How We Know What We Know About Our Changing Climate

Scientists and Kids Explore Global Warming

by Lynne Cherry and Gary Braasch

With a Foreword by Prof. David Sobel

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Dawn Publications

Birds Give Us Clues as they Respond to a Warmer World

Above, and also on page 5: These students in upstate New York are participating in *BirdSleuth*, a program developed by the Cornell Lab of Ornithology, in which people observe birds and send the information to Cornell's scientists.

Bottom Right: Years after Elizabeth Losey collected her data (see picture on page 6), she and Dr. Terry Root met and compared their experiences. Losey's 30-year record provided valuable data for comparing bird migration dates.

Every spring, millions of birds *migrate*—fly long distances from one home to another. Many *ornithologists*—scientists who study birds—noticed that migratory birds seemed to be arriving at their summer homes earlier and earlier, and leaving later and later. How could they find out if this was really true?

Dr. Terry Root is an ornithologist who is well known for figuring out where birds live by using *computer modeling*—using computers to collect and analyze data, create graphs, and test hypotheses. Her studies showed when, where and how many birds were arriving and leaving. They showed *trends*—when many birds in a certain area behave in a certain way. At one point in her data gathering, Root found field biologist Elizabeth Losey's records of bird arrival at the Seney National Wildlife Refuge in Michigan. Losey tracked bird arrival dates for 50 years. Root analyzed the last 30 years of Losey's data. She found that on average, combining the data from all the species, the birds were arriving three weeks earlier at the end of the period than they were at the beginning.

Other ornithologists were also finding that other birds were arriving earlier and changing their *range*—the places animals or plants can be found year after year. Root worked with ornithologist Dr. Jeff Price to make computer models that would predict

where birds would go over the years as temperatures changed. But why, they wondered, were these changes happening?

Root decided to look at all the studies she could find of animals and plants changing in areas where the temperature was warming. Her hypothesis was that many different living things were changing in some way in response to climate change. Were they shifting their range or the timing of blooming, nesting or migration? In her paper published in the scientific journal *Nature*, Root described 143 different studies of birds, mollusks, mammals, grasses and trees. She found that 80% of the species were changing their ranges in a way that matched climate change. She called this a “fingerprint” of global warming because rising air temperatures had touched and affected the lives of all these creatures, in just the way she thought they would with warming.

Root could not have made her discoveries about bird migration without the data from thousands of participants in such programs as the *Christmas Bird Count*, the *Breeding Bird Survey*, *Journey North* and *Project FeederWatch*. With so many people participating, scientists get a lot of data! It helps them discover trends in bird migration, their routes, what they eat and when they nest. (See the Resources section for information about these and other programs.)

Bottom left: Migrating swans at Seney National Wildlife Refuge, Michigan. It was in this location that Elizabeth Losey collected data for 50 years.

Top right: Birders and ornithologists find that many small migratory birds such as this Canada warbler photographed in northern Minnesota are flying north earlier in the spring than they did before.

Clues From Flowers – Early Bloomers

Above: For four months this student in Fran Bosi's class at Public School 205 in Queens, New York observed a taro plant, measured its changes, viewed it through a magnifying lens and wrote reports about her findings. Her class participated in *Project Budburst*.

Bottom right: The wildflower Zizia is blooming 20 days earlier in the Washington, D.C. area than it did in the 1970s, according to botanists with the Smithsonian Institution.

The cherry trees in Washington D.C. blossom spectacularly in the spring and people have been keeping records of their bloom date almost since they were planted in 1912. In 2000, they bloomed on March 20th, the second earliest date on record. Smithsonian Institution biologists Dr. Paul Peterson and Dr. Stanwyn Shetler and their colleagues noticed them blooming earlier and wondered why.

They found phenological records of daily temperature and flowering dates for 100 species of plants around Washington. The temperature records came from the Weather Bureau. The flowering records had been collected by 125 people over a 30 year period. The cherry trees were blossoming 6 to 7 days earlier than they did in 1970. Most plants were flowering 4 to 5 days earlier. The scientists compared the plants' bloom times with temperatures over the same 30 years and found a strong *correlation*—matching up—between earlier flowering and rising temperatures.

The study of the progression of the seasons, phenology, used to be much more common. Often these records of flowering of plants, budding of trees and arrival of birds were handed down from generation to generation. Thomas Jefferson was one of the original American phenologists. He kept records of the changing seasons at his home, Monticello. Another famous American who kept good records of nature was ecologist Aldo Leopold in Wisconsin. When members of his family later compared his journals of the years 1936 to 1947 to their own records of the 1980s and 1990s, they found that spring was arriving

a week earlier. A citizen in Britain, R. S. R. Fitter, personally kept the records for 385 plants over a fifty-year period, and computed that on average they are now blooming more than four days earlier.

