

Beaverlodge Scenario Approach Using RESRAD-BIOTA

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Beaver Lodge Exercise Phase II

- Provided water or/and sediment concentrations for five radionuclides (Pb-210, Po-210, Ra-226, Th-230, and U-238).
- Measured activity concentration for fish species provided in some cases
- The samples were collected from 1995 – 2008 at 6 areas at 15 sites
- Six areas are:
 - Beaver lodge Lake
 - Cluff Lake
 - Gunnar Mine Site
 - Key Lake
 - McClean Lake
 - Rabbit Lake
- Calculate whole body activity concentration and weighted absorbed dose rates for fish and invertebrates.



Methodology and Assumptions

- Used Probabilistic RESRAD-BIOTA
- Used distributions for water concentration, sediment concentration, and tissue concentrations (if available)
- If water or sediment concentration not available used conservative K_d values to estimate activity concentrations
- Used probabilistic Biv values



Input Parameters for Model Run

DOSIMETRY - Weighting factors for absorbed dose rates

Internal alpha	1.00E+01	to be consistent with other models
Internal beta gamma	1.00E+00	
Internal low beta	1.00E+00	

DOSIMETRY - Daughters explicitly included

Pb210	Bi-210 (100%)	Po-210 (100%)			
Po210	X	X	X	X	X
Ra226	Rn-222	Po-218	Bi-214	Pb-214 & Po-214	At-218 & Tl-210
Th230					
U-238	Th-234	Pa-234	Pa-234m		
U-235	Th-231				
U-234					

It was assumed U-238, U-234 and U-235 were present in their natural activity concentration ratio of 1:1:0.046.

Pb-210: Bi-210 and Po-210 was assumed to be in secular equilibrium with Pb-210.

Ra-226: Rn-222, Po-218, Bi-214 at the same conc. as Ra-226, Bi-214 and Po-214 at 99.98% of Ra-226 conc. And At-218 and Tl-210 at 0.02% of Ra-226 conc.

U-238: Th-234 at the same concentration as U-238, Pa-234m at 99.8% and Pa-234 at 0.33% of U-238 concentration.

U-235: At 4.6% of U-238 concentration. Th-231 at the same concentration as U-235

U-234: At the same concentration as U-238



Input Parameters for Model Run, cont'd

GEOMETRY, MASS, & OCCUPANCY FACTORS

	Geometry (cm)	Mass (g ww)	Occupancy-Biota run	
	Length x height x width		% water / %sediment	Geometry - used
Pelagic (e.g. Northern pike & Lake Trout)	50 x 15 x 10	1200	87.5/12.5	4
Benthic Fish - Large (White sucker & Lake whitefish)	45 x 15 x 10	1191	65/35	4
Benthic Fish - Small (Lake chub)	6.8 x 1.5 x 1	4.5	90/10	Ext -2 and Int -3
<i>Benthic Invertebrates (Chironomus riparius)</i>	0.34 x 0.17 x 0.15	0.12	62.5/37.5	1
Benthic Invertebrates (<i>Pisidium sp.</i>)	2.5 x 1.5 x 1	1.6	75/25	2
Benthic Invertebrates (Caddisfly, <i>Nemotaulius sp.</i>)	3.5x1.46x1.46	1.75	75/25	2



Assumptions for Model Run

Species	Biv - used	Pb-210	Po-210	Ra-226	Th-230	Uranium
Pelagic (e.g. Northern pike & Lake Trout)	Pelagic fish	Exponential	Exponential	Bounded Lognormal	Bounded Lognormal	Bounded Lognormal
Benthic Fish - Large (White sucker & Lake whitefish)	Benthic fish	Exponential	Exponential	Bounded Lognormal	Bounded Lognormal	Bounded Lognormal
Benthic Fish - Small (Lake chub)	Benthic fish	Exponential	Exponential	Bounded Lognormal	Bounded Lognormal	Bounded Lognormal
<i>Benthic Invertebrates (Chironomus riparius)</i>	Insect Larvae	Exponential	Exponential	Exponential	Exponential	Exponential
<i>Benthic Invertebrates (Pisidium sp.)</i>	Bivalve Mollusc	Exponential	Bounded Lognormal	Bounded Lognormal	Exponential	Exponential
<i>Benthic Invertebrates (Caddisfly, Nemotaulius sp.)</i>	Insect Larvae	Exponential	Exponential	Exponential	Exponential	Exponential

*For exponential distribution parameter required is lambda (=1/mean) and for bounded lognormal distribution parameter required are mean, error factor, minimum, and maximum



