Climate change affects our lives and our environment in New Jersey every day. Temperature increases due to climate change will continue to impair our air quality, heighten threats to water supplies and agriculture yield, and cause sea levels to rise. Climate change will also escalate intense rainfalls, such as those the state experienced with Superstorm Sandy and the remnants of Tropical Storm Ida, which lead to more extreme inland and coastal flooding.
As a teacher, you are tasked with helping the next generation of leaders prepare for the environmental challenges of the future. By incorporating climate change education across our New Jersey Student Learning Standards, your classroom discussions can inspire students to think critically and develop solutions to our climate crisis.

This summary of the 2020 NJ Scientific Report on Climate Change and the 2022 Health Addendum: Climate Change Impacts on Health and Communities is meant to provide you with the basic background and resources you need to teach about climate change.

IN THIS GUIDE, YOU WILL LEARN AND GUIDE YOUR STUDENTS IN:

WHAT WE KNOW

- Greenhouse gas emissions are causing a steady rise in global temperatures
- Transportation causes 42% of greenhouse gas emissions in New Jersey
- Carbon sinks store greenhouse gases and keep them out of the atmosphere
- Some effects of climate change on New Jersey are greater than the average for the country or world

HOW IT AFFECTS US

- Physiological and mental health
- Water supply and water quality
- Storms and flooding
- Animals and ecosystems
- Food sources
- Environmental Justice communities
**WHAT WE KNOW**

**Greenhouse gas emissions are causing a steady rise in global temperatures.** Climate change is driven by increases in atmospheric levels of greenhouse gas concentrations, particularly carbon dioxide (CO₂) and methane (CH₄) gases, which have a characteristic capacity to absorb heat. As these levels increase, additional heat is absorbed by Earth’s atmosphere. Human activities, particularly the emissions of heat-trapping greenhouse gases from the burning of fossil fuels and land use changes like deforestation, have increased atmospheric carbon dioxide concentrations by more than one-third since the early 1900s. They are now the primary driver of climate change.

The Keeling Curve charts the buildup of CO₂ in the Earth’s atmosphere since 1958. Global atmospheric carbon dioxide concentrations are recorded daily at the Mauna Loa Observatory in Hawaii. The curve shows a steady annual increase in CO₂, the most significant greenhouse gas. It also captures seasonal changes. There is a decrease in CO₂ concentrations during spring and summer, when photosynthesis is active and removes CO₂ from the air. Then, when photosynthesis slows during autumn and winter, CO₂ rises again. This seasonal change in CO₂ can be seen in the repeating zig-zag shape in the graph.

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![Atmospheric CO₂ Concentrations over 800,000 years](image)

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**Atmospheric CO₂ Concentrations over 800,000 years**

- Carbon Dioxide (ppm)
- Years Before Present
Carbon sinks store greenhouse gases. Carbon is released into the atmosphere in the form of CO₂. But the earth has the natural ability to capture and store carbon dioxide in vegetation and soils, in what are known as carbon sinks. These carbon sinks can hold carbon for short or long periods of time. New Jersey’s natural and working lands, including forests, woodlands, wetlands, seagrasses and agricultural lands, are large carbon sinks and can provide important mitigation against greenhouse gas emissions.

In forest habitats, most of the carbon storage occurs in soils, where it can remain locked for centuries or more. Carbon sequestration in forests has grown over the past two decades as a result of increased forest area, recovered forests that are no longer harvested, improved forest management and expanding tree growth. This increased tree growth is enhanced by beneficial changes in the climate, greater photosynthesis resulting from more abundant CO₂ and nitrogen, and longer growing seasons.

Blue carbon ecosystems, such as salt marshes, tidal wetlands, seagrass beds and mangroves capture and store atmospheric carbon at rates up to 10 times greater than forests on a per area basis. Additionally, the high salinity in many blue...
Greenhouse Gas Sequestration Trends in New Jersey 2006-2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Sequestration (MMTCO₂e)</th>
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<tr>
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<tr>
<td>2018</td>
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</table>

From forests and land cover, measured in million metric tons carbon dioxide equivalent (MMTCO₂e). Negative values imply that the greenhouse gases are being removed from the atmosphere.

