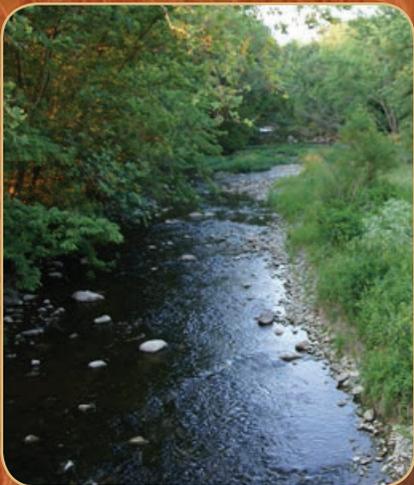


The *Nature* of Teaching

Discovering the Watershed Lesson Plan

This activity will teach students how human impacts to the environment affect water quality and indicator species.



Lesson Plan Overview	2
Teacher's Notes	6
Human Impact Cards	8
Human Impact Vocabulary Reference Sheet	12
Vocabulary Worksheet & Key	13
Ohio River Basin and Blue River Watershed Map	15
Eastern Hellbender Photo	16
Eastern Hellbender Distribution Map . . .	17
Complete Watershed Game Board	18
Watershed Game Board Parts	19
Indicator Species Cards	23

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Lesson Plan Overview

Estimated Time

60 minutes

Vocabulary

- Watershed
- Indicator Species
- Water Quality
- Erosion
- Sedimentation
- Leaching
- Groundwater

Lesson Objective

Students will be able to define the terms watershed and water quality, as well as understand how human impacts affect watersheds and their associated wildlife.

Targeted Grade-Level Indiana Standards

English

EL 5.1
ELP 5.1, ELP 5.2, ELP 5.7

Science

SC 5.2, SC 5.4, SC 5.6
SCI 5.3

Required Materials

- Watershed Game Board
- Human Impact Cards
- Indicator Species Cards
- Vocabulary Worksheet and Key
- Eastern Hellbender photo
- Eastern Hellbender Distribution Map
- Ohio River and Blue River Watershed Map
- Unique game piece per player (e.g., cubes)
- Beads/marbles to represent pollution
- Clear 8 oz. cups to hold water (1 per student)
- Dice, two per playing group

Reference Materials

See teacher's notes.

Authors

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Acknowledgments

The authors would like to thank Mrs. A. Lawson and Mrs. J. Dusseau for reviewing the lesson plan. Mrs. A. Lawson also permitted a pilot test of the lesson plan to her class. The authors also would like to credit A. Makadrakis for the Watershed Game Board and Indicator Species pictures.

Purdue University Agricultural Communication Service • Purdue University Cooperative Extension Service • Editor: Steve Leer • Designer: Dan Annarino

Apr. 2013

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Procedure

1. Begin the lesson by asking questions such as: *What do you think a watershed is? What is the size of a watershed? What types of water are included within a watershed?*
2. Define the term *watershed* for the students (a watershed is the area of land where water drains off and includes creeks, streams, rivers, ponds, lakes, oceans, etc.). Ask students what watershed they live in. Use the Ohio River Basin and Blue River Watershed Map as an example for the class. Display the map and discuss the size of the watershed, flow of water and how the surrounding area can influence these dynamics. If available, include information about your local watershed.
3. Ask the students: *What kinds of animals live in streams, rivers and ponds, and why might they live there?* Introduce the term indicator species. Indicator species have certain qualities that make them important for scientists to study. Explain that the presence or absence of an indicator species reveals the environmental condition, such as water quality. Amphibians, such as frogs and salamanders, are excellent indicator species for aquatic habitats. Explain to students why amphibians' unique characteristics make them good indicator species for a watershed (see teacher's notes for examples).
4. Introduce the Eastern Hellbender to the class and explain that they serve as an indicator species in rivers. Hellbenders are found in clean, fast-flowing water. The presence of Hellbenders in streams and rivers serves as an indicator of high water quality.
5. Shift the discussion to water quality. Ask the students: *What are ways in which water quality can be affected, both positively and negatively? Ask students: What might happen if the water quality were to change? What if the water quality became worse — what would happen to the Hellbenders in the river?*
6. Pass out the Vocabulary Worksheet and review the terms with the students. Define the ways pollution travels into and through the watershed.
 - Soil Erosion
 - Sedimentation
 - Leaching
 - Groundwater

