Native and Zebra Mussel Population Dynamics

Grade/Audience: 9-12

Activity Overview:

This activity uses generalized population density data of Zebra and native mussels collected from a fictionalized lake in central Minnesota. Students will graph population density of native and invasive mussels over a 12-year period. Stages of invasion will be identified and relate to changes in population. Students will reflect on the impact invasive Zebra Mussels have on a lake ecosystem.

Objectives:

- Students will be able to create graphs from native and invasive mussels for a fictitious lake in central Minnesota.
- Students will be able to identify the stages of invasion for invasive species from a population density-time graph and describe the community of mussels for each stage of the invasion.

Standard Connection

State

9.1.1.2.3 Identify the critical assumptions and logic used in a line of reasoning to judge the validity of a claim.

9.1.3.4.3 Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.

9.4.2.1.2 Explain how ecosystems can change as a result of the introduction of one of more new species. For example: The effect of migration, localized evolution, or disease organism.

9.4.2.1.1 Describe factors that affect the carrying capacity of an ecosystem and relate these to population growth.

9.4.4.1.2 Describe the social, economic and ecological risks and benefits of changing a

natural ecosystem as a result of human activity. For example: Changing the temperature or composition of water, air or soil; altering the populations and communities, developing artificial ecosystems; or changing the use of land or water.

9.4.4.2.4 Explain how environmental factors and personal decisions, such as water quality, air quality and smoking affect personal and community health.

9.3.4.1.2 Explain how human activity and natural processes are altering the hydrosphere, biosphere, lithosphere and atmosphere, including pollution, topography and climate. For example: Active volcanoes and the burning of fossil fuels contribute to the greenhouse effect.

NGSS

HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-6. Evaluate the 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.

AP Environmental Science

III. Population A. Population Biology Concepts
VII. Global Change C. Loss of Biodiversity

See lesson resources for source data and methods. Lesson should be modified to incorporate actual mussel population density data collected from the St. Croix river along with comparing and contrasting various sampling methods for an AP Environmental Science Course.

Materials

- Colored Pencils
- Zebra Mussels and Native mussels population dynamics student sheet
- Zebra Mussels and Native mussels population dynamics slide ideas (see Resources)

Prerequisite Knowledge

Students should be familiar with vocabulary of ecosystem, population, community and species common in most ecology units along with limiting factors and carrying capacity. This lesson fits after students have done a typical predator-prey lesson and have a good understanding of how a change in the population of one species can affect another species in an ecosystem.

Procedure

1. Introduce students to Weyberg Lake, a fictional lake located in central Minnesota. Have students read the problem section on the Zebra Mussels and Native mussels population dynamics student sheet.
2. Short class discussion reviewing the main points of Weyberg Lake of the problem. Emphasize the social, ecological, and economic impact that zebra mussels could potentially have on WeyBerg Lake.
3. Discuss the collection method for population density and discuss the difference between population and population density.
4. Instruct students to make a graph of the population density vs time for both the zebra mussels and the native mussels. They will also need to make a key and make the lines in 2 different colors. Model this for your students if they have limited experience making this type of graph. In lieu of graphing by hand, you can choose to have your students use online tools or apps to graph. Resources include Create a Graph, google sheets, or Online Chart Tool.
5. Instruct students to answer the questions after the graph, and then discuss the answers as a class.
6. Use direct instructions to describe the stages of invasion. notes for these stages found on the Zebra Mussels and Native mussels population dynamics Slides.
7. Ask students to use what they know about the stages of invasion to label the parts of the graph that Weyberg lake has experienced and record the dates of each stage on their student sheet along with the observed effects on the native mussel population data.
8. Review the answers to the stages with students.

Assessment

Successful completion of the Zebra Mussels and Native mussels population dynamics student sheet, particular attention to the conclusion section of the assignment and the graph.

Extension

Investigate native mussels species population dynamics with other factors that threaten the survival of native mussels. Information about other threats to native mussel populations can be found at the Minnesota Department of Natural Resources

Compare and contrast the invasion curve to the stages of invasion along with the social, ecological, and economical impacts of invasive species. Invasion curve animation Biosecurity Council of WA | Department of Agriculture and Food WA

