Flexing Their Mussels

In this lesson, students will analyze an informational text examining scientists' studies of freshwater mussels in an attempt to develop methods for saving threatened species. Students will learn of the researchers' hope to be able to use other species that cohabitate local ecosystems to restore the threatened species. The lesson plan includes a note-taking guide, text-dependent questions, a writing prompt, answer keys, and a writing rubric. Numerous options to extend the lesson are also included.

General Information

**Subject(s):** Science, English Language Arts  
**Grade Level(s):** 9, 10  
**Intended Audience:** Educators

**Instructional Time:** 2 Hour(s)

**Resource supports reading in content area:** Yes

**Keywords:** innovative, environment, mussels, protecting, ecosystem, aquatic ecosystem, threatened species, genetics

**Instructional Component Type(s):** Lesson Plan, Worksheet, Text Resource, Formative Assessment, Learning Goal

**Resource Collection:** STEM Reading Resources

Attachment

*Article_EndangeredMussels.pdf*  
*ArticleWithParagraphNumbering_EndangeredMussels.pdf*  
*Final_Recommendation_Placement_FreshwaterMussels.pdf*  
*Qualitative_Rubric_EndangeredMussels.pdf*  
*Text-DependentQuestionsWithSampleKey_EndangeredMussels.docx*  
*NoteTakingGuide_EndangeredMussels.docx*  
*NoteTakingGuide_SampleKey_EndangeredMussels.docx*  
*Rubric_for_Writing_Prompt_EndangeredMussels.docx*

Lesson Content

**Lesson Plan Template:** General Lesson Plan

**Learning Objectives:** What should students know and be able to do as a result of this lesson?

- Explain the role that mussels play in aquatic ecosystems and why it is important to restore their populations.
- Explain how scientists are using innovative methods to help protect threatened species of freshwater mussels and assess the effectiveness of these methods.
- Cite specific and relevant text evidence to support analysis of the text.
- Use various vocabulary strategies to define academic and domain-specific words in the text.
- Determine the central ideas of the text.
- Construct a written response that clearly establishes a main point(s), contains relevant textual evidence to support the main point, utilizes transitions to maintain flow, effectively uses domain-specific vocabulary, and provides an appropriate conclusion.
**Prior Knowledge: What prior knowledge should students have for this lesson?**

In regards to science:
- General familiarity with freshwater ecosystems will enable students to more easily comprehend the article. Students should be familiar with the niche or role the mussel plays in an aquatic ecosystem. Please refer to resources linked in the teaching phase of this lesson that could be used for before instruction, if needed.
- Familiarity with the basics of population genetics will assist students in understanding the work detailed in the article. Students should understand the importance of genetic diversity within a set population and why it is important when studying threatened or endangered species. **This video** from Khan Academy provides background information on population genetics. The video's content presents an overview of population genetics and covers some of the ideas within the article, but is not specific to the article.
- There are a number of science-specific words that may be unfamiliar to students. Pre-teaching these words will help struggling readers especially.

In regards to literacy skills:
- Students should have prior experience utilizing various vocabulary strategies to determine the meaning of unknown words in a text. For this lesson, prior experience in using context clues to determine the meaning of words in a text would be beneficial. In addition, students should have some dictionary skills that will enable them to look up words with multiple meanings and determine the most appropriate meaning based on how a word is used in a text.
- Students should understand the term “central idea” and be able to distinguish central ideas from key details.
  - “Central idea” means the same thing as “main idea.” The central idea is the author's main point about the topic or topics in a text. The central ideas are the dominant, most important, or chief ideas that emerge from all the ideas presented in a text. Students should be aware that the author can have several main points he or she wants to make about the topic or topics in a piece of writing, and as a result, there can be multiple central ideas in a text, especially in longer more complex pieces.
  - Key, or in other words, important, details in a text help an author support and develop his or her central ideas.
- Students should be able to respond to a writing prompt in a clear, organized manner that includes use of an introduction to establish the main point(s), a body paragraph(s) that support the main point(s) and includes relevant and specific textual evidence, and a conclusion that supports the main point(s).
- Students should have some awareness that use of transition words or phrases can help a piece of writing flow smoothly from one point or idea to the next. Often students will remember to use transitions at the start of the body paragraphs or conclusion paragraph, but will forget to use them in the midst of paragraphs to connect ideas or to make the content within each paragraph flow. Teachers might wish to provide students with a sheet of transitions to help them. **This site** offers transitions that teachers might provide.

