Modeling Beaverlodge Scenario Using RESRAD-BIOTA Code

Dr. Charley Yu
Dr. Sunita Kamboj
Environmental Science Division
Argonne National Laboratory

EMRAS II Biota Modeling Group

January 25-29, 2010

Beaver Lodge Exercise Description

- Provided water and sediment concentrations for five Radionuclides (Pb-210, Po-210, Ra-226, Th-230, and U-238).
- The samples were collected from 2001 – 2006 at 16 sites in four study areas.
- Four study areas are:
  - Beaver lodge Lake
  - Ace Creek Watershed
  - Lake Athabasca
  - Fulton Creek Watershed
- Calculate whole body activity concentration for four species:
  - White Sucker
  - Lake White Fish
  - Finger Nail Clam
  - Chironomus Sp.

Methodology and Assumptions

- Used probabilistic RESRAD-BIOTA V.1.5
- Used water concentration – distribution or fixed values except for Dubyna lake
- Used probabilistic Biv values
- For Lake White Fish and White Sucker used default Biv for Benthic fish
- For Chiromus sp. used default Biv for Insect Larvae
- For Finger Nail Clam used default Biv for Bivalve Mollusc

Specific Analysis Details

- For calculating biota concentrations in Dubyna Lake (shallow) where there was no water concentration available, Kd values were used along with sediment concentrations
- Kd values calculated from the water and sediment concentrations provided for Dubyna Lake Deep location

Radionuclides	**kd value* (L kg-1 for sediment)**
Pb210	6.12E+05
Po210	9.93E+05
Ra226	5.48E+04
Th230	1.74E+05
U-238	6.49E+04

Benthic Fish Biv Distribution

Radionuclide	Distributions	Distribution Parameters*			
Pb210	Exponential	3.33E-03			
Po210	Exponential	4.17E-03			
Ra226	Bounded Lognormal	80	6.3	0.3	810
Th230	Bounded Lognormal	110	4	15	560
U-238	Bounded Lognormal	30	8.95	0.3	200

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

Bivalve Mollusc Biv Distribution

Radionuclide	Distribution	Distribution Parameters*			
Pb210	Exponential	5.88E-04			
Po210	Bounded Lognormal	3.80E+04	528	3100	73200
Ra226	Bounded Lognormal	1500	4.27	330	2700
Th230	Exponential	1.00E-02			
U-238	Exponential	5.56E-03			

