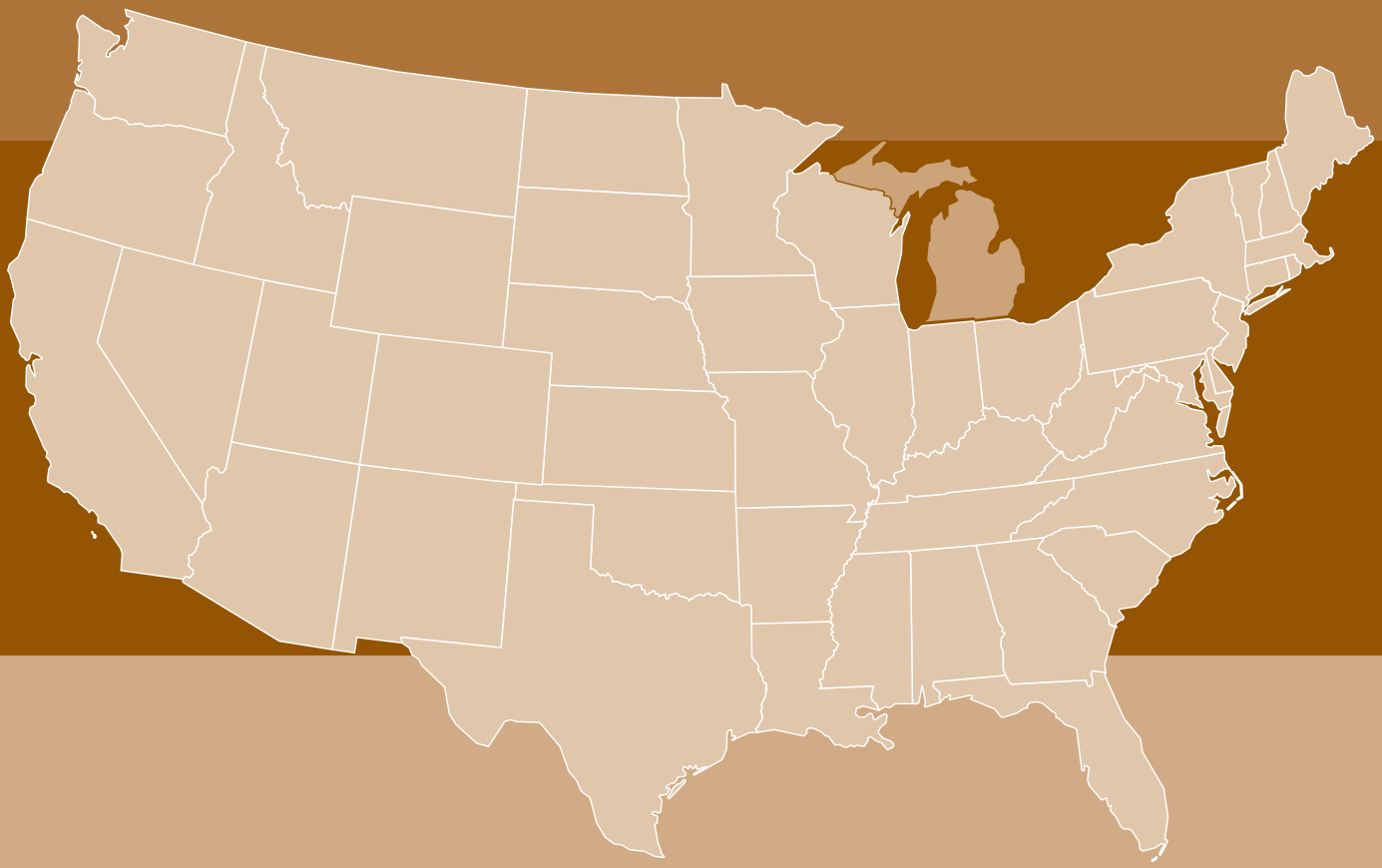
U.S. State Reports on Population and the Environment

Michigan



Center for Environment & Population

NATIONAL WILDLIFE FEDERATION

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Michigan

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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 and public education, 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 *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, university and youth programs, and for public outreach. The Center utilizes its CEP Experts Network to engage leading scientists and other experts in its programs. CEP is a project of the Tides Center and works in the U.S. at the local community-national levels, and internationally.

National Wildlife Federation (NWF)

The mission of the National Wildlife Federation (NWF), the nation's largest conservation education and advocacy organization, is to inspire Americans to protect wildlife for our children's future. Founded in 1936, NWF combines the local knowledge and focus of its strong state affiliate and grassroots network with the perspective, resources and strength of a national organization to generate unparalleled support for wildlife, wild places and a healthy environment.

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

About This Report

This is the second in a series of *U.S. State Reports on Population and the Environment*, published by the Center for Environment and Population (CEP). The brief, easy-to-read reports feature science-based information and analysis on human population and environmental interactions. The CEP series also includes the groundbreaking *U.S. National Report on Population and the Environment*, a compilation of population-environment highlights in the nation.

The U.S. State Reports are followed by directly related activities to discuss the reports' findings and generate policy and public advocacy addressing the issues at the local, national, and international levels. This project focuses on the U.S. population's environmental impact, and the nation's role within the global context.

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Introduction

The Earth's natural environment is changing in ways fundamentally different from those at any other time in our history. Air quality and water supplies are increasingly vulnerable, growing numbers of plant and animal species are threatened with extinction, land alteration is pervasive, and the global climate is changing. These present a new set of challenges for people, plants, wildlife, and the ecosystems upon which we all depend.[1]

Experts now trace these diverse environmental phenomena to the growing scale of human activity.[2]

The impact of humans on the environment is particularly acute in the United States (U.S.). While the U.S. represents about 5% of the world's population, it consumes higher amounts of nearly every resource than any other country in the world. The environmental impacts of the U.S. population and its resource consumption are felt in the country and all over the world.

Much information exists on the population-environment relationship on a global scale. Yet, comparatively little has been compiled for the U.S., particularly at the state level. This series of ***U.S. State Reports on Population and the Environment*** aims to fill that gap by highlighting population's environmental impact at the state level.

By bringing the analysis closer to home – closer to where we live and where many public and private decisions are made – this report is intended to bring into sharper focus the population-environment relationship. And, by understanding these relationships at the local community, state, and eventually national levels, we may be able to better understand the U.S. role in the context of the global community. This report, second in the series, examines how population and the scale of human activity affects the environment in Michigan. State reports for each U.S. region and a national report are also part of the series.

Population factors–such as size, distribution, growth, households, and resource consumption–influence Michigan's natural environment. How many of us there are, where we live, how we live, and how quickly we are growing are all important. The effects of these population factors are felt on Michigan's natural resources, and in some cases extend beyond the state's boundaries.

While total population numbers are critically important, large numbers of people do not always have equally detrimental environmental impacts. Individual and collective choices, in Michigan and elsewhere, help determine the level of impact of a given population. A certain number of people in one place can have a very different impact than the same number in another place, depending on the day-to-day choices that are made.[3]

A Michigan town of 20,000 people that promotes concentrated "cluster" development, energy efficiency, organic farming, and non-polluting industry or tourism will have much less negative environmental impact than the same size town that promotes sprawl development, dependence on long distance commutes, or polluting industries. Thus, impacts depend not just on the numbers of people, but also on public and private decisions, such as those related to land-use, residential development, waste disposal, industry and commerce, lifestyle, and even food preferences.

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

Individual and collective choices, in Michigan and elsewhere, help determine the level of impact of a given population.

Michigan's Population & Environment: Key Findings

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

- **Population:** Michigan's human population of approximately 10 million residents is largely urban, with nearly a third located in just two southeastern counties. The state's population grew by 12% in the past three decades, while the number of households increased by 43%.

- **Land-use:** Land development in Michigan is occurring eight times faster than the population grows. In the southeastern part of the state, 27% of developed land is a direct effect of population growth, while 43% is the result of lower density, sprawling residential development.

- **Agriculture:** Michigan ranks 9th in the country for loss of farmland due to development. It has lost 76% of its farmland, and averages an estimated loss of 40,000 acres per year from development and low density "fragmentation."

- **Forests:** Michigan ranks 11th nationwide in forested land. This may change with more people moving into the northern Lower Peninsula where a significant amount of forestland exists.

- **Water:** Michigan has the eighth largest public water supply withdrawals in the country and the largest amount of water withdrawn for public water supply within the U.S. portion of the Great Lakes Basin. More than 10,000 groundwater pollution sites have been identified in the state over the last ten years.

- **Fisheries:** Fifteen species of fish are currently listed as endangered or threatened and nine are believed to have been extirpated (rendered extinct) from the waters in and around the state.

- **Biodiversity and Wildlife:** To date, 46 plant species and 47 animal species have been extirpated in Michigan. Currently 81 animal species are threatened or endangered and 23% of native plant species face threats from invasive exotic species.

- **Invasive Species:** The invasion of exotic species is the second largest threat to biodiversity in the Great Lakes Basin. A new aquatic invasive species is introduced into the Great Lakes every eight months.

- **Energy:** Transportation accounts for most (74%) of Michigan's oil consumption. Motor fuel use in Michigan has increased by 88% since 1960 and travel on Michigan's roads increased almost 50% from 1984 to 2001. Both are increasing at a far greater rate than the state's population.

- **Climate Change:** Climate scenarios for the region suggest a year-round temperature increase of 3.6-7.2 degrees Fahrenheit and 25% more precipitation by the end of the 21st century.

- **Solid and Toxic Waste:** Michigan imports waste from eleven different states and is the third largest importer of waste in the country. The state could run out of landfill space within a decade if solid waste imports continue to increase at their current rate of 17% per year.

Michigan's Population Profile

Population's Ecological Footprint

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

A state's "ecological footprint" compares its consumption of natural resources with nature's biological production capacity. The footprint is the total land-area required to: produce the food, fibers, and energy a given population consumes; provide infrastructure space; and, absorb its wastes.[4]

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

- **Population** – the total number of people. Population always acts in combination with other IPAT factors.
- **Affluence/Consumption** – often associated with income, it is how much each person consumes in terms of resources, such as water, energy, passenger miles, space for housing and so on.
- **Technology** – this represents how a resource is used, and how much waste and pollution is created by the production and consumption of the resource.[5] Sometimes it improves environmental impact (e.g., with the use of energy efficient products), or it can worsen it (e.g., through inefficient coal-burning power plants).[6]

Population Growth

Recognizing the nature of Michigan's population, how it has changed over time, and how it will change in the future is important to understanding its influence on the state's environment.

According to the U.S. Census Bureau's 2004 estimates, Michigan was home to 10,112,620 people, representing 3.44% of the population of the U.S. It is the 8th most populous state in the nation.[7] Michigan is comprised of two peninsulas, and shares land borders with three other states: Ohio, Indiana, and Wisconsin. Ohio has a comparable population of 11,459,011, while Indiana and Wisconsin have each about half as many.[8]

Due to the nation's westward population expansion and a booming lumber industry, Michigan's population increased by more than 500% between 1850 and 1900. Not long after came the birth of the automobile industry and other new industries, causing the population to double by 1930. The peak of Michigan's population boom occurred during the 1950s when nearly one and a half million people were added through natural increase and net migration, a 22.8% increase and among the highest in the nation at the time. During this period the population was also shifting from mainly rural to urban locations, a trend that began to reverse around 1970.[9] Population growth slowed between 1980 and 1990, when 587,874 persons were lost to net out-migration, while the remaining population continued to shift away from urban areas.[10]

Population Distribution

Population can affect the environment not only through the rate of growth but also by its distribution, often increasing pressure in densely populated areas.

