Final Report

SR (02) 14

An Assessment of Aquatic Radiation Pathways in Northern Ireland

December 2002

SNIFFER
SCOTLAND & NORTHERN IRELAND FORUM FOR ENVIRONMENTAL RESEARCH

An Assessment of Aquatic Radiation Pathways in Northern Ireland

by The Centre for Environment, Fisheries and Aquaculture Science

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December 2002

CEFAS Contract C1187
CEFAS Environment Report RL20/02

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EXECUTIVE SUMMARY

This report describes an assessment of aquatic radiation exposure pathways in Northern Ireland. It comprises:

- a survey of consumption, occupancy and contact rates for local people
- an assessment of their radiation exposure using monitoring data

The aim of the habits survey was to obtain site specific habits survey data for use in identifying radiation exposure pathways to the local population and subsequent definition of critical groups. Rates for seafood consumption, occupancy of coastal areas, and handling of commercial fishing gear, seaweed, shellfish and sediment were obtained. Consideration was also given to potential radiation exposure through related terrestrial pathways, e.g. use of seaweed as a fertiliser on land used for food production, and unusual and novel exposure pathways, such as seaweed and wildfowl consumption, beach sand use and inadvertent ingestion of seawater and sediment.

The habits of more than 800 individuals were recorded. The data mainly related to adults though some observations for children are presented.

The adult critical groups of local seafood consumers were identified as eating:

- Fish 99 kg/y (the mean of 30 high-rate consumers),
- Crustaceans 34 kg/y (the mean of 66 high-rate consumers),
- Molluscs 7.7 kg/y (the mean of 11 high-rate consumers),
- Dulse seaweed 10 kg/y (the mean of 7 high-rate consumers).

The species consumed were, rounded to the nearest 5%:

- Fish – 40% Haddock and 60% mixed fish, comprising of cod, mackerel, sole, hake, plaice, pollack, herring, whiting, turbot and halibut.
- Crustaceans – 65% *Nephrops*, 25% edible crab claws, 5% edible crab and 5% lobster
- Molluscs – 75% mussels, 15% scallops and 10% clams
- Marine plants – Dulse seaweed (*Rhodymenia palmata*) – 100%

For coastal area occupancy, the survey identified the following adult critical groups:

- 1100 h/y over sand/mud (for a beach angler),
- 820 h/y over sand (the mean of three dog walkers and a lifeguard),
- 9.0 h/y over saltmarsh (the mean of 71 members of a local game and wildfowling conservation association).

For handling, the survey identified the following adult critical groups:

- 1500 h/y handling commercial fishing gear (the mean of 24 individuals handling crustacean pots and fishing nets),
- 100 h/y handling sand/mud (one individual commercially picking winkles),
- 950 h/y handling dulse seaweed (the mean of 4 individuals).

The following suggested additions or changes to the current monitoring programme are based on the findings of this survey:

1) Monitoring of haddock instead of spurdog. Haddock was the fish species most commonly consumed by members of the adult critical group. No consumption of spurdog was reported during the survey.
2) Monitoring of edible crab claws. Edible crab claws were consumed by members of the adult critical group and by many of the crustacean consumers interviewed during the survey.
3) Monitoring of clams and scallops. These molluscs were consumed by the adult critical group but are not currently sampled.
4) Given the high rates of handling of commercial fishing gear and dulse seaweed, beta dose rate monitoring of these materials could be undertaken
5) Gamma dose rate measurements over sand/mud at Greencastle. This was the location for the high occupancy rate beach angler.
6) Gamma dose rate measurements over sand/mud in Carlingford Lough where oyster baskets are tended (gamma dose rates for winkle pickers at Killough Bay are already monitored by the Environment and Heritage Service).
7) Gamma dose rate measurements over saltmarsh at Mill Bay could be considered. This was the area where wildfowling took place, though it should be noted that occupancy rates were very low.

All other sampling and in-situ measurements should remain unchanged.

For dose assessment purposes, it is considered that a conservative assessment of effective dose would be based on consumption of 99 kg/y fish, 34 kg/y crustaceans and 7.7 kg/y molluscs together with 1100 h/y occupancy over sand/mud.

The dose assessment combined the results of the habits survey with environmental monitoring data for 2000. It was found that the critical group in Northern Ireland would have received a dose of 0.018 mSv y^{-1}, with 0.015 mSv y^{-1} due to consumption of seafood. Average rate seafood consumers would have received 0.003 mSv y^{-1}. These doses are well within the recommended limit for members of the public of 1 mSv y^{-1}.

KEY WORDS

Radiological assessment
Dose assessment
Radioactivity
Aquatic radiation pathways
Habits surveys
Critical groups
Seafood consumption
Northern Ireland
Irish Sea
Sellafield

1. INTRODUCTION

Regulation of radioactive waste discharges is made under the Radioactive Substances Act 1993 (RSA93) with authorisations that set limits on the quantities and types of radioactivity released. In Northern Ireland, the Environment and Heritage Service (EHS), within the Department of Environment, Northern Ireland is the regulatory authority under RSA93.

The radiological implications of radioactive waste discharges are considered against the dose limitation system recommended by the International Commission on Radiological Protection (ICRP, 1991). The overriding requirement is that the dose received by individual members of the public shall be as low as reasonably practicable (ALARP) and not exceed appropriate limits.

Habit surveys provide information for radiological assessments. They are also used to guide the design of environmental monitoring programmes. A regular programme of radiation monitoring is conducted in the UK, which includes samples from Northern Ireland. The results of the monitoring surveys, with estimates of public radiation exposure which use the results of habits surveys, are published annually by the Food Standards Agency (FSA) jointly with the Scottish Environment Protection Agency (SEPA). This report series, 'Radioactivity in Food and the Environment' (RIFE) (e.g. FSA and SEPA, 2000), has replaced the earlier Aquatic Environment Monitoring Report series (e.g. Camplin, 1995). The results of the Northern Ireland monitoring are also published biennially in the Report of the Chief Alkali Inspector (most recently EHS, 2000) together with the results of gamma dose rate monitoring over intertidal sediments conducted along the Northern Ireland coastline by EHS.

This report presents an aquatic habits survey and an assessment of radiation doses for Northern Ireland. The work was conducted on behalf of the Scottish and Northern Ireland Forum for Environmental Research (SNIFFER) and EHS. It is primarily targeted at the potential effects of current and historic discharges from Sellafield.

2. THE HABITS SURVEY

2.1 Survey aims

The aim of the survey was to identify the aquatic pathways that could lead to members of the general public in Northern Ireland being exposed to ionising radiations primarily as a consequence of the discharge of radioactive waste into the Irish Sea.

Fieldwork was conducted in order to obtain site specific habits survey data for use in defining critical exposure pathways to the local population and subsequent definition of the critical group(s). General habits survey information for the area was also obtained.

Data were obtained by interviewing people and by reference to literature sources.

2.2 Survey area

By agreement with EHS, the survey area covered two sections of the Northern Ireland coastline. The first section, shown in Figure 1a, covered the main fishing ports within the geographical areas of Portavogie to Portaferry and Strangford to Tyrella Beach. The second (Figure 1b), covered the ports between Annalong and Rostrevor. Some additional areas (Belfast and Ballywalter) were investigated with regard to seaweed collection and consumption. Data on consumption rates relate to seafood obtained from the Irish Sea, Strangford Lough and Carlingford Lough. Consumption of seafood from other areas was not recorded.

2.3 Conduct of the survey

The survey fieldwork was carried out between 17th – 28th July 2000 using techniques described in Leonard *et al*., (1982). Prior to the start of the fieldwork, discussions were held with representatives of the EHS, and those from the Department of Agriculture and Rural Development (DARD), the Department of Health, Social Services and Public Safety (DHSSPS), and the Department of Nutrition at the University of Ulster. Through them, further contacts were established with the Environmental Health Department of DHSSPS, community dieticians and those connected with the Northern Ireland National Food Survey. A literature search was also conducted to obtain information about the survey area and on any environmental monitoring, dose assessments and habits surveys previously conducted. Sources of information included EHS, DARD, the Irish Universities Nutrition Alliance (IUNA), the Joint Nature Conservation Committee (JNCC), CEFAS and the Internet. References consulted included EHS biennial Chief Alkali Inspectors Reports from 1987 to 1999 (EHS, 1990; EHS, 1992; EHS, 1994; EHS, 1996; EHS, 1998; EHS, 2000), the 1999 National Food Survey of Northern Ireland (DARD, 2000), a North/South Ireland Food Consumption Survey (IUNA, 2001), Radioactivity in Food and the Environment, 1999 (FSA and SEPA, 2000), the Coastal Directory for Northern Ireland

(JNCC, 1997), reports dealing with radioactivity in Strangford and Carlingford Loughs (Ledgerwood *et al*., 2001; Mitchell *et al.*, 1992; Long *et al*., 1999; Caulfield *et al*., 1989; and Larmour and Ledgerwood, 1995), a report on radioactivity on the coasts of Northern Ireland (Garland *et al*., 1988), and reports on radioactive waste dumping (Department of Marine and Natural Resources, 1999 and Titley *et al*., 1997). A list of the fishing vessels licensed within the survey area and fisheries landings statistics (1997 – 2000) were obtained from CEFAS.

On commencement of the fieldwork, people with a local knowledge of the survey area were contacted for information on any aspects relevant to exposure pathways. People contacted included:

- DARD Fisheries Officers, Harbour Masters and representatives of the Anglo-North Irish Fisheries Producers' Organisation (ANIFPO), and the Northern Ireland Fish Producers Organisation (NIFPO).
- Individuals connected with the local inshore and offshore fishing industry – fishermen and potters.
- Licensed salmon, bass and sea trout netters.
- Local fish and shellfish processors, wholesalers and retailers.
- Local shellfish farms – oysters and mussels.
- Local angling clubs and tackle shops.
- Coastal area recreational activity centres – diving, sailing, water skiing, outdoor activities centre, beach wardens and lifeguards.
- Commercial and private dulse collectors and retailers.
- Queen's University of Belfast, Marine Biology Station, Portaferry.

Using the information obtained, the survey team were able to concentrate their interviewing on the higher rate consumers of locally caught or collected seafood, including seaweed, and those individuals' potentially most exposed to radiation from handling of, or occupancy over, intertidal sediments. All interviews were used to establish individuals consumption, occupancy and handling rates relevant to each exposure pathway, and to obtain general information of possible use to the survey. Those interviewed included charter boat operators, commercial and part-time fishermen, wildfowlers, seaweed and shellfish collectors, anglers, angling equipment shop staff, seafood wholesalers and retailers and their staff and customers of these suppliers. By combining the information supplied by key sources with that from subsequent interviews, a picture of potential exposure pathways was compiled.

Approximately 30 person-days were spent interviewing and the habits of more than 800 individuals were recorded.

3. LOCAL FISHING EFFORT

3.1 The fishing industry

Three major fishing ports were visited during the survey, Portavogie (64 registered vessels), Ardglass (35 registered vessels) and Kilkeel (122 registered vessels) which represent the bulk of the Northern Ireland fishing industry. Minor fishing ports visited were Portaferry (4 registered vessels), Annalong (6 registered vessels) and Greencastle (vessels registered at Kilkeel). Representatives of 71 (i.e. nearly one third) of the vessels registered at these ports were interviewed.

Two of the 20 United Kingdom's Fish Producers Organisations are based in Northern Ireland, one in Kilkeel, the Anglo-North Irish Fisheries Producers Organisation (ANIFPO), and the other in Portavogie, the Northern Ireland Fish Producers Organisation (NIFPO). There is also a NIFPO office in Ardglass. The Producers Organisations (POs) are established under the Common Fisheries Policy to enable groups of fishermen to market the seafood they catch. The POs are responsible for managing catch quotas. This allows them to plan their uptake of a particular allocation and thus optimise the benefit to their members. The POs manage most of the fishing fleet in the survey area. The NIFPO manages 98% of the fleet at Portavogie, 100% of the fleet at Ardglass and 35% of the fleet at Kilkeel. Seafood landings into Northern Ireland totalled £22.6m (28,000 tonnes) in 1999 and 86% of these landings were exported to Europe (including UK mainland). Concerns were expressed about the state of the Northern Irish fisheries, particularly the wet fish stocks and the potential over-fishing of the *Nephrops* stocks.

Kilkeel has the largest fishing fleet on the Northern Ireland coast, and two thirds of this fleet are involved with inshore *Nephrops* fishing or crab and lobster potting. The remaining third is comprised of larger, offshore pelagic fishing boats. Landings in Kilkeel accounted for £9.5m (8,500 tonnes) in 1999. Catches are currently sold by auctioneers at the fish market, but it was rumoured that electronic auctioning is soon to be trialed.

The fishing methods used were mainly trawling, drift netting, set netting and potting.

3.2 Fishing areas

The area of the Irish Sea studied is shown in Figure 2. The small inshore *Nephrops* and potting boats only fish west of the Isle of Man (Area VIIa), going out for 12 to 48 hours at a time. Potting boats usually operated from midnight to 10 am or 7 am to 6 pm, depending on the tide. Even the larger boat skippers reported staying west of the Isle of Man, preferring to fish in Beauforts Dyke (Area VIIa), up into the North Channel in the winter (Area VIa) and into St George's Channel, as far down as Milford Haven (Area VIIg), in the summer. Only the really large pelagic fishing boats reportedly went

east of the Isle of Man, generally during May and June, during which period they tended to land their catches in Whitehaven.

4. INTERNAL RADIATION EXPOSURE PATHWAYS

4.1 Fish

4.1.1 Inshore and offshore fishing

Since the decline in wet fish stocks, the pelagic boats have diversified and predominantly fish for *Nephrops* in the summer and fish in winter. The exception to this was fishing for 8 to 9 weeks in the summer (mid-June to mid-August) for mackerel and herring. Two mackerel and herring processing merchants were identified and interviewed during the survey. The fish were filleted, preserved and the majority exported to Eastern Europe, Israel and Germany. Haddock had, over the last two years, taken over from cod as the predominant species caught and landed by the pelagic trawlers. This was particularly apparent during 2000, following a ban on cod fishing between 14th Feb and 1st May 2000. Other fish landings were usually by-catches as a result of the *Nephrops* fishing activities. Eight wet fish merchants were interviewed during the survey. Some reported buying fish from Republic of Ireland for resale in the north. High quality Kilkeel cod, when available, was exported to mainland United Kingdom. Catches of prime wet fish e.g. turbot, brill, hake and monkfish, were mainly exported to France and Spain. Three of the fish merchants interviewed had their own smokehouses.

Inshore netting of salmon, sea trout and bass at sea was recorded at Kilkeel. Four licences had been issued in County Down, three of them were held for netting at Kilkeel.

