Owls and Voles: Leader Instructions

There is a delicate balance between predators and prey in an ecosystem. In this activity, each group plays the part of a family of barn owls and determines how many voles they can eat without destroying their food supply. Based on actual hunting rates, participants use their model to estimate the number of voles needed to support a barn owl family.

Levels Ages 5 and up

Topics Dynamical Systems, Arithmetic

Goals

- Participants will use a mathematical model of a biological system.
- Participants will figure out a hunting strategy that enables their family to survive.
- Participants will identify biological inaccuracies in the model.
- Participants will estimate the number of voles needed to support a real barn owl family.

Preparation Time 5 minutes for handwashing and gathering materials

Activity Time 30 to 45 minutes

Materials and Preparation

- A place to wash hands or handwipes
- Photos of a barn owl and a meadow vole
- 25 Gummy bears, raisins, sunflower seeds, or other items per person
- 1 plate for each group of four
- 1 double-sided Owls and Voles handout for each group
- 1 pencil for each group
- 1 calculator for each group
- 1 sandwich bag per person
- An easel, chalkboard, or whiteboard and markers or chalk for writing

Primary Activity Source American Forest Foundation. *Project Learning Tree: Environmental Education Activity Guide*. 1993; Pages 43-47.

Background

If possible, you may wish to have participants dissect owl pellets before or after this activity. Owl pellets are available from science stores online and typically cost about $2 or $3 apiece. Most kits include bone charts to help participants identify the animals in the pellets.

Have the participants wash their hands before beginning this activity. Allow 5 minutes for the background discussion and for explaining how the model will work.

Show a picture of a barn owl and explain that in this activity, they will be playing the role of a family of owls. Show a picture of a meadow vole, the main food source for most barn owls.

Explain that they will be working with a mathematical model of how owls and voles interact. The model is simplified from the way things work in real life, but has many realistic features.

Activity Instructions

Have the participants divide into groups with about five people in each group. Some groups may have four or six people instead of five. (If there are enough adults or older students, one person in each group should be older.) One person in the group will be the recorder and the rest will be a family of barn owls.

Give each group a plate that symbolizes the meadow where the family of owls hunts.

Give each recorder a bag of about 100 gummy bears, seeds, or other objects that stand for voles.

Give each recorder a handout and a pencil.

At the beginning of the simulation, the recorder will place 4 times as many voles in the meadow as there are owls in the family. (So if there are 4 owls, the recorder will place 16 voles in the meadow.) The recorder should write the starting number of voles next to "Month 1". Have the recorders do this.

Ask the participants to listen to the rest of the instructions before doing the steps you tell them.

Each month the recorder tells the owls to eat some voles. Participants should not actually eat the voles during the activity, but should put them in their sandwich bags to eat later. Each owl can eat as many voles as he or she likes during eating time. Any owl who does not eat at least one vole will die of starvation. Owls need to eat as much as possible over time so that they can support baby owls.

After the eating time, the group should figure out how many voles were eaten in all. The recorder writes this number next to "Voles Eaten". The group then subtracts to find the number of voles remaining. (This should match the number of voles left in the meadow.)

Next, the voles left in the meadow have babies. Each pair of voles will produce one baby, so the participants should divide the number of voles left by 2 and the recorder will write the result next to "Voles Born". If there is an odd number of voles in the meadow, the participants should subtract one and then take half of that number. So if there are 6 voles left in the meadow, then 3 baby voles are born. If there are 9 voles left in the meadow, 4 baby voles are born.

The recorder puts the new baby voles into the meadow and the group adds the number of baby voles to find the total voles for Month 2.

This process will repeat for 6 months and then stop. Remember that each family of owls needs to eat as much as possible during the 6 months to support baby owls.

Simulations

Allow 10 to 20 minutes for running simulations.

Most groups end up eating too many voles the first time they try this game so that the family of owls goes extinct. This is ideal for the first round, and it is more likely to happen if you emphasize the importance of eating enough voles during the instructions.

