**Task 2: Science Inquiry**

Exploring Interrelationships Within Food Webs and Food Chains

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Mark: ­­­­\_\_\_/50  
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**Assessment type:** Science inquiry

**Conditions**

3 Periods allowed for completion of the task

Submission: 17th of March

**Task weighting**

5% of the school mark for this pair of units

**Investigation – Exploring Interrelationships Within Food Webs and Food Chains**

**Background information**

A food web consists of all the food chains in a single ecosystem. Each living thing in an ecosystem is part of multiple food chains. Each food chain is one path that energy and nutrients may take as they move through the ecosystem. All the interconnected and overlapping food chains in an ecosystem make up a food web.

**Trophic Levels**

Organisms in food webs are grouped into categories called trophic levels. Roughly speaking, these levels are divided into producers (first trophic level), consumers, and decomposers (last trophic level).

*Producers*

Producers make up the first trophic level. Producers, also known as autotrophs, make their own food and do not depend on any other organism for nutrition. Most autotrophs use a process called photosynthesis to create food (a nutrient called glucose) from sunlight, carbon dioxide, and water.

Plants are the most familiar type of autotroph, but there are many other kinds. Algae, whose larger forms are known as seaweed, are autotrophic. Phytoplankton, tiny organisms that live in the ocean, are also autotrophs. Some types of bacteria are autotrophs. For example, bacteria living in active volcanoes use sulphur, not carbon dioxide, to produce their own food. This process is called chemosynthesis.

*Consumers*

The next trophic levels are made up of animals that eat producers. These organisms are called consumers.

Consumers can be carnivores (animals that eat other animals) or omnivores (animals that eat both plants and animals). Omnivores, like people, consume many types of foods. People eat plants, such as vegetables and fruits. We also eat animals and animal products, such as meat, milk, and eggs. We eat fungi, such as mushrooms. We also eat algae, in edible seaweeds like nori (used to wrap sushi rolls) and sea lettuce (used in salads). Bears are omnivores, too. They eat berries and mushrooms, as well as animals such as salmon and deer.

Primary consumers are herbivores. Herbivores eat plants, algae, and other producers. They are at the second trophic level. In a grassland ecosystem, deer, mice, and even elephants are herbivores. They eat grasses, shrubs, and trees. In a desert ecosystem, a mouse that eats seeds and fruits is a primary consumer.

In an ocean ecosystem, many types of fish and turtles are herbivores that eat algae and seagrass. In kelp forests, seaweeds known as giant kelp provide shelter and food for an entire ecosystem. Sea urchins are powerful primary consumers in kelp forests. These small herbivores eat dozens of kilograms (pounds) of giant kelp every day.

Secondary consumers eat herbivores. They are at the third trophic level. In a desert ecosystem, a secondary consumer may be a snake that eats a mouse. In the kelp forest, sea otters are secondary consumers that hunt sea urchins.

Tertiary consumers eat the secondary consumers. They are at the fourth trophic level. In the desert ecosystem, an owl or eagle may prey on a snake.

There may be more levels of consumers before a chain finally reaches its top predator. Top predators, also called apex predators, eat other consumers. They may be at the fourth or fifth trophic level. They have no natural enemies except humans. Lions are apex predators in the grassland ecosystem. In the ocean, fish like the great white shark are apex predators. In the desert, bobcats and mountain lions are top predators.

*Detritivores and Decomposers*

Detritivores and decomposers make up the last part of food chains. Detritivores are organisms that eat nonliving plant and animal remains. For example, scavengers such as vultures eat dead animals. Dung beetles eat animal faeces.

Decomposers, like fungi and bacteria, complete the food chain. Decomposers turn organic wastes, such as decaying plants, into inorganic materials, such as nutrient-rich soil. They complete the cycle of life, returning nutrients to the soil or oceans for use by autotrophs. This starts a whole new series of food chains.

Source: <https://www.nationalgeographic.org/encyclopedia/food-web/>

**Inquiry Task:**

All organisms rely on interactions to survive. This task requires you to use the online simulation below to analyse impacts of different organisms on their food web.