Like the nation as a whole, Michigan's population is largely urban, with approximately 80% of its population living in a metropolitan area (MSA).[11] The densest concentrations are in two main metropolitan areas located in the Lower Peninsula:

Grand Rapids-Muskegon-Holland on the state's west side near Lake Michigan, and Detroit-Ann Arbor-Flint in the southeastern corner of the state.[12] Both of these metropolitan areas encompass some of the fastest growing counties in the state, such as Livingston County, which increased 13.1% since the 2000 census, nearly twice that of other counties exhibiting rapid growth over the same time period.[13]

Of the state's 56,804 square miles, over 50% is comprised by the northern half of the Lower Peninsula and the entire Upper Peninsula. These areas contain large tracts of agricultural and forest land, including state and federal protected areas, and are generally more sparsely populated.[14] However, two of the ten counties with the highest growth rates are located in the northwestern Lower Peninsula, an area that, in percentage terms, has been the fastest growing in the state for over a decade.[15] Overall statewide density is 175 persons per square mile, compared to 80 nationwide.[16]

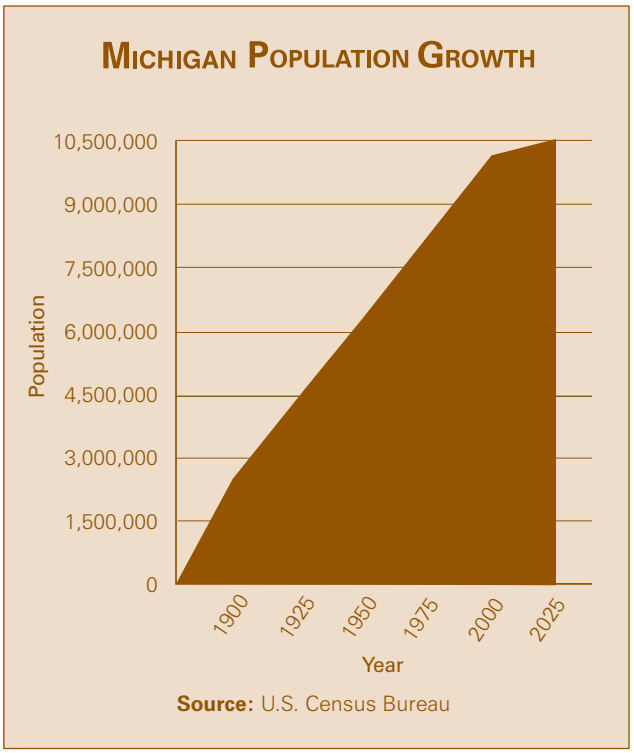
Michigan's Growth

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

Continuing its recent trend of slow and steady growth, Michigan added an average of 39,000 people to the state each year from April of 2000 through June of 2003.[17] The estimated annual growth rate is 0.4%, about half the national rate.[18] The fertility rate–the number of children a woman will have in her lifetime given today's birth rate–was 1.9 in 2002, compared to 2.0 for the country.[19] This is high in relation to other developed countries such as European nations and Japan. While the Michigan rate is below the 2.1 replacement level, 43.5% of the state's population is between the ages of 15 and 44, which could lead to a higher birth rate.[20]

Michigan also mirrors the nation with 12.3 percent of the population aged 65 and older in 2000. Life expectancy for men (74 years) is one year longer in Michigan than the national average, while life expectancy for women (79 years) is similar to that of women across the U.S.

In terms of migration, Michigan's recent history is characterized by small net out-migration to other states, with more out-migrants than in-migrants almost every year since 1970.[21] Since the 2000 census, however, the estimated annual net loss of 78,000 residents to other



states was offset by an estimated net gain of 82,000 residents from other countries. While international in-migration has contributed to Michigan's population growth it has been a smaller factor within the state than in the U.S as a whole. The principal cause of population growth in Michigan relates to the greater number of births than deaths, even as the number of births decline and the number of deaths rise.[22]

Temporary migration, or tourism, also has considerable environmental effects.[23] Tourism and natural resource-based recreation attract thousands of people to Michigan year-round from neighboring states, as well as from Ontario, Canada. An estimated 1,824,000 people fish in Michigan annually, of which 20% are out-of-state residents. In addition, over 935,000 people hunt in Michigan (more than any other state), of which 7% are non-residents.[24] Snowmobiling, downhill skiing, golfing, hiking and other tourism activities also contribute to an influx of seasonal populations.

Michigan's Population Profile

Households

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

Between 1970 and 2000 Michigan's population grew by 12%, whereas the number of households increased by 43%.[25] Household size has also declined from 3.42 people in 1950 to 2.66 in 1990.[26] This decline in the number of persons living in a household can be attributed to several factors including the postponement of marriage, later childbearing, fewer children per family, increased longevity, and an increase of single persons living alone. About 60% of all households had a household size of two or fewer in 2000.

For the past decade Michigan experienced a 10% increase in housing units, similar to the 10.1% growth in housing for the Midwest as a whole, but slightly lower than the national growth of 13.3% in the same period.[27] During this time, Michigan's population increased by only 6.9%,[28] reflecting the shift to smaller household sizes. Indeed, 386,353 new housing units were built for only 384,423 new residents. Second home development plays a minor role in increased housing development, yet Michigan ranks fourth in the country with 234,000 seasonal, recreational, and occasional-use homes, representing 5.5% of the state's housing stock.[29]

Since every household tends to have certain minimum possessions, occupy a certain minimum amount of space, and emit a minimum amount of pollutants, an increase in the number of households can significantly increase environmental impacts even when the population as a whole is not growing at a fast rate.

Consumption and Income

In addition to the population growth and distribution within the state, another important population-related driver of environmental change is the rate and manner in which large numbers of people are consuming natural resources. Rates of consumption are often associated with income, as data indicate that more affluent societies tend to consume more resources, resulting in a greater environmental impact.

Michigan's average household income is $44,667, slightly higher than the national average of $41,994. Poverty in Michigan is slightly lower than the national average, with 10.5% of the population living below the poverty level compared with 12.4% nationwide.[30] However, Michigan currently has one of the highest unemployment rates in the nation at around 6%. Poverty is found in the industrial centers of the state, and within rural and agricultural areas as well.

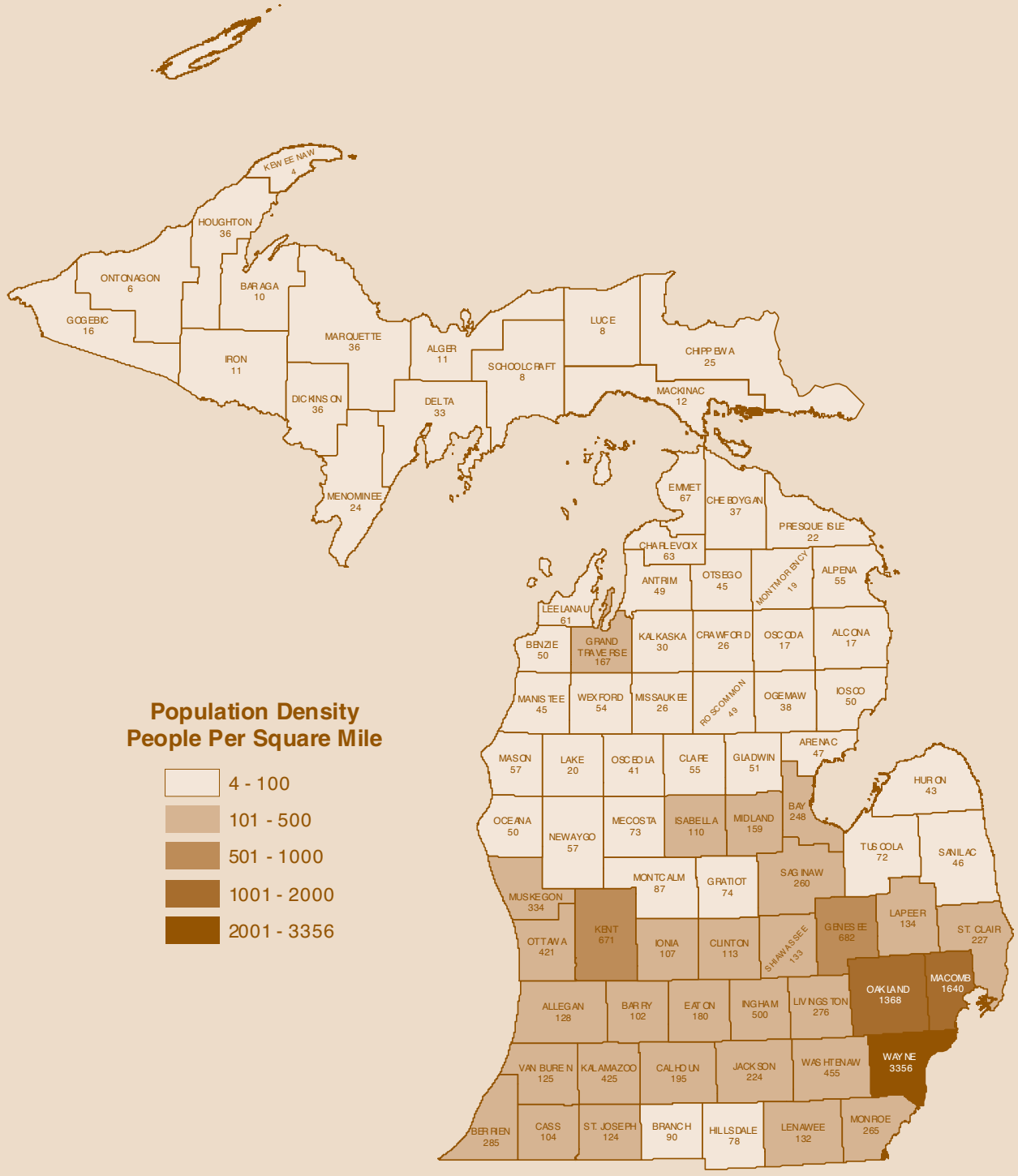
Projections

Michigan's population is projected to slowly increase in the decades to come, adding a total of 755,728 people over the next 30 years and then stabilizing between 2025 and 2030.[31] Even though the population as a whole will increase, growth is expected only in the 45 years of age and older population, with the under 18 population decreasing 6% and the 65 and older population increasing by 70.7%.[32] It is expected that the majority of population growth will occur in the outlying fringes of the metropolitan areas, specifically within the Southeastern and Western sections of the Lower Peninsula. High growth rates are also likely to continue in the northwestern corner of the Lower Peninsula, while populations will continue to decline in the Upper Peninsula.

An important population-related driver of environmental change is the rate and manner in which large numbers of people are consuming natural resources.

