TEACHER LESSON PLAN

Myocaster Multiplier

Grade	Length	Subjects/strands	Topics
6th–8th grade	40–50 minutes	Ecology, population model, math	Predation, competition, population growth

LEARNING OBJECTIVES

- Calculate population size of an invasive species
- Identify possible effects of an explosive invasive species population on an ecosystem
- Use logic and math skills to illustrate exponential growth rate of nutria populations
- Learn about scientific models and use knowledge of ecology to evaluate model assumptions

INTRODUCTION

How big can a nutria population get? In this activity, students calculate and graph the growth rate of a population of nutria based on a set of realistic assumptions. *Note that the students should not use the background information in their model.* Students should rely only on the model assumptions to create their model.

MATERIALS NEEDED

Graph paper, student worksheets, pencil.

VOCABULARY

Model assumption, disease, embryo, emigration, genetic variability, gestation, habitat, immigration, invasive, litter, mathematical model, nutria, population, rate of change, slope of a graph, wetland.

BACKGROUND

Note: Do not use numbers found in the background information for calculations.

Nutria typically reach sexual maturity at about four to six months of age, depending on food supply and availability. Nutria reproduce throughout the year, having two to three litters annually. The gestation period is approximately 130 days. A single litter can include one to 11 young (though typically four to six) that are fully haired and have open eyes (Nowak 1991) at birth. However, the rate of miscarriages is 45 percent, and only 65 percent of the embryos survive to be born.

PREPARATION

Prior to this lesson it is important to have background knowledge of invasive species, and nutria specifically. We suggest reading the article "Interview with Trevor Sheffels, the Nutria Expert" for additional background information on nutria. In it, Portland State University graduate student Trevor Sheffels studies the nutria's social and ecological impacts. The article is available at http://blogs.oregonstate.edu/wise /2014/11/21/interview-trevor-sheffels-nutria-expert/.

Provide students with an overview of models. Models simplify the real world by making realistic assumptions about how things work, and scientists use them to make predictions and test their assumptions. For example, scientists study the impacts of climate change on salmon populations.

PROCEDURE

Basic level

Students will calculate the population of nutria over a three-year period with no external forces affecting the population. They will use their results to create a graph showing how the population changes. Students may need additional guidance in figuring out a formula to use:

total births per year = initial females × no. of young per female

(no. of females from previous year + total births) ÷ 2 = total females in current year

Have students complete the chart on their worksheet.

Advanced level

Students calculate population changes, taking into account environmental factors listed in the scenario. Have students calculate the nutria population over a five-year period using the scenario on their sheet. Have students complete the chart and graph their findings.

Math instructions and formulas

Optional: Discuss with students how to figure this out, and walk through directions with them.

Start with Year 1

1 Initial females: Since there was initially only one female released, there is one female.

2 Now that the number of initial females is known, calculate the total number of births that year.

total births = (initial females) × (number of litters per year) × (number of nutria per litter)

3 How many of those total births were female nutria?

female births = (total births) ÷ 2

4 Calculate the total number of female nutria in the wetlands, keeping the initial females in mind.

total females = (female births) + (initial females)

5 If females make up half the nutria population, how many total nutria are there in the wetlands?

total nutria = (total females) × 2

6 Now, taking predation into account, how many nutria survived this year?

total surviving nutria = (total nutria) × (predation in decimal form)

7 Once the total number of surviving nutria is known, how many female nutria survived the year?

total surviving females = (total surviving nutria) ÷ 2 = year 2's initial females

The number of female nutria that survived will make up the following year's initial female population.

8 Repeat these calculations for years two through five.

Additional exercise

After calculating and plotting the population over a five-year period, calculate and plot the population again, but assume that all sexually mature females produce only one litter each year. Compare the plots.

CONCLUSION AND EVALUATION

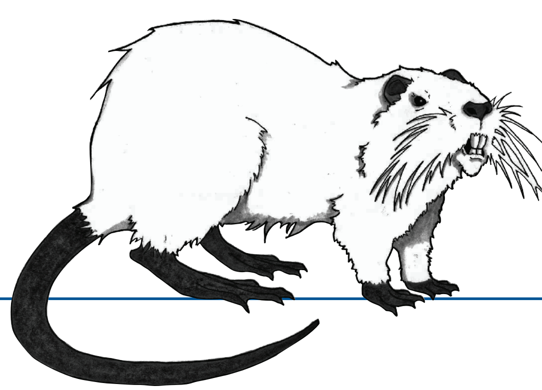
Answer key: Basic lesson

Myocastor coypus population after three years, with eight young per year

Year	Initial Females	Total Births	Female Births	Total Females	Total Nutria
1	1	8	4	5	10
2	5	40	20	25	50
3	25	200	100	125	250

Myocastor coypus population after 3 years, with 10 young per year

Year	Initial Females	Total Births	Female Births	Total Females	Total Nutria
1	1	10	5	6	12
2	6	60	30	36	72
3	36	360	180	216	432



Answer key: Advanced lesson

Myocastor coypus population after five years, with gtwo litters per year and 20 percent predation

Year	Initial Females	Total Births	Female Births	Total Females	Total Nutria	Total Surviving Nutria*	Total Surviving Females
1	1	8	4	5	10	8	4
2	4	32	16	20	40	32	16
3	16	128	64	80	160	128	64
4	64	512	256	320	640	512	256
5	256	2,048	1,024	1,280	2,560	2,048	1,024

** after 20% predation*

Myocastor coypus population after five years, with one litter per year and 20 percent predation

Year	Initial Females	Total Births	Female Births	Total Females	Total Nutria	Total Surviving Nutria	Total Surviving Females
1	1	4	2	3	6	5	3
2	3	12	6	9	18	14	7
3	7	28	14	21	42	34	17
4	17	68	34	51	102	82	41
5	41	164	82	123	246	197	99

** after 20% predation*

DISCUSSION QUESTIONS ABOUT THE USE OF MODELS IN SCIENCE

1 Based on the information in the resource guide and the background information in this activity, how realistic are the assumptions in this model?