Directions for Activity

1. The goal of the journey through the Watershed Game is to travel through the watershed and see how humans impact the water quality.
2. Split the class into groups of 4-5 students. Each group should have:
 - a. One half-filled cup of water per student
 - b. One Watershed Game Board (pdf)
 - c. Two dice
 - d. Game player piece for each student
 - e. Three stacks of Human Impact Cards: forestry, agriculture, and urban (pdf)
 - f. Cups or bags of beads/marbles to represent pollution
 - g. Set of Indicator Species Cards (4-5). Cards include Hellbenders and frogs. They serve as a prize for winning the game. A Hellbender represents the high water quality, a frog represents moderate water quality, and low water quality receives no amphibian indicator species. There can be multiple winners, so be sure there are multiples of each type of indicator species.
3. Each student starts with a clean cup of water. One by one, each student will roll the dice to determine how many spaces they will travel on the Watershed Game Board.
4. The students pick up a Human Impact Card every time they land on a new spot on the game board. The Human Impact Cards correspond with the three areas on the game board: forestry, agriculture, urban. The boundaries of the watershed are color-coded with the corresponding area: green is forestry, yellow is agriculture, and gray is urban. When in the forestry area, students are to pick up a forestry Human Impact Card; the same goes for the other two areas.
5. After the Human Impact Card is drawn, the students will read the card aloud and follow the instructions listed. Each card has either a negative or positive impact. Negative impacts require students to add pollution beads into their cup of water. Positive impacts allow students to remove pollution beads from their water. If they get a positive impact before they have any beads in their cup, then no action is needed.
6. Repeat steps 3-5 until each student has reached the end of the river. The river splits once in the urban area, but it does not matter which trail they follow.
7. To determine the winner, have students count the final number of pollution beads in their cup. The student(s) with the cleanest water (i.e., fewest beads) wins.
 - a. **0-5** beads receive the Hellbender Indicator Species Card, meaning they have the cleanest water and win the highest honor.
 - b. **6-9** beads receive a frog Indicator Species, meaning they have moderate water quality.
 - c. **10+** beads receive no Indicator Species, meaning that their water quality is unfit for an amphibian to live in.
8. After the game, review the terms *watershed* and *water quality*. Ask students for examples of some positive and negative human impacts they experienced during the activity. Review the terms they encountered in these experiences: *soil erosion*, *sedimentation*, and *leaching*.
9. Review the term *indicator species*. Ask how many students' water quality allowed them to have Hellbenders, frogs, or no amphibians at all. Ask them what factors caused them to receive the particular indicator species.
10. Ask the students if they have done any of the positive or negative impacts and how they can impact the water quality in their daily lives.

Rules of the Game

1. Setting up the board
 - Lay out the game board so that every player has access.
 - Place Human Impact Cards around the board.
 - Place game pieces on the START space at the top of the board.
 - Place beads in an area where every player has access.
 - Fill the clear cups half way with water.
 - Set the Indicator Cards aside for the end of the game.
2. To begin the game each player rolls the dice. The player rolling the highest number goes first. Each player takes a turn by rolling the dice and moving the corresponding number of spaces on the board. At each new space, pick up a Human Impact Card. Human Impact Cards are color-coded to match each section of the game board: green is forestry, yellow is agriculture, and gray/white is urban. Pick up the correct color of Human Impact Card when in each of those sections.
3. Follow instructions on the Human Impact Card.
 - If the impact is positive, remove beads from your cup.
 - If the impact is negative, add beads to your cup.
 - If you receive a positive before you have beads in your cup, no action is required.
4. Repeat steps 2-3 until the end of the game.
 - Note the urban section splits into three paths. It does not matter which path you take. The goal is not to reach the end first, but to have the cleanest water.
5. When each player has reached the end, they count the number of beads in their cup.
 - **0-5** beads receive the Eastern Hellbender Indicator Species Card: You have the cleanest water and win the highest honor.
 - **6-9** beads receive a frog Indicator Species Card: You have moderate water quality.
 - **10+** beads receive no Indicator Species Card: Your water quality is unfit for an amphibian to live.

Teacher's Notes

Watershed

A **watershed** is the area of land where all of the water drains into the same place. Watersheds can be composed of creeks, streams, rivers, ponds, lakes, wetlands, groundwater and oceans. Most water will begin its long journey far from where it ends up. For example, the Blue River Watershed is a part of the Ohio River Basin, which makes up 5,800 square miles in Indiana (see image right). In the continental United States, there are 2,110 watersheds. Every living organism needs water in order to survive. Many factors influence water and its quality, whether they be a factory polluting a river upstream, agricultural farms using poor practices that affect the nearby stream, or urban families investing in rain barrels to conserve water.



Ohio River Basin and Blue River Watershed Map

Source: www.helpthehellbender.org

organic nitrogen, phosphorus and pesticides, into the watershed.

- **Leaching:** The natural process by which chemicals, minerals, animal waste or pharmaceuticals are washed out of the soil and enter the groundwater. **Groundwater** is the water that fills the empty spaces beneath the soil. After pesticides are sprayed on crops they can leach or move through the soil and into groundwater, which, ultimately, ends up throughout the watershed.

One way to control the effects of erosion and sedimentation is by planting more trees near streams and rivers. Removing natural vegetation or buffers would increase the effects of erosion and sedimentation. Converting acres into crops takes away the land's natural ability to stabilize soil, resulting

Water Quality

Water quality is the measure of the chemical, biological, and physical characteristics of water in relation to a standard of use, such as drinking water for humans or proper habitats for amphibians. Water quality can be affected by multiple factors.

- **Soil erosion and sedimentation:** These are the primary sources of pollution in Indiana. Erosion and sedimentation results from poorly managed construction and logging sites, as well as non-environmentally conscious agricultural practices. Erosion occurs when the topsoil is removed from the land's surface. Sedimentation results in soil particles being carried by water and deposited somewhere else, which follows the land. Together, erosion and sedimentation can transport unwanted nutrients and pollutants, such as

in additional erosion of the land. Many agricultural practices, such as tilling, can increase erosion and sedimentation. Farmers can adopt no-till farming, which leaves the soil undisturbed and increases the amount of water and nutrients available while decreasing erosion. Other positive impacts include the proper disposal of chemicals and oils, and applying the proper amount of fertilizer on your lawn to reduce leaching. For more information on ways you can help improve the water quality in your watershed, visit: www.helpthehellbender.org.

