CVEN 4474/5474 Haz Waste Outline

- Ecotoxicology
- Uncertainty

Challenges of Eco-Toxicity

- Vast array of species are important
  - –Plants, fish, birds, mammals, insects
  - –All in a “food web” so all important
- Wide range of tolerance
  - –Aquatic species 100% time “in” water
  - –Biomagnification

Biomagnification

- Many toxic organics accumulate in fat tissues (due to high Kow, low solubility)
- Bioconcentration Factor, BCF = conc in biota, mg/kg **/** conc in water, mg/L
- BCF range $10^{1.3}$ to $10^{4.7}$ (see App. A txt)
- Biomagnification = increased conc in animals at higher levels in food chain

“Water Safe to drink proves deadly to frogs”

- Jan 7, 2000 Denver Post (AP)
- Nitrates typical of fertilizer run-off
  - –(<10 mg/L drinking water limit)
- Tadpoles and young frogs
- Ate less, developed physical abnormalities, suffered paralysis, eventually died

Protecting aquatic ecosystems: clean water is not enough

- Biological components of water resources are in steep decline
- Lists of chemicals not adequate
- Chemical criteria should vary geographically based on “baseline” conditions
- Lack of data on many species
- Lack of true “baseline” conditions

Endpoints for Eco Risk Assess.

- Individual toxicity effects:
  - –Death (LC50), growth, symptoms, fertility
- Population toxicity effects:
  - –Numbers, age distribution, reproductivity
- Community toxicity effects:
  - –Number of species, species diversity

Ecological Screening Values

- Contaminant levels with a low probability of unacceptable ecological risks
- Use to determine if further evaluation is needed
- Based on type of ecosystem present
  - –Surface water (fresh and salt water)
  - –Sediment
  - –Soil
  - –Wildlife tissues
  - –Groundwater
- Screening values may be pH, hardness dependent

Ecological Risk Assessment (same steps as human risk assess)

- Characterize baseline ecology, receptor populations
  - –Diversity, sensitive populations, indicator species
- Ecological toxicity assessment
  - –Qualitative and quantitative endpoints (lethal, reproductive effects, etc)
- Evaluate potential exposures
  - –Exposure pathway, exposure point concentrations
- Risk Characterization

Example: Milltown Reservoir

- Focused on wetland areas
- Characterization
  - – Plants typical of Montana riparian wetlands
  - – Wildlife: waterfowl, muskrat, beaver, deer, fish
  - – Threatened: grey wolf, grizzly, bald eagle, Peregrine falcon
- Key Concerns
  - – Elevated metals in sediments may impact benthic ecology
  - – Metals in water, sediment, and benthic invertebrates may impact fish (to higher levels)
  - – Small mammals consume vegetation and elevated metals in plants

Milltown (cont.)

- Chemicals of Concern selected (Cu, Zn, As, Cd, Pb)
- Exposure assessment
  - – Ex: Cu, Cd, Zn elevated in pore water and sediment
- Biological effects assessment
  - – Ex: Pb, Cu, Zn most toxic based on literature
  - – Ex: toxicity observed in tests with sediment & trout
- Risk characterization
  - – Ex: waterfowl not at risk from As since est. intakes of 0.01-0.2 mg/kg-d below 5 mg/kg-d associated with no adverse effects to mallards

Uncertainty with Risk Assessments

- Bruce Ames "…pollution appears to account for less than 1% of human cancer; yet public concern [is] very high, in good part because of wrong assumptions… This has successfully diverted responses from important risks to trivia."
- McClain, PhD, Hoffmann-LaRoche "since approx. 50% of all chemicals tested exhibit carcinogenic activity in the rodent bioassay, the relevance of so many positives under high dose conditions has been debated."
- Richard Wilson, Hard University "[EPA} insisted on "acceptable level" of risk so small (1 in a million per lifetime) that it cannot be used consistently. As a result, risk management has become arbitrary and capricious."

Common assumptions are highly conservative or not?

- Factor of 10s used from animals to humans, sensitive humans,…..
- Low dose effects extrapolation
- Retention and conversion in body
  - –To less or more toxic forms?
- Environmental transformations
  - –To less or more toxic forms?
- Body weight, inhaled air rate, water consumption rate, etc.