

Citizen Science 2.0

70 Minute Lesson

Suggested Grades 6-12

All seasons

Biological Indicators

Background

Macroinvertebrates are organisms that lack a spine and are visible without magnification. In an aquatic ecosystem, common macroinvertebrates include worms, crustaceans, and insects such as dragonfly nymphs. Streams and rivers are dynamic systems. As water moves downstream, it moves various pollutants and physical properties with it. Therefore, testing water chemistry from one day to the next can result in variation in water quality assessments. For example, after a heavy rainfall

the flow and turbidity of a stream may increase along with nitrates and phosphates deposited by agricultural runoff. Biological communities, however, are less likely to fluctuate due to changing weather conditions. These benthic organisms are buried in sediments and detritus at the bottom of the river or attached to rocks and plants and can remain in one location despite the flow of the stream.

Macroinvertebrates have varying degrees of sensitivity to water chemistry. As a result, different taxa, or macroinvertebrates identified to order, family, or species, have been assigned pollution tolerance scores and are used as biological indicators for ecosystem health. Taking inventory of the macroinvertebrates allows scientists to calculate a biotic index score which helps them determine the health of the water. While the presence of pollution tolerant organisms does not necessarily indicate poor water quality, the absence of pollution sensitive macroinvertebrates may be an indicator of poor water quality.

In this activity, students will become familiar with macroinvertebrate taxa that can be found in Cuyahoga Valley National Park. Students will learn how to use a dichotomous key and learn basic macroinvertebrate identification skills. They will then practice these identification skills by completing an activity called “Life on the James” from Laying the Foundation, Inc., Dallas, TX © 2012. Completing this activity ensures students will have exposure to the macroinvertebrates they might encounter and increases the reliability of the data collected during their visit to Cuyahoga Valley National Park.

Essential questions

* What are biological indicators?
* Why are macroinvertebrates good indicators of water quality?

Learning objectives

Students will:

* Be able to successfully identify macroinvertebrates using a dichotomous key.
* Understand how macroinvertebrates are important indicators of water quality.

Materials

*For instructor:*

* Macroinvertebrate Identification PowerPoint
* Computer and projector
* Teacher copy of the “Life on the James” activity

*For each student:*

* Macroinvertebrate dichotomous key (Spanish language version available)
* “Life on the James” activity

Lesson overview

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| **Activity** | **Estimated duration** |
| Opening questions | 5 minutes |
| Introduction to macroinvertebrate identification | 25 minutes |
| Dichotomous key practice | 10 minutes |
| “Life on the James” activity | 30 minutes |
| Total | 70 minutes |

Key concepts and vocabulary

**Biological Indicator/Bioindicator Species (**from the EPA):

an animal or plant species which can be used to provide information about the quality of the environment or ecosystem of interest and how it changes with time.

**Dichotomous Key** (from the EPA):

a system that classifies materials by separating choices into two categories.

**Macroinvertebrate** (from the EPA):

animals without backbones ("invertebrates") that are large enough to be seen with the naked eye ("macro"). Examples of macroinvertebrates include: crayfish, snails, clams, aquatic worms, leeches, and the larval and nymph stages of many insects, including dragonflies, mosquitoes, and mayflies. Macroinvertebrates are excellent indicators of water quality because they cannot move to a different section of water if the water they are in is uninhabitable.

**Runoff** (from the EPA):

the amount of precipitation that runs over the ground surface and returns to streams, rivers, or other surface water bodies. It can collect pollutants from air or land and carry them to receiving waters.

**Taxa** (from the EPA):

plural of taxon; groupings of living organisms, such as phylum, order, family, genus, or species. Scientists organize organisms into taxa in order to better identify and understand them.

**Tolerance** (from the EPA):

measure of degree to which a particular taxon can persist in anthropogenically-disturbed systems. We expect to find highly tolerant taxa at severely degraded sites.

Activities

**Opening questions (5 minutes)**

Ask students the following questions:

* How do we know if a stream or river ecosystem is healthy?
* What is a macroinvertebrate?

