



Food Waste and the Environment

LESSON PLAN

This unit highlights the effects of food waste on water quality, climate change, and wildlife.

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ESTIMATED TIME

Two 50-minute lessons and one 30-minute lesson

VOCABULARY

- Food waste
- Landfill
- Greenhouse gas
- Atmosphere
- Climate change
- Methane
- Carbon dioxide
- Landfill leachate
- Biodiversity

UNIT OBJECTIVES

Students will be able to:

1. Explain the ways that food waste affects water quality.
2. Describe the relationship between food waste and climate change.
3. List ways that food waste affects wildlife.

LESSON STANDARDS

Next Generation Science Standards

Lesson 1: [MS-LS2-2](#) [MS-LS1-5](#)

Lesson 2: [5-ESS2-1](#) [5-PS1-1](#)

Lesson 3:
[2-LS4-1](#) [MS-LS1-5](#) [MS-LS2-1](#) [MS-LS2-2](#)

Core Standards

Lessons 1, 2, 3:

English/Language Arts

SL.2.1	SL.3.3	RF.4.3	W.4.10	L.5.3
SL.2.2	SL.3.4	RF.4.4	RF.5.3	L.5.4
SL.2.4	L.3.1	SL.4.1	RF.5.4	L.5.6
SL.2.6	L.3.3	SL.4.4	SL.5.1	
SL.3.1	L.3.4	L.4.1	SL.5.2	
SL.3.2	L.3.6	L.4.4	L.5.1	

MATERIALS

- Mini Landfill video (available at www.purdue.edu/nature)
- One Eutrophication Sheet per student
- Five copies each of the Trash/Food and Fish/Bird cards on cardstock per group of four students
- One Biodiversity Comparison Sheet per student
- Seven empty two-liter bottles
- One cup of food trimmings
- Seven drops of biodegradable food dye
- Seven spray bottles with water
- One small screwdriver or pointed knife
- One 50-pound bag of soil, seven one-pound containers for soil, seven cups for the soil
- Several sheets of recycled newspaper
- Seven small pieces of modeling clay
- One pair of scissors per student
- One bottle/stick of glue per student
- Two plastic/Ziploc bags
- Four wide-rimmed cups
- One wide-rimmed cup per student
- Two ping pong-sized balls per student
- One can of spray paint or chalk
- Enough bandannas for each student, half one color and half another

ACTIVITY ICONS

Use these icons — located at the top of each lesson plan — to indicate the disciplines to which certain activities belong. These disciplines include:



Lesson 1: Food Waste and Water

This lesson teaches students how landfills are made and how food waste in landfills affects water quality.

VOCABULARY

- **Landfill:** a place to dispose of waste by burying it.
- **Food waste:** food that is lost, discarded, or uneaten.
- **Landfill leachate:** the liquid that drains from a landfill.
- **Eutrophication:** an excess of nutrients in the water, which causes an increased growth in algae that may lead to death of aquatic animals from lack of oxygen.

ACTIVITY MINI LANDFILL

This activity is meant to illustrate the composition of a landfill and how leachate can escape from a landfill despite protective measures. The top half of a two-liter bottle represents the landfill and the bottom half represents the groundwater, the water that we drink. Use this activity to teach how leachate affects water quality. See the “Mini Landfill Video” for a visual example of how to build a mini landfill. The clay and plastic in the two-liter bottle represents the clay and plastic in the landfill that are used to protect the groundwater from landfill leachate. The water that passes through the bottle cap and into the bottom of the two-liter bottle represents the leachate that passes through landfills. Students will notice that only a small amount of leachate passes into the bottom half of the bottle. This is because most of the leachate that passes through landfills is captured by drainage pipes and carried to a leachate collection pond. This leachate is treated and released into rivers. However, a very small amount of leachate does pass through the clay and plastic and into the groundwater. Increased amounts of food waste in a landfill leads to increased amounts of leachate because of the high water content of food.