4.1.2 Angling

A number of sea anglers were interviewed during the survey. They all fished primarily for pleasure/sport. It was reported that very little consumption of the fish caught took place. Popular sea angling locations include offshore of Portaferry and Ardglass, from the rocks at Ardglass and Cranfield, and from the beach at Greencastle. Anglers reported using lures (including feathers), shop bought dried bait, frozen sandeels or fresh mackerel as bait. None of the anglers reported using fresh worms or digging for their bait.

Members of the Kilkeel angling club were interviewed during the survey. The club had its own salmon hatchery where 90 salmon a year were stripped of their eggs. After hatching and rearing, salmon were released for angling in the White Water River (see Figure 1b). The season was from 1st March to 31st October but club members voluntarily delayed the start of the angling until 1st June in order to preserve stocks. 20% of the fish caught were salmon, the rest were indigenous sea trout and most catches were returned to the river.

Two tackle shops were identified during the survey and the owners were interviewed about angling activities and bait supplies. Each supplied information about popular local angling spots and clubs and reported selling the baits described by the anglers. No collection, sale or use of fresh worms was found or reported. One beach occupant, found netting for small prawns at Craigthomas beach (see Figure 1a) at low tide, reported using the prawns as bait for salmon and sea trout angling.

4.2 Crustaceans

4.2.1 *Nephrops*

The main commercial crustacean inshore fishery in the survey area was for *Nephrops*. Four large scale *Nephrops* merchants were interviewed during the survey. One seafood merchant in Ardglass reported that up to 2000 stone (i.e. 12700 kg) of *Nephrops* were sold to seafood merchants every week at local auctions. Kilkeel was reputed to be a centre for scampi production, with hundreds of people involved in the industry, from fishermen to process workers. Five companies processing *Nephrops* were interviewed during the survey. *Nephrops* accounted for 50% of the value and weight of catches landed at Kilkeel. *Nephrops* used to be caught during mid-July to mid-December but as wet fish stocks declined *Nephrops* fishing had increased to all the year round. Small *Nephrops* had their heads removed at sea, were landed and went to processors for scampi production. One processor, involved with breaded scampi production, reported processing 500 stone (i.e. 3200 kg) of *Nephrops* tails per week, throughout the year, for export exclusively to the Republic of Ireland and the UK mainland supermarket chains. Large *Nephrops* were landed whole and were bought by factories where they were washed, graded by sized and boxed for export. One processor reported processing between 500 – 900 stone (i.e. 3200 – 5700 kg) of whole *Nephrops* per day throughout the year for export to Spain and France. Sales of whole *Nephrops* and scampi were noted at many local retail and restaurant outlets.

4.2.2 Crabs and lobsters

The other inshore crustacean fishery was potting for crabs and lobsters. This was mostly carried out during mid-July to mid-December. The fishery was small when compared to the *Nephrops* fishery. Only one merchant dealing with crabs and lobsters was identified and interviewed during the survey. Lobsters and crabs were sold to local restaurants and exported to France. However, most of the crabs caught had only their claws (locally called ‘toes’) removed for consumption. Most crab bodies were discarded or used for pot bait. Velvet crabs were also caught and these were exported to Spain and France. Sales of locally caught crab and lobster were noted in local restaurants.

4.3 Molluscs

Four merchants involved with the buying and selling of molluscs were identified and interviewed during the survey. Information about periwinkles (sometimes locally called whelks), whelks, oysters, mussels, scallops, clams, razor fish and squid was obtained.

A report on artificial radioactivity in Carlingford Lough (Mitchell *et al*., 1992) identified experimental mariculture of abalone (*Heliotis tuberculata*). However, no evidence of abalone farming or consumption was identified during the survey.

4.3.1 Periwinkles and whelks

Winkles were harvested from beaches in the survey area for personal and commercial use. Popular locations were Annalong, Ballymartin, St John's Point area, Rostrevor, and Killough Bay. One seafood merchant employed casual workers to pick 200-300 tonnes of winkles per year, between Strangford and Carlingford Loughs, for export to France and Spain. Locally collected winkles were also sold locally through a merchant in Portavogie who reported selling between ½ and 1 tonne per week. The fish merchant in the Nautilus centre at Kilkeel collected local winkles for sale locally, but only in small quantities. A number of casual and commercial winkle collectors were also interviewed. Some crustacean potters reported potting for whelks (dog whelks) during the winter. Dredging for whelks reportedly occurred, some years ago, on a large scale to supply Far Eastern markets but this practice had now ceased.

4.3.2 Oysters and mussels

Oyster farms and commercial mussel dredging were reported at Carlingford Lough. One merchant obtained 500 tonnes of mussels a year, dredged between December and May, from the Lough and had just started one of the oyster farms there. The farm had been stocked with a million oyster seeds, obtained from Guernsey. The oysters were expected to be ready for sale in three years time (2003). The mussels and oysters were mostly for export to Spain and France. Oyster farms were also reported at Dundrum Bay and, most recently started, at Killough Bay. The farm at Killough Bay was visited but no one was available for interview. Local consumption of commercially harvested oysters and mussels from Dundrum Bay and Carlingford and Strangford Loughs was reported. Some individuals were found to regularly pick small quantities of mussels for personal consumption, and mussels were also available for purchase either fresh or preserved in brine (100g jars).

4.3.3 Scallops and clams

Scallops and clams were caught as a by-catch of *Nephrops* fishing and were also dredged (licensed season 1st November to 1st June). Two merchants dealing with scallops were identified during the

survey, both reported sending scallops to Southern Ireland. Scallop dredging was undertaken near St John's Point.

4.3.4 Razor fish and squid

One of the fish merchants interviewed reported hearing about a fleet of six boats, operating out of Cloughey Head, fishing for razor fish. No evidence was found of this fleet during the survey. Razor fish collection was recorded at Greencastle for one individual who collected for their own consumption. A number of interviewees reported eating locally caught squid.

5. EXTERNAL RADIATION EXPOSURE PATHWAYS

5.1 Beach and coastal area activities

A number of beach and coastal area activities were observed throughout the survey area. Representatives of most activities were interviewed at the following locations:

- Dog walking – Greencastle, Rostrevor, Annalong, Cranfield, Kirkistown, Ballyhornan
- Walking – beaches local to Kilkeel
- Sunbathing – Kirkistown, Tyrella, Kilclief, Ballyhornan
- Rockpooling – Craigthomas, Tyrella, Ballyhornan
- Paddling – Kirkistown, Craigthomas, Tyrella, Kilclief, Ballyhornan
- Playing – Kirkistown, Craigthomas, Murphytown, Tyrella, Kilclief, Ballyhornan
- Wildfowling - Greencastle
- Shoreline studies – Cranfield east
- Beach angling (from rocks) – Greencastle, Cranfield, Ardglass
- Netting for small prawns – Craigthomas
- Dulse collection – Ballywalter, Portaferry
- Winkle picking – near St John's Point, Killough Bay, Annalong, Ballymartin, Rostrevor
- Oyster farming – Dundrum Bay, Killough Bay, Carlingford Lough

The most popular beaches within the survey area appeared to be those at Kilclief, Tyrella and Cranfield. Kilclief comprised of a small sheltered sandy bay dotted with large rocks, which provided even more shelter. During the survey, the beach was packed with visiting families, mostly local to the area. Tyrella, by contrast was a very large, long sandy bay, with a few rocks at low tide. Part of the bay held a Blue Flag water quality award, had a beach centre and was patrolled by beach wardens/lifeguards. During the summer, it was an extremely popular destination, particularly with families on holiday or on a day trip from Belfast. The head beach warden reported an average of 150,000 visitors a year. Cranfield beach also boasted a large sandy bay and was also patrolled by

beach wardens/lifeguards. It was a very popular holiday area, incorporating two large holiday caravan sites.

5.2 Watersport activities

A number of watersport activities were observed throughout the survey area. Representatives of most activities were interviewed at the following locations:

- Sailing – Strangford Lough, Carlingford Lough (Killowen)
- Recreational and contractual diving – Strangford, Ardglass, Kilkeel
- Body boarding – Kirkistown
- Water skiing – Kirkistown, Warrenpoint, Cranfield
- Jet skiing – Kirkistown, near Minerstown, Kilkeel Harbour
- Swimming – Near Murphytown, Tyrella, Kirkistown, Annalong Harbour (children)
- Canoeing – Carlingford Lough, Strangford Lough

The survey also identified an Outdoor Education Centre (OEC), at Killowen and a young offender's school at Millisle. The OEC ran residential courses for 11-18 year olds that included sailing, canoeing, rock climbing and shoreline studies. The OEC used Cranfield east beach, which was designated an area of special scientific interest, for their shoreline studies. The young offender's school used Strangford Lough twice a week, during the summer months, for canoeing.

5.3 Handling

Handling rates of crustacean pots and fishing nets by commercial fishermen, of sediment and shellfish by mollusc collectors, and of seaweed by seaweed collectors were recorded. No bait digging was identified in the survey area. Bait digging was reported at Belfast Lough and Strangford Lough (Comber) but these were well outside the survey area.

6. NOVEL AND UNUSUAL EXPOSURE PATHWAYS

Consideration was also given to novel pathways during the survey:

6.1 Seaweed as a fertiliser

Only one individual reported using seaweed as a fertiliser, for their apple tree. It was also reported that local farmers with land bordering the foreshore used to collect large quantities of wrack weed for use on their arable crops but that this practice had now stopped. This report was confirmed by a

farmer at Cranfield and by a local game and wildfowling conservation association. However, small scale collection of the weed by individuals, from April to June, was said to persist.

6.2 Seaweed consumption

The collection and consumption of dulse (*Rhodymenia palmata*) seaweed was recorded during the survey. Two large-scale commercial operations were identified, one run by a company based in Belfast and the other by a business based in Ballywalter. One individual was also found to be collecting and selling dulse, on a small scale, at Portaferry.

The commercial operator based in Belfast was interviewed by telephone. They processed dulse collected from the Co. Down and Co. Antrim coastlines. The dulse is collected from March to September, at low tide, by hand, using small boats. During the height of the season up to eight people were said to spend three to four hours a day, five days a week, collecting. Approximately 10 tonnes of dulse is collected each year. It is dried in the sun on the beach and then packaged in 20g bags ready for wholesalers. Due to concerns about hygiene, the processing of the dulse may soon change so that it is collected, washed in a clean brine solution and then dried in dedicated drying rooms. The packaged dulse is sold, mainly in Northern Ireland, through grocery shops and pubs and was found for sale in Belfast and throughout the survey area. The company exports very little dulse. Any that is exported goes to mainland UK, the USA and Australia.

The dulse business in Ballywalter was visited during the survey. The operator reported employing four people to collect up to 200 kg of dulse per day between March and October. Processing simply involved drying the dulse on the seafront promenade. Photographs of this operation were taken and are shown in Annex 1. The dried dulse was sold wholesale at a fruit market in Belfast.

The individual in Portaferry reported collecting 25 kg of dulse per day, throughout the summer. The dulse was dried on the seafront walls and promenade (see photographs in Annex 1) and then sold to a local grocer for resale in their shop.

The consumers and collectors of dulse interviewed during the survey reported its consumption as a cooked vegetable, its use in stews and soups and eating it as a snack food, like crisps. When consumed as a snack, the dulse was either chewed and swallowed or discarded after chewing.

6.3 Beach sand use

Local sand was not used in the bunkers at local golf clubs visited as this practice was prohibited.

6.4 Inadvertent ingestion of seawater and sediment

Participation in water sports and beach activities can lead to inadvertent ingestion of seawater and sediments. The United Kingdom Atomic Energy Authority (UKAEA) have conducted measurements of artificial radioactivity in seawater, beach sand, mud, coastal soil, sea spray and air from around the Northern Irish coastline (Garland *et al*., 1988). The objectives were to determine levels and to assess the magnitude of transport of radioactivity from sea to land. The results showed that radionuclide concentrations were low in all cases and that the resulting doses to the public would only contribute a small fraction of the appropriate dose limit. Assessments were based on comparisons with Generalised Derived Limits (GDL's – see Section 7.4).

Another study (Long *et al*., 1999) considered the impact of artificial radioactivity in Carlingford Lough. The authors postulated a 'critical individual' who spends 100 h/y swimming, 1000 h/y on intertidal areas and ingests 10 g/y of sand. Assessed doses to this individual were of 'negligible radiological significance'.

No direct observations of the amounts of seawater and sediment indirectly consumed were made in this survey. However, the occupancy rate data and substrate type information obtained provide additional information which could be used in the assessment of public exposure to radioactivity via these pathways.

6.5 Cattle grazing on foreshore.

Cattle grazing on the foreshore, affected by marine-borne radioactivity, may ingest radioactivity which is subsequently transferred to members of the public through the consumption of meat and milk. During the survey, it was noted that cattle grazed the grassy dunes of the Mill Quarter Bay National Nature reserve (near Killard Point) in the winter.

6.6 Wildfowling.

Evidence of wildfowling by a local game and wildfowling conservation association was identified at Greencastle. The association organises shoots at Mill Bay, a saltmarsh area situated between Killowen and Greencastle, and were in the process of getting the rights to shoot on the land around Carlingford Lough, which is owned by the Crown. At the time of interview the Association had 71 members. On average each member was reported to visit Mill Bay twice a year and spend a total of between 6 and 12 hours, both standing and lying down, on the saltmarsh.

7. ANALYSIS OF DATA

7.1 Internal radiation exposure.

Doses received by individuals will vary due to differences in age, size, metabolism and customs. For members of the public, the ICRP (1985, 1991) considers that it is feasible to take account of these variations by the selection of an appropriate critical group, provided that it is small enough to be homogeneous with respect to these variations. The critical group should be representative of those individuals in the population likely to receive the highest doses. The data in this report are interpreted to derive critical groups following these principles.

Critical groups for internal exposure are identified using the cut-off based on the homogeneity method of Hunt, Hewett and Shepherd (1982). Each critical group's largest annual consumption rate is divided by three to calculate a lower critical group threshold value. All individuals' consumption rates which are equal to or greater than this threshold value are included in the mean consumption rate for each critical group.

Children's consumption rates need special consideration because their anatomy and physiology is different to those of adults. This generally leads to them receiving a higher dose per unit of radionuclide intake than adults do. Although data were collected on children's consumption rates, there were insufficient observations to enable critical group rates to be derived. What child observations there were in the survey are reported in Table 2.

Data on the consumption of local seafood by adults are presented in Tables 3, 4, 5 and 6. Where individuals could not provide details of edible portion weights consumed but could provide the total weight of seafood to be prepared for consumption, conversions values, obtained from earlier CEFAS studies on edible fraction weights, have been used. These values are shown in Table 1.