Now, children all over North America are collecting data about changes in plants through spring, summer and fall. Through *Project Budburst* children learn how plants respond to spring's increased sunlight by noting the appearance of buds and flowers. And in *Journey North*, young citizen scientists experience first-hand how seasonal change can be measured through the length of a day, the migration of insects, and the appearance of birds in the spring. Many scientists are interested in learning about these things. Plants sensitive to temperature will be much more affected by warming. Some may be able to *adapt*—change the way they grow or where they grow—in response to climate changes.

GLOBE URBAN PHENOLOGY YEAR BUDBURST DATA WORKSHEET				
TREE TYPE				
Genus	Platanus			
Species	acerifolia			
Common name	London/Hybrid Plane Tree			
DESCRIBE YOUR TREES				
Tree number	Tree 1	Tree 2	Tree 3	Tree 4
Latitude	N40.73888	N40.73895	N40.73893	N40.73915
Longitude	W073.75710	W073.75688	W073.75678	W073.75615
Elevation (m) (FEET)	138	138	168	151
Height (m)*				
Circumference (in)*	66IN	68.5	70.5	74
(at 1.35 m above ground) (cm)	169CM	174	179	188
RECORD YOUR OBSERVATIONS	Indicate Y (Yes) when you have observed budburst in at least 3 branches.			
Date of observation	Tree 1	Tree 2	Tree 3	Tree 4
6-Apr	N	N	N	N
13-Apr	N	N	N	N
17-Apr	N	N	N	N
19-Apr	N	N	N	N
21-Apr	N	Y	N	Y
22-Apr	N		N	
23-Apr	N		Y	
24-Apr	Y			

Above: Washington, D.C.'s famous cherry blossoms are blossoming 6 to 7 days earlier than they did in the 1970s.

Left: Many flowers such as this bluebell are blooming weeks earlier than they used to. In the Washington, D.C. area these beautiful flowers come out 17 days earlier than in the 1970s.

Bottom left: This is a sample worksheet recording the data for a particular tree species. Each tree was carefully identified using GPS-generated longitude and latitude, along with its elevation, size, and the date on which budburst was observed on at least three branches.

Taking Charge of Your "Climate Footprint"

Above: Cities use tremendous amounts of energy. This is Albuquerque, New Mexico from Highway 66 at sunset. Half the world's population—more than three and a quarter billion people—live in cities, and an even greater number live nearby or commute to work in an urban area. This means enormous concentration of pollution and waste. Each city has a huge climate footprint. But cities also are centers of mass transit, concentrated delivery of food and supplies, and new building techniques that offer hope of much more efficient use of energy.

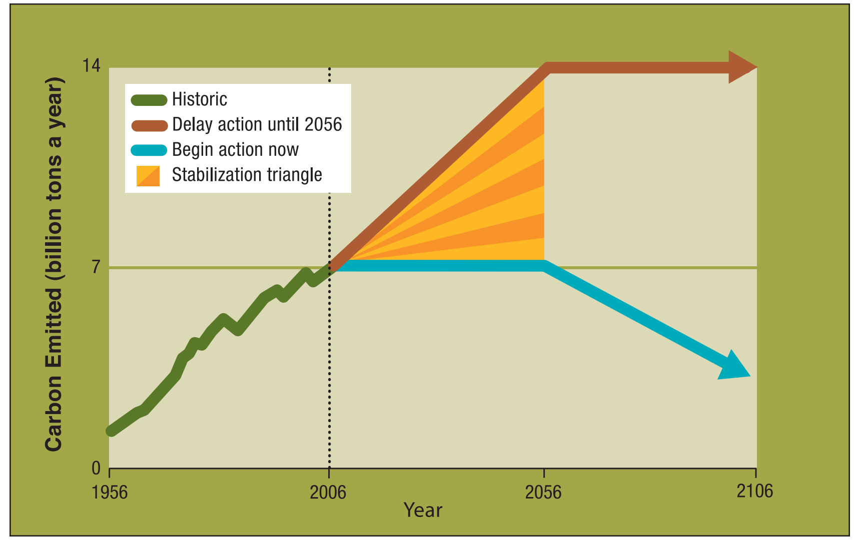
Your "climate footprint" is the amount of carbon dioxide and greenhouse gases you create as you go about your life day to day. It is also called a "carbon footprint", referring to the carbon in carbon dioxide. Everyone has a climate footprint. Among the world's nations, the U.S. and China have the two largest climate footprints, about equally big right now. As individuals, as countries and as a world there is a choice to be made: whether we are going to continue on the energy and climate warming path that we are on, or whether we are going to change.

