

Principles and Concepts in Radiation Protection of the Environment

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ICRP's environmental protection objectives are to:

- Prevent or reduce the frequency of deleterious radiation effects to a level where they would have a negligible impact on:
 - the maintenance of biological diversity,
 - the conservation of species, or
 - the health and status of natural habitats, communities, and ecosystems.

A different category of exposures – environmental exposures.

Basic questions arising from the presence or expected presence of elevated radionuclides in the environment include the following.

- What are, or will be, the doses to the biota?
- What are, or will be, the effects, or risks of effects, for the biota as a result of such doses?
- What are, or will be, the consequences, if any?
- What would/could one do about it, if anything?

So, need to examine the science base with regard to the relationships between.....

-exposure and dose,
-dose and effects, and
-effects and consequences

for different types of animals and plants that are typical of the major environments.

- First established some 'points of reference'

Reference Animals and Plants (RAPs)

- **Deer**
- **Rat**
- **Bee**
- **Worm (and egg)**
- **Pine tree**
- **Grass**

- **Duck (and egg)**
- **Frog (egg, tadpole, adult)**
- **Trout (and egg)**

- **Flat fish (and egg)**
- **Crab (and egg and larvae)**
- **Brown seaweed**

Purpose of Reference Animals and Plants

- Sound scientific basis
- Points of reference (Family level)
- Conceptual and numerical ‘models’
- Examine aspects of dosimetry (including quantities and units)
- Assess and interpret radiation effects, risks, and consequences
- But they are not, necessarily, the objects of protection

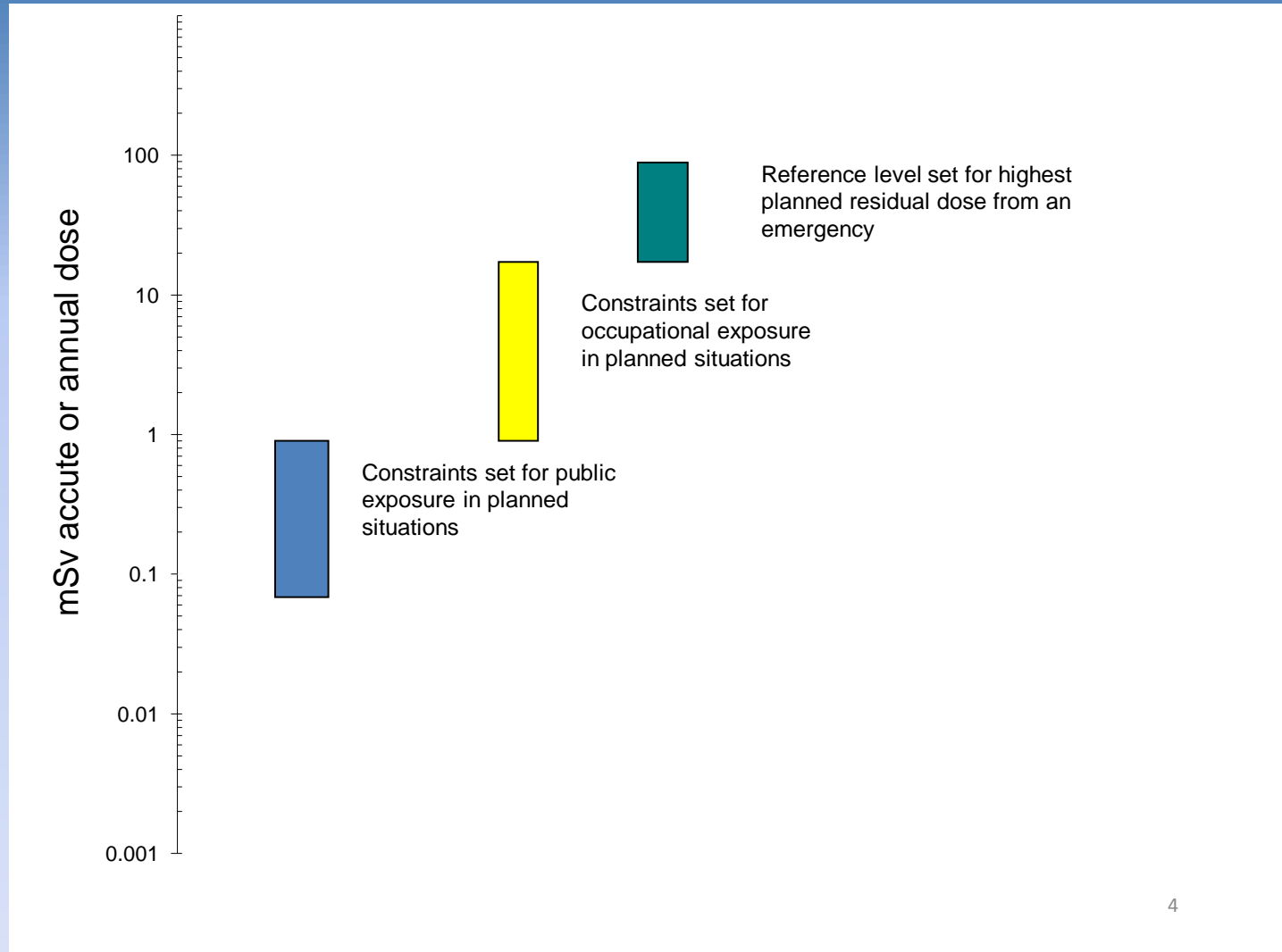
Science base – effects data

Dose rate (mGy d ⁻¹)	<u>Reference Deer</u>	<u>Reference Flatfish</u>
100 - 1000	Reduction in lifespan due to various causes.	Some mortality expected in larvae and hatchlings
10 - 100	Increased morbidity. Possible reduced lifespan. Reduced reproductive success.	Reduced reproductive success
1 - 10	Potential for reduced reproductive success	Possible reduced reproductive success due to reduced fertility
0.1 - 1	Very low probability of various effects	No information
0.01 - 0.1	No observed effects.	No information
< 0.01	Natural background	Natural background

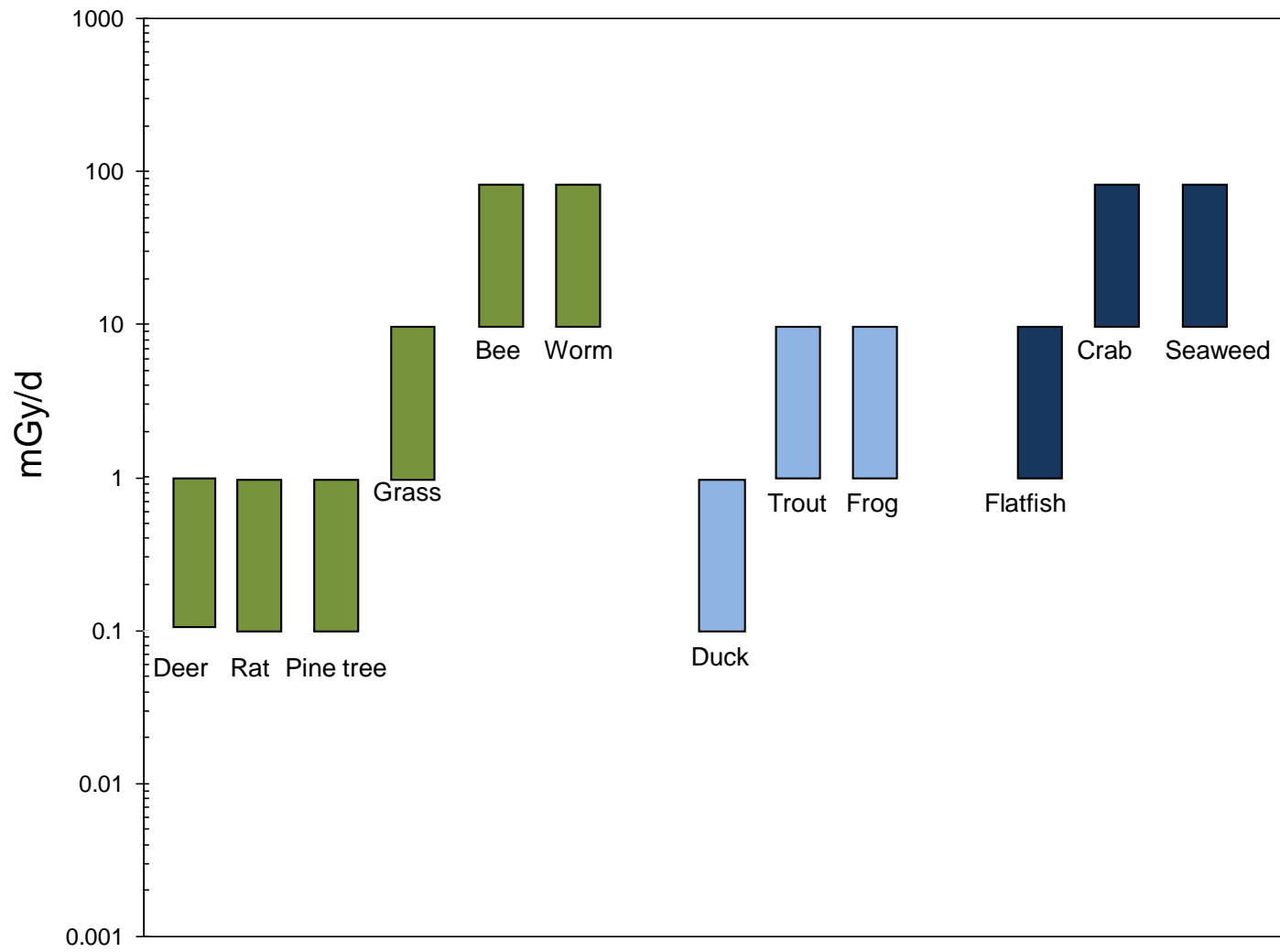
Derived Consideration Reference Levels (DCRL)

A DCRL is a band of dose rate, within which there is some chance of deleterious effects, due to ionising radiation, occurring to individuals of that type of Reference Animal or Plant

Bands of dose rates used in human radiation protection



DCRL bands for different types of animals and plants



Planned, emergency & existing exposure situations

Radionuclide intake and external exposure

Representative person

Dose limits, dose constraints, and reference levels

Reference person
Effective dose (E)

Reference male and Reference female
Male and female equivalent doses (H^M_T & H^F_T)

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Exposure situations:

- Planned (practices in operation – discharges, decommissioning, waste disposal, rehabilitation etc)
- Existing (and a decision needs to be made as to whether control has to be taken)
- Emergency (unexpected, and urgent action needed – but can be ‘planned’ for in advance)

Planned, emergency & existing exposure situations

Radionuclide intake and external exposure

Representative organisms

Derived Consideration Reference Levels

Reference Animals and Plants

Planned, emergency & existing exposure situations

Radionuclide intake and external exposure

Representative organisms

Values for different environmental exposure situations

Derived Consideration Reference Levels

Reference Animals and Plants
(Reference dosimetry and Concentration Ratios)

Representative Organism

- The organism or group of organisms that are the actual objects of protection in any particular assessment.

What are we actually trying to protect;
and hence what 'representative organisms' are relevant?

Actual object(s) of protection could be:

- Environment in general
- Specific habitats (eg fresh water, estuary, wetland)
- Specific types of biota
- Specific species

For example

Nuclear power – new build and waste repositories

Planned (normal and potential) exposures.

Questions to answer might include:

- potential impact on natural resources (eg fishery nursery grounds)
- potential impact on local habitat in general (eg estuarine, wetlands)
- potential impact on specific groups of biota or on specific species
- allaying general public concerns.

Differences between RAPs and ROs

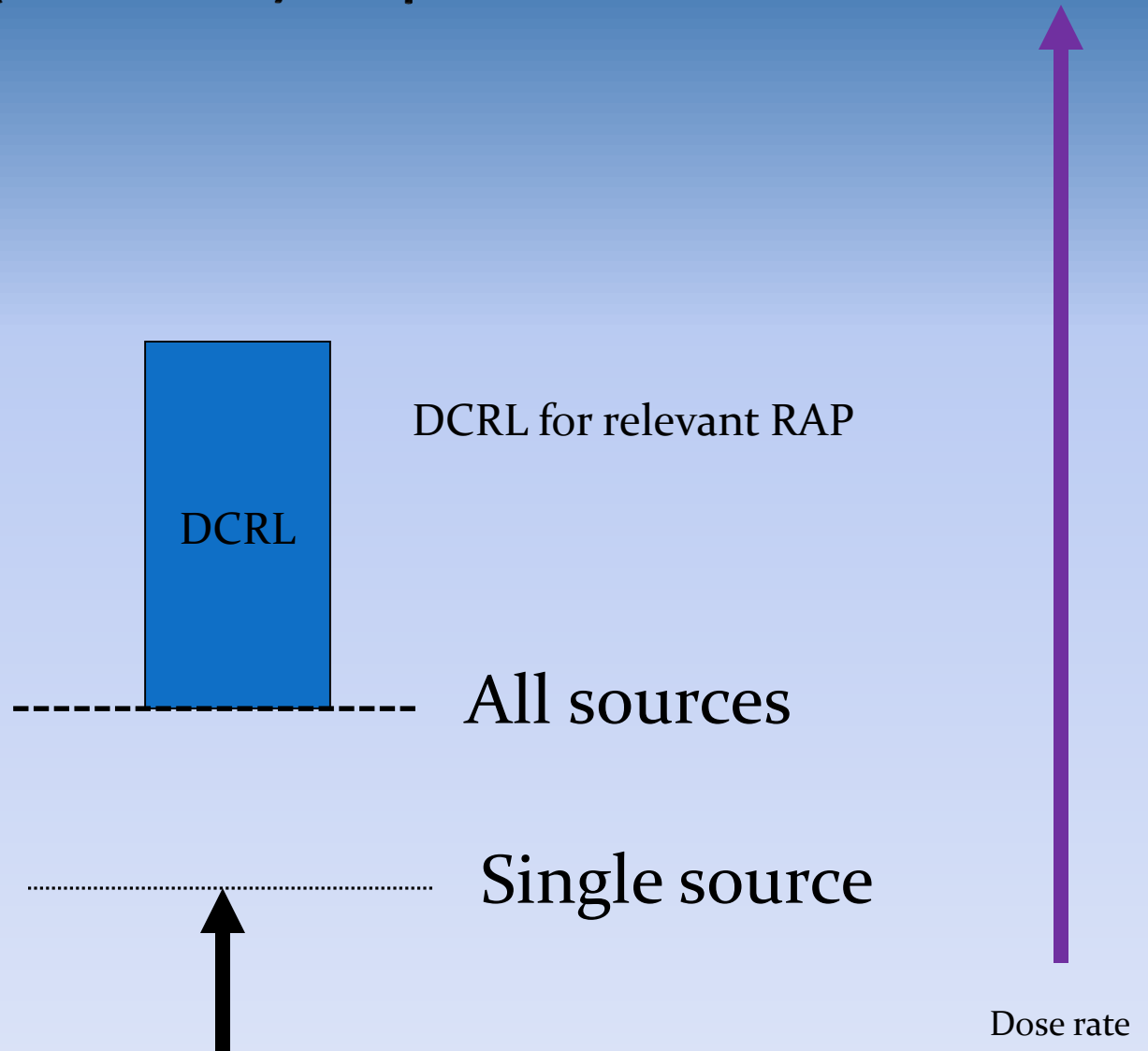
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- Biology
- Exposure pathway
- *Dosimetry (quantifiable)*
- *Effects (likely to be similar)*
- Consequences

Application to different exposure situations: the environment.

- Planned (normal) situations for individual sites
 - compliance with national/international environmental legislation
 - compliance with ICRP's objectives

Planned (normal) exposure situation



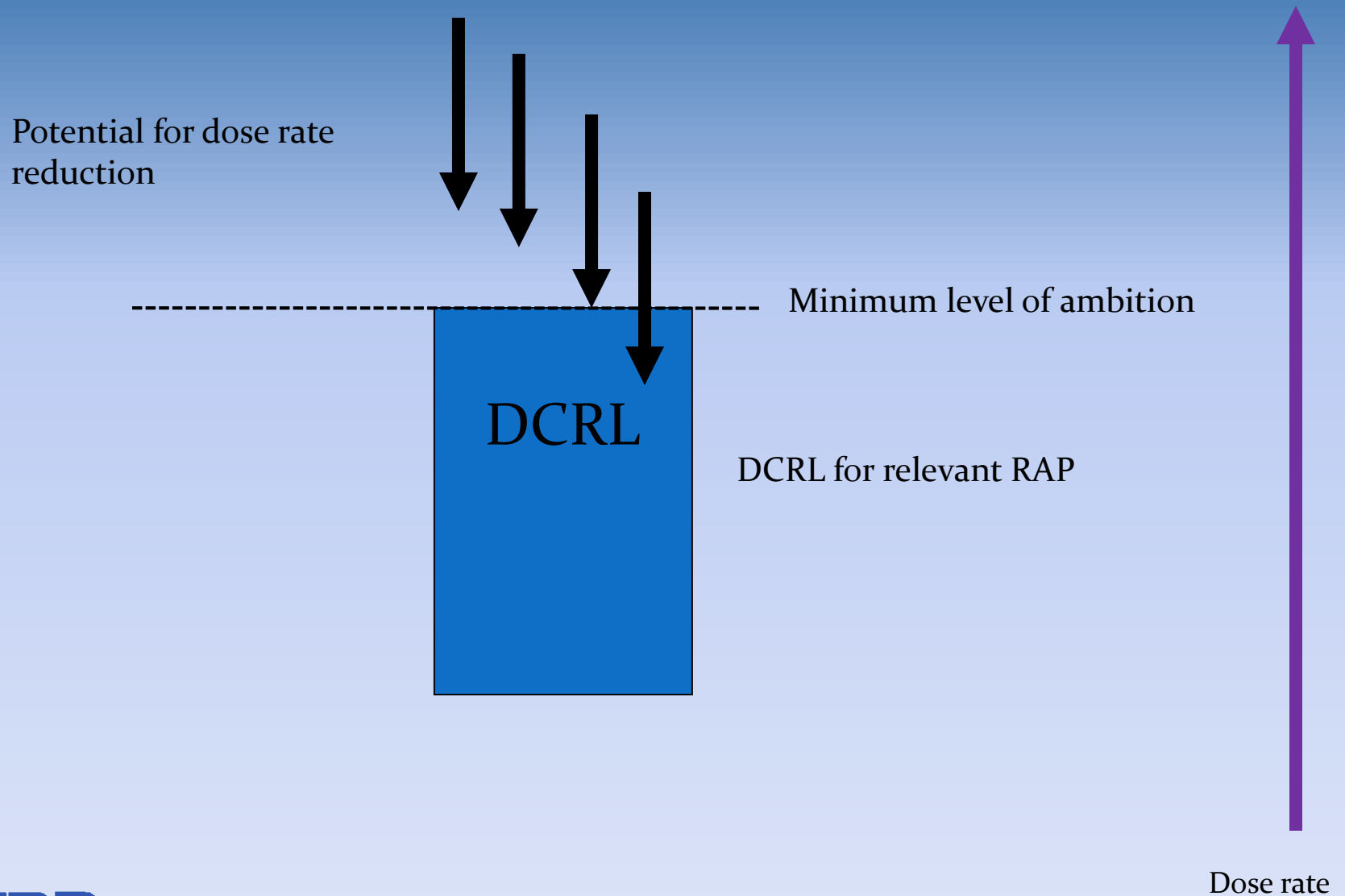
Factors to consider

- Actual objects of protection
- Spatial area of interest
- Fraction of population(s) likely to be exposed
- Other discharges/abstractions in the area
- Dialogue with stakeholders
- Degree of precaution thought necessary (ie no radiation weighting factors used etc)

Application to different exposure situations: the environment.

- Existing situations
 - consideration of whether or not remediation is sensible
 - consideration of remediation options

Existing exposure situation



Application to different exposure situations: the environment.

- Emergency situations

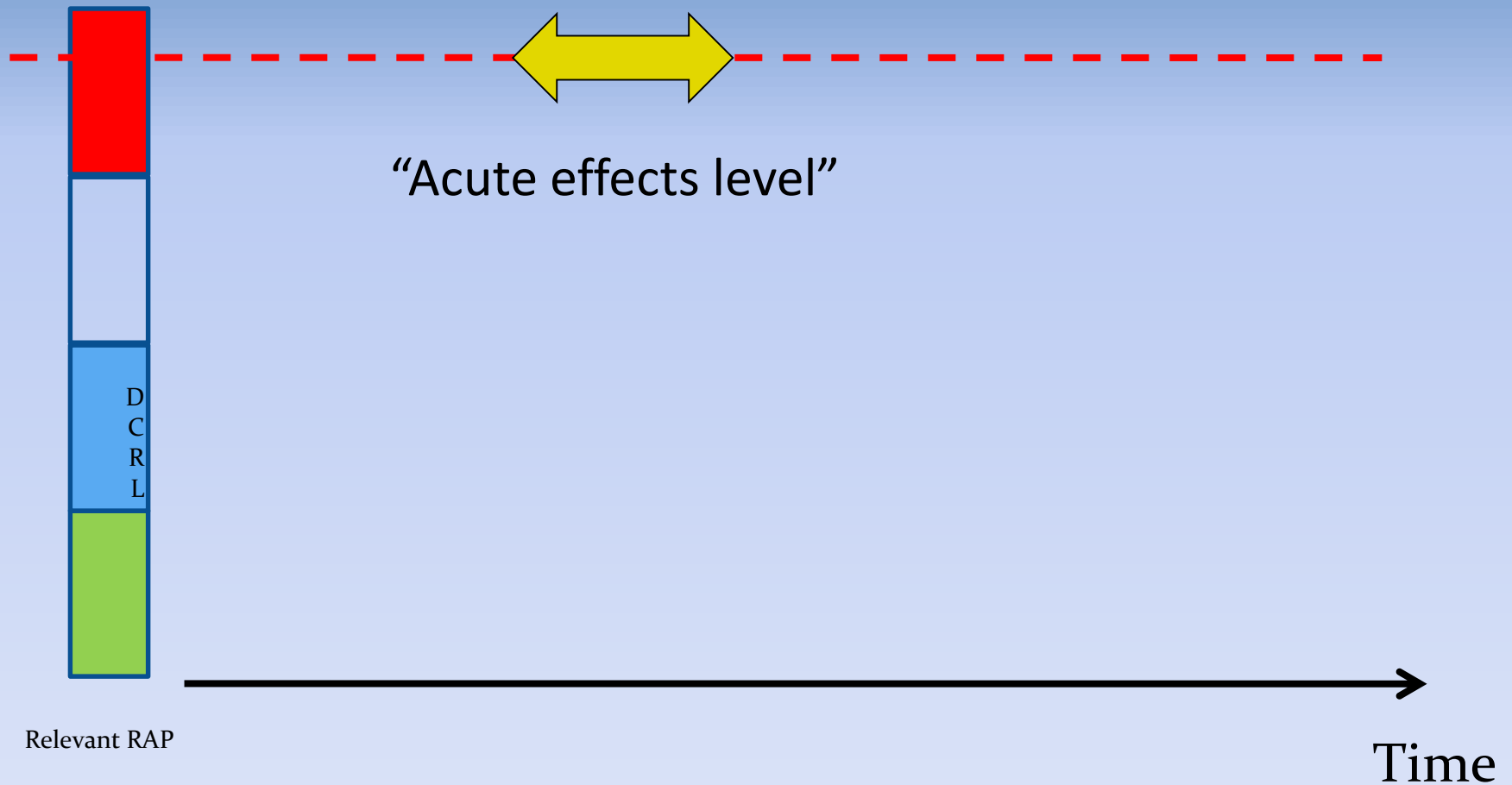
- assessing impact on environment in general resulting from releases from a specific site
- comparing impact on a specific environment amongst different possible sites

- use as a means of communicating impact when human pathways of exposure are of little relevance or under control

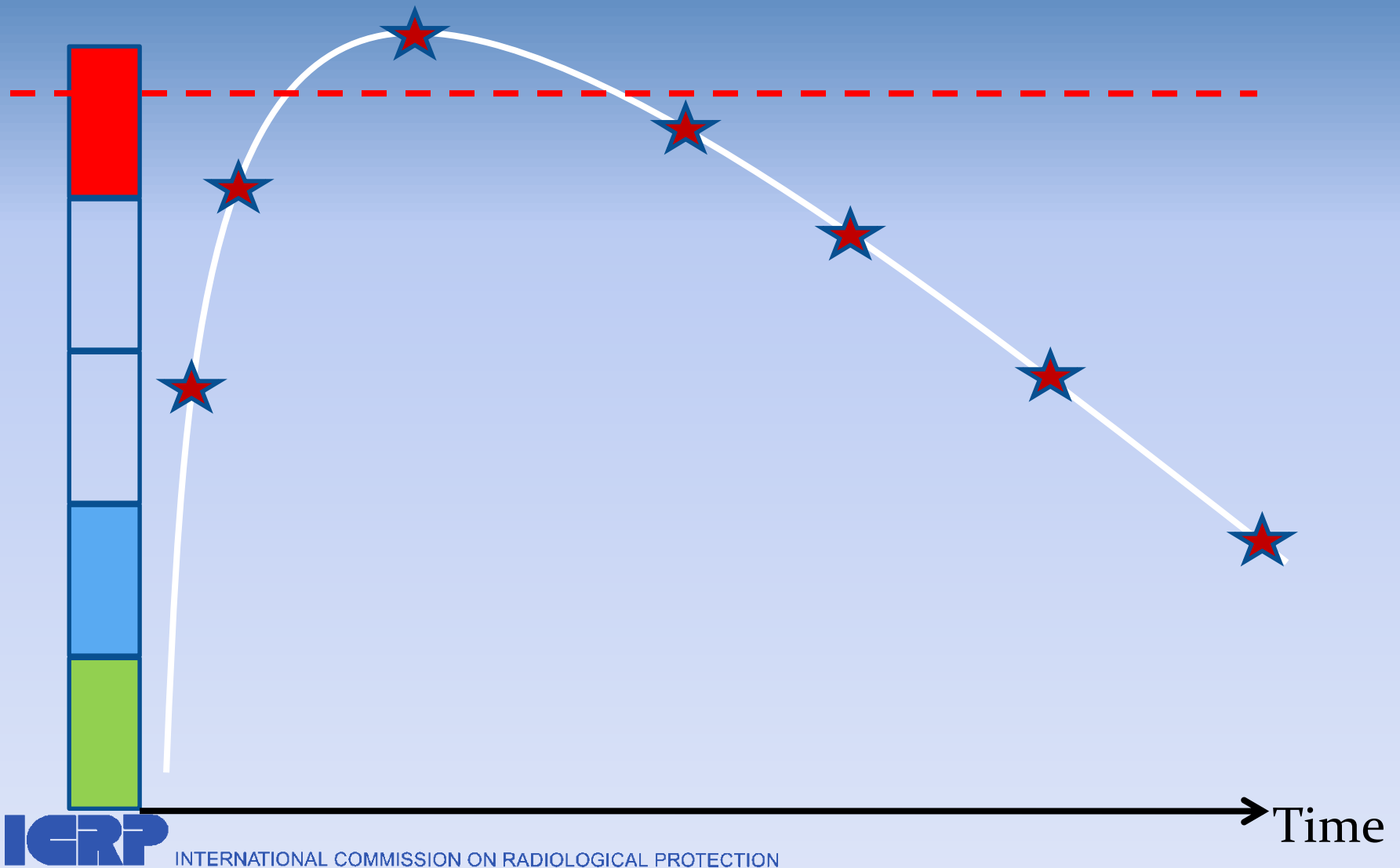
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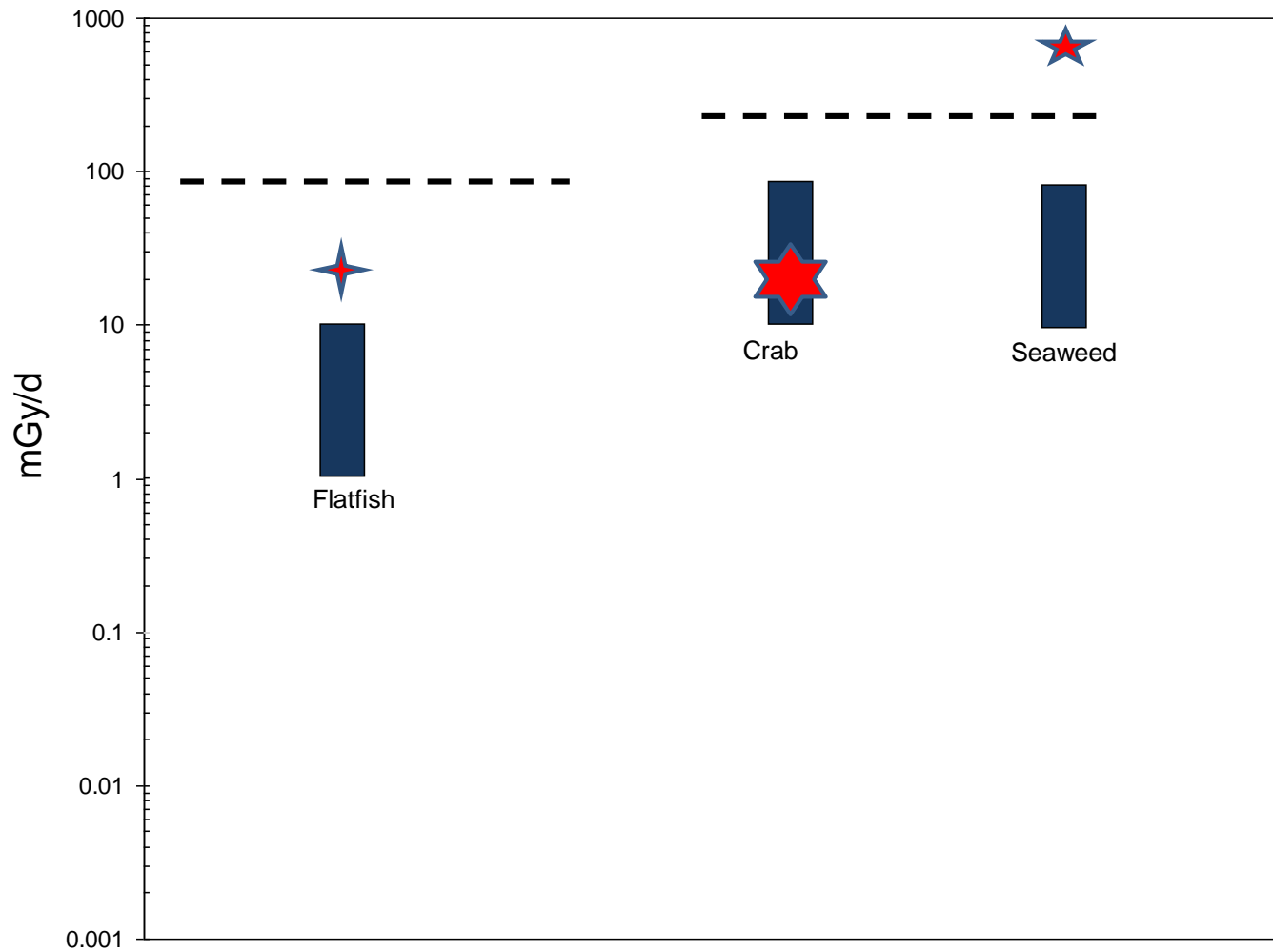
Reporting on environmental impact of emergency (or accidental) releases



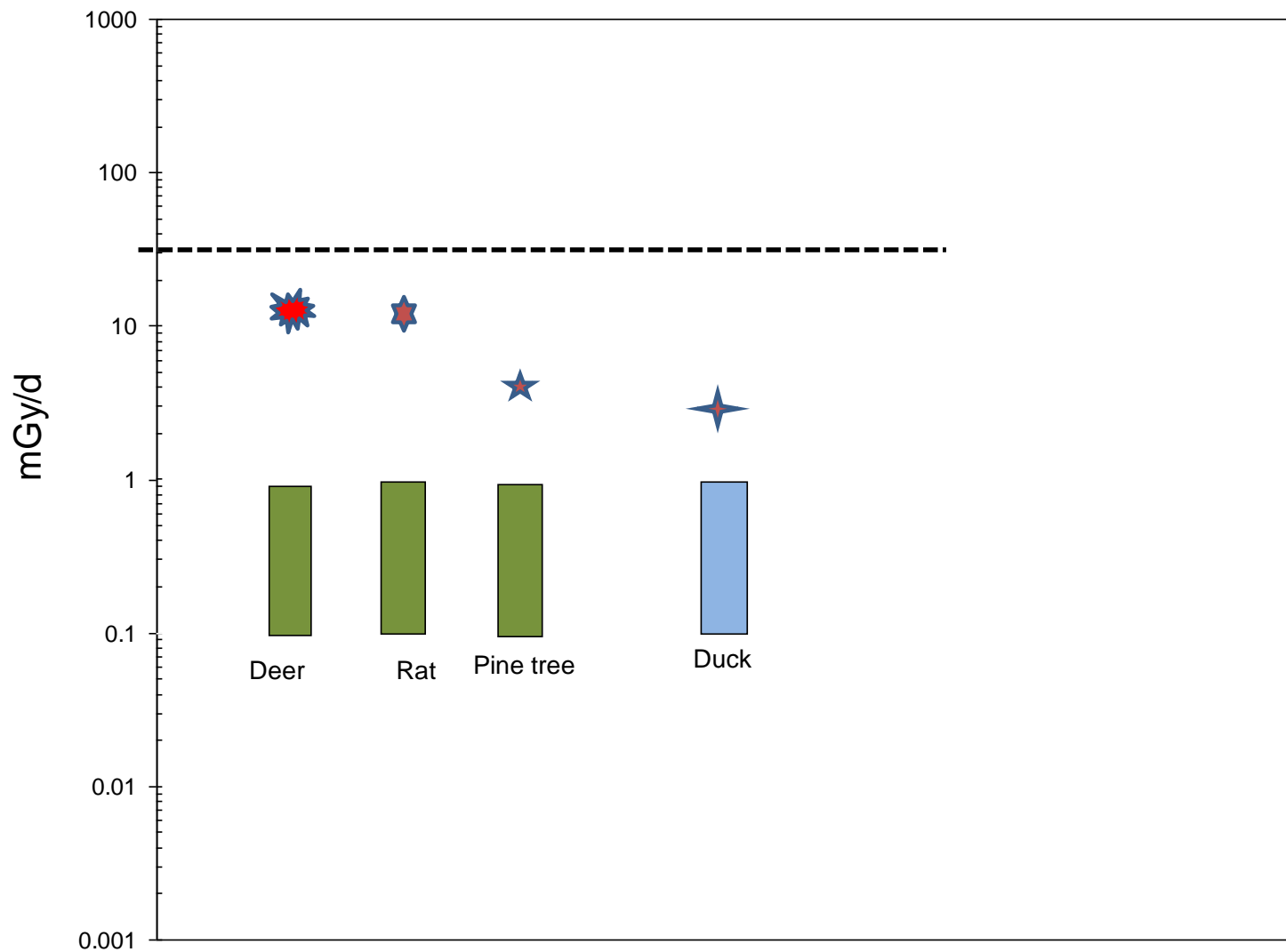
Reporting on environmental impact of emergency (or accidental) releases



Fukushima 30 March at 150m



Fukushima 30 March at 60km



Making protection of the environment more transparent

The current ICRP approach introduces more clarity

- with respect to the scientific basis relating exposure to dose, dose to effect, and effects to consequences, for different types of biota;
- with regard to what one is trying to achieve, under different exposure situations, in relation to a specific site; such as:
 - the basis for regulation of discharge consents for planned normal releases to protect both humans and biota; and
 - with regard to managing the environmental consequences of large scale releases, plus any subsequent remediation work undertaken.

For the future

- Compliance – dose rates or radionuclide concentrations
- More realistic dosimetry for organisms > 1kg
- Radiation weighting factors/RBE

