

## SCIENCE BENEATH THE SURFACE

Middle School; 6th-8th grade  
discussion guide

GRADE LEVEL: 6-12

TIMEFRAME: 3-5 LESSONS

MATERIALS: ACCESS TO COMPUTERS FOR RESEARCH PURPOSES

KEY WORDS: MIDGE FLIES, SONAR, ESTUARY, CONFLUENCE, HYDROMECHANICS, QUAGGA MUSSELS, INVASIVE, FILTER FEEDER, OCEANOGRAPHIC, TERRESTRIAL ECOLOGISTS

VIDEO LINK: [VIEW HERE](#)

### ACTIVITY SUMMARY

In this lesson, students will explore freshwater ecosystems and examine how living and nonliving components are connected within these complex systems. Using the Milwaukee Estuary as a case study, students will learn how insects, fish, birds, and water conditions depend on one another to support healthy ecosystems. Students will also investigate how freshwater scientists use tools such as sonar and underwater robots to study environments that are difficult to observe directly.

A key focus of the lesson is understanding the impact of invasive species on ecosystem balance. Students will be challenged to think like scientists by designing a realistic intervention to reduce the effects of an invasive species while considering possible trade-offs and unintended consequences.

**CRITICAL QUESTION:** How do freshwater ecosystems function as connected systems, and how can scientific tools help us understand and protect them?

### LEARNING OBJECTIVES

Students will be able to:

- Explain connections and dependencies between the various animals and water movement within an estuary.
- Describe how scientists study freshwater systems.
- Analyze the impact of invasive species on aquatic ecosystems.



## BACKGROUND INFORMATION

This clip highlights several projects at the School of Freshwater Sciences and shows how many land-based systems begin in the water. One example is the midge fly. This insect starts its life as a worm in the mud and serves as a critical food source for many fish species. Without midges, fish populations would not remain stable and many birds depend on the fish as their source of food.

The freshwater featured in today's clip is the Milwaukee Estuary, where three rivers—the Milwaukee River, Kinnickinnic River, and Menomonee River—converge. When these rivers meet, differences in water temperature create areas with higher concentrations of nutrients, which attract both fish and birds.

Freshwater scientists use sonar to identify and track species living at different depths within the water column. Sonar data can be combined to create top-down images of the entire estuary.

Scientists also use tools such as underwater robots equipped with cameras to monitor species, including invasive organisms like the quagga mussel and the round goby. Quagga mussels are filter feeders and are especially problematic because they remove large amounts of nutrients from the water.

Because the Great Lakes are so vast, much of the equipment used by freshwater scientists is similar to oceanographic technology. These tools allow scientists to observe what is happening within aquatic systems and better understand how invasive species are impacting the environment.



## LEARNING PROCEDURE

*How do freshwater ecosystems function as connected systems, and how can scientific tools help us understand and protect them?*

Begin by activating students' prior knowledge about freshwater systems. Ask students what they think lives in rivers, lakes, or estuaries and how those living things might depend on each other. Chart student ideas to surface assumptions and gaps in understanding. Introduce the idea that freshwater ecosystems are complex systems where changes in one place can affect many others; including ecosystems on land.

Next, frame the lesson around how scientists study these systems. Explain that much of what happens underwater cannot be seen directly, so scientists rely on specialized tools to collect data. Let students brainstorm how they might study underwater environments if they could not easily see or touch them.

Conclude the introduction by previewing the role of invasive species. Emphasize that ecosystems are not static and that human action, intentional or unintentional, can change them. Prepare students to think critically about cause-and-effect relationships within ecosystems.



## VOCABULARY

**MIDGE FLIES:** Small insects that begin life as worms in mud or water. They are an important food source for many fish and help support healthy freshwater ecosystems.

**SONAR:** A technology that uses sound waves to “see” underwater. Scientists use sonar to find and study plants, animals, and the shape of the water bottom.

**ESTUARY:** A place where rivers meet a lake or ocean. Estuaries mix fresh water and larger bodies of water and are rich in food and wildlife.

**CONFLUENCE:** The point where two or more rivers come together and flow as one.

**HYDROMECHANICS:** The study of how water moves and how that movement affects living things, land, and structures.

**QUAGGA MUSSELS:** A small invasive mussel species that lives in freshwater. They filter nutrients out of the water and can harm native plants and animals.

**INVASIVE:** A species that is not native to an area and spreads quickly, often causing harm to the local environment.

**FILTER FEEDER:** An organism that gets its food by filtering tiny plants, animals, or nutrients out of the water as it moves through its body.

**OCEANOGRAPHIC:** Related to the study of large bodies of water, such as oceans or large lakes, using specialized scientific tools and equipment.

**TERRESTRIAL ECOLOGISTS:** Scientists who study land-based ecosystems, including plants, animals, soil, and how they interact with each other.



## Activity 1:

*(Discussion, worksheet, or experiment done as a class or within small groups)*

Students watch the video clip and identify examples of living and nonliving components in the freshwater ecosystem (e.g., insects, fish, birds, water temperature, nutrients). In small groups, students create a simple ecosystem web or flow diagram showing how these components are connected. Encourage students to include both aquatic and land-based organisms.

