

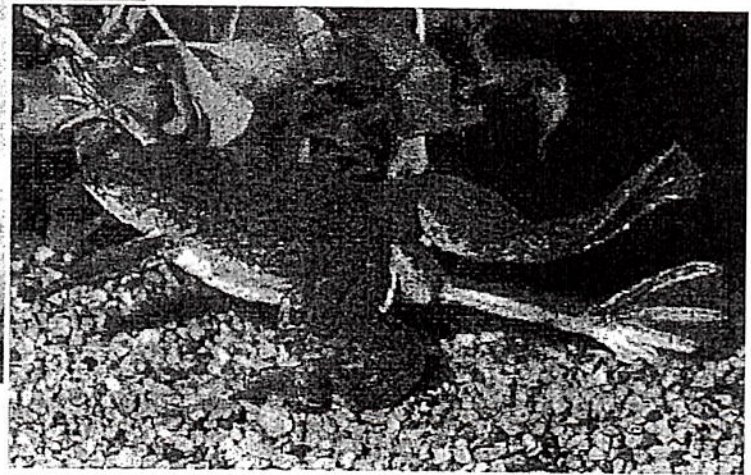
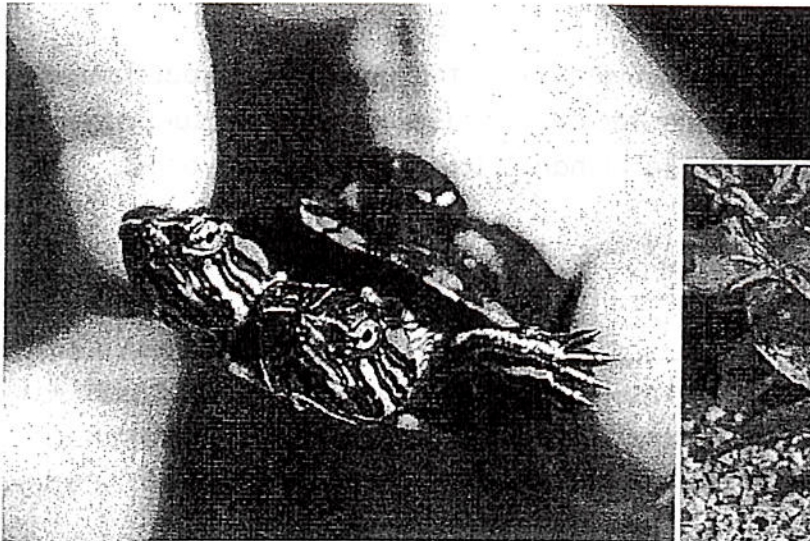
Sustainability of Ecosystems - Bioaccumulation

Name:

Date:

Period:

Over the past century, many human activities have disturbed the natural balance within ecosystems. These disturbances are very stressful for organisms, and many species have died, become malformed, or have become extinct. One of the biggest disturbances has been the introduction of man-made chemicals into the environment.



Many chemicals cannot be decomposed naturally through _____.
As a result, they are eaten, absorbed and often cannot be removed from the body of the consumer effectively. _____, the gradual build-up of synthetic or organic chemicals within living organisms, occurs when organisms take up and store chemicals in the body *faster* than they are broken down and excreted.

These chemicals build up within an organism's _____ tissues. If they are not chemically altered or excreted when the _____ is burned for energy, they can become harmful. Nervous systems, immune systems and reproductive systems are all susceptible to the effects of these toxins.

If a _____ suffers a chemical bioaccumulation, it can affect every other organism in its far-reaching niches. A _____ is one that plays a vital role in the food chain of an ecosystem, greatly influencing population numbers and ecosystem health.

Example: B.C Salmon:

- Food source for bears, wolves, eagles, and otters
- Rich source of nutrients (nitrogen) when decayed

Chemicals not only accumulate, but also become more concentrated as you move higher up a food chain. This is called bioaccumulation. At each level of the food pyramid, chemicals that do not get broken down build up within the organisms' tissue. Therefore, when a consumer in the next trophic level eats contaminated organisms, it receives a huge dose of the chemical. Due to the large amount of food that is eaten by herbivores and carnivores at higher trophic levels, even small amounts of chemicals within smaller organisms can build up and become toxic when eaten by higher level consumers.

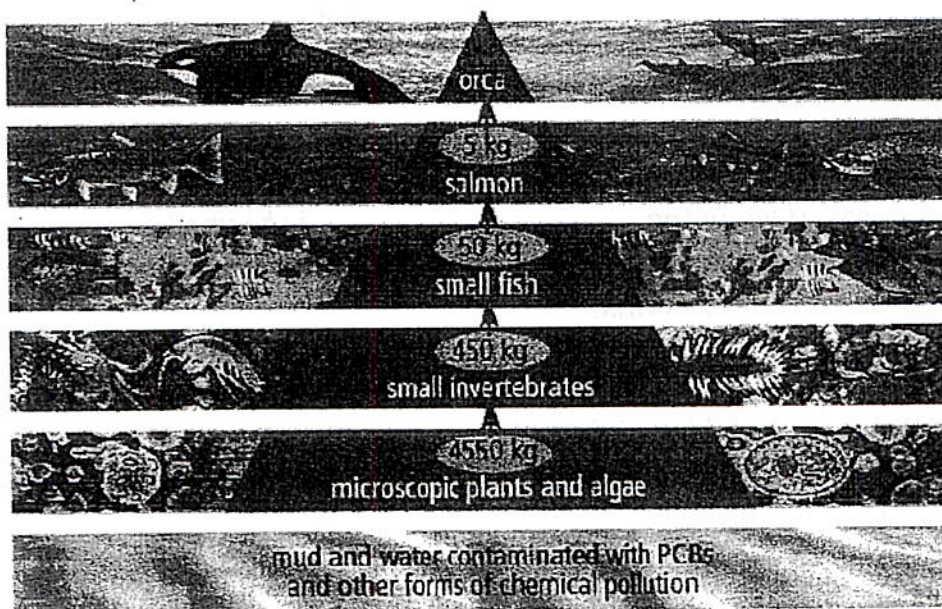
Example #1:

Paralytic shellfish poisoning is caused by an algae bloom that produces a specific nerve toxin. Shellfish (mussels, clams, etc.) consume the algae and nerve toxins accumulate in their tissues. If eaten by other organisms (i.e. humans), toxic poisoning can occur, often resulting in death.

