



Native Vs Invasive Mussels: Similarities and Differences

Show Us Your Mussels Challenge

Grade: 6-12

Audience: Science, Language Arts

Activity Overview

In this activity, students will play an interactive game to understand the influence the environment has on mussel survival and how higher tolerances in some can give them an advantage. Students will then compare invasive and native mussels. They will apply what they learned in both activities in a creative way to spread information about preserving mussel biodiversity.

Objectives

1. Students will identify the needs of freshwater mussels and some factors that influence their survival.
2. Students will compare natural history strategies of invasive and native mussels and draw conclusions about success and competition.
3. Students will develop solutions to preserve the biodiversity of Minnesota mussel species.

Standard Connections

Minnesota 2019 State Science Standards

- 7L.2.1.1.1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem
- 7L.3.2.1.1 Construct an explanation based on evidence for how environmental and genetic factors influence the growth of organisms and/or populations.

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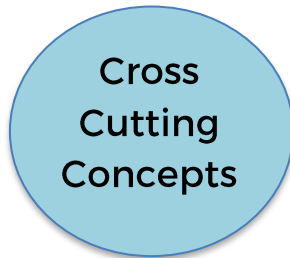
- 7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations
- 7L.4.1.2.2 Evaluate competing design solutions for maintaining biodiversity or ecosystem services.
- 9L.4.1.1.3 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species
- 9L.4.1.1.1 Evaluate evidence for the role of group behavior on an individual's and species' chances to survive and reproduce.

NGSS

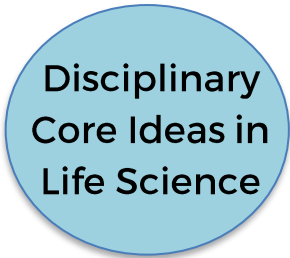
- MS-LS1-4. Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. *[Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]
- HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

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1. Cause and Effect
2. Structure and Function
3. Stability and Change



1. Native and freshwater mussel reproduction
2. Life cycle
3. Competition
4. Adaptation

Key Vocabulary

The vocabulary you use can be differentiated based on how much background knowledge your students have regarding mussels.

Beginner	Advanced
Mussel	Substrate
Invasive	Sensitive
Native	Tolerant
Pollution	Glochidia
Compete	
Host	

Time:

20-30 minutes for the game; time for research and creation is flexible as in class time or homework; presentation time depends on class size (three 45-minute sessions at most)

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Materials

- Card stock with fish hosts
- Card stock with substrates
- Computers or tablets with Internet access
- Art supplies such as posters, markers, etc. and/or student accessible design software such as Paint, Canva, etc.

Background

Native Freshwater Mussels

Mussels are an invertebrate animal belonging to the mollusc family (snails, clams, octopus, and squid). Like clams, the animal is encased in two shells but differs in the shape of the shells. It also has a muscular foot that extends from their shell and is used for horizontal movement or digging down into the riverbed. The mantle, a thin tissue lining the interior of the shells, has a unique role in their reproduction cycle. It is used as a lure to attract fish, essential to the freshwater mussel's life cycle.

Freshwater mussels reproduce sexually in a complex life cycle. Sperm is released into the water by the male and received by the female when she intakes water. Once fertilized the eggs develop into larvae, called glochidia. To finish developing the glochidia needs a specific fish host. The female mussel uses her mantle lure as an attractant to bring the fish host close enough for her to deposit her young. Once the glochidia attach to the gills of the fish host, they develop until they are large enough to drop to the riverbed and survive on their own. Mussels require a specific material for their substrate and cannot survive in areas that are frequently dry or are composed of solid rock. This creates concentrated areas of mussels in the river or lakebed called mussel beds. They are generally located in areas with a large variety of fish species where there is enough sand and gravel.

Some mussels can live 60-70 years. Their role is cleaning the water. They filter feed by taking in water, cycling it through their bodies holding onto small organisms and particles and absorbing toxins, before releasing the water back out to the environment. Because of their role, mussels are important indicators of a healthy environment and are needed for a balanced ecosystem. There are 51 species of freshwater mussels in Minnesota but 28 of them are threatened or endangered.

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Invasive Freshwater Mussels

Zebra mussels are a different type of freshwater mussel. They are an invasive species, native to Eurasia, that were likely brought to North America in the ballast water of ships¹. Many non-native species have been introduced to a new ecosystem or geographic area through human involvement. Non-native species disrupt the ecosystems they are moved to through competition, overpopulation, the spread of disease, or other traits that harm the natural nutrient cycling or population distribution of the area.

