

LESSON PLAN:

Is the Water Safe to Drink?

OVERVIEW:

Students will examine research from the Seneca Lake Archaeological & Bathymetric Survey to understand harmful algal blooms and the quality of the water in the lake.

Grade Level: 6-8

Class Periods: Three to four 45-minute class periods

ESSENTIAL QUESTIONS:

- Why is it important to protect the water quality of Seneca Lake (and other bodies of water)?
- What are the main threats to Seneca Lake?
- How can people help protect Seneca Lake?

OBJECTIVES:

- Students will discuss the importance of Seneca Lake and similar bodies of water.
- Students will identify and study ways Seneca Lake can be contaminated or harmed.
- Students will brainstorm and study how to protect Seneca Lake.

MATERIALS NEEDED:

- Copies of reading materials and worksheets
- 4 large beakers (or glass jars), water sample containing algae, liquid algae fertilizer, microscope
- Stream table(s), soil, small pebbles (optional: cheese cloth, toothpicks, paper towels, food coloring, kitchen sponges)

LESSON PLAN ACTIVITIES:

- **Activity 1:** Introduction
- **Activity 2:** What are HABs?
- **Activity 3:** Grow an Algal Bloom
- **Activity 4:** Water Runoff
- **Activity 5:** Conclusions

NEW YORK STATE EDUCATION STANDARDS:**SCIENCE STANDARDS:**

- MS. Engineering Design

MS-ESS3-3. Apply Scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3.C. Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Teacher Procedure & Answer Keys

► ACTIVITY 1: Introduction

Students will learn about the uses of Seneca Lake, both historically and today, and consider the distribution of clean drinking water throughout the world.

INFORMATION AND INSTRUCTIONS

Read “The History” on pages 12-37 from the Seneca Lake Archaeological & Bathymetric Survey, 2019 Final Report https://americancanalsociety.org/wp-content/uploads/2020/12/Seneca_Lake_Survey_2019_ONLINE_VERSION.pdf

1. Show pictures of people fishing, boating, sailing, riding personal watercraft, kayaking, swimming, conducting research on R/V David Folger, working in vineyards, walking along the Geneva Lakeshore path, camping at Sampson State Park, and people working at the Seneca Lake Sonar Test Facility. Use images provided or your own.

Ask students how many of them have done one or more of these activities or think they would enjoy doing them. Next, ask students what body of water is shown in these pictures. (Depending on where students are from, they may need some additional clues to figure out where this site is located).



Bicyclists at Seneca Lake State Park

Courtesy: New York State Office of Parks, Recreation and Historic Preservation



*True Love.
(Formerly Verona II), at the dock in Watkins Glen*

*Courtesy: True Love Charters.
Seneca Sailing Adventures, LLC*

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS



The Seneca Lake Survey Fleet

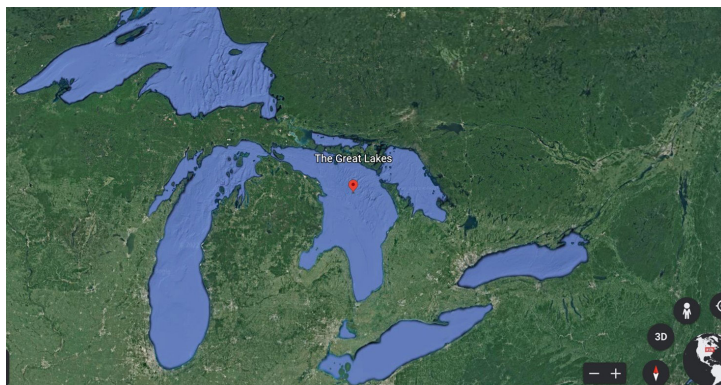
Courtesy: Dennis Gerber and Tim Caza



Fishing at Sampson State Park

Courtesy: New York State Office of Parks, Recreation and Historic Preservation

2. Show students a map of the Great Lakes watershed and then zoom in to point out Seneca Lake. Display pictures/maps of the lake and discuss some of the history of the lake.



