GLOBE Observer: Forestry

Curated by Danielle Lay

Background

Collecting data through GLOBE Observer and other citizen science platforms provides opportunities to integrate data collection and analysis into 4-H Forestry projects. In classrooms, scientific and mathematical concepts can be taught in the context of forestry with GLOBE Observer and other citizen science platforms. Submitting measurements through GLOBE Observer also integrates youth into the scientific process, since NASA uses observations as ground-truth for remotely sensed data.

Using Tree Size to Teach Forestry and Geometry with GLOBE Observer

Youth might identify species of forest vegetation to curate herbarium collections for 4-H Forestry projects. Foresters conduct *stand exams* to better understand forests, which involve collecting data on species composition but also structure, age, size, spacing, location, and condition. These data are collectively known as forest biometrics.

Size measurements, including circumference and tree height, can provide foresters with insights into stand health and ecosystem services. Tree height and circumference measurements can be used to estimate carbon storage in forest biomass. These size measurements can also help foresters understand if tree growth is stunted, which can inform forest management decisions.

Taking tree size measurements also reinforces basic geometry concepts, such 45-45-90 triangles and circumference. Use the **Lesson 16 worksheet** from the Purdue College of Science K-12 Outreach team to guide students through comparing estimates of tree height that they take with clinometers and the GLOBE Observer app (Figure 1). **Making Maths: Clinometer** guide includes directions on making a simple clinometer to estimate tree height. A flexible tape measure will also be needed to measure trunk circumference.

Materials:

- Protractor
- Poster board, cardboard, or clip board to back the protractor
- String
- Weight, such as metal nut or paper clip
- Straw
- Flexible tape measure
- Mobile device with the GLOBE Observer app

Estimate Ecosystem Services Provided by a Tree with i-Tree

Once circumference is measured and the species is identified, youth can use mytree.itreetools.org on a smart phone or tablet to learn about ecosystem services that are provided by the tree. Follow the data entry instructions to estimate intercepted stormwater volume, mass of mitigated air pollution, and sequestered carbon. This exercise provides an opportunity to explore how forests play a role in hydrologic and carbon cycles.

Materials:

- Mobile device with the GLOBE Observer app
- Flexible tape measure

Introducing Land Cover and the Electromagnetic Spectrum with GLOBE Observer

Introduce land cover with GLOBE Observer*:* Land cover are broad classifications of ecosystem type based on what covers the ground, such as agriculture, forest, or impervious surfaces. Land cover impacts many ecosystem processes and characteristics, such as erosion, surface temperatures, and wildfire vulnerability. Land cover also influences flows of energy, water, carbon, and nutrients. Youth can also make *Land Cover* observations with the GLOBE Observer app when they are collecting samples for herbarium collections or conducting stand exams (Figure 1). Students can easily follow the tutorials and prompts in GLOBE Observer to learn more about land cover through making observations. These observations will be used to verify land cover data that is captured by satellites, which is a process known as ground-truthing.

Materials:

- Mobile device with the GLOBE Observer app

Demonstrating reflection, transmission, and absorption at different wavelengths with gummies: Sensors on satellites are used to efficiently map land cover. Different land covers absorb and reflect incoming solar radiation at different wavelengths, and the intensity (i.e., amount) of light reflected at different wavelengths can be measured by certain types of sensors (Figure 2). Scientists and engineers create relationships between intensity data at different wavelengths that are collected by sensors on satellites and ground observations of known land covers at select locations, such as those entered through the GLOBE app, to develop unique electromagnetic signatures for different land covers (Figure 3).

Youth can contrast reflection, absorption, and transmission of incident light across different colors of gummy candies to demonstrate how reflectance can be used to detect differences in land covers.

Definitions:

- Absorbance: the amount of light that is not reflected nor transmitted through an object at a certain wavelength.

- Transmittance: the fraction of incoming light at a certain wavelength that passes through an object
- Reflectance: the portion of incoming light that is reflected from the surface of an object

Materials:

- Red laser point or red LED [always supervise use of lasers]
- Red & green gummy candies

Demonstration steps:

1. Shine the red laser pointer parallel to the surface on which the gummy rests through the red gummy. The gummy primarily reflects and transmits red light.
2. Shine the red laser point through the green gummy. The red light is primarily absorbed by the green gummy.
3. Optional extension: Shine a white LED light or a green laser pointer through the gummy bears. White light contains all colors in the visible spectrum. What happens in each of these instances?

