Radiological Habits Survey: HMNB Clyde (Faslane & Coulport) 2016

Public Report

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Contents

List of abbreviations and definitions viii

Units viii

Summary ix

1. Introduction 1

1.1 Regulatory Context 1

1.2 Definition of the Representative Person 2

1.3 Dose Limits and Constraints 2

1.4 Habits Survey Aim 3

2. The Survey 5

2.1 Introduction 5

2.2 Site Activity 5

2.2.1 Current Activity 5

2.2.2 Prospective Site Activity 6

2.3 Estimated Activity Concentrations from Licensed Discharges from HMNB Clyde and RNAD Coulport 6

2.4 Survey Areas 8

2.5 Land Cover Data 9

2.6 Soil Data 9

2.7 Topographic Wetness Index 14

2.8 Agricultural Production 16

3. Methods 18

3.1 Introduction 18

3.2 Postal Survey 18

3.3 Radiometric Surveys 19

3.3.1 In Situ Dosimetry 19

3.3.2 Beta Dosimetry 19

3.3.3 Sampling 19

3.4 GPS Tracking 19

3.5 Conduct of the Survey 20

3.6 Meetings and Informal Contacts 20

3.7 Data Conversion 21

3.8 Data Rounding and Grouping 21

3.9 Qualitative and Quantitative Observations 23

3.10 Dose Assessment Tool 23

4. Postal Survey 26

4.1 Introduction ... 26
5. Aquatic Radiation Pathways ... 28
5.1 Introduction ... 28
5.2 Aquatic Survey Area Descriptions ... 28
5.3 Commercial seafood operations and controls ... 28
5.4 Non-commercial fishing and angling ... 29
5.5 Wildfowling ... 30
5.6 Sailing ... 30
5.7 Royal National Lifeboat Institute ... 31
5.8 Professional dog walkers ... 31
5.9 Animals grazing ... 31
5.10 Seaweed and foraging ... 32
5.11 Internal Exposure ... 32
5.11.1 Adult Consumption Rates ... 32
5.11.2 Children and Infant Consumption Rates ... 34
5.12 External Exposure ... 36
6 Terrestrial Radiation Pathways ... 40
6.1 Introduction ... 40
6.2 Terrestrial Survey Area Descriptions ... 40
6.2.1 Rosneath Penninsula ... 40
6.2.2 Glen Fruin ... 40
6.3 Private Food Production ... 41
6.4 Commercial Food Production ... 42
6.5 Wild Foods ... 42
6.6 Production of Honey ... 43
6.7 Other pathways ... 44
6.8 GPS Survey Results ... 45
6.9 Internal Exposure ... 45
6.9.1 Internal Exposure Adult Consumption Rate ... 45
6.9.2 Children and Infants' Consumption Rates ... 48
7 Direct Radiation Exposure ... 51
7.1 Introduction ... 51
7.1.1 Mobile Gamma Survey Results ... 52
7.2 In-Situ Gamma Dosimetry ... 57
7.2.1 Terrestrial areas ... 57
7.2.2 Intertidal areas ... 58

7.3 In-Situ Beta Dosimetry 61
7.4 Sample Analyses 61
7.5 Occupancy Rates 62
7.5.1 Occupancy Data for the Survey Area 62
7.5.2 2016 Occupancy rates within 1km of HMNB Clyde (indoors/outdoors work or home) 64
8 Phase 2 Surveys 66
8.1 Introduction 66
8.2 Terrestrial - internal 66
8.3 Aquatic – internal 67
8.4 Aquatic/intertidal - external 68
8.5 Handling of equipment and handling of sediment 69
8.6 Occupancy – working and living within 1 km of site 70
9. Comparisons with the Previous Survey 71
9.1 Introduction 71
9.2 Aquatic Survey 71
9.2.1 Phase 1 - Adult Consumption Rates – Internal Exposure 71
9.2.2 Phase 1 - Children and Infants' Consumption Rates – Internal exposure 72
9.2.3 Phase 1 - Adult Intertidal/Aquatic Occupancy – External exposure 73
9.2.4 Phase 1 – Children and Infants Intertidal/Aquatic Occupancy – External Exposure 74
9.2.5 Phase 1 – Handling equipment and handling sediment 74
9.3 Terrestrial Survey 75
9.3.1 Phase 1 – Adult Consumption Rates – Internal Exposure 75
9.3.2 Phase 1 – Children and infants consumption rates - Internal exposure 76
9.4 Direct Radiation Survey 78
10. Dose Assessment 79
10.1 Dose Assessment for Phase 1 Survey 79
10.1.1 Aquatic radiation pathways 79
10.1.2 Terrestrial radiation pathways 79
10.1.3 Overall combined radiation exposure for the Phase 1 survey 80
10.2 Dose Assessment for the Phase 2 Survey 80
10.2.1 Aquatic radiation pathways 80
10.2.2 Terrestrial radiation pathways 81
10.2.3 Overall combined radiation exposure for the Phase 2 survey 81
10.3 Dose comparison of the Phase 1 and Phase 2 surveys 82
11. Recommendations and Suggestions for Monitoring Programme Changes 83

11.1 Introduction ... 83
11.2 Ongoing Monitoring ... 83
11.3 Conclusions and Recommendations ... 83
References ... 85
APPENDICES ... 87
Appendix A1 Raw Data ... 87
Appendix A2 Postal Survey ... 129
Appendix A3 Mobile Gamma Spectrometry System ... 129
Survey Area ... 130
Appendix A4 In-Situ Gamma Dose Rate Measurements ... 131
Appendix A5 Beta Skin Dosimetry Measurements ... 132
Appendix A6 GPS Tracker Device ... 132
Appendix A7 Postal Survey Results ... 133
Terrestrial – External Exposure ... 133
Aquatic – External Exposure ... 134
Intertidal – External Exposure ... 136
Internal Exposure ... 137
Appendix A8 Aquatic site descriptions and observations ... 140
A8.1 Cove Bay, Kilcreggan Bay, Portkil Bay and Mieklecross Bay ... 140
A8.2 Rosneath Point, Culwatty Bay, Castle Bay and Rosneath Bay ... 142
A8.3 Rosneath, Clynder, Rahane, Mambeg and Rockville ... 145
A8.4 Garelochhead ... 147
A8.5 Faslane Naval Base ... 149
A8.6 Shandon and Rhu ... 149
A8.7 Helensburgh, including Cairndhu Point ... 153

List of abbreviations and definitions

BSS	Basic Safety Standards
CEFAS	Centre for Environment, Fisheries and Aquaculture
DCC	Dose conversion coefficient
DORIS	Dispersion of Radionuclides into the Sea
DNSR	Defence Nuclear Safety Regulator
ERL	Environmental Radioactivity Laboratory, University of Stirling
GPS	Global positioning system
HMNB Clyde	Her Majesty's Naval Base Clyde
HSE	Health and Safety Executive
ICRP	International Commission on Radiological Protection
ILB	In-shore lifeboat
LOD	Limit of Detection
MoD	Ministry of Defence
MoGSS	Mobile Gamma Spectrometry System
NA	Not Applicable
NC	Not Consumed
ND	Not Determinable
NDAWG	National Dose Assessment Working Group
NI	Not Identified
ONR	Office of Nuclear Regulation
PC-CREAM	Consequences of Releases to the Environment: Assessment. Methodology
RIB	Rigid Inflatable Boat
RIFE	Radioactivity in Food and the Environment
RNLI	Royal National Lifeboat Institute
RSA	Radioactive Substances Act 1993
RYA	Royal Yacht Institute
SEPA	Scottish Environment Protection Agency
SGAS	Scottish Government Agriculture Statistics
UKAS	United Kingdom Accreditation Service

Units

Bq - Becquerel
Gy - gray
Sv – Sievert
kg - kilogram
g - gram
l - litre
m - metre
eV – electron-volt

y - year
h - hour
k - kilo
M – mega (one million; E6)
m – milli (one thousandth; E-3)
µ – micro (one millionth; E-6)

Summary

This report presents the results of the 2016 habits survey to determine the habits, occupancy and consumption patterns of people living and undertaking recreational activities in the vicinity of Her Majesty's Naval Base (HMNB) Clyde, which comprises the Faslane Naval Base and the Royal Naval Armaments Depot (RNAD) at Coulport. The site is authorised to discharge both gaseous radioactive waste as well as liquid radioactive waste. Liquid waste is discharged from HMNB Clyde, there are also sources of direct radiation at this location. Gaseous waste is discharged from the RNAD at Coulport.

The survey targeted three areas that were likely to be affected by discharges from the site, defined as;

- An aquatic survey area; covering the intertidal areas and waters of the Gare Loch to the end of Rosneath Point on the western side and to Helensburgh Pier on the eastern side. This was extended to Cove on the western side of the Rosneath Peninsula.
- A terrestrial survey area; this included the 5 km zone to the east of HMNB Clyde and the Rosneath Peninsula to the west of Gare Loch.
- The direct radiation survey area; extending a 1 km zone of HMNB Clyde which relates to ionising radiation emanating directly from the site.

Interviews with members of the public were carried out over a period of 12 days split into two periods, the first conducted between 2nd – 8th May and the second repeated between 14th – 18th July at both terrestrial and coastal sites to assess the seasonal difference between the pre-school holiday period and the local school holiday period. A total of 249 individual surveys are presented and discussed. Those high-rate individuals are identified using established methods comprising a 'cut-off' to define the high-rate group and 97.5th percentiles for dose assessment analysis. The face-to face surveys were followed up in the November of 2016 as a means of validation and are discussed within the report. The two survey periods are referred to as Phase 1 (14 day interview period in May and July) and Phase 2 (validating surveys undertaken in November 2016).

The aquatic survey area

Fish and molluscs are consumed by adults within the survey area. The mean consumption rates for adult high-rate groups for each of these food groups were:

- 201 kg y^{-1} for fish (cod, mackerel, pollock, dogfish, sea trout, fresh water trout and wrass)
- 13 kg y^{-1} for crustaceans (brown crab and lobster)
- 0.9 kg y^{-1} for molluscs (mussels)
- 1 kg y^{-1} for wildfowl (Teal)

Seaweed was found to be used by seven individuals collected from the shores at Garelochead, Cove Bay, Clynder and Helensburgh beach for use as a fertiliser on their gardens (for vegetables). One individual was found to collect seaweed (4 kg y^{-1}) for their own consumption.

The mean rates for the adult high-rate group for occupancy within the aquatic survey area were:

- 823 h y^{-1} for intertidal activities
- 106 h y^{-1} for activities in the water
- 1 232 h y^{-1} for activities on the water
- 568 h y^{-1} for handling of equipment
- 549 h y^{-1} for handling of sediment

A total of 23 in-situ gamma dose rate measurements were made over intertidal surfaces.

The terrestrial survey area

The mean consumption rates for the adult high-rate groups for terrestrial foods were:

- 29.9 kg y^{-1} for green vegetables
- 16.9 kg y^{-1} for other vegetables
- 43.7 kg y^{-1} for root vegetables
- 99 kg y^{-1} for potatoes
- 106 kg y^{-1} for domestic fruit
- 12 kg y^{-1} for wild fruit
- 1 kg y^{-1} for wild fungi

- 28.8 kg y^{-1} for beef
- 22 kg y^{-1} for game
- 3.8 kg y^{-1} for poultry
- 29.4 kg y^{-1} for sheep
- 17.7 kg y^{-1} for eggs
- 40 kg y^{-1} for honey
- 700 l y^{-1} for water

The direct radiation survey area

The highest occupancy rates in the direct radiation area were as follows (holidays taken into account):

- 8 760 h y^{-1} for the total occupancy rate (for a resident)
- 8 578 h y^{-1} for the indoor occupancy rate (for a resident)
- 6 616 h y^{-1} for the outdoor occupancy rate (for a resident)

A significant portion of the direct radiation survey area was surveyed by carborne and back-pack gamma spectrometry.

Suggestions for changes to the monitoring programme

The following suggestions for changes to the current environmental monitoring programme are provided for consideration;

- Seaweed (Cairndhu Point), mushrooms (Rosneath Peninsula) and clover, dock leaves and dandelion leaves (Whistlefield) may be worth considering for inclusion in either one off or the routine monitoring programmes.
- It is recommended to continue monitoring mussels and winkles.

1. Introduction

1.1 Regulatory Context

Her Majesty's Naval Base (HMNB) Clyde encompasses two sites, the Faslane Naval Base and the Royal Naval Armaments Depot (RNAD) at Coulport, Argyll. HMNB Clyde is owned and operated by the Ministry of Defence (MoD) in partnership with Babcock Marine and operates under Section 42 of the Radioactive Substances Act 1993 (RSA'93), which exempts Ministry of Defence (MOD) activities. Instead HMNB Clyde have a letter of agreement with the Scottish Environment Protection Agency (SEPA) that provides the equivalent licensing conditions of RSA '93 under the Control of Pollution Act. The impact of the waste produced needs to be monitored under the requirements of Article 35 of the Basic Safety Standards (BSS) 96/29 Euratom and to ensure that the doses to the representative person (Section 1.2) are below both 1 mSv committed effective and the 50 mSv skin annual dose limit. HMNB Clyde is regulated by the Scottish Environment Protection Agency (SEPA), the Office of Nuclear Regulation (ONR) and by the MoD's nuclear regulator, the Defence Nuclear Safety Regulator (DNSR). The DNSR regulates the nuclear and radiological safety for nuclear defence programmes with a primary focus on those aspects that are exempt from legislation.

HMNB Clyde discharges radioactivity into the environment which may result in the exposure of the public by three primary sources:

(i) discharges to the aquatic environment;
(ii) discharges to the atmosphere; and,
(iii) direct exposure from the site.

From these sources, members of the public may be exposed directly to radiation shine from the licensed site or through inhalation and/or indirectly due to exposure to contaminated materials and primarily foodstuffs (Smith and Jones, 2003). It is also recognised that enhanced doses from external exposure due to regulated discharges and the consumption of locally sourced foods may occur as a result of contemporary and historical discharges being concentrated through natural processes leading to environments with elevated concentrations of anthropogenic and technologically enhanced radioactivity (Dale *et al.,* 2008; Tyler *et al*., 2013; Tyler *et al*., 2009; Tyler *et al.,* 2006).

1.2 Definition of the Representative Person

The optimal approach for assessing doses to the public is through a combination of site-specific habit data and an environmental monitoring programme to determine ambient dose rates and concentrations in foodstuffs. In addition to the various interactions an individual may have with exposure routes, the actual doses received are also dependent upon age, size and metabolism. Thus, the standard approach is to identify and consider these sources of variability in appropriate groups. The concept of the *representative person* was introduced by the International Commission on Radiological Protection, (ICRP), (2006) and recommended to replace the previously used concept of the *critical group* in 2007 (ICRP, 2007). The *representative person* is the individual that represents the more highly exposed members of the public and is typically defined by a cut-off, for example the top 97.5 % of the dose distribution within one or more routes of exposure. Within this concept, if the dose received by the *representative person(s)* can be demonstrated to be within the accepted dose limits and constraints, then the general public are considered to be protected.

1.3 Dose Limits and Constraints

The system of dose limitation recommended by ICRP (2007), and subsequently by the Radioactive Substances Basic Safety Standards (BSS), requires that dose equivalents received by individuals shall not exceed the limits set out in Article 13 of Council Directive 96/29/Euratom (CEC, 1996).

The *retrospective* maximum permissible dose limits are set out as 1 mSv yr^{-1}. For *prospective* assessments, the maximum permissible doses or constraints used by SEPA are:

(i) 0.3 mSv yr^{-1} for any single source of radioactivity, and
(ii) 0.5 mSv yr^{-1} for a single site from which radioactive discharges are made.

It is also accepted by the UK Government that it should be possible to operate existing nuclear facilities without exceeding the 0.3 mSv yr^{-1} constraint (Hunt *et al.,* 1982; Leonard *et al.,* 1982; Sherlock *et al.,* 2006). It is therefore incumbent upon SEPA to ensure that these dose limits/constraints are not exceeded for all authorised discharges of ionising radiation to the environment.

1.4 Habits Survey Aim

The aim of the habits survey is to collect site specific data to allow a bespoke assessment to be made that identifies the representative individual(s). The identification of the representative person is a result of combining known information on the consumption of local foods and occupancy times with data from SEPA's routine environmental monitoring programme. The survey aims to collect data on the consumption rates of locally grown foods and occupancy times to identify the doses to the most representative person(s). The survey also aims to identify any habits which the routine programme does not currently adequately cover and may recommend the adoption of new monitoring due to new or changing habits or the removal of monitoring that is no longer required. The survey does this by:

(i) Collecting data on a range of habits/activities by the general public in the environment immediately surrounding the nuclear site and surrounding areas that might lead to exposure to radioactivity or radiation from any combination of licensed liquid or gaseous discharges, or direct radiation from on-site activities at HMNB Clyde;

(ii) Collecting information on consumption of food grown or produced (including wild & free foods) in the survey area and determining an annual rate of consumption for each individual surveyed and household members of all ages; and,

(iii) Quantifying the amounts of radioactivity, radiation and subsequent doses to individual members of the general public as a result of the discharges or operations of the nuclear site.

This report presents the findings for the 2016 habits survey of the Faslane site (Faslane Naval Base and RNAD at Coulport). All raw data can be found in Appendix

A1. The previous survey was undertaken during the period 1st to the 10th August 2011 (Clyne et al., 2013).

2. The Survey

2.1 Introduction

This chapter describes the site characteristics including recent and prospective site activities, a dose assessment from licensed discharges to air and sea and the surrounding land cover characteristics. In preparation for the survey, a visit to the site and a meeting with the site operators was held in March 2016. A stakeholder meeting (which occur regularly and are organised by the site) in early March 2016 was also attended which helped to raise the profile of the planned postal survey, face-to-face surveys and focus groups within the local community.

2.2 Site Activity

2.2.1 Current Activity

HMNB Clyde was initially constructed during the Second World War as a Royal Naval Base, converting to a submarine base in the 1960s and home to the UK's nuclear deterrent. Her Majesty's Naval Base Clyde (HMNB Clyde), known throughout the Royal Navy as Faslane, is home to various classes of submarine and other naval vessels. The Royal Naval Armaments Depot at Coulport (RNAD Coulport), 8 miles from Faslane, stores, processes, maintains and issues equipment for the base. More than 6,500 civilians and naval service personnel work on the site. The base operates under the Defence Nuclear Safety Regulator (DNSR) of the Ministry of Defence (MoD). The Office for Nuclear Regulation (ONR) regulates activities at this non-licensed site under the Health and Safety at Work Act 1974 and relevant statutory provisions, principally the Ionising Radiations Regulations 1999, the Radiation (Emergency Preparedness and Public Information) Regulations 2001 and the Management of Health and Safety at Work Regulations 1999. The MoD has Crown Exemption therefore SEPA administratively apply the requirements of RSA'93.

The MoD and SEPA have agreed discharges of liquid and gaseous radioactive materials into the Gare Loch and around Coulport. Liquid waste is discharged from HMNB Clyde and gaseous waste from RNAD Coulport. In 2015, there were only three occasions when liquid waste was discharged into the Gare Loch. On each occasion, the discharge was made during the tidal window (one hour prior to high tide and three hours post high tide). The solid waste from HMNB Clyde consists of low level radioactive waste and is transported offsite for authorised incineration or reprocessing. Discharge limits have been set for cobalt, tritium and caesium at HMNB Clyde and exclusion zones have been established for fishing, boating and surfing.

The Faslane Harbour Master controls the movement of all non-naval vessels and leisure vessels are not permitted within the base area.

Onsite developments at HMNB Clyde since 2011 include the Valiant Jetty, a tide floating jetty, which is the berthing facility for the new A class submarines. This development does not affect existing public access restrictions and members of the public will be unable to have closer access to the site. The onsite accommodation is also being extended at HMNB Clyde to accommodate greater numbers of naval and support staff.

2.2.2 Prospective Site Activity

Construction for the new nuclear support hub is planned to begin in 2016 and is due to finish in 2018/19. The facility will bring all laboratories and related support facilities for the handling and disposal of radioactivity into a single building. The site liquid discharge point is planned to be moved one mile north, but will remain within the footprint of the existing base.

2.3 Estimated Activity Concentrations from Licensed Discharges from HMNB Clyde and RNAD Coulport

Permitted discharges of ^{3}H (1.0E+12 Bq y^{-1}), ^{60}Co (5.0E+8 Bq y^{-1}), alpha (2.0E+8 Bq y^{-1}, assessed as ^{239}Pu) and betas (5.0E+8 Bq y^{-1}, assessed as ^{137}Cs) from HMNB Clyde were used to calculate aquatic activity concentrations in water using the DORIS model within PC-CREAM (Public Health England, 2008). Assuming an effectively continuous release, activity concentrations were modelled in unfiltered seawater, fish, seaweed, crustaceans and molluscs, with outputs at 1, 5, 50, 500, 10 000 and 100 000,000 years. For all element dependent parameters (sediment distribution coefficients, KD and deep water), local compartment details (depth, coastline length, volumetric exchange rate, suspended sediment load, sedimentation rate, sediment density and diffusion rate) and regional model information (volume, depth, suspended sediment load, sedimentation rate, sediment density, diffusion rate) the default values of HMNB Clyde on PC-CREAM were used.

Activity concentration values reported at 50 years for unfiltered seawater in the immediate vicinity of HMNB Clyde were estimated to be:

^{3}H, 1.1E-2 Bq l^{-1}

^{60}Co, 3.54E-6 Bq l^{-1}

alpha, 1.89E-6 Bq l^{-1}

betas, 5.00E-6 Bq l^{-1}

Activity concentrations in different foodstuffs (Table 2.1) were estimated to be:

Table 2.1 Estimated activity concentrations in foodstuffs.

	^{3}H Bq kg^{-1}	**^{60}Co Bq kg^{-1}**	**alpha Bq kg^{-1}**	**betas Bq kg^{-1}**
Fish	1.01E-2	1.18E-3	9.46E-5	4.85E-4
Crustaceans	1.01E-2	1.18E-2	1.89E-4	1.46E-4
Molluscs	1.01E-2	5.90E-3	2.84E-3	1.46E-4

Atmospheric activity concentrations were also modelled using the PLUME model in PC-CREAM. The permitted discharges from Coulport were modelled and included ^{3}H (5.0E+10 Bq y^{-1}). PLUME was set to calculate activity concentrations released for a range of stack heights. The activity concentrations in air for discharges from Coulport from the 14.5 m stack height are reported here over a range of distances from 500 m to 25 km. Note that PC-CREAM does not model 0.5 m stack heights so the data are from a 14 m stack. The MET sampling scheme was applied using the default settings. However, the data extracted for the dose rates were based on the MET Pasquill D with rain category as being most typical of the UK weather and checked against Glasgow Airport Meteorological Office. The calculated activity concentrations in air are presented in Table 2.2.

Table 2.2 Calculated activity concentrations in air (Bq m^{-3}) for ^{3}H for a discharge of 5.0E+10 Bq y^{-1} respectively at a 14 m stack height.

Distance (m)	^{3}H
500	2.41E-3
1 000	7.69E-4
5 000	5.14E-5
10 000	1.70E-5
15 000	9.07E-6
20 000	5.88E-6
25 000	4.23E-6

Within PC-CREAM 08, ^{3}H is assumed not to deposit to ground and therefore there is no external terrestrial exposure to be given. The only dose that comes from ^{3}H is via inhalation of the contents of the plume.

2.4 Survey Areas

The modelling from PC-CREAM (Section 2.3) demonstrates very low activity concentrations within the Gare Loch as a result of liquid discharges from HMNB Clyde and in the surrounding environment from gaseous discharges from RNAD Coulport. The survey area for the 2016 habits survey was designed to encompass these marine and terrestrial environments and include the area of potential direct radiation shine from ionising radiation emanating directly from HMNB Clyde. These areas are consistent with the previous habits survey and are shown in Figure 2.1.

The survey areas focus on:

(i) The 1 km zone of HMNB Clyde which relates to ionising radiation emanating direct from the site;

(ii) The terrestrial survey areas included the 5 km zone to the east of HMNB Clyde and the Rosneath Peninsula to the west of Gare Loch. This included an assessment of terrestrial habits within the area of prevailing wind and areas of higher occupancy; and,

(iii) The aquatic survey areas include the intertidal areas and waters of the Gare Loch to the end of Rosneath Point on the western side and to Helensburgh Pier on the eastern side. The aquatic area from Rosneath Point to Cove Bay on the western side of the Rosneath Peninsula was also included.

2.5 Land Cover Data

The land cover is presented in Figure 2.2 HMNB Clyde is immediately surrounded by broadleaved and mixed woodland, which tends to dominate the low-lying areas surrounding the Gare Loch. These are interspersed by villages, isolated buildings and small pockets of land used for arable or horticulture. To the west of Faslane, the Rosneath Peninsula is dominated by coniferous woodland, rough low productivity grassland and small areas of dwarf shrub heath with some improved grassland on the western side of the Peninsula. To the east of Faslane, and with increasing altitude, broadleaved woodland gives way to rough low productivity grassland, dwarf shrub heath to acid grassland and small areas of montane habitat. The proportions of land cover types within the different survey zones are summarised in Table 2.3.

2.6 Soil Data

The soil data are presented in Figure 2.3. The topographically low lying parts of the survey, which have had marine influences in the past, are dominated by non-calcareous gleys and brown earths. With increasing altitude, the soil type is increasingly dominated by peaty gleys with some peaty podsols and undifferentiated peat

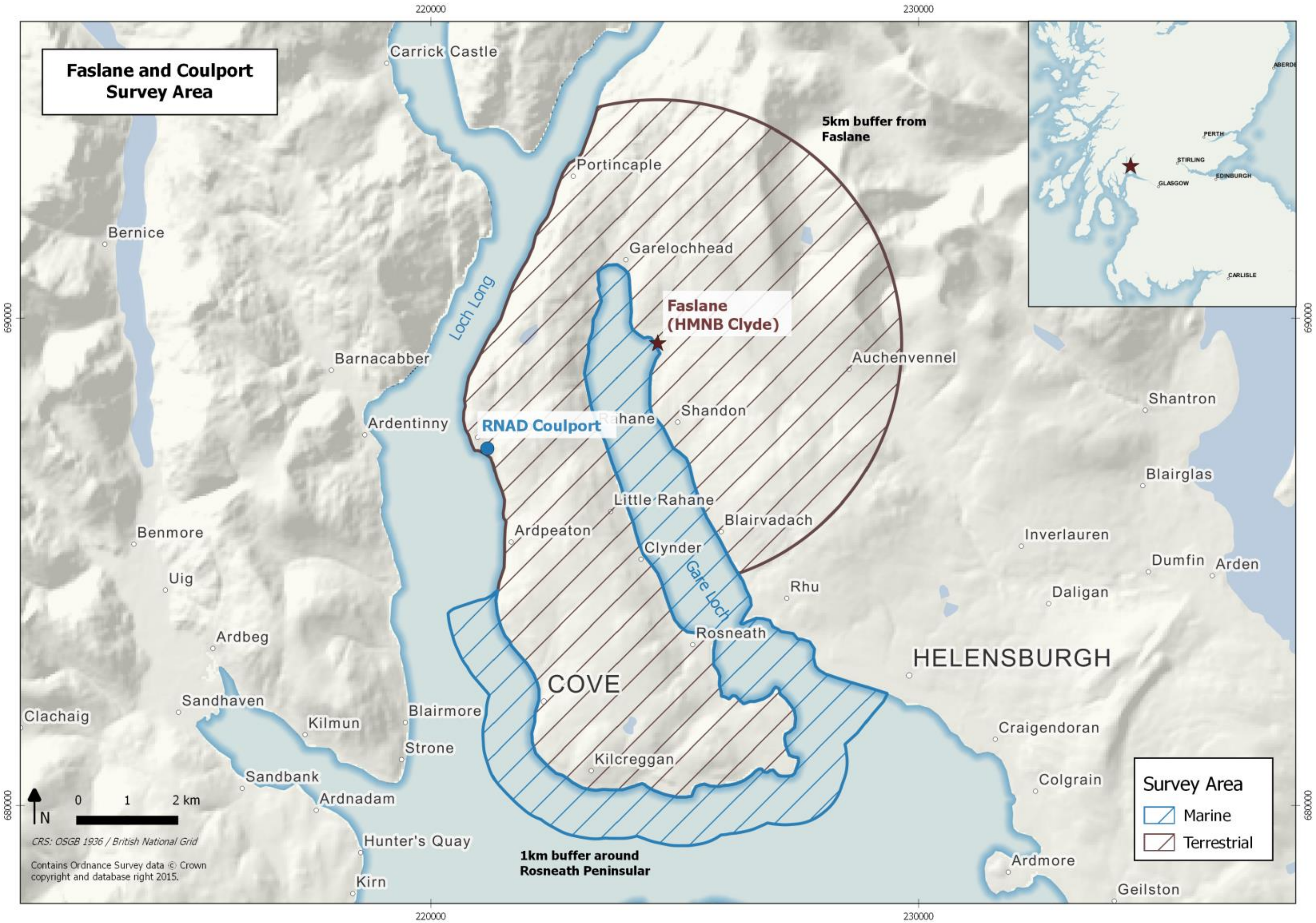

Figure 2.1 The survey areas for the 2016 HMNB Clyde Habits Survey.

