



Does the use of reference organism in impact assessments provide an adequate protection of site-specific species in routine release? Clarification and reassurance

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Does the use of reference organism in impact assessments provide an adequate protection of site-specific species in routine release? Clarification and reassurance

02 June 2022

Benoit CHARRASSE

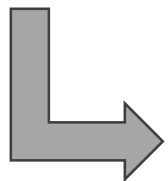
Objectives of the ICRP / IAEA

“... maintenance of biological diversity, the conservation of species, or the health and status of natural habitats, communities, and ecosystems” ...

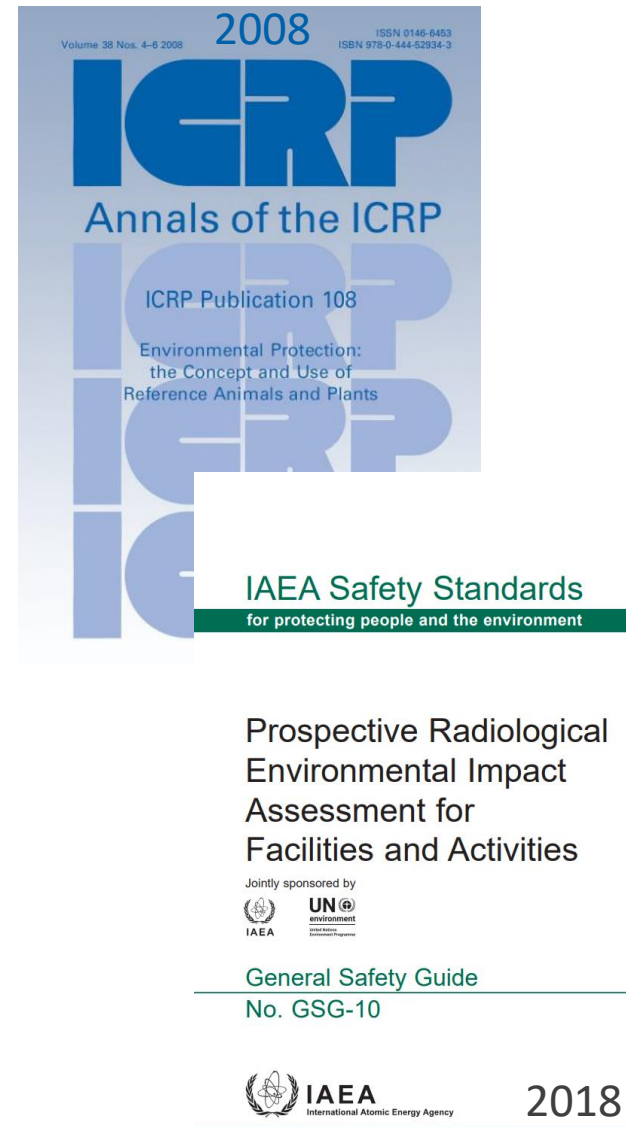
AND

“It also recognised the needs of some national authorities to demonstrate, directly and explicitly, that the environment is being protected...”

→ System developed in coherence with that for humans



The approaches are based on a set of
reference organisms



ICRP/IAEA approach (RAP for Reference Animal and Plant)

TABLE I-1. TYPES OF ANIMALS AND PLANTS FOR THREE MAJOR ECOSYSTEMS TO BE USED IN GENERIC ASSESSMENTS OF RADIOLOGICAL IMPACT ON FLORA AND FAUNA AND RELEVANT DERIVED CONSIDERATION REFERENCE LEVELS [I-1]

Ecosystem of interest	Type of animal or plant	ICRP reference animal or plant	Derived consideration reference level (mGy/d)
Terrestrial	Large plant	Reference pine tree	0.1–1
	Small plant	Reference wild grass	1–10
	Insect	Reference bee	10–100
	Annelid	Reference earthworm	10–100
	Large mammal	Reference deer	0.1–1
	Small mammal	Reference rat	0.1–1
	Aquatic bird	Reference duck	0.1–1
Freshwater	Amphibian	Reference frog	1–10
	Fish	Reference trout	1–10
	Seaweed	Reference brown seaweed	1–10
Marine	Crustacean	Reference crab	10–100
	Fish	Reference flatfish	1–10

ICRP, 2008 (publication 108)

Reference Organisms

Terrestrial Ecosystem

Amphibian (ICRP Frog)

Annelid (ICRP Earthworm)

Arthropod - detritivorous (FASSET Woodlouse)

