Environment Agency

using science to create a better place

Sampling at Drigg sand dunes

Science Report: SC070019

NATURAL ENGLAND

SCHO0308BNVQ-E-P

The Environment Agency is the leading public body protecting and improving the environment in England and Wales.

It's our job to make sure that air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world.

Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

This report is the result of work jointly funded by the Environment Agency's Science Programme and Natural England.

Published by:
Environment Agency, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, BS32 4UD
Tel: 01454 624400 Fax: 01454 624409
www.environment-agency.gov.uk

ISBN: 978-1-84432-872-7

Author(s):
Beresford, N.A., Wood, M.D., Bescoby, M., Caborn, J.C., Barnett, C.L.

Dissemination Status:
Publicly available / released to all regions

Keywords:
Drigg sand dunes, field sampling, wildlife, SSSI, radiation.

Research Contractor:
Radioecology Group, Centre for Ecology and Hydrology, Lancaster Environment Centre, Library Ave., Bailrigg, Lancaster. LA1 4AP. Tel. 01524 595856

Environment Agency's Project Manager:
Dr. D. Copplestone, Head office

Collaborator(s):
Natural England, Northminster House, Northminster Rd, Peterborough, PE1 1UA. Tel: 01733 455000

Science Project Number:
SC070019

Product Code:
SCHO0308BNVQ-E-P

Science at the Environment Agency

Science underpins the work of the Environment Agency. It provides an up-to-date understanding of the world about us and helps us to develop monitoring tools and techniques to manage our environment as efficiently and effectively as possible.

The work of the Environment Agency's Science Department is a key ingredient in the partnership between research, policy and operations that enables the Environment Agency to protect and restore our environment.

The science programme focuses on five main areas of activity:

- **Setting the agenda**, by identifying where strategic science can inform our evidence-based policies, advisory and regulatory roles;
- **Funding science**, by supporting programmes, projects and people in response to long-term strategic needs, medium-term policy priorities and shorter-term operational requirements;
- **Managing science**, by ensuring that our programmes and projects are fit for purpose and executed according to international scientific standards;
- **Carrying out science**, by undertaking research – either by contracting it out to research organisations and consultancies or by doing it ourselves;
- **Delivering information, advice, tools and techniques**, by making appropriate products available to our policy and operations staff.

Steve Killeen

Head of Science

Executive summary

A number of approaches have been developed to assess the impact of ionising radiation on the environment in the last decade. Whilst these approaches are now being used within a regulatory context, there has been limited attempt to validate the computer models used in these approaches to predict the transfer of radionuclides through the food chain.

This report describes a sampling study to collect data from the Drigg sand dunes (Cumbria, UK) with which to compare the predictions of computer models.

Samples were collected for five amphibian species, two bird species, two mammal species, three reptile species, one vegetation species and one invertebrate species. All samples were analysed to determine whole-body activity concentration of gamma-emitting radionuclides. The only anthropogenic gamma-emitting radionuclides detected were ^{137}Cs and ^{241}Am. A subset of samples were also analysed to determine activity concentrations of ^{99}Tc, ^{90}Sr, ^{239,240}Pu and ^{241}Am (by alpha analysis).

The results reported here contributed to the testing of the ERICA Integrated Approach a methodology developed to assess environmental exposure, effects and risks from ionising radiation by a European Union funded project. They will subsequently be used to test the predictions of the Environment Agency 'R&D 128' methodology currently used to estimate activity concentrations in and doses to biota from ionising radiation in England and Wales. The study also provides data with which to refine current methods (for example, previously no transfer parameters were available for Tc in wild animals).

Acknowledgements

The financial contribution of Natural England to this work is gratefully acknowledged. The sampling programme and some of the gamma analyses were funded by the European Community-funded EURATOM project ERICA.

