IAEA EMRAS Biota Working Group

Regular participants:

Belgium - SCK·CEN; Canada – AECL; Czech Republic - SÚJB; France – IRSN; Japan – NIRS; Lithuania – IoP; Netherlands – NRG; Norway – NRPA; Russia – Spa-Typhoon; UK – CEH, EA, WSC; Ukraine – IRL; USA - ANL

Models and approaches participating

- ***RESRAD-BIOTA*** **(USA)**
- ***Environment Agency 'R&D 128'*** **(England & Wales)**
- ***ERICA (& FASSET)*** **(European)**
- ***Atomic Energy Canada Limited approach***
- ***LIETDOS-BIOTA*** **(Lithuania)**
- ***DosDiMEco*** **(Belgium)**
- ***D-Max*** **(UK)**
- ***EDEN-CENTEAUR*** **(France)**
- ***LAKE(ECO)*** **(Netherlands)**
- ***ECOMOD*** **(Russia)**
- ***FASTer*** **(European)**
- ***EPIC-DOSES3D*** **(European)**
- ***SÚJB approach*** **(Czech Republic)**

Activities

- Two exercises to compare dosimetry and transfer components of models.
- Two case study scenarios (predictions v's data): Perch Lake (Canada) and terrestrial ecosystems within Chernobyl 30 km exclusion zone.

Exercise 1 - dosimetry comparison

- Assume 1 Bq per unit media or organism
- Estimate <u>unweighted</u> internal and external dose rates for Cs-137, Am-241, Co-60, U-238, C-14, Sr-90, H-3
- Organisms selected from list of proposed ICRP Reference Animals & Plants
- Equates to comparison of dose conversion coefficients (DCCs) used within models where:

$$DCC = \frac{\mathit{unweighted\ absorbed\ dose\ rate}\ (\mu Gy/h)}{\mathit{Activity\ concentration}\ (Bq/kg)\ (\mathit{whole-body\ organism\ or\ media})}$$

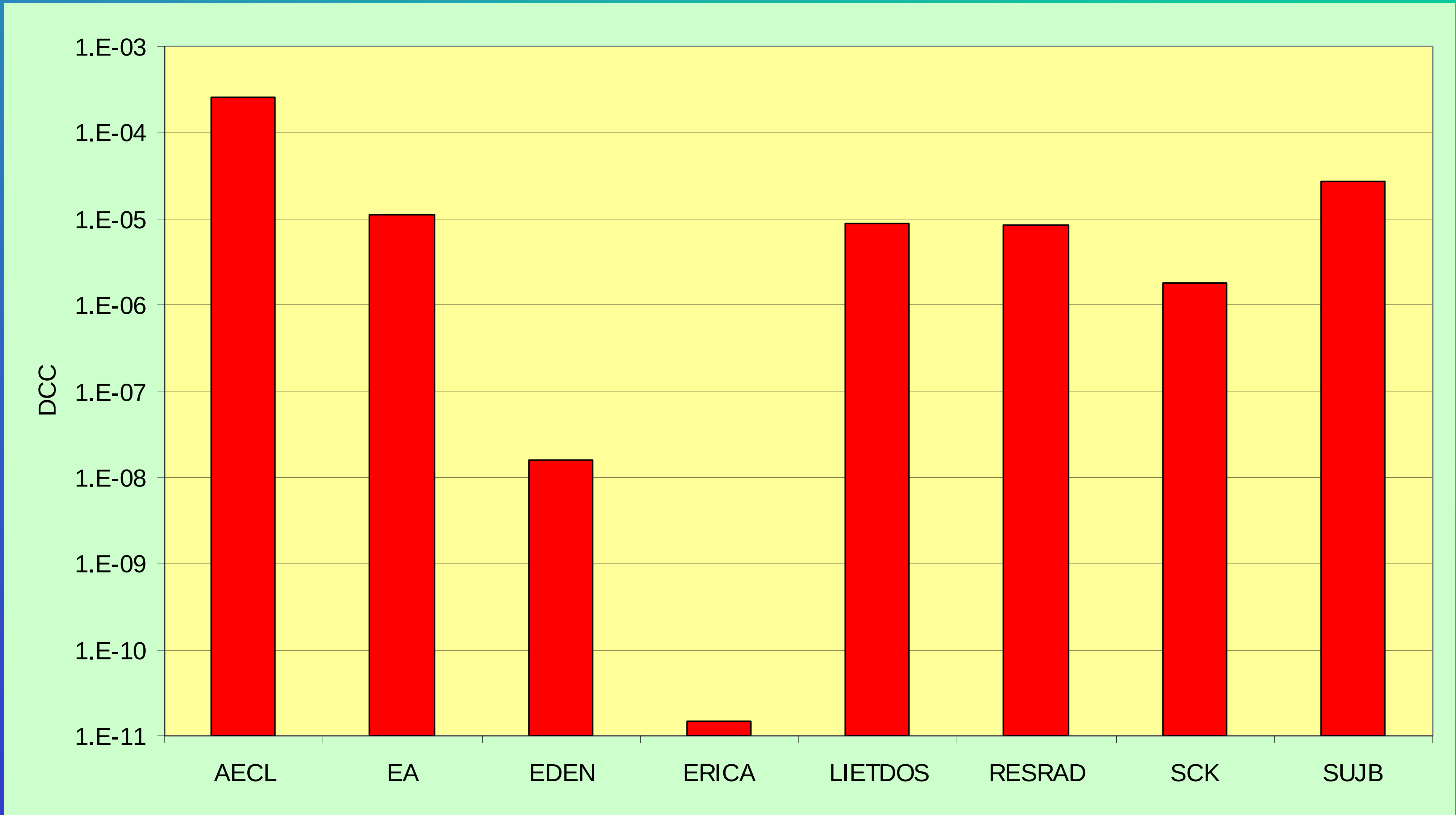
Internal dose rates

- Internal dose estimates generally all within 20 % of mean (of predictions)
  - exception being for U-238: two approaches including U-234 as daughter (resulting in 2x higher DCC)

External dose rates

- Considerably more variability between models – especially for β- emitters

e.g. Duck on soil surface predictions for Sr-90



External dose rates

- More variable between models – especially for β-emitters
  - Especially H-3 & C-14 (e.g. external DCC for duck on soil for H-3 ranged 0 to 5E-11)
- Media assumptions (density and distribution of contamination) can be seen to result in some variation
- Differences in approaches that do not matter:
  - use of specific geometries v's nearest default
  - number of emissions assumed

Exercise 2 – transfer comparison

- Assume 1 Bq per unit media to estimate wholebody freshweight activity concentration of range of radionuclides (^{241}Am, ^{14}C, ^{60}Co, ^{137}Cs, ^{131}I, ^{210}Po, ^{239}Pu, ^{226}Ra, ^{90}Sr, ^{99}Tc, ^{232}Th & ^{238}U) in 19 terrestrial & freshwater organisms

Terrestrial organisms	**Freshwater organisms**	
Grass/Herb	Phytoplankton	Pelagic fish
Shrub	Zooplankton	Benthic fish
Earthworm	Macrophyte	Fish egg
Herbivorous mammal	Benthic mollusc	Amphibian
Carnivorous mammal	Benthic crustacean	Duck
Bird egg		

