IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

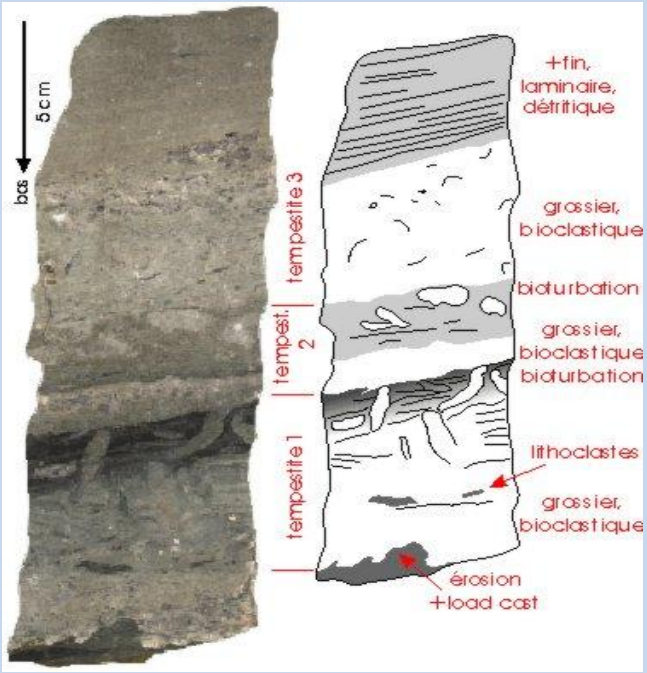
*Faire avancer la sûreté nucléaire*

# heterogeneous vs homogeneous distribution of radionuclides in sediment regarding dose rate calculation

EMRAS II BMG

Vienna January 2011

K. Beaugelin-Seiller




Système de management de la qualité IRSN certifié

# Summary of the previous episodes

## ↗ Context

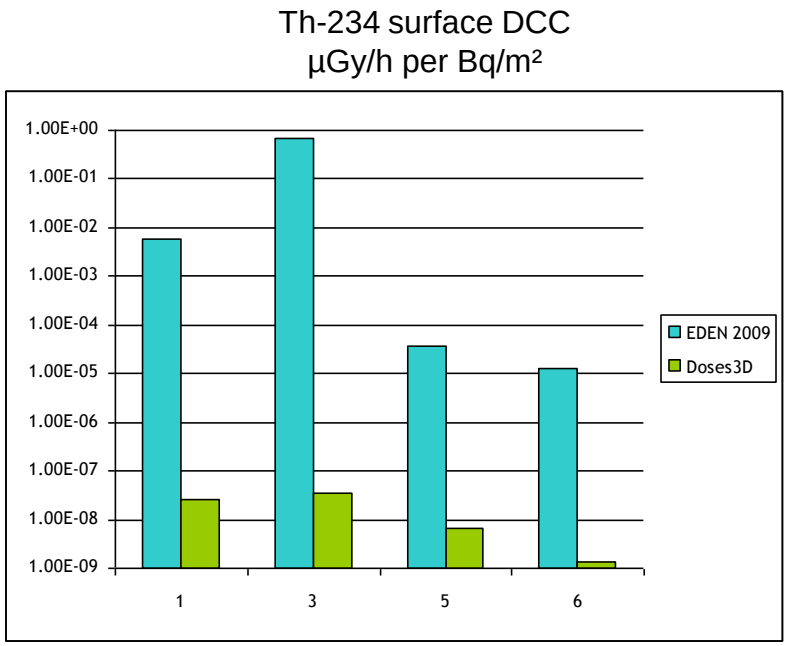
- Sediments heterogeneously contaminated: impact on dose rates for wildlife?
- Available tools consider in general at the best a single layer homogeneously contaminated
- Exceptions: Doses3D and EDEN
  - Possibility to consider at least 1 volume and 1 surface DCC for a same sediment
  - Agreement between surface DCC never tested

## ↗ Definition of common scenarios for the tests

# Summary of the previous episodes

## ↗ Results of comparisons

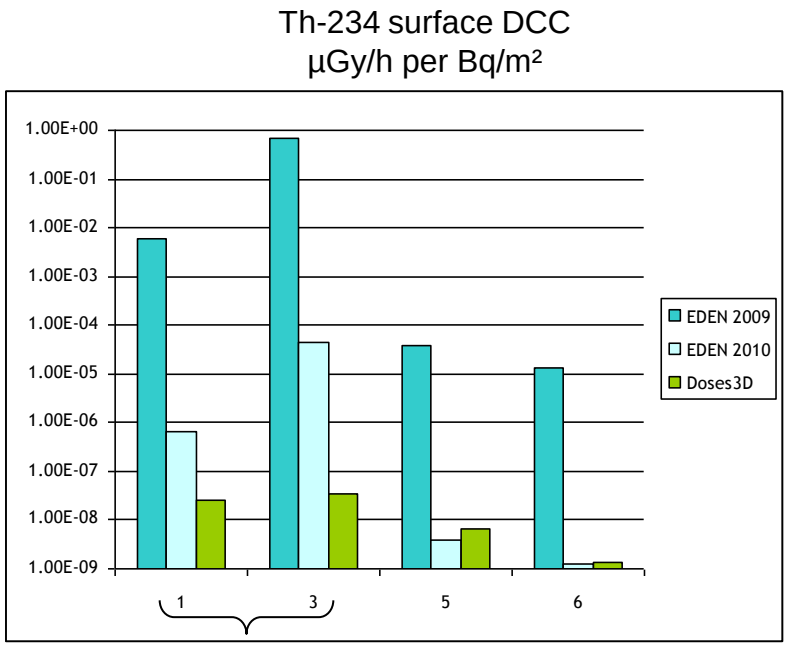
- 1 RN, 2 organisms, 3 locations, 2 DCC types
  - 9 scenarios among which 4 about surface DCCs
- Big discrepancies identified at the first run for surface DCCs
  - Bugs identified in EDEN



# Summary of the previous episodes

## ↗ Results of comparisons

- 1 RN, 2 organisms, 3 locations, 2 DCC types
  - 9 scenarios among which 4 about surface DCCs
- Big discrepancies identified at the first run for surface DCCs
  - Bugs identified in EDEN
- A second run
  - Better convergence but still some differences (organims at the interface )




## ↗ Not possible to go deeper in the comparisons

# Surface DCC calculation

## EDEN Validation


mcnp

# Continuity between volume and surface exposure

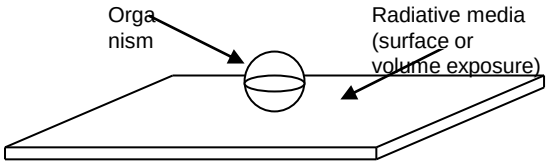
## ↗ Principles

- Basic major mono-energetic DCCs
  - $MeV.g^{-1}.s^{-1}$
- Lagrande interpolation (more energies)
- For a given RN
  - Linear interpolation on its spectrum
  - Total DCC = sum of mono-energetic DCCs

