FOREST WATCH

STUDY GUIDE

a) Maps/Photos/Images
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Contents

USING MAPS, PHOTOS AND IMAGES

D

ACTIVITY

What are some of the uses of aerial photographs, satellite images and topographic maps?

How can you determine the scale of a topographic map, aerial photograph and satellite image?

What information can you obtain from maps, photographs and images, if their scale is known?

Background

The two types of portrayals of the earth's surface you will be using in this activity are aerial photographs and satellite images. While both are representations of the ground surface, each is acquired in a different way. An aerial photograph is acquired by a camera mounted in an aircraft that flies over the ground. A satellite image is acquired by a special sensor on a Landsat satellite that orbits the earth in space. Each portrayal is processed and produced in very different ways. Aerial photographs are produced through familiar photographic processing, while satellite images are produced from digital data that has been transmitted to a receiving station on earth. The digital information is processed by a computer to produce a photo-like image. Both result in useful and interesting representations of the earth's surface below.

A map is a representation or portrayal of a place on Earth. The type of map that you will use in this activity is a topographic map. Topographic maps are made with the information gathered from aerial photographs and ground surveys of a region. Topographic maps include many surface features such as rivers and roads and land elevation.

Topographic maps may be used in a number of ways. For example, they can be used to determine a particular location, locate specific features, find the distance between two places or to calculate the area covered by a surface feature such as a lake or forest. Aerial photographs and satellite images may also be used for these purposes. You may discover some limitations, however, with each type of portrayal as you proceed with these activities.

Materials:

- aerial photograph of your town
- Landsat Thematic Mapper (TM) satellite image of your town
- topographic map for your study area
- cm transparent grids
- tape
- rulers with metric and English units
- field tape measure
- calculators
- paperclips
- toothpicks

Part I - Where Am I?

Begin this activity by answering the question: **Where am I?**. Write a description of your location below.

Exchange your description with a partner. With your partner's information, answer the following questions:

1. If you had no idea where your partner's location really is, could you use your partner's information to locate her/him on the surface of the earth?
2. Are there easily identified landmarks nearby?
3. What is useful in your partner's description in helping to locate her/him?
4. How could your partner's description be improved to help you locate her/him?

Part II - What Are Some Uses of Aerial Photographs?

Study the aerial photo(s) available to you. With your teacher and class, discuss some of the features on the photo. Develop a list of questions that you could answer using this aerial photo and write them in the space below. Discuss some of these questions with your class.

Now list several questions that you could not answer using the aerial photo. As a class, discuss some of the limitations of aerial photos.

Part III - What Are Some Uses of Satellite Images?

Study the satellite image available to you. Again, with your teacher and class, discuss some of the features on the image. Develop a list of questions that you could answer using the satellite image. Discuss some of these questions with your class.

Now list several questions that you could not answer using the satellite image. As a class, discuss some of the limitations of satellite images. What can't you see?

Part IV - What Is Scale?

Section A - How Do You Determine the Scale of an Aerial Photo?

In this activity you will learn how to determine the scale of an aerial photo if it has not been noted on the photo.

1. Measure the length (in centimeters) of an outside wall of your school building (or the length of the parking lot) on the aerial photo. Record this measurement in the space below.

	Trial 1	Trial 2	Average
Photo distance of the feature:	_______	_______	_______**cm**

2. Go outside and measure (to the nearest 0.1 meter) the same school building wall that you measured on the aerial photo (or parking lot). Record this measurement in the space below.

	Trial 1	Trial 2	Average
Ground distance of the actual feature:	_______	_______	_______**m**

Average Ground distance of the actual feature: _______m ______cm

You can write these two measurements as a ratio: **photo distance / ground distance**

Ratio : _______________ (don't forget your units!)

3. Measure the length (in centimeters) of a 2nd feature on the aerial photo. This feature can be anywhere on the photo. (You will not be going outside to measure its actual length. Instead you will calculate its actual length.) Try to identify the feature and record its length below.

	Trial 1	Trial 2	Average
Photo distance of 2nd feature:	_______	_______	_______**cm**

What do you think the feature is that you measured? _______________

4. Using the known ratio from question #2 above, calculate the actual length (**ground distance**) in meters of the 2nd feature you measured in the aerial photo. Show your work below and write your answer in the space provided.

Example: $\dfrac{\text{known photo distance}}{\text{known ground distance}} = \dfrac{\text{photo distance 2nd feature}}{\text{ground distance 2nd feature (x)}}$

Ground distance of your second feature: _______ cm _______ m

5. Find another group in the class that measured the same feature. How do your results compare? If your results differ significantly, try to figure out why. Did both groups identify the feature as the same thing? Write your answers and comments below.

6. Practice this again by locating another feature on the photo. Calculate its actual ground distance. Show your work below.

Identify the feature: ____________________

Ground distance of your third feature: _______ cm _______ m

Section B - How Do You Determine the Scale of an Aerial Photo?

Find a feature on the aerial photo that is 1 unit in length. You may use any device to measure that feature as long as its distance on the photo is 1 of that device. For example, this feature could be measured in units of inches, centimeters, paperclip lengths, toothpick lengths, etc., but it must equal 1 of that particular unit. Just like you did in section A, questions 5 and 6, calculate the actual ground distance of this 1 unit feature.

Important note: The known ratio that you use must have the same units in both the numerator and the denominator. Make the necessary changes before you calculate the ground distance of your 1 unit feature. For example, for a known ratio that is .5 cm photo distance / 7.5 m ground distance:

$$\frac{.5\text{ cm}}{7.5\text{ m}} \quad \textbf{(make numerator and denominator the same units)}$$

$$\frac{.5\text{ cm}}{7500\text{ cm}} \quad \textbf{OR} \quad \frac{.005\text{ m}}{7.5\text{ m}}$$

1. Now show your calculation below:

Ground distance of your 1 unit object: _________
(record the units used!)

2. Compare your results with other groups in the class by writing your answer and the units you used on the board. How do your answers compare?

SURPRISE! What you have just determined is something called the photo **scale**. For example, your class may have an aerial photo that has a scale of 1 : 3000. This means that every 1 cm on the aerial photo is equal to 3000 cm (30m) on the ground. OR:

1 inch on the aerial photo = 3000 inches on the ground (250 ft.)

1 paperclip length on the aerial photo = 3000 paperclip lengths on the ground

1 grid square length on the aerial photo = 3000 grid square lengths on the ground

3. As a class, develop your own working definition of **scale**. You might begin this by developing a list of things or ideas that characterize scale. Write your definition of scale below.

4. Can you think of some examples where scale is used? Write these examples below and on the board.

5. Can you think of some non-examples of scale? Write these non-examples below and on the board.

Part V - How Do You Determine the Scale of a Satellite Image?

Using the same process that you used with the aerial photograph, you may determine the scale of the satellite image of your town. Begin by locating the same feature on the aerial photo and the satellite image. You must be able to measure the length of that feature on both the photo and the image. Features that work well for this purpose are roads, powerline right-of-ways, lakes, etc. Work through the following example and then try your own.

Example: Suppose you locate a lake on both the photo and the image. Because you have already determined the scale of your aerial photo (let's say 1 : 3000), you will work first with the photo. Let's say that the lake's length on the photo is 15.7 cm.

photo distance of the feature: 15.7 cm

Using the photo scale, calculate the actual ground distance of this feature and record below. (Continue working with a photo scale of 1 : 3000.) Show your work below.

Actual ground distance of the feature: _______ cm

Now that you know the actual length of the lake (feature), use that information to determine the scale of your satellite image.

Measure and record the length of the lake (feature) on the satellite image. For this example, let's say that its length is 1.3 cm on the image. Again, use the ratio, image distance / actual ground distance.

$$\frac{1.3\text{ cm}}{\text{actual ground distance (calculated above)}} = \frac{1\text{ of any unit}}{x\text{ of that same unit}}$$

x = ___________

Satellite Image scale = 1 : _____________

1. Now work with the aerial photo and satellite image for your town. Locate a feature that is visible and easy to measure on both the photo and the image. Calculate the actual ground distance of that feature and then calculate the scale of your satellite image. Show your process below.

Satellite Image scale = 1 : ______________

2. Compare your results with another group. If your answers differ, is there a large difference? Help each other locate the problem area(s).

3. What could account for relatively small differences in your answers?

Part VI - How Do You Determine the Area of Coverage of an Aerial Photo and a Satellite Image?

Now that you know the scale of your aerial photo you may calculate the total area of coverage of your photo. Review how you would find the area of a square or rectangle. Measure the length and width of the aerial photo (in cm).

Length of the aerial photo: _______ cm (photo distance)

Width of the aerial photo: _______ cm (photo distance)

Example: The length of the aerial photo is 27.9 cm (which is the photo distance). If your photo scale is 1 : 8000, calculate the ground distance.

Remember that every 1 unit on the photo equals 8000 units on the ground. Set up your ratios.

$$\frac{\textbf{1 cm}}{\textbf{8000 cm}} = \frac{\textbf{27.9 cm}\text{ (photo distance)}}{\textbf{x cm}\text{ (ground distance)}}$$

x = ________

Ground distance of the length of the aerial photo: _________cm

_________m

_________km

(round to nearest tenth)

Repeat this same calculation for the width of the photo. Let's say that you measured a width of 20.3 cm. Set up the same ratios.

$$\frac{\textbf{1 cm}}{\textbf{8000 cm}} = \frac{\textbf{20.3 cm}\text{ (photo distance)}}{\textbf{x cm}\text{ (ground distance)}}$$

x = __________

Ground distance of the width of the aerial photo: _________cm

_________m

_________km

(round to nearest tenth)

D

Now you may calculate the ground area covered by the photo below by multiplying ground distance width by ground distance length. Show your calculations below. Report in km^2.

Ground area covered: ___________km^2

1. Compare your results with another group. If your answers differ, is there a large difference? Help each other locate the problem area(s).

2. What could account for relatively small differences in your answers?

In **Part V** you calculated the scale of your satellite image. Using this scale, you may also determine the area of coverage on the satellite image. Repeat the steps that you used above for the aerial photo.

1. Measure the length and the width of the satellite image and record below. Using the image scale, calculate the area of ground shown in this satellite image. Show your work below.