Carbon systems limit production of methane, which is a potent greenhouse gas.

The sequestration ability of New Jersey forests and wetlands is threatened by sea-level rise and other climate change factors, such as increasing survivorship of invasive, tree-killing pests like the southern pine beetle (Dendroctonus frontalis). Forests killed by beetles will regrow and, over time, will adapt in response to this disturbance, but this regrowth and adaptation is a long process and the carbon losses from such an event will cause forests to become a net carbon emitter.
Transportation causes 42% of greenhouse gas emissions in New Jersey. Since 1990, the category with greatest contribution to greenhouse gas emissions in New Jersey has been in the transportation sector. On a national level, transportation causes 29% of greenhouse gas emissions.

While transportation includes cars, trucks, buses, off-road construction vehicles, locomotives, marine engines and planes, greenhouse gas emissions are mainly produced by on-road transportation. As a result of continued dependence on gas- and diesel-powered vehicles, and increased vehicle miles traveled, New Jersey has seen an expansion in greenhouse gas emissions from transportation, despite a modest increase in fuel efficiency of the overall U.S. motor vehicle fleet. Greenhouse gas concentrations and their future trajectories will have a direct effect on how quickly Earth warms.
Some effects of climate change on NJ are greater than the average for the country or world. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5°F increase in the state's average temperature, which is faster than the rest of the Northeast region at 2°F and the world at 1.5°F. This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase from 4.1 to 5.7°F.

<table>
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<tr>
<th></th>
<th>Annual</th>
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<td>Northern NJ</td>
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<tr>
<td>Coastal NJ</td>
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<td>5.0°F</td>
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By the end of the century, New Jersey can expect to experience an average annual temperature that is consistently warmer than the historical average from 1901-1960 (low-emissions scenario). Future temperatures could be as much as 9°F warmer than the hottest year in the historical record (high-emissions scenario). New Jersey can also expect that, by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date. The increase in temperatures is additionally expected to be felt more during the winter months, resulting in less intense cold waves, fewer sub-freezing days and less snow accumulation.

Temperature increases are felt more strongly in New Jersey because of the high urbanization of the state, which results in large expanses of asphalt and concrete instead of forests, fields and other open spaces that can provide cooling effects. These conditions make heat waves especially pronounced and lead to increased impacts in densely populated urban areas. This heat island effect will be a growing concern as summer temperatures rise.

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**Observed and Projected Changes (Compared to the 1901-1960 Average) in Near-Surface Air Temperature for New Jersey**

![Graph showing observed and projected temperature changes in New Jersey](image-url)
HOW IT AFFECTS US

PHYSIOLOGICAL AND MENTAL HEALTH. Climate change has led to an increase in human exposure to more severe heat waves, forest fires, severe storms, droughts and infectious disease vectors, with dire consequences to human health and communities. From a greater incidence of cardiovascular and respiratory dysfunction associated with extreme weather to population displacement caused by floods to often-overlooked mental health, the vulnerability of the human population to climate change is tangible.

The impacts of climate change on human health and communities are anticipated to exacerbate existing environmental and public health disparities. Children, the elderly and people with chronic health problems are most vulnerable to these impacts, which will also disproportionately burden underserved communities and those already overburdened by pollution and other stressors.

**INFECTIONIOUS DISEASES** spread by arthropods, insects and microbial contamination of food and water supplies are expected to become more prevalent as climate change increases the environmental conditions that are more favorable for pathogens and their hosts. Diseases carried by ticks and mosquitoes are the most common, with infections caused by a tick bite at an all-time high. In New Jersey, infections transmitted by ticks have surpassed those transmitted by mosquitoes significantly and show a persistent increase in recent years.

