WildCam Gorongosa

hhmi | BioInteractive

STUDENT WORKSHEET

# FOOD WEBS ACTIVITY: BUILDING A FOOD CHAIN

## INTRODUCTION

A *food chain* is a simple model that identifies the feeding relationships and the flow of energy in an ecosystem. While the sun is the source of energy in the system, plants (*producers*) convert that energy into a more useable form. When an organism (*primary consumer*) eats the plant, the energy is transferred to that organism, which is then eaten by yet another animal (*secondary consumer*). Each organism in the food chain is part of a different trophic level, starting with a producer, then primary consumer, secondary consumer, and so forth.

## PROCEDURE

Fill in the blank spaces in the Gorongosa food chain below using any of the animals listed in the WildCam Gorongosa Field Guide (http://www.wildcamgorongosa.org/#/field-guide). Read about the diet and predators of each animal to learn what it eats and what preys upon it. Next, write the trophic level of the organism below the line. We have filled in the producer for you to begin your food chain. Remember, the arrows show the direction of the flow of energy from one level to the next.

Grass ➔ ______________ ➔ ______________ ➔ ______________

Producer

1. What do you think would happen to the rest of the food chain if the amount of grass is reduced in this ecosystem? Explain your reasoning.

2. What do you think would happen to the rest of the food chain if the population size of the primary consumer is reduced? Explain your reasoning.

3. What do you think would happen to the rest of the food chain if the population size of the secondary consumer is reduced? Explain your reasoning.

4. What do you think would happen to the rest of the food chain if the population size of the tertiary consumer is reduced? Explain your reasoning.

# FOOD WEBS ACTIVITY: BUILDING A FOOD WEB

## INTRODUCTION

In “Food Webs Activity: Building a Food Chain,” you built a food chain and learned how energy flows through trophic levels. In this part of the activity, you will complete a food web by modeling the energy flow between organisms. You will then model the community relationships in a different way, using an energy pyramid.

## PROCEDURE

### Part 1: Complete a Food Web

You learned in the previous activity that energy from the sun is accumulated by primary producers and then flows up trophic levels to each of the consumers in a food chain. In this exercise, you will draw arrows in the direction of energy flow within a food web.

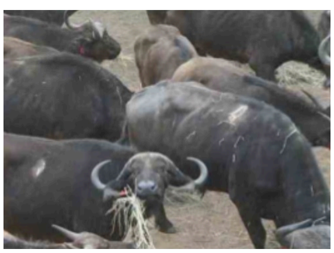
1. The following page shows the organisms in a food web. Draw arrows in the direction of energy flow to connect the different organisms. Multiple arrows can go to and from each species. Use the WildCam Gorongosa field guide (http://www.wildcamgorongosa.org/#/field-guide) to research the diet and predators for each species.

2. Next to each organism, use the following abbreviations to label it as a primary producer (PP), primary consumer (PC), secondary consumer (SC), or tertiary consumer (TC).

**Lion**

**Serval**

**Raptor**



**Buffalo**

**Rodent**

**Insect**

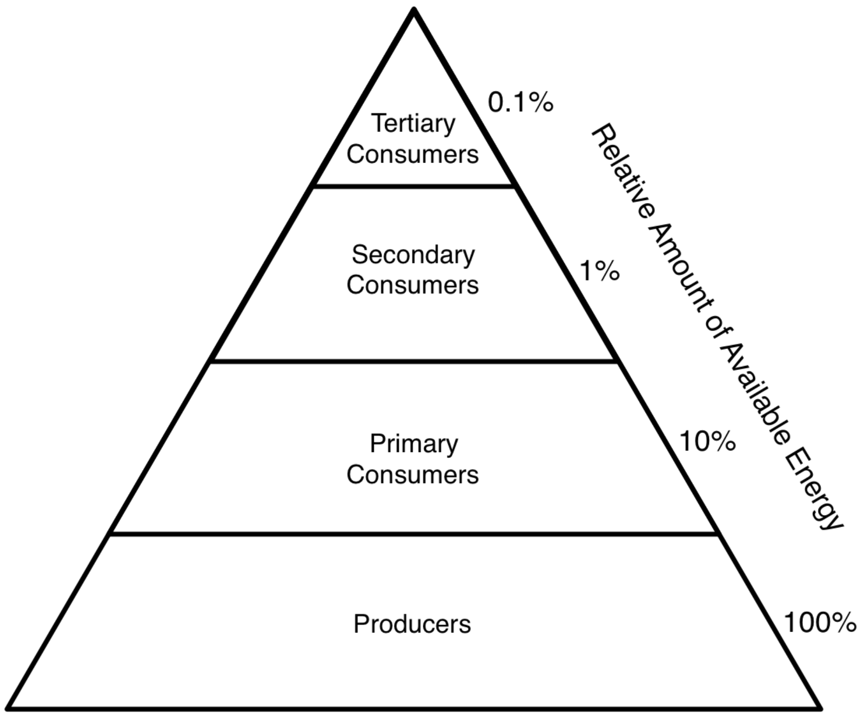
**Grass**

**Trees / Shrubs**

**Part 2: Complete an Energy Pyramid**

*"Three hundred trout are needed to support one man for a year. The trout, in turn, must consume 90,000 frogs, that must consume 27 million grasshoppers that live off of 1,000 tons of grass."*