Approaches

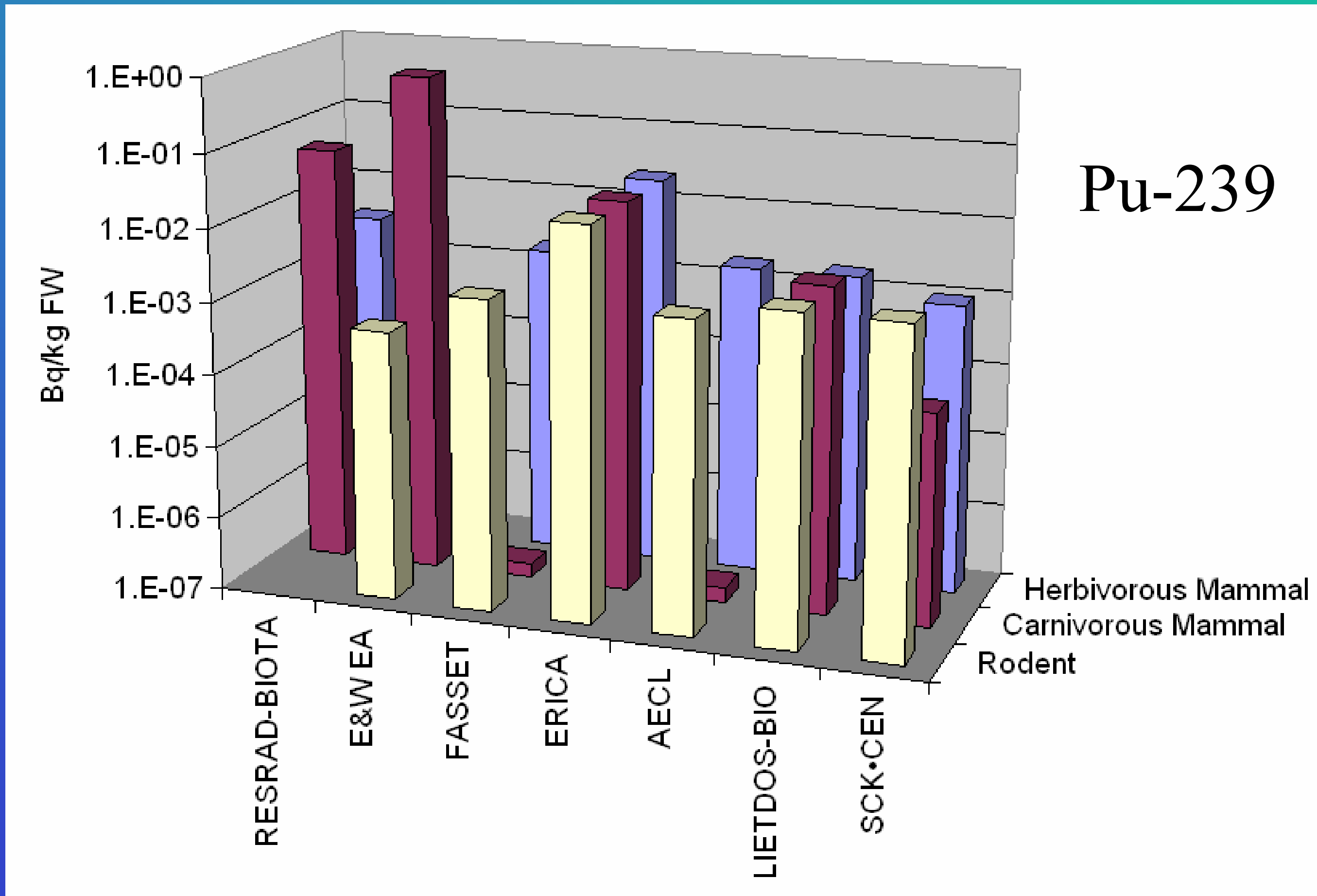
- Many use concentration ratios (CR):

$$CR = \frac{\text{Activity concentration in biota whole body (Bq kg}^{-1}\text{ fresh weight)}}{\text{Activity concentration in soil (Bq kg}^{-1}\text{ dry weight)}}$$

- But others using foodchain models, often incorporating allometric relationships for dietary intake and radionuclide biological half-lives
  - $Y = a \cdot (\text{liveweight})^b$
- Some have 'guidance' derived values in the absence of defaults

Predicted activity concentrations

- Considerable variation between predictions (3-orders of magnitude being common)

