Is My Local Stream a Healthy Habitat?

Middle School NGSS Unit

STEM

STEM
Science
Technology
Engineeering
Math

A program of Educational Service District 112 supporting Next Generation Science Standards

Background on the Core Scientific Ideas in this Unit

What is alive in my local stream? Is my local stream a healthy habitat? These are questions that can set the trajectory of a unit and introduce students to the complex interactions taking place in their own school's stream, pond, community watershed, backyard—wherever you have access to a local body of water. In this unit, students develop skills in Science and Engineering Practices of evidence-based argumentation as they analyze and report their water-sampling and watershed research data to answer the over-arching question, and learn to frame their ideas in terms of cross-cutting concepts of systems and cause and effect. Following these initial phenomenon-based questions – students will investigate these more specific questions:

- Why is it that the populations or organisms in and around my local water-course changes along its' length?
- What ecosystem services does this water-course provide?
- How is human activity impacting on the services this ecosystem provides?
- How can I design a solution to maintain this ecosystem service?

Specific student outcomes will be very dependent on the local watershed / water-course under examination. Shade provided by trees and vegetation reduces water temperature and increases dissolved oxygen. Increases in impermeable surfaces increase flooding / turbidity. Human activity / runoff may increase conductivity / decrease pH. Increased velocity increases dissolved oxygen. As soil moisture decreases, biodiversity may decrease.

BACKGROUND (cont.)

WHAT WILL STUDENTS KNOW AT THE END OF THIS UNIT?

- 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.
- 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).
- There are systematic process for evaluating solutions with respect to how well they meet the criteria and constraints of a problem (secondary).
- Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.
- Water quality can be determined using a number of parameters: chemical (D.O., conductivity, pH, etc), physical (turbidity, light) and biological (macro-invertebrates, etc).

UNIT OVERVIEW

Lesson No.	Duration	Materials Needed	Focus	Assessment Options
1	1-2 class periods	Student access to the Internet Student notebooks Evidence logs Driving question board	**Engage** • The unit Driving Question is introduced. Students demonstrate prior knowledge through a brainstorming activity.	Classroom observation of SEP #1
2	1 class period (field) and 1 class period (reflection)	Student notebooks Site assessment data sheets	**Explore** • Students make an initial visit to their site to collect data. • Students begin to establish initial claims based on evidence.	Initial claim based on evidence – "how healthy is our local stream?"
3	6 class periods	Vernier probes from Environmental Science kit Student notebooks Chromebooks/laptops	**Explain** • Students conduct investigations in the process of learning about limiting factors in environmental sciences and using Vernier tools. • Students begin to make predictions and gather evidence of acceptable water quality parameters before entering the field.	Formative assessments for each investigation linked in documents; ongoing notebook assessments; class discussion

UNIT OVERVIEW (cont.)

Lesson No.	Duration	Materials Needed	Focus	Assessment Options
4	5 class periods	Vernier probes for field work Student notebooks Safety equipment	**Expand** • Students conduct field work at the local water course they are examining in the unit. • Students dive deeper into their Claim – Evidence - Reasoning • Students extend their study to macroinvertebrates	CER based claim answering "how healthy is our local stream?"
5	5-6 class periods	Chart paper Markers Video camera (on phone) Chromebooks/laptops	**Evaluate** • Student present their arguments for protecting their local watercourse • Students prepare and propose a solution to an audience for remediating or protecting their local watershed.	Final proposed solution with CER argument and presentation

LESSON 1: Introduce the Driving Question

Strategy: Engage

Description/Summary

The opening lesson in this unit is to engage students in asking questions around a puzzling phenomenon or event that kids can observe and come to deep understanding of over the course of the unit. Throughout the course of the unit students will investigate and design projects that will help them answer the question – Is my local stream a healthy habitat?

Brainstorm prior knowledge about factors that lead to a healthy stream habitat, and the components of a stream ecosystem (food web / inputs and outputs, boundaries, processes). This can be refined over time after key learning experiences.

Elicit student questions and begin developing a Driving Question board that will support students throughout the unit.

At the end of the first lesson, you should be able to refine the driving question more clearly to your context. For example, once the water source has been chosen, and students have defined the boundary and questions they are interested in answering through the study, the Driving Question can be refined to:

How can [insert school or town] develop a plan to protect [water source] from [recent event, change in ecosystem, natural hazard, invasive species].

Driving questions are the basis of a Project-Based Learning experience, and are intended to be answered by students at the end of the unit, by multiple means of expression. For more information on developing and using Driving Questions with students, consult '[Driving Questions Webinar]" by John Larmer and Gina Olabuenaga; Buck Institute for Education/summarized.

