Molding Young Scientists During the School Day

Students contribute to the scientific community by observing the life around them.

NatureMapping (NM) is a program that provides workshops and resources to help students collect and analyze scientific field data, inspiring young scientists through class projects and field trips. NatureMapping groups have formed in Arkansas, California, Idaho, Iowa, Massachusetts, New York, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin.

The curriculum download is part of our larger New Day for Learning series, which focuses on the growing national movement to redefine how, when, and where students learn, taking an in-depth look at an exemplary full-time-learning program, including comprehensive articles, sample lessons, and video interviews with program participants. This additional information is available through Edutopia at edutopia.org/new-day-for-learning-two. These lesson plans and curriculum materials are provided by NatureMapping.

What NatureMapping Is About and Why We Picked It

Started in 1992, NatureMapping grew from the big idea of developing an international biodiversity database for use by scientists and the public. And who better to add to it than students? Across the world, students, teachers, and communities are working together to identify and record species in their areas to contribute to the database, which in turn gives scientists a tool for research and conservation efforts. NatureMapping teaches students about science while making a real contribution to the field.

Through third-party assessment of NatureMapping, there is a verifiable track record of connecting the scientific community with young students and improving student communication and presentation skills. We've found that this model can be adapted for many different age groups and environments, inspiring students of different backgrounds and education levels to learn about nature.

Who It's Best For

- K-8 teachers, especially science educators
- Principals or administrators who want to initiate a similar model
- K-8 students, but much of it is adaptable to other grade levels

How to Use the Material

- The materials (lessons, videos and tips, articles, and contacts) can be viewed in any order. There is no need to do the lessons sequentially. Everything is customizable to your teaching style and academic requirement
- There are seven lessons for teaching students. Each lesson takes about three-to-five one-hour class sessions, and each follows the same pattern: The lesson starts with steps for teaching the material and concludes with a practical activity and assessment.
- Although the lessons are focused on material for teaching students, the Articles, Videos and Tips, and Contacts sections also include materials for administrators, such as setting up a field science program or building community relationships.

What It's Designed to Teach

- Species identification, taxonomy, and biodiversity through field work
- Basic measurement, observation, note-taking, mapping, and drawing skills
- Estimations, size-distance relationships, and data analysis
- Technological skills through GPS tracking and data analysis

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Lesson 1: How to Tell the Time and Date

Teach students the basics of telling time and recording dates in various formats.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

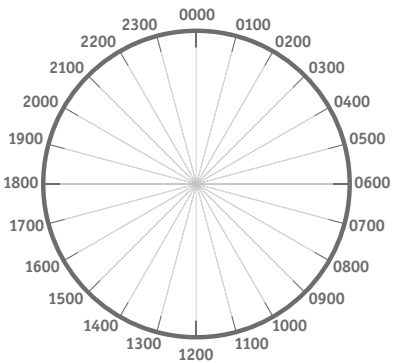
Scientists record times and dates to keep track of events, for organization, and to spot any patterns or relationships in data. Start molding your students into young scientists by teaching them the basics of telling time and formatting dates.

Before starting the lesson, give students some background about the NatureMapping (NM) program. Explain that they'll be studying various animal species, and they'll be completing the NM data-collection form in order to help create a biodiversity database used by scientists and the general population. Also, hand out field journals in the beginning, which students will use to record their observations throughout the project.

Telling Time

Pre-Lesson Preparation: Make copies of a clock that you've separated into twenty-four hour segments on 11- by 14-inch paper. (See the image below.)
In this part of the lesson, you will teach students the difference between analog and digital time and show them how to tell time in standard and military notation.

1. Explain the difference between analog and digital time using different watches or clocks as examples.
2. Explain military time and standard-to-military time conversions.
   - » Military time operates around a twenty-four-hour clock that starts at 12 A.M. (0000) and goes to 11 P.M. (2300). It does not have notations for A.M. and P.M.
   - » Times are presented in four-number increments -- the hour followed by the minute.
   - » To complete the format, add twelve to times from 1 P.M. to 11 P.M., and add zeroes when needed to complete the four-number format. For example, 1 P.M. is 1300 and 6 P.M. is 1800.



3. Ask students to speculate why military time is universal across the globe and to share strategies for converting from military time to standard time, or vice versa.
4. Ask students to use these newly learned strategies to convert–from standard notation to military notation–different times that you say out loud.

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LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- » Understand the difference between digital and analog clocks
- » Learn how to tell time in standard and military notation
- » Understand different date formats, including the NM standard of MM/DD/YYYY

MATERIALS

- » NM data-collection form
- » 11- by 14-inch paper
- » Analog and digital clocks or watches
- » Pens and pencils
- » Calendars
- » Field journals (bound scientific notebooks)
- » Live specimens, such as a caterpillar or gerbil

Telling Time (continued)

5. Distribute copies of the clock. (See image next page.) The clock should include three concentric circles. In each circle, ask students to write the time in military or standard notation and to sketch and express activities they typically perform at that time of day.
6. Distribute copies of the NM data-collection form (if students don't already have it), and show students where to enter time on the form.
7. Use live specimens to help explain the concept of elapsed time. For example, ask students to track the time for a butterfly's chrysalis to develop or for a chicken's eggs to hatch. If live specimens aren't available, visit virtual-pet Web sites.

COMMON TERMS

- **Analog:** Continuous time. An analog clock tells time by moving hands on a clock face from hours 1 to 12.
- **Digital:** Specific time. A digital clock represents finite time (every tenth of a second, for example) via numbers instead of clock hands.
- **Military time:** A method of time keeping through a 24-hour clock, in which the day runs from midnight to midnight and is divided into 24 hours.
- **Standard time:** A method of time keeping through a 12-hour clock, based on the official local time of a region or country.

Recording a Date

The International Organization for Standardization (ISO 8601) says that the correct calendar date format is written as YYYY-MM-DD. However, date formats vary by organization and individual preferences. Here, you will teach students the many different ways they can write a date, including the format used by NM.

1. Ask students to write today's date on the chalkboard in all the different ways they can think of. Here's a non-exhaustive list to refer to when adding ideas to the students' list:
   - 8/29/2008
   - August-2008
   - Thursday, August 29, 2008
   - August 29, 2008
   - 8/29
   - 8/29/08 6:00 PM
   - 8/29/08
   - 8/29/08 18:00
   - 08/29/08
   - 29 Aug
   - 29-Aug-08
   - 29-Aug-2008
   - Aug-08
2. Explain the importance of consistency for writing dates, especially to scientists. Show and explain the NM format: MM/DD/YYYY.
3. Post a list of month names and numbers for students to reference or to copy in their field journals. (January is 1, February is 2, and so on.)

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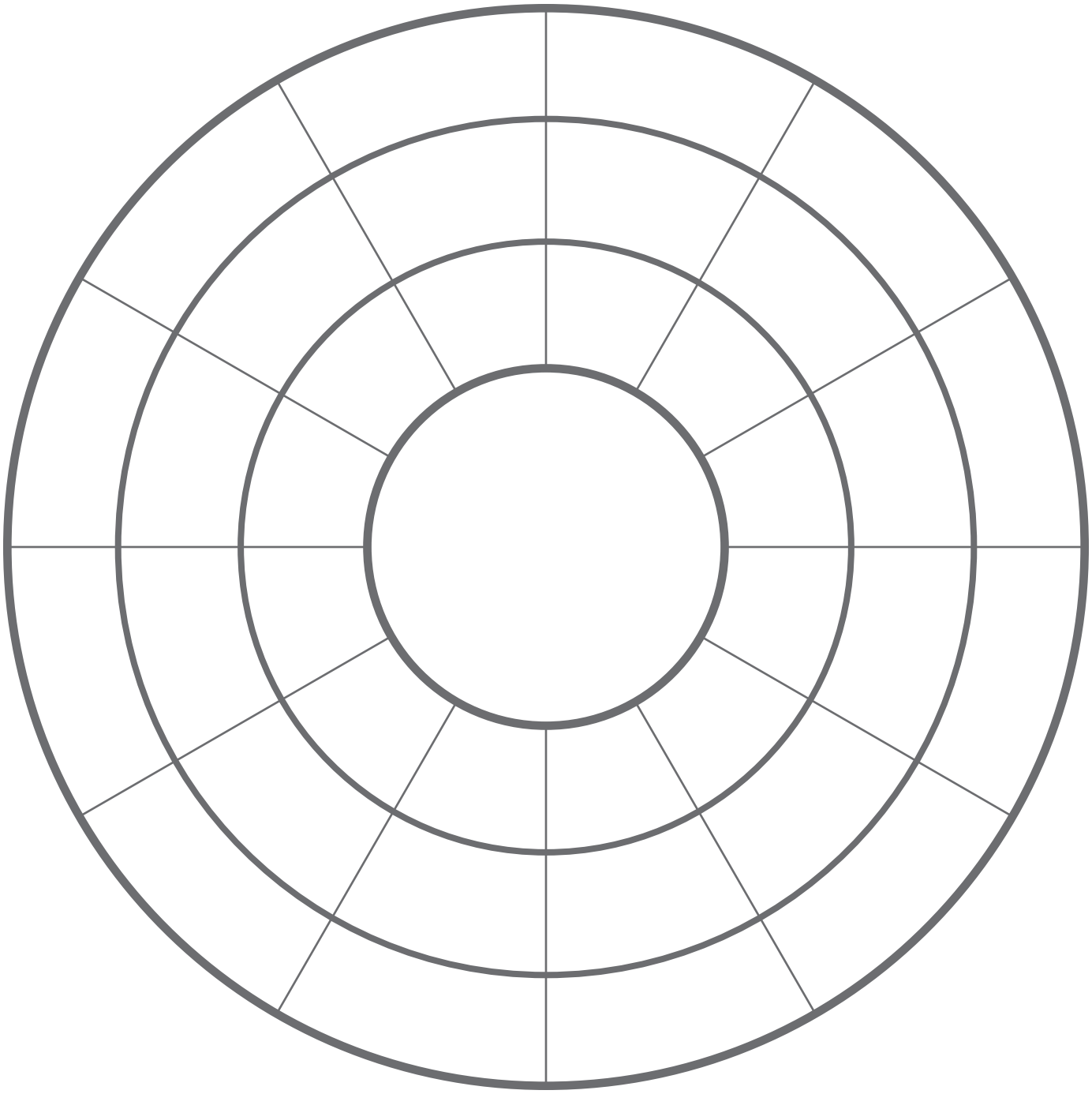
Clock Handout



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Project Application: Introduction to Orthography

4. Ask students to practice writing dates and memorizing months in the correct format. Here are some ideas to try:
   - » Dictate different dates and have students write them down in the correct format. Use whiteboards to pinpoint common mistakes quickly.
   - » Ask students to circle the correct date from a list.
   - » Have students orate names of the month in the correct order.
   - » Use dates that remain constant in your examples, such as Christmas and Independence Day.
   - » Tie in dates from other subjects, such as history, as practice examples.
   - » Show students how to select and format dates in a software program, such as Microsoft Excel.
   - » Ask students to practice using a calendar daily, inputting dates and times for assignments and events.

CUSTOMIZATION TIP

Is the lesson too advanced for your students? Here are some ways to customize the lesson for younger kids:

- » **Grades K-2:** Ask students to record time by adding clock hands to a figure of a clock face.
- » **Grades 3-5:** Ask students to record digital time on a clock they draw.

Practical and Assessment

Practical

Test your student's ability to record times and dates. Read dates and times out loud and ask students to format them appropriately—in both NM format and in military units.

Student Assessment

How'd your students do? Here are some ways to assess your student's ability, reflective of grade level. Assess students by point scale or qualitatively.

EXCEEDS STANDARD

- » **Student was able to record the time and date accurately when recited ten out of ten times.**

MEETS STANDARD

- » Student was able to record the time and date accurately when recited nine out of ten times.

BELOW STANDARD

- » Student was able to record the time and date accurately when recited eight times or fewer out of ten times; student needs more practice.

Links to Related NatureMapping Activities

If you enjoyed this lesson, check out these links to additional NatureMapping materials.

Everything Is Connected: An activity that demonstrates the interdependence of living creatures to each other and their environment:
depts.washington.edu/natmap/education/protocols/1_connected.html

KEY POINTS

Start generating student interest in biodiversity by providing an example of hour-by-hour and seasonal activities of an animal.

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Lesson 2: Using Guides and Animal Size to Teach Species Recognition

Introduce students to field guides and species identification.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

Field guides provide comprehensive information about different animal and plant species in a condensed form. In this lesson, you'll introduce the basics of using field guides for species identification. You'll teach students how to use measurements to deduce animal size, then build relevance through an activity in which students choose their nature names. Future lessons elaborate on Field Guide usage.

Field Guides and Measurements

Pre-Lesson Preparation: Set up a few different demonstrations, including models or pictures of animals, their scat, and eggs. Deer and elk make good examples.

Teach students how to take proper measurements. This will help them differentiate species by size. Follow these steps:

1. Ask students to complete the date and time portions of the NM data-collection form using the skills they learned in the last lesson.
2. Explain the part of the data-collection form that asks for the species name and description.
3. Explain what a species is and how each one has a scientific name (the binomen), such as *Canis lupus*, and a common name, such as wolf.
4. Go over ways that scientists categorize closely related animals. For example, looking at an animal's morphology can explain why the great horned owl and western screech owl are considered closely related owl species. (They both have horns.) Teach students about taxonomic groupings (from kingdom to species).
5. Explain different classes in the animal kingdom, such as amphibians, mammals, and reptiles.

LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- Understand field guides
- Be able to measure objects in different units
- Learn about different animal species and sizes
- Build observation skills

MATERIALS

- Field guides or animal fact sheets
- NM data-collection form
- Models or pictures of animals, animal scat, and animal eggs
- Tape (such as masking or carpenter's tape)
- Rulers, measuring tape, calipers
- Graph paper
- Field journals (bound scientific notebooks)

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Field Guides and Measurements (continued)

6. Show the students a field guide and the information it contains, including data on animal size and habitat. (We will discuss habitat in greater detail in the next lesson.) Using the two owls as an example, relay how images in the field guide don't reveal an animal's true size. As an example, use your hand or arm to show the difference between the great horned owl, which is the size of your arm (Fig. A) and the screech owl, which is the size of your hand (Fig. B).
7. Explain how to measure things in both the standard and metric system.
8. Ask students to look at the demonstrations of scat, eggs, and other models or pictures you've set up, taking note of each item's size (in standard and metric notations), shape, color, and other specific characteristics.
9. Have students compare their observations—especially measurements—with information in the field guide.
10. Teach students how to identify animals by tracks. Follow the instructions on the (depts.washington.edu/natmap/education/protocols/7_animal_signs.html) NM Animal Signs Activity page to create the tracks of different types of animals. Then demonstrate how to take measurements of the tracks using various tools, such as rulers, measuring tape, and calipers. Ask students which tools work best for big tracks and which work best for small tracks, contrasting the advantages and disadvantages of each.

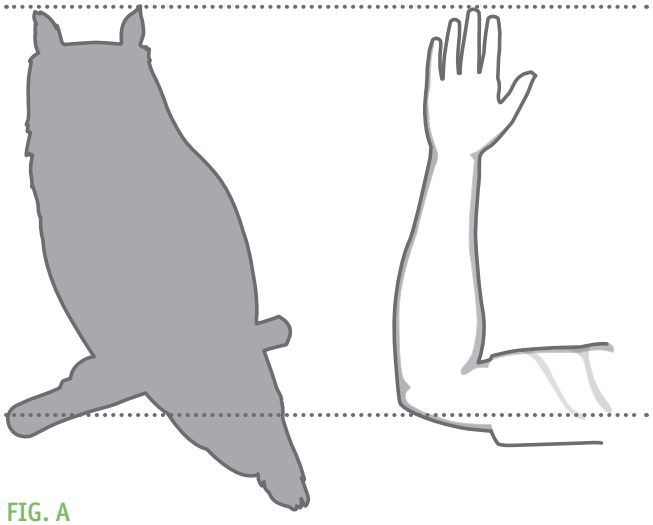

FIG. A

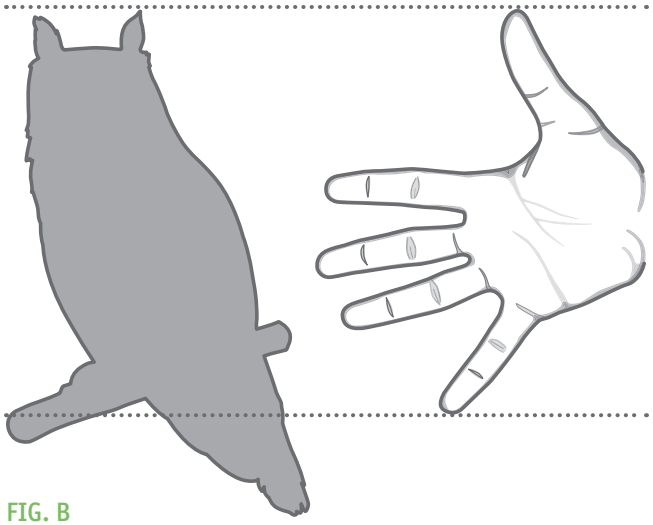

FIG. B

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Selecting a Nature Name

Pre-Lesson Preparation: Develop a list of animals in your local area or in urban areas nationwide, or brainstorm with your students about which animals they think live close by. Put the animal names on separate strips of paper for students to draw at random.

Add greater relevance to species recognition by assigning students a nature name. They will use the names they choose throughout the curriculum. Follow these steps:

1. Ask students to draw an animal name from the hat and explain that the animal they draw will be that student's nature name.
2. Ask students to read the name of the animal they draw. Then have them take three minutes to exchange names if they wish with another classmate who also wants to make an exchange. (Have additional animal names available for students who aren't happy with their final animals.)
3. Instruct students to write their nature name (by scientific name and common name) on the NM data-collection form.
4. Give students class time to review the field guides to learn more about their animals. Then ask students to reference the field guides and list their animal's measurements in their field journals, including animal size, scat size, egg size, length of stride, size of paw, and so on.
5. Reinforce measurement skills by asking students to create a life-size replication of their animals to scale. Show your students how to use tape (such as masking or carpenter's tape, depending on the floor surface) to outline their animals on the floor.
6. Add an English-learning component to the lesson. Ask students to do one of the following:
   - » Create a field guide page about their animal
   - » Create a poem about their animal
   - » Write a descriptive paragraph about the animal
   - » Write a compare/contrast paper on their animal and a similar animal
   - » Write a fiction story based on the characteristics of their animal

CUSTOMIZATION TIP

Is the lesson too simple or advanced for your students? Here are some ways to customize the lesson based on grade level:

- » **Grades K-2:** Let students practice measurement techniques by measuring something more than twelve inches long with a ruler (such as a desk).
- » **Grades 3-5:** Ask students to choose any small animal (under twelve inches) from a list of local species, and reference the field guide for the animal's size. Then ask students to use rulers and grid paper to sketch the animal close to actual size. Or have them calculate the area of the animal.
- » **Grades 6 and up:** Introduce different types of measuring tools such as measuring tapes and calipers. Or ask students to use grids to draw the animal to scale.

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Practical and Assessment

Practical

Test your students' accuracy in measuring objects. Assign students to make a life-size display or poster of an animal, scat, or egg. All objects should include measurements, labeled in standard or metric notation.

Student Assessment

How'd your students do? Here are some ways to assess your students' comprehension of the material, reflective of grade level. Assess students by point scale or qualitatively.

EXCEEDS STANDARD

» **Student has completed all measurements accurately in both metric and standard notation.**

MEETS STANDARD

» Student has completed measurements in either metric or standard notation, not both. There are up to two mistakes in measurements or labels.

BELOW STANDARD

» Student has completed measurements in either metric or standard notation, not both. There are more than two mistakes in measurements or labels.

Links to Related NatureMapping Activities

If you enjoyed this lesson, check out these links to additional NM materials.

Speaking Species Part I: An activity to help students learn to identify species: depts.washington.edu/natmap/education/protocols/2_species_1.html

Speaking Species Part II: An activity to help students identify the animals common to their area: depts.washington.edu/natmap/education/protocols/2_species_2.html

Animal Signs : An activity to help students develop observational skills recognizing common animal signs: depts.washington.edu/natmap/education/protocols/7_animal_signs.html

COMMON TERMS

» **Species:** A class of individuals having common attributes and designated by a common name

» **Morphology:** The form and structure of an organism or any of its parts

» **Binomen:** The scientific name of a species consisting of two parts. The first part is the genus name and the second part is the specific name, e.g., *Canis lupus*

» **Common name:** The name for an animal species that is in general use within a community, e.g., wolf

KEY POINTS

Ask your school's custodian about the proper tape to use on the floor. Some tape can be difficult to clean up depending on the floor's surface. Duct tape is especially troublesome on slick surfaces.

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Lesson 3: Using Environmental Clues to Teach Species Recognition

Build your students' observation skills through animal identification.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

Spotting animals in nature can be a rare experience depending on the species and environment. Scientists often home in on animal clues to help identify different species. Take concepts learned in the previous lesson to a deeper level by teaching students how to use environmental information to identify different species. Conclude the lesson with creating an animal-wanted poster.

Identifying Species Through Observations

This lesson is broken into two parts. The first part focuses on using environmental clues for animal recognition. The second part helps students improve their listening skills. Follow these steps:

PART 1: LOOKING FOR CLUES

Pre-Lesson Preparation: Leave objects belonging to an imaginary person around the classroom, such as a backpack, pencil holder, clothing, or water bottle.

1. Ask students to take out their NM data-collection form and to think about the section that asks how they have observed the animal. Brainstorm different ways to make observations, such as through sight and sound.
2. Ask students to form conclusions about the imaginary person from the objects you distributed throughout the classroom. Is the person male or female? How old? What are the person's hobbies?
3. Extend the idea to other species. Show animal silhouettes (owl, duck, squirrel, mole, swallow) one at a time. Discuss their differences.
4. Discuss habitats for each animal based on season, time of day, and temperature.
   - » Explain the difference between nocturnal (such as owl) and diurnal (such as duck) species.
   - » Explain migration and hibernation. For example, during the winter, some species migrate to the south (e.g., swallows), some hibernate (e.g., bears), and others move below the freezing line (e.g., moles).

LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- » Learn about different biospecies
- » Learn different bird calls and sounds
- » Create an animal-wanted poster
- » Build observation skills in the field

MATERIALS

- » NM data-collection form
- » Field guides or animal fact sheets
- » Animal silhouettes
- » Pictures of different birds
- » A 12- by 18-inch or 18- by 24-inch piece of construction paper
- » Pens and colored pencils
- » Field journals (bound scientific notebooks)

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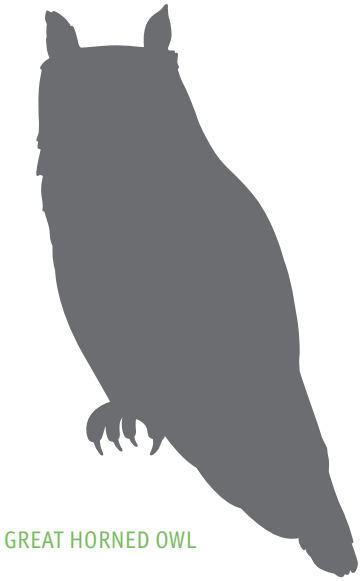
Identifying Species Through Observations (continued)

5. Discuss the types of clues animals might leave that lead to recognition, such as tracks, feathers, markings, and scat. Ask the students
   - » Where are tracks found? For example, would a cougar walk out in the open looking for deer, or along the edge of the forest where it can hide?
   - » What would feathers tell us? What about in different environments? For example, if there are a lot of feathers on the ground beneath a tree, the bird might have been killed by a hawk. If there isn't a tree, the bird might have been killed by a mammal, such as a coyote or cat.
   - » What do different markings tell us? For example, a tooth or colored feather provides information about the animal's size and species.

PART 2: LISTENING FOR CLUES

1. Explain that animals, especially birds, make different vocalizations, such as
   - » Babies begging for food
   - » Alarm calls
   - » Territorial songs by males
   - » Courting calls
   - » Members of a flock checking in with one another
2. Ask students to form teams to act out different vocalizations.
3. Go outside, sit quietly, and listen for birds. Quietly discuss which vocalization you may be hearing. It may take up to twenty minutes for birds to start "talking" after humans arrive, so move to the listening spot very quietly.
4. Blow up drawings of the following birds, cut them up into separate puzzle pieces (the younger the student, the bigger the pieces), and write the bird's vocalization on the back of each piece:
   - » Great horned owl (*who, who*)
   - » Barn swallow (*eight... eight eight eight eight*)
   - » Northern flicker (*wick-a wick-a wick*)
   - » Common Grey Squirrel (*ack, ack, ack*)–alarm call
   - » American robin (*jeep, jeep*)
   - » Mallard (*quack, quack, quack*)
5. Ask students to put the puzzle pieces together and identify each bird, focusing on markings and shape, such as head shape, body shape, beak shape, legs, eyes, and tail.



GREAT HORNED OWL

AMERICAN ROBIN

COMMON TERMS

- » **Habitat:** The area or environment in which an organism or ecological community normally lives or occurs
- » **Nocturnal:** Active at night
- » **Diurnal:** Active during the day
- » **Migrate:** To pass periodically from one region or climate to another
- » **Hibernate:** To spend the winter in close quarters in a dormant condition

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Identifying Species Through Observations (continued)

PART 3: ANIMAL-WANTED POSTER

This activity combines all the concepts students have previously learned about animal identification. Students will create an animal-wanted poster, and in doing so, they'll apply their science, English, and art skills. This finished product will suffice as the practical.

1. Ask students to create an animal-wanted poster. Encourage them to look through field guides and observe local wildlife to find ideas for choosing their animal.
2. Post a list of requirements for the animal poster. It must include
   - The student's nature name
   - The animal's common and scientific names. (Note that the NM code is made from the first two letters of each of the words in the animal's scientific name.)
   - A life-size or to-scale pencil drawing of the animal, colored accurately with pencils
   - A drawing or description of the animal's location and habitat
   - A list of the sounds the animal makes
   - Drawings of the animal's tracks, feathers, and scat
   - The animal's physical description, including its size, color, and characteristic markings
   - Why the animal is wanted (e.g., Is it a predator, prey, or invasive species?)
3. Discuss what other things students would like to include in the posters.
4. Explain the grading criteria of the project, and show the rubric as a basis. (See the Practical and Assessment section below.)
5. Work with students to create a model of the final poster, using an imaginary character, such as one from a cartoon or comic strip, for a demo.
   - Use 12- by 18-inch or 18- by 24-inch construction paper for the background.
   - Cut white paper into appropriate sizes for each of the parts of the poster so that one mistake won't ruin the entire poster.
   - For older students, use software and graphics programs to create the poster.
6. Ask students to complete the poster. (For younger students, work as a class to develop the poster.)
7. Challenge older students by asking them to create clues about the animal before presenting the poster.
   - Write five clues on different pieces of heavy construction paper.
   - Cover the animal on the poster with the paper, and ask students to read each clue as they reveal different parts of the animal, bit by bit.
   - Ask students to guess the animal after each clue is read. (You can see examples of this activity on the NatureMapping Web site at: http://depts.washington.edu/natmap/education/protocols/3_field_guide.html .)

CUSTOMIZATION TIP

Is the lesson too simple or advanced for your students? Here are some ways to customize the lesson based on grade level.

- **Grades K-1:** Help students learn different bird sounds, and put the bird puzzle together as a group. Or make black-and-white copies of animal pictures and ask students to color the pictures while referencing field guides.
- **Grade 2:** Ask students to choose a puzzle piece and practice its bird call, migrating toward other students who make similar calls.
- **Grades 3-5:** Cut five strips of paper for each bird, with one side listing the vocalization of the bird and the other side a clue about the animal. Ask students to practice bird calls, find other students making the same call, and use field guides to identify the bird.
- **Grades 6-8:** Ask students to listen to bird sounds online, and try to either identify the bird or draw the sounds as musical notes. Or create a drawing assignment that asks students to include color drawings of the bird in winter and breeding plumage.

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Practical and Assessment

Practical

Test your students' ability to draw and identify different animal species. Have your students create an animal-wanted poster as described above.

Student Assessment

How'd your students do? Use this rubric to help assess each student's poster. Circle the appropriate box for each category. Base the grade on the total points (18-20 points = excellent ; 15-17 points = good; 15 points or fewer points = proficient), or do it qualitatively.

CATEGORY	EXCELLENT (4)	GOOD (3)	PROFICIENT (2)
INFORMATION	All facts are accurate.	Most facts are accurate.	There are more than two mistakes in facts.
SCIENTIFIC LANGUAGE	Students use specific descriptive language.	Students use language that is mostly specific.	Students use language that is vague.
ILLUSTRATION	The illustration is to scale or life size and is colored accurately with colored pencils.	The illustration meets two of the three expectations.	The illustration meets one of the three expectations.
COMPLETENESS	Each section is included.	One section is incomplete	One section is missing.
OVERALL VISUAL APPEAL	Poster is visually appealing. It has neat writing and drawings. It doesn't show tape or glue, and the edges are tightly glued.	Project uses materials to achieve realism.	Project makes use of standard materials.
CONVENTIONS	Spelling, punctuation, and capitalization are correct.	Spelling, punctuation, and capitalization are mostly correct.	There are more than three mistakes in spelling, punctuation, or capitalization.

Links to Related NatureMapping Activities

If you enjoyed this lesson, check out these links to additional NM materials.

Field Guide Frenzy: Students learn to use a variety of field guides to identify species: depts.washington.edu/natmap/education/protocols/3_field_guide.html

Using Binoculars/Monoculars: Students learn about magnification, field of vision, and the use of binoculars and monoculars when observing wildlife: depts.washington.edu/natmap/education/protocols/4_binoculars.html

KEY POINTS

Blow up different animal pictures and place them around the room during the curriculum. Include the animal's scientific name, common name, habitat, and other characteristics listed in the field guides.

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Identifying Species Through Observations (continued)

GREAT HORNED OWL

BARN SWALLOW

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Identifying Species Through Observations (continued)

NORTHERN FLICKER

COMMON SQUIRREL

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Identifying Species Through Observations (continued)

AMERICAN ROBIN

MALLARD DUCK

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Lesson 4: How to Estimate Animal Size and Numbers at a Distance

Teach students about size-distance relationships and making group estimates.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

Nature observation is an inexact science. Unpredictable events that can occur, such as a flutter of butterflies passing overhead or a herd of deer crossing your path, make it difficult to collect perfect data. Therefore, nature researchers often use estimations.

In this lesson, you will teach students how to make good estimations of animal size and numbers. This lesson brings in math and art concepts to help students understand spatial relationships and approximations. Start with size-distance relationships, and end with the grid system.

Estimating Size

Teach students how to estimate size at a distance. This lesson is broken into three parts. The first part introduces techniques for measuring size; the last parts expand on the concept through an outdoor activity and perspective drawing. Be prepared to take digital pictures throughout the lesson.

PART 1: ESTIMATING SIZE AT A DISTANCE

1. Show a close-up picture of a screech owl (without background). Ask students to estimate its size in height and width, prodding them for the reasons behind their estimates.
2. Show a picture of the same owl in a tree, and ask students to estimate its size. Has anything changed? What are students basing their guesses on this time?
3. Practice measuring height at a distance. Ask students to pick an object in the distance (about ten feet away). Then have them close one eye and estimate the object's height by forming a "C" with the thumb and index finger of their left hand (or a backwards "C" with their right hand) around the image.
4. Pick three students who are about the same height, and place them ten feet away from the group. Ask the other students to use the "C" technique from the previous step to measure the three students' heights. Ask students to describe to the class how big the "C" is, from the ends of their fingers (in centimeters or inches).
5. Ask the class to measure two of the students from the previous example at fifty feet and one hundred feet using the same "C" technique as before. Explain the difference in results (i.e., the students' size gets smaller with increasing distance).
6. Take a digital picture of the three students at different locations, which you will use later in the lesson.

LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- Use estimation to help determine animal size
- Learn how to draw using perspective
- Use a grid system for estimating group size

MATERIALS

- NM data-collection form
- Field guides or animal fact sheets
- Screech owl pictures–one close-up picture without a background and one of an owl in a tree with background
- Wooden or metal stakes
- Three pictures of the same owl
- A digital camera
- Computer and graphics software (such as Adobe PhotoShop)
- Pictures of ants
- Grid paper
- Field journals (bound scientific notebooks)
- Pens and pencils

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How to Estimate Animal Size and Numbers at a Distance (continued)

PART 2: PRACTICE OUTDOORS

Pre-Lesson Preparation: Prepare three wooden stakes by attaching to each an identical, life-size picture of an animal. The great horned owl works well.

1. Take your students outside, and place the stakes at different distances–approximately ten, fifty, and one hundred feet. Then ask students to
   - » Make observations and predictions about the size of the three animals
   - » Use the "C" method to make height predictions
2. Take a digital picture of the stakes for later use.
3. Gather the stakes to show the students that the photos are the same size.
4. Ask students to discuss their observations.

PART 3: PRACTICE WITH PERSPECTIVE DRAWING

1. Explain the basic concepts of perspective drawing, describing how one can represent objects at a distance on paper by making objects appear smaller and closer together as they near the vanishing point. Explain the basic meaning of "vanishing point" and the "horizon line," using pictures and examples for emphasis.
2. Upload to a computer the photos you took previously of the students and stakes. Open each image separately in a program that allows you to edit the image using lines (such as Adobe PhotoShop).
3. Demonstrate how to draw using one-point linear perspective on the computer.
   - » First, draw the horizon line above the image. (Figure A)
   - » Next, create a small circle or square on the horizon line to indicate the vanishing point. (Figure B)
   - » Then, draw lines extending from the image (such as the owl) to the vanishing point. (Figure C)
   - » Ask students whether the image will get smaller or larger the closer it moves to the vanishing point.
   - » Copy and paste the same image at different places on screen, enlarging the image farther from the vanishing point and diminishing it closer to the vanishing point. (Figure D)
4. Ask students to practice perspective drawing in their field journals or on handouts.

FIG. A

FIG. B

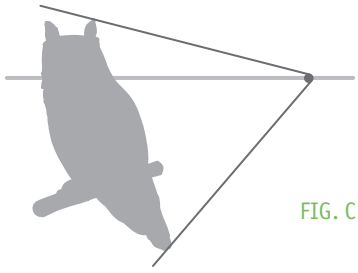

FIG. C

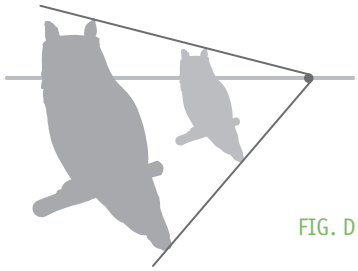

FIG. D

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Practical and Assessment

Practical

Test your students' understanding of making estimates and drawing using perspective. Show younger students different pairs of animal pictures in different sizes and ask them to speculate which one of the two animals in the pair is farther away. Ask older students to draw their nature animals using perspective–creating the horizon line, the vanishing point, and three different sketches of their animals.

Student Assessment

How'd your students do? Here are some ways to assess your students' comprehension of the material, reflective of grade level.

EXCEEDS STANDARD

- **Grades K-2:** Student was able to identify that the smaller animal was farther away five out of five times.
- **Grades 3-4:** Student was able to draw a picture of the same animal using perspective (in three different sizes).
- **Grades 5 and up:** Student was able to use vanishing point lines to draw an animal in three different sizes.

MEETS STANDARD

- Student was able to meet the above standards with only one error in size-distance relationship interpretation.

BELOW STANDARD

- Student made more than one mistake in size-distance relationship interpretation.

COMMON TERMS

- **Vanishing point:** In perspective drawing, the point at which receding axes converge
- **Perspective:** Any graphic system used to create the illusion of three-dimensional images or spatial relationships on a two-dimensional surface. There are several types of perspective, such as linear, atmospheric, and projection system
- **Horizon line:** The line in a perspective drawing where the sky meets the ground. A drawing inside a room has an eye-level line
- **Grid system:** A series of boxes or circles divided into equal areas

KEY POINTS

Keep previous lessons fresh in students' minds. Ask students to elaborate on the characteristics and behavior of the animals you use as examples.

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Estimating Group Numbers

PART 1: INTRODUCTION TO GROUP ESTIMATES

Pre-Lesson Preparation: Make copies of a picture of an ant mound. Also, create a large class chart that has at least four columns. Mount the chart on the wall for recording data throughout the lesson.

1. Refer to the NM data-collection form, and introduce the sections that relate to number and estimates. Explain that scientists need good estimates to determine the population of different species across the country.
2. Show a picture of an ant mound and ask
   - » What do you see?
   - » What questions do you have about this picture?
   - » How many ants do you think are in this picture? How do you know?
3. Ask each student or pair of students to mark their estimates on the class chart.
4. Record on the class chart the different methods students come up with for determining the number of ants.
5. Pass out pictures of an ant mound. Ask students to choose a strategy for estimating the number of ants in the picture. Some students might count by ones; some students might count groups of ants.
6. Record each student's or pair of students' estimates in another column of the class chart. Ask students what they notice about the two groups of estimates. The second group of numbers should be more similar than the first estimates.

PART 2: THE GRID SYSTEM

1. Still using the ant-mound example, ask students to speculate how to determine the number of ants without counting them or without a picture (for example, if they encountered an ant mound outdoors).
2. Overlay a grid onto the picture of the ant mound. Ask students how they would use the grid to determine the number of ants.
3. Explain how to use the grid system, which is the method scientists use when estimating large numbers of animals in nature: Count the number of animals in one box and multiply by the total number of boxes.
4. Practice the grid system using other examples, such as pictures of birds in a tree, blood cells, or gum balls. (See example below.)
5. Challenge students to imagine the grid in their heads without looking at it. Explain that scientists use an imaginary grid to recognize the number of animals traveling together in nature.
6. Ask students to practice using the imaginary grid on different objects–such as cookies on a cookie sheet or pens on a desk.
7. Take the lesson outside and practice using the imaginary grid for trees in the park, birds in a flock, plants in a flower bed, and rocks in a pile.

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Practical and Assessment

Practical

Test your students' ability to estimate the number of animals in groups. Show different groups of objects to students. Then ask them to guess the number of objects from the picture or diagram.

Student Assessment

How'd your students do? Here are some ways to assess your students' comprehension of the material, reflective of grade level.

EXCEEDS STANDARD

» Student was able to give an estimate within 90 percent of the total number.

» MEETS STANDARD

» Student was able to give an estimate within 75 percent of the total number.

BELOW STANDARD

» Student was able to give an estimate that was less than 75 percent of the total number.

COMMON TERMS

» **Vanishing point:** In perspective drawing, the point at which receding axes converge.

» **Perspective:** Any graphic system used to create the illusion of three-dimensional images or spatial relationships on a two-dimensional surface. There are several types of perspective, such as linear, atmospheric, and projection system.

» **Horizon line:** The line in a perspective drawing where the sky meets the ground. A drawing inside a room has an eye-level line.

» **Grid system:** A series of boxes or circles divided into equal areas.

KEY POINTS

Keep previous lessons fresh in students' minds. Ask students to elaborate on the characteristics and behavior of the animals you use as examples.

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Lesson 5: Teaching Directions, Maps, and Coordinates

Give students a lesson in navigation—from the points of the compass to GPS mapping.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

Teach your students some basic and more complex directional skills so they can navigate nature and the greater biosphere. This lesson starts with teaching basic directions and mapping techniques, then moves on to taking latitude and longitude coordinates and using GPS units.

Directions and Maps

In two parts, teach your students about the cardinal directions and how to use a compass and maps. The lesson includes outdoor activities.

PART 1: DIRECTIONS

1. Sit in a circle outside. Ask students
   - » Where's the sun?
   - » What direction is the sun?
   - » Which way is north?
2. Use an object, such as a branch, to depict north. Explain the other cardinal directions and use a mnemonic device to aid students' memory, such as the sentence "Never eat soggy Wheaties."
3. Ask students to use materials in the area to mark the other directions.
4. Explain what a compass is and how it functions.
5. Use a compass to test the accuracy of where students placed objects to mark directions in step 3. Make any needed corrections.
6. Say the different directions out loud, and ask students to point where the direction is on a compass wheel or on a makeshift wheel outside. You can also hand out cards with directions for students to place on the wheel. For older students, ask them to determine more precise directions, such as northwest or southeast.
7. Go inside and ask students to find north and other directions in the classroom.
8. Have the students make direction markers and post them on the walls of the classroom. Double-check the location with a compass.

LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- » Understand cardinal directions
- » Practice using maps
- » Learn how to use a compass
- » Use a GPS unit and understand latitude/longitude coordinates

MATERIALS

- » NM data-collection form
- » Field guides or animal fact sheets
- » Compass
- » Compass wheel
- » Different maps
- » Field journals (bound scientific notebooks)
- » A 4-foot square piece of colored paper
- » Transparent tape
- » Note cards
- » Globe
- » GPS unit

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Directions and Maps (continued)

PART 2: MAPS

1. Explain to students how to use maps. Demonstrate several different types of maps, such as topographic, city, or state maps.
2. Ask students to list what information they can get from a map, such as directions, landmarks, and building projects.
3. Ask students to work together to determine which map would be best to find their way in the following scenarios:
   - » Going from your house to a downtown library (city map)
   - » Going from your house to a different elevation (topographic map)
   - » Going from your house to a different country (world map)
   - » Going from the school to the airport (road map)

Practical and Assessment

Practical

Test your students' understanding of directions and mapping by taking them outside and asking them to point or position cards in the directions you say aloud (such as east, west, or southeast).

Student Assessment

How'd your students do? Here are some ways to assess your students' comprehension, reflective of grade level.

EXCEEDS STANDARD

» Student was able to point or place cards in the correct direction eight out of eight times.

MEETS STANDARD

» Student was able to point or place cards in the correct direction seven out of eight times.

BELOW STANDARD

» Student was able to point or place cards in the correct direction fewer than seven out of eight times.

KEY POINTS

Are some students picking up software skills more quickly than others? Ask them to help the students who are having trouble.

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GPS Units

Teach students about mapping latitude and longitude lines using GPS units. This lesson is split into three parts. The first part focuses on an activity of mapping the schoolyard to engage students, the second part introduces GPS units and how to use them, and the final part ties the others together by getting students to pinpoint exact locations on the schoolyard map.

PART 1: MAPPING THE SCHOOLYARD GEOGRAPHICALLY

Pre-Lesson Preparation: Create a rough diagram of your schoolyard on a 4-foot-square piece of colored paper. You will add landmarks and points of interest later.

1. Show students your diagram of the schoolyard and discuss the orientation.
   - » Which way is north on our school grounds?
   - » What kinds of things could we add to make it easier for new students to find their way around our school? Make a list.
2. Ask students to sketch a map of the schoolyard in their field journals, noting important landmarks and geography.
3. Brainstorm different elements they'd like to include on the map, such as flagpoles, swings, trees, baseball diamonds, or lights.
4. Write the points of interest you come up with on note cards, and give one to each student.
5. Each student will draw the object listed on his or her note card on small pieces of paper. They will add these to the schoolyard diagram.
6. Ask students to attach each item to the diagram where they think it belongs. Use transparent tape so that students can move the objects around easily in the next section.

PART 2: LATITUDE AND LONGITUDE LINES AND USING GPS UNITS

1. Ask students how they can validate the location of objects placed on the diagram in the previous activity. Brainstorm possible answers.
2. Refer to the NM data-collection form, and point out the section on taking latitude and longitude.
3. Show the students a globe, and explain to them the lines of latitude and longitude.
   - » Lines of latitude run horizontally and provide locations in the north/south directions, depicting north as a positive number and south as a negative number.
   - » Lines of longitude run vertically and provide locations in the east/west directions.
   - » Explain that each number reflects location in degrees, minutes, and seconds. For example, one reads 47° 15′ 25″ as "47 degrees, 15 minutes, and 25 seconds."
   - » You can write a coordinate in many different ways to precisely express a location on earth. For example, you can write 47° 15′ 25″ as 47.1525 or 47°15.25′.
   - » Each degree of latitude represents 69 miles, each minute 1.15 miles, and each second 0.02 miles.
   - » Degrees of longitude vary in size, decreasing as one moves in both directions toward the poles.

CUSTOMIZATION TIP

Is the lesson too simple or advanced for your students? Here are some ways to customize the lesson based on grade level:

- » **Grade K:** Help students create and post objects on the map.
- » **Grade 1:** Create symbols for students to place on the map.
- » **Grade 2:** Give students more independence to make symbols and to use a map key.
- » **Grades 3-6:** Encourage students to map the schoolyard using GPS locations as they learn latitude/longitude coordinates.
- » **Grades 7 and up:** Challenge students to convert GPS and map locations from degrees and minutes into decimal degrees. Use grid paper to draw the school to scale.

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GPS Units (continued)

4. Follow the NM lesson on how to use a GPS unit at: depts.washington.edu/natmp/education/protocols/8_using_maps.html.
5. Pair students together, and equip each pair with a GPS unit. Explain that one student will read the unit while the other student records readings in his or her field journal.
6. Ask students to walk the schoolyard from south to north, writing latitude numbers every fifty feet as directed.
7. Repeat the step for writing longitude numbers from east to west.
8. Return to the classroom and ask students what they observed and if there was a number pattern.
9. Use a globe or a map to review why the numbers increase and decrease.
10. Talk about satellites and show how they work.

PART 3: MAPPING THE SCHOOLYARD WITH GPS UNITS

1. Explain to students that they'll use the GPS unit to test the precision of objects placed on the schoolyard map.
2. Take latitude and longitude numbers (as a group) around different points of the schoolyard – at the corners and around the perimeter every ten feet or so.
3. Ask students to take GPS readings of their objects in the schoolyard.
4. Record all numbers on the large schoolyard map, and move the objects to the correct location as needed.

KEY POINTS

Don't have a GPS unit? Try using Google Earth or other online programs to pinpoint different longitude and latitude coordinates. Or use a globe or military map for inexact estimates.

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Practial and Assessment

Practical

Test your students' understanding of GPS units and latitude/longitude readings. Place Popsicle sticks in different locations around school grounds. Ask students to use their GPS units to record the latitude/longitude of each stick.

Student Assessment

How'd your students do? Here are some ways to assess your students' comprehension of the material, reflective of grade level.

EXCEEDS STANDARD

» Student was able to identify the correct latitude/longitude coordinates ten out of ten times.

MEETS STANDARD

» Student was able to identify the correct latitude/longitude coordinates nine out of ten times.

BELOW STANDARD

» Student was able to identify the correct latitude/longitude coordinates eight out of ten times.

Links to Related NatureMapping Activities

If you enjoyed this lesson, check out these links to additional NM materials.

Introduction to Mapping Part I: An activity that teaches students about map elements and using them to find map locations, the idea of map scale, and how to measure using pacing: depts.washington.edu/natmap/education/protocols/6_mapping_part1.html

Introduction to Mapping Part II: Teaches the idea of map scale and how to read topographic maps: depts.washington.edu/natmap/education/protocols/6_mapping_part2.html

Using Maps: Where Are You?: Students learn how to locate the Township, Range, and Section, latitude and longitude or UTM of their homes and school: depts.washington.edu/natmap/education/protocols/8_using_maps.html

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Lesson 6: A Lesson on Nature Note Taking

Teach your students the art of recording observations in the field.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

A scientist's journal goes by many aliases—nature journal, field notebook, or science notebook. No matter what you call it, people use the field journal for the purpose of recording qualitative, quantitative, and sensory data in the field.

Throughout the curriculum, students have practiced using their field journals. In this lesson, students will learn the constructs of, and good habits for, field journals, taking what they've learned in the past about time, species, measurements, and location, and recording all that data in written form.

Field Journal Basics

Pre-Lesson Preparation: Create a large wall chart with columns in which students will record their sensory observations. In addition, prepare different scents in vials.

Teach students the importance of using a field journal correctly, and work on student's note-taking abilities. Elicit good practice habits by asking questions and instructing students to make comprehensive recordings while in the field. This is a building process and will require a lot of modeling and practice. State your expectations in the beginning so students can succeed in the field when you're not around. Follow these steps:

1. Engage students in the activity by asking
   - » Who has a diary?
   - » Why do you write in a diary?
   - » What can you learn about a person from his or her diary?
   - » Would you want to read your mother's diary from when she was a girl?
   - » What do you put in your diary?
2. Explain that scientists keep track of their observations through field journals, sometimes called scientific journals or nature journals, depending on the context. (For example, lab scientists usually refer to their notebooks as scientific notebooks; nature scientists often call them field journals.)
3. Explain how students can take their notes from previous lessons and compile them in their field journal. For example, ask students what information they've needed thus far to complete the NM data-collection form. Explain that they should record such information in their field journals first.

LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- » Learn how to take good field notes
- » Use senses for making observations
- » Practice identifying species in the field

MATERIALS

- » NM data-collection form
- » Field guides or animal fact sheets
- » Field journals (bound scientific notebooks)
- » Leaves, seashells, flowers, or other objects for demonstration
- » Honey, perfume, burnt grease, rose, cinnamon, and other items to smell
- » Small containers or jars
- » Pens and pencils

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Field Journal Basics (continued)

4. Show an example of a field journal and describe the components it should contain
   - » Table of contents (Leave the first three pages blank for this component.)
   - » Entry title and date
   - » Page number
   - » Purpose of experiment
   - » Procedure or event
   - » Scientific drawings
   - » Scientific data and observations
   - » Neatness and organization (e.g., the use of tables, charts, and graphs)
   - » Calculations and results
   - » Conclusion and resources
5. Practice some basic note-taking skills on the board. Emphasize the importance of accuracy and completeness.
6. Ask students to select an object from nature (e.g., a leaf, flower, seashell) from a tray and describe the object through words and drawings in their field journals. Encourage students to record the object's
   - » Measurements
   - » Specific colors
   - » Shape
   - » Texture and smell (and other sensory information)

   Students can also record speculative information, such as how old they think the object is or what it's original habitat might be.
7. Present objects of the same color but different textures to help students enhance their descriptive abilities.
8. Encourage students to reference different materials, such as a thesaurus, the Internet, or field guides to expand their vocabulary.
9. Discuss student's findings, and record different pieces of information on a wall chart. (You might want to organize the chart by senses.)
10. Present to students at least three different scents in small, unmarked vials (e.g., honey, perfume, burnt grease, rose, cinnamon). Put each scent in more than one vial. Ask students to
    - » Find partners with vials of the same scent
    - » Work as a team to decide what the scent is and to discuss what it makes them think about
    - » Write all findings in their field journals

CUSTOMIZATION TIP

Is the lesson too advanced for your students? Here are some ways to customize the lesson for younger age groups:

- » **Grades K-1:** Bring in something to look at, such as an insect or plant. Ask students to explain and record what they see, and elicit questions about the senses.
- » **Grade 2:** Ask students to record what they see in the classroom in their field journals. Try to elicit questions related to the senses. Encourage students to use rulers and colored pencils for graphs and drawings.

KEY POINTS

Visit sciencenotebooks.org for examples of student journals, teaching tips, and classroom tools.

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Recording Entries in the Sit-Spot

Throughout several sessions, you will teach students how to record entries in their field journals from their "sit-spot." This is the location where they've chosen to sit and record their observations.

1. Inform students about the exercise, choosing a sit-spot on the school grounds from which the student will sit and observe his or her surroundings for twenty minutes (rain, shine, or snow). The student should record all sensory information and observations in the field journal according to the format you have defined previously.
2. Explain that the student will use the same sit-spot for future sessions. Define any rules about the sit-spot. For example, students should be at least ten feet apart from one another, and they are not allowed to talk.
3. Provide guidelines for what the student will be recording during each session. Focus students on observing one thing per session, for example, plants and habitat for one session, insects for another session, and animals during another. Or ask students to refine their entries for each session.
4. Lead students in initially finding the location for their sit-spot. Thereafter, help students refine their note-taking skills throughout the next sessions.
5. Ask students to use observations in their field journals to identify any species they find, referencing field guides as needed. This helps students see what improvements they need in species identification.
6. Inspire future lessons or assignments based on the observations in students' field journals. Here are some ideas:
   - » Write three "I wonder" questions about your sit-spot, and research field guides or other sources to find the answers.
   - » Write a description of your sit-spot.
   - » Draw a picture of your sit-spot and label the parts.
   - » Write a story that takes place in your sit-spot.
   - » What would happen if you were an animal living near your sit-spot?
   - » Complete an NM data-collection form for any animal species you mention.

Practical and Assessment

Practical

Test your students' ability to take good field notes. Ask students to hand in their journals on a regular basis. Use student journal information to clarify previous lessons, such as using measurements or making estimations.

Student Assessment

How'd your students do? Your students' journals should contain all the information you defined in the lesson, such as good organization and using the time and date correctly. Rather than writing directly on the pages of the field journal, make your comments or mark grades on sticky notes that you attach to the pages.

LINKS TO RELATED ACTIVITIES

If you enjoyed this lesson, check out these links to additional NM materials.

- » **Meeting Needs:** depts.washington.edu/natmap/education/protocols/9_meeting_needs.html
- » **Name the Habitat** :depts.washington.edu/natmap/education/protocols/10_habitat.html
- » **Habitat Association**: depts.washington.edu/natmap/education/protocols/11_habitat_assoc.html

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Lesson 7: How to Collect and Evaluate Observations in the Field

Wrap up the curriculum with a primer on field analysis.

by Jenny Parma; curriculum by Diane Petersen and Karen Dvornich

NatureMapping uses student data to help create a national biodiversity database, which offers scientists a great tool to learn about animal movement, behavior, and population changes. However, schools and scientists-in-the-making can also use the database. This final lesson teaches students how to use the database and similar technologies for data collection and analysis, shining a light on important math and analytical skills.

Although this lesson wraps up the curriculum, you can carry on with the project. Take students on regular field trips and explorations in which they can continue to identify, record, and analyze field data. Or ask local farmers or horticulturalists to lead a hike. For future lesson plans or ideas for student involvement in nature, visit the NatureMapping site at: depts.washington.edu/natmap.

Recording Data Accurately

Teach students the importance of recording data properly. Use the NM data-collection form as an example throughout this exercise. Follow these steps:

1. Engage students in the activity by asking
   - » Would we see different animals if we collected data at different times of the day?
   - » Why is data important to researchers and scientists?
   - » Why is it important to collect data correctly?
2. Give an example of data collection that includes inconsistencies, such as the chart below, which shows different sections of the NM data-collection form. This chart highlights how one can record data in an inconsistent way.

DATE	SPECIES NAME	HOW OBSERVED	TRS OR LAT/LONG
11/16/09	Anna's Hummingbird	Saw	37.924416/121.999096
16-Nov-09	ana's hummingbird	Saw it	37.924416/121.999096
11/16/2009	Anna's Humm	Sight	37.924416/121.999096

LESSON OBJECTIVES AND MATERIALS

OBJECTIVES

- » Understand how people use data to answer questions
- » Learn how to complete and submit the NM data-collection form
- » Use cognitive-thinking skills

MATERIALS

- » NM data-collection form
- » Field guides or animal fact sheets
- » Field journals (bound scientific notebooks)
- » Graph paper
- » 10- x 20-inch paper
- » Adhesive dots or stickers
- » Microsoft Excel

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Recording Data Accurately (continued)

1. Ask students to explain what they see, emphasizing the pros and cons. Then highlight the inconsistencies.
   - » The student wrote the date in three different formats. The NM format is MM/DD/YYYY.
   - » The student listed "Anna's hummingbird" as the species name in three different ways.
   - » In the "How Observed" column, the students has written that she observed the animal through sight in three different ways.
2. Remind students about why and how NM uses student data to study animal movement, behavior, and preservation.
3. Visit NM's Wildlife Distribution Maps page (depts.washington.edu/natmap/maps/) to see what species live in your school's location. Show students the number and types of animals that live in the area.
4. Explain the proper way to prepare and submit data to NM, emphasizing the need for consistency throughout. For example, NM asks students to enter the common name and the scientific name of each species observed and to enter the specific ways in which the students observed them (for example, *saw*, *trapped*, or *heard*). Make note of the capitalization and spelling standards.

For more information, visit: How to Participate in the NatureMapping Program at: depts.washington.edu/natmap/about/howto.html.

Practice Analyzing Data

Pre-Lesson Preparation: Prepare a large graph on 10- by 20-inch paper with several blank rows and columns. You will use this graph to list animal species and their numbers. Hang the blank paper horizontally on a flat surface.

Before this lesson, ask students to create a data-collection form that includes all the animals they've observed from their sit-spots or that they've seen from home, marking the number of times each animal was seen. Then collect the data in class to practice data analysis.

1. Ask students to name the animals they've reported on their data-collection forms. Record each animal just once in the left-hand column of the graph.
2. Ask students to record multiple sightings by sticking dots or other stickers beside the animal's name on the list. If the student saw the animal more than once, the student should write the number on the sticker.
3. Complete the graph by asking students to label the x axis and y axis and to give the graph a title. Here's an example of a simple graph:

ANIMALS SEEN IN SCHOOLYARD

Robin												
Rabbit												
Dragonfly												

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Practice Analyzing Data (continued)

4. Add more information to this graph for complexity, or create new graphs with additional information. Other graphs might include
   - » Sight time
   - » Sight date and season
   - » Animal location
   - » Animal habitat
   - » Animal activity
5. Review the graphs as a class for accuracy. Ask
   - » Do the graphs make sense?
   - » What do they tell us?
   - » Does everything add up correctly?
6. Brainstorm analytical questions from the data. For example
   - » How many more robins than rabbits did we see in the schoolyard?
   - » Why were more squirrels around at lunchtime than after school?
   - » What activities were certain animals involved in at different times during the day?
7. Copy the data into a computer spreadsheet, such as Excel, so you can analyze it using the questions above as prompts.

   Or use the following ideas to analyze the data:
   - » Graph the number of species seen according to month, time of day, or location.
   - » Plot data points on a map of the area, and see what you can learn from the map.
   - » Older students can collect data using NM's NatureTracker software on a handheld device or GPS unit, hot-sync the data onto a computer, and review the points on a map. Look over the points to determine if students made any mistakes or to interpret the data.
8. Review the results and form conclusions. Encourage students to ask questions that can be answered with the data. Work together to come up with some anchor questions that everyone can use, then encourage a lot of additional questions.

   Here are some examples:
   - » Locate places that we missed in the sampling. Do these areas lack critters, or did we forget to look in those locations?
   - » How much biodiversity exists in the areas plotted?
   - » What kinds of animals did we see most often? Hear most often? Recognize by clues most often?
   - » Have multiple students reported the same data?
   - » How do the results reflect on where humans live? For example, would people want to live in an area with a large animal population? How do human populations influence wildlife behavior?

KEY POINTS

Bring an English-learning component to the lesson by emphasizing how spelling, capitalization, and exact wording lead to better data analysis.

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Practical and Assessment

Practical

Test your students' ability to think analytically. Ask them to create a data-collection form from their field journals and to come up with at least three questions they want to answer. Then they will sort and analyze the data to answer the questions. Be sure to clearly discuss the criteria for assessment.

Student Assessment

How'd your students do? Here are some ways to assess your students' ability to analyze data, reflective of grade level.

EXCEEDS STANDARD

- Student has accurately completed the data sheet so he or she can easily transfer data to charts or graphs.
- Student was able to sort data into different categories.
- Student was able to count and sum data in different categories either by hand or using a spreadsheet.
- Student has asked and answered three questions about the data.

MEETS STANDARD

- Student has made occasional mistakes on the data sheet.
- Student was able to sort data into categories.
- Student was able to count data points in one category.
- Student was able to answer just two of the three questions about the data.

BELOW STANDARD

- Student had irregularities and made mistakes in the data sheets.
- Student had difficulty sorting and counting data points.
- Student had difficulty writing questions that he or she could answer with the data.
- Student needs more guided practice.

Links to Related NatureMapping Activities

If you enjoyed this lesson, check out these links to additional NM materials.

Data Collection Protocols
depts.washington.edu/natmap/education/protocols/12_data_collection.html

Using Emerging Technologies to Collect and Analyze Data
depts.washington.edu/natmap/education/protocols/13_technology.html

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A Glossary of Common NatureMapping Terms

Vocabulary used throughout the NatureMapping curriculum.

We use the terms listed below throughout the NatureMapping curriculum. Please peruse the list and refer back to it when needed.

Time and Date Vocabulary

Analog: Continuous time. An analog clock tells time by moving hands on a clock face from hours 1 to 12.

Digital: Specific time. A digital clock represents finite time (every tenth of a second, for example) via numbers instead of clock hands.

Military time: A method of time keeping through a 24-hour clock, in which the day runs from midnight to midnight and is divided into 24 hours.

Standard time: A method of time keeping through a 12-hour clock, based on the official local time of a region or country.

Species Recognition Vocabulary

Species: A class of individuals having common attributes and designated by a common name.

Morphology: The form and structure of an organism or any of its parts.

Binomen: The scientific name of a species consisting of two parts. The first part is the genus name and the second part is the specific name, e.g., *Canis lupus*.

Common name: Name for an animal species that is in general use within a community, e.g., wolf

Habitat: Area or environment in which an organism or ecological community normally lives or occurs.

Nocturnal: Active at night.

Diurnal: Active during the day.

Migrate: To pass periodically from one region or climate to another.

Hibernate: To spend the winter in close quarters in a dormant condition.

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A Glossary of Common NatureMapping Terms

Size-Distance Relationship Vocabulary

Vanishing point: In perspective drawing, the point at which receding axes converge.

Perspective: Any graphic system used to create the illusion of three-dimensional images or spatial relationships on a two-dimensional surface. There are several types of perspective, such as linear, atmospheric, and projection system.

Horizon line: The line in a perspective drawing where the sky meets the ground. A drawing inside a room has an eye-level line.

Grid system: A series of boxes or circles divided into equal areas.

Mapping Vocabulary

Cardinal directions: North, south, east, and west.

Latitude line: Horizontal line on the globe that shows the angular distance, in degrees, minutes, and seconds, of a point north or south of the equator. Lines of latitude are often referred to as parallels; they run from east to west.

Longitude line: Vertical line on the globe that shows the angular distance, in degrees, minutes, and seconds, of a point east or west of the prime meridian. Lines of longitude are often referred to as meridians; they run from north to south.

The Global Positioning System (GPS): A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on earth by calculating the time difference for signals from different satellites to reach the receiver.

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