PROJECT LEARNING TREE CANADA

An initiative of SFI

TEACHING WITH i-Tree

TEACHERS LOVE i-TREE

ACTUALLY USE

"This is something we can actually use with real-world application."

PATTI FARRIS
Middle School Teacher

GREAT TOOL

"This is a great tool. We talked about introducing it to the EAST students. They can use it to map the trees on campus and decide where we need more (trees) since our campus is new."

PATRICIA FINE
High School Teacher

VERY COOL PROGRAM

"I did get a feel for the i-Tree tools and how their assessment will assist in the managing of community trees. Very cool program."

JANE HOUSEAL
Master Naturalist

GLAD TO LEARN

"Glad to learn of this app. The projection tools provide the facts and figures needed for planned projects."

MARY R. COWGILL
Elementary School Teacher

PROJECT LEARNING TREE CANADA
An initiative of SFI

PLT Canada is committed to advancing environmental literacy, stewardship and career pathways using trees and forests as windows on the world.

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SUSTAINABLE FORESTRY INITIATIVE
SFI-00001

The Sustainable Forestry Initiative Inc. is a sustainability leader that stands for future forests. PLT Canada is an initiative of SFI.

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INTRODUCTION

ABOUT PROJECT LEARNING TREE CANADA

PLT Canada fosters community interest in the benefits of environmental education and responsible management of Canada's natural resources. We are committed to using the outdoors to engage students in learning about the world around them—in urban, suburban, rural, and Indigenous communities—and using trees and forests as windows on the world to inspire action. For more information, see pltcanada.org.

Project Learning Tree® (PLT) is an award-winning environmental education initiative designed for teachers and other educators, parents, and community leaders working with youth from preschool through grade 12.

For over 40 years, PLT has provided educators with high-quality professional development, hands-on activities, and multi-disciplinary supplemental curriculum that can be easily integrated into lesson plans for all grades and subject areas to help teach youth about trees, forests, and the environment.

Project Learning Tree helps develop students' awareness, knowledge, and appreciation of the environment, builds their skills and ability to make informed decisions, and encourages them to take personal responsibility for sustaining the environment and our quality of life that depends on it. Learn more at www.plt.org.

The Sustainable Forestry Initiative® Inc. is a sustainability leader that stands for future forests. PLT is an initiative of SFI. Through PLT and other initiatives, SFI supports getting youth outdoors and into nature in ways that inspire them to become environmental stewards and future forest leaders, and to introduce them to green careers. Learn more at www.sfiprogram.org.

PLT's professional development consists of carefully designed in-person workshops, online courses, or blended trainings that are customized for specific grade levels, topics, and teaching situations. More than 20,000 educators attend PLT workshops annually to learn how to integrate environmental and sustainability education into their teaching and become comfortable teaching outdoors—in urban, suburban, and rural environments.

PLT's instructional materials consist of comprehensive sets of grade-specific lesson plans and units that are practical, hands-on, and fun and aligned with curriculum. PLT activities teach children how to think—not what to think—about complex environmental issues and develop students' critical thinking and problem-solving skills.

PLT's GreenSchools program inspires students to apply STEM (science, technology, engineering, math) and investigative skills to make their school more green and healthy.

PLT's GreenWorks! grants support student-led action projects. Students learn they can make a difference in the world as they are empowered to make changes and take ownership of projects they lead to improve their school or an aspect of their community's environment.

PLT's network provides educators with customized professional development, state-specific supplements to PLT's educational materials that address the local environment, and personalized assistance for incorporating environmental education and outdoor learning into your classroom, including connections to mentor teachers, community members, and natural resource professionals.

For more information, and to contact your state's PLT Coordinator for local resources and support, visit www.plt.org.

ABOUT TEACHING WITH i-TREE

Project Learning Tree's *Teaching with i-Tree* Unit includes three hands-on activities that help middle and high school students discover and analyze the many ecosystem services that trees provide. The activities can be used in formal classroom settings or with nonformal groups, such as scouts, students enrolled in afterschool programs, and visitors to nature centers and parks. In addition, students can share what they've learned with family members to assess the trees around their home.

As they complete the activities, students will apply STEM skills to learn the following:

- The value of trees
- How to identify trees
- How to measure and assess the health of trees
- How to calculate the dollar value of the benefits that trees provide using the i-Tree Design tool
- How to analyze and interpret their findings
- How to use i-Tree tools to develop plans to improve the environmental functions that trees provide on their school grounds or in their community.

The activities incorporate the use of i-Tree Design software, which is a free, state-of-the-art online tool developed by the U.S. Forest Service and its partners (https://design.itreetools.org/). By using the i-Tree software, students will actually quantify the dollar value of the benefits provided by a tree or set of trees.

This helps them gain an understanding of the benefits trees provide related to greenhouse gas mitigation, air quality improvements, and stormwater interception. To extend the lesson, they will draw a building footprint and virtually "plant" a tree, then calculate its effects on building energy use.

Once students have collected and analyzed their data, they can use this information to implement service-learning projects, such as educating others about the ecosystem services trees provide or helping their school save money by strategically planting trees to decrease energy use. In the final activity, students apply what they've learned as they role-play being land managers.

ACTIVITIES

The activities in the *Teaching with i-Tree* Unit are designed to move the learner from awareness and knowledge to challenge and action. The Unit includes the following activities:

Activity 1. Tree Benefits and Identification
Students become aware of the many products we obtain from trees, how we all depend on trees in our daily lives, and the value that trees provide to communities and the environment. They also learn the features of trees that are used in identification and practice identifying trees using guides and free mobile apps. Finally, students are introduced to the i-Tree benefits calculator: i-Tree Design.

Activity 2: Tree Value
Students participate in a field study as they identify, measure, and assess the health of trees. They calculate the dollar value and ecosystem services of the trees using the i-Tree Design tool. Students use the information they gathered to create an Ecosystem Services Guide of the study site. They generate a tree improvement action plan and, if feasible, implement part or all of it.

Activity 3: Land Manager Role Play
Students are challenged to apply what they've learned in the first two activities as they role-play being land managers. Students also gain skills in communicating and presenting scientific information.

RELATED PLT ACTIVITIES

This activity has been adapted from Project Learning Tree (PLT). Additional curriculum materials are available from PLT.org that support and extend the learning in this Unit:

- PLT Carbon & Climate: Online Unit for Grades 6-8* with accompanying professional development
- PLT Secondary Modules: Exploring Environmental Issues: Focus on Forests; Global Connections: Forests of the World; Exploring Environmental Issues: Places We Live
- PLT GreenSchools Investigations: School Site Investigation (which could be also used to compliment EcoSchool programs!)
- PLT PreK-8 Environmental Education Guide*

See the individual activities that follow for a list of the specific PLT activities that support it. To access additional PLT curriculum materials visit www.pltcanada.org.

* Please note that these units are currently available from the US PLT store only and contain some US content. Canadian versions will be coming soon!

ACTIVITY 1
TREE BENEFITS AND IDENTIFICATION

Overview: Students will discover the many products we obtain from trees, how we all depend on trees in our daily lives, and the value of trees to communities and our environment. They will also learn the features of trees that are used in identification, and practice identifying trees using tree identification guides and free mobile apps. Finally, students will be introduced to the i-Tree software and learn how it can be used to quantify the benefits of trees.

Objectives: Students will discover their dependence on trees, how to identify trees, and methods for quantifying the benefits that trees provide.

Grades: Middle to High School

Subjects: Biology, Environmental Science, Social Studies

Skills: Comparing and contrasting, classifying and categorizing, identifying attributes and components

Technology Connections: Tree identification apps and interactive online guides, i-Tree software

Materials:

- Computer with internet connection
- Copies of the *Tree Identification Worksheet* Student Page on page 12 for each group (for both Part A and Part B)
- Pencils
- Tree flagging tape and permanent marker (or another way to mark trees)


STUDENT PAGE
TREE IDENTIFICATION WORKSHEET

- Tree identification field guides (printed or online)
- A free tree identification app, such as Leafsnap, loaded on one or more smartphones per group
- A few pieces of white paper (8 ½ x 11)
- Twigs with leaves from a variety of trees in the study area that students can use during the identification exercise. Try to collect twigs from both needle and broadleaf trees. If twigs and leaves are not available, digital images (without the species name) can be used.

Tree Identification Apps

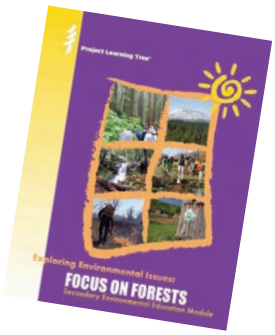
Leafsnap: A free mobile app that uses visual recognition software to help identify tree species from photographs of their leaves. The app was developed by researchers from Columbia University, the University of Maryland, and the Smithsonian Institution. Homepage: http://leafsnap.com/; YouTube video that explains how to use the app: https://www.youtube.com/watch?v=KCpR4JTEy4c&hd=1

iNaturalist: A free mobile app that allows you to take a photograph of a tree (or other living things) and share it with a global community of naturalists that can help identify it. Homepage: https://www.inaturalist.org/. Video and information on how to use the app: https://www.inaturalist.org/pages/about.

Time Considerations: Part A: One 45–60 minute session; Part B: One 45–60 minute session; Part C: One 45–60 minute session

Getting Ready: Choose a location that can be easily accessed for the outdoor study component of this activity and for Activity 2. Gather a variety of twigs with leaves from that location. Number the twigs/leaves so they can be used in the tree identification exercise. Download a tree identification app on one or more smartphones per group (see Resources). At the study site, number 10 different species of trees. To number the trees, write numbers from 1 to 10 with a permanent marker on flagging tape and tie the tape around tree trunks or branches. Consider enlisting the help of a forester, arborist, or other tree specialist to assist with the i-Tree activities. If there are more than 10 different species of trees in the study area, you can extend the exercise by flagging additional tree species.

