How the new “Derived Consideration Reference Levels” were derived

Why and how they are useful

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Structure of the TG99 report

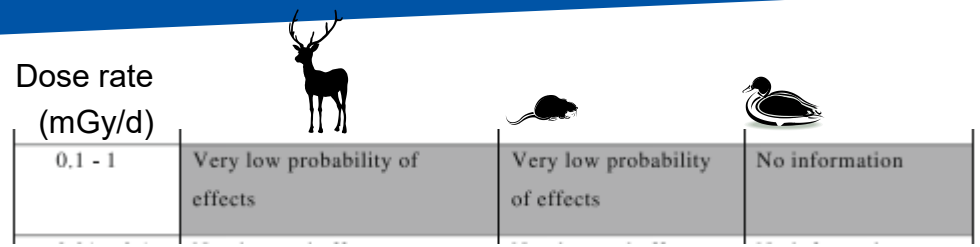
Brief reminder of the current RAP approach (P108)

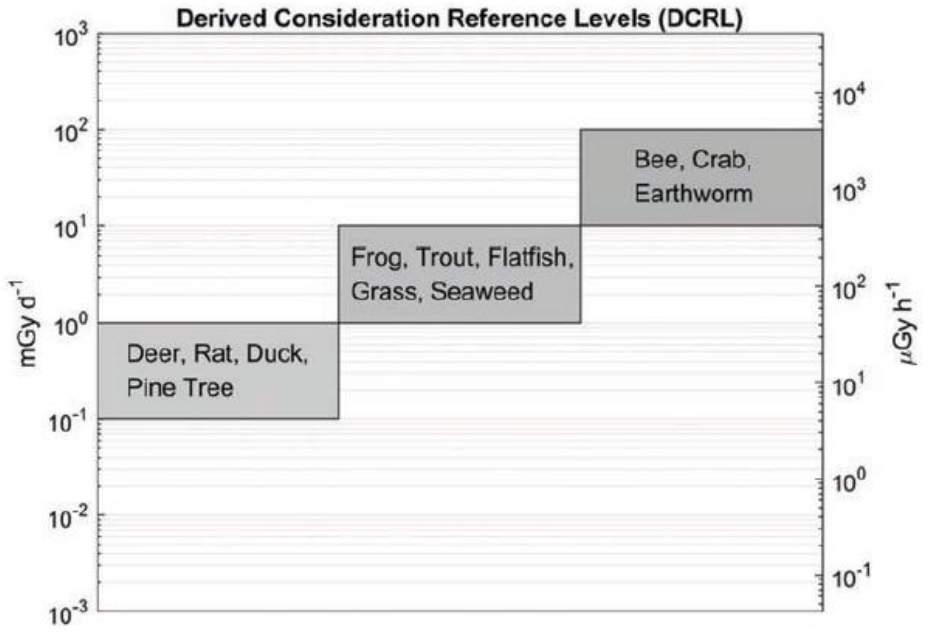
- **Demonstration of protection of non-human species is:**
  - generally targeted at the **population level** (or higher levels), rarely at the individual (except for species at risk)
  - based on:
    - **A set of 12 Reference Animals and Plants (RAPs), defined at the Family level**

    *(Species<Genus<**Family**<Order<Class<Phylum<Kingdom)*

    - **RAP-related Derived Consideration Reference Levels (DCRLs)** as benchmark for comparison with dose rate estimates and assess radiological impact

    "*DCRLs are ranges of dose rates where some deleterious effects may be expected and which are defined as benchmarks for assessing radiological impact to non-human species, either actual or potential.*"





"Revisions will need to be made as more data become available." P108 (published in 2008, with literature review until ~2006)

Broadening the RAP approach

What it means

Complementing the current set of RAP_{Family} with additional RAPs (and DCRLs) representing **higher taxonomic levels – class or phylum, non-human species groups**

How it was implemented

By pooling comparable effects data across taxa to enable **statistical analysis of the radiosensitivity variation among species within the same taxonomic level** (e.g., class)

Chap 3 & Tab3.1

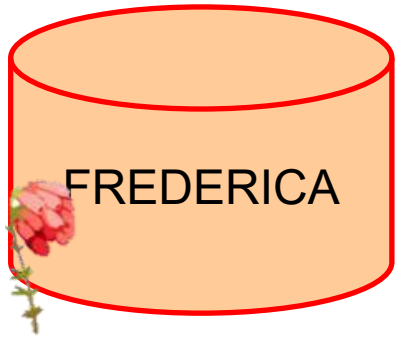
$RAP_{Class\ (or\ Phylum)}$ Common name	Scientific name (class or phylum)	RAP_{Family}
Birds	*Aves*†	Duck
Fish	*Actinopterygii*†	Trout; Flatfish
Mammals	*Mammalia*†	Deer; Rat
Crustaceans*	*Branchiopoda*†, *Malacostraca*†	Crab
Worms*	Annelida* (*Clitella*† and *Polychaeta*†)	Earthworm
Insects	*Insecta*†	—
Conifers	*Pinopsida*†	Pine tree
Grasses and monocots‡	*Liliopsida*†	Wild grass
Shrubs, trees not coniferous, dicots‡	*Magnoliopsida*†	—
Broad non-human species groups		
Vertebrates		Frog§; Mammals; Fish; Birds
Invertebrates		Bee§; Earthworm; Crab
Plants		Brown seaweed§; Pine tree; Wild grass

*Phylum. †Class. §RAP_{Family} with no existing effects data.