Robert Frost, in his famous poem *The Road Not Taken*, wrote about stopping at a fork in the road in an autumn forest, deciding which way to go. Which choice he made would determine the path that his life would take. And he would often look back and wonder what would have happened if he had taken the other road. We are now at a fork in the road in deciding our energy future and you are part of that decision.

The graph on the next page shows a choice between two energy "roads." The top line shows the consequences of "business as usual"—burning increasing amounts of fossil fuel for years to come. The bottom line shows a leveling off of CO_2 emissions over the coming few years and then reducing use. The triangle that is created by the two lines taking off in different directions has been named the "stabilization triangle" by Dr. Robert Socolow and

Dr. Stephen Pacala. It symbolizes the amount of CO_2 that we should NOT emit in order to *stabilize*—maintain at a steady level—the world's climate. The triangle is divided up into wedges—long narrow triangles—each representing one way that the world could reduce greenhouse gas production in the next 50 years.

Imagine that someone has set a big apple pie in front of you and wants you to eat the whole thing. You might enjoy a slice or two, but you couldn't be expected to eat the whole pie! But if you call your friends and they each take a piece, very soon it will be gone. We know that because of global warming, humans need to reduce the amount of carbon emissions that we produce. It may seem like an overwhelming task, but if everyone cuts the amount of carbon they usually produce, it would have a big impact. Everyone has an "energy pie" whether they know it or not—every family, school, company, state and nation. The energy pie consists of all the energy being consumed. It's another way of thinking of the "climate footprint" or "carbon footprint."



Top right: Is it really possible to reduce CO_2 emissions significantly? Dr. Robert Socolow and Dr. Steven Pacala believe it is possible to hold them constant and later reduce them. Their chart shows the rapid growth of CO_2 emissions from 1956 to 2006 (green line), which is projected to continue to go up if we do not change by 2056 (brown line). The blue line represents constant emissions, and then a reduction. The blue and brown lines create a "stabilization triangle" with seven "wedges," each representing ways that will, by 2056, save a billion tons of CO_2 emissions. Achieving this goal will require lifestyle changes and conservation, as well as changes in technology.

Bottom right: One way to reduce your climate footprint is to reduce automobile use.

The Power of Friends and Community

Above: Healthy rainforests like this one in the Children's Eternal Rainforest in Monteverde, Costa Rica, "eat", or absorb, large amounts of carbon dioxide.

Although the middle school students near Montpelier, Vermont did not set out to reduce their climate footprint, they did something that will keep lots of carbon from entering the atmosphere each year. They noticed that sometimes breathing the air in school made them feel sick, especially if they had asthma. Mornings and afternoons, school buses sat outside waiting, with their motors idling. The students wanted to know: Were the exhaust fumes coming into the school? What was in the fumes? How could they find out?

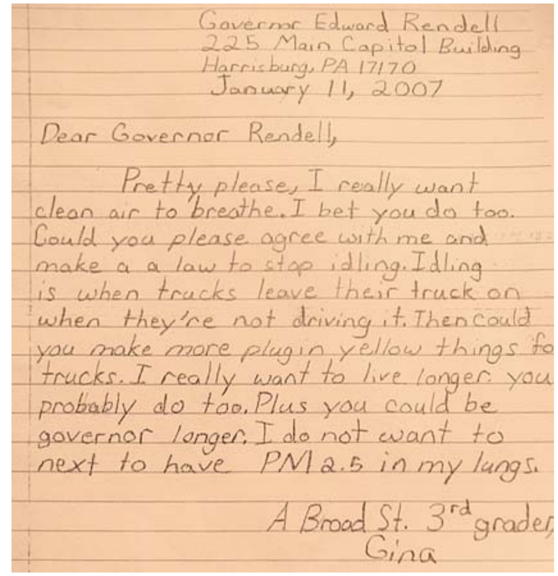
They found that a group called Air Vermont had equipment to help them. With ACCESS (A Computerized Community-Based Environmental Sampling System), students tested the indoor air before and after the buses idled in front of the school. The tests showed that unhealthy fumes from the buses were invading the school. There were 12 different pollutants. The students petitioned the school board for a "no-idling" policy to require buses and cars to turn off their engines when parked in front of the school. The school board agreed. The students went further: they testified before the state legislature, and in February, 2007, Vermont passed a no-idling law. Now the students realize that the carbon dioxide in the fumes is also a global warming gas and that while protecting their health, they are also reducing Vermont's carbon footprint.