Related PLT Activities — (available from the US PLT store: shop.plt.org.)



Exploring Environmental Issues: Focus on Forests – Activity #1: Monitoring Forest Health; Activity #6: Forest to Faucet; Activity #8: Climate Change and Forests

Global Connections: Forests of the World – Activity #1: Making the Global Connection, Activity #5: Understanding the Effects of Forest Uses, Activity #8: Making Consumer Choices

Exploring Environmental Issues: Places We Live – Activity #5: Green Space

PLT Carbon & Climate – Activity #1: What is Climate; Activity #2: The Carbon Cycle; Activity #5: Are You a Bigfoot?

PLT PreK–8 Environmental Education Guide – Activity #21: Adopt a Tree; Activity #22: Trees as Habitats; Activity #31: Plant a Tree

Assessment Opportunity: Have students create their own field guides for trees in their study area. Their guides should include the characteristics they learned about, such as leaf shape, bark color and pattern, and the branching pattern of leaves. Students can add photographs of the trees and leaves to their guides,

using word processing or presentation software.

BACKGROUND INFORMATION FOR EDUCATORS

TREE BENEFITS

Trees provide us with many products that we use in our everyday lives. From furniture and paper to chocolate and spices, products from trees are all around us. While almost everyone knows that wood and paper products come from trees, you may not be as aware of other products that come from trees, such as gums, resins, cork, natural rubber, natural fibres like rayon, and tannin. In addition to providing these products with their obvious economic value, trees can also improve property values and reduce energy costs. A 25-foot-tall tree may reduce the heating and cooling costs of a typical residence by 8 to 12 percent. In addition, trees provide social benefits, such as noise reduction, aesthetic value, and privacy.

We depend on trees for a number of beneficial *ecosystem services*. These are services that humans derive from environmental functions such as photosynthesis, biodiversity, oxygen production, watershed protection, and carbon sequestration. Though you may not receive a monthly bill or pay for them directly, you use these ecosystem services every day. Examples of the ecosystem services that trees provide include the following:

- **Clean Water.** Trees are critical to maintaining clean water supplies. Trees absorb rain, facilitate the recharge of underground aquifers, cool water and absorb the pollutants it carries, reduce flooding, and sustain watersheds. Trees also help to slow storm runoff, which helps prevent soil erosion and moderates the water cycle so that we experience a more consistent water supply.
- **Oxygen.** Like all green plants, trees use energy from the sun to make glucose (food) through *photosynthesis*. In the process, trees absorb carbon dioxide from the atmosphere and release oxygen, which humans and other animals need to live.
- **Nutrient Cycling.** Trees absorb *nutrients* from the soil through their roots and transport the nutrients to cells in their leaves, branches, and trunk. When a tree dies or when parts of a tree fall and decay, nutrients and other *organic* and *inorganic materials* are returned to the soil and atmosphere.

- **Carbon Storage.** As trees grow, they help to remove carbon dioxide from the atmosphere by absorbing and storing carbon in their tissues. To grow a pound of wood, an average tree takes in about 1.5 pounds (0.68 kg) of carbon dioxide and gives off about 1.1 pounds (0.58 kg) of oxygen. The wood continues to store the carbon, even after it is made into lumber or other products.
- **Temperature Regulation and Rainfall.** Through their roots and leaves, trees absorb and release thousands of gallons of water each day in a process called *transpiration*. In forests, this large-scale movement of water can influence regional temperatures and annual rainfall.
- **Wildlife Habitat.** Trees provide a place for thousands of animals to live. The complex structure of forests creates many niches where wildlife can find food, shelter, and water.

TREE IDENTIFICATION

In order to use the i-Tree software, students will need to be able to identify the trees in the study site. The following background information provides a basic overview of the many features of trees that are used for classification and identification.

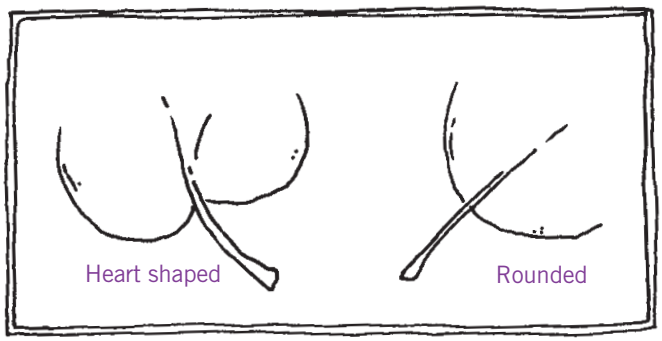
Leaf Type

Determining the type of leaf a tree has is useful for identification. Leaves can be broadleaf, needle-like, or scale-like. Broadleaf refers to leaves that are flat, thin, and typically shed each year. Most broadleaf trees are *deciduous* and bear a variety of fruit and flowers. Examples include oak, apple, maple, dogwood, and aspen. Trees that have needle-like or scale-like leaves generally bear cones and are called *conifers*. For the most part, conifers also have evergreen leaves – meaning that the leaves stay green year-round and don't all fall off each year. Examples of trees with needle-like leaves include pine, spruce, and fir. Cedars are an example of trees with scale-like leaves. Some trees, however, aren't typical conifers or deciduous trees. For example, larches have cones and needles but lose their leaves every year and a holly is a broadleaf tree that's evergreen.

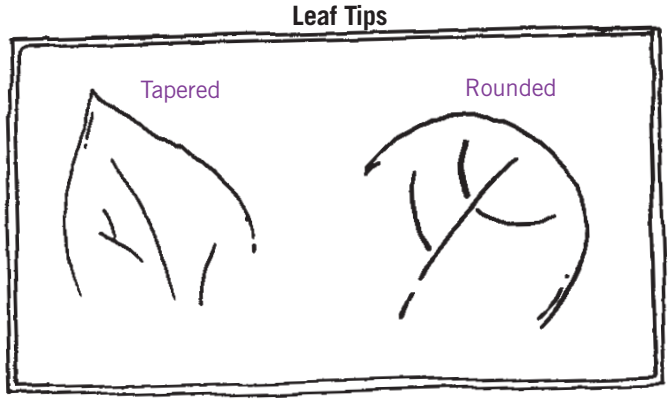
Leaf Shape

The overall shape of a leaf gives clues to the tree's identity. For example, willows have long, slender leaves; cherry trees and swamp magnolias have oval leaves; and cottonwoods have triangular leaves. Similarly, fir needles tend to be flattened, pine needles are rounded, and spruce needles are square. The shapes of leaves differ in many ways. For example, the tips of leaves may be notched, pointed, rounded, tapered, and so on. The bases of leaves may be squared, rounded, heartshaped, and so forth.

Leaf Bases

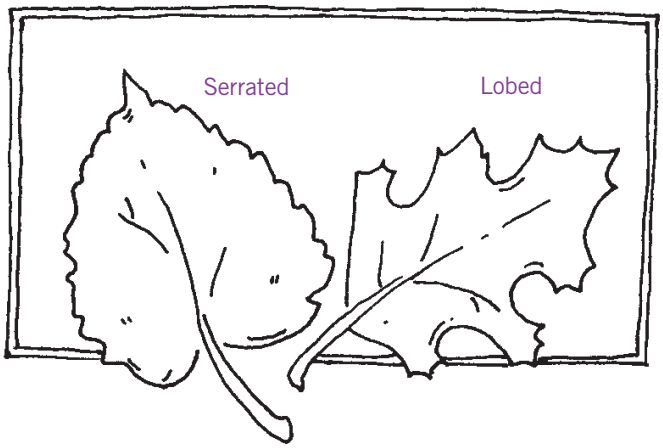


Leaf Tips



Leaf Margins

The edges or margins of leaves also provide clues to the tree's identity. For example, some leaves have teeth (serrated) along their margins, some leaves are lobed, and some leaf margins are smooth (entire).

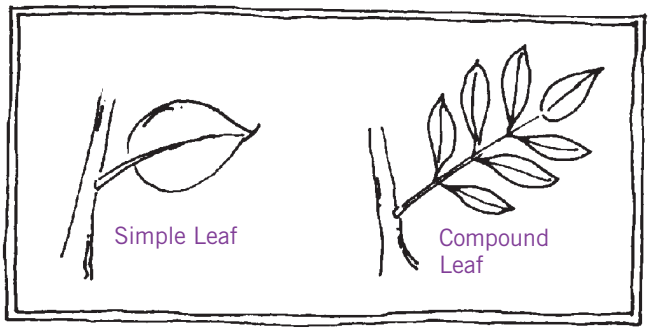


Textures

Some leaves are completely hairy, others have hairs on only one side, and others are completely smooth. Leaves may also be thick or thin, rough or waxy.

Simple and Compound

When most people think of leaves, they think of simple leaves. Simple leaves have only one piece to them. Maple, oak, aspen, sycamore, and many other trees have simple leaves. Compound leaves, on the other hand, are made up of several leaflets. Ash, walnut, and sumac trees all have compound leaves.



Leaf Arrangements

Another characteristic to identify a tree is the way its leaves are arranged on the twigs. Some trees have leaves that grow in whorls along the twig. Others have alternate leaves that are staggered along the twig. Other trees have opposite leaves that grow in pairs along the twig (see diagram). The needles on pines, spruces, firs, and other needleleaved trees also grow in patterns. For example, pine needles may grow in clusters of two, three, or more.

