

The
**NATURE OF
TEACHING**

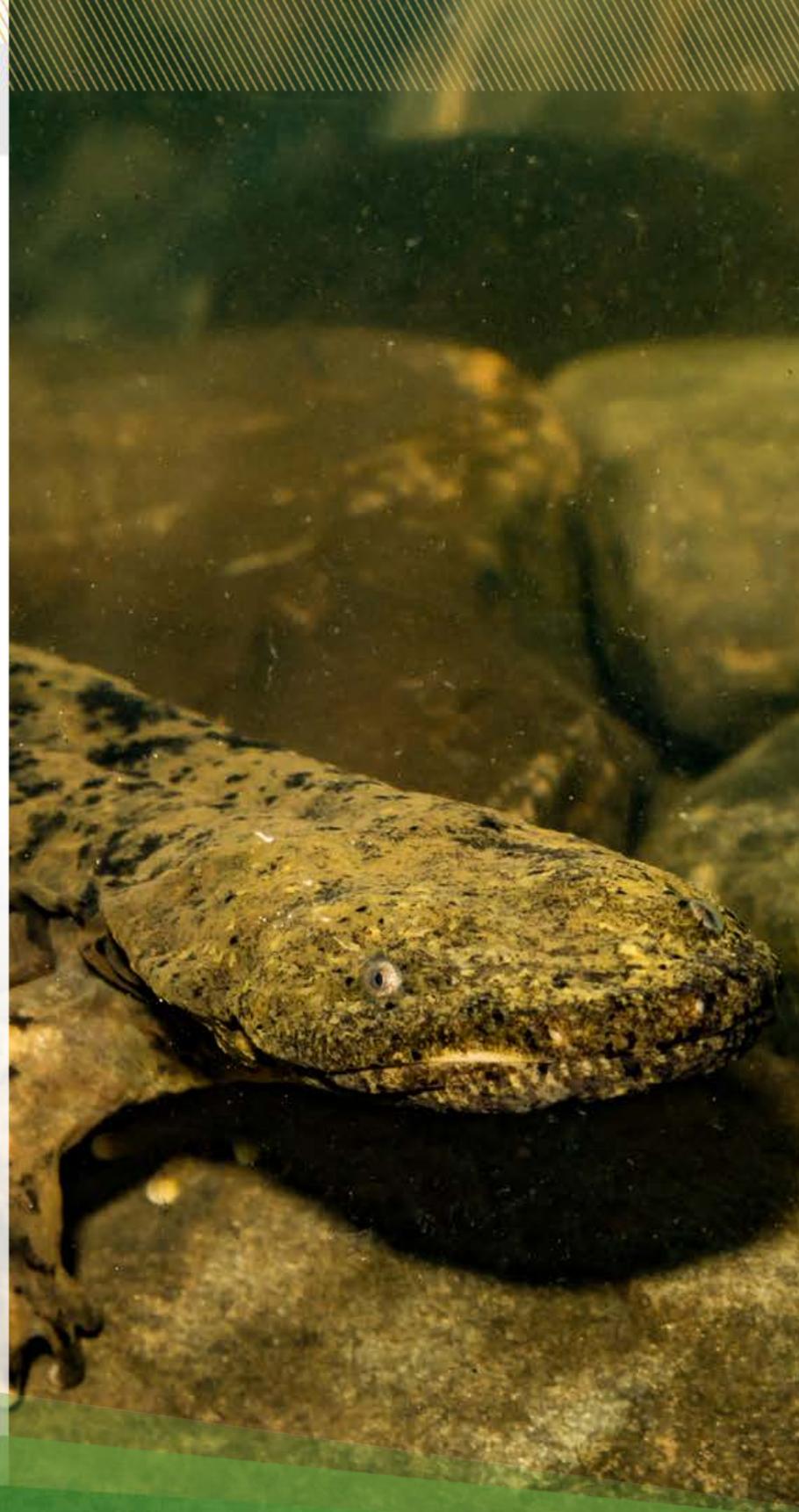


Adaptations for Aquatic Amphibians

LESSON PLAN

Understanding adaptations for aquatic amphibians can help humans learn more about healthy ecosystems.

