Formative Assessment Exemplar - BIO.1.4

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.

Of note: All formative assessment clusters were revised based on feedback from educators after being utilized in the classroom. During the revision process, each cluster was specifically checked to make sure the phenomena was authentic to the DCI, supporting information was provided for the phenomena, the SEPs, CCCs, and DCIs were appropriate for the learning progressions, the cluster supported student sensemaking through the Gather, Reason, and Communicate instructional model, and the final communication prompt aligned with the cluster phenomena. As inconsistencies were found, revisions were made to support student sensemaking. If other inconsistencies exist that need to be addressed, please email the current Utah State Science Education Specialists with feedback.

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.

Feedback:

If you have comments or suggestions for this document, please use the Online Feedback Form

References:

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

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Teacher Facing Information

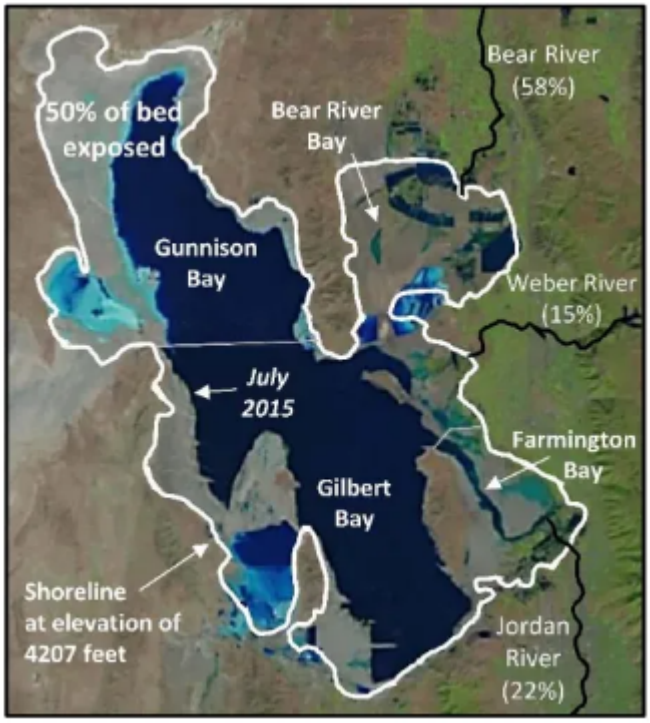
Standard: BIO.1.4 **Develop an argument from evidence** for how ecosystems maintain relatively consistent numbers and types of organisms in stable conditions

Assessment Format: Online Only (Requires students to have online access)

Phenomenon	
Declining lake depth in Utah	Proficient Student Explanation of Phenomenon: Coyotes are not native to Gunnison island, but because of the GSL is shrinking, coyotes are able to access the island via the land bridge. The coyotes eat the pelicans. This added predator affects the pelican populations negatively, leading to a decrease in shorebird as shown by the data in supporting evidence 4. The decrease in the pelican populations may then lead to an increase in brine shrimp populations, and an overall decrease in photosynthetic phytoplankton. Before the coyotes, the ecosystem was stable. The addition of coyotes creates an unstable ecosystem.
Cluster Task Statement	
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed) In the questions that follow you will **investigate** what is causing the Great Salt Lake to shrink and **evaluate using evidence** how this change is causing changes to the ecosystem.	
Supporting Information	
Supporting Information #1: Great Salt Lake Scientists have used many sources of data to show that the Great Salt Lake is shrinking. The phenomenon of shrinking saline (salt) lakes is affecting most countries around the world. Scientists are concerned because when the abiotic factors in a system changes the stability of the ecosystem also changes. The Great Salt Lake is the largest natural lake west of the Mississippi River. At the current level the Great Salt Lake is approximately 75 miles long and about 35 miles wide. Located in several wide flat basins, a slight rise in water level expands the surface area of the lake considerably. The first scientific measurements were taken in 1849 and since then the lake level has varied by 20 feet, shifting the shoreline in some places as much as 15 miles. Great Salt Lake is salty because it does not have an outlet (see figure 1 below). Tributary rivers are constantly bringing in small amounts of salt dissolved in their fresh water flow. Once in the Great Salt Lake much of the water evaporates leaving the salt behind.	

