

# RADIATION PROTECTION OF THE ENVIRONMENT

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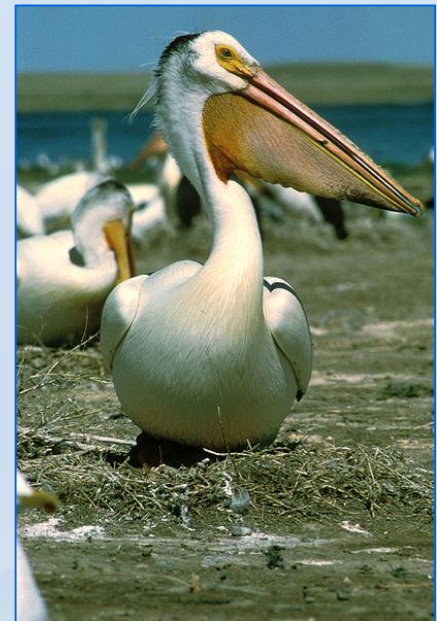
University of  
**Salford**  
MANCHESTER



UNIVERSITY OF  
**STIRLING**

# Outline

- Historical perspective of environmental radiological protection
- Why this has changed - prime motivations
- International initiatives in key international bodies



# Environmental Radiation Protection ‘the history’



# 1977 International statement

*‘Although the principal objective of radiation protection is the achievement and maintenance of appropriately safe conditions for activities involving human exposure, the level of safety required for the protection of all human individuals is thought likely to be adequate to protect other species, although not necessarily individual members of those species. The Commission therefore believes that **if man is adequately protected then other living things are also likely to be sufficiently protected.**’*

# 1991 Statement

*The Commission believes that the standard of environmental control needed to protect man to the degree currently thought desirable **will ensure that other species are not put at risk**. Occasionally, individual members of non-human species might be harmed, but not to the extent of endangering whole species or creating imbalance between species.*



**No requirement to assess the impact of released radionuclides on the environment....**





**Is that OK?**

## Is that OK?

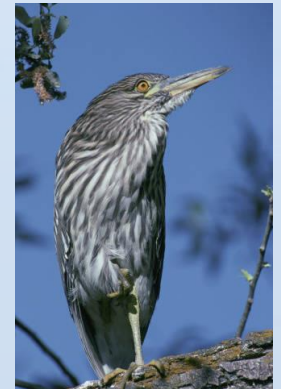
c. year 2000 various national 'regulators' begin to require environmental radiological assessments:

USA, UK, Sweden, Finland, Canada .....



# Challenges to anthropogenic approach

- Lack of demonstration that the environment is being protected
- May not be valid for some environments (e.g. those with no humans)
- Incompatible with management of other environmental chemical stressors
- Requirement for assessment under some national legislation



# National (e.g. UK)

- EC, 1979. EC Birds Directive 79/409/EEC
  - UK Parliament, 1981. Wildlife and Countryside Act
- EC, 1992. EC Habitats Directive 92/43/EEC
  - UK Parliament, 1994. Conservation (Natural Habitats) Regulations
- Requires demonstration of protection of designated sites and species from 'hazardous substances'
  - Interpreted (in UK) to include ionising radiation
- Use Initial Radiological Assessment Tool (IRAT) which is based on R&D128



# Internationally, from 2007 ICRP

‘the Commission considers that it is now necessary to provide advice with regard to all exposure situations. It also believes that it is necessary to consider a wider range of environmental situations, irrespective of any human connection with them. .... The Commission therefore believes that the development of a clearer framework is required in order to assess the relationships between exposure and dose, and between dose and effect, and the consequences of such effects, for non-human species, on a common scientific basis.’

# ICRP Publication 108 (2008)

## Provides a Concept and Use of Reference Animals and Plants

- Transfer, Dosimetry, Effects to biota
  - => **Derived Consideration Reference Levels**
- Ideas for application

## Protection targets

- Maintain biological diversity
- Conservation of species
- Protect health and status of
  - Natural habitats
  - Communities
  - Ecosystems
- Targets are all related to
  - Living organisms
  - Populations or higher organisational levels
  - **Not on individuals** (except for endangered species)
- Demonstration through a set of Reference Animals and Plants (RAPs)



**Planned, Existing and Emergency exposure situations**

**Environmental radionuclide concentrations**

**Reference Male & Female**

**Reference Animals and Plants**

**Dose limits, Constraints and  
Reference levels**

**Derived Consideration  
Reference Levels**

**Decision-making regarding public health and environmental protection for the same environmental exposure situation using representative individuals and representative organisms**

