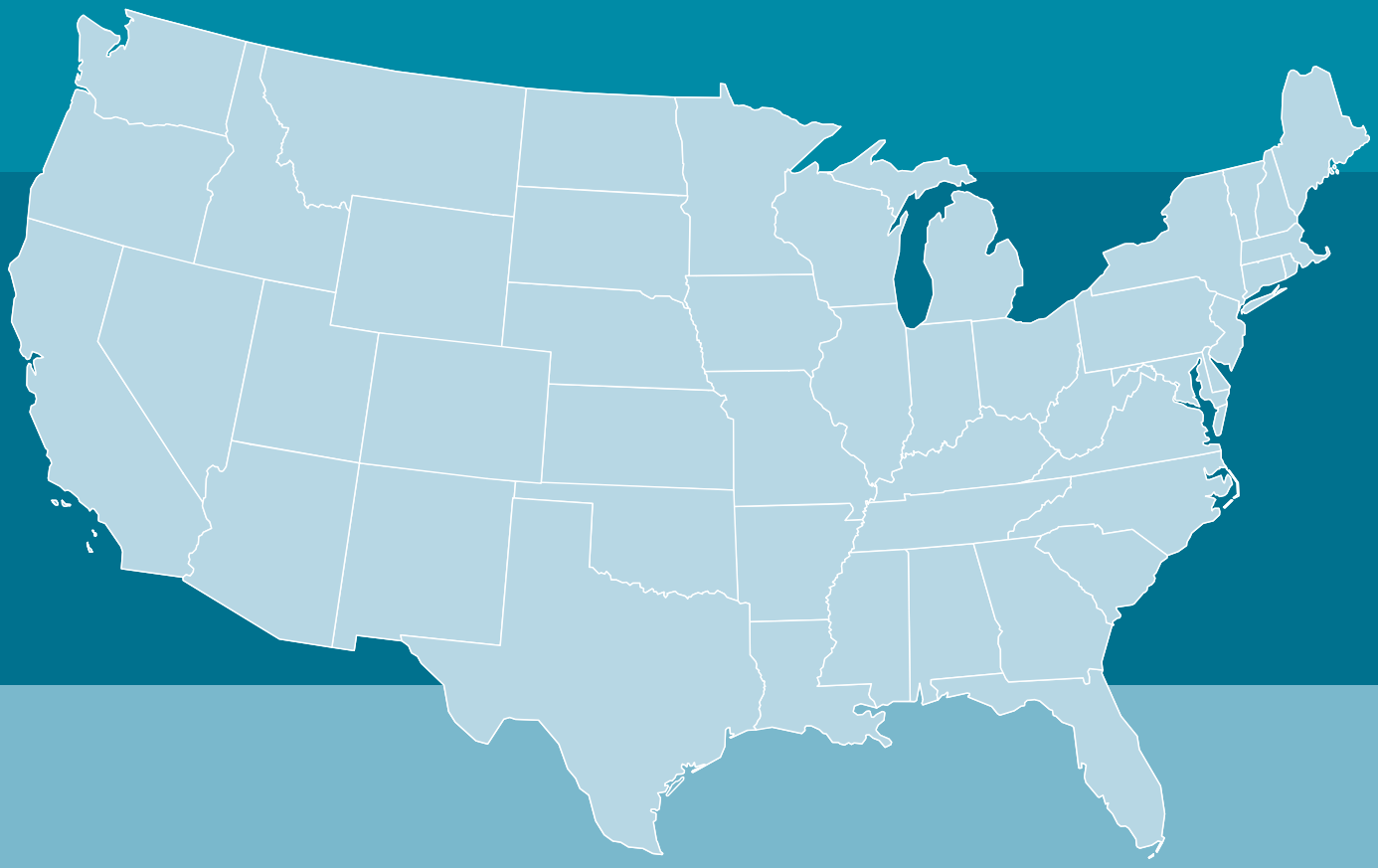
U.S. National Report on Population and the Environment



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U.S. National Report on Population and the Environment

By Victoria D. Markham
Center for Environment and Population (CEP)
with Nadia Steinzor

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Center for Environment and Population (CEP)

The Center for Environment and Population (CEP) is a non-profit research, policy, and public advocacy organization that addresses the relationship between human population, resource consumption, and the environment. 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.

CEP partners with leading organizations to link science to policy, public education and advocacy, to better understand and effectively address the issues. To do this, the Center and its 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, the media and the public, and; undertake activities to integrate the materials and information directly into policies and public outreach.

The Center has two major program areas: **Emerging Issues in Environment and Population,** and **Building New Population-Environment Leadership.** CEP produces easy to understand science-based materials including the groundbreaking *U.S. State Reports on Population and the Environment* and the *Issues on Population & the Environment* series, the *U.S. National Report on Population and the Environment* (with fact sheets and briefing materials), and the award-winning *AAAS Atlas of Population and Environment*. The Center also organizes directly linked follow-up activities that integrate the materials into policies, public outreach and advocacy, university and youth programs, and community-national-international events. The Center utilizes its CEP Experts Network to engage leading scientists and other experts in their programs. CEP is a project of the Tides Center, and works in the U.S. at the local community to national levels, and internationally.

About This Report

This report is part of the *U.S. Reports on Population and the Environment* series published by the Center for Environment and Population (CEP). The brief, easy-to-read reports, fact sheets and briefing materials, identify, analyze and address key U.S. human population and environmental trends as a nation and as a major player worldwide.

A series of directly related follow-up activities are also conducted nationwide to discuss the publications' findings and generate viable policy and public action options at the local, national, and international levels.

This and other Center for Environment and Population (CEP) projects uniquely focus on the U.S. population's environmental impact, both in the nation and within the global context.

For more information contact:

Victoria D. Markham, Director
Center for Environment and Population (CEP)
161 Cherry Street
New Canaan, CT 06840

Phone: 203-966-3425
Fax: 203-966-5443
Email: vmarkham@cepnet.org
Website: www.cepnet.org

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Introduction

Global environmental changes are occurring in ways fundamentally different than at any other time in our history. Experts tell us that virtually all of the Earth's ecosystems have been significantly transformed through human actions, and that 60% of the Earth's ecosystems have been degraded or used unsustainably. These changes have been especially rapid in the past 50 years, and are expected to continue into the foreseeable future.[1]

For the first time in human history, we are using many of the planet's natural resources faster than they can replenish themselves. The impacts are becoming more and more obvious: freshwater resources are increasingly vulnerable, more plant and animal species are becoming endangered or extinct, land-use transformation is pervasive, and even the global climate is changing. *Experts trace these seemingly disparate environmental phenomena to a single cause: the growing scale of human activities.*[2]

In simple terms, the human population is growing, we are consuming natural resources at unprecedented rates, and the planet is demonstrating the effects. Human population factors (such as growth, movement, density and resource consumption) are considered to be a main driver and multiplier of many environmental impacts in the United States and worldwide.[3] Humanity is dominating nature at a cost to species, ecosystems and human health, with social and economic implications as well.[4]

America's Role in a Global Phenomenon

America is a major contributor to these global changes. When ranked with other countries in the world, the U.S. is a leader – not only in Gross National Product, per capita income, and many health and educational standards but also in other, more dubious, ways.

The U.S. population also has the largest "ecological footprint" in the world, with greater impact on many of the planet's resources and ecosystems than any other nation on Earth.[5]

The U.S. footprint is comprised of various elements which add up to its ecological imprint. Some of the contributing factors include, for example, the U.S. as the world's largest single emitter of carbon dioxide (CO_2, the greenhouse gas that causes climate change) from fossil fuels, the world's largest forest products consumer, and generator of the most municipal waste globally per person.[6]

But, exactly how is the American "population" – its growth, density, movement, composition and resource consumption – linked to environmental impacts in the nation, and around the world? And, how do we reconcile America's comparatively large per-capita ecological footprint on the planet with its responsibility to address it, both in the country where it occurs, and internationally, where the effects are also felt? This report helps us to address these issues by outlining the basic challenges we face.

The United States in the Global Context

Today, and well into this century, over 98% of the world's population growth is occurring and will continue to occur in developing countries.[7] *With most of the global population growth occurring in other parts of the world, why focus on the U.S.?* And why is America in the hot seat of global population-environmental impacts?

Scientific data reveals the answer, showing that the impact of people on the planet is particularly acute when you look at the case of the U.S. as a global player. While America represents just 1/20th of the global population, it consumes disproportionately higher amounts, at least 1/4 of practically every natural resource, than any other nation in the world.[8] To compound things, *the U.S. is the only industrialized country in the world still experiencing significant population growth*, and this trend is expected to continue into the foreseeable future.[9]

This combination – of America's relatively high population growth and high rates of resource consumption and pollution – makes for a volatile mixture resulting in the largest environmental impact per capita, or ecological footprint, in the world.

Much information exists on the population-environmental relationship on a global scale. Comparatively little, however, has been compiled in such a manner for the United States.

This **"U.S. National Report on Population and the Environment"** aims to fill that gap. It identifies in broad strokes the *main human population trends*, their *environmental impacts*, and, for comparison, *how America ranks in the global context*.

How Does "Population" Have Environmental Impacts?

Population factors can be linked to environmental impacts in the U.S. and around the world primarily when:

- There are rapidly increasing demands by a growing population for a *finite* resource (such as water or land), or beyond a *renewable* resource's ability to regenerate (such as fisheries or forests);
- The resource use by an increasing number of people spurs increasing quantities of *contaminants* to be put into a natural system beyond its natural capacity to buffer the toxin (such as burning fossil fuel causing rises in greenhouse gases), and;
- Natural habitats are degraded or destroyed by resource extraction and use, increasing development, and other activities to meet demands of a growing population. The environment then becomes uninhabitable to plant or animal species through, for example, habitat loss or degradation.[10]

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Several additional elements emerge when you examine how human population relates to the natural environment:

- *Choice is important:* People can have impacts through the sheer numbers of people consuming or utilizing a natural resource (like water, forests, land, marine life, energy) and through the rate and kind of resource consumption (and the resulting pollution).

Yet, it is not always a straight-forward "cause and effect" relationship. People's choices are also central as to whether or not a given population is detrimental to the environment. For example, 20,000 people in one place can have a very different impact than that same number in another place. This is based on decisions made about the way land is developed (say, with "cluster development" vs. sprawl), type of transport or energy (energy efficient or not), method of agriculture (organic or not), or industry used (polluting or not).

So, while large numbers of people are critically important, the same numbers of people do not always have equally detrimental environmental impacts. Individual and collective choices make a big difference to the outcome.

Local to international government policies, business and corporate practices, and economic and social factors also have significant roles in population's environmental impacts. These, and individual choices, are often mitigating factors, and all must be part of the solutions.

- *Trends, timing, and limits:* Isolated incidents of a growing population or high rates of resource consumption and pollution, in and of themselves, do not necessarily always equate to lasting negative environmental impacts. This is largely because of the buffering capacity of nature and ecosystems to bounce back once damage occurs. But there is a limit to the earth's buffering capacity.

It is the population trends over a limited amount of time that can cause long-lasting, irreversible environmental effects. Examples of this include: rapid growth in the water-sensitive West, nation-wide land development increases of 50%, or wood product consumption rising 40% – all in just a few decades. When these trends occur over such a relatively short time period, the resources reach a critical threshold after which they can no longer provide essential "ecosystem services" such as clean air and water, pollination, or habitat.[11]

The Ecological Footprint and "IPAT"

Two helpful models for understanding the American population's environmental impacts are the *Ecological Footprint* and *IPAT* model.

A country's *"ecological footprint"* compares its per-capita 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, and to provide infrastructure such as housing, schools, stores, roads.[12]

The population-environment linkages are also explained in the ***"I = PAT"*** equation: *"Environmental **I**mpact = **P**opulation x **A**ffluence/Consumption x **T**echnology"*:

- Environmental **I**mpact: how species, natural resources and whole ecosystems are affected or impacted by humans.
- **P**opulation: the total number of people. Population always acts in combination with the other IPAT factors below.
- **A**ffluence/Consumption: often correlated with income, this is how much each person consumes in terms of resources such as water, energy, passenger miles, space/resources used for housing, and so on. Waste generated through resource consumption is part of this equation.
- **T**echnology: 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, i.e., with the use of energy efficient products, or it can worsen it, i.e., through inefficient coal-burning power plants.[13]

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In the context of these trends we are recognizing the importance of limits. Given that water is a finite resource, how far can U.S. water withdrawal or pollution go until ecosystem-threshold limits are reached? To what degree can species' habitats be degraded or fragmented before a species becomes extinct? How much municipal waste can be stored on land, until there are no more available sites?

About this Report

This report provides an overview of how human population factors affect America's environment and natural resource base. It contains **key findings**, then is divided into **two main sections**:

- First, the **"Population Profile of the United States"** describes the *main population trends in America that affect the natural environment*. They include: rates of population growth; density (where people live); movement (including migration and tourism); composition (the make-up of a given population, such as age, income, households), and; rates and types of resource consumption. Other population or demographic variables are not included in this report because they are not generally as closely associated with environmental impacts.
- Second, in **"America's Population-Environment Challenges,"** nine chapters look at how those population trends are linked to, and impact, key environmental sectors, including land use, water, forests, biological diversity, fisheries/aquatic resources, agriculture, energy, climate change, and solid/toxic waste. This is presented in terms of the national and regional perspectives. Each chapter first describes how population and the environmental sector is linked, then looks at the environmental impacts that result from that relationship.

  The latest available scientific data and select case studies are used to illustrate the trends. An "In Your Region" page with *highlights from the four U.S. regions* is included in each chapter.

Additional notes regarding the Report follow:

- Throughout the report **U.S. national** as well as **regional** (Northeast, Midwest, South, and West, as defined by the U.S. Census Bureau) **trends** are featured.

  U.S. demographic data generally falls within the Census Bureau's four regional boundaries (see map, page 10). Ecosystem, species, and natural resources data often does not fall within such administrative boundaries. For the purposes of this report, however, we chose to use the Census Bureau's regional break downs to describe the population *and* environmental connections.
- Data on the American population's environmental impacts, on its own, does not always provide a good perspective on the nation's ecological footprint. In order to better understand America's role as a global player, each chapter incorporates **U.S. ranking with other countries**, showing comparisons and contrasts with other world areas on the issues. This way we can better assess the U.S.'s role in relation to Europe, developing countries, and the world.
- Because many of the topics in the report are cross-cutting and/or cross-sectoral, they may appear in various places throughout the document and will not be cross-referenced.

Presenting the Challenges

We are changing the Earth more rapidly than we are understanding it. Yet we are lacking the role models on how to successfully manage such unprecedented, rapid change.[14]

This report aims to address this by presenting an easy-to-understand, balanced summary and analysis of the best available existing scientific research on the issues. It can be used as a baseline of information of what we know, so we can determine what we need to know, and identify the means to address critical problems.

So, while this report does not make policy recommendations or suggest solutions, it is a synopsis of the challenges we face, so that we as a country can develop well-informed, thoughtful, effective responses.

With this information we can evaluate the likely consequences of our actions, various policy and research options, and begin to identify what choices we have to address the issues.[15] In this way, this report can used as a springboard for discussion and means for identifying and implementing next steps and what is needed to actively prevent, mitigate or adapt to coming changes in the country.

Using this document as a tool we can integrate science-based analysis into real-world policies, research, and public outreach and advocacy on the issues at all levels – from local communities, to regionally and nationally in the U.S., and worldwide.

As this report shows the many challenges we face, it helps pave the way forward. There are many solutions to the issues, and some are already in place. We have never been as aware as we are now of American's impact in the country and on the planet. Now we can begin to meet the multi-faceted challenges with comprehensive solutions.

U.S. Population and Environment: Key Findings

The key findings, summarized below, provide an overall snapshot of how America's human population impacts the environment.

The United States is the only industrialized nation in the world experiencing significant population growth.[16] The combination of America's relatively high rates of population growth and associated natural resource consumption and pollution result in the largest environmental impact, or ecological footprint, in the world.[17] Over the past five decades people have altered natural ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet the rapidly growing population's demands for food, freshwater, timber, fiber, and fuel.[18]

- **Population:** U.S. population trends over the past century helped shape the country today, and are inextricably linked to its current environmental state. For example:
  - Over the past 100 years the U.S. experienced the largest population increase ever in its history, and its population density doubled.
  - Population distribution shifted South and West, and those regions dominated the century's growth.
  - The U.S. went from being primarily rural to urban and suburban, with the proportion of urban residents doubling from 40% to 80%.
  - "Metropolitanization" (growth in cities and surrounding suburbs) most characterizes the nation's demographic change. By 2000, half of all Americans lived in suburban areas, and 4 out of 5 lived in broader metropolitan areas.[19]
  - Today, America is the third most populous country in the world after China and India, yet represents only 5% of the global total. The U.S. population, at about 300 million, doubled since 1950.[20]
  - The South and West are the country's most heavily populated and fastest growing regions, and now contain over half of the entire U.S. population. The Northeast is the most densely populated region.[21]
  - Over half of all Americans live within 50 miles of the coast, in just one fifth (17%) of its land area. Population density on the coasts is five times that of other parts of the country.[22]
  - Of the nation's ten fastest growing states, half are in the coastal South and another four are in the driest Western areas, making them among the nation's most vulnerable "population-environment" hotspots.

All these population trends have significant effects on ecosystems, natural resources and plant and animal species. Following are summaries of the main population-environment linkages.

- **Land Use:** Today all U.S. land is converted for development at about twice the rate of population growth.[23] Each American effectively occupies about 20% more developed land (for housing, schools, shopping, roads, and other uses) than he/she did 20 years ago.[24] The nation's most predominant form of land-use change is "sprawl": low density development spread into suburban and rural areas, with increased vehicle use and new houses, roads, shops, and other infrastructure.
- **Water:** U.S. public freshwater supply withdrawals and the human population both grew by 8% from 1995-2000.[25] About 40% of the nation's rivers, 46% of lakes, and 50% of the estuaries are too polluted for fishing and swimming.[26] Only 2% of U.S. rivers and streams remain free-flowing due to extensive damming and diversions.[27] America is among the world's top ten in per capita water withdrawal, with each American using three times that of the world average.[28] 53% of the nation's wetlands are lost, now mainly due to urban/suburban development and land-use change for agriculture.[29]
- **Forests:** The U.S. is the world's largest consumer of forest products – in the last four decades alone, U.S. wood consumption overall grew by 50%.[30] In 2000, per capita sawn wood consumption was nearly twice that of developing countries and ten times the world's.[31] Today nearly three times as many people are being supported by the same forested area that existed 100 years ago.[32]
- **Biodiversity:** About 6,700 known plant and animal species are considered at risk of extinction in the U.S.[33] Almost 1,000 species are listed by the U.S. government as endangered, and 300 as threatened (over twice the number listed a decade ago), mainly (85%) from habitat loss and alteration.[34] Half of the continental U.S. can no longer support its original vegetation.[35] The biodiversity decline, called the "sixth mass extinction" in the Earth's history, is for the first time ever being attributed primarily to human activity.[36]

U.S. Population and Environment: Key Findings

- **Fisheries and Aquatic Resources:** Thirty percent of assessed fish populations in U.S. coastal waters are either overfished or fished unsustainably.[37] A third of all U.S. lakes, a quarter of rivers, all of the Great Lakes, and two thirds of the nation's coastline were under a fish consumption advisory from pollutants in 2004,[38] many related to mercury contamination.[39] About a third of America's freshwater animal species are "at risk."[40]
- **Agriculture:** Nearly 3,000 acres of U.S. farmland are lost every day to development, with the rate of loss increasing.[41] America's prime farmland was developed 30% faster than other rural land in the past two decades.[42]
- **Energy:** With only 5% of the global population, the U.S. consumes almost 25% of the world's energy.[43] America has the highest oil consumption worldwide[44], and is projected to use 43% more oil than current levels by 2025.[45] Transportation is the nation's fastest growing energy use sector.[46]
- **Climate Change:** The U.S. is the single largest carbon dioxide (CO_2) greenhouse gas (GHG) emitter in the world, accounting for nearly a quarter of all global emissions.[47] These are predicted to increase by nearly 43% by 2020.[48] The nation's average temperature increase over the next 100 years is projected to be 5-9°F.[49] Sea level rise and more severe weather events that will impact coastal areas are predicted, particularly in the U.S. Mid-Atlantic and Gulf Coasts.
- **Waste:** Each American produces about 5 pounds of trash daily, up from less than 3 in 1960, five times the average amount in developing countries.[50] Nearly half of the nation's 1,300 "Superfund" sites are linked to contaminated or threatened drinking water sources.[51] The U.S. is the largest per capita municipal waste producer in the world.[52]

Population Profile of the United States

In the last century, the U.S. population more than tripled, the largest population increase in its history, with most of the growth occurring in the past 15 years.[53] *These and other key U.S. population trends are closely associated with major changes in the country's natural environment during that period.*

To understand the nation's population dynamics and their environmental consequences, it is necessary to examine which population trends are important, and why. America's population is linked to the environment in several ways, through the sheer numbers of people, where and how people live and move, and their consumption of natural resources and the associated waste. First, it is important to consider some important human population trends.

National Overview: U.S. Population

Key U.S. population trends over the past century that helped shape the country today and are inextricably linked to its current environmental state include:

- ***Population growth was substantial.*** The biggest numerical increase of any decade in the country's history was the addition of over 30 million people in the 1990s alone. While the nation's growth was remarkable amongst the world's industrialized nations, its share of the world's population declined, as that of developing countries' grew.[54]
- ***Population density doubled***. However, because of America's relatively large land area, population density by the year 2000 remained low compared with the rest of the world (80 people per square mile in the U.S. and 120 per square mile as the world average).[55]
- ***The U.S. went from being primarily rural to urban and suburban,*** with the proportion of urban residents doubling from 40% to 80%.[56]
- ***"Metropolitanization" (cities plus the suburbs that surround them) particularly characterized the nation's demographic change this century***. Suburbs rather than cities accounted for most of this growth. By 2000, half of all Americans lived in suburban areas, and 4 out of 5 lived in broader metropolitan areas.[57]
- ***Regionally, distribution of the U.S. population shifted South and West, and those regions dominated the century's growth.*** The Northeast and Midwest showed corresponding losses in population.[58]
- ***The population of the West grew faster than any other region, while the population density of the Northeast far exceeded that of other regions.***[59]

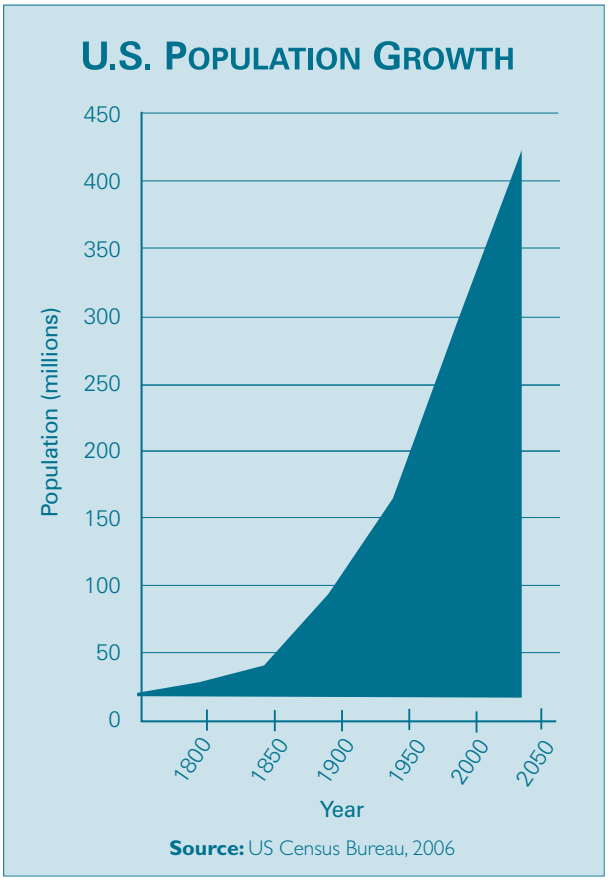
Looking at these trends in more detail, the five human population factors in the U.S. today most closely associated with the environment include:

- **Population size and growth**
- **Population distribution**
- **Population composition (or "make up")**
- **Households**
- **Consumption of natural resources**

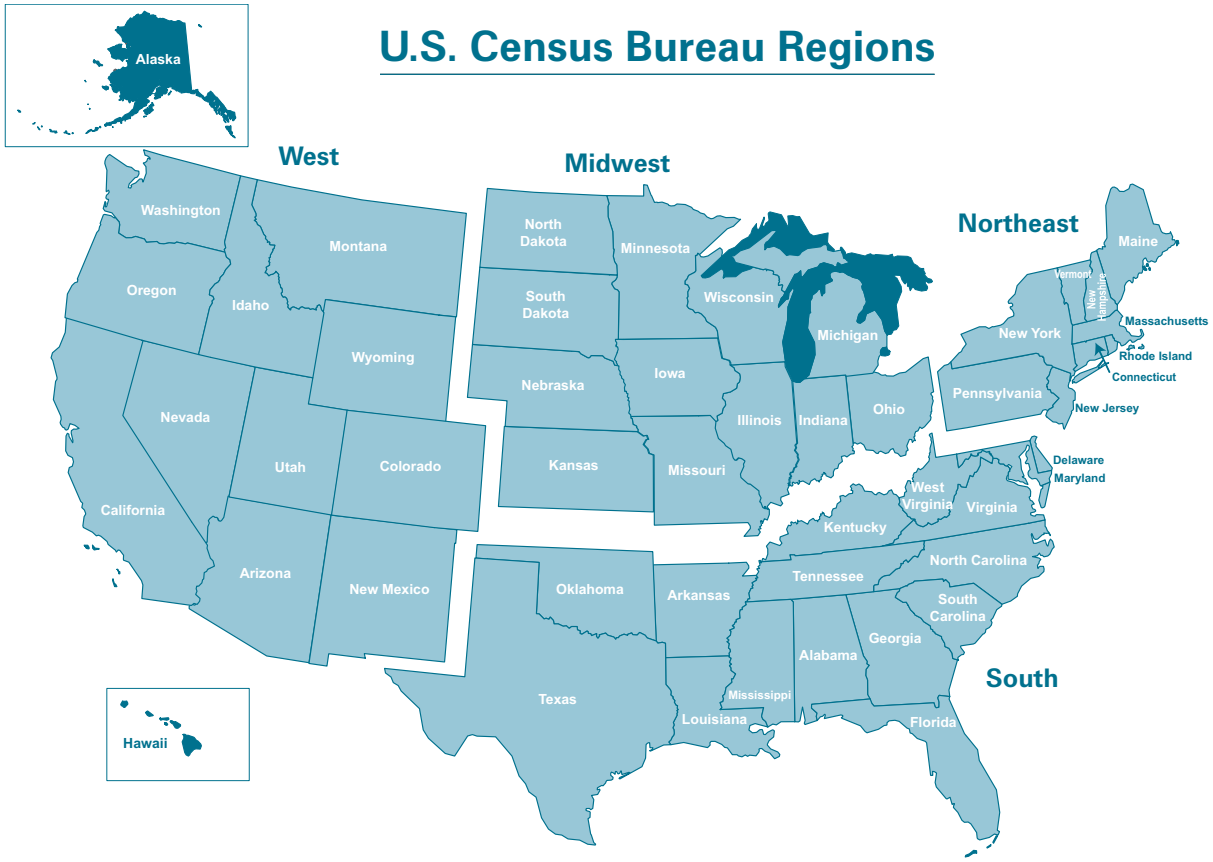
U.S. Population Size and Growth

The U.S. population and its rate of growth are linked to the environment because they demonstrate how rapidly each person on average is a "multiplier" of environmental impacts or consequences. It is important to consider the country's current population numbers, and how fast they are growing and expected to grow into the foreseeable future.

Currently, the population of the United States is about 300 million.[60] Although it is the third most populous country in the world after China and India (each with over a billion people), the U.S. accounts for less than 5% of the world's population. America's population has doubled since 1950.[61] It took 230 years for the nation to reach 300 million, and at current growth rates will top 400 million in just 40 years.[62]



Population Profile of the United States



The population is growing at just under 1% annually, adding about 3 million people per year, or 8,000 per day.[63] At this rate, the nation's population will double about every 70 years.[64] By comparison, the world's population at over 6.5 billion is growing by about 1.2% annually, adding almost 80 million people per year, or 220,000 per day, with a doubling time of about 50 years.[65] The developing countries' average growth rate is about 1.8% annually, doubling in less than 40 years.[66]

The U.S. is the only industrialized country in the world currently experiencing significant population growth.[67] This is important because Americans, with their high rates of resource consumption in comparison to most other nations, have a disproportionately large per capita environmental impact. The combination of relatively high population growth and resource-use virtually guarantees that America's "ecological footprint", or effect on the global environment, will continue to grow in size and impact for the foreseeable future (see Ecological Footprint, p. 5).

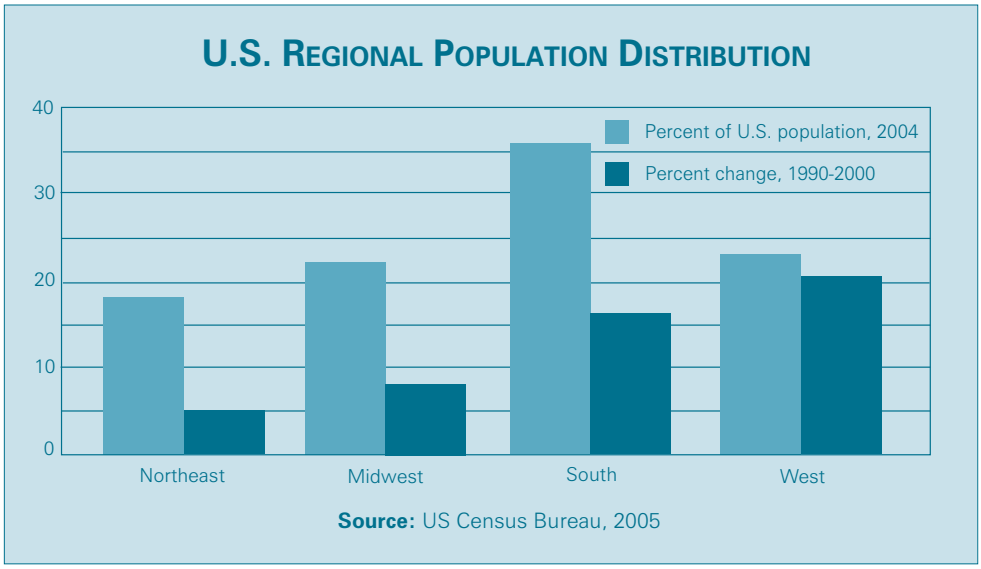
The nation's population growth is caused by natural increase (births minus deaths), plus immigration. Today, natural increase accounts for 60% of U.S. population growth, with the remaining 40% due to net international migration.[68] The legal immigration rate in America is about 4 per 1,000 residents, or just over 1 million people annually.[69] The unauthorized immigrant population is growing by about 525,000 annually.[70] Historical trends show that for every 100 immigrants admitted to the U.S., about one-third return home.[71]

The U.S. population is projected to reach about 420 million by 2050.[72] Over the next several decades, the U.S. population growth rate is expected to decline slightly, to reach about 0.7% by the middle of the century.[73] The country is becoming more diverse in terms of race and ethnic backgrounds, and doing so at a much faster rate in recent decades than earlier in the century.[74] A child born today in America will live longer (an average of 85-90 years, up from today's average of 72-79), in a nation that is more crowded, with no significant ethnic/racial majority like we have today.[75]

Population Distribution

Where the population is distributed and growing also affects the environment. A denser population can increase environmental pressures in some places (for instance, along fragile coastlines) or relieve it in others (through "clustered" rather than "sprawling" development). U.S. population distribution trends are often closely linked to environmental impacts.

Today, the South and West are the most populous and fastest growing regions in the nation. More than half of the total U.S. population (171 million people, 57%) currently live in the South and West.[76] In the past 15 years, the South and West grew twice as fast as the Northeast and



Midwest,[77] and this trend will continue into the near future, with most of the nation's growth in coming decades expected to occur in the South (52%) and West (35%), with much slower growth in Midwest (7%) and Northeast (5%).[78]

Over half (51%) of the U.S. population is concentrated in just ten states (California, Florida, Georgia, Illinois, Michigan, New York, New Jersey, Ohio, Pennsylvania, and Texas). Only 3% live in the ten least populated states (Alaska, Delaware, Hawaii, Montana, New Hampshire, North Dakota, Rhode Island, South Dakota, Vermont, and Wyoming).[79]

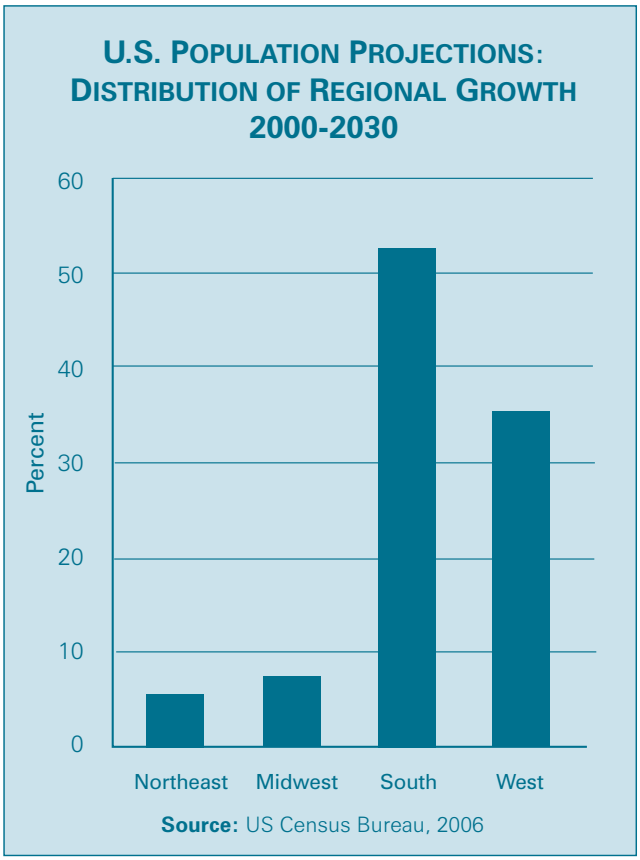
More than 50% of all U.S. residents live within 50 miles of the coast, crowding into just 17% of the nation's land area.[80] An additional 25 million people, accounting for about half of the projected U.S. population increase, are expected to move to these areas in the next decade alone. Over 180 million people visit the shore for recreation every year.[81]

The move to coastal areas reflects a trend toward living in areas rich in natural amenities (near lakes, mountains, coastal and scenic areas). The population of U.S. counties where income and employment is based largely on outdoor recreational and entertainment activities grew 20% during the 1990s, mostly due to migration from other parts of the country.[82]

Similarly, "temporary migration"(vacation and seasonal living) is on the rise.[83] More than one-third of the vacant homes nationwide (nearly 4 million) are seasonal, recreational, or for occasional use.[84] Seasonal growth "spurts" can trigger environmental impacts, such as more land and resources to build second homes, increased water and energy demands, and traffic congestion.[85] This environmental stress is most noticeable in high-tourism states (such as Florida and California), and in many of the nation's most popular national parks and other protected areas.[86]

America has become a "metropolitan nation." More than 80% of Americans (226 million people) lived in metro areas in 2000.[87] Although there are many differences amongst the regions, one thing they have in common is that nearly all of the nation's large metropolitan areas (with populations of at least 250,000) grew in the past decade.[88]

The "New York-Northern New Jersey-Long Island, NY-NJ-CT-PA" metropolitan area is the most populous, with nearly 19 million people, followed by the Los Angeles and Chicago metro areas. The Las Vegas, Nevada and McAllen-Edinburgh-Pharr, Texas metro areas are the fastest growing, followed by the Naples, Florida metro area.[89] And these areas are growing fast – most metropolitan areas have been developing land faster than

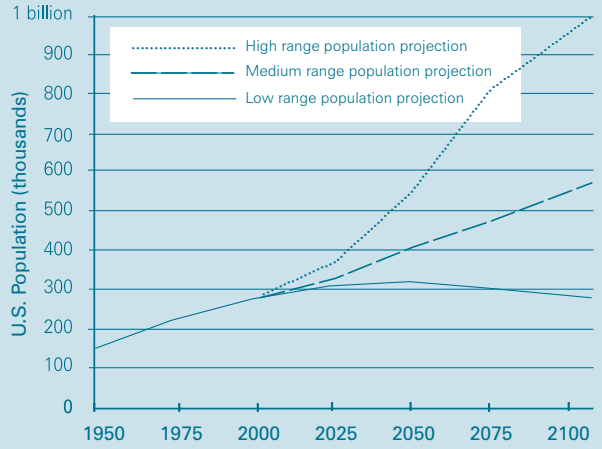


their populations are growing. In the 1980s and 1990s, the U.S. population grew by 17%, and developed land grew by 47%.[90]

Growth outside cities in the suburban and surrounding "exurban" areas far outpaces growth within cities.[91] Over the past decade, the population of America's metropolitan areas outside central cities increased by nearly 13%, where growth inside central cities grew by 4%.[92]

American cities themselves grew nearly twice as fast in the 1990s than in the previous decade. Cities in the South and West grew the fastest, while the urban industrial centers in the Midwest and Northeast declined in population. ***Today, most of the fastest growing cities and suburban areas are in the West,*** with eight of the top ten fastest growing cities all in Arizona, Nevada or California. The country's three fastest growing cities were Gilbert, Arizona (266% growth from 1990-2000), Henderson, Nevada (170% growth) and Las Vegas, Nevada (141% growth).[93]

U.S. POPULATION GROWTH PROJECTIONS



Projections for U.S. population growth show low, medium and high estimates by the U.S. Census Bureau in 2000. [94]

Source: Center for Environment and Population (CEP) based on US Census Bureau data, 2006

Population Composition

The composition or "makeup" of a population – its age, income, educational level, culture/race, and other characteristics – can determine where and how people live, move, vacation, and develop land. Many of these demographic factors are discussed throughout this report and are linked to specific environmental consequences, affecting natural resources, plant and animal species, and entire ecosystems.

"Age" is a prime example of how demographic factors can have major environmental implications in the U.S., and it applies to both young and older segments of the population. The number of young Americans and the choices they make with regard to fertility (how many children they decide to have) and resource consumption (choices made regarding to recycle or not, which vehicles to drive, etc.) will determine trends in population and environmental impacts. Today, the portion of the U.S. population aged 0-24 is about 35% and that aged 24-44 is 30%, ensuring the momentum for future population growth is already in place.[95] This momentum will also be affected by the number of young immigrants entering the country in the future.

The trend towards *aging* of the U.S. population as the proportion of older people increases is also significant. ***Today's older population is larger than it has ever been in the nation's history,*** and the overall median age in 2000 (35.3 years) was also higher than it has ever been.[96] This reflects a 28% jump in the number of U.S. residents between 35 and 64 years of age, and a 4% decline in the number of people aged 18-34 between 1990 and 2000.[97]

This aging segment of the population, the nation's *"Baby Boomers"* (born between 1946 and 1964), represent over 78 million or 26% of the total U.S. population.[98] ***They are wealthier, spend more money, consume more resources, have more homes per capita, and move more often than any generation before them.***[99] This is important because they represent both a large percent of the total American population and very high resource consumption, the combination of which is significant in terms of environmental impact.

In addition, a substantial share of America's population age 65 and older moves to and settles in "retirement magnet" states such as Arizona, Florida, and Nevada, where pressure on natural resources (especially water) is already evident. *Over the next quarter century, the proportion of elderly Americans is projected to double in at least 14 states in the South and West.* This is a result of the in-migration of retirees and out-migration of younger adults in those areas.[100]

Households

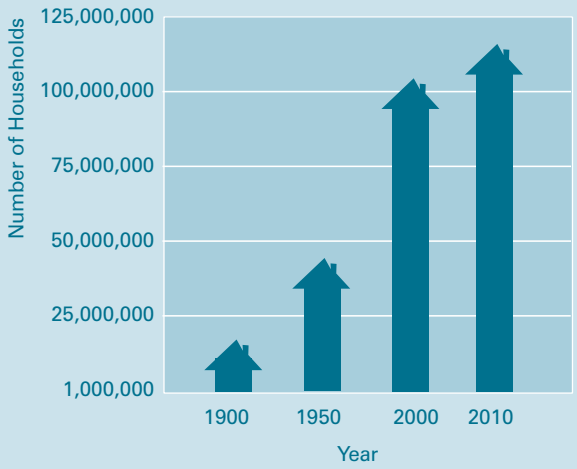
"Households" are an important demographic variable in calculating population's environmental impacts. Every household has a minimum number of possessions, occupies a certain amount of space, and emits certain waste and/or pollutants. The extent of environmental stress caused depends on household size (the number of people within a given household), the number of households, the size of homes, and the amount of land surrounding and used to build homes.

In recent years, the average U.S. household size has gone down, amount of "living space" in and around homes has gone up, and number of households has multiplied. With more people living in "super-sized" houses that occupy more land, the amount of resources (from lumber to plastic) used for new construction is rapidly on the rise, and more energy is consumed for heating and cooling.

The number of people per household was 2.6 people in 2000, down from 3.1 in 1970 (or one fewer person for every two households).[101] Smaller household size in the face of population growth is one reason behind a nationwide building boom: between 1990 and 2000, 14 million new housing units were built.[102]

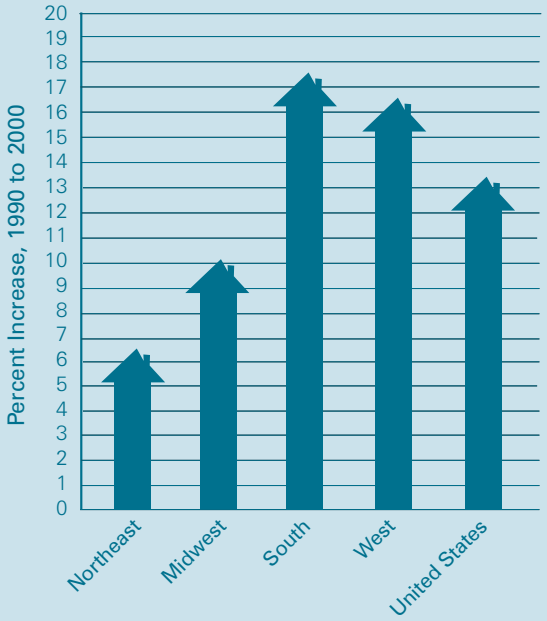
At the same time, the average size of new single-family homes increased by more than 700 square feet.[103] Between 1988 and 2003, the proportion of homes nationwide that are 3,000 square feet or more nearly

U.S. Households



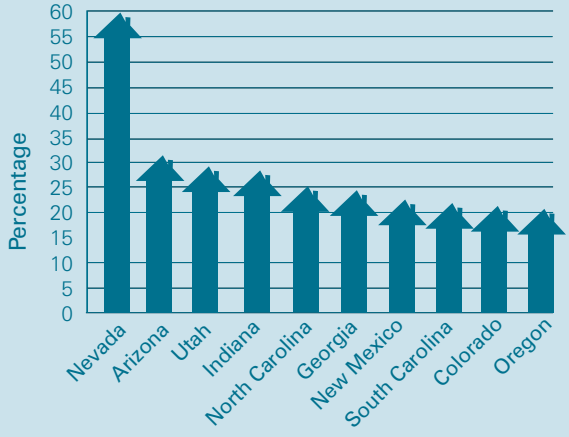
Source: US Census Bureau, 2005

Growth in U.S. Housing Units by Region



Source: US Census Bureau, 2003

Top Ten States Growth in New Housing Units



Source: US Census Bureau, 2005

doubled (from 11% to 20%), while the proportion under 1,200 square feet declined (from 12% to 5%).[104] Although the average lot size of single family homes has varied over time, 67,000 new homes on the largest lots (from 9,000 to over 22,000 square feet) were sold between 1999 and 2003.[105] In recent years, lot sizes have tended to grow the most on the outskirts of metro areas, resulting in the rapid development of already dwindling open spaces.

Consumption of Natural Resources

When rapidly expanding populations consume high levels of natural resources there are major environmental effects. This depends on what type of food, fuel, land, and manufactured goods are used by fast-increasing human populations and how they are produced – particularly over a relatively limited amount of time as is occurring today – and, if the consumption is undertaken in an environmentally sustainable (i.e. recycling or consuming organic foods) or unsustainable (i.e. using non-recycled paper or consuming non-organic foods) manner.

Solid and other kinds of waste, and pollution, are often generated when something is consumed, produced, or utilized. Examples include packaging from store-bought goods, air pollution from motor vehicle use, and agricultural chemicals and fertilizers applied to lawns and fields that run off into other areas of the environment. When high levels of resources are consumed, generally, high levels of waste and pollution enter the natural environment.

Resource consumption is often associated with level of income, or affluence (see Box on "IPAT" model). Evidence shows that as a whole, those more affluent in the population consume more resources, and generate more waste and pollution, than do lower-income populations.

The median household income in the U.S. was about $44,000 in 2004.[106] In international dollars (a measure that allows for a comparison of purchasing power among countries with disparate economies and currency values), America has a per capita income of nearly $40,000, compared to about $26,000 for more developed countries, $4,000 for developing countries, and $9,000 globally.[107]

In America, rising income generally brings about greater motor vehicle use, resulting in more road building, air pollution, and the carbon dioxide emissions that cause climate change. In addition, relative to their share of world population, Americans consume disproportionately high amounts of meat and dairy products, which require more land, water, and energy (and produce more wastes) than diets based on grains and vegetables.[108]

On the flip side, however, affluence can sometimes facilitate positive trends by encouraging the consumption of goods that are environmentally sound. People with higher levels of disposable income are often more inclined to purchase more expensive, energy efficient "hybrid" vehicles, appliances, and lighting, and to purchase higher-priced recycled paper, organic foods, and other environmentally-friendly products.

Energy Consumption by Income Level and Square Feet of Household

Household income level	Square feet of home	Energy consumption of Household (million Btus)
$15,000-$19,999	1,500	81
$30,000-$39,999	1,700	87
$75,000-$99,999	2,700	113
$100,000 or more	3,400	136

Source: Energy Information Administration, 2001

U.S. – World Population-Environment Facts

Ten Largest U.S. Cities

Rank, 2004	Population, 2004 (thousands)	Numerical change, 1990 to 2000 (thousands)	Numerical change, 2000 to 2004 (thousands)
1. New York, NY	8,104	68	96
2. Los Angeles, CA	3,846	209	151
3. Chicago, IL	2,862	112	-34
4. Houston, TX	2,013	323	59
5. Philadelphia, PA	1,470	-68	-48
6. Phoenix, AZ	1,418	338	97
7. San Diego, CA	1,264	112	41
8. San Antonio, TX	1,236	210	91
9. Dallas, TX	1,210	181	21
10. San Jose, CA	905	113	10

Source: US Census Bureau, 2006

Ten Fastest Growing U.S. Cities

Rank	Fastest growing, 1990 to 2000	Percent change, 1990 to 2000	Fastest growing, 2000 to 2004	Percent change, 2000 to 2004
1.	Augusta-Richmond County, GA	337	Gilbert, AZ	42.6
2.	Gilbert, AZ	277	Miramar, FL	39.5
3.	Vancouver, WA	210	North Las Vegas, NV	37.5
4.	Henderson, NV	170	Port St. Lucie, FL	33.4
5.	North Las Vegas, NV	141	Roseville, CA	29.6
6.	Athens-Clarke County, GA	119	Henderson, NV	28.2
7.	Peoria, AZ	114	Chandler, AZ	26.6
8.	Cary, NC	113	Cape Coral, FL	25.1
9.	Chandler, AZ	97	Rancho Cucamonga, CA	24.7
10.	Miramar, FL	79	Irvine, CA	24.6

Source: US Census Bureau, 2006

Ten Largest U.S. States

Rank, 2004		Population, 2004 (thousands)	Numerical change, 1990 to 2000 (thousands)	Numerical change, 2000 to 2004 (thousands)
1.	CA	35,894	4,061	2,022
2.	TX	22,490	3,866	1,638
3.	NY	19,227	986	250
4.	FL	17,397	3,045	1,414
5.	IL	12,714	989	294
6.	PA	12,406	398	125
7.	OH	11,459	506	306
8.	MI	10,113	643	175
9.	GA	8,829	1,709	642
10.	NJ	8,699	666	285

Source: US Census Bureau, 2006

U.S. – World Population-Environment Facts

Ten Fastest Growing U.S. States

Rank	Fastest growing, 1990 to 2000	Percent change, 1990 to 2000	Fastest growing, 2000 to 2004	Percent change, 2000 to 2004
1.	NV	66.3	NV	16.8
2.	AZ	40.0	AZ	12.0
3.	CO	30.6	TX	7.9
4.	UT	29.6	GA	7.8
5.	ID	28.5	ID	7.7
6.	GA	26.4	CO	7.0
7.	FL	23.5	UT	7.0
8.	TX	22.8	NC	6.1
9.	NC	21.3	DE	6.0
10.	WA	21.1	CA	6.0

Source: US Census Bureau, 2006

U.S. Regional Population Comparisons

Indicator	Northeast	Midwest	South	West
Population (2003)	54 million	65 million	105 million	66 million
Population growth (% increase, 1990–2003)	7%	9%	18%	21%
Density (persons per sq. mile)	335	87	120	38
% population over age 64	14%	13%	12%	11%
% population under age 18	24%	26%	26%	27%
Average household size (2000)	2.56	2.53	2.56	2.75

Source: US Census Bureau, 2006

Ten Largest U.S. Metropolitan Areas

Rank, 2004	Population, 2004 (thousands)	Numerical change, 1990 to 2000 (thousands)	Numerical change, 2000 to 2004 (thousands)
1. New York-Northern New Jersey-Long Island, NY-NJ-PA	18,641	1,477	387
2. Los Angeles-Long Beach-Santa Ana, CA	12,829	1,092	559
3. Chicago-Naperville-Joliet, IL-IN-WI	9,334	916	294
4. Philadelphia-Camden-Wilmington, PA-NJ-DE	5,773	251	114
5. Dallas-Fort Worth-Arlington, TX	5,590	1,173	538
6. Miami-Ft. Lauderdale-Miami Beach, FL	5,289	952	354
7. Houston-Sugar Land-Baytown, TX	5,076	948	465
8. Washington-Arlington-Alexandria, DC-VA-MD-WV	5,090	674	344
9. Atlanta-Sandy Springs- Marietta, GA	4,610	1,179	460
10. Detroit-Warren-Livonia, MI	4,484	204	40

Source: US Census Bureau, 2006

Ten Fastest Growing U.S. Metropolitan Areas

Rank	Fastest growing, 1990 to 2000	Percent change, 1990 to 2000	Fastest growing, 2000 to 2004	Percent change, 2000 to 2004
1.	Las Vegas-Paradise, NV	85.6	Las Vegas-Paradise, NV	20.0
2.	Naples-Marco Island, FL	65.3	Naples-Marco Island, FL	18.0
3.	McAllen-Edinburgh-Mission, TX	48.5	Cape Coral-Ft. Myers, FL	16.6
4.	Austin-Round Rock, TX	47.7	Riverside-San Bernadino-Ontario, CA	16.5
5.	Raleigh-Cary, NC	46.5	McAllen-Edinburgh-Mission, TX	15.6
6.	Boise City-Nampa, ID	45.4	Stockton, CA	15.3
7.	Phoenix-Mesa-Scottsdale, AZ	45.3	Raleigh-Cary, NC	14.8
8.	Fayetteville-Springdale-Rogers, AR-MO	44.9	Phoenix-Mesa-Scottsdale, AZ	14.3
9.	Provo-Orem, UT	39.9	Port St. Lucie-Fort Pierce, FL	14.2
10.	Atlanta-Sandy Springs- Marietta, GA	38.4	Orlando-Kissimmee, FL	13.2

Source: US Census Bureau, 2006

U.S. Regional Highlights: Population

Northeast

- The Northeast is the most densely populated region in the nation (335 persons per square mile, ranging from 40 in Maine to over 1,000 in New Jersey and Rhode Island).[109]
- It is the slowest growing U.S. region, increasing at less than half the national rate.[110]
- The region's metropolitan areas had the nation's greatest population loss (2%) from inside central cities, and slowest population growth outside cities, in the 1990s.[111]
- The Northeast has the largest proportion of elderly and the smallest proportion of youth among U.S. regions.[112] The largest U.S. state-to-state migration is from New York to Florida.[113]
- The region ranks first nationally in number of one-person households, and most units per housing structure.[114]
- Median size of new single-family homes in the Northeast is the largest in the country – more than 300 square feet larger today than in 1990.[115]
- The Northeast has the highest median household income at $48,000 annually in 2004.[116]

Midwest

- The Midwest is the nation's second least densely populated region (87 persons per square mile, ranging from 10 in North and South Dakota to nearly 300 in Ohio).[117]
- It is the second slowest growing U.S. region.[118] During the 1990s, the Midwest had the lowest rate of population change inside cities, while metropolitan areas around cities grew rapidly.[119]
- The Midwest has the second highest proportion of both the elderly and youth.[120]
- The lowest housing vacancy rates are found in the Midwest. New homes are being built at the second slowest rate in the U.S.[121]
- The region has the second lowest median income among the U.S. regions, $45,000 annually, in 2004. It is the only region where income declined and poverty rates increased from previous year.[122]
- The Midwest has the lowest poverty rates in the nation (11.6%).[123]

South

- The South has the largest numerical population of all U.S. regions[124], and second-fastest growing.[125]
- Two Southern states had the nation's second and third largest numerical increases: Texas (4 million) and Florida (3 million) in the 1990s.[126] During that time metropolitan populations surrounding cities grew three times the rate of the cities themselves.[127]
- The region is the second most densely populated, with 120 persons per square mile, ranging from 50 in Arkansas and Oklahoma, to 540 in Maryland.[128]
- Two Southern states have the nation's first and second highest numbers of elderly: Florida (18%) and West Virginia (15%).[129] Florida accounted for one-third of all migration to the region, while Georgia and North Carolina each accounted for another 20% in the 1990s.[130]
- The highest number of new housing units and smallest number of older housing are in the South.[131] Nearly 70% of houses are single-family.[132]
- The South has the highest poverty rate, (14.1%),[133] and the lowest median household income, (under $41,000)[134] in the U.S.[135]

West

- The West is the fastest growing region, increasing by one and a half times the national rate.[136]
- California is the largest state (34 million residents), accounting for over 50% of the West's, and 15% of the nation's total population.[137]
- Nevada was the nation's fastest growing state increasing by over 66% per year during the 1990s.[138]
- The lowest density is in the West, with 38 persons per square mile, ranging from 1 person per square mile in AL, to 220 per square mile in CA.[139]
- The West had the highest population growth outside metropolitan areas in the U.S., in the 1990s.[140]
- Eight of the top ten fastest growing U.S. cities (in AZ, NV, and CA) and the top three fastest growing metro areas (Phoenix, AR, Las Vegas, and Henderson, NV) are in the West.[141]
- The lowest proportion of elderly and highest proportion of youth are in the West – promising high population growth into the future.[142]
- The West is the only region where household size (about 3 people per household) exceeds the national average.[143]
- The West has the second highest median household income (nearly $48,000) in 2004.[144]

U.S. – World Population-Environment Facts

	United States	World	Europe	Developing countries
Population, 2006	300 million	6.5 billion	730 million	5.3 billion
Projected population, 2050	395 million	9.1 billion	653 million	7.8 billion
Number of people added, 1995 to 2005	29 million	772 million	504 thousand	735 million
Percent population increase, 1995 to 2005	10.6%	14.0%	0.07%	16.3%
Population doubling time at current growth rates	70 years	61 years	(negative growth)	51 years
Percent population under 15/over 65	21/12	29/7	16/16	32/5
Fertility rate (average number children born per woman)	2.0	2.7	1.4	3.0
Birth rate (number births per 1,000 people)	14	21	10	24
Life expectancy at birth, male/female	75/80	65/69	71/79	63/67
Density (persons per square mile)	80	125	82	165
Percent urban population	79%	47%	74%	41%
Gross national income per capita, 2004 (international dollars)	$39,710	$8,540	$19,980	$4,450
Percent change in natural/plantation forest area, 1990 to 2000	1.3/8.1%	-3.6/31.4%	0.9/0.2%	-1.7/55.4%
Energy consumption per capita, 2001 (kilograms oil equivalent)	7,921	1,631	3,621	828
Annual water withdrawals per capita, 2000 (cubic meters)	1,682	633	581	545
Percent of land area in permanent crops, 2002	0.21%	1.0%	0.73%	1.4%
Annual per capita food supply from fish & fishery products, 2002 (pounds)	47	36	47	31
Annual per capita paper and paperboard consumption, 2002 (pounds)	678	115	275	44
Carbon dioxide emissions per capita, 2001 (metric tons)	19.8	3.9	8.3	1.8

Sources: US Census Bureau, Population Reference Bureau, United Nations Population Division, International Union for the Conservation of Nature and Natural Resources, World Resources Institute, Earth Trends Database

U.S. Population-Environment Challenges

Land Use

America's growing population has significant impacts on the way land is used across the country. Changes in how the nation's land is utilized, or "land-use change," is inevitable as people depend on the land-base for food production, housing, roads, and other services. Yet some forms of land-use change can have major detrimental effects on land resources.

How the American population affects "land" as a natural resource is determined by how many people there are, how close together they live and work, and how the landscape is utilized and developed. The more intensively and extensively land is transformed from its natural state by humans, the less useful it is for other plant and animal species, the ecosystems in which they live, and the "natural services" they provide.

National Overview: Population and Land Use

The type of land-use change most often linked to population is "development" for residential and other purposes – a result of the nation's century-long movement from primarily rural to urban and suburban. *This "metropolitanization" is characterized by the expansion of cities and suburbs outwards, and the subsequent loss of farmland, forests, prairies, wetlands, natural coastal areas, and the remaining open spaces.*[145]

The *amount* of developed land, the rate at which it is being developed, and the way it is developed all have major land-use implications.

Development is the only U.S. land-use category that has increased significantly (by 47%) in the last two decades.[146] Although "developed land" actually represents a relatively small proportion of the nation's total land area, the trend for land development represents significant environmental impacts nationwide. Twenty years ago, about 4% (73 million acres) of the land area in the contiguous U.S. was classified as developed, but has increased to 6% (107 million acres) today.[147]

The *rate* of land development per capita has changed markedly in the past few decades. *Today, all land is developed at about twice the rate of population growth.*[148] *Each American effectively occupies almost 20% more developed land, for housing, schools, shopping, roads, and other uses, than he/she did 20 years ago.*[149] By the late 1990s, 1.7 acres of land were developed for every new person added to the U.S. population, up from 0.8 acres a decade earlier.[150]

The South is experiencing the fastest overall rate of land-use change in the form of urbanization (nearly 60%), with the West close behind (nearly 50%).[151] The Northeast is experiencing the most land-use change in proportion to its population growth, with the rate of developed land increasing nearly six times as fast as the rate of population change during the 1980s and 1990s.[152] During this time, land in the Midwest was developed at nearly five times the rate of population growth.[153]

All regions are experiencing significant movement into outer suburbs and even into rural areas, with implications for land-use change.

America's land-use changes from population growth and associated development result in three main trends that have significant environmental consequences:

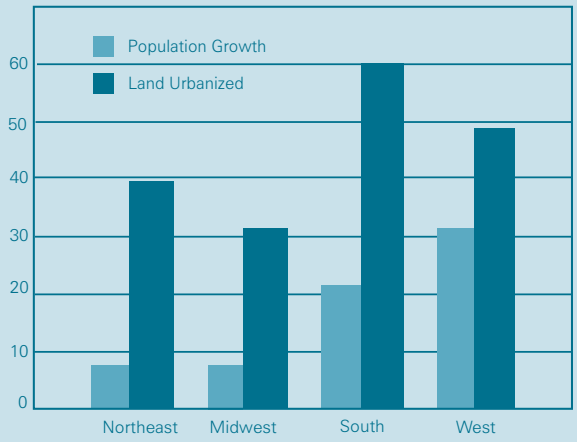
- **Sprawl development**
- **Increase in new housing**
- **Increase in vehicle use and road systems**

Sprawl development

Much of the nation's land conversion for development in the past few decades (for residential and related services) has triggered an entire set of unique land-use patterns, called "sprawl." This spread-out development generally occurs around city and town centers, and into surrounding neighborhoods and rural areas. The amount of land utilized for these sprawling metropolitan areas has increased faster than their populations are growing. Nationwide, population grew by 17%, yet the amount of developed land grew 47%, during the 1980s and 1990s.[154] By 2030, half of the buildings in which we live, work, and shop will have been built after 2000.[155]

Sprawl is characterized by high amounts of land development per unit of human activity. It is reflected in low-density residential subdivisions, commercial strips, large retail complexes surrounded by acres of parking, office parks far from homes and shops, and a growing network of roads linking them all. This type of development often causes lifestyle changes that require automobile dependency (because of the large area sprawling

U.S. Population & Urbanization



Source: Fulton, W., et al, *Who Sprawls Most? How Growth Patterns Differ Across the US, 1982-97*. Brookings Institution, 2001.

communities cover), spurs relatively high energy costs (from increased use of vehicles and larger homes to heat and cool), land consumption (from residential and other new infrastructure), high levels of traffic congestion, and higher highway expenditures.[156]

Sprawl development involves the conversion of all types of land, whether contained in natural ecosystems, or already converted for agricultural or grazing purposes. It also has other ecosystem effects. It "fragments" or breaks up wildlife habitat, and can render ecosystems (such as in watersheds or coastal areas) less than fully functional. As this development paves over land, it compacts soils, increases polluting chemical or fertilizer runoff and flooding, and reduces groundwater reserves.[157]

Forecasts show considerable expansion of sprawling development in the future, with significant implications for ecosystems. For example, forest and cropland made up most (60%) of the acreage developed nationwide during the 1980s and 1990s.[158] At current population growth and rates of sprawling development, the U.S. could lose 23 million acres of forest land to development by 2050, primarily due to increases in residential areas.[159]

Increase in new housing

Land-use change from sprawl results in a significant increase in new housing development. This takes a particularly strong environmental toll because development in new areas begins from scratch, rather than building on existing infrastructure. The result is the consumption of high volumes of resources, and fragmentation of the remaining open space.

In the last several decades, the number and size of new houses and the land area taken up by new houses have all increased. More than 3,000 square miles of land is converted annually to residential development over one acre in size.[160] In 2000, there were nearly 14 million more housing units nationwide than a decade earlier.[161] Between 1970 and 2000, average household size declined from 3.1 to 2.6 persons (one fewer person for every two households), resulting in demand for new housing units in addition to that already needed to keep pace with population growth.[162]

The average size of new, single-family homes has expanded steadily, reaching more than 2,300 square feet by 2004. *Nearly 40% of new single-family homes are over 2,400 square feet, double the proportion in 1987.*[163] And, although the national average lot size of new houses has remained relatively steady, lot increases are prevalent in many suburban areas. As an example, an estimated 55% of farmland developed since 1994 has gone to houses built on lots ten acres or larger.[164]

Increase in vehicle use and road systems

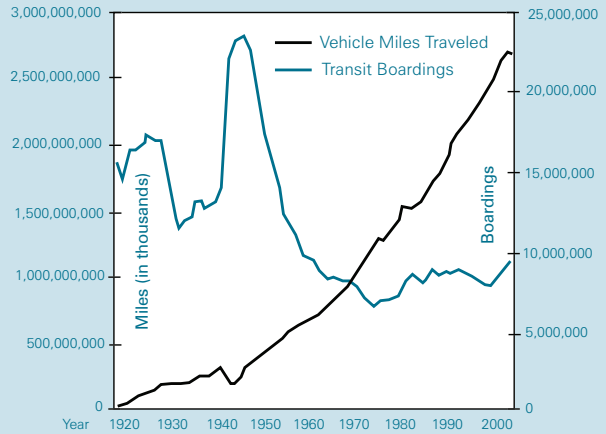
Modern land-use change reflects the population's spread into suburban and rural areas. This in turn requires more vehicle use, and increased amounts of construction and land transformed into new highways, roads, and parking lots. Almost 44,000 miles of highway have been built in the last decade, bringing the total to almost 4 million miles by 2001. At the same time there has been a downturn in train and other public transportation use and government support per capita nationwide.[165]

Driving itself has rapidly increased – the number of vehicle miles traveled rose nearly 3% annually during the 1990s (with a marked increase in the final years of the decade), reaching nearly 3 trillion miles for the nation as a whole by 2000.[166] Sprawl often dictates new road building to accommodate the need to travel further and further to get around. From 1991-2001 when the U.S. population grew about 13%, the transportation miles traveled by Americans increased by 24%.[167]

With more people taking more and longer trips as part of daily life, and a growing number of cars on the road, *congestion has also increased.* The average U.S. traveler now spends 47 hours each year stuck in traffic delays during rush hour, compared to just 16 hours two decades ago. There are also now ten times more urban areas (51) with more than 20 hours of annual rush hour delays.[168]

Looking at the environmental impacts, these trends have contributed to increased fossil fuel combustion, and thus higher greenhouse gas emissions. *The transportation sector uses 17% more energy today – primarily from petroleum – than it did a decade ago. It now accounts for one-third of all U.S. carbon dioxide (CO_2) emissions.* This reflects an annual increase of over 2% during the 1990s.[169] Most (80%) of the CO_2 emissions created on highways come from the miles Americans travel in their own personal vehicles.[170] In addition, an estimated 2.3 billion gallons of fuel are wasted every year from idling in traffic, nearly 80% more than in the early 1990s.[171]

U.S. VEHICLE USE



Source: APTA & FHWA

U.S. Regional Highlights: Population & Land Use

Northeast

- The Northeast is the most developed or "built-out" region in the U.S.
- Developed land in the Northeast's metropolitan areas increased six times the rate of its population growth (compared to three times for the nation as a whole), or about one acre of land developed for each new resident in recent years.[172]
- The Northeast's residents have the nation's longest average daily commute (28 minutes).[173]
- About 50% of buildings in the Northeast will have been built after 2000, the lowest proportion among U.S. regions, by 2030.[174]
- The New York-Newark-Connecticut metropolitan region has the second worst traffic congestion problems in the nation (after Los Angeles) in terms of annual travel delays (400 million hours)and excess fuel consumption (200 million gallons).[175]

Midwest

- Midwestern cities have undergone a "hollowing out," with central cities and inner suburbs declining in population, and suburban and exurban neighborhoods growing.
- Agriculture, the region's economic cornerstone, is threatened by the conversion of farmland to low-density residential and industrial development and related traffic infrastructure.
- Six Midwest states are among the top 20 in the nation that lost the most acres of prime farmland. Ohio, ranked second nationally, lost more than 200,000 acres during the 1990s.[176]
- Land in the Midwest was developed at about five times the rate of population growth (32% versus 7%) during 1982 to 1997.[177]
- The Midwest outpaces all other regions in projected demand for industrial construction. By 2030, 70% of industrial space in the region will have been built after 2000, much of it in the "rust belt" states of Illinois, Indiana, Michigan, and Ohio.[178]

South

- Land in the South has been urbanized at nearly three times the rate of population growth (60% versus 22%) in the past two decades.[179]
- The South accounted for nearly half of all new, single-family housing construction permits issued nationwide in 2001.[180]
- By 2030 more than 80% of the total square footage of buildings in the South will have been built after the year 2000.[181]
- The South has the highest proportion of vacant housing (10%) among the regions. Florida leads states with the greatest number of seasonal, recreational, or occasional-use homes (over 480,000 units).[182]
- Southern states with the highest population growth also have very high rates of residential-related development, particularly along the coast. Increases in housing units during the 1990s were highest in North Carolina (25%), Georgia (24%), South Carolina (23%), and Florida (20%).[183]

West

- Most of the nation's fastest growing states (such as Nevada and Arizona) and metropolitan areas (Las Vegas and Phoenix) are in the West.
- In Las Vegas, the nation's fastest growing metropolitan area, new housing permits issued during the 1990s equaled the number of homes that already existed at the beginning of the decade.[184]
- By 2030, 87% of the West's buildings will have been built after 2000, the highest proportion among U.S. regions.[185]
- Each Los Angeles metropolitan area resident experienced 98 hours of traffic delays in 2002, compared to 47 in 1982. For residents of San Francisco, the delay increased from 30 to 75 hours, while in Phoenix it jumped from 18 to 49.[186]
- The top ten worst areas in the nation for ground level ozone (linked to asthma and other chronic respiratory diseases from air pollution) are found in the same six California counties.[187]
- Metropolitan areas in the West have higher population densities when compared with other regions, in part because of geographic and resource constraints (in particular water supplies), and the relatively high proportion of federal land.

U.S. Population-Environment Challenges

Water

Water is crucial for the existence of life. It is also a finite resource. There is no more freshwater on Earth today than there was 2,000 years ago, when the global population was less than 5% of its current size.[188] *Less than 1% of all water resources on the planet are readily available for human use through freshwater supplies on the surface or underground.*[189]

Human population is linked to America's freshwater resources in two primary ways: through water "quantity," the amount of water a growing population uses for agricultural, domestic, industrial, and commercial purposes, and water "quality," the type and amounts of water contamination, pollution, and alteration caused by increasing populations.

National Overview: U.S. Population and Water

The availability of clean water in America has improved since the advent of 1970s environmental regulations, and modern water treatment technologies and conservation measures. Yet as the nation grows and uses more and more water as a common resource, its allocation and use poses continual challenges.

Water availability in the U.S. varies by region – it is relatively plentiful in the Northeast, South, and Midwest, and much less available in the West. Providing sufficient water supplies is often difficult in the fast growing, naturally arid West. Yet even the other parts of the country with significant water resources also face intense demand for the resource, while industrial and agricultural pollution threaten water resources and human health nationwide.

Among the pressures on America's freshwater supplies, three are most often linked to human population factors:

- **Water withdrawals and consumption**
- **Water pollution**
- **Alteration of waterways**

Water withdrawals and consumption

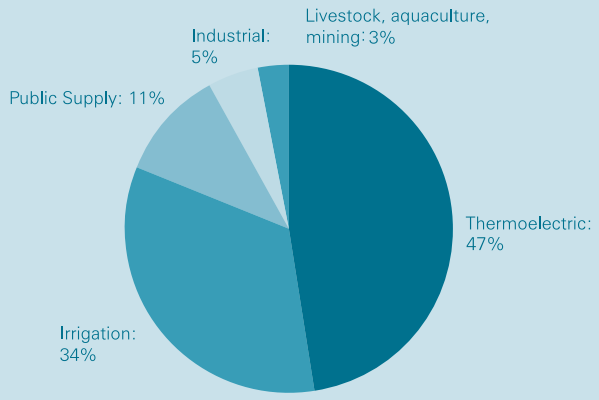
Each U.S. resident uses an average of 1,500 gallons of water daily (1,682 cubic meters annually) for all purposes (domestic consumption, recreation, energy (primarily for cooling at power plants), food production, and industry) – about three times the world average.[190]

America's water needs are provided through surface (rivers, lakes, and streams) and groundwater (wells and aquifers) supplies. About 80% of all water withdrawals were from surface and 20% from groundwater sources in 2000.[191]

Nearly half of U.S. water withdrawals are used for thermoelectric power to supply energy, and about a third is used for irrigation.[192]

The nation's total water withdrawals increased by about 2% between 1995 and 2000. During this period, public supply withdrawals, and the population served by them, grew by 8%.[193] Since 1975, per capita water use has actually declined, dropping 25%. Much of this shift was due to the greater availability of water-efficient appliances (such as washing machines and dishwashers), and conservation measures adopted by local communities and states.[194]

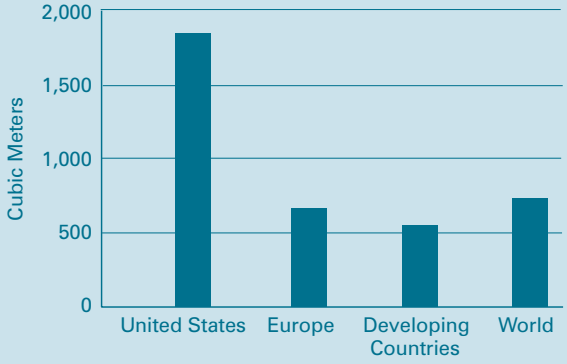
U.S. Water Use



Percent of million gallons of freshwater used per sector per day

Source: USGS

U.S.– World Comparisons Per Capita Annual Water Use



Source: World Resources Institute, UN Food and Agriculture Organization, 2004

America's "Big 3": Population & Water

One of the nation's and world's most substantial water sources, the Midwest's *Great Lakes* (containing two-thirds of North America's and a fifth of the world's freshwater supply) is under population pressure.[195] These lakes are surrounded by agricultural and commercial operations and densely populated residential areas, and support much of the nation's river-based commerce. In 2002, more than 43 billion gallons of water were withdrawn each day from the Great Lakes Basin, and an additional 803 billion gallons per day were withdrawn for hydroelectric use (yet considered "returned" to the Basin after being used in power plant cooling).[196] At the same time, less than 1% of the water contained in the lakes is renewed annually by precipitation, groundwater inflow, and surface water runoff.[197]

The West's *Ogallala Aquifer* is the largest groundwater system in North America, stretching 179,000 square miles beneath eight states (CO, KS, NE, NM, OK, SD, TX, and WY).[198] It supports 20% of all irrigated land in the U.S., and supplies 30% of all groundwater used for the nation's irrigation.[199] Irrigated farmland now covers nearly 14% of the aquifer's area, compared to only 2% 50 years ago.[200] About a third of the Ogallala's total water volume has already been withdrawn, and the withdrawal rates far exceed natural recharge from precipitation and surface absorption. This resulted in an average annual drop in groundwater level of about a foot per year since the 1970s.[201]

The South's *Florida Everglades* is unique in the nation. It once covered eight million acres, but has shrunk to half its original size in the last century due to population growth and development-related uses.[202] Massive water diversion schemes have drained south Florida to make room for residential areas and golf courses, and for flood control to enhance agriculture (in particular the sugar industry). The re-engineering of the Everglades has degraded a complex web of mangroves, ponds, creeks, and sawgrass prairies, diminishing water quality and flow, and reducing the number and variety of birds and aquatic species.[203]

Stress on America's water resources manifests itself as the demands of a growing population are placed on the changeable natural, seasonal water cycles of evaporation, precipitation, and replenishment. The consequences of intense groundwater withdrawals are evident in the depletion of aquifers and wetlands and land subsidence (which, in turn, can result in sinking buildings and roads) and the intrusion of saltwater into coastal aquifers, which can ultimately render groundwater unusable.

Water pollution

Water pollution nationwide results in an estimated 40% of rivers, 46% of lakes, and over 50% of estuaries being too polluted for fishing and swimming.[204] More than 90% of the water and fish in streams, and over 50% of shallow wells sampled nationwide, contained residues from at least one pesticide.[205]

The pollution of water is associated with population mainly as it acts as a multiplier of specific polluting activities, including chemical discharge from industry, waste products (from pharmaceuticals to household cleaners), and runoff of lawn chemicals. For example, more and more of the growing suburb's residential and commercial lawn care methods use frequent applications of chemical fertilizers and pesticides that introduce toxins and nitrates into aquifers, can pollute drinking water, contribute to nuisance algae growth, and endanger wildlife species in the springs.[206] And every year, an estimated 860 billion gallons of sewage escapes treatment systems (generally from faulty pipes) and ends up in nearby bodies of water.[207]

Another cause of water pollution associated with population is the non-point source runoff from fertilizers, pesticides, and livestock waste. These elevate nitrogen levels in rivers, streams, underground systems, and coastal area. High levels of nutrients results in excessive vegetative growth and depleted oxygen levels, which make it difficult for aquatic life to survive.

Airborne pollutants from the rising population's burning fossil fuels for transportation and energy also contaminate water systems. Acid rain – the result of emissions of sulfur dioxide and nitrogen from industries and power plants – eventually reaches the ground and degrades soil quality and the health of plants and animals. It is also closely linked to declines in the number and diversity of fish species. Mercury generated from airborne sources like power plants and incinerators has also had a major impact nationwide, with particular effects in the Northeast.[208]

Water pollution problems are also exacerbated when development leads to the removal of wetlands, trees, and vegetation, replacing the natural systems with asphalt, buildings and other infrastructure. This process eliminates natural forms of water storage and filtration and erodes soil, which restricts unnatural increases in water flow, transports polluting runoff, and raises the temperature of rivers and streams. The extent of such development on freshwater resources is substantial. An estimated 70-90,000 acres of wetlands on non-federal lands are now lost every year,[209] including 20,000 acres of coastal marshes.[210]

Wetlands and Habitat Loss

Wetlands are essential to estuary, river, and watershed health, trapping sediments and cleaning polluted waters, preventing floods, recharging groundwater aquifers, and protecting shorelines. Wetland ecosystems also provide critical nesting, rearing, feeding, and stop-over habitat for bird and other wildlife populations in watersheds across the nation.[211] For example, the wetlands of the Midwest's Prairie Pothole Region are prime breeding ground for more than half of the world's duck production.[212]

However, wetland habitat loss in the U.S. is substantial. *The lower 48 states had already lost 53% of their original wetland habitat, or about 104 million acres, by the 1980s.* Twenty-two states have lost 50% or more of their original wetlands, with California losing the largest percentage (91%), and Florida losing the most acreage (9.3 million acres). *Losses over the past two decades have been primarily due to urban/suburban development, and land-use change for agriculture.*[213]

Wetlands continue to be eliminated at over 100,000 acres per year today.[214] As they disappear, so too do vital natural habitats for many species of songbirds, frogs, fish and other birds and wildlife.[215]

Alteration of waterways

Extensive damming and diversion of America's waterways is undertaken to meet people's growing demands for water. Locks and dams built to enhance barge transport and control floods have substantially changed riverine ecosystems, altering water flows and temperatures and, in turn, the composition and health of wild fish and aquatic animal populations. With more than 5,500 large and tens of thousands of small dams nationwide, only 2% of the miles of U.S. rivers and streams remain free-flowing.[216]

Key consequences of the intense "taming" of water systems include rising numbers of threatened and endangered plant and animal species, the degradation of backwaters and marshes, loss of nutrient-rich sediment, and the siltation of waterways.[217] In many parts of the country, growing agricultural and domestic demands force the constant re-negotiation of water diversion rights. In addition, the desire of commerce and trade interests to have steady water levels maintained come up against the natural, seasonal flows of waterways.

U.S. Regional Highlights: Population & Water

Northeast

- The highest mercury concentrations nationwide are found in the Northeast, prompting fish consumption advisories in all states in the region.[218]
- Acid rain has adversely affected 41% of all lakes in the Adirondack Mountains, and 15% of all lakes in New England.[219]
- The Northeast experiences major sewage pollution, largely because of its older infrastructure and densely populated areas. Overflows from sewage systems into waterways affects more than 100 communities region wide.[220]
- The over-pumping of groundwater supplies is an ongoing problem in highly populated Northeastern coastal areas – in New Jersey's Cape May County, more than 120 supply wells had to be abandoned between 1940 and 2000 because of saltwater contamination.[221]

South

- The South's fastest growing and most populated states (particularly Texas and Florida) face extreme water stress. Population's water demands in Texas are projected to more than triple by 2050, a period when remaining water levels in major aquifers are expected to drop dramatically.[222] In parts of Florida, population growth is exceeding groundwater supplies.[223]
- Nearly half of all water withdrawals from Florida's public supplies (900 million gallons per day) are used to water residential lawns.[224]
- Georgia's fast growing coastal populations' groundwater over-pumping is projected to cause salt water intrusion into the state's Floridian Aquifer, a key water source.[225]
- Coal mining in the Appalachians is a major source of pollution. About 75% of West Virginia's streams and rivers are polluted by mining waste.[226]
- North Carolina's thousands of open-air hog farm "lagoons" contain about 19 million tons of manure annually. Many leak fecal contaminants into groundwater or coastal drainage areas, prompting periodic moratoriums on the construction or expansion of large animal operations.[227]

Midwest

- The Midwest contains some the most significant sources of freshwater on the planet: the Great Lakes, the Missouri and Mississippi Rivers (two of the longest rivers in the world), and the Mississippi river basin (the third largest watershed in the world, draining more than 40% of the continental U.S.).[228]
- More than half of the land in the upper Mississippi River basin has been cleared for farming, causing nearly one-third of the wetland loss in the area.[229]
- Irrigated land in the Midwest, the U.S. "corn belt", reached 3 million acres in 2000, a 50% increase (1 million acres) just since 1987.[230]
- Between 1992 and 2002, in Iowa alone more than 300 manure spills from large animal feeding operations reached surface waters, killing 2.6 million fish.[231]
- A comprehensive study of domestic water wells in nine Midwestern states found that 40% contained *E. coli bacteria* and 65% contained nitrate.[232]

West

- The West's "existing water supplies are inadequate to meet the demands for water for people, cities, farms, and the environment even under normal supply conditions."[233]
- In the West more than 80% of harvested cropland is irrigated (compared to 16% nationally).[234]
- Agriculture accounts for about 90% of water consumption in many Western states.[235] California alone accounts for a quarter of the nation's water withdrawals for irrigation.[236]
- The latest average water flow in the Colorado River was the lowest on record.[237]
- The 14 dams along the 1,200-mile long Columbia River have severely reduced water flow and increased water temperatures, making it difficult for many species to survive.[238] Along the Snake River, salmon populations have declined nearly 90% since four dams were built 30 years ago.[239]
- In the last few years, the West has experienced record-low mountain snow pack (which provides about 75% of the regions water supply), and earlier than usual snowmelt, prompting historically severe drought and concerns over future water supplies.[240]

Forests

Forests provide a myriad of essential goods and services that sustain life. They are a vital part of the water and climate cycle, absorb atmospheric carbon dioxide and replace it with oxygen, nourish the soil and stabilize it to prevent floods, and are critical habitat for plants and animals. They also provide irreplaceable natural sites for many forms of recreation, and are the source of forest products that add significantly to the American economy.

The nation's forests, however, also face significant challenges from human population, including forest land conversion for rapidly increasing development, high rates of forest product consumption, and forest land and water pollution. This translates into increased pressures on forest ecosystems, their plant and animal inhabitants, and the land-base they occupy.

National Overview: U.S. Population and Forests

U.S. forests cover about one-third of the nation's land area, or 750 million acres. The nation's forest cover is now a third less than what it was at the time of early European settlement.[241] Although there have been significant regional changes and there is even a slight increase in forest cover today, the total area of forest land in the country has been fairly stable for the past 100 years.[242] As a result, *today about three times as many people are essentially being supported by the same forested area that existed 100 years ago.*[243]

America's forests are owned by private individuals (54%), public agencies (37%), private industries (9%), and 10% are protected in reserves such as parks and wilderness areas.[244] About 66% is classified as timberland.[245]

Timber practices and other forested land-use changes influence forests' area, structure, biodiversity and water quality. In addition, urbanization, atmospheric pollution and the introduction of exotic plants, diseases and insects reshape the composition, productivity and ecological function of forests. These population-related influences are difficult to manage and predict, and they result in changes in forests' health, extent and structure.

Human population dynamics affect forest ecosystems and their plant and animals species mainly through:

- **Forest land conversion and degradation**
- **Forest product consumption**
- **Pollution**

Forest land conversion and degradation

America's forests are being converted for purposes of urbanization, residential and other forms of development, agriculture, pasturelands, and other uses. Among the many types of change, *urbanization is seen to have one of the most direct, immediate, and permanent effects on the extent, condition, and health of forests.* While urban uses currently represent a small share of forested land in the nation, they are expanding rapidly. For example, forecast models in the South predict that about 30 million acres of forests there will be urban/suburbanized by 2040.[246]

The results can be far reaching and sometimes irreversible. *Unlike earlier forms of deforestation, today forest lands are often subject to "terminal" or permanent long-term conversion, never to regenerate into forest ecosystems again.* Today when forest lands are converted, habitat loss, "fragmentation" (when contiguous stretches of forest land are carved into small patches) and "parcelization" (the division of forested land into smaller units of ownership) occur. The breaking up of larger intact forest parcels is becoming more and more common as population pressure increases. The number of small parcel woodland owners (with less than 49 acres) doubled to nearly 3 million between 1978 and 1994. If this trend continues, the average parcel size will be 17 acres by 2010, down from about 27 acres in 1978.[247]

These forms of forest land conversion all have major impacts on biological diversity and overall forest health. Large expanses of forests support a diverse array of plant and animal species, produce clean water supplies across large watersheds, and provide habitat for species (such as bears, wolves, and lynx) that need unbroken or deep forests to safely breed, hunt, and migrate. The presence of roads, houses, and other human-made structures in, or on the edge, of forests often causes erosion and pollution, and increases fire risks.[248]

Another effect is *the loss of irreplaceable, ecologically complex forests.* Large scale industrial timber practices generally favor clear-cutting (the removal of entire stands of trees). Although forests can regenerate after being cut down, it can take multiple decades for trees to reach their previous level of maturity so the original vegetation mix can return. During that time, many species lose their habitat. *Today, only about 5% of the country's original old-growth forests (stands that have never been subject to logging or significant disturbance) remain.*[249] More than half of U.S. timberland is less than 50 years old, while only 6% is more than 175 years old.[250]

Other common forestry practices that affect biologically complex forest ecosystems include the steady rotation of stands, and the substitution of monocultures that produce wood and pulp relatively quickly. Tree plantations with only one or two tree species (such as

pine and fir) are increasing in area, and now comprise about 11% of all U.S. timberland. Even "wild" timberland is often intensively managed to support growth of particular types of trees.[251]

The trend toward forest *simplification* from these practices (supporting fewer, less diverse species) has multiple repercussions. Newer forests are less resilient to natural events such as disease outbreaks and fire, and there is less prime habitat for diverse and rare populations of birds, fish, and wildlife. This problem is compounded by the *loss of specific forest types and habitats that support certain birds, fish, and wildlife.* For example, since European settlement, *the nation's redwood forests have declined by 40%, Great Lakes pine forests by 77%, and Midwest oak savanna by more than 99%.*[252]

In the end, population growth into and bordering on forest tracts means increasing limitations on forest management options (such as prescribed burning) that are necessary to maintain productive and healthy forest ecosystems.[253]

Forest product consumption

The U.S. is the world's largest consumer of forest products – in the last four decades alone, U.S. overall wood consumption grew by 50%.[254] In 2000, America's per capita consumption of sawn wood (at 19 cubic feet) was nearly twice as much as developing countries, and ten times the world's average.[255]

About 50% of America's wood products are used to make construction and building materials, and 30% for pulp and paper.[256] Each American consumed nearly 680 pounds of paper/paperboard in 2002 (two and a half times that of Europeans, 15 times developing countries' residents, and six times the world's per person average).[257]

Producing and disposing of paper has important environmental effects. Often, paper is bleached with chlorine which produces dioxin that builds up in soil and water and affects plants, animals, and humans. Food contaminated by dioxin can cause severe human health effects, including cancer, a weakened immune system, hormonal changes, and neurological problems. Paper also creates significant pollution (the paper industry is the third largest source of global warming pollution in the world) and solid waste problems. Each year, Americans throw away enough office and writing paper alone to build a 12-foot wall stretching from New York to California.[258] Recycling and use of sustainable forest products can decrease environmental impacts (see Box).

America is also the world's second largest producer of forest products (after Canada), with much of the production going to international export. The nation's industry is growing fast to keep up with the high demand both in and out of the country. Since the 1960s, the consumption of wood products has steadily expanded in the U.S., and timber production from western U.S. regions has declined. As a result, the South has produced nearly 60 percent of the Nation's wood output since the 1990s.[259]

Overall, America produced 203 million tons of wood and paper products in 1999, more than twice the amount as in 1950 (83 million tons).[260] Nationally, timber harvest grew 40% between 1952 and 1996.[261]

Recycling and the Forest Stewardship Council

Recycling forest product material can reduce pressure on limited forest resources. As the U.S. has the world's largest market for paper products (producing 90 million tons of paper annually and consuming 100 million tons), the roughly 50% of U.S. paper products being recaptured and recycled is significant.

However, despite the use of recycled "post-consumer" paper, "virgin" or new paper fiber is still needed to meet growing demands. Only 35% of current U.S. paper consumption is met by using recycled fiber. In addition, approximately 25% of recycled/recovered fiber is exported.

The Forest Stewardship Council (FSC) addresses this supply side of wood products in a sustainable manner. A worldwide organization, the U.S. chapter was established in 1995 to develop sustainable forest management practices, provide public information, and help retailers and consumers alike have easy access to sustainable forest products. Today over 200 million "timber" acres in the U.S. are now certified under the FSC.[262]

Pollution

Forest contamination can occur from air, land and water-borne pollution – all generated by a range of people's activities and forest-product demands, and multiplied by population growth.

Pollution of forests occurs when agricultural and household chemicals run off built-up road surfaces and other developed areas, then percolate through the soil into nearby forest areas. Also, large-scale, mechanized logging that "clear-cuts" forest tracts can erode, compact, and alter the nutrient content of soil, as well as contribute to the clogging and pollution of lakes and streams.[263]

Air and water-borne forest pollution comes from point sources like industrial and other sites, and non-point sources like motor vehicle emissions and road/pavement run off. The pollutants include mercury and acid rain (from the burning of fossil fuels), heavy metals, volatile organic hydrocarbons, and ground level ozone, all of which take a severe toll on overall forest health and functioning. Ground level ozone is known to damage trees, including in seemingly pristine areas such as national parks. Acid rain hinders the ability of trees and vegetation to absorb water and nutrients through their roots, and leaches calcium and other essential minerals from the soil, leaves, and needles.

Forests and Tourism

America's national parks and forests are experiencing a significant increase in annual visitation, thus representing a significant population-environment challenge. Today there are about 430 million visits annually, up 25% (100 million) from what it was just two decades earlier.[264] This high rate of tourist visits, or "temporary migration," can take a significant toll on the nation's protected forest areas. This is especially the case with "high intensity" tourism that utilizes gas powered vehicles, and requires access roads and other infrastructure that often damage root systems and vegetation, compact and erode soils, fragment habitat, and create air and noise pollution.

Snowmobiles generate about 68% of carbon monoxide and 90% of hydrocarbon emissions in Yellowstone National Park.[265] One Minnesota study found that about half of pines and white spruce there were damaged from snowmobiles. Scientists in Alaska concluded that one-quarter to two-thirds of damage to vegetation in Wrangell-St. Elias National Park and Preserve was caused by just ten passes by All Terrain Vehicles.[266] The U.S. Forest Service estimates the number of off-road vehicles in use nationwide has grown from 5 to 36 million in the past 30 years.[267]

Top Most Visited U.S. National Parks

Park	Number visits, 2005
Grand Canyon (AZ) *	4,401,522
Yosemite (CA) *	3,304,144
Olympic (WA)	3,142,774
Yellowstone (WY)	2,835,651
Rocky Mountain (CO)	2,798,368
Zion (UT) *	2,586,665
Cuyahoga Valley (OH)	2,533,827
Grand Teton (WY)	2,463,442
Acadia (ME) *	2,051,484

Source: US National Park Service, 2005
* Also in top 10 most polluted list, US National Park Service, Summer 2005

Top Five Most Polluted U.S. National Parks

1. Great Smoky Mountains (TN/NC)
2. Shenandoah (VA)
3. Mammoth Cave (KY)
4. Sequoia-Kings Canyon (CA)
5. Acadia (ME)

Source: National Park and Conservation Association, 2004

U.S. Regional Highlights: Population & Forests

Northeast

- Nearly 70% of the Northeast's land area has forest cover.[268]
- Remaining "old-growth" forest covers less than 0.5% of the Northeast. Most is in the Adirondacks, the largest park in the continental U.S.[269] During the 1990s, permits were issued in the Adirondacks for 820–850 new residential, commercial, and industrial buildings every year.[270]
- Forested land in New England was developed at about six times the rate of population growth, resulting in forest fragmentation and the permanent conversion of forest land to other uses, from 1982-1997.[271]
- Elevated ozone levels make Acadia in Maine the fifth most polluted national park nationwide.[272]
- About 30% of Vermont's upland forests are damaged and have stunted growth because of sulfur dioxide and nitrogen pollution.[273]
- In the Northeast's Green Mountains and the Adirondack Mountains, an estimated 50% of red spruce trees have died from acid rain.[274]

South

- About 40% of the South's land has forest cover.[275]
- The South produces about 60% of wood products consumed in the United States and 25% of the world's paper.[276]
- Three of the five most polluted national parks are in the South: the Great Smoky Mountains, Shenandoah, and Mammoth Cave.[277] In the Great Smoky Mountains, rainfall is five to ten times more acidic than normal rainwater.[278]
- The 30 million additional acres of Southern forests developed by 2040 will be in already highly populated areas such as Florida, Georgia, and North Carolina, and along the Atlantic and Gulf Coasts.[279]
- The land area covered by monoculture pine plantations in the South grew from 2 million to 32 million acres between 1952 and 1999, and is projected to increase to 54 million by 2040.[280]
- Southern timber stands have the lowest median age of all such lands nationwide.[281]

Midwest

- As the nation's agricultural heartland, less than 20% of the Midwest's land area has forest cover.[282]
- While forests in the Midwest's central states make up just 11% of all U.S. forest land, they contain 20% of forest industry lands and hardwood stock.[283]
- Most of the region's forests are in Michigan, Minnesota, and Wisconsin, which together are more than 40% forested. There, forest product output has increased by 150% of the overall national rate in recent decades.[284]
- Leaf damage and stunted growth in some species in the Great Lakes states have been linked to ozone pollution from Detroit, Chicago, and Toledo.[285]

West

- More than 30% of the West has forest cover, much of it in remote areas with low human populations.[286] The West contains nearly 80% of America's publicly held forestland and more than 80% of the country's forest reserves, where commercial activities are restricted or banned.[287]
- The West accounted for about half of all U.S. softwood timber production in 2001.[288] The amount of timber sold on National Forest lands in Montana and Idaho increased 58%, and on U.S. Forest Service lands increased 25% in California and 14% in Oregon and Washington from 2000 to 2001.[289] "Timber wars" in the West are intense amongst interest groups, coupled with the pressure to open up public lands to meet growing industry and market demands.
- The West is home to some of the oldest trees in the world. Coast Redwoods and Giant Sequoias can grow 200-300 feet tall and live 2,000 to 3,000 years.[290]
- The Tongass National Forest in Alaska, threatened by over 50 new logging projects, contains 30% of the remaining temperate rainforest in the world.[291]

U.S. Population-Environment Challenges

Biodiversity

Biological diversity, or "biodiversity", is all living plant, animal and insect species and micro-organisms on Earth, their genetic makeup, and the wide range of ecosystems in which they live. It represents the complex web of natural relationships that supports life on Earth, and is an essential building block of a stable, healthy environment.

Human population is linked to biodiversity through the numbers of people, where and how they live, what they produce and consume, and how much waste is generated. The resulting intense use of land and natural resources to support the housing, food, transportation, and other living requirements of large and growing numbers of people frequently eliminates species' habitat, and degrades the conditions they need to survive and thrive.

National Overview: U.S. Population and Biodiversity

Biodiversity is subject to three factors that are important when considering its population linkages. *First is lack of identification and cataloguing*. This makes it difficult to know which species actually exist, and how they can be saved for medicinal, agricultural, aesthetic, economic, ecological, and other purposes. Fewer than 2 million of the estimated 14 million plant and animal species on Earth have been classified.[292] *Approximately 200,000 plant and animal species have been identified in America – possibly less than half the total number that actually exist here.*[293]

The second is faster extinction rates. Although species have been evolving and disappearing since life began, extinctions now occur at 1,000–10,000 times the natural historical rate, depending on the species.[294] *Today, an estimated 6,700 known species are considered to be at risk of extinction in the U.S.295 Almost 1,000 U.S. species are included on the U.S. government list as endangered and 300 as threatened, more than twice the number listed a decade ago.*[296] Of the 40 species that have been taken off the list, only 17 have recovered and 9 have gone extinct. The rest were removed due to revisions in scientific data.[297] More than 500 species are known to have already become extinct, though the actual number may be far higher.[298] One comprehensive review has identified 30 critically endangered, 58 endangered, and 38 threatened ecosystems nationwide, in which biodiversity losses were assessed as 70–98% from natural levels.[299]

The third factor is shortened life spans. The average lifespan of species has declined from millions of years seen in the oldest fossil records, to thousands of years in the last century, to a projected hundreds of years in the foreseeable future.[300] *Many scientists are calling the current period of biodiversity decline the "sixth mass extinction" in the Earth's history. For the first time this mass decline is being attributed largely to humanity's influence on the natural world.*[301]

Many of the natural "services" on which life depends (such as pollination, soil fertility, water filtration, climate and water cycles, and medicinal values) are directly linked to particular ecosystems, habitats, or plant and animal species. Even the disappearance of one species can have far-reaching effects. For example, the loss of one wintering site in Mexico, or the milkweed plant in the U.S., can eliminate the Monarch butterfly entirely. This can happen when endemic species (those that are native to certain very limited areas on the planet) lose their specialized habitat or food source.[302]

Places where the number and variation of species is greatest and where there is significant population growth and human activity like development represent the nation's "biodiversity hotspots". Efforts in these areas to conserve biodiversity demonstrate the ongoing tension between human demands for land and resources and the maintenance of natural systems. One comprehensive study of the threats to nearly 2,000 imperiled species nationwide found more than 50% were affected by development, 40% by agriculture, 30% each by outdoor recreation and water development, and over 20% each by logging/mining and livestock grazing.[303]

Four major population-related trends affecting biodiversity include:[304]

- **Habitat loss, fragmentation, and degradation**
- **The spread of non-native (invasive) species**
- **Pollution**
- **Climate change**

Habitat loss, fragmentation, and degradation

The number one cause of biodiversity decline in the U.S. is habitat loss, from land-use changes or extraction of timber, water, and energy resources. Most (85%) of the species known to be at risk of extinction in the U.S. are in this situation because of habitat loss and alteration.[305] An estimated 27 ecosystems have lost almost all of their area in the last 500 years, while 50% of the continental U.S. can no longer support its original vegetation.[306]

Habitat fragmentation – when contiguous blocks of land are divided by development, agriculture, or roads – is often a first step in ecosystem decline. Fragmentation makes it difficult for species that need undisturbed or large territories to find mates and sufficient food to survive.[307] It also takes a toll on large predators because they play essential roles in regulating the numbers, diversity, and behavior of species down the food chain.[308] In much of North America, for example, white-tailed deer and raccoons have become overabundant in the absence of their predators, resulting in the disruption of plant communities. This in-turn eliminates the primary food source for some species of birds and small mammals, and has helped to spread diseases such as Lyme disease.[309]

Biodiversity loss or degradation of aquatic ecosystems is also a factor, affecting entire food chains, from microorganisms in the water to fish and large mammals. Less than 2% of the cumulative miles of U.S. rivers and streams remain free-flowing because of the building of locks and dams, a practice that also alters flow, temperature, nutrient content, and the ability of species to disperse.[310]

Wetlands provide irreplaceable habitat for many birds, amphibians, and reptiles, and are also declining – half of all America's wetlands have been lost since colonial times (see Box, page 25).[311] Rapid residential and commercial development along the nation's coasts results in the annual loss of 20,000 acres of wetland ecosystems' coastal marshes, which act as nurseries and hunting grounds for a large variety of species.[312]

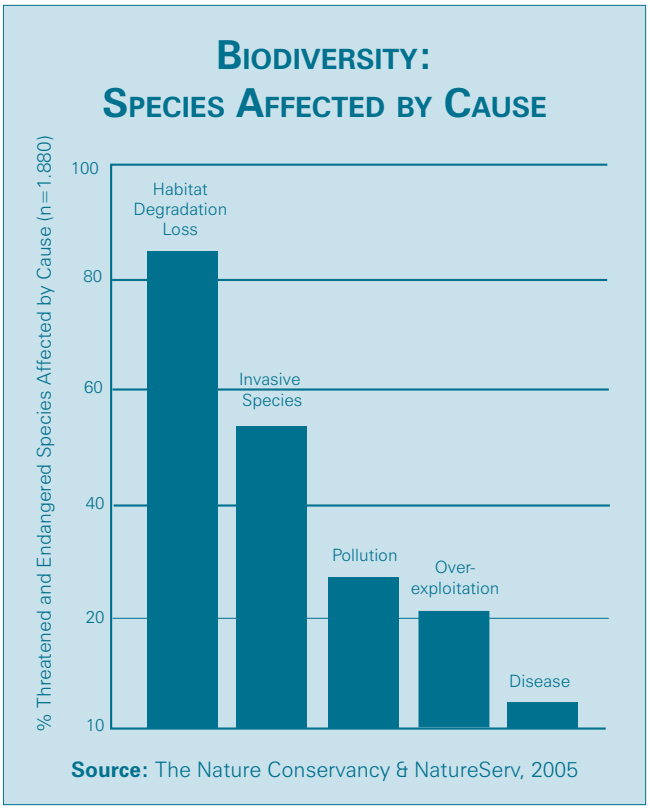
Non-native, invasive species

The introduction of "invasive" plant and animal species (ones that are not native to a particular area) *is another major cause of biodiversity loss.* Invasive species contribute directly to the decline of 49% of the threatened and endangered species in the U.S. Only habitat loss poses a greater threat.[313] The sudden introduction to a new landscape of a foreign species, one free from natural competitors and predators, can cause ecological chaos.

Invasive species are appearing in the U.S. at unprecedented rates. Some are introduced intentionally by people, including the purple loosestrife, scotch broom, and water hyacinth brought in by gardeners planting the species for their showy flowers. Anglers and game managers introduced the flathead catfish to rivers beyond its native range, and it is now making easy prey of some of America's most endangered native fish.

Others take hold accidentally, in the ballast of ships or in shipping crates or other means. For example, a Caspian Sea tanker dumped its ballast water, along with the Asian zebra mussel, into the Great Lakes a little more than a decade ago. Now the tiny mussels threaten to smother 140 native mussel species, and waterfront industries, like dams and power plants, must pay billions in on-going repairs to clogged pipes while passing the cost to consumers, and then spread to 20 U.S. states.[314] The Asian longhorned beetle hitchhiked to New York, New Jersey and Chicago in solid wood packing crates from China, where it escaped and has prompted the cutting, chipping, and burning of over 8,000 street and yard trees at considerable cost. The beetle attacks maples and other hardwood species, threatening the timber, maple syrup, nursery, and fall foliage tourism industries across the Northeast.[315]

Nearly 63% of Hawaii's species are now at risk, a higher proportion than any other state, mainly from invasives. Today over a third of Hawaii's plants are non-native. The state receives 20 new non-native species annually, resulting in a continued battle to try and save native flora and fauna.[316]



Pollution

Human activities can also affect biodiversity through high amount of various forms of pollution, affecting water, soil and the atmosphere. Such pollutants enter aquatic and terrestrial ecosystems through water, from toxic pollutants (like mercury lead, pesticides, and herbicides), increased nutrients (like nitrogen and phosphorus from city sewage and fertilizers from agricultural areas and animal feed lots), solid pollutants (like plastic bags, plastic rings, abandoned fishing gear, and other man-made materials that result from garbage dumped on land and from shore), and oil (from tanker spills into marine environments).[317]

Soil is polluted with pesticides, solid and toxic waste, herbicides and harmful chemicals. Air pollution can take many forms, but some of the most detrimental to biodiversity are airborne mercury and acidic deposition (acid rain). Acidic deposition can cause the deterioration of aquatic ecosystems by causing the water to become more acidic, and thus affect the life that can be supported by freshwater streams. Mercury and acid rain degrade the health of soil, trees and vegetation, and lakes and streams.[318]

As pollutants accumulate up the food chain, the health and reproductive abilities of many species are compromised. For example, chemical discharge and the use of herbicides and pesticides are known to cause abnormalities in the hormones, organs, and limbs of frogs and reptiles.[319]

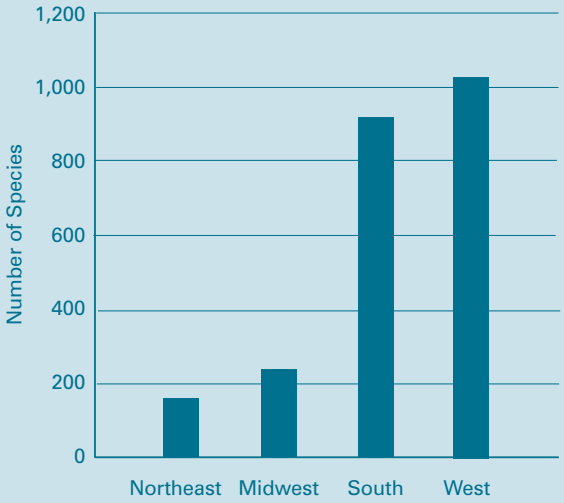
Biodiversity and climate change

A recent review of select biodiversity-rich regions worldwide (including the U.S.) predicts 15–37% of all species sampled could be extinct by 2050 because of ecological changes driven by climate change.[320] A U.S. study found that climate change is already affecting some plant and animal species. For example, some butterflies and the red fox are moving northwards in response to temperature increases in their home ranges, while egg laying among certain birds and the budding of some trees now occur earlier than in previous decades.[321]

Whether and how species are able to adjust their home ranges and migration, breeding, and feeding habits will depend on the pace and geography of climate shifts and ecological conditions, the availability and composition of new habitat, and the severity of the other threats discussed in this chapter. In addition, because all parts of an ecosystem do not adjust to ecological changes in tandem, many species could face inadequate conditions for nesting and denning and competition over habitat and prey with species already present in new ranges.

The species most vulnerable to climate change are those with habitat needs that can be met only by specific islands, streams, forests, or other micro-environments. This is already evident in the Arctic (including Alaska), where retreating sea ice makes it hard for seals and polar bears to find food. In fact, the weight and number of polar bear cubs have declined 15% in the last 25 years.[322] And the way that many trees reproduce could make large-scale adjustments difficult. For example, a temperature increase of 2°F over a period of 100 years (well within the range of current predictions) would require a one-three mile annual shift northwards in the range of some tree species if they are to survive.[323]

ENDANGERED & THREATENED SPECIES: U.S. REGIONS



Source: CEP calculation based on U.S. Fish & Wildlife Service, Threatened and Endangered Species System (TESS), 2005. (The total of regional listings far exceeds the total for the U.S. as a whole, since many species are listed in more than one region) .

Humans are also finding they have to adjust to changes in the make-up of species spurred by climate change. The Arctic Inuit native people in Alaska do not have words in their vocabulary for the robin, salmon, and hornets that are now appearing in their environments for the first time ever.[324]

Top Ten States for Biodiversity Risks

Rank	Amount of Species Diversity	Amount of Species Threatened	Amount at Risk of Extinction
1.	California	Hawaii	Hawaii
2.	Texas	California	Alabama
3.	Arizona	Nevada	California
4.	New Mexico	Alabama	Texas
5.	Alabama	Utah	Georgia
6.	Georgia	Florida	Florida
7.	Florida	Arizona	Tennessee
8.	Oregon	Georgia	Virginia
9.	North Carolina	Oregon	Kentucky
10.	Utah	Tennessee	Ohio

Source: The Nature Conservancy & NatureServ, 2002

U.S. Regional Highlights: Population & Biodiversity

Northeast

- As the most densely populated and developed region in the nation, few large, intact habitats remain in the Northeast. Its forests are relatively young, lacking the natural composition necessary to support the full range of native species it once harbored.[325]
- Many animals once native to the Northeast (such as lynx, marten, wolves, and caribou) are still scarce or "extirpated" (extinct from that region), while populations of deer, skunk, and raccoon have exploded in the absence of predators.[326]
- Mercury levels are high enough in the Northeast's habitats to contaminate species such as trout and perch, and, for the first time ever discovered, forest songbirds.[327]
- Most (90%) of southern New England's coastal "heath" habitat has been lost to commercial and urban development.[328]
- The Karner blue butterfly has declined dramatically nationwide due to agriculture, urbanization, and fire suppression, and is now extinct in New Hampshire. One of the best of its few remaining habitats is in the Albany Pine Bush, a small area in New York, which is currently threatened with development.[329]

South

- Most (seven) of the nations' top ten states in "numbers of species' extinctions" are in the South.[330]
- The South contains the most "at-risk" fish and mussel species nationwide, from habitat loss and non-native species. Many of these species exist nowhere else in the world.[331]
- Florida, North Carolina and Texas all have lost approximately 50% of their wetlands habitat in the past 200 years.[332]
- The number of birds that use coastal wetlands in the Gulf of Mexico as stopover areas (in particular Louisiana and Mississippi) has declined by half since the 1960s.[333]
- Development and road collisions have reduced the native panther population in Florida to only 30–50 individuals total.[334]
- Diverse stands of native pine and hardwoods have been converted to plantations for the South's rapidly expanding timber industry, making the region's forests younger, less diverse, and less able to support a range of species. [335]

Midwest

- Nearly 40% of native mussel species (an important food source for many animals, including ducks, fish, and otters) in the Upper Mississippi River system are gone, and 20% of those that remain are at risk of extinction.[336]
- The Central Plains tall grass prairie has declined to 4% of its original size. In the state of Illinois alone, this ecosystem has shrunk from 1 million to 2,500 acres since 1900.[337]
- In the northern Great Lakes area, timber management practices have made forests less diverse: aspen and birch now cover 80% of Minnesota's forest land, compared to 10% before logging began.[338]
- Almost all (95%) of wetland habitats in Iowa, 60% in North Dakota, and 50% in Minnesota have been drained. This affects important breeding and resting places for ducks and migratory birds.[339]
- Fish and wildlife around the Great Lakes have shown some of the region's strongest signs of chemical pollution, including physical deformities and reproductive problems.[340]

West

- Three Western states have the nation's highest percentages of species at risk: Hawaii (63%), California (29%), and Nevada (16%).[341]
- In southern California, the California gnatcatcher has lost three-quarters of its habitat to development.
- About 90% of the state's coastal sage ecosystem, which supports many small mammal and bird species, has been severely degraded by urban sprawl.[342]
- At least 30,000 salmon died in California's Klamath River basin in 2002, from low water flows – in large part the result of dams and other water diversions to support agriculture.[343]
- The coastal plain of Alaska's Arctic National Wildlife Refuge, currently the focus for oil and gas development, supports some of the world's richest biodiversity, including a 130,000-strong caribou herd, and 135 bird species.[344]

U.S. Population-Environment Challenges

Fisheries and Aquatic Resources

America's inland freshwater, coastal and marine fisheries represent a wealth of aquatic resources and ecosystems. They provide an important source of food, livelihood and recreation for millions of people nationwide, and contribute significantly to the nation's overall economic activity. Yet as the human population and its food and living demands increase, the nation's aquatic resources have become more vulnerable, and their limits more apparent.

The U.S. population's link to aquatic resources is manifested in several ways, through the amount and kind of fish and seafood a growing number of people consume (and how the seafood is caught); rapid land development in and around watersheds, wetlands, and coastal habitats; and pollution from human activities. Although fish stocks and other aquatic species and ecosystems can sometimes recover from such human-induced impacts, it is much more difficult when they occur relatively rapidly and consistently over time as is the case today.

National Overview: U.S. Population, Fisheries, and Aquatic Resources

Inland Freshwater Fisheries

The U.S. has an extensive network of inland rivers, lakes, wetlands and other freshwater aquatic habitat (including 4 million miles of rivers and 42,000 acres of lakes).[345] There are over 100 million acres of wetlands in the lower 48 states, and almost double that in Alaska alone.[346] A vast array of fish and wildlife species utilize these wetlands and freshwater ecosystems during some part of their life cycle for breeding, feeding or migration habitat. About 43 percent of federally threatened and endangered fish and wildlife species rely on wetlands for their survival.[347]

In fact, on an acre for acre basis, the nation's freshwater ecosystems are richer in species than the more extensive terrestrial and marine ecosystems. These areas have also lost a greater proportion of their species and habitat.[348] This is in part because *about 25% of the country's riparian areas have agricultural or urban sites* – and the development, runoff, and waste associated with them – *within 100 feet of the water's edge.*[349]

Nationwide, about a third of freshwater animal species are now considered to be "at risk," [350] including 40% of freshwater fish and amphibian species and 50% of crayfish. Two-thirds of America's freshwater mussels are at risk of extinction, and almost one in ten may already be extinct.[351]

Coastal and Marine Fisheries

The rich aquatic resources along America's 12,000 mile coastline and in 90,000 square miles of estuaries include coastal wetlands, coral reefs, sea grasses and shellfish beds.[352] They are key habitat for many species of fish, crabs, seabirds and other aquatic organisms.[353]

U.S. coastal areas are also home to more than half (51%) of the U.S. population, in less than one-fifth (17%) of the nation's land area (excluding in Alaska).[354] Population density along the coasts is about five times the national average.[355] An additional 25 million people, accounting for about half of the projected U.S. population increase, are expected to move to these areas in the next decade alone.[356] Over 180 million people visit the shore for recreation every year.[357]

The aquatic resources in America's fresh and saltwater ecosystems face four key population-related challenges:

- **Loss of aquatic habitat**
- **Pollution**
- **Non-native, invasive species**
- **Over-harvesting and consumption**

Loss of aquatic habitat

The high amount of human activity linked to the nation's inland freshwater resources has many impacts on its aquatic ecosystems. Among them is the erosion of river and stream banks due to residential and commercial development and agricultural, mining, and livestock operations. This results in sedimentation of bodies of water that reduces the depth and flow of water courses and raises water temperature, causing a drop in oxygen levels and making it impossible for many aquatic species to survive.

Re-routing of rivers and streams for flood control, agricultural production, and commercial transportation is also important. These activities alter wildlife's migration, breeding, and feeding patterns, and can either drain complex habitat like wetlands, or convert them into open water. By the 1990s, *an estimated 60% of U.S. streams and rivers had been truncated, causing major changes in size and level of flow.*[358]

Damming of waterways for hydropower, irrigation, reservoirs, and recreation is also an issue. America's 5,000+ large and tens of thousands of small dams cause less than 2% of the nation's total river miles (about 40 rivers longer than 125 miles) to be free-flowing.[359] Dams are a key factor behind the decline of species such as salmon, steelhead trout, and sturgeon because they hamper seasonal migrations between oceans and rivers.

Coastal development and sprawl destroy and endanger coastal wetlands and estuaries that are nurseries for many fish species. Over 20,000 acres of such habitats disappear annually. Paved surfaces create conduits for oil, grease, and toxic pollutants into coastal habitats. Every eight months, about 11 million gallons of oil run off into oceans – the equivalent of the Exxon Valdez oil spill. [360]

U.S. Population-Environment Challenges

Pollution

Much of human activity – from vehicles driven to the products and foods consumed – causes some form of *solid or airborne waste* which often makes it way into the nation's inland and coastal aquatic ecosystems. Ultimately, aquatic species are often affected and their habitats altered, sometimes irreversibly.

Pollution affects aquatic resources in a variety of ways, including through the runoff of fertilizers, hormones, and pesticides from agriculture and livestock operations, toxic waste from industry, and heavy metal residue from mining. Household chemicals are poured down drains, lawn care products wash into water systems, and vehicle products (such as antifreeze and oil) run off from roads and parking lots.

Nationwide, the monitoring of rivers, streams, and estuaries frequently reveals contaminant levels high enough to affect many organisms. About 60% of monitored estuaries have contaminant levels that might harm fish or wildlife, and 2% have levels that probably will harm them. A fifth of all estuarine bottom-dwelling organisms, an important food source for fish species, are considered degraded.[361] There is mounting evidence of the harmful effects of herbicides, industrial chemicals, and pharmaceuticals on human health and the reproductive functions of aquatic species, such as frogs and alligators.[362] Recent findings in the nation's East coast show that many fish species are changing their internal organs from male to female as a result of hormones and other chemicals discarded into the water.[363]

When large amounts of nitrogen and phosphorous (key components of agricultural and household fertilizers, herbicides, pesticides, and human sewage) reach water bodies, aquatic vegetation – such as algae – grows rapidly, consuming available oxygen in the water. This severely reduces the amount of oxygen available to fish and other organisms. This *eutrophication already affects half of U.S. estuarine waters.*[364] When oxygen is completely absent, hypoxia sets in, as dramatically illustrated by the growing number of "dead zones" in coastal areas, from the Gulf of Mexico to the Pacific Northwest.[365] Hypoxia has been recorded in nearly 40 coastal areas since the 1970s.[366]

If current trends continue, the amount of nitrogen flowing into U.S. coastal waters in 2030 will be 30% higher than today, and more than double what it was in 1960.[367]

Airborne pollution from such sources as acid rain (which hampers the ability of freshwater fish to breathe) and mercury (accumulates up the food chain from fish to predatory birds or humans) also affects aquatic systems.[368] *About 35% of lakes, 24% of rivers, all of the Great Lakes, and 65% of the U.S. coastline were under a fish consumption advisory in 2004.*[369] *That year, more than 75% of nation's fish advisories were related to mercury contamination.*[370]

Non-native, invasive species

Non-native, invasive aquatic species crowd out native species and alter habitats and food webs in inland and coastal areas. Of the 374 documented invasive species in U.S. waters, 150 have arrived just since 1970.[371] Over 175 introduced species live in the San Francisco Bay alone. About a million Atlantic salmon escaped farm pens on the West coast and are now reproducing in Canada and

Top Ten States for Imperiled Freshwater Fish

Rank	State	% Fish Species Imperiled	State	# Fish Species Imperiled
1.	Arizona	63%	Tennessee	66
2.	Utah	58%	Alabama	61
3.	Nevada	52%	Georgia	51
4.	California	42%	Virginia	41
5.	New Mexico	30%	North Carolina	39
6.	Oregon	24%	Texas	39
7.	Tennessee	23%	Kentucky	30
8.	Idaho	22%	California	28
9.	Alabama	21%	Nevada	28
10.	Texas	21%	New Mexico	25

Source: Figures from Master, L., et al, Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity, and the Nature Conservancy.

Note: The southeastern states have the highest number of freshwater fish species, while the western states lead in the proportion of their species that are extinct or threatened.

hybridizing Pacific salmon.[372] The non-natives arrive on commercial ships, through fish farms, discarded home aquariums, and through the stocking of rivers and streams with non-native fish for recreational fishing.

Overharvesting and consumption

As the human population grows and demand for fish and seafood increases, stocks of ocean resources are being severely reduced. Many ecologically and commercially crucial fish species (including groundfish and salmon populations along the Atlantic and Pacific coasts) face overfishing and other threats. *Today, thirty percent of assessed fish populations in U.S. coastal waters are either overfished or fished unsustainably.*[373] *The population trends of certain U.S. fish stocks show that 40% are shrinking, while only about 20% are expanding.*[374]

There are several trends associated with the decline in aquatic resources and overfishing, including U.S. food consumption patterns. The average U.S. resident consumed nearly 17 pounds of fish and seafood in 2004, up from 14 pounds 20 years earlier.[375] Taking all fish and fishery products together, per capita annual consumption is 47 pounds in the U.S., compared to the same level in Europe, 31 pounds in developing countries, and 36 pounds for the world.[376]

As stocks of high-demand species (such as swordfish, tuna, flounder, and cod) decline, it has become common to capture juvenile and reproductive-age individuals. Over time, this intensive fishing practice can decimate entire stocks and stymie the recovery of species. In addition, the imbalance in marine ecosystems is exacerbated by the practice of "fishing down the food chain" – as certain species disappear, others are fished instead, eventually affecting species down the entire marine food chain.

Another trend associated with stock decline is excess fishing capacity in commercial fishing fleets, where virtually no valuable stocks are left unharvested. Modern technologies have made it easier to locate fish, capture them, and enter previously inaccessible areas. The practice of trawling along the ocean bottom destroys entire habitats, while the use of lines and nets hundreds of miles long quickly reduces fish populations and kills many more aquatic species than those targeted.[377]

Incidental capture of species also endangers already depleted species such as sea turtle, marine mammals such as dolphins and seals, seabirds, and noncommercial fish populations.

Fish Farming

Demands for more fish and seafood have spurred the expansion of inland and coastal aquaculture and mariculture activities. There are more than 4,000 fish and seafood farms nationwide, concentrated in the South and along the West and Northeast coasts. The production of the most popular species has risen dramatically since the late 1980s, including striped bass by 800%, Atlantic salmon by 500%, clams by 400%, and shrimp by 200%.

Fish farming has many dietary and economic benefits, but can take a severe environmental toll. An estimated 70-80% of the nitrogen and phosphorous fed to farmed fish ends up in aquatic and marine systems. A farm with 200,000 salmon produces the same amount of fecal matter as a city with 65,000 people. In addition, the harvesting of wild fish to produce feed for farmed species reduces certain populations and the food available to marine wildlife. For example, it takes 2–3 pounds of wild fish to produce a pound of farmed shrimp or salmon.

When farm-raised fish escape from ocean pens they often interbreed with, and alter, the genetic make-up of their wild counterparts, and they often spread disease. The same problems arise in freshwater ecosystems stocked with non-native species to enhance recreational fishing.[378]

U.S. Regional Highlights: Population, Fisheries & Aquatic Resources

Northeast

- Ten of 13 fish species tested in the Northeast have mercury levels above federal health and environmental thresholds.[379]
- Following decades of over fishing, New England's famous cod industry reached the brink of collapse in the 1990s. Although it is now highly regulated, by 2002 the Georges Bank cod stock was still only 15% of historic population levels.[380]
- Fourteen major Northeast estuaries are considered "highly impacted" due to excessive nitrogen, resulting in the decline of seagrass beds and periodic fish kills.[381]
- The wild Atlantic salmon was declared an endangered species in 2000 because of the drastic reduction in the number of individuals migrating back to rivers to breed and escaped farmed salmon inter-breeding with wild populations.[382]

South

- Nearly half of all imperiled U.S. fish and mussel species are in the South – the Tennessee-Cumberland River basins, the Mobile River basin, and the Interior Highlands.[383]
- Only about 10% of the Chesapeake Bay's original seagrass beds remain, a key factor in the sharp decline of oysters and crabs.[384]
- The Gulf of Mexico provides about 18% of the U.S. annual fish catch, yet is severely degraded by development and pollution. Every year, a dead zone of several thousand square miles is recorded in the Gulf at the mouth of the Mississippi River, which carries high levels of agricultural runoff to the area.[385]
- Louisiana alone loses 24-40 square miles of coastal land per year to development and land subsidence.[386]
- About 80% (more than 300,000 acres) of the freshwater nationwide that has been converted to aquaculture is in the South.[387]

Midwest

- Half of the nearly 80 known species of mussels in the Midwest are classified as endangered, threatened, or of special concern.[388]
- The Midwest issued nearly 1,800 fish consumption advisories, far more than any other region, in 2004. The largest numbers were in the Great Lakes states and Indiana.[389]
- In just three years (1995–1998), 250 manure spills from farms in five states bordering the Upper Mississippi River killed over 3 million fish.[390]
- In the Platte River Basin of Missouri, channelization has eliminated 250 stream miles of aquatic habitat and reduced fishery production.[391]

West

- The coastal populations of California and Washington states grew by about 50% and Alaska's by more than 60%, between 1980 and 2003.[392]
- Diversions and dams have reduced the natural flow of the Colorado River by one-third. More than 40 non-native fish species have been introduced into the upper Colorado basin.[393]
- The species of wild salmon in the Pacific Northwest and California have declined 90% on average in the last 100 years, due mostly to the presence of large dams.[394]
- Along the Pacific coast, salmon are now gone from 40% of their natural range and stocks are endangered or threatened in another 30%.[395]

Agriculture

American agriculture provides the nation and the world with numerous food products, contributes to the U.S. economy, and has enormous cultural advantages. The nation's farmlands also provide ecological benefits such as clean air and water, flood control, groundwater recharge, carbon sequestration, and wildlife habitat.

The nation's population dynamics are linked to its agriculture through the number of people, and the type and amount of food they choose; whether food production and processing uses chemicals and fertilizers; and the amount of land and water required to grow and irrigate crops.

National Overview: U.S. Population and Agriculture

About 40% of all U.S. land area (940 million acres) is used for agriculture, primarily as cropland and pasture-land.[396] Most of this is considered productive land or is used for infrastructure to support agriculture. Under 4% of all farmland is set aside as part of conservation and wetlands reserve programs.[397] More than 18% of U.S. land area is devoted solely to arable and permanent cropland, compared to about 13% in Europe, 12% in developing countries, and 11% for the world as a whole.[398]

U.S. agricultural products are used to feed not only Americans, but also the world. American exports account for more than half of the volume of global trade in grains, a quarter in wheat and pork, and a third in poultry.[399] Asian, African, and Latin American countries are the largest importers of U.S. agricultural products.[400]

U.S. agriculture weighs in on both sides of population's environmental impacts. On the one hand, agricultural land and small family farms are at risk from extensive, rapid land development across the country, government subsidies, large factory farms, and other factors. *On the other, large systems of chemically-based agricultural production* threaten terrestrial and aquatic ecosystems and human health.

Population's impact on agriculture in the U.S. results in three main trends:

- **Loss of farmland**
- **Food consumption and production patterns**
- **Pollution, erosion, irrigation**

Loss of farmland

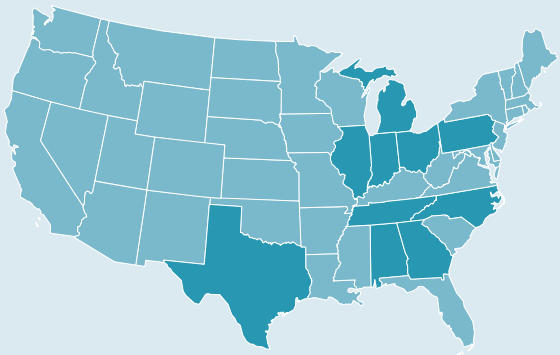
One of the most obvious, widespread changes in the U.S. agricultural sector in relation to population is the loss of farmland. This is due in large part to the fast increasing development for housing and commercial areas in suburban and surrounding areas across the country.

Agricultural land is generally seen as being desirable for development because it is relatively flat, well-drained, expansive, and more affordable for residential and commercial developers than other potential development sites.[401] *Development pressures and increased urbanization raised the monetary value of U.S. farmland by 25% during the 1990s.*[402] With demand for developable land steadily increasing, farmers are under growing pressure to sell. Nearly 3,000 acres of U.S. farmland are lost every day to various forms of development.[403] And the rate of loss is accelerating – 1.2 million acres were lost annually from 1992-1997, a rate over 50% higher than 1982-1992.[404]

Over the past two decades alone, cropland acreage in the country declined by about 12% percent (more than 50 million acres), while the acreage of non-federal land used for livestock grazing dropped 5% (more than 30 million acres).[405] Often the first land to go is the best quality. *In the past ten years, America's prime farmland was developed 30% faster than other types of rural land.*[406]

Top Ten States: Loss of Prime U.S. Farmland

1. Texas
2. Ohio
3. Georgia
4. North Carolina
5. Illinois
6. Pennsylvania
7. Indiana
8. Tennessee
9. Michigan
10. Alabama



This map shows the top ten states losing the most prime farmland in the U.S. Every minute the U.S. loses two acres of farmland, and farm and ranchland was lost 51% faster in the 1990's than in the 1980s. The rate of conversion of "prime farmland" was 30% higher, proportionately, than the rate for "non-prime rural land" from 1992-1997. This results in marginal land, which requires more resources like water, being put into production.

Source: American Farmland Trust, *Farming on the Edge,* 2000

Food consumption and production patterns

As the U.S. population grows, so does the country's agricultural requirements to feed increasing numbers of people. The average American accounted for food production worth 3,800 calories per day in 2000, 800 calories more than in the 1950s.[407] This compares to 3,300 calories per person daily in Europe, 2,700 in developing countries, and 2,800 for the world.[408]

Each American consumed nearly 60 more pounds of meat, poultry and fish, and 45 more pounds of flour and cereals in 2000 than in the 1950s.[409] Fruit and vegetable consumption per capita rose 20% in the past three decades, while the use of oils, eggs, and cheeses is also on the rise.[410] Today, nearly 30% of U.S. food consumption is met with animal products, a dietary preference that has a strong environmental impact because it requires large amounts of natural resources. Per capita annual meat consumption was nearly 300 pounds in the U.S., compared to 160 pounds in Europe, 60 pounds in developing countries, and 90 pounds for the world as a whole (in 2000).[411]

Loss of small family farms and rise of large-scale agriculture

The combined pressures of producing larger amounts of food and declining market prices for some products (largely a result of increased global competition and expanded world markets) are changing the way agricultural commodities are produced. For much of its history, U.S. agriculture was dominated by small family farms. In recent decades, however, this trend is giving way to larger farms, including many that are either directly run by or operated under contract to large agribusinesses.

In the last several years the proportion of small to mid-size farms (100–2000 acres) with mid-range earnings ($10,000–$500,000) has gone down as the proportion of very large, high-earning farms (more than 2,000 acres and $500,000) has risen.[412] *Although small, family-owned farms still account for the most number of farms, their share of the value of U.S. agricultural production fell by nearly one-third between 1993 and 2003.*[413] During this same period, *the number of large farms rose by nearly half and increased their share of production from 33% to 44%.*[414]

Overall, modern-day agricultural operations have become more specialized and consolidated to keep up with population growth and food demands. By one estimate, *at least half of all agricultural products produced in the U.S. come from just 2% of farms.*[415] For example, although nearly 450,000 hog farms have shut down since the mid-1980s, the number of hogs raised has remained about the same, while just ten companies produce more than 90% of U.S. poultry.[416]

The current trend of large-scale, mechanized agriculture has a significant environmental impact because, compared to small-scale, less industrial farming, it converts more land area, degrades soils more intensively, and pollutes more surface and groundwater. In addition, extensive irrigation practices on agricultural land have become critical issues, particularly in more arid parts of the country.

Pollution, erosion, irrigation

As large-scale U.S. agriculture focuses on meeting a growing population's demands for food, pressures on the limited agricultural land increases. One way to boost crop yields, or, grow more food on less land, is to apply pesticides, herbicides, and fertilizers that maintain output, and prevent crop damage.

Although some efforts are underway to reduce agro-chemicals, the overall amount applied to the land continues to rise. *The tons of fertilizer used nationwide grew almost 16% from 1972 to 1992, and another 11% by 2002.* The U.S. accounts for nearly 40% of all fertilizer use worldwide.[417] Potatoes (the most chemical-intensive field crop) used about 220 pounds of nitrogen and 180 pounds of phosphate per acre, while corn uses nearly 140 pounds of nitrogen, and 60 pounds of phosphate, per acre.[418]

Wherever agro-chemicals are used intensively, land and water pollution can result. Soils often become overloaded with nutrients, which then leach into groundwater supplies and run off into streams and rivers and eventually into coastal waters. The result is increased vegetative growth, toxic algal blooms, and areas where oxygen is too limited to sustain aquatic life.

To meet the population's increasing demands for food products, Concentrated Animal Feeding Operations (CAFOs) are used to provide large amounts of meat and poultry efficiently and cheaply. However, in order to do that, they utilize chemicals, antibiotics, and animal confinement. With thousands of chickens, hogs, and cattle per operation, "factory farms" produce nearly 1.5 billion tons of nitrogen and phosphate-laden waste each year. It collects in huge lagoons and pits, contaminating an estimated 27,000 miles of rivers and groundwater nationwide.[419]

Modern livestock production is also increasingly associated with air pollution. The decomposition of animal waste at CAFOs and the release of dust and toxic pollutants (such as ammonia, hydrogen sulfide, and volatile organic compounds) can travel hundreds of miles when airborne.[420]

Modern, mechanized agriculture also results in soil loss and erosion. In contrast to the formerly common practices of rotating crops and allowing some fields to lie fallow in order to regenerate, current large-scale agriculture emphasizes monoculture production, or the planting of a single crop over large areas, year after year. As a result, soil nutrients are depleted more quickly than when diverse crops are rotated, and pests attracted to specific crops can easily invade an extensive area. *Erosion on U.S. farmland is estimated to occur seven times as fast as soil formation.* Rich topsoil is not an easily renewable resource – one inch of organically rich topsoil requires decades, even centuries, to form.[421]

Agricultural activities also use large volumes of water for irrigation. Agriculture currently accounts for 80% of non-rechargeable water use in the U.S.[422] Irrigation is the second-largest source of total water use (after thermoelectric energy), accounting for one-third of all water withdrawals in 2000.[423] Although the amount of irrigation water used per acre has declined, *the amount of irrigated cropland has increased by 30% in the past three decades.*[424] Currently, about 12% of the country's cropland is irrigated, up from 10% a decade ago.[425] The result is increasing competition for water resources, pitting urban areas against farmers, farmers against ranchers, agriculture against industry, and all withdrawals for human use against the needs of ecosystems and wildlife.

Agricultural demands on water have also increased along with consumption of animal products. One recent comprehensive analysis estimated that it takes 11,000 gallons of water to produce a pound of beef, 400 gallons for a pound of chicken, and 240 gallons of water for a pound of wheat or soybeans. In addition, *an estimated 50% of U.S. grain is used to feed livestock.*[426]

While modern agriculture can have a number of detrimental impacts on the environment, a large portion of producers are good stewards of the land. Through U.S. Department of Agriculture conservation programs, farmers and ranchers are implementing conservation practices in order to increase the public environmental benefits derived from their land. Unfortunately, three out of four producers who applied for these programs in 2004 were denied due to insufficient funding.[427]

Organic Agriculture

Although about 0.5% of all cropland and pastureland nationwide was certified as organic in 2003, this agricultural sector is growing rapidly.[428] Organic acreage increased by more than 60% (nearly 1 million acres), and the number of certified organic farming operations jumped from 40 to over 8,000, between 1997 and 2003.[429] In addition, the number of animals being raised organically grew almost 200% (almost 6 million) between 2000 and 2003.[430]

The number of local "farmers markets" nationwide also increased by 117% between 1994 and 2004.[431] As market demands for locally grown and organic food increase, such practices are proving to be more profitable for small farmers, better for soil maintenance and water quality, and healthier for the consumer. The sale of organic products in major supermarkets nationwide has also seen tremendous growth in recent years.

Farming in California

California is by far the top agricultural producer and exporter in the U.S. With 1999 production values reaching $26.7 billion, California produced more than the nation's second (Texas) and third (Iowa) agricultural states combined.

California is also the nation's most populous state (over 34 million people), and one of the fastest growing. The U.S. Census Bureau says California will grow by both the greatest number of people and the largest percentage through the year 2020. Much of the growth will take place in agricultural regions of the state. For example, the Central Valley is expected to expand from a population of 4.5 million, to 10 million people by the year 2040.

The presence of high human populations on or near California's agricultural areas takes, and will continue to take, its toll. Three such sites are among the nation's twenty most threatened farming regions: the Central Valley (1st), Central California Coastal Valleys (15th) and the Imperial Valley (17th). Conversion of agricultural land to urban development is still occurring at a rapid rate in the state – it lost approximately 500,000 acres of farmland to urban development between 1988-1998. The state's San Joaquin Valley is one of the most productive agricultural regions in the country. Yet, just 60 miles east of the San Francisco Bay area, it also is one of the most threatened areas.[432]

U.S. Regional Highlights: Population & Agriculture

Northeast

- The Northeast has specialized agricultural markets, such as mushrooms in Connecticut, dairy and maple products in Vermont, apples in New York, and berries in Maine. Most Northeastern farms are relatively small, with about 94% 500 acres or less.[433]
- New York lost nearly 90,000 acres of prime farmland to development during 1992 to 1997, a rate 140% faster than in the previous five years.[434]
- Agriculture is the second leading cause of pollution in Pennsylvania's rivers and streams, primarily because of siltation and nutrient loading.[435]
- Agricultural activities impair more than 500 miles of streams and nearly 2,000 acres of lakes in Vermont, and Lake Champlain, which receives about 500 tons of phosphorous waste annually, has sections considered "biologically dead" because of pollution.[436]

Midwest

- The Midwest, the nation's "breadbasket", is the most prolific agricultural region. Four central Midwestern states (IA, IL, NE, and MN) together produce more than 50% of the nation's corn,[437] 80% of its soybean, and 70% of its hogs.[438]
- Illinois was the nation's third highest state in terms of prime farmland loss in the 1990s. At a rate 140% more rapid than in the previous five years, it lost more than 160,000 acres of prime farmland to development from 1992-1997.[439]
- Michigan, Ohio, and Indiana together have lost nearly 500 acres of farmland daily, to development in recent years.[440]
- The number of Iowa and Nebraska farms declined by over 6,000, and Missouri farms by nearly 3,000, between 1998 and 2002.[441]
- Small Wisconsin dairy farms declined by 28% over the past decade, while large farms with more than 1,000 dairy cows increased 23 times.[442]
- About 13% of drinking water wells in nine Midwest states contain nitrates (a by-product of livestock manure lagoons) at levels above those considered safe for human consumption.[443]

South

- The South accounts for more than 40% of all U.S. farms.[444] It is America's "cotton belt," key for soybean crops, and produces 20% of the nation's hogs.[445]
- The South contains 11 of the 20 U.S. states considered to be most threatened with the loss of prime farmland.[446] Texas lost more than any other state – over 330,000 acres, at a rate of loss between 1992 and 1997, 42% higher than in the previous five-year period.[447]
- Pesticides are applied to cotton at 3-5 times the level per acre as for corn or soybeans.[448] In 1995, runoff from Alabama cotton fields killed 240,000 fish along a 16-mile stretch of a creek that flows into the Tennessee River.[449]
- Agricultural runoff is the primary source of pollution in the Chesapeake Bay, contributing 40% of the nitrogen and 50% of the phosphorous entering the Bay. This form of water pollution causes "dead zones", so low in oxygen they can no longer support aquatic life there. [450]
- Texas has the most certified organic pasture and cropland acreage in the U.S. by state.[451]

West

- The arid West supports a strong agricultural sector largely due to extensive irrigation. California (the nation's "fruit basket") alone uses one-quarter of the country's irrigation water.[452]
- Most Western irrigated land is located in places that receive less than 20 inches of rain annually, unable to support crops without irrigation water.[453]
- Residential development in seven western mountain states threatens to overtake 11% of the region's ranchland by 2020.[454]
- California lost 85,000 acres of its prime farmland, at a rate 15% faster than the previous five years, between 1992 and 1997.[455]
- Some 80% of the West's streams and riparian areas are impaired by livestock grazing, which destroys vegetation, deposits polluting waste, and causes sedimentation.[456]
- Livestock production in the West has become consolidated – the number of Montana hog farms declined by 40%, yet the number of animals declined less than 3%, between 1990 and 1995.[457] In South Dakota, the number of large-scale livestock operations permitted by the state rose from 35 in 1997 to 94 in 1998.[458]

Energy

Today, almost every facet of modern American life is dependent on some form of energy. It is used to heat and cool homes and buildings, power vehicles, and supply electricity. Yet, securing sufficient energy to meet the demands of the country's growing population is a major challenge. As America's per capita energy consumption increases, demands come up against the nation's ability to provide healthy, sustainable energy sources.

Population is linked to energy through the type and amount of energy sources used, and the waste products generated. Two aspects of energy relate to these trends: energy production to keep up with rising demands, and energy consumption. Both have significant environmental impacts on the air, water, and land.

National Overview: U.S. Population and Energy

Energy is generated from non-renewable fossil fuels (such as coal, oil, and natural gas), renewable sources (such as wood, biomass, wind, waves, and the sun), and nuclear power.

The U.S. consumes almost 25% of the world's energy, yet is home to less than 5% of the global population.[459] U.S. energy consumption reached 2.3 billion metric tons oil equivalent, compared to about 10 billion metric tons for the entire world, in 2001. In contrast, Asia, the most populous continent with 3.6 billion people (12 times the U.S. population), consumes just 3 billion metric tons per year.[460] *On a per capita basis, Americans consume nearly 8,000 kilograms of oil equivalent (kgoe), compared to 3,600 by Europeans and 900 by Asians.*[461]

High U.S. consumption levels in comparison to the rest of the world can be attributed to several factors. These include high energy use in homes, offices, stores, and factories, heavy reliance on motor vehicles for personal and commercial purposes, and relatively long distances over which electricity and raw energy have to be transmitted and transported (such as oil and gas from Alaska and Canada to the lower 48 States).

Most (86%) of U.S. energy comes from a combination of oil and natural gas.[462] Nearly one-third of America's overall energy demand is met by imports.[463] About 60% of the oil consumed in the U.S., and 20% of the natural gas supplies, are imported. Coal supplies are extracted domestically and are expected to continue to surpass demand for decades to come.[464]

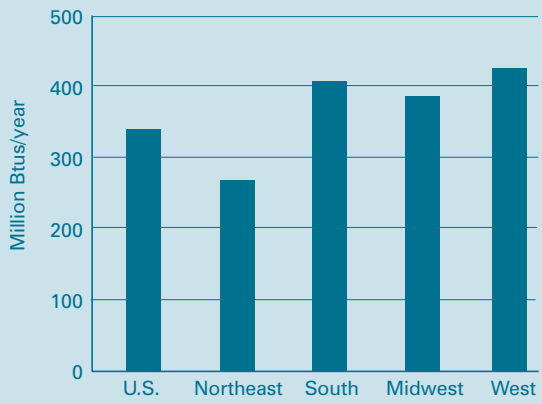
The U.S. consumes more than 20 million barrels of oil a day, with almost half used to produce gasoline for motor vehicles.[465] About 32% of U.S. energy consumption is used for road transport, compared to 19% in Europe, and 15% in developing countries.[466]

U.S. States
Energy Consumption Per Capita, 2001

Rank	State	Million Btus/year
1.	Alaska	1,164
2.	Wyoming	890
3.	Louisiana	784
4.	North Dakota	640
5.	Texas	564
6.	Kentucky	462
7.	Indiana	457
8.	Oklahoma	444
9.	Alabama	435
10.	West Virginia	423

Source: US Census Bureau, 2004

U.S. Regions
Energy Consumption Per Capita, 2001



Source: US Census Bureau, 2004

Transportation is the fastest growing energy use sector in the nation, and is expected to continue to grow at an annual rate of increase of about 2% through 2025.[467] In comparison, residential energy consumption (for such purposes as heating, cooling, and electricity) is projected to grow less than 1% per year through 2025, with much of this due to a rise in use of computers, other electronic products, and appliances.[468]

U.S. Population-Environment Challenges

The U.S. population's energy use results in two primary environmental consequences:

- **Air pollution**
- **Degradation of land, water, plants and wildlife**

Air pollution

A rise in airborne pollution is directly linked to growing populations and their energy use – as demand increases, more fossil fuels are extracted, transported, refined, and burned to meet the demand, and more airborne contaminants are produced.

The most common by-product of burning or processing fossil fuels is carbon dioxide (CO_2), the primary greenhouse gas. *The U.S. is the largest CO_2 emitter in the world, accounting for nearly one-quarter of total global emissions.*[469] At current consumption rates, *the U.S. is projected to use 43% more oil and emit 42% more greenhouse gases than current levels by the year 2025.*[470]

Industry and transportation represent the highest energy-use sectors in the country. Passenger vehicles and heavy trucks accounted for 80% of the total amount of energy used in the transportation sector in 2002.[471] Besides carbon emissions, cars and trucks also cause ground level ozone pollution (or "smog"). In addition to decreasing visibility and harming the health of trees and vegetation, smog is associated with heart disease and respiratory ailments in humans.

About 90% of coal is used for electricity generation.[472] Power plants that use coal and other fossil fuels to generate electricity emit about two-thirds of the sulfur dioxide and one-quarter of the nitrogen oxides released into the air nationwide.[473] These two emissions are the primary components of acid rain, a continuing threat to forests and aquatic systems.

About 40% of mercury emissions generated in the nation come from coal-fired power plants.[474] Toxic even in small amounts, mercury causes severe neurological health and other problems in humans, fish, and wildlife and has triggered fish consumption advisories nationwide.

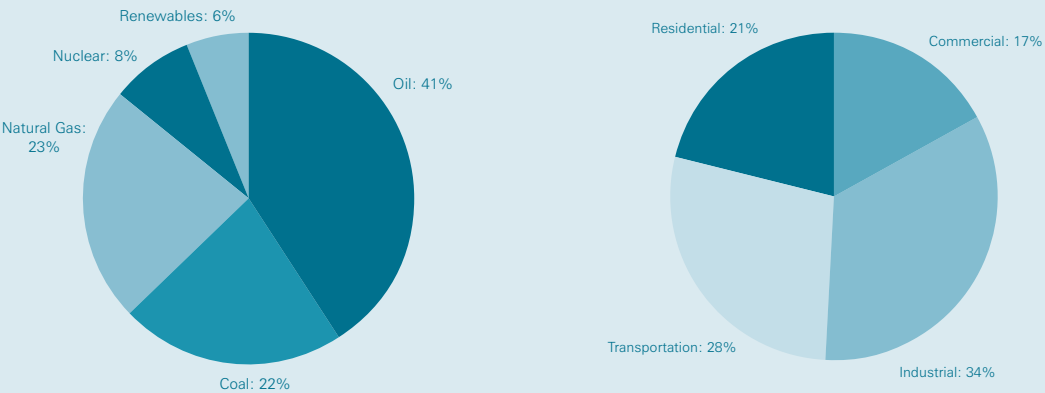
Particulate matter (a product of soot, ash, and smoke) is generated mostly from coal-fired power plants. Negative effects include hampered growth in vegetation and trees and respiratory diseases in humans. More than 240 counties in 22 states were found to be in violation of U.S. air quality standards for particulate matter in 2004, putting the health of more than 100 million people at risk.[475]

Degradation of land, water, plants and wildlife

Much of the nation's energy resources are located in natural environments where land, water, and wildlife can be negatively affected as coal, oil, and natural gas are extracted and transported. The landscape is dotted with more than 500,000 oil wells, nearly 1,400 coal mines, and 300,000 miles of natural gas pipelines.[476] One oil or gas well and its infrastructure requires a minimum of nine acres of land.[477]

Such infrastructure can fragment wildlife habitat and migration paths, while heavy machinery often destroys trees and vegetation and degrades and compacts soil. For example, several studies in Wyoming where oil and methane gas are produced and generated show that every acre disturbed by noise and traffic from drilling causes elk to avoid 100 acres of habitat.[478] Some fragile soils, particularly in desert environments, can take decades or centuries to regenerate. The most common oil exploration technique (the drilling of holes hundreds of feet in the ground) can destroy land surfaces and cause fissures and noise that harm wildlife, vegetation, and water tables.[479]

U.S. Energy Use by Source, 2004



Source: Energy Information Administration, 2005

Both *exploration and extraction processes* use substances such as acids, gelling agents, and diesel fuels that *contaminate soil, as well as aquifers and surface water systems.*[480] Because much fossil fuel extraction occurs in the arid and rapidly growing West, limited water sources come under added pressure. For example, methane and oil drilling draws significant amounts of water, sometimes tens of thousands of gallons per well, to the surface.[481] In some cases, water can comprise up to 98% of the material brought to the surface.[482] Such processed water often becomes saline or tainted with heavy metals and chemicals, and if not treated properly can contaminate water systems and kill vegetation and livestock when it is re-injected into the ground.[483]

Coal mining creates sludge that pollutes streams and rivers and can leave behind a desolate moonscape, polluted with toxic mine wastes. Even when these areas are re-vegetated by coal companies, ecological health and biological diversity are compromised. Evidence of this is particularly clear in parts of the South, where mountaintop removal has become a common coal extraction technique.

The *transport of fossil fuels* poses environmental risks both on land and at sea. An estimated 67 million gallons of petroleum products dripped and leaked from oil and natural gas pipelines nationwide, polluting soil, water, and wildlife habitat during the 1990s.[484] The health and survival of marine life are jeopardized by tanker shipments – nearly 7,600 oil spills (ranging from a few to hundreds of thousands of gallons) occurred in U.S. internal and coastal waters in 2001.[485]

Two other energy sources, *natural gas and nuclear power*, account for an increasing proportion of the nation's power generation. The share of electricity from natural gas nearly doubled (from 9% to 18%) between 1988 and 2002, while nuclear power currently accounts for 20% of electricity generation.[486]

Yet these sources can also have significant negative environmental and human health impacts. The transportation and storage of natural gas requires special care because it is a highly volatile substance, and extraction requires extensive drilling in pristine wilderness areas. Nuclear energy is a double-edged sword – it doesn't emit pollutants when operating soundly, yet accidents in its production and waste storage and transport, along with vulnerability to terrorist threats make it potentially catastrophic for human and ecosystem health or life. The risks of accidents alone are high for millions of Americans who live along vulnerable transport routes for nuclear waste.[487]

Renewable Energy

In light of the environmental problems caused by fossil fuels, nuclear and other conventional forms of energy, "renewable" energy is increasingly seen as an attractive alternative. *Although renewables account for the smallest proportion of all energy sources (6%), they are the fastest growing domestic source, set to increase 1.5% annually through 2020.*[488] An estimated 30 states have the ability to produce all of their electricity from non-hydroelectric renewables and still have power to export. [489] In 2002, biomass (biological matter such as trees, grasses, agricultural crops or other plant material used as fuel or converted for the production of electric power or other fuels) made up about half of all renewable energy (47%), followed by hydroelectric power (45%); geothermal, wind, and solar together made up less than 10% of the renewable energy consumed.[490]

The Arctic National Wildlife Refuge and Offshore Drilling

The case of oil drilling in the Arctic National Wildlife Refuge (ANWR), located along Alaska's northern coast, demonstrates how population's rising demands for domestic oil can cause long term conflicts over environmental protection. Many believe that drilling in ANWR would threaten caribou herds and destroy one of the last unspoiled habitats in the nation, and that if U.S. energy levels are reduced (through energy efficiency or other means) there will be less pressure to drill in such unique natural areas. Proponents of the drilling see it as a means to meeting the nation's increasing energy demands, and reducing dependence on foreign oil.[491]

Today, offshore drilling along the U.S. coast accounts for about one-quarter of U.S. natural gas and oil production. Recent hurricanes in the Gulf of Mexico exposed the vulnerabilities of the offshore drilling industry with regard to infrastructure damage, supply disruptions and oil costs.[492]

U.S. Regional Highlights: Population & Energy

Northeast

- The Northeast uses the least amount of energy of U.S. regions per capita (271 Btus). Maine and Pennsylvania residents account for the most, New York and Rhode Island residents the least.[493]
- Pennsylvania is the fourth largest producer of coal nationwide.[494]
- New York recently adopted standards to require 25% of its electricity to come from renewable sources by 2013,[495] while New Jersey has set a goal of 20% by 2020.[496]
- All rivers, lakes, and streams in New Hampshire are contaminated with mercury, and the state's residents are advised by the government to limit freshwater fish consumption.[497]
- The Northeast relies on a mix of natural gas, fuel oil, and coal-based electricity, but also generates more energy from wood than other regions.[498]

South

- The South has the second highest per capita rate of energy use in the U.S. (403 Btus per capita). Louisiana and Texas residents account for the most and Florida and Maryland residents the least.[499]
- Texas and Louisiana contain 44% of known U.S. oil reserves. Texas, Oklahoma, and Louisiana rank number 1, 3, and 5 among the nation's natural gas producing states.[500]
- In 2001, more than a third of all U.S. oil spills and nearly half of the spill volume occurred in Texas and Louisiana, while about one-quarter of all oil spills in U.S. waters occurred in the Gulf of Mexico.[501]
- The Appalachian region (led by Kentucky and West Virginia) accounts for 35% of U.S. coal production, using both underground and open pit (including mountaintop removal) methods.[502]
- The South's Gulf of Mexico daily oil production was reduced by 60%, and natural gas production nearly 40%, as a result of Hurricane Katrina.[503]

Midwest

- Midwesterners consume about 380 million Btus of energy per capita annually. North Dakota and Indiana residents account for the most, Michigan and Missouri residents the least.[504]
- About 70% of acid rain-causing emissions in North America come from coal-fired power plants in the Ohio River Valley, including Midwest states.[505] Ohio emits more sulfur dioxide and nitrogen oxide than any other state.[506]
- Farming areas in the Great Plains are emerging as key producers of renewable energy – six of the nation's top ten states with the greatest wind power include ND, KS, SD, NE, MN, and IA – and the largest wind farm in the world is being built in Iowa.[507]
- The longest pipeline in North America carries natural gas nearly 1,900 miles from western Canada to the Chicago area, shipped to Midwest markets.[508]
- The Midwest relies almost entirely on coal and nuclear power for electricity, making the region – as well as other regions subject to prevailing Midwestern winds, like the Northeast – especially vulnerable to resulting air pollution.

West

- The West has the nation's highest per capita annual energy use (421 Btus). Alaska and Wyoming account for the most (about three times the national per capita average), California and Arizona the least.[509]
- More than one-third of all coal produced in the U.S. comes from Wyoming and more than half from the West as a whole. As demand for low-sulfur coal increases, surface mine operations are expanding in the region.[510]
- California and Alaska have nearly 40% of known U.S. oil reserves.[511] Almost 400 spills of oil and toxic substances occur annually on Alaska's North Slope and along the Trans-Alaska Pipeline.[512] More than 600 occurred in California in 2001, both inland and offshore.[513]
- The number of leases for oil, gas, and coal mining on public lands increased more than 50% in the past few years, giving energy companies access to nearly three million additional acres.[514]

U.S. Population-Environment Challenges

Climate Change

The world's leading scientists agree that unprecedented changes to the climate of the U.S. and the planet are underway, due in large part to human-induced factors.[515] *The hottest 10 years on record all occurred since 1990, with 2005 the hottest year ever.*[516] *Temperatures are now about one degree Fahrenheit higher than a century ago.*[517] *There is increased frequency of severe weather events (like rainstorms), increased intensity of hurricanes, and major shifts in growing seasons and in the range of plant and animal species. Climatic change is causing the spread of insects that carry diseases like malaria and dengue fever. Glaciers are retreating, sea ice is melting, and sea level is rising.*[518]

Climate change is associated with human population factors through the numbers of people and rate at which the population grows, in combination with the level of per capita energy consumption and type of energy used to meet the demand. This includes, among other things, the type of vehicle driven or energy used to heat and cool buildings (polluting or non-polluting), and the energy technologies used (energy efficient or not).

National overview: U.S. Population and Climate Change

Climatic change is caused by the emission of greenhouse gases, primarily carbon dioxide (CO_2) generated by the burning of fossil fuels, and emissions of other gases such as methane.[519]

The U.S. emits nearly one quarter of the world's carbon dioxide (CO_2), yet only comprises one-twentieth of the world's population.[520] *It is the largest CO_2 emitter in the world.* Americans produce almost 20 tons of CO_2 per person a year. This is five times the world average of less than 4 tons, and compares to 8 tons for Europeans, and 2 tons for developing countries.[521]

Total U.S. greenhouse gas emissions rose 13% from 1990 to 2003.[522] *At current rates, U.S. greenhouse gas emissions are predicted to increase by nearly 43%, and CO_2 emissions by 34%, by 2020. The greatest increases are projected for the transportation and commercial sectors.*[523]

Carbon dioxide accounts for most (83%) U.S. greenhouse gas emissions, nearly all from the burning of fossil fuels (oil, gas, and coal).[524] The second leading contributor is methane (9%), which comes primarily from landfills, livestock, natural gas systems, and coal mining.[525] The remainder is a mix of nitrous oxide from agriculture, motor vehicles, electricity, and sewage, and hydro fluorocarbons, chlorofluorocarbons (which also destroy stratospheric ozone), and sulphur hexafluoride from aluminum production, electricity transmission, air conditioning, and refrigeration.[526]

The average temperature increase in the U.S. over the next 100 years is predicted to be 5-9°F.[527] Temperature increases by 2100 are predicted to vary by region and season, with a 4-5°F average increase across the Northeast and Midwest, a slightly lower 3-4°F average increase in much of the South and West, and the greatest warming, 10°F in winter, predicted for Alaska.[528]

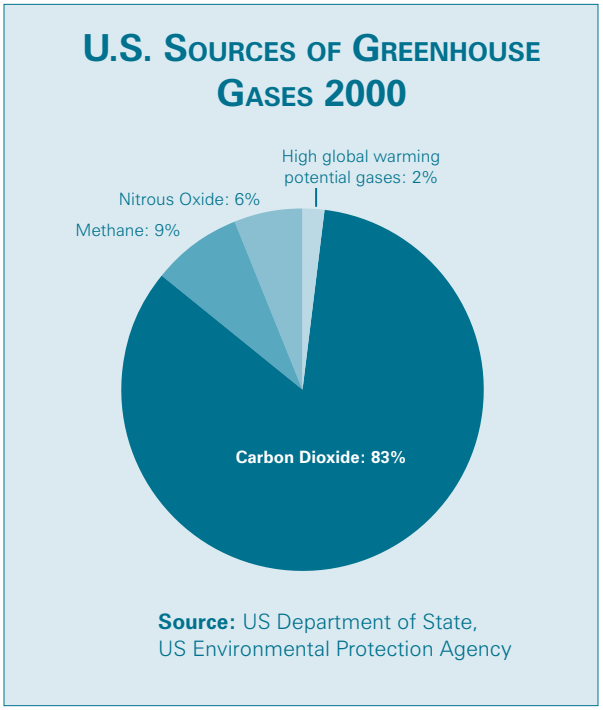
America's population growth, coupled with per capita energy consumption, result (or are projected to result) in three major environmental effects relating to climate change:

- **Altered weather and seasonal patterns**
- **Habitat and biodiversity loss**
- **Rising sea levels**

Altered weather and seasonal patterns

A main impact of climate change is seen in altered weather and seasonal patterns throughout the U.S. Some of these changes are with us today, and others are predicted by the experts to occur in the foreseeable future, depending on whether or not greenhouse gases continue to be generated as they are today.

One of these weather-related changes is an altered water cycle, and resulting higher atmospheric temperatures.[529] With higher temperatures, more precipitation will fall as rain, and less as snow. Both reduced snow pack and earlier snowmelt could reduce river and stream flow in the spring and summer, times when supplies are needed most, particularly for irrigation.[530] In some parts of the country, such as New England, snow already remains on the ground for a shorter time than in past decades.[531]



Greater fluctuation in precipitation also contributes to a wider disparity between wet and dry seasons, making planning for water supplies and use more difficult. Although overall precipitation is predicted to increase in arid states, decreases in summer months are also likely.[532] Similarly, extreme weather events would be more common. Higher temperatures and more rain falling on snow would result in rapid thawing, which in turn could spur flash floods as water rushes into rivers and streams or across dry land.[533]

Nationwide, more rain can increase pollutant runoff from agricultural fields and pavement in urban areas into water systems, a significant problem today. Higher temperatures could be exacerbated as pavement for roads, parking lots, and residential and commercial areas (which retain and radiate heat more than natural areas) spreads along with development and population growth. Reduced ice cover will mean that more heat will be absorbed rather than reflected by land and water. *Warm, wet conditions also foster carriers or "vectors" (such as mosquitoes) that spread diseases like West Nile virus, malaria, and dengue fever.*[534]

Climate change, habitat and biodiversity loss

Climate change has (and is projected to have) many impacts on the biological diversity of plant and animal species in the U.S. Among them is its effect on the composition and range of the nation's forests. An increase of 2°F over a period of 100 years, well within the range of current predictions, can force some tree species' ideal range to shift about 200 miles northwards.[535] As temperatures and moisture levels increase, some forests will expand, in particular southern types (such as oak, hickory, and cypress).[536] The tree line in alpine regions could also move higher. Drier soil conditions would decrease the range and density of some forests, which could be replaced with more extensive grasslands and pasture.[537] Increased precipitation could spur the growth of trees and vegetation, but heat could spur the loss of nutrients.[538]

Across the nation, spring is arriving sooner now than in the past. In New England, for example, this is shown by data on river flow and runoff, last-frost dates, air temperature, snow melt, and leafing and flowering patterns.[539]

Changes in freshwater temperature are also a factor. An increase of 4-5°F over the next 70 years could reduce habitat of coldwater fish by one-fourth to one-third nationwide.[540] Higher water temperatures are also linked with the bleaching and die-off of coral reefs and algal blooms, which deprive aquatic life of oxygen and light.

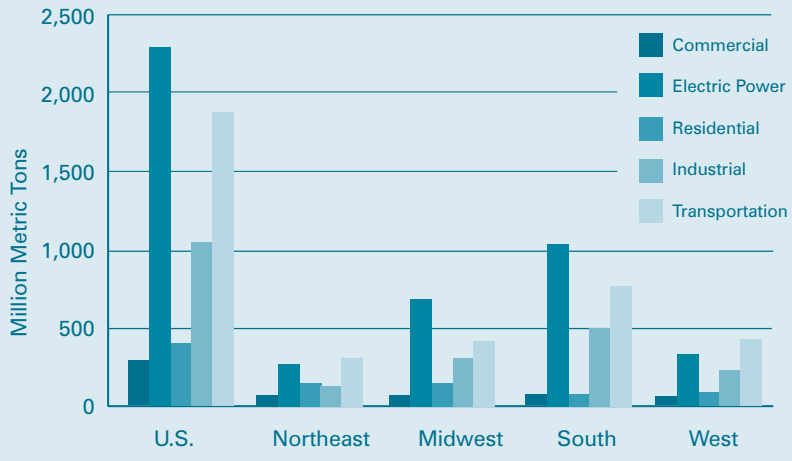
Whether and how species adapt to climate change will depend on the pace and geography of shifts, how the composition and location of habitats are altered, and the availability of habitat. *Many species will have to adjust migration, breeding, and feeding habits in order to survive.* But because all parts of an ecosystem do not adjust to climate shifts in the same way, many species could face a lack of food-base, or inadequate habitat. This is already evident in the Arctic (including Alaska), where retreating sea ice is making it harder for some seals and polar bears to find food.[541]

The species most vulnerable to climate change will be those with habitat needs afforded only by certain ecosystem types. It will be especially hard for wildlife to adjust in the face of human population and development, since fragmented, built environments prevent migration to new habitats. In addition, given current patterns of land use, there will likely be less habitat available, even if birds and animals can reach it.[542]

Rising sea levels

With over half of the U.S. population already living in coastal areas and millions more moving there each year, predictions of sea level rise resulting from climate change is a major concern. The sea level rise due to global warming is the result of higher water temperatures (which expands water volume), and the addition of freshwater from melting glaciers and ice.

CARBON DIOXIDE EMISSIONS BY SECTOR: 2001



Source: US Department of Energy, Energy and Information Administration, 2001

The greatest sea level changes are expected along the heavily populated U.S. Mid-Atlantic and Gulf Coasts because of sea level rise and the simultaneous occurrence of land subsidence from natural geological change. In these regions, studies predict that a *one foot rise in sea level is likely by 2050, and as much as a four foot rise is possible in the coming century.*[543] Rates of sea level rise are also expected to be considerably higher in the future than they have been in the past.

In the next 60 years, 25% of buildings within 500 feet of the U.S. coastline could be lost because of coastal erosion. Half of these structures are on the U.S. Atlantic Coast, and the remainder along the Gulf and Pacific Coasts and the Great Lakes.[544] The U.S. Federal Emergency Management Agency (FEMA) estimates that flood damages could increase by 36-58% with a one-foot rise, and by 100-200% with a three-foot rise.[545]

Sea level rise would also increase salt intrusion into rivers, streams, and aquifers and the salinization of water supplies. This is already a problem because of groundwater pumping and the alteration of natural water flows to satisfy growing demand.[546]

It is estimated that a two-foot rise in sea level could eliminate an estimated 17-43% of U.S. wetlands.[547] Somewhat paradoxically, the structures erected to protect populated costal areas from shoreline erosion (such as seawalls, dikes, and bulkheads) often prevent wetlands and marshes (which serve as natural buffers from the sea and storms) from "migrating" and re-forming further inland as sea levels rise.

Climate Change and Hurricanes

A growing body of evidence indicates that climate change is associated with the rise of the intensity of hurricanes. One of the most recent studies shows that the number of Category 4 and 5 hurricanes has nearly doubled, from 10 per year in the 1970s to 18 per year since 1990. Also, such storms made up 35% of all hurricanes in the past decade, compared to 20% in the 1970s.[548] This is caused by rising ocean temperatures. Since 1970, the temperature of the world's oceans has risen one degree Fahrenheit, while the tracking of temperatures in the Atlantic Ocean shows a steady increase in the last several decades.[549] The warmer the sea and atmosphere, the more water evaporates; hurricanes occur when ocean moisture and heat are high, with higher levels resulting in more intense hurricanes.[550] Hurricane Katrina's effect on the U.S. Gulf Coast in 2005 demonstrated the hazards of severe weather events on heavily populated and developed coastal areas.

Climate Change in Alaska

Alaska is experiencing some of the most profound climate change impacts now occurring in the nation. Permafrost thawing is causing the ground to subside 16-33 feet in parts of interior Alaska. And the permafrost surface has warmed by about 3.5° F since the 1960s. Summer days without snow have increased from fewer than 80 in the 1950s to more than 100 in the 1990s. Sea-ice extent has shrunk by about 5 percent over the past 40 years, and the area covered by sea ice declined by about 6 percent from 1978 to 1995. A study of 67 glaciers shows that between the mid-1950s and mid-1990s the glaciers thinned by an average of about 1.6 feet per year, and the rate of thinning had increased to nearly 6 feet more recently. The state's annual average temperatures have warmed up to 1.8° F per decade over the last three decades, and winter warming has been as high as 3° F per decade.

The consequences of global warming for Alaskan wildlife species will be severe. For example, in the case of polar bears, even now the amount of time they have on the ice storing up energy for the summer and autumn, when there is little available food, is becoming shorter. The situation is particularly serious for pregnant bears, those with cubs, and for the cubs themselves. As Arctic ice breaks up earlier and earlier, bears now come ashore roughly 22 lbs lighter and in poorer condition. The bears' reduced body condition can lead to lower reproduction rates, which in the long run could lead to local extinction.[551]

U.S. Regional Highlights: Population & Climate Change

Northeast

- Currently, changes in the Northeast's seasonal weather patterns are affecting the fall foliage and winter recreation industries, garden zones, species' habitats, and lake "ice-outs". Spring in the Northeast now occurs 1-2 weeks earlier on average than 30 years ago.[552]
- The predicted temperature rise of 4°F could contribute to the loss of 50-70% of maples and 40-50% of spruce in some parts of the region.[553]
- Higher temperatures and precipitation are associated with the spread of Lyme disease and equine encephalitis, as well as increases in health-damaging smog.[554]
- Rising water temperatures could reduce the productivity of Atlantic lobster fisheries in the southern part of their range, and reduce the populations of trout and other species in the Northeast's brooks and streams.[555]

South

- In the last 20 years, more than half of the nation's costliest weather-related disasters (in particular hurricanes and floods) occurred in the South.[556]
- In the past 100 years, annual rainfall has increased 20-30% across several southern states, including Alabama, Arkansas, Louisiana, Mississippi, South Carolina, and Tennessee.[557]
- In the Chesapeake Bay, sea level could be 27 inches higher in 2100 than it was in 1990, reflecting double the rate of the rise recorded during the 20th century.[558]
- Rising seas could make water systems in the Everglades saltier – high levels of salinity have already been linked to the die-off of 100,000 acres of sea grass beds and the decline of coral reefs in Florida.[559]

Midwest

- Despite the prediction of more rainfall in the Midwest, higher temperatures and evaporation could combine to result in a net decline in water levels in the Great Lakes by the end of the 21st century, possibly by as much as 1.5–8 feet.[560]
- A five-foot drop in the Great Lakes would result in 20–40% less flow into the St. Lawrence Seaway, increasing the costs and difficulty of navigation and commerce.[561]
- A 2-4°F temperature increase in the Midwest could increase concentrations of ozone and smog by 8%.[562]
- More than half of all prairie ponds in the Midwest could permanently dry up by 2060, reducing the number of breeding ducks by half.[563]
- Although overall the productivity of the nation's agricultural center could improve due to more rain and higher levels of carbon dioxide, the mix of crops in particular areas could also shift and yields of some (such as corn) could decline.[564]
- Growth might also be offset by the expansion of weeds, the reduced nutritional value of range-land grasses, and drier soil conditions from higher temperatures.[565]

West

- The greatest warming observed in the nation is in Alaska, where temperatures have increased 4-7°F in the last century, and the growing season has increased more than 14 days since the 1950s.[566]
- By the early 2000s the Arctic sea ice melted back 12-15% beyond its normal minimum extent. Experts say we may be about to reach a threshold beyond which the sea ice may not be able to recover.[567]
- In California and Nevada, the snow season decreased 16 days between the 1950s and the 1990s.[568]
- By 2050, the snow line in mountains of the Pacific Northwest could be more than 1,000 feet above where it is today, forcing the dying off of much spruce, fir, and pine.[569]
- Along the West coast, butterflies are leaving the southern ends of their natural range and moving north and to higher altitudes in search of tolerable climate conditions.[570]

Solid and Toxic Waste

As the U.S. population grows and consumes natural resources, there is also an increase in the amount and type of waste generated. Economic growth and rising affluence also contribute to increasing levels of waste. Not only does the generation of solid and toxic wastes impact the environment, but the method of the waste disposal and treatment can have lasting effects on the country's natural environment, and human health.

Population is associated with solid and toxic waste by how much and what kind of waste and resulting pollution is generated per capita. How the environment is affected depends on how the waste is managed or disposed of, and what happens to resources and ecosystems as a result.

National overview: U.S. Population and Waste

There are several kinds of waste, broadly categorized into municipal waste (trash), solid waste (industrial refuse), hazardous or toxic waste, and radioactive waste. Most waste is buried or burned, yet a growing amount is recycled or converted to other uses, or "neutralized" or stored (in the case of hazardous or radioactive waste).[571]

The U.S. government sets standards for the treatment and disposal of waste. These standards are adopted by states, which run their own waste management programs. Consequently, the amount and type of waste generated and methods of disposal vary nationwide.

Densely populated urban and suburban areas and the largest and fastest growing states tend to produce higher total levels of household waste. Areas with more industry and utilities generally produce a higher level of hazardous waste. Agricultural areas generate vast amounts of organic animal wastes, as well as residual wastes from the use of fertilizers, pesticides, and herbicides.

The U.S. is the highest municipal waste producer in the world.[572] Americans generated about 480 million tons of total solid waste (1.7 tons per person) in 2002, about 440 pounds more per person than in 2000.[573] Such waste consists of non-liquid, non-soluble materials like human and animal waste, demolition and construction refuse, and mining residue. The approximately 5 million tons of sludge from human sewage systems produced nationwide every year contain heavy metals, chlorine, and an army of pathogens.[574] The 910 million tons of animal waste generated annually is heavy with nitrogen, phosphorous, hormones, and antibiotics, as well as being a significant source of methane.[575]

The choices made by the increasing numbers of individuals, communities, industries, schools, and businesses, and others – whether it relates to packaging, paper use, lawn care, chemicals, baby diapers, or what we discard rather than "recycle, re-use, or repair" – all determine the type and scale of waste that enter into natural systems. The amount and type of waste that we create also depends on the durability of the products we buy and how long we keep them before buying new ones, such as appliances, cars, computers, and clothing. "Planned obsolescence" and other similar manufacturing factors also have an affect on how often we must purchase and discard new items and their packaging.

Waste generated by the American population is associated with the natural environment in two primary ways, through:

- **Waste and pollution generated**
- **Waste disposal and management**

Waste and pollution generated

Waste enters the environment through the land, air and water, in a variety of ways. Domestic and toxic waste can leach pollutants into the soil, which then percolate into groundwater aquifers or waterways. Some waste is discharged directly into aquatic systems, and some are *airborne*. The pollutants then can travel through the food chain, affecting the health and reproductive abilities of wildlife, the stability of aquatic and terrestrial ecosystems, and, human health.

Residential, commercial, and industrial activities generated nearly 370 million tons of municipal solid waste, or trash, in 2002.[576] Each U.S. resident produces almost 5 pounds of trash a day, up from less than 3 in 1960.[577] This compares to about 3 pounds per person per day in Europe, and about 0.9-1.3 pounds per person a day in developing countries.[578]

Key sources of trash in the U.S. are paper (35%), yard trimmings (12%), food scraps (12%), plastics (11%), metals (8%), and rubber, leather, and textiles (7%).[579] Such waste requires considerable space and energy for disposal, and is often mixed with polluting substances like paint, oil, batteries, plastics, and pesticides.

The U.S. produced about 30 million tons of hazardous waste in 2003.[580] Such waste is considered harmful to public health and the environment because it is highly flammable, corrosive, reactive, or toxic.[581] This includes chemicals and heavy metals from industries and utilities. Medical facilities generate more than two million tons of chemical- and pathogen-laden waste annually.[582] Electronics (which contain heavy metals such as lead and cadmium), motor vehicle oil, and certain types of batteries are also generally considered to be hazardous waste. There are now 1,300 "Superfund" sites nationwide, former industrial locations so toxic as to qualify for remediation under federal law. *Nearly half of the Superfund sites are linked to contaminated or threatened drinking water sources.*[583]

Top Ten States for Selected Types of Waste

Rank	Hazardous waste (% U.S. total), 2003[a]	Municipal solid waste (million tons/year), 2002[b]	Animal waste (million tons/year), 1997[c]	Superfund sites (number), 2002[d]	Toxic chemical releases to the environment (million pounds/ year), 2002[e]
1.	TX (22%)	CA (54)	TX (110)	NJ (116)	AK (548)
2.	LA (15%)	TX (29)	CA (55)	CA (98)	NV (498)
3.	KY (8%)	NY (25)	IA (51)	PA (95)	AZ (329)
4.	MS (7%)	FL (20)	NE (47)	NY (93)	TX (244)
5.	OH (6%)	MI (17)	KS (46)	MI (69)	OH (209)
6.	AL (4%)	OH (16)	WI (39)	FL (52)	UT (173)
7.	NJ (4%)	IL (16)	OK (36)	WA (47)	FL (151)
8.	NY (4%)	PA (13)	MO (35)	IL (45)	TN (148)
9.	IL (4%)	GA (11)	MN (33)	TX (45)	IN (137)
10.	IN (3%)	VA (11)	NC (31)	WI (40)	GA (127)

[a] U.S. Environmental Protection Agency, 2003
[b] Kaufman, Scott M., et al., *BioCycle*, 2004
[c, d, e] Environmental Defense. "Scorecard: The Pollution Information Site." http://www.scorecard.org.

Finally, nuclear power plants generate more than 2,000 tons of high-level radioactive nuclear waste annually. More than 40,000 tons of used nuclear fuel has been produced during the history of the industry, and is stored at plants nationwide.[584]

Waste disposal and management

Once generated, waste must be disposed of. The two primary disposal methods are landfills and incinerators, although a growing amount of waste is also recycled and converted into energy or fertilizer. About 55% of municipal waste ends up in landfills, 31% is recycled or composted, and 14% is incinerated.[585] Most waste is disposed of in underground injection wells, treated with water-based or other methods, recovered, or impounded.[586]

A growing challenge in waste management is the shrinking amount of land and the resistance of communities to the siting of incinerators and landfills. As a result, some municipalities move waste elsewhere. About 39 million tons of municipal solid waste was moved across state lines in 2003.[587] This intensive transport in turn uses energy resources and generates polluting air emissions. The U.S. has agreements with both Canada and Mexico to export, as well as import certain types of hazardous waste, and is party to international treaties regulating the international movement of such waste.[588]

In 2002, there were fewer than 2,000 landfills nationwide, a significant decrease from the 8,000 landfills that existed in 1988. However, capacity has remained constant, reflecting the expansion of many facilities, even as others close.[589] Some estimates indicate that for every 40,000 tons of garbage added to a landfill, at least one acre of land is lost for future uses.[590]

Landfills also cause pollution. Methane, a major greenhouse gas, is produced when organic materials decompose. The gas is vented to prevent landfills from exploding. Landfills accounted for more than 90% of the 7 million tons of methane emitted by the waste management industry in 2002.[591] Increasingly, methane is converted into energy; in 2003, more than 3 million tons of the gas was recaptured for this purpose.[592]

Depending on the type and content of waste present, landfills can also leach toxic chemicals into soil and water systems. Since the early 1990s, landfills have been required to prevent the leaching of toxins and to treat the leachate before it can reach water supplies.[593]

Incinerators can reduce the volume of waste up to 90% by burning it at high temperatures. The resulting ash is then disposed of in landfills.[594] Although the total number of incinerators nationwide is shrinking, many of those that remain are "waste to energy" facilities that use the combustion process to generate steam and electricity. About 8% of waste is disposed of in this way.[595]

However, incinerators also release hazardous substances into the atmosphere. These include heavy metals, chemicals, and particulate matter, all of which are associated with a range of neurological and respiratory disorders. A key problem is dioxins, released when plastics and products containing chlorine are burned. Exposure can lower the immune system and is associated with cancer in humans and reproductive abnormalities in wildlife.

Municipal, medical, and hazardous waste combustors are ranked second, third, and fourth (after coal-burning power plants) as sources of airborne mercury emissions.[596]

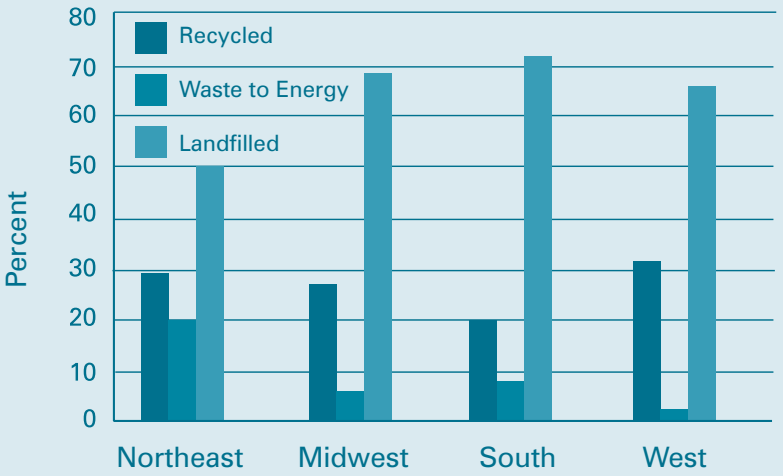
Recycling and waste

Recycling in the U.S. has risen dramatically in the past three decades – waste recycling rates were more than four times as high in 2003 (31%) as in 1970 (less than 7%), keeping about 72 million tons of waste out of landfills and incinerators.[597] Recycling rates vary greatly across states and regions, ranging from a high of 30-50% in some states (such as Arkansas, California, Maine, Vermont, Virginia, and Washington), to a low of less than 5% in others (such as Colorado, Mississippi, Oklahoma, South Dakota, and Wyoming).[598]

Certain products have very high recycling rates: corrugated cardboard (71%), newspaper (82%), steel cans (60%), yard trimmings (56%), and aluminum cans (44%).[599]

The U.S. recycles about one-third of its municipal solid waste, about the same rate as in some European countries (Denmark, England, Ireland) but less than the 50-60% recycled in others (Austria, Germany, Netherlands).[600]

MUNICIPAL SOLID WASTE DISPOSAL METHODS BY REGION, 2002



Source: Calculations based on Kaufman, Scott M., et al., *BioCycle*, 2004

U.S. Regional Highlights: Population & Waste

Northeast

- New York and New Jersey are the two largest exporters of municipal solid waste, shipping about 8 and 6 million tons, respectively, across their borders. Pennsylvania is the largest importer, accepting more than 9 million tons.[601]
- New England incinerates and converts to energy significantly more of its municipal waste than any other region (34%).[602]
- Three of the top four states with the most Superfund sites are in the Northeast (NJ, NY, and PA).[603]
- New England, New York, and New Jersey together produce about 41 million used and discarded tires annually, many of which are converted into energy or used in construction.[604]

South

- Four of the nine states nationwide set to run out of landfill space in 5–10 years (as of the late 1990s) are in the South: AL, MS, NC, and TN.[605]
- Of the top ten states in toxic releases to water, six are in the South (TX, LA, GA, NC, MS, and VA).[606]
- While several southern states have recycling rates of 20-40% – such as Arkansas (36%), Maryland and Virginia (both at 29%) and Florida (25%) – others in the region are much lower. The two U.S. states with the lowest rates are Mississippi (0.3%) and Oklahoma (1%).[607]
- Trash incinerators are the primary source of mercury pollution in Florida. Research has shown the link between pollution controls and the return of wading birds to the Everglades.[608]

Midwest

- Of the nations top ten states with the highest amounts of animal waste, six are in the Midwest (IA, KS, NE, MN, MO, and WI). Between 1987 and 1997, levels went up 18% in Nebraska and 33% in Kansas, but decreased 21% in Wisconsin and 3% in Missouri.[609]
- Two Midwest states lead the nation in per capita municipal solid waste generation, Kansas (1.73 tons/yr.) and Michigan (1.68 tons/yr.), while Indiana (1.55 tons/yr.) ties for third place with other states.[610]
- Three states in the region (MN, MO, and WI) are among nine nationwide that, as of the late 1990s, were set to run out of landfill capacity in 5-10 years.[611]
- Two cities with some of the highest recycling rates nationwide are in the Midwest: Minneapolis (60%) and Chicago (47%).[612]

West

- Alaska has the highest level of toxic releases to land of any state. More than 90% of this comes from one large zinc mine, where the worst heavy metal contamination in the world has been identified.[613] Second, third, and fourth place are held by fast-growing Western states (NV, AZ, and UT).[614]
- The nation's fastest growing U.S. city, Las Vegas, is only 70 miles from Yucca Mountain, the site long considered for the nation's only permanent high-level nuclear waste repository.[615]
- Oregon has the second highest trash recycling rate of any U.S. state, nearly 50%. Wyoming recycles less than 2% and Colorado less than 3%.[616]
- Hawaii faces such limitations on landfill space that the city of Honolulu is exploring plans to wrap its solid waste and ship it to Washington state or Idaho for disposal.[617]

Conclusion

This report demonstrates how the U.S. population is linked to the natural environment. Some key highlights include:

- America is the only industrialized nation in the world experiencing significant population growth. The nation's relatively high rates of population growth, natural resource consumption and pollution combine to create the largest environmental impact, felt both within the nation and around the world.
- These human population-related environmental changes are occurring uniquely in our lifetimes. Just over the past five decades alone, people have altered natural ecosystems more rapidly and extensively than in any comparable period of time in human history, trying to meet a rapidly growing population's requirements for food, water, shelter, and fuel.
- Population growth and density is high in many of the U.S.'s most environmentally vulnerable areas like the arid West and coastal South, making them "population-environment hot spots."
- For the first time in its history, the U.S. is primarily a "metro nation", with the average person more likely to be surrounded by other people and the infrastructure necessary to support them, than by the expanses of land and natural resources that surrounded earlier generations of Americans. This "metro-centered" lifestyle differs from urban-centered lifestyles in that it requires extensive use of motor vehicles and rapid, extensive land development. Urban-centered lifestyles depend more on public transportation and use of already existing infrastructure to support a growing population.
- The U.S. has become a "super-size" nation, with lifestyles reflected in super-sized appetites for food, houses, land and resource consumption. In fact, "more of more" seems to characterize modern day America – *more* people than any generation before us experienced, *more* natural resources being utilized to support everyday life, and now, *more* major impacts on the natural systems that support life on Earth.

The linkages don't stop there. Additional costs and consequences have become apparent, and also need our attention. These include:

- ***Economics:*** population drives environmental change, which in turn results in economic changes. An example is the decline in fisheries (in part due to population demand) which also affects jobs, as was the case in the decline of the Chesapeake Bay oyster and Georges Bank cod fisheries. Another example is the cost to businesses and livelihoods and the extent of coastal clean-up brought about by Hurricane Katrina (the hurricane itself a result, in part, of climate change, and impacting heavily on the densely populated U.S. Gulf Coast).
- ***Human health:*** the rate, volume and type of pollutants spurred by rising population's increased resource use are causing the spread of disease and disease vectors, and neurological, reproductive and respiratory disorders.
- ***Everyday life:*** the "super-sized" lifestyles of so many people affect the quality of everyday life causing, among other things, more frequent, worse traffic jams, and expenditure of more money and effort to heat and keep-up more and/or larger homes.
- ***Recreation:*** as the demand for recreation in natural areas increases with growing populations in urban and suburban areas, opportunities for forest/park or coastal recreation are becoming increasingly limited. Congestion in and competition between recreation-user groups for use of the nation's public forests and coastal amenities is increasing.

There are also significant societal implications. The Arctic Inuit don't have words for the robin and hornets that are appearing for the first time ever in Alaska due to climate change. Poor communities across America face "environmental injustice", as pollutants are disproportionately dumped in their backyards and (as in the case of hurricanes) coastal development and the effects of global warming uniquely place them in untenable positions. And looking forward, America's children and grandchildren will innocently pay if our (sometimes irreversible) decisions on these issues render the environment unable to support future generations.

Lastly, "allocation" issues emerge as we try to keep pace with more and more people depending on a limited natural resource base. As natural resources become scarce, how do we choose between the increasingly competing needs of humans, the environment, and species? How will we decide how natural resources are allocated – so we can all eat, have shelter, work and recreate in the ways to which we have become accustomed or are entitled to – and, so there is sufficient "space" left

for healthy ecosystem and species' functioning, particularly because our own health is dependent on a sustainable environment. What are we willing to change, or give up…is it species? land? wide open spaces? clean water or air? or, is it policy, lifestyle, business, or industry choices?

As we look to the future, we must remember that past decisions about resource allocation are not necessarily suitable to today's population and ecological changes. For example, the nation's water allocation laws were made years ago, when the country's population numbers and people's needs were much less than they are now. Does that mean we must face tough political decisions about land development in water-sensitive areas, or that types of agriculture that are water intensive should not be expanded? These are the types of questions we face as our nation changes.

As for next steps, there are many. We need to be aware of the population and environmental challenges we face, and apply sound, science-based planning to our approaches for addressing the trends in the coming years. The country's "population-environmental hot spots" need to be identified so we can begin to address the issues where they are most urgently needed. America's role as a major player in the global community must be discussed and addressed at the local, state, regional and national levels, and in international arenas like the United Nations. Local communities must be given the tools to better understand growth and impacts in their locales. Children, students and young leaders in the nation must be educated and trained to face the issues as their lives unfold.

With the help of this report we can decipher some of the main challenges. We must consider these challenges, along with their costs and consequences, and identify the gaps in knowledge, what is needed to fill them, and how we can act on the issues.

Now we can begin a new strategy, with new ideas and new models, to address our changing world – so we can achieve a healthy, sustainable planet for all generations.

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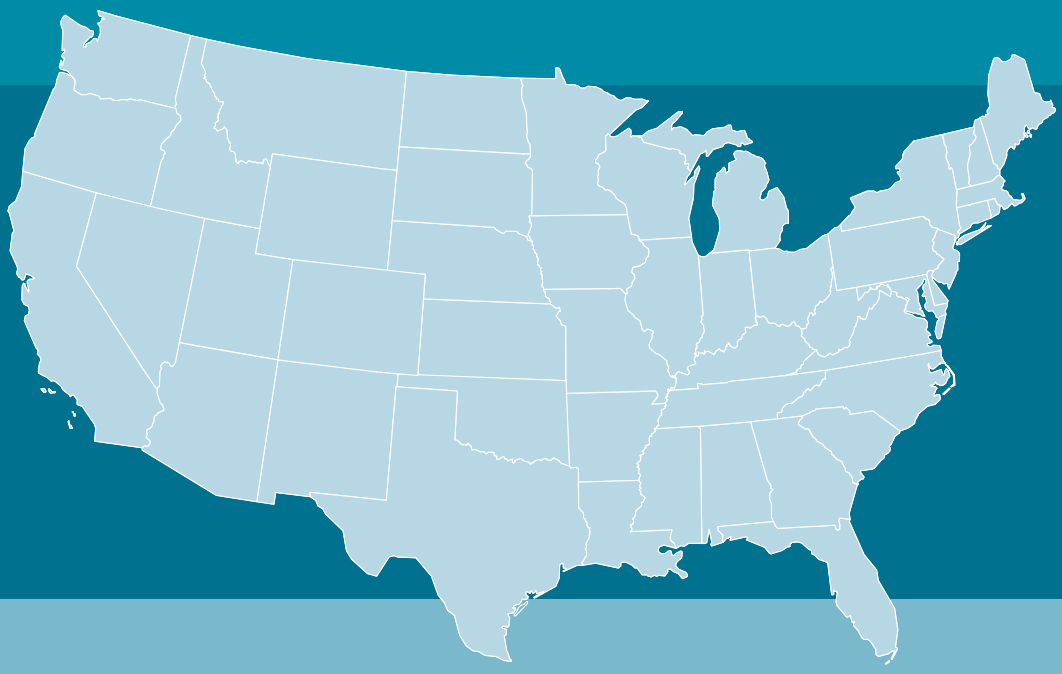

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Center for Environment and Population (CEP)
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Phone: 203-966-3425 / Fax: 203-966-5443
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