriculture

Experts agree that the loss of land to development is the most serious threat to agricultural soil and water resources, as well as to wildlife habitat on land owned by farmers. Between 1982 and 1997, New Hampshire lost 15% of its cropland (an average of 1,553 acres each year) to development. In that period, total cropland declined from 157,700 acres to 134,400 acres.¹³⁰ This decline is related to the same demographic and economic changes that drive forest loss.

Population growth within the state does represent growth in local markets for New Hampshire farmers. However, growing populations and even faster growing household numbers, coupled with rising space requirements per person for houses, parking, roads, commerce and industry, all mean intensified competition for agricultural land and water. Increasingly, New Hampshire's agriculture is giving way to more environmentally damaging forms of development, as more and more farmland disappears under concrete, tarmac and lawns.¹³¹

New Hampshire's Farming Sector

Agriculture is a small but socially and environmentally significant feature of New Hampshire's economy. Agricultural production contributes over \$675 million to the state's economy. While those product sales account for only 1.5% of the state's gross product annually, the total food and agriculture system provides 14% of jobs in the state. And agriculture's contribution to the scenic and cultural landscape of the state plays an important supporting role to tourism, New Hampshire's second-largest industry.¹³²

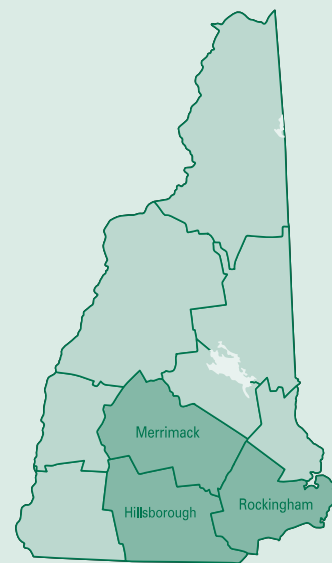
Nearly all of the 2,937 farms in New Hampshire are small, family-owned businesses. About 18% of these are operated by women, the highest proportion in the nation.¹³³ The larger enterprises are mostly dairy farms and greenhouse horticultural growers. Ornamental horticulture, the fastest-growing agricultural sector in recent decades, now ranks number one for gross sales, with \$380 million a year. Dairying remains the largest traditional agricultural sector in the state, with \$54 million in annual milk sales.¹³⁴ Most of the open fields and pastures of New Hampshire's "working landscape" are dedicated to dairying.

Agricultural Land and Soil Threatened

Only 222,000 acres, or 3.8% of the state's land area, is prime farmland, and more than 700 acres of that is being lost every year.¹³⁵ The southeastern counties of Rockingham, Hillsborough, and Merrimack are part of the Southern New England region that was ranked

Top 10 Threatened U.S. Farmlands

1. Sacramento and San Joaquin Valleys (CA)
2. Northern Piedmont (MD, NJ, PA, VA)
3. Southern Wisconsin and Northern Illinois Drift Plains (Ill, WI)
4. Texas Blackland Prairie (TX)
5. Willamette and Puget Sound Valleys (OR, WA)
6. Florida Everglades (FL)
7. Eastern Ohio Till Plain (OH)
8. Lower Rio Grande Plain (TX)
9. Mid-Atlantic Coastal Plain (DE, MD)
10. **New England and Eastern New York Upland (CT, MA, NH, NJ, NY, RI)**



Most of the population growth in the "New England and Eastern New York Upland" region that coincides with prime and unique farmland is occurring in New Hampshire (see map). Hillsborough, Merrimack, and Rockingham counties grew by over 20% between 1980 and 1992.

Source: American Farmland Trust, "Farming on the Edge", 1997-2003

number ten on the American Farmland Trust's list of most threatened, high-value farmland regions.¹³⁶ The loss of prime agricultural soils is rapid. In the 15 years prior to 1997, nearly 12,000 acres of New Hampshire's best farming soils became unavailable to farming.¹³⁷ Only 7% of the soils that classify as prime or of state-wide significance have been permanently protected from development.¹³⁸

NEW HAMPSHIRE'S POPULATION-ENVIRONMENT CHALLENGES

Competition For Water

New Hampshire's limited supplies of ground and surface water must be shared among ecological, agricultural, industrial, commercial and domestic uses. Intensified competition for water resources has recently become an issue in parts of southern New Hampshire, as a result of drought, population growth and activity by commercial water companies.