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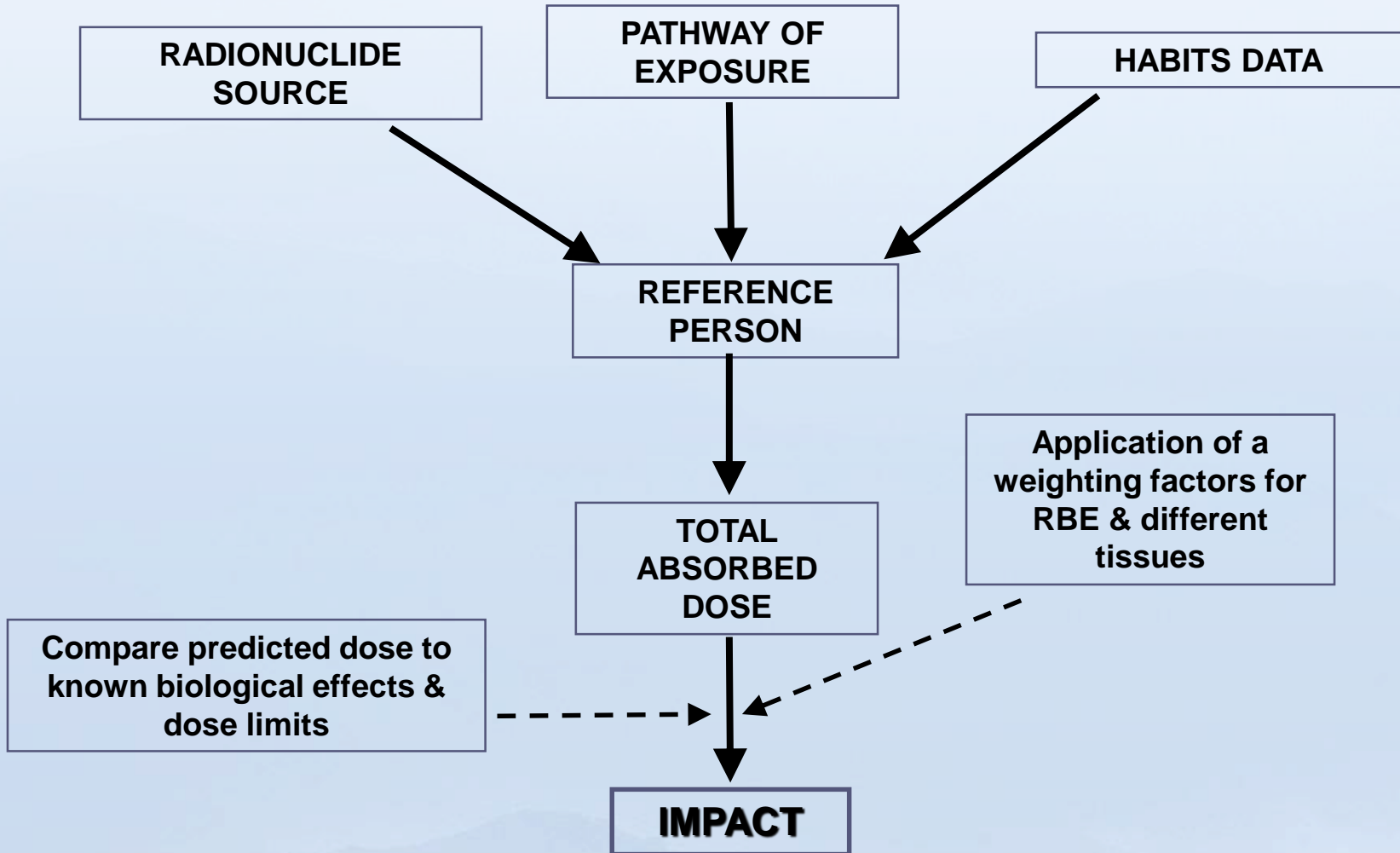
**Dose limits, Constraints and  
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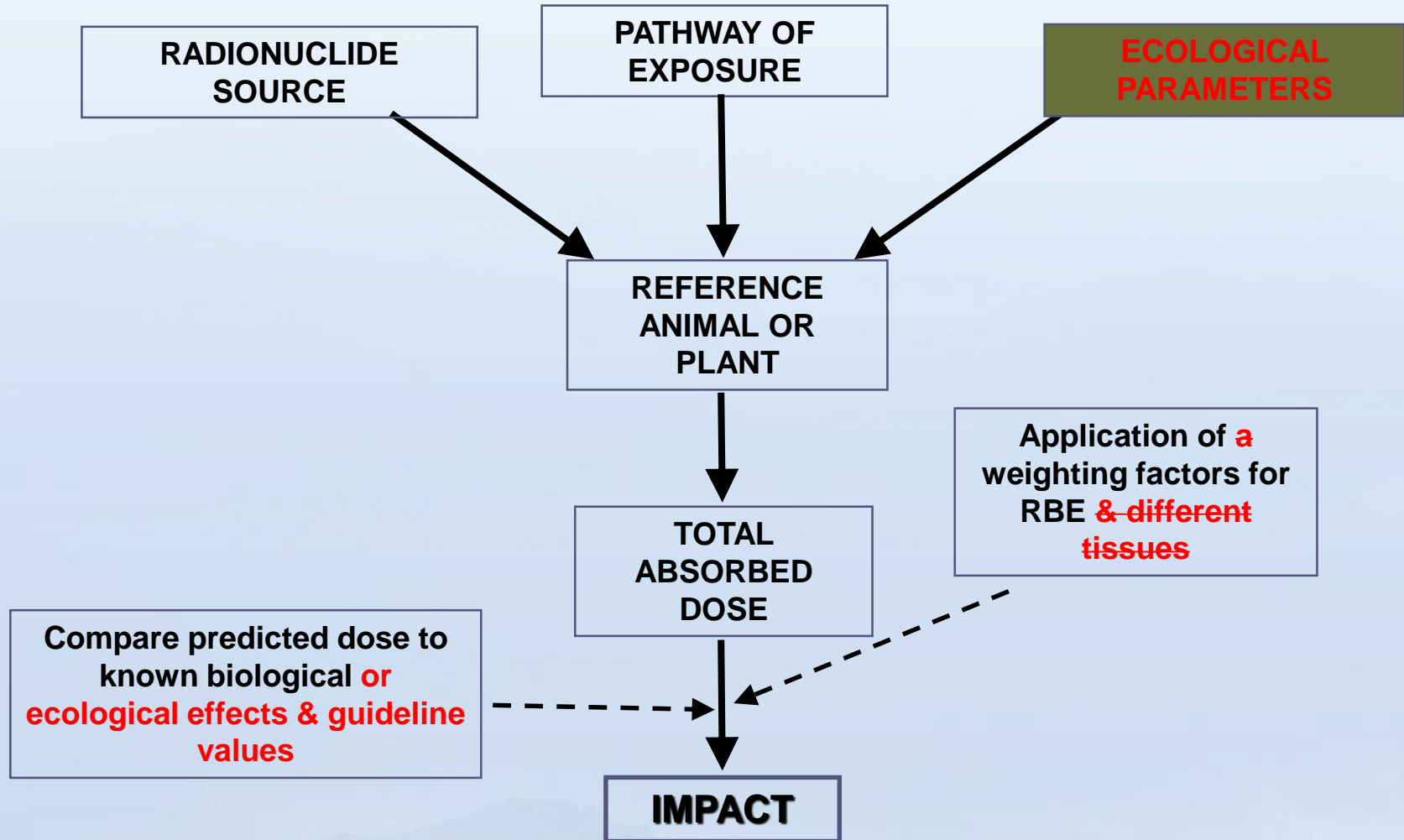
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# Human assessment (overview)