**Introduction to macroinvertebrate identification (25 minutes)**

Present the “Macroinvertebrate Identification” PowerPoint to acquaint students with taxa they could encounter in Cuyahoga Valley National Park. Point out different characteristics that help with identification as you introduce different macroinvertebrate orders and families. Furthermore, discuss macroinvertebrate sensitivity to pollutants by introducing biotic indices. Biotic indices assign tolerance scores to macroinvertebrates. Based on the number of species present within an aquatic ecosystem, biotic indices can provide invaluable information about whether a waterway is polluted.

**Dichotomous key practice (10 minutes)**

Have students practice using a dichotomous key using the photographs on the final slides of the presentation. Walk through an example together and then have students work in pairs to identify the remaining organisms. The dichotomous key is available as a PDF for printing or digital use.

**“Life on the James” activity (30 minutes)**

Distribute the “Life on the James” activity to students. The activity includes 7 different collection sites along the fictional James River. Divide students into groups and assign a site number (or multiple site numbers) to each group. Have students read the lesson plan carefully and discuss macroinvertebrates as biological indicators prior to beginning the activity. If students have not had a lesson on water chemistry spend time describing how water chemistry fluctuates regularly while the benthic macroinvertebrate community remains more stable over time. The benthic community can potentially provide a more robust indication of ecosystem quality as a result.

Access the “Life on the James” lesson plan online:

<https://www.allenisd.org/cms/lib/TX01001197/Centricity/Domain/1322/a%20bugs%20life.pdf>

Teaching objectives

* Understand which taxa are considered macroinvertebrates
* Water chemistry versus macroinvertebrate presence as indicators of ecosystem quality
* Proficiency in dichotomous key use for macroinvertebrates identification

Ohio’s Learning Standards

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| **Grade** | **Topic** | **Sub-Topic** | **Code** |
| 7 | Life Science | Cycles of Matter and Flow of Energy | 7.LS.2 |
| 8 | Life Science | Species and Reproduction | 8.LS.1 |
| 9-12 | Biology | Diversity and Interdependence of Life | B.DI.1 |
| 9-12 | Biology | Diversity and Interdependence of Life | B.DI.2 |
| 9-12 | Biology | Diversity and Interdependence of Life | B.DI.3 |
| 9-12 | Environmental Science | Earth Systems | ENV.ES.1 |
| 9-12 | Environmental Science | Earth Systems | ENV.ES.3 |
| 9-12 | Environmental Science | Earth’s Resources | ENV.ER.3 |
| 9-12 | Environmental Science | Earth’s Resources | ENV.ER.5 |
| 9-12 | Environmental Science | Global Environment Problems and Issues | ENV.GP.2 |
| 9-12 | Environmental Science | Global Environment Problems and Issues | ENV.GP.9 |
| 9-12 | Physical Geology | Earth’s Resources | PG.ER.3 |

Next Generation Science Standards

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| **Grade** | **Topic** | **Sub-Topic** | **Code** |
| 6-8 | Life Science | From Molecules to Organisms: Structures and Processes | MS-LS1-5 |
| 6-8 | Life Science | Interactions, Energy, and Dynamic Relationships in Ecosystems | MS-LS2-1 |
| 6-8 | Life Science | Interactions, Energy, and Dynamic Relationships in Ecosystems | MS-LS2-2 |
| 6-8 | Life Science | Interactions, Energy, and Dynamic Relationships in Ecosystems | MS-LS2-3 |
| 6-8 | Life Science | Interactions, Energy, and Dynamic Relationships in Ecosystems | MS-LS2-4 |
| 6-8 | Life Science | Interactions, Energy, and Dynamic Relationships in Ecosystems | MS-LS2-5 |
| 6-8 | Earth and Space Sciences | Earth and Human Activity | MS-ESS3-3 |
| 9-12 | Life Science | Ecosystems: Interactions, Energy, and Dynamics | HS-LS2-1 |
| 9-12 | Life Science | Ecosystems: Interactions, Energy, and Dynamics | HS-LS2-2 |
| 9-12 | Life Science | Ecosystems: Interactions, Energy, and Dynamics | HS-LS2-6 |
| 9-12 | Life Science | Biological Evolution: Unity and Diversity | HS-LS2-7 |