

Date: _____

Your Name: _____



**NEW ENGLAND
COMMON ASSESSMENT PROGRAM**

Released Science Inquiry Task

The Aleutian Islands Kelp Mystery

2015

Grade 11

Science

Directions:

You will be reading a story and analyzing the provided data to answer a set of questions. Read each question and thoroughly explain all of your answers. You may include labeled drawings or diagrams to help you answer the questions.

This Word Bank provides definitions for words used in this task. You may refer back to this page throughout the session.

Word Bank

Aleutian Islands	a chain of Alaskan islands that separates the Bering Sea from the main portion of the Pacific Ocean
Biomass	organic material derived from living organisms
Carrying capacity	the upper size limit of a population that an environment will support
Ecosystem	a biological community of interacting organisms and their physical environment
Great whale	one of a group of twelve whale species that are characterized as filter feeders with baleen plates instead of teeth
Kelp	large seaweeds (brown algae) that grow in coastal ocean waters from one to ten feet deep
Orca	also known as killer whales, these mammals are members of the Delphinidae (dolphin) family
Sea otter	a medium-sized mammal with webbed feet and thick fur that inhabits and feeds in coastal marine waters
Sea urchin	a spiny, hard-shelled animal that lives throughout the rocky seafloor from shallow waters to great depths

The Aleutian Islands Kelp Mystery



Michael L. Baird / Wikimedia Commons

Ms. Hinson’s biology class studied how energy and matter flow through ecosystems. The class watched a video about the marine organisms in the coastal waters off the Aleutians Islands in southwest Alaska. Ms. Hinson asked the students what they learned from the video.

“Sea otters were an important species,” said Mark. “The whole coastal ecosystem changed dramatically when their populations declined during the 1980s.”

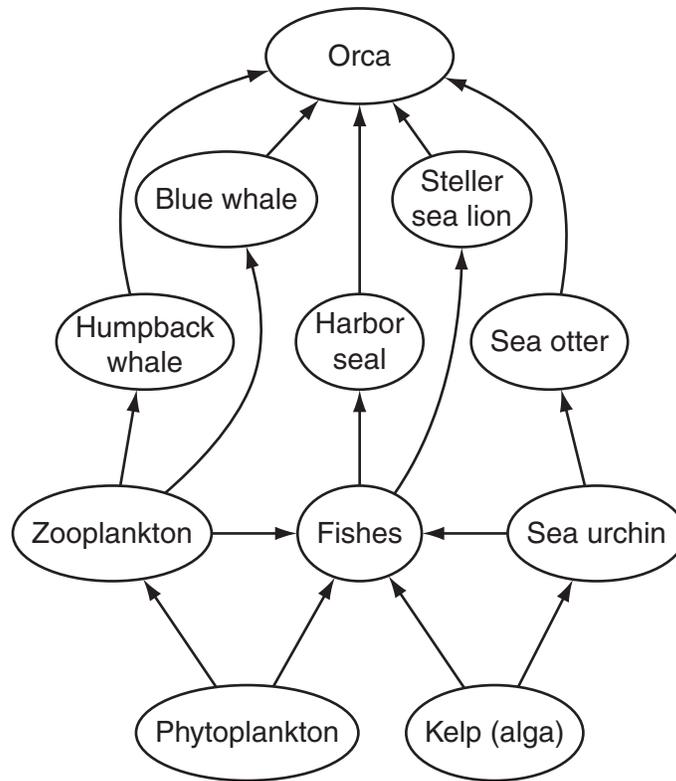
“Yes, the sea otter decline led to the loss of forests of kelp in many coastal areas,” Lydia added.

“How do sea otters affect kelp?” Mark asked Ms. Hinson.

“Maybe a food web of the marine ecosystem of the Aleutian Islands can help us answer that question,” Ms. Hinson suggested.

The class researched the marine ecosystem of the Aleutian Islands and made the food web diagram shown on the next page.

Diagram 1: Aleutian Islands Marine Food Web



The class discussed the connection between kelp and sea otters. Ms. Hinson asked the students if they had found any data during their research that helped explain the flow of matter and energy in the food web.

“I found this table,” Amelia replied. “It shows the relationship between the population density of kelp and the population density of sea urchins in two study areas on Alaska’s coast.” Amelia showed the table below to the class.

**Table 1: Kelp and Sea Urchin Population Densities
Southeast Alaska, 1978
(number of individuals/m²)**

Organism	Torch Bay	Surge Bay
Kelp	12.5	50.5
Sea urchins	5.4	0.02

“Because sea urchins eat large amounts of kelp, the comparatively large sea urchin population at Torch Bay had a limiting effect on kelp,” explained Amelia. “At Surge Bay, there were very few sea urchins, so there were many more kelp. These data show that the energy flow from kelp to urchins is a huge factor in how matter is distributed in the food web.”

Ms. Hinson asked the students to consider what they had learned so far about the organisms in the kelp forest. Then she asked the class to write a research question together about the flow of energy and matter in the marine ecosystem of the Aleutian Islands. The class wrote the following research question:

Research Question:

How can the changes in populations of some species in the marine ecosystem of the Aleutian Islands be explained by changes in the flow of matter and energy?

Answer questions 1 and 2 on page 1 of your Student Answer Booklet.

- 1 Based on Diagram 1 and Table 1, write a prediction about how the changes in populations of kelp and sea urchins affect the flow of energy in the ecosystem of the Aleutian Islands.
- 2 Suppose you are setting up an investigation to test your prediction in question 1. Describe one variable that will need to be controlled and one variable that will need to be measured to provide the **best** evidence to support or refute your prediction. Explain how each variable should be controlled or measured.

The students went to the library to find more information to help them answer their research question. Mark found one study that provided data that showed the relationship between sea otter populations and the amount of sea urchin and kelp biomass at several different study sites in the Aleutian Islands. The scientists who conducted the study had classified the sea otter populations into three status groups: no population, below carrying capacity, and at carrying capacity. Mark created the table shown below to summarize the findings in the study for the class.

**Table 2: Sea Urchin and Kelp Biomass Estimates
Aleutian Island Marine Studies 1987–1988**

Sea Otter Population Status	Sea Urchin Biomass (g/0.25 m²)	Kelp Biomass (g/0.25 m²)
No population	414	27
Below carrying capacity	209	93
At carrying capacity	39	332

Answer question 3 on page 2 of your Student Answer Booklet.

- 3 Construct a graph of the data in Table 2 that shows how the sea urchin biomass and kelp biomass are related to the three otter population statuses. Provide a key to identify the urchin data and the kelp data.

Answer question 4 on page 3 of your Student Answer Booklet.

- 4 Based on the data the students collected, identify the ecological relationships among the sea otters, sea urchins, and kelp. Explain what these relationships indicate about the flow of energy in the marine ecosystem of the Aleutian Islands.

“If there were so many sea urchins eating the kelp, why did the otter population decline?” wondered Amelia. “Sea urchins are food for sea otters, so these amounts should have helped the otters.”

“I found a study that might help answer that question,” said Cody. He summarized the results of a study of ocean mammals, as shown below.

Study Results Summary:

During the mid-1900s, great whales, including humpback whales and blue whales, were hunted by humans to near extinction. The study concludes that the diet of orcas changed in response to the loss of their main prey of great whales. Orcas turned first to seals and sea lions for more food. When the seal and sea lion populations declined, the orcas began to eat more sea otters. This change caused significant losses of sea otters.

Cody showed the class the table below from the study.

**Table 3: Orca Prey Populations
Estimated Total Biomass
(billions of kg)**

Prey Type	Pre-1900	Present
Great whales	3740	520
Seals and sea lions	130	80

Answer question 5 on page 3 of your Student Answer Booklet.

- 5 Use the data the students collected to explain how the energy flow through the food web to orcas shown in Diagram 1 has shifted from pre-1900 to the present. Use data from the students' research findings to support the shift in energy flow in your explanation.

Answer questions 6 and 7 on page 4 of your Student Answer Booklet.

- 6 Based on all the data from the students' research, explain whether the evidence **supports or refutes** your prediction. Include one specific example from the data to support your reasoning. If the data the students compiled does not provide enough data to evaluate your prediction, explain why the data does not support or refute your prediction.
- 7 A scientist wants to test this hypothesis: orca predation caused the sea otter population to decline. Describe what new data the scientist could collect to further test the hypothesis. Explain how the **new** data could support this hypothesis.

The students discussed the data from their research investigation. Ms. Hinson explained that they had strong clues to help them explain the main cause of the loss of kelp forests in the marine ecosystem of the Aleutian Islands.

"I think the main cause is orcas," said Mark, "because their behavior directly caused the decrease in sea otter populations."

"I don't agree with Mark's statement," argued Amelia. "I think the main cause is human hunting of great whales because this started a chain reaction that ended with the kelp being eaten."

"Can you justify your arguments with the data you and your classmates have gathered?" asked Ms. Hinson.

Answer question 8 on page 5 of your Student Answer Booklet.

- 8 Use the predator-prey relationships among organisms, as shown in the data gathered by the class, to justify only **one** of the students' interpretations of the data:

- Mark:

"I think the main cause is orcas because their behavior directly caused the decrease in sea otter populations."

or

- Amelia:

"I think the main cause is human hunting of great whales because this started a chain reaction that ended with the kelp being eaten."

