Biodiversity by the Numbers

Grade Level: Middle School

Overview

This lesson uses math skills to analyze data about numbers of species in the wild and at the Saint Louis Zoo. Students are given step-by-step instructions about how to find percentages using available data. Students use a 100-square grid to look at proportions and relationships in a visual way. They are asked to make predictions about the data and answer questions using the data and their own ideas. Students can work independently or in pairs to do the calculations, but will benefit from answering the questions and having discussions in small and/or large groups.

Objectives

Upon completion of this activity, students will be able to:

- Calculate percentages.
- Understand that the majority of animals on the Earth are invertebrates.
- Analyze data and discuss possible interpretations.

Important Words

- Invertebrate
- Vertebrate
- Species

Materials

Calculators, 100-square grids, pencils, data sheets, colored pencils (optional) for shading grids.

Time Needed

50 minutes

Teacher Preparation

Read the background information and the Teacher Key for sample answers to discussion questions. NOTE: Many of the questions posed on the worksheet are meant to foster discussion and analysis and do not necessarily have a “right” answer.

Background Information

Biodiversity can be defined as the variety of life forms on earth. This is often discussed in terms of the number of species in an area of the world (e.g., rainforests) or on the entire planet. In terms of numbers of species, however, even these are estimates, since most scientists believe we have not yet identified all the species of animals and plants on earth.

For instance, approximately two million invertebrate animal species have been identified. Some believe that the actual number of invertebrate species on the planet ranges anywhere from three million to 100 million! In this activity, we use five million as our estimate, as a way to show that 99% of all animals are believed to be invertebrates.

From EarthLife.net:

> "Most animals, in terms either of numbers of individuals or of number of species, are invertebrates. Of the 34 phyla of animals in the Kingdom Animalia 32.5 of them are invertebrates in that they are lacking a spine or vertebra, that collection of bones that runs along the back of animals like Fish, Frogs, Snakes, Birds and Mammals.
>
> Life evolved in water, and the greater proportion of it has stayed there, mostly in the sea, but some also in fresh water. Of the 34 phyla of animals 25 are exclusively aquatic and 19 exclusively marine. Of the 8 phyla that have some terrestrial living members only two are predominately terrestrial, Chordata (including the Vertebrata) and Arthropoda (including the Insecta). This, and the fact that many of the phyla (20) contain only a few, less than 500 species, explains why we often remain unaware of this wonderful diversity of life that shares our planet with us."

NOTE: When looking at species of animals, as you will do in this lesson, animals are classified as either vertebrates or invertebrates, and together they equal 100% of animals on the planet. This is not fully accurate. There are animals that have spinal cords that are not vertebrates. These are commonly called tunicates or sea squirts. They make up such a minute percentage of animal species that they are not usually included in activities like the ones that follow. However, information is provided as background for the teacher. To further clarify, read this description from the University of California's Berkeley Museum of Paleontology:

> "The Urochordata, sometimes known as the Tunicata, are commonly known as "sea squirts." The body of an adult tunicate is quite simple, being essentially a sack with two siphons through which water enters and exits. Water is filtered inside the sack-shaped body. However, many tunicates have a larva that is free-swimming and exhibits all chordate characteristics: it has a notochord, a dorsal nerve cord, pharyngeal slits, and a post-anal tail. This "tadpole larva" will swim for some time; in many tunicates, it eventually attaches to a hard substrate, it loses its tail and ability to move, and its nervous system largely disintegrates. Some tunicates are entirely pelagic; known as salps, they typically have barrel-shaped bodies and may be extremely abundant in the open ocean."

Finally, when discussing statistics with students, it is important that they understand the difference between numbers of *species* and numbers of *individual animals*. These are very different numbers. Humans are one species of mammal, but there are six billion of us on the planet. Grevy's zebras are another species of mammal, but there are fewer than 2,500 of them. Thus, even though there may be more species of one animal (e.g., three species of zebras) than another (one species of human) does not necessarily guarantee a larger number of individual animals. This analysis represents the type of investigation and discussion that you can have with your students.

