

Invasive Investigators

Grade Level(s): 9-12

Time: 2 class periods

Group Size: one class

Summary

Students will learn about several of NY's aquatic invasive species and learn how humans play a role in the introduction of these species.

Objectives

- Students will be able to identify at least two lakes and rivers found in NYS
- Students will be able to identify several invasive species found in NYS
- Students will be able to compare and contrast the vectors/methods in which invasive species are introduced into an environment
- Students will be able to name several prevention methods to stop the spread of invasive species

Materials

- Pictures of invasive species,
- Invasive Investigators game
 - *Invasive Investigators board*
 - *Player pieces (7):* lionfish, sea lamprey, northern snakehead, European green crab, water chestnut, Eurasian milfoil, zebra mussel
 - *Vector pieces (6):* ballast water, canals, bait release, aquarium trade, intentional introduction, hitchhiker.
 - *Cards:* 21 total (7 Species, 6 Vectors, 8 Waterbodies)
 - *Confidential Case File*
 - *Investigator Note cards*
 - *Pencil/pen for each player*
 - *1 die*
 - *Game Rules*
- *Most Wanted Posters* for each invasive species found in the game.

NYS Learning Standards

Core Curriculum MST

Standard 1: Analysis, Inquiry, and Design

Students will: use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

- *Key Idea 1:* The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Standard 4: Living Environment

Students will: understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science

- *Key Idea 1:* Living things are both similar to and different from each other and nonliving things.
- *Key Idea 6:* Plants and animals depend on each other and their physical

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Vocabulary

- **Biodiversity**- the number and variety of plant and animal species living in a given environment
- **Competition**-the simultaneous demand by two or more organisms for the same resource
- **Generalist**-a species that can live in a wide range of environmental conditions and can make use of a variety of resources
- **Invasive species**- a non-native plant or animal deliberately or accidentally introduced into a new habitat whose introduction causes or is likely to cause economic or ecological harm.
- **Non-native species/exotic species**- an organism living outside its native distributional range
- **Specialist**- a species that can only live in a narrow range of environmental conditions or has a limited diet
- **Vector**- the mode of transportation for an invasive species (ballast water, hitchhiker, intentional introduction, waterways, aquarium trade, bait release)

Background

Invasive species are also called: invaders, **exotics**, invasives, and **non-native species**. However, all names have the same definition. An **invasive species** is a non-native plant or animal deliberately or accidentally introduced into a new habitat whose introduction causes or is likely to cause economic or ecological harm.

Methods of Introduction

There are six recognized methods of introduction or **vectors**: hitchhiker, aquarium trade, ballast water, bait release, intentional introduction, and canals. All introduction methods are caused by humans, however some are deliberate and others are accidental.

Vectors

Hitchhiker-organism that “catches a ride” from one body of water to another; common rides include boat trailers, waders, nets, etc.

Aquarium Trade- Organisms introduced to new areas through aquarium and pet shop sales

Ballast Water- Large oceanic vessels take water in ballast to help with balance; organisms are taken in at one port and released at another

Bait Release- Bait is released into a new body of water after fishing

Intentional Introduction- a species is released into an ecosystem on purpose

Canals- Organisms move from one waterbody to another via canal systems

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Characteristics of a Typical Invasive Species

Invasive species possess several characteristics that allow them to survive and flourish in new ecosystems. Invasive species tend to be **generalists**, meaning that they will make use of different resources. Most invasives can tolerate a wide range of environmental conditions and are able to survive in various habitats. **Specialist** species can only live in a small range of environmental conditions and/or they depend on specific habitat or food resources.

Invasive species also tend to reproduce rapidly and disperse with ease (examples are laying thousands of eggs, or dispersing seeds in the wind). When invasives are introduced to an area, they frequently have no natural predators or parasites. This allows for growth at a fast rate, and in most cases, native species are lost or replaced by non-native species.

Impacts

One of the greatest impacts invasive species can have on an environment is loss of **biodiversity**. Invasive species represent the second leading cause of species extinction and loss of biodiversity in aquatic environments worldwide. A good example is the round goby in the Great Lakes. This small, bottom dwelling freshwater fish has outcompeted native fish such as darters and sculpins. Due to their aggressive nature, this fish can take over ideal habitat and eat other fish's eggs and young. Substantial reductions in local populations of sculpins already have been reported from areas in which gobies have become established.

