# **Owl Pellets, Food Webs, and Pyramids**

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**Purpose:**

Students will dissect owl pellets to collect and count the contents in order to create food webs and pyramids of numbers and biomass.

**Student Objectives:**

Students will learn the term pyramid is a misnomer because of the huge amount energy required by organisms to maintain homeostasis.

**Background Information**

The barred owl inhabits woodlands and swamps in the Eastern part of the United States. This owl is approximately 43-50 cm (17-20 in) long with a wingspan of 99-110 cm (39-43 in) and has a mass of 0.50-1.05 kg. Owls are nocturnal raptors that feed on small mammals, birds and reptiles. Owls swallow their food whole or if too big, may tear it into chunks. Owls are not able to digest hair, bones or feathers. The owl digestive system has a specialized section that presses the undigested portions together forming a pellet. Since the owls cannot pass the pellet through their digestive system, they must spit out the pellet.

The bones that are found in the pellet can be identified using pictorial ‘keys’. This information can be used to determine a food web and the approximate number and biomass of prey ingested in one year. This data will be used to create number and biomass pyramids.

## **Materials**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Butcher Paper | Extra large owl pellets | Forceps | Probes | Computers (optional) |
| Masking tape | Rubber gloves | Rulers | Identification Charts |  |

**Procedure**

1. Spread out and tape down butcher paper to decrease clean-up time.
2. Obtain rest of the materials.
3. Remember to use gloves, but also wash hands at the end of the procedure. These pellets have been sterilized, but remember to use proper laboratory procedures.
4. Use dissecting tools and fingers to gently pry apart the pellet. NOTE: The bones you are looking for are small and easily broken.
5. Set aside any bones found on separate sheet of paper.
6. Repeat until you have completely dismantled the pellet.
7. Separate the skull bones using the following criteria
   1. Shape and size of the skull
   2. Shape of eye sockets
   3. Length of the snout compared to the rest of the skull
8. Use the following identification keys to identify the owl’s prey. Please remember that voles, mice and rats have similar bones, but there is a huge difference in the sizes (See mass of each Table 3 - M)

* [Bird skeleton chart](http://www.carolina.com/text/pdf/owls/birdskeleton.pdf)
* [Mole skeleton chart](http://www.carolina.com/text/pdf/owls/moleskeleton.pdf)
* [Rat skeleton chart](http://www.carolina.com/text/pdf/owls/ratskeleton.pdf)
* [Bone identification chart](http://www.carolina.com/text/pdf/owls/Owl_Pellet_Bone_Chart_Grid.pdf)
* [Skull identification chart](http://www.carolina.com/text/pdf/owls/bonechart.pdf)

1. Clean up
   1. Wrap ‘waste’ material in butcher paper and throw it away.
   2. Wash, dry and return dissection equipment - Scissors, forceps, probes
   3. Return identification keys

**Evaluation**

1. Fill in **Table 1**. Use the assumption that an owl produces an average of 2.5 pellets per day. Please note that a vole is ‘equivalent’ to a mouse

**Table 1.** Number of Prey eaten by Owl

|  |  |  |  |
| --- | --- | --- | --- |
| **Prey** | **Number Found**  **(N)** | **Number Eaten per Day**  **(D = 2.5 x N)** | **Number Eaten per Year**  **(Y = 365 x D)** |
| **Mouse or Vole** |  |  |  |
| **Mole** |  |  |  |
| **Shrew** |  |  |  |
| **Rat** |  |  |  |
| **Bird** |  |  |  |
|  |  | **Total  YT =** |  |

1. Create a two-level **Numbers Pyramid**. There will be no producers in this pyramid.
   1. The top level of the pyramid is the secondary consumer
      1. Equals 1 because there is only one owl producing the pellet.
   2. The bottom level of the pyramid is the primary consumer
      1. This is the **total** number of prey eaten per year (YT)
   3. Create pyramid by hand or using a spreadsheet program. Make sure to correct numerical relationship between top and bottom level.
2. Draw the shape that most biology textbooks use to illustrate food pyramids.
3. How is the actual pyramid different?
4. What would be a better description for the actual ‘pyramid’?
5. The producer level of the numbers pyramid was not included. How could the number for the producers’ level be found?
6. Fill in **Table 2**. Note: Number of prey per year (Y) is from **Table 1**.

