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Paper 10.06: Dose Assessments for Wildlife

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1 Introduction

The Environment Agency has a duty to comply with the EU Birds and Habitats Directives (Council Directives 79/409/EEC on the conservation of wild birds and 92/43/EEC on the conservation of natural habitats, and wild flora and fauna) when planning and undertaking all of its regulatory and operational activities within England and Wales. These European Directives were introduced into UK legislation by the Conservation (Natural Habitats) Regulations 1994, as amended in 2000. Under these Regulations the Agency has obligations to review relevant existing authorisations, consents, licences and permissions (hereafter collectively referred to as permissions) to ensure that no Agency authorised permission results in an adverse effect, either directly or indirectly, on the integrity of identified European Sites within England and Wales. In this context the sites consist of classified, or potential, Special Protection Areas (SPA) created under the Birds Directive and candidate, or designated, Special Areas of Conservation (SAC) under the Habitats Directive. These sites are collectively referred to as Natura 2000 sites.

Within England and Wales, the Environment Agency made the decision that radioactive substances released under authorisation should be included in the implementation of the EU Birds and Habitats Directives. The Environment Agency therefore commissioned research in 2001 to develop its own approach for undertaking dose assessments to wildlife and this was updated in 2003 in light of European funded research in this field [1,2]. The Environment Agency has continued to be involved in European funded research [3,4] in this field and this is described briefly below.

The Environment Agency has been applying its assessment methodology to high and medium priority sites and an update on the findings from this work is also provided.

2 The current conceptual basis for protection of the environment from ionising radiation

Before summarising specific developments, it may be helpful to review the general problems faced by any framework or method, which attempts to demonstrate protection of the natural environment from the adverse impacts attributable to anthropogenic radioactivity.

The first major problem is, of course, the complexity and variety of the natural environment. Protecting man from the impacts of anthropogenic radioactivity released into the environment also involves a great deal of complexity, but this can be managed because only pathways back to a single species *(Homo sapiens)* need to be considered. Anatomical and biokinetic models for 'standard man', together with coefficients of radiation risk from human epidemiological studies, can be used as the basis of an assessment of risk.

In the case of the natural environment, it would clearly be impossible to consider every possible species of organism that may be affected and simplification is essential if any approach is to be workable. The currently accepted approach is to simplify matters by considering 'reference organisms[1]' which inhabit 'reference ecosystems'. Reference organisms are intended to be representative of the range of habitat occupancies, radionuclide uptake behaviours, and sizes and shapes (affecting dosimetric calculation) which would characterise a real ecosystem.

The second major problem is deciding what the objectives and criteria for protection should be. Clearly the aim should be to ensure 'no deleterious effect', but there are areas for debate on whether populations or individual organisms should be the object of protection. Here there appears to be some consensus that the main focus should be on protection of populations, but at the current state of knowledge this can only be assessed by considering likely effects on individual organisms and using generalisation to assess how any likely effects at the individual level may become manifest at the population level. There is general agreement that the effects, or endpoints, at individual level, which will need to be considered, are:

- Enhancement of mortality;
- Enhancement of morbidity;
- Reduction of reproductive success;
- Enhancement of scorable cytogenetic effects.

The third major problem is how to assess the likelihood of these effects in individual organisms within an exposed population. The generally accepted approach, following on from the radiological protection framework for humans, is to:

- Determine the distribution of radionuclides in the ecosystem by measurement or modelling;
- Calculate the absorbed radiation doses to organisms;
- Assess the likelihood of effects from dose-response relationships derived from laboratory experiments or field studies of heavily exposed populations.

The principal variation in approach here is whether the approach is to explicitly evaluate the likelihood of effects and consider whether the result is acceptable or whether to evaluate the results of the assessment against pre-set criteria in terms of dose.

3 Recent developments

3.1 International Commission on Radiological Protection

The current recommendations of the International Commission on Radiological Protection (ICRP, 1991 [5]) state that:

"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."

Whilst this statement may well be true in circumstances where pathways to humans are present in the environment where other species are exposed [6,7], there has been a growing acceptance that it is not a sufficient basis to demonstrate positively that wildlife is protected from the impacts of anthropogenic radioactivity.

[1] A reference organism being defined as "*a series of entities that provide a basis for the estimation of radiation dose rate to a range of organisms that are typical, or representative, of a contaminated environment. These estimates, in turn, would provide a basis for assessing the likelihood and degree of radiation effects. It is important that they are not a direct representation of any identifiable animal or plant*."

In recognition of the increased interest in the protection of the environment in recent years and because of the growing need for policy advice and guidance on environmental protection from ionising radiation the ICRP has reviewed its position in its latest draft recommendations [8] stating:

"*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*".