Michigan's Population Profile

Michigan's Population Density



Population numbers in Michigan, 2000

Source: MI Center for Geographic Information, Department of Information Technology, 2002

Population-Environment Facts

	M.I.	U.S.	World
Population, 2004	10.113m	296.807m	6.458b
Projected population, 2030	10.694m	363.584m	7.9b
Annual growth rate/% change, 2003-2004	0.4	1.0	1.3
Number of people added, 2003-2004	30,256	2.8 m	73m
Annual natural increase (births minus deaths)	42,424	1.5m	79.2m
Annual migration (interstate) 2003-04	-36,450	–	–
Annual migration (international) 2003-04	23,956	1.3m	–
Doubling time at current (2002-03) rate	190 years	71 years	53years
Percent change 1990-2000	6.9%	13.1%	–
Percent under 18 and over 65	38%	38.1%	37%
Percent female	51%	51%	50%
Percent male	49%	49%	50%
Median age	36.6	36	28.1
Fertility rate (Average number of children/woman)	1.9	2.0	2.8
Birth rate (births per 1,000)	12.9	14	21
Infant deaths per 1,000 live births	8.1	6.7	56
Life expectancy male/female	74/79	73/79	65/69
Density (persons per square mile)	175	79.6	123
Percent urban 2003	80%	79%	48%
Housing Units	4.234 mil	105.480 mil	–
Average persons per household (2000)	2.56	2.6	–
Gross State Product per capita 2004	$29,230	$27,686	$4,909
Per Capita Income/Gross National Income	$22,168	$36,110	$7,590
Median household income	$44,221	$41,994	–
Persons below poverty level	10.5%	12.4%	–
Percent in labor force	60.7 %	66.2%	–
Adults/high school graduates	87.1%	83.6%	–
Adults/bachelors degree or higher	24.3%	26.5%	–
Endangered/threatened animal species	81	398	7,180
Endangered/threatened plant species	261	599	8,321
Percent of land protected	22%	25.9%	10.7%
Wetlands loss up to 1980	73%	46%	–
Daily water use per capita (all uses)	1095 gal	1430 gal	465 gal
Water use for domestic purposes	11%	12%	8%
Water use for agriculture	2%	42%	71%
Water use for industry	6%	6%	23%
Water use for energy production	81%	47%	–
Cropland per capita (acres)	1.2	2.3	0.7
Energy use per capita (crude oil barrels equiv)	53.8	58.7	2.8
Persons per motor vehicle	.85	1.3	9
Average Daily Commute (time in minutes)	22.1	24.3	–

Sources: US Census Bureau, Center for Disease Control, State of Michigan Office of Demography, UN Population Division, Population Reference Bureau, World Bank, USDA National Agricultural Statistics Service, US Geological Survey, Energy Information Administration, The Nature Conservancy, and US Fish and Wildlife Service

Michigan's Population-Environment Challenges

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

Land-use

Michigan's human population and its appetite for land both have significant impacts on land-use in the state. Even at a slow rate of growth the development of new homes, roads, workplaces and services can consume agricultural and forest land while fragmenting wildlife habitat and reducing access to other vital resources such as water. It paves over soils with impervious surfaces, reduces groundwater replenishment and increases runoff and flooding.[33]

Between 1982 and 1992, approximately 456,000 acres in Michigan were converted to developed uses, while another 364,000 acres were converted to development within the next five years.[34] If this trend continues, between 1.5 and 2 million more acres will be converted to residential, commercial, and industrial land by 2020, an increase of 63 to 87%, despite the fact that population is projected to increase by only 11.8%.[35] Thus, most of the land development in Michigan in the next 15 years is expected to result from changes in how people consume land, while population growth itself will play a smaller role.

Sprawl Development

As in much of the Midwest, the "sprawl" pattern of Michigan's development has three main results: rapid land-use change, an increase in dispersed housing coupled with abandonment of urban centers and older communities, and an increase in travel for everyday purposes.

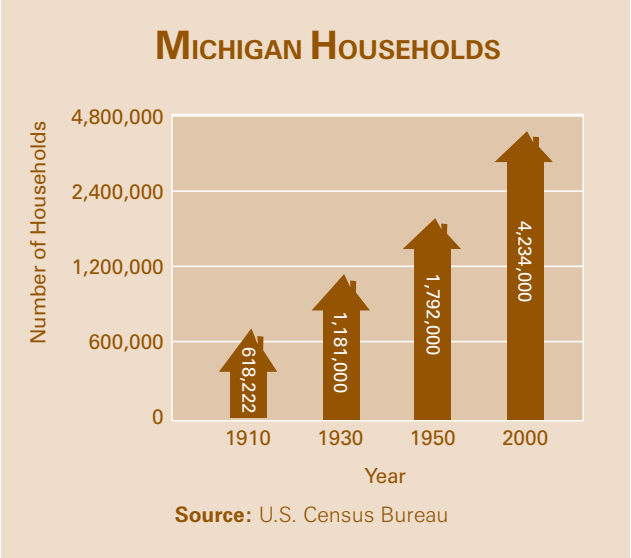
According to the Michigan Society of Planning Officials, "sprawl is a low density land-use pattern that is automobile-dependent, energy- and land-consumptive, and requires a very high ratio of road surface to development served."[36] Sprawl is apparent in low-density residential subdivisions, commercial strip development, large retail complexes surrounded by acres of parking, office parks far from homes and shops, and a growing network of roads linking them all.[37] Even without population growth, sprawl development can cause dramatic changes in local and regional land-use patterns as people change the way they use and inhabit a landscape.

Rapid land-use change: In comparison to other regions of the country the Midwest is adding few people, but consuming significant amounts of land. Between 1982 and 1997 the region's population grew by only 4.1 million people, while urbanization affected 4.5 million acres of land, resulting in a 19% decrease in population density.[38] During the early 1980s the average population density was 3.8 persons per acre, but has since dropped to 2.8 persons per acre by the late 1990s.[39] This means that the new development in Michigan is much more spread out than the development that preceded it, with dramatic effects on overall land-use.

Currently 10% of Michigan's land is developed.[40] However, built or developed areas are projected to increase 178% by 2040.[41] The majority of this land will be converted for residential and commercial development. The value of farm real estate has doubled in the last decade reaching $2,250 per acre, yet these values are much lower than the value of land for large-lot single-family development, putting tremendous pressure on farmers to sell or develop their land.[42]

Increased housing and low density housing: The number of housing units in Michigan has been growing more rapidly than the population. In fact, land in Michigan is being developed eight times faster than its population grows.[43] Second home development in parts of the Upper Peninsula and northern Lower Peninsula is predicted to increase by more than 80% by 2020.[44]

At the same time the number of dwellings is increasing, so is the average lot size, creating an increase in lower density housing. Nationally the average lot size per single family home has increased from 1.05 acres in the 1950s to 1.82 acres in 1997. In southeastern Michigan, where some of the fastest growing counties are located, 43% of the total land developed is the result of lower density housing, while 27% is a direct effect of population growth.[45] The average density of housing units per acre decreased from 2.84 in 1990 to 1.26 housing units per acre in 2000. Decreasing housing density is a result, in part, of development in newer growth areas which lack public sewer systems and thus require one-acre or larger lots for septic systems.[46]



The loss of housing can also affect land use, particularly in urban centers where abandoned and demolished housing create vacant lots. The City of Detroit lost a net 34,931 housing units between 1990 and 2000 resulting in 4,600 more acres of vacant land and a 12% increase in suburban housing units due to the relocation of residents to growing suburban areas throughout the region.[47] This shift in investment and development from the city to the suburbs presents a whole host of economic problems including declining property values, population, and tax base often leading to the deterioration of roads, sewers, buildings and other public institutions.[48]

Increased driving: Sprawl also means greater distances between people and places, and increased car dependence. The average American driver now spends 443 hours each year behind the wheel, with residents of sprawling communities driving three to four times as much as those living in more compact areas.[49] Nationwide, the number of miles driven has increased at four times the rate of population growth since 1980. [50] This holds true for Michigan, too, where land development patterns have been influenced by not only the physical relationships between transportation and land use, but also by being a leader in the automobile industry.[51]

Travel on Michigan roads has increased more than 47% since 1984, which is attributed to greater distances traveled to work and for other purposes.[52] The average commute time for residents in southeast Michigan is 26 minutes, with 12% of residents commuting more than 50 minutes.[53] Longer commutes and driving on congested highways in Metropolitan Detroit alone cost state motorists $2 billion a year in burned fuel and wasted time.[54] Increased driving is sustained by the disparity in public expenditures on highways (about $235 per person) compared with public transportation (about $44 per city resident).[55] A 1999 study by the EPA found that a few years after roadways are expanded by 10% traffic increases by 7% to 10%.[56] Increased investments in road infrastructure can create a vicious circle by attracting new residents to an area, causing another increase in cars on the road and miles traveled.

Impacts of sprawl development: Sprawl development has already had major environmental effects in Michigan. As of 1997, developed land covered 10% of the state's 37 million acres, accounting for 49% of wetland loss and a 13% decrease in farmland.[57] While forest cover will increase slightly in the near future due to farmland abandonment and natural reforestation, projections show a 1-2% decrease in forestland by 2020 and a 2-7% decrease by 2040.[58] Forestland loss is expected to be greatest in southern Michigan where up to 13% of forestland may be lost by 2020 and 25% lost to development by 2040.[59]

Forecasts show considerable expansion of built land throughout the state over the next 30 years, with much of the land remaining consisting of water, wetlands, parks and recreation areas. Further development will not only drive up housing prices as land becomes scarce, but also threaten currently protected lands in the area while making it more difficult to increase the amount of land preserved as open space.

Agriculture

Agriculture is a socially and environmentally significant feature of Michigan's working landscape and economy. Ranked as the second largest industry in the state, agriculture employs 14.7% of the state's population and accounts for $22 billion in direct economic revenue and $37 billion in indirect revenue.[60] With approximately 52,000 farms around the state, agriculture comprises nearly 28% of total land use. Ninety percent of these farms are owned by individuals or families.[61]

Agriculture is considered by many to be less environmentally damaging than other types of land use. The U.S. Department of Agriculture stated in a 1997 report from the Natural Resources Conservation Service, "Well-managed agricultural land also produces healthy soil, clean air and water, wildlife habitat, and pleasing

landscapes, all of which are increasingly valued by rural and urban citizens alike."[62] On the other hand, poorly-managed farm operations can threaten water quality and degrade wildlife habitat, among other environmental consequences.

Experts agree that the loss of land to development is the most serious threat to agricultural soil and to wildlife habitat on land owned by farmers. Growing populations, and even faster growing household numbers, will intensify the demand for development of infrastructure and services that are burying farmland under concrete, tarmac and lawns. While an increase in demand for agricultural production from a growing human population could be of economic benefit to the industry, this rise will escalate pressure on the food and water that a growing population needs.

Michigan's Farming Sector

Michigan's history of glaciations created soil variation across the state, which now has the second most diverse agricultural sector in the country after California.[63] Dairy is the major farm enterprise in the state followed by ornamentals, corn, soybeans and hay (major cash crops).[64] In 2002 Michigan ranked number one in the nation for the production of black and cranberry beans, blueberries, cucumbers (for pickles), hanging flowering baskets, geraniums, impatiens and other potted perennials (specialty crops).[65] Michigan's diverse agricultural enterprises provide stability to the agricultural sector and economy. However, changes in land use that cause fragmentation (the dividing of contiguous blocks of land by roads, residential or commercial development and other non-agricultural uses) and closer proximity of urban to rural areas could have a substantial impact on particular sectors in the industry.

