What Matters with Missing Mussels?

Grade/Audience: 4-12

Activity Overview:
Students participate in a simulation where they play roles in the ecosystem to see how mussels take toxins (pink and yellow Starbursts) out of the water and make nutrients (red and orange Starbursts) readily available.

Objectives:
- Students will understand that mussels have an important role removing toxins from freshwater ecosystem.
- Students will understand nutrient cycles and mussels roles within them.

Standard Connection

State

5	4. Life Science	1. Structure and Function of Living Systems	1. Living things are diverse with many different characteristics that enable them to grow, reproduce and survive.	5.4.1.1.1	Describe how plant and animal structures and their functions provide an advantage for survival in a given natural system. For example: Compare the physical characteristics of plants or animals from widely different environments, such as desert verses tropical, and explore how each has adapted to its environment.
7	4. Life Science	2. Interdependence Among Living Systems	1. Natural systems include a variety of organisms that interact with one another in several ways.	7.4.2.1.1	Identify a variety of populations and communities in an ecosystem and describe the relationships among the populations and communities in a stable ecosystem.
9-	4. Life	2.	1. The	9.4.2.1.	Explain how ecosystems can

12	Science	Interdependence Among Living Systems	interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.	2	change as a result of the introduction of one of more new species. For example: the effect of migration, localized evolution, or disease organism.

NGSS

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Materials

- One large clean tray- representing river.
- Blindfolds-* optional
- Player cards- (Sheet A) (*name) River System with Mussels.
- (Sheet B)- (*name) river -system Without Mussels.
- Starbursts, or any other candy in a wrapper that has more than one color. Students will use the candy as either nutrients or toxins- they will not know the difference until time after activity.
- Watch or look at the pdf for the "Life History of Conservation Needs of Freshwater Mussel Webinar" presented by Xerces Scoiety for Invertebrate Conservation (December 1, 2011). Go to: http://www.forestrywebinars.net/webinars/life-history-and-conservation-needs-of-freshwater-mussels
- For ideas on which piece of the presentation most relates to this lesson, go to the "Lesson Resources" section and look at the slide ideas.

Procedure

(1) Tell students that they will be modeling two stream/river systems. Have one river on one side of the room (River A) and the other river on the other side of the

room (River B). You may choose to divide into smaller groups of 5-6 at the river sites depending upon the size of your class. A good group size is 5-6 individuals.

(2) Give each student at River A a card from Sheet A (see "Lesson Resources" section). Deal the other team cards cut up from sheet B (see "Lesson Resources" section). Sheet A has mussels, Sheet B does not.

(3) Describe the river that they are in (maybe local that the group may know). Set the scene.

(4) Go through the rules of the game:

- Timer will be set for 30 seconds, or as long as it takes to obtain three Starbursts.
- Rules for students with invertebrate and plant cards:
    - Have all students who drew invertebrate or plant cards raise their hands so they know who they are.
    - All invertebrates and plants must close their eyes or be blindfolded if possible.
    - Ask the students why they would close their eyes? (reasoning plants and invertebrates don't know if what they are eating is a nutrient or a toxicant.)
    - Invertebrates can only use one hand and plants can only use one hand. Mussels can use both their hands.
- Rules for students with mussel cards:
    - Mussels must have eyes closed when they pick up the Starburst but can open them when the wrapper is off. If the Starburst is pink or yellow, they may eat it **(bioremidiate)** if it is orange or red, they must put it back into the "Stream" **(bioturbate)**.
- Each species must keep track of how and what color of starburst they have eaten. They can only eat three total in the round.

(5) At the end of the game write on the board **Pink and Yellow is a toxin**. Explain that if you had 2 or more toxins you died. Also, write on the board **Red and Orange are Nutrients.** Explain that if you had two or more nutrients, you live. If you were unable to eat three Starbursts, you also die. Have students total how many individuals lived and died in their group and record it on their data table.

(6) Write/project on the board and have students record their data.

Streams With Mussels			Streams Without		
# of Invertebrates and Plants			# of Invertebrates and Plants		
Group Number	Before	After	Group Number	Before	After

Results when filled should look something like the following.