Another impact is cost. Invasive species can bring about large economic costs to introduced areas. For example, the zebra mussel, originally from the Caspian Sea region of Asia, clogs waterways and irrigation systems which have cost the Great Lakes area billions of dollars in clean up efforts. In fact, since 1989, some facilities located on Lake Erie have reported big reductions in pumping capacity and occasional shutdowns caused by encrusted zebra mussels.

Prevention

To prevent the introduction or spread of invasive species, a few simple steps can be taken:

- Learn to identify common exotic species
- Tell others about the possible harm of invasive species
- If you think you've found an invasive species, contact your local NYS DEC office
- Do not release unwanted plants or animals into the wild unless they came from that body of water
- Do not release unused bait
- Remove any plants, animals or mud before transporting equipment
- Eliminate water from all equipment before transporting to prevent small larval forms of aquatic invaders from spreading
- Wash/rinse and dry anything that came in contact with the water

Main Activity

Introduction

1. Introduce yourself and the day's activities:
 - a. Presentation about invasive species

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b. Invasive Investigators Game

Invasive Presentation

- Define invasive species. Exotic and invasive species are most common.
- Define Vectors; have students brainstorm how invasive species are introduced into the environment. Review each vector (intentional introduction, canals, hitchhikers, bait release, ballast water, aquarium trade).
- Discuss the impacts of invasive species:
 - Economic: removal/repair projects can cost thousands to millions of dollars
 - Biological: loss of biodiversity, outcompetes native species
- Give a few examples and show pictures of local invasives, some suggestions include:
 - Round Goby (*Neogobius melanostomus*):
 - Native to Black and Caspian Sea areas of Eastern Europe
 - Present in the Great Lakes
 - Spread by ballast water and worked its way through canals and waterways
 - Very aggressive fish species, out competes native fish for food and shelter
 - Purple Loosestrife (*Lythrum salicaria*):
 - Native to Europe
 - Presently distributed across most of the U.S. and Canada
 - Spread by intentional introduction (ornamental) and ballast water
 - Outcompetes native plants and reduces food and habitat for wildlife
 - Water Primrose (*Ludwigia peploides*)
 - Native to tropical and subtropical South America
 - Presently in 30 U.S. States (including NY)
 - Intentionally introduced as an ornamental, spreads by fragmentation and hitchhiking
 - Blocks waterways for recreational use, reduces biodiversity and degrades water quality by decreasing pH and dissolved oxygen content

Invasive Investigators of NYS

- Explain that the object of game is to solve a mystery
 - Do that by asking questions
 - Review game procedures and rules.
 - Option: have the rules up on a projector screen or hand out a copy to each group.
- Make the comparison between *Invasive Investigators* and *Clue*:

Clue	Invasive Investigators
Players	Invasive Species
Rooms	NYS Waterbodies
Weapons	Vectors

- Split up the students into groups of 5-6, with at least one student in each group who has played Clue before, or have one instructor play with each group
- Distribute board and game pieces

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Option 1: The instructor can predetermine the case so that the correct species, location, and vector are in the case file.

Option 2: Students divide the cards into three piles (vector, species, and locations), selecting one card from each pile at random and inserting these chosen cards into the confidential case file without looking.

- Have kids play game. Circulate among students, offering help where needed.

Wrap up

Option 1: If the case was predetermined, the instructor will ask the students to record the information for each case file. The instructor will ask the students to share:

- Invasive species name
- Where found in NYS
- Vector used to get there

Option 2: If the case was randomly determined, the instructor will ask the students if this scenario is or is not possible (examples, the lionfish is a saltwater fish, cannot survive in a freshwater lake).