Indicator Species

In ecology, scientists may focus research on certain species that serve as suitable **indicator species**. An indicator species is an organism whose presence, absence and abundance reveals a specific environmental condition. Assessing the presence or absence of an indicator species can help determine the

health of a watershed and aid in diagnosing a problem. Amphibians serve as important indicator species in aquatic habitats because of their unique life history traits.

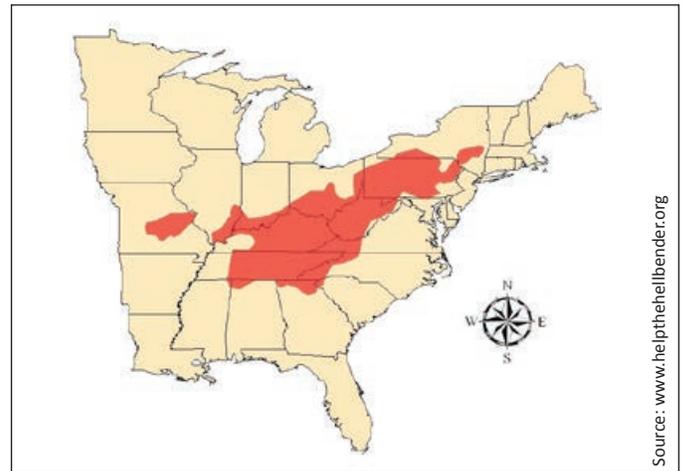
Amphibians as Indicator Species

Amphibians are unique among vertebrates in that they have a two-stage life cycle. Amphibians require water (or at least moist conditions) to reproduce. Amphibian eggs are not protected by a shell like reptiles and birds, but are encased in a jelly-like sac. Amphibian eggs deposited in water will readily absorb contaminants or pollutants in the surrounding environment. After hatching, most amphibian larvae are aquatic (e.g., tadpoles) and require weeks or years to develop into adults. Some amphibians, however, never leave the water. In these species, breathing occurs primarily through gills or through the skin. During each of these aquatic stages, poor water quality can negatively affect amphibians.

Eastern Hellbenders

One particular amphibian is in danger of extinction because of the poor water quality in its habitat. The Eastern Hellbender is a fully aquatic salamander that can grow up to 2 feet long, making it the largest salamander in North America. Hellbenders are top predators in their habitat, feeding mainly on crayfish. These long-lived salamanders rely on cool, shallow, fast-flowing and pristine streams and rivers. High water quality is important to Hellbenders because they can easily absorb pollutants through

their skin. Unfortunately, Hellbender populations are declining, likely because of human impacts on water quality. Scientists are now working to restore low populations through captive breeding, educational programs, increased protection and collaboration through universities and government programs. These efforts also will depend on increasing water quality to support the growing populations.



Eastern Hellbender Distribution Map

Further Reading

To locate and learn facts about your local watershed, click the link below to visit “Surf Your Watershed” by the US Environmental Protection Agency: <http://cfpub.epa.gov/surf/locate/index.cfm>

Hoosier Riverwatch: www.hoosieriverwatch.com

North America’s Giant Salamander, the Eastern Hellbender: www.helpthehellbender.org

Human Impact Cards

Forestry (print on green paper)

<p>John decides to restore a wetland to help filter and clean rainwater before entering the watershed. Remove 3 beads.</p>	<p>Tim decides to drain a wetland, causing unfiltered water to drain into the watershed. Add 4 beads.</p>
<p>Tom doesn't allow his crew to take machinery through the streams while harvesting trees. The streams are in good condition. Remove 1 bead.</p>	<p>Brian allows his crew's machinery to cross multiple streams while harvesting trees. The equipment hurts the habitat. Add 1 bead.</p>
<p>Nancy followed the proper instructions when applying pesticides. No chemicals entered the watershed. Remove 1 bead.</p>	<p>Mark did not follow the guidelines while applying pesticides. Chemicals entered into the watershed. Add 2 beads.</p>
<p>Along the watershed there is woody debris, which provides great habitat for indicator species. Remove 1 bead.</p>	<p>Along the watershed there is no woody debris, which is poor habitat for indicator species. Add 1 bead.</p>
<p>Maria takes out all dams, causing less fragmentation throughout the watershed. Remove 1 bead.</p>	<p>Nick decides to keep the dam in his stream, causing fragmentation. Add 1 bead.</p>
<p>The local community plants trees along the river, causing less erosion. Remove 2 beads.</p>	<p>There are no trees left along the river, causing erosion. Add 3 beads.</p>
<p>Cody restores the forest's streams by adding plants to help prevent sedimentation and erosion. Remove 2 beads.</p>	<p>Jarred removes vegetation along the forest's streams, causing sedimentation and erosion. Add 1 bead.</p>
<p>Zach has been volunteering to pick up trash in the forest to help clean polluted streams. Remove 1 bead.</p>	<p>Curtis sneaks into the forest to dump his trash. The forest and its streams are polluted. Add 3 beads.</p>
<p>Harmon allows all-terrain vehicles to only be driven on trails, keeping the streams undisturbed and clean. Remove 1 bead.</p>	<p>Sally allows all-terrain vehicles to drive through streams. Drivers cause sedimentation and damage to the environment. Add 1 bead.</p>
<p>Seth practices sustainable timber harvesting to ensure healthy forests and streams. Remove 2 beads.</p>	<p>Ethan does not regulate his timber harvesting, causing unhealthy forests and streams. Add 3 beads.</p>