**Guiding Questions: What are the guiding questions for this lesson?**

Main investigation questions: While students are reading and answering questions about the article, please use the questions below to help guide students' thinking:

1. **What was the purpose of the USGS researchers' study and what is the importance of the results?**
   
The mussel population is rapidly declining and scientists from the United States Geological Survey (USGS) were looking at ways to combat these losses. The USGS researchers are working with resource managers to stop the decline. They found out in their study they could reverse population decline by reintroducing mussels into small populations with genetically similar mussels from the same river.

2. **What is a mussel and what role does it play in an aquatic ecosystem?**
   
   A mussel is a bivalve mollusk, similar to a clam, that can be found in both freshwater and saltwater ecosystems. Mussels serve many roles in their ecosystem. They filter water, provide habitat for many different organisms, and are an important part of the food chain. Because of their filtration system, they are an indicator of the quality of water within an area. Areas with a large mussel population tend to have good water quality. This is beneficial to fish, insects, and other organisms living in the area as well as humans that use these water systems.

   **Clarification/misconception:** Students might be familiar with or have heard of the zebra mussel. The zebra mussel is not a native species to North America, so when discussing the impact of mussels on ecosystems, they should be described as an invasive species. Zebra mussels have a detrimental impact on native mussels by out competing them for food and space.

3. **How can human activities negatively affect an aquatic ecosystem?**
   
   The organisms in aquatic ecosystems depend upon the resources found there for their survival. As with all ecosystems, aquatic ecosystems depend on being in balance, meaning all of the parts are interconnected. When humans interact with aquatic ecosystems, they can pollute or otherwise disrupt this balance by habitat alteration, building structures such as dams, and the introduction of invasive species. Mussel populations are affected by all of these human actions.

4. **What role did population genetics play in helping to combat the loss of mussel populations and why is this approach considered innovative?**
   
   Scientists discovered that within the same river system, mussel populations in different areas had similar genetic structure or makeup. They have genetic compatibility which allows the reintroduction of mussels into declining populations without affecting the current genetic makeup. This is important because this knowledge can be used as a new tool to protect rare or endangered populations from extinction. Mussels in general are not easily understood and are hard to study. This approach provides a vital step in the path to restoration.

   **Clarification/misconception:** The use of population genetics is important in the process of restoration and reintroduction of mussels into declining populations. However, because mussels have such a long life span, the use of genetics is not a good indicator of population decline.

**Teaching Phase: How will the teacher present the concept or skill to students?**

1. Begin the class by asking students to describe characteristics of a mussel. Some students might be familiar with mussels and say they are similar to clams, they have shells, you can eat them, they can live in freshwater or marine environments, etc.
2. Have students visit this page from the U.S. Fish and Wildlife Service site on mussels (or it can be projected to be used by the whole class at once). The USFWS site is a resource providing a thorough overview of general information about mussels including their importance to the ecosystem. Have students create a list of why mussels are important within an ecosystem.

3. Discuss, as a class, the benefits mussels provide to an ecosystem. Make a list by taking input from students. Upon reviewing the content on the site, student responses should include the following:
   - Filter water
   - Provide nutrients for other members of the ecosystem (vital part of the food web)
   - Used by human (food, buttons, etc.)
   - Monitor aquatic health

4. After discussing the benefits of mussels within an environment with the class, have students brainstorm the consequences of losing populations of mussels in freshwater ecosystems. Give the students about 5 minutes to come up with their own ideas. If they are having problems, this article from the National Science Foundation may be helpful.

5. Then, have students work with a shoulder partner to come up with a combined list. Be sure to circulate, providing assistance as needed. Some consequences students might generate include be:
   - Loss of biodiversity to the area
   - Loss of money in the area
   - Water systems that are more polluted
   - Extinction of mussel species

6. Explain to the students they will be reading an article that discusses a new way scientists are trying to save endangered freshwater mussels by studying the genetics of mussel populations.

