Centre for Environment Fisheries & Aquaculture Science

Cefas

Radiological Habits Survey: Sellafield Review, 2022

Review of shellfish and fish consumption, and intertidal occupancy

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1. Introduction

Reviews are conducted annually at Sellafield, except every fifth year when a full survey (encompassing aquatic, terrestrial and direct radiation pathways) is undertaken. The last full habits survey in the vicinity of Sellafield was conducted by the Centre for Environment, Fisheries & Aquaculture Science (Cefas) in 2018 (Moore and others, 2019). The surveys are undertaken on behalf of the Environment Agency (EA), the Food Standards Agency (FSA) and the Office for Nuclear Regulation (ONR). This supports their roles in protecting the public from the effects of radiation.

Radiological protection of the public is based on the concept of a 'representative person'. This notional individual is defined as being representative of the more highly exposed members of the population. It follows that, if the dose to the representative person is acceptable when compared to dose limits and optimisation, then other members of the public will receive acceptable doses, and overall protection to the public is provided from the effects of radiation. Habits surveys are undertaken to collect data on the foods that people consume and time they spend in the vicinity of a nuclear site, which are combined with data on the levels of radioactivity found in locally grown or caught foods, and in the environment, to estimate the level of radiation that people may be exposed to.

This Sellafield Review survey specifically investigated the consumption of crustaceans, molluscs and fish, and occupancy over intertidal substrates, since these pathways are the major contributors to the dose of the representative person. The dose contribution is dependent upon the consumption and occupancy (habits) data, the radionuclide activity concentrations in seafood, and gamma dose rates over intertidal substrates. The annual review surveys identify any changes in consumption and occupancy rates, new individuals and activities, as well as people who have ceased consuming seafood or undertaking intertidal activities. The information and data in this report are used in radiological dose assessments as reported in the Radioactivity in Food and the Environment (RIFE) series (for example - EA, FSA, FSS, NRW, NIEA and SEPA, 2022).

This survey is also relevant to discharges from the Low Level Waste Repository (LLWR) near Drigg due to the proximity of the site, as well as the potential Moorside nuclear site adjacent to the Sellafield site.

In previous years, 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.

2. Survey area

The aquatic survey area (Figure 1) covered all tidal waters and intertidal areas from Parton to Tarn Bay and extended 11 km offshore.

Figure 1. Aquatic survey area

3. Conduct of the survey

The survey research included Internet and social media searches to identify people who consume crustaceans, molluscs or fish, and who undertake activities on intertidal areas in the survey area. A list of interviewees from previous Sellafield habits surveys, including shellfish collectors, commercial fishermen and hobby fishermen, was collated.

Two members of Cefas staff conducted the survey fieldwork from 13th to 16th June 2022, alongside desk-based telephone interviews, which were conducted between June and July. At the time of the survey fieldwork there were no COVID-19 government restrictions in place. However, the survey team followed the Cefas Health and Safety guidance to ensure the safety of the team and interviewees.

All interviewees were asked to estimate consumption rates for crustaceans, molluscs, and fish from the survey area, as well as occupancy rates over intertidal areas within the survey area, for themselves and members of their families. Information was obtained about the origins of the seafood being consumed and locations of intertidal occupancy.

The public response to the survey was positive. Members of the public who were contacted by phone and approached in person by the survey team were happy to take part in the survey and no one declined an interview. In both the telephone and fieldwork interviews, people welcomed the conversation and showed an interest in the survey.

Interview data were collected for 105 adults, eight children and three infants during the 2022 Sellafield Review survey. The activities identified in the 2022 survey were broadly representative of activities identified in previous Sellafield Review surveys.

It should be noted that the Sellafield Review targets high-rate activities (for example, dog walking, commercial/hobby fishing, angling, working on the shore) and seafood consumption, since these pathways are the major contributors to the dose of the representative person. The full habits surveys (encompassing aquatic, terrestrial and direct radiation pathways) include all activities including a wider range of activities undertaken by children, for example, paddling and swimming.

4. Methods of data analysis

4.1. Data recording and presentation

Data collected during the fieldwork and during phone interviews were recorded in logbooks. All data were examined, and any notably high rates were double-checked, where possible, by way of a follow-up phone call. In cases where follow-up phone calls were not possible (for example - interviewees who wished to remain anonymous), the data were accepted at face value. The raw data were entered into a data capture application and then uploaded to the Cefas habits survey database where each individual for whom information was obtained was given a unique identifier (the Person ID number) to assist in maintaining data quality and traceability.

The consumption and occupancy data in the text of this report are rounded to two significant figures. 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.

In habits surveys, data are structured into age groups because different dose coefficients (which are, the factors which convert intakes of radioactivity into dose) can apply to different ages. The names used for the age groups, based on the recommendations in ICRP 101 (ICRP, 2007), are shown in Table 1.

Table 1. Names of age groups and range of ages within each age group

Name of age group	Age range in group
Infant	0 to 5-year-old
Child	6-year-old to 15-year-old
Adult	16-year-old and over

4.2. Approaches for the identification of high rates

The habits data have been analysed to identify high rates of consumption and occupancy, which are suitable for use in radiological assessments. Two approaches have been used:

Firstly, the ‘cut-off’ method described by Hunt and others (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 aquatic food group and intertidal substrate identified in the survey.

Secondly, the 97.5th percentile rate was calculated for each group. 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.

The results of the individuals’ consumption and occupancy rates collected during the survey were grouped and presented in tables with the high-rate group members indicated in bold and with the calculated mean rates for the high-rate group and 97.5th percentile rates. The consumption rates and occupancy rates are presented with the high-rate group members indicated in bold text, for adults in Annex 1, for children in Annex 2, and for infants in Annex 3.

5. Internal exposure

Consumption data for aquatic foods are presented in Table 4 to Table 6 for adults and Table 7 to Table 9 for children and infants. The tables include the mean consumption rates for the high-rate groups, calculated as described in Section 4.2, and the observed 97.5th percentile rates.

5.1. Crustaceans, molluscs and fish

The people consuming the greatest quantities of crustaceans, molluscs and fish from the aquatic survey area were commercial and hobby fishermen, shellfish collectors, anglers, and the families of these groups of people. Table 2 presents a summary of the adults' consumption rates of crustaceans, molluscs, and fish for the 2022 Sellafield Review alongside the results from the 2021 Sellafield Review for comparison. The table includes the mean consumption rates for the high-rate groups and the observed 97.5th percentile rates.

Table 2. Summary of the adults' consumption rates of foods from the Sellafield aquatic survey area in 2022 alongside the 2021 results for comparison

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												
	2021	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
Crustaceans	14	26	7	11	27.6	27.6	15.3	9.2	24.9	20.0	27.6	27.6
Molluscs	1	7	1	2	5.4	4.4	5.4	2.5	5.4	3.4	N/A[a]	4.1
Fish	22	39	4	8	58.3	57.9	29.6	21.2	45.3	41.4	54.9	52.3

[a] Not applicable for one observation

Data were recorded for both the child and infant age groups in the 2022 Sellafield Review with one child eating fish (plaice) and one infant eating fish (mackerel) and crustaceans (brown crab and common lobster). No data were recorded for the child and infant age groups in 2021.

5.1.1. Seafood species and seafood collection or catch locations identified in 2022

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

The species of molluscs consumed by people in the adult high-rate group were mussels and winkles. Mussels were collected from Seamill and Parton. Winkles were collected from St Bees, Nethertown and Parton.

The species of fish consumed by people in the adult high-rate group were bass, brill, cod, Dover sole, flounder, mackerel, plaice, salmon, sea trout and thornback ray. The fish were caught throughout the survey area.

5.1.2. Changes in seafood consumption rates in 2022 compared with 2021

The number of people interviewed consuming crustaceans increased by 12 in 2022, which was due to people obtaining brown crab and common lobster directly from a commercial fisherman, as well as a newly identified commercial fisherman who caught and consumed Nephrops. The minimum and mean consumption rates decreased in 2022 compared with 2021 and the maximum consumption rate remained the same in both 2022 and 2021.

Over recent years the consumption of molluscs has been in steady decline. In 2021, only one person was identified consuming molluscs, but this increased significantly in 2022 to seven people. The person interviewed in 2021 has since stopped consuming molluscs, so all interviewees in 2022 were newly identified. These were individuals interviewed on the beaches who were collecting mussels and winkles for their own consumption, as well as two people who were consuming whelks caught by commercial fishermen. People were consuming smaller quantities of molluscs in 2022 compared with the single consumer in 2021.

The number of interviewees consuming fish increased in 2022 compared with 2021. A newly identified commercial fisherman was consuming large quantities of fish and many anglers were eating their catch. There were reports of increased quantities of thornback ray and fewer cod being caught. The maximum consumption rate was similar in both years and the mean consumption rate decreased in 2022.

5.2. Composition of the food groups for crustaceans, molluscs and fish, for use in dose assessments, and comparison with 2021 data

In the Sellafield Review reports prior to 2014, the adult high-rate crustacean food group comprised crabs, lobsters and Nephrops. Small quantities of brown shrimps and/or common prawns were consumed and for dose assessment purposes were included in the Nephrops group. From 2014 onwards, 'Nephrops' was replaced by 'other crustaceans' (a group including Nephrops, brown shrimps and common prawns) because brown shrimps represented a significant contribution to the consumption rates. The mollusc food group comprised winkles and 'other molluscs' and the fish group comprises cod and 'other fish'.

The percentage composition for the predominant shellfish and fish species consumed by the adult high-rate groups from the 2022 Sellafield Review, rounded to the nearest 5% for use in dose assessments, are as follows:

- Crustaceans - 55% common lobster, 35% brown crab and 10% other crustaceans (Nephrops only) (mean consumption rate for the adult high-rate group, 20 kg y^{-1})
- Molluscs – 70% winkles and 30% other molluscs (mussels only) (mean consumption rate for the adult high-rate group, 3.4 kg y^{-1})
- Fish - 15% cod and 85% other fish species (mainly thornback ray, mackerel, plaice and brill, with smaller quantities of bass) (mean consumption rate for the adult high-rate group, 41 kg y^{-1})

By comparison, the percentage composition for the predominant shellfish and fish species consumed by the adult high-rate groups from the 2021 Sellafield Review survey, used in RIFE-27 (EA, FSA, FSS, NRW, NIEA and SEPA, 2022) for dose assessments, were:

- Crustaceans - 65% common lobster, 35% brown crab (mean consumption rate for the adult high-rate group, 25 kg y^{-1})
- Molluscs - 100% other molluscs (mussels only) (mean consumption rate for the adult high-rate group, 5.4 kg y^{-1})
- Fish - 30% cod and 70% other fish species (mainly thornback ray, mackerel, plaice and bass, with smaller quantities of flounder and whiting) (mean consumption rate for the adult high-rate group, 45 kg y^{-1})

In 2022, compared to 2021, the mean consumption rate for the adult high-rate group for crustaceans decreased by 4.9 kg y^{-1}, the mean consumption rate for the adult high-rate group for fish decreased by 3.9 kg y^{-1}, and the mean consumption rate for the adult high-rate group for molluscs decreased by 2.0 kg y^{-1}.

The main species of crustaceans, molluscs and fish within the respective high-rate groups differed between 2021 and 2022. The main species of crustaceans within the high-rate groups changed from common lobster and brown crab in 2021, to common lobster, brown crab and Nephrops in 2022. For molluscs, the main species within the high-rate groups

changed from mussels in 2021 to mussels and winkles in 2022. For fish species, whiting was in the high-rate group in 2021 but not in in 2022, and Brill, Dover sole, salmon, and sea trout were in the high-rate group in 2022 but not in 2021.

For the percentage breakdown of species in 2022 compared with 2021, the percentage of common lobster decreased, and other crustaceans (Nephrops) were consumed, winkles were consumed, and the percentage of cod decreased, and thornback ray increased.

5.3. Consumption trends

The consumption rates for the adult high-rate groups for crustaceans and molluscs over the previous ten years (2012 - 2022) are shown in Figure 2 and Figure 3, respectively. 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 5 and Annex 6.

