Activity 9: Predators and Prey

In this activity, students work with a model of the Virtual Ecosystem with *three* species living in it: grass, rabbits, and hawks. They will learn about the parts of an ecosystem and how all the parts affect one another.

Students look at a simple food chain by exploring the effect of a predator in a grassland ecosystem. First, they become a hawk and try to catch brown and white rabbits on a snowy field. Students learn about adaptations that help rabbits survive, including protective coloration (coloring of the animal's skin or fur similar to the environment in which they live, camouflaging the animal from its predators). Chances are that as the hawk, the students will catch more brown rabbits than white. (Of course, some students will catch white rabbits, too, as they click all over the field. But as a class, no doubt that more brown rabbits will be caught, as they are easier for the hawk to see.)

Next, the students visit an environment that changes over time from a snowy environment to a warmer one, in which the field becomes brown. Some organisms will be well adapted to the new environment and be able to survive while some will die before they are able to have offspring. Thus, the prevalence of different traits in the population changes. This is natural selection.

As in earlier activities, students learn that variation exists in any population of plants or animals. The population of rabbits contains two varieties: white and brown. At first, white rabbits are favored in a white environment. Students then watch as natural selection allows the brown rabbits that blend in with a brown field to survive. Because they are able to live, brown rabbits can reproduce more successfully than white rabbits. And they will give birth to more brown rabbits because the trait for color is inherited. But there is variation in the population, so brown rabbits will sometimes give birth to white rabbits. There will always be some white rabbits in the population. Variation is good for the survival of the species! That's what allowed the population to adapt to the changing environment in the first place.

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.

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Big Idea 6: Interactions Between Species

- 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 as the environment, can affect the survivability of plants and animals.

Big Idea 7: Intra-specific differences

- Individuals of the same species may differ.
- Students should know, and be able to articulate, that not all offspring from the same parents look alike, even with respect to inherited traits.

Big Idea 8: Adaptation/Evolution

- Species are adapted to their environments and species adapt to changes in their environment. If the environment changes only certain species survive.
- Organisms with traits best suited to their environment have better chances of survival.
- Those organisms carrying traits that are better suited for a particular environment will have more offspring.
- The student will be able to explain how selection pressure could lead to a change in the characteristics of a population.
- The student will understand that adaptation requires both variability and selection pressure.
- Given an understanding of the needs of a given organism, students should be able to identify particular physical traits that would help it to survive in a given environment – e.g., "What would <organism> need to have to survive in <environment>?"
- Students should be able to reason backward from traits to environment – e.g., "What is the utility of <trait>? What environment is this organism adapted for?"

Model: Hunting for Prey in the Virtual Ecosystem

In this activity, your students will run the "Hunting for Prey" model first (page 4). This experiment illustrates protective coloration. A population of rabbits, with two variations in color, is living in the Virtual Ecosystem. The environment is snowy, so the background is white. White rabbits are thus harder for the hawk to see. They are favored to survive in this environment.

In this model, the student becomes the hawk, which s/he moves using the computer mouse. The goal is to catch as many rabbits as possible in 30 seconds. To catch a rabbit, the student clicks the mouse. After 30 seconds, the student is asked to record how many of each color rabbit is in the field. To do this, students will have to interpolate from the graph. The white rabbits are indicated by a grey line on the graph; brown rabbits, by the brown line. If necessary, students can use the arrow tool beside the graph, then click inside the graph to adjust the position of the lines relative to the y-axis.

