Cefas

Radiological Habits Survey: Sellafield Review, 2005

Shellfish consumption and intertidal occupancy review

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Radiological Habits Survey: Sellafield Review, 2005

Shellfish consumption and intertidal occupancy review

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Contents

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 mollusc and crustacean consumption and intertidal occupancy rates 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 and 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 shellfish consumption and/or intertidal occupancy in previous surveys were re-visited and interviewed. In addition, two new people who had high consumption and intertidal occupancy rates were identified. During the interviews individuals were asked to estimate seafood consumption rates and occupancy times over intertidal areas for themselves and members of their families. Individuals identified as having high crustacean

or mollusc rates or intertidal occupancy rates were also asked to provide consumption rates for fish, wildfowl and marine plants and algae. Information was also obtained about the sources of 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 external 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

Since the review did not target fish consumers *per se,* not enough data was collected to generate a dependable fish critical group value. Therefore the fish consumption rate from the full habits survey at Sellafield in 2003 of 41 kg/y will be retained.

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 species distribution for crustaceans shows a small percentage increase in crab and *Nephrops* consumption and a small percentage decrease in lobster consumption. The species

distribution for molluscs showed a small percentage increase in winkle consumption leading to a slight percentage decrease in other molluscs consumption. The trends in critical group mean consumption rates of crustaceans and molluscs over the last ten years are shown in Figures 2 and 3, respectively. The source data for the production of these charts are from the RIFE SFC five year averaging data shown in Annex 3.

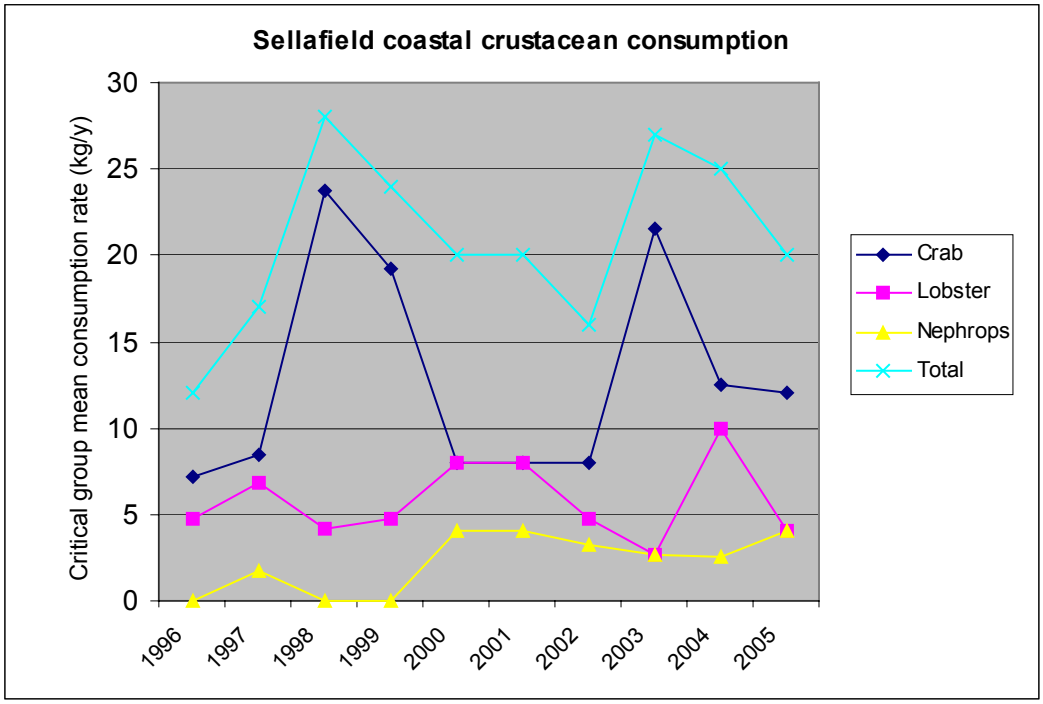

Figure 2. Critical group consumption rates of crustaceans 1996 to 2005.

