## Overview of Radiation and Chemical Ecological Risk Assessment Models and Guidance for Contaminated Sites and Selected Default Input Parameters

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### Superfund

- Comprehensive Environmental Response Compensation and Liability Act (CERCLA)
- Superfund Program → Contaminated
   Site Cleanup
- Lack of Consensus on detection and modeling for biota
- EPA → "Ecological Benchmarks for Radionuclides" calculator for
   Superfund site assessments



### Ecological Risk Assessment Framework



### **Biota Dosimetry Overview**

- International Atomic Energy Agency (IAEA) and the International Commission on Radiological Protection (ICRP)
- Internal vs. External Exposures
- Dose Conversion Coefficients (DCC)
- Absorbed Fraction



International Commission

on Radiological Protection

### Model References for Biota

- ICRP's Reference Animals and Plants
  - Deer, Rat, Duck, Frog, Trout, Flatfish, Bee, Crab, Earthworm, Pine Tree, Wild Grass, Brown Seaweed
- DOE's Organism Wizard

| Select a geometry for this organism. The geometry determines the dose<br>conversion factors that will be used for this organism. |                      |           |               |        |  |   |                        |                 |
|--|----------------------|-----------|---------------|--------|--|---|------------------------|-----------------|
| Γ  | - Use def<br>geometr | ault<br>y | · · ·         |        |  | -7] (   | 220 100.               | not to sca      |
| 1 2 3 4 3 0 7 0 220×100×100 cm   |                      |           |               |        |  |   |                        |                 |
|  | Geometru             | Mass (kg) | Evample Rec   | entors | Beference  |   | this organism          | Dimensions (cm) |
| •  | 8                    | 1000      | Grizzly bear* |        | Wild Mamr<br>America, 1<br>J.A. Chapn<br>G.A. Feldh<br>Johns Hop<br>Baltimore. | hals of Nort<br>1982.<br>Ian and<br>amer, editor<br>kins Univer | h<br>s.<br>sity Press, | 220 x 100 x 100 |
|  |                      |           |               |        |  |   |                        |                 |
|  |                      |           |               |        |  |   |                        |                 |

| Veight<br>Based on the geometry selection, a<br>suggested weight has been entered. This<br>weight may be changed. The user-defined<br>weight is used only for purposes of allometric<br>modeling. The geometry does not change. | Internal Ingestion Parameters<br>Select which organism you wish to derive the<br>internal ingestion parameters from for this<br>organism. These paramaters include biv's<br>and exposure geometries.<br>© Generic Terrestrial Animal<br>© Generic Terrestrial Plant<br>© Generic Riparian Animal<br>© Generic Aquatic Animal |
|---|--|
| Help  | Back   |

### **Risk Assessment Information System (RAIS) for Chemical and Radionuclide Models**

Select Benchmark Sources (select at least one)

New Jersey ×

Select All Benchmark Sources

Select Media (select at least one)

| Air ×  | Biota ×   |
|--------|-----------|
| Sedim  | ent ×     |
| Soil × |           |
| Surfac | e Water × |
|        |           |

#### Select All Media

Select Individual Chemicals (200 maximum)

~





# Primary Radionuclide Models

The ERICA Tool



Google Scholar ERICA tool

Articles About 448,000 results (0.08 sec)

### **RESRAD-BIOTA**

| Sensitivity Analysis Help  |  |  |
|--|--|--|
|  | Data Assembly                          |  |
| Ecosystem     Level     Units:       Tenestrial     Aquelic     0  | 2 General Screening                    | Compare media<br>concentrations with Biota<br>Concentration Guides, BCGs<br>(RESRAD-BIOTA Level 1) |
| -Nuclides<br>Potential<br>Contaminants<br>Data<br>Data<br>Contaminants<br>Data<br>Contaminants<br>Data<br>Contaminants<br>Data<br>Contaminants<br>Contaminants<br>Description<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contaminants<br>Contami | 3 Analysis<br>Site-Specific            | Site-representative parameters   |
| Bar H40<br>Ce-141<br>Ce-144<br>Cm-242<br>Cm-244<br>Co-58 ▼   | Screening<br>Site-Specific<br>Analysis | (RESRAD-BIOTA Level 2)<br>Kinetic/allometric modeling tool<br>(RESRAD-BIOTA Level 3)               |
| Concentration:     View       Sedment     Water:     Soit       1     1     Alpha       Bq/kg     Bq/kg     Bq/kg  | Site-Specific Biota<br>Dose Assessment | Collection of biota using<br>eco-risk protocols  |
|  | The Graded Approach                    | RESRAD-BIOTA Levels  |
|  |  |  |
|  |  |  |

### **The FASSET Project**



### ECOMOD





### **Other Radionuclide Models**



#### **England and Wales EA**

More limited, adapted by ERICA and FASSET



#### **EDEN**

Small French model for ionizing radiation



### CASTEAUR

Specific to river radionuclide concentrations from nuclear installations



#### DosDiMEco

Calculates energy absorption of reference organisms



LAKECO-B

Dutch model to estimate radionuclide concentrations in lakes and reservoirs



#### FASTer

Considers food chain transfer parameters to improve FASSET



### In the Field

• ERICA effective in predicting dose rates on marine organisms exposed by a decommissioned offshore oil and gas pipeline in Australia

- Success in radioactive biota detection in areas including Fukushima and Chernobyl
- However, field conditions add a level of uncertainty which prevents a full mechanistic understanding from field strategies



### **Grand Summary Table**

| Rad Model    | User Information  | Biota Covered  |
|--------------|---|--|
| RESRAD-BIOTA | RESRAD-BIOTA: A Tool<br>for Implementing a Graded<br>Approach to Biota Dose<br>Evaluation. User's Guide,<br>Version 1. (DOE Report No.<br>DOE/EH-0676; ISCORS<br>Technical Report 2004-02,<br>January 2004) | Organisms classified by: terrestrial animal, terrestrial plant, aquatic animal, riparian animal.<br>Organism parameters can then be inputed, new organisms can be added using the Organism<br>Wizard.  |
| ERICA        | ERICA Assessment Tool<br>Help Function Document   | Default Reference Organisms (page 14):<br><b>Freshwater</b> : amphibian, benthic fish, bird, crustacean, insect larvae, mammal, mollusc-<br>bivalve, mollusc – gastropod, pelagic fish, phytoplankton, reptile, vascular plant, zooplankton<br><b>Marine</b> : benthic fish, bird, crustacean, macroalgae, mammal, mollusc- bivalve, pelagic fish,<br>phytoplankton, polychaete worm, reptile, sea anemones & true coral, vascular plant,<br>zooplankton<br><b>Terrestrial</b> : amphibian, annelid, arthropod – detritivorous, bird, flying insect, grasses &<br>herbs, lichen & bryophytes, mammal – large, mammal- small-burrowing, mollusc –<br>gastropod, reptile, shrub, tree<br>Screen dose-rates found on page 15. |

### Grand Summary Table (cont.)

| FASSET   | Handbook for Assessment of<br>the Exposure of Biota to<br>Ionising Radiation from<br>Radionuclides in the<br>Environment | Reference organisms defined by their habitat: forest, semi-natural pasture and<br>healthland, agriculture, freshwater, marine, brackish waters, and rivers<br>Transfer Factors and DCCs for organisms in these ecosystems can be found on <b>pages</b><br><b>57-80</b> |
|----------|--|--|
| ECOMOD   | ECOMOD — An ecological<br>approach to radioecological<br>modelling   | Used in aquatic ecosystems: main organisms include phytoplankton, macroalgae, zooplankton, and fish of different feeding and living habits   |
| EDEN     | E.D.E.N.: A tool for the<br>estimation of dose<br>coefficients for non-human<br>biota                                    | Study system is defined within the tool. Shape of organisms (ellipses) and media, their composition, and radioactive sources (page S923).  |
| CASTEAUR | CASTEAUR: A tool for<br>operational assessments of<br>radioactive nuclides transfers<br>in river ecosystems              | Considers main biotic components of river ecosystems: phytoplankton, zooplankton, macrobenthos and fish (planktivorous and omnivorous)   |



### Help us out!

Do you know of any other ecological risk assessment models for radioactive or chemical contaminants that are not mentioned in this presentation?

If it is publicly available, please provide information on it (e.g., name of government agency, university, company, etc) and how to obtain it (e.g., website, contact name and phone number)

Any other questions?

### **Acknowledgements**



Sources available upon request.