The Good, the Bad, and the Ugly:

Aquatic Invasive Species of the Mid-Atlantic

Education Guide

December 2015

Mid-Atlantic Panel AIS on Aquatic Invasive Species

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Introduction to the Project

Each year, billions of dollars and millions of hours are spent dealing with invasive species around the globe. **Invasive species**, by definition, are non-native species that cause economic, environmental, and/or human health related harm. Invasive species can be plants, animals, and/or pathogens like West Nile Virus. These species typically grow and reproduce rapidly and often lack predators and pathogens in their introduced environments, allowing their populations to explode. Historic invasive species like Chestnut Blight and Smallpox have shaped our landscapes today while others have just begun to impact our environment.

Invasive species management can be costly and time consuming. However, proper education on invasive species can prevent invasions from occurring in the first place. Strong education and outreach efforts can increase public awareness while also promoting prevention.

Due to the need for comprehensive invasive species education, this toolkit was developed to tell the story of invasive species in the eastern United States through 5 distinct units:

1. History of Invasive Species
2. Introduction and Spread of Invasive Species
3. Impacts to Natural Areas
4. Impacts to Students' Lives
5. Student and Community Action

The goal of this project is to raise awareness about invasive species and to turn that awareness into action to prevent and to manage current and future invasions.

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Impacts to Student's Lives

An invasive species is a non-native species that threatens the economy, the environment, and/or human health. Although these threats may not have a direct effect on the students themselves, they certainly could have an impact on others around them. For example, some invasive species have such a devastating impact on ecosystems that people can no longer enjoy them for recreation or use them for commercial use. Any impact on tourism or commercial use of natural systems also impacts the economy. To understand how students are impacted by invasive species, the following module delves into lessons featuring the Green Crab, Hydrilla, Rock Snot, West Nile Virus, and Zebra Mussels.

Green Crabs are tiny terrors for some commercial fisheries, particularly for some species of clams. These predators quickly consume clams, other mollusks, and even juvenile fish, causing serious issues in the future.

Hydrilla is a classic invasive plant species: it grows rapidly (up to an inch a day), grows very large (one stem can be 25 feet long), can tolerate a wide range of temperatures, can withstand low light conditions, and reproduces easily. It can grow so dense that it forms a continuous mat of vegetation across the surface of the water that makes boating, water skiing, fishing, and swimming difficult.

Rock Snot, also known as Boulder Boogers, can quickly cover stream bottoms with a thick, wooly mat of material. These mats impact aquatic food webs and make some coldwater streams unsightly for recreation. Similarly, Zebra Mussels can cover hard surfaces including boats and docks, making water recreation difficult. Their razor-sharp shells can also be harmful to beachgoers.

West Nile Virus is a mosquito-borne virus that can cause severe neurological symptoms in infected people. Others will develop a fever with symptoms such as headache, body aches, joint pains, vomiting, diarrhea, or rash.

Zebra Mussels by the Government of Alberta

To convey the concept of how these invasive species impact students' lives, the lessons in this section include:

- **Crab Controversy -- Grades 3-5; pg**
  - *Students will actively simulate how invasive Green Crabs impact soft-shell clam fisheries.*
- **Green Crab Round Robin -- Grades 9-12; pg**
  - *Students will learn about the issues with Green Crab invasion and will represent different stakeholders in the Chesapeake Bay to understand how Green Crabs threaten their livelihoods.*
- **Hydrilla-The Traveling Plant -- Grades 3-12; pg**
  - *Students will actively simulate how Hydrilla is spread while learning about its impacts to the environment and students' lives.*
- **Spreading of Rock Snot -- Grades 6-8; pg**
  - *Students will simulate the spread of Didymo and will learn about ways to prevent the spread.*
- **West Nile Virus, Mosquitoes, and You -- Grades 9-12; pg**
  - *Students will learn about Asian Tiger Mosquitoes and West Nile Virus as well as actively trap and identify mosquitoes to assess potential threats in their communities.*
- **Zebra Mussels Invade the Chesapeake Bay -- Grades 6-8; pg**
  - *Students will map the invasion of Zebra Mussels in the Chesapeake Bay and will create a mock news segment discussing the invasion and its impacts on different people.*

Hydrilla wrapped around a boat motor by Michigan Sea Grant

Crab Controversy Gr: 3-5

Objectives: At the conclusion of the lesson, students will be able to:

- Explain what an invasive species is
- Describe the effects of the European Green Crab on native clam populations with and without the presence of native Blue Crabs
- Discuss the possible effects of the European Green Crab on the Mid-Atlantic Region

Standards:

NGSS	**3-LS4-3 -** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all **5-ESS3-1 -** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
Core Idea	**3.LS4.C: Adaptation -** For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. **3.LS2.C: Ecosystem Dynamics, Functioning, and Resilience -** When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.(secondary) **3.LS4.D: Biodiversity and Humans -** Populations live in a variety of habitats, and change in those habitats affects the organisms living there. **5.ESS3.C: Human Impacts on Earth Systems -** Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.
Practices	• Planning and Carrying Out Investigations • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information
Cross-Cutting Theme	• Cause and Effect • Systems and System Models • Interdependence of Engineering, Technology, and Science on Society and the Natural World • Systems and System Models • Science Addresses Questions about the Natural and Material World
Reading, Writing & Social Studies	**CCSS.ELA-Literacy.RI.3.7 -** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). **CCSS.ELA-Literacy.RI.4.7** - Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

	CCSS.ELA-Literacy.W.3.1 - 5.1 - Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
Environmental Literacy	**1.A.1:** Identify an environmental issue. **4.B.1.:** Analyze the growth or decline of a population and identify a variety of responsible factors **4.C.1.:** Explain how the interrelationships and interdependences of organisms and populations contribute to the dynamics of communities and ecosystems **4.D.1**.: Use models and provide examples to show how the interaction and interdependence of populations contribute to the stability of populations, communities, and ecosystems **5.A.1**.:Analyze the effects of human activities on earth's natural processes

Crab Controversy Gr: 3-5

Objectives: At the conclusion of the lesson, students will be able to:

- Explain what an invasive species is
- Describe the effects of the European Green Crab on native clam populations with and without the presence of native Blue Crabs
- Discuss the possible effects of the European Green Crab on the Mid-Atlantic Region

Materials:

- 3 containers with labels
- Blue and white tokens or poker chips (in kit)
- Pictures of Green Crabs (on CD)
- Picture of graph from research article "Investigations of the range of expansion of an invasive species: the European green crab, *Carcinus maenas*" by Paul Jivoff, Greg Ruiz, Tuck Hines, and Catherine DeRivera (on CD)
- Student record sheet (on CD)

Teacher Background: European Green Crabs (*Carcinus maenus*) are small crabs, measuring 2-3 inches in width. They are not always green but may be green, brown, gray, or red, depending on the environment and the crab's molt cycle. Green Crabs also have yellow patches on their abdomen. Like most invasive species, Green Crabs are extremely adaptable. They can tolerate temperatures ranging from 30-85° F (5-30° C) and salinities ranging from 5-30 ppt. Females can produce 200,000 eggs each year. They prey on many commercially valuable native species - scallops, hard and soft clams, oysters, mussels, other crustaceans, and juvenile fish. Adult crabs tend to occupy protected rocky shores or jetties and forage in tidal marshes and sandflats.

The Green Crab's native range includes the Atlantic coasts of Europe and North Africa, but they have been introduced to South Africa, South America, Australia, New Zealand, and both the Atlantic and Pacific coasts of the United States. They were first seen in the United States in the early 1800s and may have arrived in ballast water or by clinging to the hulls of wooden ships. They have now spread as far north as Nova Scotia and as far south as the mouth of Chesapeake Bay and the Delmarva Coastal Bays.

Even though they are present in the Coastal Bays, Green Crabs are not established in the Chesapeake Bay. Scientists believe that this is because they cannot compete with the much larger native Blue Crab (*Callinectes sapidus*). Studies have shown that the Green Crab is seldom found in areas where Blue Crabs are abundant because Blue Crabs readily feed on Green Crabs. This may account for the fact that Green Crabs are not found any farther south than the mouth of the Chesapeake. In Maryland, live Green Crabs are sold in bait stores along the Atlantic coast to be used for tautog fishing.

In this activity, students will actively simulate how invasive Green Crabs impact soft-shell clam fisheries.

Procedure:

Engage

1. Have students brainstorm a list of all the species found in coastal areas of the Atlantic that they think are economically important or caught and sold for money. (*Oysters, soft-shell clams, blue crabs, horseshoe crabs, snapping turtles and various finfish including striped bass, menhaden, flounder, shad, American eel, catfish, bluefish and others*). Explain to students that these species and similar ones are important to communities along the Atlantic Coast both environmentally and economically.
2. Ask students to define the term **invasive species** using the word invasive as a key clue. Ask them by what methods might an invasive species "take over" (*killing off native species, out competing native species for resources such as food and habitat, and/or spreading non-native diseases*).
3. Introduce the European Green Crab by showing a picture and brainstorming a list of possible food sources. Ask students what might eat a Green Crab – Fish? Birds? Other crabs? Humans? Explain that Green Crabs are causing a great deal of trouble for communities on both the Atlantic and Pacific coasts because they are fierce predators and voracious eaters. They have specifically caused a major reduction in soft-shell clam populations in Northern Atlantic communities, and scientists are studying their potential impacts on the Mid-Atlantic region. However, it is believed that areas with high Blue Crab populations may be less susceptible to Green Crab infestation.
4. For older students, show them the attached graph depicting Blue Crabs, Green Crabs, and Spider Crabs. What trends do they notice?

Explore

This simulation can be varied depending on the size of the group and the amount of time allotted. For larger groups (20-30) or short time frames, the simulation of each region can be run simultaneously with students split into 3 groups. For smaller groups or longer time frames, regional simulations can be run sequentially with the students kept in one group.