   Image scale: ___________

   Length of image: ______ cm

   Width of image: ______ cm

   Area of ground shown in the satellite image: __________km^2

   How many square miles does your satellite image cover? (There are .625 mi. in 1 km) **Show your work below.**

   ____________ mi^2

Part VII - How Can You Calculate the Area Covered by Your Forest Stand on an Aerial Photograph?

In this activity you will apply your understanding of scale to calculate the area covered by your forest stand (or park) in which your study plot will be located. In most cases, this will be an irregularly shaped feature. It therefore requires a different method than you have used before when calculating the area of coverage of your aerial photo or satellite image. You must know the scale of your aerial photo in order to do this activity.

1. Examine the aerial photo carefully. Look for the boundaries of the forested stand. If your stand boundaries appear to go beyond the edges of the aerial photo, consider the photo's edges to be the boundaries.
2. Brainstorm some ways that you might be able to calculate the area of this forest stand with your class. You don't need to go into the field to do this, simply use the scale of the aerial photo.

Finding the Area of an Irregularly Shaped Feature Using a Grid Transparency:

One way to find the area of coverage of an irregularly shaped feature such as a forest stand is to use a grid transparency that you overlay on the aerial photo. If you know the actual area of ground coverage of each grid square, all you need to do is count the number of grid squares covering your forest stand. Let's try it.

1. The length of one side of each small square in the grid is .5 cm. If the scale of an aerial photo is 1: 8000 for example, that means that 1 cm on the photo represents 8000 cm on the ground.

   a. Using the photo scale, calculate the ground distance that is represented by .5 cm.

   .5 cm photo distance = ____________cm ground distance

   ____________m ground distance

   b. Calculate the actual area of ground coverage of one small square.

   area of ground coverage = ___________m^2

D

2. Place the .5 cm square grid transparency over the aerial photo and determine the area of your forest stand. You may find small pieces of tape helpful to hold the transparency in place.
   a. Explain how you determined the area. Be sure to include your units.

area of ground coverage of your forest stand = ___________m^2

   b. What decisions did you have to make when you found the area? How did you decide whether to include the area in a grid square if it was partially over the forest and partially over some other feature?

3. When you use the grid method, you often have to decide what to do about squares that include part of another feature that you're not interested in measuring. For example, a grid square may cover both forest and water, or forest and road. One method is to find the area twice, counting squares each time. For the maximum area, include every square that contains any portion of the forest. For the minimum area, include only squares that contain only forest and no other feature. Determine the maximum area and minimum area of your forest stand.

maximum area of forest stand = ____________m^2

minimum area of forest stand = ____________m^2

   a. Average the maximum area and minimum area to find an area that, in most cases, is more accurate than either one alone.

average area of forest stand = ____________m^2

   b. How does this second method of averaging the maximum and minimum area compare to the method used in question #2?

4. Compare your results with other groups. Discuss some of the problems you may have had. Discuss factors that may have influenced your accuracy.

5. How might your accuracy change if your forest stand is located on very hilly terrain?

Part VIII - What information can you obtain from topographic maps and what are some of their uses?

Study the topographic (topo) map available to you. Your teacher will guide you through some discussion questions that focus on several map features.

1. Develop a list of questions that you could answer using your map. List these on the board.

2. List several questions that you could not answer using the map. List some of these on the board.

3. As a class, discuss some of the limitations of topographic maps. What can't you see on the map?

How Do You Determine Ground Distances and Area on a Topo Map?

1. What is the scale of your topo map?

   In the previous activities, you have learned to calculate actual ground distances of features on the aerial photos or satellite images using the scale of the photo or image. You then learned to calculate the area of coverage of your photo or image. Topo maps can make this process even simpler by providing a series of **scale bars**. The scale bars give you actual ground distance more directly. Notice the scale bars drawn below the scale designation on the bottom margin of your map.

2. What are the different units used by the various scale bars?

3. Look at the mile scale bar. Find the 0 mark on the bar. How is the bar divided to the left of the 0 mark?

4. Locate a straight stretch of road on your map. Lay a plain piece of paper next to the road and place tick marks on the paper's edge that mark the beginning and end of the stretch of road you wish to measure.

   Now use the mile scale bar to determine the actual ground distance between the tick marks on the paper. This represents the actual ground distance of the road. Record it below.

   actual ground distance of road: ___________mi

5. Look at the scale bar marked in feet. Find the 0 mark on the bar. How is the bar divided to the left of the 0 mark?

6. Use the scale bar marked in feet to determine the actual ground distance between the tick marks on the paper. This represents the actual ground distance of the road. Record this distance below.

   actual ground distance of road: ___________ft

7. Look at the scale bar marked in kilometers. Find the 0 mark on the bar. How is the bar divided to the left of the 0 mark?

8. Use the kilometer scale bar to determine the actual ground distance between the tick marks on the paper. This represents the actual ground distance of the road. Record this distance below.

   actual ground distance of road: ___________km

9. Clearly, the length of the road (also called the actual ground distance of the road) does not change. However, what <u>did</u> change?

10. What ground distance (in miles) does the length of your topo map cover? In feet? In kilometers? Record these measurements below.

   actual ground distance of map length: ___________mi

   ___________ft

   ___________km

11. What ground distance (in miles) does the width of your topo map cover? In feet? In kilometers? Record these measurements below.

actual ground distance of map width: ___________mi

___________ft

___________km

12. What is the actual area of coverage of your topo map?

actual area of coverage: ___________mi^2

___________ft^2

___________km^2

13. **For a challenge**, find the actual area of coverage using the process that you used with aerial photos and satellite images. Remember that with a map scale of 1 : 24,000 (for example), the ratio of map distance to ground distance is:

1 cm on the map = 24,000 cm on the ground

OR written as a ratio: $\frac{\textbf{1 cm}}{\textbf{24,000 cm}}$

OR written as a ratio: $\frac{\textbf{1 in}}{\textbf{24,000 in}}$

OR written as a ratio: $\frac{\textbf{1 ft.}}{\textbf{24,000 ft}}$

Show your work in the space provided. (Hint: You will need to first measure length and width of your map in inches and in centimeters, then convert these to feet, kilometers and miles before proceeding with the rest of the calculation.)

actual area of coverage: ____________mi^2

____________ft^2

____________km^2

14. How do your results in question #13 compare with your results in question #12? If your answers are different, what could have caused these differences?

15. Examine all three portrayals of your town; the map, the aerial photo, and the satellite image. Can you locate your school on all three portrayals? On which portrayal is it most difficult to locate? Why?

16. Describe several features that you can see on all 3 portrayals.

17. Can you locate your forest stand or park on all 3 portrayals?

Locate the area where you find your forest stand on the topographical map. Can you see the stand on this map? Overlay a clean transparency on your topo map and secure it with small pieces of tape. Use the aerial photo and the satellite image as references to "map" or draw the boundaries of your forest stand on the transparency with a colored marker. You will also need to trace over (on the transparency) some reference points that are actually on your topo map such as a road, river, lettering, etc. This will allow you to remove the transparency from the map and then replace it in nearly the exact same location for future observations. <u>Do not write or mark on the map with your markers!</u>

18. Were there any problems that you encountered in mapping your forest stand boundaries?

19. What did you do to solve the problems?

Part IX - How Do You Determine the Latitude and Longitude of Your Sampling Plot Using a Topographic Map?

Section A - What is meant by latitude and longitude?

Opening Activity:

Begin this activity by trying to describe the location of a black dot on a ping pong ball to a partner or to other members of your team. After attempting this, use your pencil and make any other kind of mark on the ping pong ball. Have your partner or another team member try to describe the location of the original black dot on the ball. Is it any easier this time?

Now make another mark on the ping pong ball with your pencil. Have your partner or another team member try to describe the location of the original black dot on the ball. Now is it easier?

When you're working with a spherical object, what can help you to describe the location of an object on that sphere?

Background:

Circles and spherical objects have 360˚ around their circumference. The earth, like the ball, can be divided into an imaginary 360 degree sphere. Mapmakers have given the earth a grid system similar to lines on graph paper. If a person stepped out from her front door, traveled in a 'circle' around the earth back to her door, she would travel a distance of 360˚.

The lines circling the earth running parallel to the equator are called lines of latitude. Latitude refers to distance in degrees (˚) either north or south of the equator. The equator is at 0˚ latitude while the geographic north and south poles are 90˚. No other lines of latitude are the same length as the equator. Lines of latitude that are equidistant from the equator are equal in length. One of those lines will be located in the northern hemisphere and the other in the southern hemisphere. Locations 0˚ to 90˚ north of the equator are referred to as ˚ north. Locations 0˚ to 90 ˚ south of the equator are referred to as ˚ south.

Lines that circle the earth and run from pole to pole are called meridians or lines of longitude. The 0˚ reference point for longitude passes through the Greenwich Observatory near London. This imaginary line is called the prime meridian. If you travel east or west 180˚ you will reach a second imaginary line called the international date line. Longitude refers to distance in degrees east or west of the prime meridian. Locations 0˚ to 180˚ west of the prime meridian are referred to as ˚ west. Locations 0˚ to 180˚ east of the prime meridian are referred to as ˚ east.

Just as (x,y) coordinates on a graph allow you to describe your location on the graph, latitude and longitude coordinates allow you to describe your location on the earth. Lines of latitude may be represented on the y-axis while longitude may be represented on the x-axis. Together, latitude and longitude give us a useful coordinate system that can be used to identify a location on the surface of the earth. For example, if you wanted to identify your location on the earth, you would refer to both the latitude and longitude coordinates in the following way: 42˚N, 70˚W.

To help you increase the accuracy of your location even further, scientists have divided each of the 360˚ degrees into units called minutes (not to be confused with minutes on a clock!). One degree is divided into 60 minutes and is labeled with (‘).

1 degree = 60 minutes
1˚ = 60'

1. How many minutes is the entire earth divided into? (Show your work below.)

Each minute is then divided into units called seconds (not to be confused with seconds on a clock!). Seconds are labeled with (“).

1 minute = 60 seconds
1' = 60"

2. How many seconds is the entire earth divided into? (Show your work below.)

Using this information allows for an even more accurate description of location than just degrees. For example, the location of a particular point might be 42˚ 12' 15"N, 70˚ 43' 09"W (Read 42 degrees, 12 minutes, 15 seconds north, 70 degrees, 43 minutes, 9 seconds west). Notice that you give your north or south coordinates first followed by the east or west coordinates.

