

Cefas contract report C2848

# Radiological Habits Survey: Sellafield Review, 2010

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Environment Report RL 13/11

Final report

# **Radiological Habits Survey: Sellafield Review, 2010**

**Shellfish consumption and intertidal occupancy review**

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**Peer reviewed by G.J. Hunt**

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## CONTENTS

<b>1. INTRODUCTION</b>	<b>4</b>
<b>2. SURVEY AREA</b>	<b>4</b>
<i>Figure 1. The Sellafield review aquatic survey area</i>	5
<b>3. CONDUCT OF THE SURVEY</b>	<b>6</b>
<b>4. METHODS OF DATA ANALYSIS</b>	<b>6</b>
4.1 Data recording	6
4.2 Data analysis	7
<b>5. INTERNAL EXPOSURE</b>	<b>8</b>
5.1 Crustaceans and molluscs	8
<i>Table A. Summary of consumption rates of foods from the aquatic survey area</i>	8
5.2 Species composition of the shellfish high-rate groups for adults and comparison with 2009 data	9
5.3 Consumption trends	10
<i>Figure 2. Consumption rates for the adult high-rate groups for crustaceans, 2001 – 2010 (kg y<sup>-1</sup>)</i>	10
<i>Figure 3. Consumption rates for the adult high-rate groups for molluscs, 2001 – 2010 (kg y<sup>-1</sup>).</i>	10
<b>6. EXTERNAL EXPOSURE</b>	<b>11</b>
6.1 Intertidal occupancy	11
<i>Table B. Summary of adults' intertidal occupancy rates</i>	11
<i>Table C. Summary of adults' intertidal occupancy rates from the 2009 Sellafield review</i>	12
<i>Table D. Summary of children's intertidal occupancy rates</i>	13
<b>7. USE OF HABITS DATA FOR DOSE ASSESSMENTS</b>	<b>14</b>
7.1 Aquatic combinations for adults in the Sellafield Fishing Community	14
7.2 Sellafield 5-year averages	14
7.3 Profiled habits data	14
<b>8. SUMMARY AND RECOMMENDATIONS</b>	<b>16</b>
<b>9. REFERENCES</b>	<b>17</b>

## TABLES

Table 1	Adults' consumption rates of crustaceans in the Sellafield area (kg y <sup>-1</sup> )
Table 2	Adults' consumption rates of molluscs in the Sellafield area (kg y <sup>-1</sup> )
Table 3	Children's consumption rates of crustaceans in the Sellafield area (kg y <sup>-1</sup> )
Table 4	Children's consumption rates of molluscs in the Sellafield area (kg y <sup>-1</sup> )
Table 5	Adults' intertidal occupancy rates in the Sellafield area (h y <sup>-1</sup> )
Table 6	Children's intertidal occupancy rates in the Sellafield area (h y <sup>-1</sup> )
Table 7	Aquatic combinations for adults in the Sellafield Fishing Community

## ANNEXES

Annex 1	Adults' consumption rates (kg y <sup>-1</sup> ) and intertidal occupancy rates (h y <sup>-1</sup> ) in the Sellafield area
Annex 2	Children's consumption rates (kg y <sup>-1</sup> ) and intertidal occupancy rates (h y <sup>-1</sup> ) in the Sellafield area
Annex 3a	Sellafield Fishing Community consumption and intertidal occupancy data reported in AEMR and RIFE (kg y <sup>-1</sup> and h y <sup>-1</sup> )
Annex 3b	Sellafield Fishing Community 5-year average consumption and intertidal occupancy rates (kg y <sup>-1</sup> and h y <sup>-1</sup> )
Annex 4	Summary of adults' profiled consumption data (kg y <sup>-1</sup> or l y <sup>-1</sup> ) and occupancy data (h y <sup>-1</sup> ) in the Sellafield area (2008 Sellafield full habits survey data updated with the 2009 and 2010 Sellafield review data)

## 1. INTRODUCTION

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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 Health and Safety Executive (HSE), 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 asked about their fish consumption and this has been used to improve the total dose assessment of additive exposure (see Section 7.3). For the 2010 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 2010, 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 were used to check the validity of the interview data.

## 2. SURVEY AREA

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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

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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 19<sup>th</sup> – 22<sup>nd</sup> October 2010, 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.

There were several interviewees who were not available during the October fieldwork. These interviewees were contacted at a later date and interviews were conducted by the Cefas team at Whitehaven.

Observations for 41 adults and 13 children were recorded for the 2010 Sellafield review.

### 4. METHODS OF DATA ANALYSIS

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#### 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 97.5<sup>th</sup> 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) has changed its recommendations for the age groupings to be used in radiological assessments. These recommendations have been adopted in this report and consequently the age ranges used differ from those used in previous habits survey reports produced by Cefas. The new age ranges 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 previous reports, for comparison.

Age ranges adopted in this report		Age ranges used in previous reports	
Name of age group	Age range in group	Name of age group	Age range in group
• 1-year-old	0 to 5-year-old	• 3-month-old	Under 1-year
• 10-year-old	6-year-old to 15-year-old	• 1-year-old	1-year-old
• Adult	16-year-old and over	• 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

Since there are fewer age groups for children in the new regime, there should, in general, be more observations in each group, resulting in greater robustness in the data. However, current and future data for children will not be directly comparable with historic child data, 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 given in Annexes 1 and 2 for adults and children, respectively. 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 97.5<sup>th</sup> 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 and 2010 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 97.5<sup>th</sup> 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. Table A presents a summary of the consumption rates of crustaceans and molluscs for adults and children. The table includes the mean consumption rates for the high-rate groups and the observed 97.5<sup>th</sup> percentile rates. No children in the 1-year-old age group were identified consuming crustaceans or molluscs.

<b>Table A. Summary of consumption rates of foods from the aquatic survey area</b>						
<b>Food group</b>	<b>Number of observations</b>	<b>Number of people in the high-rate group</b>	<b>Observed maximum for the high-rate group (kg y<sup>-1</sup>)</b>	<b>Observed minimum for the high-rate group (kg y<sup>-1</sup>)</b>	<b>Observed mean for the high-rate group (kg y<sup>-1</sup>)</b>	<b>Observed 97.5<sup>th</sup> percentile (kg y<sup>-1</sup>)</b>
<b>Adults</b>						
<b>Crustaceans</b>	17	5	40.7	14.8	22.1	32.0
<b>Molluscs</b>	18	5	28.4	10.4	22.1	27.1
<b>10-year-old age group (6 - 15 years old)</b>						
<b>Crustaceans</b>	4	2	7.9	7.9	7.9	7.9
<b>Molluscs</b>	2	2	0.1	0.1	0.1	0.1

The species of crustaceans consumed by adults in the high-rate group were brown crab, common lobster, *Nephrops* and common prawn (reported by the interviewees as common prawns but there is confusion regarding the identification of various species of prawns and shrimps), which were caught throughout the survey area. The species of crustaceans consumed by children in the 10-year-old age group were brown crab, common lobster and common prawn. The species of molluscs consumed by adult high-rate group were mussels, winkles, razor shells, cockles, whelks and limpets and oysters. The only species of molluscs consumed by children in the 10-year-old age group was razor shells. Mussels, cockles and oysters were collected from the Ravenglass Estuary, mussels were also

collected from St Bees, Nethertown and Drigg, and cockles were also collected from St Bees, Nethertown and Braystones. Winkles were collected from Fleswick, St Bees, Nethertown and Braystones, limpets were collected from Nethertown and razor shells were collected from Nethertown and St Bees. Whelks were caught throughout the survey area.

## 5.2 Species composition of the shellfish high-rate groups for adults and comparison with 2009 data

The percentage composition for the predominant shellfish species consumed by the adult high-rate groups from the 2010 Sellafield review, rounded to the nearest 10% for use in dose assessments, are as follows:

- Crustaceans - 50% brown crab, 30% common lobster, 20% *Nephrops* (including common prawn) (mean consumption rate for the crustacean high-rate group 22 kg y<sup>-1</sup>)
- Molluscs - 20% winkles and 80% other molluscs (mean consumption rate for the high-rate group 22 kg y<sup>-1</sup>)

By comparison, the percentage composition for the predominant shellfish species consumed in the adult high-rate groups from the 2009 Sellafield review, and used in RIFE-15 (EA, FSA, NIEA and SEPA, 2010) for dose assessments, were:

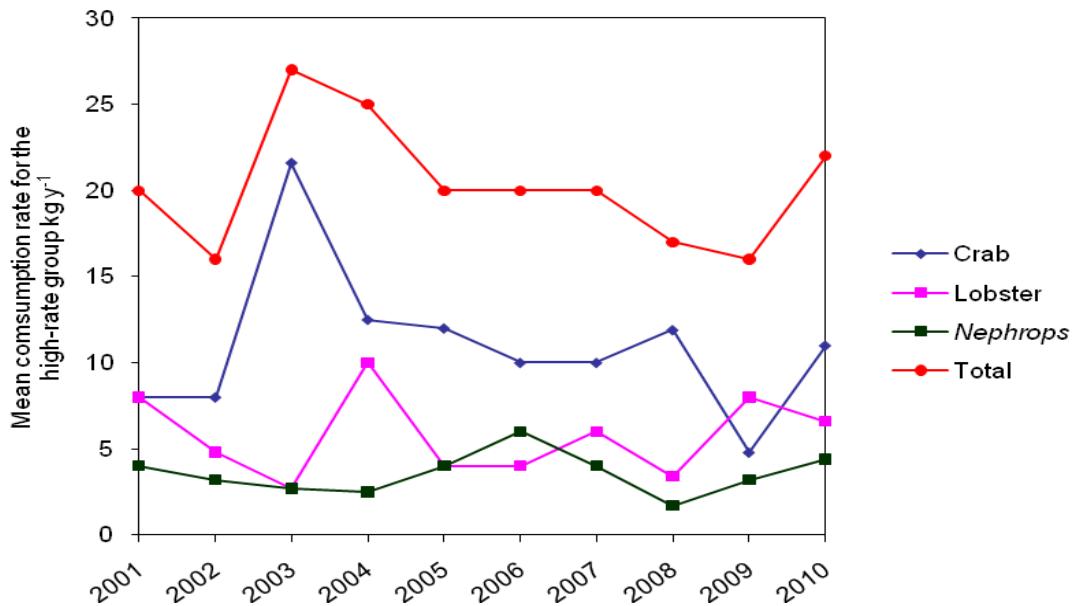
- Crustaceans - 50% common lobster, 30% brown crab and 20% *Nephrops* (mean consumption rate for the adult high-rate group 16 kg y<sup>-1</sup>)
- Molluscs - 60% winkles and 40% other molluscs (mean consumption rate for the adult high-rate group 28 kg y<sup>-1</sup>)

In 2010, the mean consumption rate for the high-rate group for crustaceans increased by 6 kg y<sup>-1</sup> compared to 2009. There was a decrease of 6 kg y<sup>-1</sup> in the mean consumption rate for the high-rate group for molluscs in 2010. The main species of crustaceans and molluscs consumed in 2010 were the same as in 2009. Additionally, in 2010 common prawns were being consumed. The percentage breakdown of species changed in both groups in 2010. For crustaceans, there was an increase in brown crab consumption and a decrease in lobster consumption in 2010. There was also an increase in the consumption of common prawns. For molluscs, there was a significant decrease in winkle consumption and a significant increase in the consumption of other molluscs in 2010.

