



Keeping Lakes Open

Middle School, Life Sciences

Task Overview

In this task, students will use a model to predict the effects of selecting a particular bull to be mated with a group of cattle, given the goal of decreasing cattle carbon emissions using genetics.

- Students are first introduced to the phenomena of a shutdown lake due to a harmful algal bloom.
- In prompt 1, students are provided with a food web and a model of a freshwater ecosystem. They identify the living and nonliving components and the interactions that occur in the ecosystem.
- In prompt 2, students apply their scientific reasoning to identify modifications to the model to represent the ecosystem during a harmful algal bloom.
- In prompt 3, students analyze actual data from Lake Owasca to help them further understand what happens during an HAB.
- In prompt 4, students use a graphic demonstrating the effects of decreased dissolved oxygen on fish. Students use this model and scientific reasoning to predict how HABs impact fish populations.
- In prompt 5, students use a model of causes of HABs and a land use map for the Lake Owasca watershed to determine that agriculture likely contributes to HABs in Lake Owasca.
- In prompt 6, students examine a series of conservation strategies that producers can use to reduce excess runoff of nutrients. Students use evidence provided throughout the task to argue or refute that HABs in Lake Owasca could be reduced by implementing a combination of conservation strategies.



Background Information

Excess nutrients in water ecosystems can contribute to an overgrowth of algae, harming other species in the ecosystem. One source of excess nutrients is agriculture through nutrient runoff into nearby streams that feed into larger waterways. If not well-managed, livestock, such as cattle, can contribute to increased nutrient runoff by increasing erosion or directly by adding nutrients via waste into the streams. There are a variety of solutions being implemented by cattle producers. Scientific evidence shows that best practices include the following solutions to mitigate excess nutrient runoff due to production. Each has a unique impact on the biodiversity of a water ecosystem. Using cover crops helps soil hold onto nutrients so they are not released into the ecosystem. Managing the life cycle of beef cattle and grazing practices by using a feedlot for a portion of the cattle's life cycle and reducing overgrazing helps maintain the local ecosystem. Buffers or filter strips can help trap nutrients that otherwise end up in the local water ecosystem. Fencing is a physical barrier that keeps water sources clean by blocking livestock access.

Next Generation Science Standards

Three-Dimensional Claim 1 (Prompts 1 – 4)

Update an existing model to represent how changes to physical or biological components of an ecosystem affect populations.

Three-Dimensional Claim 1 (Prompts 5 and 6)

Students will construct an argument to support a proposed design solution, with empirical evidence and scientific reasoning from data, to reduce harmful impacts on recreational waterways.

This task is intended to elicit student learning of the following **NGSS elements** for each of the three dimensions:

Disciplinary Core Ideas

LS2.C-M1: Ecosystem Dynamics, Functioning and Resilience

- Ecosystems are dynamic in nature, their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.



LS4.D-M1: Biodiversity and Humans

- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on – for example, water purification and recycling (secondary to MS-LS2-5).

Science and Engineering Practices

ARG-M3 and ARG-M4: Engaging in Argument from Evidence

- Construct, use, and/or present an oral & written argument supported by empirical evidence & scientific reasoning to support or refine an explanation or a model for a phenomenon or solution to a problem.
- Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.

MOD-M2: Using Models

- Develop or modify a model--based on evidence--to match what happens if a variable or component of a system is changed.

Crosscutting Concepts

SC-M2: Stability and Change

- Small changes in one part of a system might cause large changes in another part.

PAT-M4: Patterns

- Graphs, charts, and images can be used to identify patterns in data.

New York State P-12 Standards

- *MS-LS2-2:* Construct an explanation that predicts patterns of interactions among organisms in a variety of ecosystems.
- *MS-LS2-5:* Evaluate competing design solutions for maintaining biodiversity and protecting ecosystem stability.



Suggestions for Use

This task is intended for formative assessment purposes—to identify students' strengths and needs with the above dimensions, provide feedback to students, and guide shifts in instruction.

Assumptions

Students should be familiar with the concept that ecosystems are dynamic in nature and that disruptions to an ecosystem's physical or biological components can lead to shifts in all its populations. Additionally, students have had instructional experiences where they've been asked to analyze and interpret data, including graphs, diagrams, and images, to look for patterns as scientific evidence to support an argument or refine an explanation. They should also be familiar with the concept that changes in biodiversity can impact human resources and ecosystem services that humans rely on.

