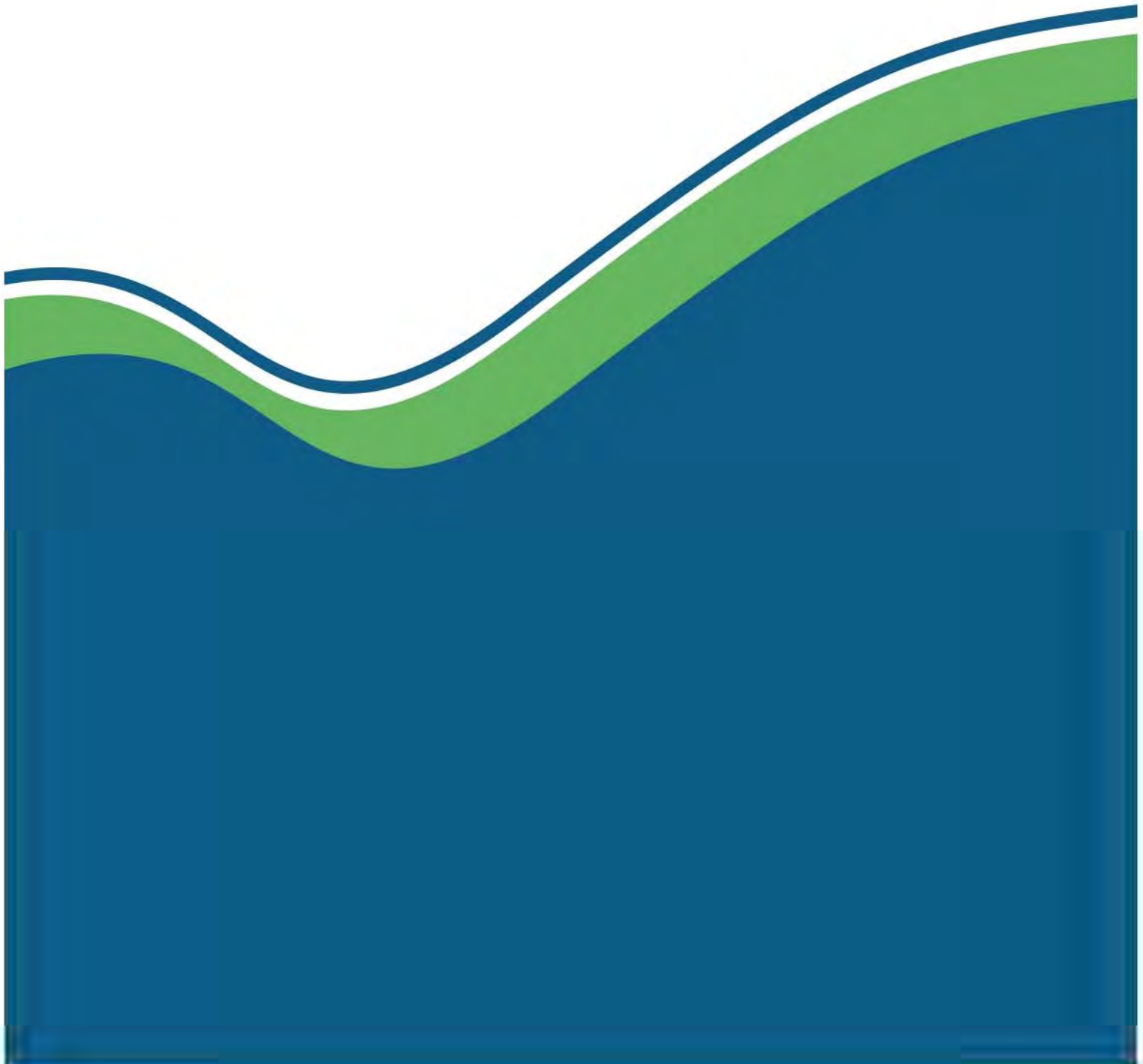




Radiological Habits Survey: Rosyth, 2010



This page has been intentionally left blank

Environment Report (RL 15/13)

Final report

Radiological Habits Survey: Rosyth, 2010

P. Rumney, C.A. Smedley, C.J. Garrod, F.J. Clyne and V.E. Ly

Peer reviewed by G.J. Hunt
Approved for publication by W.C. Camplin

2013

The work described in this report was carried out
under contract to the Scottish Environment Protection Agency
SEPA contract R90077PUR
Cefas contract C3745

This report should be cited as: Rumney, P., Smedley, C.A., Garrod, C.J., Clyne, F.J., and Ly, V.E., 2013. Radiological Habits Survey: Rosyth, 2010. RL 15/13. Cefas, Lowestoft

A copy can be obtained by downloading from the SEPA website: www.sepa.org.uk and from the Cefas website: www.cefas.defra.gov.uk

© Crown copyright, 2013

CONTENTS

SUMMARY	7
1 INTRODUCTION	13
1.1 Regulation of radioactive waste discharges.....	13
1.2 The representative person	13
1.3 Dose limits and constraints	13
2 THE SURVEY	15
2.1 Site activity	15
2.2 Survey aims.....	15
2.3 Survey areas	16
<i>Figure 1. The Rosyth aquatic survey area</i>	17
<i>Figure 2. The Rosyth terrestrial (outer ring) and direct radiation (inner ring) survey areas</i>	18
2.4 Conduct of the survey	19
3 METHODS FOR DATA ANALYSIS	20
3.1 Data recording and presentation.....	20
3.2 Data conversion	20
3.3 Rounding and grouping of data.....	20
3.4 Approaches for the identification of high rates.....	21
3.5 Infant and child ratios for use in dose assessments	22
4 AQUATIC RADIATION PATHWAYS	23
4.1 Aquatic survey area	23
<i>Figure 3. Torry Bay</i>	24
<i>Figure 4. Bay to the east of St David's Harbour</i>	26
<i>Figure 5. Silversands Bay</i>	27
<i>Figure 6. Bo'ness</i>	28
<i>Figure 7. Drum Sands and the causeway, viewed from Cramond Island</i>	30
4.2 Commercial fisheries.....	31
4.3 Seafood wholesalers and retailers.....	31
4.4 Angling, hobby fishing and shellfish collecting.....	31
4.5 Wildfowling	32
4.6 Other pathways	32
4.7 Internal exposure	32
<i>Table A. Summary of adults' consumption rates of foods from the aquatic survey area</i>	33
<i>Table B. Summary of children's and infants' consumption rates of foods from the aquatic survey area</i>	34
4.8 External exposure	35
<i>Table C. Summary of adults' intertidal occupancy rates</i>	35
<i>Table D. Summary of children's and infants' intertidal occupancy rates</i>	36
<i>Table E. Summary of adults' handling rates of fishing gear and sediment</i>	38
<i>Table F. Summary of children's and infants' handling rates of sediment.</i>	38
5 TERRESTRIAL RADIATION PATHWAYS	40
5.1 Terrestrial survey area	40
5.2 Land cover.....	41
<i>Figure 8 Soil types around the Rosyth site</i>	42
5.3 Internal exposure	43
<i>Table G. Summary of adults' consumption rates of foods from the terrestrial survey area</i>	43
<i>Table H. Summary of children's and infants' consumption rates of foods from the terrestrial survey area</i>	45
6 DIRECT RADIATION PATHWAYS	46
6.1 Direct radiation survey area	46

6.2	Occupancy rates and gamma dose rate measurements	46
7	USE OF HABITS DATA FOR DOSE ASSESSMENTS	48
8	COMPARISONS WITH THE PREVIOUS SURVEY	49
	<i>Table I. Comparison between 2005 and 2010 consumption rates of aquatic food groups for adults</i>	<i>49</i>
	<i>Table J. Comparison between 2005 and 2010 intertidal occupancy rates and handling rates of fishing gear and sediments for adults</i>	<i>50</i>
	<i>Table K. Comparison between 2005 and 2010 mean consumption rates for the adult high-rate groups for terrestrial food groups (kg y⁻¹ or l y⁻¹)</i>	<i>51</i>
	<i>Table L. Comparison between 2005 and 2010 direct radiation occupancy rates (h y⁻¹)</i>	<i>52</i>
9	MAIN FINDINGS	53
9.1	Survey findings	53
10	SUGGESTIONS FOR CHANGES TO THE MONITORING PROGRAMME	56
10.1	Summary of current environmental monitoring programme	56
10.2	Suggestions for changes	57
11	ACKNOWLEDGEMENTS	58
12	REFERENCES	59

TABLES

Table 1	Typical food groups used in habits surveys
Table 2	Ratios for determining consumption and occupancy rates for infants and children
Table 3	Adults' consumption rates of fish from the Rosyth aquatic survey area (kg y ⁻¹)
Table 4	Adults' consumption rates of crustaceans from the Rosyth aquatic survey area (kg y ⁻¹)
Table 5	Adults' consumption rates of molluscs from the Rosyth aquatic survey area (kg y ⁻¹)
Table 6	Adults' consumption rates of wildfowl from the Rosyth aquatic survey area (kg y ⁻¹)
Table 7	Adults' consumption rates of vegetables grown on land where seaweed has been used as a fertiliser (kg y ⁻¹)
Table 8	Children's and infants' consumption rates of fish from the Rosyth aquatic survey area (kg y ⁻¹)
Table 9	Infants' consumption rates of crustaceans from the Rosyth aquatic survey area (kg y ⁻¹)
Table 10	Adults' intertidal occupancy rates in the Rosyth aquatic survey area (h y ⁻¹)
Table 11	Children's and infants' intertidal occupancy rates in the Rosyth aquatic survey area (h y ⁻¹)
Table 12	Gamma dose rate measurements over intertidal substrates in the Rosyth aquatic survey area (µGy h ⁻¹)
Table 13	Adults' handling rates of fishing gear and sediment in the Rosyth aquatic survey area (h y ⁻¹)
Table 14	Children's and infants' handling rates of sediment in the Rosyth aquatic survey area (h y ⁻¹)
Table 15	Adults' occupancy rates in and on water in the Rosyth aquatic survey area (h y ⁻¹)
Table 16	Children's and infants' occupancy rates in and on water in the Rosyth aquatic survey area (h y ⁻¹)
Table 17	Adults' consumption rates of green vegetables from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 18	Adults' consumption rates of other vegetables from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 19	Adults' consumption rates of root vegetables from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 20	Adults' consumption rates of potato from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 21	Adults' consumption rates of domestic fruit from the Rosyth terrestrial survey area (kg y ⁻¹)

Table 22	Adults' consumption rates of cattle meat from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 23	Adult's consumption rates of sheep meat from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 24	Adults' consumption rates of poultry from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 25	Adults' consumption rates of wild/free foods from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 26	Adults' consumption rates of honey from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 27	Adults' consumption rates of venison from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 28	Children's and infants' consumption rates of green vegetables from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 29	Children's and infants' consumption rates of other vegetables from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 30	Children's and infants' consumption rates of root vegetables from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 31	Children's and infants' consumption rates of potato from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 32	Children's and infants' consumption rates of domestic fruit from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 33	Children's consumption rates of sheep meat from the Rosyth terrestrial survey area (kg y ⁻¹)
Table 34	Percentage contribution each food type makes to its terrestrial food group for adults
Table 35	Occupancy rates in the Rosyth direct radiation survey area (h y ⁻¹)
Table 36	Gamma dose rate measurements for the Rosyth direct radiation survey (μGy h ⁻¹)

ANNEXES

Annex 1	Adults' consumption rates (kg y ⁻¹) and occupancy rates (h y ⁻¹) in the Rosyth area
Annex 2	Children's and infants' consumption rates (kg y ⁻¹) and occupancy rates (h y ⁻¹) in the Rosyth area
Annex 3	Combinations of adult pathways for consideration in dose assessments in the Rosyth area

This page has been intentionally left blank

SUMMARY

This report presents the results of a survey conducted in 2010 to determine the habits and consumption patterns of people living, working and undertaking recreational activities in the vicinity of the Rosyth nuclear site (formerly Rosyth Royal Dockyard). The site discharges liquid radioactive waste via an outfall into the Firth of Forth and is authorised to discharge gaseous radioactive waste. The site contains sources of direct radiation.

Three survey areas, which were likely to be most affected by the discharges and sources of radiation, were defined as:

- The aquatic survey area; covering the Firth of Forth and its intertidal areas from Culross to Burntisland on the north shore and from Bo'ness to Granton on the south shore. The sea area was extended for commercial and hobby fishing to include the waters up to the A876 road bridge at Kincardine in the west and up to a line between Kinghorn and Newhaven in the east.
- The terrestrial survey area; extending 5 km from the centre of the Active Waste Accumulation Facility (National Grid Reference NT 096 828).
- The direct radiation survey area; extending 1 km from the centre of the Active Waste Accumulation Facility.

The following potential exposure pathways were investigated during the survey: the consumption of foods from the aquatic survey area; occupancy of intertidal areas; handling of fishing gear and sediment; the consumption of foods from the terrestrial survey area; and occupancy within the direct radiation survey area.

Interviews were conducted with members of the public and the data collected for 416 individuals are presented and discussed. High rates of consumption, intertidal occupancy and handling are identified using established methods comprising a 'cut off' to define the high-rate group, and 97.5th percentiles. The rates so identified can be used in dose assessments.

The aquatic survey area

Very little commercial fishing took place within the survey area. Four small commercial creel boats based at Rosyth, South Queensferry, Burntisland and Newhaven fished for brown crabs, common lobsters, velvet swimming crabs and whelks. Most of the catch was sold outside the survey area. A few hobby (*i.e.* non-commercial) fishermen used creels to fish for brown crabs and common lobsters and a hobby fisherman at Kincardine used a sweep net to catch salmon.

SUMMARY

Aquatic foods were consumed from the following food groups: fish, crustaceans, molluscs and wildfowl. The mean consumption rates for the adult high-rate groups for each of these food groups were:

- 17 kg y⁻¹ for fish (comprising mackerel and cod, caught by boat anglers and shore anglers)
- 4.6 kg y⁻¹ for crustaceans (comprising brown crab and common lobster, caught in creels by commercial and hobby fishermen)
- 5.8 kg y⁻¹ for molluscs (comprising only winkles, collected from the bay to the east of St David's Harbour)
- 4.8 kg y⁻¹ of wildfowl (comprising wigeon, mallard, pink-footed goose and teal, shot by wildfowlers)

No consumption of marine plants/algae was identified.

The relative contribution of the component species within each food group for the adult high-rate groups were:

- For fish, 69% mackerel and 31% cod
- For crustaceans, 66% brown crab and 34% common lobster
- For molluscs, 100% winkles
- For wildfowl, 41% wigeon, 32% mallard, 19% pink-footed goose and 8% teal

Three individuals were identified who collected seaweed from North Queensferry, Limekilns and Charlestown, for use as a fertiliser on their allotment plots. Consumption rates were obtained for potatoes and onions that had been grown in soil fertilised with seaweed. The use of seaweed as animal feed was not identified.

Intertidal activities identified for adults included bait digging, collecting cockles and razor clams for use as angling bait, wildfowling, angling, walking, dog walking, beach cleaning, boat maintenance, beachcombing, rock pooling, crabbing, playing and collecting seaweed, winkles and stones.

The mean rates for the adult high-rate group for occupancy over intertidal substrates were:

- 95 h y⁻¹ over mud (for one wildfowler at Torry Bay)
- 510 h y⁻¹ over mud and sand (for two dog walkers at Cramond and Burntisland)
- 39 h y⁻¹ over mud, sand and stones (for one dog walker at South Queensferry)
- 48 h y⁻¹ over rock (for four winkle collectors and one person who was rock pooling to the east of St David's Harbour, one person who was rock pooling at Cramond and two anglers at Cramond Island)

- 140 h y⁻¹ over sand (for two walkers at Limekilns and seven dog walkers at Cramond, the bay to the west of St David's Harbour, Limekilns, North Queensferry and Aberdour, one of which was also playing at Cramond)
- 350 h y⁻¹ over sand and stones (for one dog walker at Blackness)
- 1 h y⁻¹ over stones (for one person collecting seaweed at North Queensferry)
- 490 h y⁻¹ for boat over mud (for four individuals conducting boat maintenance at North Queensferry and Charlestown Harbour)

Gamma dose rate measurements were taken over intertidal substrates in the aquatic survey area where people were spending time.

The activities identified for adults involving handling fishing gear were handling creels and handling sweep nets. Activities for adults involving sediment handling included fixing moorings, bait digging, wildfowling, collecting shellfish and collecting seaweed. The mean rates for the adult high-rate groups for handling were:

- 940 h y⁻¹ for handling fishing gear (for three commercial creel fishermen operating off Burntisland, in the central survey area, and off Pettycur)
- 150 h y⁻¹ for handling sediment (for two people fixing moorings at North Queensferry, three bait diggers at Burntisland and one wildfowler at Torry Bay)

The handling of angling equipment was not considered to be a significant pathway, and therefore, as in previous surveys, data for this pathway were not collected.

The activities identified taking place in the water in the aquatic survey area were sub-aqua diving and jet skiing. Activities taking place on the water in the survey area included creeling, angling, boat maintenance, fixing moorings, sailing, canoeing, rowing, power boating, coastguard duties, being on a dive boat, skippering a charter boat, safety boat duties, salmon sweep netting and paddling. The maximum occupancy rate in water was 170 h y⁻¹ for an adult who was sub-aqua diving at various locations within the survey area including wrecks off Burntisland and Dalgety Bay. The maximum occupancy rate on water was 1600 h y⁻¹ for a commercial creel fisherman operating off Burntisland.

The terrestrial survey area

Farmers in the area predominantly produced arable crops (potatoes, broccoli, oil seed rape, field beans, wheat, barley and oats), beef and sheep. One farm produced chicken eggs for sale to hatcheries. Small quantities of potatoes and lamb were sold direct to the public. Farmers and their families were consuming potatoes, broccoli, beef and lamb produced on their own farms. A wide range of fruit and vegetables were grown at allotments and private gardens in the area and consumed by the gardeners and their families. Two beekeepers were identified who kept hives within the survey area but none of the honey produced was sold to the public. The consumption of wild foods from within the survey area was limited to small amounts of blackberries and wild garlic. Pheasant and deer shot on farmland in the area were also consumed. The human consumption of groundwater was not identified. All livestock were supplied with mains water for drinking but some also had access to stream or ditch water.

In the terrestrial area, foods were identified being consumed from 11 food groups. The mean consumption rates for the high-rate groups for terrestrial foods were:

- 39 kg y⁻¹ green vegetables
- 41 kg y⁻¹ other vegetables
- 46 kg y⁻¹ root vegetables
- 73 kg y⁻¹ potatoes
- 61 kg y⁻¹ domestic fruit
- 47 kg y⁻¹ cattle meat
- 7.9 kg y⁻¹ sheep meat
- 1.4 kg y⁻¹ poultry
- 0.7 kg y⁻¹ wild/free foods
- 8.8 kg y⁻¹ honey
- 0.7 kg y⁻¹ venison

No consumption of locally produced milk, pig meat, eggs, rabbits/hares, wild fungi or freshwater fish from the survey area was identified.

Wildlife could not gain access to any contaminated areas, which were inside a building, so it is considered unlikely that wildlife could transfer contamination off the site.

The direct radiation survey area

Occupancy rates were obtained at 22 locations within the direct radiation survey area including 17 residential properties and five businesses.

The highest occupancy rates in the direct radiation survey area were as follows:

- 8100 h y⁻¹ for the total occupancy rate (for a resident)
- 7800 h y⁻¹ for the indoor occupancy rate (for the same resident with the highest total occupancy rate)
- 1800 h y⁻¹ for the outdoor occupancy rate (for a resident who also worked in the area)

Gamma dose rate measurements were taken indoors and outdoors at most properties where interviews were conducted. For comparison, background gamma dose rate measurements were taken at distances further than 5 km from the Rosyth site centre.

Comparisons with the previous survey

The results of the 2010 Rosyth habits survey were compared with the last habits survey undertaken at Rosyth in 2005.

In the aquatic survey area, the mean consumption rate for the adult high-rate group for fish, crustaceans, molluscs and wildfowl decreased significantly in 2010 compared to 2005. The consumption of small amounts of marine plants/algae was identified in 2005 but no consumption of this food group was identified in 2010. The mean occupancy rate for the adult high-rate group over intertidal substrates increased significantly for mud and sand, and for boats resting on mud, and decreased significantly for mud, for rock and for sand, in 2010. In 2010, activities were recorded over mud, sand and stones, over sand and stones, and over stones but no activities were recorded taking place over these substrates in 2005. The mean rates for the adult high-rate group for handling fishing gear and for handling sediment both increased significantly in 2010.

In the terrestrial survey area, the food groups showing significant increases in the mean consumption rates for the adult high-rate groups in 2010 were green vegetables, other vegetables, domestic fruit, cattle meat and sheep meat. The most significant decreases in the mean consumption rates for the adult high-rate groups were for root vegetables and wild/free foods. The consumption of eggs, rabbits/hares and wild fungi were recorded in the 2005 survey but no consumption of foods from these food groups was identified in the 2010 survey.

In the direct radiation survey in 2010, the highest total occupancy rate and the highest indoor occupancy rate decreased slightly from 2005, whereas the highest outdoor occupancy rate remained the same.

Suggestions for changes to the monitoring programme

Based on the findings of this survey, the following suggestions for changes to the current environmental monitoring programme are provided for consideration:

- Adding an annual sample of mackerel.
- Replacing the annual sample of whelks with a sample of winkles. Winkles were being collected from the bay to the east of St David's Harbour and the coast to the north of Port Laing.

