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Radiological Habits Survey: Sellafield Review, 2011

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Final report

Radiological Habits Survey: Sellafield Review, 2011

Shellfish consumption and intertidal occupancy review

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1. INTRODUCTION

This report describes a review of the public's shellfish consumption and intertidal occupancy relating to liquid radioactive waste discharges from the Sellafield Ltd nuclear site in Cumbria. It is also relevant to liquid discharges from the Low Level Waste Repository (LLWR) site near Drigg. The data are for use in radiological dose assessments as reported in the Radioactivity in Food and the Environment (RIFE) series. The study was funded by the Environment Agency (EA), the Food Standards Agency (FSA) and the Office for Nuclear Regulation (ONR), to support their roles in protecting the public from the effects of radiation.

This Sellafield review specifically investigated the consumption of crustaceans and molluscs, and occupancy over intertidal substrates by members of the Sellafield Fishing Community. Reviews are conducted annually, except in years when full surveys are undertaken, because of the importance of the shellfish consumption and intertidal occupancy pathways in the Sellafield area. Additionally, consumption and occupancy rates have been known to vary from year to year with some people ceasing shellfish consumption, collection or fishing, and new individuals being identified. The last full habits survey (encompassing aquatic, terrestrial and direct radiation pathways) in the vicinity of Sellafield was conducted by the Centre for Environment, Fisheries & Aquaculture Science (Cefas) in 2008 (Clyne *et al.*, 2009).

The consumption of fish was not subject to extensive review on this occasion, because fish are of generally lower radiological significance around Sellafield than shellfish and intertidal occupancy, and this would have needed a greater coverage of interviewees. However, those people interviewed in relation to shellfish consumption and intertidal occupancy were also asked about their fish consumption and these data have been used to update the total dose assessment of additive exposure (see Section 7.3). For the 2011 Sellafield aquatic dose assessments, the mean consumption rate for the high-rate group for fish will be retained from the 2008 full habits survey. Handling rates of sediment and fishing gear were not obtained in this Sellafield review, therefore, for assessments purposes, the mean handling rates for the high-rate groups will be retained from the 2008 full habits survey.

During 2011, in addition to the review, several of the higher rate consumers of shellfish kept a diary of their seafood consumption and intertidal occupancy for a two week period every three months. These data can be used to check the validity of the interview data.

2. SURVEY AREA

The survey area, shown in Figure 1, extended from Parton to Tarn Bay. This included all intertidal areas and extended up to 11 km offshore.

Figure 1. The Sellafield review aquatic survey area

3. CONDUCT OF THE SURVEY

Prior to the fieldwork, individuals identified as having high rates of crustacean and mollusc consumption and/or intertidal occupancy in previous Sellafield full habits surveys and annual reviews were contacted and where possible interview times were arranged.

The fieldwork was carried out from 11th to 14th October 2011, by a team of three people. During the fieldwork, individuals were interviewed and asked to estimate crustacean and mollusc consumption rates, and occupancy rates over intertidal areas, for themselves and members of their families. Interviewees were also asked to provide consumption rates for fish in order to determine valid combinations of pathways and improve the total dose assessment. Information was obtained about the origins of the seafood being consumed and locations of intertidal occupancy.

Observations for 45 adults and 14 children were recorded for the 2011 Sellafield review.

4. METHODS OF DATA ANALYSIS

4.1 Data recording

Consumption and occupancy data collected during interviews were recorded in logbooks. These data were examined and any notably high rates were double-checked, by means of a follow-up phone call or against the diary data provided by some interviewees. The raw data were entered into a purpose-built database where each individual for whom information was obtained was given a unique identifier (the observation number) to assist in maintaining data quality.

The consumption and occupancy data in the text of this report are rounded to two significant figures, except for values less than 1.0, which are rounded to one decimal place. This method of presentation reflects the authors' judgement on the accuracy of the methods used. In the tables and annexes, the consumption rate data are usually presented to one decimal place. Occasionally, this rounding process causes the computed values (row totals, mean rates and 97.5th percentiles), which are based on un-rounded data, to appear slightly erroneous. External exposure data are quoted as integer number of hours per year.

Data were structured into age groups because different dose coefficients (i.e. the factors which convert intakes of radioactivity into dose) can apply to different ages. The International Commission on Radiological Protection (ICRP) revised its recommendations for the age groupings to be used in radiological assessments and these recommendations were adopted in the 2010 habits survey reports. Consequently, the age ranges used in the habits survey reports prior to 2010 differ from those used currently. The age ranges used in this report and the names used for the age groups,

based on the recommendations in ICRP 101 (ICRP, 2007), are listed below, together with those used in reports prior to 2010, for comparison.

Age ranges used from 2010 onwards	
Name of age group[a]	**Age range in group**
Infant	0 to 5-year-old
Child	6-year-old to 15-year-old
Adult	16-year-old and over

Age ranges used in reports prior to 2010	
Name of age group	**Age range in group**
3-month-old	Under 1-year-old
1-year-old	1-year-old
5-year-old	2-year-old to 6-year-old
10-year-old	7-year-old to 11-year-old
15-year-old	12-year-old to 16-year-old
Adult	17-year-old and over

Notes

[a]In the 2010 reports only, the infant age group was called the 1-year-old age group and the child age group was called the 10-year-old age group.

Since there are fewer age groups for children in the current regime, there should, in general, be more observations in each group, resulting in greater robustness in the data. However, data for children since 2010 will not be directly comparable with data for children prior to 2010, since the age ranges in the age groups will be different.

4.2 Data analysis

The results of the Sellafield review are the individuals' consumption and occupancy rates provided in Annex 1 for adults and in Annex 2 for children and infants. These can be used in radiological assessments of the effects of the discharges from the Sellafield site.

The consumption and occupancy data have been analysed in three ways. Firstly, the 'cut-off' method described by Hunt *et al.* (1982) was used. With the 'cut-off' method, the appropriate high rate was calculated by taking the arithmetic mean of the values between the maximum observed rate and one third of the maximum observed rate. In this report, the term 'high-rate group' is used to represent the individuals derived by the 'cut-off' method. The mean of the high-rate group was calculated for each food group and occupancy over each intertidal substrate identified in the survey. Secondly, the 97.5th percentile rate was calculated for each group by using the *Microsoft Excel* mathematical function for calculating percentiles. The use of percentiles accords with precedents used in risk assessments of the safety of food consumption. It should be noted that the interviewees in this study are often selected and therefore the calculated percentiles are not based on random data. Thirdly, profiles have been produced that give a complete view of the habits of the individual that might lead to exposure to all the discharges and radiation from the site. The profiles are based on values calculated by the 'cut-off' method. The profiled data can be used to assess total dose, integrated across all pathways of exposure. The profiled habits matrix in this report contains data from the 2008 Sellafield full habits survey which has been updated with the 2009, 2010 and 2011 Sellafield review data.

5. INTERNAL EXPOSURE

Consumption data for aquatic foods are presented in Tables 1 and 2 for adults and in Table 3 and 4 for children. The tables include the mean consumption rates for the high-rate groups and the observed 97.5th percentile rates calculated as described in Section 4.2.

5.1 Crustaceans and molluscs

The people consuming the greatest quantities of crustaceans and molluscs from the aquatic survey area were commercial and hobby fishermen, shellfish collectors, bait diggers and the families of these groups of people. It should be noted that not all of the people who were consuming shellfish were also collecting shellfish. Table A presents a summary of the consumption rates of crustaceans and molluscs for adults and for the child age group. The table includes the mean consumption rates for the high-rate groups and the observed 97.5th percentile rates. No individuals in the infant age group were identified consuming crustaceans or molluscs.