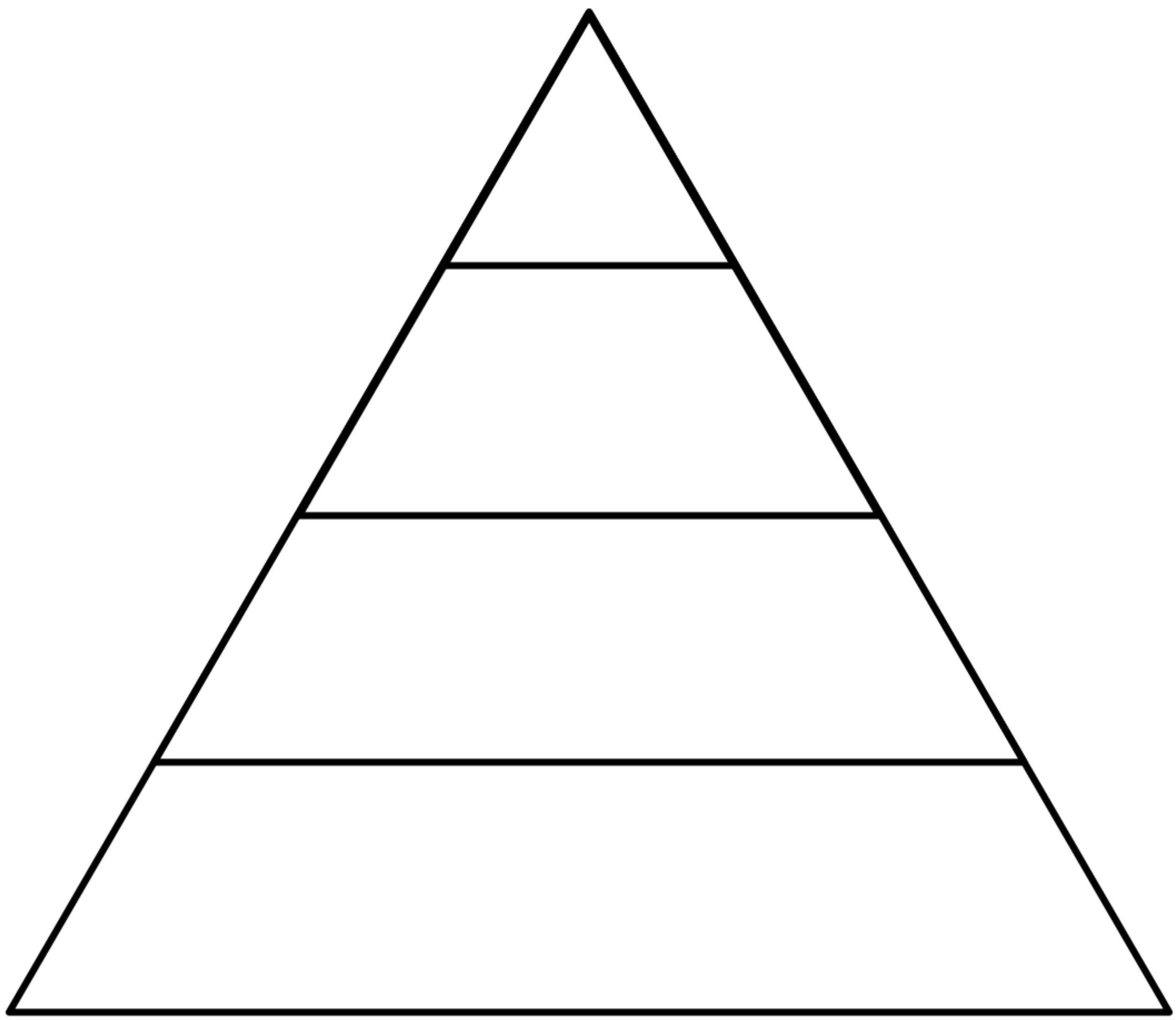
*-- G. Tyler Miller, Jr., American Chemist (1971)*




Only a small fraction of the energy available at any trophic level is transferred to the next trophic level. That fraction is estimated to be about 10 percent of the available energy. The other 90 percent of the energy is needed by organisms at that trophic level for living, growing, and reproducing.