Preventing Invasive Species

- After playing the game, have the students brainstorm ways to prevent the spread of invasive species.
 - Make sure to include the following:
 - Learn to identify common exotic species
 - Tell others about the possible harm of invasive species
 - If you think you've found an invasive species, contact your local NYS DEC office
 - Do not release unwanted plants or animals into the wild unless they came from that body of water
 - Do not release unused bait
 - Remove any plants, animals or mud before transporting equipment
 - Eliminate water from all equipment before transporting to prevent small larval forms of aquatic invaders from being carried from one waterbody to another
 - Wash/rinse and dry anything that came in contact with the water

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Relation to Fishing

Aquatic invasive species often affect recreational uses of water (fishing, boating, swimming, etc.). The NYSDEC's Freshwater Fisheries Unit is responsible for managing all of the freshwater resources in a given region, making it difficult to survey each waterbody every year. Anglers can assist the NYSDEC in finding aquatic invasive species by notifying fisheries staff if they find an invasive species. Anglers can also help prevent the spread of invasive species by properly cleaning their boats and fishing gear after every use.



Review

After this presentation:

- Have the students identify several aquatic invasive species found in NYS
- Ask the students to discuss the vectors/methods in which invasive species are introduced into an environment
- Have groups describe a prevention method to stop the spread of invasive species

Questions for Discussion

Q: Name an invasive aquatic plant species found in NYS

A: Answers may vary: Water primrose, Purple Loosestrife, Eurasian Milfoil, Water Chestnut

Q: Not all non-native species are considered invasive, why not?

A: Not all non-native species cause economic or ecological damage

Q: What can you do to prevent the spread of an invasive species?

A: Answers may vary: do not release unwanted plants or animals into the wild, do not release unused bait, clean off your fishing/boating equipment after every use

Q: Which vectors are considered accidental? deliberate?

A: Accidental vectors include canals, ballast water, and hitchhikers. Deliberate vectors include bait release, aquarium trade, and intentional introduction

Q: What are some characteristics of invasive species that allow them to outcompete native species?

A: Invasive species are usually generalists and rapid reproducers, and when initially introduced to an ecosystem they are without natural predators.

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Additional Assessment Suggestions

- Have students complete the provided *Most Wanted* posters following this lesson.
- Have students research a given invasive species and write a brief paper on the history of this species.
- Have students research the player/species they chose in the game
- Have students write a brief paper on why their case scenario is or is not possible.

Web Resources

“Common Aquatic Invasive Species,” NYSDEC

<http://www.dec.ny.gov/animals/50272.html>

Provides background information on Eurasian watermilfoil, water chestnut, fanwort, curly leaf pondweed, didymo, round goby, zebra mussel, alewife, white perch.

“Nuisance and Invasive Species,” NYSDEC

<http://www.dec.ny.gov/animals/265.html>

“Introduced, Invasive, and Noxious Plants,” USDA NRCS

<http://plants.usda.gov/java/noxiousDriver>

“National Invasive Species Information Center,” USDA National Agricultural Library.

<http://www.invasivespeciesinfo.gov/index.shtml#.UR0UkBr4-iA>

Provides a list of aquatic invasive species for each state.

“New York Invasive Species,” New York Invasive Species Clearinghouse, Cornell Cooperative Extension <http://www.nyis.info/>

“Aquatic Invasive Species,” Minnesota Sea Grant.

<http://www.seagrant.umn.edu/ais/index>

Provides species profiles with pictures for purple loosestrife, Eurasian watermilfoil, round goby, sea lamprey, rusty crayfish, and more.

“Biological Criteria,” United States Environmental Protection Agency (EPA)

<http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/biocriteria/index.cfm>

Provides information on biological assessment criteria for lakes, streams, estuaries, wetlands, and coral reefs.

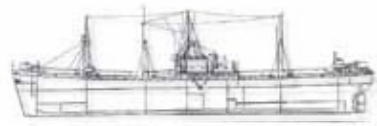
Invasive Investigators

Object:

Solve the mystery of “what Species, what Vector, and in what NYS Waterbody,” which is contained in the “Confidential Case File”.

Materials:

- *Invasive Investigators board*
- *Player pieces (7): lionfish, sea lamprey, northern snakehead, European green crab, water chestnut, Eurasian milfoil, zebra mussel*
- *Vector pieces (6): ballast water, canals, bait release, aquarium trade, intentional introduction, hitchhiker.*
- *Cards: 21 total (7 Species, 6 Vectors, 8 Waterbodies)*
- *Confidential Case File*
- *Investigator Note cards*
- *Pencil/pen for each player*
- *1 die*



Invasive Investigators Rules:

- Sort the pack of cards into three groups: Species, Vectors and Waterbodies. Shuffle each group separately and place each face down on the table.



