URBAN TREES

Subject Area: Science, Natural Resources

Grade Levels: 6-8

Time:
- Part 1: One 45-minute class
- Part 2: One to two 45-minute class periods
- Part 3: One 45-minute class period to design action plan, additional time needed if action plan will be carried out
- Parts 4 and 5: One 45-minute class period, additional time needed if you engage in any of the suggested citizen science projects

Essential Questions:
- How do trees benefit humans and the environment?
- What threats do trees face?
- What can people do to protect and promote trees in their community?

Purpose and Overview:
Students will learn about how trees are an essential part of our lives with a focus on the role they play in urban areas, including energy considerations. They will consider threats posed to trees, including non-native insects, domestic animal waste, and erosion. Students then evaluate the potential impact of local tree conservation efforts and design a plan for their community.

Themes:

Trees clean our air by filtering out dust, pollution and greenhouse gases.

Trees are a part of natural water filtration and storage systems.

Introduction:
In this lesson, students learn the value of trees and how nature works to provide clean water and air. Forests renew our air supply by absorbing carbon dioxide and producing oxygen. Trees also clean our

air by filtering out dust and greenhouse gases. One tree can absorb ten pounds of air pollutants a year. By cooling the air through the shade they provide and the evaporation of water from their leaves, trees can reduce energy use.

Federal research has shown that well thought out tree planting can lower summertime temperatures in cities and households by dramatically reducing air-conditioning bills and help trap some of the greenhouse gases responsible for global warming.   In addition to saving energy through cooling in the hotter months, trees provide a wind break during winter. This results in burning less fossil fuel to generate electricity for cooling and heating.

Forests provide natural filtration and storage systems that process nearly two-thirds of the water supply in the United States. Their root systems hold soil in place, preventing erosion and absorbing water that may result in flooding. Trees provide food and shelter for both plants and animals. They reduce noise pollution by buffering sound waves and can even relieve psychological stresses with their beauty.
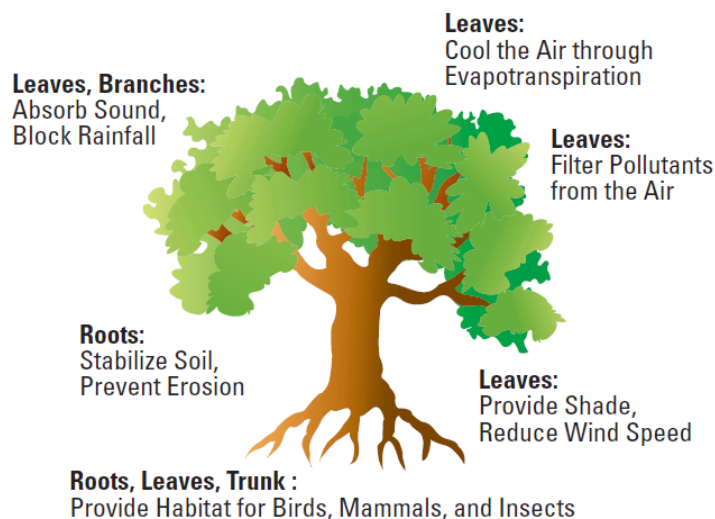
Trees provide a variety of benefits, from cooling the air to stabilizing the soil.

Image credit: Cooling Summertime Temperatures Brochure by the U.S. EPA

Objectives:

The student will…
- Describe the benefits of trees to humans and to the greater ecosystem.
- Predict and analyze the temperature difference of soil in the shade of tree compared to soil in the direct sun. (Optional)
- Explore the concept of a microclimate. (Optional)
- Use the Tree Benefit Calculator to estimate tree benefits and to determine the relationship between storm water run-off and tree size. (Optional)

- Draw a map of school grounds and indicate tree location.
- Identify tree types using a dichotomous key, tree identification guide, or app.
- Identify potential threats to tree species and learn what can be done to stop the spread of invasive species.
- Develop an action plan to promote tree conservation and stewardship in their local community.
- Engage in tree planting and other stewardship activities as determined by the action plan.
- Evaluate how their ideas about trees as a resource/asset to their community has changed.

Standards:

Next Generation Science Standards – Middle School

Disciplinary Core Ideas
- LS2.C Ecosystem Dynamics, Functioning, and Resilience
- LS4.D Biodiversity and Humans
- ETS1.B Developing Possible Solutions

Crosscutting Concepts
- Stability and Change

Science and Engineering Practices
- Engaging in an Argument from Evidence

Performance Expectations
- LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Common Core ELA Science and Technical Subjects (6-8)
- CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

- CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Vocabulary:

Dichotomous Key: A method for determining the identity of something by going through a series of choices that leads the user to the correct name of the item.

Energy: Anything that can carry out an action or maintain a process.

Invasive Species: Any kind of living organism that is not native to an ecosystem and which causes harm.

Microclimate: A small local area where the climate conditions differ from the larger surrounding area.

Transpiration: The evaporation of water from plants.

Materials:

For each group of students/individual student:
- Notebook paper/journal
- Map of school ground and/or community, can be printed from Google Maps
- Printout of dichotomous key http://www.dec.ny.gov/docs/lands_forests_pdf/treeidkey.pdf

Optional
- Smart phone or tablet or computer
- Fan (can be made from paper or powered)

For teacher:
- Images on pages 12-14 to project during discussion

Videos that support this lesson:
- **Urban Trees** introductory video https://vimeo.com/77792928
- **Meet the Scientist: Bill Toomey** http://vimeo.com/77229009
- Scientist Interview Questions
  - **Urban Trees #1: Benefits** "What benefits do trees bring to our lives?"
    https://vimeo.com/78368777
  - **Urban Trees #2: Impact** - "How do trees impact urban areas?" https://vimeo.com/78368573
  - **Urban Trees #3: Invasive Species** - "How are invasive insects affecting the North American tree
    population?" http://vimeo.com/78368572
  - **Urban Trees #4: Stop the Spread**, which answers the question, "What can be done to stop the
    spread of invasive species?" https://vimeo.com/78368571
  - **Urban Trees #5: Factors** - "What factors need to be considered when planting or adopting a tree
    in an urban community?" http://vimeo.com/78368570

Other videos by The Nature Conservancy that support this lesson:
- **Healthy Trees Healthy Cities: Planting**
  https://www.youtube.com/watch?v=wvMqCcm3ZJ4&feature=youtu.be
- **Healthy Trees Healthy Cities: Pruning**
  https://www.youtube.com/watch?v=M1wVL5InBxM&feature=youtu.be
- **Healthy Trees Healthy Cities: Stewardship**
  https://www.youtube.com/watch?v=3IEoe0X3w08&feature=youtu.be

PDFs by The Nature Conservancy that support this lesson:
- **Best Management Practices: Right Tree, Right Place** – choosing the right tree depends on many factors
  including soil type, climate, and the amount of space the tree will have both underground and overhead
  https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/B
  MP_Right%20Tree%20Right%20Place.pdf
- **Best Management Practices: Tools of the Trade** – Resources for planting, pruning, and stewarding your
  trees – young or old.
  https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/B
  MP_Tools%20of%20the%20Trade.pdf

- **Best Management Practices: Watering Your Tree** – Watering is one of the most important things you can do to help a newly-planted or young tree establish in its new home and ensure mature trees live to their fullest potential.
  https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/BMP_Watering%20Your%20Tree.pdf
- **Best Management Practices: Tree Monitoring Schedule** – To coordinate the regular care of trees in your community, use this Tree Monitoring Schedule to organize friends, family, and neighbors in three day blocks. Daily care should include checking soil moisture levels and watering if needed, weeding around base of the tree if necessary, removing debris, checking for signs of pests and diseases, and noting overall health.
  https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/BMP_Tree%20Monitoring%20Schedule.pdf

Classroom Activities:

Part 1: Engage: How do trees benefit humans and the environment?

1. Ask students to brainstorm about what trees do for us. You can have students write or draw their examples on small, individual whiteboards and then have them share their ideas with the class. Some examples may include a tire swing (recreation), shade from a tree, apples or oranges (food) and a hole in a tree or nest made by an animal (habitat). Explain to students that these are just a few of many examples of what trees do for us every day. Ask students to consider - Why do we plant trees in our yards and in our community? Are there places in the world where there are no trees? What are those places like?

2. Share with students the **Urban Trees** (https://vimeo.com/77792928) introductory video.

3. Explain to students that they will work to answer these questions during the lesson. Focus their attention on the guiding questions:
    a. How do trees benefit humans and the environment?
    b. What threats do trees face?
    c. What can people do to protect and promote trees in their community?

4. Display an image of a tree on a windy day (see page 12 for projectable version) and ask students to consider how trees affect the "air" around us. Four different benefits can be highlighted and clues can be provided to guide students in identifying each benefit. Students will identify 1) reduce wind 2) tree leaves collect dust and capture pollutants 3) tree roots, wood and leaves absorb carbon dioxide and 4) trees provide oxygen. Sharing an image of **the photosynthetic process** may support students in identifying that trees take in carbon dioxide and produce oxygen.

5. Display an image of a tree on a rainy day (see page 13 for projectable version) and ask students to consider how water benefits from trees. Four different benefits from water can be highlighted and clues can be provided to guide students in identifying each benefit. Students will

identify 1) filtering pollutants 2) collecting water 3) slowing water to prevent flooding and 4) distributing water over time for drought prevention.

6. Display an [image of a tree with evidence of animal habitats](#) (see page 14 for projectable version) and food and ask students to consider how plants and animals benefit from trees. Three different benefits from plants and animals can be highlighted and clues can be provided to guide students in identifying each benefit. Students will identify 1) habitats 2) food 3) recreation.   An additional image of a tree swing or tree rope course can be included for students to identify recreation.

7. View the **Meet the Scientist: Bill Toomey (**[http://vimeo.com/77229009)](http://vimeo.com/77229009) video and then share the scientist video **Urban Trees #1: Benefits (**[https://vimeo.com/78368777)](https://vimeo.com/78368777), which answers the question, "What benefits do trees bring to our lives?" After the video ask students what other benefits were observed in the video. Anticipated responses may be; wood, jobs, fiber, reducing asthma and trees are pleasing to look at. Ask students if they can brainstorm even more!

8. Provide students with the definition of **transpiration** – the evaporation of water from plants.

9. Explain that trees not only provide shade from the sun, they also transpire (release water vapor) through their leaves. This is an additional cooling benefit. Have students line up and walk by a bucket of water. Ask each student to dip just one hand in the water to wet it, and then hold both hands briefly in front of the fan. After all students have tried this, ask which hand felt cooler. Ask to students to come up with ideas that explain the difference in what they felt. Explain that the warmth of your skin and the air from the fan caused the water to evaporate. That process cools your skin. Nature uses evaporative cooling every day. When we sweat, our perspiration evaporates, cooling us off. When a tree transpires, releasing moisture, that moisture evaporates, cooling the air.

OPTIONAL **Engage Investigation**

10. Ask students to predict the temperature difference of soil in the shade of a tree versus the sun.

11. If the school grounds have a tree choose a site where the sun location is well away from any structure because the structure might radiate heat onto the soil where the thermometer is located. The thermometer can be concealed and will not affect the reading because the tip of the probe is detecting the soil heat, not the round gauge on top of the probe. The site in the shade should not be too close to a tree trunk. Leave probes in the ground for at least a half hour to adjust to the soil temperature.

12. Visit the site together as a class to record data or small groups of students can rotate each day to collect data. A data table should include information for students to record the date, temperature in sun, temperature in shade, windy or calm air and cloudy or sunny skies. If the school grounds

do not have a tree mock data can be provided. Trees in the shade will typically be 5-10 degrees cooler.

13. Ask students to analyze the soil temperatures in each location and form a conclusion. What patterns emerge? Why would a living organism prefer to be in the shade or sun? What could happen if shade was not available? Who could use this data? How could they use it?

14. Provide students with the definition of **microclimate** – a small local area where the climate conditions differ from the larger surrounding area.

15. Explain to students that the shade from a forest tree creates a microclimate suitable for many species of plants and animals to survive and flourish. Many small plants have adapted to the understory of a forest, and need protection from the direct rays of the sun. The forest soil is cool and moist, which is good for plants and provides cooler temperatures in the surrounding area. Ask students to consider how trees providing cooler temperatures can benefit humans. How could trees impact energy costs of buildings?

16. Provide students with the definition of **energy** – anything that can carry out an action or maintain a process.

17. The Tree Benefit Calculator (https://www.arborday.org/calculator/index.cfm?) allows students to make a simple estimation of the benefits individual street-side trees provide. Patterns and trends with the type of tree planted, size, location and their energy savings can be investigated using this web tool. Ask students to consider; do larger diameter trees provide greater energy savings? Why or why not? Is there a relationship between the size of the tree and the gallons of storm water runoff a tree can intercept?

Part 2 Explore: What threats do trees face?

1. Explain to students that they will be developing action plans to protect or promote tree conservation in order to save and/or maintain forested areas for the benefit of their local community and future generations. To successfully plan their project, they will need to survey their local school grounds or community to identify the trees species that thrive and identify current threats to tree species.

2. Student partners or teams can create maps of the entire school grounds, working first to draw the main structures, boundaries and pathways. If there are not any trees present on the school grounds, students can survey trees in the community. Another option for map creation is to use Google Maps (https://www.google.com/maps) to generate an image of your school and have students draw and label on top of the printed image. For a more tech intensive approach, have students use Google My Maps (https://www.google.com/maps/d/). Google My Maps will allow students to draw and label items on the map while online.

3. Students will survey the grounds by identifying the types of trees. If the school grounds have many trees on the property, consider gridding the property and assigning students' specific areas to survey. If there is a limited amount of trees, students can survey the entire school. It is suggested students note the species on their map by numbering each tree location and having a chart to record the corresponding name.

4. Students can choose from a couple options to identify trees on the property. Provide students with the definition of **dichotomous key** – a method for determining the identity of something by going through a series of choices that leads the user to the correct name of the item. A tree identification key can be found here: http://www.dec.ny.gov/docs/lands_forests_pdf/treeidkey.pdf.

5. Students can also download the free app for **Leafsnap** (http://leafsnap.com/). Directions for how to download and use Leafsnap can be found under Additional Resources at the end of this lesson plan.

6. Facilitate students sharing their data. Provide students with a stack of small sticky notes. For each tree they identified on the school grounds or their community, ask them to write each tree species on a sticky note. Arrange the notes on the board as a bar graph representing the different responses. Students will use this data later when identifying threats and developing an action plan.

7. Explain to students that trees in different settings may have different threats. Guide students to consider and compare the impacts of trees on suburban and urban settings and the impact these settings have on trees. Share the scientist video **Urban Trees #2: Impact** (https://vimeo.com/78368573), which answers the question, "How do trees impact urban areas?" Ask students to identify the setting their trees are in and how that may impact their tree species.

8. Provide students with the definition of **invasive species** – any kind of living organism that is not native to an ecosystem and which causes harm. Share the scientist video **Urban Trees #3: Invasive Species** (http://vimeo.com/78368572), which answers the question, "How are invasive insects affecting the North American tree population?" Review images and evidence of the **Asian Longhorned Beetle** (http://www.uvm.edu/albeetle/) and **Emerald Ash Borer** (http://www.emeraldashborer.info/#sthash.vkbD4vq9.2rdg9Qr0.dpbs) impacting trees and share the tree species they impact. Are any of the trees on the school grounds or community threatened by these insects?

9. Guide students into investigating other threats to trees: domesticated animal waste, tall buildings and small lots. Students can revisit the school grounds to observe if these are threats to their trees. They can further investigate threats by using the resource **SelecTree** (http://selectree.calpoly.edu/) . This site allows students to identify potential threats to specific tree species.

Part 3 Explain: What can people do to protect and promote trees in their community?

1. Students will develop an action plan in small groups to help trees on the school grounds or in their community. Students may choose to revisit trees from earlier in the lesson and document tree species and invasive species using suggested citizen science apps, clean tree beds of animal waste, design and post signs to educate communities about curbing their dogs, or pruning a tree.

2. Provide directions for students to chart out the threats that were identified on the school grounds or community and include a column for possible solutions. Share the scientist video **Urban Trees #4: Stop the Spread** (https://vimeo.com/78368571), which answers the question, "What can be done to stop the spread of invasive species?" Guide students to consider solutions explored in the video.

3. Share the scientist video **Urban Trees #5: Factors** (http://vimeo.com/78368570), which answers the question, "What factors need to be considered when planting or adopting a tree in an urban community?" If students are interested in evaluating their school grounds, home, or community to plant a tree after viewing the video, the videos and handouts below by The Nature Conservancy can help them with their planning. Students can use a map of their school grounds or community to design where they would plant trees. An action plan typically includes defining a goal, generating a list of actions, preparing a timeline, allocating resources, identifying possible problems, developing strategies for monitoring, assigning tasks and implementing the plan. The Arbor Day Foundation (https://www.arborday.org/) is also a great resource for tree planting activities.

   Videos by The Nature Conservancy to support tree planting and stewardship:
   - **Healthy Trees Healthy Cities: Planting**
     https://www.youtube.com/watch?v=wvMqCcm3ZJ4&feature=youtu.be
   - **Healthy Trees Healthy Cities: Pruning**
     https://www.youtube.com/watch?v=M1wVL5lnBxM&feature=youtu.be
   - **Healthy Trees Healthy Cities: Stewardship**
     https://www.youtube.com/watch?v=3lEoe0X3w08&feature=youtu.be

   PDFs on Best Management Practices by The Nature Conservancy:
   - **Best Management Practices: Right Tree, Right Place** – Choosing the right tree depends on many factors including soil type, climate, and the amount of space the tree will have both underground and overhead
     https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/BMP_Right%20Tree%20Right%20Place.pdf
   - **Best Management Practices: Tools of the Trade** – Resources for planting, pruning, and stewarding your trees – young or old.
     https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/BMP_Tools%20of%20the%20Trade.pdf
   - **Best Management Practices: Watering Your Tree** – Watering is one of the most important things you can do to help a newly-planted or young tree establish in its new home and ensure mature trees live to their fullest potential.

https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/BMP_Watering%20Your%20Tree.pdf

- **Best Management Practices: Tree Monitoring Schedule** – To coordinate the regular care of trees in your community, use this Tree Monitoring Schedule to organize friends, family, and neighbors in three day blocks. Daily care should include checking soil moisture levels and watering if needed, weeding around base of the tree if necessary, removing debris, checking for signs of pests and diseases, and noting overall health.
https://www.conservationgateway.org/ConservationPractices/cities/hthc/library/Documents/Documents/BMP_Tree%20Monitoring%20Schedule.pdf

4. Summarize with students by asking them to reflect on their action plan. What would be the impact of their action? How would it benefit trees? How would their plan benefit their community?

Part 4 Extend: How can our knowledge help benefit the larger community?

1. If the book **The Giving Tree** by Shel Silverstein is available, teachers may consider sharing in its entirety. If not, you can find an excerpt here: http://www.goodreads.com/work/quotes/30530-the-giving-tree. Read the excerpt and ask students, in what ways does this story relate to our relationship with trees?

2. Consider participating in the following citizen science projects with your students;
   a. Leafsnap http://www.scistarter.com/project/614-Leafsnap
   b. National Tree Benefit Calculator http://www.scistarter.com/project/472-National%20Tree%20Benefit%20Calculator
   c. Plant Tracker http://www.scistarter.com/project/655-PlantTracker
   d. http://www.scistarter.com/project/632-Tiny%20Terrors%20Project
   e. Tiny Terrors Project http://www.scistarter.com/project/496-Invaders%20of%20Texas
   f. PhillyTreeMap http://www.scistarter.com/project/492-PhillyTreeMap
   g. The American Chestnut Foundation http://www.scistarter.com/project/485-The%20American%20Chestnut%20Foundation
   h. Tree Trackers! http://www.scistarter.com/project/351-Tree%20Trackers%21
   i. GreenprintMaps http://scistarter.com/project/524-GreenprintMaps
      Urban Forest Map http://scistarter.com/project/234-Urban%20Forest%20Map
   j. Explore Boston's Urban Forest http://scistarter.com/project/1153-Explore%20Boston%27s%20Urban%20Forest
   k. SCARAB (Scientific Collaboration for Accessible Research About Borers) http://scistarter.com/project/1076-SCARAB%20%28Scientific%20Collaboration%20for%20Accessible%20Research%20About%20Borers%29

Part 5 Evaluate: How have your ideas changed?

1. Have students answer the questions below to reflect on the activities in this lesson.
    *   How do trees benefit humans and the environment?
    *   What threats do trees face?
    *   What can people do to protect and promote trees in their community?

2. After students have completed their reflections, have them share them with the class through a group discussion.

Additional Resources:

*   **Leafsnap**
    http://leafsnap.com/
    An electronic field guide that uses visual recognition software to identify tree species from photographs of their leaves.
*   **Tree Identification Key**
    http://www.dec.ny.gov/docs/lands_forests_pdf/treeidkey.pdf
    A PDF dichotomous key to identify trees.
*   **Center for Urban Forest Research (CUFR)**
    http://www.fs.fed.us/psw/programs/uesd/uep/
    CUFR, a unit of the US Forest Service, is the leading research institute studying the environmental benefits of urban forests.
*   **National Arbor Day Foundation**
    http://www.arborday.org/
    Their mission is to inspire people to plant, nurture, and celebrate trees.
*   **SelecTree**
    http://selectree.calpoly.edu/
    SelecTree is an interactive tree selection website developed by the Urban Forest Ecosystems Institute at Cal Poly.
*   **National Tree Benefits Calculator**
    http://www.treebenefits.com/calculator/
    The NTBC is an online tool that uses information from iTree to calculate the benefits of individual trees.
*   **American Forests: Individual Tree Calculator Tools**
    http://www.americanforests.org/our-programs/urbanforests/urban-forests-tools-resources/urban-forest-assessments-resource-guide/urban-forest-assessment-tools/individual-tree-calculator-tools/
    Different tools to estimate the benefits of trees in urban areas.

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