LONG ISLAND SOUND EELGRASS GAME

How do human actions impact Long Island Sound's water quality and eelgrass meadows?

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The Great Bay Eelgrass Game
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SUMMARY

Eelgrass (*Zostera marina*) is an aquatic flowering plant that is a critical part of the Long Island Sound ecosystem. The Sound's eelgrass meadows have been declining since the 1930s, primarily due to what is known as **wasting disease**. Following this die-off, eelgrass populations returned to the eastern Sound, but **nutrient pollution** and limiting light availability has likely inhibited recovery in the western Sound. By the 1990s, there was a trend that even the areas that began to recover in the east were now at risk because of nutrient pollution from the increasing human population. As a **bioindicator** and **keystone species**, the health of Long Island Sound's eelgrass beds directly relate to the health of the entire **estuary**.

In this game, students will assume real world scenarios and "roles" of the individuals who interact directly or indirectly with eelgrass in the Long Island Sound watershed, such as residents, farmers, fishers, and developers. Students will make decisions based on their roles that impact the estuary's water quality and health of its eelgrass beds. Each role card has a corresponding reading about a related topic in Long Island Sound watershed.

OBJECTIVES

Students will:

- Discuss water quality and eelgrass habitat challenges in the Long Island Sound watershed;
- Make reality-based choices that impact water quality and eelgrass habitat in a simulation game adapted for the Long Island Sound watershed region;
- Explain how various social, environmental, and economic factors impact decision-making; and
- Understand that individual actions can have cascading effects on society.

LOGISTICS

Grade Level: 6-12

Subject Areas: Environmental Science, Social Studies

Duration: 1-2 class periods, extension resources available

Setting: Classroom or open flow

HIGHLIGHTS

- Interactive simulation game with real world scenarios and local articles.
- Adaptable for middle and high school students with varied time constraints.

Long Island Sound Eelgrass Game

KEY CONCEPTS:

1. Long Island Sound is an **estuary** - a place where freshwater and saltwater mix, creating a unique and constantly changing habitat.
2. Eelgrass (*Zostera marina*) is an aquatic flowering plant that lives in Long Island Sound and other estuaries around the world. Eelgrass is a **keystone species** that helps keep the whole estuary ecosystem intact. Eelgrass meadows filter water, keep sediments from washing away, and provide habitat, food sources, and breeding grounds for estuary organisms.
3. Eelgrass is a **bioindicator**. The health of eelgrass beds directly relates to the health of the estuary and its inhabitants. Long Island Sound eelgrass beds have been at risk since the 1990s, due to runoff pollution caused by human activities. Restoration efforts are underway, but there are still obstacles to overcome. **Bioindicators** are species, groups of species, or biological communities whose presence, abundance and condition indicate the current and potential future health of that ecosystem.
4. Humans, as individuals and groups, make decisions that impact the Long Island Sound estuary. Many decisions are complicated and have tradeoffs that positively or negatively impact Long Island Sound's water quality and eelgrass meadows.

VOCABULARY DEFINITIONS

Bioaccumulation – the process by which toxins are concentrated in organisms that are higher on the food chain

Bioindicator – a species whose health indicates the current and potential future health of the rest of its ecosystem

Bilge – the bottom outer part of a boat's main body where the vertical outer walls meet and curve

Eelgrass - *Zostera marina*, an aquatic flowering plant that thrives in clear, salty water

Estuary – a body of water where saltwater and freshwater mix

Eutrophication – a process by which there is an overabundance of plant growth often due to excess nutrients in a water body

Fouling – accumulation of organisms or oil on surfaces

Hypoxia – a condition when there are low oxygen levels in a water body

Keystone Species – a species that the rest of its ecosystem depends on

Limiting Nutrient – a nutrient whose abundance determines the growth of plant matter

Non-point source pollution – pollution that cannot be traced back to a single source

Nutrient pollution – having too much of one nutrient, typically nitrogen, that has negative ecosystem consequences

Pathogen – a microorganism that can cause diseases

Point source pollution – pollution that can be traced back to a single source

Rhizomes – underground stem part of the root system for eelgrass that helps anchor them in the ground

Turbidity – the measure of the cloudiness of water

Wasting disease- disease that is caused by a pathogen (*Labyrinthula zosterae*) that feeds on eelgrass tissue

TEACHER BACKGROUND

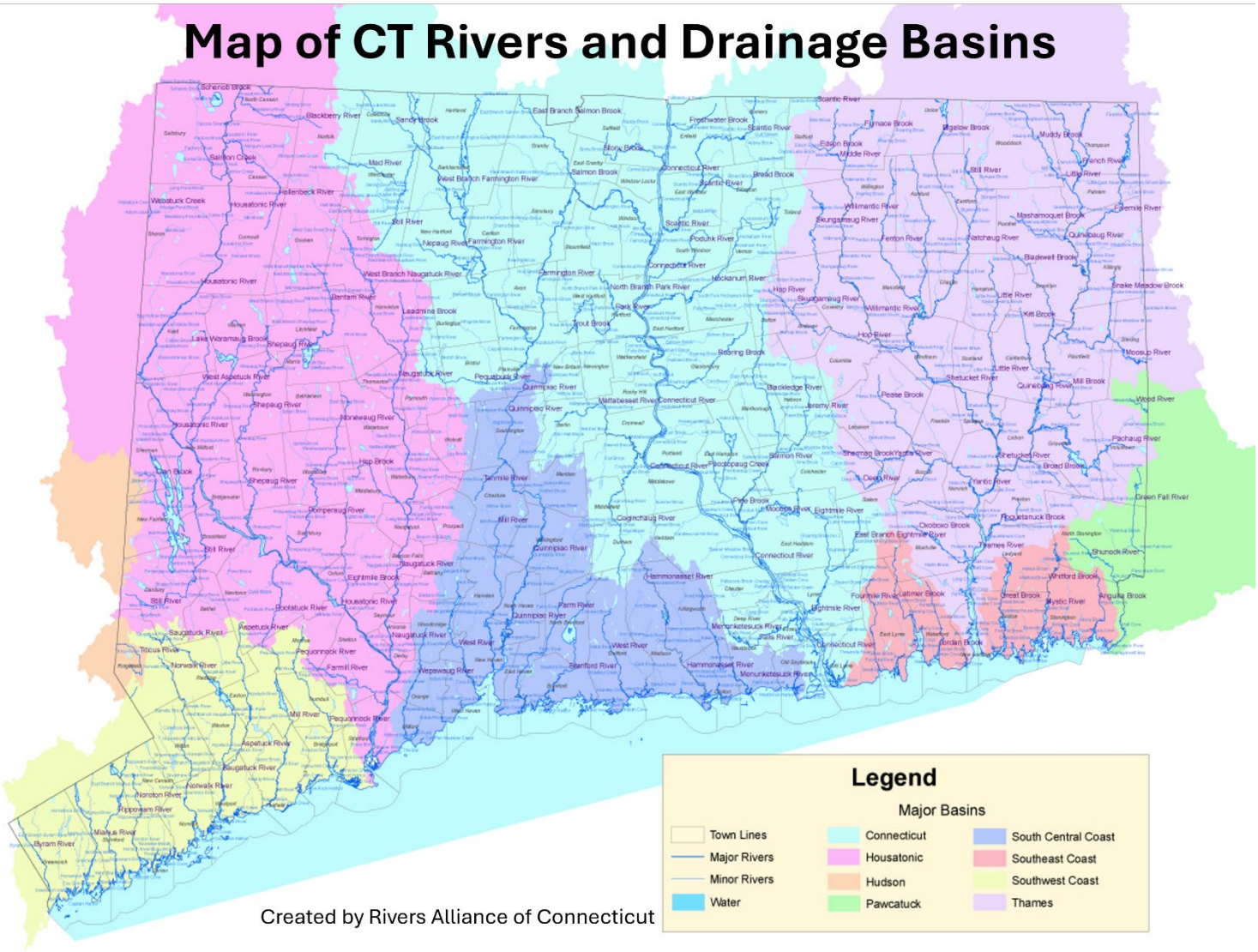
Estuaries are some of the most important habitats on the planet. The unique habitat created by the mixing of freshwater from rivers and saltwater from the ocean is rich in biodiversity and productivity. Estuaries have been prized for their commercial, ecological, and cultural importance for centuries.

