Ratios and Proportional Relationships

with eMammal

**Description**

*Students will demonstrate their understanding of ratios and proportional relationships by incorporating eMammal data, hypotheses and observations into their mathematical calculations and analyses.*

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**Objectives**

* Students will compute unit rates with different units.
* Students will use proportional relationships to solve multi-step problems.
* Students will interpret quotients of rational numbers by describing real-world contexts.

**Introduction**

In this lesson, students will use actual data collected via the eMammal citizen science project (<http://emammal.si.edu/>) to demonstrate their understanding of ratios, unit rates and proportional reasoning through calculating measures and explaining their thinking. Your class may use data collected from your own camera traps or from an outside source (see Modifications). Predictions made in this lesson may be compared against eMammal data collected from the same camera traps over the predicted time intervals, thus adding to the authenticity of the required tasks. This comprehensive lesson will identify any deficiencies in knowledge and/or misunderstandings about the learned skills and provide an opportunity for clarifications prior to the summative assessment.

**Real Science Application**

Human development activities usually have a negative effect on wildlife, yet there are many species that can thrive in altered ecosystems. Some species even seem to prefer such habitats. Besides adapting to human disturbances, mammal populations and interactions between species are changing. Some species that were overhunted are rebounding, while others have expanded their range as populations of top predators decline. For example, coyotes have moved eastward into habitats in which they have never lived. Populations are living close to and even within large cities. Scientists want to evaluate patterns of habitat use to guide the management and conservation of different mammal species. They also want to determine how potential conflicts between humans and wildlife might be avoided. To understand the impact of human development on mammal distributions, researchers need data from wildlife habitats that represent varying degrees of human use. The initial phase of the eMammal project studied the impacts of hunting on mammal populations. Volunteers placed cameras in parks and natural areas where hunting occurred and in areas where hunting did not occur. They also placed cameras along trails and away from trails to learn how mammals respond to trails and their use by humans.

eMammal researchers are now focusing on how the distribution of mammals changes from natural areas to human-dominated landscapes. Your students will be helping eMammal researchers answer important scientific questions, such as “How do animal communities change along a gradient from urban to wild areas?” and “How do different human activities affect wildlife in these areas?” By deploying camera traps on school grounds, students can help collect valuable data on mammal populations and movement in specific locations. Once students have identified all the animals in their photos and uploaded the images, one of the experts from the eMammal team will review them. The photos and data will appear in the eMammal database for researchers to use in current investigations.

**Time & Location**

Variable (See Teacher Preparation)

**Teacher Materials**

* eMammal data—(See Introduction)
* Excel spreadsheet software
* Data Analysis Sheet — Teacher Key (TeacherDataAnalysisSheet.docx)
* (optional) eMammal Implementation Essentials (eMammalEssentials.docx)
* (optional) ValleySpringsData.xlsx (See Modifications)

**Student Materials**

* Data Analysis Sheet (StudentDataAnalysisSheet.docx) (one per student)
* Hard copies of data or computers to access data
* Pencil (one per student)
* Graph paper (one or more sheets per student)
* (optional) eMammal Implementation Essentials (eMammalEssentials.docx)

**Safety**

Special considerations for this unit include the possibility of working in the field (with students setting up and taking down camera traps, and exploring and examining proposed camera trap sites) and any other outdoor environmental education activities you may do to augment this curriculum.

Some concerns while working in the field include:

● Insect bites (e.g., fire ants, mosquitoes, chiggers, ticks)

● Potentially hazardous vegetation (e.g., thorns, poison ivy)

● Unpredictable terrain (uneven ground, exposed roots and other tripping hazards)

Most districts and schools have standardized science safety procedures. We recommend you follow what has been put in place by your school and/or district. The National Science Teachers Association has provided material concerning safety in the science classroom. You can find it by following this link: http://www.nsta.org/safety/. The organization also provides a safety acknowledgement form for students and parents:

http://www.nsta.org/docs/SafetyInTheScienceClassroomLabAndField.pdf/.

**Student Prior Knowledge**

* Students should have a working knowledge of all mathematical concepts used for this activity, including ratios, unit rates, proportions and long division.
* Students should ideally be participants in the eMammal citizen science project to increase relevance and sustain interest. (See Modifications if your class is not actively collecting data.)
* Students should have collected camera trap data. (See Modifications).

**Teacher Preparation**

* Contact Dr. Stephanie Schuttler ([stephanie.schuttler@naturalsciences.org](mailto:stephanie.schuttler@naturalsciences.org)) to set up an account on the eMammal Web site.
* Prepare data sets students will use to analyze the information from their camera traps.
* Make sure you have enough lead time to prepare for this lesson, as it is highly variable (1-90 days) depending on the desired source of data and desired depth of understanding relating to the eMammal project itself. You will need time to complete eMammal Lesson 1, Camera Trap Stakeout <http://studentsdiscover.org/teaching-modules/camera-trap-stakeout/> and collect your data. A minimum of two deployments (about 40 days) is recommended.
* Decide how to provide eMammal data to students—you may choose to display data, make copies or have students access spreadsheets on available computers.
* Make copies of Data Analysis Sheet (StudentDataAnalysisSheet.docx) (one per student)
* (Optional) To gain a basic understanding of the eMammal project, you may find the following activities and resources (included in eMammalImplementationEssentials.docx) to be helpful. These tasks will take 1-1 ½ days to complete:
  + Introduction to Camera Trapping and Citizen Science (flow chart for how to participate in the eMammal project, with hyperlinks)
  + Student Engagement (link to video of a fox den and explanation of why scientists use camera traps)
  + Camera Trapping and Science (description of camera traps as a scientific tool)
  + Make a Prediction (instructions on how to predict species richness)

**Activities**

**Engage**

Remind students about all of the data they have been collecting for the eMammal project. Explain that they will be using their data to predict what animals they might expect to see in future observations.  
  