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ESTIMATED TIME

45-60 minutes

VOCABULARY

- Adaptations
- Amphibian
- Aquatic
- Behavioral adaptations
- Camouflage
- Eastern Hellbender
- Habitat
- Indicator species
- Permeable skin
- Physical adaptations

UNIT OBJECTIVES

Students will be able to:

1. Explain how amphibian adaptations benefit survival
2. Describe the importance of Eastern Hellbender adaptations
3. Identify impacts that humans have on aquatic amphibians

LESSON STANDARDS

Next Generation Science Standards

3-LS4-3

3-LS4-4

MS-ESS3-3

English/Language Arts

<u>SL.2.1</u>	<u>SL.3.1</u>	<u>SL.4.1</u>	<u>SL.5.1</u>	<u>SL.6.1</u>
<u>SL.2.2</u>	<u>SL.3.2</u>	<u>SL.4.2</u>	<u>SL.5.2</u>	
<u>SL.2.3</u>	<u>SL.3.3</u>	<u>SL.4.3</u>	<u>SL.5.3</u>	

REQUIRED MATERIALS

- Hellbender photo or model; 1 per student, pre-test; 1 per student, post-test

Activity 1: Hellbender Adaptations

- 1 large brown T-shirt
- 1 paintbrush
- 1 tube of black paint
- 1 pair of swimming goggles (competition-style)
- 6 wood clothespins (with spring)
- 1 canoe paddle
- 4 Hellbender photos: Figures 1-4
- 1 Hellbender video of vacuum mouth
- 1 container of pre-made slime

Activity 2: Herbie the Hellbender

- 1 sponge (cut in the shape of a Hellbender)
- 1 aquarium or clear plastic container
- 10 scoops of gravel or small rocks
- 1 gallon of water
- 1 cup of soil
- 2 bottles of food coloring (at least two colors; best to use blue and yellow)
- 1 cup of assorted trash (e.g., paper / cardboard scraps, plastic lids)
- 1 bottle of syrup (or food coloring for dark color)
- 1 ruler or paint mixer

Activity 3: Making Slime

- 2 16 oz. cans of corn starch
- 1 16 oz. bottle of liquid yellow dish soap
- 1 32 oz. pitcher full of cold water
- 2 measuring cups
- 1 tablespoon for measuring water
- 6 24 oz. bowls
- 6 forks for mixing
- 1 5-gallon bucket of water for washing hands
- 2 or more towels to dry hands

ACTIVITY ICONS

Use these icons — located at the top of each lesson plan — to indicate the disciplines to which certain activities belong. These disciplines include:



(science, technology, engineering, math)



(science, technology, engineering, art, math)

Cover photo credit: Rod Williams

ADAPTATIONS

Adaptations are inherited characteristics that enhance a species' chances for survival and reproduction. Adaptations allow a species to better use resources, obtain a mate, and gain protection from environmental stress. Every organism in nature is adapted to live in its environment and all species continuously adapt to the changing world. Adaptations are important because if a species does not adapt to changes in its environment, it becomes extinct (dies out).

Adaptations can be behavioral or physical. **Behavioral adaptations** occur when animals change the way they act in order to stay alive and reproduce. An example of a behavioral adaptation is migration (i.e., moving to find food or escape the cold). **Physical adaptations** are changes in animals' bodies that help them survive and reproduce. An example of a physical adaptation is toe pads on a tree frog. This lesson focuses on adaptations for survival (continuing to live in spite of difficult circumstances).

Adaptations are crucial in obtaining food. A predator captures and feeds on other organisms. Prey animals are hunted or seized as food. Many predators have developed an acute sense of smell, sight or other senses to help them find prey. However, prey species also have adaptations that deter predators. For example, toads have glands behind their head that release poison when attacked by a predator. The toad's poison causes the predator to salivate, which may allow the toad to escape. Other species have adapted to blend in with their natural environments using **camouflage** (hiding or disguising their presence). For example, a polar bear's white coat helps it blend in with the snow and ice so it can hunt seals.

