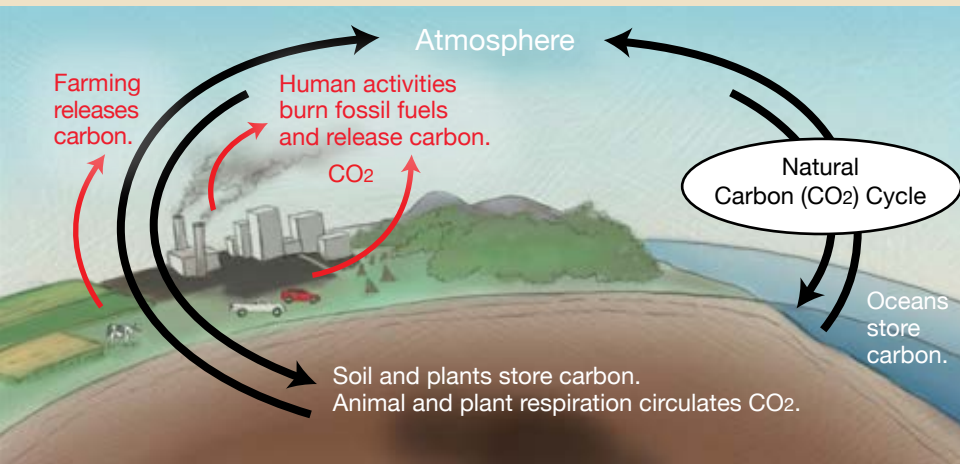


Carbon and climate

Our planet is a very special place. The Earth is able to support all life because of the thin layer of gases that makes up our *atmosphere*. The atmosphere supplies us with air to breathe and water to drink. It creates the conditions where plants, animals, insects, and other living things can survive.

Most of the atmosphere is made up of two gases—nitrogen and oxygen. The atmosphere also contains water vapor and small amounts of carbon dioxide and methane, all known as *greenhouse gases*. These gases act like a blanket to hold the sun's heat and keep the Earth at a warm, livable temperature—like a greenhouse for plants and animals.

Things people do that burn certain types of fuel—activities like driving cars, flying in airplanes, using electricity, and heating and cooling buildings—are the biggest reason for our changing climate. Fuels release carbon dioxide into the atmosphere. Like a thicker blanket, added greenhouse gases trap more heat in the atmosphere.



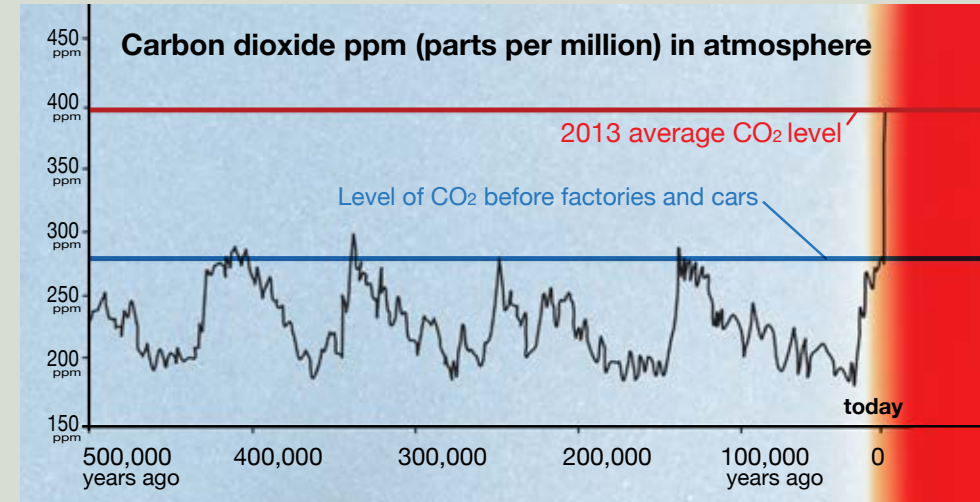
What Is Carbon? Carbon is one of the building blocks of nature. It's a chemical element that combines with oxygen to form the life-giving gas *carbon dioxide*. All living things contain carbon. It is a part of your body. Carbon

moves through the atmosphere, oceans, land, soil, rocks, plants, and animals in a loop called the *carbon cycle*.