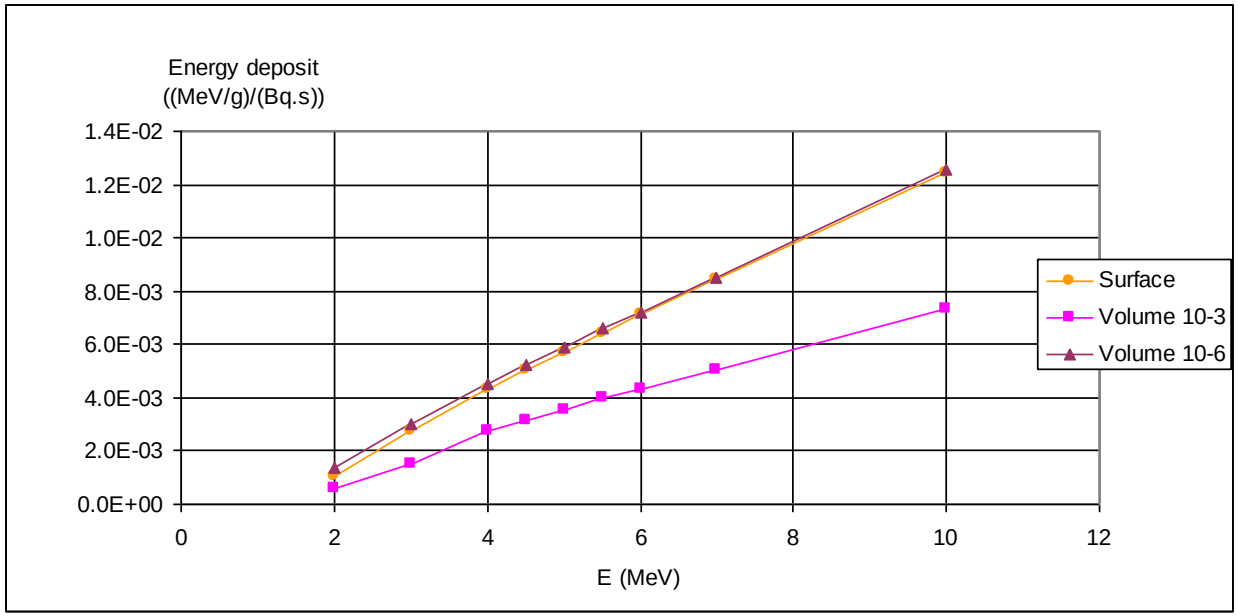
**↗ $MeV.g^{-1}.s^{-1}$ to convert into the appropriate unit**

# Continuity between volume and surface exposure

## ↗ EDEN internal consistency



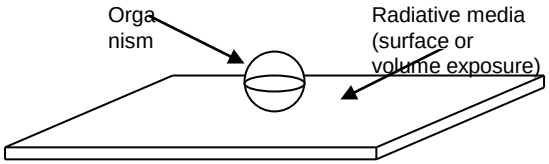

- Alpha radiation
  - V1 : 1 µm ; V2 : 1 mm ; S
  - E : 2 to 10 MeV



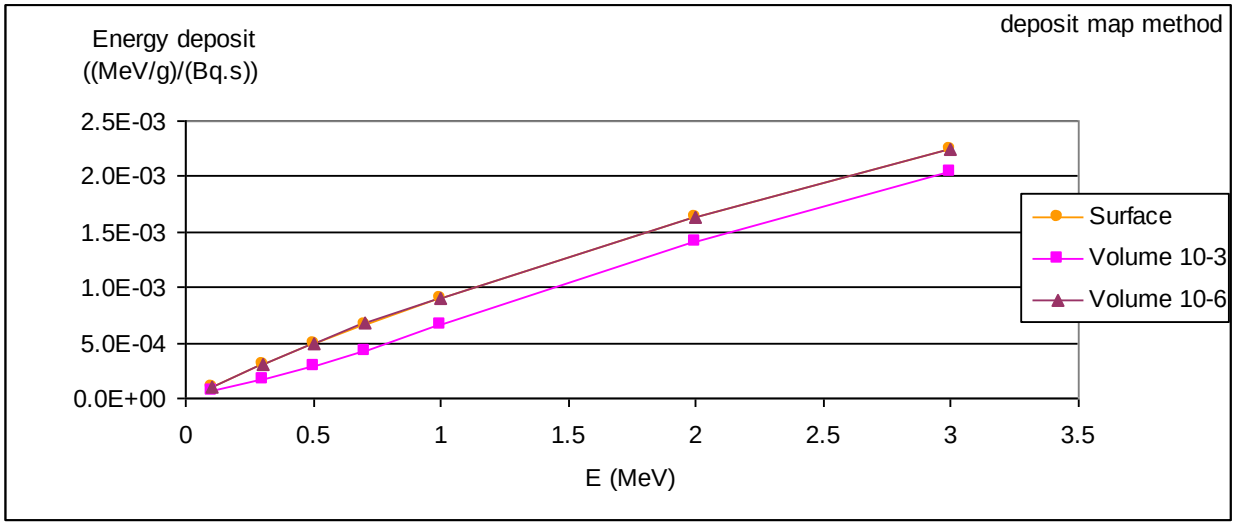

## ↗ Good agreement + influence of the layer thickness

# Continuity between volume and surface exposure

## ↗ EDEN internal consistency




- beta radiation
  - V1 : 1 µm ; V2 : 1 mm ; S
  - Two methods (statistical vs maps)

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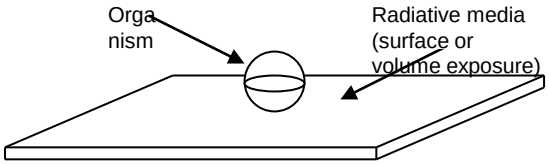
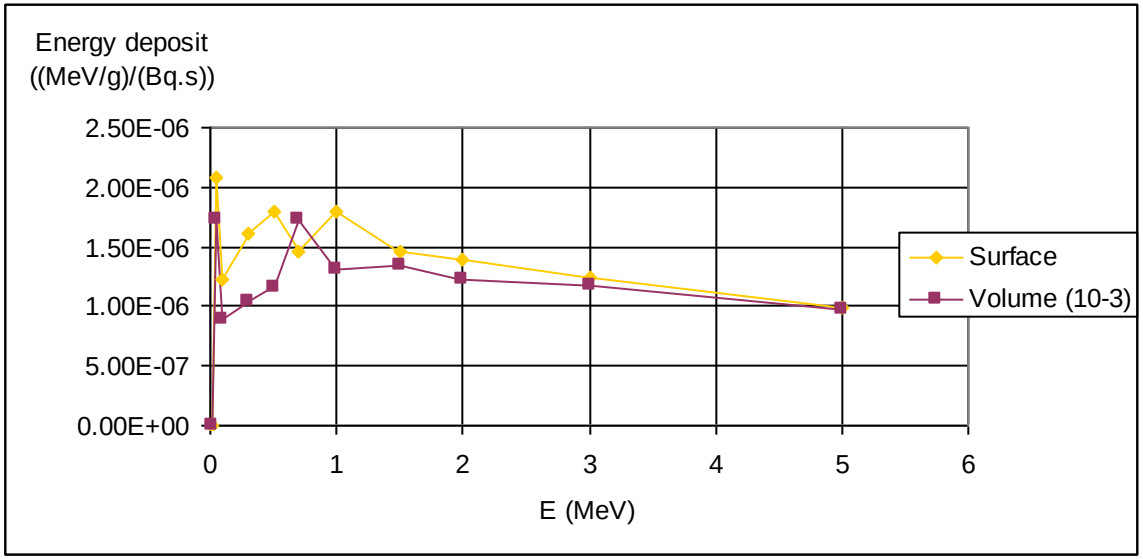
# Continuity between volume and surface exposure