Streams With Mussels			Streams Without		
# of Invertebrates and Plants			# of Invertebrates and Plants		
Group Number	Before	After	Group Number	Before	After
1	6	4	1	6	3
2	6	4	2	6	3
3	6	5	3	6	4
4	6	6	4	6	5
5	6	5	5	6	2

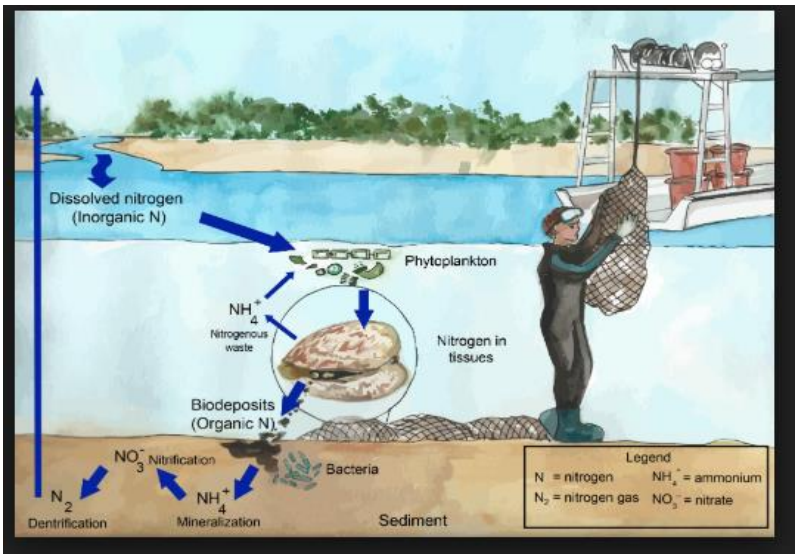
*Results- Should have more invertebrates and plants surviving in the streams with Mussels.

Assessment:

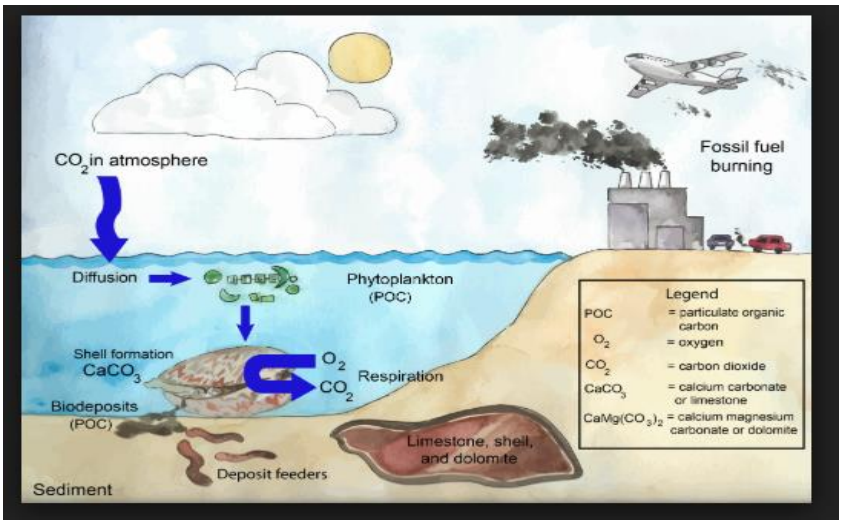
Have students review the concepts of Ecosystem Services (see suggestions for slides in the "Lesson Resources" section at the end of this document). Discuss as a group what happened in the activity and how it relates to the slides. Have students write a summary paragraph of the using the following vocabulary: Bioremediation, Biomonitoring, Bioturbation.

Extensions:

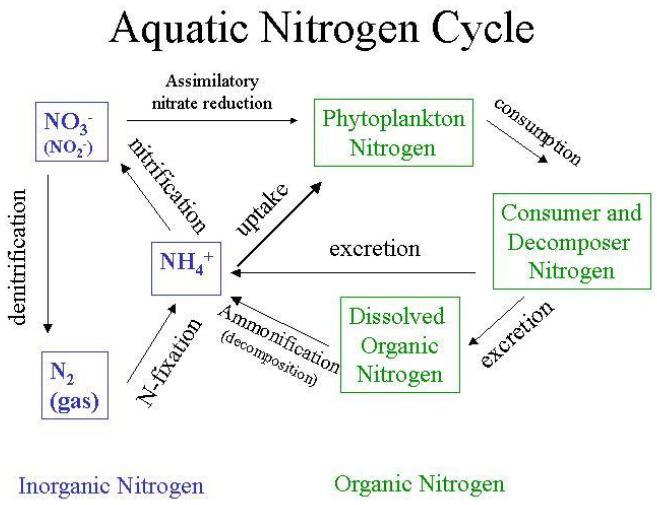
This lesson can be done as an introduction to the carbon and nitrogen cycles or can be extended to talk to about them in more depth. If it is an introduction, the next step is to say that one of the main nutrients produced is nitrogen. Nitrogen is an essential element that is only available through the air or by bacteria that can take it out of the air. In certain compounds, nitrogen can be toxic. Mussels take toxins containing nitrogen out of the water and then change the chemical structure releasing them as wastes that is less toxic and can be used to fertilize aquatic plants. (Citation: http://shellfish.ifas.ufl.edu/environmental-benefits/)