Bird (ICRP Duck)

Flying insects (ICRP Bee)

Grasses & Herbs (ICRP Wild grass)

Lichen & Bryophytes (ICRP Bryophyte)

Mammal - large (ICRP Deer)

Mammal - small-burrowing (ICRP Rat)

Mollusc - gastropod (ICRP Snail)

Reptile (FASSET snake note this is an ellipsoid)

Tree (ICRP Pine tree)

Marine Ecosystem

Benthic fish (ICRP Flat fish)

Bird (ICRP Duck, Wading bird)

Crustacean (ICRP Crab)

Macroalgae (ICRP Brown seaweed)

Mammal (FASSET Mammal)

Mollusc - bivalve (FASSET Benthic mollusc)

Pelagic fish (FASSET Pelagic fish)

Phytoplankton (ERICA Phytoplankton)^(a)

Polychaete worm (FASSET Benthic worm)

Reptile (ICRP Turtle)

Sea anemones & True coral (ICRP Polyp)

Vascular plant (FASSET Vascular plant)

Zooplankton (FASSET Zooplankton)

ERICA Approach (RO for Reference Organism)

Freshwater Ecosystem

Amphibian (ICRP – Frog)

Benthic fish (FASSET Benthic fish)

Bird (ICRP Duck)

Crustacean (FASSET Crustacean)

Insect larvae (FASSET Insect larvae)

Mammal (FASSET Mammal)

Mollusc - bivalve (FASSET Bivalve mollusc)

Mollusc - gastropod (FASSET Gastropod)

Pelagic fish (ICRP Salmonid/Trout)

Phytoplankton (ERICA Phytoplankton)^(a)

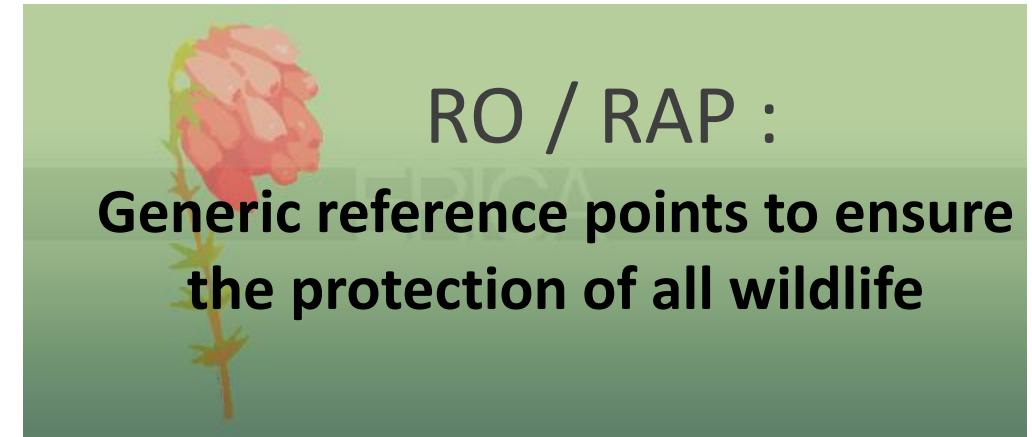
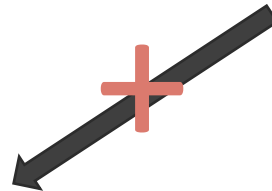
Reptile (ERICA Freshwater reptile)^(b)

Vascular plant (FASSET Vascular plant)

Zooplankton (FASSET Zooplankton)



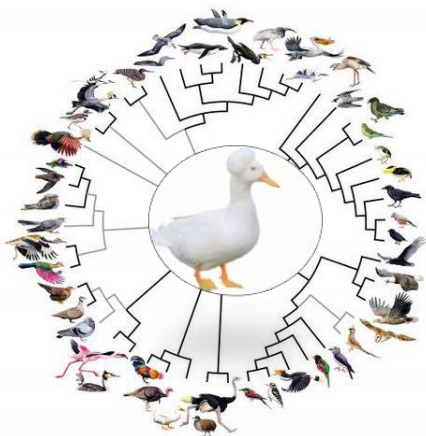
Endangered or protected species



Species identified on site (Batlle et al., 2016; Charrasse et al., 2019; Jaeschke, B et al., 2013; Posiva, 2014; Torudd and Saetre, 2013, Stark et al., 2017)

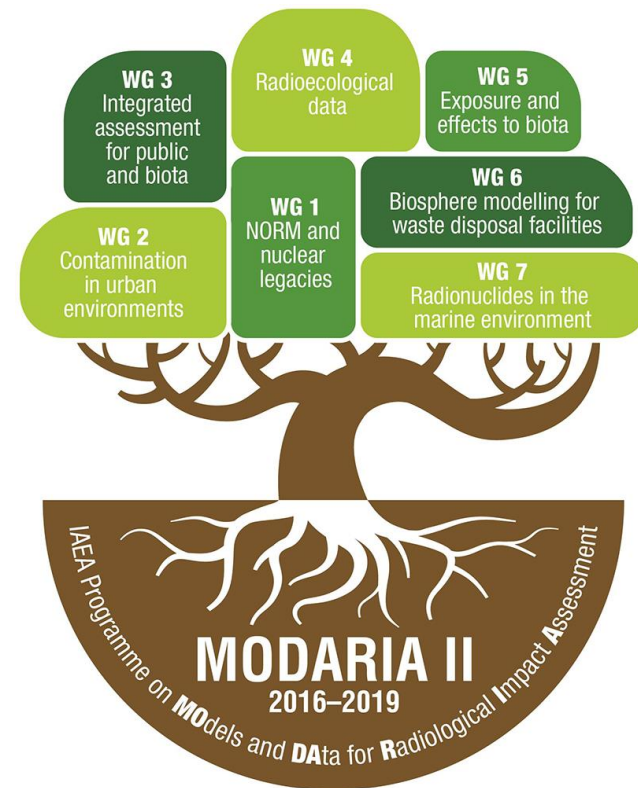
Default OR or RAP
(Ait Bout et al., 2021; Batlle et al., 2011; Brown et al., 2016; Carolan et al., 2011; Kautsky et al., 2016; Lavrentyeva et al., 2016; Robinson et al., 2010; Shishkina et al., 2016; Smith et al., 2010; Vandenhove et al., 2013, Stark et al., 2017)

Pragmatic question : “Does the use of the generic organisms defined by different approaches in a risk assessment really protect all species in the different target ecosystems in terms of dosimetry?”



❑ MODARIA II program from the IAEA (Modelling and Data for Radiological Impact Assessments)

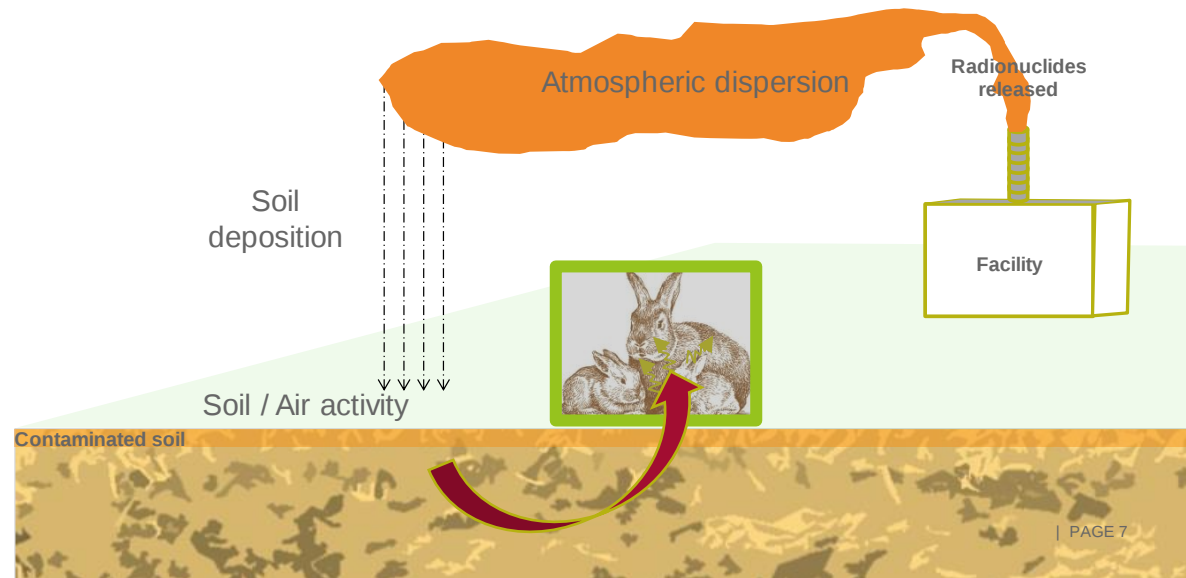
→ Collaboration with the WG 3 (*« Assessments and control of exposures to public and biota for planned releases to the environment »*)



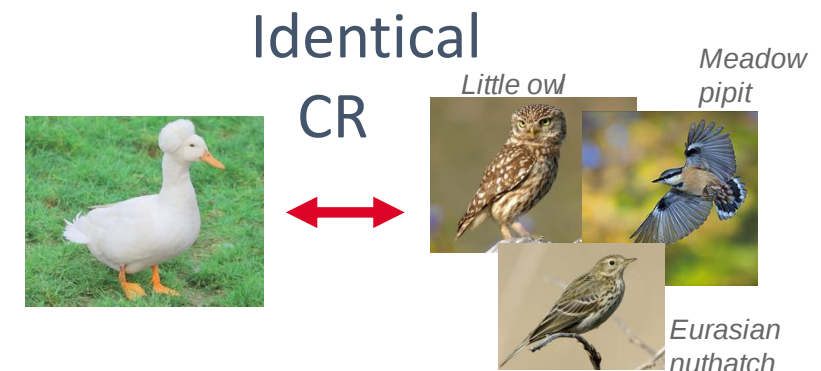
Activity concentration
in the media

Concentration ratio* (CR)

Concentration in
organism



Assumptions for endangered/protected species or not well characterized species :



*ICRP, 2008; 2009; WTD; www.wildlifetransferdatabase.org/,
Copplesstone et al., 2013, Beresford et al, 2016

Activity concentration
in the media

Concentration ratio* (CR)

Concentration in
organism

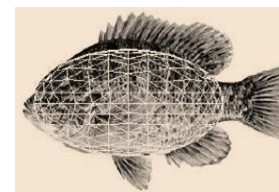
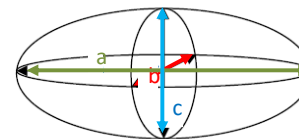
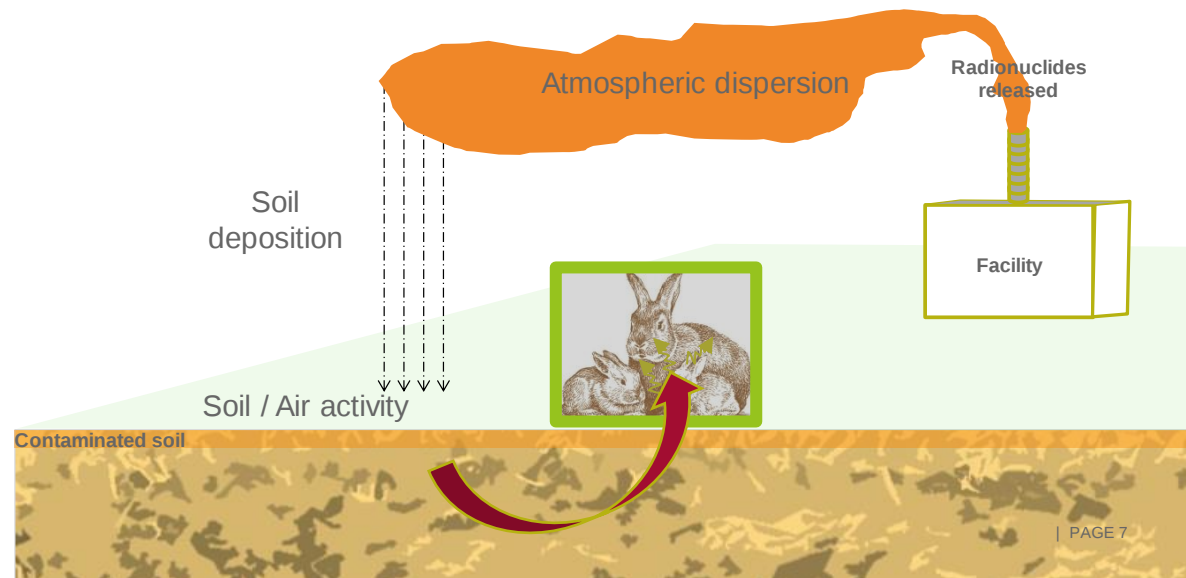
Dose coefficient (int/ext)

Dose rate

Geometric shape

Mass

Habitat



*ICRP, 2008; 2009; WTD; www.wildlifetransferdatabase.org/,
Copplesstone et al., 2013, Beresford et al, 2016

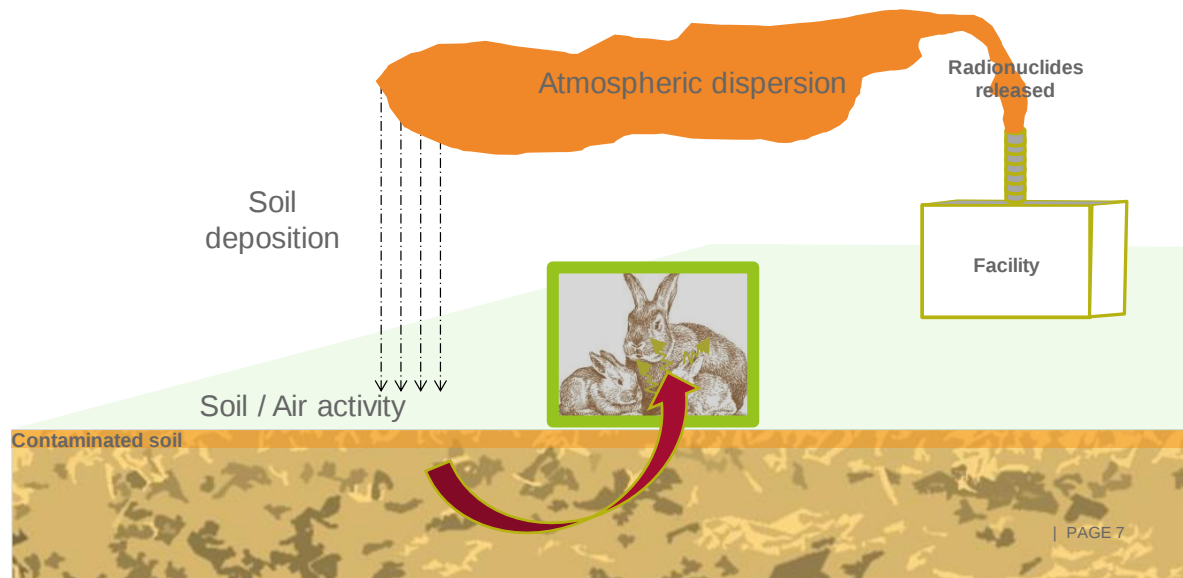
Activity concentration
in the media

Concentration ratio* (CR)

Concentration in
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Dose coefficient (int/ext)

Dose rate

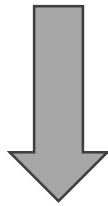


The question comes down to

What is the influence of the diversity of sizes
and shapes of the ellipsoid + Habitat diversity ?

*ICRP, 2008; 2009; WTD; www.wildlifetransferdatabase.org/,
Coppstone et al., 2013, Beresford et al, 2016

Objective : To bound uncertainties around the conceptual representation of species in assessments in case of routine atmospheric releases



Maximal predicted Dose rate (DR) differences between hypothetical organisms and its corresponding Generic Organism (GO) were estimated.

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PAPER

Bounding uncertainties around the conceptual representation of species in radiological assessment in the context of routine atmospheric release

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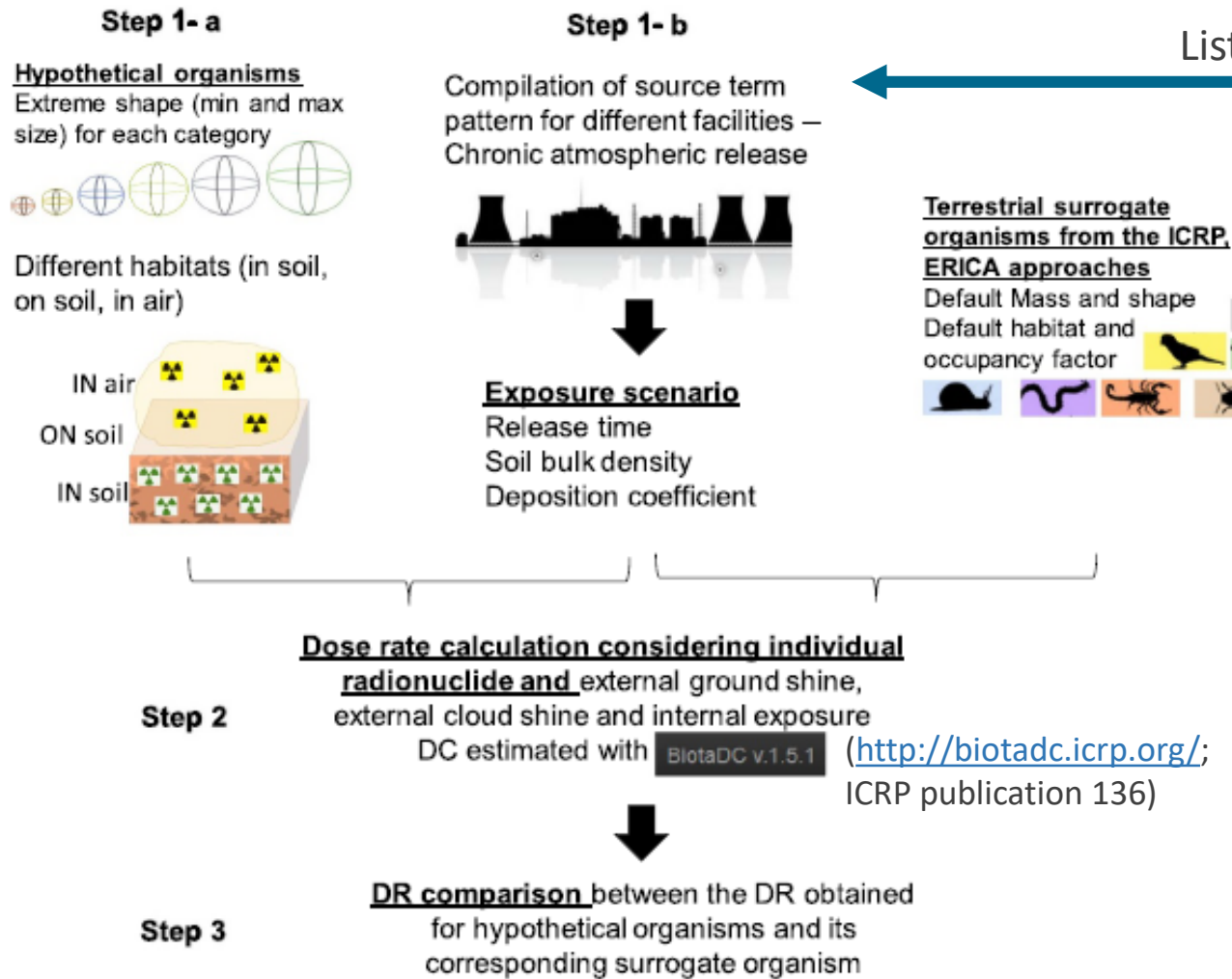
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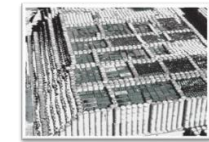


List of radionuclides (75)



Nuclear Power Plant (NPP)

110mAg 242,243,244Cm 85,85m,87,88Kr 122,124,125Sb
241Am 51Cr 141,144Ce 131m,133,135,135m,138Xe
41Ar 14C 140Ba 57,58,60Co 55,59Fe 103,106Ru 35S 65Zn 95Zr
129,131,132,133,135I 134,137Cs 63Ni 238,239,240Pu 89,90Sr
140La 54Mn 95Nb



Waste disposal

241Am 238,239,240Pu
14C 3H 125,129,131I
60Co 137Cs 85,85m,87,88Kr
90Sr



Fuel fabrication, reprocessing plants

241Am 60Co 129,131I 210,214Pb 125Sb
14C 242,243,244Cm 210,218Po 90Sr
144Ce 134,137Cs 85Kr 228,230,232Th
238,239,240,241Pu 3H 237Np 106Ru 99Tc



Radiopharmaceutical facilities and hospitals

198Au 22Na 32P 89Sr 99mTc
14C 67Ga 111In 201Tl 223Ra
47Ca 3H 123,129,131I 133Xe 90Y
169Er 177Lu 99Mo 153Sm 186Re



Research center

241Am 131m,133,135,135m,138Xe
41Ar 238,241Pu 232Th
60Co 90Sr 137Cs 125Sb 234,235,238U
14C 242Cm 3H 106Ru 129,131I



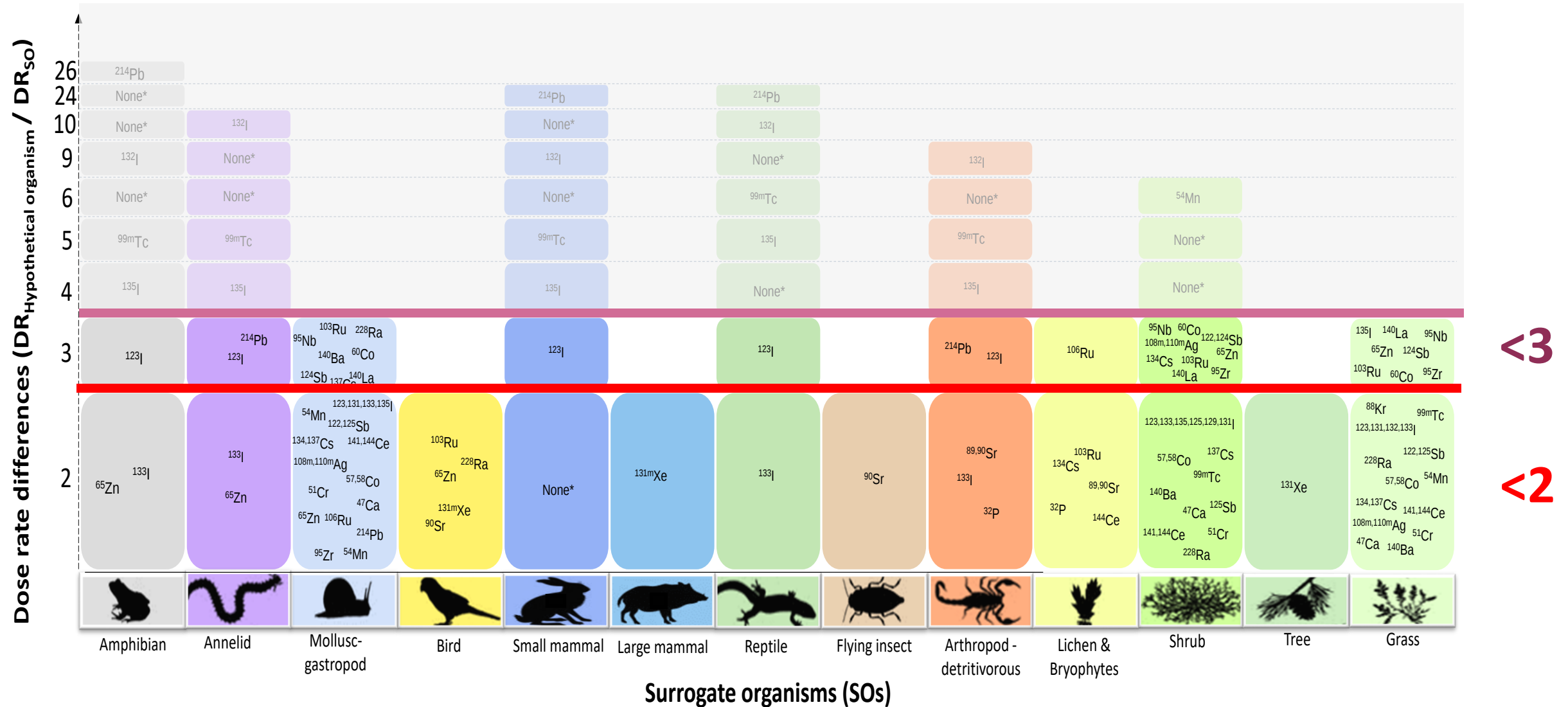
Decommissioning

108mAg 137Cs
14C 60Co 239Pu
3H



Norm activity

214Bi 220,222Rn
40K 232Th
234,235,238U
226,228Ra



*None for no radionuclide in this range of dose rate difference

“Pragmatic question : Does the use of the generic organisms defined by different approaches in a risk assessment really protect all species in the different target ecosystems in terms of dosimetry?”

YES, in the vast majority of cases, by a factor of 2/3

Particular attention to short-lived RNs if they contribute mostly to the dose rate



On the condition that the CRs/transfer factors used are identical between "real" and "reference" organism



The greatest uncertainty relies on the CR ratio (Johansen et al, 2012; Stark et al, 2015)

Adding site specific species to the set of reference organism can respond to various interests, such as demonstrating to the stakeholders more specifically the actual protection of the environment

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Does the use of reference organisms in radiological impact assessments provide adequate protection of all the species within an environment?

