

# Exercise 3 – R&D128 analogue approach

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# **R&D128**

➔ Provides an approach for the impact assessment of ionising radiation on wildlife estuarine & freshwater Published in 2001 and since superseded by ERICA ➔ Remains the basis of the **Environment Agency's** radiological assessments



Impact Assessment of Ionising Radiation on Wildlife

R&D Publication 128

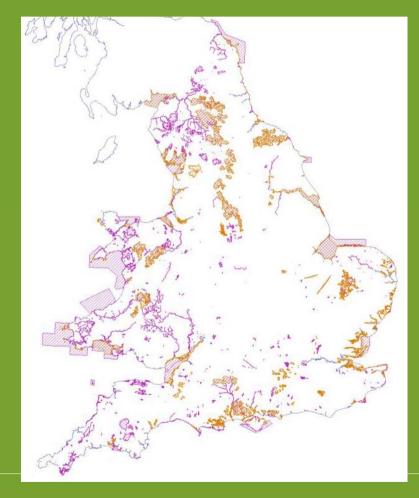




# Screening tier will be main level of assessment?

- Example England & Wales 'Habitats' [Natura2000] assessments
- •Assessed 715 radioactive discharge authorisations
- Screening level of 5  $\mu$ G/h used

 600 authorisations did not require assessment more detailed than initial conservative level (i.e. estimate < 5 µG/h)</li>





# **R&D128 - Radionuclides**

Selected based on a potentially high radiobiological significance to wildlife

### ➔ Freshwater:

H-3, C-14, P-32, Co-60, Sr-90, Tc-99, Ru-106, I-129, I-131, Cs-137, Po-210, Th-234, Pa-234m, U-238, Pu-239, Pu-240.

# Terrestrial:

H-3, C-14, P-32, S-35, Ar-41, Co-60, Kr-85, Sr-90, Ru-106, I-129, I-131, Cs-137, Po-210, Ra-226, Th-234, Pa-234m, U-238, Pu-239, Pu-240, Am-241



