Quadrant II – Transcript and Related Materials

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Module Name: Biomagnification
Module No: 12
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Biomagnification:

Toxic chemicals and heavy metals flow into the ocean when industrial, agricultural, and human wastes runs off or is deliberately discharged into rivers that then empty into the sea.

These pollutants then find its way into the food chain.

Cells have mechanisms for bioaccumulation i.e. the selective absorption and storage of a great variety of molecules and this allows them to accumulate nutrients and essential minerals, but at the same time they also may absorb and store harmful substances through the same mechanisms.

Materials that are rather dilute in the environment can reach dangerous levels inside cells and tissues through this process of bioaccumulation.

These pollutants cause disease, genetic mutations, birth defects, reproductive difficulties, behavioural changes, and death in many marine organisms.

In many cases, animals near the top of the food chain are most affected because of a process called biomagnification.

Biomagnification is a process through which the concentration of a harmful substance, such as a heavy metal, increases in organisms as it moves up a food chain.

Lake Michigan -The DDT tissue concentration in gulls, a tertiary consumer, was about 240 times more than in the small insects sharing the same environment.

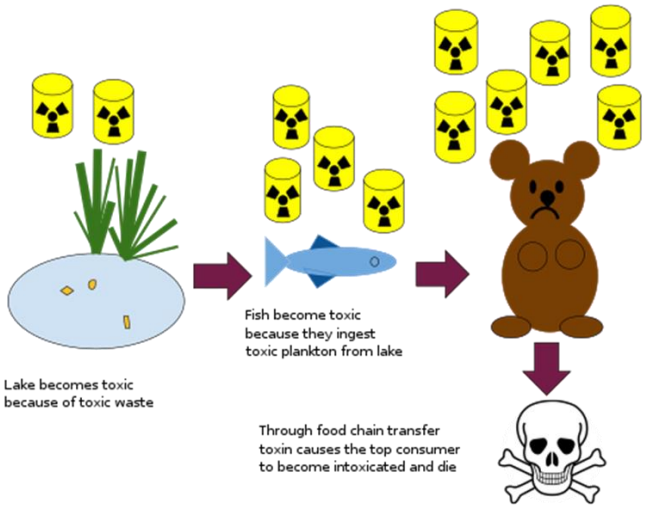
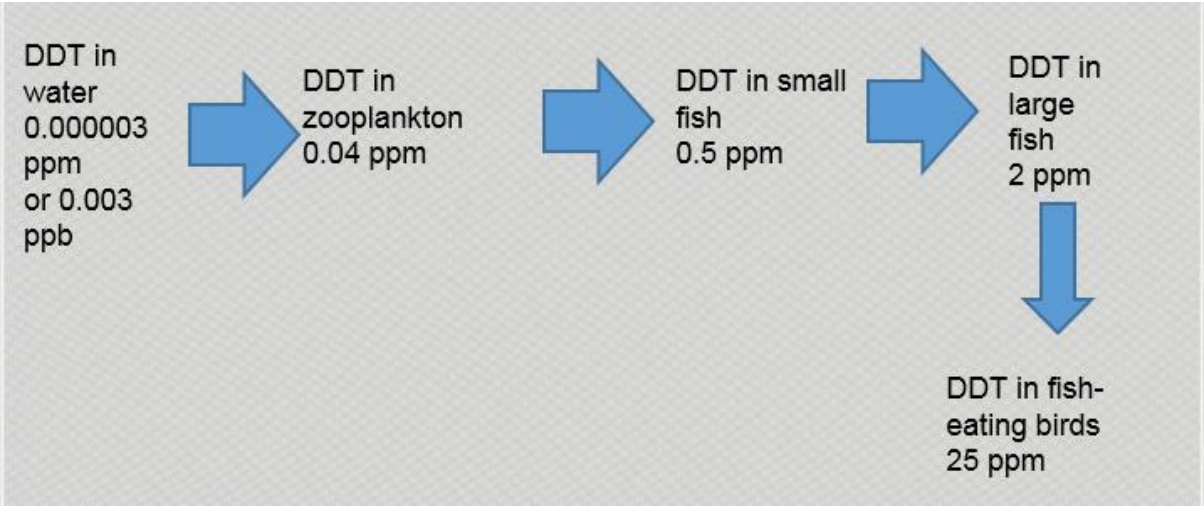


Fig 1. Bio- magnification in a pond ecosystem

Estefaniajmz, CC BY-SA 4.0, via Wikimedia Commons

CASE STUDY –DDT

The compound DDT (dichlorodiphenyl trichloroethane) was discovered to act as an insecticide during the 1930s. It was widely used during World War II- killing lice, ticks, and malaria-bearing mosquitoes. Fields were sprayed with DDT to control pests in food crops. The chemical was a remedy for insect problems. Domestic use was promoted. Subsequently, insects developed resistance to DDT