Translate satellite imagery to land cover maps: Reflectance of different wavelengths in the visible portion of the electromagnetic spectrum are perceived as different colors. Our eyes act like sensors and can similarly distinguish some land covers based on different colors. For example, trees and other vegetation may appear green during parts of the year, while roads and roofs may appear black in aerial images. Use the **LEGO Land Cover Activity** guide to introduce how aerial images from planes or satellites can be translated to land cover maps based on color differences. Only using visible light will not permit us to distinguish certain land covers from one another (Figure 4). Non-visible portions of the spectrum can also help scientists obtain more information about the environment, such as moisture content of vegetation and soils and surface temperatures.

Materials:

- Printed aerial image
- Different color LEGOs (ideally squares to represent pixels)

Supplemental Information

Figure 1: GLOBE Observer homepage with Trees and Land Cover options

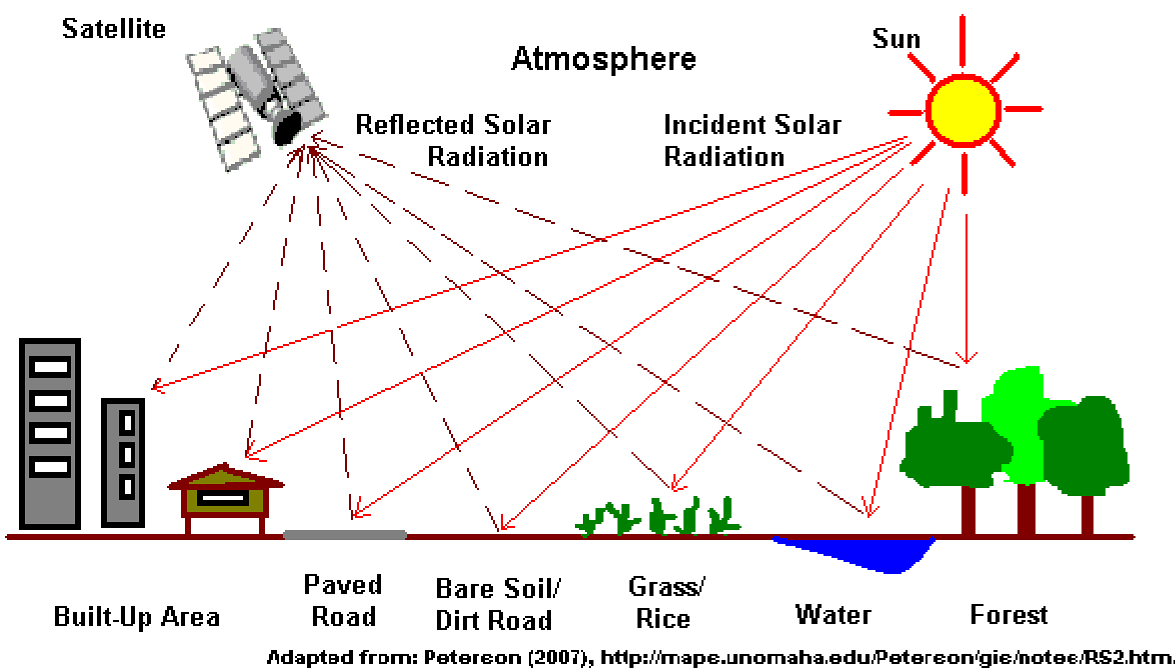

Figure 2: Satellites can map land cover based on reflectance (Source: University of North Carolina at Chapel Hill)