**Explore**

Display or hand out data and ask students: What do you notice? What do you wonder about? Discuss as a class.

**Explain**

Hand out Data Analysis Sheets to each student. Tell them they will be using their recently acquired skills of using ratios, unit rates and proportions to analyze the eMammal data and calculate a projected Rate of Detections(number of detections per day). Review each step on the sheet and answer any questions students might have about your expectations.

**Elaborate**

Discuss with students how they will use the Rate of Detections to predict the number of future sightings. Compare how this technique is different than using population estimates, which requires capture and recapture of animals that are individually identifiable through unique markings or some other tagging process. (For background, see Camera Trapping and Science, pages 3-4, in eMammalEssentials.docx.).

**Evaluate**

(See Assessment)

**Extension Activities**

* If your school is an eMammal site, have students compare predictions to actual data collected and create reasonable explanations for discrepancies. Such explanations might include seasonal changes in animal behavior (such as hibernation), changes in habitat, and location (around the camera trap site, the range is highly variable).
* Have students write a blog post about their eMammal project for the eMammal Web site (https://emammal.si.edu/). They may e-mail it to [stephanie.schuttler@gmail.com](mailto:stephanie.schuttler@gmail.com).
* Have students complete the capture/recapture activity (<http://illuminations.nctm.org/Lesson.aspx?id=2528>) by the National Council of Teachers of Mathematics to learn how population estimates are made using proportions, then compare their projections to these results.

**Assessment**

* Monitor students as they complete the analysis, frequently asking probing questions to discern possible misconceptions (e.g., how a unit rate differs from a ratio, how to calculate a unit rate, how to make a prediction using proportions). Based on observations, lead discussions with individuals, small groups or whole class to clarify points as needed.
* Evaluate students’ submitted work.
* Do a summative assessment that includes one to three questions relating to skills used to complete this activity.
* Review student answers on their Data Analysis Sheet (Responses to many questions will vary, but you may compare to answers on TeacherDataAnalysisSheet.docx).

**Community Engagement**

* Have students summarize findings and report them to the local newspaper.
* Have students create an infographic about the animals they detect near their schools and post it on the school’s Web site, Facebook page and/or Twitter page.

**Critical Vocabulary**

**Common name**: the kind of mammal detected on the camera trap

**Cumulative captures**: the total of all captures for a given period of time

**Deployment name**: a unique alphanumeric name assigned to a specific camera trap set-up period (usually three weeks)

**Proportion**: an equation written as two equivalent ratios

**Proportional relationship**:as shown on a graph—must form a straight line that passes through (0,0)

**Rate of detections**: number of detections per day

**Ratio**: a comparison of two quantities

**Reciprocal**: the inverse (or opposite) ratio that when multiplied by the original, the product = 1

**Sequence ID:** a unique identification assigned to a set of pictures taken after the camera trap is triggered

**Unit rate:** a ratio of two different units with a denominator = 1

**Modifications**

* If your school is not participating in eMammal, have students make predictions based on two deployments from ValleySpringsData.xlsx (data collected by Valley Springs Middle School) and have them compare results using additional deployments included in that document. Start by asking if anyone knows how scientists determine animal populations to set hunting and fishing limits, or how they know what animals live where, or why they put tags on animals. Once students have had a few minutes to discuss these questions, explain how they are going to use data collected by other students about animals in their schoolyards using camera traps. Provide copies of the Data Analysis Sheet (StudentDataAnalysisSheet.docx). Tell them they will be using their recently acquired skills of using ratios, unit rates and proportions to analyze the eMammal data and calculate a projected Rate of Detections(number of detections per day). Review each step on the Data Analysis Sheet and answer any questions students might have about your expectations.
* If any students are struggling to understand the basic concepts, you might have students work in small groups, monitoring them frequently to ensure accurate use of skills and understanding of key concepts.

**Alternative Assessments**

None

**References**

None

**Supplemental Information**

eMammal Implementation Essentials (eMammalEssentials.docx)

**Comments**

None

**Curriculum Alignment**

Common Core Standards

CCSS.MATH.CONTENT.7.RP.A.1 **—** Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.

CCSS.MATH.CONTENT.7.RP.A.3 — Use proportional relationships to solve multistep ratio and percent problems.

CCSS.MATH.CONTENT.7.NS.A.2.B — Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If *p* and *q* are integers, then -(*p*/*q*) = (-*p*)/*q* = *p*/(-*q*).

Interpret quotients of rational numbers by describing real-world contexts.

CCSS.MATH.CONTENT.7.NS.A.2.D — Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.

CCSS.MATH.PRACTICE.MP1 — Make sense of problems and persevere in solving them.

CCSS.MATH.PRACTICE.MP2 — Reason abstractly and quantitatively.

CCSS.MATH.PRACTICE.MP3 — Construct viable arguments and critique the reasoning of others.

CCSS.MATH.PRACTICE.MP4 — Model with mathematics.

CCSS.MATH.PRACTICE.MP5 — Use appropriate tools strategically.

CCSS.MATH.PRACTICE.MP6 — Attend to precision.

CCSS.MATH.PRACTICE.MP7 — Look for and make use of structure.

CCSS.MATH.PRACTICE.MP8 — Look for and express regularity in repeated reasoning.

Next Generation Science Standards

MS-LS2-2 — Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

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