   Teacher note: This link will allow access to the audio lecture from the USGS on "Stranger than Fiction: The Secret Lives of Freshwater Mussels." The lecture is from Heather Galbraith, the lead author from this article. It is approximately 50 minutes but it might be interesting to have the students listen to some of it.

Guided Practice: What activities or exercises will the students complete with teacher guidance?

1. Provide each student with a copy of the article "Genetics Provide New Hope for Endangered Freshwater Mussels."

2. Provide each student with a copy of the note-taking guide.

3. Direct students to fill out the note-taking guide as they read the text. This can be done individually, in pairs, or in a small group. The teacher should monitor students as they work and provide support and guidance as needed.
   - Note: Based on the needs and skills of the students, teachers can decrease the number of academic or domain-specific vocabulary students will define on the note-taking guide.

   For academic vocabulary, students will likely be able to use a variety of vocabulary strategies to define the meaning of the words. For domain-specific (in other words, subject-specific) vocabulary, students will typically need to draw on prior knowledge and use a dictionary to define the words.

4. If students struggle with determining the meaning of the selected academic vocabulary, teachers might use the following tips to help them:
   - Degradation (Paragraph 2): the act of lowering something to a lesser state.
   - Macroinvertebrates (Paragraph 2): small organisms without backbones that can be seen with the naked eye. Examples include crayfish, worms, aquatic insects, snails, and mussels. These clues help the reader infer the meaning. Students may need to be supported (through discussion, questioning techniques, etc.) in helping them understand that the populations of freshwater mussels need saving as their numbers have decreased (or degraded) and are no longer what they once were.
   - Imperiled (Paragraph 5): put at risk of being harmed, injured, or destroyed. Prior to paragraph 5, the author discusses the declining populations of some freshwater mussel species. This provides a clue to this word (in fact this is reinforced in the article's title). Also, in the same sentence as the word imperiled, the text describes the mussels’ “rapidly dwindling populations.”
   - Dwindling (Paragraph 5): diminishing in amount. In paragraph 1, the author mentions "Local population losses..." The term is used in the sentence, "Researchers found that despite drastic reductions in freshwater mussel populations..." The overall content of the article provides a clue. Also, in paragraph 5, the author explains that "More than 200 of the nearly 300 North American freshwater mussel species are imperiled." Students should recognize the far-reaching impact such a population loss can have on an ecosystem.
   - Tributaries (Paragraph 13): rivers or streams flowing into larger rivers or lakes. The context clues for this term can be difficult to pick out. The sentence in paragraph 13 notes that scientists studied mussels in four Great Lakes Tributaries. This shows that it is not the Great Lakes, but something else. Combining this with the fact that the article frequently refers to rivers provides the information necessary to infer the meaning.

Common errors/misconceptions to anticipate and how to respond: Please see the text-dependent questions sample answer key.
Independent Practice: What activities or exercises will students complete to reinforce the concepts and skills developed in the lesson?

Provide each student with a copy of the text-dependent questions to complete. Students should be reminded to continually refer back to the text and to use relevant and specific evidence from the text to support their answers.

Note: the text-dependent questions document includes both the student handout as well as a sample answer key for teachers to use to help provide redirection/feedback to students

Formative Assessment (How will teachers check for understanding?):

1. Teachers can check students’ understanding by collecting students’ answers to the text-dependent questions, checking their work, providing written feedback, and maybe grading the assignment. Or, teachers can have students share out their responses and the teacher can provide verbal corrective feedback, allowing students to make corrections to their work during the discussion.
2. Teachers can use the sample answer key to help them assess students’ answers.

Common errors/ misconceptions to anticipate and how to respond: Please see the text-dependent questions sample answer key.

Closure: How will the teacher assist students in organizing the knowledge gained in the lesson?

