Teacher

Limiting Factors

(Adapted from the "Oh Deer" activity)

NGSSS:

SC.912.L.17.5 Analyze how population size is determined by births, deaths, immigration, emigration, and limiting factors (biotic and abiotic) that determine carrying capacity. (**AA)**

Purpose of the Lab/Activity:

- Identify and describe the essential components of habitat.
- Describe the importance of good habitat for animals.
- Define "limiting factors."
- Recognize that some fluctuations in wildlife populations are natural as ecological systems undergo constant change.
- Graphing the data collected to show how population size differs over time and with changes in the environment.

Prerequisites:

- An understanding of the components of an ecosystem, organism's role and interactions that occur between them.
- The difference between abiotic and biotic factors.
- The resources necessary for an organism to survive.

Materials (per group):

- open space

Procedures: Day of Activity:

Before activity:	**What the teacher will do:** a. Ask the following question in order to review the basic needs of animals: 1. Identify some of the basic needs of animals. 2. Define the concept of a "limiting factors" in your own words. b. Before going outside, give directions on how to play. Impress upon the students that being honest is the only way to obtain accurate scientific data for the graphing activity. In nature, cheating is not an option! c. Explain that habitats provide: shelter, food, water, space, mates, etc. This game simulates the search for three of these: shelter, food and water. d. Once outside, students will count off in fours. 1s, 2s, and 3s are one side of the field. 4s are on the other. e. Space the two lines facing each other at least 20 yards apart. The width of the activity area should be slightly wider than the habitat line. f. The 4s will represent the deer. g. The 1s, 2s, 3s will be the habitat components.
During activity:	**What the teacher will do:** a. Monitor students during the activity to make they are not cheating by changing their sign after a round as begun. You may provide students with limiting factors card instead of having them do signs. b. Assist them at the end of each round to make sure they are following the procedure. Emphasize step 7. c. Occasionally the students representing habitat will conspire to all be the

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same component, thereby “killing” most, if not, all deer not seeking that component. Don’t discourage this behavior; explain that the habitat may have suffered a drought, famine or fire, which resulted in a lack of water, food or shelter.

d. Remind students to collect data at the end of each round; each round symbolizes a year.

Part B: Effects of a Flood or Drought

1. Repeat steps 1 – 8 from Part A.
2. On round two, the quietly tell all the resources to become water for round two since there is a flood predicted for that year.

   OR

   On round two, quietly tell all the resources to be shelter for round two. There is no food or water available due to a drought that is occurring in year two.
3. Continue rounds 3-10 as normal, allowing the resources to choose to be food, water, or shelter as they did in Game #1.
4. When the graph is constructed after round 10, note the effects of the drought or the flood on the deer population. Use the graph to see how long it took for the deer population to recover - if they did recover.

Part C: Predator Prey Simulation

1. Repeat steps 1 – 8 from Part A.
2. On round four, the teacher will introduce a predator such as a mountain lion or a wolf into the situation.
3. The predator starts in a designated "predator den” area off to the side.
4. The predator has to skip or hop. This reduces the possibility of violent collisions between deer and predators.
5. The predators can only tag deer when they are going towards the habitat and are between the habitat and deer lines.
6. Once a deer is tagged, the predator escorts the deer back to the predator den. This simulates the time it takes the predator to eat the deer.
7. The "eaten” deer is now a predator.
8. Predators that fail to tag someone die and become a resource. That is, in the next round, the predators that died join the habitat line. They will become available to surviving deer as either food, water, or shelter.
9. During each round, keep track of the predators as well as the deer.
10. Incorporate the data into the graphs.

e. Ask the following questions:
   1. What were the limiting factors for population growth in this simulated ecosystem? Can these factors change over time?
   2. Ecologists have found that no organism can experience indefinite exponential growth, yet *Homo sapiens* have experienced exponential growth for hundreds of years. How have humans modified the limiting factors of our population growth?