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

Insect Larvae Biv Distribution

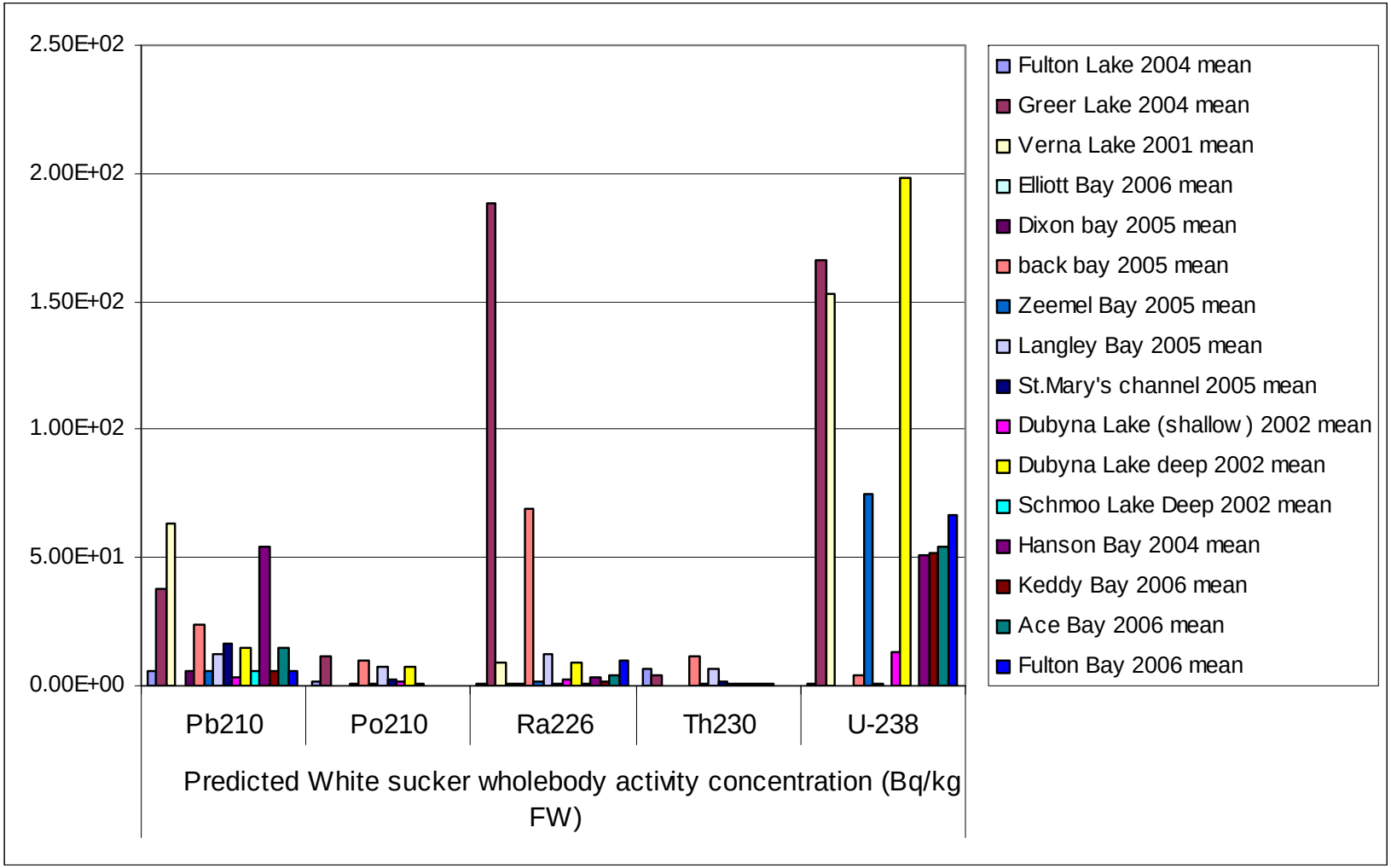
Radionuclide	Distribution	Distribution Parameter*
Pb210	Exponential	1.00E-04
Po210	Exponential	1.01E-04
Ra226	Exponential	6.67E-04
Th230	Exponential	1.00E-02
U-238	Exponential	2.00E-03

*For exponential distribution parameter required is lambda (=1/mean)

Predicted White Fish and White Sucker Whole Body Average Activity Concentration (Bq/kg FW)

Area	Site	Pb-210	Po-210	Ra-226	Th-230	U-238
Fulton creek watershed	Fulton Lake	6.02E+00	1.79E+00	5.68E-01	6.97E+00	4.24E-01
Fulton creek watershed	Greer Lake	3.76E+01	1.19E+01	1.88E+02	3.73E+00	1.66E+02
Ace Creek Watershed	Verna Lake	6.33E+01		8.77E+00		1.53E+02
Lake Athabasca	Elliott Bay			6.14E-01		6.77E-02
Lake Athabasca	Dixon bay	6.02E+00	1.19E+00	4.39E-01	1.07E-01	1.35E-01
Lake Athabasca	back bay	2.41E+01	9.54E+00	6.93E+01	1.17E+01	3.72E+00
Lake Athabasca	Zeemel Bay	6.02E+00	1.19E+00	1.75E+00	1.07E+00	7.45E+01
Lake Athabasca	Langley Bay	1.21E+01	7.13E+00	1.23E+01	6.93E+00	4.40E-01
Lake Athabasca	St.Mary's channel	1.66E+01	2.38E+00	5.27E-01	1.60E+00	3.71E-01
Ace Creek Watershed	Dubyna Lake (shallow)	3.49E+00	1.44E+00	2.42E+00	4.53E-01	1.35E+01
Ace Creek Watershed	Dubyna Lake deep	1.51E+01	7.16E+00	8.77E+00	1.07E+00	1.98E+02
Ace Creek Watershed	Schmoo Lake Deep	6.02E+00	1.19E+00	4.39E-01	1.07E+00	2.71E-01
Beaverlodge Lake	Hanson Bay	5.41E+01		3.67E+00	1.07E+00	5.12E+01
Beaverlodge Lake	Keddy Bay	5.99E+00		1.31E+00	1.07E+00	5.16E+01
Beaverlodge Lake	Ace Bay	1.50E+01		3.95E+00		5.43E+01
Beaverlodge Lake	Fulton Bay	5.99E+00		1.01E+01		6.67E+01