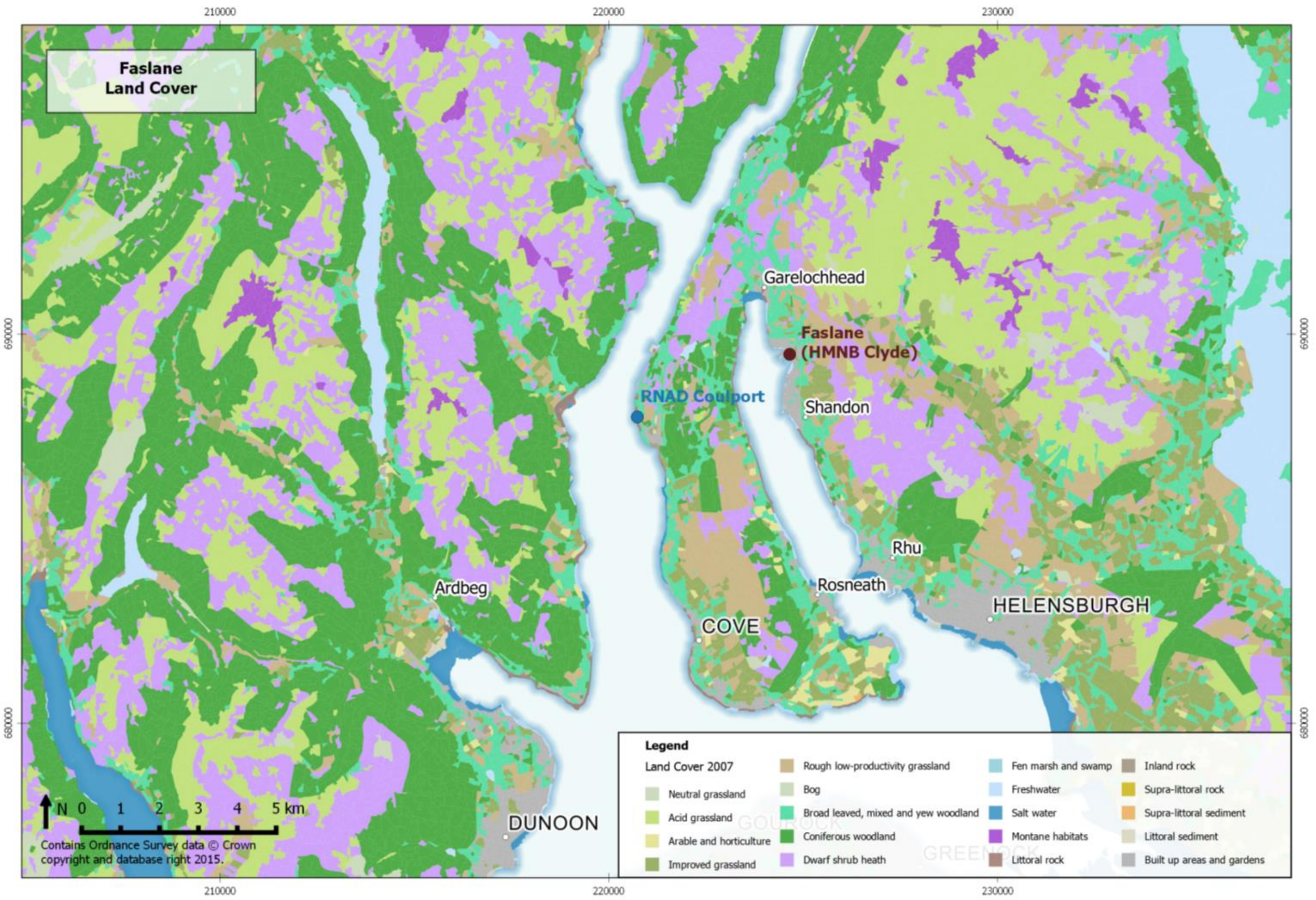

Figure 2.2 The land cover characterising the HMNB Clyde survey area and surrounds (Land Cover Map, 2007)

Table 2.3 Quantitative estimates for land cover types within the survey areas of interest with varying distances from site (1, 5 and 10 km).

	1 km	5 km	10 km
Broad Habitat	**Hectares**	**Hectares**	**Hectares**
Acid grassland	0	405	4 193
Arable and horticulture	0	48	243
Bog	0	0	85
Broad leaved, mixed and yew woodland	73	827	2 460
Built up areas and gardens	50	176	711
Coniferous woodland	1.0	1 805	7 054
Dwarf shrub heath	11	1 104	5 321
Freshwater	1.9	32	499
Improved grassland	31	290	1 376
Inland rock	0	4.6	19
Littoral rock	0.6	73	158
Littoral sediment	0	5.6	43
Montane habitats	0	45	316
Rough low-productivity grassland	40	670	2 033
Salt water	0.5	35	214
Supra-littoral rock	0	0	6.6
Supra-littoral sediment	0.6	3.3	10

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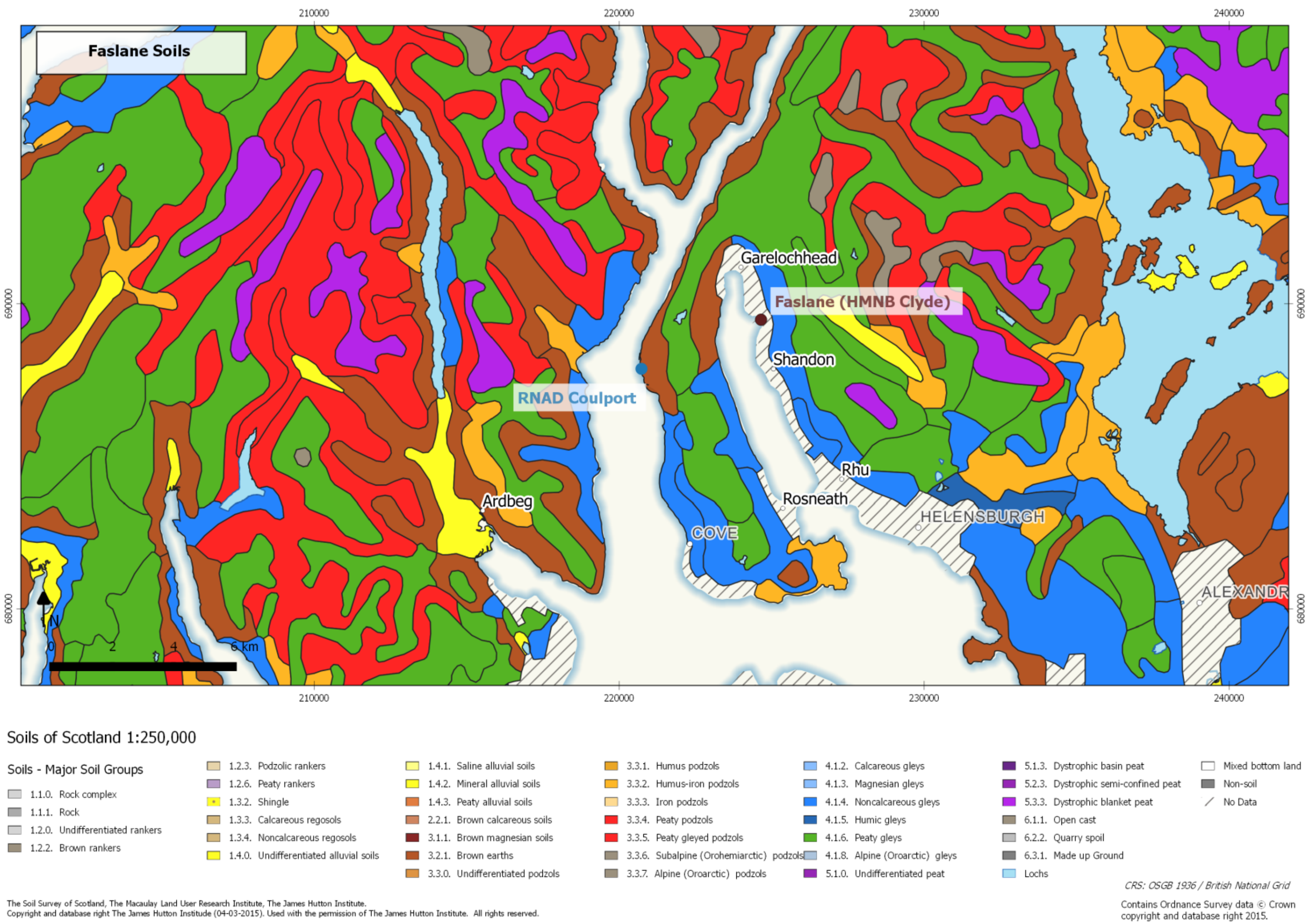

Figure 2.3 Soil types dominating the HMNB Clyde survey area (The Macauley Institute for Soil Research).

2.7 Topographic Wetness Index

Catchment hydrology can be important in the redistribution of radionuclides. For example, organic soils can allow radionuclides (e.g. ^{137}Cs from fallout) to be transported in solution as well as in particulate form. When these hydrological flow paths cross from organic to mineral rich soils, the radionuclides can become bound to clays and oxides within the soil matrices. In extreme conditions, these areas have been shown to result in elevated concentrations of radioactivity (Tyler and Heal, 2000). Building on the soil and 50 m resolution digital elevation model for Scotland using the OS Terrain 50 product, (50m resolution):

(https://www.ordnancesurvey.co.uk/business-and-government/products/terrain-50.html),

Figure 2.4 shows details of the hydrological flow paths within the survey area. The lighter area indicates low flow, water flowing away, whilst areas of increasing blueness represent wetter areas. This provides more detail of hydrological flow paths than would otherwise be possible from standard maps and highlights areas where radionuclides from atmospheric fallout might accumulate.

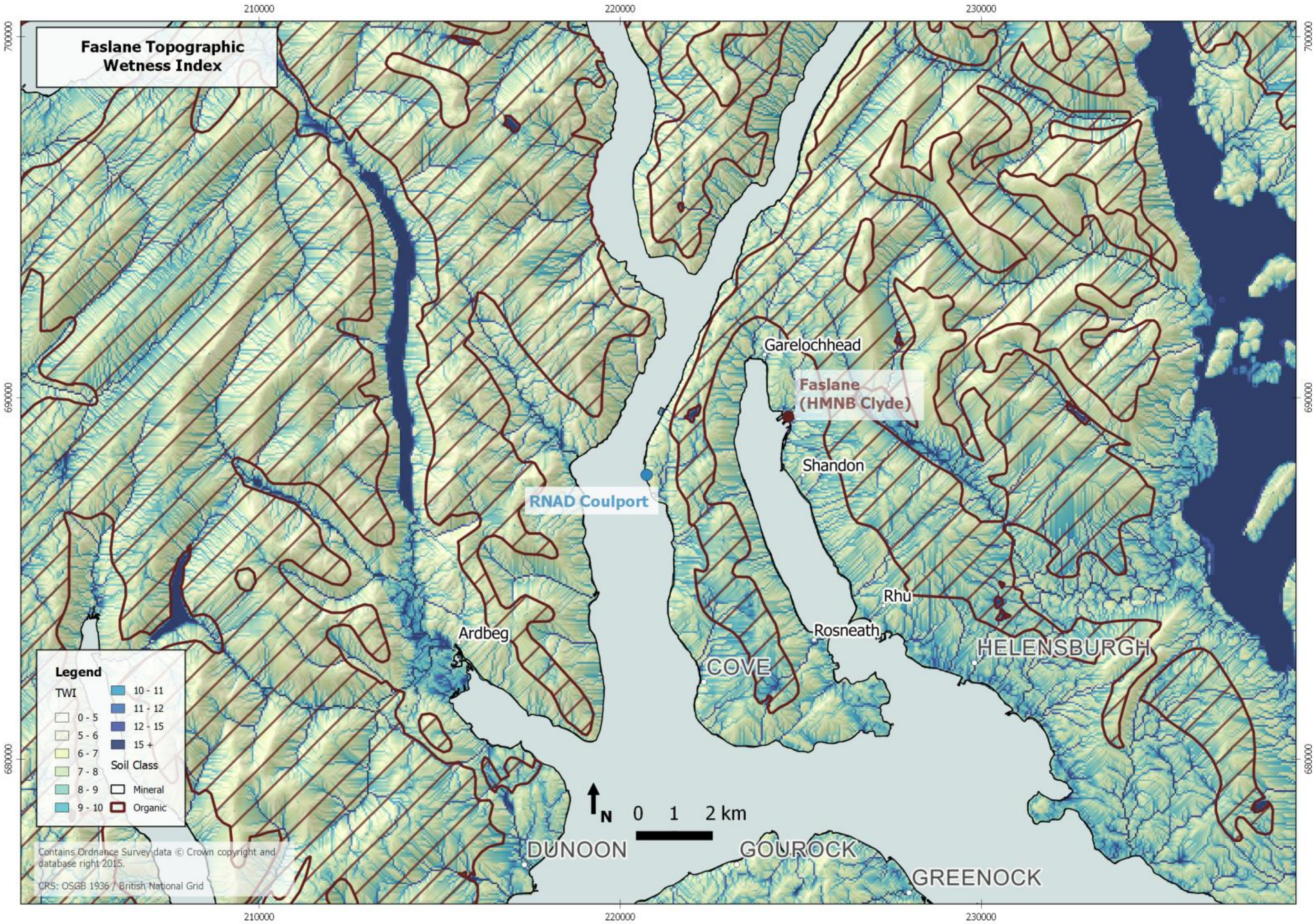

Figure 2.4 The Topographic Wetness Index in the HMNB Clyde survey area.

2.8 Agricultural Production

The Scottish Agricultural Census 2015 data for the parishes (defined by postcodes as used by the Scottish Government) surrounding HMNB Clyde have been assessed. Over 83 % of the agricultural area for arable production is given to grass and rough grazing. The data for the parishes surrounding HMNB Clyde are summarised in Table 2.4.

Almost 100 hectares of winter and spring barley and stock feeding crops are grown in the area with an additional four hectares given over to all other crops. Wheat, oats, potatoes, peas and beans are not commercially grown with approximately three hectares of land currently lying fallow.

Table 2.4 Summary of other agricultural land for HMNB Clyde (2015).

Cultivated, grazing and other	Holdings	Hectares
Grass under 5 years old	9	190
Grass 5 years and older	75	3 433
Rough grazing	79	28 503
Common grazing	0	0
Total grass and rough grazing	106	32 126
Utilised agricultural area	**108**	**32 233**
Woodland	55	4 912
Other land	59	1 424
Total Agricultural	**200**	**38 568**

Table 2.5 summarises the livestock production figures for 2015. The figures are dominated by sheep and of the 41 608 sheep a total of 17 210 are lambs. The next most dominant livestock is beef cattle. In addition, there are around 600 dairy cows, a few goats, over 100 farmed deer and twelve beehives in the area.

Table 2.5 Summary of the livestock production around HMNB Clyde (2015).

	Holdings	Hectares	Head
Total female beef cattle	34	28 682	1 392
Total male cattle	30	1 133	317
Total cattle	36		3 433
Total sheep	49	34 643	41 608
Total pigs	8	3 256	35
Fowls for producing eggs	12		2 490
Total poultry	14		2 640
Total horses	15		82

3. Methods

3.1 Introduction

To provide consistency and traceability to previous habit surveys, the methods employed and described in this chapter are largely based on the approach outlined in Leonard *et al.* (1982), Green *et al.* (2001) and National Dose Assessment Working Group (NDAWG) (2013). The previous habit surveys provided a useful frame of reference for undertaking this survey of HMNB Clyde. Chapter 2 described the desktop study undertaken to characterise and define the Habits Survey, including:

(i) a review of site activities
(ii) the modelling of the atmospheric and marine discharges from the site to define the survey area boundary
(iii) an assessment of the land cover and agricultural activity.

The 2016 Habits Survey of HMNB Clyde covers activities and food consumption. The survey introduced the following new methods:

(i) a mobile radiometric survey to characterise the heterogeneity of radiation in the environment surrounding HMNB Clyde;
(ii) GPS tracking on a limited number of volunteers to better understand the time spent by individuals as they interact with the environment; and,
(iii) information meetings during and after the face-to-face surveys to validate the data and findings.

3.2 Postal Survey

To obtain a provisional independent assessment of the activity and food consumption habits of the local community living within the study area through the survey, a postal questionnaire for households was designed, piloted and distributed to 2,000 households. The households were selected using a random sampling method utilising R Core Team (2016). The survey included question on food consumption, activities and a map for identifying the range of activities undertaken by household members. The sample included populations living within 20 km of the site. Further information can be found in Appendix A2.

3.3 Radiometric Surveys

The radiometric surveys comprised a carborne gamma spectrometry survey, in-situ gamma dosimetry and beta skin dosimetry. The carborne survey work is described in Appendix A3.

3.3.1 In Situ Dosimetry

The ERL has ISO 17025:2005 accredited procedures for the deployment and recording of gamma dose rate in air, using ISO 17025:2005 accredited (UKAS) calibrations for two Thermo Radeye instruments. Measurements were undertaken at all locations where occupancy or location may lead to higher exposure to radioactivity or radiations as a result of site activities. These included areas that may have elevated radionuclide concentrations where fine sediment is known to accumulate (e.g. salt marshes and mudflats). The effective dose from terrestrial gamma radiation was calculated and reported in $\mu Sv\ h^{-1}$. Further details of the in-situ methodology can be found in Appendix A4.

3.3.2 Beta Dosimetry

A ruggedized Thermo BP19RD /Electra instrument was deployed to assess the Beta dosimetry of skin dose [H'(0.07)]. The BP19RD provided a wide area monitor instrument (100 cm^2) and was used to monitor items that were potentially exposed to the higher radioactivity concentrations, i.e. close to licensed discharge points. Items monitored included external hulls of boats and fishing nets. Further details of the Beta skin dosimetry can be found in Appendix A5.

3.3.3 Sampling

Sample analysis of garlic and seaweed were undertaken. The results are detailed in Section 7.5.

3.4 GPS Tracking

Over a period of up to three days, GPS tracking units were provided to a number of individuals to provide empirical data on areas visited and duration. To ensure consistency in data a wearable GPS tracking device was considered the most suitable device for the HMNB Clyde habits survey. Further details of the system deployed are described in Appendix A6.

3.5 Conduct of the Survey

The pre-survey preparations involved a range of investigations with SEPA being contacted to discuss the requirements for the HMNB Clyde survey. Past surveys reports and maps for this site were investigated giving substantial and vital information. A directory of key groups involved in activities in the area was compiled from web searches and from contacting people within the local area with relevant knowledge pertaining to the survey. A proposed programme for the fieldwork being undertaken was then established and passed to SEPA for their view.

A meeting with HMNB Clyde site representatives provided details of the sites current activities, local information and the potential radiation pathways. The University of Stirling staff were invited to attend a stakeholders meeting which was between the site, local businesses and local residents within the area. This provided further relevant information and raised the profile of the habits survey.

3.6 Meetings and Informal Contacts

In the 2016 survey, a variety of data were gathered by a variety of approaches. This included holding a range of meetings including focus groups and sometimes using action-research techniques with relevant parties and individuals as well as a ‘standard’ face-to-face interview schedule. The multi-methods approach provided a means to ‘triangulate’ (verify) the data gathered through the different approaches: for example to check occupancy and activity data against the ‘snapshot’ observations recorded over a limited number of days in one season acquired from the individual face-to-face interviews. It also provided some additional information about local produce grown and consumed by householders, allotment owners, horticulturalists and farmers and consumption of particular types of local food such as honey and game. Such information also facilitated some snowballing of the survey because the individual meetings provided additional contacts to follow-up. These groups were approached prior to, during and after the face-to-face interviews by telephone and email.

Prior to the survey a directory of local groups, bodies and organisations relevant to the survey was compiled. The directory proved an invaluable resource through the survey period both for contacting groups and for use as a checklist against which responses and non-responses from potentially important groups with regard to activity, occupancy, exposure and local food consumption could be recorded. For future surveys, the directory will provide a useful starting point and a means of monitoring any changes in group/business or other activity in the area. The directory development required extensive web searches, follow-up telephone calls and use of earlier contacts across organisations and businesses.

3.7 Data Conversion

During the face-to-face interviews, data on food consumption were recorded in units provided by respondents (e.g. pounds, grams, and ounces) and later converted into kilograms per year. The weights provided are for the fresh weight prepared and consumed. In some cases, respondents were unable to estimate food consumption in kilograms per year and instead gave the number of plants grown and consumed or the length and number of rows. These data were converted into consumption rates using conversion weights where possible e.g. one broccoli plant yields 700g (Garden Forum Horticulture, 2009; Hessayon, 2014) so that all consumption figures were reported in kilograms per year. Some individuals were precise with the weight of some foods consumed with these figures mainly given as an annual consumption. Data from the paper copies of each survey were transferred to a bespoke database for analyses. The figures reported from individuals were utilised within the report with the percentage of any gifting or waste deducted from the final figure.

3.8 Data Rounding and Grouping

All data collected from the face-to-face and postal surveys were reported to two significant figures. For the food consumption data the total annual consumption (kg) of different food types were calculated by multiplying the quantity (kg) and frequency (times per year). The food items were placed into groups with similar attributes (Table 3.1). These groups are similar to those used in previous survey reports but focussed on the most common food items. Individuals were given the option to add any additional food items in ‘Other’ food category.

Table 3.1 Food groups used in Habits Survey

Food group	Example of foods within this group
Green leafy vegetables	asparagus, broccoli, brussel sprouts, cabbage, calabrese, cauliflower, celery, chard, herbs, kale, kohl rabi, lettuce, pak choi, rhubarb, marrow, spinach
Other domestic vegetables (legumes)	broad bean, french bean, pea, runner bean
Root vegetables	beetroot, carrot, celeriac, fennel, garlic, Jerusalem artichoke, leek, onion, parsnip, radish, shallot, spring onion, swede, turnip
Potato	Potato
Domestic fruit	apple, blackberry, blackcurrant, blueberries, corn, courgette, cucumber, gooseberry, grape, pear, pepper, plum, raspberry, redcurrant, strawberry, tayberry, tomato
Milk	milk, yoghurt, cheese
Cattle meat	beef, buffalo
Pig meat	Pork
Sheep meat	lamb, mutton
Poultry	chicken, duck, goose, turkey
Eggs	eggs
Wild/free foods	blackberry, chestnuts, crab apples, damson, dandelion root, garlic, elderberry, elderflower, nettle, raspberry, rowanberry, sloe, strawberry
Honey	Honey
Venison	Venison
Fish	bass, cod, Dover sole, kipper (herring), mackerel, pollock, salmon, sea trout, trout (freshwater)
Crustaceans	brown crab, common lobster, shrimps
Molluscs	mussels, razor clams, scallops, winkles
Wildfowl	mallard, pink-footed goose, teal, wigeon
Game - bird	partridge, pheasant, quail

The time individuals spent carrying out activities was calculated by multiplying frequency (occasions per year) and duration (hours) taking into account seasonality where appropriate. Individuals accounted for any holidays and working hours within their survey replies. In addition to food consumption a ‘liquid’ category was also added and individuals who carried out aquatic activities that could result in the inadvertent ingestion of water, e.g. outdoor swimming/sailing, were identified to account for this pathway where relevant. Water abstraction within this survey for human consumption was also included within this category.

The age groupings used in this report are based on International Commission of Radiological Protection (ICRP) recommendations and are listed below in Table 3.2

Table 3.2 ICRP age groups used in the dose assessment

Name of age group	Age range
Group 1 - Infant	0-5 year old
Group 2 - Child	6-15 year old
Group 3 - Adult	16 year old and over

3.9 Qualitative and Quantitative Observations

Whilst undertaking the face-to-face surveys, observational data were acquired on obvious changes to each location such as new build housing, along with information on site usage and numbers of individuals undertaking specific habits. Observations were acquired over a specified time period, e.g. 20 minutes, and on-shore and offshore (including intertidal) activities were noted. The number of individuals, their gender and their approximate age group undertaking each activity were also noted or estimated where large numbers were observed, e.g. beach activities. Some individuals were approached where possible and subsequent face-to-face surveys were conducted. Contact with individuals during face-to-face interviews frequently allowed the accuracy of observations to be checked and sometimes to be expanded: for example dog walkers might also engage in beachcombing and sailing at other times. Along with noting the weather conditions at the time of survey, this approach provided a basis for making a comparison with habits at different times and within and outwith the period of the local school holidays.

3.10 Dose Assessment Tool

The Habits Dose Assessment Spreadsheet Tool collated the data from the face-to-face survey for HMNB Clyde and then used the consumption rates and habits data to calculate the retrospective dose to each interviewed member of the public, covering the total exposure from all pathways. It should be noted that only the consumption of locally produced food has been included in the retrospective dose assessment (i.e. food from outwith the survey area is not included within the assessment). Dose assessment was carried out following the guidance in NDAWG and ICRP for the *Representative Person*.

Activity concentration values came from modelling HMNB Clyde discharges for 2014 using the default settings in PC-CREAM 08 (Public Health England, 2008) and measurements of samples collected in the field. Dose coefficients for different age groups are described by ICRP (2012). As described in Section 3.8, data for the 2016 HMNB Clyde Habits Survey were collected in three age groups. The dose conversion coefficients (DCCs) for each age group were taken from ICRP: Group 1 for infants; Group 2 for children; and Group 3 for adults.

The tool analyses four general exposure pathways:

(i) *Internal terrestrial*, which includes the consumption of locally produced meat, fruit and vegetables

(ii) *External terrestrial,* which determines the external doses from exposure to radiation present in the terrestrial environment as a result of deposition from atmospheric discharges and direct exposure through shine from on-site activities with radioactive materials

(iii) *Internal aquatic*, which includes consumption of fish, crustaceans, molluscs and inadvertent ingestion of seawater. A proxy for inadvertent drinking of water was calculated by multiplying the time spent on aquatic activities by the known average of water ingested in such activities as described in Leonard *et al.* (2015) and Stone *et al.* (2008)

(iv) *External aquatic,* which estimates the dose from external exposure through aquatic activities e.g. from radionuclides present in the aquatic environment (in water and sediments in saltmarshes or intertidal areas)

The direct exposure to shine from on-site activities was included in the analysis using in-situ measurements. These data were used to calculate direct exposure to members of the public that regularly travelled through the site.

The representative person was calculated independently for the total consumption and habits first and then by each exposure pathway. To identify the representative person, the 97.5 percentile rate cut off method was applied (Chapter 1). The representative person was calculated separately for external terrestrial and external marine exposure, internal terrestrial and internal marine consumption related exposure. The combined calculated total integrated all routes of exposure.

Limited monitoring data were available from the RIFE data. There were limited data for molluscs, beef, green leafy vegetables and honey for tritium and only mollusc for ^{60}Co and ^{137}Cs. The mollusc data were used for the fish category, the beef category (tritium) for pork, lamb and poultry and game (vension and rabbit) and green leafy vegetables (tritium) for other, root potatoes and fruit. SEPA's monitoring programme was found to be fit for purpose in the previous habits survey, as was determined during the 2016 survey.

4. Postal Survey

4.1 Introduction

The results from the postal survey provide an overview of the habits within the area centred on HMNB Clyde site extending approximately 20 km for the aquatic and intertidal areas and 5 km around the site for the terrestrial area.

Of the 2 000 postal surveys sent out to households in the survey area, 123 of these subsequently returned. Of those returned, 36 were either incomplete or illegible leaving a total of 87 complete responses for further analysis (a response rate of 4.35%). The postal survey proved useful for identifying popular activities along with the zone in which the respondent undertook specific activities. Households were asked to indicate how often and for how long they participate in certain activities. The respondents were further asked to indicate on a map where they undertake these activities (Figure 4.1).

The postal survey proved useful for identifying popular activities along with the zone in which the respondent undertook specific activities. This information was subsequently used to identify areas of high occupancy and inform the schedule for the face-to-face surveys. Zone 1 covered an area within 1 km of the HMNB Clyde site, Zone 2 was between 1 km and 5 km of the site and Zone 3 was between 5 km and 10 km of the site. It was not determined whether any repondents spending time in Zone 1 worked at the site but for the purpose of this survey it is assumed that the activities undertaken in Zone 1 were recreational and not work related to HMNB Clyde. The postal survey results are detailed in Appendix A7.

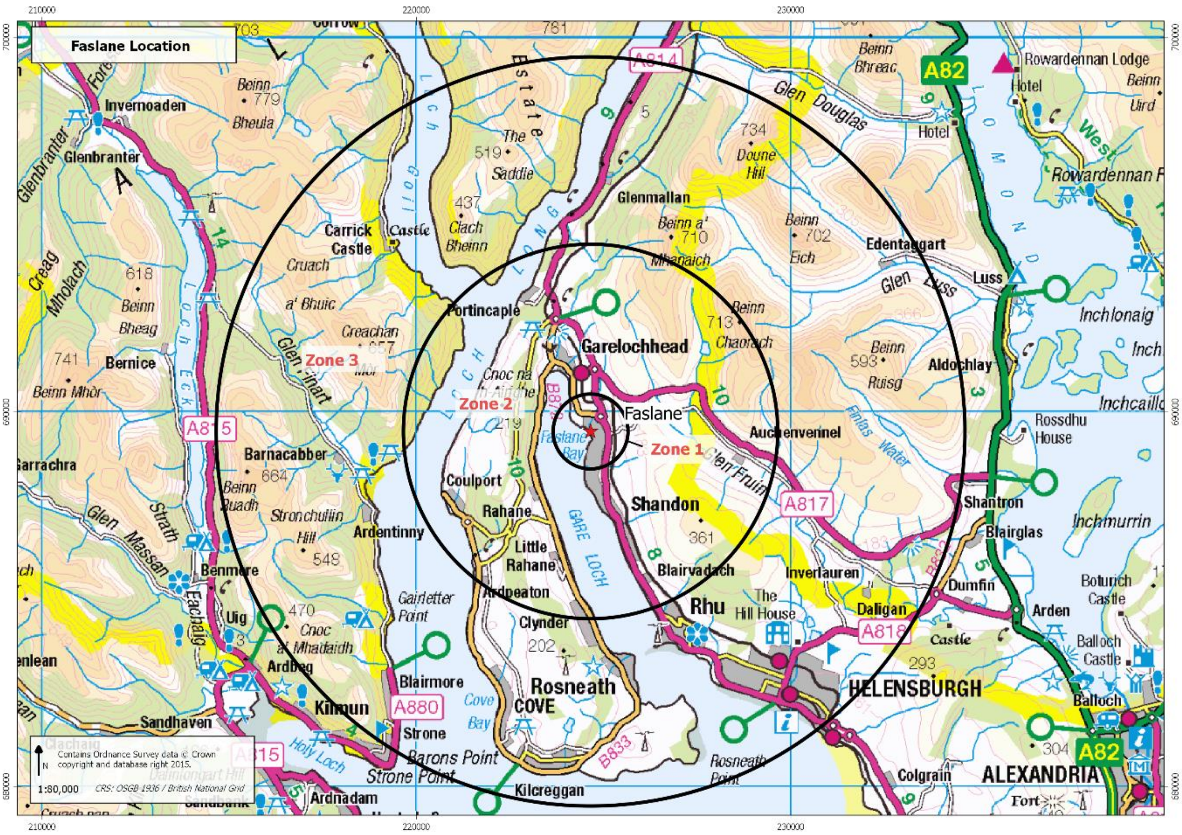

Figure 4.1. HMNB Clyde postal survey map showing the zones used to assess occupancy.