The changing nature of agriculture in the state will further increase the demand for irrigation water. Fruits, vegetables, ornamentals and specialty crops are gaining in importance in response to market demand from the state's growing urban populations. Meanwhile, rising demand for land is increasing the price of all accessible lands, thus raising the costs of agricultural production and pushing farmers into higher-value crops.

Role of Land Protection

Agriculture is generally considered to be less environmentally damaging overall than other types of development. Yet the high value of land, especially in southern New Hampshire, makes it increasingly difficult for agriculture to compete with development for land.

The same demand makes protection of farmland expensive, as it raises the cost of conservation easements. At an average cost of \$4,318 per acre, New Hampshire has the third highest cost-per-acre in the country for conservation easements purchased through the 2001 USDA Farmland Protection Program. Only New Jersey and Rhode Island have higher easement costs.¹³⁹

In addition to the federal program, which requires matching funds, the state has authorized and funded the Land and Community Heritage Investment Program to help communities protect natural and cultural resources. However, state funding is limited and unstable.

Climate Change and Agriculture

Different crop models provide various predictions regarding New Hampshire's agriculture. Some suggest that climate change will alter crop yields and production by very little, while others say it will affect them by as much as 39%. However, scientists agree that climate change will affect agriculture through changes in temperature, precipitation, length of growing season and any alteration in the frequency of extreme events such as droughts and storms.

Expert panels convened by U.S. Environmental Protection Agency (EPA) and New Hampshire Depart-

ment of Environmental Services (NHDES) warn that warming temperatures could affect the survival of some of New Hampshire's agricultural plant species, including the sugar maple.¹⁴⁰ This tree is economically valuable to the state's maple sugar industry, and to tourism because of its vivid fall color.

Over the last century the average temperature in the state has increased by two degrees, and precipitation has decreased by up to 20% in some parts of the state.¹⁴¹ One climate model projects temperature increases of four to five degrees, with 10% more rain in summer and fall, no change in spring, and precipitation increase of 25-60% in winter. Warmer, drier soils could be a serious problem for the agricultural sector unless irrigation is more widely adopted.¹⁴²

Energy

Energy is the cornerstone of a comfortable lifestyle in New Hampshire. It is used to heat and cool homes, businesses and schools; supply electricity for commercial, industrial and residential use; and power various modes of transportation. It is connected to population dynamics through the type and amount of energy sources generated and consumed, and their waste products.¹⁴³ As New Hampshire's economy and population grow, the demand for energy increases.

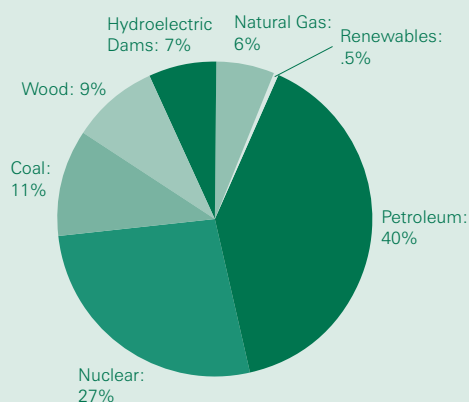
New Hampshire's two primary energy sources (in terms of percent consumed) are petroleum (40%), and nuclear power (27%). Other major sources include coal (11%), wood and wood waste (9%), hydroelectric dams (7%), and natural gas (6%). Only 0.5% of energy produced is from "renewable" sources such as geothermal heat, solar power, or wind turbines.¹⁴⁴

New Hampshire relies more heavily on nuclear energy – as opposed to coal and natural gas – than is typical for the national average. The state's energy consumption per capita is considered to be a relatively low. Only nine states consume less energy per person.¹⁴⁵

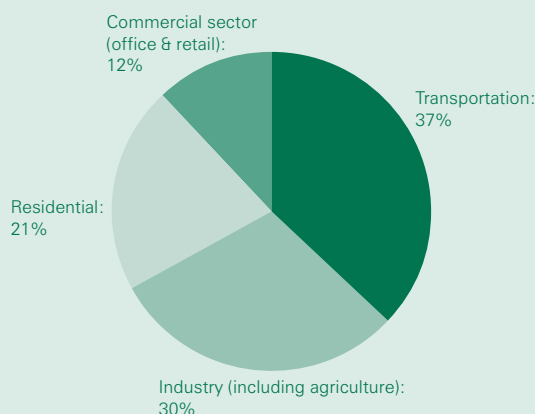
Transportation is the largest consumption sector, accounting for 37% of statewide energy use in 1999.¹⁴⁶ Transportation is almost totally dependent on fossil fuels and produces high emissions of carbon dioxide and nitrogen oxides. Today, New Hampshire residents drive an average of 9,600 miles per year.¹⁴⁷ Industry (including agriculture) is second in energy consumption, using 30%, and residential is third, accounting for 21%. New Hampshire's commercial sector (office and retail) accounted for the least energy consumption – 12% of the total energy demand in 1999.¹⁴⁸

