

# Lecture 7, Biomonitoring Non-Human Species for Ecological Receptor Exposure and Risk Assessment and for Conceptual Model Verification



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# Reasons for Biomonitoring Non-Human Species

- ◆ Can sample in a naturalistic environment, without IRB clearances (retains ecosystem complexity).
- ◆ Initially test hypothesis regarding conceptual models of contaminant fate and transport.
- ◆ Establish a baseline of contaminants in biomass as part of an ongoing monitoring program (important for assessing the need for or failure of site remediation ie, Superfund, RCRA, DOE-NNSA).



# Reasons for Biomonitoring Non-Human Species-Continued

- ◆ Establish the exposure and thus risk to humans from consumption of contaminated foods- especially fish (incredibly important to tribal groups and vulnerable sub-populations- Amish, immigrant Asians, African Americans).
- ◆ To establish the efficacy of and use aquatic and other species as sentinels for human health effects.
- ◆ To determine population risk from contaminant exposure to a species or an ecosystem.

# The Basis for Biomonitoring Ecological Receptors

- ◆ **Microbial Oxidation of Anthropogenic Compounds- Biotransformation, Biodegradation, Mineralization**
- Tremendous variety of microorganisms that have the ability to use pollutants such as alcohols, fuels and solvents as well as natural organic detritus as a source of energy.
- - The rate of microbial degradation decreases for contaminants with;
  - ✓ Increasing molecular weight.
  - ◆ ✓ Lower solubility in water.
  - ◆ ✓ Increasing number of aromatic rings.
  - ◆ ✓ Increasing numbers of branches.
  - ◆ ✓ The number of halogen atoms in their make-up (chlorine, fluorine, bromide etc.)





# The Basis for Biomonitoring Ecological Receptors-Continued

- ◆ Increasing concentrations of contaminants in sediments and water leads to bioconcentration and accumulation in aquatic organisms.
- Bioconcentration – The process of aquatic organisms accumulating chemicals from water only.
- Bioaccumulation - The process of aquatic organisms accumulating chemicals from both water and food.
- Bioconcentration Factor- (BCF) – The ratio of the concentration of a chemical in an organism to the concentration of that chemical in seawater, freshwater or brackish water.

Therefore-

$$\frac{\text{mg of chemical/kg of organism}}{\text{mg of chemical in solution/Liter}} = \text{Liter/kg}$$




# Bioconcentration and accumulation modeling

- ◆ BCF can be an observed ratio or be the prediction of a partitioning model.

## - Modeling Assumptions

- ✓ 1. Pollutant chemicals partition in passive way between water and the organism.
- 2. Chemical equilibrium exists.

These assumptions are most valid for lipophilic (hydrophobic) chemicals- they are more rapidly exchanged between the water and organism than they are excreted or biodegraded by the organism.



# Bioconcentration and accumulation modeling-continued

- ◆ Fish Model- Fish is a bag of oil and tissue water. Chemical partitions between the bag and surrounding water according to:
  1.  $K_{ow}$  which is the reciprocal of the chemicals water solubility.
  2. The lipid content of the fish.

--log BCF = 2.791 – 0.564 log S where S is Water Solubility in ppm This formula has been determined using Brook and Rainbow Trout, Sunfish, Flathead Catfish

- ◆ **Bioaccumulation** Models are Kinetic and depend on the dynamics of intake, storage, metabolic transformation and excretion of specific chemicals in specific organisms.

-Use a first order kinetic model to estimate the depuration (cleansing) or partial removal of a contaminant from a fish given a specific contaminant concentration so

- $C = C_0 e^{-kt}$  Where C is the concentration at any time t,  $C_0$  is the initial concentration, k is the first order rate constant and t is the time.