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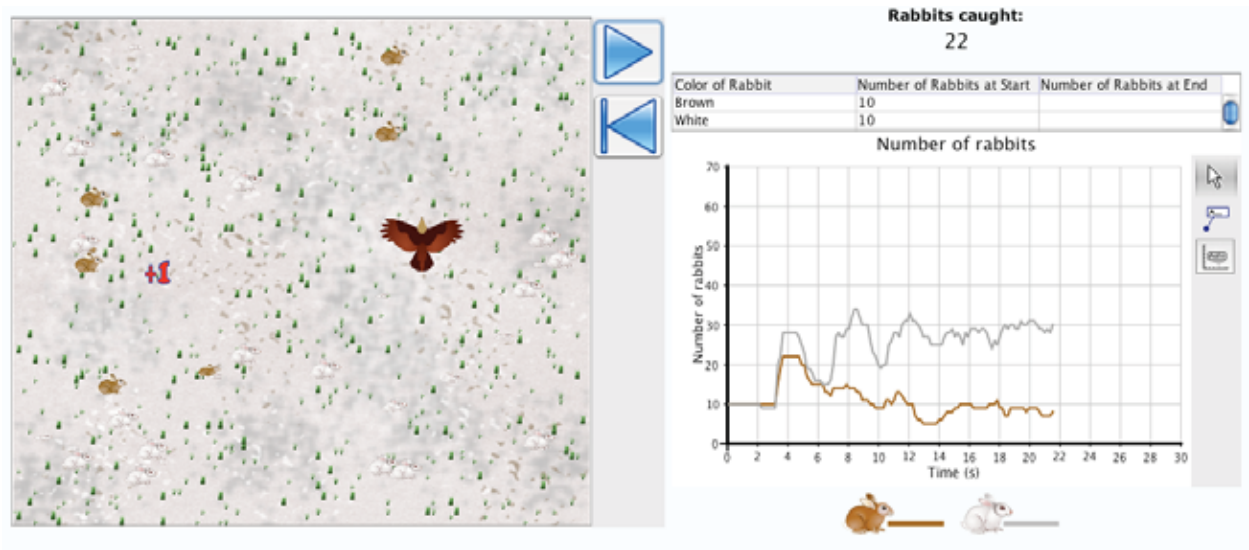

Figure 1. In the above graph, more brown rabbits were caught since they were easier to see. After running the experiment, students are asked to read the graph and fill in the number of rabbits of each type in the table.

In the second model (page 6), "Hunting in a Changing Environment," there is population of hawks catching rabbits. The environment changes over time from a snowy environment to a dry environment (with a brown background). Students are encouraged to watch the graph and notice what happens to the population of the rabbits. Which rabbits are favored in the early (snowy) environment?

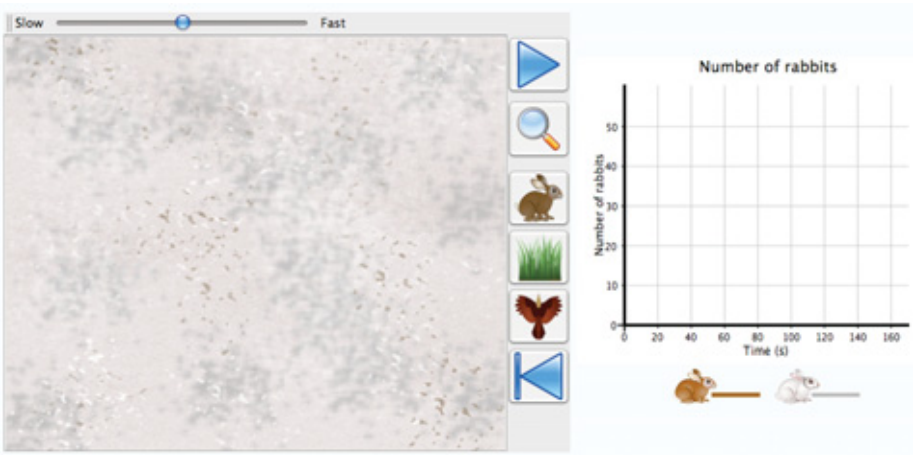

Figure 2. At the beginning of the experiment, the field is white in a snowy environment. Note that students must add plants, rabbits, and hawks, then press Play. When students click the rabbit button, both white and brown rabbits are added to the Virtual Ecosystem.