1. Label 3 containers with the following names: **Cape Cod**, **Long Island**, and **Chesapeake Bay**. These containers represent the 3 aquatic habitats that have low, medium, and high numbers of blue crabs.
2. Place in each container a certain number of white and blue tokens, white tokens represent the area's Clam population and blue tokens represent the area's Blue Crab population. Note: A starting number of **40 chips** is suggested with the following proportions of blue chips: **Low –** *5 chips* (4:1 white : blue), **Medium –** *10 chips* (2:1), and **High –** *20 chips* (1:1). An example can be found below.

   a. **Cape Cod** (Low)= 35 white and 5 blue
   b. **Long Island** (Medium)= 30 white and 10 blue
   c. **Chesapeake Bay** (High)= 20 white and 20 blue
3. Tell the students that they each represent an invasive Green Crab and will be attempting to eat one of their favorite foods, the soft-shell clam, which is a commercially important species to the Atlantic Coast.
4. If students are kept in one group, then the teacher will lead them through the population simulations for each region. If the group is large, then split the students into 3 equal groups (about 10 in each) and assign groups to carry on the simulation for 1 region. Share the data with the rest of the class.
5. Students will take turns drawing 1 token **at random** from the container until 10 tokens have been taken in the first round. If the student selects a white (clam) token, then they will eat the clam and survive to the next round. If the student selects a blue (crab) token, they will be eaten by the Blue Crab and will not survive to the next round.
6. At the end of round 1, determine the number of clams left in the container and the number of Green Crabs that have been eaten (= the number of blue tokens selected).
7. Replace the white tokens at a rate of 1 new chip for every 2 left at the end of the round (ex. If 10 white chips are left in the container, then add 5 new ones making a total of 15). Round down in the case of odd numbers (ex. 9 white chips left, add 4 new ones). The number of Green Crabs should also increase at a rate of 1 for every 2 surviving crabs.
8. To keep the simulation accurate, keep the proportion of blue chips to white chips the same throughout (ex. If there are 16 white chips in the Cape Cod container [low Blue Crab population] there should be 4 blue chips). If the number of clams increases, then increase the number of Blue Crabs as well.
9. Repeat this process allowing the surviving and newly added Green Crabs (students) to select tokens until the number of Clams reaches zero or the number of Green Crabs reaches zero. In the case of increasing Green Crabs, some students may need to select a second token during the round.
10. Keep a record on the 'Student Record Sheet' of the number of Clams, Green Crabs, and Blue Crabs each round. Use this information to determine the effect of the presence of Blue Crabs on the invasive crab population (ex. Graph the trend)

* You should see an increase in the number of Clams (white chips) in the Chesapeake Bay container. If you do not have enough white and blue chips to restock for each round simply reset the number to 20 each time but continue to keep track of what the actual totals should be.

* Note: *It is possible that the Long Island container will level off and neither Clams nor Green Crabs will reach zero. If this occurs, end the simulation at your discretion*.

Explain

1. At the end of the simulation, ask students what they noticed. Students should use the collected data to graph the trends of the populations.
2. What happened to the Clam population and Green Crab population in each of the 3 regions?
3. What effect did the Blue Crabs have on the Green Crab population?
4. Poll students to see which ones eat shellfish like clams and mussels that may be impacted by crabs. How would they feel if that seafood disappeared?
5. Ask students what impacts the loss of these species may have on other natural resources.

Evaluate

1. Discuss the impacts of invasive species on the areas they inhabit both ecologically and economically. What does the introduction of the European Green Crab mean for the Mid-Atlantic region? Should we be concerned about the Green Crab in your state?
2. Have students write a short opinion piece about what steps, if any, should be taken to control the Green Crab.
3. What does this simulation tell us about the food web and how different species are connected?

Extend

1. Have students research possible methods of controlling Green Crab populations using examples from other communities – see articles: **Fighting European Green Crabs in Seadrift Lagoon** and **Green Crabs as Lobster Bait Working in Nova Scotia.**
    a. **Fighting Green Crabs in Seadrift Lagoon** - http://www.serc.si.edu/labs/marine_invasions/feature_story/December_2011.aspx
    b. **Green Crabs as Lobster Bait** - http://www.workingwaterfront.com/articles/Green-crabs-as-lobster-bait-working-in-Nova-Scotia/15829/

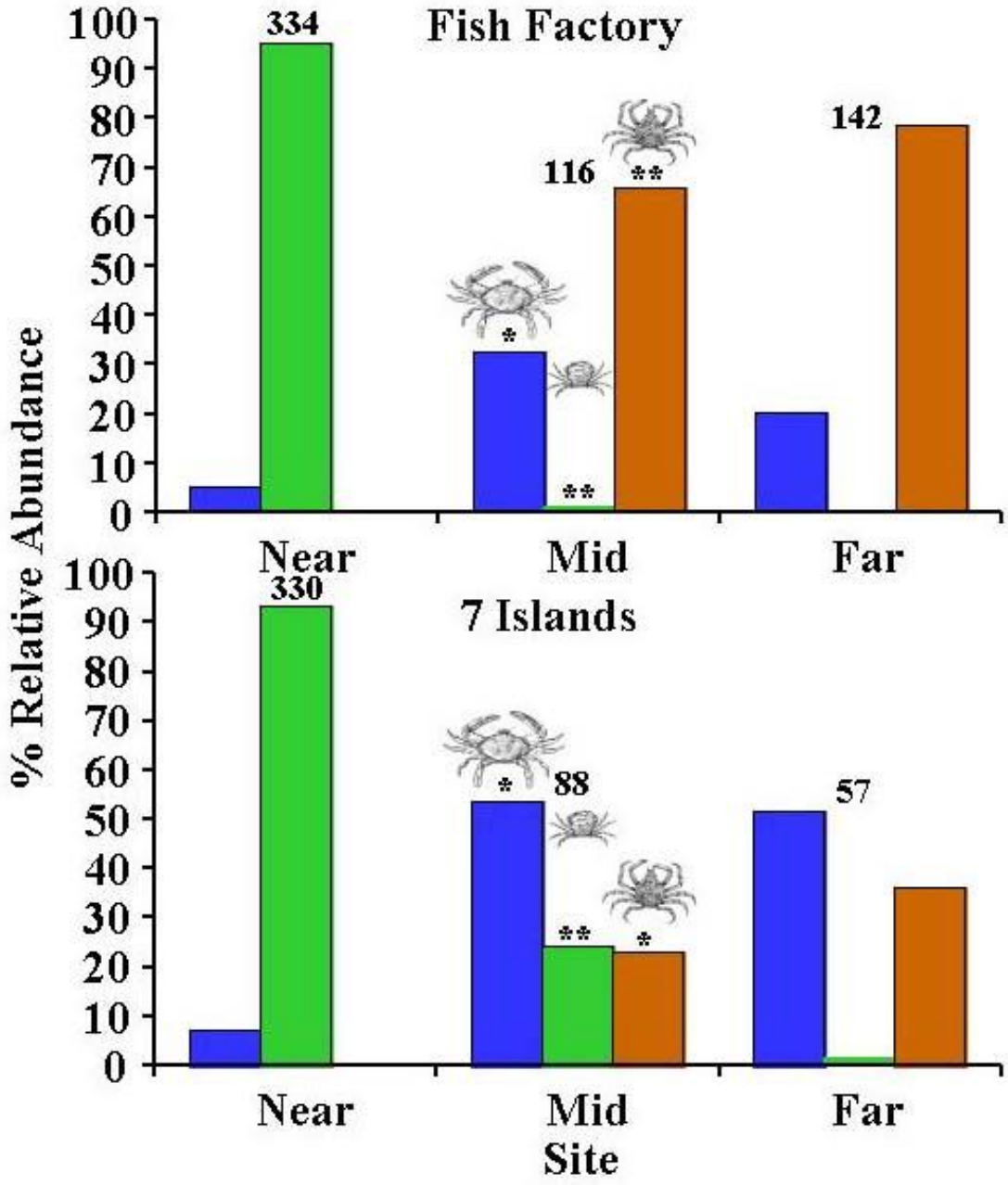


Figure 3. Relative abundance of blue crabs ( ), green crabs ( ) and spider crabs ( ) in three habitats; marsh (near), shallow open water (mid), and deep open-water (far) at two locations in the Great Bay-Mullica River estuary, New Jersey. Numbers above bars are total numbers of crabs captured at each habitat.

"Investigations of the range of expansion of an invasive species: the European green crab, Carcinus maenas" by Paul Jivoff, Greg Ruiz, Tuck Hines, and Catherine DeRivera

Student Record Sheet

Waterbody:____

Round	# clams (white)	# blue crabs (blue)	# green crabs

Waterbody:____

Round	# clams (white)	# blue crabs (blue)	# green crabs

Waterbody:____

Round	# clams (white)	# blue crabs (blue)	# green crabs

Green Crab Round Robin Gr: 9-12

Objectives: At the conclusion of the lesson, students will be able to:

- Determine the possible impacts of the European Green Crab on the Mid-Atlantic region
- Describe the impacts of European Green Crab invasions on different stakeholder groups in the Chesapeake Bay region

Standards:

NGSS	**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.
Core Idea	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience -** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
Practices	• Engaging in Argument from Evidence
Cross-Cutting Theme	• Cause and Effect • Stability and Change
Reading, Writing & Social Studies	**CCSS.ELA-Literacy.RST.9-10.2 -** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **CCSS.ELA-Literacy.RST.11-12.2 -** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **CCSS.ELA.Literacy.RI.9-10.1 –** Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. **CCSS.ELA.Literacy.RI.11-12.1 -** Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain. **CCSS.ELA.Literacy.RI.9-10.7 -** Analyze various accounts of a subject told in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account. **CCSS.ELA-Literacy.RI.11-12.7** - Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. **CCSS.ELA-Literacy.SL.9-10.4 -** Present information, findings, and supporting

	evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task. **CCSS.ELA-Literacy.SL.11-12.4 -** Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
Environmental Literacy	**1.A.1:** Identify an environmental issue. **1.A.3:** Given a specific issue, communicate the issue, the stakeholders involved and the stakeholders' beliefs and values. **4.C.1:** Explain how the interrelationships and interdependencies of organisms and populations contribute to the dynamics of communities and ecosystems. **5.A.2:** Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes

Green Crab Round Robin Gr: 9-12

Objectives: At the conclusion of the lesson, students will be able to:

- Determine the possible impacts of the European Green Crab on the Mid-Atlantic region
- Describe the impacts of European Green Crab invasions on different stakeholder groups in the Chesapeake Bay region

Materials:

- Stakeholder Cards (in kit & on CD)
  - 1/3 marked 'Bivalve' and numbered
  - 1/3 marked 'Politician' and numbered
  - 1/3 marked 'Waterman' and numbered
- Internet Access

Teacher Background: European Green Crabs (*Carcinus maenus*) are small crabs, measuring 2-3 inches in width. They are not always green but may be green, brown, gray, or red, depending on the environment and the crab's molt cycle. Green Crabs also have yellow patches on their abdomen. Like most invasive species, Green Crabs are extremely adaptable. They can tolerate temperatures ranging from 30-85° F (5-30° C) and salinities ranging from 5-30 ppt. Females can produce 200,000 eggs each year. They prey on many commercially valuable native species - scallops, hard and soft clams, oysters, mussels, other crustaceans, and juvenile fish. Adult crabs tend to occupy protected rocky shores or jetties and forage in tidal marshes and sandflats. In addition to competing with native species, European Green Crabs have been found to transmit the deadly parasite, *Profilicollus botulus*, to lobsters.

The Green Crab's native range includes the Atlantic coasts of Europe and North Africa, but they have been introduced to South Africa, South America, Australia, New Zealand, and both the Atlantic and Pacific coasts of the United States. They were first seen in the United States in the early 1800s and may have arrived in ballast water or by clinging to the hulls of wooden ships. They have now spread as far north as Nova Scotia and as far south as the mouth of Chesapeake Bay and the Delmarva Coastal Bays.

The Chesapeake Bay is the largest inland estuary in the United States. The Bay is mostly known for its seafood production, especially Blue Crabs (*Callinectes sapidus*). Oysters, rockfish (striped bass), clams, and other seafood are regularly harvested by recreational and commercial watermen. Even though Green Crabs are present in the Coastal Bays, Green Crabs are not established in the Chesapeake Bay. Scientists believe that this is because they cannot compete with the much larger native Blue Crab. Studies have shown that the Green Crab is seldom found in areas where Blue Crabs are abundant because Blue Crabs readily feed on Green Crabs. Unfortunately, the Chesapeake Bay's

Blue Crab population has been declining which may allow for further colonization by European Green Crabs. In Maryland and other parts of the Atlantic coast, live Green Crabs are sold in bait stores to be used for tautog fishing.

In this activity, students will learn about the issues with Green Crab invasion and will represent different stakeholders in the Chesapeake Bay to understand how Green Crabs threaten their livelihoods.

Procedure:

Engage

1. Have students think about the word "invasion" by thinking about a zombie invasion. Why might a zombie invasion be successful? *Lots of zombies which are often stronger, can rapidly multiply, and are able to take over, etc.*
2. Ask students how might a zombie invasion impact their lives? *Zombies may take over and drive humans out/kill humans.*
3. How does a concept like a zombie invasion relate to an invasive species? *Invasive species are often abundant as well as often larger or stronger than native species. Many invasive species can reproduce rapidly, have special adaptations, lack predators, can take over, etc.*
4. Explain that there is an invasive species called a European Green Crab that is found along the Atlantic coast as far south as the mouth of the Chesapeake Bay. Go over some of the problems with European Green Crab invasions, focusing on the impacts to seafood industries.
5. Ask students if any of them enjoy eating scallops, lobsters, clams, and/or mussels. How would they feel if these fisheries disappeared? Who else may be impacted?
6. Provide students with background information on the Chesapeake Bay and the importance of its fisheries. What impact might the European Green Crab have if it invades the Chesapeake Bay?

Explore

1. Tell students that they are now going to assume the roles of 3 different stakeholders for the Chesapeake Bay.
2. Split students into 3 stakeholder groups: bivalves, politicians, and watermen. Hand each student a numbered card with their stakeholder represented on it.
3. Allow students time to research background information on their stakeholders in the Chesapeake Bay region. You can also assign the articles and videos suggested at the end of the lesson. Be sure students research the importance of the Chesapeake Bay to their stakeholder group and how Green Crabs may impact them.
4. After researching their roles and writing supporting information down, have students look at the number on their card and change groups to meet with others

with the same number. Each group should now consist of at least 1 of each stakeholder.

5. Each member of the group should explain to the others their stake in the health of the Bay. Are any of the roles interconnected? Can students relate to any of the stakeholders? How would the different groups be impacted by Green Crab invasion?

Explain

1. After the round robin discussion, have students summarize what they have learned about the impacts of Green Crabs on different stakeholders. Have students brainstorm what other stakeholders could be impacted by a Green Crab invasion. Would the invasion of Green Crabs in your state impact students' lives? Why or why not?
2. Ask students if they found anything interesting in their search to learn more about the Green Crab.

Evaluate

1. Given what they now know, have students discuss or debate a proposal to allocate state funding to the control/eradication of Green Crab. Have students debate as their original stakeholder groups and list ideas on the board.

Extend

1. Have students research the economic and environmental impacts of the European Green Crab on the hard clam (quahog) and/or lobster industry in New England. What can be done to save these important species?

Suggested Articles/Videos:
Articles

- Politicians – http://www.cbf.org/document.doc?id=591 – Chesapeake Bay Fisheries section, pp 5-6
- Watermen- http://www.washingtonpost.com/lifestyle/travel/touring-the-chesapeake-bay-with-its-legendary-watermen/2013/10/10/b47bb55a-305f-11e3-bbed-a8a60c601153_story.html; http://www.fredericknewspost.com/archive/chesapeake-watermen-fear-blue-crab-not-coming-back/article_1f666551-5e7f-5ec4-9359-012674e37ab4.html
- Bivalve - http://www.bayjournal.com/article/bivalves_dramatic_demise_is_as_quiet_as_a_clam_
- Green Crab articles – http://dnr.maryland.gov/fisheries/articles/3exoticspp.html ; http://www.mdinvasivesp.org/archived_invaders/archived_invaders_2006_02.html

YouTube videos-

- Politician – https://www.youtube.com/watch?v=O8QGihqQ8A4
  https://www.youtube.com/watch?v=Rm0fKbLmnlg
- Watermen – http://ngm.nationalgeographic.com/2005/06/chesapeake-bay/video-interactive
- Bivalve (Oysters) – http://vimeo.com/36710387

Hydrilla-The Traveling Plant Gr: 3-12

This activity adapted with permission from The Hydrilla Game, inspired by Project WET curriculum (projectwet.org) and created as part of the Osceola County Hydrilla and Hygrophilia Demonstration Project by the University of Florida-IFAS Center for Aquatic and Invasive Plants (plants.ifas.ufl.edu) and the Florida Fish and Wildlife Conservation Commission, Invasive Plant Management Section.

Objectives: At the conclusion of the lesson, students will be able to:

- Explain why Hydrilla is considered an invasive species.
- Explain how easily Hydrilla spreads from one waterbody to another.
- Explain that this spread is often the result of human activity, in error, not on purpose.

Standards:

NGSS	**3-LS4-3 –** Construct an argument with evidence that in a particular habitat, some organisms can survive well, some survive less well, and some cannot survive at all. **4-LS1-1 –** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior and reproduction. **MS-LS1-4 –** Use argument based on empirical evidence and scientific reasoning to support an explanation for how…specialized plant structures affect the probability of successful reproduction. **MS-LS2-4 –** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **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.
Core Idea	**LS4.C: Adaptation -** For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience -** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations **LS2.C: Ecosystem Dynamics, Functioning, and Resilience -** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
Practices	• Developing and using models

	• Constructing explanations
Cross-Cutting Theme	• Cause and Effect • Stability and Change
Reading, Writing & Social Studies	**CCSS.ELA/Lit.RI.3-5.9-** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. **CCSS.ELA/Lit.RST.6-8.1 –** Cite specific textual evidence to support analysis of science and technical texts. **CCSS.ELA/Lit.RST.9-12.1-** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **CCSS.ELA/Lit.SL.3-5.1**- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics and texts, building on other's ideas and expressing their own clearly. **CCSS.ELA/Lit.SL.6-8.1**- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics and texts, building on other's ideas and expressing their own clearly.
Environmental Literacy	**4.B.1 –** Analyze the growth or decline of populations and identify a variety of responsible factors. **5.A.2 –** Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes.

Hydrilla-The Traveling Plant Gr: 3-12

This activity adapted with permission from The Hydrilla Game, inspired by Project WET curriculum (projectwet.org) and created as part of the Osceola County Hydrilla and Hygrophilia Demonstration Project by the University of Florida-IFAS Center for Aquatic and Invasive Plants (plants.ifas.ufl.edu) and the Florida Fish and Wildlife Conservation Commission, Invasive Plant Management Section.

Objectives: At the conclusion of the lesson, students will be able to:

- Explain why Hydrilla is considered an invasive species.
- Explain how easily Hydrilla spreads from one waterbody to another.
- Explain that this spread is often the result of human activity, in error, not on purpose.

Materials:

- 8 boxes
- 8 different colors of pony beads: blue, yellow, red, orange, green, pink, purple, and white
- 8 habitat signs (in kit)
- 8 small bottles
- Board
- Internet access
- Open area
- Plastic lacing (aka gimp); need at least 1 seven-inch piece per student
- Scenario cards (in kit)

Teacher Background: Hydrilla (*Hydrilla verticillata*) is a submerged, aquatic plant found in fresh and slightly brackish water. This invasive plant grows prolifically in its introduced areas. A native to Asia, Hydrilla can quickly grow to produce thick mats on water surfaces that block light and hamper water recreation.

Hydrilla can reproduce 4 different ways via fragments, tubers, turions, and seeds. Pieces of Hydrilla as small as one node can grow into a new plant. This is Hydrilla's primary mode of reproduction. It also reproduces from buds, called **turions**, in the leaf axils, and from small tubers embedded in lake bottom soil.

Hydrilla can also reproduce via sexual reproduction. Some plants have both male and female flowers (**dioecious**) while others have just a single sex (**monoecious**). The female flowers are tiny, white, and appear on elongated stalks that float on the water's surface. The male flowers are greenish and occur at the tips of the stems, attached at the leaf axils. The monoecious type, which is found in the Chesapeake region, allows for easier adaptation to different habitats.

The dioecious form of Hydrilla was first introduced in Florida as an aquarium plant in the 1950s. By the 1970s, the species was well distributed throughout Florida. The monoecious strain was introduced separately decades later in the Potomac Basin. Today, Hydrilla is unintentionally spread as castaway fragments on boats, trailers, and other water recreation equipment. Despite the fact that Hydrilla is a listed federal noxious weed, it is still sold as an aquarium plant.

In this activity, students will actively simulate how Hydrilla is spread while learning about its impacts to the environment and students' lives.

Procedure:

Engage

1. Begin by discussing invasive species. What are invasive species? Can your students list any invasive species?
2. Explain that invasive species can be plants, animals, and/or diseases.
3. Tell students that they will be simulating the spread of an invasive plant. Ask students if they know in what ways invasive plants may be introduced into new areas. List students' ideas on the board.
4. Have students perform a quick internet search to answer the following questions.
    a. How does Hydrilla spread? *Broken pieces, buds, and tubers*
    b. How easy is it for Hydrilla to spread? Why? *It's very easy as fragments can attach to many surfaces and can travel long distances.*
    c. What are some of the problems associated with Hydrilla invasions? *Blocks sunlight, which prevents growth of other aquatic vegetation. Forms large mats that make water recreation difficult. When it dies, it can deplete dissolved oxygen, which can result in fish kills.*
5. Discuss answers to research questions with students.

Explore

1. Set up a large, open area like a field or a gym with the 8 different stations. Each station should contain a sign, a box, scenario cards, and a bottle with pony beads coordinated with the station color.
2. Tell students that they are going to do an activity to see how easily Hydrilla can be spread.
3. Review the 8 habitats to make sure the students are familiar with them.
4. Tell them that they are going to be a piece of Hydrilla. Give each student a piece of plastic lacing with one end knotted. Tell students that this is a journey bracelet that will document their travels.
5. Divide students into 8 groups and send each group to a station.
6. Tell students when they get to their station, they are to take 1 bead out of the bottle and place it on their journey bracelet.

7. Each student will then take 1 of the scenario cards from the box and read it aloud to their group. The scenario will tell them where to go next. Before leaving, have each student return the card to the bottom of the box. If the card tells them to "Stay", then they will take another bead and draw another card when it is their turn.
8. Have students repeat the process for 10-15 minutes or until the students' journey bracelets are full.

Explain

1. Write the color codes for the habitats on the board so the students have something to refer to.
2. Key questions
    a. Where did you (the Hydrilla) spend the most time?
    b. What were some of the ways Hydrilla was moved from one place to another? *It was disposed of improperly. It was attached to animals, people, and/or equipment.* Compare these methods to the initial brainstorm. Ask students if they were surprised at the ways Hydrilla was spread.
    c. How does Hydrilla affect different habitats? *Grows over native aquatic plants, clogs drainage pipes, causes a creek to flood, uses up oxygen at night, etc.*
    d. How do Hydrilla invasions affect people? *It can cause fish kills and can kill aquatic vegetation. It can clog drainage areas and can cause flooding. It hampers water recreation.*
    e. How would a Hydrilla invasion in your favorite water body affect you?
    f. Discuss the spread caused by humans; give examples of when the spread was deliberate and when it was accidental.
    g. Referring back to their journey, discuss ways that people can prevent the spread of Hydrilla.

Evaluate

1. Have students create a story following their journey as Hydrilla. Have students refer to their journey bracelets to recount their stories.
2. Have students create posters or brochures on ways people can prevent the spread of Hydrilla.

Extend

1. Conduct a data collection activity using a bar graph (Example: While doing the activity, how many students ended up in a drainage ditch? A river? etc.). Discuss results with the class. Do any patterns emerge?
2. Students can research different Hydrilla habitats and create a list of potential ecological or economic impacts to those areas. What areas are the most affected and why?
3. Conduct a research project on the impact of Hydrilla in a local waterway.

Aquarium The fish in the aquarium enjoy hiding among your leaves, and you are happy to stay as long as you can.	**Aquarium** A student finishes with his science fair project and empties his aquarium into the pond at his apartment complex. There's plenty of water in the pond, so you are happy.
Aquarium The girl who put you in the aquarium forgets about you. Soon, the tank is full of plants. The air pump breaks and you use more oxygen than you produce. Her pet fish die from lack of oxygen. You remain.	**Aquarium** The owner of Marty's Pet Shop decides to close the business. Instead of putting aquarium plants in the dumpster, she tosses you into a nearby lake. You shade out the native, aquatic plants on the bottom of the lake.
Aquarium A boy decides to release his pet sunfish into the neighborhood lake. You go into the lake along with the sunfish.	**Aquarium** An employee at a local pet store needs to clean out the fish tanks. She empties the plants into the drainage ditch behind the store. She thinks the Hydrilla plants will just die, but the habitat is fine for you.
Aquarium After her pet turtle dies, Molly empties her aquarium into the creek behind her house. You were enjoying the excess nutrients in the aquarium, but it looks like the creek has plenty, too.	**Aquarium** Billy empties his aquarium into the lake behind his house, where you grow quickly in the nutrient-rich water. (He's hoping that no one saw him because the Lake Association is now asking everyone to pay $1,000 to control your growth.)

Creek A fisherman doesn't notice you attached to a lure on his fishing rod. He accidentally transports you to his next fishing spot – a pond.	**Creek** A careless boater forgets to clean off his boat propeller. You are transported to a local lake where you enjoy lots of nutrients and growing room.
Creek You have grown so much, there is no room in the creek for the water pouring in from a nearby parking lot. The street begins to flood. You like it here and decide to stay.	**Creek** A summer rainstorm washed you into the drainage ditch where you soak up extra nutrients and grow even faster, now that it's full of water.
Creek A sprig of Hydrilla is wrapped around the leg of a great blue heron feeding in the creek. His next feeding ground is the shore of the retention pond down the street, where you fall off.	**Creek** As a small clump of Hydrilla, you provide excellent habitat for juvenile fish. You put tubers down into the sediment because you want to stay awhile.
Creek It's raining hard and water is rushing off the surface of a parking lot nearby. The creek at the bottom of the hill is so full of your plants, there is no place for the water to go. It floods and you catch a free ride to the retention pond nearby.	**Creek** You completely fill the creek with your plants and keep sunlight from shining into the water. It's been hot and cloudy for days. Fish begin to die because the don't have enough oxygen (from photosynthesis). You stay awhile.

Drainage Ditch It rained recently so there is plenty of water in the ditch; plenty of sunlight, too. You stay and grow as fast as you can.	**Drainage Ditch** A summer thunderstorm flushes you from the drainage ditch into the creek, where the water level is more dependable.
Drainage Ditch A raccoon feeding near the drainage ditch picks up a sprig of Hydrilla in its thick fur. You fall off into a lake a little while later when the raccoon digs under a log for a juicy crayfish.	**Drainage Ditch** A thunderstorm washes you from the drainage ditch into the retention pond. This is even better for you; the water level is more stable and nutrients provide plenty of food. With a little luck, you'll grow an inch a day!
Drainage Ditch A glossy ibis is hunting for insects along the edge of the drainage ditch and accidentally picks you up in its beak. You enjoy a quick flight to its next stop – the river.	**Drainage Ditch** The Public Works Department mows the vegetation around the drainage ditch. They mow all the way down the road to the retention pond nearby. You hitch a ride on the mower blades.
Drainage Ditch Streets are flooding, even with very little rainfall. City workers discover that you are clogging the drainage pipes. Before they can clean you out, you've already put down tubers in the sediment.	**Drainage Ditch** Road crews were so busy, they didn't clean Hydrilla plants from the drainage ditch. You stay and continue to grow an inch a day. (Workers are in trouble a week later, when the ditch overflows during a rain storm and several houses are flooded.)

Sediment Muck (organic sediment) is dredged from a lake. Hundreds of Hydrilla tubers are exposed in the thick, black sediment. Piles of this material is left to dry along the road. A few of your tubers wash into a nearby drainage ditch during a hard rain.	**Sediment** Hurricane Lisa blew through recently and uncovered some of your tubers. You suddenly find yourself in the lake. Now that you have access to sunlight, you begin to grow. You grow and grow and grow!
Sediment Ducks feeding on submerged grasses dislodge you from the bottom. You float into the surface waters of the lake, where you sprout stems and whorled leaves.	**Sediment** High winds and rain from a hurricane stir up the sediment at the bottom of the lake. Many of your tubers are exposed. You are washed into a connecting creek, along with lots of other debris.
Sediment Children playing along the shoreline dig deep into the sediment and find your tubers. They leave these new treasures on the ground until your tubers wash into the river, where they sprout.	**Sediment** An herbicide treatment is performed on the lake. It kills your leaves and stem, but your tubers remain healthy in the sediment. You stay here for a while.
Sediment The sediment is full of nutrients and you are happy here. You stay and wait for the next move.	**Sediment** Recent storms stir up the sediment. This gives you new nutrients as a food source. You like living here and continue to stay.

Lake You put down tubers while reproducing. You sink into the sediment where you'll soak up lots of nutrients.	**Lake** A water skier cleans off his boat and equipment. You are washed down the driveway and road to a nearby drainage ditch.
Lake A careless boater hauls you away on his trailer to his next fishing area…the river, where you'll sink into the water.	**Lake** A boy, fishing in the lake, doesn't see you wrapped around his bobber. The next day, he goes fishing in a nearby pond and takes you along, where you fall off into the water.
Lake You have grown so much that people can no longer run a boat across the lake. After a tropical storm, you stick to equipment used to clean up the shoreline. You are introduced to a nearby creek where you find plenty of nutrients.	**Lake** You find a nice home in the lake. However, water skiers get tangled in your stems. This results in several injuries to the skiers. Stay and keep growing.
Lake You have grown so much, you cover the lake surface. Sunlight can no longer get through your leaves. Dissolved oxygen levels are low. This morning, hundreds of dead fish float to the surface. Stay and keep growing.	**Lake** Tommy has a lake near his house. He likes to put plants that he finds in the lake into his fish tank, so you are carried to his aquarium.

Retention Pond A summer thunderstorm brings 3 inches of rain and causes the retention pond to overflow. You travel with the runoff to the lake nearby.	**Retention Pond** You've grown so thick, you clog the stormwater outfall of the local retention pond. It overflows during a heavy rain. The excess water carries you into a creek downstream. Some of it floods into several homes nearby.
Retention Pond City workers forgot to treat the pond for Hydrilla. You cover the surface now. Photosynthesis slows from lack of sunlight and oxygen levels drop. Dozens of fish die and the odor is terrible. Stay and keep growing.	**Retention Pond** Kids used to fish for bluegill in the retention pond. You grew so much, they can't get their baited hooks to sink into the water. The kids are sad but you are happy to stay and grow some more.
Retention Pond You found your way to a retention pond in a housing development. You thrive on the constant fertilizers washed into the pond from surrounding lawns. You stay and grow.	**Retention Pond** Natalie has an indoor goldfish tank. She decides to collect live plants from the retention pond behind her house. You end up in her aquarium with an annoying goldfish nibbling on you.
Retention Pond You are constantly maintained by city workers. For now, you are stuck in the retention pond, and you are shrinking.	**Retention Pond** The retention pond receives lots of sunlight and is full of nutrients, thanks to the nutrient-rich soils. You think this is a nice place to hang out. When it is time to reproduce, you put down tubers in the sediment.

River An osprey catches a fish (and also a clump of Hydrilla) with its talons. You end up in the osprey nest, but several sprigs fall into the retention pond below.	**River** A barge delivers goods to towns along the river. When the barge pumps out its bilge water, Hydrilla is accidentally introduced into a creek that feed into the river. You head to the creek.
River You thrive on the nutrients in the river, thanks to all of the people who over-fertilize their lawns. As a result, you successfully outcompete the native plants. Stay where you are.	**River** George collects river water and plants for his new pet fish. You end up in his aquarium, where you grow an inch a day.
River An eagle spots a big fish in the river. It scoops up the fish with its talons, along with some Hydrilla. It eats the fish from the top of a tall, dead tree. You fall into the pond below.	**River** Sometimes it's difficult for Hydrilla to grow in fast-moving water. You find a cove along the river where the water is calm. You stay. Soon you've grown so much that boaters cannot move their boats away from the dock.
River A boater leaving the river does not clean his propeller or trailer. You travel with him to the lake.	**River** Turtles WERE enjoying lazy days basking in the sun on the river. But now, you have grown so thick that they are having trouble swimming. You stay, but the turtles leave.

Pond A boy fishing for bluegills in the pond doesn't see the sprig of Hydrilla wrapped around his bobber. The next day, his dad takes him fishing on a nearby lake. You go along.	**Pond** You are enjoying the quiet pond water. There is plenty of sunlight and nutrients washing off nearby farm fields. You stay and take advantage of the nutrients and sunlight.
Pond A kayaker paddling in the pond picks you up and carries you miles downstream to a creek. You fall into the creek when the kayaker accidentally flips.	**Pond** Several kids enjoy swimming in the pond in the summertime. However, you are growing so thick that it's hard to swim – and it's dangerous. Now the parents won't let them swim there anymore. Stay and continue growing.
Pond A heavy rainstorm causes the pond to overflow. You are washed out and into a nearby drainage ditch.	**Pond** Several parents decide to get together and remove the Hydrilla in the pond so their children can swim there. They toss you into a drainage ditch behind the property.
Pond An aquarium store owner decides to save money by collecting plants from a local pond. He picks up a big clump of Hydrilla to put in his aquariums. You travel to the aquarium.	**Pond** The pond used to be a place where the local children liked to come and fish for bluegills. You have grown so thick now that you cover the surface. Oxygen levels drop and dozens of bluegills die. Stay and keep growing.

Spreading of Rock Snot Gr: 6-8

Objectives: At the conclusion of the lesson, students will be able to:

- Understand how Didymo is introduced and spread
- Understand the environmental impacts of Didymo

Standards:

NGSS	**MS-LS2-5-** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-3-** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
Core Idea	**ETS1.B: Developing Possible Solutions** - There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. **ESS3.C: Human Impacts on Earth Systems** - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
Practices	• Developing and using models • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions
Cross-Cutting Theme	• Systems and system models • Stability and change
Reading, Writing & Social Studies	**CCSS.ELA-Literacy.RI.6-7.1 –** Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
Environmental Literacy	**5.A.1:** Analyze the effects of human activities on earth's natural processes. **5.A.2:** Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes. **7.A.1:** Investigate factors that influence environmental quality. **7.B.1:** Examine the influence of individual and group actions on the environment and explain how groups and individuals can work to promote and balance interests through. **7.E.1:** Analyze and explain global economic and environmental connections.

Spreading of Rock Snot Gr: 6-8

Objectives: At the conclusion of the lesson, students will be able to:

- Understand how Didymo is introduced and spread
- Understand the environmental impacts of Didymo

Materials:

- Glo Germ oil or gel
- Blacklight
- 6 sheets of large blue paper (large enough for 2 students to stand on) to represent streams (optional)
- Pictures of Didymo (in Boulder Booger Bling packet and on CD)
- Hand soap
- Paper towels
- Student Page (on CD)

Note: Glitter can be an inexpensive substitute for the Glo Germ and the blacklight

Teacher Background: As its common name suggests, Didymo may look like snot, but it's not. Didymo (*Didymosphenia geminata*) is a microscopic freshwater diatom (type of algae) that secretes a fibrous stalk that it uses to attach itself to rocks and plants in aquatic systems. During blooms, the stalks grow to form thick mats that can completely cover the stream bottom. This diatom may look slimy, but its silica cell walls make it feel more like wet wool. Didymo cells, unlike most other diatoms, grow a yellow-brown or grayish-white, muco-polysaccharide shoot that can extend up to 2 feet long…thus earning it the unflattering nicknames of "rock snot" and "boulder booger".

The first report of Didymo in the northeastern U.S. came from the northern reaches of the Connecticut River and the White River in Vermont in June 2007. In October 2007, Didymo was discovered in the east and west branches of the upper Delaware River, in New York and Pennsylvania. About five years later, in May 2012, large Didymo blooms were observed over more than 100 miles of the Delaware River, from Hancock, NY to near Dingman's Ferry, PA. Didymo was first discovered in Virginia in 2006, and is now found in three rivers below dams. Didymo was first reported in Maryland and in West Virginia in 2008.

Nuisance Didymo "blooms" are often mistaken for raw sewage spills because trailing stalks look like wet toilet paper in the water. In some situations, Didymo can proliferate rapidly, bloom (for reasons not well understood), and form large, visible clumps or mats of tangled stalks. In worst-case scenarios, these mats can cover the entire bottom of the infested river with a layer of cells and stalks up to 20 cm thick. Although Didymo

mats may look slimy, they actually feel gritty and somewhat fibrous (like wet wool) when squeezed between a finger and thumb. Didymo stalks are resistant to biodegradation by bacteria and fungi. They can break off, drift downstream, get snagged on woody debris, and can persist for up to 2 months. Didymo can spread via fishing equipment and waders, boats, and just about anything else that has come in contact with didymo-infected water. Unlike other algae, Didymo has no characteristic odor.

Like many non-native, nuisance aquatic species, Didymo poses myriad ecological threats. From an environmental perspective, the thick mats formed during blooms can completely cover the substrate, trap sediment, and have the potential to disrupt food webs. These extensive mats are a threat to biodiversity because they can smother benthic macroinvertebrates, native diatoms, and aquatic plants, thereby reducing food and habitat for fish.

It should be noted that only limited research has been done to elucidate the ecological effects of Didymo in areas where large blooms have occurred. Didymo presence causes shifts in the community composition of macrobenthos toward more midges and worms with fewer caddisflies, stoneflies, and mayflies. Studies have also observed higher macroinvertebrate densities after Didymo becomes established--the average organism size, however, has been recorded as smaller. There is minimal information on the effects of Didymo blooms on fish. Some studies report no impact on fish growth and production, while others have observed declines in native fish populations in Didymo-infested waters.

In this activity, students will simulate the spread of Didymo and will learn about ways to prevent the spread.

Procedure:

Engage

1. Show students pictures of Didymo as single cells and as blooms in streams (pictures in Boulder Booger Bling kit or on CD).
2. Ask students what they think the pictures represent. Do the blooms look healthy for streams? Why or why not? Ask students if they would swim or fish in a stream covered with the blooms.
3. After a brief discussion, teach students about Didymo-what it is, what it does, and how it was introduced to the United States.
4. Locate a stream map for your county. This information can often be found on state natural resource pages or Google Earth. Select 5 streams and have students research information on those streams such as size, animals within, recreation uses, etc.

5. Have students present information on the different streams that they researched. Ask students if they have ever visited any of the streams. If so, what did they do? Write down information for later use.

Explore

1. Hand out 'Didymo Data Table' worksheet to all students before beginning the simulation.
2. Take 5 large, blue pieces of paper and write the 5 stream names down. On the last piece of paper, label it as "Gunpowder River, Maryland". Place the "Gunpowder River" paper near the front of the room.
3. Select 5 students to stand around the room. These students represent anglers fishing in various streams. (If using blue paper to represent streams, then have the students stand on the paper.)
4. Select another student to be the angler that spreads the Didymo. Have this student come up to the front of the room to fish in the Gunpowder River.
5. While the angler is in the Gunpowder River, place a dab of Glo Germ oil/gel on his or her hand.
6. After placing the Glo Germ on the hand of the student, look at the hand under the blacklight. The hand will now glow to represent that this angler "picked up" Didymo while fishing in the stream. Point out that the Didymo/Rock Snot is not visible to the naked eye and was only visible under the blacklight.
7. After looking under the blacklight, tell students that the Gunpowder angler likes to travel around to fish and send that angler to one of the neighboring streams. As the angler enters the stream, he/she needs to shake hands with the student currently at that stream. Shaking hands represents the spread of Didymo.
8. Call another student up to Gunpowder Falls and repeat steps 4-7, sending this student to a new stream that is not yet contaminated.
9. Continue calling up students and repeat steps 4-7 until all the streams in the classroom have been contaminated. Be sure students record what has happened in the stream on their data sheets.

Explain

1. When all the streams are contaminated, have a class discussion about how the spread of Didymo can be stopped. (Students will most likely say not to shake hands. Remind them that the anglers are not actually shaking hands, but that the hand-shaking represents them entering the water and spreading what is on their boots.) Guide students in the discussion about washing boots before going to a new stream. In this case, students would be washing hands since the handshake simulates the boots spreading the Didymo.
2. Repeat the steps of having a student come to Gunpowder River, getting Glo Germ on their hands, and then traveling to a neighboring stream. Have the student from Gunpowder River thoroughly wash then dry his or her hands before traveling to the new stream. Tell students that this action represents

washing fishing gear and boots before entering the new stream. Repeat this action for all 5 of the streams that are spread around the room.

3. Have students record then review data on the Student Page. Have students answer questions at the bottom of the sheet. Review student's answers. Students should notice that by washing their hands, the spread of Didymo decreased, or ceased completely.

Evaluate

1. Have students revisit the information they researched on their streams. Remind students that Didymo impacts cold-water streams. Is it likely that Didymo could spread to their streams? Why or why not?
2. If Didymo could colonize the streams, then how might water recreation be impacted? If any students have visited the streams in the simulation, then ask them how they would feel fishing or swimming in a stream covered with Didymo. How may wildlife be impacted by the spread of Didymo?

Extend

1. Have students research Didymo presence in their state. If Didymo is present, then what is their state doing to prevent its spread? Have students evaluate education materials about the spread of Didymo, and if possible, then have them make suggestions on ways to improve material to reach wider audiences. If Didymo is not present in their state, then research ways their state is trying to prevent its introduction.
2. Didymo primarily infests cold-water streams, which are often prime trout habitat. Have students research trout fisheries in their state. What are the potential impacts of Didymo to trout fisheries?

Student Page: Didymo Data Table

Directions:

1. Fill in the names of the 6 streams your class simulated in the exercise.
2. For trial 1, as the anglers travel to each stream, record if the Didymo/Rock Snot was spread. If it was spread to the new stream circle "yes." If it was not spread, then circle "no."
3. Repeat for trial 2. Don't forget that the anglers need to wash their hands before entering each stream in trial 2. This hand washing symbolizes the anglers washing their boots before entering a new stream.

Stream Name	**Trial 1 No boot washing (hand washing)**		**Trial 2 Boot washing (hand washing)**	
	Yes	No	Yes	No
	Yes	No	Yes	No
	Yes	No	Yes	No
	Yes	No	Yes	No
	Yes	No	Yes	No
	Yes	No	Yes	No

Conclusions:

1. In trial 1, what is the ratio of streams that were contaminated with Rock Snot compared to streams that were not contaminated?

2. In trial 2, what is the ratio of streams that were contaminated with Rock Snot compared to streams that were not contaminated?

3. What can you conclude from this data?

West Nile Virus, Mosquitoes & You Gr: 9-12

Objectives: At the conclusion of the lesson, students will be able to:

- Describe the interrelationships between West Nile Virus, Asian Tiger Mosquitoes (*Aedes albopictus*), and public health
- Identify Asian Tiger Mosquitoes
- Design and build homemade mosquito traps to monitor for the presence of Asian Tiger Mosquitoes
- Develop a community education/action plan to reduce mosquito populations and prevent mosquito bites

Standards:

NGSS	**HS-LS2-7 –** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. **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. **HS-ETS1-3 –** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
Core Idea	**LS2.C- Ecosystem Dynamics, Functioning, and Resilience-**Moreover, anthropogenic changes (induced by human activity) in the environment- including introduction of invasive species… and climate change- can disrupt an ecosystem and threaten the survival of some species **LS4.C-Adaptation-** Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species
Practices	• Asking questions and defining problems • Planning and carrying out investigations • Analyzing and interpreting data • Constructing explanations and designing solutions • Obtaining, evaluating and communicating information
Cross-Cutting Theme	• Cause and Effect • Stability and Change • Science Addresses Questions about the Natural and Material World
Reading, Writing & Social Studies	**CCSS. RI.1- 9-10** - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. **CCSS.RI.1-11-12** - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain. **CCSS.SL.9-12.1** - Initiate and participate effectively in a range of collaborative

	discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–12 topics, texts, and issues. **CCSS.SL.9-12.4** - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task. **CCSS.SL.9-12.5** - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **CCSS.W.9-12.7** - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem.
Environmental Literacy	**1.A.1 –** Identify an environmental issue. **1.A.4 –** Design and conduct the research. **1.A.5 –** Use data and references to interpret findings to form conclusions. **1.B.1 –** Use recommendation(s) to develop and implement an action plan. **1.B.3 –** Analyze the effectiveness of the action plan in terms of achieving the desired outcomes**.** **4.C.1.-** Explain how the interrelationships and interdependences of organisms and populations contribute to the dynamics of communities and ecosystems.

West Nile Virus, Mosquitoes & You Gr: 9-12

Objectives: At the conclusion of the lesson, students will be able to:

- Describe the interrelationships between West Nile Virus, Asian Tiger Mosquitoes (*Aedes albopictus*), and public health
- Identify Asian Tiger Mosquitoes
- Design and build homemade mosquito traps to monitor for the presence of Asian Tiger Mosquitoes
- Develop a community education/action plan to reduce mosquito populations and prevent mosquito bites

Materials:

- CDC Factsheet on West Nile Virus (on CD)
- Mosquito trap supplies
    - If using lesson plan example, then 2-liter soda bottles, black fabric or paper, tape, brown sugar, water, yeast, and scissors will be needed for each trap
- Magnifying glasses (in kit) or dissecting scopes
- Forceps (to handle mosquitoes)
- Petri dishes
- 'Least Wanted: Asian Tiger Mosquito' (on CD)

Teacher Background: West Nile Virus (WNV) is a "vector-borne zoonosis". A **zoonosis** is a disease that normally exists in animals ("hosts") but that can infect humans; a **vector-borne disease** is a disease that is transmitted among their human or animal hosts by arthropods (insects, ticks, fleas, etc.). Birds, especially crows, robins and house sparrows, are the main hosts of WNV, which is found in high levels in the blood of the bird. When a female mosquito bites an infected bird, she takes up the virus in her salivary glands. The virus is then spread to other birds and then to humans when they are bitten by the infected mosquito. The virus cannot be passed directly to other birds or to humans-the mosquito vector is required.

West Nile Virus has been found in over 350 species of birds and is carried by over 60 species of mosquitoes. In the mid-Atlantic, the primary vector is a native species of mosquito, *Culex pipiens*, also called the "house mosquito" because it is usually the most common mosquito in urban and suburban settings. It prefers to feed on birds, but some urban mosquitoes will bite humans.

In 1985, however, the invasive species Asian Tiger Mosquito (*Aedes albopictus*) was introduced. This species commonly congregates near people's homes. In 2001, Tiger Mosquitoes collected in Maryland, New Jersey, and Pennsylvania tested positive for West Nile Virus. Asian Tiger Mosquitoes are aggressive biters that feed primarily

during the day, and they feed on humans, wild and domestic animals, and birds. Asian Tiger Mosquitoes, like house mosquitoes, can survive cold temperatures, so they are not killed over the winter. In addition, Tiger Mosquitoes lay eggs in tin cans, buckets, discarded tires, untended bird baths, clogged rain gutters, wading pools – any place there is standing water.

The most important impact of WNV is on human health. WNV is a zoonotic disease – a disease found in animals that can be passed either directly (such as rabies, anthrax) or indirectly by means of a vector (like Lyme, WNV) to humans. Approximately 80% of people who are infected with WNV will not show any symptoms at all. Up to 20% of the people who become infected have "West Nile Fever". Symptoms include fever, headache, and body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. About 1 in 150 (0.5%) people infected with WNV develop severe neurological illness (meningitis, encephalitis). The symptoms can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. The elderly and people with certain medical conditions, such as cancer, diabetes, high blood pressure, or kidney disease, are at greater risk for serious illness. There is no treatment for WNV. The disease is caused by a virus, so antibiotics are of no use. There is also no human vaccine for WNV. The only way to minimize the chance of being infected with WNV is to avoid being bitten by mosquitoes.

West Nile virus was first isolated from a feverish woman in the West Nile District of Uganda in 1937. It was first found in the United States in dead and dying crows in New York City in 1999. However, due to the migratory behavior of birds and the prevalence of mosquitoes, WNV spread rapidly from New York. It was first found in Maryland in 1999 when a dead crow was found in Baltimore City. The first human cases in Maryland were reported in 2001, and the virus is now found in all of the lower 48 states. Climate change may play a part in the frequency of West Nile Virus infections. The reasons for this are due to the fact:

- Milder winters allow more WNV-infected mosquitoes to survive, which gives the virus a head start in spring.
- Hot weather allows mosquitoes to reproduce faster and makes the breeding season longer
- Hot weather also speeds up the growth of the virus inside the mosquitoes

In this activity, students will learn about Asian Tiger Mosquitoes and West Nile Virus as well as actively trap and identify mosquitoes to assess potential threats in their communities.

Procedure:

Engage

1. Begin the discussion by asking students if they can define what a **vector borne disease** is. Go over the definition with students and ask them if they can identify any vector borne diseases.
2. If students don't mention West Nile Virus, then ask them if any had heard of the disease. Do they know anyone who has been infected?
3. Have students read the Center for Disease Control (CDC) factsheet on West Nile Virus (on CD). After the reading, discuss the following questions:
    a. What is West Nile Virus, and why is it a problem?
    b. How is West Nile Virus spread?
    c. Given what they now know about West Nile Virus, ask students if they are concerned about the virus. Could any of their friends or family be at severe risk for West Nile Virus? Why or why not?

Explore

1. Given that Asian Tiger Mosquitoes are known to carry West Nile Virus, ask students if they know if Asian Tiger Mosquitoes can be found in their neighborhoods.
2. If students are unsure about the distribution of Asian Tiger Mosquitoes, then ask them how they could find out. Students may suggest looking for mosquitoes (qualitative observations), but ask them how they could create a quantitative study.
3. One method to quantitatively survey for mosquitoes is to make homemade mosquito traps. These traps are most effective in the late spring-early fall when mosquito activity is high.
4. Have students either research trap designs or use the design provided at the end of this lesson. Be sure students justify reasons for design.
5. Once students have agreed on a design, have them work on a formal survey protocol. Some parameters to consider include:
    a. Study area(s)
    b. Number of traps to use in each area
    c. Placement of traps
    d. Duration of experiment
    e. How often traps should be checked
    f. Signage (to prevent tampering with traps)
6. Using the parameters set for the experimental design, have students put together a class data collection sheet. Encourage students to record date, time, temperature, and other weather factors with each collection point as well as incidental observations that they may find.
7. Place traps in study locations and continue with study. Periodically have students collect mosquitoes in traps to identify if any of the trapped mosquitoes are the Asian Tiger Mosquito. An identification sheet can be found at the end of

the lesson ('Least Wanted: Asian Tiger Mosquito'). Good magnifying glasses and/or a dissection scope is recommended for viewing mosquitoes. Forceps can help with handling soggy mosquitoes to place in a Petri dish.

Explain

1. At the end of the experiment, have students summarize their results. They may want to develop a formal PowerPoint presentation, or they could write up lab reports. Summaries should include:
    a. Whether or not Asian Tiger Mosquitoes were found and possible health implications if found;
        i. Have students consider people with increased risks for WNV like seniors, young children, and/or people with compromised immune systems. For example, if the mosquitoes were found near a retirement home, then that could likely pose a large health risk.
        ii. How students' findings could impact their lives
    b. If there were any differences in trap locations and number of mosquitoes caught
    c. If weather played a factor in any of their trapping days
    d. How the knowledge they learned can be applied
    e. Other factors examined with their data collection sheets
    f. Ways to improve study design

Evaluate

1. Evaluate students based on participation, study design, and analysis.
2. In addition to explaining the experiment, have students develop a community education/outreach plan designed to teach local residents about the dangers of West Nile Virus and their findings. Have students address ways that the community can prevent possible West Nile Virus outbreaks.

Extend

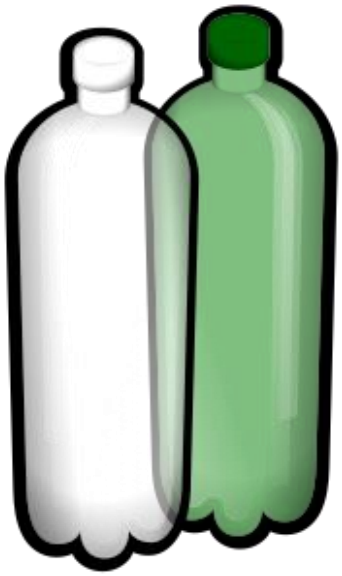
1. Have students research and debate on the pros and cons of controlling West Nile Virus. For example, pesticides are often sprayed in neighborhoods to control mosquito populations. However, these pesticides can have adverse impacts on other species.
2. Have students hypothesize whether or not climate change will impact West Nile Virus and Asian Tiger Mosquito abundance. Have students conduct research to support or reject their hypothesis.

Homemade Mosquito Traps

Have you ever wondered how mosquitoes find you? Female mosquitoes have nerve cells called cpA neurons that have a receptor to detect carbon dioxide. As you exhale, you release carbon dioxide, which in addition to skin odor, attracts hungry female mosquitoes. Therefore, to catch mosquitoes, effective mosquito traps use carbon dioxide as an attractant.

Materials:

- 1 cup of hot water
- ¼ cup of brown sugar
- 1 gram of yeast
- 1 2-L plastic bottle
- 8 inch square of screen, gauze, or cheesecloth
- Tape
- Black fabric or paper (optional)



Directions:

1. Cut the plastic bottle in half.
2. Mix sugar and hot water. Set aside to cool. When cool, pour in the bottom half of the bottle.
3. Add yeast which creates carbon dioxide.
4. Insert, screen, gauze, or cheesecloth above sugar water so mosquitoes don't fall into water.
5. Place funnel part of the bottle upside down and into the bottom half of the bottle.
6. Tape edges of bottle.
7. (Optional) Wrap top of bottle with black fabric or black paper. This action helps attract mosquitoes.
8. Leave bottle outside.
9. Be sure to replace contents once a week and remove mosquitoes.

Not Wanted: Asian Tiger Mosquitoes

Aedes albopictus

Susan Ellis, Bugwood.org [CC BY 3.0 us (http://creativecommons.org/licenses/by/3.0/us/deed.en)], via Wikimedia Commons

Wanted For: Spreading viruses including dengue fever, Eastern equine encephalitis virus, and West Nile Virus

Description:

- Black and white striped legs
- Black back (**scutum**) with white stripe down center from head to thorax
- Medium-sized mosquito (2.0-11.0 mm)
- Males have feather-like (**plumous**) antennae

Origin: Asia and Pacific Islands
Introduced Area: Introduced to North and South America, Africa, and Europe. Currently found in 26 states and 866 countries.

Zebra Mussels Invade the Chesapeake Bay Gr: 6-8

Objectives: At the conclusion of the lesson, students will be able to:

- Describe and map the spread of Zebra Mussels
- Describe how the Chesapeake Bay and students' lives may be affected in the future

Standards:

NGSS	**MS-LS2-2 –** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems **MS-LS2-4 –** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
Core Idea	**LS2.A: Interdependent Relationships in Ecosystems -** Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience -** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. **ESS3.C: Human Impacts on Earth Systems** - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
Practices	• Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence
Cross-Cutting Theme	• Cause and Effect • Patterns
Reading, Writing & Social Studies	**CCSS. Social Studies.SL.6-8-1 -** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics, texts, and issues, building on others' ideas and expressing their own clearly. **CCSS. Social Studies.SL.6-8.1.c -** Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion. **CCSS.Reading.RST.6-8.1–**Cite specific textual evidence to support analysis of science and technical text. **CCS.Writing.WHST.6-8.1–**Write arguments based on a discipline-specific content. **CCSS.Writing.WHST.6-8.2–**Write informative/explanatory texts, including the narration of historical events.

Environmental Literacy	**1.A.1:** Identify an environmental issue. **5.A.2.:** Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes.

Zebra Mussels Invade the Chesapeake Bay Gr: 6-8

Objectives: At the conclusion of the lesson, students will be able to:

- Describe and map the spread of Zebra Mussels
- Describe how the Chesapeake Bay and students' lives may be affected in the future

Materials:

- Article: "Zebra Mussels: Help Prevent Lake Champlain's Nuisance from Spreading to Other Lakes" by Lake Champlain Sea Grant (on CD)
- Internet Access
- Student Pages (on CD)

Teacher Background: An **invasive species** is an exotic species that invades natural systems and outcompetes natives or transmits disease. An **exotic** species is one that was introduced from another part of the world. Not all exotic species are invasive, but all invasive species are exotics. Zebra Mussels are one of several invasive mollusk species in North America.

Zebra Mussels are small aquatic mollusks classified as **bivalves** due to their 2 hinged shells. The species is native to streams and rivers in southern Russia but has also invaded much of Europe. The mussels were officially discovered in North America in 1988 when scientists discovered the mussels in Lake St. Clair, a body of water between Lake Huron and Lake Erie on the border of Canada and the United States. It is generally believed that these Zebra Mussels were first introduced to the Great Lakes region by transoceanic ships entering from the St. Lawrence Seaway. The Zebra Mussels may have been released through ballast water exchanges or attached to protected hull areas. From this entry point, Zebra Mussels have spread throughout numerous waterways in the United States with 30 states affected as of 2013. The Great Lakes are now a significant donor region for Zebra Mussels.

Zebra Mussels are adept at establishing themselves in new locations. They tolerate a wide-range of water temperatures and flourish in most freshwater environments. In addition, Zebra Mussels have a limited number of predators in North America. They can even survive in poor water quality conditions and out of water for several days.

Zebra Mussels grow and reproduce quickly with individuals becoming sexually mature after 1 year. The average egg production for 1 female Zebra Mussel is a million eggs per year! Eggs are released into the water where they are fertilized by males. After 3 to 5 days, the eggs hatch into microscopic Zebra Mussels called **veligers**. Veligers then drift/disperse in the water for up to a month. The juvenile stage begins when mussels

settle to the bottom, crawl around, and then find a suitable surface to attach to. Zebra Mussels can fasten themselves to most hard surfaces including boats, anchors, buoys, pipes, docks, rocks, other mollusks, and more. These characteristics combine to allow Zebra Mussels to hitchhike to new locations during each stage of their life cycle.

Zebra Mussels have a profound impact on the ecosystems they invade. Their presence causes native mussel and clam populations to plummet. They can also clog pipes, deteriorate dock pilings, sink buoys, and encrust boat hulls. Zebra Mussels disrupt aquatic food webs and can alter the flow of nutrients in an environment. Toxins accumulate in the mussels' tissues, which are then transferred to fish and birds when they are eaten. Zebra Mussels are so destructive that their introduction single handedly prompted a new division of scientific study called invasion ecology.

In this activity, students will map the invasion of Zebra Mussels in the Chesapeake Bay and will create a mock news segment discussing the invasion and its impacts on different people.

Procedure:

Engage

1. Ask students if they enjoy eating clams or mussels. Do any of their family members also like shellfish? In addition to being popular food items, what other roles do shellfish play in aquatic systems? *Shellfish help filter water and provide food for other species.*
2. What would happen if native clams and mussels disappeared in your local water bodies?
3. Tell the students that they are going to learn about how an invasive species, the Zebra Mussel, invaded Lake Champlain in Vermont.
4. Ask students what the term 'invasive' means to them. If they don't know the meaning, then have them try to deduce how an invasion could impact an aquatic system. Why would something that is invasive be a problem?
5. Handout the Sea Grant article and give students 5 minutes to read it over.
6. Guide students into a group discussion about the article using the following questions:
    a. How do Zebra Mussels spread to different lakes and areas? A: *Typically by boats or vegetation caught on boat trailers. They can also be carried by engine cooling systems, boat bilges, live wells, bait buckets, or scuba equipment.*
    b. How can Zebra Mussels affect the lives of people living around an invaded area? A: *Monetary losses for recreational and commercial boaters, dangerous beaches for beachgoers, and impact tourism and property values.*
    c. Once an area is "invaded" or taken over by Zebra Mussels, is there anything anyone can do about it? A: *Be smart about boating-wash off boats and empty bilge pumps before entering any body of water so they don't spread*

even more. There isn't much anyone can do once they have taken over an area (yet).

Explore

1. Tell students they are now going to explore the invasion of Zebra Mussels in the Chesapeake Bay using a mapping exercise.
2. Distribute the Student Page on 'Mapping the Invasion'. Have students use the steps outlined in the handout to map points on the Chesapeake Bay watershed where Zebra Mussels have been found to date. Have them write the date they were discovered next to each point.
3. Following the mapping exercise, reiterate the ways the Zebra Mussel was introduced into the different systems. Ask students if they think it would be easy or hard for Zebra Mussels to invade other systems. Why or why not?
4. Divide students into groups of 4.
5. Distribute the Student Page on 'Future Zebra Mussel Sightings'.
6. Have each group map out 10 more points where they think Zebra Mussels will be discovered in the next 10 years. Students need to have justification and a story for how each point got to where it is, and need to document that on the chart.
7. Give an example to the students, such as, "In the summer of 2013, a cluster was discovered by a fisherman in Baltimore Harbor! A boater from Maryland went on vacation to the Great Lakes and took his family's boat. They didn't wash the boat thoroughly before putting it back into the Harbor, and the Zebra Mussels survived on the boat and got into the Harbor."

Explain

1. Once maps are complete, have students create a mock TV news interview that takes place 10 years in the future. In the newscast, the newscaster will interview an avid Chesapeake Bay vacationer, a Bay fisherman, a seafood restaurant owner, and/or a boater on the Bay. Every group should decide on 1 person to play each role. Give students time to brainstorm and research questions and answers before they present their newscast to the class. Each newscast gets 4 minutes to present. Make sure they show their maps as a part of the newscast to explain the invasion.
2. After news interviews are complete, review ways different people were affected by the invasion. Were some of the people impacted more than others? Why or why not? Can students relate to any of the interviewees? Were students surprised at the impact of the Zebra Mussel invasions?

Evaluate

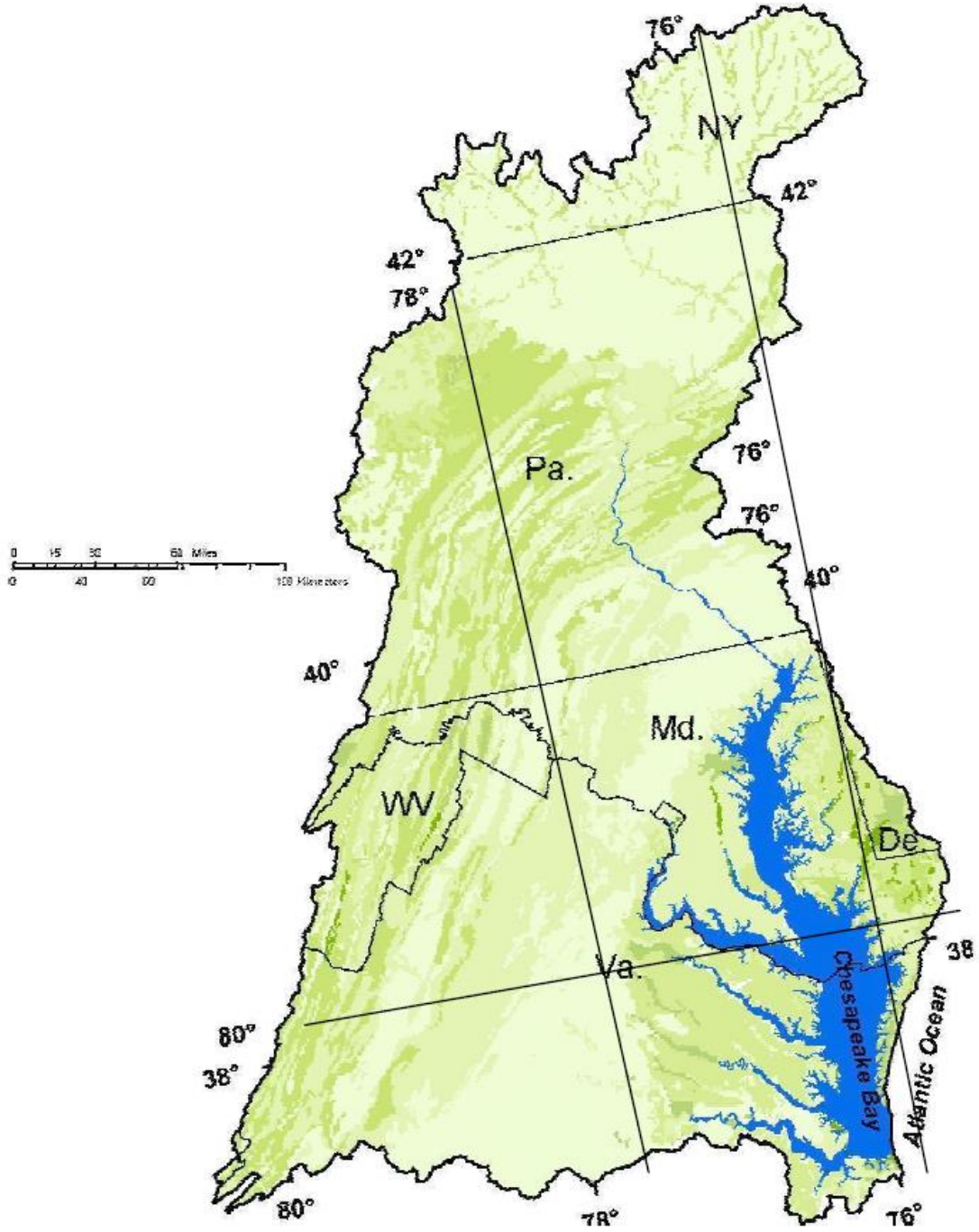
1. Have students write a newspaper article from 10 years in the future explaining how the invasion of Zebra Mussels has affected their lives.
2. Evaluate mapping sheets based on accuracy and descriptions of future Zebra Mussel invasions based on validity of reasoning.

Extend

1. Write a letter to boaters explaining the potential impact of Zebra Mussels and what they can do to stop the spread.
2. Create a poster to hang up in boating marinas explaining the potential impact of Zebra Mussels and how to stop the spread as a boater.
3. Create the ULTIMATE INVASIVE SPECIES! Have students get into groups and create the Ultimate Invasive Species! After their design, have students present their ultimate invasives to the class.
    a. Be sure students include:
        i. What the species looks like,
        ii. Where they live,
        iii. What they eat,
        iv. Where they came from,
        v. Why they are so successful at outcompeting the native species
        vi. A drawing of what the invasive looks like.

Student Page: Mapping the Invasion

Read about the invasion of the Zebra Mussel in the Chesapeake Bay watershed and map each invasion point using the latitude and longitude given. Longitude lines run vertically on the 'x' axis, and latitude lines run horizontally on the 'y' axis. Points are written out as (latitude, longitude). Next to each point, write the year discovered.



Student Page: Mapping the Invasion

Read about the invasion of the Zebra Mussel in the Chesapeake Bay watershed and map each invasion point using the latitude and longitude given. Longitude lines run vertically on the 'x' axis, and latitude lines run horizontally on the 'y' axis. Points are written out as (latitude, longitude). Next to each point, write the year discovered.

1. Zebra Mussels were first spotted in Eaton Brook Reservoir (42.8599,-77.6985) in the watershed in 2002. They were first discovered by boaters checking buoys before winter.

3. Zebra Mussels are invaders because they spread by attaching themselves to any hard surface. They attached themselves to a traveling fishing vessel which allowed them to spread to Canadarago Lake (42.7389,-76.9212) in 2002.

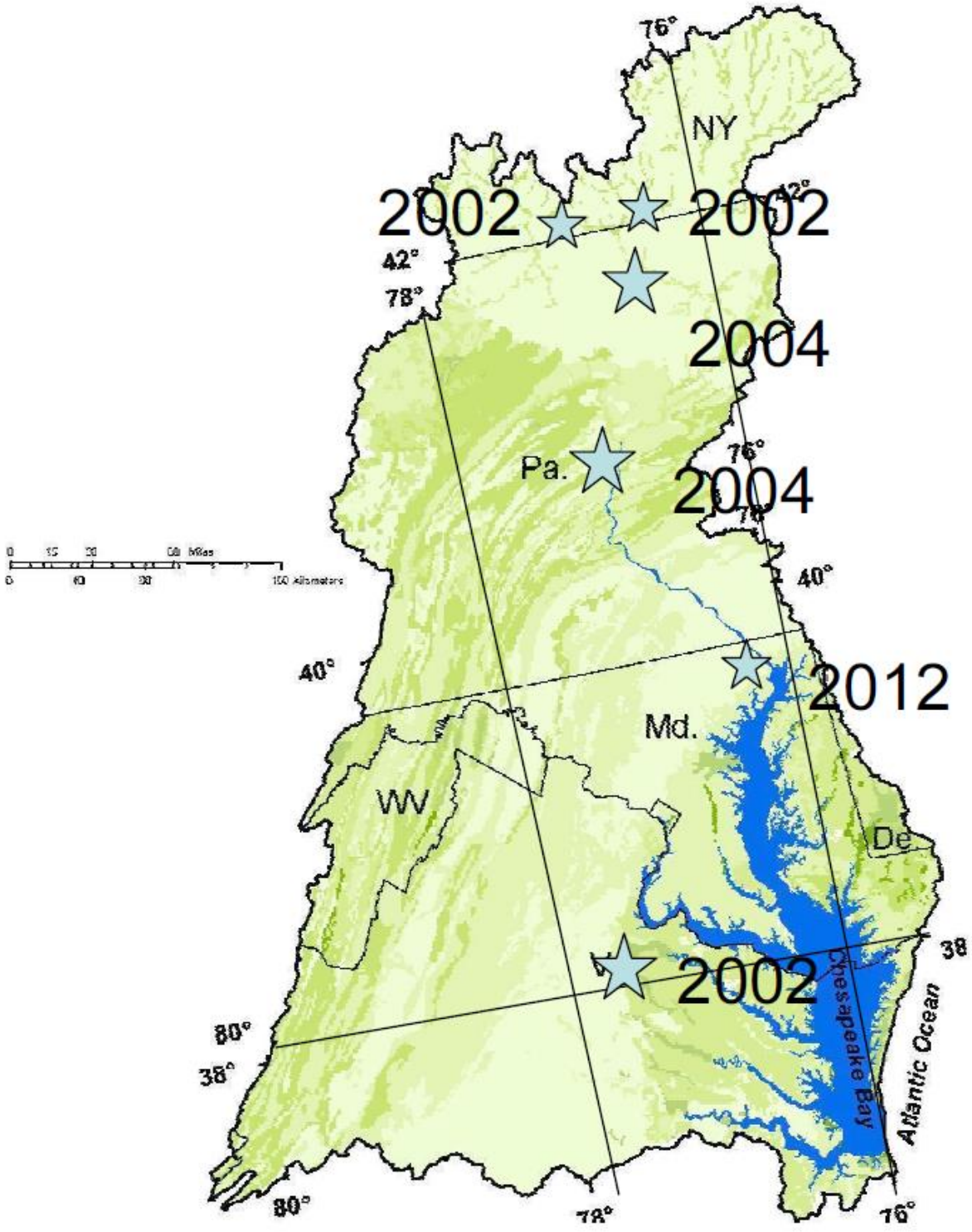
4. Also in 2002, another population of Zebra Mussels was discovered in Millbrook Quarry, a recreational diving spot in Prince William County in Virginia (38.857,-77.8422).

5. In June 2004, a fisherman found a bunch of Zebra Mussels in Goodyear Lake (42.4741,-76.9707). They were brought there by other fisherman who didn't rinse their boats after fishing trips in Lake Champlain.

6. Also in 2004, Zebra Mussels were found at the top of the Susquehanna River (40.8719,-76.7916). They originally came from Canadarago Lake, but their larvae (young) easily float downstream and attach to a new location. Unfortunately, the Susquehanna River is large and very long and can possibly enable more larvae to float all the way into the Chesapeake Bay.

7. In 2012, Zebra Mussels were finally found in the Chesapeake Bay, right off the shore of Havre de Grace (39.5527,-76.092). They had traveled down the Susquehanna River as larvae and then attached to a buoy in the Bay. This site is being closely monitored.

Answer Page


76°
NY
2002
2002
42°
78°
2004
Pa.
2004
76°
40°
40°
2012
Md.
WV
De
38
2002
80°
38°
Chesapeake Bay
Atlantic Ocean
80°
78°
76°

Student Page: Future Zebra Mussel Sightings

Number	Latitude	Longitude	Year	Method of Dispersal
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Additional Notes: