IMAGERS:

The Adventure of Echo the Bat

Teacher's Guide

Unit 2: Remote Sensing

http://imagers.gsfc.nasa.gov

Teacher's Guide

Introduction to Teacher's Guide

Welcome to the IMAGERS Adventure of Echo the Bat Teacher's Guide! The Adventure of Echo the Bat is an interactive web site featuring an Interactive Adventure and Teacher's Guide, which combine to introduce students to remote sensing and biodiversity from a constructivist approach. The Teacher's Guide contains classroom activities and lesson plans that provide a structure to integrate the interactive adventure into the classroom. The activities introduce concepts basic to the understanding of remote sensing including understanding light and the introduction to the electromagnetic spectrum. The Adventure engages students in exploring concepts of remote sensing and biodiversity. After completing the Adventure, these concepts are reinforced back in the classroom with hands-on activities provided in the Teacher's Guide.

Participants begin with classroom activities from the Understanding Light unit. The activities allow students to explore the concepts of light. They continue investigating different electromagnetic energy with the IMAGERS Electromagnetic Spectrum web site. After introductory remote sensing activities, they start the interactive component of the IMAGERS site. A story of Echo the Bat sets the stage for the interactive adventure using a Landsat mosaic of Arizona as the interface. Students need to interpret satellite imagery to receive clues to Echo's location. As students find Echo, additional content about remote sensing and biodiversity is introduced. This web site provides teachers with a vehicle for introducing complex content that can be reinforced back in the classroom through the Remote Sensing and Biodiversity units

We created three thematic units targeted for grades 5-8: Understanding Light, Remote Sensing, and Biodiversity. Within each unit, you will find lesson plans, reproducible worksheets, visuals, and links to useful resources. The lesson plans are organized according to the 5-E constructivist model.

Engagement: capture attention, stimulate their thinking, assess their prior knowledge
Exploration: activity to introduce concept, an investigation
Explanation: discussion of concept, analysis of their exploration
Extension: apply concept to real world situation, expand their understanding
Evaluation: a short activity to assess students' understanding

Though IMAGERS is intended for grades 5-8, we encourage you to customize the activities to fit your class and curriculum. Depending on your students' prior knowledge, you may choose to expand or omit certain activities. See Appendix A for specific national and local standards covered in our lesson. We hope IMAGERS enables you to introduce new and exciting science concepts to your students through interactive multimedia and constructivist activities. Happy exploring!

Josephine To, SSAI, &
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http://imagers.gsfc.nasa.gov

IMAGERS: Unit II Remote Sensing

Students begin their study of remote sensing in Lesson 1 **What are we looking at?** Students are introduced to different perspectives of viewing the Earth and their uses. This activity leads them to seeing the Earth from a satellite perspective. Before actually looking at satellite imagery, students learn about satellites and their components by building a satellite model in Lesson 2 **What are Satellites?** In Lesson 3, students begin to interpret satellite imagery in the **Adventure of Echo the Bat**. They model how satellites transmit data in Lesson 4 **How do Satellites Work?** In Lesson 5 **Interpreting Satellite Images**, students study images and identify land features.

LESSON 1 - What are we looking at?

Students will:

- Discuss the advantages of different perspectives.

Materials Needed:

Pennies (per student or group)
4 perspective pictures

Engagement

Take students to a grassy area outside and give them a random number of pennies. Tell them that they are farmers and they need to study their land. The pennies will represent the dead crops on their farm and the grass will represent their land. Have them toss the pennies onto the grass. Then, have them lay on their stomach on the grass, so that they are at eye-level with the grass, and count the pennies. Then, have them stand up and count the pennies. Bring them back to the classroom and ask "As a farmer, would you rather study your farm from the ground or from the air? Why?" Discuss briefly.

Exploration

Begin the activity by reading this scenario to students. "Farmer John noticed that plants growing next to the river were sick. He thinks it could be the water." Show picture 1. Ask students to form hypotheses on what could affect the water quality of the river. Create a list on the board. One prediction may be the train. Continue by showing picture 2. Ask students if this picture changes their hypotheses. Have them modify their list. Repeat this procedure for pictures 3 and 4.

Explanation

Discuss the advantages of the various pictures. Compare this with satellite images. Ask students why people would use satellite images rather than photos taken from the ground.

Extension

Ask students to watch the weather forecast on television for the next three days. Have them compare and contrast the local weather image and the national weather image. Which one provides more information? Which image allows them to predict next week's weather?

Evaluation

Have students write a scenario where an aerial or satellite perspective would give them more information than photos taken from the ground.

Tips for Teachers

- Perspective pictures - If student copies cannot be provided, print color transparencies. Or, if possible, display the web site on a television in the classroom.

Perspective Pictures

Image 1

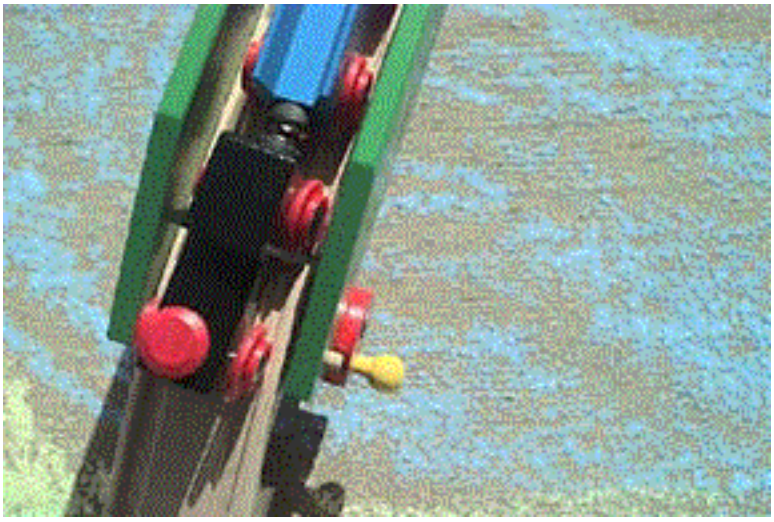


Image 2

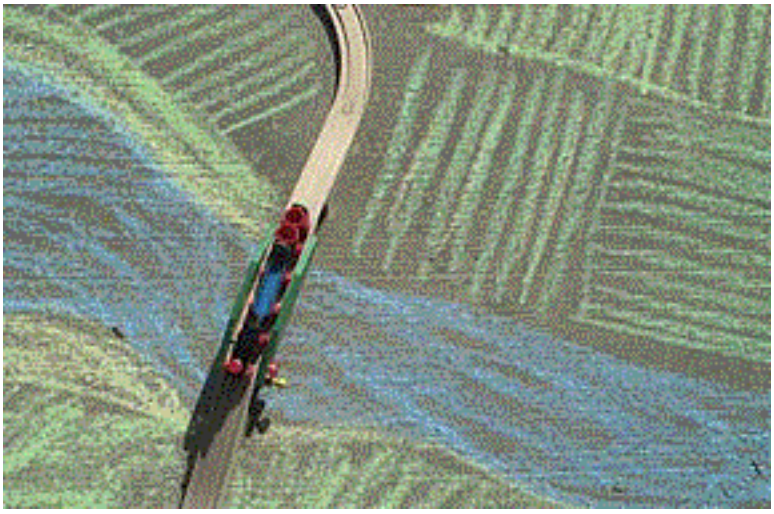
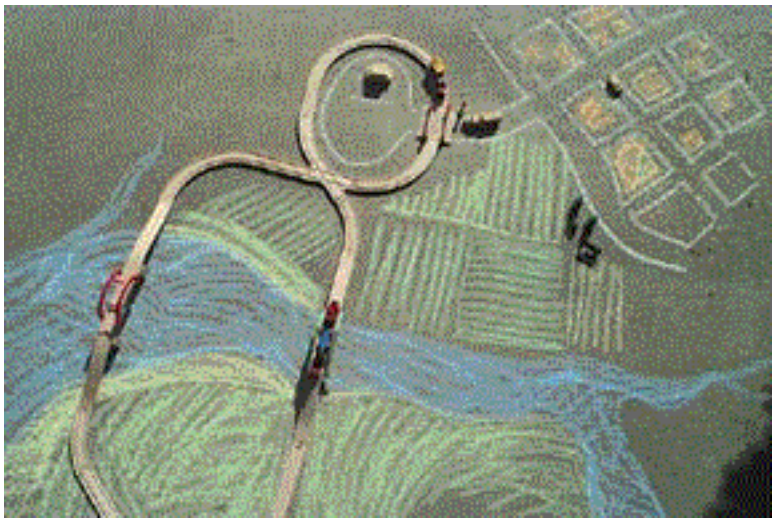


Image 3

Image 4



LESSON 2 - What are satellites?

