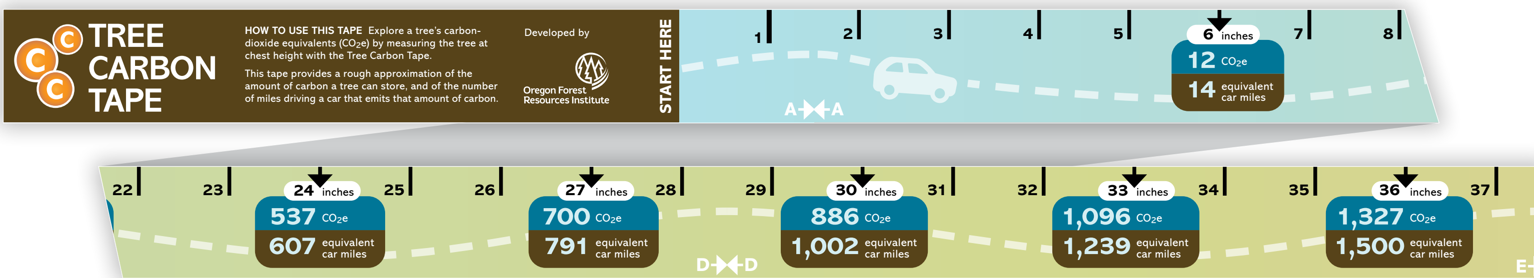
TREE CARBON TAPE

Instruction Guide

Grades 6-8



The Tree Carbon Tape was created by the Oregon Forest Resources Institute (OFRI) to give students a tangible sense of the amount of carbon stored by Oregon's forests.

This instruction guide is designed to help you use the Tree Carbon Tape in your middle school classroom. It suggests discussion questions and learning activities to help bring the idea of carbon sequestration alive for your students. It also identifies standards connections to assist you in making the necessary links with your school curriculum, and provides background information to support you in presenting this topic to students.

We invite you to add your own creative ideas, and hope you'll enjoy exploring the Tree Carbon Tape with your students.

1 "Forests and Carbon Storage." U.S. Forest Service. www.fs.usda.gov/ccrc/topics/forests-carbon.

2 "Carbon in Oregon's Managed Forests." Oregon Forest Resources Institute. oregonforests.org/node/753.

BACKGROUND

Increasing levels of carbon dioxide in the atmosphere, mostly from humans burning fossil fuels, are contributing to warmer global temperatures and changes in Earth's climate. This rise in temperature has led to melting glaciers, rising sea levels, longer wildfire seasons and other environmental impacts.

What does this have to do with forests? It turns out the trees are great at pulling atmospheric carbon out of the air and storing it. Through photosynthesis, trees absorb carbon dioxide (CO_2), transform it into carbohydrates (sugars), release oxygen into the atmosphere, and store the carbon in their woody structures as cellulose.

Carbon sequestration is the removal and capture of atmospheric carbon in plants, soils or oceans. A place where carbon is sequestered is often referred to as a "carbon sink." Trees in forests, as well as forest products, are primary carbon sinks.

The U.S. Forest Service estimates that U.S. forests sequester from 10% to 20% of U.S. fossil fuel emissions each year, reducing the presence of carbon dioxide in the atmosphere.[1] In 2016, Oregon forests sequestered 90% of the state's fossil fuel emissions due to its relatively small population and large amount of forest.[2]

Most of the carbon sequestered in a tree stays out of the atmosphere, even after the tree is harvested and the wood is used to build something. About half the dry weight of wood is carbon, which remains stored in wood products used to construct houses, apartments and office buildings, and helps offset carbon emissions that are contributing to climate change.

To compare the amount of sequestered carbon to carbon from emissions, scientists use a term called carbon dioxide equivalent, or CO_2e. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 that would have the equivalent global warming impact.

EQUATION FOR PHOTOSYNTHESIS

$$6CO_2 + 6H_2O \xrightarrow{\text{with SUNLIGHT}} C_6H_{12}O_6 + 6O_2$$

CARBON DIOXIDE + WATER → (with SUNLIGHT) GLUCOSE + OXYGEN

Discussion questions

You can use the Tree Carbon Tape to spark a discussion about the role of trees and forests in sequestering carbon, using questions such as:

Where does the matter that makes up a tree's wood originally come from?

What role does photosynthesis play in capturing carbon from the atmosphere?

How does the size of a tree affect the amount of carbon it stores?

What happens to a tree's carbon if the tree is cut down?

Activity: Estimating Carbon Stored in Trees

In this activity, students use the Tree Carbon Tape to estimate the amount of carbon stored in a stand of trees.

Materials: *Forest Fact Break: Carbon Capture* (90-second video); copies of the Tree Carbon Tape (printed at actual size on 8½"x11" paper); scissors; glue, stapler or tape; and copies of the "How Much Carbon?" student page.

1. Ask students what they think a tree's trunk and branches are made of. As necessary, review the process of photosynthesis, helping students make the connection between the carbohydrates manufactured in that process and the carbon stored in trees. Share the *Forest Fact Break: Carbon Capture* video and ask students how trees store carbon as they grow, and why carbon storage (sequestration) is important.
2. Give each group of students a copy of the Tree Carbon Tape. Direct them to cut out all 12 sections of the tape and then glue, staple or tape the sections together as indicated on the student page. The finished tape should be 72 inches long.
3. Take students to an outdoor area that has several trees. Invite students to use the Tree Carbon Tape to measure the circumference of five different trees, and to estimate the pounds of carbon dioxide equivalents (CO_2e) stored in them. Have them record their findings on the "How Much Carbon?" student page.
4. Use the Discussion Questions to frame a discussion about the role of trees and forests in storing carbon.