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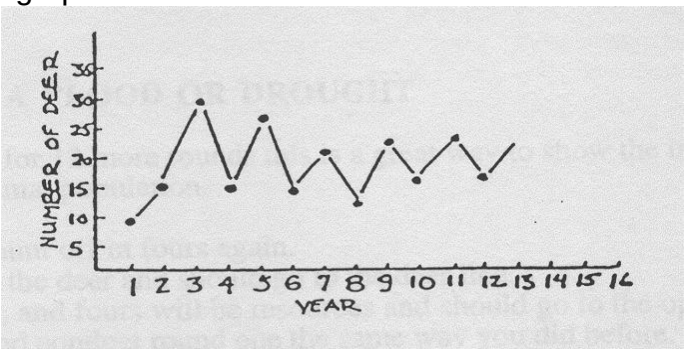
After activity:	**What the teacher will do:** a. Return to classroom, to work on analysis of lab. b. Answer Key for Results/Conclusion: 1. List the basic needs of animals. food, water, shelter, and adequate space 2. Describe the relationship between resource availability and population growth or decline. When resources are available populations grow until they reach their carrying capacity. If resources become limited then the population will decline. 3. Define "limiting factors" and provide three examples. Limiting factors prevent the continued growth of a population; Examples: predators, drought, disease, habitat loss, pollution, hunting, reduced dietary items, weather, parasites, etc. 4. What is the carrying capacity for the deer population according to your graph? Answers will vary; must be determined using their group's graph. Carrying capacity is the maximum population size a certain environment can support for an extended period of time. 5. Once the deer population goes significantly above carrying capacity, describe what happens to the deer population in the years following. The deer population naturally increases until it overshoots the carrying capacity. At this point, the environment can no longer provide for the species, due to the limiting factors which in this activity was food, water and shelter. The deer population, due to lack of resources, will begin to die out, allowing the environment to recover. As the environment recovers, the species population is able to flourish once more. c. Examine the graph.  1. What happened to the population size between years 1 and 2? declined 2. What happened to the population size between years 4 and 5? increased 3. If the environmental conditions in year 9 are the same as occurred between years 2 and 3, what can you expect to happen to the population between years 8 and 9? Why? The environmental conditions were favorable between years 2 and 3 and the population increased. The population is on the rise from years 6 to 8, but the population in year 8 is still at or below the population at year 2. With similar favorable conditions as between years 2 to 3, the population should continue to increase into year 9. d. Have groups answer the following questions: 1. How did you determine the carrying capacity?

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	2. Describe how the activity modeled the significance of limited resources in regards to a species' population. 3. List some possible sources of errors and how they could affect the lab results. 4. Make suggestions for improving the lab to make the simulation more accurate and effective.

Extension:

- Online Activity 35.2: Population Growth of Two Different Species www.biology.com Students plot exponential growth of bacteria as they view a video. Then they plot and analyze data showing changes in a hypothetical population of grizzly bears. Then they compare exponential growth to population limited by environmental factors.
- Gizmo: Rabbit Population by Season

Student

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Background:

A variety of factors affects the ability of wildlife to successfully reproduce and to maintain their populations over time. Disease, predator/prey relationships, varying impacts of weather conditions from season to season (e.g., early freezing, heavy snows, flooding, and drought), accidents, environmental pollution, and habitat destruction and degradation are among these factors.

Some naturally-caused as well as culturally-induced limiting factors serve to prevent wildlife populations from reproducing in numbers greater than their habitat can support. An excess of such limiting factors, however, leads to threatening, endangering, and eliminating whole species of animals. The most fundamental of life’s necessities for any animal are food, water, shelter, and space in a suitable arrangement. Without these essential components, animals cannot survive.

Wildlife populations are not static. They continuously fluctuate in response to a variety of stimulating and limiting factors. Natural limiting factors tend to maintain populations of species at levels within predictable ranges. This kind of “balance in nature” is not static, but is more like a teeter-totter than a balance. This cycle appears to be almost totally controlled by the habitat components of food, water, shelter, and space, which are also limiting factors. Habitat components are the most fundamental and thereby the most critical of limiting factors in most natural settings.

Problem Statement:

- Part A: How will resource availability affect the population of a species in an ecosystem?
- Part B: How will a density-independent limiting factor (flood or drought) affects the population of species in an ecosystem?
- Part C: How will a density-dependent limiting factor (predator) affect the population of species in an ecosystem?