Students will:

- Differentiate between natural satellites and artificial satellites.
- Create a model of an artificial satellite.

Materials Needed:

Satellite worksheet
Worksheet answer key
Pictures of satellites
Materials for satellite construction (see Tips for Teachers)

Engagement

Ask students "what are satellites?" Have them list what they think the characteristics of satellites are (they orbit in space, used to get information, etc.) Using this list, have them create a definition of satellites. A simple definition of a satellite is a free-flying object that orbits the Earth, another planet, or the sun. Ask them to name some types of satellites. Students may not know the specific names of the satellites or may say space, weather, television, or communications satellites. Lead them to distinguish between natural satellites and artificial satellites. The moon and the planets are natural satellites. Each orbits another object. Artificial satellites are man-made, such as weather satellites. The sun is not a satellite.

Exploration

Continue the lesson by introducing students to the parts of a satellite. Give each student the satellite worksheet. In this activity, students will make a model of an artificial satellite. (This activity may be done as an extended project or a group project.) Review the components of the satellite and their conditions. Have students work together on the conversions before constructing their satellite.

Explanation

When students complete the project, have them present their model to the class. Review the role of each component. Discuss their importance. Help students understand how each part depends on other parts. (See answer key.)

Extension

Show students pictures of actual satellites. Relate their constructed models to the pictures. Ask students to identify the components of the satellites .

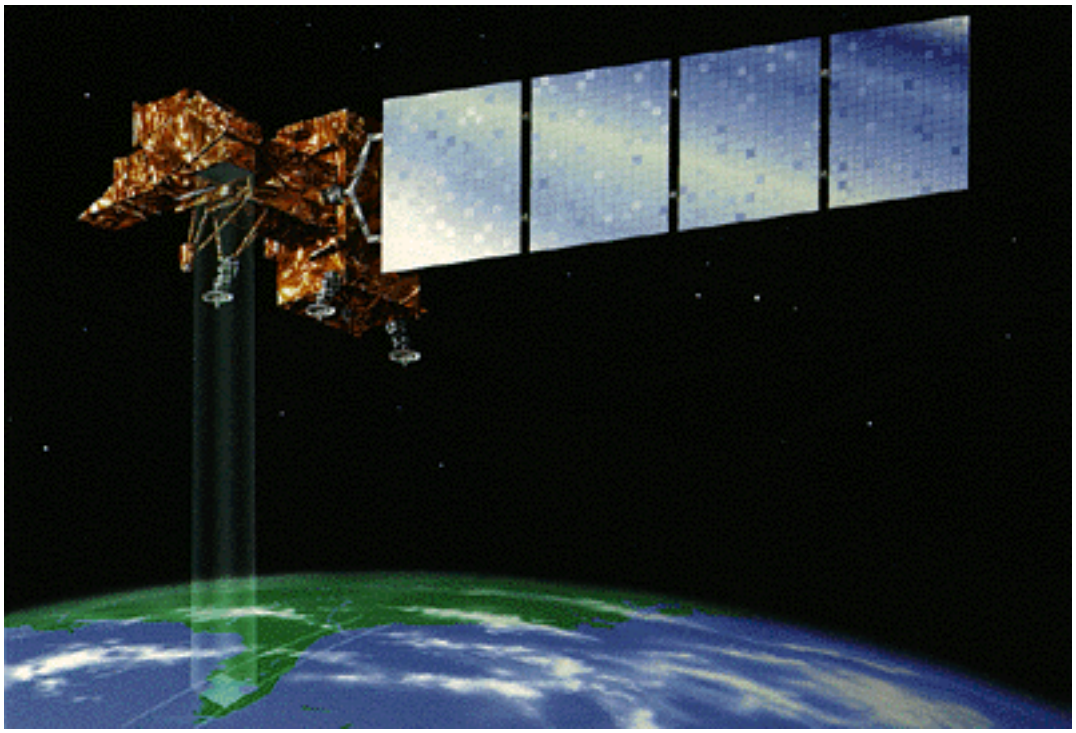
Evaluation

Have students write a paragraph describing their model and its components. Assess their model for correct measurements.

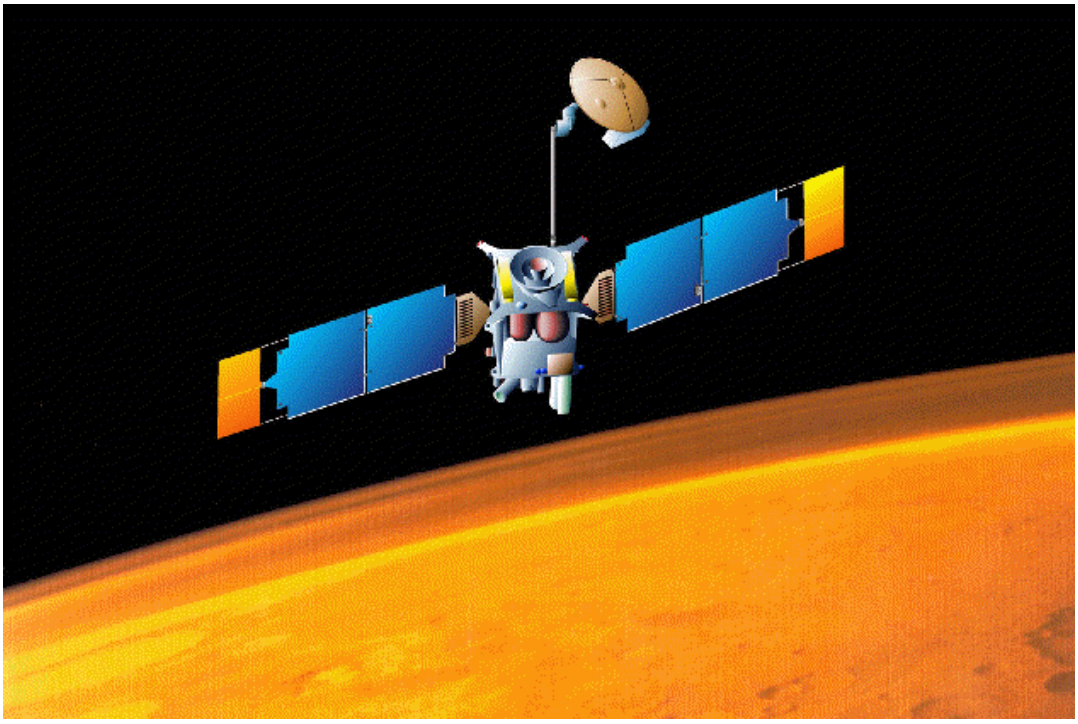
Tips for Teachers

- Suggestions for satellite model materials - styrofoam food trays from grocery stores, toothpicks, cardboard, egg cartons, and aluminum foil.
- Provide books on satellites as a reference for students to use during this project. See Remote Sensing Resources list.
- For more satellite pictures, see *Index of NASA Satellites on Spacelink* http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Space.Science/Satellites/