All species undergo unique adaptations that help them survive in their environment. For this lesson, we are going to focus on amphibians.

Amphibians are a vertebrate group that contains frogs, salamanders, and caecilians (suh-SEE-lee-uns; legless amphibians). Most are adapted to live in and out of the water. Amphibians are frequently confused with reptiles, but reptiles have scaly skin. Amphibians usually have a smooth, slimy, and **permeable skin** that allows water and air to pass through it. Some amphibians are adapted to be fully aquatic and never leave the water. **Aquatic** species live in the water for most or all of their lifespan and many have gills that allow them to breathe in water. Three classic examples of aquatic adaptations are gills, permeable skin, and a paddle-like tail to help species swim. One example of a fully aquatic amphibian is the **Eastern Hellbender**, and we will discuss some of their adaptations in detail.

HELLBENDER ADAPTATIONS AND THE ENVIRONMENT

Hellbenders are the largest salamander in North America and can grow to be over two feet in length. These giant, aquatic salamanders require clean rivers with cool, well-oxygenated water to breathe. They prefer areas of cobble and coarse gravel rather than sand, silt, and clay, and they need large rocks for cover to hide from predators and guard their young. The Hellbenders' **habitat** (all of the food, water, shelter, and space to rear their young) is crucial to their survival. Hellbenders are considered habitat specialists because they require very specific habitats and resources to survive and reproduce. Because of this, Hellbenders are extremely well-adapted to a fully aquatic lifestyle in flowing rivers under large boulders. You can find evidence of this in their adaptations.

- 1. Camouflage:** Hellbenders are mottled with dark brown or black spots, allowing them to blend in with gravel and cobble rocks on the bottom of riverbeds (see Figures 1 and 2). Hellbenders hide under rocks in the river, and camouflage is their main defense from predators (e.g., river otters and fish).
- 2. Skin folds:** Among the Hellbender's most unique characteristics are the extra folds of skin on its sides that look like lasagna noodles (see Figure 3). These skin folds increase the Hellbender's surface area and absorb oxygen from the water through its permeable skin.
- 3. Smell:** Smell helps the Hellbender detect hazards, pheromones (chemicals released by other Hellbenders), and food. Hellbenders use their sense of smell to detect predators in the water (e.g., fish), find potential mates during the breeding season, and locate their prey (e.g., crayfish).
- 4. Vacuum mouth:** The Hellbender's mouth works like a vacuum, and it swallows its prey by sucking food down. When the Hellbender opens its huge mouth, both water and the prey are sucked inside. The main prey item for Hellbenders is crayfish, but they will also eat aquatic insects and fish.
- 5. Paddle tail:** In order to escape from threats, Hellbenders can propel themselves quickly through the water with their muscular, paddle-shaped tails. Hellbenders accelerate through the water by moving their tails back and forth, and the tail's shape is advantageous to help them move as fast as they do (see Figure 4).
- 6. Slime:** Hellbenders produce slime that serves as a predator defense. The slime makes their skin slippery and has a foul taste. Slime also protects Hellbenders from dangerous pathogens (i.e., disease-causing agents) that might be in the water.

IMPORTANCE OF CLEAN WATER FOR AQUATIC AMPHIBIANS

Humans need clean freshwater to survive and so do aquatic amphibians. Amphibians are adapted to aquatic systems, but those adaptations may not be enough to protect them from all threats.

Amphibians can be negatively affected by poor water quality during their aquatic stages because they can absorb harmful pollutants through their permeable skin. Poor water quality can lead to death or disease in amphibians that cannot tolerate pollution. Excess nutrients and sediment in runoff from lawns, roads and agriculture can cause oxygen-reducing algae blooms and reduce available amphibian habitats.