This issue was discussed in Publication 91 [9] where it was concluded that it was necessary to draw upon the lessons learned from the development of the systematic framework for the protection of human beings. ICRP is now moving forward with developing the concept of "*Reference Animals and Plants*" to address this point.

The ICRP has set up a new committee (No 5) to further develop their recommendations in this area. Establishing a new committee is a major step for ICRP and clearly signals the importance that they attach to this topic.

3.2 International Atomic Energy Agency

The IAEA have developed an Action Plan on the protection of the environment from ionising radiation (available from
http://www-ns.iaea.org/tech-areas/waste-safety/coord-group-on-protec-environment.htm)
to co-ordinate the efforts of a number of international organisations with the ultimate aim of producing standards and guidance for the protection of the environment. The Action Plan was approved by the Board of Governors in September 2005 and the first co-ordination meeting was held in January 2006.

3.3 European perspective

3.3.1 FASSET project

The FASSET project commenced in November 2000 under the EC 5th Framework Programme and concluded in October 2003. Its objective was to develop a framework for the assessment of environmental impact of ionising radiation in European ecosystems. It has produced six scientific reports all of which are available from the ERICA project website (www.erica-project.org).

The FASSET project promoted a conventional stepwise environmental assessment approach, comprising:

- Planning the assessment: regulatory requirements, stakeholder views, aims and objectives;
- Problem formulation: describing practice or activity and potentially impacted ecosystems, initial hazard analysis, decision on complexity of assessment required;
- Exposure and effects analysis: quantifying exposure of relevant organisms to stressors, determination of prevalence and severity of any effects which may be expected;
- Risk characterisation: identifying, evaluation and prioritising resulting risks to the environment;
- Decision and management: determining appropriate management action - permissions and consents, remediation, amelioration.

However, the FASSET project focused on the problem formulation and exposure and effects analysis steps. It proved a basis for describing ecosystems in terms of reference systems for forests, semi-natural pastures, health lands, agricultural land, wetlands, freshwaters, marine waters and brackish waters. Data are provided on radionuclide concentration factors, dose coefficients as a basis for calculation of dose rates, and example models of radionuclide transfer are given. The data for radionuclide concentration factors were extracted from the available literature and a number of gaps were highlighted in the available data. The FASSET project also produced the FRED database, which is a compilation of experimental data on the biological effects caused by ionising radiation exposure to wildlife, available in the scientific literature.

3.3.2 ERICA project

The project started in April 2004 and is due to deliver in March 2007. It aims to extend the work of the FASSET project into the risk characterisation and management steps and to fill gaps in the data revealed by the FASSET project. The ERICA project has, as its principle objective, the following:

To provide and apply an integrated approach addressing scientific, managerial and societal issues surrounding the environmental effects of ionising contamination, at a community level, with emphasis on wildlife and ecosystems.

The final outcome of the project will be delivery of an integrated approach (shown in Figure 1) to the assessment of dose to wildlife and to help assessors with guidance on how to make decisions associated with management of environmental consequences of ionising radiation.

The conceptual structure of the ERICA Integrated Approach that has gradually evolved (and is still evolving) is shown in Figure 1. The integrated approach acknowledges that assessments are rarely linear and that the process may involve several iterations within each stage of the assessment. The approach also recognises the need to involve other interested parties (stakeholders) in the decision-making and management process.

The ERICA Integrated Approach is being developed in different tasks:

The first task has been the development of an assessment tool that will allow the user to calculate doses to wildlife using a bespoke flexible and user-friendly software application. The tool is based on a series of ‘wizards’ to work through to allow the user to input relevant information into the assessment and which reflect the tiered approach that has been developed within the ERICA project. This means that the first tier of the approach is a simple screening step which requires limited information (activity concentrations in the media (usually soil or water) of interest (depending on whether the assessor is working on a terrestrial or aquatic ecosystem). The second tier remains as a screening step but allows the user to refine the exposure pathway choosing the reference organisms, providing the ability to generate new reference organism geometries, amending the parameters associated with the assessment (eg, concentration ratios, occupancy factors, radiation weighting factors etc). Tier 3 has focused much more on the refinement of the effects component of the assessment and allows the user to undertake a probabilistic assessment and to evaluate the sensitivity of different parameters within the assessment.

