Activity 10: Experiment with Ecosystems

In the previous plant and animal activities, students were guided through various models and activities. They may have learned implicitly about what scientists do – from performing carefully controlled experiments (e.g., plant one seed in each flower box and watch what happens) to making observations, including taking and annotating pictures, and interpreting graphs. In this activity, students learn the explicit methods of thinking like a scientist with a special focus on making hypotheses, doing experiments, observing what happens, and thinking about the data.

This activity is more open-ended than the prior activities and allows students to conduct their own experiments and look more closely at their graphs with new graphing tools. This activity should be a challenging, but enjoyable experience.

In this activity, students have the opportunity to do guided inquiry with the Virtual Ecosystem model. Students will think about a hypothesis for a particular question – for example, *What will happen to the hawk population if the grass is removed from the field?* – and then be guided to set up the model in a way that allows them to test the question. Students will have to determine on their own if their hypothesis was correct. The goal of this activity is to have students investigate the strong relationship between the elements in an ecosystem. Students should think about how changes in an ecosystem, such as a change in the environment or the addition or removal of a species, affect the plants and animals living there. Sometimes a change can mean extinction for certain species. Sometimes plants and animals can adapt to the change.

To prepare for the activity, please read this guide carefully and run the activity before you run it with students.

Learning Goals

Big Idea 5: Inter-specific Differences

- There are differences between species.

Big Idea 6: Interactions Between Species

- Organisms with similar needs compete with one another for resources.
- Animals obtain energy and resources by eating other animals and plants (food web).
- An ecosystem is a collection of interacting organisms, as well as their physical environment.
- Other plants and animals, as well at the environment, can affect the survivability of plants and animals.

Big Idea 10: Reproduction

- Organisms have offspring.
- Without reproduction, a plant or animal species cannot continue.

Missing Grass Experiment

In this activity, students first run the "Missing Grass Experiment" (page 4), in which they think about the question: *What will happen to the hawk population if the grass is removed from the field?* Before starting the model, students must choose a hypothesis from four provided in multiple-choice format.

At this point, the model is available to answer the question, but unlike in past models, the student **must set up the experiment**. The student must interpret the question in terms of adding and removing populations of organisms from the model that match the question being studied.

Students add grass, rabbits, and hawks to the Virtual Ecosystem, then watch it. If they do not make any changes for 25 seconds, a pop-up box prompts them to remove the grass. When students click Ok, the model starts up again.

Students must remove the grass, using the  button.

When the grass is removed, the rabbits slowly die out. When there are no rabbits, students will see the hawks disappear. By clicking on the check boxes to the left of the graph, students can graph plants, rabbits, and hawks on the same graph in this model. (Students can take a picture of their experiments and take notes in their lab book at any time.)

The Fox Experiment

A new predator is introduced to the Virtual Ecosystem – a population of foxes. Hawks and foxes both eat rabbits.

Students now use the Virtual Ecosystem (page 7) to answer the question: *Will there be enough rabbits for both the hawk and the fox populations to survive?*

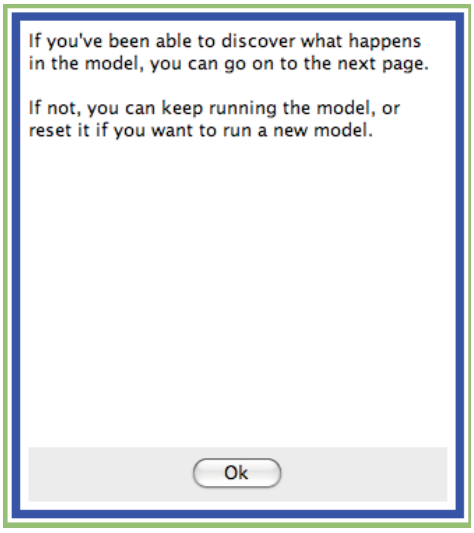
Students must choose a hypothesis from four provided before starting the model. Students are told that foxes have an advantage over hawks, but they are not told what this advantage is. Students should think about this question during class discussion.

Your Own Experiment

When students use the "Virtual Ecosystem Experiment" for the third time (page 9), they are free to do their own experiments. They may choose to study the grass, rabbit, hawk, or fox populations in relation to the other populations in the same ecosystem, reinforcing the idea that all organisms in an ecosystem are interdependent.

Students must set up the model in a way that allows them to answer their question. For example, if students want to know what happens to the rabbit population if the hawk population dies out, they should add grass, rabbits, and hawks to the field and run the model. This should set up a relatively stable simple ecosystem. At that point, they would remove the hawk population and watch what happens.