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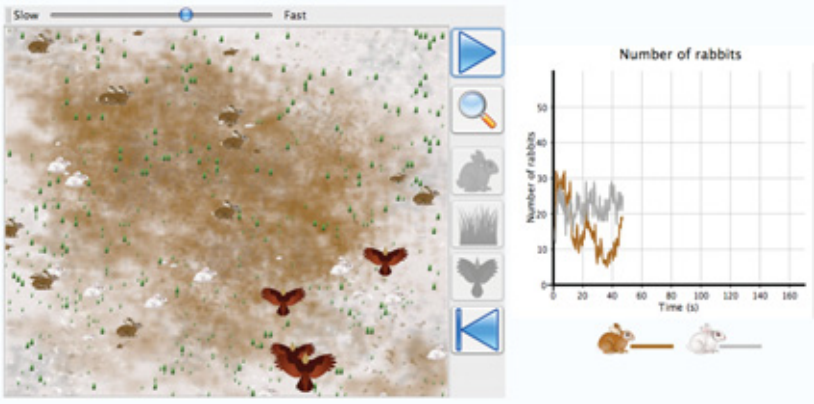

Figure 3. As the environment changes and becomes drier (browner), neither rabbit has a particular advantage. Brown rabbits can "hide" in the darker parts of the environment, where the white rabbits stand out. White rabbits blend into the white background, where brown rabbits stand out. The graph shows a relative equilibrium at this point.

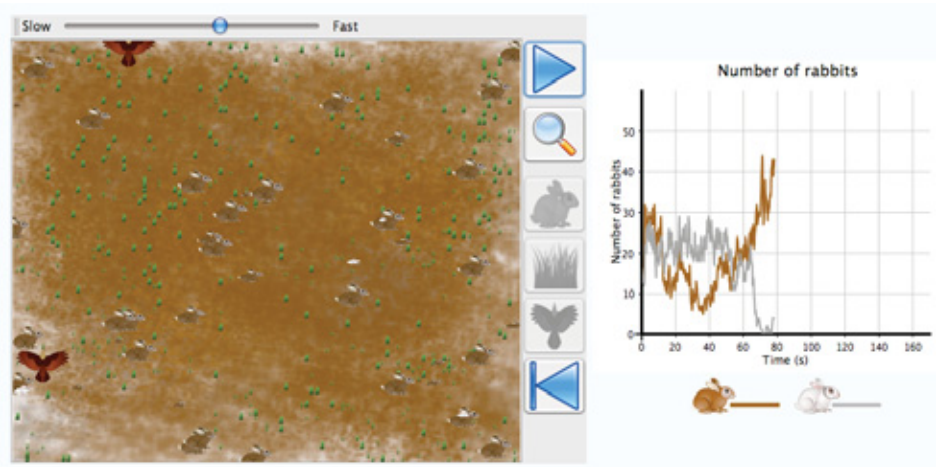

Figure 4. At the end of the experiment, the field is brown in a dry environment. Brown rabbits now have an advantage, since they blend in with the background. Note that brown rabbits can sometimes give birth to white rabbits, but since those white rabbits stand out against the brown background, they are usually caught by a hawk before they are old enough to reproduce.

The graph is key to understanding how the population is changing. Spend time as a class interpreting the graph. Note that the model is random based on rules (for instance, "eyesight" of the hawk relative to the background and health of the rabbit in terms of its ability to reproduce). *Each student's graph will be different!* It's important to notice general trends.

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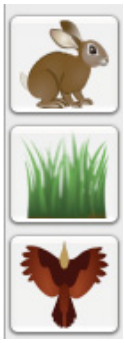
Model buttons

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

Review the use of these buttons with your students before they run the activity.

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 rabbit button to add brown and white rabbits to the Virtual Field.

Click the grass button to add all three types of grass to the Virtual Field.

Click the hawk to add a population of hawks.

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

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.

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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.

Engage students in a discussion about what an organism would need to survive in its environment. For instance, review the discussion from the plant activities in which you challenged students to think about what a cactus would need to survive in a dry environment. Now, move to animals. What physical trait helps an animal survive? Choose animals from your local environment.

Both predators and prey have evolved to be good at what they do—catching animals or trying not to be caught! As predators changed over time to be better hunters, prey also evolved to be better hiders. For example, tigers have stripes to help them hide in the tall grass so they can sneak up on deer. To protect themselves, deer move in herds and have good hearing so they might be able to hear a tiger sneaking up.

Different prey animals have interesting adaptations. Some insects blend in with their environment, like stick bugs. A bird would have a hard time finding a stick bug in a tree because it looks like a twig.