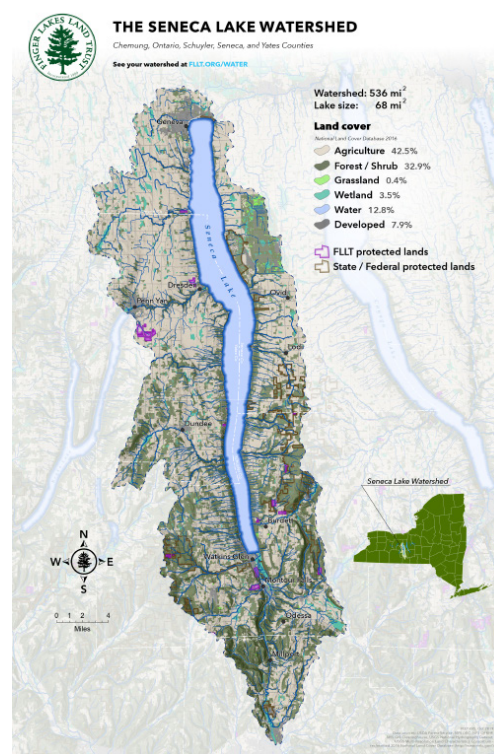
Great Lakes Watershed

Courtesy: Google Earth, 2022

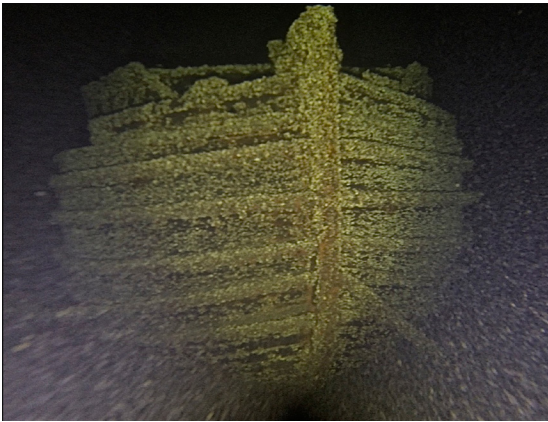
The Haudenosaunee ("People of the Longhouse") settled in the Finger Lakes region thousands of years ago and continue to reside in the region today. Seneca Lake was part of an extensive transportation route for American Indians who used birch bark and dugout canoes as the main methods of travel before and after the arrival of European colonists.

Seneca Lake Watershed Map, 2019

Courtesy: Finger Lakes Land Trust



SECTION 1: TEACHER PROCEDURE & ANSWER KEYS



The Erie Canal was completed in 1825 which ran in close proximity to the northern ends of the two largest Finger Lakes (Seneca and Cayuga). Completion of the Cayuga-Seneca Canal in 1828 connected the two lakes to the New York State Canal System, dramatically increasing commercial shipping from the lakes and surrounding areas.

Remote operated vehicle image of an Erie Canal boat from Seneca Lake Survey Project

Courtesy: Tim Caza & Dennis Gerber and the Seneca Lake Survey Project.



From the 1830s to 1890s, steamships filled Seneca Lake carrying passengers or towing canal boats loaded with cargo from one end to the other. Tourism and completion of additional canals in the region increased the number of people and goods traveling the lake in the mid-1800s. By the late 1800s, railroads became the dominant method of travel and shipping in the region.

Steamboat Seneca docked at Watkins Glen

Courtesy: Historic Geneva



During World War II, the United States established Sampson Naval Training Station on Seneca Lake. It opened in 1942 and trained over 400,000 recruits during the war. The nearby Seneca Army Depot opened as a weapons storage facility in 1941 and remained in use until 1995. During the Cold War, nuclear weapons were housed at the Depot.

Sampson Naval Training Station

Courtesy: Sampson Memorial Naval & Air Force Museum

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS



Sampson Naval Training Station closed in 1946 but was re-activated in 1950 during the Korean War as Sampson Army Airfield where air force recruits trained. The facility closed in 1955 and part of the land was transferred to New York State which established Sampson State Park.

Sampson Air Force Base

Courtesy: Sampson Memorial Naval & Air Force Museum

3. Show students images of people obtaining clean drinking water. You may want to have a picture of a person from a different part of the world without ample freshwater that is walking to gather their family's water for the day. (Many middle school students read *A Long Walk to Water*, by Linda Sue Park. A picture from this book might be a good fit).