Carbon is also an element in *fossil fuels*. People dig up coal or drill for oil and natural gas—fuels as old as rock fossils.

Fossil fuels are full of carbon because they formed from once-living things buried millions of years ago. When we burn them to make energy, we release carbon into the air as carbon dioxide. By adding extra carbon, we change the delicate natural balance in our atmosphere.

Since the dawn of the Industrial Revolution in the mid-1700s, humans have added about 40 percent more carbon dioxide to the atmosphere. The last time the Earth had this much carbon in the atmosphere, humans didn't exist.



What Is Climate? Is it snowing today, or is it clear and sunny? Is it colder or warmer than you would expect for the season? We call these daily conditions *weather*. We can observe and feel today's weather. Weather changes day to day, week to week, and month to month. When we look at weather trends over a period of 30 years or more, we call the dominant trend or pattern *climate*. This is a "big picture" way of looking at our natural environment.

Scientists who study climate have noticed that the Earth's overall average

This graph shows the amount of carbon dioxide in the air over hundreds of thousands of years. It illustrates how the burning of fossil fuels by humans has increased the amount of CO₂ in the atmosphere.

global temperature is rising and causing other changes. In Minnesota, nighttime low temperatures are warmer in both summer and winter. Winters are warmer overall, and springs are wetter.

By the year 2100, the Earth's average temperature is expected to rise by 2 to 11.5 degrees. That's a big deal for lots of plants and animals.

What's Next for wild things?

Over many thousands of years, our Earth's balance of natural forces—wind, rain, snow, ice, fire—has created the place we know as Minnesota. Here's a look at how life may change for some wild plants and animals as the climate warms.

Loons. The loon (*Gavia immer*) is our official state bird. If you've encountered a loon on a lake, you probably won't forget this large diving bird with its haunting call. In spring, loons fly north to Minnesota from the Gulf of Mexico. They mate and then raise their chicks here in summer. Loons like to live on lakes with cool, clear water, mostly in the northern part of the state. Climate change is expected to warm these lakes. This could mean more insect parasites that harm loons and more carp



BILL MARCHEL

that can cloud their fishing waters. Some scientists predict loons may go farther north to breed and nest.

Monarch Butterflies. These familiar orange-and-black insects, which we see fluttering throughout Minnesota each summer, are world travelers. Monarchs (*Danaus plexippus*) fly hundreds or thousands of miles each year. They spend winter in the mountains in Mexico. In spring they travel to North America to feed on flower nectar and lay eggs on milkweed.

Monarchs keep moving to find the right mix of conditions: not too hot, not too cold, plenty of flowers and milkweed. Because of climate change, monarchs may need to fly to new locations to survive.

ALLEN BLAKE SHELDON



CHRISTOPHER MOREY/ENGBRETSON UNDERWATER PHOTOGRAPHY

Lake Trout. Lake trout (*Salvelinus namaycush*) do best in very deep, clear, cool lakes, where they can hide out from warm water temperatures in summer. Only 99 lakes in northern Minnesota

have the right conditions for lake trout to live and reproduce. In some of those lakes, climate change could warm waters and reduce oxygen levels beyond the point where trout can survive.

Grasslands and Forests. In Minnesota the hardwood forests of eastern North America meet the grasslands of the Great Plains of the West. During the next 100 years, climate-driven changes in tree

species and more wildfires could cause some forests to become savannas with fewer trees and more nonnative grasses. The border between Minnesota's grasslands and forests could shift many miles farther north and east.



GARY ALAN NELSON



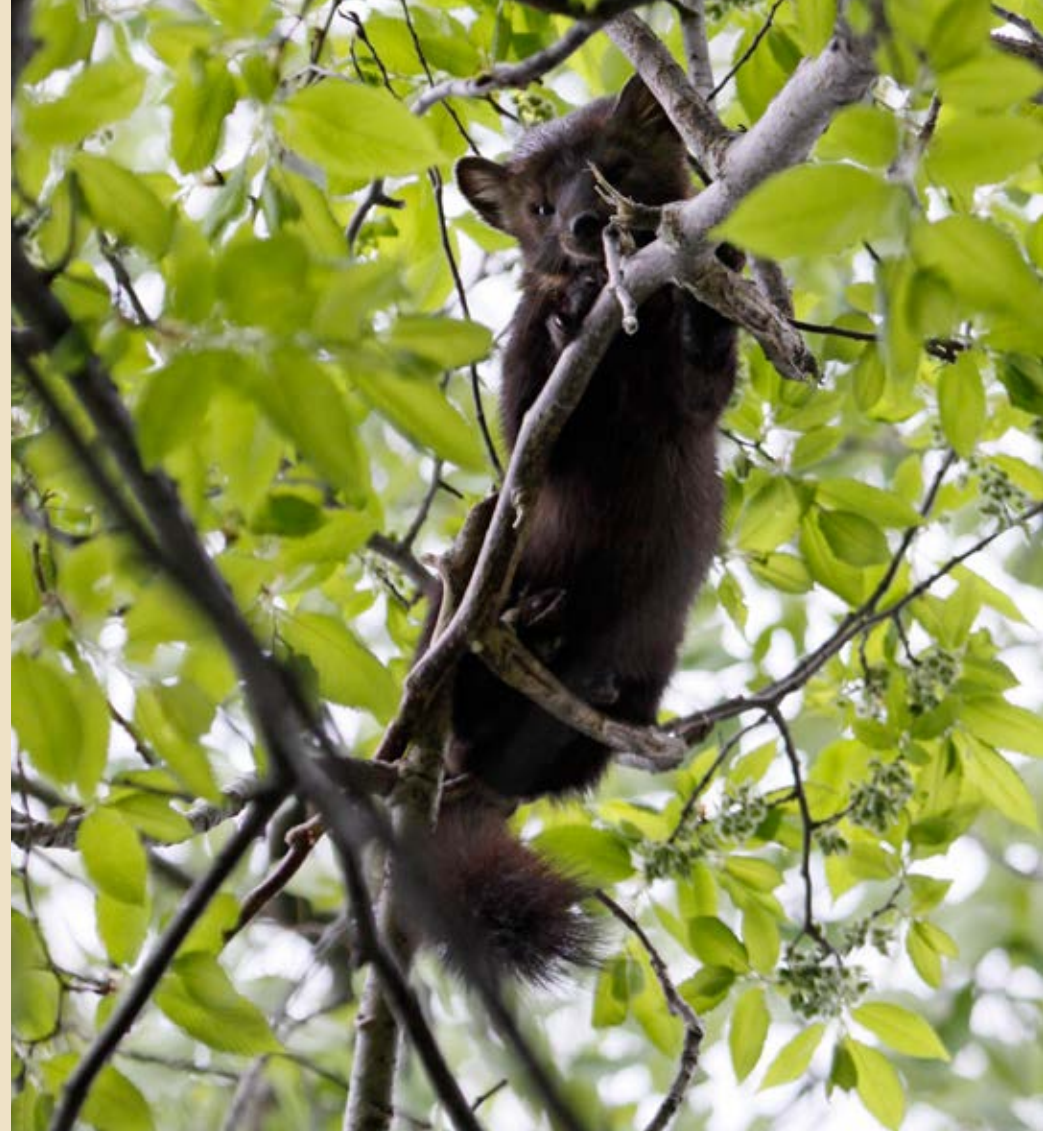
Red Pines. Named for its striking rust-red bark, the red pine (*Pinus resinosa*) is our state tree. Maybe you've seen a red pine in a park or forest or your yard. Climate change could lead to more long-lasting dry spells. Without enough water, trees struggle to grow and stay healthy.

Sick trees can be hurt by bark beetles. These native insects burrow into the tree's inner bark and block movement of water and nutrients. Then the tree might die. Foresters worry about "hot spots" in northern Minnesota where bark beetles could kill many red pines.

American Martens. This furry forest creature is a member of the weasel family. It has a long, slender body and rounded ears. American martens (*Martes americana*) live in northern conifer forests, especially those with spruce and fir. Many of these trees are likely to die if northern

Minnesota becomes too warm and dry. Martens could have difficulty finding the small forest animals they eat, such as red squirrels and red-backed voles. Because they live and hunt under the warm, protective blanket of the snow, martens may suffer if there's not enough snow.

MICHAEL FURTMAN



RICHARD HAMILTON SMITH

What We're Doing

Climate change can't be stopped entirely, but people can slow it down if we all use a lot less fossil fuel. Scientists, engineers, inventors, and others are figuring out creative ways to shrink our *carbon footprint*—the amount of carbon we burn. Here are some things people are doing.

LAYNE KENNEDY



Harness the wind. In windy western Minnesota, *wind turbines* with spinning blades capture the wind's energy. Of all the states in the nation, Minnesota is now number 5 in the amount of electricity

generated by wind power. Energy created by wind doesn't release carbon. Wind is a *renewable* source of energy because unlike the world's supply of fossil fuels, wind will never run out.

Capture sun power.

Solar energy or power comes from the sun. Like wind, it releases no carbon and it's renewable. The sun is our most abundant energy resource. The state of Minnesota has set a goal of getting 1.5 percent of its energy from solar power by 2020. Some experts say solar power could be the world's leading source of electricity by 2050.



GLENDALOUGH STATE PARK BY DEBORAH ROSE, DNR

PHOTO COURTESY OF WALMART



Save energy. People are finding ways to use less energy. For example, huge trucks with semi-trailers full of food, clothing, and other goods drive thousands of miles across the country every day. A

new federal government rule requires manufacturers to make new heavy-duty trucks with engines that burn less fossil fuel. Because these trucks will use less fuel, less carbon will pollute the air.

Innovate. The world needs awesome new ideas to help combat climate change. For example, new light-emitting diode (LED) lightbulbs use less than one-fourth the energy of traditional incandescent lightbulbs, and may last up

to 25 times longer. If we Americans use LEDs for most of our lighting by 2027, we'll burn hundreds of millions of tons less carbon than we would if we used no LEDs, according to the U.S. Department of Energy.

What You Can Do

Every day, you and your family can make choices that shrink your carbon footprint. Here are ideas to help you use less carbon-burning energy:



Take smart trips. Combine shopping and other errands in the same car trip. Your family can try to use your car less by instead walking, biking, sharing a ride with others, or using a bus or train. Before you decide to get into your car, ask a simple question: Do we really need to drive there right now?

Eat for change. Growing fruits, vegetables, and other foods in one part of the world and sending them to another takes a lot of energy. Worldwide, growing and transporting food releases about 3.3 billion metric tons of greenhouse gases each year. You can save energy by growing vegetables in a garden, window box, or other container. Buy foods from local

farmers. If someone in your family hunts or fishes or gathers wild foods, you can eat delicious meat, fish, wild rice, berries, and more from Minnesota woods and waters.

Dial it down. Save energy by turning down your home's thermostat in winter and using your air conditioner less in summer.

Think outside. If you have space in your yard, plant trees. Trees help "lock up" (store) carbon that would otherwise go into the atmosphere. Plant milkweed to feed monarch caterpillars and help those struggling butterflies.

Pitch in. Talk with your friends, neighbors, family, mayor, and representative about your ideas for making your town or neighborhood more climate friendly.

Have fun. Whatever you choose to do, take time to get outdoors and enjoy today's weather—whatever it is. ♻️

TEACHERS RESOURCES:

Teachers guide: www.mndnr.gov/young_naturalists
National Center for Science Education, www.ncse.com/climate
Will Steger Foundation, www.willstegerfoundation.org
Minnesota Energy Challenge, www.mnenergychallenge.org
National Oceanic and Atmospheric Administration, www.climate.gov/teaching
National Phenology Network, www.usanpn.org