Vocabulary: reproduction, predator, prey, degradation, limiting factor, habitat, species, population, resource, carrying capacity

Hypothesis:

Part A: _____

Part B: _____

Part C: _____

Student

Materials (per group):

- open space

Procedures:

Part A: Effects of Resource Availability

1. Make a hypothesis based on the problem statement above for the resources being supplied.
2. Obtain a number (1 through 4) from your teachers.
   a. Deer = 1
   b. Resources = 2, 3, 4
3. Go outside. Deer will all stand on one side of the sidewalk and all the resources will stand on the opposite side. Stand with backs toward other group.
4. Each student should choose a sign to make for the first round. Students 2 – 4 will decide what resource they will be and all the deer will decide what resource they are looking for. Resources will include food, water, and shelter. A deer can choose to look for any of its needs in each round, but cannot change its mind after turning around to face the "habitat".
5. Make the sign of the resource.
   a. Food = Rub stomach with hand
   b. Water = Raise hand to the mouth as if to drink from a cup
   c. Shelter = Raise arms over head
6. When teacher says “GO,” turn around and face other group. Continue to hold sign. Resources DO NOT move. They wait for a deer to come to get them. Resources or habitat components stay in place on their line until a deer needs them. If no deer needs a particular habitat component during a round, the habitat component just stays where it is in the habitat. The resource person can change which component it is at the beginning of each round.
7. When deer see a student in the habitat making the sign they need, they should walk quickly, but calmly, to get that student and take them back to the deer side. This represents the deer successfully meeting its needs and reproducing. Those deer who do not meet their needs remain in the environment to provide habitat for the other deer in the next round.
8. Record the number of deer in each round for graphing later.
9. Predict what will happen in the next round.
10. Repeat steps 3 – 8, ten more times.

Part B: Effects of a Flood or Drought

Purpose: Analyze the impact that a disaster has on an animal population.

1. Repeat steps 1 – 8 from Part A.
2. On round two, the teacher will make a modification.
3. Continue rounds 3-10 as normal, allowing the resources to choose to be food, water, or shelter as they did in Game #1.
4. When the graph is constructed after round 10, note the effects of the drought or the flood on the deer population. Use the graph to see how long it took for the deer population to recover - if they did recover.

Part C: Predator Prey Simulation

Student

1. Repeat steps 1 – 8 from Part A.
2. On round four, the teacher will introduce a predator such as a mountain lion or a wolf into the situation.
3. The predator starts in a designated "predator den" area off to the side.
4. The predator has to skip or hop. This reduces the possibility of violent collisions between deer and predators.
5. The predators can only tag deer when they are going towards the habitat and are between the habitat and deer lines.
6. Once a deer is tagged, the predator escorts the deer back to the predator den. This simulates the time it takes the predator to eat the deer.
7. The "eaten" deer is now a predator.
8. Predators that fail to tag someone die and become a resource. That is, in the next round, the predators that died join the habitat line. They will become available to surviving deer as either food, water, or shelter.
9. During each round, keep track of the predators as well as the deer.
10. Incorporate the data into the graphs.

Observation/Data:

Table 1: Effects of Resources on Deer Population

Year (round)	Deer Population (#)	Observations
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Student

Table 2: Effects of Drought or Floods on Deer Population

Year (round)	Deer Population (#)	Observations
0		
1		
2		Flood or Drought affect resources
3		
4		
5		
6		
7		
8		
9		
10		