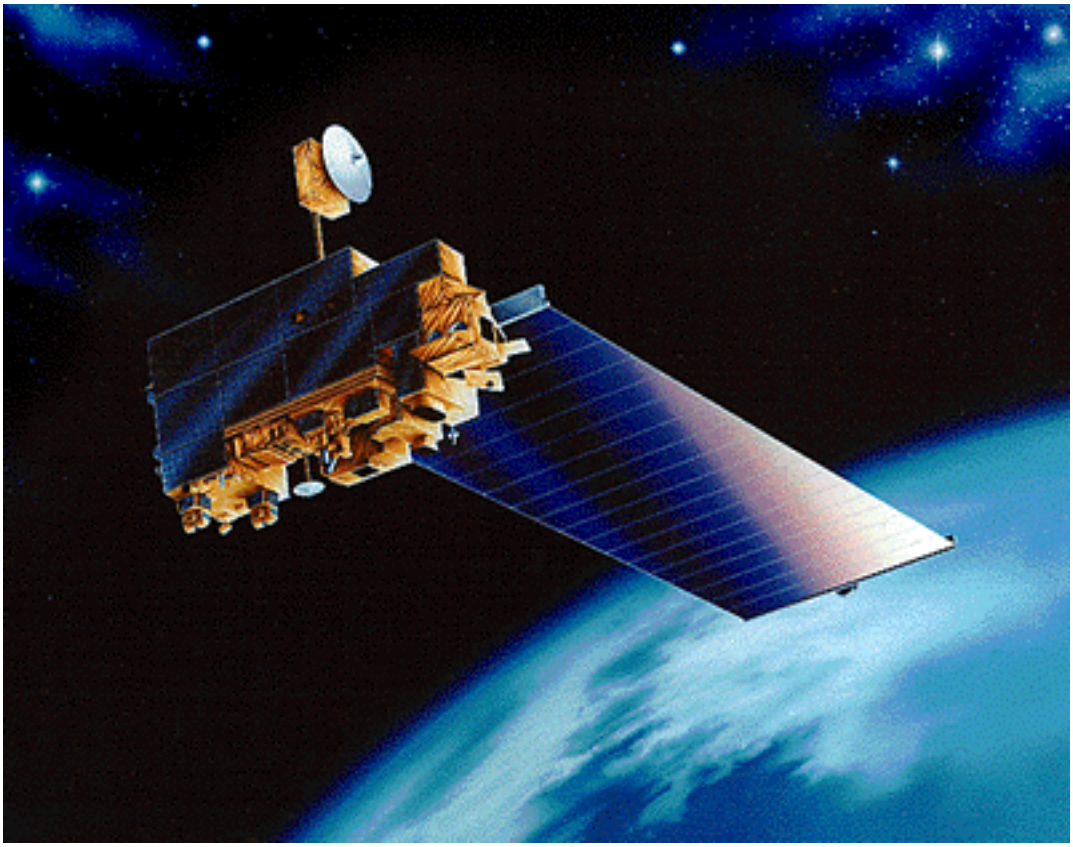
Pictures of Satellites



Landsat 7



Mars Global Surveyor



EOS AM-1

NAME_____ **DATE**_____

Construct a Satellite

Your mission is to design and build a satellite that will gather information about the Earth's surface. Before engineers at NASA can build the satellite, they need to see a model.. Using the information provided below, design and build a model satellite.

SCALE - 1cm : 250 cm (1 cm on your model = 250 centimeters in actual size)

Six Subsystems of the satellite (measurements are given in actual size)

1. Instrument package & computer

The instrument package contains all the sensors used to gather information about the Earth's surface. The computer receives instructions from ground control and tells the instruments when to turn on and off. The actual size of the instrument package & computer will be a one meter cube. The instruments require 500 watts of power and the computer requires 75 watts of power.

2. Receiving antenna

The receiving antenna is required to receive instructions from scientists on the ground. The scientists plan to send 1 signal per orbit, which requires 25 Watts of power for each reception. The actual size of the dish antenna is .25 meters in diameter.

3. Sending antenna

The sending antenna is used to send information collected by the sensors back to Earth. This transmission of data will happen twice per orbit and require 25 Watts per transmission. The actual size of the dish antenna is .25 meters in diameter.

4. Data Recorder

The data collected by the sensors are recorded and saved until the data can be transmitted to Earth. The units actual size is a .25 meter cube. Recording of the data requires 100 watts per orbit and playback for transmission requires 50 watts per send.

5. Battery (power source)

Two batteries are needed to power the satellite. Every .5 meter cube of battery can store up to 250 watts per orbit. The battery can fully recharge in 50 minutes. Batteries must be large enough to store two times the amount of energy required to run the satellite for one orbit.

6. Solar Array

A solar array is a collection of solar panels that work together to collect energy from the sun. The solar array must produce twice the amount of energy needed to run the satellite in order to charge the batteries. Each solar panel is .25 meters square. Each square can produce 17 watts of energy to charge the battery.

Hint: Figure out how much energy is required to operate the satellite for one day. Use that number to figure out what size to model the batteries and solar array

Construct a Satellite - Answers

Energy required

1. Instrument and computer require 575 watts
2. The receiving antenna requires 25 watts per orbit
3. The sending antenna requires (2 x 25) 50 watts per orbit
4. The tape back-up requires 100 watts to record + (2 x 50) 100 watts to playback

The satellite requires 850 watts per orbit to function.

5. Two batteries are needed to store twice the required energy for the satellite. Therefore, each battery must be hold 850 watts of power. Each battery is 1.7 meters in actual size.
6. The solar array must produce (850 x 2) 1700 watts of power.
   17 watts per square 1/4 meter
   68 watts per square meter
   1700 watts / 68 watts = 25
   Actual size of solar array is 25 square meters.

LESSON 3 - The Adventure of Echo the Bat

Students will:

- Compare different habitats based on satellite imagery.
- Identify land features in the satellite imagery.

Materials Needed:

Rulers
Adventure map worksheet
Worksheet – choose either or both content focuses
- Remote Sensing
- Biodiversity

Worksheet answer keys
Arizona Landsat mosaic
Computer access required for student or group of students

Engagement

How could satellite images help scientists study animals? Have students hypothesize what characteristics of satellite imagery can be of benefit to animals. For example, can you see houses from space? No. Can you see cities from space? Yes. Who lives in cities? People. Where do animals live? Forests, rivers, oceans, etc. Can you see their habitats from space? Yes!

Exploration

The Adventure of Echo the Bat is an interactive web site. Students will need access to a computer equipped with a 4.0 web browser to participate in this activity. Students begin the adventure by selecting the "Echo the Bat" section of the Student's Site.

A content map is available at http://imagers.gsfc.nasa.gov/teachersite/content.html for teachers to view the content independent of the adventure interaction.

The adventure begins with a short story about Echo the Bat. Echo is separated from his mother by a forest fire at the end of the story. Echo has to migrate to a cave somewhere in southern Arizona to meet his mother again. The Story Intro sets the stage for the interactive adventure. Using the Adventure Map, the students will map Echo's movements as he travels through Arizona. The worksheet asks questions which are answered throughout the adventure. This requires them to look more closely at the content presented. Approximate time to complete the adventure is 35-45 minutes. Depending on the computer experience of the students, it may be even faster.

Follow up the adventure with the math questions at the end of the worksheet. Students will need a ruler for this exercise.

Explanation

The adventure introduces identifying land features and interpreting the colors of satellite imagery. From this, content is introduced about how scientist can identify habitats in the satellite imagery and students are asked to find Echo in a habitat visible in the satellite image.

Application of satellite imagery for studying biodiversity - Satellite imagery is used to identify and locate different habitats. By knowing the habitats, scientists can predict what types of animals should be living in that location. Then, scientists can go visit that location to conduct a field study to confirm their predictions. By identifying and counting the animals in a particular habitat, scientists can determine whether that habitat is biodiverse. See unit 3 on biodiversity.