Figure 1

Great Salt Lake's Major Bays and Contribution of Major River Inflows



Note. Great Salt Lake showing its major bays and the relative contribution percent of each of the major river inflows. The white line shows the lake margin at its average natural elevation of 4,207 feet and the July 2015 NASA photograph shows the lake at near record-low levels exposing half of the lake bed.

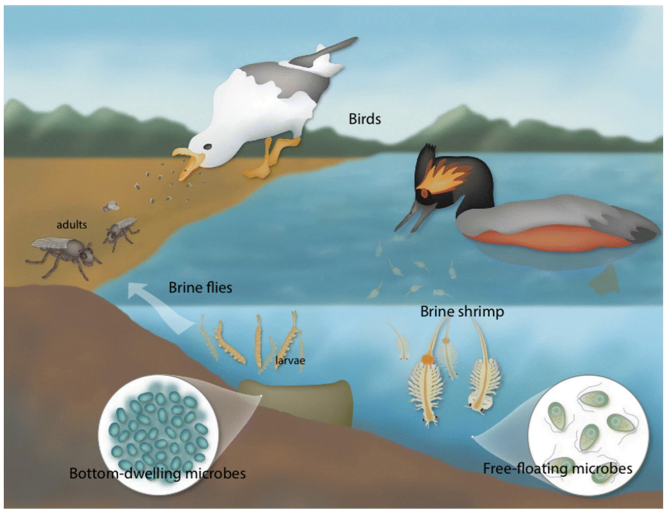
Source: (Wurtsbaugh et al, 2016)

Supporting Information #2: Great Salt Lake Food Web

Great Salt Lake is the remnant of Lake Bonneville; a great ice age lake that rose dramatically from a small saline lake 30,000 years ago. Great Salt Lake is too saline to support fish and most other aquatic species. Several types of algae live in the lake. Brine shrimp and brine flies can tolerate the high salt content and feed on the algae, creating a simple but very important food chain (see figure 2 below). The brine flies do not bite or land on people but they are the primary food source for the birds that migrate to the lake. For most of the summer brine flies form a ring around the entire shoreline and rarely venture more than a few feet from the water's edge. Biologists have estimated their population to be over one hundred billion. This abundance of food has made the Great Salt Lake one of the most important resources for migrating and nesting birds.

Figure 2

Food Web of of Modern Great Salt Lake



Note. The image above shows the organisms that are part of the Great Salt Lake food web. Source: Baxter 2018

Supporting Information #3: Stability and Change of Great Salt Lake

As with all ecosystems this lake can only maintain consistent numbers in stable conditions. Satellite images from Sept 24, 2011 to Sept 20, 2016 (five year period) show that this system is changing over time.



Figure 3

Satellite Images of the Great Salt Lake taken September 24. 2011 and September 20, 2016

Note. TheFigure 3 shows satellite images taken from Sept 24, 2011 and Sept 20, 2016 (five year period) show that this system is changing over time.

Source: NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey

(Source: https://earthobservatory.nasa.gov/images/88929/salt-lake-water-woes)

Supporting Evidence #4: Changes at Great Salt Lake

Changes in abiotic factors cause changes to biotic factors. While studying the pelican population on Gunnison Island during the spring and summer of 2017, biologists from the Utah Division of Wildlife Resources counted fewer

young pelicans than previous years. In 2017 biologists estimated that there were about 700 fledglings compared to 3,000 - 4,000 fledglings in a typical year. (Source: Westminster College, Great Salt Lake Institute.

Cluster Questions

Gather:
Cluster Question #___1__
Question Type: Multiple Choice
Addresses:
____ DCI
_X__ SEP: Developing and Using Models
_x__ CCC: Energy and Matter
Answer:
D - algae are eaten by brine shrimp, shorebirds consume brine shrimp.