Long Island Sound is an estuary of national importance.

Did you know that the Sound:

- Borders Connecticut and New York with some river input from Rhode Island? There are about 12 rivers that flow into the Sound, including the Connecticut River, Quinnipiac River, Housatonic River, Pawcatuck River, and Thames River.
- Is about 1,300 square miles with an average depth of 65 feet? Twice a day, 25 billion gallons of water rush into the Sound with the tides, making strong currents.
- Has been utilized for centuries by Indigenous people of the region? Visit the Native Land Digital website (LINK) to learn more about the native people in your region.
- Includes habitat types such as salt marshes, beaches, open water, and submerged aquatic vegetation (provided mainly by eelgrass)? These habitats are home to birds, reptiles, fish, mollusks (shelled animals), and plants. Habitat loss and the decline of eelgrass beds can harm wildlife, fish, and plant populations.

- Is one of the 28 estuaries designated by the US Environmental Protection Agency (EPA) as having national importance? The Long Island Sound Partnership was formed in 1985 as a bi-state partnership to help manage the Sound. The Partnership consists of federal and state agencies, user groups, concerned organizations, and individuals dedicated to restoring and protecting the Sound.



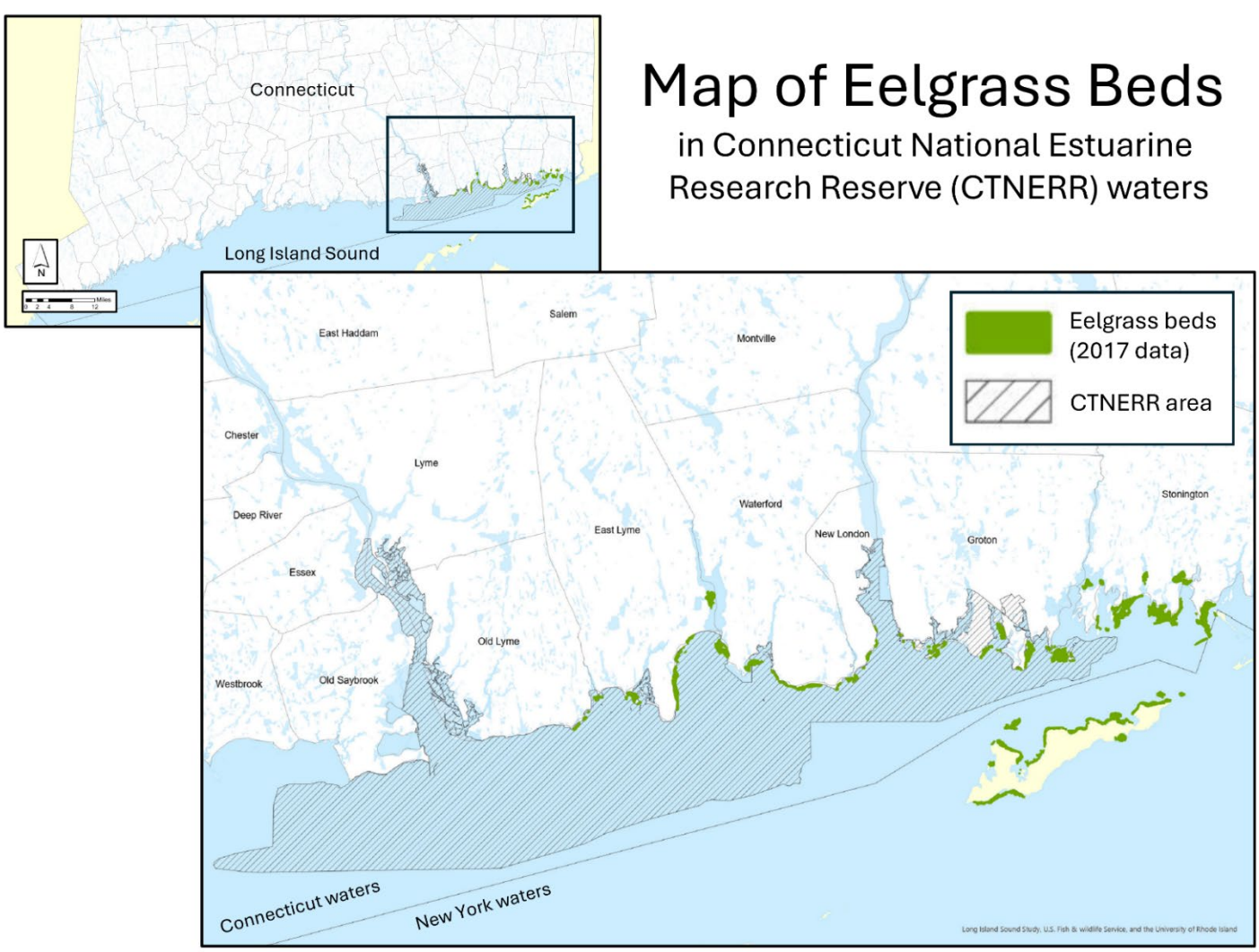
Eelgrass is a critical component of a healthy estuary. Eelgrass (*Zostera marina*) is an aquatic flowering plant and a **bioindicator**, meaning that the health of eelgrass beds directly relates to the overall health of the estuary; eelgrass has been called the “canary in the coalmine” of estuaries. Declines in eelgrass meadows foreshadow the decline of other estuarine life.

Clear water is critical to eelgrass success. Eelgrass is a rooted plant that depends on sunlight to photosynthesize. Cloudy waters block sunlight from reaching eelgrass blades. Long Island Sound's **turbidity** is primarily due to loose sediments and overgrowth of algae. Severe storms, warming waters, and disease outbreaks - all increasingly fueled by climate change - have also contributed to the decline of eelgrass. While restoration and research projects are underway, more work is needed to reduce nutrient and sediment pollution. These efforts are critical to retaining remaining and restored eelgrass meadows in Long Island Sound.

Pollution can negatively impact eelgrass. Point source (pollution that can be traced back to one location, e.g. a water treatment plant) and **non-point source pollution** (pollution that cannot be traced back to one location, e.g. fertilizers in stormwater runoff leached from multiple lawns) contribute to the contaminants in Long Island Sound, most notably nitrogen. Excess nitrogen in water bodies often results in overgrowth of algae and other nuisance plant varieties**,** a process known as **eutrophication**. Algae and seaweed - along with sediments and dissolved organic matter - cloud the water in Long Island Sound, making it difficult for eelgrass meadows to survive because of low light.