7.1.1 Fish consumption

Data on the consumption of local fish by children and adults (over 17 years old) are presented in Tables 2 and 3 respectively. The main consumers of fish were full and part-time commercial fishermen and their crew members.

About 40% of the adults interviewed reported eating a mixed fish diet. However, for those who mentioned specific species, it was evident that haddock was the most popular fish consumed, followed by cod, whiting and mackerel.

The mean fish consumption rate for the adult critical group was 99 kg/y based on the thirty highest consumers (maximum rate 165.9 kg/y). Fish species consumption preference by the critical group

was identified as 40% Haddock and 60% mixed fish comprising of cod, mackerel, sole, hake, plaice, pollack, herring, whiting, turbot and halibut. These percentages, rounded to the nearest 5%, are based on the total amount of fish consumed by this group.

7.1.2 Crustacean consumption

Data on the consumption of local crustaceans by adults and children are presented in Tables 4 and 2 respectively. The main consumers of crustaceans were full and part-time commercial fishermen/potters and their families.

The predominant crustacean species consumed by the adults interviewed was *Nephrops*. Adult consumption of edible crab claws, edible crabs and lobsters was notable. Two adult individuals were recorded as consuming velvet crab in small quantities.

The mean crustacean consumption rate for the adult critical group was 34 kg/y based on the sixty-six highest consumers (maximum rate 66.6 kg/y). Crustacean species consumption preference by the critical group was identified as 65% Nephrops, 25% edible crab claws, 5% edible crab and 5% lobster. These percentages, rounded to the nearest 5%, are based on the total amount of crustaceans consumed by this group.

7.1.3 Mollusc consumption

Data on the consumption of local molluscs by adults and children are presented in Tables 5 and 2 respectively.

Although 112 adults reported consuming locally caught molluscs, their rates of consumption were low. The predominant mollusc species consumed was clams, though a number of people consumed mussels, scallops, periwinkles and squid. Only a few adult individuals reported consuming cockles, oysters or razor fish. Subsequent to the fieldwork, it transpired that 'clams' could be used as a local term for scallops as well as meaning clams. In the absence of further information, the terms used by individuals have been maintained in compiling consumption data.

The mean mollusc consumption rate for the adult critical group was 7.7 kg/y based on the eleven highest consumers (maximum rate 12.2 kg/y). Mollusc species consumption preference by the critical group was identified as 75% mussels, 15% scallops and 10% clams. These percentages, rounded to the nearest 5%, are based on the total amount of molluscs consumed by this group.

7.1.4 Seaweed consumption.

Data on the consumption of local seaweed by adults is presented in Table 6. No children were identified as consuming seaweed. All individuals exclusively consumed dulse (*Rhodymenia palmata*). Members of the adult critical group comprised a commercial dulse collector and members of their family. The consumption rates of all other seaweed consumers identified were low.

The mean seaweed consumption rate for the adult critical group was 10 kg/y based on the seven highest consumers (maximum rate 10.4 kg/y).

7.2 External radiation exposure

External exposure from artificial radiation to members of the public who frequent coastal areas depends on the occupancy time and the dose rate from the substrate after subtraction of an appropriate figure for natural background radiation.

In this report, the adult critical groups for external exposure have been defined using CEFAS's usual method of dividing the maximum observation by 1.5 and averaging over all observations within this range. It is considered that this procedure satisfies the ICRP homogeneity principle. When defining the critical groups, if there is only one observation in the range (i.e. the maximum observation), consideration is given to including observations which are below the range in the calculation.

7.2.1 Beach and coastal area activities

Rates of beach and coastal area occupancy by adults are listed in Tables 7a, 7b and 7c for sand or rocks, sand/mud and saltmarsh respectively. Children's occupancy rates are listed in Table 8a.

A mean occupancy rate of 820 h/y over sand was identified for three dog walkers and a Lifeguard (the maximum rate was 1005 h/y). Occupancy over rocks was much less than for sand, the maximum observation being 260 h/y for an angler. For sand/mud one individual, a beach angler, had a standing occupancy of 1092 h/y. The next individuals have occupancy rates an order of magnitude lower than this, but it is considered sufficiently conservative to take the beach angler as a representative of this adult critical group, with a rounded occupancy rate of 1100 h/y.

A mean occupancy rate of 9.0 h/y over saltmarsh was recorded for 71 members of a local game and wildfowling conservation association, as estimated by the association secretary.

Maximum occupancy rates of 281 h/y over sand were noted for children, well below the rate for the adult critical group. Occupancy of sand/mud was negligible.

7.2.2 Watersport activities

The times spent annually by adults and children involved with watersport activities are listed in Tables 7a and 8a respectively. The highest rate of watersport activity was recorded for a Lifeguard at Rostrevor who spent 274 h/y swimming. Swimming rates for children were considerably less than this.

The radiological significance of this pathway is considered minor as watersport activity rates are usually lower than occupancy rates over contaminated sediments and, in most cases the potential gamma dose received will be reduced by the shielding effect of the water.

7.2.3 Handling.

Handling sediment or commercial fishing gear, which has become entrained with fine sediment particles, can give rise to skin exposure from beta radiation. This needs consideration even though the annual dose limit for skin is a factor of 50 times higher than that for effective dose. There is also a contribution to effective dose due to skin exposure (ICRP, 1991).

Fishing gear can also be a source of whole body gamma exposure due to occupancy in the vicinity of the gear. However this pathway is minor compared with the same exposure time for occupancy over contaminated sediments.

Adults and children's annual handling rates for material which could lead to their external radiation exposure are listed in Tables 9a, 9b, 9c and 8b respectively.

A mean handling rate of 1500 h/y for commercial fishing gear (crustacean pots and fishing nets) was identified for eighteen commercial fishermen (the maximum rate was 1640 h/y).

Handling of sand/mud was highest for a commercial winkle picker, at 100 h/y. The next individuals had handling rates outside the range applied for averaging purposes, but it is considered sufficiently conservative to use 100 h/y as the rate for this critical group.

The highest rate recorded for handling of seaweed was 936 h/y for four commercial dulse collectors. A rounded rate of 950 h/y should be used for this activity.

Handling rates for children are all much less than the corresponding critical group adult rates.

7.3 Combination of pathways

In this section, consideration is given to both internal and external exposure pathways and the way in which doses to these critical groups should be combined.

Table 10 shows all of the individuals who were present in more than one critical group. No one person is a member of all critical groups. However, overlap of critical groups does occur, for example some people belong to the fish and crustacean critical groups and some belong to the mollusc and handling critical groups. It is considered that a conservative assessment of effective dose would be based on consumption of the main seafood groups; fish, crustaceans and molluscs, together with occupancy over sand/mud.

7.4 Comparison with other habits data

This report describes the first aquatic habits survey undertaken in Northern Ireland, consequently there are no earlier results for comparison. However, several studies involving dose assessments in Northern Ireland have used habits data and these are described below.

Since 1997, CEFAS has included dose assessments to members of the public in Northern Ireland in the RIFE report series (e.g. FSA and SEPA, 2000). These assessments are based on consumption rates of 100 kg/y fish, 20 kg/y crustaceans and 20 kg/y molluscs.

For predictive dose assessment purposes relevant to Sellafield discharge authorisations, 50 kg/y fish, 20 kg/y crustaceans and 20 kg/y molluscs together with 1000 h/y additive occupancy (with handling) over muddy coastline areas have been used (Hunt, 2000). The corresponding rates from the present survey are 99 kg/y fish, 34 kg/y crustaceans, 7.7 kg/y molluscs, 1100 h/y occupancy over sand/mud and 100 h/y handling sand/mud.

Studies of artificial radioactivity by EHS in Carlingford Lough (Mitchell *et al*., 1992, Long *et al*., 1999 and Ledgerwood *et al*., 2001) and in Lough Foyle (Cunningham *et al*., 1996) have included habits data. In each case, dose assessments have been based on a hypothetical 'critical individual' who consumes 50 kg/y fish, 10 kg/y crustaceans and 10 kg/y molluscs and spends 100 h/y swimming, 1000 h/y over intertidal areas and ingests 10 g/y of sand. Fish and crustacean consumption and swimming rates for the hypothetical individual are less than found in the present survey, but mollusc consumption and intertidal occupancy rates are similar.

The habits data obtained during this survey may also be compared with generalised habits data used by NRPB for general radiological assessment purposes for members of the public (Robinson, 1996). Such data are also used by NRPB to calculate Generalised Derived Limits. 'Critical group' rates in

the report have been based on CEFAS (then MAFF, DFR) data, and those relevant for comparison with the present survey are summarised in Table 11.

Surveys of general population data in Northern Ireland also provide data for comparison with our survey. The Department of Agriculture and Rural Development annually publishes data for foodstuffs including fish. Their most recent report (DARD, 2000) shows that fish consumption by individuals ranged from 90 – 131 g/week (i.e. 4.7 – 6.8 kg/y) between 1996 and 1999, with the proportions being approximately 20%, 10%, 30% and 30% for fresh fish, processed and shellfish, prepared fish and frozen fish (Table 12).

A report by the Irish Universities Nutrition Alliance (IUNA, 2001) gives North/South Ireland general population mean consumption rates for fish dishes and fish/fish products of 3 and 23 g/day (i.e. 1.1 and 8.4 kg/y) respectively.

It should be noted that the habits data given by these general population surveys are significantly lower than those identified by our survey. However, this is not surprising since aquatic habits surveys are specifically designed to identify individuals who consume large quantities of local seafoods or undertake aquatic related pastimes at high rates. These individuals are the most likely to receive higher radiation doses than the rest of the population as a result of aquatic pathways. If the dose to the most exposed people (the critical group) is acceptable, it follows that overall protection of the general public is ensured. The interviewing techniques used and the design of the survey are tailored to elicit information about above-average habits. The general population surveys make no attempt in their approach to do this, and are often based on a general set of questions directed at a random cross-section of the public.

The results of the survey may also be compared with habits data used for dose assessments for members of the Irish Republic. The Radiological Protection Institute of Ireland (RPII) have routinely published assessments (e.g. Ryan *et al*., 2000) based on representative consumers of seafood. The consumption rates have remained at 40 g/day (i.e. 15 kg/y) fish and 5 g/day (i.e. 1.8 kg/y) for shellfish for a 'typical' consumer and 200 g/day (i.e. 73 kg/y) fish and 20 g/day (i.e. 7.3 kg/y) shellfish for a 'heavy' consumer. Separate (i.e. non-additive) exposure due to occupancy of sandy beach of 1 h/day is also included.

An assessment of doses to Irish seafood consumers due to polonium-210 (Pollard *et al*., 1998) used seafood consumption of 9.0 kg/y apportioned by volume market share of seafood type. The consumption data were based on general population surveys.

7.5 Applicability of data to Northern Ireland

This survey gathered data relevant to aquatic radiation exposures for part of Northern Ireland, namely the main fishing ports within the geographical areas of Portavogie to Portaferry, Strangford to Tyrella Beach, and Annalong to Rostrevor (Figures 1a and 1b). Some additional areas (Belfast and Ballywalter) were investigated with regard to seaweed collection and consumption. Consumption rates relate to seafood obtained from the Irish Sea, Strangford Lough and Carlingford Lough. Strictly speaking, the habits data only relate to members of the public within these areas, and sea food obtained from the indicated areas. However, all of the main aquatic pathways exist in the data from the necessarily limited survey area.

As shown in Table 13, there are some differences between the habits of the critical group assumed for the assessment of doses for Northern Ireland in the RIFE series of reports and the habits of the critical group recommended from this survey. Differences include mix of species consumed and consumption rates for shellfish. However, these differences do not have a significant effect on the doses calculated for the public in Northern Ireland, as demonstrated in Section 8. Consequently, it is considered appropriate that the habits derived from this survey may be applied to the whole Northern Ireland population in routine radiological assessments where doses are not significantly greater than those currently assessed.

7.6 Environmental monitoring

An important objective of habits surveys is to identify any changes needed to environmental monitoring programmes. EHS routinely collect aquatic monitoring samples and send them to CEFAS for analysis. Results appear annually in the RIFE series reports (e.g. FSA and SEPA, 2000) and biennially in the Chief Alkali Inspectors Reports (e.g. EHS, 2000). The data are used for the dose calculations in the RIFE reports.

The current (2001) programme undertaken by CEFAS for EHS is shown in Table 14.

In addition to this, EHS undertakes annual gamma dose rate monitoring at the coastal locations shown in Table 15. A summary of the results are published in the Chief Alkali Inspectors Reports (e.g. EHS, 2000).

No further dose rate monitoring or sample collection was conducted by CEFAS during the habits survey.

As a result of the habits survey, the following additions or changes to the monitoring programmes should be considered:

1) Monitoring of haddock instead of spurdog. Haddock was the fish species most commonly consumed by members of the adult critical group. No consumption of spurdog was reported during the survey.
2) Monitoring of edible crab claws. Edible crab claws were consumed by members of the adult critical group and by many of the crustacean consumers interviewed during the survey.
3) Monitoring of clams and scallops. These molluscs were consumed by the adult critical group but are not currently sampled.
4) Given the high rates of handling of commercial fishing gear and dulse seaweed, beta dose rate monitoring of these materials could be undertaken.
5) Gamma dose rate measurements over sand/mud at Greencastle. This was the location for the high occupancy-rate beach angler.
5) Gamma dose rate measurements over sand/mud in Carlingford Lough where oyster baskets are tended (gamma dose rates for winkle pickers at Killough Bay are already monitored by EHS).
6) Gamma dose rate measurements over saltmarsh at Mill Bay could be considered. This was the area where wildfowling took place, though it should be noted that occupancy rates were very low.

8. ASSESSMENT OF DOSE

This part of the report describes an assessment of dose to members of the public in Northern Ireland using the results of the habits survey. The assessment methodology is the same as that used to calculate critical group doses from aquatic pathways in Northern Ireland as reported in RIFE 6 for 2000, the same year as the habits survey.

For seafood consumption pathways, doses are assessed for RIFE by multiplying seafood consumption rates by the concentration of radioactivity in the seafoods and by dosimetric factors which convert intake of radioactivity into dose. This is represented by the following basic equation:

$$D_{indS} = \Sigma (C_{SR} \times I_S \times DPUI_R)$$

where: D_{indS} is the individual dose due to seafood consumption (mSv y^{-1});
C_{SR} is the activity concentration of radionuclide R in seafood type S (e.g. fish) (Bq kg^{-1}),
I_S is the consumption rate for seafood type S (kg y^{-1}), and
$DPUI_R$ is the dose per unit intake of radionuclide R (mSv Bq^{-1}).

