

## NATIONAL DOSE ASSESSMENT WORKING GROUP

### PAPER 13-04: UPDATE ON HABITATS ASSESSMENTS FOR ENGLAND AND WALES

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#### **SUMMARY**

The UK 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. These European Directives were introduced into UK legislation by the Conservation (Natural Habitats) Regulations 1994, as amended by the Conservation (Natural Habitats) (England) Regulations 2000. These Directives established and protect a network of conservation areas across the EU called 'Natura 2000'. Natura 2000 is made up of sites designated as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

Under the Habitats Regulations, the Environment Agency has obligations to review relevant existing, authorisations, permits, consents, licences and permissions (collectively referred to as permits) to ensure that no Environment Agency authorised activity or permission results in an adverse effect, either directly or indirectly, on the integrity of Natura 2000 sites. The Environment Agency is also required to ensure that any new or varied permits do not have an adverse effect on the integrity of the Natura sites.

The Environment Agency has adopted a staged approach to reviewing existing permits:

- Stage 1 – identify the relevant permits.
- Stage 2 – determine which permits have a potential significant effect
- Stage 3 – appropriate assessment for permits with significant effects.
- Stage 4 – revision of permits to ensure no adverse effects.

Dose rates to reference organisms and feature species were calculated for authorised discharges under the Radioactive Substances Act 1993 in the Stage 3 assessment. Dose rates have been calculated for organisms in coastal, freshwater and terrestrial habitat environments. These RSR habitats assessments have considered the combined impact of discharges from multiple authorised releases and have cautiously assumed that discharges occur at the authorisation limits. The calculated total dose rates were compared to a threshold of 40 microgray/h, below which the Environment Agency and Natural England agreed there would be no adverse affect to the integrity of a Natura 2000 site.

The total dose rates to the worst affected organism are less than 40 microgray/h for all but two Natura 2000 sites (Ribble and Alt Estuaries SPA, 520 microgray/h and Drigg Coast SAC, 41 microgray/h). The Natura 2000 site with the next highest dose rate was

Teesmouth and Cleveland Coast SPA (31 microgray/h). Most of the Natura 2000 sites had dose rates less than 20 microgray/h.

The total dose rate to the worst affected organism for the Ribble and Alt Estuaries SPA was 520 microgray/h as a result of discharges from the Springfields Fuels Ltd site. This was significantly in excess of the agreed threshold and so this Natura 2000 site was included in the Stage 4 process (determination of permissions) of the Habitats Regulations implementation. A separate report is available for this determination process which concluded that new authorisation limits for the Springfields Fuels Ltd site (in effect from January 2008) would ensure that the dose rates to reference organisms and feature species will be less than 40 microgray/h.

The total dose rate for the Drigg Coast SAC (41 microgray/h) is just greater than the 40 microgray/h threshold. The assessment methodology was generally cautious, in particular compared to a new assessment methodology resulting from an EC funded project (ERICA assessment tool). The dose rate to the worst affected organism (phytoplankton) for the Drigg Coast SAC is 20 microgray/h using the dose rate per unit concentration data from the ERICA assessment tool. The Drigg Coast SAC was also considered in an ERICA project case-study which concluded that there was no indication of significant impact from ionising radiation on the sand dune biota. This Natura 2000 site will be kept under review.

It is recommended that the assessment methodology is revised to include more realistic data from the ERICA assessment tool. The results using this new data should be reviewed. Refining assessment data for phytoplankton should be considered. The assessments for Natura 2000 sites should be kept under review where the dose rates are significant.

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## 1 Introduction

The UK 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. These European Directives were introduced into UK legislation by the Conservation (Natural Habitats) Regulations 1994, as amended by the Conservation (Natural Habitats) (England) Regulations 2000. The aim of the Habitats Directive is to contribute towards ensuring biodiversity through conserving natural habitats and wild fauna and flora. It provides measures to maintain or restore, at favourable conservation status, natural habitats and species of Community interest.

These Directives established and protect a network of conservation areas across the EU called 'Natura 2000'. Natura 2000 is made up of sites designated as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). SACs can be marine or terrestrial and support rare, endangered or vulnerable natural habitats, plant and animal species. SPAs support significant numbers of wild birds, for example wintering wildfowl, and their habitats. The designation of SAC or SPA shows the value of the site on an international level.

Natural England and the Countryside Council for Wales (CCW) are responsible for reporting the condition of Natura 2000 sites and providing advice on conservation objectives to government. Competent authorities, including the Environment Agency, have duties to protect Natura 2000 sites under the Habitats Regulations.

Under the Habitats Regulations the Environment Agency has obligations to review relevant existing, authorisations, permits, consents, licences and permissions (collectively referred to as permits) to ensure that no Environment Agency authorised activity or permission results in an adverse effect, either directly or indirectly, on the integrity of Natura 2000 sites. The Environment Agency is also required to ensure that any new or varied permits do not have an adverse effect on the integrity of the Natura sites.

The Environment Agency has adopted a staged approach to reviewing existing permits:

- Stage 1 – identify the relevant permits.
- Stage 2 – determine which permits have a potential significant effect
- Stage 3 – appropriate assessment for permits with significant effects.
- Stage 4 – revision of permits to ensure no adverse effects.

The timescales to complete Stages 3 and 4 for high, medium and low priority Natura 2000 sites are as follows:

<b>Site Priority</b>	<b>Complete Stage 3 by:</b>	<b>Complete stage 4 by:</b>
High	March 2004	March 2006
Medium	March 2006	March 2008
Low	March 2008	March 2010

The Environment Agency authorises discharges of radioactive waste to the environment under the Radioactive Substances Act 1993 (RSA93) from a variety of premises, including hospitals, universities, pharmaceutical companies and nuclear sites. These disposals include discharges to air and water.

The Environment Agency has assessed the impact of discharges of authorised radioactive substances to air and water on Natura 2000 sites (Stage 3 assessment) and the results are recorded in this report.

This paper presents the results of the assessments for the low priority sites which were completed for March 2008 and have been sent to Natural England and CCW for consultation [Ref 1]. It also includes a re-assessment of the high and medium priority Natura 2000 sites using current RSA 93 authorisations. These high and medium priority sites were originally assessed in 2004 and 2006.

## 2 Assessment Method

### 2.1 Overview

The Stage 3 assessment methodology involves the calculation of dose rates to reference organisms and feature species from exposure to authorised discharges of radioactive substances at Natura 2000 sites in England and Wales. Dose rate is a measure of harm to the organism from this exposure and is measured in units of microgray/h. The dose rates can be related to effects data (e.g. mortality, morbidity, reproductive effects) [Ref 2].

Reference organisms are defined as:

*“A series of entities that provide a basis for the estimation of radiation dose rate to a range of organisms which 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.”* [Ref 3].

The feature species are those species which are protected at each Natura 2000 site in England and Wales. The reference organisms are used in the assessment to represent prey species for the feature species.

The Stage 3 assessment methodology has been based on Environment Agency Science [Ref 4 and 5] which was developed as part of the Euratom FP5 Project “FASSET” [Ref 6] and the Environment Agency and Natural England have agreed this methodology. It involves the calculation of dose rates to organisms from the total discharges of radionuclides at RSA 93 authorisation limits which may affect a Natura 2000 site multiplied by dose rate per unit release factors.

The Environment Agency and Natural England have also agreed a dose rate threshold of 40 microgray/h, below which it can be concluded that there will be no adverse effect on the integrity of a Natura 2000 site. This has been derived as follows:

- Research from the Euratom FP5 Project “FASSET” [Ref 6] indicated that, in general and from the available data, there appear to be no significant adverse effects in biota exposed at levels of up to 100 microgray/h.
- A review paper from the FASSET Project [Ref 7] indicated that wildlife might receive up to 60 microgray/h, from natural sources in European ecosystems.
- The threshold of 40 microgray/h for authorised discharges of radioactive substances is the difference between these two values.

This threshold of 40 microgray/h is the same as the lower 1992 guideline level for terrestrial animals published by the International Atomic Energy Authority [Ref 8]. The IAEA stated that it is unlikely that there would be any significant effect on populations of terrestrial animals which are chronically exposed at these levels.

## 2.2 RSA 93 Authorisation limits

RSA 93 authorisations for the disposal of radioactive waste to the environment were collated and the authorisation limits for individual radionuclides and radionuclide groups entered into a Microsoft Access database. These were all authorisations in force in September 2007. A total of 700 authorisations and nearly 4000 authorisation limits were included in the high, medium and low priority assessments.

The authorisation limits may be over a time period of a week, month, year, rolling 12 months or more than one of these. The limits have been converted to annual limits and the lowest selected. For example, an annual limit may be lower than 12 lots of monthly limits, in which case the annual limit was selected.

Dose rate per unit release data were not available for the full range of radionuclides or radionuclide groups in the authorisations. Hence, it was necessary to assign some authorisation limits to a surrogate radionuclide or radionuclide category for which there is dose rate per unit release data available (e.g. other alpha, other beta/gamma ( $t_{1/2} < 1$  day)).

In some cases, information has been obtained on the realistic radionuclides which will be discharged in order to use these radionuclides or groups of radionuclides in the assessment. For example, some authorisations have a limit for "other radionuclides", when in reality the registrations for using radioactive substances under the RSA93 only allow the organisation to use beta/gamma emitting radionuclides and not alpha emitting radionuclides. Hence, "other beta/gamma-emitting radionuclides" was assigned to this authorisation limit as this is a more realistic group of radionuclides.

Information on the waste type (i.e. aqueous, gaseous, organic liquid, solid) and release route type (e.g. release to air, sewage treatment works, river, estuary etc) were obtained. Also, for releases which would ultimately discharge into a water body, information on the release point for that discharge was obtained. In many cases this was the relevant sewage treatment works and its associated outfall. Grid reference data for the site with the RSA 93 authorisation were recorded as this was used to determine the distance to Natura 2000 sites for the terrestrial assessment.

## 2.3 Dose rate per unit release factors

Dose rate per unit release factors for marine, freshwater and terrestrial environments have been calculated for different radionuclides and organisms from dose rate per unit concentration data in air, soil and water combined with simple dispersion modelling factors (concentration per unit release).

The dose rate per unit concentration factors have been derived for reference organisms and feature species based on Environment Agency Science [Ref 5]. These were weighted to take account of the likely effects of different radiation types. Hence all calculated dose rates were weighted dose rates.

The dose rate per unit release factors can be modified by site specific dispersion parameters. These are the water exchange rate for releases to coastal waters, the river flow for releases to freshwaters and a scaling factor for the effective release height for releases to air. These were based on the Environment Agency's initial radiological assessment methodology [Ref 9].

A radioactive substance habitats assessment spreadsheet tool was developed to assess the dose rates to terrestrial, freshwater and coastal organisms. The Environment Agency agreed with English Nature (now Natural England) that the spreadsheet tool would be used for Stage 3 radioactive substance habitats assessments. The spreadsheet tool

includes the dose rate per unit release data and allows authorisation limits and site specific dispersion parameters to be entered.