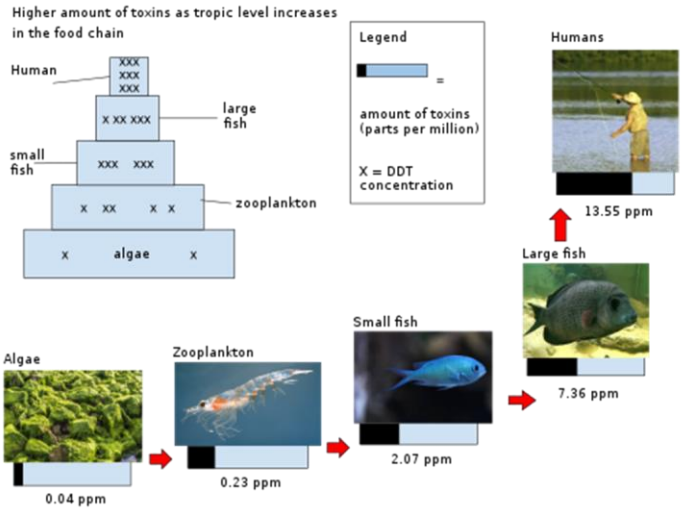


Fig 2. The build up of toxins in a food chain Øystein Paulsen, CC BY-SA 3.0, via Wikimedia Commons

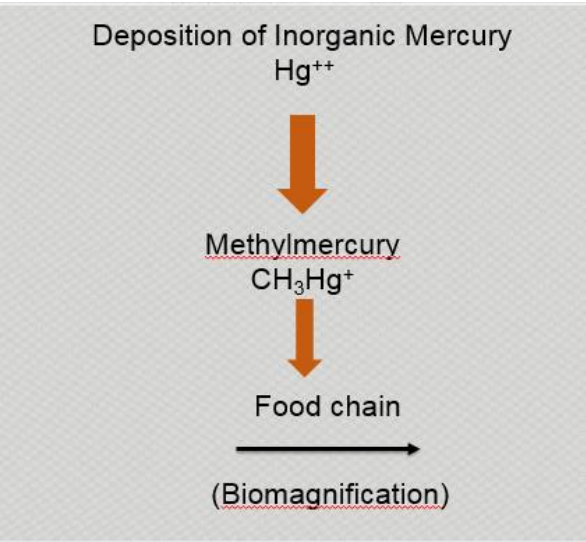
EFFECTS of DDT

DDT is a bio accumulative chemical, It is fat-soluble and builds up in the fatty tissues of humans and animals. Fish were not killed by DDT, but it accumulated concentrated doses and was passed on to the birds. DDT impairs calcium metabolism → birds lay eggs with thin, fragile shells

The eggs were crushed just by the weight of the adults sitting on the nest. Whole colonies of birds were wiped out, because not a single egg survived long enough to hatch. Subsequently, in 1972, the U.S. Environmental Protection Agency banned its use. It is so persistent in the environment that more than forty years later fish often had detectable (though much lower) levels of DDT in their tissues. Even when the threat posed by a toxic agent is recognized and its production actually ceases, it may prove long-lived in the environment. Once released and dispersed, it may be impossible to clean up. The only course is to wait for its natural destruction, which may take unexpectedly long.

Case Study - Mercury Poisoning

In the early twentieth century, Minamata was a small coastal town in western Kyushu, Japan, with a long history as a village of farmers and fishermen. In 1932, Chisso Corporation, a major local industrial firm began to manufacture acetaldehyde. Industrial wastewater was released into the Minamata Bay. Odd behavior of cats ("dancing," falling into the ocean and drowning). People began to stumble, to slur their speech, to suffer convulsions and fits of trembling. Babies were born deformed. Some victims became paralyzed, others died. The collection of symptoms was called "Minamata disease," and researchers tried to identify its cause. Mercury in Chisso's wastewater was flushed into Minamata Bay, which only slowly mixes with the open ocean.



As methylmercury, it was taken up in algae, then fish and shellfish, then the cats and the people who ate the fish, its concentration biomagnified along the way. Among the human population, the fishermen, who typically ate the most fish, were most acutely affected.

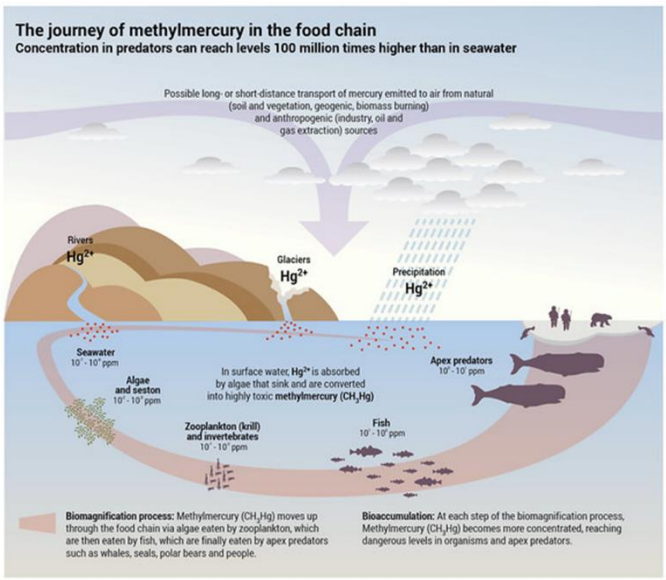


Fig 3. The journey of methylmercury in the food chain.
Source:https://live.staticflickr.com/65535/47957315233_80f24dbacd_b.jpg By Philippe Rekacewicz and Kristina Thygesen

Wastewater is not the only contributor to mercury pollution. Mercury is a very volatile (easily vaporized) metal. Mercury vapour is put into the atmosphere—by coal burning, waste incineration, smelting of mercury-bearing ores, battery manufacturing, it disperses widely before being deposited on land and water.

In recent decades, human activity has more than doubled the concentration of mercury in the atmosphere, correspondingly increasing that deposition.

It begins as a potential air-pollution issue becomes a water-pollution, mercury in air is typically elemental mercury, it becomes a health threat only after it enters water bodies where it can be methylated.