Consequences for the environment and learnings for the ICRP System of Radiological Protection

27 April 2026

Presented by
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Drawing on the work of and discussions within various ICRP TGs

Aim of the ICRP System of Radiological Protection

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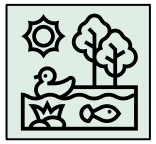

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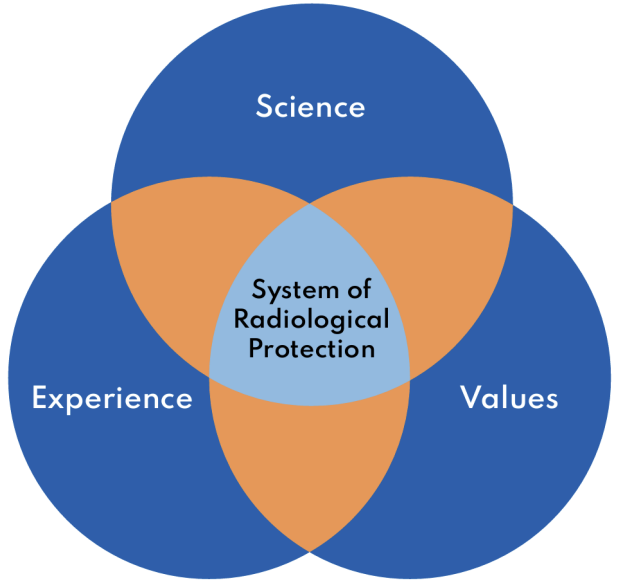

Evidence-based evolution over the years with new knowledge and experience

ICRP Publications 103 (2007); 138 (2018); 153 (2022)

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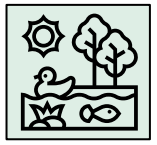

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Ethical principles for environmental protection

ICRP Publication 91 (2003)

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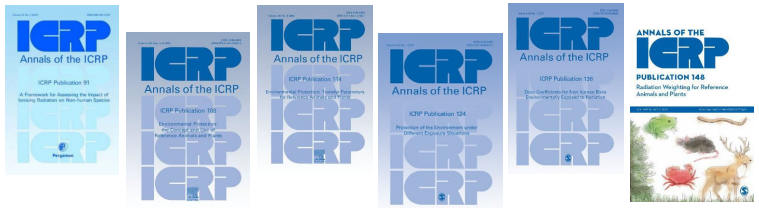
In this context, "*...the Commission recognizes that exposure to radiation is but **one factor to consider** and is often likely to be a minor one*."

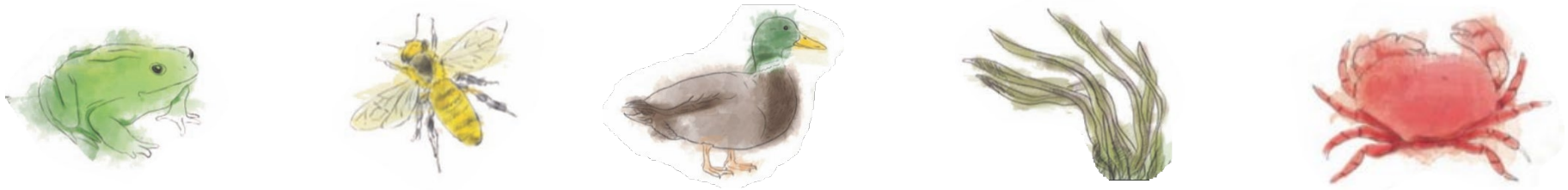
Guidance and advice is provided to support an approach that is "***commensurate with the level of risk**, and compatible with efforts being made to protect the environment form the impacts of other human activities*."



ICRP Recommendations (1)

Reference Animals and Plants (RAPs)

- **RAP: A hypothetical entity with the assumed basic characteristics of a type of animal or plant that can be used for the purposes of relating exposure to dose, and dose to effects, for that type of living organism.**
  - A large terrestrial mammal – Reference Deer
  - A small terrestrial mammal – Reference Rat
  - An aquatic bird – Reference Duck
  - An amphibian – Reference Frog
  - A freshwater fish – Reference Trout
  - A marine fish – Reference Flatfish
  - A terrestrial insect – Reference Bee
  - A marine crustacean – Reference Crab
  - A terrestrial annelid – Reference Earthworm
  - A large terrestrial plant – Reference Pine Tree
  - A small terrestrial plant – Reference Wild Grass
  - A seaweed – Reference Brown Seaweed

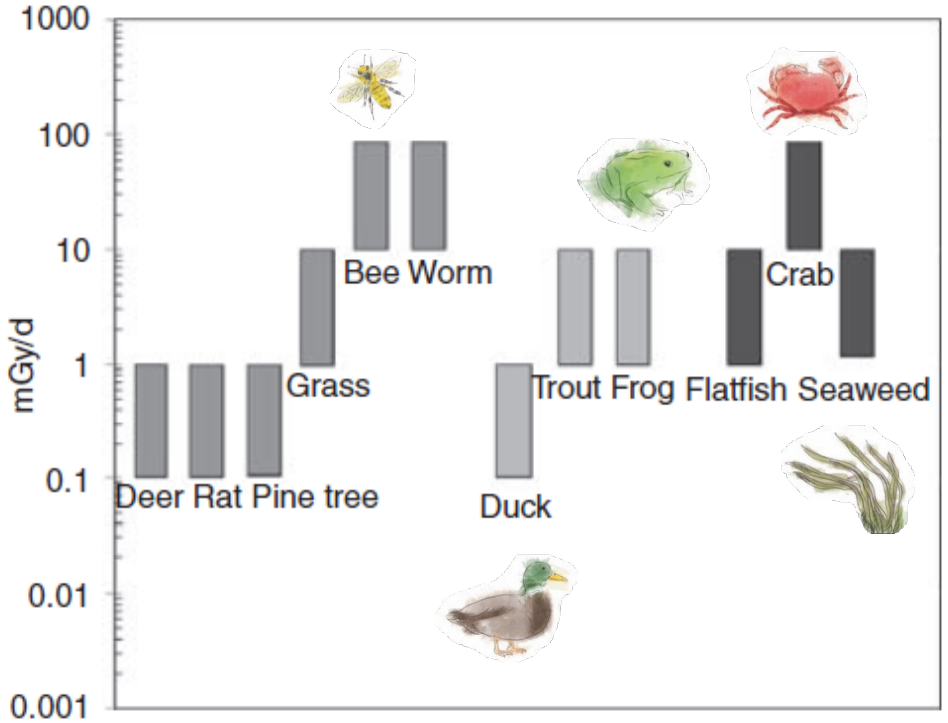


"Representative organisms" are site specific and can in some cases be linked to the closest RAP, in other cases **professional judgement may be necessary**

ICRP Publications 108 (2008); 124 (2014)

ICRP Recommendations (2)

Derived Consideration Reference Levels



DCRLs for each RAP, grouped according to habitat (terrestrial, freshwater, or marine habitat)

[ICRP Publication 124]

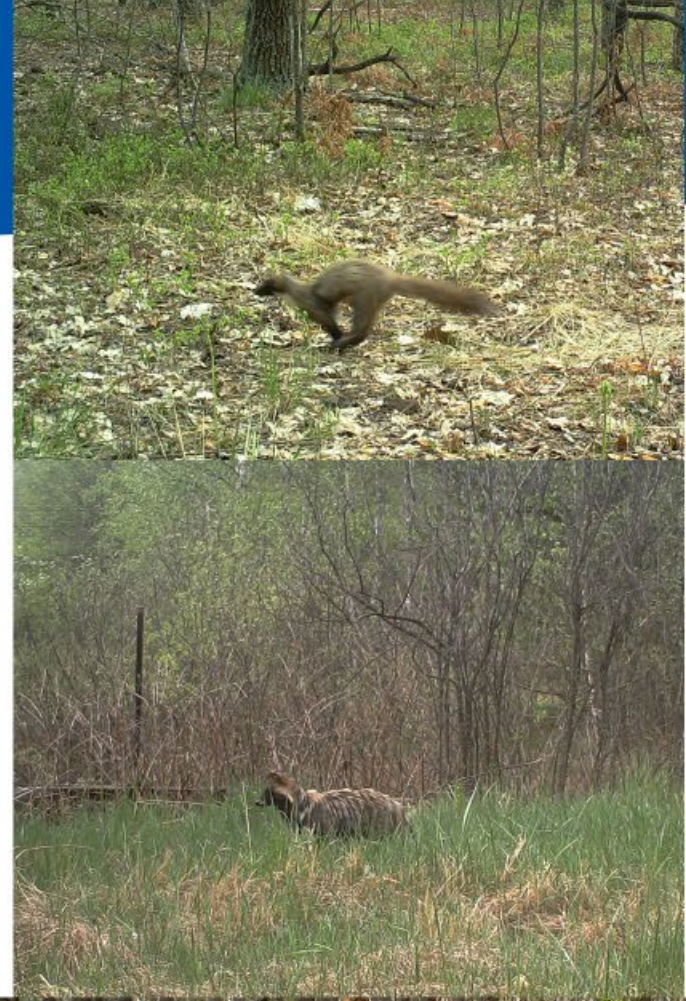
- Derived Consideration Reference Levels (DCRL) define dose rate bands for RAPs where deleterious effects could occur
- Considered with other relevant information, can be used as a point of reference to optimise the level of effort expended, dependent upon the overall management objectives and the exposure situation
- Ideally dose rates are maintained within or below DCRLs

Consequences for the environment

- Many studies on the effects of the Chornobyl and Fukushima accidents on the wildlife/the environment
- Not an attempt to summarise years of research here!
  - Key (high level) points only
  - Explore how these findings inform the development of the International System of Radiological Protection







Photographs @ TREE Project: Nick Beresford, Mike Wood, Sergii Gashchak

Key research findings

- Short- and long-term effects across multiple species – how to use?
- Dynamic fluxes in emergency phase
- Individuals v populations
- Ecosystem structure and function
- Post-accident ecological succession & recovery (absence of people?)

- Questions remain – e.g.,
  - live fast, die young?
  - Uncertainty/conflict in research findings
  - Confounding factors?

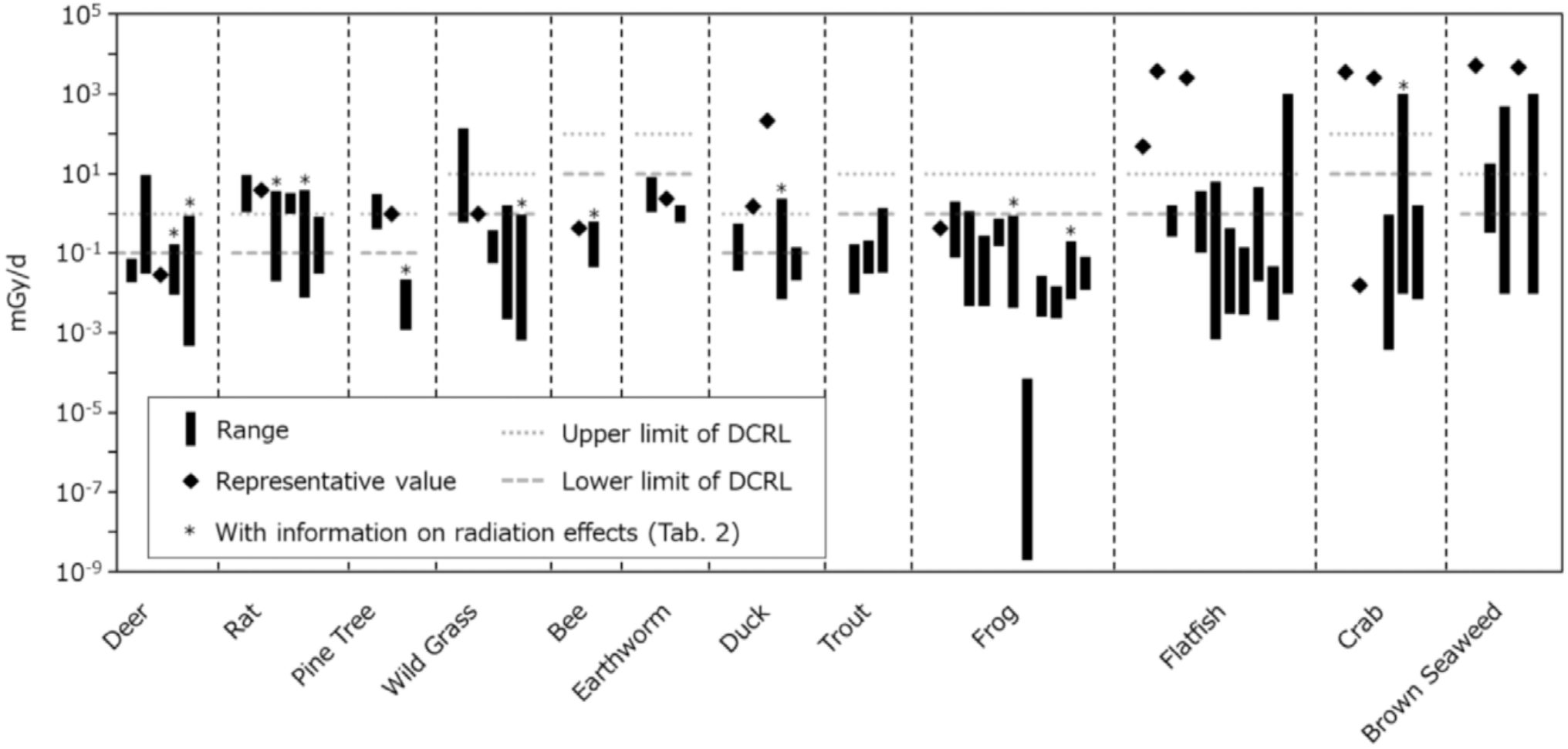


Fig. 2. Comparison between estimated dose rates and DCRLs by RAP types. Estimated dose rates providing a range of values are represented with a bar; those providing representative values are represented by points. Asterisks (*) indicate the availability of information on radiation effects (Tab. 2 and discussed in the following section). For each RAP, estimated dose rates on the left are those of the immediate aftermath of the accident.

Figure from Takada and Schneider, 2023

How have findings influenced DCRLs derived by TG99

- Broader taxonomic groupings
- Source data primarily laboratory studies
- Acute to chronic transformation approach (again primarily lab not field)
- Mathematical approach – Endpoint Sensitivity Distribution model

- Field data used to ‘check’ DCRLs
  - Fukushima studies mostly on molecular endpoints, few on population relevant
  - Chornobyl – some studies limited or no impacts (at population) in longer term
  - Both – some studies significant impacts
  - Confounding factors

Potential application of DCRLs

- **Chronic exposure**
  - Planned exposed situations should use the lower bound of the DCRL
  - Existing exposure situations and medium to long-term exposure after an emergency: DCRL range to target optimisation with the upper bound as a guide to scale the effort to be implemented

- **Acute exposure (e.g. early phase of an emergency):**
  - ESD for acute exposures may be used to support dialogue with stakeholders to help understand potential ecological consequences

HIGHER LOWER

$RAP_{Class\ or\ Phylum}$	P108 DCRLs	TG99 DCRLs	Case study 1		Case study 2		Case study 3	
			$P108_{DCRLs}$	$TG99_{DCRLs}$	$P108_{DCRLs}$	$TG99_{DCRLs}$	$P108_{DCRLs}$	$TG99_{DCRLs}$
Mammals	4-40	20-60						
Birds	4-40	90-200						
Conifers	4-40	70-300						
Fish	40-400	70-200						
Shrubs, trees not coniferous, dicots	-	200-600						
Grasses and Monocots	40-400	300-1000						
Crustaceans	400-4000	100-400						
Worms	400-4000	50-100						
Vertebrates	-	10-100						
Invertebrates	-	70-700						
Plants	-	60-600						

Case studies are all existing or emergency exposure situations,
All comparisons for the lower boundary of the DCRL band

Impact of new DCRLs

- **Greater flexibility in mapping representative species** to DCRLs
- **Adaptability** to more **complex assessments**
- **Higher** TG99 DCRL **bands** for the **more radiosensitive** taxonomic groupings, should provide more realistic assessment outputs
- **Reduction** in the TG99 DCRLs for **less radiosensitive** taxonomic groupings, these are unlikely to change assessment outputs

Key messages for the system of radiological protection (from TG105 case studies)

- Protective actions **alter** the environment
- Manage exposures in a **holistic and harmonised manner** to demonstrate protection of people and the environment
- Ideally **emergency preparedness** should be for long-term ecological and cultural resilience
- **Use multi-criteria decision analysis & adaptive management** to balance radiological, ecological, cultural and economic trade-offs
- **Stakeholder co-design**
- Environmental protection may be **driven by non-radiological considerations** (e.g. conservation)
- Non-radiological impacts on environment may be significant

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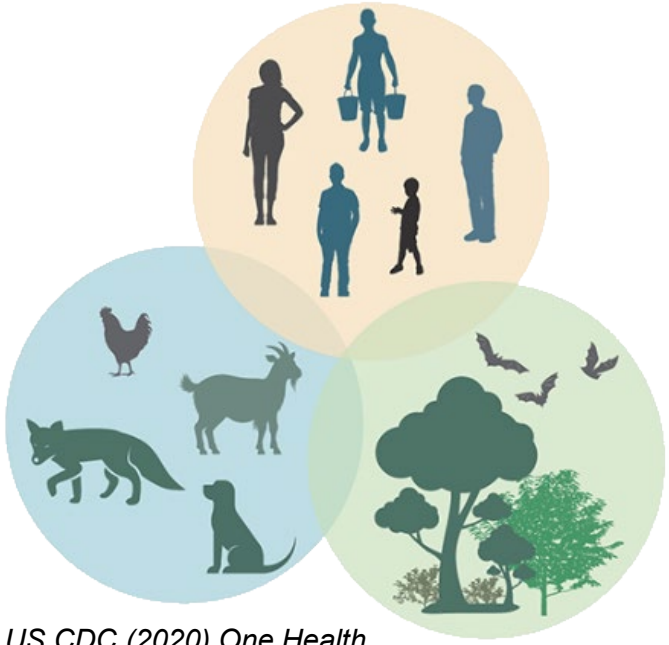

US CDC (2020) One Health

People, animals, and the environment are interconnected

Environment in the context of sustainable development

"While the work already undertaken by ICRP **will remain a cornerstone**, inclusion of more global considerations of environmental protection in the context of **'sustainable development'** and concerns about the **'quality of life'**, including the services provided by the environment and ecosystems as well as the impacts of the implementation of protective actions, may be considered for inclusion in future general recommendations" [Clement et al 2021]

17 interlinked global **Sustainable Development Goals** (SDGs) designed to be a "blueprint to achieve a better and more sustainable future for all"

Ensure healthy lives and **promote well-being** for all at all ages

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

[See Rühm et al 2024 https://doi.org/10.1007/s00411-024-01089-w]

Current (Example) Reflections on the Environment

Considerations span multiple task groups

Task Group 124

Application of the Principle of Justification

How to consider and value the benefit of protecting non-human entities and ecosystems?

Task Group 114

Reasonableness and Tolerability in the System of Radiological Protection

What is meant by tolerable and reasonable in environmental radiological protection?

Task Group 125

Ecosystem Services in Environmental Radiological Protection

What is the added value to including reflection on the human-centered benefits of nature? What would practical implementation of an ecosystem services approach look like?

Task Group 127

Exposure Situations and Categories of Exposure

Should the environment be considered a fourth category of exposure? If so, how should that category be defined?

Task Group 105

Considering the Environment when Applying the System of Radiological Protection

How should protection principles apply pragmatically in the context of both humans and biota (i.e., in an integrated manner)?

Task Group 129

Ethics in the Practice of Radiological Protection

What are the ethical issues and challenges at stake in environmental radiological protection?

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