Dose Modeling Comparison for Terrestrial Biota: IAEA EMRAS II Biota Working Group's Little Forest Burial Ground Scenario

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Motivated by:

- Increased attention on biota dose assessment (e.g., Handbook of Wildlife Transfer, Wildlife transfer database, recent/emerging ICRP docs)
- Ongoing development of biota dose codes (e.g., increased probabilistic capabilities)
- Recommendations of Chernobyl and Perch Lake model inter-comparison studies.
- Examine causes of variability

Little Forest Burial Ground near Sydney Australia

1960-68
Disposal

Today-

Ten representative organisms

Plant – Grass (*Poaceae)*

Plant, tree – Acacia (*Acacia longifolia)*

Plant, tuber – Pencil Yam (*Vigna lanceolata*)

Annelid – Earthworm (*Lumbricidae*)

Arthropods – Grasshopper (*Caelifera*)

Reptile – goanna (*Varanus varius*)

Bird – Australian raven (*Corvus coronides*)

Mammal, monotreme – Echidna (*Tachyglossus*)

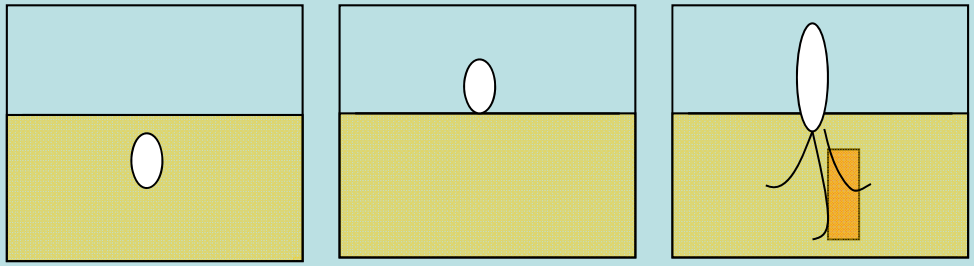
Mammal, placental canine – Fox (*Vulpes vulpes*)

Mammal, marsupial – Wallaby (*Wallabia bicolour*)

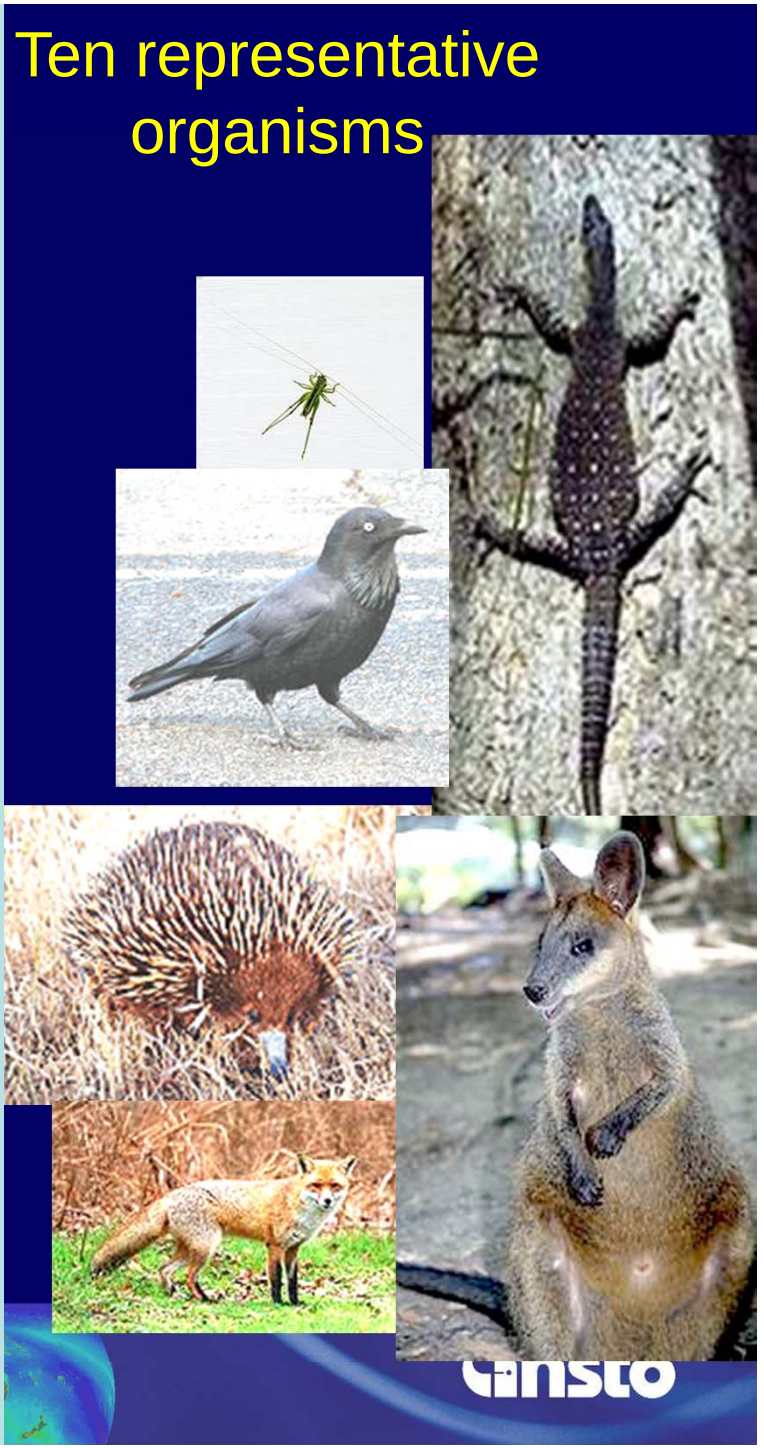
Ranges of:

Sizes & shapes

Exposure Configurations:



Uptake & assimilation



Participants, codes, and approaches

CRs

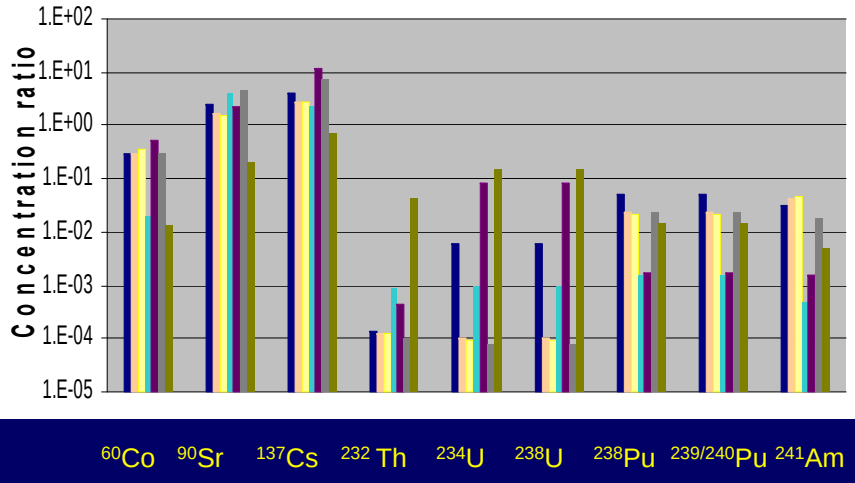
biokinetic

allometric

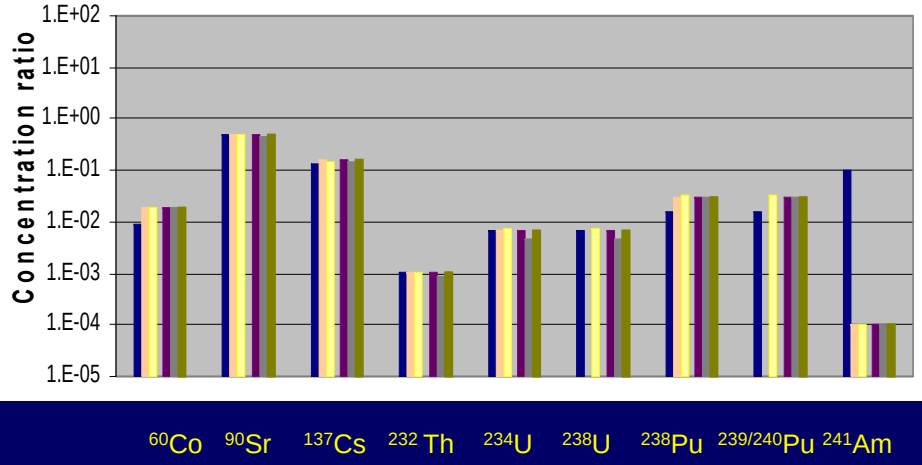
Participant	Code	Method for soil-to-organism transfer
Centre for Ecology & Hydrology, Lancaster, UK (ERICA-CEH)	ERICA Tool (tier 3)	$CR_{wo\text{-}soil}$ (Wildlife Transfer Database)
Belgian Nuclear Research Centre, Mol, Belgium (ERICA-SCK)	ERICA Tool (tier 3)	$CR_{wo\text{-}soil}$ (ERICA Tool defaults and IAEA reference docs)
Jožef Stefan Institute, Ljubljana, Slovenia (ERICA-JSI)	ERICA Tool (tier 3)	$CR_{wo\text{-}soil}$ (ERICA Tool defaults)
Norwegian Radiation Prot. Authority Oesteraas, Norway (FASTer-lite-NRPA)	FASTer-lite used with ERICA Tool, Eikos, and ECOLOGO	Biokinetic transfer (compartment) models (parameters from reference docs; soil-to-diet CR values from ERICA-Tool defaults).
Korea Atomic Energy Res. Institute Daejeon, Republic of Korea (K-Biota-KAERI)	K-Biota	$CR_{wo\text{-}soil}$ (ERICA Tool defaults for grass, tree, earthworm, insect, bird; IAEA TRS 364 for yam
		Allometric equation (goanna, echidna, fox, and wallaby -USDOE and other reference docs)
Argonne National Laboratory, Illinois, USA (RESRAD-BIOTA-ANL)	RESRAD-BIOTA	$CR_{wo\text{-}soil}$ (RESRAD-BIOTA defaults).
Manchester Metropolitan University Manchester, UK (RESRAD-BIOTA-MMU)	RESRAD-BIOTA	$CR_{wo\text{-}soil}$ (RESRAD-BIOTA defaults for grass, tree, earthworm, insect)
		Allometric equation (goanna, raven, echidna, fox, and wallaby USDOE and other reference docs)

Example results:

wallaby -



acacia-

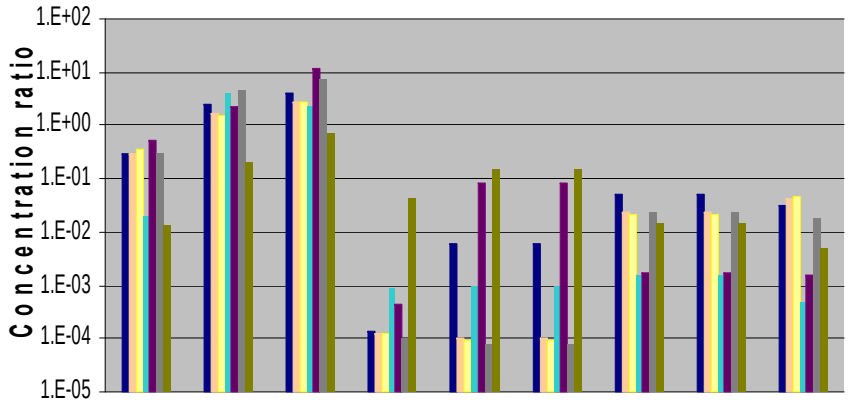


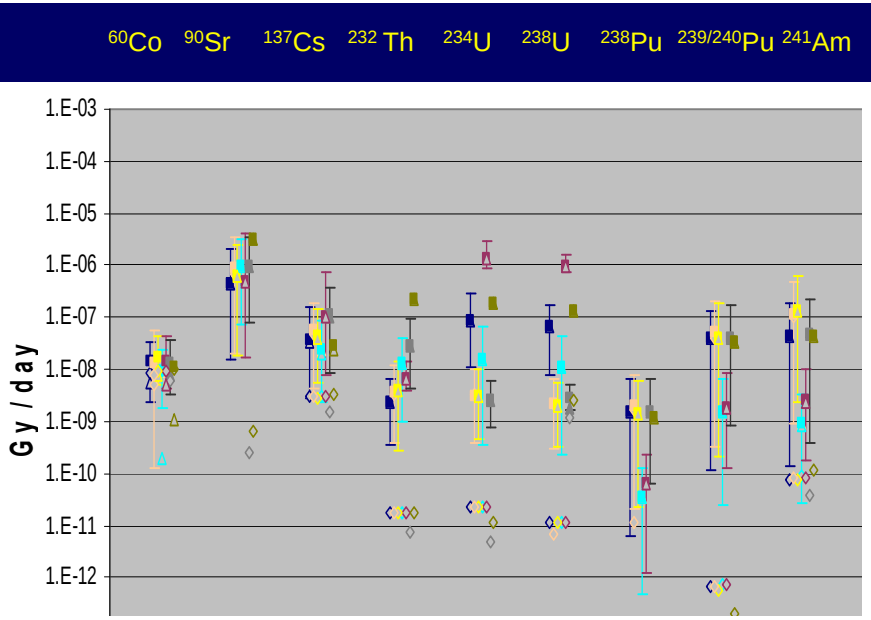
Variation in transfer (concentration ratios)

ERICA - CEH
ERICA - SCK
ERICA - JSI
FASTER-lite - NRPA
K-BIOTA - KAERI
RESRAD-BIOTA - ANL
RESRAD- BIOTA-MMU

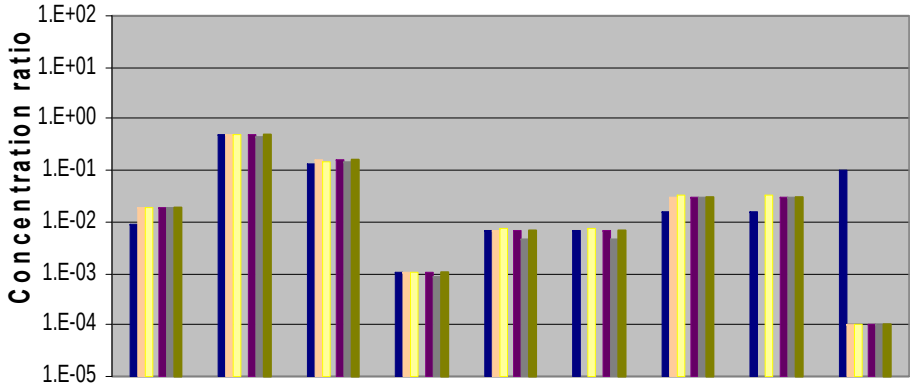
Example results:

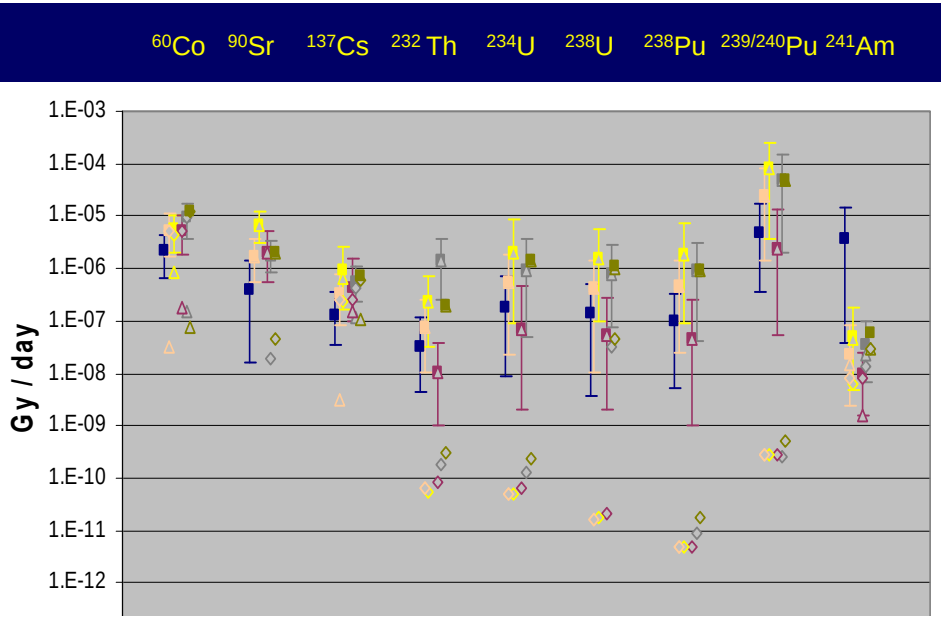
wallaby -





acacia-





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