Question 1:

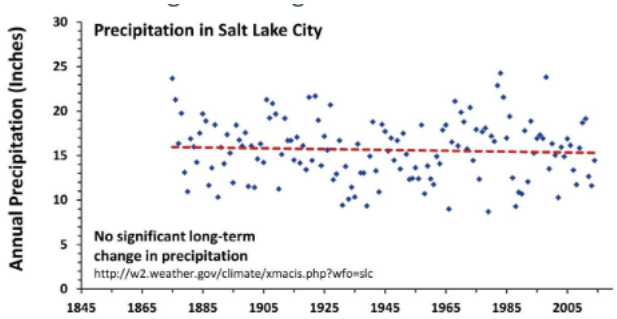
Select a food chain that best represents one that can exist in the Great Salt Lake Ecosystem.

a) Shorebirds -> Algae -> Brine Shrimp
b) Shorebirds -> Brine Shrimp -> Algae
c) Algae -> Shorebirds -> Brine Shrimp
d) Algae -> Brine Shrimp -> Shore Birds

Cluster Question #___2___
Question Type: Short Answer
Addresses:
__x__ DCI
__x__ SEP: Engage in argument from evidence
___x_ CCC: Stability and Change
Answer:
The data shows that there is no long term change in precipitation in this area over time. The amount of rainfall has remained statistically stable. This means that this change is not due to a drought. Changes in this ecosystem are human caused. Students could suggest people are diverting the water from this lake for agriculture and irrigation, or the amount of building in this area has grown over the last few decades.

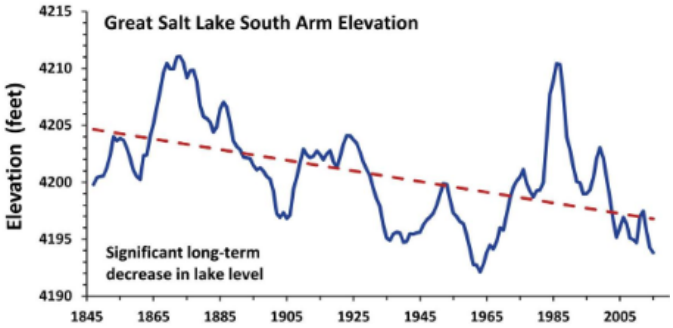
Question 2:

Graph 1
Annual Precipitation in Salt Lake City



Note. The graph above Graph 1 shows the annual precipitation recorded for Salt Lake City from 1845 to 2010.

Graph 2
Great Salt Lake South Arm Elevation



Note. The graph above Graph 2 shows the lake level of Great Salt Lake at the south end of the lake from 1845 to 2005.

	Use Graphs 1 and 2 to explain what the data is showing about stability and change in lake levels, then make a prediction about what is causing the changes to the lake levels.
Reason Cluster Question #__3___ Question Type: Multiple Answer Addresses: : _x__ DCI: Ecosystem Dynamics, Functioning, and Resilience _x__ SEP: Engaging in argument from evidence _x__ CCC Stability and Change Answer: C, E, F	Question 3: There are multiple statements below. Select all statements that are true based on your understanding of the satellite image (Figure 1) of the Great Salt Lake given in the background information. a) The Great Salt Lake is currently larger in size and depth than the historic average. b) The Great Salt Lake is currently deeper, but overall smaller than the historic average. c) The Great Salt Lake is more shallow, and has a more exposed lake bed than the historic average. d) The amount of water in the Great Salt Lake is higher than average, so the salinity is lower. e) The amount of water in the Great Salt Lake is lower than average, so the salinity is higher. f) As there is less wetland area for shorebirds compared to average, shorebird populations might not be stable g) As there is more wetland area for shorebirds compared to average, shorebird populations will be stable
Gather: Cluster Question #__4___ Question Type: Addresses: ____ DCI __x_ SEP: Analyze and Interpret Data __x__ CCC: Cause and Effect Answer: Students can either describe bridges being present or absent under or above ~4195 feet, whichever option they choose has to be accurate.	Question 4: **Table 1** *Presence of Land Bridge Data of Great Salt Lake*