Materials Needed
Student science notebooks Access to the Internet Resources linked

LESSON 1 (cont.)

Teacher Background knowledge prior to site visit:

1. Riparian zone
2. Ecosystem Services (Ecosystem Services - Water Purification)

The above lesson can be used to build student background information as well.

Finally, establish an 'Evidence Log' to be added to throughout the unit which will support the Claims Evidence Reasoning content of the culminating Evidence-based Argument answering the Driving Question. This can be maintained as a class, in small groups, or by individuals in their science notebooks.

Stream Health Evidence Log

LESSON 2: Initial Site Survey

Strategy: Explore

Description/Summary

Once the site for water quality monitoring has been selected, prepare students to conduct field work in small groups.

Use the Initial Site Survey protocol from the Vancouver Water Resources Education Center to guide students in documenting initial observations from the site.

After the initial site survey, students document their initial thinking by responding to the broad question 'how healthy is our local stream?' in their student notebooks. Their initial claim should be supported by their evidence from the site survey. Initial reasoning should document current understanding of ecosystem processes, such as water purification processes based on levels of levels of vegetation, etc.

To support and scaffold students in developing a scientific explanation, use the 'Explanation Tool' from the American Museum of Natural History.

Materials Needed
Copies of the "Watershed Monitoring Network Initial Site Assessment Data Sheet" – 1 per student
Clipboards
Pencils & Colored pencils
Explanation Tool templates

LESSON 3: Pre-Monitoring Preparation

Strategy: Explain

Description/Summary

Students will engage in the practice of Using Mathematics and Computational Thinking to develop an understanding of the causes and effects of a variety of biotic and abiotic factors in their local ecosystem. To build background on each parameter in the context of water quality in the ecosystem, use the following activities. Students will also examine what factors affect each parameter and explore how they can use a Vernier probe to measure it.

Temperature – How to use the Vernier Temperature probe

pH

- Introduction to pH (PhET simulation)
- Implications for organisms (cK-12 reading)

Dissolved Oxygen

- How much D.O. do living things need? (Water's the Matter reading and activities)

Turbidity

- Introduction to turbidity – requires access to water source
- Turbidity and Organisms reading
- Examining dataset on relationship between Turbidity and Dissolved Oxygen (pg. 4 of 'Water Quality: Temperature, pH and D.O.'

Materials Needed
Vernier probes from the Environmental Science kit
Temperature
pH
Dissolved oxygen
Turbidity
Labquest 2
Go Link!
Laptops/Chromebooks

LESSON 3 (cont.)

Stream Flow and Calculations

- Introduction to calculating stream discharge (and pages 3, 4 of Water Quality: Turbidity and Stream Measurements)
- Practice Calculations

This sequence of lessons provides an opportunity to train students on using each of the probes in the classroom before visiting the field site again.

At the end of this set of activities, revisit the Driving Question board with students. Lead a discussion in which students predict what data they believe they will collect from their local site, and have them explain their thinking on why these parameters may be reflected. Using the Washington Department of Ecology website, students can also locate the acceptable criteria for the parameters studied, and for their water course to provide a baseline for their data and claims.

http://www.ecy.wa.gov/programs/wq/swqs/criteria.html

LESSON 4: Water Quality Monitoring & Adding Macroinvertebrates

Strategy: Expand

Description/Summary

Now that students have selected a water course for study, refined their driving question and engaged with the technology necessary to collect data in the field, they are ready for their first Water Quality monitoring visit. While a preliminary determination of the health of a water course can be made after a single sample, it is best to collect several samples and compare them over time.

LIMITED AMOUNT OF TIME

- Survey one site (initial site assessment and subsequent water quality / biodiversity monitoring) and examine questions focused around habitats, biodiversity and the factors that affect these.
- Use your water quality data as evidence for your argument about whether or not this watercourse is a healthy habitat that will support diverse communities of organisms.

EXTENDED AMOUNT OF TIME

- Survey 2 - 3 sites initial site assessments and subsequent water quality / biodiversity monitoring) along the water course and compare these for factors affecting habitats and biological diversity, as well as human impacts.