- Option 1: Take the top card from each group and place it into the envelope. The Case File now contains the answers to the questions: What Species? Where in NYS? What Vector?
- Option 2: The instructor will predetermine the three cards in the Case File.



- Hand out an investigator note sheet to each player.
- Shuffle the three piles together and distribute the remaining playing cards to the players. It is ok if some players end up with more cards.
- Secretly look at your cards and check them off on your note sheet. Make sure no one can see your note sheet!
- Place all the species tokens on start. The player with the closest upcoming birthday goes first. Take turns going clockwise around the table.

Game Play:

- Roll the die to move your player. If you land on a space with footprints you can roll again!
- If you land in a “Waterbody” you can make an inquiry as to what is in the case file.

Making an Inquiry:

As soon as you enter a Waterbody, make an Inquiry. By making inquiries throughout the game, you try to determine— by process of elimination— which three cards are in the *Confidential Case File* envelope.



To make an Inquiry, move a Species token and a Vector token into the Waterbody space that you just landed on. Then suggest that the crime was committed in that Waterbody, by that Species, with that Vector.

Example: You're the lionfish token and you enter the Hudson River Waterbody space. First move another species token— European green crab, for instance— into the Hudson River Waterbody space. Then move a vector— ballast water, perhaps— into the Hudson River. Then say, "I think it was the European green crab in the Hudson River transported by ballast water."

Remember two things:

- You must land on the Waterbody that you mention in your Inquiry (if you roll a number higher than it takes to land on the Waterbody, you may stop on the Waterbody, you don't have to use the total number of spaces).
- Be sure to consider all tokens— including spare species and including yourself!— as falling under equal suspicion.

Proving a Suggestion True or False

As soon as you make an Inquiry, your opponents, in turn, try to prove it false. The first to try is the player counterclockwise from you. This player looks at his or her cards to see if one of the three cards you just named is there. If the player does have one of the cards named, he or she must show it to you and no one else. If the player has more than one of the cards named, he or she selects *just one* to show you. If that opponent has none of the cards that you named, then the chance to prove your inquiry false passes, in turn, to the next player counterclockwise. As soon as one opponent shows you one of the cards that you named, it is proof that this card cannot be in the envelope. End your turn by checking off this card in your notebook. (Some players find it helpful to mark the initials of the player who showed the card.)

*If no one is able to prove your inquiry false, you may either end your turn or make an Accusation now.

Making an Accusation

When you think you've figured out which three cards are in the envelope, you may, *on your turn*, make an Accusation and name any three elements you want. First say, "I accuse (Species) of committing the crime in the (Waterbody) with the (Vector)." Then, so no one else can see, look at the cards in the envelope.

* In an inquiry, the Waterbody you name must be the Waterbody where your token is located. But in an Accusation, you may name any Waterbody.

Remember: You may make only one Accusation during a game.

If Your Accusation Is Incorrect

If any one of the cards that you named is not inside the Case File:

- Secretly return all three cards to the envelope.
- You cannot make further moves in the game, and therefore cannot win, but you do remain involved



Winning

You win the game if your Accusation is completely correct— that is, if you find in the envelope all three of the cards that you named. When this happens, take out all three cards and lay them out for everyone to see.