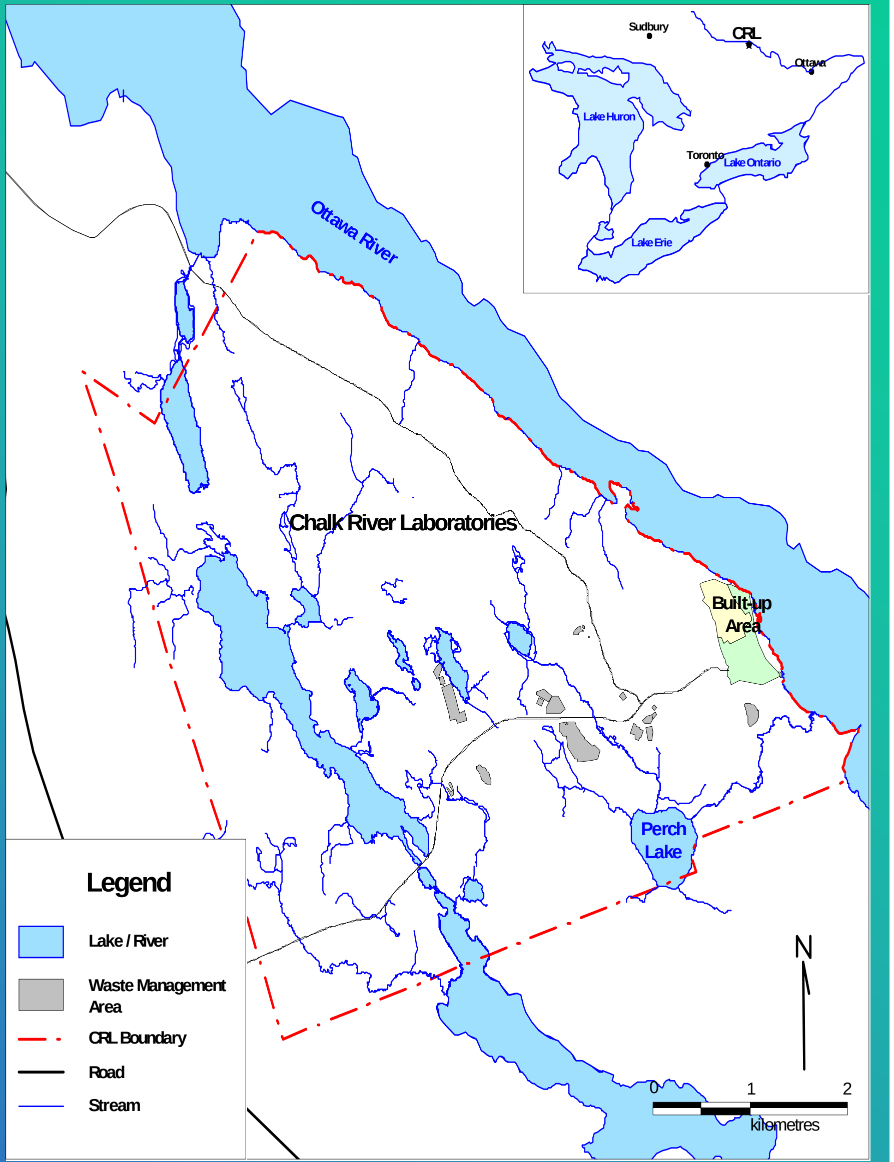


Predicted activity concentrations

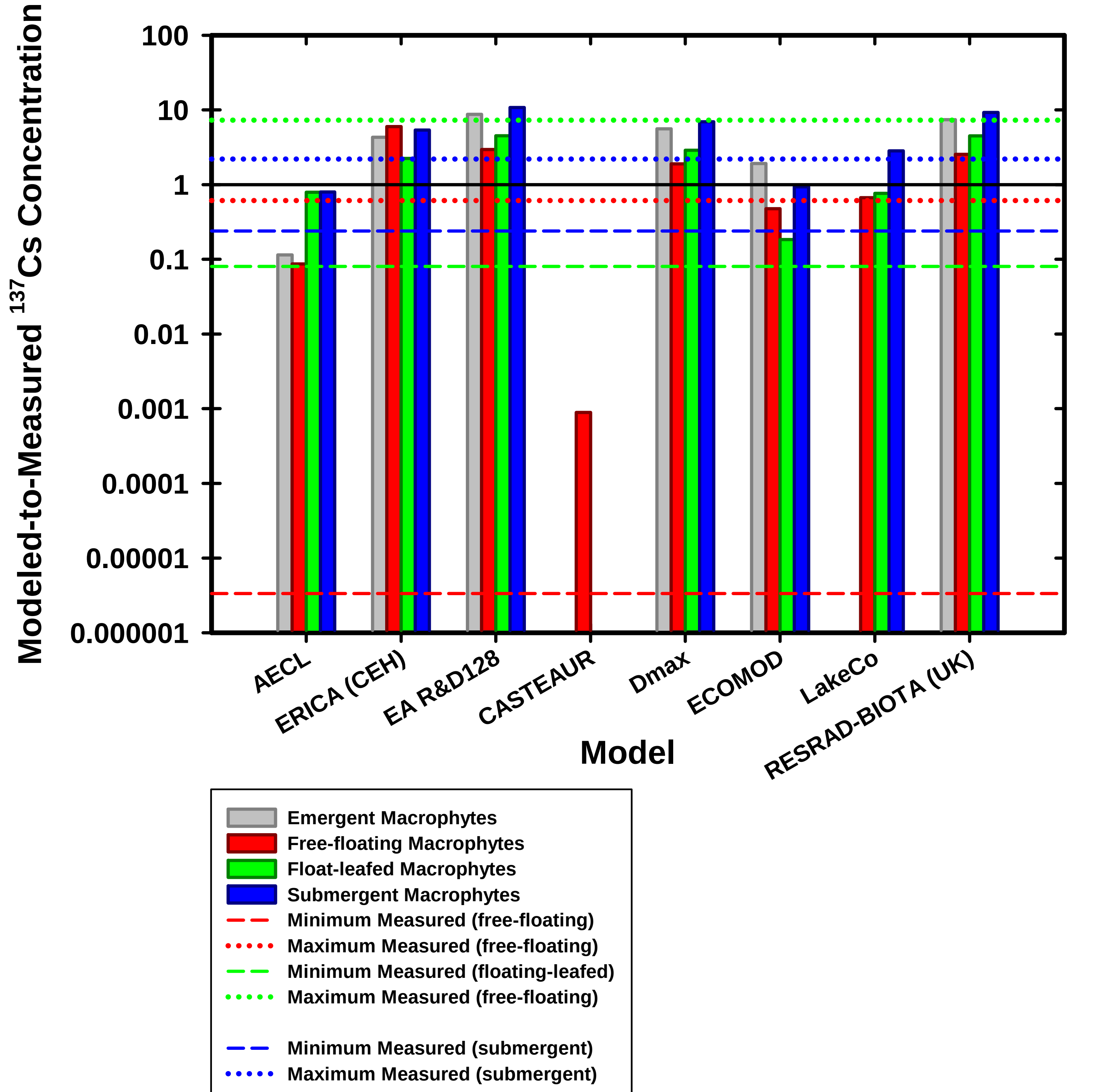
- Some variation can be understood, e.g.:
  - Missing value guidance approach often give comparatively high estimates (often for little studied organisms)
  - National (and single site) data
  - Some approaches (used to) include reindeer data in derivation of CRs leading to high predictions for mammals (especially Po-210)
- Tc-99 predictions had least variation
  - Very few data and all using similar approach

Perch Lake Case Study

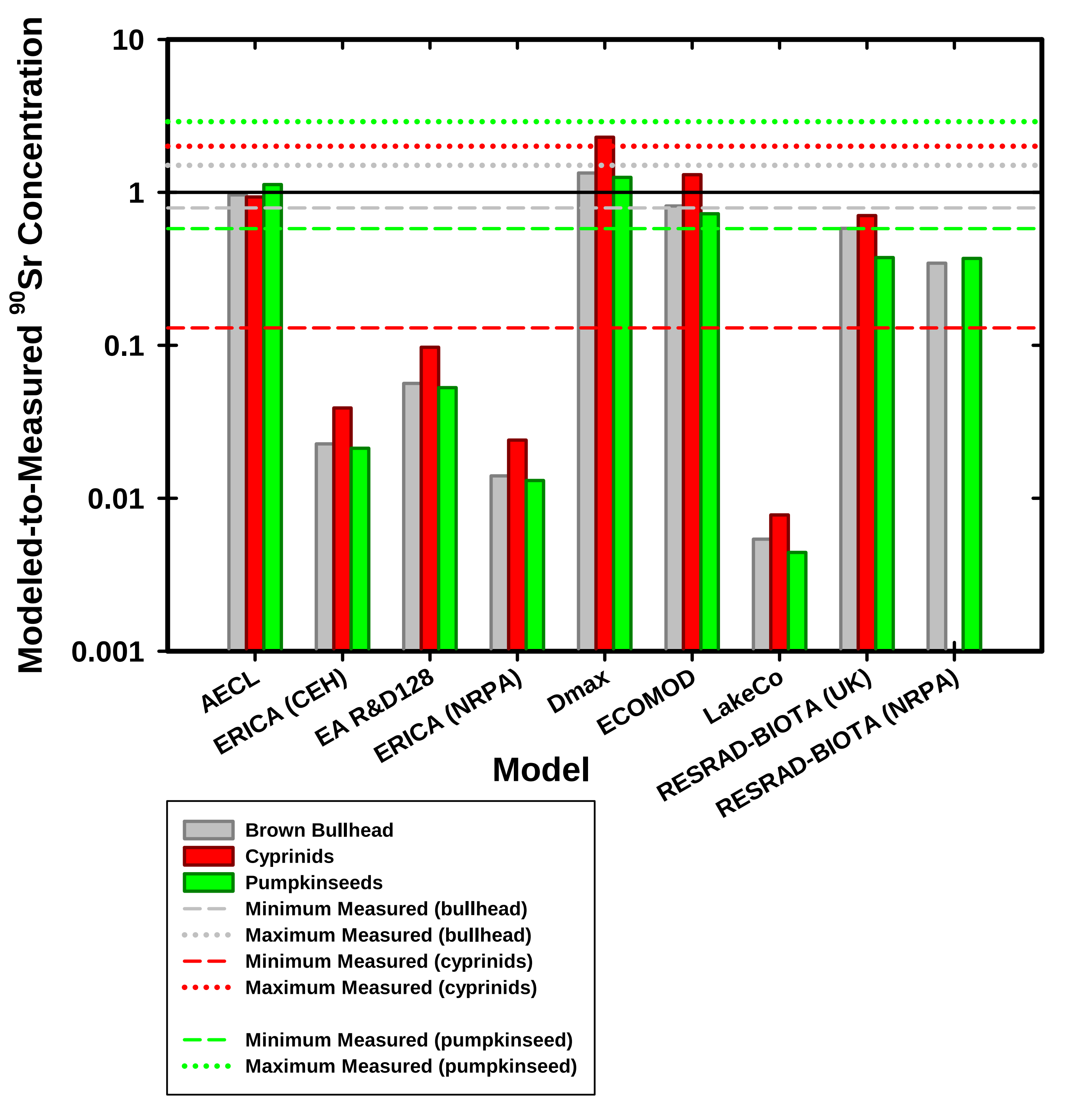
- H-3, Cs-137, Co-60, Sr-90 data for wide range of freshwater biota



