Middle School Unit of Study:
Comparisons in the Natural World*
Kentucky Core Academic Standards (KCAS) for Mathematics: 6-RP.A.3

Unit Title Comparisons in the Natural World

Teacher ____

Grade Level 6th

Approximate Length of Unit 6-8 days

Context
This unit is designed as an environment-based mathematics unit for the sixth grade. It could be taught in a self-contained sixth grade classroom or in a regular 6th grade math class, or team taught by both a math and a science teacher. The activities are designed for 45-50 minute periods. It is best to teach this unit when the weather is mild since students will go outside around the school to complete several of the activities.

***** This unit of study was written by the Kentucky Environmental Literacy Plan Implementation Advisory Team with Dr. Melinda Wilder, Director of Natural Areas at Eastern Kentucky University in Madison County, Kentucky, as the lead. The unit will be field tested during the 2014-15 academic school year and revised as needed following field testing. The template for the unit was developed by the Kentucky Department of Education, who also collaborated with KEEC on unit development.

Development of this unit of study was funded by the Southeastern Environmental Education Alliance and the Kentucky Association for Environmental Education.

Bundle Standards

Understand ratio concepts and use ratio reasoning to solve problems.

1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."

3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

   a. Make tables of equivalent ratios relating quantities with whole number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane.
   b. Use tables to compare ratios.
   c. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?
   d. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.
   e. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.\

Students who demonstrate understanding can:

06-LS2-2. **Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.** [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

Constructing Explanations and Designing Solutions	LS2.A: Interdependent Relationships in Ecosystems	Patterns
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (06-LS2-2)	• Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (06-LS2-2)	• Patterns can be used to identify cause and effect relationships. (06-LS2-2)

Kentucky Core Academic Standards Connections:
ELA/Literacy –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (06-LS2-2)
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (06-LS2-2)
WHST.6-8.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. (06-LS2-2)
SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. *(06-LS2-2)*
SL.8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(06-LS2-2)*

Unit Organizer

How can I use math to compare things in the natural world?

Supporting Standards

RST 6-8.1. Cite specific textual evidence to support analysis of science and technical texts.

Practices Emphasized in this Unit

Math

Make sense of problems and persevere in solving them.

Construct viable arguments and critique the reasoning of others

Science

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (06-LS2-2)

Essential/Guiding Questions

Where can I find ratios and proportions in the outdoors?
How can I use ratio and rate reasoning to help understand nature?
When can I use a percentage to express a relationship in the natural world?

What Students Will Know and Be Able to Do

Students will know:

K-1 Explain ratio notation
K-2 Explain that order matters when writing a ratio
K-3 Describe how ratios can be simplified
K-4 Explain that ratios compare 2 quantities: the quantities do not have to be the same unit of measure
K-5 Recognize that ratios appear in a variety of different contexts—part to part, part to whole, and rates.
K-6 Generalize that all ratios relate to quantities or measures within a given situation in a multiplicative relationship
K-7 Explain that a percent is ratio of number to 100
K-8 Explain that predatory relationships may reduce the number of organisms or eliminate whole populations
K-9 Describe different patterns of interactions of organisms with their environments, living and non, which are shared

Students will be able to:

S-1 Make a table of equivalent ratios using whole numbers.
S-2 Analyze a context to determine which kind of ratio is represented.
S-3 Find the missing values in a table of equivalent ratios
S-4 Use tables to compare proportional quantities
S-5 Solve real world and mathematical problems involving ratio and rate.
S-6 Find a percent of a number as a rate per 100
S-7 Solve real world problems involving finding the whole given a part and a percent
S-8 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems

Summative/End of Unit Assessment

Students will analyze classroom data from a sampling learning task using their knowledge of ratio and rate reasoning.

What are the Relationships between Leaf Litter Critters?

