

FOOD CHAIN CHECKERS

Summary	Students play a game that models dynamics of a simple food chain, then they improve the model by making their own rules that better account for the ways that food chains work.	<p>Materials (For each group of four)</p> <ul style="list-style-type: none"> • Checkerboard • 24 Diatom game pieces • 24 Copepod game pieces • 24 Herring game pieces • 24 Whale game pieces • <i>Food Chain Checkers</i> worksheets for each student (double-sided) • <i>Optional Graphing Populations over Time</i> worksheet for each student (double-sided) • Colored pencils for optional graphing activity
Source	<i>Windows to the Universe</i> activity by Lisa Gardiner	
Grade Level	5-9	
Time	15 minutes prep time One or two 50-minute class periods	
Student Learning Outcomes	<ul style="list-style-type: none"> • Students will learn that food chains connect organisms within an ecosystem. • Students will learn that food availability can cause changes in population size. • Students will learn that the size of populations in a balanced ecosystem stay somewhat constant over time. • Students will learn that models can be used to represent the natural world and that improvements to models allow us to more accurately represent natural conditions. 	
National Standards	<ul style="list-style-type: none"> • 5-8 Content Standard C: Populations and Ecosystems • 9-12 Content Standard C: Interdependence of Organisms • Benchmarks: 5A/5 and 5E/2 	

Preparation:

1. Copy and cut apart game pieces from the template (last page). You will need two copies of the template for each group of students.
2. Copy *Food Chain Checkers* worksheet (pages 4 and 5) and, if you wish, the optional *Graphing Populations over Time* worksheet (pages 6 and 7) for a more quantitative activity.
3. If needed, a checkerboard can be downloaded and printed on 11 x 17 paper from Windows to the Universe at: www.windows.ucar.edu/teacher_resources/gameboard.pdf

Directions:

1. Have students read the description of food chains on the first page of the *Food Chain Checkers* worksheet.
2. Discuss the main characteristics of food chains as a group. Introduce the game to students and review the rules (second page of *Food Chain Checkers* worksheet). Tell students that for this activity they are each playing the role of a different species in a food chain. They will travel around the game board trying to catch their prey (by jumping over it) and avoiding predators.
3. Introduce the concept of models to students. This game is a simple model of an aspect of the natural world. Scientists use models to help us understand how the world works. They try to make models as accurate as possible, so they are always thinking about how to improve a model to make it better represent the real world. As they play round one of the game, ask students to think about how they will improve the model. *What ecological conditions could be better represented? How would you modify the game to take them into account?*

4. Student groups play round one of the game following the rules on the worksheet and then answer the questions on the bottom of the worksheet. For a more quantitative approach, and to exercise graphing skills, have students also fill in data about population size in the *Graphing Populations over Time* worksheet. (This will add more time to the length of this activity.)
5. Discuss as a group how the game is **not** like a real food chain. The main points that students will hopefully pick up upon are listed below, however, this is not a complete list. Encourage students to brainstorm others too.
 - Without the Sun there is no way for the diatoms to reproduce.
 - Copepods, herring, and whales initially have populations of the same size and need the same amount of food to reproduce. This is not like the real world.
 - The individuals never die unless they are eaten (i.e., there is no natural death.)
6. Have student groups devise more game rules to take into account the problems with this model and make the model better. Have them write out the revised rules and the real world situation that it addresses.
7. Students play round 2 of the game using their modified rules. If data collection and graphing was done in round 1, then have students repeat the process and compare graphs.
8. Discussion - Student groups report on how they revised the model and whether they were able to maintain healthy populations of all members of the food chain.
9. If time permits, let student groups revise rules again and play one more time or use the game as a model to explore what would happen if there were an environmental change (e.g., whales killed, diatom bloom, over fishing,).

Background Information:

A food chain is a group of living things that depend on one another for energy. Energy is passed along the food chain. All living things need energy. Animals and many single-celled protists get the energy they need from the food they eat. Plants and algae get the energy they need from the Sun. Bacteria get energy in many different ways.

The living thing at the bottom of almost all food chains is something that, by photosynthesis, makes its food using sunlight, water, and carbon dioxide – a plant for example. At the other end of food chains is a top predator, an animal that eats other animals and whom nothing else eats.