Use the 'Watershed Monitoring Network Water Quality Data Sheet' found as the last page of either 'Water Quality: Temperature, pH and Dissolved Oxygen' or 'Water Quality: Turbidity and Stream Measurements'

Materials Needed
Vernier probes and sensors
Water Quality data sheets
Student notebooks
Safety equipment

ADDITIONAL EXTENSION (2-3 DAYS): STUDYING FRESHWATER MACROINVERTEBRATES

Introduce macroinvertebrates as bio indicators that can help assess the health of a stream. Facilitate a discussion around the role of a "bio-indicator species" and the role of biodiversity. How can the level of biodiversity give us insight into the health of a stream? Redirect students to the guiding question and review Freshwater Macroinvertebrates Protocol Introduction. Provide students with the Protocols worksheet and the Macroinvertebrate Log Sheet (last page). Students will benefit from having the Key to Macroinvertebrate Life in the River as a resource. Have students revisit their stream 2-3 days to collect and analyze bio samples from the stream. Students will use the data they collect as evidence for the argument they will develop in the formative assessment.

FORMATIVE ASSESSMENT

After the initial site visit, use this formative assessment which integrates data analysis, communicating information, arguing from evidence (SEPs) and looking for patterns and cause and effect (CCCs), around DCI: LS2C. Have students develop a claim based on their water quality data collected on site (and macroinvertebrate data), defend that claim with their specific evidence and reason their claim based on scientific patterns and laws.

Materials Needed for Macroinvertebrate Extension
Nets for kick-samples
Critter-condos
Transect squares (PVC tubes)
Waders / Boots for stream samples
50-meter tape

LESSON 5: Final Argument & Preparing Proposals

Strategy: Evaluate

Description/Summary

PROPOSING A SOLUTION (5-6 DAYS):

This summative assessment integrates data analysis, communicating information, arguing from evidence (SEPs) and looking for patterns and cause and effect (CCCs, DCI: LS2C). Now that students have collected data and formulated a scientific argument based on evidence, scientific patterns, and scientific laws, students will be asked to produce a proposal for either remediating of protecting the health of the watershed. First, students can research to expand their knowledge of ecosystem restoration efforts: Restoring Ecosystem Services to Prevent Flood Damage In Napa River Basin','Ecosystem Services." Then, they will use their scientific argument to create a proposal that would be presented to a specific audience (ex. local businesses, city council, specific community members, etc.) to create awareness and empower change.

Students can follow this process: (1) Conduct research about the services that are provided to humans by the watershed (articles above). How are these services valuable? Are these services replaceable? (2) Revisit and revise their CER argument as something that can be presented to the specific audience of choice. Check if the evidence supports the argument effectively. Will the argument be persuasive? (3) Create a proposal to present the argument to the chosen audience. How can the argument be presented (visual media such as brochures or memes, slides presentation, video clip, etc.)? (4) In a gallery walk or showcase, present your proposal to the classroom or school community (the teacher can reach out to the actual intended audience of the proposal if possible). Accept and analyze feedback while optimizing the solution based on suggestions.

Materials Needed
Laptops/Chromebooks Posters and markers Video Camera (or phone camera) for filming projects.

How This Unit Supports Next Generation Science Standards

MS-LS2 Ecosystems: Interactions, Energy, & Dynamics

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	**Connections to Classroom Activity** *Students:*
MS-LS2-4: Construct an explanation supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	• Conduct an investigation to collect data (initial observational, temperature, pH, dissolved oxygen, turbidity) in their local stream to investigate if it is a healthy habitat. Students study how different factors may influence populations that live within an ecosystem. • Research about ecosystem services and identify the ecosystem services and use data (abiotic and biotic) to determine if these eco-services may be under threat in their local watershed. • Design and propose a solution to an audience in their community to improve the health of their local watershed and preserve the ecological services that it provides.

How This Unit Supports Next Generation Science Standards (cont.)

SCIENCE & ENGINEERING PRACTICES	
Engaging in Argument from Evidence Planning and Conducting Investigations Analyzing and interpreting data Constructing Explanations and Designing Solutions Communicate information	• Students construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. • Students analyze data from the field to construct an argument based on evidence and propose a solution to the problem. • Students communicate their scientific argument by proposing a solution to a specific audience of their choice using the media of their choice.
DISCIPLINARY CORE IDEAS	
LS2C: Ecosystem Dynamics, Functioning, and Resilience LS4D: Biodiversity and Humans (secondary) ETS1B: Developing Possible Solutions (secondary)	• 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. • 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 – such as water purification and recycling. (secondary) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary).

How This Unit Supports Next Generation Science Standards (cont.)

CROSSCUTTING CONCEPTS	
Stability and Change Cause and Effect Influence of Science, Engineering, and Technology of Society and the Natural World	• Small changes in one part of a system might cause large changes in another part. • Students study environmental phenomena which may have been caused by human activity. • STEM practices and thinking can lead to the development of solutions to mitigate the negative impact of human activity on ecosystems.