



# Radiological Habits Survey: Sellafield Review, 2005

## Shellfish consumption and intertidal occupancy review



2006

**Radiological Habits Survey: Sellafield Review, 2005**  
**Shellfish consumption and intertidal occupancy review**

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## **1. Introduction**

This report describes a review of public radiation exposure pathways due to liquid radioactive waste discharges from the British Nuclear Fuels plc (BNFL) Sellafield, and the United Kingdom Atomic Energy Authority (UKAEA) Windscale sites. It is also relevant to marine discharges from the Drigg waste disposal site. The review, carried out during September 2005, specifically investigated consumption of crustaceans and molluscs and occupancy over intertidal sediments for members of the Sellafield Fishing Community (SFC). People who have had high shellfish consumption and/or high intertidal occupancy rates in the past were re-interviewed and contacts for new potential interviewees were sought, usually from information provided by existing interviewees.

Reviews are conducted annually because of the importance of the shellfish consumption and intertidal occupancy pathways at Sellafield. Also, consumption and occupancy rates have been known to vary significantly from year to year with some people giving up shellfish collection or fishing and new individuals being interviewed. The last full habits survey in the vicinity of Sellafield was conducted by the Centre for Environment, Fisheries & Aquaculture Science (Cefas) in 2003 (Clyne *et al*, 2004). Prior to this and in 2004, annual reviews of crustacean consumption, mollusc consumption and external exposure pathways have also been conducted.

The 2005 review used two techniques to collect data: direct interviewing and logging of selected high rate consumers. The logging data was used to check the validity of the interview data when consumption rates were considered to be exceptionally high. The results of this review could be used to direct changes to the Food Standards Agency's and the Environment Agency's environmental monitoring programmes in the Sellafield area.

## **2. Survey area**

The effects of discharges of liquid radioactive waste from Sellafield can be detected throughout the Irish Sea with a general decrease in concentrations as the distance from the source increases (EA, EHS, FSA and SEPA, 2005). The area of this review, shown in Figure 1, has been chosen to include consumption of seafood caught and collected, and intertidal activities in the local area, from Parton in the north to Tarn Bay in the south. As with previous surveys and reviews, Sellafield coastal seafood has been defined as that which was caught within 11 km of the shore.

## **3. Conduct of the survey**

Individuals known to have had high rates of crustaceans and molluscs consumption and/or intertidal occupancy in previous surveys were re-visited and interviewed. During the interviews individuals were asked to estimate crustacean and mollusc consumption rates and occupancy rates over intertidal areas for themselves and some members of their families. Individuals

interviewed as a result of their high crustacean or mollusc consumption rates or intertidal occupancy rates were also asked to provide consumption rates for fish, wildfowl and marine plants, and rates for handling intertidal sediments or fishing gear. Information was also obtained about the sources of the seafood they consumed and the locations where their intertidal occupancy most commonly took place. Selected high rate consumers identified from previous surveys and reviews had also been logging their seafood consumption and intertidal occupancy for four fortnightly periods during the year.

The habits of 28 individuals were recorded during the fieldwork. Most of these were adults. Few child observations were made and those that were made were generally of low significance, taking into account relative dose coefficients. The analysis was therefore limited to adults. Their crustacean and mollusc consumption rates and intertidal occupancy rates are shown in Tables 1 to 3, respectively. The full set of data collected can be seen in Annex 1 for adults and Annex 2 for children.

#### **4. Data analysis**

##### **4.1 Internal exposure**

The mean consumption rates of the critical groups eating Sellafield coastal shellfish were 20 kg/y for crustaceans based on eight observations (maximum rate 38 kg/y) and 33 kg/y for molluscs based on four observations (maximum rate 50 kg/y).

The main species consumed were crabs, lobsters, *Nephrops*, winkles, mussels and cockles. From observations of consumption preferences of the critical groups for different species in 2005, assessments can be based on the following:

- Crustaceans - 60% crab, 20% lobster and 20% *Nephrops*
- Molluscs - 60% winkles and 40% other molluscs

The 2005 SFC critical group mean consumption rate identified in this report for molluscs compares favourably with that identified in 2004 review. The 2005 critical group mean consumption rate for crustaceans was approximately 20% lower than the rate identified in the 2004 review. The 2004 rates currently being used for dose assessments are:

- 25 kg/y crustaceans (50% crab, 40% lobster and 10% *Nephrops*)
- 34 kg/y molluscs (50% winkles and 50% other molluscs)

The percentage species distribution for crustaceans shows a small increase in crab and *Nephrops* consumption and a small decrease in lobster consumption. The percentage species distribution for molluscs showed a small increase in winkle consumption leading to a slight decrease in the consumption of other molluscs.

Figures 2 and 3 show how the critical group mean consumption rates for crustaceans and molluscs have changed in the last ten years. The source data for the production of these charts are the RIFE SFC five year averaging data shown in Annex 3.