Unlike the native mussels, zebra mussels do not need a fish host to reproduce. They produce more offspring at a faster rate and are more tolerant of varying substrates and locations. This method makes the zebra mussels very prolific. It forms large colonies of individuals that encrust natural and artificial objects in the water. The primary concern with zebra mussels is they outcompete native mussels, causing a reduction in their population. They change the clarity of the water through over-efficient filtration which changes nutrient and sunlight levels and affects algae and animal concentrations. They can also grow directly on other mussels and kill them by preventing them from filter feeding.

Quagga mussels are a sister species with similar concerns and risks, that are even more temperature and depth tolerant. These differences in life strategy are a large part of why zebra and Quagga mussels are pushing out native species.

Lesson 8b is about the exact population dynamics and movement. This lesson is to establish the mechanisms these animals use.

Procedure

Introduction

1. If your students are not familiar with what a freshwater mussel is, you can facilitate a brief introduction.
 - a. This may include showing the students live mussels or mussel shells and asking students what they observe.
 - b. You may want to form a PowerPoint or lecture with information such as what's supplied in the background
2. The Philadelphia Water Works produced this simple video for their "The Mussel Hatchery" exhibit that explains a mussel life cycle and survival needs:
<https://www.youtube.com/watch?v=QahiUJ-JlF8>

¹ <https://www.invasivespeciesinfo.gov/subject/ballast-water>

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Game

The objective of this game is for students to explore the reproductive and life strategies of native freshwater mussels and how the environment impacts their survival. They will then compare that system with how invasive mussels function and start to consider the competition and success of these species based on differences in life strategy and reproduction.

1. Have students line up behind a row of cards with the following fish hosts face down (the number of each card will depend on the size of your group, there should be at least 1 card for every 3 students participating): carp, catfish, bass, crappie, walleye, bluegill, sunfish, and skipjack herring.
2. Inform the students that they represent the glochidia for a Mucket mussel. These mussels can use a variety of fish host species.
3. The students should walk out to the line of cards and step on one of the fish host cards. More than one student can be on the same card at once. Students should wait to turn the cards over until they are instructed.
4. After each student has their foot on a card, have them pick up their card to see which fish species they selected. Since Muckets can have a variety of fish hosts, all glochidia will survive.
5. After developing, students will then detach from their hosts and walk to the cards containing the following substrates face down (the number of cards will depend on the size of your group, there should be at least 1 card for every 3 students participating): gravel, sand and gravel, sand, mud, a sandbar that dries up, and shoreline landscaping rock. Students should wait until they are instructed to pick up their cards.
6. Have students turn over their cards and inform students with “sand bar that dries up” and “shoreline landscaping rock” that they did not survive. Mussels cannot survive in a place that is dry for long periods of time. The large landscaping rocks are used to prevent erosion along the lake and riverbeds. The crevices in the rocks are too large and erratic to allow for mussels to attach and feed.

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7. Repeat the procedure with some students acting as Elephant ear mussels instead. This time the glochidia will only survive if they find a skipjack herring host. Any remaining students should then proceed to select a substrate. The only juvenile mussels which survive are those on the sand, sand and gravel, and mud.
8. Highlight differences between the two species in both fish host specificity and substrate preference.
9. Now introduce some of the students as zebra mussel larvae. These do not require a fish host, so they can step into the water freely. They can also attach to most surfaces and resist drying for longer than most mussels.
10. At the end of each round, you may choose to remove one native mussel or one resource from the pool.
11. After a few rounds, it should become obvious the advantages that invasive mussels have. Discuss with students what they observed and have this be the basis for the Venn Diagram in the next activity.
 - a. It may be helpful to make a chart as a class of what students have learned about the lifestyles and reproduction of native and invasive mussels.

Venn Diagram

1. Have the students make a comparison diagram of invasive and native mussels. The information from the game and any previous learning will be a start. They should also be doing independent research. In their packets is a list of questions that will be answered by class activities or be supplemented by their research.
 - a. The Illinois-Indiana SeaGrant produced this video, [the Biology of Zebra Mussels](https://www.youtube.com/watch?v=XHI917OZeug) at <https://www.youtube.com/watch?v=XHI917OZeug>
2. Have students research invasive and freshwater mussels using either the links listed in resources or their own research skills.
 - a. They should use the questions on their worksheet for guidance.
 - b. You may also print off or have on a screen some of these articles to practice reading aloud and discussion/comprehension

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3. The students then compile their findings into chart or diagrams comparing invasive mussels to freshwater ones. A Venn diagram is recommended but a flowchart or other method can work. Encourage the use of multimedia.
4. In the form of pair sharing, class presentation, or short essay, have the students explain why they think the zebra and quagga mussels are more successful, based on the traits they researched.
5. Based on the differences between invasive and native mussels' life strategies and needs, students should brainstorm ways to encourage and preserve native mussels.
 - a. Depending on your goals, this can be a poster, a brochure, or even a poem.
 - b. It should demonstrate an understanding of what a mussel needs to survive and under what conditions they are outcompeted by Zebra mussels.
 - c. Additionally, at least 2 human actions that can be taken to maintain or provide an environment beneficial to native mussels.