Activity 1: Analyzing the data 30 minutes

1. Hand each student his/her own copy of the Student Worksheet.
2. Have students follow the step-by-step instructions to find percentages. NOTE: Some students may need additional help, while others may be able to do the math calculations without the need to review percentages.
3. In each section, there are questions for students to consider. Have them answer the questions in preparation for the class discussion.

Activity 2: Class discussion 15 minutes

Discuss the questions on the worksheet and the observations made by the students about the data. These questions are meant to act as a start for a larger class discussion. Teachers can also ask questions such as “Is it reasonable to compare these types of data?” or “Is it possible to make any conclusions from the data?” Ask further questions to clarify the statements students make about the data. Encourage them to come up with their own conclusions and write them down. Discuss whether their inferences are logical or not. If more data need to be gathered to support their ideas, brainstorm resources for those answers and encourage further research.

Conclusion 5 minutes

Tell students that it is always important to look at data with a critical eye. All good scientists must do this to ensure that they have made logical conclusions about their research. Further research is almost always needed to confirm findings made by scientists. If the students are interested, they can continue to research the questions that came up during the discussion.

Student Worksheet

PART I: ANIMAL BIODIVERSITY ON EARTH

Biodiversity is often defined as the variety of life forms on earth. This includes all living organisms from bacteria to fungi to plants and animals. In this activity, you will learn about the variety of animal life on the planet.

1. Look at the following data:

Number of vertebrate species on Earth: **51,100**
Number of invertebrate species on Earth: **5,000,000**

NOTE: These numbers are estimates since most scientists believe that we have not identified all the animal species on our planet, especially invertebrate species.

Convert these data on animal species to percents. To find a percentage, the general rule is to divide the part by the whole and then multiply by 100. So, it will be important to know the total number of animal species on Earth before you get started.

STEP 1: Add the data from above to find your total.

Number of invertebrate species	+	Number of vertebrate species	=	Total animal species on Earth
	+		=	

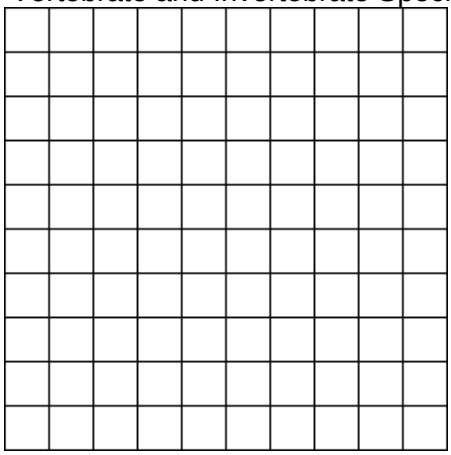
STEP 2: Divide (here we use the symbol, /, for division) and multiply by 100.

Number of invertebrate species	/	Total animal species on Earth	X 100	=	Percent of invertebrate species on Earth
	/		X 100	=	

Number of vertebrate species	/	Total animal species on Earth	X 100	=	Percent of vertebrate species on Earth
	/		X 100	=	

STEP 3: Represent this information visually by filling in the 100-square grid to show percentage of invertebrate and vertebrate species on Earth.

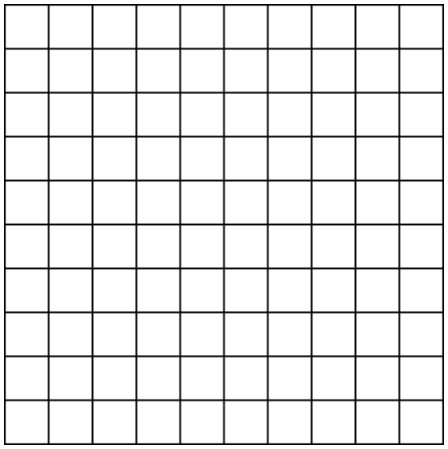
Percentages of Vertebrate and Invertebrate Species in the World



STEP 4: Now use the same process (part/whole x100) to figure out the percentage of the types of vertebrate species on Earth. The first one has been done for you.