Table 3: Effects of Predator on Deer Population

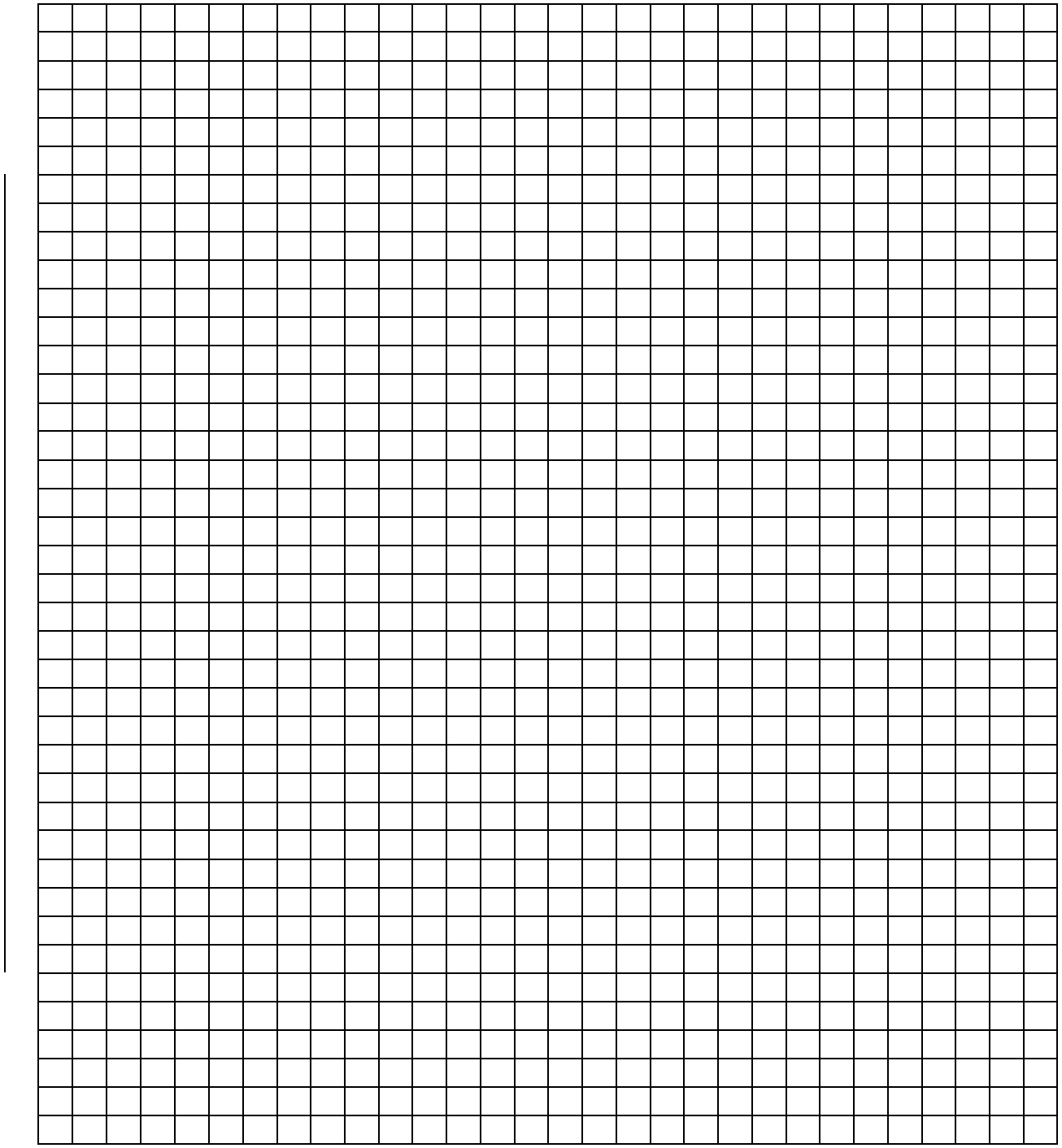
Year (round)	Deer (#) at end	Predator (#) at end
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Student

Data/Graphs:

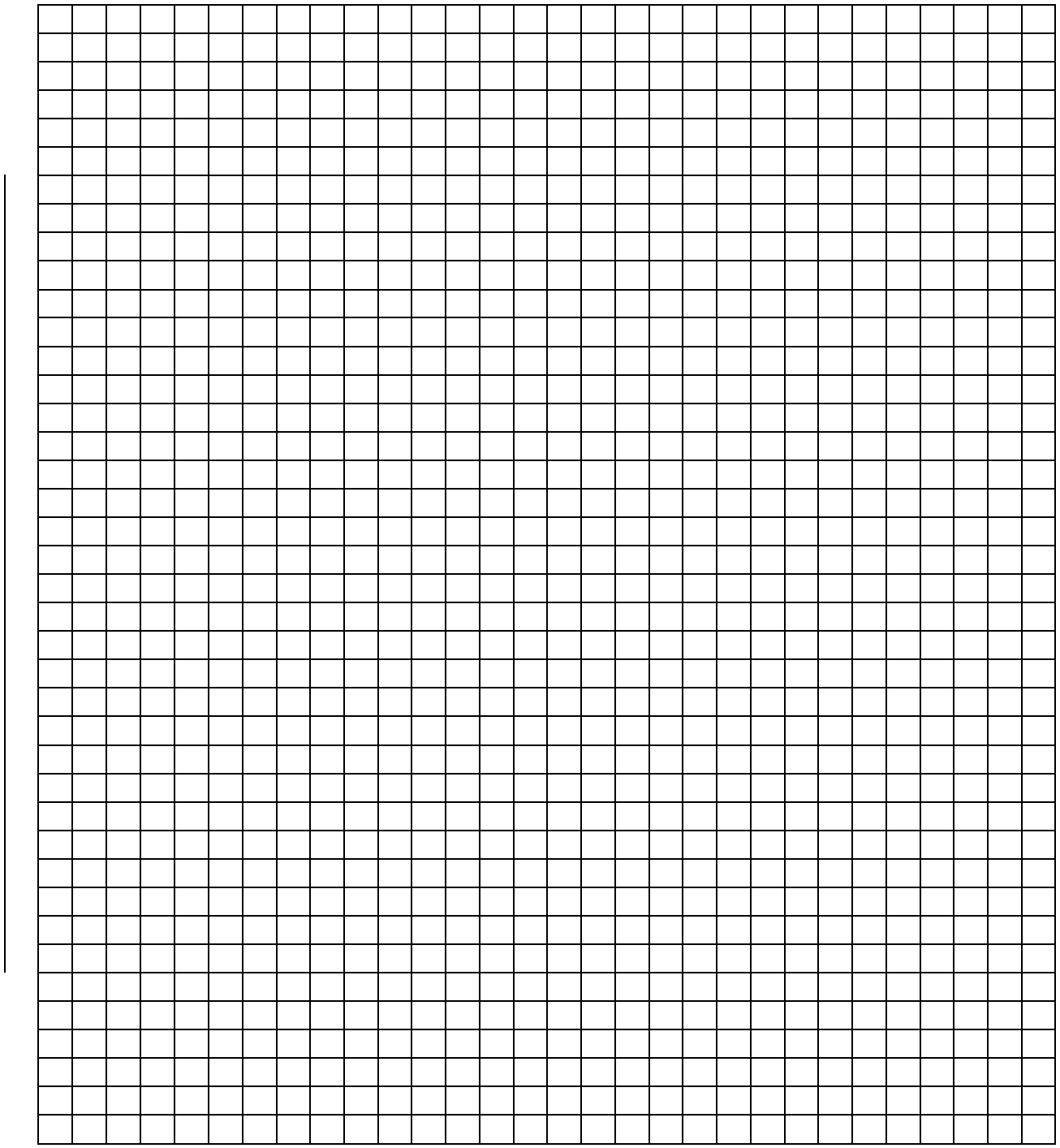
Graph the results from your data tables to show the rise and fall of the deer population. Make sure to label your axis(s) and include the units of measurements. **Remember** the **D**ependent variable is the **R**esponding variable that in a graph is recorded on the **Y**-axis; the **M**anipulated variable is the **I**ndependent variable and is graphed on the **X**-axis.

