

ARCTIC MARINE SCIENCE CURRICULUM

MODULE 2

ECOSYSTEM PRINCIPLES

STUDENT GUIDE

2001

Prepared for:
Fisheries and Oceans Canada
Northwest Territories Dept. of Education, Culture and Employment
Nunavut Department of Education
Yukon Department of Education

Prepared by:
AIMM North Heritage Tourism Consulting
with
Prairie Sea Services, Bufo Incorporated and Adrian Schimnowski

MODULE 2

STUDENT GUIDE

TABLE OF CONTENTS

INTRODUCTION: ENVIRONMENTAL VIEWS AND VALUES	1
1.1 FLOW OF ENERGY THROUGH AN ECOSYSTEM	3
1.2 BIOACCUMULATION	14
1.3 BIODIVERSITY.....	17
1.4 BIOGEOCHEMICAL CYCLES	20
1.5 PERSPECTIVES.....	26
GLOSSARY	28

INTRODUCTION: ENVIRONMENTAL VIEWS AND VALUES - THE IMPORTANCE OF RESPECT

The word respect is key to understanding wildlife and environment. If there is no respect then environmental problems arise. Everything in the environment has a place and use by people and wildlife. So, damage to any of these causes problems.

*Lucassie Arragutainaq,
Sanikiluaq*

When something in the environment changes you follow the change and look at the area where the change is occurring because when one thing changes everything around it also changes and we, as people, have to change along with it. Respect for the environment, therefore, is very important because it guides us in how we treat the environment. We know that lack of respect can cause a lot of changes.

*Lucassie Arragutainaq,
Sanikiluaq*

We, as aboriginal people, are part of the land and water... we recognize and respect the delicate balance of nature for the total existence of all living things including those we see physically, and those we don't. The Creator gave us that understanding and knowledge to visualize the harmonious relationships we have with our lands and water... Our Elders and Ancestors taught us ways to survive in co-existence with our environment. ...Once these natural processes are disturbed and denied their natural flow, the aboriginal people of this country are adversely affected... Taking away the land and water takes away our pride, dignity and ability to survive.

*Donald Saunders,
York Landing*

We have been told from our Ancestors that all the animals have to be treated properly. Even small animals that live on this planet serve a purpose. Flies, for instance, are annoying but their purpose is to clean up. The shrimp eat decaying matter, and serve as cleaning agents in the sea.

*Eli Kimaliardjuk,
Chesterfield Inlet; Jack Angoo,
Whale Cove*

Source: Voices from the Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay Bioregion, Canadian Arctic Resources Committee, Environmental Committee of Municipality of Sanikiluaq, 1997.

The Dene Elders have said that the land, Mother Earth, is life itself. If life is to continue, the land must be cared for. Students will understand the importance and meaning of their relationship to the land. The land has meant life and death to the people. ... The Elders see that the children must become keepers of the land. Children must be given love of the land. From love will come respect, care, a sense of responsibility, a pride of tribe and homeland, and identification with the ideals connected to it.

Source: Dene Kede Education: A Dene Perspective, Northwest Territories Education, Culture and Employment, 1993.

E Check Your Understanding

1. The quotes provided reflect values and beliefs. What are some values and beliefs you hold?
2. Use a few statements to summarize the values and beliefs towards the natural environment presented in the quotes.
3. Do people in your community hold similar values toward the environment? If not, why not?
4. What are your values and beliefs about the environment? How are they similar/different from the people in your community?

1.1 FLOW OF ENERGY THROUGH AN ECOSYSTEM

Food Chains and Food Webs

Cree and Inuit observe and respect a natural order of relationships connecting the largest animals to the smallest organisms. Residents of the Hudson Bay bioregion identified 138 animal and 36 plant types: 4 types of marine plants, 10 different sea-bottom animals, 11 sea mammal species, 6 species of marine fish, 14 sea birds, 7 ducks, 9 waterfowl, 21 freshwater fish, 30 land birds, 16 fur-bearing animals, 14 land animals, 17 types of berries, and 15 plant species.

Source: Voices from the Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay Bioregion, Canadian Arctic Resources Committee, Environmental Committee of Municipality of Sanikiluaq, 1997.

In order for organisms to feed, grow and reproduce, they require energy. An **ecosystem** is a group of living organisms that, along with their abiotic (non-living) environment, form a self-regulating system through which energy and materials are transferred. The "fuel" for ecosystems is energy from the Sun. Sunlight is captured by green plants during photosynthesis and stored as chemical energy. The energy passes through the ecosystem from species to species where **herbivores** eat plants and **carnivores** eat the herbivores. All organisms, dead or alive, are potential sources of food energy for other organisms and their interactions can be described as **food chains**. For example:

sun → grass → rabbit → fox

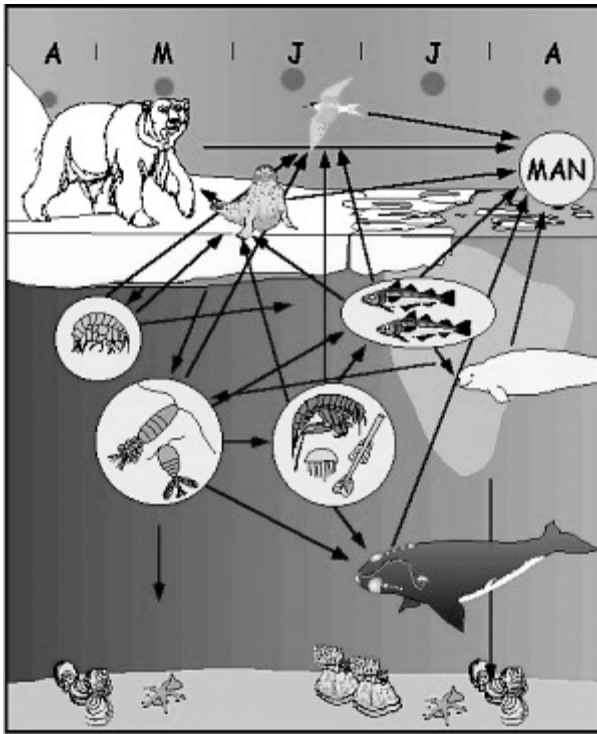


Figure 1: Arctic Marine Food Web

Source:
NOW Northwater
Polynya Website

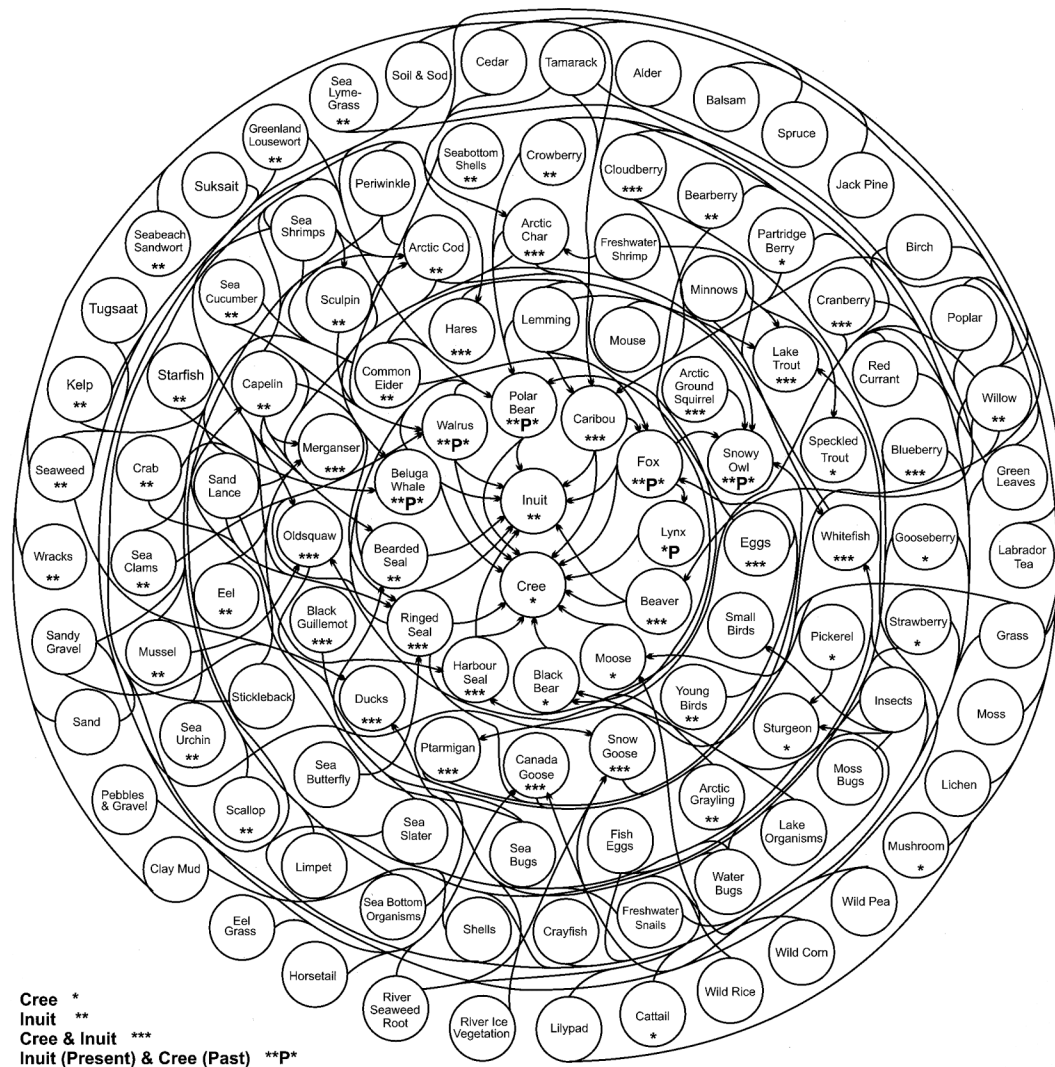
Each link in a food chain is referred to as a **trophic level**. The **primary producers** (green plants) are always the first trophic level, the herbivore (**primary consumers**) is the second trophic level, and the carnivores form the upper levels (**secondary and tertiary consumers**). To maintain an ecosystem, there must be a continual input of energy from the Sun.

Remember that animals can be at different trophic levels at the same time. For example, the simplest model says that Primary Consumers eat plants, Secondary Consumers eat plant-eaters, and Tertiary Consumers eat Secondary Consumers. This works well in a marine environment if you pick the following example:

Phytoplankton → Zooplankton → Arctic Cod → Ringed Seal → Polar Bear

However, it is not that simple. Polar bears, for example, are the most carnivorous of bears but they are really omnivores that eat plants as well as meat. They dive for kelp and in late summer when the ice is nearly all melted, they enjoy berries, sedges and grasses as much as grizzlies.

Feeding relationships are rarely simple and linear, as illustrated by a food chain. They are more often complex and branching with interrelationships among organisms, as is illustrated by the following **food web**:



Source: Hudson Bay Programme, *Traditional Ecological Knowledge of Environmental Changes in Hudson and James Bays, Part I*. (Ottawa: HBP, 1995), 26.

Figure 2: Hudson Bay Food Web

Source:
 Voices from the Bay

E Check Your Understanding

1. What is the source of energy for an ecosystem?
2. How does this energy enter the ecosystem?
3. Distinguish between producers and consumers.
4. Why is looking at food chains helpful when studying an ecosystem? Why does a food chain present an incomplete picture of the interactions within an ecosystem?
5. Suppose that volcanic eruptions send tonnes of particles high into the atmosphere. The particles create clouds of dust that filter out part of the sunlight for a period of one year. Explain what might happen to various organisms in an ecosystem following this event.

Flow of Energy

Scientists studying ecosystems have questions such as:

"Does one ecosystem hold more energy than another?"

"How is energy storied and transferred within an ecosystem?"

"How does energy leave an ecosystem?"

These questions are important because the energy that is captured by plants through photosynthesis determines the amount of energy that is available for all the other organisms in the ecosystem, including humans.

The energy from the sun that plants used originally to make their own food gets transferred to the various levels of consumers. Most of the energy that enters each trophic level is used by the organism at that level just to stay alive. Think about this concept:

If you eat 0.5 kg of food in one day, would your mass increase by 0.5 kg?

The answer is NO. Very little of the energy from that food is added to your body tissue. Almost half of this energy is used and given off as heat. Most of the rest is used for movement, digestion, thinking, and growing. Even sleeping, blinking and smiling require energy!

Figure 3 illustrates what happens to 100 kilojoules (kJ) of plant energy eaten by a mouse.

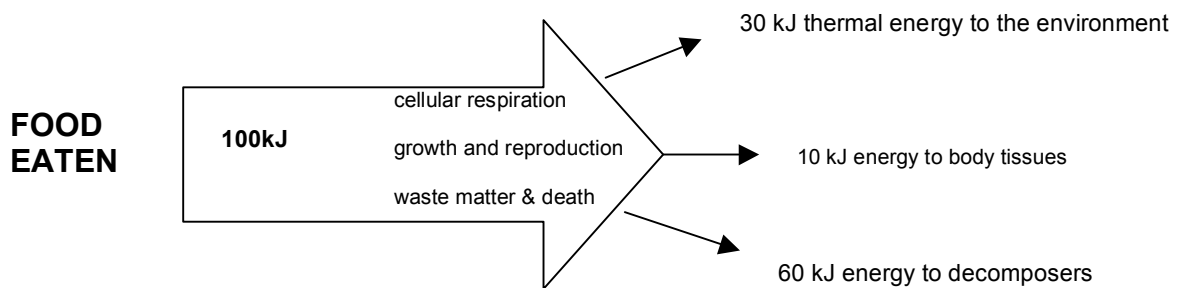


Figure 3: What Happens to Food Energy?

Source: SciencePower 10, McGraw-Hill Ryerson,

If a fox eats a mouse, at the next trophic level the amount of energy that is transferred would average 10%. Organisms that don't get eaten transfer their energy to scavengers (organisms that feed on the dead bodies of animals), and decomposers such as bacteria and fungi who break down the body.

Because of the loss of energy that happens at each trophic level, it is clear that the greatest amount of energy is in the first trophic level – the producers. They use energy directly from the Sun. In the second level there is less energy available, in the third trophic level there is still less energy, etc. Generally, the size of organisms increases as you travel up the pyramid. The following pyramid of energy represents a river ecosystem and illustrates this concept. (The figures represent net production at each trophic level expressed in kcal/m²/yr.)

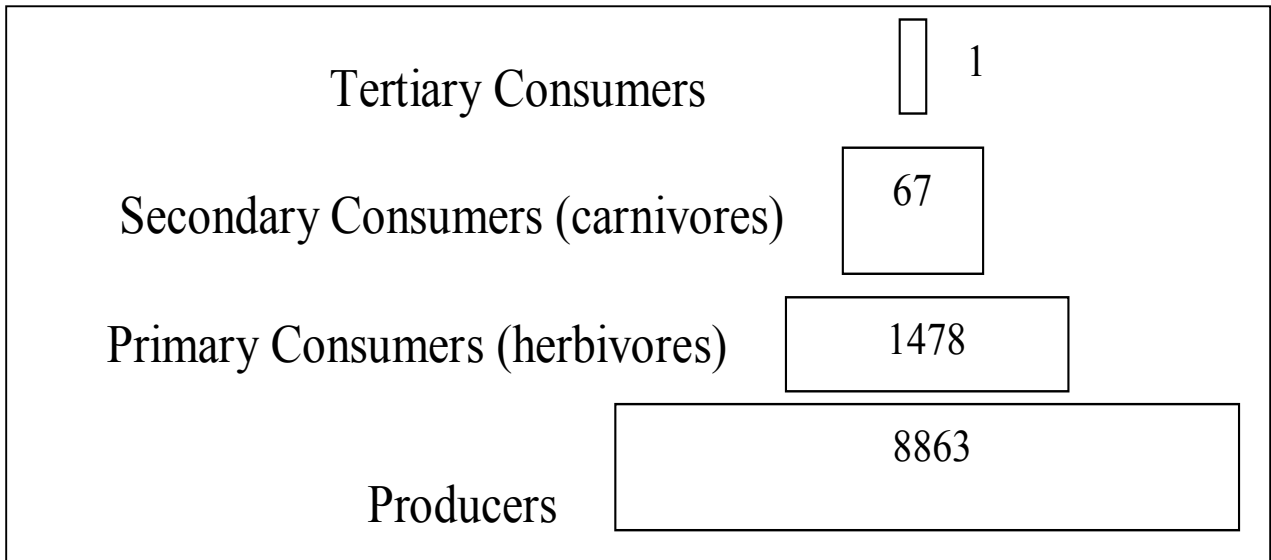


Figure 4: Energy Pyramid

The amount of energy in a population can also be measured in another way, a way that takes into account the size of the organisms. This measure, called **biomass**, indicates how much of a particular organism there is in an ecosystem. Biomass is often calculated as the total dry mass of a given population. In general, it is a good indicator of the amount of energy that is present in living matter. A pyramid of biomass shows that biomass decreases from each trophic level to the one above. The following pyramid of biomass represents the same river ecosystem as previously mentioned.

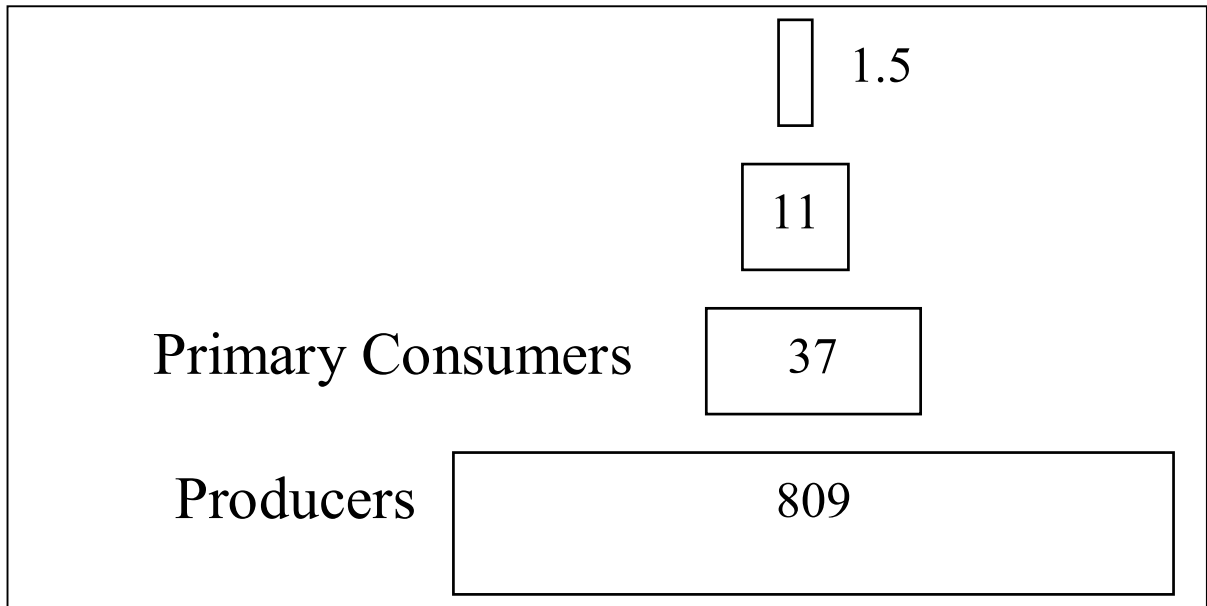


Figure 5: Biomass Pyramid

Usually, the biomass decreases from each trophic level to the one above, as shown above. However, there are important exceptions to this pattern. For example, the producers in an ocean ecosystem are microscopic algae. These plant organisms are food for the masses of small animals called zooplankton. At any given time, the biomass of the zooplankton may be greater than the biomass of the algae they are eating, resulting in a reversed pyramid.

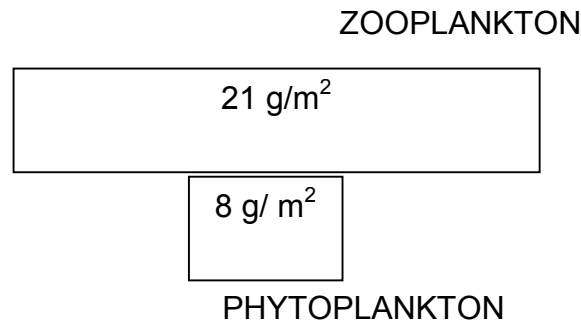


Figure 6: Inverted Pyramid of Biomass for an Ocean Ecosystem

You may wonder why this type of ecosystem does not collapse. The answer lies in the fact that the algae grow and reproduce at a much faster rate than the zooplankton. Because they reproduce as fast as they are eaten, they produce enough energy to support a larger population of zooplankton. There is a similar relationship between the biomass and reproductive rate of the zooplankton and the fish that feed on them.

Ecosystem Productivity

Productivity refers to the average amount of new plant biomass produced each year per unit area. Areas of high productivity in oceans occur along coasts where there are upwellings. These upwellings transport nutrients to the photic zone, the uppermost layer of a body of water (approximately 100m) that receives enough sunlight to permit photosynthesis to take place. Primary production by plants forms the first link in the food chains that link plants, herbivorous animals, and carnivorous animals. Together they make up the total production of the ocean. Where there is high primary production there are large populations of animals.

The main limit to productivity in Arctic Ocean is the limited time period each year when there is open water for phytoplankton to photosynthesize. The limiting factor is light, but even during the ice-on period ice-algae grows underneath the ice. The growth of ice-algae and the community that develops around it are very important to the overall productivity of the Arctic Ocean.

The most numerous and greatest marine biomass of herbivores in marine ecosystems are the plant-eating **zooplankton**. These animals are the primary consumers that convert plant tissue to animal tissue. In turn, they become the food for the other zooplankton, the carnivores or secondary consumers.

How do we measure productivity? We can do it through satellite imagery, by testing the air and water for their chemical components, or by measuring certain indicators e.g. abundance of phytoplankton. We can crudely measure the productivity of an ecosystem by biodiversity: how many different living organisms can it support? Or we could estimate the sheer volume of life in an ecosystem – its biomass. A large biomass is a clear indicator of high productivity.

Scientists study and compare the productivity of various ecosystems. The following table shows the

net productivity of a variety of ecosystems in units called kilocalories. (Remember that 1 kilocalorie is the amount of heat needed to warm 1 kg of water 1 degree Celsius.)

Tropical rain forest	15,000
Tall-grass prairie	2,000
Coastal marsh	12,000
Open ocean	800
Ocean close to shore	2,500
Field of grain	15,000
Lawn	6,800

*Figure 7: Estimated Net Productivity of Certain Ecosystems
(in kilocalories/m²/year)*

Source: *Ecosystem Productivity*
<http://www.ultranet.com/~jkimball/BiologyPages/W/Welcome.html>

E Check Your Understanding

1. Give an example of an organism at the second trophic level and one at the third trophic level.
2. Which would you expect to have a greater biomass, a population of sculpin or a population of beluga whale living in the same ocean ecosystem? Explain your answer.
3. Referring to the table "*Estimated Net Productivity of Certain Ecosystems (in kilocalories/m²/year*", why might there be such a difference in productivity between the open ocean, the ocean close to shore, and the coastal marsh?
4. What is the main producer in the Arctic Marine ecosystem?
5. What is type of organism is the most numerous herbivore in the Arctic Marine ecosystem?
6. Why is the productivity of the Arctic Ocean less than that of oceans elsewhere on Earth?
7. If Ecosystem B has 2X the plant biomass of Ecosystem A, which ecosystem has the largest population of consumers? Give reasons for your answers.

1.2 BIOACCUMULATION

The DDT Story

The risks of using powerful pesticides in ecosystems first became widely known during the 1950s and 1960s, when the toxic effects of insecticide DDT were recorded. DDT was one of the first and most powerful insecticides developed. During World War II, it was used to control populations of insects (such as body lice, fleas, and mosquitoes) that can transmit deadly diseases to people. As a result, the rate of death from malaria, bubonic plague, typhus, and yellow fever fell dramatically. DDT was also used widely on crops to control damage caused by insect pests.

In 1962, biologist and writer Rachel Carson published a book entitled *Silent Spring*, which described how pesticides had spread through the environment. As a result of her scientific evidence and the demands from an alarmed public, the use of DDT was restricted in Canada after 1969.

About ten years after the first use of DDT, signs of trouble appeared. Dead birds, fish, frogs, and other animals were found in areas that had been heavily sprayed with DDT. The fat in their bodies contained high levels of the insecticide. Harmless or beneficial insects, such as butterflies and honeybees, also started to disappear from areas that had been sprayed.

Tests of soil and water showed that DDT remained in the environment for many years. For examples, DDT was still found in the soil of some heavily sprayed orchards ten years after spraying was stopped.

DDT was also found in the bodies of many different organisms in areas around the world where the insecticide had never been used. It also began showing up in the tissues of people.

An unexpected outcome of using DDT was its effect on population of birds of prey. Numbers of hawks, eagles, and osprey on farmlands across North America and Europe fell sharply during the 1950s and 1960s. Scientists discovered that DDT reduced the ability of these birds to produce normal eggshells. Affected birds laid eggs with thin shells that broke in

Polar Bears and Pollution

Polluted Air from Eurasia migrates to the Eurasian Arctic. North American air pollution tends toward Canada, Greenland, and the North Atlantic, leaving the North American Arctic cleaner by comparison. However, the pristine nature of the entire Arctic Region is increasingly being undermined. For instance, the pesticide toxaphene, once used on cotton – a distinctively non-Arctic commodity – has been blown by air currents into Arctic regions. Acid rain also threatens.

Polychlorinated biphenyls (PCBs), heavy metals such as mercury, and radioactive waste travel by water from the former Soviet Union's rivers and the Siberian seas to Arctic coasts. Oil spills have given Siberian coastal waters a greater pollution content than North Sea waters. The search for more sources of Alaskan oil pits environment concerns against modern civilization's dependence upon petroleum fuels. As a result, the environmental watchdog group Greenpeace served a citizens/s arrest warrant to the ARCO oil company regarding the placement of that company's oil drilling platform offshore from the Arctic National Wildlife Refuge. Other voices assert that oil companies take great pains to minimally impact their work areas.

the nest, so they were unable to produce the usual numbers of young.

The adult birds had accumulated DDT in their bodies from the fish they ate. The amount of DDT had accumulated in the bodies of organisms, moving from producers to primary consumers, to secondary consumers, and so on. This process is called biological magnification, or **bioaccumulation**. Eventually concentrations of DDT became large enough in birds of prey to affect their reproduction.

Unfortunately, DDT continues to be used in some countries because it is such an effective pesticide. It not only affects species that live in these countries but also species that live elsewhere in the world, including people who consume good products imported from the tropics.

Source:
SciencePower 10,
McGraw-Hill Ryerson, 2000

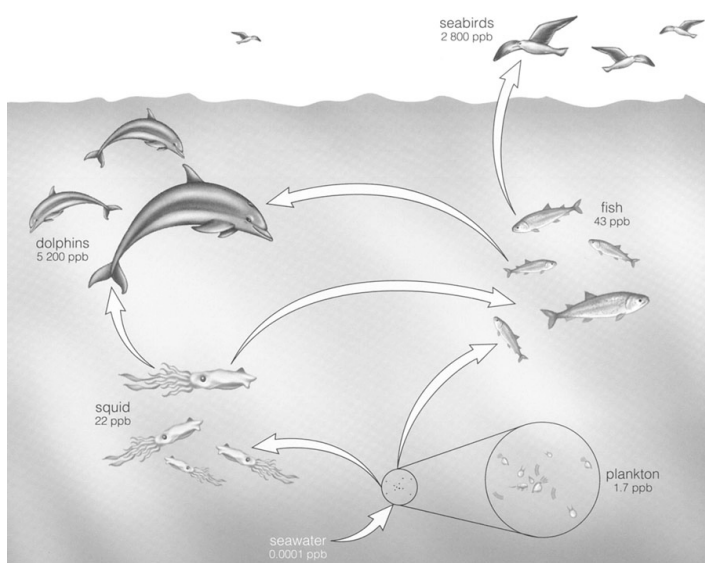


Figure 8: DDT in North Pacific

Source:
SciencePower,
McGraw-Hill Ryerson, 2001

Polar Bears and Pollution

continued...

The environmental stability of mercury and PCBs allows these substances to accumulate in living organisms. Those species at the top of the food chain have the largest concentrations of these pollutants. Because of its position at the top of the Arctic food chain, the polar bear, *Ursus maritimus*, has become a reservoir for environmental pollutants. *U. maritimus* may decide the extent to which the Arctic can support development by predicting the sensitivity of the Arctic Ecosystem to encroaching pollutants.

PCBs were used commercially without restraint for 50 years, and as a result are now found in polar bear fat. Less fat soluble than PCBs, mercury and its compounds concentrate in kidney, liver, and muscle tissue in polar bears. Because of our similar position in the food chain, humans also carry the burden of unwanted accumulated toxins. In the Canadian Arctic, Inuit women have more PCBs in their breast milk than do women of southern Quebec. A relationship has been proposed linking high breast milk PCB levels to acute ear infections in Inuit infants.

Source: *Polar Bears - Pollution of Polar Bear Arctic Marine Environment,*
by Alan Bruzel, 07/27/98
Found in: *About Chemistry*
<http://chemistry.about.com/science/chemistry>

Study the food web in *Figure 8*. Below the name of each organism is a number that indicates the amount of DDT in the organism's tissues, in parts per billion (ppb). One ppb is equivalent to 1 mg/100L. Use the food web and the information from The DDT Story to answer the following questions:

E Check Your Understanding

1. How does DDT enter a food web?
2. Which organisms contain the most DDT?
3. At what trophic level are these species?
4. What is the relationship between the trophic level of an organism and the concentration of DDT in its body?
5. How many times greater is the concentration of DDT in the fish than in the seawater? How many times greater is it in the dolphin than in the seawater?
6. Explain why animals at the top of a food chain are particularly at risk from poisons in the environment.

1.3 BIODIVERSITY

Many teenagers want to be like their peers. Students avoid being different but, as we know, being different in nature often ensures survival, especially one species in competition with others for the same food.

Biodiversity contributes to the stability of the ecosystem.

Species are disappearing at an alarming rate. From the graph below, it can be clearly seen that the rate of **extinction** is accelerating rapidly. It has now been estimated that one species will become extinct every 30 minutes.

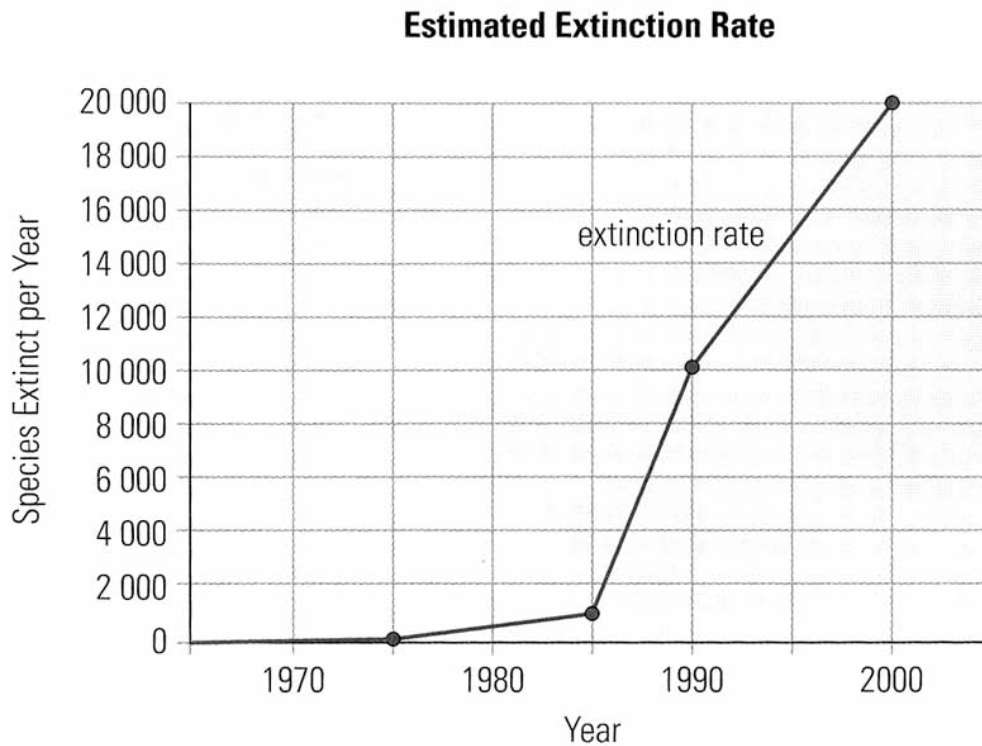


Figure 9: Rates of Extinction

Source:
Nelson Science 10,
Nelson Thomson Learning, 2001

Since every organism in an ecosystem is connected to all other organisms, the extinction of one organism in the food chain can have an impact on the complete chain. The removal of a predator by extinction then allows the lower trophic level to become unregulated and a population explosion can occur. A good example is the case of the sea otter on the West Coast of Canada. Commercial fishermen began to catch and kill sea otters, which they believed were responsible for the reduction of their fish catch. This reduction in the number of sea otters caused an alarming increase in the number of sea urchins that the sea otters eat as part of their diet. This increase in sea urchins caused the decimation of the bull kelp around the West Coast. The primary food of sea urchins is bull kelp. Only after careful study by biologists was the reason for the kelp loss discovered. The loss of kelp, in turn, could be a contributing factor to the reduced fish catches.

