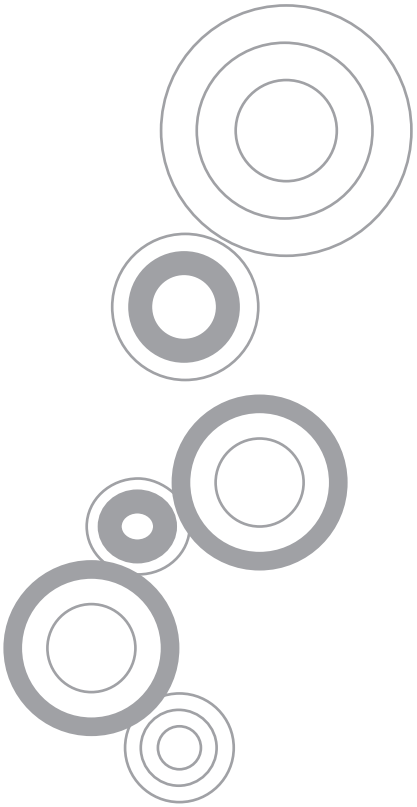
TreePeople

CANOPY INVESTIGATION PROJECT TOOLKIT!

A S.T.E.A.M. Investigation
in Tree Canopy Mapping



TreePeople's School Greening Program

Tree Canopy Investigation Project Toolkit

A S.T.E.A.M. (Science, Technology, Engineering, Art, and Math) Investigation in Tree Canopy Mapping

Who We Are

TreePeople

TreePeople is an environmental nonprofit that unites the power of trees, people and technology to grow a sustainable future for Los Angeles. Simply put, our work is about helping nature heal our cities. TreePeople's mission is to inspire, engage and support people to take personal responsibility for the urban environment, making it safe, healthy, fun and sustainable and to share the process as a model for the world.

Shifting Los Angeles From Gray to Green

TreePeople is helping to shift Los Angeles from using gray and polluting ways of handling our energy and water to using green nature-based solutions. We provide tools, programs, and education to empower Angelinos of all ages to participate in growing an ample tree canopy that cools hot urban neighborhoods and in retrofitting our landscapes to harvest rain and conserve and clean precious water. The result? A more secure local water supply, cleaner air, reduced carbon emissions, more habitat for birds, bees and animals, and a greener, healthier and more sustainable future for us all.

Founded by a Teenager!

TreePeople's founder, Andy Lipkis, was a teenager when he started the organization in the early 1970's. Since then, nearly two million trees have been planted in wilderness areas, neighborhoods and school campuses in Southern California by volunteers. We've continued to place young people at the center of our work by developing one of the largest environmental education programs in the United States. Our programs for youth create opportunities for leadership, community service, and fun.

TreeMapLA

To increase the awareness of trees in Los Angeles, TreePeople and a collaboration of nonprofits, local government and businesses have created TreeMapLA. This powerful tree mapping tool generates specific environmental and economic benefits that will help us manage the well-being of our region's urban forest. Users include students, agencies, civic organizations, everyday citizens, and more. Students are invited to map trees so they can learn, communicate, and take action on behalf of the trees around us.

S.T.E.A.M. Canopy Investigation Project Toolkit

By measuring the canopy coverage of an area, and mapping these existing trees, we can better understand the value of tree services (filtering polluntants, reducing energy costs, creating oxygen, etc.). This investigation, tied to S.T.E.A.M. – a framework for teaching across the disciplines, will help determine the canopy of a site, and how your group can help increase tree benefits and canopy by either planting trees or caring for existing trees, so they grow and thrive.

How it works

LESSON 1: INSTANT EXPERT

Use the Instant Expert lesson as an introductory, fun and informative, hands-on activity to explore the topic of trees and their many benefits.
S.T.E.A.M. Element: Art

LESSON 2: OBSERVING VEGETATION FROM ABOVE

The purpose of this lesson is to engage students in how we can observe vegetation and canopy cover from above through satellite images and make canopy coverage comparisons in two different areas of the city. Working in teams, and then in a larger group, students will use a Think–Pair–Share worksheet to identify different land cover features and describe the canopy coverage they observe, before sharing their observations as a class.
S.T.E.A.M. Element: Technology

LESSON 3: ESTIMATING CANOPY COVERAGE FROM ABOVE

Now that students have looked at a satellite image and learned how to identify land features, they will explore their own site. Students will also learn how they can find the area of the trees by using geometric shapes. Using these skills they will measure the area of trees to determine the amount of canopy coverage for a specific section of their school.
S.T.E.A.M. Element: Technology, Math

LESSON 4: DETERMINING CANOPY COVERAGE FROM BELOW - PART 1

As a Part 1 Lesson, students will learn how to do the appropriate process skills to ground truth/field check the trees in their section. They will do this by observing how to collect data for one tree. Once data is collected, they will observe how to use online tools to determine tree species, and input the data into TreeMapLA to generate tree benefits. Finally, they will learn how to calculate the canopy coverage for their section.
S.T.E.A.M. Element: Science, Technology, Engineering, Art, Math

LESSON 5: DETERMINING CANOPY COVERAGE FROM BELOW - PART 2

In this lesson students use the process skills they observed and working in their groups gather the tree data for their area. They will take the information and input and map their trees into TreeMapLA to generate tree benefits. They will also use the canopy data to calculate the area for

their trees and determine the canopy coverage of their entire area.
S.T.E.A.M. Element: Science, Technology, Engineering, Art, Math

LESSON 6: CALCULATING CANOPY COVERAGE FOR THE ENTIRE SITE

In this lesson students use online technology to calculate the canopy coverage of their entire school. They can take turns generating and verifying the survey points until the survey area is complete. Once complete, they will use the generated canopy coverage in Lesson 7 to determine how many more trees (and their size) would benefit the school.
S.T.E.A.M. Element: Technology, Math

LESSON 7: CALCULATING THE NUMBER/SIZE OF TREES NEEDED

Having learned the benefits of trees during the Instant Expert activity, and calculating them through TreeMapLA, students should understand the value of trees to their site. In this lesson, students will take the results of the school canopy cover analysis to determine both the size and the additional amount of trees needed to plant to increase the canopy.
S.T.E.A.M. Element: Math

SHARE WHAT YOU DID AND NEXT STEPS

Share your project through TreePeople's social media sites (see below) and completing a final report. Discuss planting and/or caring for trees as a next step, using TreePeople's Project Toolkits.

Stay Connected!

Facebook
Join our Project Toolkit Facebook Group to share experiences, post photos, ask questions, and find inspiration. This is a closed and private group. TreePeople will invite you to join. We also encourage setting up your own Facebook group and inviting your mentor to join. Registered TreePeople EcoClubs get an official badge for their profile.

Twitter
Follow us @tpyouthprojects for the latest news, upcoming workshops, events, tips, suggestions, nursery sales and more!

Pinterest
As you transform your school or community site check out our Pinterest page for inspirational photos of campus greening, rain gardens, native plants and more! pinterest.com/tpgreytogreen

Instagram
Along the way share you photos on Instagram. Be sure to tag #TreePeoplela

TreePeople Blog
Visit our TreePeople blog to stay connected with the TreePeople community and if you'd like, share your club's story for publication. blog.treepeople.org

TreePeople YouTube
Check out our How to Videos and more at youtube.com/user/TreePeople1

LESSON 1: INSTANT EXPERT

Exploring the Benefits of Trees

Our environment provides many services that are critical to human health and survival. This is especially true of trees in cities. Some of the services that trees provide include filtering pollutants out of the air and water, reducing energy use, and creating oxygen. Trees with large, healthy canopies – branch and leaf cover - provide the most benefits. By measuring the canopy coverage of an area, and mapping these existing trees, we can better understand the value of tree services.

This lesson is designed to provide an introduction to trees and allow students to brainstorm their benefits, work in groups to create posters to share and learn from each other, and introduce the ideas of trees, and the canopy coverage of their school.

Lesson Introduction

1. Ask students:
   - "What are the benefits of trees?"
2. Record all the answers on chart paper to refer to at the end of the lesson, and retrieve for use at the end of the unit.
3. Explain to students that they will be exploring trees in the urban environment.