A simple food chain may include:

- **Producers:** via the process of photosynthesis they make food inside their bodies using sunlight, water, and carbon dioxide. (*Note: At places without sunlight, like deep sea vents, producers make energy via chemosynthesis.*)
- **First-order consumers:** A species that eats only producers, also known as a herbivore.
- **Second-order consumers:** A species that eats herbivores, a type of carnivore.
- **Third-order consumers:** A species that eats carnivores. If it has no natural predators, it is known as a “top predator”.

The four listed above make up most simple food chains. However, there are some living things that have different patterns of eating. Living things that eat both producers and animals are called *omnivores*. Humans are omnivores. Omnivores are often a part of several different food chains. Living things that eat dead and decaying life are called *decomposers*. Many types of bacteria and all types of fungi are decomposers.

In every food chain there are more individuals at the bottom than at the top. Each first-order consumer needs to eat several producers to survive. Each second-order consumer needs to eat several herbivores to survive. So the number of producers and herbivores must be higher than the number of second- and third-order consumers.

This game uses a simple marine food chain example with four species:

- **Diatoms:** These producers are some of the most prolific in the world’s oceans. Diatoms are algae and are a part of the phytoplankton (“phyto” means they do photosynthesis and “plankton” means they float in the water.)
- **Copepods:** these little animals are first-order consumers and a part of the zooplankton (“zoo” means animals). They belong to a group of invertebrates called arthropods and are related to shrimp.
- **Herring:** These fish are second-order consumers. They are common in the North Pacific and North Atlantic Oceans. When eating, they swim with mouths open filtering out zooplankton like copepods from the ocean water.
- **Orca:** Also known as killer whales, Orcas are third-order carnivores and the top of this food chain. They eat herring in this food chain. Orcas also eat many other animals, making them a part of several other marine food chains too. Because other animals do not eat them, Orcas are top predators would only die of old age (if they were not affected by humans.)

For more information about these species, please see the links in the *Resources* section below.

Also note that living things are actually connected to many others through a food web, a collection of interconnected food chains. They are also connected to each other in other ways too. This means that thinking about a single food chain is a bit simplistic, however, food chains are important building blocks to learning about ecosystem science.

Use of Models in Science

Models are important and useful tools in geoscience education. It is important to understand both the utility and the limitations of models. Before using a model, talk to your students about the usefulness of models, but also the limitation of models. Encourage them to come up with examples. "Models can easily be misused. In fact, a frequent cause of students' science misconceptions is confusion between characteristics of a model and the characteristics of the real thing it represents.

Four questions, used routinely during instruction, can help prevent these misconceptions:

- How does this model work the same as what it represents?
- How does this model work differently from what it represents?
- What are the strengths of this model? The weaknesses?
- How does this model compare and contrast with what it represents?"*

(*From *Understanding Models in the Earth and Space Science* – Steven W. Gilbert and Shirley Watt Ireton - 2003 NSTA Press)

Improving models is an ongoing process for geoscientist who work with models of our planet and its processes. Usually, new learnings about how the Earth works lead to model improvements. In this activity, students are encouraged to modify the model so that it better represents the real world situation. Making sure that students understand the analogy of the model to the real world as they make new rules is essential for turning a simple game into a model of ecological processes.

Resources

- ***Food Chains and Food Webs - Ecological and Environmental Learning Services***
<http://www.eelsinc.org/id43.html>
- ***Food Chains and Webs from BBC Schools***
<http://www.bbc.co.uk/schools/gcsebitesize/biology/livingthingsenvironment/1feedingrelationshipsrev3.shtml>
- ***Living Things - Windows to the Universe***
<http://www.windows.ucar.edu/tour/link=/earth/Life/life.html>
- ***Ocean Life - Windows to the Universe***
http://www.windows.ucar.edu/tour/link=/earth/Life/ocean_life.html
- ***Diatoms - Microbe Zoo***
<http://commtechlab.msu.edu/sites/dlc-me/zoo/zwp0530.html>
- ***Copepods - Wikipedia***
<http://en.wikipedia.org/wiki/Copepod>
- ***Herring - Wikipedia***
<http://en.wikipedia.org/wiki/Herring>
- ***Orca Whales***
<http://new-brunswick.net/new-brunswick/whales/orca.html>
- Pimm, Stuart L. (1991) *The Balance of Nature? Ecological Issues in the Conservation of Species and Communities*, University of Chicago Press, 448 p.
- Sisson, Edith (1982) *Nature with Children of all Ages: Activities and Adventures for Exploring, Learning, and Enjoying the World Around Us*, Prentice Hall, 195 p.

Food Chain Checkers

Name: _____

What's a food chain?