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Sources of New Hampshire's Energy



Energy Consumption in New Hampshire



Source: NH Governor's Office of Energy and Community Services, 2002

Environmental Effects of Energy Use

New Hampshire's choice of energy sources – like that of other states – has profound environmental impacts. On a global scale, energy use is responsible for an estimated 80% of air pollution and 88% of the “greenhouse gases” that cause climate change.

Most of the electricity produced in New Hampshire comes from nuclear power (54%), and the burning of fossil fuels (31%).¹⁴⁹ Fossil fuels contribute to mercury pollution, acid rain and climate change (see “Climate Change” section).

Fossil fuel burning accounts for more than three-quarters of all mercury pollution in New Hampshire: 47% from power plant emissions within the state and region, and 30% from power plants outside of New England, especially those in the Midwest.¹⁵⁰

The burning of fossil fuels also emits sulfur dioxide and nitrogen oxides, which contribute to acid rain. Acidification has had a serious and sustained impact in New Hampshire's forests and high-elevation lakes. State and national efforts to curb acid rain have been ongoing since 1970; however, it continues to be a problem. At New Hampshire's Hubbard Brook Experimental Forest, they have documented a decline of approximately 50% in the amount of available calcium in the soil over the past 50 years. This change in soil conditions has made the forest and surface waters more vulnerable to current and future inputs of acid. Sulfur dioxide (SO₂) emissions have been successfully lowered – they are rela-

tively easy to regulate because most come from a small number of power plants. Meanwhile, nitrogen oxides (NO_x) continue to spew from the growing number of vehicles in the state. A solution to the acid rain problem must therefore involve a reduction in the consumption of fossil fuel consumption, electricity use and vehicle miles traveled.¹⁵¹

New Hampshire's nuclear power is a double-edged sword. It does not emit pollutants that contribute to global warming or acid rain. However, risks of devastating accidents associated with nuclear waste storage and/or transportation are high. For example, there is risk in transporting annual output of toxic radioactive waste to another site (e.g. Yucca Mountain, Nevada) for disposal. There is also risk of accident, or even terrorist attack. It is estimated that at any given time, up to 200,000 people are within the immediate ten-mile “emergency zone” around the Seabrook Nuclear Power Plant.¹⁵²

Projections for Energy Use

State planners expect future energy demand to increase in tandem with New Hampshire's economic growth, and faster than population growth. Some anticipate that the demand can be met, based partly upon recent construction of new, natural gas-fired power plants in New England.¹⁵³ However, transportation, the state's largest energy consumption sector, poses more problems. The concentration of economic growth in southern New Hampshire has produced a

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pattern of medium to long-distance commutes. This not only puts a strain on infrastructure and resources in the state, but it also results in more congestion and more passenger miles traveled, and thus to increased petroleum pollutant emissions.

Climate Change

Leading scientists agree that the world's climate is changing and that much of that change is due to human-induced factors.¹⁵⁴ The average global temperature is already about one degree Fahrenheit higher than a century ago.¹⁵⁵ Although the problem is global in extent, climate change affects New Hampshire at the state level, down to the individual person.

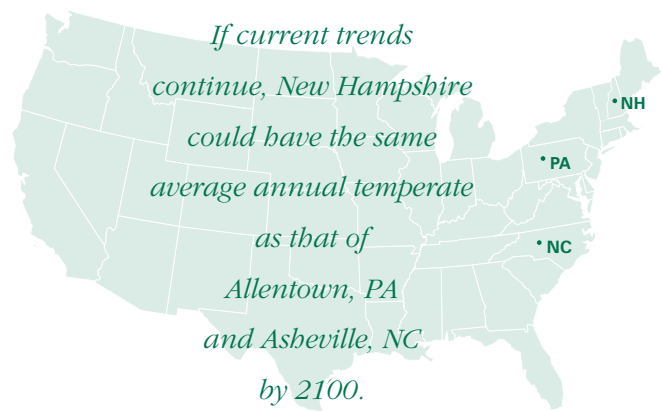
Human-induced climate change is due to increased emissions of greenhouse gases including methane from agriculture and carbon dioxide generated by burning fossil fuels. The level of these emissions is determined by population and household numbers, type of industry utilized, rates of energy consumption, and by the technologies with which consumption is met and waste gases are treated.¹⁵⁶

