Formative Assessment Exemplar - BIO.1.2

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Information

Standard: BIO.1.2

Assessment Format: Printable or Online Format (Does not require students to have online access)

Phenomenon	
Algal Blooms in Utah Freshwater Ecosystems	Proficient Student Explanation of Phenomenon: Algal blooms impact the flow of matter and energy by harming species living within and around freshwater ecosystems via hypoxia/anoxia, toxins, acid rain, and air pollution. This reduces available energy to different trophic levels within these ecosystems, overall reducing the amount of organisms and potentially lowering biodiversity, collapsing food chains/food webs.

Cluster Task Statement

(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed)

In the following task: a) you will be asked to develop and use a model explaining how energy moves between trophic levels, and b) construct an explanation for how algal blooms affect the flow of energy and matter in Utah freshwater ecosystems.

Supporting Information

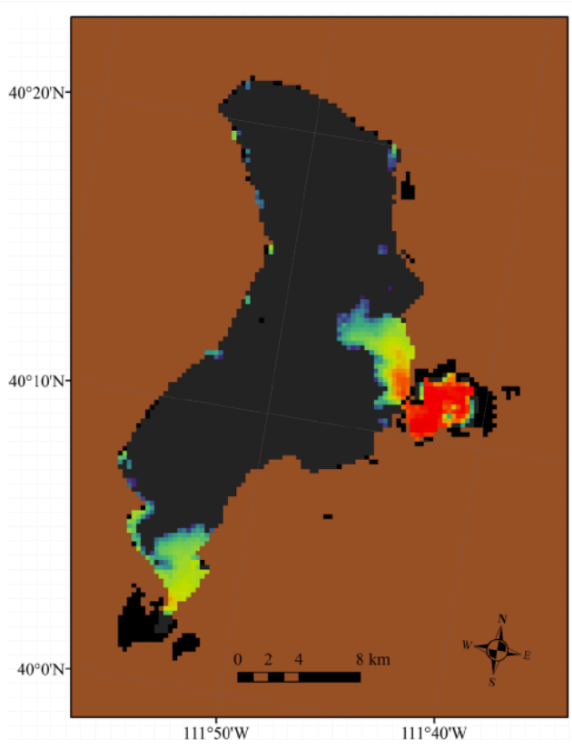
Increased human activity throughout the world affects our different environments in many different ways. One of the most striking examples of human development in our aquatic environments is the formation of harmful algal blooms (HABs). These harmful algal blooms are a significant problem in all 50 states. Examples of harmful algal blooms are red tides, blue-green algae, and cyanobacteria. An example of what a HAB looks like is displayed in the image below:

Image source: deq.utah.gov

In order for a HAB to develop, they need the following components:

1) Sunlight
2) Slow moving water (low wave energy)
3) Nutrients (typically increased nitrogen and phosphorous)

Scientists predict that climate change will increase the amount and intensity of HABs. HABs are a threat to human health, our economies, and our environments. However, organisms that cause blooms are natural components in freshwater ecosystems, providing critical energy for primary consumers.



June 2017 satellite photo of Utah Lake showing cyanobacteria density. Brown pixels are land, gray pixels in the lake indicate no detection of cyanobacteria, black pixels are quality controlled for clouds, straylight, or glint. Cool blue and purple colors are low concentrations of cyanobacterial biomass and warm colors of yellow, orange, and red are elevated concentrations of cyanobacteria. Large human populations are found on the eastern shore of Utah lake. Warmer colors (reds and oranges) are found on the Eastern shore (where higher populations of humans live). Source: *European Space Agency Sentinel-3*

Organisms that inhabit lakes in Utah are diverse -- plants, phytoplankton, zooplankton, invertebrates, fish, reptiles, amphibians, and birds. Plankton are microscopic organisms, both plants (phytoplankton) and animals (zooplankton) that live in aquatic environments that have limited movement.