When one of the populations dies out completely, a pop-up message appears, asking students if they were able to answer their question.



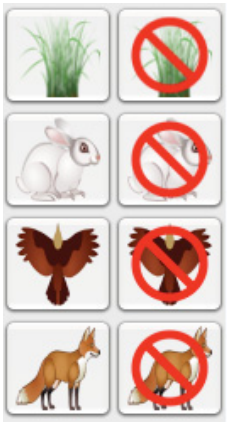
Note: students can try as many experiments as they like with this model. Encourage students to be thoughtful about *what question they are trying to answer!*

Model buttons

Make sure you run the model before your students start this activity to ensure that you are familiar with the model and the control buttons. Below are descriptions of the control buttons.

Click the Play button to start the model. Use the Pause button to stop it.

Use the magnifying glass to get more information about a plant or animal.



Click the grass button to add grass to the Virtual Field.

Click the rabbit button to add white rabbits to the Virtual Field.

Click the hawk to add a population of hawks.

Click the fox to add a population of foxes.

Click the  **version to remove a species.**

Click the Reset button to reset the model to its original condition.

The Lab Book holds all pictures.

The glossary contains definitions for the vocabulary words (in blue) used in this activity. Students can click on individual blue words for pop-up definitions or click the Glossary icon for the complete glossary.

Lesson Plan

1. Estimated time

This activity should take approximately 45 minutes.

2. Introduce the activity (Engage)

Lead brief class discussion before running the activity.

Students will use the Virtual Ecosystem to test their own questions. Review what students have already learned about ecosystems. You might ask what students know and remember about ecosystems. Use this checklist to ensure they cover the following concepts:

- An ecosystem is a place where plants and animals live together in the same environment.
- An ecosystem is made up of living and nonliving parts.
- Animals must eat to survive.
- Animals must compete for resources like food.
- Plants and animals are adapated to survive best in certain environments.
- There is variation in the members of any population.
- Organisms are born, live, and die.
- Organisms have offspring.
- Environments can change over time. If the environment changes, the animals living within the environment are forced to either move or adapt.

Then, ask students to describe the computer models they have used. What do those models allow you to do? Why do scientists use models?

Computer models are **not** movies that show a scene that was already recorded in a certain way, following a script. Computer models have information built into them about the behavior of each organism. Scientists use ecosystem models to answer questions about what would happen if a new species were introduced to an area or how a disease afflicting one species might affect other species.

In the Virtual Ecosystem, for instance, you have seen that rabbits in the model get hungry. Behind the scenes, the computer model is programmed so that if the rabbit has not moved over a plant (to eat that plant), its hunger level will go up. And hawks are programmed with a certain amount of eyesight so they can see rabbits. They see brown rabbits better on white backgrounds and white rabbits better on brown backgrounds. Foxes also hunt rabbits – and they are programmed behind the scene to be even better predators than hawks.

With all that information or *rules of behavior* programmed into the model, it acts like a real ecosystem. Computer-based models thus give scientists the ability to test a number of different conditions quickly from their desk or lab. Real scientists also go into the field and observe animals in their natural

environment. However, ecosystems, like any large system, are difficult to study in the field as they cover a large amount of area and have many components. It would be relatively easy for a field scientist to record data on how often a wolf needs to eat in order to stay healthy and how many offspring healthy wolves have in each litter. It would be more difficult for scientists to study how a disease that affects trees in the forest where the wolves live will affect the wolves in the future, as there are many other variables to consider.

Tell students that in this activity, they get to be real scientists using models to explore their own questions. What kinds of models do they already use to study the world around them? A globe is a good example of a model that is in many classrooms.

3. Guided inquiry (Explore)

Have students run the activity. If students are working in pairs or small groups, explain to them that they should discuss their answers with classmates, and then type their answers directly into the computer.

As students run the activity you may want them to keep the following discovery question in their minds. Write this question on the board so that students can see it during the class period.

How can changes in an ecosystem cause plants and animals to evolve?

Answers to Questions

Page 1
No questions.

Page 2

The screenshot on this page shows the Virtual Ecosystem with a population of grass, a population of rabbits, and a population of hawks. Ask students if there is more grass, rabbits, or hawks. Note that they do not need to COUNT, just look at the picture and estimate. Tell students that a balanced ecosystem is one where the different populations are *relatively constant* (there are fluctuations over time as individual animals are born and die). In a balanced ecosystem, there are always more producers than consumers. And more herbivores than carnivores.

