



3. The zebra mussel, a mollusk native to Eurasia, was first discovered in the Great Lakes of North America in 1988. Zebra mussels attach to solid substrates and are filter feeders. Adult zebra mussels can survive for several days or even weeks out of water if the temperature and humidity are favorable. An adult female zebra mussel can produce as many as one million eggs per year. The recent range of occurrence of zebra mussels in the United States is indicated by shading in the map above.
- (a) Why are zebra mussels located primarily in areas in the eastern United States rather than in the western United States?
  - (b) How are zebra mussels introduced into isolated lakes? Describe one viable method for preventing the spread of zebra mussels into isolated lakes.
  - (c) Identify and explain one impact that zebra mussels can have on aquatic ecosystems.
  - (d) Identify another invasive species, either terrestrial or aquatic, and describe one negative impact it has had.
  - (e) One strategy for controlling an invasive species has been to introduce another nonnative species to control it; this strategy can often have unintended results. Give a specific example of the use of this strategy and discuss a negative impact of introducing a nonnative species to control an invasive species.
  - (f) Discuss TWO specific characteristics of invasive species that enable them to thrive in new environments.

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### Question 3

**(a) Why are zebra mussels located primarily in areas in the eastern United States rather than in the western United States?**

One point can be earned for any acceptable explanation:

- The animal was introduced in the eastern U.S. and is still spreading across the continent.
- The eastern states have more surface waters available for colonization and to act as corridors to dispersal; the western states have fewer such habitats.
- The western mountain ranges (e.g., the Rockies) serve as a natural barrier to dispersal.
- Humans spread the animal, and human population density is generally higher in the East.

**(b) How are zebra mussels introduced into isolated lakes? Describe one viable method for preventing the spread of zebra mussels into isolated lakes.**

Two points can be earned: 1 point for a mechanism by which the mussels are spread and 1 point for a method to prevent mussel introductions. The two responses need not be linked.

#### Mechanisms of zebra mussel introduction

- Transport of boats or boat trailers with mussels attached
- Carried in water in boats (excluding ballast, which implies oceangoing vessels)
- Inundation of isolated lakes with floodwater containing mussels
- Building canals or other waterways between previously isolated lakes
- Transport by animal vectors (migratory waterfowl, etc.)
- Brought with fish used to stock water bodies

#### Methods to prevent spread of zebra mussels

- Thorough inspection/cleaning of boats before transport or launch
- Flushing or draining of water between water bodies
- Refraining from building connecting waterways
- Education/information campaigns to discourage practices causing spread
- Prohibiting transport of boats to unaffected lakes

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**Question 3 (continued)**

**(c) Identify and explain one impact that zebra mussels can have on aquatic ecosystems.**

One point can be earned for naming an impact, and 1 point can be earned for an appropriate explanation. The identification and explanation must be linked.

<b>Impact on Ecosystem</b>	<b>Explanation</b>
Increased water clarity/transparency	Mussels are filter feeders, removing solids from water as they feed.
Increased light penetration in water column	Remove suspended matter from water.
Increased photosynthesis/primary productivity	Results from increased water clarity.
Increased populations of other species (certain fish, waterfowl, etc.)	Results either from greater primary productivity (base of trophic pyramid) or greater ability of fish that are visual feeders to see their prey.
Competition from zebra mussels for available resources	Decreased populations of other species (mollusks, insects, etc.).
Decreased populations of other species (mollusks, insects, etc.)	Competition from zebra mussels for available resources.
Altered water chemistry	Mussels change biogeochemistry through filtering and digestion of food; shells sequester/store minerals.
Disrupts food chains/trophic dynamics	Eats food required by other species.

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### Question 3 (continued)

- (d) **Identify another invasive species, either terrestrial or aquatic, and describe one negative impact it has had.**

One point can be earned for naming a species, and 1 additional point can be earned for an appropriate explanation of its impact. The identification and explanation must be linked.

Acceptable examples include:

Invasive Species	Negative Impact
Cane toad	Toxin kills native predators.
Rats	Eat bird's eggs; spread disease.
Purple loosestrife	Crowds out native plant species in wetlands.
(Eurasian) water milfoil	Crowds out native plants, clogs waterways.
Snakehead fish	Preys on native fish, reducing populations.
Rabbits	Clear vegetation.
Kudzu vine	Smothers other vegetation.
Emerald ash borer	Burrowing and feeding kill trees.
Sea lamprey	Predation harms other fish.
Nutria	Eats marsh vegetation, destroying wetlands.
(Brazilian) pepper tree	Tissues are toxic; shades out other plants.
Pythons, constrictors	Eat native species, lowering populations.
Japanese/Asian beetles	Eat native plant species.
Pigeon/rock dove	Nuisance in cities; vectors of disease.
(European) starlings	Compete with native birds for nest sites.
Feral domestic animals (e.g., boar, cat)	Predators of native species.
Ice plant	Competes with native plant species.
Africanized ("killer") bees	Attacks people/animals; displaces honeybees.
Boll weevil	Important crop pest.

Note: A correct response must identify a specific organism. General categories of biota (e.g., "snakes") are not acceptable.

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### Question 3 (continued)

- (e) **One strategy for controlling an invasive species has been to introduce another nonnative species to control it; this strategy can often have unintended results. Give a specific example of the use of this strategy and discuss a negative impact of introducing a nonnative species to control an invasive species.**

One point can be earned for identifying a specific example of biological control, and 1 additional point can be earned for an appropriate explanation of a potential negative impact. The two responses need not be linked.

Acceptable examples include:

Biological Control
<ul style="list-style-type: none"><li>• Insects (stem borers, leaf eaters) to feed on purple loosestrife</li><li>• Ladybird beetles (ladybugs) to feed on pest insects</li><li>• Parasitoid wasps to control weevils</li><li>• Bacteria (e.g., Bt) or viruses to control animal pests</li><li>• Mongoose to hunt rats</li><li>• Cane toads to prey on insect pests</li></ul>
Negative Impact
<ul style="list-style-type: none"><li>• Predation of nontarget species</li><li>• Competition with native species</li><li>• Toxic to native predators, or reduces available food to native predators</li><li>• Alters ecological interactions, e.g., food webs or biogeochemical cycles</li></ul>

Note: The “specific example” cannot be hypothetical or a general prescription, e.g., “introduce a predator of agricultural pests.”

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### Question 3 (continued)

**(f) Discuss TWO specific characteristics of invasive species that enable them to thrive in new environments.**

Two points can be awarded: 1 point for each specific characteristic.

- Generalist species
- Excellent dispersal mechanisms, allowing it to spread
- R-selected or r-strategist

**OR** any of the following characteristics:

- Large clutch size/many offspring produced
- Early onset of reproduction/early maturation
- Frequent reproduction
- Superior defenses against predators in new environment
- Superior skills as a predator in new environment

Note: Listed characteristics must be specific. Generic qualities or life-history strategies are not acceptable.