Middle School Stream Ecology Lesson Integrating NGSS and CCSS

Introduction

Though we live on a planet that is covered in water over three-fourths of its surface, more than 97% of that water is salt water. Of the small percentage of freshwater, only 1% is readily available to humans in the form of surface freshwater, contained in lakes, rivers, and streams. Of course, humans are not the only organisms reliant on surface freshwater. A wide range of aquatic and terrestrial organisms require these water resources for their survival. Unfortunately, human activities can create devastating impacts on these biomes and their resources. Because of the importance and fragility of streams, the study of stream ecology is an important area of scientific research. It is also a surprisingly accessible area for student involvement and one that can incorporate many different disciplines.

Standard Alignment of Provided Student Task

NGSS

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.]*

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 conversion of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.]*

CCSS.ELA

CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical tests.

CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.MATH:

CCSS.MATH.CONTENT.8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

Materials

- KWL charts for lesson introduction and wrap-up
- Smartboard and projector or individual computers/tablets with headsets
- Individual copies of student task, either in print or sent digitally to students
- Graph paper or graphing software for student use

Lesson Instructions

1. Distribute KWL charts as students enter the classroom. Students should complete the "What I Know" and "What I Wonder" sections for an appropriate prompt, depending on placement of the lesson within the curriculum. Possible prompts include, "Water," "Freshwater," "Food Webs," "Stream Ecology," and "Population Ecology."

2. If you are using the lesson outside of the context of a larger stream ecology unit, you should provide context with some background information about water supplies, stream health, and water quality sampling. Resources for this introduction include, but are not limited, to: https://vimeo.com/69267782

   https://www.youtube.com/watch?v=wBX9LpZKV-A

   http://www.teachertube.com/video/macroinvertebrate-sampling-techniques-58483

   Depending on where in the curriculum the lesson is integrated, additional background information, review, or support may be required for graphing scatter plots or drawing food webs. Consider if this will be necessary for your students and integrate such support where it is most helpful for students.

3. Students will be working with partners to complete the task in the lesson. You may use a designated system for this, allow students to choose their own partners, or directly assign partners.

4. Once students are ready to work with their partner, distribute print or digital copies of the Student Task. Instruct students to read through the background information and work together to complete the task. Depending on available resources and your preference, students may create and deliver their final work in print or digital format.

5. Facilitate the lesson by observing student pairs, ensuring that both partners are contributing to the work, and answering questions to aid students as they construct their responses. Student responses should be about a page in length without the graph or food web. Depending on the sizes of the graph and food web, the entire report should be about two pages. The length of the report is not specified in the student task so that students will focus on completely answering the prompts rather than ending their work when they reach a certain page length.

6. Once students finish the task, direct students to find current news articles related to water quality and stream health. Students should find connections between the current events and their work in the lesson task.

7. Conduct a whole class discussion of the task and the current events located by the students. Have pairs share their scatter plots and food webs and discuss similarities and differences in the approaches they took. Further facilitate the discussion by having student pairs share the current event they found and the connection it has to the Student Task. Encourage students to make big-

picture connections between chemical characteristics of water and the health of organisms that rely upon it.

8. At the end of class, students can either turn in their work or add it to their notebooks or portfolio, as you prefer. Students should complete the “What I Learned” portion of their KWL chart and turn it in.

9. If used within the context of a larger water quality unit, the task provided could also be assigned as individual homework or as a performance assessment of work done previously in the classroom. In lieu of provided data, student-collected data from a series of stream observations could be used.

Lesson Extension Ideas

With careful planning, an entire unit of study or even yearly theme can be built around the study of stream ecology. There are many Internet resources available to extend the learning associated with the provided lesson. Some of these include:

- Freshwater Supplies on Earth: http://water.usgs.gov/edu/earthwherewater.html
- Water Quality Resources and Activities: http://water.usgs.gov/edu/waterquality.html
- Macroinvertebrates and Stream Health: http://wupcenter.mtu.edu/education/stream/Macroinvertebrate.pdf
- Role of Dissolved Oxygen in Stream Health: http://bcn.boulder.co.us/basin/data/NEW/info/DO.html
- Biotic Indexing: http://watermonitoring.uwex.edu/wav/monitoring/biotic.html
- Biotic Survey Techniques: http://water.epa.gov/type/rsl/monitoring/vms40.cfm
- Lesson Plan - Interpreting Water Quality Data: http://www.oakland.k12.mi.us/LinkClick.aspx?link=Learning%2FLearningScience%2FInterpreting+Water+Quality+Data.doc&tabid=1900&mid=5324
- Lesson Plan - Water Quality Assessment: http://www.ymcasf.org/ptbonita/files/Static%20Page%20Files/Water%20Quality%20Assessment%20Teacher%20Packet.pdf

In addition, local extension agencies or environmental service groups may conduct periodic stream quality testing. These groups are excellent sources for field trips. They may also be willing to sponsor a group to independently collect data on streams. The hands-on opportunity to collect stream quality data will actively engage students and provide them with an experience to remember.

Student Task

Background Information

We all need clean water each day. To have healthy water, we must also have healthy streams. Pollution can make streams unhealthy. Pollution can be directly added to streams by human activities. It can also indirectly enter streams. After storms, rainwater runs over land and can carry pollutants as it enters streams. In this way, even fertilizers containing nitrates and phosphates from farms or lawns may enter streams as pollutants.

People can monitor the health of streams with chemical and physical tests. They can also monitor stream health through biological tests. By counting the number and type of organisms that live in a section of stream, people can determine if the stream is healthy or might be polluted.

Freshwater arthropods are one type of organism that may be gathered and counted to test a stream's health. These small, but not microscopic, organisms are called macroinvertebrates. They live in the water as part of the aquatic food web, clinging to the rocks on the bottom of the stream. Macroinvertebrates may live in the water for their entire life or for only a part of their life cycle. Some may tolerate pollution and changes in the water. Other macroinvertebrates are more sensitive.

Three sensitive species of macroinvertebrates are mayflies, stoneflies, and caddisflies. Each of these species develops in the water as larvae before changing into their flying adult forms. Like many stream macroinvertebrates, these species use gills for breathing during their aquatic larval form. The larvae eat decaying matter in streams. They are eaten by fish and other macroinvertebrates. As adults, the invertebrates may be consumed by birds, bats, and other insectivores.

The following table shows biological and chemical data gathered at eight different stream sites.

Site	Nitrate Concentration (mg/L)	Number of Mayflies, Stoneflies, and Caddisflies Collected
A	25.66	4
B	18.32	4
C	0.35	2
D	0.68	16
E	3.93	24
F	3.04	127
G	6.57	34
H	3.46	46

Data source: http://courses.washington.edu/uwtoce03/webg2/results.html

Task

Using the background information provided, answer the following prompts in a scientific report, adding the graphs and diagrams required.

How might changes in nitrate concentrations affect mayflies, stoneflies, and caddisflies? Support your inferences using evidence from the text and data provided.

Construct a scatterplot using the data table. Be sure to label your *x*- and *y*-axis. Describe any patterns you observe in the data. Use terms such as clustering, outliers, positive or negative association, linear association, and nonlinear association, as required.

How might changes in nitrate concentrations and the numbers of mayflies, stoneflies, and caddisflies in a stream impact the ecosystem as a whole? Use information from the passage to create a food web to illustrate your inferences.