5. Aquatic Radiation Pathways

5.1 Introduction

The survey locations were established following a desktop review of the site characteristics presented in Chapter 2 and to allow effective comparison with the previous HMNB Clyde habits survey undertaken in 2011 (Rumney et al., 2011). The sites were visited during the survey periods and all activities observed offshore and onshore were recorded at each site. Each site was visited at different times of day according to the survey schedule, site activity and proximity to the HMNB Clyde site.

5.2 Aquatic Survey Area Descriptions

The survey locations were visited throughout the survey periods, outwith the school holiday period (between 2nd to 8th May) and during the local school holiday period (between 14th to 18th July). Offshore and onshore observations were undertaken at each site.

The aquatic survey area (Figure 2.1) covered all intertidal areas from Helensburgh Pier in the eastern side of Gare Loch stretching to Rosneath Point in the western side and to Garelochhead at the northern end of Gare Loch. The aquatic survey site was extended from Rosneath Point to Cove Bay due to the observation of habits that were noted to being undertaken in this area.

The survey sites are described systematically, starting from the western side of the survey area towards the eastern side. Site descriptions and observations are presented in Appendix A8.

5.3 Commercial seafood operations and controls

No trawling, creeling or net fishing was observed in the restricted channel at Rhu Narrows or in the protected or restricted areas at Faslane or Coulport. Rod fishing and fishing from a boat is permitted in the Gare Loch outwith the restricted area. One commercial trawler was identified that does fish in Loch Long and the water around the Rosneath Peninsula up to the restricted zone from Helensburgh Pier to Rosneath Point. The catch is langoustine where most of the catch is sold to France Spain, Italy and some reaching the Far Eastern markets. A small percentage is sold commercially locally within the survey area. A further six trawlers are reported to be moored at Greenock and Ardentinny that fish in the same areas, including Loch Long and the waters just outside the survey area around Rosneath Peninsula and Helensburgh Pier.

No commercial winkle collection was identified during the survey field work. It was reported however, as anecdotal evidence, that commercial winkle pickers do operate within the survey area for four weeks during the year. The survey team were unable to make contact with them and determine this.

Anglers were identified during both the May and July face-to-face survey periods, although none of them sold their catch commercially.

Within the survey area, a Pittenweem fish van sold produce but sourced their fish from the East Coast. The local fishmonger in Helensburgh sourced all fish from Peterhead and the Glasgow Market (who in turn source their fish from Aberdeen and Peterhead).

5.4 Non-commercial fishing and angling

Sea angling was identified in the Gare Loch with trout and mackerel the main species caught. The areas popular for fishing include Helensburgh Pier, along Helensburgh seafront, Rockville and Mambeg. Porkil Bay in the Rosneath Peninsula, west from Rosneath Point, was also observed to be a popular fishing area. Table 5.1 shows locations associated with hobby fishing activities.

Table 5.1 Locations associated with hobby fishing activities

Bait Digging	Fishing from shore/rocks/pier/kayak	Mollusc/crustacea picking (non-commercial)
Helensburgh beach front Garelochead	Helensburgh Pier Helensburgh seafront Garelochead Rockville Mambeg Castle Point Portkil Bay	Helensburgh beach

The Gare Loch and Loch Long Civil Service Angling Club were contacted and reported that very little fishing within the club is done in the Gare Loch due to reported low numbers of fish. There are approximately 15 members and there is a club boat but most fishing undertaken by its members is now sea fishing outwith the survey area.

Fishing was identified at Lindowan Reservoir and Mill Dam in the south of the Rosneath Peninsula. The fish are stocked from outwith the survey area and all fishing is undertaken with a catch and release policy.

It was reported to the survey team that mussels are collected and consumed from within the survey area. Three individuals interviewed consumed mussels which were sourced from within the survey area, with one individual at Helensburgh beach (0.9 kg y^{-1}) and two individuals at Cove Bay (0.2 kg y^{-1} each).

5.5 Wildfowling

A shooting club whose members shoot duck, goose, and wigeon operate on the intertidal area of the Clyde covering the area from Erskine to Helensburgh. They reported, however, that they do on occasions shoot within the survey area. The same club also shoot rabbit. Despite contacting the club on several occasions the survey team have been unable to obtain any further information. No other wildfowling activity was identified within the survey area though one individual reported to consume Teal from the coastal area around Cove.

5.6 Sailing

A sailing club within the aquatic survey area reported that regular meetings with approximately two hours is spent on the water within the survey area during each race meeting.

Helensburgh Sea Cadets launch from Faslane Naval Base and the Clyde Off-Site Media Centre (in Rhu). Children and adult members go out onto the water from mid-March until the end of October on a ‘week on week off’ rota spending approximately 4 hours (2 occasions of 2 hours in duration) on the water in a fortnight. They also go out every weekend. The boating area covers a four mile radius from the launching point. From the Naval Base they can sail anywhere in the Gare Loch and from the Clyde Off-

Site Media Centre, they can sail up to Helensburgh Pier. Boating activities are provided at both sites and cover sailing, power boating, rowing, sliding seats (sculling) and canoeing/kayaking (canoeing/kayaking is not undertaken from Faslane).

All boats are cleaned with freshwater on site and wetsuits are hosed down with freshwater to remove the salt water. Children take waterproofs and wetsuits home to clean. Life jackets are washed down with fresh water and stay on site after each sail.

5.7 Royal National Lifeboat Institute

Her Majesty's Coastguard and the Royal National Lifeboat Institute (RNLI) are located at Rhu Marina. The lifeboat at Rhu Marina is a small in-shore lifeboat (ILB) and, from a crew of 18 people, three go out on the ILB when there is a call out. The lifeboat crews have weekly training exercises for one to one and a half hours per session. Up to July 2016, at the time of survey, the lifeboat had been called out on 21 occasions. There are approximately between 35 and 42 call outs per year. In 10 % of these call outs, the crew are required to enter the water.

5.8 Professional dog walkers

Professional dog walkers operate within the survey area. These individuals will be active along the coastal strip for much longer periods in comparison to the 2010 survey. As dogs can enter the sea and areas of mud and sand, the group may potentially have greater exposure to intertidal substrates. One professional dog walker interviewed undertook terrestrial and intertidal walks. Typically the walks were one hour long and were undertaken three times daily. In this instance, however, the walks were undertaken outwith the survey area. A second professional dog walker and dog boarder was interviewed during the survey period and this individual undertakes six hours of dog walking daily all year. The walks are typically one hour in duration and encompass both terrestrial (three hours) and intertidal (three hours) areas in the eastern area of Rosneath Peninsula daily.

5.9 Animals grazing

Cows and sheep were observed grazing in several fields within and around the survey area. No cattle were observed grazing on seaweed or within intertidal areas anywhere within the survey area. However, several sheep and lambs were noted to be on the intertidal area just north of Cove on the western side of the Rosneath Peninsula and at Rosneath Bay. Evidence of cattle was noted at Meikleross Bay (Appendix A8).

5.10 Seaweed and foraging

Seven individuals interviewed reported to collect seaweed from Garelochead, Cove Bay, Clynder and the shore between Helensburgh and Rhu for use on their garden which was used to grow vegetables. An eighth individual collected seaweed from Ardmore shore south of Helensburgh to use on their vegetable allotment. Seaweed was also collected by one further individual interviewed for human consumption. The seaweed collected was sourced from Cairndhu Point within the survey area and from outwith the survey area on the shore of Loch Long. One further individual reported that they collected seaweed and that they typically consumed 4 kg annually. The seaweed collected from all parties was seaweed that was washed ashore and then harvested for its use.

5.11 Internal Exposure

5.11.1 Adult Consumption Rates

Table 5.2 presents a summary of the consumption rates for aquatic food types including; fish, crustaceans, molluscs and wildfowl. Mean adult consumption rates for the high-rate groups and the observed 97.5th percentile rates are included in Table 5.4. The high-rate group was determined using a ‘cut-off’ method described by Hunt *et al*., (1982). This ‘cut-off’ method calculates the high-rate value by taking the mean of the values between the maximum observed rate and one third of the maximum observed rate. Therefore, the ‘cut-off’ method within this report is represented as the individuals derived to obtain the ‘high-rate group’. The table also includes mean consumption rates and 97.5th percentile rates based on the full dataset. The generic mean and generic 97.5th percentile rates based on National Habit Data are also included (Smith and Jones, 2003). The national data is used to compare the high-rate mean and high-rate maximum consumers within the habits survey. During the course of the Faslane habits survey it became apparent that the national data does not consider any extreme habits of consumption. For example, there may be regional or local differences in habits which may result in very different rates of consumption, such as fish (Table 5.2), which is vastly greater than the national mean and may represent an important local pathway. It may be necessary to consider that the national data cannot capture local or regional variations in habits, which may have local significance within habits based assessments.

Adults consumed cod (4 individuals), mackerel (38 individuals), pollock (6 individuals), sea trout (4 individuals), trout (1 individual), wrass (1 individual), dogfish (1 individual) all sourced from within the aquatic survey area. It should be noted that some adults consumed more than one fish type. The observed maximum consumption (quantity multiplied by frequency) of fish was 201 kg y^{-1} and this individual consumed cod (3 kg y^{-1}), mackerel (126 kg y^{-1}), pollock (33 kg y^{-1}), dogfish (6 kg y^{-1}) and wrass (33 kg y^{-1}), all were self-caught on the coast near Rhu.

Crustacean consumption consisted of brown crab and common lobster. Of the crustaceans consumed, three individuals consumed brown crab and three individuals consumed common lobster. The highest consumption was 13 kg y^{-1}, this individual consumed common lobster (13 kg y^{-1}) sourced from Loch Long, outside the survey area, from a family member. Mollusc consumption consisted solely of mussels (three individuals) consumed by adults. The observed maximum consumption was 0.9 kg y^{-1} and this individual consumed mussels sourced from Helensburgh Beach. One individual was found to consume 1 kg y^{-1} of wildfowl (teal) and this was sourced from the coastal area around Cove. One individual consumed seaweed of unknown type (4 kg y^{-1}) sourced from Cairndhu Point.

Table 5.2 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 97.5th percentile (kg y^{-1})	Full dataset – Observed mean (kg y^{-1})	Full dataset – 97.5th percentile (kg y^{-1})	National Data mean (kg y^{-1})	National data 97.5th percentile (kg y^{-1})
Fish	41	1	201	201	201	201	11.5	47.9	15	40
Crustaceans	4	1	13.0	13.0	13.0	13.0	3.7	12.1	4	10
Molluscs	3	1	0.9	0.9	0.9	0.9	0.4	0.9	4	10
Wildfowl	1	1	1.0	1.0	1.0	1.0	1.0	1.0	ND	ND
Seaweed	1	1	4.0	4.0	4.0	4.0	4.0	4.0	ND	ND

5.11.2 Children and Infant Consumption Rates

Table 5.3 presents a summary of children and infants' consumption rates of fish, crustaceans, molluscs and wildfowl from the aquatic survey area. Mean consumption rates for the high-rate groups and the observed 97.5th percentile rates are included in Table 5.3. The high-rate group was determined using a cut-off method, those found at 80% and over were included in the high-rate group.

For the child age group mackerel and pollock were consumed. The observed maximum consumption of two individuals was found to be 0.5 kg y^{-1}, of which 0.25 kg y^{-1} was mackerel and 0.25 kg y^{-1} was pollock, which were sourced from the coastal area near Rhu. No consumption of crustaceans, molluscs or wildfowl was found for the child age group.

For the infant age group mackerel and pollock were consumed by infants'. The observed maximum consumption was 0.33 kg y^{-1}, of which 0.166 kg y^{-1} was mackerel and 0.166 kg y^{-1} was pollock, which was sourced from Cove Bay. Crustacean consumption consisted of brown crab and common lobster. Of the crustaceans consumed, four individuals consumed brown crab and the same four individuals consumed common lobster. The highest consumption was 0.33 kg y^{-1} (from all individuals) of which 0.166 kg y^{-1} was brown crab and 0.166 kg y^{-1} was common lobster sourced from Cove Bay. Mollusc consumption consisted solely of mussels (four individuals). The observed maximum consumption was 0.17 kg y^{-1} and the consumed mussels were sourced from Cove Bay. No consumption of wildfowl was found for the infant age group.

Table 5.3 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 95.7th percentile (kg y^{-1})	Full dataset – Observed mean (kg y^{-1})	Full dataset – 97.5th percentile (kg y^{-1})
Child age group (6 - 15 years old)								
Fish	9	9	0.50	0.20	0.33	0.50	0.33	0.50
Crustaceans	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Molluscs	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Wildfowl	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Infant age group (0 - 5 years old)								
Fish	4	4	0.33	0.33	0.33	0.33	0.33	0.33
Crustaceans	4	4	0.33	0.33	0.33	0.33	0.33	0.33
Molluscs	4	4	0.17	0.17	0.17	0.17	0.17	0.17
Wildfowl	0	0	0.00	0.00	0.00	0.00	0.00	NA

5.12 External Exposure

Occupancy rates for adults in intertidal, aquatic (in water), aquatic (on water), handling rates of equipment and handling rates of sediment can be found in Table 5.4.

Intertidal activities for adults included bait digging, beachcombing, boat maintenance, collecting mussels, collecting seaweed, dog walking, fixing moorings, horse-riding, paddling, playing, rock pooling, walking, litter picking, painting, bbq/picnicking, fishing, launching small boats, clearing trip lines, beach clean and Guides and Brownies events. The highest intertidal occupancy rate was 1 369 h y^{-1} for an individual who spent time dog walking (1 095 h y^{-1}) and horse riding (274 h y^{-1}).

Activities in the water included sub-aqua diving and outdoor swimming. The highest occupancy rate for adults in the water was 120 h y^{-1} for a respondent who undertakes outdoor swimming near Rockville in the Gare Loch. Activities on the water included sea and fresh water angling, boat maintenance, being on a dive boat, canoeing, commute via boat, rowing, safety boat duties, sailing, power boating, working on a boat and windsurfing**.** The highest occupancy rate for adults on the water was 1 872 h y^{-1} for a respondent who goes sailing (832 h y^{-1}), power boating (832 h y^{-1}) and undertakes boat maintenance (208 h y^{-1}) on the Gare Loch.

Adults were also found to handle equipment within the survey area; the activities for adults involved handling boats and boating equipment, handling of clothes and overalls and the handling fishing gear. The highest level of handling equipment was 1 027 h y^{-1}, This individual spent time handling clearing trip lines (208 h y^{-1}), sea-angling (39 h y^{-1}), boat maintenance (468 h y^{-1}) and boats and boating equipment (312 h y^{-1}). The highest level of handling sediment was 1 095 h y^{-1} and this is for individual who spent time dog walking (1 095 h y^{-1}). The occupancy data for intertidal activities were used for estimating the external gamma dose rate. Some intertidal activity occupancy data were also used to derive the handling sediment category which was then used for estimating the beta skin dose rate.

Table 5.4 Summary of adults' external exposure for intertidal, aquatic, handling of equipment and handling of sediment.

Activity	Number of observations	Number of people in the high-rate group	Observed maximum for the high-rate group ($h\ y^{-1}$)	Observed minimum for the high-rate group ($h\ y^{-1}$)	Observed mean for the high-rate group ($h\ y^{-1}$)	Observed 97.5th percentile ($h\ y^{-1}$)
Intertidal	77	6	1 369	520	823	1 305
Aquatic (in water)	6	2	120	91.3	105.6	119.3
Aquatic (on water)	64	4	1 872	832	1 232	1 819
Handling equipment	54	8	1 027	361	568	1 002
Handling sediment	61	14	1 095	365	549.2	1 019

Table 5.5 presents a summary of the children and infants' intertidal, aquatic (in water) and aquatic (on water) occupancy rates, handling rates of equipment and handling rates of sediment. Intertidal activities for children included beachcombing, paddling, fishing and playing on the intertidal area and beachcombing and playing for infants. The highest intertidal occupancy rate for children was 52 h y^{-1} for two individuals who spent time playing (26 h y^{-1}) and paddling (26 h y^{-1}). For infants', the highest intertidal occupancy was 104 h y^{-1} for an infant who spends time playing. Activities on the water included sea angling, canoeing and sailing. The highest occupancy rate for children carrying out activities on the water was 72 h y^{-1}. This individual goes sailing in the Gare Loch. For infants, the highest occupancy was 39 h y^{-1} for sailing. The highest level of handling equipment for children was 351 h y^{-1} and this was for a child that goes shore based fishing at Rhu Spit and Helensburgh. No infants' were found to handle equipment. The occupancy data for intertidal activities were used for estimating the external gamma dose rate. Some intertidal activity occupancy data were also used to derive the handling sediment category which was then used for estimating the beta skin dose rate.

The highest level for handling sediment for children was 52 h y^{-1} for two children for playing (26 h y^{-1}) and paddling (26 h y^{-1}). The highest level for infants' handling sediment was 104 h y^{-1} for an infant who spends time playing. No children or infants' were identified with an occupancy in the water.

Table 5.5 Summary of children's and infants' external exposure for intertidal, aquatic and handling of equipment

Activity	Number of observations	Number of people in the high-rate group	Observed maximum for the high-rate group (h y^{-1})	Observed minimum for the high-rate group (h y^{-1})	Observed mean for the high-rate group (h y^{-1})	Observed 97.5th percentile (h y^{-1})
Child age group (6 - 15 years old)						
Intertidal	12	1	353	353	353	353
Aquatic (in water)	0	0	0	0	0	0
Aquatic (on water)	6	5	72	29	41.6	68.7
Handling equipment	4	1	351	351	351	351
Handling sediment	12	7	52	36	46.6	52
Infant age group (0 – 5 years old)						
Intertidal	5	2	104	104	104	104
Aquatic (in water)	0	0	0	0	0	0
Aquatic (on water)	1	1	39	39	39	39
Handling equipment	0	0	0	0	0	0
Handling sediment	5	2	104	104	104	104

Gamma dose rate measurements over different substrates within the survey area can be found in Chapter 7.

6 Terrestrial Radiation Pathways

6.1 Introduction

Chapter 6 reports the inland routes of exposure immediately adjacent to HMNB Clyde, coastal and intertidal areas (refer to Figure 2.1). This chapter reports on the results from the face-to-face consumption levels for privately produced food stuffs.

6.2 Terrestrial Survey Area Descriptions

The terrestrial survey area consisted largely of the Rosneath Peninsula to the west of Gare Loch. Much of the land within the survey area is agricultural with either cattle or crops. The terrestrial survey also included Glen Fruin, which had several houses and farms scattered throughout the 5 km radius north and east from HMNB Clyde. The Glenn Fruin area was characterised by small conurbations with communities ranging from as small as single houses within the farming areas to villages.

The survey sites are reported from west to east.

6.2.1 Rosneath Penninsula

The Rosneath Penninsula is located between the Gare Loch on the east and Loch Long on the west projecting south to the Firth of Clyde. The area consists of small towns with some small conurbations with much of the peninsula woodland. There are some hill and woodland walks in the peninsula such as the Rosneath Peninsula West Heritage Trail, with much of it following coastal paths, and the Peaton Hill Nature Reserve.

6.2.2 Glen Fruin

Glen Fruin is hill area inland east of the Gare Loch with houses interspersed throughout the landscape. One individual stated that they noted that since HMNB Clyde water treatment works had been built some years ago, the Fruin Water level had significantly dropped. Previous to this they had observed otter, trout and salmon but since the water treatment works had been built, no otters and very few trout and salmon had been observed.

6.3 Private Food Production

No allotments were identified within the 5 km terrestrial survey area of HMNB Clyde. However, just outside the 5 km survey area are the Henry Bell Allotments situated on Henry Bell Street near the train line with 15 plots. Plot sizes are reported approximately to be 25 feet by 18 feet with two plots being split evenly into two. This determines 17 individuals (some being families) are working the plots. There is an active group here growing a variety of vegetables and fruit, which are consumed by the plot holders, friends and family. In addition, several kilometres south of Helensburgh are the Ardardan Allotments (as part of the Cardross Estate). Again, there is an active group growing a variety of vegetables and fruit consumed by the plot holders, friends and family. Following discussion with SEPA these data (from the allotments) have been included in the results.

During both the May and July survey periods, many individuals were found to produce a wide variety of fruit and vegetables within the survey area. Of those individuals interviewed some were specific with the yield of their products, many of which had a record of the amount of each vegetable and fruit planted and the yield. Face-to-face interviews indicated that much of the produce on the survey list were produced to varying degrees by one or more individuals with the food grown being consumed by their families and friends. Over the survey period, 120 people were interviewed who grew their own fruit and vegetables within their own home gardens. These individuals yielded data of sufficient quality for quantitative estimates of food quantities grown and consumed.

Within Helensburgh a local school promotes education and experience for children in the growing of vegetables and fruit. All pupils will consume some of the produce grown. This year some of the vegetables and fruit growing are tomatoes and cucumbers in their greenhouse and potatoes, peas and apples. All the produce is prepared and used within school meals as part of their healthy diet and is consumed by pupils.

6.4 Commercial Food Production

Local butchers were contacted and it was determined that one butcher sourced game locally and another butcher sourced some of its lamb locally. All other meat and produce was source from outwith the terrestrial survey area.

6.5 Wild Foods

Within the terrestrial survey area wild food foraging was reported by 65 individuals. A breakdown of the foods, number of individuals, consumption and locations are detailed in Table 6.1.

Table 6.1. Wild food summary of total number of individuals, highest annual consumption and locations

Food type	Total number of individuals	Highest annual individual consumption (kg y^{-1})	Location of highest consumption foraged	All other locations of foraging
Bilberries	1	0.02	Rosneath Peninsula	-
Blackberries	50	12	Glen Fruin	Cove, Clynder, Faslane, Garelochead, Kilcreggan, Portincaple, Rockville, Shandon
Clover	3	0.06	Whistlefield	-
Elderberry	7	0.15	Rosneath Peninsula	Garelochead
Elderflower	10	0.23	Shandon	Rosneath Peninsula, Garelochead
Mushrooms	4	1	Kilcreggan, Rosneath Peninsula, Shandon House	-
Dock leaves	3	0.06	Whistlefield	-
Raspberries	10	1	Rosneath Peninsula	Shandon
Rowan berry	2	4	Glen Fruin	-
Sloe berry	2	1	Rosneath Peninsula	-
Strawberries	2	0.1	Faslane	-
Wild garlic	10	0.5	Rosneath	Garelochead, Faslane, Cove
Dandelion leaves	3	0.06	Whistlefield	-
Wood sorrel	1	0.2	Faslane	-

6.6 Production of Honey

Beekeepers are not required to be a member of a bee keeping association or be registered. The precise numbers in HMNB Clyde survey area were therefore difficult to establish. The Helensburgh and District Beekeepers Association were contacted on several occasions prior to the survey period but were unable to provide any information. During the survey period eight beekeepers were identified with annual honey yields varying from 9.5 kg to 100 kg of which was for individual and family/friends consumption and for sale.

6.7 Other pathways

The Helensburgh and West Dumbartonshire Ramblers were contacted but no individuals were willing to comment on their activities.

Blairvadach Outdoor Centre based at Rhu provide cycling and hill walks. Some of the hill walks are within the survey area and are undertaken at Tom na h-Airidh and at Peaton Hill Nature Reserve, this is one area that is accessible to wheelchair users. Some cycling is also undertaken in the Rosneath Peninsula.

A private shooting syndicate operates between Cardross and Helensburgh. All members shoot and consume pheasant. Following discussion with SEPA, these data from individuals interviewed were included.

Luss Estates (Glen Fruin), organise pheasant shoots weekly. Individuals involved consume pheasant and the estate also supply game to a local butcher within the survey area. Game is also sold outwith the survey area to a game dealer.

Both gamekeepers for the Luss Estates are new in post this year and were unable to give any consumption of game as the season had not commenced at the time of the survey.

Ten farms were identified within the survey area on both the Rosneath Peninsula and within the 5 km terrestrial survey area on the eastern side of the Gare Loch. Some of the farms reported that lamb, beef and eggs were consumed by family members and gifted to friends. Venison, pheasant and pigeon was also reported to be consumed by family members. One farms water supply is from a private water supply. It is reported that this farm do not consume this water but the cattle and sheep consume ditch water. One other farm keep sheep which have access to ditch water.

6.8 GPS Survey Results

To provide more details on the use of the environment around HMNB Clyde survey area, five individuals were selected to wear GPS trackers based from the knowledge gained of their habits from the face-to-face interviews. Trackers were deployed for a period of several days. The trackers revealed that individuals tended to overestimate occupancy in the face-to-face surveys compared to what was determined with the tracker. The data however varied with individuals and it was determined that deploying the GPS trackers for a longer period than several days may be necessary to achieve a more robust comparison.

6.9 Internal Exposure

6.9.1 Internal Exposure Adult Consumption Rate

Consumption data for locally produced foodstuffs potentially affected by atmospheric releases from HMNB Clyde are presented in Table 6.2 for adults, Table 6.3 for children and Table 6.4 for infants.

Table 6.2 presents a summary of the adult consumption rates. The table summarises the number of observations made, the number of people in the high-rate consumer group, the minimum and maximum observed consumption rates for the high-rate consumer group and the observed 97.5% consumption rate. The table contains the mean consumption rate for both the high-rate consumer group and the whole dataset collected from around Faslane. In addition, the table also provides the mean and 97.5% consumption rates from national data (Smith and Jones, 2003) for comparison. The national data is used to compare the high-rate mean and high-rate maximum consumers within the habits survey. During the course of the Faslane habits survey it became apparent that the national data does not consider any extreme habits of consumption. For example, there may be regional or local differences in habits which may result in very different rates of consumption, such as domestic fruit and honey (Table 6.2), which is nearly double the national mean and may represent an important local pathway. It may be necessary to consider that the national data cannot capture local or regional variations in habits, which may have local significance within habits based assessments.

Consumption of locally produced foods was identified for all food groups with the exception of pork and milk.

Four observed mean consumption rates for the high-rate consumer group were found to be greater than the 97.5% value for the full 2016 dataset. These were for potatoes, fruit (domestic and wild) and water. Seven of the observed mean consumption rates for the high-rate consumer group were found to exceed the national 97.5 % consumption rate. These were for root vegetables, domestic fruit, wild fungi, game, sheep meat, honey and water. The remaining eleven groups (of food groups identified) for which data were collected in the 2016 survey were all found to have lower mean consumption rates for the high-rate consumer group than the national 97.5 % consumption rate.

Table 6.2 Summary of adult consumption rate of foods from the terrestrial survey area.

Food type	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 97.5th percentile (kg y^{-1} or l y^{-1})	Full dataset – Observed mean (kg y^{-1} or l y^{-1})	Full dataset –97.5th percentile (kg y^{-1} or l y^{-1})	National mean (kg y^{-1} or l y^{-1})	National 97.5th percentile (kg y^{-1} or l y^{-1})
Vegetables-Green	70	8	47	17.6	29.9	45	7.33	35.0	15	45
Vegetables-Other	53	9	26.8	9	16.9	26.5	4.38	23.2	20	50
Vegetables - Root	59	5	65	23.2	43.7	63.3	7.57	44.9	10	40
Vegetables - Potatoes	66	2	146	52	99	144	10.12	43.6	50	120
Fruit - Domestic	82	2	132	81.6	106	130	13.9	37.0	20	75
Fruit - Wild	52	2	16	8	12	15.8	1.74	7.24	7	25
Wild Fungi	4	4	1	1	1	1	1	1	ND	ND
Meat - Beef	10	4	34.3	27	28.8	33.8	13.5	32.7	15	45
Meat - Game	7	3	30	18	22	29.4	11.1	28.2	NA	NA
Meat - Poultry	1	1	3.75	3.75	3.75	3.75	3.75	3.75	10	30
Meat - Sheep	9	3	34.3	27	29.4	34.0	12.1	32.9	8	25
Meat - Pork	0	0	0	0	0	0	0	0	15	40
Eggs	42	17	36.2	12.1	17.7	36.2	10.8	35.8	8.50	25
Honey	22	2	40	40	40	40	5.28	40	2.50	9.50
Milk	0	0	0	0	0	0	0	0	95	240
Water	2	2	700	624	662	698	662	662	ND	ND

6.9.2 Children and Infants' Consumption Rates

Table 6.3 presents a summary of the children consumption rates. The table summarises the number of observations made, the number of people in the high-rate consumer group, the minimum and maximum observed consumption rates for the high-rate consumer group and the observed 97.5% consumption rate. The table also contains the mean consumption rate for both the high-rate consumer group and the whole dataset collected from around HMNB Clyde.