1. Before students complete the writing prompt, be sure to review responses to the text-dependent questions as a class, including covering the misconceptions and key points described in the sample answer key.
2. After students’ written responses have been graded and returned with feedback, teachers might wish to use the provided sample response with the class. Students who are struggling writers can benefit greatly from seeing a well-organized, detailed written response. Going over how the response is structured, pointing out ways to open and close the piece, showing use of effective transitions, and pointing out places to incorporate the natural use of vocabulary can really help students grow in their own writing skills for future writing tasks. The teacher could show the sample response on an overhead or with an LCD projector and discuss some of the following:
   - Have students examine how the topic is introduced in the opening sentences of the introductory paragraph. (Students often struggle with ideas in how to start a written response, and they often want to repeat the prompt back in the first sentence because they are not sure what other options they have. Go over how this writer opened his or her piece of writing. Brainstorm with students other ways the writer could have opened the piece.)
   - Point out how the author outlined the key points of the response throughout the introductory paragraph. Direct the students back to the prompt and show them how the author broke down the prompt into the areas that needed to be addressed.
   - Point out how the author responds to the prompt in a sequential manner. Paragraph 2 addresses the portion of the prompt that asks why mussels are important. Paragraph 3 addresses the portion about what the scientists discovered. Paragraph 4 addresses how the scientists will use this new information. Finally, Paragraph 5 summarizes the prompt while addressing how this demonstrates an innovative technique for protecting the environment.
   - Point out how the author uses quotes from the article to provide evidence to back up his explanation.
   - In the final paragraph, point out how the author used a summary of the prompt to answer the question of innovativeness. Brainstorm with students additional ideas about how to wrap up the piece.
   - As one final option, teachers might want students to use the rubric to provide a score for the sample written response and have them justify the score they gave, possibly providing revision suggestions for any categories they scored lower than a 4.

Science Closure:

Have students respond to the following questions using an exit ticket. Review the responses and follow up with a short discussion the next day.

1. What science concept do I understand better now?
2. What science concept do I still have questions about?
3. The most important idea from this article is...

Summative Assessment

1. Students will individually respond to the writing prompt. They should be directed to respond with a multi-paragraph response, with a clear introduction, body section, and conclusion. They can refer back to the text as they construct their response.
2. Before having the students respond to the prompt, go over the meaning of the word innovative. The standard that is being addressed states, "Assess the effectiveness of innovative methods of protecting the environment." Students will be addressing how the technique developed by scientists is innovative. One good definition of innovative is "featuring new or advanced methods."
3. Provide students with a copy of the rubric and go over the rubric with them so they will know how their written response will be assessed.
4. Go over the writing prompt with students and make sure students understand what the prompt is asking them to address. Encourage students to underline key parts of the prompt as the teacher goes over it so they will remember to answer all the required parts.
   - **The prompt:** Summarize the article, explaining why mussels are important, what the scientists discovered, and how they hope to use this information to help protect imperiled species of freshwater mussels. Finally, explain why the method scientists used in this research is innovative.
5. Teachers will use the rubric to assess students’ written responses.

Formative Assessment
Specific suggestions for conducting Formative Assessment can be found in the Guided Practice and Independent Practice phases of the lesson where it says, “How will you check for student understanding?”

Feedback to Students
Specific suggestions for providing Feedback to Students can be found in the Guided Practice and Independent Practice phases of the lesson where it says, “Common errors/misconceptions to anticipate and how to respond.”

Accommodations & Recommendations

Accommodations:
1. The US Fish and Wildlife Service and The Virginia Department of Game and Inland Fisheries provide detailed websites to explain what freshwater mussels are and why they are important. Having students look at these sites prior to reading the article would help them have some foundational knowledge that might make the article easier to understand.

2. For struggling readers:
   - On the note-taking guide, teachers might want to fill in some answers or identify specific paragraphs that students should focus on.
   - Teachers might want to modify the instruction for the vocabulary at the end of the student guide. Requiring all definitions to be exactly 4 words long might present problems for struggling readers because they need to grasp the meaning well enough to provide such a definition. Allowing these students to answer in more words (or fewer) might make it easier while still requiring students to demonstrate understanding.

3. For struggling writers, it might help struggling writers to provide them with an outline to help them structure their response. The outline might include places for
   - the introduction paragraph:
     - Ideas on how to introduce the topic
     - A few specifics from the text they might want to use to support or explain the topic
     - A place to write down their main point(s)
   - body paragraphs:
     - Topic sentence (the first sentence of each body paragraph that will reveal the point of the paragraph and will connect to the paper's overall main point)
     - Specific evidence from the text for support in each body paragraph
     - Ideas for transition words
     - Ideas for use of selected vocabulary
   - conclusion:
     - Ideas on how to wrap up their piece and connect back to the main point(s).