Lake Erie



Western NY



Finger Lakes

Start



Footprints=roll again

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St. Lawrence River



Adirondacks

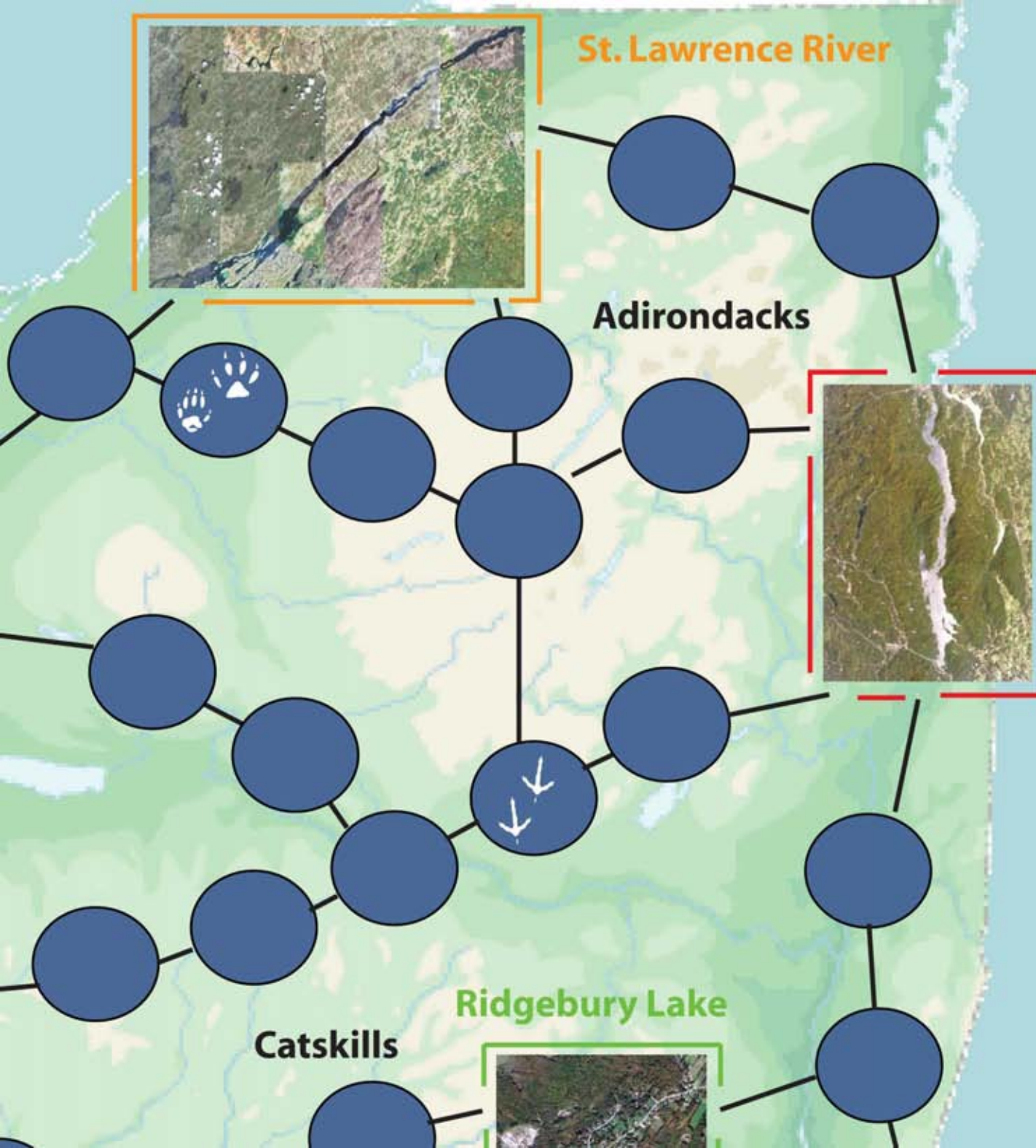


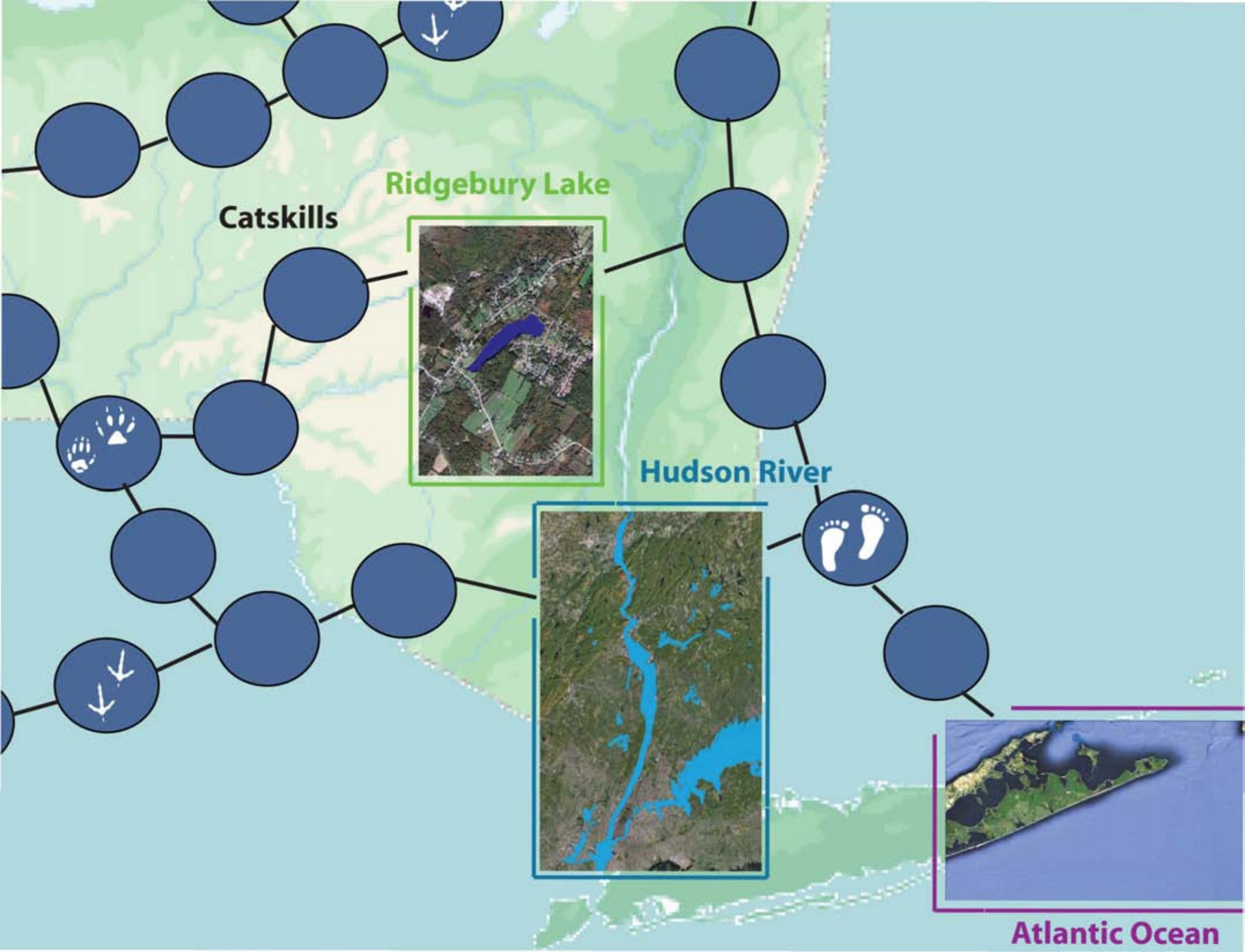
Lake George

Ridgebury Lake



Catskills





Catskills

Ridgebury Lake

Hudson River

Atlantic Ocean

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European green crab



Carcinus maenas

Lionfish



Pterois volitans

Eurasian watermilfoil



Myriophyllum spicatum

Water chestnut



Trapa natans

Sea lamprey



Petromyzon marinus

Zebra mussel



Dreissena polymorpha

Northern Snakehead



Channa argus

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Atlantic Ocean



Lake George



St. Lawrence River



Lake Erie



Finger Lakes



Ridgebury Lake



Lake Ontario



Hudson River



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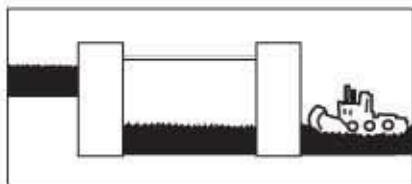
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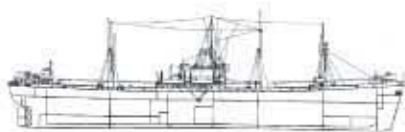
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canals