The U.S. is the world's leading emitter of greenhouse gases, producing almost 20 tons of carbon dioxide per person in 1998.¹⁵⁷ In comparison, New Hampshire emits just over 15 tons per person. This is significantly less than the U.S. average, due mainly to a higher-than-U.S.-national-average share of nuclear and hydroelectric power. However, it is still high in comparison with Europe, where average annual emissions per person are ten tons or less.¹⁵⁸

Changes to New Hampshire

New Hampshire has experienced a warming of 1.8°F over the past 100 years – nearly three times greater than the New England average of about 0.7°F.¹⁵⁹ As a result, some climate-related changes are already underway, including earlier “ice out” dates on New Hampshire lakes and an earlier lilac flowering season.¹⁶⁰

According to scientists from the Northeast U.S. Regional Assessment of the U.S. Global Change Research Program, if current trends continue, a 6-10°F increase in average annual temperature in New Hampshire is possible by the year 2100. This would give the state an average annual temperature somewhere between that of Allentown, PA and Asheville, NC.¹⁶¹ During the past century, warming has been greater in winter than in spring and summer. Climate models indicate a likely increase in average annual precipitation, and a possible increase in the number of extreme weather events.



Additional potential adverse impacts in New Hampshire cited by the IPCC include sea level rise, shifts in the distribution of plant and animal species, and effects on the economy and human health.

Since early in the 20th century, tidal records for Portsmouth, New Hampshire show that sea level has been rising by approximately 8/10 of an inch per decade. The US EPA predicts that the rate of sea level rise will accelerate in the rest of the century, at least doubling by the year 2100.¹⁶² A two-foot sea level rise along the New Hampshire coast is quite possible in the next 100 years. This would increase the land vulnerable to 10-year floods by 77% (more than 1000 acres), and to 100-year floods by 50% (more than 990 acres).¹⁶³

Such a rise is likely to damage the precarious ecological balance of New Hampshire's resource-rich Great Bay. It will impact fish and seabird populations, and increase vulnerability to flooding of inland rivers. The potential property damage and adaptation costs are huge, possibly reaching up to \$304 billion for sand replenishment alone.¹⁶⁴

Impacts on Plant and Animal Species

A warmer climate will also threaten the health and vitality of New Hampshire's forests and wildlife and the many economic activities they support. It will widen the range of various “pest” insects that thrive in warmer climates (such as the gypsy moth, bark beetle and pear thrip).¹⁶⁵

Climate change will threaten New Hampshire bird species such as the spruce grouse and the endangered Bicknell's thrush, both of which depend on the high elevation spruce and fir forests most vulnerable to global warming.¹⁶⁶ The purple finch, New Hampshire's state bird, along with at least 30 other bird species, could disappear entirely from the state, while other species are expected to have significantly reduced

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ranges.¹⁶⁷ Overall, 35% of New Hampshire's wildlife habitat has been estimated to be at risk as a result of climate change, with the southern edge of the northern forests the most threatened.¹⁶⁸

Forests and wildlife will also suffer in the event of increased frequency of droughts, forest fires, or extreme weather events. The ice storm of 1998, for example, caused lasting damage to more than one million acres of New Hampshire's forests. Finally, the range of hardwood trees such as the sugar maple, which cannot flourish in a warmer climate, may migrate northward by 100 to 300 miles.¹⁶⁹

The projected shifts in the health and character of New Hampshire's forests could have severe economic consequences for the state. More people visited New Hampshire's forested White Mountains for recreation in 2000 than visited Yosemite and Yellowstone National Parks combined. The brilliant fall foliage of hardwoods such as sugar maples currently brings in about \$292 million in tourist dollars annually.¹⁷⁰

Warming in New Hampshire is also likely to result in changes to the hydrological cycle, impacting freshwater ecosystems. There will be more sporadic and potentially violent precipitation, less snow pack, and warmer ocean and inland water temperatures. These changes will reduce water tables, which in turn will increase the potential for water shortages and source contamination. They will also mean altered aquatic landscapes, with a loss of habitat and food sources for freshwater fish that prefer colder waters (such as trout) and for migratory bird species.¹⁷¹

