

Effects of Bioaccumulation on Ecosystems

Textbook pages 92–103

Before You Read

Everyday activities, such as driving or heating your home, often pollute ecosystems. In your opinion, which human activity is the most harmful to the environment? Explain.



Mark the Text

Summarize

As you read this section, highlight the main points in each paragraph. Then write a short paragraph summarizing what you have learned.

How can pollutants affect food chains and ecosystems?

Human activity creates many harmful pollutants. These build up in the environment when decomposers are unable to break them down. Plants take up these pollutants. The pollutants are then transferred along the food chain until they reach the highest trophic level. **Bioaccumulation** refers to the gradual build-up of pollutants in living organisms. **Biomagnification** refers to the process in which pollutants not only accumulate, but also become more concentrated at each trophic level. Organisms at lower trophic levels may be affected by the pollutant, but primary, secondary, and tertiary consumers will be more affected, because levels will build up in their tissues as they consume contaminated food. An example of this is the PCB concentrations in the orca's food web. When orcas consume food contaminated with PCBs, they store some of the PCBs in their blubber. When salmon (their primary food) is not available, orcas use their blubber for energy. This releases PCBs into their system. Pollutants can build up to toxic levels in organisms at the top of the food chain. They can also affect entire ecosystems when **keystone species**, species that greatly affect ecosystem health, or the reproductive abilities of species are harmed. ✓

What are some human-made compounds that bioaccumulate and biomagnify?

PCBs (polychlorinated biphenyls)

- ◆ PCBs were once widely used in industrial products but are now banned in North America. They interfere with normal functioning of the body's immune system and cause problems with reproduction.



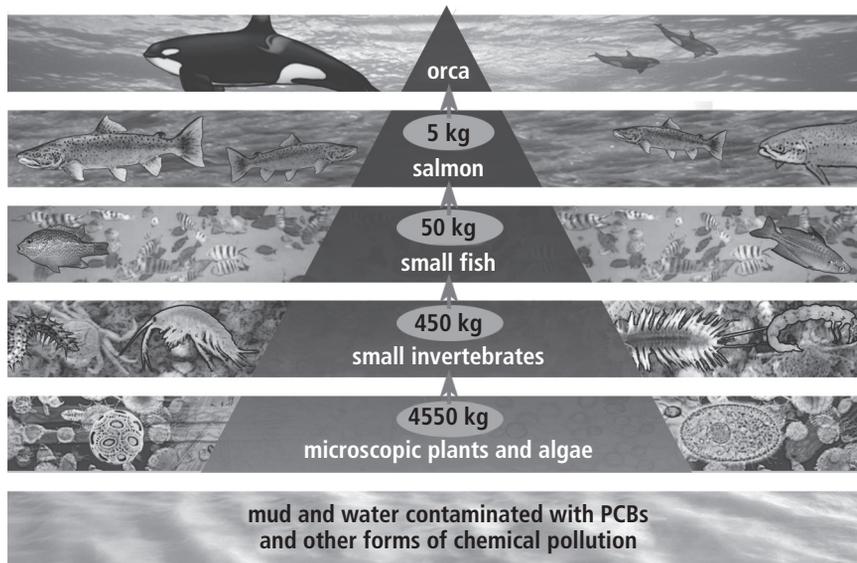
Reading Check

1. What is the difference between bioaccumulation and biomagnification?

- ◆ PCBs have a long **half-life** (time it takes for the amount of a substance to decrease by half). They stay in the environment for a long time. Aquatic ecosystems are most sensitive to PCBs. Organisms at high trophic levels, like the orca, retain high levels of the pollutant.

POPs (persistent organic pollutants)

- ◆ POPs are harmful, carbon-containing compounds that remain in water and soil for many years.
- ◆ **DDT** (dichloro-diphenyl-trichloroethane) is a toxic POP that was used as a **pesticide** in the past to control disease-carrying mosquitoes.
- ◆ Accumulation is measured in **parts per million (ppm)**. This refers to one particle of a given substance mixed with 999 999 other particles. DDT is harmful at 5 ppm.



• **Heavy metals**

• Once heavy metals enter the biosphere, they do not degrade, and they can not be destroyed.

• ◆ Heavy metals, such as lead (Pb), cadmium (Cd), and mercury (Hg), are toxic at low concentrations; however, small amounts are naturally present in soil. For humans, the most serious source of cadmium poisoning is smoking.

• ◆ Human activities can cause these metals to build up in ecosystems. In the past, use of lead-based insecticides, batteries, and paints, increased lead to harmful levels. Despite reductions, lead still enters ecosystems through improperly disposed electronic waste.

✔ **Reading Check**

1. Provide an example of how the effects of chemical pollution can be reduced.

• **How can the effects of chemical pollution be reduced?**

• Some harmful chemical pollutants can be removed from the environment by **bioremediation**, a process where micro-organisms or plants help clean them up. Reacting contaminants with certain chemicals can also make them less harmful. ✔

Use with textbook pages 92–99.

Bioaccumulation

Vocabulary

bioaccumulation	lead
biomagnification	mercury
bioremediation	parts per million
cadmium	PCBs
half-life	persistent organic pollutants
heavy metals	producers
keystone species	

Use the terms in the vocabulary box to fill in the blanks. Use each term only once.

- _____ is the gradual build-up of synthetic and organic chemicals in living organisms.
- _____ are species that can greatly affect population numbers and the health of an ecosystem.
- _____ is the process in which chemicals not only accumulate but become more concentrated at each trophic level in a food pyramid.
- Even small concentrations of chemicals in _____ and primary and secondary consumers can build up to cause problems in higher trophic levels.
- _____ are synthetic chemicals that were widely used from the 1930s to the 1970s in industrial products.
- _____ is the time it takes for the amount of a chemical to decrease by half.
- _____ are carbon-containing compounds that remain in water and soil for many years.
- Chemical accumulation is measured in _____.
- _____ are metallic elements with a high density that are toxic to organisms at low concentrations.
- Three polluting heavy metals are _____, _____, and _____.
- _____ is the use of living organisms to clean up chemical pollution naturally, only faster, through biodegradation.

Use with textbook pages 94–98.

Impact of bioaccumulation on consumers

Complete the following table to demonstrate the effects of each of these chemicals on various trophic levels in their ecosystems.

Chemical	Effects on producers, primary consumers, and secondary consumers	Effects on humans
toxic organic chemicals from red tide 		
DDT 		

Name

Date

**Applying
Knowledge**

Section 2.3

lead



cadmium



mercury



Use with textbook page 95.

PCBs and the orca

1. What are PCBs? What is their full chemical name?

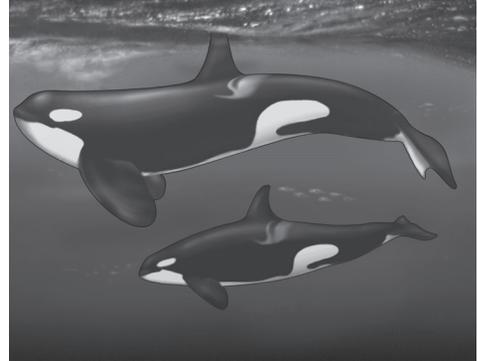
2. What were PCBs used for in the 1970s?

3. In North America, PCBs were banned in 1977. Explain why they are still having an effect on organisms today.

4. Explain what happens to PCBs when they enter an orca's body.

5. How do orcas survive when salmon stocks are low? What effect does this have on their survival?

6. Draw a diagram to illustrate how biomagnification occurs in orcas.



Effects of bioaccumulation on ecosystems

Use with textbook pages 92–99.