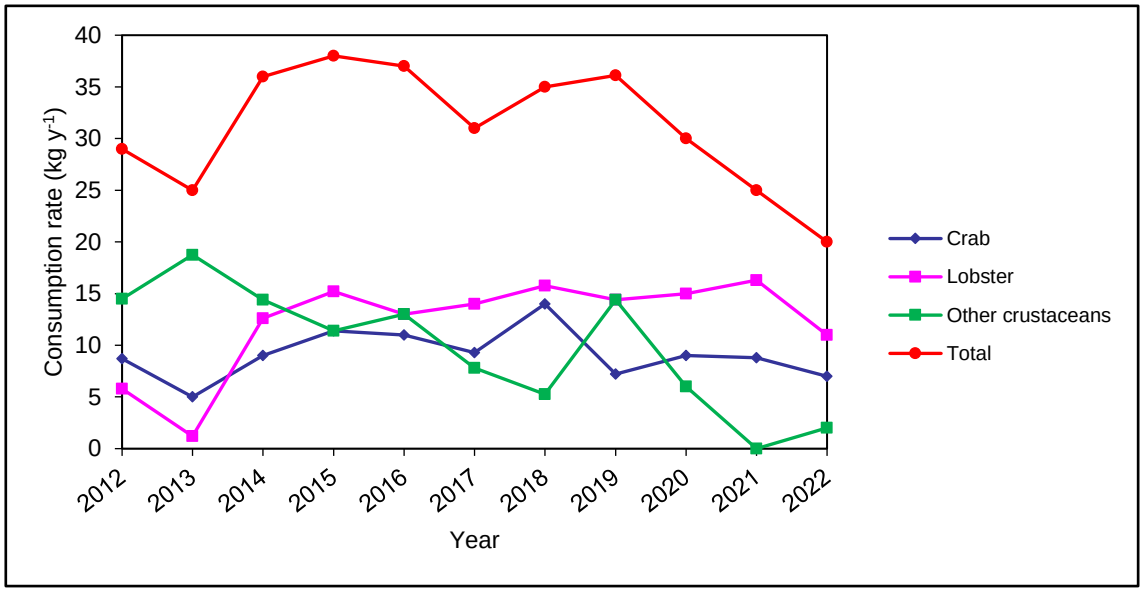

Figure 2. Consumption rates (kg y^{-1}) for the adult high-rate group for crustaceans, 2012 – 2022

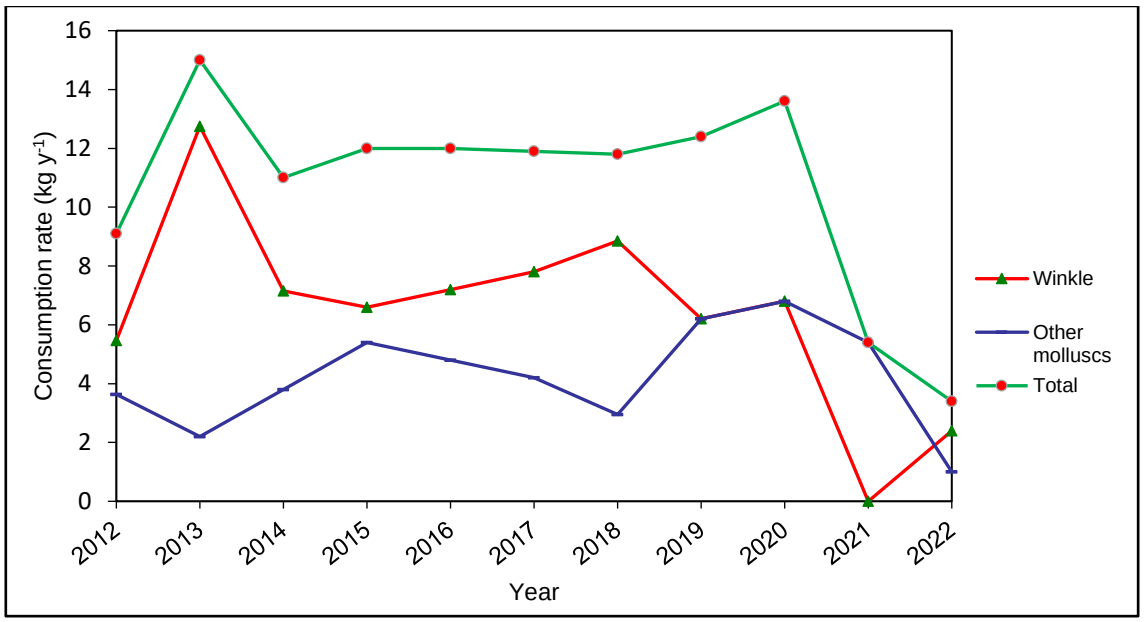

Figure 3. Consumption rates (kg y^{-1}) for the adult high-rate group for molluscs, 2012 – 2022

6. External exposure

Intertidal occupancy rates for adults are presented in Table 10 and intertidal occupancy rates for children and infants are presented in Table 11 and Table 12. It should be noted that there is 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

Table 3 presents a summary of the 2022 adults' intertidal occupancy rates in the Sellafield aquatic survey area, by substrate. The table includes the mean occupancy rates for the high-rate groups and the observed 97.5th percentile rates. The 2021 Sellafield Review data are included for comparison. A comparison between the 2021 and 2022 mean rates of the high-rate groups for occupancy over each intertidal substrate is also shown in Figure 4.

Table 3. Summary of adults' intertidal occupancy rates for the 2022 Sellafield Review survey alongside the 2021 results for comparison

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})	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Mud	2	N/I[a]	1	N/I[a]	104	N/I[a]	104	N/I[a]	102	N/I[a]
Mud and sand	2	5	2	4	131	78	105	59	130	78
Mud, sand and stones	6	14	4	7	912	409	632	299	890	394
Rock	1	2	1	1	54	110	54	110	N/A[b]	108
Salt marsh	2	7	2	2	730	548	639	548	725	548
Sand	34	77	20	20	730	1187	497	640	730	884
Sand and stones	4	5	2	3	529	130	421	96	513	128
Stones	1	4	1	2	20	20	20	19	N/A[b]	20

[a] No activities were identified taking place

[b] Not applicable for one observation

The following activities were undertaken by people in the adult high-rate groups for occupancy over intertidal substrates in the 2022 Sellafield Review:

- For mud and sand: playing at Whitehaven Outer Harbour
- For mud, sand and stones: dog walking at Saltcoats and Ravenglass and beachcombing at Parton
- For rock: angling at Whitehaven North Beach
- For salt marsh: tending livestock at Saltcoats
- For sand: angling at Parton, St Bees, Coulderton, Nethertown, Braystones, Sellafield, Seascale, Drigg and Ravenglass, bait digging at various locations throughout the survey area, setting nets at Coulderton, tending livestock at Drigg, dog walking at St Bees, Braystones, Coulderton, Sellafield, Seascale, Drigg and Tarn Bay, walking at St Bees, Seamill, Nethertown, collecting driftwood at Braystones, quad biking at Braystones and playing at Tarn Bay
- For sand and stones: beach cleaning at Parton and bird watching at Sellafield and Seascale
- For stones: collecting seaweed at Nethertown and collecting winkles and mussels at Parton

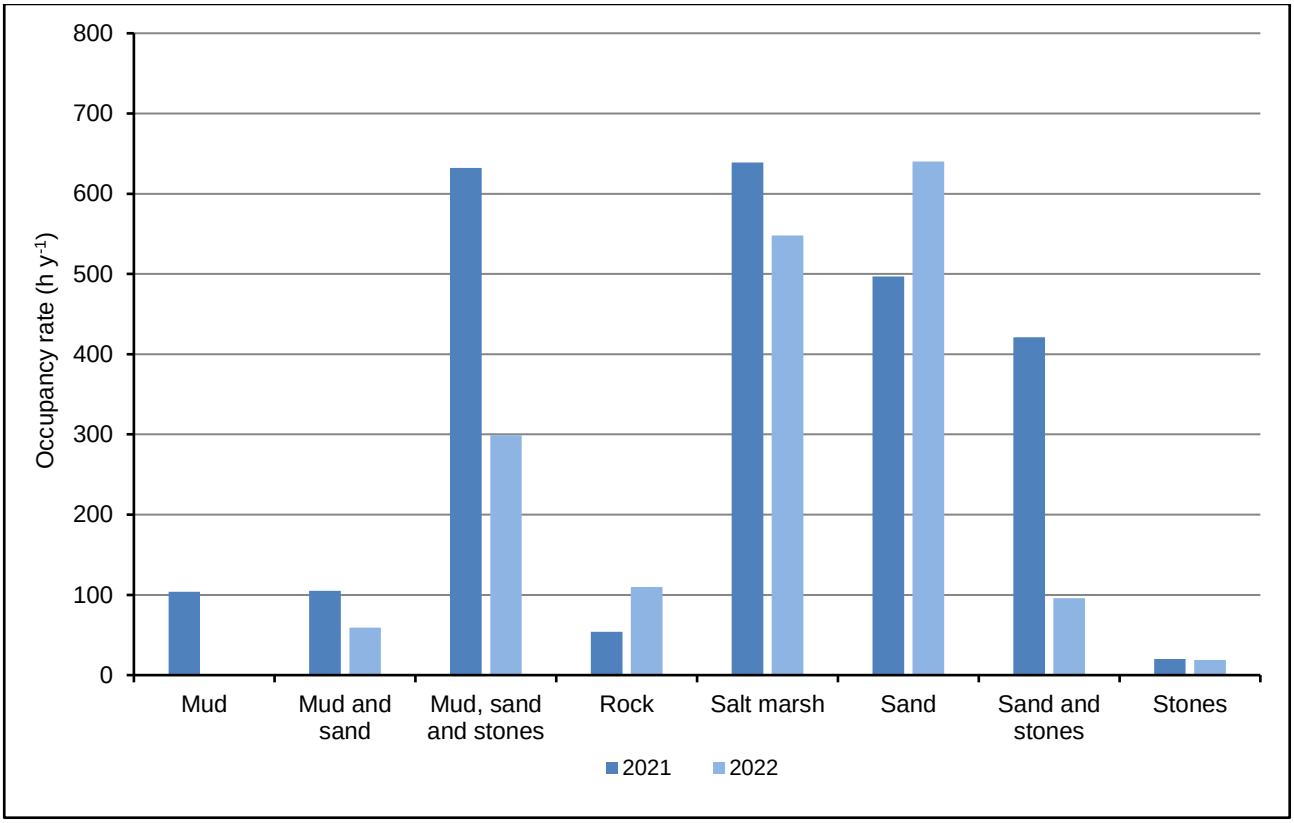

Figure 4. Comparison between the 2021 and 2022 mean rates of the high-rate groups for occupancy over each intertidal substrate

In 2022, compared with 2021, there were increases in the following mean intertidal occupancy rate for the high-rate groups (data rounded to two significant figures):

- For rock: from 54 h y^{-1} to 110 h y^{-1}
- For sand: from 500 h y^{-1} to 640 h y^{-1}

There was a large increase in occupancy over rock due to a newly identified individual who was angling from rocks at Whitehaven North Beach. There was an increase in occupancy over sand which was partly due to two newly identified individuals. One of these individuals spent large quantities of time collecting driftwood, quad biking and dog walking at Braystones. The other newly identified individual spent large quantities of time bait digging, angling and setting nets on the shore within the aquatic survey area.

In 2022, compared with 2021, there were decreases in the following mean intertidal occupancy rates for the high-rate groups (data rounded to two significant figures):

- For mud and sand: from 110 h y^{-1} to 59 h y^{-1}
- For mud, sand and stones: from 630 h y^{-1} to 300 h y^{-1}

- For salt marsh: from 640 h y^{-1} to 550 h y^{-1}
- For sand and stones: from 420 h y^{-1} to 96 h y^{-1}
- For stones: 20 h y^{-1} to 19 h y^{-1}

There was a significant decrease in occupancy over mud and sand as bait diggers were identified in Whitehaven Harbour in 2021 but not in 2022. In 2021, dog walkers had increased their occupancy over mud sand and stones because of the pandemic, but this decreased significantly in 2022. There was a decrease in the occupancy over salt marsh due to an individual who was no longer walking their dog on salt marsh. The significant decrease in occupancy over sand and stones was due anglers being identified spending time on other substrates in 2022. There was a small decrease in occupancy over stones.

In 2022 no one was identified spending time on mud, whereas in 2021, one individual spent time walking their dog over the mud along the River Esk.

Intertidal occupancy data were recorded for both the child and infant age groups in the 2022 Sellafield Review. No data were recorded for the child and infant age groups in 2021.

7. Use of habits data for dose assessments

7.1. Aquatic combinations for adults in the Sellafield area

Table 13 presents the consumption rates and occupancy rates for people who appear in at least one of the high-rate groups for fish, crustaceans, molluscs or intertidal substrates. The table shows that several individuals are members of multiple high-rate groups. For example, Person ID number 3354/1/1 is in the high-rate group for fish, occupancy over sand, and occupancy over stones. 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) dose assessments for the ‘Cumbrian coastal community’ for 2023 will be based on combinations of consumption and intertidal occupancy pathways. In RIFE, the ‘Cumbrian coastal community’ are described as being exposed to radioactivity resulting from both current and historical discharges from the Sellafield site and naturally occurring radioactivity discharged from the former phosphate processing works at Whitehaven, near Sellafield (EA, FSA, FSS, NRW, NIEA and SEPA, 2022).