Threats to Agricultural Land and Soil

On average, land use for farming has been declining. Since the beginning of the 20th century Michigan has lost 76% of its farmland. Between 1982 and 1992, Michigan lost roughly 85,000 acres of farmland per year for a total of 854,000 acres. This is comparable to losing the area of 3.75 Michigan townships per year. At present, Michigan averages a loss of approximately 38,900 acres per year due to development and low density fragmentation.[66] Today farmland occupies approximately 10 million acres, though this is expected to decline in the future.[67]

In an analysis completed by Michigan State University's Department of Agricultural Economics, only modest losses of 2.8% in agricultural land were predicted based on estimates of the relationship between population change and urban development. However, the model predicts a 15% statewide loss of farmland by 2040 when taking into account the effects of sprawl. This reduction in farmland is expected to be most significant in the southern half of the Lower Peninsula–a primarily urban region that represents 80% of the state's total farmland and where 50% of the land area is occupied by farms.[68] Specialty crops and fruit production are expected to be the most vulnerable to urban expansion. If development rates continue, for example, Michigan could lose 25% of its orchard land within the next 40 years.[69]

The American Farmland Trust has placed Michigan in the top 10 states for farmland loss due to development, ranking 9th.[70] Farmers in the Lower Peninsula face increased pressure from development when they see land values of $1,839 per acre for agricultural use dwarfed by values of $7,423 per acre for residential development and $19,495 per acre for commercial/industrial use. Of the 245,000 acres of farmland sold in 1999, only 52% was sold to other farmers, meaning nearly half was sold for non-farm purposes.[71] This movement of land classified as agricultural to other designations contributes to an annual value cash loss of agricultural land of $1.14 billion.[72]

Competition for Water

Although precipitation in Michigan is usually sufficient for crop growth, irrigation has become more common throughout the Great Lakes region, allowing for greater control over the amount and timing of water applied. The amount of irrigated farmland within the Great Lakes Region increased by almost 30% from 1987 to 1997 and is expected to steadily increase.[73]

Water withdrawals for irrigation of cropland surveyed in Michigan in 2001 were estimated at 207 million gallons of water per day. Over half (65%) of the water withdrawn for irrigation purposes came from groundwater, 35% from inland lakes and streams, and 3% from the Great Lakes.[74] The majority of irrigation occurs throughout the summer months, straining water supplies in nearby lakes and streams.[75] In some areas, elevated ground water withdrawals for municipal and industrial irrigation uses have also caused some residential wells to run dry.

Top 10 States Losing Prime Farmland

State	Prime Acres Lost	Increase in Rate of Loss Over Previous 5 Years
TX	332,800	42%
OH	212,200	45%
GA	184,000	66%
NC	168,300	1%
IL	160,900	137%
PA	134,900	23%
IN	124,200	65%
TN	124,000	42%
MI	**121,400**	**67%**
AL	113,800	127%

Michigan is among the top ten states in the U.S. losing the most prime farmland between 1992-1997.

Source: American Farmland Trust "Farming on the Edge"

With the majority of water for irrigation coming from ground sources it would seem that irrigation water use is of no consequence to the Great Lakes themselves. Unfortunately, little is known about the relationship of groundwater (and the return of used irrigation water to the ground) to Great Lakes water levels.[76] Though the Great Lakes may appear to be an unlimited supply of freshwater, competition for this large source of fresh water is becoming fierce locally and globally.

Farmland Protection

The Agricultural Preservation Fund and Board provide state cost sharing for purchase of development rights (PDR) programs. These programs allow farmers to sell the development rights of their property to a local government unit which holds the rights and permanently protects the land for agricultural use. Due to the shortage of state funding, however, only 55 PDRs have been funded of the 1200 applications for the program that have been received since 1995.[77]

Other federal and state funded programs such as the Farmland Preservation Act, Right to Farm Act, and Michigan Agricultural Environmental Assurance Program have also been enacted to assist farmers. Still, today only 2.9% of Michigan's total farmland is covered by conservation or wetlands reserve programs.[78]

Forests

Michigan's 19.3 million acres of forestland cover over half of the state, which ranks 11th nationally in area of forested land.[79] Michigan forests make significant contributions to the quality of life for humans and wildlife by improving air and water quality, providing wildlife habitat and ecological connectivity, supporting outdoor recreation and adding $12 billion in economic resources from various forest industries.[80]

Prior to settlement, Michigan was nearly entirely forested leading the first settlers to believe that the timberland would exceed market demands for hundreds of years. However, from 1830 through the turn of the 20th century logging and wildfires depleted the state's forests, leaving a barren and eroding landscape. After 1930, improved forest management methods, reforestation, and the acquisition of land by the state and federal government began to restore much of the timberland.[81] Some of this recovered forest land was later converted to farmland, tree plantations, or reforested monocultures.

The state's forest cover provides the equivalent of 2 acres of forest per person, similar to the national average.[82] Timberland acreage (forests capable of growing commercial wood) ranks fifth largest in the nation, accounting for 98% of forestland in Michigan.[83] Even so, forests are not distributed equally around the state. Monroe (38,000 acres) and Wayne (36,000 acres) counties, located in the densely populated southeast corner of the state, posses the smallest acreage of forested land, while Marquette (1.02 million acres) and Ontonagon (752,000 acres) counties posses the largest.[84]

Thirty-eight percent of Michigan's forestland is publicly owned, with state-owned forestland totaling 3.9 million acres (20% of state forestland) and federally-owned lands (including three National Forests) comprising 14% of the total land acres. In total, Michigan boasts 7 million acres of publicly-owned forestlands, the largest amount of public land in any state east of the Mississippi River.[85] These public lands support nearly 20 million user-activity days per year of recreational uses, and provide essential ecological services and wildlife habitat year-round.[86]

Although large areas of Michigan's land are under public ownership, two-thirds of all land in the state is privately owned. The largest sector of private land ownership–private individuals–accounts for 44% of timberland (8.4 million acres). This ownership group – with divergent backgrounds, goals, and management strategies – typically manages relatively small tracts of land, resulting in a patchwork of forest conditions.[87] Forestry-related industries and other corporations own 19% of all Michigan timberlands, typically in large tracts, and contribute $9 billion annually to the state's economy.[88]

Forest Land Conversion, Parcelization and Fragmentation

Michigan's forests are facing significant threats, including: the conversion of forests to residential and commercial development, "parcelization" (the division of land into smaller units of ownership), forest "fragmentation" (the dividing of contiguous blocks by roads, development, and other non-forest uses), invasive species, and unsustainable timber management practices.[89]

A majority of forested land is located in the Upper Peninsula and northern Lower Peninsula of Michigan – where there are fewer people there is more forest, and vice versa.[90] However, an increasing number of people are moving into the northern Lower Peninsula for retirement living, or buying vacation homes, with parcels averaging 10 acres in size capturing a large share of new residential construction. Increasing low-density residential development in the southern Lower Peninsula during the last 40 years has also been responsible for significant loss of woodland area on farms.[91]

Forest fragmentation jeopardizes wildlife species that require large continuous tracts of land for foraging, raising young, and dispersion to maintain genetic diversity. Generally, fragmentation is most advanced where population and recreational development are heaviest, particularly affecting terrestrial animals. Michigan forests provide essential resting and feeding sites for neo-tropical birds migrating to and from their northern breeding grounds. Some of these migrants prefer the larger existing forest tracts found in this region, which provide the only major resting opportunity between the Ohio River and forests further north.[92] In addition, Michigan's forests are the nesting sites of migratory birds such as the endangered Kirtland's Warbler which prefers to nest in jack pine communities that are threatened by fragmentation and forest land conversion. Decreases in 17 species of Michigan birds have been attributed to deforestation within the state.[93]

Forest Health

As the state's population has grown, so has the means for invasive, non-native and exotic species (those that arrive accidentally or were intentionally introduced) to enter the state's borders. Such species can spread diseases that threaten Michigan's forests. For example, the emerald ash borer, native to China, Korea, Japan, and Far East Russia, most likely found its way to Michigan in shipping material in the late 1990s. To date, an estimated 6 million ash trees have been reported infested or dead in southeastern Michigan due to the emerald ash borer.[94]

Increased populations of native pests and parasites are also of great concern. Many epidemics of forest disease are triggered during years of drought when trees can be stressed and more susceptible to disease or invasion by insects. In its peak year of 2001, the forest tent caterpillar defoliated 11.5 million acres. Other diseases and insects of concern include the Eastern larch beetle, larch casebearer, red-headed pine sawfly, oat wilt, sphaeropsis canker and spruce budworm.[95]

As the state's growing human population disperses into more rural areas, containment of such pest species will become increasingly difficult, further endangering forest resources.

Future Trends

As demand for wood products nationwide continues to increase, growing twice as fast as the U.S. population, Michigan's forests will most likely be called upon to help meet the demand. Michigan's forests are considered highly productive in the amount of mature timber for harvest, with a surplus growth of 255% – larger than any other state and twice the national excess growth of 132%.[96] This surplus growth is important for a recovering ecosystem that was destroyed less than a century ago and is now becoming a maturing resource that can be managed for old growth or improved structural diversity of forest types.

While the amount of timberland increased between 1980 and 1993 by more than 1.1 million acres, most of this increase can be attributed to the natural reforestation of abandoned agricultural lands.[97]

Forestland acreage may increase if the current trend of reforestation efforts and natural succession continues to generate an increase in net forested area after timber removals. However, if population growth and residential and commercial development continue to drive the demand for wood products and decrease forestland area, timber removals could exceed forest growth by 2023.[98]

Water

Water is essential for all life. Natural ecosystems and the plant and wildlife species they support would not function without freshwater. Human activity from housing to agriculture to industry and commerce also requires freshwater, but our growing population and the ways we utilize water can threaten water supply and quality. Population growth and economic development within the U.S. and around the world are rapidly increasing the demand for water, intensifying the pressures on freshwater.

Michigan is the only state entirely within the Great Lakes basin, making water an integral part of the state's heritage, economy and quality of life. The Great Lakes serve as a primary source of domestic and industrial water, provide economical means to transport raw materials, agricultural products and manufactured goods, offer an abundance of recreational opportunities, and are the backbone of the state's tourism industry.[99] The Great Lakes contain 90% of the surface freshwater in North America, and 18% of all surface freshwater on Earth. In addition to the 25 million acres of water surrounding Michigan's two peninsulas, 40% of the state's surface area is covered with more than 35,000 lakes and ponds and 36,000 miles of streams.[100]

Threats to the Great Lakes and to Michigan's inland waters include: toxic contamination, non-point source pollution, excessive nutrients, exotic species, water diversions, declining lake levels, and habitat loss.[101] Combined, these threats can mean serious consequences for humans and wildlife.

Water Withdrawal and Use

With millions of acres of surface water and plentiful rain and snowfall, Michigan has a relative abundance of freshwater that supports human activity and natural ecological processes. For many human uses, withdrawn water is later returned to the water source after appropriate treatment and so is available for re-use. In contrast, consumptive use refers to water that is not returned to the water source but rather lost through evaporation, incorporation into a product, or transpired into the atmosphere through plants.