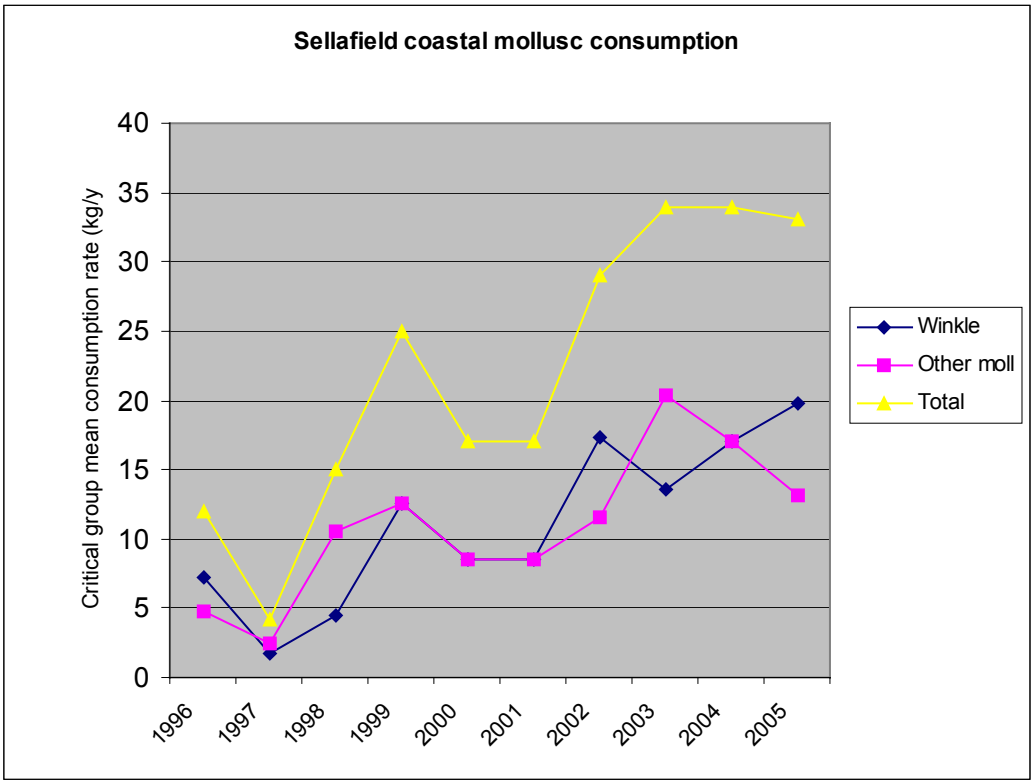

Figure 3. Critical group consumption rates of molluscs 1996 to 2005.

The 2005 review did not seek to identify new critical group rates for consumption of wildfowl or marine plants and algae. Consumption of these foods was noted 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 (bait digging, angling, dog walking, conducting boat maintenance, beach combing and shellfish collecting), 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 1100 h/y for a commercial bait digger and angler.

Four individuals (angling, shellfish collecting, 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/sand and stones was 750 h/y for an individual who was angling and bait digging.

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.

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 both the mud and sand and sand and stone substrates.

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 intertidal occupancy of other Sellafield groups (as defined in Appendix 4 of Radioactivity in Food and the Environment, 2004, (EA, EHS, FSA and SEPA, 2005)) were not specifically targeted, the handling times and occupancy over saltmarsh will remain the same. 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.

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).