The loss of eelgrass has lasting effects. Eelgrass meadows help maintain water quality and decrease **water turbidity** (the measure of the cloudiness of water and a critical metric for measuring eelgrass, ecosystem, and overall estuary health). Eelgrass stabilizes coastal sediments. Its rhizomes grip seafloor sediment and its ribbon-like leaves trap loose particles in the bay's water column in addition to slowing the movement of water. Eelgrass also provides habitats for water-filtering organisms such as oysters. Eelgrass meadows provide food, mating grounds, and habitat for numerous crustaceans, shellfish, fish, amphibians, birds, and mammals. Eelgrass is a **keystone species**, which means that it helps hold its home ecosystem together. Without eelgrass, the estuary ecosystem can fall apart.

The Connecticut Reserve studies Long Island Sound eelgrass meadows. The Connecticut National Estuarine Research Reserve includes over 50,000 acres in eastern Long Island Sound and more than half of the eelgrass beds in the Connecticut portion of Long Island Sound (Figure 2). Reserve staff study eelgrass meadows and help protect this important habitat.



ACTIVITY OVERVIEW

The Eelgrass Game is an interactive simulation game geared towards middle and high school students. Students assume the roles of "real world" individuals who interact with the Long Island Sound watershed, such as homeowners, farmers, fishers, and developers. These roles require students to make decisions that impact the water quality and the health of eelgrass beds in Long Island Sound, demonstrated by completing "actions" that change the water quality of the simulated "Long Island Sound." Students then rate their model's final water quality to a predetermined gradient and explore what that means for the future of their eelgrass meadows.

USEFUL INFORMATION

Student/Teacher Role Cards

Each student receives a **Role Card** which presents a situation that affects Long Island Sound's water quality and eelgrass meadows. In this game, every role card scenario has either happened in real-life or is a plausible situation in the Long Island Sound watershed region.

Each situation has a corresponding **Action**, many of which result in physical or chemical changes to the composition of the simulated Long Island Sound. Background **Context** and corresponding **Real World Reference** reading are also included to provide additional information about the role.

Throughout the game, students introduce various materials to the Sound. Each material represents a type of pollutant that impacts the water quality and eelgrass health of Long Island Sound. These include:

- Food coloring to represent visible liquid contaminants such as oil, paint, or fertilizer (Color Contaminant bottle);
- Clay dust represents silt and suspended sediments (Silt container);
- Small items to represent litter (Trash Bag pouch); and
- Vinegar to simulate invisible contaminants such as nutrient runoff, nitrate, PFAS, or mercury (Invisible Contaminant bottle).

Testing Water Quality

Students are prompted at various points in the game to test the Sound's water quality using the three methods described below:

1. **Colorimetric analysis** estimates the concentration of a substance in the water by comparing the intensity of the color. To simulate a colorimetric analysis, fill the "Water Sample" bottle with water from the Long Island Sound simulation and visually compare the color to the "Water Quality Standard.". If the water sample is darker than the standard, the water is considered to be contaminated. Have the students mark the comparison as lighter, the same color, or darker than the standard. This provides a simple simulation of a test that might be used to measure the presence of oil or organic contaminants.
2. A **Secchi disk** is a standard piece of water quality equipment used for measuring the turbidity or cloudiness of water. A mini-Secchi disk is included in the "Measuring Tools" pouch. Lower the mini-Secchi disk from the surface of the water and record

the depth at which it is no longer visible. The string is marked by inches. (Please note: Secchi disks used in the field are marked by meters.)

3. A **pH meter** represents methods that scientists use to measure contaminants that cannot be seen. The pH meter is included in the "Measuring Tools" pouch. As students add vinegar, the sound's pH will drop, indicating contamination. If the pH is lower than 6.0, the water is considered to be contaminated for this activity. Students do not need to understand pH for this game; the pH test is meant to simulate chemical analyses that might be used for nutrients or pesticides but, please note that other meters are used to measure different contaminants in the real world.

Quick Reference: Testing Water Quality

Simulated pollutant	Sampling tool	Real world examples
Colored contaminant (Food coloring)	Colorimetric analysis	Oil, gasoline, paint
Silt (Clay dust)	Mini-Secchi disk	Soil from eroding riverbank and sediment churned up from the bottom
Invisible contaminant (Vinegar)	pH Meter	Nutrients or pesticides, PFAS, mercury

Discussion Ideas

Students have role cards that prompt them to make decisions and take actions which directly affect Long Island Sound's eelgrass populations. For example, a student may have a card that prompts them to add silt to the bay and remove one eelgrass. This demonstrates how the addition of nutrients can result in eutrophication and **hypoxia** that causes eelgrass to die off. Take time to answer students' questions. Discussion is encouraged.

The Long Island Sound Eelgrass Game deals with realistic topics that can have negative consequences for estuary health, eelgrass populations, and human wellbeing. The goal is for students to understand that water quality issues are complicated and multi-faceted. Individuals' and organizations' contributions to pollution vary, as do each of their abilities to influence and adapt to policy changes. Remind students that while these issues exist, we can help fix them. Pairing serious conversations with humor and fun while offering relatable strategies to help Long Island Sound can push your students to get the most out of this activity.

SUGGESTED PREPARATORY CONTENT

The eelgrass game can be used to teach and reinforce a variety of concepts depending on the class and curriculum. For example, concepts related to water chemistry or plant biology could be emphasized along with the central goal of fostering a sense of place and environmental stewardship.

Teachers are encouraged to spend time preparing students for the eelgrass game during a separate class period or through a homework assignment. Played in its entirety, the eelgrass game assigns various readings, short answer and data collection worksheets, and discussion periods over two 50-minute classes. This game is highly customizable, so additional preparation ideas are listed below.

Foster a sense of place. Introduce your students to the Long Island Sound estuary and its watershed. Ask them what they know about estuaries, specifically Long Island Sound, and whether they've visited it before. Some example questions include: Have they visited a local beach or state park? Have they seen horseshoe crabs or gone fishing in the Sound?

A great way of fostering a sense of place is to prompt your students to indicate the location of their home on a large map of Connecticut (included in Kit). Point out the five major rivers that flow into Long Island Sound and explain how the twice-daily tides push and pull freshwater from the rivers and salt water from the Atlantic Ocean. Have students examine the Map of Eelgrass Beds (included in Kit) to see if any are close to where they live.

Share some of the facts about the Sound that you find most interesting. A great general overview of the Sound's eelgrass meadows is located here: https://storymaps.arcgis.com/stories/232ad1570c3f4f2cabbb6a8ea8440f55

Introduce concepts of pollution and stewardship. Ensure your students are familiar with the terms used in this lesson that are important for your curriculum. For example, students should understand that pollution comes from many sources, but it may not be appropriate to discuss limiting nutrients with younger students. For older students, discussing the relationship between limiting nutrients and eutrophication could substantially boost the content of this game. Located here: https://lispartnership.org/

Use the background readings and preparatory worksheet. The readings linked below contain information about Long Island Sound's water quality and eelgrass status. These are great resources for students to read before playing the game to help them see the real-world context of this activity and understand the complexity of their individual roles. Additionally, each role card contains a Real-World Reference that links to a reading about a topic that is relevant to the specific role.

A comprehensive list of the References is located at the end. Teachers can use these readings in different ways. For older students, incorporating these preparatory readings and Real-World References can greatly boost their experience. For younger students and time-constrained groups, omitting these resources could significantly shorten the duration of this activity.