Amphibians intolerant to pollution may serve as suitable indicator species. **Indicator species** are those that represent the health of an ecosystem based on either their presence or absence. The ecosystem includes the interconnected network of all biotic (living) species and abiotic (nonliving) factors. Because amphibians have permeable skin, they are often among the first groups to be negatively affected by pollution in their ecosystem. Healthy amphibian populations indicate a healthy ecosystem.

Human influences — like habitat degradation and destruction — are linked to several aquatic amphibian declines. At present, Hellbenders are threatened or endangered throughout their range. Threatened means the species is vulnerable for endangerment in the near future while endangered means the species is at serious risk of extinction. If a species cannot adapt as fast as its surrounding environment is changing, it goes extinct.

Protecting Hellbenders is important because they are considered indicators of a healthy freshwater ecosystem and are high-level predators that serve the role of a keystone species helping keep the freshwater ecosystem in balance. Keystone species are species on which the entire ecosystem depends. Removing keystone species can cause drastic changes to the environment in which they are found. Conservation practices that help protect Hellbenders in turn help to protect entire rivers because the pristine environment Hellbenders need to survive is also beneficial for most other aquatic organisms.

Hellbenders are a prime example of a species whose protection helps better the environment for all other species, including humans. Soil erosion and sedimentation, littering, and runoff from paved surfaces are examples of human-caused impacts that negatively affect the freshwater ecosystem.

We can help protect the freshwater ecosystem by:

- 1. Planting more trees near streams and rivers to prevent soil erosion and sedimentation.**
Hellbender larvae (babies) have evolved to burrow into spaces between rocks. When heavy loads of sediment erode into the river, the sediment fills in the areas of the rocks where larvae hide, making it easier for predators to eat them.
- 2. Picking up trash and recycling to help keep litter from reaching the river.**
Wildlife can eat trash in the river that may cause them to get sick and die.
- 3. Reducing impervious (hardened) surfaces by leaving sections of our property unpaved or unmown to absorb water and help prevent runoff from picking up pollutants and reaching storm drains that flow into the river.**
Amphibians can absorb pollutants (i.e., chemicals) in the river through their permeable skin, potentially causing disease or death.
- 4. Installing a rain barrel or planting rain gardens with native plants to help catch any runoff, provide habitat to pollinators, and help protect other species.**
Catching runoff can prevent harmful chemicals from reaching the river.

Understanding how human behaviors impact aquatic amphibians and the entire freshwater ecosystem offers an example for people to relate to and consider the next time they see erosion into a river or trash along the bank. Ultimately, this may cause a change in their behavior that can lead to cleaner water and improved protection of the freshwater ecosystem. This is crucial because not all animals can adapt to humans' destructive impacts on the environment.

RESOURCES

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ADDITIONAL RELATED EDUCATIONAL MATERIALS

1. Help The Hellbender, Purdue Agriculture website <https://www2.ag.purdue.edu/extension/hellbender/Pages/default.aspx>
2. Hellbenders Rock! Lesson Plan https://edustore.purdue.edu/item.asp?Item_Number=FNR-532-W
3. Healthy Water, Happy Home Lesson Plan https://edustore.purdue.edu/item.asp?Item_Number=FNR-527-W
4. Discovering the Watershed Lesson Plan https://edustore.purdue.edu/item.asp?Item_Number=FNR-476-W

FIGURES

Figure 1. *Camouflage with no red outline of Hellbender.*



Photo credit: Shem Unger

Figure 2. Camouflage picture with red outline of Hellbender.



Photo credit: Shem Unger

Figure 3. Hellbender's nostril and skin folds.



Photo credit: T. Travis Brown

Figure 4. *Hellbender paddle-shaped tail.*



Photo credit: Erin Kenison



1. Before teaching about adaptations, have each student complete one pre-test and then collect these pre-tests. Pretests are available at www.purdue.edu/nature.
2. Begin the lesson by defining **adaptations**. Define the different types of adaptations. Describe examples of why these are important for species to survive. Explain that today the class will focus on adaptations for aquatic **amphibians** and provide examples. Use the **Eastern Hellbender** as an example species to explain why adaptations are important for survival (see Teachers' Notes).