After mapping the ecosystem, guide students to connect scientific tools to what they observe in the video. Groups discuss how sonar and underwater robots help scientists gather information that cannot be seen from the surface. Facilitate a class discussion about why data collection is important for understanding ecosystem health.

Educator Note: Prompt students to explain why connections matter and how missing information could lead to misunderstandings about ecosystem health.

## Activity 2:

*(Independent or team project)*

In groups of 2-4, students will apply their understanding of freshwater ecosystems, scientific tools, and invasive species to design a realistic intervention that reduces the impact of an invasive species without disrupting the entire ecosystem. The emphasis is on problem-solving, trade-offs, and systems thinking, not “perfect” solutions.

Student groups will act as freshwater scientists or environmental designers to design an intervention that helps manage an invasive species in a freshwater ecosystem.

### Remind students that:

- The goal is not to eliminate the species completely.
- Every action in an ecosystem has intended and unintended effects.
- Solutions must be realistic, ethical and science-based.

Provide students with one class period for problem definition and brainstorming where they identify the invasive species they are addressing, where it lives and what problem it causes. Some potential guiding prompts may include: What is changing in the ecosystem because of this species? Who or what is most affected?

Students should spend an additional two class periods in the design and creation process. The following should be included within the proposal:

- Chosen invasive species characteristics and how it affects the ecosystem.
- One intervention strategy that could realistically be tried using current or near-future technology.
- Step-by-step description of how the intervention would work.

- How scientists would monitor its effectiveness.
- One positive outcome as well as one possible unintended consequence.

Students should be provided with a choice of how the product design will be communicated. Some possible examples include: labeled diagram or blueprint, physical model or one-page design brief with visuals.

To extend this activity into a fourth day, the educator may choose to add the option of an interactive gallery walk or short presentation.

Evaluation/Assessment points for consideration by the teacher and could be further developed into a rubric. Does the final product include the following: Understanding of ecosystem connections, realism of the intervention, quality of explanation and reasoning, consideration of trade-offs and clear communication.

## Conclusion:

Invite students to respond to one of the following prompts:

- How does studying freshwater ecosystems help scientists protect life on land and in water?
- What surprised you most about how ecosystems are connected?
- Why are invasive species difficult to manage once they are established?

As a closing, revisit the critical question: How do freshwater ecosystems function as connected systems, and how can scientific tools help us understand and protect them? Ask students to share one new insight they gained about freshwater ecosystems or scientific research tools.

### Related Links

- [University of Wisconsin School of Freshwater Sciences](#)
- [Society for Freshwater Science](#)
- [Frontiers in Freshwater Science](#)





## EDUCATIONAL STANDARDS

### 7th Grade

- CCSS.ELA-Literacy.RI.6.1** Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- CCSS.ELA-Literacy.RI.6.7** Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
- CCSS.ELA-Literacy.W.6.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- CCSS.ELA-Literacy.W.6.7** Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- CCSS.ELA-Literacy.W.6.8** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- CCSS.ELA-Literacy.W.6.10** Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- CCSS.ELA-Literacy.SL.6.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- CCSS.ELA-Literacy.SL.6.2** Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.
- CCSS.ELA-Literacy.SL.6.4** Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
- CCSS.ELA-Literacy.SL.6.5** Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

### 7th Grade

- CCSS.ELA-Literacy.RI.7.1** Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- CCSS.ELA-Literacy.W.7.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- CCSS.ELA-Literacy.W.7.7** Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- CCSS.ELA-Literacy.W.7.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- CCSS.ELA-Literacy.SL.7.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.



- CCSS.ELA-Literacy.SL.7.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
- CCSS.ELA-Literacy.SL.7.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

## 8th Grade

- CCSS.ELA-Literacy.RI.8.1** Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
- CCSS.ELA-Literacy.W.8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- CCSS.ELA-Literacy.W.8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- CCSS.ELA-Literacy.W.8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- CCSS.ELA-Literacy.SL.8.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- CCSS.ELA-Literacy.SL.8.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- CCSS.ELA-Literacy.SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

## 9-10th Grade

- CCSS.ELA-Literacy.RI.9-10.1** Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- CCSS.ELA-Literacy.W.9-10.2** Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
- CCSS.ELA-Literacy.W.9-10.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- CCSS.ELA-Literacy.W.9-10.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research



question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

**CCSS.ELA-Literacy.SL.9-10.1**

Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

**CCSS.ELA-Literacy.SL.9-10.4**

Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

**CCSS.ELA-Literacy.SL.9-10.5**

Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

## 11-12th Grade

**CCSS.ELA-Literacy.RI.11-12.1**

Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

**CCSS.ELA-Literacy.W.11-12.2**

Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

**CCSS.ELA-Literacy.W.11-12.7**

Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

**CCSS.ELA-Literacy.W.11-12.8**

Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

**CCSS.ELA-Literacy.SL.11-12.1**

Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

**CCSS.ELA-Literacy.SL.11-12.4**

Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

**CCSS.ELA-Literacy.SL.11-12.5**

Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.