## ↗ EDEN internal consistency




### gamma radiation

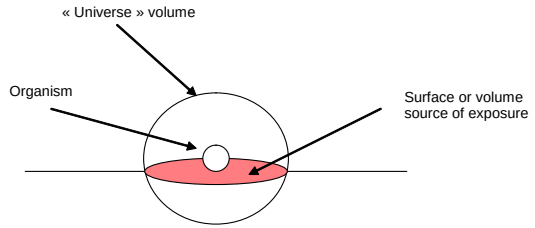
- Three methodes implemented in EDEN
- Result retained : best convergence scheme among the three
- V : 1 mm ; S

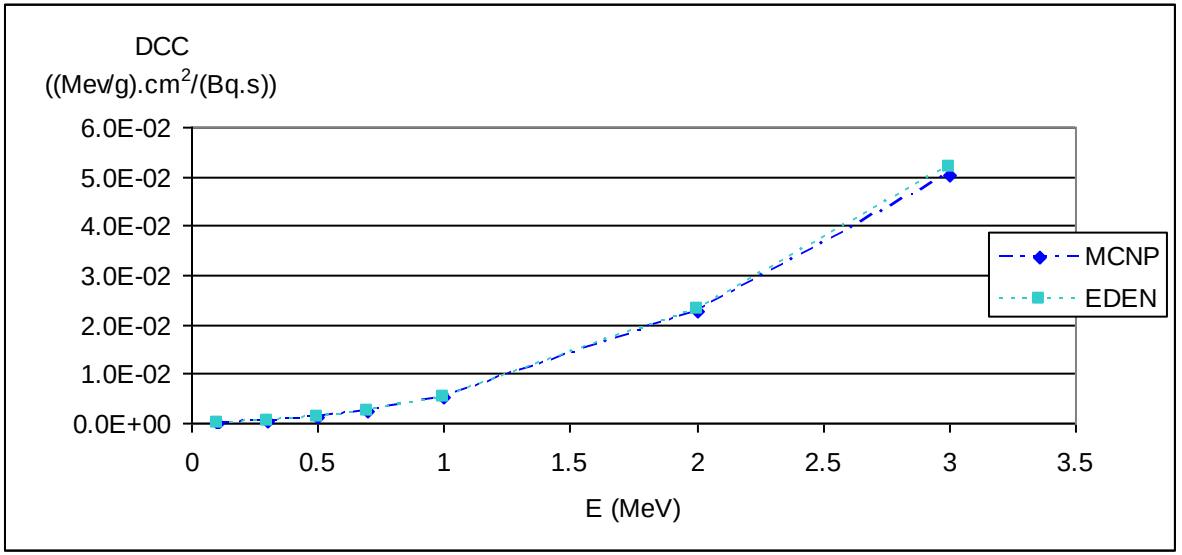



## ↗ Good agreement especially for high energy

# Comparison EDEN vs MCNP

## Beta radiation

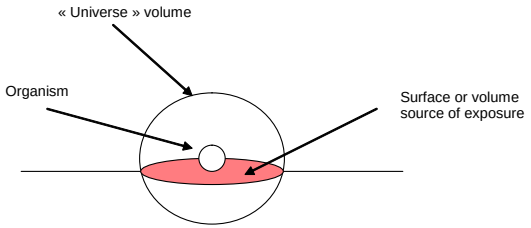


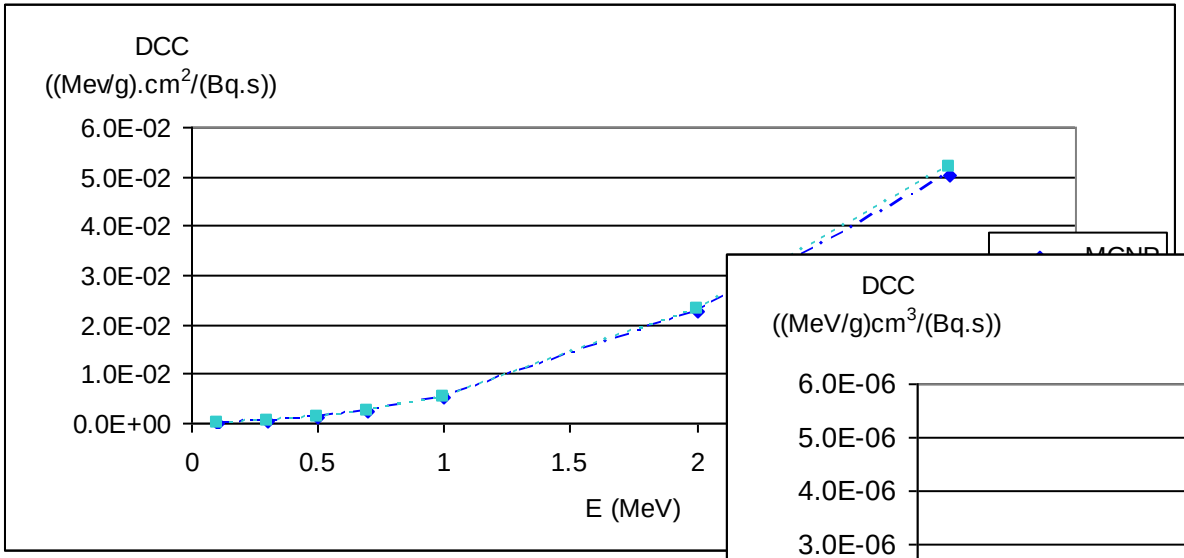




Surface DCC

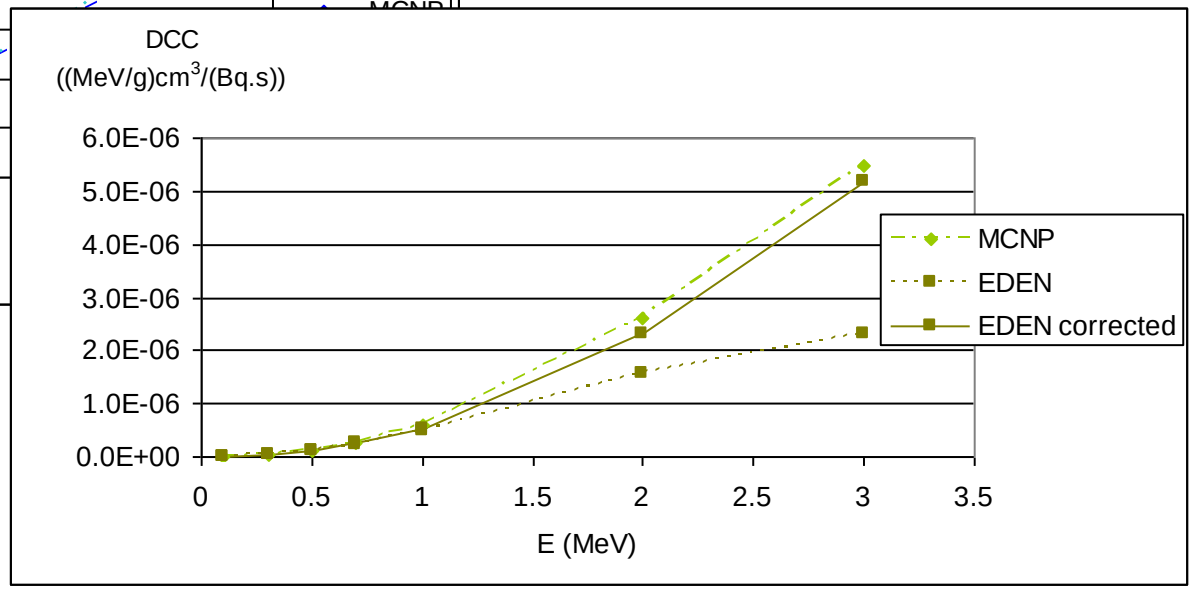