Table A. Summary of consumption rates of foods from the aquatic survey area

Food group	Number of observations	Number of individuals in the high-rate group	Observed maximum for the high-rate group (kg y^{-1})	Observed minimum for the high-rate group (kg y^{-1})	Observed mean for the high-rate group (kg y^{-1})	Observed 97.5th percentile (kg y^{-1})
Adults						
Crustaceans	25	7	47.4	18.6	26.8	42.1
Molluscs	18	4	18.8	8.8	12.3	15.8
Child age group (6 - 15 years old)						
Crustaceans	3	1	7.8	7.8	7.8	7.5
Molluscs	2	2	0.1	0.04	0.1	0.1

The species of crustaceans consumed by people in the adult high-rate group were brown crab, common lobster, common prawn and *Nephrops*. The species of crustaceans consumed by individuals in the child high-rate group were brown crab, common lobster and common prawn. The crustaceans were caught throughout the survey area.

The species of molluscs consumed by people in the adult high-rate group were cockles, limpets, mussels and winkles. The only species of molluscs consumed by individuals in the child age group was razor shells. Mussels and cockles were collected from the Ravenglass Estuary; mussels were also collected from Parton, Whitehaven south beach, Whitehaven Harbour and Drigg. Winkles were collected from Whitehaven south beach and Nethertown, and limpets were collected from Nethertown.

5.2 Species composition of the shellfish high-rate groups for adults and comparison with 2010 data

The percentage composition for the predominant shellfish species consumed by the adult high-rate groups from the 2011 Sellafield review, rounded to the nearest 10% for use in dose assessments, are as follows:

- Crustaceans - 40% brown crab, 30% common lobster, 30% *Nephrops* (including common prawn) (mean consumption rate for the adult high-rate group, 27 kg y^{-1})
- Molluscs - 60% winkles and 40% other molluscs (mean consumption rate for the adult high-rate group, 12 kg y^{-1})

By comparison, the percentage composition for the predominant shellfish species consumed in the adult high-rate groups from the 2010 Sellafield review, and used in RIFE-16 (EA, FSA, NIEA and SEPA, 2011) for dose assessments, were:

- Crustaceans - 50% brown crab, 30% common lobster, 20% *Nephrops* (including common prawn) (mean consumption rate for the adult high-rate group, 22 kg y^{-1})
- Molluscs - 20% winkles and 80% other molluscs (mean consumption rate for the adult high-rate group, 22 kg y^{-1})

In 2011, the mean consumption rate for the adult high-rate group for crustaceans increased by 5 kg y^{-1} compared to 2010. There was a significant decrease of 10 kg y^{-1} in the mean consumption rate for the adult high-rate group for molluscs in 2011, which was attributed to several people who were collecting and consuming large quantities of molluscs in 2010 who had ceased collecting in 2011 due to ill health or old age, and were therefore not consuming.

The main species of crustaceans and molluscs consumed in 2011 were the same as in 2010. The percentage breakdown of species changed in both groups in 2011 compared with 2010: for crustaceans, there was a decrease in brown crab and an increase in *Nephrops*; for molluscs, there was a significant increase in winkles and a significant decrease in other molluscs.

5.3 Consumption trends

The consumption rates for the adult high-rate groups for crustaceans and molluscs over the previous ten years (2002 - 2011) are shown in Figures 2 and 3. These figures were plotted using the adult means for the high-rate groups distributed according to the percentage breakdowns as described in Section 5.2. The raw data are presented in Annex 3a.

Figure 2. Consumption rates for the adult high-rate group for crustaceans, 2002 – 2011 (kg y^{-1})

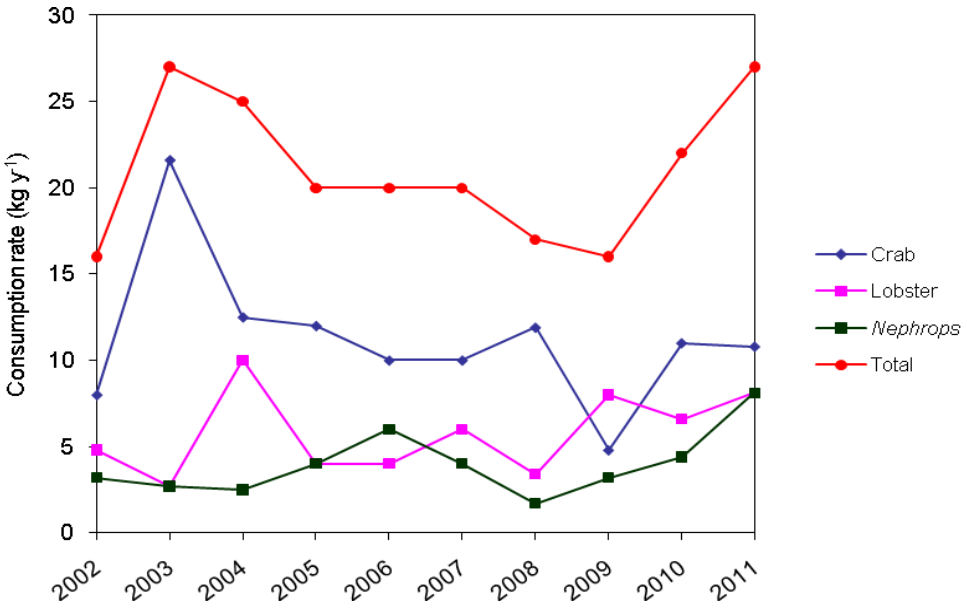
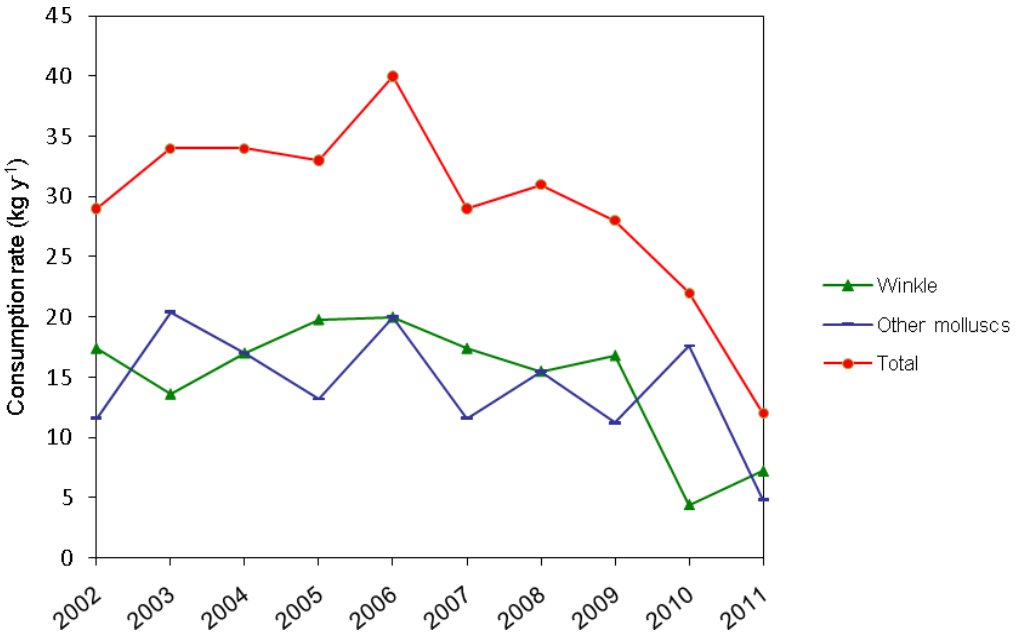


Figure 3. Consumption rates for the adult high-rate group for molluscs, 2002 – 2011 (kg y^{-1})



6. EXTERNAL EXPOSURE

Intertidal occupancy rates for adults are presented in Table 5 and intertidal occupancy rates for children and infants are presented in Table 6. It should be noted that there are often more than one substrate at one named location and that substrates at a given location are liable to change over time. Activities were assigned to the predominant substrate over which they were taking place.

6.1 Intertidal occupancy

Adults' intertidal occupancy rates

Table B presents a summary of the adults' intertidal occupancy rates in the aquatic survey area. The table includes the mean occupancy rates for the high-rate groups and the observed 97.5th percentile rates.