Procedure

1. Divide the students up into five working groups.
2. Each group has 15 minutes to do the following:
   - Receive one *More Trees, Please!* topic sheet with instructions and information on a tree-related issue.
   - Read the information on the topic sheet. Learn about and discuss the specific topic related to trees.
   - Using poster paper, answer and illustrate the answers to the questions listed on the topic sheet.
3. Once complete, have each group present their poster, sharing what they have learned.

MATERIALS

- Chart paper
- More Trees, Please! topic sheets (Figure A)
- Poster paper – 1 per group
- Markers – 1 set per group

TIME

- Approximately 45 minutes to complete
  - 5 minutes for lesson introduction.
  - 5 minutes to get students into groups, pass out materials and give directions to students.
  - 15 minutes for students to read their topic sheets, discuss their answers and create a poster.
  - 20 minutes for the five groups to share their posters with the other groups.

Stretching Their Thinking

- Looking at the benefits that we charted earlier, what would you add, if anything?
- What is meant by "tree services"?
- When you think of our site, what services are trees providing?

Introducing the Next Activity

- What do you think is involved in measuring the canopy coverage of an area?

Figure A

START HERE!

Our environment provides many services that are critical to human health and survival. This is especially true of trees in cities. Some of the services that trees provide include filtering pollutants out of the air and water, reducing energy use, and creating oxygen. Trees with large, healthy canopies – branch and leaf cover - provide the most benefits. By measuring the canopy coverage of an area, and mapping these existing trees, we can better understand the value of tree services. We can also better manage – and increase – the trees that surround us. We need more trees, please!

Your Instructions:

1. As a group, read and discuss the information on the right.

2. Use a large sheet of paper and markers to create a poster that answers the following:
   - What should we know about low-income areas in Los Angeles?
   - How is do trees impact these areas?
   - What is an action we can take at home and/or in our community to help?

More Trees, Please!

COMMUNITY BENEFITS

- Research in Los Angeles shows that low-income areas have significantly fewer trees than surrounding areas.
- In these same areas, public-health scientists have found the highest incidences of diabetes, morbid obesity and lung disease.
- Additional health risks occur during extreme hot weather when the lack of trees and the presence of too much concrete and asphalt creates higher temperatures.
- As a natural element, trees help improve urban life and are critical to human health and emotional well-being.
- Communities throughout Los Angeles are addressing the need for trees by working together to form “green teams” and plant shade and fruit trees on streets and in local schools.
- Planting trees and caring for them to increase canopy coverage provides an opportunity for community involvement and empowerment that improves the quality of life in our neighborhoods.

START HERE!

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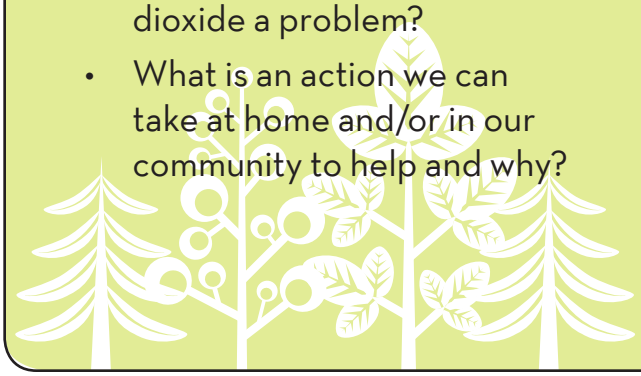
Your Instructions:

1. As a group, read and discuss the information on the right.

2. Use a large sheet of paper and markers to create a poster that answers the following:
   - What should we know about sun exposure in the city?
   - Why is human-made carbon dioxide a problem?
   - What is an action we can take at home and/or in our community to help and why?



More Trees, Please!

ENERGY BENEFITS

- Due to the angle of the sun, the south side of a building receives the most sun exposure during the day. As the building heats up, the need for air conditioning increases.
- Fossil fuels, such as coal, are burned to generate the electricity needed to run air conditioners, and more. Burning fossil fuels results in 75% of the human-made carbon dioxide that goes into our air every year. Human-made carbon dioxide is an ingredient of air pollution and contributes to climate change.
- Strategically planting trees on the south side of buildings, near air conditioning units and over large areas of concrete and asphalt, can provide much needed shade.
- When buildings are shaded by trees, the inside temperatures are generally 15 degrees cooler. This allows air conditioners to run more efficiently.
- Planting trees and caring for them to increase canopy coverage not only helps save in energy bills, but by reducing the need for additional power generation, one less pound of carbon is dumped into the air for each kilowatt-hour of electricity saved!

START HERE!

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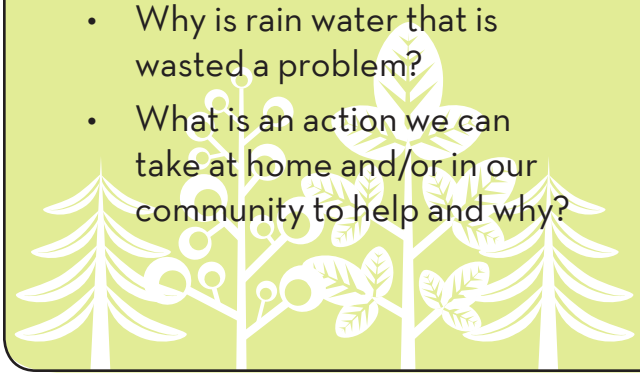
Your Instructions:

1. As a group, read and discuss the information on the right.

2. Use a large sheet of paper and markers to create a poster that answers the following:
   - What should we know about rainwater that hits concrete and asphalt?
   - Why is rain water that is wasted a problem?
   - What is an action we can take at home and/or in our community to help and why?



More Trees, Please!

WATER BENEFITS

- With an increase in paved areas throughout Los Angeles, rainwater hits concrete, rushes into the street and down into a complex flood control system that leads to the ocean.
- This "runoff" carries with it anything that is left on the ground including trash, oil, and pesticides, creating poor water quality.
- Most of our rainfall flows to the ocean as polluted run-off instead of seeping into healthy soil. As a result, rainfall – a natural resource that could be used to fill local underground water supplies is wasted, reducing our water quantity.
- Studies show that tree branches that form a canopy (like an umbrella) over soil and grassy areas can reduce polluted runoff by as much as 43%. Trees over concrete and asphalt can reduce the amount of runoff by as much as 10%.
- Trees capture rainfall and hold water on their leaf, branch and trunk surfaces. Rain then drips into the soil below. This helps to replenish underground stores of water.
- Planting and caring for trees so they reach maturity to create a large canopy, helps to protect water quality and increase water quantity.

START HERE!

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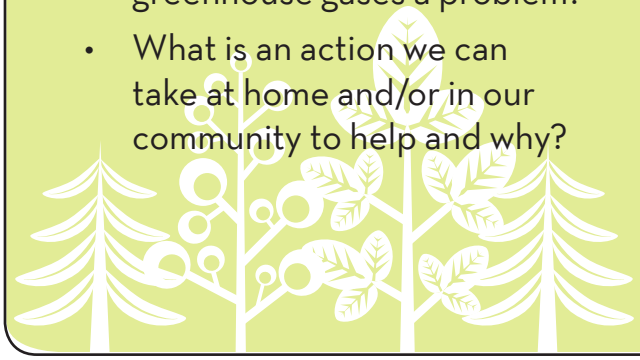
Your Instructions:

1. As a group, read and discuss the information on the right.

2. Use a large sheet of paper and markers to create a poster that answers the following:
   - What should we know about the greenhouse effect?
   - Why is an accumulation of greenhouse gases a problem?
   - What is an action we can take at home and/or in our community to help and why?



More Trees, Please!

GREENHOUSE GAS BENEFITS

- The Earth's temperature is controlled by water vapor, methane and carbon dioxide, three of the most important greenhouse gases in the atmosphere. This phenomenon is called the greenhouse effect.
- When greenhouse gases, such as carbon dioxide, accumulate it raises the Earth's average temperature causing climate change.
- The burning of fossil fuels (oil, gas and coal), such as from driving a car, is the largest source of emissions of carbon dioxide. Heat from the sun, reflects back from the earth and is trapped in this thickening layer of gases causing global temperatures to rise.
- As part of the air cycle, trees absorb carbon dioxide, removing and storing the carbon while releasing the oxygen back into the air. In one year, an acre of trees can absorb the amount of carbon dioxide that is produced when you drive your car 26,000 miles.
- Planting trees and caring for them to increase canopy coverage, helps reduce the impact of climate change.

START HERE!

Our environment provides many services that are critical to human health and survival. This is especially true of trees in cities. Some of the services that trees provide include filtering pollutants out of the air and water, reducing energy use, and creating oxygen. Trees with large, healthy canopies – branch and leaf cover - provide the most benefits. By measuring the canopy coverage of an area, and mapping these existing trees, we can better understand the value of tree services. We can also better manage – and increase – the trees that surround us. We need more trees, please!

Your Instructions:

1. As a group, read and discuss the information on the right.

2. Use a large sheet of paper and markers to create a poster that answers the following:
   - What should we know about pollutants in the air?
   - What should we know about the air in Los Angeles?
   - What is an action we can take at home and/or in our community to help?

More Trees, Please!

AIR QUALITY BENEFITS

- Clean air is a mixture of about 78 percent nitrogen, 21 percent oxygen, less than 1 percent of carbon dioxide, argon, and other gases; and varying amounts of water vapor.
- If there are other particles or gases in the air, they are considered air pollution. The most common air pollutants in California are ozone and particulate matter.
- Air pollution causes breathing difficulties, damages lungs, and worsens existing respiratory problems such as asthma.
- Although air quality has improved dramatically in Los Angeles in recent decades, it still remains among the most polluted areas in America.
- Trees absorb odors and pollutant gases such as ozone, and filter particulates out of the air by trapping them on their leaves and bark.
- Planting trees and caring for them to increase canopy coverage helps improve air quality!

LESSON 2: OBSERVING VEGETATION FROM ABOVE

Comparing Satellite Images

The 1960s marked a pivotal decade in our understanding of the changes that occur on the surface of the earth. It was in that decade that the first satellite that focused its attention on monitoring the changes in land cover was launched. Since that time many other satellites have launched with the ability to see the earth with wavelengths that are invisible to the human eye.

The purpose of this lesson is to engage students in how we can observe vegetation and canopy cover from above through satellite images and make canopy coverage comparisons in two different areas of the city. Working in teams, and then in a larger group, students will use a Think-Pair-Share worksheet to identify different land cover features and describe the canopy coverage they observe, before sharing their observations as a class.

MATERIALS

- Satellite images of two neighborhoods. (Figure B) - 1 per group
- Think-Pair-Share worksheet - 1 per student (Figure C)
- Pen or Pencil

TIME

- Approximately 40 minutes to complete
  - 5 minutes to get students into groups, pass out materials and give directions.
  - 20 minutes for groups to explore and discuss the differences between images and record their findings.
  - 15 minutes for groups to briefly report their findings to the rest of the class.

Procedure

1. Divide students into working groups of 4 - 6 students each.
2. Pass out a pair of i-Tree satellite images (Fig. B) that depict two different neighborhoods in the city.
3. Pass out a *Think-Pair-Share* worksheet (Fig. C) to each student.
4. Explain to students that they are going to examine the two different neighborhoods and using their *Think-Pair-Share* worksheet, answer the following:
   - Looking at the distribution of trees, what does that tell you about these two different neighborhoods?
5. Within their group, have students share what they observed with a partner and have the partner write down what she/he heard them say. Then, switch roles and have the partner share what s/he observed and write down any additional changes that were observed.
6. In their groups:
   - Discuss the findings that were shared and determine what the group will share with the class. Each student writes this on their *Think-Pair-Share* worksheet.
   - Determine who will represent the group and share the findings to the class.

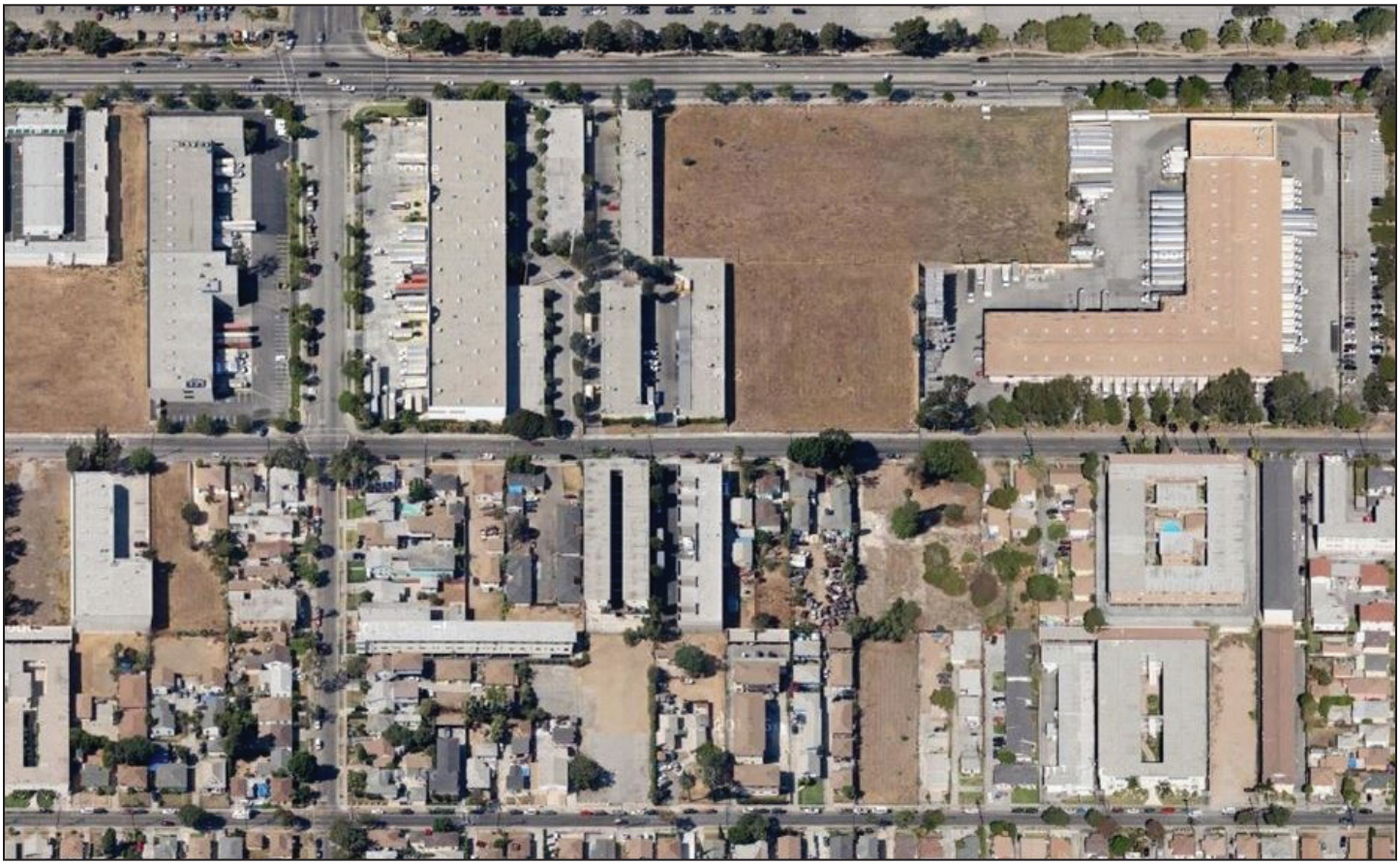
Stretching Their Thinking

- How do the colors, shapes and patterns allow you to distinguish between the different land cover features on the earth?
- How were the two city maps different?
- What do you think is the percent of canopy coverage represented in the two images? (top image: 10%; bottom image: 25%)
- Based on what you learned in Lesson 1, which image would you prefer, represents the tree coverage you want to see in your city?