# Comparison EDEN vs MCNP

## ↗ Beta radiation




Surface DCC

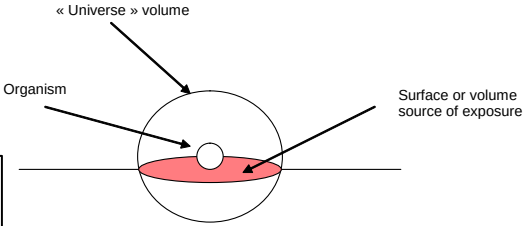


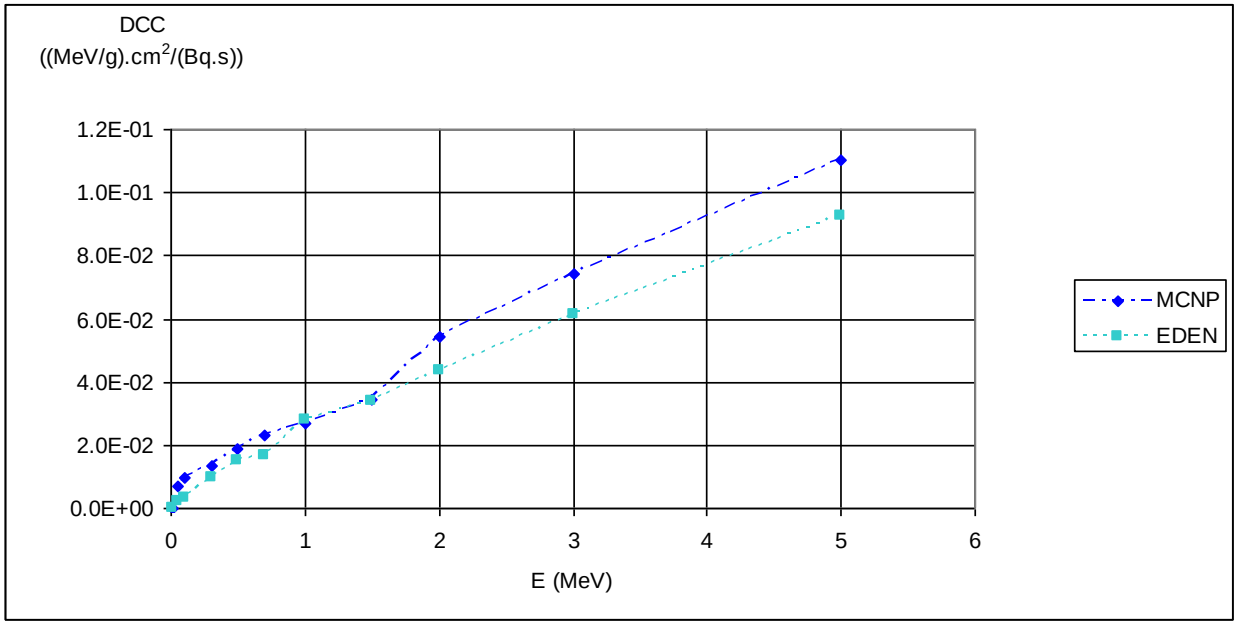

Volume DCC

## ↗ Good agreement

# Comparison EDEN vs MCNP

## ↗ Gamma radiation

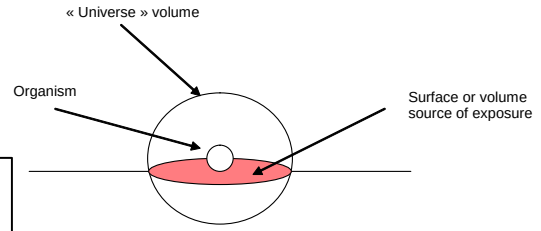


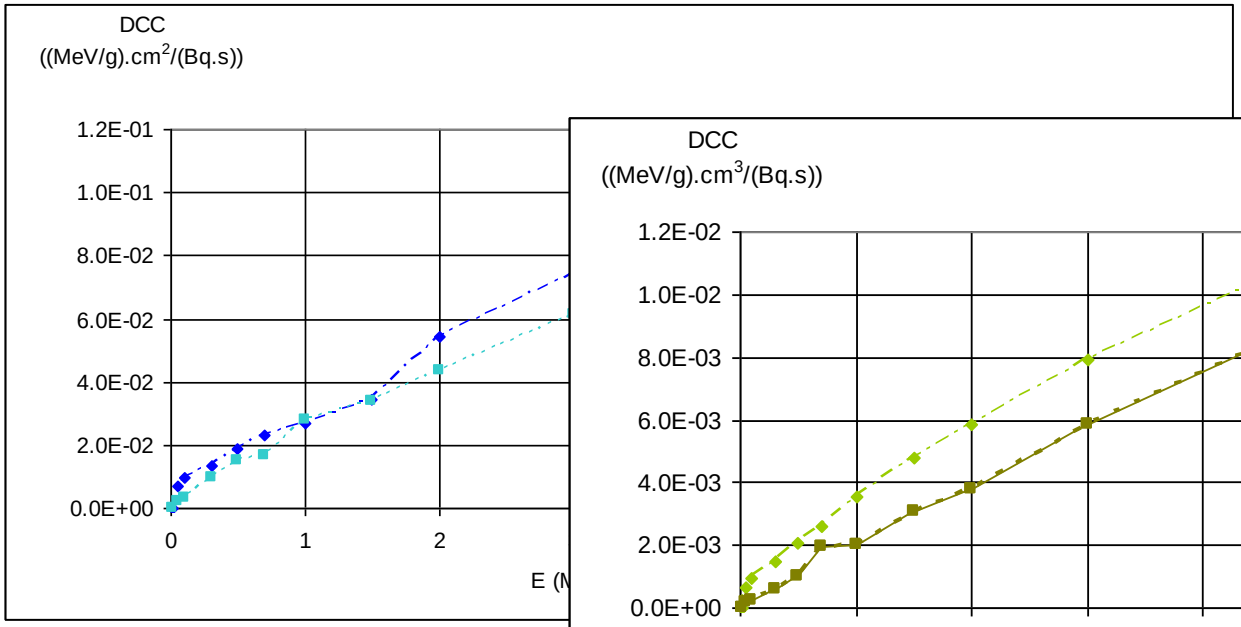




Surface DCC

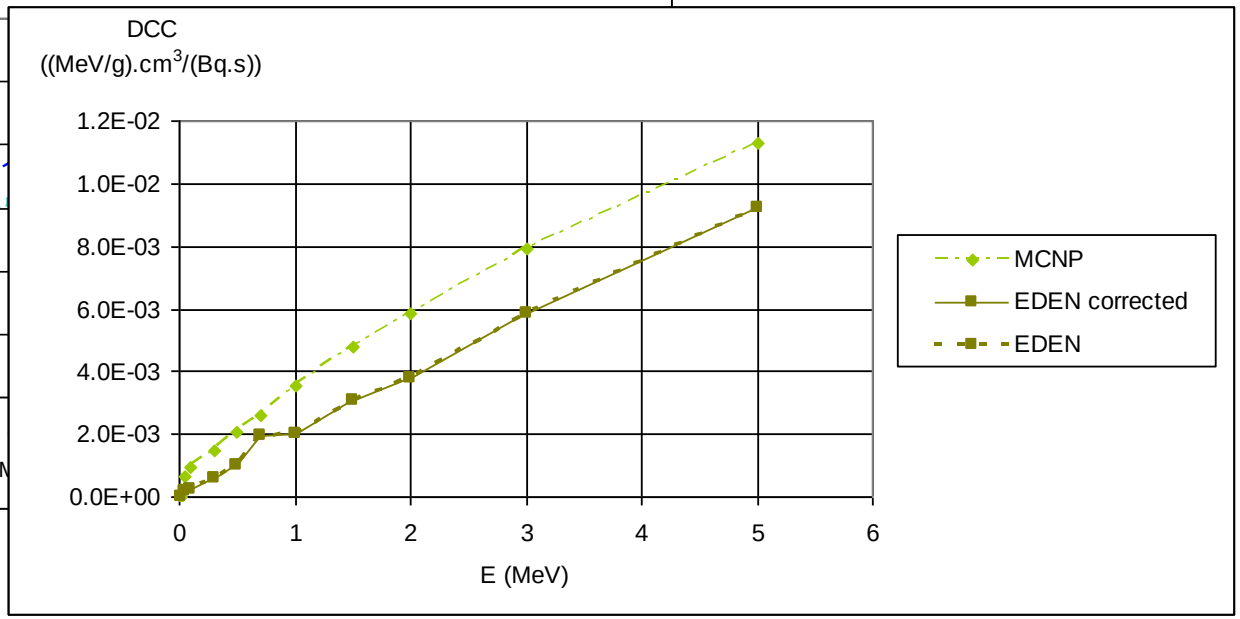
# Comparison EDEN vs MCNP

## ↗ Gamma radiation




Surface DCC




Volume DCC

