Hellbender Education

LESSON PLAN 4: STREAM FOOD WEBS

MIDDLE SCHOOL STANDARDS ADDRESSED (BY STATE):

NGSS (Kentucky, Maryland)	**MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.** ***Clarification Statement:*** Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial. .***Disciplinary Core Ideas:*** ● Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. **MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.** ***Clarification Statement:*** Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system. ***Disciplinary Core Ideas:*** ● Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.
Pennsylvania	**4.1.7.A.: Describe the relationships between biotic and abiotic components of an ecosystem.** ● Compare and contrast different biomes and their characteristics. ● Describe symbiotic and predator/prey relationships. **4.1.7.C.: Explain the flow of energy within an ecosystem.** ● Compare and contrast the flow of energy between organisms in different habitats. ● Explain the concept of trophic levels.
West Virginia	**S.6.LS.1: Students will construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.**

	S.6.LS.5: Students will analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **S.6.LS.6: Students will develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.**
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	**6.L.2: Understand the flow of energy through ecosystems and the responses of populations to the biotic and abiotic factors in their environment.** ● 6.L.2.1: Summarize how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within food chains and food webs (terrestrial and aquatic) from producers to consumers to decomposers. **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. ● 8.L.3.3: Explain how the flow of energy within food webs is interconnected with the cycling of matter (including water, nitrogen, carbon dioxide and oxygen
Tennessee	**6.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Evaluate and communicate the impact of environmental variables on population size. 2. Determine the impact of competitive, symbiotic, and predatory interactions in an ecosystem. 3. Draw conclusions about the transfer of energy through a food web and energy pyramid in an ecosystem. 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.

	7. Compare and contrast auditory and visual methods of communication among organisms in relation to survival strategies of a population. **7.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Develop a model to depict the cycling of matter, including carbon and oxygen, including the flow of energy among biotic and abiotic parts of an ecosystem.

HIGH SCHOOL STANDARDS ADDRESSED (BY STATE):

NGSS (Kentucky, Maryland)	**HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** ***Clarification Statement:*** Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem. ***Disciplinary Core Ideas:*** ● Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. **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.
Pennsylvania	**4.1.10.C. Evaluate the efficiency of energy flow within a food web.** ● Describe how energy is converted from one form to another as it moves through a food web (photosynthetic, geothermal). **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.
West Virginia	**S.10.LS.8: Students will use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** **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.**
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	**Bio.2.1: Analyze the interdependence of living organisms within their environments.** ● Bio2.1.3: Explain various ways organisms interact with each other (including predation, competition, parasitism, mutualism) and with their environments resulting in stability within ecosystems.
Tennessee	**BIO1.LS2: Ecosystems: Interactions, Energy, and Dynamics** 1. Analyze mathematical and/or computational representations of population data that support explanations of factors that affect population size and carrying capacities of populations within an ecosystem. Examine a representative ecosystem and, based on interdependent relationships present, predict population size effects due to a given disturbance.

STUDENT OBJECTIVE: Students will:

a) Identify some common aquatic species found throughout Appalachia.
b) Recognize the importance of terrestrial and aquatic linkages in stream food webs.
c) Identify the trophic relationships between hellbenders and other stream species.
d) Understand the various ways that human activities can impact and alter stream food webs.

LESSON OVERVIEW:

Time	Instructional Sequence	Activity Summary
	Engage	*Hellbender: Observe and Infer!*
	Explore	*Linking Up: Who's Who in Appalachian Streams*
	Explain	*Stream Food Webs* PowerPoint
	Elaborate	*Case Studies: Human Impacts in Food Webs*
	Evaluate	*Food Web Concepts and Vocabulary* Quiz

LESSON STEP 1: ENGAGE
Objective: Students will make inferences about the hellbender's trophic relationships based on their observations.