Twigs

If you know what to look for, even leafless twigs on a tree can tell you the tree's identity. This is especially helpful when you're identifying deciduous trees in the winter. By looking at where the leaf scars or buds are on the twig, you can tell whether the leaves grow in a whorled, alternate, or opposite pattern. (Leaf scars are the places on the twigs where leaves used to be attached.) The size, color, and shape of buds can also be used to identify trees. In addition, spines and thorns on twigs can help identify a tree.

Fruit and Flowers

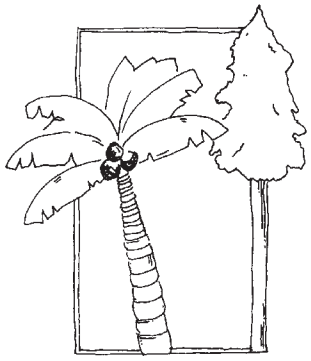
Trees produce different kinds of fruits, seeds, nuts, and pods. Various conifers produce different kinds of cones. Different trees also have distinct flowers. The shape, color, texture, size, and other characteristics of the fruit, cones, and flowers can be used to identify trees.

Bark

Many people can identify trees just by looking at the color and texture of tree bark. For instance, bark may be shaggy, smooth, or rough; it may have deep furrows or markings. Paper birch is an example of a tree that is easily identified by its white, paperlike bark. When you're using bark to identify a tree, it's best to look at bark growing on the trunk rather than on the branches and twigs, because the bark on a branch is thinner and newer, and it may look quite different from the trunk. Bark also looks different as a tree gets older.

Tree Shape

Many trees have characteristic shapes that can be used to identify them. In fact, just by glancing at the shape of a distant tree and the color of its leaves, some people can tell what kind of tree it is.



** Note: The information presented here is a basic overview of the features that can be used to identify trees. For more detailed information and illustrations on tree identification, please visit: treebee.ca: an identfication resource by Forests Ontario.*

DOING THE ACTIVITY

PART A: TREE BENEFITS

1. Ask students to guess how many products people use that come from trees. Record their responses. Have students, individually or in small groups, write down as many products as they can that are derived from trees.

2. Once they have completed their lists, reveal that more than 5,000 products come from trees. Have students share their responses. Tell them some of the common products we get from trees, listed below, if they do not mention them.

- Wood products – lumber, planks, packaging, wood panel veneers, particle board, plywood furniture, flooring, baseball bats, hockey sticks, chopsticks, guitars
- Cellulose products – carpeting, cellophane, rayon, paper products, fiberboard, books, magazines, newspaper, writing paper, tissues
- Sap products (gums and resins) – paint thinner, rubber products, waxes, printing ink, flavorings, syrup, soap, perfumes, adhesives, car wax, maple syrup
- Fruit – apple, mangos, bananas, and many more
- Nuts – pine nuts, cola nuts, walnuts, and many more
- Leaves – bay leaves
- Bark products – cork, tannin, quinine (the drug used to cure and prevent malaria)

  ** Note: Some of the products listed aren't always or exclusively made from trees.*

3. Ask students what other benefits we get from trees. Steer them to thinking about the environmental benefits that trees provide. Have students work in groups to create a list of the benefits that trees provide.

4. Invite each group to share some responses while making a class list on the board. After looking at the class list, ask students if they can think of any benefits that are missing. (Be sure that the list includes energy savings, stormwater control, air quality improvement, and carbon sequestration; See the *Background Information* section for more details.) Discuss how trees provides a variety of *ecosystem services*.

Ask students what they think the term ecosystem services means. Explain that ecosystem services are the services that humans derive from environmental functions such as photosynthesis, biodiversity, oxygen production, watershed protection, and carbon sequestration.

5. Now ask students if they think there is a way to calculate the dollar value of these ecosystem services. Explain that i-Tree is an online tool that enables users to assign a dollar value to the benefits trees provide. Introduce students to the i-Tree website at https://design.iTreetools.org/ and explain that they will use the online calculator to assess the ecosystem services of the trees on the school grounds (or other chosen location). Give students time to review the website so that they become familiar with the steps necessary to use i-Tree Design. This will help them understand why they have to accurately collect data in the field. For example, they will need to determine each tree's species and measure the circumference of the tree at 4.5 feet above the ground in order to calculate the tree's diameter at breast height (DBH), a standard measurement. More about DBH is provided in Activity 2: Tree Value.

** Note: You may want to show students an introductory video about i-Tree: https://www.plt.org/i-tree/how-to-calculate-tree-benefits/video*

PART B: TREE IDENTIFICATION

1. Explain to students that in order to use the i-Tree tool, they will need to know what types of trees are in the study area. Ask: What characteristics can we use to identify trees? Display their list of ideas.

2. Now hold up the twigs and leaves you collected earlier, or pass them around the room. Have students examine and compare them. Can students suggest any additional ways they might be able to identify trees?

Review their list, making sure it includes the following basic characteristics used to identify trees. (See the *Background Information* for details on each characteristic.)

- Leaf type (needles vs. broad leaves)
- Leaf shape
- Leaf margins
- Leaf texture
- Simple vs. compound leaves
- Leaf arrangements
- Twigs
- Fruits, flowers, and seeds
- Bark
- Tree shape

3. Now give each group of students the *Tree Identification Worksheet* Student Page and a variety of the twigs and leaves that you collected from the study area. Explain that they should use the field guides to practice identifying the trees based on the twigs and leaves, and record their observations and findings on the worksheet.

Once students have become comfortable using the field guides, have them try one or more of the free tree identification apps, (See *Materials* and *Resources*). Remind students to completely fill out their worksheets.

4. Once students have completed the exercise, have them share the names of the trees they identified and discuss what worked and didn't work as they tried to identify the twigs and leaves. Develop a class list of the trees that they identified for use with the next activity.

PART C: TREE ID OUTDOORS

1. Divide the students into small groups. Give each group tree identification guides and/or have the free tree identification apps loaded on one or more smartphones per group. In addition, give each group another copy of the *Tree Identification Worksheet* Student Page.

Explain that they will be going outside to the study area to practice their tree identification skills in a friendly competition. The goal is to correctly identify the 10 numbered trees in the allotted time that you establish.

2. Take students outside and remind them to stay in the designated area. Tell them how much time they have to correctly identify the 10 trees. Start the timer and begin the competition.

3. Once the time is up, gather the groups and review their results. Go to each tree with the groups to make sure that they correctly identified it on their worksheet.

4. Debrief by asking the following questions:

- Which group was the first to correctly identify all the trees (or, which group identified the most trees correctly)?
- Which tools were the most effective? (printed or online field guides, apps)
- Which tools were the least effective?
- How did students cooperate within their groups?
- What are some ways to improve the exercise?

RESOURCES

i-TREE TOOLS: https://design.iTreetools.org/

i-Tree Design allows users to estimate the benefits provided by individual trees. After providing inputs of location, species, tree size, and condition, users will receive information on tree benefits related to greenhouse gas mitigation, air quality improvements, and stormwater interception. Users can draw a building footprint and virtually "plant" or place a tree nearby, then calculate the tree's effects on building energy use.

i-TREE VIDEO

Interactive video about how to use the i-Tree software: https://www.plt.org/i-tree/how-to-calculate-tree-benefits/video

TREE IDENTIFICATION APPS

Leafsnap: A free mobile app that uses visual recognition software to identify tree species from photographs of leaves. Homepage: http://leafsnap.com/; Video about the app: https://www.youtube.com/watch?v=KCpR4JTEy4c&hd=1

iNaturalist: A free mobile app where you can take a photograph of a tree and share it with a global community of naturalists that can help identify it. Homepage: https://www.inaturalist.org/; Video about the app: https://www.inaturalist.org/pages/about

TREE IDENTIFICATION GUIDES – ONLINE

Arbor Day Foundation hosts an interactive online guide, What Tree Is That?, for trees in the United States: https://www.arborday.org/trees/whattree/

Many provinces have state-specific tools for online tree identification. Search the internet by using "tree identification" and your state's name. A few examples follow:

"Ontario Tree Atlas" (online guide to native trees in Ontario) https://www.ontario.ca/environment-and-energy/tree-atlas

"Trees Inside Out" (identification keys for Quebec): https://www.aucoeurdelarbre.ca/en/branching-out/identify-trees-key.php

"Tree Book" (Identification resource for Native trees in BC): https://www.for.gov.bc.ca/hfd/library/documents/treebook/TreeBook.pdf

TREE IDENTIFICATION GUIDES – PRINT

Arbor Day Foundation and Karina I. Helm. 2009. What Tree Is That? A Guide to the More Common Trees Found in North America. Lincoln, NE.

Brockman, C. Frank, and Rebecca Merrilees. 2001. Trees of North America: A Guide to Field Identification. Rev. ed. (Golden Field Guide Series). New York: St. Martin's Press.

STUDENT PAGE

TREE IDENTIFICATION WORKSHEET

Date: ____________________ **Team Members:** ____

Number	Needle or Broad Leaf?	Leaf Shape?	Leaf Margin?	Simple or Compound Leaf?	Leaf Arrangement?	Other Clues (bark, trunk shape, twigs, etc.)	Common & Scientific Name
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			
	❐ Needle ❐ Broad Leaf			❐ Simple ❐ Compound			

ACTIVITY 2
TREE VALUE

Overview: Students learn to calculate the annual dollar value and ecosystem services of trees in a study site using the online i-Tree tool. After entering and analyzing their data, they create an "Ecosystem Services Guide" for the study site, which includes suggestions for improving the health of the trees. If feasible, they will implement part or all of their improvement plan.