Contents

1 Introduction

A number of approaches have been developed to assess the impact of ionising radiation on the environment in the last decade (Copplestone *et al*., 2001; USDOE, 2002; Beresford *et al.,* 2007a). Whilst these approaches are now being used within a regulatory context, there has been limited attempt to validate the computer models used by these methods to predict the transfer of radionuclides through the food chain

This report describes a sampling study to collect data with which to compare the predictions of these models. The study site was the Drigg sand dunes (Cumbria, UK), an area protected under international and national environmental legislation which is contaminated indirectly by permitted discharges from the Sellafield nuclear reprocessing plant. The site forms one of the case studies of the ERICA project (see Beresford *et al*., 2007b), but little data has to date been available for many of the species present, such as amphibians and reptiles (Beresford and Howard, 2005).

2 Materials and methods

2.1 Sampling site

The Drigg sand dunes (Ordinance Survey National Grid Reference: SD065965) are a local nature reserve situated within the Lake District National Park, the Drigg Coast Site of Special Scientific Interest (SSSI) and the Drigg Coast Natura 2000 site. They are the most extensive semi-natural dune system in Cumbria (UK) and are of radioecological interest due to their proximity to the Sellafield reprocessing plant and the low level waste repository near Drigg.

Drigg is primarily an acidic dune system, supporting considerable areas of Atlantic decalcified fixed dunes. All principal phases of dune development are present (embryonic dunes, shifting white dunes, fixed grey dunes and dune heath). The majority of the area is covered by fixed grey dunes and dune heath, with many humid dune slacks also present. There is public access to all parts of the dunes and signs of human disturbance, mainly erosion around footpaths, are apparent in some areas. Some limited agricultural livestock grazing also retards the natural plant succession. The combination of these circumstances results in a varied flora and fauna and makes the dunes of considerable importance for a range of rare and endangered species.

2.2 Sampling programme

Sampling was undertaken by the University of Liverpool at the Drigg sand dunes in 2005 and 2006. The sampling programme was designed to collect data for the testing and validation of computer models used to assess the impact of ionising radiation on wildlife (Copplestone *et al*., 2001; Beresford *et al*., 2007a). The biota and vegetation samples collected are listed in Table 2.1. Samples of environmental media (soil and pool water) were collected and a number of gamma air kerma measurements were made, but these data are outwith this project and are not reported here (results can be found in Beresford *et al*. (2007) and Wood *et al*. (submitted)). Results of all biota measurements are reported, although not all were funded by this project.

Table 2.1: Samples collected from the Drigg Dunes during 2005 and 2006

Organism group	Species (common)	Species (Latin)	n
Amphibian	Common toad	*Bufo bufo*	*1*
	Common frog	*Rana temporaria*	*3*
	Great crested newt	*Triturus cristatus*	*3*
	Natterjack toad	*Bufo calamita*	*2*
	Palmate newt	*Triturus helveticus*	*2*
Bird	Mallard	*Anas platyrhynchos*	*1*
	Teal	*Anas crecca*	*2*
Invertebrate	Caterpillar		3
Mammal	Wood mouse	*Apodemus sylvaticus*	*2*
	Field vole	*Microtus agrestis*	*3*
Reptile	Common lizard	*Lacerta vivipara*	*3*
	Adder	*Vipera berus*	*2*
	Slow worm	*Anguis fragilis*	*2*
Vegetation	Red fescue	*Festuca rubra*	*3*

Due to the protected nature of the Drigg dune habitat and many of the biota present, approvals, consents and licences were obtained from the relevant authorities prior to commencing work. These included a protected species licence from Natural England for the sampling of reptiles and the two protected amphibian species, great crested newt (*Triturus Cristatus*) and natterjack toad (*Bufo calamita*).

2.2.1 Biota

Biota sampling was conducted in accordance with the requirements of the Wildlife and Countryside Act 1981 (amended by the Environmental Protection Act 1980), the Conservation (Natural Habitats) Regulations 1994 and the Animals (Scientific Procedures) Act 1986. The sampling methods are described below.

2.2.1.1 Amphibian sampling

Amphibian sampling was conducted using the methods described in Gent and Gibson (1998). The two methods that proved effective at Drigg were bottle trapping and torching (with hand capture).

2.2.1.1.1 Bottle trapping

Bottle traps are simple and cheap to make and are very effective for collecting amphibians. The construction of a bottle trap is shown in Figure 2.1; each was made from a two-litre plastic drinks bottle. The top was cut off the bottle, inverted and inserted into the body of the bottle to form a funnel. This was then secured in place by punching one set of holes at one side of the bottle and tying a loop of string through these holes to form a hinge. Two similar sets of holes were punched at the other side of the bottle and a cocktail stick inserted to secure the assembly. This allowed the contents of the bottle trap to be accessed with ease by removing the cocktail stick and lifting the funnel.

The traps were deployed during late afternoon/early evening, the number of traps used being dependent upon the size of the pool. The traps were positioned at approximately two-metre intervals around the perimeter of the pool, which usually resulted in 25-30 traps per pool. Each bottle trap was slowly submerged until 60 per cent of the trap was filled with water. The trap was then positioned at a 45 degree angle so that the mouth of the trap was lowest and there was an air pocket in the end of the trap. The air pocket ensured that trapped amphibians would have a sufficient oxygen supply until the bottle traps were retrieved. The traps were secured in this position using a garden cane and a length of elastic. Traps were retrieved the morning after deployment and the animals collected.

At Drigg, the bottle traps proved particularly effective at trapping newts of all species, namely the great crested newt (*T. cristatus*), the palmate newt (*Triturus helveticus*) and the smooth newt (*Triturus vulgaris*). They also caught some common frogs (*Rana temporaria*) and a few common toads (*Bufo bufo*).

2.2.1.1.2 Torching (with hand capture)

Torching does not require any special equipment and proved particularly useful for locating both toad species (*B. bufo* and *B. calamita*). Amphibians are most active at night, so, with illumination from torches, a visit to a pool after dark permitted identification of the amphibian species present and, as a result, selective hand capture of the individuals required. At each pool, the perimeter of the pool was walked slowly and any signs of movement investigated. Care was taken to avoid shining the torch

beam directly at the amphibians. Approximately 30 minutes were spent searching each pool. In order to minimise disturbance, pools were not visited for torching on nights when the bottle traps were in place.

Any animals collected using the bottle trapping or torching method had basic details recorded (such as species, sex, snout-vent length). Those that were not required were released at the point of capture. The others were euthanised immediately using the appropriate humane method given in Schedule 1 of the Animals (Scientific Procedures) Act 1986. The animals were then transferred into labelled plastic bags and packed into cool boxes with ice packs for transport. They were subsequently stored frozen (-20^{o}C).

Figure 2.1: Construction of bottle traps for amphibian sampling. On the left is the drinks bottle from which the trap is constructed. In the centre, the top section has been removed and the hinge fitted to one side of the inverted top section. On the right is the completed trap with the cocktail stick inserted to act as a lock.

2.2.1.2 Bird sampling

The British Association for Shooting and Conservation were contacted in order to identify members that shoot in the vicinity of Drigg. Whilst there is no shooting permitted on the dunes themselves, the Egremont and District Wildfowlers Association have rights to shoot on the opposite side of the River Irt. This was the closest location to the dunes at which shooting occurs. Some species of wildfowl, especially resident mallards (*Anas platyrhynchos*), were thought likely to feed on the dune heath. The Egremont and District Wildfowlers Association were asked if they would be willing to supply any of their excess bagged birds for inclusion within the analytical programme. They donated one mallard and two teal (*Anas crecca*).

The wildfowlers provided details of the date and location where each bird was shot and they confirmed that, in shot birds, death was assured according to the method given in Schedule 1 of the Animals (Scientific Procedures) Act 1986. The wildfowlers supplied the birds from their freezers, so the frozen birds were packed into a cool box with ice packs for transport. They were subsequently stored frozen (-20^{o}C).

2.2.1.3 Mammal sampling

Small mammal sampling was undertaken using Longworth, Pipe and Trip traps. All three traps follow the same basic design, with a chamber into which bedding and food (bait) are placed, an access tunnel leading to this chamber and a trip mechanism inside the access tunnel which, when disturbed by an animal entering the main chamber, closes a door over the tunnel entrance so that the animal cannot exit the trap.

The trapping was conducted following standard procedures. Traps were set out in a grid pattern, with approximately 10 metres between traps, in an area likely to support small mammal populations. On the dunes, these were areas where substantial red fescue (*Festuca rubra*) cover was present and where small mammal burrows had been identified. However, time constraints prevented a pre-baiting period to allow the animals to become accustomed to the traps and, as a consequence, trapping success was low. In total, five voles (*Microtus agrestis*) and two mice (*Apodemus sylvaticus*) were obtained.

Animals were euthanised according to the method given in Schedule 1 of the Animals (Scientific Procedures) Act 1986. The animals were then transferred to labelled plastic bags and packed into a cool box with ice packs for transport. They were subsequently stored frozen (-20^{o}C).

2.2.1.4 Reptile sampling

Reptile sampling was conducted using the methodologies described in Reading (1996) and Gent and Gibson (1998). The two approaches that were used were hand capture and the use of artificial refuges (see Figure 2.2).

2.2.1.4.1 Artificial refuges

Artificial refuges are relatively simple and cheap to make. Reptiles are poikilotherms and are thus unable to raise their own body temperature through internal regulation. They require external heat sources and actively seek out areas of direct sunlight where they can bask, or places that provide warmth such as natural or artificial refuges (Figure 2.2). Refuges were constructed from sheets of corrugated iron cut into squares measuring 0.81 x 0.75 metres. Each square was an individual refuge and its upper surface was painted black using a durable paint. Two holes were drilled 10 cm apart along one side of the square. A piece of rope was tied through these to form a handle.

Figure 2.2: Artificial refuge for reptile sampling

The refuges were positioned so that their black-painted surface was uppermost. This promoted heat absorption by the refuges, elevating their temperature over that of the surrounding environment. Temperature measurements made during refuge searches at Drigg showed that the temperature difference between the ground surface immediately next to the refuge and the area underneath the refuge could exceed 16°C. The corrugated nature of the refuges helped to raise them up off the ground, facilitating reptile access to the warm area underneath the refuges.

Three locations were identified for the artificial refuge arrays. Each was selected to ensure that it met the likely habitat requirements for reptiles, in terms of the physical structure of the habitat and presence of suitable foodstuffs. Each array consisted of 19 individual refuges which were set out in a hexagonal pattern as shown in Figure 2.3. Inter-refuge distance (IRD) was 15 m, so the array covered a total area of 0.336 ha.