Further extension can be showing how mussels are part of the Carbon cycle (Citation: http://shellfish.ifas.ufl.edu/environmental-benefits/)



If students are already familiar with the Nitrogen cycle, show a diagram of the Nitrogen cycle like the one below. Mussels have been called a “hotbed of Denitrification”. Ask students why Denitrification is so important? What part of the activity represented Denitrification? Answers should include: helps complete the nitrogen cycle by turning Nitrates- NO3- back into Nitrogen gas which can then be fixed and used by plants in the ecosystem. The part of the activity is when they made nutrients available (the mussels took off the wrapper) for the plants and invertebrates.

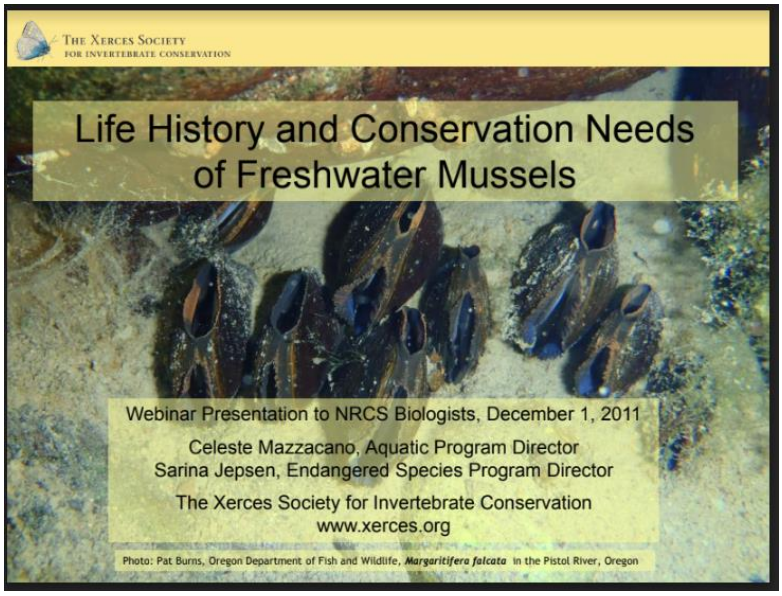


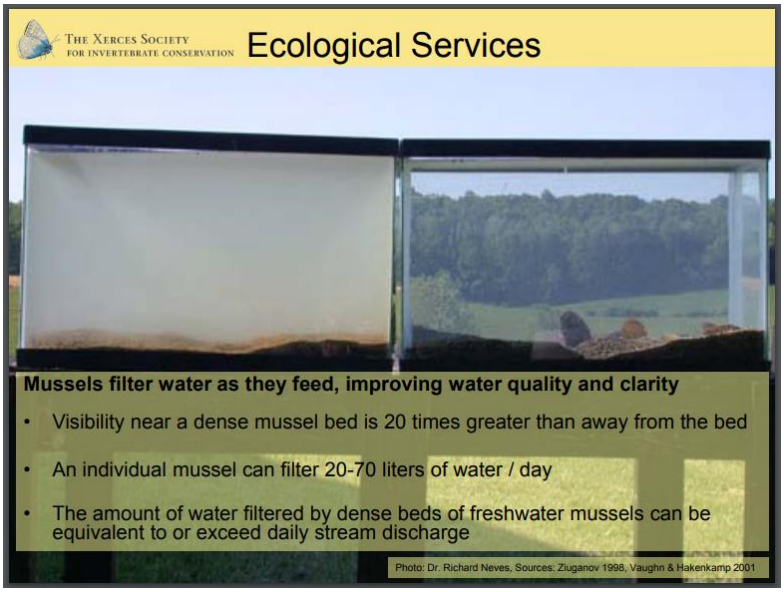
Another extension is to have students look up specific toxicants and fill out a 3x5 notecard to share with group on specific nutrients that mussels Bioturbation and specific toxicants they help Bioremediation.