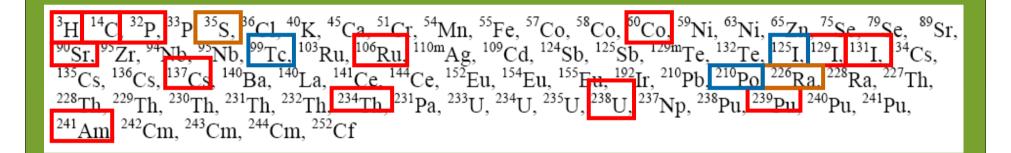
# **R&D128 - Assessment spreadsheets**

	A	в	С	D	E	F	G	Н	1	J	K	L	M	N	0	
1					Concentration	actors, organis	:m:water		•							
2	Nuclide	Water conc.	Sediment	Bacteria	Phytoplankton	Zooplankton	oplankton Macrophyte Benthic molluse Small b. crust. I				Amphibian	Pelagic fish	Benthic fish	Aqu. mammal	Duck	
3		Bq m <sup>-1</sup>	m³ kg-1	m³ kg-1	m³ kg-1	m³ kg-1	m³ kg <sup>-1</sup>	m³ kg-1	m³ kg-1	m³ kg-1	m³ kg <sup>-1</sup>	m³ kg-1	m³ kg-1	m³ kg-1	m³ kg-1	
5	°Н		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	
6	<sup>14</sup> C		2.0E+00	2.0E+00	1.8E+00	4.0E+00	4.6E+00	7.3E+00	7.3E+00	7.3E+00		4.6E+00	4.6E+00			
7	<sup>32</sup> P				2.0E+00	2.0E+00	1.0E+01					5.0E+01	5.0E+01			
8	60 <b>CO</b>		5.0E+00	5.0E+00	1.0E+00	4.0E-01	1.0E+00	2.0E+00	2.0E+00	2.0E+00		3.0E-01	3.0E-01			
9	<sup>90</sup> Sr		1.0E+00	1.0E+00	4.0E-02	2.0E-02	1.2E+00	2.5E-01	2.7E-01	2.7E-01		4.3E-02	4.3E-02			
10	<sup>99</sup> TC		5.0E-03	5.0E-03	8.0E-03	2.0E-02	1.3E+00	2.4E-02	1.3E-02	1.3E-02		4.5E-02	4.5E-02			
11	<sup>106</sup> Ru		1.0E-01	1.0E-01	1.0E+01	6.0E+00						1.0E-02	1.0E-02			
12	<sup>125</sup>		1.0E-02	1.0E-02	2.0E-01	6.0E-01	4.0E-01	1.7E-01	1.7E-01	1.7E-01		4.0E-02	4.0E-02			
13	<sup>129</sup>		1.0E-02	1.0E-02	2.0E-01	6.0E-01	4.0E-01	1.7E-01	1.7E-01	1.7E-01		4.0E-02	4.0E-02			
14	<sup>13 1</sup>		1.0E-02	1.0E-02	2.0E-01	6.0E-01	4.0E-01	1.7E-01	1.7E-01	1.7E-01		4.0E-02	4.0E-02			
15	<sup>137</sup> Cs		1.0E+00	1.0E+00	1.8E-01	2.0E-02	2.3E+00	5.8E-01	5.2E+00	6.3E-01		1.1E+01	1.1E+01			
16	<sup>210</sup> Po	0.00E+00	2.7E+00	2.7E+00	6.0E+00	6.0E+00	1.4E+00	1.0E+02	1.0E+02	1.0E+02		5.0E-02	5.0E-02			
17	<sup>234</sup> Th		1.0E+01	1.0E+01	4.0E+00	2.0E+00	3.0E+00	1.0E-01	1.0E-01	1.0E-01		1.0E-01	1.0E-01			
18	<sup>238</sup> U	0.00E+00	5.0E-02	5.0E-02	4.0E-03	1.0E-03	6.5E+00	1.8E-01	1.8E-01	1.8E-01		1.0E-02	1.0E-02			
19	<sup>239</sup> Pu	0.00E+00	1.0E+02	1.0E+02	1.8E-01	2.0E-02	1.8E+00	8.2E-01	1.4E-01	1.4E-01		6.9E-02	6.9E-02	2.3E-01	2.0E-03	
20	<sup>241</sup> Am		5.0E+00	5.0E+00	4.0E+01	4.0E-01	3.0E+00	1.0E-01	1.0E-01	1.0E-01		3.0E-02	3.0E-02			
21																-
22		Habitat factors:														
23		f sediment		1.0E+00	0.0E+00	0.0E+00	1.0E+00	0.0E+00	0.0E+00	0.0E+00	4.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	
24		f sediment surface		0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E+00	1.0E+00	1.0E+00	3.0E-01	1.0E-01	9.0E-01	2.0E-01	3.0E-01	<u> </u>
25		f water		0.0E+00	1.0E+00	1.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-01	9.0E-01	1.0E-01	6.0E-01	5.0E-01	4
26		Radiation weighting	a fastora													II
27		naulation weighting	y raciors:													
29		Low energy beta	3.0E+00	Sediment concentration factor is Bq kg <sup>-1</sup> sediment (drg wt) per Bq m <sup>-3</sup> water (solution phase)												
30		beta and photon 1.0E+00														
31		Alpha	2.0E+01	Biota concentration factors are Bq kg <sup>-1</sup> whole organism (fresh vt) per Bq m <sup>-1</sup> water (solution phase)												
32																
33																
34							Shee			CFs"						<u> </u>
H 4 > PI Concentrations and CFs / Unweighted Doses / Unweighted dose chart / Weighted Doses / Weighted dose chart / Biota conc 4																
34 Sheet "Concentrations and CFs"   35 This is the data input sheet   36 This is the data input sheet   36 This is the data input sheet   36 This is the data input sheet																



# **Exercise 3 – Radionuclides**

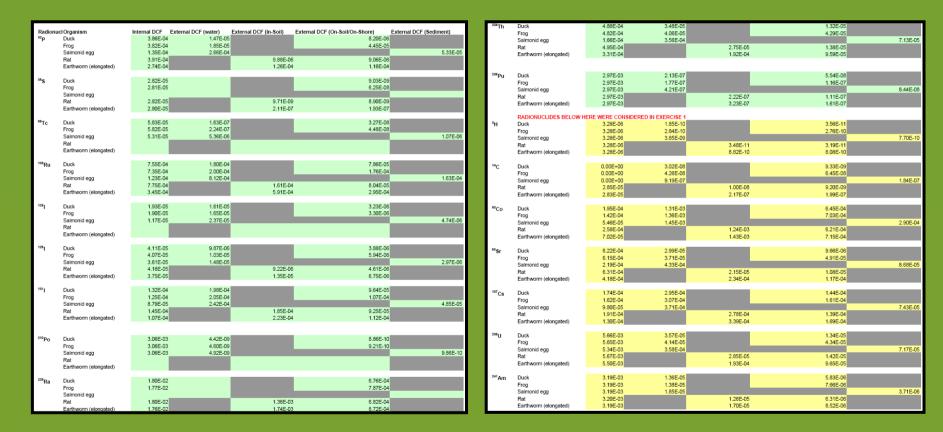
### 



- Terrestrial & freshwater
- Freshwater
  - Terrestrial



# Exercise 3 – R&D128 results



#### Results without analogues - not many!



# **Technical Report SP1a**

Updated guidance for undertaking assessments using R&D128 Advice – when need to model radionuclides that are not in the R&D128 spreadsheets, use recommended analogues ⇒ Internal EA report



Habitats regulations for Stage 3 assessments: radioactive substances authorisations

R&D Technical Report P3-101/SP1a





# Exercise 3 – Analogue radionuclides

Analogue	<b>Cs-137</b> (beta gamma > 10 d)	Co-60	<b>I-131</b> (beta gamma 1- 10 d)	P-32	<b>Pu-239</b> (other alpha)	<b>U-238</b> (uranium alpha)
Terrestrial & Freshwater	CI-36, K-40, Ca-45, Cr-51, Mn-54, Fe-55, Co-57, Co- 58, Ni-59, Ni-63, Zn-65, Se-75, Se-79, Sr-89, Zr- 95, Nb-94, Nb-95, Ru-103, Cd-109, Sb-124, Sb-125, Te-129m, Cs-134, Cs-135, Cs-136, Ba-140, Ce-141, Ce-144, Eu-154, Eu-155, Ir-192, Pb-210, Ra-228, Pu-241	Ag-110m	Te-132, La-140, Eu-152, Th-231	P-33	Th-227, Th- 228, Th-229, Th-230, Th- 232, Pa-231, U-233, Np- 237, Pu-238, Pu-240, Cm- 242, Cm- 243, Cm- 244, Cf-252	U-234, U- 235
Terrestrial	Tc-99, I-125				Po-210	
Freshwater	S-35				Ra-226	



# Exercise 3 – R&D128 results

Model used Participant	R&D 128 L NEWSOME analogue radioructide used	Cell colour coding:	No result required Please complete	ou want your BWG Exercise 1 results entering													
Redionuclide	uctide Organism Internal DCF External DCF (water) Ext				DCF (Sediment)							Results with analogues					
¤p	Duck Frog	3.82E-04 1.85E-0	5	8.20E-08 4.45E-05					1			Kes	ults wi	th an:	aloques	\$	
	Salmonid egg Rat	1.35E-04 2.66E-0 3.91E-04	9.885-06	9.05E-06	5.33E-06	I DCF (In-Soli) External DCF (On 2.78E-04	1.39E-04	nal DCF (Sediment)							alogaot		
	Earthworm (elongated)	2.745-04 3.885-04 1.475-0	1.285-04	1.192-04		3.395-04	1.69E-04										
~p	Duck Frog Salworkl egg	3.888-04 1.478-0 3.825-04 1.855-0 1.355-04 2.685-0	5	8.20E-06 4.45E-05	5 335-05		1.44E-04 1.61E-04		_								
	Rat Earthworm (elongated)	3.91E-04 2.74E-04	9.85E-06 1.28E-04	9.08E-08 1.18E-04	5.525-15	2.78E-04	1.396-04	7.43E-0	External DCF (On-Se	oli/On-Shore) External 1.39E-04 1.69E-04	DCF (Sediment)						
-,	Dirk	2.825-05 2.955-0	4	9.035-09		3.39E-04	1.69E-04	_		3.816-06							
	Frog Salmonid egg	2.81E-05 3.07E-0 9.80E-05 3.71E-0	4	6.25E-08	7.435-05		1.61E-04	7.435-0		6.94E-06	2.975-08						
	Rat Earthworm (elongated)	2.825-05 2.805-05	9.71E-09 2.11E-07	8.90E-09 1.93E-07		2.78E-04 3.39E-04	1.39E-04 1.69E-04	/	6	4.61E-06 6.75E-06		F (In-Soli) External DI 2.22E-07	CF (On-Soli/On-Shore) External DCF 1.11E-07	F (Sediment)			
×cı	Duck	1.745-04 2.955-0		1.44E-04			1.446-04			9.84E-05 1.07E-04		3.238-07	1.616-07				
	Frog Salwonid egg Rat	1.625-04 3.075-0 9.805-05 3.715-0 1.915-04	2.785-04	1.81E-04	7.43E-05		1.61E-04	7.436-0			4.855-05		6.76E-04 7.87E-04				
	Earthworm (elongated)	1.30E-04	3.395-04	1.69E-04		2.78E-04 3.39E-04	1.39E-04 1.69E-04		4	9.25E-05 1.12E-04		1.38E-03 1.74E-03	6.82E-04 8.72E-04	8.44E-06			
<b>*</b> K	Duck Frog	1.74E-04 2.95E-0 1.62E-04 3.07E-0	4	1.44E-04 1.61E-04			1.44E-04 1.61E-04			1.44E-04 1.81E-04	7.435-05	1.740403	1.448-04	oli) Extern	nal DCF (On-Soli/On-Shore) External DC	CF (Sediment)	
	Salmonid egg Rat	9.80E-05 3.71E-0 1.91E-04	2.78E-04	1.396-04	7.43E-06	2755.04	136-04	7.43E-0		1.396-04	7.435-05			22E-07 7.43E-05 23E-07	1.11E-07 1.61E-07		
*ca	Earthworm (elongated) Duck	1.305-04	3.395-04	1.696-04		2.78E-04 3.39E-04	1.69E-04			1.44E-04		2.78E-04 3.39E-04	1.39E-04 1.69E-04		5.54E-08 1.16E-07		
Ca	Frog Salmonid egg	1.625-04 2.305-0 1.625-04 3.075-0 9.605-05 3.715-0	4	1.61E-04	7.435-06		1.44E-04 1.61E-04			1.61E-04	7.435-05		5.54E-03 1.19E-07	225-07	1.116-07	8.44E-06	
	Rat Earthworm (elongated)	1.91E-04 1.30E-04	2.78E-04 3.39E-04	1.39E-04 1.69E-04		2.785-04	1.396-04	7.43E-0	4	1.39E-04 1.69E-04		2.226-07	1.116-07	8.44E-06 23E-07	1.816-07		
"Cr	Duck	1.745-04 2.955-0		1.446-04		3.395-04	1.69E-04 3.27E-08			1.44E-04 1.61E-04		3.236-07	1.81E-07		6.54E-08 1.19E-07	8.44E-06	
	Frog Salwonid egg Rat	1.62E-04 3.07E-0 9.80E-05 3.71E-0 1.91E-04	2.785-04	1.816-04	7.435-05		4.48E-08	1.07E-0	4	1.396-04	7.43E-05		5.54E-03 1.19E-07	225-07 8.44E-06 236-07	1.11E-07 1.81E-07		
	Fait Earthworm (elongated)	1.305-04	3.395-04	1.696-04		2.78E-04 3.39E-04	1.39E-04 1.69E-04	1.070-0	4	1.695-04		2:22E-07 3:23E-07	1.11E-07 1.81E-07		1.44E-04 1.81E-04		
<sup>54</sup> btn	Duck Free	1.745-04 2.955-0 1.625-04 3.075-0	4	1.44E-04 1.61E-04			1.44E-04			1.61E-04	7.435-05		5.54E-08 1.16E-07	785.04		7.435-05	
	Frog Salmonid egg Rat	9.80E-05 3.71E-0 1.91E-04 1.30E-04	4 2.78E-04 3.39E-04	13(6-04	7.43E-05		1.616-04	7.436-0	5 4	1.395-04 1.695-04		2.226-07	1.116-07	8.44E-06 39E-04	1.80E-04 1.60E-04	p	
	Earthworm (elongated)			1.696-04		2.78E-04 3.39E-04	1.39E-04 1.69E-04			9.84E-05 1.07E-04		3.23E-07	1.616-07		5.54E-08 1.16E-07		
*Fo	Duck Frog Salmonid egg	1.745-04 2.955-0 1.625-04 3.075-0 9.805-05 3.715-0	4	1.61E-04	7.435-06		7.88E-05 1.78E-04				4.855-05		6.54E-08 1.19E-07	225-07 8.44E-06 23E-07	1.11E-07 1.81E-07	8.44E-06	
	Rat Earthworm (elongated)	1.91E-04 1.30E-04	2.78E-04 3.39E-04	1.39E-04 1.69E-04	1.440-00	1.61E-04	8.04E-05	1.835-0	4	9.25E-05 1.12E-04		2.22E-07 3.23E-07	1.11E-07 1.61E-07	5.64E-06	5.54E-08		
"co	Duck	1745-04 2.955-04	4	146-04		5.91E-04	2.95E-04			1.44E-04 1.61E-04	7.438-05		9.84E-05	226,07	1.198-07	8.44E-06	
	Frog Salmonid egg	1.62E-04 3.07E-0 9.80E-05 3.71E-0	4	1.816-04	7.435-05		6.45E-04 7.03E-04		t	1.395-04	7.430-00	1.855-04	9.255-05	4.85E-05 23E-07	1.11E-07 1.61E-07		
	Rat Earthworm (elongated)	1.915-04 1.305-04	2.78E-04 3.39E-04	1.00E-04 1.60E-04		1.24E-03 1.43E-03	6.21E-04 7.15E-04	2.905-0	4	1.446-04		2.235-04	1.126-04		5.54E-08 1.16E-07		
™Co	Duck Frog	1.745-04 2.955-04 1.825-04 3.075-04	4	1.44E-04 1.61E-04		1432903	146-04	_		1.815-04	7.435-05		5.54E-08 1.19E-07	225-07	1.11E-07 1.61E-07	8.44E-06	
	Salmonid egg Rat	9.80E-05 3.71E-0 1.91E-04	4 2.785-04	1.316-04	7.43E-05		1.61E-04	7.43E-00		1.39E-04 1.69E-04		2.228-07 3.238-07	1.116-07	8.44E-06 23E-07			
	Earthworm (elongated)	1.305-04	3.395-04	1.69E-04		2.78E-04 3.39E-04	1.39E-04 1.69E-04			9.64E-05 1.07E-04		3.236-07	1.81E-07		6.54E-08 1.16E-07	8.445-06	
<sup>10</sup> NI	Duck Frog	1.74E-04 2.95E-0 1.82E-04 3.07E-0 9.80E-05 3.71E-0	4	1.44E-04 1.81E-04	7.435-05		1.446-04		4	9.25E-05 1.12E-04	4.855-05		4.296-05	22E-07 23E-07 7.13E-06	1.11E-07 1.61E-07		
	Salmonid egg Rat Earthworm (elongated)	9.80E-05 3.71E-0 1.91E-04 1.30E-04	2.785-04 3.395-04	1.30E-04 1.60E-04	7.432-00		1.61E-04	7.435-0	4	1.12E-04		2.75E-05 1.92E-04	1.38E-05 9.59E-05		3.55E-11 2.76E-10		