Child consumption of locally produced foods were identified for green, root and other vegetables, potatoes, domestic fruit, wild fruit, beef, eggs and honey. No consumption of locally produced wild fungi, game, poultry, sheep, pork, milk and water were observed.

Table 6.4 presents a summary of the infants' consumption rates. The table summarises the number of observations made, the number of people in the high-rate consumer group, the minimum and maximum observed consumption rates for the high-rate consumer group and the observed 97.5% consumption rate. The table also contains the mean consumption rate for both the high-rate consumer group and the whole dataset collected from around Faslane.

Infant consumption of locally produced foods was identified for green, other and root vegetables, potatoes, domestic fruit, wild fruit and eggs. No consumption of locally produced wild fungi, beef, game, poultry, sheep, pork, honey, milk and water were observed.

Table 6.3 Summary of children's consumption rates.

Food type	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 97.5th percentile (kg y^{-1} or l y^{-1})	Full dataset – Observed mean (kg y^{-1} or l y^{-1})	Full dataset – 97.5th percentile (kg y^{-1} or l y^{-1})
Vegetables-Green	7	7	3.75	2.25	2.96	3.75	2.96	3.75
Vegetables-Other	8	4	0.5	0.42	0.48	0.50	0.28	0.50
Vegetables - Root	7	7	2.27	0.97	1.48	2.27	1.48	2.27
Vegetables - Potatoes	8	3	15	15	15	15	7.07	15
Fruit - Domestic	9	7	6.80	3.90	5.51	6.80	4.76	6.80
Fruit - Wild	7	7	0.15	0.06	0.11	0.15	0.11	0.15
Wild Fungi	0	0	0	0	0	0	0	0
Meat - Beef	2	2	2.5	2.5	2.5	2.5	2.5	2.5
Meat - Game	0	0	0	0	0	0	0	0
Meat - Poultry	0	0	0	0	0	0	0	0
Meat - Sheep	0	0	0	0	0	0	0	0
Meat - Pork	0	0	0	0	0	0	0	0
Eggs	9	7	12.1	6.03	7.16	11.3	6.24	11.0
Honey	3	3	0.8	0.8	0.8	0.8	0.8	0.8
Milk	0	0	0	0	0	0	0	0
Water	0	0	0	0	0	0	0	0

Table 6.4 Summary of infants' consumption rates

Food type	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 97.5th percentile (kg y^{-1} or l y^{-1})	Full dataset – Observed mean (kg y^{-1} or l y^{-1})	Full dataset –97.5th percentile (kg y^{-1} or l y^{-1})
Vegetables-Green	5	1	4.33	4.33	4.33	4.33	1.31	3.96
Vegetables-Other	4	4	0.50	0.17	0.33	0.50	0.33	0.50
Vegetables - Root	5	2	5.50	5.50	5.50	5.50	3.01	5.50
Vegetables - Potatoes	5	5	15.00	5.13	9.08	15.00	9.08	15.00
Fruit - Domestic	3	3	32.5	11.3	25.5	32.5	25.5	32.5
Fruit - Wild	5	4	3.33	3.33	3.33	3.33	2.77	3.33
Wild Fungi	0	0	0	0	0	0	0	0
Meat - Beef	0	0	0	0	0	0	0	0
Meat - Game	0	0	0	0	0	0	0	0
Meat - Poultry	0	0	0	0	0	0	0	0
Meat - Sheep	0	0	0	0	0	0	0	0
Meat - Pork	0	0	0	0	0	0	0	0
Eggs	2	2	9.05	9.05	9.05	9.05	9.05	9.05
Honey	0	0	0	0	0	0	0	0
Milk	0	0	0	0	0	0	0	0
Water	0	0	0	0	0	0	0	0

7 Direct Radiation Exposure

7.1 Introduction

To estimate the dose received by the public around HMNB Clyde facility a gamma-ray spectrometry survey was undertaken. The survey had a particular focus on characterising the dose rate in a 1 km radius of the facility and additionally any potential access points to intertidal areas. In addition, all major roads and large sections of the coast were surveyed, covering more than 30 km.

To achieve this type of large-scale coverage, MoGSS was used to measure the differential contributions to the gamma dose rate, including the natural radioelements (^{40}K and the ^{238}U and ^{232}Th series) alongside estimates for anthropogenic ^{137}Cs. The ability to separate the contributors is especially important given that any potential contributions from ^{137}Cs could potentially be singled out from the spatial variability within the natural background. This type of capability is not possible using conventional gamma dose rate measurements. This approach however does not allow for the measurement of ^{3}H that is known to be released from the RNAD at Coulport.

MoGSS data were used to help target follow up in-situ terrestrial gamma dose rate measurements, which were undertaken at all face-to-face survey locations, access point to intertidal area or at any location where an apparent anomaly was observed. Beta dosimetry was undertaken over intertidal environments to estimate the skin dose associated with any anthropogenic radioactivity in the environment. Measurements were conducted in intertidal areas surrounding Gare Loch and the Rosneath peninsula that incorporates the Firth of Clyde. Measurements in these areas were made on fishing equipment, boats and articles of clothing that were frequently immersed in the waters of Gare Loch or the firth of Clyde.

This chapter also presents the occupancy rates within the terrestrial, intertidal and aquatic environments of the survey area.

7.1.1 Mobile Gamma Survey Results

In total, over 9 hours of data were captured encompassing 33,624 spectral measurements. (12360 – road survey; 21264 – backpack). Distances between points were approximately 15 m and 1 m for road and backpack survey, respectively.

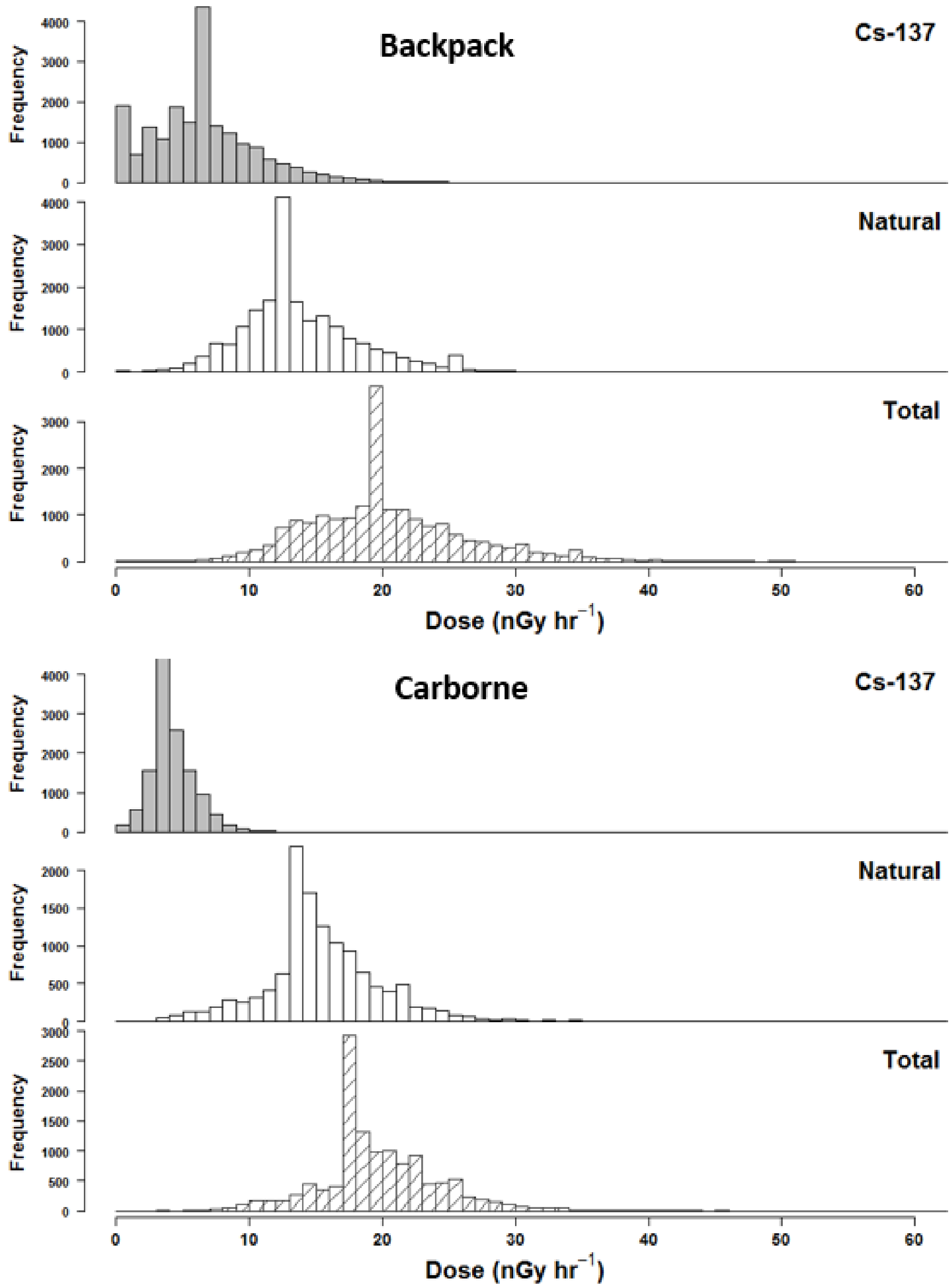

Figure 7.1 Dose rates distributions estimate from carborne and backpack systems for HMNB Clyde site. Dose contribution is separated into ^{137}Cs, the natural radioelements and the total dose

The estimated dose distribution for both systems is presented in Figure 7.2. Notice that the natural populations are similar between instruments; this provides support that each system is well calibrated. Yet, doses from ^{137}Cs generally differ between systems. Although, no direct comparisons were made, three carparks in which a number of measurements were taken using both systems have been isolated and summarised (Table 7.1). Values indicate the mean and standard deviation of aggregated points. Notice there is good agreement in ^{40}K but there is more discrepancy between ^{283}U, ^{232}Th and ^{137}Cs. This is potentially due to the noise present in the backpack system or there was significantly spatial heterogeneity in these elements across the carparks.

Table 7.1 Comparisons of background dose rates (nGy hr^{-1}) between car and backpack systems at three carparks

Location	GPS Location	System	^{40}K	^{238}U	^{232}Th	^{137}Cs
Gaerlochhead carpark	NS 23551 91133	Car	8.17 ± 1.2	2.67 ± 0.92	0.70 ± 0.48	8.17 ± 1.20
		BP	8.33 ± 0.21	3.95 ± 0.86	4.72 ± 1.01	3.41 ± 1.08
Blairvadach carpark	NS 26196 85100	Car	7.27 ± 0.54	4.54 ± 1.66	3.29 ± 1.68	2.93 ± 1.46
		BP	10.57 ± 1.09	2.90 ± 1.44	2.21 ± 0.98	4.90 ± 2.55
Cairndhu carpark	NS 27943 82918	Car	4.34 ± 1.25	1.97 ± 1.18	1.17 ± 0.62	2.06 ± 2.3
		BP	4.28 ± 0.1	2.05 ± 0.06	2.04 ± 0.08	1.06 ± 0.07

This discrepancy is thought to be noise issue arising as a result of the stripping process in the handheld devices. For example, very few counts tend to be recorded in the high energy windows in the handheld devices, leaving the system vulnerable to under or over stripping. ^{137}Cs being the lowest energy window can be significantly influenced by this effect, producing a much broader population of estimated activity and ultimately dose contribution. Therefore, it would be appropriate to exercise caution when interpreting handheld results for dose rates derived for individual radionuclides. Fortunately, given that most of the access points are along the main road, and a road also runs along the periphery of the site, most dose rates are derived from the carborne system.

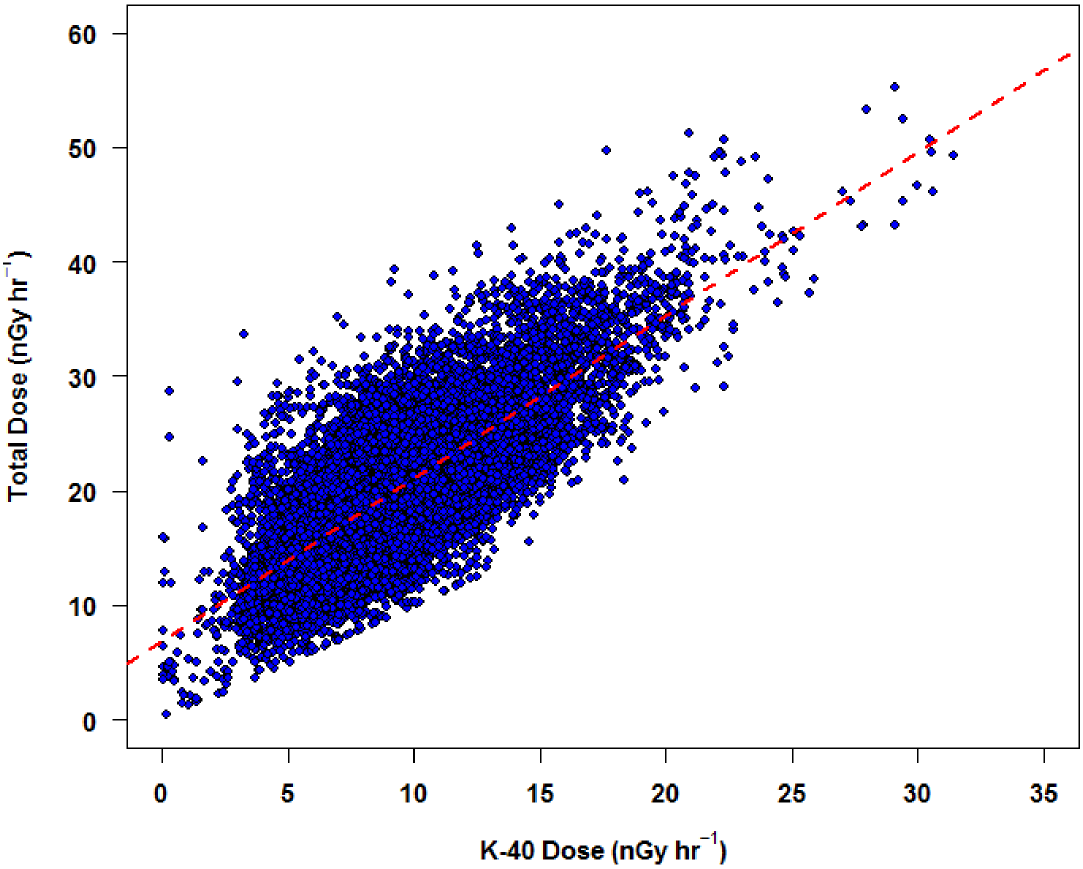

Figure 7.2 Relationship between ^{40}K estimates and total dose.

In terms of general spatial patterns in dose rate, much of the dose rate can be attributed to ^{40}K contributions and further contributions from the natural series (Figure 7.2). Elevated areas of dose are found in the hills, more than likely originated from the geological formations or elevated ^{40}K in the road surface (Figure 7.3). Initial assessment suggests that very low contributions from ^{137}Cs are present across the entire area with the highest contributions found on elevated areas most likely as a result of Chernobyl accident in 1986 and global weapons testing fallout from the 1960s.

In close proximity to HMNB Clyde site (Figure 7.4), the dose rate would appear to be relatively low, compared to that of the entire survey area. For example, higher dose rates are found on the opposing side of the loch, where elevation is greater and perhaps there is exposed geology.

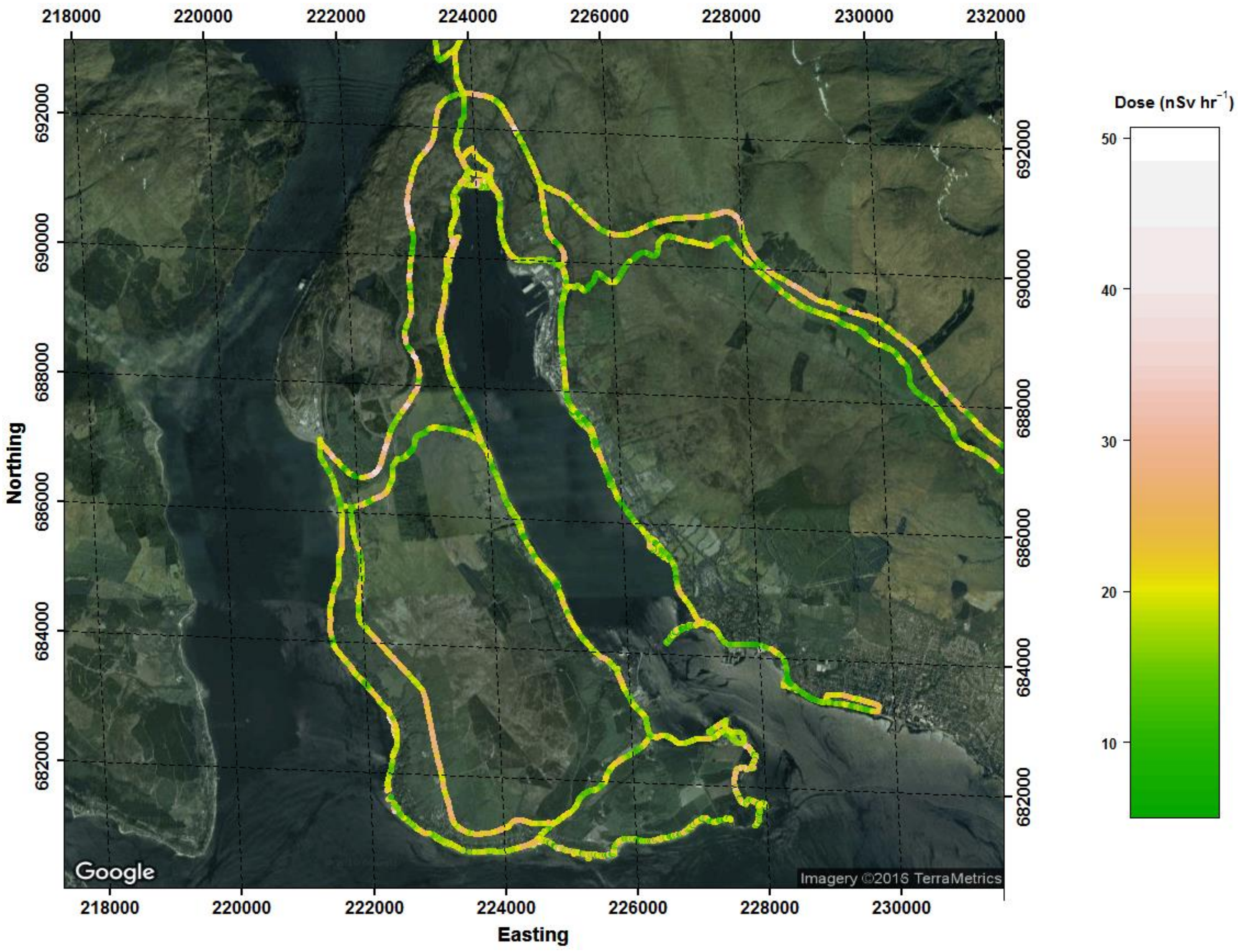

Figure 7.3 All dose rate measurements across HMNB Clyde site

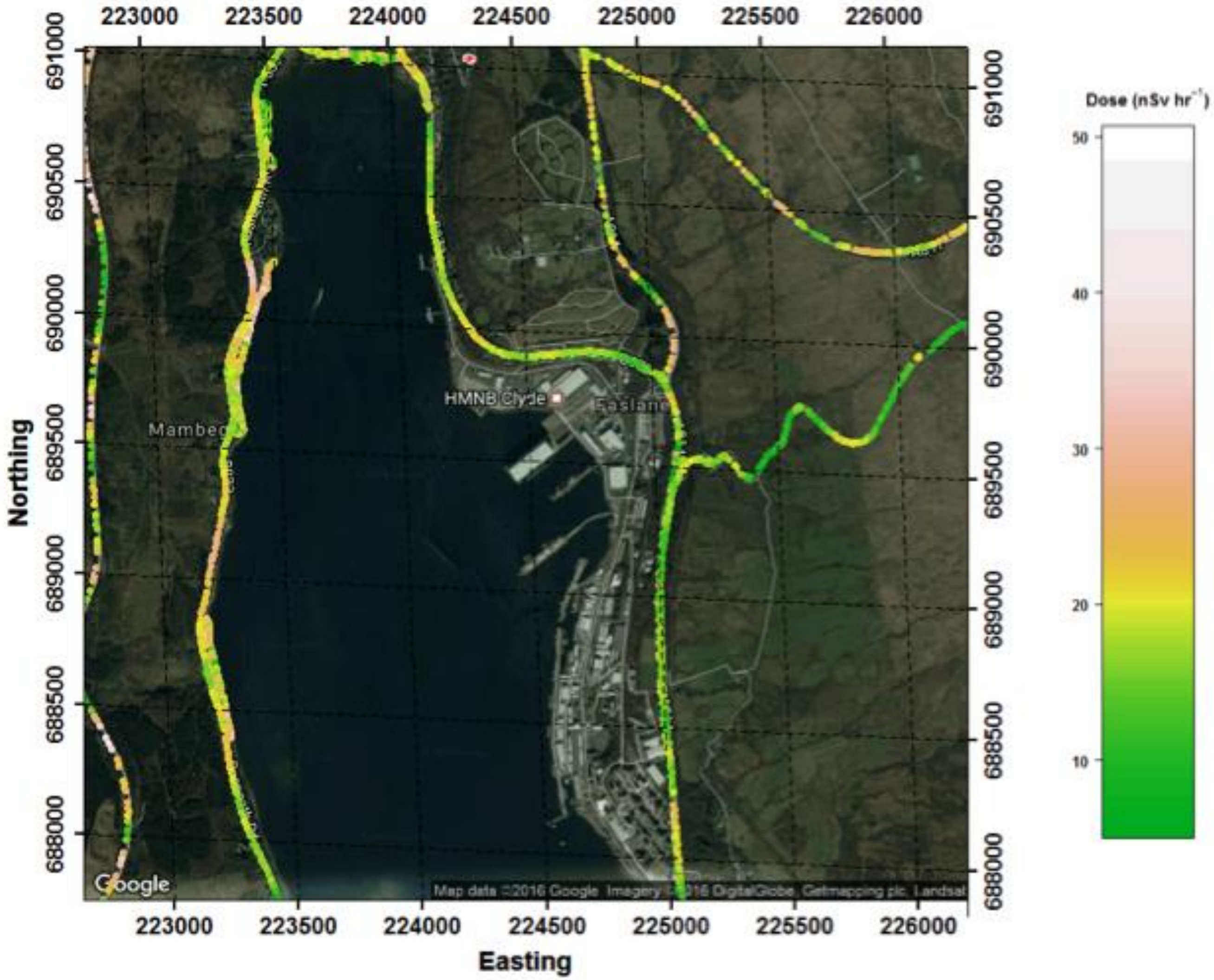

Figure 7.4 Dose rates close to HMNB Clyde facility

7.2 In-Situ Gamma Dosimetry

7.2.1 Terrestrial areas

Five terrestrial in-situ gamma dose rate measurements were collected in conjunction with MoGSS data. All but one inland measurement (centre of Rosneath peninsula) were made along in on or nearby the coastal road (Figure 7.5). Gamma dose rate measurements were used to estimate the terrestrial gamma dose rate through a UKAS accredited procedure. Since the vast majority of dose contribution was thought to be from the natural radionuclides a ^{226}Ra calibration was used to estimate dose rate as ^{226}Ra occurs naturally in the environment. Elevated dose rates found at Cove Sailing Club are thought to be attributed to the hard-standing asphalt surface dose rate in air were made on.

Table 7.2 Summary of gamma dose rate measurements collected across the terrestrial environments.

Location	GPS Location	Surface	Gamma Dose Rate (μGy h^{-1})	Uncertainty 2σ (μGy h^{-1})
Cove sailing club	NS 22108 81304	Hard standing	**0.1235**	0.0076
Cairndhu	NS 27952 82897	Grass	**0.0116**	0.0033
Cairndhu Point	NS 27943 82918	Grass	**0.0245**	0.0037
Peace camp	NS 25253 87193	Grass	**0.0240**	0.0036
Peace camp roadside	NS 25136 87308	Grass	**0.0286**	0.0038

Figure 7.5 also provides a summary of the dose rate measurements made across the site for intertidal and terrestrial areas.

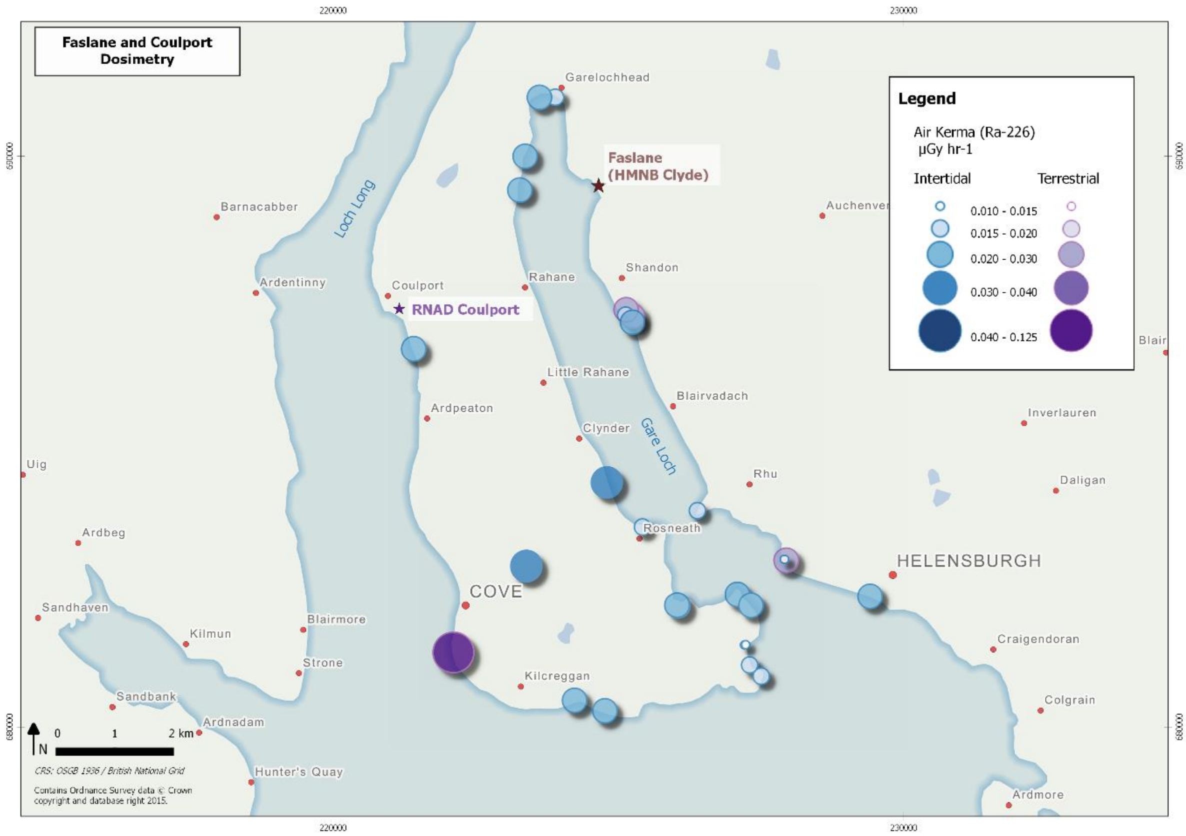

Figure 7.5 Summary of the gamma dose rate measurements in the terrestrial and intertidal environments surrounding HMNB Clyde.

7.2.2 Intertidal areas

A total of 23 in-situ gamma dose rate measurements were made over intertidal surfaces (Table 7.3). At each site, gamma dose rate measurements were made over the dominant intertidal surfaces observed; in the study area, this surface tended to be pebbles although many of the sites were observed to be an aggregate of mud and pebbles. It would seem that the location of measurement and the surface type had little effect of the dose rate. For example the maximum dose rate recorded was 0.035 µGy h^{-1} measured over pebbles at Rahane (NS 23388 82818), whilst the minimum dose rate of 0.011 µGy h^{-1} was recorded also over pebbles at Cairndhu point (NS 27910 82935).

The combination of MoGSS and in-situ gamma dose rate data would suggest there is little spatial pattern in dose rate, confirming that the natural background is dominating the dose rate measurements.

Table 7.3 Gamma dose rate recorded over different intertidal substrates

Location (n)	**GPS Location**	**Gamma dose rate over Substrate type ($\mu Gy\ h^{-1}$)**							
		Salt-marsh	**2 σ**	**Mud**	**2 σ**	**Sand**	**2 σ**	**Pebbles**	**2 σ**
Coulport (1)	NS 21412 86624							**0.0259**	0.0037
Castle point beach (1)	NS 27086 82323							**0.0248**	0.0037
Rosneath Bay (3)	NS 26042 82122							**0.0212**	0.0036
Rhu Spit (2)	NS 26361 83772							**0.0128**	0.0034
Helensburgh (1)	NS 29413 82290					**0.0215**	0.0036		
Cairndhu point (1)	NS 27910 82935							**0.0118**	0.0033
Peace camp beach (1)	NS 25127 87214							**0.0157**	0.0034
Garelochhead foreshore (1)	NS 23894 91030							**0.0181**	0.0035
Rockville (3)	NS 23617 91027	**0.0279**	0.0027					**0.0225**	0.0036
Rosneath point (1)	NS 27506 80889							**0.0196**	0.0035
Culwatty Bay (3)	NS 27301 81084							**0.0188**	0.0035
Castle Point (2)	NS 27325 82132							**0.0203**	0.0025
Kilcreggan (1)	NS 24229 80468							**0.0210**	0.0025
Portkil Bay (1)	NS 24763 80284							**0.0228**	0.0025
Rahane (1)	NS 23388 82818							**0.0356**	0.0029
	Mean	**0.0279**		NA		**0.0215**		**0.0211**	
	Maximum	**0.0279**		NA		**0.0215**		**0.0356**	

7.3 In-Situ Beta Dosimetry

Beta dosimetry of skin dose [H*(0.07)] was measured over intertidal areas (pebbles, mud, sand and seaweed) and fishing and rowing boats that were stored close to the coast. A total of 24 measurements were made, the vast majority of which were below the 0.2 µSv h^{-1} cm^{-2} detection limit. Only four readings that were above this detection limit, which were made at Castle point beach (NS 27086 82324) on intertidal surfaces comprising of seaweed, sand and pebbles (0.291 ± 0.105).

7.4 Sample Analyses

A garlic sample and two seaweed samples were taken from different locations around HMNB Clyde survey area (Table 7.4). ^{131}I and ^{228}Th within the garlic sample were below the limit of detection and a ^{137}Cs concentration of 1.84 ± 0.61 Bq kg^{-1} was present. Seaweed 1 contained ^{137}Cs, ^{131}I and ^{228}Th concentrations of 0.55 ± 0.15, 0.94 ± 0.16 and 8.99 ± 4.89 Bq kg^{-1}, respectively. Concentrations of ^{137}Cs and ^{131}I for Seaweed 2 were below the limit of detection, whilst an activity of 28.5 ± 12.1 Bq kg^{-1} for was found for ^{228Th} at Garelochhead.

Table 7.4 Radionuclide concentration from different environmental samples

Sample	Location	Coordinates	Bq/kg					
			^{137}Cs	**2σ**	**^{131}I**	**2σ**	**^{228}Th**	**2σ (%)**
Garlic	Helenburgh	NS 30432 82148	1.84	0.61	0.21	< LOD	13.4	< LOD
Seaweed 1	Helenburgh	NS 28770 82483	0.55	0.15	0.94	0.16	8.99	4.89
Seaweed 2	Garelochhead	NS 24076 90885	0.165	< LOD	0.138	< LOD	28.5	12.1

7.5 Occupancy Rates

7.5.1 Occupancy Data for the Survey Area

A summary of the types of activities that individuals participate in within the survey area can be found in Table 7.5, and include a range of terrestrial, aquatic and intertidal activities within the survey area. For the terrestrial activities, the most popular activity was the collection of wild produce (65 individuals) with the maximum individual occupancy time being 1 460 h y^{-1} collecting wild produce around Cove and Kilcreggan. For the aquatic activities, sailing was the most popular activity (34 individuals) with the maximum individual occupancy time being 1 008 h y^{-1} sailing in the Gare Loch. For intertidal activities, beachcombing was the most popular activity (31 individuals) with the maximum individual occupancy time being 730 h y^{-1} beachcombing at Garelochead.

Table 7.5 Summary of the activities and total number of individuals that take part in the activities. The location of the maximum occupancy is also given.

Activity type	Activity	Number of individuals	Maximum occupancy (h y^{-1})	Location (if provided)
Terrestrial	Allotment	1	26	Faslane Peace Camp
Terrestrial	Bee keeping	4	172	Near Coulport
Terrestrial	Bird/nature watching	15	1 040	Shandon
Terrestrial	Bowling	2	208	Cove
Terrestrial	Cycling	46	416	Garelochead, Rosneath Peninsula, Shandon
Terrestrial	Farming	2	4 000	Glen Fruin
Terrestrial	Dog walking	56	1 095	Shandon, Faslane, Rosneath Peninsula
Terrestrial	Gardening	55	2 080	Garelochead, Rosneath Peninsula
Terrestrial	Litter picking	1	6	Rosneath Peninsula
Terrestrial	Horse riding	5	1 092	Portincaple
Terrestrial	Playing	15	2 190	Kilcreggan
Terrestrial	Rambling/walking	30	730	Rosneath Peninsula, Garelochead, Glen Fruin
Terrestrial	Running	16	234	Garelochead, Shandon
Terrestrial	Railway track inspection	1	208	Shandon, Garelochead, Faslane
Terrestrial	Sitting/picnicking	14	365	Shandon
Terrestrial	Sports	4	1 456	Portincaple

Activity type	Activity	Number of individuals	Maximum occupancy (h y^{-1})	Location (if provided)
Terrestrial	Collecting wild produce	65	104	Cove, Kilcreggan
Terrestrial	Fixing farmers fence	1	2	Shandon
Terrestrial	Geocaching	1	4	Garelochead
Aquatic	Angling – Sea	29	832	Cove, Kilcreggan
Aquatic	Angling - Freshwater	2	390	Mill Dam, Lindowan pond
Aquatic	Boat maintenance	13	468	Garelochead
Aquatic	Canoeing	9	234	Gare Loch
Aquatic	Being on a dive boat	1	60	Gare Loch
Aquatic	Commute via boat	1	2.67	Rhu Marina
Aquatic	Safety boat duties	1	52	Gare Loch
Aquatic	Sailing	34	1 008	Gare Loch
Aquatic	Windsurfing	1	6	Rhu Bay
Aquatic	Sub-aqua diving	2	12	Cove Bay
Aquatic	Outdoor swimming	4	120	Rockville
Aquatic	Power boating	9	832	Gare Loch. Rhu Marina
Aquatic	Working on a boat	1	48	Helensburgh
Aquatic	Rowing	2	3	Gare Loch
Intertidal	Bait digging	6	12	Garelochead
Intertidal	Beachcombing	31	730	Garelochead
Intertidal	Boat maintenance	1	8	Portincaple
Intertidal	BBQ/picnicking	1	6	Cove
Intertidal	Beach clean	1	6	Helensburgh shore
Intertidal	Collecting seaweed	3	13	Cairndhu Point and Helensburgh shore
Intertidal	Clearing trip lines	1	8	Garelochead
Intertidal	Collecting mussels	4	26	Cove
Intertidal	Walking	11	365	Rhu Spit
Intertidal	Litter picking	2	4	Rhu shorline, Garelochead and Helensburgh shore
Intertidal	Dog walking	30	1 095	Kilcreggan
Intertidal	Fixing moorings	1	8	Cove
Intertidal	Painting (art)	1	6	Coast around Rosneath Peninsula
Intertidal	Horse riding	1	274	Cove
Intertidal	Paddling	7	26	Rosneath
Intertidal	Playing	16	104	Garelochead
Intertidal	Guides and Brownies event	1	26	Cove

Activity type	Activity	Number of individuals	Maximum occupancy ($h\ y^{-1}$)	Location (if provided)
Intertidal	Rock pooling	2	12	Clynder
Intertidal	Fishing	6	351	Rhu Spit and Rhu Marina
Intertidal	Launching small boat	2	39	Rhu Spit
Maintaining equipment	Boats and boating equipment	24	780	Garelochead
Maintaining equipment	Fishing gear	31	858	Cove and Kilcreggan
Maintaining equipment	Clothes and overalls	14	78	-

7.5.2 2016 Occupancy rates within 1km of HMNB Clyde (indoors/outdoors work or home)

Individuals living or working within the immediate area of HMNB Clyde were asked to estimate how much time they spend inside and outside their home or workplace. The results presented in Table 7.6 show the time spent indoors and outdoors on an annual basis. A total of four individuals were interviewed who worked within 1 km of Faslane (this excludes any individual working at HMNB Clyde). The highest amount of time spent indoors at work was 1 920 $h\ y^{-1}$ and the highest amount of time spent outdoors at work 470 $h\ y^{-1}$. These totals take into account holiday periods. A total of 14 individuals were interviewed who lived within 1 km of Faslane, the highest amount of time spent indoors for one individual was 8 578 $h\ y^{-1}$ and the highest amount of time spent in the immediate area outside their house was 5 616 $h\ y^{-1}$. The high figures for indoor and outdoor occupancy at home also take into account any holiday period away from home and have been checked and confirmed.

Table 7.6 Occupancy rates of those individuals working or living within 1 km of HMNB Clyde

Unique ID	Indoors at home (h y^{-1})	Outdoors at home (h y^{-1})	Indoors at work (h y^{-1})	Outdoors at work (h y^{-1})
176	-	-	1 880	0
231	-	-	1 410	470
243	-	-	1 920	0
80	-	-	1 645	235
98	8 578	182		
99	4 380	1 460	-	-
100	3 574	807.5	-	-
101	3 574	182	-	-
42	3 196	376	-	-
43	3 196	376	-	-
4	5 265	3 159	-	-
5	2 808	5 616	-	-
6	5 265	3 159	-	-
7	5 265	3 159	-	-
225	3 948	987	-	-
226	3 948	2 632	-	-
227	1 880	376	-	-
229	3 948	329	-	-

8 Phase 2 Surveys

8.1 Introduction

The aim of the Phase 2 surveys was to validate the 2016 Phase 1 surveys, identify any major changes to internal/external exposure paths and to identify any new pathways within a select group of participants. Through discussion with SEPA it was determined that the Phase 2 surveys for nine individuals (three from the high exposure group, three from the medium exposure group and three from the low exposure group) should be established. These groups were determined according to the total dose received as calculated from the dose assessment tool. Contact was made with individuals in each group. Sampling individuals in the Phase 2 surveys was influenced by some individuals not wishing to be contacted again (when asked during the face-to-face surveys), incorrect follow-up details, or individuals not responding to approaches made by the survey team. There were only three individuals identified in the high-rate group of which only one had provided contact information. This one remaining individual did not respond to the contact made by the survey team. As a result of this, numerous approaches were made to individuals within the middle and low exposure groups and eight individuals were successfully contacted for Phase 2. This included three individuals from the medium exposure group and five individuals from the low exposure.

8.2 Terrestrial - internal

Terrestrial internal consumption is detailed in Table 8.1. The table largely shows that all individuals' consumption of the listed food groups (food groups consumed by the Phase 2 individuals) remains fairly similar to the Phase 1 survey.

Three individuals did not consume any terrestrial food in the Phase 1 surveys and this did not change in Phase 2. One individual, B, from the low exposure group reduced their consumption of green vegetables and eggs by almost 50 % and the same individual reported to not consuming any game in the Phase 2 however they had reported to consuming game in the Phase 1 survey. These were the only changes identified, all other figures remained largely the same.

Table 8.1. Phase 2 comparison table for terrestrial food consumption.

		A LOW (kg y^{-1})	B LOW (kg y^{-1})	E MED (kg y^{-1})	F LOW (kg y^{-1})	G MED (kg y^{-1})
Vegetables-Green	**Phase 1**	3.8	13.4			
	Phase 2	3.8	7.99			
Vegetables-Other	**Phase 1**	0.26	7.5			
	Phase 2	0.26	7.5			
Vegetables-Roots	**Phase 1**	5.22	8.5			
	Phase 2	5.79	8.5			
Vegetables-Potatoes	**Phase 1**	19.3	10			
	Phase 2	20	10			
Fruit-Domestic	**Phase 1**	7.71	23.3	0.5		0.5
	Phase 2	8	22.3	0.5		0.5
Food-Wild	**Phase 1**		16	3.15	0.25	3.15
	Phase 2		17	3.15	0.5	3.15
Meat - Game	**Phase 1**		2.3			
	Phase 2		0			
Eggs	**Phase 1**		12.1	9.05		9.05
	Phase 2		7.00	9.05		9.05
Drinking Water	**Phase 1**		624			
	Phase 2		624			

8.3 Aquatic – internal

Table 8.2 shows the results for the aquatic consumption. Aquatic consumption was only identified within three of the Phase 2 individuals. Two of the individuals (B and D) show that consumption of fish remained the same as the Phase 1 survey whilst one individual, H, (who had the highest fish consumption in the Phase 1 survey) substantially reduced their consumption from 201 kg y^{-1} to 13.5 kg y^{-1}. Both figures were checked and confirmed and this is accounted for due to the individual reducing the amount of time they spend fishing and catching their own fish. This same individual also reported to consuming mussels (1.4 kg y^{-1} collected Rhu Spit) which were not previously consumed. No crustacean or wildfowl were consumed by any individuals during the Phase 1 or the Phase 2 surveys.

Table 8.2. Phase 1 and Phase 2 comparison of aquatic consumption.

		B LOW (kg y^{-1})	D LOW (kg y^{-1})	H MED (kg y^{-1})
Fish	Phase 1	2.00	3	201
	Phase 2	2.00	4.99	13.5
Crustaceans	Phase 1			
	Phase 2			
Molluscs	Phase 1			0
	Phase 2			1.4
Wildfowl	Phase 1			
	Phase 2			

8.4 Aquatic/intertidal - external

Table 8.3 shows the intertidal/aquatic occupancy. Two of the medium exposure individuals showed similar occupancy to the Phase 1 survey with activities remaining the same. One medium exposure individual (H) shows a substantial reduction in intertidal occupancy. This was accounted for by to the individual no longer undertaking bait digging activities and reducing their fishing activities from daily, as was reported in the Phase 1 survey, to weekly as reported in in the Phase 2 survey.

A medium exposure individual (D) increased their intertidal occupancy. This was accounted for by an increase in intertidal fishing and the frequency of bait digging hours and frequency during the Phase 2 survey. The same individual also reported in the Phase 2 survey to spending time collecting mussels for bait. An increase of intertidal occupancy was also noted for F (low exposure) and this was accounted for due to an increase of dog walking daily around the shores at Rhu Spit and Shandon. Two individuals, B and C (both low exposure) during the Phase 2 survey reported undertaking intertidal activities, which they had not previously done, including litter picking and dog walking respectively.

Occupancy on the water was determined and one individuals' occupancy remained the same during the Phase 2 survey. Two individuals, C and E, decreased their occupancy on water whilst one individual, H, increased their occupancy on water. The decrease of aquatic on water occupancy for C is accounted for due to the individual now spending less time canoeing and windsurfing. For E the decrease is accounted for in a reduction of their sailing hours.

No individuals undertook any activities in the water in the Phase 1 survey or in the Phase 2 survey.

8.5 Handling of equipment and handling of sediment

The handling of equipment and handling of sediment was determined for the Phase 2 survey and this is shown in Table 8.3. One individual (B) undertook the same hours per year for handling equipment as in the Phase 1 survey but had added new hours for sediment handling of 4 h y^{-1} due to their new litter picking activity during a beach clean-up. Individual C maintained the same handling of sediment hours with the same activities and frequency reported but had increased their handling of equipment which had not previously been reported. Individual D has increased their handling of equipment and their handling of sediment during the Phase 2. This was accounted for by an increase in intertidal fishing (handling of fishing gear) and thus an increase in the frequency of bait digging (which included collecting mussels for bait) respectively.

One individual, G, undertook the same handling of sediment with the same activities and frequency reported with no handling of equipment, as was reported in the Phase 1 survey. Individual H decreased both their handling of equipment and handling of sediment and this was accounted for by the individual reducing their fishing occupancy from daily to weekly and no longer bait digging. The individual however does collect mussels for 2 h y^{-1} which is a new activity.

Individual A did not undertake any aquatic or intertidal activities in both the Phase 1 survey and the Phase 2 survey and therefore there was no handling of equipment or handling sediment occupancy noted.

Table 8.3. Phase 1 and Phase 2 intertidal occupancy, handling of equipment and handling sediment.

		B LOW (h y^{-1})	C MED (h y^{-1})	D LOW (h y^{-1})	E MED (h y^{-1})	F LOW (h y^{-1})	G MED (h y^{-1})	H MED (h y^{-1})
Intertidal	**Phase 1**	0	0	132	365	110	365	430
	Phase 2	4	365	226	404	365	365	54
Aquatic (on water)	**Phase 1**	1 167	110		247			
	Phase 2	1 167	84		208			
Handling equipment	**Phase 1**	156	0	120	103	0		274
	Phase 2	156	4.5	200	51	6		57.2
Handling sediment	**Phase 1**	0	365	12	365	110	365	156
	Phase 2	4	365	26.5	365	365	365	2

8.6 Occupancy – working and living within 1 km of site

No individuals contacted reported to worked or lived within 1 km of HMNB Clyde during the Phase 1 or Phase 2 surveys.

9. Comparisons with the Previous Survey

9.1 Introduction

The results from this 2016 HMNB Clyde habits survey have been reported in chapters 4, 5 and 6 for the Phase 1 survey. These results can be compared with results from the previous habits survey, undertaken in HMNB Clyde in 2011 by the Centre for Environment Fisheries and Aquaculture Science (CEFAS).

The aquatic and terrestrial Phase 1 survey area in the 2016 survey extended (for the aquatic survey) from Helensburgh Pier to Cove on the south west side of the Rosneath Peninsula and (for the terrestrial survey) the area within a 5 km radius of HMNB Clyde site and the Rosneath Peninsula. The 2011 survey extended from Helensburgh Pier to Rosneath Point for the aquatic survey and was the same as that in 2016 for the terrestrial survey.

9.2 Aquatic Survey

9.2.1 Phase 1 - Adult Consumption Rates – Internal Exposure

In 2016 the mean consumption rate for the adult high-rate group is substantially increased for fish compared with 2011. Molluscs mean consumption rate compared with 2011 is decreased. In 2016 the mean consumption of crustacean and wildfowl was higher compared to there being no consumption of these groups in 2011. The main species of fish consumed by adults were mackerel and pollock in 2016 compared with mackerel and sea trout in 2011. The main crustaceans consumed by adults in 2016 were the common lobster and brown crab compared with no crustacean consumption 2011. Mollusc consumption in 2016 (consisting only of mussels) was decreased compared with mollusc consumption (consisting of only winkles) in 2011. In 2016 one species of wildfowl (Teal) was consumed compared to no wildfowl consumed in 2011. The consumption of marine/intertidal plant/algae (seaweed) by adults was identified in 2016 but not in 2011.

A comparison between 2011 and 2016 adult consumption rates of aquatic foods is presented in Table 9.1. The table also provides the mean consumption rates from national data (Smith and Jones, 2003) for comparison. Refer to Section 5.9.1 for further details.

Table 9.1 Comparison between 2011 and 2016 adult consumption rates of aquatic foods. NC = not consumed. ND = not determined.

	2011			2016			National
Food Group	Number of people in the high-rate group	Maximum consumption rate (kg y^{-1})	Mean consumption rate (kg y^{-1})	Number of people in the high-rate group	Maximum consumption rate (kg y^{-1})	Mean consumption rate (kg y^{-1})	Mean (kg y^{-1})
Fish	4	25.1	18.7	1	201	201	15
Crustaceans	NC	NC	NC	1	13	13	4
Molluscs	7	2.4	1.2	1	0.9	0.9	4
Wild Fowl	NC	NC	NC	1	1	1	ND
Seaweed	NC	NC	NC	1	4	4	ND

9.2.2 Phase 1 - Children and Infants' Consumption Rates – Internal exposure

The consumption rate of crustaceans and wild fowl for children was not determined in both the 2016 and 2011 habits surveys. There was no consumption of molluscs identified for children in 2016 compared to consumption being identified in 2011. The only fish species consumed for the child age group was cod and the consumption was decreased in 2016 compared to 2011.

No infants were found to consume wildfowl in both the 2016 and 2011 habits surveys. Both fish and crustaceans consumption was identified in 2016 compared to no consumption being identified in 2011. The consumption of molluscs decreased in 2016 compared to 2011. Refer to Section 5.8.2 for further details.

A comparison between 2011 and 2016 children and infants consumption rates of aquatic foods is presented in Table 9.2.

Table 9.2 Comparison between 2011 and 2016 children and infants consumption rates of aquatic foods. NC = not consumed

	2011			2016		
Food group	**Number of people in the high-rate group**	**Maximum consumption rate (kg y^{-1})**	**Mean consumption rate (kg y^{-1})**	**Number of people in the high-rate group**	**Maximum consumption rate (kg y^{-1})**	**Mean consumption rate (kg y^{-1})**
Child (6 - 15 years old)						
Fish	4	6.0	4.1	9	0.50	0.33
Crustaceans	NC	NC	NC	NC	NC	NC
Molluscs	2	1.8	1.6	NC	NC	NC
Wildfowl	NC	NC	NC	NC	NC	NC
Infant (0 - 5 years old)						
Fish	NC	NC	NC	4	0.33	0.33
Crustaceans	NC	NC	NC	4	0.33	0.33
Molluscs	2	0.6	0.5	4	0.17	0.17
Wildfowl	NC	NC	NC	NC	NC	NC

9.2.3 Phase 1 - Adult Intertidal/Aquatic Occupancy – External exposure

In contrast to the 2011 survey, external exposure was divided into five groups: intertidal activities, aquatic in water activities, aquatic on water activities, handling of equipment and handling of sediment - all of which are discussed in further detail in Section 4.12.

In 2016 the highest intertidal occupancy was 1 369 h y^{-1}. There is no comparison in 2011. The highest occupancy on water for an adult was 1 872 h y^{-1} in 2016 which increased from 400 y^{-1} in the 2011 survey. The highest occupancy in the water for an adult was 120 h y^{-1}.which is decreased from 2011.

Mean occupancy rates and 97.5th percentile rates were determined in 2016 but there is no comparison for this with the 2011 data.

9.2.4 Phase 1 – Children and Infants Intertidal/Aquatic Occupancy – External Exposure

As with the adult intertidal/aquatic occupancy, in contrast to the 2011 survey, external exposure was divided into five groups: intertidal activities, aquatic in water activities, aquatic on water activities, handling of equipment and handling of sediment - all of which are discussed in further detail in Section 4.12.

In 2016 the intertidal occupancy for children and infants was determined. The intertidal occupancy was highest for a child fishing and for an infant playing in 2016. There is no comparison with the 2011 survey.

There was no child or infant occupancy in the water.

The highest occupancy on water for a child was sailing for 39 h y^{-1} in 2016 which increased from the 2011 survey with 26 h y^{-1} for canoeing. The highest occupancy on the water for an infant was sailing for 39 h y^{-1} in 2016. There is no comparison with 2011 as no infants were identified.

Mean occupancy rates and 97.5th percentile rates were determined in 2016 but there are no comparisons for these with the 2011 survey.

9.2.5 Phase 1 – Handling equipment and handling sediment

Handling of equipment by adults within the 2016 survey area was determined. These activities included handling of boats and boating equipment, handling clothes and overalls and handling fishing gear. In 2016 a total of 568 h y^{-1} for handling of equipment was determined as a mean occupancy handling rate for the adult high rate group. There was no comparison with the 2011 survey as this was not determined. Handling of sediment in 2016 was determined as 549 h y^{-1} for the mean for the high rate group in 2016. This was substantially higher than 79 h y^{-1} determined in the 2011 survey.

In 2016 a total of 351 h y^{-1} for handling of equipment was determined as a mean occupancy handling rate for the child high rate group. There was no comparison with the 2011 survey as this was not determined. No infants were found to handle equipment in 2016. The mean for the high rate group in 2016 for handling of sediment was determined for children as 46.6 h y^{-1} which decreased from 89 h y^{-1} determined in the 2011 survey. For infants, 104 h y^{-1} was determined for the high rate group in 2016 which increased from 42 h y^{-1} determined in 2011.

9.3 Terrestrial Survey

9.3.1 Phase 1 – Adult Consumption Rates – Internal Exposure

Consumption rates of locally produced food items have increased in the 2016 survey in the vegetables (green), vegetables (root), vegetables (potatoes), fruit (domestic), fruit (wild), fungi (wild), game, poultry and sheep meat and honey food groups in comparison to the 2011 survey.

Consumption rates decreased in the 2016 survey in the following food groups: vegetables (other) and meat (beef) in comparison to the 2011 survey.

Water was identified as being consumed in the 2016 survey (spring water) and in the 2011 survey.

A comparison between the 2011 and 2016 mean consumption rates for adult consumption of the terrestrial food groups is presented in Table 9.3. The table also provides the mean consumption rates from national data (Smith and Jones, 2003) for comparison. It is notable how both the 2011 and 2016 surveys differ compared with the national consumption rates (see also Section 6.8.1), which may in part reflect variations in local and regional habits, changes in trends and also the ability to capture more extreme habits within the survey.

Table 9.3 Comparison between 2011 and 2016 mean consumption rates of local terrestrial food groups for adults (kg y^{-1} or l y^{-1}).

Food group	2011 Mean consumption rate for the high-rate group (kg y^{-1} or l y^{-1})	2016 Mean consumption rate for the high-rate group (kg y^{-1} or l y^{-1})	National
Vegetables – Green	22.6	30	15
Vegetables – Other	36.1	17	20
Vegetables – Root	16.6	44	10
Vegetables - Potatoes	18.1	99	50
Fruit - Domestic	28.3	105.	20
Fruit – Wild	2.8	12	7
Fungi – Wild	0.4	1	3
Meat – Beef	52.6	29	15
Meat - Game	2.2	22	-
Meat - Poultry	1.3	3.8	10
Meat – Sheep	22.2	29NI	8
Meat – Pork	50.6	18	15
Eggs	15.3		25
Honey	15.0	40	2.5
Milk	273.8	NI	95
Water (spring)	ND	662	-

9.3.2 Phase 1 – Children and infants consumption rates - Internal exposure

Consumption rates of locally produced food items increased in the 2016 survey in green vegetables, other vegetables, root vegetables, potatoes, wild fruit and eggs. Domestic fruit, beef and honey were found to be consumed by children in 2016 but no children were found to consume these foods in 2011. The mean consumption rates for children are presented in Table 9.4.

Infants were found to consume green vegetables, other vegetables, root vegetables, potatoes, fruit (domestic and wild) and eggs in 2016. There is no comparison for infants as there was no consumption identified in 2011. The mean consumption rates for infants are presented in Table 9.5.

Table 9.4 Comparison between 2011 and 2016 mean consumption rates of local terrestrial food groups for children (kg y^{-1} or l y^{-1}).

Food group	2011 Mean consumption rate for the high-rate group (kg y^{-1} or l y^{-1})	2016 Mean consumption rate for the high-rate group (kg y^{-1} or l y^{-1})
Vegetables – Green	0.1	3
Vegetables – Other	0.1	0.48
Vegetables – Root	0.1	1.5
Vegetables - Potatoes	0.6	15
Fruit - Domestic	NI	5.5
Fruit – Wild	0.1	0.1
Fungi – Wild	NI	NI
Meat – Beef	NI	2.5
Meat - Game	NI	NI
Meat - Poultry	NI	NI
Meat – Sheep	NI	NI
Meat – Pork	NI	NI
Eggs	0.9	7.2
Honey	NI	0.8
Milk	NI	NI
Water	NI	NI

Table 9.5 Comparison between 2011 and 2016 mean consumption rates of local terrestrial food groups for infants (kg y^{-1} or l y^{-1}).

Food group	2011 Mean consumption rate for the high-rate group (kg y^{-1} or l y^{-1})	2016 Mean consumption rate for the high-rate group (kg y^{-1} or l y^{-1})
Vegetables – Green	NI	4
Vegetables – Other	NI	0.33
Vegetables – Root	NI	5.5
Vegetables - Potatoes	NI	9.08
Fruit - Domestic	NI	25
Eggs	NI	9

9.4 Direct Radiation Survey

Comparison of the occupancy rates for individuals living and working within 1 km of HMNB Clyde site. The time spent indoors and outdoors of their home and for those who work and spend time indoors and outdoors within 1 km of HMNB Clyde site was determined. Table 9.6 presents the comparisons between the 2011 and 2016 survey occupancy rates within the direct radiation survey area (h y^{-1}).

Table 9.6 Comparison between 2011 and 2016 occupancy rates for people living and working within the direct radiation area (h y^{-1}).

	2011	**2016**
Highest total	8 200	8 760
Highest indoor at home	8 100	8 578
Highest outdoor at home	5 000	5 616
Highest indoor at work	-	1 920
Highest outdoor at work	-	470

In 2016 the total occupancy, indoor occupancy and outdoor occupancies were all higher than those estimated in 2011. There was no comparison for individuals working within 1 km of HMNB Clyde site.

10. Dose Assessment

10.1 Dose Assessment for Phase 1 Survey

10.1.1 Aquatic radiation pathways

The retrospective dose arising from internal exposure (via food sources from the aquatic environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 1.1E-2 mSv y^{-1}. The dose to the representative person (97.5%) is 1.08E-2 mSv y^{-1}. In the case of the most exposed person the dose arises from the consumption of locally obtained fish (201 kg y^{-1}).

The retrospective dose arising from external exposure (via people's habit activities in and on the aquatic environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 1.9E-3 mSv y^{-1}. The dose to the representative person (97.5%) is 1.85E-3 mSv y^{-1}. In the case of the most exposed person the dose arises from the handling of sediment (1095 h y^{-1} respectively).

10.1.2 Terrestrial radiation pathways

The retrospective dose arising from internal exposure (via food sources from the terrestrial environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 1.44E-5 mSv y^{-1}. The dose to the representative person (97.5%) is 1.41E-5 mSv y^{-1}. In the case of the most exposed person the dose arises from the consumption of beef (34 kg y^{-1}) and lamb (34 kg y^{-1}).