Discuss what is different about the pictures. Talk about the availability of fresh water and what they know or do not know about this. Let students know that Seneca Lake provides drinking water to about 100,000 people. Discuss all the ways the lake (and other lakes) is/are important.



Women in Nyanza province, Kenya, walking to collect water

Courtesy: United Nations University, photo by Peter Bregg. <https://ourworld.unu.edu/en/water-for-life-an-african-photo-exhibit>



Center for Disease Control, <https://www.cdc.gov/healthywater/drinking/drinking-water-week.html>

4. Have students brainstorm ways the lake can become contaminated or harmed on **Worksheet 1: Introduction**.

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

► KEY > WORKSHEET 1: Introduction**1. Why are lakes important?**

- *Drinking water*
- *Irrigation source for agriculture*
- *Habitats for fish, aquatic life, and wildlife*
- *Limit impacts of floods and droughts*
- *Replenish groundwater*
- *Provide recreation and tourism opportunities*

2. What are some ways lakes may become contaminated or harmed?

- *Sewage outlets from home septic systems*
- *Municipal wastewater treatment plants*
- *Agricultural runoff (fertilizers, animal wastes, and herbicides/pesticides)*
- *Road salt runoff and salt mines at the south end of Seneca Lake*
- *Power plant cooling water outflow*
- *Harmful algal blooms (HABs)**
- *Warmer temperatures (climate change)*
- *Invasive mussels—quagga and zebra mussels (alter nutrient cycle in the lake to promote HABs)*

*We will be focusing on HABs throughout the rest of this lesson.

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

► ACTIVITY 2: What are HABs?

Students will learn about harmful algal blooms and create a KWL (know, want to know, learn) chart about them.

INFORMATION AND INSTRUCTIONS

Review information about Harmful Algal Blooms (HABs) from the New York State Department of Environmental Conservation <https://www.dec.ny.gov/chemical/77118.html>.

Teachers note: Not all algal blooms are HABs. There are thousands of types of algae. Harmful algal blooms occur when phytoplankton (microscopic plants) grow fast in large amounts while producing toxins.

1. Have students complete a KWL (know, want to know, learn) chart on **Worksheet 2: What are HABs?** Give students 5 minutes to write down/illustrate what they already know about HABs and what questions they have (want to know).
2. Break students into groups (or do as a class discussion) and have them share what they know and what questions they have. While students share, the others should write down things they learn and new questions that arise.

► KEY > WORKSHEET 2: What are HABs?

Be sure all students agree on the following:

- *HABs are one of the biggest threats to our water sources (including Seneca Lake)*
- *They are a type of cyanobacteria*
- *These blooms occur when water is warm and full of nutrients*
- *Not all algal blooms are harmful*
- *Scientists do not fully understand the blooms or how to predict when the bacteria will produce toxins, but when they do, they are called harmful algal blooms. These can cause diarrhea, nausea and vomiting, eye or throat irritations, and allergic reactions or breathing difficulties*
- *HABs are not always filtered out of drinking water*
- *Pets such as dogs are also affected*

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

► ACTIVITY 3: Grow an Algal Bloom

Students will conduct a laboratory experiment about harmful algal blooms and research conditions in lakes which cause them to develop.

INFORMATION AND INSTRUCTIONS

In this lesson, your students will examine the conditions that contribute to harmful algal blooms.

Materials needed:

- At least four glass jars or large beakers
- Water sample containing algae (you should be able to see slight specks of green or brown flecks in the water) from a fish tank, pond, or lake
- Liquid algae fertilizer



Teacher note: It may be helpful to prepare this a week or so ahead of time so that students can see the results right away.