<https://www.learner.org/wp-content/interactive/envsci/ecology/ecology.html>

You will be given different scenarios to set up on the food web. You will be required to make predictions about population size based on your knowledge of food chains and food webs before running the simulation. You will then be required to answer some questions based on the simulation. If you use any additional resources to answer these questions (i.e.. websites or books) please include a reference for them on the final page.

**Part One:** Producers

Imagine the ecosystem is newly forming—the previous ecosystem has been destroyed by fire or flood—and the first colonizers of the successive ecosystem are, of course, producers. Given the two fictitious species of plants in the simulator, predict what will happen in this young system and record your prediction in the table below. Then run the simulator to time 100 steps and record the population numbers for both plants *(the teacher will demonstrate how to set up this part of the simulation).*

|  |  |  |
| --- | --- | --- |
|  | Plant A | Plant B |
| Prediction: starting population | 0 | 0 |
| Prediction: ending population | 7800 | 7880 |
| Starting population | 5000 | 5000 |
| Ending population | 10000 | 0 |

1. Compare your population predictions to the actual values. Are they what you expected? Why/why not? No, my expectations were incorrect, and it was not what I had anticipated. Because their was not much nutrition.
2. Do you find one producer to be dominant (consistently greater population)? Why might one producer be dominant over another?

Yes, I discovered Plant A to be the most powerful producer. One producer may have an advantage over the other since one can exhaust all the resources required to develop and thrive. Plant A utilised up all the resources needed for growth, while plant B died off over time, as seen in the diagram below.

Define co-dominance

Being one of two or more species in a biotic community that are equally dominant

1. What assumptions does this model make about co-dominance?

Co-dominance was not possible, according to this model, because one of the species overthrew the other. One hypothesis is that co-dominance in an ecosystem is uncommon since most species do not have equal dominance.

**Part Two:** Partial Chain

Now introduce an herbivore into the environment. In theory, an herbivore native should feed primarily on the dominant species. In this system, the herbivore may consume enough of the dominant species to give the non-dominant species a chance for population growth and survival.

Click on herbivore A (the rabbit) and choose "eats plant A." Predict and record what will happen to the population numbers in the ecosystem. Then, run the simulator and record your results in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Plant A | Plant B | Herbivore A |
| Prediction: starting population | 0 | 0 | 0 |
| Prediction: ending population | 9994 | 7899 | 2299 |
| Starting population | 5000 | 5000 | 1000 |
| Ending population | 3335 | 4998 | 2055 |

1. How do producer population numbers with the presence of an herbivore compared to the model in Part One? Explain the impact the herbivore had on the producer populations.

Both plants survived by introducing an herbivore. Plant B was more dominant, owing to herbivores' preference for plant A. The more rabbits there are in the population, the less plant A there is and the more plant B there is. With the addition of the herbivore, the ecology became more balanced.

1. Is there still a dominant producer? Suggest why this might be.

Yes, I discovered Plant B because the rabbits eat plant A, allowing plant B to thrive more in the environment.

1. Define a decomposer: An organism that decomposes organic substances to produce inorganic materials such as soil. Various fungi and soil bacteria operate as decomposers.
2. If the simulation included decomposers, predict how your current results would change. Give a reason for this change.

I believe that by include a decomposer, both producers would benefit because the soil would contain more nutrients (such as nitrogen) that they require to grow. However, if there was too much degraded material, it may have the reverse effect.

**Part Three:** Food Web

# Now run a simple food web; choose only one organism from each trophic level and make sure that the food chain goes in a straight line from one trophic level to the next, i.e., Herbivore A eats Plant A, Omnivore A eats Herbivore A, and the Top Predator eats Omnivore A.

# Predict whether each species will survive, and whether it will increase or decrease in number. Record your prediction in the Data Table and then run the simulation twice and record your data. Use X for "die out," ↑ for "increase in numbers," and ↓ for "decrease in numbers."

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| (X, ­, or ¯) | Plant A | Herbivore A | Omnivore A | Top Predator |
| Prediction |  | ¯ | ¯ | X |
| Simulation 1 | 4557 | 1814 | 122 | 11 |
| Simulation 2 | 4582 | 1806 | 125 | 10 |

1. Was your prediction correct? How did you arrive at your prediction? What differences were there between your prediction and the simulation? My predictions for plant A and herbivore A were right, however I was wrong about the top predator. I assumed that the top predator would go extinct since there would be insufficient food sources to keep it alive. Between the two simulations, the omnivore population increased marginally, but it fell from the starting population.
2. What would happen to this imaginary ecosystem if the producers were to die out? I believe the entire ecosystem would finally become extinct. For food, each creature is reliant on the other. If the producers went extinct, the herbivores would starve to death without a food source. Omnivores would be harmed as well, as both of their food sources would be compromised, resulting in a scarcity of resources for them to exist. Once they are extinct, the top predators will follow suit.
3. Did any of the species increase in number? What could account for this increase? Which species decreased in number and what might account for this decrease?

Yes, the producer and omnivore populations increased, due to less competition for scarce resources. Because they did not have as many food sources as the other creatures and faced more competition, top predators and herbivores declined dramatically.

1. Which populations would benefit the most from the presence of decomposers? Explain why.

Decomposers, I believe, would benefit the producers the most because they make nutrients for the plants, which would promote their growth. I believe that because of the producers' success, herbivores would benefit as well.

**Part Four:** Real Life Scenario- Food Web

Now try a more "real-life" scenario and experiment with what might happen in an ecosystem that is more like a web. This time click the "all on" button. The model shows who eats whom and where energy is transferred. Predict which populations will die out, increase in numbers, or decrease in numbers and record your predictions. Run the simulation twice and record the results in the table below.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (X, ­, or ¯) | Plant A | Plant B | Plant C | Herbivore A | Herbivore B | Herbivore C | Omnivore A | Omnivore B | Top  Predator |
| Prediction | ­ | ¯ | x | x | x | ¯ | x | x | ¯ |
| Simulation 1 | 4938 | 937 | x | x | xx | 553 | x | x | 254 |
| Simulation 2 | 4902 | 980 | x | x | x | 556 | x | x | 255 |

1. Explain how you made your prediction. What assumptions did you make?   
   I reasoned that by introducing more species, there would be a lot more competition, and some of them would go extinct. I assumed that some species would survive but that their numbers would decline.
2. Compare your prediction to the simulation, was your prediction correct? What were the similarities between the prediction and the simulation?   
   My prediction was true, but not entirely correct. I was correct in predicting the extinction of some species and population declines.
3. Compare your prediction to the simulation, what were some differences between them? Suggest some possible reasons for these differences. Several of my predictions turned out to be inaccurate. Plant A's numbers were supposed to increase, but they fell. Plant B, on the other hand, increased rather than decreased. The top predator did not go extinct; in fact, it grew in number. This could be due to less competition or more food for other species as some of the species fell in numbers.

Now try to modify who eats whom in order to ensure the survival of all species and record the population change in the table below.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (X, ­, or ¯) | Plant A | Plant B | Plant C | Herbivore A | Herbivore B | Herbivore C | Omnivore A | Omnivore B | Top  Predator |
| Modification | ¯ |  |  |  |  | ¯ |  |  | ¯ |

1. Were you able to modify the parameters so that each species survived? Explain how you decided what changes to make. I kept experimenting with different models until I found one that worked for most of the species. I assumed that for it to operate, each species would require around the same quantity of food sources and that there would not be too many species feeding off the same one. I discovered that omnivores, top predators, and plant eaters were the most difficult to accommodate, therefore I had to make more changes to secure their survival. I made sure that the top predator only ate one of the herbivores and that the herbivore it ate had a sufficient supply of food.
2. Which way does energy flow through this food web and how does eating an organism result in energy transfer?  
   The energy in a food web starts with the producers and then moves on to the species that consume it. The energy begins at the lowest trophic level (producers) and ascends to the highest level (consumers) (consumers). The flow and energy transmission are shown by the arrows. When an organism is consumed, its energy is transferred to the consumer in the form of sugar (glucose) for cellular respiration. Although most of the energy is lost, there is still some that is used.

# **References:**

Please reference any additional resources you used to answer the questions.

|  |  |  |
| --- | --- | --- |
| **Type of resource**  (Book, website etc.) | **Author of Resource** | **How to find the resource** (URL, Book title etc.) |
|  |  |  |