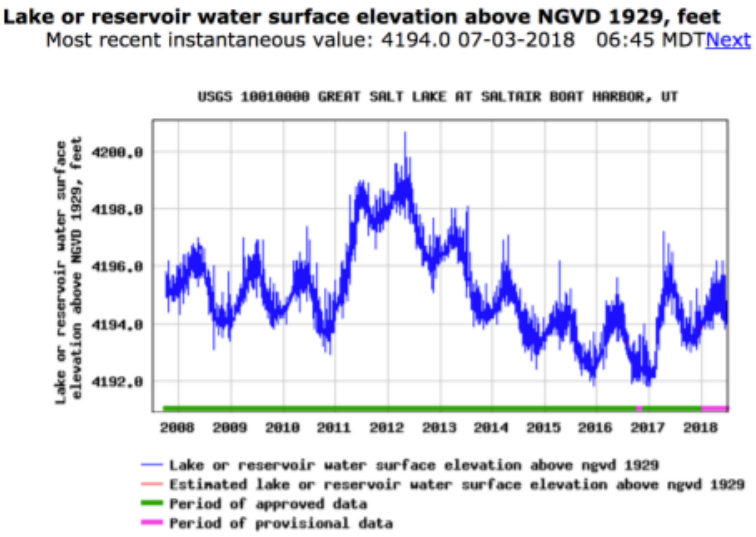
Presence of Land bridge

Year	Land bridge Present
2008	yes
2009	no
2010	yes
2011	no
2012	no
2013	no
2014	yes
2015	yes
2016	yes
2017	yes

Note. The table above shows the years a land bridge was present between islands in Great Salt Lake and the shoreline.

Graph 3:

Lake or Reservoir Water Surface Elevation Great Salt Lake



Note. The graph above shows the water surface elevation of the Great Salt Lake from 2008 to 2018 at the Saltair Boat Harbor.

Land bridges between the shore and the islands in the Great Salt Lake are present when certain conditions are met. Use the data above to fill in the blank

	in the following sentence: Land bridges are _____(present/absent) when lake water surface elevation is _____(above/below) _____ .(x feet)
Communicate: Cluster Question #___5___ Question Type: Modeling Addresses: __x_ DCI: Ecosystem Dynamics, Functioning, and Resilience __x_ SEP: Analyze and Interpret Data __x_ CCC: Cause and Effect Answer: Algae -Brine Shrimp-Shorebirds-Coyotes	Question 5: Gunnison Island is found in the Great Salt Lake. This island is a nesting spot for Pelicans and other migratory birds. Scientists have cameras on this island to monitor the birds. Scientists were concerned when in the year 2017 they caught a coyote on camera. Coyotes are not typically found on this island. Draw a model showing a new food chain due to the presence of coyotes:
Communicate: Cluster Question #___6___ Question Type: Short answer Addresses: __x_ DCI: Ecosystem Dynamics, Functioning, and Resilience __x_ SEP: Analyze and Interpret Data __x_ CCC: Cause and Effect Answer: See below	Question 6: Using the data presented in this investigation explain how a shrinking Great Salt Lake could lead to the presence of coyotes in the ecosystem and how this biotic factor might affect ecosystem dynamics. You should compare your model now to the “traditional” model where coyotes are separated from pelican populations.

Proficiency Scale

Proficient Student Explanation:

Coyotes are not native to Gunnison island, but because of the GSL is shrinking, coyotes are able to access the island via the land bridge. The coyotes eat the pelicans. This added predator affects the pelican populations negatively, leading to a decrease in shorebird as shown by the data in supporting evidence 4. The decrease in the pelican populations may then lead to an increase in brine shrimp populations, and an overall decrease in photosynthetic phytoplankton. Before the coyotes, the ecosystem was stable. The addition of coyotes creates an unstable ecosystem.

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:** Construct, use, and/or present an oral and written argument	**SEP:** Construct, use, and/or present an oral and written argument or	**SEP:** Extends beyond proficient in any way.

	supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	counter-arguments based on data and evidence	
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time. Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.	**CCC:** Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system.	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** 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. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often	**DCI:** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can	**DCI:** Extends beyond proficient in any way.

	used as a measure of its health.	challenge the functioning of ecosystems in terms of resources and habitat availability. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.	