## 2.4 Natura 2000 sites

The Natura 2000 sites in England and Wales (as of September 2007) are shown in Figure 1. These are comprised of Special Areas of Conservation and Special Protection Areas. There are currently a total of 429 Special Protection Areas and Special Areas of Conservation in England and Wales.

## 2.5 Calculation of coastal, freshwater and terrestrial dose rates

The calculation of dose rates to organisms from releases to coastal waters, freshwater and to air involved the selection of RSA authorisations for which their releases could lead to an impact on coastal, freshwater and terrestrial Natura 2000 sites. For coastal and freshwater Natura 2000 sites, these were release to water which could ultimately flow through the Natura 2000 site. For terrestrial sites, these were releases to air which were within 10 km of the Natura 2000 site.

For each Natura 2000 site, the total releases of radionuclides at RSA 93 authorisation limits which could affect the Natura 2000 site were summed and multiplied by dose rate per unit release values to calculate the dose rates. The radioactive substance habitats assessment spreadsheet tool was used to perform these calculations:

- ***Dose rates to coastal Natura 2000 sites*** from releases which ultimately flow to coastal waters (e.g. via sewage treatment works, pipeline to sea). For releases to coastal waters, dose rates were assessed for releases in the immediate vicinity of the Natura 2000 site (local compartment) and from releases which are further away but could be transported to the Natura site as a result of marine dispersion (regional compartment).
- ***Dose rates to freshwater Natura 2000 sites*** from releases to freshwater (e.g. via sewage treatment works, outfall into river).
- ***Dose rates to terrestrial Natura 2000 sites*** from releases to air.

The radioactive substance habitat assessment tool used for the Stage 3 assessments calculates the dose rate to all reference organisms and feature species for releases to coastal waters, freshwater and air. The spreadsheet identifies the dose rate to the worst affected organism(s) for each of these release routes. It is these dose rates to the worst affected organism which are recorded in this paper.

The freshwater dose rate has also been used to represent the dose rate to the worst affected organism from flooding of terrestrial sites as this has been shown to be a worst case scenario [Ref 1].

## 2.6 Calculation of total dose rates

The total dose rate for the worst affected organism has been calculated from:

- a. sum of the terrestrial dose rate and maximum water dose rate, where;
- b. the maximum water dose rate is the maximum of the freshwater dose rate and the coastal water dose rate, and where;
- c. the coastal water dose rate is the sum of the dose rate from a local and a regional compartment.

This was a cautious calculation as the worst affected organism for the terrestrial and water aspects of a Natura 2000 site will not necessarily be the same in each case.

## 2.7 Summary of key assumptions

The key assumptions in the Stage 3 radioactive substances assessment are as follows:

- **Discharges at authorisation limits** – The assessments have been made on the basis that discharges are at RSA 93 authorisation limits. Actual discharges will be lower than the discharge limits, often less than 50% of the discharge limit.
- **Dose rate per unit concentration data** – The dose rate per unit concentration data has been source from an Environment Agency Science project [Ref 5] which was based on the EC FASSET project. In the intervening period, there has been a successor project, EC ERICA [Ref 10], which has extended the work of FASSET. The ERICA project has delivered an assessment tool [Ref 11] which is now 'good practice' for radioactive substance habitat assessments. For most reference organisms and radionuclides, the data from the Environment Agency Science project [Ref 5] is cautious compared to the ERICA data. The main exception is for phytoplankton.
- **Generic modelling approach** – Dose rate per unit release data have been derived using generic modelling approaches with cautious assumptions. Monitoring data have not been used in the assessments.
- **Surrogate radionuclides** – Dose rate per unit release data are only available for a limited range of radionuclides. Where there is no data for radionuclides with authorisation limits, a surrogate (generally cautious) radionuclide has been selected.
- **Realistic radionuclides** – Where there is information on the most likely radionuclide or group of radionuclides which can be discharged, this more realistic radionuclide (or group) has been used for the assessment.
- **Realistic dispersion data** – Where appropriate, more realistic site specific data have been included in the assessments, including effective release height of releases to air, river flow rate for releases to river and exchange rate for releases to estuaries/coastal areas.
- **Historical discharges not included** – The assessment is based on modelling of discharges at current authorisation limits. The assessment does not include concentrations of radionuclides which may have been discharged when historical limits were significantly higher. This will only be an issue for radionuclides with longer radioactive half-lives and which concentrate in the local environment. The Sellafield site in Cumbria is the one site in England and Wales which had significantly higher historical discharges of longer-lived radionuclides compared to the current authorisation limits. The nearest Natura 2000 site to Sellafield is the Drigg coast SAC.

The dose rates to reference organisms at this location have been calculated using the ERICA tool [Ref 11] from monitoring data to assess historical discharges from Sellafield and the contribution from natural radioactivity. This shows that for all reference organisms, except phytoplankton, the total dose rates from natural radioactivity and historical discharges were less than 4 microgray/h [Ref 1]. These total dose rates are much less than the 60 microgray/h which has been assumed for natural background (see Section 2.1). In the case of phytoplankton, the total dose rate was 170 microgray/h with contributions of 81 microgray/h from historical discharges and 89 microgray/h from natural radioactivity. In this case the dose rate to phytoplankton from natural radioactivity is higher than the 60 microgray/h assumed for background.

The ERICA assessment tool is probably cautious for phytoplankton. Also, the dose rate threshold above which there is likely to be an adverse affect on the integrity of populations of phytoplankton is much higher than the 100 microgray/h threshold discussed in Section 2.1. In the literature, effects that might lead to a reduction in the phytoplankton population have only been observed under laboratory conditions

at dose rates in excess of 10 000 microgray/h [Ref 2]. Hence, dose rates from historical discharges are unlikely to be a problem with the possible exception of phytoplankton. A review of the ERICA methodology for phytoplankton along with some targeted monitoring of phytoplankton would help to reduce the uncertainty in the assessment of dose rates for this reference organism.

- **Flooding of terrestrial sites** – One of the potential routes for contamination of a Natura 2000 site with terrestrial feature species is by flooding of that site with river water containing discharged radionuclides. It has been shown that it is cautious to use the freshwater assessment methodology for assessing the dose rate to the worst affected organism as a result of flooding of terrestrial sites [Ref 1].
- **Total dose rate** - The total dose rate from releases to air and releases to water to the worst affected organism has been calculated from the terrestrial dose rate and water environment dose rate for the worst affected organism. This is a cautious assumption as the worst affected organism may not be the same for the terrestrial and water environments.

### 3 Results

Of the 429 Natura 2000 sites in England and Wales, four have not been assessed as the Natura site status has not been confirmed. 156 Natura 2000 sites have no radiological authorisations which affect them. For the remaining Natura 2000 sites, the total dose rates ranged from  $7.7 \times 10^{-8}$  to 520 microgray/h. There were two Natura 2000 sites with dose rates greater than the agreed threshold of 40 microgray/h:

- Ribble and Alt Estuaries SPA – 520 microgray/h.
- Drigg Coast SAC – 41 microgray/h.

The frequency distribution of dose rates is shown in Figure 2. Most of the Natura 2000 sites had dose rates less than 20 microgray/h. Sixteen Natura 2000 sites have dose rates greater than 20 microgray/h and these are listed in Table 1. The locations of sites with dose rates less than 20 microgray/h (green), 20 – 40 microgray/h (amber) and >40 microgray/h (red) are shown in Figure 3.

The two Natura 2000 sites with dose rates greater than 40 microgray/h along with the Teesmouth and Cleveland Coast SPA which had a dose rate of 31 microgray/h are discussed in more detail below.

#### 3.1 Ribble and Alt Estuaries SPA

The dose rates to reference organisms for the marine/coastal, freshwater and terrestrial stage 3 assessments for the Ribble and Alt Estuaries SPA are shown in Figures 4, 5 and 6. For the marine/coastal assessment, the reference organisms with the highest dose rates were the seabird (500 microgray/h), seal and whale (520 microgray/h). For the freshwater assessment the reference organisms with the highest dose rate were amphibian (260 microgray/h) and duck (130 microgray/h). The reference organism with the highest dose rate for the terrestrial assessment was fungi (3.6 microgray/h).

The radionuclides which provide the greatest contribution to the dose rates to the seabird and seal for the coastal/marine assessment are thorium-234 and the group of 'other alpha-emitting radionuclides' (Figure 7). These radionuclides are also dominant contributors to the amphibian and duck total dose rates in the freshwater assessment (Figure 8). The dose rate for the terrestrial assessments arises from uranium isotopes. The source of the discharges of these radionuclides is the Springfields Fuels Ltd site.

The total dose rate for the Ribble and Alt Estuaries SPA is significantly in excess of the agreed threshold of 40 microgray/h. This Natura 2000 site went forward into the Stage 4 permit determination process and this is the subject of a separate report [Ref 12].

In summary, Springfields Fuels Ltd had new lower authorisation limits from January 2008 for operational reasons. The dose rates to reference organisms and feature species were re-calculated using the ERCIA assessment tool and monitoring data for sediment and biota which equated to discharges at these new limits. The dose rates to reference organisms for the marine and freshwater assessment are shown in Figures 9 and 10. The calculated dose rates were all less than 40 microgray/h, due to the lower limits and use of more realistic data in the ERICA assessment tool. An uncertainty analysis showed that under certain circumstances, dose rates to phytoplankton could exceed 40 microgray/h and some monitoring of phytoplankton will be undertaken if this is practicable.

### **3.2 Drigg Coast SAC**

The dose rates to reference organisms for the marine/coastal and terrestrial assessments for the Drigg Coast SAC are shown in Figures 11 and 12. For the marine/coastal assessment, the reference organisms with the highest dose rates were the seabird (41 microgray/h), seal and whale (41 microgray/h). The reference organisms with the highest dose rates for the terrestrial assessment were carnivorous mammal (0.13 microgray/h) and fungi (0.12 microgray/h).

The radionuclides which provide the greatest contribution to the dose rates to the seabird and seal for the coastal/marine assessment are plutonium-alpha emitting isotopes, americium-241 and the group of 'other alpha-emitting radionuclides' (Figure 13). Krypton-85, the group of 'other alpha-emitting radionuclides' and the group of 'other beta/gamma emitting radionuclides with half-lives greater than 10 days' were the radionuclides which dominated the total dose rates to the carnivorous mammal and fungi in the terrestrial assessment (Figure 14). The source of the discharges of these radionuclides is the Sellafield site.

The total dose rate for the Drigg coast SAC is just above the agreed threshold of 40 microgray/h. The assessment methodology used is generally cautious compared to the new ERICA assessment tool. The dose rate to the worst affected organism (phytoplankton) is 20 microgray/h using the dose rate per unit concentration data from the ERICA assessment tool. The Drigg Coast SAC was also considered in an ERICA project case-study which concluded that there was no indication of significant impact from ionising radiation on the sand dune biota [Ref 13]. A final decision has not yet been taken whether the Drigg Coast SAC will go into Stage 4, but this site will be kept under review.