1 INTRODUCTION

1.1 Regulation of radioactive waste discharges

There are generally three main sources of radiation exposure to members of the public from nuclear sites during routine operations: discharges of liquid radioactive waste to the aquatic environment, discharges of gaseous radioactive waste to the atmosphere and direct radiation emanating from the site. Regulation of radioactive waste discharges in Scotland is carried out under the Radioactive Substances Act 1993, (RSA93) (UK Parliament, 1993). Authorisations granted under RSA93 set limits on the activities of specified radionuclides that are authorised to be released from the site. For discharges in Scotland, the Scottish Environment Protection Agency (SEPA) is the regulatory authority under RSA93. Sources of direct radiation from sites are regulated by the Nuclear Installations Inspectorate (NII) of the Health and Safety Executive (HSE).

1.2 The representative person

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 relevant dose limits and constraints, members of the public generally will receive lower doses, and overall protection of the public is provided from the effects of radiation. The term 'representative person' is equivalent to, and replaces, the term 'average member of the critical group' as recommended by the International Commission on Radiological Protection (ICRP) (ICRP, 2007).

The representative person can only be established once a dose assessment using environmental monitoring data and habits survey data has been undertaken. This survey provides information to assist SEPA in determining the representative person in the Rosyth area.

1.3 Dose limits and constraints

Doses to the representative person can be compared to nationally and internationally recommended dose limits and constraints. The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000 (Scottish Executive, 2000) directs SEPA to ensure that the sum of doses of ionising radiation to the public do not exceed the limits set out in Article 13 of Council Directive 96/29/Euratom (CEC, 1996) and that doses should be as low as reasonably achievable (ALARA), economic and social factors being taken into account. In connection with this, SEPA is directed to have regard to the following maximum doses which may result from a defined source, for use at the planning stage in radiation protection:

- a) 0.3 millisieverts per year from any source from which radioactive discharges are first made on, or after 13 May, 2000: or
- b) 0.5 millisieverts per year from the discharges from any single site.

Additionally, the Government accepts that, in general it should be possible to operate existing facilities within the 0.3 mSv per year constraint. The ICRP recommends a dose limit of 1 mSv per year to members of the public from all anthropogenic sources.

2 THE SURVEY

2.1 Site activity

The Rosyth nuclear site, formerly the Rosyth Royal Dockyard, is owned and operated by Babcock International Group plc. The dockyard used to support the Royal Navy's nuclear submarine fleet but many of the facilities associated with that work have been decommissioned. At the time of the survey the main activities at the dockyard included the construction and refurbishment of surface warships and the storage and monitoring of decommissioned nuclear submarines, pending decisions on their future disposal. The site incorporates the Rosyth Business Park and various premises are rented out to private businesses. The site discharges liquid radioactive waste via an outfall into the Firth of Forth and is authorised to discharge gaseous radioactive waste into the atmosphere. The site contains sources of direct radiation.

At the time of the survey there were three discrete nuclear licensed site areas within the Babcock site. Two of these had been decommissioned and may be de-licensed. The only remaining active licensed area was the Active Waste Accumulation Facility, which was located in the north-west of the site.

2.2 Survey aims

The Centre for Environment, Fisheries & Aquaculture Science (Cefas) undertook the survey on behalf of SEPA (Cefas contract C3745 and SEPA contract R90077PUR). The aim of the survey was to obtain information on the habits of the public that might lead them to be exposed to the effects of liquid discharges, gaseous discharges and direct radiation arising from the routine activities undertaken at the Rosyth nuclear site. The survey provided comprehensive information to ensure that all potential pathways were identified.

Specifically, investigations were carried out to ascertain the following:

- The consumption of food from the aquatic survey area
- Activities and occupancy over intertidal areas
- The handling of fishing gear and sediment
- Activities and occupancy in and on water
- The use of seaweed as human or animal food or use as a fertiliser
- The consumption of food from the terrestrial survey area
- The production, use and destination of local produce
- The consumption and use of groundwater and surface water in the terrestrial survey area
- The transfer of contamination off-site by wildlife
- Activities and occupancy within the direct radiation survey area

- Any new or unusual exposure pathways

No additional site-specific investigations were requested by SEPA.

2.3 Survey areas

Three survey areas were defined to encompass the main areas potentially affected by the discharges from the site and sources of radioactivity. These were an aquatic area relating to liquid discharges, a terrestrial area relating to deposition from gaseous discharges and a direct radiation area relating to ionising radiation emanating directly from the site.

The aquatic survey area (Figure 1) covered the Firth of Forth and its intertidal areas from Culross to Burntisland on the north shore and from Bo'ness to Granton on the south shore. Owing to the low amount of commercial and hobby fishing taking place within this area, the sea area for these activities was extended to include the waters up to the A876 road bridge at Kincardine in the west and up to a line between Kinghorn and Newhaven in the east. The aquatic survey area and the extended sea area used in this survey were the same as those used in the previous habits survey conducted by Cefas in the Rosyth area in 2005 (Tipple *et al.*, 2004).

Because two of the three nuclear licensed areas on the Rosyth site had been decommissioned, the terrestrial survey area and the direct radiation survey area were centred on the single remaining active nuclear licensed area, *i.e.* the Active Waste Accumulation Facility. The terrestrial survey area (Figure 2) covered all land within 5 km from the centre of the Active Waste Accumulation Facility (National Grid Reference NT 096 828) and the direct radiation survey area was defined as the area within 1 km of the centre of the Active Waste Accumulation Facility. The terrestrial survey area and the direct radiation survey area were slightly different from those used in the previous habits survey conducted in 2005 since for that survey the site centre was based on the positions of the three nuclear licensed areas.

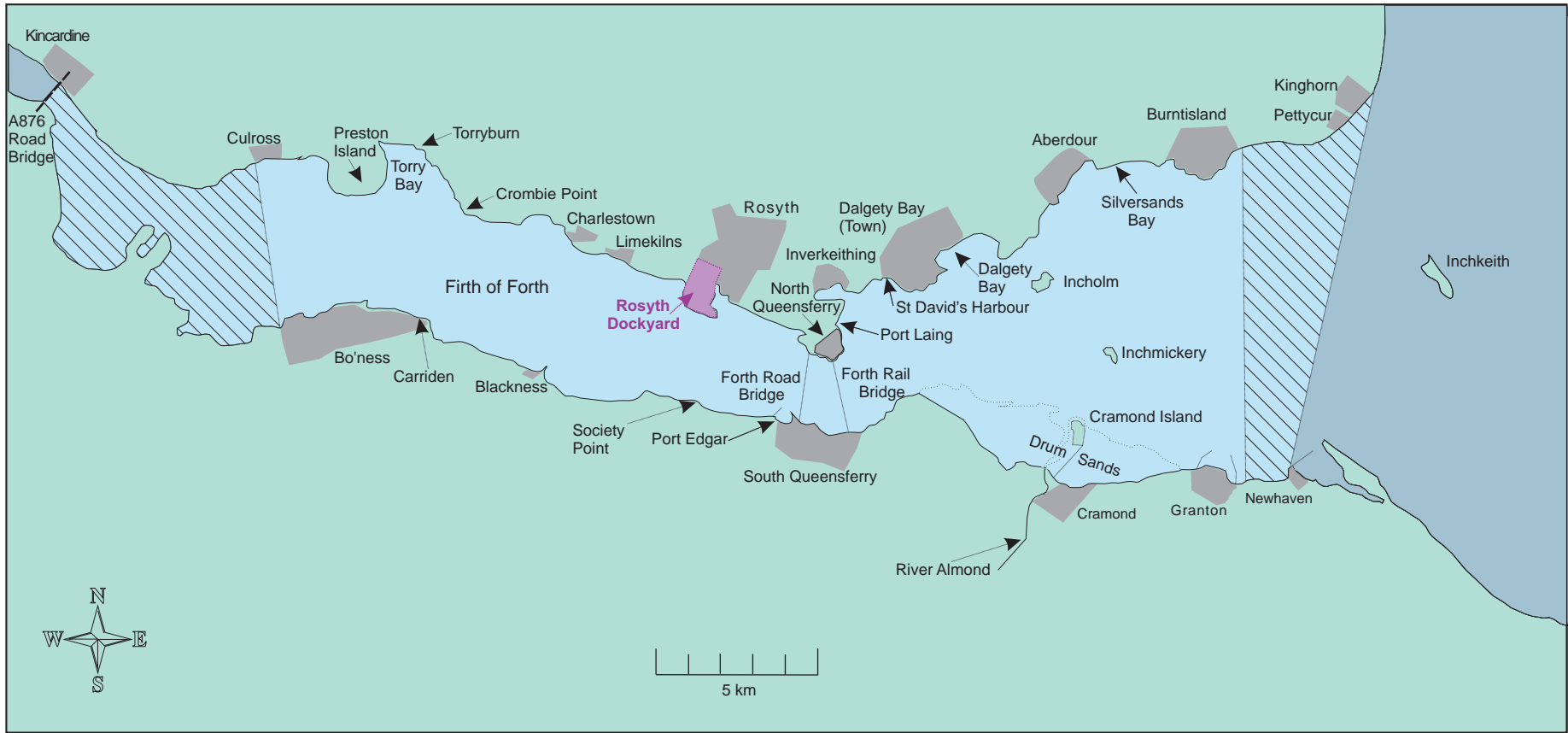


Figure 1. The Rosyth aquatic survey area

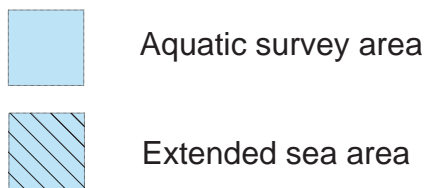




Figure 2. The Rosyth terrestrial (outer ring) and direct radiation (inner ring) survey areas.

- 1 Whirlbut allotments
- 2 Wemyss Road allotments
- 3 Admiralty Road allotments
- 4 Calais View allotments
- 5 Hope Street allotments

2.4 Conduct of the survey

As part of the pre-survey preparation, SEPA was contacted to identify any additional requirements. Information relating to the activities of people in the aquatic and terrestrial survey areas was obtained from internet searches, Ordnance Survey maps and from previous habits surveys undertaken at Rosyth. People with local knowledge of the survey area were contacted for information on any aspects relevant to the exposure pathways. These included representatives from Fife Council, local allotment sites and a beekeeping organisation. Prior to the fieldwork a proposed fieldwork programme was distributed to SEPA for their comment.

The fieldwork component of the survey was carried out during the period 26th July to 3rd August, 2010 by three members of staff from the Cefas laboratory at Lowestoft, according to techniques described by Leonard *et al.*, (1982). At the start of the fieldwork, a meeting was held between the survey team and Rosyth site representatives. These discussions provided details about current site activities, local information, potential pathways and activities in the area, and the potential transfer of contamination off-site by wildlife.

Interviews were conducted with individuals who were identified from the pre-survey preparation, or encountered during the fieldwork, that had the potential to be exposed to radioactivity from the site. These included, for example, fishermen, anglers, sailors, people carrying out activities on intertidal areas, farmers, gardeners, beekeepers and people living or working close to the site. Interviews were used to establish individuals' consumption, occupancy and handling rates relevant to the aquatic, terrestrial and direct radiation areas. Any general information of use to the survey was also obtained. Gamma dose rate measurements were taken over intertidal substrates in the aquatic area and were taken indoors and outdoors at most properties visited within the direct radiation area. Measurements of background gamma dose rates were taken at locations beyond 5 km from the site centre.

3 METHODS FOR DATA ANALYSIS

3.1 Data recording and presentation

Data collected during the fieldwork were recorded in logbooks. On return to the laboratory, the data were examined and any notably high rates were double-checked, where possible, by way of a follow-up phone call. In rare cases where follow-up phone calls were not possible (e.g. interviewees who wished to remain anonymous), the data were accepted at face value. 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 results of the individuals' consumption, occupancy and handling rates collected during the survey were grouped and presented in tables with the high-rate group members indicated in bold print and with the calculated mean rates for the high-rate group and 97.5th percentile rates noted at the foot of each table. The consumption rates, occupancy rates and handling rates for all groups are presented in Annex 1 for adults and Annex 2 for children and infants, with the high-rate group members indicated in bold print.

3.2 Data conversion

During the interviews, people could not always provide consumption rates in kilograms per year for food or litres per year for milk. In these circumstances, interviewees were asked to provide the information in a different format. For example, some estimated the size and number of items (e.g. eggs) consumed per year, whereas others gave the number of plants in a crop or the length and number of rows in which the crop was grown per year. These data were converted into consumption rates by the database using a variety of standard conversion factors. These factors included produce weights (Hessayon, 1997 and Good Housekeeping, 1994), edible fraction data researched by Cefas, and information supplied by the Meat and Livestock Commission.

3.3 Rounding and grouping of data

The consumption and occupancy data in the text of this report are rounded to two significant figures, except for values less than 1.0, which are rounded to one decimal place. This method of presentation reflects the authors' judgement on the accuracy of the methods used. In the tables and annexes, the consumption rate data are usually presented to one decimal place. Occasionally, this rounding process causes the computed values (row totals, mean rates and 97.5th percentiles), which are based on un-rounded data, to appear slightly erroneous. Consumption rates less than 0.05 kg y⁻¹ are

presented to two decimal places in order to avoid the value of 0.0 kg y⁻¹. External exposure data are quoted as integer numbers of hours per year.

The habits data are structured into groups of food items or substrate types with similar attributes. For example, when considering terrestrial food consumption, all types of root vegetables are grouped together in a food group called 'root vegetables'. Similarly, for aquatic food consumption, all crustacean species are grouped as 'crustaceans'. For external exposure over intertidal sediments, occupancies over the same substrate, such as sand, are grouped together. The typical food groups used in habits surveys are shown in Table 1.

Data were structured into age groups because different dose coefficients (i.e. the factors which convert intakes of radioactivity into dose) can apply to different ages. The International Commission on Radiological Protection (ICRP) revised its recommendations for the age groupings to be used in radiological assessments and these recommendations were adopted in the 2010 habits survey reports. Consequently, the age ranges used in the habits survey reports prior to 2010 differ from those used currently. The age ranges used in this report and the names used for the age groups, based on the recommendations in ICRP 101 (ICRP, 2007), are listed below, together with those used in reports prior to 2010, for comparison.

Age ranges used from 2010 onwards		Age ranges used in reports prior to 2010	
Name of age group	Age range in group	Name of age group	Age range in group
• Infant	0 to 5-year-old	• 3-month-old	Under 1-year-old
• Child	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 current regime, there should, in general, be more observations in each group, resulting in greater robustness in the data. However, data for children since 2010 will not be directly comparable with data for children prior to 2010, since the age ranges in the age groups will be different.

3.4 Approaches for the identification of high rates

The habits data have been analysed to indicate high rates of consumption, occupancy and handling, prior to a formal assessment being undertaken. Two approaches have been used:

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, intertidal substrate and handling pathway identified in the survey. In certain cases, using the 'cut-off' method resulted in only one person being in the high-rate group. In these cases, expert judgement was used to decide whether the high-rate group should remain as one individual or whether others should be included. If others were included, the second highest rate was divided by three and all observations above this were included in the high-rate group.

Secondly, 97.5th percentile rates were calculated using the Excel mathematical function for calculating percentiles. The use of percentiles accords with precedents used in risk assessment 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.

Mean and 97.5th percentile rates based on national statistics have been derived by the Ministry of Agriculture, Fisheries and Food (MAFF) (now part of Defra) and the Food Standards Agency (Byrom *et al.*, 1995 and FSA, 2002), and these are referred to as generic rates in this report. The observed rates can be compared with the generic rates.

For the direct radiation pathway, mean occupancy rates and 97.5th percentile rates have not been calculated. Such an analysis is of limited value without a detailed knowledge of the spatial extent of dose rates due to direct radiation.

3.5 Infant and child ratios for use in dose assessments

For ingestion pathways, mean rates for the high-rate groups for infants and children have been calculated from the survey data. However, because few infant and child observations were identified, the rates should be viewed with caution. For assessment purposes, an alternative approach may be taken which involves scaling the mean rates for the adult high-rate groups by ratios. These ratios are given in Table 2 and have been calculated using generic 97.5th percentile consumption rates. Note that the age ranges within the age groups in Table 2 do not correspond exactly with the age ranges within the age groups used throughout the rest of this report.

4 AQUATIC RADIATION PATHWAYS

4.1 Aquatic survey area

The aquatic survey area, shown in Figure 1, covered the Firth of Forth and its intertidal areas from Culross to Burntisland on the north shore and from Bo'ness to Granton on the south shore. Owing to the low amount of commercial and hobby fishing taking place within this area, the sea area for these activities was extended to include the waters up to the A876 road bridge at Kincardine in the west and up to a line between Kinghorn and Newhaven in the east. Since the intertidal regions of the extended sea area were not included in the survey they are not described below.

Firth of Forth north shore (west to east)

Culross, Torry Bay and Crombie Point

At Culross a railway line ran directly along the top of the shore and the stone faced railway embankment formed a sea wall. There were two large car parks on the landward side of the railway line. Access to the shore was only possible via a single pedestrian crossing over the railway line. The upper shore consisted of rocks and seaweed covered boulders, while the lower shore was mainly mud with scattered boulders. There was a derelict pier with three yachts and a speed boat moored close by at the time of the survey. No intertidal activities were observed taking place at Culross.

Preston Island formed a promontory separating Culross from Torry Bay to the east. At the head of Torry Bay there was a small car park at the village of Torryburn and there was easy access to the shore in this area. The upper shore at Torryburn was a narrow band of sand, sea coal dust, stones and boulders and several dog walkers were seen using this area. At low tide Torry Bay dried out to expose a large expanse of mud and boulders (see Figure 3). The area included small pockets of salt marsh and was part of a designated Local Nature Reserve, but wildfowling was permitted.

At the eastern end of Torry Bay there was a small car park and access to the shore at Crombie Point. One person was identified bait digging here. From Crombie Point eastwards towards Charlestown the substrate was mud, sand, boulders and patches of rocks but public access to the shore was prevented by the MoD base, RNAD Crombie.



Figure 3. Torry Bay

Charlestown, Limekilns and Rosyth

From Charleston to Limekilns and further east along the coast to the dockyard at Rosyth there was a series of small bays and the shore consisted of a mixture of rocky outcrops and patches of mud, sand and stones. There were narrow sand beaches on the upper shore in places. At Charlestown there was a small harbour and numerous small boats, mostly yachts and pleasure craft, were moored there. At low tide the harbour dried out and the boats rested on mud. The owners of one boat spent significant amounts of time on the boat in the harbour undertaking maintenance. There was a quay at Limekilns and approximately 25 sail boats were moored close by. The activities noted in the Limekilns area were dog walking, walking, paddling, playing and rock pooling. During the survey, two individuals were interviewed who had collected seaweed from Charlestown and Limekilns to use as fertiliser on their vegetable gardens.

At Rosyth the shoreline was occupied by the quays of the dockyard and the adjacent commercial port, which included a ferry terminal. One part time commercial creel fishing boat was based in the port at Rosyth.

North Queensferry, St David's Harbour and Dalgety Bay

North Queensferry was located at the tip of a peninsula to the east of Rosyth. Most of the upper shore was rocks, boulders and stones, with expanses of mud and seaweed covered rocky outcrops on the lower shore, which were exposed at low tide. There was a small beach of sand and stones directly to the west of the Forth Rail Bridge. The activities identified taking place on the shore in the area were dog walking, collecting seaweed, playing and beachcombing. Two piers, each with slipways, were situated between the Forth Road Bridge and the Forth Rail Bridge. High speed adventure boat trips were offered to the public on an inflatable craft operating from one of the piers and a boat club operated from the other pier. Approximately 70 boats were affiliated to the club, mainly sailing yachts, but also motor cruisers and angling boats. Some of the boats were kept in a boatyard on the pier while others, which were moored at a small jetty or in the sheltered waters between the two piers, rested on mud at low water. Two people were identified spending significant amounts of time renovating a boat that rested on mud for much of the time and other people were identified fixing moorings from boats. To the northeast of the rail bridge there was a small harbour, which was home to a few small pleasure craft.

Further north on the east side of the peninsular was Port Laing, which was a small sandy beach with stones and boulders at either end. The beach was accessed via a footpath down a cliff and the only activity identified taking place on the beach was dog walking. One individual reported that they collected winkles from the rocky shore to the north of Port Laing.

At Inverkeithing there was an inlet that dried out to expose mud flats at low tide. Access to the shore was limited as the area was industrial and much of it was fenced off. No intertidal activities were identified taking place in the area at the time of the survey.

Further to the east, St David's Harbour appeared to be disused, although it was reported that yachts moored there occasionally. There was a bay on either side of the harbour. The bay to the west of the harbour was backed by sea defence boulders. Both bays were sand and stones on the upper shore with mud and areas of seaweed covered rocks and boulders exposed on the lower shore at low tide (see Figure 4). The bays were easily accessible from nearby residential areas and were popular with visitors. The activities recorded at the west bay included dog walking and playing, and at the east bay included dog walking, bait digging, collecting winkles and rock pooling. There were two other similar small bays between rocky headlands further east towards Dalgety Bay but they were not as easy to access and no activities were observed taking place at the time of the survey.



Figure 4. Bay to the east of St David's Harbour

At the rocky headland at the western end of Dalgety Bay there was a small natural harbour with a sailing club nearby whose members were mostly dinghy sailors. There were slipways at the harbour and at the sailing club and approximately 25 pleasure boats were anchored offshore at the time of the survey. A family was identified crabbing on the rocks near the sailing club. The upper shore of Dalgety Bay was a thin strip of sand and stones but at low tide most of the bay dried out to reveal a large expanse of mud, sand and stones. A path above the intertidal area ran around the bay, and this was the preferred route for walkers and dog walkers rather than on the intertidal area. Notices warned the public not to remove any materials from the shore, including bait and seafood, because radioactive contamination (originating from old aircraft dismantled at a former airfield nearby) had been found on the beach.