Part IX - How Do You Determine the Latitude and Longitude of Your Sampling Plot Using a Topographic Map?

Section B - What are all those numbers on a topographic map?

Begin this activity by studying your 7.5 minute series topo map. You have already worked with the map scale bars at the bottom and your map tells you the scale used to represent ground distances. Look at the different roads on the green area of the map. Use the map key to identify the different kinds of roads. Now look at all those numbers along the vertical and horizontal margins of the map. Don't worry, we'll only be using a few of these for this activity. Read through the following background information to learn about the numbers that give you your latitude and longitude coordinates.

Background:

Always begin reading a map by looking at the coordinates (latitude and longitude) located at the four corners of the map in the margins. Note the degrees and minutes given for each coordinate, latitude and longitude. Assume that if seconds are not indicated at these corner marks that there are 0 seconds. For example, if your line of latitude at the top of your map reads 42˚ 30', this means that there are 0 seconds.

The next thing that you will want to observe on the map are the blue tick marks along the outside edge of your map margins and the black tick marks along the inside edge of your map margins. These different tick marks indicate different coordinate systems given on the topo maps. The blue tick marks are used in the Universal Transverse Mercator (UTM) system and they represent meters from the equator. There are 1000 meters between each blue tick mark. We will <u>not</u> be using these blue tick marks or this system for this activity.

The black tick marks along the inside edge of your map margin are used in the latitude and longitude coordinate system. These marks along the inside edge of your <u>vertical</u> (north-south) map margins represent the number of degrees, minutes and seconds from the equator. These indicate latitude. The black tick marks along the inside edge of your <u>horizontal</u> (east-west) map margins represent the number of degrees, minutes and seconds from the prime meridian. These indicate longitude. We will be using the latitude and longitude coordinate system for this activity.

1. How many black tick marks are there along the inside edge of your vertical map margins?

2. How many minutes and seconds are there between these tick marks along the vertical map margins?

3. What do these tick marks represent?

4. How many black tick marks are there along the inside edge of your horizontal map margins?

5. What do these tick marks represent?

6. How many minutes and seconds are there between these tick marks along the horizontal map margins?

7. Write down the degrees, minutes, and seconds represented by each black tick mark on your map.

Begin with a vertical margin at the bottom of the map

bottom corner = _______

1st tick mark = _______

2nd tick mark = _______

top corner = _______

For a horizontal margin of your map

right corner = _______

1st tick mark = _______

2nd tick mark = _______

left corner = _______

Part IX - How Do You Determine the Latitude and Longitude of Your Sampling Plot Using a Topographic Map?

Section C - Where is your sampling plot on your topographic map?

This activity requires you to make a reasonable estimation of the location of your sampling plot on the topographic map and to mark that location with an X on your map. (Your sampling plot also called the PSSP is the study site that you will use for the duration of your work with Forest Watch.) This may require some “ground truthing” or a hike in your forest stand.

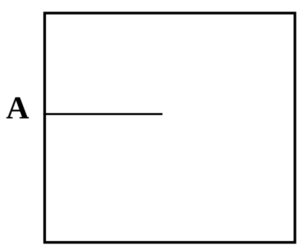
1. On your topo map, look for some visible landmark that is also near your forest stand. Such landmarks may include a road intersection or corner or a bend in a river or stream.
2. Once you and your teacher have surveyed the forest stand and decided on the best location for your PSSP, locate that area as best you can on your topo map. Use the landmarks described above to help you. Place an X on the map where you think your site is located.

Part IX - How Do You Determine the Latitude and Longitude of Your Sampling Plot Using a Topographic Map?

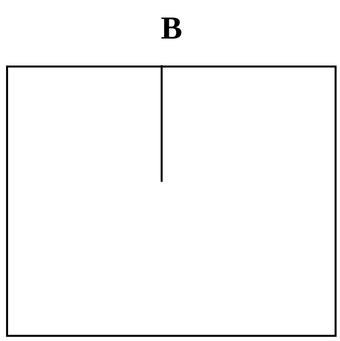
Section D - What are the coordinates of your sampling plot (PSSP)?

Procedure:

- Locate the PSSP study site on the topographic map.
- Using a marker place an **X** at the PSSP site.
- Line up the file folder along the edge of the map. Using the edge of the folder as a guide, draw a line from the **X** to the edge of the map that is parallel to the top or bottom of the map. (see diagram) Label this **line 1**. Where **line 1** intersects the edge of the map label this **pt. A**



- Line up the folder along the top edge of the map. Using the file folder as a guide, draw a line from the **X** to the top or bottom of the map that is parallel to the side edge of the map. Label this **line 2**. Where **line 2** intersects the top or bottom of the map label this **pt.B**.



- Identify the latitude and longitude of your site. You will estimate these if **pt. A** and **pt. B** do not fall exactly on a latitude or longitude tick mark on your topo map.

latitude ______________________

longitude ____________________

Questions:

1. Would these coordinates get you to the center of your plot? What are the limitations?

2. How can we be more accurate? Brainstorm some ideas. Try them out.

3. Compare your predictions with your GPS readings. (If they are available to you)

4. Now that you have completed the series of activities on maps, photos and images, go back and answer the questions that were listed at the beginning of the activity. They were as follows:

   • What are some of the uses of aerial photographs, satellite images and topographic maps?

   • How can you determine the scale of a topographic map, aerial photograph and satellite image?

   • What information can you obtain from maps, photographs and images if their scale is known?

Part IX - How Do You Determine the Latitude and Longitude of Your Sampling Plot Using a Topographic Map?

EXTENSION ACTIVITY: Increasing the accuracy of the estimated latitude and longitude coordinates.

1. Measure the map distance in cm along a vertical map edge between two latitude marks.
   Distance between latitude markings _______________

   The distance between lines of latitude on a 7.5 minute series topo map is 19.2 cm. The distance between lines of longitude varies depending on your location because distance between lines of longitude become less at the poles than at the equator. You will always need to measure this distance on your map.
2. Work with latitude first. Using a ratio, calculate the map distance per second. Before you begin, recall that there are 2'30" between latitude marks on your map. You must convert 2'30" to seconds only.

   $$\textbf{2 min} \times \frac{\textbf{60 sec}}{\textbf{1 min}} = \textbf{120 sec}$$

   Now add the remaining 30 seconds to the 120 seconds.

   120" + 30" = 150"

   Now proceed with the ratio:

   $$\frac{\textbf{19.2cm}}{\textbf{150 sec}} = \frac{\textbf{x}}{\textbf{1 second}} \qquad \textbf{x = 0.128 cm / sec}$$
3. Measure the distance in cm from **pt. A** to the nearest latitude tick mark .

   Distance ________________
4. Again, use a ratio to convert this cm distance to seconds.

   distance / x seconds = 0.128 cm / 1 second

   Example:
   If your measured distance is 8.9 cm from **pt. A** to the nearest latitude tick mark, then

   $$\frac{\textbf{8.9 cm}}{\textbf{x seconds}} = \frac{\textbf{0.128 cm}}{\textbf{1 second}} \qquad \textbf{x = 69.5 seconds}$$
5. Convert 69.5 seconds back into minutes and seconds.

   69.5 seconds - 60 seconds* = 9.5 seconds (round to 10 seconds)

   * 60 seconds = 1 minute

Therefore, the difference in latitude from your site to the nearest latitude tick mark is 1' 10".

6. Use this information to find <u>your</u> latitude coordinate. If your site is located <u>below</u> the nearest latitude line do the following:

   Let's say that the nearest latitude line is 42° 50'. You will subtract the 1' 10" from this latitude line. To do this, change the 42° 50' to 42° 49' 60" and then subtract.

   42° 49' 60"
   - 1' 10"
   ___
   42° 48' 50"

   If your site is located <u>above</u> the nearest latitude line do the following:

   Let's say that the nearest latitude line is 42° 47' 30". You will add the 1' 10" to this latitude line.

   42° 47' 30"
   + 1' 10"
   ___
   42° 48' 40"

7. Find your longitude using reference **pt. B**. Measure the distance from **pt. B** to the nearest longitude mark. Calculate your longitude using the same procedure as shown above. However, if your site is located to the right of the longitude line, you will subtract in your final step. If your site is located to the left of the longitude line, you will add in your final step.

   Now state your coordinates*.

   ____

   *By convention:

   - State the latitude coordinate first
   - Identify north or south latitude
   - State the longitude coordinate next
   - Identify east or west longitude

   Example: 42° 47' 55" N, 71° 37' 16" W

8. Compare your coordinates determined from your topo map with your GPS readings if they are available to you. Is there a difference between your topo map coordinates and the GPS reading? List several factors that may have contributed to these differences.

USING MAPS, PHOTOS, AND IMAGES

TEACHER RESOURCES

Introduction

In these activities, students will become familiar with topographic maps, aerial photos and satellite images. Using these tools, they will determine the extent of their forest stand and examine change over time in the surrounding landscape. They will also discover how to determine their location on the surface of the earth. While completing these activities, students will learn how the scale of a map, photo or image is used to determine ground distance and the area of coverage of various surface features.

Guiding Questions

What are some of the uses of aerial photographs, satellite images and topographic maps?

How can you determine the scale of a topographic map, aerial photograph and satellite image?

What information can you obtain from maps, photographs and images if their scale is known?

Materials

- copies of student activities
- aerial photograph(s) of your town
- Landsat Thematic Mapper (TM) satellite image of your town
- topographic map(s) for your study area (7.5 minute series - laminated)
- .5 cm transparent grid (last page of teacher section)
- tape
- rulers with metric and English units
- field tape measure
- calculators
- paper clips
- toothpicks
- transparencies (8 1/2 X 11)
- non-permanent markers
- ping pong balls marked with a small black dot (1 per group)

Management Suggestions

Method and Procedure:

This series of activities has been divided into nine different parts. Part IV and Part IX are further divided into sub-sections. Suggested time for completion of each part or section is given based on a 50 minute class period. These will vary depending on grade level. An attempt has been made in formatting the student activity handouts to allow for reasonable starting and stopping points. In the teacher resource section, each part of the student activity has been broken down and annotated to provide teaching tips and answers to the questions.