Human Impact Cards

Agriculture (print on yellow paper)

<p>Megan practices no-till farming that minimizes soil erosion. Remove 2 beads.</p>	<p>Matt tills his farmland and increases soil erosion. Add 3 beads.</p>
<p>Shem installs wind breaks to prevent sedimentation and erosion. Remove 1 bead.</p>	<p>Bart does not have any wind breaks on his farm, increasing the sedimentation carried to the watershed. Add 1 bead.</p>
<p>Connor enrolls his land in the Conservation Reserve Program to help stop erosion and protect the watershed. Remove 2 beads.</p>	<p>Kelly does not enroll his land in the Conservation Reserve Program, increasing erosion and providing less protection of the watershed. Add 3 beads.</p>
<p>Anders installs a two-ditch system to filter sediment before it reaches the watershed. Remove 1 bead.</p>	<p>Anton does not install a two-ditch system, which causes more sedimentation to enter the watershed. Add 1 bead.</p>
<p>Staci installs a wetland by her cattle ranch to filter out waste before it drains into the watershed. Remove 2 beads.</p>	<p>The cattle's waste from Johanna's ranch leaches into the watershed because there is no wetland to filter the water. Add 2 beads.</p>
<p>Anne installs a retention pond to manage runoff while preventing erosion. Remove 2 beads.</p>	<p>Mike does not install a retention pond, causing erosion and polluted runoff to enter the watershed. Add 3 beads.</p>
<p>Randy uses cover cropping by planting a seasonal crop to prevent erosion. Remove 2 beads.</p>	<p>Anthony does not use a cover crop, which leads to erosion. Add 3 beads.</p>
<p>Barney fences off his cattle to prevent pollution and disturbance to the stream. Remove 1 bead.</p>	<p>Patrick does not have a fence for his cattle and they pollute and disturb the nearby stream. Add 1 bead.</p>
<p>Betty follows all regulations and limits on fertilizers to prevent pollution. Remove 1 bead.</p>	<p>Carolyn does not read the limits on fertilizers and the extra chemicals cause pollution. Add 2 beads.</p>
<p>Reuben properly disposes of all pesticides and herbicides, preventing any polluted runoff from going into the watershed. Remove 1 bead.</p>	<p>Thomas does not properly dispose of his pesticides and herbicides, causing pollution in the watershed. Add 2 beads.</p>

Human Impact Cards

Urban (print on gray or white paper) 1 of 2

<p>Daniel follows the label limits on the fertilizers, which prevents many chemicals from entering the watershed.</p> <p>Remove 1 bead.</p>	<p>Karen applies more fertilizer than the label recommends and the chemicals leach into the watershed.</p> <p>Add 1 bead.</p>
<p>Rob's car shop properly disposes of oil and keeps it out of the watershed.</p> <p>Remove 1 bead.</p>	<p>Andre's car shop pours oil down the drain and oil enters the watershed.</p> <p>Add 5 beads.</p>
<p>Lily's construction crew installs sediment fences on their construction site, which prevents sedimentation and runoff.</p> <p>Remove 2 beads.</p>	<p>Peter's construction crew does not install sediment fences on their construction site, which causes sedimentation in the local streams.</p> <p>Add 3 beads.</p>
<p>The Smith family installs rain barrels to capture rainwater and reduce pollution and runoff into their local river.</p> <p>Remove 1 bead.</p>	<p>The Johnson family does not install rain barrels. All the water runs across their property and adds pollutants to the river.</p> <p>Add 1 bead.</p>
<p>Bill maintains his septic system to prevent waste from leaching into the water.</p> <p>Remove 2 beads.</p>	<p>Louis fails to maintain his septic system and the waste leaches into the groundwater.</p> <p>Add 3 beads.</p>
<p>There is a pipe with clean, treated water flowing from it. There are no unwanted chemicals entering the river.</p> <p>Remove 1 bead.</p>	<p>There is a pipe draining into the river with many chemicals and unhealthy substances entering the water.</p> <p>Add 2 beads.</p>
<p>A superstore is built on top of a wetland and causes habitat reduction and pollution to the wetland.</p> <p>Add 3 beads.</p>	<p>A superstore tries to build a new store in town. The locals don't allow it to be built to protect the wetland habitat.</p> <p>Remove 1 bead.</p>
<p>Tom makes sure that none of his fishing bait escapes into the river. The bait species won't compete with the indicator species.</p> <p>Remove 1 bead.</p>	<p>Adam releases his fishing bait into the river. The bait species out-compete the indicator species, causing many to die.</p> <p>Add 1 bead.</p>

Human Impact Cards

Urban (print on gray or white paper) 2 of 2

<p>Lauren properly disposes of her unused medication. No harmful chemicals enter the watershed. Remove 1 bead.</p>	<p>Lana dumps her unused medication down the toilet, which causes many chemicals to enter the watershed. Add 3 beads.</p>
<p>Shelly goes to her local car wash to have her car cleaned. The soap used isn't put directly into the water. Remove 1 bead.</p>	<p>Rod drives his truck into the local river and washes his car there. The soap he uses pollutes the water. Add 2 beads.</p>
<p>People from the community join Hoosier Riverwatch and help clean debris and pollutants from their local river. Remove 1 bead.</p>	<p>There are no local volunteer groups to help clean the river. Pollution and garbage remain in the river. Add 2 beads.</p>
<p>The factories monitor and clean their wastewater to make sure no pollutants enter the local watershed. Remove 1 bead.</p>	<p>The factories allow their wastewater to be dumped straight into the watershed. Many harmful chemicals enter the watershed. Add 4 beads.</p>
<p>Maggie relies on the rain to water her lawn. Water is preserved and there is no cause of sedimentation. Remove 1 bead.</p>	<p>Carl waters his lawn every morning and every night. This use of water causes sedimentation and runoff from his lawn into the watershed. Add 1 bead.</p>
<p>Linda makes sure her family uses only phosphate-free soaps for laundry and dishes. This prevents leaching into the groundwater. Remove 1 bead.</p>	<p>Julie uses dangerous chemicals in her household, which then leach into the groundwater. Add 1 bead.</p>

Human Impact Vocabulary Reference Sheet

Cover crops

By planting seasonal cover on annual cropland, farmers can reduce soil erosion and reduce fertilizer use. Some common examples of cover crops are grasses or legumes such as ryegrass, wheat, crimson clover and radishes.

No-till farming

This type of farming involves planting a crop into the undisturbed soil that still contains the previous season's crop residue. In other words, there is no plowing the cropland before planting. This planting technique increases the amount of water and nutrients in the soil, while decreasing erosion.

Two-ditch system

This type of agricultural drainage closely mimics the function of natural streams. Using a two-ditch system reduces sedimentation across the cropland.

Low head dam

Low head dams are a type of barrier installed in rivers to alter the stream flow and prevent flooding. Because it is a barrier, dams can prevent various water-dependent species from moving through the river.

Conservation Reserve Program (CRP)

By enrolling farmland into the CRP, farmers can receive annual rental payments and cost-share assistance for conserving resources on eligible farmland. CRP protects millions of acres of topsoil from erosion. By reducing sedimentation, CRP protects groundwater and helps improve the condition of the local watershed.

Retention pond

These often are created in urban areas because there is less land available to absorb water because of buildings and pavement. Retention ponds are useful because they catch the unabsorbed water and help to remove pollutants before they can enter the watershed.

Sediment fences

These devices are installed to protect water quality by controlling sedimentation and runoff on various sites.

Windbreaks

Windbreaks are a linear planting of trees or other vegetation to reduce soil erosion caused by wind.

Rain barrels

Rain barrels are used to collect rainwater from roofs and downspouts. Installing rain barrels helps conserve water and reduce erosion.

Habitat fragmentation

The reduction of overall size of habitat patches. This results in breaking one large area into smaller habitat patches.

Vocabulary Worksheet

WORD BANK

Watershed

Water Quality

Indicator Species

Erosion

Sedimentation

Groundwater

Leaching

1. _____ An organism whose presence or absence reveals the environmental condition.
2. _____ When soil is removed from the land's surface.
3. _____ The area of land where all of the water drains off into the same place.
4. _____ When soil particles are carried by water and deposited somewhere else.
5. _____ The measure of the chemical, biological and physical characteristics of water.
6. _____ The natural process by which chemicals, minerals or particles are washed out of the soil and enter the groundwater.
7. _____ Water located beneath the ground that fills the empty spaces.

Vocabulary Worksheet — **KEY**

WORD BANK

Watershed

Water Quality

Indicator Species

Erosion

Sedimentation

Groundwater

Leaching

1. **Indicator Species**

An organism whose presence or absence reveals the environmental condition.

2. **Erosion**

When soil is removed from the land's surface.

3. **Watershed**

The area of land where all of the water drains off into the same place.

4. **Sedimentation**

When soil particles are carried by water and deposited somewhere else.

5. **Water Quality**

The measure of the chemical, biological and physical characteristics of water.

6. **Leaching**

The natural process by which chemicals, minerals or particles are washed out of the soil and enter the groundwater.

7. **Groundwater**

Water located beneath the ground that fills the empty spaces.