Consider assigning students their "Role" ahead of time. Ask them to read the articles and complete the preparatory worksheet in class or as homework. During the game, students are prompted to share what they learned about their role, its connection to the corresponding "real-world" example, and the potential impacts of various choices they may make.

A History of Eelgrass. A story map that explains the history of eelgrass in Long Island Sound. It contains images and videos of eelgrass in the Sound that exemplify its beauty and necessity for the ecosystem. The link is located here: Historical and Current Distribution of Eelgrass in Long Island Sound

The Strategy for Eelgrass Restoration. The Long Island Sound Partnership has developed a plan for eelgrass restoration. There are many stakeholders involved with the project. This website also includes what individuals can do to help with the restoration project's success. The link is located here: Long Island Sound Eelgrass Strategy - Long Island Sound Study

Water Quality Monitoring Program. The article here by the Long Island Sound Partnership includes the water quality monitoring systems in the Sound. This would be important to review as further knowledge because the assignment involves testing water quality simulation. The link is found here: Water Quality Monitoring in the Sound and Embayments - Long Island Sound Study

Materials included with Kit

- A large, clear 10-gallon bin with lid
- A bottle of food coloring, labeled: "Colored Contaminant"
- A bottle of white vinegar, labeled: “Invisible Contaminant"
- A bottle of tinted water labeled "Water Quality Standard” (already filled for use int eh game, please do not empty)
- An empty bottle for taking water samples, labeled: "Water Sample"
- A container with bag of silt
- An empty container to hold food coloring to keep area clean
- A bag labeled “Trash Bag” of small items to represent trash
- A bag labeled "Money Pouch” that contains play money
- A bag labeled “Measuring Tools”, which includes
  - A miniature Secchi disk for measuring water turbidity
  - pH meter
  - 5 spoons
- 10 plastic eelgrasses with plastic container to keep area dry
- Laminated map of eelgrass beds (5)
- Laminated map of CT rivers (5)
- Role cards (23) and Teacher Role (1)
- Reusable gloves (3 pairs – small, medium, and large)
- Pipette (5)
- Dry erase board and marker
- Paper towels

Before class preparation

1. Fill the clear container with clean water. Note: It may be helpful to place on a rolling cart so it can be easily filled and/or moved aside if needed.
2. Add 7 plastic eelgrass plants to the container full of water. Note: as the game goes on, if you reach the full 10 eelgrass pieces, you cannot add any more and the Sound beds are at full capacity.
3. Set out the Invisible Contaminant, Colored Contaminant (we recommend keeping this in the white container to protect surfaces from the dye), Silt, Trash Pouch, Water Sample bottle, and Measuring Tools pouch. Display the Map of Eelgrass and Map of the Long Island Sound watershed.
4. Prepare the Water Quality Standard by filling the container labeled “Water Quality Standard” with water. Add 2 drops of food coloring and 1/8 teaspoon of silt. (NOTE: This is already prepared with the lending kit. Please do not empty.)
5. Decide how to distribute the money from the Money Pouch. Some teachers prefer equal distribution among students, while others prefer unequal distribution to give the game a more “real-life” feel. Use discretion to determine what is best for your students. If at some point in the game students run out of money, they will need to vote for the options that do not require payment (typically the polluting option).

6. Print The Eelgrass Game Worksheet and The Eelgrass Game Datasheet included in Readings, References, and Resources section.
7. Provide the class with general background information included in Readings, References, and Resources section.
8. Provide students with role cards so they can review the introductory readings, roles, context, and actions. Note: The real-world references are links and are not included on the laminated role cards.

INSTRUCTIONS FOR GUIDING STUDENTS THROUGH THE GAME

The Eelgrass Game takes one to two 50-minute periods to complete, depending on the grade level, content coverage, and depth of discussions. This game can be tailored to be shorter (reducing the number of role cards or content coverage) or longer (use Resources to include more content, foster discussions for each role card, etc.).

One recommended timeline includes completing the readings, worksheet, scene-setting, and any desired preparatory content in one period, then playing the game the next day. If you need to interrupt the game, save all props (storing "the Sound" and other materials on a rolling cart is recommended) and record students' roles and amount of money. If you plan to do this activity with more than one class per day, using separate bins for each class or continuing to add contaminants to the same bin for exaggerated results are two options.

First class period

1. Set the stage. Reference resources in "Teacher Background", "Vocabulary", "Suggested preparatory content", and "Readings, References, and Resources". Introduce and discuss new terms and content. If appropriate, distribute the introductory readings for students to read. Discussion is recommended.
2. Distribute a Role Card, The Eelgrass Game Worksheet, and The Eelgrass Game Datasheet to each student. Have the students read their card information and articles to complete the worksheet. Note: The real-world references are links and are not included on the laminated role cards.

Second class period

Before class, ensure everything is set up.

1. Introduce the students to the game. Inform them that they will play the roles of many people who live, work, and play around Long Island Sound. Show them the materials and demonstrate the three water quality procedures. Alternatively,

introduce each action (explain the types of pollutants, water testing methods, voting procedures, etc.) as it arises throughout the game.

2. Starting with the student who has the role card numbered "Role Card 1," have the students read aloud their card's Role, Context, and Action. Encourage a short discussion about the various actions the student could take and potential implications, referencing any background reading and classroom content. The goal is for students to realize that most issues are complicated, many factors affect decision-making, and information is constantly changing
3. Depending on the card's action, take a class vote, have the student decide, or discuss the designated action on that student's card. Have the student complete the action (such as adding a scoop of silt to "Long Island Sound," testing the water quality, or paying money). When testing the water quality, have the students note the measurements in their Water Quality Data Sheet. For voting actions where payment is a consequence, students who cannot afford the payment must vote for the option that does not require money. If the votes select the option to pay for environmental protection, the students without the amount to pay will turn in whatever amount they have.
4. Move on to the student with card number "2" and continue the game.
5. The last card (Role Card 24) is for the teacher. Your role is a US Environmental Protection Agency official who synthesizes the eelgrass and water quality data to determine the health of the Sound. Guide the students through the calculation of final eelgrass coverage (one simulated eelgrass = 190 square acres of eelgrass in the "real" Long Island Sound - determined from the Sound's peak recorded eelgrass coverage of 1,900 acres in 2012).
6. Guide the students through a comparison of the data in their Water Quality Data Sheet to determine whether the simulated Sound's water quality is "Ideal," "Fair," or "Poor." Discuss what this means for eelgrass populations. What happens if the simulated bay has few eelgrasses but good water quality (restoration efforts may succeed)? What happens if the bay has a lot of eelgrasses but bad water quality (eelgrass may die in large quantities)?
7. Foster some reflection at the end of the game using an approach that works for your time constraints and student dynamics. This sets the stage for the Reflection Questions worksheet which has questions like, How did the eelgrass population and water quality change over the game and why? How did it feel to take the action on your card? Was your decision difficult, and why?
8. Have students fill out the Reflection Questions worksheet.
9. Clean up (A Return Checklist is included in the folder with cleaning instructions).

READINGS, REFERENCES, AND RESOURCES

Background reading suggested for all students

- What is the Long Island Sound Eelgrass Restoration Strategy?
- Diving into Long Island Sound's Seagrass Meadows
- Historical and Current Distribution of Eelgrass in Long Island Sound

Teacher References

- EPA: Long Island Sound Study
- EPA: Long Island Sound Water Quality

Extension Resources

- Long Island Sound Eelgrass Strategy Partner Projects
- Eelgrass Extent
- Long Island Sound Restoration: Improved Reporting and Cost Estimates Could Help Guide Future Efforts
- Marine Eelgrass Meadow
- Water Quality Monitoring in the Sound and Embayment

ROLE CARDS WITH REAL-WORLD REFERENCE LINKS

Role Card 1.