The headland to the east of Dalgety Bay was occupied by an oil terminal and further east towards Aberdour were two small bays that were difficult to access.

Aberdour, Silversands Bay and Burntisland

In the bay at Aberdour there was a harbour with a stone pier and slipway. There were approximately 40 yachts and motor boats moored in the harbour or just offshore at the time of the survey. The shore of the bay was predominantly rocks and boulders but also incorporated a small sand beach. The beach was easily accessible from the town and was popular with local families who were observed

playing, walking and dog walking. Silversands Bay was situated on the eastern side of a rocky promontory to the east of the harbour. There was a large sandy beach at the head of the bay with mud and sand on the lower shore and rocks and boulders at either end (see Figure 5). There was car parking close by and this beach was popular with visitors, who were playing on the beach and paddling. Dog walkers were discouraged from walking their dogs on the sand but this was not prohibited. The beaches at Aberdour and at Silversands were both cleaned regularly by council workers.



Figure 5. Silversands Bay

A rocky stretch of shore, where no activities were observed, extended eastwards from the beach at Silversands Bay towards Burntisland Docks. The docks included two inner basins, used by commercial shipping, and an outer harbour where approximately 20 yachts and six pleasure boats were moored at the time of the survey. A commercial creel fishing boat that fished within the survey area and a larger trawler that fished outside the survey area were also based here. A yacht club was situated near the entrance of the outer harbour and a sub-aqua diving school had premises close by. Angling was very popular from the pier and breakwater to the eastern side of the harbour.

There was a small rocky promontory at the eastern end of the breakwater and to the east of this a large expanse of mud and sand was exposed at low water. These mud and sand flats were very popular with bait diggers, who mainly collected lugworm and ragworm. Cockles and razor clams were also collected from the area for use as angling bait but razor shells inhabited areas very low on the shore and could only be collected on low spring tides. In front of the town of Burntisland there was a

narrow strip of fine sand beach with patches of coal dust, backed by a concrete promenade. The beach was cleaned using a tractor rake to collect washed up seaweed and this area was very popular with families who were playing and paddling. Dog walking was prohibited on the sandy part of the beach but was allowed on the flats of mud and sand below. There was a public slipway nearby which was used by people launching jet skis and small leisure craft.

Firth of Forth south shore (west to east)

Bo'ness and Blackness

The shore at Bo'ness was mud, sand and stones and although there was access to the shore at several locations, people were observed walking and dog walking along the footpaths that were not tide washed rather than on the shore. The harbour at Bo'ness, which appeared disused at the time of the survey, was tidal and dried out at low tide leaving a large area of exposed mud. The only activity identified in the harbour area was angling from the eastern pier (see Figure 6). A member of a wildfowling club was noted shooting on the mud and stones shore to the west of the harbour. There was a small boat club based to the east of the harbour in Bo'ness and another small boat club based at Carriden on the eastern edge of Bo'ness. There was access to the shore at Carriden where the substrate was mud, sand and stones backed by a strip of sand. Dog walking was noted to occur at this location.



Figure 6. Bo'ness

The shore between Carriden and Port Edgar for the most part comprised a strip of sand or sand and stones on the upper shore, mud, sand, stones and occasional rocks on the mid shore and large areas of mud flats on the lower shore. Access to the shore within this area was limited to tracks and footpaths except at Blackness and between Society Point and Port Edgar where there was road access and parking. The only activities observed or noted were at Blackness where people were dog walking and children were playing on the sandy beach and wildfowling was taking place on the mud and stones. There was a small boat club based at Blackness whose members participated in yacht racing in the Firth of Forth and cruising further afield.

Port Edgar and South Queensferry

Port Edgar was a large marina located to the west of the Forth Road Bridge in South Queensferry. The marina had a slipway and approximately 300 berths where sail boats and motor boats were moored. Several organisations were based at Port Edgar; these included the Sea Cadets, a sailing school, HMS Coastguard, and a yacht club which had approximately 200 members. A commercial creeler was based in the marina and sea angling trips were offered to the eastern survey area. Other activities undertaken by people based at the marina included sailing, power-boating, rowing, canoeing and boat angling.

The town of South Queensferry was popular with tourists. Most of the intertidal activities took place between the Forth Road Bridge and the Forth Rail Bridge where the shore comprised mud, sand, stones and rock, with a strip of stones on the upper shore. People were identified rock pooling, dog walking and bait digging on the shore in this area. There was a small tidal harbour at South Queensferry that dried out at low tide and approximately 30 leisure yachts were moored there at the time of the survey. To the east of the harbour was a pier that sloped down into the water and was also used as a slipway. The RNLI were based at the pier and several vessels operated from the pier including two pleasure boats providing cruises around the Firth of Forth and a ferry that took workers to an oil terminal located approximately 1.5 km east of the Forth Rail Bridge.

To the east of the Forth Rail Bridge there was small sailing club with a slipway. The land bordering the shore between the Forth Rail Bridge and Cramond was part of a country estate and a coastal walk through the estate's land provided public access to the shore. No intertidal activities were observed taking place there at the time of the survey.

Cramond and Granton

The village of Cramond was located to the east of the River Almond. A sailing club was based near the mouth of the river and there were approximately 60 sail boats moored in the river at the time of the survey. The upper shore at Cramond was a strip of sand with stones and at low tide there was a vast expanse of mud and sand called Drum Sands which extended approximately 1.5 km offshore.

There was a causeway that led from Cramond to Cramond Island across Drum Sands (see Figure 7). Activities at Cramond were taking place to the east of the causeway on the upper and lower shore and this area was popular with dog walkers, beachcombers and families playing. Bait digging and horse riding were also noted to take place on the shore. Mussels and winkles were observed along the causeway, although no one was identified collecting them during the survey. Notices warned the public not to consume shellfish collected from the shore in this area because of possible bacterial contamination. The shore at Cramond Island was mainly rocky and although many people walked along the causeway to the island, the only people noted spending time on the shore were anglers.



Figure 7. Drum Sands and the causeway, viewed from Cramond Island

To the east of Drum Sands there was access to the sand and stones shore on the western side of Granton Harbour, although no one was observed in this area at the time of the survey. A large part of Granton Harbour was being re-developed for residential and commercial use and a new marina was planned. Two yacht clubs were based in the harbour and approximately 60 sailboats were observed in the harbour at the time of the survey. No commercial fishing vessels were identified. The eastern breakwater at Granton Harbour was popular with anglers, particularly fishing for mackerel in the summer months. There was a small sandy beach on the south side of the harbour but no activities were observed taking place there at the time of the survey. As at Cramond, notices warned the public not to consume shellfish collected from the shore in this area because of possible bacterial contamination.

4.2 Commercial fisheries

Very little commercial fishing took place within the aquatic survey area and the extended sea area. Four small commercial fishing vessels were identified and these operated either on a part-time basis, or were full time but only fished within the survey area for part of the time. They were based at Rosyth, Burntisland, Port Edgar and Newhaven. All the boats were used for creel fishing and, weather permitting, were operated throughout the year. They fished primarily for brown crabs (*Cancer pagurus*) and common lobsters (*Homarus gammarus*) although three of the boats also occasionally fished for velvet swimming crabs (*Necora puber*) and one also landed a by-catch of whelks (*Buccinum undatum*).

The fisherman at Burntisland also operated a small trawler targeting Norway lobsters (*Nephrops norvegicus*) but this fished well outside the survey area, further to the east.

4.3 Seafood wholesalers and retailers

Most of the crustaceans and whelks were sent to wholesalers and distributors based outside the survey area. The majority of the catch was then exported, particularly to France and Spain. Additionally, part of the catch of brown crabs and common lobsters was sold through the market at Newhaven to supply retail outlets in Edinburgh and brown crabs were periodically sent to processors in Eyemouth.

4.4 Angling, hobby fishing and shellfish collecting

The term 'hobby fishing' is used here to denote fishing on a small scale for recreational purposes with fishing gear such as creels and nets. The boats used for hobby fishing are usually not licensed for commercial fishing and therefore the fishermen are not permitted to sell their catch. Hobby fishing boats were identified operating from Kincardine, Pettycur and Kinghorn. The fishermen mainly used creels to fish for brown crabs and common lobsters, which were consumed by their families and friends. One fisherman at Kincardine held a licence to fish for salmon (*Salmo salar*) with a sweep net, but he no longer fished commercially and now only fished on a hobby basis. The catch of salmon was consumed by his family and acquaintances.

Recreational boat anglers were identified operating from Charlestown, Port Edgar, Burntisland slipway and Kinghorn, and a commercial creel fisherman based at Port Edgar also used his boat for chartered angling trips in the Firth of Forth. The east breakwater at Burntisland Docks and the east pier at Granton Harbour were popular shore angling locations and angling also took place from the rocks at Cramond Island. Angling was carried out all year but was most popular in the summer months. The main species caught and consumed were mackerel (*Scomber scombrus*) during the

summer and cod (*Gadus morhua*) during the winter. A few bass (*Dicentracus labrax*) and pollack (*Pollachius pollachius*) were also caught and eaten.

A few people collected winkles (*Littorina littorea*) from the shore for their own consumption. Winkle collecting was identified taking place in the bay to the east of St David's Harbour and on the eastern shore of the North Queensferry peninsular to the north of Port Laing. At Burntisland one individual was identified collecting razor clams and another identified collecting cockles, both for use as angling bait. Notices at Cramond and at Granton warned the public not to collect shellfish from the shore in these areas because of potential bacterial contamination and notices at Dalgety Bay advised the public not to collect seafood from the shore because of possible radioactive contamination arising from operations to dismantle old aircraft at a former airfield close by.

4.5 Wildfowling

A member of one wildfowling club was identified shooting at Bo'ness and Blackness over areas of firm mud, although the club's main shooting grounds were outside the survey area to the west of Bo'ness. It was reported that six people participated in wildfowling at Blackness and that approximately 30 birds per season were shot. One wildfowler, who was not a member of a club, was shooting at Torry Bay over mud. The species of wildfowl shot in the survey area and consumed were wigeon, mallard, pink-footed goose and teal.

4.6 Other pathways

Three people were identified collecting seaweed, mainly bladder wrack (*Fucus vesiculosus*), from the shore at North Queensferry, Limekilns and Charlestown to use as a fertiliser on their allotment plots. This fertiliser was only applied to soil where potatoes and onions were grown and these were consumed by eight people.

The use of seaweed for animal feed was not identified. It was reported that there were small areas of salt marsh in the Torry Bay Local Nature Reserve but no livestock were identified grazing on salt marsh in the survey area.

4.7 Internal exposure

Consumption data for foods from the aquatic survey area are shown in Tables 3 to 6 for adults. Adult's consumption data for vegetables grown in soil that had been fertilised with seaweed are shown in Table 7. Consumption data for foods from the aquatic survey area are shown in Tables 8 and 9 for children and infants.

Adults' consumption rates

The main consumers of seafood from the aquatic survey area were commercial fishermen, hobby fishermen, anglers, non-commercial shellfish collectors, wildfowlers and their families.

Table A presents a summary of the consumption rates for fish, crustaceans, molluscs and wildfowl from the aquatic survey area. No consumption of marine plants/algae was identified. The table includes the mean consumption rates for the high-rate groups and the observed 97.5th percentile rates. For comparison, the table also includes mean consumption rates and 97.5th percentile consumption rates based on national data, which are referred to as 'generic' data in this report.

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

Food group	Number of observations	Number of people 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 97.5 th percentile (kg y ⁻¹)	Generic mean (kg y ⁻¹)	Generic 97.5 th percentile (kg y ⁻¹)
Fish	56	8	35.0	12.5	17.0	19.7	15.0	40.0
Crustaceans	17	10	7.8	2.9	4.6	7.5	3.5	10.0
Molluscs	5	4	5.8	5.8	5.8	5.8	3.5	10.0
Wildfowl	5	3	8.3	3.0	4.8	7.7	ND	ND

Notes

ND = not determined

The predominant species of fish consumed by adults were mackerel and cod. Smaller quantities of bass, pollack and salmon were also consumed. These fish were mainly caught from Burntisland breakwater and Granton pier, but also off Kincardine, off Kinghorn, at Cramond Island, and in the waters between North Queensferry and South Queensferry. Of the fish consumed by the eight people in the high-rate group, the percentage breakdown of species was 69% mackerel and 31% cod.

The predominant species of crustacean consumed by adults were brown crab and common lobster. These were caught off Rosyth, off Burntisland, near islands in the eastern survey area, off Kinghorn and in the waters between North Queensferry and South Queensferry. Of the crustaceans consumed by the 10 people in the high-rate group, the percentage breakdown of species was 66% brown crab and 34% common lobster.

The only species of molluscs consumed by adults was winkles, which were collected from the bay to the east of St David's Harbour and from the shore to the north of Port Laing on the North Queensferry peninsular.

The predominant species of wildfowl consumed by adults were wigeon, mallard, pink-footed goose, and teal. These were shot at Torry Bay, Blackness and Bo'ness. Of the wildfowl consumed by the three people in the high-rate group, the percentage breakdown of species was 41% wigeon, 32% mallard, 19% pink-footed goose and 8% teal.

Adults' consumption rates of onions and potatoes grown in seaweed fertilised soil are presented in Table 7. These foods are included in the aquatic section of this report as the exposure pathway is sea to land transfer and the source of potential exposure is liquid discharges from Rosyth. These foods were grown in the terrestrial survey area and they are also potentially subject to gaseous discharges. Therefore, they are also included in the terrestrial food groups and are included once in Annex 1 as terrestrial foods.

Children's and infants' consumption rates

Table B presents a summary of children's and infants' consumption rates of fish and crustaceans from the aquatic survey area. The table includes the mean consumption rates for the high-rate groups and the observed 97.5th percentile rates. For the child age group, no consumption of crustaceans, molluscs, wildfowl or marine plants/algae was identified. For the infant age group, no consumption of molluscs, wildfowl or marine plants/algae was identified. The age group names and their relevant age ranges are listed in Section 3.3.

Table B. Summary of children's and infants' consumption rates of foods from the aquatic survey area

Food group	Number of observations	Number of people 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 97.5 th percentile (kg y ⁻¹)
Child age group (6 – 15 years old)						
Fish	11	5	9.9	3.8	6.7	9.9
Infant age group (0 – 5 years old)						
Fish	2	2	3.1	2.4	2.8	3.1
Crustaceans	1	1	1.5	1.5	1.5	NA

Notes

NA = not applicable

The species of fish consumed by the child age group were mackerel and cod, which were caught at Granton pier, Burntisland breakwater, and in the waters between North Queensferry and South Queensferry. The percentage breakdown of fish species consumed by the high-rate group was 90% mackerel and 10% cod.

The species of fish consumed by the infant age group were mackerel and cod, which were caught at Granton pier. The percentage breakdown of fish species consumed by the high-rate group was 95% mackerel and 5% cod.

The species of crustaceans consumed by the infant age group were brown crab and common lobster, which were caught between North Queensferry and South Queensferry. The percentage breakdown of crustacean species consumed by the high-rate group was 53% common lobster and 47% brown crab.

4.8 External exposure

Intertidal occupancy

Intertidal occupancy rates for adults are presented in Table 10 and intertidal occupancy rates for children and infants are presented in Table 11. 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.

Adults' intertidal occupancy rates

Intertidal activities identified for adults included bait digging, wildfowling, angling, walking, dog walking, beach cleaning, boat maintenance, beachcombing, rock pooling, crabbing, playing and collecting seaweed, winkles, cockles, razor clams and stones.

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

Table C. Summary of adults' intertidal occupancy rates					
Intertidal substrate	Number of observations	Number of people in the high-rate group	Maximum of the high-rate group (h y⁻¹)	Mean of the high-rate group (h y⁻¹)	97.5th percentile (h y⁻¹)
Mud	2	1	95	95	93
Mud and sand	25	2	548	514	507
Mud, sand and stones	2	1	39	39	38
Rock	13	8	60	48	60
Sand	43	9	248	141	221
Sand and stones	8	1	351	351	308
Stones	1	1	1	1	Not applicable
Boat on mud	4	4	507	494	507

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

- For mud: wildfowling at Torry Bay
- For mud and sand: dog walking at Cramond and Burntisland
- For mud, sand and stones: dog walking at South Queensferry
- For rock: collecting winkles in the bay to the east of St David's Harbour, rock pooling in the bay to the east of St David's Harbour and at Cramond, and angling at Cramond Island
- For sand: dog walking at Cramond, Aberdour, North Queensferry, Limekilns and the bay to the west St David's Harbour, playing at Cramond, and walking at Limekilns
- For sand and stones: dog walking at Blackness
- For stones: collecting seaweed at North Queensferry
- For boats resting on mud: boat maintenance at North Queensferry and Charlestown Harbour

Children's and infants' intertidal occupancy rates

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

Table D. Summary of children's and infants' intertidal occupancy rates					
Intertidal substrate	Number of observations	Number of 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)
Child age group (6 - 15 years old)					
Mud, sand and stones	4	2	39	39	39
Rock	3	3	12	10	12
Sand	16	1	248	248	172
Sand and stones	2	1	15	15	15
Infant age group (0 - 5 years old)					
Mud and sand	1	1	36	36	Not Applicable
Rock	3	3	50	45	50
Sand	11	3	144	81	121
Sand and stones	2	1	15	15	15

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

- For mud, sand and stones: rock pooling at South Queensferry
- For rock: crabbing at Dalgety Bay and playing at Aberdour and Limekilns
- For sand: playing and dog walking at Cramond
- For sand and stones: collecting stones at Cramond

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

- For mud and sand: bait digging in the bay to the east of St David's Harbour
- For rock: rock pooling at Cramond and in the bay to the east of St David's Harbour
- For sand: dog walking at Aberdour, North Queensferry and Limekilns, and playing at Cramond
- For sand and stones: collecting stones at Cramond

Gamma dose rate measurements

Gamma dose rate measurements were taken over intertidal substrates to supplement those of SEPA's scheduled monitoring programme. The results are presented in Table 12 and are summarised below.

- One measurement taken over mud was $0.062 \mu\text{Gy h}^{-1}$
- Four measurements taken over mud and sand ranged from $0.050 \mu\text{Gy h}^{-1}$ to $0.076 \mu\text{Gy h}^{-1}$
- Four measurements taken over sand ranged from $0.052 \mu\text{Gy h}^{-1}$ to $0.074 \mu\text{Gy h}^{-1}$
- One measurement taken over sand and stones was $0.058 \mu\text{Gy h}^{-1}$

Handling fishing gear and sediment

Handling fishing gear that has become entrained with fine sediment particles, or handling sediment while undertaking activities such as bait digging or mollusc collecting, can potentially give rise to skin exposure from beta radiation. Doses to the skin need consideration, as there is a separate dose limit for skin for members of the public. There is also a contribution to effective dose due to skin exposure (ICRP, 1991). The handling of angling equipment was not considered to be a significant pathway since angling equipment does not generally become entrained with sediment. Therefore, as in previous surveys, data for this pathway were not collected.

Table 13 presents the adults' handling rates of fishing gear and sediment recorded during the survey and Table 14 presents the children's and infants' handling rates of sediment. No children or infants were identified handling fishing gear.

Adults' handling rates of fishing gear and sediment

The activities for adults involving handling fishing gear included handling creels and handling sweep nets. Activities for adults involving sediment handling included fixing moorings, bait digging, wildfowling, collecting shellfish and collecting seaweed.

Table E presents a summary of the handling rates of fishing gear and sediment for adults. The table includes the mean handling rates for the high-rate groups and the observed 97.5th percentile rates.

Handling activity	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)	97.5 th percentile (h y ⁻¹)
Handling fishing gear	14	3	1280	943	1205
Handling sediment	30	6	240	154	240

The people in the adult high-rate group for handling fishing gear were all handling creels and this took place off Burntisland, off Pettycur and in the central part of the survey area. The activities undertaken by the people in the high-rate group for handling sediment were fixing moorings at North Queensferry, bait digging at Burntisland and wildfowling at Torry Bay. Most of the fishermen wore gloves when handling creels while fishing but did not wear gloves when handling creels to repair them. Most of the bait diggers did not wear gloves and those that did wear them were using knitted nylon gloves which allowed sediment to pass through the fabric and contact the skin. The wildfowler at Torry Bay spent much of his time lying or kneeling in the mud and often did not wear gloves.

Children's and infants' handling rates of sediment

Table F presents a summary of the handling rates of sediment for individuals in the child and infant age groups. The table includes the mean handling rates for the high-rate groups and the observed 97.5th percentile rates.

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)	97.5 th percentile (h y ⁻¹)
Child age group (6 – 15 years old)				
4	2	12	12	12
Infant age group (0 – 5 years old)				
1	1	36	36	Not applicable

The activity undertaken by the individuals in the child age group high-rate group for handling sediment was crabbing at Dalgety Bay. The activity undertaken by the only individual in the infant age group was bait digging. This individual was 5 years old and was bait digging with his grandfather in the bay to the east of St David's Harbour.

Water based activities

Activities taking place in or on the water can potentially lead to ingestion of water and/or inhalation of spray. These pathways are generally considered to be minor in comparison with other exposure pathways such as the ingestion of foods produced in the vicinity of a nuclear site. However, relevant data have been collected for consideration in dose assessments. Mean occupancy rates and 97.5th percentile rates have not been calculated. Activities where there is a high potential of the individual's face submersing under the water have been classified as activities 'in water' since they are likely to lead to ingestion of water. All other activities have been classified as activities 'on water'. Occupancy rates for activities taking place 'in water' and 'on water' in the survey area for adults are presented in Tables 15 and occupancy rates for activities taking place 'in water' and 'on water' for children and infants are presented in Table 16.

