

PCBs and the Orca

The significance of bioaccumulation is seen in the way PCBs affect orcas (killer whales). PCBs (polychlorinated biphenyls) are synthetic chemicals that were widely used from the 1930s to the 1970s in industrial products such as heat exchange fluids, paints, plastics, and lubricants for electrical transformers. In 1977, they were banned in North America as concerns grew about their impact on the environment and human health. Many synthetic chemicals such as PCBs that bioaccumulate and biomagnify also have a long half-life. **Half-life** is the time it takes for the amount of a substance to decrease by half. PCBs stay in organisms and the environment a very long time, suppress the immune system, and probably cause cancer in humans. Aquatic ecosystems and species that feed on aquatic organisms are especially sensitive to the effect of PCBs.

Hardest hit of all are orcas (Figure 2.54). One study found that PCBs will interfere with the reproductive success of British Columbia's resident orcas until at least 2030. Even though these chemicals have been banned for decades, orcas retain high levels of PCBs, especially the calves.

Figure 2.55 shows how biomagnification occurs in an orca. Even if the PCBs enter the food chain at a relatively low level, by the time they get to the orca, they are highly concentrated in the blubber. When salmon stocks are low, magnification is increased, since blubber is then burned for energy. The PCBs are released into the orca's bloodstream where they interfere with immune function, making the orca more susceptible to disease.



Figure 2.54 A newborn orca calf has the same PCB level as its mother and then receives more through its mother's fat-rich milk.

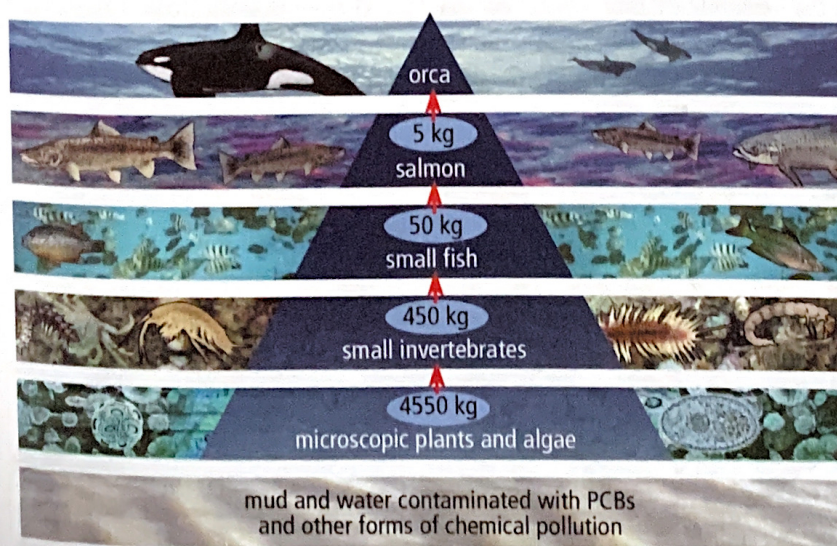


Figure 2.55 The PCB load of orcas is much higher than that of any other animal in the world. When an orca eats 5 kg of salmon, it is ingesting PCBs and other pollutants from about 4550 kg of microscopic plants and algae.

Persistent Organic Pollutants

PCBs belong to a class of compounds called **persistent organic pollutants** or POPs. POPs are carbon-containing compounds that remain in water and soil for many years. Many POPs enter ecosystems in the form of insecticide sprays (Figure 2.56).



Figure 2.56 Insecticide spraying is a common method by which POPs are introduced into ecosystems.

Table 2.2 Bioaccumulation of DDT in a Food Chain

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



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Some chemicals, called endocrine disruptors, affect the endocrine (hormone) system by mimicking the female hormone estrogen. One effect is eggshell thinning in birds of prey such as eagles. To find out more about endocrine disruptors, go to www.bcscience10.ca.

One well-known POP is the insecticide **DDT** (dichlorodiphenyl trichloroethane). DDT was introduced in 1941 to control disease-carrying mosquitoes. Although now banned in many countries because it biomagnifies, it has a long half-life and persists in the environment. DDT binds strongly to soil particles and persists for as long as 15 years. Bound in soil, DDT begins to bioaccumulate in plants and then in the fatty tissue of the fish, birds, and animals that eat the plants. Washed into streams and lakes, it affects aquatic food chains by first accumulating in plankton. In Table 2.2, you can see how low levels of DDT become magnified through the food chain.

Chemical accumulation is measured in **parts per million (ppm)**. One ppm means one particle of a given substance mixed with 999 999 other particles, which is equivalent to one drop of dye mixed with 150 L of water (about what a home hot-water tank holds). DDT is considered toxic or harmful at levels of 5 ppm. In animals, DDT is changed into a chemical form that bioaccumulates in fat tissue and can cause nervous system, immune system, and reproductive disorders.

Reading Check

1. What is bioaccumulation?
2. What is biomagnification?
3. How does a chemical bioaccumulate in an organism?
4. What are persistent organic pollutants?
5. What does ppm mean?