The retrospective dose arising from external exposure (via people's habit activities in the terrestrial environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 3.7E-4 mSv y^{-1}. The dose to the representative person (97.5%) is 3.6E-4 mSv y^{-1}. The most exposed person's external terrestrial dose was dominated from time spent in the intertidal environment (a total of 1 095 h y^{-1}).

10.1.3 Overall combined radiation exposure for the Phase 1 survey

The retrospective dose arising from all exposure pathways (e.g. via people's habit activities in and on the aquatic, intertidal or terrestrial environments and the consumption of all foodstuffs derived locally from the aquatic or terrestrial environments) has been used to determine the representative person.

The dose rate to the most exposed person from all exposure pathways is 1.16E-2 mSv y^{-1}. The retrospective dose to the representative person (97.5%) is 1.13E-2 mSv y^{-1}. In the case of the most exposed person, the dose was dominated by the internal aquatic dose (this is in fact the same individual as that for the internal aquatic pathways consuming 201 kg y^{-1} of fish). These doses are all very small in comparison with the 1 mSv y^{-1} public dose limit.

Table 10.1 contains some summarised dose information based on the average doses to different people based on age profile.

Table 10.1 Average dose estimates (mSv y^{-1}) to stylised people averaged by age (Phase 1 survey).

Age Category	Dose (mSv y^{-1})
Infant	6.7E-5
Child	6.2E-5
Adult	2.5E-4
All	2.2E-4

10.2 Dose Assessment for the Phase 2 Survey

The Phase 2 surveys were undertaken in the winter of 2016 and were re-analysed to determine the dose from each radiation exposure pathway, using the same approach and data as for the Phase 1 survey to allow comparisons to be drawn between the two survey periods. The results are described below.

10.2.1 Aquatic radiation pathways

The retrospective dose arising from internal exposure (via food sources from the aquatic environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 8.2E-4 mSv y^{-1}. The dose to the representative person (97.5%) is 8.0E-4 mSv y^{-1}. In the case of the most exposed person and the dose arises from the consumption of locally obtained fish (13.5 kg y^{-1}) and molluscs (1.4 kg y^{-1}).

The retrospective dose arising from external exposure (via people's habit activities in and on the aquatic environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 6.8E-4 mSv y^{-1}. The dose to the representative person (97.5%) is 6.6E-4 mSv y^{-1}. In the case of the most exposed person the dose arises from the handling of sediment and fishing gear (365 and 51 h y^{-1} respectively).

10.2.2 Terrestrial radiation pathways

The retrospective dose arising from internal exposure (via food sources from the terrestrial environment,) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 2.4E-6 mSv y^{-1}. The dose to the representative person (97.5%) is 2.3E-6 mSv y^{-1}. In the case of the most exposed person the dose arises from the consumption of green leafy vegetables (8 kg y^{-1}), root vegetables (8.5 kg y^{-1}), potatoes (10 kg y^{-1}), domestic fruit (22 kg y^{-1}), eggs (12 kg y^{-1}) and other vegetables (7.5 kg y^{-1}).

The retrospective dose arising from external exposure (via people's habit activities in the terrestrial environment) was used to determine the representative person from this pathway. The retrospective dose to the most exposed person from this exposure pathway is 1.73E-4 mSv y^{-1}. The dose to the representative person (97.5%) is 1.69E-4 mSv y^{-1}. The most exposed person's external terrestrial dose was dominated by direct shine from the site (15.2 h y^{-1}) and intertidal activities (365 h y^{-1}).

10.2.3 Overall combined radiation exposure for the Phase 2 survey

The retrospective dose arising from all exposure pathways (e.g. via people's habit activities in and on the aquatic, intertidal or terrestrial environments and the consumption of all foodstuffs derived locally from the aquatic or terrestrial environments) has been used to determine the representative person.

The dose rate to the most exposed person from all exposure pathways is 8.8E-4 mSv y^{-1}. The retrospective dose to the representative person (97.5%) is 8.6E-4 mSv y^{-1}. The most exposed person's total dose was dominated by the consumption of locally obtained fish (13.5 kg y^{-1}) and molluscs (1.4 kg y^{-1}). These doses are all very small in comparison with the 1 mSv y^{-1} public dose limit.

10.3 Dose comparison of the Phase 1 and Phase 2 surveys

The doses calculated for the different exposure pathways from data in the Phase 2 and Phase 2 surveys are provided in Table 10.2. For all pathways, the doses for the Phase 1 survey are higher than or the same order of magnitude as those for Phase 2 survey. Within our survey this difference is due to the substantial reduction in fish consumption by the high-rate individual. All doses are well within the 1 mSv y^{-1} public dose limit.

Table 10.2 Comparison of doses calculated from the 1Phase 2 and Phase 2 survey data (mSv y^{-1})

	Phase 1 survey		Phase 2 survey	
Pathway	**97.5 percentile dose**	**Maximum dose**	**97.5 percentile dose**	**Maximum dose**
Internal Aquatic	1.08E-2	1.1E-2	8.0E-4	8.2E-4
External Aquatic	1.85E-3	1.9E-3	6.6E-4	6.8E-4
Internal Terrestrial	1.41E-5	1.44E-5	2.31E-6	2.36E-6
External Terrestrial	3.59E-4	3.68E-4	1.69E-4	1.73E-4
All pathways	1.13E-2	1.16E-2	8.6E-4	8.8E-4

The Phase 2 surveys provide significant added value in either validating or refining dose estimates attributable to more extreme habits and any changes in the individual's habits following the initial survey.

11. Recommendations and Suggestions for Monitoring Programme Changes

11.1 Introduction

The Habits Survey presents results for occupancy, activity and food consumption from three main sources of community engagement: (i) Postal questionnaire (n = 87); (ii) face-to-face surveys (n = 249); and (iii) a number of meetings and informal contacts. These data have been supplemented with radiometric surveys including: (i) a carborne and hand held gamma spectrometry survey (n = 33 624); (ii) *in situ* gamma dose rate (n = 22 intertidal; n = 5 inland); (iii) additional sampling of produce with laboratory based gamma spectrometry (n = 3) and (iv) Beta skin dose assessments (n = 24).

11.2 Ongoing Monitoring

The RIFE report demonstrates a comprehensive set of monitoring undertaken annually around HMNB Clyde encompassing a range of food types and environmental substrates. The gamma dose rates reported by RIFE are generally higher than those reported here because the RIFE data include the cosmic contribution to dose. This assessment reports the terrestrial gamma dose rate only. When taking this into account, the results are similar. Samples taken and reported in the RIFE/SEPA Report 2014 (published 2015:pp164) covered mussels, winkles, *fucus vesiculosus*, sediment, sea water, beef muscle, honey, grass, soil and freshwater.

11.3 Conclusions and Recommendations

Of all the pathways identified and considered, the highest retrospective dose for all exposure pathways was 1.16E-2 mSv y^{-1} from the Phase 1 survey data. The highest retrospective dose for all exposure pathways from the Phase 2 survey data was lower at 8.8E-4 mSv y^{-1}. The doses from the Phase 2 survey were lower than those from the Phase 1 survey.

For the Phase 1 survey, the highest dose from internal exposure associated with the terrestrial food pathway was 1.44E-5 mSv y^{-1} arising from the consumption of locally sourced beef and lamb. The highest dose from external exposure was from doses received by people spending time in the intertidal environment (3.68E-4 mSv y^{-1}). The highest dose from internal exposure associated with the aquatic food pathway was 1.1E-2 mSv y^{-1} arising from the consumption of locally sourced fish. The highest dose from external exposure in the aquatic environment was from doses received by people handling fishing gear and sediment (1.9E-3 mSv y^{-1}).

These are very small compared with the 1 mSv annual public dose limit.

In future surveys, consideration could be given to the following areas:

(i) It is recommended that mussel sampling remain as part of the monitoring programme due to individuals identified who consume mussels collected at Helesburgh foreshore;

(ii) Despite no winkle pickers being identified in the 2016 survey, it is recommended that winkles remain to be part of the monitoring programme due to it being reported that winkle pickers do operate in the survey area for approximately four weeks during the year;

(iii) It is recommended that the seaweed sampling location be moved from Rhu to Cairndhu Point (or an additional sample be obtained) due to the identification of seaweed being collected and consumed from this site. In addition, consideration should be given to the sampling of seaweed at Helensburgh foreshore due to the presence of $I^{-1}31$ as a one-off sample;

(iv) It is recommended that mushrooms be added to the routine monitoring programme. Mushrooms were identified to being foraged and consumed at Kilcreggan, around the Rosneath Peninsula and at Shandon House and therefore it is recommended they be included in the routine monitoring programme annually from Rosneath Peninsula; and,

(v) Within the wild/free food groups, we also note that the following are the most consumed: (a) blackberries with the highest consumption in Glen Fruin within the survey area; (b) clover, dock leaves and dandelion leaves were all consumed within the Whistlefield area. Consideration should be given to the inclusion of these additional food items within the routine sampling campaigns: blackberries could be sampled once a year in Glen Fruin within the survey area and clover, dock leaves and dandelion leaves could be sampled in the Whistlefield area once a year.

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APPENDICES

Appendix A1 Raw Data

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

Unique ID	Food type	Consumption rate (kg y^{-1})
19	Mackerel	9
22	Mackerel	0.2
23	Mackerel	0.2
39	Cod	0.5
39	Mackerel	0.5
39	Mackerel	0.5
41	Cod	0.5
41	Mackerel	0.5
41	Mackerel	0.5
44	Mackerel	2
64	Mackerel	27.3
83	Mackerel	4
85	Mackerel	4
86	Mackerel	4
87	Mackerel	4
88	Mackerel	4
106	Mackerel	9
114	Mackerel	0.5
120	Mackerel	20
121	Mackerel	0.166
121	Pollock	0.166
125	Mackerel	0.166
125	Pollock	0.166
128	Mackerel	2
136	Mackerel	2
136	Sea trout	1
160	Mackerel	0.5
161	Mackerel	0.5
180	Mackerel	22
180	Pollock	22
182	Sea trout	9.6
183	Mackerel	8
183	Sea trout	4
189	Mackerel	0.5
189	Sea trout	1.5

Unique ID	Food type	Consumption rate (kg y^{-1})
190	Mackerel	2
208	Mackerel	1
209	Mackerel	1
212	Mackerel	0.6
212	Pollock	0.6
213	Mackerel	0.6
213	Pollock	0.6
220	Trout (freshwater)	9
223	Mackerel	2
224	Mackerel	1.5
226	Mackerel	1.5
235	Mackerel	1
246	Cod	7.8
252	Cod	3
252	Dogfish	6
252	Mackerel	126
252	Pollock	33
252	Wrass	33
253	Mackerel	32
254	Mackerel	9
256	Mackerel	24
266	Mackerel	6

Table 2. Adult consumption rates of crustaceans from the aquatic survey area (kg y^{-1})

Unique ID	Food type	Consumption rate (kg y^{-1})
189	Brown crab	1
125	Brown crab	0.166
121	Brown crab	0.166
246	Common lobster	13
125	Common lobster	0.166
121	Common lobster	0.166

Table 3. Adult consumption rates of molluscs from the aquatic survey area (kg y^{-1})

Unique ID	Food type	Consumption rate (kg y^{-1}
180	Mussels	0.9
125	Mussels	0.166
121	Mussels	0.166

Table 4. Adult consumption rates of wildfowl from the aquatic survey area (kg y^{-1})

Unique ID	Food type	Consumption rate (kg y^{-1})
183	Teal	1

Table 5. Children's consumption rates of fish from the aquatic survey area (kg y^{-1})

Unique ID	Food type	Consumption rate (kg y^{-1})
237	Mackerel	0.4
238	Mackerel	0.4
236	Mackerel	0.4
215	Mackerel	0.25
214	Mackerel	0.25
26	Mackerel	0.2
25	Mackerel	0.2
24	Mackerel	0.2
240	Mackerel	0.2
215	Pollock	0.25
214	Pollock	0.25

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

Unique ID	Food type	Consumption rate (kg y^{-1})
127	Mackerel	0.166
126	Mackerel	0.166
123	Mackerel	0.166
122	Mackerel	0.166
127	Pollock	0.166
126	Pollock	0.166
123	Pollock	0.166
122	Pollock	0.166

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

Unique ID	Food type	Consumption rate (kg y^{-1})
127	Brown crab	0.166
126	Brown crab	0.166
123	Brown crab	0.166
122	Brown crab	0.166
127	Common lobster	0.166
126	Common lobster	0.166
123	Common lobster	0.166

Unique ID	Food type	Consumption rate (kg y^{-1})
122	Common lobster	0.166

Table 8. Infants' consumption rates of molluscs from the aquatic survey area (kg y^{-1})

Unique ID	Food type	Consumption rate (kg y^{-1})
127	Mussels	0.166
126	Mussels	0.166
123	Mussels	0.166
122	Mussels	0.166

Table 9. Adult intertidal occupancy rates in the survey area (h y^{-1})

Unique ID	Intertidal activity	Total occupancy (h y^{-1})
136	Bait digging	12
253	Bait digging	2
252	Bait digging	156
188	Bait digging	3.6
27	Bait digging	3
180	Bait digging	6
160	Beachcombing	8
11	Beachcombing	416
134	Beachcombing	18.7
219	Beachcombing	39
129	Beachcombing	117
190	Beachcombing	4
121	Beachcombing	12
212	Beachcombing	2
146	Beachcombing	1.5
135	Beachcombing	1.5
8	Beachcombing	8
15	Beachcombing	2
14	Beachcombing	2
255	Beachcombing	26
235	Beachcombing	36
76	Beachcombing	730
139	Beachcombing	43.8
175	Beachcombing	6.5
72	Beachcombing	24
71	Beachcombing	24
176	Beachcombing	6.5

Unique ID	Intertidal activity	Total occupancy (h y^{-1})
213	Beachcombing	2
189	Boat maintenance	8
180	Collecting mussels	12
156	Collecting mussels	3
255	Collecting mussels	26
121	Collecting mussels	12
121	Collecting seaweed	12
129	Collecting seaweed	1
264	Collecting seaweed	13
FT9	Dog walking	39
268	Dog walking	6
239	Dog walking	39
228	Dog walking	365
253	Dog walking	24
250	Dog walking	208
164	Dog walking	110
266	Dog walking	234
178	Dog walking	156
246	Dog walking	365
179	Dog walking	156
173	Dog walking	365
185	Dog walking	365
202	Dog walking	730
192	Dog walking	156
177	Dog walking	730
56	Dog walking	1 095
46	Dog walking	6.75
47	Dog walking	52
129	Dog walking	730
257	Dog walking	52
134	Dog walking	104
14	Dog walking	416
60	Dog walking	156
61	Dog walking	156
66	Dog walking	365
71	Dog walking	52
1	Dog walking	520
162	Dog walking	365
72	Dog walking	52
189	Fixing moorings	8

Unique ID	Intertidal activity	Total occupancy ($h\ y^{-1}$)
56	Horse riding	274
121	Paddling	3
134	Paddling	2.5
210	Playing	13
135	Playing	12
4	Playing	104
5	Playing	104
129	Rock pooling	12
260	Rock pooling	3.75
102	Walking	3.96
12	Walking	104
13	Walking	104
218	Walking	12
62	Walking	137
51	Walking	137
18	Walking	3.5
137	Walking	365
249	Walking	73
220	Walking	24
138	Walking	365
167	Litter picking	3
45	Litter picking	4
167	Painting	6
183	BBQ/Picnicking	6
219	Guides & Brownies	26
260	Beach Clean	6
251	Clearing trip lines	208
256	Fishing	52
252	Fishing	274
136	Fishing	120
121	Fishing	52
262	Launching small boat	39
254	Launching small boat	3

Table10. Children's intertidal occupancy rates in the survey area ($h\ y^{-1}$)

Unique ID	Intertidal activity	Total occupancy ($h\ y^{-1}$)
16	Beachcombing	2
158	Beachcombing	1.5

Unique ID	Intertidal activity	Total occupancy (h y^{-1})
157	Beachcombing	1.5
214	Beachcombing	2
215	Beachcombing	2
240	Beachcombing	36
237	Beachcombing	36
26	Paddling	2
25	Paddling	2
174	Paddling	26
24	Paddling	2
172	Paddling	26
172	Playing	26
174	Playing	26
157	Playing	12
26	Playing	48
158	Playing	12
24	Playing	48
25	Playing	48
16	Playing	4
214	Fishing	351

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

Unique ID	Intertidal activity	Total occupancy (h y^{-1})
17	Beachcombing	2
216	Beachcombing	1
159	Playing	12
7	Playing	104
6	Playing	104
17	Playing	4

Table 12. Adult aquatic occupancy rates in the survey area (h y^{-1})

Unique ID	Aquatic activity	Occupancy (h y^{-1})
182	Angling - Sea	832
212	Angling - Sea	468
120	Angling - Sea	416
76	Angling - Sea	312
204	Angling - Sea	234
183	Angling - Sea	156
223	Angling - Sea	117

Unique ID	Aquatic activity	Occupancy (h y^{-1})
43	Angling - Sea	104
42	Angling - Sea	104
224	Angling - Sea	78
253	Angling - Sea	64
121	Angling - Sea	52
266	Angling - Sea	48
188	Angling - Sea	48
162	Angling - Sea	39
251	Angling - Sea	39
64	Angling - Sea	23.3
63	Angling - Sea	26.3
41	Angling - Sea	26
189	Angling - Sea	26
39	Angling - Sea	26
220	Angling - Sea	24
180	Angling - Sea	24
259	Angling - Sea	16
23	Angling - Sea	2
22	Angling - Sea	2
220	Angling - Freshwater	390
95	Angling - Freshwater	28
251	Boat maintenance	468
261	Boat maintenance	208
44	Boat maintenance	156
47	Boat maintenance	104
206	Boat maintenance	104
190	Boat maintenance	52
106	Boat maintenance	39
128	Boat maintenance	36
36	Boat maintenance	30
100	Boat maintenance	26
184	Boat maintenance	26
20	Boat maintenance	20
144	Boat maintenance	5
220	Being on a dive boat	60
178	Canoeing	234
66	Canoeing	104
262	Canoeing	78
23	Canoeing	27
218	Canoeing	26
259	Canoeing	8

Unique ID	Aquatic activity	Occupancy (h y^{-1})
FT9	Canoeing	6
20	Commute via boat	2.67
190	Rowing	3
44	Rowing	3
20	Safety boat duties	52
44	Sailing	1 008
190	Sailing	1 000
261	Sailing	832
222	Sailing	288
50	Sailing	246
52	Sailing	246
162	Sailing	208
184	Sailing	208
20	Sailing	160
206	Sailing	156
106	Sailing	156
144	Sailing	104
32	Sailing	98
219	Sailing	96
36	Sailing	78
230	Sailing	72
231	Sailing	72
128	Sailing	52
178	Sailing	52
189	Sailing	48
208	Sailing	48
209	Sailing	48
146	Sailing	39
135	Sailing	39
21	Sailing	30
47	Sailing	26
169	Sailing	26
262	Sailing	18
140	Sailing	3
147	Sailing	3
189	Sub-aqua diving	12
178	Sub-aqua diving	6
76	Outdoor swimming	120
246	Outdoor swimming	91.3
209	Outdoor swimming	3
190	Outdoor swimming	1.5

Unique ID	Aquatic activity	Occupancy (h y^{-1})
261	Power boating	832
255	Power boating	234
226	Power boating	180
225	Power boating	180
20	Power boating	52
246	Power boating	52
140	Power boating	36
47	Power boating	26
254	Power boating	24
206	Working on a boat	48
66	Windsurfing	6

Table 13. Children's aquatic occupancy rates in the survey area (h y^{-1})

Unique D	Aquatic activity	Occupancy (h y^{-1})
26	Angling - Sea	2
25	Angling - Sea	2
24	Angling - Sea	2
25	Canoeing	27
24	Canoeing	27
232	Sailing	72
158	Sailing	39
157	Sailing	39

Table 14. Infants' aquatic occupancy rates in the survey area (h y^{-1})

Unique ID	Aquatic activity	Occupancy (h y^{-1})
159	Sailing	39

Table 15. Adult handling rates of equipment used within the survey area (h y^{-1})

Unique ID	Equipment	Total (h y^{-1})
20	Boats and boating equipment	100
32	Boats and boating equipment	36
36	Boats and boating equipment	30
47	Boats and boating equipment	104
100	Boats and boating equipment	26
106	Boats and boating equipment	39
121	Boats and boating equipment	12
128	Boats and boating equipment	36
144	Boats and boating equipment	5
162	Boats and boating equipment	12
184	Boats and boating equipment	130

Unique ID	Equipment	Total (h y$^{-1)}$
189	Boats and boating equipment	432
190	Boats and boating equipment	64
206	Boats and boating equipment	360
208	Boats and boating equipment	36
209	Boats and boating equipment	12
218	Boats and boating equipment	1
225	Boats and boating equipment	2
226	Boats and boating equipment	2
231	Boats and boating equipment	10
251	Boats and boating equipment	780
255	Boats and boating equipment	468
261	Boats and boating equipment	208
262	Boats and boating equipment	78
63	Clothes and overalls	5.1
162	Clothes and overalls	26
178	Clothes and overalls	52
182	Clothes and overalls	26
189	Clothes and overalls	1
190	Clothes and overalls	4
206	Clothes and overalls	1
218	Clothes and overalls	6.5
219	Clothes and overalls	1
220	Clothes and overalls	6
222	Clothes and overalls	0.25
225	Clothes and overalls	0.5
226	Clothes and overalls	1
262	Clothes and overalls	78
22	Fishing gear	2
23	Fishing gear	2
39	Fishing gear	26
41	Fishing gear	26
42	Fishing gear	104
43	Fishing gear	104
63	Fishing gear	36.2
64	Fishing gear	26.3
76	Fishing gear	312
95	Fishing gear	28
120	Fishing gear	442
121	Fishing gear	104
136	Fishing gear	120
162	Fishing gear	65
180	Fishing gear	24
182	Fishing gear	858

Unique ID	Equipment	Total (h y^{-1})
183	Fishing gear	195
188	Fishing gear	48
189	Fishing gear	26
204	Fishing gear	234
212	Fishing gear	480
220	Fishing gear	420
223	Fishing gear	156
224	Fishing gear	104
226	Fishing gear	9
251	Fishing gear	247
252	Fishing gear	274
253	Fishing gear	64
256	Fishing gear	52
259	Fishing gear	16
266	Fishing gear	48

Table 16. Children's handling rates of equipment used within the survey area (h y^{-1})

Unique ID	Equipment	Total (h y^{-1})
24	Fishing gear	2
25	Fishing gear	2
26	Fishing gear	2
214	Fishing gear	351

Table 17. Adult consumption rates of green vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
4	0.50
5	0.50
10	0.60
12	3.50
13	3.50
22	2.40
23	2.40
28	34.8
29	3.82
30	34.8
37	11.8
38	11.8
39	8.50

Unique ID	Total consumption (kg y^{-1})
40	3.80
41	8.50
42	0.60
43	0.60
44	13.4
47	0.49
48	0.49
49	0.49
51	3.90
62	3.90
73	3.86
83	0.40
84	4.00
85	0.40
86	0.40
87	0.40
88	0.40
92	3.37
93	3.37
94	3.37
95	0.70
113	17.6
114	0.15
115	0.15
116	0.15
117	0.15
121	0.60
124	17.6
125	0.60
129	10.42
130	12.8
131	8.02
132	12.8
133	8.02
145	12.3
148	12.0
149	12.0
150	47.0
151	34.0
152	8.40
153	8.40

Unique ID	Total consumption (kg y^{-1})
154	20.0
155	20.0
156	35.6
160	0.15
161	0.15
190	9.10
205	13.5
207	13.5
208	0.05
209	0.05
219	17.6
225	4.33
226	4.33
234	8.96
235	9.14
250	1.50

Table 18. Adult consumption rates of other vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
4	0.50
5	0.50
12	1.00
13	1.00
22	0.50
23	0.50
28	3.00
29	3.90
30	3.00
37	12.0
38	13.0
39	18.5
40	0.26
41	18.5
44	7.50
47	0.16
48	0.16
49	0.16
51	20.5
62	20.5
73	3.69

Unique ID	Total consumption (kg y^{-1})
84	9.00
113	10.6
114	1.50
115	0.25
116	0.25
117	0.25
121	0.17
124	10.6
125	0.17
129	1.96
130	1.96
131	1.96
132	1.96
133	1.96
148	25.1
149	26.8
150	15.0
151	14.0
152	1.50
153	10.5
154	3.50
155	3.50
156	5.00
160	0.25
161	0.25
190	6.00
230	0.08
231	0.08
233	0.08
234	2.82
235	1.62
FT9	5.40

Table 19. Adult consumption rates of root vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
4	5.50
5	5.50
12	2.50
13	2.50
22	1.30

Unique ID	Total consumption (kg y^{-1})
23	2.90
28	8.50
29	4.49
30	8.50
37	41.1
38	41.1
39	6.13
40	5.22
41	6.13
44	8.50
51	2.50
62	2.50
73	6.68
83	0.30
84	2.00
85	0.30
86	0.30
87	0.30
88	0.30
95	48.0
113	20.6
114	0.00
115	2.86
116	2.86
117	2.86
121	1.25
124	17.5
125	1.25
129	1.56
130	2.20
131	2.20
132	2.20
133	2.20
145	4.47
149	5.85
150	131
151	65.0
152	4.50
153	4.50
154	9.50
155	9.50

Unique ID	Total consumption (kg y^{-1})
156	23.2
160	2.86
161	2.86
189	8.37
190	8.50
205	5.20
207	5.20
219	2.63
225	1.55
226	1.55
234	3.13
235	2.27
246	4.72
FT9	2.80

Table 20. Adult consumption rates of potatoes from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
4	15
5	15
10	15
22	15
23	15
28	15
29	2.6
30	15
37	5
38	5
39	37.5
40	19.3
41	37.5
44	10
47	3.33
48	0.33
49	0.33
73	19.3
83	1.2
84	4
85	1.2
86	1.2
87	1.2

Unique ID	Total consumption (kg y^{-1})
88	1.2
92	6.67
93	6.67
94	6.67
95	120
113	15.4
114	0.77
115	0.77
116	0.77
117	0.77
121	5.13
124	15.4
125	5.13
129	1.85
130	1.85
131	1.85
132	1.85
133	1.85
140	3.85
141	3.85
142	3.85
145	38.5
148	12.7
149	5.39
150	100
151	30
152	10
153	10
154	200
155	200
156	3
160	0.77
161	0.77
189	23.1
190	10
219	13.9
225	5.13
226	5.13
234	1.93
235	1.93
246	3.85

Unique ID	Total consumption (kg y^{-1})
250	52
FT9	146

Table 21. Adult consumption rates of domestic fruit from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
10	1.00
12	13.3
13	13.3
22	6.80
23	6.80
28	14.0
29	13.2
30	14.0
37	32.6
38	32.6
39	10.0
40	7.71
41	10.0
44	23.3
47	6.34
48	6.34
49	6.34
51	17.0
62	17.0
69	80.0
70	80.0
73	13.3
83	1.60
84	8.00
85	1.60
86	1.60
87	1.60
88	1.60
92	4.17
93	4.17
94	4.17
100	5.00
101	5.00
113	12.5
114	21.8

Unique ID	Total consumption (kg y^{-1})
115	21.8
116	21.8
117	21.8
121	32.5
124	10.0
125	32.5
129	37.0
130	37.0
131	36.7
132	37.0
133	37.0
134	16.0
140	2.25
141	2.25
142	2.25
145	4.80
148	60.0
149	2.00
150	27.0
151	132
152	12.0
153	12.0
154	7.00
155	7.00
156	81.6
160	21.8
161	21.8
162	0.50
173	0.50
178	0.50
179	201
189	12.0
190	23.3
193	0.60
205	90.6
207	90.6
210	8.50
211	8.50
219	18.3
225	11.3
226	11.0

Unique ID	Total consumption (kg y^{-1})
230	2.00
231	2.00
233	2.00
234	6.89
235	6.84
250	0.10

Table 22. Adult consumption rates of wild foods from the survey area (kg y^{-1})

Unique ID	Type of wild food	Total consumption (kg y^{-1})
116	Blackberry	0.1
130	Blackberry	0.5
233	Blackberry	0.06
246	Blackberry	8
113	Blackberry	1.5
124	Blackberry	1.5
162	Blackberry	1
230	Blackberry	0.25
115	Blackberry	0.1
226	Blackberry	1.5
117	Blackberry	0.1
118	Blackberry	1.67
119	Blackberry	1.67
121	Blackberry	3.33
125	Blackberry	3.33
129	Blackberry	0.5
161	Blackberry	0.1
189	Blackberry	2
173	Blackberry	1
164	Blackberry	0.25
167	Blackberry	0.02
170	Blackberry	0.15
171	Blackberry	0.15
178	Blackberry	0.5
231	Blackberry	0.06
183	Blackberry	5
114	Blackberry	0.1
190	Blackberry	1
208	Blackberry	0.05
209	Blackberry	0.05
211	Blackberry	1.75

Unique ID	Type of wild food	Total consumption (kg y^{-1})
219	Blackberry	2
225	Blackberry	2
179	Blackberry	0.5
132	Blackberry	0.5
134	Blackberry	2
49	Blackberry	2
133	Blackberry	0.5
71	Blackberry	4.5
44	Blackberry	12
131	Blackberry	0.5
160	Blackberry	0.1
72	Blackberry	4.5
131	Elderberry	0.075
167	Elderberry	0.05
234	Elderberry	0.075
173	Elderberry	0.15
130	Elderflower	0.075
72	Elderflower	0.225
235	Elderflower	0.075
71	Elderflower	0.225
177	Elderflower	0.05
129	Elderflower	0.075
132	Elderflower	0.075
133	Elderflower	0.075
162	Elderflower	0.15
129	Raspberry	0.6
130	Raspberry	0.6
131	Raspberry	0.6
173	Raspberry	1
133	Raspberry	0.6
162	Raspberry	1
167	Raspberry	0.02
72	Raspberry	0.5
71	Raspberry	0.5
132	Raspberry	0.6
190	Rowanberry	4
44	Rowanberry	4
162	Sloe	1
173	Sloe	1
250	Strawberry	0.1
FT9	Strawberry	0.1