Objectives: Students will learn to identify, measure, and assess the health of the trees in the study site; use their collected data with the online i-Tree Design application; and understand the ecosystem services that trees provide.

Grades: Middle to High School

Subjects: Biology, Economics, English Language Arts, Environmental Science, Social Studies

Skills: observing, comparing and contrasting, organizing information, representing, summarizing, synthesizing, creating

Technology Connections: online i-Tree Design tool, tree identification apps and interactive online guides, word processing software, presentation software

Materials:

- One copy of the *How to Use i-Tree Design* and *Tree Value Worksheet* Student Pages for each group (see pages 17–20)
- Tree identification field guides (printed or online)
- Free tree identification app (such as Leafsnap) loaded on one or more smartphones per group (see the Resources section)
- Computer with internet connection to access the i-Tree Design tool (https://design.iTreetools.org)
- Measuring tape(s) or DBH tape(s) – 20 feet or longer
- Close-up aerial photo of study area that shows individual trees (possible source: Google.com/maps – "Earth" view)
- Pencils, notebooks
- Solid white paper (approximately 8 1/2 x 11 inches); two pieces per group
- Tree flagging tape and permanent marker (or another way to mark trees)
- Cameras (digital cameras or cameras on smartphones/tablets)

Time Considerations: Two to three 45-60 minute sessions depending on the location of the study site and the number of trees on the site.

Getting Ready: Arrange for students to visit the field study site (selected in Activity 1). Gather the supplies listed in Materials. Depending on the number of trees on the study site, determine whether students will assess every tree or take a representative sample. Be sure to include trees of varying sizes and species. Number the trees that will be assessed in advance by writing numbers with a permanent marker on flagging tape and tying it around the tree trunks or branches. Make copies of the Student Pages for each group. You may want to review the following interactive videos on how to use the i-Tree software and how to calculate the DBH of a tree: https://www.plt.org/i-tree/how-to-calculate-dbh/video; https://www.plt.org/i-tree/how-to-calculate-tree-benefits/video. You can also preview the i-Tree software at: https://design.iTreetools.org.

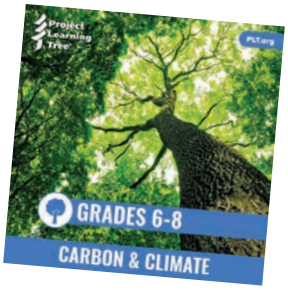
** Note: If you plan to calculate the impact of trees on the cooling and heating utility bills of any building on the study site, you will need to know the approximate date the structure was built, (e.g., pre-1950, 1950–1980, or post-1980).*

Related PLT Activities —
(available from the US PLT store: shop.plt.org.)

Exploring Environmental Issues: Focus on Forests – Activity #1: Monitoring Forest Health; Activity #6: Forest to Faucet; Activity #8: Climate Change and Forests

Global Connections: Forests of the World – Activity #1: Making the Global Connection; Activity #2: What Is a Forest?; Activity #3: Mapping the World's Forests; Activity #4: Analyzing Patterns of Forest Change; Activity #5: Understanding the Effects of Forest Uses; Activity #8: Making Consumer Choices

Exploring Environmental Issues: Places We Live – Activity #5: Green Space;
Activity #6: A Vision for the Future



PLT Carbon & Climate – Activity #1: What Is Climate?; Activity #2: The Carbon Cycle; Activity #5: Are You a Bigfoot?

PLT PreK–8 Environmental Education Guide – Activity #12: Invasive Species; Activity #21: Adopt a Tree; Activity #22: Trees as Habitats; Activity #27: Every Tree for Itself; Activity #31: Plant a Tree; Activity #67: How Big Is Your Tree?; Activity #76: Tree Cookies; Activity #77: Trees in Trouble; Activity #81: Living with Fire; Activity #84: The Global Climate

Assessment Opportunity: Use students' Ecosystem Services Guides as a means of assessment. (See Step 6 that follows.)

BACKGROUND INFORMATION FOR EDUCATORS

The following information may be useful as you explain to students how to use the i-Tree software to calculate the benefits of trees on the study site.

DBH

DBH is an abbreviation for the term Diameter at Breast Height. It is a measurement used by foresters and arborists to assess the size of a tree trunk. For consistency, DBH is always measured at 4.5 feet above ground level. To measure circumference, simply wrap a measuring tape completely around the tree trunk at 4.5 feet above the ground. You can calculate the DBH by dividing the circumference by 3.14.

Map of the Study Area

Provide, or have students print, a close-up aerial photo of the study area that shows individual trees. A possible source for this photograph is Google.com/maps – "Earth" view.

Tree Condition

Students will assess the condition of the trees in the study area. Guidelines for determining tree health are provided on the *Tree Value Worksheet* Student Page. Keep in mind that if you think a tree doesn't look healthy, it probably isn't. Once you become familiar with how specific trees are supposed to look, rating their condition will be easy.

Tree Value Worksheet

The *Tree Value Worksheet* Student Page provides a simple way for students to record the data they collect at the study site. They will record information related to each tree in the study area, including species, DBH, sun exposure, and overall condition.

Data Processing

i-Tree Design (https://design.iTreetools.org) is a simple tool that students can use to estimate the benefits provided by trees. After students input information on a tree's location, species, size, and condition, the online tree benefits calculator will generate a report that includes information on the tree's contribution to greenhouse gas mitigation, its contribution to improved air quality, and its effect on stormwater interception. Students can draw a building footprint and virtually "plant" or place a tree near it, then evaluate the tree's effects on building energy use. Multiple trees and buildings can be added to compare benefits or to provide a full accounting of a property's trees. This tool is intended as a simple and accessible starting point for understanding the value of individual trees or a small population of trees.

DOING THE ACTIVITY

1. Review how to calculate the dollar value of the ecosystem services that trees provide, using i-Tree Design, an online tool that provides tree benefit assessments. You may want to show students the following interactive videos on how to use the i-Tree software and how to calculate the DBH of a tree: https://www.plt.org/i-tree/how-to-calculate-dbh/video; https://www.plt.org/i-tree/how-to-calculate-tree-benefits/video.

2. Tell students that they will be going to the study area to collect the data for use with i-Tree Design. Hand out or display the *Tree Value Worksheet* Student Page and go over each category.

Explain that in addition to completing the worksheet at the study site, they will also be taking a photograph of each tree they assess. The photos will be used during step 6 when students create an Ecosystem Services Guide.

Checklist of supplies for the field study:

- ❒ Aerial photo of the study site (one per group)
- ❒ *Tree Value Worksheet* Student Page (one per group)
- ❒ Digital cameras (one per group; can be a smartphone or tablet)
- ❒ Tree identification guides/apps (for each group)
- ❒ Measuring tape or DBH tape (one per group)
- ❒ Pencils, notebook (one per group)
- ❒ Solid white paper (approximately 8 1/2 x 11 inches); two pieces per group

3. Take your students to the selected study site and divide them into groups. Assign each group tree(s) to identify, measure, and assess using the directions on the *Tree Value Worksheet*. Groups should record their results and take photos of the trees.

4. Back in the classroom, give students copies of the *How to Use i-Tree Design* Student Page and allow time for them to explore the online i-Tree tool found at: https://design.iTreetools.org/. Using the tool, students will determine the dollar value and ecosystem services of their assigned tree(s). Have students record their results on their *Tree Value Worksheet*. They can also print detailed reports. Then discuss the following questions as a class:

- Were you surprised to learn the dollar value of the tree?
- What ecosystem services does your tree provide?
- Why are these ecosystem services important? (Be sure students discuss the tree's stormwater, energy, air quality, and CO2 benefits, as well as how trees improve property values.)
- How does the value of your tree compare to those of other trees?
- Why is it important to care for trees?
- Now that we know the value these trees provide, how might that influence the future management of the study area?

5. Have students share their data and create a graph of the results for all the trees in the study area. They should place "Tree Diameter" on the x-axis and "Dollar Value" on the y-axis. Once graphs are complete, discuss the following questions:

- What was the diameter of the tree with the greatest value? The least value?
- What trends do you notice? Why do you think those trends exist?

6. Have students, individually or in groups, create an "*Ecosystem Services Guide*" to the study area that includes the following:

- An overview of the ecosystem services and other benefits the trees provide (including dollar values),
- A map that shows a route for walking in the study area that highlights interesting trees and the various ecosystem services the trees are providing,
- Descriptions of tree species and other pertinent features of the trees and study area (with photographs), and
- Suggestions for caring for and improving the health of the trees in the study area.

Once students have completed their guides, have them present their projects. Consider having them present to students in other classes, as well as to community members at functions such as local public service groups (Lions, Optimist, Kiwanis, etc.). Using the data provided by i-Tree, their presentations can be used to make a case for protecting trees in your area and planting more.

7. If feasible, have students develop and implement a service-learning action project. For example, students could care for damaged trees, remove invasive species, or plant more trees. Invite local tree care experts and foresters to assist students. Please note that planting native trees is preferred. To find out which trees would be best for the location, contact your state forester or extension agent, or utilize web resources. i-Tree Species (https://species.itreetools.org/) can help with advanced tree species selection.

EXTENSIONS

1. Have students share their findings on the value of trees through school websites, newspaper articles, blogs, and so forth.

2. Have students become Citizen Scientists by sharing their i-Tree data with local community planning committees, Forestry Extension offices, and so forth.

3. Visit a different study site and repeat the activity. Compare the results. What factors might explain any differences?

