Zebra Mussels vs. Quagga Mussels: A Case Study Investigation

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Grade/Subject: Grades 9-10, Biology

Lesson Overview:

Students will investigate aquatic invasive species, namely the zebra and quagga mussel, in order to understand their impact and consequences for the ecology, environment, maritime commerce and economics of the Great Lakes region. This lesson connects to my current curriculum by expanding my ecology unit and offering a case study approach to learning. My students now spend a number of days exploring current ecological issues, but invasive species are not explored in lengthy detail. This activity will allow students to read media articles to perform an in-depth exploration of both species of invasive mussel and critically analyze the similarities and differences between them. Students will explain the causes that brought these organisms to our region, the effects they are having, any possible future consequences of these invasions, and actions we can take to reduce or stop them. It is my hope that my students will gain an increased awareness of aquatic invasive species, their relevance to our region, and the consequences they are having on our ecology, commerce, and economics.

Sources Consulted:

Michigan Department of Education. *High School Science Content Expectations/ Biology.* <http://www.michigan.gov/documents/Biology_HCSE_168202_7.pdf>. Accessed 2011 July 26.

Whitefish Point Lighthouse and Great Lakes Shipwreck Museum K-8 Lessons and Activities. Edited by Joan Chadde, Western U.P. Center for Science, Mathematics and Environmental Education, Michigan Technological University, pg. 132-133. (used for vocabulary)

Articles for Student Use:

CBS Detroit—"Invasive Mussels Causing 'Massive Ecological Changes' In Great Lakes":http://detroit.cbslocal.com/2011/04/13/invasive-mussels-causing-massive-ecological-changes-in-great-lakes/

Milwaukee Journal Sentinel—"Prey fish dwindling in Lake Michigan Population halved as invasive mussels rule": http://www.jsonline.com/features/food/29465749.html

NOAA National Center for Research on Aquatic Invasive Species-- How many aquatic non-native(nonindigenous, exotic) species are there in the Great Lakes?: http://www.glerl.noaa.gov/pubs/brochures/invasive/AIS.pdf

Sea Grant Michigan, Upwellings—"Expansion of Quagga Mussels in Lake Michigan Adds to Food Web Uncertainties": http://www.miseagrant.umich.edu/upwellings/issues/06june/06june-article2.html

Wisconsin Department of Natural Resources—"Alien Profile: Zebra Mussel"
http://dnr.wi.gov/org/caer/ce/eek/critter/invert/zebramussel.htm

Wisconsin Department of Natural Resources—"Quagga Mussel"
http://dnr.wi.gov/org/caer/ce/eek/critter/invert/quaggamussel.htm

USGS Southeast Ecological Science Center—"Dreissena Species FAQs, A Closer Look"
http://fl.biology.usgs.gov/Nonindigenous_Species/Zebra_mussel_FAQs/Dreissena_FAQs/dreissena_faqs.html

USGS—Zebra Mussel and Quagga Mussel Information resource Page:
http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/

SeaGrant Michigan—"Quagga Mussels":
http://www.miseagrant.umich.edu/downloads/ais/fs_quagga_mussel.pdf

The BayView Compass—"Little quagga mussel has big impact on Lake Michigan":
http://bayviewcompass.com/archives/872 graphs

USGS Great Lakes Science Center—"Zebra Mussel":
http://www.glsc.usgs.gov/main.php?content=research_invasive_zebramussel&title=Invasive%20Invertebrates0&menu=research_invasive_invertebrates

Science Daily—"Zebra Mussels Hang On While Quagga Mussels Take Over":
http://www.sciencedaily.com/releases/2009/06/090612092733.htm

Science Daily—"Invasive Mussels Causing Massive Ecological Changes in Great Lake":
http://www.sciencedaily.com/releases/2011/04/110413171331.htm

Science Daily—"Lake Michigan Fish Populations Threatened By Decline Of Tiny Creature":
http://www.sciencedaily.com/releases/2009/02/090219081038.htm

Science Daily—"Lake Michigan Ecosystem May Crash: 'Doughnut' of Phytoplankton Disappearing": http://www.sciencedaily.com/releases/2010/09/100903210420.htm

Learning Objectives:

At the end of this lesson, students will be able to:

1. Explain how aquatic invasive species are introduced and spread throughout the Great Lakes.
2. Identify aquatic invasive species (i.e. zebra mussel and quagga mussel) and their effect on the environment, ecology, economics, and maritime industry/commerce.
3. Analyze methods for controlling invasive species, reducing their negative impacts and continued spread.
4. Describe the importance of natural resource use and how the regional and U.S. economy are dependent upon Great Lakes shipping.

