Biotic sampling

Focus questions	How can the health of an aquatic ecosystem be determined by the macroinvertebrates present in the ecosystem?
Learning target	Students identify macroinvertebrates and rate the health of an aquatic ecosystem.
Vocabulary	Riffle zone, range of tolerance, dichotomous key

MS-ESS3: Earth and Human Activity

Performance expectation MS-ESS3-3	**Classroom connection:** Students analyze the different macroinvertebrate groups that live in a water ecosystem.

Science and engineering practices

Constructing Explanations and Designing Solutions	**Classroom connection:** Students add to their explanation of the water health of an aquatic ecosystem by gathering macroinvertebrate data. **Classroom connection:** Students continue to design solutions to improve the health of the aquatic ecosystem based upon their observations of the site and taxonomic data collected.

Disciplinary core ideas

ESS3.C: Human Impacts on Earth Systems	**Classroom connection:** The macroinvertebrate testing will provide data to indicate the health of the aquatic ecosystem. Students will determine if the data supports human impact in the aquatic ecosystem.

Cross-cutting concepts

Cause and Effect	**Classroom connection:** Humans have made significant impacts on aquatic ecosystems. Students will test for the biotic data that demonstrate the water health of the ecosystem and design possible solutions to correct a decline, if present, or to protect the health from human impact.

This lesson focuses on Constructing Explanations and Designing Solutions as a means to identify biotic indicators that help to determine the health of an aquatic ecosystem and the corresponding conditions that allow aquatic organisms to survive. Students will collect data on aquatic macroinvertebrates of an aquatic ecosystem and create a water health explanation for the ecosystem. Students will collect data on aquatic macroinvertebrates in an aquatic ecosystem and create a water health explanation for the ecosystem.

Background

Macroinvertebrates are animals without a backbone that can be seen with the naked eye. These bottom-dwelling animals include crustaceans and worms, but most are aquatic insects. Macroinvertebrates form permanent, relatively immobile stream communities that can be easily collected in large numbers for observation. They occupy all stream habitats and display a wide range of functional feeding preferences. They are important to the ecosystem and inhabit the middle of the aquatic food web as a major source of food for fish and other aquatic and terrestrial animals. Macroinvertebrates are a good indicator of changing water conditions because they demonstrate both acute and chronic reactions to environmental changes in the aquatic habitat.

The kick seine technique is a useful way to measure the macroinvertebrate diversity of an aquatic ecosystem. Macroinvertebrate taxa can tolerate varying levels of water quality conditions. Some macroinvertebrates groups can only tolerate excellent water quality, whereas other groups have a different *range of tolerance* for environmental conditions. Field sampling should be done when the water is warm and macroinvertebrates are active, usually from the end of May through the end of September. The best areas to locate macroinvertebrates are in areas of high oxygen concentration such as *riffle zones* or rapids in the benthic zone. Students will find that macroinvertebrates may cling to the bottom on rocks and humus and will need to be wiped and kicked into the net for collection.

Materials

- Kick seine net
- White bucket, tub, or ice cube tray (to place organisms in for identification)
- Macroinvertebrate dichotomous key
- Closed-toe shoes
- *Suggested:* Aqua Bugs app by the Izaak Walton League

Prior knowledge

- Students should have prior knowledge about the kick-seining method used to collect macroinvertebrates from aquatic ecosystems. There are several video tutorials available. Here is a short video that demonstrates how the kick technique should be performed: **youtu.be/MHt56nhqgFk**
- Students will need to be familiar with a macroinvertebrate dichotomous key such as the Stroud Water Research Center Key found here: **3jgs2o4a02n22u73bi2gnd3l-wpengine.netdna-ssl.com/wp-content/uploads/MacroKey_Complete.pdf**
- Students can also use the photo identification key located here: **stroudcenter.org/macros/gallery/**

Student handout

Reflection

Create an explanation for the current water health of the water sample above. Look at the recorded information above. Reflect on the following questions while creating your explanation.

1. How did the stream appear to your group? Healthy or not healthy? Did the stream have an odor or a layer of oil on its surface? Did you notice anything that stood out as unusual? Write details about the stream below.

Possible answers: Students should observe the layout of the stream and write down their observations. Answers will vary.

2. How did your water sample results compare? Did you have organisms from more than one index group? What was your index rating?

Possible answers: Students should record and explain their group index data. Answers will vary.

3. If your stream rating was less than 'excellent' water quality, what are some factors that could be affecting the rating? Could human impact have changed stream conditions and lessened the water quality rating? If so, how?

Possible answers: Students should explain how their group index data could be maintained or improved. Answers will vary.

Rubric for self-assessment

Skill	Yes	No	Unsure
I can identify macroinvertebrates.			
I can use the collected taxa data to determine a water quality rating of poor, fair, good, or excellent.			
I can use the collected data and assessment to describe possible ways that the health of a disrupted aquatic ecosystem can be improved.			

Teacher preparation

1. Prepare students by watching the kick seining video (`youtu.be/MHt56nhqgFk`) with the class to learn the kick seining technique that will be used in this investigation.
2. Prepare copies of both the student handouts as well as the macroinvertebrate dichotomous keys.
3. Help students to select roles for their group—2 people will hold the net and the remaining 2+ participants will be kickers to move macroinvertebrates into the net.
4. It is a good idea to practice macroinvertebrate testing in the classroom. This can be done by passing out pictures of macroinvertebrates for student practice. You can also create a simulated stream on your classroom floor to practice the kick seine technique and identification.
5. Students must have closed-toed shoes to enter the stream. Students may wear plastic gloves if they are concerned about touching live organisms.
6. Take hand wipes or hand sanitizer for students to clean up after macroinvertebrate testing if a bathroom/sink is not available.

Differentiation

Other ways to connect with students with various needs:

- **Local Community:** Students may investigate local aquatic ecosystems to conduct testing of the ecosystem and observe human activities that have impacted the testing site.
- **Students with special needs (language/reading/auditory/visual):** Students in cooperative groups can rotate tasks and utilize all students' strengths. Students can design an alternative solution by creating a model of their design solution.
- **Extra support:** Volunteer Stream Monitoring, A Methods Manual: `epa.gov/sites/ production/files/2015-06/documents/stream.pdf`. Nebraska Department of Environmental Quality, Stream Monitoring: `deq.ne.gov/NDEQProg.nsf/OnWeb/SBMP`
- **Extensions:** Students can observe real-time data in Nebraska through USGS: `nrtwq.usgs.gov/ne/`. Students can help to solve real water problems within their community. Take part in organizations such as Give Water a Hand: `erc.cals.wisc.edu/gwah/`.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Constructing Explanations	Student can conduct macroinvertebrate kick seine testing and identify local benthic macroinvertebrates. Student can create an explanation for the data resulting from the macroinvertebrate kick seine water quality testing and design some forms of remediation for any negative test results.	Student can conduct macroinvertebrate kick seine testing and identify local benthic macroinvertebrates. Student can create an explanation for the data that resulted from the macroinvertebrate kick seine water quality testing.	Student can conduct macroinvertebrate kick seine testing and identify local benthic macroinvertebrates. Student can create an explanation for the data resulting from the macroinvertebrate kick seine water quality testing and design some forms of remediation for any negative test results.

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