If any families die out, ask them to explain what happened. Point out that they need a hunting strategy that lets them eat as much as possible over time, but that also leaves enough voles to reproduce and replace the ones they have eaten. Ask the participants to discuss a strategy that will enable all of the owls to survive for 6 months. Once they have a strategy, have the recorder begin a new simulation using the tally sheet in the next column.

If all of the families survive for 6 months, ask the participants to record the voles left in the meadow and the total number of voles eaten by the family during all 6 months.

Explain that their family can only support babies if they have eaten enough and if there are enough voles left to provide for additional owls. Use the table below to award baby owls to each family. BOTH requirements in each box must be met to award babies.

Number of owls in the family	Requirements for 1 Baby	Requirements for 2 Babies
3	At least 14 voles left At least 21 voles eaten	At last 17 voles left At least 24 voles eaten
4	At least 17 voles left At least 28 voles eaten	At last 20 voles left At least 32 voles eaten
5	At least 20 voles left At least 35 voles eaten	At last 23 voles left At least 40 voles eaten

If the participants are eager to try the simulation again, they may.

Taking it Further

If the participants are older and they are still focused, lead them through the following discussion. Allow about 10 minutes for this part of the activity. Otherwise, skip to the conclusion.

Gather the participants together as a group around the easel or board. Build the table shown below by asking the following questions.

Ask the participants to figure out the smallest number of voles that the meadow could contain to feed a family of 3 owls sustainably. (Answer: 9 voles.) How many voles would they need to feed a family of 4? (Answer: 12 voles.) What about a family of 5? (Answer: 15 voles.) Ask them if they can see a pattern in these numbers. (Answer: Notice that there must be at least three times as many voles as there are owls in the family).

What if each owl had to eat 2 voles each month to survive instead of just 1? Now how many voles are required to feed a family of 3? (Answer: 18 voles.) How many voles would they need to feed a family of 4? What about a family of 5?

Repeat these questions for the case where each owl must eat 3 voles each month.

Minimum Number of Voles Needed

Number of owls in the family	If each owl eats 1 vole	If each owl eats 2 voles	If each owl eats 3 voles
3	9	18	27
4	12	24	36
5	15	30	45

Point out that they can get answers in the table if they multiply 3 by the number of voles each owl eats and then multiply by the number of owls in the family. Write this formula as:

Minimum Voles Needed = 3 $\times$ # of Voles Needed Each Month $\times$ # of Owls

Conclusion

Allow 5 to 10 minutes for the conclusion.

Remind the participants that they have been working with a mathematical model of the interaction between barn owls and meadow voles. Ask them what aspects of the model they think are not very realistic. Some points they might make include:

- Owls need to eat more than one vole each month. (They need about 6 each night.)
- Voles usually have more than one baby at a time. (Voles typically have 4-12 babies each month.)
- Owls can eat other animals if the vole population gets low. (They can eat small lizards, birds, and other rodents.)
- Voles are eaten by other animals besides owls. (Foxes, hawks, crows, cats, and snakes are just some animals that eat voles.)
- Animals can also die of old age.
- Owls and voles require good nesting and feeding grounds to survive.
- Our model does not account for the fact that owls must hunt for the voles.
- Our model does not account for the fact that it is more difficult for owls to find voles during the winter.

Note: Barn owls do reproduce once every six months if conditions are favorable, so that aspect of the model is somewhat realistic. Owls typically lay 6 to 12 eggs.

Explain that the model can be adapted to take more of these factors into consideration.

Owls do need to eat more than one vole each month. In fact, owls must eat about 6 voles each night in order to survive. If the participants are older, ask them how many voles each owl must eat per month if there are about 30 days in a month. (Answer: $6 \times 30 = 180$ voles). If you completed the chart in the previous section, then the participants can use a calculator to multiply 3 times 180 times the number of owls in their family. This will give them a better estimate of how many voles would really be required to sustain a family of owls over time. If they had 3 owls in their family, then they would need at least 1,620 voles to survive. If they had 4 owls, they would need at least 2,160 voles to survive. A family of 5 owls would need 2,700 voles.

These rough estimates show that it takes a LARGE population of voles to support a small number of owls. This illustrates why predators are almost always much less numerous than the animals they eat.