Hellbender Education

LESSON 5: APPALACHIAN STREAM CONSERVATION

MIDDLE SCHOOL STANDARDS ADDRESSED (BY STATE):

NGSS (Kentucky, Maryland)	**MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** ***Clarification Statement:*** Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems. ***Disciplinary Core Ideas:*** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. **MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.** ***Clarification Statement:*** Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations. ***Disciplinary Core Ideas:*** • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. *(secondary)* • (ETS1.B) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary)*
Pennsylvania	**4.2.6.C.: Identify natural and human- made factors that affect water quality.** **4.2.7.C.: Use appropriate tools and techniques to analyze a freshwater environment.** • Interpret physical, chemical, and biological data as a means of assessing the environmental quality of a freshwater environment.
West Virginia	**S.6.LS.2: Students will evaluate competing design solutions for maintaining biodiversity and ecosystem services.** **S.6.LS.7: Students will construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.**

	S.8.ESS.1: Students will construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
Virginia	**LS.10: The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include** a) phototropism, hibernation, and dormancy; b) factors that increase or decrease population size; and c) eutrophication, climate changes, and catastrophic disturbances. **LS.11: The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include** a) food production and harvest; b) change in habitat size, quality, or structure; c) change in species competition; d) population disturbances and factors that threaten or enhance species survival; and e) environmental issues.
North Carolina	**8.L.3: Understand how organisms interact with and respond to the biotic and abiotic components of their environment.** ● 8.L.3.1: Explain how factors such as food, water, shelter and space affect populations in an ecosystem.
Tennessee	**6.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Evaluate and communicate the impact of environmental variables on population size. 6. Research the ways in which an ecosystem has changed over time in response to changes in physical conditions, population balances, human interactions, and natural catastrophes. **6.LS4: Biological Change: Unity and Diversity** 1. Explain how changes in biodiversity would impact ecosystem stability and natural resources. 2. Design a possible solution for maintaining biodiversity of ecosystems while still providing necessary human resources without disrupting environmental equilibrium.

HIGH SCHOOL STANDARDS ADDRESSED (BY STATE):

NGSS (Kentucky, Maryland)	HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. ***Clarification Statement:*** Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

	Disciplinary Core Ideas: ● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. **HS-LS2-6: Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** ***Clarification Statement:*** Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise. ***Disciplinary Core Ideas:*** ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. **HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** ***Clarification Statement:*** Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species. ***Disciplinary Core Ideas:*** ● Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

	● Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)* ● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary)* ● (ETS1.B) When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary)*
Pennsylvania	**4.1.10.A.: Examine the effects of limiting factors on population dynamics.** ● Analyze possible causes of population fluctuations. ● Explain the concept of carrying capacity in an ecosystem. ● Describe how organisms become classified as threatened or endangered. ● Describe how limiting factors cause organisms to become extinct. **4.1.12.A.: Analyze the significance of biological diversity in an ecosystem.** ● Explain how species adapt to limiting factors in an ecosystem. ● Analyze the differences between natural causes and human causes of extinction. ● Research wildlife management laws and their effects on biodiversity. **4.1.12.C: Research how humans affect energy flow within an ecosystem.** ● Describe the impact of industrial, agricultural, and commercial enterprises on an ecosystem. **4.5.10.D: Research practices that impact biodiversity in specific ecosystems.** ● Analyze the relationship between habitat changes to plant and animal population fluctuations. **4.5.12.D.: Analyze the effects of new and emerging technologies on biodiversity in specific ecosystems.** ● Evaluate the impact of laws and regulations on reducing the number of threatened and endangered species. **4.1.12.E.: Research solutions addressing human impacts on ecosystems over time.**

	4.2.10.A.: Examine the interactions between abiotic and biotic factors within a watershed. ● Describe how topography influences the flow of water in a watershed. ● Describe how vegetation affects water runoff. ● Investigate and analyze the effects of land use on the quality of water in a watershed. **4.2.12.A.: Examine environmental laws related to land use management and its impact on the water quality and flow within a watershed.** **4.2.10.C.: Explain the relationship between water quality and the diversity of life in a freshwater ecosystem.** ● Explain how limiting factors affect the growth and reproduction of freshwater organisms. **4.2.12.C.: Analyze the effects of policies and regulations at various governmental levels on water quality.** ● Assess the intended and unintended effects of public policies and regulations relating to water quality.
West Virginia	**S.10.LS.12: Students will evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.** **S.10.LS.13: Students will design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** **S.10.LS.15: Students will create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.** **S.HS.ENV.9: Students will evaluate the leading causes of species decline and premature extinction: habitat destruction and degradation, invasive species, pollution, human population growth, over exploitation.** **S.HS.ENV.11: Students will relate habitat changes to plant and animal populations and climate influences: variations in habitat size, fragmentation, fluctuation in conditions of abiotic factors, albedo, surface temperature.** **S.HS.ENV.17: Students will debate climate change as it relates to natural forces, greenhouse gases, human changes in atmospheric concentrations of greenhouse gases, and relevant laws and treaties.**
Virginia	**BIO.8: The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include**