As in previous years, since several individuals were undertaking activities over multiple substrates, the occupancy rates over five substrates (mud and sand; mud, sand and stones; sand; sand and stones; stones) have been combined into a single substrate called ‘mud and sand’. Rock and salt marsh are not included in the combined substrate since

rock is not assessed and salt marsh is assessed separately. The mean rate for the high-rate group for the reclassified 'mud and sand' substrate is 670 h y^{-1}. For comparison, the mean rate for the high-rate group for the reclassified 'mud and sand' substrate in 2021 was 530 h y^{-1}.

7.2. Habits data for source specific assessments

Annex 4, Annex 5, Annex 6, Annex 7 and Annex 8 show the historic consumption and occupancy rates, updated with the 2022 data, for use in source specific assessments for the RIFE reports. Annex 4, Annex 5, Annex 6 and Annex 7 show the data for use in single year assessments and Annex 8 shows the data for use in the 5-year average assessments. The consumption and occupancy data from these annexes, with the exception of Annex 8, are presented in Figure 5, Figure 6, Figure 7 and Figure 8 for fish, crustaceans, molluscs, and intertidal occupancy, respectively.

Prior to 2015, for Sellafield Reviews and full Sellafield habits surveys, the consumption rates of crustaceans and molluscs, and intertidal occupancy rates, were updated annually in these annexes using the Sellafield Review data or full survey data, as applicable. The fish consumption rates were only updated when a full habits survey was conducted. However, since 2015, the annexes have been updated with the consumption rates of fish from the current year's survey, since the relative contribution to doses arising from fish consumption has increased. Handling rates of sediment and fishing gear are not obtained during Sellafield Reviews. Therefore, for assessments purposes, the mean handling rates for the high-rate groups for fishing gear and sediment will be retained from the 2018 full Sellafield habits survey.

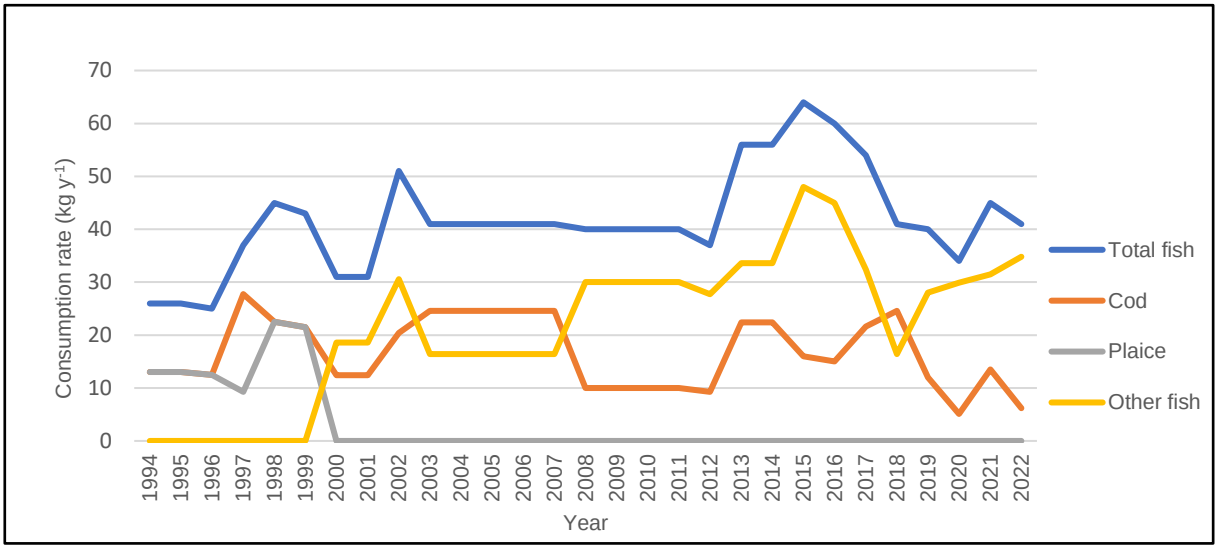

Figure 5. Consumption rates (kg y^{-1}) for the adult high-rate group for fish 1994 – 2022

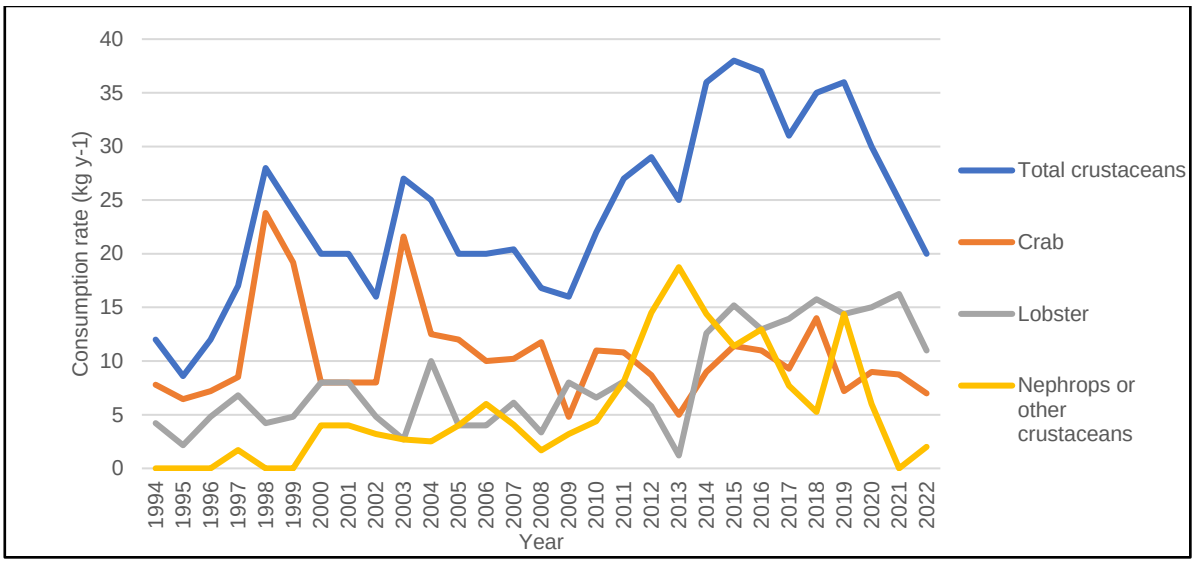

Figure 6. Consumption rates (kg y^{-1}) for the adult high-rate group for crustaceans 1994 – 2022

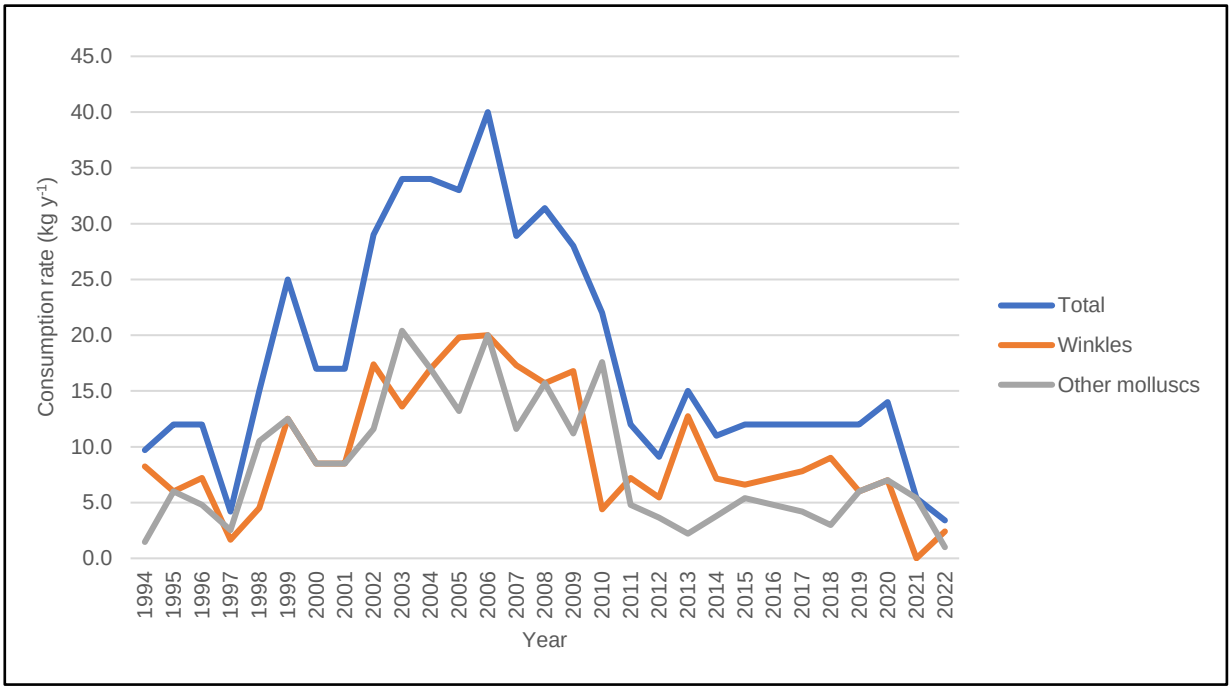

Figure 7. Consumption rates (kg y^{-1}) for the adult high-rate group for molluscs 1994 – 2022

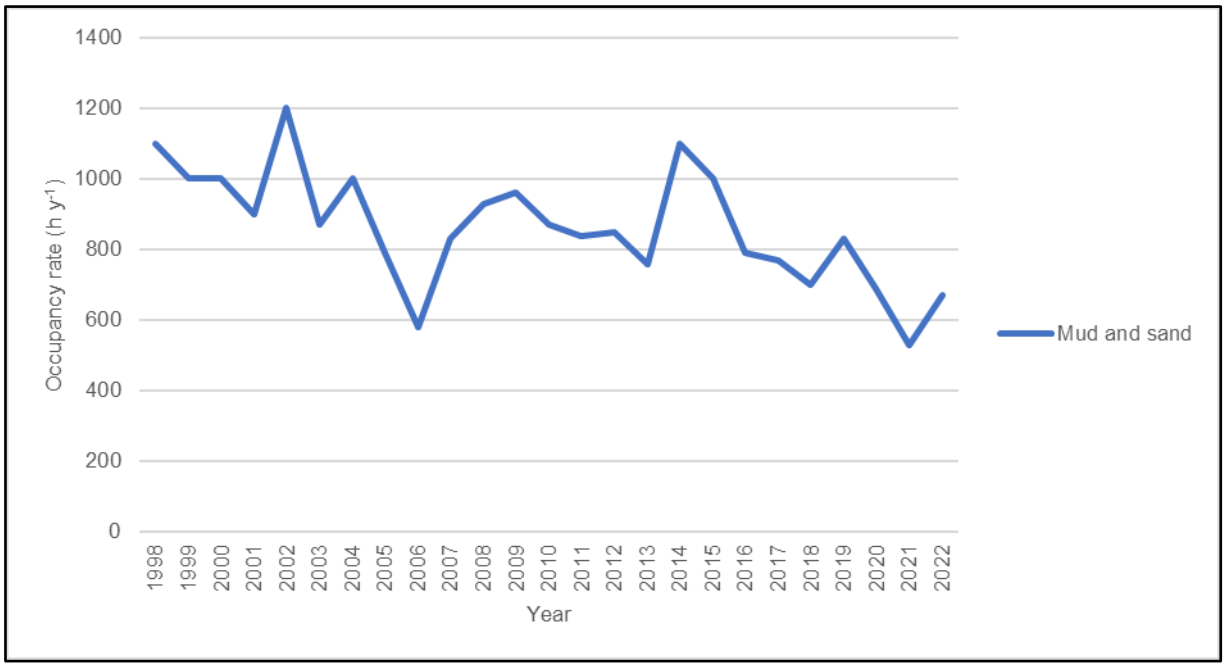

Figure 8. Intertidal occupancy rates (h y^{-1}) for a combined mud and sand substrate 1998 - 2022

7.3. Profiled habits data for total dose assessments

The matrix for the 2022 Sellafield adults' profiled habits data is presented in Annex 9. It is based on data from the 2018 Sellafield full habits survey (aquatic, terrestrial and direct radiation pathways), which has been updated with data from the 2019, 2020, 2021 and 2022 annual Sellafield Reviews. All pathways and observations from the original 2018 profiled habits matrix were retained, and for the subsequent years' profiles, only data asked about during the subsequent years' 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 profiles have been created using the data from the 2018, 2019, 2020, 2021 and 2022 surveys, the profiled data shown in Annex 9 are not comparable with the data presented in Annex 1.

8. Summary and recommended data for use in RIFE-28 dose assessments

The survey investigated the consumption of shellfish and fish, and intertidal occupancy, relating to liquid discharges from the Sellafield nuclear site. The number of people consuming crustaceans increased compared with the previous survey due to newly identified commercial fishermen. After a steady decline in the consumption of molluscs in recent years, seven new people were identified consuming molluscs, albeit in small quantities. The number of people consuming fish increased with more anglers being interviewed.

The consumption and occupancy rates in this section are for adults and are presented to two significant figures.

The mean rates for the adult high-rate groups from the 2022 Sellafield Review are as follows:

- Crustaceans 20 kg y^{-1}
- Molluscs 3.4 kg y^{-1}
- Fish 41 kg y^{-1}
- Occupancy over mud and sand 59 h y^{-1}
- Occupancy over mud, sand and stones 300 h y^{-1}
- Occupancy over rock 110 h y^{-1}
- Occupancy over salt marsh 550 h y^{-1}
- Occupancy over sand 640 h y^{-1}
- Occupancy over sand and stones 96 h y^{-1}
- Occupancy over stones 19 h y^{-1}

In 2022, compared to 2021, the mean consumption rate for the adult high-rate group for crustaceans decreased by 4.9 kg y^{-1}, the mean consumption rate for the adult high-rate group for molluscs decreased by 2.0 kg y^{-1} and the mean consumption rate for the adult high-rate group for fish decreased by 3.9 kg y^{-1}. For occupancy over intertidal substrates, the mean rates for the adult high-rate groups increased in 2022 compared to 2021 by 56 h y^{-1} for rock, by 140 h y^{-1} for sand, and decreased by 46 h y^{-1} for mud and sand, by 330 h y^{-1} for mud, sand and stones, by 91 h y^{-1} for salt marsh, by 330 h y^{-1} for sand and stones, and by 1 h y^{-1} for stones. In 2022 no one was identified spending time on mud, whereas in 2021 one individual spent 100 h y^{-1} over mud.

The following recommendations for data to be used in RIFE-28 dose assessments are for the adult age group only. For the ‘Cumbrian coastal community’ dose assessment, the mean consumption rates for the adult high-rate groups and species breakdown are:

- Fish 41 kg y^{-1}, comprising 15% cod and 85% other fish (mainly thornback ray, mackerel, plaice and brill, with smaller quantities of bass)
- Crustaceans 20 kg y^{-1}, comprising 55% common lobster, 35% brown crab and 10% other crustaceans (Nephrops only)
- Molluscs 3.4 kg y^{-1}, comprising 70% winkles and 30% other molluscs (mussels only)
- Occupancy over an intertidal substrate termed ‘mud and sand’ (mud and sand; mud, sand and stones; sand; sand and stones; and stones combined) 670 h y^{-1}

For the ‘Cumbrian coastal community 5-year average’ dose assessments:

- Cod 12 kg y^{-1}
- Other fish 28 kg y^{-1}
- Crab 9.2 kg y^{-1}
- Lobster 15 kg y^{-1}
- Other crustaceans 5.5 kg y^{-1}
- Winkles 4.9 kg y^{-1}
- Other molluscs 4.5 kg y^{-1}
- Occupancy over an intertidal substrate termed ‘mud and sand’ (mud and sand; mud, sand and stones; sand; sand and stones; and stones combined) 680 h y^{-1}

For the ‘Fisherman’s Nets and Pots’ dose assessment:

- Handling fishing gear 1400 h y^{-1} (mean rate for the high-rate group retained from the 2018 Sellafield habits survey)

For the ‘Bait Digging and Mollusc Collection’ dose assessment:

- Handling sediment 510 h y^{-1} (mean rate for the high-rate group retained from the 2018 Sellafield habits survey)

9. References

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Table 4. Adults' consumption rates of crustaceans from the Sellafield aquatic survey area (kg y^{-1})

Person ID number	Brown crab	Common lobster	Common prawn	Nephrops	Spiny spider crab	Total
3348/1/1	**10.7**	**16.8**	**-**	**-**	**-**	**27.6**
3348/2/1	**10.7**	**16.8**	**-**	**-**	**-**	**27.6**
3348/3/1	**10.7**	**16.8**	**-**	**-**	**-**	**27.6**
3348/4/1	**10.7**	**16.8**	**-**	**-**	**-**	**27.6**
3350/1/1	**8.6**	**13.5**	**-**	**0.6**	**-**	**22.7**
3319/1/1	**6.2**	**13.0**	**-**	**0.4**	**-**	**19.7**
3319/2/1	**6.2**	**13.0**	**-**	**0.4**	**-**	**19.7**
3350/2/1	**5.7**	**9.0**	**-**	**0.6**	**-**	**15.3**
3324/1/1	**-**	**-**	**-**	**11.5**	**-**	**11.5**
3324/2/1	**-**	**-**	**-**	**11.5**	**-**	**11.5**
3346/1/1	**4.5**	**4.7**	**-**	**-**	**-**	**9.2**
3343/1/1	3.8	-	-	-	-	3.8
3343/2/1	3.8	-	-	-	-	3.8
3349/1/1	-	0.2	-	3.3	-	3.5
3349/2/1	-	0.2	-	3.3	-	3.5
3355/2/1	0.7	1.2	-	-	0.5	2.4
3355/1/1	0.7	1.2	-	-	0.2	2.1
3355/3/1	0.7	1.2	-	-	-	1.9
3355/4/1	0.7	1.2	-	-	-	1.9
3355/5/1	0.7	1.2	-	-	-	1.9
3320/1/1	0.8	-	-	-	-	0.8
3320/2/1	0.8	-	-	-	-	0.8
3305/1/1	0.1	-	-	-	-	0.1
3305/2/1	0.1	-	-	-	-	0.1
3305/3/1	0.1	-	-	-	-	0.1
3309/1/1	-	-	0.05	-	-	0.05

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of crustaceans for adults based on the 11 high-rate consumers is 20.0 kg y^{-1}

The observed 97.5th percentile rate based on 26 observations is 27.6 kg y^{-1}

Table 5. Adults' consumption rates of molluscs from the Sellafield aquatic survey area (kg y^{-1})

Person ID number	Mussel	Whelk	Winkle	Total
3343/1/1	**2.1**	**-**	**2.3**	**4.4**
3365/1/1	**-**	**-**	**2.5**	**2.5**
3349/1/1	-	1.1	-	1.1
3349/2/1	-	1.1	-	1.1
3309/2/1	-	-	0.7	0.7
3302/1/1	0.2	-	-	0.2
3302/2/1	0.2	-	-	0.2

Notes

Emboldened observation are the high-rate consumers

The mean consumption rate of molluscs for adults based on the 2 high-rate consumers is 3.4 kg y^{-1}

The observed 97.5th percentile rate based on 7 observations is 4.1 kg y^{-1}

Table 6. Adults' consumption rates of fish from the Sellafield aquatic survey area (kg y^{-1})

Person ID number	Bass	Brill	Cod	Dover sole	Flounder	Herring	Mackerel	Plaice	Pollack	Salmon	Sea trout	Thornback ray	Total
3351/1/1	**9.6**	**-**	**-**	**-**	**-**	**-**	**-**	**5.1**	**-**	**-**	**-**	**43.3**	**57.9**
3346/1/1	**-**	**-**	**10.5**	**-**	**-**	**-**	**7.6**	**4.0**	**-**	**-**	**-**	**29.9**	**52.0**
3346/2/1	**-**	**-**	**10.5**	**-**	**-**	**-**	**7.6**	**4.0**	**-**	**-**	**-**	**29.9**	**52.0**
3350/1/1	**-**	**-**	**3.9**	**-**	**-**	**-**	**-**	**8.2**	**-**	**-**	**-**	**35.5**	**47.5**
3309/1/1	**2.6**	**-**	**1.5**	**-**	**-**	**-**	**12.2**	**0.9**	**-**	**1.1**	**1.1**	**26.2**	**45.6**
3354/1/1	**5.4**	**-**	**17.7**	**-**	**5.4**	**-**	**-**	**5.4**	**-**	**-**	**-**	**-**	**34.0**
3324/1/1	**-**	**16.2**	**1.3**	**2.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.3**	**21.2**
3324/2/1	**-**	**16.2**	**1.3**	**2.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.3**	**21.2**
3336/1/1	8.5	-	10.5	-	-	-	-	-	-	-	-	-	19.0
3336/2/1	8.5	-	10.5	-	-	-	-	-	-	-	-	-	19.0
3311/1/1	-	-	18.0	-	-	-	-	-	-	-	-	-	18.0
3302/1/1	5.1	-	6.3	-	-	-	2.3	-	-	-	-	-	13.7
3302/2/1	5.1	-	6.3	-	-	-	2.3	-	-	-	-	-	13.7
3319/1/1	-	-	5.3	-	-	-	-	0.8	-	-	-	5.3	11.3
3319/2/1	-	-	5.3	-	-	-	-	0.8	-	-	-	5.3	11.3
3350/2/1	-	-	3.4	-	-	-	-	6.8	-	-	-	-	10.2
3305/1/1	-	-	5.4	-	-	-	1.8	-	-	-	-	-	7.2
3305/2/1	-	-	5.4	-	-	-	1.8	-	-	-	-	-	7.2
3305/3/1	-	-	5.4	-	-	-	1.8	-	-	-	-	-	7.2
3312/1/1	-	-	-	-	-	-	6.2	-	-	-	-	-	6.2

Person ID number	Bass	Brill	Cod	Dover sole	Flounder	Herring	Mackerel	Plaice	Pollack	Salmon	Sea trout	Thornback ray	Total
3312/2/1	-	-	-	-	-	-	6.2	-	-	-	-	-	6.2
3289/1/1	1.3	-	-	-	-	-	2.6	-	1.1	-	-	-	5.0
3289/2/1	1.3	-	-	-	-	-	2.6	-	1.1	-	-	-	5.0
3294/1/1	-	-	-	-	-	-	-	3.0	-	-	-	-	3.0
3294/2/1	-	-	-	-	-	-	-	3.0	-	-	-	-	3.0
3314/1/1	0.9	-	-	-	-	-	-	-	1.7	-	-	-	2.5
3310/1/1	-	-	-	-	-	-	2.5	-	-	-	-	-	2.5
3349/1/1	-	-	-	-	-	1.7	0.8	-	-	-	-	-	2.4
3349/2/1	-	-	-	-	-	1.7	0.8	-	-	-	-	-	2.4
3288/1/1	1.7	-	-	-	-	-	0.4	0.3	-	-	-	-	2.4
3355/1/1	-	-	-	-	-	-	2.3	-	-	-	-	-	2.3
3355/2/1	-	-	-	-	-	-	2.3	-	-	-	-	-	2.3
3355/3/1	-	-	-	-	-	-	2.3	-	-	-	-	-	2.3
3355/4/1	-	-	-	-	-	-	2.3	-	-	-	-	-	2.3
3355/5/1	-	-	-	-	-	-	2.3	-	-	-	-	-	2.3
3366/1/1	-	-	-	-	-	-	-	1.8	-	-	-	-	1.8
3366/2/1	-	-	-	-	-	-	-	1.8	-	-	-	-	1.8
3332/1/1	0.2	-	0.3	-	-	-	-	-	0.3	-	-	-	0.8
3332/2/1	0.2	-	0.3	-	-	-	-	-	0.3	-	-	-	0.8

Notes

Emboldened observations are the high-rate consumers
The mean consumption rate of fish for adults based on the 8 high-rate consumers is 41.4 kg y^{-1}
The observed 97.5th percentile rate based on 39 observations is 52.3 kg y^{-1}

Table 7. Infants' consumption rates of crustaceans from the Sellafield aquatic survey area (kg y^{-1})

Person ID number	Age	Brown crab	Common Lobster	Total
3355/6/1	**3**	**0.4**	**0.6**	**1.0**

Notes

The emboldened observation is the high-rate consumer
The mean consumption rate of crustaceans for the infant age group based on the only high-rate consumer is 1.0 kg y^{-1}
The observed 97.5th percentile is not applicable for one observation

Table 8. Children's consumption rates of fish from the Sellafield aquatic survey area (kg y^{-1})

Person ID number	Age	Plaice
3366/3/1	10	1.8

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of crustaceans for the infant age group based on the only high-rate consumer is 1.8 kg y^{-1}

The observed 97.5th percentile is not applicable for one observation

Table 9. Infants' consumption rates of fish from the Sellafield aquatic survey area (kg y^{-1})

Person ID number	Age	Mackerel
3355/6/1	3	1.1

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of crustaceans for the infant age group based on the only high-rate consumer is 1.1 kg y^{-1}

The observed 97.5th percentile is not applicable for one observation

Table 10. Adults' intertidal occupancy rates in the Sellafield aquatic survey area (h y^{-1})