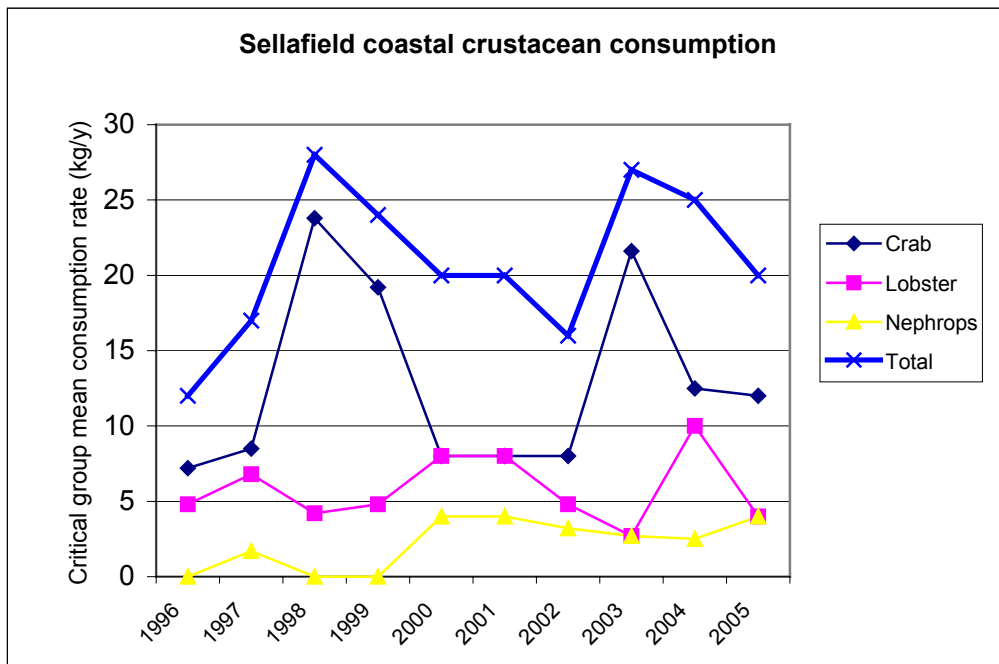


Figure 2. Critical group mean consumption rates of crustaceans 1996 to 2005.

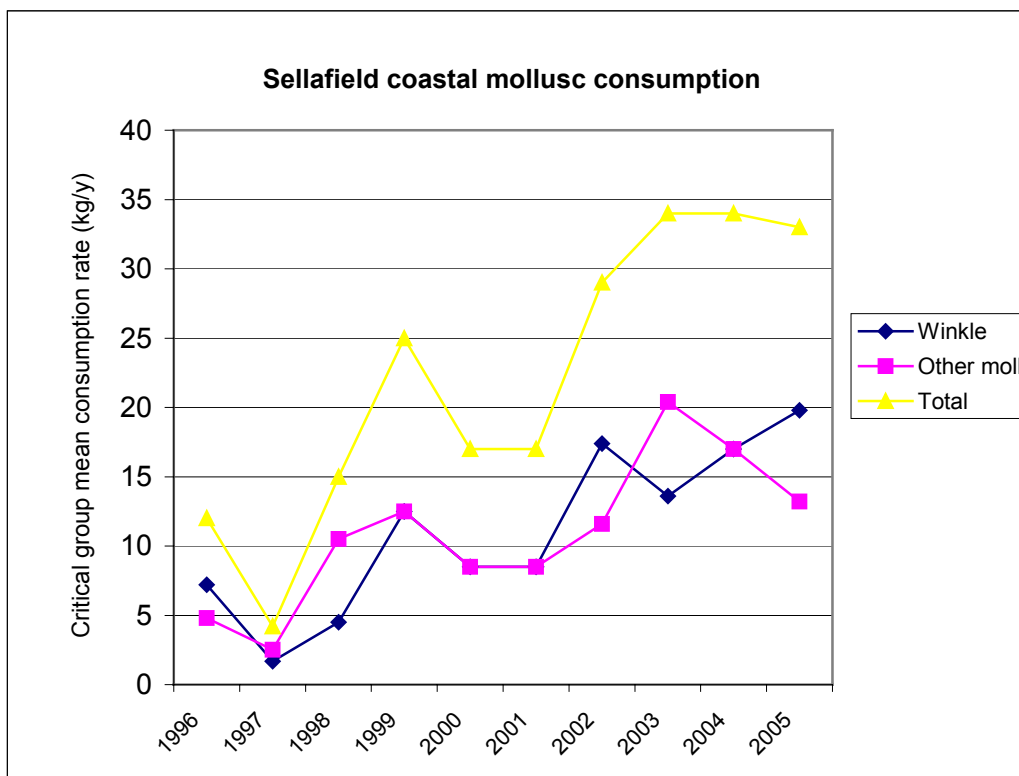


Figure 3. Critical group mean consumption rates of molluscs 1996 to 2005.