When leachate passes through a landfill and into the groundwater, that groundwater becomes toxic to drink. Groundwater is where we get most of our drinking water. Groundwater is also connected to rivers, streams, ponds, lakes, and oceans where plants and animals live. Here, leachate can make water bodies unfit to live in and lead to eutrophication.

ACTIVITY EUTROPHICATION SHEET

This activity is meant to illustrate the eutrophication cycle. Even though most leachate is captured from landfills by drainage pipes and is treated by a wastewater facility, these facilities are ill-equipped to remove nutrients released by decomposing food, such as phosphorous and nitrogen. These nutrients encourage algal blooms to grow in rivers and streams. The algae prevents the sunlight from getting to the aquatic plants, so the plants die. When the plants die, they no longer produce oxygen in the water that fish need to breathe, so the fish also die. This process is called the eutrophication cycle. See “What is Eutrophication: Biology for All: FuseSchool” on YouTube to watch a helpful visual explaining eutrophication: <https://youtu.be/6LAT1gLMPu4>.

One option to reduce food waste is composting. Anyone can compost, inside or outside, in an apartment, a house, or a school. See the “Food Waste Solutions” lesson at www.purdue.edu/nature to learn more.

Lesson 2:

Food Waste and Climate Change

This lesson teaches students about climate change and how food waste affects it.

VOCABULARY

- **Climate change:** a long-term change in the earth's climate due to an increase in the earth's atmospheric temperature.
- **Ecosystem:** organisms (plants, animals, fungi, bacteria) interacting with each other and their environment.
- **Greenhouse gas:** a gas that contributes to the greenhouse effect by absorbing infrared radiation.
- **Atmosphere:** the layer of gases surrounding the earth.
- **Decomposition:** the process of rotting.
- **Methane:** a colorless, odorless, flammable gas produced by decomposing organic matter (made of carbon-based compounds).

Lesson 3: Food Waste and Wildlife

This lesson teaches students how food waste affects wildlife.

VOCABULARY

Biodiversity: variety of life.

ACTIVITY WILDLIFE AND FOOD WASTE

The Wildlife Card Game is meant to illustrate the relationship between food waste and wildlife populations. Food waste in landfills attracts wildlife, drawing them nearer to human populations and encouraging them to scavenge food from the landfills. Wildlife can then consume non-food items that can make them sick or even kill them. Successful landfill scavenging can cause some species to overpopulate. When these species overpopulate, they impact other species in their food web. Example: The more food waste, the more fish-eating birds and the less fish (see Osterback et al. 2015 example). The birds in the Wildlife Card Game are called western gulls. The landfill (pile of trash and food cards) in this game is in California. The fish in the Wildlife Card Game are called steelhead trout and they live in the nearby Monterey Bay (the card pile next to the landfill). The more food waste there is, the more birds and the less fish because the birds become overpopulated. This will be demonstrated in the game. Whenever a bird collects two food waste cards, they will collect one baby bird card. Whenever they collect two baby bird cards, they will collect a fish card.

The Wildlife Run Game illustrates the same concepts as the Wildlife Card Game but gets kids active and is easier to play outdoors. In this game, the kids are the birds, plastic bags (instead of trash), and the food waste. We reuse the fish cards from the card game.

RESOURCES

Buzby, J. and J. Hyman. 2012. Total and per capita value of food loss in the United States. *Food Policy* 37:561-570

Buzby, J. Z., H. F. Wells, and J. Hyman. 2014. The estimated amount, value, and calories of post-harvest food losses at the retail and consumer levels in the United States. U. S. Department of Agriculture, Economic Research Service.

Natural Resources Defense Council (NRDC). 2013. Your scraps add up: reducing food waste can save money and resources. NRDC.

Osterback, A. M. K., D. M. Frechette, S. a. Hayes, S. A. Shaffer, J. W. Moore. 2015. Long-term shifts in anthropogenic subsidies to gulls and implications for an imperiled fish. *Biological Conservation* 191: 606-613. <https://www.sciencedirect.com/science/article/pii/S0006320715300458>.