Michigan High School Content Expectations for Science

B1.2 Scientific Reflection and Social Implications

B1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

B1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.

B1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.

B1.2f Critique solutions to problems, given criteria and scientific constraints.

B3.5 Populations

B3.5C Predict the consequences of an invading organism on the survival of other organisms.

B3.4 Changes in Ecosystems

B3.4C Examine the negative impact of human activities.

Materials Needed:

Copies of reference articles for students (see sources consulted)
Copies of student handouts

Seating arrangements for groups of four in the classroom area

New Vocabulary:

Inter-modal transportation: Moving cargo using more than one mode of transportation, such as truck, railway, ship, or plane.

Invasive species: Non-native species that are transported to a new area that typically have no natural predators (example: zebra mussels).

Maritime shipping: Transportation of cargo via waterways.

Port: A city or town with a harbor for loading/unloading ships.

Shipping: Transportation of cargo via water, road, rail or airplane using a freighter, train, truck, or plane.

Focus Questions

1. What is that cutting our feet at the bottom of the local lake? Is it alive?
2. What is an aquatic invasive species?
3. How do invasive species invade an area?
4. What other invasive species are threatening the Great Lakes?

Classroom Activities

Opener: Begin by asking students the focus questions—What is that cutting our feet at the bottom of the local lake? Is it alive? Have students "Think, Pair, Share" to answer these questions by thinking independently, discussing with a partner, then sharing ideas orally as a whole class. Utilize the other focus questions in the same manner.

Interpreting scientific text and organizing information: Students will read media articles about the zebra mussel and quagga mussel of their choosing from samples provided by the instructor. The various articles from the sources consulted section can be printed and copied, spread out through the lab area for students to use. Students should fill the Zebra Mussel vs. Quagga Mussel Venn Diagram as they read (see student handouts). For instance, have students read four articles of their choosing, allowing 5-6 minutes per article.

Analyzing information and summarizing: Students should be organized into groups of four to discuss what they learned from the articles and share ideas written on Venn diagrams. Ideas from each group can then be shared with the class. If time allows, have students choose two or three more articles to read at this point. Next, students will summarize information about invasive mussels on the case study flow chart into the following sections: causes, effects, and the future by again discussing with their small group (see student handouts). Ideas from each group can then be shared with the class.

Extending Ideas: Students should lastly use the Extending Ideas table (see student handouts) to explore the various ways that individuals involved in this issue can contribute in a positive manner. Each student should choose a stakeholder from the first four listed (each student chooses a different one) and explain what that individual could do to help with this serious problem. After answering independently (and perhaps going back to the media articles if needed), each student will share their ideas with their group. The process should be repeated for the last four stakeholders in the same manner. Moreover, a "Final Word" protocol could be used for this exercise—one student offers an opening statement on their stakeholder, other students each comment once in turn, then the original student shares any closing thoughts, or final words. This protocol could be used for each stakeholder. This ensures equal participation of all students. This protocol would require students being associated with this learning strategy prior to the lesson, or would require more time for explanation and questions.