Parts I, II, and III - These three sections may be completed in a single class period. They begin by focusing the students' attention on where they are on the surface of the earth. From there they move to an overhead (bird's eye) view of their location on an aerial photograph and then to a view of a satellite image taken from a Landsat satellite which is orbiting the earth. Students may work in pairs for these activities.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part I - Where Am I?

Begin this activity by answering the question, **Where am I?**. Write a description of your location.

Exchange your description with a partner. With your partner's information, answer the following questions:

1. If you had no idea where your partner's location really is, could you use your partner's information to locate her/him on the surface of the earth?
2. Are there easily identified landmarks nearby?
3. What is useful in your partner's description in helping to locate her/him?
4. How could your partner's description be improved to help you locate her/him?

Part II - What Are Some Uses of Aerial Photographs?

After students complete part I, direct their attention to the aerial photo(s). Aerial photographs of your area may be obtained from agencies such as a County Cooperative Extension Office, U.S. Natural Resources Conservation Service, town offices, or regional planning offices. You should be able to obtain at least two aerial photos that were taken in different years (called a chronosequence). Those sequences that have a long period of time between photo dates will show the greatest amount of change. Allow students some time to study their photo(s) before you begin to focus the discussion. Use the following questions for initiating part II:

- What does this photo represent or portray?
- What are some of the different textures that you see on the photo? What do these different textures represent?
- What are some of the different shapes? What do these shapes represent?
- What do the different shades of gray represent?
- Can you see patterns? Where? What do these patterns tell you?
- What kinds of <u>natural features</u> can you see on the photo?
- What kinds of <u>cultural features</u> (man-made) can you see on the photo?
- What's going on in this photo? What kind of land use can you see?
- Because this is a photo of your town, you are somewhat familiar with the area portrayed. Can you see something that you've never seen from the ground?
- Can you find where you are right now on the photo?

ANNOTATED STUDENT ACTIVITY HANDOUT

Part II - What Are Some Uses of Aerial Photographs?

Study the aerial photo(s) available to you. With your teacher and class, discuss some of the features on the photo. Develop a list of questions that you could answer using this photo and write them in the space below. Discuss some of these questions with your class. Now list several questions that you could not answer using the aerial photo. As a class, discuss some of the limitations of aerial photos.

Questions you could answer using the aerial photo:

Answers will vary but suggestions include:

How far could you estimate you are from a particular object in the photo?

In what direction would you go to get from one ground feature to another?

What ground features are close to your location on the photo?

How is land being used? What bodies of water can be seen?

Where are the forested areas?

Other ideas?

Questions you could not answer using the aerial photo:

Answers will vary but suggestions include:

What is the soil type in a certain area of the photo?

What is growing in the fields?

What is the population of the neighborhood or town?

Does the forested vegetation appear healthy?

Other ideas?

If you have been able to obtain a chronosequence of aerial photographs have your students compare them to look for changes that have occurred over time. You may want to use the following questions:

What are some of the changes you can see when you compare the photos?

Can you observe any changes in the amount of forest cover?

Can you observe any changes in cultural features?

What factors may have contributed to or caused these changes?

How might these changes impact the forest community in your area?

Part III - What Are Some Uses of Satellite Images?

For Part III you will use the satellite image of your town or community provided in the Forest Watch materials. Because this is too small for the entire class to view at once, a color overhead transparency of this image may be useful. When it is projected you lose some detail, but it provides a reasonable comparison for this activity. Alternatively, you may have access to an LCD plate with your computer and simply project the image that you receive with the MultiSpec disk.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part III - What Are Some Uses of Satellite Images?

Study the satellite image available to you. Again, with your teacher and class, discuss some of the features on the image. Develop a list of questions that you could answer using the satellite image. Discuss some of these questions with your class. Now list several questions that you could not answer using the satellite image. As a class, discuss some of the limitations of satellite images. What can't you see?

Questions you could answer using the satellite image:

Answers will vary but suggestions include:

How can you tell what features are roads, bodies of water, forests or fields?

Is it winter , summer, spring or fall?

Other ideas?

Questions you could not answer using the satellite image:

Answers will vary but suggestions include:

What is each building in the bright area of the image?

What time of day was the image acquired?

Can the students identify certain features?

Other ideas?

Finish this activity by asking students to compare the satellite image with the aerial photo. Ask your students to describe how they are similar and how they differ.

Part IV - Scale of an Aerial Photograph

Section A - How Do You Determine the Ground Distance on an Aerial Photo?

In this activity students will learn to determine the scale of an aerial photograph. This may require at least two class periods to complete and students may work in small groups. On the first day of this activity (Section A - Determining the Ground Distance of a Feature in an Aerial Photo), students will be going outside to measure the length of a feature they can see on the photo. It is suggested that two different features are measured. For example, half of the students might measure the length of the school building (providing it can be easily seen and measured on the aerial photo) and the other half measure the length of the parking lot or a nearby athletic field that they've seen on the aerial photo. It is interesting for students to discover that in using either feature for their known photo distance to ground distance ratio, they will come up with the same photo scale.

If your aerial photo(s) show the scale somewhere, try to cover it. Students will learn to calculate the scale. You may want to ask the agency from which you obtained the photo to tell you the scale (so you can check your students work) if it has not been noted on the photo.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part IV - What Is Scale?

Section A - How Do You Determine the Ground Distance on an Aerial Photo?

In this activity you will learn how to determine the scale of an aerial photo if it has not been noted on the photo.

1. On your aerial photo, measure the length (in centimeters) of a parking lot (or an athletic field) located on your school site. Record this measurement in the space below.

   (These distances are simply used as examples. Your distances will vary.)

	Trial 1	Trial 2	Average
Photo distance of the feature:	1.6	1.8	1.7 **cm**

2. Go outside and measure (to the nearest 0.1 meter) that same parking lot (or athletic field) that you measured on the aerial photo. Record this measurement in the space below.

	Trial 1	Trial 2	Average
Ground distance of the actual feature:	136.3	136.5	136.4 **m**

   Average Ground distance of the actual feature: 136.4m or 13,640 cm

   You can write these two measurements as a ratio: **photo distance / ground distance**

   Ratio : 1.7 cm / 13,640 cm (don't forget your units!)

   Teacher Note: If you calculate this, you will end up with a photo scale of 1 : 8023 that is close enough to a photo scale of 1 : 8000. (This may be the scale listed on the aerial photo.) This scale, also called the representative fraction (R.F.) is calculated as follows:

   $$\frac{1.7 \text{ cm}}{13{,}640 \text{ cm}} = \frac{1 \text{ cm}}{x}$$

   solving for x: 8023 (Written 1 : 8023)

3. Measure the length (in centimeters) of a 2nd feature on the aerial photo. This feature can be anywhere on the photo. (You will not be going outside to measure its actual length. Instead, you will calculate its actual length.) Try to identify the feature and record its length below. For example, you may wish to measure the length of the road to your school.

	Trial 1	Trial 2	Average
Photo distance of 2nd feature:	4.9	5.1	5.0 **cm**

   What do you think the feature is that you measured? the road to the school (for example)

4. Using the known ratio from question #2, above, calculate the actual length (**ground distance**) in meters of the 2nd feature you measured in the aerial photo. Show your work below and write your answer in the space provided.

Example: $\dfrac{\textbf{known photo distance}}{\textbf{known ground distance}} = \dfrac{\textbf{photo distance 2nd feature}}{\textbf{ground distance 2nd feature (x)}}$

$\dfrac{1.7\text{ cm}}{13{,}640\text{ cm}} = \dfrac{5.0\text{ cm}}{x}$ $\quad x = 40{,}117$ cm

Ground distance of your second feature: <u>40,117 m</u> <u>401.2 m</u>

5. Find another group in the class that measured the <u>same</u> feature. How do your results compare? If your results differ significantly, try to figure out why. Did both groups identify the feature as the same thing? Write your answers and comments below.

   Answers will vary. Some ideas may include accuracy with which the ground distance of the 1st feature was measured as well as the accuracy with which the features on the map were measured.

6. Practice this again by locating another feature on the photo. Calculate its actual ground distance. Show your work below.

   For example students could measure the length of the football field = 1.1 cm

$\dfrac{1.7\text{ cm}}{13{,}640\text{ cm}} = \dfrac{1.1\text{ cm}}{x}$ $\quad x = 8825$ cm or 88.25 m

Identify the feature: <u>Football field</u>

Ground distance of your third feature: <u>8825 cm</u> <u>88.25 m</u>

Teacher Note: Because we can only measure to the nearest 0.1 cm, the calculated length of the football field if converted to feet is 291.2 ft instead of 300 ft. (the actual length of a football field.) Keep going, you're close enough and on the right track.

Part IV - Scale of an Aerial Photograph

Section B - Determining the Photo Scale

In determining the aerial photo scale, make sure that the class uses a variety of materials to find a 1 unit feature on the photo. For example, one group might find a feature on the photo that is 1 cm in length, another may find a feature that is 1 inch in length, another may find a feature that is 1 toothpick in length, etc.

It is very important to allow students to compare and discuss their findings. Have them write their results on the board and discuss them. Take your time! A good understanding of scale is difficult to develop.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part IV - What is Scale?

Section B - How Do You Determine the Scale of an Aerial Photo?

Find a feature on the aerial photo that is 1 unit in length. You may use any device to measure that feature as long as its distance on the photo is 1 of that device. For example, this feature could be measured in units of inches, centimeters, paper clip lengths, toothpick lengths, etc., but it must equal 1 of that particular unit. Just like you did in section A, questions 5 and 6, calculate the actual ground distance of this 1 unit feature. (**Important note:** the known ratio that you use must have the same units in both the numerator and the denominator. Make the necessary changes before you calculate the ground distance of your 1 unit feature. For example, for a known ratio that is .5 cm photo distance / 7.5 m ground distance:

$$\frac{.5 \text{ cm}}{7.5 \text{ m}}$$ **(make numerator and denominator the same units)**

$$\frac{.5 \text{ cm}}{7500 \text{ cm}} \quad \textbf{OR} \quad \frac{.005 \text{ m}}{7.5 \text{ m}}$$

1. Now show your calculation below:

   Example:

$$\frac{\text{1 inch on photo}}{\text{x inches on ground}} = \frac{\text{1.7 cm (known photo distance)}}{\text{13,640 cm (known ground distance)}}$$

$$x = 8{,}023.5 \text{ inches}$$

   Ground distance of your 1 unit object: _8,023.5 inches
   (record the units used!)

