NAME: ________________________ DATE:______________

Limiting Factors of the RI Woodlands and Forests

Adapted from the TN Gateway Institute-S2/ from Woodrow Wilson

Objective(s):

1. identify factors that limit population growth as density-dependent (DD) or density-independent (DI)
2. develop and use models to explain how limiting factors affect population growth
3. develop and use models to explain how carrying capacity can differ in various scenarios
4. use mathematical and computational thinking to identify and support claims that limiting factors affect the number of individuals that an ecosystem can support
5. accurately predict how limiting factors will limit the growth of populations

Materials:

masking tape
meter stick or measuring tape
pipe cleaners bent into 10 x 10 cm squares to represent the sparrows
large bag of pinto beans (or other dried beans) to represent the grasshoppers
student data sheet
colored pencils/markers/etc.

Background:

In nature, populations of organisms rarely grow uncontrolled. Each ecosystem has a **carrying capacity** or number of organisms it can sustain.

Limiting Factors are biotic and abiotic factors that prevent the continuous growth of a population. Limiting factors can be classified as **density-dependent** or **density-independent**.

- **Density-dependent** limiting factors are those that operate more strongly as population density (crowding) increases. Some examples of density-dependent factors include competition, predation, parasitism, and disease.
- **Density-independent** limiting factors are those that occur regardless of how dense (crowded) the population may be. These factors reduce the size of all populations in the area in which they occur by the same proportion. Some examples of density-independent factors are mostly abiotic such as weather, pollution, and natural disasters.

This activity will look at limiting factors found in the Rhode Island Woodlands and Forests and their impact on population growth.

Procedure:

1. Assign each of these roles to ONE member of your group (i.e. one person will have one job):

Job	Role
Bean counter (grasshopper counter)	Scatters beans between rounds and records the number of beans caught. Beans represent grasshoppers.
Recorder	Reads directions for the activity and records the data
Female Henslow Sparrow	Stands outside the forest area, tosses the sample square (to model the sparrow feeding), collects all beans (grasshoppers) located inside the square
Male Henslow Sparrow	Same role as female sparrow

2. With masking tape, mark off an area (approximately 1.5 meter square) on the floor. This represents an area in the forest where the sparrows will hunt.
3. Scatter 80 beans over the grid. Each bean represents a grasshopper in the savanna.
4. The two pipe cleaner squares represent a male and female sparrow, which separately hunt the area. Students should stand about one foot from the grid and toss the square into the grid.
5. Remove any beans that are inside the square. Repeat. Each "sparrow" has two chances to "hunt" (toss) each day.
6. Do the same thing with the other sparrow. This process represents hunting grasshoppers.
7. In nature, each sparrow hunts twice a day. In order to stay alive, each sparrow must eat at least 4 grasshoppers in a three day period! If fewer than 4 grasshoppers are eaten in any three-day period, the sparrow grows too weak to hunt and dies.

Investigation 1: Forest in spring-summer conditions is usually favorable for grasshopper population

A. Each sparrow hunts 2 times per day beginning with the female. Any grasshoppers caught must be removed before the next sparrow hunts. Enter the numbers in **Table 1**. Continue as long as there is a surviving sparrow. Enter an X in the appropriate box on the table indicating the date of death (if it occurs).

TABLE 1:

Grasshoppers Eaten	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Female Sparrow										
Male Sparrow										

1. Using the 20 X 20 graph template below, graph the data you recorded in Table 1. **INCLUDE ALL GRAPH COMPONENTS!**

   a) Overall title (descriptive)
   b) Label the X and Y axis
   c) Include both male and female data
   d) Use proper scale/units
   b) Make a legend for graph

Investigation 2: An unprecedented freeze led to winter-like conditions early in the forest. 25% of the grasshoppers died (20 total). Remove these 20 from your area ***before*** the sparrows hunt.

A. Complete Table 2 for 10 days as in Investigation 1.

TABLE 2:

Grasshoppers Eaten	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Female Sparrow										
Male Sparrow										

1. Using the 20 X 20 graph template below, graph the data you recorded in Table 2. **INCLUDE ALL GRAPH COMPONENTS!**

Investigation 3: The spring season this year has been a successful one for the Northern Pine Snake and its numbers have increased by 25%. The Northern Pine Snake also feeds on grasshoppers, and the sparrows are in direct competition with the snakes for grasshoppers.

Begin with 80 grasshoppers; remove 3 grasshoppers (beans) each day before each of the sparrows hunt (6 removed total each day for male and female).