For the Northern Ireland dose assessments, the critical group is assumed to consume fish (100 kg y^{-1}), crustaceans (20 kg y^{-1}) and molluscs (20 kg y^{-1}). It is also assumed that there is no external exposure, for example, due to occupancy of intertidal areas or handling of fishing gear.

Monitoring data used in the dose calculations are those which appear in RIFE 6 under the sample identifications 'Northern Ireland' cod, herring, spurdog, whiting, nephrops, lobsters, mussels and winkles. In 2000, these samples were obtained from the following locations:

cod	-	Portrush and Kilkeel
whiting	-	Portavogie and Kilkeel
spurdog	-	Portrush and Portavogie
herring	-	Ardglass
nephrops	-	Portavogie and Kilkeel
lobsters	-	Portrush and Kilkeel
mussels	-	Carlingford
winkles	-	Ards Peninsula

The locations provide a set of samples which are representative of all of the Northern Ireland coast, and are considered appropriate for dose calculations for high rate seafood consumers in Northern Ireland.

As noted previously (Section 7.5), the habits survey described here covers only part of Northern Ireland - in effect, Portavogie to Rostrevor. Furthermore, this group consumes a different mix of seafoods than assumed for the assessments in RIFE, namely:

fish	-	haddock and mixed fish
crustaceans	-	nephrops, crab and lobster
molluscs	-	mussels, scallops and clams

Consumption rates for these seafood groups are 99 kg y^{-1}, 34 kg y^{-1} and 7.7 kg y^{-1} respectively. In order to carry out a dose assessment appropriate to this group, monitoring data would be needed for these species obtained within the survey area. However, such data do not exist, though it would be possible to choose some data from the routine monitoring programme (e.g. from Portavogie samples). In order to provide a comparison with the current RIFE assessments, it is considered appropriate to use the same monitoring data set for this assessment as used for RIFE. Therefore, fish concentrations used were the mean of Northern Ireland cod, herring, spurdog and whiting, crustacean concentrations were the mean of Northern Ireland nephrops and lobsters, and mollusc concentrations were the mean of Northern Ireland mussels and winkles. These monitoring data are shown in Table 16. It should be noted that where concentrations are below limits of detection, the values are assumed to be positive ones at these limits.

On this basis, the assessed consumption dose to the group is 0.015 mSv y^{-1} which is the same result for the Northern Ireland group published in RIFE 6. This equivalence is coincidental since the different consumption rates lead to different components of dose for the three pathways. Thus, for

the new group the doses are 0.008, 0.006 and 0.001 mSv y^{-1} for fish, crustaceans and molluscs respectively, whereas they are 0.008, 0.004 and 0.003 mSv y^{-1} for fish, crustaceans and molluscs respectively for the assessments for RIFE.

In addition to consumption doses, it is recommended that doses due to occupancy of sand/mud are included for the new group. For external exposure due to occupancy of such intertidal areas, doses are assessed in one of two ways in RIFE. Both involve multiplying the occupancy rate of the area by the dose rate over it. This is represented by the following basic equation:

$$D_{indExt} = O_A \times G_A \times F$$

where: D_{indExt} is the individual dose due to occupancy (mSv y^{-1});
G_A is the dose rate over area A (µGy h^{-1});
F is a conversion factor (mSv µGy^{-1}) and
O_A is the occupancy rate for area A (h y^{-1}).

Where direct measurements of environmental gamma dose rates are available, these are used in the calculations. Where such measurements are not available, or it is not possible to distinguish the measured rates from normal background, dose rates are calculated using concentrations of man-made radionuclides in sediment as described in Hunt (1984).

For this study, doses were based on the latter method since measured environmental gamma dose rates are consistent with normal background levels (e.g. EHS, 2000). As with the consumption dose calculations, it was also decided to use sediment concentrations appropriate to the whole Northern Ireland coast rather than just that covered by the habits survey. These concentrations are shown in Table 16, the assessments being based on the mean concentrations of all locations. Where concentrations were below limits of detection, the results were assumed to be positive values at the limits of detection. The assessed dose was 0.003 mSv y^{-1}, giving a total dose to the critical group of 0.018 mSv y^{-1}. Doses for external exposures are not assessed in RIFE for the Northern Ireland group, so no comparison is possible. However, the overall critical group dose of 0.018 mSv y^{-1} is well within the ICRP recommended dose limit for members of the public of 1mSv y^{-1}, and may also be compared with the dose received by the average members of the Northern Ireland population of 2.5 mSv y^{-1} most of which is due to natural radioactivity (Hughes,1999).

As well as critical group doses, a further set of calculations was carried out for average adult members of the Northern Ireland population. This was done in two ways. The habits survey identified many adult seafood consumers who were not part of the critical groups. Their consumption rates ranged from 0.3 - 54 kg y^{-1} for fish, 0.3 - 21 kg y^{-1} for crustaceans and 0.1 - 3.8 kg y^{-1} for molluscs (Tables 3 - 5). Average rates for these three groups, calculated using all observations within these ranges, were 19 kg y^{-1} for 375 individuals consuming fish, 7.1 kg y^{-1} for 218 individuals consuming

crustaceans and 1.3 kg y^{-1} for 101 individuals consuming molluscs. Using the same average seafood concentrations as for the critical group dose calculations, the assessed dose to these average seafood consumers was 0.003 mSv y^{-1}.

The other dose calculation was based on general population survey data (DARD, 2000 and Table 12). Fish consumption rates in this study ranged from 4.7 - 6.8 kg y^{-1}, for which the calculated average rate is 5.5 kg y^{-1}. Since it was not possible to distinguish the rates for fish, crustaceans and molluscs from the study, the dose calculations were based on average radioactivity concentrations in fish. The calculated dose was 0.0005 mSv y^{-1}.

The foregoing dose assessments relate to adults since there were few children observed in the habits survey. This is consistent with other studies which show that child doses are invariably less than those of adults (FSA and SEPA, 2001).

9. ACKNOWLEDGEMENTS

Thanks are expressed to the representatives of local bodies and companies contacted during the habits survey and to the members of the public who took part.

Thanks are also expressed to staff of the Environment and Heritage Service for their assistance and guidance in the conduct of the habits survey. The work described in this report was undertaken for the Scottish and Northern Ireland Forum for Environmental Research and the Environment and Heritage Service.

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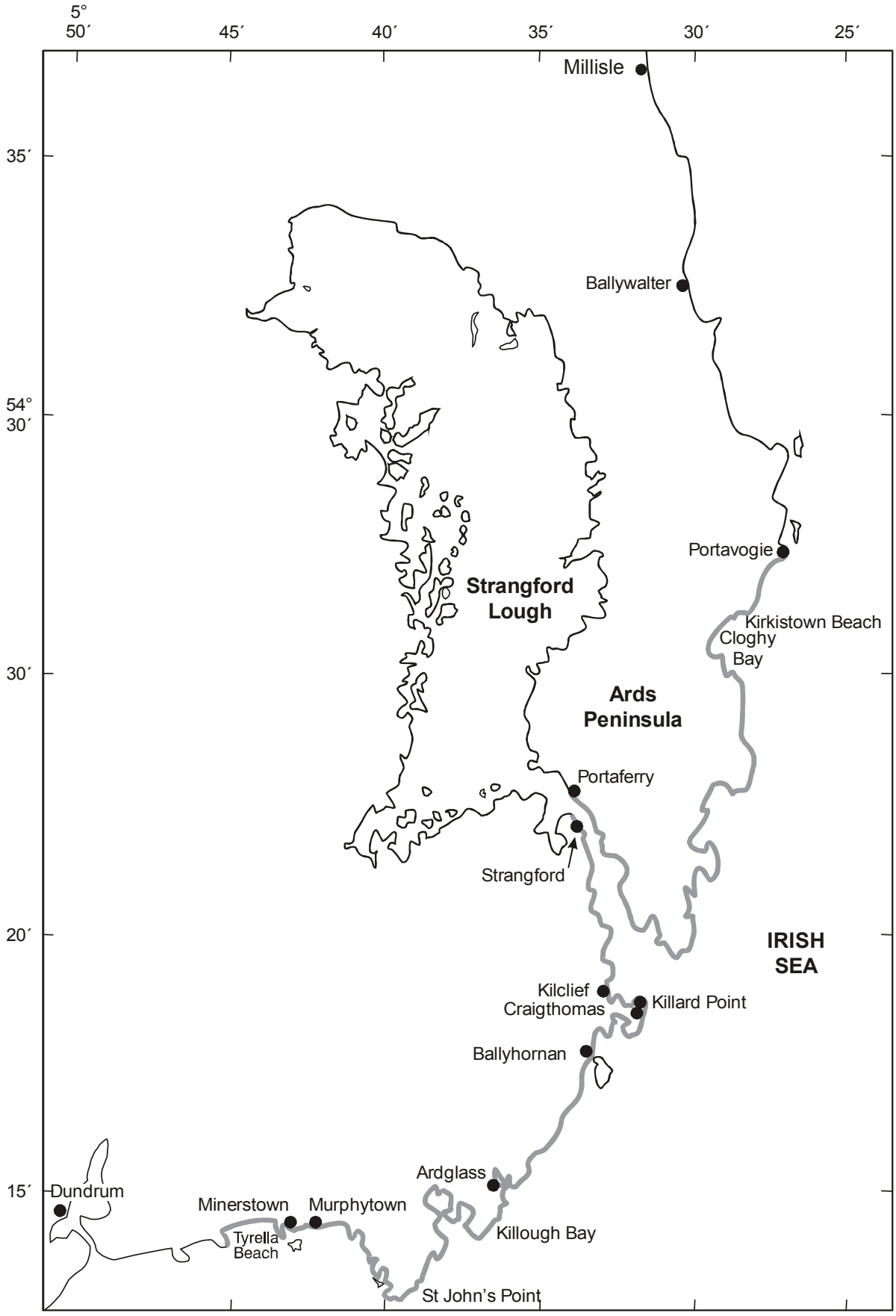

Figure 1a. The survey area - Portavogie to Portaferry and Strangford to Tyrella Beach.

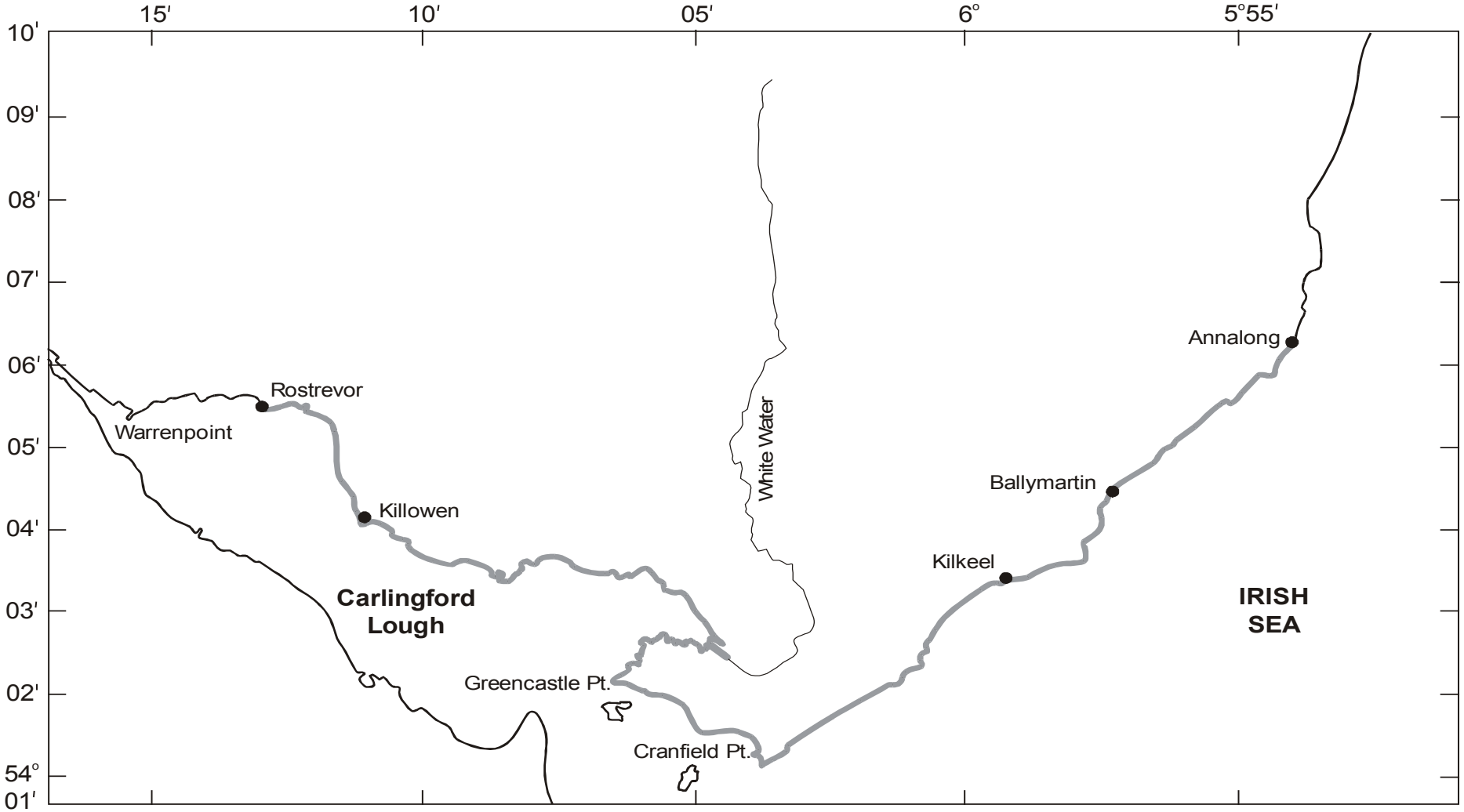

Figure 1b. The survey area - Annalong to Rostrevor.