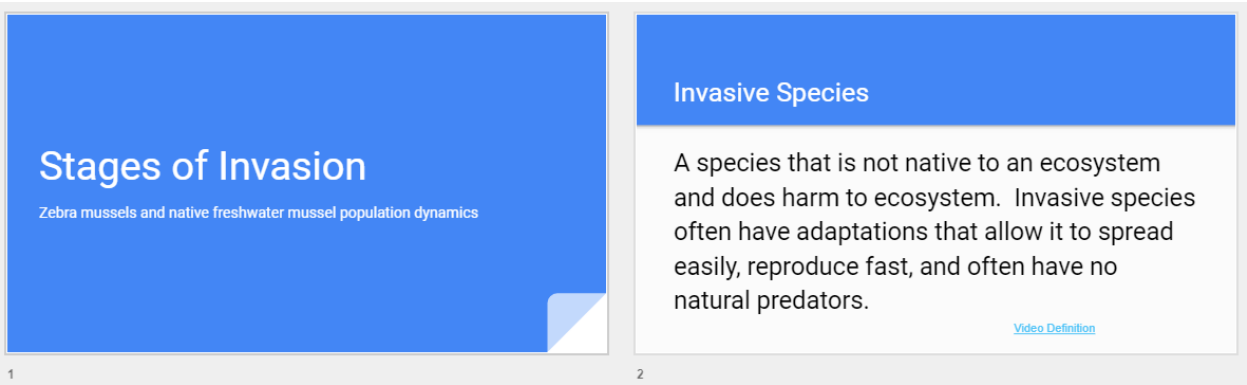
Look at the online mapping tool developed by the USGS to track spread of Zebra Mussels and have students make estimates about how the population spread across the United States. USGS Mussel Data Map

Lesson Resources

Web links

Quantitative Assessment of Zebra Mussels at Native Mussels Beds in the Lower St. Croix River - 2005.
Results of 2009 Monitoring of Freshwater Mussel Communities of the Saint Croix National Scenic Riverway, Minnesota and Wisconsin.
Invasion Ecology Definitions & Stages

Slide Ideas



MINNESOTA ZOO

Stage 1: Transport

- Moving a species from one location to other.
- Zebra mussels came to the US and Canada in the ballast water of ships from the Caspian Sea and into the great lakes.
- Weyberg Lake's Zebra Mussels were moved by humans from another lake or river most likely on a boat or fishing equipment.

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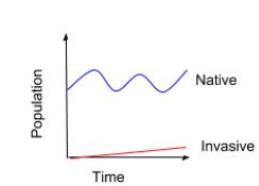
Stage 1: Transport

Native Population: Native population is not affected at this stage. Abiotic and biotic limiting factors in ecosystem keeps population in balance.

Invasive Population: Invasive species arrived in new ecosystem. Population is small and often not measurable by surveying techniques.



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Niche

Each organism in an ecosystem has a "job" to do in an ecosystem and can act as biotic limiting factors for other species in the community.

A **niche** is a job that a species does in the ecosystem.

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Stage 2: Establishment

Invasive species has adaptations to compete with native species. Begins to grow and reproduce in new ecosystem.

Two possible hypothesis for establishment:

- Invasive species takes over an available niche
- Invasive species outcompetes native species because it:
  - Can reproduce quickly
  - Has no natural predators
  - Spread easily

MANY NON NATIVE SPECIES DO NOT PASS THIS STAGE BECAUSE THEY DO NOT HAVE ADAPTATIONS TO SURVIVE IN ITS NON NATIVE ECOSYSTEM

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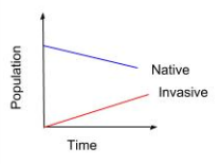
Stage 2: Establishment

Native Population: Native population starts to decrease as invasive species uses its resources.

Invasive Population: Invasive species population increases as it is able to find resources in the new ecosystem.



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Stage 3: Spread

Invasive species reproduces quickly and takes over the habit.

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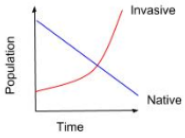
MNZOO.ORG/DIGITALMUSSELS

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Stage 3: Spread

Native Population: Native population decreases at a high rate as the invasive species outcompete the native for resources.

Invasive Population: Exponential growth of invasive species as it outcompetes native species for resources. Limiting factors in ecosystem do not limit the the population.



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Extirpation

When a species no longer exist in a specific location but still exist in other places.

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Stage 4: Impact

Invasive species has made a negative impact on the ecosystem changing it to a new ecosystem with the invasive species part of the community.

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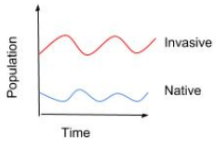
Stage 4: Impact

Native Population: Native population is either extirpated or reduced to very low numbers.

Invasive Population: Invasive species population has reached its carrying capacity for the new ecosystem. Limiting factors regulate the population.



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