Consequences for the Economic and Health Sectors

Among the other economic impacts already mentioned in this report, New Hampshire's ski industry will also be affected. It faces the prospect of decreased snow pack; more granular, less powdery snow; warmer temperatures; and increased need for snow-making. The ski industry is estimated to have brought \$566 million in visitor dollars and another \$58 million in taxes into the state's economy in the year 2000. During the past 20 years, New Hampshire and Vermont together averaged 700,000 less ski days in the years with the worst snow conditions.¹⁷² Climate change could mean losses in this economic sector for the state.

As the climate becomes more favorable to ticks, mosquitoes, and other disease vectors, ailments such as Lyme disease and West Nile Virus may increase in New Hampshire. There could also be more casualties from severe weather events. Studies have shown a link

What Does Global Warming Mean for New Hampshire's State Bird?

The purple finch is an ecologically and economically important species to New Hampshire. In 1996, wildlife viewing – primarily bird watching – brought in approximately \$282 million to the state. However, this state bird is just one of many bird species under threat from global warming. In conjunction with other population pressures, climate change may cause the purple finch and other bird species to find new habitat as their summer range shifts northward.

Source: American Bird Conservancy and National Wildlife Federation, "Global Warming & Songbirds: New Hampshire," 2002

between high temperatures, intense sunlight and air pollution, which taken together increase smog and the incidence of asthma and respiratory diseases. All these changes will stress the emergency care system, and increase the costs of Medicaid and health insurance for New Hampshire residents.¹⁷³

Solid and Toxic Waste

When the human population increases, there is generally an increase in both the amount and type of waste generated. Not only does the generation of added solid and toxic waste impact the environment, but the method of disposal of such waste can have lasting effects on New Hampshire's natural landscape as well.

Waste Generation and Disposal

New Hampshire has the highest per capita rate of solid waste disposal among seven northeastern states, and generates an average of almost six pounds per person per day.¹⁷⁴

New Hampshire imports waste for disposal within the state. In the mid 1990s, it imported nearly as much solid waste as it generated. Currently, the state imports about 300,000 tons annually. About 23% of this is incinerated, while 27% is diverted for recycling, reuse, or composting. The remaining half is permanently buried in the state's landfills.¹⁷⁵

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Landfills sometimes release pollutants into the ground and air. New Hampshire's household hazardous waste, such as paint thinners, engine degreasers or batteries, makes up 2% of the volume of solid waste, yet it accounts for over 80% of the toxic material in landfills.¹⁷⁶

Landfills are especially hazardous when they are unlined. In the late 1980s, there were 150 unlined landfills in New Hampshire. Eighty of these have been closed, and the remaining 70 are expected to close by 2010. Double-lined landfills with drainage and gas controls are now required, and the leachate must be collected, transported and treated before disposal. Costs of constructing and operating landfills have increased with increased regulatory standards.¹⁷⁷

Waste for incineration in New Hampshire goes to two "waste-to-energy" plants. These generate energy, yet also produce pollution from air emissions as well as the transport of ash. The ash from these two plants is disposed of in landfills in New Hampshire and Massachusetts. In 1999, the air emissions from incinerators were responsible for 17% of all mercury emissions in the state.¹⁷⁸

Toxic wastes are materials which, when released into the environment, pose a threat to human or environmental health. Some are only mildly toxic or dissipate quickly, while others persist, travel long distances, are highly toxic and bio-accumulate in the food chain. Toxic wastes can cause neurological and developmental problems and other illnesses in children.¹⁷⁹ They can also cause reproductive damage, cancer, neurological disorders and other chronic health effects in adults. Toxic substances can also harm birds and other wildlife.

Seen within the national context, New Hampshire emits a relatively small number of toxic substances, ranking 48th nationwide in 2000. It also ranks 45th in the amount of toxic waste that is managed and not released.¹⁸⁰

Federal law has required the reporting of over 650 toxic chemicals generated by industry since 1995. Of the approximately 6,000 known hazardous waste sources in New Hampshire, 120 facilities generate enough of the more toxic chemicals to be required to report their annual volumes to the U.S. Federal Toxics Release Inventory Program (TRI). Fortunately, the vast majority of toxic wastes produced are not released into the environment, but managed or treated.