1. Fill at least four glass jars with water that contains algae. Don't put covers on the jars.
 - a. Jar 1: Place in a cool dark place, such as a refrigerator.
 - b. Jar 2: Place in a warm, well-lit area such as a windowsill.
 - c. Jar 3: Add four drops of liquid fertilizer and place in a cool dark place such as a refrigerator.
 - d. Jar 4: Add four drops of liquid fertilizer and place in a warm, well-lit area such as a windowsill.
2. Have students make a prediction about what will happen in the jars and whether there will be a difference between the jars on **Worksheet 3: Grow an Algal Bloom**.
3. Bring out jars that have been sitting for 5-7 days and have students make observations of the jars. They may look at the water samples under microscopes to look for algae growth.
4. Students should break up into groups or discuss as a class what conditions created the most algae growth. Students should write down their findings on **Worksheet 3: Grow an Algal Bloom**.

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

5. Have students visualize the jars as mini lakes. Tell students that we are now going to explore how the conditions found in the jars occur in actual lakes. Present groups of students with different sources which discuss water quality in the Finger Lakes. Give groups 10 minutes and challenge students to identify a specific issue that may be contributing to HABs in Seneca Lake. Students will add other causes from other groups once the class has a discussion.
 - Group 1: <http://senecacountycce.org/agriculture/harmful-algal-blooms-and-invasive-mussels-what-s-the-connection>
 - Group 2: <https://www.nrdc.org/stories/bitcoin-mining-bad-climate-and-local-communities-too>
 - Group 3: https://senecalake.org/resources/Documents/Water%20Quality/Streams/Reeder_Creek_factsheet_2018.pdf
 - Group 4: <https://www.epa.gov/sites/default/files/documents/climatehabs.pdf>
 - Group 5: https://www.fltimes.com/news/sewage-release-results-in-beach-closure-at-seneca-lake-state-park/article_40bbe286-5d56-5adb-ab4b-386b0387dd7e.html#:~:text=GENEVA%20%E2%80%94%20A%20discharge%20of%20an,after%20the%20spill%20was%20reported
 - Group 6: <https://waterfrontonline.blog/2022/08/18/seneca-and-skaneateles-lakes-are-hit-with-first-toxic-blooms-of-summer-plans-seek-to-cut-farming-phosphorus/>
6. After the class has heard from each group, ask students to write down five specific issues that are contributing to an increase in HABs in Seneca Lake on **Worksheet 3: Grow an Algal Bloom**.

► **KEY > WORKSHEET 3: Grow an Algal Bloom**

1. Which conditions will promote the most growth of algae in the jars?

Hypothesis:

warm temperatures, sunlight, and fertilizers will create more algae growth

Observations:

Jar 1- lowest algae growth

Jar 2- moderate algae growth

Jar 3- moderate algae growth

Jar 4- highest algae growth

2. Which condition(s) promoted the most growth of algae in the jars?

Claim: *Jar 4 promoted the most algae growth*

Evidence: *warmer temperatures, sunlight, and fertilizers increase the growth of algae*



SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

3. Think of the jars as mini lakes. What causes the conditions we found in the jars to happen in Seneca Lake?

- *Climate change contributes to rising water temperatures, which increases occurrence of HABs*
- *Bitcoin mining water outflow put extremely warm water into Seneca Lake, which would increase the occurrence of HABs*
- *Munitions disposals at the decommissioned Seneca Army Depot generate phosphorus runoff into Reeder Creek, which increases nutrient levels in the lake which increases the occurrence of HABs*
- *Invasive quagga and zebra mussels disrupt the nutrient cycle in the lakes which increases the occurrence of HABs*
- *Sewage leaks add excess nutrients (and harmful bacteria) to the lake*
- *Runoff from farmland containing fertilizer (phosphorus) increases the occurrence of HABs*

SECTION 1: **TEACHER PROCEDURE & ANSWER KEYS**

► ACTIVITY 4: Water Runoff

Students will explore how runoff containing harmful bacteria, phosphorus, nitrogen, and other chemicals get into lakes. This lesson also helps students consider what towns, farms, businesses, and individuals can do to protect Seneca Lake.

INFORMATION AND INSTRUCTIONS

Materials needed:

- stream table(s)
 - soil
 - small pebbles
 - optional: cheese cloth, toothpicks, paper towels, cut up pieces of kitchen sponges, food coloring
1. Create a small stream bed and/or ditch down the center of the table with pebbles. Line the side of the stream bed with soil. Demonstrate how rain carries sediment, and nutrients into the lake (you may add drops of food coloring into the soil which represent contaminants such as phosphorus, nitrogen, E-Coli, etc.). You may choose to pretend the stream bed is a specific creek that flows into Seneca Lake. Reeder Creek is a large source of phosphorus. Have students also visualize dug out ditches that line many of the roads in rural areas. These ditches often surround farmland.