Materials Needed

- [Keeping Lakes Open Student Task](#)
- Writing utensil

Assessment Guidance

Introduction

Recreational use of the lakes, rivers, and ocean waters in New York State is a popular way for residents and tourists to spend time; according to an analysis from the US Bureau of Economics, boating and fishing brought in 1.4 billion dollars to New York's economy in 2020.

Imagine it's late summer, the sun is out, and the temperature is nearing 90°F. Your family decides to spend an afternoon at the beach, cooling off in the water, and perhaps enjoy some fishing from the dock. As you approach the beach, you see the following sign on the left (Figure 1). Typically, the water is relatively clear, and you can see the rocks along the bottom of the lake when near the shoreline, but today, the view of the water from the dock looks like the photo on the right (Figure 2).



Figure 1: Sign on the beach at Lake Owasco¹

Figure 2: Photo of the water near the beach

Introduction Prompt a: NOT ASSESSED. This is scaffolding to introduce students to the phenomenon.

Introduction Prompt b: NOT ASSESSED. This is scaffolding to introduce students to the phenomenon.

Prompt 1

Prompt 1a: NOT ASSESSED. This is a scaffolding prompt used to familiarize students with the living and nonliving components and interactions in a freshwater ecosystem.

Prompt 1b: NOT ASSESSED. This is a scaffolding prompt used to familiarize students with the living and nonliving components and interactions in a freshwater ecosystem.

¹Photo from NY Department of Environmental Conservation

<https://dec.ny.gov/environmental-protection/water/water-quality/harmful-algal-blooms>



Prompt 1c: NOT ASSESSED. This is a scaffolding prompt used to familiarize students with the living and nonliving components and interactions in a freshwater ecosystem.

Prompt 2

Prompt 2a: NOT ASSESSED. This is a scaffolding prompt used to familiarize students with the changes that occur in the ecosystem during an HAB

Prompt 2b: NOT ASSESSED. This is a scaffolding prompt used to elicit previous knowledge and make a prediction about the effects of an HAB.

Prompt 3

Scientists can now use technology to monitor the occurrence of algal blooms and even predict when a body of water is at risk of one. Below is data collected on Lake Owasco in 2015². An algal bloom was detected and confirmed in late July and persisted through September. It looks at the effects on some of the ecosystem's non-living components.

Prompt 3a: NOT ASSESSED. This is a scaffolding prompt used to introduce data offering clues about the changes occurring in the ecosystem during an HAB.

Prompt 3b: NOT ASSESSED. This is a scaffolding prompt used to introduce data offering clues about the changes occurring in the ecosystem during an HAB.

Prompt 3c: NOT ASSESSED. This is a scaffolding prompt used to introduce data offering clues about the changes occurring in the ecosystem during an HAB.

² Harmful Algal Bloom Action Plan: Owasco Lake. Multiagency HABs Initiative 2018 including the New York Department of Environmental Conservation, Department of Health, and Agriculture and Markets.



Prompt 3d: NOT ASSESSED. This is a scaffolding prompt used to introduce data offering clues about the changes occurring in the ecosystem during an HAB.

Prompt 4

- a. Cite evidence from the charts and graphs provided throughout the task to explain how HABs cause changes in the freshwater ecosystem that ultimately affect fish populations in the ecosystem.
- Include two different ways fish are impacted and note how they affect the fish population

Prompt 4 Performance Outcome

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

SEP

ARG-M3: Construct, use, and/or present an oral & written argument supported by empirical evidence & scientific reasoning to support or refine an explanation or a model for a phenomenon or solution to a problem.

DCI

LS2.C-M1: Ecosystems are dynamic in nature, their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

CCC

SC-M2: Small changes in one part of a system might cause large changes in another part.



Prompt 4 Assessment Rubric			
	Emerging	Developing	Proficient
Sample Student Response	The chart shows that dissolved oxygen levels are lower during an HAB. Two possible impacts on fish are disease outbreak and oxidative stress.	Figure 5 shows us that dissolved oxygen levels drop during an HAB. According to Figure 6, low levels of dissolved oxygen cause fish asphyxiation which can be fatal to fish. Disease outbreak is another problem for fish in water with low dissolved oxygen levels.	One of the changes in the ecosystem, caused by an HAB, is a decrease in dissolved oxygen in the water, which can be seen in Figure 5. Figure 6 explains some of the effects of low dissolved oxygen levels on fish. According to Figure 6, fish populations could decrease during an HAB due to less oxygen because: 1. Disease outbreaks may kill some fish or keep them from reproducing. 2. Fish may die due to a lack of dissolved oxygen.
Look-fors	• Student should clearly connect the pattern of HABs and lower dissolved oxygen levels from Figure 5 • Student identifies 0 – 1 ways fish are affected by lower dissolved oxygen from Figure 6, but	• Student should clearly connect the pattern of HABs and lower dissolved oxygen levels from Figure 5 • Student identifies 2 ways fish are affected by lower dissolved oxygen from Figure 6, but accurately connects how only 1 would	• Student should clearly connect the pattern of HABs and lower dissolved oxygen levels from Figure 5 • Student should clearly identify that figure 6 indicates that low dissolved