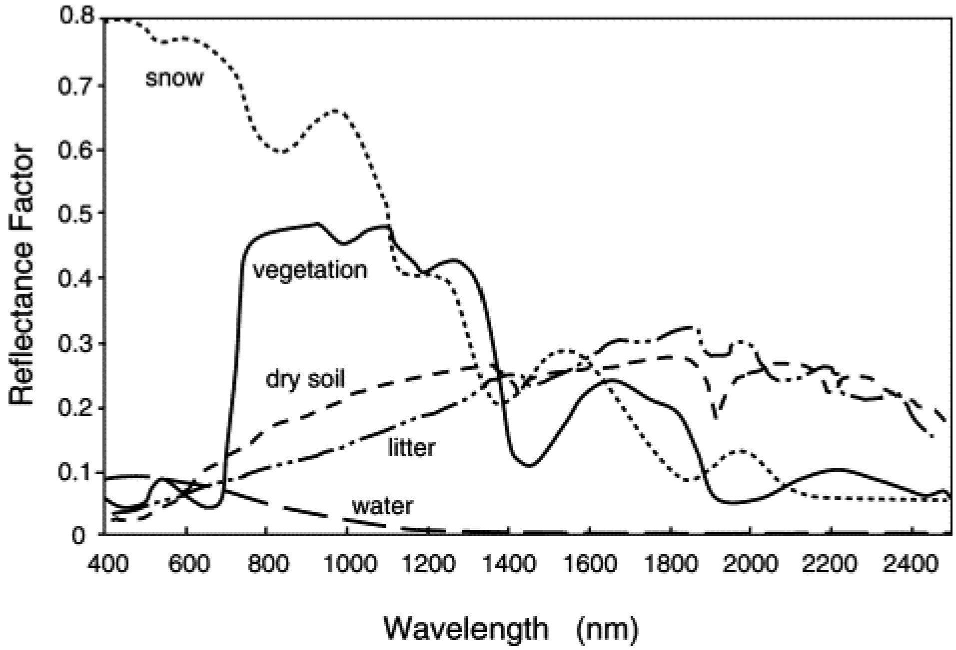

Figure 3: Different land covers have unique spectral reflectance signatures (Source: A.R. Huete, 2004)

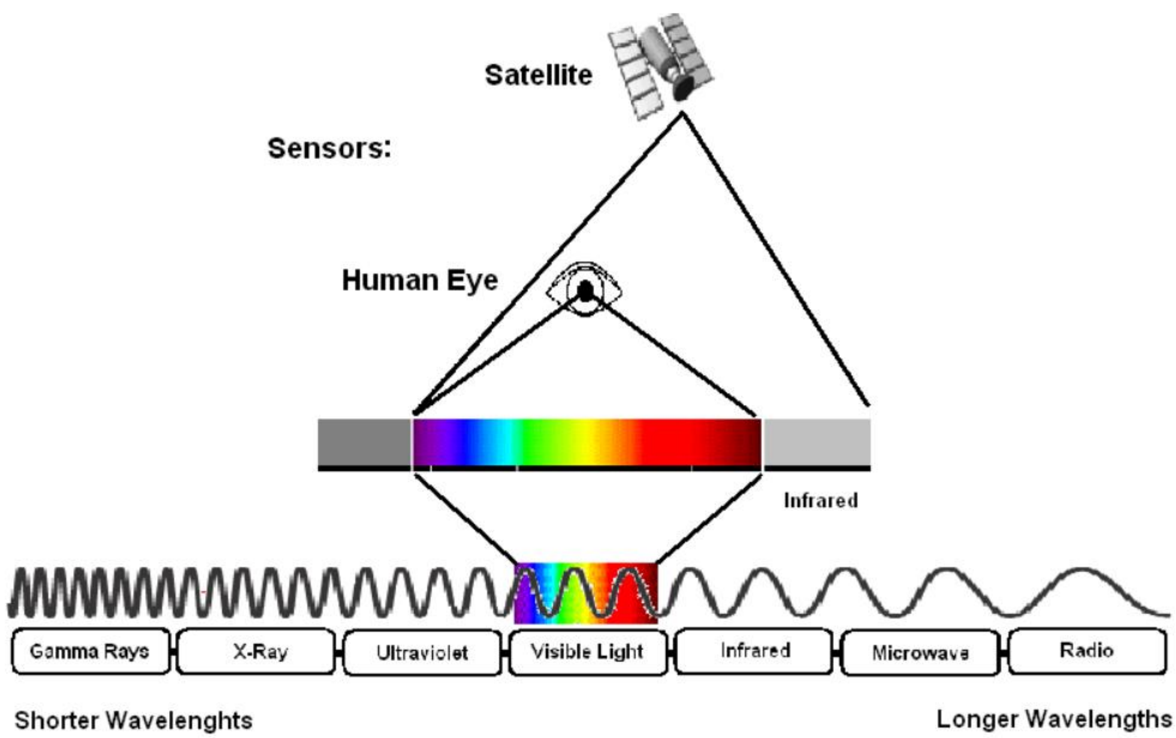

Figure 4: Human eyes can perceive only a portion of the electromagnetic spectrum, while satellites measure intensities are a broader spectrum (Source: University of North Carolina at Chapel Hill)

More ideas for augmenting 4-H Forestry projects:

- Along with leaves for an herbarium collection, collect additional data on each tree, such as tree height with GLOBE Observer and tree benefits with i-Tree.
- Conduct a stand exam of a local forest using a combination of ground-based measurements and remotely sensed data and present the resulting forest characterization as a poster. Remotely sensed forest data can be easily explored through online platforms that do not require a working knowledge of programming for geospatial analyses, such as Global Forest Watch and U.S. Forest Service Geospatial Data Discovery.

Additional Resources:

Download the GLOBE Observer app

- GLOBE Observer on the App Store
- GLOBE Observer - Apps on Google Play

TAMU Physics and Astronomy Light Reflection versus Light Absorption with Gummy Bears video

Superheroes of Science Constructing a Clinometer video tutorial

Using Trees to Teach Math, Science, and Technology

Background:
During this activity your group will estimate tree height and circumference in two different ways. Tree height is the most widely used indicator of an environment's ability to grow trees. Observing tree height allows scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere.