Ask questions such as:
 - *Has anyone ever heard of a Hellbender?*
 - *If so, where was it and what did you learn?*
 - *Do you think a Hellbender is an amphibian or reptile?*
3. Discuss that the **Eastern Hellbender** is the largest salamander in North America. Use the **Eastern Hellbender** as an example species to explain why adaptations are important for survival. (See "Adaptations" section.)
4. Ask students if they have any questions before moving on to the Adaptations activity.
5. **Transition:** *Now that we know the Hellbender is a type of amphibian and a salamander, we are going to discuss some of the adaptations that make them unique and help them survive.*
6. Guide students through Activity 1: *Hellbender Adaptations*.
7. Ask students if they have any questions before moving on to the Herbie story.
8. **Transition:** *Hellbenders are adapted to live in the river and play a key role in the ecosystem. The Hellbender population is declining, and there are several potential reasons why this is happening. We are going to discuss some of the reasons why Hellbenders are disappearing by telling a story about a Hellbender named Herbie that decided to go on vacation.*
9. Guide students through Activity 2: *Herbie the Hellbender*.
10. Ask students if they have any questions before moving on to the slime activity.
11. **Transition:** *As you can see, there are many potential threats to Hellbenders that can lower their chances of survival. However, they have evolved in some ways to help them survive. We are going to make some Hellbender slime and discuss how it can protect them from harm.*
12. Guide students through Activity 3: *Slime Making (optional)*.
13. Ask students if they have any questions before moving onto the conclusion.
14. Have each student complete one post-test. Collect these post-tests for points and to evaluate their change in knowledge about adaptations and Hellbenders. Post-tests are available at www.purdue.edu/nature.

(Make sure all materials for this activity are laid out and easily accessible.)

1. Ask a student to volunteer and make sure they are aware that they will be helping teach the class about Eastern Hellbender adaptations by dressing up like a Hellbender.
2. Describe the Hellbender's habitat (see Teachers' Notes)
 - a. **Camouflage:** Have the student volunteer put on the T-shirt and ask other students what they think is significant about the T-shirt. Explain that Hellbenders are mottled brown so that they can use camouflage and blend in with the bottom of the stream. Show all students the camouflage picture without the red line (Figure 1) and then the camouflage photo with the red line (Figure 2).
 - b. **Skin folds:** Pin clothespins on the sides of the student volunteer's T-shirt to make flaps. Show the Hellbender picture (Figure 3) or model and explain that like all amphibians, Hellbenders have **permeable** skin. Point out the extra flaps of skin and ask the class what they think the extra folds of skin might be used for (i.e., extra surface area for oxygen absorption).
 - c. **Smell:** Have the student volunteer put on goggles. Explain that Hellbenders are fully aquatic and live in rivers. Explain that Hellbenders have small eyes and typically use their sense of smell to find prey. Explain that their main prey item is crayfish but that they also will occasionally eat aquatic insects and fish. Show the nostril picture (Figure 3). If asked by the students, Hellbenders have nostrils that lead to lungs, but they don't really use their lungs for breathing. They help them control buoyancy.
 - d. **Vacuum mouth:** Explain that Hellbenders not only hide to avoid being eaten but also to help them hunt for their prey. Explain how the Hellbender's mouth works like a vacuum. Show video. [_https://www.youtube.com/watch?timecontinue=9&v=4oSm32xZHIQ](https://www.youtube.com/watch?timecontinue=9&v=4oSm32xZHIQ)
 - e. **Paddle tail:** Hold up the Hellbender picture (Figure 4) or model and ask students what they notice about the Hellbender's tail and then hold up the paddle. Then, have the student volunteer hold the paddle behind them like a tail. Explain that Hellbenders have tails shaped like a paddle so that they can propel themselves through the water.
 - f. **Slime:** Hold up the Hellbender slime. Explain that Hellbenders produce slime that serves as a predator defense and protects them from dangerous pathogens that might be transmitted from the water through their permeable skin.