ResearchManiacs.com. 2014. <http://researchmaniacs.com/Numbers/Billions/How-much-is-161-1-billion.html>

LESSON 1 FOOD WASTE AND WATER

Food Waste and the Environment LESSON PLAN



READING



SCIENCE

This lesson teaches students how landfills are made and how food waste in landfills affects water quality.

ESTIMATED TIME

50 mins

REQUIRED MATERIALS

- Mini Landfill video OR one Landfill Construction Instructions Sheet per student
- Seven empty two-liter bottles
- One cup of food trimmings
- Seven drops of biodegradable food dye
- Seven spray bottles with water
- One small screwdriver or pointed knife
- One 50-pound bag of soil
- Seven one-gallon containers for soil
- Seven cups for the soil
- Several sheets of recycled newspaper
- Seven small pieces of modeling clay
- Two plastic/Ziploc bags
- One Eutrophication Sheet per student
- One pair of scissors per student
- One bottle/stick of glue per student

PROCEDURE

1. Introduce the term “food waste.” Ask students: “Where does food waste go when it is thrown away?” Introduce the terms “landfill” and “landfill leachate.”
2. Have students build a mini landfill (see directions for activity below). Discuss each step of building the landfill. Discuss landfill leachate and its effects on groundwater, rivers and ponds, wildlife, and humans. Discuss the effects of food waste on landfill leachate (see Teacher Materials).
3. Explain the eutrophication cycle (see Teacher Materials). Have students complete the Eutrophication Sheet (see directions below).
4. Discuss what students learned by asking questions like: “What is leachate? Who/what is affected by leachate?”
5. Have students explain the process of eutrophication using their Eutrophication Sheets.

DIRECTIONS FOR MINI LANDFILL

Before the lesson:

Watch the “Mini Landfill” video to familiarize yourself with this activity. Have students bring in empty two-liter bottles (one for each group of three to four students). Use scissors to cut the two-liter bottles in half and use a small screwdriver or pointed knife to cut several small holes in their caps. Cut eight small squares (enough to cover the bottle cap) from two plastic bags/Ziploc bags. Pour a few drops of food dye into the spray bottles of water. Fill one container with soil for every group.

1. Divide the class into groups of four students. Each group of four students gets one two-liter bottle cut in half with holes in the cap, one container of soil, some food trimmings, one cup, one spray bottle full of colored water, one small piece of modeling clay, one square piece of plastic bag, and several sheets of newspaper. Have the students cover the desks with newspaper to keep the surface clean during this activity.
2. Designate an area in the classroom for the students to place their mini landfills when finished with this activity. Mini landfills and their supplies can be reused in the Solutions to Food Waste lesson on www.purdue.edu/nature.
3. Guide students through building a mini landfill using the steps in the “Mini Landfill” video and/or the Landfill Construction Instructions sheet below.

This activity can be used to teach engineering design by providing an array of materials to protect the “groundwater” from “leachate” in the landfill. Have students do their best to protect the groundwater from leachate by deciding what materials to use and in what order (plastic and then clay, or clay and then plastic in the bottle cap). Then, have students test, revise, and compare their designs with their peers.

DIRECTIONS FOR EUTROPHICATION SHEET

1. Explain the eutrophication cycle to the class using a completed Eutrophication Sheet.
2. Have each student put together a Eutrophication Sheet with scissors and glue. Glue pieces of the eutrophication cycle to the Eutrophication Sheet Page 2 below.
3. Ask a few students to explain the eutrophication cycle to the class.

LANDFILL CONSTRUCTION INSTRUCTION SHEET

Please build your landfill on top of the newspaper to keep your desks from getting dirty.

1. Take the top half of a two-liter bottle. Keeping the cap screwed on tightly, place one small piece of clay inside the bottle cap. Try to cover the holes in the bottle cap.
2. Place one square of plastic over the clay in the bottle cap



3. Place the top half of your two-liter bottle upside down, inside the bottom half of the same two-liter bottle, cap pointing down.