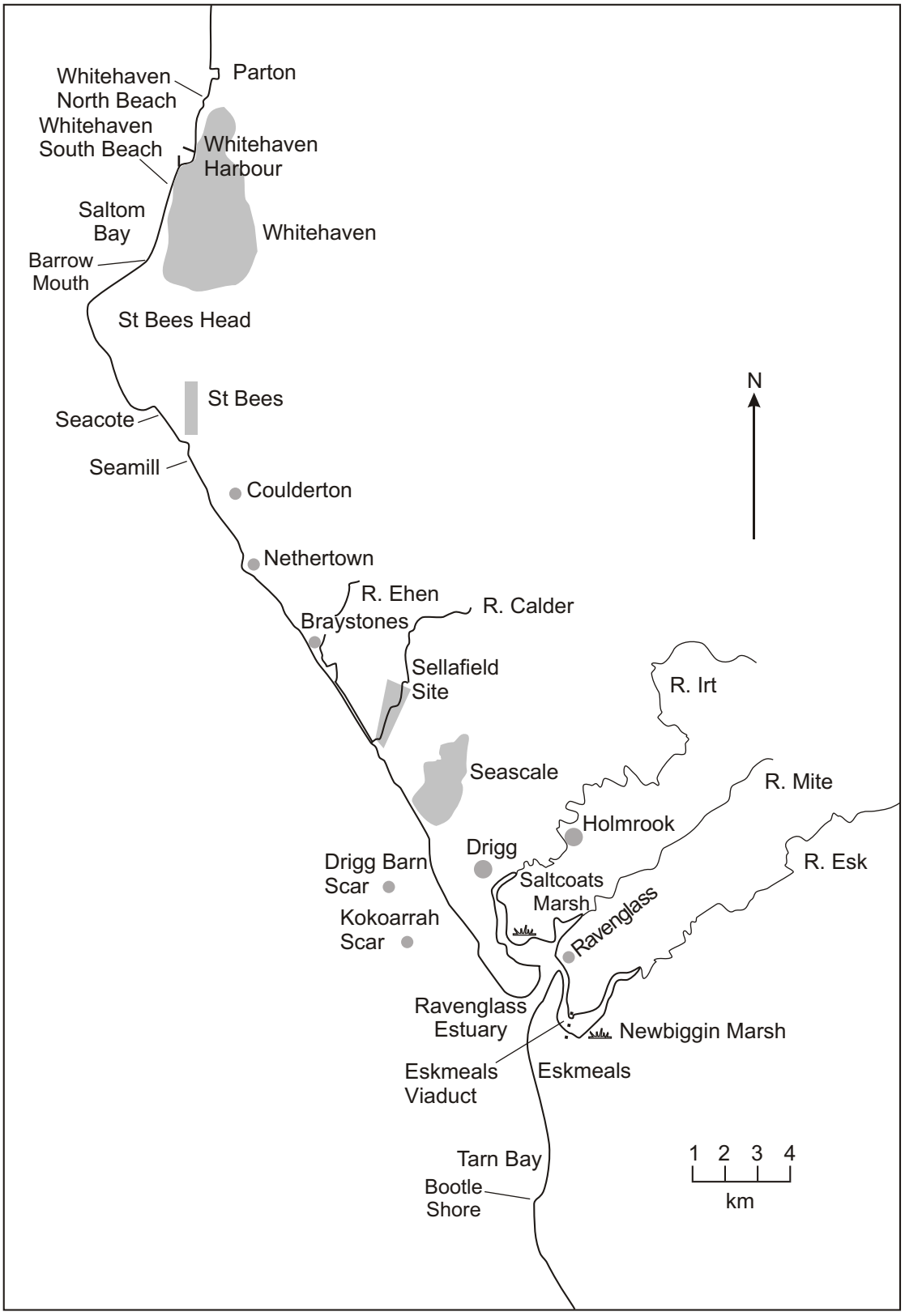

Figure 1. The Sellafield aquatic survey area

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

Observation number	Brown shrimp	Crab	Lobster	*Nephrops*	Total
4		**35.4**	**2.7**		**38.1**
18		**9.3**	**3.9**	**7.2**	**20.5**
19		**9.3**	**3.9**	**7.2**	**20.5**
5		**18.4**	**1.4**		**19.8**
28				**16.8**	**16.8**
20		**6.3**	**7.1**	**0.9**	**14.3**
6		**8.8**	**5.4**		**14.3**
8		**8.8**	**5.4**		**14.3**
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
22			1.0		1.0
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
16	**5.1**	**10.9**			**34.1**	**50.1**
17	**5.1**	**8.5**			**29.6**	**43.2**
4	**11.8**	**5.9**			**5.0**	**22.6**
28	**4.0**	**6.4**			**6.4**	**16.8**
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)

Obs. number	Location	Activity	Mud and sand	Rock	Salt marsh	Sand and stones
3	**Ravenglass and St Bees/**St. Bees Beach	**Shellfish collecting/**angling	**1191**			208
14	**Braystones and Drigg/Braystones**	**Bait digging/angling**	**1125**			**750**
2	**Various/**St Bees and Whitehaven	**Shellfish collecting/**angling	**878**			208
1	**Drigg Beach**	**Dog walking**	**750**			
4	**Whitehaven and Ravenglass**	**Bait digging, boat maintenance and shellfish collecting**	**624**			
5	**Whitehaven and Ravenglass**	**Bait digging, boat maintenance and shellfish collecting**	**624**			
6	**Ravenglass beach/Unknown**	**Boat maintenance/wildfowling**	**572**		**65**	
7	**Ravenglass beach**	**Boat maintenance**	**572**			
18	Eskmeals to Whitehaven**/St Bees, Nethertown and Sellafield**	Bait digging**/angling**	375			**400**
16	Ravenglass, Barrow Mouth and Whitehaven/Whitehaven beach	Shellfish collecting/dog walking	144			150
15	Caulderton, Ravenglass and Seascale	Shellfish collecting and walking	125			
11	**Parton Beach**	**Shellfish collecting/beach combing**		**80**		**480**
23	**Braystones**	**Angling**				**520**
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 consumers

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

	Internal exposure Consumption rates (kg/y)					Intertidal occupancy (h/y)			
Observation number	Fish	Crustaceans	Molluscs	Marine plants and algae	Wildfowl	Mud and sand	Sand and stones	Salt marsh	Rock
3	46.6	3.5	2.4			**1191**	208		
25	29.0	0.1					182		
26	29.0	0.1							
6	28.1	**14.3**	0.2		**7.6**	**572**		**65**	
8	28.1	**14.3**			**7.6**				
4	25.9	**38.1**	**22.6**			**624**			
27	24.9	0.1					60		
18	15.0	**20.5**	1.1			375	**400**		
19	15.0	**20.5**	1.1						
23	14.8	1.8	1.9				**520**		
2	14.1	4.7	1.2			**878**	208		
5	12.9	**19.8**	11.3			**624**			
20	8.1	**14.3**	0.1						
28	6.0	**16.8**	16.8				68		
11	4.5	9.6	0.1				**480**		**80**
1		1.0		**0.03**		**750**			
16			**50.1**			144	150		
17			**43.2**						
7						**572**			
14						**1125**	**750**		

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 (U if unknown)	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		**0.03**		**2.3**	**20.4**	**15.9**	**750**				
2	M	25	13.0	14.1	4.7	1.2						**878**			208	**878**
3	M	21	13.0	**46.6**	3.5	2.4						**1191**			208	**1191**
4	M	55	13.0	**25.9**	**38.1**	**22.6**						**624**				144
5	M	24	13.0	12.9	**19.8**	11.3						**624**				144
6	M	U	2.8	**28.1**	**14.3**	0.2		**7.6**				**572**		**65**		65
7	M	U	U									**572**				
8	F	U	2.8	**28.1**	**14.3**			**7.6**								
11	M	66	13.0	4.5	9.6	0.1							**80**		**480**	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									**1125**			**750**	**1125**
15	M	66	7.0			8.2						125				25
16	M	48	14.0			**50.1**						144			150	144
17	M	17	14.0			**43.2**										
18	M	25	U	15.0	**20.5**	1.1						375			**400**	375
19	M	47	U	15.0	**20.5**	1.1										
20	M	U	U	8.1	**14.3**	0.1										
21	F	U	U	8.1	8.0											
22	F	U	U	4.0	1.0											
23	M	U	U	14.8	1.8	1.9									**520**	
24	F	U	U	14.8	1.8	1.9										
25	M	U	U	**29.0**	0.1										182	
26	F	U	U	**29.0**	0.1											
27	F	U	U	**24.9**	0.1										60	
28	M	U	U	6.0	**16.8**	**16.8**									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 (U if unknown)	Age in years	Distance of residence from site (km)	Fish	Crustaceans	Wildfowl
10 year old age group						
9	M	10	2.8	**14.0**	**7.1**	**4**
10	M	8	2.8	**14.0**	**7.1**	**4**

Annex 3. RIFE SFC 5 year averaging data

Year	Report	Fish					Crustaceans					Molluscs				External		Habits source data	
		kg/y	Species	cod	plaice	other fish	kg/y	Species	crabs	lobsters	nephrops	kg/y	Species	winkles	other molluscs	h/y	Substrate	Consumption	External
1994	AEMR 45	26	plaice and cod	13	13	0	12	crabs and lobsters	6	6	0	9.7	winkles and other molluscs	4.85	4.85	0		1993/94 Full Survey	(1993/94 Full Survey)
1995	RIFE 1	26	plaice and cod	13	13	0	8.6	crabs and lobsters (75%:25%)	6.45	2.15	0	12	winkles and other molluscs	6	6	0		1995 Review (crus + moll)	
1996	RIFE 2	25	plaice and cod	12.5	12.5	0	12	crabs and lobsters (60%:40%)	7.2	4.8	0	12	winkles and other molluscs (60%:40%)	7.2	4.8	0		1996 Review	(1997 Review)
1997	RIFE 3	37	plaice and cod (25%:75%)	27.75	9.25	0	17	crabs, lobsters and nephrops (50%:40%:10%)	8.5	6.8	1.7	4.2	winkles and other molluscs (40%:60%)	1.68	2.52	0		1997 Review	
1998	RIFE 4	45	plaice and cod (50%:50%)	22.5	22.5	0	28	crabs and lobsters (85%:15%)	23.8	4.2	0	15	winkles and other molluscs (30%:70%)	4.5	10.5	1100	over sand and mollusc beds	1998 Full Survey	1998 Full Survey
1999	RIFE 5	43	plaice and cod (50%:50%)	21.5	21.5	0	24	crabs and lobsters (80%:20%)	19.2	4.8	0	25	winkles and other molluscs (50%:50%)	12.5	12.5	1000	over sand and mollusc beds	1999 Review	1999 Review
2000	RIFE 6	31	cod and other fish (40%:60%)	12.4	0	18.6	20	crabs, lobsters and nephrops (40%:40%:20%)	8	8	4	17	winkles and other molluscs (50%:50%)	8.5	8.5	1000	over sand and mollusc beds	2000 Review	2000 Review
2001	RIFE 7	31	cod and other fish (40%:60%)	12.4	0	18.6	20	crabs, lobsters and Nephrops(40%, 40%, 20%)	8	8	4	17	winkles and other molluscs (50%:50%)	8.5	8.5	900	over sand and mollusc beds	2001 Review	2001 Review
2002	RIFE 8	51	cod and other fish (40%:60%)	20.4	0	30.6	16	crabs, lobsters and Nephrops (50%:30%:20)	8	4.8	3.2	29	winkles and mussels (60%:40%)	17.4	11.6	1200	over mud and sand	2002 Review	2002 Review
2003	RIFE 9	41	cod and other fish (60%:40%)	24.6	0	16.4	27	crabs, lobsters and Nephrops(80%:10%:10%)	21.6	2.7	2.7	34	winkles and other molluscs (40%:60%)	13.6	20.4	870	over mud and sand	2003 Full survey	2003 Full survey
2004	RIFE 10	41	cod and other fish (60%:40%)	24.6	0	16.4	25	crabs, lobsters and Nephrops(50%:40%:10%)	12.5	10	2.5	34	winkles and other molluscs (50%:50%)	17	17	1000	over mud and sand	2004 Review	2003 Full survey

5-YEAR AVERAGES

		Fish	check sum	cod	plaice	other fish	Crust	check sum	crabs	lobsters	nephrops	Molluscs	check sum	winkles	other molluscs	external
1994-98		31.8	31.8	17.8	14.1	0.0	15.5	15.5	10.4	4.8	0.3	10.6	10.6	4.8	5.7	220
1995-99		35.2	35.2	19.5	15.8	0.0	17.9	17.9	13.0	4.6	0.3	13.6	13.6	6.4	7.3	420
1996-00		36.2	36.2	19.3	13.2	3.7	20.2	20.2	13.3	5.7	1.1	14.6	14.6	6.9	7.8	620
1997-01		37.4	37.4	19.3	10.7	7.4	21.8	21.8	13.5	6.4	1.9	15.6	15.6	7.1	8.5	800
1998-02		40.2	40.2	17.8	8.8	13.6	21.6	21.6	13.4	6.0	2.2	20.6	20.6	10.3	10.3	1040.0
1999-03		39.4	39.4	18.3	4.3	16.8	21.4	21.4	13.0	5.7	2.8	24.4	24.4	12.1	12.3	994.0
2000-04		39.0	39.0	18.9	0.0	20.1	21.6	21.6	11.6	6.7	3.3	26.2	26.2	13.0	13.2	994.0

SUGGESTED 5 YEAR AVERAGE TO USE IN RIFE 10 DOSE CALCULATIONS

	kg/y	h/y
fish	**39**	
crabs	**12**	
lobsters	**6.7**	
nephrops	**3.3**	
winkles	**13**	
other molluscs	**13**	
external		**990 over mud and sand**

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