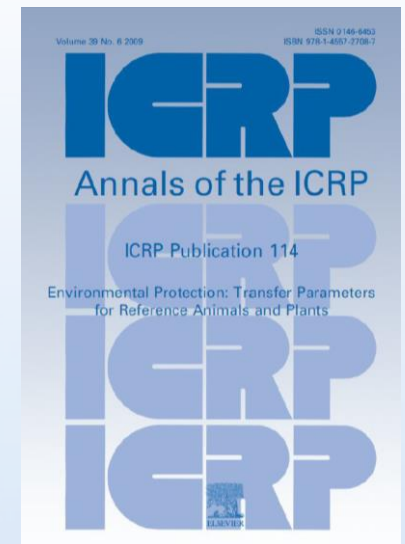


# Wildlife assessment (overview)










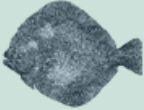




# Further ICRP published work

- ICRP, 2003. A Framework for Assessing the Impact of Ionising Radiation on Non-human Species. ICRP Publication 91. Ann. ICRP 33 (3).
- ICRP, 2008. Environmental Protection - the Concept and Use of Reference Animals and Plants. ICRP Publication 108. Ann. ICRP 38 (4-6).
- ICRP, 2009. Environmental Protection: Transfer Parameters for Reference Animals and Plants. ICRP Publication 114. Ann. ICRP 39 (6).
- ICRP, 2014. Protection of the Environment under Different Exposure Situations. ICRP Publication 124. Ann. ICRP 43(1).
- Dosimetry report out for consultation (summer 2016), others in progress .....



# RAPs

- Considers 12 RAPs (adult life stages) and 39 elements
- RAPs defined at taxonomic level of Family

<ul style="list-style-type: none"><li>• Deer</li><li>• Rat</li><li>• Bee</li><li>• Earthworm</li></ul>				
<ul style="list-style-type: none"><li>• Duck</li><li>• Frog</li><li>• Trout</li></ul>				
<ul style="list-style-type: none"><li>• Marine Flatfish</li><li>• Crab</li></ul>				
<ul style="list-style-type: none"><li>• Pine Tree</li><li>• Grass</li><li>• Seaweed</li></ul>				



■ Safety objective is:

*“The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation”*

# IAEA Safety Standards

for protecting people and the environment

## Fundamental Safety Principles



### Safety Fundamentals

No. SF-1





# IAEA Fundamental Safety Principles

- Principle 7 Protection of present and future generations
  - People and the environment, present and future, must be protected against radiation risks
  - Environment = Ecosystems and populations

# Basic Safety Standards

- Objectives
  - Prevention of radiological effects on flora and fauna
  - Man is an integral part of the environment
  - Ensure the sustainable use of natural resources now and in the future
    - Agriculture
    - Forestry
    - Fisheries
    - Tourism

## IAEA Safety Standards

for protecting people and the environment

Radiation Protection and  
Safety of Radiation Sources:  
International Basic  
Safety Standards

INTERIM EDITION

General Safety Requirements Part 3  
No. GSR Part 3 (Interim)



**PROBLEM FORMULATION AND DATA COLLATION**

Define scope of assessment  
(ecosystem, organisms, radionuclides etc)

Predict or measure activity concentrations  
in air/soil/sediment/water

**ASSESSMENT OF RADIATION DOSE TO ORGANISMS**

Predict/measure biota  
activity concentrations

Calculate external  
radiation dose

Calculate internal  
radiation dose

Calculate total  
radiation dose

**IMPACT PREDICTION AND DECISION MAKING**

Compare with guidelines and/or  
radiation effects data to determine  
likely impacts