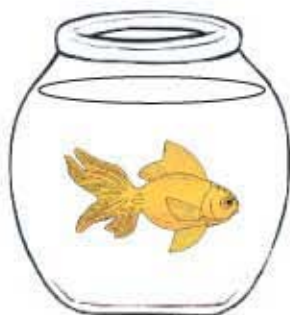
ballast water



intentional
introduction



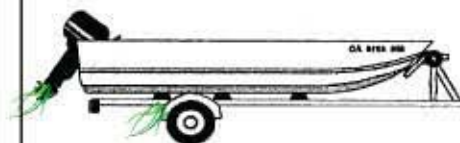
aquarium trade



bait release



hitch hiker





Eurasian watermilfoil



Eurasian watermilfoil



northern snakehead



northern snakehead



zebra mussel



zebra mussel



lionfish



lionfish



sea lamprey



sea lamprey



European green crab



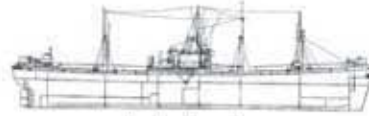
European green crab



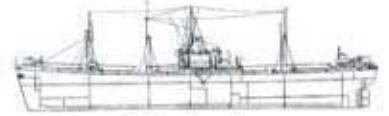
water chestnut



water chestnut



ballast water



ballast water



intentional introduction



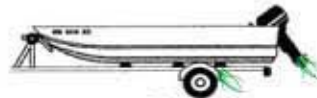
intentional introduction



Aquarium Trade



Aquarium Trade



Hitchhiker



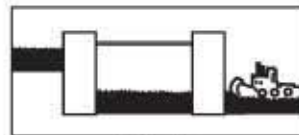
Hitchhiker



Bait Release



Bait Release



Canals



Canals

CLASSIFIED CASE FILE



INVESTIGATOR NOTES	
SPECIES	
sea lamprey	
Eurasian watermilfoil	
lionfish	
European green crab	
zebra mussel	
northern snakehead	
water chestnut	
VECTOR	
intentional release	
bait release	
ballast water	
canals	
aquarium trade	
hitch hiker	
WATERBODY	
Lake Ontario	
Lake Erie	
Hudson River	
Atlantic Ocean	
Ridgebury Lake	
St. Lawrence River	
Finger Lakes	
Lake George	
NOTES	

INVESTIGATOR NOTES	
SPECIES	
sea lamprey	
Eurasian watermilfoil	
lionfish	
European green crab	
zebra mussel	
northern snakehead	
water chestnut	
VECTOR	
intentional release	
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INVESTIGATOR NOTES	
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Eurasian watermilfoil	
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WATERBODY	
Lake Ontario	
Lake Erie	
Hudson River	
Atlantic Ocean	
Ridgebury Lake	
St. Lawrence River	
Finger Lakes	
Lake George	
NOTES	

INVASIVE SPECIES MOST WANTED:



EUROPEAN GREEN CRAB

You are an Invasive Species Investigator and you are informing the public about European green crabs. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



EURASIAN WATERMILFOIL

You are an Invasive Species Investigator and you are informing the public about eurasian watermilfoil. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



LIONFISH

You are an Invasive Species Investigator and you are informing the public about lionfish. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



NORTHERN SNAKEHEAD

You are an Invasive Species Investigator and you are informing the public about northern snakeheads. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

INVASIVE SPECIES MOST WANTED:



ROUND GOBY

You are an Invasive Species Investigator and you are informing the public about round gobies. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



RUDD

You are an Invasive Species Investigator and you are informing the public about rudd. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



SEA LAMPREY

You are an Invasive Species Investigator and you are informing the public about sea lamprey. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



STRIPED BARNACLE

You are an Invasive Species Investigator and you are informing the public about striped barnacles. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



WATER CHESTNUT

You are an Invasive Species Investigator and you are informing the public about water chestnut. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.

INVASIVE SPECIES MOST WANTED:



ZEBRA MUSSELS

You are an Invasive Species Investigator and you are informing the public about zebra mussels. You will create a “Most Wanted” flyer using the information you just learned about your invasive species.

In the space below write a brief paragraph or description of the invasive species. Include information such as: where it is native to; how it got here; where it is present; and the consequences of the species being introduced.

Be sure to list **TWO** ways that you can help stop the spread of invasive species.