**Table 2.** Biomass of Prey and Producers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Prey** | **Number of Prey/year (Y)** | **Mass (kg)**  **(M)** | **Mass of Prey (PM = Y x M)** | **Mass (kg) of Producers**  **eaten by Prey (Prod)** | **Biomass of Producers**  **(BM = PM x Prod)** |
| **Mouse** |  | *0.020* |  | **45.6** |  |
| **Mole** |  | *0.055* |  | **365** |  |
| **Shrew** |  | *0.005* |  | **1168** |  |
| **Rat** |  | *0.240* |  | **12.8** |  |
| **Bird** |  | *0.020* |  | **127** |  |
|  |  | **Total PMT (kg)** |  | **Total Biomass of**  **Producers BMT (kg)** |  |

1. Use your calculations from **Table 2** to create a three-level Biomass Pyramid
   1. The secondary consumer (top-level) is the Barred Owl and its approximate biomass is indicated in the section called Background Information.
   2. The biomass of all primary consumers (middle-level) is the Total Mass of the Prey (PMT).
   3. The biomass of all producers (bottom-level) is the Total Biomass of the Producers (BMT).

1. Does the shape of the pyramid illustrate the concept of ecological efficiency of 10% (p. 62)?
2. Which of these two pyramids better represents this concept?
3. What is the relationship between the mass of the prey and the mass of producers it eats?
4. With energy conservation in mind: Is it better for people to eat for vegtables or meat? Explain.
5. Would the mass of producers consumed increase or decrease as the pellet collection location goes from the equator towards the poles? Why?

**Table 3**. Owl prey and their respective diet

|  |  |
| --- | --- |
| **Prey** | **Diet** |
| **Mouse** | It eats a wide variety of plant and animal matter depending on what is available, including insects and other invertebrates, seeds, fruits, flowers, nuts, and other plant products. |
| **Mole** | A mole's diet is mostly insects and other invertebrates, including earthworms, centipedes, millipedes, snails, slugs, grubs, ants, sowbugs, termites, beetles, and crickets |
| **Shrew** | Food habit studies have revealed that shrews eat beetles, grasshoppers, butterfly and moth larvae, wasps, crickets, spiders, snails, earthworms, slugs, centipedes, and millipedes. Shrews also eat small birds, mice, small snakes, and even other shrews when the opportunity presents itself. Seeds, roots, and other vegetable matter are also eaten by some species of shrews. |
| **Rat** | The rat's diet typically includes seeds, nuts, grains, vegetables, fruits, meats and invertebrates. They consume about one-third of their weight in food every 24 hours. Because of their inability to vomit, rats are very hesitant to try new foods that may be poisonous. They will take a small nibble and wait to see if they feel sick and, if so, will avoid that food in the future. |
| **Bird** | insects; terrestrial non-insect arthropods, seeds, grains, and nuts; fruit |

1. On a separate sheet of paper use the information from **Table 3** to draw a **Food Web** that is representative of **your** pellet.
   1. Draw and label the owl as the top consumer.
   2. Draw and label all prey found in the feces as the next level of consumer (shrew).
   3. Draw and label any consumers eaten by the prey (crickets eaten by shrew).
   4. Draw and label any producers eaten by prey or any producers eaten by consumers eaten by prey (seeds, fruit and grass eaten by crickets; seeds and roots eaten by shrew).
   5. Draw ‘energy’ arrows from victim towards consumer (head of the arrow points towards consumer).
   6. From each producer towards each primary consumer that eats that producer.
   7. Repeat for each level towards the owl. Note: some arrows may be drawn sideways.
2. Why are the arrows pointing towards the top of the food web?
3. How does this relate to the shape of either pyramid?
4. What happens to the number of producers if there is plenty of sunshine and rain?
5. What therefore happens to the number of consumers if there is plenty of sunshine and rain?

1. Does the change in numbers in #17 and #18 occur at the same time? Why?
2. What therefore happens to the number of owls if there is plenty of sunshine and rain?
3. Does the change in numbers in #17, #18, and #20 occur at the same time? Why?
4. What would happen to the number of prey if the owl was removed due to something like habitat destruction? Why?
5. What would happen to the number of producers? Why?
6. How would this change the shape of the Numbers Pyramid? Why?
7. How would this change the shape of the Biomass Pyramid? Why?
8. Would this cause the collapse of the food web?
9. Which organism is probably responsible for keeping the food web and the pyramids in their respective shapes? The Earth is an open system for energy. Explain what that means using evidence from pyramids.
10. The Earth is an open system for energy. What should be added to the pyramids to make them correct due to that statement?

**CONCLUSION:**

1. What did you learn about food webs and pyramids?
2. What did you learn about the flow of energy and cycling of matter?
3. Why do chemists and physicists say that energy is never destroyed only transformed into another form? Does your data support this?
4. Why do chemists and physicists say that matter is never destroyed only transformed into another form? Does your data support this?

**Information**

1. Important terms

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 10% rule  Biomass Pyramid  Bird | Energy  Food Webs  Identification Keys | Matter  Mouse  Numbers Pyramid | Owl  Raptors  Rat | Shrew  Vole |

1. Works Cited
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