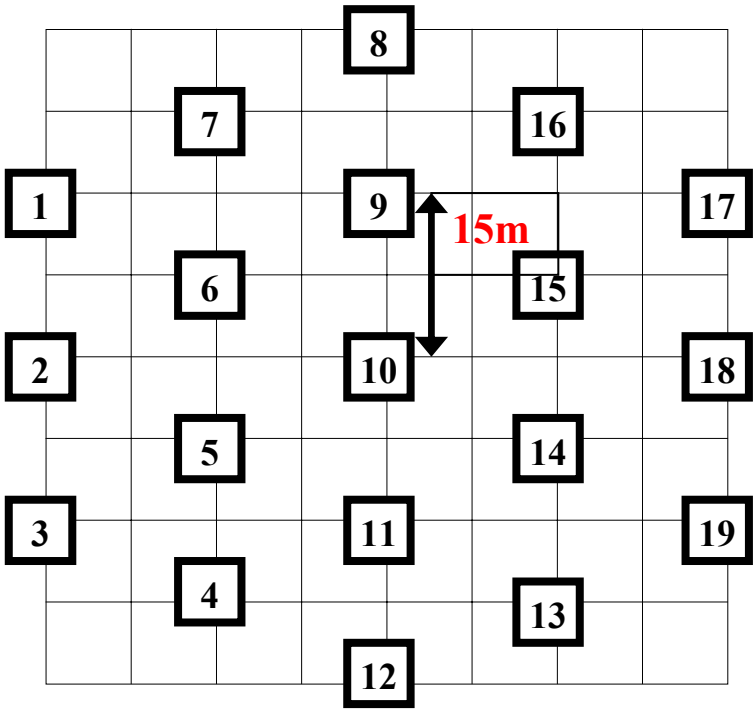

Figure 2.3: Standard layouts for each reptile refuge array used at Drigg

Each numbered box indicates the position of a refuge, with the numbers corresponding to the order in which the refuges were checked. The three arrays were visited on 10 occasions during 2006. Each was walked systematically by two field workers. One worker lifted the refuges while the other captured any reptiles found underneath. All proved successful at attracting common lizards (*Lacerta vivipara*), which are abundant at Drigg. Slow worms (*Anguis fragilis*) were also found under the refuges but appeared less abundant than *L. vivipara*. None of the refuges were found to be used by *Vipera berus* (adder) at any point during the study. For this reason, additional hand capture techniques had to be employed.

2.2.1.4.2 Hand capture

To enable *V. berus* to be collected, it was necessary to search for signs of snake activity, such as skin sloughs, in areas of suitable habitat and then target these areas for intensive searches at times when the snakes were most likely to be basking. This approach was much more labour intensive than the use of artificial refuges and it was only possible to collect two adders. More were encountered, but they were either too fast to catch in a terrain dominated by tufts of marram grass (*Ammophila arenaria*) or were females, which had their basic details recorded (species, sex, length) but were

then released at the point of capture. This was in accordance with an agreement with the Herpetological Conservation Trust to protect the adder population at Drigg.

Animals to be taken for analysis were euthanised using the method given in Schedule 1 of the Animals (Scientific Procedures) Act 1986. The animals were then transferred to labelled plastic bags and packed into a cool box with ice packs for transport. They were subsequently stored frozen (-20^{o}C).

2.2.1.5 Invertebrate sampling

Invertebrate sampling was opportunistic. Many caterpillars were found in the vicinity of some of the reptile sampling locations (see Figure 2.3). Samples of these were collected by hand. The animals were euthanised by immersion in 70 per cent ethanol. They were kept in the ethanol to preserve them during transport.

2.2.1.6 Vegetation sampling

The method used to collect vegetation was that described in Wood *et al*. (2007). The vegetation was clipped to 2-3 cm above the soil surface using garden shears. The cut vegetation was transferred to a labelled plastic bag. Once 400 g fresh weight (FW) of material had been collected, the bag was sealed and a record made of the area of vegetation cover that had been cut. The labelled plastic bags were packed into a cool box with ice packs for transport.

2.3 Sample preparation and analysis

2.3.1 Sample preparation

2.3.1.1 Animals

After defrosting, individual animals were weighed. Amphibian and reptile samples were then washed, the gastrointestinal tract (GIT) removed, re-washed, chopped into small pieces and freeze-dried. Bird samples were plucked, washed, the GIT removed, chopped into small pieces and freeze-dried; mammals were treated similarly, the pelt being removed. Caterpillar samples were bulked for each sampling location, washed, freeze-dried and then ashed at 450^{0}C. Freeze-dried samples were ground using a coffee mill housed in a dust extraction cupboard.

2.3.1.2 Vegetation

Upon receipt, the three vegetation samples (predominately Fescue spp.) were air-dried (20^{O}C) to a constant weight. Moss spp. (mainly sphagnum spp.) were removed prior to grinding in a Glen Creston vegetation mill using a 2-mm sieve. A significant proportion of two of the samples was dead material (up to approximately 80 per cent).

2.3.2 Sample analysis

All methods used, with the exception of ^{99}Tc, are UKAS accredited.

2.3.2.1 Gamma spectrometry

Depending on sample size, the dried and ground samples were accurately weighed into 25 ml Petri dishes or 130 ml plastic containers, sealed and analysed on hyper-pure germanium detectors for two to four days. The detectors were calibrated for efficiency using a mixed radionuclide standard covering an energy range of approximately 59 -1,850 keV. Stored spectra were analysed using the Canberra Genie-ESP software for photopeak identification and subsequent quantification.

Following gamma spectrometry, 26 samples were prioritised for radiochemical analysis. As sample sizes were often below 10g dry weight (DW) (see Table 3.1) not all of the samples could be analysed for all of the radionuclides.

2.3.2.2 Strontium-90

Depending upon sample size, between one and 10 grams of dried and ground sample was ashed at 450°C and leached with aqua regia to extract strontium. Strontium was initially concentrated from the sample solution by co-precipitation with calcium oxalate. After dissolution, strontium was isolated by extraction chromatography and, after a suitable ingrowth period, ^{90}Y was separated from ^{90}Sr and measured by Cerenkov counting for one hour on a Quantulus liquid scintillation counter to derive the ^{90}Sr content. ^{85}Sr was used as the yield monitor.

2.3.2.3 Plutonium-239,240 and Am-241

Depending upon sample size, between one and 10 grams of dried and ground sample was spiked with ^{242}Pu and ^{243}Am yield monitors and then ashed at 450^{o}C. The ashed residue was leached with aqua regia to extract plutonium and americium. The actinides were concentrated by co-precipitation with iron (III) hydroxide and purified using ion-exchange and extraction chromatography. The purified actinides were electrodeposited onto stainless-steel discs; the discs were analysed by alpha spectrometry using PIPS detectors.

2.3.2.4 Technetium-99

Depending upon sample size, between one and 10 grams of dried sample was spiked with ^{99m}Tc and gradually ignited in a muffle furnace until 550^{o}C was reached. The ^{99}Tc was purified using anion-exchange chromatography and solvent extraction. The recovery of ^{99}Tc in the purified fraction was determined by gamma spectrometric measurement of ^{99m}Tc. The activity of ^{99}Tc in the purified fraction was determined by low-level liquid scintillation counting (Quantulus liquid scintillation counter) after a two-week period to permit the decay of ^{99m}Tc. The analysis time was one hour.

3 Results

Table 3.1 presents results for gamma-emitting radionuclides. Apart from ^{137}Cs and ^{241}Am, no other anthropogenic radionuclides were detectable. Results for ^{90}Sr, ^{99}Tc, ^{239,240} Pu and ^{241}Am are presented in Table 3.2.

Table 3.1: Activity concentration (Bq kg^{-1}) in biota and vegetation samples measured by gamma analysis

Sample	Dry weight (g)	Analysed weight (g)	Activity concentration (Bq kg^{-1} (FW*)) (Uncertainties are total method uncertainties at two-sigma confidence level)		
			^{40}K	^{137}Cs	^{241}Am
Mallard 1**	150	14	110±23	3.2±0.69	0.32±0.13
Teal 2	198	14	64±14	2.2±0.56	1.4±0.38
Teal 3	65	14	84±18	2.0±0.47	0.53±0.25
Common frog 1	7.3	5.5	34±32	<1.0	2.3±1.5
Common frog 2	8.0	5.9	29±28	2.7±2.0	2.0±1.3
Common frog 3	7.2	5.9	53±32	2.5±2.2	<1.7
Slow worm 1	13	6.5	58±39	14±3.5	<2.2
Slow worm 2	15	6.3	73±37	31±6.5	<2.1
Slow worm 3	10	7.2	104±61	6.4±3.2	<3.3
Natterjack toad 1	4.5	4.4	54±41	<1.5	<2.2
Natterjack toad 2	3.3	3.2	<28	<2.7	<4.4
Common toad	6.0	6.0	<22	2.3±0.98	<2.8
Palmate newt 1	2.6	2.5	<38	13±6.1	<6.2
Palmate newt 2	2.5	2.4	118±71	13±3.5	<4.3
Palmate newt 3	3.9	3.8	<18	9.0±4.1	3.0±2.1
Caterpillar 1	4.3	3.6	<17	<2.5	2.7±1.9
Caterpillar 2	2.2	1.9	<18	<1.6	<2.7
Caterpillar 3	0.99	0.9	<37	4.2±2.7	<5.2
Fescue 1#	115	20	162±76	<2.2	9.6±3.9
Fescue 2	84	20	162±80	7.2±2.3	4.2±1.6
Fescue 3#	10	20	248±68	4.1±1.4	2.9±1.3
Common lizard 1	2.0	1.9	<37	<6.2	<6.4
Common lizard 2	4.4	4.1	<23	7.8±2.6	<3.1
Common lizard 3	3.7	3.7	90±58	8.0±2.5	<3.3
Great crested newt 1	4.3	4.2	95±44	4.6±1.8	<2.4
Great crested newt 2	6.4	6.4	51±34	13±3.6	<1.8
Great crested newt 3	4.8	4.8	91±65	6.5±3.5	<4.9
Wood mouse	3.9	3.9	137±64	3.0±2.0	<7.4
Wood mouse	4.9	4.9	111±44	4.5±1.8	<4.8
Field vole	3.7	3.6	121±68	5.0±2.7	<8.1
Field vole	1.2	1.2	<66	<9.6	<9.0
Field vole	1.7	1.7	<63	9.9±4.4	<13
Adder	8.9	8.1	67±31	<1.6	<1.4
Adder	6.8	6.7	105±39	<1.1	<1.8

*Fescue activity concentrations are presented on a dry weight basis.
**Liver missing from sample.
#Contained up to 80 per cent dead material.

Table 3.2: Actinide activity concentration (Bq kg^{-1}) in biota and vegetation samples

Sample	Activity concentration (Bq kg^{-1} (FW*)) (Uncertainties are total method uncertainties at two-sigma confidence level) ^{90}Sr	^{99}Tc	^{239,240}Pu	^{241}Am
Mallard 1**	0.63±0.5	<0.51	0.13±0.04	0.31±0.06
Mallard 1**[d]	0.87±0.6	<0.52	0.23±0.05	0.36±0.06
Teal 2	<0.22	4.9±1.6	0.44±0.06	0.88±0.09
Teal 3	<0.95	<0.6	0.41±0.06	0.48±0.06
Common frog 1	7.9±1.1	<7.4		
Common frog 2	6.7±1.1	<1.6		
Common frog 3	10±2.2	<5.5		
Slow worm 1	23±4.0	<2.3		
Slow worm 2	11±2.9	<2.2		
Slow worm 3	4.0±2.4	<9.1		
Natterjack toad 1	<1.2	<11.8		
Natterjack toad 2	2.5±3.2	4.8±3.1		
Palmate newt 1	21±4.3	n/a		
Palmate newt 2	9.8±4.2	n/a		
Palmate newt 3	5.2±3.7	<10		
Caterpillar 1	<1.2	<18		
Caterpillar 2	<0.8	n/a		
Caterpillar 3		n/a		
Fescue 1	4.0±1.5	2.5±1.8	4.2±0.35	7.7±0.53
Fescue 1[d]	5.6±1.9	2.5±1.8	4.3±0.36	7.3±0.56
Fescue 2	1.6±1.5	<2.5	1.7±0.2	3.8±0.33
Fescue 3	17±2.9	<2.5	1.3±0.18	2.5±0.26
Common lizard 1	<1.4	n/a		
Common lizard 2	<1.9	<10		
Common lizard 3	<1.9	<13		
Great crested newt 1	7.7±4.4	<3.9		
Great crested newt 2	7.3±3.3	6.6±4.0		
Great crested newt 3	8.2±4.0	<8.0		

*Fescue activity concentrations are presented on a dry weight basis.
**Liver missing from sample.
[d]Duplicate analysis.

4 Discussion

The results reported here contributed to the testing of the ERICA Integrated Approach, a methodology developed to assess environmental exposure, effects and risks from ionising radiation (Beresford et al., 2007a,b). The results of this testing indicate that there is likely to be no adverse impact on wildlife in the sand dunes (Beresford et al., 2007a,b). They will subsequently be used to test the predictions of the Environment Agency 'R&D 128' methodology currently used to estimate activity concentrations in and doses to biota from ionising radiation in England and Wales. (Copplestone et al., 2001). For this, more samples will be analysed to determine actinide activity concentrations.

The organism-radionuclide combinations analysed here include some of the most poorly represented combinations within transfer computer model databases (because of the lack of previously reported data). For instance, the terrestrial database included within the ERICA Integrated Approach contains no measured data for the transfer of Tc to animals. Therefore, in addition to providing useful validation data, the study offers new data with which to refine current methods.

5 References

BERESFORD, N.A. AND HOWARD, B.J. 2005. Ecological systems – data requirements and availability. In: *Protection of the environment from the effects of environmental radioactivity*. International Atomic Energy Agency, Vienna. pp 305-314.

BERESFORD, N.A., BROWN, J., COPPLESTONE, D., GARNIER-LAPLACE, J., HOWARD, B.J., LARSSON, C-M., OUGHTON, D., PRÖHL, G. AND ZINGER, I. 2007a. *D-ERICA: An integrated approach to the assessment and management of environmental risks from ionising radiation*. Deliverable of the ERICA project (FI6R-CT-2004-508847). Centre for Ecology and Hydrology, Lancaster.

BERESFORD, N.A., HOWARD, B.J., BARNETT, C.L. 2007b. *Application of ERICA Integrated Approach at case study sites.* Deliverable 10 of the ERICA project (FI6R-CT-2004-508847). Centre for Ecology and Hydrology, Lancaster.

COPPLESTONE, D., BIELBY S., JONES S.R., PATTON D., DANIEL P. AND GIZE, I. 2001. *Impact assessment of ionising radiation on wildlife.* R&D Publication 128. ISBN 1 85705590. Environment Agency, Bristol.

GENT, A.H. AND GIBSON, S.D. 1998. *Herpetofauna workers' manual*. Joint Nature Conservation Committee: Peterborough.

READING, C.J. 1996. *Evaluation of reptile survey methodologies*. English Nature Research Report No. 200. English Nature, Peterborough.

SCHEDULE 1 OF THE ANIMALS (SCIENTIFIC PROCEDURES) ACT 1986. http://www.archive.official-documents.co.uk/document/hoc/321/321.htm

UNITED STATES DEPARTMENT OF ENERGY (USDOE). 2002. *A graded approach for evaluating radiation doses to aquatic and terrestrial biota.* Technical Standard DOE-STD-1153-2002. US DOE, Washington D.C.

WOOD, M.D., COPPLESTONE, D. AND CROOK, P. 2007. *UKSHS Report No. 2: Chemical and radiometric sample collection methods.* Science report for Project SC000027. Environment Agency, Bristol. pp. 28. Product No: SCH06607BMSV-E-P.

WOOD, M.D., MARSHALL, W.A., BERESFORD, N.A., JONES, S.R., HOWARD, B.J. COPPLESTONE, D.D. AND LEAH, R.T. Application of the ERICA Integrated Approach to the Drigg coastal sand dunes. Submitted to *Journal of Environmental Radioactivity*

6 List of abbreviations

CEH:	Centre for Ecology and Hydrology
DW:	Dry weight
ERICA:	Environmental risk from ionising contaminants: assessment and management- EC Sixth Framework Project at http://www.erica-project.org/
FW:	Fresh weight
IRD:	Inter-refuge distance
SSSI:	Site of Special Scientific Interest
UK:	United Kingdom
PIPS:	Passivated implanted planar silicon detector

7 Glossary

Becquerel (Bq)	The International System of Units (SI) definition of activity. One Bq = one disintegration per second.
Gamma air kerma	Kerma is the kinetic energy released in material, measured in Gy. Kerma can be quoted for any specified material at a point in free space or in an absorbing medium. Gamma air kerma is the exposure measured in air (in the case of values quoted here, one metre above the soil surface), which is in effect the absorbed dose measured in air.
Natura 2000 site	The European network of protected sites established under the Birds Directive and the Habitats Directive.

We are The Environment Agency. It's our job to look after your environment and make it **a better place** – for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

Published by:

Environment Agency
Rio House
Waterside Drive, Aztec West
Almondsbury, Bristol BS32 4UD
Tel: 0870 8506506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk