Lesson Plan – Quantifying (Measuring) Healthy Ecosystems

Summary

This lesson utilizes the example of healthy estuaries to demonstrate tools scientists use to measure ecosystem health. Students will learn the definition and function of an estuary, an essential coastal ocean ecosystem. Students will then learn methods to measure parameters of large areas using quadrats and subsets.

Content Area

Coastal Ecology

Grade Level

5-8

Key Concept(s)

- Estuaries are transition zones where land meets the ocean.
- There are different types of estuarine systems based on physical parameters such as temperature, salinity, and energy.
- Estuaries perform vital functions including serving as nurseries for ocean organisms, filtering toxins and sediments from coastal waters, and protecting adjacent land from coastal flooding.

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Lesson Plan – Quantifying (Measuring) Healthy Ecosystems

Key Concept(s)

- Scientists can learn about large areas of an ecosystem by studying small subsets using transects and quadrats.

Objectives

Students will be able to:

- Define ecosystem and estuary and understand that estuaries are vital transition ecosystems essential to the health and productivity of the Gulf of Mexico.
- Name some marsh plants found in Tampa Bay and Gulf of Mexico estuaries.
- Understand the important functions marsh and mangrove ecosystems provide the Gulf of Mexico.
- Explain density of organisms and understand how the density of organisms in an ecosystem can be related to determining the heath and productivity of an ecosystem.
- Understand and perform density experiments.

Resources

Marine Biodiversity Observation Network
http://www.marinebon.org

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National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Unifying Concepts and Processes 1. Systems, order, and organization	The natural and designed world is complex. It is too large and complicated to investigate and comprehend all at once. Scientists and students learn to define small portions for the convenience of investigation.
Unifying Concepts and Processes 5. Evidence, models, and explanation	Evidence consists of observations and data on which to base scientific explanations.
A.1: Abilities necessary to do scientific inquiry	Identify questions that can be answered through scientific investigations.

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National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
C.4: Life Science: Population and ecosystems	Populations of organisms can be categorized by the function they serve in an ecosystem.
Principle 5 (6-8: A) The ocean supports a great diversity of life and ecosystems.	Ocean ecosystems vary widely, based on the variety of environmental factors and the community of organisms living there.
Principle 5 (6-8: A.13.) The ocean supports a great diversity of life and ecosystems.	Environmental conditions in estuaries (e.g. shallow brackish water) and in marshes and mangroves (lots of decaying organisms) result in highly productive nursery areas for a great many ocean organisms.

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Think about it….

If you had only a few minutes to quantify* the number of red M&Ms in a 1,000 lb bag, how might you do it?

*Quantify means to figure out the amount

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Healthy Ecosystems

Ecosystem means a group of interconnected elements, formed by the interaction of a community of organisms with their environment.

The word comes from the Greek oikos, meaning "home," and systema, or "system."

Did you know: Etymology is the study of the origin of words and how their meanings have developed over time (and this word goes back to the Latin word etumos or “true”)!

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One Ecosystem is the Tampa Bay Estuary

Estuaries are places where saltwater and freshwater mix.

Estuaries have a variety of habitats.

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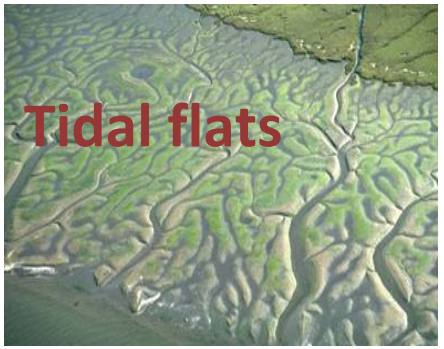
There are different types of estuaries

- Many are bordered by marshes.
- Marshes usually form a transition zone between land and water.
- Examples include:
  - Tidal flats (think oysters and clams)
  - Mangrove forests (mostly in warmer climates)



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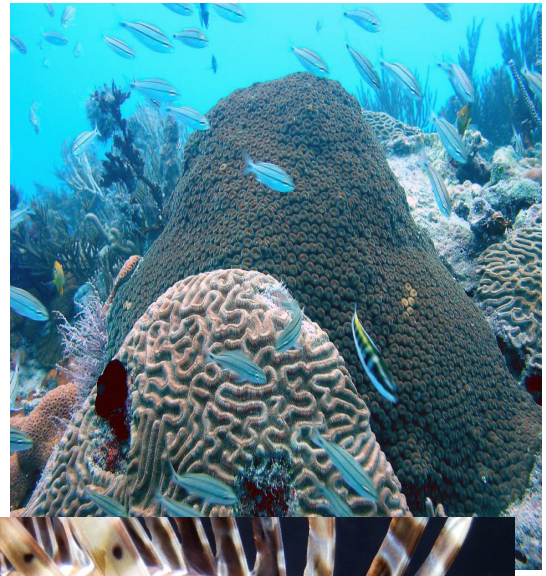

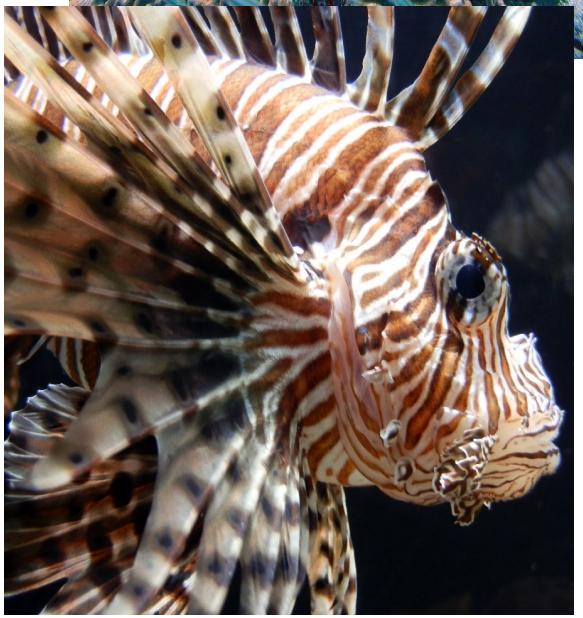

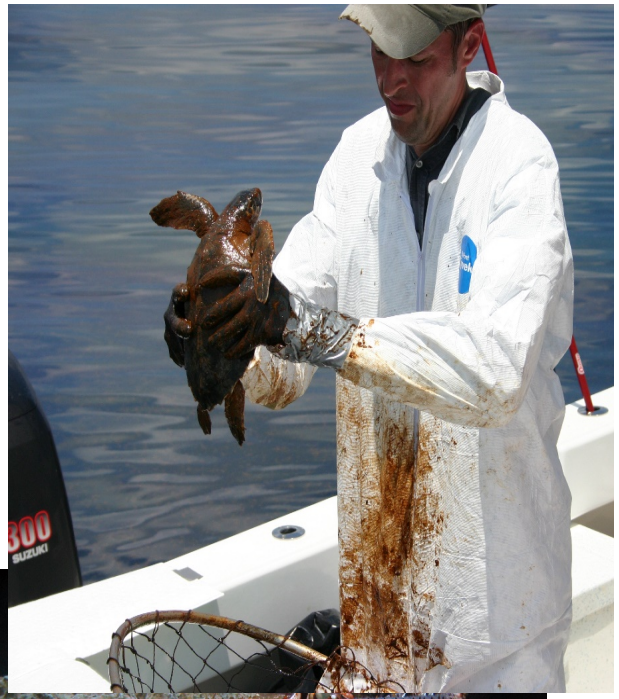

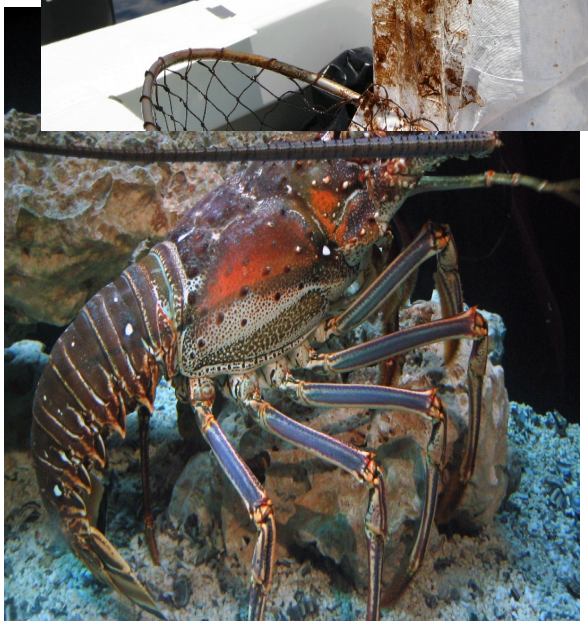

Marshes provide important habitat

Healthy Ecosystems

Our estuary is formed where Tampa Bay meets the Gulf of Mexico.

More than 75 % of commercial fish species spend all or part of their life cycle in estuaries!

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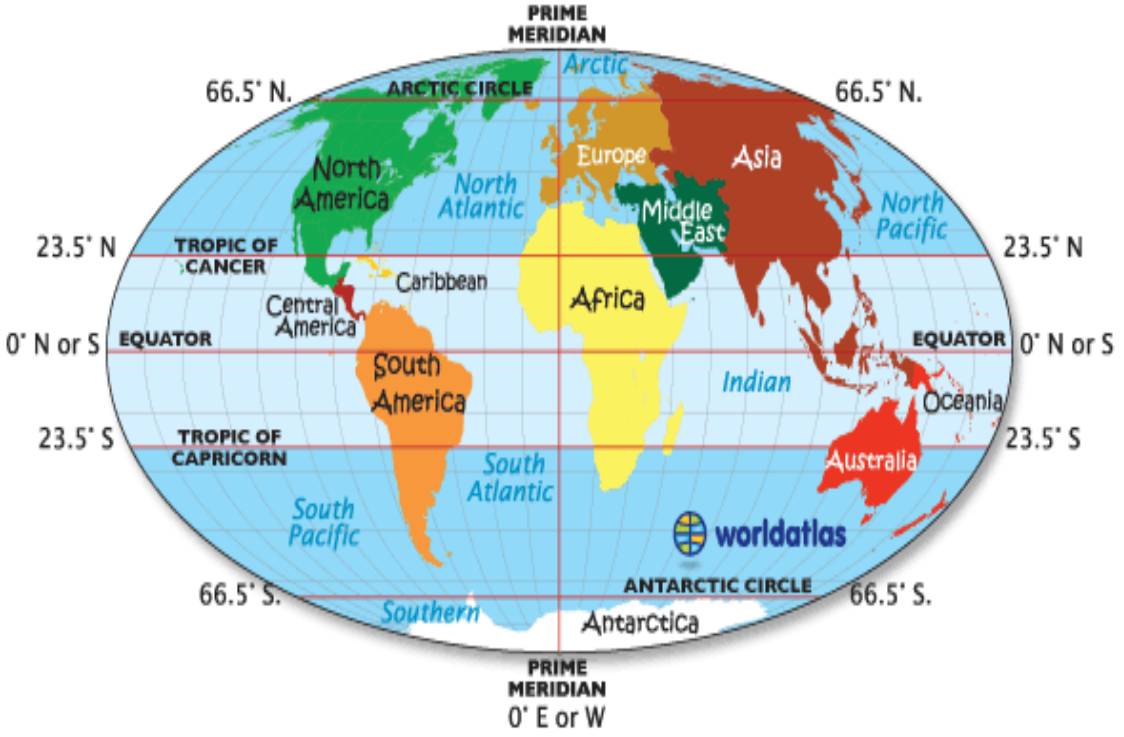
Our subtropical latitude results in many different habitats!

Coordinates for St. Petersburg, FL, are about:

27.7° N, 82.6° W

We are north of the Tropic of Cancer--the northern extent of the tropics.

We are south of 40° N which transitions to the temperate zone (PA, NY, NJ have cities at this latitude).



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Many plants grow in estuaries

- A common marsh plant is smooth cordgrass, *Spartina alterniflora*.
  - Also called saltmarsh cordgrass or saltwater cord grass.

- Eelgrass is another common plant that grows in brackish water.

- Mangroves are common in the Tampa Bay estuary.

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Marshes absorb toxins: Public Health

Wetlands, especially the sediment and root systems of plants, are important for good water quality. They act as natural filters, trapping things like heavy metals, nutrients and chemicals.

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Marshes Trap Sediment and Reduce Erosion: Coastal Hazards

Healthy marshes and barrier islands contribute to protecting lives and property by acting as barriers to reduce wave energy before it reaches the shore.