### **3.3 Teesmouth and Cleveland Coast SPA**

The dose rates to reference organisms for the marine/coastal and terrestrial assessments for the Teesmouth and Cleveland Coast SPA are shown in Figures 15 and 16. For the marine/coastal assessment, the reference organisms and feature species with the highest dose rates were Bittern (12 microgray/h), seabird (9.6 microgray/h) and seal (6.2 microgray/h). The reference organisms with the highest dose rates for the terrestrial assessment were carnivorous mammal (19 microgray/h) and reptile (16 microgray/h).

The radionuclides which provide the greatest contribution to the dose rates to the seabird and seal for the coastal/marine assessment are sulphur-35, caesium-137 and the group of 'other beta/gamma emitting radionuclides with half-lives greater than 10 days' (Figure 17). Other beta/gamma emitting radionuclides with half-lives greater than 10 days were the radionuclides which dominated the total dose rates to the carnivorous mammal and reptile in the terrestrial assessment (Figure 18). The source of the discharges of these radionuclides is a combination of the Hartlepool power station and agrochemical industry, in particular Blychem, which produce radio-labelled tracers.

## 4 Conclusions

Dose rates to wildlife arising from discharges to the environment from authorisations granted by the Environment Agency under RSA 93 have been assessed for Natura 2000 sites in England and Wales. Dose rates have been calculated for organisms in coastal, freshwater and terrestrial habitat environments. These RSR habitats assessments have considered the combined impact of discharges from multiple authorised releases and have cautiously assumed that discharges occur at the authorisation limits.

The total dose rates to the worst affected organism are less than the agreed threshold of 40 microgray/h for all but two Natura 2000 sites (Ribble and Alt Estuaries SPA, 520 microgray/h and Drigg Coast SAC, 41 microgray/h). This threshold represents the level below which it is accepted that there will be no adverse effect on the integrity of a Natura 2000 site. The Natura 2000 site with the next highest dose rate was Teesmouth and Cleveland Coast SPA (31 microgray/h). Most of the Natura 2000 sites had dose rates less than 20 microgray/h.

The total dose rate from the Stage 3 assessment to the worst affected organism for the Ribble and Alt Estuaries SPA was 520 microgray/h. This was significantly in excess of the agreed threshold and so this Natura 2000 site was included in the Stage 4 process (determination of permissions) of the Habitats Regulations implementation. A separate report is available for this determination process which concluded that new authorisation limits for the Springfields site (which came into effect from January 2008) would ensure that the dose rates to reference organisms and feature species will be less than 40 microgray/h.

The total dose rate for the Drigg SAC site is just greater than the 40 microgray/h threshold. However, the assessment methodology is generally cautious, in particular when compared with the new ERICA assessment tool. The dose rate to the worst affected organism (phytoplankton) is 20 microgray/h using the dose rate per unit concentration data from the ERICA assessment tool. The Drigg Coast SAC was also considered in an ERICA project case-study which concluded that there was no indication of significant impact from ionising radiation on the sand dune biota. This Natura 2000 site will be kept under review.

## 5 Recommendations

Recommendations arising from this assessment process are:

- Revise the assessment methodology to include more realistic data from the ERICA assessment tool. The results using this new data should be reviewed.
- Review ERICA assessment methodology for phytoplankton, using monitoring data if practicable.
- Keep assessments for Natura 2000 sites under review where the dose rates are significant. This will need to ensure that the effect of new or varied authorisations is considered.

## 6 References

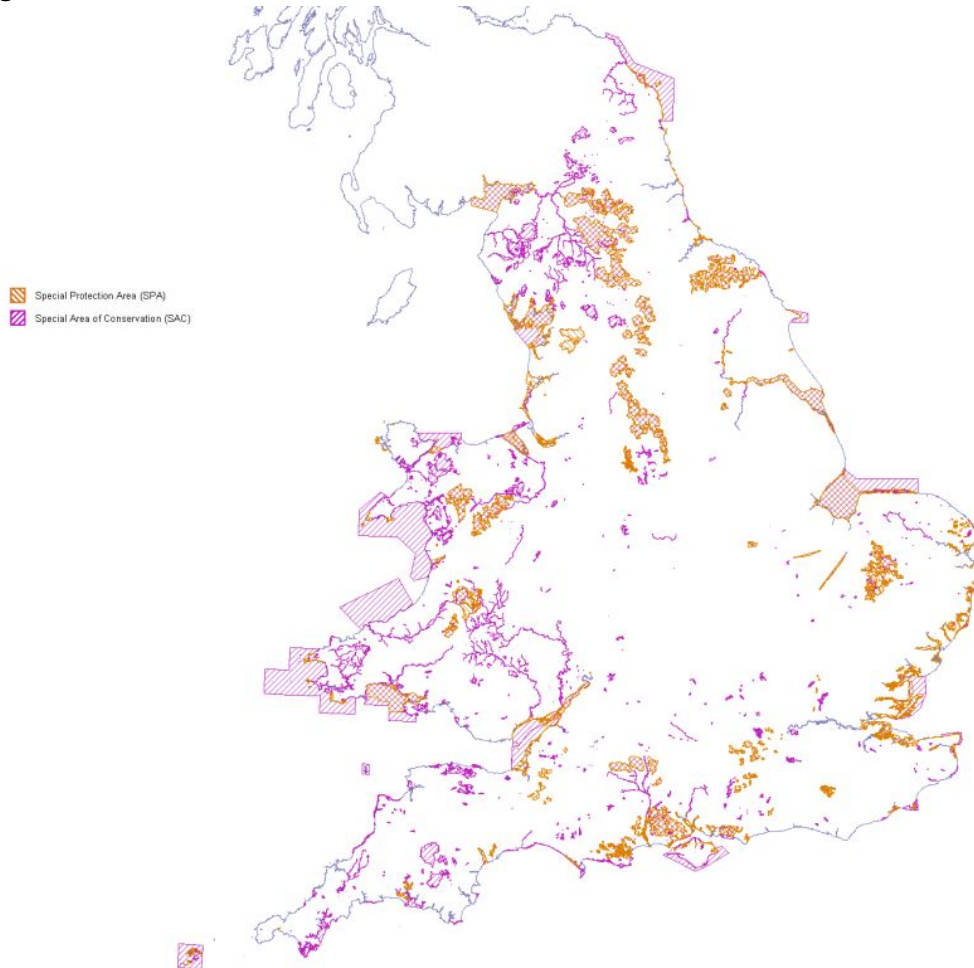
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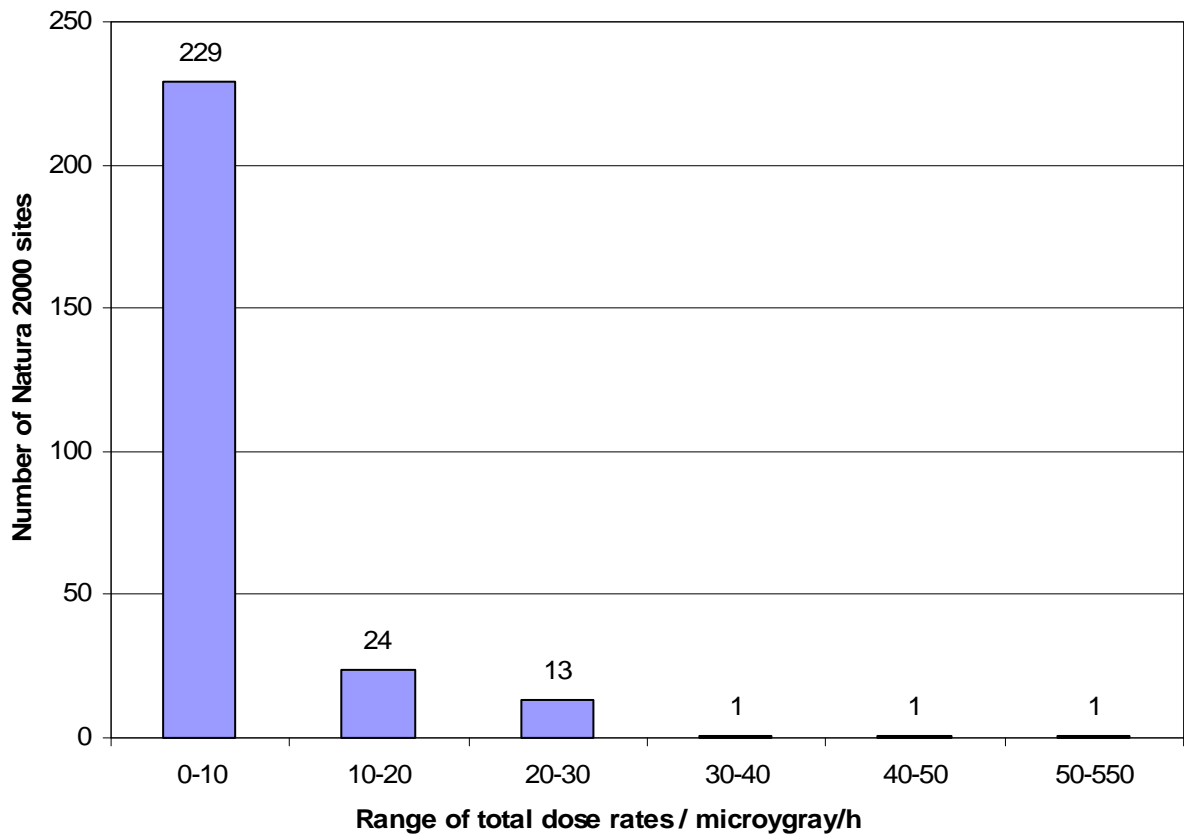
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Table 1 Natura 2000 sites with total dose rates greater than 20 microgray/h

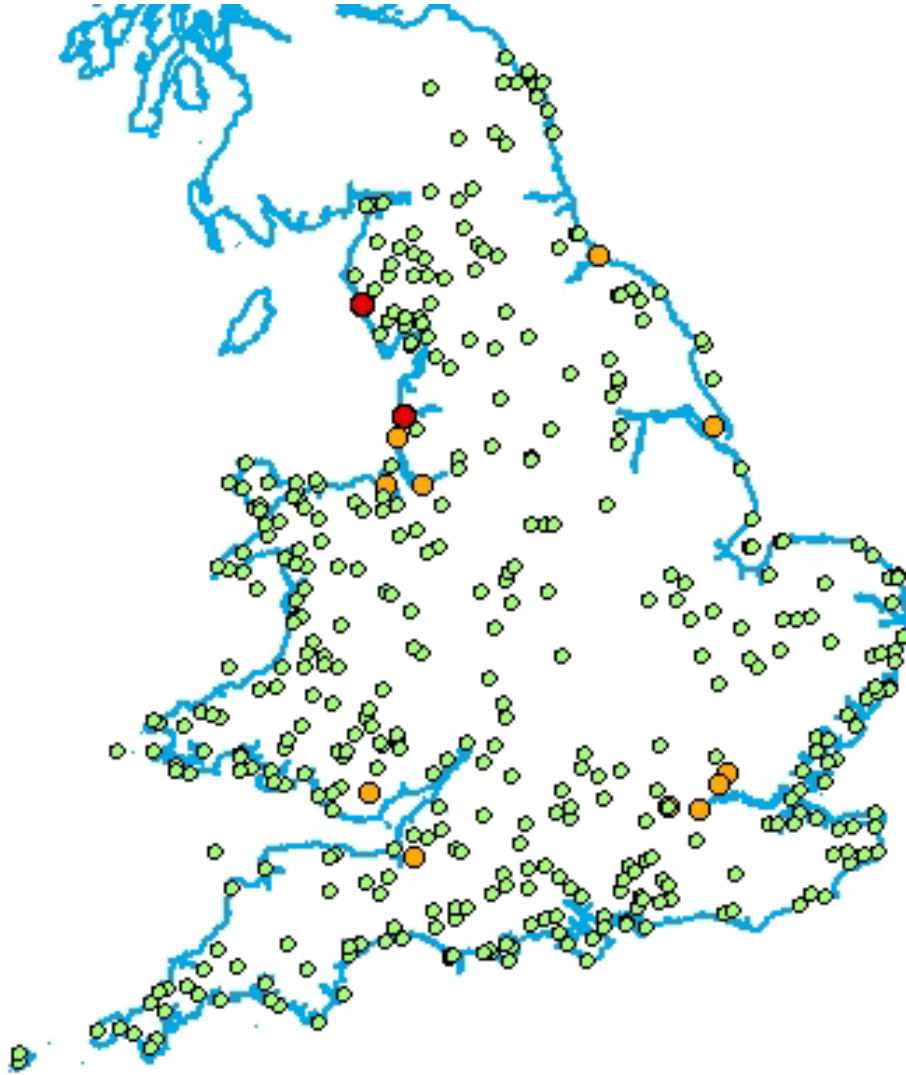
EA Site Code	Priority	Site name	Total dose rate (microgray/h)	Coastal dose rate - Local compartment (microgray/h)	Coastal dose rate - Regional compartment (microgray/h)	Total coastal rate (microgray/h)	Freshwater dose rate (microgray/h)	Maximum water dose rate (microgray/h)	Terrestrial dose rate (microgray/h)
NE18	Medium	Humber Estuary	<b>2.5E+01</b>	2.3E+01	5.4E-02	2.3E+01	2.1E+01	2.3E+01	1.7E+00
NE19	Medium	Humber Flats, Marshes and Coast SPA (Phase 1) UK9006111	<b>2.5E+01</b>	2.3E+01	5.4E-02	2.3E+01	2.1E+01	2.3E+01	1.7E+00
NE20	Medium	Humber Flats, Marshes and Coast (Phase I and II) UK9006112 (Phase 2 only)	<b>2.5E+01</b>	2.3E+01	5.4E-02	2.3E+01	2.1E+01	2.3E+01	1.7E+00
NE44	High	Teesmouth and Cleveland Coast	<b>3.1E+01</b>	1.2E+01	5.9E-02	1.2E+01	0.0E+00	1.2E+01	1.9E+01
NW08	Low	Drigg Coast	<b>4.1E+01</b>	4.1E+01	1.5E-04	4.1E+01	0.0E+00	4.1E+01	1.3E-01
NW18	Medium	Mersey Estuary	<b>2.4E+01</b>	7.8E+00	1.4E+01	2.2E+01	0.0E+00	2.2E+01	2.6E+00
NW25	Medium	Ribble/Alt Estuaries	<b>5.2E+02</b>	5.1E+02	1.6E+00	5.1E+02	2.6E+02	5.1E+02	3.6E+00
NW33	Medium	Sefton Coast	<b>2.5E+01</b>	7.7E+00	1.4E+01	2.2E+01	0.0E+00	2.2E+01	3.6E+00
SW64	Low	Somerset Levels and Moors	<b>2.2E+01</b>	0.0E+00	0.0E+00	0.0E+00	1.6E+01	1.6E+01	5.6E+00
T06	Medium	Epping Forest	<b>2.5E+01</b>	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.5E+01
T11	Medium	Lee Valley	<b>2.9E+01</b>	0.0E+00	0.0E+00	0.0E+00	3.6E+00	3.6E+00	2.5E+01
T19	Low	South West London Waterbodies	<b>2.2E+01</b>	0.0E+00	0.0E+00	0.0E+00	2.1E+01	2.1E+01	1.1E+00
T24	Medium	Wimbledon Common	<b>2.5E+01</b>	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.5E+01
W019	Low	Cardiff Beech Woods	<b>2.1E+01</b>	0.0E+00	0.0E+00	0.0E+00	6.3E+00	6.3E+00	1.5E+01
W046	Medium	Dee Estuary - SPA	<b>2.2E+01</b>	5.2E+00	1.4E+01	1.9E+01	4.3E+00	1.9E+01	2.6E+00
W047	Medium	Dee Estuary - pSAC	<b>2.2E+01</b>	5.2E+00	1.4E+01	1.9E+01	4.3E+00	1.9E+01	2.6E+00

**Figure 1 Natura 2000 sites in England and Wales**





**Figure 2 Summary of total dose rate frequency distributions for Natura 2000 sites**



**Figure 3 Natura 2000 sites in England and Wales**

Key - dose rates less than 20 microgray/h (green), 20 – 40 microgray/h (amber) and >40 microgray/h (red)

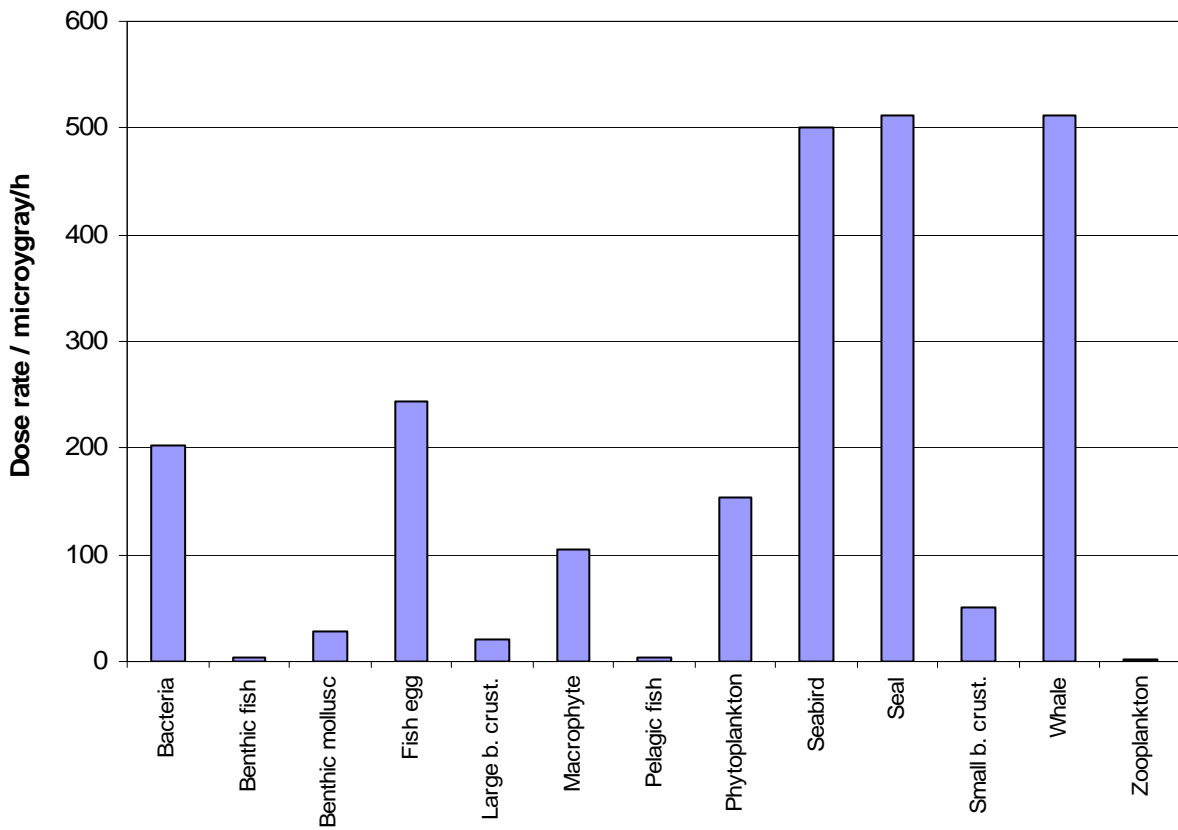


Figure 4 NW25 Ribble/Alt Estuaries SPA – Marine assessment – Total dose rates to reference organisms

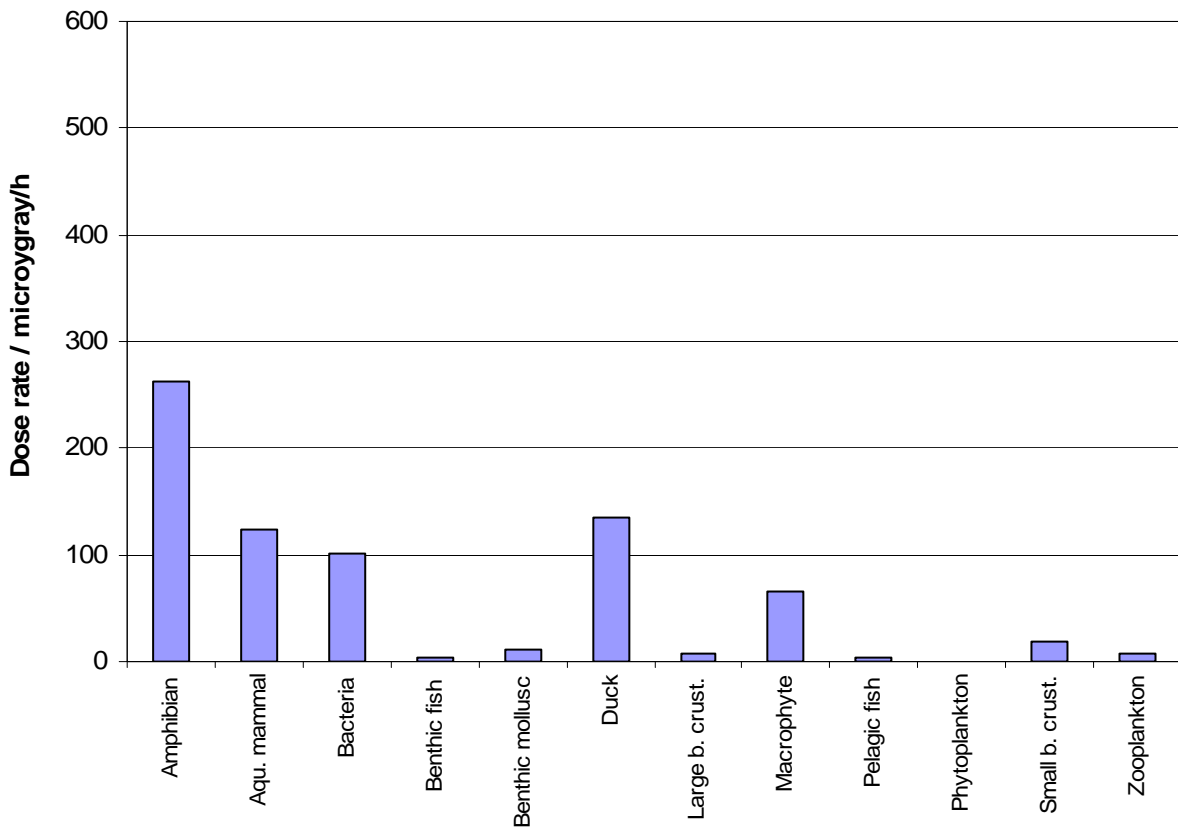


Figure 5 NW25 Ribble/Alt Estuaries SPA – Freshwater assessment – Total dose rates to reference organisms

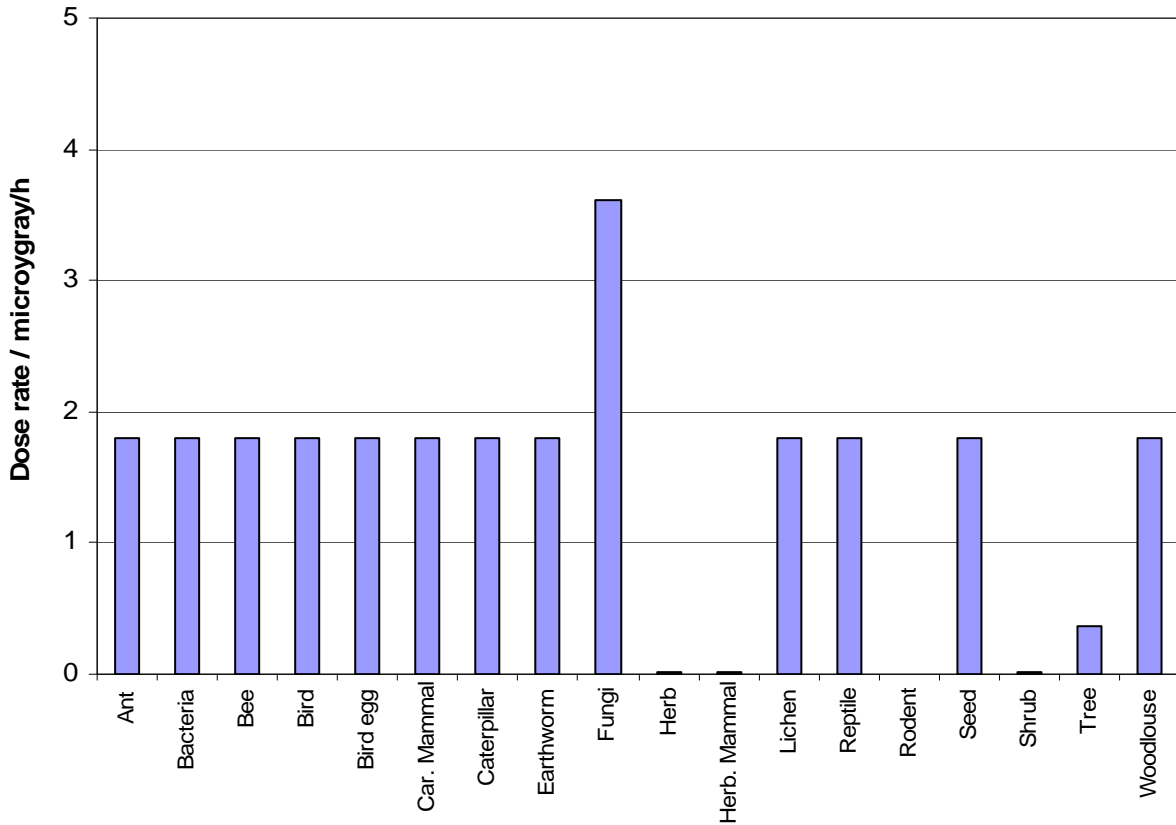


Figure 6 NW25 Ribble/Alt Estuaries SPA –Terrestrial assessment – Total dose rates to reference organisms

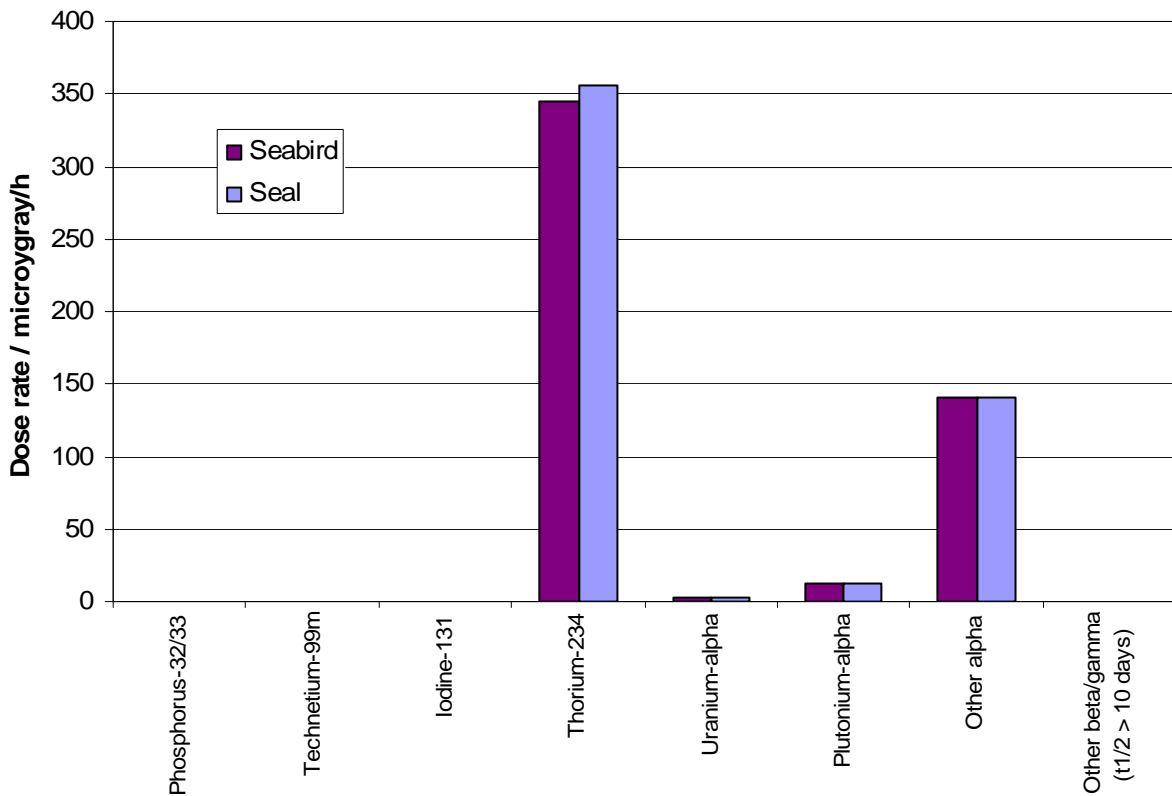


Figure 7 NW25 Ribble/Alt Estuaries SPA – Marine assessment – Radionuclide contribution to dose rates

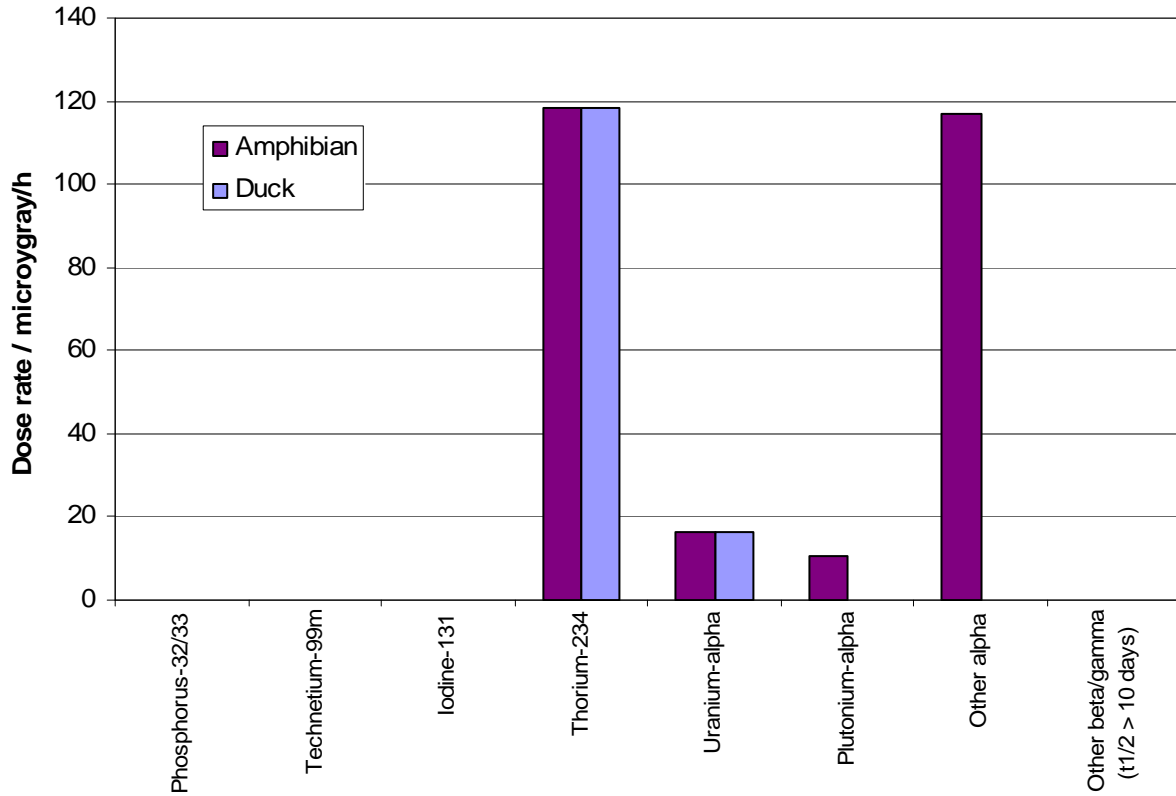


Figure 8 NW25 Ribble/Alt Estuaries SPA – Freshwater assessment – Radionuclide contribution to dose rates

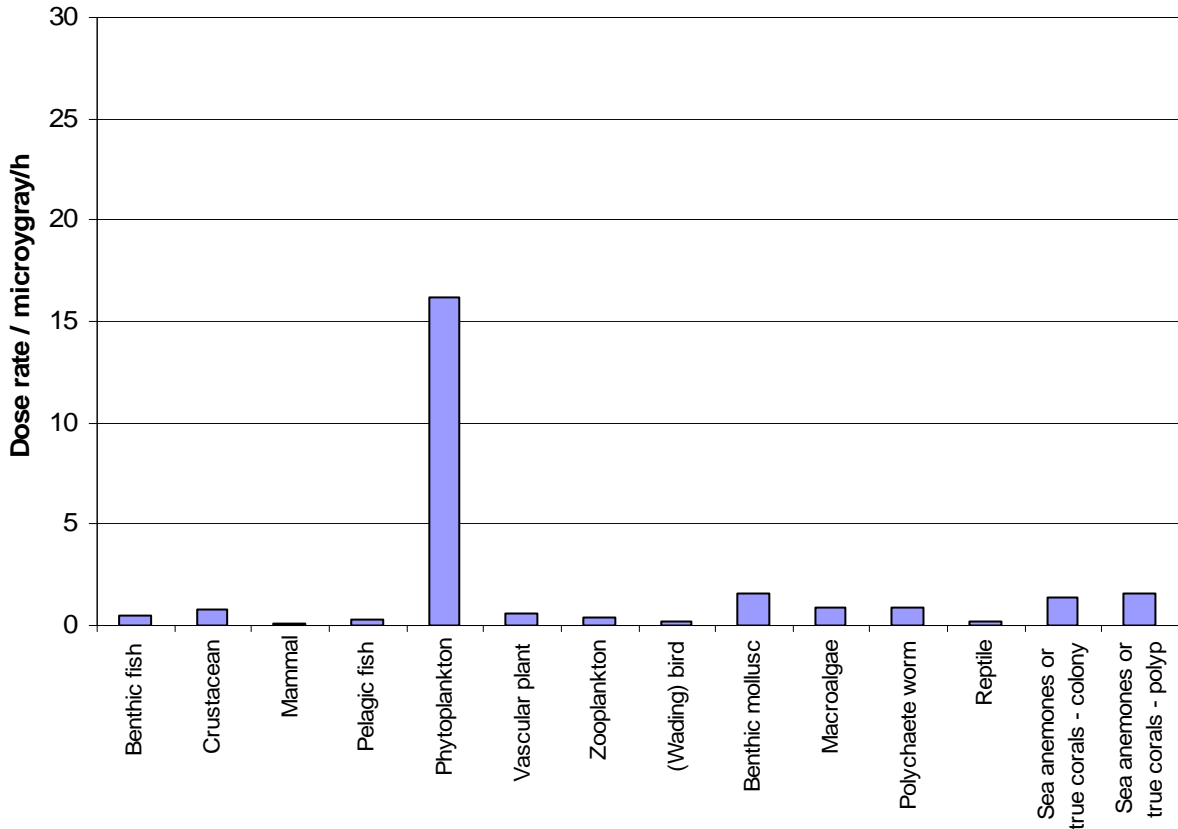


Figure 9 NW25 Ribble/Alt Estuaries SPA – Springfields Jan 2008 limits – ERICA marine assessment – Total dose rates to reference organisms

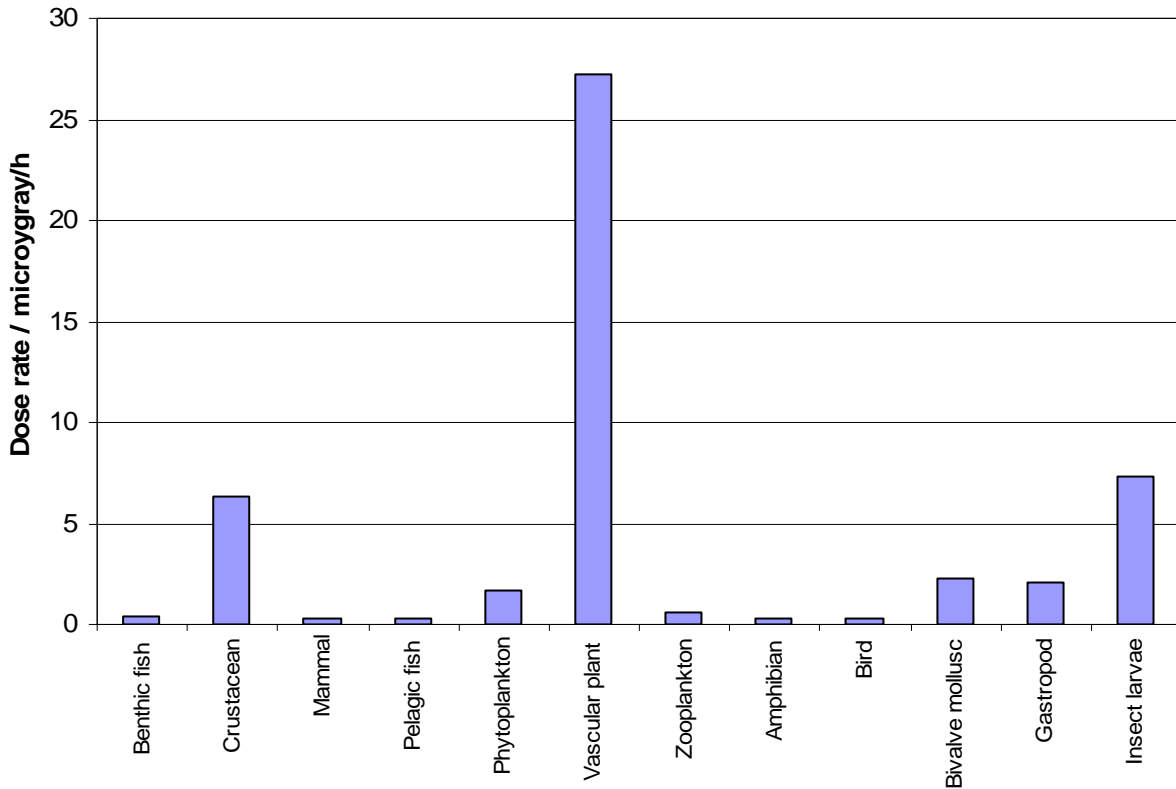


Figure 10 NW25 Ribble/Alt Estuaries SPA – Springfields Jan 2008 limits – ERICA freshwater assessment – Total dose rates to reference organisms

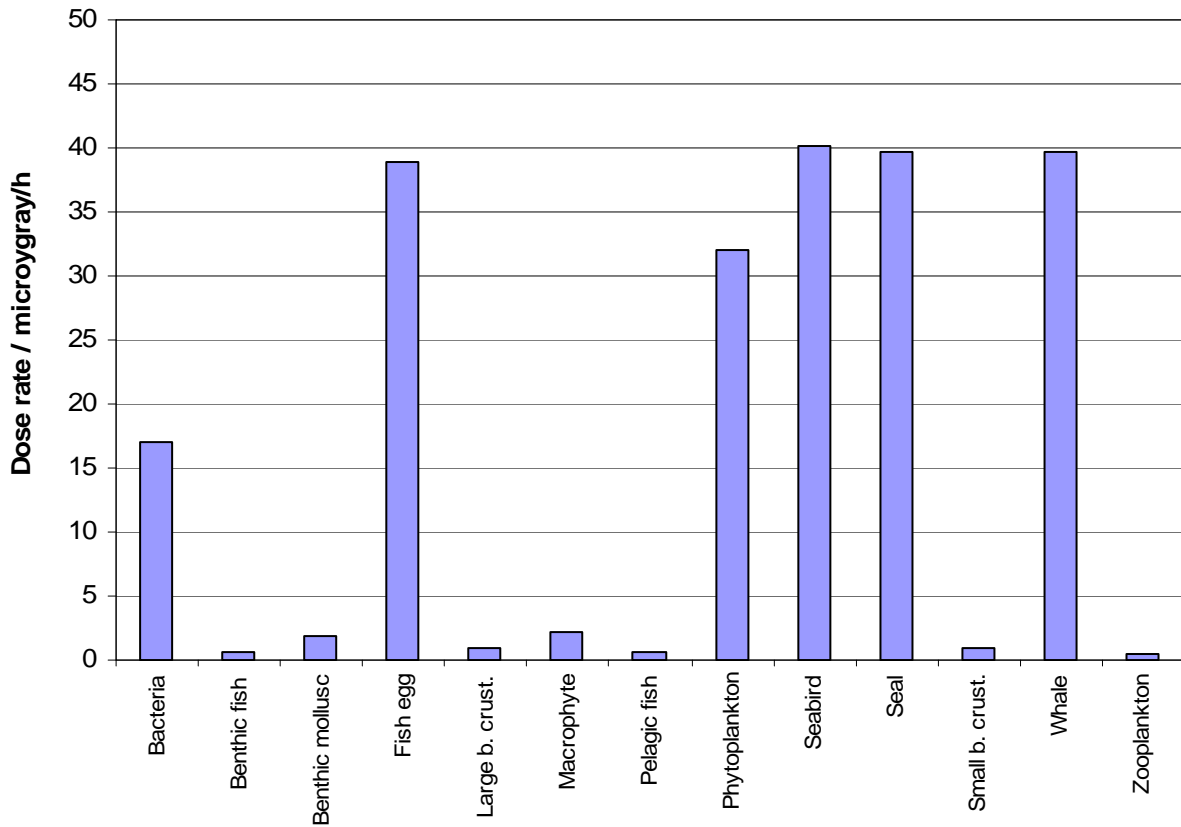


Figure 11 NW08 Drigg Coast SAC – Marine assessment – Total dose rates to reference organisms

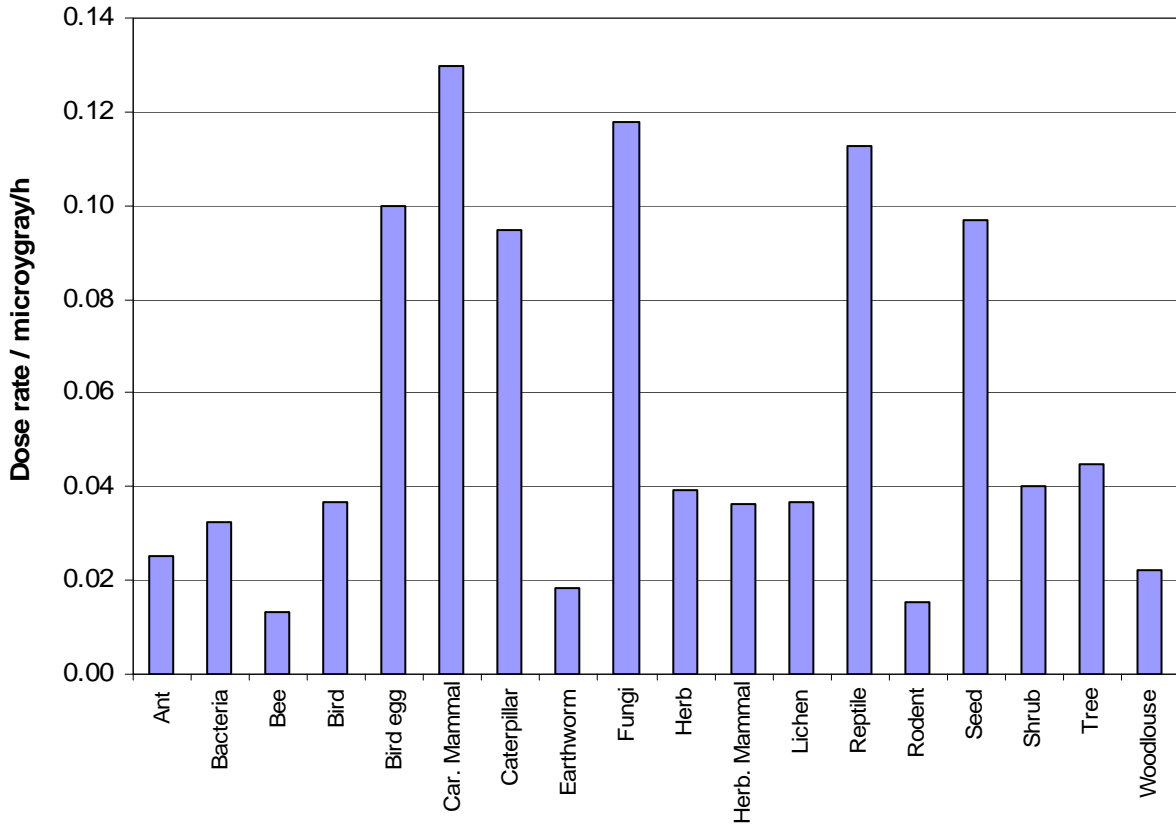


Figure 12 NW08 Drigg Coast SAC – Terrestrial assessment – Total dose rates to reference organisms

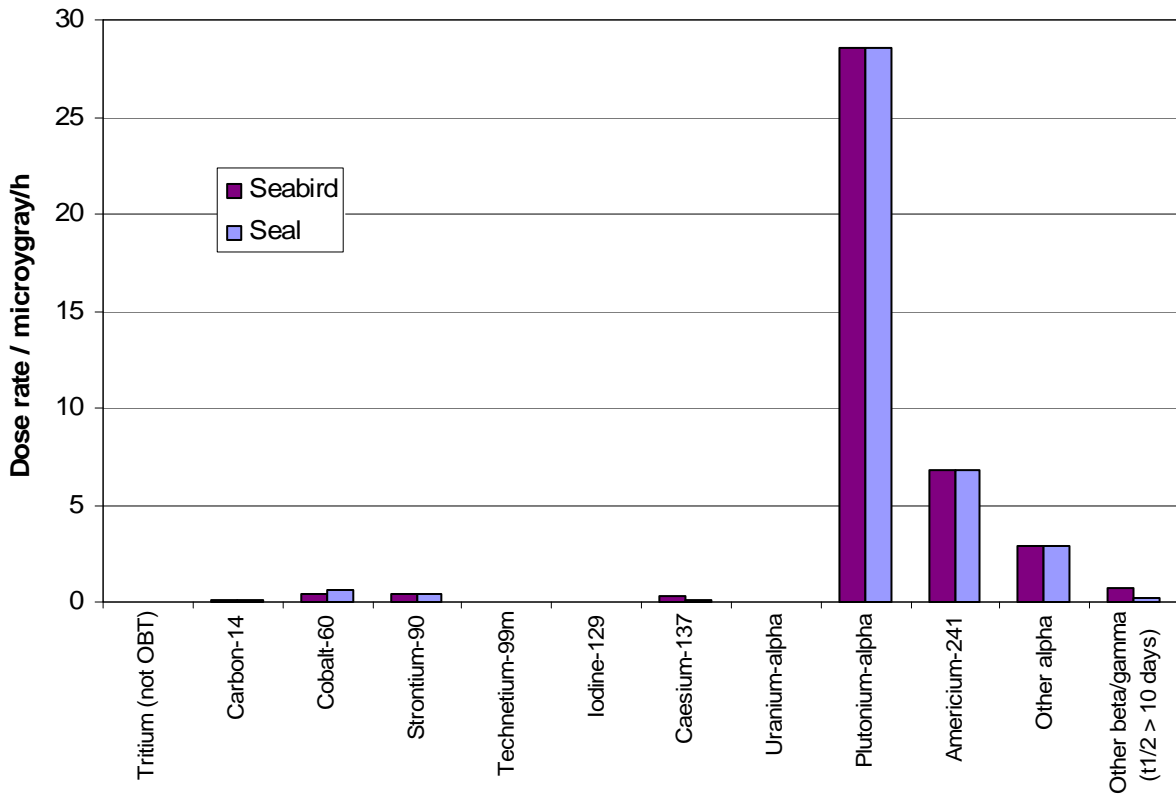


Figure 13 NW08 Drigg Coast SAC – Marine assessment – Radionuclide contribution to dose rates

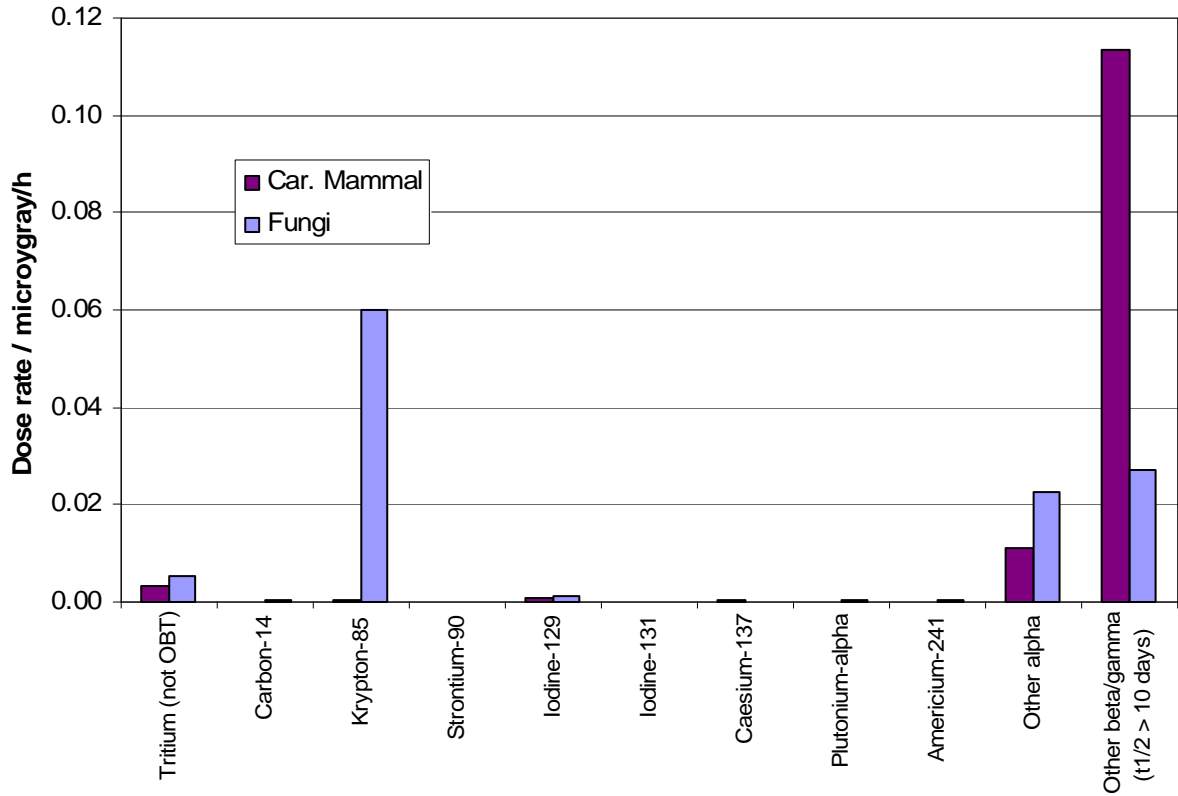


Figure 14 NW08 Drigg Coast SAC – Terrestrial assessment – Radionuclide contribution to dose rates

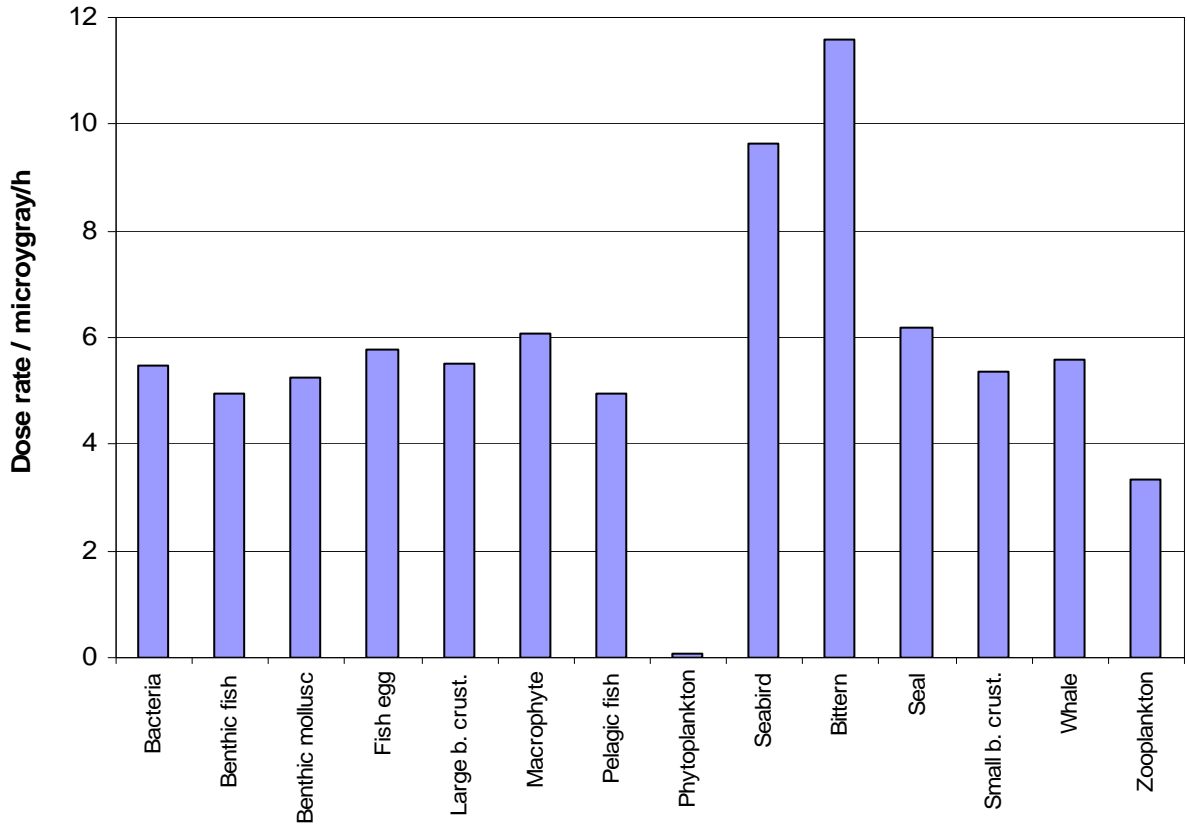


Figure 15 NE44 Teesmouth and Cleveland Coast SPA – Marine assessment – Total dose rates to reference organisms