	a) interactions within and among populations including carrying capacities, limiting factors, and growth curves; b) nutrient cycling with energy flow through ecosystems; c) succession patterns in ecosystems; d) the effects of natural events and human activities on ecosystems; and e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.
North Carolina	**Bio2.2: Understand the impact of human activities on the environment (one generation affects the next).** ● Bio2.2.1: Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment. ● Bio2.2.2: Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.
Tennessee	**BIO1.LS2: Ecosystems: Interactions, Energy, and Dynamics** ● 4. Analyze data demonstrating the decrease in biomass observed in each successive trophic level. Construct an explanation considering the laws of conservation of energy and matter and represent this phenomenon in a mathematical model to describe the transfer of energy and matter between trophic levels.

STUDENT OBJECTIVES: Students will:

a) Confront gaps in their knowledge of endangered species by tapping into misconceptions.
b) Identify threatened and endangered species in Appalachia and compare the various ways in which humans impact their populations.
c) Review pertinent environmental legislation and current efforts to restore the health of Appalachian streams and rivers.
d) Synthesize their knowledge of human impacts and stream conservation by constructing educational materials to share with others.

LESSON OVERVIEW:

Time	Instructional Sequence	Activity Summary
	Engage	*What Species are Endangered and Why?*
	Explore	*Endangered in Appalachia: Species Profile*
	Explain	*Protecting Appalachian Streams and Rivers* PowerPoint
	Elaborate	*River Conservation Profile*
	Evaluate	*Spread the Word: Share the Hellbender Story*

LESSON STEP 1: ENGAGE

Objective: Students will identify species commonly known to be endangered and compare them to threatened and endangered species in Appalachia.

- This step should allow students to confront their knowledge gaps when it comes to endangered species.

Materials:
- Computer with internet access
- *Appalachian Stream Conservation* PowerPoint
- *Appalachian Stream Conservation* Student Handout

Sequence:
1. Teacher should show the first slide in the presentation.
2. Ask students to identify species they know as "threatened" or "endangered". Species identified by students will likely be commonly known ones: giant panda, tigers, elephants, gorillas, etc.
3. Ask if any of the students can identify endangered species in Appalachia.
4. Show students various threatened and endangered stream species found throughout Appalachia.

LESSON STEP 2: EXPLORE
Objective: Students will research threatened and endangered species in Appalachia and compare the reasons for their decline.

Materials:
- List of threatened and endangered species in Appalachia
- *Endangered in Appalachia: Species Profile* Student Handout
- Computers with internet access (for student research)
- *Appalachian Stream Conservation* PowerPoint

Sequence:
1. Assign students one of the species from the list.
2. Students should research the species assigned to them and complete the *Endangered in Appalachia: Species Profile* Student Handout.
3. When students have finished their research, the teacher should ask students to share *reasons* for the decline in these organisms' populations, and list them on the board.
4. Students should fill in the table on their handout linking population decline and specific human activities.

LESSON STEP 3: EXPLAIN
Objective: Students will review recent legislation and stream conservation/restoration efforts across Appalachia.

Materials:
- *Appalachian Stream Conservation* PowerPoint
- *Appalachian Stream Conservation* Student Handout

Sequence:
1. Teacher should show *Appalachian Stream Conservation* PowerPoint.
2. Students should take notes on their Student Handout.

LESSON STEP 4: ELABORATE
Objective: Students will research individual rivers across Appalachia to learn about past, current, and future conservation and restoration efforts.

Materials:

- *List of Appalachian Rivers* (teacher)
- *River Conservation Profile* Student Handout
- *Appalachian Stream Conservation* PowerPoint
- Computers with internet access for student research

Sequence:

1. Teacher should assign each student group or pair (can also be done individually) a river from the list. Other rivers can be included (and should be, particularly in your local area), provided enough information is available to students during their research.
2. Students should work in pairs to complete the *River Conservation Profile* student handout.
3. Students can present their profile to the class, or the teacher can collect this assignment for a grade upon completion.

LESSON STEP 5: EVALUATE

Objective: Students will construct a short instructional plan for sharing information about hellbender salamanders and stream conservation with friends, family, and/or other students.

Materials:

- Paper
- Colored pencils, markers, posterboard, etc.
- Computers with internet access for student research
- *Appalachian Stream Conservation* powerpoint
- *Spread the Word: Share the Hellbender Story* Grading Rubric

Sequence:

1. Teacher should describe the assignment using slides from the *Appalachian Stream Conservation* PowerPoint.
2. Students should construct their presentation materials.
3. Teacher should encourage students to share their materials with other teachers, students, friends, or family members by providing an incentive – teacher might choose to have the recipient of the short “lesson” sign the document once the student has finished presenting the information to them (this could be part of the final grade for this assignment).
4. This assignment will count as the final grade for this lesson.