Materials:
- Computer with internet access and a projector
- *Hellbender* video (Untamed Science)

Sequence:
1. Teacher should discuss the terms "observation" and "inference" with the class.
2. Teacher should play the video and ask students to write down three observations about the hellbender and/or its habitat.
3. Teacher should ask students to "infer" the trophic position of the hellbender – what it eats and what eats it – based on their observations from the video.
4. Teacher should also discuss with students what makes scientific observation and experimentation with these animals so difficult! The challenges of working in this environment and with these salamanders is an important part of why we're still learning so much about them.

LESSON STEP 2: EXPLORE
Objective: Students will research species that are found in Appalachian rivers and streams, then construct a food web to show their trophic relationships.

Materials:
- *Linking Up* organism cards
- Yarn or string, 2 different colors
- Computers with internet access for student research

Sequence:
1. Teacher should pass out organism cards to individual students or pairs of students.
2. Students will research the organism on their card to fill out the information (scientific name, predators/prey, etc.).
3. Students present their organism cards to the class.
4. In a large group in the center of the classroom, students should begin linking their organisms with yarn or string to show trophic relationships – one color for consuming and one for being consumed. For example, the freshwater amphipod would link to detritus with

one color (to represent that it eats detritus), and link to the river chub, the southern two-lined salamander, and any other predators with the other color.

5. Students should proceed linking all organisms until all likely or possible trophic relationships have been shown using string.
6. Teacher can facilitate discussion during this activity by asking students to identify which relationships represent a terrestrial-aquatic link (i.e. occur between organisms that originate or live in the two distinct habitats).
7. Once all links are made, teacher can further facilitate class discussion by posing some scenarios about stream disturbance and their impacts, such as:
    - A tropical depression has moved slowly through the area, causing high amounts of sedimentation in the stream. Which organisms are directly impacted? Which are indirectly impacted?
    - Increased levels of farm fertilizer has caused a reduction in stream oxygen levels. Which organisms are directly impacted? Which are indirectly impacted?
    - A new predator of the river chub has been introduced, and its population grows rapidly. Which organisms are directly impacted? Which are indirectly impacted?

LESSON STEP 3: EXPLAIN

Objective: Students will review important food web vocabulary, and learn about how hellbenders fit in to stream food webs.

Materials:

- Computer and projector
- *Stream Food Webs* PowerPoint
- *Stream Food Webs* Student Notes Sheet

Sequence:

- Teacher will show *Stream Food Webs* PowerPoint.
- Students will fill out notes on their notes sheet.

LESSON STEP 4: ELABORATE – *Dissect an Abstract!*

Objective: Students will closely examine an abstract from a scientific paper about human impacts in food webs to:

1) Become familiar with a scientific writing style
2) Understand the function of an abstract in a scientific paper
3) Dissect science and non-science vocabulary terms to construct alternate and more grade-level-appropriate text

Materials:

- *Dissect an Abstract* student handout
- Computers with internet access for student pairs

Sequence:

1. Teacher should give each student a handout and a worksheet and group students in pairs (this assignment can also be done individually).
2. Teacher should assign each student pair a sentence from the abstract (1-11).
3. Students should work together to answer the questions on the handout.

Optional steps:

4. Teacher can ask students to write their newly-constructed sentences on the board in order, to form a new abstract (one that has been rewritten to reflect students' understanding, interpretation).
5. Teacher can review the new abstract as a whole with the class, and highlight different sentences.
6. Teacher can correct students' misinterpretations of different parts of the abstract.

Possible extension (for upper grade-level students):

7. Teacher can ask students to review the whole article, with a particular focus on the "Summary Points" and "Future Issues" sections. Questions from the "Future Issues" section can be used to generate whole-class teacher-facilitated discussion.

LESSON STEP 5: EVALUATE

Objective: Students will demonstrate their knowledge of important food web concepts and vocabulary.

Materials:

- *Food Webs Concepts* Quiz

Sequence:

1. Teacher should hand out a quiz paper to each student.
2. Quizzes should be collected and graded when students are finished.