Types of animals	Number of species on Earth	%
Vertebrates: Fish	24,000	**46 %**
Vertebrates: Amphibians	5400	
Vertebrates: Reptiles	7700	
Vertebrates: Birds	9000	
Vertebrates: Mammals	5000	
Total number of vertebrate species on Earth	**51,100**	**100%**

STEP 5: Represent this information visually by filling in the 100-square grid to show percentage of types of vertebrate species out of all the vertebrate species on Earth.



NOTE: This 100-square grid is a magnified version of **ONE** square from the grid in STEP 3. Therefore, each square is equal to **.01%** of all the animal species in the world.

STEP 6: Answer the questions.

1. Are there more vertebrate or invertebrate species of animals on Earth?

_____

2. Was this new information for you or something you were already familiar with?

_____

3. Why is it helpful to look at data in terms of percents rather than the actual numbers?

_____

4. If you were to use data about types of invertebrates and compare numbers of species, what are some types of invertebrates for which you would gather data?

_____

PART II: ANIMAL BIODIVERSITY AT THE SAINT LOUIS ZOO

Now that you know the numbers of species on Earth, let's see how well the Saint Louis Zoo's animal collection reflects these percentages.

A. First, make a prediction. Do you think the Saint Louis Zoo has a collection where 99% of the species are invertebrates and 1% of the species are vertebrates? _____

Why or why not? _____

_____

ZOO FACT: Each year the Saint Louis Zoo takes a census of its animal population. The following data are from the 2004 census. Remember that this is not the number of animals at the zoo, just the number of species. We'll look at numbers of animals later.

STEP 1: Find the percent of animal species at the Saint Louis Zoo.

Types of animals	Number of species at Zoo	%
Vertebrates: Fish	110	
Vertebrates: Amphibians	37	
Vertebrates: Reptiles	180	
Vertebrates: Birds	197	
Vertebrates: Mammals	115	
Invertebrates	180	
	Total number of species at Zoo: 819	**Total: 100%**

B. Make another prediction. Do you think the Saint Louis Zoo has a collection where 99% of the individual animals are invertebrates and 1% of the individual animals are vertebrates? _____

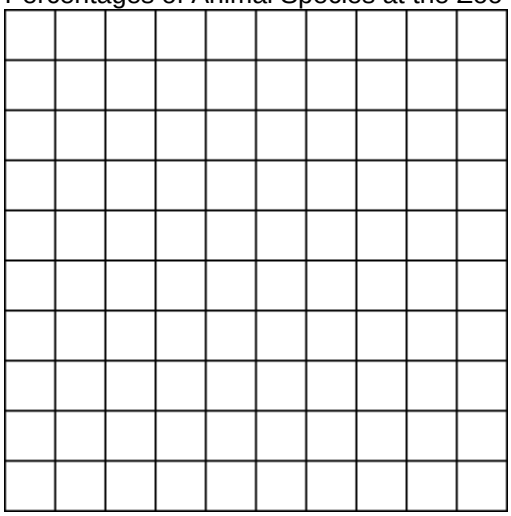
Why or why not? _____

STEP 2: Now make a table looking at the percentage of the individual animals in the Saint Louis Zoo. This table lists the number of individual animals by species type.

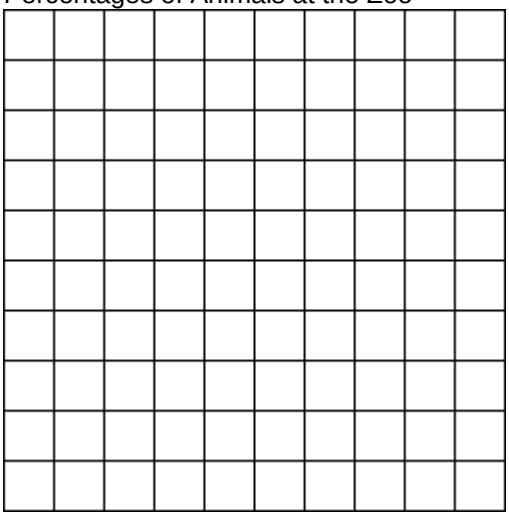
Types of animals	Number of animals at Zoo	%
Vertebrates: Fish	2,258	
Vertebrates: Amphibians	351	
Vertebrates: Reptiles	743	
Vertebrates: Birds	876	
Vertebrates: Mammals	513	
Invertebrates	6,653	
	Total number of animals at Zoo: 11,394	**Total: 100%**