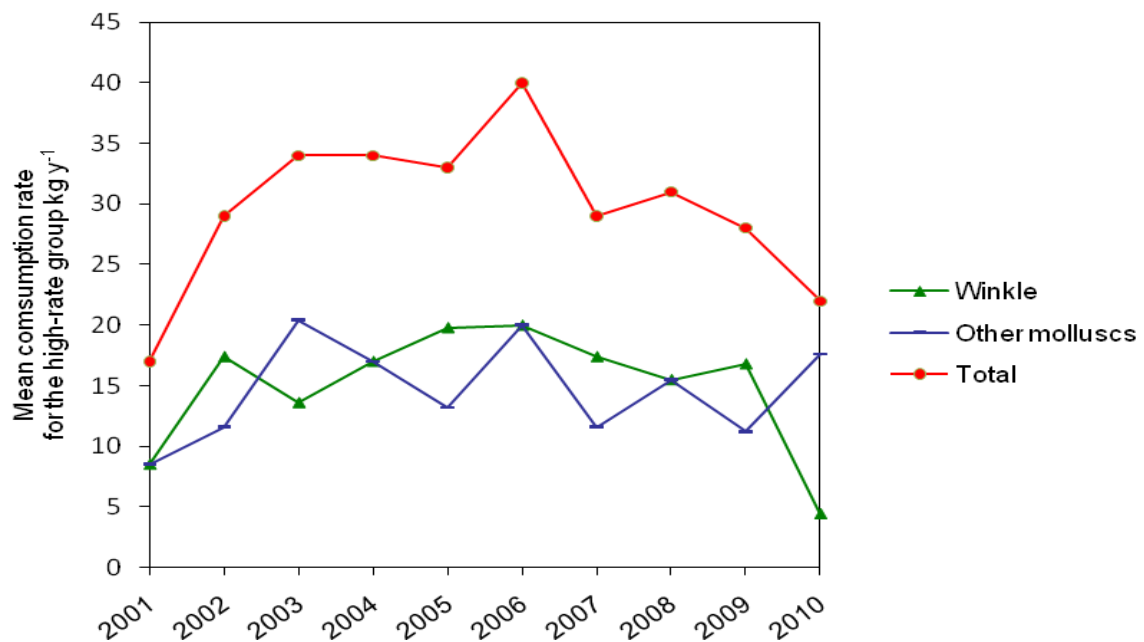
### 5.3 Consumption trends

The consumption rates for the adult high-rate groups for crustaceans and molluscs over the previous ten years (2001 - 2010) are shown in Figures 2 and 3. These figures were plotted using adult mean for the high-rate groups distributed according to the percentage breakdowns described as in Section 5.2. The raw data are presented in Annex 3a.

**Figure 2. Consumption rates for the adult high-rate groups for crustaceans, 2001 – 2010 ( $\text{kg y}^{-1}$ )**



**Figure 3. Consumption rates for the adult high-rate groups for molluscs, 2001 – 2010 ( $\text{kg y}^{-1}$ )**



## 6. EXTERNAL EXPOSURE

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Intertidal occupancy rates for adults and children are presented in Tables 5 and 6, respectively. 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***

Adults were identified undertaking activities over the following seven types of substrate:

- mud
- mud and sand
- mud, sand and stones
- rock
- salt marsh
- sand
- sand and stones

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 97.5<sup>th</sup> percentile rates.

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

The following activities were undertaken by people in the adult high-rate groups for occupancy over intertidal substrates. For mud, the activities were bait digging at Whitehaven Harbour and wildfowling on the River Irt. For mud and sand, the only activity was nature warden duties in the Eskmeals

Nature Reserve. For mud, sand and stones the activities were undertaking boat maintenance and walking at Ravenglass. For rock, the activities were collecting winkles, walking and angling at Saltom Bay and Whitehaven. For salt marsh the activities were wildfowling in the Ravenglass Estuary and nature warden duties in the Eskmeals Nature Reserve. For sand, the activities were collecting winkles and limpets at Seascale, Nethertown and Braystones; angling at Braystones and St Bees; attending set nets at Braystones; beachcombing from Drigg to Sellafield; collecting razor shells at Nethertown, Braystones and St Bees; bait digging and walking at Braystones, Seascale and Drigg; dog walking at Seascale, Drigg and Sellafield; playing at Seascale. For sand and stones, the activities were collecting winkles from Parton to Drigg and angling from St Bees to Drigg.

The adult mean occupancy rates for the high-rate groups from the 2010 Sellafield review can be compared with those from the 2009 Sellafield review which are presented in Table C.

<b>Table C. Summary of adults' intertidal occupancy rates from the 2009 Sellafield review</b>					
<b>Intertidal substrate</b>	<b>Number of observations</b>	<b>Number of people in the high-rate group</b>	<b>Maximum of the high-rate group (h y<sup>-1</sup>)</b>	<b>Mean of the high-rate group (h y<sup>-1</sup>)</b>	<b>97.5<sup>th</sup> percentile (h y<sup>-1</sup>)</b>
<b>Mud</b>	6	1	228	228	207
<b>Mud and sand</b>	9	4	520	295	462
<b>Mud, sand and stones</b>	1	1	112	112	Not applicable
<b>Rock</b>	1	1	27	27	Not applicable
<b>Salt marsh</b>	2	1	156	156	153
<b>Sand</b>	9	4	1072	807	1040
<b>Sand and stones</b>	10	5	216	153	203

In 2010, compared with 2009, the mean consumption rate for the high-rate group for occupancy over mud, decreased by 160 h y<sup>-1</sup>; for occupancy over mud and sand, increased by 220 h y<sup>-1</sup>; for occupancy over mud, sand and stones, increased by 1100 h y<sup>-1</sup> (due to one person undertaking boat maintenance and walking for long periods of time), for occupancy over rock, increased by 74 h y<sup>-1</sup>; for occupancy over salt marsh, decreased by 100 h y<sup>-1</sup>; for occupancy over sand, decreased by 300 h y<sup>-1</sup>; for occupancy over sand and stones, increased by 650 h y<sup>-1</sup>.

### **Children's intertidal occupancy rates**

Children in the 10-year-old age group were identified undertaking activities over the following three types of intertidal substrate:

- salt marsh
- sand
- sand and stones

No children in the 1-year-old age group were identified undertaking activities over intertidal substrates.

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

<b>Table D. Summary of children's intertidal occupancy rates</b>					
<b>Intertidal substrate</b>	<b>Number of observations</b>	<b>Number of children in the high-rate group</b>	<b>Maximum of the high-rate group (h y<sup>-1</sup>)</b>	<b>Mean of the high-rate group (h y<sup>-1</sup>)</b>	<b>97.5<sup>th</sup> percentile (h y<sup>-1</sup>)</b>
<b>10-year-old age group (6 – 15 years old)</b>					
<b>Salt marsh</b>	2	2	60	60	60
<b>Sand</b>	9	7	269	185	251
<b>Sand and stones</b>	1	1	292	292	Not applicable

The following activities were undertaken by children in the 10-year-old age group high-rate groups for occupancy over intertidal substrates. For salt marsh, the only activity was wildfowling in the Ravenglass Estuary. For sand, the activities were dog walking at Seascale and playing at Braystones. For sand and stones, the activities were collecting winkles from Parton to Drigg and angling from St Bees to Drigg.

## 7. USE OF HABITS DATA FOR DOSE ASSESSMENTS

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### 7.1 Aquatic combinations for adults in the Sellafield Fishing Community

The consumption rates of crustaceans and molluscs, and intertidal occupancy rates for each individual are presented in Table 7. Fish consumption rates are also shown. The table shows that several individuals are members of multiple high-rate groups. For example, observation number 9 is in the high-rate group for crustaceans and molluscs, spends time on intertidal substrates 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 2010 will be based on combinations of consumption and intertidal occupancy pathways 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. 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 (2006 - 2010) of the high-rate group data (for fish, crustaceans, molluscs and intertidal occupancy) will be used in RIFE-16 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, 2010).

The matrix for the 2010 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 and 2010 Sellafield annual review. All pathways and observations from the original 2008 profiled habits matrix were retained and for the 2010 profile, only data asked about during the 2010 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. Because the profile has been created using the data from 2008, 2009 and 2010, the profiled data shown in Annex 4 are not comparable with the raw data presented in Annex 1.

## 8. SUMMARY AND RECOMMENDATIONS

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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 41 adults and 13 children. The recommendations are based on the adult data.

The mean rates for the adult high-rate groups from the 2010 Sellafield review are as follows:

- Crustaceans 22 kg y<sup>-1</sup>
- Molluscs 22 kg y<sup>-1</sup>
- Occupancy over mud 67 h y<sup>-1</sup>
- Occupancy over mud and sand 520 h y<sup>-1</sup>
- Occupancy over mud, sand and stones 1200 h y<sup>-1</sup>
- Occupancy over rock 100 h y<sup>-1</sup>
- Occupancy over salt marsh 56 h y<sup>-1</sup>
- Occupancy over sand 510 h y<sup>-1</sup>
- Occupancy over sand and stones 800 h y<sup>-1</sup>

In comparison to 2009, the mean rates for the high-rate groups in 2010 increased by 6 kg y<sup>-1</sup> for crustaceans, decreased by 6 kg y<sup>-1</sup> for molluscs. For occupancy over intertidal substrates, the mean rates for the high-rate groups increased by 220 h y<sup>-1</sup> for occupancy over mud and sand, by 1100 h y<sup>-1</sup> for mud, sand and stones, by 74 h y<sup>-1</sup> for rock, by 650 h y<sup>-1</sup> for sand and stones, and decreased by 160 h y<sup>-1</sup> for occupancy over mud, by 100 h y<sup>-1</sup> for occupancy over salt marsh and by 300 h y<sup>-1</sup> for occupancy over sand.

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<sup>-1</sup>
- Handling sediment 960 h y<sup>-1</sup>
- Handling fishing gear 980 h y<sup>-1</sup>

The recommended 5-year averages for use in RIFE 16 dose assessments are as follows:

- Fish 40 kg y<sup>-1</sup>
- Crabs 9.6 kg y<sup>-1</sup>
- Lobsters 5.6 kg y<sup>-1</sup>
- *Nephrops* (including common prawns) 3.9 kg y<sup>-1</sup>
- Winkles 15 kg y<sup>-1</sup>
- Other molluscs 15 kg y<sup>-1</sup>
- Occupancy over an intertidal substrate termed 'mud and sand' (mud; mud and sand; mud, sand and stones; sand; and sand and stones combined) 830 h y<sup>-1</sup>

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

Observation number	Brown crab	Common lobster	Common prawn <sup>a</sup>	<i>Nephrops</i>	Total
<b>9</b>	<b>21.3</b>	<b>3.4</b>	-	<b>16.0</b>	<b>40.7</b>
<b>1</b>	<b>9.0</b>	<b>9.3</b>	<b>0.7</b>	-	<b>19.0</b>
<b>2</b>	<b>9.0</b>	<b>9.3</b>	<b>0.7</b>	-	<b>19.0</b>
<b>45</b>	<b>4.5</b>	<b>2.1</b>	<b>10.5</b>	-	<b>17.2</b>
<b>7</b>	<b>7.5</b>	<b>7.3</b>	-	-	<b>14.8</b>
4	7.9	3.0	0.4	-	11.3
5	7.9	3.0	0.4	-	11.3
6	7.9	3.0	0.4	-	11.3
8	2.7	-	-	8.0	10.7
46	2.2	4.7	1.0	-	7.9
47	2.2	4.7	1.0	-	7.9
36	4.4	-	-	-	4.4
37	1.0	3.0	-	-	4.0
44	1.0	2.1	-	-	3.2
17	2.4	-	-	-	2.4
3	1.0	1.0	-	-	2.0
38	1.0	1.0	-	-	2.0

**Notes**

Emboldened observations are the high-rate consumers

The mean consumption rate of crustaceans based on the 5 high-rate adult consumers is 22.1 kg y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 17 observations is 32.0 kg y<sup>-1</sup>

<sup>a</sup>Reported as common prawns but there is confusion regarding the identification of various species of prawns and shrimps.

**Table 2. Adults' consumption rates of molluscs in the Sellafield area (kg y<sup>-1</sup>)**

Observation number	Cockle	Limpet	Mussel	Pacific oyster	Razor shell	Whelk	Winkle	Total
<b>17</b>	-	-	<b>11.3</b>	-	-	<b>14.1</b>	<b>3.0</b>	<b>28.4</b>
<b>45</b>	<b>1.0</b>	-	<b>5.1</b>	<b>1.4</b>	<b>17.5</b>	-	<b>0.4</b>	<b>25.4</b>
<b>9</b>	<b>11.8</b>	-	<b>11.8</b>	-	-	-	-	<b>23.6</b>
<b>32</b>	-	<b>5.0</b>	-	-	-	-	<b>17.8</b>	<b>22.8</b>
<b>44</b>	-	-	<b>5.2</b>	-	-	-	<b>5.2</b>	<b>10.4</b>
36	1.1	-	2.1	-	-	-	2.0	5.2
42	-	-	-	-	-	-	3.9	3.9
43	-	-	-	-	-	-	3.9	3.9
37	-	-	-	-	2.0	-	-	2.0
33	-	-	0.5	-	-	-	1.3	1.8
34	-	-	0.5	-	-	-	1.3	1.8
35	-	-	-	-	-	-	1.8	1.8
41	-	-	-	-	-	-	1.1	1.1
1	-	-	1.0	-	-	-	-	1.0
2	-	-	1.0	-	-	-	-	1.0
38	-	-	-	-	1.0	-	-	1.0
8	0.2	-	0.2	-	-	-	-	0.5
31	-	-	-	-	-	-	0.1	0.1

**Notes**

Emboldened observations are the high-rate consumers

The mean consumption rate of molluscs based on the 5 high-rate adult consumers is 22.1 kg y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 18 observations is 27.1 kg y<sup>-1</sup>

**Table 3. Children's consumption rates of crustaceans in the Sellafield area (kg y<sup>-1</sup>)**

**10-year-old age group (6 - 15 years old)**

Observation number	Age	Brown crab	Common lobster	Common prawn	<i>Nephrops</i>	Total
<b>48</b>	<b>15</b>	<b>2.2</b>	<b>4.7</b>	<b>1.0</b>	-	<b>7.9</b>
<b>49</b>	<b>13</b>	<b>2.2</b>	<b>4.7</b>	<b>1.0</b>	-	<b>7.9</b>
10	14	0.5	-	-	1.6	2.1
12	11	0.4	-	-	1.1	1.5

**Notes**

Emboldened observations are the high-rate consumers

The mean consumption rate of crustaceans for the 10-year-old age group based upon the 2 high-rate consumers is 7.9 kg y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 4 observations is 7.9 kg y<sup>-1</sup>

**Table 4. Children's consumption rates of molluscs in the Sellafield area (kg y<sup>-1</sup>)**

**10-year-old age group (6 - 15 years old)**

Observation number	Age	Razor shell
<b>39</b>	<b>8</b>	<b>0.1</b>
<b>40</b>	<b>7</b>	<b>0.1</b>

**Notes**

Emboldened observations are the high-rate consumers

The mean consumption rate of molluscs for the 10-year-old age group based upon the 2 high-rate consumers is 0.1 kg y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 2 observations is 0.1 kg y<sup>-1</sup>

**Table 5. Adults' intertidal occupancy rates in the Sellafield area (h y<sup>-1</sup>)**

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones
31	Whitehaven Harbour	Bait digging	83	-	-	-	-	-	-
	Ravenglass Estuary	Collecting mussels	-	85	-	-	-	-	-
	Eskmeals	Bait digging	-	-	-	-	-	-	-
	Seascale, Nethertown and Braystones	Collecting winkles and limpets	-	-	-	-	-	-	-
	Seascale, Braystones and Drigg	Bait digging and walking	-	-	-	-	-	593	-
	Braystones	Angling	-	-	-	-	-	-	-
51	River Irt	Wildfowling	63	-	-	-	-	-	-
52	River Irt	Wildfowling	63	-	-	-	-	-	-
53	River Irt	Wildfowling	63	-	-	-	-	-	-
54	River Irt	Wildfowling	63	-	-	-	-	-	-
50	Eskmeals Range Reserve	Nature warden duties	-	520	-	-	-	-	-
			-	-	-	-	52	-	-
45	Ravenglass Estuary	Collecting mussels, cockles and oysters	-	117	-	-	-	-	-
	Drigg to Sellafield	Beachcombing	-	-	-	-	-	345	-
	Nethertown and St Bees	Collecting razor shells	-	-	-	-	-	-	-
	Nethertown to Braystones	Collecting winkles	-	-	-	-	-	-	59
8	Ravenglass to Whitehaven	Bait digging	-	79	-	-	-	-	-
	Braystones	Attending set-nets	-	-	-	-	-	440	-
	Parton to Drigg	Collecting winkles	-	-	-	-	-	-	1001
	St Bees to Drigg	Angling	-	-	-	-	-	-	-
14	Nethertown and Ravenglass	Walking	-	4	-	-	-	-	-
	Parton		-	-	50	-	-	-	-
	Seascale		-	-	-	-	-	2	-
16	Nethertown and Ravenglass	Walking	-	4	-	-	-	-	-
	Seascale		-	-	-	-	-	2	-
36	Ravenglass Estuary	Collecting mussels	-	3	-	-	-	-	-
	Nethertown	Hooking for crabs	-	-	-	9	-	-	-
	Braystones	Angling	-	-	-	-	-	-	-
	Braystones, Seascale and Eskmeals	Bait digging	-	-	-	-	-	84	-
	Nethertown	Collecting winkles	-	-	-	-	-	-	3

**Table 5. Adults' intertidal occupancy rates in the Sellafield area (h y<sup>-1</sup>)**

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones
	Nethertown	Collecting mussels	-	2	-	-	-	-	-
17	Barrow Mouth and Whitehaven	Angling	-	-	-	23	-	-	-
	Drigg Barn Scar and St Bees	Hooking for crabs	-	-	-	-	-	-	-
	St Bees	Collecting mussels	-	-	-	-	-	6	-
	Fleswick Bay	Collecting winkles	-	-	-	-	-	-	-
33	Ravenglass Estuary	Collecting mussels	-	2	-	-	-	-	-
34	Ravenglass Estuary	Collecting mussels	-	2	-	-	-	-	-
<b>7</b>	<b>Ravenglass</b>	<b>Boat maintenance and walking</b>	-	-	<b>1186</b>	-	-	-	-
<b>46</b>	Ravenglass	Walking	-	-	330	-	-	-	-
	<b>Ravenglass Estuary</b>	<b>Wildfowling</b>	-	-	-	-	<b>60</b>	-	-
1	Parton	Collecting winkles, walking, angling and netting	-	-	170	-	-	-	-
	<b>Saltom Bay</b>	<b>Walking, angling and collecting</b>	-	-	-	<b>99</b>	-	-	-
	<b>Whitehaven</b>	<b>winkles</b>	-	-	-	-	-	-	-
4	Saltom Bay	Collecting winkles	-	-	-	-	-	-	33
	<b>Saltom Bay</b>	<b>Collecting winkles</b>	-	-	-	<b>102</b>	-	-	-
37	<b>Braystones</b>	<b>Attending set-nets, angling, collecting razor shells and bait digging</b>	-	-	-	-	-	<b>798</b>	-
	Braystones, Nethertown and Sellafield	Collecting crabs	-	-	-	-	-	-	-
	Braystones and Sellafield	Walking and beachcombing	-	-	-	-	-	-	220
	Braystones	Playing and collecting seaweed	-	-	-	-	-	-	-
<b>44</b>	<b>St Bees</b>	<b>Angling</b>	-	-	-	-	-	<b>750</b>	-
<b>47</b>	<b>Seascale, Drigg and Sellafield</b>	<b>Dog walking</b>	-	-	-	-	-	<b>365</b>	-
<b>26</b>	<b>Seascale</b>	<b>Dog walking and playing</b>	-	-	-	-	-	<b>289</b>	-
22	Seascale	Dog walking	-	-	-	-	-	264	-
21	Seascale	Dog walking	-	-	-	-	-	264	-
9	Braystones	Walking and attending set-nets	-	-	-	-	-	228	-
	St Bees to Drigg	Angling	-	-	-	-	-	-	90
18	Seascale	Dog walking	-	-	-	-	-	168	-
29	Drigg	Dog walking	-	-	-	-	-	112	-
30	Drigg	Dog walking	-	-	-	-	-	56	-
24	Seascale	Walking	-	-	-	-	-	48	-

**Table 5. Adults' intertidal occupancy rates in the Sellafield area (h y<sup>-1</sup>)**

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones
25	Seascale	Walking	-	-	-	-	-	48	-
<b>41</b>	<b>Parton</b>	<b>Collecting winkles</b>	-	-	-	-	-	-	<b>600</b>
38	Braystones	Playing	-	-	-	-	-	-	48
	Braystones and Sellafield	Walking	-	-	-	-	-	-	

**Notes**

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud based on 5 observations is 67 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 5 observations for mud is 81 h y<sup>-1</sup>

The mean intertidal occupancy rate over mud and sand based on 1 high-rate observation is 520 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 10 observations for mud and sand is 429 h y<sup>-1</sup>

The mean intertidal occupancy rate over mud, sand and stones based on 1 high-rate observations is 1186 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 4 observations for mud, sand and stones is 1122 h y<sup>-1</sup>

The mean intertidal occupancy rate over rock based on 2 high-rate observations is 101 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 4 observations for rock is 102 h y<sup>-1</sup>

The mean intertidal occupancy rate over salt marsh based on 2 high-rate observations is 56 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 2 observations for salt marsh is 60 h y<sup>-1</sup>

The mean intertidal occupancy rate over sand based on 7 high-rate observations is 511 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 19 observations for sand is 776 h y<sup>-1</sup>

The mean intertidal occupancy rate over sand and stones based on 2 high-rate observations is 801 h y<sup>-1</sup>

The observed 97.5<sup>th</sup> percentile rate based on 8 observations for sand and stones is 931 h y<sup>-1</sup>

**Table 6. Children's intertidal occupancy rates in the Sellafield area ( $\text{h y}^{-1}$ )**

**10-year-old age group (6 - 15 years old)**

<b>Observation number</b>	<b>Age</b>	<b>Location</b>	<b>Activity</b>	<b>Salt marsh</b>	<b>Sand</b>	<b>Sand and stones</b>
<b>49</b>	<b>13</b>	<b>Ravenglass Estuary</b>	<b>Wildfowling</b>	<b>60</b>	-	-
<b>48</b>	<b>15</b>	<b>Ravenglass Estuary</b>	<b>Wildfowling</b>	<b>60</b>	-	-
<b>23</b>	<b>13</b>	<b>Seascale</b>	<b>Dog walking</b>	-	<b>269</b>	-
<b>13</b>	<b>7</b>	<b>Braystones</b>	<b>Playing</b>	-	<b>180</b>	-
<b>12</b>	<b>11</b>	<b>Braystones</b>	<b>Playing</b>	-	<b>180</b>	-
<b>11</b>	<b>12</b>	<b>Braystones</b>	<b>Playing</b>	-	<b>180</b>	-
<b>10</b>	<b>14</b>	<b>Braystones</b>	<b>Playing</b>	-	<b>180</b>	-
		<b>Parton to Drigg</b>	<b>Collecting winkles</b>	-	-	<b>292</b>
		<b>St Bees to Drigg</b>	<b>Angling</b>	-	-	
<b>19</b>	<b>10</b>	<b>Seascale</b>	<b>Dog walking</b>	-	<b>153</b>	-
<b>20</b>	<b>13</b>	<b>Seascale</b>	<b>Dog walking</b>	-	<b>153</b>	-
<b>27</b>	<b>7</b>	Seascale	Playing	-	22	-
<b>28</b>	<b>9</b>	Seascale	Playing	-	22	-

**Notes**

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over salt marsh based on 2 high-rate observations is  $60 \text{ h y}^{-1}$

The observed 97.5<sup>th</sup> percentile rate based on 2 observations for salt marsh is  $60 \text{ h y}^{-1}$

The mean intertidal occupancy rate over sand based on 7 high-rate observations is  $185 \text{ h y}^{-1}$

The observed 97.5<sup>th</sup> percentile rate based on 9 observations for sand is  $251 \text{ h y}^{-1}$

The mean intertidal occupancy rate over sand and stones based on 1 high-rate observation is  $292 \text{ h y}^{-1}$

The observed 97.5<sup>th</sup> percentile rate is not applicable for 1 observation

No children in the 1-year-old age group (0 - 5 years old) were identified spending time on intertidal substrates

**Table 7. Aquatic combinations for adults in the Sellafeld Fishing Community**

Observation number	Consumption rates (kg y <sup>-1</sup> )			Occupancy rates (h y <sup>-1</sup> )						
	Fish	Crustaceans	Molluscs	Mud	Mud and sand	Mud, sand and stones	Sand	Sand and stones	Salt marsh	Rock
9	80.7	<b>40.7</b>	<b>23.6</b>	-	-	-	228	90	-	-
8	47.1	10.7	0.5	-	<b>79</b>	-	<b>440</b>	<b>1001</b>	-	-
37	41.0	4.0	2.0	-	-	-	<b>798</b>	220	-	-
1	23.6	<b>19.0</b>	1.0	-	-	<b>170</b>	-	33	-	<b>99</b>
17	18.2	2.4	<b>28.4</b>	-	2	-	6	-	-	23
2	17.7	<b>19.0</b>	1.0	-	-	-	-	-	-	-
7	10.2	<b>14.8</b>	-	-	-	<b>1186</b>	-	-	-	-
4	6.8	11.3	-	-	-	-	-	-	-	<b>102</b>
46	5.9	7.9	-	-	-	<b>330</b>	-	-	<b>60</b>	-
47	5.9	7.9	-	-	-	-	<b>365</b>	-	-	-
45	-	<b>17.2</b>	<b>25.4</b>	-	<b>117</b>	-	<b>345</b>	59	-	-
44	-	3.2	<b>10.4</b>	-	-	-	<b>750</b>	-	-	-
32	-	-	<b>22.8</b>	-	-	-	-	-	-	-
41	-	-	1.1	-	-	-	-	<b>600</b>	-	-
31	-	-	0.1	<b>83</b>	<b>85</b>	-	<b>593</b>	-	-	-
26	-	-	-	-	-	-	<b>289</b>	-	-	-
51	-	-	-	<b>63</b>	-	-	-	-	-	-
52	-	-	-	<b>63</b>	-	-	-	-	-	-
53	-	-	-	<b>63</b>	-	-	-	-	-	-
54	-	-	-	<b>63</b>	-	-	-	-	-	-
50	-	-	-	-	<b>520</b>	-	-	-	<b>52</b>	-

**Notes**

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

**Annex 1. Adults' consumption rates (kg y<sup>-1</sup>) and intertidal occupancy rates (h y<sup>-1</sup>) in the Sellafield area**

Observation number	Sex	Age (years)	Fish	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	71	23.6	<b>19.0</b>	1.0	-	-	170	<b>99</b>	-	-	33
2	F	70	17.7	<b>19.0</b>	1.0	-	-	-	-	-	-	-
3	F	38	-	2.0	-	-	-	-	-	-	-	-
4	M	46	6.8	11.3	-	-	-	-	<b>102</b>	-	-	-
5	F	46	6.8	11.3	-	-	-	-	-	-	-	-
6	F	16	3.4	11.3	-	-	-	-	-	-	-	-
7	M	79	10.2	<b>14.8</b>	-	-	-	<b>1186</b>	-	-	-	-
8	M	U	<b>47.1</b>	10.7	0.5	-	79	-	-	-	<b>440</b>	<b>1001</b>
9	F	U	<b>80.7</b>	<b>40.7</b>	<b>23.6</b>	-	-	-	-	-	228	90
14	M	69	14.1	-	-	-	4	50	-	-	2	-
15	F	66	13.9	-	-	-	-	-	-	-	-	-
16	F	38	11.5	-	-	-	4	-	-	-	2	-
17	M	74	18.2	2.4	<b>28.4</b>	-	2	-	23	-	6	-
18	F	40	-	-	-	-	-	-	-	-	168	-
21	M	78	-	-	-	-	-	-	-	-	264	-
22	F	74	-	-	-	-	-	-	-	-	264	-
24	F	41	-	-	-	-	-	-	-	-	48	-
25	M	51	-	-	-	-	-	-	-	-	48	-
26	F	72	-	-	-	-	-	-	-	-	<b>289</b>	-
29	F	45	-	-	-	-	-	-	-	-	112	-
30	M	45	-	-	-	-	-	-	-	-	56	-
31	M	U	-	-	0.1	<b>83</b>	85	-	-	-	<b>593</b>	-
32	F	U	-	-	<b>22.8</b>	-	-	-	-	-	-	-
33	F	U	-	-	1.8	-	2	-	-	-	-	-
34	M	U	-	-	1.8	-	2	-	-	-	-	-
35	M	U	-	-	1.8	-	-	-	-	-	-	-
36	M	U	10.9	4.4	5.2	-	3	-	9	-	84	3
37	M	56	<b>41.0</b>	4.0	2.0	-	-	-	-	-	<b>798</b>	220
38	F	55	20.5	2.0	1.0	-	-	-	-	-	-	48
41	M	45	-	-	1.1	-	-	-	-	-	-	<b>600</b>
42	M	U	-	-	3.9	-	-	-	-	-	-	-
43	F	U	-	-	3.9	-	-	-	-	-	-	-
44	M	U	-	3.2	<b>10.4</b>	-	-	-	-	-	<b>750</b>	-
45	M	68	-	<b>17.2</b>	<b>25.4</b>	-	117	-	-	-	<b>345</b>	59

**Annex 1. Adults' consumption rates (kg y<sup>-1</sup>) and intertidal occupancy rates (h y<sup>-1</sup>) in the Sellafield area**

Observation number	Sex	Age (years)	Fish	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
46	M	51	5.9	7.9	-	-	-	330	-	<b>60</b>	-	-
47	F	47	5.9	7.9	-	-	-	-	-	-	<b>365</b>	-
50	M	75	-	-	-	-	<b>520</b>	-	-	<b>52</b>	-	-
51	M	U	-	-	-	<b>63</b>	-	-	-	-	-	-
52	M	U	-	-	-	<b>63</b>	-	-	-	-	-	-
53	M	U	-	-	-	<b>63</b>	-	-	-	-	-	-
54	M	U	-	-	-	<b>63</b>	-	-	-	-	-	-

**Notes**

Emboldened observations are the high-rate individuals

U - Unknown

**Annex 2. Children's consumption rates ( $\text{kg y}^{-1}$ ) and intertidal occupancy rates ( $\text{h y}^{-1}$ ) in the Sellafeld area**

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over salt marsh
<b>10-year-old age group (6 - 15 years old)</b>								
48	M	15	<b>5.9</b>	<b>7.9</b>	-	-	-	<b>60</b>
10	M	14	<b>7.9</b>	2.1	-	<b>180</b>	<b>292</b>	-
20	F	13	-	-	-	<b>153</b>	-	-
23	M	13	-	-	-	<b>269</b>	-	-
49	M	13	<b>5.9</b>	<b>7.9</b>	-	-	-	<b>60</b>
11	M	12	-	-	-	<b>180</b>	-	-
12	M	11	<b>5.6</b>	1.5	-	<b>180</b>	-	-
19	F	10	-	-	-	<b>153</b>	-	-
28	F	9	-	-	-	22	-	-
39	F	8	1.0	-	<b>0.1</b>	-	-	-
13	F	7	-	-	-	<b>180</b>	-	-
27	M	7	-	-	-	22	-	-
40	F	7	1.0	-	<b>0.1</b>	-	-	-

**Notes**

Emboldened observations are the high-rate individuals

**Annex 3a. Sellafeld Fishing Community consumption and intertidal occupancy data reported in AEMR and RIFE (kg y<sup>-1</sup> and h y<sup>-1</sup>)**

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 <sup>-1</sup>	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

**Annex 3b. Sellafield Fishing Community 5-year average consumption and intertidal occupancy rates (kg y<sup>-1</sup> and h y<sup>-1</sup>)**

5-year period	FISH				CRUSTACEANS				MOLLUSCS			EXTERNAL
	Total fish	Cod	Plaice	Other fish	Total crustaceans	Crab	Lobster	<i>Nephrops</i>	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

**Annex 4. Summary of adults' profiled consumption data (kg y<sup>-1</sup> and l y<sup>-1</sup>) and occupancy data (h y<sup>-1</sup>) in the Sellafield area (2008 Sellafield full habits survey data updated with the 2009 and 2010 Sellafield review data)**

Profile Name	Number of individuals	Pathway Name																												
		Crustacea	Direct <sup>a</sup>	Eggs	Fish - Fresh	Fish - Sea	Fruit - Domestic	Fruit and nuts - Wild	Gamma ext - mud/sand <sup>b</sup>	Gamma ext - salt marsh	Honey	Marine plants/algae	Meat - Cow	Meat - Game <sup>c</sup>	Meat - Poultry	Meat - Sheep	Milk	Mollusca	Mushrooms	Occupancy IN water	Occupancy ON water	Plume (IN; 0-0.25km) <sup>d</sup>	Plume (MID; >0.25-0.5km) <sup>d</sup>	Plume (OUT; >0.5-1km) <sup>d</sup>	Vegetables - Green	Vegetables - Other Domestic	Vegetables - Potatoes	Vegetables - Root		
		kg	-	kg	kg	kg	kg	h	h	kg	kg	kg	kg	kg	kg	l	kg	kg	h	h	h	h	h	h	kg	kg	kg	kg		
Crustacean consumers	10	22.7	-	-	33.6	-	-	450	-	-	-	-	-	-	-	-	6.3	-	-	450	-	-	-	-	-	-	-	0.3	-	
Occupants for direct radiation	52	0.1	1	5	1.7	1.8	0.5	70	-	0.2	-	4.3	0.2	0.2	0.9	11.9	-	0.1	-	-	1250	1320	2050	0.8	1.9	3.3	0.8	-	-	
Egg consumers	16	-	0.7	22	-	2	3.9	0.7	-	0.2	-	6.1	-	0.1	-	46.6	-	0.2	-	-	1320	190	2400	0.3	2.9	19.6	0.3	-	-	
Freshwater fish consumers	1	-	1	-	2.3	16.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	290	-	-	-	-	-	-	-	-	
Sea fish consumers	15	13.4	0.1	-	42	0.1	0.5	390	-	-	-	-	-	-	-	-	2.5	0.1	-	490	-	-	-	-	0.5	0.4	0.7	0.8	-	
Domestic fruit consumers	4	-	-	4.4	-	45.5	0.2	10	-	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.8	35.3	54.4	23.3	-	
Wild fruit and nut consumers	5	1.2	0.6	3.5	-	12.3	4.4	6.2	230	-	0.3	-	-	-	0.1	-	23.6	0.6	0.7	-	-	-	-	510	500	3.6	4.5	13.4	5	
Occupants for exposure - mud/sand	28	5.3	0.1	-	0.1	14.4	-	0.3	730	-	-	-	-	-	-	-	1.9	0.1	-	180	10	-	-	0.3	0.2	0.5	0.4	-	-	
Occupants for exposure - salt marsh	3	2.6	-	-	-	2	-	-	350	50	-	-	-	-	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Honey consumers	3	-	0.3	-	-	-	18.9	-	20	-	8.7	-	-	-	-	-	-	-	-	-	-	-	-	570	-	7.8	17.3	-	-	
Marine plants/algae consumers	3	17.3	-	-	-	43.6	-	-	620	-	0.2	-	-	-	-	-	8.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Cattle meat consumers	14	-	0.3	7.5	-	0.6	3.2	0.5	10	-	0.1	-	33.9	-	0.2	6.1	108.9	-	1	-	-	1440	40	-	-	0.3	15.1	-	-	-
Game meat consumers	5	3.2	-	-	0.1	6.3	0.5	1.3	140	10	-	-	-	14.4	2.4	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
Poultry meat consumers	5	-	-	1.8	0.4	1.8	-	0.6	10	-	-	-	-	0.9	9	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
Sheep meat consumers	10	0.1	0.2	3.9	-	0.7	0.9	0.6	-	-	-	-	20.7	-	0.3	14.4	35.5	-	1.2	-	-	260	-	-	-	-	-	-	-	-
Milk consumers	37	-	-	3.3	-	0.2	0.7	0.5	-	-	-	-	6.1	0.1	0.3	1.6	221.3	-	0.2	-	-	-	20	-	3.3	0.1	43.7	4.6	-	-
Mollusc consumers	7	9.1	-	-	-	16.4	-	-	240	-	-	-	-	-	-	-	24.2	-	-	-	-	-	-	-	-	-	-	0.5	-	-
Mushroom consumers	16	0.4	0.1	9.4	-	5.4	9.4	1.8	70	-	-	-	9.2	-	0.2	5.4	41.6	0.2	1.9	-	-	-	-	-	5.8	8	14.8	7.4	-	-
Occupancy IN water	28	-	-	0.1	-	-	-	-	-	-	-	-	1	-	-	-	5.2	-	-	30	30	-	-	-	-	-	-	-	-	-
Occupancy ON water	12	13.4	-	-	-	25.7	-	-	340	-	-	-	-	-	-	-	-	1	-	-	1020	-	-	-	-	-	-	-	-	-
Occupants for plume pathways (inner area)	9	-	1	6.6	-	0.9	3.3	-	-	-	-	-	17.3	-	-	-	26.3	-	-	-	-	6780	-	-	-	-	-	-	-	-
Occupants for plume pathways (mid area)	8	-	1	0.6	-	-	0.6	-	50	-	-	-	-	-	0.1	1.4	-	-	-	-	-	-	7490	-	-	-	-	4.2	-	-
Occupants for plume pathways (outer area)	15	-	1	8.3	-	1	1.2	0.4	60	-	-	-	-	-	0.1	-	-	-	-	0.1	-	-	-	6640	2.2	5.3	2.4	1.9	-	-
Green vegetable consumers	5	-	0.2	4.8	-	-	29.6	0.2	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	-	1490	40.7	33.3	38.6	31.6	-	-
Other domestic vegetable consumers	6	-	0.3	7	-	-	24.7	0.2	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	-	2610	16.6	37.6	57.1	21	-	-
Potato consumers	23	-	-	3.1	-	0.3	6.1	-	-	-	-	-	2.3	0.1	0.2	-	153.3	-	0.2	-	-	-	-	-	8.2	7.6	89.7	9.7	-	-
Root vegetable consumers	6	-	-	3	-	-	23.6	0.5	-	-	-	-	-	0.2	0.6	1.3	60.8	0.1	0.6	-	-	-	-	-	33.4	23.1	46	35.2	-	-

**Notes**

<sup>a</sup>Expressed as the proportion of the profile members who are exposed to direct radiation.

<sup>b</sup>Gamma ext - mud/sand includes occupancy over mud; mud and sand; mud, sand and stones; sand; and sand and stones

<sup>c</sup>Game meat includes venison, rabbits/hares and willdowl

<sup>d</sup>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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