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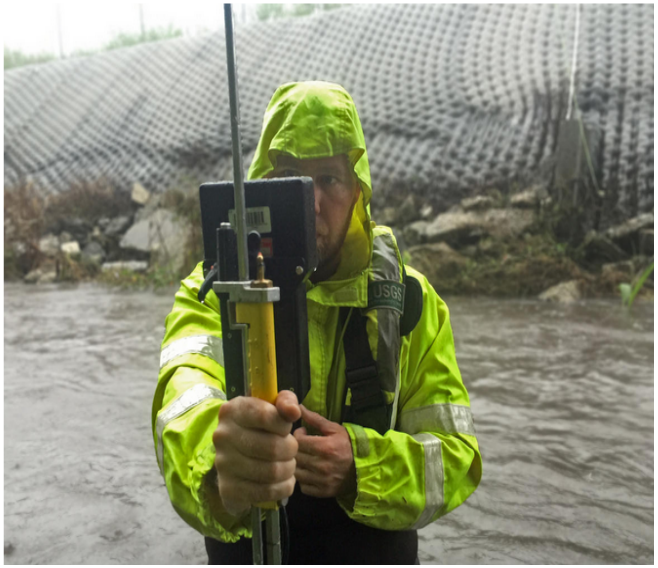
Erosion in Panama City Beach, FL, from Hurricane Hermine, Sept 1, 2016



Neil Yobbi, USGS, uses an ADV (Acoustic Doppler Velocimeter to measure stream flow in Tampa.

A rain gauge in Pinellas County measured more than 16” of rain during the 3-day Tropical Storm Hermine event, causing a lot of flooding!

Marshes Trap Sediment and Reduce Erosion: Coastal Erosion

Hurricane Hermine passed by us as a Category 1 storm.

She packed a lot of punch along our beaches!

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Marshes Sequester (absorb) carbon dioxide—a greenhouse gas: Healthy Ecosystems

Plants need carbon dioxide. The process of photosynthesis converts carbon dioxide and water to sugars and oxygen.

When carbon is tied up in plants this way, it is removed from the atmosphere.

What happens when plants die?

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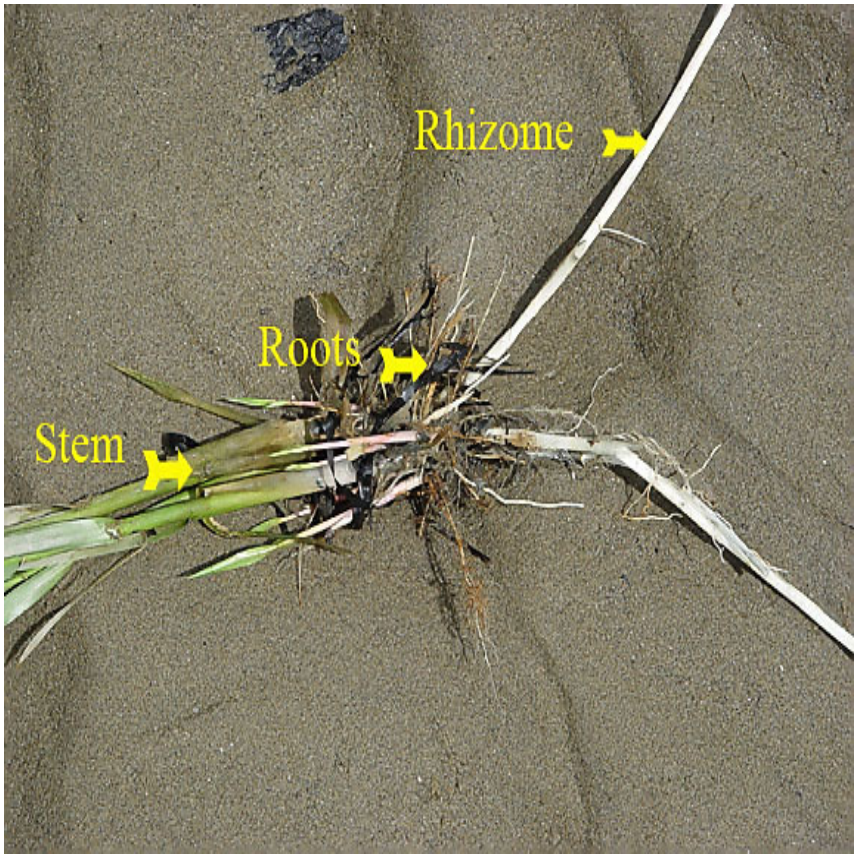
All parts of the plant, root system and surrounding environment are important in the



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In order to estimate how well the marsh is functioning, we need to know how healthy it is.

Are more plants growing than dying?

Are the conditions favorable for growing?

Counting every marsh plant is not an option!

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Scientists often use transects to estimate abundance over a large area.

