Quad Squad Lesson Plan

Overview

Have you ever been awakened by lightning and thunder in the middle of the night? In this lesson, students will pretend they have visited a forest research station on an overnight field trip. During their overnight stay, a terrific thunderstorm cuts through the area. As daylight breaks the next morning, students and scientists at the research station form the "Quad Squad", a team whose mission is to locate and make discoveries about possible forest fires that may have been ignited by lightning. Using maps and images of a forested area, the students will be introduced to the 4-quadrant coordinate plane as they learn about forest fires, use compass directions, read maps, interpret imagery, and think about the impact of fire on ecosystems.

Suggested Lesson Sequence	Please see the Maps and More, Earth Systems & Humans, and Landscape Changes module descriptions.
Lesson Level	Extended
Science Connections	- Students will investigate the role of **fire** in **preserving and restoring natural ecosystems**. - Students will investigate **tree distributions** across a landscape.
Math Connections	- Students will explore the **coordinate plane**: the **four quadrants**. - Students will utilize **negative numbers** on the horizontal and vertical **axes** of the coordinate plane. - Students will graph using **ordered pairs**. - Students will compute **distances** using a **scale**. - Students will develop number sense: **place value** to the **thousands place**. - Students will infer distances between marked **coordinates** on a map. - Students will infer the difference between **scale units** and **direction**. - Students will develop **spatial sense** using maps and images.
Technology Connections	- Students will interpret ground objects and **landforms** using satellite imagery.

	- Students will use a computer to compare a satellite image with a map.
Human Connections	- Students will investigate the impact of forest fires on ecosystems and humans.
Lesson Assessment	- Assessment and Standards Table (Word) - Assessment Activity Description - Authentic Assessment

Materials

Forest Maps and Images (Powerpoint)
Mapping Eagle's Nest activity sheet (Word)
Forest on Fire! activity sheet (Word)
Forest Fires slideshow (Powerpoint), to be read together as a class
Nighttime at Eagle's Nest--nocturnal forest sounds (requires the free Macromedia Shockwave Player: click here for free software download from the Internet)

Vocabulary

Note: Students may be unfamiliar with other vocabulary in this lesson. This is done intentionally, to spur additional conversations and discussion about these words and their meanings. The activity sheet in this lesson contains considerable text. As your students read through the lesson context, encourage them to ask about words that may be new to them.

Quadrant: one quarter of a coordinate plane. Four quadrants make up one full coordinate plane. "Quad" is short for "quadrant".

Logging: the practice of harvesting, or cutting, forest trees in order to gather wood for lumber or pulp (pulp is used for papermaking). Some areas that are logged are allowed to re-grow, while other logged areas are used for various other purposes

Lakota Sioux: a tribe of Native American peoples living in the north-central plains of the United States.

Paha: a Lakota Sioux word meaning "mountain" in English.

Tatanka: a Lakota Sioux word meaning "bison" or "buffalo" in English.

Hehaka: a Lakota Sioux word meaning "elk" in English. A *hehaka* is a large mammal with majestic antlers.

Mato: a Lakota Sioux word meaning "bear" in English.

Procedure

This lesson is structured around three separate activities that will each take at least one class period. The first two activities are designed to familiarize students with graphing on the four-quadrant, coordinate plane. Students will describe locations using ordered pairs (in all four quadrants) as they explore maps and images of a region of land. The third activity is a photo essay that encourages students to think about the ecological implications of forest fires.

I. Assessing Prior Knowledge

Both science and mathematics concepts are explicitly developed in this lesson. For science, students will explore the impact of fires on forest ecology. Most students will probably associate forest fires with negative consequences. As students will learn, however, forest fires are essential for healthy forests. In math, students will continue to explore the coordinate plane, solving problems with both positive and negative coordinates.

As a way to assess the prior knowledge of the students with respect to forest fires and ecology, lead a discussion around the following questions:

Are forest fires good, or bad?

> *Fires play an essential role in forest (and many other vegetation types, such as prairie) ecosystems. However, forest fires can also cause great damage to plants, animals, buildings and homes (for humans, and for animals).*

How are forest fires started?