	fails to accurately connect how it would ultimately impact fish populations (typically by death, or lower reproduction)	ultimately impact fish populations (typically by death, or lower reproduction)	oxygen levels can negatively affect fish populations in two different ways (e.g. by death, or lower reproduction)
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Prompt 5

Prompt 5a: NOT ASSESSED. This is a scaffolding prompt used to introduce potential contributors to HABs.

Prompt 5b: NOT ASSESSED. This is a scaffolding prompt used to orient students to a particular contributor to HABs.

Prompt 6

- a. Select two conservation practices from Figure 10. Using evidence from the figures provided throughout the task, and scientific reasoning, support or refute the argument that the conservation practices can reduce agriculture's contribution to HABs downstream which would positively impact the biodiversity and water quality of the bodies of water downstream. Be sure to include the following in your response:

- How does agriculture contribute to increased HABs in downstream lakes?
- How does each of the practices you chose help reduce agriculture's contribution to HABs?

How does preventing HABs allow humans to utilize and enjoy recreational waterways?



Prompt 6 Performance Outcome

Construct a written argument to support or refute that implementing conservation practices could lead to changes upstream from lakes, and reduce harmful impacts on recreational waterways.

SEP	ARG-M4: Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.
DCI	LS4.D-M1: Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on – for example, water purification and recycling (secondary to MS-LS2-5).
CCC	SC-M2: Small changes in one part of a system might cause large changes in another part.

Prompt 6a Assessment Rubric

	Emerging	Developing	Proficient
Sample Student Response	Fencing around waterways would keep cattle away from the streams and cause less HABs in the lakes downstream.	Figure 7 shows that agriculture runoff is how agriculture contributes to HABs in downstream lakes. I would choose fencing and filter strips of vegetation to help prevent the runoff. The fencing would keep cattle manure and pee from entering the water directly. Less HABs means that the lakes would be open to for swimming.	Figure 7 shows that agriculture runoff is how agriculture contributes to HABs in downstream lakes. I would choose fencing and filter strips of vegetation to help prevent the runoff. The filter strips would help protect the soil around the stream from erosion because the plants and their roots would hold it together. The plants could also use the nutrients to



			grow. Using fencing would keep cattle manure and pee from directly flowing into the stream and prevent the cattle from causing erosion along the sides of the stream. These practices would prevent excess nutrients from agricultural runoff from reaching the streams that feed into Lake Owasco. Less excess nutrients would lead to fewer HABs in the lake. Less HABs means that the lakes and swimming areas can remain open and safe for fishing, boating, and kayaking.
Look-fors	• Student identifies 0 – 2 practices but does not provide relevant evidence and scientific reasoning for one to support the argument that the practice(s) would prevent excess runoff of nutrients from reaching lakes downstream • Students do not clearly identify that	• Student identifies 1 – 2 practices as a proposed solution and provides relevant evidence and scientific reasoning for one of the practices to support the argument that it would prevent excess runoff of nutrients from reaching lakes downstream • Students identify one of the following two things: 1. that agriculture contributes to HABs	• Student identifies 2 practices as a proposed solution and provides relevant evidence and scientific reasoning for each to support the argument that the practice(s) would prevent excess runoff of nutrients from reaching lakes downstream • Student identifies that agriculture contributes to HABs as a result of



	agriculture contributes to HABs as a result of increased runoff of nutrients from agricultural lands reaching lakes • Students do not list any ways recreational waters are used by humans that be positively impacted by fewer HABs	as a result of increased runoff of nutrients from agricultural lands reaching lakes. 2. Students identify the excess nutrients create conditions that can cause algae to grow rapidly leading to an HAB. • Students list 1-way humans use recreational waterways that would be positively impacted by fewer HABs	increased runoff of nutrients from agricultural lands reaching lakes. • Student identifies the excess nutrients create conditions that can cause algae to grow rapidly leading to an HAB. • Student lists 2 ways humans use recreational waterways that would be positively impacted by fewer HABs.
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