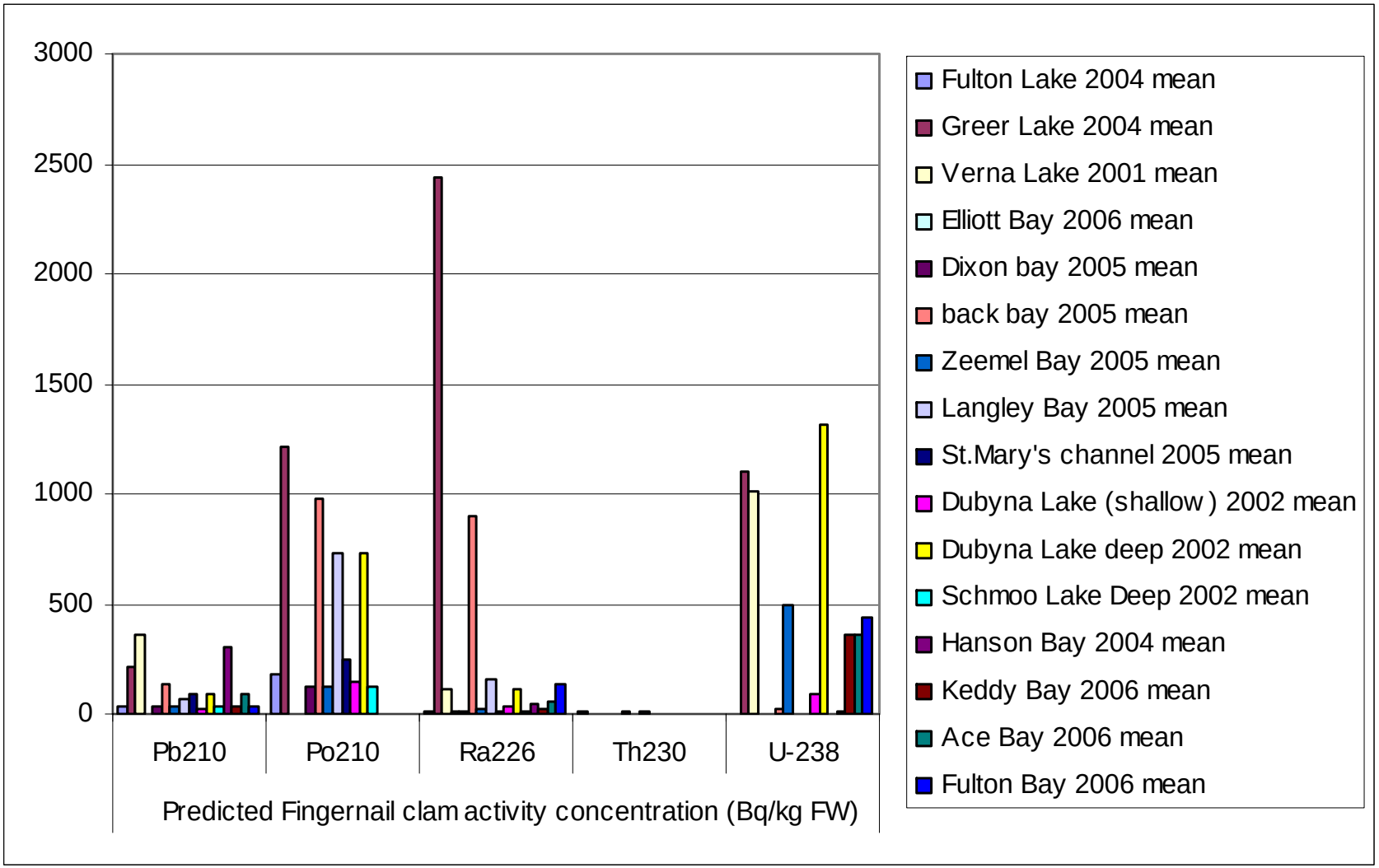
Predicted White Fish and White Sucker Whole Body Average Activity Concentrations at Different Sites



Predicted Finger Nail Clam Whole body Average Activity Concentration (Bq/kg FW)