4. Evaluate different management schemes for your study area. Use i-Tree tools to compare the effects of various plans, for example: leaving the land as is, planting more trees, or thinning the trees.

5. Tree growth over time is another useful indicator of forest health. If you have access to an increment borer, you can take core samples to determine tree health. More closely spaced rings indicate a stressed tree, while wider rings indicate fast growth as a result of abundant sunlight, water, nutrients, and so forth. Consider enlisting a forester or arborist to help with this activity.

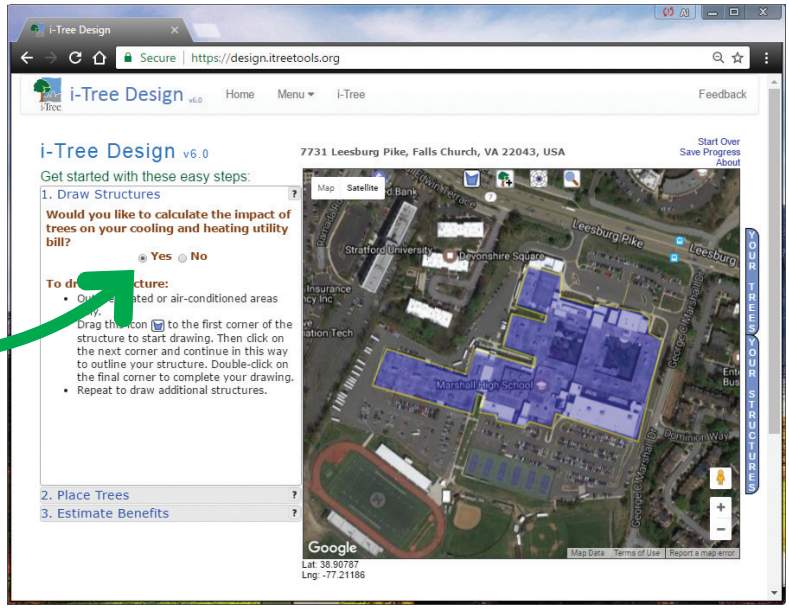
STUDENT PAGE
HOW TO USE i-TREE DESIGN

On a computer, navigate to https://design.iTreetools.org/. Enter your school address or the specific address of the area you are studying (including the street address and city). A pop-up dialog box will appear to confirm the address.

1. DRAW STRUCTURE

Trees affect the heating and cooling costs associated with a building by modifying climate, producing shade, and reducing wind speeds. These effects depend on the species, size, and location of a tree. On the next screen, you will be asked, "Would you like to calculate the impact of trees on your cooling and heating utility bill?" Click "Yes."

You will then be instructed to "draw" the building structure. Basically, this means outlining the building. When you draw a structure, outline heated or air-conditioned areas only because trees have no effect on energy use in structures that are not heated or cooled, such as unheated garages.



To draw a structure:

- Zoom in as needed.
- Drag this icon to the first corner of the structure to start drawing.
- Click on the next corner, moving around the perimeter of the building in one direction. Continue in this way to outline your structure.
- **Double-click** on the final corner to complete your drawing.
- Select characteristics about the structure in the "house information" pop up.
- Repeat to draw additional structures.

HOW TO USE i-TREE DESIGN (CONTINUED)

If needed, you can:

- Hit the "Delete" key to delete your last point.
- Hit the "Esc" key to cancel drawing your structure entirely.

Additional tips and tricks:

- Click the "Your Structures" tab on the right-hand side of the screen to View/Delete structures.
- Click this button to toggle between the current structure and the address.
- Click this button ? to access more information about the steps.

2. PLACE TREES

To complete this section, you will need the data collected from the outside tree assessments that was entered on the Tree Value Worksheet Student Page. Start with tree #1 on your worksheet. Use the drop-down menus to indicate the tree's species, diameter/ circumference, condition, and exposure to sunlight.

For each tree on the property that you want to assess, you will have to "place" it on the map. Do this using the "add a tree" icon.

To place a tree:

- Drag the icon to the location on the map where you would like to place your tree. *(Zoom in if needed)*
- Repeat to place additional trees. *(Change tree descriptors for each new tree.)*
- Hover over any tree you have placed on the map to display its benefits.
- Click the "Your Trees" tab on the right-hand side of the screen to View/Delete trees.

Hint: Although "placing" each tree that you want to assess may seem time consuming, it is worthwhile because the program will automatically add up the energy-saving benefits and dollar value for all the trees, and you will be able to print reports with detailed data, graphs, and more!

Tree benefit zones: As you describe your tree, you will see colored zones around your structure(s) that represent energy benefits. The benefit zones are colored according to the potential monetary value of energy savings provided by the tree. You can hover over each zone to see energy benefit information displayed on the map. Click this button to turn the benefit zones on and off.

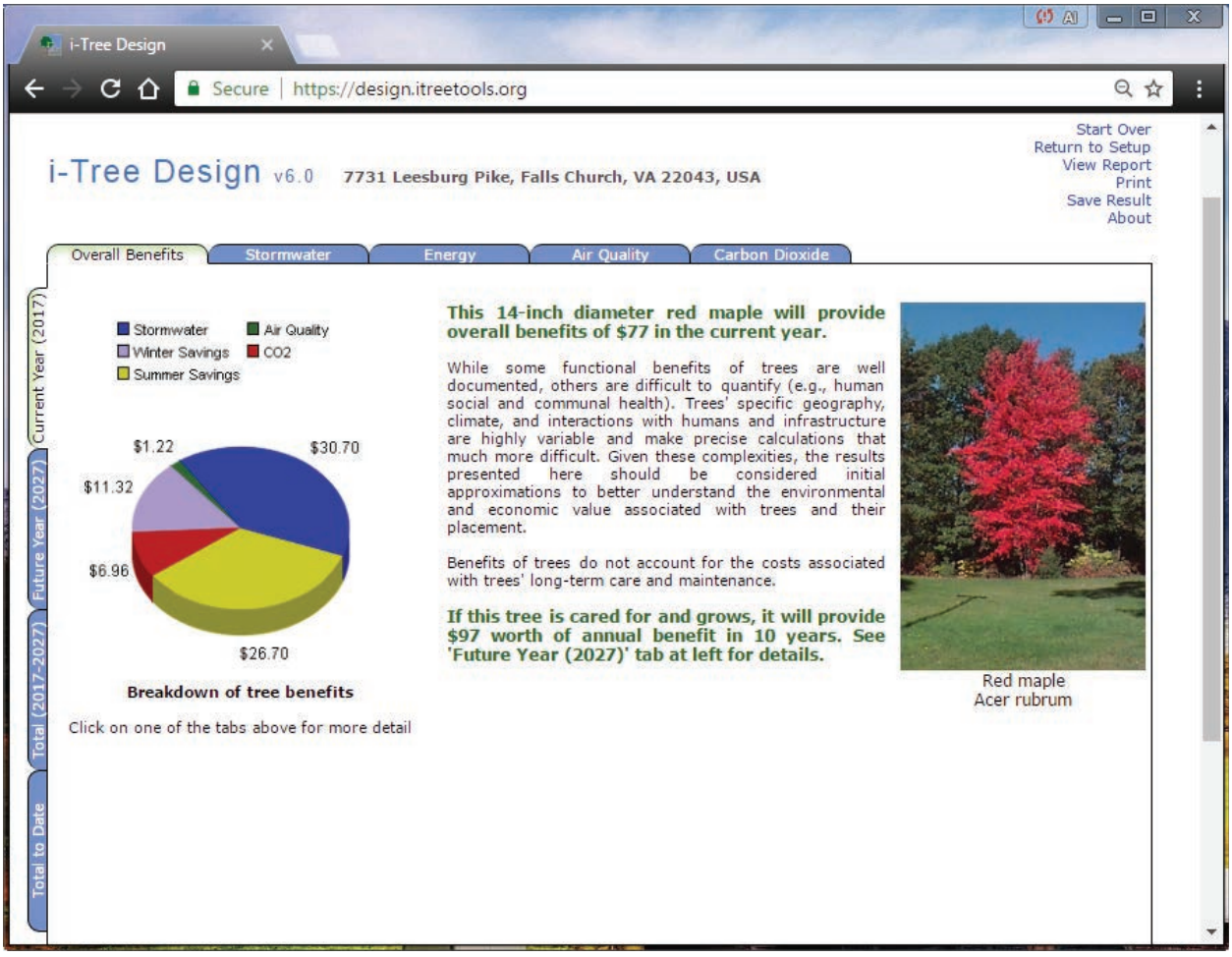
Model the tree(s) future crown growth over time: Click on the "Model Crown Growth" button for a time-lapse view of how the tree crown will grow.

HOW TO USE i-TREE DESIGN (CONTINUED)

3. ESTIMATE BENEFITS

Enter the number of years in the box for which you would like to calculate the projected benefits into the future. Press the "Calculate" button to get the results. (For consistency, use the same number of years for each tree you enter, e.g., 10 years). You can project tree benefits for up to 99 years into the future. These projections are based on typical growth patterns of each tree. Results will include estimates for the current year, the specified future year, projected totals across that future timespan, and the total benefits provided to date.

Hint: Use the "Display Results For" yellow bar at the top of the page to select results for "All Trees" or an individual tree.