Ohio River Basin and Blue River Watershed Map



Source: www.helpthehellbender.org

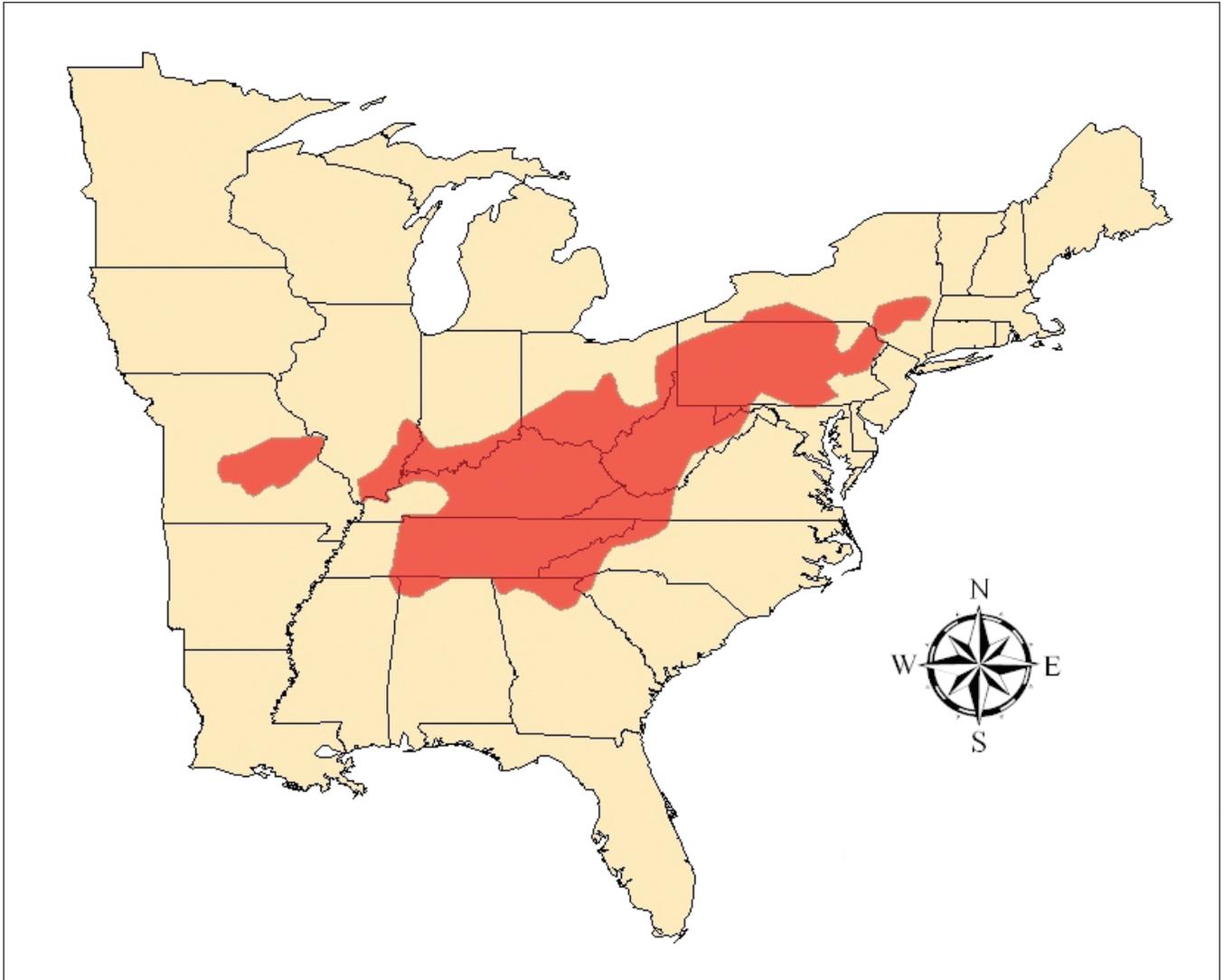
Eastern Hellbender



Photo by Shem Unger

An adult Eastern Hellbender walking along the bottom of a river.