   Teacher Note: Another student may use cm or a toothpick length as their 1 unit measure of a ground feature. The problem is set up the same way.

Example:

$$\frac{\text{1 cm on photo}}{\text{x cm on ground}} = \frac{\text{1.7 cm (known photo distance)}}{\text{13,640 cm (known ground distance)}}$$

$$x = 8{,}023.5 \text{ cm}$$

The question above asks students to find a feature on the aerial photo that is 1 unit long. That feature might be the length of 1 inch or 1 cm. It may even be the length of 1 paper clip. They'll need to do some careful examination of the photo to find these 1 unit features. This activity works best if the class uses a variety of measuring devices and then reports their results and their measuring device on the board (question 2 below). They should all come up with the same ground distance for their 1 unit object, however, their units will vary. Explain to your students that when you give the scale of your aerial photo it may be written as **1 : some number** (in this case the ground distance the class has determined in questions 1 and 2).

2. Compare your results with other groups in the class by writing your answer and the units you used on the board. How do your answers compare?

The actual ground distance is the same for all units - 8023.5 units

SURPRISE! What you have just determined is something called the photo **scale**. For example, your class may have an aerial photo that has a scale of 1 : 3000. This means that every 1 cm on the aerial photo is equal to 3000 cm (30m) on the ground. OR:

1 inch on the aerial photo = 3000 inches on the ground (250 ft.)

1 paper clip length on the aerial photo = 3000 paper clip lengths on the ground

1 grid square length on the aerial photo = 3000 grid square lengths on the ground

3. As a class, develop your own working definition of **scale**. You might begin this by developing a list of things or ideas that characterize scale. Write your definition of scale below.

You may look for some key words or ideas that could include the following attributes of scale:

- appropriateness of measure
- type and size of measurement
- its function is in relation to other known objects
- representative
- model vs. measurement
- variability
- manipulation

Scale is a ratio on a map, photo, or image that describes the relationship between a distance on the map, photo, or image and the corresponding distance on the ground. Different maps, photos, and images have different scales.

4. Can you think of some examples where scale is used? Write these examples below and on the board.

   Examples where you might use scale are in sports to map out a play on the playing field, a scale model of a building, model planes and cars, set construction for a play, the child's toy nesting eggs, a globe, etc.

5. Can you think of some non-examples of scale? Write these non-examples below and on the board.

   Some non-examples of scale may include, a musical scale, a bathroom scale, fish scales, etc.

Additional background on scale:

Scale is the actual ground distance represented by the photo distance. It is written as a ratio of 1: some number. (photo distance : ground distance). These numbers may be any units providing they are the same for both the photo distance and the ground distance.

If you know the photo scale, you can easily determine the actual ground distance of a feature that you measure on the photo. A large photo scale has a relatively large ratio compared to a small photo scale. For example:

Large photo scales:	1 : 6000	or	1/6000 = .0001666
	1 : 8000	or	1/8000 = .000125
Medium photo scales:	1 : 20,000	or	1/20,000 = .00005
	1 : 24,000	or	1/24,000 = .0000416
Small photo scale:	1: 100,000	or	1/100,000 = .00001

Objects in a small scale aerial photo appear very small on the photo compared to the same objects on a large scale aerial photo which appear larger. Small scale maps cover large areas, but with less detail. Large scale maps cover less area, but with greater detail.

Part V - Determining the Scale of a Satellite Image

In this section students will apply their understanding of scale to determine the scale of a satellite image. Use the hard copy of the satellite image of your town that accompanies the remote sensing materials. Again, students may work in small groups unless they prefer to work individually. Allow time for them to compare and discuss their results/answers. This activity may be completed in a class period or less.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part V - How Do You Determine the Scale of a Satellite Image?

Using the same process that you used with the aerial photograph, you may determine the scale of the satellite image of your town. Begin by locating the same feature on the aerial photo <u>and</u> the satellite image. You must be able to measure the length of that feature on both the photo and the image. Features that work well for this purpose are roads, powerline right-of-ways, lakes, etc. Work through the following example and then try your own.

Example: Suppose you locate a lake on both the photo and the image. <u>Because you have already determined the scale of your aerial photo (let's say 1 : 3000), you will work first with the photo</u>. Let's say that the lake's length on the photo is 15.7 cm.

photo distance of the feature: <u>15.7 cm</u>

Using the photo scale, calculate the actual ground distance of this feature and record below. (Continue working with a photo scale of 1 : 3000.) Show your work below.

$$\frac{1}{3000} = \frac{15.7}{x}$$

x = 125,600 cm (This is the actual ground distance of the lake)

Actual ground distance of the feature: <u>125,600 cm</u>

Now that you know the length of the lake (actual ground distance of the feature), use that information to determine the scale of your satellite image.

Measure and record the length of the lake on the satellite image. For this example, let's say that its length is 1.3 cm on the image. Again, use the ratio image distance / actual ground distance.

$$\frac{\text{1.3 cm (image distance)}}{\text{actual ground distance (calculated above)}} = \frac{\text{1 of any unit}}{\text{x of that same unit}}$$

$$\frac{\textbf{1.3 cm}}{\textbf{125,600 cm}} = \frac{\textbf{1 of any unit}}{\textbf{x of that same unit}}$$

x = 96,615.4

Satellite Image scale = 1 : <u>96,615.4</u> (or 1:97,000)

D

1. Now work with the aerial photo and satellite image for your town. Locate a feature that is visible <u>and</u> easy to measure on both the photo and the image. Calculate the actual ground distance of that feature on your aerial photo and then calculate the scale of your satellite image. Show your process below.

   This is calculated like the example above.

   Satellite Image scale = 1 : _____________

2. Compare your results with another group. If your answers differ, is there a large difference? Help each other locate the problem area(s).

   Answers may vary slightly depending upon the accuracy of the students' measurements.

3. What could account for relatively small differences in your answers?

Answers may include: inaccuracy in measuring the length of the feature, it may be difficult to measure the feature on the satellite image because its edges may not be clearly visible, etc.

After you have completed this activity, it may be interesting to revisit your study of remote sensing to compare how to determine the scale of a satellite image using a different method. This method uses the number of pixels on the TM image. (The TM pixel represents a 30 meter by 30 meter square.)

Example: The TM satellite image of your community measures approximately 15.8 cm across. (This is the image distance.)

The actual ground distance may be determined by:

512 pixels across the image x 30 m/pixel = 15,360 m = 1,536,000 cm

The scale may be determined by:

$$\frac{15.8 \text{ cm (image distance)}}{1{,}536{,}000 \text{ cm (ground distance)}} = \frac{1 \text{ of any unit}}{x \text{ of that same unit}}$$

x=97,215

The image scale = 1: 97,000

Part VI - Determining the Area of Coverage of an Aerial Photo and a Satellite Image

In this section, students will apply their understanding of scale to determine the area of coverage of both an aerial photo and a satellite image. Students may work in groups or individually. Allow time for them to compare and discuss their results/answers. This activity may be completed in a class period or less. Begin the activity by reviewing the way to calculate the area of a rectangle and a square.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part VI - How Do You Determine the Area of Coverage of an Aerial Photo and a Satellite Image?

Now that you know the scale of your aerial photo you may calculate the total area of coverage of your photo. Review how you would find the area of a square or rectangle. Measure the length and width of the aerial photo (in cm).

Length of the aerial photo: _______ cm (photo distance)

Width of the aerial photo: _______ cm (photo distance)

Example: The length of the aerial photo is 27.9 cm (which is the photo distance). If your photo scale is 1 : 8000, calculate the ground distance.

Remember that every 1 unit on the photo equals 8000 units on the ground. Set up your ratios.

$$\frac{\textbf{1 cm}}{\textbf{8000 cm}} = \frac{\textbf{27.9 cm}\text{ (photo distance)}}{\textbf{x cm}\text{ (ground distance)}}$$

x = 223,200

Ground distance of the length of the aerial photo: **223,200 cm**
2,232 m
2.2 km
(round to nearest tenth)

Teacher Note: You may wish to have your students calculate this distance in feet and miles so they have a better feel for the actual ground distance

Repeat this same calculation for the width of the photo. Let's say that you measured a width of 20.3 cm. Set up the same ratios.

$$\frac{\mathbf{1\ cm}}{\mathbf{8000\ cm}} = \frac{\mathbf{20.3\ cm}\ \text{(photo distance)}}{\mathbf{x\ cm}\ \text{(ground distance)}}$$

x = 162,400 cm

Ground distance of the width of the aerial photo: 162,400 cm

1,624 m

1.6 km
(round to nearest tenth)

Teacher Note: You may wish to have your students calculate this distance in feet and miles so they have a better feel for the actual ground distance

Now you may calculate the ground area covered by the photo below by multiplying ground distance width by ground distance length. Show your calculations below. Report in km^2.

2.2 km x 1.6 km = 3.5 km^2

Ground area covered: 3.5 km^2

1. Compare your results with another group. If your answers differ, is there a large difference? Help each other locate the problem area(s).

   Answers will vary.
2. What could account for relatively small differences in your answers?

   Inaccuracy in measuring the lengths and widths of the photo

In **Part V** you calculated the scale of your satellite image. Using this scale, you may also determine the area of ground coverage on the satellite image. Repeat the steps that you used above for the aerial photo.

1. Measure the length and the width of the satellite image and record below. Using the image scale, calculate the area of ground shown in this satellite image. Show your work below.

   Image scale: 1: 97,000 (1: 96,615)

   Length of image: 15.8 cm

   Width of image: 15.8 cm

(The satellite image is a square that measures 15.8 cm on a side. Therefore, simply measure one side of the image.)

$$\frac{1}{96{,}615} = \frac{15.8\text{ cm (image distance)}}{x\text{ cm (ground distance)}}$$

x = 1,526,517 cm

15,265.2 m

15.3 km

AREA = 15.3 km x 15.3 km

= 234.1 km^2

Area of ground shown in the satellite image: **234.1 km^2**

Teacher Note: If your students want to think about this area in square miles:

$$15.3\text{ km} \times \frac{.625\text{ mi}}{1\text{ km}} = 9.6\text{ mi}$$

AREA = 9.6 mi. x 9.6 mi.
= 92.2 mi^2

After you have completed this activity, again, it may be interesting to revisit your study of remote sensing to compare how you find the area of coverage of a satellite image using a different method. This method uses the number of pixels on the TM image. (The TM pixel represents a 30 meter by 30 meter square.)