By stopping school bus idling, students can save 20 gallons of gasoline per bus—and 400 pounds of carbon dioxide per year—from going into the atmosphere. If 100,000 schools did this for all their school buses, it would prevent 97,000 tons of CO_2 from going into the air each year. *Clean School Bus USA* is an organization that can assist in stopping idling in your school and state. (See Resources.)

All around the world young people are planting trees, which is a good thing. But nothing can take the place of existing forests, which provide many essential life-support functions. A mature tree can absorb 48 lbs. of carbon dioxide a year and release enough oxygen back into the atmosphere to support 2 human beings. Tropical forests are even more important. “Tropical forests are good for climate, so we should be particularly careful to preserve them,” says Ken Caldeira of Carnegie Institute’s Department of Global Ecology. A wonderful example of a rain forest that would otherwise have been cut for farming is the *Bosque Eterno de los Niños*—the “Children’s Eternal Forest” in Monteverde, Costa Rica. That spectacular forest of over 50,000 acres of rain forest was saved by contributions from children all over the world.

In the upper peninsula of Michigan young people wrote letters to their local newspaper and did radio and TV interviews to educate their community and raised $200,000 to buy a threatened forest. When young people in Maryland heard that a 600 acre forest that was owned by the Episcopal church was going to be cut down, they wrote letters to the bishop. They read their letters on “Sunday Morning With Charles Osgood,” a national news program, and the church was so deluged with letters of protest that the forest was saved.

Young people can make a difference by asking others to put the next generation—and the planet—at the top of their list of priorities. There is a saying: “We do not inherit the Earth from our ancestors, we borrow it from our children.”



Governor Edward Rendell
225 Main Capitol Building
Harrisburg, PA 17170
January 11, 2007

Dear Governor Rendell,

Pretty please, I really want clean air to breathe. I bet you do too. Could you please agree with me and make a a law to stop idling. Idling is when trucks leave their truck on when they're not driving it. Then could you make more plugin yellow things fo trucks. I really want to live longer. you probably do too. Plus you could be governor longer. I do not want to next to have PM2.5 in my lungs.

A Broad St. 3rd grader,
Gina

Two photos, top right: Around Carlisle, Pennsylvania, children have been writing to their governor and other elected officials asking for a no-idling law. They are citing data collected from the Clean Air Board’s air monitor in their town. Most of the students in Carlisle couldn’t see or smell the pollution, but those who suffered from asthma could feel its effects.

Bottom right: These children in a Mexican village worked with *Journey North* to track the migration patterns of the monarch butterfly that winters over in that part of Mexico.

What You–and a Million Kids–Can Do

These students are planting pumpkins in their school garden in California. In the autumn, some pumpkins became jack-o'-lanterns. The seeds were dried and eaten. Others became pumpkin pies and spicy cookies.

The things you do every day use energy and release greenhouse gases into the air. From sunrise to sunset, and even through the night as your house keeps you comfortable, you are using energy—and leaving a climate footprint. When you flip a switch to turn on a light, a power plant somewhere burns fossil fuels. Gasoline powers cars, trucks, SUVs, lawnmowers, leaf-blowers, and boats, and sends up clouds of *anthropogenic*—human generated—CO_2. One gallon of gas gives off nearly 20 pounds of carbon dioxide.

The actions below will reduce your climate footprint. They are easy changes that will make a difference right away. And it is better to prevent your own CO_2 from going skyward than to pay someone else to "carbon offset" your emissions!

- ***Walk or ride your bike to school***, if it's safe. Use public transportation. Shop near your home and make one trip instead of many. Vacation by train rather than airplane.

- ***Ask your parents to turn off the engine***. Idling the car 10 minutes less a day will save 550 pounds of CO_2 per year.

- ***Stop school bus idling*** and save 20 gallons of gasoline per bus—and 400 pounds of carbon dioxide per year—from going into the atmosphere!

- ***Drive an energy-efficient car***—a hybrid if possible. Driving a car that gets at least 32 miles per gallon saves 5,200 pounds of CO_2 per year. Some hybrids can get 50 miles per gallon!

- ***Re-use, recycle and reduce*** paper, glass and plastic. Start or improve a recycling program in your community and school.

- ***Replace*** incandescent light bulbs with compact fluorescents.

