**Lesson Plan: 6-8.5**
**Grade Levels: Grades 6 & 7**

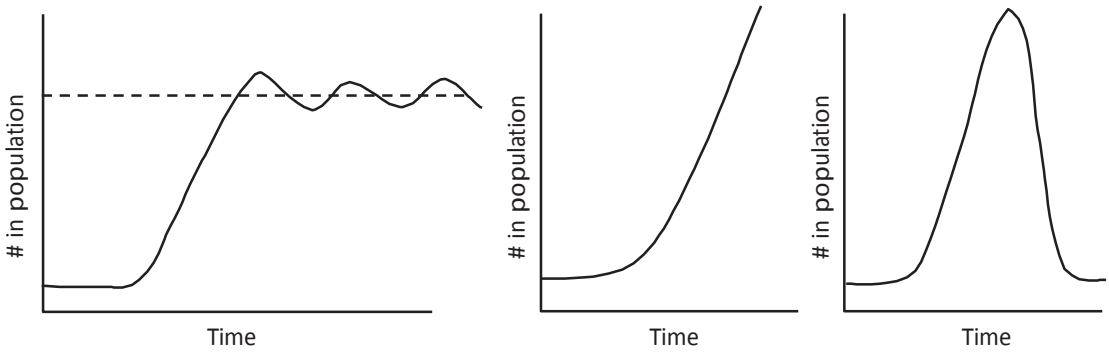
California State Framework: Grade 6 Standard Set 5. Ecology
Grade 7 Standard Set 3. Evolution

# Keeping Track of Numbers

## Background

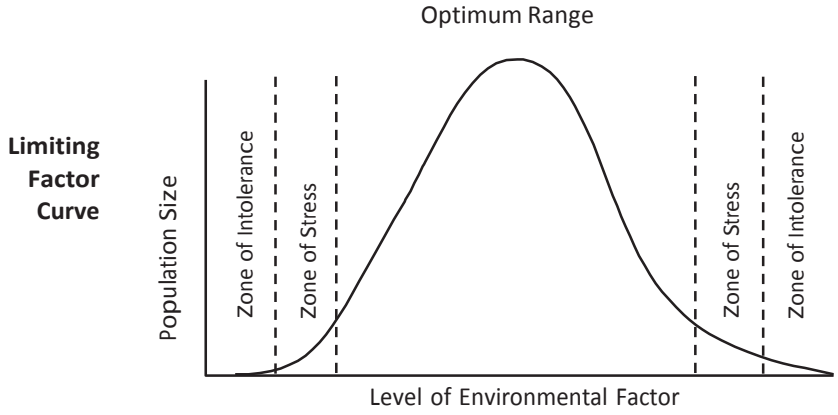
The term "population" refers to all the members of the same species living in the same place at the same time. Population studies are central to the study of ecology. Keeping track of population numbers is vital to monitoring the well-being of species; it is also central to sustainable harvesting and to the control of pest species. To maintain populations in a preserve, scientists must keep track of their numbers.

Population growth shows a common pattern known as the logistic growth curve. Contrast the logistic growth curve shown below with the logarithmic growth curve and the population crash graph. In logistic growth, growth begins slowly and continues steadily until the reproductive base has increased sufficiently, then it enters a period of logarithmic growth. At some point the population reaches a size that is the maximum the ecosystem can sustain. This number is referred to as "the carrying capacity" of that ecosystem for that population. After reaching the carrying capacity, the population will fluctuate slightly around that number.




**Logistic Growth** **Logarithmic Growth** **Population Crash**

What determines the size of the carrying capacity is a variety of factors such as water, light, temperature, nutrients, space (including nesting space and denning space). The graph below shows a limiting factors curve. It reminds us that population size can be limited not only by too little of a substance, but also by too much.

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# Keeping Track of Numbers continued...

## Background continued

Estimating the population is an important kind of field work done by an ecologist. In some situations, wherein the organisms are neither too plentiful nor too mobile, scientists may perform an actual count. Otherwise, they will use a sampling method to estimate the population size.

You may wish to have your students attempt to interpret the above graphs (see the accompanying Student Graph Interpretation Sheet) before you explain them.

## Goal

The specific goal of this lesson is to offer students the experience of making population estimates, using one method for non-motile species and one for motile ones.

## Before Your Visit

Numbers! How do scientists know the size of a population living in a particular ecosystem? Following are two activities for estimating population size. One will take students outdoors to estimate an actual population. The other can be performed indoors using pasta shells to simulate hermit crabs or mollusks. The math skills involved in both activities are limited to counting, multiplication and division (finding averages), and setting up proportions.

Activity 1: Estimating Clovers in an Area of a Lawn (see worksheet)

In advance: Find a lawn area on campus that has grass with some clovers mixed in. Obtain six to eight hula hoops of the same size. Alternatively you can use coat hangers which students have bent into a square shape. If using hula hoops, cut two pieces of yarn for each hoop. The yarn should be long enough to stretch across the hoop, dividing it into four quarters. You will also need a tape measure of sufficient length to measure the lawn area. Meter sticks or the tape measure may also be used to measure the hula hoops. Run off copies of the accompanying student worksheet, if desired.