Graph Title: **Effects of Resources on Deer Population**



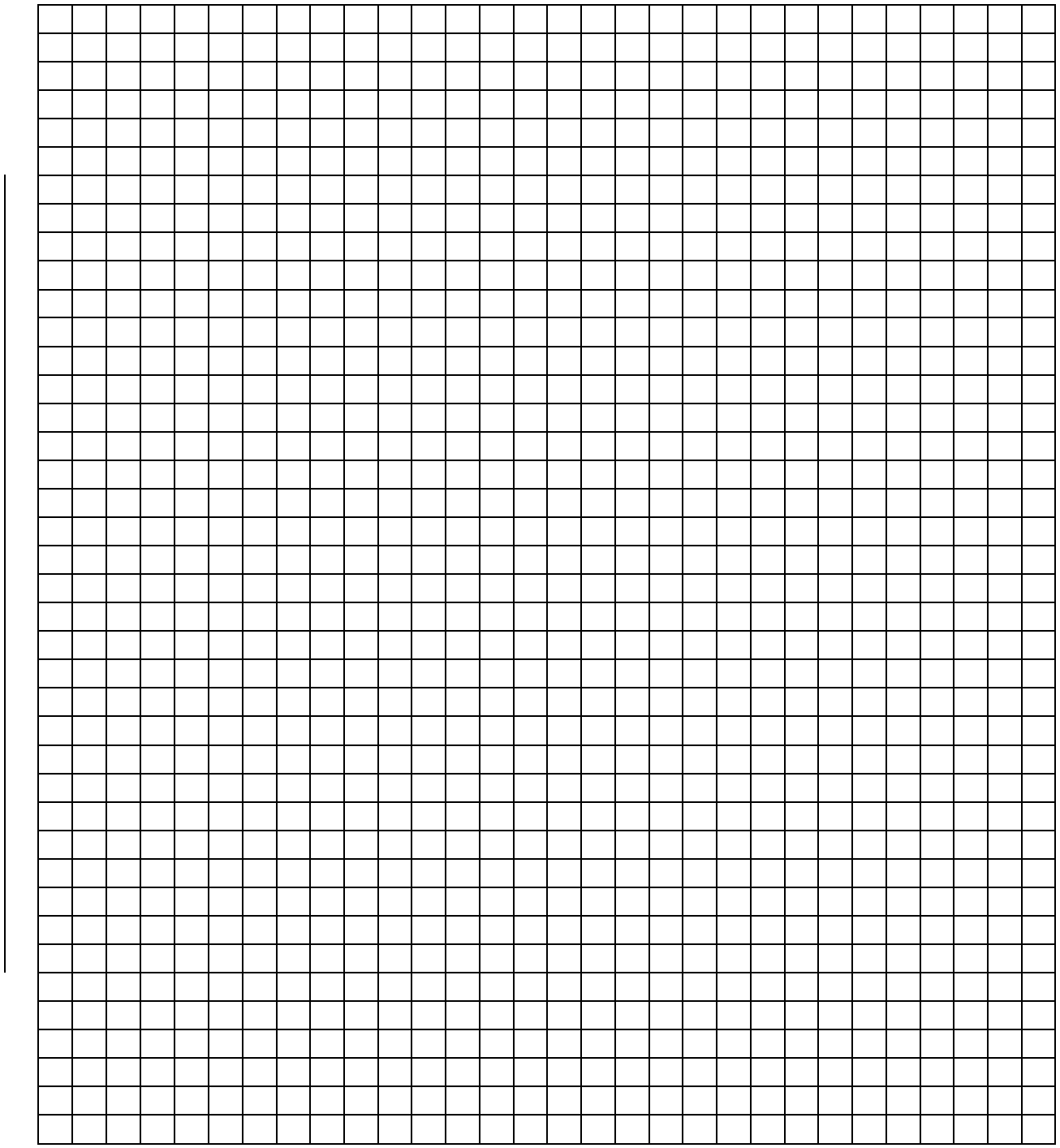
Student

Graph Title: **Effects of Drought or Floods on Deer Population**



Student

Graph Title: **Effects of Predator on Deer Population**



Student

Analysis:

1. List the basic needs of animals.
2. Describe the relationship between resource availability and population growth or decline.
3. Describe reasons for the fluctuation of the population.
4. Define “limiting factors” and provide three examples.
5. What is the carrying capacity for the deer population according to your graph?
6. Once the deer population goes significantly above carrying capacity, describe what happens to the deer population in the years following.
7. How did the introduction of a predator affect the deer population in terms of population size and deer behavior?
8. What was the peak population for the deer population when there were no predators? What happened after the peak? Why?
9. How might this “simulation” differ from the real relationship between deer and their environment? Write at least two differences and explain.
10. How do you think this “simulation” game differs from real predator-prey relationships? Explain.

Conclusion:

Write a conclusion using the “Power Writing Model 2009”. Make sure to answer the following questions:

- What was investigated?
- Was the hypothesis supported by the data?
- What were the major findings?
- How did your findings compare with other researchers?
- What possible explanations can you offer for your findings?
- What recommendations do you have for further study and for improving the experiment?
- What are some possible applications of the experiment?