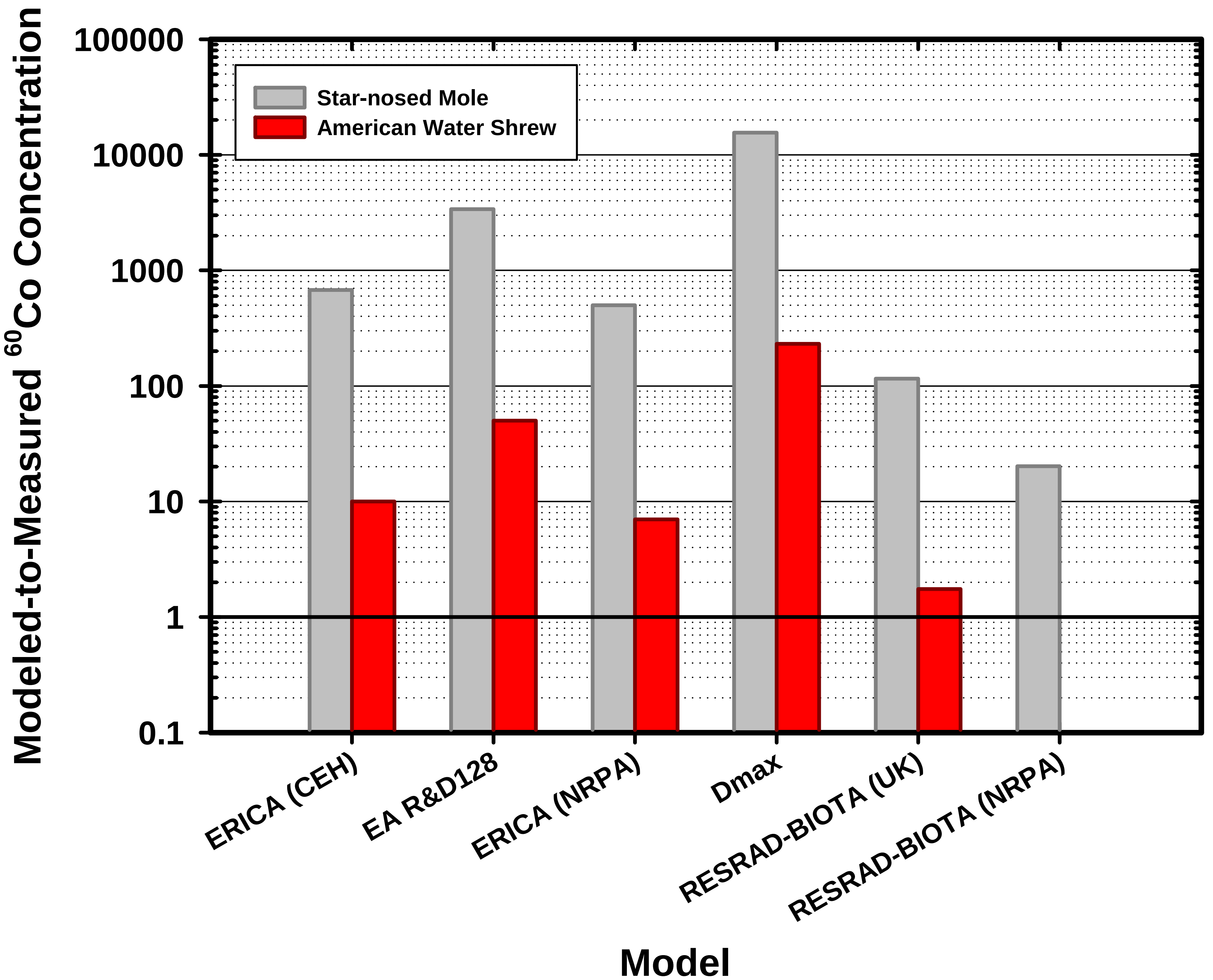
Cesium-137 in Aquatic Macrophytes



Strontium-90 in Freshwater Fishes



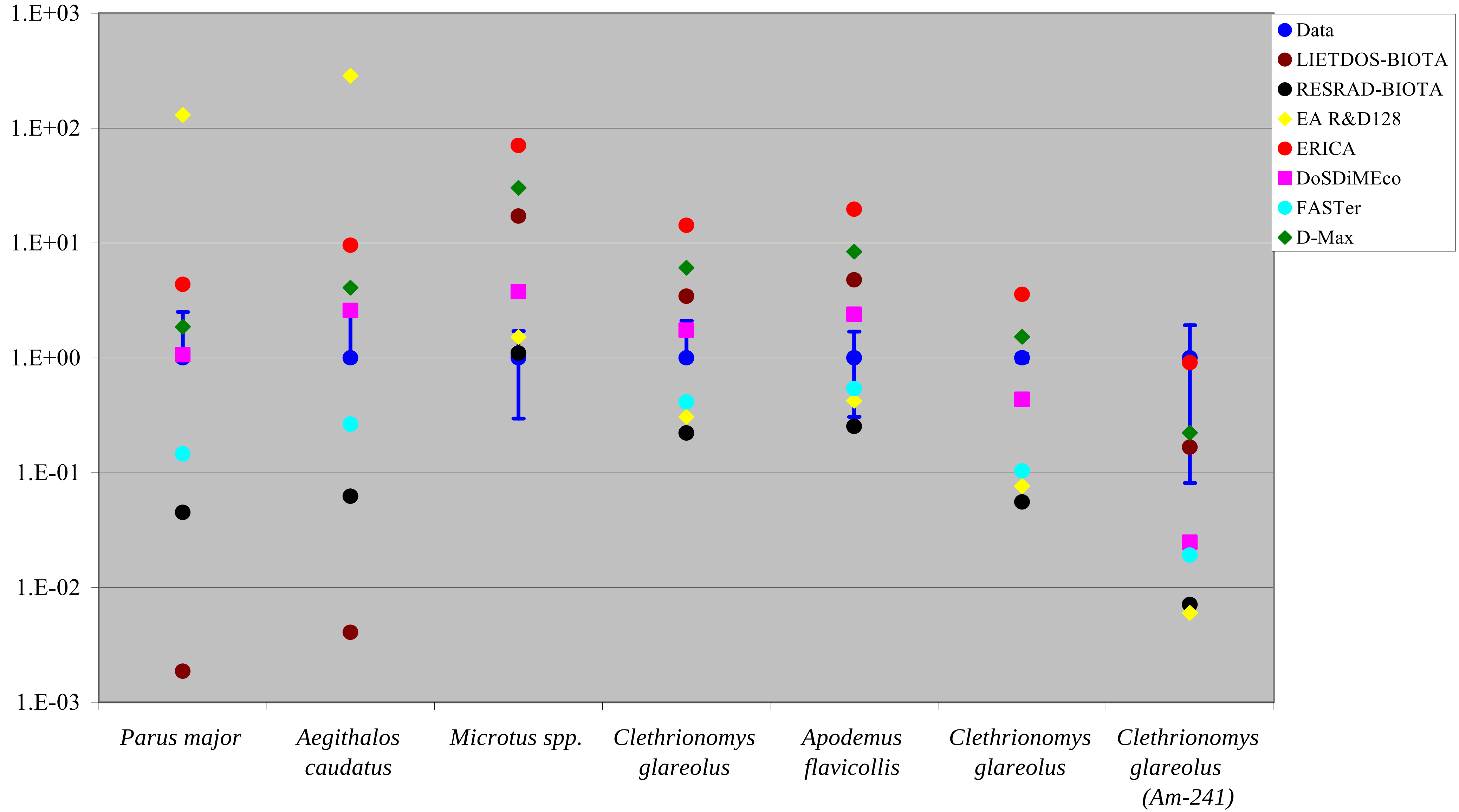
Cobalt-60 in Freshwater Mammals



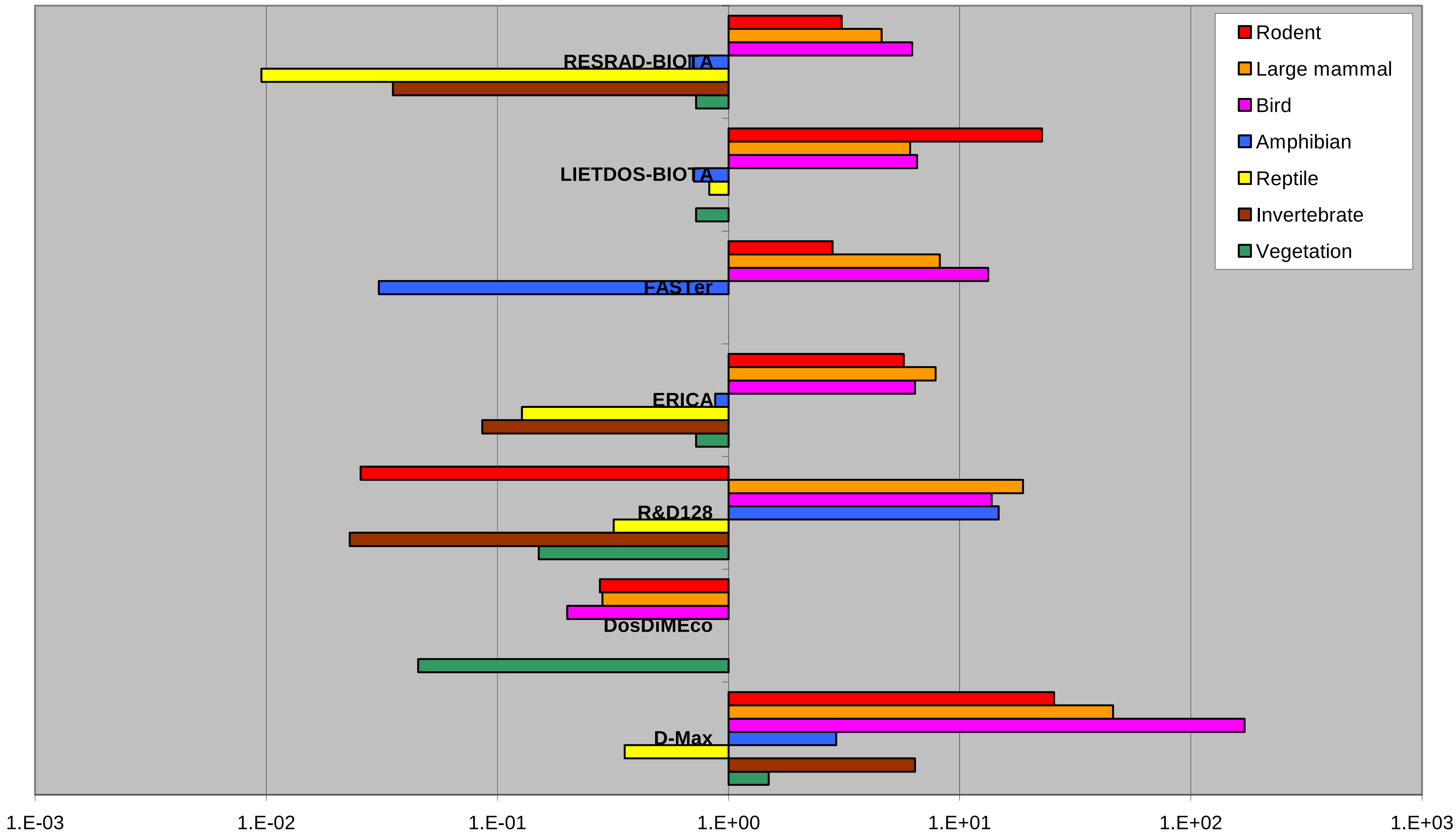
Chernobyl Case Study

- Available data for Cs-137, Sr-90 Am-241, Pu-isotopes data - bias towards mammals (some birds, amphibians, invertebrate, plant, reptile).
- TLD measurements for small mammals.