Extension

Print out the Arizona Landsat mosaic. Have students pick three points on the image. Ask them to write a paragraph about the land features and animals they would see at each point. Then, using an atlas and other resources, have them check there answers by comparing the Landsat image with the map. Hint: If they can identify a location (city or mountain range) they could use other resources to identify the habitat.

If a color printer is not available, have students view the Arizona Landsat mosaic provided on the Remote Sensing section of the student's site:(http://imagers.gsfc.nasa.gov/teachersite/rs_student.html")

Evaluation

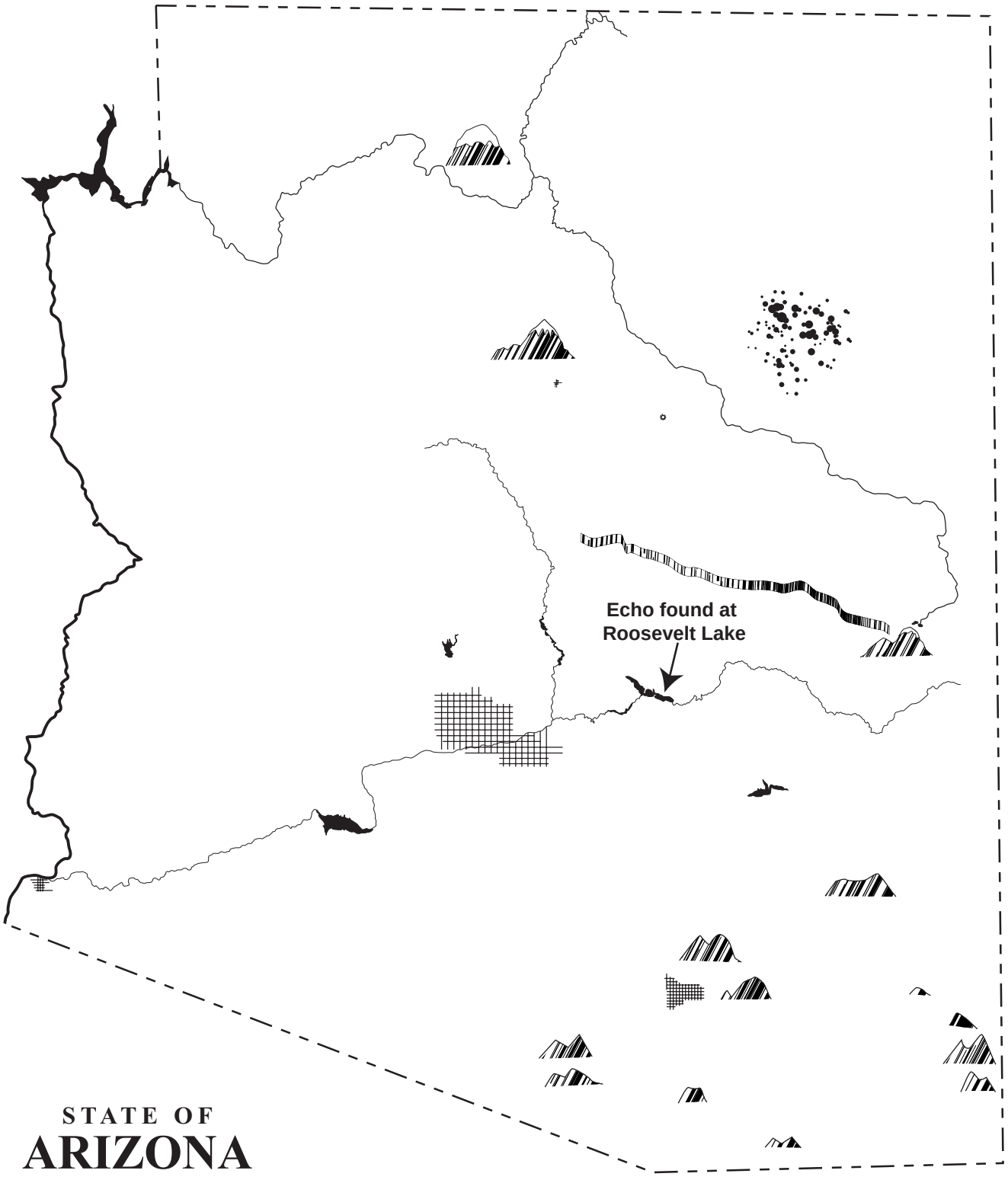
Use the writing sample to assess their knowledge of identifying land features and habitats from a satellite image.

Tips for Teachers

- The computer portion of this activity may be done individually or in groups of two or three.
- If time is limited, omit the worksheet activity. Then present the math questions at the next class period. They only need there adventure maps to work the math problems.

NAME_____ **DATE**_____

The Adventure of Echo the Bat - Adventure Map



NAME_____ **DATE**_____

The Adventure of Echo the Bat (remote sensing)

As you follow Echo, list 10 land features visible from space and describe how each one looks from space.

Ex: Roosevelt Lake (or Lake) Solid black area, connected to small black lines

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

At the end of the Adventure, calculate the distance Echo traveled. Use Lake Roosevelt to determine the scale of your Adventure map then measure the distance between each location you found Echo. Lake Roosevelt is 25 km long.

Scale of Adventure Map: _____ cm = _____km

Calculate distances between the habitats Echo visited:

From Roosevelt Lake to location 2 : _____ cm = _____km
From location 2 to location 3 : _____ cm = _____km
From location 3 to location 4 : _____ cm = _____km
From location 4 to location 5 : _____ cm = _____km
From location 5 to location 6 : _____ cm = _____km

Total distance Echo traveled: _____ cm = _____km

NAME_____ **DATE**_____

The Adventure of Echo the Bat (biodiversity)

Directions: Read through the following questions before starting the adventure. Then answer the questions as you follow Echo.

1. **What kind of Bat is Echo?** _____

2. **List places where Echo found food.**

_____ _____

_____ _____

3. **Identify and count the animals in the Sonoran Desert picture.**

Name of Animal	How Many ?	Name of animal	How Many?
_____		_____	
_____		_____	
_____		_____	

4. Echo can eat 15 insects in one minute. He spends 90 minutes eating in the morning and 90 minutes eating at night. How many bugs does Echo eat in one day? In 5 days?

Scale of Adventure Map: _____ cm = _____ km

Because it takes so much energy to fly, Echo must eat as he flies. Therefore, he can only fly 3 hours in a day. Echo can fly 10 km in 90 minutes. How long will it take him to fly from Lake Roosevelt to Phoenix? How many bugs will he need to eat between Roosevelt Lake and Phoenix?

_____

BONUS QUESTION: How many bugs will Echo eat as he travels from Lake Roosevelt to the cave at the end of his adventure?