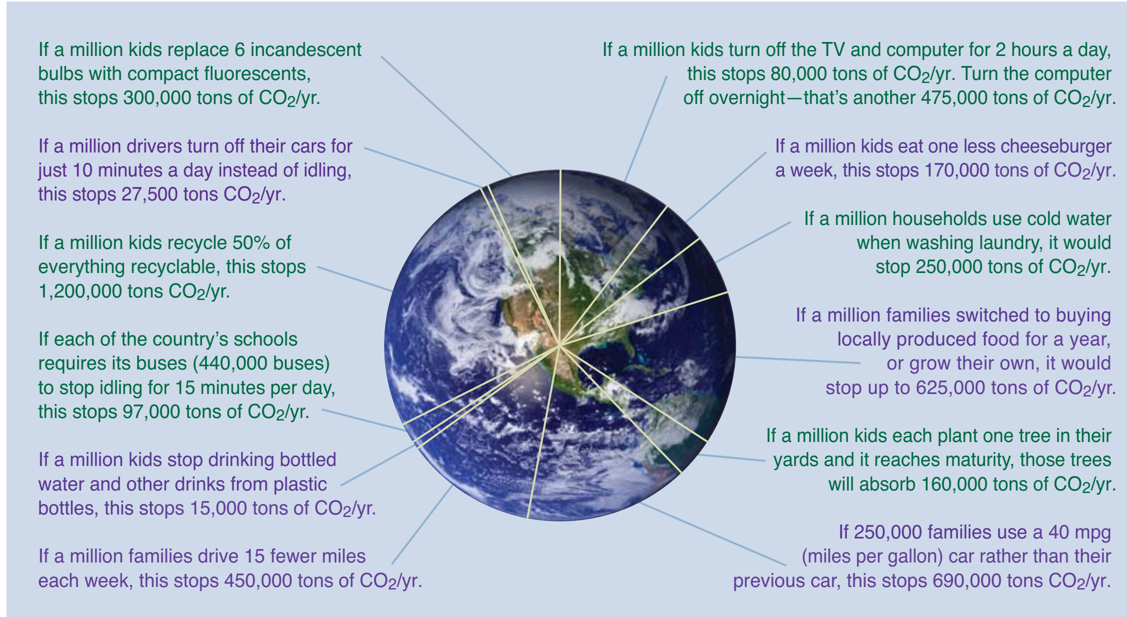
- ***Unplug your house***. Heat and electricity in your house make up one-third of the average family's greenhouse emissions. Turn things off, unplug them, and use appliances less.

■ ***Drink filtered tap water*** rather than buying water in plastic bottles. Carry your own reusable travel-cup for drinks, rather than throwing away bottles and cups each day.

■ ***Help to preserve old trees in forests***, especially rain forests, which soak up a lot of CO_2. If a million kids each raise $100 which is used to protect a million acres of tropical forest, those forests will continue to absorb and store 286,000,000 tons of CO_2/yr!

■ ***Eat less meat***. Cows and sheep produce *methane*, a greenhouse gas. Raising and processing livestock creates more greenhouse emissions than all the gases from cars and SUVs combined.

■ ***Buy mindfully and buy less.*** Think: Where did it come from? What was it made from? Buy locally grown, in-season food, which takes less fuel to transport, or grow some of your own. Buy un-packaged products. Think about thneeds. A thneed, as Dr. Seuss said in *The Lorax*, is something you think you need but don't really need.



The pie chart above shows how a million kids could help save about 4.5 million tons of CO_2/yr right away—that's a coal-burning power plant we won't need! These are only some of many things you can do to reduce your climate footprint. Something else you and your family can do is so big that it's almost literally "off the chart": household appliances—washers, dryers refrigerators, etc.—use a huge amount of energy. If one million families replace their old appliances with energy-star models, it will stop more than 3,000,000 tons of CO_2/yr. There are 55 million school-age kids in the United States. Think of all that CO_2 stopped!

■ ***Share what you've learned with your school.*** Help your school to be smarter about climate change. Encourage your school to recycle, reduce throw-aways, encourage car-pooling, stop school bus idling, and install a green roof and solar panels.

■ ***Get involved in your community.*** Write a letter to the newspaper editor suggesting that the town reduce its CO_2 emissions. Ask elected officials to sign the Step It Up pledge. Volunteer to help town leaders who are already doing something. Let companies know that you care about using less energy.

■ ***Check out*** the Resources in this book to find out much more you can do. Thank you for showing how much you care about planet Earth.