In its simplest terms, biodiversity is a measure of the variety of species found on Earth. Why should we conserve biodiversity? A few reasons include:

1. Ethical and moral argument: the extinction of any species diminishes the environment in both real and intangible ways, and diminishes the human species.
2. Aesthetic and Recreational Potential. Diversity is essential to humankind's general view of its place in the world, and the well-being of individuals.
3. Ecological Impact. Simplification of complex ecosystems leads to lack of stability and loss of productivity. Environmental degradation may trigger environmental disasters, make a disaster worse, or impact biodiversity and then trigger other effects.
4. Economic Impact:
 - a. Gene banking is important to maintain genetic diversity. (e.g. if there were only one type of wheat and a disease wiped it out, we would be unable to develop another type)
 - b. Undiscovered resources such as new medicines – e.g. Taxol (cancer fighting drug)

Did You Know ...

There are many definitions of biodiversity. Many explain different scales or levels of variety, for example:

“Biodiversity is the degree of nature's variety, including both the number and frequency of ecosystems, species, or genes in a given assemblage.”

J. A. McNealey

E Check your Understanding

Discuss the following questions with a classmate and then answer them in your notebook. Be prepared to discuss these questions in class.

1. How important to your community is the study of ecology and why?
2. What effect can the general public have on the conservation of our environment? What might you be able to do as an individual; as a class or a school?
3. How does traditional knowledge relate to conservation today?
4. What are some of the major pollutants in your community?
5. What is being done to control these pollutants?
6. Project what the rate of extinction might be in 2010 for species per year. Justify your answer
7. List two species that have become extinct in the Arctic.

1.4 BIOGEOCHEMICAL CYCLES

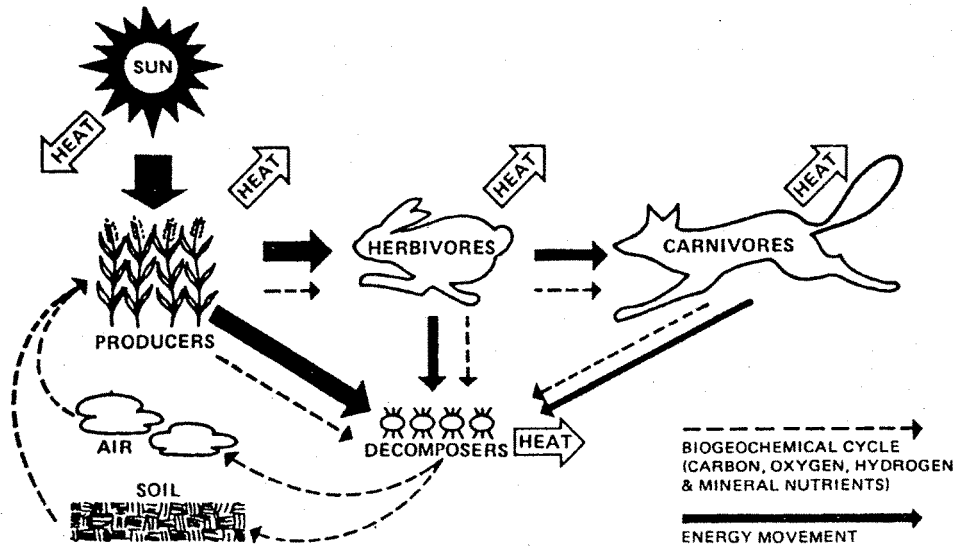


Figure 10: Biogeochemical Cycles

Source:
 Discover Habitats,
 Communities and Ecosystems,
 Exclusive Educational Products,
 1000

Earth is often referred to as a "closed system". This is because there is little or no new materials that enter from outside the system. In order for life to continue, the materials, or nutrients that are present must be constantly recycled. Organisms such as decomposers help in this recycling by breaking down dead plant matter to the nutrients can be used again. There are several cycles that are a part of this overall recycling of nutrients, referred to as **biogeochemical cycles**. In this section we will examine some of those cycles, focusing on carbon, nitrogen and silicates as they cycle through the environment.

THE CARBON CYCLE

Carbon can be found in the atmosphere and dissolved in the oceans as part of inorganic carbon dioxide (CO₂). It is the key element for living things. During **photosynthesis**, plants take carbon from the atmosphere (as carbon dioxide) and combine it with water to make carbohydrates. Some of the carbon in the carbohydrates is later used to make other carbon compounds such as fats and proteins. When consumers eat the plants, the carbon compounds

Did You Know...

Energy from the sun is also needed to sustain life on Earth. This energy is transformed and passed along through the food chain, **BUT IT IS NOT RECYCLED**. There must be continual replacement of this energy in order for life to be sustained.

are broken down and recombined to build animal tissues, moving carbon through the food chain. Each year, about 50 to 70 billions tonnes of carbon from **inorganic** carbon dioxide are cycled into these more complex **organic** compounds.

Photosynthesis occurs in a series of complex reactions but is easily summarized in the reaction below:

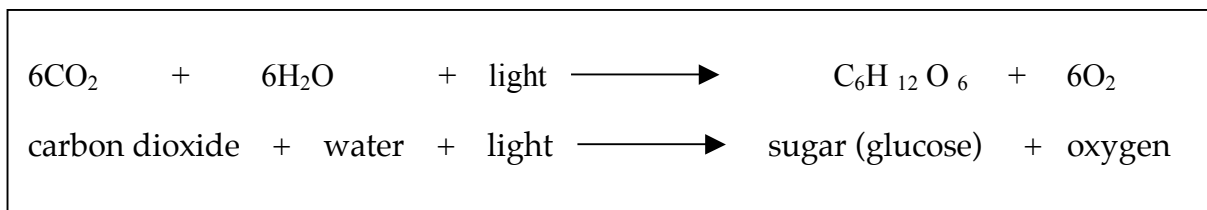


Figure 11: Photosynthesis Energy Flow

Cells, which are a part of all living organisms, carry out a process called **cellular respiration** as part of their normal functioning. Some of the organic carbon in the form of glucose is released back to the environment through cellular respiration as carbon dioxide. This reaction is summarized in *Figure 12*.

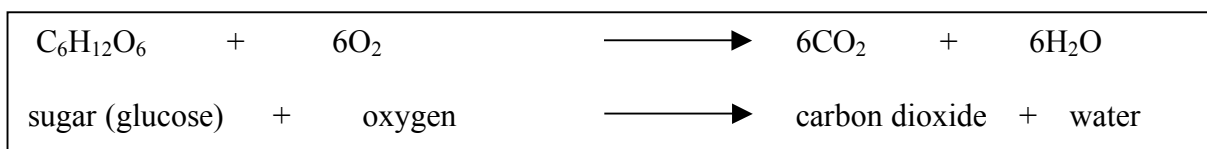


Figure 12: Cellular Respiration Energy Flow

You should recognize from the equations, that photosynthesis and cellular respiration are identical, yet reversed processes that result in the cycling of carbon. The products of photosynthesis are the reactants for cellular respiration, and the products of cellular respiration are the reactants for photosynthesis. The combined processes are referred to as the **carbon cycle**.