Per capita water use in the U.S. is more than four times higher than the global average, and Michigan follows suit. The average Michigan household uses 75 gallons of water per person per day.[102] The Great Lakes account for a significant portion of the public water supply not just in Michigan, but regionally, providing freshwater for almost 40 million people in the United States and Canada.[103] Although water may appear to be a vast resource, each year rainfall and snow melt replenish only about 1% of the water in the basin–the other 99% is finite and nonrenewable.[104]

Due to this slow rate of recharge, the Great Lakes are susceptible to long term damage. A failure to manage the combined demands on the water supply could result in the depletion of local groundwater reserves and reduce the amount of water that naturally sustains wetlands, rivers, and wildlife. In Monroe County, on the western shore of Lake Erie, a combination of drought and groundwater withdrawals, primarily from rock mining operations, have resulted in the decline of subsurface water levels, affecting the ability of local townships to meet the water needs of residents.[105] Increased water withdrawals to meet the needs of the growing residential, commercial and agricultural demands have also contributed to the declining fish population of the St. Joseph River, where species depend on the strong currents and cold waters that high waters bring.[106]

The major water use sectors in the state include thermoelectric power generation (81%), public water supply systems (11%), self-supplied industries (6%), and agricultural and golf course irrigation (2%). Of all water withdrawn in Michigan, 91% comes from Great Lakes water sources. In 2001 thermoelectric power generation withdrew four times the amount of water as the other three sectors combined. Thermoelectric power plants withdraw water from the Great Lakes for use as a cooling medium, later releasing virtually all the water back into the Great Lakes. While an estimated 90% of water withdrawn is treated and returned, distribution varies as water is often returned to other waters than the original withdrawal source.[107] Irrigation water is primarily withdrawn from groundwater sources (64%) and is not as dependent on the Great Lakes. Consumptive use of water is difficult to determine since only water withdrawals are reported, estimated at 5-10%, with irrigation being on the higher end and thermoelectric power generation on the lower end.[108]

Michigan's Population-Environment Challenges

Michigan has the eighth largest public water supply withdrawals in the country, and accounts for the largest amount of water withdrawn for public water supply within the U.S. portion of the Great Lakes Basin. Community water supplies within the state serve 7.2 million people through residential, commercial, industrial, and public facilities. In 2001, it was reported that 77% of the water withdrawn for public water supplies came from the Great Lakes and their connecting waters, 21% from groundwater, and less than 2% from inland lakes and streams. Southeastern Michigan, the most populated corner of the state, is responsible for 44% of the community water supplies in the state withdrawing 97% of their water directly from the Great Lakes and connecting waters.[109]

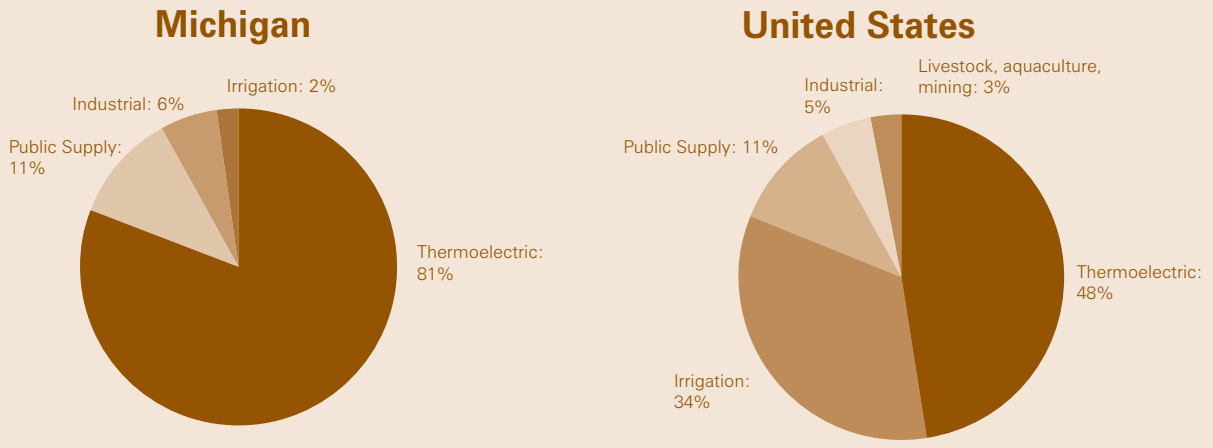
There are more households (1.12 million) in Michigan served by private wells than any other state in the country. Every year approximately 25,000 new domestic wells are drilled to meet the demand for low density housing in new subdivision developments.[110]

Water Quality

Water quality is affected by five main elements: pollution from point sources (chemical and industrial), non-point sources (urban and agricultural runoff), septic and sewage systems, site development activities, and the atmospheric deposition of toxic chemicals such as mercury. These types of contamination all stem from population pressures and economic activity, including housing and road development, industrial development, agricultural practices, human waste disposal, and air pollution from cars, homes and factories.

Lakes and streams in the northern two-thirds of Michigan generally exhibit high water quality, with the exception of areas of high population density or areas near industrial and mining sites. The more-populated southern third of the state has many lakes, rivers and streams that do not meet water quality standards. Statewide more than 10,000 groundwater pollution sites have been identified over the last ten years, and in 2001 it was estimated that 560 municipal water supplies have been affected by groundwater pollution. Near surface groundwater is a main source for many of Michigan's rivers and lakes and close to half of the population relies on groundwater for domestic use.[111]

The International Joint Commission (IJC) has identified approximately 360 toxic pollutants in the water, sediment and wildlife of the Great Lakes region.[112] Persistent toxic chemicals such as dioxin, polychlorinated biphenyls (PCBs), mercury and lead, poly-aromatic hydrocarbons, and pesticides are major threats to the Great Lakes and Michigan's inland waters including ground and surface water. Toxic at even low concentrations, these pollutants accumulate in species lower on the food chain such as plankton and macro invertebrates (bioaccumulation), increasing in concentration in fish and wildlife at successive levels of the food chain (biomagnification). The majority of these toxic chemicals enter Michigan's waters from surface runoff, direct discharge and air deposition. As a result of elevated levels of dioxins and the bacteria *E. coli*,



Percent of million gallons of freshwater used per sector per day

Source: Michigan Department of Environmental Quality, Water Use Reporting Program, USGS

3,250 miles of Great Lakes shoreline (nearly 30%) and 10% of inland lakes and streams do not fully support designated uses (swimming, drinking water, fishing, etc.).[113]

In a 2004 report on the nation's water quality the United States Geological Survey (USGS) noted that even low levels of urbanization can have an effect on aquatic ecosystems. While restrictions on PCBs and the pesticide DDT have helped to improve water quality overall, increasing motor vehicle traffic in urbanized watershed areas is increasing the levels of polycyclic aromatic hydrocarbons (PAHs).[114] Harsh winters and increasing vehicle traffic adds to the use of salt to de-ice roads, resulting in increased levels of sodium chloride in Michigan's rivers and streams. Road salt is a primary source of chloride in urban runoff, along with municipal wastewater discharges.[115]

Microbial contamination is also an increasing threat to surface and ground water quality, especially in southeastern Michigan, where a boom in housing development is surrounding existing farms with new domestic water wells. Surface runoff from farm manure stockpiles, sludge applications, spills from holding pens or ponds, and waste storage lagoons can often leach into soil and groundwater and contaminate nearby wells.[116] Discharges of liquid manure (often illegal), and contaminated runoff from Concentrated Animal Feeding Operations (CAFOs–defined as operations of 700 or more animals) have become a serious issue all over the state and provoked citizen action in the south central Hillsdale and Lenawee counties where 10 new CAFOs have been constructed in the last few years.[117]

As regulated by the Clean Water Act, all wastewater must be treated before being returned to the receiving waters. However, older cities with a combined sewer system–consisting of a single pipe for sanitary waste, industrial waste and storm water–are susceptible to overflow, often discharging untreated waste directly into surface waters after heavy rains or excessive snowmelt. More than 50 cities in Michigan still operate combined systems and release a billion gallons of sewer water, called combined sewer overflows (CSOs), into surface waters every year.[118] Older urban centers with declining populations could be especially at risk as the shrinking tax base fails to support public infrastructure.

Aquatic Invasive Species

Aquatic invasive species are harmful, non-native plants, animals and microorganisms that are introduced into an environment in which they did not evolve. Historically, as Michigan's human population increased, so too did the number and variety of invasive species.

The primary path of entry for aquatic invasive species into the Great Lakes Basin is by way of ballast water from ocean-going ships. Since the opening of the St. Lawrence Seaway in 1959, ballast water discharge has been the pathway of entry for 77% of non-native organisms introduced in the Great Lakes.[119] Invasive species can also arrive in local rivers and lakes stuck on the sides of recreational boats, through accidental releases from fish farms, live fish market sales and dumping of bait buckets.

Aquatic invasive species can also have implications for water quality; for example, the zebra mussel, which scientists believe is responsible for the increased frequency of toxic blue algae blooms (Microcystis), resulting in health concerns for humans and wildlife and the fouling of drinking water supplies.[120] Zebra and quagga mussels have also caused major problems by attaching to municipal and industrial water supply intake pipes. The control costs of the zebra mussel alone are estimated at $5 billion basin-wide.[121] And every eight months a new aquatic invasive species is introduced into the Great Lakes.[122]

Fisheries

Michigan's fisheries are an essential food source and component of the state's economy providing jobs, a popular source of recreation, and an important subsistence food for the Native American tribal community. Commercial and recreational fishing support 9,000 and 75,000 jobs respectively.[123] According to a 2001 survey, more than 1.3 million people (resident and non-residents) fish in Michigan, generating more than $838 million statewide.[124] Combined, the commercial and sport fisheries on the Great Lakes are valued at $5 billion annually.[125] Michigan's fish populations also comprise a key link in the web of life, as fish consume smaller aquatic species and provide an important food source for birds.

Great Lakes & Inland Fisheries

At one time an estimated 185 fish species were indigenous to the Great Lakes. However, a combination of population-related factors such as habitat destruction, dam construction, over-harvesting, pollution, and logging, and the lack of enforcement of regulations regarding the taking of fish and game throughout the late 1800s and early 1900s led to the collapse of many fish populations in the Great Lakes and Michigan's inland lakes. Fifteen species of fish are currently listed as endangered or threatened and nine are believed to have been extirpated (rendered extinct) from the waters in and around the state.[126]

The establishment of fish hatcheries has allowed fisheries managers to curb the loss of many diminishing fish populations and continue to be important in maintaining the diversity of prey fish in order to meet predator demands. Hatcheries are also essential in supporting Michigan's sport and recreational fisheries, with 40% depending on stocked fish including 70% of the Great Lakes trout and salmon fishery. Currently the Fisheries Division of the Michigan Department of Natural Resources operates six hatcheries and five permanent salmonid[127] egg take stations for chinook salmon, coho salmon and steelhead trout (a migratory form of rainbow trout). In 2002 a total of 62 million fish representing 12 different species and 1 hybrid were reared.[128] The continued loss of aquatic habitat and increasing pressure on fish populations for recreational and commercial fishing will require the continual stocking of fish throughout the state.

Aquatic Ecosystem Health

Lake trout serve as a good indicator of aquatic ecosystem health since they are long-lived and accumulate toxins such as PCBs and mercury in their bodies.[129] Since 1970 Michigan has issued fish consumption advisories restricting the consumption of fish from its waters. The first statewide advisory for mercury contamination was issued in 1988, and continues to be released on a yearly basis.[130] Among the species on the "Do Not Eat" list for many of Michigan's waters are carp and catfish, along with larger whitefish, lake trout, and smallmouth and largemouth bass. Many of these species, particularly whitefish and lake trout, make up a substantial portion of traditional diets among Native Americans.[131]

Reducing Mercury Pollution

Reducing mercury from local sources directly benefits local watersheds, and local mercury reduction policies, initiatives and pilot projects demonstrate that dramatic mercury reduction is possible. The National Wildlife Federation's (NWF) Great Lakes office is promoting local, regional and national policies to eliminate mercury pollution. NWF is working in coalition with conservation, environmental, community and public health organizations in 16 states and nationally to eliminate or greatly reduce industrial mercury emissions (from coal-fired power plants, incinerators, and manufacturers), to end the manufacture and use of mercury-containing products and to increase awareness of fish consumption advisories. In addition to posing serious human health threats, unsafe levels of mercury in fish threaten the survival of the fish themselves, and of the many bird species such as great blue herons and cormorants that depend on fish for their survival.

Michigan's stream fish populations also serve as useful indicators of ecosystem health, given that the quality of their habitat is contingent on the conditions of the watershed upstream. Human activities such as housing and road construction, land clearing, well drilling and groundwater pumping can diminish habitat quality by changing stream flow, reducing ground water yield, increasing soil erosion and reducing shading and shelter. For example, brown and brook trout require relatively specialized conditions and are particularly sensitive to such disruptions in their environment.[132] Engineering controls such as dams and canals can also stress fish populations causing some species to migrate out or perish.