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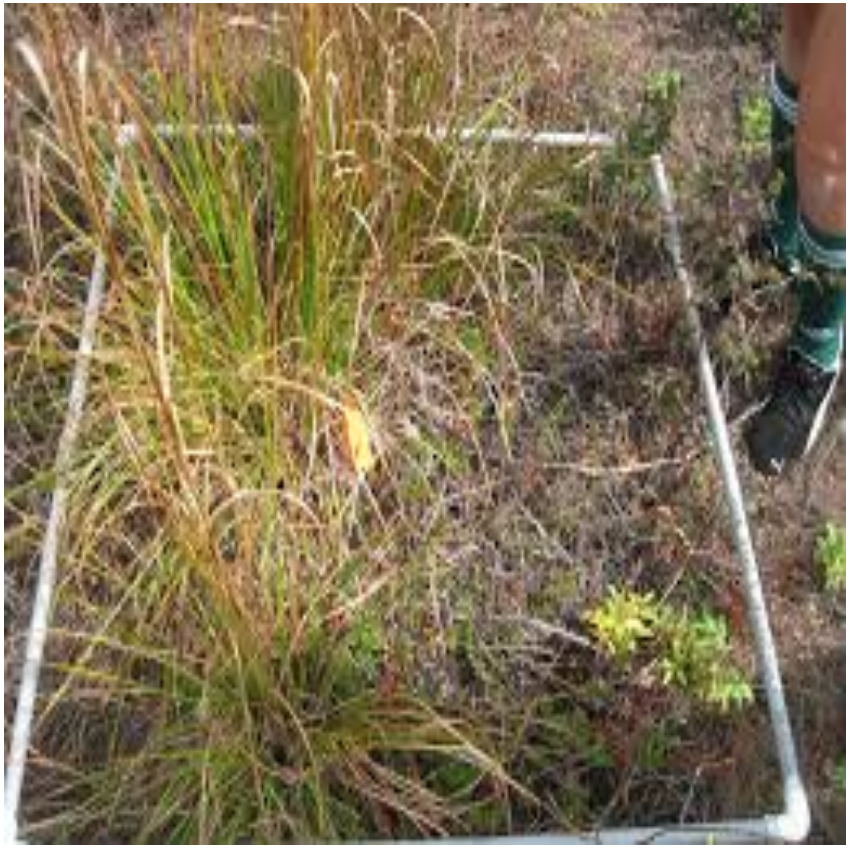
Instead of trying to count everything in an area, you sample a subset of what is there.



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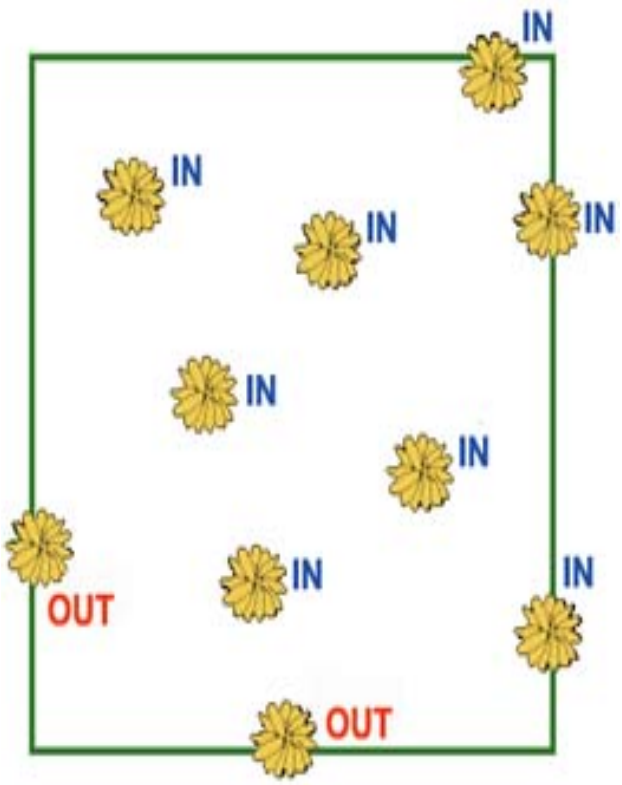
QUADRAT

A quadrat is a small plot used in ecology to separate a small area from a large area in order to study the distribution of species.



It is important for everyone to sample and count using the same rules!