## ↗ Good agreement

# Conclusions

## ↗ EDEN validation

- Surface exposure treatment consistent with continuity V->S
- DCC consistent with energy released X size of radiating source
- Beta radiation: good agreement EDEN results vs MCNP
- Gamma radiation: order of magnitude consistent (EDEN<MCNP)

## ↗ Confidence in EDEN results

# Case study: U family in sediment

## Canadian lakes data

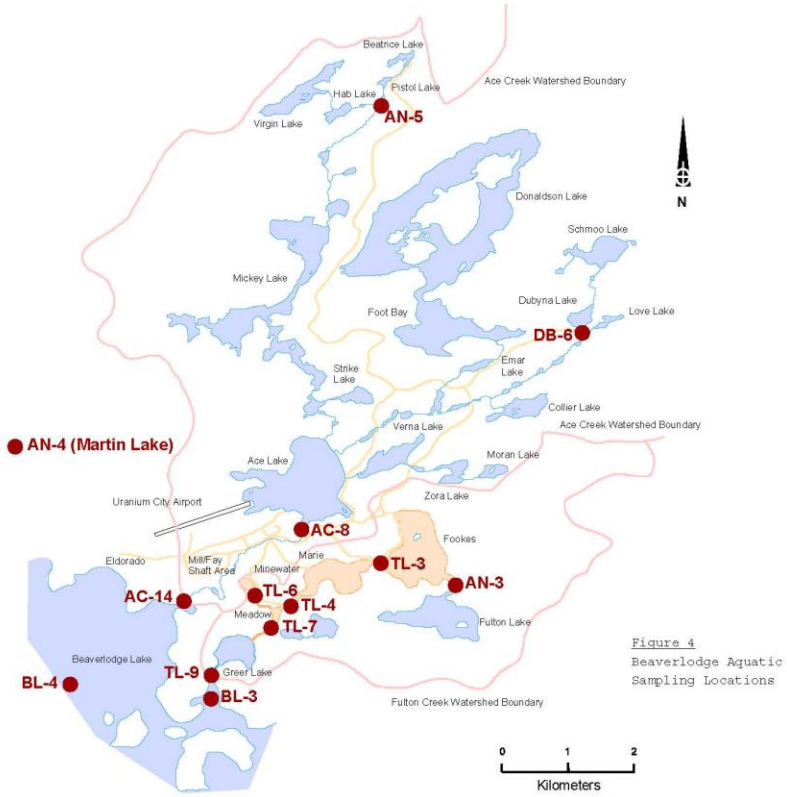
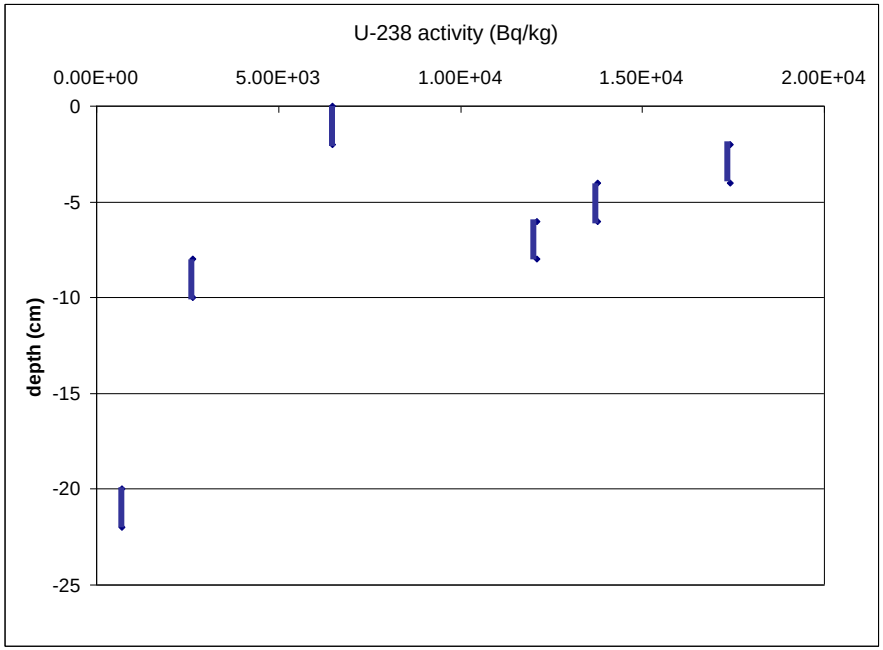