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3356/1/1	**Whitehaven Outer Harbour**	**Playing**	**78**	-	-	-	-	-	-
	St Bees, Braystones and Seascale		-	-	-	-	79	-	-
3356/2/1	**Whitehaven Outer Harbour**	**Playing**	**78**	-	-	-	-	-	-
	St Bees, Braystones and Seascale		-	-	-	-	79	-	-
3295/1/1	**Whitehaven Outer Harbour**	**Playing**	**40**	-	-	-	-	-	-
	St Bees and Seascale		-	-	-	-	6	-	-
	Parton	Angling	-	-	-	-	-	-	4
3295/2/1	**Whitehaven Outer Harbour**	**Playing**	**40**	-	-	-	-	-	-
	St Bees and Seascale		-	-	-	-	6	-	-
	Parton	Angling	-	-	-	-	-	-	4
3289/1/1	Whitehaven Outer Harbour	Bait digging	3	-	-	-	-	-	-
	Parton to Ravenglass	Angling	-	-	-	-	19	-	-
	Drigg	Bait digging	-	-	-	-		-	-
3338/1/1	**Ravenglass**	**Dog walking**	-	**409**	-	-	-	-	-
	Drigg		-	-	-	-	**409**	-	-
3355/1/1	**Saltcoats and Ravenglass**	**Dog walking**	-	**365**	-	-	-	-	-
	Saltcoats	**Tending livestock**	-	-	-	**548**	-	-	-
3355/2/1	**Saltcoats and Ravenglass**	**Dog walking**	**-**	**365**	-	-	-	-	-
3338/2/1	**Ravenglass**	**Dog walking**	-	**273**	-	-	-	-	-
	Drigg		-	-	-	-	273	-	-
3296/1/1	**Parton**	**Beachcombing**	-	**271**	-	-	-	-	-

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3337/1/1	**Ravenglass**	**Dog walking**	-	**205**	-	-	-	-	-
	Seascale and Drigg		-	-	-	-	**410**	-	-
3337/2/1	**Ravenglass**	**Dog walking**	-	**205**	-	-	-	-	-
	Seascale and Drigg		-	-	-	-	**410**	-	-
3346/1/1	Ravenglass	Boat maintenance and walking	-	130	-	-	-	-	-
3355/4/1	Saltcoats and Ravenglass	Playing	-	39	-	-	-	-	-
3354/1/1	Ravenglass	Collecting seaweed	-	20	-	-	-	-	-
	St Bees, Coulderton, Nethertown, Sellafield, Seascale, Drigg and Ravenglass	**Angling**	-	-	-	-	**561**	-	-
	Drigg and Ravenglass	**Bait digging**	-	-	-	-		-	-
	Nethertown	**Collecting seaweed**	-	-	-	-	-	-	**20**
3348/1/1	Ravenglass	Walking	-	17	-	-	-	-	-
		Wildfowling	-	-	-	153	-	-	-
	Seascale	Playing	-	-	-	-	39	-	-
3348/2/1	Ravenglass	Walking	-	17	-	-	-	-	-
	Sellafield, Seascale and Drigg	**Dog walking**	-	-	-	-	**469**	-	-
	Seascale	**Playing**	-	-	-	-		-	-
3348/3/1	Ravenglass	Walking	-	17	-	-	-	-	-
		Wildfowling	-	-	-	153	-	-	-
	Seascale	Playing	-	-	-	-	39	-	-
3360/1/1	Ravenglass	Walking	-	14	-	-	-	-	-
	Seascale and Drigg		-	-	-	-	29	-	-
3287/1/1	**Whitehaven North Beach**	**Angling**	-	-	**110**	-	-	-	-

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3365/1/1	St Bees	Collecting winkles	-	-	12	-	-	-	-
	Drigg To Parton	**Angling**	-	-	-	-	**423**	-	-
	St Bees	**Dog walking**	-	-	-	-		-	-
3355/5/1	**Saltcoats**	**Tending livestock**	**-**	**-**	**-**	**548**	-	-	-
3327/1/1	Drigg and Newbiggin Marsh	Wildfowling	-	-	-	78	-	-	-
	Seascale	Dog walking	-	-	-	-	251	-	-
3322/1/1	**Drigg**	**Tending livestock**	-	-	-	32	-	-	-
			-	-	-	-	**548**	-	-
3322/2/1	**Drigg**	**Tending livestock**	-	-	-	32	-	-	-
			-	-	-	-	**548**	-	-
3362/1/1	**Braystones**	**Collecting driftwood, quad biking and dog walking**	-	-	-	-	**1187**	-	-
3314/1/1	**Various Locations Throughout the Survey Area**	**Bait digging**	**-**	**-**	**-**	**-**	**1095**	-	-
	Coulderton and Braystones	**Angling**	-	-	-	-		-	-
	Coulderton	**Setting nets**	-	-	-	-		-	-
3363/1/1	**Tarn Bay**	**Dog walking and playing**	-	-	-	-	**861**		-
3363/2/1	**Tarn Bay**	**Dog walking and playing**	-	-	-	-	**861**		-
3341/1/1	**St Bees, Drigg and Seascale**	**Dog walking**	-	-	-	-	**730**	-	-
3314/2/1	**Various Locations Throughout the Survey Area**	**Bait digging**	-	-	-	-	**720**	-	-

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3314/3/1	**Various Locations Throughout the Survey Area**	**Bait digging**	-	-	-	-	**720**	-	-
3305/3/1	**Coulderton**	**Dog walking**	-	-	-	-	**668**	-	-
3320/2/1	**St Bees and Drigg**	**Angling**	-	-	-	-	**626**	-	-
3301/1/1	**St Bees, Seamill and Nethertown**	**Walking**	-	-	-	-	**548**	-	-
3301/2/1	**St Bees, Seamill and Nethertown**	**Walking**	-	-	-	-	**548**	-	-
3305/1/1	**Coulderton**	**Dog walking**	-	-	-	-	**457**	-	-
3294/1/1	St Bees and Drigg	Angling	-	-	-	-	365	-	-
3299/1/1	St Bees and Seamill	Dog walking	-	-	-	-	387	-	-
	Coulderton, Nethertown and Seascale		-	-	-	-	-	30	-
3329/1/1	Drigg	Walking	-	-	-	-	365	-	-
3366/1/1	Parton and St Bees	Dog walking	-	-	-	-	365	-	-
3364/1/1	Parton	Dog walking	-	-	-	-	365	-	-
3311/1/1	Various Locations Throughout the Survey Area	Angling	-	-	-	-	357	-	-
	Sellafield, Seascale and Drigg	Bait digging	-	-	-	-		-	-
3326/1/1	St Bees, Sellafield and Seascale	Dog walking	-	-	-	-	352	-	-
3336/1/1	Drigg, Ravenglass and Tarn Bay	Angling	-	-	-	-	338	-	-
		Bait digging	-	-	-	-		-	-
3336/2/1	Drigg, Ravenglass and Tarn Bay	Angling	-	-	-	-	338	-	-
		Bait digging	-	-	-	-		-	-
3306/1/1	St Bees	Angling	-	-	-	-	326	-	-

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3359/1/1	Seascale and Drigg	Walking and playing	-	-	-	-	319	-	-
3359/2/1	Seascale and Drigg	Walking and playing	-	-	-	-	319	-	-
3302/1/1	St Bees and Seamill	Walking	-	-	-	-	274	-	-
	Seamill	Collecting mussels	-	-	-	-		-	-
	Braystones	Angling	-	-	-	-		-	-
3303/2/1	Braystones	Dog walking	-	-	-	-	274	-	-
3319/1/1	Parton and Whitehaven North Beach	Dog walking	-	-	-	-	274	-	-
3342/1/1	Drigg and Seascale	Dog walking	-	-	-	-	274	-	-
3351/1/1	Various Locations Throughout the Survey Area	Angling	-	-	-	-	271	-	-
	Braystones and Drigg	Bait digging	-	-	-	-		-	-
3351/2/1	Various Locations Throughout the Survey Area	Angling	-	-	-	-	235	-	-
3351/3/1	Various Locations Throughout the Survey Area	Angling	-	-	-	-	235	-	-
3351/4/1	Various Locations Throughout the Survey Area	Angling	-	-	-	-	235	-	-
3335/1/1	Drigg	Dog walking	-	-	-	-	228	-	-
3335/2/1	Drigg	Dog walking	-	-	-	-	228	-	-
3332/1/1	Parton, St Bees, Nethertown and Ravenglass	Angling	-	-	-	-	224	-	-
	Nethertown	Dog walking	-	-	-	-		-	-
3298/1/1	St Bees and Seamill	Angling	-	-	-	-	209	-	-

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3344/1/1	Seascale and Tarn Bay	Walking	-	-	-	-	196	-	-
3302/2/1	St Bees and Seamill	Walking	-	-	-	-	184	-	-
	Seamill	Collecting mussels	-	-	-	-		-	-
3315/1/1	Braystones	Angling and walking	-	-	-	-	182	-	-
3329/2/1	Drigg	Walking	-	-	-	-	182	-	-
3307/1/1	St Bees	Walking	-	-	-	-	137	-	-
3307/2/1	St Bees	Walking	-	-	-	-	137	-	-
3300/1/1	St Bees and Seamill	Walking	-	-	-	-	120	-	-
3294/2/1	St Bees and Drigg	Angling	-	-	-	-	104	-	-
3326/2/1	St Bees and Seascale	Dog walking	-	-	-	-	78	-	-
3330/1/1	Seascale and Drigg	Walking	-	-	-	-	78	-	-
3330/2/1	Seascale and Drigg	Walking	-	-	-	-	78	-	-
3343/1/1	St Bees and Seascale	Dog walking	-	-	-	-	73	-	-
	Parton	**Collecting winkles and mussels**	-	-	-	-	-	-	**18**
3343/2/1	St Bees and Seascale	Dog walking	-	-	-	-	73	-	-
3288/1/1	Braystones and Nethertown	Angling and bait digging	-	-	-	-	65	-	-
3304/1/1	Braystones	Walking	-	-	-	-	60	-	-
3299/2/1	Seamill	Dog walking	-	-	-	-	52	-	-
3303/1/1	Braystones	Dog walking	-	-	-	-	52	-	-
3325/1/1	Braystones	Walking	-	-	-	-	52	-	-
	Sellafield and Seascale	**Bird watching**	-	-	-	-	-	**104**	-

Person ID number	Location	Activity	Mud and sand	Mud, sand and stones	Rock	Salt marsh	Sand	Sand and stones	Stones
3325/2/1	Braystones	Walking	-	-	-	-	52	-	-
	Sellafield and Seascale	**Bird watching**	-	-	-	-	-	**52**	-
3308/1/1	Parton	Angling	-	-	-	-	48	-	-
3309/1/1	Various Locations Throughout the Survey Area	Angling	-	-	-	-	18	-	-
3329/3/1	Drigg	Walking	-	-	-	-	18	-	-
3329/4/1	Drigg	Walking	-	-	-	-	18	-	-
3297/1/1	**Parton**	**Beach cleaning**	-	-	-	-	-	**130**	-
3309/2/1	St Bees and Nethertown	Collecting winkles	-	-	-	-	-	18	-

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud and sand for adults based on 4 high-rate observations is 59 h y^{-1}

The observed 97.5th percentile rate based on 5 observations is 78 h y^{-1}

The mean intertidal occupancy rate over mud, sand and stones for adults based on 7 high-rate observations is 299 h y^{-1}

The observed 97.5th percentile rate based on 14 observations is 394 h y^{-1}

The mean intertidal occupancy rate over rock for adults based on 1 high-rate observation is 110 h y^{-1}

The observed 97.5th percentile rate based on 2 observations is 108 h y^{-1}

The mean intertidal occupancy rate over salt marsh for adults based on 2 high-rate observations is 548 h y^{-1}

The observed 97.5th percentile rate based on 7 observations is 548 h y^{-1}

The mean intertidal occupancy rate over sand for adults based on 20 high-rate observations is 640 h y^{-1}

The observed 97.5th percentile rate based on 77 observations is 884 h y^{-1}

The mean intertidal occupancy rate over sand and stones for adults based on 3 high-rate observations is 96 h y^{-1}

The observed 97.5th percentile rate based on 5 observations is 128 h y^{-1}

The mean intertidal occupancy rate over stones for adults based on 2 high-rate observations is 19 h y^{-1}

The observed 97.5th percentile rate based on 4 observations is 20 h y^{-1}

Table 11. Children's' intertidal occupancy rates in the Sellafield aquatic survey area (h y^{-1})

Person ID number	Age	Location	Activity	Mud and sand	Sand
3356/3/1	**12**	**Whitehaven Outer Harbour**	**Playing**	**78**	-
		Braystones, St Bees and Seascale		-	79
3356/4/1	**10**	**Whitehaven Outer Harbour**	**Playing**	**78**	-
		Braystones, St Bees and Seascale		-	79
3356/5/1	**11**	**Whitehaven Outer Harbour**	**Playing**	**78**	-
		Braystones, St Bees and Seascale		-	79
3356/6/1	**8**	**Whitehaven Outer Harbour**	**Playing**	**78**	-
		Braystones, St Bees and Seascale		-	79
3363/3/1	**6**	**Tarn Bay**	**Playing**	**-**	**496**
3359/3/1	**11**	**Seascale and Drigg**	**Walking and playing**	**-**	**319**
3359/4/1	**14**	**Seascale and Drigg**	**Walking and playing**	**-**	**319**

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud and sand for the child age group based on 4 high-rate observations is 78 h y^{-1}

The observed 97.5th percentile rate based on 4 observations is 78 h y^{-1}

The mean intertidal occupancy rate over sand for the child age group based on 3 high-rate observations is 379 h y^{-1}

The observed 97.5th percentile rate based on 7 observations is 469 h y^{-1}

Table 12. Infants' intertidal occupancy rates in the Sellafield aquatic survey area (h y^{-1})

Person ID number	Age	Location	Activity	Mud, sand and stones	Sand
3355/6/1	**3**	**Saltcoats and Ravenglass**	**Playing and walking**	**39**	-
3360/2/1	**5**	**Ravenglass**	**Walking**	**14**	-
		Seascale and Drigg		-	29
3363/4/1	**4**	**Tarn Bay**	**Playing**	**-**	**496**

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud and sand for the infant age group based on 2 high-rate observations is 27 h y^{-1}

The observed 97.5th percentile rate based on 2 observations is 39 h y^{-1}

The mean intertidal occupancy rate over sand for the infant age group based on the only high-rate observation is 496 h y^{-1}

The observed 97.5th percentile rate based on 2 observations is 484 h y^{-1}

Table 13. Aquatic combinations for adults in the Sellafield aquatic survey area

Person ID number	Consumption rates (kg y^{-1})			Intertidal occupancy rates (h y^{-1})				
	Fish	Crustaceans	Molluscs	Mud and sand	Mud, sand and stones	Sand	Sand and stones	Stones
3319/1/1	11.3	**19.7**	-	-	-	274	-	-
3343/1/1	-	3.8	**4.4**	-	-	73	-	**18**
3354/1/1	**34.0**	-	-	-	20	**561**	-	**20**
3346/1/1	**52.0**	**9.2**	-	-	130	-	-	-
3348/2/1	-	**27.6**	-	-	17	**469**	-	-
3295/1/1	-	-	-	**40**	-	6	-	4
3296/1/1	-	-	-	-	**271**	-	-	-

Notes

Values in high-rate groups are emboldened

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

Person ID number	Age	Gender	Fish	Crustaceans	Molluscs	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	Intertidal occupancy over stones
3287/1/1	55	M	-	-	-	-	-	**110**	-	-	-	-
3288/1/1	63	M	2.4	-	-	-	-	-	-	65	-	-
3289/1/1	77	M	5.0	-	-	3	-	-	-	19	-	-
3289/2/1	75	F	5.0	-	-	-	-	-	-	-	-	-
3294/1/1	66	M	3.0	-	-	-	-	-	-	365	-	-
3294/2/1	65	F	3.0	-	-	-	-	-	-	104	-	-
3295/1/1	35	M	-	-	-	**40**	-	-	-	6	-	4
3295/2/1	35	F	-	-	-	**40**	-	-	-	6	-	4
3296/1/1	69	F	-	-	-	-	**271**	-	-	-	-	-
3297/1/1	80	M	-	-	-	-	-	-	-	-	**130**	-
3298/1/1	62	F	-	-	-	-	-	-	-	209	-	-
3299/1/1	40	F	-	-	-	-	-	-	-	387	30	-
3299/2/1	40	F	-	-	-	-	-	-	-	52	-	-
3300/1/1	73	M	-	-	-	-	-	-	-	120	-	-
3301/1/1	65	F	-	-	-	-	-	-	-	**548**	-	-
3301/2/1	68	M	-	-	-	-	-	-	-	**548**	-	-
3302/1/1	50	M	13.7	-	0.2	-	-	-	-	274	-	-
3302/2/1	55	F	13.7	-	0.2	-	-	-	-	184	-	-
3303/1/1	63	F	-	-	-	-	-	-	-	52	-	-

Person ID number	Age	Gender	Fish	Crustaceans	Molluscs	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	Intertidal occupancy over stones
3303/2/1	65	M	-	-	-	-	-	-	-	274	-	-
3304/1/1	84	M	-	-	-	-	-	-	-	60	-	-
3305/1/1	70	M	7.2	0.1	-	-	-	-	-	**457**	-	-
3305/2/1	29	M	7.2	0.1	-	-	-	-	-	-	-	-
3305/3/1	63	F	7.2	0.1	-	-	-	-	-	**668**	-	-
3306/1/1	85	M	-	-	-	-	-	-	-	326	-	-
3307/1/1	67	F	-	-	-	-	-	-	-	137	-	-
3307/2/1	69	M	-	-	-	-	-	-	-	137	-	-
3308/1/1	74	M	-	-	-	-	-	-	-	48	-	-
3309/1/1	58	M	**45.6**	0.05	-	-	-	-	-	18	-	-
3309/2/1	32	M	-	-	0.7	-	-	-	-	-	18	-
3310/1/1	67	M	2.5	-	-	-	-	-	-	-	-	-
3311/1/1	69	M	18.0	-	-	-	-	-	-	357	-	-
3312/1/1	65	M	6.2	-	-	-	-	-	-	-	-	-
3312/2/1	65	F	6.2	-	-	-	-	-	-	-	-	-
3314/1/1	35	M	2.5	-	-	-	-	-	-	**1095**	-	-
3314/2/1	35	M	-	-	-	-	-	-	-	**720**	-	-
3314/3/1	62	M	-	-	-	-	-	-	-	**720**	-	-
3315/1/1	25	M	-	-	-	-	-	-	-	182	-	-
3319/1/1	57	M	11.3	**19.7**	-	-	-	-	-	274	-	-
3319/2/1	57	F	11.3	**19.7**	-	-	-	-	-	-	-	-

Person ID number	Age	Gender	Fish	Crustaceans	Molluscs	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	Intertidal occupancy over stones
3320/1/1	86	M	-	0.8	-	-	-	-	-	-	-	-
3320/2/1	63	M	-	0.8	-	-	-	-	-	**626**	-	-
3322/1/1	72	M	-	-	-	-	-	-	32	**548**	-	-
3322/2/1	42	M	-	-	-	-	-	-	32	**548**	-	-
3324/1/1	56	M	**21.2**	**11.5**	-	-	-	-	-	-	-	-
3324/2/1	41	F	**21.2**	**11.5**	-	-	-	-	-	-	-	-
3325/1/1	65	F	-	-	-	-	-	-	-	52	**104**	-
3325/2/1	68	M	-	-	-	-	-	-	-	52	**52**	-
3326/1/1	68	M	-	-	-	-	-	-	-	352	-	-
3326/2/1	63	F	-	-	-	-	-	-	-	78	-	-
3327/1/1	79	U	-	-	-	-	-	-	78	251	-	-
3329/1/1	52	F	-	-	-	-	-	-	-	365	-	-
3329/2/1	57	M	-	-	-	-	-	-	-	182	-	-
3329/3/1	19	M	-	-	-	-	-	-	-	18	-	-
3329/4/1	20	F	-	-	-	-	-	-	-	18	-	-
3330/1/1	41	M	-	-	-	-	-	-	-	78	-	-
3330/2/1	41	F	-	-	-	-	-	-	-	78	-	-
3332/1/1	60	M	0.8	-	-	-	-	-	-	224	-	-
3332/2/1	62	F	0.8	-	-	-	-	-	-	-	-	-
3335/1/1	64	M	-	-	-	-	-	-	-	228	-	-
3335/2/1	61	F	-	-	-	-	-	-	-	228	-	-

Person ID number	Age	Gender	Fish	Crustaceans	Molluscs	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	Intertidal occupancy over stones
3336/1/1	52	M	19.0	-	-	-	-	-	-	338	-	-
3336/2/1	51	M	19.0	-	-	-	-	-	-	338	-	-
3337/1/1	57	M	-	-	-	-	**205**	-	-	**410**	-	-
3337/2/1	47	F	-	-	-	-	**205**	-	-	**410**	-	-
3338/1/1	73	M	-	-	-	-	**409**	-	-	**409**	-	-
3338/2/1	57	F	-	-	-	-	**273**	-	-	273	-	-
3341/1/1	50	F	-	-	-	-	-	-	-	**730**	-	-
3342/1/1	78	M	-	-	-	-	-	-	-	274	-	-
3343/1/1	71	M	-	3.8	**4.4**	-	-	-	-	73	-	**18**
3343/2/1	56	F	-	3.8	-	-	-	-	-	73	-	-
3344/1/1	71	M	-	-	-	-	-	-	-	196	-	-
3346/1/1	90	M	**52.0**	**9.2**	-	-	130	-	-	-	-	-
3346/2/1	72	M	**52.0**	-	-	-	-	-	-	-	-	-
3348/1/1	63	M	-	**27.6**	-	-	17	-	153	39	-	-
3348/2/1	60	F	-	**27.6**	-	-	17	-	-	**469**	-	-
3348/3/1	27	M	-	**27.6**	-	-	17	-	153	39	-	-
3348/4/1	25	M	-	**27.6**	-	-	-	-	-	-	-	-
3349/1/1	59	M	2.4	3.5	1.1	-	-	-	-	-	-	-
3349/2/1	53	F	2.4	3.5	1.1	-	-	-	-	-	-	-
3350/1/1	84	M	**47.5**	**22.7**	-	-	-	-	-	-	-	-
3350/2/1	83	F	10.2	**15.3**	-	-	-	-	-	-	-	-

Person ID number	Age	Gender	Fish	Crustaceans	Molluscs	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	Intertidal occupancy over stones
3351/1/1	48	M	**57.9**	-	-	-	-	-	-	271	-	-
3351/2/1	70	M	-	-	-	-	-	-	-	235	-	-
3351/3/1	60	M	-	-	-	-	-	-	-	235	-	-
3351/4/1	28	F	-	-	-	-	-	-	-	235	-	-
3354/1/1	70	M	**34.0**	-	-	-	20	-	-	**561**	-	**20**
3355/1/1	61	F	2.3	2.1	-	-	**365**	-	**548**	-	-	-
3355/2/1	64	M	2.3	2.4	-	-	**365**	-	-	-	-	-
3355/3/1	33	F	2.3	1.9	-	-	-	-	-	-	-	-
3355/4/1	30	F	2.3	1.9	-	-	39	-	-	-	-	-
3355/5/1	41	M	2.3	1.9	-	-	-	-	**548**	-	-	-
3356/1/1	37	F	-	-	-	**78**	-	-	-	79	-	-
3356/2/1	37	M	-	-	-	**78**	-	-	-	79	-	-
3359/1/1	44	M	-	-	-	-	-	-	-	319	-	-
3359/2/1	45	F	-	-	-	-	-	-	-	319	-	-
3360/1/1	43	F	-	-	-	-	14	-	-	29	-	-
3362/1/1	55	M	-	-	-	-	-	-	-	**1187**	-	-
3363/1/1	38	M	-	-	-	-	-	-	-	**861**	-	-
3363/2/1	34	F	-	-	-	-	-	-	-	**861**	-	-
3364/1/1	42	M	-	-	-	-	-	-	-	365	-	-
3365/1/1	28	M	-	-	**2.5**	-	-	12	-	**423**	-	-
3366/1/1	31	F	1.8	-	-	-	-	-	-	365	-	-

Person ID number	Age	Gender	Fish	Crustaceans	Molluscs	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	Intertidal occupancy over stones
3366/2/1	35	M	1.8	-	-	-	-	-	-	-	-	-

Notes

U = Unknown

Emboldened observations are the high-rate individuals

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

Person ID number	Age	Gender	Fish	Intertidal occupancy over mud and sand	Intertidal occupancy over sand
3356/3/1	**12**	**M**	-	**78**	79
3356/4/1	**10**	**M**	-	**78**	79
3356/5/1	**11**	**M**	-	**78**	79
3356/6/1	**8**	**F**	-	**78**	79
3359/3/1	**11**	**M**	-	-	**319**
3359/4/1	**14**	**F**	-	-	**319**
3363/3/1	**6**	**F**	-	-	**496**
3366/3/1	**10**	**F**	**1.8**	-	-

Notes
Emboldened observations are the high-rate individuals

Annex 3. Infants' consumption rates (kg y^{-1}) and occupancy rates (h y^{-1}) in the Sellafield aquatic area

Person ID number	Age	Gender	Fish	Crustaceans	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over sand
3355/6/1	**3**	**M**	**1.1**	**1.0**	**39**	-
3360/2/1	**5**	**M**	-	-	**14**	29
3363/4/1	**4**	**F**	-	-	-	**496**

Notes
Emboldened observations are the high-rate individuals

Annex 4. Cumbrian Coastal Community fish consumption data reported in AEMR and RIFE (kg y^{-1})

Year (report)	FISH					
	Species Composition	Total	Cod	Plaice	Other fish	Source of habits data
1994 (AEMR 45)	Plaice and Cod (50%:50%)	26	13.0	13.0	0	1993/94 Survey
1995 (RIFE 1)	Plaice and Cod (50%:50%)	26	13.0	13.0	0	1995 Review (crust and moll) and 1993/4 survey (fish)
1996 (RIFE 2)	Plaice and Cod (50%:50%)	25	12.5	12.5	0	1995 Review (crust and moll) and 1996 logging data (fish)
1997 (RIFE 3)	Plaice and Cod (25%:75%)	37	27.8	9.3	0	1997 Review
1998 (RIFE 4)	Plaice and Cod (50%:50%)	45	22.5	22.5	0	1998 Survey
1999 (RIFE 5)	Plaice and Cod (50%:50%)	43	21.5	21.5	0	1999 Review
2000 (RIFE 6)	Cod and other fish (40%:60%)	31	12.4	0	18.6	2000 Review
2001 (RIFE 7)	Cod and other fish (40%:60%)	31	12.4	0	18.6	2001 Review
2002 (RIFE 8)	Cod and other fish (40%:60%)	51	20.4	0	30.6	2002 Review
2003 (RIFE 9)	Cod and other fish (60%:40%)	41	24.6	0	16.4	2003 Survey
2004 (RIFE 10)	Cod and other fish (60%:40%)	41	24.6	0	16.4	2004 Review (crust and moll) and 2003 Survey (fish)
2005 (RIFE 11)	Cod and other fish (60%:40%)	41	24.6	0	16.4	2005 Review (crust and moll) and 2003 Survey (fish)

Year (report)	FISH					
	Species Composition	Total	Cod	Plaice	Other fish	Source of habits data
2006 (RIFE 12)	Cod and other fish (60%:40%)	41	24.6	0	16.4	2006 Review (crust and moll) and 2003 Survey (fish)
2007 (RIFE 13)	Cod and other fish (60%:40%)	41	24.6	0	16.4	2007 Review (crust and moll) and 2003 Survey (fish)
2008 (RIFE 14)	Cod and other fish (25%:75%)	40	10.0	0	30.0	2008 Survey
2009 (RIFE 15)	Cod and other fish (25%:75%)	40	10.0	0	30.0	2009 Review (crust & moll) 2008 Survey (fish)
2010 (RIFE 16)	Cod and other fish (25%:75%)	40	10.0	0	30.0	2010 Review (crust & moll) 2008 Survey (fish)
2011 (RIFE 17)	Cod and other fish (25%:75%)	40	10.0	0	30.0	2011 Review (crust & moll) 2008 Survey (fish)
2012 (RIFE 18)	Cod and other fish (25%:75%)	37	9.3	0	27.8	2012 LLWR Habits Survey
2013 (RIFE 19)	Cod and other fish (40%:60%)	56	22.4	0	33.6	2013 Survey
2014 (RIFE 20)	Cod and other fish (40%:60%)	56	22.4	0	33.6	2014 Review (crust and moll) 2013 Survey (fish)
2015 (RIFE 21)	Cod and other fish (25%:75%)	64	16.0	0	48.0	2015 Review
2016 (RIFE 22)	Cod and other fish (25%:75%)	60	15.0	0	45.0	2016 Review
2017 (RIFE 23)	Cod and other fish (40%:60%)	54	21.6	0	32.4	2017 Review
2018 (RIFE 24)	Cod and other fish (60%:40%)	41	24.6	0	16.4	2018 Survey
2019 (RIFE 25)	Cod and other fish (30%:70%)	40	12.0	0	28.0	2019 Review

Year (report)	FISH					
	Species Composition	Total	Cod	Plaice	Other fish	Source of habits data
2020 (RIFE 26)	Cod and other fish (15%:85%)	34	5.1	0	28.9	2020 Review
2021 (RIFE 27)	Cod and other fish (30%:70%)	45	13.5	0	31.5	2021 Review
2022 (RIFE 28)	Cod and other fish (15%:85%)	41	6.2	0	34.8	2022 Review

Annex 5. Cumbrian Coastal Community crustacean consumption data reported in AEMR and RIFE (kg y^{-1})

Year (report)	CRUSTACEANS					
	Species Composition	Total	Crab	Lobster	Nephrops or other crustaceans	Source of habits data
1994 (AEMR 45)	Crabs and Lobsters (65%:35%)	12	7.8	4.2	0	1993/94 Survey
1995 (RIFE 1)	Crabs and Lobsters (75%:25%)	8.6	6.5	2.2	0	1995 Review (crust and moll) and 1993/4 survey (fish)
1996 (RIFE 2)	Crabs and Lobsters (60%:40%)	12	7.2	4.8	0	1995 Review (crust and moll) and 1996 logging data (fish)
1997 (RIFE 3)	Crabs, Lobsters and Nephrops (50%:40%:10%)	17	8.5	6.8	1.7	1997 Review
1998 (RIFE 4)	Crabs and Lobsters (85%:15%)	28	23.8	4.2	0	1998 Survey
1999 (RIFE 5)	Crabs and Lobsters (80%:20%)	24	19.2	4.8	0	1999 Review

Year (report)	CRUSTACEANS					
	Species Composition	Total	Crab	Lobster	Nephrops or other crustaceans	Source of habits data
2000 (RIFE 6)	Crabs, Lobsters and Nephrops (40%:40%:20%)	20	8.0	8.0	4.0	2000 Review
2001 (RIFE 7)	Crabs, Lobsters and Nephrops (40%:40%:20%)	20	8.0	8.0	4.0	2001 Review
2002 (RIFE 8)	Crabs, Lobsters and Nephrops (50%:30%:20%)	16	8.0	4.8	3.2	2002 Review
2003 (RIFE 9)	Crabs, Lobsters and Nephrops (80%:10%:10%)	27	21.6	2.7	2.7	2003 Survey
2004 (RIFE 10)	Crabs, Lobsters and Nephrops (50%:40%:10%)	25	12.5	10.0	2.5	2004 Review (crust and moll) and 2003 Survey (fish)
2005 (RIFE 11)	Crabs, Lobsters and Nephrops (60%:20%:20%)	20	12.0	4.0	4.0	2005 Review (crust and moll) and 2003 Survey (fish)
2006 (RIFE 12)	Crabs, Lobsters and Nephrops (50%:20%:30%)	20	10.0	4.0	6.0	2006 Review (crust and moll) and 2003 Survey (fish)
2007 (RIFE 13)	Crabs, Lobsters and Nephrops (50%:30%:20%)	20.4	10.2	6.1	4.1	2007 Review (crust and moll) and 2003 Survey (fish)
2008 (RIFE 14)	Crabs, Lobsters and Nephrops (70%:20%:10%)	16.8	11.8	3.4	1.7	2008 Survey

Year (report)	CRUSTACEANS					
	Species Composition	Total	Crab	Lobster	Nephrops or other crustaceans	Source of habits data
2009 (RIFE 15)	Crabs, Lobsters and Nephrops (30%:50%:20%)	16	4.8	8	3.2	2009 Review (crust & moll) 2008 Survey (fish)
2010 (RIFE 16)	Crabs, Lobsters and Nephrops (50%:30%:20%)	22	11.0	6.6	4.4	2010 Review (crust & moll) 2008 Survey (fish)
2011 (RIFE 17)	Crabs, Lobsters and Nephrops (40%:30%:30%)	27	10.8	8.1	8.1	2011 Review (crust & moll) 2008 Survey (fish)
2012 (RIFE 18)	Crabs, Lobsters and Nephrops (30%:20%:50%)	29	8.7	5.8	14.5	2012 LLWR Habits Survey
2013 (RIFE 19)	Crabs, Lobsters and Nephrops (20%:5%:75%)	25	5.0	1.2	18.8	2013 Survey
2014 (RIFE 20)	Crabs, Lobsters and other crustaceans (25%:35%:40%)	36	9.0	12.6	14.4	2014 Review (crust and moll) 2013 Survey (fish)
2015 (RIFE 21)	Crabs, Lobsters and other crustaceans (30%:40%:30%)	38	11.4	15.2	11.4	2015 Review
2016 (RIFE 22)	Crabs, Lobsters and other crustaceans (30%:35%:35%)	37	11.0	13.0	13.0	2016 Review
2017 (RIFE 23)	Crabs, Lobsters and other crustaceans (30%:45%:25%)	31	9.3	14.0	7.7	2017 Review

Year (report)	CRUSTACEANS					
	Species Composition	Total	Crab	Lobster	Nephrops or other crustaceans	Source of habits data
2018 (RIFE 24)	Crabs, Lobsters and other crustaceans (40%:45%:15%)	35	14.0	15.8	5.3	2018 Survey
2019 (RIFE 25)	Crabs, Lobsters and other crustaceans (20%:40%:40%)	36	7.2	14.4	14.4	2019 Review
2020 (RIFE 26)	Crabs, Lobsters and other crustaceans (30%:50%:20%)	30	9.0	15.0	6.0	2020 Review
2021 (RIFE 27)	Crabs, Lobsters and other crustaceans (35%:65%:0%)	25	8.8	16.2	0.0	2021 Review
2022 (RIFE 28)	Crabs, Lobsters and other crustaceans (35%:55%:10%)	20	7.0	11.0	2.0	2022 Review

Annex 6. Cumbrian Coastal Community mollusc consumption data reported in AEMR and RIFE (kg y^{-1})

Year (report)	MOLLUSCS				
	Species Composition	Total	Winkles	Other molluscs	Source of habits data
1994 (AEMR 45)	Winkles and other molluscs (85%:15%)	9.7	8.2	1.5	1993/94 Survey
1995 (RIFE 1)	Winkles and other molluscs (50%:50%)	12	6.0	6.0	1995 Review (crust and moll) and 1993/4 survey (fish)
1996 (RIFE 2)	Winkles and other molluscs (60%:40%)	12	7.2	4.8	1995 Review (crust and moll) and 1996 logging data (fish)
1997 (RIFE 3)	Winkles and other molluscs (40%:60%)	4.2	1.7	2.5	1997 Review
1998 (RIFE 4)	Winkles and other molluscs (30%:70%)	15	4.5	10.5	1998 Survey
1999 (RIFE 5)	Winkles and other molluscs (50%:50%)	25	12.5	12.5	1999 Review
2000 (RIFE 6)	Winkles and other molluscs (50%:50%)	17	8.5	8.5	2000 Review
2001 (RIFE 7)	Winkles and other molluscs (50%:50%)	17	8.5	8.5	2001 Review
2002 (RIFE 8)	Winkles and mussels (60%:40%)	29	17.4	11.6	2002 Review
2003 (RIFE 9)	Winkles and other molluscs (40%:60%)	34	13.6	20.4	2003 Survey
2004 (RIFE 10)	Winkles and other molluscs (50%:50%)	34	17.0	17.0	2004 Review (crust and moll) and 2003 Survey (fish)
2005 (RIFE 11)	Winkles and other molluscs (60%:40%)	33	19.8	13.2	2005 Review (crust and moll) and 2003 Survey (fish)

Year (report)	MOLLUSCS				
	Species Composition	Total	Winkles	Other molluscs	Source of habits data
2006 (RIFE 12)	Winkles and other molluscs (50%:50%)	40	20.0	20.0	2006 Review (crust and moll) and 2003 Survey (fish)
2007 (RIFE 13)	Winkles and other molluscs (60%:40%)	28.9	17.3	11.6	2007 Review (crust and moll) and 2003 Survey (fish)
2008 (RIFE 14)	Winkles and other molluscs (50%:50%)	31.4	15.7	15.7	2008 Survey
2009 (RIFE 15)	Winkles and other molluscs (60%:40%)	28	16.8	11.2	2009 Review (crust & moll) 2008 Survey (fish)
2010 (RIFE 16)	Winkles and other molluscs (20%:80%)	22	4.4	17.6	2010 Review (crust & moll) 2008 Survey (fish)
2011 (RIFE 17)	Winkles and other molluscs (60%:40%)	12	7.2	4.8	2011 Review (crust & moll) 2008 Survey (fish)
2012 (RIFE 18)	Winkles and other molluscs (60%:40%)	9.1	5.5	3.6	2012 LLWR Habits Survey
2013 (RIFE 19)	Winkles and other molluscs (85%:15%)	15	12.8	2.2	2013 Survey
2014 (RIFE 20)	Winkles and other molluscs (65%:35%)	11	7.2	3.8	2014 Review (crust and moll) 2013 Survey (fish)
2015 (RIFE 21)	Winkles and other molluscs (55%:45%)	12	6.6	5.4	2015 Review
2016 (RIFE 22)	Winkles and other molluscs (60%:40%)	12	7.2	4.8	2016 Review
2017 (RIFE 23)	Winkles and other molluscs (65%:35%)	12	7.8	4.2	2017 Review
2018 (RIFE 24)	Winkles and other molluscs (75%:25%)	12	9.0	3.0	2018 Survey
2019 (RIFE 25)	Winkles and other molluscs (50%:50%)	12	6.0	6.0	2019 Review