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Figuring out density

- We want to know how many plants or animals of a particular kind live in an area.
- We have to figure out the density of that species.
- First, we figure out how much is in a small area by sampling and counting.
- Then we use math to figure out the density of the species over a large area.

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Example: How do you estimate how many 5th graders attend BPE without counting every kid?

- What do we need to know?
  - You know about how many kids are in each class (about 22)
  - You know how many 5th grade classes there are (5)
  - So, about (22 x 5 =?) kids total.

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- We can use this same strategy to estimate plant and animal abundance in ecology studies
  - How abundant is a particular species?
  - We measure the amount in a small area
  - Than we calculate the density over a large area

Density = the number of a species counted within the quadrat divided by the area of the quadrat

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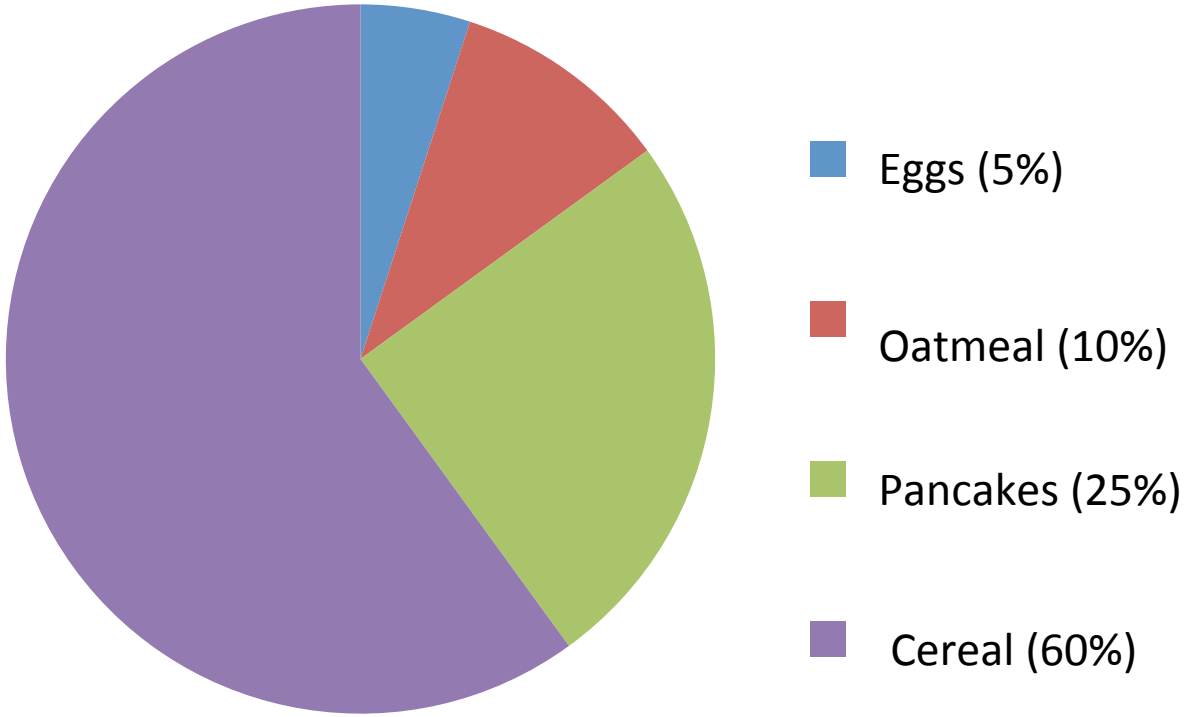
Example of density problem

- My quadrat has a length of 20 centimeters (cm) and a width of 20 cm.
- The AREA of the quadrat is

20 cm X 20 cm = 400 square centimeters.

- I counted 800 ants in the quadrat.
- The density of ants = 800 ÷ 400 = 2 ants per square centimeter.

Making a Pie Chart
What did 100 people have for breakfast?



