

Lab #10: Food Webs and Community Dynamics

Objectives:

- Use data gathered from owl pellets to understand relationships between trophic levels and learn about energy pyramids.
- Explore community interactions using a case study from Yellowstone National Park.

General Procedures

- For Part 1: Food Webs (Owl pellet), you will work in groups of two.
- For Part 2: Community Dynamics (Yellowstone case study) you will work in groups of 3-4.

Part 1: Food Webs – Owl pellet study

General Introduction:

Trophic levels describe the feeding relationships within a community. A **food chain** is a diagram that shows the transfer of food energy up the trophic levels. There are several different trophic levels, starting with primary producers as the bottom of all food chains.

Primary producers (Autotrophs): - Use energy from the sun to make chemical energy.

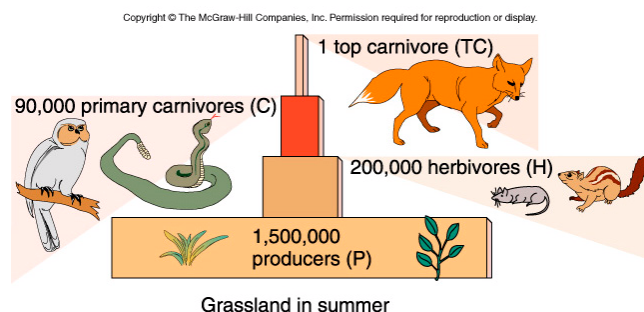
Primary productivity is the amount of light energy converted to chemical energy (organic compounds or biomass) by autotrophs during a given period of time

Consumers (Heterotrophs) - Feed on other organisms for energy and nutrients

- Primary consumers (**herbivores**) - eat primary producers
- Secondary consumers (**carnivores**) - eat herbivores
- Tertiary consumers (**carnivores**) - eat other carnivores
- Quaternary consumers (**top carnivores**) - eat other carnivores

Detritivores (decomposers) - eat dead organic material

In reality, food chains are more often found as **food webs**, with most interactions showing a web of connectivity rather than a direct chain. An important aspect of trophic level interactions produces an **energy pyramid**. Energy pyramids represent the **ecological efficiency** within a food chain, which is the amount of usable energy transferred from one trophic level to the next. The figure below shows an energy pyramid. It shows that a top carnivore (fox) needs to eat many more carnivores to survive over its lifetime. Each carnivore it eats needs to eat many more herbivores and the herbivores need to eat many more producers.

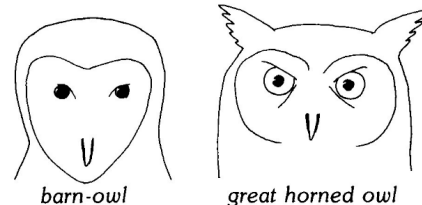


This is because, for every meal eaten by the fox, only a portion of that food goes to producing energy for the fox (cellular respiration) and only a portion goes to growth. The rest of it gets lost as heat in the transfer of energy and much also gets passed as waste products (feces), or is not digested at all (bones, etc). The same is true for every organism down the energy pyramid.

We will examine food chains (webs) by determining the prey of owls. Owls typically swallow their prey whole or in large pieces. Bird stomachs include an anterior pouch called the proventriculus and a muscular posterior portion called the gizzard. In owls, the gizzard compresses indigestible parts of their prey (hair, bones, teeth, and feathers) into matted pellets that pass into the proventriculus where they remain until something stimulates the owl to spit them out (regurgitate).

Pellets are not exclusive to owls. Hawks and related birds of prey also regurgitate undigested remains, and so do some gulls and herons. Even some robins have been seen ejecting parts of their food.

Scientists study pellets to discover any regional, seasonal, and habitat differences in owl prey. Pellets also reveal information about the relative numbers of small animals found in an owl's feeding area. The owl pellets used in our study will be from Barn owls, Great Horned owls, or Great Gray owls. The majority of the pellets are collected from the wild. These pellets have been autoclaved and are, therefore, sterile.