TREE CARBON TAPE ASSUMPTIONS

Data for the Tree Carbon Tape is based on these assumptions: Calculations are for a medium-taper, western Oregon Douglas-fir tree. The volume of the tree includes top and stump, and is calculated using Tarif #35 from Washington Department of Natural Resources Comprehensive Tree-Volume Tarif Tables (1963). Wood density is assumed to be 28.1 pounds per cubic feet at 0% moisture content, and carbon to be 50% of wood weight. For car miles, gas mileage is assumed to be 25 miles per gallon.

RESOURCES

Carbon Footprint Calculator. This student-friendly calculator from the U.S. Environmental Protection Agency estimates the impact of daily activities on carbon emissions. It may be found at www3.epa.gov/carbon-footprint-calculator/.

"How are Forests, Carbon and Climate Change Related?" This OFRI fact sheet explains the connection between Oregon's forests and climate change. Available to order or download at www.oregonforest.org/node/145.

Global Forest Watch. www.globalforestwatch.org/map/global/. An interactive map and other tools provide information on where and how forests are changing around the world.

Inside Oregon's Forests: A High School Forestry Curriculum. This 37-lesson module from OFRI provides an in-depth exploration of Oregon's forests and forestry. Available to order or download at LearnForests.org.

Where's All the Carbon? A poster and accompanying instruction guide help students see the relationship between Oregon's forests and the carbon cycle. Available to order or download at LearnForests.org.

More Activity Suggestions

Choose one or more of the following activities to deepen your students' understanding of the connection between trees, carbon and climate change:

- Challenge students to determine how many trees would store the same quantity of carbon as their annual carbon emissions. First, have them use the Carbon Footprint Calculator listed in Resources to find out their "carbon footprint," an estimate of the impact of daily activities on carbon emissions. Then have them compute how many trees growing to the average circumference from their investigation would total the CO_2e indicated from their footprint. (Note that the Carbon Foot Calculator estimates the carbon footprint in pounds of CO_2 per year.)
- Using the data presented on the Tree Carbon Tape, have students graph tree carbon equivalents by tree circumference. What relationship do they observe between the two variables? (As the circumference doubles, the carbon equivalents will increase fourfold.)
- Challenge students to create a model depicting the carbon cycle, including where photosynthesis occurs and the various carbon sinks. See *Where's All the Carbon?* listed in Resources for more information.
- Invite students to examine tree growth over time using cross-sections of tree trunks. (You may obtain these "tree cookies" from a forester or arborist in your area.) Note that light rings indicate fast, spring growth; dark rings indicate slower, summer growth; and each pair of dark and light rings equals one year of growth. Have students measure the distance from the center of the tree cookie to just inside the bark, and from the center to the outside edge of the tenth summer growth ring. Ask them to use this information to calculate the percent of radial growth in the tree's first ten years. How does that rate compare with other time periods in the tree's life?
- Explore an interactive map that tracks changes in forest cover, and discuss things people can do to increase the world's forest area. See Global Forest Watch in Resources for details.

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OREGON FOREST LITERACY PLAN

The Oregon Forest Literacy Plan, developed by a diverse statewide stakeholder group, identifies critical concepts for K-12 students in understanding Oregon forests. Concepts relevant to the Tree Carbon Tape include:

- Theme 1, C.3. Forest ecosystems include processes such as photosynthesis, energy flow and the cycling of nutrients, water, carbon and other matter.
- Theme 2, B.4. Forests sequester carbon from the atmosphere and are an essential component of the global carbon cycle. Forest products made from wood also store carbon.
- Theme 2, D.3. Forest products are an important component of Oregon's "green" economy. They come from a renewable resource and store carbon, and most are also reusable and recyclable.

STANDARDS CONNECTIONS

NEXT GENERATION SCIENCE STANDARDS

Performance Expectations

- MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

DISCIPLINARY CORE IDEAS

- LS1.C. Organization for Matter and Energy Flow in Organisms. Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.
- LS2.C. Ecosystem Dynamics, Functioning, and Resilience. Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

SCIENCE AND ENGINEERING PRACTICES

- Planning and Conducting Investigations

COMMON CORE STATE STANDARDS – ENGLISH LANGUAGE ARTS

- SL.6.1, SL.7.1, SL.8.1. Speaking and Listening. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade-appropriate topics, texts, and issues, building on others' ideas and expressing their own clearly.

COMMON CORE STATE STANDARDS – MATHEMATICS

- MP.4. Mathematical Practice. Model with mathematics.

STUDENT PAGE

NAME ____

DATE ____________________

How Much Carbon?

1. Identify five trees to measure using the Tree Carbon Tape.
2. Determine the circumference of each tree: Hold the tape at chest height (about 4.5 feet, or 1.4 meters) from the ground and wrap it once around the tree trunk. Find the measurement to the nearest 3 inches, and record the result below.
3. Use the tape to find the approximate carbon dioxide equivalent (CO_2e) contained in each tree. Record below.
4. Use the tape to the find the approximate number of miles in a car that would emit the same amount of carbon as stored in the tree. In growing to that size, the tree can "offset" the emissions from driving that number of miles.
5. For each tree, look at a map of Oregon or the United States and find a city or town that is about that number of miles from your home.

Tree location	Circumference at chest height (in inches)	Approximate carbon dioxide equivalent of tree (pounds CO_2e)	Approximate car miles offset by tree	City or town that distance from your home

Questions

What is the average circumference of this group of trees? ____________ inches

What is the average pounds CO_2e of this group of trees? ____________

About how many total car miles are offset by this group of trees? ____________ miles