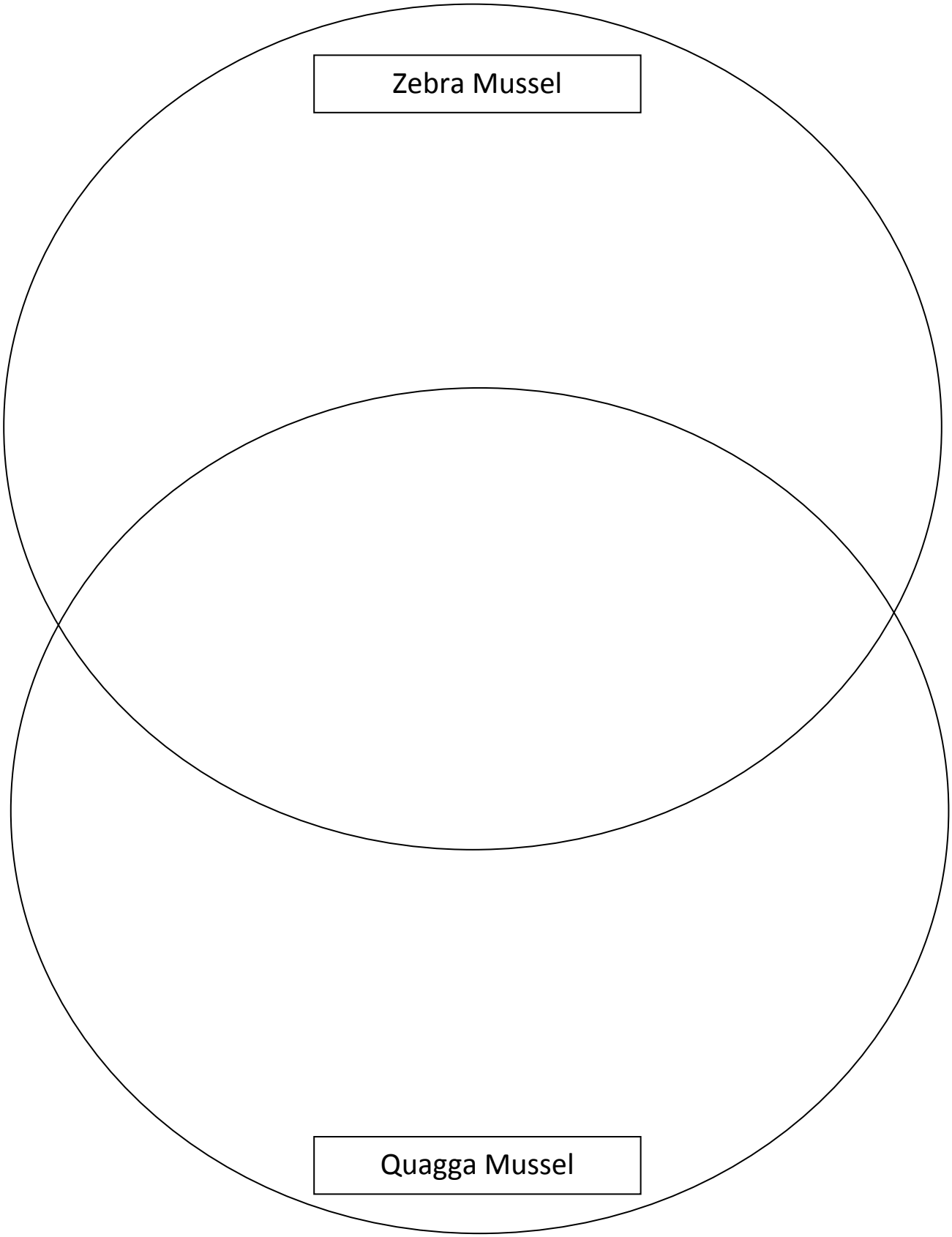
Assessment:

Formative Assessment: During the discussions and time devoted to analyzing and summarizing ideas, the instructor should be assessing the knowledge of students and their grasp of the concepts as the lesson activities progress. It is important to offer insight and feedback to students as they develop a working knowledge of the topics investigated. By mentoring students and pointing them in the right direction, they will gain confidence with the concepts and be ready to