(Make sure all materials for this activity are laid out and easily accessible. Be sure you have the aquarium lined with small gravel rocks to mimic the bottom of the riverbed and fill the aquarium 3/4 full of water. Herbie the Hellbender is an adaptation of the original story, Freddie the Fish.)

1. Ask for four student volunteers to help you with props as you tell the story of Herbie the Hellbender.
2. **Story Plot and Introduction:** Describe the story's setting and plot.

As we have learned so far today, Hellbenders are fully aquatic amphibians who rely on their adaptations — such as camouflage, extra skin folds, et cetera — to help them survive. However, the Hellbender's adaptations do not help protect them from harmful human impacts, like pollution, to the freshwater ecosystem where they live.

Now we are going to tell the story of a young Hellbender named Herbie who wanted to go on a vacation and ran into some trouble caused by humans along the way. Herbie decided to leave his home in the river surrounded by the state forest, which helped keep the river clean, and journey down the river that ran by a city park, along a busy road, through a golf course, and by a farm field."

- a. **Herbie leaving the State Forest:** First, hold up the Herbie Hellbender sponge to show to the class. Next, place it in the water and tell the class that Herbie is preparing to leave the clean river in the state forest and go on his vacation by continuing the story.

As you can see, the river water in the state forest is very clean and clear. Also, notice that the bottom of the river is made up of gravel rocks and not sand or silt. Herbie is now ready to head to the first stop on his vacation, the city park.

- b. **Herbie swims by the city park:** Have the first student volunteer dump some trash into the water before you continue the story.

The first place Herbie went after leaving the state forest was a city park. Once he arrived at the park, Herbie noticed some trash floating around in the river.

Ask students how they think swimming through the trash made Herbie feel and why. Prompt for kids: Did the trash in the water make Herbie feel happy or sad? Reinforce the importance of not littering. Explain how the trash and litter may negatively impact wildlife by continuing the story.

Example: Eating trash can kill wildlife by choking them or blocking their stomachs and intestines.

- c. **Herbie swims by the road:** Have the second student volunteer pour some syrup (or mixed food coloring) in the water and mix the contents around before you continue the story.

After leaving the park, Herbie swam underneath a road where some oil washed down into the river. The oil got all over his skin and skin folds which made it harder for him to breathe.

Ask students how they think swimming through the oil made Herbie feel and why. Explain how oil and other pollutants from cars and other sources can negatively impact wildlife, especially amphibians because they have **permeable** skin and can absorb the pollution. Explain the importance of properly disposing of chemicals and oil so it doesn't run off into our water by continuing the story.

Example: Oil can be absorbed through an amphibian's permeable skin. This may cause the amphibians to get sick and could lead to death.

- d. **Herbie swims by a golf course:** Have the third student volunteer dump some food coloring into the water, then stir around the contents before you continue the story.

Herbie continued swimming away from the road when he came across some grass that was very green and cut short where people were out swinging golf clubs. In the river, Herbie noticed some golf balls floating, chemicals on his permeable skin, and a few algae blooms.

Ask students how they think swimming through the chemicals and algae blooms made Herbie feel and why. Explain that to keep golf courses green, greenskeepers apply a lot of fertilizers and chemicals. If there are no plants to absorb, and filter out, these chemicals and fertilizers, they can be carried off the golf course and into the river. Explain that people can help protect the water at their own home by installing a rain barrel or leaving sections of their yard unpaved / unmown to absorb water and nutrients. Planting rain gardens with native plants will help catch any runoff. Then continue the story.

Example: The chemicals on an amphibian's permeable skin can make them sick. The algae blooms use oxygen and can make it harder to for Hellbenders to breathe.

- e. **Herbie swims by a farm field:** Have the fourth student volunteer dump some soil into the water and mix contents around before you continue the story.

Herbie continued swimming away from the golf course when he came across a mucky part of the river next to a farm field where sediment was eroding away from the bank and being carried downstream in the river.