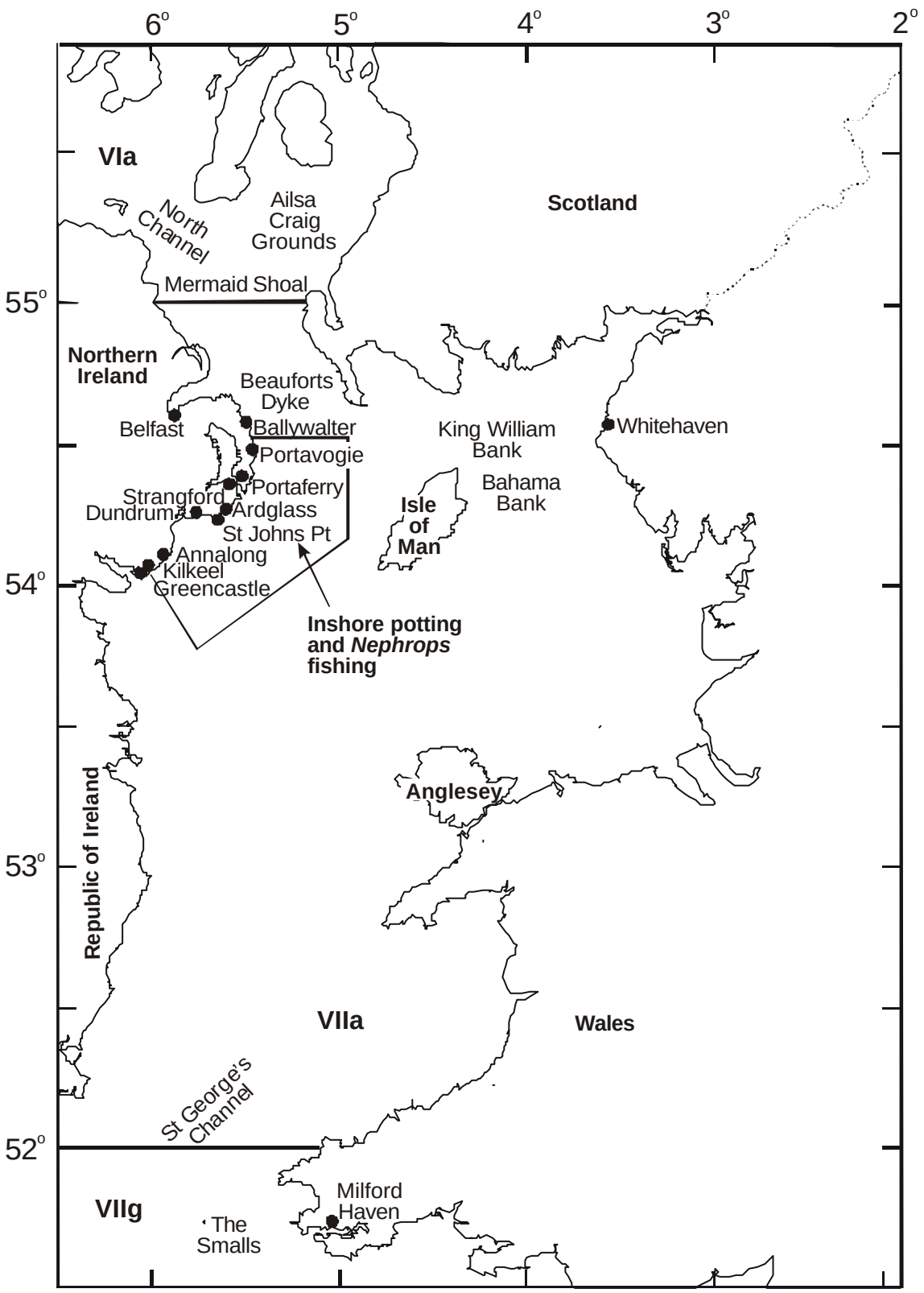

Figure 2. Fishing areas.

Table 1. Edible fractions or flesh weights.

Species	Edible fraction	Flesh weight	
Fish			
Cod	0.66		
Conger eel	0.60		
Haddock	0.42		
Hake	0.50		
Herring	0.74		
Kippers		137g	
Ling	0.48		
Mackerel	0.61		
Monkfish	0.66		
Plaice	0.44		
Pollack	0.62		
Salmon	0.72		
Seabass	0.47		
Seatrout	0.69		
Sole	0.62		
Turbot	0.62		
Whiting	0.57		
Crustaceans			
Edible crab	0.40	Small (127mm)	95g
		Medium (152mm)	142g
		Large (178mm)	191g
Crab claws	0.39	20g each claw	
Lobster	0.42		
Nephrops (whole)	0.22	17.5g	
Nephrops (tails)	0.66	5g	
Velvet crab	0.25		
Molluscs			
Clams	0.28	11.5g	
Cockles	0.21	1.6g	
Mussels	0.21	2.5g	
Oysters	0.19		
Scallops	0.29	36g	
Squid	1.00		
Razor fish		28 g	
Winkles	0.21		

Edible fraction = Average value for weight of edible flesh / Total weight of animal

Table 2. Child consumption rates of locally caught seafood (kg/y)

		Fish												Crustaceans				Molluscs						Total
Obs No.	Age	Cod	Haddock	Herring	Hake	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sea trout	Whiting	Mixed fish	Lobster	Nephrops	Edible crab	Edible crab claws	Clams	Cockles	Mussels	Oyster	Periwinkle	Scallops	
280	13		46.8												23.5			0.7						71.0
454	15	10.9											35.4		17.7				2.9					66.9
455	15	10.9											35.4		17.7				2.9					66.9
659	9											21.0		6.5	13.0		19.6							60.1
660	12		6.1										19.7		12.2		18.4							56.4
653	10													5.4	33.5		12.6							51.5
592	8				4.9	4.2									42.2									51.3
593	10				4.9	4.2									41.2									50.3
594	13				4.6	3.9									39.5									48.0
717	6												31.8		7.0	4.2		3.0						46.0
31	16		26.6														15.7							42.3
718	2												25.3		5.6	3.4		2.4						36.7
264A	3		35.4																					35.4
264B	4		35.4																					35.4
400	12		23.4												11.4									34.8
448	8		34.3																					34.3
650	7			1.8			5.9								26.5									34.2
649	6			1.8			5.9								23.0									30.7
727	16	13.7		13.7						1.1												1.7		30.2
726	15	13.7		13.7						1.1												1.7		30.2
725	12	13.7		13.7						1.1												1.7		30.2
724	10	13.7		13.7						1.1												1.7		30.2
252	12		23.4												5.7									29.1
388	7		11.4												15.6									27.0
311	14		23.4												2.2									25.6
553	14												23.7											23.7
645	16														23.7									23.7
281	7		23.4																					23.4
282	5		23.4																					23.4
421	6												23.4											23.4
422	4												23.4											23.4
94	16												17.7		3.0			1.7						22.4
108	7												10.3		2.1		3.6	0.2		5.9				22.1
110	5												10.3		2.1		3.6	0.2		5.9				22.1
343	15		11.4														2.1						3.7	17.2
344	12		11.4														2.1						3.7	17.2
109	5												10.3		2.1		3.6							16.0
9	13												11.8		2.6									14.4
188	13												11.8			1.1	1.2							14.1
243	8												9.6		4.4									14.0
244	6												9.6		4.4									14.0
345	7		11.4														2.1							13.5
430	3	12.9																						12.9
488	4	1.4	1.8		0.9										8.7									12.8
466	12												5.9		6.8									12.7
258	15		11.4												0.7									12.1
260	11		11.4												0.7									12.1

Table 2. Child consumption rates of locally caught seafood (kg/y)

		Fish												Crustaceans				Molluscs						Total
Obs No.	Age	Cod	Haddock	Herring	Hake	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sea trout	Whiting	Mixed fish	Lobster	Nephrops	Edible crab	Edible crab claws	Clams	Cockles	Mussels	Oyster	Periwinkle	Scallops	
259	10		11.4												0.7									12.1
407	9		11.4												0.3									11.7
82	14												7.4		0.8		3.4	0.1						11.7
253	13		11.4																					11.4
254	9		11.4																					11.4
423	1.5												11.4											11.4
465	10												5.9		5.4									11.3
464	6												5.9		5.3									11.2
218	2												9.2		1.3					0.2				10.7
20	16												7.4		2.2					0.2			0.6	10.4
21	13												7.4		2.2					0.2			0.6	10.4
25	15												7.9		2.0			0.3						10.2
26	10												7.9		2.0			0.3						10.2
217	4												6.5		2.6					0.2	0.6			9.9
212	11												8.9		0.4		0.6							9.9
534	8			7.4															1.0	1.0				9.4
443	5		5.7												2.9									8.6
444	2		5.7												2.9									8.6
75	14												7.4		0.7			0.4						8.5
533	8			6.4															1.0	1.0				8.4
470	10	7.4												0.4			0.5							8.3
111	2												5.2		1.1		1.8							8.1
112	2												5.2		1.1		1.8							8.1
86	16												7.4		0.7									8.1
87	15												7.4		0.7									8.1
346	3		5.7														2.1							7.8
166	12		4.1												3.7									7.8
167	9		4.1												3.7									7.8
624	16			0.7	2.7		4.1																	7.5
532	5			5.4															1.0	1.0				7.4
688	9														7.1									7.1
175	3									0.2	0.4		3.0		3.0									6.5
15	2		5.9												0.4									6.3
687	4														6.3									6.3
450	2														6.2									6.2
408	5		5.7												0.2									5.9
542	12							5.9																5.9
541	10							5.9																5.9
540	6							5.9																5.9
325	1		5.9																					5.9
389	3		5.7																					5.7
434	7		5.7																					5.7
735	8			1.0		1.0						2.1			1.5									5.6
451	4														5.5									5.5
734	6			1.0		1.0						2.1			1.3									5.4
452	6														5.0									5.0
733	3			1.0		1.0						2.1			0.9									5.0

Table 2. Child consumption rates of locally caught seafood (kg/y)

		Fish												Crustaceans				Molluscs						Total
Obs No.	Age	Cod	Haddock	Herring	Hake	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sea trout	Whiting	Mixed fish	Lobster	Nephrops	Edible crab	Edible crab claws	Clams	Cockles	Mussels	Oyster	Periwinkle	Scallops	
686	2.5														4.8									4.8
240	15												4.4											4.4
630	10												2.7		1.6									4.3
228	3												3.0	0.4	0.7		0.2							4.2
227	2												3.0	0.4	0.7		0.2							4.2
100	11												3.7											3.7
101	7												3.7											3.7
102	7												3.7											3.7
575	15					3.6																		3.6
539	4							3.0																3.0
440	3												3.0											3.0
631	15												2.7											2.7
528	12	2.7																						2.7
148	<13												2.6											2.6
149	<13												2.6											2.6
150	<13												2.6											2.6
151	<13												2.6											2.6
152	<13												2.6											2.6
250	11		2.6																					2.6
292	3		2.6																					2.6
549	9	1.0	1.4																					2.4
548	7	1.0	1.4																					2.4
547	3	1.0	1.4																					2.4
623	14			0.7	0.5		0.7																	1.8
622	7			0.7	0.5		0.7																	1.8
621	2			0.7	0.5		0.7																	1.8
573	10					1.8																		1.8
153	<6												1.3											1.3
154	<6												1.3											1.3
155	<6												1.3											1.3
156	<6												1.3											1.3
469	14													0.5										0.5
598	3														0.4									0.4
597	2														0.4									0.4
471	6													0.3										0.3
638	9								0.3															0.3
637	6								0.2															0.2
77	5														0.2									0.2
37	10																					0.2		0.2
36	8																					0.2		0.2
Total Obs	**134**	**13**	**37**	**16**	**8**	**8**	**6**	**4**	**2**	**5**	**1**	**4**	**52**	**7**	**68**	**3**	**19**		**5**	**9**	**1**	**6**	**4**	**134**

NOTES

Total number of children eating fish, crustaceans and molluscs were 119, 77 and 27 respectively

Table 3. **Adult consumption rates of locally caught fish (kg/y)**

Obs No.	Cod	Conger eel	Sea bass	Haddock	Haddock & Cod	Herring	Hake	Ling	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sole	Sea trout	Turbot	Whiting	Mixed fish	Total
224																		**165.9**	**165.9**
303				**163.8**															**163.8**
304				**163.8**															**163.8**
305				**163.8**															**163.8**
306				**163.8**															**163.8**
378																		**108.0**	**108.0**
379																		**108.0**	**108.0**
380																		**108.0**	**108.0**
381																		**108.0**	**108.0**
382																		**108.0**	**108.0**
383																		**108.0**	**108.0**
384																		**108.0**	**108.0**
385																		**108.0**	**108.0**
386																		**108.0**	**108.0**
390																		**102.5**	**102.5**
561																		**94.6**	**94.6**
17																		**83.0**	**83.0**
28																		**83.0**	**83.0**
543																		**71.0**	**71.0**
544																		**71.0**	**71.0**
261				**70.7**															**70.7**
262				**70.7**															**70.7**
263				**70.7**															**70.7**
264				**70.7**															**70.7**
437				**70.2**															**70.2**
287				**68.6**															**68.6**
288				**68.6**															**68.6**
233																		**62.2**	**62.2**
427	**61.9**																		**61.9**
651				**13.7**							**44.4**								**58.1**
494				9.1						29.6							14.8		53.5
714																		52.4	52.4
2																		49.1	49.1
242																		47.3	47.3
170			0.82	15.5		28.5							1.2		1.2				47.2
245-246																		46.8	46.8
277-279				46.8															46.8
314-317				46.8															46.8
350-352				46.8															46.8
419, 420																		46.8	46.8
472-478	10.9								10.9								21.8		43.6
493, 495				7.3						23.7							11.8		42.8
29, 30																		42.5	42.5
489-492																	41.3		41.3
402-405				40.5															40.5

Table 3. **Adult consumption rates of locally caught fish (kg/y)**

Obs No.	Cod	Conger eel	Sea bass	Haddock	Haddock & Cod	Herring	Hake	Ling	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sole	Sea trout	Turbot	Whiting	Mixed fish	Total
715, 716																		39.9	39.9
654, 655				18.2			9.1									11.8			39.1
503-511	16.4	0.46						5.5	16.4										38.8
657				8.4													27.2		35.6
8																		35.5	35.5
293																		35.4	35.4
425, 426				35.4															35.4
428	34.3																		34.3
289, 445-447				34.3															34.3
234																		31.1	31.1
537				7.3							23.7								31.0
705, 706	2.7			3.6										11.8		11.8			29.9
563-569																		29.6	29.6
449																		29.5	29.5
721-723	13.7					13.7							1.1						28.5
658				6.4													20.8		27.2
392-397																		27.0	27.0
162, 163					25.9														25.9
215																		25.9	25.9
23	1.4																	23.6	25.0
535-536,550-552																		23.7	23.7
557, 558											23.7								23.7
554-556,570, 576																		23.7	23.7
14,16,90				23.6															23.6
70,184																		23.6	23.6
251,265-272				23.4															23.4
273, 290, 291				23.4															23.4
294-298																		23.4	23.4
307-310,312-313				23.4															23.4
318-324,326-331				23.4															23.4
391, 398, 399, 435				23.4															23.4
602-605				5.5							17.8								23.3
107,190-192,231																		20.7	20.7
241																		19.2	19.2
634																		18.8	18.8
173													0.38		0.71			17.7	18.8
633																		17.8	17.8
91-93,95																		17.7	17.7
193				17.7															17.7
205,206,235																		17.7	17.7
366-369,519, 520																		17.7	17.7
681, 682				3.6			1.8				11.8								17.2
728-732						4.1			4.1								8.2		16.4
538				3.6							11.8								15.4
647, 648				3.6						11.8									15.4