STUDENT PAGE
TREE VALUE WORKSHEET

Date: _____ **Team Members:** _____

Tree Number	Tree Species	Circumference at 4.5 feet (1.5 meters) above ground	Calculated diameter (Diameter = Circumference/3.14)	Tree Condition (see guide that follows)					Exposure to Sunlight (Full Sun, Partial Sun, Full Shade)	Dollar Value per Year	Ecosystem Services
				Excellent	Good	Fair	Poor	Dead/ Dying			

Tree Condition Guide

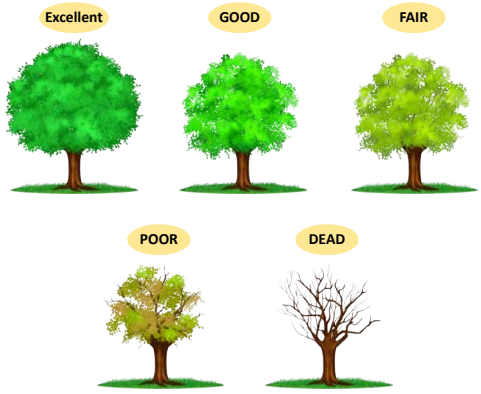
EXCELLENT • Full canopy • No damage to trunk • No dieback of branches in the upper crown • No suckering (upright shoots growing from the roots or branches that appear out of place)

GOOD • Mostly full canopy • Little damage to trunk • No dieback of branches over 2" in diameter in the upper crown • Little to no suckering (upright shoots growing from the roots or branches that appear out of place)

FAIR • Thinning canopy (tree may look different from similar trees around it) • Significant damage to trunk caused by insects or disease • Premature fall coloring on foliage (leaves change color too early in the year)

POOR • Visible dead branches over 2" in diameter in canopy • Significant dieback of living branches, with no leaves on tips • Severe damage to trunk, including decay • Bark may be peeling in dead or dying areas

DEAD/DYING • Tree is dead or significant portions of the tree are dead



Credit: David Bloniarz, U.S. Forest Service

RESOURCES

i-TREE TOOLS: https://design.iTreetools.org/

i-Tree Design allows users to estimate the benefits provided by individual trees. After providing inputs of location, species, tree size, and condition, users will receive information on tree benefits related to greenhouse gas mitigation, air quality improvements, and stormwater interception. Users can draw a building footprint and virtually "plant" or place a tree nearby, then calculate the tree's effects on building energy use.

i-TREE VIDEOS

The following interactive videos explain how to use the i-Tree software and how to calculate the DBH of a tree: https://www.plt.org/i-tree/how-to-calculate-dbh/video; https://www.plt.org/i-tree/how-to-calculate-tree-benefits/video

TREE IDENTIFICATION APPS

Leafsnap: A free mobile app that uses visual recognition software to identify tree species from photographs of leaves. Homepage: http://leafsnap.com/; Video about the app: https://www.youtube.com/watch?v=KCpR4JTEy4c&hd=1

iNaturalist: A free mobile app where you can take a photograph of a tree and share it with a global community of naturalists that can help identify it. Homepage: https://www.inaturalist.org/; Video about the app: https://www.inaturalist.org/pages/about

TREE IDENTIFICATION GUIDES – ONLINE

Arbor Day Foundation hosts an interactive online guide, What Tree Is That?, for trees in the United States: https://www.arborday.org/trees/whattree/

Many provinces have state-specific tools for online tree identification. Search the internet by using "tree identification" and your province's name. A few examples follow:

"Ontario Tree Atlas" (online guide to native trees in Ontario) https://www.ontario.ca/environment-and-energy/tree-atlas

"Trees Inside Out" (identification keys for Quebec): https://www.aucoeurdelarbre.ca/en/branching-out/identify-trees-key.php

"Tree Book" (Identification resource for Native trees in BC): https://www.for.gov.bc.ca/hfd/library/documents/treebook/TreeBook.pdf

TREE IDENTIFICATION GUIDES – PRINT

Arbor Day Foundation and Karina I. Helm. 2009. *What Tree Is That? A Guide to the More Common Trees Found in North America.* Lincoln, NE.

Brockman, C. Frank, and Rebecca Merrilees. 2001. *Trees of North America: A Guide to Field Identification.* Revised and Updated. Golden Field Guide Series. New York: St. Martin's Press.

ACTIVITY 3
LAND MANAGER ROLE PLAY

Overview: Now that students know how to use the i-Tree tool, they will apply what they've learned as they role-play being land managers.

Objectives: Students learn how the i-Tree tool can be used to help solve landscape design problems and gain skills in presenting and communicating scientific information.

Grades: Middle to High School

Subjects: Biology, English Language Arts, Environmental Science, Social Studies

Skills: observing, comparing and contrasting, organizing information, representing, summarizing, synthesizing, creating

Technology Connections: Online i-Tree software, tree identification apps and online guides, word processing software, and presentation software.

Materials:

- One copy of the *Land Management Plan* and *How to Use i-Tree Species* Student Pages for each group
- Computers with internet connection
- Paper
- Printer
- Other presentation tools, such as smartboards, posterboard, and so forth

Time Considerations: Two to three 45-60 minute sessions

Getting Ready: Gather the materials needed for the activity as noted above. If feasible, invite a land manager to speak to students about this career and to assist students with their plans.

Related PLT Activities —
(available from the US PLT store: shop.plt.org.)

Exploring Environmental Issues: Focus on Forests – Activity #1: Monitoring Forest Health; Activity #4: Tough Choices

Exploring Environmental Issues: Places We Live – Activity #1: Personal Places; Activity #2: Community Character; Activity #3: Mapping Your Community Through Time; Activity #4: Neighborhood Design; Activity #5: Green Space; Activity #6: A Vision for the Future

PLT PreK–8 Environmental Education Guide – Activity #21: Adopt a Tree; Activity #31: Plant a Tree; Activity #54: I'd Like to Visit a Place Where…; Activity #55: Planning the Ideal Community

Assessment Opportunity: Use student plans and presentations as a means of assessment.

BACKGROUND INFORMATION FOR EDUCATORS

COMMUNITY PLANNING

Decisions concerning land use are among the most important—and contentious—that our provincial communities will make over the next several decades. Local and state government officials, residents, business leaders, farmers, ecologists, developers, architects, designers, and planners all have a voice in land use decisions for their community. The decisions made today will affect the future. For instance, a decision to develop a plot of land for housing, a shopping mall, or a park has lasting repercussions on the community's visual character and the watershed and ecology of the area. The way in which we use our land resources today will influence the cleanliness of our air, the purity of our water, and the health of our ecosystems for years to come.

LAND MANAGERS

Land managers have an important role to play in helping communities debate the merits of different land development choices. They work with a variety of stakeholders and need excellent communication and planning skills in order to convey land management plans and options. Careers in land management combine science, technology, engineering, art, and math.

Land manager duties may include:

- Working with private land owners and government agencies
- Understanding and conveying pertinent land use legislation and regulations
- Designing and implementing ways to improve the land with minimal environmental impact
- Choosing and preparing sites for planting trees
- Monitoring trees for signs of disease or insect infestation
- Caring for trees
- Supervising harvests

CAREERS

There are a variety of professions involved with land management and caring for trees: forester, arborist, landscape designer, forest fire manager, and many more. Here are descriptions of several land management careers:

Landscape Architect/Designer

Landscape architects plan and design functional and appealing outdoor spaces, such as parks, gardens, and playgrounds. They also develop plans for outdoor spaces around residential areas, schools, college campuses, and public spaces. Their plans include the locations of trees, shrubs, and flowers. Landscape architects design outdoor areas that are not only easy to use but also harmonious with the natural environment. Their job combines science, design, technology, math, art, and the outdoors.

Urban Planner

Urban planners specialize in land use within cities. They create plans and programs to use land and public facilities, such as schools and libraries. In addition, they develop land use plans and programs that help create communities, accommodate population growth, and revitalize physical facilities in metropolitan areas. Urban planners know that trees provide benefits in cities, not only in terms of aesthetic and psychological benefits, but also in the form of many valuable ecosystem services, such as absorbing air pollution and reducing the urban heat island effect.

Forester

Foresters are professionals who are involved in the science of managing forests. They may devise plans for planting and growing new trees, monitoring trees for healthy growth, and determining optimal harvesting schedules. Foresters work on both public and private lands. On public lands, they balance timber needs with wilderness protection and recreation. They are also responsible for planning and implementing projects to control tree diseases, insect pests, and forest fires. On private lands, foresters advise landowners on forestry management techniques to assist them with achieving their land management goals.

Forest Fire Manager

A Forest Fire Manager specializes in fire management and prevention on forested and natural lands to promote

healthy ecosystems and safe urban areas. Duties may involve fire prevention, patrol, detection, and suppression. Additional responsibilities may include prescribed burning and educating the public about fire prevention.

Urban Forester

Urban forests include urban parks, street trees, landscaped boulevards, gardens, greenways, nature preserves, and more. Urban foresters are responsible for the care and management of trees in these urban settings. In addition, they conduct research and develop strategic plans to manage trees and natural systems in urban areas. Urban foresters must take into account a variety of factors as they develop tree management plans, including ecological, climatic, urban, political, and cultural conditions.

Arborist

Arborists care for shrubs and trees of all sizes, particularly in urban settings. They are concerned with the health and safety of trees. Their work includes pruning, fertilizing, and monitoring trees for diseases and insect infestations. Much of the tree maintenance work occurs high in trees, where the arborist is secured with ropes or standing in a lift.

Silviculturist

A silviculturist is a specialized type of forester who is focused on the health and harvest of forests to meet the needs and values of forest landowners on a sustainable basis. Silviculturists are dedicated to sound forest science, engineering, management, and conservation. For example, a silviculturist may conduct research on the effects of fire and animal grazing on the growth, seed production, and germination of different species of trees.