Ask students how they think swimming through the mucky water full of sediment made Herbie feel and why. Explain that when it rains, the soil, chemicals, and nutrients are washed into the river. Explain that erosion can negatively affect animals in the river by covering them and their habitat with silt. Explain that planting trees along the riverbank or areas of native plants between the river and field can help keep the water cool by providing shade and can also prevent soil from eroding and washing chemicals and fertilizers that may be in the soil into the river.

Example: Sedimentation negatively affects Hellbenders because the silt fills in the areas under and between the rocks where Hellbenders live. This is especially harmful for larval or baby Hellbenders that have adapted to hide between the small spaces in the rocks.

3. Thank your student volunteers and let them return to their seats. Ask students to summarize the story: Where did Herbie go and what did he find in the water? What would you tell your family and friends about Herbie's journey and the troubles caused by humans that he encountered?
4. **Story Conclusion:** Conclude the Herbie the Hellbender story and introduce the concept of an indicator species.

When you look at the water now, you see a mix of all the harmful pollutants that Herbie Hellbender was exposed to during his vacation. Protecting our rivers is very important because most aquatic life is negatively impacted by pollution, especially amphibians because of their permeable skin. Just like the sponge Herbie absorbed the water with harmful pollutants, amphibians can absorb harmful pollutants through their permeable skin in real life. Hellbenders are often one of the first species to disappear from the environment when a river becomes polluted or full of sediment. Because of this, Hellbenders are considered an indicator species.

- a. Ask students if anyone knows what an indicator species is. Explain that indicator species tell us about the health of the environment in which they live.

- b. Ask students: If the Hellbender is an indicator species and has been declining in Indiana (or your relevant state), what does that tell us about the health of our rivers where Hellbenders live? Are the rivers of good or bad quality?

5. Explain that if Hellbenders start disappearing, it tells us something bad is happening in a river. By helping conserve and protect Hellbenders, we can help protect all the animals in the freshwater river ecosystem, as well as people who use the river.

- a. Discuss that the Hellbender is declining across most of their range. Explain that many Hellbender populations are threatened or endangered and that if animals do not adapt to the changing environment, they will become extinct.

- b. Explain that Hellbenders help regulate the ecosystem in which they live by serving a role like a keystone species. Explain the meaning of a keystone species (i.e., *Hellbenders help keep the freshwater ecosystem in balance.*)

6. **Take Home Message:** Hellbenders are adapted to the aquatic environment and play a key role in the ecosystem. By conserving Hellbenders, we help protect all the animals that live in and use a river, as well as the water quality. Ask students what they can do to help conserve hellbenders. Ask them to reference specific parts of the Herbie the Hellbender story as justification for the solutions they might create. (See Teachers' Notes for example solutions.)

(Ensure all materials for this section of the program are laid out and easily accessible.)

1. Explain this activity.

We are now going to make slime out of corn starch, dish soap, and water. The ability to produce slime is another adaptation that helps Hellbenders survive. It helps deter predators by being distasteful and acts as a barrier to potential diseases. (See Teacher Notes)

2. Split students into groups of three or four. If you are inside, make sure that the activity takes place over a tile floor, plastic tablecloth, or covering that can easily be wiped off.
 - a. Give each group a bowl that holds at least 24 oz. with $\frac{1}{2}$ cup of corn starch and fork for mixing. Note: $\frac{1}{2}$ cup of cornstarch will produce $\frac{1}{2}$ cup of slime.
 - b. Add $\frac{1}{4}$ cup of dish soap to the corn starch in the bowl and have kids in each group take turns mixing.
 - c. Add 1 tablespoon of cold water and mix until each group has a slimy texture that is gooey and easily runs off their forks. (If the mixture is too runny, add corn starch; if the mixture is too thick, add water.)
 - d. Keep towels and a 5-gallon bucket with clean water nearby for students to wash their hands. **DO NOT** wash slime down a drain because it can clog pipes.
3. Conclude the lesson by emphasizing the importance of adaptations for aquatic amphibians and all species to survive. Explain that just like Hellbenders are adapted to produce slime that helps them survive, animals all over the world are adapting to help them survive in their ecosystem.