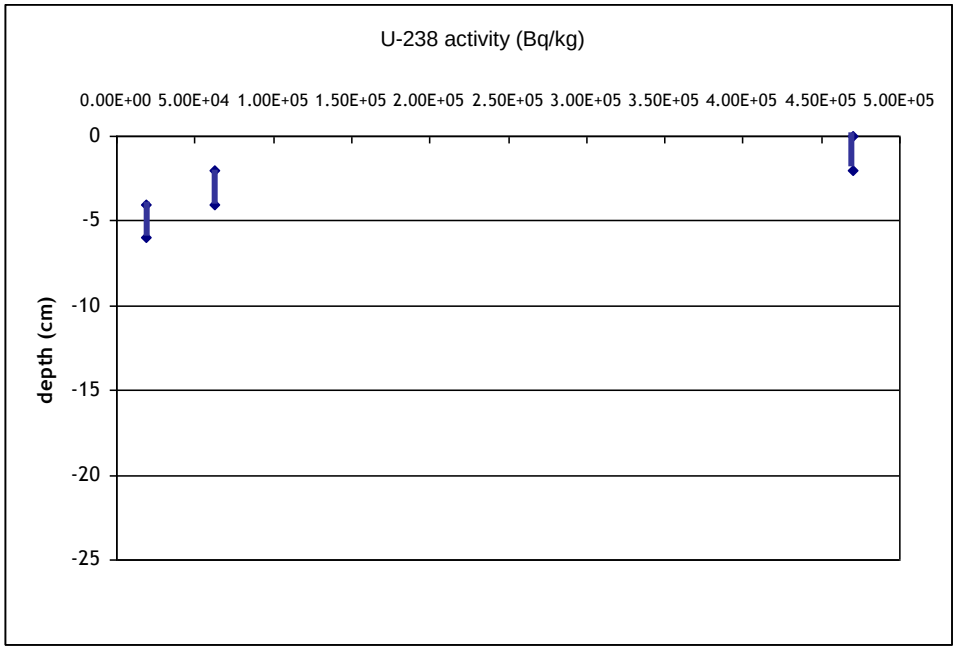

Figure 4
Beaverlodge Aquatic Sampling Locations

# An heterogeneous contamination of sediment

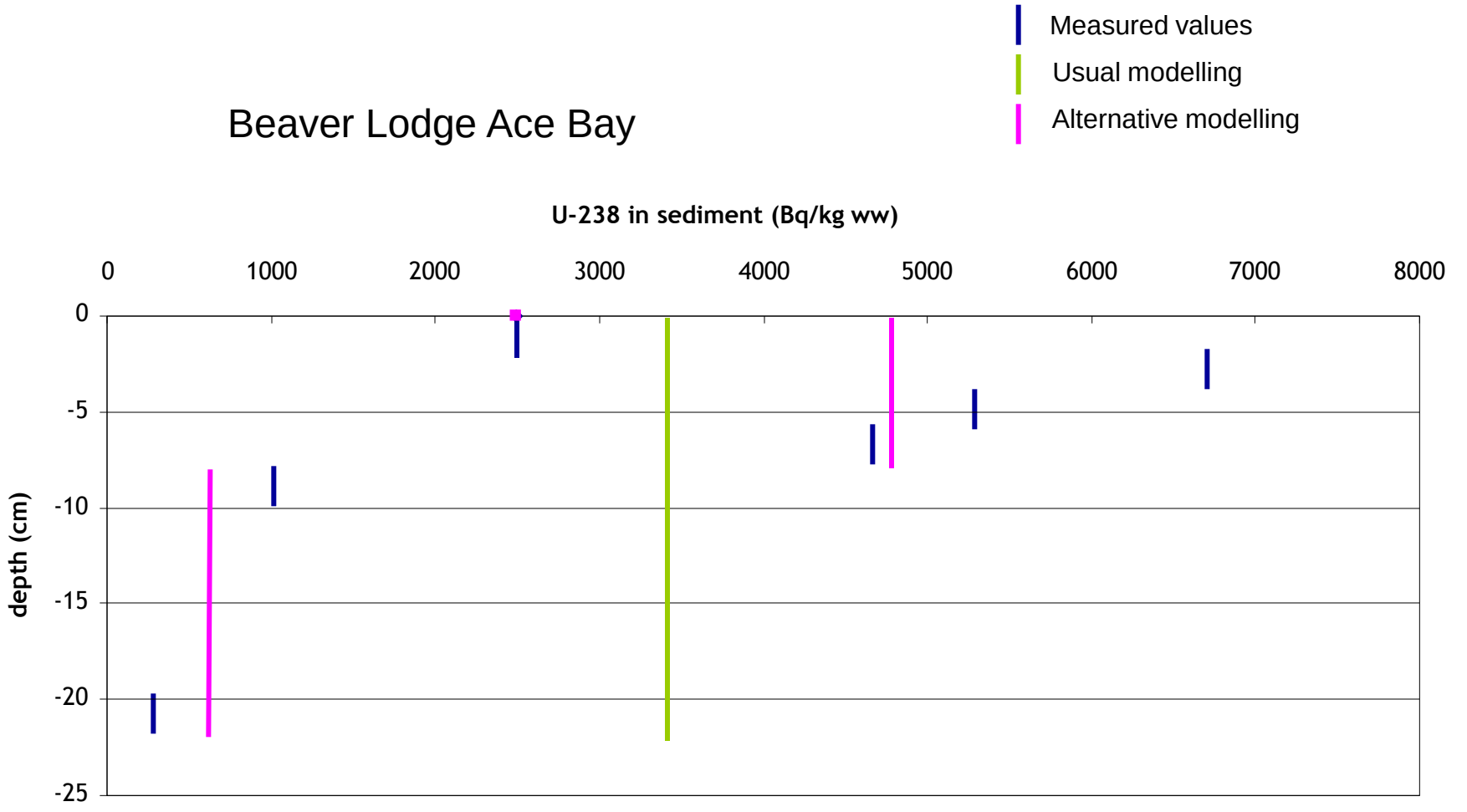
Beaver Lodge Ace Bay




Dubyna Lake Deep

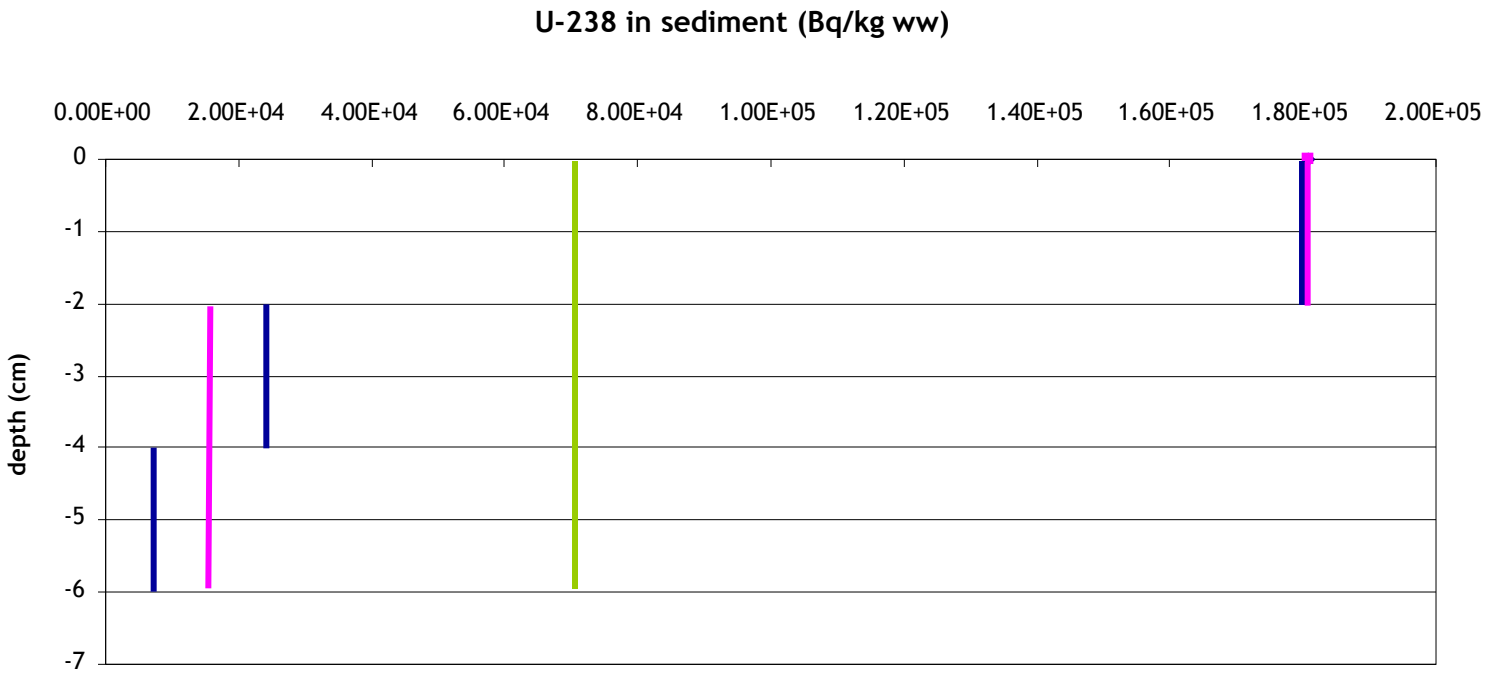


# The proposed approach (1/2)

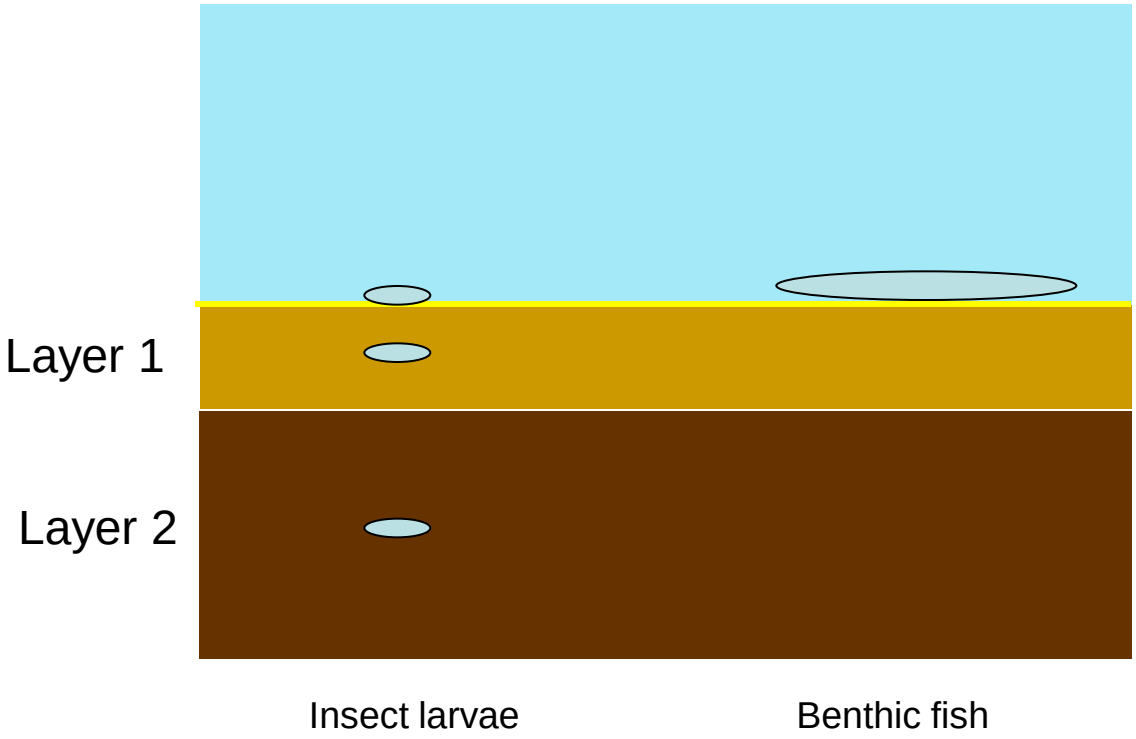


# The proposed approach (2/2)

Dubyna Lake Deep

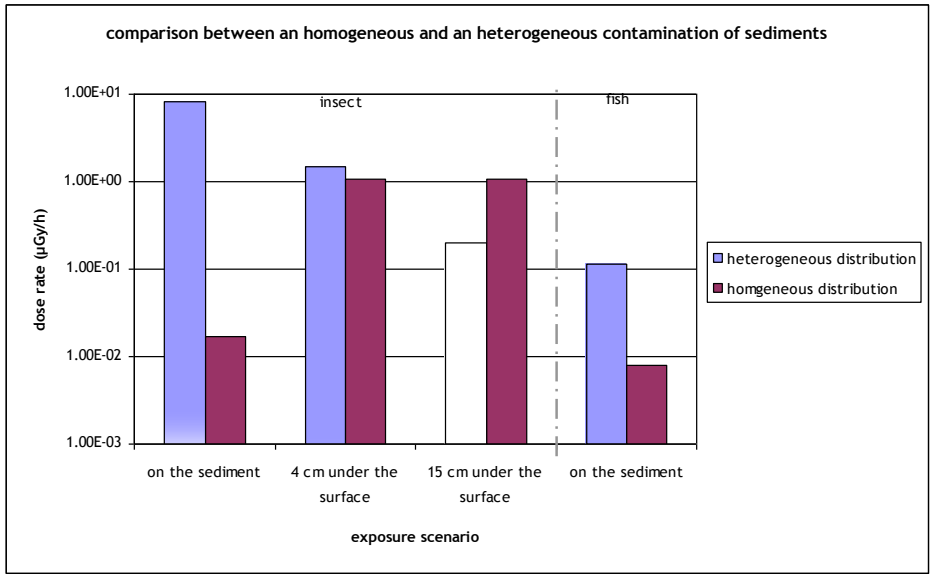


# Exposure scene

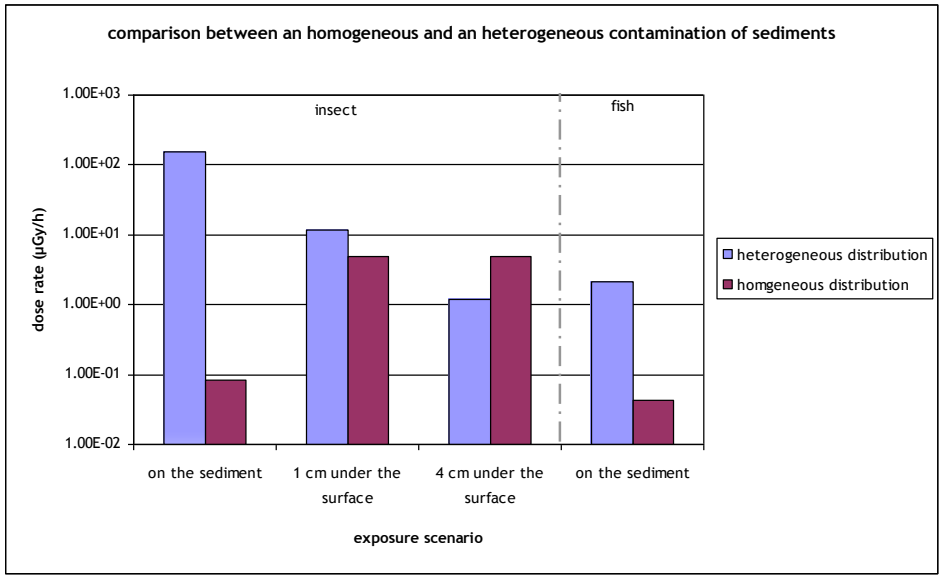


# Total dose rates received

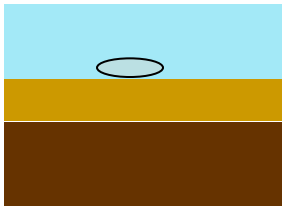
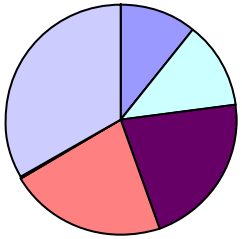
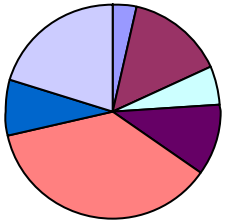
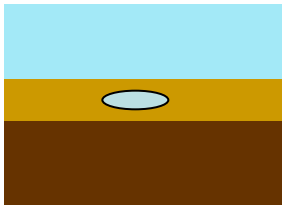