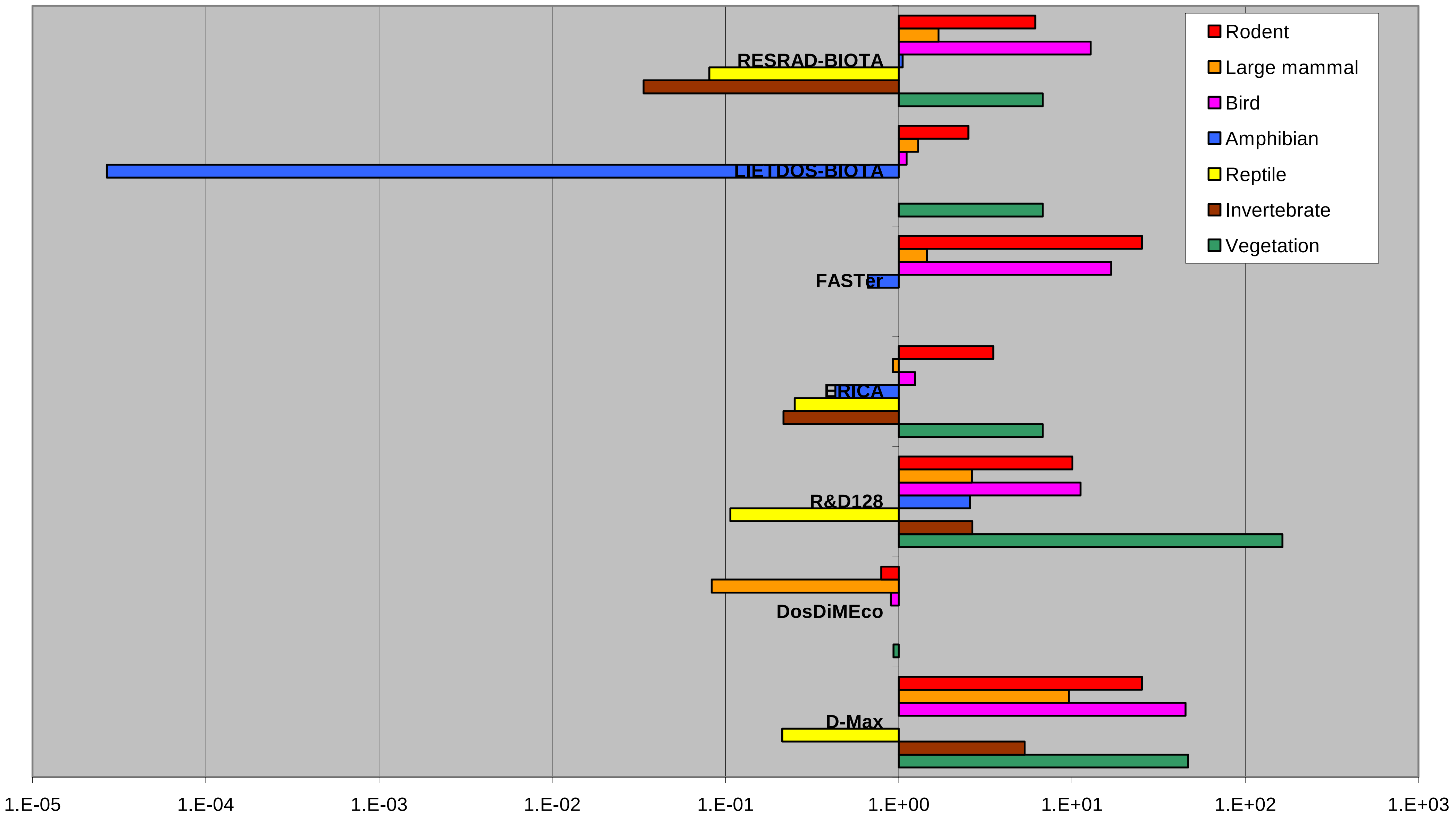
Species	Common name (English)	Number of predictions					
		^{90}Sr	^{137}Cs	Pu	^{241}Am	Dose rates	TLD
Aegithalos caudatus	Long-tailed tit	-	-	1	-	1	-
Apodemus flavicollis	Yellow necked mouse	5	5	1	-	2	2
Apodemus sylvaticus	Wood mouse	1	1	-	-	1	-
Canis lupus	Wolf	2	2	-	-	1	-
Capreolus capreolus	Roe deer	7	7	-	-	1	-
Clethrionomys glareolus	Bank vole	7	6	2	1	2	2
Erithacus rubecula	Robin	2	2	-	-	1	-
Hirundo rustica	Barn swallow	1	1	-	-	1	-
Lactera agilis	Sand Lizard	1	1	-	-	1	-
Microtus arvalis	Common vole	2	2	-	-	1	-
Microtus oeconomus	Root vole	2	3	-	-	1	1
Microtus spp.	Vole species	1	1	1	-	1	1
Parus major	Great tit	2	2	1	-	1	-
Perdix perdix	Partridge	-	2	-	-	1	-
Rana esculenta	Edible frog	-	2	-	-	1	-
Rana terrestris	Brown frog	2	4	-	-	1	-
Sicista betulina	Northern birch mouse	1	1	-	-	1	-
Sorex araneus	Common shrew	5	5	-	-	1	-
Sturnus vulgaris	Starling	1	1	-	-	1	-
Sus scofa	Wild boar	9	9	-	-	1	-
	Beetles	1	1	-	-	1	-
	Grassy vegetation	4	4	-	-	1	-



Pu and Am-241 results


RESRAD-BIOTA
LIETDOS-BIOTA
FASTer
ERICA
R&D128
DosDiMEco
D-Max
Rodent
Large mammal
Bird
Amphibian
Reptile
Invertebrate
Vegetation
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03

Cs-137



Rodent
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1.E-05
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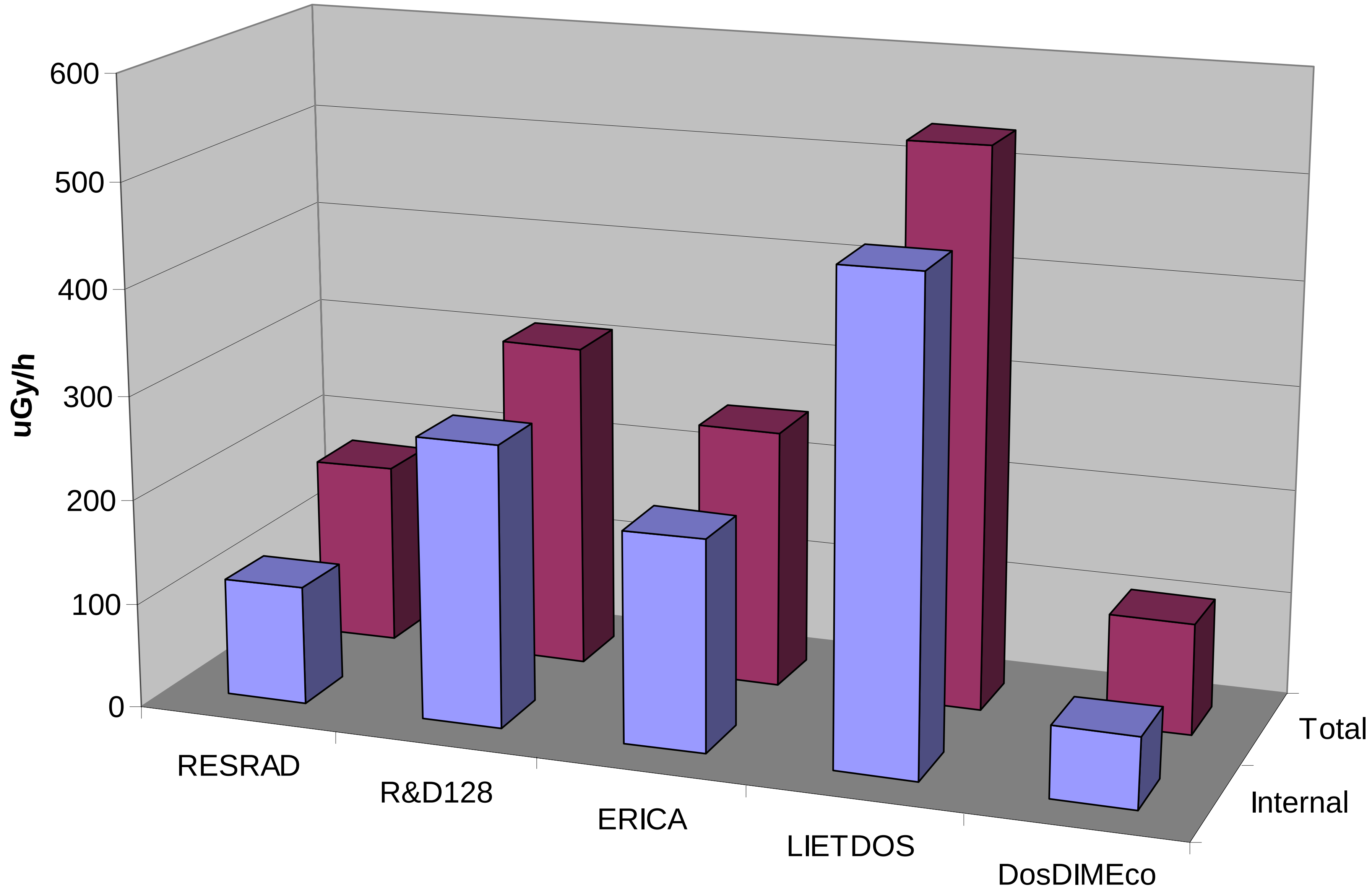
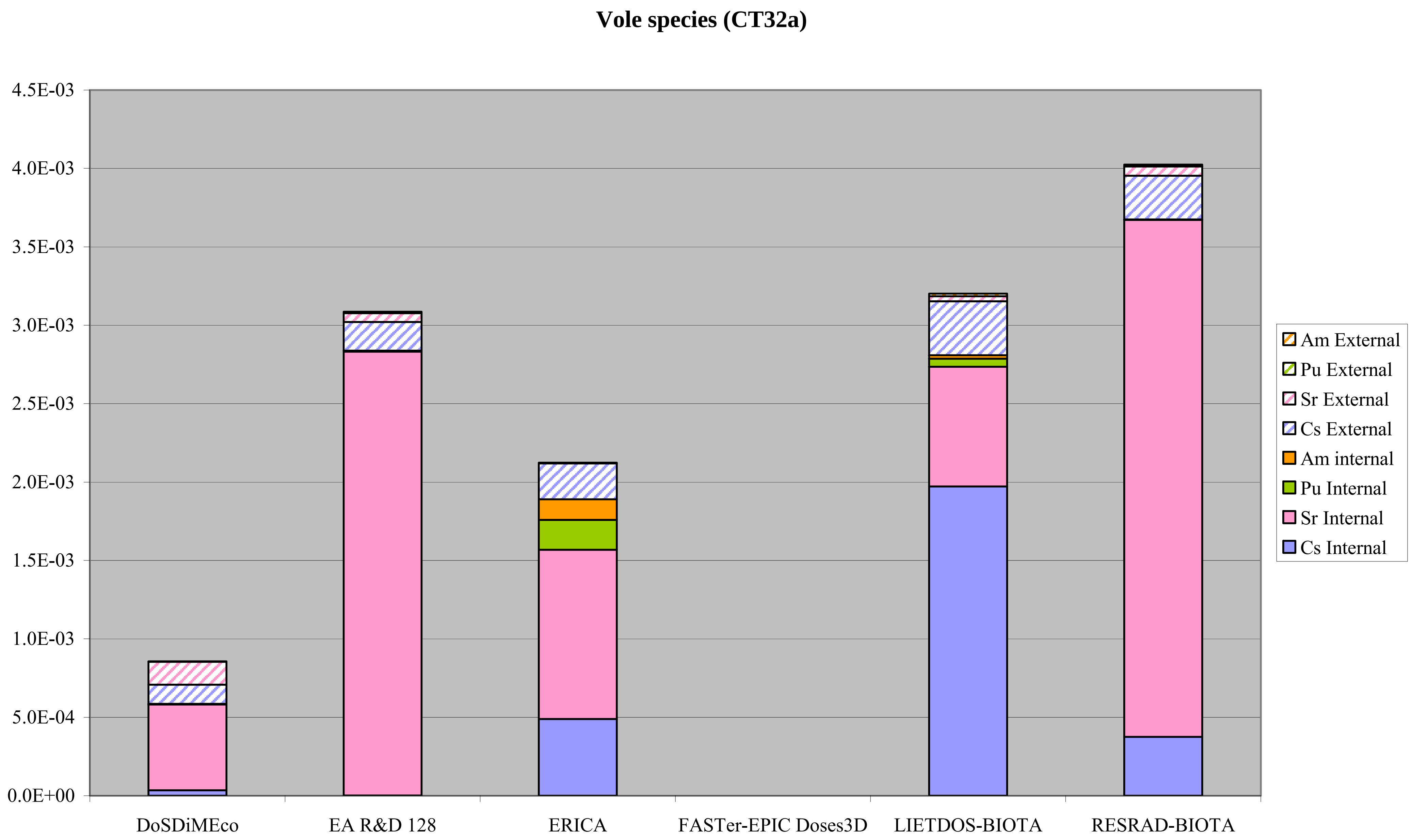
1.E+00
1.E+01
1.E+02
1.E+03

