Determining Carrying Capacity:
How Many Codling Moths Can an Apple Orchard Support*?

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Background Information:
Within natural and agricultural ecosystems, population size is determined by the interaction between *biotic potential*, or growth factors which increase population size, and *environmental resistance*, or factors which decrease population size. For many insect populations, the number of individuals is determined not just by reproductive potential, but by the environment. A given environment can support only a limited number of individuals under any specific circumstances. Population size oscillates around this theoretical number which is known as the *carrying capacity*. Carrying capacity is the maximum number of individuals of a given species that an ecosystem is capable of supporting.

Introduction:
The codling moth is a destructive, globally distributed pest of apples and pears. The larvae burrow into apples and feed on the fruit and seeds. If the larvae do not completely destroy the fruit, they pave the way for secondary infestations or infection. Apple orchards infested with codling moths have decreased yields and lower quality fruit, resulting in serious economic loss for the orchard grower (Pedigo, 1999).

Learning Objectives:
1. Calculate average annual apple yield of a model orchard.
2. Estimate the pest carrying capacity of a model orchard.
3. Understand and explain the carrying capacity concept.
4. List and discuss factors that influence population size and carrying capacity.

Materials Needed:
Large piece of poster board
Colored construction paper
Scissors
Ruler with metric scale
Circular objects of three diameters - 20, 30, 40mm
Calculator

Timeline:
Ninety minutes

Procedure:
1. Divide into groups of three or four individuals.

2. Obtain a piece of poster board. The poster board represents a 5 acre parcel of land.

3. Cut 10 -20 colored circles for each of the three diameters (20mm, 30mm, 40mm). Use a different color for each diameter. The diameter of the circle corresponds to the actual diameter of an apple tree (diameter at breast height or dbh). One circle mm equals one cm of the diameter of an actual apple tree.*

4. Arrange circles of each diameter on the poster board or land area to form a model of an apple orchard. Record the number of trees you used of each diameter in Table 1.

5. Refer to Table 2. Calculate the annual apple yield in kg/year for each tree diameter and record in Table1. Add the three subtotals to determine the annual apple yield in kg/year for the entire orchard.

6. Laboratory and field research conducted on codling moths indicates that a coding moth larva requires .26 kg of apples to survive for a year.* Using this information and your total kg/year from number four, determine the number of codling moths that you orchard can support.

   Our orchard can support _____ codling moths.

Note that codling moth apple kg requirement, and all tree diameters, yields are fictitious and are based on educated intuition only, not real data. RET

Table 1.

Apple Tree Diameter	Number of Trees at Each Diameter	Total Kg of Apples at Each Diameter
20 cm		
30 cm		
40 cm		
	Total Kg of Apples, Orchard =	

Table 2.

Apple Tree Diameter	Kg of Apples Produced by Each Tree / Year
20 cm	**48.6**
30 cm	**98.5**
40 cm	**88.3**

Analysis and Discussion:

1. Which orchard would have a higher carrying capacity, one with many smaller trees or one with many larger trees? What would the outcome of this activity be if a group chose a higher proportion of 30 cm diameter apple trees for their orchard?

2. The carrying capacity that you have predicted is probably grossly inflated. In other words, if this orchard existed, the carrying capacity would actually be much less than what you calculated. Why? What other factors would influence the carrying capacity of your apple orchard? List at least three.

3. The apple orchard in this activity is a monoculture. How might the codling moth population or carrying capacity be effected if other crops, other fruit trees, or other apple varieties were interspersed among, or alternated with, your apple trees?

Resources:

*Adapted from**:**
Christensen, John W. 1991. "How Many Squirrels Can An Oak Forest Support"

Global Science Laboratory Manual, Third Edition. Kendall Hunt Publishing Co., Dubuque, Iowa

References:

Miller, G. Tyler, Jr. 1997. *Living in the Environment: Principals, Connections, and Solutions*, 10th ed. Wadsworth, Belmont, CA.

Pedigo, L. P. 1999. *Entomology and Pest Management*, 3rd ed. Prentice Hall, Upper Saddle River, NJ.