(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

Reading 1: Great Salt Lake

Scientists have used many sources of data to show that the Great Salt Lake is shrinking. The phenomenon of shrinking saline (salt) lakes is affecting most countries around the world. Scientists are concerned because when the abiotic factors in a system changes the stability of the ecosystem also changes.

The Great Salt Lake is the largest natural lake west of the Mississippi River. At the current level the Great Salt Lake is approximately 75 miles long and about 35 miles wide. Located in several wide flat basins, a slight rise in water level expands the surface area of the lake considerably. The first scientific measurements were taken in 1849 and since then the lake level has varied by 20 feet, shifting the shoreline in some places as much as 15 miles.

Great Salt Lake is salty because it does not have an outlet (see figure 1 below). Tributary rivers are constantly bringing in small amounts of salt dissolved in their fresh water flow. Once in the Great Salt Lake much of the water evaporates leaving the salt behind.

Figure 1

Great Salt Lake's Major Bays and Contribution of Major River Inflows



Note. Great Salt Lake showing its major bays and the relative contribution percent of each of the major river inflows. The white line shows the lake margin at its average natural elevation of 4,207 feet and the July 2015 NASA photograph shows the lake at near record-low levels exposing half of the lake bed.

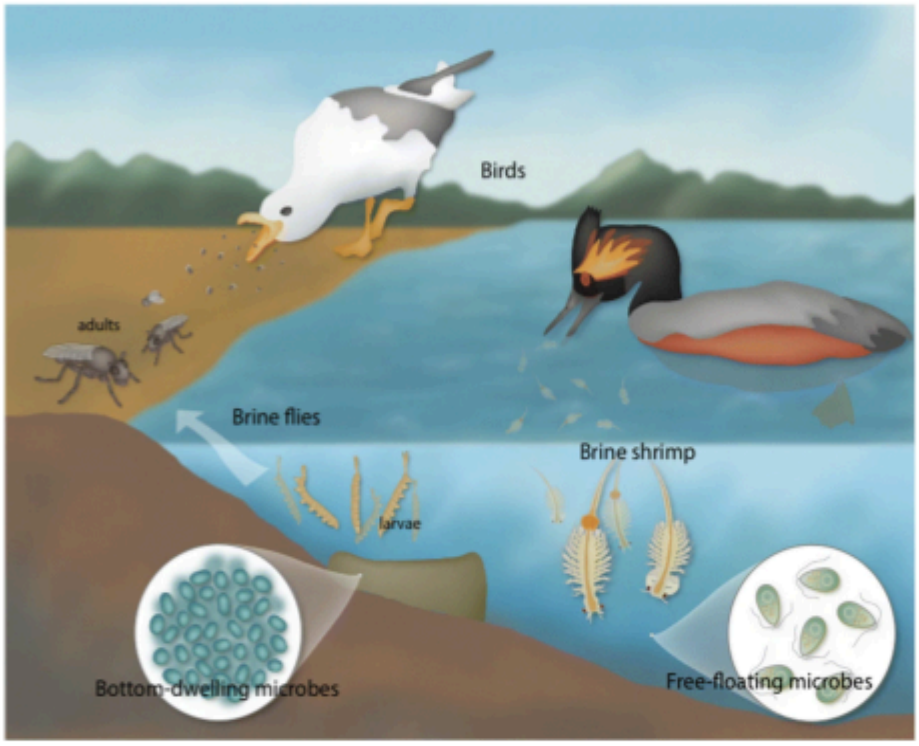
Source: (Wurtsbaugh et al, 2016)

Reading 2: Great Salt Lake Food Web

Great Salt Lake is the remnant of Lake Bonneville; a great ice age lake that rose dramatically from a small saline lake 30,000 years ago. Great Salt Lake is too saline to support fish and most other aquatic species. Several types of algae live in the lake. Brine shrimp and brine flies can tolerate the high salt content and feed on the algae, creating a simple but very important food chain (see figure 2). The brine flies do not bite or land on people but they are the primary food source for the birds that migrate to the lake. For most of the summer brine flies form a ring around the entire shoreline and rarely venture more than a few feet from the water's edge. Biologists have estimated their population to be over one hundred billion. This abundance of food has made the Great Salt Lake one of the most important resources for migrating and nesting birds.

