Enough is Enough

Real World Ecosystems
Backgrounder
Grade Level: 5-8

So far in this program, we have discovered **ecosystems** and the relationships that different kinds of **organisms** have with each other and with their physical **environment**. In this section, we will learn more about the factors that control the number of organisms that live within ecosystems.

Organizing Organisms

A population is defined as the number of organisms of a single **species** (a group of organisms that resemble and reproduce with each other) living within an ecosystem or **habitat**. For example, on Banks Island in Canada's High Arctic, there are estimated to be about 70,000 muskoxen. In another example, there may be a population of more than 500,000 red ants living in the habitat provided by a single fallen log.

It is a general rule in nature that the populations of very large organisms are usually small in number, while the populations of very small organisms such as ants or **bacteria** are very large. This rule applies to most kinds of organisms, including mammals, trees, birds, insects, and **microorganisms**. For example, a teaspoon of typical garden soil can contain as many as 1000 microscopic worms called nematodes. There may be trillions of nematodes in a single piece of wheat or cornfield. By contrast, the worldwide population of blue whales is estimated at around 25,000. Even before they were exploited by humans, they are thought never to have been greater than 228,000.

Estimating Populations

For some organisms, it is easy to get an accurate count of their numbers. For instance, it is very easy to count the number of trees in an ecosystem. Trees are usually large and easy to spot, and they always stay in one place. Other organisms, even large ones, can be difficult to count. For example, biologists have an extremely difficult time getting accurate counts of the numbers of grizzly bears in the province of Alberta. Can you think of reasons why this might be true?

One way to get an idea of how many organisms there are in a large area is to take a **representative sample** of its population. This means counting the number of individuals in a small area and using this number to estimate the size of the entire population, based on the size of the ecosystem. The sample of the population along with the size of its habitat must be carefully measured. The result will obviously be an estimate, hopefully, accurate enough to be useful for making decisions about the population. For example, a biologist wanted to know how many Saskatoon bushes there were in a forest that contained 3,6000 square metres. She set out some 10-square metre sample plots and determined that on average, there were roughly 2 Saskatoon plants in each square metre of the forest. This means that in this forest there are approximately 2 x 36,000 = 72,000 Saskatoon plants.

If each square represents one hectare and there are exactly 123 trees within each hectare, can you estimate the number of trees in this forest?

Populations can be described not only by their total numbers within an ecosystem or habitat but also by the way they are distributed within it. For instance, there may be hundreds of millions of ants in a forest, but in Alberta, they are most likely concentrated in colonies. Some animals tend to be widely spaced throughout the habitat. This is especially true of solitary predators such as bears and cougars. These animals need a lot of space and do not tolerate the presence of others of their own kind (except briefly during mating season).

An important aspect of distribution is **population density**. Population density is defined as the number of organisms per unit area or volume (square metre, hectare, square kilometre, cubic metre, etc.). For example, a certain mountain valley has an area of 250 square kilometres and is home to a population of pine martins numbering 560 in total. The density of this population is 560 ÷ 250 = 2.24 pine martins per square kilometre. Obviously, there are no fractions of a pine martin living anywhere, and the martins might not be evenly distributed in the valley. This number simply means that in any square kilometre area, you could expect to find between two and three pine martins.

The Biology of Multiplication

As far as we know, only humans can do algebra, but all organisms know how to multiply! In fact, the ability to have offspring is one of the most important traits shared by all living things. Some species, especially small organisms, such as insects and microorganisms, can multiply extremely rapidly. They often produce large numbers of young, most of which do not survive to adulthood. For example, most species of frogs produce hundreds, and sometimes thousands, of eggs. Once the eggs are laid, the parents abandon them, leaving the tadpoles to fend for themselves. The tadpoles are a favourite food for many pond predators, so only a few survive to become adult frogs.

Organisms that reproduce this way often experience large but short-lived changes in their populations. For example, Alberta has experienced several years of unusually warm, dry summers. Under these conditions, grasshoppers thrive and multiply rapidly and can reach epidemic proportions in just one season.