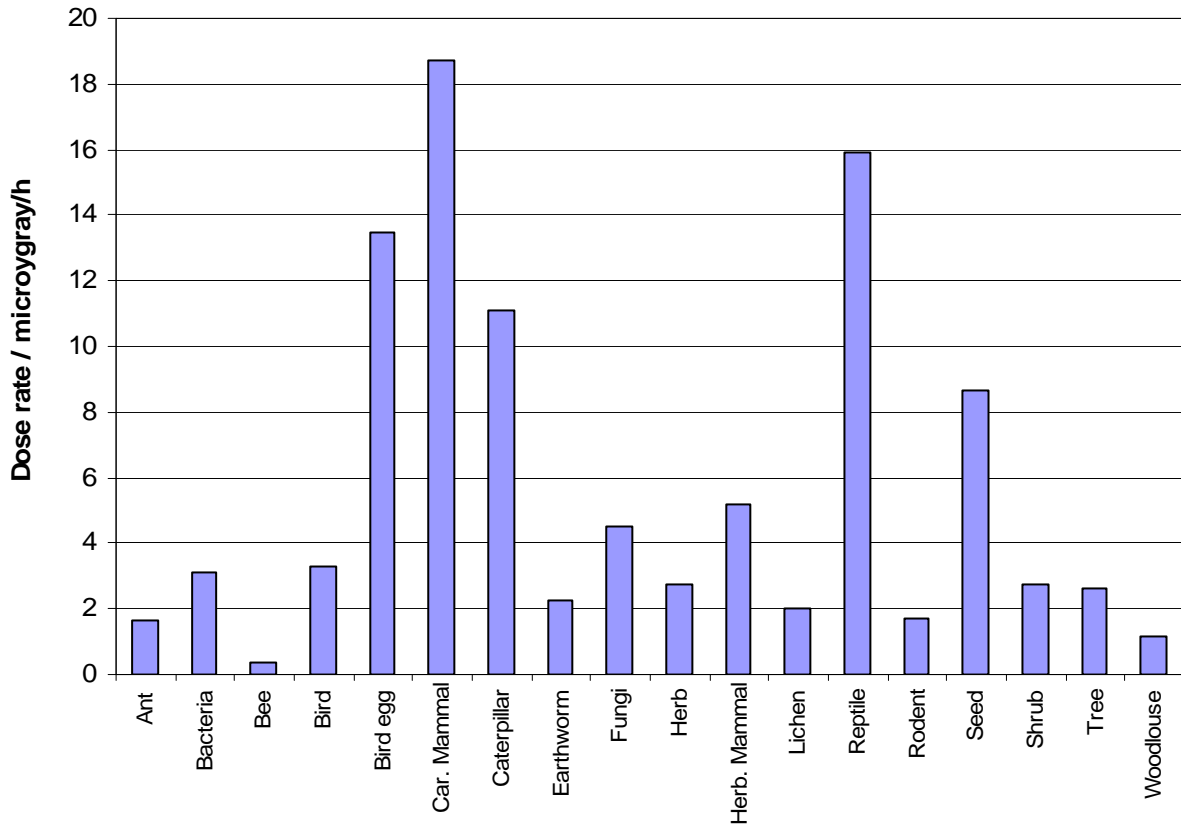


Figure 16 NE44 Teesmouth and Cleveland Coast SPA – Terrestrial assessment – Total dose rates to reference organisms

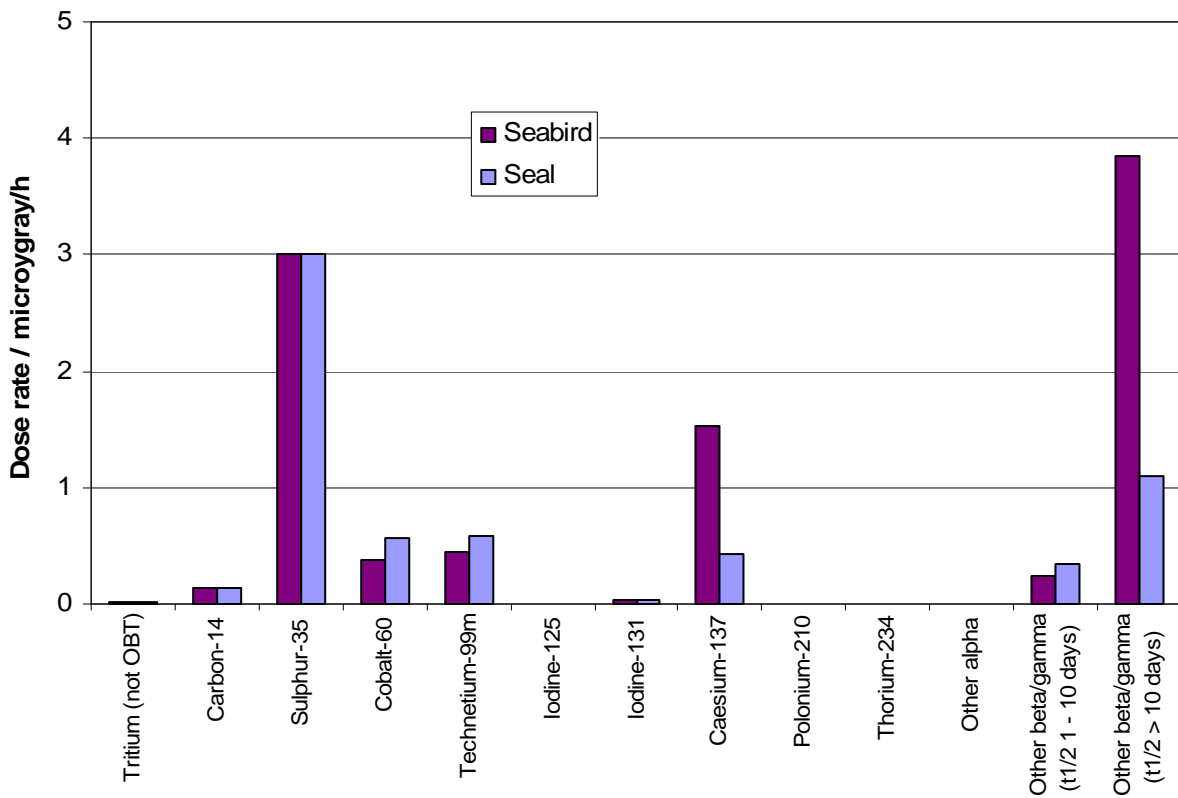


Figure 17 NE44 Teesmouth and Cleveland Coast SPA – Marine assessment – Radionuclide contribution to dose rates

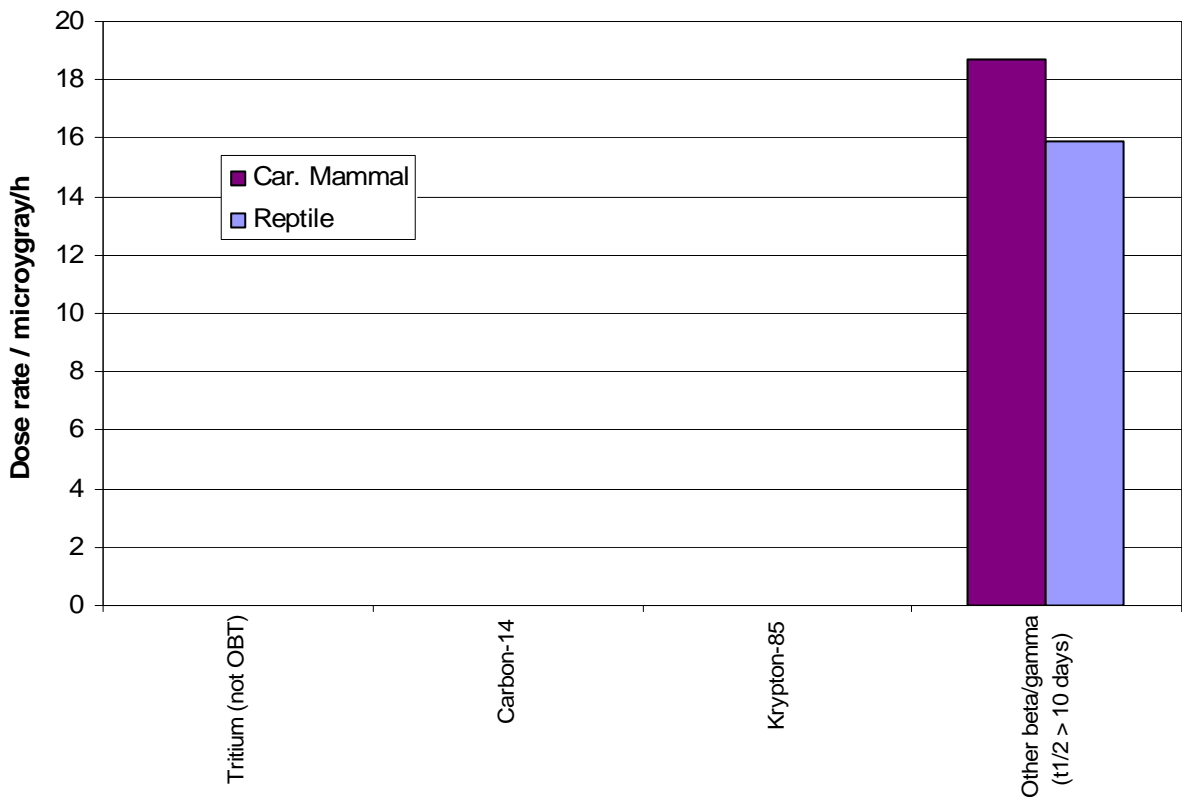


Figure 18 NE44 Teesmouth and Cleveland Coast SPA – Terrestrial assessment – Radionuclide contribution to dose rates