Table B. Summary of adults' intertidal occupancy rates

Intertidal substrate	Number of observations	Number of people in the high-rate group	Maximum of the high-rate group (h y^{-1})	Mean of the high-rate group (h y^{-1})	97.5th percentile (h y^{-1})
Mud	9	9	117	80	116
Mud and sand	5	3	520	307	488
Mud, sand and stones	6	3	1095	744	1046
Rock	1	1	9	9	Not applicable
Salt marsh	3	3	60	57	60
Sand	19	12	912	633	895
Sand and stones	15	2	927	859	879

The following activities were undertaken by people in the adult high-rate groups for occupancy over intertidal substrates:

- For mud: bait digging at Whitehaven outer harbour; wildfowling on the River Irt.
- For mud and sand: nature reserve warden duties in the Eskmeals Range Nature Reserve; collecting cockles and mussels at Ravenglass.
- For mud, sand and stones: angling at Parton; walking and boat maintenance at Ravenglass; dog walking at Parton.
- For rock: hooking for lobsters at Nethertown.
- For salt marsh: wildfowling in the Ravenglass Estuary; nature reserve warden duties in the Eskmeals Range Nature Reserve.

- For sand: angling at Braystones, Nethertown and Sellafield; bait digging at Braystones, Drigg, Eskmeals and Nethertown; walking at Braystones, Drigg and Eskmeals; setting nets at Braystones and Sellafield; dog walking at Whitehaven outer harbour, St Bees and between Drigg and Sellafield; sunbathing and playing at St Bees; collecting razor shells and playing at Braystones.
- For sand and stones: angling from St Bees to Drigg; collecting winkles from Parton to Drigg.

The adults' intertidal occupancy rates from the 2011 Sellafield review can be compared with those from the 2010 Sellafield review, which are presented in Table C.

Table C. Summary of adults' intertidal occupancy rates from the 2010 Sellafield review

Intertidal substrate	Number of observations	Number of people in the high-rate group	Maximum of the high-rate group (h y^{-1})	Mean of the high-rate group (h y^{-1})	97.5th percentile (h y^{-1})
Mud	5	5	83	67	81
Mud and sand	10	1	520	520	429
Mud, sand and stones	4	1	1186	1186	1122
Rock	4	2	102	101	102
Salt marsh	2	2	60	56	60
Sand	19	7	798	511	776
Sand and stones	8	2	1001	801	931

In 2011, compared with 2010, there were increases in the following mean intertidal occupancy rates for the high-rate groups:

- From 67 h y^{-1} to 80 h y^{-1} for mud
- From 56 h y^{-1} to 57 h y^{-1} for salt marsh
- From 510 h y^{-1} to 630 h y^{-1} for sand
- From 800 h y^{-1} to 860 h y^{-1} for sand and stones

In 2011, compared with 2010, there were decreases in the following mean intertidal occupancy rates for the high-rate groups:

- From 520 h y^{-1} to 310 h y^{-1} for mud and sand
- From 1200 h y^{-1} to 740 h y^{-1} for mud sand and stones
- From 100 h y^{-1} to 9 h y^{-1} for rock

Children's and infants' intertidal occupancy rates

Table D presents a summary of the children's and infants' intertidal occupancy rates in the aquatic survey area. The table includes the mean occupancy rates for the high-rate groups and the observed 97.5th percentile rates.

Table D. Summary of children's and infants' intertidal occupancy rates

Intertidal substrate	Number of observations	Number of individuals in the high-rate group	Maximum of the high-rate group (h y^{-1})	Mean of the high-rate group (h y^{-1})	97.5th percentile (h y^{-1})
Child age group (6 – 15 years old)					
Sand	10	8	148	118	148
Sand and stones	4	4	216	176	216
Infant age group (0 – 5 years old)					
Sand	3	2	274	274	274

The following activities were undertaken by individuals in the child age group high-rate groups for occupancy over intertidal substrates:

- For sand: playing at Braystones; dog walking at Whitehaven outer harbour.
- For sand and stones: collecting winkles from Parton to Drigg; angling from St Bees to Drigg.

The only activity undertaken by individuals in the infant age group high-rate group for sand was playing at St Bees.

7. USE OF HABITS DATA FOR DOSE ASSESSMENTS

7.1 Aquatic combinations for adults in the Sellafield Fishing Community

Table 7 presents the consumption rates and occupancy rates for people who appear in at least one of the high-rate groups for crustaceans, molluscs or intertidal substrates. The table shows that several individuals are members of multiple high-rate groups. For example, observation number 35 is in the high-rate group for crustaceans, molluscs and occupancy over mud and sand, and also consumes significant amounts of fish. This supports the continuation of assessing the dose to the representative person based on a combination of internal and external pathways. Therefore, the Radioactivity in Food and the Environment (RIFE) Sellafield Fishing Community aquatic assessments for 2011 will be based on combinations of consumption and intertidal occupancy pathways identified from Table 7.

7.2 Sellafield 5-year averages

Annex 3a shows the Sellafield Fishing Community consumption and occupancy rates which are presented in the RIFE reports. The consumption rates of crustaceans and molluscs, and intertidal occupancy rates are updated annually using the Sellafield review data or full survey data, as applicable. The fish consumption rates are updated when a full survey is conducted. Annex 3b presents the 5-year averages of the data in Annex 3a. The 5-year average (2007 - 2011) of the high-rate group data (for fish, crustaceans, molluscs and intertidal occupancy) will be used in RIFE-17 assessments in order to provide a longer term trend of dose to members of the Sellafield Fishing Community group.

7.3 Profiled habits data

The environment agencies and the Food Standards Agency have considered ways of using habits data to calculate total dose retrospectively. The adopted approach is to use the adult consumption and occupancy data collected in each habits survey to create a matrix with a series of habits profiles for each nuclear licensed site. The National Dose Assessment Working Group (NDAWG) has considered this approach to assessing retrospective total doses (Camplin *et al.*, 2005) and has agreed that using habits profiles is an appropriate approach. Retrospective total doses around Sellafield are made using these profiles and reported in the RIFE reports (e.g. EA, FSA, NIEA and SEPA, 2011).

The matrix for the 2011 Sellafield adults' profiled habits data is presented in Annex 4. It is based on data from the 2008 Sellafield full habits survey (aquatic, terrestrial and direct radiation pathways), which has been updated with data from the 2009, 2010 and 2011 Sellafield annual review. All pathways and observations from the original 2008 profiled habits matrix were retained and for the 2011 profile, only data asked about during the 2011 reviews were updated; that is, intertidal occupancy and consumption of crustaceans, molluscs and fish. If data were collected for new interviewees, these were added as new observations, and if it was known that an individual who had been interviewed in previous years had stopped their activity, then their data was deleted. Because the profile has been created using the data from 2008, 2009, 2010 and 2011, the profiled data shown in Annex 4 are not comparable with the raw data presented in Annex 1.

8. SUMMARY AND RECOMMENDATIONS

The survey investigated the consumption of shellfish and intertidal occupancy, relating to liquid discharges from the Sellafield nuclear site. Consumption and occupancy data were collected for 45 adults and 14 children. The recommendations are based on the adult data.

The mean rates for the adult high-rate groups from the 2011 Sellafield review are as follows:

- Crustaceans 27 kg y^{-1}
- Molluscs 12 kg y^{-1}
- Occupancy over mud 80 h y^{-1}
- Occupancy over mud and sand 310 h y^{-1}
- Occupancy over mud, sand and stones 740 h y^{-1}
- Occupancy over rock 9 h y^{-1}
- Occupancy over salt marsh 57 h y^{-1}
- Occupancy over sand 630 h y^{-1}
- Occupancy over sand and stones 860 h y^{-1}

In comparison to 2010, the mean rates for the high-rate groups in 2011 increased by 5 kg y^{-1} for crustaceans and decreased by 10 kg y^{-1} for molluscs. For occupancy over intertidal substrates, the mean rates for the high-rate groups increased in 2011 compared with 2010 by 13 h y^{-1} for mud, by 1 h y^{-1} for salt marsh, by 120 h y^{-1} for sand, and by 60 h y^{-1} for sand and stones, and decreased by 210 h y^{-1} for mud and sand, by 460 h y^{-1} for mud, sand and stones, and by 91 h y^{-1} for rock.

The mean rates for the adult high-rate groups retained from the 2008 Sellafield full habits survey for assessments purposes are as follows:

- Fish 40 kg y^{-1}
- Handling sediment 960 h y^{-1}
- Handling fishing gear 980 h y^{-1}

The recommended 5-year averages for use in RIFE 17 dose assessments are as follows:

- Fish 40 kg y^{-1}
- Crabs 9.7 kg y^{-1}
- Lobsters 6.4 kg y^{-1}
- *Nephrops* (including common prawns) 4.3 kg y^{-1}
- Winkles 12 kg y^{-1}
- Other molluscs 12 kg y^{-1}
- Occupancy over an intertidal substrate termed ‘mud and sand’ (mud; mud and sand; mud, sand and stones; sand; and sand and stones combined) 890 h y^{-1}

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Table 1. Adults' consumption rates of crustaceans in the Sellafield area (kg y^{-1})

Observation number	Brown crab	Common lobster	Common prawn	*Nephrops*	Total
28	**15.4**	**6.1**	**-**	**25.9**	**47.4**
35	**22.4**	**4.3**	-	**12.0**	**38.7**
36	**11.2**	**2.1**	**-**	**12.0**	**25.3**
24	**9.2**	**9.3**	**0.6**	**0.6**	**19.6**
25	**9.2**	**9.3**	**-**	**0.6**	**19.1**
26	**9.2**	**9.3**	-	**0.6**	**19.1**
15	**7.8**	**10.8**	**-**	**-**	**18.6**
1	4.5	9.3	**-**	**-**	13.8
2	4.5	9.3	-	-	13.8
27	1.0	0.5	**-**	11.6	13.1
12	3.0	5.3	**-**	**-**	8.3
13	3.0	5.3	-	-	8.3
14	3.0	5.3	**-**	**-**	8.3
50	2.2	4.7	0.9	**-**	7.8
51	2.2	4.7	0.9	**-**	7.8
52	2.2	4.7	0.9	**-**	7.8
3	2.2	4.7	**-**	**-**	6.9
33	**-**	**-**	**-**	5.9	5.9
54	4.4	**-**	**-**	**-**	4.4
43	1.0	3.0	**-**	**-**	4.0
9	0.7	1.4	**-**	**-**	2.1
44	1.0	1.0	**-**	**-**	2.0
17	0.3	0.7	**-**	**-**	1.0
18	0.3	0.7	**-**	**-**	1.0
19	0.3	0.7	**-**	**-**	1.0

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of crustaceans based on the 7 high-rate adult consumers is 26.8 kg y^{-1}

The observed 97.5^{th} percentile rate based on 25 observations is 42.1 kg y^{-1}

Table 2. Adults' consumption rates of molluscs in the Sellafield area (kg y^{-1})

Observation number	Cockle	Limpet	Mussel	Razor shell	Whelk	Winkle	Total
39	**-**	**1.0**	**-**	**-**	**-**	**17.8**	**18.8**
28	**5.9**	**-**	**5.9**	**-**	**-**	**-**	**11.8**
40	**-**	**1.0**	**-**	**-**	**-**	**8.9**	**9.9**
35	**2.9**	**-**	**2.9**	**-**	**-**	**2.9**	**8.8**
54	1.1	-	2.1	-	-	2.0	5.2
43	-	-	1.0	4.0	-	-	5.0
36	1.5	-	1.5	-	-	1.5	4.4
1	-	-	3.2	-	-	-	3.2
2	-	-	3.2	-	-	-	3.2
3	-	-	1.6	-	-	-	1.6
24	0.3	-	0.5	-	0.5	0.2	1.6
41	-	-	-	-	-	1.3	1.3
42	-	-	-	-	-	1.3	1.3
44	-	-	-	1.0	-	-	1.0
25	0.3	-	0.5	-	-	-	0.9
27	0.3	-	0.3	-	-	-	0.7
12	-	-	0.4	-	-	-	0.4
38	-	-	-	-	-	0.4	0.4

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of molluscs based on the 4 high-rate adult consumers is 12.3 kg y^{-1}

The observed 97.5th percentile rate based on 18 observations is 15.8 kg y^{-1}

Table 3. Children's consumption rates of crustaceans in the Sellafield area (kg y^{-1})

Child age group (6 - 15 years old)

Observation number	Age	Brown crab	Common lobster	Common prawn	*Nephrops*	Total
53	**14**	**2.2**	**4.7**	**0.9**	**-**	**7.8**
29	15	0.2	-	-	2.3	2.5
31	12	0.2	-	-	2.3	2.5

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of crustaceans for the child age group based upon the only high-rate consumer is 7.8 kg y^{-1}

The observed 97.5th percentile rate based on 3 observations is 7.5 kg y^{-1}

Table 4. Children's consumption rates of molluscs in the Sellafield area (kg y^{-1})

Child age group (6 - 15 years old)

Observation number	Age	Razor shell
45	**8**	**0.1**
46	**9**	**0.04**

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of molluscs for the child age group based upon the 2 high-rate consumers is 0.1 kg y^{-1}

The observed 97.5th percentile rate based on 2 observations is 0.1 kg y^{-1}

Table 5. Adults' intertidal occupancy rates in the Sellafield area (h y^{-1})

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones
38	**Whitehaven outer harbour**	**Bait digging**	**117**	-	-	-	-	-	-
	Braystones	**Angling**	**-**	-	-	-	-	**698**	-
	Braystones, Drigg and Eskmeals	**Bait digging and walking**	**-**	-	-	-	-		-
	Nethertown	Collecting winkles	**-**	-	-	-	-	**-**	140
	Coulderton	Collecting limpets	**-**	-	-	-	-	**-**	
11	**Whitehaven outer harbour**	**Bait digging**	**112**	-	-	-	-	-	-
	St Bees	Walking	**-**	-	-	-	-	8	-
12	**Whitehaven outer harbour**	**Bait digging**	**108**	-	-	-	-	-	-
	Parton	Collecting mussels	**-**	-	7	-	-	-	-
8	**Whitehaven outer harbour**	**Bait digging**	**80**	-	-	-	-	-	-
	Braystones and Nethertown	**Angling**	**-**	-	-	-	-	**912**	-
	Nethertown	**Bait digging**	**-**	-	-	-	-		-
56	**River Irt**	**Wildfowling**	**63**	-	-	-	-	-	-
57	**River Irt**	**Wildfowling**	**63**	-	-	-	-	-	-
58	**River Irt**	**Wildfowling**	**63**	-	-	-	-	-	-
59	**River Irt**	**Wildfowling**	**63**	-	-	-	-	-	-
9	**Whitehaven outer harbour**	**Bait digging**	**54**	-	-	-	-	-	-
	Parton	**Angling**	**-**	-	**432**	-	-	-	-
	Parton	Dog walking	**-**	-	**-**	-	-	-	274
55	**Eskmeals Range Nature Reserve**	**Nature reserve warden duties**	-	**520**	-	-	-	-	-
	Eskmeals Range Nature Reserve	**Nature reserve warden duties**	-	**-**	-	-	**52**	-	-
35	**Ravenglass**	**Collecting cockles and mussels**	-	**200**	-	-	-	-	-
	Whitehaven south beach	Collecting winkles	-	**-**	-	-	-	-	125
37	**Ravenglass**	**Collecting cockles and mussels**	-	**200**	-	-	-	-	-
	Whitehaven south beach	Collecting winkles	-	**-**	-	-	-	-	125
27	Ravenglass to Whitehaven outer harbour	Bait digging	-	51	-	-	-	-	-
	Braystones and Sellafield	**Setting nets**	-	-	-	-	-	**360**	**-**
	St Bees to Drigg	**Angling**	-	-	-	-	-	**-**	**927**
	Parton to Drigg	**Collecting winkles**	-	-	-	-	-	**-**	
54	Ravenglass	Collecting cockles and mussels	-	3	-	-	-	-	-
	Nethertown	**Hooking for lobsters**	-	-	-	**9**	-	-	-
	Braystones	Angling	-	-	-	**-**	-	84	-
	Braystones, Seascale and Eskmeals	Bait digging	-	-	-	**-**	-		-
	Nethertown	Collecting winkles	-	-	-	**-**	-	-	3

Table 5. Adults' intertidal occupancy rates in the Sellafield area (h y^{-1})

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones
15	**Ravenglass**	**Walking and boat maintenance**	-	-	**1095**	-	-	-	-
10	**Parton**	**Dog walking**	-	-	**706**	-	-	-	-
	St Bees	Dog walking	-	-	**-**	-	-	12	-
52	Ravenglass	Boat maintenance	-	-	330	-	-	-	-
	Ravenglass Estuary	**Wildfowling**	-	-	-	-	**60**	-	-
50	Ravenglass	Boat maintenance	-	-	330	-	-	-	-
	Ravenglass Estuary	**Wildfowling**	-	-	-	-	**60**	-	-
34	**Braystones**	**Setting nets**	-	-	-	-	-	**875**	-
23	**St Bees**	**Dog walking**	-	-	-	-	-	**821**	-
43	**Braystones, Nethertown and Sellafield**	**Angling**	-	-	-	-	-	**796**	-
	Braystones	**Bait digging, setting nets, collecting razor shells, playing and walking**	-	-	-	-	-		-
	Braystones and Sellafield	Beachcombing	-	-	-	-	-	**-**	64
	Braystones	Collecting seaweed	-	-	-	-	-	**-**	
	Braystones, Nethertown and Sellafield	Collecting crabs	-	-	-	-	-	**-**	
16	**St Bees**	**Dog walking and sunbathing**	-	-	-	-	-	**748**	-
5	**Whitehaven outer harbour**	**Dog walking**	-	-	-	-	-	**554**	-
	Parton	Dog walking	-	-	-	-	-	**-**	52
4	**Whitehaven outer harbour**	**Dog walking**	-	-	-	-	-	**554**	-
	Parton	Dog walking	-	-	-	-	-	**-**	12
20	**St Bees**	**Dog walking and playing**	-	-	-	-	-	**548**	-
51	**Drigg to Sellafield**	**Dog walking**	-	-	-	-	-	**365**	-
33	**Braystones and Sellafield**	**Setting nets**	-	-	-	-	-	**360**	-
	Parton to Drigg	**Collecting winkles**	-	-	-	-	-	**-**	**791**
28	Braystones	Walking and setting nets	-	-	-	-	-	196	-
	St Bees to Drigg	Angling	-	-	-	-	-	-	68
19	Coulderton, Ravenglass, Nethertown and Drigg	Walking	-	-	-	-	-	57	-
	Parton	Walking	-	-	-	-	-	-	46
17	Coulderton, Ravenglass, Nethertown and Drigg	Walking	-	-	-	-	-	57	-
	Parton	Walking	-	-	-	-	-	-	46
44	Braystones and Sellafield	Walking	-	-	-	-	-	48	-
	Braystones	Playing	-	-	-	-	-		-
1	Parton and Redness Point	Collecting winkles	-	-	-	-	-	-	234
	Whitehaven south beach	Collecting mussels	-	-	-	-	-	-	

Table 5. Adults' intertidal occupancy rates in the Sellafield area (h y^{-1})

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones
24	Ravenglass	Collecting cockles and mussels	-	-	-	-	-	-	5
	Whitehaven south beach	Collecting winkles	-	-	-	-	-	-	

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud based on 9 high-rate observations is 80 h y^{-1}

The observed 97.5th percentile rate based on 9 observations for mud is 116 h y^{-1}

The mean intertidal occupancy rate over mud and sand based on 3 high-rate observations is 307 h y^{-1}

The observed 97.5th percentile rate based on 5 observations for mud and sand is 488 h y^{-1}

The mean intertidal occupancy rate over mud, sand and stones based on 3 high-rate observations is 744 h y^{-1}

The observed 97.5th percentile rate based on 6 observations for mud, sand and stones is 1046 h y^{-1}

The mean intertidal occupancy rate over rock based on 1 observation is 9 h y^{-1}

The observed 97.5th percentile rate is not applicable for 1 observation

The mean intertidal occupancy rate over salt marsh based on 3 high-rate observations is 57 h y^{-1}

The observed 97.5th percentile rate based on 3 observations for salt marsh is 60 h y^{-1}

The mean intertidal occupancy rate over sand based on 12 high-rate observations is 633 h y^{-1}

The observed 97.5th percentile rate based on 19 observations for sand is 895 h y^{-1}

The mean intertidal occupancy rate over sand and stones based on 2 high-rate observations is 859 h y^{-1}

The observed 97.5th percentile rate based on 15 observations for sand and stones is 879 h y^{-1}

Table 6. Children's and infants' intertidal occupancy rates in the Sellafield area (h y^{-1})

Child age group (6 - 15 years old)

Observation number	Age	Location	Activity	Sand	Sand and stones
29	**15**	**Braystones**	**Playing**	**148**	-
		Parton to Drigg	**Collecting winkles**	**-**	**216**
		St Bees to Drigg	**Angling**	**-**	
31	**12**	**Braystones**	**Playing**	**148**	-
		Parton to Drigg	**Collecting winkles**	**-**	**216**
		St Bees to Drigg	**Angling**	**-**	
30	**13**	**Braystones**	**Playing**	**148**	-
		St Bees to Drigg	**Angling**	**-**	**136**
32	**8**	**Braystones**	**Playing**	**148**	-
		St Bees to Drigg	**Angling**	**-**	**136**
6	**11**	**Whitehaven outer harbour**	**Dog walking**	**120**	-
7	**9**	**Whitehaven outer harbour**	**Dog walking**	**120**	-
45	**8**	**Braystones**	**Playing**	**54**	-
46	**9**	**Braystones**	**Playing**	**54**	-
47	10	Braystones	Playing	18	-
48	8	Braystones	Playing	18	-

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over sand based on 8 high-rate observations is 118 h y^{-1}

The observed 97.5th percentile rate based on 10 observations for sand is 148 h y^{-1}

The mean intertidal occupancy rate over sand and stones based on 4 high-rate observations is 176 h y^{-1}

The observed 97.5th percentile rate based on 4 observations for sand and stones is 216 h y^{-1}

Infant age group (0 - 5 years old)

Observation number	Age	Location	Activity	Sand
21	**3**	**St Bees**	**Playing**	**274**
22	**1**	**St Bees**	**Playing**	**274**
49	3	Braystones	Playing	18

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over sand based on 2 high-rate observations is 274 h y^{-1}

The observed 97.5th percentile rate based on 3 observations for sand is 274 h y^{-1}