**MENTAL HEALTH** is a challenge as individuals cope with the environmental and personal consequences of climate change. Population displacement as a result of sea-level rise, flooding events and resource insecurity may add to the cumulative detrimental effects. Property loss, displacement and the related traumatic experience of living through a catastrophic climate event increase the potential for mental illnesses such as post-traumatic stress disorder, depression and insomnia.

**RESPIRATORY AND CARDIOVASCULAR** health problems and a greater number of premature deaths are likely to increase due to growing air pollution. Increased air pollution can aggravate chronic conditions, such as asthma, COPD and cardiovascular diseases, and increase the incidence of lung cancer. There are more than 600,000 adults and 167,000 children with asthma in New Jersey, with almost 40% of the 50,000 annual emergency department visits for asthma-related symptoms occurring in children.

**HEAT STROKE**, heat exhaustion, heat cramps, heat edema and heat syncope cases increase with heat waves and are expected to impact larger areas, with more frequency and longer duration by 2050. Climate change could result in a 55% increase in summer heat-related mortalities. In New Jersey alone, heat-related hospital admissions during the warm season (May to September) increased approximately 156% from 2004 to 2013.

**HARMFUL ALGAL BLOOMS** (cyanobacteria) will increase with more heavy precipitation, which washes additional nutrients into the water. Water temperatures will also warm, which helps the algae grow. Human exposure to cyanobacteria and their toxins occur during recreational activities through accidental swallowing, skin contact and breathing aerosols; and local and systemic toxic effects can lead to a range of adverse reactions, from a mild skin rash to serious illness. Exposure to cyanobacteria can be harmful to the nervous system, liver and skin.
WATER SUPPLY AND WATER QUALITY. Due to climate change, the intensity and frequency of precipitation events is anticipated to increase and the duration of drier periods will extend. In New Jersey, annual precipitation is expected to increase from 4% to 11% by 2050. Such changes could have immediate impacts to public safety due to increased flooding, water supply availability, water quality, stormwater infrastructure and ecological impacts.

Also, small decreases in the amount of precipitation may occur during the summer months, resulting in greater potential for more frequent and prolonged droughts. Drought conditions, even short-lived, can bring permanent changes to the water supply. If a state has adequate water storage in lakes and reservoirs to get through a drought or dry season, there will be negligible changes. But reductions in streamflow – the amount of water flowing in rivers and streams – can alter a state’s ability to have sufficient water storage, since water flowing into lakes and reservoirs will be reduced.

Changing climatic norms, if occurring simultaneously, can cause significant impacts. For example, a heat wave, in conjunction with extended periods of dry weather in summer, can cause drought and significant societal and environmental impacts, despite the insignificance of either event occurring alone.

SURFACE AND GROUNDWATER quality will be impaired as increased nutrients and contaminants enter waters due to runoff from more intense rain events. Groundwater is an important source of water in New Jersey – in addition to sustaining baseflow in streams, it supplies 25% of the state’s total water supply needs.

COMBINED SEWER OVERFLOW communities may be further challenged as sea-level rise and/or increased rain events submerge discharge points currently above the waterline. As these systems are overwhelmed from inundation, contaminants are free to move into waterways and the surrounding environment. Human exposure to pollutants from combined sewer overflows would escalate the risk of both food and waterborne illness, and exposure would increase during recreational activities, such as swimming in lakes.

WATER SUPPLIES will be stressed from the increase in the growing season and extreme temperatures expected due to climate change. Droughts may occur more frequently with expected changes in precipitation patterns. It is anticipated that droughts lasting three to six months and longer may slightly increase in frequency in the northeastern United States under a low-emissions scenario and will significantly increase under a high-emissions scenario.
STORMS AND FLOODING. As temperatures rise, so will the energy in a storm system, increasing the potential for more intense tropical storms. In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms and, on rare occasions, hurricanes. Most of these events occur in the warmer months, between April and October, with nor'easters occurring between September and April.