4. Scoop one layer of soil into the top half of the two-liter bottle, on top of the plastic and clay.



5. Scoop one layer of food trimmings on top of the soil.



6. Scoop one layer of soil on top of the food trimmings.
7. Spray the soil and food trimmings with water from the water bottle until all the soil is damp.



8. Observe if water/leachate drips from the cup.

EUTROPHICATION SHEET PAGE 1

Build a diagram that shows the process of eutrophication using the pieces below. Cut the pieces out by cutting along the dashed line. Then glue the pieces onto page 2 where each piece fits in the eutrophication cycle.

Leachate

1



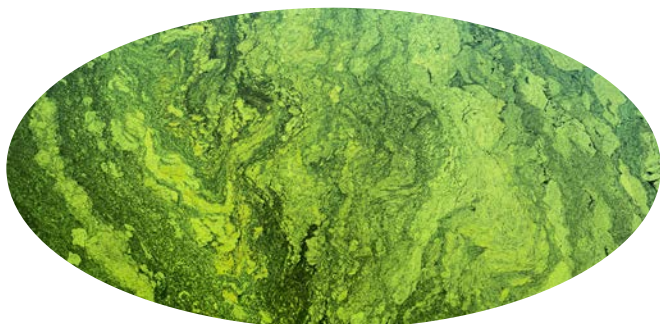
Sunlight

2



Algae

3



Dead Plants

4



Dead Fish

5



EUTROPHICATION SHEET PAGE 2

Build a diagram that shows the process of eutrophication using the pieces from page 1. Place the pieces where their number matches in the eutrophication cycle.

2

1) Nutrients in leachate
cause algae to grow.

2) Algae blocks sunlight.

1

3

3) Plants die without sunlight and
do not produce oxygen.

4) Fish die without oxygen from
plants.

4

5

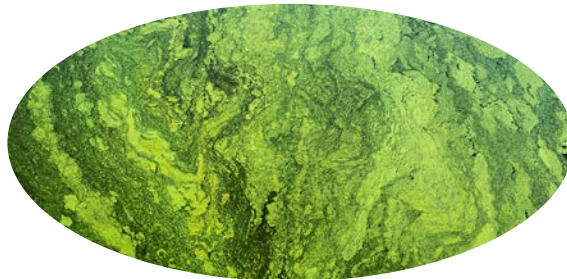
EXAMPLE OF COMPLETED EUTROPHICATION SHEET



1) Nutrients in leachate cause algae to grow.



2) Algae blocks sunlight.



3) Plants die without sunlight and do not produce oxygen.



4) Fish die without oxygen from plants.



LESSON 2 FOOD WASTE AND CLIMATE CHANGE

Food Waste and the Environment LESSON PLAN



READING



SCIENCE

This lesson teaches students about climate change and how food waste affects climate change.

ESTIMATED TIME

30 mins

REQUIRED MATERIALS

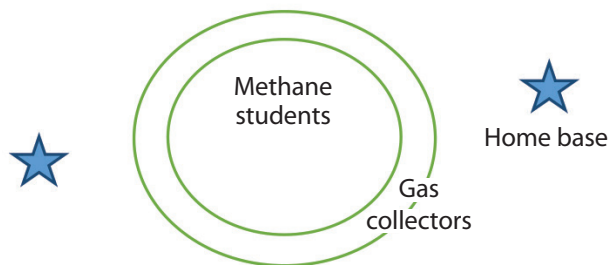
- One wide-rimmed cup per student
- Two ping pong-sized balls per student
- One can of spray paint or chalk
- Five bandannas

PROCEDURE

1. Have students watch this video to explain climate change, atmosphere, and greenhouse gases: <https://youtu.be/Sv7OHfpIRfU> (Climate Change According to a Kid).
 2. Show students an example of a gas by having them inhale and exhale. They are exhaling a type of gas called carbon dioxide and inhaling oxygen.
 3. Explain that when food waste decomposes in landfills, it creates methane, a type of greenhouse gas. This is because we cover our landfills with soil to prevent foul odors. Covering landfills with soil does not allow oxygen to reach the food waste. Decomposition without oxygen releases methane.
 4. Have students play the Methane Game or Methane Action Game (active) (see below).
 5. Discuss as a class:
 - a. How would you explain climate change to a little kid? Think back to the video we watched.
 - b. Who/what do you think are affected by climate change?
 - c. How can we reduce the amount of methane released into the atmosphere?
- ### DIRECTIONS FOR METHANE GAME
1. Explain that many landfills now have methods for collecting methane to use for energy to power buildings. But just as the protective liners in a landfill release a small amount of leachate, some methane escapes into the atmosphere. In this game, students will try to capture the methane before it is released into the atmosphere. Show students how methane is captured by searching "Methane Capture and Use A Student's Guide to Global Climate Change."
 2. Divide students into four equal groups. Each group gets one cup and two balls per student. Students must capture the methane molecules (balls) with cups before they escape into the atmosphere.
 3. Round 1: There is not a lot of food waste in the landfill. Each group should assign one methane roller (this student is acting as food waste, emitting methane) and the rest methane catchers (like the EPA image of the gas collection wells). The roller will start with all the methane molecules, or balls. The catchers should start with no molecules. The methane roller will roll the methane molecules one at a time across the desks to the catchers. If someone catches a methane molecule with a cup, they should keep it.
 4. Round 2: There is a LOT of food waste in the landfill. Now, the person who was the roller last round is the only catcher. The rest are rollers. Each roller should start with approximately two methane molecules. The catcher should start with no molecules. The same rules apply as in Round 1.
 5. Discuss as a class what happened when there was more food waste:
 - a. Was there more methane produced and faster?
 - b. Was it harder to catch all the methane?
 - c. Reiterate that methane is produced by food waste decomposing in a landfill because there is no oxygen in the landfill. The more food waste in a landfill, the more methane is produced.

DIRECTIONS FOR METHANE ACTION GAME

1. Complete step 1 from the Directions for Methane Game above. Explain that some students will act as methane molecules escaping from the landfill and some students will act as the landfill gas collection wells/gas collectors (seen in the image on the EPA site).
2. Draw a large circle on the ground with spray paint or chalk to designate that area as the landfill. Designate two to three places outside the circle as home base-place the home bases in different places relative to the landfill. Methane students will start in the middle of the landfill. Draw a second, larger circle around outside of the landfill circle, only about two feet beyond the landfill circle.
3. Gas collectors will stand between the two circles. Give five gas collectors bandannas to wear. Methane students will run to get outside the landfill without getting tagged by a gas collector. If they are tagged, they are out for the round and should sit or move to the side to cheer on their peers. If methane students escape the landfill and make it to a home base without getting tagged, they have escaped into the atmosphere and are contributing to climate change. They should stay at home base for the round.



4. Round 1: There is not a lot of food waste in the landfill. Have five students be the gas collectors and only two students be the methane.
5. Round 2. There is a lot of food waste in the landfill. Have the same five students be gas collectors and the rest of the class be methane.
6. Discuss as a class what happened when there was more food waste.
 - a. Was it harder to catch all the methane in round 2? Why? Reiterate that methane is produced by food waste decomposing in a landfill because there is no oxygen in the landfill. The more food waste in a landfill, the more methane is produced.

LESSON 3 FOOD WASTE AND WILDLIFE

Food Waste and the Environment LESSON PLAN



READING



SCIENCE

ESTIMATED TIME

50 minutes

REQUIRED MATERIALS

- Each group of four students will receive:
- Five copies of the Trash/Food and Fish/Bird cards on cardstock
- One can of spray paint or chalk
- Enough bandannas for each student, half one color and half another
- One Biodiversity Comparison Sheet per student

PROCEDURE

1. Before the lesson: Print five copies each of the Trash/Food and Fish/Bird cards per group of four students. Print the cards on cardstock so that students cannot see the picture on the front of the cards through the back of the cards. Cut out the cards and group them by type of card (trash, food, fish, or bird).
2. Guide students through the Picture This Activity (see below).
3. Explain to students that more different kinds of animals can live in a forest than a farm field or landfill because of the increased biodiversity in the forest. Biodiversity means the variety of life, or the number of different living things. More different kinds of plants grow in the forest, so more different kinds of animals can live there. There are also more places for animals to hide and raise their young.
4. Explain to students that scientists are researching ways to grow more food to feed the growing number of people on Earth, but science shows that we can feed all the hungry people in the world with the food we are throwing away. Ask students:
 - a. What might happen to biodiversity if we plant more farm fields and take away more forests?
 - b. Explain that biodiversity would decrease as we plant more farm fields.
5. Ask students:
 - a. Since we already grow enough food to feed everyone, but we are currently throwing away about one-third of that food, what can we do to protect biodiversity?
 - b. Explain that reducing food waste can help protect biodiversity because we are not turning more wildlands into farm fields or into landfills (where we dispose of most of our food waste).
6. Explain that food waste in landfills affects wildlife in other ways, too. Explain the relationship between Wildlife and Food Waste (see Teacher Materials). Then, guide students through the Wildlife Card Game or the Wildlife Run Game (active) (see below).
7. Ask students how else food waste affects wildlife. Remind students who completed Lesson 1 and/or 2 that food waste affects wildlife by affecting water that they drink and live in and by contributing to climate change, which affects the whole planet. See the notes on Mini Landfill and Eutrophication in the Teacher Materials and the "Climate Change According to a Kid" video from Lesson 2.

DIRECTIONS FOR PICTURE THIS ACTIVITY

1. Explain to students that they will be doing a guided imagery exercise where they will imagine different kinds of places and then write and draw about them. Read the passages below to lead students through the guided imagery exercise. Read each passage slowly and clearly with a smooth, relaxed tone of voice. Give time for your students to fully visualize the environment you are describing by pausing for five to 10 seconds after reading each sentence.
2. Sit comfortably, close your eyes and breathe deeply. Picture a farm field. There is grass all around you. You see animals grazing in a fenced paddock. You see crops like corn and soybeans growing in rows. You feel the breeze on your skin. You smell hay and corn. What else do you see? What do you smell? What do you hear? What is growing in the farm field? What animals live there? Take another deep breath, count to three, and slowly open your eyes. Now, draw and write what you saw in the farm square of the Biodiversity Comparison Sheet.
3. Now we're going to go somewhere else. Close your eyes, breathe deeply, and picture a landfill. You see dump trucks driving over a huge pile of trash. You see birds flying and digging in the landfill in search of food. You smell the food waste and other trash in the landfill. Some food is sour and spoiled, and other food is perfectly fine. What else do you see? What else do you smell? What do you hear? What animals live there? Take another deep breath, count to three, and slowly open your eyes. Now draw and write what you saw in the landfill square of the Biodiversity Comparison Sheet.

- Finally, we're going to go one last place. Close your eyes, breathe deeply, and picture a forest. You see trees blowing in the breeze. You smell leaves on the ground. You hear birds chirping. You hear small animals scuttling through the leaf litter around you. What else do you see? What else do you smell? What else do you hear? What is growing in the forest? What animals live there? Take another deep breath, count to three, and slowly open your eyes. Now, draw and write what you saw in the forest square of the Biodiversity Comparison Sheet.
- Ask students to compare the farm field, landfill, and forest using their completed Biodiversity Comparison Sheet. Discuss with the class how many different species of plants and animals were found in each location. Ask: "Which location had the most biodiversity, which had the least, and why?"

because they had a baby. If they collect two baby bird cards, they should collect a fish card because the birds are also eating fish, their native prey. The birds should count their fish cards at the end of one minute. Keep record of the number of fishes consumed and put all cards back from where they came.

- Round 2: There is a LOT of food waste. Add all remaining food waste cards to the landfill. At the end of the round, the birds should count how many fish cards they have collected.
- Discuss with the class: How did the amount of food waste in the landfill affect the amount of baby birds that were born? Were more fish eaten in round 1 or round 2? Why?

DIRECTIONS FOR WILDLIFE CARD GAME

- Each group of students gets five cut-out pages each of Trash/Food and Fish/Bird cards.
- Round 1: There is only a little food waste. Students will be acting as birds. They should spread and mix all trash cards and half of the food waste cards out face-down on a table. This is the landfill. Keep the baby bird cards in a stack next to the landfill. They have not been born yet. Spread the fish cards out in a separate pile next to the landfill. This is the Monterey Bay near the landfill, where the fish live.



- Birds will have one minute (use the timer) to flip over cards one at a time. They should only use one hand to pick up cards. If they pick up a trash card, they should hold the card in the air, and count out loud for five seconds, then put the trash card back face-down in the pile. This is because accidentally eating the trash made the birds sick. If they collect a food card, they should keep it. If they collect two food waste cards, they should collect a baby bird card

DIRECTIONS FOR WILDLIFE RUN GAME

1. Explain that some students will act as birds in a landfill, some will act as plastic bags (to avoid name-calling for trash), and some will act as food waste.
2. Use spray paint or chalk to draw two parallel lines on the ground on opposite sides of the play space several yards apart (Line A and Line B). Place all the fish cards from the card game behind Line B. This is the Monterey Bay, where the fish live. Have students acting as birds stand behind Line A. Students acting as bags should wear one color of bandanna and stand in between the two lines. This area is the landfill. Students acting as food waste should wear another color of bandanna and stand in the landfill. The object of the game is for students acting as birds to run to get the fish cards behind Line B and then run the fish back behind Line A without getting freeze-tagged by a student acting as bags. The bags freeze the birds because accidentally consuming trash like plastic bags makes birds sick. Students acting as food waste can unfreeze the birds because birds like eating food waste.
3. Round 1: There is only a little food waste in the landfill. Have half of students act as birds, two students act as food waste, and the remaining students act as bags.
4. Round 2: There is a lot of food waste. Have the same students act as birds, two students act as bags, and the remaining students act as food waste.
5. Discuss with the class: Were more fish eaten in round 1 or round 2? Why?

Line B: Where fish cards are spread out.
This is the Monterey Bay.

Students acting as bags and food waste
spread out in the center between the
two lines.

Line A: Where birds start.

Trash



Trash



Trash



Trash



Trash



Trash



Trash



Trash



Trash



Food Waste



Food Waste



Food Waste



Food Waste



Food Waste



Food Waste



Food Waste



Food Waste



Food Waste



Fish



Fish



Fish



Fish



Fish



Fish



Fish



Fish



Fish



Birds



Birds



Birds



Birds



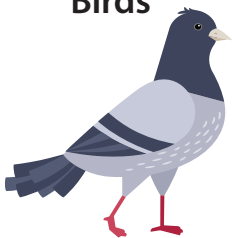
Birds



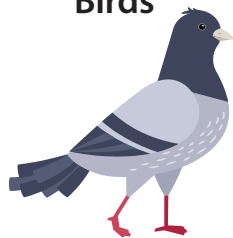
Birds



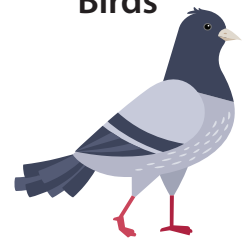
Birds



Birds



Birds



Name: _____

BIODIVERSITY COMPARISON SHEET

Write and draw what you saw in the farm, landfill, and forest. Be descriptive.

1 Farm

2 Landfill

3 Forest