2.2 Bioconcentration, Bioaccumulation and Biomagnification

In order to understand how contaminants travel through the various trophic levels of the ecosystem, the risk assessment team must be knowledgeable of the potential for the chemicals of concern to bioaccumulate. Bioaccumulation refers to the degree to which an organism takes up and retains a contaminant from all applicable exposure routes. Bioaccumulation takes into account that organisms may accumulate contaminants through multiple exposure routes and that the total accumulation will depend upon the rate of intake versus the rate at which the organism is capable of eliminating (through urine or feces) or breaking down the chemical through metabolic processes

Bioconcentration refers to the absorption or uptake of a chemical from the media to concentrations in the organism's tissues that are greater than in surrounding environment. The degree to which a contaminant will concentrate in an organisms is expressed as a bioconcentration factor (BCF), which is defined as the concentration of a chemical in an organism's tissues divided by the exposure concentration. Thus, a BCF of 100 means that the organism concentrates that chemical to a concentration 100 times greater than in the surrounding media. Bioconcentration factors are most commonly applied to aquatic organisms such as fish or aquatic invertebrates. Within a species, bioconcentration factors differ for different chemical compounds. For example, the BCF for the water flea (*Daphnia magna*) for three chemicals is shown in Table 2.1. BCFs also vary among species for the same contaminant and site-specific environmental conditions can affect BCFs. Consequently, the data needed to calculate site-specific BCFs for particular species is collected for some ecological risk assessments. This usually involves analyzing the concentrations of contaminants in an organism's tissues and comparing this to the concentrations of those contaminants in the surrounding media.

Biomagnification refers to the tendency of some chemicals to become increasingly concentrated at successively higher trophic levels of a food chain or food web. As discussed in Section 1.3, producers take up nutrients from the surrounding environment in order to synthesize the complex molecules required for various biological processes. Because the available supply of many nutrients tend to be limited in the environment, plants often utilize considerable energy to actively pump these nutrients into their cells. They may even take up more than immediately needed and store them for future use. Thus, plants often have tissue concentrations of important nutrients that are higher than concentrations in the surrounding media. In some cases, pollutants that are chemically similar to some of these inorganic nutrients are present in the surrounding environment and are taken up and stored in plant tissues as well.

The first step in biomagnification occurs when contaminants are stored in producer tissues at concentration higher than in the surrounding environment. The second stage of biomagnification occurs when the producer is eaten by a consumer. Recall from Section 1.4, that relatively little energy is available from one trophic level to the next. This means that a consumer (of any level) has to consume a lot of biomass from lower trophic levels. If that biomass contains a contaminant, the contaminant will be taken up in large quantities by the consumer. Contaminants that biomagnify have another