Activities taking place in the water around Rosyth included sub-aqua diving and jet skiing. Eight observations were recorded for adults and children with occupancy in the water. The highest occupancy rate in water for adults was 170 h y⁻¹ for a person who was sub-aqua diving at various locations within the survey area including wrecks off Burntisland and Dalgety Bay. The highest occupancy rate in water for the child age group was 90 h y⁻¹ for an individual who was sub-aqua diving at the same locations as the adult with the highest occupancy rate. No individuals in the infant age group were identified spending time in the water.

Activities taking place on the water in the survey area included creeling, angling, boat maintenance, fixing moorings, sailing, canoeing, rowing, power boating, coastguard duties, being on a dive boat, skippering a charter boat, safety boat duties, salmon sweep netting and paddling. Eighty observations were recorded for adults, children and infants. The highest occupancy rate on water for adults was 1600 h y⁻¹ for a commercial creel fisherman operating off Burntisland. The highest occupancy rate on water for the child age group was 560 h y⁻¹, for an individual who was on a dive boat at various locations within the survey area including wrecks off Burntisland and Dalgety Bay, and the highest occupancy rate on water for the infant age group was 10 h y⁻¹, for an individual who was sailing with their parents off Dalgety Bay.

5 TERRESTRIAL RADIATION PATHWAYS

5.1 Terrestrial survey area

The terrestrial survey area is shown in Figure 2. The survey area was split into two by the Firth of Forth and a significant proportion of the land was covered by the built-up areas of Dunfermline, Rosyth and other smaller towns. Six working farms were identified on the north side of the Firth of Forth and one of these was a large enterprise that farmed most of the agricultural land in the northwest and some of the agricultural land in the east of the survey area. Farming on the north side of the Firth of Forth was predominantly arable with a small amount of beef cattle and one farm produced chicken eggs for rearing. On the south side of the Firth of Forth a country estate and three tenant farms were identified, which produced beef, lamb and arable crops. Game, including deer, pheasants, rabbits and pigeons were shot on the estate.

The crops grown in the survey area were potatoes, broccoli, oil seed rape, field beans, wheat, barley and oats. Broccoli was sold to a national supermarket chain. Potatoes, oats, wheat and oil seed rape were sold to national wholesalers for the human food chain and barley was sold outside the area for use in whisky production. Field beans and barley were sold to national merchants for use in animal feeds and a small amount of barley was used for winter animal feed at farms within the area. A small amount of potatoes was sold directly to the public from one farm. Beef cattle were sold through Stirling market. A small amount of lamb was sold to the public from a farm shop but most sheep were sold outside the survey area. Chicken eggs were sold to hatcheries outside the survey area. Deer, pheasants, rabbits and pigeons from the estate were sold to a game dealer outside the survey area. Farmers and their families were consuming potatoes, broccoli, beef and lamb produced on their own farms.

Five allotment sites were identified in the survey area and their locations are shown in Figure 2. They varied in size between approximately five and 50 plots. Interviews were mainly conducted at the Admiralty Road allotments, which was the largest and most active site and was also the closest allotment site to the Rosyth nuclear site. The allotment holders grew a large variety of vegetables and fruit, which were consumed by their families and friends. Vegetables and fruit were also grown in the gardens of private houses.

Two beekeepers were identified with hives in the survey area near Dunfermline. One beekeeper had four hives and the other beekeeper had five hives. The honey produced per hive ranged from 6 kg y⁻¹ to 10 kg y⁻¹. All the honey produced was consumed by the beekeepers and their families and none was sold.

The consumption of wild foods from within the survey area was limited to small amounts of blackberries and wild garlic. Pheasant and deer shot on farmland in the area were also consumed.

The human consumption of groundwater was not identified. All livestock were supplied with mains water for drinking but some also had access to stream or ditch water.

The transfer of contamination off-site by wildlife was investigated as radionuclides could enter the food chain or contaminate the environment through this pathway. A representative from the Rosyth site reported that rabbits had been observed inside the perimeter fence of the Active Waste Accumulation Facility but that they could not gain access to the active area inside the building, which was the only active area on the site. Similarly, seagulls that flew around the site could not access the active area. Any seagulls eggs found anywhere on the site were disturbed in order to discourage the birds from nesting in the area. No routine culling or monitoring of wildlife found on site was undertaken.

5.2 Land cover

Figure 8 shows the soil types in the area around the Rosyth site. The figure is reproduced from a land cover map produced by Macaulay Land Use Research Institute, with their consent.

Approximately one third of the land in the terrestrial survey area was non-agricultural. The majority of the agricultural land in the terrestrial survey area was classified as Class 2 and Class 3₁. Class 2 soil is capable of producing a wide range of crops with high yield. The land may be unsuited to winter harvested crops. Class 3₁ soil is capable of producing good yields of a narrow range of cereal crops or moderate yields of a wider range of crops, including some vegetable crops, potatoes and oil seed rape.

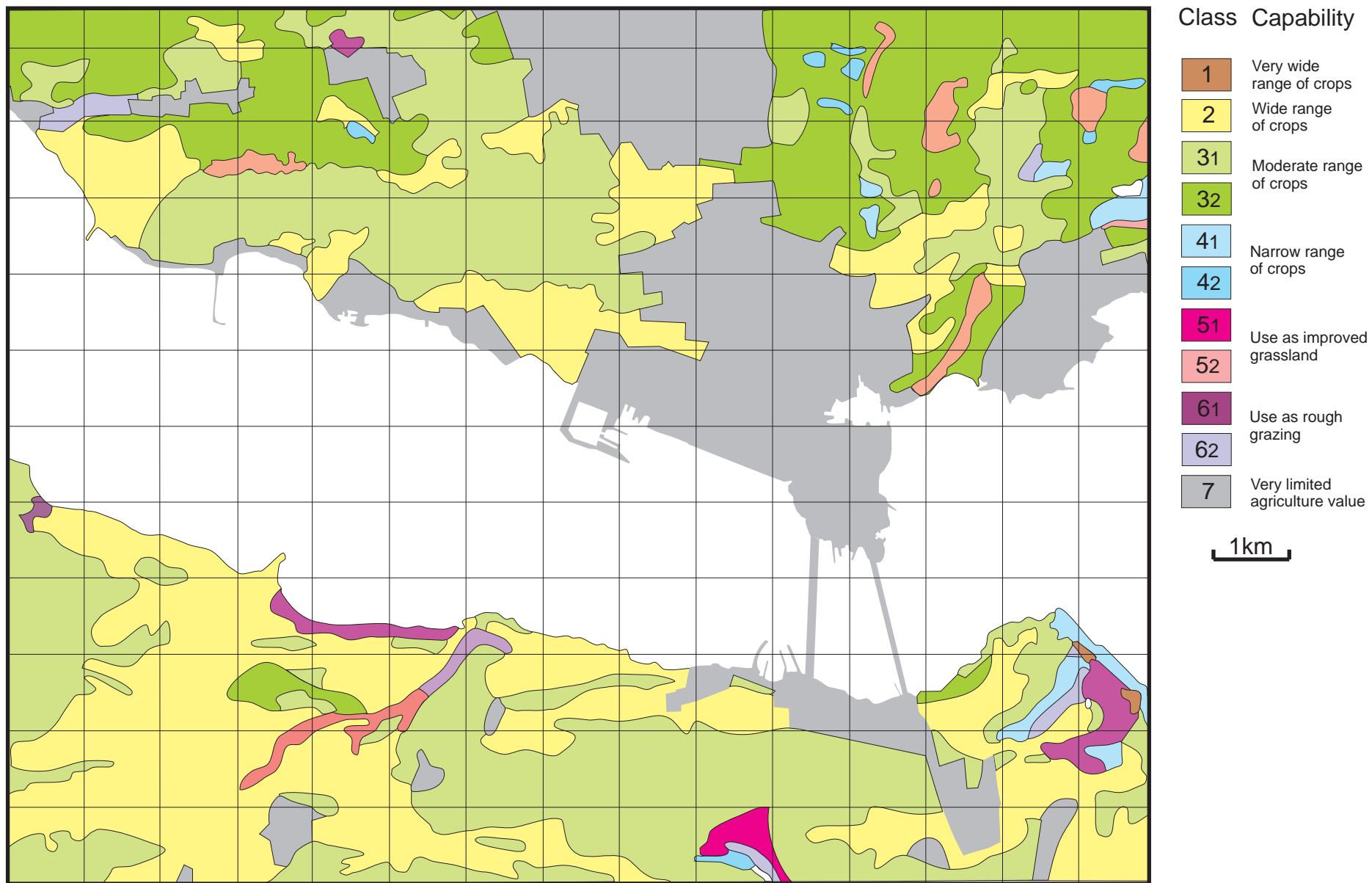


Figure 8. Soil types around the Rosyth site

Reproduced with the permission of The Macaulay Institute for Soil Research, Aberdeen.

Base scale is 1:50000

5.3 Internal exposure

Consumption data for locally produced foodstuffs potentially affected by gaseous discharges are presented in Tables 17 to 27 for adults and Tables 28 to 33 for children and infants.

Adults' consumption rates

Table G presents a summary of the consumption rates for the foods consumed from the terrestrial survey area for adults. The table includes the mean consumption rates for the high-rate groups and the observed 97.5th percentile rates. For comparison, the table also includes mean consumption rates and 97.5th percentile consumption rates based on national data, which are referred to as 'generic' data in this report.

Consumption of locally produced foods was identified in the following 11 food groups: green vegetables, other vegetables, root vegetables, potato, domestic fruit, cattle meat, sheep meat, poultry, wild/free foods, honey and venison. No consumption was identified for locally produced milk, pig meat, eggs, rabbits/hares, wild fungi or freshwater fish.

Table G. Summary of adults' consumption rates of foods from the terrestrial survey area

Food group	Number of observations	Number of people in the high-rate group	Observed maximum for the high-rate group (kg y ⁻¹ or l y ⁻¹)	Observed minimum for the high-rate group (kg y ⁻¹ or l y ⁻¹)	Observed mean for the high-rate group (kg y ⁻¹ or l y ⁻¹)	Observed 97.5 th percentile (kg y ⁻¹ or l y ⁻¹)	Generic mean (kg y ⁻¹ or l y ⁻¹)	Generic 97.5 th percentile (kg y ⁻¹ or l y ⁻¹)
Green vegetables	38	11	63.2	21.9	39.2	63.2	15.0	45.0
Other vegetables	38	5	66.2	33.0	41.2	39.0	20.0	50.0
Root vegetables	39	13	71.3	24.6	45.6	71.3	10.0	40.0
Potato	29	11	120.0	46.0	73.4	120.0	50.0	120.0
Domestic fruit	31	4	78.8	44.5	60.6	75.6	20.0	75.0
Cattle meat	2	2	47.3	47.3	47.3	47.3	15.0	45.0
Sheep meat	10	10	7.9	7.9	7.9	7.9	8.0	25.0
Poultry	2	2	1.4	1.4	1.4	1.4	10.0	30.0
Wild/free foods	6	3	0.7	0.7	0.7	0.7	7.0	25.0
Honey	5	5	9.6	8.3	8.8	9.6	2.5	9.5
Venison	1	1	0.7	0.7	0.7	NA	ND	ND

Notes

ND = not determined

NA = not applicable

Two observed mean consumption rates for the high-rate groups were found to be greater than the generic 97.5th percentile consumption rates. These were for root vegetables and cattle meat. Seven observed mean consumption rates for the high-rate groups exceeded the generic mean consumption rates. These were for green vegetables, other vegetables, root vegetables, potato, domestic fruit, cattle meat and honey. Five observed 97.5th percentile consumption rates exceeded the generic 97.5th percentile consumption rates. These were for green vegetables, root vegetables, domestic fruit, cattle meat and honey. There are currently no generic consumption data available for venison so no comparisons can be made.

The percentage contribution each food type makes to its terrestrial food group, for adults, is presented in Table 34.

Children's and infants' consumption rates

Consumption rate data were obtained for individuals in the child age group and in the infant age group. Table H presents a summary of the consumption rates for the foods consumed from the terrestrial survey area for children and infants. No generic rates have been determined for the child and infant age groups so no comparisons with the observed rates can be made.

For the child age group, consumption of terrestrial foods was identified in the following six food groups: green vegetables, other vegetables, root vegetables, potato, domestic fruit and sheep meat. No consumption was identified for the following food groups: milk, cattle meat, pig meat, poultry, eggs, wild/free foods, rabbits/hares, honey, wild fungi, venison and freshwater fish.

For the infant age group, consumption of terrestrial foods was identified in the following five food groups: green vegetables, other vegetables, root vegetables, potato and domestic fruit. No consumption was identified for the following food groups: milk, cattle meat, pig meat, sheep meat, poultry, eggs, wild/free foods, rabbits/hares, honey, wild fungi, venison and freshwater fish.

Table H. Summary of children's and infants' consumption rates of foods from the terrestrial survey area

Food group	Number of observations	Number of people in the high-rate group	Observed maximum for the high-rate group (kg y ⁻¹ or l y ⁻¹)	Observed minimum for the high-rate group (kg y ⁻¹ or l y ⁻¹)	Observed mean for the high-rate group (kg y ⁻¹ or l y ⁻¹)	Observed 97.5 th percentile (kg y ⁻¹ or l y ⁻¹)
Child age group (6 - 15 years old)						
Green vegetables	1	1	17.9	17.9	17.9	NA
Other vegetables	2	1	1.8	1.8	1.8	1.8
Root vegetables	1	1	46.4	46.4	46.4	NA
Potato	1	1	51.0	51.0	51.0	NA
Domestic fruit	2	1	12.2	12.2	12.2	11.9
Sheep meat	3	3	3.9	3.9	3.9	3.9
Infant age group (0 - 5 years old)						
Green vegetables	1	1	0.9	0.9	0.9	NA
Other vegetables	3	2	0.3	0.3	0.3	0.3
Root vegetables	1	1	2.3	2.3	2.3	NA
Potato	1	1	2.5	2.5	2.5	NA
Domestic fruit	3	3	0.6	0.6	0.6	0.6

Notes

NA = not applicable

6 DIRECT RADIATION PATHWAYS

6.1 Direct radiation survey area

The direct radiation survey area, shown in Figure 2, covered the area within 1 km of the site centre, which was taken as the centre of the Active Waste Accumulation Facility.

Most of the land to the west, north and north-east of the survey area was agricultural and there were small clusters of residential properties to the north. The main concentration of residential properties was located towards the eastern boundary of the survey area and the MoD accommodation and support facility, HMS Caledonia, was situated just to the north of the centre of the survey area. Most of the south-eastern quadrant of the survey area was taken up by the Rosyth Business Park and dockyard. The Babcock International Group owned the business park and rented out buildings to businesses, most of which were located in a broad arc extending from the centre of the area towards the south-east. A technical college campus, which was closed for refurbishment at the time of the survey, was located on the north side of the business park. There were other businesses and light industrial units situated further to the south-east, outside the business park. Many of the business properties, both inside and outside the business park, were unoccupied at the time of the survey.

6.2 Occupancy rates and gamma dose rate measurements

Interviews were conducted at 17 residential properties and five businesses. Six of the residential properties were occupied by families. Indoor, outdoor and total occupancy rates for adults, children and infants are presented in Table 35. The highest total occupancy rate was 8100 h y⁻¹ for a resident. The highest indoor occupancy rate was 7800 h y⁻¹ for a resident, who was the same individual that had the highest total occupancy rate. The highest outdoor occupancy rate was 1800 h y⁻¹ for a resident who also worked in the area.

It should be noted that the activities of the employees and contractors of Babcock International Group, while at work, were not considered in the direct radiation survey.

Gamma dose rate measurements were taken both indoors and outdoors at most properties where interviews were conducted. Outdoor measurements were taken approximately 5 to 10 metres from the nearest building. Gamma dose rate measurements over rough grass were taken at locations at distances further than 5 km from the site centre to obtain background dose rates. All measurements were taken at a height of 1 metre above the substrate. It should be noted that the indoor and outdoor measurements have not been adjusted for natural background dose rates.

The results are presented in Table 36 and are summarised below.

Indoor measurements

- Sixteen measurements taken over concrete ranged from 0.064 $\mu\text{Gy h}^{-1}$ to 0.120 $\mu\text{Gy h}^{-1}$
- One measurement taken over granite was 0.084 $\mu\text{Gy h}^{-1}$
- Two measurements taken over wood ranged from 0.109 $\mu\text{Gy h}^{-1}$ to 0.113 $\mu\text{Gy h}^{-1}$

Outdoor measurements

- Nineteen measurements taken over grass ranged from 0.071 $\mu\text{Gy h}^{-1}$ to 0.099 $\mu\text{Gy h}^{-1}$
- Two measurements taken over gravel ranged from 0.072 $\mu\text{Gy h}^{-1}$ to 0.077 $\mu\text{Gy h}^{-1}$

Background measurements

- Three measurements taken over grass ranged from 0.068 $\mu\text{Gy h}^{-1}$ to 0.075 $\mu\text{Gy h}^{-1}$.

It should be noted that the underlying geology may cause variations in the gamma dose measurement readings. The geology of the areas where measurements were taken during this survey was not investigated. The gamma dose rate measurements were taken at varying times of the day.

7 USE OF HABITS DATA FOR DOSE ASSESSMENTS

In determining habits data for the purposes of assessing radiological doses to the public, it may be necessary to consider a combination of pathways. Data are provided in Annex 1 and Annex 2 so that the full effect of combining pathways can be assessed for individual observations, given the concentrations and dose rates for a particular assessment. The rates for individuals in the high-rate groups are emboldened and are therefore apparent. In some circumstances, it will be possible to make simplifying assumptions and define the consumption and external exposure rates appropriate to a series of potential high-rate groups.

The most extensive combinations of pathways for adult dose assessment are shown in Annex 3. Each of the 23 combinations shown in this table represents an actual individual (or individuals) from Annex 1 who has positive data (irrespective of the magnitude), for each pathway marked with a cross. It should be noted that combination numbers in Annex 3 do not correlate directly with observation numbers in Annex 1. Other individuals from Annex 1 have combinations that are not listed in Annex 3 because they have fewer pathways and a dose assessment for them would be adequately covered by one of the 23 listed combinations.

8 COMPARISONS WITH THE PREVIOUS SURVEY

The results from this 2010 survey can be compared with results from the last habits survey, undertaken at Rosyth in 2005. The aquatic survey area in the 2010 survey was the same as that in the 2005 survey. However, the terrestrial survey area and the direct radiation survey area had changed slightly between 2005 and 2010 since the site centre was based on the positions of three nuclear licensed areas in 2005 but was based on the position of the single remaining active nuclear licensed area in 2010.

Aquatic survey

A comparison between the 2005 and 2010 adults' consumption rates of aquatic foods is presented in Table I.

Food group	2005			2010		
	Number of people in the high-rate group	Maximum consumption rate (kg y ⁻¹)	Mean consumption rate for the high-rate group (kg y ⁻¹)	Number of people in the high-rate group	Maximum consumption rate (kg y ⁻¹)	Mean consumption rate for the high-rate group (kg y ⁻¹)
Fish	8	48.9	31.0	8	35.0	17.0
Crustaceans	2	35.8	28.3	10	7.8	4.6
Molluscs	2	16.7	13.7	4	5.8	5.8
Wildfowl	2	13.4	11.0	3	8.3	4.8
Marine plants/algae	2	0.1	0.1	Not identified		

The mean consumption rate for the adult high-rate group decreased for fish, crustaceans, molluscs and wildfowl in 2010 when compared with 2005. The consumption of marine plants/algae was identified in 2005 but was not identified in 2010. The main species of fish consumed by the adult high-rate group in 2005 were mackerel, pollack, cod and flounder, and in 2010 were mackerel and cod. The main crustacean species consumed by the adult high-rate group in 2005 and 2010 were brown crab and common lobster. In 2005, the main species of molluscs consumed by the adult high-rate group were winkles and mussels, and in 2010 the only species of mollusc consumed was winkles. The main species of wildfowl consumed by the adult high-rate group in 2005 were mallard, unidentified goose species, teal and wigeon and in 2010 were wigeon, mallard, pink-footed goose and teal. In 2005 the only species of marine plant/algae consumed by the adult high-rate group was samphire but in the 2010 survey no consumption of marine plants/algae was recorded.

A comparison between the 2005 and 2010 aquatic external exposure pathways for adults is presented in Table J.

Table J. Comparison between 2005 and 2010 intertidal occupancy rates and handling rates of fishing gear and sediments for adults

Intertidal substrate or handling pathway	2005			2010		
	Number of people in the high-rate group	Maximum occupancy or handling rate (h y ⁻¹)	Mean occupancy or handling rate for the high-rate group (h y ⁻¹)	Number of people in the high-rate group	Maximum occupancy or handling rate (h y ⁻¹)	Mean occupancy or handling rate for the high-rate group (h y ⁻¹)
Mud	1	423	423	1	95	95
Mud and sand	33	305	294	2	548	514
Mud, sand and stones	Not observed			1	39	39
Rock	1	84	84	8	60	48
Sand	2	1092	729	9	248	141
Sand and stones	Not observed			1	351	351
Stones	Not observed			1	1	1
Boat on mud	3	624	270	4	507	494
Handling fishing gear	8	1170	674	3	1280	943
Handling sediment	20	130	66	6	240	154

In 2005, intertidal occupancy was identified over mud, over mud and sand, over rock, over sand and on board boats resting on mud. In 2010, occupancy was identified over mud, over mud and sand, over mud, sand and stones, over rock, over sand, over sand and stones, over stones and on board boats resting on mud. In 2010, compared to 2005, the mean occupancy rate for the adult high-rate group increased significantly for mud and sand, and for boats on mud, and decreased significantly for mud, for rock and for sand. Activities were recorded over mud, sand and stones, over sand and stones, and over stones in 2010 but no activities were recorded taking place over these substrates in 2005. Changes in occupancy rates on various substrates may be partially attributable to substrates at given locations changing over time. The range of intertidal activities observed in 2010 was broadly the same as in 2005.