The Adventure of Echo the Bat
Answer Key to Worksheets

Remote Sensing Worksheet

Part 1 : Sample list of land features and their descriptions:

Red areas = forest (Signal Peak/ Mogollon Rim)
Grid pattern of cyan (bluish) lines = city of Phoenix / Tuscon
Black lines = rivers (Salt River / Little Colorado River / Gila River)
Red square patterns = Crops of vegetation on a farm
Red areas following a black line = riparian area aside a river (L. Colorado River)
Red square pattern along a black line = farm irrigation along a river (Gila River)
Dark areas in white sand areas = exposed rock outcrops in the desert

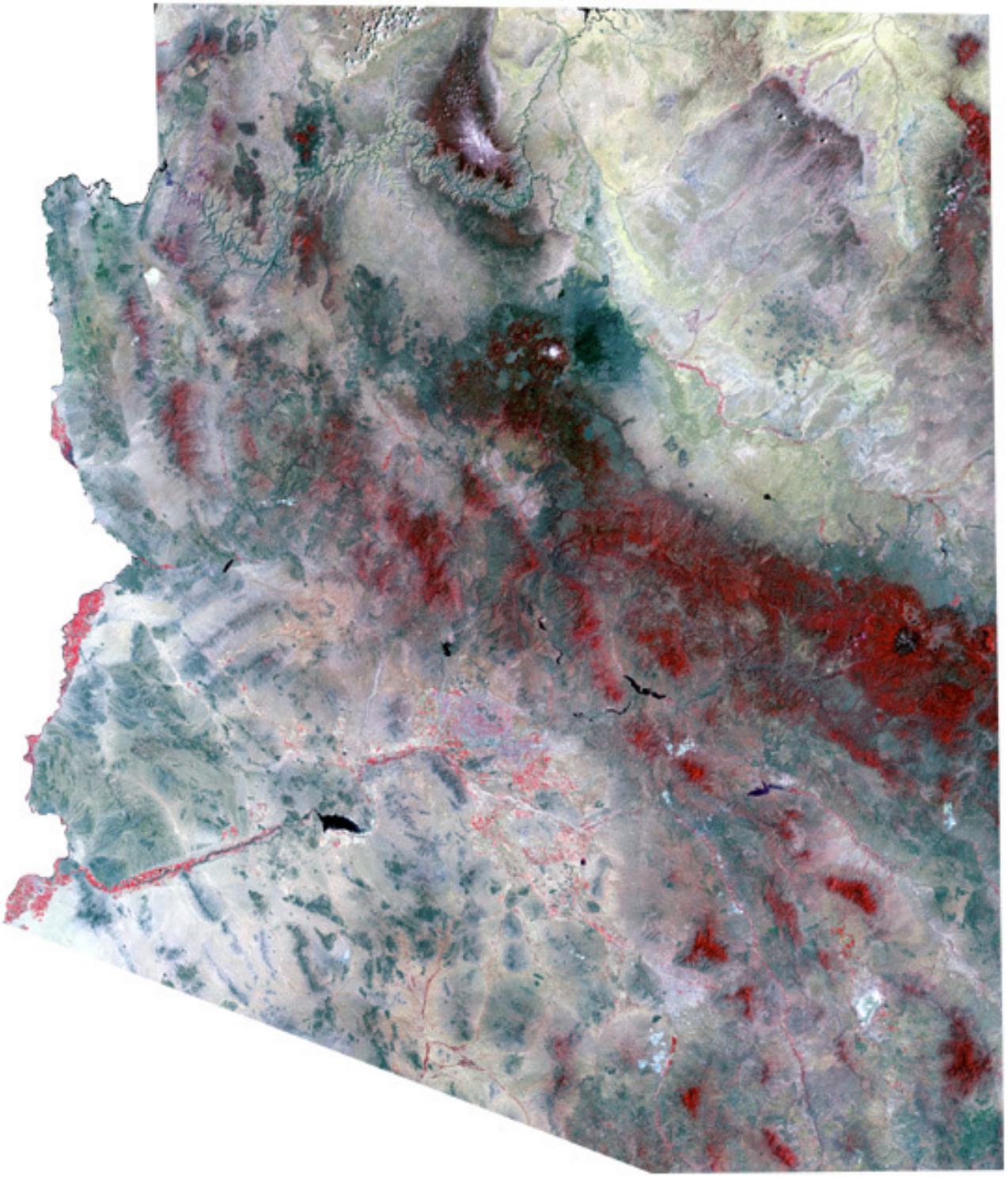
Part 2

Scale of Adventure Map: 1 cm = 25 km
From Roosevelt Lake to Phoenix: ~2.5 cm = 62.5 km
From Phoenix to Grand Canyon (near Kaibab Plateau): ~9.5 cm = 237.5 km
From Grand Canyon to Mogollon Rim (near White Mountains): 12 cm = 300 km
From Mogollon Rim to Sonoran Desert: ~14 cm = 350 km
From Sonoran Desert to Chiricuahua Mountains: ~14 cm = 350 km
Total distance traveled: 52 cm = 1300 km

Biodiversity Worksheet

1. Echo is a Big Brown Bat (Eptesicus fuscus)
2. Places where Echo food: Street Lights of Phoenix, Colorado River in the Grand Canyon, Pine Forest of the Mogollon Rim, Organ Pipe Cactus National Park.
3. Animals in the Sonoran Desert
   2 Road runners
   3 Javalinas
   1 Racoon
   1 Gila Monster
   1 Long-nosed snake
   1 Gila Woodpecker
4. Scale of Adventure Map: 1 cm = 25 km
   Echo eats 2700 bugs per day: 15(90) = 1350 * 2 = 2700 bugs
   Echo eats 13,500 bugs in 5 days: 2700 * 5 = 13,500 bugs
   It will take Echo about 3.5 days to fly from Roosevelt Lake to Phoenix.
   He will eat about 9450 bugs during his trip. (3.5 * 2700) = 9450
   Bonus Question: About 175,500 (see above for distance calculations)

Arizona Landsat Mosaic



LESSON 4 - How do satellites work?

Students will:

- Model how satellites transmit data.
- Learn that satellites transmit numbers not images.

Materials Needed:

Digital art worksheet
Manila file folders

Engagement

Ask students to predict how satellites collect information about the earth. Explain to students that today's activity will model how satellites transmit their data to the computers on earth.

Exploration

Give each student the digital art worksheet. Divide the class into groups of two. Have the students read the directions on the worksheet then begin the activity. Provide a manila file folder for each group to use to cover their "data."

Explanation

When students complete the activity, ask them the following questions. Based on this activity, how do satellites transmit data? In reality, what is the sender? What is the receiver? What is the data? What happens to the data when it reaches the "receiver?" Did your partner end up with the same image as yours? Why or why not? Ask students to reflect on their earlier predictions and refine their definition of how satellites transmit data.

Extension

Ask student to predict what would happen to the quality of an image if there were more squares in the grid. What are some advantages or disadvantages? Explain that a grid with more squares would provide finer detail, or more information about the given area.

Evaluation

Ask students to write a letter explaining to an alien in space how humans receive information from satellites.

Tips for Teachers

- Instead of using manila file folders, students can also use their notebooks or textbooks.
- See sample pictures for digital art activity.
- Simple pictures work best - see samples.

NAME_____ **DATE**_____

Digital Art Activity

Directions: (Do this activity with a partner.)

1. In your pair, choose one person to be the "sender" and one to be the "receiver."

2. Label grid A. Above the top row (horizontal), label from left to right using the letters A to J. Next to the far left column (vertical), label from top to bottom using numbers 1 to 10. Check to make sure your grid matches your partner's grid.

3. If you are the sender, draw a simple black-and-white picture by coloring in complete boxes in the grid. Each box should be completely filled or completely empty. **Do not** show your picture to your partner. Use the manila file folder to cover your worksheet.

4. After the sender draws the picture, he/she will "read" their picture to the receiver using a "digital code." The receiver will say "A1." Then, the sender will answer "0" if the box is empty or "1" if the box is filled in.

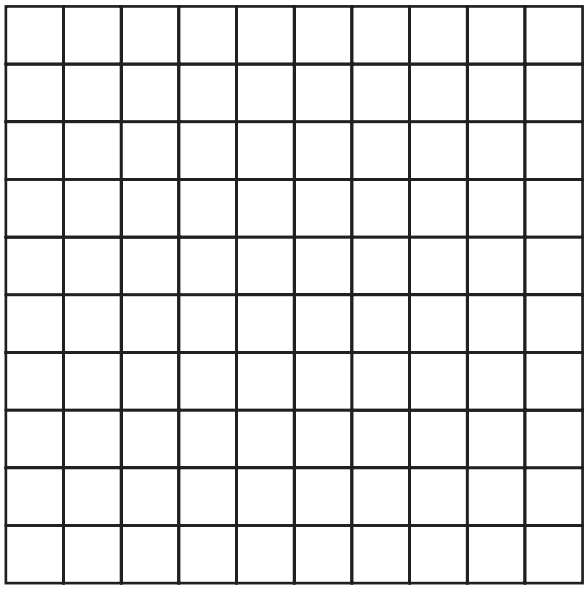
5. Continue step 4 until all the boxes are "read." Compare pictures. Are they the same?

6. Switch roles. Repeat steps 2 through 5.

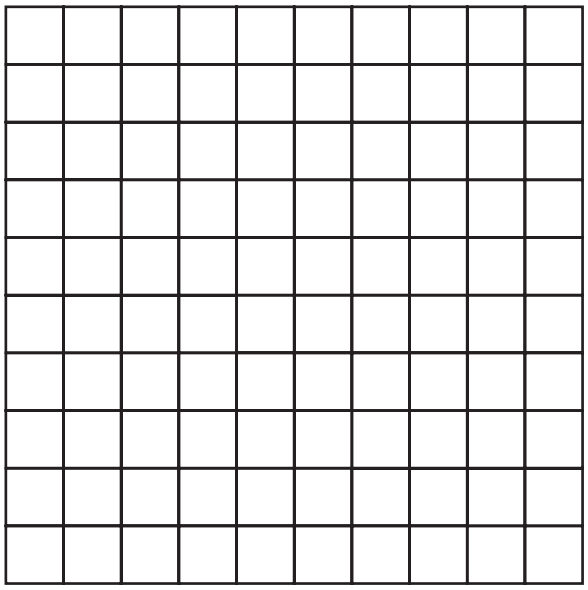
NAME_____ **DATE**_____

Digital Art Worksheet

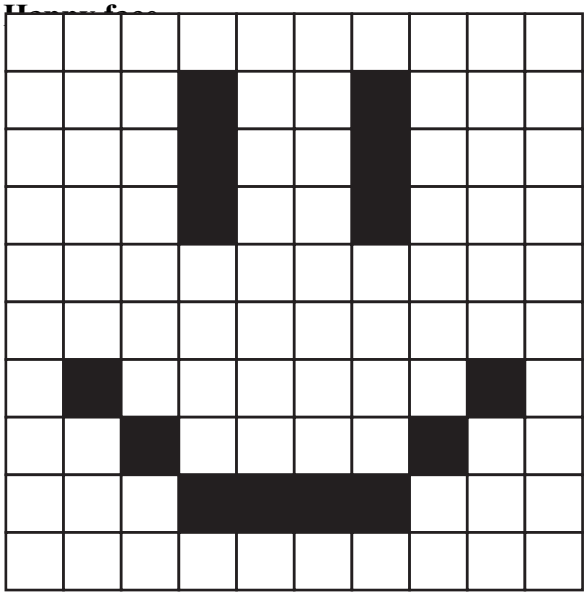
Grid A

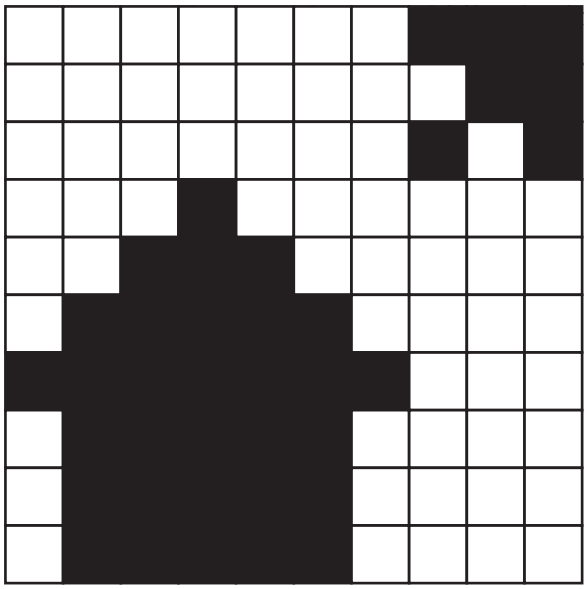


Grid B

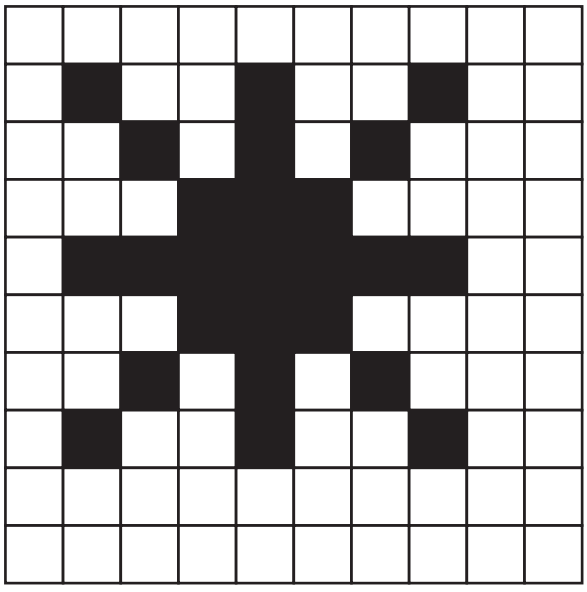


Digital Art Sample Pictures





Star



LESSON 5 - Interpreting satellite images

Students will:

- Identify differences between photography and satellite imagery space.
- Identify features in a satellite image.

Materials Needed:

Images from the Remote Sensing section of the IMAGERS Student's site (http://imagers.gsfc.nasa.gov/student.html)
Interpreting satellite image worksheet
Atlas (1 per student or group)
Computer access required for student or groups of students

Engagement

Begin at the Remote Sensing section of the IMAGERS - Student's Site.

Have students look at the **photograph**, a photo taken from a space shuttle of Phoenix, Arizona. What can they learn about the Earth from this image? Look at the **true color** image. What can they learn about the Earth from this image? How does this image differ from image 1? Lastly, look at the **false color** image. What else can they learn about the Earth from this image? Explain that this is a false color image, created by manipulating satellite data. Discuss with students the difference between a photo and a satellite image.

Exploration

Bring students to the index of the four Landsat images. Give each student the worksheet that accompanies this activity. Have students follow the directions on the worksheet. They will be looking at satellite images for land features and describing what they see under question one. Then, they will look up the latitude and longitude in an atlas to answer questions two and three.

Explanation

Review the activity with students. Discuss the advantages of satellite images over an atlas or a road map. In satellite images, we can see features not always noted on maps such as land features (volcanoes, mountains, etc.), vegetation, sediment and water, geological features (sand dunes, alluvial fans, etc.), and more.

Extension

Show students a satellite image of an area near their school or a familiar land feature. Ask students to interpret the image. Go to the *LANDSAT Images of the U.S.A - Archive* http://www.nasm.edu:2020/RPIF/LANDSAT/ LOYS.html for images of US cities, or see the Remote Sensing Resources list.

Evaluation

Give students a false color image to interpret. Check Remote Sensing Resources list for additional Landsat images. Have students identify land features and write how this image would be useful in studying the earth.

Tips for Teachers

- Have students work in pairs if computers are limited.
- The images can be printed out on a color printer for use in the classroom. Note: black and white copies will be difficult to interpret. Use the computer if a color printer is not available.
- Any satellite images can be used for this activity provided you have the latitude and longitude of the image.

NAME_____ **DATE**_____

Interpreting Satellite Images

Directions: Look at the five images provided on the IMAGERS web site. Pick any two images and answer question 1 for each image. Then get an atlas to answer questions 2 and 3. You will be interpreting these images.

Image 1:_____

1. Predict the features you see in this image, i.e. a lake or river. How do you know?

_____

2. Using the latitude and longitude of the satellite image, locate the image in an atlas. Describe the location, i.e. city, state, etc.