Match each Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.	
Term	Descriptor
1. _____ bioaccumulation	A. synthetic chemicals containing chlorine that are used in the manufacture of plastics and other industrial products
2. _____ bioremediation	B. species that can greatly affect population numbers and the health of an ecosystem
3. _____ heavy metals	C. a measurement of chemical accumulation
4. _____ keystone species	D. the use organisms to break down chemical pollutants in water or soil to reverse or lessen environmental damage
5. _____ parts per million	E. metallic elements with a high density that are toxic to organisms at low concentrations
6. _____ PCBs	F. the gradual build-up of synthetic and organic chemicals in living organisms

Circle the letter of the best answer.

7. Over the last century, which human activity has caused the greatest change to the environment?
- recycling
 - forest fires
 - introduction of synthetic chemicals
 - building of hydro plants
8. Which of the following would be identified as a keystone species in the BC forest ecosystem?
- bacteria
 - fungi
 - pine trees
 - salmon
9. POPs, or persistent organic pollutants, are compounds that contain:
- oxygen
 - carbon
 - phosphorus
 - nitrogen
10. For humans, the most serious source of cadmium poisoning is exposure to:
- air pollution
 - water pollution
 - tobacco smoke
 - pesticides
11. Within the biosphere, heavy metals:
- do not degrade and cannot be destroyed
 - do not degrade and can be destroyed
 - do degrade and can be recycled
 - do degrade and can not be recycled
12. The process by which microorganisms break down chemical pollutants to lessen environmental damage is known as:
- bioaccumulation
 - biodiversity
 - biomagnification
 - bioremediation

Name several human activities that affect the carbon cycle.	industry, motorized transport, land clearing, agriculture, urban expansion
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The nitrogen cycle

Why is the nitrogen cycle important?	component of DNA, proteins, muscle function in animals; growth of plants
How is nitrogen stored?	nitrogen gas in atmosphere, oceans, organic matter in soil
How is nitrogen cycled?	nitrogen fixation, nitrification, uptake, denitrification
Name several human activities that affect the nitrogen cycle.	fossil fuel combustion, power plants, sewage treatment, motorized forms of transport, clearing forests, grassland burning, chemical fertilizers leading to eutrophication

The phosphorus cycle

Why is the phosphorus cycle important?	carries energy to plant cells and animal cells; root development in plants; bone development
How is phosphorus stored?	phosphate rock; ocean floor sediments as PO_4^{-3} , HPO_4^{-2} , $H_2PO_4^{-}$
How is phosphorus cycled?	chemical weathering, physical weathering
Name several human activities that affect the phosphorus cycle.	commercial fertilization and detergents negatively affect species, causing fish death

Assessment

Nutrient cycles in ecosystems

Page 29

1. F 2. A 3. E 4. B 5. D 6. G 7. C 8. B 9. A 10. D 11. C
12. B

Section 2.3 Effects of Bioaccumulation on Ecosystems

Cloze activity

Bioaccumulation

Page 33

1. bioaccumulation
2. keystone species
3. biomagnification
4. producers
5. PCBs
6. half-life
7. persistent organic pollutants
8. parts per million
9. heavy metals

