

# RBE weighted absorbed dose

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Panel Discussion

Joint IES-ICRP Symposium  
Aomori, Japan, October 4, 2016

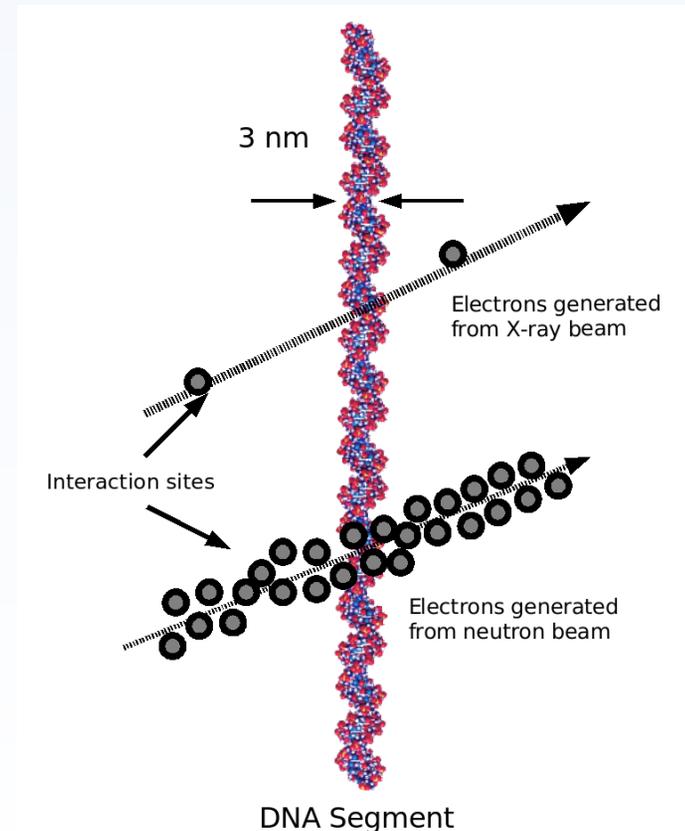
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Vice-Chair, ICRP Committee 5

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# The Relative Biological Effectiveness of Ionising Radiations

- Different radiation types produce different degree of biological effects, at the same absorbed dose.
- Differences in energy deposition patterns.
- The Relative Biological Effectiveness (RBE) is a unitless quantity defined as:

The ratio of the dose of a reference radiation required to produce a specific level of response to the dose of the test radiation that produces an equal response



# The Relative Biological Effectiveness of Ionising Radiations

- RBE values represent empirically derived values from laboratory experiments.
- The RBE values are influenced by:
  - Reference radiation (X-rays (200-250 kVp); C0-60, Cs-137)
  - Irradiation scheme:
    - Dose and Dose-rate
    - Type of exposure: chronic, acute, fractionated
    - Radiation source: internal vs external
  - Biological aspects:
    - Endpoint
    - Species

# The Relative Biological Effectiveness of Ionising Radiations

- RBE and the radiation weighting factors in human radiological protection.
- RBE in the context of radiological protection of the environment.
  - Some controversy related to the endpoints
  - RBE values have been proposed by different organization.

