

LESSON PLAN

What Matters to a Mussel?

Predicting Zebra Mussel Infestation Severity by Lake Characteristics

Essential Questions:

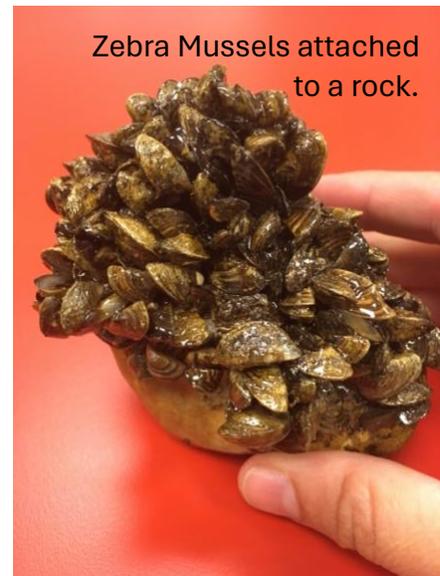
- How do abiotic factors affect infestation levels for aquatic invasive species?
- How do changes in environmental conditions impact the management of aquatic invasive species?

SWBAT:

- Analyze lake data to determine if a lake is likely to be suitable for large populations of aquatic invasive species.
- Describe how and why zebra mussels are a threat to Minnesota's lakes.

Applicable MN Science Standards (6-12)

- 6E.3.2.1.3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* (P: 6, CC: 2, CI: ESS3, ETS1)
- 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.** (P: 4, CC: 2, CI: LS2)
- 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. (P: 6, CC: 2, CI: LS1, ETS2)
- 7L.4.1.2.1 Construct an argument supported by empirical evidence that changes in physical or biological components of an ecosystem affect populations.* (P: 7, CC: 7, CI: LS2)
- 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. (P: 7, CC: 2, CI: LS4)



Background

The chemical and physical makeup of a lake determines the suitability of the lake to support zebra mussels. Like many organisms, there is a wide range of suitable conditions in which zebra mussels can survive. Optimal conditions are conditions in which there are no limiting variables that are controlling an organism's ability to grow and reproduce.

By examining lake characteristics, water resource managers can predict how severe an infestation of zebra mussels may be and make informed decisions about potential treatment options (if any) and be able to anticipate potential ecological and economic impacts to the lake.

Preparation

1. Define aquatic invasive species (AIS):
An aquatic plant, animal or other organism that is not native to a particular area and causes or has the potential to cause ecological or economic harm.
2. Discuss characteristics of AIS:
 - Fast growth
 - Aggressive & prolific reproduction
 - Tolerance of wide range of environmental conditions
 - Outcompetes native organisms
 - Negatively impacts ecosystem or humans (recreation, economy, etc.)
 - Plants: Provide unsuitable habitat for native species
3. Have students put together a presentation or report on zebra mussels including their introduction to the U.S./Minnesota, their distribution in the U.S./Minnesota, life cycle, ecological and/or economic harm they cause, and the AIS characteristics they exhibit.
4. Based on their research, have students hypothesize about the conditions (aside from introduction) that would cause increased zebra mussel populations.
5. Also have students hypothesize about why such information might be important to scientists.

Materials

- Lake datasets: RBPCWD lakes; Lake Okeechobee (Florida)
- Zebra Mussel Suitability Table
- Suitability Form

Activity

1. Provide students with raw data from multiple lakes. Ask them to determine the average for each variable for each lake. [Shortcut: Instead of raw data, provide variable averages to students.]
2. Provide Zebra Mussel Suitability Table and Lake Suitability Form to students. Ask students to determine if each variable for each lake is of low, moderate, or maximum suitability for zebra mussels.
3. Ask students to predict the overall suitability of the lake for zebra mussels based upon the suitability of each variable, keeping in mind that the top four variables are the most limiting.

Follow up questions

- How do you think the variables are related to zebra mussel survival, habitat, growth, and/or reproduction?
- Would you expect a large lake with multiple bays to have the same variables in each bay? How might that impact the level of zebra mussel infestation?
- In the raw dataset, do you see any trends for variables related to when data was collected?

Zebra Mussel Suitability Table

Like many organisms, there is a wide range of suitable conditions in which zebra mussels can survive. Optimal conditions are conditions in which there are no limiting variables that are controlling an organism's ability to grow and reproduce. The table below shows ten variables that can limit zebra mussel survival in a lake. By measuring these variables in a lake, you can determine if a variable is limiting (low suitability), suboptimal (moderate suitability), or optimal (maximum suitability) for zebra mussel growth and reproduction.

	Variable*	Suitability for Zebra Mussels**		
		Low	Moderate	Maximum
Shell formation	Calcium (mg/L)	8-15	15-30	30-80
	Alkalinity (mg/L)	30-55	55-100	100-280
	pH	7-7.8; 9-9.5	7.8-8.2; 8.8-9	8.2-8.8
Nutrient variables	Chlorophyll-a (µg/L)	2-2.5; 20-25	8-20	2.5-8
	Total Phosphorus (µg/L)	5-10; 35-50	10-25	25-35
	Secchi/clarity (m)	1-2; 6-8	4-6	2-4
Physical variables	Temperature (°C)	26-32	10-20	20-26
	Dissolved Oxygen (mg/L)	3-7	7-8	>8
	Conductivity (uS/cm)	0-60	60-110	>110
	Hard Structure (rocks, logs, etc.)	Low amount	Moderate amount	High amount

*The top four variables (highlighted in yellow) are the most limiting to zebra mussel growth and reproduction. If all four of these variables in a lake fall into the "low" suitability category, then the lake will overall be of low suitability regardless of the suitability of the other variables.

**If data for a variable is outside the ranges given for low, moderate, or maximum, then that variable is considered unsuitable for zebra mussels.

Lake Suitability Form

VARIABLES		<i>Indicate suitability (low/moderate/maximum) level for each lake variable.</i>		
		Lake 1	Lake 2	Lake 3
Shell formation	Calcium (mg/L)			
	Alkalinity (mg/L)			
	pH			
Nutrient variables	Chlorophyl-a (µg/L)			
	Total Phosphorus (µg/L)			
	Secchi/clarity (m)			
Physical variables	Temperature (°C)			
	Dissolved Oxygen (mg/L)			
	Conductivity (uS/cm)			
	Hard Structure1 (rocks, logs, etc.)			
<i>Count the number of times each suitability level was assigned to a lake variable.</i>				
Low				
Moderate				
Maximum				
<i>Decide what you think the overall suitability of the lake is based upon the above totals. Take into account that the top four variables are the most limiting for zebra mussel growth and reproduction.</i>				
Overall suitability of lake				