If you have a class set of stream tables you may have groups use cheese cloth, paper towels, and toothpicks to design the best ditch and challenge the groups to compete for the cleanest lake. (Cheese cloth, sponges and paper towel represent grasses like cat tails, and toothpicks represent larger trees). Challenge students to think of ways to reduce the amount of runoff that ends up in lakes.

2. Give students 5 minutes to brainstorm other ways the lake can be protected. After brainstorming, break students up into groups on **Worksheet 4: Water Runoff**. Give each group a simple step from the following Seneca Lake Pure Waters Association publication: https://senecalake.org/resources/Documents/Water%20Quality/Publications/SLPWA%20Homeowners%20Guide_8-2-2017.pdf
3. Give the groups 10 minutes to become experts on their simple step. Students will then share what they have learned with the entire class. Students should write down the ways towns, farms, businesses, and individuals can help protect Seneca Lake on **Worksheet 4: Water Runoff**.



SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

► KEY > WORKSHEET 4: Water Runoff

1. After experimenting with the stream table, what did you conclude will help reduce the number of pollutants entering the lake through runoff?

Claim:

- *Dirt lined ditches or streams without vegetation carry the most contaminants into the lake*
- *Adding grasses and other plants slow or decrease the flow of contaminants into the lake*

Evidence:

- *cheese cloth, paper towels, and toothpicks helped prevent soil and contaminants from reaching bottom of the water table*
2. After brainstorming and reading the publication from Seneca Lake Pure Waters Association, list the ways towns, farms, businesses, and individuals can help protect Seneca Lake.
 - *Minimize Runoff*
 - *Eliminate Pollutants*
 - *Capture and Infiltrate*

SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

► ACTIVITY 5: Conclusions

Students will discuss the main threats to Seneca Lake and explore ways to help protect the lake.

INFORMATION AND INSTRUCTIONS

1. Have a class discussion to wrap up the lesson. Ask students to answer the following questions on **Worksheet 5: Conclusions**:
 - Why should we care about protecting the water quality in Seneca Lake, and others like it?
 - Have students listen to a portion of a podcast from the Executive Director of the Finger Lakes Land Trust, Andy Zepp <https://www.flit.org/press-stories-about-flit-water-quality-work>. Help students identify the three (3) main concerns Andy identifies as threats to our lakes. They are:
 - a. Climate change
 - b. Nutrient runoff
 - c. Invasive mussels
2. Ask students if they agree or disagree with Andy Zepp's assessment and why. Challenge students to brainstorm ways students can help educate the public and help protect Seneca Lake and other waterbodies like it?

► KEY > WORKSHEET 5: Conclusions**1. Why should we care about protecting Seneca Lake and others like it?**

- *Clean drinking water*
- *Natural beauty*
- *Recreation*
- *Healthy habitats and ecosystems*
- *Benefit local economies*

2. The three main threats to Seneca Lake are:

- *Climate change*
- *Nutrient runoff*
- *Invasive mussels*

3. What else can we do to help protect Seneca Lake and other bodies of water like it?

- *Participate in stream or lake monitoring and citizen science programs*
- *Volunteer with a local conservation group*
- *Practice good water stewardship*
- *Reduce pollution*



SECTION 1: TEACHER PROCEDURE & ANSWER KEYS

EXTENSION IDEAS

SCIENCE ON SENECA RESEARCH VESSEL (FIELD TRIP)

<https://www.hws.edu/centers/finger-lakes-institute/education.aspx>

STREAM MONITORING PROGRAM

<https://www.hws.edu/centers/finger-lakes-institute/education.aspx>

SOURCES

PUBLICATIONS:

Cohn, Art, Principal Investigator and Dr. Tom Manley, Chief Scientist. *Seneca Lake Archaeological & Bathymetric Survey*, 2019 Final Report. Published June 2020. https://americancanalsociety.org/wp-content/uploads/2020/12/Seneca_Lake_Survey_2019_ONLINE_VERSION.pdf