Procedure: Divide students into groups. Show students a clover and instruct them to look at the base of the clover to distinguish the leaves from the plant they grew from so the students are counting plants rather than individual leaves.

Select two students to measure the length and width of the lawn area.

1. Each group first measures the diameter of the hula hoop and then performs seven counts in the following way:
2. One person in the group is designated as the thrower. She/he stands with his/her back to the lawn area and throws the hula hoop backwards over his/her head randomly.
3. Without moving the hoop, students then layout the yarn to divide the hoop area into quarters.
4. Each student counts clovers in one of the quarters. Students add together and then record the total number of clovers for that throw.
5. After repeating steps 1-3 seven times, students find the average number of clovers for all seven throws.
6. Students calculate the area of the lawn and the area of the hula hoop. Students divide the area of the lawn by the area of the hula hoop.
7. Students multiply that answer times the average number of clovers for all throws. Students may then further average the answers found by all different groups.

For discussion: How does the method followed here seek to avoid bias? Why is it important for scientists to be objective?

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# Keeping Track of Numbers continued...

**Before Your Visit**
continued

Activity 2: Mark-Recapture: Estimating Population Size Using Pasta Shells (see worksheet)
In advance: Obtain several hundred pasta shells for each group of four students. The shells can represent any mollusks or, perhaps, hermit crabs in a tidal zone. Place pasta shells in a brown paper bag of lunch bag size or larger. Obtain small paper cups for each group to use as traps. Each group will also need a felt-tip marker.

Procedure: Divide students into groups of four. Have each group get a bag of shells, a cup and a marker. Groups trap shells using their paper cups. Each shell that is captured must be marked. All of these captured and marked shells must be counted. Marked shells are then released back into the study area (bag). Holding the bag shut, students shake the bag gently. This allows the captured specimens to mix back into the population. Students then recapture a cupful from the study area. (Note: They must fill the cup to the same level each time. Either top it off or mark a fill line inside the cup.) Students must count and record the total number recaptured and the number of marked individuals that are recaptured.

Mix **all** shells back into the bag, mix, and perform another recapture. Do this a total of seven times, calculating the population count each time and averaging findings at the end.

NOTE: Only the individuals trapped in the first capture are marked. At the end of each capture all individuals that were trapped, whether marked or unmarked, must be returned to the bag.

Calculations:
1. Although only calculation #2 is necessary to obtain the answer, #1 is shown to point out that this process is based on a simple ratio.

$$\frac{\text{number first captured, marked and released}}{\text{total number in population}} = \frac{\text{total number of marked individuals in the recapture}}{\text{total number recaptured}}$$

2. $$\text{total number in population} = \frac{\text{\# first captured, marked, released} \times \text{total recaptured}}{\text{total \# of marked individuals in the recapture}}$$

For discussion: What represents the study area? Why must the individuals be thoroughly mixed back in at the end of each recapture? What considerations would be important about the marking process?

The paint, dye, tagging or whatever other method is used to mark animals must not affect them adversely. Neither should it make them more, or less, attractive to predators or to the other members of their own population. Discuss with your students the importance of randomness and how marking might impact it.

What would the biologist need to know about the animals being studied in order to perform this count accurately? Such things as migration patterns and habits, population dispersion patterns, denning habits, reproductive patterns and when the animal is most and least active could all impact the count.

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# Keeping Track of Numbers continued...

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|---|---|
| **Before Your Visit** continued | At the end of this discussion, perhaps for homework, have students choose a species that is found at Safari West and prepare a list of questions for the naturalist/guide. For example: How is the population size tracked at Safari West? How is it done in the wild? How do migration patterns (or dispersion or reproductive patterns) help scientists decide how to keep track of numbers? |
| **Matierals to Bring** | Students should come with their prepared questions, a pencil, clipboard and paper or binder so they can take notes. |
| **At Safari West** | Inform your naturalist beforehand that students will ask questions about keeping track of population size for animals at Safari West and in their native range. Have students observe their chosen species and note relative behavior in addition to asking the naturalist. |
| **Back in the Classroom** | Class discussion of observations and the answers they obtained will give students a chance to form insights into monitoring population size for a variety of species. |

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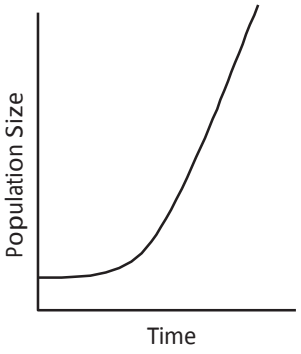
Lesson Plan: 6-8.5

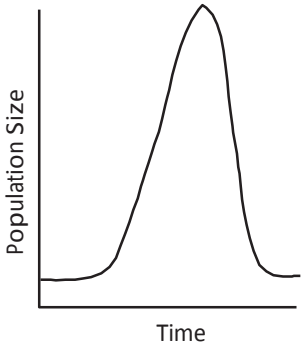
# Worksheet: Graph Interpretation

Name:_____

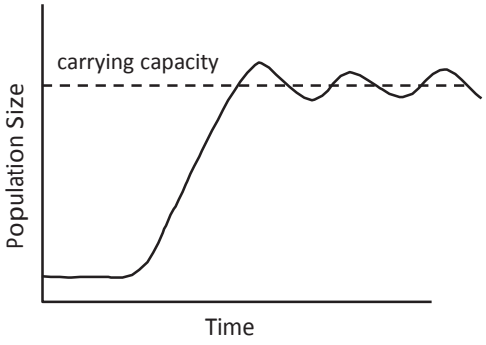
Write a brief explanation of each graph below.




