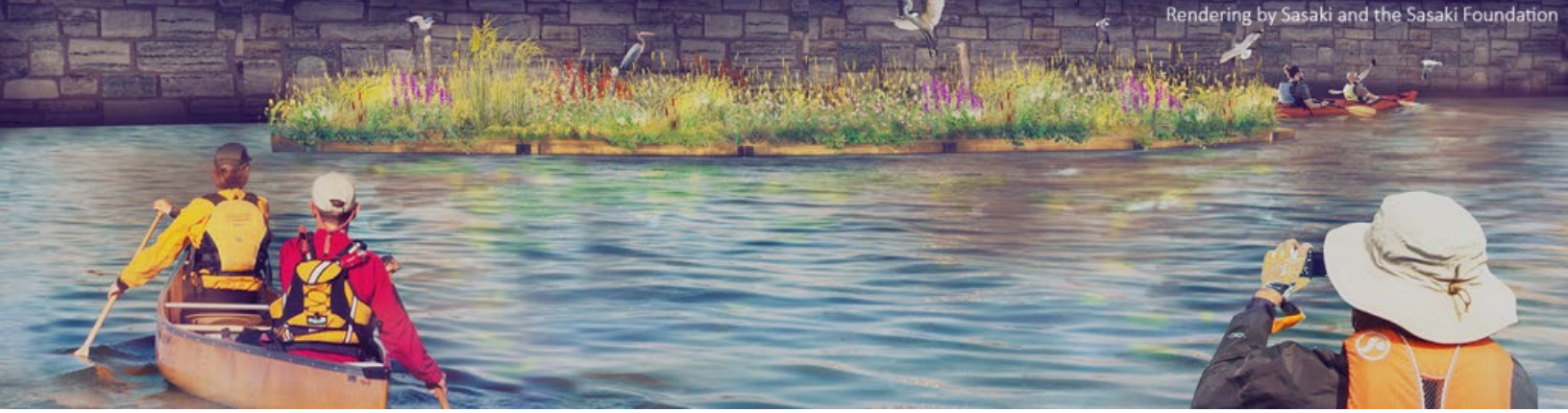


Charles River Floating Wetland Model Instructions and Lessons

Please also feel free to use or reference these additional materials:

- Activity Booklet Exploring the Charles River Floating Wetland (https://bit.ly/37UbY7H)
- Slides from the Floating Wetland STEAM Saturday classes (https://bit.ly/3iYFXBW)
- Floating Wetland Resource page (https://seagrant.mit.edu/floating-wetland-resources/)

Charles River 101

80 miles long | 8,000 acres of wetlands

Despite being the most densely populated watershed in Massachusetts, the Charles River is home to many thriving ecosystems preserved by the government and advocates like the Charles River Conservancy.

The Charles River used to be a free-flowing tidal estuary. A complex habitat of wetlands and mud-flats supported a diversity of species including shellfish, birds, and anadromous fish. Today, dams maintain a near-constant water level. Hardscape covers much of the river, and nutrient pollution carried by rainwater from the city streets acts as fertilizer fueling the growth of algae.

Current Challenges:

- Lack of vegetation
- Loss of habitat
- Broken food chain
- Nutrient pollution
- Algal blooms
- Water quality

Materials for Model

- Daphnia eggs OR live daphnia culture
- Spring water
- Adhesive aquarium thermometer strip
- Wheat straws OR chopsticks
- Spray bottle
- Plastic tray
- Plate
- Paper towels
- Hemp grow mat
- Wheatgrass seeds
- Baker's dry yeast
- Spirulina powder
- Magnifying glass (optional)
- Aquarium test strips (optional)

Glossary of Terms

Algae: organisms like seaweed that live in water and make their food by using sunlight to turn carbon dioxide and water into food through photosynthesis

Algal bloom: an overgrowth of algae or cyanobacteria that often results in scum on the surface of water, which can be harmful to other organisms

Anadromous fish: a type of fish, such as river herring, that migrates from saltwater to freshwater to release eggs

Cyanobacteria: microscopic organisms (blue-green algae), which can create algal blooms on the water's surface

Daphnia: small swimming zooplankton known as water fleas that live in aquatic environments and eat mostly algae

Ecological intervention: habitat restoration and other environmental solutions to help improve ecosystem health

Ecology: a branch of science focusing on the relationships between living things and their environment

Ecosystem: a community of living organisms interacting with one another and their environment