Peruvian stick bug

Other insects stand out. They have bright colors that let predators know that they are poisonous or taste yucky! Even more interesting is that there are insects with bright colors that aren't poisonous, but just look like they may be. These insects are mimics; they have traits that mimic another species in order to protect themselves.

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

What adaptations help prey animals survive?
What adaptations help predators survive?

3. Guided inquiry (Explore)

Have students run the activity.

Refer to the stop sign symbols in the following section. Stop on those activity pages and lead a full-class discussion.

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.

Page 1
No questions.

Page 2

Q1. What do you think would happen if there were no producers in the Virtual Ecosystem?
A. Student answers will vary. If there were no producers (plants), there would be no food for the rest of the animals in the ecosystem. They would die.

Ask students about other food chains they have studied.

Page 3
No questions.

While there are no questions on this page for students to answer, they are asked, "Can you find the rabbit in the photograph below?"

- Stop the class and ask everyone to point to the rabbit.
- Ask: How long did it take to spot the rabbit?
- Ask: Why might it have been difficult to see the rabbit at first?

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Page 4
No questions.

Page 5

Q2. Were there more white rabbits or brown rabbits at the end?
A. Note: *most students* will have more white rabbits at the end, though some students may catch white rabbits and, thus, have more brown rabbits at the end.

Q3. Why was it more difficult to catch white rabbits?
A. Student answers will vary. The white rabbits blended into the background environment and were harder to see.

Page 6
No questions.

- Walk around the room and look at students' graphs. Remember that each graph will be different.
- Encourage students to look at their neighbor's graph. They can pause their own model while they do so.
- Talk as a class about different graphs and what each student noticed.
- Ask: When did the environment support both white and brown rabbits equally well?
- Ask: What happened when the environment got browner and browner?

Page 7

Q4. Look at the graph. What did the Virtual Field look like at time 40 seconds?
A. The Virtual Field was more white.

Q5. Look at the graph. What did the Virtual Field look like between time 100 and 120 seconds?
A. The Virtual Field was white and brown.

Q6. As the environment went from white to brown, what happened to the color of the rabbits in the population?
A. Over time, there were more brown rabbits in the population.

Page 8

Q7. What would happen to the rabbit population in the snowy field if there were no hawks?
A. There would be about the same number of brown and white rabbits.

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Q8. If there were no hawks, and the environment changed from snowy to brown, what would happen to the rabbit population?
A. There would be about the same number of brown and white rabbits.

Page 9
No questions.

Wrap up the activity with the discussion below.

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:

> *What adaptations help prey animals survive?*
> *What adaptations help predators survive?*

First, have students answer this question. *What adaptation helped the rabbits avoid being eaten by predators?* (Answer: Their color!)

Second, ask students the following question. If there were no hawks, which color rabbits would survive better in the snowy environment? (Answer: Both would survive equally well. The color of the land is an environmental pressure only when used as an advantage for hawks on the hunt!)

Predator-Prey Relationships

Discuss how predator/prey pairs have evolved in step. As prey animals get better at hiding from predators, predators must get better at hunting prey! If the hawks developed very good eyesight and could see white rabbits on a snowy background, what would happen? Ask students how they think the rabbit population might change.

Perhaps rabbits with a different trait would survive. For example, a long-legged, faster rabbit might be able to outrun hawks. A smaller rabbit might be able to hide in tiny holes in the ground. A rabbit whose eyes are closer to the top of its head might see hawks flying above it. Encourage students to be creative when thinking about adaptations. What adaptations do other prey animals have against predators?

Some animals are so well adapted to their environment that they have not evolved much in millions of years. Sharks, for example, are extremely efficient hunters. Their bodies are well adapted to the lifestyle of hunter. They are fast, agile swimmers. They can locate prey easily through their keen sense of smell

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and their ability to sense vibrations in the water. And, of course, all those sharp teeth help them catch and eat many different types of fish! Sharks sit comfortably at the top of the ocean's food chain.

They also use coloration to their advantage. They have a light underside to camouflage them when fish are looking up at them. They are darker on top to camouflage them when fish are looking down at them from above.

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