The top five toxics released in New Hampshire in 2000 were hydrochloric acid, sulfuric acid, methanol, xylene and ammonia. Of these, hydrochloric acid was



by far the greatest pollutant, at approximately 2.5 million pounds. The bulk of all toxic waste releases go into the air. Much smaller amounts are released into surface water or underground, or are taken to landfills.¹⁸¹

Of the persistent and bio-accumulative toxics, the top five known to be released are the polycyclic aromatic compounds; benzopyrene; mercury; mercury compounds; and dioxin and dioxin-like compounds.¹⁸² Most dioxin releases come from medical waste incinerators, wood fired boilers and backyard burning of trash. Most mercury emissions come from fuel oil combustion, coal-fired power plants and large municipal waste incinerators.¹⁸³

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Nuclear waste is another concern. New Hampshire now has 261 metric tons stored on-site at the Seabrook Nuclear Power Plant, and this is expected to increase in the future. Shipping nuclear waste to out-of-state disposal sites also poses risks of release and exposure.¹⁸⁴

The electric power industry (including coal and nuclear power plants) and the pulp and paper industry are responsible for most toxic chemical releases in New Hampshire. Bow, New Hampshire's coal-fired power plant stands out with the largest annual volume of emissions, at 2.7 million pounds – more than four times the next highest facility. While this one facility is responsible for nearly half of all toxic releases in New Hampshire, several smaller industries release significant amounts of toxics as well.¹⁸⁵

Though there has been an increase in the number of facilities generating and reporting toxic releases in recent years, New Hampshire has been successful in reducing the total amounts released. Toxic chemical releases from manufacturing facilities have been reduced by 85% in New Hampshire since 1988, compared to a 63% reduction nationwide.¹⁸⁶

Past releases of toxic or hazardous chemicals, permitted or not, can cause persistent problems. New Hampshire has 18 federally-recognized hazardous waste sites in the Superfund program.¹⁸⁷ The state has 645 additional hazardous waste sites not covered by the Superfund program.

Brownfields are industrial or commercial sites which may have been contaminated in the past by hazardous waste, but which are otherwise desirable for reuse or redevelopment. Federal and state programs encourage the redevelopment of brownfields sites as a means of preventing sprawl and optimizing the use of existing infrastructure. Such programs assist with site clean up and/or liability protection. Estimates of the number of brownfields sites in New Hampshire range from 150 to 450 or more. Of known sites, 40 to 45 have benefited from state assistance to date.¹⁸⁸

Unreported toxic waste disposal, illegal dumping of toxic chemicals, and the application of pesticides and agricultural chemicals for which reporting is not currently required are other significant issues for New Hampshire.

Recycling

New Hampshire is increasingly relying on recycling; however, the state is not recycling rapidly enough to keep up with the state's solid waste generation. In 2000, approximately 100,000 tons of recyclable materials were recovered from the waste stream, up from 87,000 tons in 1997. The recycling rate in 1999 was estimated at between 27% and 30%. This is similar to the national rate of approximately 28%.¹⁸⁹

Residents in all but seven communities have access to recycling. In 134 of New Hampshire's 236 towns, recycling is mandatory. The highest recycling rates in the state are found in the 35 towns with pay-as-you-throw programs, which create financial incentives for recycling. The lowest recycling rates are found in the large cities.

CONCLUSION

This report provides an overview of how human population factors affect New Hampshire's environment and natural resource base. It is a science-based compendium of what we know about the issues. It is not designed to be comprehensive, nor to present solutions. Rather, it is to be used as a springboard for discussion on the topic and on the policy responses, public outreach, and action that can help New Hampshire's citizens address the issues in the short, medium, and long term. On a broader scale, it also enables us to better grasp Americans' unique role in the population-environmental equation worldwide.

As permanent and seasonal residents continue to move to New Hampshire, it is critical to understand their impacts on the state's natural resources – the very resources that often draw people to New Hampshire in the first place. Local/state/federal incentives, regulatory mechanisms, and individual choices can help to stabilize the population and minimize or alleviate environmental damage.