Estuary: the mouth of a river where fresh and saltwater mix, home to unique plant and animal communities and wetlands

Floating Wetland: a human-made island of plants; the Charles River Floating Wetland aims to restore zooplankton habitat and help improve river health

Hardscape: man-made features in landscape architecture like paths or the concrete walls lining the Charles River

Mud-flats: an area of land that lies just below the surface of water or repeatedly covered by the tide

Nutrient pollution: too many nutrients running from urban areas into a body of water, causing an overgrowth of algae

Organism: a living thing – a person, plant, or animal

Spawn: the process of aquatic animals releasing eggs in water; river herring migrate to the Charles River to spawn

Spirulina: a type of blue-green algae (cyanobacteria)

Watershed: an area that drains streams and rainfall to a common body of water

Wetlands: areas and ecosystems flooded by water, such as marshes or swamps, supporting aquatic and land species

Zooplankton: tiny creatures living in oceans, seas, and bodies of fresh water, which are an important part of the food chain

Week 1

In this lesson, students are introduced to the Charles River and its history, with an emphasis on events that have led up to challenges that the river ecosystem currently faces. Students are also briefly introduced to the Charles River Floating Wetland Project as a concept for ecological intervention to curb the aforementioned challenges. In the activity, students set up the spring water-filled trays and release their daphnia eggs to observe for hatching. Additionally, students will prepare food for their daphnia to feed after hatching is observed.

Resources:

- mywaterway.epa.gov (Interactive maps by the US Environmental Protection Agency)
- An Introduction to the Charles River Floating Wetland (Charles River Conservancy video)

Step-by-Step:

Releasing daphnia

1. Find a spot on a flat, stable surface by a window to set up your mini ecosystem. You can waterproof your area by putting wax paper or newspaper down first.
2. Fix the adhesive thermometer to the inside of the tray along the side towards the bottom of the tray.
3. Fill the tray almost to the top with bottled spring water, leaving about half an inch between the surface of the water and the top of the tray.
4. Check the water temperature. Daphnia hatch best in water that is at least 65°F, with several hours of morning or afternoon sun.
5. Carefully pour the daphnia eggs into the water in the tray. It's normal for eggs to float.

Preparing daphnia nutrients

1. Mix 1 pinch of spirulina powder (blue-green algae) with 1 pinch of baker's yeast in a small container with a lid, or a water bottle.
2. Add 1 oz of spring water to the nutrient mixture, close the container and shake.
3. Refrigerate the mixture.

Instructions for the Week:

Daphnia can take several days to hatch (around 4 days). Every day, look closely to see if you can spot any movement. They will look like swimming fleas. Once they have hatched, use a straw to add one drop of the prepared nutrients every day.

Core Questions:

- What challenges does the Charles River face today?
- What is the Floating Wetland Project? What are its goals?

Week 2

In this lesson, students learn about the construction of the Charles River Floating Wetland. Students also are taught basic concepts of wetland ecosystems, including features and functions, including water filtration. In the activity, students begin growing seeds on a grow mat to serve as a miniature homemade floating wetland.

Resources:

- Making of the Charles River Floating Wetland – timestamped at assembly section (Charles River Conservancy video)

Step-by-Step:

Soak the seeds

1. Fill the container of wheatgrass seeds with water and put the lid on. You can rinse them for best results.
2. Let the seeds soak in the water for about 8 hours. This will soften their seed coat and help them to sprout! Create a reminder for yourself to place the seeds on the grow mat later!

Mat the seeds

1. After 8 hours of soaking the seeds, place the grow mat on the bamboo plate and dump the seeds and water onto the mat. Use your fingers to spread the seeds out evenly.
2. Fold and dampen a paper towel and use it to cover the mat and seeds. Keep the paper towel wet by spraying with water every day, until you see sprouts.

Instructions for the week:

Every day, spray your wheatgrass and grow mat. After 2-3 days, once you see sprouts, uncover your wheatgrass and grow mat and keep spraying with water every day.

If you have daphnia, keep feeding them one drop of nutrients every day! If you haven't seen any swimming, don't add nutrients yet. It can take up to 10 days for daphnia to hatch, and sometimes they don't hatch at all.

Core Questions:

- What is a wetland? What are its functions?
- What are some food chains within an ecosystem like the Charles River?

Week 3

Students first share their progress with their daphnia hatching and plant growth. Afterwards, students learn about the anatomy and function of daphnia, the model organism for zooplankton. The concept of zooplankton is connected to the wider topic of the food chain. In the activity, students finally put the daphnia tray together with the miniature floating wetland, creating a floating wetland ecosystem while paying attention to any root growth that can serve as refuge for the daphnia.