In 2010, the mean rates for the adults' high-rate groups for handling fishing gear and for handling sediment both increased significantly compared with 2005.

Terrestrial survey

Because of the change in the position of the site centre between 2005 and 2010 there was a slight difference in the terrestrial survey area between the two surveys. However, this change had no discernable effect on the results. A comparison between the 2005 and 2010 mean consumption rates for the adult high-rate groups for terrestrial foods is presented in Table K.

Table K. Comparison between 2005 and 2010 mean consumption rates for the adult high-rate groups for terrestrial food groups (kg y⁻¹ or l y⁻¹)		
Food group	2005	2010
Green vegetables	18.7	39.2
Other vegetables	17.6	41.2
Root vegetables	102.2	45.6
Potato	85.5	73.4
Domestic fruit	13.0	60.6
Cattle meat	2.5	47.3
Sheep meat	3.9	7.9
Poultry	1.4	1.4
Eggs	6.9	Not identified
Wild/free foods	1.8	0.7
Rabbits/hares	0.5	Not identified
Honey	11.8	8.8
Wild fungi	0.3	Not identified
Venison	0.6	0.7

In 2010, consumption rates had increased in the following food groups; green vegetables, other vegetables, domestic fruit, cattle meat, sheep meat and venison. Consumption rates had decreased in the following food groups: root vegetables, potato, wild/free foods and honey. The consumption rate of poultry was the same in both years. Eggs, rabbits/hares and wild fungi were not recorded in the 2010 survey but were being consumed in the 2005 survey. Neither survey identified any consumption of locally produced milk, pig meat or freshwater fish.

The increase in the consumption rates of cattle meat and sheep meat were due to single families increasing the amount of these meats that they consumed. The single family that were identified consuming eggs, rabbits/hares and wild fungi in 2005 had moved out of the area in 2010.

Direct radiation survey

Because of the change in the position of the site centre between 2005 and 2010 there was a difference in the direct radiation survey area between the two surveys. The main differences were that the residential properties scattered across the farmland in the north, which were outside the survey area in 2005, were included within the survey area in 2010, and that a nursery and some of the business properties associated with the Port of Rosyth, which were within the eastern part of the survey area in 2005, were outside the survey area in 2010.

A comparison between the 2005 and 2010 direct radiation occupancy rates is presented in Table L.

Table L. Comparison between 2005 and 2010 direct radiation occupancy rates ($h\ y^{-1}$)		
	2005	2010
Highest total	8400	8100
Highest indoor	8400	7800
Highest outdoor	1800	1800

The highest outdoor occupancy rate in 2005 was for an individual who worked at a business that was outside the survey area in 2010 but all the other highest occupancy rate individuals were from parts of the survey area that were common to 2005 and 2010.

In 2010 the highest total occupancy rate and the highest indoor occupancy rate decreased slightly from 2005, whereas the highest outdoor occupancy rate remained the same. In 2005 the highest total occupancy rate and the highest indoor occupancy rate were for the same individual, who was an adult resident, and the highest outdoor occupancy rate was for an adult employee at a business. In 2010, the highest total occupancy rate and the highest indoor occupancy rate were again both for one adult individual, who was a resident, but a different person to the one identified in 2005. In 2010 the highest outdoor occupancy rate was for an adult resident who also worked in the area.

9 MAIN FINDINGS

9.1 Survey findings

The survey investigated three potential sources of public radiation exposure from the Rosyth site, which were:

- Discharges of liquid radioactive waste to the Firth of Forth
- Discharges of gaseous radioactive waste to the atmosphere
- Emissions of direct radiation

Data were collected for 416 individuals including, for example, commercial fishermen, anglers, sailors, people spending time on intertidal substrates, farmers, allotment holders, beekeepers and people spending time within the direct radiation survey area. These people were targeted because their habits or where they live may cause them to be exposed to radioactivity or radiation from the site. However, it should be noted that the most exposed people could only be defined with the outcome of a dose assessment.

All consumption rates recorded are only for foods produced, collected or caught from within the aquatic and terrestrial survey areas as defined in Section 2.3. The consumption and occupancy rates presented in this section are for adults only. However, consumption and occupancy rates were also obtained for individuals in the child age group (6 - 15 years old), and in the infant age group (0 - 5 years old).

Aquatic survey area

The mean consumption rate for the adult high-rate group (as defined in Section 3.4) for the separate aquatic consumption pathways for foods potentially affected by liquid discharges were:

- 17.0 kg y⁻¹ for fish
- 4.6 kg y⁻¹ for crustaceans
- 5.8 kg y⁻¹ for molluscs
- 4.8 kg y⁻¹ for wildfowl

The predominant foods consumed by the high-rate groups for fish were mackerel and cod; for crustaceans were brown crab and common lobster; for molluscs were winkles; and for wildfowl were wigeon, mallard, pink-footed goose and teal. No consumption of marine plants/algae was identified.

MAIN FINDINGS

Three people were identified collecting seaweed from the shore at North Queensferry, Limekilns and Charlestown, which was used as a fertiliser on soil where potatoes and onions were grown. The use of seaweed for animal feed was not identified. There were small patches of salt marsh in the survey area but no livestock were identified grazing in these areas.

The mean occupancy rates for adult high-rate groups over the separate intertidal substrates were:

- 95 h y⁻¹ for mud
- 510 h y⁻¹ for mud and sand
- 39 h y⁻¹ for mud, sand and stones
- 48 h y⁻¹ for rock
- 140 h y⁻¹ for sand
- 350 h y⁻¹ for sand and stones
- 1 h y⁻¹ for stones
- 490 h y⁻¹ for boat on mud

The mean handling rates for the adult high-rate groups were:

- 940 h y⁻¹ for handling fishing gear
- 150 h y⁻¹ for handling sediment

The handling of angling equipment was not considered to be a significant pathway, and therefore, as in previous surveys, data for this pathway were not collected.

The adult maximum occupancy rate in water was 170 h y⁻¹ and on water was 1600 h y⁻¹.

Terrestrial survey area

The mean consumption rates for the adult high-rate groups for the separate consumption pathways for foods potentially affected by airborne discharges were:

- 39 kg y⁻¹ for green vegetables
- 41 kg y⁻¹ for other vegetables
- 46 kg y⁻¹ for root vegetables
- 73 kg y⁻¹ for potato
- 61 kg y⁻¹ for domestic fruit
- 47 kg y⁻¹ for cattle meat
- 7.9 kg y⁻¹ for sheep meat
- 1.4 kg y⁻¹ for poultry
- 0.7 kg y⁻¹ for wild/free foods
- 8.8 kg y⁻¹ for honey

- 0.7 kg y⁻¹ for venison

No consumption of locally produced milk, pig meat, eggs, rabbits/hares, wild fungi, or freshwater fish was identified.

The human consumption of groundwater was not identified. All livestock were supplied with mains water for drinking but also had access to stream or ditch water.

Wildlife could not gain access to any active areas, which were inside a building, so it is considered unlikely that wildlife could transfer contamination offsite.

Direct radiation survey area

The highest occupancy rates by members of the public within the direct radiation survey area were:

- 8100 h y⁻¹ for the total occupancy rate (for a resident)
- 7800 h y⁻¹ for the indoor occupancy rate (for the same resident with the highest total occupancy rate)
- 1800 h y⁻¹ for the outdoor occupancy rate (for a resident who also worked in the area)

10 SUGGESTIONS FOR CHANGES TO THE MONITORING PROGRAMME

Information collected during the 2010 Rosyth habits survey can be used to make recommendations for changes to the current SEPA environmental monitoring programme. A summary of the current programme is provided below, followed by the suggestions for changes to the programme.

10.1 Summary of the current environmental monitoring programme

The 2009 SEPA environmental monitoring programme was composed of the following samples and measurements (EA, FSA, NIEA and SEPA, 2010):

Aquatic monitoring

Sample	Location
Crabs	East of dockyard
Whelks	East of dockyard
<i>Fucus vesiculosus</i>	East of dockyard
Sediment	East of dockyard
Sediment	Port Edgar
Sediment	West of dockyard
Sediment	East Ness Pier
Sediment	Blackness Castle
Sediment	Charlestown Pier
Seawater	East of dockyard

Gamma dose rate measurements over intertidal areas

Substrate	Location
Mud and sand	Blackness Castle
Sand	Charlestown Pier
Sand	East Ness Pier
Sand	East of dockyard
Mud	Port Edgar
Mud and rock	West of dockyard

In 2009 SEPA did not conduct any terrestrial monitoring specifically relating to the gaseous discharges from the Rosyth site as the discharges have been below the limit of detection for several years. However, as part of the UK wide monitoring of drinking water sources, SEPA reported results for the following samples taken from locations in the region around Rosyth (EA, FSA, NIEA and SEPA, 2010):

- Freshwater from Castlehill, Holl Reservoir, Gartmorn and Morton No. 2.

10.2 Suggestions for changes

It is considered that SEPA's current monitoring programme provides adequate coverage. However, based on the findings of this habits survey, the following suggestions are presented for consideration:

- An annual sample of mackerel could be added to the aquatic monitoring programme since mackerel was the most highly consumed fish species and no samples are currently taken in the 'fish' food group. Mackerel occur in the Firth of Forth during the summer months.
- Within the 'mollusc' food group the annual sample of whelks could be replaced by a sample of winkles since winkles were positively identified as being consumed, whereas whelks were being landed by a commercial fishing boat in the survey area but were being sold outside the survey area. Winkles were being collected for human consumption from the rocks to the north of Port Laing on the North Queensferry peninsular (NGR: NT 136 817), and from rocks in the bay to the east of St David's Harbour (NGR: NT 149 822).

It is recommended that all other samples currently monitored remain unchanged.

Although the consumption of terrestrial foods from the area was identified during the survey, the authorised gaseous discharges from Rosyth have been below the limit of detection for several years so there is little reason to introduce new terrestrial monitoring samples at this time. If gaseous discharges should increase in the future the consumption data presented in this report could be used to guide a terrestrial sampling programme.

11 ACKNOWLEDGEMENTS

Gratitude is expressed to representatives of local authorities and associations and members of the public who offered helpful advice and information during the survey. This survey was undertaken on behalf of the Scottish Environment Protection Agency, who provided the funding for this study.

12 REFERENCES

Byrom, J., Robinson, C., Simmonds, J. R., Walters, B., and Taylor, R.R., 1995. Food consumption rates for use in generalised radiological dose assessments. *J. Radiol. Prot.* Vol. 15 (4) 335-341.

CEC, 1996. Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. *Off. J. Eur. Commun.*, 39 (L159): 1-114.

EA, FSA, NIEA and SEPA, 2010. Radioactivity in Food and the Environment, 2009. EA, FSA, NIEA and SEPA, Warrington, London, Belfast and Stirling. RIFE (15).

FSA, 2002. Assessment Methodology for the Potential Impact on Food of Radioactive Discharges to the Environment. FSA, London.

Good Housekeeping, 1994. Good Housekeeping Cook Book. Ebury Press, London.

Hessayon, D. G., 1997. The New Vegetable & Herb Expert. Expert Books, London.

Hunt, G. J., Hewett, C. J. and Shepherd, J.G., 1982. The identification of critical groups and its application to fish and shellfish consumers in the coastal area of the north-east Irish Sea. *Health Physics*, Vol. 43, No 6, pp. 875-889.

ICRP, 1991. 1990 Recommendations of the International Commission on Radiological Protection. *Annal. ICRP* 21 (1-3). Pergamon Press, Oxford, 201 pp. (ICRP Publ. 60.).

ICRP, 1996. Age-dependant doses to members of the public from intake of radionuclides. *Annal. ICRP* 26 (1). Elsevier Science, Oxford, (ICRP Publ. (72)).

ICRP, 2007. Assessing the dose of the representative person for the purpose of radiological protection of the public and the optimisation of radiological protection. *Annal. ICRP* 36 (3). Elsevier Science, Oxford, (ICRP Publ. 101.).

Leonard, D. R. P., Hunt, G. J. AND Jones, P. G. W., 1982. Investigations of individual radiation exposures from discharges to the aquatic environment: the technique of habit surveys. pp. 512-517 *In: 'Proceedings of the Third International Symposium on Radiological Protection - Advances in Theory and Practice', Inverness, 6-11 June 1982, Volume 2. The Society of Radiological Protection.*

REFERENCES

Macaulay Institute for Soil Research, Land cover of Scotland 1988, (LCS88) 1:50,000 series.

Scottish Executive, 2000. Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000. Scottish Executive, Edinburgh.

Smith, K.R. and Jones, A.L., 2003. Generalised habit data for radiological assessments. NRPB-W41. NRPB, Chiltern.

Tipple, J.R., McTaggart, K.A., and Clyne, F.J., 2006. Radiological Habits Survey, Rosyth Business Park, 2005. Environment Report RL 07/06. Cefas, Lowestoft.

UK Parliament, 1993. Radioactive Substances Act, 1993. HMSO, London.

Table 1. Typical food groups used in habits surveys

Food group	Examples of foods within the group
Green vegetables	Asparagus, broccoli, Brussels sprout, cabbage, calabrese, cauliflower, chard, courgettes, cucumber, gherkin, globe artichoke, herbs, kale, leaf beet, lettuce, marrow, spinach
Other vegetables	Aubergine, broad bean, chilli pepper, French bean, mangetout, pea, kohlrabi, pepper, pumpkin, runner bean, sweetcorn, tomato
Root vegetables	Beetroot, carrot, celeriac, celery, chicory, fennel, garlic, Jerusalem artichoke, leek, onion, parsnip, radish, shallot, spring onion, swede, turnip
Potato	Potato
Domestic fruit	Apple, apricot, blackberry, blackcurrant, boysenberry, cherry, damson, fig, gooseberry, grapes, greengages, huckleberry, loganberry, melon, nectarines, peach, pear, plum, raspberry, redcurrants, rhubarb, rowanberry, strawberry, tayberry, whitecurrant
Milk	Cows' milk, cream, yoghurt, goats' milk
Cattle meat ^a	Beef
Pig meat ^a	Pork
Sheep meat ^a	Lamb, mutton
Poultry ^b	Chicken, duck, goose, grouse, guinea fowl, partridge, pheasant, pigeon, snipe, turkey, woodcock
Eggs	Chicken egg, duck egg, goose egg
Wild/free foods	Blackberry, chestnut, crab apple, damson, dandelion root, elderberry, nettle, raspberry, rowanberry, sloe, strawberry,
Honey	Honey
Wild Fungi	Mushrooms, other edible fungi
Rabbits/Hares	Rabbit, hare
Venison ^a	Venison
Fish (sea)	Bass, brill, cod, common ling, dab, Dover sole, flounder, gurnard, haddock, hake, herring, lemon sole, mackerel, monkfish, mullet, plaice, pollack, witch saithe, salmon, sea trout, squid ^c , cuttlefish ^c , rays, turbot, whitebait, whiting
Fish (freshwater)	Brown trout, rainbow trout, perch, pike, salmon (river), eels
Crustaceans	Brown crab, spider crab, crawfish, lobster, <i>Nephrops</i> , squat lobster, prawn, shrimp
Molluscs	Cockles, limpets, mussels, oysters, scallops, razor clams, whelks, winkles
Wildfowl ^b	Canada goose, greylag goose, mallard, pink-footed goose, pintail, shoveler, teal, wigeon

Notes^a Including offal^b Domesticated ducks and geese are classified as poultry. Wild ducks and geese are classified as wildfowl^c Although squid and cuttlefish are molluscs, radiologically they are more akin to fish

Table 2. Ratios for determining consumption and occupancy rates for infants and children

Group	Ratio ^a	
	Infant ^e /adult	Child ^e /adult
Fish ^b	0.050	0.200
Crustaceans ^b	0.050	0.250
Molluscs ^b	0.050	0.250
Green vegetables	0.222	0.444
Other vegetables	0.200	0.500
Root vegetables	0.375	0.500
Potatoes	0.292	0.708
Domestic fruit	0.467	0.667
Milk	1.333	1.000
Cattle meat	0.222	0.667
Pig meat	0.138	0.625
Sheep meat	0.120	0.400
Poultry	0.183	0.500
Eggs	0.600	0.800
Wild/free foods ^c	0.110	0.490
Game ^d	0.140	0.500
Honey	0.789	0.789
Wild fungi	0.150	0.450
Freshwater fish ^b	0.050	0.250
External exposure over intertidal sediments	0.030	0.500

Notes

^aExcepting notes b and c, consumption ratios were derived from Byrom et al., (1995) which presented data for infants aged 6 to 12 months and children aged 10 to 11 years.

^bRatios were derived from Smith and Jones, (2003) which presented data for infants and children of unspecified ages.

^cRatios were derived from FSA data for wild fruit and nuts for infants and 10-year-old children.

^dGame includes rabbits/hares and venison.

^eNote that the age ranges within the age groups in this table do not correspond exactly with the age ranges within the age groups used throughout the rest of this report.

Table 3. Adults' consumption rates of fish from the Rosyth aquatic survey area (kg y⁻¹)

Observation number	Bass	Cod	Mackerel	Pollack	Salmon	Total
361	-	23.7	11.3	-	-	35.0
360	-	15.8	7.5	-	-	23.3
283	-	1.5	12.2	-	-	13.7
284	-	1.5	12.2	-	-	13.7
204	-	-	12.5	-	-	12.5
205	-	-	12.5	-	-	12.5
206	-	-	12.5	-	-	12.5
207	-	-	12.5	-	-	12.5
274	-	4.8	6.1	-	-	10.9
275	-	4.8	6.1	-	-	10.9
276	-	4.8	6.1	-	-	10.9
109	-	-	10.0	-	-	10.0
192	-	1.1	8.8	-	-	9.9
193	-	1.1	8.8	-	-	9.9
280	-	3.0	6.1	-	-	9.1
107	-	3.3	5.0	-	-	8.3
108	-	3.3	5.0	-	-	8.3
258	-	-	6.1	-	-	6.1
213	-	1.8	3.5	0.8	-	6.1
214	-	1.8	3.5	0.8	-	6.1
110	-	-	5.0	-	-	5.0
111	-	-	5.0	-	-	5.0
112	-	-	5.0	-	-	5.0
226	-	-	4.9	-	-	4.9
281	-	1.5	3.1	-	-	4.5
282	-	1.5	3.1	-	-	4.5
294	-	-	-	-	4.5	4.5
187	-	-	4.2	-	-	4.2
188	-	-	4.2	-	-	4.2
209	-	-	4.0	-	-	4.0
210	-	-	4.0	-	-	4.0
245	-	-	3.8	-	-	3.8
246	-	-	3.8	-	-	3.8
247	-	-	3.8	-	-	3.8
106	-	-	3.6	-	-	3.6
223	-	-	3.1	-	-	3.1
224	-	-	3.1	-	-	3.1
225	-	-	3.1	-	-	3.1
241	0.6	-	2.3	-	-	2.9
242	0.6	-	2.3	-	-	2.9
243	0.6	-	2.3	-	-	2.9
244	0.6	-	2.3	-	-	2.9
295	-	-	-	-	2.7	2.7
200	-	-	1.5	-	-	1.5
201	-	-	1.5	-	-	1.5
221	-	-	1.5	-	-	1.5

Table 3. Adults' consumption rates of fish from the Rosyth aquatic survey area (kg y⁻¹)

Observation number	Bass	Cod	Mackerel	Pollack	Salmon	Total
222	-	-	1.5	-	-	1.5
227	-	-	1.5	-	-	1.5
4	0.3	-	0.9	-	-	1.2
5	0.3	-	0.9	-	-	1.2
6	0.3	-	0.9	-	-	1.2
7	0.3	-	0.9	-	-	1.2
369	-	-	1.0	-	-	1.0
370	-	-	1.0	-	-	1.0
371	-	-	1.0	-	-	1.0
372	-	-	1.0	-	-	1.0

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of fish based on the 8 high-rate adult consumers is 17.0 kg y⁻¹

The observed 97.5th percentile rate based on 56 observations is 19.7 kg y⁻¹

Table 4. Adults' consumption rates of crustaceans from the Rosyth aquatic survey area (kg y⁻¹)

Observation number	Brown crab	Common lobster	Total
280	4.4	3.4	7.8
296	6.9	-	6.9
297	6.9	-	6.9
281	2.2	1.7	3.9
282	2.2	1.7	3.9
283	2.2	1.7	3.9
284	2.2	1.7	3.9
291	1.1	1.8	2.9
292	1.1	1.8	2.9
293	1.1	1.8	2.9
358	0.7	0.8	1.5
289	0.1	0.6	0.8
290	0.1	0.6	0.8
286	0.4	0.2	0.6
287	0.4	0.2	0.6
288	0.4	0.2	0.6
241	-	0.2	0.2

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of crustaceans based on the 10 high-rate adult consumers is 4.6 kg y⁻¹

The observed 97.5th percentile rate based on 17 observations is 7.5 kg y⁻¹

Table 5. Adults' consumption rates of molluscs from the Rosyth aquatic survey area (kg y⁻¹)

Observation number	Winkle
4	5.8
5	5.8
6	5.8
7	5.8
46	0.4

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of molluscs based on the 4 high-rate adult consumers is 5.8 kg y⁻¹

The observed 97.5th percentile rate based on 5 observations is 5.8 kg y⁻¹

Table 6. Adults' consumption rates of wildfowl from the Rosyth aquatic survey area (kg y⁻¹)

Observation number	Mallard	Pink-footed goose	Teal	Wigeon	Total
403	4.1	-	-	4.2	8.3
301	0.2	1.4	0.6	0.9	3.0
302	0.2	1.4	0.6	0.9	3.0
1	1.4	-	-	-	1.4
2	1.4	-	-	-	1.4

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of wildfowl based on the 3 high-rate adult consumers is 4.8 kg y⁻¹

The observed 97.5th percentile rate based on 5 observations is 7.7 kg y⁻¹

Table 7. Adults' consumption rates of vegetables grown on land where seaweed has been used as a fertiliser (kg y⁻¹)

Observation number	Onion	Potato
350	17.6	46.0
351	17.6	46.0
308	5.8	-
309	5.8	-
344	3.9	109.2
345	3.9	-
346	3.9	-
347	3.9	-

Notes

These foods are included in the aquatic section of this report as the exposure pathway is sea to land transfer and the source of potential exposure is liquid discharge. However these foods were grown in the terrestrial survey area and they are also potentially subject to gaseous discharges. Therefore they are also included in the terrestrial food groups and are included in Annex 1 as terrestrial foods.