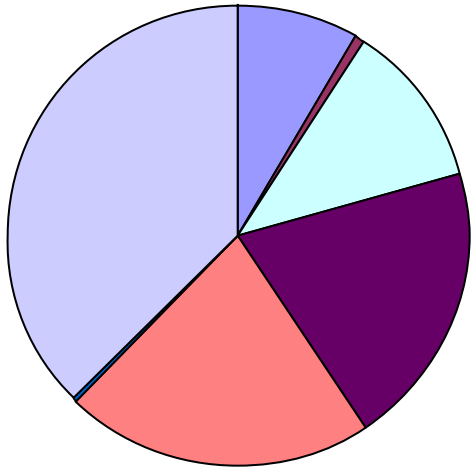
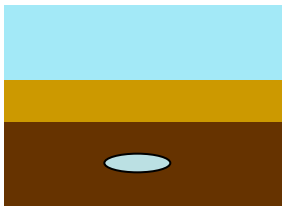
## Beaver Lodge Ace Bay



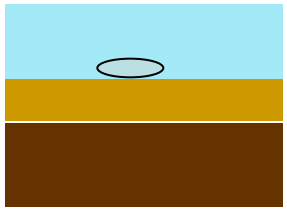
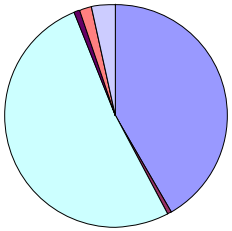
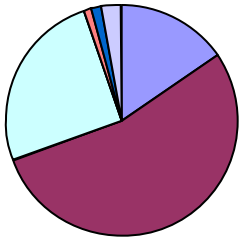
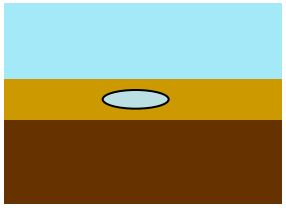
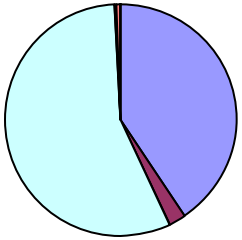
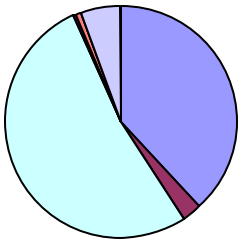
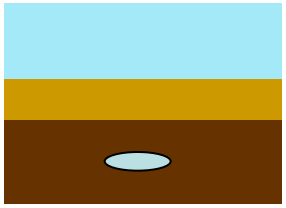
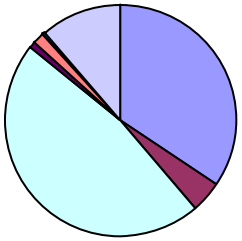

## Dubyna Lake Deep



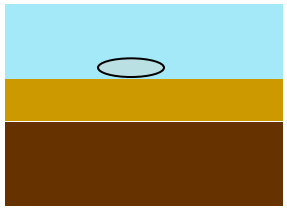
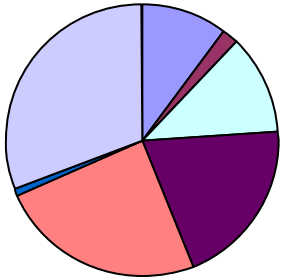
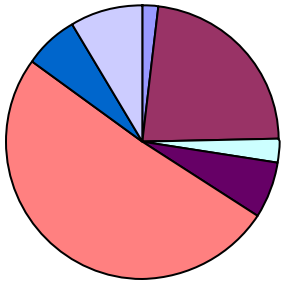
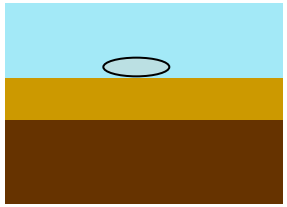
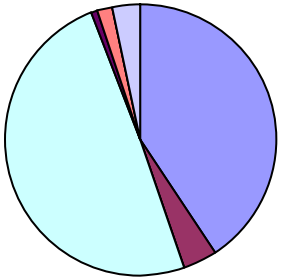
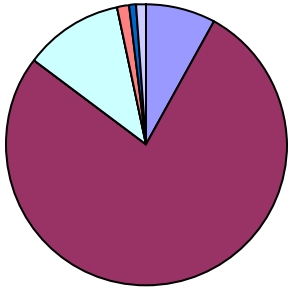
# RNs contribution/ insect larvae (1/2)

| Beaver Lodge Ace Bay | Heterogeneous distribution | Homogeneous distribution |
|---|---|---|
|  |  |  |
|  BL insect larvae under a 4 cm layer of sediment |   | |
|  BL insect larvae under a 15 cm layer of sediment | | |

# RNs contribution/ insect larvae (2/2)

| Dubyna Lake Deep | Heterogeneous distribution | Homogeneous distribution |
|---|---|---|
|  |  |  |
|  DLD insect larvae under a 1 cm layer of sediment |  |  |
|  DLD insect larvae under a 4 cm layer of sediment |  | |

# RNs contribution/ fish

| | Heterogeneous distribution | Homogeneous distribution |
|---|---|---|
| Beaver Lodge Ace Bay  |  |  |
| Dubyna Lake Deep  |  |  |