This relationship is shown in the energy pyramid above. It suggests that for any food chain, the primary producer trophic level has the most energy and the top trophic level has the least.

1. Write the names of each organism from your food web in the correct level of the pyramid on the following page.



2. Assuming that your producer level has 3,500,000 kilocalories of energy/area, use the rule of 10 percent in energy transfer to calculate the amount of energy available at each consumer level. Write those numbers to the right of each trophic level in the pyramid. Show your calculations in the space below.

3. In one or two sentences, describe how the amount of available energy may affect the population sizes of organisms at different trophic levels.

## INTRODUCTION

Gorongosa National Park is a 1,570-square-mile protected area in Mozambique. Decades of war, ending in the 1990s, decimated the populations of many of Gorongosa's large animals, but thanks to a large-scale restoration effort some are now rebounding. Gorongosa's researchers are working to discover and catalog animal species in Gorongosa in order to track their recovery using remote trail cameras. To fulfill the restoration goals of Gorongosa, it is important for biologists to collect data on the current status of biodiversity in the park.

Biodiversity can be defined simply as the variety of life, but biodiversity can be studied at many levels, including genetic diversity, species diversity, and ecosystem diversity. High biodiversity is an indicator of ecological resilience, or the ability of an ecosystem to resist change or recover from disturbances. E.O. Wilson has championed the importance of assessing biodiversity and supports the work of conservation scientists like those working in Gorongosa National Park.

The high biodiversity of organisms found in Gorongosa is due, in part, to the different vegetation types, which characterize habitats, including grassland, limestone gorges, and savanna/woodland. Because biodiversity cannot easily be captured in a single number, there are various indices, or measurements, that when examined together provide a more comprehensive picture of biodiversity. In this activity you will calculate and analyze richness, Shannon diversity index, and evenness to compare the biodiversity of different habitats in Gorongosa using real data captured by trail cameras.

## PROCEDURES AND QUESTIONS

### Part 1: Introduction to Diversity Indices

Before measuring biodiversity using a large data set, like the trail camera data, you will be introduced to calculating richness, evenness, and the Shannon diversity index by hand using a small sample data set.

**Richness** (S) is the total number of species in an ecosystem. Richness does not take into account the number of individuals, proportion, or distribution of each species within the ecosystem.

1. Based on the species list below, what is the richness of this ecosystem?

   Species: Wildebeest, Warthog, Elephant, Zebra, Hippo, Impala, Lion, Baboon, Warbler, Crane

   S = ____________________

Richness alone misses an important component of species diversity: the abundance (number of individuals) of some species may be rare while others may be common. The **Shannon**

**diversity index** (H) accounts for species abundance by calculating the proportion of individuals of each species compared to the total number of individuals in the community ($P_i$).

$H = -SUM (P_i * ln(P_i))$
Where:
$P_i$ = species abundance/total abundance in the community
ln = natural log

For most ecosystems, the value for H ranges from 1.5 to 3.5, with the higher score being the most diverse.

2. Using the table below, calculate the total abundance in the community and the $P_i$ value for each species. Next, calculate the natural log of $P_i$ for each species ($ln(P_i)$) and then multiply the two columns to calculate $P_i * ln(P_i)$. Limit your numbers to 3 decimal places.

| Species | Abundance | $P_i$ | $ln(P_i)$ | $P_i * ln(P_i)$ |
|---|---|---|---|---|
| Wildebeest | 3 | | | |
| Warthog | 3 | | | |
| Elephant | 2 | | | |
| Zebra | 1 | | | |
| Hippo | 1 | | | |
| Impala | 4 | | | |
| Lion | 1 | | | |
| Baboon | 15 | | | |
| Warbler | 25 | | | |
| Crane | 18 | | | |
| **Total Abundance** | | | | |

3. Calculate H by adding each of the values in the $P_i * ln(P_i)$ column of the table above and taking the negative of that value.

   H = ___________________

**Evenness** (E) is a measurement to compare the abundances of each species in the community. Communities where the abundance of each species are more evenly represented are considered more diverse than communities where a few species are very common and other species are very rare. Low values indicate that one or a few species dominate, and high values indicate that all of the species in a community have similar abundances. Evenness values range from 0 to 1, with 0 signifying low evenness and 1, complete evenness.

$E = H/H_{MAX}$
Where:
H = Shannon Diversity Index
$H_{MAX}$ = the highest possible diversity value for the community (calculated by ln(richness))

4. Use the richness value you calculated in question 1 to calculate $H_{MAX}$.

   $H_{MAX}$ = ln(richness)) = ___________________

5. Use the Shannon diversity index value you calculated in question 3 and the $H_{MAX}$ value you calculated in question 4 to calculate E.

   $E = H/H_{MAX}$ = ___________________