Benoit Charrasse ^{a,*}, Amanda Anderson ^b, Juan C. Mora ^c, Justin Smith ^d, Emilie Cohenny ^a, Ari T.K. Ikonen ^e, Ville Kangasniemi ^e, Benjamin Zorko ^f, Yuri Bonchuk ^g, Léa Beaumelle ^h, Nipun Gunawardena ⁱ, Valeria Amado ^j, Lodovit Liptak ^k, Elisabeth Leclerc ^l, Diego Telleria ^m



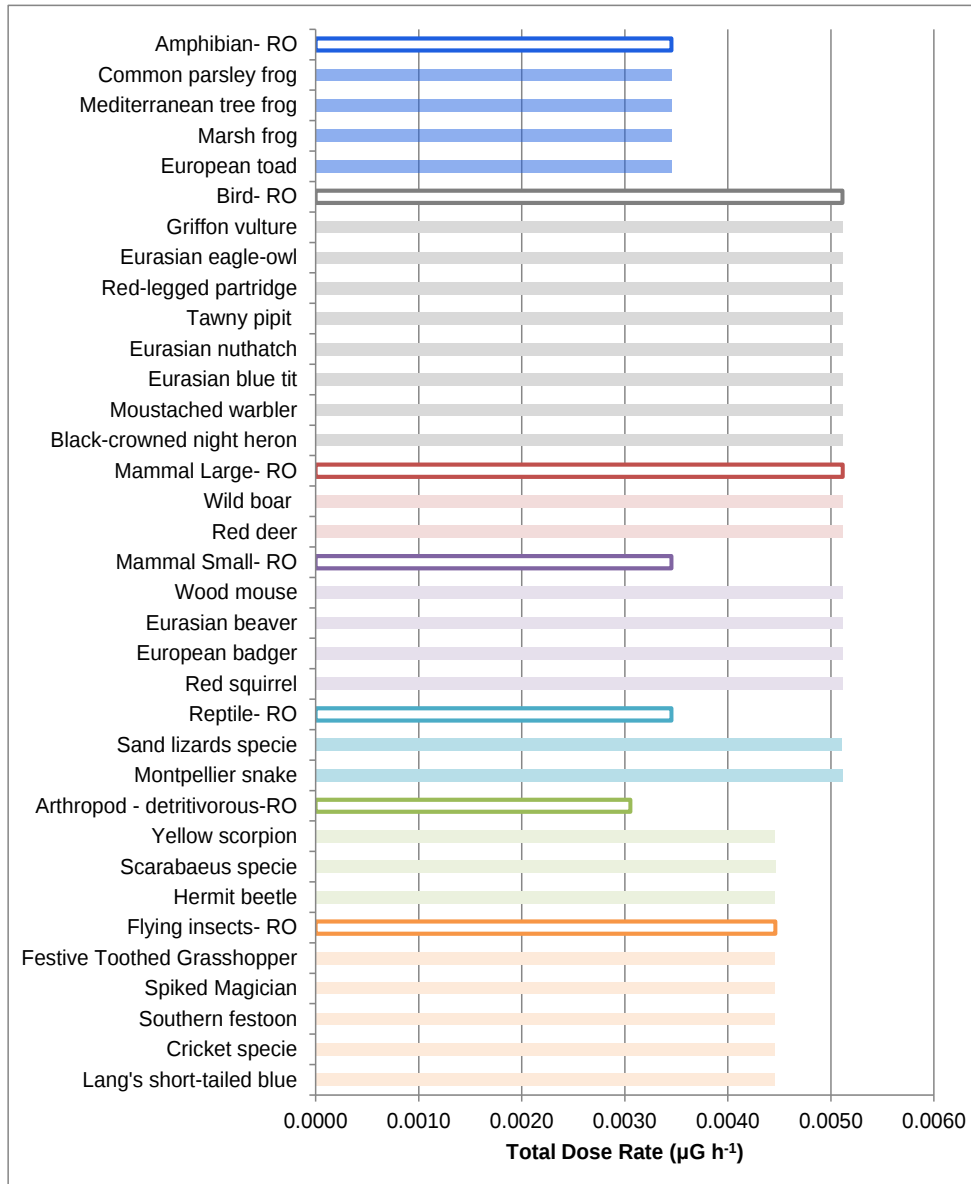
- Species selection based on ecological stakes
- Species selection based on non-human biota representation for dosimetric calculation

❑ Application of two filters

28 species

❑ Consideration of 400 species (terrestrial) (initial step)





28 species selected



Intra- species DR_{tot} difference
less than a factor of 2

Despite the range of geometric
characteristics, habits and habitats
numerical risk assessment **is not**
improved for any selected biota in this
release scenario



THANKS FOR YOUR ATTENTION 😊

AND

A special thanks to all the participants from the WG3 and the scientific secretaries