Table 8. Children's and infants' consumption rates of fish from the Rosyth aquatic survey area (kg y⁻¹)**Child age group (6 - 15 years old)**

Observation number	Age	Cod	Mackerel	Total
194	14	1.1	8.8	9.9
195	12	1.1	8.8	9.9
196	10	0.5	4.4	5.0
197	8	0.5	4.4	5.0
248	15	-	3.8	3.8
198	7	0.3	2.1	2.4
211	8	-	2.0	2.0
212	6	-	2.0	2.0
202	10	-	1.5	1.5
203	8	-	1.5	1.5
373	10	-	1.0	1.0

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of fish for the child age group based on the 5 high-rate consumers is 6.7 kg y⁻¹

The observed 97.5th percentile rate based on 11 observations is 9.9 kg y⁻¹

Infant age group (0 - 5 years old)

Observation number	Age	Cod	Mackerel	Total
208	5	-	3.1	3.1
199	5	0.3	2.1	2.4

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of fish for the infant age group based on the 2 high-rate consumers is 2.8 kg y⁻¹

The observed 97.5th percentile rate based on 2 observations is 3.1 kg y⁻¹

Table 9. Infants' consumption rates of crustaceans from the Rosyth aquatic survey area (kg y⁻¹)**Infant age group (0 - 5 years old)**

Observation number	Age	Brown crab	Common lobster	Total
359	4	0.7	0.8	1.5

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of crustaceans for the infant age group based on the only consumer is 1.5 kg y⁻¹

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

Table 10. Adults' intertidal occupancy rates in the Rosyth aquatic survey area (h y⁻¹)

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Sand	Sand and stones	Stones	Boat on mud
403	Torry Bay	Wildfowling	95	-	-	-	-	-	-	-
301	Bo'ness and Blackness	Wildfowling	30	-	-	-	-	-	-	-
	Carriden	Dog walking	-	6	-	-	-	-	-	-
189	Cramond	Dog walking	-	548	-	-	-	-	-	-
216	Burntisland	Dog walking	-	480	-	-	-	-	-	-
251	Burntisland	Bait digging	-	126	-	-	-	-	-	-
215	Burntisland	Bait digging	-	125	-	-	-	-	-	-
250	Burntisland	Bait digging	-	100	-	-	-	-	-	-
186	Cramond	Dog walking	-	91	-	-	-	-	-	-
252	Burntisland	Bait digging	-	65	-	-	-	-	-	-
255	Burntisland	Bait digging	-	61	-	-	-	-	-	-
256	Burntisland	Bait digging	-	61	-	-	-	-	-	-
213	Burntisland	Bait digging	-	52	-	-	-	-	-	-
264	Burntisland	Bait digging	-	40	-	-	-	-	-	-
265	Burntisland	Bait digging	-	40	-	-	-	-	-	-
190	Cramond	Dog walking	-	39	-	-	-	-	-	-
191	Cramond	Dog walking	-	39	-	-	-	-	-	-
65	East of St David's Harbour	Bait digging	-	36	-	-	-	-	-	-
		Rock pooling	-	-	-	36	-	-	-	-
254	Burntisland	Bait digging and collecting razor clams for bait	-	27	-	-	-	-	-	-
358	Crombie Point	Bait digging	-	24	-	-	-	-	-	-
332	Burntisland	Dog walking	-	18	-	-	-	-	-	-
333	Burntisland	Dog walking	-	18	-	-	-	-	-	-
253	Burntisland	Bait digging	-	12	-	-	-	-	-	-
233	Burntisland	Bait digging and collecting cockles for bait	-	12	-	-	-	-	-	-
257	Burntisland	Bait digging	-	6	-	-	-	-	-	-
350	Limekilns and Charlestown	Collecting seaweed	-	4	-	-	-	-	-	-
308	Limekilns and Charlestown	Collecting seaweed	-	2	-	-	-	-	-	-
375	South Queensferry	Dog walking	-	-	39	-	-	-	-	-
378	South Queensferry	Bait digging	-	-	2	-	-	-	-	-

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

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Sand	Sand and stones	Stones	Boat on mud
4	East of St David's Harbour	Collecting winkles	-	-	-	60	-	-	-	-
5	East of St David's Harbour	Collecting winkles	-	-	-	60	-	-	-	-
6	East of St David's Harbour	Collecting winkles	-	-	-	60	-	-	-	-
7	East of St David's Harbour	Collecting winkles	-	-	-	60	-	-	-	-
86	Cramond	Rock pooling	-	-	-	50	-	-	-	-
		Playing	-	-	-	-	50	-	-	-
187	Cramond Island	Angling	-	-	-	30	-	-	-	-
188	Cramond Island	Angling	-	-	-	30	-	-	-	-
8	Dalgety Bay	Crabbing	-	-	-	12	-	-	-	-
9	Dalgety Bay	Crabbing	-	-	-	12	-	-	-	-
47	Aberdour and Limekilns	Playing and walking	-	-	-	6	-	-	-	-
			-	-	-	-	15	-	-	-
48	Aberdour and Limekilns	Playing and walking	-	-	-	6	-	-	-	-
			-	-	-	-	15	-	-	-
46	North of Port Laing	Collecting winkles	-	-	-	5	-	-	-	-
101	Cramond	Dog walking and playing	-	-	-	-	248	-	-	-
383	Aberdour, North Queensferry and Limekilns	Dog walking	-	-	-	-	225	-	-	-
82	Cramond	Dog walking	-	-	-	-	140	-	-	-
83	Cramond	Dog walking	-	-	-	-	140	-	-	-
70	West of St David's Harbour	Dog walking	-	-	-	-	104	-	-	-
71	West of St David's Harbour	Dog walking	-	-	-	-	104	-	-	-
352	Limekilns	Walking	-	-	-	-	104	-	-	-
353	Limekilns	Walking	-	-	-	-	104	-	-	-
240	Aberdour	Dog walking	-	-	-	-	98	-	-	-
259	West of St David's Harbour	Playing and dog walking	-	-	-	-	72	-	-	-
266	Burntisland	Beach cleaning	-	-	-	-	52	-	-	-
267	Burntisland	Beach cleaning	-	-	-	-	52	-	-	-
268	Burntisland	Beach cleaning	-	-	-	-	52	-	-	-
269	Burntisland	Beach cleaning	-	-	-	-	52	-	-	-
270	Burntisland	Beach cleaning	-	-	-	-	52	-	-	-
30	Limekilns	Playing	-	-	-	-	40	-	-	-

Table 10. Adults' intertidal occupancy rates in the Rosyth aquatic survey area (h y⁻¹)

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Sand	Sand and stones	Stones	Boat on mud
271	Burntisland	Beach cleaning	-	-	-	-	40	-	-	-
272	Burntisland	Beach cleaning	-	-	-	-	40	-	-	-
273	Burntisland	Beach cleaning	-	-	-	-	40	-	-	-
96	Cramond	Dog walking and beachcombing	-	-	-	-	36	-	-	-
12	North Queensferry	Playing	-	-	-	-	30	-	-	-
13	North Queensferry	Playing	-	-	-	-	30	-	-	-
239	Aberdour	Dog walking	-	-	-	-	26	-	-	-
234	Silversands	Playing	-	-	-	-	24	-	-	-
235	Silversands	Playing	-	-	-	-	24	-	-	-
262	East of St David's Harbour	Dog walking	-	-	-	-	20	-	-	-
263	East of St David's Harbour	Dog walking	-	-	-	-	20	-	-	-
90	Cramond	Playing	-	-	-	-	15	-	-	-
		Collecting stones	-	-	-	-	-	15	-	-
91	Cramond	Playing	-	-	-	-	15	-	-	-
		Collecting stones	-	-	-	-	-	15	-	-
85	Cramond	Dog walking	-	-	-	-	15	-	-	-
84	Cramond	Dog walking	-	-	-	-	15	-	-	-
217	Burntisland	Playing	-	-	-	-	14	-	-	-
218	Burntisland	Playing	-	-	-	-	14	-	-	-
249	Port Laing	Dog walking	-	-	-	-	12	-	-	-
97	Cramond	Playing	-	-	-	-	9	-	-	-
		Collecting stones	-	-	-	-	-	2	-	-
98	Cramond	Playing	-	-	-	-	9	-	-	-
		Collecting stones	-	-	-	-	-	2	-	-
54	Cramond	Walking	-	-	-	-	5	-	-	-
55	Cramond	Walking	-	-	-	-	5	-	-	-
94	Cramond	Dog walking	-	-	-	-	5	-	-	-
95	Cramond	Dog walking	-	-	-	-	5	-	-	-
381	Blackness	Dog walking	-	-	-	-	-	351	-	-
382	Blackness	Dog walking	-	-	-	-	-	105	-	-

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

Observation number	Location	Activity	Mud	Mud and sand	Mud, sand and stones	Rock	Sand	Sand and stones	Stones	Boat on mud
16	North Queensferry	Beach combing	-	-	-	-	-	26	-	-
		Boat maintenance	-	-	-	-	-	-	-	481
17	North Queensferry	Beach combing	-	-	-	-	-	26	-	-
		Boat maintenance	-	-	-	-	-	-	-	481
344	North Queensferry	Collecting seaweed	-	-	-	-	-	-	1	-
80	Charlestown Harbour	Boat maintenance	-	-	-	-	-	-	-	507
81	Charlestown Harbour	Boat maintenance	-	-	-	-	-	-	-	507

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud based on 1 high-rate observation is 95 h y^{-1}

The observed 97.5th percentile rate based on 2 observations for mud is 93 h y^{-1}

The mean intertidal occupancy rate over mud and sand based on 2 high-rate observations is 514 h y^{-1}

The observed 97.5th percentile rate based on 25 observations for mud and sand is 507 h y^{-1}

The mean intertidal occupancy rate over mud, sand and stones based on 1 high-rate observation is 39 h y^{-1}

The observed 97.5th percentile rate based on 2 observations for mud, sand and stones is 38 h y^{-1}

The mean intertidal occupancy rate over rock based on 8 high-rate observations is 48 h y^{-1}

The observed 97.5th percentile rate based on 13 observations for rock is 60 h y^{-1}

The mean intertidal occupancy rate over sand based on 9 high-rate observations is 141 h y^{-1}

The observed 97.5th percentile rate based on 43 observations for sand is 221 h y^{-1}

The mean intertidal occupancy rate over sand and stones based on 1 high-rate observation is 351 h y^{-1}

The observed 97.5th percentile rate based on 8 observations for sand and stones is 308 h y^{-1}

The mean intertidal occupancy rate over stone based on the only observation is 1 h y^{-1}

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

The mean intertidal occupancy rate over a boat on mud based on 4 high-rate observations is 494 h y^{-1}

The observed 97.5th percentile rate based on 4 observations for boat on mud is 507 h y^{-1}

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

Child age group (6 - 15 years old)

Observation number	Age	Location	Activity	Mud, sand and stones	Rock	Sand	Sand and stones
376	10	South Queensferry	Rock pooling	39	-	-	-
377	9	South Queensferry	Rock pooling	39	-	-	-
379	13	South Queensferry	Bait digging	2	-	-	-
380	12	South Queensferry	Bait digging	2	-	-	-
10	13	Dalgety Bay	Crabbing	-	12	-	-
11	9	Dalgety Bay	Crabbing	-	12	-	-
49	6	Aberdour and Limekilns	Playing	-	6	-	-
102	8	Cramond	Playing and dog walking	-	-	248	-
67	8	West of St David's Harbour	Playing	-	-	45	-
68	10	West of St David's Harbour	Playing	-	-	45	-
32	9	Limekilns	Walking and sunbathing	-	-	40	-
33	9	Limekilns	Walking and sunbathing	-	-	40	-
34	10	Limekilns	Walking and playing	-	-	40	-
50	10	Limekilns	Walking and sunbathing	-	-	40	-
14	6	North Queensferry	Playing	-	-	30	-
236	13	Silversands	Playing	-	-	24	-
237	11	Silversands	Playing	-	-	24	-
260	11	West of St David's Harbour	Playing	-	-	20	-
261	6	West of St David's Harbour	Playing	-	-	20	-
93	6	Cramond	Playing	-	-	15	-
			Collecting stones	-	-	-	15
99	6	Cramond	Playing	-	-	9	-
			Collecting stones	-	-	-	2
56	9	Cramond	Walking	-	-	5	-

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud, sand and stones for the child age group based on 2 high-rate observations is 39 h y^{-1}

The observed 97.5th percentile rate based on 4 observations for mud, sand and stones is 39 h y^{-1}

The mean intertidal occupancy rate over rock for the child age group based on 3 high-rate observations is 10 h y^{-1}

The observed 97.5th percentile rate based on 3 observations for rock is 12 h y^{-1}

The mean intertidal occupancy rate over sand for the child age group based on 1 high-rate observation is 248 h y^{-1}

The observed 97.5th percentile rate based on 16 observations for sand is 172 h y^{-1}

The mean intertidal occupancy rate over sand and stones for the child age group based on 1 high-rate observation is 15 h y^{-1}

The observed 97.5th percentile rate based on 2 observation for sand and stones is 15 h y^{-1}

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

Infant age group (0 - 5 years old)

Observation number	Age	Location	Activity	Mud and sand	Rock	Sand	Sand and stones
66	5	East of St David's Harbour	Bait digging	36	-	-	-
			Rock pooling	-	36	-	-
87	2	Cramond	Rock pooling	-	50	-	-
			Playing	-	-	50	-
88	3	Cramond	Rock pooling	-	50	-	-
			Playing	-	-	50	-
384	5	Aberdour, North Queensferry and Limekilns	Dog walking	-	-	144	-
69	5	West of St David's Harbour	Playing	-	-	45	-
31	2	Limekilns	Playing	-	-	40	-
15	4	North Queensferry	Playing	-	-	30	-
238	3	Silversands	Playing	-	-	24	-
92	3	Cramond	Playing	-	-	15	-
			Collecting stones	-	-	-	15
220	2	Burntisland	Playing	-	-	14	-
219	3	Burntisland	Playing	-	-	14	-
100	3	Cramond	Playing	-	-	9	-
			Collecting stones	-	-	-	2

Notes

Emboldened observations are the high-rate individuals

The mean intertidal occupancy rate over mud and sand for the infant age group based on the only observation is 36 h y^{-1}

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

The mean intertidal occupancy rate over rock for the infant age group based on 3 high-rate observations is 45 h y^{-1}

The observed 97.5th percentile rate based on 3 observations for rock is 50 h y^{-1}

The mean intertidal occupancy rate over sand for the infant age group based on 3 high-rate observations is 81 h y^{-1}

The observed 97.5th percentile rate based on 11 observations for sand is 121 h y^{-1}

The mean intertidal occupancy rate over sand and stones for the infant age group based on 1 high-rate observation is 15 h y^{-1}

The observed 97.5th percentile rate based on 2 observations for sand and stones is 15 h y^{-1}

Table 12. Gamma dose rate measurements over intertidal substrates in the Rosyth aquatic survey area ($\mu\text{Gy h}^{-1}$)

Location	NGR	Substrate	Gamma dose rate at 1 metre ^a
North shore (west to east)			
Torryburn	NT 020 860	Mud	0.062
Limekilns	NT 077 832	Sand	0.060
West of St David's Harbour	NT 142 826	Sand	0.074
East of St David's Harbour	NT 149 822	Mud and sand	0.061
Aberdour	NT 192 849	Sand	0.052
Silversands Bay	NT 200 852	Sand	0.053
Burntisland	NT 241 860	Mud and sand	0.050
South shore (west to east)			
Blackness	NT 053 800	Sand and stones	0.058
East of Blackness	NT 057 800	Mud and sand	0.076
Cramond	NT 192 773	Mud and sand	0.052

Notes

^a These measurements have not been adjusted for natural background dose rates.

Table 13. Adults handling rates of fishing gear and sediment in the Rosyth aquatic survey area (h y^{-1})

Observation number	Location	Activity	Fishing gear	Sediment
291	Off Burntisland	Handling creels	1280	-
296	Central survey area	Handling creels	1050	-
285	Off Pettycur	Handling creels	500	-
28	North Queensferry	Fixing moorings	-	240
29	North Queensferry	Fixing moorings	-	240
358	Between North Queensferry and South Queensferry	Handling creels	208	-
	Crombie Point	Bait digging	-	24
286	Eastern end of survey area	Handling creels	180	-
288	Eastern end of survey area	Handling creels	180	-
289	Eastern end of survey area	Handling creels	180	-
294	Off Kincardine	Handling sweep net	75	-
295	Off Kincardine	Handling sweep net	75	-
280	Off Kinghorn	Handling creels	60	-
281	Off Kinghorn	Handling creels	60	-
282	Off Kinghorn	Handling creels	60	-
283	Off Kinghorn	Handling creels	60	-
284	Off Kinghorn	Handling creels	60	-
251	Burntisland	Bait digging	-	126
215	Burntisland	Bait digging	-	125
250	Burntisland	Bait digging	-	100
403	Torry Bay	Wildfowling	-	95
252	Burntisland	Bait digging	-	65
255	Burntisland	Bait digging	-	61
256	Burntisland	Bait digging	-	61
4	East of St David's Harbour	Collecting winkles	-	60
5	East of St David's Harbour	Collecting winkles	-	60
6	East of St David's Harbour	Collecting winkles	-	60
7	East of St David's Harbour	Collecting winkles	-	60
213	Burntisland	Bait digging	-	52
264	Burntisland	Bait digging	-	40
265	Burntisland	Bait digging	-	40
65	East of St David's Harbour	Bait digging	-	36
301	Bo'ness and Blackness	Wildfowling	-	30
254	Burntisland	Bait digging and collecting razor clams for bait	-	27
253	Burntisland	Bait digging	-	12
233	Burntisland	Bait digging and collecting cockles for bait	-	12
8	Dalgety Bay	Crabbing	-	12
9	Dalgety Bay	Crabbing	-	12
257	Burntisland	Bait digging	-	6
46	North of Port Laing	Collecting winkles	-	5
350	Limekilns and Charlestown	Collecting seaweed	-	4
378	South Queensferry	Bait digging	-	2
308	Limekilns and Charlestown	Collecting seaweed	-	2
344	North Queensferry	Collecting seaweed	-	1

Notes

Emboldened observations are the high-rate individuals

The mean fishing gear handling rate based on 3 high-rate observations is 943 h y^{-1}

The observed 97.5th percentile rate based on 14 observations for handling fishing gear is 1205 h y^{-1}

The mean sediment handling rate based on 6 high-rate observations is 154 h y^{-1}

The observed 97.5th percentile rate based on 30 observations for handling sediment is 240 h y^{-1}

Most fishermen wore gloves when handling creels while fishing but did not wear gloves when repairing the creels. Most of the bait diggers did not wear gloves and those that did wear them were using knitted nylon gloves which allowed sediment to pass through the fabric and contact the skin. The wildfowler at Torry Bay spent much of his time lying or kneeling in the mud and often did not wear gloves.