Table 3. **Adult consumption rates of locally caught fish (kg/y)**

Obs No.	Cod	Conger eel	Sea bass	Haddock	Haddock & Cod	Herring	Hake	Ling	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sole	Sea trout	Turbot	Whiting	Mixed fish	Total
656	11.8			3.6															15.4
18																		14.8	14.8
530						8.1			5.4										13.5
216																		12.9	12.9
710-713	5.5			7.3															12.8
10-12,27																		11.8	11.8
89,159, 160,179																		11.8	11.8
185-187,189,207																		11.8	11.8
209-211,225																		11.8	11.8
462,463,498,499																		11.8	11.8
13,562				11.8															11.8
619, 620						5.5	3.6			2.7									11.8
436				11.7															11.7
590							6.3		5.4										11.7
354				11.4															11.4
255-257				11.4															11.4
274-276				11.4															11.4
283-286	11.4																		11.4
332-335				11.4															11.4
336-339, 356-365																		11.4	11.4
340-342,347-349				11.4															11.4
377,387,401,406				11.4															11.4
438-439																		11.4	11.4
355,441-442				11.4															11.4
577-581				7.3			3.6												10.9
113																		10.3	10.3
200, 201				10.3															10.3
177													0.38		0.71			8.9	10.0
410-414																		9.9	9.9
586, 587	9.6																		9.6
615-618	4.1			5.5															9.6
606, 607				9.2					10 .0										9.2
481-485				9.1															9.1
661-672				3.6													5.5		9.1
121, 122																		8.9	8.9
198,203,204				8.9															8.9
213,214,236																		8.9	8.9
591							4.8		4.1										8.9
164				8.2															8.2
486, 487	2.7			3.6			1.8												8.1
531						8.1													8.1
24																		7.9	7.9
19, 22, 74, 88																		7.4	7.4
78, 79, 84, 85																		7.4	7.4
81, 99, 103, 104																		7.4	7.4

Table 3. **Adult consumption rates of locally caught fish (kg/y)**

Obs No.	Cod	Conger eel	Sea bass	Haddock	Haddock & Cod	Herring	Hake	Ling	Mackerel	Monkfish	Plaice	Pollack	Salmon	Sole	Sea trout	Turbot	Whiting	Mixed fish	Total
202				7.4															7.4
467	7.4																		7.4
611				7.3															7.3
169				6.1															6.1
226																		5.9	5.9
409,415-418																		5.7	5.7
424				2.9															2.9
431-433				5.7															5.7
595, 596																	5.5		5.5
600, 601				5.5															5.5
353				5.4															5.4
371, 372																		5.4	5.4
571									5.4										5.4
698-701				3.6			1.8												5.4
373-376																		5.3	5.3
639				3.1			1.8												4.9
545, 546	2.1			2.7															4.8
237-239																		4.4	4.4
370				1.3		2.6													3.9
610				3.6															3.6
424				2.9															2.9
526	2.7																		2.7
628-629,632																		2.7	2.7
632																		2.7	2.7
247-249				2.6															2.6
161			1.3																1.3
157						0.40													0.40
635												0.36							0.36
636												0.27							0.27
Total Obs	**45**	**9**	**2**	**182**	**2**	**15**	**20**	**9**	**25**	**7**	**11**	**2**	**6**	**2**	**3**	**4**	**35**	**168**	**405**

NOTES

The data highlighted in bold indicate those consumers in the critical group
The critical group mean consumption rate, based on the thirty highest adult consumers, is **99 kg/y**

Observation no 23. Cod was cod roe
Observation no 242. Mixed fish was mixed fish and shellfish

Table 4. Adult consumption rates of locally caught crustaceans (kg/y)

Obs No.	Edible crab	Edible crab claws	Lobster	Velvet crab	Nephrops	Total
651		**16.3**	**7.0**		**43.3**	**66.6**
390		**8.6**	**26.9**		**26.6**	**62.1**
590					**54.5**	**54.5**
652		**12.4**	**5.3**		**33.0**	**50.7**
303	**3.4**				**46.8**	**50.2**
304	**3.4**				**46.8**	**50.2**
305	**3.4**				**46.8**	**50.2**
306	**3.4**				**46.8**	**50.2**
419	**29.8**				**17.7**	**47.5**
657		**25.4**			**16.9**	**42.3**
591					**41.5**	**41.5**
409		**31.2**	**8.0**			**39.2**
415		**31.2**	**8.0**			**39.2**
416		**31.2**	**8.0**			**39.2**
417		**31.2**	**8.0**			**39.2**
418		**31.2**	**8.0**			**39.2**
323		**31.2**			**5.7**	**36.9**
324		**31.2**			**5.7**	**36.9**
561					**35.5**	**35.5**
314					**35.4**	**35.4**
315					**35.4**	**35.4**
316					**35.4**	**35.4**
317					**35.4**	**35.4**
435		**12.5**			**22.9**	**35.4**
647					**34.3**	**34.3**
675	**15.6**				**18.1**	**33.7**
676	**15.6**				**18.1**	**33.7**
661		**6.2**	**2.7**		**23.7**	**32.6**
662		**6.2**	**2.7**		**23.7**	**32.6**
663		**6.2**	**2.7**		**23.7**	**32.6**
664		**6.2**	**2.7**		**23.7**	**32.6**
665		**6.2**	**2.7**		**23.7**	**32.6**
666		**6.2**	**2.7**		**23.7**	**32.6**
667		**6.2**	**2.7**		**23.7**	**32.6**
668		**6.2**	**2.7**		**23.7**	**32.6**
669		**6.2**	**2.7**		**23.7**	**32.6**
670		**6.2**	**2.7**		**23.7**	**32.6**
671		**6.2**	**2.7**		**23.7**	**32.6**
672		**6.2**	**2.7**		**23.7**	**32.6**
658		**19.4**			**12.8**	**32.2**
425	**29.5**					**29.5**
426	**29.5**					**29.5**
563					**29.6**	**29.6**
565					**29.6**	**29.6**
566					**29.6**	**29.6**
567					**29.6**	**29.6**
568					**29.6**	**29.6**
648					**26.1**	**26.1**
287		**10.4**			**15.6**	**26.0**
288		**10.4**			**15.6**	**26.0**
289		**10.4**			**15.6**	**26.0**
192	**14.6**	**9.6**				**24.2**
643					**23.7**	**23.7**
644					**23.7**	**23.7**
646					**23.7**	**23.7**
277					**23.5**	**23.5**
278					**23.5**	**23.5**

Table 4. Adult consumption rates of locally caught crustaceans (kg/y)

Obs No.	Edible crab	Edible crab claws	Lobster	Velvet crab	Nephrops	Total
279					**23.5**	**23.5**
290					**23.4**	**23.4**
291					**23.4**	**23.4**
224		**5.8**	**6.8**		**10.5**	**23.0**
350		**12.5**	**6.6**		**3.9**	**23.0**
351		**12.5**	**6.6**		**3.9**	**23.0**
352		**12.5**	**6.6**		**3.9**	**23.0**
162		**19.4**	**2.1**		**0.66**	**22.2**
163		**19.4**	**2.1**		**0.66**	**22.2**
200, 201	11.6		0.85		8.4	20.9
173		5.5	2.0		11.7	19.2
261-264		3.1	4.6		11.4	19.2
99		0.58			18.4	19.0
318-322	14.8		0.10		4.0	18.9
714	7.0				11.6	18.5
103					18.4	18.4
177		5.5	1.0		11.7	18.2
602-605					17.8	17.8
606	17.3					17.3
202	11.6				4.2	15.9
274-276,377,387					15.6	15.6
326-329	13.8				1.3	15.1
715-716	5.3				8.8	14.1
445-447		12.5	1.5			14.0
438-439,486					13.0	13.0
431-433,654-655					13.0	13.0
436		12.5				12.5
441		6.2			5.7	12.0
498-499					11.8	11.8
557-558,611					11.8	11.8
107		7.3			4.2	11.5
391,398-400					11.4	11.4
427, 428					11.4	11.4
332-335		7.8			2.9	10.7
215, 684					10.4	10.4
689-695	4.4		5.7			10.1
340-342		2.1			7.8	9.9
487					9.8	9.8
164, 169		0.48	1.7		7.4	9.6
241					8.9	8.9
89	0.21				8.2	8.4
449					8.4	8.4
2		0.18			7.9	8.1
543, 544	4.2		0.74		3.1	8.0
13, 462, 685					7.9	7.9
569					7.8	7.8
536			1.3		5.9	7.2
203-204	1.5	1.9			3.1	6.5
681-682		6.2				6.2
347-349			0.40		5.7	6.1
104		0.11			5.9	6.0
463					6.0	6.0
70		0.64			5.3	5.9
23, 570					5.9	5.9
213, 214		1.6	0.99	0.38	2.8	5.8
113		3.6			2.1	5.7
251, 370, 442					5.7	5.7

Table 4. Adult consumption rates of locally caught crustaceans (kg/y)

Obs No.	Edible crab	Edible crab claws	Lobster	Velvet crab	Nephrops	Total
245, 246					5.3	5.3
216,481-485					5.2	5.2
437		3.8			1.3	5.2
146, 147					5.1	5.1
17					4.9	4.9
225		0.66	1.4		2.7	4.8
312, 313			2.30		2.5	4.8
610		2.9	1.9			4.7
170		1.1			3.5	4.6
184	2.2	2.4				4.6
293			4.5			4.5
336-339		3.1			1.3	4.4
18, 519, 520					4.4	4.4
80, 81		3.4			0.78	4.1
330, 331			1.20		2.9	4.1
453					3.8	3.8
615-618		1.8	1.6			3.4
193		0.24			3.1	3.4
27,91-93,95					3.0	3.0
121, 122	1.1		1.1		0.60	2.8
10-12.					2.6	2.6
226		0.33	0.71		1.4	2.4
185-187,189	1.1	1.2				2.3
467, 468		1.2	0.55		0.54	2.3
19,22,307-310					2.2	2.2
8, 24, 28					2.0	2.0
206		1.2			0.80	2.0
728, 730, 732					2.0	2.0
14, 16, 233					1.7	1.7
190, 191					1.6	1.6
198		1.6				1.6
729, 731					1.5	1.5
207,209-211		0.53			0.80	1.3
535			1.3			1.3
299-302, 354, 355					1.3	1.3
29-30,283-286					1.0	1.0
234					0.86	0.86
79,83					0.78	0.78
255-257					0.70	0.70
84, 85, 88					0.68	0.68
179		0.36			0.30	0.66
74, 78					0.65	0.65
205		0.63				0.63
595, 596					0.60	0.60
401, 406					0.30	0.30
656					0.29	0.29
703, 704					0.28	0.28
Total Obs	**45**	**98**	**76**	**2**	**248**	**284**

NOTES

The data highlighted in bold indicates those consumers in the critical group
The critical group mean consumption, based on the sixty six highest adult consumers, is **34 kg/y**

Observation no 89. Crab was dressed crab

Table 5. Adult consumption rates of locally caught molluscs (kg/y)

Obs No.	Clams	Cockles	Razor fish	Mussels	Oysters	Periwinkles	Scallops	Squid	Total
107	**0.36**			**11.8**					**12.2**
340							**11.2**		**11.2**
293	**0.82**			**7.0**					**7.8**
294	**0.82**			**7.0**					**7.8**
295	**0.82**			**7.0**					**7.8**
296	**0.82**			**7.0**					**7.8**
298	**0.82**			**7.0**					**7.8**
297	**0.82**			**7.0**					**7.8**
714	**4.9**								**4.9**
569				**4.5**					**4.5**
570				**4.5**					**4.5**
190, 191				0.36			2.6	0.85	3.8
715, 716	3.8								3.8
341, 342							3.7		3.7
215				0.96	2.3				3.3
347-349				0.50			2.6		3.1
89								2.7	2.7
190-191								2.6	2.6
371-372							2.6		2.6
121-122								2.2	2.2
314-317							2.2		2.2
530-531		1.0		1.0					2.0
192								2.0	2.0
427, 428				1.8					1.8
721-723						1.7			1.7
162, 163						1.4		0.32	1.7
91-93,95	1.7								1.7
216				0.48	1.2				1.7
312, 313	1.7								1.7
17				0.32	0.08			1.2	1.6
261-264							1.5		1.5
18				0.36				1.2	1.5
332-335							1.3		1.3
203, 204								1.2	1.2
173, 177	0.96								0.96
23,299-302	0.82								0.82
303-306	0.76								0.76
19, 22				0.18				0.58	0.76
277-279	0.69								0.69
184			0.59						0.59
274-276	0.55								0.55
27	0.44								0.44
193, 198								0.43	0.43
74	0.41								0.41
373-376						0.34			0.34
200, 201								0.34	0.34
189			0.30						0.30
24,265-273	0.27								0.27
170								0.25	0.25
2				0.13	0.11				0.24
32-35						0.15			0.15
79, 81, 164, 169	0.14								0.14
Total Obs	**49**	**2**	**2**	**25**	**4**	**13**	**22**	**21**	**112**

NOTES

The data highlighted in bold indicates those consumers in the critical group
The critical group mean consumption, based on the eleven highest adult consumers, is **7.7 kg/y**

Table 6. Adult consumption rates of locally collected dulse (kg/y)

Obs No.	kg/y	Comments
472	**10.4**	**Commercial dulse collector. Dulse collected from a boat. Also a hobby fisherman, potting.**
473	**10.4**	**Family of 472**
474	**10.4**	**Family of 472**
475	**10.4**	**Family of 472**
476	**10.4**	**Family of 472**
477	**10.4**	**Family of 472**
478	**10.4**	**Family of 472**
1	0.12	Shop bought dulse
79, 104, 107	0.05	Shop bought dulse
2, 17, 89	0.02	Shop bought dulse

NOTES

The data highlighted in bold indicates those consumers in the critical group
The critical group mean consumption, based on the seven highest adult consumers, is **10 kg/y**