Table 7. Aquatic combinations for adults in the Sellafield Fishing Community

Observation number	Consumption rates (kg y^{-1})			Occupancy rates (h y^{-1})						
	Fish	Crustaceans	Molluscs	Mud	Mud and sand	Mud, sand and stones	Salt marsh	Sand	Sand and stones	Rock
4	-	-	-	-	-	-	-	**554**	12	-
5	-	**-**	**-**	**-**	**-**	**-**	**-**	**554**	52	**-**
8	*12.4*	**-**	**-**	**80**	**-**	**-**	**-**	**912**	**-**	**-**
9	*19.9*	2.1	**-**	**54**	**-**	**432**	**-**	**-**	274	**-**
10	-	**-**	**-**	**-**	**-**	**706**	**-**	12	**-**	**-**
11	*1.3*	**-**	**-**	**112**	**-**	**-**	**-**	8	**-**	**-**
12	*39.9*	8.3	0.4	**108**	**-**	7	**-**	**-**	**-**	**-**
15	*8.2*	**18.6**	**-**	**-**	**-**	**1095**	**-**	**-**	**-**	**-**
16	-	-	-	**-**	**-**	-	**-**	**748**	**-**	**-**
20	-	**-**	**-**	**-**	**-**	-	**-**	**548**	**-**	**-**
23	-	**-**	**-**	**-**	**-**	-	**-**	**821**	**-**	**-**
24	*12.0*	**19.6**	1.6	-	**-**	-	**-**	**-**	5	**-**
25	*12.0*	**19.1**	0.9	-	**-**	-	**-**	**-**	**-**	**-**
26	*12.0*	**19.1**	-	-	**-**	-	**-**	**-**	**-**	**-**
27	*46.7*	13.1	0.7	-	51	-	**-**	**360**	**927**	**-**
28	*64.5*	**47.4**	**11.8**	-	-	-	**-**	196	68	**-**
33	*27.2*	5.9	-	-	-	-	**-**	**360**	**791**	**-**
34	-	-	-	-	-	-	**-**	**875**	-	**-**
35	*35.4*	**38.7**	**8.8**	-	**200**	-	**-**	-	125	**-**
36	*35.4*	**25.3**	4.4	-	-	-	**-**	-	-	**-**
37	-	-	-	-	**200**	-	**-**	-	125	**-**
38	-	-	0.4	**117**	-	-	**-**	**698**	140	**-**
39	-	-	**18.8**	-	-	-	**-**	-	-	**-**
40	-	-	**9.9**	-	-	-	**-**	-	-	**-**
43	*41.0*	4.0	5.0	-	-	-	**-**	**796**	64	**-**
50	*5.9*	7.8	-	-	-	330	**60**	-	-	-
51	*5.9*	7.8	-	-	-	-	-	**365**	-	-
52	*5.9*	7.8	-	-	-	330	**60**	-	-	-
54	*12.5*	4.4	5.2	-	3	-	-	84	3	**9**
55	-	-	-	-	**520**	-	**52**	-	-	-
56	-	-	-	**63**	-	-	-	-	-	-
57	-	-	-	**63**	-	-	-	-	-	-
58	-	-	-	**63**	-	-	-	-	-	-
59	-	-	-	**63**	-	-	-	-	-	-

Notes

Values in high-rate groups are emboldened

Annex 1. Adults' consumption rates (kg y^{-1}) and intertidal occupancy rates (h y^{-1}) in the Sellafield area

Observation number	Sex	Age (years)	*Fish*[a]	Crustaceans	Molluscs	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over salt marsh	Intertidal occupancy over sand	Intertidal occupancy over sand and stones
1	M	72	*45.6*	13.8	3.2	**-**	**-**	**-**	**-**	**-**	**-**	234
2	F	73	*27.2*	13.8	3.2	-	-	-	-	-	-	-
3	F	42	*14.5*	6.9	1.6	**-**	**-**	**-**	**-**	**-**	**-**	**-**
4	M	56	-	-	-	-	-	-	-	-	**554**	12
5	F	45	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**554**	52
8	M	27	*12.4*	**-**	**-**	**80**	**-**	**-**	**-**	**-**	**912**	**-**
9	M	75	*19.9*	2.1	**-**	**54**	**-**	**432**	**-**	**-**	**-**	274
10	F	21	-	**-**	**-**	**-**	**-**	**706**	**-**	**-**	12	**-**
11	M	49	*1.3*	**-**	**-**	**112**	**-**	**-**	**-**	**-**	8	**-**
12	M	53	*39.9*	8.3	0.4	**108**	**-**	7	**-**	**-**	**-**	**-**
13	F	52	*21.2*	8.3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
14	M	24	*21.2*	8.3	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
15	M	80	*8.2*	**18.6**	**-**	**-**	**-**	**1095**	**-**	**-**	**-**	**-**
16	F	43	-	-	-	**-**	**-**	-	**-**	**-**	**748**	**-**
17	M	70	*2.7*	1.0	**-**	**-**	**-**	-	**-**	**-**	57	46
18	F	67	*2.7*	1.0	**-**	**-**	**-**	-	**-**	**-**	**-**	**-**
19	F	39	*2.7*	1.0	**-**	**-**	**-**	-	**-**	**-**	57	46
20	M	44	-	**-**	**-**	**-**	**-**	-	**-**	**-**	**548**	**-**
23	M	52	-	**-**	**-**	**-**	**-**	-	**-**	**-**	**821**	**-**
24	M	47	*12.0*	**19.6**	1.6	-	**-**	-	**-**	**-**	**-**	5
25	F	47	*12.0*	**19.1**	0.9	-	**-**	-	**-**	**-**	**-**	**-**
26	F	17	*12.0*	**19.1**	-	-	**-**	-	**-**	**-**	**-**	**-**
27	M	64	*46.7*	13.1	0.7	-	51	-	**-**	**-**	**360**	**927**
28	F	60	*64.5*	**47.4**	**11.8**	-	-	-	**-**	**-**	196	68
33	M	29	*27.2*	5.9	-	-	-	-	**-**	**-**	**360**	**791**
34	M	52	-	-	-	-	-	-	**-**	**-**	**875**	-
35	M	61	*35.4*	**38.7**	**8.8**	-	**200**	-	**-**	**-**	-	125
36	F	45	*35.4*	**25.3**	4.4	-	-	-	**-**	**-**	-	-
37	M	U	-	-	-	-	**200**	-	**-**	**-**	-	125
38	M	U	-	-	0.4	**117**	-	-	**-**	**-**	**698**	140
39	F	U	-	-	**18.8**	-	-	-	**-**	**-**	-	-
40	M	U	-	-	**9.9**	-	-	-	**-**	**-**	-	-
41	F	U	-	-	1.3	-	-	-	**-**	**-**	-	-
42	M	U	-	-	1.3	-	-	-	**-**	**-**	-	-

Annex 1. Adults' consumption rates (kg y^{-1}) and intertidal occupancy rates (h y^{-1}) in the Sellafield area

Observation number	Sex	Age (years)	*Fish*[a]	Crustaceans	Molluscs	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over salt marsh	Intertidal occupancy over sand	Intertidal occupancy over sand and stones
43	M	57	*41.0*	4.0	5.0	-	-	-	**-**	**-**	**796**	64
44	F	56	*20.5*	2.0	1.0	-	-	-	**-**	**-**	48	-
50	M	52	*5.9*	7.8	-	-	-	330	-	**60**	-	-
51	F	49	*5.9*	7.8	-	-	-	-	-	-	**365**	-
52	M	17	*5.9*	7.8	-	-	-	330	-	**60**	-	-
54	M	U	*12.5*	4.4	5.2	-	3	-	**9**	-	84	3
55	M	76	-	-	-	-	**520**	-	-	**52**	-	-
56	M	U	-	-	-	**63**	-	-	-	-	-	-
57	M	U	-	-	-	**63**	-	-	-	-	-	-
58	M	U	-	-	-	**63**	-	-	-	-	-	-
59	M	U	-	-	-	**63**	-	-	-	-	-	-

Notes

Emboldened observations are the high-rate individuals

U - Unknown

[a]Consumption rates for fish are included in this annex for use in dose assessments if required.

Annex 2. Children's and infants' consumption rates (kg y^{-1}) and intertidal occupancy rates (h y^{-1}) in the Sellafield area

Observation number	Sex	Age (years)	*Fish*[a]	Crustaceans	Molluscs	Intertidal occupancy over sand	Intertidal occupancy over sand and stones
Child age group (6 - 15 years old)							
6	F	11	-	-	-	**120**	-
7	F	9	-	-	-	**120**	-
29	M	15	*8.2*	2.5	-	**148**	**216**
30	M	13	-	-	-	**148**	**136**
31	M	12	*8.2*	2.5	-	**148**	**216**
32	F	8	-	-	-	**148**	**136**
45	F	8	*2.0*	-	**0.1**	**54**	-
46	F	9	*2.0*	-	**0.04**	**54**	-
47	F	10	*2.0*	-	-	18	-
48	M	8	*2.0*	-	-	18	-
53	M	14	*5.9*	**7.8**	-	-	-
Infant age group (0 - 5 years old)							
21	M	3	-	-	-	**274**	-
22	F	1	-	-	-	**274**	-
49	F	3	*2.0*	-	-	18	-

Notes

Emboldened observations are the high-rate individuals

[a]Consumption rates for fish are included in this annex for use in dose assessments if required.

Annex 3a. Sellafield Fishing Community consumption and intertidal occupancy data reported in AEMR and RIFE (kg y^{-1} and h y^{-1})

Year (report)	FISH					CRUSTACEANS					MOLLUSCS				INTERTIDAL OCCUPANCY		Source of habits data	
	Species Composition	Total	Cod	Plaice	Other fish	Species Composition	Total	Crab	Lobster	*Nephrops*	Species Composition	Total	Winkles	Other molluscs	Substrate	h y^{-1}	Consumption	Occupancy
1994 (AEMR 45)	Plaice and Cod (50%:50%)	26.0	13.0	13.0	0.0	Crabs and Lobsters (65%:35%)	12.0	7.8	4.2	0.0	Winkles and other molluscs (85%:15%)	9.7	8.2	1.5	-	0	1993/94 Survey	-
1995 (RIFE 1)	Plaice and Cod (50%:50%)	26.0	13.0	13.0	0.0	Crabs and Lobsters (75%:25%)	8.6	6.5	2.2	0.0	Winkles and other molluscs (50%:50%)	12.0	6.0	6.0	-	0	1995 Review (crust and moll) and 1993/4 survey (fish)	-
1996 (RIFE 2)	Plaice and Cod (50%:50%)	25.0	12.5	12.5	0.0	Crabs and Lobsters (60%:40%)	12.0	7.2	4.8	0.0	Winkles and other molluscs (60%:40%)	12.0	7.2	4.8	-	0	1995 Review (crust and moll) and 1996 logging data (fish)	-
1997 (RIFE 3)	Plaice and Cod (25%:75%)	37.0	27.8	9.3	0.0	Crabs, Lobsters and *Nephrops* (50%:40%:10%)	17.0	8.5	6.8	1.7	Winkles and other molluscs (40%:60%)	4.2	1.7	2.5	-	0	1997 Review	-
1998 (RIFE 4)	Plaice and Cod (50%:50%)	45.0	22.5	22.5	0.0	Crabs and Lobsters (85%:15%)	28.0	23.8	4.2	0.0	Winkles and other molluscs (30%:70%)	15.0	4.5	10.5	Sand and mollusc beds	1100	1998 Survey	1998 Survey
1999 (RIFE 5)	Plaice and Cod (50%:50%)	43.0	21.5	21.5	0.0	Crabs and Lobsters (80%:20%)	24.0	19.2	4.8	0.0	Winkles and other molluscs (50%:50%)	25.0	12.5	12.5	Sand and mollusc beds	1000	1999 Review	1999 Review
2000 (RIFE 6)	Cod and other fish (40%:60%)	31.0	12.4	0.0	18.6	Crabs, Lobsters and *Nephrops* (40%:40%:20%)	20.0	8.0	8.0	4.0	Winkles and other molluscs (50%:50%)	17.0	8.5	8.5	Sand and mollusc beds	1000	2000 Review	2000 Review
2001 (RIFE 7)	Cod and other fish (40%:60%)	31.0	12.4	0.0	18.6	Crabs, Lobsters and *Nephrops* (40%:40%:20%)	20.0	8.0	8.0	4.0	Winkles and other molluscs (50%:50%)	17.0	8.5	8.5	Sand and mollusc beds	900	2000 Review	2000 Review
2002 (RIFE 8)	Cod and other fish (40%:60%)	51.0	20.4	0.0	30.6	Crabs, Lobsters and *Nephrops* (50%:30%:20%)	16.0	8.0	4.8	3.2	Winkles and mussels (60%:40%)	29.0	17.4	11.6	Mud and sand	1200	2002 Review	2002 Review
2003 (RIFE 9)	Cod and other fish (60%:40%)	41.0	24.6	0.0	16.4	Crabs, Lobsters and *Nephrops* (80%:10%:10%)	27.0	21.6	2.7	2.7	Winkles and other molluscs (40%:60%)	34.0	13.6	20.4	Mud and sand	870	2003 Survey	2003 Survey
2004 (RIFE 10)	Cod and other fish (60%:40%)	41.0	24.6	0.0	16.4	Crabs, Lobsters and *Nephrops* (50%:40%:10%)	25.0	12.5	10.0	2.5	Winkles and other molluscs (50%:50%)	34.0	17.0	17.0	Mud and sand	1000	2004 Review (crust and moll) and 2003 Survey (fish)	2004 Review
2005 (RIFE 11)	Cod and other fish (60%:40%)	41.0	24.6	0.0	16.4	Crabs, Lobsters and *Nephrops* (60%:20%:20%)	20.0	12.0	4.0	4.0	Winkles and other molluscs (60%:40%)	33.0	19.8	13.2	Mud and sand	790	2005 Review (crust and moll) and 2003 Survey (fish)	2005 Review
2006 (RIFE 12)	Cod and other fish (60%:40%)	41.0	24.6	0.0	16.4	Crabs, Lobsters and *Nephrops* (50%:20%:30%)	20.0	10.0	4.0	6.0	Winkles and other molluscs (50%:50%)	40.0	20.0	20.0	Mud and sand	580	2006 Review (crust and moll) and 2003 Survey (fish)	2006 Review
2007 (RIFE 13)	Cod and other fish (60%:40%)	41.0	24.6	0.0	16.4	Crabs, Lobsters and *Nephrops* (50%:30%:20%)	20.4	10.2	6.1	4.1	Winkles and other molluscs (60%:40%)	28.9	17.3	11.6	Mud and sand	830	2007 Review (crust and moll) and 2003 Survey (fish)	2007 Review
2008 (RIFE 14)	Cod and other fish (25%:75%)	40.0	10.0	0.0	30.0	Crabs, Lobsters and *Nephrops* (70%:20%:10%)	16.8	11.8	3.4	1.7	Winkles and other molluscs (50%:50%)	31.4	15.7	15.7	Mud and sand	930	2008 Survey	2008 Survey
2009 (RIFE 15)	Cod and other fish (25%:75%)	40.0	10.0	0.0	30.0	Crabs, Lobsters and *Nephrops* (30%:50%:20%)	16.0	4.8	8	3.2	Winkles and other molluscs (60%:40%)	28.0	16.8	11.2	Mud and sand	960	2009 Review (crust & moll) 2008 Survey (fish)	2009 Review
2010 (RIFE 16)	Cod and other fish (25%:75%)	40.0	10.0	0.0	30.0	Crabs, Lobsters and *Nephrops* (50%:30%:20%)	22.0	11.0	6.6	4.4	Winkles and other molluscs (20%:80%)	22.0	4.4	17.6	Mud and sand	870	2010 Review (crust & moll) 2008 Survey (fish)	2010 Review
2011 (RIFE 17)	Cod and other fish (25%:75%)	40.0	10.0	0.0	30.0	Crabs, Lobsters and *Nephrops* (40%:30%:30%)	27.0	10.8	8.1	8.1	Winkles and other molluscs (60%:40%)	12.0	7.2	4.8	Mud and sand	840	2011 Review (crust & moll) 2008 Survey (fish)	2011 Review

Annex 3b. Sellafield Fishing Community 5-year average consumption and intertidal occupancy rates (kg y^{-1} and h y^{-1})

5-year period	FISH				CRUSTACEANS				MOLLUSCS			EXTERNAL
	Total fish	Cod	Plaice	Other fish	Total crustaceans	Crab	Lobster	*Nephrops*	Total molluscs	Winkles	Other molluscs	Intertidal occupancy
1994-98	31.8	17.8	14.1	0.0	15.5	10.8	4.4	0.3	10.6	5.5	5.1	1100
1995-99	35.2	19.5	15.8	0.0	17.9	13.0	4.6	0.3	13.6	6.4	7.3	1050
1996-00	36.2	19.3	13.2	3.7	20.2	13.3	5.7	1.1	14.6	6.9	7.8	1033
1997-01	37.4	19.3	10.7	7.4	21.8	13.5	6.4	1.9	15.6	7.1	8.5	1000
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
2002-06	43.0	23.8	0.0	19.2	21.6	12.8	5.1	3.7	34.0	17.6	16.4	888
2003-07	41.0	24.6	0.0	16.4	22.5	13.3	5.4	3.9	34.0	17.5	16.4	814
2004-08	40.8	21.7	0.0	19.1	20.4	11.3	5.5	3.7	33.5	18.0	15.5	826
2005-09	40.6	18.8	0.0	21.8	18.6	9.8	5.1	3.8	32.3	17.9	14.3	818
2006-10	40.4	15.8	0.0	24.6	19.0	9.6	5.6	3.9	30.1	14.8	15.2	834
2007-11	40.2	12.9	0.0	27.3	20.4	9.7	6.4	4.3	24.5	12.3	12.2	886

Annex 4. Summary of adults' profiled consumption data (kg y^{-1} or l y^{-1}) and occupancy data (h y^{-1}) in the Sellafield area (2008 Sellafield full habits survey data updated with the 2009, 2010 and 2011 Sellafield review data)

		Pathway Name																										
Profile Name	Number of individuals	Crustacea	Direct[a]	Eggs	Fish - Fresh	Fish - Sea	Fruit - Domestic	Fruit and nuts - Wild	Gamma ext - sediments[b]	Gamma ext - salt marsh	Honey	Marine plants/algae	Meat - Cow	Meat - Game[c]	Meat - Poultry	Meat - Sheep	Milk	Mollusc	Mushrooms	Occupancy IN water	Occupancy ON water	Plume (IN; 0-0.25km)[d]	Plume (MID; >0.25-0.5km)[d]	Plume (OUT; >0.5-1km)[d]	Vegetables - Green	Vegetables - Other Domestic	Vegetables - Potatoes	Vegetables - Root
		kg	-	kg	kg	kg	kg	kg	h	h	kg	kg	kg	kg	kg	kg	l	kg	kg	h	h	h	h	h	kg	kg	kg	kg
Crustacean consumers	**10**	26.6	-	-	-	28.1	-	-	-	270	-	0.02	-	-	-	-	-	3.3	-	-	320	-	-	-	-	-	-	-
Occupants for direct radiation	**54**	0.07	1.0	4.3	0.04	1.6	2.1	0.59	-	66	0.05	-	4.7	0.15	0.16	1.1	13.1	0.09	0.07	-	<1	1200	1270	1970	0.80	1.9	2.8	0.77
Egg consumers	**16**	-	0.56	22.0	-	2.0	3.9	0.68	-	2	0.17	-	6.1	-	0.06	-	46.6	-	0.20	-	<1	1390	1060	1430	0.28	2.9	19.6	0.33
Freshwater fish consumers	**1**	-	1.0	-	2.3	16.8	-	-	-	680	-	-	-	-	-	-	-	-	-	-	-	290	-	-	-	-	-	-
Sea fish consumers	**20**	14.6	0.05	-	-	39.5	0.05	0.38	-	320	-	0.02	-	-	-	-	-	2.2	0.08	-	370	-	3	-	0.35	0.28	0.50	0.63
Domestic fruit consumers	**4**	-	-	4.4	-	-	45.5	0.23	-	12	4.3	-	-	-	-	-	-	-	0.85	-	-	-	-	-	19.8	35.3	54.4	23.3
Wild fruit and nut consumers	**5**	1.2	0.80	3.5	-	12.3	4.4	6.2	-	190	0.27	-	-	-	0.09	-	23.6	1.2	0.74	-	-	-	4510	-	3.6	4.5	13.4	5.0
Occupants for exposure - mud/sand	**4**	3.9	-	-	-	3.0	-	-	55	340	-	-	-	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Occupants for exposure - salt marsh	**37**	2.6	0.05	-	0.06	10.1	0.03	0.20	1	740	-	<0.01	-	-	-	-	-	0.51	0.04	-	68	8	1	-	0.19	0.15	0.27	0.34
Honey consumers	**3**	-	-	-	-	-	18.9	-	-	16	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.8	17.3	-
Marine plants/algae consumers	**3**	20.3	-	-	-	38.0	-	-	-	540	-	0.22	-	-	-	-	-	4.3	-	-	-	-	-	-	-	-	-	-
Cattle meat consumers	**14**	-	0.36	7.5	-	0.61	3.2	0.52	-	6	0.10	-	33.9	-	0.19	6.1	108.9	-	0.98	4	-	1440	770	-	-	0.26	15.1	-
Game meat consumers	**5**	3.1	-	-	0.11	6.3	0.45	1.3	12	140	-	-	-	14.4	2.4	-	-	-	0.11	-	-	-	-	-	-	-	-	-
Poultry meat consumers	**5**	-	-	1.8	0.42	1.8	-	0.60	-	8	-	-	-	0.90	9.0	-	-	-	0.12	-	-	-	-	-	-	-	-	-
Sheep meat consumers	**10**	0.09	0.30	3.9	-	0.66	0.86	0.58	-	3	-	-	20.7	-	0.27	14.4	35.5	-	1.2	-	-	1370	-	-	-	-	-	-
Milk consumers	**37**	-	0.05	3.3	-	0.18	0.73	0.50	<1	3	0.04	-	6.1	0.11	0.28	1.6	221.3	0.01	0.19	2	-	-	290	-	3.3	0.10	43.7	4.6
Mollusc consumers	**5**	17.8	-	-	-	20.0	-	-	-	270	-	0.05	-	-	-	-	-	11.9	-	-	200	-	-	-	-	-	-	-
Mushroom consumers	**16**	0.37	0.06	9.4	-	5.4	9.4	1.8	-	59	-	-	9.2	-	0.23	5.4	41.6	0.38	1.9	-	-	-	3	-	5.8	8.0	14.8	7.4
Occupancy IN water	**28**	-	-	0.08	-	-	<0.01	<0.01	-	2	-	-	1.0	-	-	-	5.2	-	<0.01	35	28	-	-	-	-	-	-	-
Occupancy ON water	**11**	15.3	-	-	-	27.6	-	-	-	230	-	-	-	-	-	-	-	1.5	-	-	1070	-	-	-	-	-	-	-
Occupants for plume pathways (inner area)	**9**	-	1.0	8.2	-	0.87	3.5	0.09	-	<1	-	-	20.0	-	-	2.6	19.7	-	-	-	-	6780	-	-	-	-	-	-
Occupants for plume pathways (mid area)	**8**	-	1.0	4.4	-	-	5.6	2.2	-	47	0.34	-	5.8	-	0.11	1.4	40.1	-	0.14	-	-	-	7490	-	0.50	1.9	11.8	-
Occupants for plume pathways (outer area)	**15**	-	1.0	6.2	-	1.0	2.0	0.29	-	64	-	-	-	0.21	0.53	0.75	-	-	0.09	-	2	-	-	6640	2.2	5.3	2.3	1.9
Green vegetable consumers	**5**	-	0.20	4.8	-	-	29.6	0.18	-	-	-	-	-	-	-	-	-	-	0.68	-	-	-	-	1490	40.7	33.3	38.6	31.6
Other domestic vegetable consumers	**6**	-	0.33	7.0	-	-	24.7	0.15	-	1	-	-	-	-	-	-	-	-	0.72	-	-	-	-	2610	16.6	37.6	57.1	21.0
Potato consumers	**23**	-	-	3.1	-	0.28	6.1	0.04	-	-	-	-	2.3	0.12	0.17	-	153.3	-	0.21	-	-	-	-	-	8.2	7.6	89.7	9.7
Root vegetable consumers	**6**	-	-	3.0	-	-	23.6	0.48	-	<1	-	-	-	0.24	0.63	1.3	60.8	0.08	0.57	-	-	-	-	-	33.4	23.1	46.0	35.2

Notes

[a]Expressed as the proportion of the profile members who are exposed to direct radiation.

[b]Gamma ext - sediment includes occupancy over mud; mud and sand; mud, sand and stones; sand; and sand and stones.

[c]Game meat includes venison, rabbits/hares and wildfowl.

[d]Plume times are the sums of individuals' indoor and outdoor times.

The means of the high-rate groups are determined by the 'cut-off' method and are highlighted on the diagonal.

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