Figure 2

Food Web of of Modern Great Salt Lake



Note. The image above shows the organisms that are part of the Great Salt Lake food web.
Source: Baxter 2018

Reading 3: Stability and Change of Great Salt Lake

As with all ecosystems this lake can only maintain consistent numbers in stable conditions. Satellite images from Sept 24, 2011 to Sept 20, 2016 (five year period) show that this system is changing over time.

Figure 3 *Satellite Images of Great Salt Lake take Sept 24, 2011 and Sept 20, 2016*

Note. The satellite images taken Sept 24, 2011 and Sept 20, 2016 (five year period) show that this system is changing over time.
Source: NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey



Reading 4: Changes at Great Salt Lake

Changes in abiotic factors cause changes to biotic factors. While studying the pelican population on Gunnison Island during the spring and summer of 2017, biologists from the Utah Division of Wildlife Resources counted fewer young pelicans than previous years. In 2017 biologists estimated that there were about 700 fledglings compared to 3,000 - 4,000 fledglings in a typical year. (Source: Westminster College, Great Salt Lake Institute.

Your Task

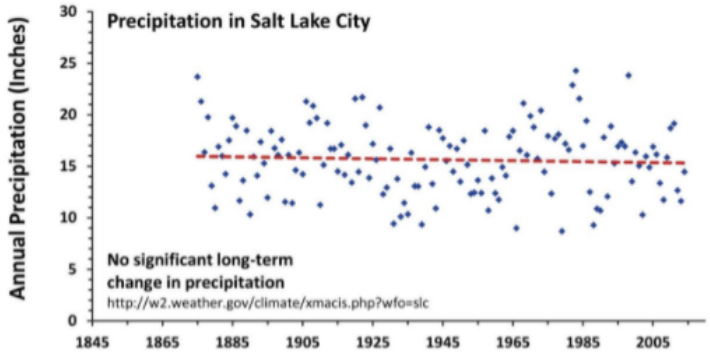
In the questions that follow you will **investigate** what is causing the Great Salt Lake to shrink and **evaluate using evidence** how this change is causing changes to the ecosystem.

Question 1

Select a food chain that best represents one that can exist in the Great Salt Lake Ecosystem.

a) Shorebirds -> Algae -> Brine Shrimp
b) Shorebirds -> Brine Shrimp -> Algae
c) Algae -> Shorebirds -> Brine Shrimp
d) Algae -> Brine Shrimp -> Shore Birds

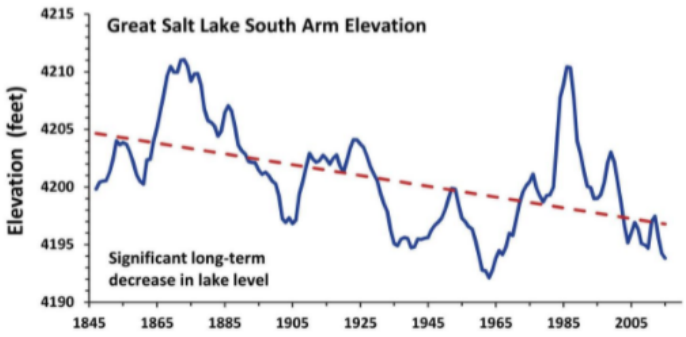
Question 2



Note. The graph above shows the annual precipitation recorded for Salt Lake City from 1845 to 2010.

Graph 2

Great Salt Lake South Arm Elevation



Note. The graph above shows the lake level of Great Salt Lake at the south end of the lake from 1845 to 2005.

Use Graphs 1 and 2 to explain what the data is showing about stability and change in lake levels, then make a prediction about what is causing the changes to the lake levels.