Q1. What does the grass need to survive?
A. All of the above

Q2. What do rabbits eat?
A. Grass

Q3. What do hawks eat?
A. Rabbits

Page 3
No questions.

Page 4
No questions.

Students choose a hypothesis for the grass experiment. There is no right or wrong answer for a hypothesis. This is a student's prediction for what will happen. The model should show that the hawks die eventually because no grass means no rabbits. However, due to randomness in the model, this may not always be the case in the amount of time that students run the model.

Page 5

Q4. What happened to the hawk population when the grass was removed from the Virtual Ecosystem?
A. Student answers will vary. Note that occasionally hawks will die while there are still rabbits living in the field. This is due to the random ups and downs within the hawk population, since individual hawks are being born and are dying at different times unrelated to the rabbit population.

Q5. Why do you think that happened?
A. Student answers will vary. Students should note that when the grass is removed, rabbits will die because they will have no food supply. Since the rabbits *are* the food supply for the hawks, the hawks will then die. This is a food chain – changes at the beginning of the chain influence organisms throughout the chain.

Page 6
No questions.

Page 7
No questions.

Students choose a hypothesis for the grass experiment. There is no right or wrong answer for a hypothesis. This is a student's prediction for what will happen.

Page 8

Q6. What happened when there were foxes AND hawks in the Virtual Ecosystem?
A. Student answers will vary, since there is randomness built into the model. Most students will likely see the fox population survive and the hawk population die since the foxes have an advantage over the hawks in terms of their ability to catch rabbits.

There are two points to be made here. First, there are more prey animals in an ecosystem than predators. If additional predators are introduced, more prey is needed to support them. Second, the fox population has a selective advantage over the hawks. Ask students what kind of advantage the foxes might have over the hawks (answers could be that the foxes are faster or have better eyesight).

Q7. Why do you think this happened?
A. Student answers will vary. Students should note that foxes and hawks are both predators, competing for the same prey – rabbits. The addition of a predator to a balanced ecosystem upsets the balance, and in this case, there is not a large enough rabbit population to support both predator populations. One predator population will likely die.

Page 9
No questions.

Allow students as much time as possible to explore the model on this page and to run several experiments. Students will need approximately 5 minutes to complete the activity after this point, so watch the clock, and have students move on when there are about 5 minutes left in the class period.

Page 10

Q8. What did you learn in the last experiment?
A. Student answers will vary. Students should comment on their particular experiment and what they were trying to test.

Q9. Is it easy to keep an ecosystem in balance?
A. No. [Some students may note that they could keep an ecosystem balanced by adding or removing different populations. This is true, but this does not happen in the natural world.]

Q10. How does adding or removing a plant or an animal from an ecosystem affect the other organisms living there?

A. Student answers will vary. Since all organisms in an ecosystem are interconnected, removing a plant or an animal affects all the others. Removing plants, for instance, means there's no food for the rabbits. Since rabbits *are* the food for hawks, that means hawks would not have anything to eat. Removing hawks, on the other hand, means that there are no predators for the rabbits. The rabbit population, therefore, might grow too high and deplete the plant population. Everything is connected!

Page 11
No questions.

4. Discuss the activity (Explain)

After your students run this activity, discuss what students concluded from the activity. In particular, it is important to discuss the discovery question with your students:

How can changes in an ecosystem cause plants and animals to evolve?

Lead a class discussion to determine if students understand the importance of the relationship between the various elements of an ecosystem. When the environment changes, plants and animals must change, too. If the changes are slow, species can adapt to these changes. Student answers to the discovery question may include:

- In the mountain model, gradual changes in sunlight level caused the Mystery Plants to adapt from a common ancestor to two new species.
- In the field model, variation in the Mystery Plant roots allowed the plants to spread across a field with various levels of water.
- In the dam experiment, a change in water level shifted the plant and rabbit populations such that only those types that could live in the new environment were able to survive (tall grass and large rabbits).
- A change in tree bark color forced the population of peppered moths in England to go from mostly white moths to mostly black moths. When the pollution was gone, and the trees turned white again, more white moths survived and the black moths were eaten by birds more often. Slowly, the population returned to having more white moths.
- When a new animal species is introduced to an environment, as in the fox model, the predators need to compete to survive. Only those animals with an advantage will live and be able to have babies.
- If a species is removed, as in the missing grass model, it affects all the other species connected in the food web.

Encourage students to think about the activities and models in this curriculum. What examples do they remember where a change in the ecosystem caused plants and animals to evolve. Students may also note