**1. Logarithmic Growth**




**2. Population Crash**




**1. Logistic Growth**

**Interpretation:** (the first one is started for you)

1. As time goes by, the population size _____

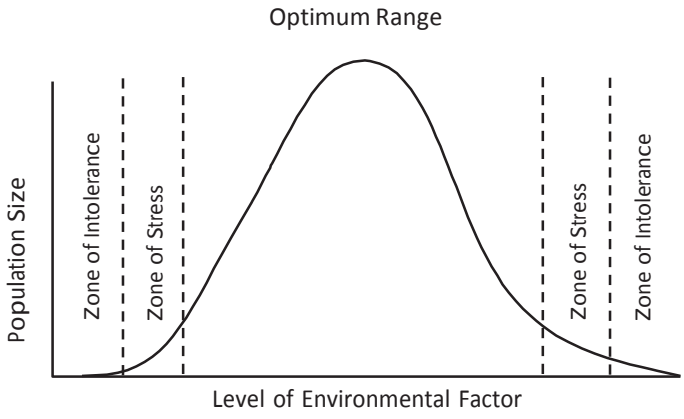
_____

2. _____

_____

3. _____

_____




**4. Limiting Factor Curve**

4. _____

_____

Lesson Plan: 6-8.5

# Worksheet: Estimating the Clover Population in an Area of Lawn

Name:_

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1. Choose one person in your group to throw the hula hoop. That person must throw the hoop backwards over his or her head into the study area without looking.
2. Using yarn, divide the area inside the hoop into four sections and have four group members count the number of clovers in each section. Add the results together and record.
3. Repeat steps 1 and 2 seven times.
4. Total the numbers from all seven throws and find the average.

   Throw #1: #2: #3: #4: #5: _

   #6: #7: Total: Average # per throw: _

5. Find the area of the lawn (length X width = area). Remember to record units! (For example, did you measure the lawn in inches, feet, yards, or meters?)

   length: X width: = area: _

6. Find the area of the hula hoop (area of a circle = )

   radius: area: _

7. Divide the area of the lawn by the area of the hula hoop. Show your work.

   answer: _

8. Multiply the answer to G by the average number of clovers per throw to find the number of clovers in the study area. Show your work.

   answer: _

9. Calculate the average of answers to part H for all groups.

   answer: _

**Questions to discuss:**

- Why is it important to have the same person throw all seven times?
- Why should the thrower throw the hoop backwards?
- Compare the answers found by the different groups. If the answers are quite different, how can you explain that?
- Why did you average the answers from all the groups in the last step?

Try this: For your parents or a friend, summarize the steps in this activity and explain why a biologist would do this.

Lesson Plan: 6-8.5

# Worksheet: Mark-Recapture: Estimating Population Size Using Pasta Shells

Name:_____

Materials for each group: one bag with pasta shells, one cup, and one felt-tip marker.

A. Using your paper cup as a trap, capture a group of the shells.
B. Count and mark each individual that was captured. Record this number.
C. Return all shells to the bag.
D. Hold the bag closed and shake it gently, so as not to break the shells.
E. Recapture another cupful. Be sure to fill the cup to the same level for each capture.
F. Count the total number in the recaptured group. Record.
G. Count the number in this group that are marked. Record.
H. Perform the calculation shown below to find the population estimate. Record.
I. REPEAT steps C-H, six more times. Record.

$$\text{Population Estimate} = \frac{\text{\# first captured, marked, released X total \# recaptured}}{\text{total \# of marked individuals in the recapture}}$$

**Data and Results**

| | 1st capture | 2nd recapture | 3rd recapture | 4th recapture | 5th recapture | 6th recapture | 7th recapture |
|---|---|---|---|---|---|---|---|
| # first captured, marked and released | | | | | | | |
| total # recaptured | | | | | | | |
| # of marked individuals in recapture | | | | | | | |
| population estimate | | | | | | | |

**Questions to discuss:**

- What must you be careful of when marking animals in a study that is real rather than simulated?
- Why must you shake the bag after each release?
- If you were the biologist and you wanted to perform a mark-recapture study to estimate the population size of kangaroo rats in a certain part of California's Central Valley, what kinds of information would you need to know about these animals to design a good study?

Try this: Compare and contrast the two methods of estimating populations that were covered in this lesson. When would you use one kind of study, and when would you use the other?