A **food chain** is a group of living things that depend on one another for energy. Energy is passed along the food chain. All living things need energy. They have different ways of getting the energy they need. The living things at one end of almost all food chains make their food using sunlight, water, and carbon dioxide (such as plants and algae). At the other end of food chains is a top predator, an animal that eats other animals and whom nothing else eats.

A simple food chain includes:

- **Producers:** A species that can make its own food, usually using sunlight, water, and carbon dioxide through a process called photosynthesis.
- **First-order consumers:** A species that eats only producers. It is also called an herbivore.
- **Second-order consumers:** A species that eats herbivores. It is a type of carnivore.
- **Third-order consumer:** A species that eats carnivores. If it has no predators, it is called a "top predator".

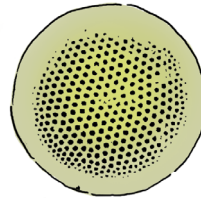
Some living things have different patterns of eating, such as eating both producers and animals (omnivores) or eating dead and decaying life (decomposers). Many types of bacteria and all types of fungi are decomposers.

In every food chain there are more individuals at the bottom than at the top. Each first-order consumer needs to eat several producers to survive. Each second-order consumer needs to eat several herbivores to survive. So the number of producers and herbivores must be higher than the number of second- and third-order consumers.

For example, in this food chain one meal for a whale would be approximately 5000 herring. Each of those herring has 6500 copepods in its stomach so that many herring would need 32,500,000 (32.5 million) copepods for a meal. Each copepod eats 130,000 diatoms, so that many copepods would need 4,225,000,000,000 (4.225 trillion) diatoms for a meal!

The Players

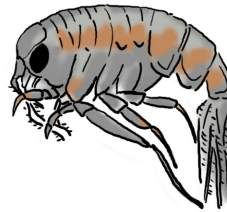
Diatoms



100 microns wide

These *producers* are some of the most abundant in the world's oceans. Diatoms are a type of algae and are a part of the phytoplankton. They float through the oceans and make their own food by photosynthesis.

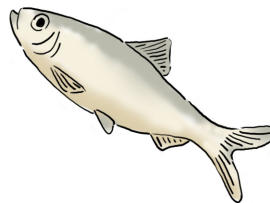
Copepods



1 - 2 mm long

These little animals are *first-order consumers* and a part of the zooplankton. They belong to a group of invertebrates called arthropods and are related to shrimp. Copepods are found in oceans worldwide.

Herring



14 - 35 cm long

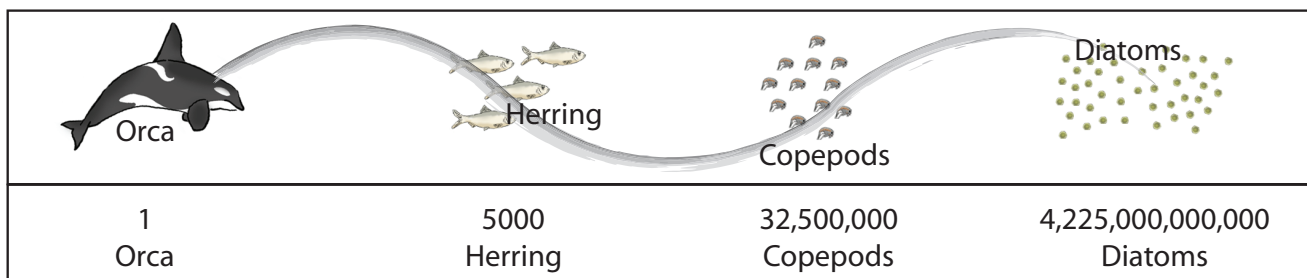
These fish are *second-order consumers*. They are common in the North Pacific and North Atlantic oceans. When eating, they swim with their mouths open to catch zooplankton like copepods from the ocean water.

Orca Whales



8 - 10 meters long

Orca whales are *third-order carnivores* and the top of this food chain. They eat herring (and many other animals). Because other animals do not eat them, Orcas would usually only die of natural causes (if they were not affected by humans.)



Food Chain Checkers: Directions for Round 1

Objective: Capture your prey! You do this by jumping over it.

To begin:

- First decide which player will represent diatoms, copepods, herring, and whales. Record this at the right.
- Each player puts six game pieces on the board in any squares he or she chooses. The diatom player gets to put his or her pieces on the board first, then the copepod player, then the herring player, and then the Orca player.