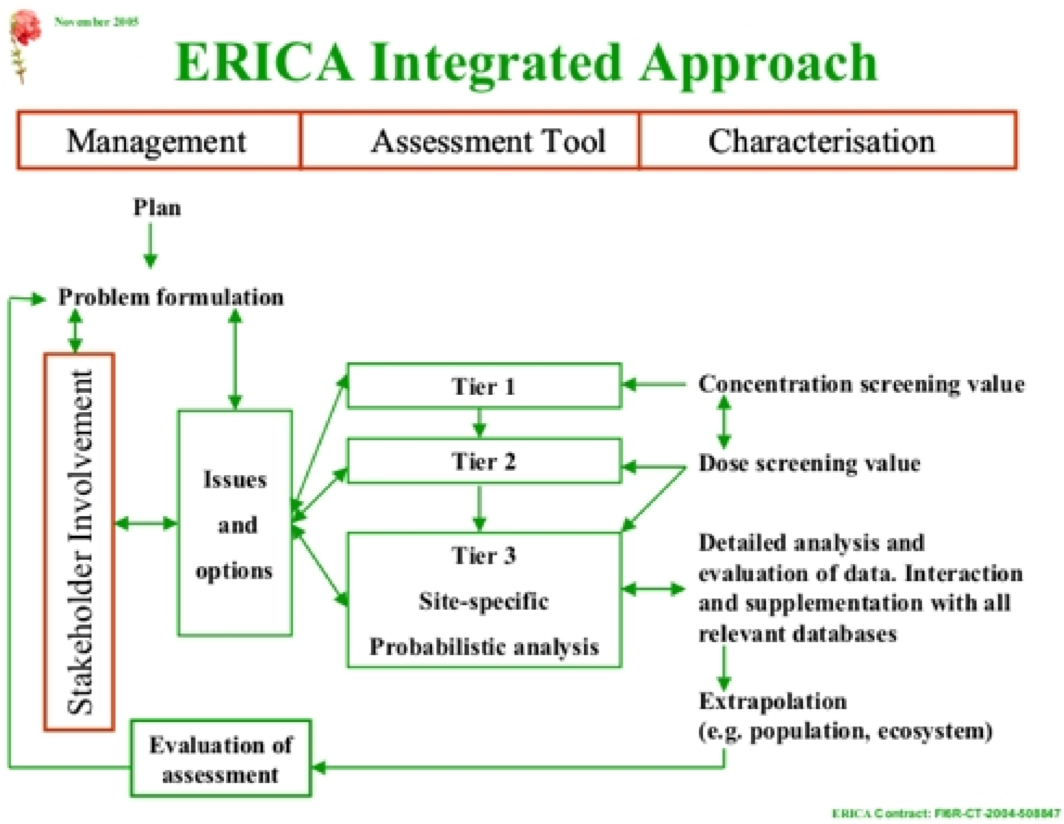

Figure 1 **Working model of the ERICA Integrated Approach, depicting its three main features: the assessment tool, the methodology for risk characterisation and guidance to stakeholder involvement and decision-making (management)**

The development of an online database on radiation effects on wildlife (the FREDERICA database (www.frederica-online.org)). The online version has greater flexibility in searching the information contained within the database than the Access database released during the FASSET project. It also includes the effects data from another European FP5 funded project, Environmental Protection from Ionising Contaminants in the Arctic (EPIC, reference number ICA2-CT-2000-10032), which contains effects data from the Russian literature.

The second task was then to apply a scientific approach using sound reasoning to solve a number of the main extrapolation issues by combining desk studies and experiments to establish a series of rules that might be applied to this problem. Experiments have been conducted to evaluate how chronic external and internal irradiation might influence the effects data that is available and to explore extrapolation issues such as individual to the population using population modelling approach.

The third task was a thorough evaluation of the effects data contained within the FREDERICA database and an evaluation of the different ways of exploring such data to provide benchmarks of effects. In this case different approaches have been adopted from the European Technical Guidance document (TGD) for chemical risk assessment and these methods have been applied to the data within the FREDERICA database. For example this has involved the application of safety factors to the effects data and to the generation of species sensitivity distribution curves. Both methods allow you to determine predicted no effect levels (called predicted no effects dose rates (PNEDR) in ERICA) and from this you can define screening level thresholds for the use in tiers 1 and 2. ERICA has adopted a screening dose rate of 10 μGyh^{-1}. Advice and guidance on decision making at tier 3 is also being provided for the effects analysis component.

The fourth task has been the provision of managerial guidance together with stakeholder involvement to support the protection of the environment from ionising radiation frameworks. To do this ERICA has been engaged in dialogue with an End Users Group (EUG) to help to define the decision-making guidance, which will form part of the integrated approach, through a series of workshops. This has provided an input into the managerial/decision-making processes that need to be refined within the project in order to assist assessors through the provision of guidance on what to do next during the assessment.