Introducing the Next Activity

- How does our site or the neighborhood around our site compare to the land cover we see in these satellite images?
- Are there more trees around our site or the surrounding area?
- What would you guess is the percentage of tree canopy coverage at our site?

Figure B



My name:_____ Date: _____

My Partner's name:_____

THINK – PAIR – SHARE

1. What I observed:

2. What my partner observed:

3. What our group will share:

LESSON 3: ESTIMATING CANOPY COVERAGE FROM ABOVE

Investigating Your Site

With the availability of high resolution air photos available through programs such as Google Maps and i-Tree, the crowns of individual trees can be distinguished providing a way to measure the area of a tree and determine the overall canopy coverage of a specific site.

Now that students have looked at a satellite image and learned how to identify land features, they will explore their own site. Students will also learn how they can find the area of the trees by using geometric shapes. Using these skills they will measure the area of trees to determine the amount of canopy coverage for a specific section of their school. See Teacher Preparation on page 17.

Lesson Introduction

1. Explain to students that when looking above, we are able to see the tops of trees which shows the canopy spread of the tree.
   - Sometimes this is a circle, sometimes it can be an irregular shape.
   - In order to determine the canopy coverage of a site, we need to calculate the area of each tree.
2. Pass out an *Area Calculation Worksheet* to each student. Ask the students:
   - How do you calculate the area of a square or rectangle? (base X height)
   - How do you calculate the area of a triangle? (.5 X base X height)
   - How do you calculate the area of a circle? (πR^2)
3. Using the *Area Calculation Worksheet*, have students practice:
   - Finding the areas of the trees using a circle.
   - Finding the areas of the irregular shaped trees using various geometric shapes, and adding them up to get the area.
     - When using triangles, it is best to use isosceles triangles and determine which line is the base.

MATERIALS

- Color printer
- Area Calculation Worksheet (Figure D) - 1 per student
- Canopy Calculation Chart (Figure E) - 1 per group
- Satellite sections of the site (see box on page 17) – 1 per group
- Drafting Compass – 1 per student/group
- Ruler – 1 per student/group
- Calculator - 1 per student/group
- Marking pen - 1 per group

TIME

- Approximately 45 minutes to complete
  - 15 minutes for Lesson Introduction
  - 5 minutes to get students into working groups
  - 15 minutes for groups to calculate the canopy coverage of their assigned area.
  - 10 minutes for groups to briefly report their findings to the rest of the class

TEACHER PREPARATION

Creating Satellite Sections of Your School

1. You will need to divide your site up into different sections and create an image for each one. When dividing up the school to create different sections, remember the following:
   - Only create sections that have trees.
   - If possible, try to have about the same number of trees in each section.
   - The number of sections will determine the number of student groups.

2. Create each section by doing the following:
   - Go to https://www.google.com/maps.
   - Type in the address of the site to do a search.
   - Click on "earth" in the lower left corner.
   - Zoom in to indicate a section.
   - Print the section.

Determining the Total Area for Each Section Created

1. Determine the area of each section by doing the following;
   - Go to http://www.freemaptools.com/area-calculator.htm
   - Type in the address of the site.
   - Use the dropdown menu in the upper right corner and select "satellite".
   - Click on the corners of a section to indicate the total area being measured.
   - The total area will appear under "Area Output" as m^2.

2. Put this information on each of the section maps.

3. Assign a number to each of the section maps.

Determining the Total Acreage for the Entire Site

1. This will be used in Lesson 7.

2. Determine the acreage of the entire site by doing the following;
   - Go to http://www.freemaptools.com/area-calculator.htm
   - Type in the address of the site.
   - Click on "satellite" in the upper right corner.
   - Click on the corners of the site to indicate the total acreage being measured.
   - The total acres will appear under "Area Output."

Procedure

1. Divide students up into working groups (determined by the number of map sections of the school).

2. Explain to the students that they are going to use the same techniques they practiced, to determine the area of trees for a specific section of their site. Using the *Canopy Calculation Chart* (Fig. E), they will then determine the percent of canopy coverage for their section.

3. Pass out to each group:
   - Satellite image map section of a section
   - Drafting compass
   - Ruler
   - Calculator
   - Marking pen
   - *Canopy Calculation Chart*

4. In their groups, have students do the following:
   - Place the number of their section on their *Canopy Calculation Chart*.
   - Outline all of the trees using geometric shapes (such as a circle or triangles) to calculate area as they practiced on the Area Calculation Worksheet - Satellite Area Calculation part of the worksheet.
   - After they have outlined all of the trees in their section, make an estimated guess as to what they think is the percentage of canopy cover. Write the estimate on their *Canopy Calculation Chart*.
   - Determine the canopy coverage of the section:
     1. Calculate the area of each tree and add it to the chart.
     2. Add the areas for each individual tree together and add the total to the chart.
     3. Divide that number by the total area (pre-written on the map section). For example, if the total section outlined measured 100 cm and the area calculated for trees was 10 cm then the ratio of trees to total area is 10/100 or 10% canopy.

4. Add the percentage of canopy to the chart.

5. Ask the groups:
   - What is the percentage of canopy coverage for your section?
   - How does it compare to what you estimated?

Stretching Their Thinking

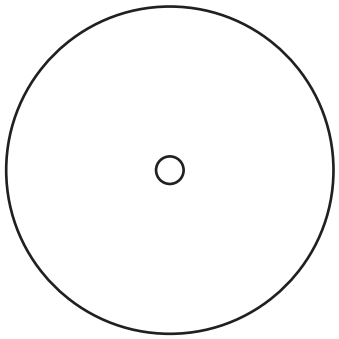
- What does the term, "percentage of canopy cover" refer to?
- Do you notice any patterns in the distribution of vegetation? Bare ground? Buildings?
- How do you think this compares to the surrounding neighborhood?

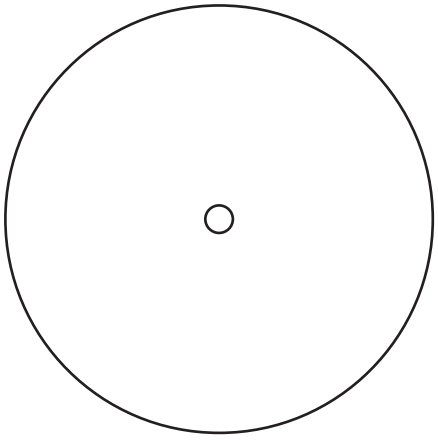
Introducing the Next Activity

- How could we be sure that what we see from a satellite image is actually what we think it is? For example, if we see an area that is all green, can we assume that it is a tree?

AREA CALCULATION WORKSHEET

1. Calculate the area of the trees below using πR^2.

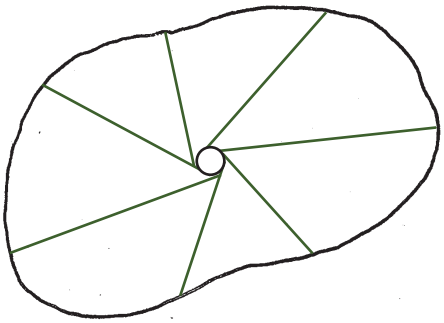


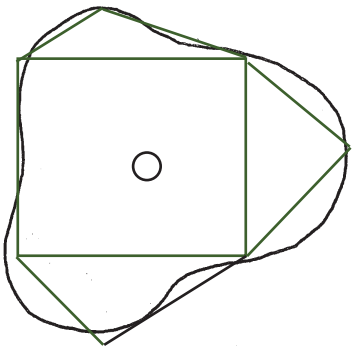


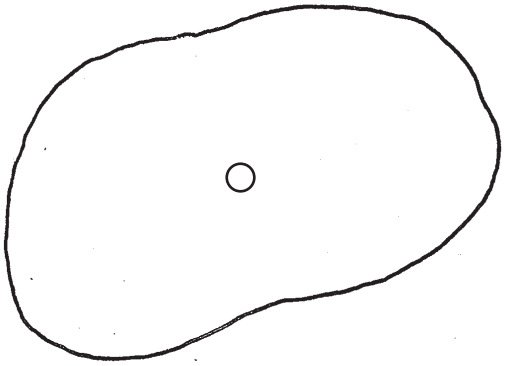
Tree A _____ Tree B _____

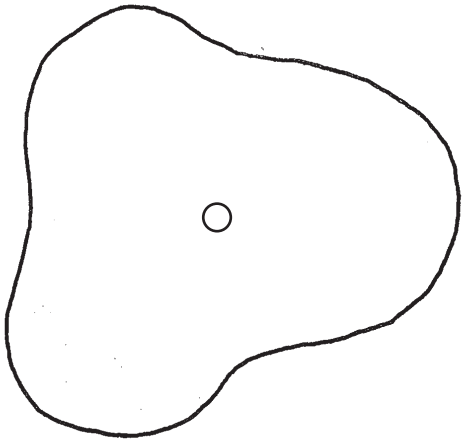
2. As illustrated, use different geometric shapes to calculate the area of the irregular-shaped trees below.