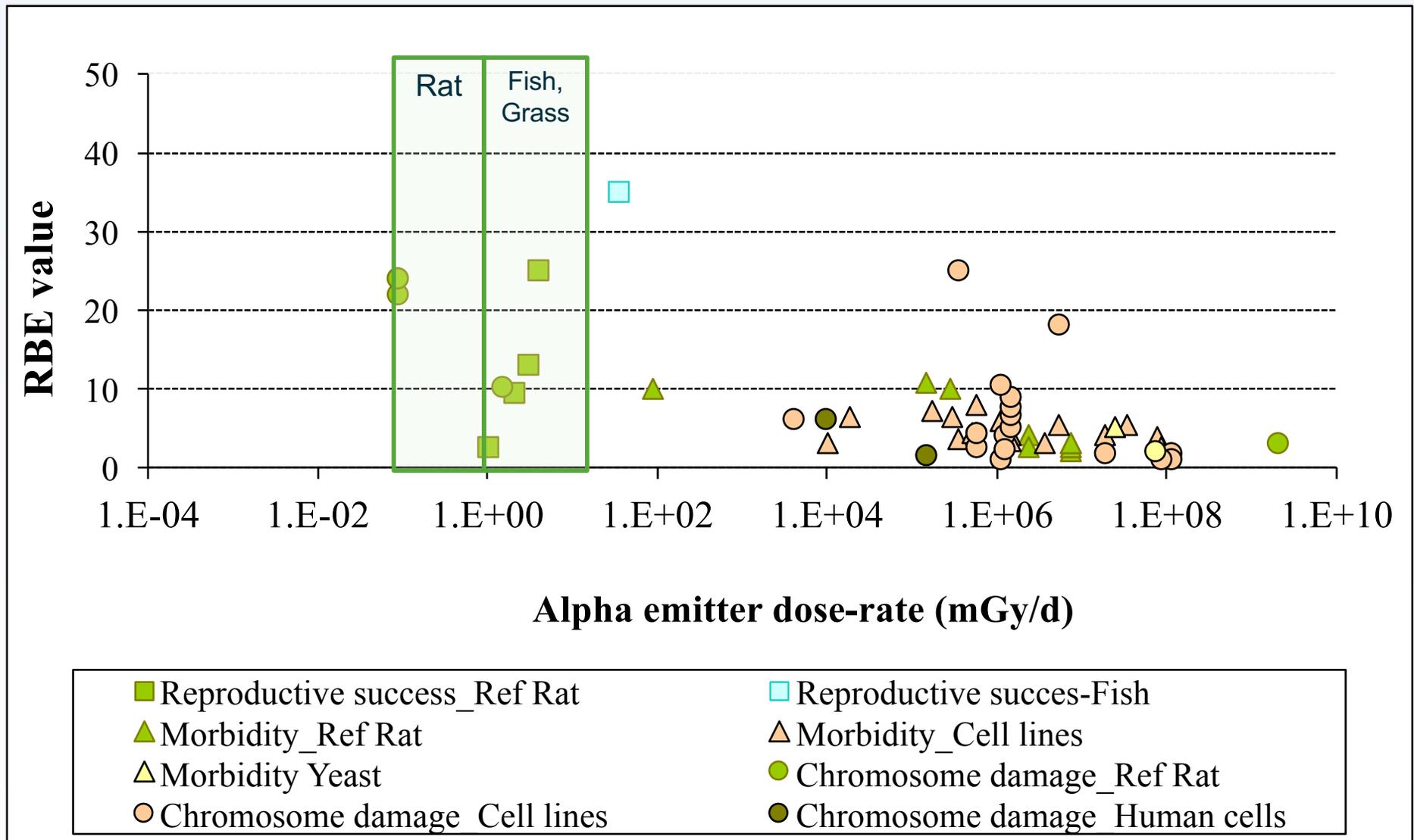
# ICRP-C5, TG72: Data / Process

- **Papers reviewed; selected based on:**
  - Data quality
  - Robust dosimetry
  - Some RBE values for non alpha included  
(e.g. neutrons in same energy range, same LET)
- **Attempt at  $RBE_M$  calculations**
  - Not possible for tritium
  - Not always possible for alphas
- **Review considered both stochastic and deterministic effects**
  - Impact on RBE will be illustrated

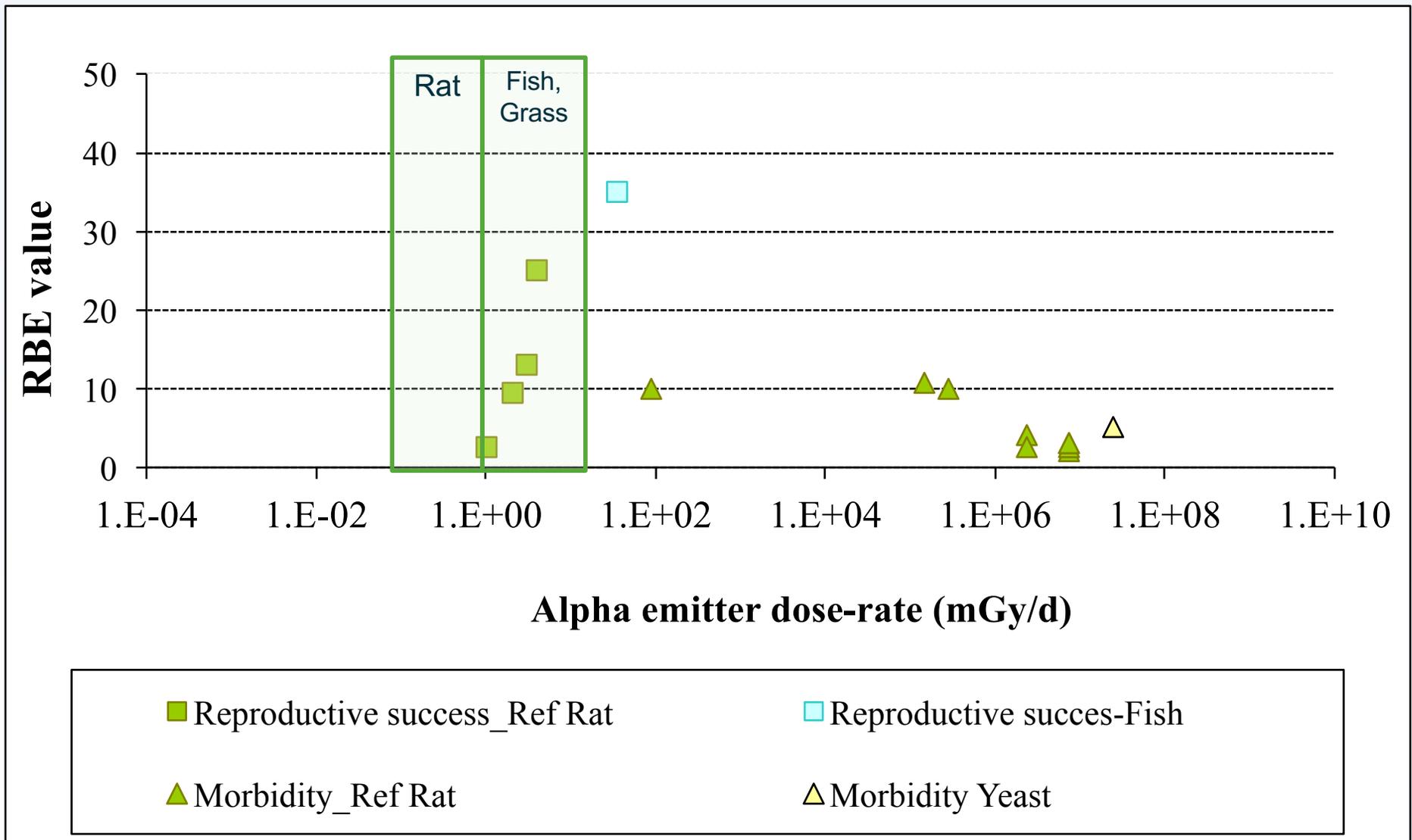


# RBE DATA FOR ALPHA-EMITTERS

# ALPHA-EMITTERS: ALL RBE DATA (STOCHASTIC & DETERMINISTIC)



# ALPHA-EMITTERS: RBE DATA ON DETERMINISTIC EFFECTS



# Alpha-Emitters: CONCLUSIONS

- Overall the non-human biota data on RBE for alpha emitters is limited.
- The RBE values for alpha emitters in the available studies were all obtained at dose rates that were in or above the relevant DCRL bands and were  $<40$  in value.
- One question is how comparable the mammal data are for other non-human species? In the case of alpha RBE, the data for fish is around 35 and yeast around 5. These values span the range found in mammal data.

# Alpha-Emitters: CONCLUSIONS

- In mammals, the endpoints relevant for wildlife are different to those used when considering the RBE (and choice of radiation weighting factor) for humans. For wildlife the endpoints considered are those which are most relevant for sustaining populations of wildlife.

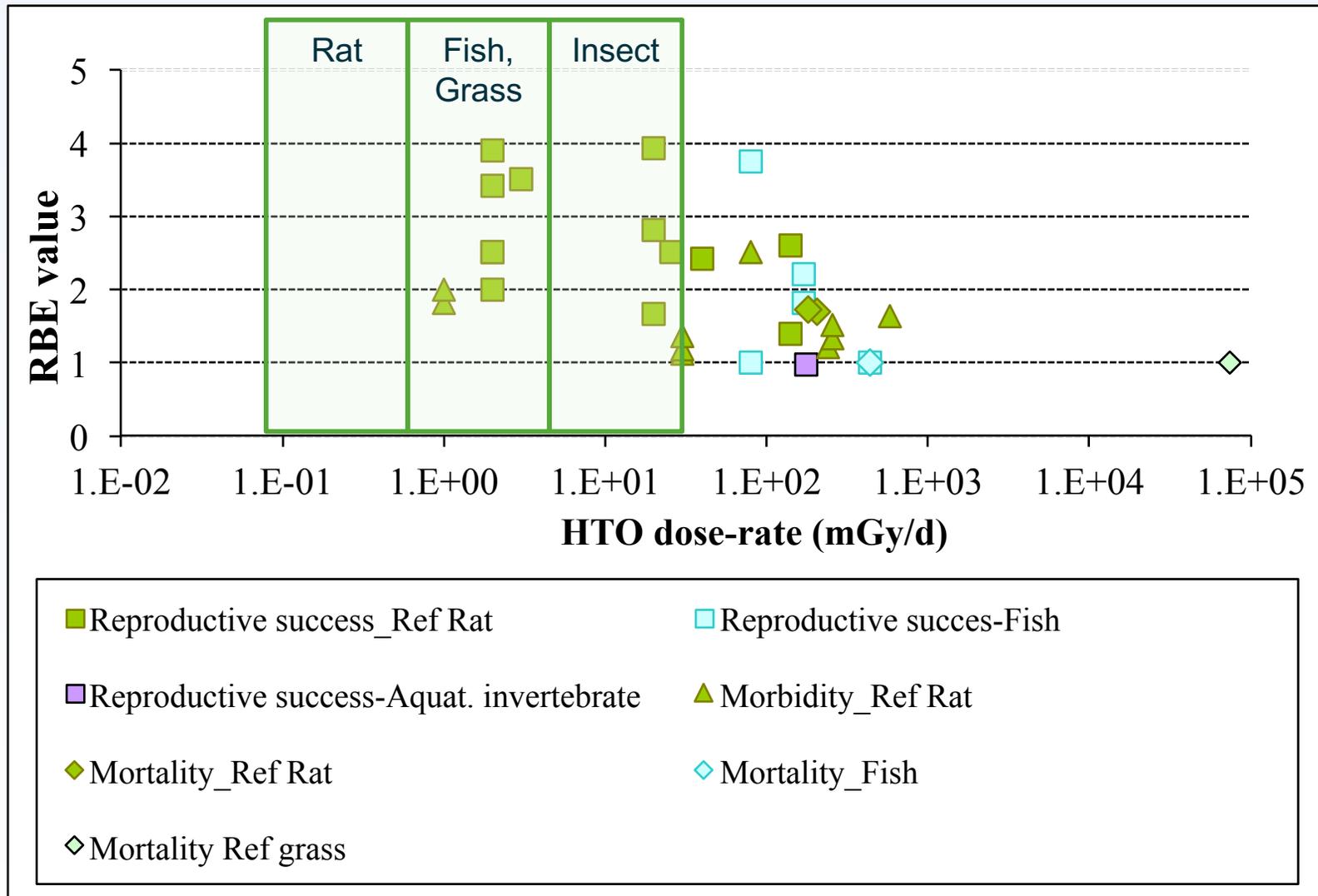
## RECOMMENDATIONS

- A radiation weighting factor of 10 for the different exposure scenarios being considered would be prudent for alpha emitters.
- If alpha-emitters are a significant component of the dose rate for a given exposure scenario, one may wish to consider the greater range of RBE values reported.

# RBE DATA FOR TRITIUM BETA PARTICLES



# TRITIUM BETA PARTICLES: RBE DATA ON DETERMINISTIC EFFECTS



# Tritium beta particles: CONCLUSIONS

- Overall, the non-human biota database on RBE for tritium beta particles is very limited.
- The RBE values for tritium beta particles in the available studies were all obtained at dose rates that were in or above the relevant DCRL bands and were  $<4$  in value.
- One question is how comparable the mammal data are for other non-human species. In the case of tritium RBE, the spread of data for fish are from 1 to nearly 4, with aquatic invertebrates around 1. These data are consistent therefore with the data for mammals.

# Tritium beta particles: CONCLUSIONS

- In mammals, the endpoints relevant for wildlife are different to those used when considering the RBE (and choice of radiation weighting factor) for humans. For wildlife the endpoints considered are those which are most relevant for sustaining populations of wildlife.

## RECOMMENDATIONS

- A radiation weighting factor of between 1 and 3 is therefore recommended based on the tritium beta particles RBE data overall.
- The exact choice of the radiation-weighting factor should be based on consideration of how significant tritium is in the exposure scenario being considered.

# OVERARCHING ISSUES

- Limited data on RBE in the DCRLs dose-rates ranges.
- Limited data available on deterministic effects relevant to populations of non-human biota.
- Exclusion/inclusion of stochastic and cell line data doesn't perturb RBE much.

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