Table 7a. Occupancy by adults over sand or rocks (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
513	**Dog walking on beach - Sand**	**1005**	
427	**Lifeguard - Sand**	**821**	**Also spends 243 h/y swimming**
569	**Dog walking on beach - Sand**	**728**	
570	**Dog walking on beach - Sand**	**728**	
438	Lifeguard - Sand	537	Also spends 274 h/y swimming
431	Lifeguard - Sand	380	Also spends 122 h/y swimming
38-45,47-53	Beach warden - Sand	335	
56	On beach - Sand	335	
537	Chief beach warden - Sand	296	
521, 522, 526	On beach - Sand	281	
121	Dog walking on beach - Sand	274	
204	Dog walking on beach - Sand	273	
159	Angling - Rocks	260	
559, 560	Walking on beach - Sand	208	
247, 248, 249	On beach - Sand	192	
122, 203	Dog walking on beach - Sand	137	
530, 531	On beach - Sand	135	
128	On beach - Sand	130	
557, 558	Walking on beach - Sand	104	
241, 242	On beach - Sand	90	Also spends 30 h/y water skiing locally
535, 536	Dog walking on beach - Sand	85	
61-63,251	On beach - Sand	72	
123	On beach - Sand	70	
157	Angling - Rocks	70	
514,515	Walking on beach - Sand	69	
190,191	Walking on beach - Sand	52	
602-605	Walking on beach - Sand	52	Also sails
66,140,141,146,147	On beach - Sand	50	
230	Lifeguard - Sand	45	Also spends 168 h/y water skiing / cannoeing
456, 457	On beach - Sand	40	Also spends 33 h/y body boarding
127	On beach - Sand	35	Also spends 12 h/y water skiing
133	On beach - Sand	27	
54, 55	On beach - Sand	25	
14	On beach - Sand	19	Also spends 3 h/y surfing / body boarding
16,136,137,467,468	On beach - Sand	16	
132	Netting for prawns in rock pools - Rocks	15	
519, 520	Dog walking on beach - Sand	12	
225	On beach - Sand	2	Also spends 4 h/y jet skiing
3-7.		N/A	Spends 65 h/y diving
164		N/A	Spends 15 h/y diving, also commercial potter

NOTES

The data highlighted in bold indicates those occupants in the critical group
The critical group mean occupancy rate over sand, based on the four highest adult occupants, is **820 h/y**

Table 7b. Occupancy by adults over sand/mud (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
356	**Beach angling (standing) - Sand/mud**	**1092**	**Hobby angler (unemployed)**
193-197	Tending oyster baskets - Sand/mud	130	Commercial oyster farm worker
232	Winkle picking - Sand/mud	100	Commercial picker
721	Winkle picking - Sand/mud	54	Commercial picker
162, 163	Winkle picking - Sand/mud	36	Commercial picker
728	Winkle picking - Sand/mud	33	Commercial picker
373-376	Winkle picking - Sand/mud	16	Picked for own consumption
32-35	Winkle picking - Sand/mud	1	Picked for own consumption

NOTES

The data highlighted in bold indicates those occupants in the critical group
The critical group mean occupancy rate standing over sand/mud, based on the highest adult occupant, is **1100 h/y**

Table 7c. Occupancy by adults over saltmarsh (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
750 - 820	**Wildfowling - saltmarsh**	**9**	**Average occupancy 6-12 h/y**

NOTES

The data highlighted in bold indicates those occupants in the critical group
The critical group mean occupancy rate over saltmarsh, based on averaged adult occupancy, is **9.0 h/y**

Table 8a. Occupancy by children over intertidal areas (h/y)

Obs No.	Sex	Age	Activity / Exposed to	h/y	Comments
523	M	7	Playing on beach - Sand	281	
524	M	12	Playing on beach - Sand	281	
525	F	15	Playing on beach - Sand	281	
527	M	10	Playing on beach - Sand	281	
528	M	12	Playing on beach - Sand	281	
529	M	14	Playing on beach - Sand	281	
250	M	11	Playing on beach - Sand	192	
454	F	15	Playing on beach - Sand	135	
455	F	15	Playing on beach - Sand	135	
532	M	5	Playing on beach - Sand	135	
533	M	8	Playing on beach - Sand	135	
534	F	8	Playing on beach - Sand	135	
129	F	6	Playing on beach - Sand	130	
130	F	7	Playing on beach - Sand	130	
131	M	3	Playing on beach - Sand	130	
243	M	8	Playing on beach - Sand	90	
244	F	6	Playing on beach - Sand	90	
64	F	6	Playing on beach - Sand	72	
65	M	7	Playing on beach - Sand	72	
252	F	12	Playing on beach - Sand	72	
253	M	13	Playing on beach - Sand	72	
254	M	9	Playing on beach - Sand	72	
124	M	8	Playing on beach - Sand	70	
125	F	6	Playing on beach - Sand	70	
126	F	2	Playing on beach - Sand	70	
479	F	13	Playing on beach - Sand	70	Also spends 40 h/y body boarding
480	F	13	Playing on beach - Sand	70	Also spends 40 h/y body boarding
158	M	UC	Angling - Rocks	70	
516	M	6	Walking on beach - Sand	69	
517	F	3	Walking on beach - Sand	69	
518	F	2	Walking on beach - Sand	69	
67	F	12	Playing on beach - Sand	50	
68	M	8	Playing on beach - Sand	50	
69	F	5	Playing on beach - Sand	50	
142	F	2	Playing on beach - Sand	50	
143	M	3	Playing on beach - Sand	50	
144	F	9	Playing on beach - Sand	50	
145	F	12	Playing on beach - Sand	50	
148-152	U	<13	Playing on beach - Sand	50	
153-156	U	<6	Playing on beach - Sand	50	
458	M	4	Playing on beach - Sand	40	Also spends 33 h/y body boarding
459	M	5	Playing on beach - Sand	40	Also spends 33 h/y body boarding

Table 8a. (cont.) **Occupancy by children over intertidal areas (h/y)**

Obs No.	Sex	Age	Activity / Exposed to	h/y	Comments
460	F	6	Playing on beach - Sand	40	Also spends 33 h/y body boarding
134	F	4	Playing on beach - Sand	27	
135	F	2	Playing on beach - Sand	27	
56	F	4	Playing on beach - Sand	25	
57	F	2	Playing on beach - Sand	25	
58	F	12	Playing on beach - Sand	25	
59	F	9	Playing on beach - Sand	25	
60	M	1	Playing on beach - Sand	25	
119	M	10	Playing on beach - Sand	24	
120	M	14	Playing on beach - Sand	24	
138	F	2	Playing on beach - Sand	16	
139	M	5	Playing on beach - Sand	16	
469	M	14	Playing on beach - Sand	16	
470	M	10	Playing on beach - Sand	16	
471	F	6	Playing on beach - Sand	16	
15	M	2	Playing on beach - Sand	16	
36	F	8	Winkle picking - Sand and mud	1	Picked for own consumption
37	F	10	Winkle picking - Sand and mud	1	Picked for own consumption

Table 8b. **Handling of fishing gear and sand/mud by children (h/y)**

Obs No.	Sex	Age	Activity / Exposed to	h/y	Comments
575	M	15	Handling crustacea pots	615	Part-time commercial potting crew
31	M	16	Handling crustacea pots	330	Part-time commercial potter
36	F	8	Winkle picking - Sand/mud	1	Picked for own consumption
37	F	10	Winkle picking - Sand/mud	1	Picked for own consumption

Table 9a. Handling of commercial fishing gear by adults (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
173	**Handling crustacea pots**	**1640**	**Commercial potter**
178	**Handling crustacea pots**	**1640**	**Commercial potter**
610	**Handling crustacea pots**	**1640**	**Commercial potter**
714	**Handling crustacea pots and fishing nets**	**1640**	**Commercial fisherman and potting skipper**
719	**Handling crustacea pots and fishing nets**	**1640**	**Commercial potting and fishing crew**
720	**Handling crustacea pots and fishing nets**	**1640**	**Commercial potting and fishing crew**
299	**Handling crustacea pots**	**1476**	**Commercial potting skipper [1]**
300	**Handling crustacea pots**	**1476**	**Commercial potting crew [1]**
409	**Handling fishing nets**	**1435**	**Commercial fishing skipper**
410	**Handling fishing nets**	**1435**	**Commercial fishing crew**
411	**Handling fishing nets**	**1435**	**Commercial fishing crew**
412	**Handling fishing nets**	**1435**	**Commercial fishing crew**
413	**Handling fishing nets**	**1435**	**Commercial fishing crew**
414	**Handling fishing nets**	**1435**	**Commercial fishing crew**
425	**Handling fishing nets**	**1260**	**Net maker and repairer**
674	**Handling crustacea pots and fishing nets**	**1230**	**Commercial potting and fishing crew**
661	**Handling crustacea pots and fishing nets**	**1230**	**Commercial potting and fishing crew**
673	**Handling crustacea pots and fishing nets**	**1230**	**Commercial potting and fishing crew**
611-614	Handling fishing nets	1078	Commercial fishing skipper
595	Handling crustacea pots	1025	Commercial potter
599	Handling crustacea pots	1025	Commercial potting crew
164	Handling crustacea pots	1000	Commercial potter, Also spends 15 h/y diving
165	Handling crustacea pots	1000	Commercial potting crew
679, 680	Handling crustacea pots	984	Commercial potting crew
675	Handling crustacea pots	984	Commercial potter
215	Handling fishing nets	903	Commercial *Nephrops* fisherman
219-223	Handling fishing nets	903	Commercial *Nephrops* fishing crew
170	Handling fishing nets	880	Commercial *Nephrops* and fisherman
171	Handling fishing nets	880	Commercial fishing crew
340	Handling crustacea pots and fishing nets	830	Commercial potting and scallop fishing skipper [2]
391	Handling fishing nets	765	Commercial fishing and *Nephrops* skipper [3]
392-397	Handling fishing nets	765	Commercial fishing and *Nephrops* crew [3]
377	Handling fishing nets	720	Commercial fishing skipper [3]
378-386	Handling fishing nets	720	Commercial fishing crew [3]
628, 633, 635	Handling fishing nets	718	Commercial *Nephrops* fishing crew
445	Handling fishing nets	675	Commercial *Nephrops* fisherman [3]
224	Handling crustacea pots	641	Commercial potter

Table 9a. Handling of commercial fishing gear by adults (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
99, 105, 106	Handling fishing nets	630	Commercial fishing crew
561	Handling crustacea pots and fishing nets	615	Commercial *Nephrops* fisherman and potter
563	Handling fishing nets	615	Commercial fishing crew
571	Handling crustacea pots and fishing nets	615	Commercial fisherman and potter
606	Handling crustacea pots	615	Commercial potter
608, 609	Handling crustacea pots	615	Commercial potting crew
354	Handling fishing nets	615	Commercial fisherman [3]
256,287,402-405	Handling fishing nets	615	Commercial fishing crew [3]
255,401	Handling fishing nets	615	Commercial fishing skipper [3]
265,283,293	Handling fishing nets	615	Commercial *Nephrops* fishing skipper [3]
266-270, 284, 285	Handling fishing nets	615	Commercial *Nephrops* fishing crew [3]
294, 295	Handling fishing nets	615	Commercial *Nephrops* fishing crew [3]
303	Handling fishing nets	615	Commercial *Nephrops* fisherman [3]
29, 30, 647	Handling fishing nets	600	Commercial *Nephrops* and fishing crew
651, 654	Handling fishing nets	554	Commercial fishing crew
179	Handling fishing nets	551	Commercial *Nephrops* and fishing skipper
180-183	Handling fishing nets	551	Commercial *Nephrops* and fishing crew
114-118	Handling fishing nets	540	Commercial fishing crew
481	Handling crustacea pots and fishing nets	513	Commecial *Nephrops* and potting skipper
437	Handling fishing nets	492	Commercial fishing skipper [3]
290	Handling fishing nets	492	Commercial Nephrops crew [3]
323	Handling crustacea pots	492	Hobby potter [4]
231	Handling crustacea pots	450	Part-time commercial potting crew
318	Handling crustacea pots	431	Hobby potter [4]
350	Handling crustacea pots	431	Hobby potter [4]
96-98	Handling fishing nets	410	Commercial fishing crew
493	Handling fishing nets	410	Commercial *Nephrops* and fishing skipper
494	Handling fishing nets	410	Commercial *Nephrops* and fishing crew
502	Handling crustacea pots	410	Commercial potting crew
503	Handling fishing nets	410	Commercial scallop fisherman. Also spends 287 h/y sea angling from a boat.
504	Handling fishing nets	410	Commercial scallop fishing crew
577,582-585	Handling fishing nets	410	Commercial *Nephrops* and fishing crew
619	Handling fishing nets	410	Commercial *Nephrops* fisherman
512,625-627	Handling fishing nets	410	Commercial fishing crew
184	Handling fishing nets	392	Part-time commercial *Nephrops* fisherman
689	Handling fishing nets	369	Commercial *Nephrops* fisherman
696, 697	Handling fishing nets	369	Commercial fishing crew

Table 9a. Handling of commercial fishing gear by adults (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
705	Handling fishing nets	369	Commercial *Nephrops* fishing skipper
707-709	Handling fishing nets	369	Commercial *Nephrops* fishing crew
71-73	Handling crustacea pots	360	Commercial potting crew
435	Handling crustacea pots	359	Hobby potter [4]
657	Handling fishing lines	328	Commercial sea angler
639	Handling fishing nets	308	Commercial *Nephrops* fishing skipper
640-642	Handling fishing nets	308	Commercial *Nephrops* fishing crew
28	Handling fishing nets	300	Commercial *Nephrops* fisherman
2	Handling fishing nets	288	Part-time commercial fishing crew
656	Handling fishing nets	256	Commercial *Nephrops* fisherman
615	Handling crustacea pots and fishing nets	216	Crew member of various boats
461	Handling fishing nets	208	Commercial *Nephrops* fisherman
698	Handling fishing nets	185	Commercial *Nephrops* fishing skipper
702, 703	Handling fishing nets	185	Commercial *Nephrops* fishing crew
330	Handling crustacea pots	164	Hobby potter [4]
472	Handling crustacea pots	156	Hobby potter. Also commercial dulse collector (see Table 9c).
193-197	Handling oyster baskets	130	Commercial oyster farm worker
332	Handling crustacea pots	123	Hobby potter [4]
347	Handling crustacea pots	92	Hobby potter [4]
543	Handling crustacea pots	62	Hobby potter
462	Handling fishing nets	55	Hobby *Nephrops* fisherman
213	Handling crustacea pots	52	Hobby potter
336	Handling crustacea pots	48	Hobby potter [4]
203	Handling crustacea pots	11	Hobby potter

NOTES

[1] Rates are based on typical rates for handling pots of 6 h/d when at sea

[2] Rates are based on typical rates for handling pots and nets averaged to give 4.5 h/d when at sea