Role: I like to fish on the weekends. I have the best luck near the eelgrass beds in Long Island Sound, but the fish haven't been biting lately. I've heard that Long Island Sound is losing its eelgrass beds and that fish depend on those beds for food, but I didn't think it was this bad. Are the fish really gone?

Context: Eelgrass beds serve as nurseries of the estuary and provide food for juvenile fish and small organisms, which in turn attracts larger fish. Many fish reproduce in eelgrass beds because of their protection, and eelgrass rhizomes anchor sediments which create stable shelter for burrowing organisms.

Action: Test Long Island Sound's water using all three methods and count the number of eelgrass. Record these in the "Test 1" cells on the Water Quality Data Sheet.

Real World Reference: Critical Habitat – Save Our Seagrass

Role Card 2.

Role: The Homeowners Association where I live requires residents to keep very neat lawns, so I use fertilizers and pesticides to feed my grass and keep weeds at bay. I also have non-native flowers in my garden that can only survive if I use pesticides to kill native insects. I know some of these chemicals flow into stormwater drains, but I like how everything looks. I could be fined if my lawn doesn't look well maintained.

Context: Lawn fertilizers contain nutrients that help plants grow, like nitrogen. Unfortunately, these nutrients can easily wash into rivers and bays where they can cause an excessive growth of algae and seaweed in a process called eutrophication. An abundance of algae can cloud the water and limit the amount of sunlight that can reach eelgrass plants. As a bioindicator, eelgrass is one of the first species to show signs of distress in toxic conditions.

Action: Add 1 tablespoon of Invisible Contaminant to Long Island Sound.

Real World Reference: What is the Nitrogen Reduction Strategy?

Role Card 3.

Role: I change my truck's oil at home. I catch the used oil in a pan, but then I throw it in the trash because I don't want to bring the container to a recycling facility. Somewhere between my garage and the landfill, the oil leaks out of the container and into the Long Island Sound watershed.

Context: Non-Point source water pollution is a major problem for Long Island Sound. Motor oil is not water soluble, can persist in the environment for a long time, and often contains other toxic compounds. Oil is often seen as a surface pollutant that washes into water bodies, but groundwater can be contaminated too. Spilled motor oil from a single vehicle can contaminate a million gallons of freshwater. Polluted water supplies pose health risks not only for humans, but wildlife and plants too.

Action: Put on gloves and add 2 drops of Colored Contaminant to Long Island Sound.

Real World Reference: How Humans Impact the Long Island Sound and A Citizen's Guide to Curbing Polluted Runoff

Role Card 4.

Role: My class visited our local park. After lunch we left our wrappers on the picnic tables and threw our apple cores in the woods instead of putting our trash in the garbage. The litter washed Into Long Island Sound and the apple core attracted nuisance wildlife. While litter doesn't directly kill eelgrass, it still stresses the whole estuarine ecosystem which makes it harder for eelgrass to survive. Increasing stress to the native fish species would ultimately link to eelgrass stress and loss because of their important relationship with one another.

Context: Litter is one of the most visible pollutants in the Sound. Litter often floats on the surface of the water and can get caught on shorelines and in marshes after high tides. Plastic materials such as wrappers, fishing lines, and Styrofoam items do not naturally decompose and therefore remain in the environment for a long time. Though these materials do not decompose they break down into smaller particles called microplastics that are often ingested by marine animals.

Action: Dump the contents of the Trash Pouch to Long Island Sound.

Real World Reference: Save the Sound Report Highlights Impact of Trash in the Long Island Sound

Role Card 5.

Role: I have a sailboat that I like to take out on the weekends. I forgot to schedule a pump out of my onboard toilet. I don't want to turn around midday to find a marina with a stationary pump, and the Royal Flush pump out boat is nowhere near me. I release the toilet waste into New London Harbor because it saves me a lot of time.

Context: Untreated wastewater like sewage and runoff can be full of nutrients such as nitrogen. Nitrogen is a limiting nutrient, meaning that the growth of plants – such as seaweed – is controlled by the quantity of the nutrient. Long Island Sound's nitrogen content has increased since the early 2000s, enabling algae and seaweed to become more abundant. Large amounts of seaweed can crowd out eelgrass, and algae clouds Long Island Sound's water, decreasing the amount of sunlight that can reach the eelgrass beds.

Action: Put on gloves and add 2 drops of Colored Contaminant to Long Island Sound. Add two tablespoons of Invisible Contaminant.

Real World Reference: Massive Sewage Spill Leaves Long Island Harbor 'Green' as Locals Told to Stay Away

Role Card 6.

Role: I have a thriving aquaculture business in Long Island Sound. I partner with the University of Connecticut to restore oyster beds and use the oyster market to boost Connecticut's economy. One oyster can filter 30 gallons of water per day, but if Long Island Sound's water is too polluted, my oysters will become contaminated. Then, the Connecticut government will close the Sound to harvesting, until the pollutants wash out of Long Island Sound. These closures have been occurring more often in recent years and I'm worried that if the Sound becomes too polluted, the oysters, eelgrass, and other estuary organisms will die. I really hope that I don't go out of business.

Context: Shellfish can become contaminated by water pollutants. Oysters are part of a group of aquatic organisms called filter feeders. These organisms suck in water, filter out microorganisms for their own consumption, and release the "clean" water. Filter feeders often accumulate pollutants and toxins as they filter. Consumption of contaminated shellfish can be harmful for humans – a prime example of bioaccumulation. Additionally, polluted water makes it harder for the whole ecosystem to thrive. Long Island Sound has seen declines in shellfish and eelgrass populations, primarily due to water pollution.

Action: Test Long Island Sound's water using all three methods and count the number of eelgrass. Record these in the "Test 2" cells on the Water Quality Data Sheet. If two or more of the methods show that the water is polluted, remove 1 eelgrass from the Sound.

Real World Reference: Nutrient Bioextraction: Extracting Pollution from the Sound

Role Card 7.

Role: I work at my town's Wastewater Treatment Plant. Our treated wastewater is released into a tributary that flows into Long Island Sound and, although it's treated, it still has a high nitrogen content. Our system is old and needs to be updated, but a replacement is expensive and will require residents to pay more in taxes and their water bill will increase.

Context: Wastewater treatment plants are large contributors to the point source pollution that flowed into Long Island Sound. This pollution primarily contains high nitrogen content. Excess nitrogen causes eutrophication and hypoxic (low oxygen) conditions that make it hard for eelgrass to survive. Joint efforts by the EPA and state agencies have reduced the hypoxia area by more than half from 2001 to 2024.

Action: Many communities face this problem, so take a class vote. Would your class tax themselves and each other to build a better treatment plant? If the majority votes yes, each person in the class must pay 2 pieces of money. If the class votes no, add 2 tablespoons of Invisible Contaminant to the Sound and remove 3 eelgrasses. Make a debate for either side.

Real World Reference: Reducing Long Island Sound's Hypoxic Waters

Role Card 8.

Role: I grow fruits and vegetables on my farm near the Thames River. I use chemical fertilizers and pesticides on my crops, and some of these chemicals wash into the Sound. I know that other farmers have switched to organic farming methods that don't use chemicals, but I also know that they don't produce as many crops anymore. I'm worried I will go out of business.