Formulate  
management decision

# A Generic Framework for Environmental Radiation Risk Assessment

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**Stakeholder  
input**

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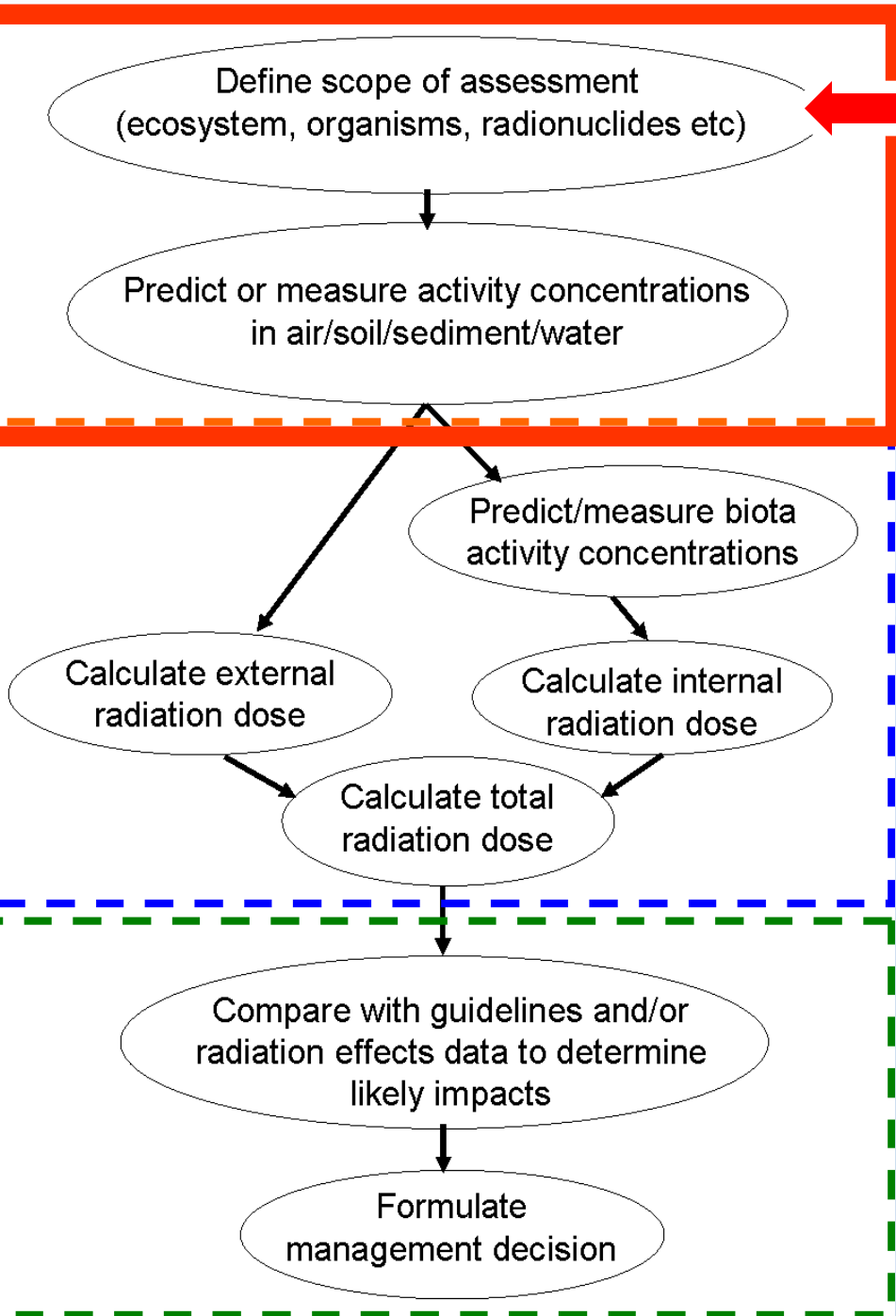
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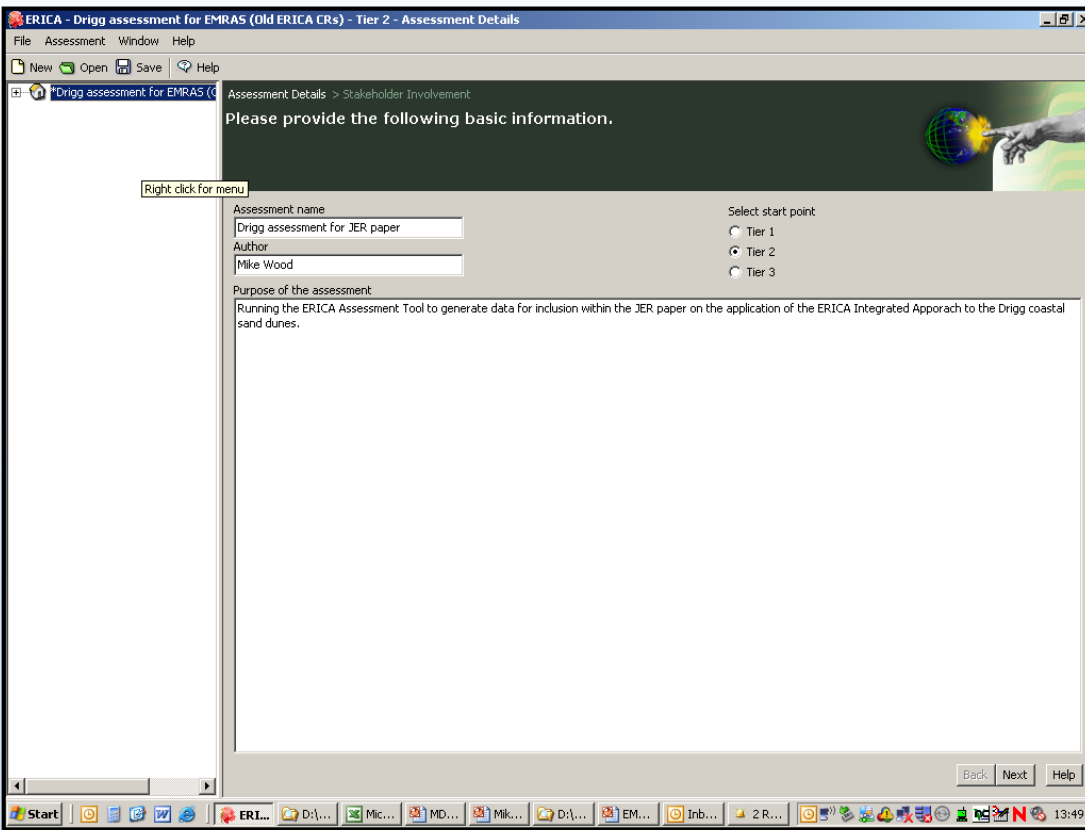
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Formulate  
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**Target of  
protection =  
Population**







# ERICA Tool

<http://www.ericatool.eu/>

the tabs to see the assessment details  
provide a justification.

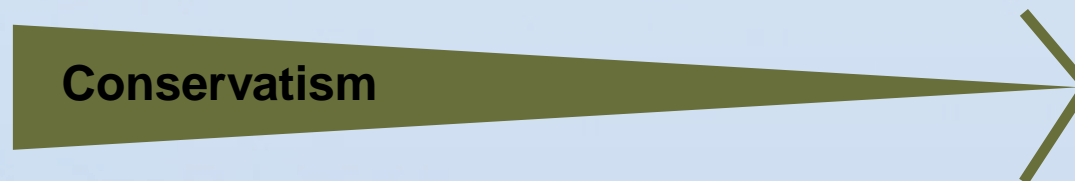
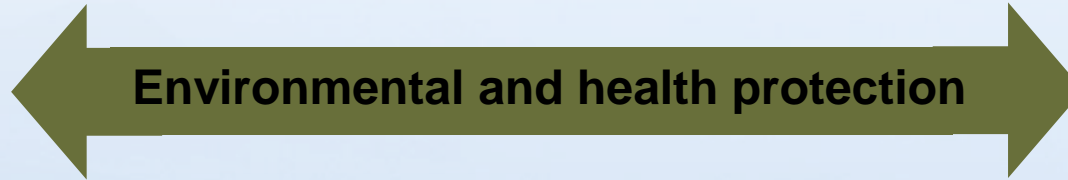
For at least one organism the screening dose rate is exceeded.  
We recommend you continue your assessment.

Uncertainty Factor = 3.0; This tests for 5% probability of exceeding the dose screening value, assuming that the RQ distribution is exponential

Organism	Total Dose Rate per organism [μGy h <sup>-1</sup> ]	Screening Value [μGy h <sup>-1</sup> ]	Risk Quotient (expected value) [unitless]	Risk Quotient (conservative value) [unitless]
Amphibian	4.31E-1	1.00E1	4.31E-2	1.29E-1
Benthic fish	1.40E0	1.00E1	1.40E-1	4.21E-1
Bird	4.10E-1	1.00E1	4.10E-2	1.23E-1
Bivalve mollusc	1.30E1	1.00E1	1.30E0	3.91E0
Crustacean	9.04E0	1.00E1	9.04E-1	2.71E0
Gastropod	8.37E0	1.00E1	8.37E-1	2.51E0
Insect larvae	1.03E1	1.00E1	1.03E0	3.09E0
Mammal	4.79E-1	1.00E1	4.79E-2	1.44E-1
Pelagic fish	4.45E-1	1.00E1	4.45E-2	1.33E-1
Phytoplankton	8.78E0	1.00E1	8.78E-1	2.63E0
Vascular plant	9.32E0	1.00E1	9.32E-1	2.80E0
Zooplankton	8.73E0	1.00E1	8.73E-1	2.62E0

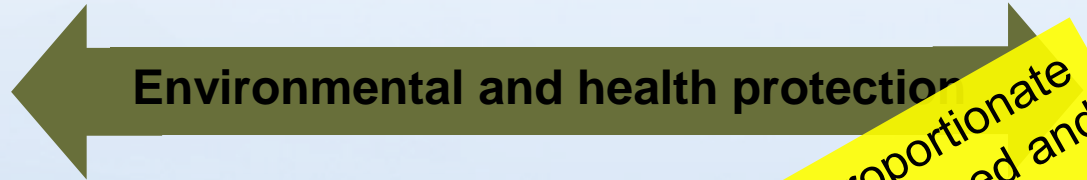
# Tiered approach

**TIER 1**                      **TIER 2**                      **TIER 3**  
Risk screening      Generic quantitative      Detailed Quantitative



# Tiered approach

**TIER 1**                      **TIER 2**                      **TIER 3**  
Risk screening      Generic quantitative      Detailed Quantitative



The level of detail in a risk assessment should be proportionate with the nature and complexity of the risk being addressed and consistent with decision-making needs

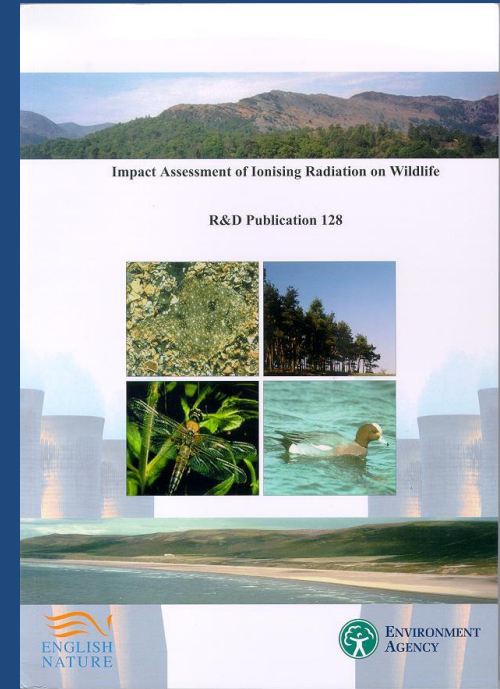


# UK Example

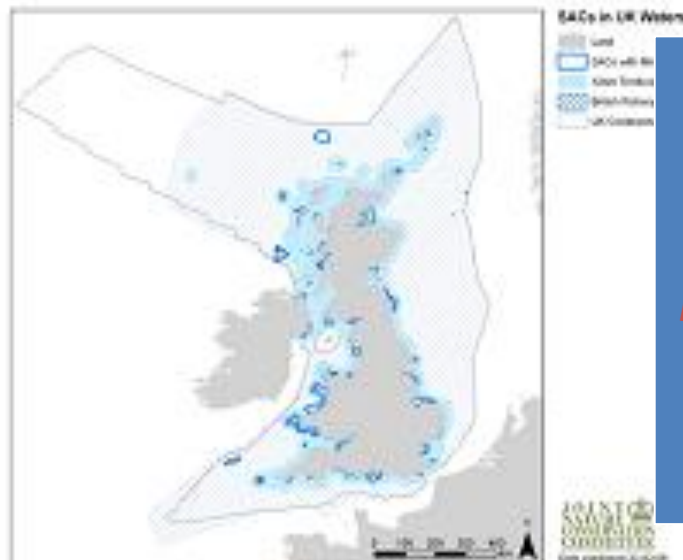


# United Kingdom

The UK has interpreted the EC Birds & Habitats Directives as requiring assessments to determine that no authorised discharges of radioactivity will impact upon protected (Natura 2000) sites.



SACs with Marine Components

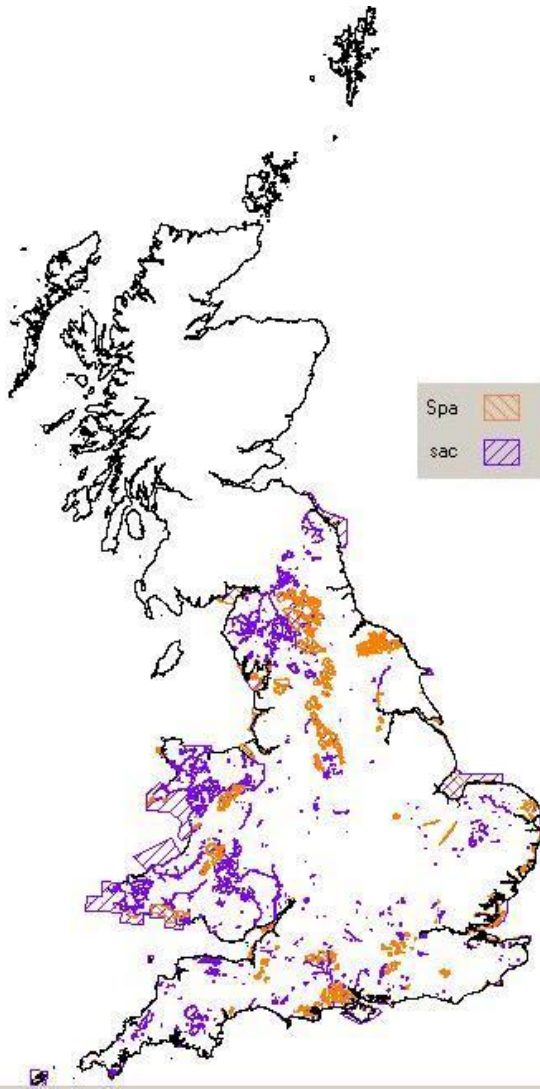


*Species listed on Annex 1 of EC Directive 79/409/EEC on the Conservation of Wild Birds, requires special measures be taken, including the designation of Special Protection Areas, to ensure the survival and reproduction of these species throughout their area of distribution*

# England & Wales Natura 2000 sites

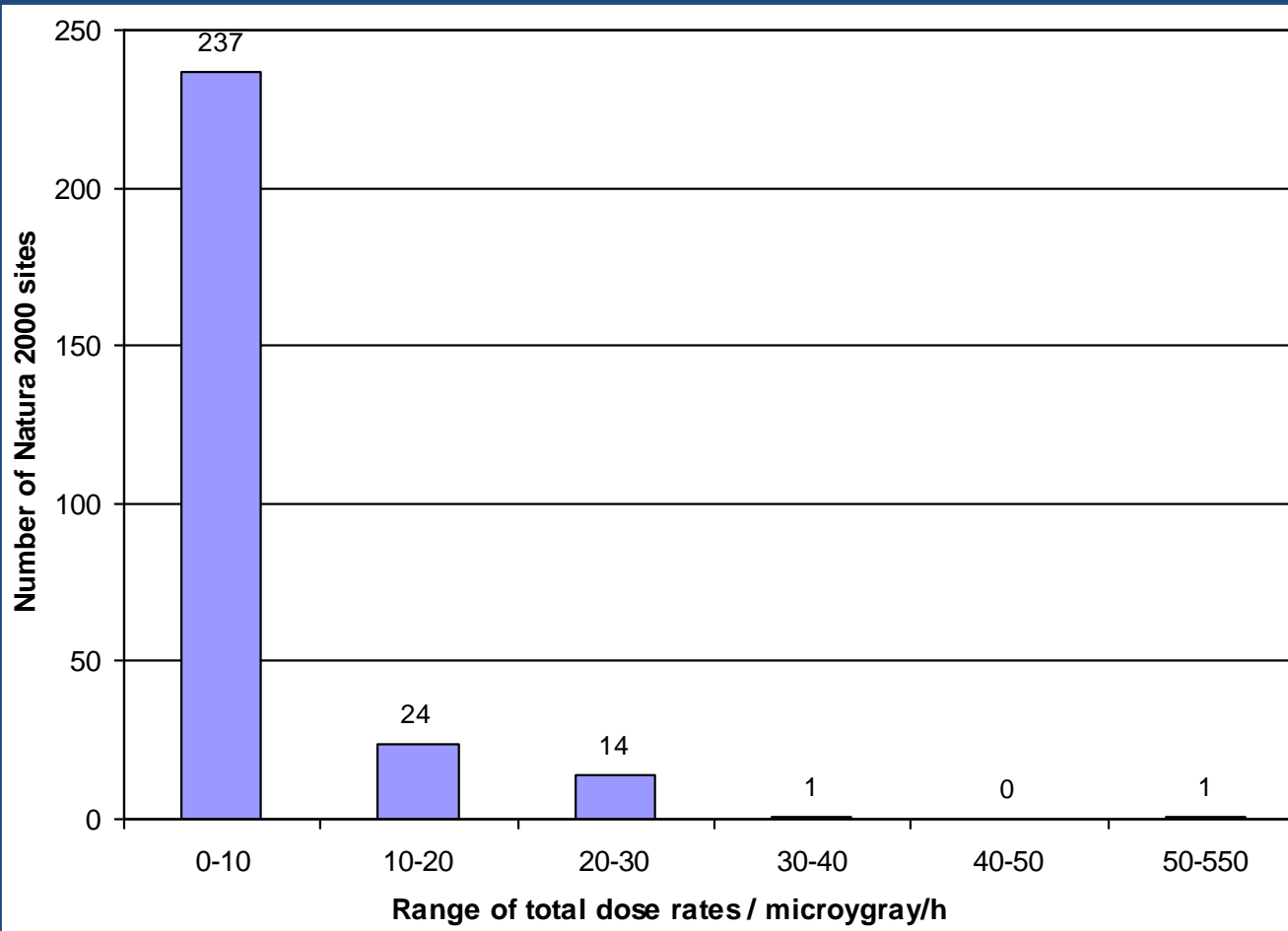
~ 430 Natura 2000 sites in E & W

- Include Special Areas of Conservation (SAC) and Special Protection Areas (SPA)
- Deadlines 2004, 2006, 2008
- Need for proportionality, transparency, fairness
- Risk based approach adopted
- All RSA 93 authorisations included in the assessments, 'threshold'  $40 \mu\text{Gyh}^{-1}$  for all species used
- Results reviewed by Natural England and Countryside Council for Wales
- 700 authorisations

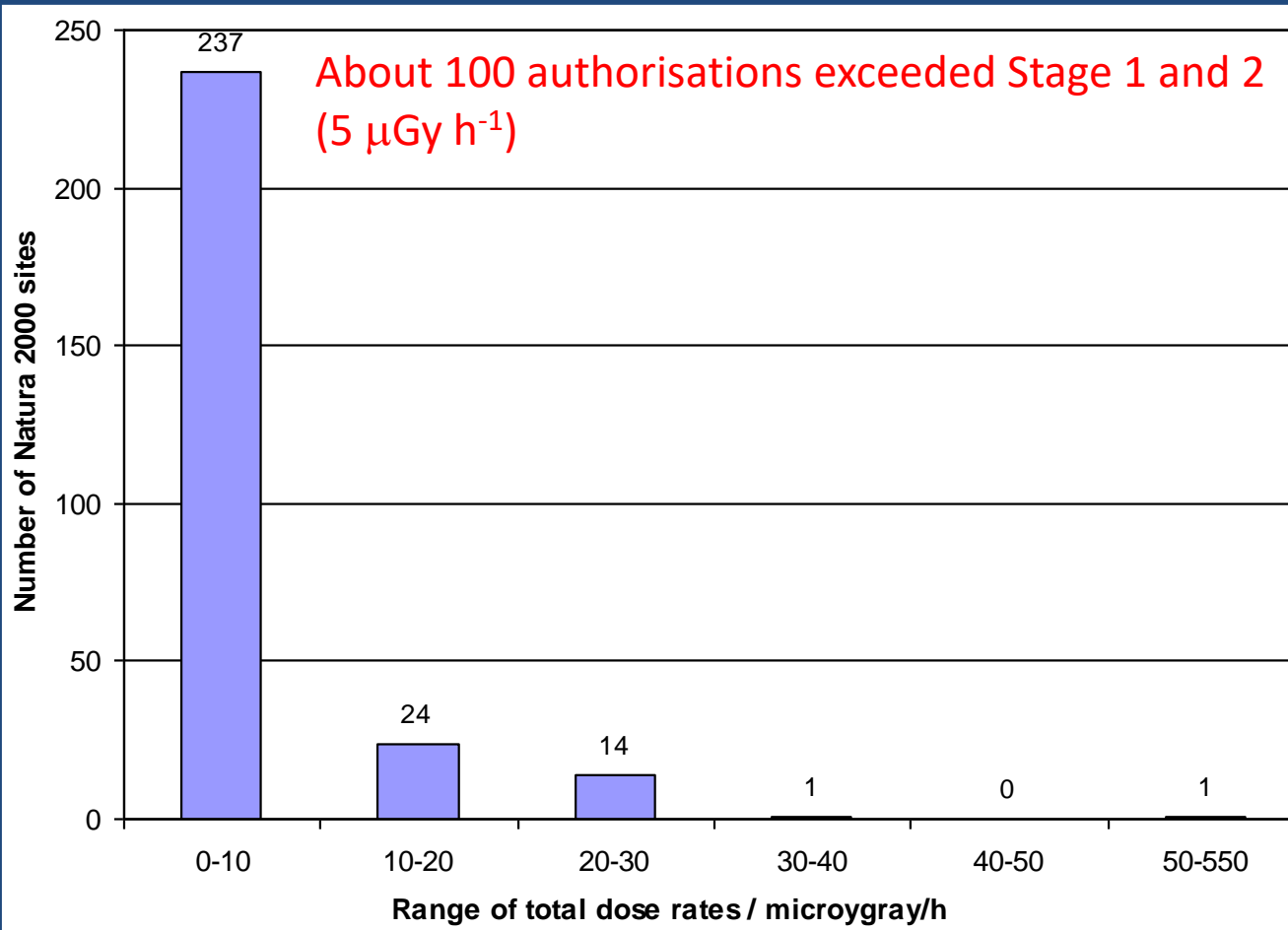




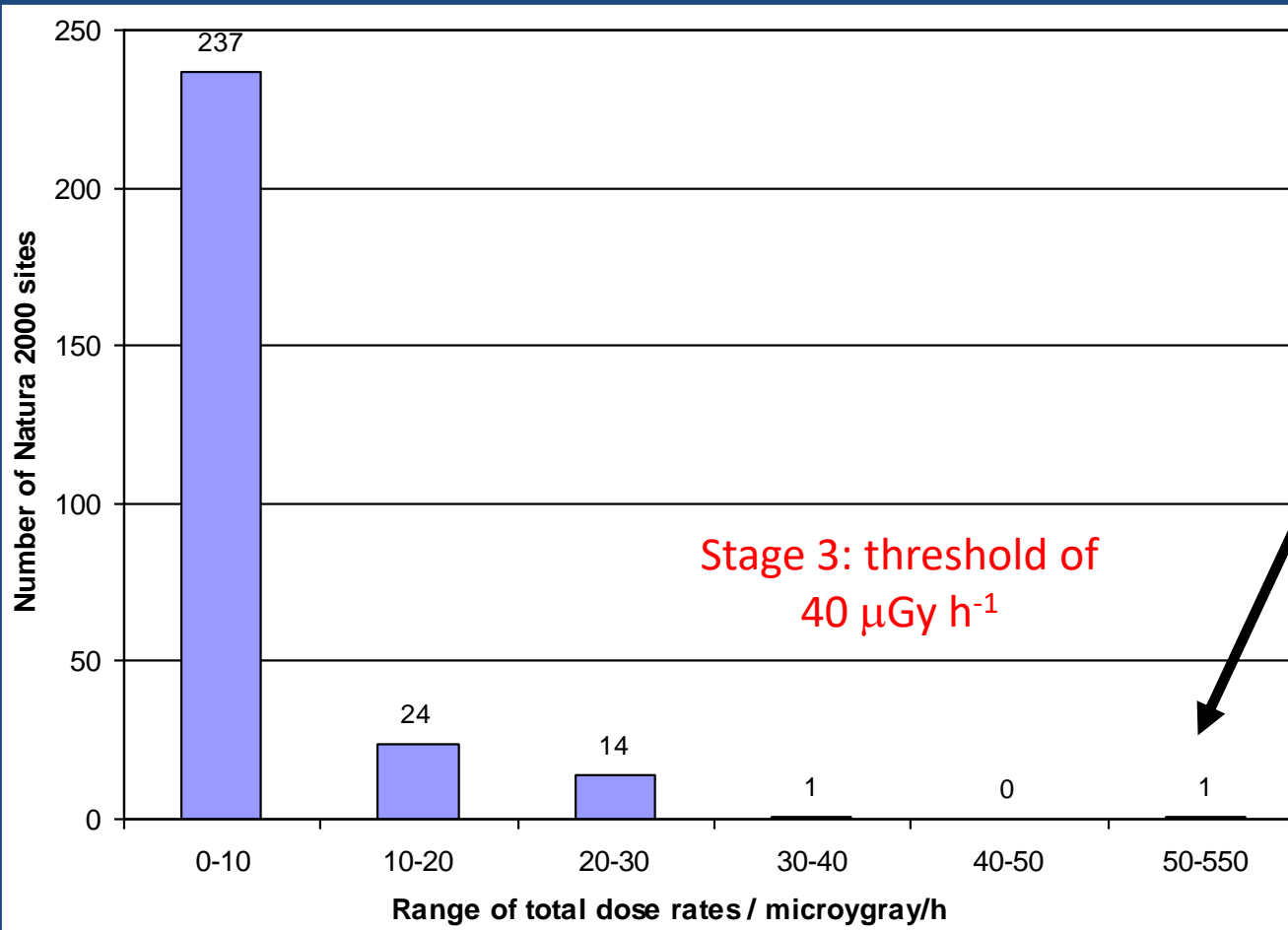
# Summary of Total Dose Rates for all sites



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# Summary of Total Dose Rates for all sites



Ribble and Alt Estuaries SPA, permit pre change 2008 (Springfields)

Dose rate > 500  $\mu\text{Gy/h}$  to phytoplankton



Questions?