Unique ID	Type of wild food	Total consumption (kg y^{-1})
189	Mushrooms	1
72	Mushrooms	1
71	Mushrooms	1
219	Mushrooms	1
90	Clover	0.06
89	Clover	0.06
91	Clover	0.06
167	Bilberries	0.02
91	Pineapple Grass	0.06
90	Pineapple Grass	0.06
89	Pineapple Grass	0.06
90	Wild Grass	0.06
89	Wild Grass	0.06
91	Wild Grass	0.06
250	Wood Sorrel	0.2
208	Wild Garlic	0.025
209	Wild Garlic	0.025
234	Wild Garlic	0.025
235	Wild Garlic	0.025
102	Wild Garlic	0.5
250	Wild Garlic	0.1

Table 23. Adult consumption rates of wild funghi from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
71	1
72	1
189	1
219	1

Table 24. Adult consumption rates of beef from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
18	8.90
31	34.3
67	27
68	27

Unique ID	Total consumption (kg y^{-1})
79	2.5
80	2.5
92	20
93	20
94	20
112	27

Table 25. Adult consumption rates of game from the survey area (kg y^{-1})

Unique ID	Food type	Total consumption (kg y^{-1})
44	Pheasant	0.5
44	Venison	0.6
67	Pheasant	0.25
67	Venison	2.5
68	Pheasant	0.25
68	Venison	2.5
103	Pheasant	18
104	Pheasant	18

Table 26. Adult consumption rates of poultry from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
76	3.75

Table 27. Adult consumption rates of sheep meat from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
18	8.90
31	34.32
67	27
68	30
92	20
93	20
94	20
112	27
247	30

Table 28. Adult consumption rates of eggs from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
1	18.10
2	9.05

Unique ID	Total consumption (kg y^{-1})
3	9.05
8	15.08
12	9.05
13	9.05
22	6.03
23	6.03
36	15.08
44	12.06
45	12.06
47	5.04
56	12.06
57	12.06
67	36.19
68	36.19
71	18.10
72	18.10
83	1.28
85	1.28
86	1.28
87	1.28
88	1.28
92	4.64
93	4.64
94	4.64
105	6.96
107	6.96
108	6.96
111	9.05
128	16.36
129	9.05
130	9.05
131	9.05
162	9.05
173	9.05
190	12.06
208	21.84
209	21.84
219	4.18
234	12.06
235	12.06

Table 29. Adult consumption rates of honey from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
22	0.8
23	0.8
28	0.125
30	0.125
39	1
41	1
51	0.9
62	0.9
71	40
72	40
102	6.67
111	12.27
114	1.5
115	1.5
116	1.5
117	1.5
128	0.5
134	1.5
160	1.5
161	1.5
219	0.3
250	0.15

Table 30. Adult consumption rates of water from the survey area (l y^{-1})

Unique ID	Total consumption (l y^{-1})
190	700
44	624

Table 31. Children's consumption rates of green vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	2.40
25	2.40
26	2.40
236	3.75
237	3.75
238	2.25
240	3.75

Table 32. Children's consumption rates of other vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	0.50
25	0.50
26	0.50
232	0.08
236	0.42
237	0.08
238	0.08
240	0.08

Table 33. Children's consumption rates of root vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	1.30
25	1.30
26	1.30
236	2.27
237	2.27
238	0.97
240	0.97

Table 34. Children's consumption rates of potatoes from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	15
25	15
26	15
143	3.85
236	1.925
237	1.925
238	1.925
240	1.925

Table 35. Children's consumption rates of domestic fruit from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	6.80
25	6.80
26	6.80
143	2.25
232	2.00

Unique ID	Total consumption (kg y^{-1})
236	4.21
237	6.18
238	3.90
240	3.90

Table 36. Children's consumption rates of wild foods from the survey area (kg y^{-1})

Unique ID	Type of wild food	Total consumption (kg y^{-1})
232	Blackberry	0.06
174	Blackberry	0.15
172	Blackberry	0.15
240	Elderberry	0.075
237	Elderberry	0.075
236	Elderberry	0.075
238	Elderflower	0.075
240	Wild Garlic	0.025
238	Wild Garlic	0.025
237	Wild Garlic	0.025
236	Wild Garlic	0.025

Table 37. Children's consumption rates of beef from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
81	2.5
82	2.5

Table 38. Children's consumption rates of eggs from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	6.03
25	3.02
26	3.02
109	6.96
110	6.96
236	6.03
237	12.06
238	6.03
240	6.03

Table 39. Children's consumption rates of honey from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
24	0.8
25	0.8
26	0.8

Table 40. Infants' consumption rates of green vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
6	0.50
7	0.50
122	0.60
123	0.60
227	4.33

Table 41. Infants' consumption rates of other vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
6	0.50
7	0.50
122	0.17
123	0.17

Table 42. Infants' consumption rates of root vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
6	5.50
7	5.50
122	1.25
123	1.25
227	1.55

Table 43. Infants' consumption rates of potatoes from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
6	15
7	15
122	5.13
123	5.13
227	5.13

Table 44. Infants' consumption rates of domestic fruit from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
122	32.54
123	32.54
227	11.27

Table 45. Infants' consumption rates of wild foods from the survey area (kg y^{-1})

Unique ID	Type of wild food	Total consumption (kg y^{-1})
127	Blackberry	3.33
126	Blackberry	3.33
123	Blackberry	3.33
122	Blackberry	3.33
227	Blackberry	0.5

Table 46. Infants' consumption rates of eggs from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
58	9.05
59	9.05

Table 47. Adult terrestrial occupancy rates in the survey area (h y^{-1})

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
250	Allotments	26
71	Bee keeping	78
111	Bee keeping	19.5
39	Bee keeping	128.7
41	Bee keeping	128.7
225	Bird/nature watching	24
213	Bird/nature watching	312
212	Bird/nature watching	780
76	Bird/nature watching	730
226	Bird/nature watching	24
3	Bird/nature watching	1040
162	Bird/nature watching	208
121	Bird/nature watching	104
156	Bird/nature watching	36
167	Bird/nature watching	168

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
2	Bird/nature watching	1040
176	Bowling (outdoors)	52
171	Bowling (outdoors)	104
85	Cycling	52
83	Cycling	52
160	Cycling	104
79	Cycling	86.84
36	Cycling	52
260	Cycling	365
268	Cycling	117
28	Cycling	78
106	Cycling	26
75	Cycling	3
121	Cycling	104
74	Cycling	3
255	Cycling	13
72	Cycling	104
1	Cycling	104
144	Cycling	48
231	Cycling	12
57	Cycling	156
66	Cycling	26
111	Cycling	182.5
56	Cycling	156
208	Cycling	52
179	Cycling	87.75
94	Cycling	52
178	Cycling	87.75
86	Cycling	52
176	Cycling	117
102	Cycling	104
92	Cycling	52
105	Cycling	52
205	Cycling	416
209	Cycling	312
107	Cycling	52
87	Cycling	52
88	Cycling	52
221	Cycling	78
222	Cycling	52
108	Cycling	52

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
220	Cycling	24
171	Dog walking	156
162	Dog walking	365
118	Dog walking	182.5
178	Dog walking	730
35	Dog walking	104
18	Dog walking	365
134	Dog walking	260
34	Dog walking	730
160	Dog walking	182.5
33	Dog walking	104
186	Dog walking	730
170	Dog walking	156
168	Dog walking	78
129	Dog walking	730
190	Dog walking	78
225	Dog walking	1095
226	Dog walking	1095
230	Dog walking	365
222	Dog walking	365
243	Dog walking	365
246	Dog walking	730
219	Dog walking	78
268	Dog walking	365
185	Dog walking	365
250	Dog walking	912.5
173	Dog walking	365
257	Dog walking	1825
258	Dog walking	912.5
189	Dog walking	182.5
262	Dog walking	1095
1	Dog walking	104
231	Dog walking	365
183	Dog walking	365
8	Dog walking	547.5
FT9	Dog walking	730
101	Dog walking	39
44	Dog walking	365
96	Dog walking	91.25
79	Dog walking	78
80	Dog walking	78

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
93	Dog walking	240.9
100	Dog walking	39
56	Dog walking	1095
86	Dog walking	156
71	Dog walking	730
105	Dog walking	365
107	Dog walking	365
87	Dog walking	156
108	Dog walking	365
85	Dog walking	365
225	Gardening	104
234	Gardening	117
235	Gardening	117
89	Gardening	130
242	Gardening	52
78	Gardening	156
77	Gardening	156
90	Gardening	130
75	Gardening	104
208	Gardening	13
74	Gardening	104
255	Gardening	6.5
72	Gardening	26
71	Gardening	26
1	Gardening	104
10	Gardening	364
2	Gardening	273
69	Gardening	260
268	Gardening	104
93	Gardening	182.5
162	Gardening	365
167	Gardening	9
101	Gardening	547.5
171	Gardening	6
175	Gardening	78
99	Gardening	351
178	Gardening	130
96	Gardening	91.25
179	Gardening	390
94	Gardening	182.5
209	Gardening	13

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
183	Gardening	2080
219	Gardening	19.5
186	Gardening	208
187	Gardening	104
92	Gardening	182.5
190	Gardening	117
196	Gardening	234
205	Gardening	547.5
207	Gardening	26
241	Gardening	52
91	Gardening	130
3	Gardening	273
210	Gardening	365
173	Gardening	26
8	Gardening	104
57	Gardening	1280
134	Gardening	273.75
44	Gardening	78
121	Gardening	104
44	Gardening	117
84	Gardening	912.5
92	Horse riding	156
93	Horse riding	156
67	Horse riding	365
56	Horse riding	273.75
67	Horse riding	365
121	Playing	104
225	Playing	104
226	Playing	104
76	Playing	1095
259	Playing	104
176	Rambling/walking	39
60	Rambling/walking	72
106	Rambling/walking	104
175	Rambling/walking	39
160	Rambling/walking	156
61	Rambling/walking	72
121	Rambling/walking	104
89	Rambling/walking	52
241	Rambling/walking	130
178	Rambling/walking	39

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
78	Rambling/walking	117
90	Rambling/walking	52
179	Rambling/walking	39
211	Rambling/walking	104
210	Rambling/walking	730
208	Rambling/walking	12
91	Rambling/walking	52
220	Rambling/walking	730
164	Rambling/walking	36
74	Rambling/walking	104
FT9	Rambling/walking	104
268	Rambling/walking	60
255	Rambling/walking	52
75	Rambling/walking	104
42	Rambling/walking	730
66	Rambling/walking	52
170	Rambling/walking	730
43	Rambling/walking	730
77	Rambling/walking	117
8	Rambling/walking	182.5
209	Running	117
179	Running	156
222	Running	78
257	Running	234
1	Running	104
219	Running	26
160	Running	52
106	Running	69.68
259	Running	156
79	Running	172.64
121	Running	104
168	Running	130
260	Running	78
268	Running	26
176	Running	104
57	Sitting/picnicking	104
171	Sitting/picnicking	2.5
56	Sitting/picnicking	104
170	Sitting/picnicking	2.5
72	Sitting/picnicking	91.25
71	Sitting/picnicking	91.25

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
134	Sitting/picnicking	91.25
FT9	Sitting/picnicking	36
121	Sitting/picnicking	104
44	Sitting/picnicking	130
108	Sports	728
121	Sports	104
173	Collecting wild produce	0.125
183	Collecting wild produce	0.5
134	Collecting wild produce	0.125
102	Collecting wild produce	0.5
162	Collecting wild produce	0.125
44	Collecting wild produce	72
149	Collecting wild produce	0.125
44	Collecting wild produce	0.125
171	Collecting wild produce	0.125
90	Collecting wild produce	0.125
164	Collecting wild produce	0.125
49	Collecting wild produce	0.125
170	Collecting wild produce	0.125
167	Collecting wild produce	0.5
177	Collecting wild produce	2
179	Collecting wild produce	0.5
117	Collecting wild produce	0.125
61	Collecting wild produce	0.9375
189	Collecting wild produce	0.125
124	Collecting wild produce	0.125
211	Collecting wild produce	0.25
231	Collecting wild produce	0.125
233	Collecting wild produce	0.125
119	Collecting wild produce	0.125
234	Collecting wild produce	0.125
226	Collecting wild produce	0.5
118	Collecting wild produce	52
225	Collecting wild produce	0.5
71	Collecting wild produce	6
116	Collecting wild produce	0.125
115	Collecting wild produce	0.125
114	Collecting wild produce	0.125
FT9	Collecting wild produce	0.25
161	Collecting wild produce	0.125
250	Collecting wild produce	1

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
72	Collecting wild produce	6
118	Collecting wild produce	3
129	Collecting wild produce	3
133	Collecting wild produce	0.125
190	Collecting wild produce	0.375
132	Collecting wild produce	0.125
91	Collecting wild produce	0.125
131	Collecting wild produce	0.125
130	Collecting wild produce	0.125
230	Collecting wild produce	0.125
208	Collecting wild produce	0.25
60	Collecting wild produce	0.9375
209	Collecting wild produce	0.25
125	Collecting wild produce	0.125
235	Collecting wild produce	0.5
90	Collecting wild produce	0.125
8	Collecting wild produce	1
121	Collecting wild produce	104
219	Collecting wild produce	1
89	Collecting wild produce	0.5
113	Collecting wild produce	0.125
129	Collecting wild produce	0.125
167	Litter picking	6
247	Farmer	3640
31	Farmer	1825
31	Farmer	2555
53	Railway track inspection	208
53	Fixing of farmers fence	2

Table 48. Children's terrestrial occupancy rates in the survey area (h y^{-1})

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
214	Bird/nature watching	312
215	Bird/nature watching	312
109	Cycling	730
172	Cycling	26
232	Cycling	96
110	Cycling	52
174	Cycling	26
109	Dog walking	365
110	Dog walking	365

Unique ID	Terrestrial activity	Occupancy (h y^{-1})
232	Dog walking	156
81	Dog walking	78
244	Dog walking	365
82	Dog walking	78
240	Gardening	78
238	Gardening	78
236	Gardening	78
237	Gardening	78
110	Horse riding	1092
172	Playing	156
174	Playing	156
82	Playing	26
81	Playing	26
245	Playing	416
244	Playing	416
240	Playing	260
110	Running	182.5
174	Sitting/picnicking	2.5
172	Sitting/picnicking	2.5
110	Sports	728
109	Sports	728
236	Collecting wild produce	0.5
232	Collecting wild produce	0.125
237	Collecting wild produce	0.5
238	Collecting wild produce	0.5
174	Collecting wild produce	0.5
240	Collecting wild produce	0.5
172	Collecting wild produce	0.125

Table 49. Infants' terrestrial occupancy rates in the survey area (h y^{-1})

Unique ID	Terrestrial Activity	Occupancy (h y^{-1})
122	Bird/nature watching	104
216	Bird/nature watching	312
59	Cycling	156
58	Cycling	156
59	Playing	2190
58	Playing	2190
227	Playing	104
59	Sitting/picnicking	104
58	Sitting/picnicking	104

Unique ID	Terrestrial Activity	Occupancy (h y^{-1})
127	Collecting wild produce	0.125
126	Collecting wild produce	0.125
123	Collecting wild produce	0.125
122	Collecting wild produce	0.125
227	Collecting wild produce	0.125
199	Geocaching	4

Table 50. Occupancy rates in the direct radiation survey area (h y^{-1})

Unique ID	Indoors at home (h y^{-1})	Outdoors at home (h y^{-1})	Indoors at work (h y^{-1})	Outdoors at work (h y^{-1})
176	-	-	1 880	0
231	-	-	1 410	470
243	-	-	1 920	0
80	-	-	1 645	235
98	8 578	182		
99	4 380	1 460	-	-
100	3 574	807.5	-	-
101	3 574	182	-	-
42	3 196	376	-	-
43	3 196	376	-	-
4	5 265	3 159	-	-
5	2 808	5 616	-	-
6	5 265	3 159	-	-
7	5 265	3 159	-	-
225	3 948	987	-	-
226	3 948	2 632	-	-
227	1 880	376	-	-
229	3 948	329	-	-

Table 51. Phase 2 survey adult consumption rates of fish from the aquatic survey area (h y^{-1})

Unique ID	Food type	Total consumption (kg y^{-1})
44	Mackerel	2
136	Mackerel	2.27
136	Sea trout	2.72
252	Cod	4.5
252	Mackerel	9

Table 52. Phase 2 survey adult consumption rates of molluscs from the aquatic survey area (h y^{-1})

Unique ID	Food type	Total consumption (kg y^{-1})
252	Mussels	1.4

Table 53. Follow-up survey adult intertidal occupancy rates in the survey area (h y^{-1})

Unique ID	Intertidal activity	Total occupancy (h y^{-1})
136	Bait digging	22
252	Collecting mussels	2
136	Collecting mussels	4.5
173	Dog walking	365
164	Dog walking	365
162	Dog walking	365
66	Dog walking	365
44	Beach Clean	4
252	Fishing	52
162	Fishing	39
136	Fishing	200

Table 54. Phase 2 survey - adult aquatic occupancy rates in the survey area (h y^{-1})

Unique ID	Aquatic Activity	Occupancy (h y^{-1})
44	Boat maintenance	156
66	Canoeing	72
44	Rowing	3
44	Sailing	1008
162	Sailing	208
66	Windsurfing	12

Table 55. Phase 2 survey adult handling rates of equipment used within the survey area (h y^{-1})

Unique ID	Equipment	Total (h y^{-1})
66	Boats and boating equipment	160.5
136	Fishing gear	200
162	Boats and boating equipment	12
162	Clothes and overalls	26
162	Fishing gear	52
164	Clothes and overalls	6
252	Clothes and overalls	5.2
252	Fishing gear	52

Table 56. Phase 2 survey adult consumption rates of green vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
40	3.80
44	7.99

Table 57. Phase 2 survey adult consumption rates of other vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
40	0.26
44	7.50

Table 58. Phase 2 survey adult consumption rates of root vegetables from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
40	5.79
44	8.50

Table 59. Phase 2 survey adult consumption rates of potatoes from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
40	20
44	10

Table 60. Phase 2 survey adult consumption rates of domestic fruit from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
40	8.00
44	22.30
162	0.50
173	0.50

Table 61. Phase 2 survey adult consumption rates of wild foods from the survey area (kg y^{-1})

Unique ID	Type of wild food	Total consumption (kg y^{-1})
44	Blackberry	12
173	Blackberry	1
162	Blackberry	1
164	Blackberry	0.5
44	Damson	1
173	Elderflower	0.15
162	Elderflower	0.15
173	Raspberry	1
162	Raspberry	1
44	Rowanberry	4
173	Sloe	1
162	Sloe	1

Table 62. Phase 2 survey adult consumption rates of eggs from the survey area (kg y^{-1})

Unique ID	Total consumption (kg y^{-1})
4	121
162	9.05
173	9.05

Table 63. Phase 2 survey adult consumption rates of private drinking water from the survey area (kg y^{-1})

Unique ID	Total consumption (l y^{-1})
44	624

Appendix A2 Postal Survey

The postal survey produced an independent data set from a broader cross section of the population living in the area potentially providing the means to identify new or missed habits that might provide useful focus to target some of the face-to-face surveys or meetings with local groups.

The postal survey helped refine and revise the face-to-face survey tools and identify the optimal areas to target the face-to-face surveys. It also provided additional information on sites to be identified for the collection of observation data and indicated the optimum timings to visit each site. Further information and contacts were obtained with regard to both individuals and a wider range of activities that might merit further investigation in the later survey work.

Appendix A3 Mobile Gamma Spectrometry System

The Mobile Gamma Spectrometry System (MoGSS) deploys 76 mm x 76 mm and large volume (4 or 8 litre) NaI(Tl) detectors for real time data acquisition gamma ray spectra. One second spectra were acquired whilst driving with the detector mounted in the roof box of the survey vehicle to characterise the heterogeneity in the radiation environment around HMNB Clyde and further afield to identify exposure pathways that might otherwise be missed through conventional point measurements. Acquisition rate is limited by road and traffic conditions, but aims to achieve better than one measurement per 20 m. MoGSS comprises a real time differential Global Positioning System (GPS) providing < 0.6 m positional accuracy, controlled by bespoke software through a tablet computer. Spectra were collected with 1 second integration times and data are presented as counts per second (gross counts or counts in the window >350 keV). MoGSS was deployed to identify anomalies in the radiation field to help target follow-up *in situ* dosimetry surveys and identify the likely source of the radioactive anomaly and spatially extrapolate any anomalous observations identified.

This approach provided a better understanding of the underlying natural background and any anthropogenic contribution to the radiation environment. The MoGSS system was deployed in vehicular mode to undertake a carborne survey along the road network and in hand held mode to map the site perimeter.

Survey Area

Two MoGSS were deployed during the survey period, producing gamma-ray spectra data recorded at 1 second integration times alongside high accuracy (<0.6 m) differential GPS readings. Firstly, two large volume sodium iodide detectors were mounted in a box on top of the field vehicle and was driven along all the major roads within the area of interest. The system whilst highly efficient is bulky and therefore only allowing data to be collected from roads. To hone in on smaller areas not accessible by the field vehicle, and to cover the coast line and to measure the dose at relevant access points, two separate backpack systems were deployed. Each backpack system comprised of a 76 × 76 mm sodium iodide detector. Rosneath Peninsula for example was only accessible using this system and presented a large number of access points, which would have otherwise not have been measured using the car system (Figure A3i). Red points demonstrate the area walked using the backpack system and blue points represent roads covered by the carborne system. Access points are also marked on the map.

Conversion of detector count rate (counts s^{-1}) to activity (Bq kg^{-1}) was performed using Monte Carlo calibrations and a conventional window stripping routine. Cosmic background was measured on Loch Lomond and stripped from all spectral data. Prior to stripping, window counts were smoothed using a Gaussian window function. Finally, dose (nGy hr^{-1}) was calculated using ICRU conversion factors (ICRU, 1994).

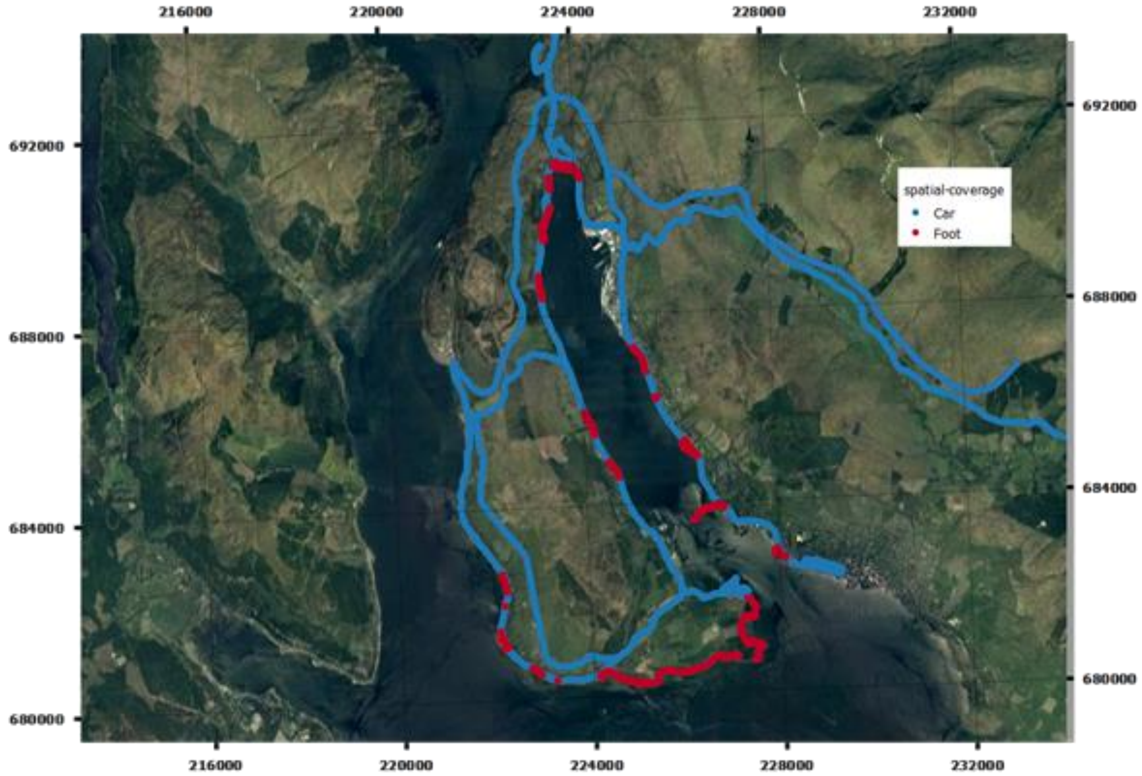

Figure A3i MoGGS coverage of Rosneath Peninsula

Appendix A4 In-Situ Gamma Dose Rate Measurements

The protocol requires the detector to be maintained at 1 m above the surface and counts acquired over a 600 second integration time and the cosmic and intrinsic component to the measurement subtracted. The protocol also requires no persons operating the detector to be within 5 m of the probe during the count. Both instruments are calibrated with ^{226}Ra and ^{137}Cs. Here, gamma dose rates were dominated by the natural background so all results are reported with the ^{226}Ra calibration and reported as μGy h^{-1}.

For the dose assessment tool, gamma dose rates were converted to Effective Dose (μSv hr^{-1}) using a conversion factor of 0.85, which assumes an individual is standing and exposed to terrestrial derived gamma radiation. This conversion factor is used for most statutory monitoring programmes (Punt *et al*., 2011). All survey measurements are reported as terrestrial gamma dose measurements and have had the cosmic and intrinsic component subtracted.

Appendix A5 Beta Skin Dosimetry Measurements

The instrument was calibrated under UKAS accreditation against: strontium-90 (^{90}Sr) and yttrium-90 (^{90}Y); chlorine-36 (^{36}Cl) and carbon-14 (^{14}C) (and put inside a file poly-pocket to protect the system from the weather). A 12 mm Perspex shield was used to shield out any beta emissions and so enable the gamma contribution to the instrument to be established. All measurements were made with a 20 second integration time and in duplicate, with and without the 12 mm Perspex shield, enabling the net beta contribution to skin dose rate to be estimated (effective dose, or ambient dose equivalent) and reported in μSv h^{-1}. The system is estimated to have a detection limit of around 0.2 μSv h^{-1}.

Appendix A6 GPS Tracker Device

To ensure consistency in data a wearable GPS tracking device was considered the most suitable device for HMNB Clyde habits survey.

The devices used were iGOTU GT600 trackers (Figure A6i), which have a capacity to record 262,000 waypoints, at user defined intervals. The battery life varies depending on the sampling rate which was set to record once every 6 seconds, giving 30 hours of use on a single charge. This battery life could be extended by enabling motion detection, whereby the device sleeps until an on-board accelerometer detects motion and then enables the GPS tracking (which has a bigger battery cost). However initial tests showed that the device would not wake from its sleep mode if used on certain modes of transport, such as trains, where the motion was not severe enough to be detected. For this reason the motion detection was disabled so that the tracker logged continuously.

Figure A6i iGOTU GPS tracker

The devices require specialist software to download the trajectory data, and all units were password protected to maintain data security and privacy. The participants were informed that the tracker worked best when positioned on their wrist, or on a bag/belt strap, where they had a clear line of sight to the sky. The participants were asked to take the device with them whenever they left their home and instructions were given regarding use and recharging of the device.

With the 6 second sample rate, the device was able to store the last 16 days of position data on board. Participants were asked to stop charging the unit on the last day of use before collection, to ensure it would run out of power and stop logging position data.

Appendix A7 Postal Survey Results

Terrestrial – External Exposure

The postal survey revealed that rambling/walking, gardening, dog walking and cycling were the most frequently reported terrestrial activities (Figure A7i). Zone 1 was visited by 16 respondents for a total of 2 278 hours annually, Zone 2 was visited by 37 respondents for a total of 8 687 hours annually and Zone 3 was visited by 70 respondents for a total of 24 455 hours annually

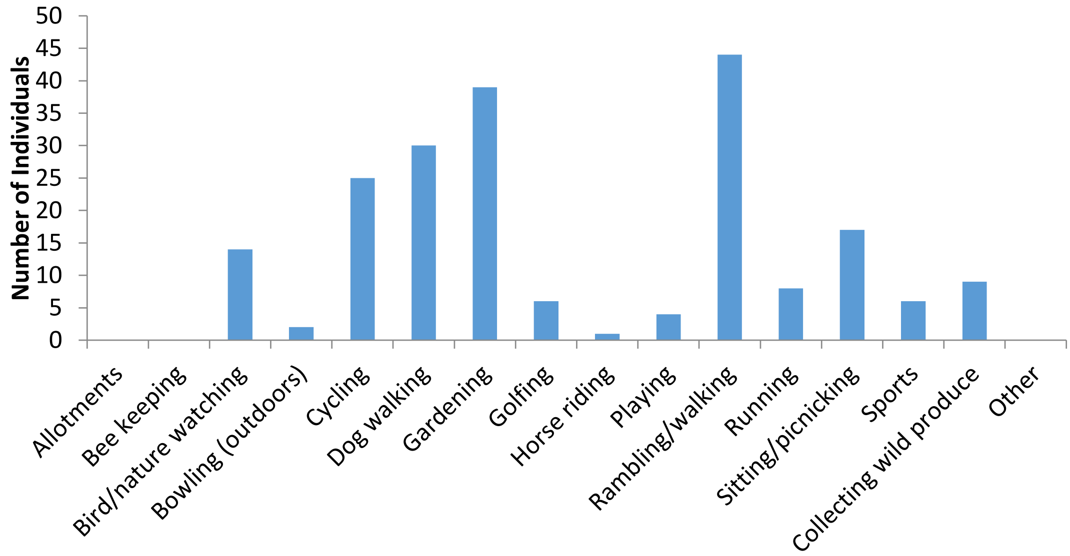

Figure A7ii. Terrestrial activities undertaken by respondents to the postal survey.