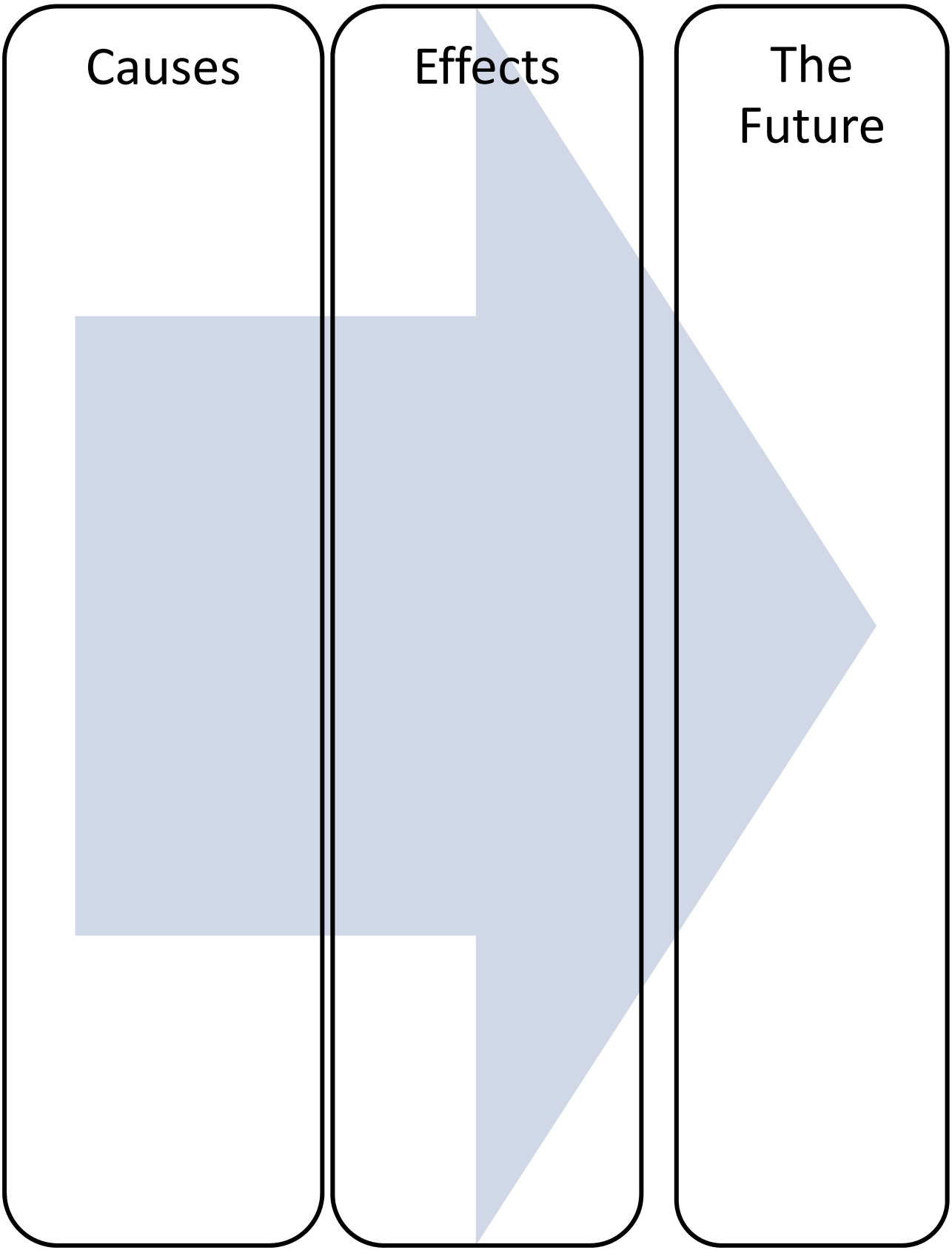
discuss their ideas with their peers. Accurate completion of the Venn diagram, flow chart, and stakeholders table can be assessed for graded points during the lesson activities.

Summative Assessment: During the final extending ideas discussion, students can be assessed on their knowledge of the zebra and quagga mussel and the various perspectives of the stakeholders. Each student should be expected to contribute to the discussion, and that can be recorded by the instructor for graded points. Following the lesson activities each student will write a 50 word summary (exactly 50 words, no more and no less) in which they will be expected to display their knowledge of the impact of the zebra and quagga mussel on the Great Lakes and what can be done in the future to reduce or stop invasive species. These will be assessed for completion and accuracy by the instructor.

Invasive Mussels in the Great Lakes—Zebra Mussels vs. Quagga Mussels



Invasive Mussels in the Great Lakes—A Case Study of the Zebra & Quagga Mussel



Invasive Mussels in the Great Lakes—Extending Ideas

So we have this problem, about a quadrillion invasive mussels in the Great Lakes, do we just give up? No! There are lots of things that can be done! How can you help? Read each of the following descriptions and based on your new knowledge of invasive mussels explain what each stakeholder could do to help with this serious problem. Each person in your group will choose one stakeholder from the first four as their role #1, and one stakeholder from the second four as their role #2. Make sure all eight stakeholders are covered; you will be sharing ideas as a small group to complete the table.

Sport Fisherman: You are a fisherman that enjoys nature. You take your boat out on the Great Lakes and also on your local lake. What can you do to help?	
Scientist: You are an aquatic biologist at a Michigan university who specializes in invasive species, namely invasive mussels. How can you use your expertise to help?	
Maritime Shipping Company: You own numerous vessels that ship raw materials between the Great Lakes and other countries around the globe. What can you do to help?	
Biology Teacher: You are a teacher at a Michigan high school and are interested in Great Lakes ecology issues and the environment. How can you educate your students about this?	
Government Regulator: You are a member of a task force that is writing new guidelines for maritime shipping and commerce in the Great Lakes. What are your recommendations?	
Citizen: You are a local Michigan citizen who is following the news about invasive mussels. You want to protect the environment, but are worried about your taxes going up. How can you help?	
Environmental Engineer: You are an engineer working on technology to reduce or stop the spread of invasive species in the Great Lakes. What are your ideas?	
Michigan DNR Officer: You are a Dept. of Natural Resources employee who inspects maritime shipping vessels to make sure they are following laws and regulations. What are your suggestions?	