Since the review did not target consumers of fish, wildfowl or marine plants, not enough data was collected to generate dependable critical group values. Therefore the fish consumption

rate from the full habits survey at Sellafield in 2003 of 41 kg/y will be retained. Consumption of fish, wildfowl and marine plants was noted in the 2005 review and rates can be seen in Annex 1.

#### **4.2 External exposure**

In 2005 intertidal occupancy rates were noted for four different substrate types. These rates and substrates are shown in Table 3. The substrates were mud and sand, sand and stones, rock and salt marsh.

Eight individuals (shellfish collecting, bait digging, dog walking and conducting boat maintenance) formed the critical group over mud and sand with a mean occupancy time of 790 h/y. The maximum occupancy time over mud and sand was 1200 h/y for a shellfish collector.

Four individuals (angling and beach combing) formed the critical group over sand and stones with a mean occupancy time of 540 h/y. The maximum occupancy time over sand and stones was 750 h/y for an individual who was angling.

The only occupancy over rock was 80 h/y for a shellfish collector and the only occupancy over salt marsh was 65 h/y for a wildfowler.

Handling of sediment was identified in the 2005 review and handling rates can be seen in Annexes 1 and 2. No handling of fishing gear was noted in the review.

Table 3 shows that some individuals were noted to have occupancies over more than one substrate type. Notably, Observation Number 14 had the maximum occupancy times over the sand and stone substrate and the second highest occupancy time over the mud and sand substrate.

These rates compare with occupancy rates identified during the 2004 review of 1000 h/y over mud and sand for nine individuals (maximum time 1500 h/y), 610 h/y over sand and stones for five individuals (maximum time 1100 h/y) and 220 h/y over rock for one individual. No occupancy over salt marsh was identified in the 2004 review.

As handling of sediment and fishing gear and the intertidal occupancy of other Sellafield groups (as defined in Appendix 4 of Radioactivity in Food and the Environment, 2004, (RIFE 10) (EA, EHS, FSA and SEPA, 2005)) were not specifically targeted, recommended rates for handling and occupancy over saltmarsh will remain as they were in RIFE 10. These were 1000 h/y for handling sediment, 730 h/y for handling fishing gear and 400 h/y occupancy over salt marsh.

## **5. Conclusions**

The overlap between pathways, shown in Table 4, has been considered. One individual is a member of three critical groups and other observations are members of two critical groups for the following pathways; crustaceans, molluscs and occupancy over mud and sand. They also consume fish. Therefore, it is recommended that a direct combination of critical rates for fish, crustacean and mollusc consumption and occupancy over sand and mud is made.

The National Dose Assessments Working Group (NDAWG) has considered methods for calculating total dose from consumption and occupancy data provided by habits surveys. The relevant profile for Sellafield is shown in Annex 4. It is based on data from the full 2003 habits survey at Sellafield but includes updates from the 2004 and 2005 reviews. Further discussion of the use of these data in assessments is given in RIFE 10 (EA, EHS, FSA and SEPA, 2005).

## **6. Recommendations**

In view of the importance of shellfish consumption and intertidal occupancy pathways at Sellafield and the fact that consumption and occupancy may vary from year to year, it is recommended that the annual shellfish consumption and intertidal occupancy review of the SFC be continued.

## **7. References**

Clyne, F.J., McTaggart, K.A. and Tipple, J.R., 2004. Radiological Habits Survey: Sellafield, 2003. EA, FSA and HSE, Warrington, London and Bootle.

EA, EHS, FSA and SEPA, 2005. Radioactivity in Food and the Environment, 2004. EA, EHS, FSA and SEPA, Warrington, Belfast, London and Stirling. RIFE(10).

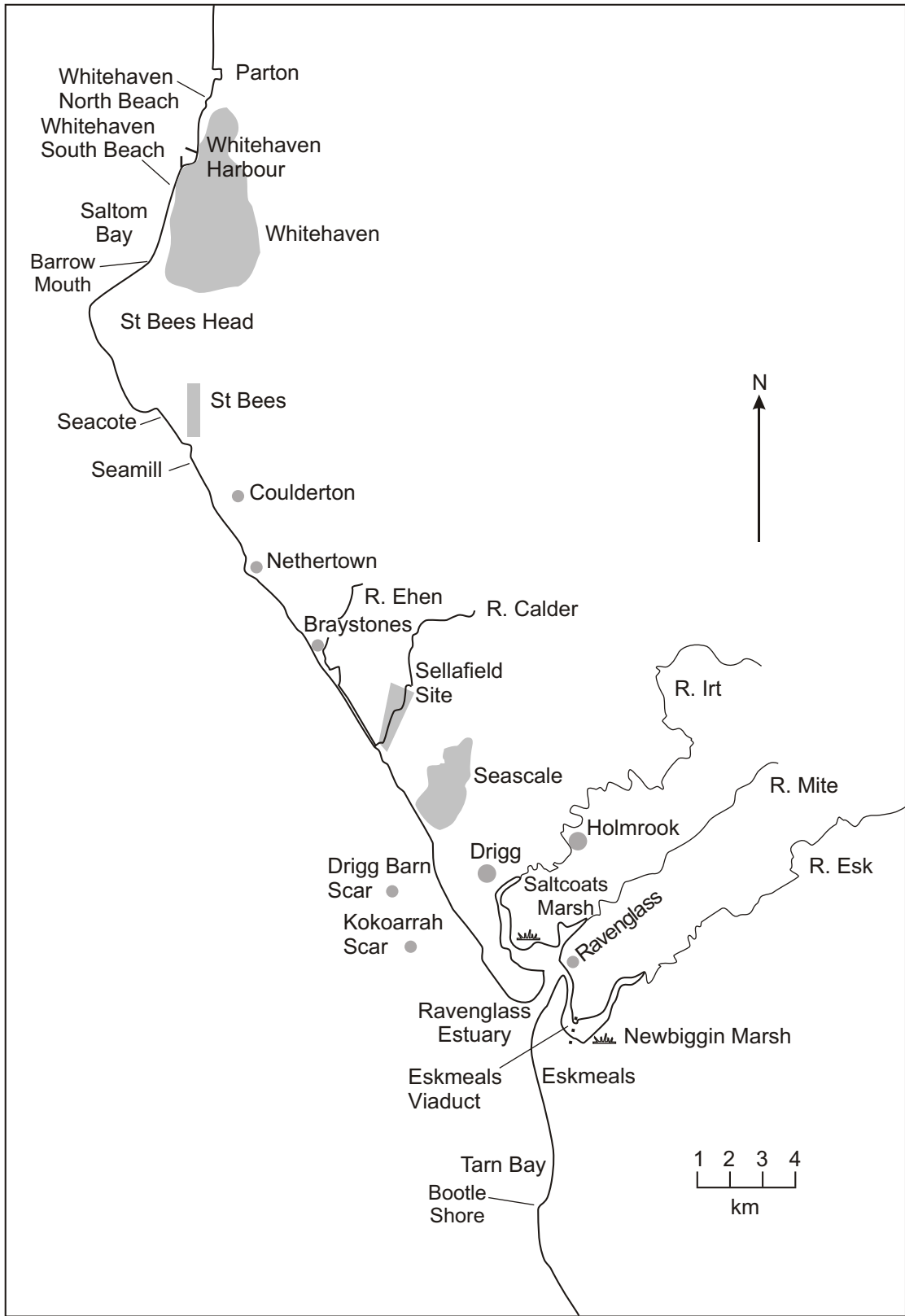


Figure 1. The Sellafield aquatic survey area

**Table 1. Adults' consumption rates of crustaceans in the Sellafield area (kg/y)**

Observation number	Brown shrimp	Crab	Lobster	<i>Nephrops</i>	Total
<b>4</b>		<b>35.4</b>	<b>2.7</b>		<b>38.1</b>
<b>18</b>		<b>9.3</b>	<b>3.9</b>	<b>7.2</b>	<b>20.5</b>
<b>19</b>		<b>9.3</b>	<b>3.9</b>	<b>7.2</b>	<b>20.5</b>
<b>5</b>		<b>18.4</b>	<b>1.4</b>		<b>19.8</b>
<b>28</b>				<b>16.8</b>	<b>16.8</b>
<b>20</b>		<b>6.3</b>	<b>7.1</b>	<b>0.9</b>	<b>14.3</b>
<b>6</b>		<b>8.8</b>	<b>5.4</b>		<b>14.3</b>
<b>8</b>		<b>8.8</b>	<b>5.4</b>		<b>14.3</b>
11		5.0	4.5	0.1	9.6
12		5.0	4.5	0.1	9.6
13		5.0	4.5	0.1	9.6
21			7.1	0.9	8.0
2		2.6	2.1		4.7
3		1.4	2.1		3.5
23	0.7	0.5	0.6		1.8
24	0.7	0.5	0.6		1.8
1		0.8	0.2		1.0
25			0.1		0.1
26			0.1		0.1
27			0.1		0.1

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of crustaceans based on the 8 highest adult consumers is 19.8 kg/y

**Table 2. Adults' consumption rates of molluscs in the Sellafield area (kg/y)**

Observation number	Cockle	Mussel	Razor shell	Whelk	Winkle	Total
<b>16</b>	<b>5.1</b>	<b>10.9</b>			<b>34.1</b>	<b>50.1</b>
<b>17</b>	<b>5.1</b>	<b>8.5</b>			<b>29.6</b>	<b>43.2</b>
<b>4</b>	<b>11.8</b>	<b>5.9</b>			<b>5.0</b>	<b>22.6</b>
<b>28</b>	<b>4.0</b>	<b>6.4</b>			<b>6.4</b>	<b>16.8</b>
5	5.9	2.9			2.5	11.3
15				8.2	0.0	8.2
3		1.4			1.0	2.4
23		0.9	0.8		0.2	1.9
24		0.9	0.8		0.2	1.9
2	0.8				0.3	1.2
18	0.6			0.5		1.1
19	0.6			0.5		1.1
6				0.2		0.2
11		0.1				0.1
12		0.1				0.1
13		0.1				0.1
20		0.1				0.1

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of molluscs based on the 4 highest adult consumers is 33.2 kg/y

**Table 3. Intertidal occupancy rates in the Sellafield area (h/y)**

Observation number	Location	Activity	Mud and sand	Rock	Salt marsh	Sand and stones
<b>3</b>	<b>Ravenglass and St Bees/St. Bees Beach</b>	<b>Shellfish collecting/Angling</b>	<b>1191</b>			208
<b>14</b>	<b>Braystones and Drigg/Braystones</b>	<b>Bait digging/Angling</b>	<b>1125</b>			<b>750</b>
<b>2</b>	<b>Various/St Bees and Whitehaven</b>	<b>Shellfish collecting/Angling</b>	<b>878</b>			208
<b>1</b>	<b>Drigg Beach</b>	<b>Dog walking</b>	<b>750</b>			
<b>4</b>	<b>Whitehaven and Ravenglass</b>	<b>Bait digging, boat maintenance and shellfish collecting</b>	<b>624</b>			
<b>5</b>	<b>Whitehaven and Ravenglass</b>	<b>Bait digging, boat maintenance and shellfish collecting</b>	<b>624</b>			
<b>6</b>	<b>Ravenglass Beach/Unknown</b>	<b>Boat maintenance/Wildfowling</b>	<b>572</b>		<b>65</b>	
<b>7</b>	<b>Ravenglass Beach</b>	<b>Boat maintenance</b>	<b>572</b>			
<b>18</b>	<b>Eskmeals to Whitehaven/St Bees, Nethertown and Sellafield</b>	<b>Bait digging/Angling</b>	375			<b>400</b>
16	Ravenglass, Barrow Mouth and Whitehaven/Whitehaven beach	Shellfish collecting/Dog walking	144			150
15	Coulderton, Ravenglass and Seascale	Shellfish collecting and walking	125			
<b>11</b>	<b>Parton Beach</b>	<b>Shellfish collecting/Beach combing</b>		<b>80</b>		<b>480</b>
<b>23</b>	<b>Braystones</b>	<b>Angling</b>				<b>520</b>
25	Parton Beach	Angling				182
28	St Bees and Sellafield	Shellfish collecting				68
27	Parton Beach	Walking				60

**Notes**

Emboldened observations are the critical group members

The critical group intertidal occupancy over mud and sand based on 8 observations is 792 h/y

The critical group intertidal occupancy over rock based on 1 observation is 80 h/y

The critical group intertidal occupancy over salt marsh based on 1 observation is 65 h/y

The critical group intertidal occupancy over sand and stones based on 4 observations is 538 h/y

**Table 4. Aquatic combinations table for adults in the Sellafield area**

Observation number	Internal exposure Consumption rates (kg/y)					Intertidal occupancy (h/y)			
	Fish	Crustaceans	Molluscs	Marine plants and algae	Wildfowl	Mud and sand	Sand and stones	Salt marsh	Rock
3	46.6	3.5	2.4			<b>1191</b>	208		
6	28.1	<b>14.3</b>	0.2		<b>7.6</b>	<b>572</b>		<b>65</b>	
8	28.1	<b>14.3</b>			<b>7.6</b>				
4	25.9	<b>38.1</b>	<b>22.6</b>			<b>624</b>			
18	15.0	<b>20.5</b>	1.1			375	<b>400</b>		
19	15.0	<b>20.5</b>	1.1						
23	14.8	1.8	1.9				<b>520</b>		
2	14.1	4.7	1.2			<b>878</b>	208		
5	12.9	<b>19.8</b>	11.3			<b>624</b>			
20	8.1	<b>14.3</b>	0.1						
28	6.0	<b>16.8</b>	16.8				68		
11	4.5	9.6	0.1				<b>480</b>		<b>80</b>
1		1.0		<b>0.03</b>		<b>750</b>			
16			<b>50.1</b>			144	150		
17			<b>43.2</b>						
7						<b>572</b>			
14						<b>1125</b>	<b>750</b>		

**NOTES**

Emboldened text represents members of the most exposed sub-groups within each pathway

**Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Sellafield area**

Observation number	Sex	Age in years (U if unknown)	Distance of residence from site (km) (U if unknown)	Fish	Crustaceans	Molluscs	Marine plants and algae	Wildfowl	Other vegetables grown in a seaweed fertiliser	Root vegetables grown in a seaweed fertiliser	Potato grown in a seaweed fertiliser	Intertidal occupancy over mud and sand	Intertidal occupancy over rock	Intertidal occupancy over salt marsh	Intertidal occupancy over sand and stones	Handling sediment
1	M	U	4.5		1.0		<b>0.03</b>		<b>2.3</b>	<b>20.4</b>	<b>15.9</b>	<b>750</b>				
2	M	25	13.0	14.1	4.7	1.2						<b>878</b>			208	<b>878</b>
3	M	21	13.0	<b>46.6</b>	3.5	2.4						<b>1191</b>			208	<b>1191</b>
4	M	55	13.0	<b>25.9</b>	<b>38.1</b>	<b>22.6</b>						<b>624</b>				144
5	M	24	13.0	12.9	<b>19.8</b>	11.3						<b>624</b>				144
6	M	U	2.8	<b>28.1</b>	<b>14.3</b>	0.2		<b>7.6</b>				<b>572</b>		<b>65</b>		65
7	M	U	U									<b>572</b>				
8	F	U	2.8	<b>28.1</b>	<b>14.3</b>			<b>7.6</b>								
11	M	66	13.0	4.5	9.6	0.1							<b>80</b>		<b>480</b>	80
12	F	67	13.0	4.5	9.6	0.1										
13	F	34	13.0	4.5	9.6	0.1										
14	M	64	5.0									<b>1125</b>			<b>750</b>	<b>1125</b>
15	M	66	7.0			8.2						125				25
16	M	48	14.0			<b>50.1</b>						144			150	144
17	M	17	14.0			<b>43.2</b>										
18	M	25	U	15.0	<b>20.5</b>	1.1						375			<b>400</b>	375
19	M	47	U	15.0	<b>20.5</b>	1.1										
20	M	U	U	8.1	<b>14.3</b>	0.1										
21	F	U	U	8.1	8.0											
23	M	U	U	14.8	1.8	1.9									<b>520</b>	
24	F	U	U	14.8	1.8	1.9										
25	M	U	U	<b>29.0</b>	0.1										182	
26	F	U	U	<b>29.0</b>	0.1											
27	F	U	U	<b>24.9</b>	0.1										60	
28	M	U	U	6.0	<b>16.8</b>	<b>16.8</b>									68	68

**Annex 2. Children's consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Sellafield area**

Observation number	Sex	Age in years	Distance of residence from site (km)	Fish	Crustaceans	Wildfowl
<b>10 year old age group</b>						
9	M	10	2.8	<b>14.0</b>	<b>7.1</b>	<b>4</b>
10	M	8	2.8	<b>14.0</b>	<b>7.1</b>	<b>4</b>
22	F	12	U	4.0	1.0	

Annex 3. RIFE SFC 5 year averaging data

Year (and report)	FISH					CRUSTACEANS					MOLLUSCS				EXTERNAL		Habits source data	
	kg/y	Species	Cod	Plaice	Other fish	kg/y	Species	Crab	Lobster	<i>Nephrops</i>	kg/y	Species	Winkles	Other molluscs	h/y	Substrate	Consumption	External
1994 (AEMR 45)	26.0	plaice and cod	13.0	13.0	0.0	12.0	Crabs and Lobsters	6.0	6.0	0.0	9.7	winkles and other molluscs	4.9	4.9	0		1993/94 Survey	1993/94 Survey
1995 (RIFE 1)	26.0	plaice and cod	13.0	13.0	0.0	8.6	Crabs and Lobsters (75%:25%)	6.5	2.2	0.0	12.0	winkles and other molluscs	6.0	6.0	0		1995 Review (crus + moll)	
1996 (RIFE 2)	25.0	plaice and cod	12.5	12.5	0.0	12.0	Crabs and Lobsters (60%:40%)	7.2	4.8	0.0	12.0	winkles and other molluscs (60%:40%)	7.2	4.8	0		1996 Review	1997 Review
1997 (RIFE 3)	37.0	plaice and cod (25%:75%)	27.8	9.3	0.0	17.0	Crabs, Lobsters and <i>Nephrops</i> (50%:40%:10%)	8.5	6.8	1.7	4.2	winkles and other molluscs (40%:60%)	1.7	2.5	0		1997 Review	
1998 (RIFE 4)	45.0	plaice and cod (50%:50%)	22.5	22.5	0.0	28.0	Crabs and Lobsters (85%:15%)	23.8	4.2	0.0	15.0	winkles and other molluscs (30%:70%)	4.5	10.5	1100	Sand and mollusc beds	1998 Survey	1999 Survey
1999 (RIFE 5)	43.0	plaice and cod (50%:50%)	21.5	21.5	0.0	24.0	Crabs and Lobsters (80%:20%)	19.2	4.8	0.0	25.0	winkles and other molluscs (50%:50%)	12.5	12.5	1000	Sand and mollusc beds	1999 Review	2000 Review
2000 (RIFE 6)	31.0	cod and other fish (40%:60%)	12.4	0.0	18.6	20.0	Crabs, Lobsters and <i>Nephrops</i> (40%:40%:20%)	8.0	8.0	4.0	17.0	winkles and other molluscs (50%:50%)	8.5	8.5	1000	Sand and mollusc beds	2000 Review	2001 Review
2001 (RIFE 7)	31.0	cod and other fish (40%:60%)	12.4	0.0	18.6	20.0	Crabs, Lobsters and <i>Nephrops</i> (40%:40%:20%)	8.0	8.0	4.0	17.0	winkles and other molluscs (50%:50%)	8.5	8.5	900	Sand and mollusc beds	2001 Review	2002 Review
2002 (RIFE 8)	51.0	cod and other fish (40%:60%)	20.4	0.0	30.6	16.0	Crabs, Lobsters and <i>Nephrops</i> (50%:30%:20%)	8.0	4.8	3.2	29.0	winkles and mussels (60%:40%)	17.4	11.6	1200	Mud and sand	2002 Review	2003 Review
2003 (RIFE 9)	41.0	cod and other fish (60%:40%)	24.6	0.0	16.4	27.0	Crabs, Lobsters and <i>Nephrops</i> (80%:10%:10%)	21.6	2.7	2.7	34.0	winkles and other molluscs (40%:60%)	13.6	20.4	870	Mud and sand	2003 Survey	2003 Survey
2004 (RIFE 10)	41.0	cod and other fish (60%:40%)	24.6	0.0	16.4	25.0	Crabs, Lobsters and <i>Nephrops</i> (50%:40%:10%)	12.5	10.0	2.5	34.0	winkles and other molluscs (50%:50%)	17.0	17.0	1000	Mud and sand	2004 Review	2004 Review
2005 (RIFE 11)	41.0	cod and other fish (60%:40%)	24.6	0.0	16.4	20.0	Crabs, Lobsters and <i>Nephrops</i> (60%:20%:20%)	12.0	4.0	4.0	33.0	winkles and other molluscs (60%:40%)	19.8	13.2	790	Mud and sand	2005 Review	2005 Review

5-YEAR AVERAGES

5 year period	Fish	Cod	Plaice	Other fish	Crustaceans	Crab	Lobster	<i>Nephrops</i>	Molluscs	Winkles	Other molluscs	External
1994-98	31.8	17.8	14.1	0.0	15.5	10.4	4.8	0.3	10.6	4.8	5.7	220
1995-99	35.2	19.5	15.8	0.0	17.9	13.0	4.6	0.3	13.6	6.4	7.3	420
1996-00	36.2	19.3	13.2	3.7	20.2	13.3	5.7	1.1	14.6	6.9	7.8	620
1997-01	37.4	19.3	10.7	7.4	21.8	13.5	6.4	1.9	15.6	7.1	8.5	800
1998-02	40.2	17.8	8.8	13.6	21.6	13.4	6.0	2.2	20.6	10.3	10.3	1040
1999-03	39.4	18.3	4.3	16.8	21.4	13.0	5.7	2.8	24.4	12.1	12.3	994
2000-04	39.0	18.9	0.0	20.1	21.6	11.6	6.7	3.3	26.2	13.0	13.2	994
2001-05	41.0	21.3	0.0	19.7	21.6	12.4	5.9	3.3	29.4	15.3	14.1	952

SUGGESTED 5 YEAR AVERAGES TO USE IN RIFE 11 DOSE CALCULATIONS	
	kg/y
<b>Fish</b>	<b>41 kg/y</b>
<b>Crabs</b>	<b>12 kg/y</b>
<b>Lobsters</b>	<b>5.9 kg/y</b>
<b><i>Nephrops</i></b>	<b>3.3 kg/y</b>
<b>Winkles</b>	<b>15 kg/y</b>
<b>Other molluscs</b>	<b>14 kg/y</b>
<b>External</b>	<b>950 h/y (mud and sand)</b>