Methodology of effects data treatment

Chap 4.1 to 4.3

Select QC data for each test [series of data pairs for (species, endpoint, exposure conditions)]



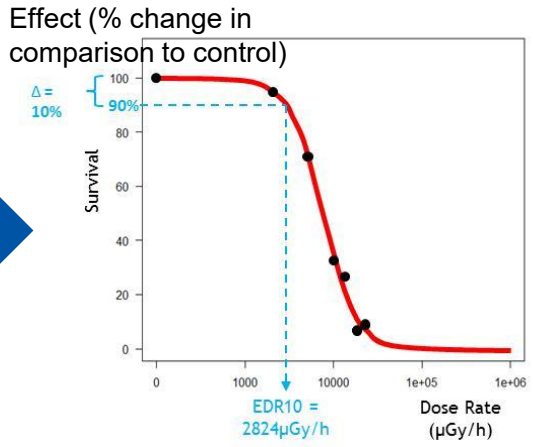
www.frederica-online.org

(> 1500 references; 26 000 data entries – version 2010 – complemented by references reviewed under the IAEA EMRAS programme)

Copplestone et al., JER 2013
Garnier-Laplace et al., JER 2010

Reconstruct dose(rate)-effect relationship for each test

Chronic test – Observed EDR_{10}
Acute test -- Observed ED_{50}



Develop the Acute-to-Chronic Transformation of Radiation effects (ACTR) model

Observed ED_{50} → ACTR → Predicted EDR_{10}

Beaugelin-Seiller et al., EST 2021

Establish Endpoint Sensitivity Distribution (ESD) per taxonomic group

Chronic ESD *[EDR_{10} observed and predicted]*
Acute ESD [*ED_{50} observed*]

ESD Generator

Endpoint Sensitivity Distribution

An ASNR software
Developed & Designed by Zackary BEAUGELIN

DCRL derivation per taxonomic group

Real and Garnier-Laplace, JER 2020

Interpretation of ESD and derivation of DCRLs

Chap 4.4 & 4.3

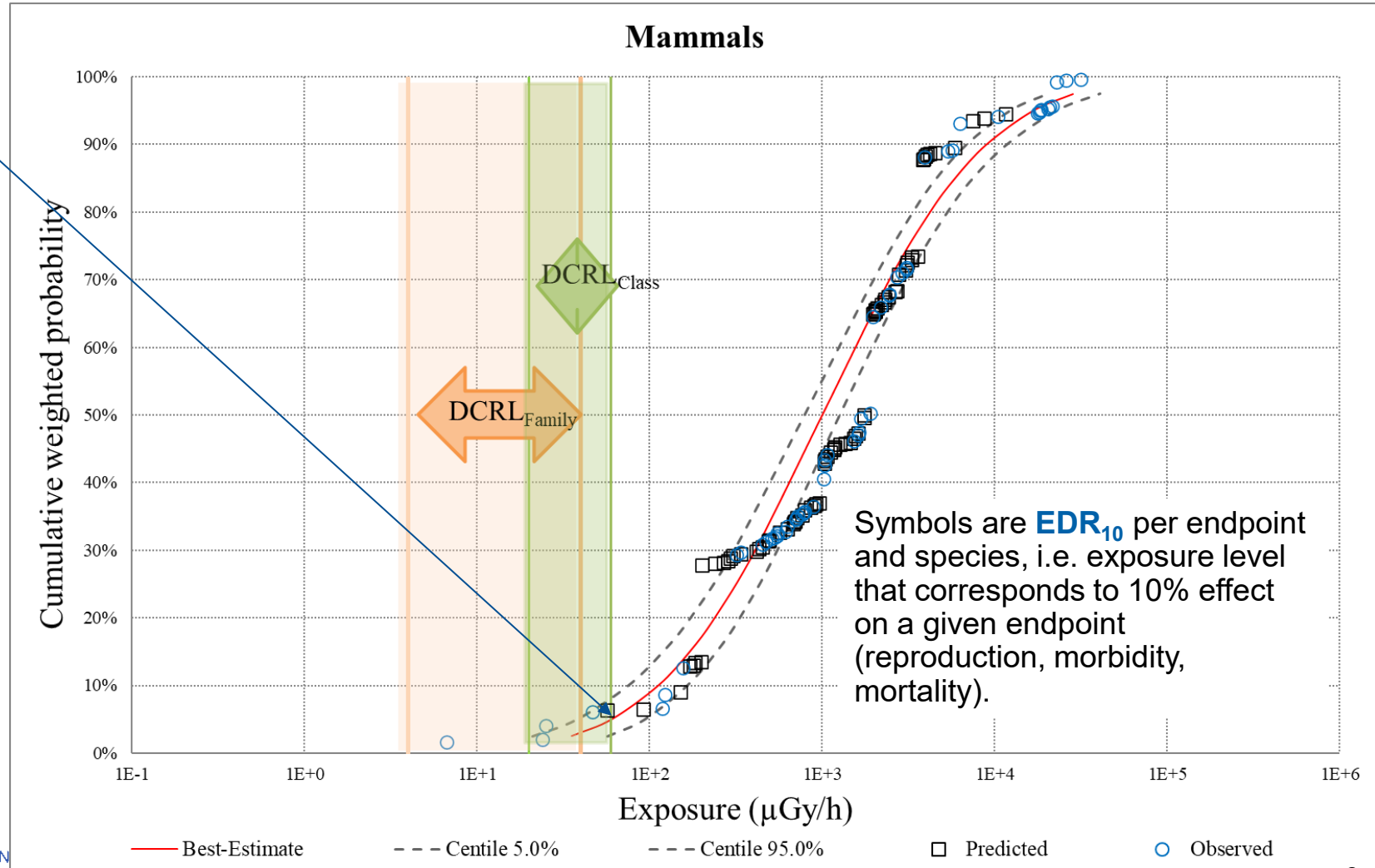
- **DCRL derivation**

Upper boundary = **best estimate of 5th percentile**

Lower boundary = **upper bound divided by an Extrapolation Factor (EF)** accounting for the quality of the dataset

- **Semi-quantitative assessment of the quality of the data set to define EF**

Criterion\level of uncertainty (low-intermediate-high)
#1. Total number of data
#2. Observed data proportion
#3. Reproductive endpoints proportion
#4. Ratio of observed data below 5th
#5. Number of species
TOTAL SCORE
EF= from 1 (low) to 5 (high)



Comparison of DCRLs (families vs. higher taxonomic groups)

- The two approaches used to determine DCRLs do not result in major differences to their values (**ca. one order of magnitude**)

- Lower boundary values of **$DCRL_{Class\ or\ Phylum}$, or broad groups are generally higher than $DCRL_{Family}$** values.

Exceptions:

Lower $DCRL_{Class\ or\ Phylum}$, or broad groups than their corresponding $DCRL_{Family}$

more effects data and statistical analysis reduce uncertainty in $DCRL_{Class\ or\ Phylum}$, or broad groups estimates for invertebrates.

Chap 4.5 (Tab4.7; Tab 4.8)

Dose rates in µG/h

P108

Expert judgement based on critical literature review

Band of one order of magnitude

RAP_{Family}	$DCRL_{Family}$
duck	4-40
trout; flat fish	40-400
deer; rat	4-40
frog	40-400
bee	400-4000
crab	400-4000
earthworm	400-4000
pine tree	4-40
wild grass	40-400
none	—
brown seaweed	40-400

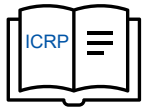
This Publication

5th percentile of the ESD per group and Extrapolation Factor to define the lower boundary

EF from 3 to 5 **EF fixed at 10**

$RAP_{Class\ or\ Phylum}$*	$DCRL_{Class\ or\ Phylum}$	Broad groups
Birds	100-300	Vertebrates
Fish	70-200	10-100
Mammals	20-60	
Amphibians	No data	
Insects	No data	Invertebrates
*Crustaceans**	100-400	70-700
Worms*	100-500	
Conifers	70-300	Plants
Grasses and Monocots	200-1000	60-600
Shrubs, Trees not coniferous, Dicots	200-600	
Brown Algae	No data	

Simple guidance on using $DCRL_{Family}$ and higher taxonomic level DCRLs in conjunction



Chap 4.5

- $DCRL_{Family}$ (from P108) are the **benchmarks recommended for environmental impact assessments**.
- The additional DCRLs at higher taxonomic levels provide an **important complement for assessing environmental impact in complex cases**
  - Enable more refined assessments along with a transparent evaluation of the level of confidence in the assessment conclusions (e.g., consider uncertainties when selecting which values to apply)
  - Option to derive **site-specific DCRLs** by using case-specific effects data or adjusting the level of protection
- Irrespective of the DCRLs used, **guidance from Publication 124 applies**.
- For early stage of an emergency: option to use acute ESD models per class, phylum or broad groups **retrospectively to support dialogue with stakeholders on any ecological impacts that may have occurred**

User-oriented concluding points

Chap 6

- There is **reasonable confidence in the current RAP_{Family} and related DRCLs**, as demonstrated by international standards and guidance - *particularly for **planned exposure situations***.

- The DCRLs at higher taxonomic levels introduced in this publication offer the possibility of **more refined assessments along with a transparent evaluation of the level of confidence in the assessment conclusions**.

- This publication strengthens environmental radiological protection by broadening the RAP approach and improving the **scientific and methodological basis for benchmarks, thereby increasing confidence in impact assessments and protective decision-making.**

- The integration of the proposed methodology along with the existing RAP_{Family} and related DCRLs is currently being examined further in the forthcoming publication on their application within the radiological protection system

  "Considering the environment when applying the System of Radiological Protection Part 2:

  Integration within the system, including practical use of Derived Consideration Reference Levels"

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