RESRAD-BIOTA Inputs for Contamination at Beaverlodge Lake

RESRAD-BIOTA - R:\Biota\Development\Sunita\canada-all-species-beaverlodge-lake-tot (2).bio

File View Sensitivity Analysis Uncertainty Analysis Help

BIOTA Case
 Title: Canada-all-species-beaverlodge-lake-tot [Run]
 Ecosystem: Terrestrial Aquatic
 Level: 1 2 3
 Units: Traditional SI

Nuclides
 Potential Contaminants: Am-241, Ba-140, C-14, Ce-141, Ce-144, Cf-252
 Contaminants: Pb-210, Ra-226, U-234, U-235, U-238
 Concentration: Sediment: 15840 Bq/kg; Water: 60 Bq/m³; Soil: 0 Bq/kg
 Kd: 2.64e5
 Mean L/kg

Organism
 Type: Benthic fish-large, Benthic fish-small, Bivalve-mollusc, Caddisfly, Insect-larvae, pelagic fish
 RBE's: Alpha: 10, Beta: 1, Gamma: 1
 Cut-off Half-life: 180 Days

Organism-Specific Parameters
 Organism: Sensitivity Analysis Uncertainty Analysis
 Selected Organisms: Benthic fish-large, Benthic fish-small, Bivalve-mollusc, Caddisfly, Insect-larvae, pelagic fish
 Organism Name: Benthic fish-large
 DCF / Exposure Input Source Input Reference
 DCFs(Gy/y)/(Bq/kg)

Nuclide	External	Internal
Pb-210	3.42E-08	2.75E-04
Ra-226	7.99E-06	1.23E-03
U-234	1.20E-09	2.44E-04
U-235	7.82E-07	2.24E-04
U-238	2.58E-07	2.19E-04

 Internal Size: 4
 External Size: 4
 Dose Limit: 0.01 Gy/d
 Area Factor: 1
 External Exposure Geometry Factors:

	Sediment	Water	Soil
Ingestion:	0.35	0.65	0

 Ingestion:

RBE and cutoff half-life adjusted

Sediment concentration calculated from Maximum Pb-210 Kd in Beaverlodge lake area

Occupancy factors for water and sediment



Uncertainty Analysis Setup in the RESRAD-BIOTA Code

Uncertainty Analysis Input Summary

Sample specifications | Parameter distributions | Input Rank Correlations | Output specifications

Sample specifications

Sampling parameters

Random Seed: 1000

Number of Observations: 1500

Number of Repetitions: 1

Information about current selection

The random seed determines the series numbers that are generated. Specific seed will permit the same set of input parameters generated if the simulation needs to be repeated.

Sampling Technique

Latin Hypercube

Monte Carlo

Grouping of observations

Correlated or Uncorrelated

Random

Perform uncertainty analysis

Suppress uncertainty analysis this session

Help

Uncertainty Analysis Input Summary

Sample specifications | **Parameter distributions** | Input Rank Correlations | Output specifications

Variable Description

Water BIV of Pb-210 in Benthic fish-large
Water BIV of Pb-210 in Benthic fish-small
Water BIV of Pb-210 in Bivalve-mollusc
Water BIV of Pb-210 in Caddisfly
Water BIV of Pb-210 in Insect-larvae
Water BIV of Pb-210 in pelagic fish
Water BIV of Po-210 in Benthic fish-large
Water BIV of Po-210 in Benthic fish-small
Water BIV of Po-210 in Bivalve-mollusc
Water BIV of Po-210 in Caddisfly
Water BIV of Po-210 in Insect-larvae
Water BIV of Po-210 in pelagic fish
Water BIV of Ra-226 in Benthic fish-large
Water BIV of Ra-226 in Benthic fish-small
Water BIV of Ra-226 in Bivalve-mollusc
Water BIV of Ra-226 in Caddisfly
Water BIV of Ra-226 in Insect-larvae
Water BIV of Ra-226 in pelagic fish
Water BIV of Th-230 in Benthic fish-large
Water BIV of Th-230 in Benthic fish-small
Water BIV of Th-230 in Bivalve-mollusc
Water BIV of Th-230 in Caddisfly
Water BIV of Th-230 in Insect-larvae

Statistics of Uncertain variable

Water BIV of Ra-226 in Benthic fish-small

Distribution: BOUNDED LOGNORMAL

Default

Mean: 80

Error Factor (Erf): 6.5

Minimum: .3

Maximum: 810

Previous parameter

Next parameter

Remove parameter | Distribution Help | Restore Default

Perform uncertainty analysis

Suppress uncertainty analysis this session

Help | OK