Materials:

Device with the GLOBE Observer app installed
Clipboard Clinometer
Tape measure
Handout
Pen or pencil

Activity 1: ***Using a Clinometer***

1.) Locate and select your study tree
   - Find a tree 7-15 meters away that you have a clear view of the top and bottom of the tree
   - The tree measured should be at least 5m (16.4ft) tall
   - The tree measured should be isolated trees or the tallest trees in a large grouping of trees

2.) Estimate the height of the tree:

3.) Record the following: Year _____ Month _______ Day ____ Hour (UT) _______

Recorded By: ____

Use the clinometer, tape measure, and your group to record the tree height. Measure three times and find the average.

Dominant Tree Species	Clinometer Reading (˚)	Tree Height (m) = Distance from Base of the Tree (m) plus height of Eyes (m)	Average Tree Height (m)	Height according to the app	Average Tree height according to the app
Tree # 1	45˚				
	45˚				
	45˚				

Activity 2: ***Using the app***

- Open the GLOBE Observer app on your device
- Follow the short tutorial and the the directions in the app to estimate tree height. Record the height on the table above (Measure it three times)
- Use a tape measure and measure/record tree circumference. Record the circumference (from breast height ~1.35 m up the tree) in the app and here:
  Tree #1 circumference (in cm):

Find a second tree and repeat:

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   - Find a tree 7-15 meters away that you have a clear view of the top and bottom of the tree
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  Tree #1 circumference (in cm):

Reflection Questions:

1. Using illustrations, labels, and text explain the math behind calculating tree height and circumference.

2) How do the calculations you did by hand compare to the measurements generated by the app?

3) What are possible sources of error for each method of calculating tree height?

Resources:

- GLOBE Trees https://observer.globe.gov/do-globe-observer/trees
- How to Build a GLOBE Clinometer https://www.globe.gov/documents/355050/ba6cd381-02be-4525-8fd4-f061515b9862
- Purdue College of Science K-12 Outreach https://www.science.purdue.edu/K12/index.html

NRICH

Making Maths: Clinometer

Age 11 to 14
Challenge Level

A clinometer is a tool that is used to measure the angle of elevation, or angle from the ground, in a right - angled triangle. You can use a clinometer to measure the height of tall things that you can't possibly reach to the top of, flag poles, buildings, trees. Follow the directions below to create your own clinometer.

You will need:

A protractor with a small hole on the centre spot or

Print out of paper protractor (see below)

Poster board or card board (can be from a box) to back the protractor

20 cm or about 8 inches of string or strong cotton

Weight - such as a metal nut, paper clips or a small piece of clay

Glue and Scissors

A straw

Clear Tape

Items marked with the red check are needed with either type of protractor.

Directions:

If you are making a protractor, cut out the copy of the protractor.

Get the piece of poster board or an empty box. Stick the paper protractor on top of the card and cut the joined pieces.

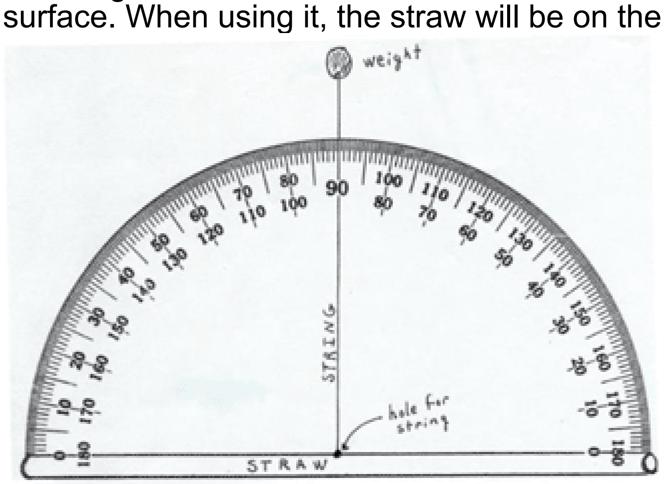
Get the straw and tape it to the straight edge of your protractor that you made above.

With your pen or pencil, poke a hole through the center of the protractor where it meets the straw. Push the string through the hole and tie a large knot on the other side so it won't pull through.

Tie your weight to the other end of the string.

To use the clinometer:

The diagram shows what the assembled clinometer will look like when laying an a flat surface. When using it, the straw will be on the top.



You will need two people: one to look through the straw and site the top of an object and one to read the degrees that the string makes with the protractor.

Find a tall tree (or building, flag pole etc.) in a place where there is plenty of space to move away from the object that you are measuring.

Look through the straw and find the top of the tree.

Ask your friend to read the angle being recorded on the clinometer. This is read where the string or cotton is touching the protractor.

Keep moving back (or forward if you've gone too far) until you have the clinometer angle measuring 45 degrees. With a 45 degree angle your job will be much easier as the distance from you to the tree will be equal to the distance from the ground to the top of the tree.

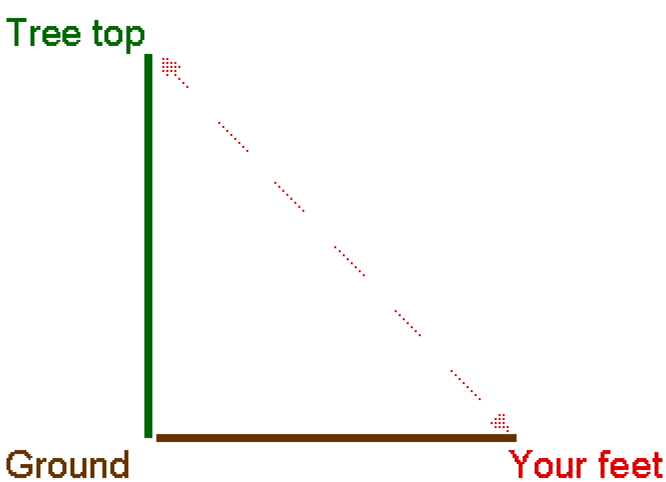
Measure the distance between where you are standing and the base of the tree.

Measure the distance from your eyes to the ground (this is where your partner is indispensible!)

Add these two distances together - because to be most accurate the triangle has to finish at your feet not your eyes.

You now have a very close approximation of the height of the tree, building or other tall structure.

You, the base of the tree and the top of the tree, form an isosceles triangle meaning the distance from you to the base of the tree is equal to the height of the tree (from the viewer's eyes to the top).



Lego Land Cover

Activity Guide

GLOBE Observer

Overview
Participants build a land cover map with blocks or Legos.

Purpose
- Learn how to classify land cover in a grid
- Visualize a pixel and match land cover to the pixel scale
- Explore the purpose of land cover mapping; see the value of satellite-based mapping

Audience
This activity is extremely flexible and may be used with young children to adults. The description includes variations based on audience level. Since all variations use the same materials, it may be used as a tabling activity that is modified based on the group that comes to the table.

Engagement Time
2-10 minutes

Materials
- Square blocks, such as Legos, Megablocks, Duplos, etc. It works well to have 3-4 colors matching land cover, though can be modified so color does not matter
- Mat for building
- Satellite image of your location or a photo of mixed land cover in your region (a park works well)
- Grid printed on clear transparency paper

Background
Land cover is what is on the surface of the land. It includes things like trees, grasses and flowers, rocks, cultivated land, and urban land. Land cover defines our homes and the homes of wildlife. What is on the land contributes to a community's vulnerability to hazards like floods, fires, and landslides. Land cover also plays a role in many processes on Earth such as the water cycle, the way energy is distributed around the planet, and the carbon cycle. Scientists map land cover to study all of these things and to help communities make good decisions about the way they use the land.

Younger Children and Family Groups

Preparation

- Make blocks available.

Steps

1. Ask the child to build a park using the blocks (color doesn't matter, let the child be creative).
2. Ask the child to tell you about the park. Where are the trees? What else is in the park?
3. Ask the child to imagine that she or he is drawing a picture of the park sitting in one section. Would they be able to see the whole park from one place?
4. If you used blocks on a mat, hold the park up so the child can look at it as if she were seeing it from above. Imagine drawing a picture of the park from an airplane or hot air balloon. Would it be easier to see the whole park? What might you miss? Could you see under the trees? Can you tell how many blocks are in the park?
5. Look at the block model on the table as if you're in the park again. Can you tell how many blocks are in the park now? If the blocks are plants, and you wanted to know how much plant material (carbon, for adults) is in the park, which perspective might be easier to use?
6. NASA maps from space, so we can see a big area all at once, but that makes it harder to see some of the details. It's hard to see how tall trees are or if there's grass or a sidewalk under the trees. We need information from the ground too.
7. Message to parents or adults, if present: You can help us see the details by mapping the land with GLOBE Observer.

Elementary Students

Preparation

- Print a photo of a park or some place familiar to the audience.
- Print the grid on a transparency film.