The individual with the highest occupancy in Zone 1 spent a total of 763 hours undertaking a variety of activities including bird/nature watching (365 hours), dog walking (365 hours), gardening (26 hours) and rambling/walking (6.6 hours). The individual with the highest occupancy in Zone 2 spent a total of 2 438 hours annually undertaking bird/nature watching (52 hours), cycling (365 hours), dog walking (365 hours), horse riding (365 hours), rambling/walking (730 hours), running (183 hours), sitting/picnicking (13 hours) and sports (365 hours). The individual with the highest occupancy in Zone 3 spent a total of 1 590 hours annually undertaking dog walking (730 hours), rambling/walking (730 hours) and sitting/picnicking (130 hours). The individual with the combined highest occupancy for all zones spent 2 685 hours annually (and had the highest occupancy for Zone 2) on activities including bird/nature watching, cycling, dog walking, horse riding, rambling/walking, running, sitting/picnicking and sports. Table A7i details a statistical summary of occupancy per zone based on actual replies.

Table A7i. Terrestrial occupancy within Zones 1, 2 and 3.

	Zone 1 ($h\ y^{-1}$)	Zone 2 ($h\ y^{-1}$)	Zone 3 ($h\ y^{-1}$)	Total all zones ($h\ y^{-1}$)
Maximum	763	2 438	1 590	2 685
Minimum	0	0	0	0
Mean	26	100	281	407
Median	0	0	228	311
97.5th percentile	278	998	1 016	1 545

Aquatic – External Exposure

The postal survey showed that few people were exposed via aquatic external exposure with sailing being the highest reported aquatic activity (Figure A7ii). Zone 1 was visited by one respondent for a total of 16 hours annually, Zone 2 was visited by nine respondents for a total of 734 hours annually and Zone 3 was visited by 16 respondents for a total of 1 127 hours annually.

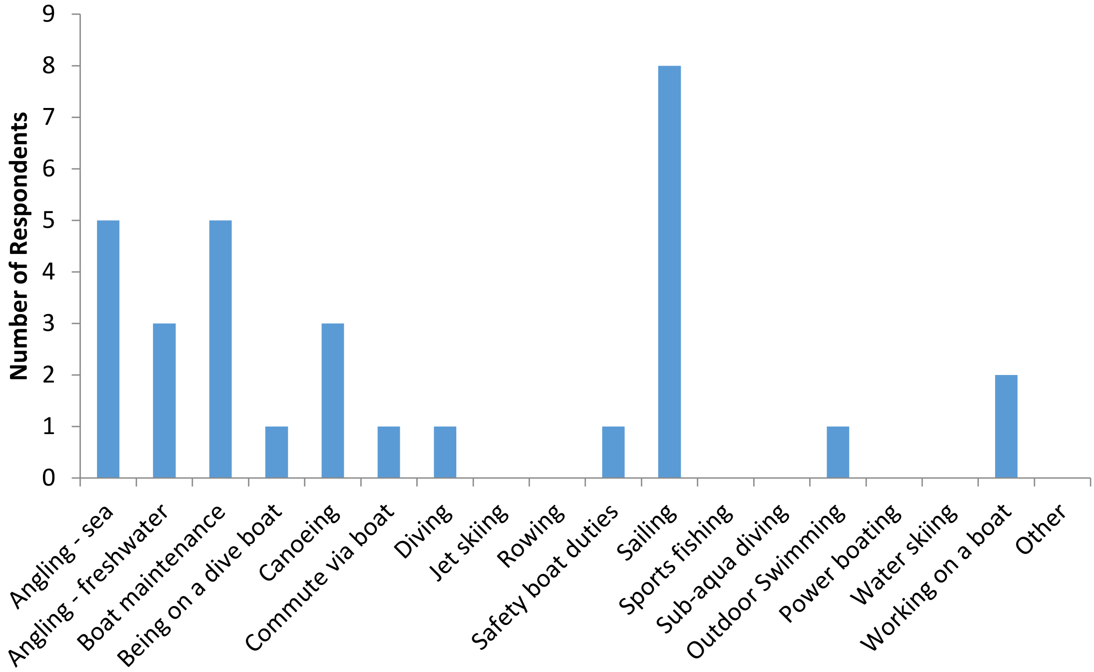

Figure A7ii. Aquatic external exposure activities undertaken.

The individual with the highest occupancy in Zone 1 spent a total of 16 hours annually encompassing time spent on a dive boat (8 hours) and time spent diving (8 hours). The individual with the highest occupancy in Zone 2 for 336 hours annually undertook boat maintenance (78 hours), canoeing (27 hours), safety boat duties (36 hours) and sailing (195 hours). The individual with the highest occupancy in Zone 3 for 260 hours annually undertook sea angling (130 hours) and freshwater angling (130 hours). The individual with the combined highest occupancy for all zones totalled 558 hours annually (and had the highest occupancy for Zone 2) on activities including boat maintenance, canoeing, safety boat duties and sailing. Table A7ii details a statistical summary of aquatic occupancy per zone based on actual replies.

Table A7ii. Aquatic occupancy within Zones 1, 2 and 3.

	Zone 1 (h y^{-1})	Zone 2 (h y^{-1})	Zone 3 (h y^{-1})	Total all zones (h y^{-1})
Maximum	16	336	260	558
Minimum	0	0	0	0

Mean	0.2	8	13	22
Median	0	0	0	0
97.5th percentile	0	221	217	455

Intertidal – External Exposure

The postal survey showed that dog walking was the highest reported intertidal activity (Figure A7iii). Zone 1 was visited by three respondents for a total of 834 hours annually, Zone 2 was visited by ten respondents for a total of 1 157 hours annually and Zone 3 was visited by 16 respondents for a total of 1 851 hours annually.

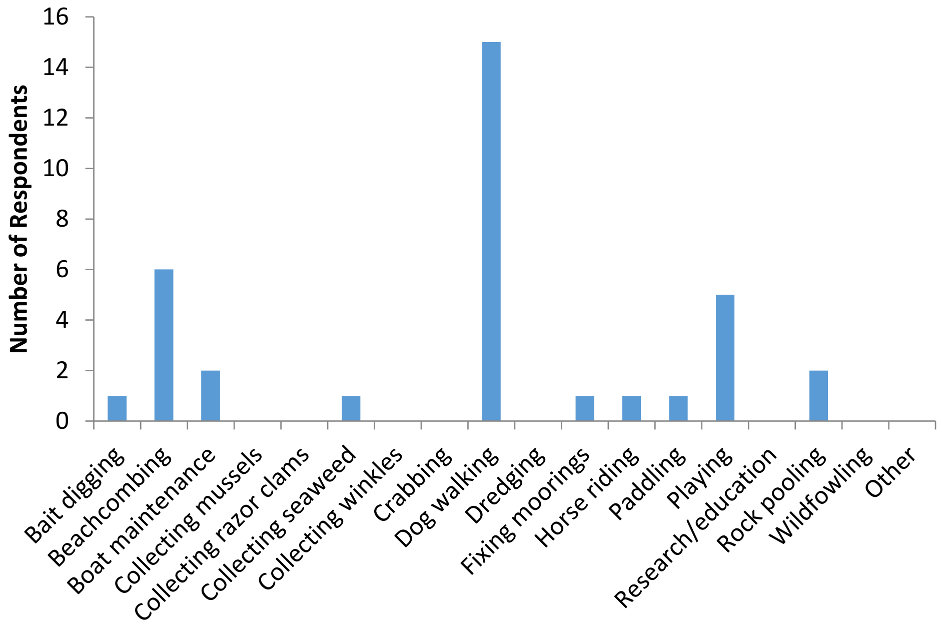

Figure A7iii. Intertidal activities undertaken by survey respondents.

The individual with the highest occupancy in Zone 1 spent a total of 548 hours annually engaged solely in dog walking. Two individuals shared the highest occupancy in Zone 2 spending 365 hours annually undertaking dog walking (365 hours). The individual with the highest occupancy in Zone 3, (and one of the same individuals with the highest occupancy in Zone 2), totalling 365 hours annually undertook dog walking (365 hours). The individual with the combined highest occupancy for all zones totalled 730 hours annually (and had the highest occupancy for Zones 2 and 3) and undertook dog walking. Table A7iii details a statistical summary of intertidal occupancy per zone based on actual replies.

Table A7iii. Intertidal occupancy within Zones 1, 2 and 3.

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	Zone 1 ($h\ y^{-1}$)	Zone 2 ($h\ y^{-1}$)	Zone 3 ($h\ y^{-1}$)	Total all zones ($h\ y^{-1}$)
Maximum	548	365	365	730
Minimum	0	0	0	0
Mean	10	13	21	44
Median	0	0	0	0
97.5th percentile	146	322	297	527

Internal Exposure

Household respondents were asked to provide information on where they sourced their food (Figure A7iv). Results show that the respondents sourced most of their food from outwith the zoned areas. This was consistent across all food groups.

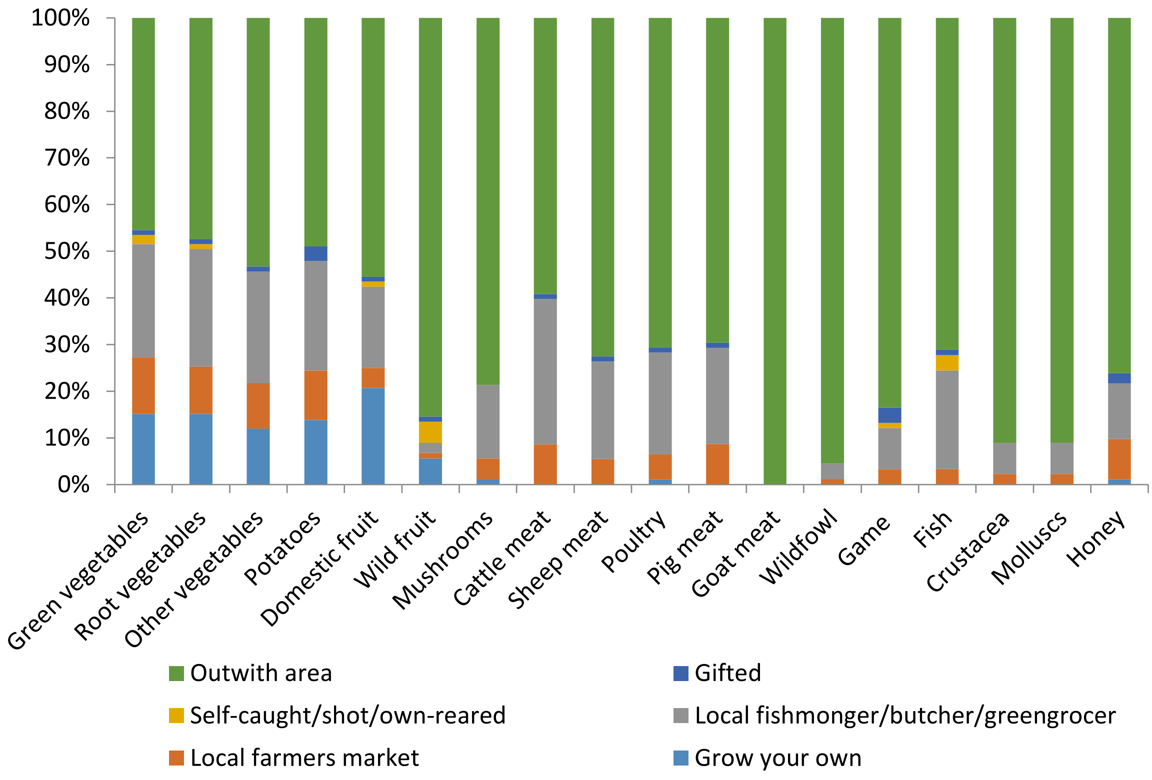

Figure A7iv. Sources of food consumed by the surveyed households.

The survey showed respondents most frequently consumed locally sourced green vegetables, root vegetables, mushrooms and potatoes from a greengrocer, while other vegetables and domestic fruit were mostly home grown. All meat was sourced from a local butcher with the exception of one respondent who home reared chicken. Fish, crustacea and molluscs were all mostly sourced from a local fishmonger. Game and wildfowl were mostly sourced from a local butcher with some game gifted. Honey was mostly sourced from a local fishmonger/butcher/greengrocer and a local farmers' market. Table A7iv presents the percentage of respondents consuming food from different local sources. It should be noted that some respondents consumed produce from more than one source in the same food group. For produce sourced within the zoned areas, it may be useful for future surveys to determine which zone they were sourced from (within 1 km, within 1 – 5 km or within 5 – 10 km).

Table A7iv. Percentage of respondents sourcing food locally.

	Total Individuals	Grow your own (%)	Local farmers market (%)	Local fishmonger/butcher/greengrocer (%)	Self-caught/shot/own-reared (%)	Gifted (%)
Green vegetables	42	36	29	57	5	2
Root vegetables	40	38	25	63	23	3
Other vegetables	38	29	10	25	0	1
Potatoes	41	32	24	54	0	7
Domestic fruit	36	53	11	44	2.8	3
Wild fruit	11	45	9	18	36	9
Mushrooms	17	59	24	82	0	0

Cattle meat	32	0	25	91	0	3
Sheep meat	21	0	24	90	0	5
Poultry	22	5	23	91	0	5
Pig meat	23	0	35	83	0	4
Goat meat	0	0	0	0	0	0
Wildfowl	3	0	33	100	0	0
Game	11	0	27	73	9	27
Fish	23	0	13	83	13	4
Crustacea	6	0	33	100	0	0
Molluscs	6	0	33	100	0	0
Honey	17	6	47	65	0	12

Appendix A8 Aquatic site descriptions and observations

A8.1 Cove Bay, Kilcreggan Bay, Portkil Bay and Mieklecross Bay

Cove Bay is the most western point of the aquatic survey area and it includes the southern-most part of the Rosneath peninsula where Loch Long meets the Firth of Clyde. Offshore activities observed outside the school holiday period included five people paddle boating and lobster potting at Cove Bay and five people beachcombing. A family interviewed reported that they regularly undertook activities along this stretch of the coastline. Cove Sailing Club is located on the shores of Loch Long and club members meet twice weekly to race during the summer season. The substrate at this site was primarily pebbles and rock. The shore is accessible from several access points from the roadside. The shoreline stretches along to Kilcreggan Bay where the pebbly substrate in the upper shore changes to rocks with boulders and seaweed on the lower shore. A small stream flows into the Firth of Clyde from Kilcreggan. One person was observed fishing from this bay. The surrounding area was mainly scrub and grassy fields with no livestock or sheep observed. Within the school holiday survey period a single dog walker along with two additional walkers were observed at Kilcreggan Bay. Kilcreggan is served by a highly trafficked ferry that regularly crosses the Clyde to Gourock and is accessed via a well-maintained pier (Figure A8i). No activities were observed on the beach during either survey period.

Access to Portkil Bay was limited to a public path, found behind an embroidery company, and which then continued on to Rosneath Point. Several houses are located in this area. The intertidal substrate graded from pebble and sand on the upper shore to large pebbles, rocks and some boulders towards the low tide line. No onshore or offshore activities were observed at this site outwith the school holidays, although it was reported during an interview from a member of the public that one individual regularly fishes for trout at this site. The surrounding area was largely farmland, but no livestock or sheep were observed. Within the school holiday survey period a single dog walker was observed on the shore at Portkil Bay and a farmer was working in the fields behind the bay with sheep grazing in the upper field.

The intertidal environment at Meilkleross Bay was mainly sand and pebbles. Observed occupancy levels before the summer holidays were low and tended to be limited to a single dog walker and a single sailing boat offshore. Dairy cows were observed grazing the lower fields behind the bay and sheep occupied the upper fields. A farm gate preventing cattle and sheep accessing the foreshore was apparent, although the gate did not close properly there was no evidence of cattle gaining access before the summer holiday period. During the summer holiday survey period, both sheep and cattle were grazing together in the upper field between Portkil Bay and Meikleross Bay. There was also evidence that cattle had been accessing the intertidal area at Meikleross Bay, but an electric fence was now in place to prevent cattle access to the bay. During the summer holiday period no aquatic activity was observed on the coastline between Cove Bay and Meikleross Bay.

Figure A8i View looking South at Kilcreggan Pier and across the Clyde to Gourock (July 2016).

The shoreline between Meikleross Bay and Rosneath Point was dominated by rocky outcrops covered in seaweed, with areas of saltmarsh vegetation on the upper shore. Wooded areas and gorse were present in the area behind the beach.

Spume was observed only at Porkil Bay and Meikleross Bay outwith the school holiday period. No spume was observed at these sites within the school holiday survey period.

A8.2 Rosneath Point, Culwatty Bay, Castle Bay and Rosneath Bay

Rosneath Point is a rocky promontory with much of it covered by seaweed. It is accessed either from Castle Bay Caravan Park in the east along a private road and through a wooded area or from Meikleross Bay in the west. No onshore or offshore activities were observed within and outwith the school holiday period.

Eastwards from Rosneath Point is Culwatty Bay (Figure A8ii) The substrate at this site is predominantly pebble, rock and mud with seaweed and rocks and sand apparent within the upper shore. A small stream flows into Culwatty Bay and sporadic houses within the wooded area behind the bay are present. One bird watcher was noted in the woodland beside the shore at this site. During the site visits within the school holiday period, two people were observed walking along the intertidal area, whilst there were no offshore activities observed.

Spume was observed only at Culwatty Bay outwith the school holiday period. No spume was observed at any sites within the school holiday period.

Figure A8ii Looking east across Gare Loch towards Helensburgh at Culwatty Bay (July 2016).

Castle Bay Caravan Park is a large caravan park which stretches from Castle Bay to Rosneath Bay. On the private tarmac road from Castle Bay Caravan Park one dog walker, three walkers and several cars were noted. Five sailboats and one Rigid Inflatable Boat (RIB) were observed offshore. The foreshore at Castle Bay is primarily a rock, pebble and sand substrate (Figure A8iii). Despite the fact that some visitors were observed at a local caravan site during the face-to-face surveys in May, only two dog walkers were noted outwith the school holiday period and no offshore activities were observed. During the survey conducted during the school holiday in July there was a small increase in intertidal occupancy, with one adult and two children fishing off the pebbles at Castle Bay and two sailing boats were observed in the Gare Loch from Rosneath Point.

Figure 8iii View looking north east across Gare Loch at Castle Bay (July 2016).

There is a coastal path and road leading from Castle Bay to Rosneath and Camsail Bay. The intertidal environment here was dominated by shingle mixed with finer silty sediment (Figure A8iv) and the foreshore was enclosed by small areas of salt marsh. No onshore or offshore activities were observed at Rosneath Bay, although a container vessel was observed moored off Rosneath near to the sailing club. The surrounding inland area was characterised by farmland with no cattle or sheep observed, although several sheep were noted to be grazing on the shoreline. A few residential houses were noted at this area.

Figure A8iv Rosneath /Camsail Bay overlooking Rosneath Peninsular, Gare Loch towards Rhu (July 2016).

A8.3 Rosneath, Clynder, Rahane, Mambeg and Rockville

The intertidal substrate between Rosneath and Rockville was predominantly rock and pebble, with seaweed and large expanses of mud and rocks exposed at low tide. The shore in this area was accessible from numerous points, many of which were associated with lay-bys. Some stretches of the shore, particularly between Mambeg to Rockville, were difficult to access from the road due to thick vegetation.

No activities were observed at Rosneath shore either onshore or offshore outwith the school holiday period. DRB Marine Services and McGruer & Co. Ltd. Yacht and Boat Surveyors are situated at Rosneath with moorings for pleasure craft and boat maintenance. The boat yard included areas of hard standing occupied by a range of pleasure boats. Four boat maintenance workers were observed along with one office staff member. Within the school holiday survey period there observed no activities observed onshore or offshore at Rosneath. Similarly, no activities were noted onshore or offshore at either Clynder or Rahane.

Figure A8v Looking North towards Garelochhead from Mambeg (July 2016).

Multiple lay-bys and slipways are located between Clynder and Rahane allowing access for boats to the water and providing access for individuals to the shore. Six sail boats were anchored offshore at Clynder with ten dinghies sitting on the hard standing by a slipway. Clynder itself is mainly residential with one small shop. From Rahane to Mambeg there are again multiple lay-bys allowing access to the shore. Outwith the summer holiday period, observed onshore activities included three cyclists on the road near Mambeg and one individual fishing off the rocks. The only offshore activities observed in this area were two police boats. Much of the area immediately behind the foreshore from Mambeg is covered with thick vegetation and trees. North of Mambeg to Rockville (Figure A8v), one family was observed playing on the beach and throwing stones, one child fishing and four dog walkers were also observed. In addition three children were observed dog walking on the beach at this site. The family playing on the foreshore and the child fishing were outwith the survey area. Access to the beach was via a lay-by. During the July survey, Mambeg was very popular for angling (Figure

A8vi), especially in the afternoon and evening period, with 20 people observed fishing (including three children) on one occasion and seven individuals, visiting from Glasgow, fishing for the first time on a separate occasion. There were no onshore activities at Rockville, although offshore three commercial boats, ten sailing yachts, two sailing dinghies and four power boats were observed.

Figure A8vi Fishing from Mambeg (July 2016).

Spume was not observed at any sites in this area outwith or within the school holiday period at any point along this shoreline.

A8.4 Garelochhead

Garelochhead is situated at the northern end of the Gare Loch and is a residential area with two shops and a public house. There is good access to the shore from Garelochhead with a large grassy area and footpath joining the east and west side. A footbridge was situated over a small stream which flowed into the Gare Loch and a small stream also flowed in to the Gare Loch at the eastern side. The substrate consisted of some sand, silt pebbles and mud, with a significant proportion of the intertidal environment covered in algae and seaweed. The upper shore was heavily covered with seaweed and the western side of the bay was backed by salt marsh (Figure A8vii). Onshore activities observed included five dog walkers and one walker. Two rowing boats were beached on the pebbles and mud and a further three boats were located on the eastern side on seaweed and rock. One individual interviewed was walking along the intertidal area with their chickens; the eggs from these chickens were only consumed by the individual. Six boats were anchored offshore in the water and two RIBs were observed offshore.

Within the school holiday survey period five children were observed playing, swimming and paddling in the water beside the footbridge and a further five children playing and paddling. One cyclist and three joggers were noted on the path at the back of the bay and two beach combers, three dog walkers and two walkers were observed on the substrate at Garelochhead. One individual was observed clearing the seaweed and other debris from the ropes on a boat on the intertidal area. One individual was observed on the water in a rowing boat while a further six boats remained anchored offshore. It was reported that the owners of two of the boats live on them for part of the year. The two boats were reported to have arrived within the last two years and have not moved since.

No spume was observed at this site outwith or within the school holidays.

Figure A8vii View looking west across the bay at Garelochhead (July 2016).

A8.5 Faslane Naval Base

HMNB Clyde is situated to the south of Garelochhead and borders approximately 2 km of the surrounding shoreline. This area is inaccessible to the public. Individuals are not permitted to fish (from the shore or boat) or swim within 150 metres of any walls, slipways, roadways or boundaries of Her Majesties Naval Establishment.

A foot and cycle path around the perimeter of the site are accessible on the roadside of the base.

Please refer to Chapter 2 for further details.

A8.6 Shandon and Rhu

Shandon is a small residential conurbation and also includes the Faslane Peace Camp. The occupancy of the Faslane Peace Camp can vary from as few as 11 individuals to over 100 individuals. The shore is easily accessible by several slip ways for both boats and individuals and is accessed by locals for dog walking and launching canoes and kayaks. Two walkers were observed at Shandon beach, two boats were moored offshore and one motor boat was in use offshore outwith the school holiday period. Within the school holiday survey period one individual was observed at Shandon on the intertidal substrate launching an outboard motor boat to go fishing. The foreshore at Shandon is dominated by sand, single and shells. The substrate from Shandon to Rhu Spit (Figure A8viii) consists of predominantly of pebbles, shingle and sand on the upper shore and pebbles/stones and mud exposed at low tide. Seaweed is prevalent.

Figure A8viii View North towards HMNB Clyde site from Shandon foreshore (July 2016).

South of Shandon, at Blairvadach, an outdoor education centre provides water activities on the Gare Loch (sailing, power boating, canoeing/kayaking and bike and walking within the survey area). Continuing south, The Royal Northern and Clyde Yacht Club is situated at Rhu Spit primarily with a very active keel boat racing and development programme and sail boat cruising for members. Rhu is predominantly residential and home to the Rhu Marina, south of Rhu Spit, which provides approximately 235 deep water berths and 35 swinging moorings. It also provides an in shore storage area which can accommodate 140 boats. Her Majesty's Coastguard and the Royal National Lifeboat Institute (RNLI) are located at Rhu Marina and the marina provides a Royal Yacht Association (RYA) Active marina with events organised for customers with diving available (Figure A8ix). A Powerboat Training and Sailing School is also available at Rhu Marina. Marine electronics, engine maintenance and boat building services are provided on site along with a chandlery, boat sales and café. One individual interviewed stated that on occasions when the water level is very low they have noted raw sewage in the marina which they have reported to the Rhu Marina manager on several occasions. The survey team were unable to determine if there had been any change in occupancy as a result. Commercial divers identified in the 2011 Habits Survey based at Rhu Marina moved premises two years ago to the eastern side of the Rosneath Peninsula to Gareloch Support Services (GSS) and Silvers Marine Services (GSS bought Silvers Marine Services when they moved). Less than 10 % of their work is based within the survey area at HMNB Clyde, the Gare Loch and outwith the survey area in the Clyde.

Figure A8ix View west over Rhu Marina (July 2016).

Rhu Spit was a popular area for locals and visitors extending out into the Gare Loch (Figure A8x). A family of seven picking up litter (this is done on a few occasions whilst visiting family throughout the year), one dog walker and seven people walking were observed at Rhu Spit but no offshore activities were noted outwith the school holiday period. Rhu was popular with cyclists, dog walkers and walkers and a couple with a parrot were observed walking along the Rhu seafront outwith the school holiday period.

Figure A8x View looking west along Rhu Spit (July 2016).

One sailboat and one RIB were observed offshore on the water with three sailboats and one RIB moored near the shore. Rhu Spit was more highly trafficked with four dog walkers, five people walking and six adults and two children fishing off the end of the Spit during the school holiday survey period. Many people were observed walking along the tarmac road adjacent to the intertidal area.

Blairvadach Outdoor Centre in Rhu provide beach study walks along the intertidal area from Blairvadach for a duration of approximately two hours which can cater for up to 32 people.

No spume was observed outwith or within the school holiday period.

A8.7 Helensburgh, including Cairndhu Point

Continuing south to Cairndhu Point (the western end of Helensburgh) a café is situated at the seafront with a children’s play park (Figure A8xi) on a grassed area between the beach wall and the café. Many people were observed cycling, walking and dog walking in the area but only one dog walker was on the beach outside the school holiday period. Within the school holiday period the café and play park area at Cairndhu Point was very popular with families and several people engaged in jogging, walking and dog walking. On the intertidal substrate one individual was observed sitting and six dog walkers were noted.

Figure A8xi View south west from Cairndhu Point (July 2016).

Helensburgh Sailing Club has approximately 400 members including children and provides approximately 70 moorings to members. The club operates a training school for children during the summer period and organises regular racing meetings in the bay. Approximately 12 sailboats were observed racing outwith the school holiday period. Also outwith the school holiday period approximately 40 boats were observed moored offshore and 50 sail boats were counted on the hard standing. There is a rocky shore area adjacent to the sailing club leading to a substrate of pebbles, shingles and sand with seaweed (Figure A8xii). One dog walker and two fishermen were observed in the club area and one rowing boat was sitting on the pebbles, rocks and seaweed.

During the July survey, a group of 20 adults and children were observed launching sailing boats from the beach at Helensburgh Sailing Club. Approximately 40 boats were moored here on the water.

Figure A8xii View north towards the Helensburgh Sailing Club from Cairndhu Point (July 2016).

The Helensburgh seafront extends from Cairndhu Point approximately 3 km south to the Helensburgh Pier and this seafront and pier are very popular with locals and visitors walking, dog walking, cycling and jogging. The foreshore is composed of shingle and shells (Figure A8xiii). A fairground was setup adjacent to the pier and was due to open late May. This was not a permanent structure. Towards Helensburgh Pier six dog walkers, five individuals playing on the sand, pebbles and seaweed, one person collecting driftwood and one person fishing off the pier were observed outwith the school holiday period. Two people bait-digging for ragworms in the mud (clay) at low tide, stated that they fished in the Gare Loch approximately six times per year. Two windsurfers were observed offshore outwith the school holiday period. During the July survey period, Helensburgh Pier and promenade was very popular with in excess of 100 people observed on one occasion. On the intertidal substrate several families were observed playing along with four dog walkers and one individual walking.

No spume was observed outside or within the school holiday period.

Figure A8xiii Foreshore and Pier at Helensburgh (July 2016).