Eastern Hellbender Distribution Map

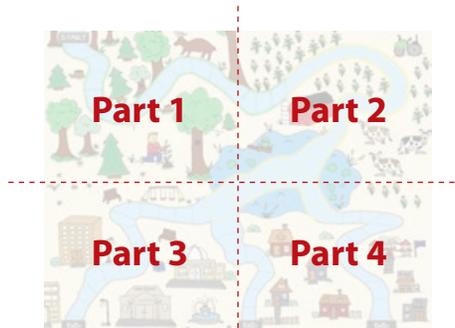


Source: www.helpthehellbender.org

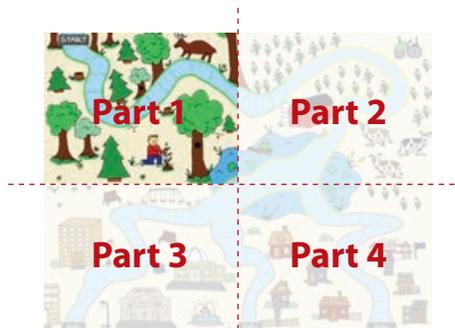
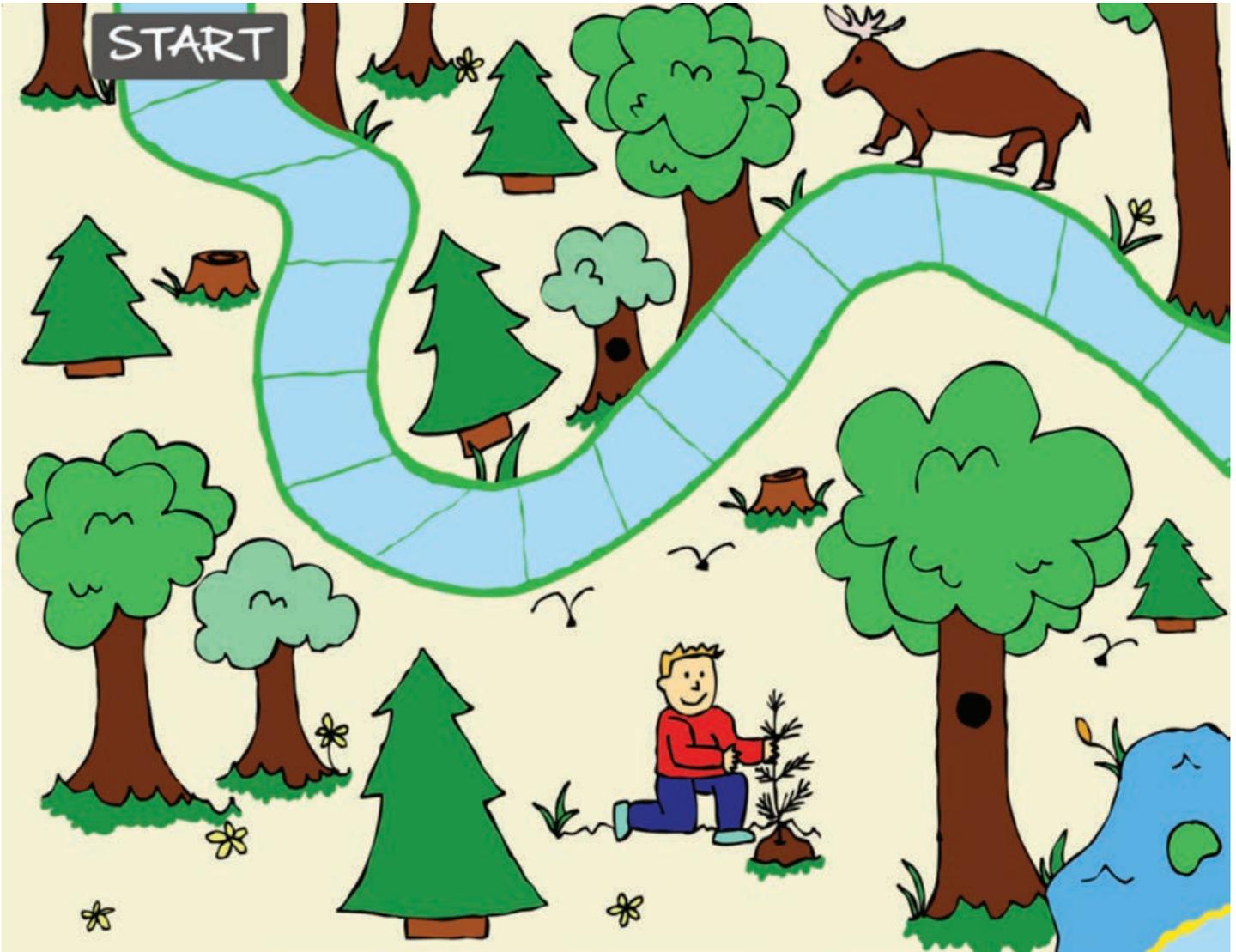
Complete Watershed Game Board