The width of the TM satellite image of your local community is 512 pixels across. Each pixel measures 30 meters on a side.

Width of the image:

30 m/pixel x 512 pixels = 15,360 m

= 15.4 km

Length of the image: (Same as above because the image is a 512 x 512 image)

Area of the image:

15.4 km x 15.4 km = 237.2 km

Area of the image in mi^2:

$$15.4\text{ km} \times \frac{.625\text{ mi}}{1\text{ km}} = 9.6\text{ mi}$$

9.6 mi. x 9.6 mi = 92.2 mi^2

Part VII - Calculating the Area Covered By Your Forest Stand on an Aerial Photograph

D

In this activity students will determine the area of an irregularly shaped feature and their forest stand on an aerial photo. You will need several transparent .5 cm grids to complete the activity. Students may work in groups or individually and be completed in one class period.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part VII - How Can You Calculate the Area Covered by Your Forest Stand on an Aerial Photograph?

In this activity you will apply your understanding of scale to calculate the area covered by your forest stand (or park) in which your study plot will be located. In most cases, this will be an irregularly shaped feature. It therefore requires a different method than you have used before when calculating the area of coverage of your aerial photo or satellite image. You must know the scale of your aerial photo in order to do this activity.

1. Examine the aerial photo carefully. Look for the boundaries of the forested stand. If your stand boundaries appear to go beyond the edges of the aerial photo, consider the photo's edges to be the boundaries.
2. Brainstorm some ways that you might be able to calculate the area of this forest stand with your class. You don't need to go into the field to do this, simply use the scale of the aerial photo.

   Some ideas for calculating the area of the forest stand that students may describe might include:

   - **Estimate the area by measuring a representative length across the stand and a representative width across the stand and then the photo scale to calculate actual ground distances. Determine the actual by multiplying those distances.**
   - **Overlay a circle that represents most of the stand and find the area of a circle. Use the photo scale to determine the actual ground distance for the radius of the circle.**
   - **Students may even suggest the grid method that they will use for this activity.**

Finding the Area of an Irregularly Shaped Feature Using a Grid Transparency:

One way to find the area of coverage of an irregularly shaped feature such as a forest stand is to use a grid transparency that you overlay on the aerial photo. If you know the actual area of ground coverage of each grid square, all you need to do is count the number of grid squares covering your forest stand. Let's try it.

Teacher Note: Students frequently have difficulty understanding the difference between linear and area measurement. The grid method of finding areas of irregularly shaped regions reinforces area as a square measurement. Have students overlay the grid transparency on the aerial photo and count the number of squares covering a particular ground feature. Ask the students to describe how they chose to determine the area if a grid square included another ground feature other than the one they wished to measure. Different methods are useful under different circumstances. Students might enjoy speculating about circumstances under which their method would be most useful.

1. The length of one side of each small square in the grid is .5 cm. If the scale of an aerial photo is 1: 8000 for example, that means that 1 cm on the photo represents 8000 cm on the ground.

   a. Using the photo scale, calculate the ground distance that is represented by .5 cm.

$$\frac{1}{8000} = \frac{.5\ \text{cm (photo distance)}}{x\ \text{cm (ground distance)}}$$

x = 4000 cm

.5 cm photo distance = 4000 cm ground distance

40.0 m ground distance

   b. Find the actual area of ground coverage of one small square.

40m x 40 m = 1600 m^2

area of ground coverage = 1600 m^2

2. Place the .5 cm square grid transparency over the aerial photo and determine the area of your forest stand. You may find small pieces of tape helpful to hold the transparency in place.

   a. Explain how you determined the area. Be sure to include your units.

Example: Let's say that the number of grid squares covering your forested area = 468.

Then 468 grid squares x 1600 m^2 = 748,800 m^2

area of ground coverage of your forest stand = 748,800 m^2

   b. What decisions did you have to make when you found the area? How did you decide whether to include the area in a grid square if it was partially over the forest and partially over some other feature?

   If a grid square contains land cover other than your forested, how do you decide to count the grid square? Answers will vary on how students decide what to include or exclude in their grid square count.

3. When you use the grid method, you often have to decide what to do about squares that include part of another feature that you're not interested in measuring. For example, a grid square may cover both forest and water or forest and road. One method is to find the area twice by counting squares two times and finding the average between the two. For the maximum area, include every square that contains any portion of the forest. For the minimum area, include only squares that contain only forest and no other feature. Determine the maximum area and minimum area of your forest stand.

   For Example:

   The maximum number of grid squares covering forest and other features mixed is 498 squares.

   498 grid squares x 1600 m^2/ grid = 796,800 m^2

   The minimum number of grid squares covering forest only is 473 squares.

   473 grid squares x 1600 m^2/ grid = 756,800 m^2

   maximum area of forest stand = 796,800 m^2

   minimum area of forest stand = 756,800 m^2

   Teacher Note: One method of using the minimum and maximum areas described is to average the two values. This is the basis for the trapezoidal rule in calculus. Students may develop other methods using the maximum and minimum value.

   a. Average the maximum area and minimum area to find an area that, in most cases, is more accurate than either one alone.

   (796,800 m^2 + 756,800 m^2) / 2 = 776,800 m^2

   average area of forest stand = 776,800 m^2

   b. How does this second method of averaging the maximum and minimum area compare to the method used in question #2?

   Answers will vary. For this example, the maximum and minimum area method is greater. From question 2, the area was determined to be 748,800 m^2. From the second method (max/min method) the area was determined to be 776,800 m^2.

4. Compare your results with other groups. Discuss some of the problems you may have had. Discuss factors that may have influenced your accuracy.
   - **Keeping track of your count,**
   - **Decisions of what to include/exclude, and**
   - **The need for consistency in your decisions.**

5. How might your accuracy change if your forest stand is located on very hilly terrain?

   Explain to students that this method does not work well if the terrain is very uneven. They are working with a 2 dimensional photo (flat surface). If your forest stand is located in hilly terrain, you will be inaccurate in your calculation of area because the area is 2 dimensional and does not take into account a third dimension such as elevation.

Finish this activity with a discussion about how you can observe changes using the aerial photos. If you have a chronosequence of aerial photos that visibly shows a change in the extent of your forest stand have the students determine the area of coverage on each of the photos. Students will then have a quantitative example of change over time as well as a qualitative example. (If the extent of the forest stand shows little change, students may measure the area of another feature that shows change from one aerial photo to the next. It is very important that the photo scale is known or has been determined for each photo before students make their comparisons.

Alternative Method: Area of an irregularly shaped feature may also be determined using a device called a planogrid measuring overlay which may be purchased for about $20 from Forestry Suppliers, Inc. Another device is called JIM - GEM English area grid which runs around $4. Both devices come with instructions for their use.

Part VIII - Using Topographic Maps

In this activity students will explore 7.5 minute series topo maps to understand the various features they portray, the use of the scale bars and how they compare to satellite images and aerial photos. They will use them to help locate and find the area of the forest stand in which your study plot will be (or is already) located. Topographic maps may be obtained from the National Cartographic Information Center, 507 National Center, Reston, VA 22092 (1-800-USA-MAPS). You may also purchase your maps from a U.S. Soil Conservation Service or most retail stores that sell hiking or mountaineering gear.

It is helpful to laminate your topo maps or use transparencies taped to the map for mapping the boundaries of your forested area. Make sure students don't write on the maps. This activity may be completed in one class period.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part VIII - What information can you obtain from topographic maps and what are some of their uses?

Study the topographic (topo) map available to you. Your teacher will guide you through some discussion questions that focus on several map features.

Teacher Note: The following questions are not listed on the student activity handout.

• **What does this map represent or portray?**

The land surface with different features like water, roads, buildings, forests, etc.

• **In what ways is this map marked?**

Examples may include:
- numbers along the margins
- lines and concentric circles and shapes
- elevation numbers
- towns are named
- names of rivers, lakes, and streams
- road classifications
- scale is given
- other ideas?

• **What are some of the different colors you see and what does each portray?**

Green - open land, forested areas
Blue - water
White - populated areas cultural features
Red - may show boundaries, roads, etc.

• **Can you see patterns? What do they tell you?**

Series of lines and circular shapes indicate changes in elevation and land surfaces

• **What kinds of natural features can you see on the map?**

Lakes, rivers, streams, hills, valleys, forested areas, etc.

• **What kinds of cultural features (man-made) can you see on the map?**

Roads, powerline cuts, town boundaries, houses, etc.

• **What kind of land use can you observe?**

Forested areas, recreational areas, urban areas, etc.

• **Because this is a map of our community, you are somewhat familiar with the area portrayed. Can you see something that you've never seen from the ground?**

Answers will vary.

• **Can you find where you are right now on the map?**

Have student's point to their present location on the map.

• **Can you estimate the distance between two points that your teacher shows you on the map? What is this estimated distance?**

Locate two objects and allow students to guess the distance between them

• **What is the distance between the same two points that you can determine using the scale bars at the bottom of the map?**

If students do not know how to use the scale bar, the following activity guides them through its use. At this point students may be given the activity handout.

Teacher Note: The following questions <u>are</u> included on the student activity handout.

1. Develop a list of questions that you could answer using your map. List these on the board.

2. List several questions that you could not answer using the map. List these on the board.

3. As a class, discuss some of the limitations of topographic maps. What can't you see on the map?

How Do You Determine Ground Distances and Area on a Topo Map?

1. What is the scale of your topo map?

Answers will vary depending on the topographic map series that you use. The scale is given in the bottom margin of the topo map. For the 7.5 minute series map, the scale is 1: 24,000.

In the previous activities, you have learned to calculate actual ground distances of features on the aerial photos or satellite images using the scale of the photo or image. You then learned to calculate the area of coverage of your photo or image. Topo maps can make this process even simpler by providing a series of **scale bars**. The scale bars give you actual ground distance more directly. Notice the scale bars drawn below the scale designation on the bottom margin of your map.

2. What are the different units used by the various scale bars?

   Miles, feet, kilometers

3. Look at the mile scale bar. Find the 0 mark on the bar. How is the bar divided to the left of the 0 mark?

   Tenths of a mile (0.1 mile)

4. Locate a straight stretch of road on your map. Lay a plain piece of paper next to the road and place tick marks on the paper's edge that mark the beginning and end of the stretch of road you wish to measure.