Extensions:
1. In paragraph 13, the author lists the six species of mussels that the scientists study. Students could be assigned one or more of these species to research. These students could create a poster, PowerPoint, or other product to tell about the species they researched and their current status in terms of population numbers. This could lead to a class discussion in endangered species, interconnectedness of ecosystems, invasive species, etc.

2. Students could use the information included in the article as well as the Internet to learn more about the changing nature of scientific knowledge. The article provides a good example of changing scientific knowledge. Students could be assigned to find additional examples where scientific research has led to changes in scientific knowledge. Students could explore different TED Talks to see how new science is being used to solve world problems. An example would be a new weapon found to fight cancer or improving and using fish farming to combat overfishing.

Suggested Technology: Computer for Presenter, Computers for Students, Internet Connection, LCD Projector, Overhead Projector

Further Recommendations:
This article could be used to address some of the Nature of Science standards. It could easily be used to address standards that deal with changing scientific knowledge and the scientific method.

For teachers who would like more support in understanding and implementing Reading Standards for Literacy in Science and Technical Subjects into their science curriculum, please see the teacher tutorials featured in the section of this lesson's CPALMS resource page labeled “Attached Resources.”

Additional Information/Instructions
### Aligned Standards

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<tr>
<th>Name</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>LAFS.910.RST.1.1:</strong></td>
<td>Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.</td>
</tr>
<tr>
<td><strong>LAFS.910.RST.1.2:</strong></td>
<td>Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.</td>
</tr>
<tr>
<td><strong>LAFS.910.RST.2.4:</strong></td>
<td>Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.</td>
</tr>
<tr>
<td><strong>LAFS.910.RST.4.10:</strong></td>
<td>By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.</td>
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<tr>
<td><strong>LAFS.910.WHST.1.2:</strong></td>
<td>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</td>
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<tr>
<td>a.</td>
<td>Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</td>
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<td>b.</td>
<td>Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.</td>
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<tr>
<td>c.</td>
<td>Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.</td>
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<td>d.</td>
<td>Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.</td>
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<td>e.</td>
<td>Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</td>
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<td>f.</td>
<td>Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</td>
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<tr>
<td><strong>LAFS.910.WHST.3.9:</strong></td>
<td>Draw evidence from informational texts to support analysis, reflection, and research.</td>
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<tr>
<td>SC.912.L.17.8:</td>
<td>Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.</td>
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<tr>
<td>SC.912.L.17.17:</td>
<td>Assess the effectiveness of innovative methods of protecting the environment.</td>
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### Related Resources

#### Tutorials

**Infectious Evidence:**
- Click "View Site" to open a full-screen version. This tutorial is designed to help secondary science teachers learn how to integrate literacy skills within their science curriculum. This tutorial focuses on using specific textual evidence to support students' responses as they analyze science texts. The focus on literacy across content areas is designed to help students independently build knowledge in different disciplines through reading and writing.

**Words in the Wild: Vocabulary Strategies:**
- Click "View Site" to open a full-screen version. This tutorial is designed to help secondary science teachers learn how to integrate literacy skills into their science curriculum. This tutorial will demonstrate a number of strategies teachers can impart to students to help them use context clues to determine the meaning of unfamiliar words within science texts. It will also help them teach students how to select the appropriate definition from reference materials. The focus on literacy across content areas is intended to help foster students' reading, writing, and thinking skills in multiple disciplines.

**Sparks Fly: Discovering Central Ideas:**
- Click "View Site" to open a full-screen version. This tutorial is designed to help secondary science teachers learn how to integrate literacy skills within their science curriculum. The focus on literacy across content areas is designed to help students independently build knowledge in different disciplines through reading and writing. This tutorial will demonstrate a series of steps that teachers can use with students to help them determine the central ideas of a science text. It will also demonstrate how students can trace a text's explanation or depiction of a complex process. Finally, it will explain what an effective summary contains.