Anastasia Makadrakis



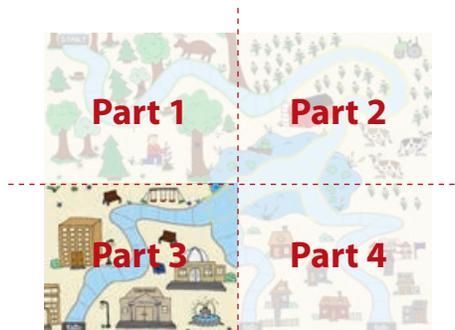
Watershed Game Board — Part 1



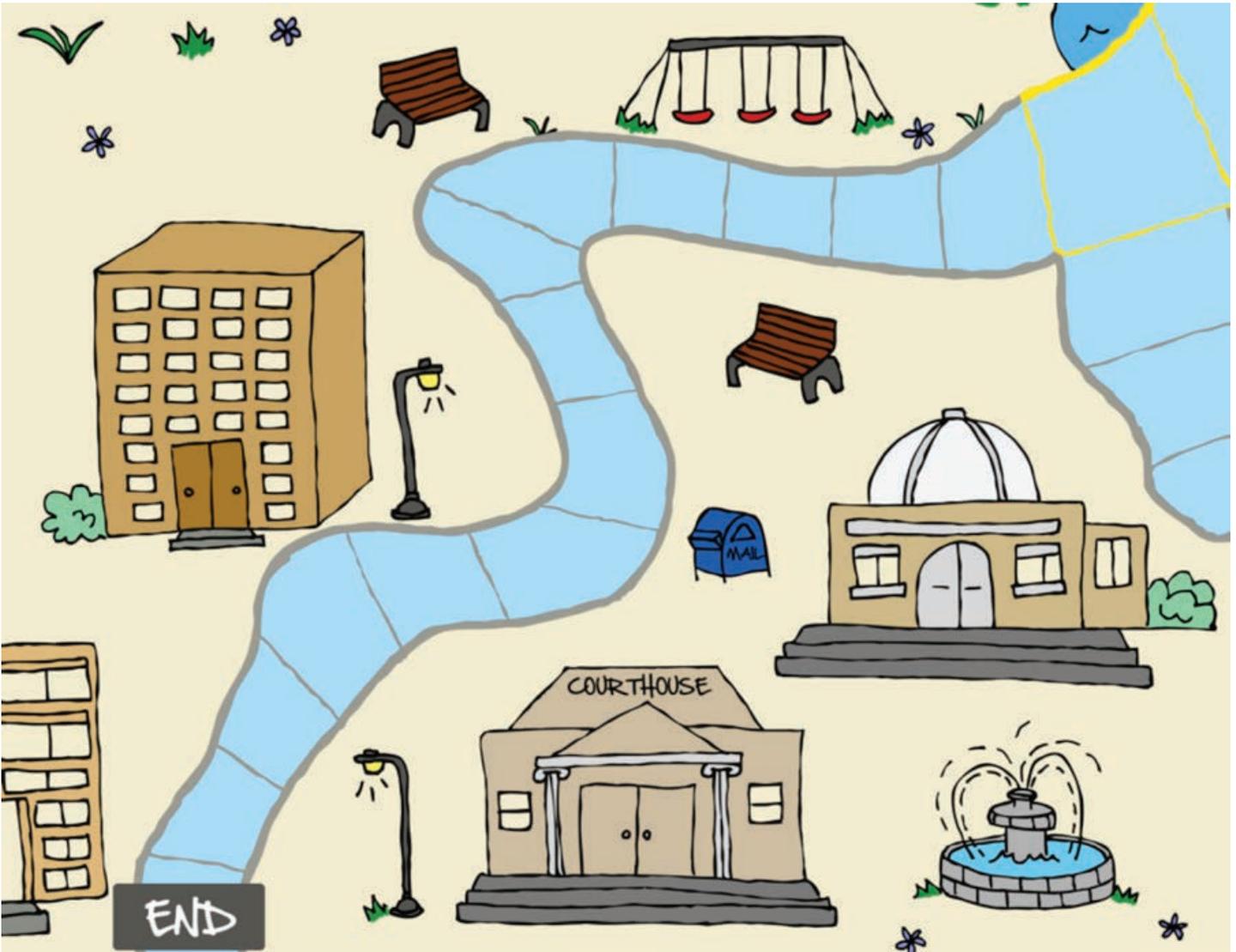
Watershed Game Board — Part 2



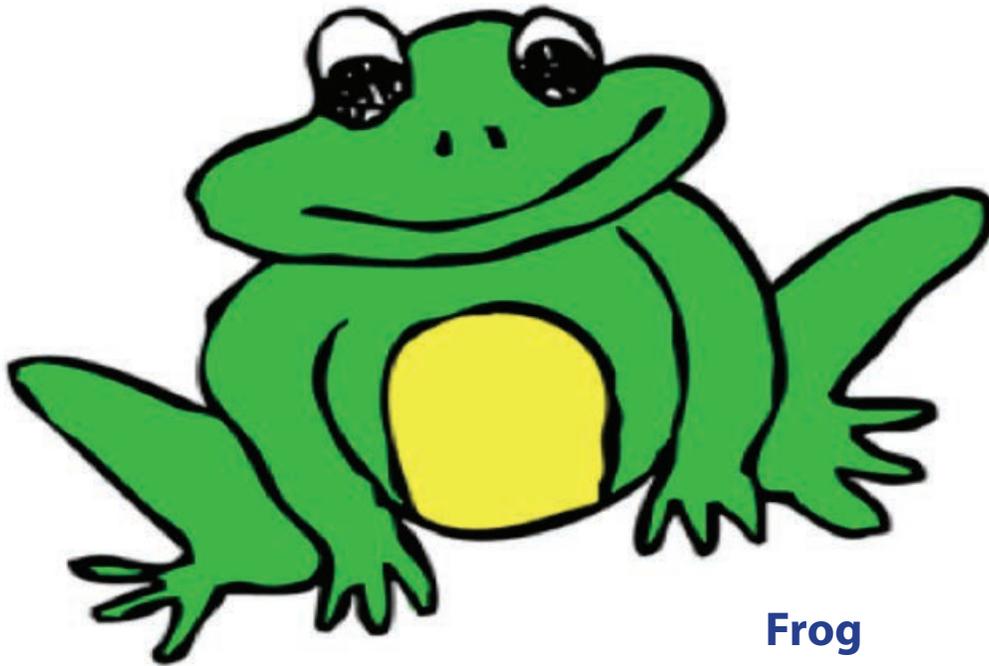
Watershed Game Board — Part 3



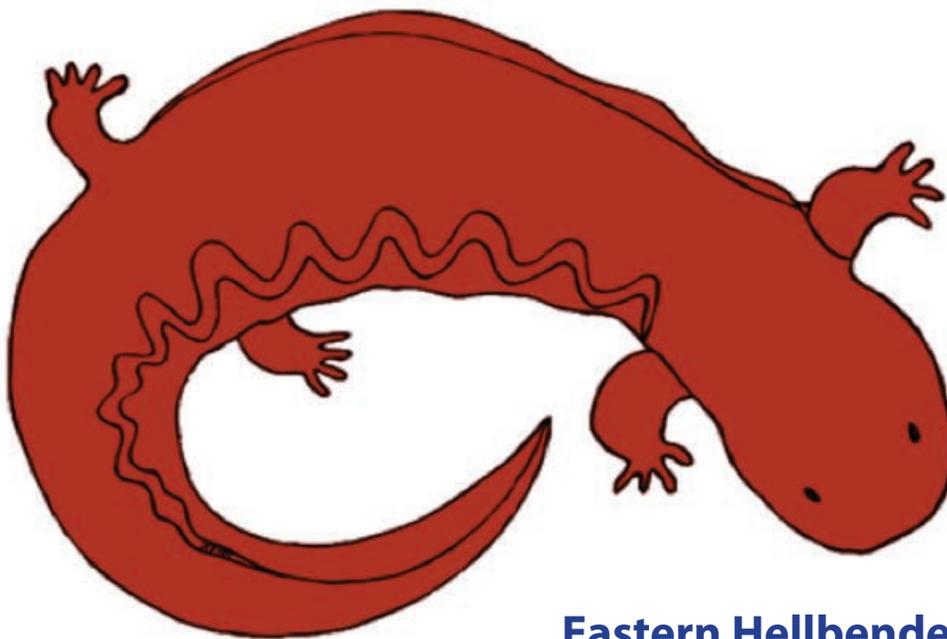
Watershed Game Board — Part 4



Indicator Species Cards



Frog



Eastern Hellbender