Example #2:

PCBs are chemicals that were used for many industrial and electrical applications (paints, fluids, plastics and lubricants) in the mid-20th century. They were banned in 1977 because of their environmental impact. It was discovered that PCBs suppress the immune system and cause cancer in animals.

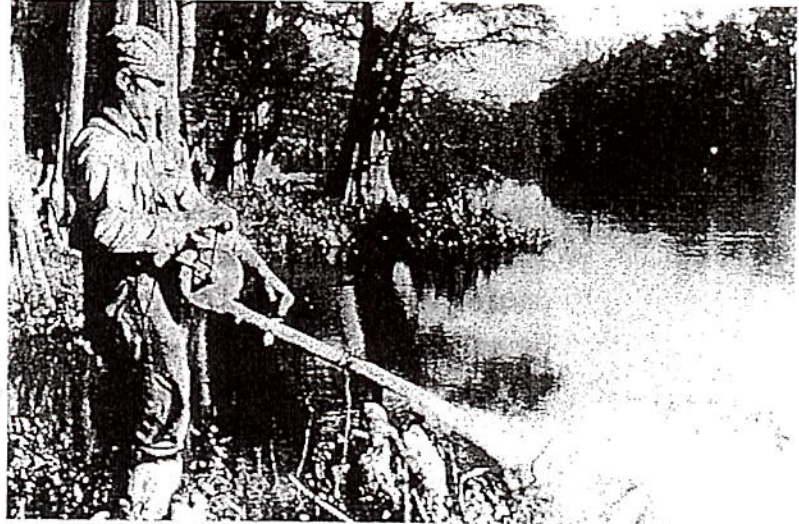
Even though PCBs have been banned for decades, high levels are still found in BC's Orcas. They have a long half-life (the time it takes for half the chemicals to degrade); therefore, they remain in an organism's body tissues for really long time. PCBs are predicted to affect the reproductive cycles of orcas until at least 2030.



- The bioaccumulation of PCBs begins with the absorption of the chemicals by microscopic plants and algae.
- If an orca eats 5kg of salmon, it is ingesting the equivalent amount of PCBs that were accumulated in 4550 kg of microscopic plants and algae!

Chemicals such as PCBs and DDT are called _____ POPs, like all organic compounds, contain _____, and remain in water and soil for many years. Many POPs are insecticides, used to control pest populations.

- The insecticide DDT was introduced in 1941 to control _____ carrying mosquitoes and other insects.
- Unfortunately, years after being introduced, problems began appearing at the tertiary level of the food chain (weakened shells of birds) and birds of prey (eagles) populations became endangered. Studies showed that DDT was the culprit and it was banned in North America.



- DDT is still used in many parts of the world including many food-producing countries. The risk to environment versus the risks to human is under constant debate. _____ humans have died from malaria since banning DDT.

Chemical accumulation is measured in _____ (ppm).

| Consumer | Bioaccumulation (ppm) |
|------------|-----------------------|
| Plankton | 0.04 |
| Minnow | 0.94 |
| Adult Fish | 2.07 |
| Heron | 3.57 |
| Osprey | 13.80 |
| Cormorant | 26.40 |

- One particle for every 999,999 other particles.
- One drop in a container of 150 L of water.
- Even at low levels (5 ppm), DDT in animals can cause nervous, immune, and reproductive system disorders.

Heavy Metals

- Metals with a high _____ that are toxic in low concentration
- In small amounts, perform vital functions, but can _____ and _____ to toxic levels in food chains.

Lead

- Small amounts are found naturally in soils.
- Lead based insecticides, paints, and gasoline have resulted in increased levels.
- Currently found in electronics therefore appropriate disposal (i.e. recycling) is required.
- Toxic at 0.0012 ppm. Lead is not considered safe at any level.
- Causes anemia, damages nervous system, sterility and infertility, impairs mental development and kidney failure, and death.



Mercury

- Released naturally into the environment through, volcanoes, geothermal springs and weathering.
- Released unnaturally through burning fossil fuels (coal burning = 40%), waste incineration, mining, manufacturing of batteries.
- Bioaccumulates in the food chain (i.e. tuna fish) and causes damage to nerve cells, kidneys, the heart, lungs, and suppress the immune system

Cadmium

- Found naturally in the earth's crust, released through weathering, volcanoes, and forest fires,
- Used in the manufacture of plastics and rechargeable nickel-cadmium batteries.
- It is toxic to earthworms and causes many health problems in fish.
- Tobacco plants absorb cadmium, making cigarettes the main source for humans.
- Exposure leads to infertility, damages the nervous system, immune system and DNA (causing cancer).

Reducing the effects of chemical pollution

_____ is the use of microorganisms or plants to help clean up toxic chemicals through biodegradation. Example: "Oil eating bacteria" are added to soils at old mining sites. By trapping chemicals in the soil, they cannot enter the food chains as easily. These bacteria are also being used to clean up oil spills.