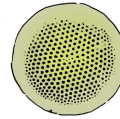
To move:

- During your turn, you can move ONE of your pieces to any adjacent open square (including diagonal ones) or jump over your prey in an adjacent square.
- You can move in any direction on the board. *(You are not trying to get to a specific location - just get your prey.)*
- You cannot jump pieces that are not your prey or move into a square if there is already someone there.

To capture your prey:

- Capture a prey piece by jumping it.
- Capturing food allows your species to reproduce, so take the prey that you jumped off the board and replace it with a piece from your reserve.
- *Note: If your prey is at the edge of the board, and to jump over it your piece is moved off the edge of the board, you can make the jump and then place your piece in any open space on the opposite edge. If there are no open spaces on the opposite edge, you can not make the jump.*

Record who is playing each species.



Name: _____

Will be **diatoms.**

(Put 6 pieces on the board 1st.)



Name: _____

Will be **copepods.**

(Put 6 pieces on the board 2nd.)



Name: _____

Will be **herring.**

(Put 6 pieces on the board 3rd.)



Name: _____

Will be **Orca whales.**

(Put 6 pieces on the board 4th.)

Play for 10 minutes and answer these questions...

How is this game like a real food chain?

How is this game *not* like a real food chain?

How many do you have on the board after 10 minutes of play?

Diatoms	
Copepods	
Herring	
Whales	

How can you make it better? Suggest a way that you would change the rules of the game to better account for each of your items that you identified as missing above. In other words, how would you build a better game? In round two of the game, you will play according to your new rules.

Food Chain Checkers

Name: _____

Graphing Populations Over Time

A population is the number of individuals of a species that live in an area.

Ecologists study changes in the size of populations of species over time to figure out if an ecosystem is in balance. Having balance is very important for ecosystems. More balanced ecosystems will often have populations that stay about the same size year after year. Ecosystems that are not balanced are more likely to have populations that grow or shrink year after year.

Do you think Round 1 of Food Chain Checkers is like an ecosystem in balance? What about Round 2?

In Food Chain Checkers,





- The area where our populations live is the game board.
- The number of individuals is the number of game pieces in play on the board.

By recording the total number of individuals of each species at several points during the game, you can figure out if this game is like an ecosystem in balance or if it is not balanced. *(Remember that this game is a simplified ecosystem, so the living things are only affected by this food chain.)*

Every time the first player (diatom) moves, record the number of individuals of each species that are on the board (number of diatom game pieces, copepod game pieces, etc.) Then graph the information on the next page.





Populations Over Time

Round 1 (basic rules)

				
Time	Diatom	Copepod	Herring	Whale
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

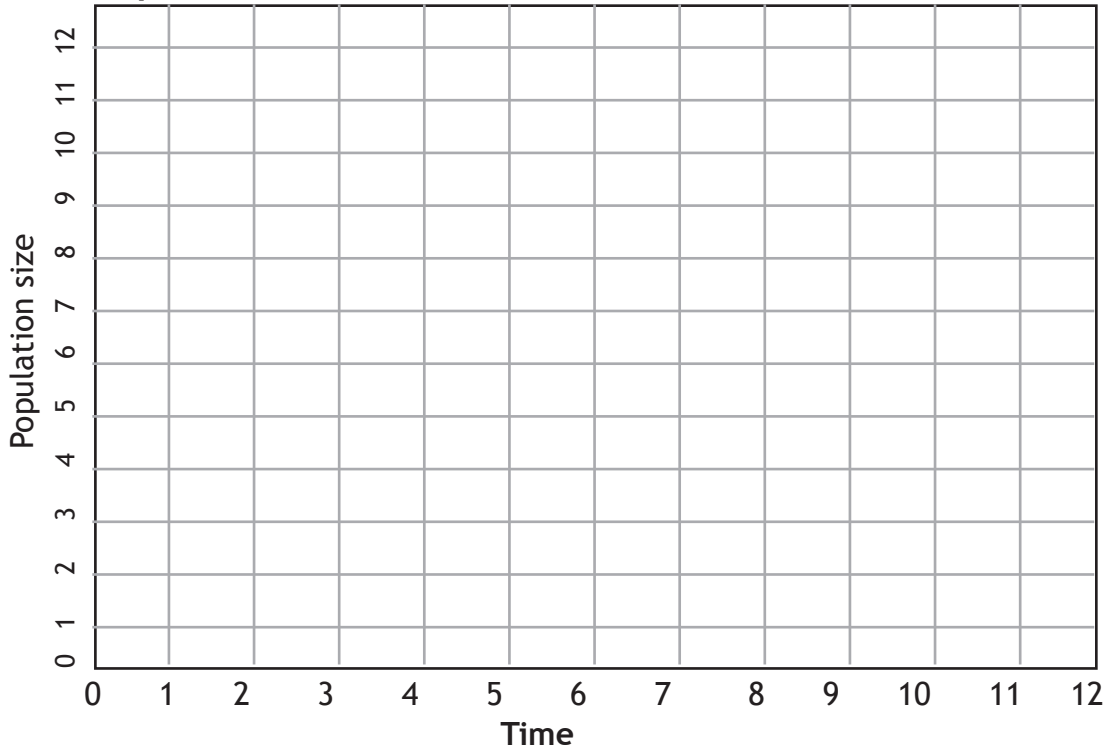
Populations Over Time

Round 2 (modified rules)

				
Time	Diatom	Copepod	Herring	Whale
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

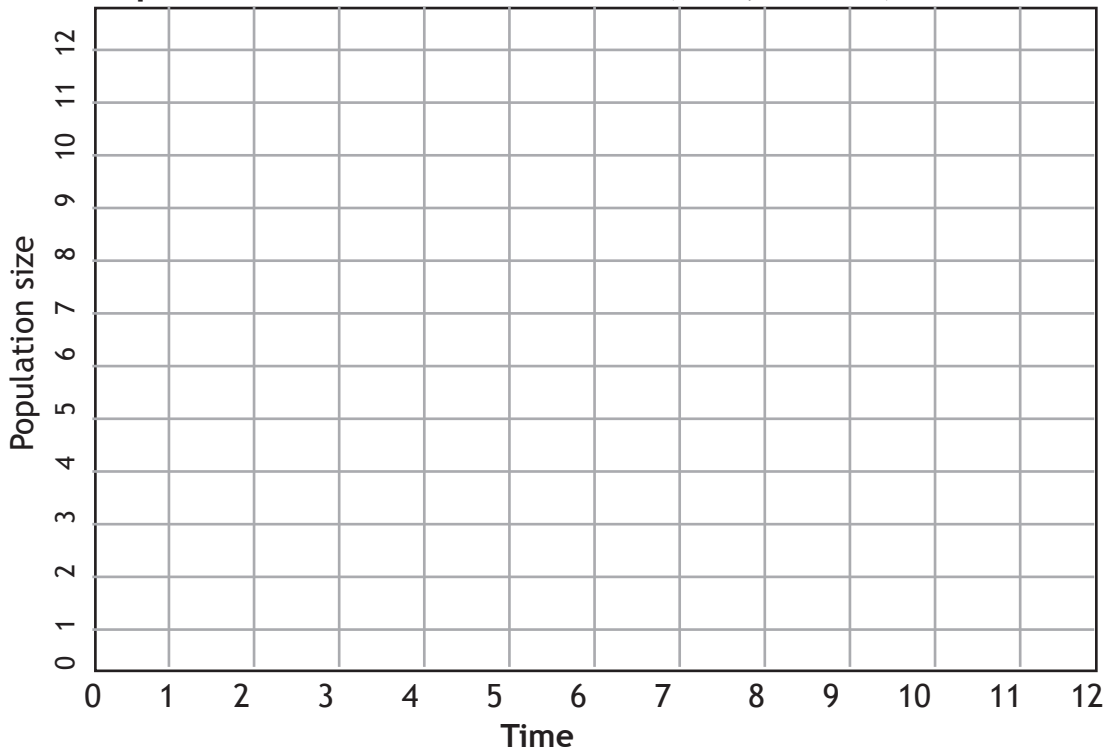
Graph your data from the previous page. Use a different color line to represent each population (diatoms, copepods, herring, and whales). Color the key at the bottom to show which color represents each species.

Populations Over Time: Round 1 *(basic rules)*



Is the Round 1 ecosystem in balance? Why or why not?

Populations Over Time: Round 2 *(modified rules)*



Is the Round 2 ecosystem in balance? Why or why not?

Key (Color squares below to indicate which color line is for which population.)

Diatoms

Copepods

Herring

Whales

Food Chain Checkers: Game Pieces

Directions: You will need two copies of this template page for each game. Cut pieces apart along gray lines. For a more durable set of pieces, print on cardstock and/or laminate pieces.