-ni	Duck	1.745-04 2.955-0	4	1.44E-04		2.78E-04 3.39E-04	1.39E-04 1.69E-04		_	1.616-04	7.435-05		5.54E-03 1.19E-07	485-11	3.196-11	7.70E-10	
	Frog Salmonid egg	1.62E-04 3.07E-0 9.60E-05 3.71E-0	•	1.61E-04	7.435-05		1.44E-04 1.61E-04		4	1.395-04 1.695-04		2.226-07	1.116-07	8.44E-06	8.05E-10 9.33E-09		
	Rat Earthworm (elongated)	1.91E-04 1.30E-04	2.78E-04 3.39E-04	1.39E-04 1.69E-04		2.78E-04	1.396-04	7.43E-0	5	1.44E-04 1.81E-04		3.236-07	1.61E-07		6.455-05	1.846-07	
"Zn	Duck Frog	1.745-04 2.955-0	:	1.44E-04 1.81E-04		3.39E-04	1.696-04			1.815-04	7.435-05		5.54E-03 1.19E-07	00E-08 17E-07	9.20E-00 1.99E-07		
	Salmonid egg Rat	1.625-04 3.075-0 9.805-05 3.715-0 1.915-04	2.785-04	1.30E-04	7.435-06		1.44E-04 1.61E-04		4	1.69E-04		2.22E-07 3.23E-07	1.11E-07 1.61E-07		6.45E-04 7.03E-04		
	Earthworm (elongated)	1.30E-04	3.395-04	1.696-04		2.78E-04 3.39E-04	1.30E-04 1.60E-04	7.43E-00	×	1.44E-04 1.61E-04			1346-05	245-03	8,215-04	2.905-04	
<sup>76</sup> Se	Duck Frog	1.745-04 2.955-0 1.625-04 3.075-0 9.805-05 3.715-0		1.44E-04 1.61E-04		3.396-04	9.64E-05	_	t	1.396-04	7.435-05	2,855-05	4.348-05	7.175-05 435-03	7.15E-04		
	Salmonid egg	9.806-05 3.716-0	4 Salmonid eg	0 8.79E-05 1.45E-04	7.43E-05 2.42E-04		1.07E-04	4.85E-00		1.446-04		1.935-04	9.656-05		9.69E-06 4.91E-05		
			Rat Earthworn (	1.45E-04 elongated) 1.07E-04		1.85E-04 2.23E-04	9:25E-05 1.12E-04				7.435-05		1.34E-05 4.34E-05	155-05	1.01E-05 1.17E-04	8.885-05	
			<sup>108</sup> 1 Duck	1.93E-05	1.615-05		3.235-05		1	1.39E-04 1.69E-04		2.855-05	1.425-05	7.176-06	1.44E-04		
			Frog Salmonid eg	1.938-05 1.908-05 19 1.178-05	1.815-05 1.855-05 2.375-05		3.30E-08	4.745-0		8.86E-10 9.21E-10	9.865-10				1.016-04	7.435-05	
6	Emples					omono e30 - 270	4.3224						6.54E-08 1.19E-07	78E-04 39E-04 8.44E-06	1.39E-04 1.69E-04		
(@	Enviro							Rat Earth	worm (elongated)	2.975-03 2.975-03		2:22E-07 3:23E-07	1.11E-07 1.61E-07		1.34E-05 4.34E-05		
S.	Agency	y						<sup>236</sup> Pu Duck Frog Salm		2.97E-03 2.97E-03 2.97E-03	2.135-07 1.775-07 4.215-07		6.54E-08 1.19E-07	855-05	1.42E-05	7.17E-06	
								Salm	onid egg	2.97E-03	241 <sub>Am</sub> Du	ck.	3.195-03 1.365-05	8.445-06 935-04	9.65E-05 5.83E-06		
											Fix	ng Imonisi egg	3.19E-03 1.38E-05 3.19E-03 1.85E-05		7.65E-06	3.71E-06	
											754	t rthworm (elongated)	3.20E-03 3.19E-03	1.28E-05 1.70E-05	6.31E-06 8.52E-06		

# SP1a also notes

"Analogues, unless selected with great care, can give rise to misleading assessments. Analogues are often cautious because of the need to ensure a precautionary approach taking into account the uncertainties associated with their use."



# Keep all this in mind when Nick presents the Exercise 3 results!!