Students research local stream and look for nutrient and toxin level and then make predictions about native mussel populations.

Lesson Resources

Slide Ideas





MINNESOTA ZOO

Ecological Services

The Xerces Society for Invertebrate Conservation

Freshwater mussels increase the abundance of benthic macroinvertebrates:

- Consuming suspended particles from the water column; transferring those nutrients to the sediment as 'pseudofaeces'
- Increasing substrate complexity

Filter feeding activity can decrease algal blooms

Photo: Sue Scott, Sources: Howard & Cuffey 2006, Vaughn, Nichols & Spooner 2008

Ecological Services

The Xerces Society for Invertebrate Conservation

Food source for:

- Muskrats
- Predatory fish
- Mammals
- Waterfowl
- Crayfish
- Turtles
- Frogs
- Aquatic salamanders

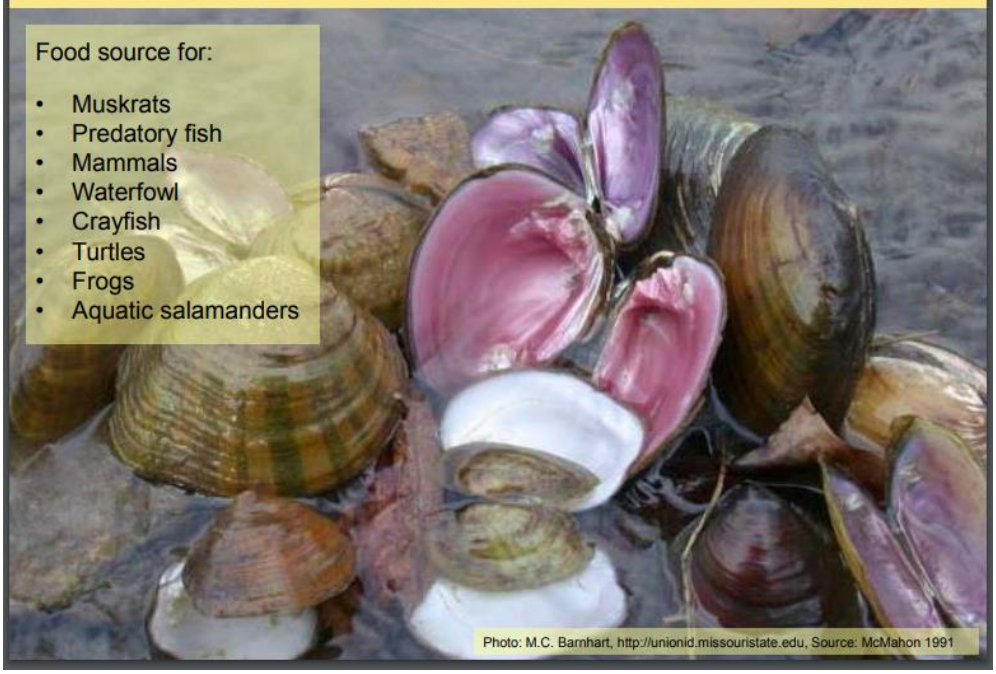


Photo: M.C. Barnhart, http://unionid.missouristate.edu, Source: McMahon 1991

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Simulation Resources

Form A

Mussels	Invertebrates	Plants
Mussels	Invertebrates	Plants

Mussels	Invertebrates	Plants
Mussels	Invertebrates	Plants

Mussels	Invertebrates	Plants
Mussels	Invertebrates	Plants

Mussels	Invertebrates	Plants
Mussels	Invertebrates	Plants

Mussels	Invertebrates	Plants
Mussels	Invertebrates	Plants

Form B

Invertebrates	Invertebrates	Plants
Plants	Invertebrates	Plants

Invertebrates	Invertebrates	Plants
Plants	Invertebrates	Plants

Invertebrates	Invertebrates	Plants
Plants	Invertebrates	Plants

Invertebrates	Invertebrates	Plants
Plants	Invertebrates	Plants

Invertebrates	Invertebrates	Plants
Plants	Invertebrates	Plants