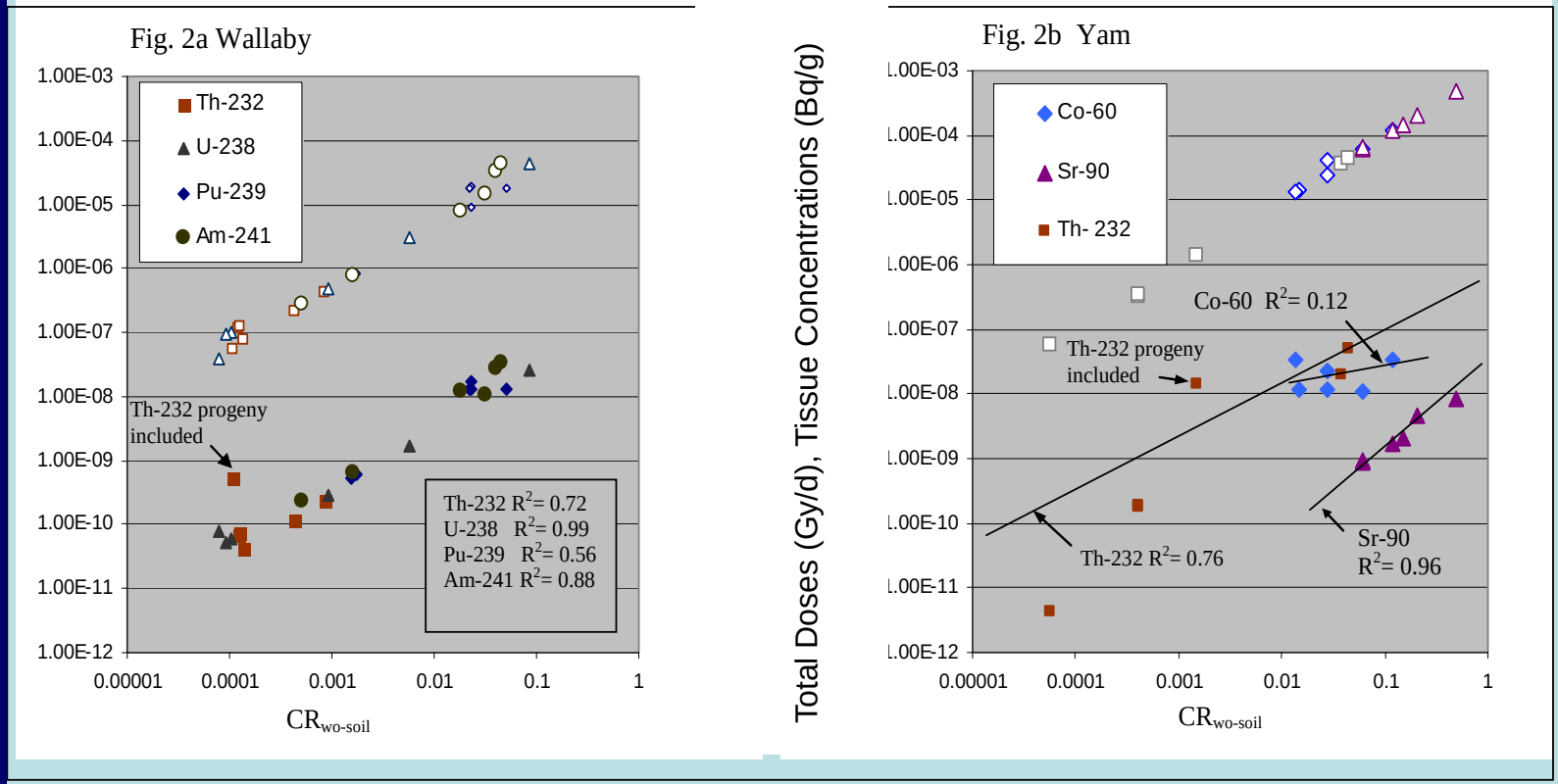
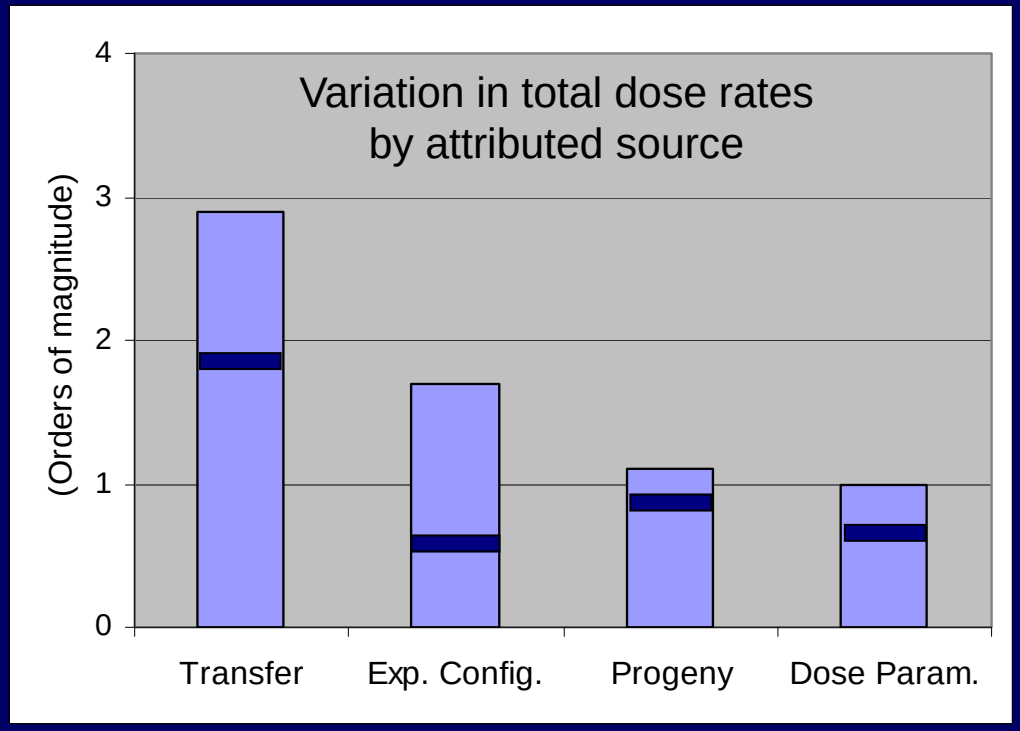
Total dose v. CRs, considering α,β,γ

Fig. 2. Predicted tissue concentrations (Bq/g) and total dose rates (Gy/d) vs. $CR_{wo\text{-}soil}$ for (a) Yam and (b) wallaby. Values have been normalized relative to soil concentrations of 1 Bq kg^{-1}.



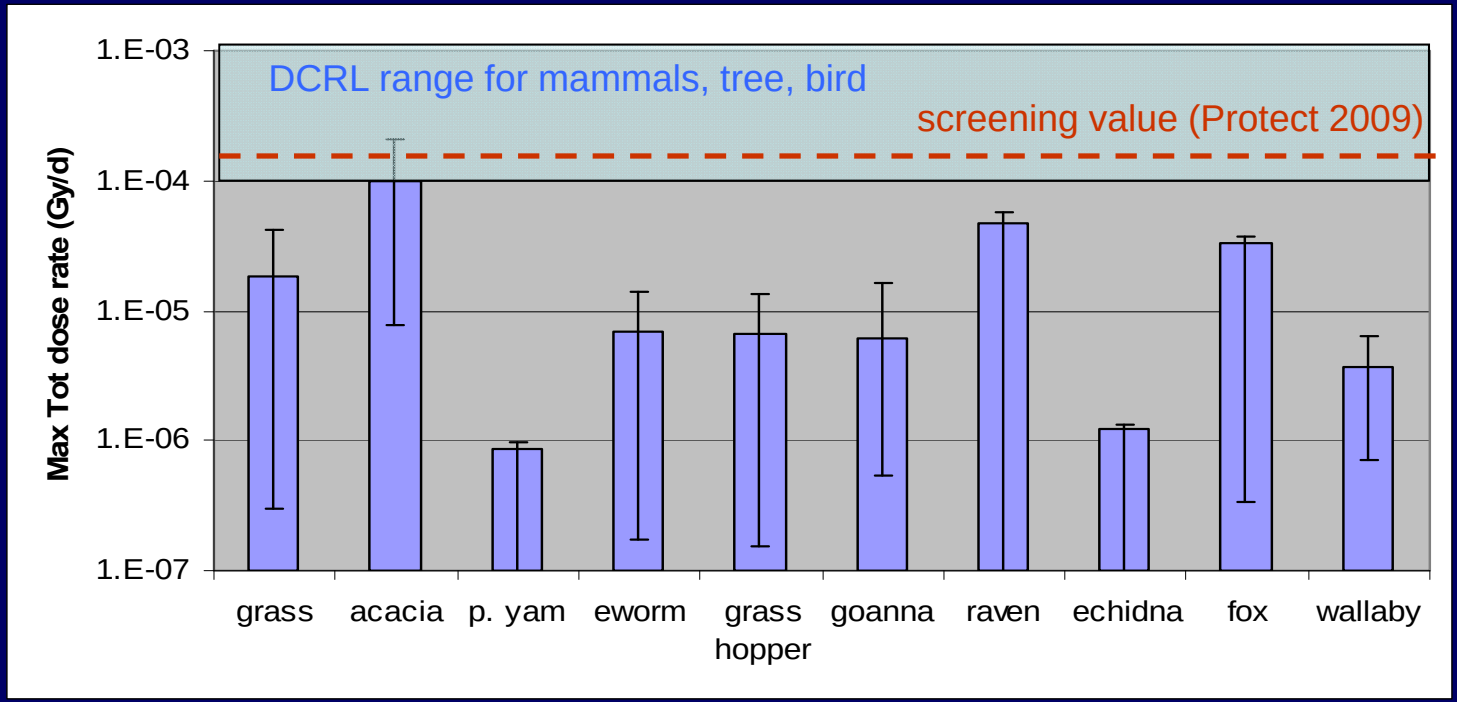
Conclusions:

Orders-of-magnitude variation in total dose rate predictions among approaches due to:



Conclusions:

- Probabilistic functions allowed 95th & 5th envelope of predicted dose rates.



Conclusions:

- Provides useful feedback to model users and model developers:
  - Transfer

    Careful/considered use of ref values. Continued need to better understand & parameterize fundamental transfer mechanisms.
  - Exposure configurations

    Some configurations (tree roots accessing waste) were not easily modeled
  - Progeny

    Need to consider appropriate progeny cutoff periods relative to site waste emplacement and ecosystem persistence
  - Dose parameters (rad weighting factors, DCCs)

    <1 Order of magnitude variability is consistent with previous studies.

Thank you

Comments:

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Summary statistics measuring variation across all radionuclides

	Soil-to-organism transfer ($CR_{wo\text{-}soil}$)	Whole-organism Tissue Concentration	Internal dose rates	External dose rates	Total dose Rates
grass	0.44	0.44	0.65	0.38	0.61
acacia	0.16	0.41	0.66	0.47	0.57
pencil yam	0.59	0.60	0.67	0.43	0.64
earthworm	0.15	0.16	0.49	0.33	0.47
grasshopper	0.27	0.28	0.54	0.38	0.49
goanna	0.65	0.64	0.64	0.40	0.60
raven	0.34	0.57	0.64	0.47	0.61
echidna	0.58	0.44	0.65	0.38	0.61
fox	0.58	0.44	0.65	0.38	0.61
wallaby	0.58	0.44	0.65	0.38	0.61