Materials

- One large tray
- One small tray
- Magnifying glasses or bug boxes
- Forceps
- Meter stick
- Rope
- Pencil and paper
- Field guide or identification key

Suggestions
Bugs & Slugs: A Folding Pocket Guide to Familiar North American Invertebrates
Bugguide, http://bugguide.net/node/view/589694/bgimage
Hope College Guide to Arthropods, http://www.hope.edu/academic/biology/leaflitterarthropods/

Preparation: Find a site with a thick layer of natural ground litter. These areas may be as simple as a neglected pile of leaves against a building or most unmannered areas. If it is not possible to take the class to such a site, the same activity can be done using the Berlese Funnel methods. Do a web search for "Leaf Litter, It's a Critters World" by Texas Instruments.

Safety: Find a site that is not likely to include organisms that might be dangerous to humans. Demonstrate how to search under logs. To search under logs, roll the log toward you so the any animals under it will have an escape route away from you. Stinging or biting insects such as centipedes, large ants, and spiders should not be handled with bare hands. Students can scoop them up with an index card or cup and observe them in a tray or plastic cup.

1. Explain to the students that they will be discovering the different kinds of critters that live in the leaf litter and their relationships to each other.
2. Ask the students what kind of animals they might find.
3. Divide the students into groups.
4. When you've found a suitable patch of leaf litter, have each group of students measure out an area of one meter squared using the meter stick. Use the rope to build a rough frame. This will serve as their one-meter vegetation sampling frame.
5. With the vegetation sampling frame on the ground, students should collect all of the leaf layer within the frame and put it all the in the large tray.
6. Using their fingers, have students spread out the leaf litter so an even layer is created. Students should gently sift through the litter and using forceps, gently place any animals found in the litter into the smaller tray.
7. Using their magnifying glasses or bug boxes, students should examine the small animals.
8. Students should identify each organism and record the number and kind in a chart.
9. Give groups about 10-15 minutes to collect organisms
10. All specimens and leaf litter material should be returned to where they were found.

11. Students should disassemble their rope frame and make sure they do not leave anything behind as they leave their site.
12. When back in the classroom, collate the data from each group into a class data chart.
13. Ask what might be the relationships between the animals they found in the leaf litter. (Predator-prey)
14. Have students research the organisms to determine which are predators and which are prey. Assigning each group or each student a different organism will save time. This information should then be recorded on the class data chart.
15. Each group should then analyze the data using their knowledge of ratios, percent, and predator prey relationships to answer the following questions

a. What is the relationship between the number of predators and the number of prey in the leaf litter?
b. Based on your knowledge of predator and prey, explain if the relationship you found is realistic.
c. How is the class data similar or different from your group's data? Explain using ratios or percent.
d. Would you expect to find a similar relationship in other decomposing vegetation such as a compost pile? Explain your answer.

Extension: If time is available, each group of students prepares a method of sharing this information about predatory prey relationships in leaf litter to elementary students.

References: http://www.scientificamerican.com/article/bring-science-home-leaf-litter-biodiversity/

Success Criteria
In collaboration with students, develop an outline of success criteria for the summative/end of unit assessment.
Suggested criteria

- Correctly prepares a chart to record results
- Correctly states the relationships of predator to prey organisms using a ratio
- Analyzes data to determine if the relationship of predator to prey organisms is realistic
- Correctly compares group data to class data using ratios or percentages
- Correctly applies knowledge of predator-prey relationships to another situation

Entry-level Assessment
Use data table from http://www.wolfquest.org/pdfs/Deer%20Predation%20or%20Starvation%20Lesson.pdf to ask questions directly related to ratio and percentages.

Year	Wolf Population	Deer Population	Deer Offspring
1997	10	2,000	800
1998	12	2,300	920
1999	16	2,500	1,000
2000	22	2,360	944
2001	28	2,224	996
2002	24	2,094	836
2003	21	1,968	788
2004	18	1,916	766
2005	19	1,952	780
2006	19	1,972	790

Sample questions could include:

1. Compare the number of wolves to the number of deer in 1997.
2. What is the relationship between the deer population and the deer offspring in 2006?
3. Compare the number of wolves with the number of deer offspring in 2001.
4. What percent of the deer population had offspring in 1999 if the deer population was 50% female and all females had single births?

Types of Assessments			
Assessment	**Learning target aligned to assessment**	**Write F for Formative an S for Summative (may be both)**	How Often?
Anecdotal records	__K-5____	_______ _______	_______
Class discussions	_______	__F____ _______	daily
Conferences and interviews	_______	_______ _______	_______
End of unit tests	K-1, K-2, K-3, K-4,	_______ _______	_______
Journals, learning logs	K-6, K-11, S-1, S-3	_F_____ _______	daily
	K-7, K-8, K-9, S-4, S-5, S-6		_______
			_______
Performance tasks/assessment	_______	F______ ___S___	_______
	_______		_______
Projects	_______	_______ _______	_______
Running records	_______	_______ _______	_______
Selected and/or constructed responses	_______	_______ _______	_______
Self-assessment/reflection	_______	_______ _______	_______
Student revision of assessment	_______	_______ _______	
Student work folder		_______ _______	
Writing tasks		_______ _______	
Other: Case Studies	K-10, S-2,	F_______ _______	_1-2___

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Performance Task/Assessment (PBA)

Use (circle one) Formative Summative

Same as Summative Assessment-see above

Learning Experiences
See the chart below

Unit Sequencing
See the chart below

Resources/Technology/Tools
See chart below.

Day 1 *Essential Question* Where can I find ratios and proportions outdoors?			
Standard & Learning Target	Learning Experiences	Assessment	Materials/Resources
6 R.P. A. 1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. I can: K-1 Explain ratio notation K-2 Explain that order matters when writing a ratio K-3 Describe how ratios can be simplified K-5 Recognize that ratios appear in a variety of different contexts—part to part, part to whole and rates.	Using digital camera/phone/iPADs, small groups of students will be directed to take pictures of living and non-living things in the school yard within a certain amount of time, e.g. 5 minutes. Each picture should focus on 1 thing. Have students review their pictures and tally how many living, non-living, and total are represented. Ask students to compare the number of living to non-living, the number of living to total, and the number of non-living to total. Using this information, introduce ratio notation, the fact that order matters, and how to simplify ratios. Then compile the class data and have students answer the same questions.	In learning log, students should answer exit questions related to class data.	Digital camera or iPADs
Days 2 & 3 How can I use ratio and rate reasoning to help understand nature?			
6 R.P. A. 1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. K-4 Explain that ratios compare 2 quantities: the quantities do not have to be the same unit of measure K-5 Recognize that ratios appear in a variety of different contexts—part to part, part to whole and rates.	Fishy, Fishy activity. www.pbs.org/teachers/mathline/lessonplans/pdf/msmp/somethingfishy.pdf This activity will engage students in a simulation to learn how to estimate a large population through the capture-recapture methods. Engage students by asking them how they would determine how many fish live in a local pond or lake. Then have groups of students simulate the capture-recapture method using goldfish crackers or other tokens. The students will calculate the estimated population using the following assumption.	Student answers to questions on bottom of p. 2 in their learning log.	Each group: 1 large container 300-350 fish shaped cheese crackers 30-40 fish-shaped pretzel crackers 1 small aquarium fish net 1 plate Other counters can be used besides crackers, such as beans, tokens, or macaroni. Students will then need a pen to mark their tagged fish.

<table>
<tr><td></td><td>$$\frac{\text{Number of tagged fish}}{\text{Total Number in body of water}} = \frac{\text{Number tagged in Recapture}}{\text{Total Number in Recapture}}$$
After gathering the data, explain how and why a proportion can be used to analyze their data to estimate the total number of fish.

Then have students practice solving a variety of other proportion problems such as those found at http://betterlesson.com/community/document/57725/cw-setting-up-proportions-from-word-problems-modified
Students can also develop their own real world proportion problems and swap with classmates to solve.</td><td></td><td></td></tr>
<tr><td colspan="4">Days 4 & 5
Essential Questions
How can I use ratio and rate reasoning to help understand nature?</td></tr>
<tr><td>6.RP.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

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

K-6 Generalize that all ratios relate to quantities or measures within a given situation in a multiplicative relationship

K-8 Predatory</td><td>Use the Quick Frozen Critters activity, http://4h.uwex.edu/pubs/showdoc.cfm?documentid=33871
This activity simulates how predator prey interactions affect population changes. Before beginning the game, have the students predict what will happen to the number of prey. Using the data from 3-4 rounds, have students make a table to analyze their data showing the ratio between predators and prey. Review how ratios can be used to analyze data. Then have them construct an scientific explanation about the patterns of predators and prey using their results as evidence by:
1. Making a claim—what happened to the population of prey.</td><td>In learning log, students will record their tables of data.</td><td>3 food tokens per student
Predator identifiers for at least half of the group (example: gym vest or necklaces)
Cones to identify boundaries
5 hula hoops
Bandanas or flags for every student (similar to what is used to play flag football)
Whistle
Space large enough for children to freely move around</td></tr>
</table>

relationships may reduce the number of organisms or eliminate whole populations S-1 Make a table of equivalent ratios using whole numbers. S-2 Analyze your context to determine which kind of ratio is represented. S-3 Find the missing values in a table of equivalent ratios S-4 Use tables to compare proportional quantities S-5 Solve real world and mathematical problems involving ratio and rate. S-6 Find a percent of a number as a rate per 100	2. Stating their evidence for the claim 3. Explaining the reasoning behind the claim Explain how ratios can be calculated as a percent. Play the game again using the extension of changing locomotion. Have students analyze the data from their table using percentages this time. Ask them if their scientific explanation would be any different and why. Then have students use a table to predict what the numbers and ratios would be in successive rounds.		
Day 6 *Essential Questions* When can I use a percentage to express a relationship in the natural world?			
6.RP.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. 06-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems K-7 Explain that a percent is ratio of number to 100	How Many Bears Live in this Forest, http://www.clemson.edu/extension/county/orangeburg/programs/4h/pdf/natural%20resources/Wildlife%20Lesson.pdf Students will analyze data from a simulation by calculating percentages of "surviving" bears based on food availability. Students will also use this information to conduct an explanation about how food availability predicts other populations of animals in Kentucky.	In their learning logs, students will answer all questions in #14	One Felt pen Plastic bags (stomachs) one per participant Paper and pencil per student One White board and marker One blindfold 5 different colored tokens or cards amount depending on size of group (colors can vary and label them according to chart).

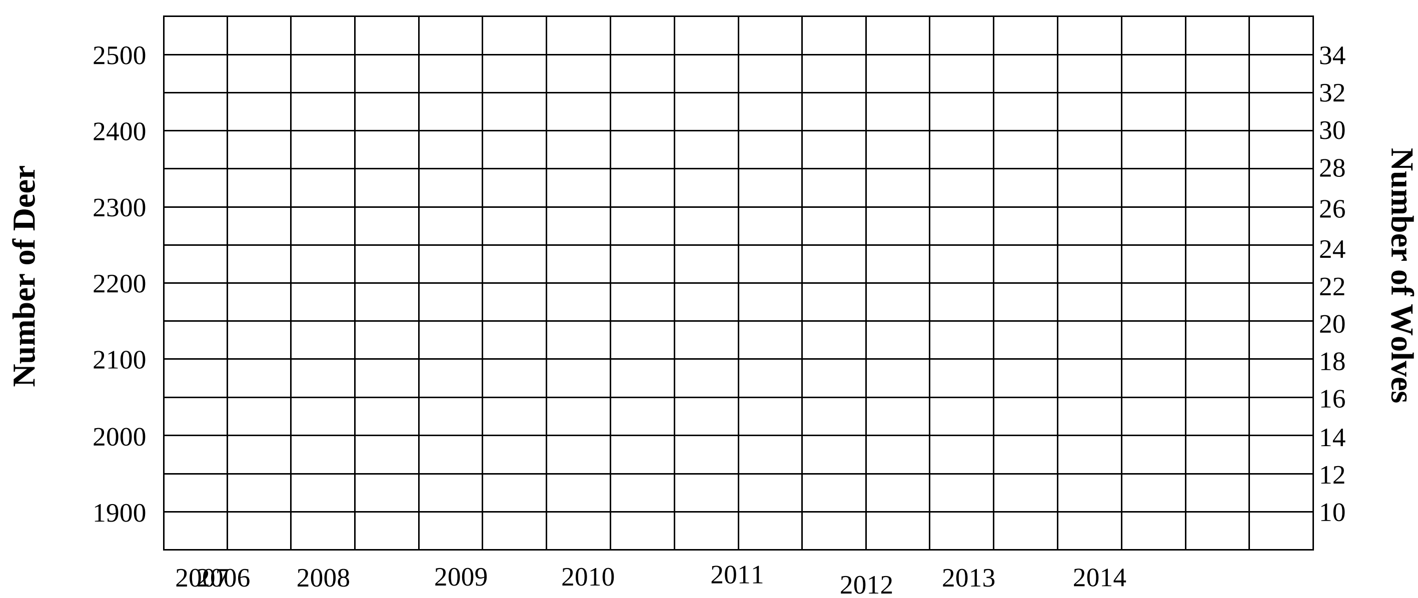
S-6 Find a percent of a number as a rate per 100 K-9 Describe different patterns of interactions of organisms with their environments, living and non, which are shared S-7 Solve real world problems involving finding the whole given a part and a percent			
Day 7 Where can I find ratios and proportions in the outdoors? How can I use ratio and rate reasoning to help understand nature?			
6.RP.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. 06-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems K-8 Explain that predatory relationships may reduce the number of organisms or eliminate whole populations S-8 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystem	Deer and Wolf Activity Students analyze data using ratio and proportions to determine if "Deer are better off with wolves", "Deer are worse off with wolves", or "Deer are about the same with wolves" See attached activity sheet.	Completion of activity sheet.	3 Posters or Poster Paper Deer: Predation or Starvation Worksheets (One per student) attached to lesson Two different colored Sticky notes (one of each color per student)

Scenario: In 2006 the deer population of an island forest reserve about 518 square kilometers in size was about 2000 animals. Although the island had excellent vegetation for feeding, the food supply obviously had limits. Thus the forest management personnel feared that overgrazing might lead to mass starvation. Since the area was too remote for hunters, the wildlife service decided to bring in natural predators to control the deer population. It was hoped that natural predation would keep the deer population from becoming too large and also increase the deer quality (or health), as predators often eliminate the weaker members of the herd. In 2006, ten wolves were flown into the island.

The results of this program are shown in the following table. The Population Change is the number of deer born (deer offspring) minus the number of deer that died (predation and starvation) during that year.

Year	Wolf Population	Deer Population	Deer Offspring	Predation	Starvation	Change in Deer Population	Change in Wolf Population
2006	10	2,000	800	400	100	+300	+10
2007	12	2,300	920	480	240	+200	+2
2008	16	2,500	1,000	640	500		
2009	22	2,360	944	880	180		
2010	28	2,224	996	1,120	26		
2011	24	2,094	836	960	2		
2011	21	1,968	788	840	0		
2012	18	1,916	766	720	0		
2013	19	1,952	780	760	0		
2014	19	1,972	790	760	0		

Graph the deer and wolf populations on the graph provided. Use one color to show deer populations and another color to show wolf populations.



Total Deer and Wolf Populations by Year

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Name:________________________ Date:___________

1. What was the ratio of wolves to deer in 2006? ___________
2. What was the ratio of wolves to deer in 2010? ___________
3. What was the ratio of wolves to deer in 2014? ___________
4. What was the percentage of change in the deer population between the years of 2009 and 2013? __________
5. What caused this change in the deer population?_______________________________

____
____
____

6. What do you think would have happened to the deer on the island had wolves NOT been introduced?

____
____
____

7. Express as a ratio the difference of the number of deer who died from predation and those who died from starvation in 2006. __________
8. Express as a ratio the difference of the number of deer who died from predation and those who died from starvation in 2014. __________
9. Is the ratios different or the same and explain why there was a difference or why there was not a difference?____

____
____

10. Looking at the data and graph predict the deer population and wolf population for 2015._________________
11. Why do you think these predictions occur?_____________________________________

____
____

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