Annex 4. Summary of adults' profiled habits data in the Sellafield area

Profile Name	Number of Individuals	Pathway Name	Consumption Categories																										
			Crustacea	Direct <sup>4</sup>	Eggs	Fish - Fresh	Fish - Sea	Fruit - Domestic	Fruit and nuts - Wild	Gamma ext - Sand/Mud <sup>1</sup>	Gamma ext - Salt marsh	Honey	Meat - Cattle	Meat - Game <sup>2</sup>	Meat - Poultry	Meat - Sheep	Milk	Mollusca	Mushrooms	Occupancy In Water	Occupancy On Water	Plume (IN; 0-0.25km) <sup>3</sup>	Plume (MID; 0.25-0.5km) <sup>3</sup>	Plume (OUT; 0.5-1km) <sup>3</sup>	Vegetables - Green	Vegetables - Other Domestic	Vegetables - Potatoes	Vegetables - Root	
			kg	-	kg	kg	kg	kg	kg	h	h	kg	kg	kg	kg	kg	l	kg	kg	h	h	h	h	h	kg	kg	kg	kg	
Crustacean consumers	12		21.0							33.2								9.1											
Occupants for direct radiation	74		1	3.7		0.6	0.8	0.5	46			6.0	0.1	0.5	1.6	46.8		0.1		8	892	909	1658	0.8	1.0	7.2	1.0		
Egg consumers	58		0.36	13.1		0.6	4.8	0.8	14			10.9		1.9	3.1	92.0		0.2			1017	868	504	6.2	4.7	30.2	6.0		
Fresh fish consumers	10			1.2	0.2	1.4							0.3	2.0				0.1									33.3		
Sea fish consumers	13	7.4				58.6				494							4.0			132									
Domestic fruit consumers	13			6.4		32.1	0.3	24		1.5			3.1	1.6				0.1		12				15.3	25.5	65.9	21.4		
Wild fruit and nut consumers	13		0.62	10.0		0.1	3.7	3.4				7.3	0.2	1.0	2.0	8.0		0.4				2167	1812	8.7	3.7	36.0	10.9		
Occupants for exposure - Sand/Mud	53	1.0	0.04			6.3			828								1.1			10		7							
Occupants for exposure - Salt marsh	1	4.8				9.4			381	171			3.4				0.1												
Honey consumers	4							42.1	0.7	78		5.0		2.8						40				3.5	12.9	12.3	19.0		
Cattle meat consumers	28		0.32	5.2		0.1	1.4	0.5				46.3	0.1	2.4	6.4	113.9		0.2			819	457	1014	0.1	2.0	28.8	2.8		
Game meat consumers	3												25.7	6.1															
Poultry meat consumers	24		0.25	6.2		0.2	10.2	0.6	13		0.3	17.7	3.4	6.6	6.3	57.8		0.3		7	689	533	504	2.5	6.9	31.9	6.4		
Sheep meat consumers	6		0.67	8.9			5.4	2.0				49.8	0.5	3.9	23.6	139.0		0.4				2134	2018	0.3	2.4	1.5	1.9		
Milk consumers	35		0.37	4.8		0.4	1.7	0.4	18			12.7		0.9	2.0	260.0					1357	1030	465	0.7	0.2	16.4	3.6		
Mollusc consumers	7	12.5				21.9			326							34.0				180									
Mushroom consumers	9		0.22	6.6			11.1	1.3	13		0.1			0.6	1.7	46.1	0.1	2.1					1621	12.0	7.6	35.3	15.1		
Occupants in water	15	0.2				2.0			36								0.3		87										
Occupants on water	7	14.4	0.14			18.0			278								6.3			925		6							
Occupants for plume pathways (inner area)	8		1	10.8		0.2		0.4	33			14.2		1.3	2.8	165.9					7372						3.2		
Occupants for plume pathways (middle area)	9		1	11.5			4.3	1.6	13			15.7		1.2	7.9	156.2		0.1				7136					36.8	1.1	
Occupants for plume pathways (outer area)	19		1	3.4		0.6	1.1	0.9				10.0	0.1	0.9	1.3	38.2		0.5					6305	0.1	2.3	0.5	0.2		
Green vegetable consumers	14		0.07	11.7		1.2	17.8	0.6						0.7	1.5			0.3						71	35.8	26.3	81.3	31.4	
Other domestic vegetable consumers	9		0.11	9.3			21.4	0.1						1.0	2.3			0.2						111	32.8	38.4	93.2	35.0	
Potato consumers	36		0.08	6.4		0.6	5.5	0.3	1			10.5		2.4	0.9	43.1		0.2				401	28	10.5	9.6	109.4	11.4		
Root vegetable consumers	21		0.05	7.8		0.8	16.5	1.2	15		0.3	4.5		1.0	1.0	29.6		0.2		8		48	25.5	19.8	65.4	30.9			

Notes

1. Gamma ext - Sand/Mud includes occupancy over coal and sand, sand, sand and mud, and sand and stone
2. Game meat includes wildfowl, rabbits/hares and venison
3. Plume times are the sums of individuals' indoor and outdoor times
4. Expressed as proportion of group who are present within 1km of site



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