The state of New Hampshire has made much progress in confronting its many population-environmental challenges, for example:

- State government agencies and non-governmental organizations are working to identify ways to prevent sprawl. The New Hampshire Sprawl Roundtable, a coalition of groups statewide, has identified legislation and actions to take to affect sprawl-related policies, as well as public opinion. The Society for the Protection of New Hampshire Forests (SPNHF) with New Hampshire Public Television and Cross Current Productions has produced a public television program on the topic. The New Hampshire Office of State Planning (NHOSP) has a CD available titled "Achieving Smart Growth." The state's Smart Growth initiatives involve: funneling new development into existing developed areas; making optimum use of existing public services, including transportation, water, sewer, and schools;¹⁹⁰ and redeveloping existing buildings and using the space in between them through village or in-town zoning.
- New Hampshire has shown significant leadership in confronting air pollution and climate change, major population-environmental challenges for the state. It was the first state in the nation to introduce a voluntary greenhouse gas registry, and in 2002, passed the New Hampshire Clean Power Act – the first such act in the U.S. – to cap power

plant emissions of four major pollutants including carbon dioxide and mercury.¹⁹¹ Further, the recent New Hampshire Climate Change Challenge presents over 70 "recommendations" for reducing greenhouse gas emissions. The Challenge includes options for reducing emissions from the transportation, residential, electric utility, commercial and industrial sectors. It also points out opportunities for greenhouse gas sequestration.

- New Hampshire's Concord Pine Barrens was the only New England site where Karner blue butterflies remained, until 2001. Then, habitat loss due to human encroachment most likely forced the federally endangered species to extirpation in New Hampshire. A unique recovery effort by the New Hampshire Fish and Game Department, Concord School District, U.S. Fish and Wildlife Service, and National Wildlife Federation is now working with teachers and students to develop an integrated conservation program for this species. Students learn about Karner blue butterflies, endangered species and habitat conservation. They engage in hands-on activities such as raising wild blue lupine, the Karner blue caterpillar's only food source, and transplanting the seedlings each spring to a U.S. Fish and Wildlife conservation easement.

These efforts, among others, demonstrate New Hampshire's commitment to addressing current population-environment issues in order to mitigate future threats.

However, we need to go further. This report, for example, is among just a handful of efforts in New Hampshire that explicitly address the state's population-environment relationship specifically as one integrated topic, and it is just a start.¹⁹² From here, we need to discuss the issues, and act on them.

Achieving environmental sustainability that also meets the needs of New Hampshire's growing population of residents and visitors poses continued challenges. But these challenges can be met if government agencies, social and environmental non-governmental organizations, businesses and residents continue to move in a positive direction by understanding the issues they face, and working together to address them. Only then can New Hampshire achieve long term sustainability for its human population, wildlife, and natural resources.

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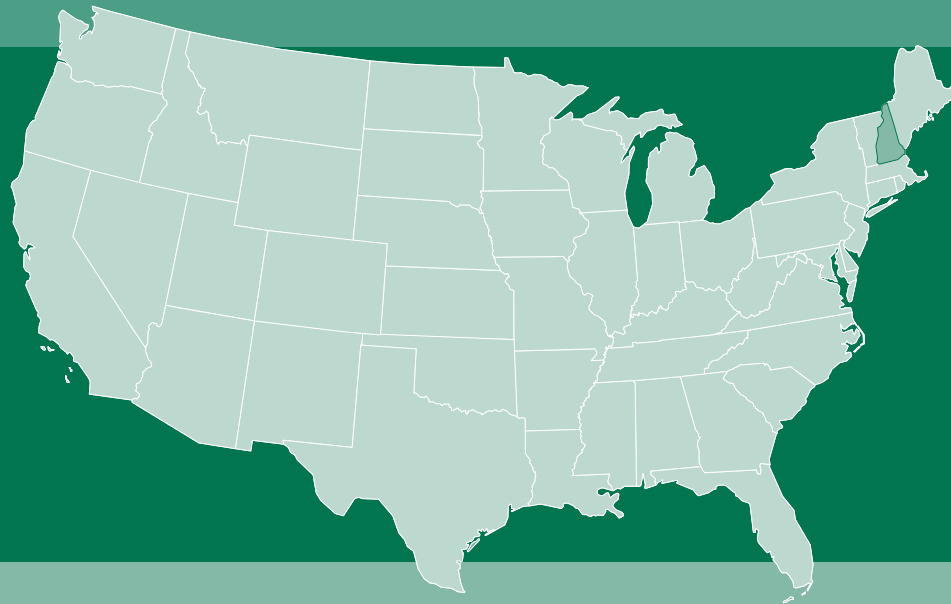
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