STEP 3: Now fill in the 100-square grids to show the percentages of animal <u>species</u> and <u>individual</u> animals at the Saint Louis Zoo.

Percentages of Animal Species at the Zoo



Percentages of Animals at the Zoo



STEP 4: Answer the questions.

1. How accurate were your predictions? _____

2. Does it make sense to compare species of animals to numbers of individual animals at the Zoo? Why or why not?

_____

3. Look back at all of the grids you shaded. Are any of them similar? How would you explain any similarities?

_____

PART III: GENERAL OBSERVATIONS

1. What observations can you make about the data by looking at the grids?

_____

2. What do these grids tell you about biodiversity in the wild and at zoos?

_____

_____

3. Can you relate species and actual animal populations? Why or why not? _____

_____

_____

4. What other observations can you make about the data you have examined?

_____

5. a. What other questions do you have? _____

_____

b. How could you find the answers to these questions? _____

_____

Worksheet 1 Teacher Key

STEP 1: Add the data from above to find your total.

Number of invertebrate species		Number of vertebrate species		Total animal species on Earth
5,000,000	+	**51,100**	=	**5,051,100**

STEP 2: Divide (here we use the symbol, /, for division) and multiply by 100.

Number of invertebrate species		Total animal species on Earth			Percent of invertebrate species on Earth
5,000,000	/	**5,051,100**	X 100	=	**99%**

Number of vertebrate species		Total animal species on Earth			Percent of vertebrate species on Earth
51,100	/	**5,051,100**	X 100	=	**1%**

STEP 3: Represent this information visually by filling in the 100-square grid to show percentages of invertebrate and vertebrate species on Earth.

Percentages of Vertebrate and Invertebrate Species in the World
1 square=Vertebrates
99 squares=Invertebrates

STEP 4: Now use the same process (part/whole x100) to figure out the percentage of the types of vertebrate species on Earth. The first one has been done for you.

Types of animals	Number of species on Earth	**%**
Vertebrates: Fish	24,000	**46 %**
Vertebrates: Amphibians	5,400	**11%**
Vertebrates: Reptiles	7,700	**15%**
Vertebrates: Birds	9,000	**18%**
Vertebrates: Mammals	5,000	**10%**
Total number of vertebrate species on Earth	**51,100**	**100%**

STEP 5: Represent this information visually by filling in the 100-square grid to show percentage of types of vertebrate species out of all the vertebrate species on Earth.

46 squares=Fish
11 squares=Amphibians
15 squares=Reptiles
18 squares=Birds
10 squares=Mammals

STEP 6: Answer the questions.

1. Are there more vertebrate or invertebrate species of animals on Earth?
   Invertebrate species.
2. Was this new information for you or something you were already familiar with?
   Answers will vary.
3. Why is it helpful to look at data in terms of percents rather than the actual numbers?
   Percent relates everything in terms of 100, which is easier to understand. Other answers may apply.
4. If you were to use data about types of invertebrates and compare numbers of species, what are some types of invertebrates for which you would gather data?
   Options might include: arthropods (insects, spiders, etc.), worms, marine invertebrates, etc. See "Background Information" on lesson plan instructions for more information about types of invertebrates.

PART II: ANIMAL BIODIVERSITY AT THE SAINT LOUIS ZOO

Now that you know the numbers of species on Earth, let's see how well the Zoo represents the percentages in the wild.

A. First, make a prediction. Do you think the Saint Louis Zoo has a collection where 99% of the species are invertebrates and 1% of the species are vertebrates? **Answers may vary.**

Why or why not? **Answers may vary. Some may think the Zoo would represent these numbers to educate the public. Some might say no since visitors enjoy looking at vertebrates more than invertebrates.**

ZOO FACT: Each year the Saint Louis Zoo takes a census of its animal population. The following data are from the 2004 census. Remember that this is not the number of animals at the zoo, just the number of species. We'll look at numbers of animals later.

STEP 1: Find the percent of animal species at the Saint Louis Zoo.

Types of animals	Number of species at Zoo	**%**
Vertebrates: Fish	110	**13%**
Vertebrates: Amphibians	37	**5%**
Vertebrates: Reptiles	180	**22%**
Vertebrates: Birds	197	**24%**
Vertebrates: Mammals	115	**14%**
Invertebrates	180	**22%**
	Total number of species at Zoo: 819	**Total: 100%**

B. Make another prediction. Do you think the Saint Louis Zoo has a collection where 99% of the individual animals are invertebrates and 1% of the individual animals are vertebrates? **Answers vary.**

Why or why not? **Answers may vary. See Part A above. Also, you can discuss if and how numbers of species relates to numbers of animals.**

STEP 2: Now make a table looking at the percentage of the actual animals in the Saint Louis Zoo. This table lists the number of individual animals by species type.

Types of animals	Number of animals at Zoo	%
Vertebrates: Fish	2,258	**20%**
Vertebrates: Amphibians	351	**3%**
Vertebrates: Reptiles	743	**6%**
Vertebrates: Birds	876	**8%**
Vertebrates: Mammals	513	**4%**
Invertebrates	6,653	**58%**
	Total number of animals at Zoo: 11,394	**Total: 100%**

STEP 3: Now fill in the 100-square grids to show the percentages of animal species and individual animals at the Saint Louis Zoo.

Percentages of Animal Species at the Zoo

13 squares=Fish
5 squares=Amphibians
22 squares=Reptiles
24 squares=Birds
14 squares=Mammals
22 squares=Invertebrates

Percentages of Animals at the Zoo

20 squares=Fish
3 squares=Amphibians
6 squares=Reptiles
8 squares=Birds
4 squares=Mammals
58 squares=Invertebrates

STEP 4: Answer the questions.

1. How accurate were your predictions? **Answers may vary.**
2. Does it make sense to compare species of animals to actual numbers of animals at the Zoo? Why or why not? **Answers may vary.**
3. Look back at all of the grids you shaded. Are any of them similar? How would you explain any similarities?

Answers may vary. The most similar grids should be Percentages of Vertebrate and Invertebrate Species on Earth and Numbers of Animals at the Zoo. Allow for any logical interpretations.

PART III: GENERAL OBSERVATIONS

1. What observations can you make about the data by looking at the grids? **Answers vary.**

3. What do these grids tell you about biodiversity in the wild and at zoos? **Zoos keep a larger variety of vertebrate species than is represented in the wild as a whole, rather than having mostly invertebrates. The actual numbers of animals in the Zoo represent a closer match to percentages in the wild. *Other answers acceptable.***

4. Can you relate species and actual animal populations? Why or why not? **Just because there is a small or large number of species (variety of animals) doesn't tell us how many of that particular species is currently living on the planet. Unless the animal is endangered, there are few numbers available about total numbers of animals in the wild. For example, it would be extremely difficult to count the actual number of a certain species of fish. Scientists have been more successful in finding numbers of species rather than individuals. *Other answers acceptable.***

5. What other observations can you make about the data you have examined? **Answers vary.**

6. a. What other questions do you have? **Answers may vary.**
   b. How could you find the answers to these questions? **Answers may vary. Most students will say the library or internet. Zoos have detailed websites. Optional: Make a wall chart with additional student questions and encourage them to find answers(making sure they document their sources) to continue investigations in the classroom. Post answers as they come in.**