On the other hand, many large organisms, such as bison, whales, bears, and humans usually multiply more slowly. These organisms usually live a long time and have relatively small populations compared to other species. They have only one or two offspring at a time and mate once a year or less. These organisms generally take good care of their young and defend them when danger threatens. Populations of these organisms are usually far more stable than smaller, faster-reproducing animals.

Population Limits

Australia has a serious mouse problem. Every four years or so, the population of mice explodes in southeast Australia. Millions of mice overrun farms, where they feed on wheat and corn crops, attack livestock, ruin stored animal and human food, damage electrical equipment, and much more. The cost of these outbreaks runs in the hundreds of millions of dollars each year. Why do mouse populations do this?

There are many reasons why mice flourish in Australia. These include:

- **A favourable climate.** South Australia has a warm climate and very mild winters. Frosts are rare, and mice, which come from much colder climates, have little to fear from bad weather in Australia.

- **Abundant food.** House mice are able to eat a wide variety of foods and are not choosy.
- **Few predators.** Mice are not native to Australia. They arrived with the first white settlers who came to the country in the 1700s. None of Australia's native animals are capable of controlling mice populations.
- **Few diseases.** Again, because mice are such recent newcomers to Australia, there were no bacterial and viral diseases present in the country that could cause the mouse population to fall.
- **Humans.** House mice are well adapted to living with humans and are especially well suited to the environment created around a farm. As colonists settled and began changing the **landscape** in Australia, they created a new habitat favourable to mice.

Most natural populations of organisms are controlled by factors in their habitat. Those factors include the amount of space, food, the presence of predators or disease organisms, and many others. When the population increases to a certain point, greater numbers of individuals begin to die or are forced to leave.

Did You Know? Skin Home to Huge Bacteria Population

The population of naturally occurring bacteria on your skin is greater than the entire population of humans on planet Earth! There are even more bacteria living inside your large intestine.

The story about Australia highlights just four of the many different factors that control the populations of organisms and what can happen when those factors are not present. Other factors limiting populations include:

Space

Organisms need room to grow and carry out their life cycle. If there is not enough room for them, they begin to suffer symptoms of overcrowding, which can include stress, injuries from fighting, the rapid spread of diseases, among other things.

Food

Organisms must be able to find the right amount and kind of food in their habitat. Often, it is the supply of food that limits the growth of populations. As the population grows, the amount of food available gets smaller and the population begins to starve.

Diseases and Parasites

Diseases can be an important factor, especially when organisms are living in crowded conditions. Deadly diseases can spread rapidly, killing many, and sometimes all of the organisms in the population. Human populations in Europe were reduced dramatically by several "Great Plagues" that raged across the continent between five and six hundred years ago. About 25 million people died in Europe, a third of the entire population.

Weather, Climate, and Other Physical Conditions

Weather and climate are also very important population-limiting factors. Climate essentially determines where a species can live. The weather may affect the survival of young, or the ability of adults of the species to survive a winter. For example, in the spring of 2003 in Alberta, thousands of mountain bluebirds and tree sparrows died because a late snow eliminated the supply of insects at the beginning of the nesting season.

Predators

This is one of the most important population control factors, especially of herbivorous (plant-eating) animals. Predators can seriously reduce the size of an organism's population in an ecosystem. For instance, hares in Canada's boreal forest are the favourite prey of many predators, including wolverines, lynx, wolves, owls, hawks, cougars, coyotes, and others. Lynx, in particular, eats almost nothing but hares. It is estimated that only one in ten young hares survives long enough to produce young.

Immigration and Emigration

Immigration happens when animals move into an area, and **emigration** occurs when they leave. Here's an example: beavers typically raise three or four young each spring. Because the amount of food is limited in the pond or creek, young beavers are forced to leave to search for creeks or ponds with more food and fewer beavers. By mid-summer, young beavers are on the move, walking overland to find places to live. Leaving the area where they were born is an example of emigration.