** Note: There are many more green jobs related to land and resource management. See the Resources section for websites that provide additional land management career descriptions.*

DOING THE ACTIVITY

1. Brainstorm with students the types of careers that involve land management. Be sure that they include the careers listed in the *Background Information for Educators* section. Then review the main duties for each land manager position.

2. Divide students into teams and explain that they will role-play being land managers who are tasked with developing a plan to increase the number of trees on the school grounds (or another nearby area that you designate). Project or provide copies of the *Land Management Plan* and *How to Use i-Tree Species* Student Pages. In addition, within each team, the students should come up with a list of tasks, decide who will be responsible for each task, and develop a timeline to complete the work. Explain to students that this is an opportunity for them to apply their critical-thinking and problem-solving skills to a real-world situation, and that there are no right or wrong solutions.

Students should use the following i-Tree online tools to help them with their plans:

- i-Tree Design (https://design.iTreetools.org/) can be used to determine the value of the ecosystem services that a tree provides. It also can be used to model crown growth.
- i-Tree Species (https://species.itreetools.org/) can be used to select species of trees that have particular environmental benefits, such as improving air quality, storing carbon, and reducing energy costs.

Optional: Invite a forester or arborist to help students think through their plans.

Teams should answer the following questions as they develop their plans:

- What is the goal of our plan?Some sample goals might be
    - Increase shade to cool the landscape
    - Provide shelter and food for wildlife to increase biodiversity
    - Intercept stormwater runoff to slow down erosion and protect a nearby stream
    - Enhance the beauty of the area and provide a relaxing place to study
    - Absorb air pollutants
    - Reduce carbon dioxide
    - Combination of two or more of the above goals

- How many additional trees could be planted at the site?

  Help students by showing them how they can print a map of the site using the Google Maps "Earth" view. This map will show the existing trees and space available to plant additional trees. Students can use the i-Tree Design tool to help them determine how close together trees can be planted. For example, students can input the site location, select the tree species they want to plant, "plant" the tree, and then see how the crown of the tree will grow over time. This will help students determine how many additional trees can be planted and where.

- Which tree species should be planted to help achieve our goal?

  Students can use the i-Tree Species tool to determine which species of tree will help them best meet their goal. This tool asks a series of simple questions (address, minimum and maximum tree height constraints, and importance of various environmental services) and then provides a list of recommended trees.

3. Once teams have developed their plans, they should create a presentation that explains it. Their presentation should state their goal, why they choose certain tree species, and how they decided where to plant the trees. They can use a PowerPoint, poster, or other tools to aid with their presentation.

4. Have teams present their plans. Consider inviting other classes and/or school leaders to view their presentations.

5. Debrief by discussing the following questions:

- Did the plan meet the team's stated goal? Why or why not?
- Could students develop an action plan to implement one or more of their plans on their school grounds or in their community?

EXTENSIONS

- Have students share their findings through school websites, newspaper articles, blogs, and so forth.
- Have students partially or fully implement one or more of their plans.

STUDENT PAGE
LAND MANAGEMENT PLAN

Date: _____ **Team Members:** _____

1. Goal of our plan:

- Increase shade to cool the landscape
- Intercept stormwater runoff to slow down erosion and protect a nearby stream
- Enhance the beauty of the area and provide a relaxing place to study
- Absorb air pollutants
- Reduce carbon dioxide emissions
- Combination of two or more of the above goals
- Other: _____

_____

2. How many additional trees can we plant?

Hint: Print a map of the site using the Google Maps "Earth" view. Use the map to count the existing trees and determine how much space is available to plant additional trees. Use the i-Tree Design tool to model crown growth and determine how close together trees can be planted (https://design.iTreetools.org/).

3. Which tree species should we plant to meet our goal?

Hint: Use the i-Tree Species (https://species.itreetools.org/) tool to determine which species of tree will best meet your goal(s). This tool asks a series of simple questions, (address, minimum and maximum tree height constraints, and importance of various environmental services) and then provides a list of recommended trees.

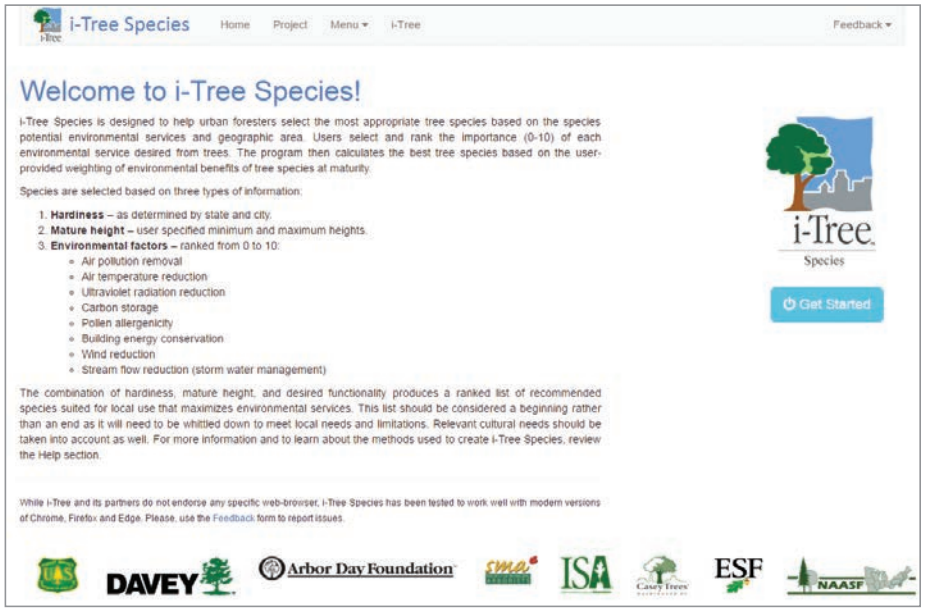
4. Where should the trees be planted?

Hint: Use the i-Tree Design tool to help determine where the trees could be planted (https://design.iTreetools.org/).

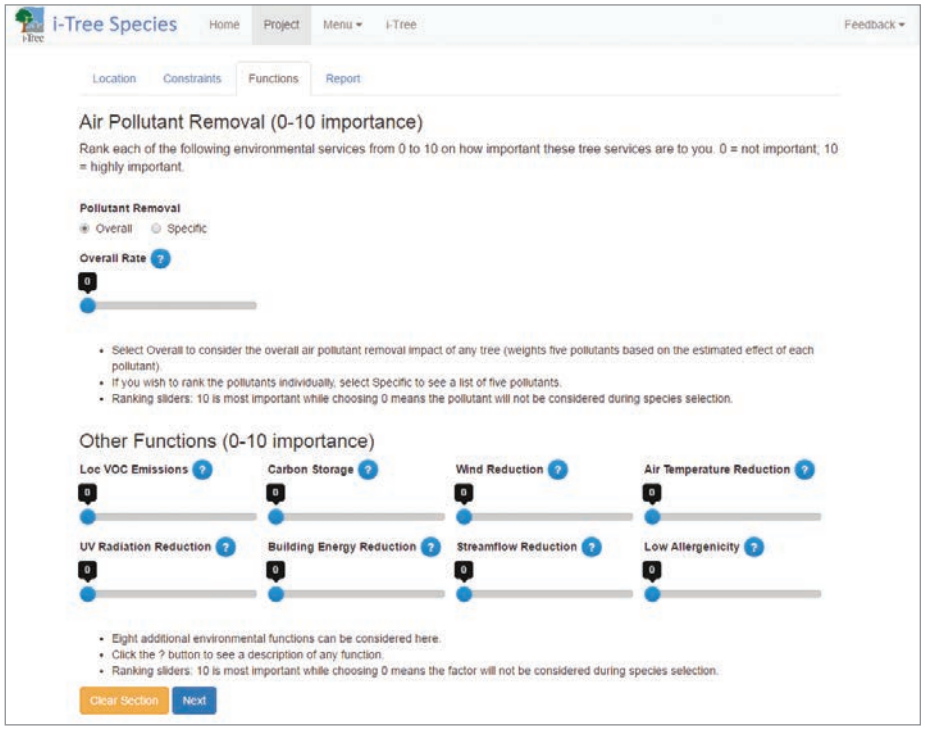
STUDENT PAGE
HOW TO USE i-TREE SPECIES

i-Tree Species is a free online tool that can be used to select the most appropriate tree species to plant in order to receive specific environmental benefits. Users select and rank the importance (0–10) of each environmental service desired from trees. The program then calculates the best tree species to plant, based on geographic area and weighting of environmental benefits.

1. On a computer, navigate to https://species.itreetools.org/, click "Get Started," enter your location information, and then click "Next." The "Height Constraints" page is optional. It can be used to indicate minimum and maximum heights of a mature tree. If appropriate, enter that data, otherwise, navigate to the next screen.



2. Slide the blue circles to indicate the importance of each environmental benefit. Under "Pollutant Removal," select "Specific" if you want to rank five different air pollutants by importance. Once done, click "Next."



HOW TO USE i-TREE SPECIES (CONTINUED)

3. The program will generate a report of the tree species that are the best match for the criteria provided.

Report

Report Type

(•) Top 10% ( ) All

Save Report | Print Report | Start Over

Using your location and the importance of each environmental factor, all of the species in the database are ordered according to your choices based on an algorithm. Species outside of your mature height range and outside of your hardiness zone are dropped from the list.

- Top 10% shows the best matches.
- All shows the entire ranked list.