   Now use the mile scale bar to determine the actual ground distance between the tick marks on the paper. This represents the actual ground distance of the road. Record it below.

   actual ground distance of road: ___________mi

   Answers will vary

5. Look at the scale bar marked in feet. Find the 0 mark on the bar. How is the bar divided to the left of the 0 mark?

   200 ft

6. Use the scale bar marked in feet to determine the actual ground distance between the tick marks on the paper. Record this distance below.

   actual ground distance of road: ___________ft

   Answers will vary

7. Look at the scale bar marked in kilometers. Find the 0 mark on the bar. How is the bar divided to the left of the 0 mark?

   Tenths of a kilometer (0.1 km)

8. Use the kilometer scale bar to determine the actual ground distance between the tick marks on the paper. Record this distance below.

actual ground distance of road: ___________km

Answers will vary

9. Clearly, the length of the road (also called the actual ground distance of the road) does not change. However, what did change?

The units that the students use to measure the distance change, however, their measurements are equivalent regardless of the units used.

10. What ground distance (in miles) does the length of your topo map cover? In feet? In kilometers? Record these measurements below.

actual ground distance of map length: ___________mi

___________ft

___________km

Students may use the scale bars to measure this distance.

11. What ground distance (in miles) does the width of your topo map cover? In feet? In kilometers? Record these measurements below.

actual ground distance of map width: ___________mi

___________ft

___________km

Students may use the scale bars to measure this distance.

12. What is the actual area of coverage of your topo map?

actual area of coverage: ___________mi^2

___________ft^2

___________km^2

Again, students multiply length x width to find the area

13. **For a challenge**, find the actual area of coverage using the process that you used with aerial photos and satellite images. Remember that with a map scale of 1 : 24,000 (for example), the ratio of map distance to ground distance is:

1 cm on the map = 24,000 cm on the ground

OR written as a ratio: $\frac{\textbf{1 cm}}{\textbf{24,000 cm}}$

OR written as a ratio: $\frac{\textbf{1 in}}{\textbf{24,000 in}}$

OR written as a ratio: $\frac{\textbf{1 ft.}}{\textbf{24,000 ft}}$

Show your work in the space provided. (Hint: You will need to first measure length and width of your map in inches and in centimeters, then convert these to feet, kilometers and miles before proceeding with the rest of the calculation.)

Students may work through this problem using the same method they used in Part VI - Determining the Area of Coverage of an Aerial Photo and a Satellite Image

actual area of coverage: ____________$\mathbf{mi^2}$

____________$\mathbf{ft^2}$

____________$\mathbf{km^2}$

14. How do your results in question #13 compare with your results in question #12? If your answers are different, what could have caused these differences?

Accuracy in measurement is always very important.

15. Examine all three portrayals of your town; the map, the aerial photo, and the satellite image. Can you locate your school on all three portrayals? On which portrayal is it most difficult to locate? Why?

In most cases, the satellite image will be the most difficult portrayal on which to locate your school. Ask the students to compare the scale of each portrayal. Discuss the relationship between the abilityto see the feature on the ground and the portrayal scale.

See Part IV, Section B - What is Scale?

16. Describe several features that you can see on all three portrayals.

Answers will vary

17. Can you locate your forest stand or park on all three portrayals?

Answers will vary

Locate the area where you find your forest stand on the topographical map. Can you see the stand on this map? Overlay a clean transparency on your topo map and secure it with small pieces of tape. Use the aerial photo and the satellite image as references to “map” or draw the boundaries of your forest stand on the transparency with a colored marker. You will also need to trace over (on the transparency) some reference points that are actually on your topo map such as a road, river, lettering, etc. This will allow you to remove the transparency from the map and then replace it in nearly the exact same location for future observations. <u>Do not write or mark on the map with your markers!</u>

18. Were there any problems that you encountered in mapping your forest stand boundaries?

Answers will vary

19. What did you do to solve the problems?

Answers will vary

Part IX - DETERMINING THE LATITUDE AND LONGITUDE OF YOUR SAMPLING PLOT USING A TOPOGRAPHIC MAP

This activity zeros in on locating your position on the earth's surface using latitude and longitude coordinates that you determine from a topo map. For some students, the process may become too difficult at which point they can estimate their coordinates using the map. Students should work in groups. The activity is subdivided into four sections and includes an extension activity. This entire activity may require two - four class periods depending on your students' math skills.

ANNOTATED STUDENT ACTIVITY HANDOUT

Part IX - How Do You Determine the Latitude and Longitude of Your Sampling Plot Using a Topographic Map?

Section A - What is meant by latitude and longitude?

Hand out a ping pong ball to each team of students. Ask students to work as partners or in teams and work through the introduction. Ask students to read the opening activity.

Opening Activity:

Begin this activity by trying to describe the location of a black dot on a ping pong ball to a partner or to other members of your team. After attempting this, use your pencil and make any other kind of mark on the ping pong ball. Have your partner or another team member try to describe the location of the original black dot on the ball. Is it any easier this time?

Now make another mark on the ping pong ball with your pencil. Have your partner or another team member try to describe the location of the original black dot on the ball. Now is it easier?

When you're working with a spherical object, what can help you to describe the location of an object on that sphere?

Discuss the following questions with your students:

1. **Were you successful in giving a complete description of the location of the mark the first time around? If so, what methods did you use?**
2. **Were any of you successful in giving a complete description of the location of the mark the 2nd or 3rd time around? If so, what did students use for their marks on the ping pong ball?**

   Focus the discussion on the need for reference points when trying to find a position on a sphere. Now have students read the background information for this activity.

Background:

Circles and spherical objects have 360˚ around their circumference. The earth, like the ball, can be divided into an imaginary 360 degree sphere. Mapmakers have given the earth a grid system similar to lines on graph paper. If a person stepped out from her front door, traveled in a 'circle' around the earth back to her door, she would travel a distance of 360˚.

The lines circling the earth running parallel to the equator are called lines of latitude. Latitude refers to distance in degrees (˚) either north or south of the equator. The equator is at 0˚ latitude while the geographic north and south poles are 90˚. No other lines of latitude are the same length as the equator. Lines of latitude that are equidistant from the equator are equal in length. One of those lines will be located in the northern hemisphere and the other in the southern hemisphere. Locations 0˚ to 90˚ north of the equator are referred to as ˚ north. Locations 0˚ to 90 ˚ south of the equator are referred to as ˚ south.

Lines that circle the earth and run from pole to pole are called meridians or lines of longitude. The 0˚ reference point for longitude passes through the Greenwich Observatory near London. This imaginary line is called the prime meridian. If you travel east or west 180˚ you will reach a second imaginary line called the international date line. Longitude refers to distance in degrees east or west of the prime meridian. Locations 0˚ to 180˚ west of the prime meridian are referred to as ˚ west. Locations 0˚ to 180˚ east of the prime meridian are referred to as ˚ east.

Just as (x,y) coordinates on a graph allow you to describe your location on the graph, latitude and longitude coordinates allow you to describe your location on the earth. Lines of latitude may be represented on the y-axis while longitude may be represented on the x-axis. Together, latitude and longitude give us a useful coordinate system that can be used to identify a location on the surface of the earth. For example, if you wanted to identify your location on the earth, you would refer to both the latitude and longitude coordinates in the following way: 42˚N, 70˚W.

Students might practice identifying x,y coordinates by playing the board game <u>Battleship</u> or by plotting the location of chess pieces on a chess board.

To help you increase the accuracy of your location even further, scientists have divided each of the 360˚ degrees into units called minutes (not to be confused with minutes on a clock!). One degree is divided into 60 minutes and is labeled with (').

Teacher Note: See Converting Units of Measure in Introductory Math Activities Section for questions 1 and 2.

1 degree = 60 minutes
1˚ = 60'

1. How many minutes is the entire earth divided into? (Show your work below.)

   The earth can be divided into 21,600 minutes. $\mathbf{(360^\circ \times \frac{60'}{1^\circ} = 21{,}600')}$

   Each minute is then divided into units called seconds (not to be confused with seconds on a clock!). Seconds are labeled with (“).

   1 minute = 60 seconds
   1' = 60"

2. How many seconds is the entire earth divided into? (Show your work below.)

   The earth can be divided into 1,296,000 seconds.

   $$\mathbf{(21{,}600' \times \frac{60''}{1'} = 1{,}296{,}000'')}$$

Using this information allows for an even more accurate description of location than just degrees. For example, the location of a particular point might be 42˚ 12' 15"N, 70˚ 43' 09"W (Read 42 degrees, 12 minutes, 15 seconds north, 70 degrees, 43 minutes, 9 seconds west). Notice that you give your north or south coordinates first followed by the east or west coordinates.

Part IX - Determining the Latitude and Longitude of Your Sampling Plot Using a Topographic Map

Section B - What Are All Those Numbers on a Topographic Map?

Students must read through the background information to understand how to read the map for the latitude and longitude coordinates. You may want to discuss this material with the class and have them point out the different tick marks to you. They can be very confusing!

Begin this activity by studying your 7.5 minute series topo map. You have already worked with the map scale bars at the bottom and your map tells you the scale used to represent ground distances. Look at the different roads on the green area of the map. Use the map key to identify the different kinds of roads. Now look at all those numbers along the vertical and horizontal margins of the map. Don't worry, we'll only be using a few of these for this activity. Read through the following background information to learn about the numbers that give you your latitude and longitude coordinates.

Background:

Always begin reading a map by looking at the coordinates (latitude and longitude) located at the four corners of the map in the margins. Note the degrees and minutes given for each coordinate, latitude and longitude. Assume that if seconds are not indicated at these corner marks that there are 0 seconds. For example, if your line of latitude at the top of your map reads 42˚ 30', this means that there are 0 seconds.

The next thing that you will want to observe on the map are the blue tick marks along the outside edge of your map margins and the black tick marks along the inside edge of your map margins. These different tick marks indicate different coordinate systems given on the topo maps. The blue tick marks are used in the Universal Transverse Mercator (UTM) system and they represent meters from the equator. There are 1000 meters between each blue tick mark. We will not be using these blue tick marks or this system for this activity.