Population Cycles

Certain species have populations that go through regular ups and downs. For instance, the population of hares in the boreal forest peaks every 7 to 10 years. In some years, the sighting of a single hare in the forest is a rare thing. In other years, they are so numerous that they strip the forest clean of all available food. In years when there are plenty of hares, their predators have lots of food and produce large numbers of young. The large population of predators takes a serious toll on the hare population, along with diseases and food shortages. The population of hares "crashes," and the predators then have to cope with several very lean years. In those years, they may produce very few young, and their populations begin to crash also. At a certain point, the forest has only small populations of both hares and predators of hares but is growing lots of plant food, making conditions ideal for the hares to make a come-back. The cycle begins again.
Population cycles affect a great many species, and not just in the boreal forest. Similar cycles are observed in many species of birds, rodents, amphibians, insects, and others. Among the insects of North America, those often noted for their population cycles include grasshoppers, forest tent caterpillars, and wasps.

Human Populations

Human populations have been on a steady and rapid increase for about 2000 years. Currently, the human population stands at about 7.9 billion people. It is set to reach 10 billion by the year 2055. No one really knows how large our population will get before it stops growing. There are concerns that humans will outgrow the Earth's ability to produce food, clean water, and other resources we need, and that conditions will become very poor for many countries around the world. In fact, this is already happening in places like East Africa, and parts of Asia. Despite all the efforts to provide these countries with humanitarian help, many million humans die of starvation and poverty-related diseases every year.

Wildlife Management

People have always relied on wild and domestic animals and plants for food, fibre, building materials, and other needs. In many cases, care was taken to limit the number of organisms collected in the wild, to protect the supply for everyone's benefit. This represents the earliest form of wildlife management. It was practiced by indigenous people around the world long before the science of wildlife management became recognized.

One of the most important things wildlife managers need to know is the size of the population of the species they are trying to manage. The problem is, how do you count the number of wild animals living in a habitat? For big animals that live in wide-open places where they can easily be seen, this isn't too hard to do. But for animals that live well hidden, such as in dense forests or in lakes, this can be a real problem.

One way to estimate the population of wild animals is the "mark and recapture" method. To do this, the biologist catches a number of animals from the wild population, marks them with a harmless tag, and returns them to the wild. Later, the biologist returns and captures more animals from the same habitat. He or she counts the number of marked and unmarked animals in the sample. The ratio between marked and unmarked animals tells the biologist something about the size of the population.

For example, let's say a fish biologist uses a net to capture 250 trout from a lake. The fish are marked and released unharmed. On her return, the biologist nets another sample, this time of 320 fish. Examining all the fish in her sample, she observes that 10 have the mark she placed on them earlier. This tells her that approximately 1 in 32 fish in this lake were marked. Given that there were 250 fish in the lake with the mark, there must be around 8,000 fish in the lake in total (250 x 32).

In modern times, wildlife management has become a highly refined science. Biologists who study wildlife to go extremes to learn about the size of wildlife populations, their patterns of movement or migration, their sources of food, causes of death, and other factors that control their populations. This information is used to set regulations that restrict the number of animals or plants that can be harvested from the wild or to protect their habitat. Wildlife managers often work closely with enforcement officers to be sure people are obeying the rules and regulations.

Wildlife biologists have a range of new high-tech tools to help them understand animal populations better. These include radio-tracking by satellite, identification of individual animals using genetic engineering techniques, and surveillance of **nocturnal** animals (active at night) with starlight or infrared cameras. Armed with this knowledge, they can make better decisions to help protect those species from unnecessary human impacts.

Sometimes, protecting a species is as simple as making sure it has adequate habitat. Much has been learned about how much habitat is needed by animals and plants to guarantee their survival. Biologists aim to provide all organisms with enough habitat to meet their needs. The Province of Alberta maintains a system of parks and natural areas where it is hoped most of Alberta's plant and animal species will find places to live.