2 How likely is it that the population will remain isolated (no immigration or emigration)?

3 What factors could limit an increase in the population?

4 What impacts will an increase in the population have on the wetland?

5 Compare the two curves. How are they similar or different?

SUGGESTED EVALUATION QUESTIONS (ALL STUDENTS)

1 The change that the nutria population experienced could be described as **exponential** growth.

2 (TRUE/**FALSE**) Nutria always have an equal number of male and female young in a litter.

3 Assumptions . . . (choose the most accurate definition)

- **a are used by scientists to simplify how things work.**
- b are always true and make models 100% correct.
- c don't need to be tested.
- d don't have to be realistic to make a model correct.

4 The model created would have eventually shown that the nutria population would reach infinite numbers. Would the nutria population in the wetlands have continued to grow to infinite numbers in real life? (select one)

- a Yes, the model showed exponential growth, which can be used to show real-life population numbers exactly.

b Yes, nutria reproduce really fast and would have overcome any setbacks such as disease and lack of resources until there would be an infinite number of nutria.

c No, the model created used assumptions that didn't include concepts such as limited resources, predation, loss of habitat, genetic variability, or disease.

d No, because nutria don't like being crowded and would have started to move away from the wetlands when population levels got to around 100,000,000,000 nutria.

5 Some people think nutria are cute and feed them. What do you think about that idea? (select one)

a I think this is a bad idea. Feeding them helps them survive and reproduce in areas where they are hazardous to the environment and human health.

b I think this is a good idea. If I feed them now, they won't eat the roots of plants later and help cause erosion of river banks.

c I think this is a good idea. I can't get sick from them, so what's it hurting if I give them a little snack?

Suggested evaluation questions (advanced students only)

6 Because limitations were not considered, the nutria population grew exponentially. An equation can be used to predict exponential population growth over time: $N_t = N_0e^{rt}$, where N_t = population size at time t; N_0 = original population size, r = intrinsic rate of increase and t = time. Use the following: (N_0 = 2 nutria and r = 1.38629) to find the nutria population at t = 10 years. **[2,097,060 nutria]**

7 But some models consider limitations. This growth model is typically called *logarithmic*. The formula that calculates a logarithmic growth curve is $N_t = N_0e^{kt}$, where N_t = population size at time t; N_0 = original population size, K = carrying capacity, and t = time. Use the following: (N_0 = 2 nutria and r = 0.5) to find the nutria population at t = 10 years. **[297 nutria]**

ADDITIONAL EXERCISES

1 Have students create a model that shows the impact of the nutria population on the wetland.

2 If a teacher is interested in performing a stewardship project with his or her class, the following activity can be found in the toolkit and can be tied in with the concepts covered in this activity.

Population Count

Connecting your classroom to the community could result in important findings that will help control invasive species. Make a classroom-community connection by helping research invasive species. Managers need to map the abundance and distribution of nutria and other invasive species, but often lack the resources and funds for this research. Students can help!

Contact your local natural-resource manager to see whether they could use help collecting data about nutria or other invasive species. Often this involves simple protocols that your students could develop through classroom lessons, including concepts in ecology, invasive species, and scientific inquiry.

Vocabulary worksheet

Define vocabulary words and write a sentence using each word.

- **Model assumption:** Accepting that what a graphic is depicting is true or certain to happen, without proof.
- **Disease:** An illness that affects a person, animal, or plant: a condition that prevents the body or mind from working normally.
- **Embryo:** An unborn or unhatched offspring in the process of development.
- **Emigration:** The action of leaving an area with the intent to settle elsewhere.
- **Genetic variability:** The tendency of individual genetic characteristics in a population to vary from one another.
- **Gestation:** The process of carrying or being carried in the womb between conception and birth.
- **Habitat:** Area where a species has the necessary food, water, shelter, and space to live and reproduce.
- **Immigration:** The action of coming into a new area from another area.

- **Invasive:** Tending to spread prolifically and undesirably or harmfully.
- **Litter:** The group of young animals born to an animal at one time.
- **Mathematical model:** A representation in mathematical terms of the behavior of real devices and objects.
- **Nutria:** A large, invasive, herbivorous, semi-aquatic rodent that is native to subtropical and temperate South America.
- **Population:** All the inhabitants of a particular town, area, or country.
- **Rate of change:** The slope of a line, or a way to describe how one quantity changes in relation to another quantity.
- **Slope of a graph:** The measurement of the steepness of a straight line.
- **Wetland:** Where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.

STANDARDS ADDRESSED

Reading

- Key ideas and details 6.1, 7.1, 8.1
- Integration of knowledge and ideas 4.9, 5.9, 6.7, 7.7, 87.7

Speaking and Listening

- Comprehension and collaboration 4.1, 5.1, 6.1, 6.2, 7.1, 7.2, 8.1, 8.2

Mathematics

- Represent and interpret data 4MD, 5MD
- Expressions and equations 6EE, 7EE
- Functions 8F

Science

- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment
- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-4. Construct an argument, supported by empirical evidence, that changes to physical or biological components of an ecosystem affect populations.