Much of the carbon cycle actually takes place in aquatic ecosystems. The world's oceans and lakes hold over 50 times as much carbon dioxide as the atmosphere does. Carbon dioxide is readily dissolved at the surface of the water to form carbonic acid, which water plants use as their source of carbon.

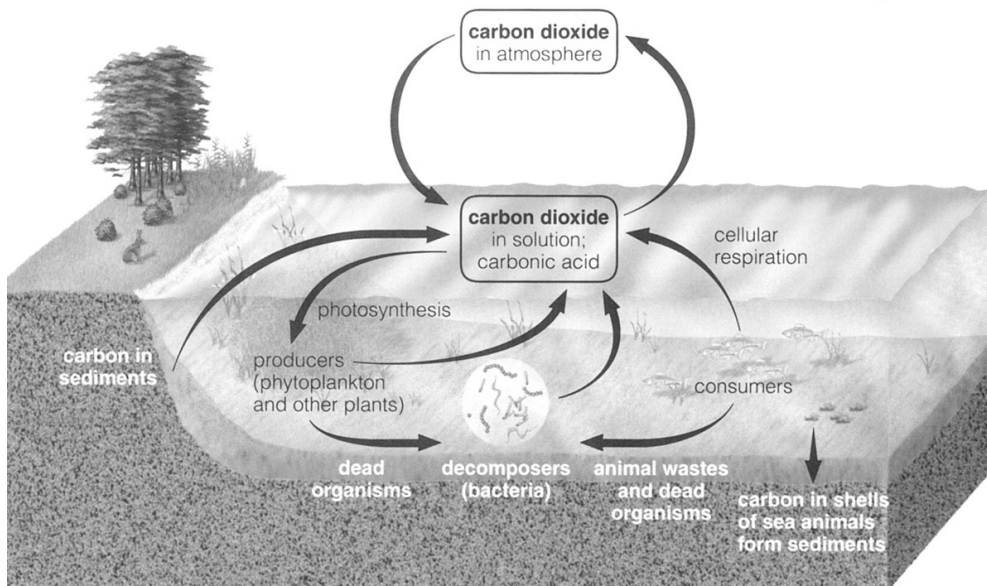


Figure 13: The Carbon Cycle in Aquatic Environments

Source:
 SciencePower,
 McGraw-Hill Ryerson, 2001

As you can see from *Figure 13*, the oceans remove some of the carbon from the cycle. This carbon is contained within the shells of sea animals. When these animals die, the shells form thick layer on the ocean floor and eventually harden into sedimentary rock. This rock may eventually return the carbon to the cycle millions of years later through geological processes that push the rock to the surface.

THE NITROGEN CYCLE

Life also depends on the cycling of nitrogen. Nitrogen is an important nutrient for growth and reproduction of plants. This is important in the oceans for the growth of **phytoplankton**. Nitrogen atoms are required so that cells can make proteins. Nitrogen is also required for the synthesis of deoxyribonucleic acid or **DNA**, the heredity material found in all living things. The movement of nitrogen through the environment is called the **nitrogen cycle**.

This cycle is also complex but it can be simplified into two processes, that of **nitrogen fixation** and **denitrification**.

Nitrogen Fixation

Nitrogen fixation is the process by which bacteria and/or algae convert nitrogen gas in the atmosphere into forms that plants can use (water-soluble nitrates, NO_3^- and nitrites, NO_2^- by bacteria). These nitrogen compounds are then used by plants for normal growth and reproduction and are therefore able to move through the food chain, and returning to the soil and water again. In this sub-cycle of the nitrogen cycle, these compounds can re-enter plants without ever having been converted into gaseous nitrogen. In an aquatic ecosystem the nitrogen fixation is carried out by **cyanobacteria**, or blue-green algae.

Nitrification

One of the products of the decomposition of animal wastes and dead organisms is ammonia. Some plants can use ammonia directly as a source of nitrogen. Ammonia can also be converted back into nitrates by nitrifying bacteria, in a process called **nitrification**. **Denitrifying bacteria** are needed in the decay process to breakdown the nitrogen compounds into free nitrogen and so release nitrogen back into the atmosphere as part of the larger nitrogen cycle.

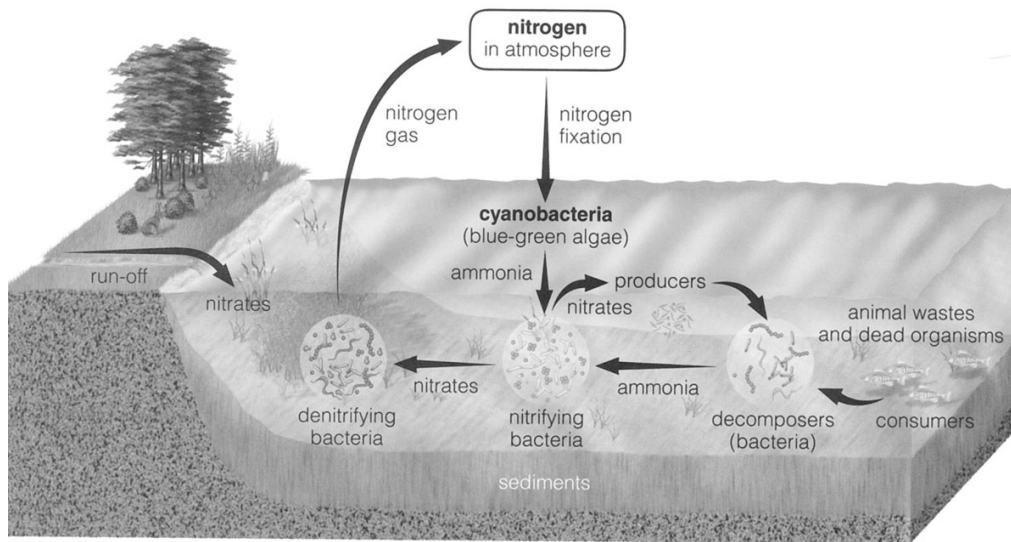


Figure 14: Nitrogen Cycle

Source:
 SciencePower,
 McGraw-Hill Ryerson, 2001

THE SILICON CYCLE

Large amounts of silica are found in ocean sediments. These sediments are an important habitat for organisms that are part of oceanic food chains. Silica (SiO_2), a glass like material, is derived primarily from **diatoms** and the protozoan *Radiolaria*. Diatoms are the single most important group of organisms undergoing photosynthesis in the oceans. They serve as much needed food, as well as provide oxygen for other forms of life.

Radiolaria are **protozoa** generally having an intricate skeleton made of silica. Their symmetrical structure has fascinated biologists from the time that they were first studied with powerful microscopes.

As diatoms and *Radiolaria* are consumed by other organisms, the silica contained in them moves through the food chain. They are very important open-water primary producers in temperate and polar regions. In fact, billions of diatom cells in the ocean account for a large share of the food and oxygen produced on planet Earth.