_____

3. For each feature, describe whether your predictions were correct. Explain why.

_____

Image 2:_____

1. Predict the features you see in this image, i.e. a lake or river. How do you know?

_____

2. Using the latitude and longitude of the satellite image, locate the image in an atlas. Describe the location, i.e. city, state, etc.

_____

3. For each feature, describe whether your predictions were correct. Explain why.

_____

Think about it:

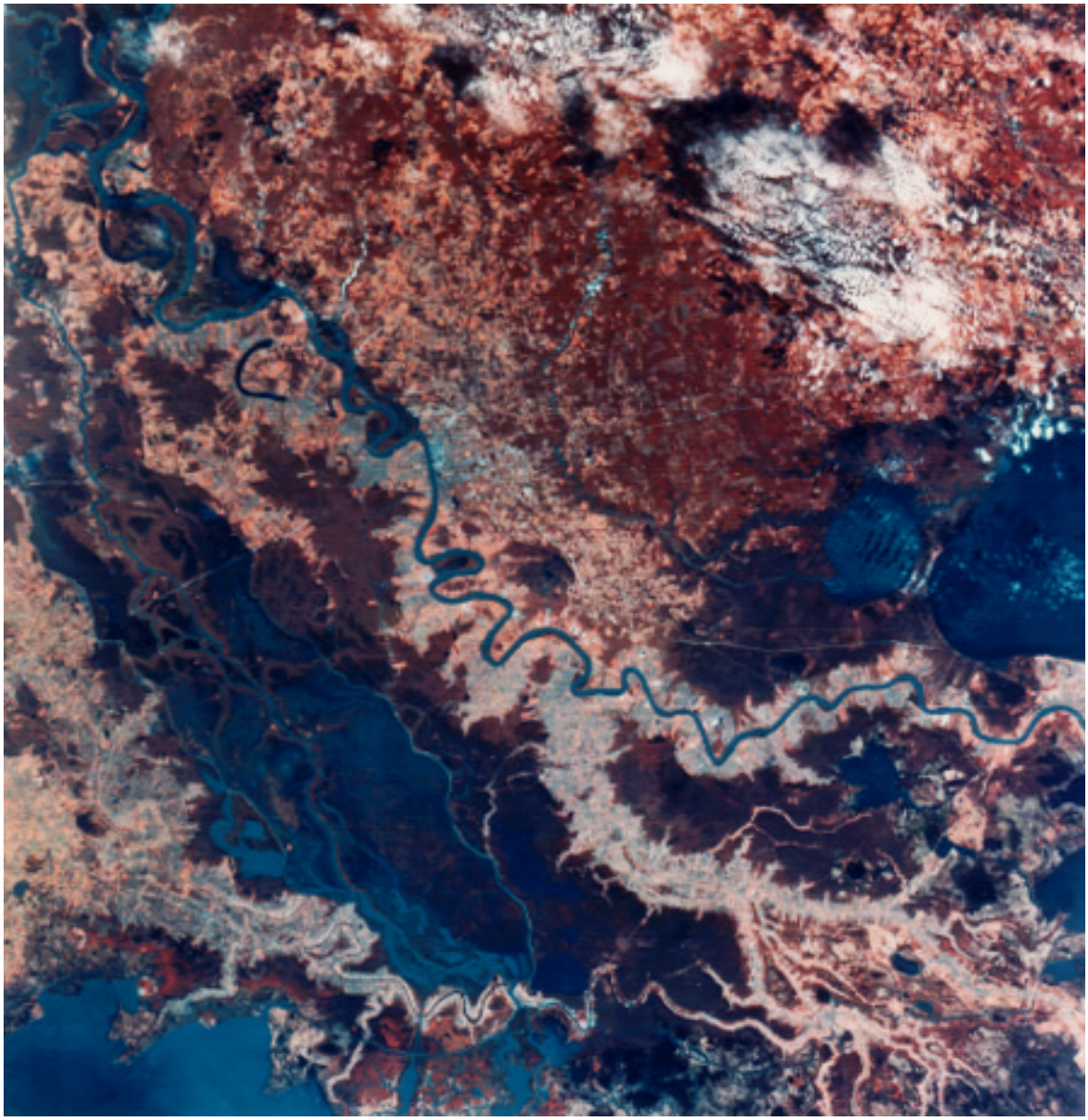
1. What kinds of information can you get from the satellite image that you cannot get from the atlas?