Of equal significance is the loss of near shore habitat, which plays a major role in the life history of Great Lakes fishes. More than 75% of juvenile and 65% of adult fish use gravel, sand, or silt habitats in near shore areas and rely on them for food, residence, spawning and migration. Direct alteration of shorelines by housing and commercial development can affect water levels, increase soil hardening, and reduce aquatic habitat diversity. In addition, sedimentation and nutrient enrichment (from phosphates in detergents,

excessive nutrients from agriculture and poor waste management) can cause spawning habitat loss and declines in fish populations. As population growth continues in shoreline areas, these impacts are expected to worsen. More studies are needed to understand the linkages between human-induced environmental change and Great Lakes fisheries.[133]

Biodiversity

Michigan – in large part because it comprises the majority of land within the Great Lakes Basin – is considered relatively rich in biological diversity (the range of plant and wildlife species and ecosystems which provide habitat and invaluable "natural services" such as clean air and water, food and fiber production, and waste absorption). In addition to the state's extensive and distinctive shoreline ecosystems, Michigan's 74 natural communities range from marsh to prairie to boreal forests. These natural communities support over 350 animal species and 2,600 plant species throughout the state. However, at least 46 species of plants and 47 species of animals have become extirpated or locally extinct (meaning it no longer survives in an area once part of its range). Human disturbances, including the conversion of land for agriculture, buildings and roads, mining and solid waste disposal, development of shorelines, and drainage of wetlands have contributed to permanent habitat destruction or long term degradation, leaving many species still at risk today.

The Great Lakes Basin is home to 130 species considered to be globally rare.[134] The Michigan Department of Natural Resources lists 81 threatened or endangered animal species and 261 plant species, as well as another 200 species of special concern.[135] Of these state-protected species, 21 are federally listed as threatened or endangered.[136] The Michigan Wildlife Conservation Strategy, established by the Department of Natural Resources, designates 419 species of greatest conservation need.

Habitat Destruction

Habitat destruction is the primary cause of biodiversity loss in Michigan, and permanent land conversion is widespread throughout the state and the Great Lakes region. Between 1950 and 2000 the amount of land developed at urban densities increased three to four times, while ex-urbanization (population growth in broad regions of rural areas) has been even more rapid.[137] A continued trend of low density development could result in a 40% increase in land conversion by 2020.[138] Development in primarily rural or scarcely inhabited areas can fragment existing wildlife populations, isolating them from one another and disrupting natural processes.

At the state level it is difficult to see trends in migratory songbird populations, but on a landscape scale these small creatures can reflect big changes in land use. Declines in grassland species such as the bobolink, eastern meadowlark, Henslow's and vespers sparrow have been significant. At the same time, generalist species that are more compatible with human activity, such as the house finch, cardinal and house wren, have shown increases in populations.[139]

Biodiversity loss can occur both on land and in aquatic ecosystems, and in Michigan these ecosystems are often inter-connected and have direct and indirect impacts on each other. Today nearly one-half of Michigan's human population lives in a coastal county. This encroachment on shoreline habitat by agriculture, recreation, industry and urban and suburban development may contribute to the fact that approximately 34% of bald eagle shoreline habitat is unsuitable for nesting.[140] The increase of human activity and presence near the lakeshore exacerbates the loss of eagle nesting area, and shrinking habitat availability will mean fewer eagles.

It is estimated that at one time wetlands covered more than 30% of Michigan's surface area. Today wetlands cover less than 5% of the state's total land area. In particular, Michigan has lost 99% of its coastal wet prairie habitat, and virtually eliminated original black soil, dry and sand prairie habitats. Globally rare species such as the piping plover, Pitcher's thistle, Lake Huron tansy, and Houghton's golden rod, among others, require coastal areas as habitat.[141]

Non-Native Species

The invasion of exotic nuisance species into aquatic and terrestrial ecosystems is the second largest threat to biodiversity in the Great Lakes Basin, and the leading cause of extinctions in North American freshwater ecosystems.[142] Since the 1800s 162 exotic aquatic plant and animal species are known to have been introduced into the Great Lakes Basin.[143]

Many exotic plant species introduced in Michigan have become weeds, invasive and/or disruptive to native plant communities. Of the 2,600 plant species currently identified in the state, 800 are non-native, placing 23% of all native plant species at risk by out competing them for resources such as light, moisture, nutrients, soil and space.

Endangered and Threatened Wildlife of Michigan

	Endangered	Threatened
Mammals	Cougar Canada Lynx* Prairie vole Indiana bat*	Gray wolf* Least shrew
Birds	Short-eared owl Piping plover* Prairie warbler Kirtland's warbler* Peregrine falcon Migrant loggerhead shrike King rail Barn owl The lark sparrow is thought to be extirpated (extinct) from Michigan	Henslow's sparrow Long-eared owl Red-shouldered hawk Yellow rail Yellow-throated warbler Merlin Common loon Bald eagle* Least bittern Osprey Caspian tern Common tern Trumpeter swan
Fish	Redside dace Creek chubsucker Silver shiner Northern madtom Pugnose minnow River darter Channel darter Southern redbelly dace	Lake Sturgeon Eastern sand darter Cisco or lake herring Shortjaw cisco Mooneye River redhorse Sauger
	The following species of fish are thought to be extirpated from Michigan: Deepwater cisco, Blackfin cisco, Shortnose cisco, Bigeye chub, Ironcolor shiner, Weed shiner, Paddlefish, Bluepike and Arctic grayling	
Reptiles	Kirtland's snake Copperbelly watersnake* Eastern Massasauga* (candidate)	Eastern fox snake Spotted turtle
Amphibians	Smallmouth salamander	Marbled salamander
Insects	Hungerford's crawling water beetle* Three-staff underwing French Mitchell's satyr* American burying beetle* Phlox moth Leadplant moth Hine's emerald dragonfly* Regal fritillary Karner Blue Butterfly*	Dusted skipper Persius dusky wing Dukes' skipper Ottoe skipper Frosted elfin Great Plains spittlebug Northern blue Powesheik skipperling Silphium borer moth Lake Huron locust
Mollusks	White catspaw Northern riffleshell* Snuffbox Round hickorynut Clubshell* Salamander Mussel Rayed bean* (candidate) Purple lilliput Petosky pondsnail Acorn ramshorn	Lake floater Wavyrayed lampmussel Cherrystone drop Deepwater pondsnail

*Federally designated as threatened or endangered.

In addition, Michigan designates 51 species of native plants as endangered and 210 species of native plants as threatened, of which 8 are federally protected. 46 of Michigan's native plants have been extirpated from the state.

Source: Michigan Department of Natural Resources, Wildlife Division, 2004 and U.S. Fish and Wildlife Service, Region 3, 2004[147]

A few of the most pervasive include: purple loosestrife, spotted knapweed, garlic mustard, buckthorn, honeysuckle, Norway maple, and mile-a-minute weed.[144]

Purple loosestrife, a European plant species, has significantly reduced biodiversity throughout the region's wetlands, inland lakes and rivers by displacing native species and degrading habitat quality for wildlife. The Michigan Sea Grant Program, in conjunction with state and federal agencies, is working to decrease the density of purple loosestrife by introducing natural enemies such as Galerucella beetles. First released in 1994 by the Michigan Department of Natural Resources, these beetles have established large populations in three mid-Michigan sites and caused 100% defoliation of purple loosestrife.[145]

Invasive species often have no natural enemies to limit their reproduction and spread, allowing them to out-compete native species and in the process disrupt entire ecosystems. Nationally, invasive species cost at least $137 billion a year in economic losses.[146]

Energy

Michigan residents use energy to heat and cool houses and businesses, supply electricity for commercial, industrial and residential needs, and provide power for various modes of transportation and recreational vehicles. Energy usage is a function of economic activity, the size and density of human population, and their consumption and use-efficiency levels. The environmental impact of energy use is connected to population dynamics through the types and amounts of energy consumed and their subsequent waste products.[148]

Energy consumption in the state has been steadily increasing over the last 20 years, about 1.3% per year, three times the annual growth rate (0.4%) of the state's population. In 2001 Michigan ranked 9th in the nation for total energy consumption and 34th for energy consumption per person.[149] Consumers spent $20 billion on energy in 1999 alone, accounting for a level of energy intensity (the amount of energy consumed per dollar of gross state product) of 10.5 BTU/$-slightly higher than the national average of 10.3 BTU/$.[150]

Michigan's Energy Supply and Demand

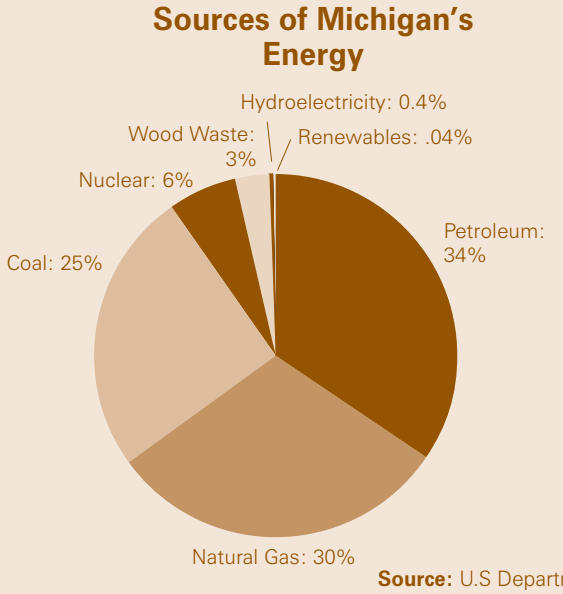
Michigan's primary sources of energy in 2000 were petroleum (34% of energy consumed), natural gas (30%) and coal (25%). Smaller sources included nuclear (6%) and wood waste (3%). Less than 1% of energy consumed was derived from renewable sources, including hydroelectricity (0.4%), geothermal heat, solar power, and wind turbines.[151]

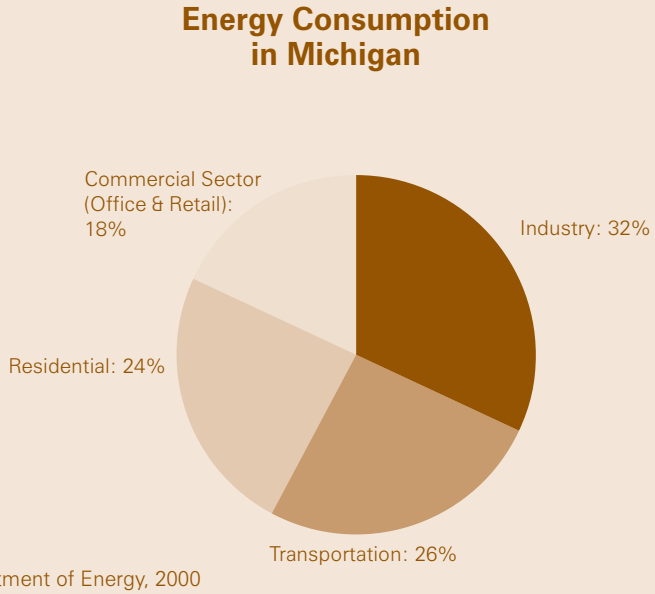
The industrial sector is Michigan's largest energy consumer, accounting for 32% of statewide energy use in 2000. The transportation and residential sectors consumed 26% and 24%, respectively. The commercial sector (including office and retail) represented 18% of the total energy demand.[152] Similar to the nation as a whole, Michigan relies more heavily on coal (56.6%) for its electricity generation than nuclear power (26.4%) and natural gas (13.4%).[153] Michigan ranks 12th in the nation for natural gas production and 16th for crude oil, accounting for 3% of U.S. crude oil production.[154]