E Check your Understanding

1. From what you have now read about the biogeochemical cycles, how important are they to the overall balance of materials on the earth?
2. Which of the cycles presented here affect you the most? Briefly explain why.
3. Compare and contrast the nitrogen and carbon cycle with the water cycle.

1.5 PERSPECTIVES

The following figures illustrate two different ways of looking at ecosystems. In your notebook, compare and contrast these two perspectives in *Figures 15 and 16*.

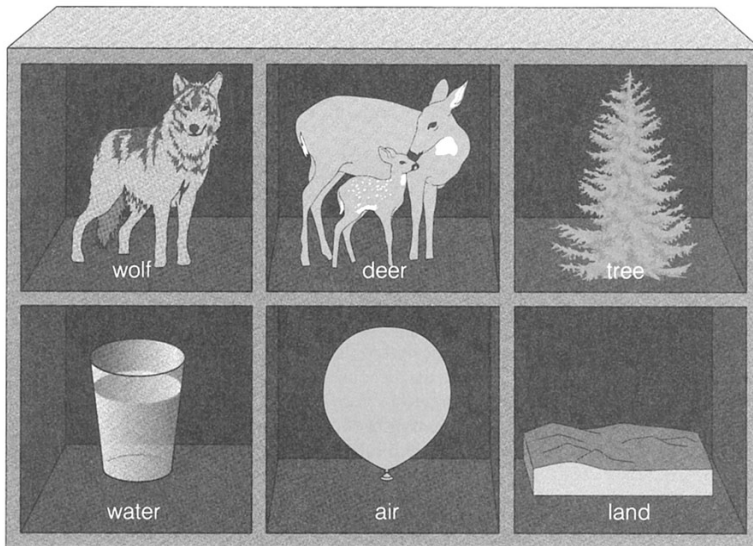


Figure 15: Ecosystem View A

Source:
SciencePower,
McGraw-Hill Ryerson,
2001

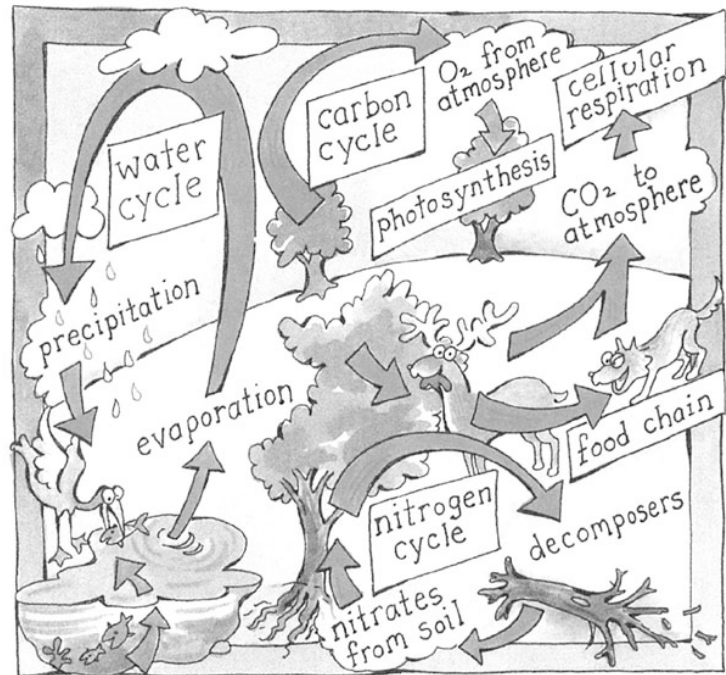


Figure 16: Ecosystem View B

E Check Your Understanding

1. Which perspective would be similar to way you see ecosystems? Why?
2. Talk to an Elder about their view of ecosystems and draw a figurative representation of that perspective. Explain how this perspective is similar and/or different from each of the two presented above.

GLOSSARY

Abiotic This is a factor in an ecosystem created by non-living agents, for example, amount of sunlight, temperature, and strength and direction of the wind.

Autotroph An organism that obtains energy from sunlight or chemicals. (e.g. green plants)

Bioaccumulation or Biological Magnification Processes by which substances (e.g. toxic compounds) collect in the bodies of organisms in progressively higher concentrations with each trophic level.

Bio-diversity Variety of living organisms that inhabit Earth.

Biogeochemical Cycle The chemical interactions that exist between the atmosphere, hydrosphere, lithosphere, and biosphere.

Biomass Weight (often expressed as dry weight) of an organism in a population or trophic level for a given area, used to determine the amount of energy in trophic levels.

Biotic Living part of the environment (e.g. plant and animal organisms)

Carnivores An animal that consumes other species of animals.

Carbon Cycle The flow of carbon through an ecosystem, from the atmosphere to organisms and back to the atmosphere; in aquatic ecosystems, much carbon dioxide is in solution in the water.

Cellular Respiration The conversion of carbohydrates (sugars) by organisms into energy.

Cyanobacteria A group of one-celled to many-celled aquatic organism. Also known as blue-green algae.

Dentrification The conversion of nitrates to from nitrogen gas.

Denitrifying Bacteria Bacteria that can convert nitrates to form nitrogen gas.

Diatoms A microscopic, unicellular type of plant occurring singly or in colonies. A very important kind of phytoplankton in marine Arctic waters.

DNA Deoxyribonucleic acid. This complex compound stores hereditary genetic information.

Ecosystem A group of living organisms that, along with their abiotic environment, forms a self-regulating system through which energy and materials are transferred.

Extinction When a species no longer exists anywhere on earth.

Food Chain A linear pathway of energy transfer in an ecosystem.

Food Web A network of feeding relationships or food chains in an ecosystem.

Herbivores An organism that consumes only plant material.

Heterotrophs Animals and bacteria that depend on the organic compounds produced by other animals and plants as food; they are organisms not capable of producing their own food by photosynthesis.

Inorganic Composed of chemical compounds that do not contain carbon as the principal element (e.g. matter other than plant or animal)

Nitrogen Cycle A cycle of matter in which nitrogen atoms move from nitrogen gas in the atmosphere, to inorganic form in the soil, to organic form in living things, and then back to inorganic form in the soil and nitrogen gas in the atmosphere.

Nitrogen Fixation The conversion of nitrogen gas in the atmosphere to ammonia.

Nitrification The conversion of ammonia to form nitrates.

Organic Compounds that contain carbon as a building material.

Photosynthesis The metabolic process in which organisms can convert solar energy into chemical energy, which is then used to manufacture sugars from carbon dioxide and water.

Primary Consumer An organism in a food chain that feeds on autotrophs; they are organisms in the second trophic level.

Primary Producer Green plants and some species of bacteria, such as cyanobacteria, that carry out photosynthesis to produce food. An autotroph.

Productivity The amount of plant growth in a given area within a given period of time; often expressed as biomass/area/time.

Protozoa Aquatic organisms made up of one or more cells that contain a nucleus.

Secondary Consumers Second consuming organism in a food chain, occupying the third trophic level.

Trophic Level A group of organisms that have the same source of energy; a step in a food chain.