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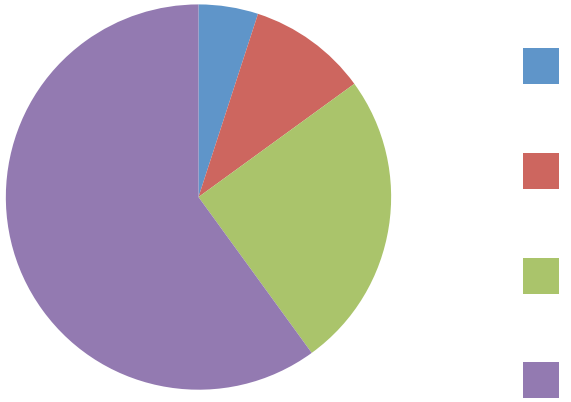
Making a pie chart with your density data



Total area in square centimeters of my quadrat =50				
What I saw	Number	Density		
Blades of grass	36	0.72		
Dandelion	10	0.2		
Ants	3	0.06		
Snails	1	0.02		

The Density of grass = The number of blades of grass you counted divided by the area of the quadrat

$36 \div 50 = 0.72$

Another way to think of this is as about 7 tenths

The Density of dandelions = The number of dandelions you counted divided by the area of the quadrat

$10 \div 50 = 0.2$

Another way to think of this is as 2 tenths

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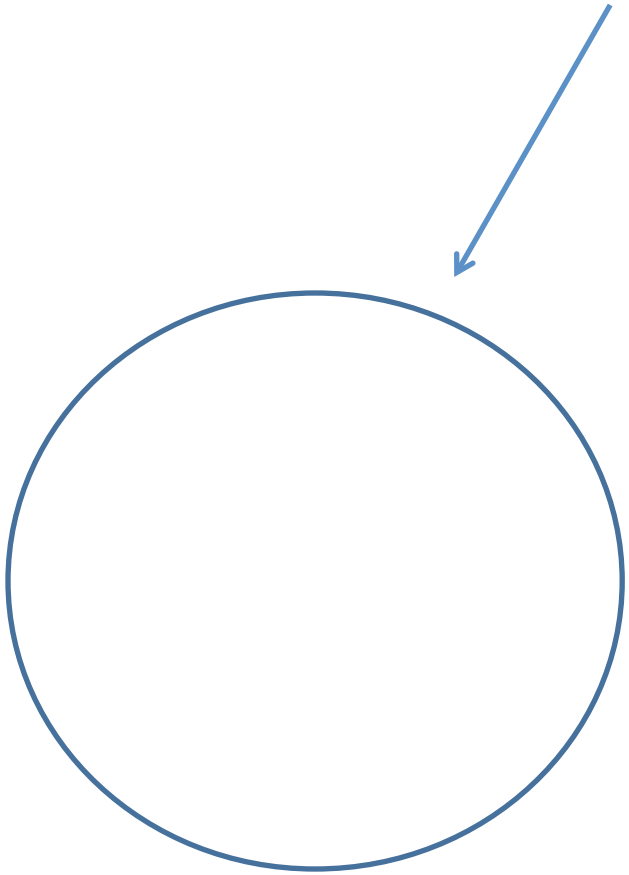
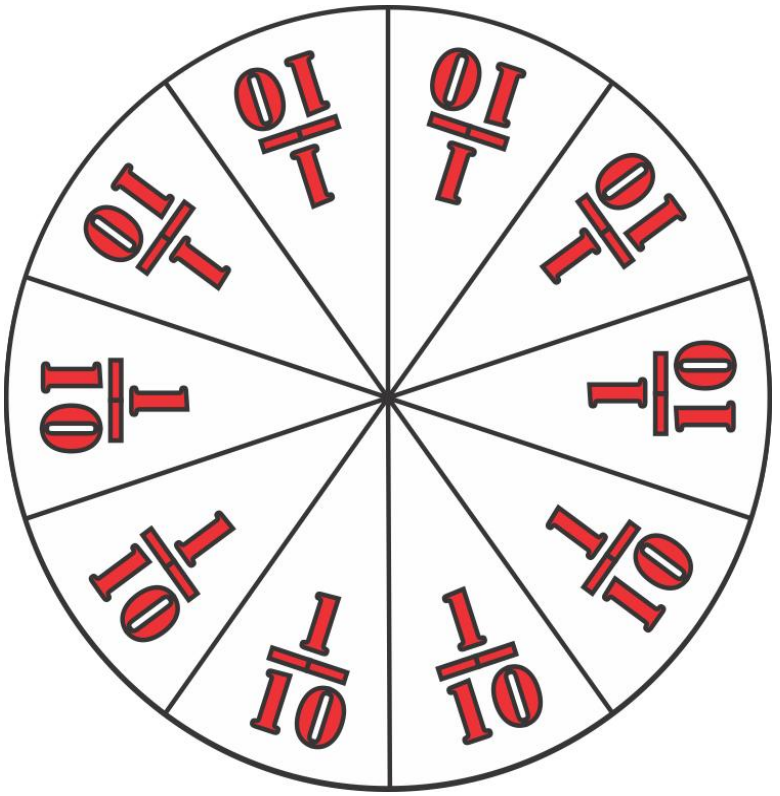
Draw a Circle on the back of your data sheet