> *Natural sources include lightning and volcanic activity. Many other fires, however, are caused by errors in human judgment or carelessness.*

II. Contextual Preparation

To set the stage for the hypothetical series of events that students will experience in this lesson, engage a discussion about sounds of the forest. To introduce lesson activity one, teachers should first tell the class to imagine that they are overnight visitors at the Eagle's Nest Ecological Research Station. As an introduction to the activity, the teacher may choose to play the file "Nighttime at the Eagle's Nest Ecological Research Station" on the Earth Systems Connections CD-ROM. The file contains the sounds of the wilderness that the students might hear if camping in the woods - owls, coyotes, wolves, mountain lions, wind, rain, thunder, etc. The teacher may turn out the lights and encourage the students to pretend that they are listening for different nocturnal creatures. Save the sound of thunder for the end of this brief introduction, as it is the connecting point to the main theme of the lesson - fires in

the forest.

III. Lesson Activities

1. Lesson activity introduction and background information

The audio file includes the sounds of a thunderstorm. At the conclusion of the audio introduction, play the audio clip of a thunderstorm and encourage the children to imagine an intense electrical storm with many bright lightning strikes that light up the sky like giant camera flashes. This may serve as the introduction to the lesson activity.

Background Information: The teacher should then explain to the students that lightning strikes often cause forest fires, and are a natural process that affects many ecosystems. Scientists and foresters use maps and images as important tools to locate and manage wildfires today. However, before settlers arrived in the United States, grassland and forest ecosystems burned with high regularity (ranging from about once per year in some grassland ecosystems in Georgia and South Carolina, to once every 10 years in dry ponderosa pine forests such as in the Black Hills of South Dakota, to once every 50 years in hardwood forests such as in the Great Lakes region, to once every 125-400 years in moist Douglas-fir forests in many parts of the Rocky Mountains and Pacific Northwest). Unlike today, these fires burned naturally, sometimes for many days or even weeks, and were not extinguished by humans.

Because of this long history of natural fires, plants across the United States have evolved to resist or even depend upon fires for their own success. Some examples of fire-dependent and fire-adjusted plants include the Venus fly trap, the pitcher plant, the giant Sequoia, and ponderosa pine. Additional information on fire/species relationships may be found in Extension Activity #1 near the end of the lesson plan. Use this information to discuss the pros and cons of fires in ecosystems. This discussion might include some mention of how increased human settlement in the United States over the past 200 years make the effects of fires much different today than used to be the case.

Near the end of this introduction, mention that in this lesson students will set out on an "adventure" to locate any fires that may have been set by the lightning strikes near the Eagle's Nest Ecological Research Station, where they "slept" during the storm.

2. Lesson One: Mapping Eagle's Nest

After this introduction, prepare students to begin the activity. For this set of activities, the students will need to have (or view) four different pages, each one containing a particular map or satellite image. These four pages can be found on the Powerpoint presentation entitled Forest Maps and Images.

To begin this entry activity, hand out (and also project if possible) the "Station Region Map 1," from the first page of the Forest Maps and Images slideshow, and the Mapping Eagle's Nest activity sheet. Have the students study the map carefully, noting the locations of the Research Station, surrounding forests, and other features. The students should then begin working through the questions on the activity sheet.

Beginning at question #3 on the Mapping Eagle's Nest activity sheet, students will also need the "Station Region Image #1". Beginning at question #4, students will need the "Station Region Map #2".

Mapping Eagle's Nest Guide (Questions 1-9)

Question 1 is designed to help students see that although Station Region Map #1 is helpful in determining *relative* distances and sizes of objects and landforms, it is difficult to determine exact size and distance without the use of a scale. Possible answers might include:

a) The research station is closer to the campsite at Tatanka Lake.
b) Estimates may vary, but this question is impossible to answer accurately without some sort of scale.
c) This question is impossible to answer without knowing both the actual length of Mato Path and the pace of the walker.
d) Hehaka Meadow appears to be larger in area than the Logged Patch.

Question 2 provides students with an opportunity to learn several words in the Lakota Sioux language. The teacher may encourage students to guess at what the words mean before providing them with the definitions that appear in the vocabulary list above.

Question 3 requires the use of Station Region Image #1. Students may work from a printed copy of the image, or view it on a computer or with a projection device. This image is an unlabeled satellite image of the same area. Question three of the Student Activity Sheet asks the students to label the mapped features on the satellite image so that the image and map can both be used to help locate and possibly predict the path of any fires they find as a group. (Note: An ink pen or marker may work best.) The four questions that follow this activity (a - d) help students understand how a satellite image can provide information about the amount of vegetation in a particular area that is not visible on a map. This information will be important later as students try to determine the likely path of the fire. The teacher may wish to discuss the notion of *forest density* - the more trees in a given area, the more *dense* that forest is. The dark green sections of the image map represent dense forest growth.