The total collapse of the cod fishing industry on Canada's east coast is an example of how a failure to carefully control the amount of fish caught each year led to codfish being nearly wiped out. In the 1600s northern cod were so plentiful off the east coast that it was rumoured ships were slowed down by the sheer numbers of fish in the water. Now, cod has become so rare that they appear to be in danger of **extinction**.

The Canadian government declared a halt to all fishing of northern cod in 1992. Consequently, many fishing communities on the coast have lost their main source of income and are facing a bleak future unless northern cod populations return.

What happened to the northern cod? According to marine scientists, the answer is over-fishing. In the early years of the cod fishing industry, techniques were fairly primitive and did not harvest enough of the total population of fish to hurt it much. But as time went on, larger and larger numbers of fishing boats operated the fishing grounds each year, using ever-better technology. Recent inventions such as fish-finding sonar and global positioning satellites have made it possible to track down schools of fish over greater distances. The codfish were being harvested far faster than they could reproduce. The result was a crash in their populations in the Atlantic. It could take more than a decade for northern cod to return to healthy numbers.

When a population is lost from an ecosystem, we say it has been "**extirpated**". This does not mean that is extinct. It means simply that a species is no longer found within an ecosystem that it once inhabited, but it may still be found elsewhere. For example, the grizzly bear once roamed most of the western half of North America from Mexico to Alaska, and most of the prairies as far east as the Mississippi River in the US. Now, it has been extirpated throughout most of its former territory and lives in a few isolated pockets, mostly in the mountain parks of the United States and Canada. Wildlife managers are very concerned about species like the grizzly and are working hard to ensure they do not become extinct.

Did You Know? Humans Have History!

Anthropologists believe that humans lived as hunter-gatherers until 8,000 B.C. Anthropologists estimate that the population was about 5 million. When agriculture was invented, more people could be supported, so the population increased to about 500 million in A.D. 1650. Over the next 200 years, the human population doubled to 1 billion by 1850. With medical advancement, the death rate began to drop and the world population reached 2 billion in 1930. So, like animal populations, we also have a history.

Green Thumb: Help! I've Got Fruit Flies!

If you have an indoor composter, a vermicomposter, indoor plants or rotten fruit in your locker, you may have fruit flies. The scientific name for a fruit fly is *Drosophila melanogaster*. It means "black-bellied dew lover." They are only a few millimetres long and can have up to 100 offspring each time. A new generation can be produced every two weeks! So what do you do if you are under attack? Here are some tips to reduce the pesky *Drosophila melanogaster* population:

- Buy special fruit fly sticky papers for your plants. You can find them in the gardening section of department stores. They consist of a little plastic stick and a yellow loop of sticky paper.
- Keep drain covers over sink drains. Fruit flies can live off of the scum in your drains.
- Fill a cap-full of pop or sugar water. Set your trap in areas where you see them flying around. The cap-full of the sugary treat can also be easily set in potted plants.
- Clean up and get rid of whatever is rotting!

Key Points to Remember

- A population is a group of organisms of one species living within a single ecosystem.
- Most large organisms reproduce slowly and have small populations within ecosystems. On the other hand, organisms that are very small in size often have very large populations and have the ability to reproduce very rapidly.
- Populations are described in terms of simple numbers, population density (number of organisms per unit area or volume), and by their distribution within the habitat.
- The size of populations in the wild are controlled by factors such as climate and weather, competition, predators, the amount of food, diseases, and others.
- The populations of some organisms go through periodic booms and busts, or cycles.
- When a population of organisms is completely eliminated from an ecosystem, it is said to be extirpated.
- The world's population of humans is increasing very rapidly and may reach 10 billion individuals by the year 2055.
- Populations of some wild species have been managed to control their numbers and ensure they are not over-harvested.

Think About...

- What would happen to a population that has lots of food but too little space? For instance, what would happen if you kept mice in a big cage and fed them all the food and water they could eat?
- Some biologists think that by continuing to allow the hunting of grizzly bears in Alberta, we could totally wipe them out here. They say that if their numbers fall to a few hundred animals, even if no more are hunted, they could still disappear. Why?
- What are the factors that determine the size of a population of humans living in a town?