[3] Rates are based on typical rates for handling nets of 3 h/d when at sea

[4] Rates are based on half the amount of time spent at sea

The data highlighted in bold indicates those handlers in the critical group

The critical group mean handling rate for commercial fishing gear, based on the eighteen highest adult handlers, is **1500 h/y**

Table 9b. Handling of sand/mud by adults (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
232	**Winkle picking - Sand/mud**	**100**	**Commercial winkle picker**
721	Winkle picking - Sand/mud	54	Commercial winkle picker
162, 163	Winkle picking - Sand/mud	36	Commercial winkle picker
728	Winkle picking - Sand/mud	33	Commercial winkle picker
373-376	Winkle picking - Sand/mud	16	Picked for own consumption
32-35	Winkle picking - Sand/mud	1	Picked for own consumption

NOTES

The data highlighted in bold indicates those handlers in the critical group
The critical group mean handling rate for sand/mud, based on the highest adult handler, is **100 h/y**

Table 9c. Handling of seaweed by adults (h/y)

Obs No.	Activity / Exposed to	h/y	Comments
746	**Handling dulse seaweed**	**936**	**Commercial dulse collector from a boat**
747	**Handling dulse seaweed**	**936**	**Commercial dulse collector from a boat**
748	**Handling dulse seaweed**	**936**	**Commercial dulse collector from a boat**
749	**Handling dulse seaweed**	**936**	**Commercial dulse collector from a boat**
738-745	Handling dulse seaweed	490	Commercial dulse collector from a boat
472	Handling dulse seaweed	468	Commercial dulse collector from a boat. Also hobby potter

NOTES

The data highlighted in bold indicates those handlers in the critical group
The critical group mean handling rate for seaweed, based on the highest adult handlers, is **936 h/y**

Table 10. Examples of combinations of exposure for interviewees in Northern Ireland

	Internal exposure - consumption rate (kg/y)			External exposure (h/y)		
Obs No.	Fish	Crustaceans	Molluscs	Occupancy	Handling	Comments
224	**165.9**	**23.0**			641	Commercial potter
287	**68.6**	**26.0**			615	Commercial potting and fishing crew
288	**68.6**	**26.0**				
303	**163.8**	**50.2**	0.76		615	Commercial fishing skipper
304	**163.8**	**50.2**	0.76			
305	**163.8**	**50.2**	0.76			
306	**163.8**	**50.2**	0.76			
390	**102.5**	**62.1**				
409	5.7	**39.2**			**1435 n**	Commercial fishing skipper
425	35.4	**29.5**			**1260 n**	Net maker and repairer
427	**61.9**	11.4	1.8	**821 s**		Lifeguard, also swims 243 h/y
561	**94.6**	**35.5**			615	Commercial *Nephrops* fisherman and potter
569	29.6	7.8	**4.5**	**728 s**		Dog walking
570	23.7	5.9	**4.5**	**728 s**		Dog walking
651	**58.1**	**66.6**			554	Commercial fishing crew
661	9.1	**32.6**			**1230 p + n**	Commercial potting and fishing crew
714	52.4		**4.9**		**1640 p + n**	Commercial fisherman and potting skipper

NOTES

The data highlighted in bold indicates members of the critical groups for each exposure pathway

s = sand
n = nets
p = pots

Table 11. Generalised critical group rates for comparison with the present survey.

'Critical Group' intake (kg/y)

	Adult	Child[1]
Marine Fish	100	20
Crustaceans	20	5
Molluscs	20	5

'Critical Group' intertidal occupancy (h/y)

Adult	2000
Child	300

'Critical Group' handling of fishing gear (h/y)

2000

'Critical Group' swimming (h/y)

300

NOTES

Data are taken from Robinson (1996)

[1] The data for the child age group are appropriate for both the 10 year old and 15 year old child. Data for children have been obtained by scaling the adult information and using information from the national surveys of child diet

Table 12. National Food Survey data on consumption of fish in Northern Ireland, 1999.

	grams/week[1]				Equivalent annual rate (kg/y)			
Individuals fish consumption	1996	1997	1998	1999	1996	1997	1998	1999
Fresh	33	23	16	19	1.7	1.2	0.83	0.99
Processed and shell	12	10	5	8	0.62	0.52	0.26	0.42
Prepared, including fish products	38	32	33	30	2	1.7	1.7	1.6
Frozen, including fish products	50	46	38	33	2.6	2.4	2	1.7
Total fish	131	112	93	90	6.8	5.8	4.8	4.7

NOTES

[1] Data are taken from Department of Agriculture and Rural Development (2000)

Table 13. **Comparison of critical group habits data recommended from the survey, and those used in assessments of dose in RIFE.**

Recommended critical group		
Pathway	Rate	Species/type
Fish	99 kg/y	haddock (40%) mixed fish (60%)
Crustaceans	34 kg/y	nephrops (65%) edible crab claws (25%) edible crab (5%) lobster (5%)
Molluscs	7.7 kg/y	mussels (75%) scallops (15%) clams (10%)
Occupancy	1100 h/y	sand/mud

RIFE assessments' critical group, 2000[1]		
Pathway	Rate	Species/type
Fish	100 kg/y	mixed fish (100%)
Crustaceans	20 kg/y	nephrops (50%) lobster (50%)
Molluscs	20 kg/y	mussels (50%) winkles (50%)

NOTES

[1] Data taken from FSA and SEPA (2001)

Table 14. Monitoring programme for Northern Ireland, 2001

Material	Location	Frequency	Gamma spectrometry	^{14}C	^{99}Tc	Transuranics
Cod	Kilkeel	Quarterly	✓			
		Biannually		✓		
Cod	Portrush	Quarterly	✓			
Whiting	Kilkeel	Quarterly	✓		✓	
Herring	Portavogie	4/y	✓			
Spurdog	Portavogie	Quarterly	✓			
Spurdog	Portrush	Quarterly	✓			
Whiting	Portavogie	Quarterly	✓			
		Annually				✓
Nephrops	Portavogie	Quarterly	✓		✓	
		Biannually		✓		
		Annually				✓
Nephrops	Kilkeel	Quarterly	✓			
Lobster	Kilkeel	4/y	✓			
		Biannually		✓		
		Annually			✓	
Lobster	Portrush	4/y	✓			
		Annually			✓	
Winkles	Ards Peninsula	Quarterly	✓			
		Annually				✓
Mussels	Carlingford Lough	Quarterly			✓	
Mud	Ballymacormick	Biannually	✓			
		Annually				✓
Mud	Carrickhugh House	Biannually	✓			
		Annually				✓
Mud	Carlingford Lough	Biannually	✓			
		Annually				✓
Mud	Dundrum Bay	Biannually	✓			
Mud	Strangford Lough	Biannually	✓			
		Annually				✓
Mud	Oldmill Bay	Biannually	✓			
		Annually				✓
Sand	Portrush	Biannually	✓			
Seawater	North of Larne Harbour	Monthly	^{134}Cs, ^{137}Cs			
		Biannually			✓	
Fucus vesiculosus	Carlingford Lough	Quarterly	✓			
		Annually			✓	
	Portrush	Quarterly	✓			
	Ardglass	Quarterly	✓			
		Biannually		✓		
		Annually			✓	
Rhodymenia spp.	Strangford Lough	Quarterly	✓			
		Biannually			✓	
		Annually				✓

NOTES

Programme is carried out by CEFAS for EHS
Transuranics means ^{238}Pu, $^{239+240}Pu$, ^{241}Am, ^{242}Cm and $^{243+244}Cm$.

Table 15. Environment and Heritage Service gamma dose rate monitoring locations.

Location	Irish grid reference	Ground type
Co Down		
Narrow Water	J125/195	mud/silt
Rostrevor *	J 184/177	sand
Cranfield Bay*	J 269/105	sand
Annalong*	J 372/187	sand
Newcastle	J 382/231	sand
Dundrum	J 395/355	sand
Tyrella Beach*	J 470/361	sand
Rossglass*	J 500/359	sand
Killough*	J 539/373	mud/silt
Ardglass*	J 560/372	sand
Kilclief*	J 598/457	sand
Strangford*	J 590/497	mud/silt
Nickey's Point	J 525/516	mud/silt
Island Hill	J 490/689	mud/silt
Ards Maltings	J 512/720	mud/silt
Greyabbey	J 582/673	sand
Kircubbin	J 596/631	sand
Portaferry*	J 594/508	shingle/stones
Cloghy*	J 637/566	sand
Ballyhalbert	J 659/631	sand
Ballywalter	J 627/696	sand
Millisle	J 593/777	sand
Groomsport	J 540/835	sand
Helens Bay	J 461/829	sand
Co Antrim		
Jordanstown	J 369/838	sand
Carrickfergus	J 421/878	sand
Whitehead	J 479/925	sand
Larne	D 415/029	sand
Drains Bay	D 389/056	sand
Ballygalley Youth Hostel	D 378/078	sand
Half-way House Hotel	D 360/089	sand
Glenarm	D 309/155	sand
Carnlough	D 287/182	shingle/stones
Red Bay	D 249/247	sand
Cushendall	D 243/280	sand
Cushendun	D 249/328	sand
Ballycastle	D 120/415	sand
Giants Causeway	C 946/447	sand
Portballintrae	C 934/426	sand
Londonderry		
Portrush – Whiterocks	C 887/408	sand
Portrush – Blue Pool	C 856/407	shingle/stones
Portstewart Strand	C 800/364	sand
Castlerock	C 770/364	sand
Benone	C 718/362	sand
Bellerina	C 645/304	sand
Carrichue House	C 601/226	sand
Donneybrewer	C 522/240	shingle/stones
Lisahally	C 470/215	mud/silt

NOTES

* Monitoring sites within the areas surveyed for this report

Table 16. **Radioactivity in samples from Northern Ireland, 2000**

Location	Material	No. of sampling observ-ations	Mean radioactivity concentration (+), Bq kg^{-1}										
			^{14}C	^{54}Mn	^{60}Co	^{65}Zn	^{95}Zr	^{95}Nb	^{99}Tc	^{103}Ru	^{106}Ru	^{110m}Ag	^{125}Sb	^{134}Cs
Northern Ireland	Cod	6	31		<0.08		<0.28	<0.38			<0.69			<0.08
Northern Ireland	Whiting	7			<0.11		<0.47	<0.72			<1.1			<0.11
Northern Ireland	Herring	2			<0.15		<0.72	<1.2			<1.7			<0.17
Northern Ireland	Spurdog	5			<0.08		<0.36	<0.53			<0.84			<0.08
Northern Ireland	Lobsters	5			<0.19	<0.47	<0.73	<1.0	130	<0.75	<1.9	<0.34	<0.43	<0.19
Northern Ireland	*Nephrops*	8	36		<0.11	<0.30	<0.50	<0.78	60	<0.60	<1.2	<0.21	<0.26	<0.11
Northern Ireland	Winkles	4			<0.12	<0.22	<0.31	<0.41		<0.32	<0.87	<0.16	<0.21	<0.09
Northern Ireland	Mussels	1							58					
Lough Foyle	Mud	1		<0.23	<0.18		<0.78	<1.1			<2.1		<0.60	<0.26
Lough Foyle	Sand	1		<0.29	<0.26		<0.90	<0.94			<2.8		<0.78	<0.34
Portrush	Sand	2		<0.35	<0.31		<1.3	<1.9			<3.2		<0.81	<0.36
Ballymacormick	Mud	2		<0.48	<0.43		<1.6	<2.1			<4.2		<1.2	<0.57
Strangford Lough-Nickey's point	Mud	2		<0.38	<0.34		<1.3	<1.5			<3.3		<0.89	<0.44
Dundrum Bay	Mud	1		<0.43	<0.37		<1.3	<1.4			<3.6		<1.0	<0.46
Dundrum Bay	Sand	1		<0.42	<0.38		<1.5	<2.0			<3.7		<0.95	<0.46
Carlingford Lough	Mud	2		<0.50	<0.41		<1.9	<2.9			<4.5		<1.3	<0.61
Oldmill Bay	Mud	2		<0.70	<0.68		<2.3	<2.8			<6.2		<1.8	<0.78
Mean used for dose assessment	Mud/sand			0.42	0.37		1.43	1.85			3.73		1.04	0.48

** not detected by the method used*
(+) *concentrations are wet for biota and dry for sediments*
These data are published in RIFE 6.

Table 16. **Radioactivity in samples from Northern Ireland, 2000**

Location	Material	No. of sampling observ-ations	Mean radioactivity concentration (+), Bq kg^{-1}								
			^{137}Cs	^{144}Ce	^{154}Eu	^{155}Eu	^{238}Pu	^{239}Pu+ ^{240}Pu	^{241}Am	^{242}Cm	^{243}Cm+ ^{244}Cm
Northern Ireland	Cod	6	2.9	<0.35					<0.13		
Northern Ireland	Whiting	7	3.3	<0.46			0.00011	0.00058	0.00098	*	*
Northern Ireland	Herring	2	1.3	<0.89					<0.30		
Northern Ireland	Spurdog	5	3.0	<0.48					<0.20		
Northern Ireland	Lobsters	5	<0.31	<0.81	<0.52	<0.35			<0.40		
Northern Ireland	*Nephrops*	8	1.3	<0.55	<0.32	<0.22	0.0045	0.027	0.14	*	0.00023
Northern Ireland	Winkles	4	0.44	<0.43	<0.24	<0.20	0.031	0.16	0.15	*	0.00018
Northern Ireland	Mussels	1									
Lough Foyle	Mud	1	3.7	<1.7	<0.56	<0.82	0.058	0.45	0.60	*	0.0012
Lough Foyle	Sand	1	2.0	<2.0	<0.73	<1.1			<1.9		
Portrush	Sand	2	1.0	<1.8	<0.92	<0.86			<1.1		
Ballymacormick	Mud	2	50	<2.4	<1.4	<1.1	3.2	17	26	*	0.041
Strangford Lough-Nickey's point	Mud	2	33	<1.8	<1.1	<0.89	1.4	7.8	8.1	0.016	0.018
Dundrum Bay	Mud	1	7.3	<2.8	<1.2	<1.5			<2.7		
Dundrum Bay	Sand	1	5.7	<2.4	<1.2	<1.2			2.3		
Carlingford Lough	Mud	2	67	<3.5	<1.3	<1.7	1.7	11	6.9	*	0.012
Oldmill Bay	Mud	2	66	<3.6	<2.0	<1.7	3.3	18	25	*	0.027
Mean used for dose assessment	Mud/sand		26.19	2.44	1.16	1.21	1.93	10.85	8.29	0.016	0.020

* *not detected by the method used*
(+) *concentrations are wet for biota and dry for sediments*
These data are published in RIFE 6.

ANNEX 1 Photographs of commercial dulse collection at Ballywalter and Portaferry