Draw lines to break it into tenths
(but you do not have to write 1/10 in each section)

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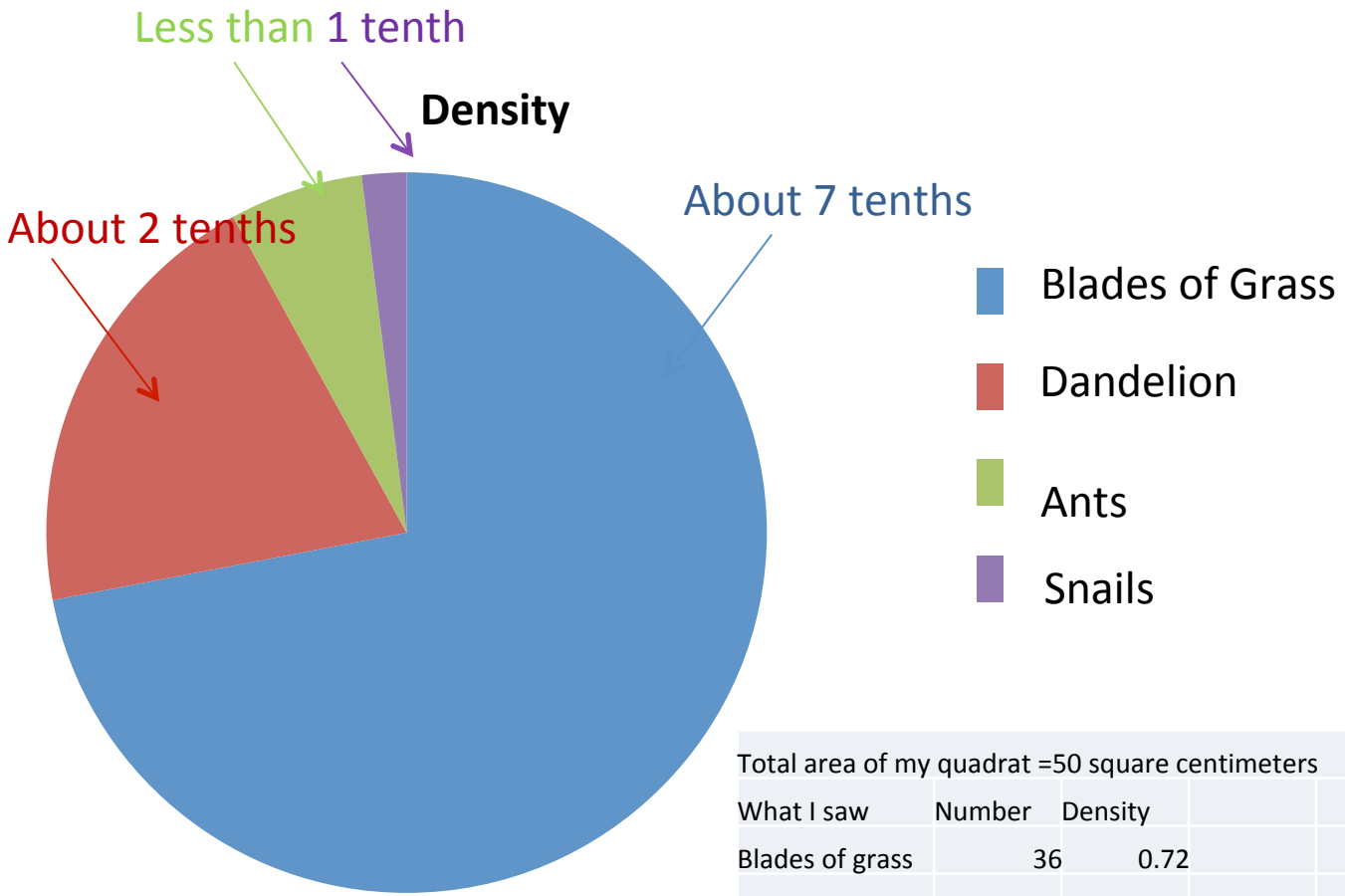

Total area of my quadrat =50 square centimeters				
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