Example:









Tree A _____ Tree B _____

CANOPY CALCULATION CHART

Section #_____ Students_____

Satellite Instructions

1. Write the number of your section above.
2. Outline all of the trees in this section using geometric shapes (such as a circle or triangles).
3. Give each tree a number.
4. Looking at your section, and what you have outlined, what do you think is the percentage of canopy cover of your section? Put your guess in the chart below.
5. Place the total area of the section given, in the chart below.
6. Calculate the area of each tree. Put your answers in the chart below.
7. Add the areas of each tree together. Put your answer in the chart below under total tree area.
8. Divide the total area of the site by the combined areas of the trees to calculate the canopy of the section. Place your answer in the chart below.

Estimated Canopy _____%

LESSON 3 SATELLITE AREA CALCULATIONS		LESSON 4 GROUND CALCULATIONS	
Tree #		Tree #	
1	_____	1	_____
2	_____	2	_____
3	_____	3	_____
4	_____	4	_____
5	_____	5	_____
6	_____	6	_____
7	_____	7	_____
8	_____	8	_____
9	_____	9	_____
10	_____	10	_____
_____m^2 ÷ _____ m^2 = _____%		_____m^2 ÷ _____ m^2 = _____%	
Total Tree Area Section Area Canopy		Total Tree Area Section Area Canopy	

LESSON 4: DETERMINING CANOPY COVERAGE FROM BELOW – Part 1

Learning the Appropriate Process Skills

Satellites can only see the top part of a canopy from their position in space. For accuracy it is important to use ground truthing. This is a term used in remote sensing and refers to data collection on the ground. Ground truthing of the image data students collected and analyzed allows it to be related to on-the-ground features and to verify what is being sensed. As part of the ground truthing process, students will not only measure canopy coverage, but will make additional observations, calculating tree height and circumference, and determining tree species. They will then use technology to input the data.

As a Part 1 Lesson, students will learn how to do the appropriate process skills to ground truth the trees in their section. They will do this by observing data collection of one tree. Once data is collected, they will observe how to use online tools to determine trees species, and input the data into TreeMapLA to generate tree benefits. Finally, they will learn how to calculate the canopy coverage for their section. See Teacher Preparation on page 17.

MATERIALS

- Computer or other device with access to internet
- Square piece of paper
- Measuring tape
- Camera/phone
- Tree Data Collection Worksheet (Figure F)
- Tree Benefits Worksheet (Figure G)
- Tree Canopy Area Calculation worksheet. (Figure H)

TIME

- This lesson could take 1 – 2 class sessions:
  - 1 session to demonstrate data collection methods
  - 1 session to demonstrate using the computer to determine tree species and input data in TreeMapLA.

Procedure - Outside Session

1. Discuss with students what it means to "ground truth" and that they will be working in their teams to gather data on the trees in their section. The data that will be collected:
   - Pictures of the tree to help determine its species
   - Tree height
   - Tree circumference
   - Tree canopy
2. Take students outside to the tree, and using the *Tree Data Collection Worksheet* (Fig. F), demonstrate the following:

   Photographing to Determine Tree Species

   - Using a camera or phone, show students what images to take of the tree that will help them in determining its species. This includes:
     - Bark (texture)
     - Leaves (top, underside, attachment to branch, width)
     - Fruit and/or flowers

TEACHER PREPARATION

Plan to demonstrate the various process skills needed to collected the tree data.

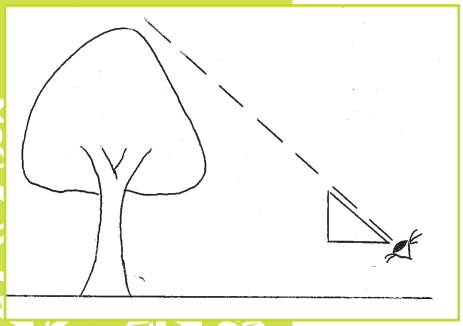
- Choose one tree for the demonstration that was outlined in the last lesson.
- Be sure to have the materials needed ahead of time.
- Create a Log In ID for TreeMapLA. See Sidebar below for instructions.
- Videos are available throughTreeMapLA for instructions on measuring tree circumference/ diameter, and height. Use these as a guide, if necessary. See Sidebar on page 24.

CREATE A LOG IN ID FOR TREEMAPLA

- Go to https://www.opentreemap.org/latreemap/
- Click on "Sign Up" in the upper right corner.
- Fill out the information to generate Log In information.
- For Username and Organization, use the name of the classroom, EcoClub or other.

CLINOMETER

A clinometer is an instrument used for measuring the angle or elevation of slopes. This homemade clinometer is used to help determine height.



Measuring Tree Height

- Demonstrate to students how, if the tree is short enough, they can use a measuring tape to determine the height by measuring the tree from the ground up to the highest point.
- If the tree is too tall, demonstrate to the students how to calculate the height using a handmade clinometer.

  Step 1: Measure Stride Length
  - With a tape measure mark 10 feet on the ground.
  - Walk the distance and note how many steps it takes. (For example: It took 5 steps to walk 10'.)
  - Divide the distance (10') by the number of steps. (For example: 10'/5 steps = Every step is 2'.)
  - For the best results, repeat a couple of times and take the average.

  Step 2: Measure Eyeline Height
  - Use a tape measure to measure the distance from the ground to eye level.

  Step 3: Make a clinometer
  - Pass out a square piece of paper.
  - Fold the paper into an isosceles triangle.
- Demonstrate to students how to use their pace, eyeline height, and the clinometer to measure tree height:
  - Walk away from the tree to a point where you can see the top.
  - Use the clinometer to find the top of the tree by holding the paper up at eye level so that the right triangle (the square corner) is pointing away from you and the long length of the triangle (the hypotenuse) goes from your eye and is pointed upward toward the tree.
  - Make sure the bottom of the triangle is parallel to the ground.
  - Adjust your position to the place where you can look up the long leg of the triangle and just see the top of the tree.

- Demonstrate how to calculate the height of the tree by doing the following:
  - Walk toward the tree and count your steps to calculate the distance.
  - The distance (steps) plus your height at eye level is equal to the height of the tree.

    Distance to the tree + eye level height = tree height
- Add this information to the data sheet.

Measuring Tree Circumference

- Demonstrate to students how to use a tape measure to determine where 4 feet 6 inches is from the ground up, on their body.
  - This is the height at which the group will take the measurement of all the trees.
  - This is to make the process of measuring more than one tree efficient.
- Demonstrate to students how to determine tree circumference by doing the following:
  - At the determined height (4 feet, 6 inches), wrap the tape measure around the tree to get the measurement.
  - For a multi-trunk tree, take measurements for each trunk of the tree.
  - For short trees, take the measurement at the point where the branches begin to flare out.
- Add this information to the data sheet.