Extension

- Have the students list the fish host species and substrate requirements for a specific assigned mussel species (list included at the end of the lesson)
- Have the students brainstorm 2 different human activities which could impede the life cycle of their chosen or assigned mussel.

Assessment

Students should be able to use observations from the group game as well as research to create a visual product displaying key characteristics that unite and differentiate native vs invasive mussels. They should apply this knowledge to assess why invasive mussels are successful, and what human action can be taken to preserve native mussels.

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Lesson Resources

Game Diagram:



Students

Fish
Cards

Substrate
Cards

Links

- Ask the DNR: the Difference Between Invasive and Native Mussels:
<https://www.grandforksherald.com/sports/ask-the-dnr-whats-the-difference-between-native-and-zebra-mussels#:~:text=Using%2osticky%2othreads%2C%20a%20zebra,surrounding%20ecosystem%20are%20quite%20different.>
- Science IQ: Why Zebra Mussels are Successful Invaders:
<https://www.scienceiq.com/facts/zebramusselsinvaders.cfm>
- Cary Institute, Changing Hudson Project: Zebra Mussel fact Sheet
https://www.caryinstitute.org/sites/default/files/public/downloads/curriculum-project/zebra_mussel_fact_sheet.pdf
- Zebra Mussels: A Guide to the Good and the Bad:
<https://www.greatlakesnow.org/2020/02/zebra-mussels-impact-good-bad/>

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- UC Riverside: Zebra and Quagga Mussels:
<https://www.greatlakesnow.org/2020/02/zebra-mussels-impact-good-bad/>
- NRCS: Native Freshwater Mussels:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_054084.pdf
- USGS: What Makes a Healthy Environment for Freshwater Mussels:
<https://pubs.usgs.gov/fs/2000/0124/report.pdf>

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List of Common Minnesota Freshwater mussels

The Minnesota Department of Natural Resources has information on common Minnesota Mussels. For the complete list, visit: <https://www.dnr.state.mn.us/rsg/> or the direct webpage for any of the mussels listed below.

<u>Common name</u>	<u>Scientific name</u>
Black Sandshell	<u>Ligumia recta</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV26020</u>	
Butterfly	<u>Ellipsaria lineolata</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV13010</u>	
Creek Heelsplitter	<u>Lasmigona compressa</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV22020</u>	
Ebonyshell	<u>Fusconaia ebena</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV17060</u>	
Elephant-ear	<u>Elliptio crassidens</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV14080</u>	



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<u>Common name</u>	<u>Scientific name</u>
Elktoe	<u><i>Alasmidonta marginata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV02040	
Ellipse	<u><i>Venustaconcha ellipsiformis</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIVA4010	
Fluted-shell	<u><i>Lasmigona costata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV22030	
Hickorynut	<u><i>Obovaria olivaria</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV31020	
Higgins Eye	<u><i>Lampsilis higginsii</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV21100	

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<u>Common name</u>	<u>Scientific name</u>
Monkeyface	<u><i>Quadrula metanevra</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV39080	
Mucket	<u><i>Actinonaias ligamentina</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV01020	
Pistolgrip	<u><i>Tritogonia verrucosa</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV44010	
Purple Wartyback	<u><i>Cyclonaias tuberculata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV09010	
Rock Pocketbook	<u><i>Arcidens confragosus</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV06010	

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<u>Common name</u>	<u>Scientific name</u>
Round Pigtoe	<u><i>Pleurobema sintoxia</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV35070	
Salamander Mussel	<u><i>Simpsonaias ambigua</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV41010	
Sheepnose	<u><i>Plethobasus cyphus</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV34030	
Snuffbox	<u><i>Epioblasma triquetra</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV16190	
Spectaclecase	<u><i>Cumberlandia monodonta</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV08010	

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<u>Common name</u>	<u>Scientific name</u>
Spike	<u><i>Elliptio dilatata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV14100	
Wartyback	<u><i>Quadrula nodulata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV39090	
Washboard	<u><i>Megaloniaias nervosa</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV29020	
Winged Mapleleaf	<u><i>Quadrula fragosa</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV39050	
Yellow Sandshell	<u><i>Lampsilis teres</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV21240	

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