Area	Site	Pb-210	Po-210	Ra-226	Th-230	U-238
Fulton creek watershed	Fulton Lake	3.39E+01	1.83E+02	7.38E+00	6.44E+00	2.79E+00
Fulton creek watershed	Greer Lake	2.12E+02	1.22E+03	2.44E+03	3.51E+00	1.11E+03
Ace Creek Watershed	Verna Lake	3.56E+02		1.14E+02	0.00E+00	1.01E+03
Lake Athabasca	Elliott Bay			7.95E+00	0.00E+00	4.47E-01
Lake Athabasca	Dixon bay	3.39E+01	1.22E+02	5.68E+00	1.00E-01	8.94E-01
Lake Athabasca	back bay	1.36E+02	9.79E+02	8.97E+02	1.10E+01	2.46E+01
Lake Athabasca	Zeemel Bay	3.39E+01	1.22E+02	2.27E+01	1.00E+00	4.92E+02
Lake Athabasca	Langley Bay	6.78E+01	7.35E+02	1.59E+02	6.48E+00	2.92E+00
Lake Athabasca	St.Mary's channel	9.31E+01	2.44E+02	6.81E+00	1.50E+00	2.45E+00
Ace Creek Watershed	Dubyna Lake (shallow)	1.96E+01	1.48E+02	3.10E+01	4.23E-01	9.12E+01
Ace Creek Watershed	Dubyna Lake deep	8.47E+01	7.35E+02	1.14E+02	1.00E+00	1.31E+03
Ace Creek Watershed	Schmoo Lake Deep	3.39E+01	1.22E+02	5.68E+00	1.00E+00	1.79E+00
Beaverlodge Lake	Hanson Bay	3.07E+02		4.77E+01	1.00E+00	9.87E+00
Beaverlodge Lake	Keddy Bay	3.39E+01		1.71E+01	1.00E+00	3.59E+02
Beaverlodge Lake	Ace Bay	8.47E+01		5.40E+01		3.59E+02
Beaverlodge Lake	Fulton Bay	3.39E+01		1.31E+02		4.43E+02

Predicted Fingernail Clam Whole Body Average Activity Concentrations at Different Sites



Predicted Chironomus sp. Whole body Average Activity Concentration (Bq/kg FW)

Area	Site	Pb-210	Po-210	Ra-226	Th-230	U-238
Fulton creek watershed	Fulton Lake	1.99E+02	7.38E+01	9.81E+00	6.56E+00	7.66E+00
Fulton creek watershed	Greer Lake	1.24E+03	4.92E+02	3.24E+03	3.51E+00	3.03E+03
Ace Creek Watershed	Verna Lake	2.09E+03		1.51E+02	0.00E+00	2.77E+03
Lake Athabasca	Elliott Bay	0.00E+00		1.05E+01	0.00E+00	1.23E+00
Lake Athabasca	Dixon bay	1.99E+02	4.90E+01	7.53E+00	1.00E-01	2.45E+00
Lake Athabasca	back bay	7.97E+02	3.92E+02	1.19E+03	1.10E+01	6.74E+01
Lake Athabasca	Zeemel Bay	1.99E+02	4.90E+01	3.01E+01	1.00E+00	1.35E+03
Lake Athabasca	Langley Bay	3.97E+02	2.96E+02	2.11E+02	6.52E+00	7.97E+00
Lake Athabasca	St.Mary's channel	5.51E+02	9.79E+01	9.03E+00	1.50E+00	6.76E+00
Ace Creek Watershed	Dubyna Lake (shallow)	1.15E+02	5.93E+01	4.12E+01	4.23E-01	2.50E+02
Ace Creek Watershed	Dubyna Lake deep	4.98E+02	2.94E+02	1.51E+02	1.00E+00	3.59E+03
Ace Creek Watershed	Schmoo Lake Deep	1.99E+02	4.90E+01	7.53E+00	1.00E+00	4.90E+00
Beaverlodge Lake	Hanson Bay	1.79E+03		6.30E+01	1.00E+00	9.28E+02
Beaverlodge Lake	Keddy Bay	1.99E+02		2.24E+01	1.00E+00	9.80E+02
Beaverlodge Lake	Ace Bay	4.97E+02		6.76E+01		9.83E+02
Beaverlodge Lake	Fulton Bay	1.99E+02		1.72E+02		1.21E+03

Predicted Chironomus sp. Whole Body Average Activity Concentrations at Different Sites