Food Waste: Impact on the Environment

NOURISH SMART

Hunger Solutions Institute
Utah State University

Course Standards

Standard ENVS.4.1
Construct an argument to evaluate how human population growth affects natural resources and the potential solutions to these effects. Examples of resources affected by human population growth could include food demand, food supply, waste disposal, or land use. Examples of potential solutions could include genetically modified organisms, hydroponics, wastewater treatment, or improved recycling systems.

Standard ENVS.4.2
Construct explanations about the relationship between the quality of life and human impact (effect) on the environment in terms of population growth, education, and gross national product. Emphasize the role of sustainable practices to support both humans and nature.

Standard BIO.1.5
"Design a solution that reduces the impact caused by human activities on the environment and biodiversity. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution.

What do you think of when you hear the term "Food Waste"?

1. Present question to your class and allow them to think about it for a minute.

2. Next, invite the class to share which words, ideas, or images come to mind when they hear the term "Food Waste".

2a. This can be done by creating a wordcloud (https://www.freewordcloudgenerator.com/), by having them write their ideas on the whiteboard, or by asking the class to share by raise of hands.

3. Ask them to provide a definition of what food waste is using the words, ideas and images formulated by the class in the previous activity. This can be discussed as a class.

What is food waste?

Uneaten food and inedible parts (e.g., peels, pits, bones) going to the following eight destinations:

Composting	Anaerobic digestion
Landfill	Combustion
Sewer	Dumping
Spread onto land	Not harvested

Definition from: https://refed.org/food-waste/the-problem/

1. Read the definition and then provide more details as to what each of 8 food waste destinations mean as they are introduced.

-Composting: recycling organic matter (food) into fertilizer
-Anaerobic digestion: when microorganisms break down organic matter without oxygen
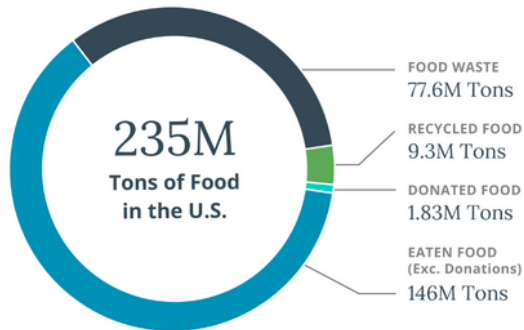-Landfill
-Combustion: Sent to an incinerator
-Sewer
-Dumping: disposal of waste without environmental controls (improper, out of place; could have significant environmental repurcussions)
-Spread onto land: Spreading organic waste onto agricultural land as a form of natural fertilizer
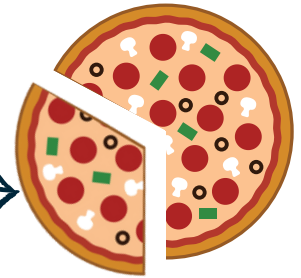-Not harvested: Food is produced, but not ever removed from the field to be used

How much food do we waste?

235M Tons of Food in the U.S.

FOOD WASTE
77.6M Tons

RECYCLED FOOD
9.3M Tons

DONATED FOOD
1.83M Tons

EATEN FOOD
(Exc. Donations)
146M Tons

Source: ReFED/2022 Data (Published 11/23)

33% of U.S. food supply becomes food waste (77.6 million tons)

Food Waste →

Data from: https://refed.org/food-waste/the-problem/

1. Breakdown graphic by going through each of the categories and explaining where all of the food in the United States ends up. Most is eaten (about 2/3), but food waste is the next most common fate for food.

2. Use the statistic about food waste and the pizza image to help emphasize exactly how much food is wasted.

2a. With the pizza image, invite the students to imagine that when they buy a pizza, 1/3 of it has to be thrown in to the trash. This makes the visual of food waste easier to see. Explain how it may be more difficult to understand the impact of food waste in our lives when we typically discard portions of food throughout the day that add up to be the equivalent of wasting 1/3 of our food supply.
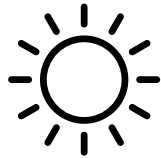
In what ways does food waste impact our enviroment?

Water

Wildlife

Climate

1. We will be discussing the three primary ways in which food waste affects our environment. Food waste has a direct negative impact on water, wildlife, and climate.

Food Waste and Water

1. Ask the class in what ways they think food waste can affect water

Wasting Food is Wasting Water

- **Water is essential to the production process of food. Therefore when we waste food, we are wasting fresh water.**

- **Agriculture accounts for 70% of global water usage.**

- **Uneaten food accounts for nearly a quarter of our water supply.**

Sources:
https://earth.org/how-does-food-waste-affect-the-environment/

1. Read these bullet points to help introduce the idea that wasting food is wasting water.
2. Ask the students if the facts are surprising to them. Why or why not?

How many gallons of water are required to produce the foods we eat?

Example: 95 gallons of water are required to produce 4 oz of cheese

1. Invite students to search on the internet to understand how much water common foods require to be produced. To ensure accurate and credible numbers, invite the students to use the following website:
https://watercalculator.org/water-footprint-of-food-guide/
Please post this link somewhere the students can easily click on it and gain access.

If they don't have access to the internet or you would prefer them to stay off their phone/laptop, you can skip to the next slide as a reference for examples of these numbers (sourced from the website listed above).

2. Give them a few minutes to research this and have them turn and discuss their results with a neighbor for 1 minute.

3. Have them share their results as a class by inviting them to the board to write down a food item and its respective water requirements to be produced.

How many gallons of water are required to produce the foods we eat?

4 oz almonds- 483 gallons	4 oz orange- 17 gallons
4 oz chocolate- 516 gallons	4 oz pork/bacon- 180 gallons
4 oz beef- 463 gallons	4 oz cheese- 95 gallons
4 oz cashews- 427 gallons	4 oz white rice- 73 gallons
4 oz chicken- 130 gallons	8 fl oz orange juice- 64 gallons
4 oz eggs- 98 gallons	4 oz pizza- 53 gallons
4 oz pasta- 56 gallons	4 oz apple- 25 gallons

1. Facilitate a discussion using the following questions:

A) Of the foods listed on the board (and on this slide), which ones are most surprising to you?
B) Why do you think that meats usually require more water than other foods?
C) Other questions that you would like to propose to your class.

ACTIVITY:
1. Give the students a limit of 1000 gallons (or another amount) to work with to try to come up with a list of food items that would be able to be produced from the decided water allotment.
2. Ask a few the students to share what foods they grouped together to reach the water allotment provided to them.

Food Waste Causes Water Contamination

In 2022, 42% of U.S. food waste ended up in landfills. This food waste increases leachate.

What is leachate?

The liquid that drains from landfills, carrying toxic substances and pollutants to surrounding water and soils.

How does food waste create leachate?

1. When food is broken down anaerobically, ammonia is created. Ammonia is a toxic substance harmful to animal and human health.
2. Decomposing food waste generates a lot of moisture. The generated water aids in moving harmful substances to the groundwater.

Source-https://foodcyclescience.com/blogs/food-waste-industry/leachate-the-ugly-truth-about-food-waste-in-landfills

1. Read the statistic at the top of the slide.
2. Read the definition of leachate. Explain that even though landfills have leachate collection systems, leaks of leachate into the ground water happen in most landfills (according to the EPA).
3a. Explain the anaerobic breakdown of food waste and that it produces ammonia.
3b. Explain that as food breaks down in landfills, it releases a lot of moisture. In fact, most food waste has a moisture content of about 73%. This water helps move harmful substances (like heavy metals, ammonia, microplastics, and other contaminants) into groundwater sources.

Leachate Process
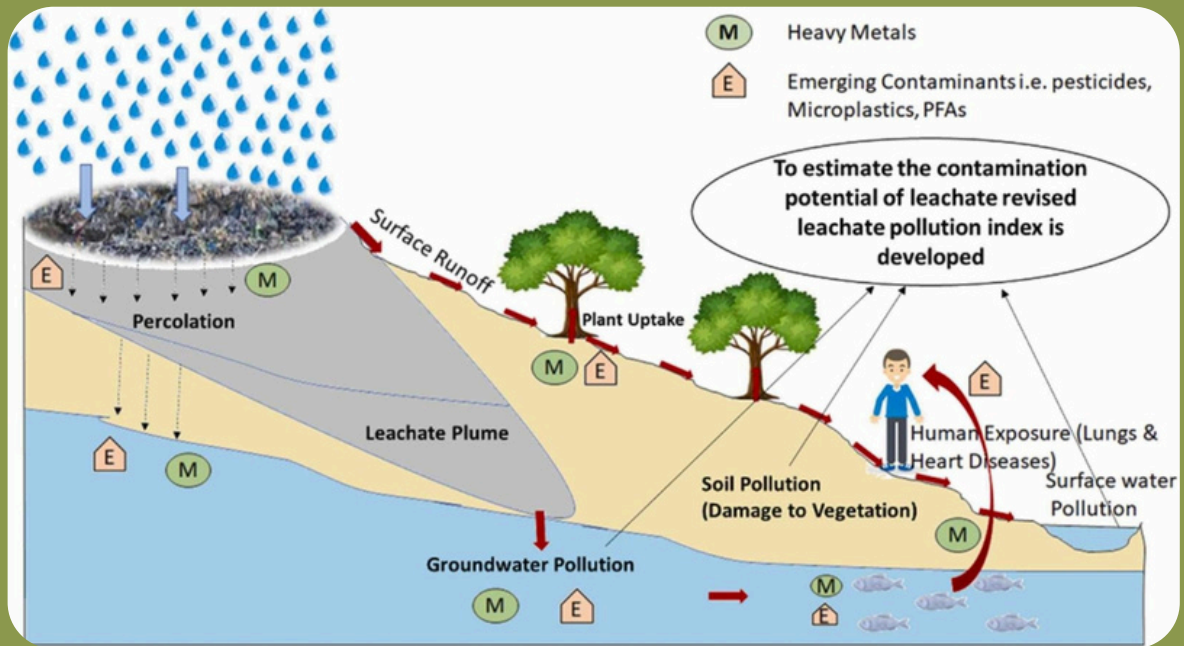
1. Explain how when it rains or when food waste produces moisture, harmful substances leak into the ground and end up in the ground water.
2. Explain that surface runoff can also occur and lead to harmful substances making their way to bodies of water on the surface. This can have negative effects on both human and environmental health. Eutrophication is a great example of the impact on environmental health (next slide).

Sources-
https://foodcyclescience.com/blogs/food-waste-industry/leachate-the-ugly-truth-about-food-waste-in-landfills
https://insights-engine.refed.org/food-waste-monitor?
break_by=destination&indicator=tons-waste&view=detail&year=2022
https://www.sciencedirect.com/science/article/abs/pii/S0957582022009223

Eutrophication

Eutrophication from food waste occurs when nutrients, such as nitrogen or phosphorus, end up in surface runoff and into bodies of water causing algal blooms.

How do algal blooms impact aquatic ecosystems?

1. **Oxygen depletion in water**
2. **Blocked sunlight for photosynthetic plants**
3. **Production of toxins harmful to the food chain**

Source:
https://oceanservice.noaa.gov/facts/eutrophication.html#:~:text=the%20nation's%20estuaries.-,Harmful%20algal%20blooms%2C%20dead%20zones%2C%20and%20fish%20kills%20are%20the,to%20estuaries%20and%20coastal%20waters.

1. Read the definition of eutrophication.
2. Explain how it causes algal blooms which impact aquatic ecosystems in 3 ways.
3. Read the 3 ways in which algal blooms can impact the ecosystem.
3a. Oxygen depletion causes death of fish and other aquatic life... Lead into next subject, which is "Food Waste and Wildlife"
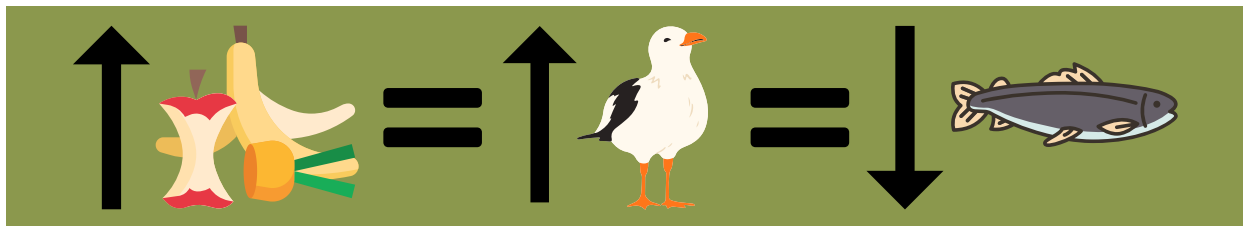
Food Waste and Wildlife

1. Ask the class in what ways they think food waste can affect wildlife

Food Waste Disrupts Ecosystems

- Landfills attract animals to areas they aren't normally found in and in numbers larger than normal.
- Increased food waste leads to increased **predation pressure.**
- Increased predation pressure can disrupt existing food chains.

Predation Pressure:
The effect of predation upon a population, resulting in the decrease in size of that population

Monterey Bay Western Gulls and Steelhead Trout

Sources-
https://e360.yale.edu/features/unnatural_balance_how_food_waste_impacts_worlds_wildlife

1. Read the first two bullet points on the slide. After reading these, explain what predation is:
"Predation is when animals kill another animal and consumes it."
2. Read the definition of predation pressure.
3. Read the last bullet point.
2. Refer to the case study on predation pressure found in the back of this manual, titled "Western gull and steelhead trout case study". Read the document aloud or ask students to volunteer reading it aloud.

Food Waste and Habitat Loss

- Land used for agricultural purposes is a leading cause of habitat loss.
- Habitats are being destroyed to make space for farmland to grow food. However, a lot of the food produced from this land is wasted.
- Loss of habitat leads to ecosystem disruptions and **loss of biodiversity.**

Uneaten meat and dairy account for more than three-quarters of the habitat loss associated with food waste.

Sources:
https://www.unep.org/news-and-stories/press-release/our-global-food-system-primary-driver-biodiversity-loss

https://www.biologicaldiversity.org/takeextinctionoffyourplate/waste/index.html

https://www.worldwildlife.org/pages/what-is-biodiversity

https://ugc.berkeley.edu/background-content/habitat-loss-restoration/#:~:text=Habitat%20loss%20and%20restoration%20impact,local%20biodiversity%20and%20species%20populations.

1. Ask the class to think about the different impacts that habitat loss can have on an ecosystem. Have them share their thoughts.
2. Read the points on the slide
3. Ask the students if they can explain what biodiversity is. Once some ideas of what biodiversity are shared, read the following definition:
"Biodiversity is all the different kinds of life you'll find in one area—the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world. Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life."
4. Explain that if we make improvements with our use of food (using it more effectively), we will lessen the demand for new farmland to be created and habitats to be destroyed.
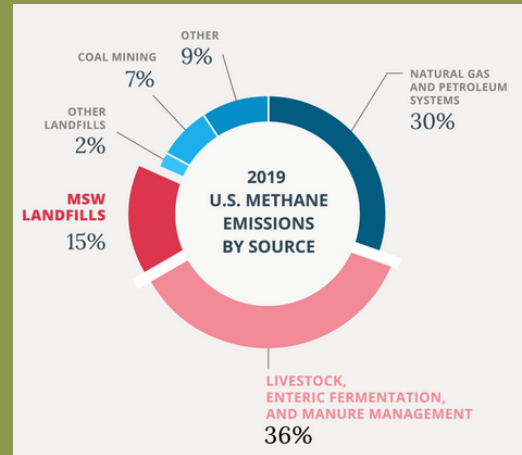
Food Waste and Climate

1. Ask the class in what ways they think food waste can affect the climate

Greenhouse Gases (GHGs)

- GHGs are gases in the Earth's atmosphere that trap heat.
- An increase in the release of GHGs contributes to global warming and climate change.
- Carbon dioxide (CO_2) and methane are common GHGs.
- Scientists agree that addressing methane emissions is a good way to decrease the impact of climate change more rapidly.
- **Food waste directly produces methane in 2 ways!**

1. Landfills
2. Livestock

2019 U.S. METHANE EMISSIONS BY SOURCE

- OTHER 9%
- COAL MINING 7%
- OTHER LANDFILLS 2%
- MSW LANDFILLS 15%
- NATURAL GAS AND PETROLEUM SYSTEMS 30%
- LIVESTOCK, ENTERIC FERMENTATION, AND MANURE MANAGEMENT 36%

1. Read the points on the slide.

2. Explain that methane is generally regarded to be about 30 times more harmful to our environment as compared to carbon dioxide. Methane has a greater capacity to trap heat as compared to carbon dioxide.

3. Emphasize that our emissions of GHGs are getting to a dangerous point where we are facing the threat of climate change.

Methane Produced in Landfills

- In 2019, 15% of methane production was sourced from landfills.
- In the U.S., food in landfills produces 124 million tons of greenhouse gas emissions, which is enough energy to power 13 million homes for one year!

- When food waste in landfills is broken down by anaerobic bacteria, **methane is produced.**

1. Read the points on the slide. Remind the students that anaerobic bacteria break down waste without the presence of oxygen to create methane. When oxygen is present, carbon dioxide is produced.

Methane Produced by Livestock

- In 2019, 36% of methane production was sourced from livestock related agricultural practices.
- Livestock emit methane into the atmosphere through a process called enteric fermentation.
- By reducing waste of animal meat and dairy products, we will decrease the demand for these products, leading to less overproduction and decreased methane emissions.

Source: https://refed.org/food-waste/climate-and-resources/

1. Read the first point on the slide.
2. With the second point, explain that enteric fermentation is the natural digestion process in grazing animals, like cattle. Microbes in their gut ferment the food products and create methane which is released into the air through belching or flatulence.
3. Read the third point. Read the following numbers about the waste of meat products: "Currently, about 14% of beef, 18% of pork, and 15% of dairy products go uneaten."

What is your footprint?

1. Have the students follow this link: https://harvard-foodprint-calculator.github.io/
1a. If you prefer to have your students stay off of their devices, you can do this activity together as a class.
2. Allow students to input their footprint information on the website to get data on their annual carbon, nitrogen, and water emissions.
3. Ask the class to report their numbers for carbon. Who has the lowest number? Who has the highest number? Ask them what ways they could possibly decrease their footprint.

1. Introduce the EPA's Food Recovery Hierarchy diagram and explain there exists a preferred order of what happens to uneaten food.
2. Ask the students to think about the question on the slide considering the footprint activity they just completed and this diagram. Give them some time to think and then ask a few people to share their ideas.
3. The next lesson will go into further details about how food can be recovered.

Western gull and steelhead trout case study

Sourced from:

"A new study in the journal *Biological Conservation* looks, for instance, at California's Monterey Bay, where the threatened steelhead trout population has declined by 80 to 90 percent over the past century. Efforts to restore the species along the Pacific Coast have focused on major initiatives like the recent demolition of a dam that had blocked access to critical steelhead breeding grounds on the Carmel River, which empties into Monterey Bay.

But a team of co-authors led by Ann-Marie Osterback, a marine ecologist at the University of California-Santa Cruz, suspects that garbage and fishery discards might also play an underrated part in the problem. The hypothesis is that local food wastes inadvertently subsidize Western gulls in the Monterrey Bay area, and these gulls in turn prey on the juvenile steelhead trout.

The dramatic decline in steelhead numbers would normally mean that fish-eating birds around Monterey Bay would have to move down the food chain to survive.

But according to Osterback, the number of gulls have doubled or quadrupled in different parts of the bay just since the 1980s — thanks to a steady diet of landfill garbage and fishery discards. Osterback and her co-authors found that each individual gull now eats less steelhead than in the past, but the combination of a greatly increased gull population and a severely reduced run of steelhead trout adds up to a dramatic rise in predation pressure. She estimates that the gulls may eat up to 30 percent of juvenile steelhead en route to the sea."

How much food do I waste?

Instructions:

1. Track the different types and quantity of foods you waste by recording it in the log below.
2. Answer the questions that follow the food waste log.

Food Waste Log

Examples: Apple core, overripe banana, end piece of a bread loaf

What are some of the environmental impacts of the foods you wasted?

What are some ways you can think of to reduce your food waste?

FOOD WASTE: IMPACT ON THE ENVIRONMENT
ASSESSMENT

Questions:	Circle One
1 Peels, pits, and bones from food are considered food waste.	True / False
2 10% of U.S. food supply becomes food waste.	True / False
3 The amount of water required to produce meat is less than that required to produce fruits or vegetables.	True / False
4 Food waste has a direct impact on the production of leachate.	True / False
5 Ammonia is a toxic byproduct of the anaerobic breakdown of food waste.	True / False
6 Produce accounts for more than three-quarters of the habitat loss associated with food waste.	True / False
7 Food waste contributes to the production of methane, a dangerous greenhouse gas.	True / False
8 Livestock emit methane into the atmosphere through a process called enteric fermentation.	True / False

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FOOD WASTE: IMPACT ON THE ENVIRONMENT
ASSESSMENT

Questions:		Circle One
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2	10% of U.S. food supply becomes food waste.	True / False
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5	Ammonia is a toxic byproduct of the anaerobic breakdown of food waste.	True / False
6	Produce accounts for more than three-quarters of the habitat loss associated with food waste.	True / False
7	Food waste contributes to the production of methane, a dangerous greenhouse gas.	True / False
8	Livestock emit methane into the atmosphere through a process called enteric fermentation.	True / False

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Answer Key:
1. True
2. False; 33% becomes food waste
3. False; meat requires more water
4. True
5. True
6. False; uneaten meat and dairy
7. True
8. True