The final task has been to test both the original FASSET outputs and is currently engaged in testing the ERICA tools and ERICA derived guidance against a series of case studies to ensure:

- appropriateness of the information and tools being provided within the project; and
- to ensure that the integrated approach works.

The case study sites were: Sellafield, Loire River, North Sea oil and gas platforms, the Chernobyl exclusion zone and areas of enhanced natural radionuclides in the Komi Republic.

4 Overview of the Environment Agency habitats assessments for RAS

The Environment Agency is required to determine whether the discharges it permits could have an adverse effect on the integrity of Natura 2000 habitat sites. There are about 430 Natura 2000 in England and Wales, which include Special Areas of Conservation (SAC) and Special Protection Areas (SPA) (see Figure 2).

The impact of authorised discharges of radioactive substances on these Natura 2000 sites is being assessed as part of the overall Habitats project. Staged screening assessments have been made to identify those Natura 2000 sites which may be affected by permitted releases of pollutants and thus require a more detailed assessment (Stage 3 assessment).

4.1 Assessment methodology

The methodology developed for assessing the impact of releases of radioactive substances on Natura 2000 habitat sites is based on Science project work for the Environment Agency [1,2].

4.1.1 Stages 1 and 2 assessments

The Radioactive Substances Act 1993 (RSA 93) authorisations, which can impact on each Natura 2000 site, have been identified as follows. For terrestrial Natura 2000 sites, these were RSA 93 authorisations for premises within 10 km of the Natura 2000 site. For freshwater Natura 2000 sites, these were discharges to sewer or direct to river, which can flow in to the Natura sites. For coastal Natura 2000 sites, these were the discharges to sewer or river, which may ultimately flow into the direct locality of the Natura site. Account has also been taken of more remote regional discharges which may be transported into a coastal Natura 2000 site, but where dispersion and hence dilution will be greater. Full details are provided elsewhere [10].

The stage 2 assessment then reviewed the maximum permissible radioactive discharge levels from authorised sites and compared these to defined screening levels [11]. Dose per unit release data have been derived for a range of reference organisms.