TABLE 3:

Grasshoppers Eaten	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Female Sparrow										
Male Sparrow										

1. Using the 20 X 20 graph template below, graph the data you recorded in Table 3. **INCLUDE ALL GRAPH COMPONENTS!**

Analysis:

Part I--Group Analysis: Answer the following questions with your group; however, **EACH** individual should fill in data (tables), construct graphs, and answer the analysis questions on their **OWN** paper.

1. Are any limiting factors present in **Investigation 1**? Why or why not?

2. Identify the NEW limiting factor introduced in **Investigation 2** and classify the factor as either density-dependent or density-independent ***AND*** abiotic or biotic.

3. How did the cold conditions affect the hunting success of the sparrows as compared with Investigation 1? REFERENCE SPECIFIC DATA TO COMPARE. Use the vocabulary word “carrying capacity” in your response.

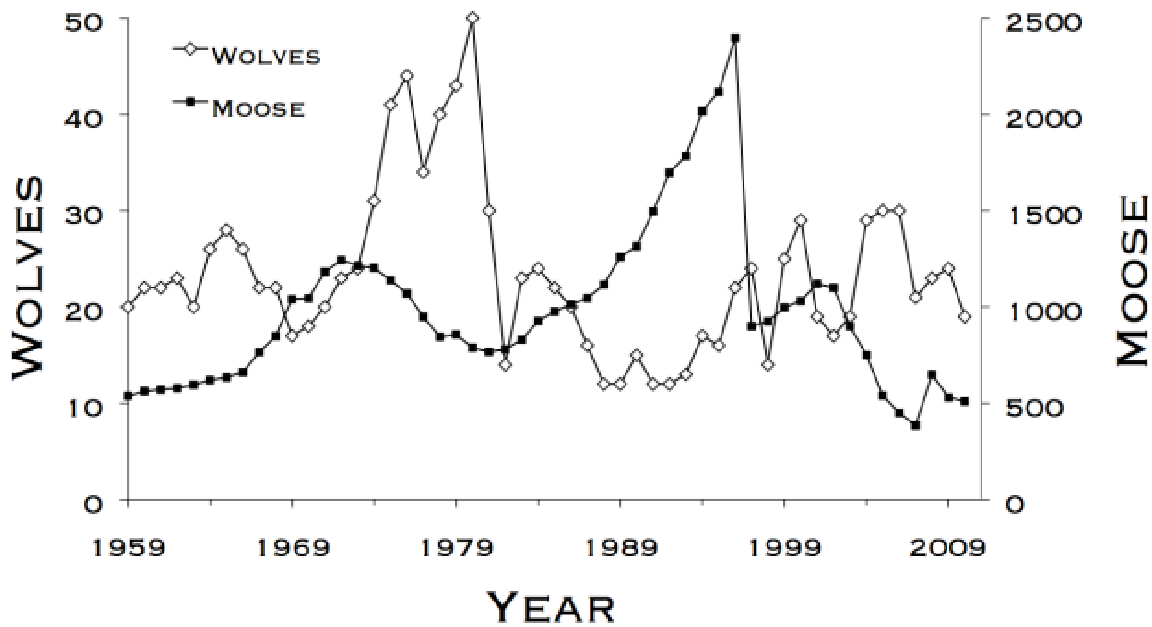
4. What do you think would happen if the winter-like conditions had killed 50% of the grasshoppers? USE SPECIFIC, QUANTITATIVE DATA IN YOUR ANSWER.

5. Identify the NEW limiting factor introduced in **Investigation 3** and classify the factor as either density-dependent or density-independent ***AND*** abiotic or biotic.

6. How did the addition of a competitor affect the survival rate of the sparrows? REFERENCE SPECIFIC DATA TO COMPARE. Use the vocabulary word “carrying capacity” in your response.

Part 2: Individual Analysis
Answer the following questions INDIVIDUALLY.

The Wolves and Moose study on Isle Royale is a **CLASSIC** example of how limiting factors affect population growth. Use the graph below to help you answer the following questions:



1. Intense competition for a declining forage (food), an outbreak of winter ticks, and the severe winter all conspired against the moose population which collapsed in 1996. Identify the limiting factors that occurred in 1996 and classify them as DD or DI ***AND*** abiotic or biotic.

2. Use specific data from the graph to support the following claim: limiting factors affect the number of individuals that an ecosystem can support.

3. Predict a limiting factor that may have led to the drastic decrease of the wolf population between 1980-1982. Consider the graphs you created in the above investigations when predicting the factor. Why would this factor result in a decline as seen on the graph?