Measuring Tree Canopy

- Demonstrate to students how to measure tree canopy. Have the team do the following:
  - Using a tape measure, measure the longest axis from one edge of the tree canopy (branches) to the opposite edge, touching the trunk of the tree as the tape measure stretches across the ground. Measure the distance in centimeters.
  - Take a second measurement perpendicular to this first line, touching the trunk of the tree as the tape measure stretches across the ground. Measure the distance in centimeters.
- Add this information to the data sheet.

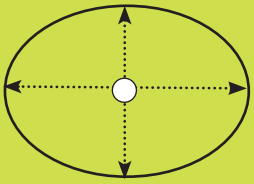
4. Head back to the classroom with the data collected.

HOW-TO VIDEOS

If possible, share with students the following TreeMapLA videos for:

How to Map a Tree
https://www.youtube.com/watch?v=P8b8D9aNwD4

How to Measure Tree Height
https://youtube.com/watch?v=fw7OnimBtpE&list



Lesson 4

TREE BENEFITS

TreeMapLA calculates the economic benefits and environmental impacts use i-Tree software provided by the USDA Forest Service's Urban Ecosystems and Processes team.

For more specifics on the algorithms used, go to the lesson introduction on page 32.

Procedure - Inside Session

1. As a class demonstrate how to use the photographs to help determine the tree species by doing the following:
   - Go to **urbantreekey.calpoly.edu**
   - Follow the instructions by clicking on the appropriate images to determine the species of the tree.
   - Add the information to the *Tree Data Collection Worksheet*.
2. As a class demonstrate how to input the data into TreeMapLA and generate tree benefits by doing the following:
   - Go to https://www.opentreemap.org/latreemap/
     - Log In for the class.
     - Click on “Add A Tree."
     - Input the site's address in "Search by Location" in upper right.
     - Use the dropdown menu in the upper right corner of the map and select "Satellite."
     - Set the trees location by placing the tree symbol on the map.
     - Click "Next" in lower right corner.
     - Using the information on the *Tree Data Collection* worksheet input tree species, circumference and height. Then, click "Next."
     - Check "Add Another Tree With New Details" to continue adding trees. Click "Done" each time to continue.
     - Once complete, check "I'm Done!" and click "Done.".
     - To view the tree benefits, click on the tree. The benefits and the economic savings for the tree will appear to the right.
     - Add this information to the *Tree Benefits Worksheet* (Fig. G).
3. As a class, demonstrate how to use the *Tree Canopy Area Calculation* worksheet.
   - Calculate the area of the tree using the canopy data:
     - Divide the two measurements by two to get the average canopy diameter.
     - Divide the canopy diameter by two to get the radius of the tree canopy.
     - Calculate the area of the canopy using πR^2.
   - Explain to students that once the class has the area calculation for all the trees in their section, they will add the data to the *Canopy Calculation Chart* (Fig. H) to determine canopy coverage.

Stretching Their Thinking

- What is a difference and a similarity in the method that was used to measure canopy with your satellite map and on the ground?
- What problems do you think exist with the techniques that were used to measure canopy, height and circumference?
- How does technology help in finding and maintaining data?
- How does technology help in determining key environmental benefits?

Introducing the Next Activity

- What should be considered when gathering data for more than one tree?
- Why is getting accurate data important?

TREE DATA COLLECTION WORKSHEET

Student Name(s):_____ Date: _____

Go to the numbered trees in your section. Follow the instructions below and record the results on page two.

Tree Species

1. Take several pictures of the tree.
   - Be sure to keep track of which photos belong with each numbered tree.
   - Make sure to get shots of the bark, leaf, and any other features.

Tree Height

1. If the tree is short enough, use a measuring tape to determine the height by measuring up from the ground to the tallest point on the tree.
2. For taller trees, make sure that a group member knows the length of their natural walking step. (For example: every step is 2 feet) and the height at their eye level.
3. Walk to a point to view the top of the tree. Use the clinometer to find the top by holding the paper up at eye level so that the right triangle (the square corner) is pointing away from you and the long length of the triangle (the hypotenuse) goes from your eye and is pointed upward toward the tree.
4. Make sure the bottom of the triangle is parallel to the ground.
5. Adjust your position to a place where you can look up the long leg of the triangle and just see the top of the tree.
6. Calculate the height of the tree by doing the following:
   - Walk toward the tree and count your steps to calculate the distance.
   - The distance (steps) plus your height at eye level is equal to the height of the tree.

Tree Circumference

1. Have one member of your group use a tape measure to determine where 4 feet 6 inches is from the ground up, on their body.
   - This is the height at which your group will take the measurement of each tree.
2. At the determined height, wrap the tape measure around the tree to get the measurement.
   - For a multi-trunk tree, take measurements for each trunk of the tree.
   - For short trees, take the measurement at the point where the branches begin to flare out.

Tree Canopy

1. Using a tape measure, measure the longest axis from one edge of the tree canopy (branches) to the opposite edge, touching the trunk of the tree with the tape measure as it stretches across.
   - Measure the distance in centimeters.
2. Take a second measurement perpendicular to this first line, touching the trunk of the tree with the tape measure as it stretches across.
   - Measure the distance in centimeters.

Tree # ___ Species_____

Height: _____ feet Circumference: _____ inches

Canopy measurements: _____ cm _____cm

Tree # ___ Species_____

Height: _____ feet Circumference: _____ inches

Canopy measurements: _____ cm _____cm

Tree # ___ Species_____

Height: _____ feet Circumference: _____ inches

Canopy measurements: _____ cm _____cm

Tree # ___ Species_____

Height: _____ feet Circumference:_____ inches

Canopy measurements: _____ cm _____cm

Tree # ___ Species_____

Height: _____ feet Circumference: _____ inches

Canopy measurements: _____ cm _____cm

Tree # ___ Species_____

Height: _____ feet Circumference: _____ inches

Canopy measurements: _____ cm _____cm

Figure G

TREE BENEFITS WORKSHEET

1. Fill out the information below the box, for each tree mapped in your section, using the data from TreeMapLA. Use more than one worksheet, as necessary.
2. Add up the totals for each benefit and insert them in the box below.

Total Benefit of Trees in Section # ________

Energy Conserved: ______/year Savings $_______

Stormwater Filtered: ______/year Savings $_______

Air Quality Improved: ______/year Savings $_______

Carbon Dioxide Removed: ______/year Savings $_______

Carbon Dioxide Stored: ______/year Savings $_______

Tree # _____

Energy Conserved: ______/year Savings $_______

Stormwater Filtered: ______/year Savings $_______

Air Quality Improved: ______/year Savings $_______

Carbon Dioxide Removed: ______/year Savings $_______

Carbon Dioxide Stored : ______/year Savings $_______

Tree # _____

Energy Conserved: ______/year Savings $_______

Stormwater Filtered: ______/year Savings $_______

Air Quality Improved: ______/year Savings $_______

Carbon Dioxide Removed: ______/year Savings $_______

Carbon Dioxide Stored : ______/year Savings $_______

Tree # _____

Energy Conserved: ______/year Savings $_______

Stormwater Filtered: ______/year Savings $_______

Air Quality Improved: ______/year Savings $_______

Carbon Dioxide Removed: ______/year Savings $_______

Carbon Dioxide Stored : ______/year Savings $_______

TREE CANOPY AREA CALCULATION WORKSHEET

Tree # ___

Canopy measurements: _____ cm X _____ cm ÷ 2 = _____ average diameter

Average diameter:_____ X 2 = radius

Area = πR^2 Tree Area =_____

Tree # ___

Canopy measurements: _____ cm X _____ cm ÷ 2 = _____ average diameter

Average diameter:_____ X 2 = radius

Area = πR^2 Tree Area =_____

Tree # ___

Canopy measurements: _____ cm X _____ cm ÷ 2 = _____ average diameter

Average diameter:_____ X 2 = radius

Area = πR^2 Tree Area =_____

Tree # ___

Canopy measurements: _____ cm X _____cm ÷ 2 = _____ average diameter

Average diameter:_____ X 2 = radius

Area = πR^2 Tree Area =_____

Tree # ___

Canopy measurements: _____ cm X _____ cm ÷ 2 = _____ average diameter

Average diameter:_____ X 2 = radius

Area = πR^2 Tree Area =_____

Tree # ___

Canopy measurements: _____ cm X _____ cm ÷ 2 = _____ average diameter

Average diameter:_____ X 2 = radius

Area = πR^2 Tree Area =_____

LESSON 5: DETERMINING CANOPY COVERAGE FROM BELOW- Part 2

Gathering, Inputting and Calculating Data

With the access of online tools, like TreeMapLA, the economic benefits and environmental impacts of individual trees is now available and serves as an incentive for increasing canopy coverage. This information is generated using i-Tree software provided by the USDA Forest Service's Urban Ecosystems and Processes team. This software provides options for calculating benefits by assigning a dollar value to the impact of trees in a number of ecological areas. These areas include electricity, natural gas, carbon dioxide, particulate matter, nitrogen dioxide, sulfur dioxide, volatile organic compounds, and stormwater interception. The USDA Forest Service provides default dollar values for each of the categories in i-Tree. These default values were used for the Southern California Coast region for all of the aforementioned fields except electricity and natural gas. For the electricity fields, a price of $0.1323 per Kwh based on local Los Angeles electricity rates for residential customers was used. For natural gas rates, a price of $1.50 per therm was used.

In this lesson students use the process skills they observed and working in their groups gather the tree data for their area. They will take the information and input and map their trees into TreeMapLA to generate tree benefits. They will also use the canopy data to calculate the area for their trees and determine the canopy coverage of their entire area.

Procedure - Outside Session

1. In their groups, have students assign numbers to the trees on the satellite map of their assigned section.
2. Make sure each group has all the materials they need to gather data for each of the trees in their assigned section.
   - Data Collection Worksheet
   - Square piece of paper
   - Measuring tape
   - Camera/phone
   - Pencil
3. Make sure groups are prepared by:
   - Measuring the pace of a team member.
   - Measuring the location at 4 feet, 6 inches up from the ground of a team member.
   - Making a clinometer.

MATERIALS

- Computer or other device with access to internet
- Satellite maps of each section
- Square piece of paper
- Measuring tape
- Camera/phone
- Tree Data Collection Worksheet (Figure F) - 1 per group
- Tree Benefit Worksheet (Figure G) - 1 per group
- Tree Canopy Area Calculation Worksheet (Figure H)
- Canopy Calculation Chart (Figure E)

TIME

- This lesson could take 1 – 2 class sessions
  - 1 session to collect data
  - 1 session to use the computer to determine tree species, input data in TreeMapLA, and determine tree canopy.

4. Have student groups go outside to collect data.
    - Make sure they know the time to return to the classroom.

Procedure - Inside Session

1. Using the photographs collected for each tree, have student groups determine the species of the trees using Selectree.com, and add it to their *Tree Data Collection Worksheet*.
2. Using their *Tree Data Collection Worksheet*, have student groups map their trees and input their data into TreeMapLA.
    - Have them generate the benefits and add the information to a *Tree Benefits Worksheet*.
3. Using the information on the *Tree Benefits Worksheet* have students add up the benefits for their section.
4. Using a *Tree Canopy Area Calculation Worksheet*, have groups generate the area for each of their trees.
5. Using their *Canopy Calculation Chart*, have students enter the data and determine the canopy coverage for their section.

Stretching Their Thinking

- How does the survey that you conducted on the ground differ from the survey you did with the satellite map in class?
- Is there a problem using some of the geometric formulas you used with the measurements you took?
- What did you learn about the tree benefits generated for your section?
- How can recording data about trees help in the overall maintenance of the trees?

Introducing the Next Activity

- How accurate would measuring canopy be if it were done by random sampling (conducting an assessment using Google Maps, at random points)?
- Do you think the amount of canopy calculated would be adequate?

LESSON 6: CALCULATING CANOPY COVERAGE FOR THE ENTIRE SITE

Using i-Tree to Generate Canopy Coverage

Today, most canopy, for a given area, is calculated using a computerized random sampling process. One well known program is i-Tree Canopy. With i-Tree Canopy, Google Maps aerial photography is used at random points to conduct a cover assessment within a defined area. i-Tree Canopy randomly generates sample points and zooms to each one so the User can choose from pre-defined cover types (trees) for that spot. The more survey spots completed the better the canopy coverage estimate for the study area.

In this lesson students use online technology to calculate the canopy coverage of their entire site. They can take turns generating and verifying the survey points until the survey area is complete. Once complete, they will use the generated canopy coverage in Lesson 7 to help determine how many more trees (and their size) their site could use. See Teacher Preparation on page 35.

Procedure

1. Discuss with students how using technology has helped make the process of determining canopy coverage easier for larger areas:
   - Today, most canopy, for a given area, is calculated using a computerized random sampling process. One well known program is i-Tree Canopy.
   - With i-Tree Canopy, Google Maps aerial photography is used at random points to conduct a cover assessment within a defined area. i-Tree Canopy randomly generates sample points and zooms to each one so the User can choose from pre-defined cover types (trees) for that spot.
   - The more survey points completed the lower the margin of error and the more accurate the sampling will be.
2. Assign students to take turns conducting the survey by doing the following:
   - Click on the + sign in the gray chart to begin. The program will place a yellow + sign on the map.
   - Select if the plus sign shows the location of a Tree, or Non-Tree from the drop-down menu.
   - Once a Tree, or Non-Tree is selected for a given point, click on the next + to define another point.
     – Some of the points will be quite close together.
     – Several dozen non-tree points may come up before a tree is defined.

MATERIALS

- Computer or other device with access to internet
- i-Tree Program located at: www.itreetool.org

TIME

- One class session, depending on the size of the site.

NOTE

- Some of the points may seem silly in that i-Tree will ask to define a point that is a building or even a car. Continue by clicking that it is a Non-Tree.
- Keep going as this helps the system to better recognize what are and are not trees.

TEACHER PREPARATION

Plan to set up a computer with the i-Tree program and create a shape file of the school to conduct a canopy analysis for the entire site. Create the file by doing the following:

- Go to www.itreetools.org
- Create an Account/Login. Register to allow login for an i-Tree account
- Under Applications, select iTree Canopy
- Click on "Define Project Area" and "Accept" terms.
- Enter school address
- Zoom in to desired area
- In the upper left of the screen click on the blue shape to "Add Polygon"
- Use your mouse to click and draw a shape file around the perimeter of your desired site
  - When complete your area will turn red
- Click "Finish" in the lower right corner
- Click on "Step 2 : Configure and Begin Your Survey"
- Click on "Next"
- Choose your State by unclicking "United States of America" and clicking on "California"
- Under Benefit Options make sure the following options are highlighted:
  - Tree
  - US Dollars
  - English, if this is your preferred language.
- Click on "Begin Survey" in the lower right corner

Follow directions outlined in the Procedure

3. Once a significant number of points are completed (the more the better), select "Report" in the top menu bar to generate the canopy coverage.

Stretching Their Thinking

- Of all the methods used for determining canopy which one do you think was the most accurate?
- When calculating canopy coverage for an entire city, how does the use of a program like i-Tree Canopy help?

Introducing the Next Activity

- What are the value of trees to our site?
- What would be the ideal percentage of canopy coverage for our site?
- How many more trees do you think our site could use?
- What do you think is the ideal canopy coverage for a city in Southern California given its average yearly weather?

LESSON 7: DETERMINING IDEAL CANOPY COVERAGE

Calculating the Number/Size of Trees Needed

What is the ideal canopy cover for an urban area such as Los Angeles? Some city planners and other professionals who work with trees calculate that trees have an ideal positive and significant affect when an area has 25% canopy over the total land cover. What advantages are there to having more rather than less canopy cover? When water evaporates from a surface, it cools the surface from which it evaporated. Trees are like huge evaporative coolers that wick up water through their roots and transport them through the xylem to the leaves. When the water leaves the leaf into the atmosphere, in a process called transpiration, the tree surface just like your skin with the alcohol is cooled and so is the surrounding area. Climate change makes this cooling effect all the more important. Anyone walking down a burning-hot LA street can tell you that it's cooler – far cooler – to be in the shade. The difference of a few degrees can prevent heat stroke, something of concern for our more vulnerable populations such as children and the elderly. This is especially true during times of drought.

Having learned the other benefits of trees during the Instant Expert activity, and calculating them through TreeMapLA, students should understand the value of trees to their site. In this lesson, students will take the results of the canopy coverage analysis for the site and determine how many more trees, and the size of trees, they would need to plant to bring the canopy up to an ideal coverage.

MATERIALS

- Ideal Canopy Coverage Worksheet (Figure I) - 1 per group
- Calculator

TIME

- Approximately 45 minutes to complete
  - 5 minutes for Lesson Introduction.
  - 5 minutes to get students into groups, pass out materials and give directions.
  - 25 minutes for groups to explore the questions and determine their answers.
  - 10 minutes for groups to briefly report their findings to the rest of the class.

Lesson Introduction

1. Discuss with students how according to the American Forests Association, the tree canopy goals suggested for metropolitan areas in the dry West area is a minimum of 25%. Ask the students:
   - How many trees to you think we would need to plant at our site, to increase the amount of canopy coverage from where it is currently to meet a 25% canopy goal (or more)?
   - Write this number on the board.

2. Discuss with students how tree size is an important factor when calculating the number of trees needed.
   - At maturity, large trees can have a 50-foot crown/canopy
   - At maturity, medium trees can have a 30-foot crown/canopy
   - At maturity, small trees can have a 15-foot crown/canopy
3. Ask students:
   - How does this change the number of trees needed, when considering tree size?
   - How would you estimate the number of trees for our site by tree size?
   - Write this number on the board.

Procedure

1. Break students up into working groups of 3 - 4 students each. Explain that they will determine:
   - The number and size of trees needed to meet their ideal canopy coverage.
   - A plan for where these trees might go.
2. Pass out the *Ideal Canopy Coverage Worksheet* to each group. Have them follow the instructions to answer the questions.
   - Give the students the acreage for the entire site to use in their calculations.
   - Give the students the canopy coverage for the site that was determined by i-Tree.
3. After completed, have each group share their results with the class.

Stretching Their Thinking

- How did the actual number of trees needed compare to the numbers estimated?
- Is it doable to plant more trees to bring the site up to the desired canopy coverage?
- What about the community around our site?
- How will the benefits calculated on TreeMapLA change if the site increases canopy coverage?
- Do any of the trees on our site need tree care to ensure they grow and increase their canopy?

IDEAL CANOPY COVERAGE WORKSHEET

Student name(s):_____ Date: _____

1. What is your desired percentage of canopy coverage for our site? _____%

   Explain why you chose this percentage:

   _____

2. Following the instructions below, determine the number and size of the trees needed for your ideal canopy coverage if your canopy coverage is less than 25%, multiply the site acreage by 25%. If the canopy coverage of your site is 25% or more do it for an increase of 5%.

   a. Determine the acreage of existing canopy:
      - Multiply the total acres of the site by the current canopy coverage
      - For example: for a 20 acre site with 15% canopy: 20 X .15 = 1 acre of existing canopy

      _____ = acreage of existing canopy

   b. Determine the desired canopy acreage needed to meet the target:
      - Multiply the total acres of the site by the desired canopy percentage
      - For example: for a 20 acre site with a desired canopy of 25%: 20 X .25 = 5 acres needed

      _____= desired canopy acreage

   c. Determine the amount of acreage needed to plant with trees and convert to square feet:
      - Subtract the desired canopy acreage from the acreage of existing canopy
      - For example: 5 - 1 = 4 acres needed to meet the target
      - Multiply the acres needed to meet the target by **43560** to convert to square feet
      - For example 1 acres converts to 174,240 square feet

      _____square feet for planting trees

   d. Determine how many trees needed to meet the canopy goal, by size:
      - Small tree: Divide square feet for planting trees by **177**
      - Medium tree: Divide square feet for planting trees by **707**
      - Large tree: Divide square feet for planting trees by **1963**
      - For example: 174,240 ÷ 1963 = 89 large trees needed to meet canopy goal

      _____ small trees _____ medium trees _____ large trees

3. What are some ideas you have for where some of these trees can be planted?

   _____

SHARE WHAT YOU DID
Let Us Know About Your Project!

Projects like this serve as an inspiration to others, and count toward TreePeople's goal of transforming our city into a safe and sustainable environment! There are a variety of ways to share what you did.

Social Media

Share photos and videos on the Project Toolkit Facebook Group. If your group has not been invited to join, contact youthleadership@treepeople.org. See page 3 for other ways to share.

Final Report

Send an email to youthleadership@treepeople.org and tell us:

1. What is the name of your school/Eco club?
2. What are the names of the students who participated?
3. What project did you complete?
4. What was the canopy coveage of your school?
5. What plans, if any, do you have for increasing canopy coverage?
6. Are you interested in another Project Toolkit?

We would love photos and/or videos of the project too!

TREE PLANTING OR TREE CARE EVENT

Use the Planting Trees Project Toolkit or the Caring For Trees Project Toolkit as a next step to increasing the tree canopy coverage of your school.

A great way to continue the work and invite others to get involved.

APPENDIX

Glossary

accumulate: Aquire an increasing number or quanitity of.

atmosphere: The layer of gases surrounding Earth that are composed mainly of nitrogen and oxygen.

asphalt: A product used in paving, specifically for streets and play grounds.

aquifer: An underground zone of earth that contains water.

berm: A raised mound of dirt designed to slow, spread and sink water much like a dam. They can be covered with shrubs, ground covers, turf or mulch.

clay: A mineral part of soil and soil type whose individual particles are flat and less than .002 millimeters in size. It has the greatest water and nutrient-holding capacity.

climate change: A long-term change in the Earth's climate due to a change is the average atmospheric temperature.

climate zone: An area in which a common set of temperature ranges, humidity patterns, and seasonal characteristics combine to allow certain plants/trees to succeed and others to fail.

coal: A material used as a fuel, formed from fossilized plants.

concrete: A building material used for sidewalks, patios, and more. It contains a mix of cement, water, sand and gravel.

deciduous: Refers to a tree that looses its leaves annually.

dependent: Relying on or requiring the aid of another for support.

emissions: A substance discharged into the air, especially by an internal combustion engine.

fossil fuel: Petroleum, coal, or natural gas, derived from fossilized plants, and used for fuel.

greenhouse effect: The phenomenon caused when the earth's atmosphere traps solar radiation, as a result of the presence in the atmosphere of gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through but absorb heat radiated back from the earth's surface.

hardscape: Refers to hard elements on the land such as those composed of concrete, brick and stone. It includes driveways, patios and sidewalks.

impervious: Presenting a barrier to the passage of water.

kilowatt: One thousand watts of electrical power.

kilowatt-hour: A unit of electric energy equal to the work done by one kilowatt acting for one hour.

landscape: Garden or planted area.

loam: A mineral part of soil and soil type whose individual particles are round and .002 millimeters to .05 millimeters in size.

maturity: The state of being fully grown or developed.

methane: An odorless, colorless, flammable gas, the major component of natural gas, that is used as a fuel.

mulch: A ground covering, especially of organic materials, that holds water, slows evaporation, enriches the soil and encourages plant growth.

native: Originating in, or inhabiting, a specific place for many years.

non-native: Not coming from a given locality; synonymous with "exotic."

oxygen: A colorless, odorless gas that is the life-supporting component of the air.

permeate: To flow through.

pollution: The addition of any substance that has a negative effect on the environment and the living things that depend on it.

sand: A mineral part of soil and soil type whose individual particles are round and .05millimeter to 2 millimeters in size.

soil texture test: A test, done by hand, that determines soil type.

storm drain: Above ground or below ground pipes and channels that transport stormwater to the ocean for flood control purposes.

***Sunset* climate zones**: Twenty-four different climate zones described in the *Sunset Western Garden Book*. The Los Angeles area has zones 18 to 24.

sustainability: The use of natural resources in a way that avoids depleting them or otherwise damaging the environment.

watershed: The land area that drains water to a particular stream, river, lake or ocean.

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