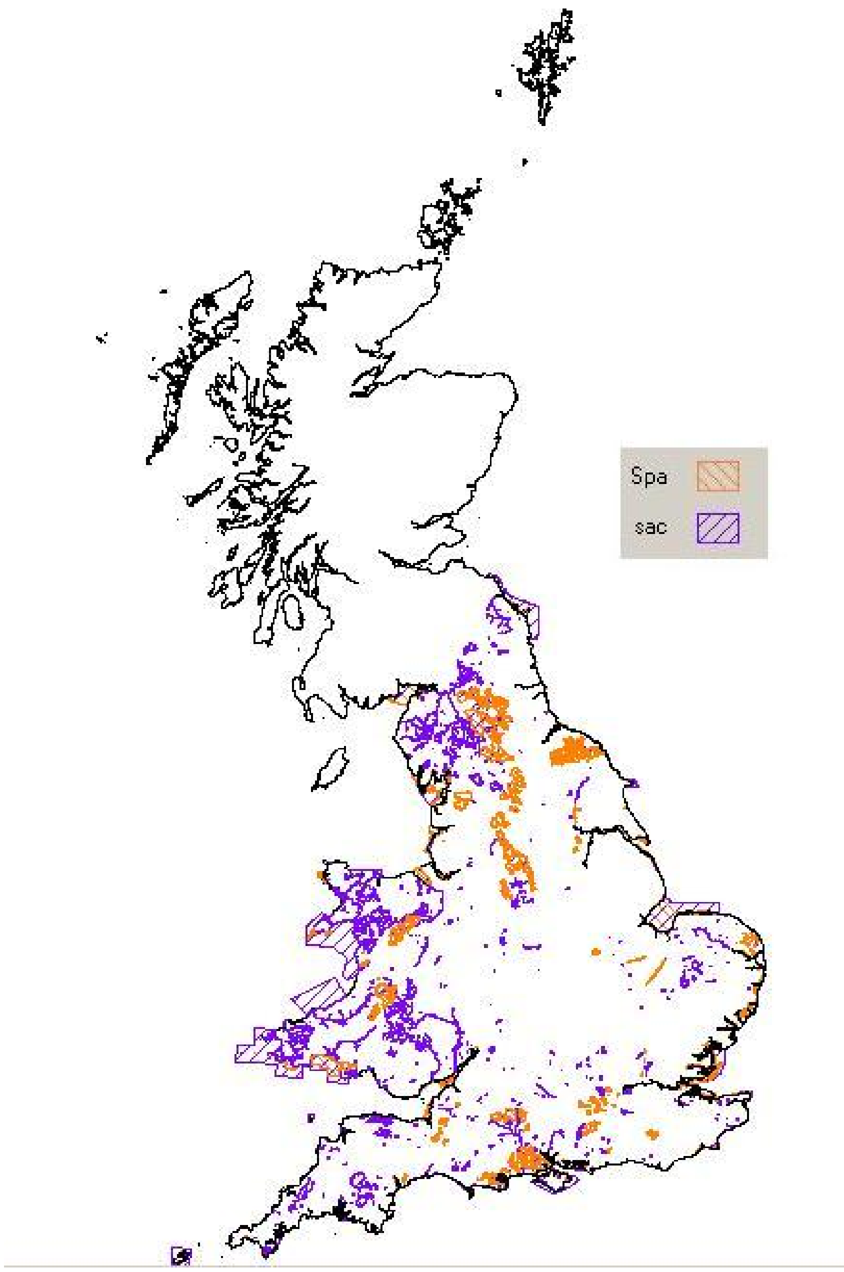

Figure 2 Natura 2000 Habitats sites

The reference organism concept therefore provides a series of organism types, which can be considered representative of different trophic levels (see Table 1). In each case it is possible to determine relevant ecological parameters for a species representative of the reference organism (for example, for a pelagic fish you might select a salmon). The ecological parameters provide information on prey, predators and the time spent in different compartments of the ecosystem, for example for a duck, how much time is spent on sediment, surface of the water, flying, etc. It is also possible to define a simplified geometry (usually as an ellipsoid) for the purposes of dosimetric calculations (full details are provided in Ref [1]). The equations used are given below. For each reference organism a concentration factor has been defined relative to soil, water or air depending upon the type of assessment (freshwater, estuarine/marine or terrestrial) and radionuclide. Figure 3 provides an overview of the assessment methodology [1] process.

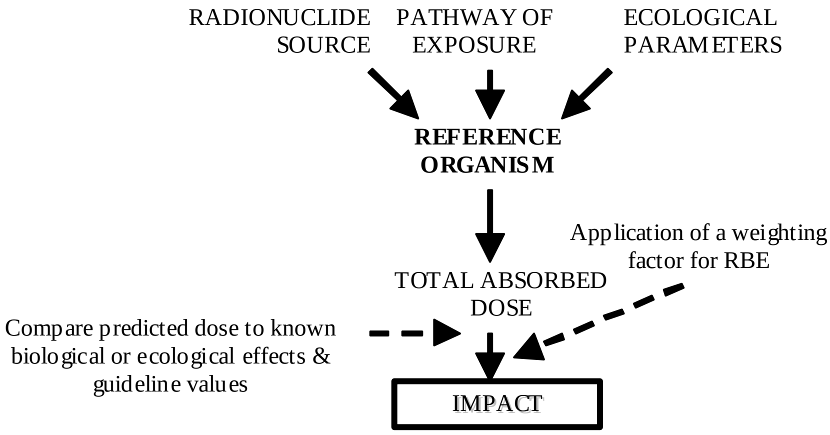

Figure 3 Overview of the assessment process given in Ref [1]

The assessment approach was developed for the following radionuclides for different ecosystems: terrestrial only: ^{35}S, ^{41}Ar, ^{85}Kr, ^{226}Ra; aquatic only: ^{99}Tc, ^{125}I, ^{210}Po; both terrestrial and aquatic: ^{3}H, ^{14}C, ^{32}P, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{129}I, ^{131}I, ^{137}Cs, ^{234}Th, ^{238}U, ^{239}Pu and ^{241}Am.

The dosimetry equations used are as follows:

Terrestrial ecosystems (soil)

$$\dot{H} = \sum_i (C_i^{soil} \times CF_i^{soil} \times DPUC_{total,i}^{\mathrm{int}}) + \left(\left(f_{soil} + 0.5 f_{surface}\right) C_i^{soil} \times DPUC_{total,i}^{ext}\right) \quad (1)$$

where:

$\sum_i$ represents summation over all nuclides;

C^{soil} is the concentration of the radionuclide in surface soil;

CF^{soil} is the concentration factor for the organism referenced to soil;

f_{soil} is the fraction of time the organism spends under the soil surface; and

$f_{surface}$ is the fraction of time the organism spends on the ground surface.

Terrestrial ecosystems (air)

$$\dot{H} = \sum_i (C_i^{air} \times CF_i^{air} \times DPUC_{total,i}^{\mathrm{int}}) + \left(\left(f_{soil} + 0.5 f_{surface}\right) C_i^{soil} \times DPUC_{total,i}^{ext}\right) \quad (2)$$

where:

$\sum_i$ represents summation over all nuclides;

C^{air} is the concentration of the radionuclide in air;

C^{soil} is the concentration of the radionuclide in surface soil, calculated from the air concentration and the relevant concentration ratio;

CF^{air} is the concentration factor for the organism referenced to air;

f_{soil} is the fraction of time the organism spends under the soil surface; and

$f_{surface}$ is the fraction of time the organism spends on the ground surface.

Aquatic ecosystems

$$\dot{H} = \sum_i (C_i^{water} \times CF_i^{water} \times DPUC_{total,i}^{\text{int}}) + \left(\left(\left(f_{sediment} + 0.5 f_{surface}\right) C_i^{sediment} + \left(f_{water} \times C_i^{water}\right)\right) \times DPUC_{total,i}^{ext}\right) \quad (3)$$

where:

C^{water} and $C^{sediment}$ are the radionuclide concentrations in water and sediment respectively;

CF^{water} is the concentration factor for non-human species referenced to water;

$f_{sediment}$ is the fraction of time spent buried in sediment;

$f_{surface}$ the fraction of time spent on the sediment surface; and

f_{water} the fraction of time spent free swimming in the water column or on the water surface.

Table 1 Reference organisms as listed in Ref [1]

Freshwater	Estuarine/marine	Terrestrial	
Bacteria	Bacteria	Bacteria	Bee
Macrophyte	Macrophyte	Lichen	Woodlouse
Phytoplankton	Phytoplankton	Tree	Earthworm
Zooplankton	Zooplankton	Shrub	Herbivorous
Benthic Mollusc	Benthic Mollusc	Herb	Mammal
Small Benthic	Small Benthic Crustacean	Seed	Carnivorous
Crustacean	Large Benthic Crustacean	Fungus	Mammal
Large Benthic	Pelagic & Benthic Fish	Caterpillar	Rodent
Crustacean	Fish Egg	Ant	Bird
Pelagic & Benthic	Seabird		Bird Egg
Fish	Seal & Whale		Reptile
Amphibian			
Duck			
Aquatic Mammal			

As a result of Stage 2 and a screening level of 5 μGyh^{-1}, approximately 100 authorisations were identified as potentially impacting on a total of 51 Natura 2000 sites and these require further assessment (Stage 3). One of the main reasons that an authorisation exceeded the screening level is because of the selection of a suitable radionuclide analogue for use in the assessment. This is because not all radionuclides authorised for release are included in the list of radionuclides used in Ref [1]. For example ^{99m}Tc is released from medical institutions in relatively large quantities but it has a short (6 hour) half-life. It is usually released into the sewer system, which means that there will be a time delay in the ^{99m}Tc reaching any Natura 2000 site and hence radioactive decay will reduce the activity concentration arriving at the site. Furthermore, the short half-life means a rapid reduction in activity concentration of any ^{99m}Tc that reaches the Natura 2000 site. However ^{99m}Tc was not included in the original list of radionuclides used in Ref [1] and so has to be represented by an analogue. In the case of the Stages 2 and 3 assessments this has been done using another gamma emitting radionuclide, ^{137}Cs, which has a 30-year half-life. As a consequence the dose rate from ^{99m}Tc to the organisms are over estimated.

4.2 Current status of the (stages 3 & 4) assessments

Detailed (Stage 3) assessments for 42 high and 135 medium priority Natura 2000 sites were completed by March 2004 and March 2006 respectively. Detailed assessments for 162 low priority sites do not need to be completed until March 2008.

The methodology for the stage 3 assessments was extended [2] from that used in the Stage 1 and 2 assessments to include additional radionuclides and also to include those species identified as representative of the habitats listed in the legislation.

The first part of the Stage 3 assessment is to identify information associated with the Natura 2000 site, so for example Table 2 lists the 81 species that were identified as needing protection [2]. Having identified the feature species present, then the occupancy factors (time spent in different compartments of the ecosystem), and concentration factors (for each radionuclide/species combination) should be determined.

Table 2 Feature species (only common names given) identified at the 51 Natura 2000 sites potentially impacted by the Stage 2 screened authorisations. The number of species is given in brackets. Those species marked with * are found in the Humber Estuary Natura 2000 sites

Bird species (55)	Avocet*, Bar-tailed Godwit*, Bewicks Swan, Bittern*, Black-tailed Godwit*, Brent goose, Chough, Common Scoter, Common Tern, Cormorant, Curlew*, Dartford Warbler, Dunlin*, Gadwall*, Gannet, Golden Plover*, Great Crested Grebe, Grey plover*, Guillemot, Hen Harrier*, Honey Buzzard, Kittiwake, Knot*, Lapwing*, Lesser Black-backed Gull, Little Tern*, Manx Shearwater, Marsh Harrier*, Mediterranean Gull, Nightjar, Oystercatcher*, Peregrine, Pink-footed Goose, Pintail, Puffin, Razorbill, Redshank*, Ringed Plover*, Ruff*, Sanderling*, Sandwich Tern, Scaup*, Shelduck*, Short-Eared Owl, Shoveler, Snipe*, Stone Curlew, Storm Petrel, Teal, Tufted Duck*, Turnstone, White-fronted Goose, Whooper Swan, Wigeon*, Woodlark
Plant species (4)	Early Gentian, Fen Orchid, Petal Wort, Shore Dock
Terrestrial invertebrates (2)	Southern Damselfly, Stag Beetle
Amphibians (2)	Great Crested Newt, Natterjack Toad
Terrestrial mammals (4)	Bechsteins Bat, Dormouse, Greater Horseshoe Bat, Lesser Horseshoe Bat
Aquatic mammals (3)	Common Seal, Grey Seal, Otter
Aquatic invertebrate	Desmoulins Whorl Snail
Fish species (8)	Allis Shad, Atlantic Salmon, Brook Lamprey, Bullhead, River Lamprey, Sea Lamprey, Spined Loach, Twaite Shad
Reptiles (2)	Sand Lizard, Smooth Snake

4.2.1 Derivation of concentration factor (CF) values

Probably the main source of uncertainty in the Stage 3 assessment results from the derivation of concentration factors (CFs) for the radionuclide/species combination. A review of the scientific literature revealed little data on the concentration of the radionuclides of interest in the feature species. This was not surprising given that most of the feature species are of conservation value and therefore unlikely to be included in routine sampling and monitoring programmes. Some CF data have been obtained from the literature and from species with a similar ecology but which are not of conservation value and that have been sampled.

In the absence of feature species and radionuclide specific CF values, an approach has been developed, which should provide a consistent manner for selecting CF values for inclusion in the assessment. Essentially, the approach is as follows: determine if a CF is available for the species and radionuclide of interest. This is used if available. If not, a CF is selected based on a series of rules defined in Ref [2] and listed below:

Select CF for a reference organism with similar ecology. If this is not available, the CF and K_d (aquatic only) values for the radionuclide of interest are reviewed and expert judgement is used to determine which value should be recommended. Expert judgement is needed because, although the use of the K_d to equate to CF can be viewed as generally conservative in aquatic ecosystems, certain radionuclides, eg, ^{131}I, are known to accumulate in organisms and in these situations the use of the K_d is unlikely to be appropriate. Finally, where no CF is available for another plant or animal group, the CF for the Environment Agency recommended analogue radionuclide [10] has been used. It should be noted that this approach might produce some highly conservative CFs (as for example in the case of using ^{137}Cs as an analogue for ^{99m}Tc above). It is important to note the origins of the CFs used when interpreting the outputs of dose rate assessments. It is emphasised that the overall assessment must be supported by field measurements to produce site-specific data if there is any doubt over the results although this may be difficult if you have to measure the radionuclide content of a protected species.

4.2.2 Linking feature species geometry to that of reference organism geometries listed in Ref [1]

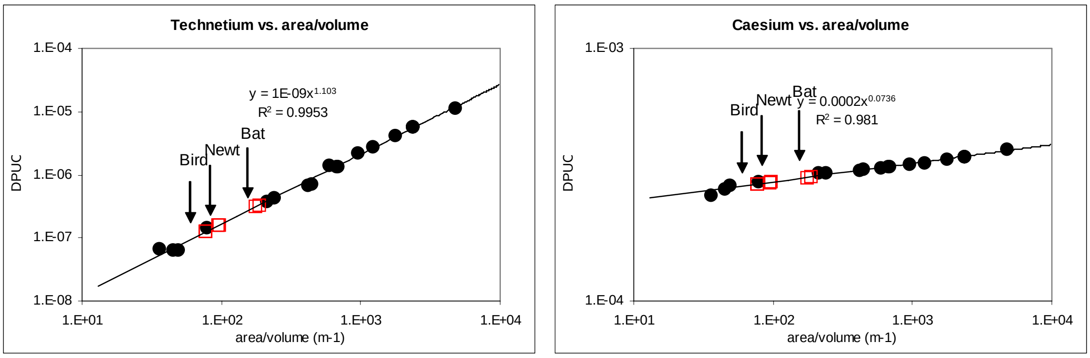

Figure 4 Plots of ^{99}Tc and ^{137}Cs as examples of the observed relationship between organism area/volume ratio and the DPUC values