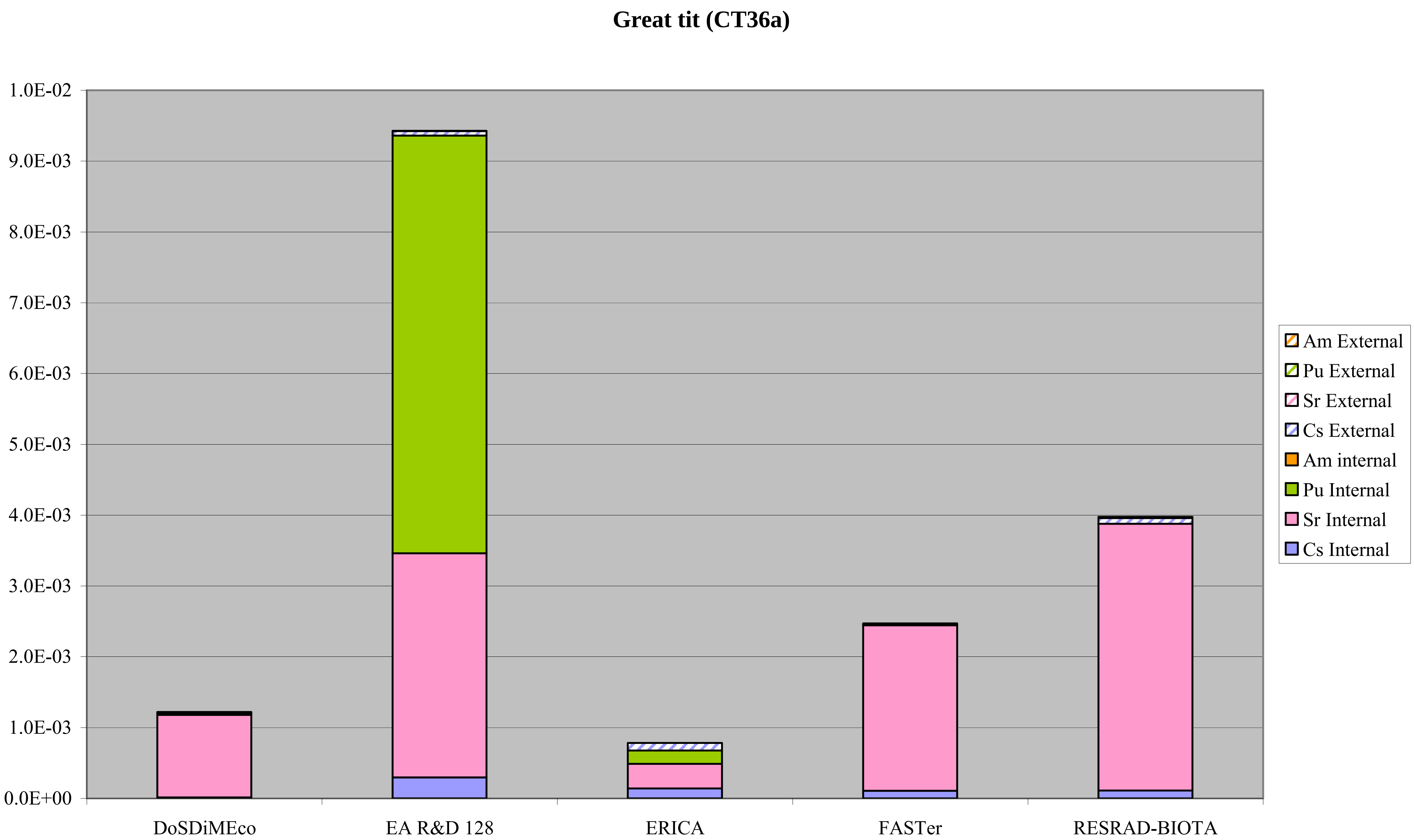
Sr-90



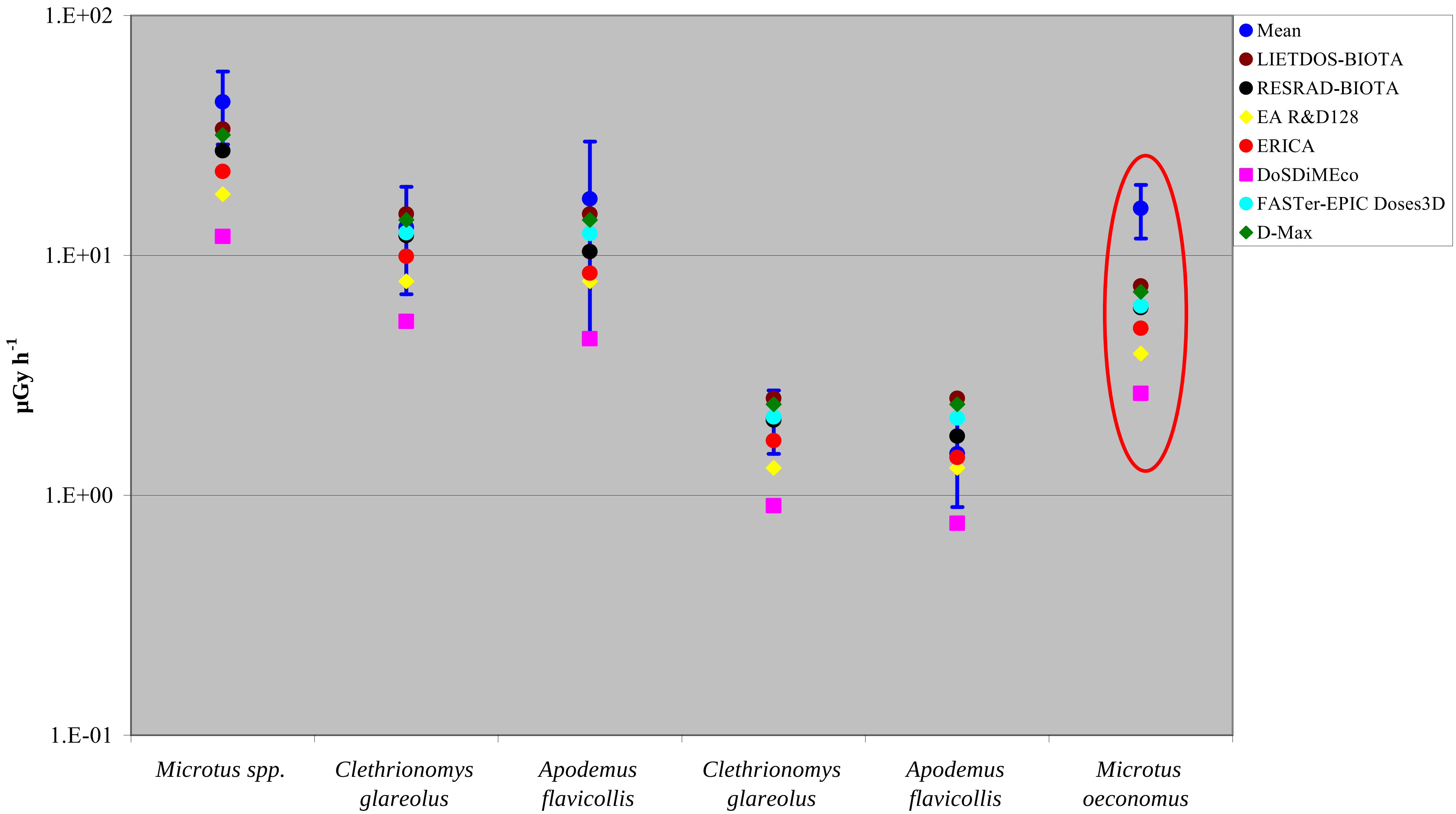
Absorded dose rate -Microtus arvalis



Contributions to total dose rate



Contributions to total dose rate



1.E+02
1.E+01
1.E+00
1.E-01
μGy h⁻¹
Mean
LIETDOS-BIOTA
RESRAD-BIOTA
EA R&D128
ERICA
DoSDiMEco
FASTer-EPIC Doses3D
D-Max
Microtus spp.
Clethrionomys glareolus
Apodemus flavicollis
Clethrionomys glareolus
Apodemus flavicollis
Microtus oeconomus

Summary

- Dosimetry – largely comparable
  - External dose minor contributor (occupancy factor assumptions have little impact)
- Transfer – highly variable
  - Concentration ratio and foodchain model approaches – broadly comparable

Future

- Collaboration with ICRP C4 (+ PROTECT project)
  - Discussion began yesterday
- Biota 'TRS364' Transfer sub-group
- Effects data sub-group – quality & interpretation (population modelling?)
- Scenarios – focused to consider situations regulators/industry having to consider
  - Waste repository/new build NPP's/TeNORM

http://www.ceh.ac.uk/protect/

PROTECT: Work Package 2 index - Microsoft Internet Explorer

Address: http://www.ceh.ac.uk/protect/package2/

PROTECT
Protection of the environment from ionising radiation in a regulatory context
(EC Euratom 6th Framework programme: Contract No. FP6-036425)

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WP2: Assessment approaches: practicality, relevance and merits

Contribute your views on models/tools used to estimate the radiation exposure of non-human biota

One of the objectives of PROTECT is to evaluate existing and developing approaches (i.e. the models and tools) used for demonstrating protection of the environment from ionising radiation. To obtain as many opinions as possible we are also asking interested parties to complete a simple (only four questions) feedback form. Please return completed form to clb@ceh.ac.uk **by 18th January 2008**.

Please accept our thanks in advance if you can find the time to do this.

Specific Aims

Evaluate existing and developing approaches (i.e. the models and tools) used for demonstrating protection of the environment from ionising radiation. Apply recommended benchmark values and assess the potential consequences of their use.

Approach

This work package will bring together those organisations using or developing approaches to the protection of the environment from ionising radiation in order to:

- Evaluate the practicability of existing and developing approaches
- Consider acceptability and relevance of the approaches with respect to the requirements of regulators and industry (identified by WP1)
- Apply numerical targets recommended by WP3 and others
- Assess the user friendliness of the approaches to potential users

Application of the available approaches to case studies will be used to help achieve these objectives.

Output

Local intranet