Table 14. Children's and infants' handling rates of sediment in the Rosyth aquatic survey area (h y⁻¹)

Child age group (6 - 15 years old)

Observation number	Age	Location	Activity	Sediment
10	13	Dalgety Bay	Crabbing	12
11	9	Dalgety Bay	Crabbing	12
379	13	South Queensferry	Bait digging	2
380	12	South Queensferry	Bait digging	2

Notes

Emboldened observations are the high-rate individuals

The mean sediment handling rate for the child age group based on 2 high-rate observations is 12 h y⁻¹

The observed 97.5th percentile rate based on 4 observations for sediment is 12 h y⁻¹

Infant age group (0 - 5 years old)

Observation number	Age	Location	Activity	Sediment
66	5	East of St David's Harbour	Bait digging	36

Notes

The emboldened observation is the high-rate individual

The mean sediment handling rate for the infant age group based on the only observation is 36 h y⁻¹

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

Table 15. Adults' occupancy rates in and on water in the Rosyth aquatic survey area (h y⁻¹)

Observation number	Location	Activity	In water	On water
278	Various locations, including wrecks off Burntisland and Dalgety Bay	Sub-aqua diving	167	-
		Being on a dive boat	-	1000
277	Various locations, including wrecks off Burntisland and Dalgety Bay	Sub-aqua diving	27	-
		Being on a dive boat	-	40
228	Off Burntisland	Jet skiing	22	-
229	Off Burntisland	Jet skiing	22	-
230	Off Burntisland	Jet skiing	22	-
291	Off Burntisland	Creeling	-	1600
296	Central survey area	Creeling	-	1200
358	Eastern survey area	Skipper of a charter boat	-	624
	Between North Queensferry and South Queensferry	Creeling and safety boat duties	-	-
366	Off Port Edgar	Sailing and power boating	-	600
80	Charlestown Harbour	Boat maintenance	-	507
81	Charlestown Harbour	Boat maintenance	-	507
285	Off Pettycur	Creeling	-	500
374	Firth of Forth	Coastguard duties	-	405
	Off Port Edgar	Sailing and power boating	-	-
28	North Queensferry	Fixing moorings	-	240
29	North Queensferry	Fixing moorings	-	240
286	Eastern end of survey area	Creeling	-	220
288	Eastern end of survey area	Creeling	-	220
289	Eastern end of survey area	Creeling	-	220
355	Off Port Edgar	Power boating, sailing and rowing	-	200
356	Off Port Edgar	Power boating, sailing and rowing	-	200
357	Off Port Edgar	Power boating, sailing and rowing	-	200
280	Off Kinghorn	Angling and creeling	-	170
281	Off Kinghorn	Angling and creeling	-	170
283	Off Kinghorn	Angling and creeling	-	170
284	Off Kinghorn	Angling and creeling	-	170
362	Western survey area	Sailing	-	168
363	Western survey area	Sailing	-	168
274	Eastern survey area	Angling	-	158
275	Eastern survey area	Angling	-	158
105	Throughout survey area	Sailing	-	128
72	Off Dalgety Bay	Sailing	-	126
75	Off Dalgety Bay	Sailing	-	126
76	Off Dalgety Bay	Sailing	-	126
77	Off Dalgety Bay	Sailing	-	126
78	Off Dalgety Bay	Sailing	-	126
79	Off Dalgety Bay	Sailing	-	126
16	North Queensferry	Boat maintenance	-	104
17	North Queensferry	Boat maintenance	-	104
54	Off Port Edgar	Power boating and canoeing	-	96
89	Throughout survey area	Sailing	-	96
103	Throughout survey area	Sailing	-	84
104	Throughout survey area	Sailing	-	84
294	Off Kincardine	Salmon sweep netting	-	75
295	Off Kincardine	Salmon sweep netting	-	75
369	Firth of Forth	Coastguard duties	-	50
	Between North Queensferry and South Queensferry	Angling	-	-
61	Off Port Edgar	Power boating and canoeing	-	48
62	Off Port Edgar	Power boating and canoeing	-	48
276	Eastern survey area	Angling	-	40
18	Throughout survey area	Sailing	-	30
19	Throughout survey area	Sailing	-	30
20	Throughout survey area	Sailing	-	30
21	Throughout survey area	Sailing	-	30
22	Throughout survey area	Sailing	-	30
23	Throughout survey area	Sailing	-	30

Table 15. Adults' occupancy rates in and on water in the Rosyth aquatic survey area (h y⁻¹)

Observation number	Location	Activity	In water	On water
24	Throughout survey area	Sailing	-	30
25	Throughout survey area	Sailing	-	30
26	Throughout survey area	Sailing	-	30
27	Throughout survey area	Sailing	-	30
367	Off Port Edgar	Sailing	-	24
46	Off Charlestown	Angling	-	18
234	Silversands	Paddling	-	6
235	Silversands	Paddling	-	6
368	Off Port Edgar	Sailing	-	6
97	Cramond	Paddling	-	1
98	Cramond	Paddling	-	1

Table 16. Children's and infants' occupancy rates in and on water in the Rosyth aquatic survey area (h y⁻¹)

Observation number	Age	Location	Activity	In water	On water
Child age group (6 - 15 years old)					
279	15	Various locations, including wrecks off Burntisland and Dalgety Bay	Sub-aqua diving	93	-
			Being on a dive boat	-	556
231	10	Off Burntisland	Jet skiing	11	-
232	7	Off Burntisland	Jet skiing	11	-
364	14	Western survey area	Sailing	-	168
365	13	Western survey area	Sailing	-	168
57	12	Off Port Edgar	Power boating and canoeing	-	48
58	13	Off Port Edgar	Power boating and canoeing	-	48
59	14	Off Port Edgar	Power boating and canoeing	-	48
60	15	Off Port Edgar	Power boating and canoeing	-	48
74	7	Off Dalgety Bay	Sailing	-	20
236	13	Silversands	Paddling	-	6
237	11	Silversands	Paddling	-	6
32	9	Limekilns	Paddling	-	2
33	9	Limekilns	Paddling	-	2
34	10	Limekilns	Paddling	-	2
50	10	Limekilns	Paddling	-	2
99	6	Cramond	Paddling	-	1
Infant age group (0 - 5 years old)					
73	5	Off Dalgety Bay	Sailing	-	10
238	3	Silversands	Paddling	-	6
100	3	Cramond	Paddling	-	1

Table 17. Adults' consumption rates of green vegetables from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Asparagus	Broccoli	Brussels sprout	Cabbage	Calabrese	Cauliflower	Chard	Courgette	Cucumber	Herbs	Kale	Lettuce	Marrow	Pak choi	Spinach	Total
347	-	-	-	1.6	-	-	-	-	-	-	-	-	-	-	-	1.6
316	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	0.7

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of green vegetables based on the 11 high-rate adult consumers is 39.2 kg y⁻¹

The observed 97.5th percentile rate based on 38 observations is 63.2 kg y⁻¹

Table 18. Adults' consumption rates of other vegetables from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Broad bean	French bean	Pea	Pepper	Runner bean	Squash	Sweetcorn	Tomato	Total
314	12.3	2.7	2.0	-	49.0	0.2	-	-	66.2
308	-	-	5.4	2.0	5.1	-	2.8	21.6	36.8
309	-	-	5.4	2.0	5.1	-	2.8	21.6	36.8
348	-	-	5.1	-	17.1	-	-	10.8	33.0
349	-	-	5.1	-	17.1	-	-	10.8	33.0
303	-	-	-	-	-	-	-	21.6	21.6
304	-	-	-	-	-	-	-	21.6	21.6
321	3.7	4.9	8.1	-	-	-	-	-	16.6
322	3.7	4.9	8.1	-	-	-	-	-	16.6
35	-	-	1.6	-	9.2	-	-	-	10.8
36	-	-	1.6	-	9.2	-	-	-	10.8
352	-	-	-	-	-	-	-	7.8	7.8
353	-	-	-	-	-	-	-	7.8	7.8
354	-	-	-	-	-	-	-	7.8	7.8
350	6.4	-	-	-	-	-	-	-	6.4
351	6.4	-	-	-	-	-	-	-	6.4
44	-	-	-	-	-	-	1.2	4.5	5.7
45	-	-	-	-	-	-	1.2	4.5	5.7
344	-	-	5.4	-	-	-	-	-	5.4
305	-	-	3.6	-	-	-	-	-	3.6
306	-	-	3.6	-	-	-	-	-	3.6
307	-	-	3.6	-	-	-	-	-	3.6
54	-	-	-	-	-	-	-	2.7	2.7
55	-	-	-	-	-	-	-	2.7	2.7
315	-	-	2.0	-	-	-	-	-	2.0
316	-	-	2.0	-	-	-	-	-	2.0
310	-	-	1.8	-	-	-	-	-	1.8
311	-	-	1.8	-	-	-	-	-	1.8
341	1.4	-	0.1	-	-	-	-	-	1.5
317	-	-	0.1	-	0.5	-	-	-	0.6
318	-	-	0.1	-	0.5	-	-	-	0.6
320	-	-	-	-	0.5	-	-	-	0.5
319	-	-	0.1	-	-	-	-	-	0.1
400	-	0.1	-	-	-	-	-	-	0.1
401	-	0.1	-	-	-	-	-	-	0.1
402	-	0.1	-	-	-	-	-	-	0.1
342	-	-	0.1	-	-	-	-	-	0.1
343	-	-	0.1	-	-	-	-	-	0.1

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of other vegetables based on the 5 high-rate adult consumers is 41.2 kg y⁻¹

The observed 97.5th percentile rate based on 38 observations is 39.0 kg y⁻¹

Table 19. Adults' consumption rates of root vegetables from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Beetroot	Carrot	Celery	Fennel	Garlic	Jerusalem artichoke	Kohl rabi	Leek	Onion	Parsnip	Radish	Shallot	Spring onion	Swede	Turnip	Total
350	23.4	7.2	-	-	0.4	-	-	4.3	17.6	-	-	2.6	0.6	10.9	4.3	71.3
351	23.4	7.2	-	-	0.4	-	-	4.3	17.6	-	-	2.6	0.6	10.9	4.3	71.3
348	13.5	-	-	0.2	-	-	10.1	16.7	-	1.1	-	1.0	-	-	8.9	51.5
349	13.5	-	-	0.2	-	-	10.1	16.7	-	1.1	-	1.0	-	-	8.9	51.5
308	9.8	12.6	0.9	-	-	-	-	8.0	5.8	0.9	2.3	-	-	10.9	-	51.2
309	9.8	12.6	0.9	-	-	-	-	8.0	5.8	0.9	2.3	-	-	10.9	-	51.2
310	19.7	7.2	-	-	-	-	-	10.1	7.2	-	-	-	-	-	2.2	46.4
311	19.7	7.2	-	-	-	-	-	10.1	7.2	-	-	-	-	-	2.2	46.4
314	0.7	2.7	-	-	-	19.0	4.2	5.1	1.1	-	0.7	-	-	8.2	3.2	44.9
320	1.9	1.8	-	-	0.1	-	-	-	1.8	18.0	-	-	2.5	-	4.1	30.2
321	5.7	3.6	-	-	0.3	-	-	3.2	5.8	2.5	-	1.4	-	-	3.6	26.2
322	5.7	3.6	-	-	0.3	-	-	3.2	5.8	2.5	-	1.4	-	-	3.6	26.2
344	12.1	5.1	-	-	-	-	-	1.5	3.9	-	-	-	-	-	2.0	24.6
35	10.3	5.6	-	-	-	-	-	-	3.3	-	-	-	-	-	2.7	21.9
36	10.3	5.6	-	-	-	-	-	-	3.3	-	-	-	-	-	2.7	21.9
315	-	2.7	-	-	-	-	-	5.1	1.1	-	-	-	-	8.2	3.2	20.2
316	-	2.7	-	-	-	-	-	5.1	1.1	-	-	-	-	8.2	3.2	20.2
305	6.6	3.6	-	-	-	-	-	0.9	0.7	-	-	-	-	5.4	-	17.2
306	6.6	3.6	-	-	-	-	-	0.9	0.7	-	-	-	-	5.4	-	17.2
307	6.6	3.6	-	-	-	-	-	0.9	0.7	-	-	-	-	5.4	-	17.2
341	4.1	1.4	-	-	-	-	4.5	0.7	0.6	-	-	1.6	-	-	-	12.8
345	-	5.1	-	-	-	-	-	1.5	3.9	-	-	-	-	-	2.0	12.5
346	-	5.1	-	-	-	-	-	1.5	3.9	-	-	-	-	-	2.0	12.5
347	-	5.1	-	-	-	-	-	1.5	3.9	-	-	-	-	-	2.0	12.5
318	1.9	1.8	-	-	0.1	-	-	-	1.8	-	-	-	2.5	-	4.1	12.2
317	1.9	1.8	-	-	0.1	-	-	-	1.8	-	-	-	2.5	-	4.1	12.2
400	8.2	-	-	-	1.8	-	-	-	-	-	-	-	-	-	-	10.0
401	8.2	-	-	-	1.8	-	-	-	-	-	-	-	-	-	-	10.0
402	8.2	-	-	-	1.8	-	-	-	-	-	-	-	-	-	-	10.0
319	1.9	1.8	-	-	0.1	-	-	-	1.8	-	-	-	-	-	4.1	9.7
342	4.1	1.4	-	-	-	-	-	0.7	0.6	-	-	-	-	-	-	6.7

Table 19. Adults' consumption rates of root vegetables from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Beetroot	Carrot	Celery	Fennel	Garlic	Jerusalem artichoke	Kohl rabi	Leek	Onion	Parsnip	Radish	Shallot	Spring onion	Swede	Turnip	Total
343	4.1	1.4	-	-	-	-	-	0.7	0.6	-	-	-	-	-	-	6.7
352	-	-	-	-	-	-	-	-	2.6	-	-	-	-	3.2	-	5.8
353	-	-	-	-	-	-	-	-	2.6	-	-	-	-	3.2	-	5.8
354	-	-	-	-	-	-	-	-	2.6	-	-	-	-	3.2	-	5.8
44	-	-	2.1	-	-	-	-	-	-	-	-	-	-	-	-	2.1
45	-	-	2.1	-	-	-	-	-	-	-	-	-	-	-	-	2.1
54	-	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1
55	-	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of root vegetables based on the 13 high-rate adult consumers is 45.6 kg y⁻¹

The observed 97.5th percentile rate based on 39 observations is 71.3 kg y⁻¹

Table 20. Adults' consumption rates of potato from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Potato
1	120.0
2	120.0
344	109.2
348	75.1
349	75.1
321	57.3
322	57.3
310	51.0
311	51.0
350	46.0
351	46.0
317	36.9
318	36.9
319	36.9
320	36.9
314	22.5
315	22.5
316	22.5
305	21.8
306	21.8
307	21.8
54	6.1
55	6.1
341	2.7
342	2.7
343	2.7
352	2.1
353	2.1
354	2.1

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of potato based on the 11 high-rate adult consumers is 73.4 kg y⁻¹

The observed 97.5th percentile rate based on 29 observations is 120.0 kg y⁻¹

Table 21. Adults' consumption rates of domestic fruit from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Apple	Blackberry	Blackcurrant	Gooseberry	Grape	Pear	Plum	Raspberry	Redcurrant	Rhubarb	Strawberry	Tayberry	Total
321	22.8	-	4.5	1.6	-	13.2	6.4	7.5	5.4	3.1	10.7	3.6	78.8
322	22.8	-	4.5	1.6	-	13.2	2.1	7.5	5.4	3.1	10.7	3.6	74.6
308	22.7	-	-	-	5.1	11.6	5.1	-	-	-	-	-	44.5
309	22.7	-	-	-	5.1	11.6	5.1	-	-	-	-	-	44.5
350	-	-	5.7	-	-	-	-	-	-	3.5	9.0	-	18.2
351	-	-	5.7	-	-	-	-	-	-	3.5	9.0	-	18.2
344	1.8	-	-	12.3	-	-	1.8	-	-	-	-	-	15.9
310	-	0.5	-	-	-	-	-	-	-	4.5	7.6	-	12.6
311	-	-	-	-	-	-	-	-	-	4.5	7.6	-	12.2
303	11.3	-	-	-	-	-	-	-	-	-	-	-	11.3
304	11.3	-	-	-	-	-	-	-	-	-	-	-	11.3
35	3.4	-	-	-	-	-	-	1.0	-	3.5	1.7	-	9.6
36	3.4	-	-	-	-	-	-	1.0	-	3.5	1.7	-	9.6
341	-	-	5.7	3.2	-	-	-	-	0.5	-	-	-	9.3
342	-	-	5.7	-	-	-	-	-	0.5	-	-	-	6.1
343	-	-	5.7	-	-	-	-	-	0.5	-	-	-	6.1
1	-	-	-	-	-	-	-	-	-	4.5	-	-	4.5
2	-	-	-	-	-	-	-	-	-	4.5	-	-	4.5
348	-	-	-	-	-	-	-	-	2.3	-	-	-	2.3
349	-	-	-	-	-	-	-	-	2.3	-	-	-	2.3
44	-	-	2.3	-	-	-	-	-	-	-	-	-	2.3
45	-	-	2.3	-	-	-	-	-	-	-	-	-	2.3
400	-	0.5	-	-	-	-	-	0.3	-	-	-	-	0.8
401	-	0.5	-	-	-	-	-	0.3	-	-	-	-	0.8
402	-	0.5	-	-	-	-	-	0.3	-	-	-	-	0.8
387	-	-	-	-	-	-	-	-	-	0.5	0.2	-	0.6
388	-	-	-	-	-	-	-	-	-	0.5	0.2	-	0.6
314	-	0.5	-	-	-	-	-	-	-	-	-	-	0.5
317	-	-	-	-	-	-	-	0.2	-	-	-	-	0.2
318	-	-	-	-	-	-	-	0.2	-	-	-	-	0.2
320	-	-	-	-	-	-	-	0.2	-	-	-	-	0.2

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of domestic fruit based on the 4 high-rate adult consumers is 60.6 kg y⁻¹

The observed 97.5th percentile rate based on 31 observations is 75.6 kg y⁻¹

Table 22. Adults' consumption rates of cattle meat from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Beef
1	47.3
2	47.3

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of cattle meat based on the 2 high-rate adult consumers is 47.3 kg y⁻¹

The observed 97.5th percentile rate based on 2 observations is 47.3 kg y⁻¹

Table 23. Adults' consumption rates of sheep meat from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Lamb
404	7.9
405	7.9
406	7.9
407	7.9
408	7.9
409	7.9
410	7.9
411	7.9
412	7.9
413	7.9

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of sheep meat based on the 10 high-rate adult consumers is 7.9 kg y⁻¹

The observed 97.5th percentile rate based on 10 observations is 7.9 kg y⁻¹

Table 24. Adults' consumption rates of poultry from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Pheasant
1	1.4
2	1.4

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of poultry based on the 2 high-rate adult consumers is 1.4 kg y⁻¹

The observed 97.5th percentile rate based on 2 observations is 1.4 kg y⁻¹

Table 25. Adults' consumption rates of wild/free foods from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Blackberry	Wild garlic	Total
400	-	0.7	0.7
401	-	0.7	0.7
402	-	0.7	0.7
341	0.2	-	0.2
342	0.2	-	0.2
343	0.2	-	0.2

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of wild/free foods based on the 3 high-rate adult consumers is 0.7 kg y⁻¹

The observed 97.5th percentile rate based on 6 observations is 0.7 kg y⁻¹

Table 26. Adults' consumption rates of honey from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Honey
321	9.6
322	9.6
400	8.3
401	8.3
402	8.3

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of honey based on the 5 high-rate adult consumers is 8.8 kg y⁻¹

The observed 97.5th percentile rate based on 5 observations is 9.6 kg y⁻¹

Table 27. Adults' consumption rates of venison from the Rosyth terrestrial survey area (kg y⁻¹)

Observation number	Venison
341	0.7

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of venison based on the only adult consumer is 0.7 kg y⁻¹

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

Table 28. Children's and infants' consumption rates of green vegetables from the Rosyth terrestrial survey area (kg y⁻¹)**Child age group (6 - 15 years old)**

Observation number	Age	Brussels sprout	Cabbage	Cauliflower	Lettuce	Total
312	13	3.6	11.0	1.5	1.8	17.9

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of green vegetables for the child age group based on the only consumer is 17.9 kg y⁻¹

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

Infant age group (0 - 5 years old)

Observation number	Age	Brussels sprout	Cabbage	Cauliflower	Lettuce	Total
313	4	0.2	0.5	0.1	0.1	0.9

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of green vegetables for the infant age group based on the only consumer is 0.9 kg y⁻¹

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

Table 29. Children's and infants' consumption rates of other vegetables from the Rosyth terrestrial survey area (kg y⁻¹)**Child age group (6 - 15 years old)**

Observation number	Age	Pea
312	13	1.8
389	8	0.3

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of other vegetables for the child age group based on 1 high-rate consumer is 1.8 kg y⁻¹

The observed 97.5th percentile rate based on 2 observations is 1.8 kg y⁻¹

Infant age group (0 - 5 years old)

Observation number	Age	Pea
390	5	0.3
391	4	0.3
313	4	0.1

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of other vegetables for the infant age group based on the 2 high-rate consumers is 0.3 kg y⁻¹

The observed 97.5th percentile rate based on 3 observations is 0.3 kg y⁻¹

Table 30. Children's and infants' consumption rates of root vegetables from the Rosyth terrestrial survey area (kg y⁻¹)

Child age group (6 - 15 years old)

Observation number	Age	Beetroot	Carrot	Leek	Onion	Turnip	Total
312	13	19.7	7.2	10.1	7.2	2.2	46.4

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of root vegetables for the child age group based on the only consumer is 46.4 kg y⁻¹

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

Infant age group (0 - 5 years old)

Observation number	Age	Beetroot	Carrot	Leek	Onion	Turnip	Total
313	4	1.0	0.4	0.5	0.4	0.1	2.3

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of root vegetables for the infant age group based on the only consumer is 2.3 kg y⁻¹

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

Table 31. Children's and infants' consumption rates of potato from the Rosyth terrestrial survey area (kg y⁻¹)**Child age group (6 - 15 years old)**

Observation number	Age	Potato
312	13	51.0

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of potato for the child age group based on the only consumer is 51.0 kg y⁻¹

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

Infant age group (0 - 5 years old)

Observation number	Age	Potato
313	4	2.5

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of potato for the infant age group based on the only consumer is 2.5 kg y⁻¹

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

Table 32. Children's and infants' consumption rates of domestic fruit from the Rosyth terrestrial survey area (kg y⁻¹)**Child age group (6 - 15 years old)**

Observation number	Age	Rhubarb	Strawberry	Total
312	13	4.5	7.6	12.2
389	8	0.5	0.2	0.6