In order to adapt the assessment methodology [1] to enable dose rates to be predicted for a number of species, a method to relate the geometry of the new species to the nearest reference organism geometry has been devised using an area/volume ratio. This assumes that both the feature species and the reference organism geometries are ellipsoids. Full details of the method are given elsewhere [2] but Figure 4 demonstrates the method graphically. It is important to note that the reference organism geometry in Ref [1] is just a geometric shape. Therefore a benthic fish is actually a geometric shape of size 225 mm x 43.5 mm x 24.5 mm with an area/volume ratio of 75.9 for the purposes of dosimetry and hence can be used to represent, for example, Guillemot with an ellipsoid shape of 207.5 mm x 31.2 mm x 31.2 mm and an area/volume ratio of 76.4. Seventy-seven feature species identified were included in this mathematical assessment of area/volume ratios and were assigned to the appropriate reference organism geometry from Ref [1]. The selection was conducted mathematically to give the best fit to the data [2]. It should be noted however that plants are not conducive to representation by means of an ellipsoid and hence were excluded from this process. Therefore any plant species should be represented by the macrophyte (for aquatic), shrub or herb (for terrestrial) geometries during Natura 2000 site assessments.

Ideally, absorbed doses for all new geometries should be calculated using the Monte Carlo absorbed fraction functional method [1] and conducted for all reference organism geometries. However, these calculations are onerous and, as the above approximations give rise to generally small errors in the dosimetric calculations (on average 3.5% and 7.5% for internal and external doses respectively), the area/volume approach seems an acceptable way of addressing the wide range of geometries of the identified feature species.

4.3 Current status

The doses to organisms are compared to a threshold of 40 μGy/h which the Environment Agency agreed with English Nature would be used to decide whether a Natura 2000 site should go forward into Stage 4 of the Habitats project process. Stage 4 involves the potential variation of authorisation limits. Where doses are above this threshold, it cannot be concluded that there is no adverse effect on site integrity.

The combined impact of RSA 93 discharges has been assessed for the 177 high and medium priority Natura 2000 sites. Only, one Natura 2000 site has a dose to the worst affected organism greater than

40 μGy/h, this is the Ribble estuary with an assessed dose of 690 μGy/h. The majority of this dose arises from discharges of Th-234 and other alpha activity from the Westinghouse Springfields site.

The dispersion modelling used to derive the dose per unit release data is reasonably realistic for the Ribble estuary as the parameters used in this modelling were those for the Ribble estuary. The Th-234 dose per unit concentration data has cautious concentration factors. The other alpha activity is probably short-lived radionuclides, but there are currently no dose per unit concentration data available for short-lived alpha radionuclides, although outputs from ERICA will help to derive such data.

Springfields are due to cease processing uranium ore in April 2006 and their current RSA 93 authorisation already has lower limits, which will come into effect from 2008. The Environment Agency has until March 2008 to determine whether these planned reductions are sufficient to ensure that the Ribble Estuary is protected from a habitats point of view or whether further action is required.

5 Conclusions

There is much ongoing work in the field of environmental protection from ionising radiation. We now have tools to calculate doses to wildlife and guidance documents are being written to help assessors know how the tools can be used and in particular to highlight their limitations. The ERICA project is due to complete in March 2007 and is currently on target to do so and the findings of this work will be incorporated into the Environment Agency's assessment approach for wildlife and radioactive substances released under authorisation. The ERICA assessment tool is currently going through a round of testing to ensure that it i) functions correctly and ii) eliminates bugs from the programming. The tool will be applied to the case studies to, it is hoped, highlight any deficiencies in the approach/tool that can then be addressed by the project participants – the testing will be conducted until the end of December 2006.

Once the project has delivered then the Environment Agency need to consider how best to implement the assessment tool within the current regime of Habitats assessments.

Full details of the ERICA project can be found on the following websites:

- ERICA project website: www.erica-project.org
- FREDERICA online database: www.frederica-online.org

The Environment Agency is progressing with assessments for Natura 2000 habitats sites. Assessments have been completed for 177 Natura 2000 sites and for all but one of these sites it has been concluded that there is no adverse effect on the integrity of the Natura site from authorised discharges of radioactive substances. The one exception is the Ribble Estuary and the Environment Agency is considering what action should be taken to ensure that this Natura site is protected from a habitats point of view.

6 References

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