Possible responses:

a) Light green.
b) The meadow is a lighter green. The forest appears to be relatively thick with darker green vegetation (trees).
c) It is a lighter shade of green, and appears to be less dense than other forested regions.
d) The south side of the path is more heavily forested. It is darker green, and appears to be more dense than the north side of the path.

Question 4 requires the use of Station Region Map #2. Answers include:

a) a coordinate grid.
b) The numbers to the left of the station are negative in sign. Likewise, the numbers below the station are negative in sign.

Question 5

West; east; north; south

Question 6

Possible responses might include the idea that the map contains a grid that can help the researchers give more exact locations of possible fires by providing distances and directions.

Question 7

The research station.

Question 8

Answers vary. One possible response: (-700, 200)

Question 9

Blank 1: Northeast;
Blank 2: Southwest;
Blank 3: The second quadrant (northwest) and the fourth quadrant (southeast).

3. **Lesson Two: Forest on Fire!**

Teacher Information: After completing the "Mapping Eagle's Nest" activity sheet, students may move on to the second set of activities. Distribute the Forest on Fire activity sheet. Read the opening paragraphs aloud with the class, and begin a discussion about how

forest ecologists might detect where fires may have started, and where they may spread. Students may suggest ideas like: looking for smoke, climbing to a high vantage point to see over the entire valley, determining wind speed and direction, or recognizing where likely sources of fuel for the fire might be. From the Forest Maps and Images Powerpoint slides, distribute (and project if possible) Station Region Image #2.

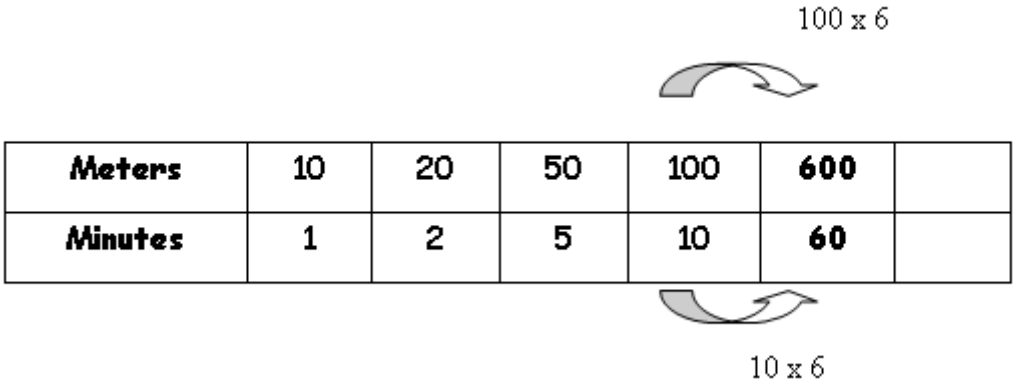
For the next set of questions, teachers should review the key concepts involving the structure and use(s) of the coordinate plane. For example, locations on maps can be determined precisely through the use of ***coordinates.*** That is, every location on a coordinate plane can be identified through the use of two numbers - the coordinates of the point. In this case, the coordinates refer to distances both to the north/south, and to the east/west of the Research Station (the origin). Remind students that the *distance* (in this case, the unit if measurement is the metric meter) and the *direction* are two distance pieces of information about a coordinate. Coordinates can be positive or negative in sign, and correspond to the compass directions: north, south, east, and west. By convention, we label map coordinates to the north and east of the ***origin*** as positive, and coordinates to the south and west as negative. The coordinate plane is divided into four ***quadrants*** based on these directions: NE (1st quadrant), NW (2nd), SW (3rd), and SE (4th). Students may wish to label the four quadrants (both by number and by compass direction) in the margins of their map.

Students may continue to proceed through the activity sheet at their own pace or in small groups. Be sure that they can identify the northwest (2nd) quadrant of the map prior to starting the questions.

Forest on Fire! Guide (Questions 1-16, and final summary questions)

1) Answers might include: North Pine Forest, South Pine Forest, on top of Paha Hill, etc.
2) Answers might include: campsite, Hehaka Meadow, North Pine Forest, etc.
3) A fire in a forest is more dangerous because of the fuel that exists in the forest. Also, fire can spread throughout a forest much more quickly as it jumps from branch to branch. Fires also spread more quickly through trees if windy conditions exist.
4) Forests are dark green on the screen, and appear to have a rougher texture (or density).
5) Yes. Answers might include: At the coordinate (-400, 200), or the edge of Hehaka Meadow. There are differences in color (dark vs. light green) and texture (forest density).
6) (550, 1100)
7) Answers will vary. Students might suggest measuring the distance with a string, and then using the scale at the bottom of the map to measure the string. Using this method, students should get an answer around 1,250 meters.
8) The first (Northeast) and fourth (Southeast) quadrants.

9) A campsite
10) Answers will vary, but might include a campfire.
11) Campfire.
12) The density of the forest at the place of the fire is medium to high relative to other areas. Only along the southeast edge of Lake Tatanka is the forest more dense than where the fire currently exists.
13) The Logged Patch
14) Answers will vary depending on how accurately students have outlined the fire region. The correct answer is about 100-150 meters if you walked <u>in a northwest direction</u> from the western most part of the fire. If you were to walk <u>straight west</u> (from the western-most part of the fire) to this less densely forested area, it would be almost exactly 200 meters.
15) No, because there is less fuel for the fire.
16) The fire is roughly 600 meters from the shore at its shortest distance. If the fire travels straight north at 10 meters per minute, the following ratio table can be used to determine that it will take 60 minutes to go 600 meters.



17) Answers will vary. Be sure to check that students are using terminology and tools developed in the lesson (e.g., the directions, coordinates, quadrants, etc.)

<u>Final Assessment Questions</u>. The final questions are intended to provide teachers with an opportunity to assess students' understandings of the math and science concepts of the lessons. Answers will vary, and could lead to a good discussion as students compare and contrast their understandings of the content of the activity.

<u>Possible Answers:</u>

1) A quadrant is one-fourth of the coordinate plane. Quadrants are defined by the intersection of the vertical and horizontal axes.

2) Quadrants provide a uniform system through which maps can be read, and data can be displayed. They are helpful in determining scales, distances, and locations represented on a map or image.

3) Satellite images provide data about the surface of the earth. For example, images can indicate where forests may be more or less dense, meadows, sources of water, etc.

4) North: Vertical (up) from the origin; represented with positive numbers.
South: Vertical (down) from the origin; represented with negative numbers.
East: Horizontal (right) from the origin; represented with positive numbers.
West: Horizontal (left) from the origin; represented with negative numbers.

4. **Lesson Three: Forest Fires Interactive Slideshow**

The third activity of this lesson is designed to help students think about the ecological issues associated with wildfires and, in particular, the human practice of fire suppression. This photo essay (Forest Fires Interactive Slideshow) contains a number of images and photographs with accompanying questions. If possible, students should view these images on the computer or with a projection device. (They will be able to use photocopies of the activity if computers and/or color projections are not available.)

Answers to the questions posed with each photograph/image will vary. Use this opportunity to engage students in group or class discussions around the questions and the important ecological issues they describe. In the **Extensions** section of the lesson plan below, there is a listing of helpful facts and information about ecology and forest fire suppression. Teachers may wish to review this information prior to engaging students in discussion about the Forest Fires Interactive Slideshow.

Responses to the **final summary assessment** questions on the photo essay include:

1) Possible benefits of fire include (see extension section below):

- Promotes new growth for many plant species by clearing away dead underbrush; sunlight striking the ground can warm the soil and more light is available for growth.
- Improves nutritional quality of plants for both wild and domestic animals.
- Enhances nutrient cycling and enriches soil.
- Maintains/creates conditions that some plants and animals need for survival.
- Results in a more varied forest habitat.
- Prevents the development of conditions that would lead to larger, more destructive fires (i.e., the accumulation of lots of dead wood and plant material that would become fuel for a fire.)

2) Answers will vary. Possible responses include that the forest will become cluttered with dead wood and plants (providing fuel that would make a larger fire more likely), new plant growth is slowed, etc.

IV. Assessment

Throughout this lesson, look for opportunities to assess children's thinking about the way that the coordinate plane can help us understand and use maps to describe locations and determine distances. In particular, look for opportunities to assess your students' understanding of the four quadrants and the meaning of the positive and negative numbers associated with each. Students should also be assessed on the connections between satellite images and corresponding maps and the ways that each can assist in locating and managing forest fires. Ideas about the ecological implications of forest fires are presented in the third set of activities, and can also be used as a site for assessing students' understanding of the concepts in this lesson.

Specific opportunities for assessment include:

- **Final Assessment Questions** (found at the end of the Forest on Fire Activity Sheet)
- **Final Assessment Questions** (found at the end of the Forest Fires Interactive Slideshow)

Lesson Extensions for Authentic Assessment

1. As mentioned in the lesson plan above, many species are dependent upon fires in order to be successful in their own growth and reproduction. The following table summarizes just a few of these relationships. Students may wish to explore the ideas contained below in more detail, perhaps culminating in a written report or story that highlights a balanced view of both the good and bad elements of forest fires.

Species	Occurrence	Did you know?
Venus fly trap	North and South Carolina	Venus fly traps are highly dependent upon frequent low-intensity fires so that they don't become shaded out by tall grasses. Venus fly traps can increase their numbers by 5 times after such a fire. With fires, the nutrient nitrogen often goes into the atmosphere. So these ingenious plants get much of their necessary nitrogen from the insects they digest! Fire suppression across the Venus fly trap range has greatly decreased its habitat, but prescribed fire programs are now in place to restore populations of the fly trap.
Venus fly trap moth	North and South Carolina	The caterpillar of this moth relies entirely upon the Venus fly trap for its food. So it is even rarer than the Venus fly trap itself!

Pitcher plant	SE United States	Like the Venus fly trap, this insect-eating species can be out-competed by other species without annual fires. Also like the fly trap, its numbers are declining across its range due to fire suppression.
Lodgepole pine	Western United States	Lodgepole pine have very tight cones which can only be opened by a hot fire. After a fire, the cones split apart, distributing the new seeds for regrowth.
Giant Sequoia	California	Giant Sequoia are extremely large trees that have very thick, fire-resistant bark. It has been found that some Giant Sequoia have bark that is one meter thick! Some Giant Sequoia have been found to be over 3000 years old. Over the lifetime of one of these magnificent trees, it may withstand hundreds of small ground fires. However, with fire suppression, other trees have been able to grow in the understory of the Giant Sequoia and can carry ground flames up to the lower branches of the giant trees. These flames can then burn the entire forest-including the Sequoia.

The following information lists some of the benefits and downsides of fire. Along with the above species information, summarize these points on the board and engage students in a discussion of fires, both in terms of their impacts on ecosystems as well as their impacts on human life. Can we learn to live with fires? What can people do to better live in fire-prone areas? *(Build fire-resistant structures, thin out plants around structures, develop a positive attitude towards living in an ecosystem that experiences, and is dependent upon, frequent fires,*)

(The following information is taken from G.W. Tanner, W.R. Marion, and J.J. Mullahey, "Understanding Fire: Nature's Land Management Tool", University of Florida Cooperative Extension Service. 1997.)

Ecological benefits of fire

- Promotes flowering of herbaceous species and fruit production of woody species.
- Improves nutritional quality of plants for both wild and domestic animals.
- Enhances nutrient cycling of some elements and elevates soil pH.
- Maintains required habitat conditions for fire-adapted plant and animal species.
- Results in a more heterogeneous and diverse habitat--if natural fires are patchy--leaving pockets of unburned areas.
- Prohibits wildfire conditions from developing (i.e., vast accumulation of highly-flammable,

dead vegetation.)

Negative aspects of fire occurrence

- Temporary (two to twelve months) degradation of aesthetic quality until vegetation recovers.
- Temporary (two to twelve months) displacement of some animal species requiring thick ground cover.
- Some danger of fire leaving a prescribed area.
- Smoke and soot impacting off-site areas.

Negative aspects of fire suppression

- Loss or alteration of native plant and animal species composition.
- Disruption of an ecosystem's functioning (e.g., mineral cycling, plant and animal succession).
- Alteration of a plant community's general appearance.
- Reduction of flowering and production of plants.
- Possibility of uncontrollable wildfires (due to high amount of fuel buildup) that may devastate natural areas, homes, and buildings.