WEBSITES:

<https://www.cdc.gov/healthywater/drinking/drinking-water-week.html>

<https://www.dec.ny.gov/chemical/77118.html>

<https://www.epa.gov/sites/default/files/documents/climatehabs.pdf>

https://www.fltimes.com/news/sewage-release-results-in-beach-closure-at-seneca-lake-state-park/article_40bbe286-5d56-5adb-ab4b-386b0387dd7e.html#:~:text=GENEVA%20%E2%80%94%20A%20discharge%20of%20an,after%20the%20spill%20was%20reported

<https://www.flit.org/press-stories-about-flit-water-quality-work>

<https://www.nrdc.org/stories/bitcoin-mining-bad-climate-and-local-communities-too>

<https://ourworld.unu.edu/en/water-for-life-an-african-photo-exhibit>

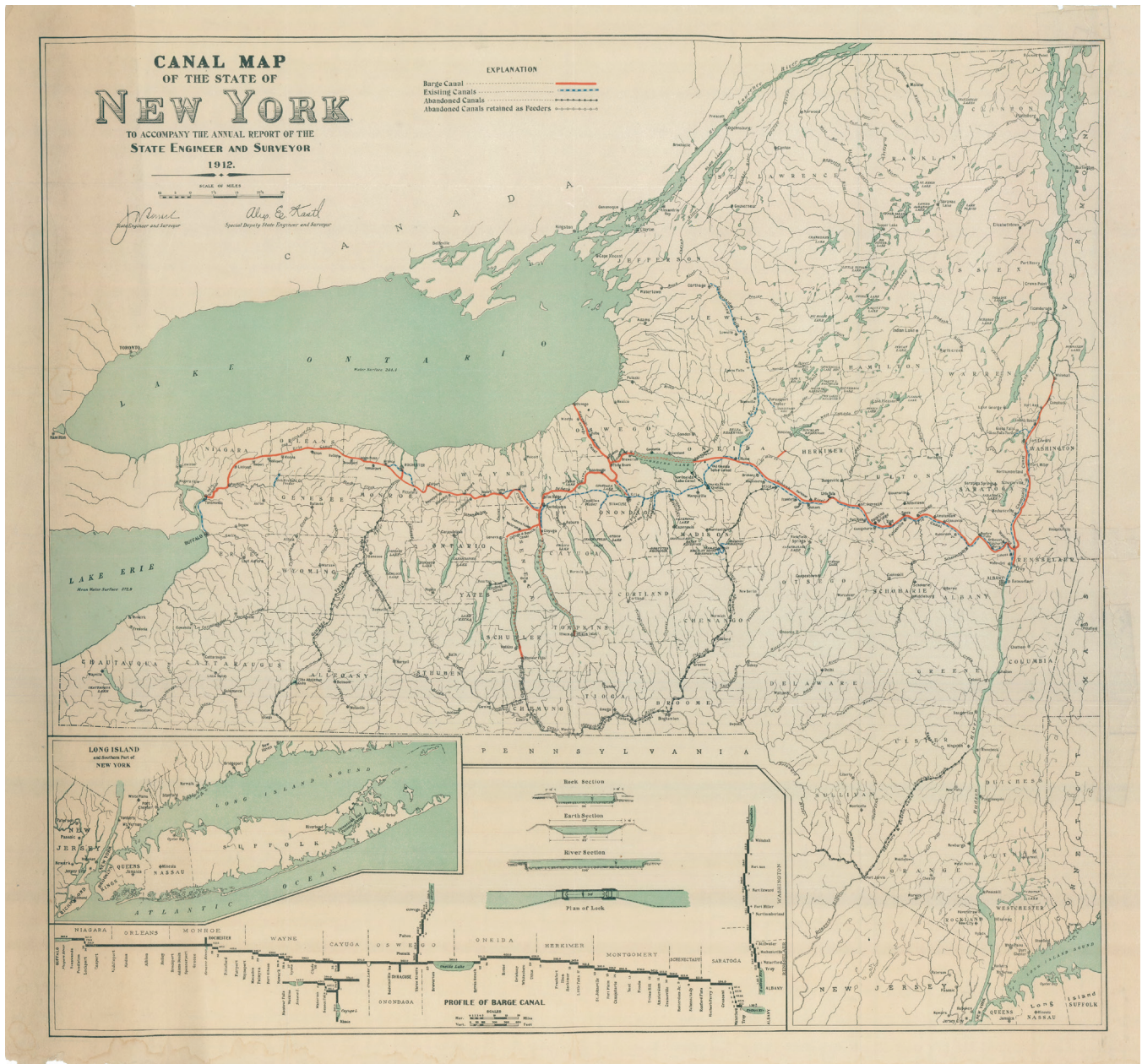
<http://senecacountycce.org/agriculture/harmful-algal-blooms-and-invasive-mussels-what-s-the-connection>