Context: Many farms use fertilizers and pesticides to enhance crop growth. Synthetic fertilizers are made of specific mineral components such as nitrogen and phosphorus. Oftentimes fertilizers drain from fields and lawns into water supplies. Nitrogen and phosphorus are both limiting nutrients, so excess quantities of nitrogen and phosphorus contribute to eutrophication and harmful algal blooms. Pesticides are chemicals designed to poison targeted organisms, but they can also poison other animals and humans through bioaccumulation. Alternative farming methods include fertilizing with compost and using integrated pest management strategies.

Action: If you decide to farm organically, pay 2 pieces of money for potential crop losses. If you decide against it, add 1 tablespoon of Invisible Contaminant to Long Island Sound.

Real World Reference: Waste Not, Want Not: Connecticut Farm Gets New Manure Storage Facility

Role Card 9.

Role: I work for the U.S. Army Corps of Engineers (USACE). We help maintain deep shipping channels for large vessels moving in and out of New London Harbor. We received $1.6 million to dredge (remove sediments from the river bottom) a portion of the Thames River to make it easier for large ships to dock here. Dredging can increase risks to native habitats, and this will increase the turbidity of the waters that flow in and out of the Sound. However,

by not dredging, it will make it harder for ships to dock in New London which will hurt Connecticut's economy.

Context: The amount of suspended particulate matter in water is called turbidity. Eelgrass thrives in clear waters because they are rooted flowering plants that need sunlight to photosynthesize. Turbid waters prevent sunlight from penetrating the water column and reaching eelgrass leaves. This USACE project decided to relocate clean sediments to Cornfield Shoals and New London in Connecticut.

Action: Take a class vote to decide whether to dredge the harbor or not. If the class chooses to dredge, remove 1 eelgrass, add 1 drop of Colored Contaminant, and 1 tablespoon of Silt to Long Island Sound. If the class votes not to dredge, pay 1 piece of money.

Real World Reference: Dredged Material Management in Long Island Sound

Role Card 10.

Role: I am a marine scientist for the Connecticut National Estuarine Research Reserve. Part of my work is to research which methods of re-planting eelgrass beds are most effective in Long Island Sound. These trials, in addition to pollution mitigation projects, are part of an effort to restore eelgrass habitats in the estuary.

Context: Long Island Sound eelgrass is threatened by pollution from construction and declining water quality. Efforts to replant eelgrass beds and reduce nutrient runoff and water pollution in Long Island Sound are underway, but obstacles persist. Eelgrasses thrive in cold, clear waters, so warming waters due to climate change make it even more difficult for eelgrass to survive. Warming water temperatures also lead to the migration of non-native species (such as blue crabs) that damage the beds from burrowing.

Action: Test long Island Sound's water using all three methods and count the number of eelgrass plants. Record these in the "Test 3" cells on the Water Quality Data Sheet. If two or more of the methods show that the water is polluted, remove 1 eelgrass from Long Island Sound.

Real World Reference: Eelgrass Restoration in Long Island Sound: Seed Collection

Role Card 11.

Role: I live near the Connecticut River and have a septic system for my home. My septic system is old and releases nitrogen. Replacing my septic is very expensive, but if I don't do this, waste could leach into the watershed and contribute to nitrogen pollution. Excess nitrogen and other nutrients cause algae growth that outcompete eelgrass.

Context: Septic systems release filtered wastewater into the ground. Unfortunately, most septic systems aren't designed to remove nitrogen from wastewater and so some nitrogen is released into the soil around a septic tank and can leach into nearby streams. Nitrogen is a limiting nutrient, meaning that the growth of plants – such as macroalgae – is controlled by its quantity. Increased nitrogen results in increased algae growth. In addition to crowding out eelgrass, algae clouds the Sound's water, decreasing the amount of sunlight that can reach the eelgrass beds.

Action: Either pay 2 pieces of money to replace your septic system or add 1 tablespoon of Invisible Contaminant to Long Island Sound to represent nitrogen.

Real World Reference: The Impact of Septic Systems on the Environment

Role Card 12.

Role: I am the mayor of a small city in the Long Island Sound watershed. I know that many of the septic systems in our city are aging and are likely leaking nitrogen into our groundwater and creeks, but it's not clear how to best manage this source of pollution. We could put pressure on these homeowners to upgrade their septic systems, which would be a large and on-going expense for these individuals. Or we could choose to extend sewer pipes to more of the neighborhoods in our city, which will raise taxes.

Context: About half the homes in CT have individual septic systems that manage their waste, often because there aren't any accessible sewer lines to connect to. Many septic system leak nitrogen, which can leach into groundwater and nearby waterways where it can fuel algae blooms, reduce water clarity, and impact eelgrass. The decision to build or expand a municipal sewer treatment system is often controversial because of the expense and hassle.

Action: Take a class vote. Will the students approve higher taxes to expand the city's sewer system? If they vote yes, everyone must pay 1 piece of money. If this is voted down, everyone that is born between January and May must pay 2 pieces of money to clean and upgrade their personal septic systems. If someone cannot pay, add 2 drops of Invisible Contaminant to Long Island Sound.

Real World Reference: New Septic Systems to Reduce Nitrogen Pollution into Long Island Sound

Role Card 13.

Role: I am a student doing a project about eelgrass. I found out that there is a pathogen called *Labyrinthula zosterae* that causes seagrass wasting disease. Warming waters from climate change make it easier for this disease to spread throughout eelgrass meadows. Considering that eelgrass populations are already low, I'm worried about what would happen if the wasting disease spread in Long Island Sound. I want to write to my state politicians to ask them to fund eelgrass restoration projects, pass pollution restrictions, and fight climate change. Of course, this costs money, but how much will it cost when we have no eelgrass to keep Long Island Sound alive?

Context: *Labyrinthula zosterae* is a slime mold that kills eelgrass by colonizing on the surface of the leaves. Seagrass Wasting Disease was responsible for the mass die-off of eelgrass in Long Island Sound in the early 1930s. Although wasting disease is still an issue, Long Island Sound's eelgrass has recovered a lot. Other issues threaten the plant's existence. *Labyrinthula zosterae* thrive in warm, salty waters conditions that will become more common due to climate change.

Action: If you choose to write to your state representatives, explain your stance to your classmates. If you choose not to write, remove 1 eelgrass plant and add a scoop of Silt.

Real World Reference: Planting Eelgrass and Funding Available for Long Island Sound Eelgrass Habitat Suitability Model

Role Card 14.

Role: I just bought a house. I've heard that surface runoff picks up contaminants and washes it all into Long Island Sound. This process is known as runoff. I know that the water from my gutters ends up in the street, but I could plant a rain garden. I would have to spend part of my weekend digging the garden bed and planting flowers, but then my soil would absorb the runoff, and I would have a pretty garden.

Context: Stormwater runoff is a significant source of non-point source pollution. Pollutants often lead to murkier water and warmer temperatures which can damage eelgrass. Rain gardens are built to catch water so that they can slowly absorb into the soil. The plants in

the garden also filter out contaminants and cool the water temperature. This all helps keep Long Island Sound clean so that eelgrass can thrive.

Action: If you choose to create a rain garden, plant 1 eelgrass plant and pay 1 piece of money. If you choose not to plant a rain garden, put on gloves and add 1 drop of Invisible Contaminant, 1 drop of Colored Contaminant, and 1/2 teaspoon of Silt.

Real World Reference: Long Island Explorium's Port Jefferson Rain Gardens

Role Card 15.