The black tick marks along the inside edge of your map margin are used in the latitude and longitude coordinate system. These marks along the inside edge of your vertical (north-south) map margins represent the number of degrees, minutes and seconds from the equator. These indicate latitude. The black tick marks along the inside edge of your horizontal (east-west) map margins represent the number of degrees, minutes and seconds from the prime meridian. These indicate longitude. We will be using the latitude and longitude coordinate system for this activity.

1. How many black tick marks are there along the inside edge of your vertical map margins?

   2 marks along the vertical margins
   (Including the corners there are 4)

2. How many minutes and seconds are there between these tick marks along the vertical map margins?

   Start at the bottom right or bottom left corner and read up the vertical margin. There are 2 minutes and 30 seconds between each black tick mark. As students locate the tick marks and read the minutes and seconds next to them have them also report the degrees. Note that the degrees are only shown at the corners.

3. What do these tick marks represent?

   Lines of latitude. If your maps are laminated, you may want students to draw straight lines that connect the black tick marks on the right and left side margins of the map. These lines represent the lines of latitude.

4. How many black tick marks are there along the inside edge of your horizontal map margins?

   2 marks along the horizontal margins
   (Including the corners there are 4)

5. What do these tick marks represent?

   Lines of longitude. Again, if your maps are laminated, you may want students to draw straight lines that connect the black tick marks on the top and bottom margins of the map. These lines represent the lines of longitude.

6. How many minutes and seconds are there between these tick marks along the horizontal map margins?

   Start at the upper right or bottom right corner and read along the horizontal margin toward your left. There are 2 minutes and 30 seconds between each black tick mark.

7. Write down the degrees, minutes, and seconds represented by each black tick mark on your map.

   Begin with a vertical margin at the bottom of the map

   bottom corner = _______

   1st tick mark = _______

   2nd tick mark = _______

   top corner = _______

For a horizontal margin of your map

right corner = _______

1st tick mark = _______

2nd tick mark = _______

left corner = _______

(Answers will vary depending on your map)

Part IX - Determining the Latitude and Longitude of Your Sampling Plot Using a Topographic Map

Section C - Where is your sampling plot on your topographic map?

This activity requires you to make a reasonable estimation of the location of your sampling plot on the topographic map and to mark that location with an X on your map. (Your sampling plot also called the PSSP is the study site that you will use for the duration of your work with Forest Watch.) This may require some "ground truthing" or a hike into your forest stand.

1. On your topo map, look for some visible landmark that is also near your forest stand. Such landmarks may include a road intersection or corner or a bend in a river or stream.
2. Once you and your teacher have surveyed the forest stand and decided on the best location for your PSSP, locate that area as best you can on your topo map. Use the landmarks described above to help you. Place an X on the map where you think your site is located.

This activity requires that you have already surveyed the area and decided on the location of your sampling plot (PSSP). If you have had any hiking or orienteering experience where you've used topo maps, you might design an activity that gets students using compasses and pacing to determine the location of their sampling plot. However, this takes time to set up, and you may be able to locate your PSSP fairly accurately using landmarks and estimation.

Section D - What are the coordinates of your PSSP?

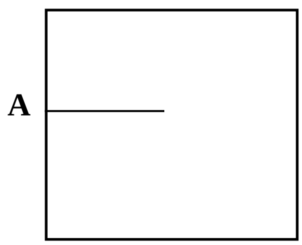
In the first part of this activity students are asked to estimate the coordinates of their PSSP. You may need to work through this with them step by step. It can be confusing. The extension allows students to be more accurate in locating their plot. It, too, may require step by step instruction while students complete each part of the activity. The extension is suggested for students with more math experience.

Preparation:

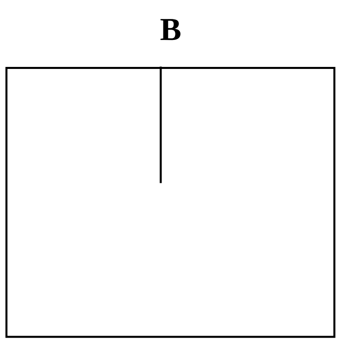
If laminated topographic maps are not available tape sheets of transparency film over the study site or make copies of the map. Copies of maps should include the study site and latitude and longitude markings.

Procedure:

- Locate the PSSP study site on the topographic map.
- Using a marker place an **X** at the PSSP site.
- Line up the file folder along the edge of the map. Using the edge of the folder as a guide, draw a line from the **X** to the edge of the map that is parallel to the top or bottom of the map. (see diagram) Label this **line 1**. Where **line 1** intersects the edge of the map label this **pt. A**



- Line up the folder along the top edge of the map. Using the file folder as a guide, draw a line from the **X** to the top or bottom of the map that is parallel to the side edge of the map. Label this **line 2**. Where **line 2** intersects the top or bottom of the map label this **pt.B**.



- Identify the latitude and longitude of your site. You will estimate these if **pt.A** and **pt.B** do not fall exactly on a latitude or longitude tick mark on your topo map.

latitude ________________________

longitude ______________________

Answers will vary depending on your PSSP location. Because this is an estimate, students may not be able to include the number of seconds in their answers. Remind them that, by convention, they read the latitude first including a north or south designation followed by longitude including an east or west designation.

Questions:

1. Would these coordinates get you to the center of your plot? What are the limitations?

   Because of the map scale, 1: 24,000, it would be very difficult to locate the center of a 30 m x 30 m plot. (Remember: 30 m x 30 m is the size of your PSSP). Other limitations may include: accuracy in marking your site on your topo map, the fact that the site location was estimated and accuracy in measuring the distance to the nearest latitude or longitude tick marks.

2. How can we be more accurate? Brainstorm some ideas. Try them out.

   Answers will vary. This question may lead to the extension activity where students calculate their coordinates.

3. Compare your predictions with your GPS readings. (If they are available to you)

   If you have determined the location of your PSSP using a GPS locator, you may want to discuss this question with your students. There are many factors that may contribute to differences that you might see in the latitude and longitude coordinates between the GPS method and the topo map method. One of these factors may be the result of the person's location within the PSSP when taking the GPS readings. Also it depends on how close the X on their topo map is to the actual location on the ground.

Finally, bring this entire activity to a close by asking students to describe and discuss all the things they have practiced using maps, aerial photos, and satellite images. Use the following research questions to guide your discussion.

4. Now that you have completed the series of activities on maps, photos, and images, go back and answer the questions that were listed at the beginning of the activity. They were as follows:

   • What are some of the uses of aerial photographs, satellite images and topographic maps?

Students may have several answers, some of these may include :

- **used to study extent of forest cover**
- **to study change over time in forest cover or other land use**
- **to locate certain things on the ground**
- **to look at slope and elevation patterns in the landscape**
- **to find your location**
- **other ideas???**

• How can you determine the scale of a topographic map, aerial photograph and satellite image?

You must first measure an object on the map, photo, or image, then measure its actual length on the ground. You may then use the ratio of map distance (or photo/image distance) to actual ground distance and set that equal to 1 of any unit/ x of that same unit.

For example:

$$\frac{\text{2.0 cm (map distance)}}{\text{16,000 cm (ground distance)}} = \frac{1}{x} \quad x = 8000$$

map scale 1: 8000

• What information can you obtain from maps, photographs and images if their scale is known?

Answers will vary and may include the distances between two objects and how large a feature is on the ground.

With all 3 of these portrayals available to your students, ask them to try to find their PSSP on all three portrayals. Clearly, it becomes a difficult task with the satellite image. At best they can estimate its location on the aerial photo and the satellite image.

Part IX - Determining the Latitude and Longitude of Your Sampling Plot Using a Topographic Map

EXTENSION ACTIVITY: Increasing the accuracy of the estimated latitude and longitude coordinates.

Important Teacher Note: The student extension activity includes examples for a 7.5 minute series topo map. This teacher resource section provides a sample problem for a 15 minute series topo map.

To determine latitude:

1. Measure the map distance in cm along a map edge between 2 latitude marks.

   Distance between latitude markings ___________ (14.7 cm)

   The distance between lines of latitude on a 15 minute series topo map is _______ (14.7 cm). The distance between lines of longitude varies depending on your location because lines of longitude become narrower at the poles than they are at the equator. You will always need to measure this distance on your map.
2. Using a ratio, calculate the map distance per second. Before you begin, recall that there are 5 minutes between latitude marks on your map. Convert 5 minutes to seconds. (5' x 60" = 300")

   In 5 minutes there are 300 seconds.

   Now proceed with the ratio:

   $$\frac{14.7 \text{ cm}}{300\text{sec}} = \frac{x}{1 \text{ sec}} \qquad x = .049 \text{ cm/sec}$$
3. Measure the distance in cm from **pt. A** to the nearest latitude mark in a northern direction.

   Distance _____________ (13.3 cm)
4. Again, use a ratio to convert this cm distance to seconds.

   distance / x seconds = .049cm/1sec

   $$\frac{13.3 \text{ cm}}{x \text{ sec}} = \frac{.049 \text{ cm}}{1\text{sec}} \qquad x = 271.43 \text{ sec}$$
5. Convert 271.43 seconds back into minutes and seconds.

   271.43 sec ÷ 60 sec = 4.5 minutes

   $$.5\text{min} \times \frac{60\text{sec}}{1 \text{ min}} = 30 \text{ sec}$$

Therefore, the difference in latitude from your site to the nearest latitude mark is 4' 30".

D

Example: If your site is located below the nearest latitude line:

Let’s say that the nearest latitude line is 43˚ 30'. You will subtract the 4’30" from this latitude line. To do this, change the 43˚ 30' to 42˚ 29' 60".

42˚ 29' 60"
- 4' 30"
42˚ 25' 30"

Example: If your site is located above the nearest latitude line:

Let’s say that the nearest latitude line is 42˚ 47' 30". You will add the 4' 30" to this latitude line.

42˚ 47' 30"
+ 4' 30"
42˚ 52'

To determine longitude:

Find your longitude using reference **pt.B**. Measure the distance from **pt.B** to the nearest longitude mark. Calculate your longitude using the same procedure as shown above. However, if your site is located to the right of the longitude line, you will subtract in your final step. If your site is located to the left of the longitude line, you will add in your final step.

Now state your coordinates* ____

*By convention:

- State the latitude first
- Identify north or south latitude
- State the longitude second
- Identify east or west longitude

Example: 42˚ 47' 55" N, 71˚ 37' 16" W