10. lead; cadmium; mercury

11. bioremediation

Applying Knowledge

Impact of bioaccumulation on consumers

Page 34

CHEMICAL	EFFECTS ON PRODUCERS, PRIMARY CONSUMERS, AND SECONDARY CONSUMERS	EFFECTS ON HUMANS
toxic organic chemicals from red tide	Produces toxic chemicals that affect clams, mussels, and oysters. Toxins bioaccumulate in fish and mammals.	Can cause paralytic shellfish poisoning, leading to serious illness or death.
DDT	Bioaccumulates in plants and then in fatty tissue of fish, birds, and animals that eat the plants. Affects aquatic food chains.	Changed into a chemical form that is stored in fat tissue. Can cause nervous system, immune system, and reproductive disorders.
lead	In fish and birds it can cause nervous system damage, affect fertility rates, kidney failure, and impair mental development.	Harmful effects range from anemia, nervous system damage, sterility in men, low fertility rates in women, impaired mental development, and kidney failure.
cadmium	Plants take up cadmium from the soil and pass it on to the animals that eat them. Highly toxic to earthworms and other soil organisms. In fish, cadmium contributes to higher death rates, and lower reproduction and growth rates.	Accumulates in lung tissues, causing lung diseases, such as cancer. Leads to infertility and damage to central nervous system, immune system, and DNA.
mercury	Bacteria change mercury into methylmercury, a toxin that accumulates in the brain, heart, and kidneys of vertebrates. Levels of methylmercury in fish depend on how high they are on the food chain.	Methylmercury is absorbed in digestion and enters the blood and then the brain. It affects nerve cells, heart, kidney, lungs, and it suppresses the immune system.

Comprehension
PCBs and the orca
Page 36

1. PCBs are synthetic chemicals. Their full chemical name is polychlorinated biphenyl.
2. PCBs were used for industrial products, such as heat exchange fluids, paints, plastics, and lubricants for electrical transformers.
3. PCBs stay in the environment for a long time. Aquatic ecosystems and species that feed on aquatic organisms are especially sensitive to the effects of PCBs. PCBs bioaccumulate and biomagnify and also have a long half-life.
4. PCBs become concentrated in the orca's blubber.
5. When salmon stocks are low, the orca's blubber is burned for energy. The PCBs are released into the orca's bloodstream and interfere with its immune system making it more susceptible to disease.
6. Diagram should be similar to Fig. 2.55 on page 95 of the student textbook. The pyramid should include the food chain for orcas and demonstrate the total PCB load that the orca is exposed to.

Assessment
Effects of bioaccumulation on ecosystems
Page 37

1. F
2. D
3. E
4. B
5. C
6. A
7. C
8. D
9. B
10. C
11. A
12. D

Chapter 3 Ecosystems continually change over time.

Section 3.1 How Changes Occur Naturally in Ecosystems

Cloze Activity
Change in ecosystems
Page 40

1. natural selection
2. adaptive radiation
3. ecological succession
4. primary succession
5. pioneer species
6. climax community
7. secondary succession
8. flooding
9. tsunami
10. drought
11. insect infestations

Analyzing Information
Primary and secondary succession
Page 41

1. Answer should include the following sequence:
 - Lichens begin to grow. This begins the process of soil formation.
 - Plants, such as mosses, begin to grow.
 - Insects, micro-organisms, and other organisms move in.
 - Grasses, wildflowers, and shrubs begin to grow. More insects and micro-organisms move in.
 - Tree seeds are transported by animals. Deciduous trees grow.
 - Coniferous trees germinate.
 - Mature community develops.
2. Answer should include the following sequence:
 - Exposed soil will contain micro-organisms, worms, and insects as well as the seeds of wildflowers, weeds, grasses, and trees.
 - Other seeds may blow in or be carried in by animals.
 - Deciduous trees grow.
 - Coniferous trees return.
 - Mature community may only take decades to establish.

Applying Knowledge
How natural events affect ecosystems
Page 42

NATURAL EVENT	EFFECTS ON MATURE COMMUNITY
Fire	<ul style="list-style-type: none"> • causes secondary succession • results in regrowth
Flooding	<ul style="list-style-type: none"> • causes soil erosion • results in soil and water pollution, leading to widespread disease
Tsunami	<ul style="list-style-type: none"> • water carries away or destroys plants and animals • disrupts habitats and food webs • salt from salt water changes composition of soil
Drought	<ul style="list-style-type: none"> • destroys habitats • results in the death of plants and animals • leads to crop failures and livestock deaths
Insect Infestation	<ul style="list-style-type: none"> • results in losses to forest canopy • disrupts habitats and food webs

Assessment
How changes occur naturally in ecosystems
Page 43

1. B
2. A
3. D
4. E
5. C
6. C
7. D
8. C
9. B