Top 10% of Species for Selected Functions

Location: Tysons Corner, Fairfax, Virginia, United States of America
Hardiness: 7
Constraints:

- Minimum Height: 20 feet
- Maximum Height: 30 feet

Air Pollutant Removal (0-10 Importance):

- Overall: 8

Other Functions (0-10 Importance):

- Low VOC: 6
- Carbon Storage: 8
- Wind Reduction: 4
- Air Temperature Reduction: 4
- UV Radiation Reduction: 4
- Building Energy Reduction: 8
- Streamflow Reduction: 5
- Low Allergenicity: 3

Generated: 6/6/2017

S = Sensitive I = Intermediate S/I = Indeterminate

Species				Sensitivity			Pest Risk
Scientific Name	Common Name	Hardiness Zone	Invasive	Ozone (O3)	Nitrogen Dioxide (NO2)	Sulfur Dioxide (SO2)	Possible Pests
MAGNOLIA TRIPETALA	UMBRELLA MAGNOLIA	5 ~ 8					
ACER TRUNCATUM	PURPLE BLOW MAPLE	4 ~ 8					Asian Longhorned Beetle
PRUNUS AVIUM	SWEET CHERRY	3 ~ 7					Winter Moth
TAXUS CUSPIDATA	JAPANESE YEW	5 ~ 7					
MALUS IOENSIS	PRAIRIE CRABAPPLE	4 ~ 8		S			Gypsy Moth, Winter Moth
MALUS ANGUSTIFOLIA	SOUTHERN CRABAPPLE	4 ~ 8		S			Gypsy Moth, Winter Moth
SAMBUCUS RACEMOSA	RED ELDERBERRY	4 ~ 7*		S			
SAMBUCUS NIGRA	EUROPEAN BLACK ELDERBERRY	6 ~ 7*					

RESOURCES

American Forests: Measuring Guidelines Handbook

This document describes and illustrates how to measure the circumference and height of trees, including those with irregular tree trunks. https://bigtreesreg.sites.olt.ubc.ca/files/2014/04/BC-BigTree-Field-Package.pdf

Canadian Forest Service: My Tree

My Tree is a free app by the Canadian Forest Service that shows which trees will grow best in which Canadian locations. The My Tree app now includes more than 180 native and introduced tree species and their colour-coded hardiness zones. https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/sustainable-forest-management/my-tree/19974

Forestry Professionals Job Descriptions

The Greenest Workforce application provides information on a wide range of careers involving forestry, such as forest engineer, hydrologist, forester, and soil scientist. Visit the Pacific Forest Foundation for a variety of forest-related job descriptions: https://thegreenestworkforce.ca/index.php/en/forestry-career-types/

i-Tree Design

This free online tool can be used to determine where to plant trees in a particular location in order to receive maximum environmental benefits: https://design.iTreetools.org/

i-Tree Species

This free online tool can be used to find species of trees that have particular environmental benefits: https://species.itreetools.org/

i-Tree Video

The following interactive videos explain how to use the i-Tree software and how to calculate the DBH of a tree: https://www.plt.org/i-tree/how-to-calculate-dbh/video; https://www.plt.org/i-tree/how-to-calculate-tree-benefits/video

Natural Inquirer Scientist Card Series

The Natural Inquirer Scientist Card Series highlights over 160 scientists. The Scientist Cards are organized into categories, such as “Forests and Plants,” “Wildlife,” and “Science Communication.” Cards and posters can be downloaded and printed directly from the web site: http://www.naturalinquirer.org/scientists-v-168.html

GLOSSARY

Carbon storage – the process by which carbon dioxide is transformed into above- and below-ground biomass and is stored as carbon, primarily in plants.

Diameter at Breast Height (DBH) – a standard method for measuring the diameter of a tree trunk taken at 4.5 feet above the ground.

Ecosystem services – the services that humans derive from environmental functions such as photosynthesis, biodiversity, oxygen production, watershed protection, and carbon sequestration.

Inorganic material – matter that is not from a living thing, that does not have the organized structure of living organisms.

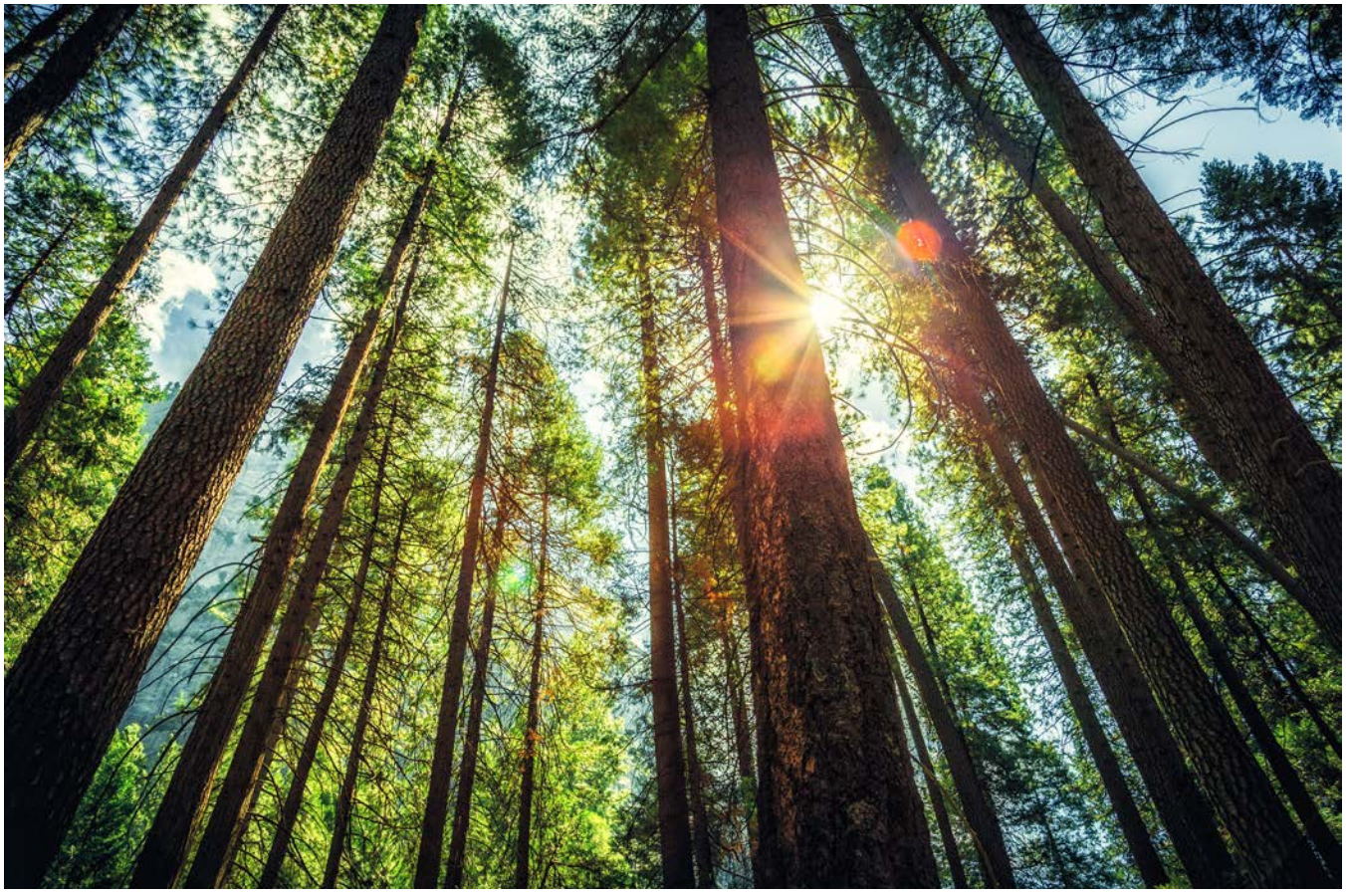
Nutrient – a substance required for growth and development. Plants, for example, need water and minerals to grow and reproduce.

Nutrient cycling – the uptake, use, release, and storage of nutrients in an ecosystem.

Organic material – matter that is derived from living organisms; in chemistry, any compound containing carbon.

Photosynthesis – the process by which green plants manufacture simple sugars in the presence of sunlight, carbon dioxide, and water. Chlorophyll is essential to the series of complex chemical reactions involved in photosynthesis.

Transpiration – the process whereby water evaporates from plant tissues.



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ADDITIONAL PLT RESOURCES

E-UNITS FOR GRADES K-2, 3-5, AND 6-8

PLT's new online curriculum includes *Treemendous Science!* for grades K-2, *Energy in Ecosystems* for grades 3-5, and *Carbon & Climate* for grades 6-8. The e-units include step-by-step lesson plans and multi-disciplinary, hands-on activities constructed around NGSS, aligned with Common Core and the C3 Framework for Social Studies. They incorporate background information, downloadable student pages, assessment tools and rubrics, links to supplementary resources, and more! Learn more.

PREK–8 ENVIRONMENTAL EDUCATION ACTIVITY GUIDE

This curriculum resource contains 96 multi-disciplinary activities each tailored to specific grade levels and correlated to state and national academic standards. Hands-on activities develop students' STEM, critical-thinking, problem-solving, and other 21st century skills. Each activity includes background information; assessment tools; literature connections; technology extensions; cooperative learning; and differentiated instruction. Learn more.

SECONDARY MODULES

For high school educators, PLT's secondary modules challenge students to explore in depth the many facets of environmental issues. Hands-on classroom studies, research, and collaborative field investigations provide students opportunities to debate issues and engage with experts. PLT's secondary modules include: Focus on Forests; Forests of the World; Places We Live; Municipal Solid Waste; Biodiversity; Focus on Risk; and Biotechnology. Learn more.

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