https://senecalake.org/resources/Documents/Water%20Quality/Publications/SLPWA%20Homeowners%20Guide_8-2-2017.pdf

https://senecalake.org/resources/Documents/Water%20Quality/Streams/Reeder_Creek_factsheet_2018.pdf

<https://waterfrontonline.blog/2022/08/18/seneca-and-skaneateles-lakes-are-hit-with-first-toxic-blooms-of-summer-plans-seek-to-cut-farming-phosphorus/>

Student Worksheets



NAME _____

► WORKSHEET 1: Introduction

1. Why are lakes important?

2. What are some ways lakes may become contaminated or harmed?





NAME _____

► **WORKSHEET 2:** What are HABs?

What I know about HABs	I want to know about HABs	What I learned about HABs

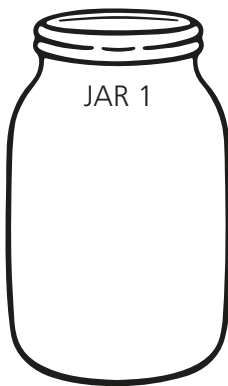
NAME _____

► WORKSHEET 3: Grow an Algal Bloom

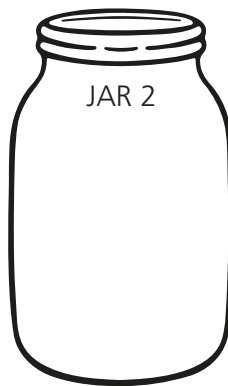
1. Which conditions will promote the most growth of algae in the jars?

Hypothesis:

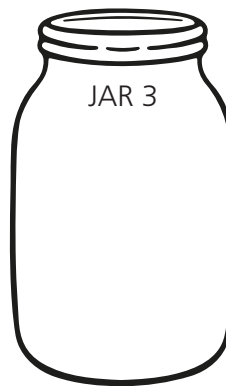
Observations:



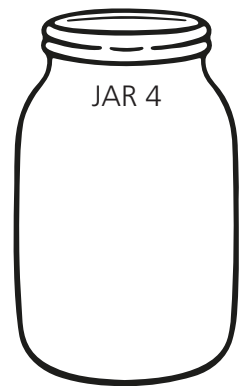
no fertilizer,
in refrigerator



no fertilizer,
window sill



fertilizer,
in refrigerator



fertilizer,
window sill

2. Which condition(s) promoted the most growth of algae in the jars?

Claim:

Evidence:

3. Think of the jars as mini lakes. What causes the conditions we found in the jars to happen in a lake, like Seneca? Read the article your group was given and identify one specific example of how the water quality is affected in Seneca Lake.



NAME _____

► WORKSHEET 4: Water Runoff

1. After experimenting with the stream table, what did you conclude will help reduce the number of pollutants entering the lake through runoff?

Claim: _____

Evidence: _____

2. After brainstorming and reading the publication from Seneca Lake Pure Waters Association, list the top 6 ways towns, farms, businesses, and individuals can help protect Seneca Lake.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____



NAME _____

► WORKSHEET 5: Conclusions

1. Why should we care about protecting Seneca Lake and others like it?

2. The three main threats to Seneca Lake are:

1.

2.

3.

3. What else can we do to help protect Seneca Lake and other waterbodies like it?