Role: I serve on my town's Conservation Commission. Unlike many of the surrounding towns, we don't have any specific rules about stormwater management. This makes it difficult to convince property owners and developers to make choices that will help keep Long Island Sound's water clean. The commission can implement pervious pavements or add stormwater filtration to help with the issue, but no one wants more construction.

Context: Stormwater runoff is a significant source of non-point source pollution. When rain falls and snow melts on impervious surfaces like roads, parking lots, and buildings, pollutants on the surface leach into streams. These pollutants often lead to murkier water, algae blooms, and warmer temperatures which can damage eelgrass. Many towns and cities have rules that require new developments to manage stormwater on their property to minimize the amount of stormwater that runs off.

Action: Make a choice to either create new stormwater rules and add 1 eelgrass plant or add 1/2 teaspoon of the Invisible Contaminant and 1 tablespoon of Silt to Long Island Sound.

Real World Reference: Municipal Stormwater Pollution

Role Card 16.

Role: I fish commercially. The engine on my boat leaks oil into the bilge inside my boat. Water also collects in the bilge, so every so often I must pump out the mess. If the Coast Guard spotted me dumping the bilge into the water, I would be fined a lot of money, so before I start the bilge pump, I pour detergent into the mix. This makes the oil break up and mix with the water so nobody can see it. I know that this is harmful to the water quality, but I don't want to be caught with an oil slick behind my boat.

Context: Connecticut has different agencies, like the Connecticut Department of Energy and Environmental Protection (CTDEEP), that work together to respond to situations such as bilge, oil, and fuel tank spills. Oil is not water soluble, can persist in the environment for a long time, and often contains other toxic compounds. Oil is often seen as a pollutant on the surface of the water, but detergents such as soap can disperse the oil particles. Oil coats and smothers eelgrass, especially when the spill is near eelgrass beds. Polluted water supplies pose health risks not only for humans, but wildlife and plants too.

Action: Put on gloves and add 2 drops of Colored Contaminant to Long Island Sound.

Real World Reference: Sensitive Habitats

Role Card 17.

Role: I just bought a house near Long Island Sound. I've decided to test the water in my well because I want to make sure it's safe for my family.

Context: Despite efforts to reduce point and nonpoint source pollution, Long Island Sound still has water quality problems. Recent Wastewater Treatment Plant updates have substantially decreased the quantity of point source pollutants in the Sound, but it has also revealed how much of the pollution comes from non-point sources, including runoff, nutrient leaching, and increased turbidity and sedimentation rates. Groundwater supplies connect to the Long Island Sound watershed's surface water, so polluted water bodies pose health risks not only for wildlife and plants, but for humans too.

Action: Test the Long Island Sound's water with all three methods and count the number of eelgrass plants. Record these in the "Test 4" cells on the Water Quality Data Sheet. If two or more of the methods show that the water is polluted, pay 1 piece of money to connect to the city water supply.

Real World Reference: What is Non-Point Source Pollution?

Role Card 18.

Role: I am a developer, and I build residential subdivisions in several towns in the Long Island Sound watershed. I am proposing to build a new neighborhood that will have excellent views of the Mystic River. I have learned that some towns have more limited rules about development close to the water's edge and I've also learned how to get a conditional use permit to develop within the protected buffer when needed. Homes with water views sell better and raise more tax revenue for the town. I also believe that people need to see

and connect with nature in order to care about it. Why should only a few wealthy people get homes with water views? Maybe if we all had views of the Mystic River or Long Island Sound, we would work harder to protect clean water.

Context: Vegetated buffers filter runoff and prevent harmful particles from entering rivers, wetlands, and other water bodies. These areas also help to slow water movement and cool water temperatures, which help keep water clear and appropriate for eelgrass meadows. Without these buffers, pollutants and sediments wash right into the water. This is a big issue for the Sound. Water that has too many nutrients and too much floating sediment makes it hard for eelgrass to survive.

Action: The class is the town's planning board, and they need to approve your project in the river buffer area. Take a vote. If the class votes to allow you to develop within the river buffer zone add 1 tablespoon of Silt and remove 2 eelgrass plants. If the class denies your permit request, pay 4 pieces of money because you designed a subdivision that you couldn't build. If you don't have 4 pieces of money, pay what you have left.

Real World Reference: Sustainable and Resilient Communities

Role Card 19.

Role: I work at the Ocean House in Westerly, Rhode Island. People from all over the country come to spend their vacations boating, swimming, and fishing along the Rhode Island seacoast. If the rivers, bays, and ocean are polluted, people will stop coming here, and I'll go out of business. This is why it is important that tourism is responsibly conducted to maintain the health of the habitats.

Context: Tourism is a critical component of New England's economy. Tourists funnel millions of dollars of revenue into the state during vacations to the mountains, lakes, and coastal regions of New England. Beyond preserving ecological integrity, it is economically savvy to keep the state's water bodies healthy, including Long Island Sound. Maintaining eelgrass meadows are a critical component of the estuary's ecosystem, so efforts to decrease nutrient leaching, wastewater releasing, and stormwater runoff should continue.

Action: Count the number of eelgrass in Long Island Sound. If the total number of eelgrass is less than a half of the amount you began with, turn in all your money - you go out of business.

Real World Reference: Around the Sound

Role Card 20.

Role: I work for the US Coast Guard. A yacht caught fire in New London Harbor. Aerial images show that diesel is leaking from the fuel tank on the boat. I have to coordinate with multiple agencies because the boat sank in a difficult position that makes removal dangerous. The leaked diesel hasn't reached any Connecticut shorelines yet, but if it does, the diesel could smother eelgrass beds, damage nearby ecosystems, and cause unhealthy conditions for human activities. My team needs to decide if we will go forward with the expensive clean-up effort of the wreck.

Context: Diesel directly and indirectly harms eelgrass populations. Eelgrass mortality can occur due to fouling from direct contact with oil substances. Juvenile plants are especially susceptible. Diesel pollution can not only block sunlight from reaching eelgrass but also make eelgrass more vulnerable to other stressors and decrease eelgrass's ability to trap harmful particles in the estuary.

Action: If you choose to clean up the wreck, tax everyone 1 piece of money to put in the bank. If you choose to leave the wreck, put on gloves and add 3 drops of Colored Contaminant to Long Island Sound.

Real World Reference: Sound Values

Role Card 21.

Role: I serve on the selectboard in Bristol, CT. The Middle Street Dam on the Pequabuck River harms migratory fish populations and the health of the river itself. Some residents want to get rid of the dam, and others want to build a new one. Getting rid of the dam will drain the historic pond but will create a healthier river ecosystem that will benefit Long Island Sound. There is grant funding available to pay for the removal, so the town won't have to increase taxes to pay for it. Rebuilding the dam will keep the pond and its recreational, aesthetic, and historic characteristics intact, but will not allow the ecosystem to recover.

Context: The Middle Street Dam currently obstructs the natural flow of the Pequabuck River and blocks fish and other aquatic organisms from migrating up and down river to feed and reproduce. In addition, the water behind the dam warms more than it naturally would, and since it flows into Long Island Sound, it raises the temperature of the Sound as a whole. Warmer water temperatures put stress on fish and eelgrass, which makes them more susceptible to disease.

Action: Take a class vote on whether or not to remove the Mill Pond Dam. If the class votes to remove it, add 1 eelgrass to Long Island Sound If the class votes to rebuild it, remove 1 eelgrass plant.