Extreme weather events involving heavy precipitation often lead to flooding. Floods may occur following heavy rainfalls, localized thunderstorms or rapid melting of snow; and the size and frequency of floods will increase as annual precipitation increases. Major floods are characterized as events that have caused extensive inundation of structures and roads, significant evacuations of people and/or transfer of property to higher elevations.

In addition to the flooding risk from increases in precipitation, coastal areas are particularly vulnerable to flooding from storm surge and increased intensity of coastal storms, and will most likely be faced with worsening conditions as sea levels rise. Sea levels are increasing at a greater rate in New Jersey than other parts of the world. By 2050, there is a 50% chance that sea-level rise will meet or exceed 1.4 feet and a 17% chance it will exceed 2.1 feet. Those levels increase to 3.3 and 5.1 feet by the end of the century (under a moderate emission scenario).

**TROPICAL STORMS** have the potential to increase in intensity due to the warmer atmosphere and warmer oceans that will occur with climate change. These have the potential to be more intense than those seen during Superstorm Sandy in 2012.

"**SUNNY DAY FLOODING**" will occur more often across the entire coastal area of New Jersey due to sea-level rise. It is extremely likely that Atlantic City will experience "sunny day flooding" 95 days a year, with a 50% chance it will experience this kind of flooding 355 days a year by 2100 (under a moderate emission scenario).

**SALTWATER INTRUSION** may increase in New Jersey aquifers where wells are overpumped due to rising sea levels. Efforts to combat saltwater intrusion, like the construction of desalination plants, may be complicated if systems are vulnerable to coastal flooding and storm surges.
ANIMALS AND ECOSYSTEMS. Climate change can alter where species live, how they interact and the timing of biological events, which could fundamentally transform current ecosystems and food webs. Climate change can overwhelm the capacity of ecosystems to mitigate extreme events and disturbances, such as wildfires, floods and drought.

In New Jersey and elsewhere, rising sea-levels will inundate animal habitats, particularly in low-lying areas such as wetlands and beaches. This will reduce the amount of habitat available for terrestrial animals, especially as coastal communities continue to armor coastlines and prevent systems from migrating naturally.

After storm and erosion events, replenishment of ocean and estuarine beaches may also impact habitat availability and/or quality for species. Moreover, as temperatures and precipitation patterns shift, species compositions may also change, particularly at the edges of their current ranges. Warmer temperatures will push plants to flower earlier, will likely result in declines in reproductive success of plant and pollinator species, and will not provide needed periods of historically cold weather necessary for some plant life cycles.

**WILDFIRE** seasons could be lengthened, and the frequency of large fires increased due to the hot, dry periods that result from increased temperatures. The dry, sandy soils and fire-prone nature of the New Jersey Pinelands make this area susceptible to elevated fire threats, especially along the wildland-urban interface, where people live adjacent to the forest.

**WETLANDS** Some freshwater wetlands may be lost due to inundation with saltwater. Some New Jersey tidal wetlands may not gain elevation at a rate that equals the rate of sea-level rise and are expected to be lost as rates of sea-level rise increase. Increased flooding and salinity are projected to lead to a loss of 92% of brackish marshes, 32% of tidal swamps and 6% of tidal fresh marshes in the Delaware Estuary by 2100.

**ATLANTIC WHITE CEDAR**, a globally rare species, is expected to lose habitat in New Jersey because of rising sea levels. Periodic and unpredictable exposure to flooding from saltwater storm surges are all that is needed to kill a forest. Hence, loss of area and range of this globally rare species is expected with rising seas.

**BIRDS** 29% of New Jersey’s bird species are vulnerable to climate change, including the American Goldfinch, which is the state bird. Saltmarsh sparrows, a globally endangered species, may reach quasi-extinction population numbers by 2040, due to habitat loss from sea-level rise.