Resources:

- Water Fleas: Look Weird, Adapt Weirder (Journey to the Microcosmos video)
- Making of the Charles River Floating Wetland – timestamped at research section (Charles River Conservancy video)

Step-by-Step:

Build the model

1. Position four straws across the top of the tray an inch apart and parallel to each other.
2. Using both hands, pick up the grow mat from the plate and carefully lay it on top of the straws. Any roots that have begun to grow should hang down towards the water, and eventually grow into it as a water source.

Add plants and animals

1. Color the species in the booklet (pg 11) or draw your own animals and plants! Cut them out and add them to your wetland. We used toothpicks to poke two holes in each cut-out and stood them up in our mats.
2. We colored in the blue flag iris, a beaver, great blue heron, and a painted turtle! You could even add a Lego or other small toy to your wetland model.

Prepare the paint

1. Mix spirulina powder (blue-green algae) with water in a small container with a lid.
2. Refrigerate the natural paint for the week – try not to move or shake the container and let the algae turn blue due to a pigment-protein called phycocyanin.

Instructions for the week:

Every day, continue to feed your daphnia one drop of food, and spray your wetland.

Core Questions:

- What are daphnia?
- What are some methods that daphnia employ for survival?
- Can the Charles River Floating Wetland increase the size and number of zooplankton and reduce algae in the river?

Week 4

In this lesson, students learn about cyanobacteria in more detail. The discussion of cyanobacteria includes topics such as photosynthesis, adaptation, and evolution, and emphasizes their proliferation, leading to algal blooms. Factors attributed to cyanobacterial growth and population crashes of daphnia and other zooplankton are identified. Harmful algal blooms are specifically targeted, and students learn to identify harmful algal blooms, namely through a visual comparison to green algae and duckweed, and their distinct effects on the wetland ecosystem. Students also paint a wetland with spirulina powder.

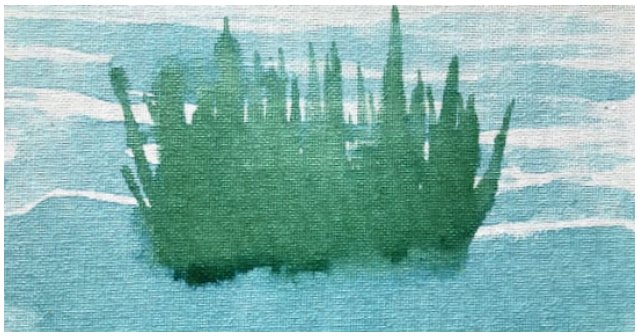
Resources:

- All About Cyanobacteria (Charles River Conservancy video)
- Why Cyanobacteria Thrive in the Charles (Charles River Conservancy video)

Step-by-Step:

Art with algae

1. Remove paint container from last week from the refrigerator – careful not to shake it!
2. Paint a floating wetland on your watercolor art board using blue first, and then shaking the container for a green color. Start with the sky and the water. Then put the lid on, shake, and paint the wetland and plants. Get creative!



Instructions for clean-up:

Clean your paintbrush and reuse! The bamboo paper towels, plate, and wheat straws are biodegradable. Please recycle any water bottles.

By the end of the month, your daphnia will likely have completed their natural life cycle. You can continue to feed any remaining living daphnia this week. You can use the contents of the tray to water an indoor plant – these are healthy nutrients for your plants! OR…Ask an adult to help add a small amount of bleach to the tray and pour down the drain with water. (These species are present in Massachusetts, but this is a good practice to prevent invasive species).

Core Questions:

- What are cyanobacteria?
- What behaviors do cyanobacteria exhibit?
- What are algal blooms, and how do they prosper?
- How has urban development affected the Charles River ecosystem?
- What factors cause population crashes to occur?
- How does a decrease in zooplankton populations affect cyanobacteria populations?
- What are harmful algal blooms? What do they look like, and how can they be distinguished?

For More Information

Please visit the MIT Sea Grant Floating Wetland Educational Kit & Resources page for more: (https://seagrant.mit.edu/floating-wetland-resources/)

Learn more about the Charles River Conservancy Floating Wetlands: (https://thecharles.org/floating-wetlands/)

Questions?
Contact MIT Sea Grant Communications Specialist Lily Keyes: (keyes@mit.edu)