The Biological Basis for Protection of the Environment

ICRP Symposium on the International System of Radiological Protection

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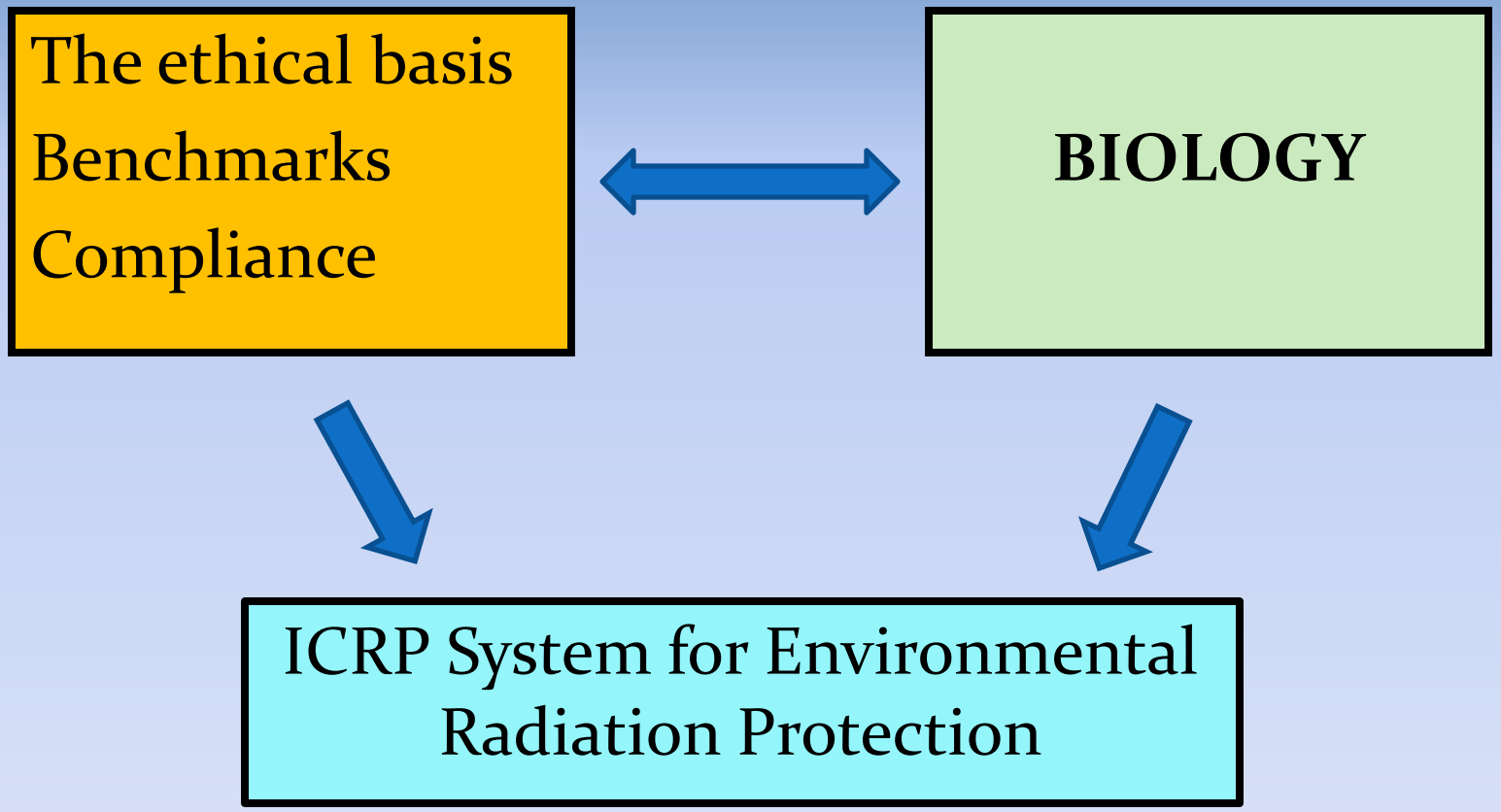
Vice-chair, ICRP Committee 5

Outline


The ethical basis
Benchmarks
Compliance
BIOLOGY
ICRP System for Environmental Radiation Protection

The Ethical Basis

Protection of the environment in its own right and for its own good.....