_____

2. What kinds of information can you get from the atlas that you cannot get from the satellite image?

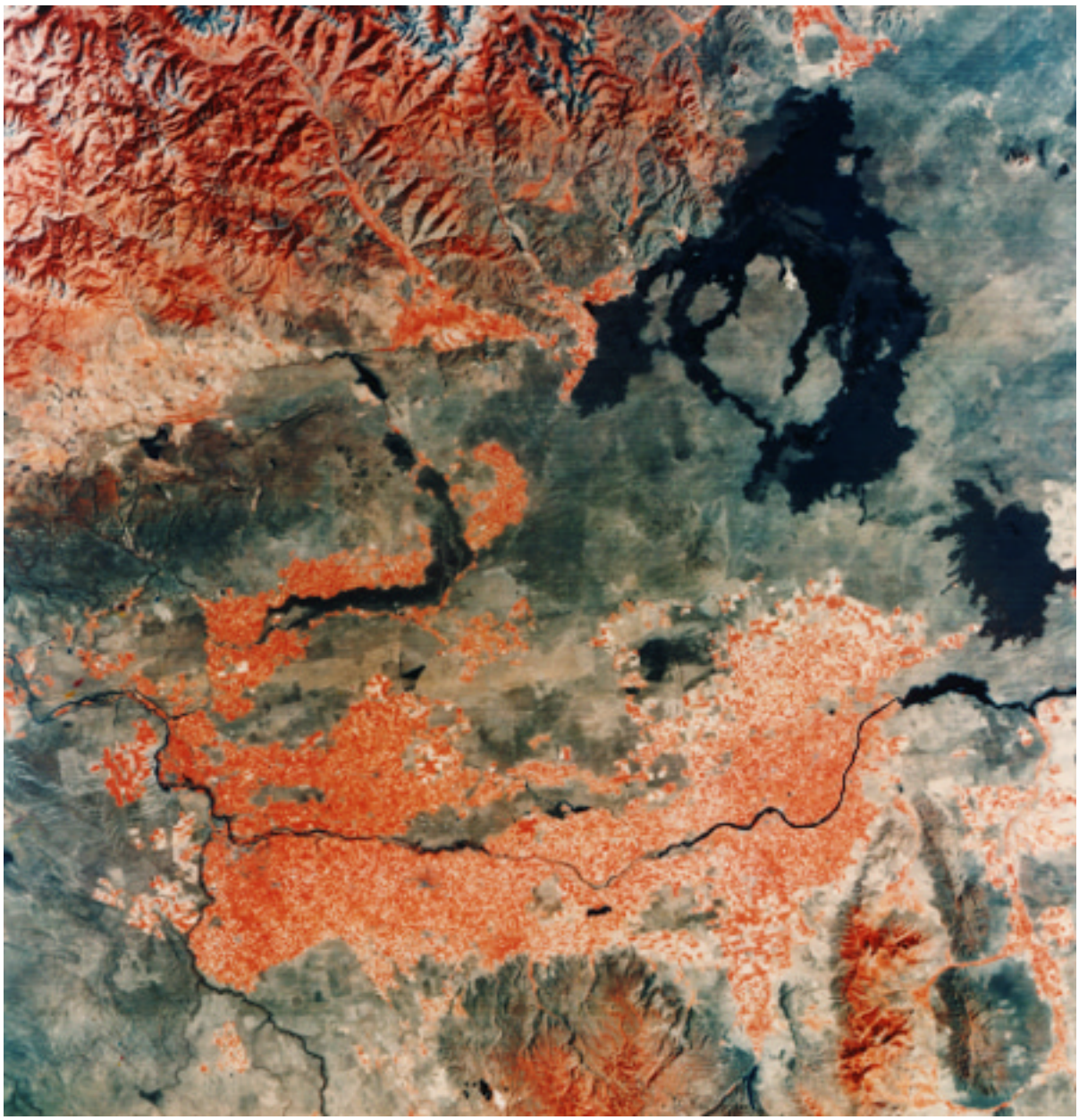
_____

Landsat Images

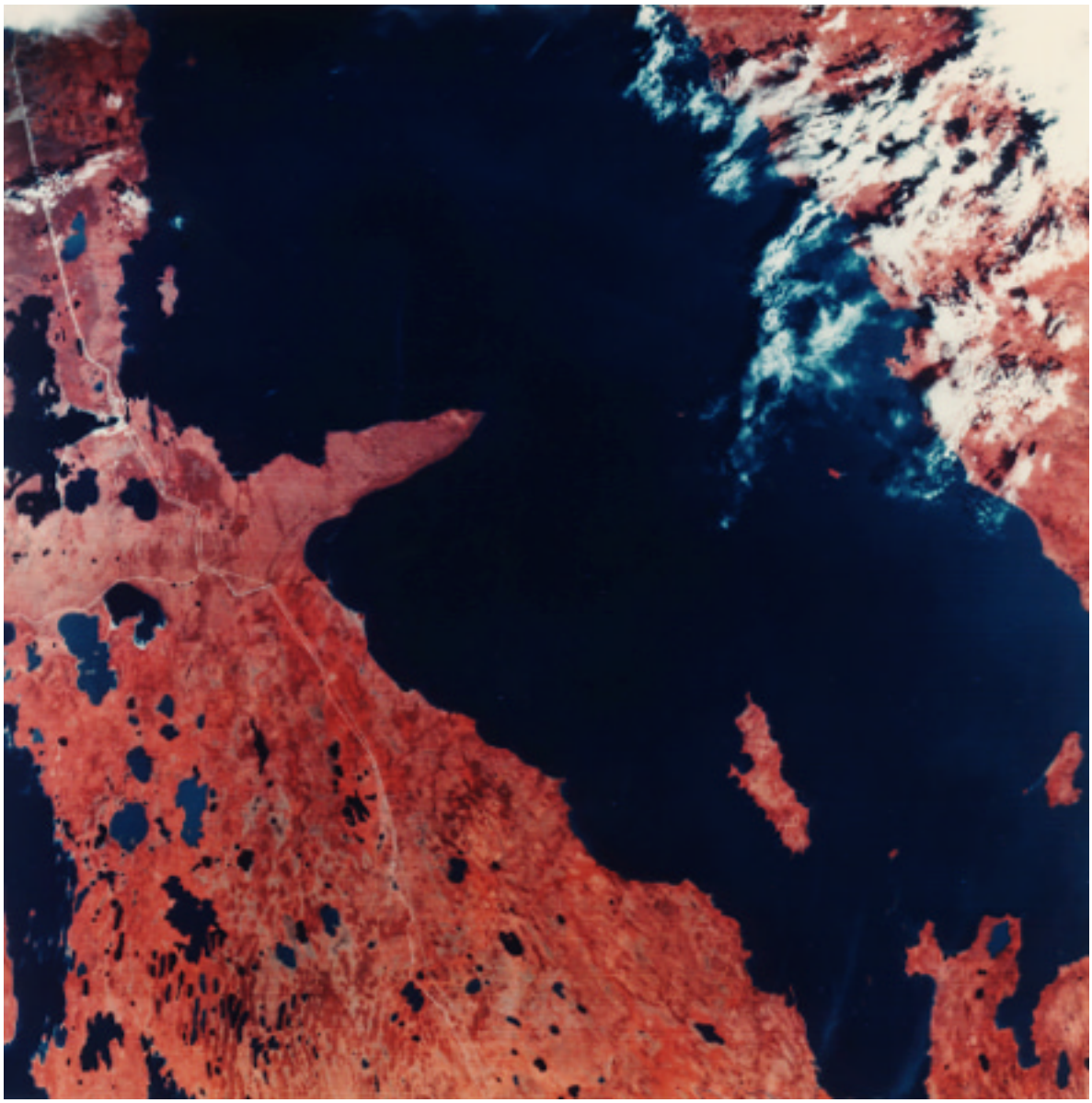


North 30º West 91º

North 36º West 89º



North 43º West 114º



North 52º West 98º

Remote Sensing Resources

Web Sites

- *LANDSAT Images of the U.S.A - Archive* http://www.nasm.edu:2020/RPIF/LANDSAT/ LOYS.html An archive of Landsat 1-3 Multispectral Scanner imagery covering 48 states (excluding Alaska and Hawaii.) Indexed by U.S. states and cities.
- *Space Shuttle Photographs - Web Archive* http://www.nasm.edu/ceps/RPIF/SSFR.html Includes shuttle photography of various locations throughout the world. Compiled by the Center for Earth and Planetary Studies (CEPS) unit within the Collections and Research Department of the National Air and Space Museum, Smithsonian Institution.
- *Geography from Space* http://www.nasm.edu/ceps/GAW/ Test your geographic knowledge using satellite imagery and Space Shuttle and aerial photographs! Read the clue and try to determine the geographic features visible in each image. Appropriate for upper elementary and middle school.
- *Eyes in the Sky: A Remote Sensing Activity* http://observe.ivv.nasa.gov/nasa/exhibits/eyes_sky/home.html A lesson module with a brief overview of remote sensing and an activity in image processing.
- *Learning without Touching: What is Remote Sensing?* http://observe.ivv.nasa.gov/nasa/exhibits/learning/learning_0.html A resource written for students featuring four lessons beginning with an overview of remote sensing, then an introduction to perspectives, concluding with remote sensing and its applications.
- *NASA Observatorium Education Resources* http://observe.ivv.nasa.gov/nasa/education/reference/main.html An extensive list of resources for teachers on remote sensing basics and online tutorials.
- *NASA Spacelink - An Aeronautics and Space Resource for Teachers* http://spacelink.nasa.gov/.index.html A starting point to find educational materials on remote sensing and satellites. Includes search engine and library of NASA publications and web sites.

Books

- Exploring Space by Barbara Bourne and Wendy Saul, Morrow Junior Books, 1994. An activity book on space including an activity on how satellites transmit data. Includes simple photographs.
- Seeing Earth From Space by Patricia Lauber, Orchard Books, 1990. A thorough introduction to remote sensing and its applications for middle school students. Includes photographs from space and satellite images.
- Satellites by David Jefferis, Franklin Watts Ltd., 1987. A general resource on satellites for upper elementary grades. Easy-to-read text and colorful pictures. Includes how a satellite works and its applications.
- Looking Down by Steve Jenkins, Houghton Mifflin Company, 1995. A picture book showing different perspectives of landscape starting from space and ending with a bug's perspective. Excellent cut-paper collage illustrations, no text.

Related Science Standards

Remote Sensing Unit

AAAS Project 2061 Benchmarks

- **3A (6-8)** Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.
- **8D (3-5)** Communication involves coding and decoding information. In any language, both the sender and the receiver have to know the same code, which means that secret codes can be used to keep communication private.
- **8D (6-8)** Information can be carried by many media, including sound, light, and objects. In this century, the ability to code information as electric currents in wires, electromagnetic waves in space, and light in glass fibers has made communication millions of times faster than is possible by mail or sound.
- **8E (6-8)** Most computers use digital codes containing only two symbols, 0 and 1, to perform all operations. Continuous signals must be transformed into digital codes before they can be processed by a computer.

National Science Education Standards

Grades 5-8

- **Understanding about Science and Technology** - Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed. Technology also provides tools for investigations, inquiry, and analysis.

Maryland School Performance Assessment Program Concept Indicators

Earth Science

- **(K-3)** - The place where you live has a variety of earth features to be investigated, including streams, hills, slopes, and soils.