**INVASIVE SPECIES** are likely to expand due to climate change. As temperatures increase, environmental conditions in New Jersey estuaries may improve for invasive species like the clinging jellyfish. The persistence of southern pine beetle in New Jersey represents an early example of the destruction of invasive pests that can occur due to climate change impacts.
CROP AND LIVESTOCK productivity are expected to change due to climate-induced changes in temperature and precipitation patterns. Increased temperatures during critical growth and reproductive stages can result in crop stress and loss in profits due to a change in flavor or visual appeal. Pathogens and parasites will be able to better survive through the winter season and reproduce at higher rates, increasing pressure on livestock.

BLUEBERRIES AND CRANBERRIES are New Jersey specialty crops and depend on a long winter chill for optimum flowering and fruit development. They may become unsuitable for our state as temperatures increase.

SHELLFISH SPECIES, including hard clam, scallops and oysters will develop thinner and frailer shells due to ocean acidification. This will greatly affect southern New Jersey counties whose fishing and aquaculture industries rank second in the United States in economic dependence on shelled mollusks. Shellfish and finfish populations will also be impacted by beach nourishment projects, where sand will be mined from off shore and placed on beaches. As a result, essential habitat for shellfish will be removed or changed.

RECREATIONAL FISH SPECIES like brook trout need cold-water habitats. In New Jersey, the majority of current cold-water fisheries are projected to be warm-water fisheries by 2100. Current climate changes could also result in more "dead zones" from hypoxic events, which are of particular concern for summer flounder, New Jersey’s largest recreational fish species.

FOOD SOURCES. Environmental degradation from climate-induced increases in air pollution will cause damage to crops and forests, and our ability to produce plentiful and nutritious food. Climate change can disrupt food availability, reduce access to food, increase food prices and affect food quality. For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events and reductions in water availability may all result in lower agricultural productivity.

In addition to food produced on land, both salt and freshwater species that are harvested or caught will be affected by climate change. Recreational activities, such as fishing and shellfish harvesting, will likely become less favorable, as the organisms become contaminated with waterborne pathogens.
ENVIRONMENTAL JUSTICE COMMUNITIES. New Jersey defines “environmental justice communities” by three criteria: presence in a community of concern; the presence of disproportionate environmental and public health stressors; and the absence or lack of environmental and public health benefits. While climate change is a threat to everyone's physical and mental health, socially and economically disadvantaged individuals are particularly vulnerable to the greatest impacts of climate change.

A lack of physical mobility and resilience capacity due to structural or systems-level inequities puts vulnerable populations, such as the chronically ill and elderly, communities of color, urban and rural poor, and non-English speaking communities at greater risk from storms, floods, heat waves and other extreme weather events.

FOOD INSECURITY is worsened by climate injustices, which increase the already high frequency of chronic illnesses in impoverished areas. Climate change can affect all aspects of food supply chain, including production, transportation, trade, storage, processing and packaging, wholesale, retail, consumption and disposal of food.

HEALTH EFFECTS disproportionately affect economically disadvantaged households and communities of color as they are subjected to a greater number of environmental and public health stressors. As a result, these communities experience asthma, cancer, elevated blood lead levels, cardiovascular disease and other adverse health effects at higher rates than richer and whiter communities.

HIGH TEMPERATURES occur more often in urban communities because the "built environment" (e.g., buildings, roads and sidewalks) absorbs and re-emits the sun's heat more readily than natural landscapes, a concept known as the heat-island effect. Heat waves are expected to impact larger areas, with more frequency and longer durations. Urban populations are particularly vulnerable as climate models predict an increase in the number of days per year with temperatures affecting human health due to heat stress.

FLOODING is a concern for environmental justice communities, as New Jersey has the largest number of affordable-housing units in areas susceptible to sea-level rise among all coastal states and can expect that number to surge as waters climb in the next 30 years. Coastal cities like Jersey City, Atlantic City and Newark may have floods that destabilize building foundations, which will necessitate community displacement as the climate situation worsens. Overburdened communities may not have the resources available to rebuild deteriorating infrastructure.
Scan for lessons and more information

Or visit dep.nj.gov/seeds/climate for a resource list to:

- Download climate change lessons
- Get more information and resources
- Learn more ways to get involved