....or, for the benefit of mankind

IAEA Tecdoc 1270 (2002)

- Anthropocentrism
- Non-anthropocentrism
  - Biocentrism – *individual life forms have value in themselves that should be respected – not only because they affect the situation of humans*
  - Ecocentrism – *general concern for biotic and abiotic community as a whole*

IAEA Tecdoc 1270 (2002)

Principles in International Instruments:

- *activities within a jurisdiction should not cause damage to the environment of other States;*
- *maintain ecosystems and processes that are essential for the functioning of the biosphere;*
- *maintain biodiversity: and*
- *observe the 'principle' of optimum sustainable yield in the use of living natural resources*

ICRP 91 (2003)

Review of ethics and principles, recommending that the System for Environmental Protection should

- *focus on biota;*
- *consider **adequate protection** on the basis of understanding of effects;*
- *identify reference animals and plants (RAPs); and*
- *let the RAPs guide the derivation of*
  - *exposure scenarios (CFs and DCFs)*
  - *effects data*
  - *dose rates benchmarks*

ICRP103

(30) ….aim is…preventing and reducing the frequency of deleterious radiation effects to a level where they would have negligible impact on the maintenance of **biological diversity**, the **conservation of species**, or the health and status of **natural habitats**, **communities** and **ecosystems**.

(366) …..Reference Animals and Plants…….

ICRP 108

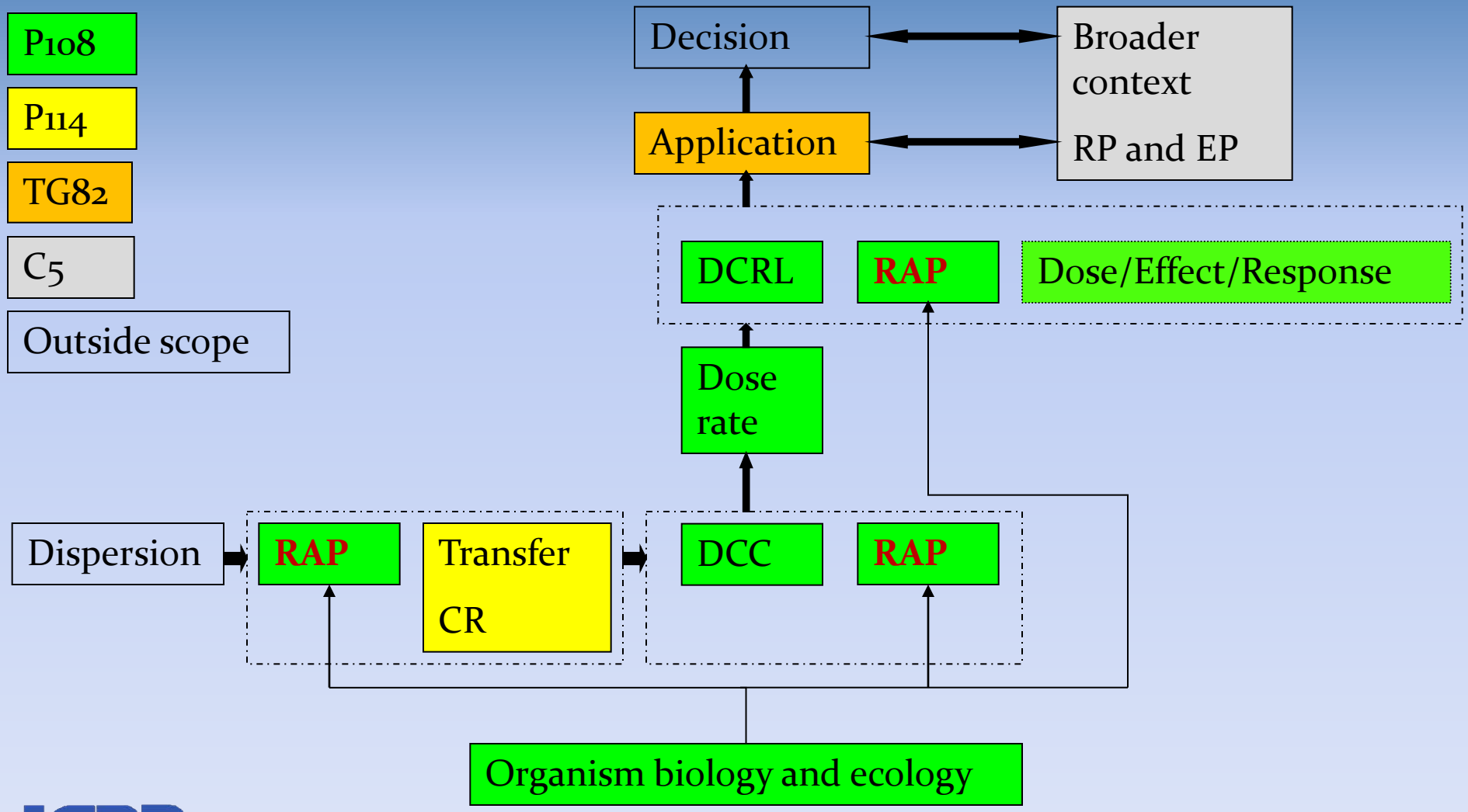
WILDLIFE GROUP	RAP
Large terrestrial mammals	Deer
Small terrestrial mammals	Rat
Aquatic birds	Duck
Amphibians	Frog
Freshwater pelagic fish	Trout
Marine fish	Flatfish
Terrestrial insects	Bee
Marine crustaceans	Crab
Terrestrial annelids	Earthworm
Large terrestrial plants	Pine tree
Small terrestrial plants	Wild grass
Seaweeds	Brown seaweed

Biology of RAPs

ICRP 108 reviews biological characteristics

- *Occurrence*
- *Taxonomy*
- *Life cycle and life span*
- *Reproductive strategy*
- *Physiology*
- *Ecology*
- *.....other factors.....*

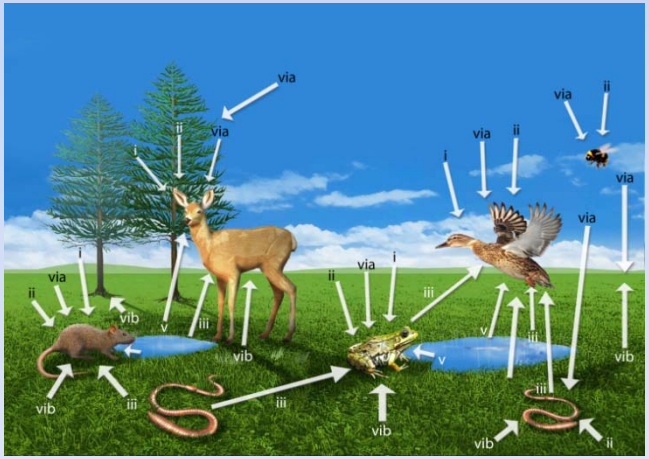
ICRP System


P108
P114
TG82
C5
Outside scope
Decision
Application
Broader context
RP and EP
DCRL
RAP
Dose/Effect/Response
Dose rate
Dispersion
RAP
Transfer
CR
DCC
RAP
Organism biology and ecology

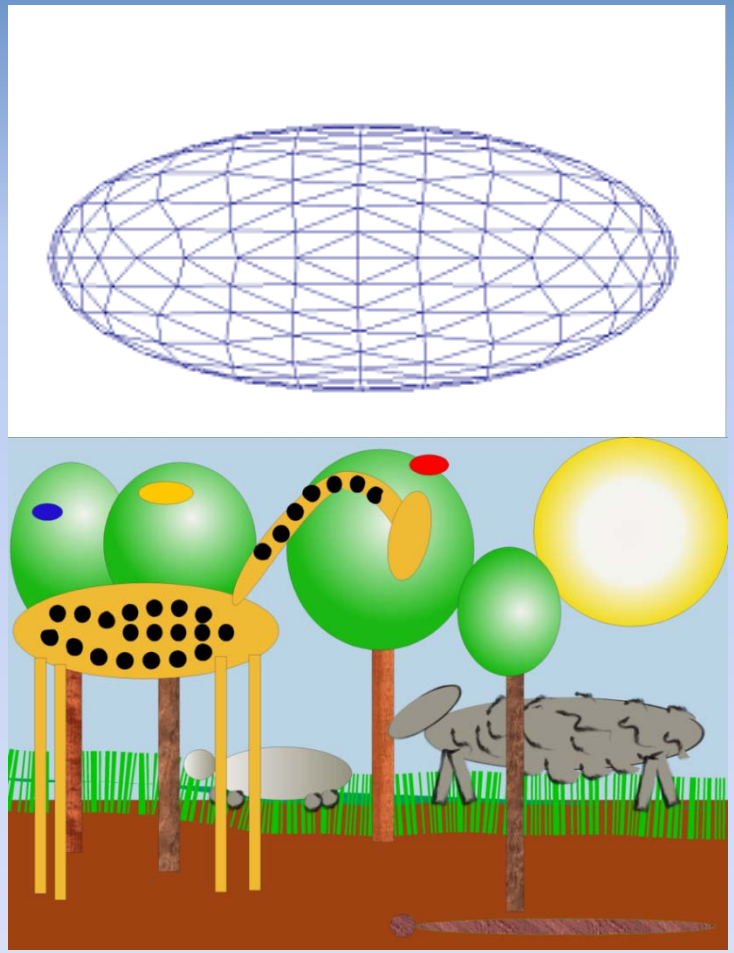
Environmental context, ICRP 114

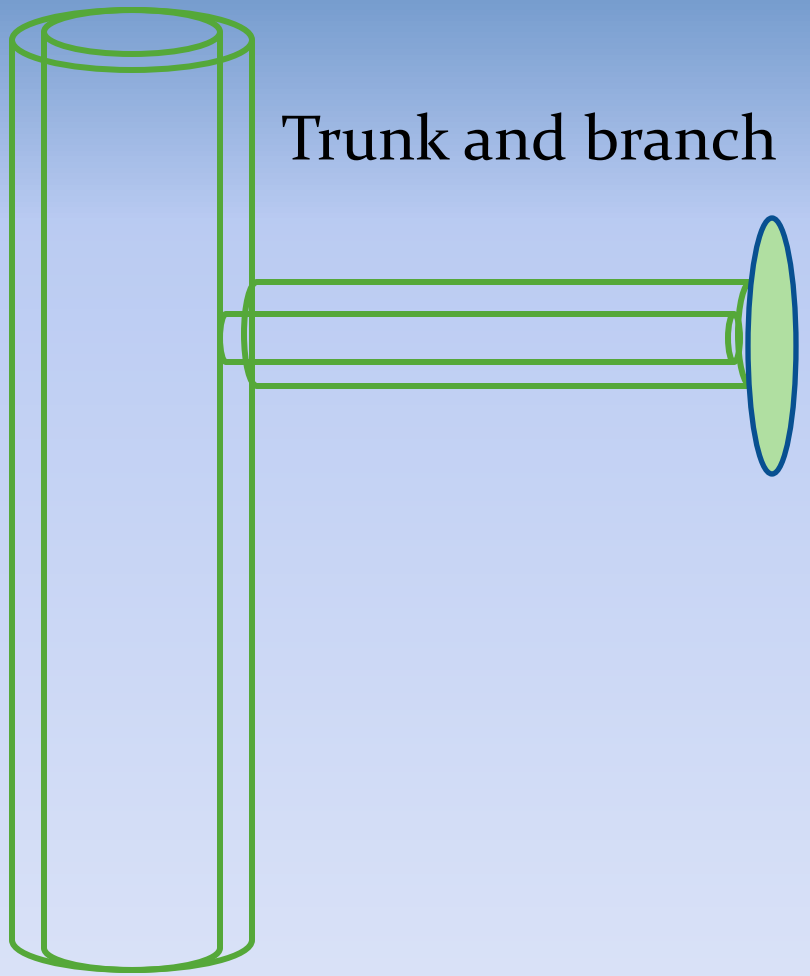
Concentration Ratios for 39 elements and 12 RAPs

- *with associated statistics;*
- *based on existing field and laboratory data;*
- *using new methodology to derive data ('surrogate data') where such are missing;*
- *taking in to account life cycle stages and habitats, when possible; and*
- *discussing the robustness of the data*

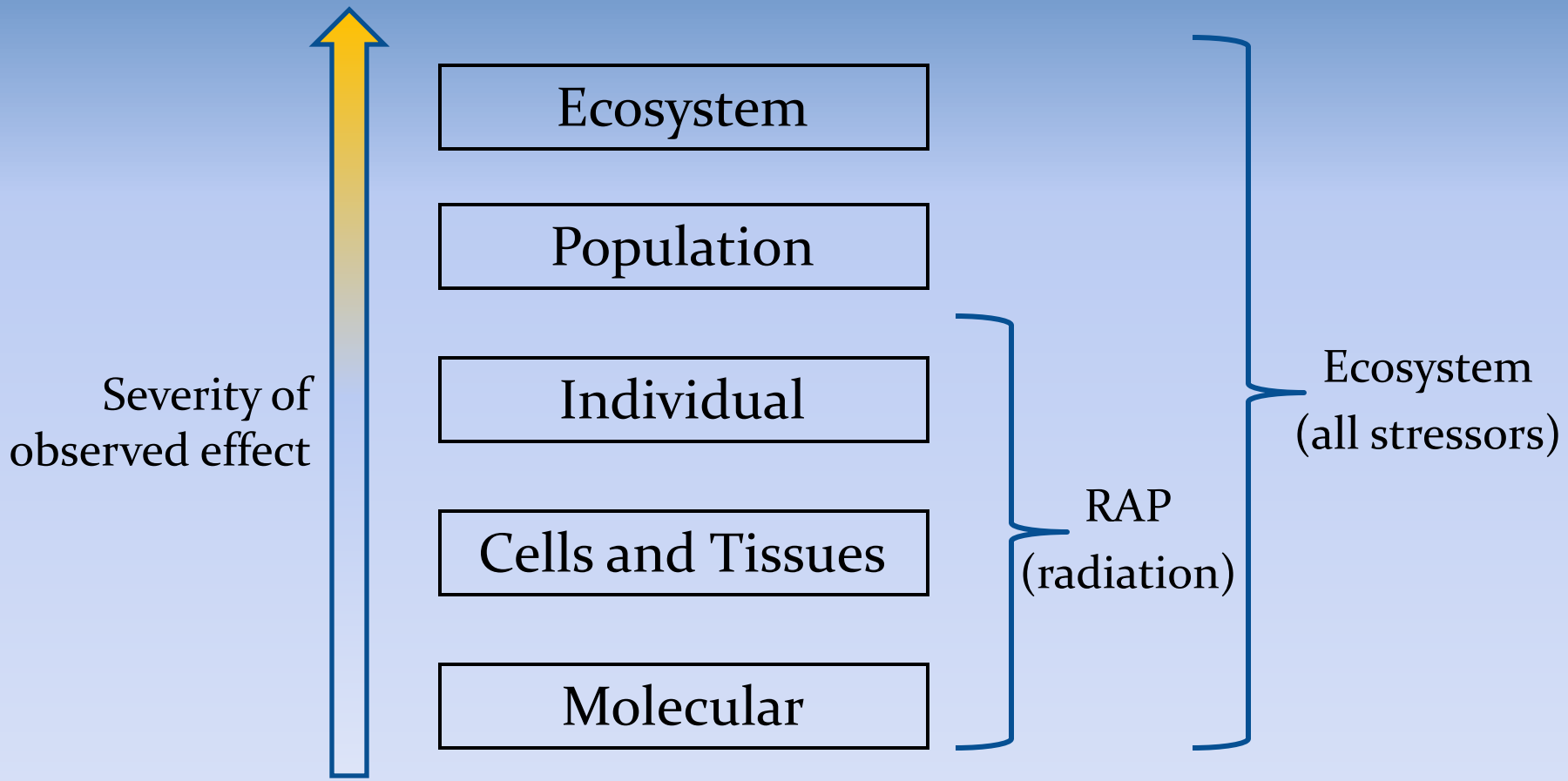


Exposure





Biological Hierarchy



Effects

Ecosystem (number of references)	Total number of data	(%)		Total number	(%)	External	Internal	Other[a]
Terrestrial (579)	19983	(72.6)	acute	12273	(61.4)	11564	288	421
			chronic	6795	(34.0)	3449	344	3002
			transitory[b]	913	(4.57)	670	40	203
			not stated	2	(0.03)	0	0	2
Freshwater (195)	6067	(22.0)	acute	4526	(74.6)	4058	97	371
			chronic	1484	(24.5)	970	20	494
			transitory	54	(0.89)	12	2	40
			not stated	3	(0.01)	0	0	3
Marine (45)	1470	(5.4)	acute	1116	(75.9)	995	58	63
			chronic	353	(24.1)	286	0	67
			transitory	0	(0)	0	0	0
			not stated	1	(0)	0	0	1

Endpoint Grouping

ICRP 108, international and national research projects, UNSCEAR 2008 (Vol II Annex E)

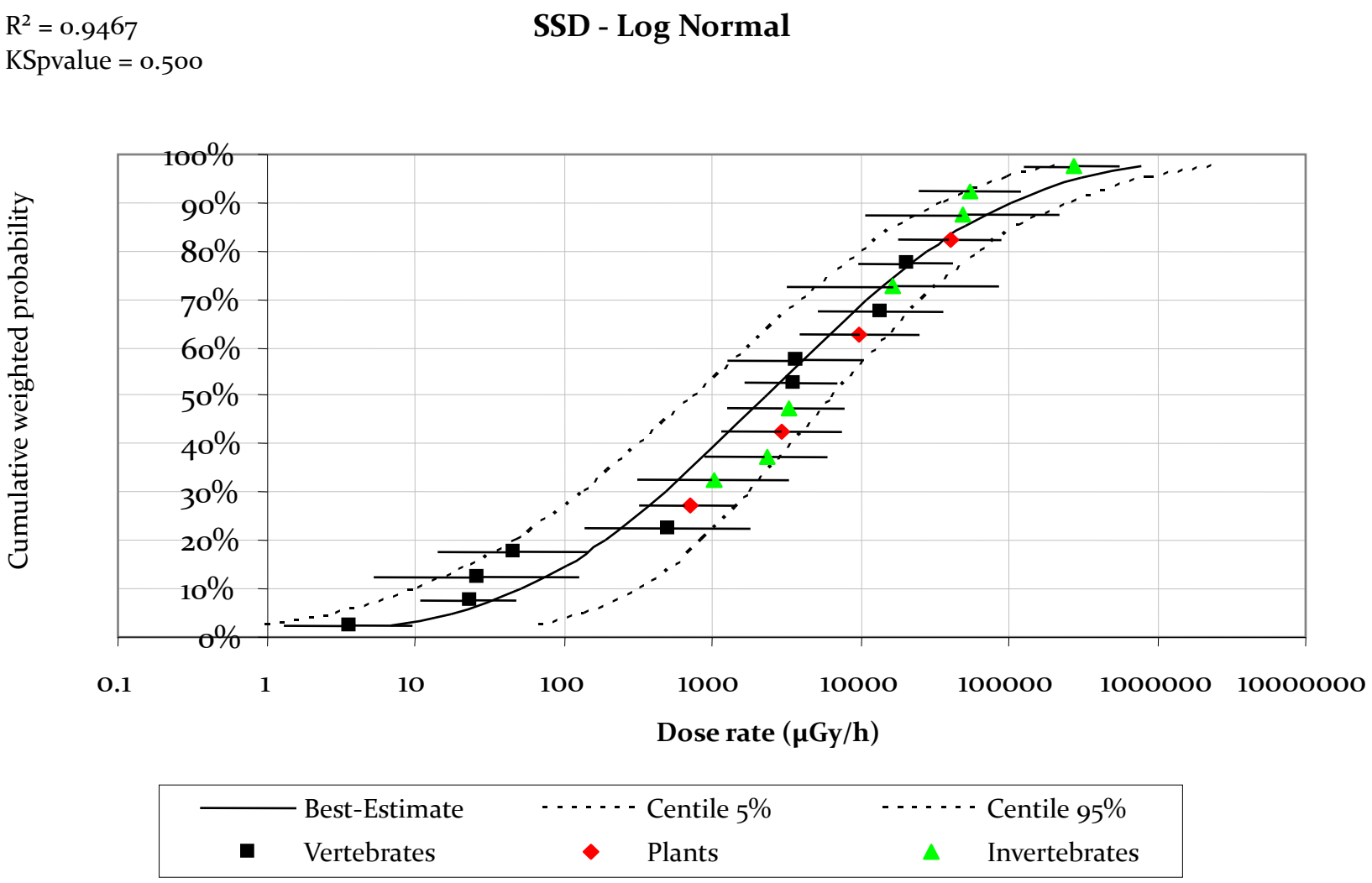
- *Mortality*
- *Morbitity*
- *Reduced reproductive success*
- *Mutation*

(multiple endpoints, consideration of RBE)

Derivation of dose (rate) benchmarks

- Species Sensitivity Distribution (SSD) approach (all data, all endpoints, weighted)
- Small data set approach (individual species, individual enpoints)
- Deterministic, expert judgement approach (weighted, extrapolated)

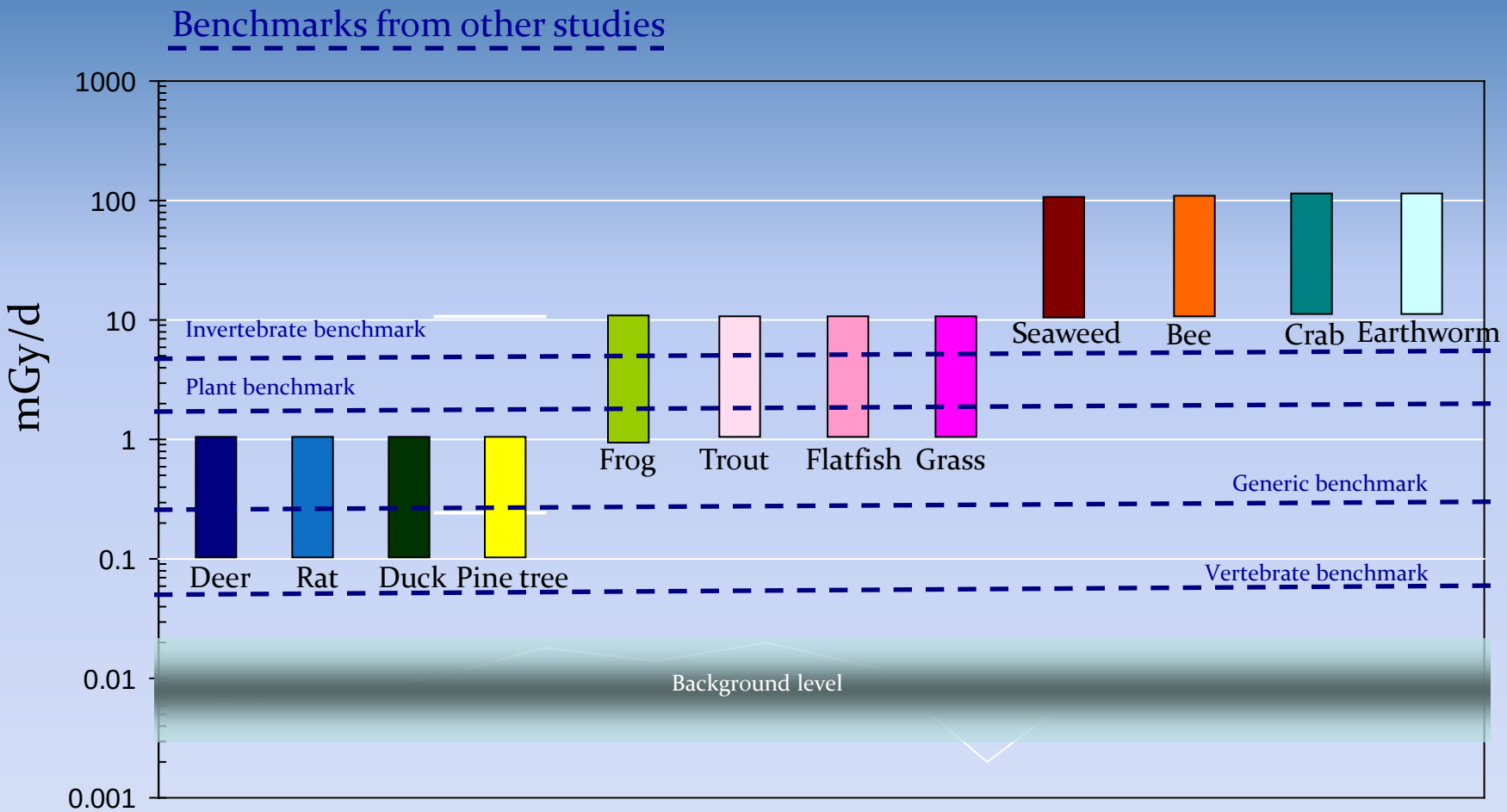
Species Sensitivity Distribution, SSD



DCRLs

mGy d^{-1}	Pine	Grass	Seaweed
100-1000	Mortality of some trees after prolonged exposure. [46 Gy LD_{50} at 130 mGy d^{-1}]	Reduced reproductive capacity	No information*
10-100	Mortality of some trees after very long exposure [76 Gy LD_{50} at ~30 mGy d^{-1} for ten years] • Growth defects. • Reduced reproductive success.	Reduced reproductive capacity	No information
1-10	Morbidity as expressed through anatomical and morphological damage. Prolonged exposure leads to reduced reproductive success.	No information	No information
0.1-1	No information	No information	No information
0.01 – 0.1	No information	No information	No information

DCRLs


Benchmarks from other studies
1000
100
10
1
0.1
0.01
0.001
mGy/d
Invertebrate benchmark
Plant benchmark
Generic benchmark
Vertebrate benchmark
Background level
Deer
Rat
Duck
Pine tree
Frog
Trout
Flatfish
Grass
Seaweed
Bee
Crab
Earthworm

DCRLs

DCRLs – help consider radiation effects data alongside other information, e.g.

- *data relate to actual or theoretical studies,*
- *the type of exposure situation*
- *the size of the area affected,*
- *the status of the population,*
- *the fraction of a population exposed, and*
- *the legal framework within which management action are taken*
- *other stressors*

In order to characterise the risk

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