MATERIALS:

- Owl pellets (sterilized)
- Owl pellet bone charts for identification.
- Gloves
- Dissecting tools

CAUTION: Please let me know if you suffer from asthma or have strong allergies to animal hair. The animal hair found in many owl pellets could aggravate your condition.

PROCEDURE:

1. Find a lab partner.
2. Obtain an owl pellet from your instructor.
3. Select some dissection tools and gloves.
4. Carefully dissect your pellet.
5. Identify the bones and sort into different species, using the bone identification charts.

8. Looking at the histogram (bar graph), what can you say about the mammal population in our area?

9. Sketch a food chain, with an owl at the top, for our area. Label the chain (primary producer, etc.) Add in other organisms that would make this a food web rather than a food chain.

10. Using your data above, and making inferences for unknown data, construct an energy pyramid for the owls in our region.

Part 2: Community Dynamics - A Yellowstone Case Study

General Introduction:

The movie “Strange Days on Planet Earth: Predators” depicts the dynamic relationships within the Yellowstone National Park ecosystem. An **ecosystem** is a dynamic complex of plant, animal and micro-organism communities and their non-living (abiotic) environment interacting as a functional unit. A **community** is an assemblage of populations of different species living and interacting in a particular area at the same time. A **population** is a group of individuals from the same species living in a particular area at the same time. The Yellowstone community consists of interactions between populations of elk, wolves, aspen, willows, songbirds, beavers and many other species.

Species can interact in a number of ways. There can be competition between and within species for food or territory, predator/prey interactions, mutualisms and parasitism. In order to discuss the movie in this context, several terms need to be introduced.

A **dominant species** is the species within a community whose population is the most abundant or which has the highest biomass (total mass of all individuals in a population). Dominant species may control which other species are present in a community, due to species interactions like competition. Traits that may make a species dominant in one environment may not be competitive in another environment.

A **keystone species** is a species that has an exceptionally great impact on the other species in its ecosystem relative to its abundance. Keystone species are typically not the dominant species in an ecosystem, yet despite their low population numbers, they have a strong impact on the other species within a community.

A **foundation species**, also known as an “ecosystem engineer” is a species that plays a major role in shaping communities by creating and enhancing a habitat that benefits other species.

We also need to look at what factors affect the size and growth of a population. There are two main factors that determine how much a population can grow: biotic potential and environmental resistance. A species **biotic potential** is its capacity for growth. It contains such factors as how many offspring an individual can have, how often it can reproduce, how old it has to be before reproducing and how many of its offspring survive to reproduce themselves. If a population has plenty of food and space and no predators or illness, they will probably be reproducing at their maximum biotic potential and the rate of population growth will increase.

Carrying capacity is the maximum population of a given species that a particular habitat can sustain indefinitely without degrading the habitat. Species reproducing at their maximum biotic potential can exceed the carrying capacity of their environment. **Environmental resistance** is all the factors that act to limit the growth of a population. These can include predation, competition for limited resources (food, breeding sites), diseases and also abiotic (non-living) factors such as severe storms and droughts. Environmental resistance usually acts to keep a population under the carrying capacity, but factors that change the dynamics within a community can affect this.

5. b) Describe the population ecology of the elk prior to the reintroduction of wolves in terms of biotic potential and environmental resistance.

6. Do you think the elk population was above the carrying capacity of the Yellowstone environment prior to the reintroduction of wolves? Why or why not?

7. Using the axes provided, graph the population of elk and the population of wolves. Clearly label your lines to designate wolf or elk. Use the following data and the understanding of community dynamics gained from the movie:

Data: 1926 last wolf in Yellowstone killed
1926 1000 elk living in Yellowstone
1996 25 wolves reintroduced to Yellowstone



8. To the graph above, add a line representing the population of willow over time.