Year (report)	MOLLUSCS				
	Species Composition	Total	Winkles	Other molluscs	Source of habits data
2020 (RIFE 26)	Winkles and other molluscs (50%:50%)	14	7.0	7.0	2020 Review
2021 (RIFE 27)	Winkles and other molluscs (0%:100%)	5.4	0.0	5.4	2021 Review
2022 (RIFE 28)	Winkles and other molluscs (70%:30%)	3.4	2.4	1.0	2022 Review

Annex 7. Cumbrian Coastal Community intertidal occupancy data reported in AEMR and RIFE (h y^{-1})

Year (report)	INTERTIDAL OCCUPANCY		
	Substrate	h y^{-1}	Source of habits data
1994 (AEMR 45)	-	-	-
1995 (RIFE 1)	-	-	-
1996 (RIFE 2)	-	-	-
1997 (RIFE 3)	-	-	-
1998 (RIFE 4)	Sand and mollusc beds	1100	1998 Survey
1999 (RIFE 5)	Sand and mollusc beds	1000	1999 Review
2000 (RIFE 6)	Sand and mollusc beds	1000	2000 Review
2001 (RIFE 7)	Sand and mollusc beds	900	2001 Review
2002 (RIFE 8)	Mud and sand	1200	2002 Review
2003 (RIFE 9)	Mud and sand	870	2003 Survey
2004 (RIFE 10)	Mud and sand	1000	2004 Review
2005 (RIFE 11)	Mud and sand	790	2005 Review
2006 (RIFE 12)	Mud and sand	580	2006 Review
2007 (RIFE 13)	Mud and sand	830	2007 Review

Year (report)	INTERTIDAL OCCUPANCY		
	Substrate	h y^{-1}	Source of habits data
2008 (RIFE 14)	Mud and sand	930	2008 Survey
2009 (RIFE 15)	Mud and sand	960	2009 Review
2010 (RIFE 16)	Mud and sand	870	2010 Review
2011 (RIFE 17)	Mud and sand	840	2011 Review
2012 (RIFE 18)	Mud and sand	850	2012 LLWR Habits Survey
2013 (RIFE 19)	Mud and sand	760	2013 Survey
2014 (RIFE 20)	Mud and sand	1100	2014 Review
2015 (RIFE 21)	Mud and sand	1000	2015 Review
2016 (RIFE 22)	Mud and sand	790	2016 Review
2017 (RIFE 23)	Mud and sand	770	2017 Review
2018 (RIFE 24)	Mud and sand	700	2018 Survey
2019 (RIFE 25)	Mud and sand	830	2019 Review
2020 (RIFE 26)	Mud and sand	690	2020 Review
2021 (RIFE 27)	Mud and sand	530	2021 Review
2022 (RIFE 28)	Mud and sand	670	2022 Review

Annex 8. Cumbrian Coastal 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* or other crustaceans	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
2008-12	39.4	9.9	0.0	29.6	22.2	9.4	6.4	6.4	20.5	9.9	10.6	890
2009-13	42.6	12.3	0.0	30.3	23.8	8.1	5.9	9.8	17.2	9.3	7.9	856
2010-14	45.8	14.8	0.0	31.0	27.8	8.9	6.9	12.0	13.8	7.4	6.4	884
2011-15	50.6	16.0	0.0	34.6	31.0	9.0	8.6	13.4	11.8	7.8	4.0	910
2012-16	54.6	17.0	0.0	37.6	33.0	9.0	9.6	14.4	11.8	7.8	4.0	900
2013-17	58.0	19.5	0.0	38.5	33.4	9.1	11.2	13.0	12.4	8.3	4.1	884
2014-18	55.0	19.9	0.0	35.1	35.4	10.9	14.1	10.3	11.8	7.6	4.2	872
2015-19	51.8	17.8	0.0	34.0	35.4	10.6	14.5	10.3	12.0	7.3	4.7	818
2016-20	45.8	15.7	0.0	30.3	33.8	10.1	14.4	9.3	12.4	7.4	5.0	756
2017-21	42.8	15.4	0.0	27.4	31.4	9.7	15.1	6.7	11.1	6.0	5.1	704
2018-22	40.2	12.3	0.0	28.1	29.2	9.2	14.5	5.5	9.4	4.9	4.5	684

Annex 9. Summary of profiles for adults in the Sellafield area for use in the assessment of total dose

Profile Name	Pathway Name / Number of Individuals		Crustacea	Direct	Eggs	Fish - Fresh	Fish - Sea	Fruit - Domestic	Fruit and nuts - Wild	Gamma ext - Salt marsh	Gamma ext - Sediments	Honey	Marine plants/algae	Meat - Cow	Meat - Game	Meat - Poultry	Meat - Sheep	Meat - Wildfowl	Milk	Mollusca	Mushrooms	Mushrooms grown on salt marsh	Occupancy IN water	Occupancy ON water	Plume (IN; 0-0.25 km)	Plume (MID; 0.25-0.5 km)	Plume (OUT; 0.5-1 km)	Vegetables - Green	Vegetables - Other Domestic	Vegetables - Potatoes	Vegetables - Root
		Notes		1						2	3				4										5	5	5				
		Units	kg	-	kg	kg	kg	kg	kg	h	h	kg	kg	kg	kg	kg	kg	kg	l	kg	kg	kg	h	h	h	h	h	kg	kg	kg	kg
Crustacean Consumers	18		**21.9**	0.22	-	-	15.6	-	0.05	17	78	-	-	-	-	-	-	-	-	-	0.11	-	-	450	-	4	17	-	-	0.28	-
Occupants for Direct Radiation	162		0.73	**1.00**	0.54	-	1.0	0.73	0.09	-	57	<0.01	-	1.3	0.05	0.42	0.89	-	3.7	<0.01	0.07	-	<1	11	290	130	1420	0.82	1.4	0.98	1.0
Egg Consumers	6		-	0.17	**26.9**	-	-	6.8	0.15	-	4	-	-	-	-	-	19.8	-	-	-	-	-	-	-	-	1420	-	1.2	5.4	9.5	1.3
Freshwater Fish Consumers	2		-	-	-	**4.2**	-	-	5.0	-	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	38.9	10.0	2.5
Sea Fish Consumers	30		5.6	0.10	-	-	**37.2**	0.04	-	-	120	-	-	-	-	0.06	-	-	-	0.10	-	-	-	14	-	2	4	0.11	0.11	0.16	0.13
Domestic Fruit Consumers	10		0.09	0.10	1.9	-	0.19	**37.7**	0.75	-	58	-	-	-	-	0.29	1.1	-	34.6	0.06	0.19	-	-	-	-	-	73	8.4	18.9	16.9	14.3
Wild Fruit and Nut Consumers	13		0.61	0.15	0.95	0.65	0.15	10.9	**2.9**	-	2	0.35	-	7.7	1.3	2.3	8.2	0.10	26.6	0.05	0.32	-	-	-	1210	-	-	2.1	6.4	5.2	4.1
Occupants over Salt marsh	15		0.27	-	-	-	0.31	-	-	**460**	38	-	0.03	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Occupants over Sediment	70		0.02	0.07	-	-	2.0	1.2	<0.01	<1	**720**	-	-	-	-	0.33	-	-	-	0.18	-	-	<1	6	3	1	11	0.69	0.98	0.59	0.81
Honey Consumers	2		-	-	-	4.2	-	-	5.0	-	-	**2.3**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	38.9	10.0	2.5
Consumers of Marine Plants and Algae	5		1.7	-	-	-	1.8	-	-	110	200	-	**0.49**	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-	-	-
Cattle Meat Consumers	12		-	0.42	2.7	-	-	1.1	0.63	-	2	-	-	**33.1**	-	0.07	7.5	-	-	-	0.23	-	-	-	2560	-	150	-	0.42	-	0.42
Game Meat Consumers	1		7.0	-	-	-	-	-	3.0	-	-	-	-	-	**17.4**	28.3	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Poultry Meat Consumers	5		1.4	0.40	3.3	-	2.6	1.8	1.0	16	380	0.18	-	1.0	3.5	**20.1**	1.0	0.71	-	-	-	-	-	-	-	-	3110	4.2	5.2	4.8	4.9
Sheep Meat Consumers	14		-	0.43	6.1	-	1.2	1.6	0.96	-	-	-	-	7.1	-	1.0	**23.4**	-	-	-	0.19	-	-	2	1120	610	680	0.03	1.9	5.7	0.36
Wildfowl Consumers	1		-	-	-	-	-	-	-	2	14	-	-	-	-	-	-	**39.8**	-	-	-	-	-	-	-	-	-	-	-	-	-
Milk Consumers	15		-	0.13	1.5	-	-	3.3	0.20	-	<1	0.20	-	-	-	-	-	-	**202.1**	-	0.19	-	-	-	-	-	350	1.9	3.1	-	0.07
Mollusc Consumers	2		1.9	-	-	-	-	-	-	-	410	-	-	-	-	-	-	-	-	**8.5**	-	-	-	-	-	-	-	-	-	-	-
Mushroom Consumers	11		-	0.45	1.1	-	0.79	2.8	0.77	-	13	-	-	9.1	-	0.12	3.6	-	35.5	-	**1.6**	-	<1	-	1430	-	270	2.9	9.4	10.8	4.2
Consumers of Mushrooms grown on Salt Marsh	5		-	-	-	-	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	**1.1**	-	-	-	-	-	-	-	-	-
Occupants In Water	4		-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	**940**	3	-	-	-	-	-	-	-
Occupants On Water	8		11.5	-	-	-	1.5	-	0.06	38	14	-	-	-	-	-	-	-	-	-	0.13	-	-	**1650**	-	-	-	-	-	-	-
Local Inhabitants (0 - 0.25 km)	6		-	1.00	4.3	-	-	1.8	0.83	-	3	-	-	28.7	-	-	8.4	-	-	-	0.45	-	-	-	**6080**	-	-	-	0.83	-	0.83
Local Inhabitants (0.25 - 0.5 km)	1		-	1.00	24.2	-	-	-	-	-	-	-	-	-	-	-	39.5	-	-	-	-	-	-	-	-	**8510**	-	-	-	-	-
Local Inhabitants (0.5 - 1 km)	24		0.05	1.00	0.68	-	0.68	1.3	0.24	-	25	0.04	-	0.21	0.36	2.6	1.5	-	14.5	<0.01	0.07	-	-	3	-	-	**6330**	0.89	1.9	0.67	0.20
Green Vegetable Consumers	15		-	0.27	0.59	-	1.7	15.8	0.03	-	110	-	-	-	-	1.5	-	-	-	-	0.33	-	-	-	-	-	96	**30.5**	24.5	45.8	20.0
Other Domestic Vegetable Consumers	19		-	0.37	1.8	0.47	1.4	15.5	0.55	-	120	0.24	-	-	-	1.2	-	-	-	-	0.26	-	-	-	-	-	480	14.3	**31.1**	16.8	16.9
Potato Consumers	31		-	0.03	0.29	-	-	6.6	-	-	-	-	-	2.6	-	0.20	1.8	-	10.1	-	0.16	-	-	-	-	-	18	10.6	6.5	**86.1**	7.6
Root Vegetable Consumers	18		0.05	0.33	-	-	1.5	22.1	0.30	-	110	-	-	-	-	1.3	0.59	-	19.2	0.03	0.36	-	-	-	-	-	110	22.6	23.0	35.7	**23.4**

Notes

This annex is based on data from the 2018 Sellafield full habits survey (aquatic, terrestrial and direct radiation pathways), which has been updated with data from the 2019, 2020, 2021 and 2022 annual Sellafield Reviews.

1. Direct radiation is expressed as proportion of group who are present within 1 km of site perimeter
2. Gamma ext (external gamma) - Salt marsh represents occupancy over salt marsh only
3. Gamma ext (external gamma) - Sediments represents occupancy over all substrates except rock and salt marsh
4. Meat - Game includes consumption of venison and rabbits/hares
5. Plume times are the sum of individuals' indoor and outdoor times

The means of the high-rate groups are determined by the ‘cut-off’ method and are emboldened on the diagonal

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