Both transportation and electrical power generation rely heavily on fossil fuels, contributing significantly to air pollution in the state. Transportation, a sector totally dependent on fossil fuels, accounts for 74.3% of Michigan's oil consumption.[155] Since 1960, motor fuel usage in Michigan has increased by 88% while population growth has slowed and residents have begun moving farther from urban centers. Travel on Michigan's roads increased more than 47% from 1984 to 2001, and is increasing at a far greater rate than the state's population. According to the Federal Highway Statistics, increased number of vehicles and increased number miles driven have outpaced moderate fuel economy gains. Motor fuel usage across the state totaled 5.94 billion gallons in 2000, an average of 16 million gallons a day.[156]

Environmental Effects of Energy Use

Michigan's energy choices have profound environmental impacts both at home and around the world. The burning of fossil fuels contributes to air and water pollution, acid rain and climate change through the emissions of sulfur dioxide, nitrogen oxide, carbon dioxide and mercury. Coal fired power plants are responsible for the majority of sulfur dioxide and nitrogen oxide releases, which contribute to acid rain, smog and ozone, and contribute to high levels of asthma and other health conditions. Although Michigan contributes greatly to the emissions that cause acid rain, it escapes some of the worst acid rain damage due to the eastward prevailing winds that carry much





Source: U.S Department of Energy, 2000

of the pollution to the eastern U.S. and Canada. [157]

Eighty-three percent of total greenhouse gas emissions in the U.S. and 87% of total emissions in Michigan consist of carbon dioxide (CO2) from the burning of fossil fuels such as coal, natural gas and petroleum.[158] Electricity generation in Michigan was the largest contributor to overall greenhouse gas emissions at 33% followed by the transportation sector at 26%, comparable to the national averages.[159] In Michigan, of the 79,781 short tons of carbon dioxide emitted in 2002 by the electric power industry, 70,623 short tons came from coal.[160]

Coal-fired power plants are the largest source of mercury in the U.S. and are responsible for 60% of all mercury emissions in the state of Michigan.[161] According to the EPA coal-fired power plants emit about 48 tons of mercury in the U.S. every year, accounting for 41% of the total industrial emissions of mercury in 1999.[162] Human activities have caused the rate of mercury deposition around the world to increase by as much as ten times over pre-industrial levels.[163]

Projections for Energy Use

Industry – accounting for nearly a third of the state's energy consumption – forms the basis of Michigan's economy. Without significant increases in energy efficiency Michigan's energy requirement is likely to rise as the state's population and economic activity continue to grow. Continued dependence on fossil fuels for transportation coupled with the lack of efficient public transportation and suburban sprawl throughout the state will also contribute to increasing Michigan's energy demands. Addressing energy efficiency in industry, transportation and housing development and increasing use of cleaner, more renewable fuels will be necessary just to offset the impacts of increased energy demands that come with economic growth and increased population.

Climate Change

The world's leading climate scientists agree that changes to our climate are occurring and that much of this change is due to human-induced factors.[164] The average global temperature is already around 1 degree Fahrenheit higher than a century ago.[165] The global extent of the problem will affect many corners of the world, including the people, plants, wildlife, and natural ecosystems of Michigan.

Human-induced climate change is attributable to the increased emissions of greenhouse gases, primarily carbon dioxide (C02), released in the burning of fossil fuels. The level of these emissions is determined by population and household size, per capita energy consumption, the type of energy used, and the technologies related to energy efficiency and pollution reduction. Michigan's population growth and energy consumption per person contribute to global greenhouse gas emissions and climate change.

Michigan's Population-Environment Challenges

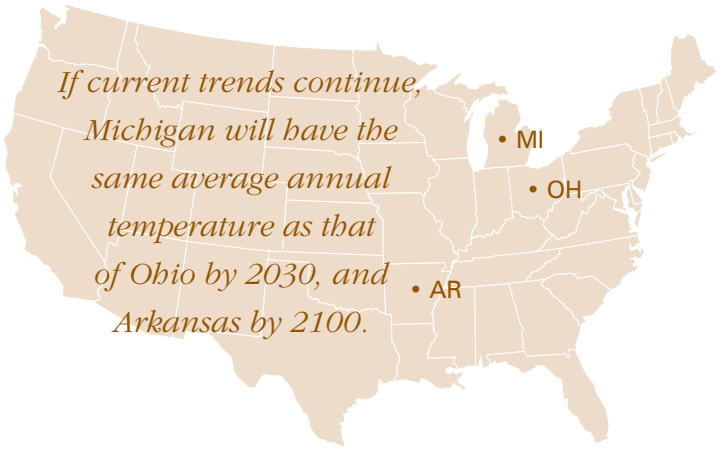
The U.S. is the world's leading emitter of carbon dioxide, producing almost 20 tons per person in 1999.[166] While global per capita greenhouse gas emissions have remained stable over the past three decades at 1.1–1.2 metric tons, total emissions have climbed from 4.1 to 6.6 billion metric tons. With Americans producing five times the amount of carbon dioxide as the world average, population growth will be a large determining factor in future greenhouse gas emissions.[167] Of all global carbon dioxide emissions, 80% come from automobiles and from energy use by residences, businesses and power plants.[168]

Michigan accounts for 3.4% of the total U.S. greenhouse gas emissions. In an inventory of statewide greenhouse gas emissions from 1990-2002 greenhouse gas emissions in Michigan showed a 9% increase. During this 12-year period U.S. greenhouse gas emissions exhibited a similar increase although the population grew at twice the rate of that in Michigan. Per capita greenhouse gas emissions in 2002 were 6.23 metric tons carbon equivalent (MTCE), slightly lower than the U.S. value of 6.57 MTCE.[169]

Changes to Michigan

The signs of climate change are already apparent throughout the Great Lakes region, with an increase in average annual temperatures, frequent severe rainstorms, shorter winters, and shorter duration of ice cover on the lakes.[170] Climate scenarios for the region suggest a year round temperature increase of 3.6 degrees to 7.2 degrees Fahrenheit and 25% more precipitation by the end of the 21st century.[171]

The average temperature in Ann Arbor has increased by 1.1 degrees Fahrenheit from 46.6 in the late 1800s to 47.7 in the late 1900s.[172] Scientists project the number of days in Detroit with temperatures above 90 degrees Fahrenheit to double or even triple towards the end of the 21st century, up to as many as 50 days per year. Without significant action to reduce global warming Michigan summers will appear more similar, in temperature and rainfall, to those of Ohio as early as 2030, and by the end of the century a Michigan summer could more closely resemble the current climate of northern Arkansas.[173] This shift in seasons would also mean a prolonged growing season, making way for double crop production or higher yields, while increasing the strain on Great Lakes water resources if more farmers are forced to turn to irrigation. Warmer temperatures could also bring on an influx of new pests, such as the bean leaf beetle which feeds on soybeans, a major cash crop in Michigan, and also carries a damaging disease that affects soybeans.[174]



During the last century precipitation in some locations around the state has increased by up to 20%.[175] Precipitation under these climate change scenarios will not be evenly distributed, but instead will show increased frequency of heavy rainstorms and fewer occurrences of light rainfall. Such a change in rainfall pattern would lead to a decline in mean soil moisture, resulting in an increased risk of flooding during the spring, and increased drought throughout the summer months.[176] This could also be very damaging to the agricultural sector causing farmers lacking fertile soil to supplement with various nutrients, costing them money and endangering the health of local human and wildlife residents if surface runoff from farms were to contaminate the water supply and surrounding ecosystems.[177]

Impacts on Plant & Animal Species

The interdependent nature of ecosystems could allow an individual species' response to climatic change to alter the entire ecosystem. This may especially be true for exotic and pest species as disturbed ecosystems provide opportunities for resource competition. A logical result will be increased stress on native species and natural communities.

Forests are adapted to specific climate conditions and will be forced to change in response to climatic shifts, declining by as much as 50%-70% around the state. Drier soil, resulting from hotter and drier weather, could accelerate the frequency and intensity of other stresses such as fire, pests, and disease.[178]

Michigan's summer bird species are also likely to respond to climatic changes by altering their range of territory both within and outside of the state. Some of the species that might disappear as summer residents from the Lower Peninsula include alder flycatcher, least flycatcher, tree swallow, pine warbler, savannah sparrow and bobolink.[179] Climate models project a 32% loss of neotropical migratory bird species in Michigan, with wood warblers facing possible extirpation from the entire state.[180]

With a rise in water temperatures and changes in the flow patterns of spawning rivers, aquatic ecosystems will be the most severely affected by climate change. If average stream temperatures rise by 6 degrees Fahrenheit, the potential loss of habitat for brook and rainbow trout in Michigan is 50% to 100%.[181] The distribution of wetlands could gradually shift, but in areas where topography impedes the establishment of new wetlands they would disappear, resulting in serious consequences for the wildlife that depend on them.[182]

Consequences for the Economic and Health Sectors

History has proven the Great Lakes to be highly sensitive to fluctuations in weather with even the normal range of lake level fluctuation of 12 to 24 inches per year having caused considerable damage to coastal ecosystems and human dwellings. Increases in the costs of navigation on the Great Lakes due to lower lake levels could range from 5% to 40%.[183] However, if warmer winter temperatures reduce ice cover the navigation season could be extended, to the benefit of some shippers. Because of the high economic stakes in water-based transportation, lower lake levels could create added pressure for dredging in harbors and channels, further endangering the health of these ecosystems.

As the climate becomes more favorable to mosquitoes, ticks and other disease carrying insects, the risk of transmission of diseases such as malaria, dengue fever, St. Louis encephalitis, Lyme disease, and West Nile Virus may increase. Water borne diseases, such as giardiasis (which already sickens 1,000 residents per year in Michigan), could also become more frequent and widespread.[184]

Deterioration of air quality and increased temperatures as a result of climate change could lead to increased respiratory illnesses, heart disease and heat related mortality. Without factoring in changes in weather or emissions, a 4 degree Fahrenheit warming in the Midwest could increase the concentrations of ground-level ozone, a component of smog, by 8%. Ozone levels in 1997 sent 6,300 people to the emergency room and caused 280,000 asthma attacks in Michigan.[185]

What Does Global Warming Mean for Waterfowl?

Global warming poses a serious threat to Michigan's waterfowl. According to a recent report by the National Wildlife Federation, changes in average temperatures and precipitation patterns are projected to significantly reduce both breeding and migratory habitat throughout the Great Lakes region. Recent studies suggest that these changes could cause duck numbers in the region to decline by up to 39% by the 2030s. Reductions in waterfowl populations would have economic as well as ecological consequences, as hunters spent more than $30 million on migratory bird hunting in Michigan in 2001. To help address the problem, NWF's Waterfowler's Guide to Global Warming, found at www.nwf.org/globalwarming, includes a comprehensive list of recommendations to help improve the forecast for North America's waterfowl.

Solid and Toxic Waste

An increase in human population often leads to an increase in the quantity of solid and toxic waste generated–more people use more things, and more waste is generated. In addition, economic growth and rising affluence contribute to increasing volumes of waste that need to be treated or disposed of. The technologies with which we produce, transport and dispose of goods also affect how much waste is generated. More durable products stay out of landfills longer, while recyclable products may avoid a landfill or incinerator altogether. The volume and type of waste to be managed, and the various disposal methods used, have implications for the natural environment.

