Biological Magnification

Biological magnification is the tendency of pollutants to become concentrated in successive trophic levels.

Often, this is to the detriment of the organisms in which these materials concentrate, since the pollutants are often toxic.

- **Biomagnification** occurs when organisms at the bottom of the food chain concentrate the material above its concentration in the surrounding soil or water.
- Producers, as we saw earlier, take in inorganic nutrients from their surroundings.
- Since a lack of these nutrients can limit the growth of the producer, producers will go to great lengths to obtain the nutrients.
- They will spend considerable energy to pump them into their bodies.
- They will even take up more than they need immediately and store it, since they can't be "sure" of when the nutrient will be available again (of course, plants don't think about such things, but, as it turns out, those plants, which, for whatever reason, tended to concentrate inorganic nutrients have done better over the years).
- The problem comes up when a pollutant, such as DDT or mercury, is present in the environment.
- Chemically, these pollutants resemble essential inorganic nutrients and are brought into the producer's body and stored "by mistake".
- This first step in biomagnification is called **bioaccumulation**; the pollutant is at a higher concentration inside the producer than it is in the environment.
- The second stage of biomagnification occurs when the producer is eaten.
- Remember from our discussion of a pyramid of biomass 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 the lower trophic level.
- If that biomass contains the pollutant, the pollutant will be taken up in large quantities by the consumer.
- Pollutants that biomagnify have another characteristic.
- Not only are they taken up by the producers, but they are absorbed and stored in the bodies of the consumers.
- This often occurs with **pollutants soluble in fat** such as DDT or PCB's.
- These materials are digested from the producer and move into the fat of the consumer.
- If the consumer is caught and eaten, its fat is digested and the pollutant moves to the fat of the new consumer.
- In this way, the pollutant builds up in the fatty tissues of the consumers.

- Water-soluble pollutants usually cannot biomagnify in this way because they would dissolve in the bodily fluids of the consumer.
- Since every organism loses water to the environment, as the water is lost the pollutant would leave as well.
- Alas, fat simply does not leave the body.

The "best" example of biomagnification comes from **DDT**. This long-lived pesticide (insecticide) has improved human health in many countries by killing insects such as mosquitoes that spread disease.

- On the other hand, DDT is effective in part because it does not break down in the environment.
- It is picked up by organisms in the environment and incorporated into fat.
- Even here, it does no real damage in many organisms (including humans).
- In others, however, DDT is deadly or may have more insidious, long-term effects. In birds, for instance, DDT interferes with the deposition of calcium in the shells of the bird's eggs.
- The eggs laid are very soft and easily broken; birds so afflicted are rarely able to raise young and this causes a decline in their numbers.
- This was so apparent in the early 1960's that it led the scientist **Rachel Carson** to postulate a "silent spring" without the sound of bird calls.
- Her book "***Silent Spring***" led to the banning of DDT, the search for pesticides that would not biomagnify, and the birth of the "modern" environmental movement in the 1960's.
- Birds such as the bald eagle have made comebacks in response to the banning of DDT in the US.
- Ironically, many of the pesticides which replaced DDT are more dangerous to humans, and, without DDT, disease (primarily in the tropics) claims more human lives.

Summary:

In order for a pollutant to biomagnify, the following conditions must be met:

1. The pollutant must be long-lived.
2. The pollutant must be concentrated by the producers.
3. The pollutant must be fat-soluble.