between a pulse input of DDT over cropland and the subsequent level of the pesticide in the tissues of marine fish. The length of the transmission delay depends in part on the number of trophic levels involved in the movement and concentration of DDT; for example, there is a lag of about 8 years between peak generation rates and maximum levels of DDT in the second trophic level of marine fish. The peak concentration of DDT would occur somewhat earlier in fish than in fish-eating birds or man. DDT is transmitted to man through other paths as well. Delays along these other pathways could be either longer or shorter than those observed in the DDT model.

Mercury exhibits an even longer transmission delay than DDT. By slightly altering the model of global mercury flows described in Anderson et al. (1973), one can employ simulation to determine the time required for a pulse input of mercury, in the absence of all other natural or man-made sources, to travel through the environment. Figure 6-16 illustrates the results obtained when the revised model was used to simulate the effects of mercury added to the global environment in 1910. The con-

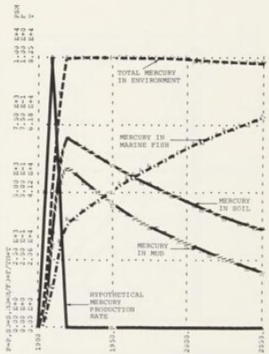

Figure 6-16 An illustration of the transmission delays associated with the diffusion of mercury through the global environment—the relation between the rate of mercury release to fresh water and the level of mercury in marine fish tissue

Note: Appendix B to this chapter lists the changes required in the standard DYNAMO program of the mercury model to obtain the results illustrated in this figure.

centration of mercury in mud and soil peaked within 5 to 10 years after the metal was released into the environment. However, even after 140 years the level of mercury in marine fish was still rising. Other studies suggest that the transmission delay in specific regions may be many times that indicated by the model run: "It is estimated that at the current rate of microbial action, the supply of mercury now at the bottom of Lake St. Clair, Michigan, will continue to be absorbed in to the food chain for several thousand years" (Wood 1972).

Until recently, significant quantities of radioactive materials were released by atmospheric nuclear tests. Figure 6-6 suggests a transmission delay of about 3 years for these materials.

Although their ultimate importance is not yet clear, stored radioactive wastes deserve mention as pollutants that may exhibit a very long transmission delay. By 1970 the U.S. Atomic Energy Commission had accumulated about 75 million gallons of liquid radioactive wastes in underground storage tanks.

> Many authorities now assume that the tanks can be relied upon only for about 20 years, the principal cause of failure being corrosion of welded seams. Even if it is assumed that a tank can be relied upon for about 40 years, the poisonous contents of those tanks would have to be transferred to new tanks more than 10 times before their radioactivity had died out enough for safe disposal. [Snow 1967]

If the tanks and the transfer procedures never fail, the transmission delay for these liquid radioactive wastes will be essentially infinite. None of the associated radioactivity will ever affect the biosphere. However, if accidents occur in the transfer, processing, or storage of these wastes, then the transmission delay is finite and equals the mean time to failure of the transfer and storage procedures. It is extremely difficult to estimate the severity, timing, or likelihood of such a release, though catastrophic consequences are at least conceivable, and small accidents are inevitable.

The transmission delay for radioactivity may in some instances be even longer than the lag introduced by storage. Radioactivity shares with some chemical substances, such as diesterstylbestrol, the ability to decrease the average lifetime of the generation following that actually exposed to the pollutant. Exposure to radioactivity may alter an individual's egg or sperm cells. When affected cells are employed in the conception of children, the children may inherit genetic defects that affect their health only after they mature. This factor alone adds fifteen or more years to the transmission delays of radioactive substances.

In summary, the transmission delay associated with the diffusion and the concentration of persistent materials in the biosphere is an important general characteristic of the pollutants' behavior. The delay may vary in specific instances from a year or less to many decades. The magnitude of the delay that characterizes the global burden of persistent materials will depend on the location and the mode of pollution generation, on the precise composition of the pollution level, and on the location and the nature of the affected organisms. These factors are not fully understood and will, in any event, change in the future in ways that cannot be fully anticipated today.

As an example, there will be a tendency for the composition of persistent pollution to shift as society discriminates against pollutants whose harmful consequences are more quickly apparent. The move in the 1960s toward increased reliance on