_____

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_____

Question 3

There are multiple statements below. Select all statements that are true based on your understanding of the satellite image (Figure 1) of the Great Salt Lake given in the background information.

a) The Great Salt Lake is currently larger in size and depth than the historic average.
b) The Great Salt Lake is currently deeper, but overall smaller than the historic average.
c) The Great Salt Lake is more shallow, and has a more exposed lake bed than the historic average.
d) The amount of water in the Great Salt Lake is higher than average, so the salinity is lower.
e) The amount of water in the Great Salt Lake is lower than average, so the salinity is higher.
f) As there is less wetland area for shorebirds compared to average, shorebird populations might not be stable
g) As there is more wetland area for shorebirds compared to average, shorebird populations will be stable

Question 4

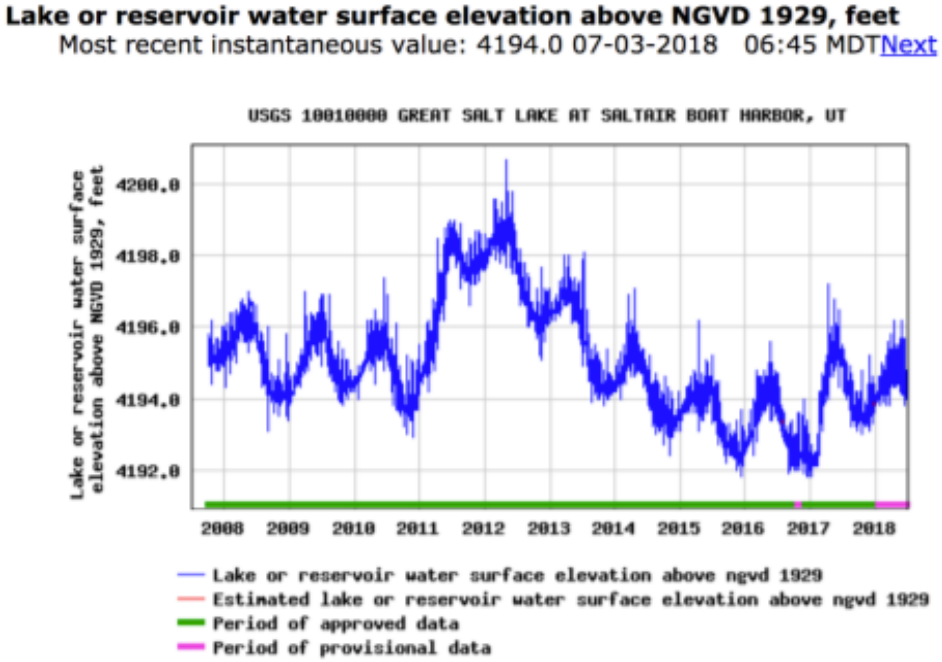
Table 1
Presence of Land Bridge in Great Salt Lake

Presence of Land bridge

Year	Land bridge Present
2008	yes
2009	no
2010	yes
2011	no
2012	no
2013	no
2014	yes
2015	yes
2016	yes
2017	yes

Note. The table above shows the years a land bridge was present between islands in Great Salt Lake and the shoreline.

Graph 3
Lake or Reservoir Water Surface Elevation Great Salt Lake



Use the data above to fill in the blank in the following sentence:

Land bridges are _____ *(present/absent)* when lake water surface elevation is

_____ *(above/below)* _____ *(x feet)*

Question 5

Gunnison Island is found in the Great Salt Lake. This island is a nesting spot for Pelicans and other migratory birds. Scientists have cameras on this island to monitor the birds. Scientists were concerned when in the year 2017 they caught a coyote on camera. Coyotes are not typically found on this island.

Draw a model showing a new food chain due to the presence of coyotes:

Question 6

Using the data presented in this investigation explain how a shrinking Great Salt Lake could lead to the presence of coyotes in the ecosystem and how this biotic factor might affect ecosystem dynamics. You should compare your model now to the "traditional" model where coyotes are separated from pelican populations.

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