Steps

1. Provide a photo of a park or some place familiar to the audience. Place the transparency grid over the photo. Each square in the grid corresponds to a single square block.
2. Place a block in every grid that has plants. Leave bare ground or paved areas blank. Stack two or more blocks to represent trees or shrubs. Block colors don't matter in this variation of the activity.
3. Ask the child to imagine that she or he is drawing a picture of the park sitting in one section. Would they be able to see the whole park from one place?
4. If you used blocks on a mat, hold the park up so the child can look at it as if she were seeing it from above. Imagine drawing a picture of the park from an airplane or hot air balloon. Would it be easier to see the whole park? What might you miss? Could you see under the trees? Can you tell how many blocks are in the park?
5. Look at the block model on the table as if you're in the park again. Can you tell how many blocks are in the park now? If the blocks are plants, and you wanted to know how much plant material (carbon, for adults) is in the park, which perspective might be easier to use?
6. NASA maps from space, so we can see a big area all at once, but that makes it harder to see some of the details. It's hard to see how tall trees are or if there's grass or a sidewalk under the trees. We need information from the ground too.

7. Message to parents or adults, if present: You can help us see the details by mapping the land with GLOBE Observer.

Upper Elementary and Middle School Students

Preparation

- Print a photo of a park, museum grounds, etc.
- Print the grid on transparency film.
- Sort the blocks by color. Assign each color to a land cover type. It is helpful to print a key for reference.

Steps

1. Provide a photo of a park or some place familiar to the audience. Place the transparency grid over the photo. Each square in the grid corresponds to a single square block.
2. Using dark green blocks for trees, light green for grasses and flowering plants, gray for pavement or buildings, and tan for bare ground, make a map of the park. If there is more than one kind of land cover in a square, choose the land cover type that is dominant. (You may use whatever color combination you have on hand, however, children respond better when the colors match the land cover type.)
3. How many squares are trees? How many squares are the other land cover types? What kind of land cover is there most of in the block model?
4. If you had to assign one land cover type to the entire scene, what would it be? (The most dominant land cover wins. So, if you had more trees than any other kind of land cover, the scene would get a tree land cover classification.)
5. NASA maps from space, so we can see a big area all at once, but that makes it harder to see some of the details. If there's mixed land cover, NASA assigns the primary type to that area. What might we miss by mapping that way?
6. Message to parents, adults, or older teens if present: You can help us see the details by mapping the land with GLOBE Observer.

Teens and Adults

Preparation

- Print a satellite image of your location, a national park, or some other place familiar to or valued by your audience. The Earth Observatory is a good site to find satellite images. Mapping programs that use a satellite base layer are also a source of satellite data.
- Print the grid on transparency film
- Sort the blocks by color. Assign each color to a land cover type. It is helpful to print a key for reference.

Steps

1. Provide the satellite image. Place the transparency grid over the image. Each square in the grid corresponds to a single square block.
    a. NOTE: You may have to discuss how to recognize what might be on the ground. Colors generally correspond to land cover types in natural color satellite imagery, so forests are dark green, grasses are lighter green, cities are gray, etc.

2. Using dark green blocks for trees, light green for grasses and flowering plants, gray for pavement or buildings, and tan for bare ground, make a map of region. If there is more than one kind of land cover in a square, choose the land cover type that is dominant.
3. What are the advantages to mapping land cover this way? What are the disadvantages? What might we miss?
4. Discussion questions to understand the value of mapping land cover:
    - Based on your land cover map, where do you think it will be hottest on a warm day? Where will it be coolest?
    - Where are you most likely to find mosquitoes?
    - Where is the greatest fire risk?
    - How will water flow through the area? Where is the greatest flood risk?
    - How does elevation influence land cover?
5. NASA maps from space, so we can see a big area all at once, but that makes it harder to see some of the details. If there's mixed land cover, NASA assigns the primary type to that area. What might we miss by mapping that way?
6. You can help us see the details by mapping the land with GLOBE Observer. GLOBE Observer provides verification for satellite-based mapping.

