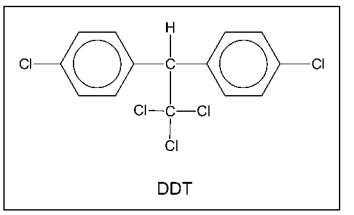
30. DDT

CHEMICAL NAME = 1-chloro-2-[2,2,2-trichloro-1-(4-chlorophenyl)ethyl]benzene
CAS NUMBER = 50–29–3
MOLECULAR FORMULA = $C_{14}H_9Cl_5$
MOLAR MASS = 354.5 g/mol
COMPOSITION = C(47.4%) H(2.6%) Cl(50.0%)
MELTING POINT = 108.5°C
BOILING POINT = 260°C
DENSITY = 1.5 g/cm^3



DDT

DDT is a polychlorinated persistent chemical that exists as a solid under normal conditions. In 1939, the Swiss chemist Paul Müller (1899–1965), working for the Geigy chemical company, discovered that the compound dichlorodiphenyltrichloroethane (DDT) was an effective insecticide. DDT was first synthesized in 1873 by an Austrian student, but it was Müller who discovered its efficacy as an insecticide. DDT was initially marketed in 1941 and found its first widespread use during World War II. During World War I several million deaths, including 150,000 soldiers, were attributed to typhus. There are several forms of typhus, but the most common form is due to bacteria carried by lice. During World War II, fearing a repeat of World War I typhus outbreaks, the Allied forces used DDT to combat typhus in addition to malaria, yellow fever, and other diseases carried by insects. Soldiers liberally applied talcum powder containing 10% DDT to clothes and bedding to kill lice. America and its European allies were relatively free from typhus and other diseases, whereas the Germans, who did not use DDT, had many more noncombat deaths resulting from infectious diseases. DDT solutions were sprayed in areas of the Pacific Theater to prevent malaria and yellow fever. In addition to its use in the war, DDT was used by civilians in tropical areas as a generic insecticide to prevent infectious diseases, especially malaria. Once the war ended, the use of DDT to advance public health in tropical developing countries was expanded for use in agriculture in developed countries. Paul Müller was awarded the Nobel Prize in physiology or medicine in 1948 for his discovery of the insecticide potential of DDT. By 1950, DDT and several related

compounds were viewed as miracle insecticides that were inexpensive and that could be used indiscriminately.

Even though DDT seemed to be a cheap and effective pesticide, enough was known in its early development to raise concerns. DDT is a persistent chemical that lasts a long time in the environment. DDT is fat-soluble and not readily metabolized by higher organisms. This meant that DDT accumulated in the fat tissues of higher organisms. Organisms with longer life spans residing higher on the food chain continually fed on organisms lower on the food chain, accumulating DDT in their tissues. For example, the concentration of DDT in a lake might be measured in parts per trillion, plankton in the lake may contain DDT in parts per billion, fish a few parts per million, and bird feeding on fish from the lake several hundred parts per million. The accumulation of a chemical moving up the food chain is a process known as biological magnification (Figure 30.1). Another concern was that certain pests seemed to develop immunity to DDT and the application rate had to be increased to combat insects. This immunity occurred because natural selection favored insects that had the genetic characteristics to survive DDT and passed this ability on to their offspring. Direct deaths of bird and fish populations had also been observed in areas with heavy DDT use. Problems associated with DDT and other post World War II organic pesticides became a national concern with Rachael Carson's (1906–1964) publication of *Silent Spring* in 1962. Carson's book alerted the public to the hazards of insecticides, and although the book did not call for a ban, Carson challenged the chemical and agricultural industry to curtail its widespread use of chemical pesticides. Most developed countries started to ban the use of DDT and related compounds in the late 1960s. DDT was banned in the United States in 1973. Although it has been banned in developed countries, its use to improve public health in developing countries continues. The World Health Organization estimates that DDT has saved 25 million lives from malaria and hundreds of millions of other lives from other diseases.

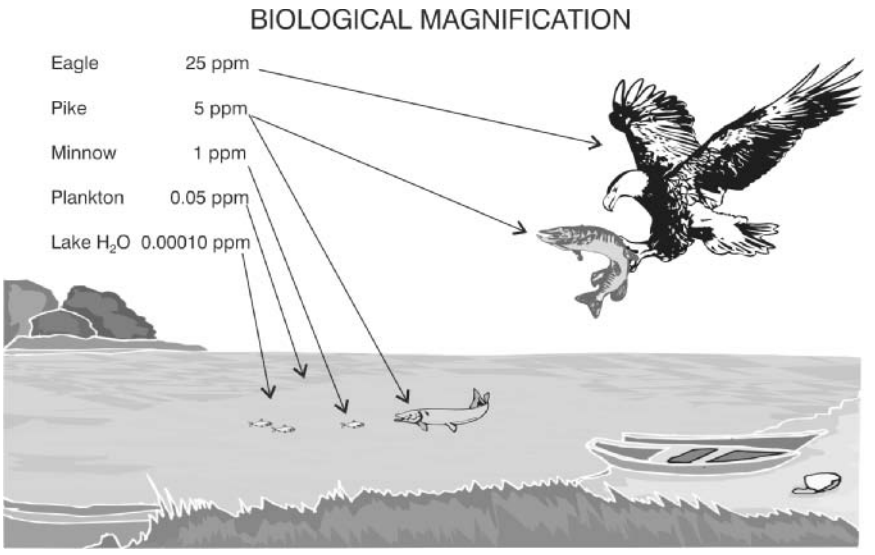


Figure 30.1 Pollutants can be concentrated as they move up the food chain.
Drawing by Rae Déjur.

The United Nations' Stockholm Treaty on persistent organic pollutants calls for the phase out of DDT but recognizes its efficacy as a deterrent to vector-borne diseases such as malaria and typhus. According to the treaty, the continued use of DDT is discouraged, but until effective economical alternatives are found, DDT use will be continued in countries with high rates of vector diseases. A number of developing countries still use DDT. It is applied primarily in the interior of homes to prevent malaria. Currently DDT is produced only in India and China, and current production volumes are unknown.

DDT belongs to a group of chemical insecticides know as organochlorides. These contain hydrogen, carbon, and chlorine and kill by interfering with nerve transmission, making them neurotoxins. Organochlorides were the dominant type of chemical insecticide used from 1940 to 1970. Some common organochlorides besides DDT are chlordane, heptachlor, aldrin, and dieldrin. Because of their problems and subsequent ban in many regions, numerous other classes of insecticides have been synthesized to replace organochlorides.