Notes

The emboldened observation is the high-rate consumer

The mean consumption rate of domestic fruit for the child age group based on 1 high-rate consumer is 12.2 kg y⁻¹

The observed 97.5th percentile rate based on 2 observations is 11.9 kg y⁻¹

Infant age group (0 - 5 years old)

Observation number	Age	Rhubarb	Strawberry	Total
390	5	0.5	0.2	0.6
391	4	0.5	0.2	0.6
313	4	0.2	0.4	0.6

Notes

Embodened observations are the high-rate consumers

The mean consumption rate of domestic fruit for the infant age group based on the 3 high-rate consumers is 0.6 kg y⁻¹

The observed 97.5th percentile rate based on 3 observations is 0.6 kg y⁻¹

Table 33. Children's consumption rates of sheep meat from the Rosyth terrestrial survey area (kg y⁻¹)

Child age group (6 - 15 years old)

Observation number	Age	Lamb
414	9	3.9
415	8	3.9
416	7	3.9

Notes

Emboldened observations are the high-rate consumers

The mean consumption rate of sheep meat for the child age group based on the 3 high-rate consumers is 3.9 kg y⁻¹

The observed 97.5th percentile rate based on 3 observations is 3.9 kg y⁻¹

Table 34. Percentage contribution each food type makes to its terrestrial food group for adults

<p>Green vegetables</p> <p>Cabbage 30.0 % Courgettes 16.1 % Cauliflower 11.3 % Brussel sprout 8.4 % Broccoli 7.9 % Cucumber 7.1 % Lettuce 5.3 % Kale 4.9 % Calabrese 3.6 % Pak choi 1.7 % Spinach 1.2 % Marrow 1.2 % Herbs 0.8 % Chard 0.4 % Asparagus 0.2 %</p>	<p>Potato</p> <p>Potato 100.0 %</p>
<p>Other vegetables</p> <p>Tomato 37.9 % Runner bean 29.5 % Pea 17.3 % Broad bean 8.8 % French bean 3.3 % Sweetcorn 2.0 % Pepper 1.0 % Squash 0.1 %</p>	<p>Domestic fruit</p> <p>Apple 30.2 % Strawberry 14.4 % Pear 12.2 % Blackcurrant 10.4 % Rhubarb 9.6 % Plum 5.1 % Gooseberry 4.6 % Raspberry 4.5 % Redcurrant 4.1 % Grape 2.5 % Tayberry 1.8 % Blackberry 0.6 %</p>
<p>Root vegetables</p> <p>Beetroot 27.5 % Carrot 14.2 % Onion 13.3 % Leek 12.6 % Swede 10.7 % Turnip 8.8 % Kohl rabi 3.3 % Parsnip 3.1 % Artichoke 2.2 % Shallot 1.3 % Spring onion 1.0 % Garlic 0.8 % Celery 0.7 % Radish 0.6 % Fennel 0.0 %</p>	<p>Cattle meat</p> <p>Beef 100.0 %</p>
	<p>Sheep meat</p> <p>Lamb 100.0 %</p>
	<p>Poultry</p> <p>Pheasant 100.0 %</p>
	<p>Wild/free foods</p> <p>Wild garlic 81.5 % Blackberry 18.5 %</p>
	<p>Honey</p> <p>Honey 100.0 %</p>
	<p>Venison</p> <p>Venison 100.0 %</p>

Table 35. Occupancy rates in the Rosyth direct radiation survey area (h y^{-1})

Observation number	Sex	Age (years)	Indoor occupancy (h y^{-1})	Outdoor occupancy (h y^{-1})	Total occupancy (h y^{-1})
Adult observations					
53	F	20	7772	358	8130
399	M	48	7354	184	7538
387	F	38	7088	266	7354
63	M	63	7178	164	7342
393	F	27	6805	420	7225
51	F	50	6811	364	7175
325	M	18	5244	1776	7020
35	M	70	6400	392	6792
36	F	64	6400	392	6792
383	F	32	6594	184	6778
388	M	38	6540	192	6732
338	F	43	6454	198	6652
54	M	53	6004	640	6644
335	F	41	6584	37	6621
392	F	57	5894	708	6602
324	M	44	6384	100	6484
394	F	23	6063	420	6483
323	F	44	6234	200	6434
64	F	61	6100	164	6264
44	F	62	5704	448	6152
339	M	38	6040	52	6092
395	F	22	5975	100	6075
55	F	54	5392	640	6032
336	F	16	5759	20	5779
385	F	48	5265	465	5730
396	M	54	5586	108	5694
397	F	54	5646	48	5694
386	M	49	5599	41	5640
328	F	51	5377	203	5580
37	M	56	4988	196	5184
38	F	56	4988	196	5184
334	M	39	4652	100	4752
52	M	25	4488	121	4609
340	M	22	3908	52	3960
398	M	26	3089	55	3144
45	M	60	2816	168	2984
329	F	27	2764	-	2764
296	M	44	2700	-	2700
298	M	U	2700	-	2700
299	M	U	2700	-	2700
300	M	U	2700	-	2700
331	M	20	2532	96	2628
332	M	33	1787	364	2151
333	F	31	1787	364	2151
144	M	U	1998	70	2068
145	M	U	1998	70	2068
146	M	U	1998	70	2068
147	M	U	1998	70	2068
148	M	U	1998	70	2068
149	M	U	1998	70	2068

Table 35. Occupancy rates in the Rosyth direct radiation survey area (h y^{-1})

Observation number	Sex	Age (years)	Indoor occupancy (h y^{-1})	Outdoor occupancy (h y^{-1})	Total occupancy (h y^{-1})
150	M	U	1998	70	2068
151	M	U	1998	70	2068
152	M	U	1998	70	2068
133	F	U	2021	47	2068
134	F	U	2021	47	2068
135	M	U	2021	47	2068
136	M	U	2021	47	2068
137	M	U	2021	47	2068
138	M	U	2021	47	2068
139	M	U	2021	47	2068
140	M	U	2021	47	2068
141	M	U	2021	47	2068
142	M	U	2021	47	2068
143	M	U	2021	47	2068
114	F	U	1890	47	1937
115	F	U	1890	47	1937
116	F	U	1890	47	1937
117	F	U	1890	47	1937
118	F	U	1890	47	1937
119	M	U	1890	47	1937
120	M	U	1890	47	1937
121	M	U	1890	47	1937
122	M	U	1890	47	1937
123	M	U	1890	47	1937
124	M	U	1890	47	1937
125	M	U	1890	47	1937
126	M	U	1890	47	1937
127	M	U	1890	47	1937
128	M	U	1890	47	1937
129	M	U	1890	47	1937
130	M	U	1890	47	1937
131	M	U	1890	47	1937
132	M	U	1890	47	1937
161	U	U	1794	46	1840
162	U	U	1794	46	1840
163	U	U	1794	46	1840
164	U	U	1794	46	1840
165	U	U	1794	46	1840
166	U	U	1794	46	1840
167	U	U	1794	46	1840
168	U	U	1794	46	1840
169	U	U	1794	46	1840
170	U	U	1794	46	1840
171	U	U	1794	46	1840
172	U	U	1794	46	1840
173	U	U	1794	46	1840
153	F	U	1755	45	1800
154	F	U	1755	45	1800
155	F	U	1755	45	1800
156	F	U	1755	45	1800
157	M	U	1755	45	1800

Table 35. Occupancy rates in the Rosyth direct radiation survey area (h y^{-1})

Observation number	Sex	Age (years)	Indoor occupancy (h y^{-1})	Outdoor occupancy (h y^{-1})	Total occupancy (h y^{-1})
158	M	U	1755	45	1800
159	M	U	1755	45	1800
160	M	U	1058	46	1104
113	F	U	893	47	940
174	U	U	322	46	368
175	U	U	322	46	368
176	U	U	322	46	368
177	U	U	322	46	368
178	U	U	322	46	368
179	U	U	322	46	368
180	U	U	322	46	368
181	U	U	322	46	368
182	U	U	322	46	368
183	U	U	322	46	368
184	U	U	322	46	368
185	U	U	322	46	368
330	F	24	186	-	186
Child and infant observations					
391	F	4	7026	262	7288
389	M	8	6456	262	6718
390	F	5	6456	262	6718
326	M	15	5972	592	6564
327	M	13	6102	462	6564
337	F	10	5024	804	5828
384	M	5	4980	180	5160
39	M	2	1574	78	1652
40	F	5	1574	78	1652
41	F	8	1574	78	1652
42	F	6	1574	78	1652
43	M	5	1574	78	1652
56	F	9	838	72	910

Notes

U - Unknown

Table 36. Gamma dose rate measurements for the Rosyth direct radiation survey ($\mu\text{Gy h}^{-1}$)

Properties

Location	Indoor substrate	Indoor gamma dose rate at 1 metre ^a	Outdoor substrate	Outdoor gamma dose rate at 1 metre ^a
Property 1	Concrete	0.064	Gravel	0.072
Property 2	Concrete	0.067	Gravel	0.077
Property 3	Concrete	0.120 ^b	Grass	0.099 ^b
Property 4	Concrete	0.120 ^b	Grass	0.099 ^b
Property 5	Wood	0.109	Grass	0.086
Property 6	Concrete	0.087	Grass	0.082
Property 7	Not recorded	Not recorded	Grass	0.085
Property 8	Concrete	0.123	Grass	0.086
Property 9	Concrete	0.109	Grass	0.071
Property 10	Wood	0.113	Grass	0.072
Property 11	Granite	0.084	Grass	0.073
Property 12	Concrete	0.113	Grass	0.075
Property 13	Concrete	0.090	Grass	0.076
Property 14	Concrete	0.107	Grass	0.079
Property 15	Concrete	0.081	Grass	0.074
Property 16	Concrete	0.111	Grass	0.079
Property 17	Concrete	0.110	Grass	0.080
Property 18	Concrete	0.103	Grass	0.082
Property 19	Concrete	0.108	Grass	0.077
Property 20	Concrete	0.083	Grass	0.079
Property 21	Not recorded	Not recorded	Grass	0.084

Backgrounds

Location	NGR	Substrate	Background gamma dose rate at 1 metre	
Background 1	Cullaloe Wildlife Reserve	NT 186 876	Grass	0.072
Background 2	Dean Plantation	NT 061 880	Grass	0.068
Background 3	Southeast of South Queensferry	NT 147 775	Grass	0.075
Mean background				0.072

Notes

^a These measurements have not been adjusted for natural background dose rates.

^b One set of readings were taken for two businesses in the same building.

Annex 1. Adults' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre	
1	F	U	-	-	-	1.4	-	-	-	120.0	4.5	47.3	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	M	U	-	-	-	1.4	-	-	-	120.0	4.5	47.3	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	F	U	-	-	-	-	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	M	46	1.2	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-	60	-	-	-	-	-
5	F	45	1.2	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-	60	-	-	-	-	-
6	F	18	1.2	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-	60	-	-	-	-	-
7	M	16	1.2	-	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-	60	-	-	-	-	-
8	M	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	12	-	-	-	-	-
9	F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	12	-	-	-	-	-
12	M	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
13	F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-
16	M	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	481	-	-	-	104	-	-	-
17	M	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	481	-	-	-	104	-	-	-
18	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
19	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
20	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
21	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
22	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
23	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
24	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
25	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
26	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
27	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
28	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	240	-	240	-	-	-
29	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	240	-	240	-	-	-

Annex 1. Adults' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
30	F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-	-
35	M	70	-	-	-	-	7.3	10.8	21.9	-	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6400	392
36	F	64	-	-	-	-	7.3	10.8	21.9	-	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6400	392
37	M	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4988	196
38	F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4988	196
44	F	62	-	-	-	-	2.3	5.7	2.1	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5704	448
45	M	60	-	-	-	-	2.3	5.7	2.1	-	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2816	168
46	M	40	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	5	18	-	-	
47	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	15	-	-	-	-	-	-	-	-	-
48	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	15	-	-	-	-	-	-	-	-	-
51	F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6811	364
52	M	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4488	121
53	F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7772	358
54	M	53	-	-	-	-	9.5	2.7	1.1	6.1	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	96	6004	640	
55	F	54	-	-	-	-	9.5	2.7	1.1	6.1	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	5392	640	
61	M	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-	
62	F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-	
63	M	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7178	164	
64	F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6100	164	
65	M	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	36	-	-	-	36	-	-	-	-	-
70	M	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104	-	-	-	-	-	-	-	-	-
71	F	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104	-	-	-	-	-	-	-	-	-
72	M	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126	-	-	
75	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126	-	-	
76	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126	-	-	

Annex 1. Adults' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
222	F	U	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223	M	65	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
224	M	36	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
225	F	20	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
226	M	32	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
227	M	60	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
228	M	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-
229	F	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-
230	M	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-
233	M	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	12	-	-	-	-
234	M	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	6	-	-
235	F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	6	-	-
239	M	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	-	-	-	-	-	-	-	-
240	F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	98	-	-	-	-	-	-	-	-	-
241	M	44	2.9	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
242	M	46	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
243	M	57	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
244	F	U	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
245	M	19	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
246	M	44	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
247	F	44	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
249	M	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-
250	M	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-	100	-	-	-
251	M	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126	-	-	-	-	-	-	-	-	126	-	-	-
252	M	83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-	-	-	-	65	-	-	-

Annex 1. Adults' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
253	M	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	12	-	-	-	-
254	M	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	-	-	-	-	-	-	-	27	-	-	-	-
255	M	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61	-	-	-	-	-	-	-	61	-	-	-	-
256	M	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61	-	-	-	-	-	-	-	61	-	-	-	-
257	M	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	6	-	-	-	-
258	F	45	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
259	F	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	72	-	-	-	-	-	-	-	-	-
262	M	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-
263	F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-
264	M	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	40	-	-	-	-
265	M	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	40	-	-	-	-
266	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	-	-	-
267	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	-	-	-
268	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	-	-	-
269	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	-	-	-
270	M	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	-	-	-
271	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-
272	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-
273	F	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-
274	M	42	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	158	-	-
275	M	19	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	158	-	-
276	F	42	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	
277	M	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	40	-	-	
278	M	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	167	1000	-	-	
280	M	67	9.1	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	170	-	-	

Annex 1. Adults' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
306	F	66	-	-	-	-	5.5	3.6	17.2	21.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
307	M	25	-	-	-	-	5.5	3.6	17.2	21.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
308	M	65	-	-	-	-	38.9	36.8	51.2	-	44.5	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	-	-	-	-
309	F	63	-	-	-	-	38.9	36.8	51.2	-	44.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
310	M	40	-	-	-	-	17.9	1.8	46.4	51.0	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
311	F	34	-	-	-	-	17.9	1.8	46.4	51.0	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
314	M	58	-	-	-	-	18.5	66.2	44.9	22.5	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
315	M	38	-	-	-	-	3.0	2.0	20.2	22.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
316	F	82	-	-	-	-	0.7	2.0	20.2	22.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
317	F	42	-	-	-	-	24.7	0.6	12.2	36.9	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
318	M	43	-	-	-	-	24.7	0.6	12.2	36.9	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
319	F	17	-	-	-	-	21.1	0.1	9.7	36.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
320	F	19	-	-	-	-	24.7	0.5	30.2	36.9	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
321	M	63	-	-	-	-	22.8	16.6	26.2	57.3	78.8	-	-	-	-	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
322	F	63	-	-	-	-	21.9	16.6	26.2	57.3	74.6	-	-	-	-	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
323	F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6234	200
324	M	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6384	100
325	M	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5244	1776
328	F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5377	203
329	F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2764	-
330	F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	186	-
331	M	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2532	96
332	M	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	1787	364
333	F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	1787	364
334	M	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4652	100

Annex 2. Children's and infants' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Sheep meat	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
Child age group (6 - 15 years old)																				
10	M	13	-	-	-	-	-	-	-	-	-	-	12	-	-	12	-	-	-	-
11	F	9	-	-	-	-	-	-	-	-	-	-	12	-	-	12	-	-	-	-
14	M	6	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-
32	F	9	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	2	-	-
33	F	9	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	2	-	-
34	F	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	2	-	-
41	F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1574	78
42	F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1574	78
49	M	6	-	-	-	-	-	-	-	-	-	-	6	6	-	-	-	-	-	-
50	F	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	2	-	-
56	F	9	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	838	72
57	M	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-
58	F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-
59	M	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-
60	F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	-	-
67	M	8	-	-	-	-	-	-	-	-	-	-	-	45	-	-	-	-	-	-
68	F	10	-	-	-	-	-	-	-	-	-	-	-	45	-	-	-	-	-	-
74	F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-
93	M	6	-	-	-	-	-	-	-	-	-	-	-	15	15	-	-	-	-	-

Annex 2. Children's and infants' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Sheep meat	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
326	M	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5972	592
327	M	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6102	462
337	F	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5024	804
364	M	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	168	-	-
365	F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	168	-	-
373	M	10	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
376	F	10	-	-	-	-	-	-	-	-	-	39	-	-	-	-	-	-	-	-
377	M	9	-	-	-	-	-	-	-	-	-	39	-	-	-	-	-	-	-	-
379	M	13	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-
380	F	12	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-
389	M	8	-	-	-	0.3	-	-	0.6	-	-	-	-	-	-	-	-	-	6456	262
414	F	9	-	-	-	-	-	-	-	3.9	-	-	-	-	-	-	-	-	-	-
415	F	8	-	-	-	-	-	-	-	3.9	-	-	-	-	-	-	-	-	-	-
416	M	7	-	-	-	-	-	-	-	3.9	-	-	-	-	-	-	-	-	-	-
Infant age group (0 - 5 years old)																				
15	M	4	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	-
31	F	2	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-
39	M	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1574	78
40	F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1574	78
43	M	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1574	78

Annex 2. Children's and infants' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Sheep meat	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
66	M	5	-	-	-	-	-	-	-	-	36	-	36	-	-	36	-	-	-	-
69	F	5	-	-	-	-	-	-	-	-	-	-	-	45	-	-	-	-	-	-
73	M	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
87	M	2	-	-	-	-	-	-	-	-	-	-	50	50	-	-	-	-	-	-
88	M	3	-	-	-	-	-	-	-	-	-	-	50	50	-	-	-	-	-	-
92	F	3	-	-	-	-	-	-	-	-	-	-	-	15	15	-	-	-	-	-
100	M	3	-	-	-	-	-	-	-	-	-	-	-	9	2	-	-	1	-	-
199	M	5	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
208	F	5	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
219	M	3	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
220	F	2	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
238	F	3	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	6	-	-
313	M	4	-	-	0.9	0.1	2.3	2.5	0.6	-	-	-	-	-	-	-	-	-	-	-
359	M	4	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
384	M	5	-	-	-	-	-	-	-	-	-	-	-	144	-	-	-	-	4980	180
390	F	5	-	-	-	0.3	-	-	0.6	-	-	-	-	-	-	-	-	-	6456	262
391	F	4	-	-	-	0.3	-	-	0.6	-	-	-	-	-	-	-	-	-	7026	262

Notes

Emboldened observations are the high-rate individuals

U - Unknown

Annex 1. Adults' consumption rates (kg y⁻¹) and occupancy rates (h y⁻¹) in the Rosyth area

Observation number	Sex	Age (years)	Fish	Crustaceans	Molluscs	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre
398	M	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3089	55
399	M	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7354	184
400	M	68	-	-	-	-	4.9	0.1	10.0	-	0.8	-	-	-	0.7	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
401	F	65	-	-	-	-	4.9	0.1	10.0	-	0.8	-	-	-	0.7	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
402	F	34	-	-	-	-	4.9	0.1	10.0	-	0.8	-	-	-	0.7	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
403	M	52	-	-	-	8.3	-	-	-	-	-	-	-	-	-	-	-	95	-	-	-	-	-	-	-	95	-	-	-	-	-
404	M	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
405	F	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
406	M	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
407	F	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
408	M	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
409	F	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
410	M	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
411	F	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
412	M	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
413	F	U	-	-	-	-	-	-	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes

Emboldened observations are the high-rate individuals

U - Unknown

Annex 3. Combinations of adult pathways for consideration in dose assessments in the Rosyth area

Combination number	Fish	Crustaceans	Molluscs	Wildfowl	Vegetables fertilised with seaweed	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Cattle meat	Sheep meat	Poultry	Wild/free foods	Honey	Venison	Intertidal occupancy over mud and sand	Intertidal occupancy over mud, sand and stones	Intertidal occupancy over mud	Intertidal occupancy over rock	Intertidal occupancy over sand	Intertidal occupancy over sand and stones	Intertidal occupancy over stones	Intertidal occupancy over boat on mud	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy within 1 km of the site centre	Outdoor occupancy within 1 km of the site centre	
1				X					X	X	X		X																		
2						X	X	X		X																				X	X
3	X		X																	X							X				
4																				X	X										
5																							X		X						X
6	X	X																								X				X	
7			X																	X							X			X	
8						X	X	X	X												X								X	X	X
9																	X			X						X					
10																					X	X								X	
11	X																X									X					
12																												X	X		
13		X																								X			X	X	
14				X													X		X								X				
15					X	X	X	X	X	X							X										X				
16						X	X	X	X	X					X																
17																	X													X	X
18						X	X	X	X	X				X		X															
19					X	X	X	X	X	X														X			X				
20	X																X									X	X		X		
21																			X								X				
22						X	X	X		X				X	X																
23												X																			

Notes

The food groups and external exposure pathways marked with a cross are combined for the corresponding combination number. For example, combination number 1 represents an individual (or individuals) from Annex 1 who had positive data in the following pathways; wildfowl, potato, domestic fruit, cattle meat, and poultry.