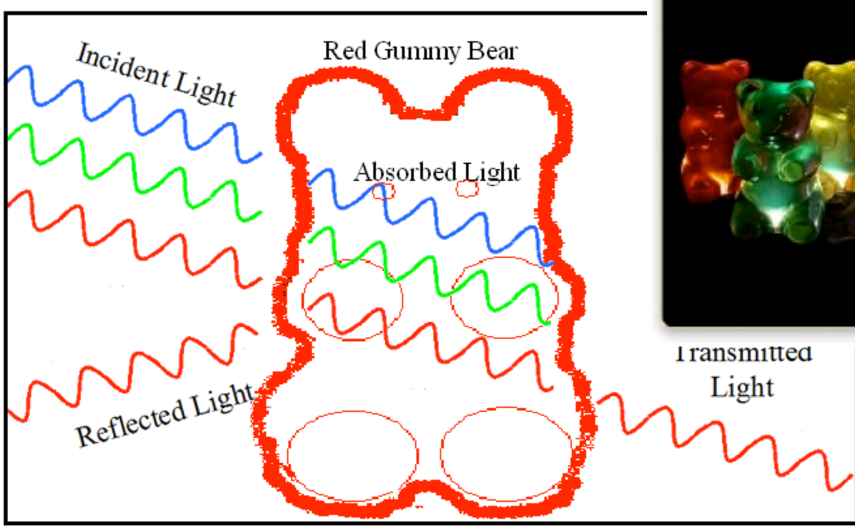
Note

In all variations of the activity, you may substitute dry erase markers for blocks. Simply color the land cover type on the transparency. Or, you may print the grid on standard paper, and ask participants to color the grid with crayons, colored pencils, or markers. The tactile blocks work extremely well, but coloring the grid can work too. One library suggested using carpet squares to build a large land cover map with a group. Feel free to adapt the concept to your local resources.

What Happens to the Light?

Gummy Bear Activity

<u>Learning goals</u>: *Students use colored LEDs and gummy bears to investigate light and matter interactions.*



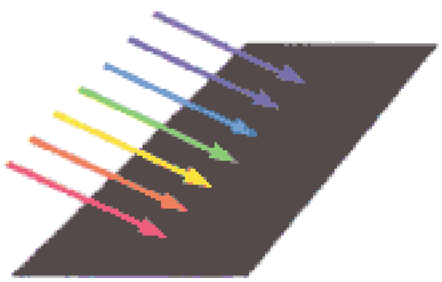
Background Information

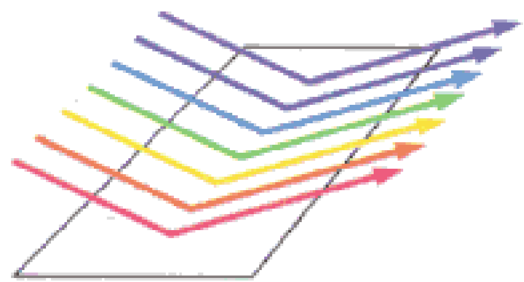
Light interacts with matter in different ways. The properties of the material and the properties of the light source both affect what happens to the light when it interacts with matter. One important property of light is its color.

The sun gives off different types of light. One type, visible light (white light), is composed of lights of the colors of the rainbow: red, orange, yellow, green, blue, indigo and violet. The color of an object is determined by the colors of light it absorbs and the colors of light it reflects. When white light falls on a red object, the object appears red because its surface subtracts (absorbs) all colors of light except red.

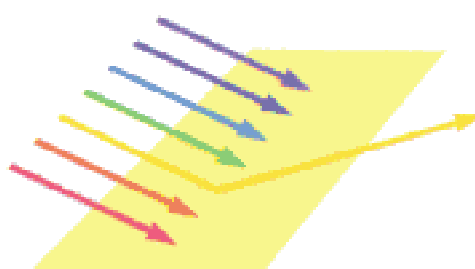
Students, even in high school, commonly have misconceptions about how we see color. One misconception is that a white light source, such as an incandescent or fluorescent bulb, produces light made up of only one color. Passing white light through a prism can help students see that white light is made up of many different colors of light.

Another misconception that students may have is color is a property of an object, and is independent of both the illuminating light and the receiver (eye). However, we perceive the reflected light from an object as color. Objects appear black if the object absorbs all colors of light and white when all the colors of light are reflected as shown in these figures.

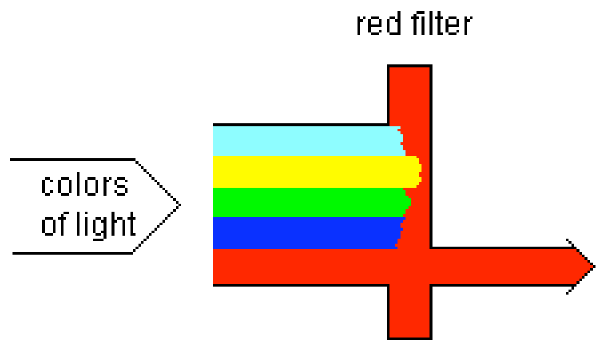




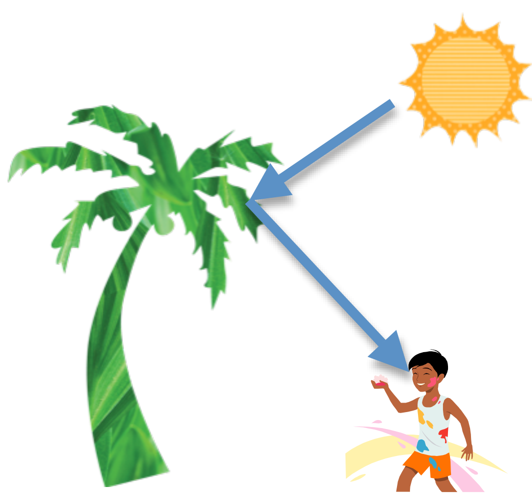
When only green light is reflected, an object appears green. Students might find diagrams like these helpful to visualize how we see color. The yellow strip in the figure absorbs red, orange, green, blue, indigo and violet light. It reflects yellow light and we see it as yellow.