Real World Reference: BIL Funding to Remove Middle Street Dam, Reconnect 8.5 Miles of Stream to Long Island Sound

Role Card 22.

Role: I am a State Representative in the Connecticut legislature. I have to decide whether to vote "yes" or "no" on an eelgrass restoration project. Eelgrass roots help keep shorelines stable by reducing the erosion from wave action. This is becoming more and more important as climate change creates stronger storms bringing in intense waves, and I know that supporting this project will help protect Connecticut's residents and the coast. I also know that I am under pressure to decrease Connecticut's state spending, and these kinds of projects cost a lot of money.

Context: Eelgrass is both a keystone species and a bioindicator. Eelgrass meadows protect shorelines from erosion by gripping shoreline sediments, but they also are vulnerable to climate change impacts. Eelgrass relies on clear water for photosynthesis, but increasingly strong storms churn up underwater sediments and wash surface pollutants into the Sound, making it difficult for eelgrass to survive. This creates a positive feedback loop: turbid water makes it difficult for eelgrass to survive and protect the coast, which means stronger storms from climate change can cause more erosion which increases turbidity.

Action: Either collect 1 piece of money from everyone and add 1 eelgrass plant to Long Island Sound or remove 2 eelgrass plants.

Real World Reference: Saving Seagrass

Role Card 23.

Role: I am a resident of Old Saybrook, and I own a large piece of undeveloped land. Many of my neighbors have been approached by a developer that wants to buy our land to build an oil refinery. There is a group of very concerned citizens working on this; they believe the refinery would destroy Connecticut's coastline: estuary ecosystems would be crisscrossed by pipelines, and historic farms would be replaced by refinery tanks. The developer claims the refinery would create jobs, reduce taxes and lower gas prices, but they don't have good answers to any of my questions.

Context: In 1974, the town of Old Saybrook rejected a proposal for an oil refinery to be built in Long Island Sound. The plan was resoundingly defeated by the local residents who raised awareness of the harmful nature of a facility like this on the shorelines.

Action: Take a class vote. If the class votes against the refinery, tax everyone 1 piece of money for the loss of potential economic benefits. If the class votes for the refinery, add 5 drops of colored contaminant to Long Island Sound and remove 4 eelgrass plants.

Real World Reference: The Connecticut River gateway Commission at Fifty: A unique conservation compact looks to the future (Read: 50 years later only)

Role Card 24 (Teacher)

Teacher Role: I work for the United States Environmental Protection Agency. Part of my job is to test the water quality in various places around the US. Today, I am testing the water in Long Island Sound. There are many ways to test water quality. Today, I'm using a Secchi disk, pH reader, visible contaminant comparison, and counting the number of eelgrass present. The results of these tests determine whether the Sound is safe for human use. These tests are also used to measure the health of the Sound's estuarine ecosystem and eelgrass meadows.

Context: There are no conclusive standards for water quality in Long Island Sound due to the variability of its day-to-day conditions. Ask the students why this could be (tides, rainstorms, seasons, etc.).

Action: Count the number of eelgrass present in the Sound. Have the students complete the eelgrass coverage calculation on the Water Quality Data Sheet. The Game has a goal to include all 10 eelgrass plants equaling the peak coverage of 1,900 square acres in 2012. Long Island Sound started with 7 eelgrass models. Each individual eelgrass plant represents 190 acres of eelgrass beds. Multiply the final count of eelgrass plants by 190 to calculate the game's final eelgrass coverage.

Real World Reference: EPA: Long Island Sound Study and EPA: Long Island Sound Water Quality

Action continued: Next, have the students assess the Sound's water quality with all three metrics, using the Water Quality Data Sheet. Ask the students how the water quality impacts eelgrass and how eelgrass health foreshadows the health of the estuary. Have them hypothesize the "fate" of their Long Island Sound eelgrass based on the water quality. For example, if the colored contamination is "Fair," and the

turbidity is “Poor,” the water will be too cloudy for eelgrass to photosynthesize, so even if the Sound has lots of eelgrass, the eelgrass meadows will still have a hard time surviving. Discussion is highly encouraged.

THE EELGRASS GAME DATASHEET

NAME: _____

	Pollutants - Colored contamination	**Water Clarity - Turbidity**	**Pollutants - Invisible contamination**	**Eelgrass coverage**
Directions	Fill the Water Sample bottle and compare the color to the Water Quality Standard. Record as "clear", "lighter" "equal color", or "darker".	Lower the mini-Secchi disk until you can no longer see the difference between the black and white colors. Record depth in inches.	Use the pH meter to measure pH. Directions included in the package, if needed.	Count the number of eelgrass and record below.
Test 1 (Role Card 1)				
Test 2 (Role Card 6)				
Test 3 (Role Card 10)				
Test 4 (Role Card 17)				
Test 5 (Teacher)				

PART 1: EELGRASS COVERAGE COMPARISON

1. Calculate the final coverage of eelgrass in Long Island Sound. One eelgrass = 190 square acres of "real" eelgrass coverage in the Sound.

2. The ideal number of eelgrass in the Sound to match the peak from 2012 would be 1,900 acres of coverage. The goal set for restoration aims to be about 2,000 acres greater than this coverage by 2035 (~ 4000 acres total). How does the final "Long Island Sound" compare to this goal?

(MORE ON BACK)

3. How do you think the changes in water quality in “your Sound” will affect your eelgrass meadows? Explain your thinking.

PART 2: WATER QUALITY vs. EELGRASS HEALTH

Use the following criteria to determine how healthy the water quality is in your eelgrass meadow after you have finished the Game.

	Pollutants - Colored contamination	**Water Clarity - Turbidity**	**Pollutants - Invisible contamination**	**Eelgrass coverage**
Ideal	Clear	>12 cm depth	6.5-8	8-10
Fair	Lighter or same color as standard	8-12 cm depth	5.5-6.5	5-7
Poor	Darker color than standard	<8 cm depth	Less than 5.5	<6

	Pollutants - Colored contamination	**Water Clarity - Turbidity**	**Pollutants - Invisible contamination**	**Eelgrass coverage**
Test 5 Results				

4. Based on these water quality results, how do you think eelgrass and the health of the estuary will be impacted?

THE EELGRASS GAME WORKSHEET

NAME: _____

PREPARATORY QUESTIONS

1. Use the terms watershed, estuary, point source, and non-point source pollution to summarize what you know about Long Island Sound and its eelgrass health.

2. What is a bioindicator? What does eelgrass health explain to researchers about the health of the estuary?

3. Paraphrase the article you read. Describe the issue, possible controversies associated with the topic, and main takeaways.

4. What does your article have to do with Long Island Sound's water quality and eelgrass meadows?

REFLECTION QUESTIONS

1. Why was it sometimes difficult for people to make decisions in favor of protecting the water quality in this game? What were some long-term social, environmental, and economic costs to individuals or groups because of such decisions?

(More on back)

2. What were some motivations that influenced decision making during the game?

3. If your role's situation happened in real life, would your choice be different from the choice you made during? Why?

4. How does water quality impact eelgrass? What happens to the rest of the estuary ecosystem when eelgrass beds die?

5. Provide examples of both point source and non-point source pollution from the eelgrass game and explain the direct and indirect impacts.

6. How did your article relate to your role card about a real-life situation around Long Island Sound? How does it relate to eelgrass health?

7. Big issues like pollution and habitat degradation can be overwhelming to individuals, but even little choices add up. What can you do to help Long Island Sound's eelgrass?