Waste Generation and Disposal

Michigan generates an average of 46 million cubic yards (15 million tons) of municipal solid waste (MSW, also known as trash or garbage) annually, but disposes of over 64 million cubic yards (21 million tons) per year.[186] These estimates only account for trash that is reported at landfills and other disposal facilities. Michigan uses the national average of 4.6 pounds per person per day to calculate a more comprehensive estimate of solid waste generation of 46 million tons annually.[187]

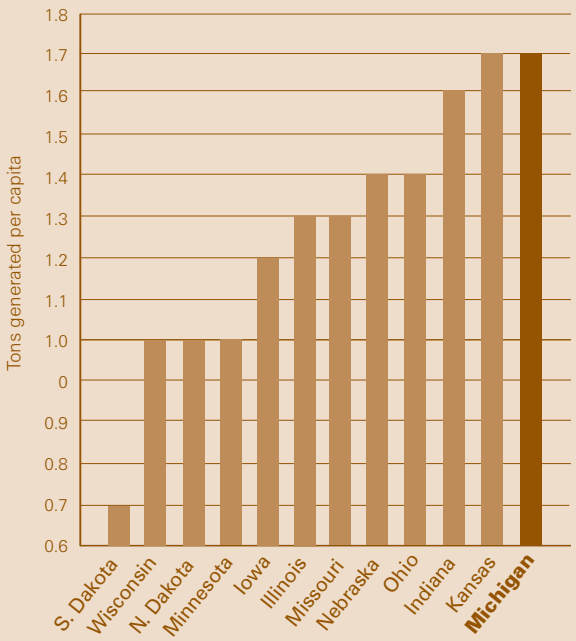
The State of Michigan imports municipal solid waste from twelve different states and Canada, and is the third largest importer of MSW in the country. Four million tons were imported in 2001 from Canada, Illinois, Indiana, New Jersey, New York, Ohio, Pennsylvania, and Wisconsin.[188] Approximately 25% of all waste disposed of in Michigan is imported, and of that 18% is from Canada.[189]

In 2001, 20 million tons of MSW were disposed of in Michigan landfills, 43% more than in 1996.[190] This is equal to 5.74 pounds disposed per person per day, or 30% above the national average.[191] Estimates predict that Michigan's landfills will not reach capacity for another 19 years. However, if solid waste imports continue to increase at their current rate of 17% per year the state could run out of room within a decade, requiring the construction of additional landfills in Michigan.[192] Landfills not only use up space, but, if poorly constructed or managed, can leak harmful gases and liquids into surrounding air, surface water and groundwater.

While landfills are a major method for disposing of solid waste in Michigan, incinerators are also significant. Over 1.5 million tons of municipal solid waste was incinerated in 1999, resulting in 339,774 tons of ash that was then disposed of in landfills.[193] The Greater Detroit Resource Recovery facility is a "waste-to-energy" plant which generates pollution as well as energy. According to the 1999 EPA National Emissions Inventory, incinerators were responsible for over 17% of all mercury emissions released into the air in Michigan.[194]

Unreported waste disposal and illegal dumping on public lands are other issues that need to be addressed in the state. Currently there are 765 known major trash sites on Michigan's public lands, of which 25% are cleaned up each year by volunteer groups around the state. These sites contain everything from appliances and mattresses to building materials and vehicles.[195]

MUNICIPAL SOLID WASTE GENERATED PER CAPITA IN THE MIDWEST REGION



Source: Kaufman, Scott, et al, "The State of Garbage in America," BioCycle, 2004

Recycling

Michigan recycles about 20% of the state's discarded glass, metal, organic matter, paper, plastic, and other products. This is lower than the average of 26% for the Great Lakes states and the national average of 28%. The per capita recycling rate is 1.4 pounds of MSW recycled per Michigan resident per day.[196]

Curbside recycling collection programs currently serve only one-third of the state's population. Many residents have access to a combination of services including yard waste collection, however, residents in 30 counties do not have access to curbside recycling and 18 counties are without drop-off sites.[197]

Michigan's bottle deposit system helps to divert waste from disposal in landfills and incinerators. In 1999, more than four billion containers were recycled generating over $428 million in deposits. Recycling in Michigan is a $2 billion industry, yet Michigan is one of eight states that do not collect annual data on the amount of municipal solid waste that is recycled and/or composted, making it difficult to project future trends.[198]

Hazardous Wastes

Toxic waste poses a threat to the health of humans and wildlife. Chemicals that are persistent and bioaccumulative are of particular concern since they can cause neurological and developmental disorders in children and developing fetuses, and reproductive damage, cancer, neurological disorders and other chronic health issues in adults.[199]

The top five such chemicals (or classes of chemicals) released in the state are lead and lead compounds, polychlorinated biphenyls (PCBs), polycyclic aromatic compounds, mercury and mercury compounds, and dioxin and dioxin-like compounds.[200] Lead can be released into the environment through mining practices, steel production, crop enhancers, improperly disposed batteries or metal parts from machinery.[201] Most dioxin releases originate from industrial and combustion activities such as chemical and pesticide manufacture, burning household trash, medical waste incineration and forest fires.

Major sources of mercury emissions in Michigan include coal-fired power plants, municipal waste incinerators, hazardous waste incinerators and secondary steel production.[202] In addition to being the largest source of mercury emissions in Michigan, the Monroe Power Plant was ranked among the 50 electric utilities in the nation with the largest on- and off-site releases, accounting for over 8 million pounds of point source air emissions, double the emissions of the majority of facilities listed.[203]

Past releases of toxic or hazardous chemicals, permitted or not, can cause persistent problems. The state of Michigan contains over 350 hazardous waste sites, of which 69 are classified under the National Priorities List (NPL) of the Superfund Program managed by the U.S. Environmental Protection Agency. Michigan is among the top five states nationwide with the most Superfund Sites.[204]

Brownfields are industrial or commercial sites which may have been contaminated in the past by hazardous chemicals, but which are otherwise desirable for reuse or redevelopment and not designated as hazardous waste sites in the NPL. Federal and state programs encourage the redevelopment of brownfields as a means of preventing sprawl, optimizing the use of existing infrastructure and revitalizing urban areas. Such programs assist with site clean up and/or liability protection. In 1998 a nationwide survey ranked Michigan number one for making brownfield redevelopment successful.[205]

It's critical to understand population's impacts on Michigan's natural resources–the very resources that attract people to the state in the first place.

Conclusion

This report provides an overview of how human population factors affect Michigan's environment and natural resource base. It is to be used as a springboard for discussion on the topic and on the policy responses, public outreach, and action that can assist Michigan's residents in addressing the issues in the short, medium and long term. As such, it is not designed to be comprehensive, nor to present solutions. On a broader scale, it also enables us to better grasp Americans' unique role in the population-environmental equation worldwide.

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

The state of Michigan has begun to confront its many population-environmental challenges, for example:

- The Michigan Beverage Container Act ("bottle bill") and the Clean Michigan Initiative (CMI) are evidence that Michigan residents are deeply concerned about the natural environment and committed to preserving their natural history. Initiatives such as these have distributed millions of dollars to address brownfield redevelopment and environmental clean-up; protect and enhance Michigan's lakes, rivers, and streams; reclaim and revitalize local waterfronts; make critical state park improvements; enhance local parks and recreational opportunities; prevent pollution, and; protect the public from lead hazards. Continued funding is needed to support such initiatives that have helped improve Michigan's environment to date.
- Members of the Michigan Land-Use Leadership Council (MLULC), formed by executive order of the governor in 2003, investigated and analyzed the trends, causes and consequences of unmanaged growth in Michigan.[206] The final report, *Michigan's Land Michigan's Future*, highlighted 150 recommendations that represent the first step to addressing Michigan's current land use issues. National Wildlife Federation's Lake Superior Program, under a grant from Michigan Coastal Management Program, has also been working with local units of government, community planners, conservation practitioners, and other land use stakeholders to increase understanding of the value and role of wetlands, natural rivers, and shoreline protection in land use planning and in enhancing the natural environment.
- In an effort to protect water resources from diversions out of the basin and encourage wise water use in the basin, the state of Michigan signed the 2005 Great Lakes-St. Lawrence River Basin Water Resources Compact. Several organizations and individuals around the state are also taking part in another historic effort, as part of the Healing Our Waters – Great Lakes Coalition, to restore the Great Lakes from decades of abuse. The plan calls for $23 billion in federal, state, local and private investments in such projects as modernizing waste treatment systems and restoring wetlands and other vital habitat.
- A number of policies in the state which could reduce energy use or aid the state in shifting to cleaner renewable sources of energy are currently underway. These efforts include Governor Granholm's recent Energy Efficiency executive order and state rule for 90% mercury emissions reduction by 2015, Michigan's Mercury Electric Utility stakeholder workgroup (whose report shows the feasibility of stronger mercury controls for the state's coal fired utilities), and consideration of a renewable portfolio. Other collaborations such as EDGE2 (Economic Development and Growth through Environmental Efficiency), between the Michigan Department of Environmental Quality and the Michigan Department of Labor and Economic Growth, designed to attract start-up companies in energy efficiency and clean technology, are essential to the future of Michigan's economy and environment.[207]

These efforts, among others, demonstrate a commitment to addressing current population-environment issues in order to mitigate future threats and create a healthy environment for all of Michigan's inhabitants.

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

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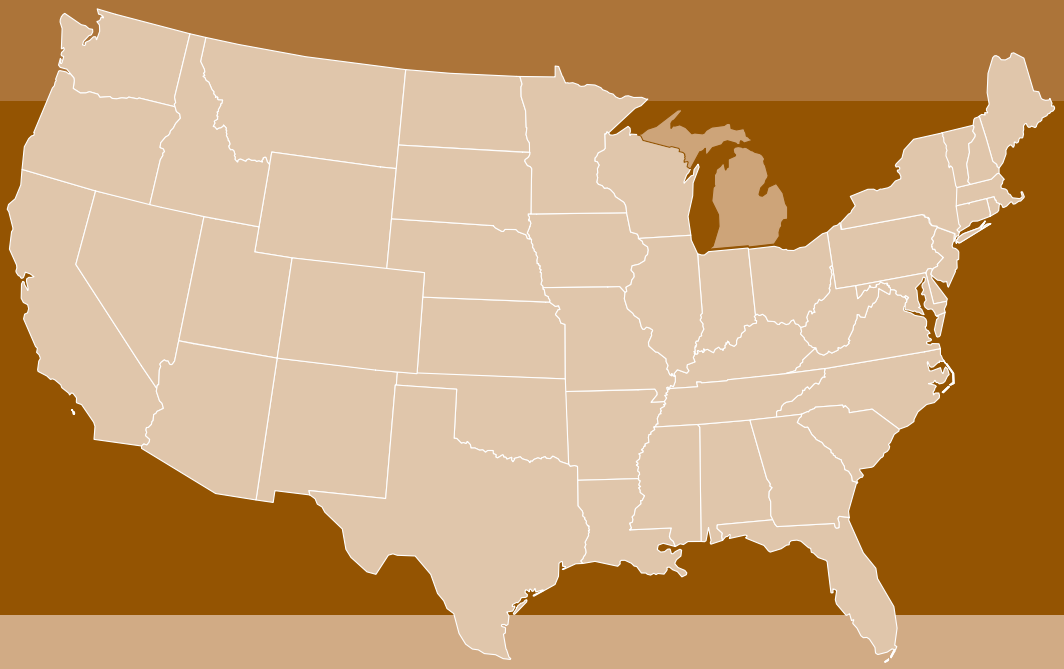

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