Cluster Questions	
Gather: Cluster Question #___1___ Question Type: Table Match Addresses:	Question 1: Classify the following organisms into their appropriate trophic level: **Carp (fish), Cyanobacteria (Phytoplankton), Zooplankton, Pelican (bird)**

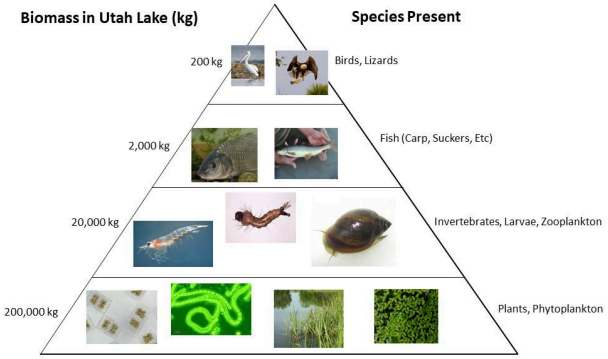
<table>
<tr>
<td>__x__ DCI Cycles of matter and energy
_____ SEP
___x_ CCC Energy and Matter
Answer:
Producer: Cyanobacteria
Primary Consumer: Zooplankton
Secondary Consumer: Carp
Tertiary Consumer: Pelican</td>
<td>
<table>
<tr><th>Trophic Level</th><th>Organism</th></tr>
<tr><td>Producer</td><td></td></tr>
<tr><td>Primary Consumer</td><td></td></tr>
<tr><td>Secondary Consumer</td><td></td></tr>
<tr><td>Tertiary Consumer</td><td></td></tr>
</table>
</td>
</tr>
<tr>
<td>Cluster Question #___2___
Question Type: Multi-Select
Addresses:
_____ DCI
_x__ SEP Obtaining and Communicating Information
_x__ CCC Cause and Effect
Answer:
2, 4, 6</td>
<td>Question 2:

Using the satellite image above, identify 3 potential factors for what might be contributing to the increased algal bloom seen in parts of the image.

1) This data was collected in winter, where HABs are at their peak due to lower temperatures
2) This data was collected in summer, where HABs are at their peak due to higher temperatures
3) Human development (construction, pollution, agriculture) does not contribute to HABs
4) Human development (construction, pollution, agriculture) contributes to HABs
5) Utah Lake has high wave energy
6) Utah Lake has low wave energy</td>
</tr>
<tr>
<td>Cluster Question #__3___
Question Type: Multiple Choice
Addresses:
_x__ DCI Cycles of Matter and Energy
_____ SEP
_x__ CCC Energy and Matter
Answer:
B</td>
<td>Question 3:

Construct a simple food chain that shows the transfer of energy in a freshwater ecosystem using the following groups of organisms (arrows indicate energy transferring to the next organism):
Birds, Fish, Phytoplankton, Zooplankton
a) Zooplankton -> Phytoplankton -> Birds -> Fish
b) Phytoplankton -> Zooplankton -> Fish -> Birds
c) Birds -> Fish -> Phytoplankton -> Zooplankton
d) Fish -> Birds -> Zooplankton -> Phytoplankton</td>
</tr>
<tr>
<td>Communicate:
Cluster Question #__4___
Question Type: Modeling
Addresses:
_x__ DCI Cycles of Matter and Energy</td>
<td>Question 4:

Harmful Algal Blooms (HAB’s) impact the food web. These algae reproduce quickly. As their numbers increase, they consume most oxygen (matter) that is available in the water. This creates a condition called hypoxia (lack of oxygen) in the lake. Modify this</td>
</tr>
</table>

____ SEP _x__ CCC Energy and Matter Answer: Students should create a model that demonstrates all available energy going towards producers, which then eliminates any available oxygen for the next trophic level, causing a system collapse with little to no biomass in 1st-3rd consumers. Biomass number shouldn't really influence student success criteria -- the shape of the model is more important. Bottom heavy with high producers, very little consumers.	trophic pyramid to demonstrate how the bloom you are seeing in the satellite image affects biomass on the east side of the lake. 
Cluster Question #___5___ Question Type: Short Answer Addresses: __x__ DCI ___x_ SEP ____ CCC Answer: Algal blooms impact the flow of matter and energy by harming species living within and around freshwater ecosystems via hypoxia/anoxia. This reduces available energy to different trophic levels within these ecosystems, overall reducing the amount of organisms and potentially lowering biodiversity, collapsing food chains/food webs.	Question 5: Construct an explanation for how an algal bloom affects the flow of matter and energy in Utah Lake.
Proficiency Scale	
Proficient Student Explanation: Algal blooms impact the flow of matter and energy by harming species living within and around freshwater ecosystems via hypoxia. This reduces available energy to different trophic levels within these ecosystems, overall reducing the amount of organisms and potentially lowering biodiversity, collapsing food chains/food webs.	

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	SEP: Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. Develop and/or use a model to predict and/or describe phenomena.	SEP: Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.	**SEP:** Extends beyond proficient in any way.
CCC: Does not meet the minimum standard to receive a 2.	CCC: Can track the transfer of energy drives the motion and/or cycling of matter, within a natural or designed system. Understands that the transfer of energy can be tracked as energy flows through a designed or natural system.	CCC: Describes changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. Understands that energy drives the cycling of matter within and between systems	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	DCI: Within a natural or designed system, the transfer of energy drives the motion	DCI: Changes in energy and matter in a system can be described in terms of energy and matter	**DCI:** Extends beyond proficient in any way.

	and/or cycling of matter. The transfer of energy can be tracked as energy flows through a designed or natural system.	flows into, out of, and within that system. Energy drives the cycling of matter within and between systems	

(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

Increased human activity throughout the world affects our different environments in many different ways. One of the most striking examples of human development in our aquatic environments is the formation of harmful algal blooms (HABs). These harmful algal blooms are a significant problem in all 50 states. Examples of harmful algal blooms are red tides, blue-green algae, and cyanobacteria. An example of what a HAB looks like is displayed in the image below:

Figure 1 - Harmful Algal Bloom

Figure 1 shows a lake with a harmful algal bloom.
Source: deq.utah.gov

In order for a HAB to develop, they need the following components:

1) Sunlight
2) Slow moving water (low wave energy)
3) Nutrients (typically increased nitrogen and phosphorous)

Scientists predict that climate change will increase the amount and intensity of HABs. HABs are a threat to human health, our economies, and our environments. However, organisms that cause blooms are natural components in freshwater ecosystems, providing critical energy for primary consumers.

Figure 2: Satellite Photo of Utah Lake, June 2017

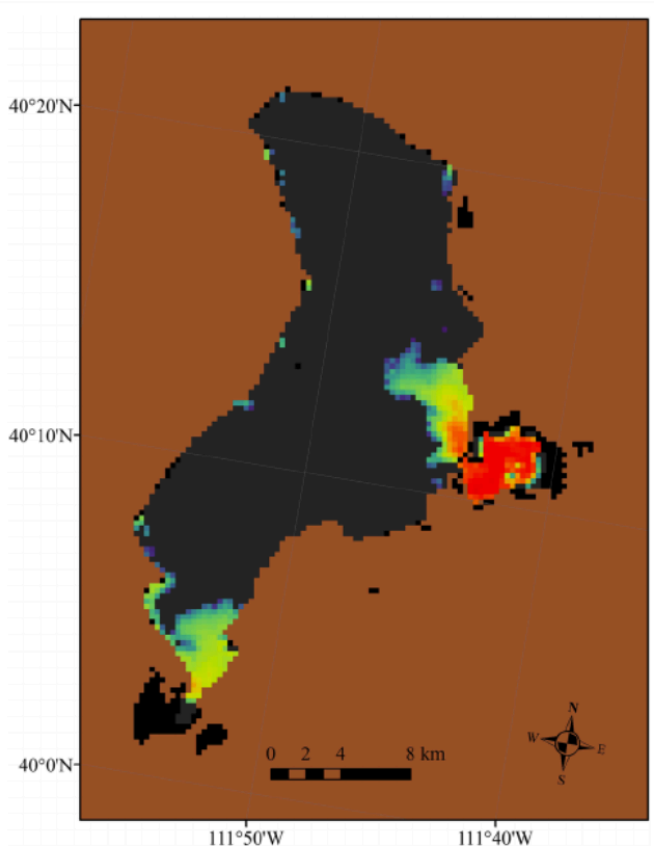


Image 2 is a satellite photo of Utah Lake showing cyanobacteria density in June 2017.

In the satellite image, brown pixels are land, gray pixels in the lake indicate no detection of cyanobacteria, black pixels are quality controlled for clouds, straylight, or glint. Cool blue and purple colors are low concentrations of cyanobacterial biomass and warm colors of yellow, orange, and red are elevated concentrations of cyanobacteria. Large human populations are found on the eastern shore of Utah lake. Warmer colors (reds and oranges) are found on the Eastern shore (where higher populations of humans live). Source: *European Space Agency Sentinel-3*

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Your Task

In the following task: a) you will be asked to develop and use a model explaining how energy moves between trophic levels, and b) construct an explanation for how algal blooms affect the flow of energy and matter in Utah freshwater ecosystems.

Question 1

Classify the following organisms into their appropriate trophic level: **Carp (fish), Cyanobacteria (Phytoplankton), Zooplankton, Pelican (bird)**

Trophic Level	Organism
Producer	
Primary Consumer	
Secondary Consumer	
Tertiary Consumer	

Question 2

Using the satellite image above, identify 3 potential factors for what might be contributing to the increased algal bloom seen in parts of the image.

1) This data was collected in winter, where HABs are at their peak due to lower temperatures
2) This data was collected in summer, where HABs are at their peak due to higher temperatures
3) Human development (construction, pollution, agriculture) does not contribute to HABs
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5) Utah Lake has high wave energy
6) Utah Lake has low wave energy

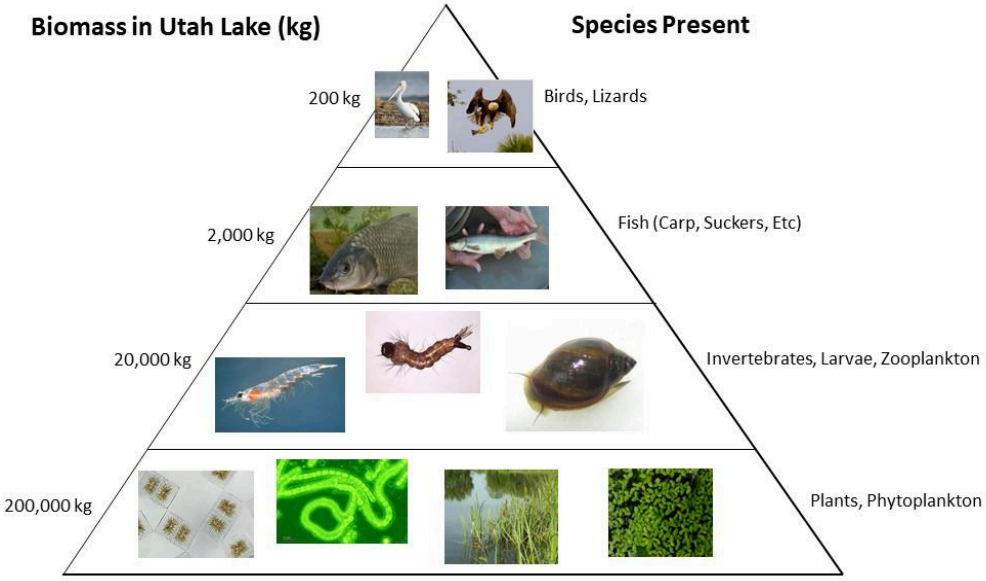
Question 3

Construct a simple food chain that shows the transfer of energy in a freshwater ecosystem using the following groups of organisms (arrows indicate energy transferring to the next organism):
Birds, Fish, Phytoplankton, Zooplankton

a) Zooplankton -> Phytoplankton -> Birds -> Fish
b) Phytoplankton -> Zooplankton -> Fish -> Birds
c) Birds -> Fish -> Phytoplankton -> Zooplankton
d) Fish -> Birds -> Zooplankton -> Phytoplankton

Question 4

Harmful Algal Blooms (HAB's) impact the food web. These algae reproduce quickly. As their numbers increase, they consume most oxygen (matter) that is available in the water. This creates a condition called hypoxia (lack of oxygen) in the lake. Modify this trophic pyramid to demonstrate how the bloom you are seeing in the satellite image affects biomass on the east side of the lake.



Modified Pyramid:

Question 5

Construct an explanation for how an algal bloom affects the flow of matter and energy in Utah Lake.