When a colored filter or gel is placed over a camera lens or light, the same type of color subtraction takes place. For example, a pure red filter placed over a camera lens will absorb all colors of light except red. Many people erroneously assume that the red filter simply "turns all of the light red," which, as you can see in the diagram, is not the case.



Another reason students may have misconceptions about how we see color is because they have misconceptions about the role light plays in vision. They may believe that light makes an object brighter and we see the object directly. Again, this is not the case – we see when reflected light enters the eye. Again, a drawing like the one below may help students visualize the process.



What's Going on in the Gummy Bear Activity?

Results: When the students shine the green and red LEDs on the gummy bears, here are the expected results:

	Clear Gummy Bear	Red Gummy Bear	Green Gummy Bear
Red Light	Actual: Red light passes through	Actual: Red light passes through	Actual: Red light does not pass through
Green Light	Actual: Green light passes through	Actual: Green light does not pass through	Actual: Green light passes through

Explanation for what's happening to the light: The gummy bears are made out of gelatin, a colloid that scatters the light and makes the gummy bears appear to glow. Light passes through the gummy bears dependent on its properties. The clear gummy bear appears colorless because all colors of light can pass through it while only green light can pass through the green gummy bears and red light through the red gummy bears. In other words, they transmit and reflect the color of light that they don't absorb.

For the finger activity, have students hold the LED in the middle section of the index finger. The green light will not be visible through the other side of the finger but the red light will make the finger appear to glow red! Since blood appears red, it reflects red light.

What Happens to the Light?
Gummy Bear Activity

Learning goals: *Students use colored LEDs and gummy bears to investigate light and matter interactions.*

A major medical focus, in the field of biophotonics is using light to help identify the condition of various cells and tissues –locating cancer tumors, heart disease and nervous system abnormalities are just a few of the current research areas. Light is also being used for LASIK eye surgery and acne treatment.

Understanding how different wavelengths of light interact with different cell and tissue types is critical to the development of new diagnostic tools and treatments. In this activity, you will explore the interaction of different wavelengths of light with simulated tissue (Gummy Bears).

Predict!

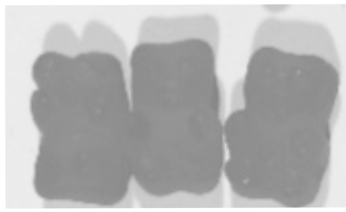
Before doing your investigation, make some predictions about what will happen to the light in the data chart. For example, will the light go through the gummy bear (transmitted)? Will it change color?

1. What do you think will happen when the *red* light is shined on
   A red Gummy Bear?
   A green Gummy Bear?
   A clear Gummy Bear?

2. What do you think will happen when the *green* light is shined on
   A red Gummy Bears?
   A green Gummy Bear?
   A clear Gummy Bear?

Investigate!

1. Line up your Gummy Bears the same way as shown below:



2. Shine the lights through the different colored Gummy Bears and draw/write your observations in the data chart (Things to consider: How many Gummy Bears does the light go through? Does the light form a point or light up the whole Gummy Bear? What color(s) are the gummy bears when lit?)

Discuss!

Compare you findings with your teammates. Did you all observe the same things? Which observations did you find most surprising?

Explain!

In a few sentences explain <u>why</u> you think the light behaved as it did.

Apply!

Now shine both lights on your index finger.

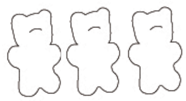
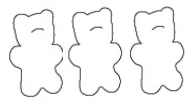
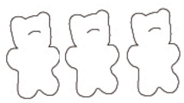
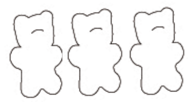
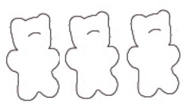
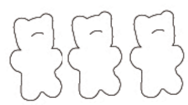
What happens with the red light?

What happens with the green light?

Which Gummy Bear behaves more like your finger?

Why do you think the light interacts with your finger the way it does?

Data Chart

	Clear Gummy Bear	Red Gummy Bear	Green Gummy Bear
Red Light	Prediction: 	Prediction: 	Prediction: 
	Actual: 	Actual: 	Actual: 
Green Light	Prediction: 	Prediction: 	Prediction: 
	Actual: 	Actual: 	Actual: